Landesamt für Natur,
Umwelt und Verbraucherschutz
Nordrhein-Westfalen

River habitat survey in North Rhine-Westphalia

Survey instruction for small to large rivers

LANUV-Arbeitsblatt 18

Second revised edition

LANUV
Kompetenz für ein
lebenswertes Land

Content

1 Introduction

Rivers are more than water. Water quality, discharge dynamics, river morphology and the surroundings determine very significantly the functionality and the living conditions in and at rivers. The Water Resource Act (WHG) demands in § 1 to protect the rivers as a component of the nature balance, as life resource for human beings, as habitats for plants and animals and as usable goods. The protection and restoration of ecological functional close-to-nature rivers is therefore an essential task of water management.

Water protection dealt with water pollution control up into the 1990s. In this field billions have been invested and, concerning the water quality, good results have been achieved. A further improvement of the functionality of rivers can be realised by the protection and creation of ecological functional water structures. Only then, the investments on this field of water pollution control are in fact paid off. River morphology may have influence on the water quality, e. g., on the oxygen balance. This holistic view is reflected in the WFD which came into force on 23/10/2000.

River morphology should be used as a general basis for evaluation of the renaturation of rivers, for the planning and evaluation of watercourse development but also for the assessment of possible impacts by harmful interventions. The mapping procedure of river morphology is designed as a tool for planning and for decision-making in the different fields of application.

The results gained from the application of this procedure may serve for the following purposes:

- Recording and documentation of the present morphological quality of rivers,
- Proof of the need for continuing actions
- Formulation of structure objectives which should be pursued or ensured in general or in individual cases,
- Evaluation of planned hydraulic engineering measures, of water maintenance works, of compensatory measures but also of interferences,
- Efficiency certification (success monitoring) of implemented watercourse development and restoration measures.

The survey of the morphological quality of waters is performed by an on-site recording in direct contact with the river. The structures of the riverbed (bed and -banks) and of the adjacent land zones (floodplain) are recorded and evaluated. The data collection is performed by means of standardised questionnaires or in North Rhine-Westphalia digitally by the mapping software, called BEACH. As standard for the assessment serves the present-day potential natural state (Leitbild). This approach will enable to assess the morphological quality of rivers objectively on a scale according to the increasing deviations from the natural conditions on a scientific basis. The assessment enables to derive measures which are necessary for a river development and for maintenance work close to nature.

The presented procedure has been developed for natural rivers. Since there often is no difference between morphological strongly changed natural rivers und artificially constructed rivers with respect to morphology, it can also be applied for heavily modified and artificial rivers (e. g., water moats and small water watercourses). The procedure is applicable in the landscape or in built-up areas. It is designed for the survey mapping of all sizes of rivers from the source to its mouth.

The presented mapping instruction is based on the first edition of the Arbeitsblatt 18 „River Morphology in North Rhine-Westphalia – mapping instruction for small to large rivers" (LANUV 2012) and on the two previous procedures for small to middle-sized rivers (LUA 1998) and medium-sized to large rivers (LUA 2001c) as well as the revised LAWA-procedure recommendation for the mapping of small to medium-sized and medium-sized to large rivers (LAWA 2018).

2 Procedure description

2.1 Process overview and definition of terms

The term "**river morphology**" includes all spatial and material differentiations of a riverbed and its surroundings as far as they are hydraulically, morphologically and hydrobiologically effective and relevant to the ecological functions of rivers and floodplains. The single structure characteristics can be of natural origin or were created or initiated anthropogenically. River morphology is a measure of the ecological quality of the river morphology and of the dynamic processes, caused by these structures.

River morphology is classified in seven classes. For a comparable description according to the WFD also a classification in five classes is possible.

The determination of the morphological quality of rivers is an evaluation procedure. It is initially based on the objective and comprehensible **collection** of structural elements in and at rivers and its surroundings by a predeterminated system of parameters. These structural elements are called "single parameters" (SPs). The SPs are especially relevant for the valuation of the ecological functionality of rivers. In the questionnaire, the SPs are grouped according to their indicator properties and assigned to the following six **main parameters (MPs)**:

- "Watercourse development" (MP 1),
- "Longitudinal profile" (MP 2),
- "Bed structure" (MP 3),
- "Cross profile" (MP 4),
- "Bank structure" (MP 5) and
- "Adjacent land zone" (MP 6).

Depending on the natural area or human impact, the SPs show different characteristics. The manifestation is queried in a defined sequence of characteristics (so called "**condition characteristics**").

The scale of the evaluation is the **present-day potential natural state** which would be re-established after the omission of all uses in rivers and its floodplains and the removement of all reversible pressures (German term "Leitbild"). The term "Leitbild" which describes the present-day potential natural state has been introduced in Germany before the implementation of the WFD. In the WFD, the term "reference condition" is defined as the very good ecological status. In Germany, these reference conditions are equated with the "Leitbild". The best score (morphology class 1) is the orientation mark for this scale. Since this scale can be different, depending on the natural area and on the size of the river, different reference assessments (biotope-specific "Leitbilder") are taken as basis for the differentiation of the morphological river types.

The **assessment procedure** for each survey consists of two components: the evaluation of functional units and the index-based evaluation system (see chapter 4). The **evaluation of the functional units** is performed by the cartographers as a result of an expert assessment of the river type compliant water structures in the field. Fourteen functional units are evaluated which are assigned to the MPs, e. g., "watercourse curvature" and "movability" to MP 1. For the assessment of the functional units, the cartographer must take into account the recorded characteristics of the different SPs, such as for the functional unit "watercourse curvature" the SP 1.1 "watercourse curvature/bends", SP 1.3 "longitudinal bars" and SP 1.4, "watercourse features". In case of an assessment by functional units, the evaluation of the functional units are aggregated to an evaluation of the six MPs. The assessed MPs are the relevant evaluation in North Rhine-Westphalia.

Type-specific index values is assigned to the characteristics of the SPs for the **index-based evaluation**. These index values are offset in the evaluation of the MPs (after predeterminated calculation rules).

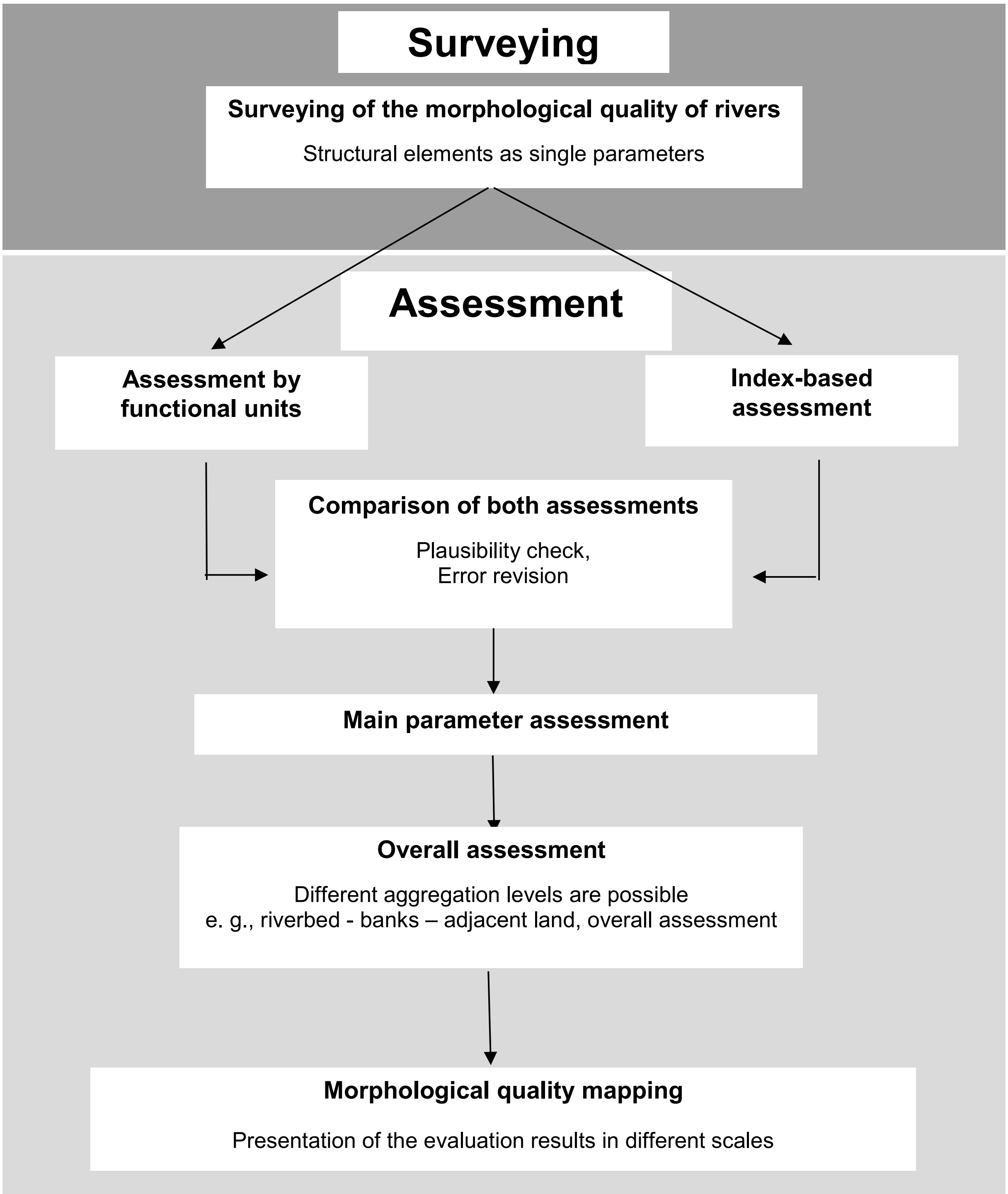


Figure: Overview on the mapping and assessment procedure

The results the evaluation of functional units and the index-based evaluation system are compared and allow a **plausibility check** at the level of the six MPs. If differences exist between the evaluation on the MP-level by the evaluation of functional units and the index-based evaluation, then the cartographer must determine the final valuation. If the deviation is more than one morphology class, then a plausibility check is necessary.

The overall assessment or the assessment of the sectors “bed”, “banks” and “adjacent land zones” are performed by simple averaging calculation of the valuation results of the six MPs.

The result can subsequently be visualised in **river morphology maps**.

The **scope of application** of the presented mapping instruction includes all watercourses. The used differentiation of smallest, small and large rivers is shown in the following table:

Table: Definition of the size of waters

Smallest rivers	Small rivers, heads of rivers, water moats with a medium water-level width of <1 m
Small rivers	Small rivers (medium water-level width of 1 – 5 m), larger rivers (medium water-level width of 5 – 10 m) and small rivers (medium water-level width of 10 – 20 m) and visible bed.
Large rivers	Large and mighty rivers with a medium water-level width of >20 m and normally without visible bed.

2.2 Survey

The survey mapping serves to determine the morphological quality of rivers. Only distinct structures are recorded. An objective and reproducible result is achieved, when it is determined which of the defined features in the mapping section are appropiate. This determination is performed by crossing the box adjacent to the feature in the standardised surveying sheet on paper or by a mapping software.

Generally, the survey mapping is performed from the mouth to the source or against the flow direction. Exceptions are the Rhine and the Weser. In these cases, the survey mapping is carried out in the flow direction.

The length of an individual survey unit depends on the actual watercourse width and varies between 100 meters and 1,000 meters.

Since the data and valuation results of the survey mapping are the basis of a series of different water management questions and tasks, the professional diligence in conjunction with mapping and evalution must be ensured, especially in the cases of field operations over the entire day. In cases that data have been recorded by different cartographers, it must be ensured that the recorded features of morphologically uniform rivers do not change from cartographer to cartographer.

2.3 Evaluation

2.3.1 Definition of the morphology classes

The scale of the evaluation is the present-day potential natural water status (hpnG). From the hpnG the "Leitbilder" or reference conditions of the typical natural area and rivers are derived. They define the morphology class 1. Rivers which do not show impacts or only a low level of impacts with regard to their natural physical structures and dynamics belong to the morphology class 1.

The deviation of the recorded physical features from the reference conditions of the respective morphological river type is assessed in a 7-level classification scale. The table summarises the definition of morphology classes, the signature colour for the cartographical presentation and the assignment instructions for the calculated values for a 7-level classification. The range of values (rounded to one decimal place to fit in one class) have been chosen equidistantly, so all classes have the same width.

The term "morphology class" is used for the different 7-level scale, e. g. for the functional units, for the assessment of the MP or for the overall evaluation. This table is therefore a classification scheme for all ratings in various levels.

Table: Definition of the morphology classes (the degree of impact and the colour for the cartographical presentation) for a 7-level evaluation.

Morphology class	Range of values	Degree of impact	Colour coding
1	1.0 – 1.7	Unchanged	Dark blue
2	1.8 – 2.6	Slightly changed	Light blue
3	2.7 – 3.5	Moderately changed	Green
4	3.6 – 4.4	Distinctly changed	Light green
5	4.5 – 5.3	Obiously changed	Yellow
6	5.4 – 6.2	Strongly changed	Orange
7	6.3 – 7.0	Completely changed	Red

For a 5-level evaluation according to the WFD classification the following assignment set must be used:

Table: Definition of the morphology classes (the degree of impact and the colour for the cartographical presentation) for a 5-level evaluation.

Morphology class	Range of values	Colour coding
1	1.0 – 2.2	Dark blue
2	>2.2 – 3.4	Green
3	>3.4 – 4.6	Yellow
4	>4.6 – 5.8	Orange
5	>5.8	Red

2.3.2 Assessment methods

The assessment procedure for each survey unit consists of two components: the evaluation of functional units and the index-based evaluation. The results of both components are then compared and allow a plausibility check of the recorded data.

The following evaluation steps must be performed:

1) Evaluation procedure based on functional units

The cartographers get an impression of the ecological status of a river by analysing the required information and thematic maps, by walking along the river bank of the mapping section and during the completion of the questionnaire. On the basis of the specific reference conditions of the related morphological river type and of the holistic view of the situation at site, the cartographer assesses the functional units according to the seven-level classification. Subsequently, the cartographers make an evaluation of the MPs with the help of the evaluation of the functional units. This is performed by averaging calculations of the corresponding functional units (except for the MP “longitudinal profile“). A valuation example is shown in chapter 4.5. These results are then transferred, according to the classification table in chapter 2.3.1, to a morphology class. In the case of the MP ”longitudinal profile” there is no formation of a mean value. To the functional unit “natural longitudinal profile features”, the functional unit “anthropogenic continuity barriers“ must be added as malus.

2) The index-based evaluation procedure

This assessment of the morphology class is based on a system of indexes. Ratings between index number 1 and 7 are assigned to the SPs. The assignments of the index numbers depend on the morphological river type.

The index numbers resulting from the data acquisition for a survey unit are processed through predefined summarising steps from single to main parameters. The index system and the calculation rules are shown in chapter 4.

3) Comparison of evaluations

The plausibility check of the results takes place using the comparison of the evaluation of the MP-level on the basis of the functional units and of the index-based procedure. If the deviation between both components exceeds more than one morphology class, the cartographers must make a professional decision on the evaluation of the main parameters after the review of the possible source of errors and justify it in a note form. By this, the decision for the evaluation is transparent.

Table: Evaluation of the main parameters by an index-based evaluation of single parameters or by functional units and their single parameters to be considered

Index-based evaluation of the single parameters		Evaluation of the main parameter		Evaluation by functional unit	On the basis of single parameters to be considered
SP1.1 Curvature/Bends SP1.2 Erosion at bends SP1.3 Longitudinal bars SP1.4 Channel structures	→	**MP1 Channel development**	←	Curvature	SP1.1 Curvature/Bends SP1.3 Longitudinal bars SP1.4 Channel structures
				Movability	SP1.2 Erosion at bends SP4.2 Passage/Bridge SP5.2 Bank features
SP2.1 Transverse structures SP2.2 Piping/Culvert SP2.3 Backwater SP2.4 Transverse bars SP2.5 Flow variation SP2.6 Depth variation SP2.7 Diverted channel	→	**MP2 Longitudinal profile**	←	Natural longitudinal features	SP2.4 Transverse bars SP2.5 Flow variation SP2.6 Depth variation
				Anthropogenic migration barriers	SP2.1 Transverse structures SP2.2 Piping/Culvert SP2.3 Backwater SP2.7 Diverted channel SP4.5 Passage/Bridge
SP3.1 River bed substratum SP3.2 Substratum diversity SP3.3 River bed fixation SP3.4 River bed features	→	**MP3 River bed structure**	←	Type and distribution of substratum	SP3.1 River bed substratum SP3.2 Substratum diversity SP3.4 River bed features SP3.01 River bed pressures
				Bed fixation	SP3.1 River bed substratum SP3.3 River bed fixation
SP4.1 Profile type SP4.2 Profile depth SP4.3 Width erosion SP4.4 Width variation SP4.5 Passage/Bridges	→	**MP4 Cross profile**	←	Profile type	SP4.1 Profile type
				Profile depth	SP4.2 Profile depth
				Width development	SP4.3 Width erosion SP4.4 Width variation
SP5.1 Bank vegetation SP5.2 Bank protection SP5.3 Bank features	→	**MP5 Bank structure**	←	Typical natural vegetation	SP5.1 Bank vegetation SP5.02 Shading
				Bank protection	SP5.2 Bank protection
				Typical natural features	SP5.3 Bank features SP5.01 Bank pressures
SP6.1 Land use SP6.2 Riparian zone SP6.3 Land pressures	→	**MP6 Land use**	←	Foreland	6.1 Land use 6.3 Land pressures 6.01 Land features
				Riparian zone	6.2 Riparian zone

2.3.3 Aggregation of the evaluations

The result of the assessment is an evaluation of the MPs. The MP 5 “bank structure” and MP 6 “adjacent land zone” are divided into left and right side of the river.

The following table shows possible alternatives for the aggregation of the evaluation on the main parameter level. Thus, the MP 5 and 6 can be summarised to an overall assessment of these MPs. Besides, it is possible to summarise the MPs to the sectors “bed”, “banks” and “adjacent land zones”. The evaluation of all main parameters can also be transferred to an overall assessment by simple averaging calculation.

Table: Possible aggregations of the evaluations.

<table>
<tr><th>Assessment main parameter left/right distinction</th><th colspan="3">Possible aggregations of assessments</th></tr>
<tr><td>MP 1: Watercourse curvature/Bends</td><td>MP 1: Watercourse curvature/Bends</td><td rowspan="3">Sector bed</td><td rowspan="8">Overall score</td></tr>
<tr><td>MP 2: Longitudinal profile</td><td>MP 2: Longitudinal profile</td></tr>
<tr><td>MP 3: Bed structure</td><td>MP 3: Bed structure</td></tr>
<tr><td>MP 4: Cross profile</td><td>MP 4: Cross profile</td><td rowspan="3">Sector bank</td></tr>
<tr><td>MP 5: Bank structure left</td><td rowspan="2">MP 5: Bank structure</td></tr>
<tr><td>MP 5: Bank structure right</td></tr>
<tr><td>MP 6: Adjacent land zone left</td><td rowspan="2">MP 6: Land zone</td><td rowspan="2">Sector land</td></tr>
<tr><td>MP 6: Adjacent land zone right</td></tr>
</table>

2.4 Result Presentation

The results are documented in the mapping software or in the surveying sheets and in river morphology maps by coloured bands. Besides, the data are imported into environmental information systems.

River morphology maps show the morphological quality of surveyed rivers by coloured bands, for instance based on topographic maps. The presentation is carried out on the 7-level classification, according to the colour code of the morphology classes as RGB- and CMYK-colours in the following table.

Table: Colours coding of the morphology classes

Morphology class			RGB			CMYK			
			R	G	B	C	M	Y	K
1	Unchanged	Dark blue	0	0	255	100 %	100 %	0 %	0 %
2	Slightly changed	Light blue	0	255	255	100 %	0 %	0 %	0 %
3	Moderately changed	Dark green	0	128	0	100 %	50 %	100%	0 %
4	Distinctly changed	Light green	0	255	0	100 %	0 %	100 %	0 %
5	Obviously changed	Yellow	255	255	0	0 %	0 %	100 %	0 %
6	Strongly changed	Orange	255	128	0	0 %	50 %	100 %	0 %
7	Completely changed	Red	255	0	0	0 %	100 %	100 %	0 %
	Not yet evaluated	Black	0	0	0	0 %	0 %	0 %	100 %

The river morphology map can show, depending on the application and scale, different evaluation results, for instance:

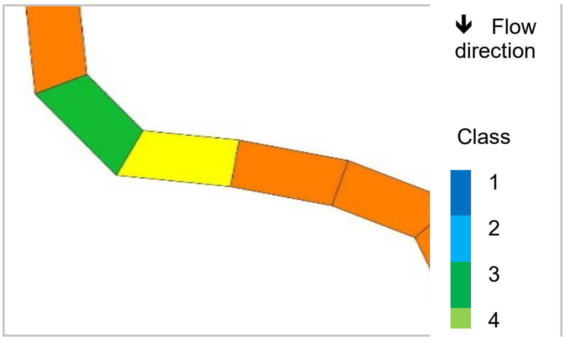
- Selected SP-evaluations
- The six MP-evaluations (six single bands or eight single bands for each river, when both sides are considered)
- The evaluation for the bed, banks and adjacent land zones (three bands or five bands for each side of the watercourse)
- The overall assessment of the river shown by one band

The presentation by bands can be completed by pictograms for singularities, like ”river constructions“. By shading or hatching rivers can be marked within settlements.

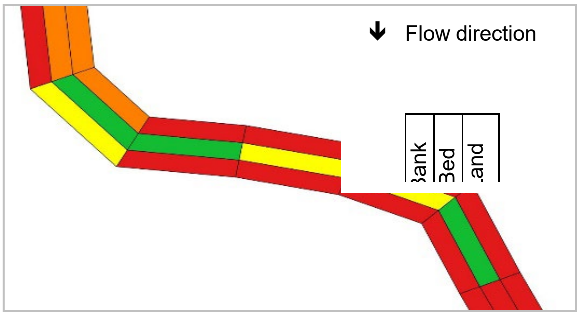
Examples for the presentation by bands

Overall assessment – Overview

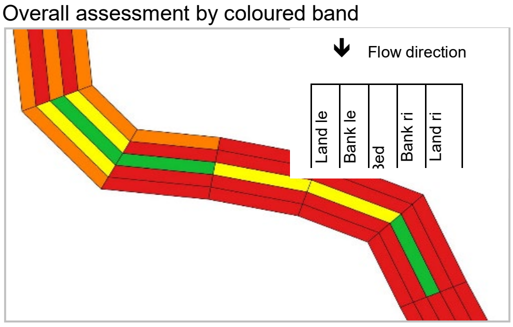
Overall assessment– Detail



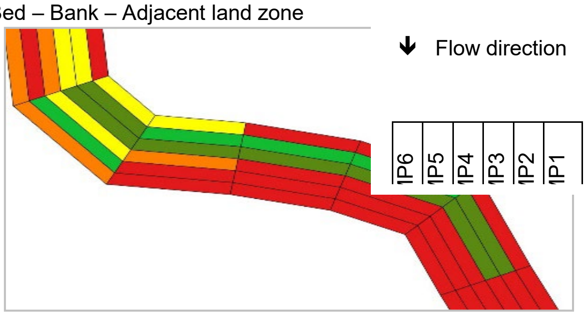
Overall assessment by coloured band



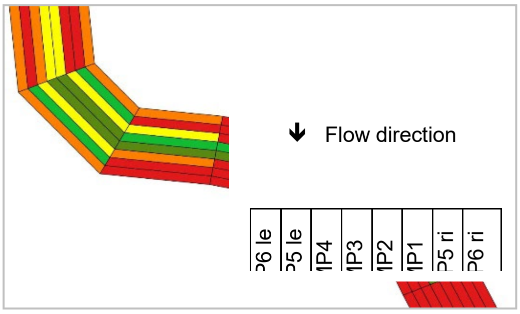
Bed – Bank – Adjacent land zone



Bed – Banks – Adjacent land zones with right/left distinction



Evaluation of the main parameters



Valuation of the MP with left/right distinction

2.5 Work instruction for the field mapping

The survey mapping of the morphological quality of rivers is primary performed in the field. Before the evaluation procedures are carried out, a series of preparatory works in the office is needed based on different data basis.

For the large rivers the mapping is predominantly based on the evaluation of available data basis, added by verifications in the field.

Fundamentally, the survey process demands different professional requirements to guarantee the quality of the recorded and evaluated data.

2.5.1 Professional requirements for the carthographers

Methodological know-how

The quality of the survey mappings depends, to a considerable degree, on the know-how and experience of the cartographers. For the performance of the survey, a very good methodological knowledge and intensive preparation of the fieldwork is needed (also see chapter 2.5.2). In particular, an extended knowledge in morphological river typology serves as an essential basis, since it is crucial for the evaluation results.

In the service descriptions, the requirements related to the cartographers are to be described in detail.

Experience in river morphology mapping for quality control

Before the survey mapping, the cartographers should have mapped several rivers, morphologically different according to this worksheet if necessary, also for testing purposes.

The field mapping of some rivers or selected unit lengths should be repeated after a certain time interval. The cartographers should always produce the same result for the same survey unit.

Objective Survey

The analogue and digital questionnaire must be filled out according to this worksheet. Additional impressions, special knowledge and subjective preferences must be ignored. Different cartographers must come to the same result at the same survey unit independently (cross mapping).

Detection of the water level

The cartographers must be able to classify the actual water level within the total runoff of the river (e. g., mean discharge, low discharge). If it is necessary, current water levels have to be checked, especially for large rivers, for instance by gauge data. In North Rhine-Westphalia for instance the technical information system ELWAS-WEB or HYGON are available.

2.5.2 Data basis

State-of-the-art for the survey of the morphologicalquality of rivers is the use of the geographic information system (GIS) by means of WMS-services. High-resolution remote sensing data cannot replace an on-site survey, but support the preparation especially in the case of large rivers and provide additional information in rough terrain. Especially current high-resolution aerial photos or satellite images are worth considering. The following map basis and tools are necessary in their respectively applicable version:

- Topographic maps (especially TK 10 or DTK 5, where appropriate overview maps for orientation)
- Aerial photos (preferably coloured or colour-infrared (CIR), potentially in black and white, georeferenced ortho-photos)
- Digital terrain models (DTM)

Additional helpful data basis are:

- River typology maps of NRW and of the Federal Republic of Germany and the map of the river water landscapes
- Maps of actual uses and/or biotope type maps
- Geological and soil maps
- Stationed watercourse based on TK 10 or alternatively TK 25 as well as the watercourse generalized on survey units with the survey units' limits as bisector lines or as vertical lines to the valley or floodplain axis in order to differentiate relevant floodplain areas of large rivers for each survey unit.
- Photos, sloped images, videos by multicopter flights

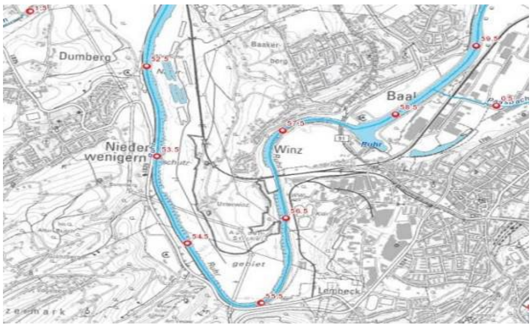
Moreover, the following information of the competent authorities for the survey of large rivers, especially for federal waterways can be helpful:

- Width of the navigable watercourse in waterways
- Extraction and addition of bed-load (dredging)
- Head of the reservoirs and length of the backwater, e. g., from FLYS
- Position, purpose and effect of constructions
- Sediment freight within pipings, overbuildings and culverts
- Position and type of bed fixation
- Position and type of bed pressures
- Position and type of bank protection
- Position and type of bank pressures
- Position and type of adjacent land pressures
- Frequency of overflowing and the area of flooding
- Range of the potential natural floodplain
- Historical maps

Map basis

Stationed watercourse

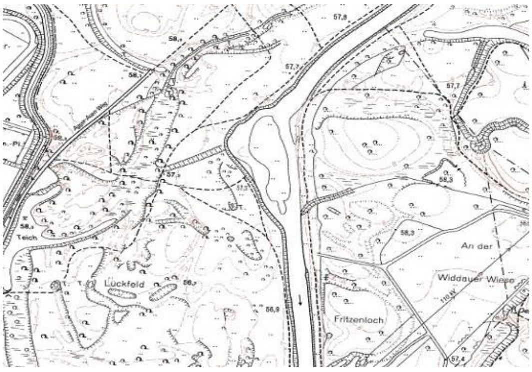
- Current digital river stationing maps containing information on diversion watercourses or bifurcations



Source: Geobasis NRW

German basic map with contour lines **(DTK 5 H)**

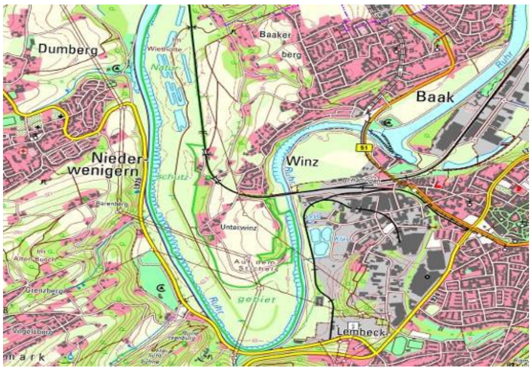
- Overview of the river width, watercourse curvatures/bends, locations of constructions and the uses in the adjacent land zones.



Source: Geobasis NRW

Topographic map TK 25 (1:25,000)

- Overview of the watercourse development and of the watercourse type of the watercourse



Source: Geobasis NRW

(Detail) aerial photo

- Coloured photo perpendicular to the longitudinal axis: survey of bed, banks and land structures, flow variation, width variation, backwater, vegetation, bank protection, use
- Orientation in the terrain, since possibly not plotted route might be recognisable

Source: Geobasis NRW

Map basis

Aerial photo

- Black and white orthophoto: Survey of bed, banks and land structures, flow variation, backwater

Source: Geobasis NRW

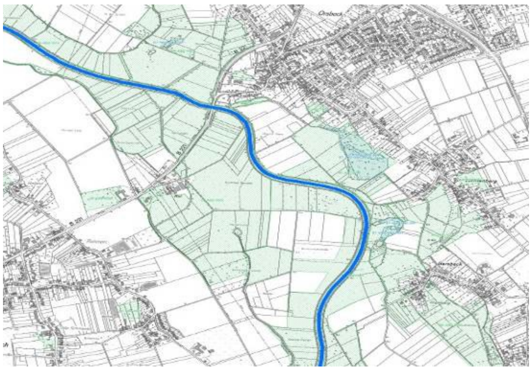
Aerial photo

- CIR (colour-infrared)-aerial photo: especially for the recording of vegetation

Source: Geobasis NRW

Real use maps/biotope type maps

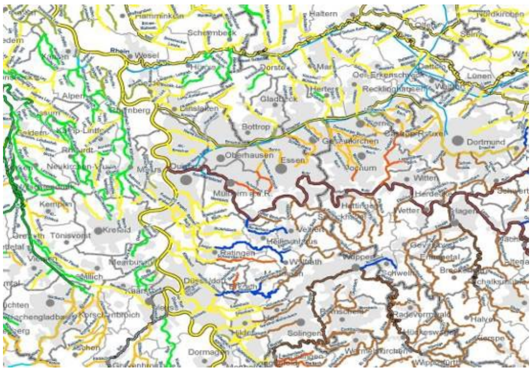
- Information service with the location of the biotope types



Source: Geobasis NRW

Map of the LAWA-morphological river types

- LAWA-morphological river type with indications to the bed substrate under reference conditions

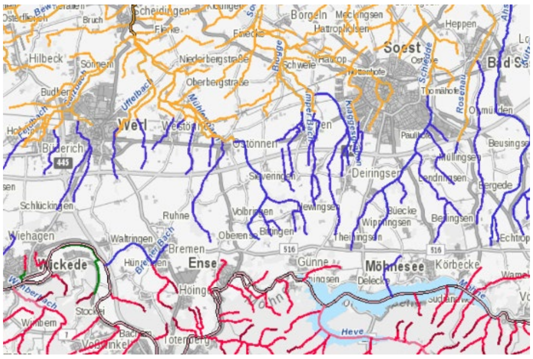


Source: Geobasis NRW / LANUV (2015)

Map basis

Map of the morphological river types in NRW

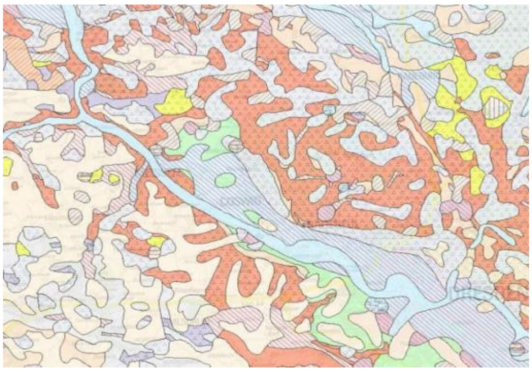
- Morphological river type in NRW with information on bed substrate under reference conditions, on the watercourse type, the degree of twisting of the major rivers



Source: Geobasis NRW / LANUV (2015)

Map of the riverine landscapes

- With references to the bed substrate under reference conditions



Source: LUA (2002)

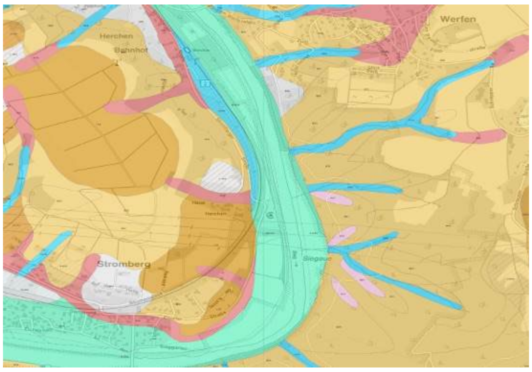
Geological maps

- Indirect information based on petrographic indications on the covering rock layers in the catchment area, for instance clay and siltstones of the Devonian-age, partly overlaid by loess

Source: Geobasis NRW

Soil maps

- Indirect informations on recent bottom substrates in the floodplain and substrates under reference conditions, for instance loamy sand over gravelly sands and gravel



Source: Geobasis NRW

2.5.3 Preliminary works

Determination of survey units

The survey units are defined and based on the respective current edition of the stationed watercourse map (GSK) of the State NRW. Each survey unit is uniquely identified by a survey unit identity as well as by a river code (GEWKZ) and by the stationed values of the starting point and of the endpoint (in metres).

If there are no survey units for a river, based on the current stationed watercourse mapriver, then the watercourse will be devided continuously from the mouth to the source along the midline of the river in 100 m sections based on the topographic map TK 10 (1:10,000). Thereby, the eastern and northern values for the starting and endpoints of the new defined sections are determined.

For the survey of large rivers, the 100 m sections are aggregated to 500 m or 1,000 m long survey units.

The limits of the sections are marked and continuously numbered upstream from the mouth to the source. If the watercourse is available as digital vector theme (for instance ATKIS Basis-DLM), the limits of the sections can be performed semi-automatically by GIS.

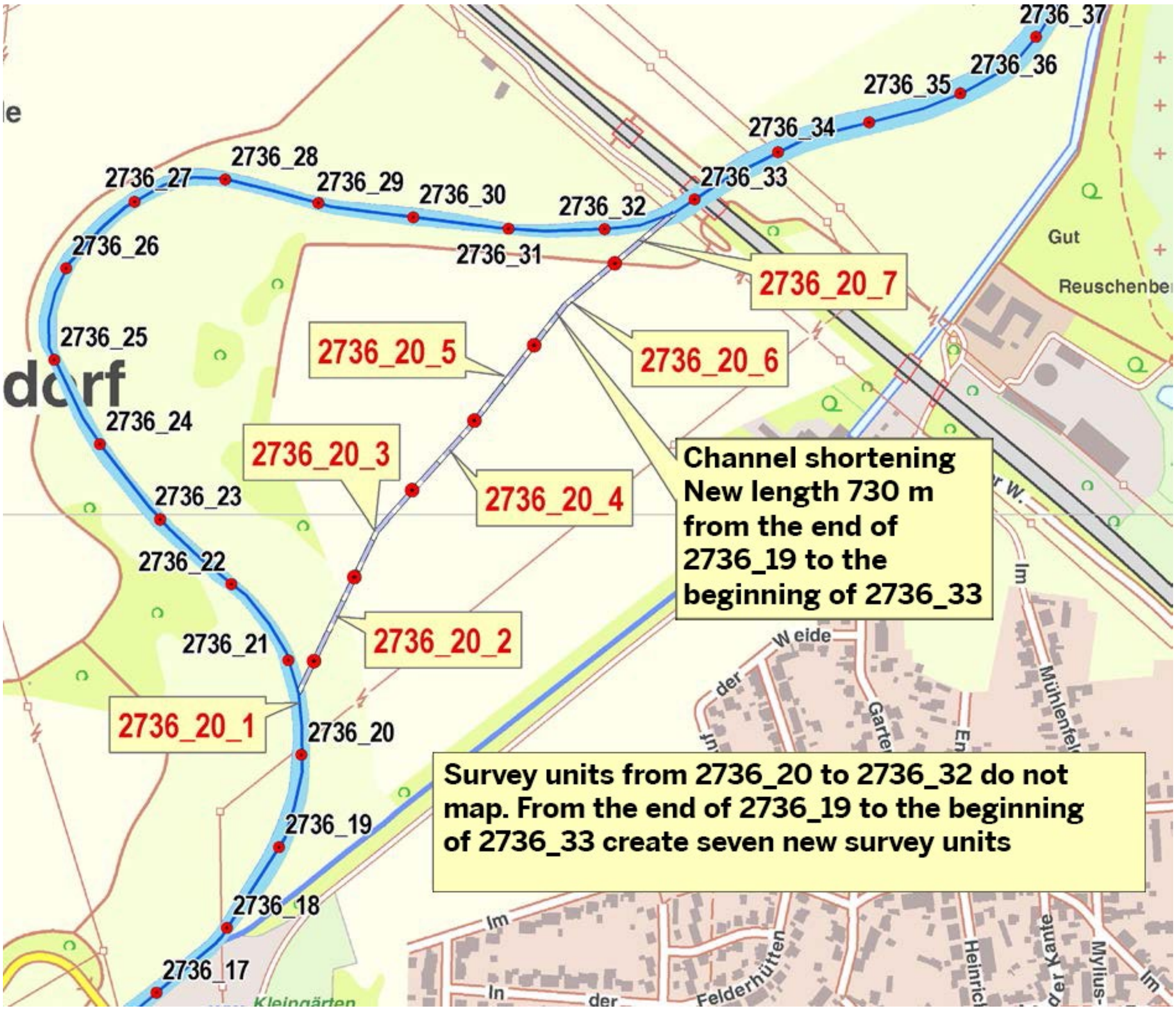
The subdivision of the sections and the numbering are also consecutively performed in case the river section is piped for a longer distance.

The length of the survey section is given, but a deviating section length can be determined in the field for rivers showing a width between 10 and 20 m or between 20 and 40 m where appropriate. Local narrowings or widenings of a river are not considered. Once a unit length has been selected, it cannot be undercut in the further watercourse (when working in the flow direction), even though the river shows a smaller real width in the lower course (e. g., because of obstructions) than in the more natural upper course. By this procedure, it is avoided that section lengths vary often.

If the actual watercourse differs significantly from the watercourse determined by survey units, then **new survey units** must be created between the two sections which are not affected. This is to be done regardless of whether the real river length is shorter, longer or equal. The referencing of survey units which are be replaced by new survey units is not necessary.

Significant deviations mean that watercourse sections lie outside a 200 m wide corridor (100 m to the left as well as to the right side of the river) from the predetermined survey units or where there are changes in the length of the watercourse for the survey units by more than 50 % (watercourse extension or shortening). This includes also changed drainage aspects (for instance change of the estuary), changed regulation of the main watercourse (e.g. mill-races), the branching of rivers and extended upper courses.

For the new survey units, the starting and ending points must be recorded by UTM-coordinates (by GPS or maps). For newly created survey units, unique IDs must be generated. This is done by attaching a further digit to the first concerned survey unit which is counted up for each new survey unit until the next survey unit which is not affected.



Picture: Designation of new created survey units.

Example:

In a river to be mapped, the watercourse has been changed in a section, in this case by watercourse shortening. The first of the affected survey unit has the ID „2736_20“. Because of the watercourse alteration, seven new survey units must be created until a survey unit has been reached within the stationed course which corresponds to the old state (e. g. unit “2736_33”).

The new survey units obtain the

IDs ”2736_20_1“, ”2736_20_2“, ”2736_20_3“, ”2736_20_4“, ”2736_20_5“, ”2736_20_6“, ”2736_20_7“.

In the case of smaller deviations or changes in length than described above, no new survey units should be created but corresponding instructions should be noted under the term “short description”.

Normally the survey units are predefined by the customer. Within the description of services the length of survey units can be set individually.

Creation of survey units

For the assessment of the SP 1.1 ”watercourse curvature/bends“ and the SP 1.2 ”erosion at bends“ it is necessary for smaller, medium-sized and large watercourses, to take the characteristics of the adjacent river sections into account river(creation of survey unit blocks). The following survey units within the considered section and in the direction of mapping are aggregated to form a block.

River width (actual state)	Length of survey unit	Sectionblock
>5 until 10 m	100 m	2 sections (200 m)
>10 m until 20 m	100 m 500 m	5 sections á 100 m (500 m) 2 sections á 500 m (1,000 m)
>20 m until 40 m	500 m 1,000 m	3 sections á 500 m (1,500 m) 2 sections á 1,000 m (2,000 m)
>40 m until 80 m	1,000 m	3 sections (3,000 m)
>80 until 160 m	1,000 m	6 sections (6,000 m)
>160 m	1,000 m	12 sections (12,000 m)

Remaining segments

If there are remaining segments at the border of the mapping area, for instance at reservoirs, then the remaining segments minor 50 % of their length are part of the preceeding regular section. Longer remaining pieces are treated like individual survey units. In these cases, new survey units have to be created.

The quantitative manifestation of the features must be put into relation to the real length of this section.

The defined survey units contain the information if they are located in a reservoir. If necessary, this allocation can be changed by the cartographers on-site. Reservoirs are not mapped in general. The overall assessment of these survey units is the index number 7. The length of the reservoir is determined between the dam and the area where the watercourse regains the character of a river (e. g., visible flow speed).

Determination of morphological river types and reference conditions

In NRW all rivers are assigned to regional NRW-morphological river types, for instance as basis for river restorations (LANUV 2015, LUA 2002, 2001b) and additionally for the reporting rivers to the so-called LAWA-morphological river types (LANUV 2015), as basis for the biological assessment according to the WFD. The type-specific morphological models or rather the type-specific reference conditions of these morphological river types are assessment scales for the evaluation of the morphology class of rivers by the functional units. Also, the “bed substrate “Leitbild” is derived from the morphological river types.

The NRW- and LAWA-types shown in the nationwide maps are determined. If it is considered necessary, because of the assessment of the morphological quality, to redefine the mprphologyclass in deviation from the river type map, then this must be coordinated with the competent supervisory authorities and with the North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection (LANUV). It is necessary to send a written justification for the different typification to the LANUV, as editor of the river type map (Fachbereich54@lanuv.nrw.de). The relevant criteria for the new classification must be plausible and reasonable. The LANUV collects all specific information, so that they can be used for future revisions of the river type map.

The morphological river types are the basis for the index-based evaluation procedure. The rating scale of the index system is calibrated using the river type specific river models. For large rivers there is only one morphological river type, defined as basis for evaluation. For small rivers the morphological river type is derived from the combination of bed substrate under reference conditions and the valley shape in its current state. Thus, the morphological river type is defined only during the survey. The most common morphological river types in North Rhine-Westphalia are taken into consideration for the index-based procedure. If the rare case of a combination of valley shape and bed substrate in the morphological model without an index evaluation occurs, theindex can be surveyed. For the assessment the next similar morphological river type must be used.

Determination of diversion watercourse (SP 2.7)

For this single parameter a carefull preparation is needed. For all known diversion watercourses own river identification numbers are allocated and shown in the river stationing map of NRW. Also, bifurcations are marked in the river stationing map. Thus, they can be shown cartographically. The results must be checked on-site.

2.5.4 Fieldworks

The fieldworks must be planned carefully, such as the day`s route. In addition, the necessary (technical) equipment of the cartographers for the field works must be provided.

Equipment

For the facilitation of the on-site recording, for the acceleration of the data handling, but also for the improvement of the data quality, different technical tools have to be carried along.

Mapping instruction	The analogue and digital mapping instruction must be carried along.
Questionnaire, clipboard, pin	To fill out the questionnaire a solid surface like a clipboard and a waterproof marker (a soft pencil preferred) are needed. A sufficient number of surveying sheets must be carried along. Prior to the beginning of the survey, it is recommended to fill out the master data of each survey unit in the questionnaire. This is not required for the use of systems using mobile and digital registrations.
Mobile terminals, spare batteries, protective cover	When mobile terminals are used for the data collection, the transmission of the questionnaires to a data base is unnecessary. Plausibility checks and automatical index calculations accelerate the registration additionally.

Mobile terminals should be suitable for the fieldwork (e. g. protected according to the standard IP 67), if necessary, a waterproof integument should protect the mobile terminal from rain.

It should be ensured that the battery runtime is sufficient (>8 h in permanent operation). Having spare batteries is recommended.

Digitale cameras

Spare batteries

Digital cameras must be used (optionally with GPS and compass) to facilitate the assignment of digital photos to the corresponding survey units. With cameras which are applicable for underwater photography it is possible to take pictures from the bed substrate. It is recommended to carry along spare batteries.

Ranging rod

For the recording of some features it can be advantageous to use a ranging rod. It can be useful for size estimations, for the assessment of the bed structure or for the inspection of the overgrown bank protection.

Laser measuring instrument, folding rule

Distances and measures can be easily and precisely determinated by laser measuring instruments. Technical devices with different scales between a few centimeters and at least 100 metres are useful. As alternative serves a folding rule or a tape measure.

GPS device

For the exact position of constructions and other local significant features and for a general orientation, a GPS device must be carried along to determine the respective eastern and northing value.

Binoculars

A binocular should be carried along when surveying large rivers for the verification of the characteristics standing on dams and in paths for river maintenance works.

Topographic overview map

For orientation purposes on land, it is recommended to carry along topographic overview maps with a scale of 1:25,000 or 1:10,000 with actual watercourse stations.

Mobile phone

For safety reasons, a mobile phone should be carried along (see also Chapter 2.5.8) for possible emergencies, since the cartographer normally works alone.

Legitimacy card

The custumer should provide an authorisation pass to the cartographers, according to the State Water Act with the authority to access relevant private lands to determine the water management basis according to the State Water Act.

Timing

Principally, the survey mapping can be performed throughout the whole year, on the condition that the water level shows mean-flow conditions or below. Generally, the most convenient time for survey mapping is from November to the end of April, since for the rest parts of the year a dense vegetation cover might impede a visual inspection of morphological features. This must be taken into account for the time management.

Day`s route

On average, a cartographer daily covers a water route between two and four kilometers. Depending on the availability of pre-informations, terrain situation and the structure of the survey units highly fluctuating daily outputs can be expected. Before each on-site recording, the day`s route must be planned carefully.

Orientation in the open field

Before the start of the survey mapping, the cartographers must acquaint themselves with the environment of the river to be mapped and with a most practical sequence of the survey units using topographic maps and available aerial photos.

The surveyed sections must be oriented towards the official stationing. The structure of the survey units in the surveying sheet can be checked by GPS coordinates. Possible prominent site features and structures in the direct proximity of the survey unit boundaries facilitate the division of water stretches and enable an additional control of the conformity between the division of sections in the map sheet and the division of sections in the field.

The use of a GPS-device is recommended. If the GPS data cannot be recorded, then the length of the survey units must be estimated at site. The estimation of the entire route with long survey units will be facilitated in a difficult terrain by the estimation of subsections.

The number of survey units between two prominent landmarks in the field must correspond with the respective number of survey units in the map.

On-site inspection of the survey units

The survey mapping of the morphological quality of rivers is performed from the mouth to the source or more specifically against the flow direction. Exceptions are the Rhine and the Weser. In these cases, the mapping is carried out in the direction of flow. To guarantee a rapid processing, each survey unit should be walked along the riverbank only once. Both adjacent land zones must be mapped separately. The terms ”left“ and ”right“ are related to the vision direction “in the flow direction“.

Photo documentation

The photos should clearly show the survey unit and ideally special features. Therefore, for the photo documentation a sufficient visibility is necessary (if possible, at least a half length of a survey unit) to have a comprehensive overview of the survey unit. A good quality of the photos should be ensured, that means prevention of backlit scenes and optimal depth of focus. The photo must be checked immediately in the field and when required, for instance due to bad lighting, it must be taken again.

When taking pictures, the legal aspects must be considered. In the photos persons or car licence plates must not be visible. If this cannot be avoided, then they must be made unrecognisable afterwards.

Photo documentation

Good photo quality: Overview: Near-natural river in low mountain area

Inadequate photo quality: Horizon tilt

Good photo quality: Overview on a near-nature river in low-land areas

Inadequate photo quality: No river detectable

Good photo quality: Overview on a river

Inadequate photo quality: Too dark

Good photo quality: Overview of a modified river

Inadequate photo quality blurred, backlight

2.5.5 Postprocessing

The postprocessing should be done preferably on the same day like the on-site recording. This process includes the following tasks:

- The check for completeness
- The assignment of the photos
- The check for plausibility

The check for completeness

It must be checked if the surveying sheets of all surveyed units are completely filled out and if for all survey units and constructions the respective photos are existent. For the survey units and constructions for which this is not the case, appropiate reasons should be provided.

Assignment of the photos

The photos must be assigned to the survey units and to the constructions and should be named according to the specifications of the customer. In NRW the software ”Beach GS 3 Foto-Manager“ is available.

The check for plausibility

The recorded data must be checked for plausibility,

- as the SP 2.5 “artificially increased flow variation“ normally only occurs in connection with discharges or with excessive fluctuations of water levels, with wave impacts (SP 5.01) or with a water construction (SP 2.1, SP 2.2, SP 4.5).
- The mapping of a backwater under the SP 2.3 always occurs in connection with the flow pattern “smooth” (SP 2.01).
- The SP 2.4 ”anthropogenically no transverse bars“ normally occurs only in connection with technical profiles (SP 4.1).
- The SP 1.2 ”naturally no erosion at bends“ normally occurs in connection with the valley shape ”V-shaped valley“ and “U-shaped valley” or rather in the particular case “small waters”.
- The SP 1.2 ”anthropogenically no erosion at bends” normally occurs in connection with a complete bank protection (SP 5.2) or technical profiles (SP 4.1).

The program Beach GS 3 Desktop that is used in NRW contains a series of plausibility checks which can be used automatically for whole data sets.

2.5.6 Specific instructions for the assessment of the morphological quality of large rivers

The survey of the morphological quality of large rivers is divided, like for small rivers, in three data-based working phases: preparatory works, fieldwork and desk-based manual correction. However, the morphological survey mapping of large rivers is principally based on the evaluation of available data sets, especially on aerial photographs and only secondary on the performance by on-site recording.

Numerous SPs can only be recorded by data sets. Other SPs demand, besides a solid data base, a verification in the field. A third group of SPs can only be recorded in the field.

Table: Working phases for the assessment of morphological quality of large rivers

Working phase	Description
Preparatory work	• Data-based preparatory works by the evaluation of available data • The characteristics of the SPs are, where possible, recorded by the data base in the office (see chapter 2.5.2).
Fieldwork	**Verification** • The pre-filled questionnaires are checked concerning the recorded characteristics in the field **Mapping** • The characteristics of the SPs are only recorded in the field. **Or** • Taking aerial photographs, e. g., by flights with multicopters
Postprocessing	• Evaluation of the aerial photographs: Recording of the characteristics on the basis of the aerial photographs in the office • Photo allocation • Check for completeness and plausibility

For each survey, the used basis or data must be documented precisely (minimum information: editor, title or name, source of supply, publication date.). It is recommended to create a report in a tabular form in which the sources (with details about the up-to-dateness) and the evaluation methods (photogrammetry, GIS-evaluations, …) are listed. In some circumstances different sources are used which should be annotated accordingly. The level of detail of the report must be coordinated between the customer and the contractor.

In addition, it should be shown how the performance by the on-site recording has been carried out (by walking along, by boat, by the use of multicopters).

Preparatory works

For the data-based performance of the survey, different map basis and high resolution images, made by planes or satellites, are offered. (see Chapter 2.5.2). The data-based survey is performed in an online-enabled office. A data-based survey by means of WMS-services or map viewer in the field failed in light of past experience, mostly because of poor reception.

By the 3-D-assessment of stereoskopic aerial photos, the quality of data-based survey can be improved. This applies to river segments with shadows on the river by wood on its banks. If the survey unit cannot be mapped by an aerial photo because of shadowing and because of difficulties to access the site in the field, oblique aerial views using flights with multicopters can improve the quality of the survey.

The WMS-services are loaded in GIS and the layer principle is used for the recording of the survey data. Numerous WMS-services und map viewers are linked with information of an Environmental Information System, which can be requested by an info button.

Further information can be enquired by competent institutions of river maintenance (e. g., water boards, dam associations).

Particularly for waterways, information is kept available in geodata- and specialist services of the Federal Waterways and Shipping Administration (WSV). Furthermore, needed information can be requested by the regional offices of the WSV.

As a general rule, the quality of the survey of large rivers by the intensive use of remote-sensing data or a data-based performance is to be rated higher than a performance by an on-site recording of data.

Based on the experiences of the last years the following table shows exemplary the possibilities of the SP-data-collection for rivers with a minimum width of 10 m. Partially, in the aerial photos the sight on the survey unit is affected by wooded groves or by its shadowing.

Table: The evaluation of single parameters of large rivers.

SP	Single Parameter	Preparatory work with data basis	Fieldwork
Watercourse development	Watercourse curvature/Bends	DTK 5, TK 25; Aerial photos/WMS-services	Verification
	Erosion at bends	Aerial photo/WMS-services Detailed aerial photo/Oblique image (Multicopter)	Survey mapping Verification
	Longitudinal bars		
	Watercourse features		
Longitudinal profile	Transverse and special features	DTK 5, Aerial photo Detailed aerial photo/Oblique image (Multicopter) DBWK 2, Authority requests/WMS-services	Survey mapping Verification
	Piping/Overbuilding	DTK 5, aerial photo	Verification
	Backwater	Aerial photo, DGM, Authority request/WMS-services Detailed aerial photo/Oblique image (Multicopter)	Survey mapping verification
	Transverse bars	Aerial photo, DGM, Bearing of the bed substrate/WMS-services Detailed aerial photo/Oblique image (Multicopter)	Survey mapping Verification
	Flow patterns	Aerial photo/WMS-services Detailed aerial photo/Oblique image (Multicopter) Bearing of the bed substrate	Survey mapping Verification
	Flow variation		
	Variation in depth		
	Divesion watercourse	Aerial photo/WMS-services Detailed aerial photo/Oblique image (Multicopter)	Verification
Bed srtucture	Bed substrate	Authority request Research for bed substrate investigations Detailed aerial photo (Multicopter) Questionnaire of the biological monitoring Bearing of the bed substrate	Survey mapping Verification
	Substrate diversity		
	Bed fixation		
	Bed features		
	Bed pressures		
Cross profile	Profile type	Aerial photo/WMS-services Detailed aerial photo/oblique image (Multicopter)	Survey mapping Verification
	Profile depth	Detailed aerial photo/oblique image (Multicopter) Bearing of the bed substrate	Verification
	Width erosion	Detailed photo/oblique image (Multicopter)	Survey mapping Verification
	Width variation	DTK 5, TK 25; Aerial photo/WMS-services	Verification
	Culvert/Bridge	Authority request, DTK 5, aerial photo	Verification
Bank structure	Bank vegetation	Aerial photo/Detailed photo/Oblique image (Multicopter)/biotop mapping (BTK) / WMS-services	Verification
	Bank fixation	Aerial photo/WMS-services Detailed aerial photo/Oblique image (Multicopter) Authority request	Survey mapping Verification
	Bank features	Aerial photo/WMS-services Detailed photo/Oblique image (Multicopter)	Survey mapping Verification
	Bank pressures	DTK 5, TK 25, Aerial photo/WMS-services Detailed photo/oblique Image (Multicopter) Authority request	Survey mapping Verification
	Shading	Aerial photo/WMS-services Detailed photo/oblique image (Multicopter)	Survey mapping Verification
Adjacent land zone	Adjacent land use	Aerial photo/WMS-service/biotop mapping	Verification
	Riparian zone		
	Adjacent land pressures	DTK 5, TK 25, Aerial photo/WMS-service/biotop mappning, BfN (map service, floodplains in Germany)	Verification
	Adjacent land features		

Fieldwork

The method for the assessment of details in the field, like the on-site recording by walking along, by car or by multicopter, should be coordinated with the customer. Possibly, a combination of different assessment methods along the riverbank is recommended. To guarantee a rapid processing, each survey unit should be visited only one time. Thereby, both adjacent land zones must be mapped separately.

The survey can be carried out completely overland. All passable bridges should be used for a deeper look at the bed substrate. In individual cases a river additional mapping in the field by boat can be useful. But this depends on the navigability of the river (a too strong current or a too small navigable watercourse are problematic). The need for using a boat should be investigated in advance and the effort should correlate with the expected results. Especially, deeply cut larger rivers with wooded banks can be almost solely mapped at the foot of the embankment from the riverside. Concerning waterways, the mapping by ship is the most efficient evaluation procedure.

Detailed aerial photos taken for example by multicopters enable a complete recording of the SPs with high quality and actuality. Thereby, the current legal requirements must be taken into account.

Postprocessing

If aerial photos have been taken by multicopters during the fieldwork, then these photos must be evaluated at first. The registration of the features is made based on these photos. This is followed by the described work in chapter 2.5.5.

2.5.7 Data collection of water constructions

The survey mapping of the morphological quality of rivers is an independent procedure which can be performed together with a detailed survey of hydromorphological relevant constructions (especially transverse water constructions and crossway buildings) according to the LANUV-Arbeitsblatt 38 (2018). If the survey of the morphological quality and of the constructions is done at the same time, at first the water constructions within the survey unit with their features and geometrics should be registered.

In the event that the survey of the morphological quality is performed with surveying sheets, it is recommended to transfer the data from the survey mapping of water constructions to the corresponding SP 2.1 “transverse and special features“, SP 2.2 “piping/overbuilding“ or SP 4.5 ”culvert/bridge”. The reason for this procedure is the collection of detailed results of the construction mapping and to avoid a duplication of work or different data.

In the event that a mapping software is used, the features und geometrics of the constructions are automatically transferred into the corresponding SPs (SP 2.1 “transverse and special features“, SP 2.2 “piping/“ or SP 4.5 “culvert/bridge”) of the assessment of morphological quality.

If only the mapping of the morphological quality is carried out, then an adequate knowledge of the different constructions for the above-mentioned SPs is required for an ensured data quality. For this, it is necessary to consult the detailed definitions and descriptions of the construction mapping (LANUV-Arbeitsblatt 38, 2018).

If constructions are found at a watercourse which are not defined within the frame of this procedure, then this construction regarding to its impact must be assigned to a described water construction. In the field “comment” a corresponding information must e given. If appropiate, this construction should be documented by a photo.

2.5.8 Safety at work

Each employee in Germany is ensured with the statutory accident insurance against accidents at work and work-related diseases. The insurance companies laid down some partial rules which are beyond legal requirements and must be complied by the employers and employees. Violations of these regulations may lead to the loss of the insurance cover. The BG-provision BGV A 1 ”Principles of Prevention“defines fundamental requirements on the protection of employees, for instance:

- The entrepreneurs have to take the necessary measures for the prevention of occupational accidents, work-related diseases, work-related health risks and for an effective first aid and bear the costs of these measures.
- The entrepreneur must identify by so-called risk assessments which concrete protection measures are needed and must document them. The risk assessments must be verified and revised in case of changes of the operational circumstances if necessary.
- The staff must be instructed about dangers and protective measures.
- The customers must support the contractors concerning the risk assessment, e. g., by information on known dangers.

Especially four features characterise the specific hazards which are linked to the work ”survey mapping”:

- Working at watercourses
- Working in changing localities
- Working alone
- Working in the open field

River habitat mapping is working along watercourses

For a thorough mapping of the morphological quality, the cartographer must permanently stay in close proximity to the rivers. This leads to diverse dangers (e. g., slipping, hypothermia because of wet clothes, drowning because of falling in the river or a flood wafe, sinking into mud). This risk analysis must be taken into account by the contractor.

River habitat mapping is working in changing localities

River habitat mappings are often performed in areas which are unknown for the cartographers. There is an additional danger in comparison with stationary workplaces because the personal must be adapted to new situations. Therefore, for each new mission the risk assessment must be proved by the contractor and further protective measures must be taken if necessary.

River habitat mapping is often working alone

If a person is not within a calling distance and outside of the range of vision for others, then this is termed “working alone”. In the event of an accident, this may not lead to a disadvantage for the cartographers. Working alone is the norm for cartographers. It is necessary to guarantee a quick intervention in case of an accident. A constant accessibility and a good knowledge of the current area must be ensured. All cartographers must be equipped with mobile phones and must be obliged to check the proper function (network accessibility, charge status) regularly and to report regularly. In a far distance from settlements, in a spot of no reception, under adverse circumstances (weather condition, impassability, dense wood, narrow valey, etc.) it is appropriate to employ several cartographers at the same river (e. g., in a distance of a daily output) or at least in the same catchment area. After the mapping, a feedback should be given.

It is also recommended that all cartographers have been trained in first aid.

River habitat mapping is working outdoors

Here, the following aspects must be considered:

- Protective measures for cold and wet weather. Weatherproof clothing according to DIN EN 343. Working at temperatures below -5 degrees: protective clothes against cold according to DIN EN 342.
- Protective measures on sunny days. Although the winter half year is recommended for survey mapping (outside the growing season), survey mappings are also possible in the summer half year (e. g., because of project delays). For the protection against sunbeams: tight clothing, head covering, effective sunscreen and sunglasses. For the protection against ozone and high heat: avoid longer periods of physical activities at noon. These works must be postponed in the morning or in the evening hours.
- For the protection against ticks: tight clothing, head covering, after the work inspecting the body for ticks. When working in risk areas, a prophylactic vaccination is recommended. Special caution is needed in marshy areas and rough terrain.

Special case ”self-employed“

The Working Conditions Act aims at the protection of employees. Self-employed persons are not included.

Legal regulations which also include self-employed persons are for instance the building site regulation: ”Guaranteeing the safety and health of the workforce at work, also the contractors working on a construction site without employees must follow the workplace safety regulations. They have to pay attention to the information of the coordinator and to the safety and health plans”. The subsections 1 and 2 also apply to contractors, which are at a construction site themselves (§6 BaustellV).

Besides, self-employed persons may obtain insurance voluntary from the relevant professional association. Then, the insurance cover shall apply to them as to employed persons. Otherwise self-employed persons and contractors which are operating for themselves are responsible for their own health protection.

The support of the employers for risk assessments must be also provided for self-employed people, even though they are not obliged to perform a formal risk assessmen

3 Description of the questionnaire

The division of the questionnaire into three blocks is shown in the following table.

Table: Division of the questionnaire

Block	Description
Identification block (Chapter 3.2)	• Clear identification of the mapped river and its survey units • Typological classification of the survey unit • Characterisation of the survey unit
Main parameter block (Chapter 3.3)	• Determination of SPs and their features • Determination of the water structure predominantly in the open field
Assessment block (Chapter 3.4)	• Results of the recorded functional units

The identification and main parameter blocks contain the features of the SPs which are predominantly recorded on-site. These data are the basis for the index-based evaluation procedure. Their determination is necessary to get an accurate impression of the river and to perform an expert evaluation by functional units. The parameters are queried based on tables.

In the following, the data, parameters, and features to be recorded are described which are classified in three blocks:

- **Definition** (a short textual description of the single parameter)
- **Indicator properties** (a short description of the significant indicator properties of the river ecosystem)
- **Information on the determination**

This is followed by the definitions of the features. They are shown by additional figures.

The data collection is made in specific fields which are assigned to the features of a SP. Relating to the type of data collection, the following acquisition types can be distinguished:

- Filling in text fields
- Ticking the dominant feature (= simple registration)
- Ticking various features (= multiple registration)
- Counting the number of features
- Collection of length classes
- Simple or multiple registration depending on the homogeneity of the expression of a feature
- Parameters differentiating the left und right river side
- Other

Filling in the text fields

In the block "identification" of the questionnaire some information, e. g., on the master data, is to be specified as text.

Simple registration

In accordance with the information sign (☝) only one feature should be ticked. The SP 1.1 ”watercourse curvature/bends“ for instance only describes a dimension, namely the degree of the watercourse curvature which is requested by a simple series of features.

Multiple registration

In these cases, various features can be ticked. This is shown by the sign ”(✋)“. For example, all occurring features assigned to the SP 3.3 ”bed fixation“ must be recorded by ticking.

Counting the number of features

For all SPs marked with the sign (✍) the number of features are recorded. This survey method serves for the recording of small-scale structures which are relevant for colonisation and for habitats, like the SP 3.4 ”bed features“ and for different constructions, listed in the SP 2.1 ”transverse and special features“.

Survey operation of length classes

The SP 2.3 ”backwater“, SP 2.7 ”diversion watercourse“, SP 5.2 ”bank protection“ and SP 6.2 ”riparian zone“ are recorded in absolute length classes. In a 100 m survey unit a feature may have a maximal length of 100 m or rather the sum of all features must have the length of 100 m.

Simple or multiple registration

If a homogeneous manifestation of a feature is given, then a simple registration of the dominant manifestation is made. If a homogeneous manifestation of a feature is not given, then a detailed recording with multiple registrations follows, e. g., for the SP 3.3 ”bed fixation“ with a length of more then 10 m per survey unit (multiple registration).

Parameters differentiated by the left und right river side

Each relevant feature is recorded separately for the left (le) and the right (ri) river side by ticking. This concerns the MPs 5 ”bank structures“ and 6 "adjacent land zone“.

Other

For the SP 6.3 ”adjacent land pressures“, the distance from the river must be estimated in three classes <10 m, 10 – 40 m, and >40 m. Multiple registrations are possible.

For the SP 2.2 „"piping/overbuilding" and SP 4.5 "culvert/bridge" the coverage with sediments in the construction must be noted.

For the SPs 2.5 "flow variation" and 2.6 "depth variation" it must be additionally noted when the feature is artificially elevated, e. g. by discharges.

For the specific cases "small waters" (K), "major part watercourseised" (V), "watercourse dried up" (T) and "pool in main connection" (G) a minimum data set to be mapped is determined. Each SP to be mapped must be marked accordingly with the letter K, V, T and/or G.

3.1 Information on the mapping

The survey of the river structures is generally carried out from the mouth to the source or against the flow direction. Exceptions are the Rhine and the Weser. In these cases, the mapping is performed in the flow direction.

Only areawide and distinct structures are determinated:

- Small branches are no deadwood clauses, wood collection or fallen trees,
- A branch hanging in the water is not a fallen tree,
- single stones or blocks are no bank features or cascades,
- Local bays are no watercourse widening.

The river structures which are recorded by the SPs 1.4 "watercourse features", SP 3.4 "bed features", SP 5.3 "bank features" or SP 6.01 "adjacent land features", are natural river type specific structures. That means, garden ponds are no standing waters in the meaning of the SP 6.01 "adjacent land features", artificial built fords are no watercourses in the meaning of the SP 3.4 "bed features".

There is, as a rule, no multiple registration of a feature within a main parameter. However, it is possible to record a feature within several main parameters, like "runs" as "transverse bars" by the SP 2.4 "transverse bars" or as runs/riffles by the SP 3.4 "bed features".

If river structures occur which are not defined in the context of the procedure like wire netting, geotextiles for the riverbed protection, then they must be assigned to a described feature with regard to their impact. In the field "comment" a corresponding information must be given. If necessary, the structure should be documented by a photo.

River habitat survey in North Rhine-Westphalia

Questionnaire according to LANUV-Arbeitsblatt 18 (2018)

Identification

Master data

Name of the river	
/ater identification number	
Mapping section-ID	
Stationing from/to	
Edition stationing map	
Beginning (e32/n32)	
End (e32/n32)	
Name of surveyor	
Institution	
Mapping date	
Connecting sheet to	

Status of mapping

not mapped, because

- Watercourse changed
- Upper course reduced
- Section length reduced
- Construction w ork
- No trespassing
- Reservoir
- Other

Length of mapping section

- 100 m
- 500 m
- 1,000 m

Typification

River type

LAWA-river type	
NRW-river type	
River type	
Winding degree	

River bed substrate under reference conditions

- Clay/Loam/Loess (fl)
- Sand (fs)
- Shingle (g)
- Gravel (g)
- Stone (g)
- Stone block (g)
- Outcropping rock (g)
- Organic substrate (o)

Valley shape

- V-shaped valley (KT)
- U-shaped valley (ST)
- Flood plain w atercourse (AT)
- Hollow valley (AT)
- River w ithout valley (OT)

Characterisation of the actual state

Bed width and section length

Bed width	Length
<1 m	100 m
1 - 2 m	100 m
>2 - 5 m	100 m
>5 - 10 m	100 m
>10 - 20 m	100 / 500 m
>20 - 40 m	500 / 1,000 m
>40 - 80 m	1,000 m
>80 - 160 m	1,000 m
>160 m	1,000 m

Upper width

- <1 m
- 1 - 2 m
- >2 - 5 m
- >5 - 10 m
- >10 - 20 m
- >20 - 40 m
- >40 - 80 m
- >80 - 160 m
- >160 m

Incision depth

- <0.2 m
- 0.2 - 0.5 m
- >0.5 - 1 m
- >1 - 2 m
- >2 - 3 m
- >3 - 5 m
- >5 m

Depth at mean flo

- <0.1 m
- 0.1 - 0.3 m
- >0.3 - 0.5 m
- >0.5 - 1 m
- >1 - 2 m
- >2 m
- Not visible

Water level

- Mean w ater level
- < Mean w ater level

Anthropogenic manifestation

- Shipping
- Hydropow er
- Flood protection
- Fish farming
- Restricted floodplain flooding
- Restricted channel development/movability
- Restricted cross channel development
- Considerably changes in flow character
- Fragmented w atercourse
- Relocation of w atercourse to valley edge
- Watercourse in elevated position
- Change of flow direction

Special case

- Smallest w aters (K)
- Restored section
- Major part piped/overbuilt (V)
- Completely piped/overbuilt (V)
- Watercourse dried up (T)
- Puddles existing (T)
- River bed not visible
- Pond in main connection (G)

Water site

- Urban area
- Open landscape

Documentation

Description

Short description	
Biological specificities	
Special features	

Beaver tracks

- yes
- no

Photos

In flow direction | Against flow direction

Valuation justification

River habitat survey in North Rhine-Westphalia

Questionnaire according to LANUV-Arbeitsblatt 18 (2018)

Stream name | Identification number | Mapping section-ID

1. Channel development

1.1 Watercourse curvature/Bends (K, T)

Straight (1 - 1.01)
Elongated (1.01 - 1.06)
Slightly curved (>1.06 - 1.25)
Curved (>1.25 - 1.5)
Meandering (>1.5 - 2)
Highly meandering (>2)

(ungekrümmt / gekrümmt)

Unbranched
With side watercourses
Branched

1.2 Erosion at bends (T)

Naturally, none
Anthropogenically, none
Weak, occasionally
Weak, frequently
Strong, occasionally
Strong, frequently

1.3 Longitudinal bars

None
One to two
Several
Many
Not visible

1.4 Watercourse structures (K, T)

None
Deadwood jam
Fallen tree
Island formation
Watercourse widening
Watercourse narrowing
Watercourse bifurcation
Oxbow lake, side watercourse
Beaver dam

Evaluation funct. units

Curvature (1.1, 1.3, 1.4

Movability (1.2, 4.2, 5.2)

Index

Class

2. Longitudinal profile

2.1 Transverse structures (K,T)

No barrier

Altitude difference Up-/downstream: 0.1-0.3 m | >0.3-1 m | >1 m

Movable weir/bed fall/-cascade
ovable weir/bed fall/-cascades w. fish passage
vable weir/bed fall/-cascade w. bypass channel
Wild construction
Bottom threshold (≤0.1 m)
Smooth sliding
Rough sliding
Smooth ramp
Rough ramp
Transverse construction with a near bed outlet
Dam
Pumping station
Culvert

2.2 Piping/Overbuilding (K, T)

Survey unit length

100 m	500 m	1,000 m	without sediment	with sediment	not visible
None	None	None			
>10 - 20 m	>50 - 100 m	>100 - 200 m			
>20 - 50 m	>100 - 250 m	>200 - 500 m			
>50 m	>250 m	>500 m			

2.3 Backwater (K)

technical | natural

None
<10 m
10 - 50 m
>50 - 100 m
>100 - 250 m
>250 m

2.4 Transverse bars

None, naturally
None, anthropogenically
One to two
Several
Many
Not visible

2.7 Diversion channel

None
<50 m
>50 - 100 m
>100 - 250 m
>250 - 500 m
>500 m

2.6 Depth variation

None
Low
Moderate
High
Very high
Not visible
Add.: artificially increased

2.01 Flow patterns (K)

Smooth
Ribbed
Gently lapping
Waved
Comb shaped
Turbulent

2.5 Flow variation (K)

None
Low
Moderate
High
Very high
Add.: artificially increased

Evaluation funct. units

Natural longitudinal features (2.4, 2.5, 2.6)

Anthropogenic migration barriers (2.1, 2.2, 2.3, 2.7, 4.5)

Malus-Addition

Index

Class

Key/ List of abbreviations

K	Smallest waters (minimum data set to be mapped)	nat.	natural
V	Piped/overbuilt (minimum data set to be mapped)	unnat.	unnatural
T	Stream dried up (minimum data set to be mapped)		
G	Pool in main connection (minimum data set to be mapped)	Sed.	Sediment
(hand)	Multiple registration	QBW	Migration barrier
(finger)	Simple registration		
(pen)	Record number (counting)	funct.	functional
le	In flow direction left-sided	MW	Mean water
ri	In flow direction right-sided		

River habitat survey in North Rhine-Westphalia

Questionnaire according to LANUV-Arbeitsblatt 18 (2018)

Stream name | Identification number | Mapping section-ID

3. River bed structure

3.1 River bed substrate (K, T)

nat. (domininating, subordinated) / unnat.

Mineral substrates
- None
- Silt/mud
- Clay/loess/loam (<6 µm)
- Sand (>6 µm - 2 mm)
- Shingle (0.2 - 6 cm)
- Gravel (6 - 10 cm)
- Stones (10 - 30 cm)
- Blocks (>30 cm)
- Outcropping bed rock
- Solid bed
- Not visible

Organic substrates
- None
- Algae
- Fallen leaves, organic particles
- Deadwood
- Makrophytes
- Living parts of terrestrial plants
- Fine detritus
- Peat
- Not visible

3.2 Substrate diversity (K)
- None
- Small
- Moderate
- High
- Very high
- Not visible

3.01 Riverbed pressures (K)
- None
- Domestic waste, building rubble
- Garden waste
- Sedimentation of iron
- Erosion of sand
- Clogging
- Erosion
- River maintenance
- Trampling damage
- Groynes/tail units
- Shipping channel
- Debris supplies
- Debris withdrawal
- Not visible

3.3 Riverbed fixation (K, T)

	completely	<10 m	10-50 m	>50-100 m	>100-250 m	>250-500 m	>500 m
No fixation							
Riprap, stones sticking							
Solid bed with sediment							
Solid bed without sediment							
Not visible							

3.4 Riverbed features (K)
- None
- Pools/Still waters
- Runs/Riffles
- Pothole/Deep channel
- Eddy
- Cascade
- Deadwood
- Root surface
- Makrophytes
- Not visible

Evaluation funct. units
- Type and distribution of substrate (3.1, 3.2, 3.4, 3.01)
- Bed fixation* (3.1, 3.3)
- Index
- Class

* Only considerated if there is no upgrading

4. Cross profile

4.1 Profile type (K, T)
- Natural profile
- Approximately natural profile
- Eroded profile
- Profile with groynes
- Technical standard profile, decaying
- Technical standard profile

4.2 Profile depth (K, T)
- Very shallow
- Shallow
- Moderately deep
- Deep
- Very deep
- Not visible

4.5 Culvert/Bridge (K, T)

	without sediment	with sediment	not visible
No passage/bridge			
Structurally not harmful			
Natural bank, interrupted			
Channel narrowed			

4.3 Width erosion (T)
- None
- Weak
- Strong

4.4 Width variation
- None
- Small
- Moderate
- Large
- Very large

Evaluation funct. units
- Profile type (4.1)
- Profile depth (4.2)
- Width development (4.3, 4.4)
- Index
- Class

Structural class	Value range
1	1.0 - 1.7
2	1.8 - 2.6
3	2.7 - 3.5
4	3.6 - 4.4
5	4.5 - 5.3
6	5.4 - 6.2
7	6.3 - 7.0

River habitat survey in Nort Rhine-Westphalia

According to LANUV-Arbeitsblatt 18 (2018)

Stream name | Identification number | Mapping section-ID

5. Bank structure

5.1 Bank vegetation (K, T)

	le	ri
No bank vegetation		
Naturally		
Anthropogenically		
Native wood		
None, naturally		
None, anthropogenically		
Native wood		
Wood		
Gallery		
Bushes, single trees		
Young woody plants		
Non-native wood		
Wood, gallery		
Bushes, single trees		
Young woody plants		
Herbaceous vegetation		
None, naturally		
None, anthropogenically		
Near-natural herbs, grasses		
Anthr. caused hedges, tall forbes, grasses		
Slope lawn		
Neophytes		

5.3 Bank features (K, T)

	le	ri
None		
Flow around single trees		
Tree as flow obstacle		
Fallen tree		
Shelter		
Nat. bank break-offs		
Nesting wall, steep faces		

5.01 Bank pressures (K, T)

	li	ri
None		
Domestic waste, building rubble		
Green waste		
Erosion		
Stream maintenance work		
Trampling damage		
Discharge		
Hydropeaking/wave impact		

5.2 Bank protection (K, T)

	le completely	le <10 m	le 10-50 m	le >50-100 m	le >100-250 m	le >250-500 m	le >500 m	ri completely	ri <10 m	ri 10-50 m	ri >50-100 m	ri >100-250 m	ri >250-500 m	ri >500 m
No bank protection														
Decaying bank protection														
Flow control elements														
With living elements														
Woody bank protection														
Riprap/sttones														
Wild bank protection														
Solid bed protection														

5.02 Shading (K, T)

Sunny	
Semi-shading	
Shady	
Not visible	

Evaluation funct. units

Typical vegetation (5.1, 5.02) le re

Bank protection* (5.2) le ri

Typical natural features (5.3, 5.01) le ri

le Index ri

le Class ri

* Only considerated if there is no upgrading

6. Adjacent land zone

6.1 Ajacent land use (K, T, V, G)

	le 10-50 %	le >50 %	ri 10-50 %	ri >50 %
Woodland, native				
Floodplain vegetation (excl. wood)				
Natural wasteland, succession				
Pastureland				
Woodland not native, coniferous forest				
Arable land, special cultures				
Park, green area				
Development with free areas				
Dense development				
Land pressures according to 6.3				

6.3 Adjacent land pressures (K, T, V, G)

Distance from the stream

	le <10 m	le 10-40 m	le >40 m	ri <10 m	ri 10-40 m	ri >40 m
None						
Excavation						
Fishpond in a side channel						
Water structure harmfull constructions						
Traffic area, unpaved						
Traffic area, paved						
Landfill, waste discharging						
Flood protection constructions						

6.2 Riparian zone (K, T)

Survey unit length

100 m	500 m / 1,000 m	le complete	le <10 m	le 10-50 m	le >50-100 m	le >100-250 m	le >250-500 m	le >500 m	ri complete	ri <10 m	ri 10-50 m	ri >50-100 m	ri >100-250 m	ri >250-500 m	ri >500 m
Width of riparian zone															
<2 m	<2 m														
2 - 5 m	2 - 10 m														
10 - 20 m	10 - 50 m														
>20 m	>50 m														

6.01 Adj. Land features (K, T)

	le	ri
None		
Rock face		
Terrace edge		
Natural embankment		
Flood-/high tide channel		
Source		
Standing waters		

Evaluation funct. Units

Foreland (6.1, 6.3, 6.01) le ri

Riparian zone (6.2) le ri

le Index ri

le Class ri

3.2 Identification block

The identification block serves as clear identification of the river to be mapped, of the survey units, of its river type allocation with the following information:

Table: Structure of the identification block

Parameter block	Description
Identification	• Collecting the master data containing information on the river`s name, river identification number, survey unit-ID, name of the cartographer and the date of mapping; furthermore, it is noted, if this is an adjacent sheet. • Reasons for not mapped survey units under survey status, • Information on the length of the survey unit (100 m, 500 m or 1,000 m)
Typification	• Allocation of the survey unit to a river type as basis of the assessment.
Characterisation of the current status	• Acquisition of selected water geometries, • Recording of the location of river as well as if it is a special case, e. g., a dammed water and which anthropogenic degradation exist due to uses
Documentation	• Short characterisation of the survey unit or river • Information on biological features and noticeable structures • Other comments on the survey unit like information on implausabilies resulting from the plausibility checks • Note of the photo and direction of photo capture • A shorthand justification if there are discrepancies of more than one class between the evaluation procedure based on functional and the index-based procedure

Identification

For the clear identification of the survey unit, the master data, the status of mapping, and the length of survey unit are recorded.

Master data

The master data are text fields which must be partially filled out in advance behind the desk, like information on the river´s name and the river identification number.

River`s name
The current river name based on the current stationing map is entered. Any other names which can be possibly found in topographic maps should not be used. The discrepancy should be noted in the field “comments” of the surveying sheet.

River identification number
Here the identification number is entered based on the current stationing map.

Survey unit-ID
A clear identification of the survey unit based on the predeterminated ID.

In cases, where new survey units must be generated by the cartographers in the field, they assign clear IDs by attaching a further digit to the first concerned survey unit which will be counted up for each new survey unit until the next unaffected survey unit has been arrived.

Stationing from/to
Here the stationings of the survey unit limits are entered (e. g., 0-100). For rivers that are not stationed a temporary stationing must be created by means of the assessed GPS-coordinates or estimated by the map basis.

Edition of the stationing map
Here, the edition of the stationing map which has been used is entered.

Beginning (e32/n32)
Beginning of the survey unit as coordinate in the projection ETRS89 / UTM Zone 32N.

For new created survey units, the beginning of the survey units must be assessed as coordinate (GPS or from the map) by the cartographer.

End (e32/n32)
End of the survey unit als coordinate in the projection ETRS89 / UTM Zone 32N.

For new created survey units, the end of the survey unit must be assessed as coordinate (GPS or from the map) by the cartographer.

Master data

Name of the cartographer

Here the name of the cartographer is entered.

Institution

Here the name of the institution of the cartographer is entered.

Date of mapping

Here the date of the survey unit's mapping in the field is entered.

Connecting sheet

For up to ten consecutive sheets, which are substantially identical it is not necessary to fill out the complete surveying sheet for each survey unit. In these cases, the number (survey unit-ID) **of the last completely filled out survey unit** (not the ID of the predecessor) is entered in the field "connecting sheet". In the connecting sheet, only the deviating characteristics are noted.

Particular attention should be paid to the following SPs:

SP 1.4 Watercourse features

SP 2.1 Transverse and special features

SP 2.2 Piping/overbuilding

SP 2.3 Backwater

SP 2.7 Diversion watercourse

SP 3.4 Bed features

SP 3.01 Bed pressures

SP 4.5 Culvert/Bridge

SP 5.3 Bank features

SP 5.01 Bank pressures

SP 6.3 Adjacent land pressures

SP 6.01Adjacent land features

Two consecutive survey units are regarded as substantially identic, when the character of the river does not change (especially the river type) and deviations are only shown for some features but not for the assessment of the MPs. Differences in the assessment of the MPs of homogeneous survey units may only occur if there are anthropogenic barriers for aquatic organisms (SPs with a malus evaluation). Two successive survey units with different relief energies, flow behaviors, morphological qualities or adjacent land uses shall not be summarised.

Mapping status

If a survey unit cannot be mapped, then a reason must be given. This also applies to new created survey units by the cartographers.

Changed watercourse

In reality, the watercourse deviates significantly from the predeterminated watercourses, e. g., the watercourse lies outside of a corridor of approx. 200 m, change of the length of more than 50 % (lengthening or shortening of the watercourse), changed drainage aspects, changed determination of the main watercourse, extended upper reaches.

At least one new survey unit must be created and mapped unless it is a shortened upper course (see below).

Upper course shortened

If the upper course of a river is shortened by more than 50 % of the survey unit length, then this mapping status must be ticked. The filling out of a surveying sheet is cancelled.

Changed length of the survey unit

In reality, the length of the given survey unit deviates significantly.

At least one new survey unit must be created and mapped.

Construction project

The field mapping is not possible, because the survey unit is actually reshaped.

Prohibition of the right of entry

To access a property for mapping is forbidden, e. g., military areas.

Water reservoir

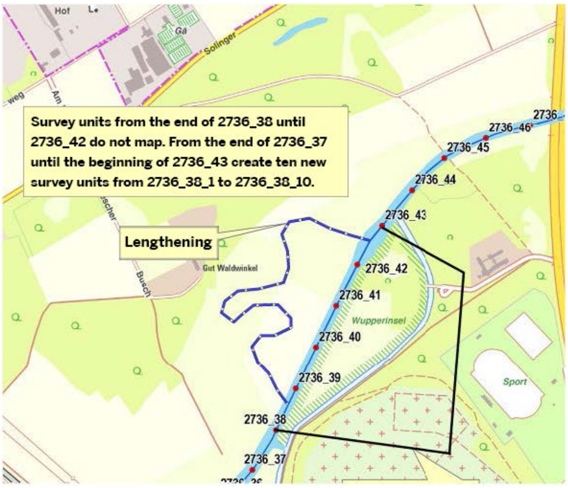
The survey unit is a water reservoir: the backwater, as the result of a dam, exhibits a length of more than 1 km and the middle watercourse width in this river section upstream of the dam is more than three times of the average watercourse width.

The mapping is cancelled and the overall assessment is the morphology class 7.

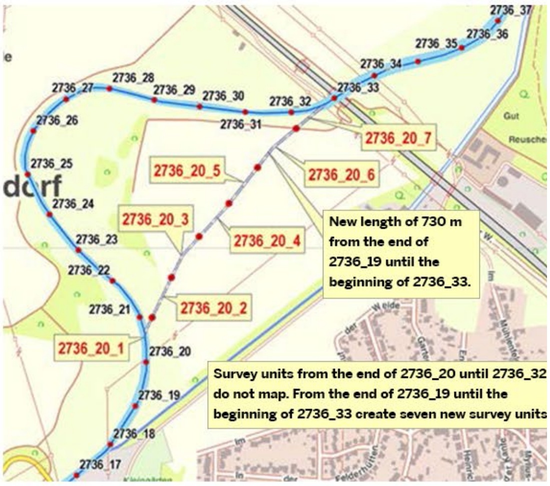
Other

Further reasons which could make a survey field mapping impossible must be noted here (e. g., fencing, free-roaming dogs).

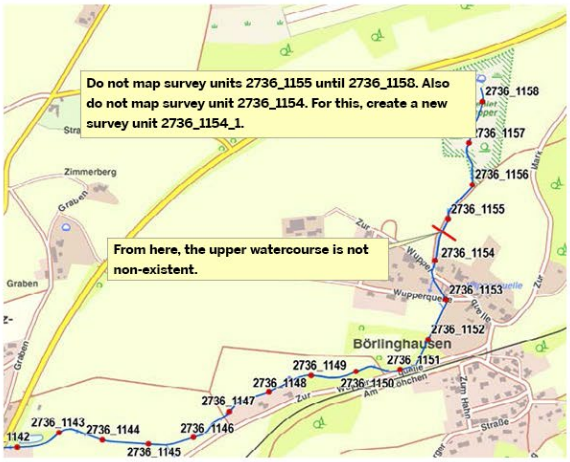
Mapping status



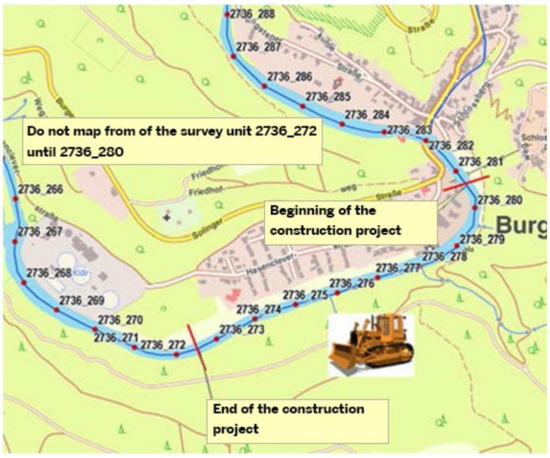
Changed watercourse: channel lengthening



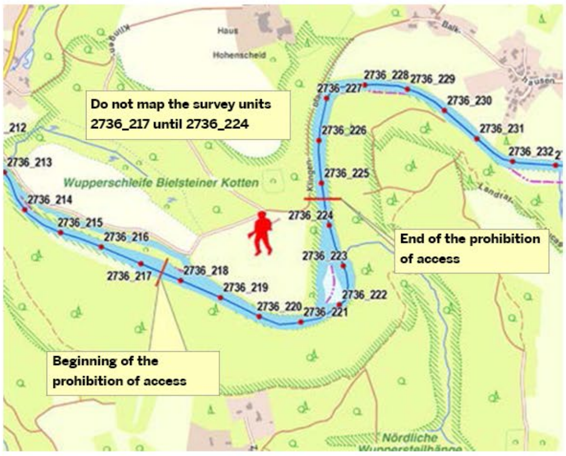
Changed watercourse: channel shortening



Upstream section shorten



Construction project



Prohibition of access

Length of the mapping section

The length of the mapping section must be indicated here. This also applies to new created sections by the cartographers.

100 m

This is normally the mapping section for smallest rivers <1 m and for small and larger rivers with an average watercourse width of maximum 10 m. Also, smaller rivers with a width up to 20 m can normally be mapped with this section length, on the condition that the riverbed is visible.

Special attention must be paid to the transition area of smaller rivers with an average watercourse width between 10 and 20 m. In justified cases, the cartographers must determine the section length themselves, when for instance the riverbed is not visible. Here, the cartographers can choose a section length of 500 m.

500 m

This is normally the mapping section for small und large rivers with an average watercourse width up to 40 m and with a visible riverbed.

Special attention must be paid to the transition area of large rivers with an average watercourse width between 20 and 400 m. In justified cases, the cartographers must determine the section length themselves, when for instance the riverbed is not visible. Here, the cartographers can choose a section length of 1,000 m.

1,000 m

This is normally the mapping section for very large rivers with an average watercourse width of more than 40 m.

Typification

Most of the assessed parameters in the context of the survey mapping depend on the environmental conditions and therefore must be evaluated according to the type specific reference conditions. Essential factors that determine the most natural characterisation of a river, within this procedure, are the shape of the valley bottom and the geological or pedological conditions, consequently the substrate.

The typification of the mapping section includes information on the LAWA- and on the NRW-river types and additionally for the large rivers the type of course and the degree of twist. Derived from the information on the bed substrate under reference conditions and the valley shape, the morphological river type is determined as basis for the index-based evaluation procedure.

River type

LAWA-river type

For the implementation of the EG-WFD the so-called biocenotically relevant river types (LAWA-river types) have been defined nationwide. For NRW 18 LAWA-river types are relevant. In the following table the translation key from LAWA- to NRW-river type is shown.

For the reporting rivers with a catchment area of >10 km² the LAWA-river type is normally predeterminated and can be only changed in exceptional cases and after consultation with the customer, provided that the river section is more than 1 km long.

For additional references related to the LAWA-river types see Dahm et al. (2014), LANUV (2015), Pottgiesser & Sommerhäuser (2008a, b, 2004) and Sommerhäuser & Pottgiesser (2005).

NRW-river type

The information on the NRW-river type is provided based on the river type map of NRW (LANUV 2015). For NRW 23 regional river types have been defined. In the following table the translation key from LAWA- to NRW-river types is shown. The NRW-river type is normally predeterminated and can be only changed in exceptional cases and after consultation with the client, when the river section is more than 1 km long.

For additional references related to the NRW-river types see LANUV (2015), LUA (2003, 2002, 1999a, b, 2001a, b) and Koenzen (2001).

River type

Table: Translation key for the regional river types of North Rhine-Westphalia (LUA 2003, 2001b, 1999b, LANUV 2015) and for the LAWA-river types (Pottgiesser & Sommerhäuser 2008a, b, 2004, LANUV 2015).

NRW-Types	LAWA-Types
Lowland	
Sand-dominated rivers in outwash plains and sandy landfills	**Type 14:** Small sand-dominated lowland rivers
Shingle-dominated rivers in fluvial terraces, weathering regions and morains	**Type 16:** Small shingle-dominated lowland rivers
Sand-dominated lowland rivers	**Type 15:** Mid-sized to large sand- and loam-dominated lowland rivers or **Type 15_g:** Large mid-sized to large sand- and loam-dominated lowland rivers
Loam-dominated lowland rivers	
Shingle-dominated lowland rivers	**Type 17:** Mid-sized to large shingle-dominated lowland rivers
Loess-loam-dominated rivers in fertile plains	**Type 18:** Small loess-loam-dominated lowland rivers
Gravel-dominated large lowland rivers	**Type 20:** Sand-dominated large river (Rhine and Weser) **Type 10:** Gravel-dominated larve river (Rhein)
Organically dominated rivers of outwash plains and sandy landfills	**Type 11:** Small organic rivers
Organically-dominated lowland rivers	**Type 12:** Large organic rivers
Rivers in the lowlands	Type 19: Small rivers in the lowlands in river- and large river valleys
Low mountain ranges	
V-shaped rivers in bedrocks	**Type 5:** coarse material rich siliceous rivers in low mountain areas In exceptional cases: **Type 5.1:** small siliceous sediment rich rivers in low mountain areas
Small U-shaped rivers in bedrocks	
Large U-shaped rivers in bedrocks	
Rivers in volcanic areas	
Colliner rivers	**Type 5.1:** fine siliceous sediment rich rivers in the mountain areas
U-shaped rivers in the overburden	**Type 6:** fine calcareous sediment rich rivers in low mountain areas
Large U-shaped rivers in the overburden	
Coquina rivers	**Type 7:** Small calcareous rivers in low mountain areas
Karst rivers	
Gravel-dominated rivers in bedrocks	**Type 9:** Mid-sized siliceous rivers in low mountain areas **Type 9.2:** Large calcareous rivers in the mountain areas
Shingle-dominated karst rivers in the overburden.	**Type 9.1:** Mid-sized calcareous rivers in low mountain areas
Gravel-dominated karst rivers in the overburden.	
Gravel-dominated larve rivers in the overburden.	**Type 10:** Shingle-dominated large rivers

River type

The **NRW-river types** are characterised as follows:

Sand-dominated rivers in outwash plains and sandy landfills

Sandy-bottom rivers in outwash plains and sandy landfills predominantly have a bed substrate composed of sand, stored in a stable condition, locally also clay und gravel can be found. Organic substrates like deadwood are significant hard substrates. On the more or less distinct valley bottom, this type forms meanders with steep concave and shallow convex banks. The water depth in a box-shaped watercourse is on average at a shallow level, but there are regularly deep watercourses in midstream, sandbanks, and potholes in the range of flow obstacles.

Shingle-dominated rivers in fluvial terraces, weathering regions and morains

Shingle-dominated rivers in fluvial terrace, weathering regions, and morains have a bed substrate going from fine to rough material with less or more significant admixtures of sand, detritus, and deadwood. Characteristic valley shapes are hollow- or floodplain valleys. On their bottom, the rivers run stretched at deeper gradients and twisting at lower gradients. The water depth is relatively low and in the box-shaped cross profile uniformly distributed, while along the watercourse a regular change of small shallow overflowed substrates and longer deeper ponds occur.

Sand-dominated lowland rivers

Sand-dominated lowland rivers have sandy substrates. Segments of gravel can be found for instance within the transition to low mountain ranges. Locally, lowland moors may occur. Marly banks are more widespread. Depending on the width and on the gradient of the valley bottom, two types of sections can be found: segments of valleys with small bottom widths lead from stretched to weak twisting single watercourses. The dominant wide floodplain valleys permit watercourses from meandering to intensively meandering forms with a strong relocation potential. These relocations lead to a distinct fine relief of the floodplains which are structured by numerous watercourses and ponds. It should be noted that there are very high steep and sparsely vegetated banks, which are created by cutting of the terrace rim.

Loam-dominated lowland rivers

Loam-dominated lowland rivers are characterised by cohesive sediments and may also contain shingly and sandy components, depending on the degree of manifestation. These rivers running in flat valleys and lowlands, have single watercourses from a twisting to a meandering form. The erosion resistant and binding sediments of the banks lead to slow lateral displacements and to a large incision depth of the often unequal box-shaped profiles.

Shingle-dominated lowland rivers

The particle size range of the bed substrate of the shingle-dominated lowland rivers extends from loamy to stony/gravelly components, whereby the bed substrate is dominated by rounded shingles. The widths and the slopes of the valley bottom determine the degree of twisting which extends from twisting stretches in small bottom width to a meandering form of the single watercourses in low slopes in the lowlands. Single watercourses are predominant. Side watercourses only appear sporadically in rich standing waters and strongly relief-like floodplains.

Loess-loam-dominated rivers in flat plains

The bed substrate of loess-loam-dominated rivers in flat plains consists predominantly of fine clay and silt particles, which have partially turned to hard lumps. Typical valley shapes are hollow valleys and riverbed valleys in which the river flows in irregular arches in a tortuous form. The cross profile is distinctly box-shaped with stable vertical river banks and a heterogeneous shoreline along the watercourse.

Organically dominated rivers of outwash plains and sandy landfills

The organic rivers of outwash plains and sandy landfills have a bed substrate consisting of peat, detritus, wood and other organic materials. Characteristic valley shape is the floodplain valley. On its shallow valley bottom, the river flows in irregularly interconnected watercourses (anastomosis). The riverbed has a cross profile which is varying in its depth and breadth. Along long stretches, the water body is deep in relation to its width and shows fuzzy transitions in the floodplain. Riverbed erosion hardly occurs.

Organically dominated lowland rivers

The floodplains and riverbeds of organically domintated lowland rivers are partly composed of biogenic substrates. Pure organic characteristics can be found in NRW only in small sections, because mineral materials are introduced into these rivers from sediments in the floodplains and upper catchment areas. By a gentle slope of the valley bottom moderate discharge fluctuations and a high organic proportion of the floodplain, anastomosing watercourses are the result. In contrast, a higher slope of the valley floor results in twisting and meandering rivers without side watercourses.

Rivers in the lowlands

Depending on the deposited sediments in the lowlands, this river type has different composed bed substrates. Rivers in the lowlands are small rivers which flow (often completely) in a valley area normally created by a larger river. A valley shape is always lacking; the small river flows through a vast plain in several interconnected watercourses (anastomosis). Rivers in the lowlands have a cross profile in a width and depth irregular box form.

Shingle-dominated large rivers in the lowlands

The cross profile of the riverbed is predominantly flat and broad. It is determined by fords and asymmetrical profiles of the concave and convex banks. There are also numerous bed features like banks, islands, pools, and deep watercourses. The riverbed predominantly consists of shingles and, in a descending order of frequency, of sand, of stones, and of silt. Depending on the valley shape, slope and substrates, different river forms can be created: from twisting to meandering single watercourses and branched multi-watercourses.

V-shaped rivers in bedrocks

Rivers through V-shaped valleys in bedrocks run along the watercourse after leaving the source regions. The V-shaped valleys are the result of a vertical erosion, caused by a sufficient flow rate and a steep gradient. By this valley shape, stretched and slightly curved lines and the absence of a floodplain is predetermined. The riverbed mainly consists of stony and blocky decomposed debris coming from the surrounding valley slopes. These river types have a flat morphological diverse cross profile. Horizontal erosions are only visible at local bottlenecks.

Small U-shaped rivers in bedrocks

Typical valley shapes of this river type are hollow- and U-shaped valleys with very wide bottoms. The U-shaped rivers in bedrocks runs, depending on the slope, slightly curved or twisting and often cut the slopeside. Somewhat flat, morphologically divers designed riverbeds with a large variation in width and depth are typical. Coarse substrates lead to a very diverse flow pattern. Along the watercourse there is a regular change from local fast-flowing segments to deep potholes.

Large U-shaped rivers in bedrocks

The large U-shaped river shows a great discharche dynamic caused by numerous tributaries of the highly branched water network that influence the shape of the riverbed and of the floodplain. In the meandering area at the cutbanks, deep erosions of banks occur in partially mighty clay banks. Outside of the meanders, the riverbed and -banks are flatter and covered with rougher bed-load discharge. The strong horizontal erosion leads to curved and meandering watercourses which have deeply entrenched themselves into the loam of the floodplains.

River in volcanic areas

Rivers in volcanic areas flow in deeply cut valleys. Because of the valley shape and of the steep gradient, the rivers flow in a stretched or twisting way. The riverbed consists, besides gravels, of loamy soils of tuff stones. Rivers in volcanic areas have a variable design of the cross profile. Besides flat and graveled profiles, the riverbed in tuff stone normally are box-shaped deepened on the softer sediments. In theses areas erosion marks may occur in the form of breaks and of undercutting of river banks.

Colliner rivers

Typical valley shapes of colliner rivers are riverbed valleys and in upper reaches hollow-dominated valleys. They have a curved and meandering watercourse below the source region. The gravels on the riverbed are often covered with deadwood, fallen leaves and detritus. The cross profile shows a moderately deep irregular box form with a highly structured shoreline. By the twisting watercourse concave and convex banks are predominant.

U-shaped rivers in overburdens

These rivers flow in short and steep hollow valleys, which quickly expand to U-shaped valleys in the flow direction. Some rivers have a steeper gradient and flow in V- and U-shaped valleys. They have a cross profile with an irregular box form. The river banks are flat and in loamy substrates they are a bit steeper. Their shoreline depends on the local gradient. Mostly, they run rapidly and turbulently in curved to twisting watercourses. Normally fine-grained sediments and small marl plates or stones are dominant.

Large U-shaped rivers in overburdens

The large U-shaped rivers in overburdens run curved and meandering in a wide hollow or U-shaped valley whereby side watercourses are possible. The cross profile variable in depth and width shows multiple erosion marks. Horizontal erosion results in breakoff edges and outwashed bank sections in the loamy and sandy embankment. In the range of fast overflowed substrates, the rivers have a bed consisting of plate-like debris and single larger blocks. Outside of fast overflowed substrates, the riverbed has stony debris only in parts which is especially covered by small marly plates, sand and loamy substrates in varying proportions in quietly flowing stretches.

Coquina rivers

Coquina rivers have a bed substrate consisting of loamy substrates and limestones which are often sintered. Typical valley shapes are flat hollow- and U-shaped valleys. Especially in more karstified regions, the rivers run slightly curved, since the low discharge only generates small erosive power. Larger coquina rivers are more winded. The coquina river has an irregular box-shaped cross profile. The river banks are stable by cohesive loams. The shoreline of small rivers is straight. Horizontal erosion only occurs locally. The riverbed is narrow.

Karst rivers

Karst rivers have a bed substrate consisting of plates of limestone and limestone blocks which can be nearly completely covered with fallen leaves and deadwood after a long phase of drought. The karst river occurs in hollow- and U-shaped valleys. As soon as the banks are built by hard limestones, which would impede a horizontal erosion, the cross profile is significantly box-shaped. The bed of large rivers lies up to 2 m below the ground level. Small and large coquina rivers run stretched or winding. Meandering watercourses occur only rarely.

Gravel-dominated rivers in bedrocks

The riverbed and floodplains of gravel-bottom rivers in bedrocks shows the whole grain size spectrum from loamy to blocky substrates. Locally, the riverbed can reach the outcropping bedrocks. The dominant stones and gravels are formed like plates with rounding-off edges. The changing width of the valley floor and gradients, both at a small scale, leads to various patterns on the riverbed. In narrow valley segments there are stretched and weak twisting watercourses with single side watercourses. The strongly inclined and narrow valley floor of the medium-sized rivers result in frequent deepended narrow high tide riverbed which is structured by a large amount of side watercourses being stretched or winding. In U-shaped valleys there are, depending on the slope, debris and the outflow, segments with a large amount of side twisting watercourses or segments with meandering single bed watercourses.

Gravel-dominated rivers in the overburden

The gravel-dominated rivers in overburdens have, besides the eponymous gravels, a very high sand proportion. The gradients and outflows that are more moderate in comparison with bedrocks leading to mostly twisting and meandering single bed watercourses. Their development only depends on narrower valley segments. In those segments stretched and weak twisting watercourses are formed.

Gravel-dominated karst rivers in the overburden

The essential characteristic of gravel bottom karst rivers in the overburdens is its temporary drying-up and the distinct variation of outflow which is determined by the karst-phenomenon of the Paderborn-plateau. The forms of the riverbeds can be distinguished in two morphological segment types: the river segments of the meandering and box-shaped valleys with a flat valley bottom containing narrow graveled high tide beds and the discharge area in the lowlands which are characterised by extended gravel corridors with temporally main and side watercourses.

Gravel-dominated large rivers in the overburden

Twisting to meandering large river sections in narrow to wide valley shapes. In broad valleys, the creation of wide flood areas is possible. Locally, the creation of multiwatercourses is also possible depending on the gradient and the bed-load. This river type has a flat cross profile in which fords, islands and river splittings are often created.

River type

Sand-dominated river in outwash plains and sandy landfills

Sand-dominated lowland river

Shingle-dominated river in fluvial terraces, weathering regions and morains

Shingle-dominated lowland river

Loess-loam-dominated river in fertile plains

Loam-dominated lowland river

Organically dominated rivers of outwash plains and sandy sandfills

Organically dominated lowland rivers

River type

Gravel-dominated large lowland rivers

River in floodplains

V-shaped river in bedrocks

U-shaped river in bedrocks

Large U-shaped river in bedrocks

Gravel-dominated river in bedrocks

River in volcanic areas

Colliner river

River type

Small U-shaped river in bedrocks

Large U-shaped river in bedrocks

Coquina river

Karst river

Gravel-dominated karst river in the overburden

Gravel-dominated karst river in the overburden

Gravel-dominated large river in the overburden

River type

Watercourse type

The information on the watercourse type in addition to the NRW-river type are only provided for large rivers on the basis of the defined river and large river stretches according to the ”Leitbilder für mittelgroße bis große Fließgewässer in Nordrhein-Westfalen“ and according to the ”Fließgewässertypenatlas Nordrhein-Westfalens“ (LUA 2002, 2001b).

The watercourse type differentiates the rivers between single- and multiwatercourses. The following river types are distinguished:

- Unbranched
- With side watercourses/rich in side watercourses
- Branched

The branched watercourses can be distinguished again, depending on the gradients, between variation a) with a poor gradient and interconnected watercourses (gradient of valley floor <0.5 ‰ and organic substrate) and variation b) gradient-rich and interwoven (gradient of the valley floor >2.0 ‰ and a surplus of debris).

Normally, the watercourse type is determined and can only be changed in exceptional cases and after consultation with the customer in the event that it is a longer river segment (at least 1 km).

Degree of meandering

The information on the degree of meandering as supplement to the NRW river type is only provided for the large rivers based on the defined large river segments (LUA 2002, 2001b).

The degree of meandering indicates the ratio between river length and the midline of the valley floor. A degree close to 1 corresponds to stretched watercourses. Numbers >1.5 correspond to meandering watercourses. Linear watercourses do not exist under the principles of reference conditions.

The degree of meandering is normally predefined and can only be changed in exceptional cases and after consultation with the customer in the event that it is a longer river segment (at least 1 km).

Bed substrate under reference conditions

Definition

The natural substrate determines the characteristic of a river and its colonisation to a great extent. Here, the striking substrate of the riverbed is described which gives a crucial impression of hydraulic potential as well as of the expected dynamic.

Instructions on the survey process

The type-specific and characterising bed substrate (simple registration) must be assessed. Single findings, e. g., blocks in gravel characterising rivers, are not considered.

The mapping of the bed substrate is performed behind the desk based on the defined river type (LAWA- or NRW-river type) and river water landscape (LUA 2002, LANUV 2015). Supplementary, also soil or geological maps can be evaluated. In the field, the defined substrates for local characterisations have to be validated, e. g., “outcropping rock”, whereby it should be noted that the current state due to use can substantially deviate from the reference conditions. Therefore, longer river segments (at least 1 km) can only be changed in special cases and after consultation with the customer.

The bed substrate under reference conditions normally applies to longer river segments and does not change from one survey mapping section to the next.

Clay/loess/loam (fl)	**Fine-material rich –loess-loam:** cohesive material, e. g., loam in the floodplains or cohesive material or (<0.06 mm)
Sand (fs)	**Fine-material rich –sand:** from fine to coarse sand (>0.06 mm – 2 mm)
Gravel (g)	**Coarse material rich:** rounded and angular formed fine to coarse gravel (>0.2 cm – 6 cm)
Crushed rock (g)	**Coarse material rich:** round or angularly formed stones with a particle size of 6 – 10 cm; unnatural gravel is recorded under ”rock fills”.
Stones (g)	**Coarse material rich:** round or angularly formed stones with a particle size of 10–30 cm.
Blocks (g)	**Coarse material rich:** blocks with a particle size >30 cm.
Outcropping rock (g)	**Coarse material rich:** the riverbed consists predominantly or completely of rock.
Organic Substrate (o)	**Organic:** the riverbed consists predominantly or completely of aquatic macrophytes, peat, detritus or deadwood.

Detailed informations on the bed substrates can be found under SP 3.1 “bed substrate“.

Valley shape

Definition

The part of the adjacent land zone which naturally interacts with the river without anthropogenic impact is defined as valley shape. The differentiation criteria are the longitudinal and latitudinal slopes of the valley bottom and in the lowlands, the typical natural substrate.

Notes on the survey process

A simple registration is performed.

The assessment of the valley shape is performed on-site. The valley shape normally applies to longer river sections and does not change from survey unit to survey unit.

For all rivers in NRW, five valley shapes, regardless of the ecoregion, are differentiated:

V-shaped valley (KT)	Deep cut erosion valleys with a V-shaped cross profile without or with a narrow valley bottom. The river banks go beyond the valley slope; for this reason and because of the normally steep longitudinal slope the river shows a stretched watercourse.
U-shaped valley (ST)	Deep cut erosion valleys with an originally U-shaped cross profile which have a flat and a narrow to moderately broad valley bottom (maximum threefold watercourse width). The river can swing over the whole width of the valley bottom. The rivercan also lean against a valley slope. In these cases, the river banks have been directly resulted from the valley slope while on the opposite side a floodplain has been created.
Floodplain valley (AT)	Also called riverbed valleys; flat to moderately inclined valley slopes which merge more or less distinctly into a broad and flat valley (larger than the triple river width), so that sufficient space is created for a self-dynamic watercourse development, e. g., for meandering.
Hollow valley (AT)	Flat to moderately inclined valley slopes which gradually merge into the valley bottom without a sharp turn. The river swings or flows stretched on the slightly trough-shaped valley bottom.
River without valley (OT)	A distinct valley shape cannot be detected, since the river has, in proportion to the river width, very broad and flat plains (lowland, flowing through river or large river valleys). This valley shape can be found rivers in the lowlands.

Valley shape

V-shaped valley

V-shaped valley

U-shaped valley

U-shaped valley

Hollow valley

Floodplain valley

River without valley

Morphological river type

The morphological river type is the basis of the index-based evaluation. Since numerous index values depend on the morphological river type, the following specifications have a major influence on the evaluation.

The morphological river type is determined for **small rivers**, that means very small and small rivers with survey mapping units of 100 m, based on the valley shape and on the bed substrate under reference conditions. Here, a special care is to be exercised since numerous index values are depending on the morphological river type and therefore the specifications may have a major influence on the evaluation.

For the index-based evaluation of **large riverss**, i. e. large rivers with survey mapping units of 500 m or 1,000 m (with the exception of the SP 1.1 “watercourse curvature/bends” und the SP “width variation”) only one morphological river type (g_FG) is taken as basis. For this morphological river type the information on the watercourse type and the degree of twisting are relevant.

As basis for the index-based evaluation the following 13 morphological river types are relevant:

Morphological river types	Abbreviations
V-shaped river, coarse material rich	**KT_g**
U-shaped river, coarse material rich	**ST_g**
Hollow and floodplain river, coarse material rich	**AT_g**
Rivers without valleys, coarse material rich	**OT_g**
Hollow and floodplain river –organic	**AT_o**
Rivers without valleys –organic	**OT_o**
U-shaped rivers, fine material rich –loess-loam	**ST_fl**
Hollow and floodplain river, fine material rich –loess –loam	**AT_fl**
Rivers without valleys, fine material rich –loess –loam	**OT_fl**
U-shaped rivers, fine material rich –sand	**ST_fs**
Hollow and floodplain river, fine material rich –sand	**AT_fs**
Rivers without rivers, fine material rich –sand	**OT_fs**
Large river	**g_FG**

The reference conditions of some morphological river types for small rivers are, with regard to the parameters and features, very similar. For the index-based evaluation this means that the morphological river types can be evaluated by a common table (see chapter 4.2.2).

In the present mapping instruction the morphological river types which are common and wide spread in NRW are listed in the index-system. If in the rare case of a combination between valley shape and bed substrate under reference conditions and if an index for an assigned evaluation is not existent, like for example “clay and loess in V-shaped valleys”, then an evaluation can be performed. In this case, the next related morphological river type will be used, i. e., “clay and loess in U-shaped valleys” according to ST_fl.

KT_g V-shaped river, coarse material rich

General information	
Valley shape	V-shaped valley with a very small valley floor.
Bed substrate	In low mountain range: dominating gravel, (coarse)shingles and blocks, in addition there are also portions of finer substrates like sand; in the lowlands, shingles and stones are dominating with sand, regionally also with clay proportions. In all natural areas there are organic substrates (deadwood, fallen leaves, roots).

V-shaped river, coarse material-rich

V-shaped river, coarse material-rich

Watercourse development	
Watercourse curvature	• The river follows the determinated valley course. On a relatively small valley bottom hardly any possibilities exist to form windings, that means a free watercourse curvature is not possible • Because of the valley shape and of the normally steep gradient, the river predominantly flows slightly curved. In very narrow valleys, the watercourse is stretched
Erosion at bends	• Since these rivers cannot develop a free watercourse curvature, due to the narrow valley, no cutbanks can be developed
Longitudinal bars	**many** • Some banks, islands and banks in estuary areas
Watercourse features	**many** • Numerous deadwood accumulations, fallen trees, island formations, watercourse widening and narrowing
Longitudinal profile	
Transverse bars	• Normally do not occur
Flow variation	**very high** • The diverse structure elements lead to a high flow variation
Depth variation	**very high** • An irregular sequence of cascade-like steps in the riverbed with potholes is typical for these rivers with a stretched watercourse in very narrow valleys with a steep gradient

KT_g V-shaped river, coarse material rich

Bed structure	
Bed substrate	Depends on the natural area: blocks, gravel and stones, boulders or outcropping bedrock
Substrate diversity	**very high** • Mineral substrates show a wide variety of different particle sizes • Organic substrates (e. g., roots, deadwood, fallen leaves)
Bed features	**many** • Numerous bed features like cascades, potholes pools, root surfaces
Cross profile	
Profile type	**natural profile** • The river banks directly merge into the valley slopes which can be very steep
Profile depth	**very shallow**
Width erosion	• Because of the narrow valley and very steep gradient, the rivers do not erode in width
Width variation	**very high**
Bank structure	
Bank vegetation	**wood and near-native herbs and grasses**
Bank features	**many** • Numerous bank features like trees as flow obstacles, flow around single trees or fallen trees
Adjacent land zones	
Adjacent land use	**native woodland or naturally no bank**
Riparian zone	**>20 m**
Adjacent land features	• Adjacent land features like rocky walls, sources

ST_g U-shaped river, coarse material rich

General information	
Valley shape	U-shaped valley with narrow to moderate wide valley bottom
Bed substrate under reference conditions	In mid-mountain areas: (coarse)gravels and blocks. But also amounts of finer substrates like sand are possible; in the lowlands: shingles and stones with sand proportions, regionally also with loam; in all natural areas organic substrates like deadwood, fallen leaves and roots

U-shaped river, coarse material-rich

U-shaped river, coarse material-rich

Watercourse development	
Watercourse curvature	**from curved to meandering** • In broad U-shaped valleys meandering • In narrow U-shaped twisting
Erosion at bends	occasionally from **none** to **weak** or **frequently weak**
Longitudinal bars	**many** • Some river-, watercourse curvature-, isle- and estuary banks banks
Watercourse features	**many** • Numerous accumulations of deadwood, fallen trees, island formations, watercourse widening and narrowing
Longitudinal profile	
Transverse bars	**many** • Regular change between turbulently and slowly flowing stretches (ripple-pool-squence)
Flow variation	**very high** • The diverse structure elements lead to a very high flow diversity: locally fast, quiet, turbulent and precipitating flowing sections, low-flow areas at the bank zones
Depth variation	**very large**

ST_g U-shaped river, coarse material rich

Bed structure	
Bed substrate	depending on the natural area: shingles, gravels and stones, blocks, gravels and pure stoneblocks and outcropping bedrock
Substrate diversity	**very high** • Mineral substrates show a wide variety of different particle sizes • Besides the dominant coarse substrates, also finer substrates like sand in the low-flow areas at the bank zones are possible • Also organic substrates (roots, deadwood, fallen leaves)
Bed features	**Many** • Numerous bed features like high-flow areas, deadwood, root surfaces, potholes
Cross profile	
Profile type	**natural profile** • Broad and flat irregular and feature rich profiles
Profile depth	**very shallow**
Width erosion	**none to weak**
Width variation	**very high** • Because of numerous longitudinal bars and longitudidal features the width variation of the meandering rivers is very high
Bank structure	
Bank vegetation	**wood** and near-native herbs and grasses • E. g., alder-riverside forest, alder-esh-wood, hornbeam forest, at larger rivers also willow wood and willow bushes
Bank features	**many**
Adjacent land zones	
Adjacent land use	**native woodland** • E. g., penduculate oaks/hornbeam forest, alder/ash forest
Riparian zone	**>20 m**
Adjacent land features	• Adjacent land features like rock face, sources

AT_g Hollow and floodplain rivers, coarse material rich
OT_g Rivers without valleys, coarse material rich

General information

Valley shape	Hollow, floodplain valley, rivers without valley
Bed substrate under reference conditions	In mid-mountain areas: dominant gravels (coarse)shingles and blocks, in addition, also amounts of finer substrates like sand; in the lowlands: dominant shingles and stones with sand proportions, regionally also with loam; in all natural areas there are organic substrates (deadwood, fallen leaves, roots)

Floodplain river, coarse material-rich

Floodplain river, coarse material-rich

Longitudinal development

Watercourse curvature

meandering to high meandering with partially side watercourses or bifurcations

- On the shallow valley bottom of the riverbed or floodplain valleys distinct sling courses can be designed
- On the slightly curved valley bottom of the hollow valleys, the watercourse curvature is normally less strong
- Depending on the bed-load and substrate, these rivers create numerous side watercourses

Erosion at bends

none to individually weak or frequently weak

Longitudinal bars

many

- Some river-, watercourse curvature-, isle- and estuary banks

Watercourse features

many

- Numerous accumulations of deadwood, fallen trees, island formations, watercourse widening and narrowing

Longitudinal profile

Transverse bars

many

- Regular change between turbulently and slowly flowing stretches (ripple-pool-squence)

Flow variation

very high

- The diverse structure elements lead to a very high flow variation: shallow overflowed segments, slowly flowing areas, turbulent and precipitating flowing areas, low-flow areas at the bank zones

AT_g Hollow and floodplain rivers, coarse material rich
OT_g Rivers without valleys, coarse material rich

Depth variation	**very large**
Bed structure	
Bed substrate	depending on the natural area: shingles and gravels; gravel; gravel and stones; blocks, gravel and stones, pure stoneblocks and outcropping bed-rock
Substrate diversity	**very high** • Mineral substrates show a wide variety of the different particle sizes • Coarse substrates are dominating, there are also finer substrates like sand in the low-flow areas at the bank zones • Organic substrates (roots, deadwood, fallen leaves)
Bed features	**Many** • Numerous bed features like high-flow areas, deadwood, root surfaces, potholes
Cross profile	
Profile type	**natural profile** • Broad and flat irregular and features rich profiles
Profile depth	**very shallow**
Width erosion	**none to weak**
Width variation	**very high** • Because of numerous longitudinal bars and longitudidal features, the width variation of the meandering rivers is very high
Bank structure	
Bank vegetation	**wood** and **near-native herbs, grasses** • E. g., alder-riverside alder-esh-wood, hornbeam forest, at larger rivers also willow wood and willow bushes
Bank features	**many** • Numerous bank features like trees as flow obstacle, flow around single trees or fallen trees, larger rivers with nests on walls
Adjacent land zones	
Adjacent land use	**native woodland** or **floodplain vegetation** • E. g., penduculate oaks/hornbeam forest, alder/ash forest
Riparian zone	**>20 m**
Adjacent land features	• E. g., creation of abandoned meanders, flood watercourses and wa-tercourses

AT_o Hollow and floodplain river -organic
OT_o Rivers without valleys -organic

General information	
Valley shape	Hollow-, floodplain valley, river without valley
Bed substrate under reference conditions	Organic substrates are dominating: peat and peat moss, fallen leaves, deadwood, macrophytes but also mineral substrates (sand and shingles)

Floodplain valley, organic

Floodplain valley, organic

Watercourse development

Watercourse curvature

meandering to high meandering with side watercourses or branchings

- This morphological river type tends to the formation of multiwatercourses (anastomosis)

Erosion at bends

- Anastomosing rivers show, in comparison with meandering rivers, only a slight tendency to erosions

Longitudinal bars

- Longitudinal bars, consisting of mineral substrates like vegetationless island banks or slip-off banks only play a minor role
- In a close to natural condition few to none longitudinal bars; many longitudinal bars are an indicator to a degradation of the river

Watercourse features

many

- Numerous islands during the formation of multiwatercourses but also accumulations of deadwood and fallen trees

Longitudinal profile

Transverse bars

- In pure organic rivers, mineral substrates only play a very subordinate role with the consequence that a sediment transport which would lead to the formation of transverse bars cannot take place
- Under degraded conditions (after the decomposition of organic substrates), the dominating mineral riverbed can lead to appropriate quantities of more or less transverse bars
- Organic rivers which naturally have a higher quantity of mineral substrates appropiately develop more transverse bars

Flow variation

high to very high

- The divers structure elements lead to a very high flow variation

AT_o Hollow and floodplain river -organic
OT_o Rivers without valleys -organic

Depth variation	**large to very large**
Bed structure	
Bed substrate	**upcoming peat** • The following organic substrates are dominating: peat and peat moss, fallen leaves, deadwood, macrophytes but also mineral substrates (and and shigles)
Substrate diversity	• In the case of pure organic rivers, the diversity of the organic substrates is high in comparison with the mineral substrates; but this is not taken into account by survey mapping in the field with the result that for these rivers no high substrate diversity can be recorded • Organic rivers which are naturally characterised by an higher portions of mineral substrates can show a high diversity
Bed features	**various** to **many** • Numerous bed features like pools, root surfaces and makrophyte cushions
Cross profile	
Profile type	**natural profile**
Profile depth	**very shallow**
Width erosion	**none to weak**
Width variation	**high** to **very high**
Bank structure	
Bank vegetation	**wood** and **near-native herbs, grasses** • Alder- and birch forests
Bank features	**many** • Numerous bank features like flow around alders, trees as flow obstacles or fallen trees
Adjacent land zones	
Adjacent land use	**native woodland** or **floodplain vegetation** • E. g., alder-ash, oak-birch or pedunculate oak-horbeam
Riparian zone	**>20 m**
Adjacent land features	• E. g., sources and standing waters

ST_fl U-shaped river, fine material rich –loess-loam

General information

Valley shape Narrow to moderate U-shaped valley with moderately wide floor

Bed substrate under reference conditions Loess and loam are dominant but also portions of sand or shingles, also clay and marl are possible; in the mid-mountains locally also stones and gravel; organic substrates (deadwood, fallen leaves)

U-shaped river, loess-loam dominated

U-shaped river, loess-loam dominated

Watercourse development

Watercourse curvature **curved** to **meandering**

- In narrow U-shaped valleys tortuous
- In wider U-shaped valleys also meandering

Erosion at bends

- In these rivers steep sided banks without vegetation are naturally found, even though only a slow dynamic exists (bank erosion)
- Since only the shape of the river is recorded, a correct mapping by the shape of the collapsed river banks is very difficult

Longitudinal bars **various** to **many**

- Due to the cohesive bed substrate and the lower sediment transport, these rivers naturally show a small number of longitudinal banks

Watercourse features **many**

- Numerous accumulations of deadwood or fallen trees
- Because of the cohesive river bank material island formations, watercourse widening and narrowing are relatively rare

Longitudinal profile

Transverse bars

- Because of the predominant loess-loamy bed substrate, this morphological river type naturally shows only a few mineral transverse bars; locally shingles- or marl-banks and ground sills made of deadwood may occur
- “Many“ or „various“ transverse bars normally are a sign of degradation and are not of natural origin

Flow variation **high** to **very high**

Depth variation **high** to **very high**

ST_fl U-shaped river, fine material rich –loess-loam

Bed structure	
Bed substrate	**clay, loam** • Loess and loam are dominant but also portions of sand or shingles, clay and marl; in the mid-mountains locally also stones and gravels; organic substrate (deadwood, fallen leaves) • The mapping of unnatural clay is very difficult
Substrate diversity	**high** to **very high**
Bed features	**many** • Numerous bed features like potholes, pools, root surfaces, dead-wood
Cross profile	
Profile type	**natural profile** • Near-natural rivers show a deep box-like profile with steep banks without vegetation; this corresponds to the description of the feature “erosion profile, varying” and “erosion profile, deep” • The distinction between a natural deep box-type profile and an un-natural deeply incised erosion profile is difficult: to reduce the conse-quences of a confusion with a nature-like profile, both features are upgraded
Profile depth	• The rivers naturally show a great cutting depth • Shallow profiles must therefore be considered as degradation
Width erosion	• Because of the strongly cohesive bank material, the rivers naturally show steep-sided banks without vegetation and without a sign of strong side erosion • In the field only the shape of the river is recorded
Width variation	**high** to **very high** • Because of the cohesive bank substrate, the rivers naturally show a low width variation
Bank structure	
Bank vegetation	**wood** and **near-native herbs and grasses.** Also, **naturally no vegeta-tion cover** • Near-natural rivers show a deep box-like profile with steep-sided banks without vegetation
Bank features	**many** • Numerous bank features like trees as flow obstacle or fallen trees
Adhacent land zones	
Adjacent land use	**native woodland** • E. g., oak-elm forest or bird cherry-alder-ash forest
Riparian zone	**>20 m**
Adjacent land features	• Only a few adjacent land features like sources

ST_fs U-shaped river, fine material rich -sand

General information

Valley shape U-shaped valley with narrow to moderately broad valley bottom

Bed substrate under reference conditions Sand but also amounts of gravels, clay and marl are dominating; in the mid-mountains locally also stones; organic substrates (deadwood, fallen leaves, macrophytes)

U-shaped valley, sand dominated

U-shaped valley, sand dominated

Watercourse development

Watercourse curvature **curved to meandering**

- In narrow U-shaped valleys tortuous
- In broader U-shaped valleys also meandering

Erosion at bends **frequently weak to occasionally weak**

- The shape of the erosion of bends is a useful indicator for the description of the temporal river dynamic (relocation of bank sections): in case of achieving the natural degree of twist, the attack of the currents on the banks becomes weaker and the banks flatten
- Because of the high soil erosion risk of the sandy bank material, it must be expected that the downstream following meander still shows a weak erosion at the banks

Longitudinal bars **many**

- Some longitudinal, watercourse curvature, islands and estuary banks

Watercourse features **many**

- Numerous accumulations of deadwood, fallen trees, island formations, watercourse widening and -narrowing
- Accumulations of deadwood are very important for the biocoenosis, e. g., as fish shelters or as habitats for invertebrates

Longitudinal profile

Transverse bars

- Because of the dominant sandy bed substrate, these rivers naturally only show few mineral transverse bars
- Numerous river ground sills made of deadwood or fallen leaves may occur which are not recorded

ST_fs U-shaped river, fine material rich -sand

	• “Many“ or ”various“ transverse bars normally are a sign of degradation and are not of natural origin
Flow variation	**high** to **very high**
Depth variation	**high** to **very high**
Bed structure	
Bed substrate	**sand**
	• Dominating substrates are sand, organic substrates like deadwood and fallen leaves, peat or fine particulate organic matter in the form of detritus. Locally also shingles, clay or loam may occur. In the mid-mountains also stones
	• The mapping of unnatural sand is very difficult
Substrate diversity	**high** to **very high**
Bed features	**many**
	• Numerous bed features like potholes, pools, root surfaces, deadwood and cushions made of macrophytes
Cross profile	
Profiltyp	**natural profile**
Profile depth	**very shallow**
	• Larger rivers may be cut deeper in a close to natural condition because of the sandy substrate without showing negative effects for the biocoenosis
Width erosion	**none**
Width variation	**great** to **very great**
	• Due to numerous longitudinal banks and watercourse features
Bank structure	
Bank vegetation	**native woodland** and **near-natural herbs, grasses**
Bank features	**many**
	• Numerous bank features like flow around alders, trees as flow obstacles or fallen trees. Larger rivers have nesting walls
Adjacent land zones	
Adjacent land use	**native woodland**
	• E. g., alkaline-poor deciduous forests (base-poor beech mixed forests, pendiculate aok/birch wood and poorer variants of oak/hornbeam forests or river-accompanying marsh forests (birch or lader swamps)
Riparian zone	**>20 m**
Adjacent land features	• Only few adjacent land features like sources

AT_fs Hollow and floodplain rivers, fine material rich -sand
OT_fs Rivers without valleys, fine material rich –sand

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Valley shape	Hollow-, floodplain valley, river without valley
Bed substrate under reference conditions	Dominating substrates are sand but also amounts of shingles, clay and marl; in the mid-mountains locally also stones; organic substrates (deadwood, fallen leaves, macrophytes)

Floodplain valley, sand dominated

Floodplain valley, sand dominated

Watercourse development

Watercourse curvature — **meandering to high meandering**

- In broad valleys meandering

Erosion at bends — **frequently weak** to **occasionally weak**

- The shape of the erosion of bank sections is a useful indicator for the description of the temporal river dynamic (local relocation of banks): in case of achieving the natural degree of twist, the attack of the currents on the banks becomes weaker and the banks flatten
- Because of the high soil erosion risk of the sandy bank material, it must be expected that the downstream following meander still show a partial weak erosion of the banks

Longitudinal bars — **many**

- Some longitudinal-, watercourse curvature-, island- and eastuary banks

Watercourse features — **many**

- Numerous accumulations of deadwood, fallen trees, island formations, watercourse widening and narrowing
- Accumulations of deadwood are very important for the biocoenosis, e. g. as fish shelters or as habitats for invertebrates

Longitudinal profile

Transverse bars

- Because of the dominant sandy bed substrate, these rivers naturally only show few mineral transverse bars
- Numerous river ground sills made of deadwood or fallen leaves may occur which are not recorded during the survey mapping

AT_fs Hollow and floodplain rivers, fine material rich -sand
OT_fs Rivers without valleys, fine material rich –sand

	• "Many" or "various" transverse bars normally are a sign of degradation and are not of natural origin
Flow variation	**high** to **very high**
Depth variation	**high** to **very high**
Bed structure	
Bed substrate	**sand**
	• Dominating substrates are sand, organic substrates like deadwood and fallen leaves, peat or fine particulate organic matter in the form of detritus. Locally also shingles, clay or loam may occur. In the mid-mountains also stones • The mapping of unnatural sand is very difficult
Substrate diversity	**high** to **very high**
Bed features	**many**
	• Numerous bank features, like potholes root surfaces, deadwood and cushions made of macrophytes,
Cross profile	
Profile type	**natural profile**
Profile depth	**very shallow**
	• Larger rivers may be cut deeper in a close to natural condition because of the sandy substrate without showing negative effects for the biocoenosis
Width erosion	**none**
Width variation	**great** to **very great**
	• Due to numerous longitudinal banks and watercourse features
Bank structures	
Bank vegetation	**native woodland** and **near-natural herbs, grasses**
Bank features	**many**
	• Numerous bank features, like flow around alders, trees as flow obstacles or fallen trees. Larger rivers have nesting walls
Adjacent land zones	
Adjacent land use	**native woodland or floodplain vegetation**
	• E. g., alkaline-poor deciduous forests (alkaline-poor beech mixed forests, penduculate aok/birch wood and poorer variants of oak/hornbeam forests or river-accompanying marsh forests (birch or alder swamps) • Creation of abandoned meanders
Riparian zone	**>20 m**
Adjacent land features	Numerous adjacent land features like distinct terrace rims, natural embankment, flood watercourse/high tide watercourse, standing waters

AT_fs Hollow and floodplain rivers, fine material rich -sand
OT_fs Rivers without valleys, fine material rich –sand

g_FG Large rivers

General information	
Valley shape	Floodplain valley; river without valley
Bed substrate under reference conditions	Depending on the natural area, different bed substrates: • In the lowlands, fine sediments like sand or fine gravels are dominant • In the mid-mountains more coarser substrates like coarser shingles, gravels, stones

Large river in mid-mountains

Large river in the lowlands

Longitudinal profile	
Watercourse curvature	**Meandering** to **high meandering** or **with side watercourses** partially also **branched** • In narrow valleys also weakly curved to curved
Erosion at bends	**frequently weak** to **occasionally weak**
Longitudinal bars	**many** • Some longitudinal-, watercourse curvature-, island- and eastuary banks
Watercourse features	**many** • Numerous accumulations of deadwood, fallen trees, island formations, watercourse widening and -narrowing • Accumulations of deadwood are very important for the biocoenosis, e. g., as fish shelters or as habitats for invertebrates

Longitudinal profile	
Transverse bars	• The formation of transverse bars depends on the bed substrate • Coarse material rich small bars or large rivers with **various to many** transverse bars • Fine sediment rich small bars or large rivers **naturally none to one to two** transverse bars

AT_fs Hollow and floodplain rivers, fine material rich -sand
OT_fs Rivers without valleys, fine material rich –sand

Flow variation	**high** to **very high**
Depth variation	**high** to **very high**

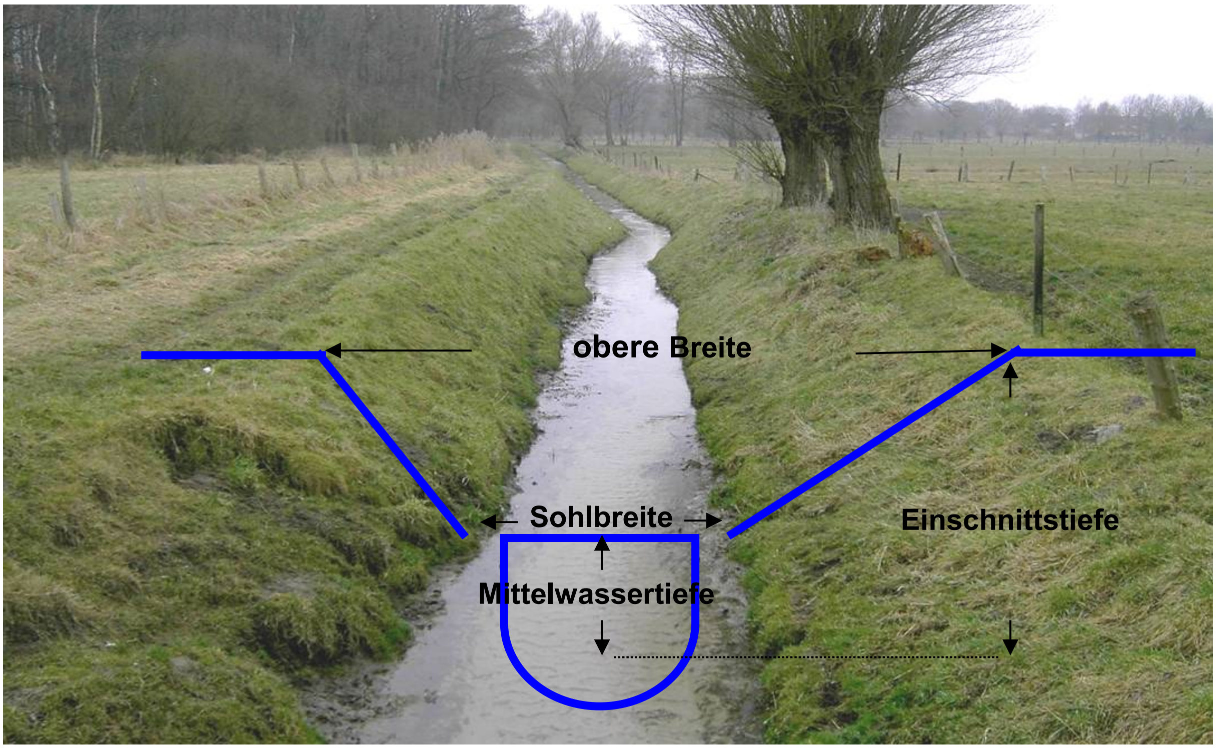
Bed structure	
Bed substrate	**depending on the natural area different dominating substrates:** • In the lowlands sand, clay/silt/loam, sludge/mud are dominating among the mineral substrates, or many organic substrates, like fallen leaves/coarser organic particles, deadwood, macrophytes • In the mid-mountains coarse sediments like gravels, stones or shingles are dominating among the mineral substrates. Subordinated sandy-muddy deposits may exist, but also many organic substrates like deadwood
Substrate diversity	**high** to **very high**
Bed features	**many** • Numerous bed features like shoots, potholes, eddies, root surfaces, deadwood
Cross profile	
Profile type	**natural profile**
Profile depth	**very shallow** to **shallow** • In a close to natural condition, larger rivers can be cut deeper in the fine sediment rich substrate without negative consequences to the biocoenosis
Width erosion	**none**
Width variation	**high** to **very high** • Because of numerous longitudinal bars and watercourse features
Bank structure	
Bank vegetation	**native woodland** and **near-natural herbs, grasses**
Bank features	**many** • Numerous bank features like fallen trees, fish shelters, natural bank demolitions
Adjacent land zones	
Adjacent land use	**native wood and close to nature biotopes**
Riparian zone	**>50 m**
Adjacent land features	• Numerous adjacent land features like distinct terrace rims, natural earth walls, flood watercourse/high tide watercourse, creation of oxbow lakes

Characterisation of the current state

For the characterisation of the current state of the survey unit as the recording of geometrical data and the water level also the position of the river is recorded. It is registered if there is a special case, e. g., a dammed river and which anthropogenic pressures exist as results of the uses.

River geometry

For the characterisation of the survey unit, the current state of the parameters ”bed width“, ”actual upper width“,”actual incision depth“, “actual depth of the meanflow conditions“, and ”water level“ are collected.



Bed width and

length of the survey unit

The acquisition and estimation of the actual mean **river width** = waterlevel width at mean water level inclusive bars in nine classes (<1 m, 1 – 2 m, >2 – 5 m, >5 – 10 m, >10 – 20 m, >20 – 40 m, >40 – 80 m, >80 – 160 m, > 160 m).

- **Smallest rivers:** heads of rivers, water moats with a medium water-level width of <1 m
- **Small rivers:** small rivers (medium water-level width of 1- 5 m), large rivers (medium water-level width of 5–10 m) and small rivers (medium water-level width of 10–20 m) and visible bed.
- **Large rivers:** Large and mighty rivers with a medium water-level width of >20 m and normally without visible bed.

River geometries

The **length of the survey unit** results from the actual riverbed width:

Rivers showing a bed width <1 m are small rivers. The length of the survey unit is 100 m.

If rivers have a riverbed width between 1 and 20 m, the length of the survey unit is 100 m. In the individual case that the riverbed is not visible or the survey unit is located in the transition zone between two river size categories (small river → large river), a survey unit length of 500 m can be chosen for watercourses with a width between 10 and 20 m. This occurs when a large river by construction measures shows a relatively small actual width.

If rivers have a riverbed width of >20 m two survey unit lengths must be differentiated. For rivers >20 – 40 m the survey unit length is 500 m. For very large rivers with a bed width >40 m the length of the survey unit is 1,000 m. In the transition zone between rivers and mighty rivers the rule is: cartographers have to justify if they make changes to the survey unit length, in case this is necessary in their professional point of view.

Local changes of the watercourse bed width (widening or narrowing) are no reason for changes of the survey unit lengths. The recorded geometries must correspond with the data of the SP 4.2 ”profile depth depth“.

Upper width

The recording of the actual average distance between both upper edges of the embankment in nine classes (<1 m, 1 – 2 m, >2 – 5 m, >5 –1 0 m, >10 – 20 m, >20 – 40 m, >40 – 80 m, >80 – 160 m, >160 m).

In case of V-shaped rivers, shallow natural profiles or rivers in a secondary floodplain (see SP 4.2 ”profile depth“), all without recognisable upper edges of the embankment, the upper width of the river corresponds to the mean water level, inclusive banks.

In case of double-trapeziodal profiles, the upper width of the upper trapeze is used.

For rivers with different high banks, the upper width is measured by means of an imaginary line between the right and the left low edge of the river banks.

For dammed water routes, the upper edge between the right and left river bank must be taken.

For piped watercourses this information is omitted.

Incision depth

Recording of the current mean incision depth (top of the bank to the riverbed) in seven classes (< 0,2 m, 0,2 – 0,5 m, > 0,5 – 1 m, > 1 – 2 m, > 2 – 3 m, > 3 – 5 m, > 5 m).

Regarding V-shaped rivers, shallow natural profiles or in a secondary floodplain (see SP “4.2 profile depth”) each without a visible top of the banks, the current incision depth corresponds approximately the maximal mean water depth.

In cases of double-trapezoid profiles, the current incision depth is determined starting from the highest trapeze.

In cases of rivers showing different high banks, the current incision depth is determined by the low top of the bank.

Mean water depth

For piped, dried up and dammed river sections, these informations are omitted.

Mapping of the actual mean water level in 6 classes (<0.1 m, 0.1 – 0.3 m, >0.3 – 0.5 m, >0.5 – 1 m, > 1 – 2 m, >2 m).

If the riverbed is not visible, then “not visible” must be ticked.

For piped, dried up and dammed river sections, these informations are omitted.

River geometries

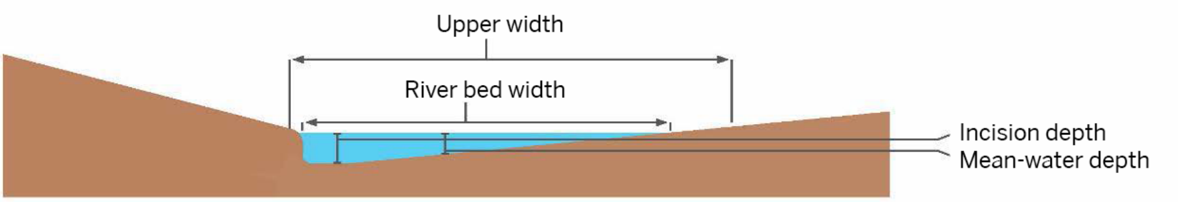


Illustration: natural profile

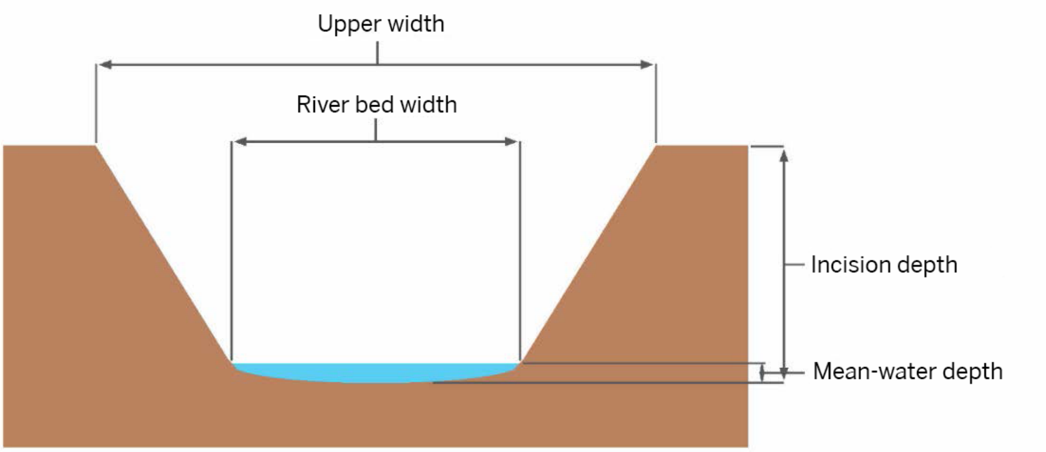


Illustration: technical rule profile (trapezoidal profile)

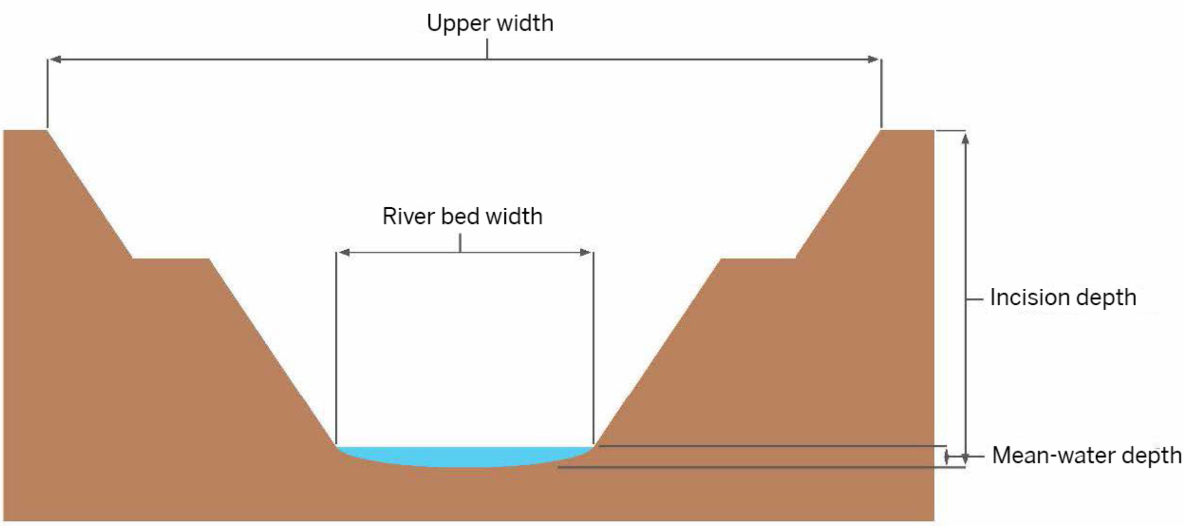


Illustration: technical rule profile (double trapezoidal profile)

River geometries

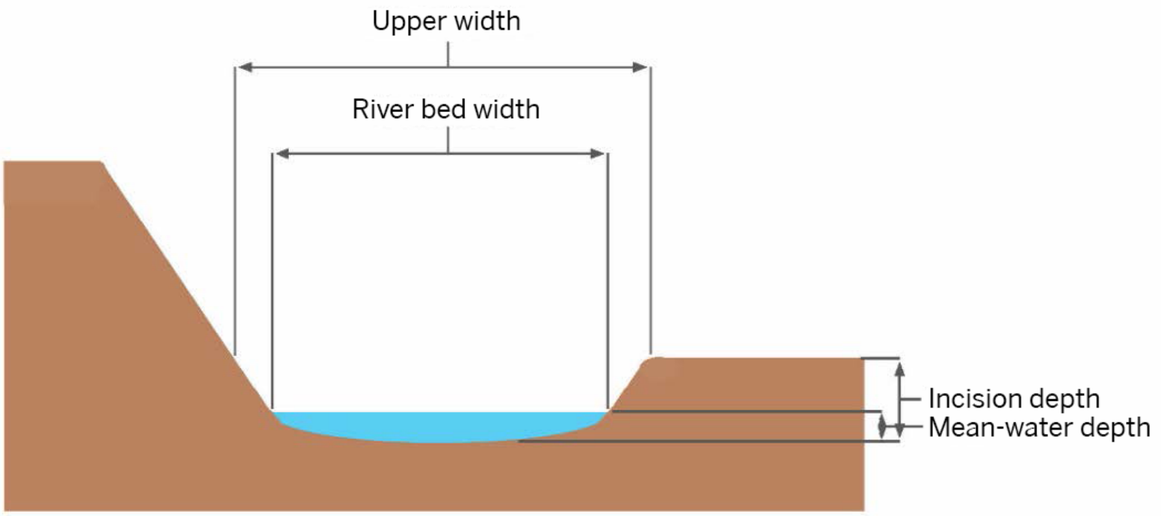


Illustration: triver showing different high banks

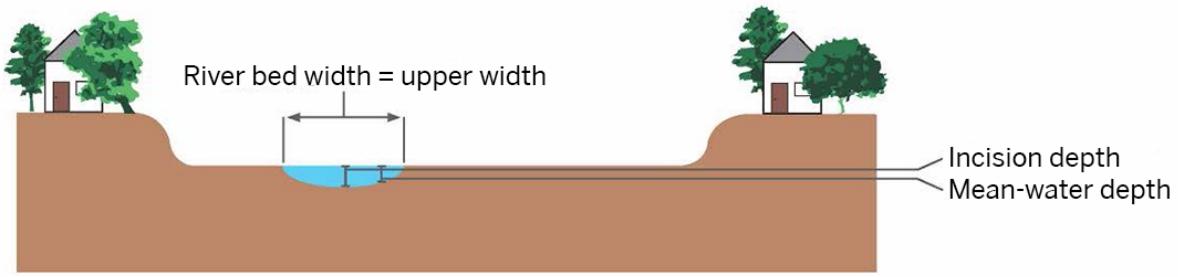


Illustration: river flowing in a secundary floodplain

Water level

Definition

The height of the water level in relation to the average waterline is defined as water level.

Indicator properties

The information on the water level is used to make the mapping- and assessment results of a survey unit mapped at different times and water levels plausible and transparent .

Informations on mapping

The water level is normally visible by means of the bank vegetation, erosion, discoloration on rocks or boundaries of bank protections.

“Mean-water level” is the optimal water level during the field mapping, whereby in principle the mapping can also be performed during below mean water level. As mean water a mean water level is understood and not a statistically calculated discharge.

However, water levels below mean-water level lead to the fact that within the scope of mapping, the features normally can be seen more clearly and are recorded in a larger number. This concerns e. g., bank features, which are still overflowed at mean water level and therefore are not considered as features according to the SP 1.3 “longitudinal bars” or SP 2.4 “transverse bars”. At lower water levels, they are recognised as features and thus are recorded.

Figure: the same survey unit at different water levels: left side, mea-water level, right side, low water level

Water level

Especially during the survey of water constructions, the water level has a decisive influence on the parameters to be assessed. If the water level is significantly increased, then there is danger risk that certain parameters (e. g., the actual water level difference) are measured with a value that is too low or constructions are completely overlooked. Constructions like ground sills (<0.1 m) are normally clearly visible at lower level than at mean-water level, whereas during the mapping at high water levels they are not recognisable. **To garantee a reliable and comparable data quality, it is urgently recommended to perform the survey mapping during a mean-water level.**

Tthe actual water level is distinguished in the two classes ”mean-water level“ and ”water level below mean-water level“. The water level must be estimated.

For larger rivers available actual water levels must be querried, e. g., in ELWAS-WEB or HYGON.

For piped, dried and dammed watercourses this information is omitted.

Mean-water level

The riverbed normally is completely covered with water. Possible bank features are clearly visible also without being completely dried-out.

<Mean-water level

The riverbed is not completety covered with water and the shore areas have clearly fallen dry. Bank features might also have fallen dry.

Also rivers which have been fallen dry as well as rivers in which there only are pools containing residual water at the date of mapping must be marked as ”<mean water level“. Further, by the term ”special case“ the appropiate feature must be recorded.

Water level

Mean-water level

< Mean-water level

Mean-water level

< Mean-water level

Location of river

Definition

It must be recorded if the survey unit is part of the landscape or located in an urban area.

Indicator properties

The information should be used to make the evaluations of the survey mapping plausible and comprehensible. This applies in particular to differences between the evaluation procedures based on indexes and on functional units.

Information on the survey mapping

The survey of the parameters is performed in the open field. Additionally, aerial photos, biotope cartographies and utilisation maps can be analysed for large rivers.

The distinction is predominantly made via the use intensity of the adjacent land zones.

The information on the river location must be consisten with the recorded features under the SP 6.1 ”adjacent land use“.

Open landscape	Regardless of the river width, the double-sided adjacent land zones within a survey unit must be characterised as ”open landscape“, if the land zone is unexploited (>50 % as reference point) or predominantly used for foresty or agriculture. Within the area of the survey unit only individual construction borders the river per at each side (e.g. a farmhouse or a mill). Paved traffic routes or railway lines only lead along the river at one side.
Urban area	If the land zone predominantly (>50 % as reference point) only shows built-up areas, traffic routes, industrial wasteland or partially sealed parking areas, then ”urban area“ must be mapped. This also includes (besides inner-city areas) settlements or small villages in the environment of larger cities or in the open landscape when this use negatively impacts the natural watercourse development by morphological stabilising measures. That means, if one river side is unused or used for foresty or agriculture and the other river side shows built-up areas, then the term ”urban area“ must be ticked.

Location of river

Open landscape

Urban area

Open landscape

Urban area

Special case

Smallest waters

Smallest waters with a river width of <1 m, e. g., springs or headwaters of natural rivers, but also drainage watercourses.

These rivers have very small outflows. This results in a distinctly poor capacity for self-dynamic developments. Certain features need stronger outflows for the creation because only such hydrological situations have the formative power for the riverbed developments. Furthermore, stronger outflows often correlate with greater discharge dynamics which are not the normal case for smallest rivers. Because of the lower sediment transport, e. g., the bank features only play a tangential role. Also, the erosion capability is severely limited.

It must be taken into account that natural features mostly are formed at a small scale and are partially pronounced to a lesser extent. The following minimum set of data must be surveyed:

1. Watercourse development	1.1 Watercourse curvature/Bends
	1.4 Watercourse features
2. Longitudinal profile	2.1 Transverse and special features
	2.2 Piping/Overbuilding
	2.3 Backwater
	2.01 Flow patterns
	2.5 Flow variation
3. Bed structure	3.1 Bed substrate
	3.2 Substrate diversity
	3.3 Bed fixation
	3.4 Bed features
	3.01 Bed pressures
4. Cross profile	4.1 Profile type
	4.2 Profile depth
	4.4 Width variation
	4.5 Culvert/Bridge
5. Bank structure	All single parameters
6. Adjacent land zones	All single parameters

For the evaluation of the functional units, especially a minimum data set of predefined SPs must be considered.

Restored section

If the survey unit shows a river which has been actually restored, then this section is recorded as “restored” section.

Predominantly or completely piped/built over

If more than 50 % of a survey unit is piped or built over, then this special case must be recorded as ”predominantly piped/built over”

If 100 % of a survey unit is piped/overbuilt, then this unit must be recorded as completely piped /built over.

For both special cases only the SPs 6.1 ”adacent land use“ and

Special case

6.3 ”adjacent land pressures“ are recorded. The main parameters and the overall assessment obtain an index value of 7.

River sections with a change of degraded and open sections (=fragmented watercourses) are not considered for this special case, even if the sum of the piped sections are >50 % of the survey unit. Fragmental river stretches are mapped under the term ”anthropogenic pressures“.

River dried up or pools with present residual water

Because of special natural conditions it can be expected that rivers to be mapped have episodically or regularly fallen dry (e. g., karst rivers). The date of mapping must therefore be chosen so that sufficient water conditions can be expected. If it becomes evident in the field that a survey unit is dry or only has residual water, then the special case “watercourse dried up” or “residual water existent” must be chosen.

These rivers must be mapped in agreement with the client at a later time. If a re-mapping is not taken into consideration, then the following minimum data set must be recorded under the condition that they are visible and are not covered by fallen leaves (*):

1. Watercourse development	1.1 Watercourse curvature/Bends
	1.2 Erosion at bends
	1.4 Watercourse features
2. Longitudinal profile	2.1 Transverse and special features
	2.2 Piping/Overbuilding
3. Bed structure	3.1 Bed substrate (*)
	3.3 Bed fixation (*)
4. Cross profile	All SPs
5. Bank structure	All SPs
6. Adjacent land zone	All SPs

For the evaluation of the functional units, especially the determined SPs in the minimum data set must be considered.

Riverbed not visible

In cases of very deep and strongly turbid rivers, the riverbed is often not visible, so that this special case is ticked. The SPs which document the features of the riverbed “not visible” must be normally ticked.

The mapping and evaluation of the MP 3 ”bed structure“ is omitted.

Pool in main connection

If a survey unit is dominated by a technical backwater on more than 50 % of its length (see SP 2.3 „backwater“) and the average watercouse width in this section is three times broader than the average width below the dam, then the special case ”pond in main connection” must be recorded. This applies to reservoirs, ponds or millponds.

With the exception of the SPs 6.1 ”adjacent land use“ and 6.3 ”adjacent land pressures“ the mapping is omitted. The MP and the overall assessment obtain an index value of 7.

Information

Within a survey unit several special cases may occur, like dry, piped or dammed smallest rivers. For dammed or piped smallest rivers, the above-mentioned regulations and evaluations should be applied to

Special case

dammed and piped rivers.

For dried smallest rivers only the following parameters (as minimum data set) must be recorded which are determined for both special cases:

1. Watercourse development	1.1 Watercourse curvature/Bends
	1.4 Watercourse features
2. Longitudinal profile	2.1 Transverse and special structure
	2.2 Piping/Overbuilding
3. Bed structure	3.1 Bed substrate
	3.3 Bed fixation
4. Cross profile	4.1 Profile type
	4.2 Profile depth
	4.4 Width variation
	4.5 Culvert/Bridge
5. Bank structure	All SPs
6. Adjacent land zone	All SPs

Special Case

Smallest river, degraded

Restored river sections

Open landscape, completely piped

Built-up area, completely piped

River fallen dry (with residual waters)

River fallen dry

Pond in main connection

Riverbed not visible

Anthropogenic pressures

Definition

The characterisation of a survey unit by its uses and hydromorphological impacts which are recognisable in the context of a survey mapping.

Indicator properties

These information serves to make the survey mapping and the evaluations plausible and transparent, especially if there are differences between the index-based evaluation and the evaluation by functional units.

Instructions on the survey mapping

All occuring uses and their fundamental hydromorphological impacts are recorded as ”antropogenic degradation“ (multiple registration).

The mapping takes place on-site. Where appropriate, additional information can be requested from the authorities or be taken from topographic maps or aerial photographs.

Local features are not mapped. **They are recorded by the relevant SPs, e. g., fishponds in a neighbouring watercourse are recorded by the SP 6.3 “adjacent land pressures”.**

Use	
Navigation	The use of a river for professional navigation or motorised recreational boating. For the use of shipping, structural morphological changes can be made (e. g. groynes, barrages).
Hydropower	If there are one or more hydroelectric power plants within a survey unit, which have a decisively pressure on a river section (backwater, river continuity, minimum outflow), then this must be noted.
Flood protection	The use ”flood protection“ is for instance characterised by the existence of river banks.
Fish farming	For the use of ”fish farming“, the river is dammed; the pond is in main or neighbouring connection.
Hydromorphological impacts	
Limited flooding of the floodplains	The flooding of the floodplains is not possible or only to a limited extent, because of the deeply incised profiles or dykes on the waterside.
Limited watercourse development /mobility	The free watercourse development/mobility is affected or no longer possible by rule profiles or uses directly adjacent to the river banks (e. g., settlement areas).
Limited cross profile development	The cross profile is straightened and protected. The width erosion is prevented or limited. Relocation activities of the watercourse cannot take place or only to a lesser extent.
Heavily modified discharge conditions	The hydrological and hydraulical discharge conditions are heaviliy modified because of changes in the catchment area (e. g., by sealings, drainages), water abstractions or discharge. Increased flow velocity and overwidth- or to narrow profiles can be indicators for changes of the flow conditions.
Fragmented watercourses	Fragmented watercourses are characerised by numerous changes in open and watercourseised river sections.

Anthropogenic pressures

Relocation of the watercourse at the edge of the valley	Relocation of a river from the deepest valley depth, for instance to install a continous agricultural area or in an area of mining subsidence for the restoration of the drainage capability.
Rivers in high position	The river is elevated highly in comparison to its surroundings.
Change of flow direction	Within a watercourse the flow direction changes from one survey unit to another, e. g., as a result of mining subsidence.

Anthropogenic pressures

Limited flooding of the floodplain

Modified watercourse development/mobility

Limited cross profile development

Heavily modified discharge conditions

Fragmented watercourse

Relocation of the watercourse at the edge of the valley

Rivers in elevated position

Change of flow direction

Documentation

The different textual and photographic documentations help to understand the survey mapping process better. In particular, when there are individual characterisations or ecological specifics which could only be insufficiently described. The descriptions also serve to make the evaluation results of the survey mapping plausible. This is especially the case if there are deviations between the index-based evaluation and the evaluation by functional units.

Short description

Depending on the performance specification, particularities of a survey unit or of a complete river can be described and also information on implausibilities can be given here.

Ohter remarks to the survey unit can be entered here, for example that the river continues flowing subterraneously due to a streamsink.

If there is a description of the complete river, it must be attached to all its survey units, so that these informations is available, even if single survey units have been transfered.

For a short description in total 2,148 signs are at disposal.

Biological characteristics

In this field, indications to FFH-habitat types or habitat species can be noted.

Beaver tracks

In the survey unit there are signs of beaver activities like beaver dam, beaver’s lodge, beaver slides, felled trees or characteristic conically gnowed trees or crop plants.

Special features

Here, information on adequate spawning grounds and growth habitats for salmons can be given.

Photos

Each survey unit must be documented by at least two photos in landscape format (in and against flow direction) and in a good quality (approx. 2 MB per photo) (see also chapter 2.5.4). The images that are generated must clearly show the survey unit including the banks and ideally also the land zones.

In the case that an automatical location of the photos and their assignment to a survey unit are not possible, the photo numbers and the information on the flow direction (shot made in or against flow direction) should be entered here.

Valuation justification

If there are deviations of more than one class between the index-based evaluation and the evaluation of functional units, then a short reason for the chosen MP-class must be given here.

Beaver tracks

Beaver tracks

Beaver’s lodge

Gnowed trees

Wood chips

Beaver slides

Beaver pond

3.3 Main parameter block with descriptions of the single parameters and features

In this chapter the 31 SPs and their characteristics (features) are described. The SPs must be assigned to the following 6 MPS.

Table: Assignment of single parameters to main parameters. VP = Value-based parameter, DP = Derogatory parameter.

Main parameter	Single parameter	VP / HP
Main Parameter 1: Watercourse development	SP 1.1 Watercourse curvature/Bends	VP
	SP 1.2 Erosion at bends	VP
	SP 1.3 Longitudinal bars	VP
	SP 1.4 Watercourse features	VP
Main parameter 2: Longitudinal profile	SP 2.1 Transverse and special features	DP
	SP 2.2 Piping/Overbuilding	DP
	SP 2.3 Backwater	DP
	SP 2.4 Transverse bars	VP
	SP 2.01 Flow patterns	VP
	SP 2.5 Flow variation	VP
	SP 2.6 Depth variation	VP
	SP 2.7 Diversion watercourse	DP
Main parameter 3: Bed structure	SP 3.1 Bed substrate	DP
	SP 3.2 Substrate diversity	VP
	SP 3.3 Bed fixation	DP
	SP 3.4 Bed features	VP
	SP 3.01 Bed pressures	DP
Main parameter 4: Cross profile	SP 4.1 Profile type	VP
	SP 4.2 Profile depth	VP
	SP 4.3 Width erosion	VP
	SP 4.4 Width variation	VP
	SP 4.5 Culvert/Bridge	DP
Main parameter 5: Bank structure	SP 5.1 Bank vegetation	VP
	SP 5.2 Bank protection	VP
	SP 5.3 Bank features	VP
	SP 5.01 Bank pressures	DP
	SP 5.02 Shading	VP
Main parameter 6: Adjacent land zone	SP 6.1 Adjacent land use	VP
	SP 6.2 Riparian zone	VP
	SP 6.3 Adjacent land pressures	DP
	SP 6.01 Adjacent land features	VP

The acquisition of river structures and its environment is performed by the recording of features for the SPs. The SPs are assigned to one of the six MPs (MP 1 to 6) and accordingly numbered.

Upgrading parameters serve to record and to evaluate typical and type-specific features. Downgrading parameters serve to record and to evaluate, by anthropogenic pressures, caused atypical and not type-specific features.

The habitat features of the SPs are, depending on the respective morphological river type, assigned to index values between 1 and 7. The index values, as results of the assessment of the features for one survey unit, are offset, by given calculation steps, to an evaluation class for one MP. Which SPs are considered for the evaluation of a MP is shown in the table above. Chapter 4.2 describes the index-system and the valuation rules for the index-based evaluation.

For the index-based calculation 26 SPs are relevant with hierarchical consecutive numbering from 1 to 7 (e. g., SP 1.1 „watercourse curvature/bends“, SP 1.2 „erosion at bends“, etc.). In NRW 5 additional parameters must be recorded which do not enter into the index-calculation. They can be identified by the number 0 behind the MP-number, e.g., SP 2.01 „flow patterns“.

Main parameter 1: Watercourse development

SP 1.1 Watercourse curvature/Bends

Definition

Type and extent of existing curvatures and type and amount of branchings.

Indicator properties

This parameter, depending on the reference conditions, characterises the state of the ground layout by the parameters ”degree of twist“ (expressed as ratio between the watercourse and the valley length) and the distinction between one- and multiwatercourses.

The deviation from the potential natural status is evaluated. Rivers respond to watercourse regulations with a deficient bed-load balance, depth erosion and with the inability to restore all the structures which would be created in a natural state. The greater the deficits in natural watercourse curvatures are, the more radical the ecological functions of the impacted river are. Changes from one- to multi-watercourses are particularly delicate with regard to the ecological consequences.

Information on survey mapping

Single registrations are performed by the actual watercourse curvature of the river watercourse and the degree of branching (= riverbed patterns).

For small and larger rivers the survey mapping is done on-site.

For larger rivers, small, large and huge rivers, a survey unit may occur as not curved, although it is a part of a watercourse sling. Therefore, for larger, large and huge rivers section blocks must be generated for the evaluation of the watercourse form.

For large and huge rivers, the mapping of the watercourse curvature is based on topografic maps or aerial photos. In the field, only the verification is carried out. The degree of twist can also be determined by GIS-querries. Here, the quotient of watercourse and valley length is calculated. The degree of branching can be read from maps or much better from aerial photos. For the determination of the actual watercourse form it must be differentiated between branched rivers with side watercourses and not branched rivers. Only for naturally unbranched rivers (see reference conditions) the curving degree must be determined and evaluated. For naturally branched rivers the degree of branching must be determined additionally.

For small rivers, the degree of branching is only surveyed for informational purposes.

SP 1.1 Watercourse curvature/Bends

The following three features are summarised as ”non-curved“.

Linear	The watercourse is linear and canal-like within the survey unit, like drawn by a ruler. Changes of direction only take place at property bounderies or at constructions. They have not been created by self-dynamic conditions of the river but they are of anthropogenic origin.
Elongated **(Degree of twist 1.01 – 1.06)**	The watercourse follows a straight or elongated baseline. Larger windings do not occur.
Slightly curved (**degree of twisting >1.06 – 1.25)**	The watercourse shows continuously or irregularly windings with large radius. The flow direction deviates between 10 and 20 degrees at the the turning points, rarely between up to 40 degrees from valley axis.

The following three features are summarised as ”curved“.

Curved **(Degree of twisting >1.25 – 1.5)**	The watercourse is continuously intensively and regularly curved. The flow direction deviates between 30 and 60 degrees, at the turning points in few cases also up to 90 degrees from the valley axis. There is rarely a tendency to the creation of watercourse slings or sling strangulations.
Meandering **(Degree of twisting >1.5 – 2)**	The watercourse is continuously very intensively and irregularly curved within this survey unit. The oscillation width is predominantly of the same size like or larger than the oscillation length. The flow direction deviates regularly by more than 60 degrees at the turning points, frequently also by more than 90 degrees from the valley axis. There is a distinct tendency to the creation of watercourse slings and occasional sling strangulations.
Intensely meandering **(Degree of twisting >2)**	The watercourse is continuously very intensively and very irregularly curved within this survey unit. The oscillation width is larger than the oscillation length. The length of the watercourse shows at least double the length of the midst of the valley floor. The flow direction often deviates by more than 90 degrees from the valley axis at the turning points. There is a clear tendency to the creation of watercourse slings and occasional sling strangulations.

SP 1.1 Watercourse curvature/Bends

Features of the riverbed pattern	
Unbranched	Watercourse form with only one watercourse, only locally and occasionally with watercourse splittings (islands), often in connection with sandy, loamy and gravely substrates and with a medium valley slope. In an unbranched survey unit it is possible to find a side watercourse, a bifurcation or an island. However, multiwatercourses are characterised by the creation of numerous watercourse bifurcations.
With side watercourses	Watercourse forms with a dominating main watercourse and one or various side watercourses which are mostly tied to a steep valley floor gradient (>2 ‰) and to shingles and gravels. In contrast to interwoven watercourses, the areas between the watercourses are often covered with vegetation and wood.
Branched	Branched watercourses may occur in two forms: **Interwoven:** watercourse form which is bonded with a surplus of bed-load, coarse bed substrate, and with a steep valley floor gradient and which is characterised by numerous high-dynamic closely interwoven watercourses which are located in sparsely vegetated high tide beds. **Anastomosing:** Watercourse form which occurs in cases of very slight valley bottom gradients (<0.5 ‰) in combination with a large proportion of organic or very fine mineral substrates. The numerous watercourses are fixed to a great extent and mostly move as a result of deadwood displacement and of the growth of organic material.

SP 1.1 Watercourse cuvature/Bends

Intensely meandering

Intensely meandering

Meandering

Meandering

Curved

Curved

Slightly curved

Slightly curved

SP 1.1 Watercourse cuvature/Bends

Elongated

Elongated

Linear

Linear

Branched - interwoven

With side watercourses

SP 1.2 Erosion at bends

Definition

The presence and dimension of clear traces of a constant, mutual bank erosion in certain areas at existing or emerging cutbanks (cutbank erosion) in relation to the present watercourse curvature. In river segments with bank protection, the erosions at bends are purposely prevented.

Indicator properties

If a river shows distinct signs of erosion at bends, this indicates that the river is in a condition of relocation. Appropiate material in the floodplain provided, the watercourses are constantly in motion that means horizontal erosion can be found in the area of cutbanks.

The stronger a river is straightened, the more important and effective is the erosion at bends for the return of a near-natural state.

Information for the survey mapping

There is a single registration.

The parameter is determined on-site or is validated for the large rivers in the field. For the assessment of the watercourse features belonging to large rivers, aerial photographs and the German Base Map are available.

For very small rivers the assessment is performed on site.

For small, large and huge rivers, the survey unit may appear not curved, although it is a part of a long watercourse sling. Therefore, for larger rivers, small, large and huge rivers, section blocks must be generated for the evaluation of the erosion at bends.

Two forms of bank erosions are differentiated: the broad-based erosion which leads to a general broading of the riverbed, and the erosion at bends which leads to an expansion of the watercourse curvatures. The erosion of the width occurs at both opposite banks always equally. The erosion of bends only occurs at the cutbanks. The erosions of the affected river banks differ from the other banks in such a manner that they are steeper, more fragile and with a poor vegetation or completely without vegetation.

Only the typical erosion at bends is considered (cutbank erosion). If width erosion occurs as well, only the stronger erosion at the cutbanks minus the width erosion at the other river banks must be recorded.

SP 1.2 Erosion at bends

Extent of the existent watercourse curvature

Curved	The river watercourse is either "intensely curved" or "intensely meandering" or "curvaceous" (compare SP 1.1 "erosion at bends").
Not curved	The river watercourse is either "linear", "stretched" or "slightly curvaceous" (compare SP 1.1 "erosion at bends").

Intensity of the erosion at bends

None, naturally	Naturally, there are either no cutbanks, e. g., for V-shaped rivers, or the cutbanks do not show any signs of an acute erosion.
None, anthropogenic	Caused by river regulations, there are no cutbanks or the cutbanks do not show any sign of acute erosions. If a profile with constructions of groynes or a technical standard profile has been mapped under the SP 4.1 "profile type" or under the SP 5.2 "bank protection" a double-sided bank protection has been documented, normally there are "anthopogenically no erosion at bends".
Weak, occasionally	Less than one third of the existent cutbanks is characterised by weak erosions. The remaining cutbanks are steep but do not show any signs of erosions.
Frequently weak	One third of the existent cutbanks are steep-walled over the whole height or are overhanging, instable and sparsely vegetated, but without distinct signs of heavy annually progress in bank break-offs. The remaining cutbanks are not or only at areas of mean-flow conditions steep faced or overhanging and without any signs of erosions.
Occasionally strong	One third of the existent cutbanks are characterised by strong erosions. Another third of the cutbanks is characterised by weak erosions. The remaining cutbanks do not show any signs of erosion.
Strong, frequently	The cutbanks are predominantly extremely steep faced or overhanging over the whole height. They are very instable, up to the upper edge without any vegetation and distinctly characterised by annually progressive bank break-offs.

SP 1.2 Erosion at bends


Naturally no erosion at bends


Anthopogenically no erosion at bends


Strongly curved


Not-curved, strongly eroded


Strongly curved


Not-curved, weakly eroded


Curved, weakly eroded


Not-curved/weakly eroded

SP 1.3 Longitudinal bars

Definition

The number and characterisation of stretched accumulations of debris in the flow direction and distinctly separated from the remaining riverbed in the form of shorebanking, curvature bank, island bench and estuary banks.

Indicator properties

The above-mentioned watercourse features are typical shape elements of the near-natural and natural riverbed. Since they are recorded together, a reliable and instructive parameter has been created for the morphological condition of the river.

The creation of longitudinal bars is generally a sign of a bed-load balance and the river has no lack of debris, so that during flooding a good energy distribution and transformation can take place. The riverbed is wide enough to give rise to low flow areas and eddies on a larger scale during flooding. The presence of the mentioned shape elements shows that the river has a high morphological development potential and it is not or only little affected by river regulation and maintenance work.

Information on the mapping

There is a simple registration of the distinct longitudinal bars. They are counted and registered in the classes none, one to two, various and many. In cases of very deep or strongly muddied rivers, the riverbed and thus longitudinal bars are not visible. Here, the feature “not visible“ must be ticked.

This parameter must be mapped in the field or rather for the large rivers it must be validated on-site. For the assessment of watercourse features of large rivers, aerial photos and the German Basic Map are available.

Only distinct longitudinal bars are taken into account, which are clearly visible and definable at medium and low water levels as special selective debris accumulations. The creation of bars is fully developed in their typical form. They are unmissable due to their size and height. Their further continued existence seems certain. For large mid-mountain rivers, generally the highest number of longitudinal bars must be expected. For smaller rivers, water-specifically, the ground sill of mapping of distinct longitudinal bars should be set at a lower level.

Because it is not generally possible to determine in advance how many longitudinal bars in a near-natural survey unit can be discovered, the classification of the terms ”many“ and ”various“ must be done by a professional assessment against the background of the reference conditions,. As general rule, three to five can be regarded as ”various“ and >5 longitudinal bars as “many”.

If the bed substrates consist of ”loam“ and ”organic“, then no longitudinal bars can be naturally created. Here, a particular care is needed.

SP 1.3 Longitudinal bars

Types of longitudinal bars	
Shore bar	Narrow and elongated debris accumulations directly at the foot of the side slope or in a short distance from it. The grain size of the shore bar is distinctly mostly smaller than the particles of the surrounding bed substrates.
Curved bar	Debris accumulations at a slip-off bank of an emerging or already advanced curved bar. The particle size does not differ significantly from the particles of the remaining riverbed.
Island bar	Narrow, elongated debris accumulations in the centre of the riverbed. They can be formed on a transverse bar or subsequently to a transverse bar or by a river strangulation or relocation. The predominant particle size is mostly substantially coarser than the particles of the surrounding substrates. Island bars are free of vegetation, otherwise they must be recorded by the SP 1.4 ”watercourse features“ as islands.
Estuary bar	Debris accumulations at the river banks in the estuary area of tributaries. The particle size of the debris accumulations below the mouth is significantly smaller, the particle size above the mouth is significantly bigger than the particles of the remaining sediment area.
Bed-load accumulation	Bed-load accumulations downstream of a curved bar. In the riverbed below an overflowed substrate, by a pothole, by a flowed pool or below a watercourse narrowing or also in the flow shade of flow obstacles.

Longitudinal bars per survey unit	
None	Within the survey unit there is no longitudinal bar noticeable.
One to two	Within the survey unit there are one to two formed longitudinal bars.
Several	Since it is not possible to determine how many formed longitudinal bars within a survey unit can be discovered, the classificsation of the term ”various“ must be conducted by the cartographers against the background of the respective reference conditions. As general orientation, 3 to 5 longitudinal bars can be considered as “various”.
Many	Since it is not possible to determine how many created longitudinal bars within a survey unit can be discovered, the classification of the term ”many“ must be conducted by the cartographers against the background of the respective reference conditions. As general orientation >5 longitudinal bars can be considered as “many”.
Not visible	Very deep and strongly turbid rivers have an invisible riverbed.Therefore, it is not noticeable if or how many longitudinal bars exist

SP 1.3 Longitudinal bars

Shore bar

Shore bar

Island bar

Island bar

Curvature bar

Curvature bar

Estuary bar (tributary from the left side)

Bed-load accumulation

SP 1.4 Watercourse features

Definition

Number and development of a series of different natural form elements of the riverbed which characterise the morphological state in a similar way. To these form elements belong: deadwood jam, fallen trees, island formation, watercourse widening and -narrowing, oxbow, side watercourses and beaver dams.

Indicator properties

The mentioned watercourse features are typical form elements of the near-nature and natural status of the riverbed. Each of these form elements occurs isolated only in a small number (”singular“ form element). By recording them together, a reliable and more informative parameter has been created for the actual morphological quality of the river.

The existence of the mentioned form elements shows that the river has a high level of morphological development and is not or only a little impeded by river regulations and maintenance works.

Information on the mapping

The individual formed watercourse features per survey unit are counted.

The parameter is recorded on-site and validated for larger rivers. For the mapping of watercourse features of large rivers aerial photos or the German Basic Map are available.

Only those watercourse features which are clearly discernable from the other differentiations of the riverbed or which shape the visual appearance of the river are recorded. For smaller rivers, the ground sill for mapping of formed structures must be set lower. For large and huge rivers, the importance of structures on a smaller scale influencing the midstream, moves into the background in comparison with medium-sized rivers. This applies in particular to natural watercourse widenings and watercourse narrowings. For this reason, the importances of these structures must be estimated. They must only be recorded if they significantly have a morpho-dynamic relevance.

The river type appropiate number of watercourse features is assessed in the classes (none, one to two, various and many). That means, for the index-based evaluation, the different single structures are added up. Since it is generally not possible to predict how many structures within a close to nature survey unit are normally found, the classification of the term ”many“ and “various” must be conducted by the cartographers against the background of the respective reference conditions. As general orientation, 3 to 5 watercourse features can be considered as ”various“ and >5 as ”many“.

SP 1.4 Watercourse features

Features	
None	There are no watercourse features within the survey unit.
Deadwood jam	These are large local accumulations of trees or wood wedged into each other in such a stable and extensive way that they impede the flood discharge significantly. Deadwood influences the flood runoff to such an extent that the formation of potholes and watercourse narrowing is possible.
Fallen tree	Fallen trees are trunks or trees with roots and treetops, which have fallen independedly or were purposefully placed in the context of restoration measures, for instance as flow control. Fallen trees divert the mid-water stream or hinder it. Their impact is already shown at mean water level, so that they are able to initiate for instance scourings, watercourse narrowings or other features for a large part of the year. If a fallen tree has a structure-forming effect only at high water level, then this characteristic is not be be recorded here but under the SP 5.3 ”bank features“.
Island formation	These are land areas on the riverbed that are flown around on both sides. They rise out of the water at mean water level and show a permanent vegetation. If there is a island, then additionally the feature ”watercourse bifurcation“ must be recorded.
Watercourse widening	They are local widenings of the riverbed. For smaller rivers it is more than doubled, for larger rivers at least 1.5 times of their average width. Small, local bays, for instance between wood should normally not be recorded as watercourse widening. If within a survey unit there is a watercourse narrowing and the riverbed returns to its original width in the downstream course, there is no additional watercourse widening.
Watercourse narrowing	They are local narrowings of the riverbed. For smaller rivers it is less than the half, for larger rivers at least 2/3 of their average width. If within a survey unit there is a watercourse widening and the riverbed returns to its original width in the downstream watercourse, there is no additional watercourse narrowing.
Watercourse bifurcation	These are natural bifurcations of the river in two or more arms, which are constantly flooded, as they are found with branched rivers or rivers with side watercourses. In the genesis, there is a difference between the island formation, the shore bars and the watercourse bifurcation. The shore bar is characterised by debris accumulations surrounded with water without land vegetation. Islands are land areas surrounded by water with durable land vegetation.

SP 1.4 Watercourse features

	Artificial drainages should not be recorded.
Oxbow lakes, side watercourses	**Oxbow lakes:** e. g., a river segment which has been created by a meander strangulation which is still connected with the river permanently. **Side watercourses**: permanently flooded watercourses which are much smaller than the main course.
Beaver dam	Transverse structure made of deadwood, built by beavers which result in backwaters in the river.

SP 1.4 Watercourse features

Deadwood jam

Deadwood jam

Fallen tree

Fallen tree

Watercourse narrowing

Watercourse narrowing

Watercourse widening

Watercourse widening

SP 1.4 Watercourse features

Watercourse bifurcation

Watercourse bifurcation

Island formation

Island formation

Oxbow lake

Side watercourse

Beaver dam

Main parameter 2: Longitudinal profile

SP 2.1 Transverse and special features

Definition

Transverse and special artificial constructions can take various forms. They are all installed across or obliquely to the direction of flow over the entire width of the riverbed. They are hydromorphologically and ecologically effective and have a great importance for the assessment of the ecological functions of a river. Transverse structure includes for instance the construction types movable dams, bed fall/bed fall stairs, ground sills, ramps, slidings or dams. “Special steuctures” are “pumping stations” or “culverts”.

Indicator properties

Transverse and special structuress are continuity barriers for organisms, but also for the transport of debris and sediments. Because of lacking debris, type specific features cannot be built to a river type conform extent. Thereby, they are responsible for bed-load traps or continuity barriers and lead to interruptions and malfunctions of the river ecosystem in the longitudinal continuum. Furthermore, these constructions are able to cause low-flow backwaters with atypical morphological conditions and biotops.

Information for the mapping

The characteristics of all transverse and special structures that exist in the survey unit must be counted (multiple registration).

For small rivers this parameter must be recorded in the field.

For large rivers the transverse and special contructions are to be requested from the authorities or shall be determined by analysis of aerial photos which must be subsequently verified in the field. Information on type and number of transverse and special structures must be requested from the competent agencies in the field of maintenance work or they must be taken from construction registers. Since, in light of past experiences, these data can be incomplete, this parameter must be additionally recorded in the field. For the determination of the precise location, aerial photos or the German Basic Map can be used.

Since the barrier effect is greater if the difference of water levels before and behind a barrier is increasing, which can lead to a complete impassability for aquatic organisms and sediments, for bed falls and bed fall cascades, the water level difference between up- and downstream must be recorded and classified in the classes 0.1–0.3 m, >0.3–1 m and >1 m.

For movable weirs with a near-surface closure, the maximum water level difference must always be assessed, even if it is open at the time of mapping.

SP 2.1 Transverse and special features

Movable weirs with outlets close to the riverbed are always recorded as ”transverse structures with an outlet close to bed“, regardless of whether they are open or closed at the time of mapping, because they are normally open all year long.

Follow up structures induced by transverse or special structures like potholes or stilling basins, watercourse widening by flowing around a construction are not regarded as valuable features, even if they lead to a local upgrading of the ecological status.

If a transverse or special structure is positioned exactly between two survey units, it will always be mapped in the upper survey unit, since also the damming impact is registered in the upper survey unit.

Bed falls caused by in- and outputs of culverts or pipings/overbuildings with a water level difference of ≥10 cm, are (regardless of the culvert and piping) additionally recorded as “bed falls” by the SP 2.1 “transverse and special features” in accordance with the actual water level difference.

Beaver dams and other natural morphological structures like ”overflowed substrates“, “bed falls” (transverse bars made by outcroppingg bedrock or fallen trees) and “transverse structuress” resembling natural transverse bars and not classified as “constructions” (e. g., assistance for restauration measures made of autochtonous material like inserted stones to slow the flow) are mapped under the SP 1.4 “watercourse features“, SP 2.4 “transverse bars“, SP 3.4 “bed features“ or SP 5.2 “bank protection“.

SP 2.1 Transverse and special structures

If a transverse or special stucture is composed of a series of different construction types, e. g.,”bed fall with ramp downstream”, then both features must be recorded.

If a transverse or special structure is composed of adjoining independed construction types, e. g., “bed fall” >1 m and located next to it a ”rough ramp“, then only the construction type with the highest = worst index value is recorded and evaluated per index value (in this example the bed fall >1 m).

For neighbouring transverse and special structures which have the same index value (see tables in chapter 4.2.2), the following sequence must be observed:

Transverse and special structures with an index value of 7

1. Pumping station
2. Culvert construction
3. Dam
4. Movable weir/bed fall/-cascades >1 m

Transverse and special structures with an index value of 6

1. Movable weir/bed fall/-cascades with a fish passage >1 m
2. Movable weir/bed fall/-cascades > 0.3 – 1 m
3. Movable weir/bed fall/-cascades 0.1 – 0.3 m
4. Smooth ramp

Transverse and special structures with an index value of 5

1. Movable weir/bed fall/-cascades with a bypass watercourse >1 m
2. Movable weir/bed fall/-cascades with a fish passage >0.3 – 1 m
3. Movable weir/bed fall/-cascades with a fish passage 0.1 – 0.3 m
4. Not assignable construction
5. Smooth ramp

Transverse and special structure index x

1. Transverse structures with a near-bed outlet/sewer watercourse
2. Ground sill (<0.1 m)

SP 2.1 Transverse and special structures

Forms of transverse structures	
No transverse features	There is none of the below described transverse and special features identifiable within the survey unit. A natural transverse structure like a beaver dam is not regarded as a transverse structure.
Movable weir/bed fall/-cascade	**Movable weir:** transverse structuress with movable components, with a near-water surface closure and with a maximum water level difference between up- and downstream of at least 10 cm, that means there is a solid base with a permanent water level difference of >10 cm. A movable weir shows e. g., functioning rails or other building components for fixing a closure, even if they are not present at the mapping date. A movable closure can be built in different ways using different materials (e. g., wood, metal, concrete, brickwork). A movable weir can be composed of one or various normally separately controllable closures, placed side by side. Constructions with movable closures fort he regulation of fish ponds are not recorded here. Earth bodies, dykes and reservoirs are not to be recorded as movable weirs because their throughflow structures with movables closures are only closed in the case of a flood event. These throughflow structures are, depending on the length, recorded by the SP 2.2 “piping/overbuilding” or by the SP 4.5 “culvert/bridge“. Incisions of dykes with movable closures are not recorded here, but mapped as “sluice”. **Bed fall:** a solid weir across the entire river width with a vertical inclination from 1:0 to a steeply sloped crash wall with an inclination of 1:3 without movable components like slides or gates. Possibly existent stilling basins downstream are not considered for the determination of the inclination as ratio between current water level difference and construction length. The bed fall is inserted in the river perpendicularly or obliquely to the flow direction. Its upper edge is distinctly located above the riverbed and causes an actual water level difference of at least 10 cm. Construction materials can be wood, armourstones or concrete. Also a bed fall below a piping or a culvert construction must be recorded here, additionally to the mapping of the construction according to its length by the SP 2.2 “piping/overbuilding“ or SP 4.5 ”culvert/bridge“. **Cascade:** a solid weir across the entire river width with a vertical steep sloping wall in the shape of a cascade and a water level difference of at least 10 cm. The bed fall cascade is inserted perpendicularly or obliquely to the flow direction in the river. A cascade consists of at least two steps. The highest water level difference between the steps is ≥0.10 m. The water level difference of further teps can also be <0.10 m. The step spacing of the single bed falls must be ≤2 m and form a clear functional/constructional unit. If one of the aforementioned parameters is not applicable, then the bed

SP 2.1 Transverse and special structures

falls are recorded individually or they form, depending on the actual water level difference and length of the construction, other construction types (e. g., ramps, slidings).

Movable weir/bed fall/-cascade with a fish migration path

Movable weirs, bed falls or bed fall cascades which are equipped with a technical facility for upstream fish migration.

The fish passage serves for the fish migration but not for invertebrates or only to a smaller extent.

Movable weir/bed fall/- cascade with a bypass watercourse

Movable weirs, bed falls or bed fall cascades with a near-naturally designed bypass watercourse in which water flows permanently. The bypass watercourse has been constructed or formed by natural erosion. It has a riverbed free of bed falls which is slightly inclined. The side watercourse can flow around the construction for a longer distance.

The bypass watercourse has a water depth of more than 10 cm permanently. It is passable for large and small fishes and invertebrates. If it does not meet the requirements, only the construction must be be registered.

Unpermitted constructions

All types of transverse structures that are apparently not designed and constructed professionally, like dams built by children. The unpermittedconstructions can be made of different materials like wood, stones, rubble or waste.

The unpermitted constructions can look, with respect to their form, similar to a bed fall or a dam.

Unpermitted constructions in the form of ”bridges“ are not recorded, like single wooden planks over the river.

Ground sill (<0.1 m)

A transverse structure over the entire river width e. g., made of concrete, metal, brickwork, wood or tile set which only rises a little from the riverbed level, so that the actual water level difference is <0.10 m. The ground sill is inserted in the river transversely or obliquely to the flow direction.

A man-made ground sill should not be confused with natural structures, like stone ribs or rock ridges.

A ground sill has only a low barrier effect to bed-load.

Smooth sliding

Slidings are constructions without movable components across the whole river width and are transversely or obliquely inserted in the river.

The sliding surfaces show a height to length ratio from <1:10 to 1:30. The surface of this construction is smooth, the current is very strong and uniform. Probably downstream existent stilling basins are not considered for the determination of the inclination as ratio between current water level difference and construction length.

The construction surface is smooth. The flow is uniform and strong.

The constructions are passable for large fishes at mean water level due to their floatability and jumping power. For small fishes and invertebrates, the slidings are not passable.

The sediment transport is normaly only slightly reduced.

Rough sliding

Slidings are constructions without movable components across the entire river width and are transversely or obliquely inserted in the

SP 2.1 Transverse and special structures

river. The sliding surfaces show a height to length ration from <1:10 to 1:30. Possibly existing stilling basins downstream are not taken for the determination of the inclination as ration between the actual water level difference and the contruction length

The surface of this construction is rough, the current is variing and turbulent.

These constructions are often passable for large and small fishes and invertebrates at mean water level. This applies in particular to very flat-formed rough slidings which are often built within the scope of restauration measures (e. g. restructuring of bed falls: rockfill sliding made of armourstones).

The sediment transport is normally only slightly reduced.

Smooth ramp

Ramps are constructions without movable components over the entire river width and are transversely or obliquely inserted in the river. The sliding surface is inclined at a ratio of <1:3 to 1:10. The surface of the construction is smooth. The flow is uniform and large.

The constructions are passable for large fishes at mean water level due to their floatability and jumping power. For small fishes and invertebrates the ramps are not passable.

The sediment passability is normally only slightly reduced.

Rough ramp

Ramps are constructions without movable components across the entire river width and are transversely or obliquely inserted in the river. The ramp surface is inclined at a ratio of <1:10 to 1:30. The surface of this construction is rough, the current is variing and turbulent.

These constructions are limitedly passable for large and small fishes and invertebrates at mean water level.

The sediment passability is normally only slightly reduced.

Transverse structures with a near-bed outlet/sluice

Transverse structures with a near-bed outlet e. g., movable transverse structures with a slide or a sluice gate without a solid base. The opened transverse structure with a near-bed outlet does not show any water level difference that means in the surrounding area of the construction the natural riverbed is in a normal condition.

It can surely be excluded that constructions or closure elements are existent in or on the river bottom. If this cannot be excluded, then this construction must be recorded as ”movable weir“.

Monk buildings are not covered by this feature.

Transverse structures with a near-bed outlet are normally open and for instance only closed for the storage of water in a short period of time. Therefore, they are regarded as a barrier for the passability of aquatic organisms and bed-load.

Sluices: sluices are closing devices to conduct surface waters through a pond. They can be designed in the form of sluice gates.

Sluices are normally open and are only closed in a short term, e. g., at flood. Therefore, they are not an obstacle for the migration of aquatic organisms or for bed-load.

Sluices incisions which are open on top, later established bridges are

SP 2.1 Transverse and special structures

addionally recorded under the SP 4.5.

Incisions in earth bodies of flood control reservoirs that are not operated as permanently accumulated water which are installed with closures are not recorded as sluices.

Dam

A dam is a construction which is transversely or obliquely inserted in the river and not overflowed at mean water level. A dam distinctly emerges from the riverbed and causes a permanent backwater in the river at mean water level, even if leakages partially are possible. It is built by armourstones, natural stones, brickwork, concrete or steel.

It can fundamentally be assumed that a dam has a discharge or overflow option. Such construction elements belong to the dam and are not recorded separately.

The dam of a flood control reservoir (HRB) which causes an accumulation effect on the river at mean water level is not recorded as dam. The culvert through the HRB is recorded depending on its length in the SP 2.2 or SP 4.5.

Dams of reservoirs and auxiliary dams are not recorded.

The passability for fishes, aquatic organisms and bed-load is not possible.

Types of special structures

Pumping station, ladling facility

A pumping station or a ladling facility serves as technical lifting device for overcoming height differences in a river, e.g., because of mining-related subsidence. The river or the majority of water to be mapped disappears via rakes and inflows into a company building.

Using a **ladling facility,** the water is elevated from a lower (not free flowing) to a higher level in order to create a slope for its discharge.

A **pumping station** is a technical facility in order to elevate water under pump pressure from a lower (not free flowing) river to a higher river to create a slope for its discharge.

The passability for fishes, invertebrates and bed-load is not possible.

Inverted siphon

An inverted siphon is a crossing construction in which the river to be mapped subterranneously crosses another generally artificial river, like a shipping watercourse. The river to be mapped ”disappears“ into the underground and after under-crossing comes to the surface again and flows further on the previous terrain height.

Inverted siphons normally are water-filled pipelines which watercourse the river to be mapped below an obstacle without pumps by hydrostatic pressure according to the principle of communicating vessels.

An aqueduct is not a culvert.

A passability for fishes is only possible to a limited extent. The passability for bed-load is significantly restricted.

SP 2.1 Transverse and special structures

Water level difference between up- and downstream at the time of survey mapping

0.1 – 0.3 m

For movable weirs, the maximum water level difference between up- and downstream waters is 0.1 – 0.3 m. For bed falls and cascades the actual water level difference is 0.1 – 0.3 m.

The bed fall is passable for large fishes. For small fishes or invertebrates, this is only possible to a limited extent.

The passage for bed-load is normally only limited to a smaller extent.

>0.3 - 1 m

For movable weirs the maximum water level difference between upper- und downstream is >0.3 – 1 m. For bed falls and bed fall cascades the actual water level difference is >0.1 – 0.3 m.

The construction is only passable for large fishes to a limited extent at mean water level due to their floatability and jumping power. For small fishes and invertebrates the ramps are not passable.

The sediment transport is normally reduced.

>1 m

For movable weirs the maximum water level difference between upper- und downstream is >1 m or rather for bed falls and bed fall cascades the actual water level difference is >1 m.

An autonomous passage for large and small fishes or invertebrates is not possible.

The sediment transport is clearely restricted.

SP 2.1 Transverse and special features


Movable weir 0.3 – 1 m


Movable weir 0.3 – 1 m


Movable weir 0.3 – 1 m


Movable weir >1 m


Small bed fall 0.1 – 0.3 m


Small bed fall 0.1 – 0.3 m


Medium bed fall 0.3 – 1 m


Medium bed fall 0.3 – 1 m

SP 2.1 Transverse and special features

High bed fall >1 m

High bed fall >1 m

Cascade 0.3 – 1 m

Cascade >1 m

Movable weir >1 m with fish passage (left)

Bed fall >1 m with fish passage (fish ladder)

Movable weir >1 m with bypass watercourse (right)

Movable weir >1 m with bypass watercourse

SP 2.1 Transverse and special features

Unpermitted construction

Unpermittedconstruction

Ground sill (<0.1 m)

Ground sill (<0.1 m)

Rough ramp

Rough ramp

Smooth sliding

Smooth sliding

SP 2.1 Transverse and special features

Smooth ramp

Smooth ramp

Rough ramp

Rough ramp

Transverse structure with a near-bed outflow

Transverse structure with a near-bed outflow

Sluice

Sluice

SP 2.1 Transverse and special features

Dam

Dam

Pumping station

Inverted siphon

Bed fall, downstream of a rough ramp

Bed fall, downstream of a smooth sliding

No inverted siphon

SP 2.2 Piping/Overbuilding

Definition

Piping/Overbuilding normally are subterranean pipeline relocations or overbuildings over the rivers, e. g., areawide barriers like agriculturally used and forested areas or buildings but also traffic routes (e. g., motorways, railway lines, streets) and passages of earth bodies in connection with flood control reservoirs which account for more than 10 % of the survey unit.

Indicator properties

The river has been built over or piped at least sectionwise. Interrelations with its surroundings and the groundwater body are normally no longer possible. The overbuildings or pipings serve as barrier for many organisms as barriers for the migration and spreading.

Information for the mapping

All separated and differently characterised pipings/overbuildings (in relation to length and sediment management) within a survey unit are counted separately (multiple registration).

A piping or a culvert exists if a river flows through a pipe or an artificial watercourse (especially for large rivers), extensively covered or overbuilt and if this construction is longer than 10 % of the survey unit. Also passages through earth bodies belonging to flood control reservoirs with movable components (for instance flaps) and with a relevant length must be recorded.

For small rivers the assessment of this parameter is performed in the field.

For large rivers, the determination of the location of culverts is firstly made by the analysis of aerial photos or the German Basic Map. Information on the sediment freight can partially be requested from the competent responsables of the river maintenance. Since these data can be incomplete, this parameter must be additionally recorded in the field.

If a piping/overbuildingt intrudes into two adjacent survey units, this construction will be recorded in each survey unit according to its length which it takes up there. The result might be that one construction is recorded in one survey unit as “piping/overbuilding” and in the neighbouring survey unit as “culvert/bridge”.

If a construction consists of two or more adjoining identical pipings or overbuildings, they are recorded as one construction.

If the total length of pipings takes more than half of the survey unit, then the special case “major part watercourse-sized” must be registered in the master data. If the survey unit is completely piped, the special case “completely watercourse-sized“ must be entered in the master data.

SP 2.2 Piping/Overbuilding

By reasons of safety at work it is explicitly forbidden to enter pipings/overbuildings.

For the mapping of sediments, the thickness of the natural sediment in the entire construction or at their openings is recorded.

Pipings/overbuildings of a river which take less than 10 % of the survey unit, are mapped by the SP 4.5 ”culvert/bridge“.

If the bottom of the piping/overbuilding has a bed fall with an actual water level difference of ≥10 cm at its downstream opening or rather causes a backwater at mean water level above upstream of the culvert, this must additionally be mapped by the SP 2.1 ”transverse and special features“ and the SP 2.3 ”backwater“.

Special case	
Major length piped/overbuilt	If more than 50 % of the survey unit is piped or overbuilt, this will be registered in the questionnaire in the block “identification“, as the special case “characterisation of the actual state”. For informational purposes, only the SP 6.1 “adjacent land use“ and the SP 6.3 ”harmful adjacent land pressures“ are evaluated. Other SPs are not taken into consideration. For the main parameter and the overall evaluation the index value of 7 is given.
Completely piped/overbuilt	If 100 % of the survey unit is piped or overbuilt, this must be registered as ”special case” in the identification block of the questionnaire under the block “characterisation of the current state”. The mapping is cancelled, except for the SPs 6.1 ”adjacent land use“ and 6.3 ”adjacent land pressures“. For the main parameter and the overall evaluation the index value of 7 is given.

Features	
None	There is no piping/overbuilding.

Length of the piping/overbuilding of a 100 m long survey unit

>10 - 20 m	The total length of a piping/overbuilding is more than 10-20 m within the survey unit.
>20 - 50 m	The total length of a piping/overbuilding is more than 20-50 m within the survey unit.
>50 m	The total length of a piping/overbuilding is more than 50 m within the survey unit. There is a ”special case“.

Length of the piping/overbuilding of a 500 m long survey unit

>50 - 100 m	The total length of a piping/overbuilding is more than 50 – 100 m

SP 2.2 Piping/Overbuilding

By reasons of safety at work it is explicitly forbidden to enter pipings/overbuildings.

For the mapping of sediments, the thickness of the natural sediment in the entire construction or at their openings is recorded.

Pipings/overbuildings of a river which take less than 10 % of the survey unit, are mapped by the SP 4.5 ”culvert/bridge“.

If the bottom of the piping/overbuilding has a bed fall with an actual water level difference of ≥10 cm at its downstream opening or rather causes a backwater at mean water level above upstream of the culvert, this must additionally be mapped by the SP 2.1 ”transverse and special features“ and the SP 2.3 ”backwater“.

	within the survey unit.
>100 - 250 m	The total length of a piping/overbuilding is more than 100 - 250 m within the survey unit.
>250 m	The total length of a piping/overbuilding is more than 250 m within the survey unit.

Length of the piping/overbuilding of a 1000 m long survey unit

>100 - 200 m	The total length of a piping/overbuilding is between 100 and 200 m within the survey unit.
>200 - 500 m	The total length of a piping/overbuilding is between 200 and 500 m within the survey unit.
>500 m	The total length of a piping/overbuilding is more than 500 m within the survey unit.
	There is a „special case“.

Structure of the riverbed in the piping/overbuilding	
Without sediment	The bed or rather the overflowed section of the piping/overbuilding is not or only partially covered with sediments. The possible partial coverage has a layer thickness up to 10 cm. This is expected to be the case, if at the ends of the tube only one end shows a sediment coverage.
With sediment	The bed in the overbuilt or piped segment consists of continuous natural sediments coverage in the complete area. **The riverbed is passable for rivers with a width of below 10 m on the condition that the natural sediment thickness is at least 10 cm.** Rivers with a width over 10 m are passable in the event that the natural thickness is at least 20 cm. This is to be assumed in the event that both pipe ends show this characteristic.
Not visible	The bed is not visible in case of high turbidity or great depth, so that it cannot be recognised if there are sediments in the pipings/overbuildings or rather at their openings.

SP 2.2 Piping/Overbuilding

By reasons of safety at work it is explicitly forbidden to enter pipings/overbuildings.

For the mapping of sediments, the thickness of the natural sediment in the entire construction or at their openings is recorded.

Pipings/overbuildings of a river which take less than 10 % of the survey unit, are mapped by the SP 4.5 ”culvert/bridge“.

If the bottom of the piping/overbuilding has a bed fall with an actual water level difference of ≥10 cm at its downstream opening or rather causes a backwater at mean water level above up-stream of the culvert, this must additionally be mapped by the SP 2.1 ”transverse and special features“ and the SP 2.3 ”backwater“.

SP 2.2 Piping/Overbuilding


Piping/Overbuilding >10 m, with sediment


Piping/Overbuilding >10 m, without sediment


Piping/Overbuilding >20 m, with sediment


Piping/Overbuilding >20 m, without sediment


Piping/Overbuilding >100 m, with sediment


Piping/Overbuilding >250 m, not visible


Piping/Overbuilding >10 m, without sediment (flow through an earth body of a flood control reservoir)

SP 2.3 Backwater

Definition

The clearly visible reduced water flow across the entire river width (flow pattern smooth) in the upper reaches of constructions (e. g., transverse structures, pipings or culverts) or natural transverse structures (like deadwood jam or beaver dams, but not transverse bars) in comparison with the free-flowing downstream reaches.

Indicator properties

The higher the flow speed is reduced and the longer the backwater is, caused by reservoirs, the higher the negative impact of the water retention on the dynamic of the riverbed is. This applies in particular to the physical and chemical conditions of the flow and of the sediment transport.

The recognisable backwater length of the clearly dammed watercourse can be regarded as measure of the potential harmful effect at mean water levels.

Information on mapping

The parameter is recorded upstream of the constructions (e. g., transverse or special structures, pipings/overbuildings or culverts) as technical backwater. For natural transverse structures, for instance because of beaver dams, this parameter is recorded as natural backwater.

There is a multiple registration. All features of backwater within a survey unit are counted.

The parameter must be assessed in the field and for large rivers it must be verified on-site. For the determination of the exact position of the constructions causing backwaters, aerial photos or the German Basic Map are available.

A request to national competent authorities can facilitate the survey mapping of large rivers.

The clearly visible reduction of the river velocity across the entire river width (flow pattern smooth) at mean water level in comparison with the flow velocity within the open river segments is recorded as backwater. Decisive for the comparison of river velocities is the mean flow velocity at the water surface in the middle of the river section upstream of the construction or of the natural transverse and downstream of the construction or of the natural crossing structure in the free-flowing section. Stilling basins directly below the construction are excluded for this comparison.

Decisive is the length of the river section which shows a clearly reduced river velocity at the water surface in the middle of the water body at mean water level in comparison with the free-flowing not dammed water stretches. Indicators can be: watercourse widening, size of the water level difference, smoother water surface.

SP 2.3 Backwater

If there is a technical backwater stretch with a length of >50 % within a survey unit and the medium latitude exceedes more than three times of the average river width, this is the special case of “standing waters in main connection”, like reservoirs, fish ponds or miller’s ponds. This must already be registered in the block “identification“ of the surveying sheet as “special case” under the the “characterisation of the current state”. The mapping is cancelled except for the SPs 6.1 ”adjacent land use“ and 6.3 ”adjacent land pressures“. For the main parameters and for the overall evaluation the index value of 7 is given.

If the backwater extends over various survey units, it will be recorded in each survey unit and evaluated corresponding to its length.

For small fine material-rich rivers in the lowlands with (very) slight gradients, the registration of backwater is very difficult, because these rivers have a natural low flow with a smooth flow pattern. The recorded length of the backwater should be in relation to the construction which causes this backwater. Normally, sleepers, slidings or ramps do not lead to a long backwater stretch.

Due to the above-mentioned circumstance, the assessment of the backwater for the following morphological river types is only performed for informational purposes and is not included in the valuation:

- AT_o: hollow and floodplain rivers, organic
- OT_o: rivers without valleys, organic
- AT_fl: hollow and floodplain rivers, fine matrial rich –loess, -loam
- OT_fl: rivers without valleys, fine material rich –loess -loam
- AT_fs: hollow and floodplain rivers, fine material rich -sand
- OT_fs: rivers without valleys, fine material rich –sand

The coarse material-rich (gravelly) lowland river of the morphological type AT_g (hollow and floodplain river, coarse material rich) or OT_g (rivers without valleys, coarse material rich) naturally have a steeper gradient. For these morphological types the anthropogenic caused backwater can be clearly mapped and evaluated.

Naturally caused backwaters are only registerd for informational purposes.

SP 2.3 Backwater

Kinds of backwater	
Technical backwater	A permanent backwater in rivers upstream of constructions, like transverse structures but also pipings or culverts.
Natural backwater	Normally a time-limited backwater phenomenon in rivers, for instance because of beaver dams or massy deadwood jams. Natural backwater is only recorded for informational purposes.

Features	
None	Either there is no transverse structure and consequently no artificial backwater or there are only such constructions which do not visibly cause a decrease of river velocity and an identifiable backwater.
<10 m	The length of the backwater is less than 10 m within the survey unit.
10 - 50 m	The length of the backwater is more than 10 - 50 m within the survey unit.
>50 - 100 m	The length of the backwater is more than 50 - 100 m within the survey unit.
>100 - 250 m	The length of the backwater is more than 100 - 250 m within the survey unit.
>250 m	The length of the backwater is more than 250 m within the survey unit.

SP 2.3 Backwater

Technical backwater <10 m

Technical backwater 10 – 50 m

Technical backwater 10 – 50 m

Technical backwater 50 – 100 m

Natural backwater <10 m (photo: Pottgiesser)

Natural backwater >100 m (photo: LANUV)

SP 2.4 Transverse bars

Definition

Natural transverse bars are local accumulations of bed-load of coarse substrates partially over the whole river width. Depending on the morphological river type and the riverbed characteristic, ripple-pool structures are created resulting in highly differentiated flow conditions.

Transverse structures are identifiable by a visible corrugation of the water level. Their extent reaches mostly over the whole river width. They can run perpendicularly or obliquely to the flow direction.

Also natural ground sills in the riverbed must be counted as transverse construtions.

Indicator properties

Natural transverse bars are formed by nature in nearly all rivers in a regular spatial sequence. They are based on a natural unevenness of the debris transport and on a rhythmical trend change between erosion and accumulation in the flow direction. The complete stock of river type conform transverse bars is a reflexion of a well-balanced bed-load regime, natural floods, high diversity and a dynamic river stability. The transverse bars are especially indicators for the morphological integrity of a river.

Information on mapping

There is a simple registration of the formed transverse bars. The transeverse bars are counted and classified in the classes ”none, naturally”, “none, anthropogenically”, “one to two”, “various”, and “many”. If rivers are strongly turbid, then the riverbed is not visible and therefore transverse bars are not identifiable. In these cases, this feature must be recorded as “not identifiable”.

This parameter must be mapped in the field for smaller rivers and must be verified for large rivers. For the assessment of transverse bars of large rivers aerial photos and the German Basic Map are available.

Transverse bars are normally overflowed at mean water level (ripple-structures). Only transverse bars are recorded which are clearly identifiable and definable by the roughness of the water level or by a local uprising of the riverbed and their length expansion at least correspond to the half river width.

The transverse bars mapped here and under the SP 3.4 ”bed features“ recorded runs and ripples are the same feature. The mapping of both features should be consistent using both SPs.

Shingle- and gravel rich rivers generally have the largest amount of transverse bars. For smaller rivers, like brooks, the ground sill for mapping of transverse bars should be water-specifically determined at a lower level. For large rivers the elongation of the transverse bars is variable and can amount to a maximum of 100 m (depending on the valley type and on the natural bed substrate).

SP 2.4 Transverse bars

Because it is not generally possible to determine how many transverse bars must be found within a natural survey unit, the classification of the terms ”many“ and ”various“ against the background of the respective reference conditions must be done by professional assessment. As a rough guide, 3 to 5 transverse bars can be considered as ”various“ and >5 transverse bars as “many”. In the presence of the substrate types “sand”, “loam” and “organic” the term ”none, naturally“ is entered for the term “natural profile”, since the feasibility for mapping is naturally highly restricted. In case of regulated profiles, rivers with these substrate types must be recorded as ”none, anthropogenically“.

SP 2.4 Transverse bars

Types of transverse bars

Ripples / Runs

These are local elevations of the riverbed in the longitudinal profile. They extend across the entire river width and are the result of natural accumulations of extremely coarse sediments. The water depth is considerably reduced above the elevations at low and mean water level. The water level is either widely visible roughed or significantly expanded.

The runs, by nature in all riverbeds characterised by shingles and gravels, exist in large quantities and in relatively regular distances (natural sequence of pools and ripples).

Man-made fords for the crossing of a river are not recorded as transverse bars. They are assessed corresponding to their construction type by the SP 3.3 “bed fixation“.

Cascades

Cascades are natural longer stairs-like gradients of the riverbed. In the rivers they have the shape of smooth stairs with a moderate gradient or of small rapids. In gradient-rich rivers they have the shape of a regular bottom, of large rapids or of rocky bed falls.

Number of transverse bars per survey unit

None, naturally

For near-natural rivers which are dominated by substrates like ”sand“, ”loam“ or ”organic substrates“ (peat, fallen leaves, macrophytes, deadwood) the term “none, naturally“ is entered because the survey mapping is naturally highly restricted.

None, anthopogenically

Caused by river regulations, there are no transverse bars within a survey unit.

For river types which naturally show no or only a few transverse bars, like sand-bottom or organic rivers, ”none, anthropogenically“ transverse bars must be noted, if by the SP 4.1 “profile type“ a (decaying) technical rule profile is mapped.

One to two

There are one to two distinct transverse bars within the survey unit.

Various

Since it is not possible to determine in general how many transverse bars must be found within a near-natural survey unit, the classification of the term ”various“ must be conducted by the cartographers against the background of the respective reference conditions. As general orientation 3 to 5 transverse bars can be considered as “various”.

Many

Since it is not possible to determine how many formed transverse bars can be discovered within a survey unit, the classification of the term ”many“ must be conducted by the cartographers against the

SP 2.4 Transverse bars

Types of transverse bars	
Ripples / Runs	These are local elevations of the riverbed in the longitudinal profile. They extend across the entire river width and are the result of natural accumulations of extremely coarse sediments. The water depth is considerably reduced above the elevations at low and mean water level. The water level is either widely visible roughed or significantly expanded. The runs, by nature in all riverbeds characterised by shingles and gravels, exist in large quantities and in relatively regular distances (natural sequence of pools and ripples). Man-made fords for the crossing of a river are not recorded as transverse bars. They are assessed corresponding to their construction type by the SP 3.3 “bed fixation“. background of the respective reference conditions. As general orientation >5 longitudinal bars can be considered as “many”.
Not visible	Very deep and strongly muddied rivers have an invisible riverbed. Therefore, it is not noticeable if or how many transverse bars exist.

SP 2.4 Transverse bars


Rapid


Rapid


Cascade


Cascade


No transeverse bar, man-made ford

SP 2.01 Flow patterns

Definition

The structure of the surface water reflexion.

Indicator properties

The diversity of the visible different currents on the water surface forms the basis for the assessment of the flow diversity.

Informations on the mapping

There is a multiple registration.

This parameter must be recorded in the field and must be veryfied for large rivers. For the assessment of transverse bars of large rivers aerial photos or the German Basic Map are available.

Only the structure of the clear visible water level is recorded, divided into river sections with different surface structures.

The flow patterns are only recorded for informational purposes. **But the number of flow patterns and the mapped features by the SP 2.5 “flow variation” have to fit together.**

SP 2.01 Flow patterns

Features	
Smooth	Sections of the river in which no current-induced deformation of the water surface is visible. Any potential existing furrows and waves on the water surface are wind-created deformations. The water surface would be completely smooth without wind effect. The flow velocity is moderate to low.
Ribbed	Sections of the river in which the water surface is characterised by many small waves flowing with the current and mixing and interfering with each other, caused by small punctual flow obstacles (wooden parts, riparian plants, larger stones). The flow velocity is moderate to vivid.
Gently lapping	The river velocity is vivid. The water flow is noticeable by gently lapping background noises.
Waved	Sections of the river in which the entire water surface is deformed like ribbed corrugated iron by many large waves with round wave-tops. The waves are stationary or flowing with the current. The river velocity is high or very high.
Comb-shaped	Sections of the river in which the entire water surface is deformed by large comb-shaped wave-tops partly breaking. The waves are stationery and do not flow with the current. The river velocity is very high.
Turbulent	Sections of the river in which the entire water surface is thunderuous, spraying and full of rollers and whitecaps. The river velocity is very high.

SP 2.01 Flow patterns

Smooth

Ribbed

Gently lapping

Waved

Comb-shaped

Turbulent

SP 2.5 Flow variation

Definition

The spatial complexity of the current flow, as far as it is recognisable at low water level by the different structures of the water surface and the abundance and the extent of the spatial change of water depths in the longitudinal and transversal flow direction (in the middle of the water body), insofar as the depth changes are identifiable by an on-site visual inspection or by exploration using a ranging rod.

Indicator properties

The visible flow differences on the water surface are signs for hydraulical, sedimentological and biological effective formations and the morphological complexity of the riverbed at all water levels. They are the result of interactions between flow- and depth differences of the riverbed.

Information on mapping

There is a simple registration.

This parameter must be recorded in the field and must be veryfied for large rivers. For the assessment of transverse bars of large rivers aerial photos or the German Basic Map are available.

The registration of the flow variation is performed by the clear organisation of the survey unit, according to the structure of the water surface. Only the clear visible structure of the water surface in several sections with different surface structures is recorded. **The mapped flow variation and the number of flow patterns, recorded by the SP "2.01", have to fit together.**

The feature "artificially increased" is additionally intended for the cases in which the flow variation is artificially increased, e. g., because of a discharge.

SP 2.5 Flow variation

Features	
None	The water surface is completely smooth throughout the whole survey unit. There is only one flow pattern.
Low	The water surface shows clear sporadic differences but in total only low local differences within the survey unit. There are two flow patterns, one of these only to a minor extent.
Moderate	The water surface is characterised by a repeated alternation of the flow velocity within the survey unit. The flow differences are mostly low. There are three flow patterns, two of them to a minor extent.
High	The water surface is characterised by a repeated clear alternation of the flow velocity within the survey unit. There are at least tree flow patterns, two of them to a large extent.
Very high	The water surface is characterised by multiple and strong changes of the water flow within the survey unit. There are more than three flow patterns, assessed by the SP 2.01 “flow patterns”, at least tree of them to a large extent.
Artificially increased	The flow variation is, e. g., because of a discharge, a construction or a riverbed reshaping, increased in comparison with the natural state.

SP 2.5 Flow variation

None

Low

Moderate

High

Very high

Artificially increased: rough ramp with root elements

SP 2.6 Depth variation

Definition

Abundance and extent of spatial changes of the water depth along the river course (in the middle of the water body), insofar as the depth changes are identifiable by an on-site visual inspection or by exploration using a ranging rod.

Indicator properties

The depth changes of the riverbed at mean water level is, like the flow variation, a similar parameter for hydraulical, sedimentological and biological complexity of the water body and of the riverbed.

Information on mapping

There is a simple registration.

The parameter must be recorded in the field and must be veryfied for large rivers. For the assessment of transverse bars of large rivers, aerial photos or the German Basic Map are available.

Only the clear visible depth class differences are considered. The water body is, concerning its changing depths, mentally divided into sub-sections.

The feature ”artificially elevated“. This characteristic is additionally provided for the cases with a discharge impact.

SP 2.6 Depth variation

Depth classes	
Extremely deep water	Sub-sections of the river in which the water depth is three times deeper than the average water depth within the whole survey unit at mean water level.
Deep water	Sub-sections of the river in which the water depth is twice as deep as the average wasser depth level within the whole survey unit at mean water.
„Average water depth“	Sub-sections of the river in which the water depth corresponds to the average wasser depth within the whole survey unit at mean water level.
Shallow water	Sub-sections of the river in which the water depth is only a third deeper than the average wasser depth within the whole survey unit at mean water level.
Extremely shallow water	Sub-sections of the river in which the water depth is less than a third as deep than the average water depth within the whole survey unit at mean water level.

Depth variation	
None	The water depth of the river is completely homogeneous within the whole survey unit. It corresponds to the average water depth.
Low	The river shows occasionally clear, but in total only small local differences within the survey unit. There are two depth classes, one of these only to a minor extent.
Moderate	The river is characterised by a repeated change of the water depth within the survey unit. But the differences in depth are mostly small. There are namely three depth classes, but two of these only to a minor extent.
High	The river is characterised by a clear repeated change of the water depth within the survey unit. There are at least three depth classes, two of them to a large extent.
Very high	The river is characterised by a multiple and clear repeated change of the water depth within the survey unit. There are more than three depth classes, three of them to a large extent.
Not visible	For very deep or strongly turbid rivers, the riverbed may be invisible, so that the depth class is not identifiable.
Artificially elevated	The depth variation is, for instance as a result of a backwater or a riverbed restructuration (e. g., a stilling basin behind a bed fall), elevated in comparison with the natural state.

SP 2.6 Depth variation

Extremely deep water

Deep water

Average water depth

Shallow water

Extremely shallow water

SP 2.7 Diversion watercourse

Definition

A diversion watercourse is a permanent or temporal diversion of water from riverbed in a diversion watercourse e. g., for hydroelectric power plants. The affected section in the riverbed is defined as diversion watercourse.

A special case of diversion is the bifurcation: here the water output is no longer returned into the main watercourse of the donor river but diversion into a second river (with another water identification number).

The section in the main watercourse of a river that is affected by a reduced amount of water is called **diversion reach**.

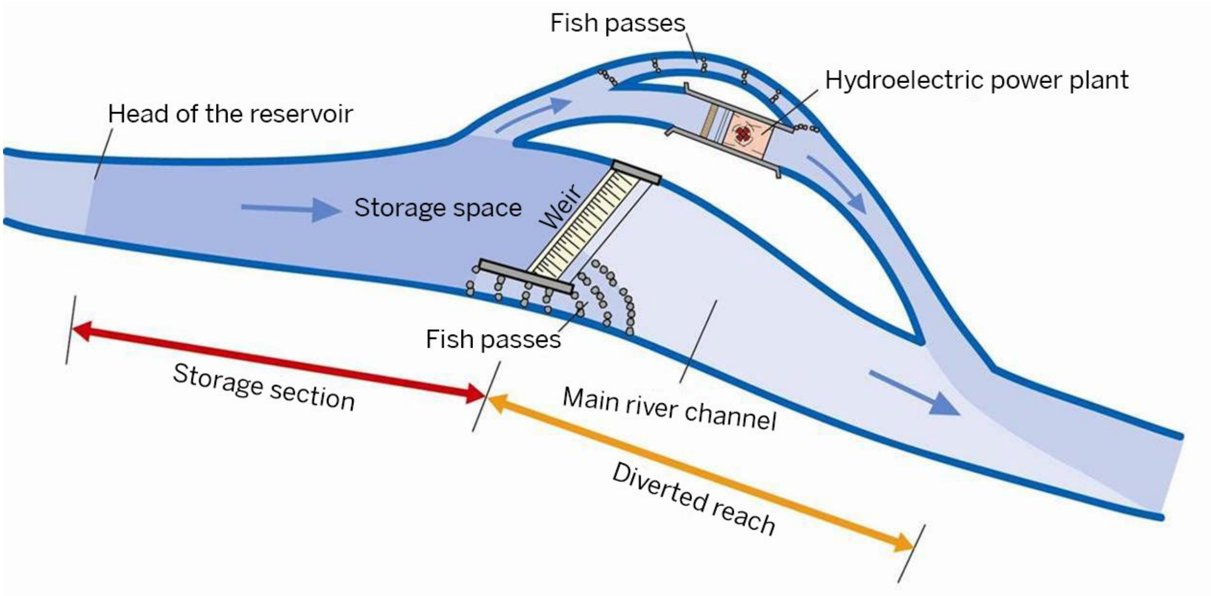


Figure: Construction with diversion (from MUNLV 2005). The diversion watercourse is situated on the left side of the flow direction and is led through the hydroelectric power plant; the river section between the dam and its confluence with the main watercourse is designated as diversion reach

Indicator properties

By the diversion of large amounts of water, the natural discharge dynamic is changed and the natural flow rate is reduced. Especially at low water level, diversions lead to negative impacts affecting the natural ecological functions in the diversion watercourse. At the same time, the river type specific features within the survey unit are distinctly changed by the reduction of the natural flow regime.

Information on mapping

The length of the diversion watercourse is recorded. The diversion watercourse extends from the return of the diversion watercourse in the main watercourse to the point of diversion.

SP 2.7 Diversion watercourse

In the case of a bifurcation, the length of the diversion reach from the mouth or the confluence with a larger river to the construction for diversion purposes is assessed. As larger tributary, a larger river is understood whose outflow shows – so far as it is visually assessable - same dimensions like the river to be mapped.

The survey mapping or rather the validation of the diversion watercourse of small rivers is performed in the field.

For the survey mapping of diversion watercourses of large rivers, aerial photos or the German Basic Map are available. Additionally, requests addressed to competent authorities can be useful. In the field mainly a verification of the assessment is performed for large rivers.

All diversion watercourses within a survey unit are counted corresponding to their length.

For the determination of the exact position of the construction which is relevant for the diversion, aerial photos or the German Basic Map are available. The diversion watercourse begins at the point of recirculation of the water or at the confluence with a larger inflow and ends with the construction for the diversion (mostly a weir).

Because of the direction of the survey mapping from the mouth to the source, for this single parameter (SP) and for all river sizes, a careful preparation is absolutely necessary. In the river stationing map of NRW an own river code has been assigned to all known diversion watercourses and can be presented cartographically. Bifurcations are also shown on the map.

The length of the diversion reaches or water moat is not important for the assessment of the morphological quality. For certain questions also a survey mapping of the diversion watercourse can make sense, e. g., for the evaluation of the ecological passability.

Features	
None	There is no diversion.
<50 m	The length of the diversion watercourse is less than 50 m within the survey unit.
>50 – 100 m	The length of the diversion watercourse is more than 50 – 100 m within the survey unit.
>100 – 250 m	The length of the diversion watercourse is more than 100 – 250 m within the survey unit.
>250 - 500 m	The length of the diversion watercourse is more than 250 – 500 m within the survey unit.
>500 m	The length of the diversion watercourse is more than 500 m within the survey unit.

SP 2.7 Diversion watercourse

Diversion reach > 50 – 100 m

Diversion reach (right) > 50 – 100 m

Diversion reach (left) > 50 – 100 m

Main parameter 3: Bed structure

SP 3.1 Bed substrate

Definition

The type and structure of the occurring substrate, so far as it is assessed on the basis of a simple substrate typification, of visual inspections or of explorations using a ranging rod. Especially for large rivers, the dominant maximum grain size is important, since it describes well the transport capacity and thus defines the river type.

Indicator properties

The SP ”bed substrate“ serves for the survey mapping of occurring mineral and organic bed substrates, for the evaluation of atypical bed substrates and for the evaluation of the river type. Especially in the lowlands, the natural substrate is the basis of the river typification. Below constructions, the grain size distribution can be heavily disturbed.

The bed substrate can be characterised by artificially covered riverbeds and by anthropogenic changes of the sedimentation conditions and therefore obviously changed from the natural river type specific conditions. A change of the substrates, in comparison with natural reference conditions, causes a change of the river ecosystem.

Information on mapping

The mineral and organic substrates are recorded. The distinction between natural and unnatural substrates is made based on the natural habitats and the river type.

Within the mineral substrates, a distincion is made between natural and unnatural substrates (= atypical substrates or bed fixation). The dominating natural substrate type within the survey unit is to be mapped (simple registration). Additionally, all further substrates are marked with a cross if they have an area coverage of more than 5 % (multiple registration). Furthermore, all atypical deposits of substrates are registerd which have a total area of >5 % (multiple registration).

For the organic substrates, a distinction is also made between the dominating (simple registration) and the subordinately occurring substrates (multiple registration).

The assessment of the parameter is performed for the small rivers in the field.

Information on the bed substrates for large rivers can be obtained from competent maintenance authorities. Since this information can be incomplete in the light of experience, they should be additionally verified in the field. If the authorities of maintenance have no or only fragmentary information, then an on-site recording is necessary. Where appropriate, an analysis of aerial photos, of bearing the riverbed or of field protocols for the survey of the biological quality components “macrozoobenthos” or “macrophytes” can be helpful.

SP 3.1 Bed substrate

The recording is performed in consecutive steps. Initially, the amount of the natural mineral substrates is evaluated. The bed substrate which has an area percentage >50% is assessed as ”dominating“; all further mineral substrates with an area coverage >5 % are recorded as “subordinated”. The sum of the mapped mineral substrates must be 100 %.

Subsequently, all unnatural substrates and bed fixations with an area coverage >5 % existing within the survey unit are mapped. In NRW the substrate type ”mud/silk“ is normally an unnatural substrate.

Finally, the organic substrates which cover the mineral substrates are registered. The organic substrate which has an area coverage >50% is assessed as “dominating“. All further organic substrates with an area coverage >5 % are recorded as “subordinated”. The sum of the mapped organic substrates must be 100 %.

Information on the grain sizes of the sediment fractions of “shingles”, “gravels”, “stones” and “blocks” is generalised in the field for easier detection. Therefore, they do not correspond exactly to pedological definitions.

For very deeply or strongly turbid rivers, the riverbed may be invisible, so that the feature “not visible” must be ticked.

If necessary, unnatural mineral substrates with an area coverage <5 % can be recorded under the SP 3.01 “bed pressures“ as building rubble.

SP 3.1 Bed substrate

Types of bed substrates	
Not visible	For very deeply or strongly turbid rivers, the riverbed may be invisible, so that the mineral and organic substrates are not recognisable.

Mineral substrates	
None	Within the survey unit there are no mineral substrates, type-specifically for instance in organic characterised rivers.
Silt/Mud	Predominantly mineral silt or mud with a pasty consistency or a silty material; sludge is for instance mainly of organic origin, but here it is recorded as unnatural silt/mud.
Clay/Loess/Loam	Cohesive material, e. g., loam in the floodplain or loess (<0.06 mm)
Sand	Fine- to coarse sand (>0.06 mm – 2 mm)
Shingles	Rounded and angular fine- to coarse shingles (>0.2 cm – 6 cm)
Gravels	Rounded and angular stones with a particle size of 6 – 10 cm; unnatural gravels are recorded as “riprap”.
Stones	Rounded and angular stones with a particle size of 10 – 30 cm; unnatural stones are recorded as “riprap”.
Blocks	Blocks with a particle size of >30 cm. The stone blocks are tightly bonded and wedged tight into each other.
Outcropping bedrock	The riverbed consists mostly or completely of rock. The rocks can be partialy or mostly covered by bed load material.
Solid bed	Artificial riverbed, protected by concrete, concrete slabs, half-shells or grouted tiles; The bed fixation is not or only partially covered with sediment.

Organic substrates	
None	Within the survey unit there are no organic substrates.
Algae	Filamentous (green)algae or alga bundles/-cotton.
Fallen leaves/Organic particles	Coarse organic material; e. g., fallen leaves, small branches, fruits.
	Dead trees or parts thereof which lie in the river (whole trees trunks/fallen trees, big branches, larger roots).
Deadwood	Dead trees or parts thereof which lie in the river (whole tree trunks/fallen trees, large branches, larger roots)
Macrophytes	**Submerged vascular plants:** aquatic macrophytes with mostly underwater leaves looking like filaments or grass, like *Glyceria fluitans*, *Myriophyllum spicatum* or *Potamogeton crispus*.
	Floating-leaves plants: plants with floating leaves on the water, like *Nuphar lutea*, *Hydrocharis morsus-ranae, Nymphoides peltat*, *Potamogeton natans.*
	Emergent macrophytes: higher forms of water plants with terrestrial like surface organs, e. g., reed, *Schoenoplectus lacustris*, *Sagittaria*, *Alisma*.

Living parts of terrestrial plants	Living parts of higher forms of plants which extend deeply into the water, like roots or overhanging terrestrial vegetation.
Fine detritus	Fine particulate organic matter; degradation products of plant and animal origin.
Peat	Fibrous-crumbly degradation material which still contains free cellulose; brown to black colour, watercolour brown. The occurrence of this attribute is characteristic for the organic river types.

Origin of the bed substrate	
Natural	Typical for the natural area or for the river type specific bed substrate.
Unnatural	Artificially introduced bed substrate with an area coverage of >5 %, like construction stones, ripraps or no river type specific substrates like dominating silt/mud in a river which normally shows a gravelly bed substrate.

Proportions of the bed substrates	
Dominating	The dominating bed substrate has an area coverage of at least 50 %.
Subordinated	Subordinated bed substrates occur with an area coverage of >5 – 50 %.

SP 3.1 Bed substrate


Silt/mud


Clay/loess/loam


Sand


Shingles


Gravel


Stones


Blocks


Outcropping rock

SP 3.1 Bed substrate

Algae

Fallen leaves/organic particles

Deadwood

Living parts of terrestrial plants (root surface)

Floating-leaves plants

Submerged vascular plants

Fine detritus

Peat

SP 3.2 Substrate diversity

Definition

The abundance and extent of changes in the mineral- and organic substrate composition in the longitudinal and cross profile within the survey unit, so far as it is identifiable by visual inspections or by explorations using a ranging rod.

Indicator properties

The spatial differentiation of the **mineral bed substrate** is both: a product and a reason for the hydraulic differentiation of the river. Substrate differentiations are caused in such a way that in the event of flooding, the bed-load traverses stationary zones with different flow speeds and thereby a flow-controlled selection of the grain size takes place. The local differences in the sediment granulation contribute for their part to the creation and enhancement of hydraulic effective structures of the riverbed. The finer material sediments in low flow areas, the coarser material at higher flow velocities. The diversity of the substrates increases in direct proportion to the morphological dynamic and activity of the river and the substrate supply. It can approximately serve as level of the morphological dynamic.

A high diversity of **organic substrates** is typical for near-natural rivers. In rivers with mainly sandy and loamy riverbeds, the substrate diversity is reduced to smaller grain sizes but the organic substrates, especially deadwood as hard substrate, gain an enormous importance.

Information on mapping

For the whole survey unit, only one of five diversity levels is to be registered (simple registration).

During the monitoring, problems can occur because of water turbidity or of water depth, so that the registration is impeded or impossible. In these cases, the feature “not visible” must be ticked.

The assessment of this parameter is performed in the field for small rivers.

For information on the substrate diversity for large rivers a request can be made to competent maintenance authorities. Since this information can be incomplete in the light of experience, they should be additionally verified in the field. If the authorities of maintenance have no or only fragmentary information, then an on-site recording is necessary. Where appropriate, an analysis of aerial photos, of bearing the riverbed or of field protocols for the survey of the biological quality components macrozoobenthos or macrophytes can be helpful.

Remarkable sediment differences must be recorded in large areas of the riverbed. As level of the subtrate diversity, the amount of the existent bed substrates is regarded within a survey unit. Which substrates in this respect must be distinguished, can be be taken from the definition of the features by the SP 3.1 “bed substrate”.

SP 3.2 Substrate diversity

The occuring substrates should take an area of >5 % of the riverbed in order to be considered as an indicator for the substrate diversity. A substrate type occurs to ”a smaller extent“, if its coverage is less that 20 % of the riverbed within the survey unit. It occurs to a “large extent” if it takes up more than 20 % of the riverbed. Anthropogenic substrates are not included in the assessment.

Bed substrates

The substrates to be distinguished are determined by the definitions of the features described by the SP 3.1 “bed substrate“.
This includes the mineral substrates silt/mud, clay/loess/loam, sand, shingles, gravels, stones, blocks and outcropping rock and the organic substrates like fallen leaves/organic particles, deadwood, living parts of terrestrial plants, macrophytes, fine detritus and peat.

Only natural bed substrates with a total coverage area of more than 5 % must be considered.

Substrate diversity

None	The bed substrate is completely homogeneous within the survey unit. There is only one substrate type to be found (see SP 3.1) to a great extent or the survey unit is completely hydromorphologically changed.
Small	The riverbed sporadically shows clear but in total only slight local differences within the survey unit. There are two substrate types (see SP 3.1), but one of them only occurs sporadically and to a small extent.
Moderate	The riverbed within the survey unit is characterised by repeated changes of the substrates. However, the substrate differences are mostly small. Namely, there are three substrate types (see SP 3.1), but two of them only occur sporadically and to a smaller extent.
High	The riverbed within the survey unit is characterised by a repeated clear change of the substrates. There are at least three substrate types under the point a) mentioned bed substrates. Two of them occur to a large extent.
Very high	The riverbed within the survey unit is characterised by a repeated clear change of the substrates (see SP 3.1). There are more than three substrate types, three of them occur to a large extent.
Not visible	For very deep or strongly turbid rivers, the riverbed may be invisible, so that substrate diversity is not recognisable.

SP 3.3 Bed fixation

Definition

Artificial riverbed fixation that can be clearly identified as anthropogenic and cover the riverbed within the survey unit.

Indicator properties

Bed fixation generally points to the fact that the riverbed is exposed to an excessive drag force of the flow that would lead to bed erosion effects without riverbed fixation. The existence of a bed protection shows that the riverbed-system is or was extremely disturbed within the survey unit.

The bed fixation effectively prevents the natural development of the riverbed and separates, by a solid codstruction, the water body from the groundwater body.

Information on mapping

All intact and effective types of bed fixations with regard to their length are registerd. Short bed fixations with a length of <10 m within a survey unit are only recorded for informational purposes.

If the development of the feature is homogeneous, then only a simple registration of the dominating manifestation is carried out (tick in the column “complete”).

If the manifestation of the riverbed is not homogeneous, then all different morphological types of bed protections are recorded (multiple registration).

The bed fixations of small rivers are mapped in the field.

Information on the type and extent of the riverbed fixations of large rivers can be called up at the competent authorities of maintenance. Since this information can be incomplete in the light of experience, they should be additionally verified in the field. If the authorities of maintenance have no or only fragmentary information, then an on-site recording is necessary. Where appropriate, an analysis of aerial photos, of bearing the riverbed or of field protocols for the survey of the biological quality components macrozoobenthos or macrophytes can be helpful.

Bed fixations which are components of pipings or culverts are not considered here, that means for pipings and culverts, the bed fixation is not additionally recorded again. However, bed fixations caused by transverse- or special structures or under bridges are recorded as ”bed fixation“.

The artificial bed fixation can be covered by a loose sediment layer. Within river sections, where a covered bed protection is suspected, this can be explored by a ranging rod.

Artificial bed fixations made of riprap are generally recognisable by a disproportionately ratio between the coarse large grain size of the bed fixation and the smaller grain size of the bed-load regime (so-called oversized grains, riprap).

Because of turbidity and depth, problems may occur with the effect that the mapping is impeded or impossible. In these cases, the feature “not visible” is ticked.

SP 3.3 Bed fixation

Types of bed protections	
No fixation	There is no extensive river fixation within the survey unit.
Riprap, stones-sticking	There is an artificial bed fixation made of tossed or sticked stones or ungrouted tile set within the survey unit. The particle size is considerably larger than the average grain size of the river type typical natural bed substrate.
Solid bed substrate with sediment	There is an artificial bed fixation made of concrete, concrete slabs, half-shells or grouted tile set within the survey unit. The bed fixation is mainly or completely covered by natural sediments with a layer thickness of at least 10 - 20 cm.
Solid bed substrate without sediment	There is an artificial bed fixation made of concrete, concrete slabs, half-shells or grouted tyle set within the survey unit. The bed protection is partially or not at all covered by sediments.
Not visible	Because of turbid and deep waters, the riverbed is not visible, so that it is not recognisable for the cartographers if the riverbed is fixed.

Length of the bed fixation	
<10 m	The length of the bed fixation accounts for less than 10 m of the whole survey unit.
10 - 50 m	The length of the bed fixation accounts for between 10 m and 50 m of the whole survey unit.
>50 - 100 m	The length of the bed fixation accounts for more than 50 m and up to 100 m of the whole survey unit.
>100 - 250 m	The length of the bed fixation accounts for more than 100 m and up to 250 m of the whole survey unit.
>250 - 500 m	The length of the bed fixation accounts for more than 250 m and up to 500 m of the whole survey unit.
>500 m	The length of the bed fixation accounts for more than 500 m of the whole survey unit.
Completely	The correspondig type of bed fixation amounts to aproximately 100 % of the survey unit.

SP 3.3 Bed fixation

Solid bed substrate without sediment, <10 m (ford)

Riprap

Stones-sticking

Stones-sticking

Solid bed substrate with sediment

Solid bed substrate with sediment

Solid bed substrate without sediment

Solid bed substrate without sediment

SP 3.4 Bed features

Definition

A sequence of natural form elements of the bed substrate that has a similar morphological pointer function. Pools/still waters, runs/riffles, potholes, deep watercourses, eddies, cascades, deadwood, root surfaces and macrophytes belong to these form elements.

Indicator properties

Except for drifted sediments within the groyne fields, the mentioned form elements are typical components of river sections in their natural states. They are created during the course of a natural development of the riverbed or by accumulations or erosions of the bed material in certain areas. They are the result of stationary flow differences in the event of flooding and contribute to the conservation or the increase of the flow differences themselves. They are components of important hydromorphological feedback mechanisms.

In general, the creation of bank features is a sign of a stable bed-load balance and not a sign of an acute lack of debris. In the event of flooding, there is a good energy distribution and conversion, since the riverbed is wide enough to enable low flow areas and eddies to a greater extent.

Information on mapping

The individual features within a survey unit are counted.

This parameter is recorded for small rivers in the field.

Information on bed features of large rivers can be called up from the competent authorities of maintenance. Since this information can be incomplete in the light of experience, they should be additionally verified in the field. If the authorities of maintenance have no or only fragmentary information, then an on-site recording is necessary. Where appropriate, an analysis of aerial photos, of bearing the riverbed or of field protocols for the survey of the biological quality components macrozoobenthos or macrophytes can be helpful.

Only distinct features which clearly differ from the other differentiations of the riverbed or cause a striking division of the water body at mean water level are recorded as local singularities. For rivers with naturally finer bed substrates and for smaller rivers, the river-specific ground sill of survey mappings for distinct bed features must be set lower. For large and huge rivers, the importance and influence of small scale features on the river watercourse line recedes into the background in comparison with medium-sized rivers. Therefore, the importance of these features must be estimated during the mapping procedure and should only be noted if they are significantly relevant.

Riverbed structures which for instance, after a restoration measure, develop a natural coarse-material-rich river, despite of a protected riverbed with a riprap, are also recorded here.

SP 3.4 Bed features

Form elements wich are recorded by the SPs 1.3 ”longitudinal bars“, watercourse features“, and 2.4 „transverse bars,“ are here not taken into account. Dominant organic substrates, which are recorded by the SP 3.1 „bed substrate“ are also not taken into account.

The type-specific number of bed features is assessed in the classes (none, one to two, various, and many), that means for the index-based evaluation, the different individually recorded features are summed up. Because it cannot generally be defined how many bed features within a near-nature survey unit must be found, the distinction betwen the terms ”various“ and ”many“ for the evaluation of the functional units must be peformed by professional judgement against the background of the respective reference conditions. As a rough guide, three to five bed features can be regared as “various” and >5 bed features as ”many“.

Features	
None	There are no riverbed features within the survey unit.
Pools/Still waters	Deepenings of the riverbed which are constantly flowed through by the river with reduced speed; it is a part of the riffle-pool-sequence.
Runs/Riffles	Quickly overflowed shallow water section; it is a part of the riffle-pool-sequence
Pothole/Deep watercourse	**Potholes:** extreme local identations of the riverbed that are three times deeper than the average water-depth within the survey unit at mean water level. **Deep watercourses:** elongated watercourse like indentations of the riverbed which are twice as deep as the average water-depth within a survey unit at mean water level; the deep watercourse takes the complete outflow at low water level.
Eddy	Local part-water body at mean water level along the side of the watercourse that is laterally flowed and constantly kept in rotation. The rotation moves facing away from the half of the pool in the opposite direction of the flow (opposite flow).
Cascade	Short stairs-like sequence of high natural (!) bed falls made of rubble and/or outcropping rock plates and/or root systems.
Deadwood	Dead trees or parts thereof, if they are lying in the river watercourse (tree trunks/fallen trees, branches, larger roots, single trees or wood accumulations). Deawood with a total area of >5 % is only to be recorded by the SP 3.1 “bed substrate“. There is no double registration within a main parameter.
Root surface	In small rivers at least 1 m^2, in large rivers at least 2 m^2 large surfaces which are mainly overgrown by reddish roots of riparian woods.

SP 3.4 Bed features

Root surfaces with a total coverage of >5 % must be mapped by the SP 3.1 “bed substrate“ as ”living parts of terrestrial plants”. There is no double registration within a main parameter.

Macrophytes

Submersing macrophytes: Macrophytes with mostly from herbaceous to filamentous submersing leaves, e. g., water crowfoot, water milfoil, curly-leave pondweed.

Floating-leave plants: Plants with leaves swimming flat on the water surface like yellow water-lili, frogbit, floating heart, broad leaved-pondweed.

Emersing macrophytes: higher water plants with overwater organs similar to terrestrial plants like reed beds, canes, arrowhead grass, water plantain.

Especially in rivers of the lowlands permanently emergent or sub-emergent water plant stocks which represent the only noticeably features.

Macrophytes with a total covered area of >5 % are to be mapped by the SP 3.1 “bed substrate”. There is no double registration within a main parameter.

Not visible

Because of strongly turbid and very deep waters, the riverbed is invisible, so that the riverbed is not recognisable for the cartographers.

SP 3.4 Bed features

Pool/still waters

Runs/riffles

Deep watercourse

Pothole

Cascade

Deadwood cascade

Deadwood

Root surface

SP 3.01 Bed pressures

Definition

The presence of local features, harmful elements and processes which represent a pressure for the riverbed and their functions. This includes houshold waste, building rubble, waste, sedimentation of iron, sand drift, clogging, erosions, indications of river maintenance works, trampling damage, groynes, tail unit, shipping watercourse, debris supplies, and debris withdrawals.

Indicator properties

Besides their direct harmful effects, the ”bed pressures” can also be regarded as indicators for increased anthropogenic activities along the watercourse. The registration of these data is for instance designed for the support of river maintenance work.

Informations for mapping

There is a multiple registration.

For the small rivers this parameter is recorded in the field.

For large rivers, the information on the type and on the extent of this single parameter can be called up from the competent authorities of maintenance. Since this information can be incomplete in the light of experience, they should be additionally verified in the field. If the authorities of maintenance have no or only fragmentary information, then an on-site recording is necessary. Where appropriate, an analysis of aerial photos, of bearing the riverbed or of field protocols for the survey of the biological quality components macrozoobenthos or macrophytes can be helpful.

Information on bed-load addition and -extraction must be requested to the competent authorities of maintenance and should not be recorded on-site.

SP 3.01 Bed pressures

Features	
None	There are no bed pressures within the survey unit.
Domestic waste, building rubble	Waste from domestic fields or manufacturing industry, completely or mostly mineral-based.
Greene waste	For instance, cut grass, compost.
Sedimentation of iron	Large scale deposits of iron on the riverbed.
Sand drift	Strong ripple creations on the riverbed in watercourseled profiles.
Colmation	Blockage of the interstitial spaces by fine sediments or by impurities causing turbidity for instance because of increased soil additions; coarser mineral substrates are also covered by fine sediments.
Erosion	Excessive depth erosions.
River maintenance	Information on the conducting work maintenance in the riverbed, for instances dams along the river side because of the clearing of the riverbed.
Trampling damage	Clear trampling damages by grazing animals or because of leisure use.
Groynes/Tail units	**Groynes**: in large (navigables) rivers obliquely or vertically from the river bank starting dams like rows of walls or of piles, which primarly serve for the control of the fairway. **Tail units** in large (navigable) river bank parallel ripraps, walls or sheet pile walls to influence the flow. Groynes set (engineer-biologically) for the current control in very small and small rivers are to be recorded by the SP 5.2 “bank features”.
Shipping channel	Area of the river profile which serves for the passenger- and cargo shipping with a draught of at least 1 m.
Not visible	Because of strongly turbid and very deep waters, the riverbed is not visible, so that bed pressures are not recognisable.
Bed-load addition	Lacking bed-load as addition into the water which does not correspond to the river type. This can be done by the direct addition on the riverbed or in the form of accumulated dredged material on existing isle bars or isles. In these cases, the river itself supplies independendly with bed-load over time by relocations.
Bed-load exraction	To keep the shipping watercourses free from bed-load or for the raw material extraction (e. g., gravel removal), bed-load is removed from the riverbed.

SP 3.01 Bed pressures

Household waste

Building rubble

Green waste

Sedimentation of iron

Sand drift

Colmation

Erosion

River maintenance

SP 3.01 Bed pressures

Trampling damage

Shipping watercourse

Groyne

Tail unit

Debris supply

Main parameter 4: Cross profile

SP 4.1 Profile type

Definition

The dominating cross profile type of the riverbed. By means of characteristic physiognomic features and forms, generalised cross profile types are differentiated.

Indicator properties

The different profile types characterise the riverbed with regard to their past genesis, their static stability, their further morphological development and their morphological complexity.

Information on mapping

There is a simple registration.

The registration of this parameter is performed in the field and must be verified on-site for large rivers. For the survey mapping of the profile type of large rivers aerial photos are available.

For the survey mapping only the profile type is registered which mainly shapes the survey unit. Profile types which occur to a smaller extent remain unconsidered. If there are different profile types within a survey unit sectionwise or depending on the side of the embankment (e.g., at the cut banks a standard profile and at the slip-off slope a natural profile) the more unnatural feature is recorded, following the pessimistic approach.

For rivers flowing in a secondary floodplain, the profile type within the secondary floodplain river profile is to be recorded (look also SP 4.2 “profile depth“).

Also profiles for instance containing embankments covered with grass as bank protection (SP 5.2 ”bank protection“) which are clear standard profiles normally showing high cutting depths and missing wooded banks are mapped as technical standard profile.

SP 4.1 Profile type

Features	
Natural profile	The riverbed corresponds to the potentially natural state. This state is predominantly or completely very shallow with irregular embankments for the most river types. In fine-grained or cohesive substrates, the rivers are naturally more deepened. The embankment on both river sides consists of river type specific wood or is surrounded by reed belts along the entire watercourse. The profile is not characterised by pressures caused by hydraulic engineering or by maintenance work. The relocation capacity has been maintained to full extent.
Approximately natural profile	The riverbed corresponds to a great extent to the potential natural state. It is predominantly shallow with irregular bay-rich river banks. The river banks contain river type-specific vegetation in parts. The profile can be partially influenced by early expansion or maintenance work. The relocation capacity has been maintained to a great extent.
Eroded profile	Use related, the embankment of both river sides is shaped from steep-walled to overhanging, without vegetation and characterised by constant river bank erosion. The riverbed is predominantly very deep and relatively monotonous.
Profile with groynes	To a great extent, groynes were built in the river. This applies to the cases where there are no revetments between single groynes.
Technical standard profile, decaying	The riverbed consists predominantly of a uniform standard profile with an embankment constructed against erosion and is normally recognisably straightened. Actually, traces of bank protection may occur, but it has been transformed by aggregations and overgrown by vegetation in the meantime. The river banks are mostly planted with wood. They do not show signs of maintenance work.
Technical standard profile	The riverbed consists mostly of an artificial, trapeziodal-, double-trapeziodal shaped, box- or V-shaped profil. Bank erosion is eliminated to a large extent by slope reinforcement for instance by stoneset, brickwork, concrete, sheet pile walls or embankment base protections. The riverbed can be untreated or be covered with an artificial revetment with or without overlying sediment. Also profiles, for instance with banks covered with lawn as bank protection (SP 5.2 ”bank protection“), which are clear standard profiles with normally high cutting depth and missing wooded banks are recorded as technical standard profiles.

SP 4.1 Profile type

Natural profile

Natural profile

Approximately natural profile

Approximately natural profile

Eroded profile

Eroded profile

Profile with groynes

Profile with groynes

SP 4.1 Profile type

Technical standard profile, decaying

Technical standard profile, decaying

Technical standard profile (trapezoidal shaped)

Technical standard profile (box-shaped)

Technical standard profile

Technical standard profile

SP 4.2 Profile depth

Definition

The ration between the average depth and the width of the riverbed, i.e. the altitude difference between the riverbed and the top of the bank in proportion to the width of the river at the top of the banks.

Indicator properties

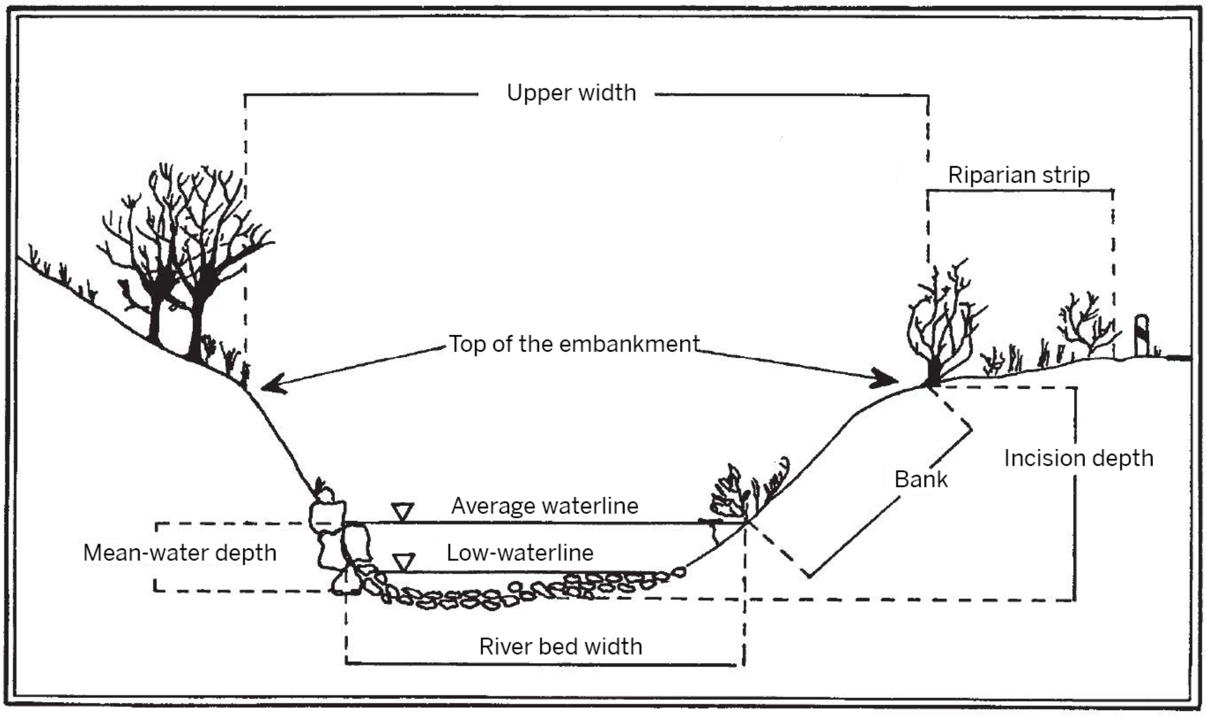
The depth to width ratio of a river has a decisive influence on its discharge dynamic. The discharge dynamic forms the riverbed. A low deepening results in frequent and early overflowings in the event of flooding and year-round a low depth of the natural groundwater in the floodplain. Thus, the runoff behaviour changes with increasing profile depth since more water can be taken up in the river watercourse. A great profile depth is normally unnatural but can be also natural in case of soft substrates.

The riverbed can be unnaturally deepened by depth erosion, by works in the course of maintenance and by morphological measures, by an alluvial elevation of the floodplain or by other anthropogenic pressures. This results in a higher discharge capacity, in a higher drag of the flow and in a corresponding poor structure of the riverbed and banks.

Information for mapping

For each survey unit only an average profile depth is registered (simple registration).

This parameter is recorded in the field or must be verified in the field for large rivers. For the survey mapping of the profile depth of large rivers aerial photos or information on the bearing of the river bottom are available.



Picture: Cross profile (from LUA 1998).

SP 4.2 Profile depth

The average depth to width ratio of the riverbed is estimated in size classes and registered. Locally limited depths (potholes, deepened watercourses) remain unconsidered.

In the case of for instance weir-regulated rivers, the survey mapping of the depth is not possible. It is recorded by the feature “not visible”. **The effects of the backwater are not assessed here, only by the SP 2.3. “backwater“.**

Rivers in a secondary floodplain

Rivers in a secondary floodplain

Figure: Examples for secondary floodplains.

If a riverbed degradation caused by constructions has taken place, then a so-called secondary floodplain can be developed by soil excavation work. Because of different restrictions (e. g., deepened rivers, existing adjacent land use) the primary floodplain is not longer available for the river development. A secondary floodplain is a restored original floodplain on a lower foundation level than the natural one. However, within the secondary floodplain a flooding is normally possible. The slightly deepened new profile frequently leads to flooding which promotes the development of appropriate typical floodplain communities (MUNLV NRW 2010).

For rivers which flow in a secondary floodplain, the profile depth is measured for the river profile within the secondary floodplain.

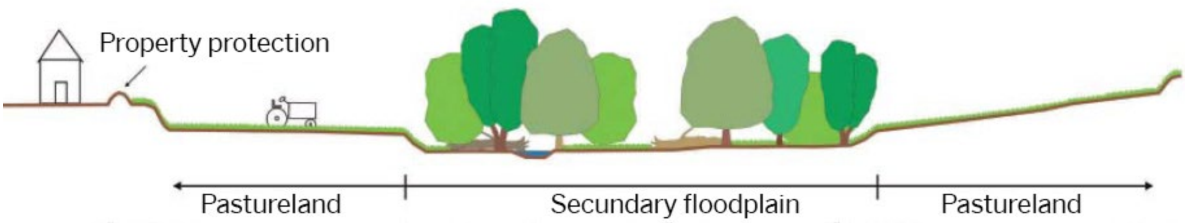


Figure: Diagram of a secondary floodplain (from MUNLV 2010)

SP 4.2 Profile depth

The feature “profile depth” is described via the ratio between the cutting depth and the river width as the width of the top of the banks.

For the different river size classes (river width up to 20 m, river width >20 to 80 m and river width >80 m), the ratios in the table listed below must be applied.

	The ratio between profile depth (= altitude difference from the top of the bank to the riverbed) **and river width** (= width between the top of the banks)		
	River width until 20 m	River width >20 to 80 m	River width >80 m
Very shallow	<1:10	<1:50	<1:100
Shallow	1:6 until 1:10	1:30 until 1:50	1:70 until 1:100
Moderately deep	1:4 until 1:6	1:20 until 1:30	1:50 until 1:70
Deep	1:3 until 1:4	1:20 until 1:10	1:20 until 1:50
Very deep	>1:3	>1:10	>1:20
Not visible	Because of strongly turbid and very deep waters, the riverbed might not be visible, so that the profile depth cannot be measured, e. g., for weir-regulated rivers.		

SP 4.2 Profile depth

Very shallow

Very shallow

shallow

shallow

Moderately deep

Moderately deep

Deep

Deep

SP 4.2 Profile depth

Very deep

Very deep

Not recognisable (weir-regulated)

SP 4.3 Width erosion

Definition

The existence of bank erosion that has an equal negative impact on both river banks and causes an expansion of the river watercourse. Curved river watercourses differ from curvatures caused by erosions, in such a way that the erosion takes place synchronously at the cut- and at the slip-of banks.

Indicator properties

Rivers naturally tend to form a relatively wide and shallow riverbed with a specific ratio between river width and depth. If the riverbed has become too deep caused by depth erosion, by works of maintenance and/or constructional measures or by other reasons, or has become too narrow by advancing sediment accumulations at the river banks or by obstructions of the banks, then the river has the natural tendency to re-establish the balanced ratio between width and depth by intensive bank erosion.

If a river is disturbed in the self-dynamic development of its riverbed by bank protection (river captivation), the possibility of recuperation of the natural river type-specific structures at the embankment and on the riverbed area is deleted. The ability of a river to react to different disturbances with erosions of width belongs to its most important natural basic functions.

Information for mapping

There is a simple registration.

This parameter must be recorded in the field and must be verified on-site for large rivers. For the survey mapping of width erosion in case of large rivers aerial photos are available.

No single spots of width erosions are recorded, but the recognisable tendency within the whole survey unit for width erosion. Weak width erosions are limited to the embankment base, while strong width erosions include the complete embankment until its top. The width erosion is registered in the event that the major part of the survey unit is characterised by weak or strong width erosions at both river banks.

If within a whole survey unit the width erosion has a share of less than 50 %, then a width erosion is not registered. This is also not the case, if the erosion is partially very strong.

If the sum accounts for more than 50 % of the width eroded sections within a survey unit, but single sections have been eroded different severely and in different lengths (e. g., 30 % + 40 %), then the dominant erosion form is recorded, even if, considered individually, the total length is less than 50 %

All existent erosions at bends (cutbank erosions) are not taken into consideration here. They are recorded by the SP 1.2 ”erosion at bends“. The classification of this parameter can be difficult, because it is often unclear for disturbed river profiles if coincidently a width erosion and erosions at bends take place. In cases of doubt, "weak width erosion“ must be noted.

SP 4.3 Width erosion

Profile depths

Features According to SP 4.2 "profile depth":	Depth-width-ratio of the profile		
	River width until 20 m	River width >20 to 80 m	River width >80 m
Very deep, deep	**<1 : 4**	**<1 : 20**	**<1 : 50**
Moderately deep, shallow, very shallow	**>1 : 4**	**>1 : 20**	**>1 : 50**

Erosion intensity

None

The riverbed shows a visible width erosion for a distance of less than 50 % of the survey unit. A possible bank erosion is restricted to the cutbank and has the character of an erosion at bends.

Weak

The riverbed is mostly shaped by a weak width erosion (over 50 % of the shoreline without erosions at bends). Both river banks are constantly steep to very steep. They are constantly steep-walled, concave to overhanging and unstable below mean water level. They are mostly oblique, overgrown and without signs of erosion above mean water level.

Strong

The riverbed is mostly shaped by strong width erosions (over 50 % of the shoreline without erosion at bends). Both river banks are constantly, over the full height up to the top of the banks, steep or overhanging, almost free from vegetation and very unstable. They show the naked incision of the bank bottom.

SP 4.3 Width erosion

Very deep / deeply, strongly eroded

Moderately deep to shallow, strongly eroded

Very deep / deeply, weakly eroded

Moderately deep, weekly eroded

Very deep, non erosion

Moderately deep to shallow, no erosion

No width erosion! (erosion at bends)

SP 4.4 Width variation

Definition

Frequency and extent of the spacial change of the watersurface width at mean water level. For shallow natural banks, the principle of "mean water level" has been applied. For narrow valleys, the width variation can be naturally limited because of the fixing by outcropping rocks. In Central Europe large variances of the river width are to be expected due to the natural large-spatial supply of deadwood.

Indicator properties

The natural change of the surface water width at mean water level results from debris relocations, from deadwood jam and from uneveness and incompleteness of the naturally wooded river banks. The width variation is therefore particularly an expression of the natural morphological dynamic and response capacity of the river. A river achieves, under a permanent natural morphological status, a certain river-specific width variation. Today, natural extreme width variations can only be found very rarely, e. g., in special semi-natural rivers in the Alpine region.

Information on mapping

There is a simple registration.

The survey mapping of the width variation is performed in the field for small rivers.

For large rivers, the recording of the current situation is at first desk-based by the analysis of aerial photos or by the German Basic Map. In the field, the plausibility of the collected information is verified. If there are aerial photos, then an on-site inspection of only one river side is sufficient. If this is not the case, then both river sides should be inspected on-site.

Decisive is the change of the surface water width at mean water level.

A width variation only exists, if the riverbed can be separated into different river sections of varying widths. The very small bays with narrow-standing planted bank galleries are not considered as width variation.

SP 4.4 Width variation

Width classes	
Extremely widening	Sections of the survey unit in which the width of the surface water is more than three times broader than the average width of the river within the survey unit at mean water level.
Widening	Sections of the survey unit in which the width of the surface water is twice as broad as the average width of the river within the survey unit at mean water level.
Average width	Sections of the survey unit in which the width of the surface water corresponds to the average width of the river within the survey unit at mean water level.
Narrowing	Sections of the survey unit in which the width of the surface water is only half as wide as the average width of the river within the survey unit at mean water level.
Extremely narrowing	Sections of the survey unit in which the width of the surface water is less then one third of the average width of the river within the survey unit at mean water level.

Width variation	
None	The width of the surface water at mean water level is regular and does not show clear width differences. It corresponds without exceptions to the average width.
Small	The width of the surface water rarely shows clear but in total only small local differences. There are two width classes, one of them occurs only to a smaller extent.
Moderate	The width of the surface water shows multiple clear but in total only moderately local differences. There are three width classes, two of them occur only to a smaller extent.
Large	The width of the surface water shows multiple clear differences. There are at least three width classes, two of them occur to a larger extent.
Very large	The width of the surface water shows multiple clear differences. There are more than three width classes, at least three of them occur to a larger extent.

SP 4.4 Width variation


None


Small


Moderate


Large


Very large

SP 4.5 Culvert/Bridge

Definition

Culverts or bridges are constructions which serve for instance for the crossing of rivers by paths, streets, railways or for accesses to riparian properties.

Culverts normally are completely closed structures down to the river bottom whose length is shorter or equal to 10 % of the survey unit. Also culverts of earth bodies to flood control reservoirs with these lengths must be registered as culverts.

Bridges are river crossing constructions which are flown freely through without pressure or a technical lifting device, normally with an open riverbed. The clear width (inside diameter) between the bridge piers or the bank limits is at least (≥) 2 m.

Indicator properties

Culverts or bridges represent spatial constraint points (bottlenecks) for rivers which locally limit or impede the lateral development. They also can be combined with dam constructions that restrict flood discharge. To ensure the stability of the construction, the adjoining embankment is protected, the constructions often stretch to the waterline. Hereby, the self-dynamic river development is locally prevented.

Information on mapping

There is a multiple registration. All culverts and bridges are counted in accordance with their features per survey unit.

Also culverts of earth bodies to flood control with movable components, e. g., flaps with the corresponding lengths, must be recorded here.

For small rivers the survey mapping is performed in the field.

For large rivers the survey mapping of this parameter is firstly performed desk-based by the evaluation of aerial photos or the German basic map. The sediment cover should be requested from the competent authorities for maintenance. The plausibility of the information is checked in the field.

Bridges which have at least one pier concreted in the river or in the adjacent land zone (100 m corridor per river side) are recorded by the SP 4.5, regardless of the length of the spanned distance, If there is no bridge pier in this area, the bridge is not recorded (e. g., highway bridges).

If the construction is an ensemble of two or more culverts, then they still are to be registered as one construction.

A culvert/bridge which narrows the watercourse and therefore interrupts the shore is only recorded as ”watercourse narrowed“.

SP 4.5 Culvert/Bridge

The feature “natural embankment interrupted” only exists when the banks in the area of the construction are massively protected by riprap, gabions, concrete, etc., but the banks outside of the construction do not show protection measures or at most living protection materials. In the event that the embankment outside of the construction has been changed (SP 5.2), then the feature ”natural embankment interrupted“ is not given.

For the survey mapping of the sediment, the thickness of the natural sediment is recorded in the whole construction or at their openings.

For reasons of occupational safety it is forbidden to access culverts

Pipeline bridges, e. g., of long-distance gas pipelines, are not registered in the course of the survey mapping, just like all other above-ground and underground supply- and/or waste lines.

Bridges as ”unpermitted constructions“, like single planks to cross a river are not recorded as bridges.

Closed oberbuildings of a river which take more than 10 % of the survey unit are recorded by the SP 2.2 “piping/overbuilding”.

If the bottom of the culvert at its downstream opening has a bed fall with an actual water level difference of ≥10 cm or rather causes upstream of the culvert a backwater at mean water level, then this must be additionally mapped by the SP 2.1 ”transverse and special features“ and SP 2.3 ”backwater“.

SP 4.5 Culvert/Bridge

Effects of culvert/bridge

No culvert/bridge
There is no culvert/bridge within the survey unit.

Morphologically not harmful
The watercourse is not narrowed and the embankment is not interrupted. There are culverts or bridges which are not regarded as a constriction of the riverbed, not even in the event of flood events. The mean water level is not narrowed in the culvert under the bridge in comparison with the open flow. Land animals are able to wander unimpededly through the culverts/bridges along the embankment.

Natural river bank, interrupted
At least one river bank is fixed with stone rubbles, gabions, concrete or the like on the whole slope in the area of a construction. Outside of the construction the bank does not show a protection or at most a bioengineered protection. Land animals can only wander restrictedly through the culverts/bridges along the embankment.

Watercourse narrowed
There are one or various culverts/bridges which represent a partial constriction of the riverbed. In the culvert, the mean water surface is narrowed in comparison with the open flow. The flood runoff is hindered.

If there are bridge piers in the river, then it must be estimated whether the watercourse is narrowed. Generally, the river watercourse is narrowed when the sum of the piers is >20 % of the mean water surface in the cross profile of a river.

Structure of the riverbed in the culvert/bridge

Without sediment
The riverbed in the culvert is made of massive concrete, concrete elements or revetments. The riverbed can be partially covered by sediments. The sediment coverage does not extend over the entire surface and has a natural total thickness of less than 0.10 m for rivers with a width less than 10 m. For rivers over a width of 10 m, the sediment coverage has naturally a thickness of less than 0.20 m.

With Sediment
The riverbed in the culvert has for rivers with a width below 10 m a passing function and is covered by sediments with a natural thickness of at least 10 cm. For rivers over a width of 10 m, the sediment coverage has a naturally a thickness of at least 0.20 m

Not visible
Because of strongly turbid and very deep waters, the riverbed is not visible, so that it is not recognizable, if there are sediments in the culverts or under the bridges or at the openings of the culverts.

SP 4.5 Culvert/Bridge

(Water)bridge, morphologically not harmful

Bridge, morphologically not harmful

Bridge, natural embankment interrupted, with sediment

Culvert, natural embankment interrupted, with sediment

Culvert, natural embankment interrupted, with sediment

Culvert, natural embankment interrupted, without sediment

Bridge, watercourse narrowed, with sediment

Culvert,watercourse narrowed, with sediment

SP 4.5 Culvert/Bridge

Bridge, watercourse narrowed, without sediment

Culvert, watercourse narrowed, without sediment

Culvert, watercourse narrowed, with sediment (flow through an earth body of a flood control reservoir)

Culvert, watercourse narrowed without sediment (flow through of aa earth bodey of a flood control reservoir)

No bridge

No bridge

Main parameter 5: Bank structure

SP 5.1 Bank vegetation

Definition

Type and extent of wooded areas and of herbaceous vegetation at the river banks and on the top of the banks (up to 1 m maximal width). The vegetation behind the top of the banks is not taken into account.

For very small and small rivers until 20 m without a clear determinable embankment, a riparian strip with a width of 5 m is regarded as bank. For larger rivers over 10 m riverbed width a riparian strip of 10 m is regarded as bank. This riparian strip begins on the water side at the edge of the planar growth of the terrestrial vegetation (corresponding to the mean water level in the summer time). If the natural river is located in a secondary floodplain, then also the vegetation on the foot of the embankment is considered.

For shallow near-nature river banks, as in gravel-rich near-natural river sections, the longitudinal bars made of gravels and a narrow strip of to the land side extending vegetation (riparian wood) form the river bank. Here, the separation has to be considered as case specific.

In case of dyked rivers for whom the mean water level reaches up to the dam, the waterside slope serves as river bank.

Indicator properties

The vegetation cover gives information on utilisation pressures and the self-development of the river. To the river type-specific tree- and bush species belong the black alder, the common ash tree, various tree-like willow species and for larger rivers different willow- and alder bushes. River type-specific also are floodplain forests bordering the river. The most beneficial ecological influence is caused by a loose forest stand and not by a tight forest stock.

The embankment of natural large rivers with a strong bed-load discharge is populated by gravel- or pioneer corridors. In extended lowland fields, the embankment can be primary free of woods and be covered with reed beds up to the waterline.

The vegetation cover at the embankment or at less profiled amphibian zones has a great influence on the dynamic of sedimentation and erosion at the riparian zones and thereby influence on the whole watercourse- and profile development of a river in a longer term. Type and extent of the present embankment vegetation therefore shows the morphological development activity and the developmental readiness of a river.

SP 5.1 Bank vegetation

Information on mapping

The survey of the vegetation is performed for the left and the right river bank.

The survey mapping operation for small rivers is performed in the field.

For large rivers the recording of the current vegetation cover is performed by the evaluation of aerial photos, CIR-maps and biotope and factual adjacent land use mappings. In the event that the data are available in a digital form, so the shares of the occuring usage forms can be determined immediately by the help of GIS. In the field, the plausability of the information is checked.

Within each survey unit the features “no bank vegetation“, ”woodland“, and ”herbaceous vegetation“ are mapped separately. Only the dominating feature is ticked. If there are concurrently woody and herbaceous vegetation types, only the dominating features in both categories are ticked.

If ”no bank vegetation“ is recorded, then the features ”no woodland“ and ”no herbaceous vegetation“ must not be additionally ticked.

For rivers which noticeably flow through woodland, the feature ”native wood“ must be ticked as “bank vegetation”, even if only single trees are naturally seen on the river bank.

SP 5.1 Bank vegetation

No bank vegetation	
None, naturally	Naturally, the river banks have no vegetation. This applies to naturally eroded banks of loess-clay characterised rivers.
None, anthropogenically	Because of protection measures or uses, the river banks show no vegetation, for instance for rivers with anthropogenically induced bank erosions.

Native wood	
None, naturally	Because of varying water levels in connection with frequent floodings or because of exceeding bed-load transport, the bank vegetation naturally has no wood. Also, smaller lowland rivers may be naturally without vegetation naturally.
None, anthropogenically	Because of protections or uses, the bank vegetation has no wood, for instance for rivers with anthropogenically induced bank erosion.
Wood	The river bank is covered by a tree population consisting of bank typical trees more than half of the total distance, which are part of the adjacent indigenous deciduous forest. The trees are cropped at large distances and irregular intervals and show varying distances from the embankment edge.
Gallery	The river bank is cropped at more than half of the entire section with a simple row of black alders, ashes or willows. The woody plants stand on the embankment or on top of the slope. The clear distance between the treetops are considerably smaller than the crown diameters. Behind the tree row, there is an unforested area or a not-native forest like a coniferous forest.
Bushes, single trees	The river bank is cropped in more than half of the entire section with solitary black alders, ashes, willows or native bushes. The clear distance between the treetops are several times larger than the crown diameters.
Young woody plants	The riparian woods have been planted recently or have been grown up independently, so that they still cannot fulfill the shadowing or structure-forming function. This also includes woody plants like willows that are planted in multiple rows as renewable resources (plantations with short rotation coppice).

Non-native wood	
Wood, Gallery	The river bank is covered with coniferous-, hybrid poplars- or with another non-native woods for more than half of the entire section. Or the river bank is covered with a simple closed serie of trees like hybrid poplars, conifers or other non-native woods for more than half of the entire section. The woody plants are situated at or on top of the embankment. The clear distance between the treetops are normally significantly smaller than the crown diameters. Behind the

SP 5.1 Bank vegetation

	tree row there is an unforested area.
Bushes, single trees	The river bank is covered with single hybrid poplars, conifers or other non-native woody plants or bushes for more than half of the entire section. The clear distance between the treetops are normally several times larger than the crown diameters.
Young woody plants	Riparian woods like Christmas trees plantations have been planted recently, so that they still cannot fulfill the shadowing or structure-forming function.

Herbaceous vegetation

None, naturally	For more than half of the entire section, the river bank is not or almost not covered with herbaceous vegetation because of shady tree populations (native or non-native) or because of too strong bed-load relocations.
None, anthropogenically	Because of anthropogenically caused erosions, the river banks are composed of steep slopes for more than half of the entire section. On top of these slopes there is no vegetation or only residues of vegetation. Or the river banks are covered with revetments (concrete, brickwork, paving, half-shells) which prevent a dense bank vegetation at least until half of the slope height.
Near-natural herbs, grasses	This includes near-natural vegetation types like gravel-, pioneer corridors, source meadows or near-natural herbaceous vegetation of natural forests like spring flowers, grasses, etc. Or the river banks are more than half of the entire section nearly completely covered with reed beds (principally with reed canarygrass, rushes, sedges, tall grasses and possibly reeds) or with flood lawn (principally low-growing sweet grasses like Water Mannagrass).
Anthropogenically induced hedges and tall forbs, meadow	The embankment is covered with a closed anthropogenically controlled herbaceous vegetation like grassland or pasture vegetation (as managed grassland or as reseeding) for more than half of the total bank section.
Slope lawn	The embankment is relatively flat with a closed lawn consisting of grasses. In the appearance and composition it resembles culture lawn of a hay-meadows with the domination of sode grass and low-growing herbs. **If the slope lawn has been mapped by the SP 5.2 “bed protection“, then the term “bioingeneered protection” must also be recorded.**
Neophytes	The embankment is covered with a non-native vegetation e. g., Himalayan balsam, Knotweed species, Canadian goldenrod or giant hogweed.

SP 5.1 Bank vegetation

No bank vegetation, naturally

No bank vegetation anthropogenically (because of protection measures)

No woody plants, anthropogenically (lowland rivers)

No woody plants, anthropogenically

Native forest

Native gallery

Native shrubbery, single trees

Native young trees

SP 5.1 Bank vegetation

Not-native wood

Not-native gallery (on the left side)

Not-native bushes, single trees

Not-native young forest

No herbaceous vegetation, naturally

No herbaceous vegetation, anthropogenically

Near-natural herbs, grasses

Near-natural herbs, grasses

SP 5.1 Bank vegetation

Antropogenically induced herbaceous corridor

Anthropogenically induced herbaceous corridor

Slope lawn

Neophytes (Giant Hogweed)

SP 5.2 Bank protection

Definition

Technical bank constructions for the purpose of bank protection against erosion and for the preservation of a navigation watercourse. In the bank area, the banks are mostly protected by ungrouted riprap. In navigable rivers, the in the river reaching groynes and parallel to the shore installed tail units serve for the control of the flow.

Indicator properties

A bank protection indicates to which extent the riverbed, especially the shape and the river course, does not correspond to the spacial needs of the river. The bank protection replaces ecological precious structures by, as general rule, ecologically inferior structures. A natural river dynamic is not possible because of the very restricted relocation capability. Bank protection measures prevent sustainably the natural regeneration of the river typical morphology (= river fettering).

Bank protection serves for the protection of the embankment and for the preservation of the watercourse development determined by planning. Especially in navigable rivers or large rivers, it serves for the warranty of a minimum waterdepth or for a navigable watercourse.

Information on the survey mapping

All intact and effective types of bank protection are recorded per river side. Short bank protections of <10 m length are only recorded for informational purposes.

In cases of a homogeneous feature manifestation, there is a simple registration of the dominant manifestation (by marking the column “completely”).

If there are different types of bed protection in a row within a survey unit, then all morphologically different types of bank protections are recorded per river side (multiple registration). Example: If a 100 m long survey unit has a bioingeneered bank protection within the first 60 m and for the following 40 m a massive bank protection, then both bank protection types are recorded within this survey unit.

If there are types of bed protection parallel to the river within a survey unit different, then only the most massive protection type is recorded (with the mostly poor index value). Example: If at the foot of an embankment the bank is protected by a riprap which is above followed by a slope lawn within a 100 m long survey unit, then the riprap is recorded corresponding to its length within the survey unit.

The bank protection is separately recorded for the left and right river side. The bed protection of small rivers is recorded in the open terrain.

Information on size and on type of bank protections for large rivers can be obtained from the competent maintenance authorities. Since experiences have shown that the information can be fragmentary, they must be verified additionally in the field. If the maintenance authorities have no such information, then a complete survey mapping is needed.

SP 5.2 Bank protection

Bank protection which is component of pipings or culverts is not considered here, that means, for piping or culverts the parameter “bank protection” is not additionally recorded. But bank protection of transverse- or special structures or under bridges are registered as bank protection.

During the survey mapping, problems of registrations may occur because of the vegetation cover. In cases of doubts, the ranging rod must be used to determine by spot checks or by effective explorations, if there is at reduced depth under the substrate surface and already overgrown bank revetment. If there are large quantities of very coarse rock material (Ø >20 cm) on the riverbed, then the suspicion of an overgrown revetment is justified. In the event that the rock material on the riverbed is densely packed, then a bank revetment made of riprap or tile sets must be registered.

If by the SP 5.1 “bank vegetation“ slope lawn has been recorded, then additionally “bioingeenered” must be recorded by the SP 5.2 “bank protection”. If by the SP 4.1 “profile type” a “technical rule profile” and by the SP 5.1 “bank vegetation” a “anthropogenic herbaceous vegetation, tall forb, meadow” has been registered, then also “bioingeneered” must be noted by the SP 5.2 “bank protection”.

SP 5.2 Bank protection

Types of bank protection

No bank protection None of both river banks shows a protected river section in the above-mentioned form within the survey unit.

Decaying bank protection The existent bank protection is still recognisable, however decayed in such a way that a natural bank development is possible. The bank protection is clearly not maintained any more.

Flow control element Flow control elements, as technical constructions, usually are made of hydraulic construction stones and extend from the bank into the river. In a near-natural version (= bioengineered application), trunk wood is used which can be fixed at the bank with tile set. Flow control elements are often installed alternately. Depending on the required intensity of the effect, they reach until midstream at mean water level. Flow control elements are, depending on the desired effect, installed transversely or perpendicularly to the flow direction.

Bank protection using living elements The embankment is protected by herbaceous and woody plants. Multiplicatively it is characterised by densely and regularly arranged willows or black alders. It could be a young planting or an old stock. The wood can stand in a dense line at the foot of the embankment or also be extensively spread on the embankment (e. g., after budding of branches of willows). The woody plants are placed so closely and regularly that this would not be the case by nature.

Woody bank protection The embankment is stabilised by an intact professional timber structure at its foot or also above. It can be wooden stakes with a network of twigs or rods, shore-parallel wooden planks (made of planks or thick boards), installations of rods or complex constructions made of crossed planks.

Riprap/stones The embankment is covered by a layer composed of coarse rock material (normally 20 cm Ø and larger) at its foot, on the bottom half or in the entire area or secured by a dense row composed of quarry stones (30 cm Ø and larger). The rock material can lie freely or be overgrown or covered by soil particles. The embankment is permeated by a large amount of coarse rock material that does not correspond to its river type. Also, natural dry stony walls should be recorded.

Unpermitted bank protection The embankment is unprofessionally protected against bank erosion. As building material waste wood, building rubble, scrap, old car tyres have been used.

Solid bed protection The embankment is covered and secured at its foot, on the bottom half or in the entire area, for instance by:

Paving: made of massive paving stones or lattice blocks or by a

SP 5.2 Bank protection

tightly joint tile sets or rubble stones. The revetment is professionally made and full of gaps. The gaps are not mortared.

Pouring of concrete: big prefabricated components made of concrete or mortared brickwork, or paving; the upper part of the embankment can be vegetated.

Metal walls: vertical metal walls, sometimes covered by a wall coping made of concrete; This construction type is often found at ship landing points and bottlenecks, where constructional uses extend directly to the river.

Tail unit: parallel to the river bank ripraps, walls or sheet pile walls for influencing the flow and for the protection of the banks in large navigable river.

Groynes: inclined and vertical walls or rows of stakes starting from the river bank; the groynes serve in large (navigable) rivers for the water level regulation; If the groyne field width is more than 1.5-fold of the groyne length, then the extent of the regulation is noted as 10-50 %, if the groynes spread over a larger section within a survey unit.

Length of bank protection	
<10 m	The length of the bank protection is less than 10 m within a survey unit.
10 - 50 m	The length of the bank protection is between 10 and 50 m within a survey unit.
>50 - 100 m	The length of the bank protection is more than 50 m until 100 m within a survey unit.
>100 - 250 m	The length of the bank protection is more than 100 - 250 m within a survey unit.
>250 - 500 m	The length of the bank protection is more than 250 - 300 m within a survey unit.
>500	The length of the bank protection amounts more than 500 m within a survey unit.
Completely	The corresponding type of bank protection ist approximately 100 % of the survey unit length.

SP 5.2 Bank protection

Decaying bank protection

Flow control elements

Protection using natural material („greene pipework“)

n

Bioingennered bank protection

Woody bank protection

Unpermitted bank protection

Ripraps/stones

Riprap/stones

SP 5.2 Bank protection

Massive bank protection: tile set, ungrouted (gabions)

Massive bank protection: lattice blocks

Massive bank protection: brickwork (grouted)

Massive bank protection: concrete

Massive bank protection: sheet pile wall

Massive bank protection: flow control elements

Massive bank protection: groynes

SP 5.3 Bank features

Definition

A series of natural form elements of the river bank like break off banks and small scaled structures like flows around single trees, trees as flow obstacle, shelters for fishes, fallen trees or nesting walls.

Indicator properties

The bank features are typical elements of near-natural river sections. They are signs of a natural morphological development of the river dynamic, are in close connection with the discharge dynamic and contribute to the deviation of the flow. The existence of special bank features shows how large the natural morphological development of a river is.

Information on the survey mapping

The individually manifestated bank features are counted separately for the left and for the right river bank for each survey unit.

The parameter is recorded in the field or rather verified for large rivers. For the assessment of river bank features of large rivers aerial photos can be used.

Only the bank features which clearly differ from the other differentiations of the riverbed or characterise the visual appearance of the river bank are recorded. For smaller rivers the ground sill for mapping activities for fully developed structures should be set type-specifically lower. For larger rivers the importance of structures on a small scale, in comparison with mid-sized rivers, moves to the background. For this reason, the relevance of bank features is only estimated and only recorded, if they have a clear relevance.

The typical number of bank features is assessed in the classes (none, one, two, various, and many), that means for the index-based evaluation, the single mapped features are summed up. Since it is not generally possible to determine how many bank features are found within a near-natural survey unit, the differentiation between the terms ”many“ and ”various“ for the evaluation of functional units must be performed by professional estimation, against the background of the „Leitbild = german term for reference conditions“. For rough orientation purposes, the numbers of 3 up to 5 bank features can be regarded as ”many“.

SP 5.3 Bank features

Features	
None	There are no bank features within the survey unit.
Flow around single trees	A tree or a sequence of various trees which forces the river at mean water level to a “flow around”. At higher water level, the trees are also rear-flowed. Normally, the roots of the trees extend into the river.
Trees as flow obstacles	A tree with a thick rootstock which is situated in an advanced position in front of the real shore line and well ahead of the riparian wood on the water side, so that at high water marks it is fully exposed to the force of the flow. The root plate extends into the river.
Fallen tree	A tree on the river bank which has been blown over for reasons of age, because of undermining activities directly in the bank nearness or specifically introduced into the river. Ideally, it should be positioned above the riverbed with its trunk, treetop and pulled out rootstock in such a way that it is capable to influence the high-water current. For that, it must be completely or partially located in the transverse section between the riverbed and the river banks. However, if it is positioned in a way that has a structure-forming effect on the river at mean water level, then it must not be recorded here, but by the SP 1.4 “watercourse features”. A fallen tree which lies on both river banks is recorded for both river sides.
Fish shelter	Bank area that is deeply washed- and scored out towards the bank, so that it can serve as hiding- and resting place for fishes. Only fully manifestated features which also offer shelter places for larger fishes, like trouts, are recorded.
Nesting walls/bank break-offs/steep faces	Bank break-offs are often formed on the outer bows of curved watercourses in sediments which are capable for erosions. In flat floodplains they reach a height from few decimetres to several meters. In case of reaching the edges of the floodplain – provided that there is loose rock – extremely high steep banks can be generated. Bank break offs made of loess, clay or silt can offer nesting opportunities for birds (san martin, kingfisher). Small local erosions with an area of maximal 1–2 m² are not recorded within a survey unit with a length of 100 m.

SP 5.3 Bank features

Flow around trees

Trees as flow obstacle

Fallen trees

Fish shelter

Nesting wall

Natural bank break-off

SP 5.01 Bank pressures

Definition

The occurence of local impacts on the river banks. This includes for instance domestic waste, building rubble, green waste, trampling damage, discharge, anthropogenically caused erosion, effects of hydropeaking, waves or flood.

Indicator properties

The bank impacts must not only be regarded relating to their direct harmful effects but also as an indicator for increased human activities on the water. The survey mapping of these data is intended as support for maintenance works. Unnatural forms of erosion may also serve as indicator for intensified intervention with the water balance within the catchment area.

Information on survey mapping

There is a simple registration.

The bank impacts are separately recorded in the field for the left and the right river side and verified for large rivers.

For the survey of transverse bars of large rivers, aerial photos and the German Basic Map are available. Additionally, information on type and size of the single parameter can be requested from the maintenance authorities.

All fully manifestated (with a length of minimal 10 % of the survey unit and river side) morphologically different bank impacts are recorded.

The bank impacts are only registered for informational purposes.

SP 5.01 Bank pressures

Features	
None	There is no bank pressure within the survey unit.
Domestic waste, building rubble	Waste from the domestic surroundings or trades, completely or predominantly mineral.
Green waste	E. g., lawn cuttings, compost
Erosion	Very strong bank erosion untypical for this river type.
Maintenance work	Signs of river maintenance works on the river banks, for instance when cuttings are deposited on the top of the embankment.
Trampling damage	Clear trampling damage by grazing animals or because of recreational use.
Discharge	Discharge of untreated or treated wastewater and visible drainage, rainwater overflows or other brine outfalls, even if they are not fed with water/waste water at the moment of mapping
Hydropeaking, wash of waves	**Hydropeaking:** sudden discharge increase (surge) and sudden discharge decrease (sink), causes for instance a running dry and flooding of groyne fields, e. g., by navigation. **Wash of waves:** hydraulic impact on river banks by wash of waves, caused for instance by navigation.

SP 5.01 Bank pressures


Domestic waste


Building rubble


Green waste


Erosion


Maintenance work (deposited lawn cuttings right side)


Trampling damage


Discharge


Wash of waves

SP 5.02 Shading

Definition

The shadowing of a river by bank vegetation or by adjacent land use.

Indicator properties

Near-natural rivers are accompanied by river typical bank– and adjacent land zone vegetation which primarily is composed for the most rivers of woody plants. In conjunction with this, the shadowing of rivers is enabled. Type-specifically (e. g., for rivers in the lowlands with partial pronounced reed zones) or also locally free from woods sites can be found in a natural way (e. g., because of windstorms, floodings or bed-load relocations) on the river banks and in the floodplains. Therefore, near-natural rivers show a mosaic, composed of illuminated and shadowed river sections. The shading prevents an excessive heating of the river in the summer time and an excessive macrophyte vegetation which could lead to a complete increasing grow of herbs and weed.

By the removal of riparian wood or by damming a river, the water temperature is increased, so that the water contains less oxygen leading to a significant negative impact on the composition of the biocoenosis.

Information for the survey mapping

There is a simple registration.

The estimation of the summerlike shadowing due to bank vegetation and adjacent land use is performed in the field. If the bank vegetation is one-sided, then also the compass direction of the vegetation must be noted.

The determination of the shading is performed in the field for rivers with a surface water width of <20 m. For the survey of shadowed large rivers also aerial photos are on offer.

The shading is only noted for informational purposes.

Features	
Sunny	No shading over the whole day e. g., lacking wood.
Semi-shady	Medial shading e. g., because of one-sided existing trees or constructions.
Shady	Full of shadows e. g., below trees with dense cover.
Indistinguishable	The summer shading cannot be assessed.

SP 5.02 Shading

Sunny

Semi-shady

Shady

Shady

Main parameter 6: adjacent land zone

SP 6.1 Adjacent land use

Definition

Type and extent of uses starting from the upper edges of the embankments or from a possible riparian zone or -strip up to a maximal distance of 100 m from each river side or inside of morphological floodplain (including the dam and the border of the valley). That means, in V-shaped and U-shaped valleys, the valley slopes are considered up to the valley border (as far as they are visble).

For rivers flowing in a secondary floodplain, the adjacent land use is recorded starting from the river bank or from the top of the embankment or from to a possible riparian zone within a strip of 100 m from each river side, potentially also outside of the secondary floodplain.

Indicator properties

The floodplain is as biotope for typical animal- and plant species, for the self-dynamic development of the river, as retention area in case of flooding and for the material retention in cases of floods of crucial importance.

To the natural and near-natural and thus to the water-compatible adjacent land uses in the adjacent land zones – also beyond the morphological floodplain – counts the native forests, floodplain vegetation (excluding forests), wasteland and extensive pastureland. Incompatible with the river ecosystem and their floodplains are building development (settlements, trades/industries, traffic), all intensively used agricultural, horticultural and not-indigenous forestry uses. Agricultural or forestry activities which influence the water balance negatively must be also generally regarded as incompatible.

If there is a large amount of wetness incompatible crops in the nearness of the adjacent land zone, then this indicates a disturbance of the natural river water balance and its floodplains. Reasons for this are often waterway constructions, foreland drainage, flood control of the foreland and depth erosions in the river. The most serious interventions in the floodplain are longitudinal constructions (dykes of different types) which completely separate a part of the inundation area from the river watercourse.

Information on the survey mapping

It must be noted which area coverage is in possession of the type of uses. The determination is carried out by estimation or through a GIS-based calculation. All types of use which occur along the water body are registered from an area coverage of 10 % (multiple registration).

For small rivers the parameter is recorded in the field.

SP 6.1 Adjacent land use

For large rivers, the recording of the existing situation is performed by evaluation of aerial photos, biotope survey and a survey of factual adjacent land uses. Especially landfill sites should be queried from the competent authorities, since it is possible that they are no longer recognisable, depending on age and recultivation.

The adjacent land use is separately recorded for the right and left river side. Per side from the upper edges of embankments or from a possible riparian zone or –strip, up to a maximal distance of 100 m along the river or the morphological floodplain (including the dam and the border of the valley).

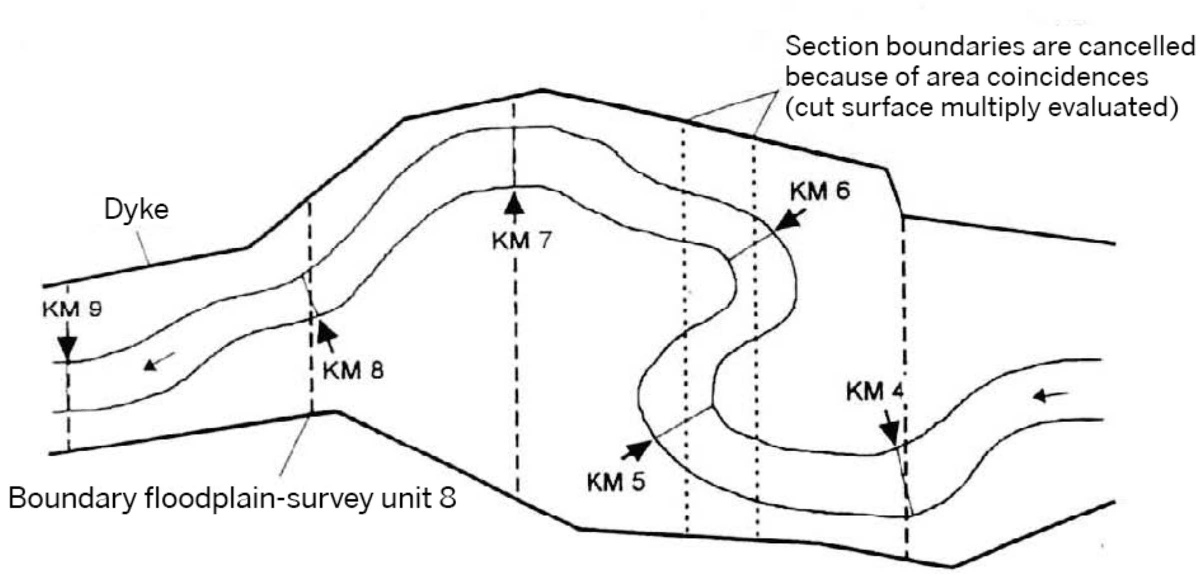
If there are digital data, then the spatial proportion of the existing form of usage can be directly determinated by means of GIS. In the field, the plausibility control of the data is performed.

The **adjacent land zone- or floodplain sections** of large rivers are oriented to the survey units of the river in order to enable a distinct assignment. The borders of the adjacent land zones or floodplain sections are vertically drawn to the valley- or floodplain axis or as angle bisector at the corresponding river kilometre (midstream). The version of the angle bisector is used when the survey unit refers to the riverbed, to the banks and the narrow floodplain or when the floodplain shows a relatively elongated course.

In cases of broader floodplains or stronger windings of the river watercourse, an orientation towards the perpendicular to the valley- or floodplain axis is helpful for the creation of floodplain- and adjacent land zone sections. However, for the establishment of plausible sections, a modification of the created sections of both versions is possible. It is important to record and to determine the structure of the adjacent land zone- or floodplain sections binding for subsequent mappings. This documentation should include figures and explanations of the applied method and justifications for the applied procedure. In this way, the location and assignment of the adjacent land zone- and floodplain segments are transparent and comprehensible for third parties.

On the valley midline (valley-/floodplain axis) there is no valid information up to now. It must be illustrated as generalised course of the middle axis of the potential naturalfloodplain. But it must be noted that in exceptional cases, various adjacent land zone- and floodplain segments must be compiled. This would be for instance the case, when the river shows strong turns. In this example, the section boundaries of the floodplain at km 5 and 6 cause an overlapping surface. Therefore, the boundary up to the next river kilometre, containing a suitable border situation, must be relocated. That means, without coincidences with the following or preceding river section (in the example river kilometre 7).

SP 6.1 Adjacent land use



Picture: Assignement of adjacent land zone- and floodplain survey units (from LUA 2001).

In individual cases, for instance in cases of heterogeneous floodplain uses, this procedure can lead to the fact that singular extremes, which would exceed the survey-mapping-relevant-10 %-threshold within a land zone- or floodplain section, would not be longer recorded within the framework of a needed aggregation of river survey units (below the 10 %-threshold). This must be then noted in the short description.

The existence of adjacent land zone impacts is indicated here, the evaluation is proceeded by the single parameter 6.3 “adjacent land pressures”.

SP 6.1 Adjacent land use

Feature	
Woodland, native	Near natural, locally adapted and endemic deciduous woodland. In the floodplains and lowlands of small to mid-sized rivers, in the low mountain ranges and hill countries there are: alders-, alder-ash-, hornbeam- and common oak forests with humid to fresh specifications. In the lowland plains and lowlands of large rivers there are also forest communities of hardwood- and softwood floodplain forests.
Floodplain vegetation (exclusively wood)	Natural or near-natural or meadow-typical non-forest floodplain vegetation like unused coherent moors, canary grass, reeds, sedge reeds, springs or pioneer meadows on dry, sandy or gravely areas.
Natural wasteland, succession	Larger, for a longer term unused connected spaces at an early stage of succession which are characterised by long term fallows, ruderal meadows, tall forb communities, bush-, cleared- or hedge corridors.
Pastureland	**Extensive pastureland:** agriculturally used meadows and pastureland, also meadow orchards with a low or moderate intensity of fertilisation and grazing. Extensive pastureland is clearly identified by the low growing of rhizomatous grass species, by faded straw-like colours and by a high abundance of herbs. **Intensive pastureland:** Intensively agriculturally used grass- and pastureland with high intensity of fertilisation and grazing. Clearly visible is intensive pastureland is clearly identified by high growing grasses (predominantly rhizomatous grass), by rich green colours, by poverty of herbs or a high abundance of nitrogen indicators (e. g., large leaved docks), turf damages and their colonisation by annual plant species
Woodland, not-native, coniferous forest	Not-native and/or moisture-sensitive coniferous-, mixed- and deciduous plantations (e. g., poplars, red oaks, black walnut, spruce, pines, robinia, Duglas).
Arable land, special cultures	All types of agriculture, Christmas trees plantations, moisture-sensitive vegetable crops, fruit cultivation, tree nurseries, commercial horticulture and fresh grassland sowing with large proportions of topsoil without vegetation cover.
Garden, park, green area	Larger, publicly accessible horticulturally cultivated open spaces in the local- or local edge area.

SP 6.1 Adjacent land use

Development with open space
Urban- or suburban areas with scattered architecture, inclusive of traffic areas, which are to a grater extent (>50 %) interrupted by unpaved areas, like garden plots of private gardens.

Dense development without open space
Urban- or suburban areas with dense concentration of buildings, inclusive of traffic areas, which are not or only to a smaller extent (<50 %) interrupted by unpaved areas, like garden plots of private gardens.

Adjacent land pressures according to SP 6.3
See single parameter 6.3: excavation, landfill, dumping area, fish pond in a bypass watercourse, paved and not paved traffic areas, single farmhouses, flood protection constructions, retention basins, other harmful constructions.

Proportions of the adjacent land use

10 - 50 %
The adjacent land use within the survey unit takes between 10 and 50 % of the adjacent land zone on the regarded river side.

>50%
The adjacent land use within the survey unit takes more than 50 % of the adjacent land zone on the regarded river side.

EP 6.1 Adjacent land use


Woodland, native


Woodland, native


Floodplain vegetation (exclusive wood)


Natural wasteland, succession


Pastureland


Not-native wood, coniferous forest


Special culture


Arable land

EP 6.1 Adjacent land use

Park

Green area

Development with open areas

Development with open areas

Dense development without open spaces

Dense development

EP 6.2 Riparian zone

Definition

Natural riparian zones along the river watercourse which are at the disposal for the river development without restrictions. They directly border on the top of the embankment and are not part of the embankment themselves.

Riparian zones can be covered by a locally adapted and native wood or by a naturally succession area.

The riparian zone extends from the landside to the embankment or to its top.

On shallow natural shorelines, such as at coarse-rich near-natural river sections with numerous relocations, the exterior river banks out of gravels as well as a narrow strip of vegetation that follows up landside (“riparian wood”) form the river bank. To the river banks, the riparian strip is attached from the landside. Therefore, it is also part of the “riparian wood” (if present). The demarcation takes place on a case-by-case basis. Generally, as riparian strip a land strip must be regarded, which the river can make use of for its natural dynamic relocation activities.

In dyked river sections in which the mean water level reaches up to the dam, a riparian strip is lacking. If there is an unused strip between the dam and the river, then it can have a various width.

Indicator properties

Rivers have no rigid shorelines by nature but, depending on the morphological river type, they are variable, showing different varying dynamics. They need an adequate lateral optimum range of movement for watercourse- and profile development. Unnaturally regulated rivers need a multiple large space for further development with a corresponding large supply of space for their regeneration. Without a release of required areas, a restoration of ecological functioning rivers is not possible.

Riparian zones only fulfil their function, if they are sufficiently broad. A common characteristic of a riparian zone is that it is not used and therefore is characterised by natural vegetation in contrast to the following cultural cultivation.

Information for survey mapping

A homogeneous manifestation of a feature leads to a simple registration of the dominant appearance (tick the column “complete”). If the manifestation of the riparian zone is not homogeneous, then there is a detailed mapping by a multiple registration.

The parameter is separately recorded in the field for the left and the right river side. The adoption of the actual situation on-site for larger rivers is performed at the desk by evaluation of aerial photos and by the survey of factual adjacent land uses. On-site, the plausibility of the gathered information is checked.

For rivers which flow through not-native wood, normally a riparian strip <2 m should be recorded.

SP 6.2 Riparian zone

Within each survey unit the proportion of sections with different broad riparian zones are registered. Depending on the river size, the following width classes are distinguished:

	Length of the survey unit 100 m	Length of the survey unit 500 m or 1,000 m
Width of the riparian zone	<2 m	<2 m
	2 - 5 m	2 - 10 m
	10 - 20 m	10 - 50 m
	>20 m	>50 m

Riparian zones are covered with natural wood, natural floodplain vegetation, wasteland or succession corridors. They are neither agriculturally nor silviculturally cultivated, also not used as leisure area (e. g., as hiking trail or as bridle path). A riparian zone is also present if between a natural riparian strip and the river a massive bank protection exists or in other words, a natural possibility of a self-dynamic activities are currently not given.

Width of the riparian zone

Width of the riparian zone <2 m

The riparian zone does not exceed 2 m. The foreshore area is used close to the riverbed as agriculturally usable area, as path for maintenance, as public path or street, as garden grounds, for public and commercial institutions, for sport- and leisure activities, for recreation or for not-native silvicultures or as construction land.

Width of the riparian zone 2-5 m for 100 m survey units

Width of the riparian zone 2-10 m for 500 m or 1,000 m survey units

The riparian zone shows a width between 2 and 5 m for 100 m long survey units or rather between 2 and 10 m for 500 or rather 1,000 m long survey units. It is occupied by natural succession corridors. Growing wild hedges, bushes and river typical riparian wood in unlimited numbers and arrangements can be found. There is no agricultural use, no extensive pasture- and meadow use. The riparian zone is not used as public way.

Width of the riparian zone 5 - 20 m for 100 m survey units

The riparian zone shows a width between 5 and 20 m for 100 m survey units or rather between 10 and 50 m for 1,000 m survey units. The foreshore area being closely attached to the top of the embankment is covered with native wood, with wild growing bushes or other untouched vegetation. There is neither agricultural use nor the adjacent land zone is crossed by paths. However, an extensively use for e. g., sheep grazing is possible.

Width of the riparian zone 10 - 50 m for 500 m or 1,000 m survey units	
Width of the riparian zone >20 m for 100 m survey units **Width of the riparian zone >50 m for 500 m or rather 1,000 m survey units**	The riparian zone shows a width exceeding 20 m for 100 m long survey units or rather >50 m for 500 m or 1,000 m long survey units. The foreshore area being closely attached to the top of the embankment is covered by native wood or untouched vegetation. Sporadically single not native woody plants are possible. Closed not native woody plant cultures do not occur.

Length of the riparian zone	
<10 m	The respective length of the riparian zone takes less than 10 m at the concerned river side of the survey unit.
10 - 50 m	The respective length of the riparian zone takes between 10 and 50 m at the concerned river side of the survey unit.
>50 - 100 m	The respective length of the riparian zone takes between 50 and 100 m at the concerned river side of the survey unit.
>100 – 250 m	The respective length of the riparian zone takes between 100 and 250 m at the concerned river side of the survey unit.
>250 – 500 m	The respective length of the riparian zone takes between 250 and 500 m at the concerned river side of the survey unit.
>500 m	The respective length of the riparian zone takes more than 500 m at the concerned river side of the survey unit.
Complete	The respective length of the riparian zone takes approximately 100 % at the concerned river side of the survey unit.

SP 6.2 Riparian zone

Riparian strip <2 m

Riparian strip <2 m

Riparian strip 2 – 5 m

Riparian strip 2 – 10 m

Riparian strip 5–20 m

Riparian strip 10–50 m

Riparian strip >20 m

Riparian strip >50 m

SP 6.3 Adjacent land pressures

Definition

As adjacent land pressures especially local or linear structures are recorded, like excavations, mining subsidence, landfil, discharging of waste, fishponds, paved and unpaved routes, flood protection constructions, developments, campsite, storage locations, wastewater treatment plants and other water management constructions. The harmful effects also include the restriction of the natural morphodynamic, the change of the water balance or the negative impact by diffuse and punctual inputs.

For some features, the river ecological negative impact depends on the distance to the watercourse and whether there is a riparian zone between the listed pressures and the watercourse.

Indicator properties

Ecologically intact rivers in the landscape require a water-compatible adjacent land zone. Constructions which directly or indirectly impede the river development are important obstacles.

Information on the survey mapping

There is a multiple registration.

The adjacent land pressures are separately recorded for the left and the right adjacent land zone. Per river side it is recorded which adjacent land pressures from the top of the embankment or from a possible riparian zone within a strip up to 100 m of width along the river or within the morphological floodplain (including the dam or until the valley edge) can be found.

The structures are recorded with the distance to the river in three distance classes <10 m, 10 - 40 m and >40 m.

The survey mapping of smaller rivers is performed in the field.

The survey mapping of large rivers is performed desk-based by the actual situation on-site which is realised by the evaluation of aerial photos, the German Basic Map and the survey mapping of factual adjacent land uses. In the field, the plausibility of the information is checked.

Adjacent land pressures are only recorded when they are not already registered by the SP ”6.1 adjacent land use“, that means paved traffic areas which belong to the SP 6.1 as “development >50 %” are not additionally recorded as “traffic areas, paved” by the SP 6.3.

Paths which cross the river and do not run parallel to the river are not recorded as a harmful land feature but, if appropriate, registered by the SP 2.2 “piping/overbuilding or SP ”4.5 culvert/bridge“.

Features	
None	In the foreshore area there are none of the below listed adjacent land pressures within a strip of up to 100 m or within the morphological floodplain (including the dam or rather until the valley edge).
Excavation	In the foreshore area within a strip of up to 100 m or within the morphological floodplain (including the dam or rather until the valley edge) there are one or more areas for the mining of raw materials and natural resources, like mining of raw gravel from extraction sites. Recultivated areas or areas that are left to develop completely naturally for a longer period are to be registered according to their current use/development. In the short description, the former excavation use must be pointed out.
Fishpond in a side watercourse	In the foreshore area within a strip of up to 100 m or within the morphological floodplain (including the dam or rather until the valley edge) there are one or more fishponds in a neighbouring watercourse which lie at the river side and are directly connected by an in- and outflow with the river.
Water structure harmful constructions	In the foreshore area within a strip of up to 100 m or within the morphological floodplain (including the dam or rather until the valley edge) there are one or more harmful constructions for the water structure like farmsteads and individual buildings like sport facilities, storage locations, heap-like earth fills and water management constructions like wastewater treatment plants.
Traffic area, unpaved	In the foreshore area within a strip of up to 100 m or within the morphological floodplain (including the dam or rather until the valley edge) there are one or more parallel to the river running footpaths, dirt tracks or non-asphalted service roads with a water-bound cover, stamped loam which act as bottlenecks for a possible morphological river development.
Traffic area, paved	In the foreshore area within a strip of up to 100 m or within the morphological floodplain (including the dam or rather until the valley edge) there are one or more paved traffic routes running parallel to the river, railway lines or extensive sealed areas. Due to their their surface design (concrete slabs, interlocking paving stones) and due to the construction of their substructure, these areas permit no or only a low infiltration to the groundwater and act as local bottlenecks for a possible morphological river development.
Landfill, waste discharging	In the foreshore area within a strip of up to 100 m or within the morphological floodplain (including the dam or rather until the valley edge) there are: **Waste dischargings**: Waste and rubble of any kind from homes and gardens, farming and industry of more than 1 m^3. **Dump:** areas being in operation aboveground or subterrestrial (e.g., filled excavations) for the deposition of no longer required

	substances. Recultivated deposition sites are not recognisable as such and only identified by requests to competent authorities. Recultivated deposition sites which are left to a natural development are to be registered corresponding to their actual use/vegetation growth. In the short description, the former use as deposition must me noted.
	Landfills: there are one or more landfills (excavated earth) or heaps.
Flood protection constructions	In the foreshore within a strip of up to 100 m or within the morphological floodplain, there are one or more flood protection constructions like dams, dykes or flood control reservoirs. If the river to be mapped is regulated by a flood control reservoir, then it will not be registered here, but by the SP ”2.1 transverse and special structuress“, or corresponding to the length of the culvert by the SP ”.2.2 piping/overbuilding“ or by the SP ”4.5 culvert/bridge“.

Distance to the river	
<10 m	The adjacent land zone pressure is maximally 10 m away from the top of the river embankment.
10 – 40 m	The adjacent land zone pressure is between 10 m and 40 m away from the top of the river embankment.
>40 m	The adjacent land zone pressure is more than 40 m away from the top of the river embankment but it is still part of the adjacent land zone.

SP 6.3 Adjacent land pressures


Excavation


Fishpond in a side watercourse


Water structure harmful constructions: sport facility


Water structure harmful constructions: farmhouse, single construction


Traffic area, paved


Traffic area, paved


Traffic area, unpaved


Traffic area, unpaved

SP 6.3 Adjacent land pressures

Landfill: heap

Waste deposit

Flood protection construction: dyke

Flood protection construction: retention basin

SP 6.01 Adjacent land features

Definition

Natural elements like rock faces, manifestated edges of the terrace, natural embankments, high tide watercourses, springs, pools, ponds or near-natural oxbow lakes belong to adjacent land features.

Indicator properties

The listed structures represent especially valuable landscape elements being legally protected in parts. A number of them characterises an intact water balance within the floodplain.

Information on the survey mapping

There is a multiple registration.

The adjacent land features are separately recorded for the left and the right river side. Per river side all adjacent land features within a strip width of 100 m along the watercourse or rather within the morphological floodplain (including the dam and up to valley edge) are registered. **Adjacent land features which are already recorded by the SP ”6.1 adjacent land use“ are not considered here.**

For small rivers, the survey mapping is performed in the field.

The survey of large rivers of the current situation on-site is performed desk-based by evaluating aerial photos, the German Basic Map and the survey of factual adjacent land uses. In the field, the plausibility of the information is checked.

Only fully developed bank features are recorded.

The land structures are only recorded for informational purposes.

SP 6.01 Adjacent land features

Features	
None	There are none of the below listed adjacent land features within the survey unit.
Rock face	Steep slope face without weathering mantle, sparsely vegetated.
Manifestated edge of the terrace	Transition zone between valley bottom and terrace hill which can be very distinctive. Above the terrace hill follows the terrace surface.
Natural embankment	Dams at the river banks along the river which have been naturally created by sediment accumulations during flooding.
Flood watercourse/high tide watercourse	Troughshaped deepening in the floodplain area, in which the flooding runs out. They can be filled with water at high groundwater levels.
Source	Natural or fixed discharge point of groundwater or leachate to the earth`s surface.
Standing waters	It includes the different natural and anthropogenically created standing waters like still waters with temporary water supply (ponds); natural shallow standing waters with constant water supply or oxbow lakes (former river watercourse which has been separated by watercourse relocation measures or by water management measures). Artificially created still waters like ponds, ditches or quarry ponds. Fish- or garden ponds are not recorded here.

SP 6.01 Adjacent land features

Rock face

Sandy embankment

Flood watercourse

High tide watercourse

Spring (near-natural)

Spring (protected)

Still waters (oxbow lake)

Still waters (floodplain waters)

3.4 Assessment block

In the "evaluation block" of the surveying sheet (right side of the grey block "evaluation of functional units") the assessment of the functional units carried out by the cartographer is documented. The functional units form a link between the "measurable" single parameters and the more abstract main parameters. The assessment of the functional units serves for the validation and verification of the evaluation results of the index-based assessment.

The assessment block is filled out at the end of the assessment procedure.

The cartographers are obliged to give a satisfatory reason for the chosen main parameter classes in note form, if the deviation between the index-based evaluation and the assessment of functional units exceeds more than one class (comments and valuation justification of the identification block).

4 Performance of the evaluation

For each survey unit, two different and independent assessment procedures must be performed. The components are: the evaluation of functional units and the index-based evaluation system.

The evalution of the functional units and of the main parameters form the basis for the determination of the overall assessment. The index-based calculation of the main parameter indexes serves for the statistical validation and plausibility check of the evaluation results.

4.1 The valuation based on functional units

4.1.1 Valuation principles based on functional units

The assessment of the river morphology by functional units requires the understanding of the specific reference conditions ”Leitbild“ of the relevant river type. Characteristic for the reference conditions “Leitbilder” are the following general requirements:

minimal changes of the natural discharge dynamics

- minimal changes of natural riverbed dynamic
- minimal changes of the natural floodplain

The cartographers have to carry out an assessment on the basis of the above listed general requirements for the main parameters and for functional units which are allocated to the main parameters. This is done based on the reference conditions. The reference conditions relate to the different morphological river types like “V-shaped rivers, coarse material rich”, “hollow and floodplain river, organic” or for the large rivers, like the “mid-sized siliceous rivers in the lower mountains”. Rivers with their floodplains, which completely correspond to these reference conditions, can rarely be found in the wider countryside. This especially concerns the lowlands and the large rivers. But in the lower mountain ranges it is still possible to find near-natural reference rivers.

The river type specific reference conditions define the morphological quality corresponding to class 1 for each main parameter. Since each classe shows a certain class width, it represents the respective optimum. However, to what extent a survey unit can still be assigned to the class 1, also in cases of slight deviations from the reference conditions, is a decision of the cartographers. The degradation levels (classes 2 to 7) can be assigned, according to the below classification, to the main parameters. This sequence forms the basis of the evaluation.

Since the main parameters are highly abstracted and their manifestation not directly quantifiable or identifiable, they are substantiated by so-called functional units. For instance, the main parameter ”watercourse development“ is more precisely described by the functional unit “watercourse curvature” and “-movability”. If these parameters correspond in their individual appearance to their respective reference conditions (e. g., “natural curvature 100 %”, “natural movability 100 %”), then the main parameter is evaluated with the morphoöogyclass 1.

The evaluation by functional units requires the cartographer’s attention for such single parameters of some main parameters which are assigned to the index calcultion of other main parameters (example: A great profile depth also has an influence on the movability of a river). Therefore, for each main parameter, the single parameters to be considered are listed.

Table: Definition of the morphology class of a seven-level evaluation

Morphology class	Value range	Designation
1	1.0 – 1.7	Unchanged
2	1.8 – 2.6	Slightly changed
3	2.7 – 3.5	Moderately changed
4	3.6 – 4.4	Distinctly changed
5	4.5 – 5.3	Obviously changed
6	5.4 – 6.2	Strongly changed
7	6.3 – 7.0	Completely changed

Table: Definition of the classes in connection with a five-level valuation

Class	Value range
1	1.0 – 2.2
2	>2.2 – 3.4
3	>3.4 – 4.6
4	>4.6 – 5.8
5	>5.8

The valuation of the five main parameters ”watercourse development“, ”bed features“, ”cross profile“, “bank features“ and “adjacent land zone” can be calculated by the arithmetic mean of the valuations of the corresponding functional units. Fractional values are transferred according to the classification scheme to amorphologyclass (seven- or five-level evaluation). In the case of the evaluation of the main parameter ”bed structure“ (see chapter 4.1.2, MP 3) and ”bank features“ (see chapter 4.1.2, MP 5), the functional units “bed fixation” and “bank protection” shall not have the effect of an invalid upgrading of the respective results. In these cases, the respective functional unit (“bed fixation” or “bank protection” is not considered for the mean value calculation.

Regarding the main parameter “longitudinal profile” the functional unit “anthropogenic continuity barriers” must be added as malus. (see chapter 4.1.2, MP 2). If a number higher than 7 is achieved, this always results in the morphology class 7 for the respective main parameter. For the determination of the malus for the functional unit “anthropogenic continuity barriers” the barrier with the highest malus is relevant (“pessimistic” valuation).

4.1.2 Description of the functional units

In the following, the main parameters are described with the characterisation of the respective functional units.

The percentage for the individual classes indicates the degree of nearness to nature in terms of size. They must be understood as orientation and not as numerical values.

Main Parameter 1: Watercourse development

Functional unit a: Curvature (amplitude and oscillating length)

Functional unit b: Movability (erosion at bends, migration)

Class		Examples
1	a	Natural curvature (100 %)
	b	Nature-conforming movability
2	a	Close to nature conforming curvature (>80 %)
	b	Close to nature conforming movability
3	a	Mainly natural curvature (50 – 80 %)
	b	Reduced movablity by bank planting (bioengineered fixation)
4	a	Distinctly, but anthropogenically manifestated curvature (30 – 50 %)
	b	Distinctly decreased movability by intensive bank planting or woody fixation, (bioengineered fixation, wickerwork, frugal riprap)
5	a	Slight curvature (10 – 30 %), predominantly straightened
	b	Little movability because of bank protection (fixation of the foot of the embankment by stones, riprap)
6	a	Small curvature (<10 %), largely straightened
	b	Currently no movability because of bank protection (fixation of the foot of the embankment)
7	a	No curvature, completely straightened, dead-straight line (0 %)
	b	No movability because of massive bank- and slope protection

Single parameters to be considered

Curvature: SP 1.1 watercourse curvature, SP 1.3 longitudinal bars, SP 1.4 watercourse features

Movability: SP 1.2 erosion at bends, SP 4.2 profile depth, SP 5.2 bank protection

Main parameter 2: Longitudinal profile

Functional unit a:

Natural longitudinal profle features

Class		Examples
1	a	Natural sequence of bars, in conjunction with nature-conforming flow variation and depth variation (100 %)
2	a	Close to nature conforming longitudinal profile elements (>80 %)
3	a	Numerous natural longitudinal profile features (50 – 80 %)
4	a	Multiple natural length profile features (30 – 50 %)
5	a	Rare natural longitudinal profile features (10 – 30 %)
6	a	Very rare natural longitudinal profil features (<10 %)
7	a	No natural longitudinal profile features

Single parameters to be considered

SP 2.4 transverse bars, SP 2.5 flow diversity, SP 2.6 depth variation

Functional unit b:

Anthropogenic continuity barriers

Malus		Examples
0	b b b b b	No constructions Transverse structures with a discharge close to bed or a ground sill (<0.1 m) morphologically not harming culvert or bridge No backwater No diversion watercourse
1	b b b	Bed fall (0.1 – 0.3 m) Rough sliding Short piping/overbuilding with sediment
2	b b b b b b	Bed fall (0.3 – 1 m) Rough sliding Short piping/overbuilding without sediment or intermediate piping/overbuilding with sediment, Watercourse narrowed without sediment, Less than half of the survey unit shows backwater effects Less than half of the survey unit shows a diversion watercourse
3	b b b b b	Bed fall (>1 m) Dam, pumping station, dyke Long piping/overbuilding without sediment More than half of the survey unit shows backwater effects More than half of the survey unit shows a diversion watercourse

Single parameters to be considered

SP 2.1 transverse and special features, SP 2.2 piping/overbuilding, SP 2.3 backwater, SP 2.7 diversion watercourse, SP 4.5 culvert/bridge

Main parameter 3: Bed structure

Functional unit a: Type/distribution of substrates

Functional unit b: Bed fixation

Class		Examples
1	a	Complete indigenous substrate conditions (100 %), no artificial or non-natural substrates
	b	No fixation
2	a	Largely indigenous substrate conditions (>80 %), artificial or non-natural substrates are rare
	b	Rare or punctual fixation with near-natural methods (<20 %)
3	A	Mainly indigenous substrate conditions (50 – 80 %), artificial or non-natural substrates are rare
	b	Seldom bed fixation with near-natural methods, no fixation by technical means (20 – 50 %)
4	a	Significant indigenous substrate conditions (30 – 50 %), multiple artificial or non-natural substrates
	b	Multiple bed fixation (30 – 50 %), porous for instance by coverage of cobbles
5	a	Moderate indigenous substrate conditions (10 – 30 %), multiple artificial or non-natural substrates frequent
	b	Substantial bed fixation (50 – 80 %)
6	a	Rare indigenous substrate conditions (<10 %), multiple artificial or non-natural substrates very frequent
	b	Largely bed fixation (>80 %), porous for instance by coverage of cobbles
7	a	No indigenous substrate conditions, complete artificial or non-natural substrates
	b	Largely dense bed fixation (>80 %), like concrete, sheet pile

Parameters to be considered

Type and distribution of the substrates: SP 3.1 bed substrate, SP 3.2 substrate diversity, SP 3.4 bed features, SP 3.01 bed pressures

Bed fixation: SP 3.1 bed substrate, SP 3.3 bed fixation

Main parameter 4: Cross profile

Functional unit a: Profile type

Functional unit b: Profile depth

Functional unit c: Width development

Class		Examples
1	a	Irregular indigeneous profile shape
	b	Natural profile depth (for the most river types <1:10)
	c	Natural width variation
2	a	Irregular, approximately indigenous profile type
	b	Slightly increased profile depth
	c	Approximately natural width variation
3	a	Irregular, approximately indigenous profile form or erosion profile
	b	Distinctly increased profile depth
	c	Slightly decreased width variation
4	a	Uniform profile form, erosion profile
	b	Significantly deepening
	c	Significantly decreased width variation
5	a	Technical rule profile, decaying or monotonous erosion profile
	b	Severely deepening
	c	Slight width variation
6	a	Technically covered rule profile
	b	Very severe deepening
	c	Very slight width variation
7	a	Technically covered rule profile
	b	Excessive deepening (mostly >1:3)
	c	No width variation

Single parameters to be considered

Profile type: SP 4.1 profile type

Profile depth: SP 4.2 profile depth

Width variation: SP 4.3 width erosion, SP 4.4 width variation, SP 4.5 culvert/bridge, SP 2.2 piping/overbuilding

Main parameter 5: Bank structure

Functional unit a: Typical bank vegetation

Functional unit b: Bank protection

Functional unit c: Typical natural features

Class		Examples
1	a	Continuous indigenous woody bank vegetation andriver typically not wooden bank vegetation (100 %); shady
	b	No constructions/protection
	c	Complete indigenous manifestation (100 %)
2	a	Substantial indigenous woody bank vegetation and river typical not wooden bank vegetation (>80 %); shady
	b	No constructions/protection, at most selectively
	c	Substantial indigenous manifestation (>80 %)
3	a	Mainly indigenous woody bank vegetation and river typical not wooden bank vegetation (50-80 %); semi-shady
	b	Rarely technical shoring (<30 %) or protection with near-natural methods (30 – 50 %)
	c	Predominantly indigenous manifestation (50 – 80 %)
4	a	Significant indigenous woody bank vegetation and river typical not wooden bank vegetation (30 - 50 %); semi-shady
	b	Considerable near-natural construction (50 – 80 %) or purely technical shoring (30 – 50 %)
	c	Considerable indigenous manifestation (30 – 50 %)
5	a	Sporadically indigenous woody bank vegetation and typically not wooden bank vegetation (10 - 30 %); sunny
	b	Largely technical protection (50 – 80 %), but distinctly interrupted or in a state of decay
	c	Moderately indigenous manifestation (10 – 30 %)
6	a	Rarely indigenous woody bank vegetation and river typical not wooden bank vegetation (>10 %); sonny
	b	Substantial technical protection (>80 %), open-pored like cobble stones, lawn checker bricks ungrouted brickwork
	c	Slight indigenous manifestation (<10 %)
7	a	No indigenous woody bank vegetation and river typical not wooden bank vegetation (<10 %); sunny
	b	Substantial technical protection, tight like concrete, metal, brickwork
	c	Completely unnatural manifestation

Single parameters to be considered

Indigenous vegetation: SP 5.1 bank vegetation, SP 5.02 shading

Bank protection: SP 5.2 bank protection

Indigenous manifestation: SP 5.3 bank features, SP 5.01 bank pressures

Main parameter 6: Adjacent land zone

Functional unit a: Foreland

Functional unit b: Riparian strip

Class		Examples
1	a	Complete near-natural manifestation, only water-compatible use
	b	Complete and sufficiently broad riparian zone (100 %)
2	a	Significant near-natural manifestation, only water-compatible use
	b	Poorly interrupted or in parts too narrow zone (>80 %)
3	a	Partially near-natural manifestation with predominantly water-compatible use
	b	Partially interrupted and frequently too narrow riparian strip (50 - 80 %)
4	a	Distinctly near-natural manifestation with widespread water-incompatible use
	b	Interrupted or frequently too narrow riparian strip (30 – 50 %)
5	a	Significant unnatural manifestation with widespread water-incompatible use
	b	Significantly lacking (10 – 30 %) or predominantly too narrow riparian strip
6	a	Significant unnatural manifestation with dominantly water-incompatible use
	b	Significantly lacking (<10 %) or fragmentary developed riparian strip
7	a	Complete unnatural manifestation with completely water-incompatible use
	b	Complete lacking riparian strip (e. g., sealed commercial spaces)

Single parameters to be considered

Foreland: SP 6.1 **adjacent** land use, SP 6.3 adjacent land presures, SP 6.01 adjacent-land features

Riparian zone: SP 6.2 riparian zone

4.2 The index-based evaluation

4.2.1 Basics of the index-based evaluation

The index-based evaluation is performed on the level of single parameters and of their features. In the index-system, depending on the reference conditions and on the morphological river type, specific index values between 1 and 7 are assigned to the the features. This results, after the survey mapping of the features, in a standardised, evaluation of every single parameter that cannot be influenced by the cartographer. From the assessment of all single parameters the overall evaluation is calculated summarisingly.

The evaluation scales of the index system have been calibrated, depending on the morphological river type, with the present-day potential natural state. This calibration has been normally performed by the type-specific descriptions of the morphological river types.

During the survey mapping, the cartographers realise which of the features assigned to a single parameter are characteristic for the given river section. Since the features are linked by the index system to a certain value system, the status assessment is already carried out by ticking the right feature. Consequently, the index-based evaluation is not performed by the cartographers but reproducible at any time by the defined system.

For the single parameters 1.4 ”watercourse features“, 3.4 “bed features“ and 5.3 “bank features” the different features are counted separately. For the index-based evaluation, the sums of all counted features are taken as basis. If in this context:

- the sum of the different separately counted features results in the number one or two, then for the index-based evaluation the value for the feature “one to two” is assumed,
- the sum of the different separately counted features results in the number three to five, then for the index-based evaluation the value for the feature “various” is assumed,
- the sum of the different separately counted features results in the number six or more, then for the index-based evaluation the value for the feature “many” is assumed.

In case of an electronic survey, the index for the main parameters or for the MP 5 ”bank structure“ and the MP 6 ”adjacent land zone“ is separated for the left and the right river side and automatically calculated following the below described algorithm.

The aggregation for the evaluation of the six main paramteres is carried out by the arithmetic mean value calculation of the index values of the single parameters. However, not always all index values contribute to the calculation (see chapter 4.2.2). Therefore, for the main parameters normally values with fraction numbers between 1.0 and 7.0 arise which are standardly transferred, in case of an electronic surveying, to a morphology class with 7 valuation levels, according to the following table.

Table: Definition of the stuctural class in the course of a 7-level-evaluation

M;orphology class	Range of values	Determination
1	1.0 – 1.7	Unchanged
2	1.8 – 2.6	Slightly changed
3	2.7 – 3.5	Moderately changed
4	3.6 – 4.4	Distinctly changed
5	4.5 – 5.3	Obviously changed
6	5.4 – 6.2	Strongly changed
7	6.3 – 7.0	Completely changed

4.2.2 Index allocation of the features

In the following, the index allocation of the single parameters are summarised. The following applies:

Valuation rules	
☝	Simple registration; only the dominating feature is included in the calculation
✋	Multiple registration
☹	Only the worst value is included in the calculation
➘	Feature is only included in the calculation, when it contributes to a devaluation of the index
X	Feature is not included in the valuation
li / re	Left and right river side are separately calculated

Morphological types of small rivers (survey unit 100 m)	
KT_g	V-shaped rivers, coarse material-rich
ST_g	U-shaped rivers, coarse material-rich
AT_g	Hollow and floodplain river, coarse material-rich
OT_g	Rivers without valleys, coarse material-rich
AT_o	Hollow and floodplain rivers, organic
OT_o	Rivers without valley, organic
ST_fl	U-shaped rivers, fine material-rich -loess-loam
AT_fl	Hollow and floodplain rivers, fine material rich -loess-loam
OT_fl	Rivers without valley, fine material-rich -loess-loam
ST_fs	U-shaped rivers, fine material rich -sand
AT_fs	Hollow and floodplain rivers, fine material-rich -sand
OT_fs	Rivers without valley, fine material-rich -sand

Morphological types of large rivers (survey unit 500 m / 1,000 m)	
g_FG	Large rivers

Main parameter 1: Watercourse development

Morphological types	KT_g	ST_g	AT_g OT_g
1.1 Watercourse curvature/Bends			
Strongly meandering	**X**	**1**	**1**
Meandering	**X**	**1**	**2**
Curved	**X**	**2**	**3**
Slightly curved	**X**	**4**	**5**
Elongated	**X**	**5**	**6**
Straight	**X**	**7**	**7**
unbranched	**X**	**X**	**X**
with side watercourses	**X**	**X**	**X**
branched	**X**	**X**	**X**

1.2 Erosion at bends					
		curved	not curved	curved	not curved
Strong, frequently	**X**	**2**	**2**	**2**	**2**
Strong, occasionally	**X**	**2**	**3**	**2**	**3**
Weak, frequently	**X**	**1**	**4**	**1**	**4**
Weak, occasionally	**X**	**1**	**5**	**1**	**5**
None, naturally	**X**	**1**	**1**	**1**	**1**
None, anthopogenically	**X**	**7**	**7**	**7**	**7**

1.3 Longitudinal bars			
Many	**1**	**1**	**1**
Several	**2**	**2**	**2**
One or two	**3**	**3**	**4**
None	**7**	**7**	**7**
Not visible	**X**	**X**	**X**

1.4 Watercourse features			
Many	**1**	**1**	**1**
Several	**2**	**2**	**2**
One or two	**3**	**3**	**4**
None	**7**	**7**	**7**

Main parameter 1: Watercourse development

Morphological types	AT_o OT_o	ST_fl	AT_fl OT_fl	ST_fs	AT_fs OT_fs
1.1 Watercourse curvature/Bends					
Strong meandering	**1**	**1**	**1**	**1**	**1**
Meandering	**2**	**1**	**2**	**1**	**2**
Curved	**3**	**2**	**3**	**3**	**3**
Slightly curved	**5**	**4**	**5**	**5**	**5**
Elongated	**6**	**5**	**6**	**6**	**6**
Straight	**7**	**7**	**7**	**7**	**7**
Unbranched	**X**	**X**	**X**	**X**	**X**
With side watercourses	**X**	**X**	**X**	**X**	**X**
Branched	**X**	**X**	**X**	**X**	**X**
1.2 Erosion at bends					

	curved	not-curved	curved	not-curved	curved	not-cirved	curved	not-curved	curved	not-curved
Strong, frequently	**X**	**X**	**X**	**X**	**X**	**X**	**2**	**2**	**2**	**2**
Strong, occasionally	**X**	**X**	**X**	**X**	**X**	**X**	**2**	**3**	**2**	**3**
Weak, frequently	**X**	**X**	**X**	**X**	**X**	**X**	**1**	**4**	**1**	**4**
Weak, occasionally	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
None, naturally	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
None, anthopogenically	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**	**7**

1.3 Longitudinal bars					
Many	**X**	**1**	**1**	**1**	**1**
Several	**X**	**1**	**1**	**2**	**2**
One or two	**X**	**2**	**2**	**3**	**3**
None	**X**	**7**	**7**	**7**	**7**
Not visible	**X**	**X**	**X**	**X**	**X**
1.4 Watercourse features					
Many	**1**	**1**	**1**	**1**	**1**
Several	**2**	**2**	**2**	**2**	**2**
One or two	**4**	**3**	**4**	**3**	**4**
None	**7**	**7**	**7**	**7**	**7**

Main parameter 1: Watercourse development

Morphological types	G_FG							
1.1 Watercourse curvature/Bends								
	curved	not-cur-ved	curved	not-cur-ved	curved	not-cur-ved	curved	not-cur-ved
Strong meandering	**3**	**3**	**3**	**1**	**1**			
Meandering	**3**	**3**	**1**	**3**	**3**			
Curved	**3**	**1**	**2**	**4**	**4**			
Slightly curved	**1**	**3**	**4**	**5**	**5**			
Elongated	**1**	**4**	**6**	**6**	**6**			
Straight	**6**	**7**	**7**	**7**	**7**			
Unbranched						**1**	**4**	**7**
With side watercourses						**X**	**1**	**4**
Branched						**X**	**X**	**1**

1.2 Erosion at bends		
	curved	not-cur-ved
Strong, frequently	**1**	**1**
Strong, occasionally	**1**	**1**
Weak, frequently	**3**	**4**
Weak, occasionally	**4**	**5**
None, naturally	**1**	**1**
None, anthopogenically	**5**	**6**

1.3 Longitudinal bars	
Many	**1**
Several	**2**
One or two	**3**
None	**7**
Not visible	**X**

1.4 Watercourse features	
Many	**1**
Several	**2**
One or two	**4**
None	**7**

Main parameter 2: Longitudinal profile

Morphological types	KT_g ST _g AT _g OT_g			
2.1 Transverse and special structures ✋ ☹ ➘	**0.1 - 0.3 m**	**>0.3 - 1 m**	**>1 m**	
Movable weir/bed fall	**6**	**6**	**7**	
Movable weir/ bed fall with fish passage	**5**	**5**	**6**	
Movable weir/bed fall with bypass watercourse	**4**	**4**	**5**	
Unpermitted construction				**5**
Ground sill (<0.1 m)				**X**
Smoth sliding				**5**
Rough sliding				**3**
Smooth ramp				**6**
Rough ramp				**4**
Transverse constructions with near-bed outflow				**X**
Dam				**7**
Pumping station				**7**
Culvert				**7**
No transverse construction				**X**

Morphological types	AT_o ST_fl OT_o AT_fl ST_fs OT_fl AT_fs			
2.1 Transverse and special structures ✋ ☹ ➘	**0.1 - 0.3 m**	**>0.3 - 1 m**	**>1 m**	
Movable weir/bed fall	**6**	**6**	**7**	
Movable weir/ bed fall with fish passage	**5**	**5**	**6**	
Movable weir/bed fall with bypass watercourse	**4**	**4**	**5**	
Unpermitted construction				**5**
Ground sill (<0.1 m)				**X**
Smoth sliding				**5**
Rough sliding				**3**
Smooth ramp				**6**
Rough ramp				**4**
Transverse constructions with near-bed outflow				**X**
Dam				**7**
Pumping station				**7**
Culvert				**7**
No transverse construction				**X**

Morphological types	g_FG			
2.1 Transverse and special features ✋ ☹ ➘	**0.1 - 0.3 m**	**>0.3 - 1 m**	**>1 m**	
Movable weir/bed fall	**6**	**6**	**7**	
Movable weir/ bed fall with fish passage	**5**	**5**	**6**	
Movable weir/bed fall with bypass watercourse	**4**	**4**	**5**	
Unpermitted construction				**5**
Ground sill (<0.1 m)				**X**
Smoth sliding				**5**
Rough sliding				**3**
Smooth ramp				**6**
Rough ramp				**4**
Transverse constructions with near-bed outflow				**X**
Dam				**7**
Pumping station				**7**
Culvert				**7**
No transverse construction				**X**

Main parameter 2: Longitudinal profile

Morphological types	KT_g			ST_g			AT_g OT_g		
2.2 Piping/Overbuilding ✋ ☹ ➘									
	with. sed.	wit-hout sed.	not vi-sible	with sed.	wit-hout sed.	not vi-sible	with sed.	wit-hout	not vi-sible
>10 - 20 m	**5**	**7**	**7**	**5**	**7**	**7**	**5**	**7**	**7**
>20 - 50 m	**6**	**7**	**7**	**6**	**7**	**7**	**6**	**7**	**7**
>50 m	**X (Special case)**			**X (Special case)**			**X (Special case)**		
2.3 Backwater ✋ ☹ ➘									
No backwater	**X**			**X**			**X**		
Technical <10 m	**X**			**X**			**X**		
Technical 10 - 50 m	**6**			**6**			**6**		
Technical >50 -1 00 m	**7**			**7**			**7**		
Technical >100 - 250	**X**			**X**			**X**		
Technical >250 m	**X**			**X**			**X**		
Natural <10 m	**X**			**X**			**X**		
Natural 10 - 50 m	**X**			**X**			**X**		
Natural >50 - 100 m	**X**			**X**			**X**		
Natural >100 - 250 m	**X**			**X**			**X**		
Natural >250 m	**X**			**X**			**X**		
2.4 Transverse bars 👍									
Many	**X**			**1**			**1**		
Several	**X**			**2**			**2**		
One to two	**X**			**4**			**4**		
None, anthropogenically	**7**			**7**			**7**		
None, naturally	**1**			**1**			**1**		
Not visible	**X**			**X**			**X**		

2.5 Flow variation 👍			
Very high	**1**	**1**	**1**
High	**2**	**2**	**2**
Moderate	**4**	**4**	**4**
Small	**5**	**5**	**5**
None	**7**	**7**	**7**
Artificially increased	**X**	**X**	**X**
2.6 Depth variation👍			
Very high	**1**	**1**	**1**
High	**2**	**2**	**2**
Moderate	**4**	**4**	**4**
Small	**5**	**5**	**5**
None	**7**	**7**	**7**
Not visible	**X**	**X**	**X**
Artificially increased	**X**	**X**	**X**
2.7 Diversion watercourse 👍 ➘			
None	**X**	**X**	**X**
<50 m	**4**	**4**	**4**
>50 - 100 m	**7**	**7**	**7**
>100 - 250 m	**X**	**X**	**X**
>250 - 500 m	**X**	**X**	**X**
>500 m	**X**	**X**	**X**

Main parameter 2: Longitudinal profile

Morphological types	AT_o OT_o			ST_fl			AT_fl OT_fl			ST_fs			AT_fs OT_fs		
2.2 Piping/Overbuilding															
	wi	wi	no	wi	wi	no	wi	wi	no	wi	wi	no	wi	wi	no
>10 - 20 m	5	7	7	5	7	7	5	7	7	5	7	7	5	7	7
>20 - 50 m	6	7	7	6	7	7	6	7	7	6	7	7	6	7	7
>50 m	X (special case)			X (special case)			X (special case)			X (special case)			X (special case)		
None	x			x			x			x			x		

Morphological types	AT_o OT_o	ST_fl	AT_fl OT_fl	ST_fs	AT_fs OT_fs
2.3 Backwater					
No backwater	X	X	X	X	X
Technical <10 m	X	X	X	X	X
Technical 10 - 50 m	6	6	6	6	6
Technical >50 - 100 m	7	7	7	7	7
Technical >100 - 250	X	X	X	X	X
Technical >250 m	X	X	X	X	X
Natural <10 m	X	X	X	X	X
Natural 10 - 50 m	X	X	X	X	X
Natural >50 - 100 m	X	X	X	X	X
Natural >100 - 250 m	X	X	X	X	X
Natural >250 m	X	X	X	X	X
2.4 Transverse bars					
Many	X	X	X	X	X
Several	X	X	X	X	X
One to two	X	X	X	X	X
None, anthropogenically	7	7	7	7	7
None, naturally	1	1	1	1	1
Flow variation	X	X	X	X	X
2.5 Flow variation					
Very high	1	1	1	1	1
High	1	1	1	1	1
Moderate	3	3	3	3	3
Small	5	5	5	5	5
None	7	7	7	7	7
Artificially increased	X	X	X	X	X

2.6 Depth variation					
Very high	1	1	1	1	1
High	1	1	1	1	1
Moderate	3	2	2	3	3
Small	5	4	4	5	5
None	7	7	7	7	7
Not visible	X	X	X	X	X
Artificially increased	X	X	X	X	X
2.7 Diversion watercourse					
None	X	X	X	X	X
<50 m	4	4	4	4	4
>50 - 100 m	7	7	7	7	7
>100 - 250 m	X	X	X	X	X
>250 - 500 m	X	X	X	X	X
>500 m	X	X	X	X	X

Main parameter 2: Longitudinal profile

Morphological types	**g_FG**		
2.2 Piping/Overbuilding ✋ ☹ ➘			
	with sed.	without sed.	not visible
Survey unit 500 m: >500 - 100 m/section 1,000: >100 - 20	**5**	**7**	**7**
Survey unit 500 m: 100 - 250/section 1,000 m: >200 - 50	**6**	**7**	**7**
Survey unit 500: >250 m/section 1,000: >500 m	X (Special case)		
None	**x**		

2.3 Backwater ✋ ☹ ➘	
No backwater	**X**
Technical <10 m	**X**
Technical 10 - 50 m	**4**
Technical >50 - 100 m	**5**
Technical >100 - 250	**6**
Technical >250 m	**7**
Natural <10 m	**X**
Natural 10 - 50 m	**X**
Natural >50 - 100 m	**X**
Natural >100 - 250 m	**X**
Natural >250 m	**X**

2.4 Transverse bars ☝	
Many	**1**
Several	**2**
One to two	**3**
None, anthropogenically	**7**
None, naturally	**1**
Flow variation	**X**

2.5 Flow variation ☝	
Very high	**1**
High	**1**
Moderate	**3**
Small	**5**
None	**7**
Artificially increased	**X**

2.6 Depth variation ☝	
Very high	**1**
High	**1**
Moderate	**3**
Small	**5**
None	**7**
Not visible	**X**
Artificially increased	**X**

2.7 Diversion watercourse ☝ ➘	500 m survey unit	1,000 survey unit
None	**X**	
<50 m	**3**	**3**
>50 - 100 m	**4**	**3**
>100 - 250 m	**4**	**4**
>250 - 500 m	**7**	**4**
>500 m	**x**	**7**

Main parameter 3: Bed structure

Morphological types	KT_G		ST_g		AT_g OT_g	
3.1 Bed substrate						
	natural	unnatural	natural	unnatural	natural	unnatural
No mineral substrates	X	X	X	X	X	X
Sludge, mud	X	7	X	7	X	7
Clay/loess/loam	X	7	X	7	X	7
Sand	X	7	X	7	X	7
Shingle	X	7	X	7	X	7
Gravel	X	7	X	7	X	7
Blocks	X	7	X	7	X	7
Outcropping rock	X		X		X	
Massive riverbed		7		7		7
Not visible	X		X		X	
No organic substrate	X		X		X	
Algae	X		X		X	
Fallen leaves/floating debris	X		X		X	
Deadwood	X		X		X	
Macrophytes	X		X		X	
Living terrestrial plant parts	X		X		X	
Fine detritus	X		X		X	
Peat	X		X		X	
Not visible	X		X		X	
3.2 Substrate diversity						
Very high	1		1		1	
High	2		2		2	
Moderate	4		4		4	
Small	5		5		5	
None	7		7		7	
Artificially increased	X		X		X	
3.4 Bed features						
Many	1		1		1	
Several	2		2		2	
One to two	3		3		3	
None	7		7		7	
Not visible	X		X		X	

Main parameter 3: Bed structure

Morphological types	AT_o OT_o		ST_fl		AT_fl OT_fl		ST_fs		AT_fs OT_fs	
3.1 Bed substrate										
	natural	unnatural	natural	unnatural	natural	unnatural	natural	unnatural	natural	unnatural
No mineral substrates	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Sludge, mud	**X**	**7**	**X**	**7**	**X**	**7**	**X**	**7**	**X**	**7**
Clay/loess/loam	**X**	**7**	**X**	**7**	**X**	**7**	**X**	**7**	**X**	**7**
Sand	**X**	**7**	**X**	**7**	**X**	**7**	**X**	**7**	**X**	**7**
Shingle	**X**	**7**	**X**	**7**	**X**	**7**	**X**	**7**	**X**	**7**
Gravel	**X**	**7**	**X**	**7**	**X**	**7**	**X**	**7**	**X**	**7**
Blocks	**X**	**7**	**X**	**7**	**X**	**7**	**X**	**7**	**X**	**7**
Outcropping rock	**X**		**X**		**X**		**X**		**X**	
Massive riverbed		**7**		**7**		**7**		**7**		**7**
Not visible	**X**		**X**		**X**		**X**		**X**	
No organic substrate	**X**		**X**		**X**		**X**		**X**	
Algae	**X**		**X**		**X**		**X**		**X**	
Fallen leaves/floating debris	**X**		**X**		**X**		**X**		**X**	
Deadwood	**X**		**X**		**X**		**X**		**X**	
Macrophytes	**X**		**X**		**X**		**X**		**X**	
Living terrestrial plant parts	**X**		**X**		**X**		**X**		**X**	
Fine detritus	**X**		**X**		**X**		**X**		**X**	
Peat	**X**		**X**		**X**		**X**		**X**	
Not visible	**X**		**X**		**X**		**X**		**X**	
3.2 Substrate diversity										
Very high	**1**		**1**		**1**		**1**		**1**	
High	**2**		**2**		**2**		**2**		**2**	
Moderate	**4**		**4**		**4**		**4**		**4**	
Small	**5**		**5**		**5**		**5**		**5**	
None	**7**		**7**		**7**		**7**		**7**	
Artificially increased	**X**		**X**		**X**		**X**		**X**	
3.4 Bed features										
Many	**1**		**1**		**1**		**1**		**1**	
Several	**2**		**2**		**2**		**2**		**2**	
One to two	**3**		**3**		**3**		**3**		**3**	
None	**7**		**7**		**7**		**7**		**7**	
Not visible	**X**		**X**		**X**		**X**		**X**	

Main parameter 3: Bed structure

Morphological types	g_FG	
3.1 Bed substrate		
	natural	unnatural
No mineral substrates	X	7
Sludge, mud	X	7
Clay/loess/loam	X	7
Sand	X	7
Shingle	X	7
Gravel	X	7
Blocks	X	7
Outcropping rock	X	
Massive riverbed		7
Not visible	X	
No organic substrate	X	
Algae	X	
Fallen leaves/floating debris	X	
Deadwood	X	
Macrophytes	X	
Living terrestrial plant parts	X	
Fine detritus	X	
Peat	X	
Not visible	X	
3.2 Substrate diversity		
Very high	1	
High	2	
Moderate	4	
Small	5	
None	7	
Not visible	X	
3.4 Bed features		
Many	1	
Several	2	
One to two	4	
None	7	
Not visible	X	

Main parameter 3: Bed structure

Morphological types	**KT_g ST_g AT_g OT_g**						
	m						
3.3 Bed fixation ✋ ☹ ➘	com-plete	<10	10 - 50	50 - 100	100 - 250	>250	>500
Riprap	**5**	**X**	**4**	**5**			
Massive bed with sediment	**6**	**X**	**5**	**6**			
Massive bed without sed.	**7**	**X**	**6**	**7**			
No bed fixation	**X**	**X**	**X**	**X**			
Not visible	**X**	**X**	**X**	**X**			

Morphological types	**AT_o OT_o, ST_fl, AT_fl OT_fl, ST_fs, AT_fs OT_fs**						
	m						
3.3 Bed fixation ✋ ☹ ➘	com-plete	<10	10 - 50	50 - 100	100 - 250	>250	>500
Riprap	**6**	**X**	**5**	**6**			
Massive bed with sediment	**6**	**X**	**5**	**6**			
Massive bed without sed.	**7**	**X**	**6**	**7**			
No bed fixation	**X**	**X**	**X**	**X**			
Not visible	X	X	X	X			

Morphological types	**g_FG**						
3.3 Bed fixation ✋ ☹ ➘	Survey unit 500 m						
	m						
	com-plete	<10	10 - 50	50 - 100	100 - 250	>250	>500
Riprap	**5**	**X**	**X**	**5**	**5**	**5**	
Massive bed with sediment	**6**	**X**	**X**	**6**	**6**	**6**	
Massive bed without sed.	**7**	**X**	**X**	**7**	**7**	**7**	
No bed fixation	**X**	**X**	**X**	**X**	**X**	**X**	
Not visible	**X**	**X**	**X**	**X**	**X**	**X**	

	Survey unit 1,000 m						
	m						
	com-plete	<10	10 - 50	50 - 100	100 – 250	>250	>500
Riprap	**5**	**X**	**X**	**X**	**5**	**5**	**5**
Massive bed with sediment	**6**	**X**	**X**	**X**	**6**	**6**	**6**
Massive bed without sed.	**7**	**X**	**X**	**X**	**7**	**7**	**7**
No bed fixation	**X**	**X**	**X**	**X**	**X**	**X**	**X**
Not visible	**X**	**X**	**X**	**X**	**X**	**X**	**X**

Main parameter 4: Cross profile

Morphological type	KT_g	ST_g		AT_g OT_g	
4.1 Profile type □					
Natural profile	**1**	**1**		**1**	
Approximately natural profile	**2**	**2**		**2**	
Erosion profile	**5**	**5**		**5**	
Profile with groyne development	**X**	**5**		**5**	
Technical rule profile, decaying	**5**	**5**		**5**	
Technical rule profile	**7**	**7**		**7**	
4.2 Profile depth □					
Very shallow	**1**	**1**		**1**	
Shallow	**2**	**2**		**2**	
Moderately deep	**4**	**4**		**4**	
Deep	**6**	**6**		**6**	
Very deep	**7**	**7**		**7**	
Not visible	**X**	**X**		**X**	
4.3 Width erosion □					
		very deep to deep	moderately deep to very shallow	very deep to deep	moderately deep to very shallow
Strong	**X**	**3**	**3**	**3**	**3**
Weak	**X**	**5**	**1**	**5**	**1**
None	**X**	**7**	**1**	**7**	**1**
4.4 Width variation □					
Very high	**1**	**1**		**1**	
High	**1**	**1**		**2**	
Moderate	**2**	**2**		**4**	
Low	**4**	**4**		**6**	
None	**7**	**7**		**7**	
4.5 Culvert/Bridge □ □ □					
morphologically not harmul	**X**	**X**		**X**	
Watercourse narrowed with sediment	**6**	**6**		**6**	
Watercourse narrowed without sediment	**7**	**7**		**7**	
Watercourse narrowed, not visible	**7**	**7**		**7**	
Natural shoreline interrupted, with sediment	**6**	**6**		**6**	
Natural shoreline interrupted, without sed.	**6**	**6**		**6**	
Natural shoreline interrupted, not visible	**6**	**6**		**6**	
No culvert/bridge	**X**	**X**		**X**	

Main parameter 4: Cross profile

Morphological types	AT_o OT_o	ST_fl	AT_fl OT_fl	ST_fs	AT_fs OT_fs
4.1 Profile type □					
Natural profile	**1**	**1**	**1**	**1**	**1**
Approximately natural profile	**2**	**2**	**2**	**2**	**2**
Erosion profile	**5**	**4**	**2**	**5**	**5**
Profile with groyne development	**5**	**5**	**5**	**5**	**5**
Technical rule profile, decaying	**5**	**5**	**5**	**5**	**5**
Technical rule profile	**7**	**7**	**7**	**7**	**7**
4.2 Profile depth □					
Very shallow	**1**	**X**	**X**	**1**	**1**
Shallow	**2**	**X**	**X**	**2**	**2**
Moderately deep	**4**	**X**	**X**	**4**	**4**
Deep	**6**	**X**	**X**	**6**	**6**
Very deep	**7**	**X**	**X**	**7**	**7**
Not visible	**X**	**X**	**X**	**X**	**X**
4.3 Width erosion □					

	very deep to deep	moderately deep to very deep	very deep to deep	moderately deep to very deep	very deep to deep	moderately deep to very deep	very deep to deep	moderately deep to very deep	very deep to deep	moderately deep to very
Strong	**3**	**3**	**X**	**X**	**X**	**X**	**3**	**3**	**3**	**3**
Weak	**5**	**1**	**X**	**X**	**X**	**X**	**5**	**1**	**5**	**1**
None	**7**	**1**	**X**	**X**	**X**	**X**	**7**	**1**	**7**	**1**

Morphological types	AT_o OT_o	ST_fl	AT_fl OT_fl	ST_fs	AT_fs OT_fs
4.4 Width variation □					
Very high	**1**	**1**	**1**	**1**	**1**
High	**1**	**1**	**1**	**1**	**1**
Moderate	**2**	**2**	**2**	**2**	**2**
Low	**4**	**3**	**3**	**4**	**4**
None	**7**	**7**	**7**	**7**	**7**
4.5 Culvert/Bridge □ □ □					
morphologically not harmul	**X**	**X**	**X**	**X**	**X**
Watercourse narrowed with sediment	**6**	**6**	**6**	**6**	**6**
Watercourse narrowed without sediment	**7**	**7**	**7**	**7**	**7**
Watercourse narrowed, not visible	**7**	**7**	**7**	**7**	**7**
Nat. shoreline interrupted, with sediment	**5**	**5**	**5**	**5**	**5**
Nat. shoreline interrupted, without sediment	**6**	**6**	**6**	**6**	**6**
Nat. shoreline interrupted, not visible	**6**	**6**	**6**	**6**	**6**
No culvert/bridge	**X**	**X**	**X**	**X**	**X**

Main parameter 4: Cross profile

Morphological river type	g_FG	
4.1 Profile type		
Natural profile	**1**	
Approximately natural profile	**1**	
Erosion profile	**5**	
Profile with groyne development	**5**	
Technical rule profile, decaying	**5**	
Technical rule profile	**7**	
4.2 Profile depth		
Very shallow	**1**	
Shallow	**1**	
Moderately deep	**4**	
Deep	**6**	
Very deep	**7**	
Not visible	**X**	
4.3 Width erosion		
	very deep to deep	moderately deep to very shal-low
Strong	**3**	**3**
Weak	**5**	**1**
None	**7**	**1**
4.4 Width variation		
	not stretched	stretched
Very high	**1**	**1**
High	**2**	**1**
Moderate	**4**	**2**
Low	**6**	**4**
None	**7**	**7**
4.5 Culvert/Bridge		
morphologically not harmul	**X**	
Watercourse narrowed with sediment	**6**	
Watercourse narrowed without sediment	**7**	
Watercourse narrowed, not visible	**7**	
Nat. shoreline interrupted, with sediment	**5**	
Nat. shoreline interrupted, without sediment	**6**	
Nat. shoreline interrupted, not visible	**6**	
No culvert/bridge	**X**	

Main parameter 5: Bank vegetation

Morphological types	KT_g	ST_g	AT_g OT_g
5.1 Bank vegetation ✋ ☹	left / right	left / right	left / right
No bank vegetation, naturally	**1**	**1**	**1**
No bank vegetation, anthropogenically	**7**	**7**	**7**
No woody plants, naturally	**1**	**1**	**1**
No woody plants, anthropogenically	**7**	**7**	**7**
Wood, indigenously	**1**	**1**	**1**
Galery, indigenously	**2**	**2**	**2**
Indigenous bushes, single trees	**3**	**3**	**3**
Young woody plants, indigenously	**4**	**4**	**4**
Not indigenous forest, galery	**5**	**5**	**5**
Not indigenous bushes, single trees	**6**	**6**	**6**
Not indigenous young woody plants	**7**	**7**	**7**
Not herbaceous vegetation, naturally	**1**	**1**	**1**
Not herbaceous vegetation, anthropogenically	**7**	**7**	**7**
Near-natural herbs, grasses	**1**	**1**	**1**
Herb plots, tall forbs, meadow	**4**	**4**	**4**
Embankment lawn	**6**	**6**	**6**
Neophytes	**6**	**6**	**6**
5.3 Bank features ☝	left / right	left / right	left / right
Many	**1**	**1**	**1**
Several	**2**	**2**	**2**
One to two	**3**	**3**	**4**
None	**7**	**7**	**7**

Morphological types	KT_g ST_g AT_g OT_g						
5.2 Bank protection ✋ ☹ ➘	left / right						
	m						
	Complete	<10	10 - 50	50 - 100	100 - 250	>250	>500
Decaying protection	**4**	**X**	3	4			
Flow control elements	**4**	**X**	**3**	**4**			
Bioengineered protection	**5**	**X**	**4**	**5**			
Woody protection	**5**	**X**	**4**	**5**			
Riprap	**6**	**X**	**5**	**6**			
Unpermitted protection	**7**	**X**	**6**	**7**			
Massive protection	**7**	**X**	**6**	**7**			
No protection	**X**	**X**	**X**	**X**			

Main parameter 5: Bank vegetation

Morphological types	AT_o OT_o	ST_fl	AT_fl OT_fl	ST_fs	AT_fs OT_fs
5.1 Bank vegetation ✋ ☹	left/right	left/right	left/right	left/right	left/right
No bank vegetation, naturally	**1**	**1**	**1**	**1**	**1**
No bank vegetation, anthropogenically	**7**	**7**	**7**	**7**	**7**
No woody plants, naturally	**1**	**1**	**1**	**1**	**1**
No woody plants, anthropogenically	**7**	**7**	**7**	**7**	**7**
Wood, indigenously	**1**	**1**	**1**	**1**	**1**
Galery, indigenously	**2**	**2**	**2**	**2**	**2**
Indigenous bushes, single trees	**3**	**3**	**3**	**3**	**3**
Young woody plants, indigenously	**4**	**4**	**4**	**4**	**4**
Not indigenous forest, galery	**5**	**5**	**5**	**5**	**5**
Not indigenous bushes, single trees	**6**	**6**	**6**	**6**	**6**
Not indigenous young woody plants	**7**	**7**	**7**	**7**	**7**
Not herbaceous vegetation, naturally	**1**	**1**	**1**	**1**	**1**
Not herbaceous vegetation, anthropogenically	**7**	**7**	**7**	**7**	**7**
Near-natural herbs, grasses	**1**	**1**	**1**	**1**	**1**
Herb plots, tall forbs, meadow	**4**	**4**	**4**	**4**	**4**
Embankment lawn	**6**	**6**	**6**	**6**	**6**
Neophytes	**6**	**6**	**6**	**6**	**6**
5.3 Bank features ☝	left/right	left/right	left/right	left/right	left/right
Many	**1**	**1**	**1**	**1**	**1**
Several	**2**	**2**	**2**	**2**	**2**
One to two	**4**	**3**	**4**	**3**	**4**
None	**7**	**7**	**7**	**7**	**7**

Mophological types		AT_o OT_o	ST_fl	AT_fl OT_fl	ST_fs	AT_fs OT_fs	
5.2 Bank protection ✋ ☹ ↘	left / right						
	m						
	Com-plete	<10	10 - 50	50 - 100	100 - 250	>250	>500
Decaying protection	**4**	**X**	**3**	**4**			
Flow control elements	**4**	**X**	**3**	**4**			
Bioengineered protection	**5**	**X**	**4**	**5**			
Woody protection	**5**	**X**	**4**	**5**			
Riprap	**6**	**X**	**5**	**6**			
Unpermitted protection	**7**	**X**	**6**	**7**			
Massive protection	**7**	**X**	**6**	**7**			
No bank protection	**X**	**X**	**X**	**X**			

Main parameter 5: Bank structure

Morphological types	**g_FG**
5.1 Bank vegetation ✋ ☹	**left / right**
No bank vegetation, naturally	**1**
No bank vegetation, anthropogenically	**7**
No woody plants, naturally	**1**
No woody plants, anthropogenically	**7**
Wood, indigenously	**1**
Gallery, indigenously	**2**
Indigenous bushes, single trees	**5**
Young woody plants, indigenously	**4**
Not indigenous forest, gallery	**5**
Not indigenous bushes, single trees	**6**
Not indigenous young woody plants	**6**
Not herbaceous vegetation, naturally	**1**
Not herbaceous vegetation, anthropogenically	**7**
Near-natural herbs, grasses	**1**
Herb plots, tall forbs, meadow	**4**
Embankment lawn	**6**
Neophytes	**6**
5.3 Bank features ☝	**left / right**
Many	**1**
Several	**2**
One to two	**4**
None	**7**

Morphological types	**G_FG**						
5.2 Bank protection ✋ ☹ ↘	left / right						
	Survey unit 500 m						
	Com-plete	<10	10 - 50	50 -1 00	100 - 250	>250	>500
Decaying protection	**4**	**X**	**X**	**3**	**3**	**3**	
Flow control elements	**4**	**X**	**X**	**3**	**3**	**3**	
Bioengineered protection	**4**	**X**	**X**	**3**	**3**	**3**	
Woody protection	**4**	**X**	**X**	**3**	**3**	**3**	
Riprap	**6**	**X**	**X**	**3**	**5**	**5**	
Unpermitted protection	**7**	**X**	**X**	**3**	**6**	**6**	
Massive protection	**7**	**X**	**X**	**3**	**6**	**6**	
No bank protection	**X**	**X**	**X**	**3**	**X**	**X**	

5.2 Bank protection ✋ ☹ ↘	left / right						
	Survey unit 1,000 m						
	Com-plete	<10	10 - 50	50 -1 00	100 - 250	>250	>500
Decaying protection	**4**	**X**	**X**	**X**	**3**	**3**	**4**
Flow control elements	**4**	**X**	**X**	**X**	**3**	**3**	**4**
Bioengineered protection	**4**	**X**	**X**	**X**	**3**	**3**	**4**
Woody protection	**4**	**X**	**X**	**X**	**3**	**3**	**4**
Riprap	**6**	**X**	**X**	**X**	**5**	**5**	**6**
Unpermitted protection	**7**	**X**	**X**	**X**	**6**	**6**	**7**
Massive protection	**7**	**X**	**X**	**X**	**6**	**6**	**7**
No bank protection	**X**	**X**	**X**	**X**	**X**	**X**	**X**

Main parameter 6: Adjacent land zone

Morphological types	**KT_g**	**ST_g**		**AT_g OT_g**	
6.1 Adjacent land use ✋ ☹	left / right	left / right		left / right	
		>50 %	10 - 50 %	>50 %	10 - 50 %
Woodland, native	**X**	**1**	**1**	**1**	**1**
Vegetation (exclusive wood)	**X**	**1**	**1**	**1**	**1**
Wasteland / succession	**X**	**2**	**2**	**2**	**2**
Grassland	**X**	**4**	**3**	**4**	**3**
Not-native woodland, conifers	**X**	**5**	**4**	**5**	**4**
Arable land, special crops	**X**	**6**	**5**	**6**	**5**
Park, green area	**X**	**5**	**4**	**5**	**4**
Constructions with open space	**X**	**6**	**5**	**6**	**5**
Constructions without open space	**X**	**7**	**6**	**7**	**6**
Further environ. impacts according SP 6.3	**X**	**X**		**X**	

6.2 Morphological types ✋ ☹	**KT_g**	**ST_g**	**AT_g**	**OT_g**		
Riparian strip	left / right					
Survey unit length 100 m	Com-plete	10 - 50 m	50 - 100 m	100 - 250 m	>250 m	>500
>20 m	**1**	**2**	**1**			
10 - 20 m	**1**	**2**	**1**			
2 - 5 m	**5**	**3**	**5**			
<2 m	**7**	**6**	**7**			

Morphological types	**KT_g**	**ST_g**	**AT_g**
6.3 Adjacent land pressures ✋ ☹ ➘	left / right		
	<10 m	10 - 40 m	>40 m
Excavation	**7**	**6**	**5**
Fishpond in a neighbouring watercourse	**7**	**6**	**5**
Water structure harmful constructions	**7**	**6**	**5**
Traffic area, paved	**7**	**6**	**5**
Traffic area, unpaved	**7**	**6**	**5**
Flood protection construction	**7**	**6**	**5**
Deposition, waste dumpling	**7**	**5**	**3**
None	**X**		

Main parameter 6: Adjacent land zone

Morphologigal types	AT_o OT_o		ST_fl		AT_fl OT_fl		ST_fs		AT_fs OT_fs	
Adjacent land use	left/right		left/right		left/right		left/right		left/right	
	10 - 50 %	>50 %	10 – 50 %	>50 %	10 – 50 %	>50 %	10 – 50 %	>50 %	10 – 50 %	>50 %
Woodland, native	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Vegetation (exclusive wood)	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Wasteland / succession	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
Grassland	**3**	**4**	**3**	**4**	**3**	**4**	**3**	**4**	**3**	**4**
Not-native woodland, conifers	**4**	**5**	**4**	**5**	**4**	**5**	**4**	**5**	**4**	**5**
Arable land, special crops	**5**	**6**	**5**	**6**	**5**	**6**	**5**	**6**	**5**	**6**
Park, green area	**4**	**5**	**4**	**5**	**4**	**5**	**4**	**5**	**4**	**5**
Constructions with open space	**5**	**6**	**5**	**6**	**5**	**6**	**5**	**6**	**5**	**6**
Constructions without open space	**6**	**7**	**6**	**7**	**6**	**7**	**6**	**7**	**6**	**7**
Further environ. impacts according SP 6.3	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**

Morphological types	AT_o OT_o	ST_fl	AT_fl OT_fl	ST_fs	AT_fs OT_fs
6.2 Riparian zone	left/ right				
Survey unit length 100 m	Complete	10 - 50 m	50 - 100 m	100 - 250 m	>250 m	>500
>20 m	**1**	**2**	**1**			
10-20 m	**1**	**2**	**1**			
2-5 m	**5**	**3**	**5**			
<2 m	**7**	**6**	**7**			

Morphological types	AT_o OT_o	ST_fl	AT_fl OT_fl	ST_fs	AT_fs OT_fs
6.3 Adjacent land pressures	left / right				
	<10 m	10 - 40 m	>40 m		
Excavation	**7**	**6**	**5**		
Fishpond in a neighbouring watercourse	**7**	**6**	**5**		
Water structure harmful constructions	**7**	**6**	**5**		
Traffic area, paved	**7**	**6**	**5**		
Traffic area, unpaved	**7**	**6**	**5**		
Flood protection construction	**7**	**6**	**5**		
Deposition, waste dumpling	**7**	**6**	**5**		
None	**7**	**6**	**5**		

Main parameter 6: Adjacent land zone

Morphological types	**g_FG**	
6.1 Adjacent land use ✋ ☹	left / right	
	>50 %	10 - 50 %
Woodland, native	**1**	**1**
Vegetation (exclusive wood)	**1**	**1**
Wasteland / succession	**2**	**2**
Grassland	**4**	**3**
Not-native woodland, conifers	**5**	**4**
Arable land, special crops	**6**	**5**
Park, green area	**5**	**4**
Constructions with open space	**6**	**5**
Constructions without open space	**7**	**6**
Further environ. impacts according to 6.3	**X**	

Morphological types	**g_FG**					
6.2 Riparian zone ✋ ☹	left / right					
Survey unit length 500 m / 1000 m	Complete	10 - 50 m	50 - 100 m	100 - 250 m	>250 m	>500
>50 m	**1**	**X**	**X**	**2**	**2**	**1**
10 -50 m	**1**	**X**	**X**	**2**	**2**	**1**
2-10 m	**3**	**X**	**X**	**5**	**5**	**3**
<2 m	**7**	**X**	**X**	**6**	**6**	**7**

Morphological type	**g_FG**		
6.3 Adjacent land pressures ✋ ☹ ➘	left / right		
	<10 m	10 - 40 m	>40 m
Excavation	**7**	**6**	**5**
Fishpond in a neighbouring watercourse	**7**	**6**	**5**
Water structure harmful constructions	**7**	**6**	**5**
Traffic area, paved	**7**	**6**	**5**
Traffic area, unpaved	**7**	**6**	**5**
Flod protection construction	**7**	**6**	**5**
Deposition, waste dumpling	**7**	**6**	**5**
None	**X**		

4.2.3 Index calculation - examples

For the different single parameters the determination of the respective relevant index is performed in a number of different ways.

Simple registration

In the context of the simple registration (symbol ”☝“ index allocation) the dominant feature is ticked. The resulting index is included in the calculation for the main parameter.

Example: For the single parameter SP 4.1 “profile type“, the following features have been registered:

Profile type	☝
Natural profile	**1**
Approaching natural profile	**2**
Erosion profile	**5**
Profile with groynes	**5**
Techn. rule profile, decaying	**5**
Technical rule profile	**7**

Explanation

Mapped feature: approaching nat. profile

Index: 2

Multiple registration

In the context of multiple registrations (Symbol ”✋“ index allocation), all relevant features are ticked. In the index calculation always the highest index value is included, ”pessimistic evaluation“ (symbol ”☹“).

Example: for the single parameter SP 2.1 “transverse and special features“, the following features have been mapped:

Transverse structures ✋ ☹ ➘	0.1-0.3 m	0.3-1 m	>1 m	
Movable weir/ Bed fall/cascade	**6**	**6**	**7**	
Movable weir/bed fall/-stairs with fish passage	**5**	**5**	**6**	
Movable weir/bed fall/cascade with bypass watercourse	**4**	**4**	**5**	
Unpermittedconstruction				**5**
Ground sill (< 0.1 m)				**x**
Smooth sliding				**5**
Rough sliding				**3**
Smoth ramp				**6**
Rough ramp				**4**
TC with near-bed outflow				**4**
Dam				**7**
Pumping station				**7**
Culvert				**7**
No transverse structures				**x**

Explanation

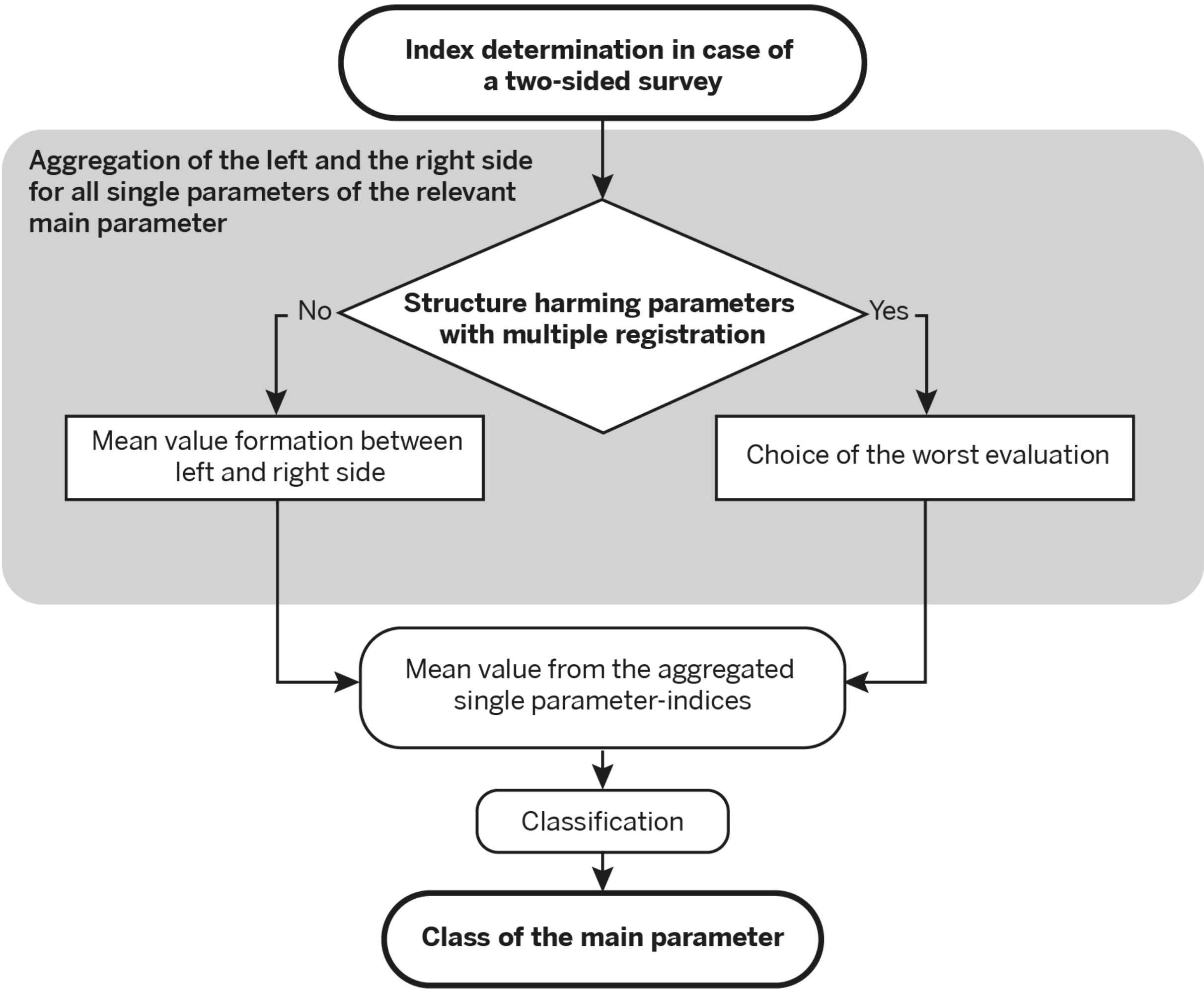
mapped features: rough sliding (3)
bed fall >1 m (7)

Index: 7

Left- and right differentiation

The single parameters allocated to the main parameters 5 “bank structure“ and 6 ”adjacent land zone“ are separately recorded for the right and left riverside ((ri) und (le) in the index description). An index results for each river side. If for the mapping results the index values for the left and right river side should be brought together, for instance for presentation purposes, then the following is to be applied:

Firstly, for each river side the single parameters are individually brought together. For the downgrading parameters with multiple registrations, the respective worst value is used as result. For the other single parameters there is a mean value calculation. Subsequently, the index of the respective main parameter is calculated as arithmetic mean of the aggregated single values. Afterwards, if necessary, it can be transfered into a morphologyclass (see chapter 4.2).



Picture: Procedure for the index valuation with different registrations for the left and right river side.

Example: For the SP ”5.1 bank vegetation“ in the context of the morphological river type ”hollow and floodplain river, coarse material rich” (AT_g), the following features have been mapped:

Bank vegetation	☹	Ø le/ri	☹
	le		**ri**
No bank vegetation, naturally	1		1
No bank vegetation, anthropogically	7		7
No woody plants, naturally	1		1
No woody plants, anthropogenically	7		7
Wood, indigenously	1		1
Galery, indigenously	2		2
Indigenous bushes, single trees	3		3
Young woody plants, indigenously	4		4
Not indigenous forest, gallery	5		5
Not indigenous bushes, single trees	6		6
Not indigenous young woody plants	7		7
No herbaceous vegetation, naturally	1		1
No herbaceous vegetation, anthropogenically	7		7
Near-natural herbs, grasses	1		1
anthropogen ically herb plots, tall forbs, meadow	4		4
Embankment lawn	6		6
Neophytes	6		6

Explanation

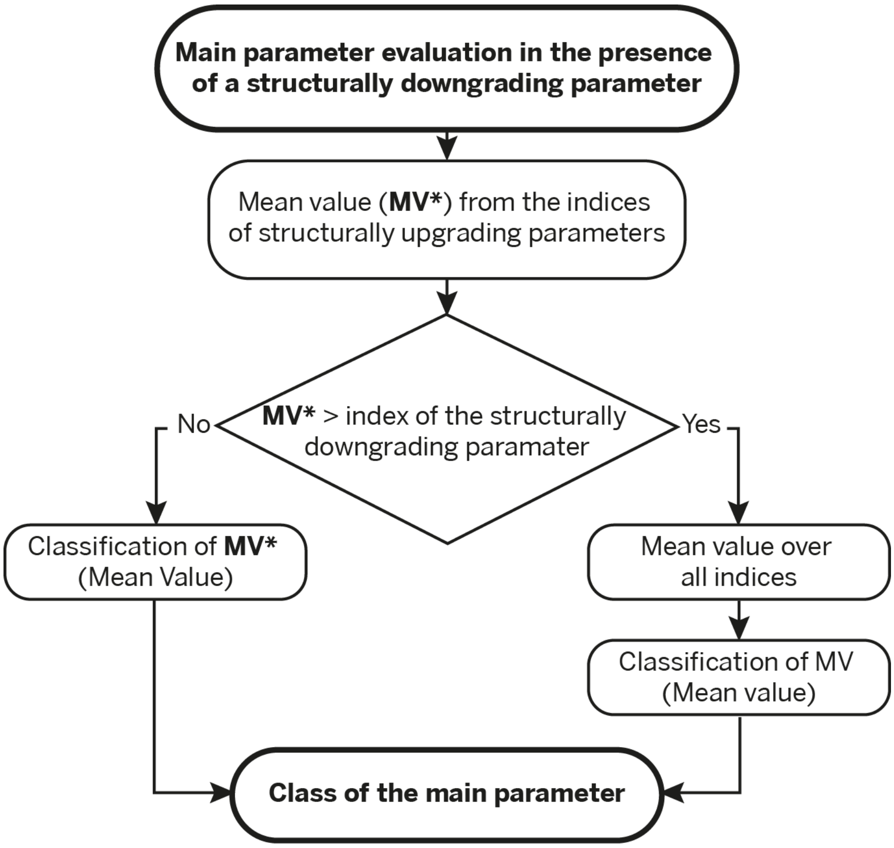
mapped features:	**links:**	
	Native wood (1)	
	No herbaceous vegetation, naturally (1)	
Index left:	1	
	right:	
	not indigenous forest, Gallery (5)	
	Embankment lawn (6)	
Index right:	6	
Index:	3.5	

For the SP 5.1 ”bank vegetation“ for each river bank woody plants and herbaceous vegetation are recorded. For the index-based evaluation of one river side, only the feature with the worst value is considered.

No upgrading by harming parameters

Downgrading parameters (symbol ”➘“), like transverse structures, may theoretically lead to an upgrading of a survey unit by the presence of a less negative feature (e. g., rough sliding, index “3”) when calculating the mean value.

The indices of the single parameters 2.1 “transverse and special structures”, 2.2 “piping/overbuilding”, 2.3 “backwater”, 2.7 “diversion watercourse”, 3.3 “bed fixation”, 4.5 “culvert/bridge”, 5.2 “bank protection”, and 6.3 “adjacent land pressures “ are only included in the calculation when they to not lead to an increase (= improvement) of the main parameter index. Downgrading parameters may be neglected from the very beginning of the index calculation on the level of the main parameters, when the have been registered as “non-existent” (for this, see the respective information in the description of the single parameters).



Picture: Valuation in the presence of downgrading parameters (see table in Chapter 3.2).

For the main parameters 3, 4, 5 and 6 the following procedure must be applied:

1. An interim index (= mean value MW*) is calculated, not including the downgrading parameters.

   Example: the ”interim index“ for the main parameter 3 “bed structure” is calculated without the single parameter 3.3 “bed fixation”.

2. This „interim index“ is compared with the index of the ”downgrading parameter“.

   Example: ”interim index“ for bed structure: 4. Index for degrading parameter ”bed fixation“: 5.

3. If the index of the downgrading parameter is higher then the ”interim index”, then it will be considered for the overall calculation, if it is smaller then it will be excluded.

   Example: the index for bed fixation is higher than the ”interim index“. Therefore, it will be considered, that means, there is a mean value calculation using all indices.

Example 1: For the main parameter **"**bed structure", the following features have been mapped for the morphological river type "hollow and floodplain river, coarse material rich" (AT_g):

Single parameter	Feature	Index
Bed substrate:	Sludge (unnatural)	7
Bed fixation:	Massive bed with sediment (complete)	6
Substrate diversity:	None	7
Bed features:	None	7

This results in a mean value of 6.75.

If this survey unit would not have a bed fixation, the following emerges:

Single parameter	Feature	Index
Bed substrate:	Sludge (unnatural)	7
Bed fixation:	None	x
Substrate diversity:	None	7
Bed features:	None	7

It results in a mean value of 21 / 3 = 7.

This results in both cases in the same morphology class, but the index for the second, not regulated survey unit is worse than the regulated survey unit.

Example 2: For the main parameter "bed structure" the following features have been mapped for the morphological river type "hollow and floodplain river, coarse material rich" (AT_g):

Single parameter	Feature	Index
Bed substrate:	Sludge/mud (unnatural)	7
Bed fixation:	Massive bed with sediment (complete)	6
Substrate diversity:	Small	5
Bed features:	One to two	4

Without downgrading parameters, this results in a mean value of 5.3 which corresponds to themorphology class 5.

The index for "massive riverbed with sediment (complete)" amounts to 6 and is therefore higher than the calculated "interim index". Therefore, the bed fixation with an index of 6 is considered for the mean value formation. The index value for the main parameter "bed structure" is 5.5 which corresponds to a morphology class of 6.

Special case “longitudinal profile” (main parameter 2)

To the main parameter “longitudinal profile” the downgrading parameters “transverse and special structures”, “piping/overbuilding”, “backwater” and “diversion watercourse” are allocated. In this case special care is necessary. Beyond the above-mentioned procedure, the sequence of the indices of the downgrading parameters still plays a role.

Therefore, it must be proceeded as follows:

- The downgrading indices are individually compared with the interim main parameter index (composed of the indices of “transverse bars”, “flow diversity” and “depth variation”).
- Initially, the highest downgrading index (showing negative impacts) is tested for upgrading effects. If it does not lead to an upgrading, then a new interim index value is calculated. Otherwise, none of the four downgrading indices are taken for the main parameter calculation.
- If the highest index is taken, then the other three downgrading indices will be treated analogously.

In the following examples it is shown, which effect this convention has:

Example 1: Without application of the above-mentioned rule, the following mapped features for the morphological river type “hollow and floodplain river, coarse material rich” (AT_g) would result:

Single parameter	Feature	Index
2.1 Transverse and special structures	Rough sliding	3
2.2 Piping/Overbuilding	>20 - 50 m without sediment	7
2.3 Backwater	10 – 50 m	6
2.4 Transverse bars	Various	2
2.5 Flow variation	Moderate	4
2.6 Depth variation	Moderate	4
2.7 Diversion watercourse	<50 m	4

If all indices are considered for the next calculation step, then the consequence is the mean value (3 + 7 + 6 + 2 + 4 + 4 + 4) / 7 = 30 / 7 = 4.29, which would lead to the morphology class 4.

If this river section is now compared with a survey unit showing the same single parameter results but no transverse- or special structures, the result for this survey unit would be:

Single parameter	Feature	Index
2.1 Transverse and special structures	None	x
2.2 Piping/Overbuilding	>20 - 50 m without sediment	7
2.3 Backwater	10 – 50 m	6
2.4 Transverse bars	Various	2
2.5 Flow variation	Moderate	4
2.6 Depth variation	Moderate	4
2.7 Diversion watercourse	<50 m	4

This results in the mean value: (0 + 7 + 6 + 2 + 4 + 4 + 4) / 6 = 27 / 6 = 4.5, which would lead to the morphology class 5.

Consequently, the removal of a transverse structure would lead to a downgrading of one morphology **class**. To avoid this, the indices are sorted by order of their valuation (beginning with the highest) and step-by-step examined for admissibility and then respectively a new interim index is calculated (see example 2).

Example 2: With the application of the aforementioned rule for the main parameter 2 ”longitudinal profile“ and for the morphological river type “hollow and floodplain river, coarse material rich” (AT_g).

Single parameter	Feature	Index
2.1 Transverse and special features	Rough sliding	3
2.2 Piping/Overbuilding	>20 - 50 m without sediment	7
2.3 Backwater	10 – 50 m	6
2.4 Transverse bars	Various	2
2.5 Flow variation	Moderate	4
2.6 Depth variation	Moderate	4
2.7 Diversion watercourse	<50 m	4

Firstly, an interim subindex is calculated from the single parameters 2.4 to 2.6 again, since they all represent upgrading parameters. This results in the mean value: (2 + 4 + 4) / 3 = 10 / 3 = 3.3.

Now all downgrading parameters are examined (2.1 to 2.3 and 2.7) and sorted by order of their index values. The result is: 2.2 > 2.3 > 2.7 > 2.1.

The first downgrading parameter in this series (showing negative impacts) is the SP 2.2. Its index value of 7 is higher than the interim subindex of 3.3. Therefore, this single parameter is considered for the next calculation step. A new subindex is calculated, this time from the single parameters 2.2, 2.4, 2.5 and 2.6. This leads to: (7+ 2 + 4 + 4) / 4 = 17 / 4 = 4.25.

Now, the following downgrading parameter (here SP 2.3) will be regarded and compared with the new subindex of 4.25. This index is higher than 4.25. Therefore, also the SP 2.3 will be considered for the next calculation step. The next subindex will now be calculated from the SPs 2.2, 2.3, 2.4, 2.5 and 2.6. The formula (7+ 6 + 2 + 4 + 4) / 5 generates the new subindex of 4.6.

Then, the next downgrading parameter (here 2.7) is compared with the new and actual subindex of 4.6. This index of 4 is smaller than the actual subindex of 4.6. This single parameter will be excluded from the subsequent calculation.

The final index for the main parameter 2 “longitudinal profile” is the result of the single parameters 2.2 to 2.6. and results in an index value of 4.6. The index values of the single parameters 2.7 and 2.1 would lead to an inadmissible upgrading and are therefore excluded in the calculation.

4.3 Comparison of evaluations

As final step of the evaluation process, a comparison between both in parallel conducted methods (index-based evaluation and assessment by functional units) must be carried out.

Because of the different processes, slight deviations can be reasonably expected. These deviations on the main parameter level should not exceed one morphology class. Significant deviations of more than one morphology class point out mistakes in the survey, a faulty assignment of the river type, a lack of experience on the cartographer’s side or an inadequate calibration of the index sets.

If the evaluation remains the same after a plausability check and a potentially error remediation, the result is determined by the cartographer with an appropriate justification. However, an accumulation of valuation differences indicates above-mentioned systematic errors.

4.4 Aggregations of the valuation

The results of the river habitat survey are in total 8 evaluations for 6 main parameters. For the main parameter 5 (bank structure) and 6 (adjacent land zone) a separate evaluation is made by the cartographer for the left and the right river side.

The evalution of the main parameters by the cartographers can be summarised to the zones “riverbed-bank-land” (with left-right differentiation) or to an overall assessment.

The calculation results are respectively transferred, according to the classification scheme in chapter 4.1.1, into a morphological quality class. The different aggregation steps of the valuation procedure can be graphically presented (see Chapter 2.4).

4.4.1 Evaluation of the zones bed-bank-land

Riverbed

The evaluation of the water structure for the sector “riverbed“ is performed by mean value formation of the mapped results of the main parameters 1 ”watercourse development”, 2 ”longitudinal profile“ and 3 ”bed structure“.

Left bank: The valuation is carried out by arithmetic averaging of the valuation results of the main parameters 4 ”cross profile“ and 5 “bank structure“ for the left river side.

Right Bank: The valuation is carried out by arithmetic averaging of the valuation results of the main parameters 4 ”cross profile“ and 5 “bank structure“ for the right river side.

Bank: The valuation is carried out by arithmetic averaging of the valuation results of the main parameter 4 ”cross profile“ and the worse assessed river side of the main parameter 5 “bank structure“.

Table: Aggregation of the main parameters for the valuation of the zones, bed, bank, land

MP-valuation with left-right differentiation	Aggregation rule	MP-valuation	Aggregation rule	Valuation zone
MP 1		MP 1	Ø	Bed
MP 2		MP 2		
MP 3		MP 3		
MP 4		MP 4	Ø	Bank
MP 5 left	Worse assessed side of the bank	MP 5		
MP 5 right				
MP 6 left	Worse assessed side of the land	MP 6	Ø	Land
MP 6 right				

Land

Left landside: The valuation of the left adjacent land zone corresponds to the valuation results of the main parameter 6 “adjacent land zone” for the left adjacent land zone.

Right landside: The valuation of the right adjacent land zone corresponds to the valuation results of the main parameter 6 “adjacent land zone” for the right adjacent land zone.

Land: The valuation of the water structure of the zone “land” corresponds to the worse assessed river side of the main parameter 6 “bank adjacent land zone“.

4.4.2 Overall evaluation

The overall evaluation is performed by the arithmetic mean calculation from the results of all main parameters. Here, the worse assessed river side of the main parameters 5 and 6 are included in the calculation, according to the worst-case principle.

Table: Aggregation steps of the main parameters to the overall assessment

MP-valuation with left-right differentiation	Aggregation rule	MP-valuation	Aggregation rule	Valuation sector
MP 1		MP 1	Ø	Overall assessment
MP 2		MP 2		
MP 3		MP 3		
MP 4		MP 4		
MP 5 left	Worse assessed side of the bank	MP 5		
MP 5 right				
MP 6 left	Worse assessed land-side	MP 6		
MP 6 right		MP 6		

4.5 Valuation example

For a survey unit of the morphological river type “hollow and floodplain river, fine material rich -sand” AT_fs (present status in the figure below on the left and under reference conditions in the figure below on the right) the features of the single parameters have been recorded and the valuation of the functional units is carried out.

Mapped survey unit

Reference conditions

The valuations for the respective main parameters, potentially with left-right differentiation, have been calculated by the cartographer by an arithmetic mean value formation of the functional units (MP 1, MP3, MP 4, MP 5 and MP 6) or malus-addition (MP 2), as it is described in the chapter 4.1.1, and the calculated values are then transferred to a morphology class with regard to a seven-step evaluation according to the table “definition of the morphology class in the context of a seven-level classification”.

The valuations of the main parameters by the cartographers (= class in the surveying sheet), determined by the functional units, are the relevant assessments. For the purpose of plausibility checks, the main parameters are additionally assessed by the index values according to the scoring algorithm described in chapter 4.2, which is automatically carried out during the mapping process. For this example, the automatically calculated index valuations of the main parameters have been entered in the questionnaire in the field “index”. The assessment of the main parameters by functional units and by the index values must not deviate from one another by more than one class, without the need of a justification.

In this example the following assessments of functional units are carried out by the cartographers from which the evaluations of the main parameters with left/right differentiation arise.

The valuations of the main parameters determined by the cartographers, according to chapter 4.4 can be further aggregated.

River habitat survey in North Rhine-Westphalia

Questionnaire according to LANUV-Arbeitsblatt 18 (2018)

Identification

Master data

Name of the river	Rotbach
/ater identification number	2 7 7 4
Mapping section-ID	
Stationing from/to	
Edition stationing map	
Beginning (e32/n32)	
End (e32/n32)	
Name of cartographer	
Institution	
Mapping date	
Connecting sheet to	

Status of mapping

not mapped, because

Watercourse changed	
Upper course reduced	
Section length reduced	
Construction w ork	
No trespassing	
Reservoir	
Other	

Survey unit length

100 m	X
500 m	
1,000 m	

Typification

River type

LAWA-river type	
NRW-river type	
River type	Rivers without valleys, fine material rich –sand
Winding degree	

Bed substrate under reference conditions

Clay/Loam/Loess (fl)	
Sand (fs)	X
Shingle (g)	
Gravel (g)	
Stone (g)	
Stone block (g)	
Outcropping rock (g)	
Organisches Substrat (o)	

Valley shape

V-shaped valley (KT)	
U-shaped valley (ST)	
Flood plain stream (AT)	
Hollow valley (AT)	
River w ithout valley (OT)	X

Characterization of the actual state

Bed width and section length

Stream width		Length
<1 m		100 m
1 - 2 m		100 m
>2 - 5 m	X	100 m
>5 - 10 m		100 m
>10 - 20 m		100 / 500 m
>20 - 40 m		500 / 1.000 m
>40 - 80 m		1.000 m
>80 - 160 m		1.000 m
>160 m		1.000 m

Upper width

<1 m	
1 - 2 m	
>2 - 5 m	
>5 - 10 m	
>10 - 20 m	X
>20 - 40 m	
>40 - 80 m	
>80 - 160 m	
>160 m	

Incision depth

<0.2 m	
0.2 - 0.5 m	
>0.5 - 1 m	
>1 - 2 m	
>2 - 3 m	X
>3 - 5 m	
>5 m	

Depth at mean flo

<0.1 m	
0.1 - 0.3 m	X
>0.3 - 0.5 m	
>0.5 - 1 m	
>1 - 2 m	
>2 m	
Not visible	

Water level

Mean w ater level	
< Mean w ater level	

Anthropogenic manifestation

Shipping	
Hydropow er	
Flood protection	
Fish farming	
Restricted floodplain flooding	X
Restricted channel development/movability	X
Restricted cross channel development	X
Considerably changes in flow character	
Fragmented w atercourse	
Relocation of the stream to valley edge	
Watercourse in elevated position	
Change of flow direction	

Special case

Smallest rivers (K)	
Restored section	
Major part piped/overbuilt (V)	
Completely piped/overbuilt (V)	
Watercourse dried up (T)	
Puddles existing (T)	
River bed not visible	
Pond in main connection (G)	

Water site

Urban area	
Open landscape	X

Documentation

Description

Short description	
Biological specificities	Kingfisher
Special features	

Beaver tracks

yes	
no	X

Photos

In flow direction		Against flow direction	

Valuation justification

River habitat survey in North Rhine-Westphalia

Questionnaire according to LANUV-Arbeitsblatt 18 (2018)

Stream name: Rotbach | Identification number: 2 7 7 4 | Mapping section-ID:

1. Channel development

1.1 Watercourse curvature/Bends (K, T)

Straight (1 - 1.01)	X
Elongated (1.01 - 1.06)	
Slightly curved (> 1.06-1.25)	
Curved (> 1.25 - 1.5)	
Meandering (> 1.5 - 2)	
Highly meandering (> 2)	

(ungekrümmt / gekrümmt)

unbranched	X
With side channels	
Branched	

1.2 Erosion at bends (T)

Naturall, none	
Anthropogenically, none	X
Weak, occasionally	
Weak, frequently	
Strong, occasionally	
Strong, frequently	

1.3 Longitudinal bars

None	X
One to two	
Several	
Many	
Not visible	

1.4 Watercourse structures (K, T)

None	X
Deadwood jam	
Falltree	
Island formation	
Watercourse widening	
Warercourse narrowing	
Watercourse bifurcation	
Oxbow lake, side watercourse	
Beaver dam	

Evaluation funct. units

Curvature (1.1, 1.3, 1.4)	7
Movability (1.2, 4.2, 5.2)	7
Index	7
Class	7

2. Longitudinal profile

2.1 Transverse structures (K,T)

No barrier: X

Altitude difference Up-/downstream: 0.1-0.3 m | >0.3-1 m | >1 m

	0.1-0.3 m	>0.3-1 m	>1 m
Novable weir/bed fall/-cascade			
Novable weir/bed fall/-cascades w. fish passage			
Novable weir/bed fall/-cascade w. bypass channel			

Wild construction	
Threshold (≤ 0.1 m)	
Smooth sliding	
Rough sliding	
Smooth ramp	
Rough ramp	
Transverse construction with a near bed outlet	
Dam	
Pumping station	
Culvert	

2.2 Piping/Overbuilding (K, T)

Survey unit length

100 m	500 m	1.000 m	without sediment	with sediment	not visible
None	None	None		X	
>10 - 20 m	>50 - 100 m	>100 - 200 m			
>20 - 50 m	>100 - 250 m	>200 - 500 m			
>50 m	>250 m	>500 m			

2.3 Backwater (K)

	technical	natural
None	X	
<10 m		
10 - 50 m		
>50 - 100 m		
>100 - 250 m		
>250 m		

2.4 Transverse bars

None, naturally	
None, anthropogenically	X
One to two	
Several	
Many	
Not visible	

2.7 Diversion watercours

None	X
<50 m	
>50 - 100 m	
>100 - 250 m	
>250 - 500 m	
>500 m	

2.01 Flow patterns (K)

Smooth	
Ribbed	X
Gently lapping	X
Wafed	
Comb shaped	
Turbulent	

2.5 Flow variation (K)

None	
Low	X
Moderate	
High	
Very high	
Add.: artificially increased	

2.6 Depth variation

None	
Low	X
Moderate	
High	
Very high	
Not visible	
Add.: artificially increased	

Evaluation funct. units

Natural longitudinal features (2.4, 2.5, 2.6)	6
Anthropogenic migration barriers (2.1, 2.2, 2.3, 2.7, 4.5) Malus-Addition	0
Index	6
Class	6

Key/ List of abbreviations

K	Smallest waters (minimum data set to be mapped)	**nat.**	natural
V	Piped/overbuilt (minimum data set to be mapped)	**unnat.**	unnatural
T	Stream dried up (minimum data set to be mapped)		
G	Pool in main connection (minimum data set to be mapped)	**Sed.**	Sediment
	Multiple registration	**QBW**	Migration barrier
	Simple registration		
	Record number (count)	**fkt.**	functional
le	Inflow direction left-sided	**MW**	Mean water
ri	In flow direction right-sided		
		bew.	movable

River habitat survey in North Rhine-Westphalia

Questionnaire according to LANUV-Arbeitsblatt 18 (2018)

Stream name: Rotbach | Identification number: 2 7 7 4 | Mapping section-ID:

3. Bed structure

3.1 Bed substrate (K, T)

Mineral substrates	nat. dominating	nat. subordinated	unnat.
None	X		
Silt/mud			
Clay/loess/loam (<6 µm)			
Sand (>6 µm - 2 mm)			X
Shingle (0,2 - 6 cm)			
Gravel (6 - 10 cm)			
Stones (10 - 30 cm)			
Blocks (>30 cm)			
Outcropping bed rock			
Solid bed			X
Not visible			

Organic substrates	dominating	subordinated
None	X	
Algae		X
Fallen leaves, organic particles		
Deadwood		
Makrophytes		
Living parts of terrestrial plants		
Finedetritus		
Peat		
Not visible		

3.2 Substrate diversity (K)

None	X
Small	
Moderate	
High	
Very high	
Not visible	

3.01 Bed pressures (K)

None	X
Domestic waste, building rubble	
Garden waste	
Sedimentation of iron	
Erosion of sand	
Clogging	
Erosion	
Stream maintenance	
Trampling damage	
Groynes/tail units	
Shipping channel	
Debris supplies	
Debris withdrawal	
Not visible	

3.3 Bed fixation (K, T)

	completely	<10 m	10-50 m	>50-100 m	>100-250 m	>250-500 m	>500 m
No fixation			X				
Riprap, stones sticking				X			
Solid bed with sediment							
Solid bed without sediment							
Not visible							

3.4 Bed features (K)

None	X
Pools/Still waters	
Runs/Riffles	
Pothole/Deep channel	
Eddy	
Cascade	
Deadwood	
Root surface	
Makrophytes	
Not visible	

Evaluation funct. Units

Type and distribution of substrates (3.1, 3.2, 3.4, 3.01)	6
Bed fixation* (3.1, 3.3)	6
Index	5
Class	6

* Only considerated if there is no upgrading

4. Cross profile

4.1 Profile type (K, T)

Natural profile	
Aprproximately natural profile	
Eroded profile	
Profile with groynes	
Technical standard profile, decaying	
Technical rule profile	X

4.2 Profile depth (K, T)

Very shallow	
Shallow	
Moderately deep	
Deep	
Very deep	X
Not visible	

4.5 Culvert/Bridge (K, T)

	without sediment	with sediment	not visible
No passage/bridge			
Structurally not harmfull			
Natural stream bank, interrupted			
Watercourse narrowed			

4.3 Width erosion (T)

None	X
Weak	
Strong	

4.4 Width variation

None	X
Small	
Moderate	
Large	
Very large	

Evaluation funct. Units

Profile type (4.1)	7
Profile depth (4.2)	7
Width development (4.3, 4.4)	6
Index	7
Class	7

Structural class	Value range
1	1.0 - 1.7
2	1.8 - 2.6
3	2.7 - 3.5
4	3.6 - 4.4
5	4.5 - 5.3
6	5.4 - 6.2
7	6.3 - 7.0

River habitat survey in Nort Rhine-Westphalia

According to LANUV-Arbeitsblatt 18 (2018)

Stream name: Rotbach | Identification number: 2 7 7 4 | Mapping section-ID:

5. Bank structure

5.1 Bank vegetation (K, T)

	le	ri
No bank vegetation		
Naturally		
Anthropogenically		
Native wood		
None, naturally		
None, anthropogenically	X	X
Native wood		
Wood		
Gallery		
Bushes, single trees		
Young woody plants		
Non-native wood		
Wood, gallery		
Bushes, single trees		
Young woody plants		
Herbaceous vegetation		
None, naturally		
None, anthropogenically		
Near-natural herbs, grasses		
Anthr. caused hedges, tal forbes, grasses	X	X
Slope lawn		
Neophytes		

5.3 Bank features (K, T)

	le	ri
None	X	X
Flow around single trees		
Tree as flow obstacle		
Fallen tree		
Shelter		
Nat. bank break-offs		
Nesting wall, steep faces		

5.01 Bank pressures (K, T)

	li	ri
None		
Domestic waste, building rubble		
Green waste		
Erosion		
Stream maintenance work		
Trampling damage		
Discharge	X	X
Hydropeaking/wash of waves		

5.2 Bank protection (K, T)

	le completely	le <10 m	le 10-50 m	le >50-100 m	le >100-250 m	le >250-500 m	le >500 m	ri completely	ri <10 m	ri 10-50 m	ri >50-100 m	ri >100-250 m	ri >250-500 m	ri >500 m
No bank protection														
Decaying bank protection														
Flow control elements														
With living elements			X								X			
Woody bank protection				X										
Riprap/sttones												X		
Wild bank protection														
Solid bed protection														

5.02 Shading (K, T)

Sunny	X
Semi-shading	
Shady	
Not visible	

Evaluation funct. units

	le	ri
Typical bank vegetation (5.1, 5.02)	6	6 (re)
Bank protection* (5.2)	5	6
Typical natural characteristics (5.3, 5.01)	7	7
Index	7	7
Class	6	7

* Only considered if there is no upgrading

6. Adjacent land zone

6.1 Adjacent land use (K, T, V, G)

	le 10-50 %	le >50 %	ri 10-50 %	ri >50 %
Woodland, native				
Floodplain vegetation (excl. wood)				
Natural wasteland, succession		X		
Pastureland				X
Woodland not native, coniferous forest				
Arable land, special cultures				
Park, green area				
Development with free areas				
Dense development				
Land pressures according to 6.3				

6.3 Adjacent land pressures (K, T, V, G)

Distance from the stream

	le <10 m	le 10-40 m	le >40 m	ri <10 m	ri 10-40 m	ri >40 m
None						
Excavation						
Fishpond in a side channel						
Water structure harmful constructions						X
Traffic area, unpaved	X					
Traffic area, paved						
Landfill, waste discharging						
Flood protection constructions						

6.2 Riparian zone (K, T)

Survey unit length: 100 m | 500 m / 1.000 m

Width of riparian zone

100 m	500 m / 1.000 m	le complete	le <10 m	le 10-50 m	le >50-100 m	le >100-250 m	le >250-500 m	le >500 m	ri complete	ri <10 m	ri 10-50 m	ri >50-100 m	ri >100-250 m	ri >250-500 m	ri >500 m
< 2 m	< 2 m	X							X						
2 - 5 m	2 - 10 m														
10 - 20 m	10 - 50 m														
> 20 m	> 50 m														

6.01 Adj. land features (K, T)

	le	ri
None	X	X
Rock face		
Terrace edge		
Natural embankment		
Flood-/high tide channel		
Scource		
Standing waters		

Evaluation funct. Units

	le	ri
Foreland (6.1, 6.3, 6.01)	3	4
Riparian zone (6.2)	7	7
Index	5	6
Class	5	6

Table: The functional units evaluated by the cartographers and the calculated evaluation results and the transfer into a morphology class of the main parameters with a left-right differentiation

Main parameter	Assessment functional units	Calculation	morphology **class**
MP 1: Watercourse develop.	Curvature: 7 Movability: 7	7 + 7 = 14 14 / 2 = 7	7
MP 2: Longitudinal profile	Nat. longitudinal features: 6 Anthr. continuity barriers: 0	6 + 0 = 6	6
MP 3: Bed structure	Form and distribution of the substrates: 6 Bed fixation: 6	6 + 6 = 12 12 / 2 = 6	6
MP 4: Cross profile	Profile form: 7 Profile depth: 7 Width development: 6	7 + 7 + 6 = 20 20 / 3 = 6.7	7
MP 5: Bank structure le	Typical bank vegetation le: 6 Bank protection le: 5 Typical natural characteristics le: 7	6 + 5 + 7 = 18 18 / 3 = 6	6
MP 5: Bank structure ri	Natural typical vegetation ri: 6 Bank fixation ri: 6 Typical natural characteristics ri: 7	6 + 6 + 7 = 19 19 / 3 = 6.3	7
MP 6: Adj. land zone li	Foreland le: 3 Riparian strip le: 7	3 + 7 = 10 10 / 2 = 5	5
MP 6: Adj. land zone re	Foreland ri: 4 Riparian strip ri: 7	4 + 7 = 11 11 / 2 = 5.5	6

The evaluations of the main parameters with left-right differentiation for the MP 5 and MP 6 can be calculated to an evaluation of the main parameters as follows:

Table: Calculation of the main parameters

Main parameter	Regulation	Calculation	morphology **class**
MP 1: Watercourse develop.			7
MP 2: Longitudinal profile			6
MP 3: Bed structure			6
MP 4: Cross profile			7
MP 5: Bank structure	The worse valuated river side defines the valuation of the MP	Here, ri river side	7
MP 6: Adjacent land zone	The worse valuated river side defines the valuation of the MP	Here, ri river side	6

The evaluations of the main parameters 5 and 6, with a left-right differentiation, can be carried out by the calculation of the zone riverbed, bank and adjacent land as follows:

Table: Calculation of the zones bed-bank-land with lift-right differentiation

	Rule	Calculation	Class
Bed	Arithmetic mean value formation for the evaluation of MP 1 “watercourse development“, 2 “longitudinal profile“ and 3 “bed structure“; Transfer into a morphology class according to the table in chapter 4.1.1.	7 + 6 + 6 = 19 19 / 3 = 6.3	7
Bank left	Arithmetic mean value formation for the evaluation of the MP 4 “cross profile“ and MP 5 “bank structure le“; Transfer into a morphology class according to the table in chapter 4.1.1.	7 + 6 = 13 13 / 2 = 6.5	7
Bank right	Arithmetic mean value formation for the evaluation of the MP 4 “cross profile“ and MP 5 “bank structure ri“; Transfer into a morphology class according to the table in chapter 4.1.1.	7 + 6 = 13 13 / 2 = 6.5	7
Land left	The zone „land le“ corresponds to the evaluation of the MP 6 ”adjacent land zone le“.		5
Land right	The zone „land ri“ corresponds to the evaluation of the MP 6 “adjacent land zone ri”.		6

The evaluations of the main parameters, with left-right differentiations for the MP 5 and MP 6, can be performed to an overall evaluation of the zones bed, banks and land as follows:

Table: Calculation of the zones bed - bank - land

	Rule	Calculation	Class
Bed	Arithmetic mean value formation for the evaluations of the MP 1 “watercourse development“, 2 “longitudinal profile“ and 3 “bed structure“;Transfer into a morphology class according to the table in chapter 4.1.1.	7 + 6 + 6 = 19 19 / 3 = 6.3	7
Bank	Arithmetic mean value formation for the evaluation of the MP 4 “cross profile“ and the more poorly assessed bank side of the MP 5 “bank structure“;Transfer into a morphology class according to the table in chapter 4.1.1.	7 + 6 = 13 13 / 2 = 6.5	7
Land	Corresponds to the valuation result of the worse assessed river side of the MP 6 “adjacent land zone”	Here the right river side	6

The evaluation of the main parameters 5 and 6, with left-right differentiations, can be transferred into an overall evaluation by the following calculation:

Table: Calculation of the overall assessment

	Rule	Calculation	Class
Overall evaluation	Arithmetic mean value calculation of all main parameter evaluations; For the MP 5 and 6 the values with the worse ratings for the river side enter into the calculation. Transfer into a morphology class according to the table in Chapter 4.1.1.	7 + 6 + 6 + 7 + 7 + 6 = 39 39 / 6 = 6.5	7

5 List of symbols and abbreviations

☝	Simple registration during the mapping process. The dominating feature enters into the calculation
✍	During the mapping process the features are counted individually
✋	Multiple registration during the survey mapping
☹	Only the worst value enters into the calculation
➘	The feature only enters into the calculation, when it leads to a downgrading of the index
X	The feature does not enter into the calculation

AT_fl	Hollow and floodplain rivers, fine material-rich –loess, -loam
AT_fs	Hollow and floodplain rivers, fine material-rich -sand
AT_g	Hollow and floodplain rivers, coarse material-rich
AT_o	Hollow and floodplain rivers, fine material-rich -organic
ATKIS	Official topographic-cartographic information system
BaustellV	Construction site regulation
BG	Trade Association
BGV	Occupational Health and safety regulations of the Trade Association
BRD	Federal Republic of Germany
CIR	Colour-Infrared
DGM	Digital terrain model
DLM	German Digital Landscape Model
DTK	Digital topografic maps
ELWAS	Electronic Water Management Network
EP	Single parameter
FFH	Fauna-Flora-Habitat
G	Special case: Standing water in the main connection
g_FG	River type
GEWKZ	Water identification number
GIS	Geographical information system
GPS	Global Positioning System
GSK	Positioning map of water bodies
MP	Main parameter
hpnG	Current potential natural water status
HRB	Flood control reservoir

HYGON	Hydrological raw data online
ID	Identity document
K	Special case: small ponds
KT_g	V-shaped rivers, coarse material-rich
LAWA	Federal States on Water Issues
le	left (in flow direction)
MW	Mean value
NRW	North Rhine-Westphalia
OT_fl	River without valleys, fine material-rich –loes -loam
OT_fs	River without valleys, fine material-rich –sand
OT_g	River without valleys, coarse material-rich
OT_o	River without valleys, organic
ri	right (in flow direction)
SP	Single parameter
ST_fl	U-shaped rivers, fine material-rich –loess -loam
ST_fs	U-shaped rivers, fine material-rich -sand
ST_g	U-shaped rivers, coarse material-rich
T	Special case: Water body dried up
TK	Topographic map
UTM	Universal Transverse Mercator (coordinate system)
V	Special case: piped/overbuilt
WMS	Web Map Service
WP	Upgrading parameter
WFD	Water Framework Directive
WSV	Federal Waterways and Shipping Administration

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