Landesamt für Natur,
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Nordrhein-Westfalen

River constructions in North Rhine-Westphalia

Guide for the field survey of constructions in rivers

LANUV-Arbeitsblatt 38

LANUV
Kompetenz für ein
lebenswertes Land

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Editor	North Rhine-Westphalia Office of Nature, Environment and Consumer Protection (LANUV) Leibnizstraße 10, 45659 Recklinghausen, Germany Telephone +49 2361 305-0, Telefax +49 2361 305-3215 E-Mail: poststelle@lanuv.nrw.de
Project management	Ingo Nienhaus, Andrea Mees, Fides Wagner, Svenja Franke (all DIE GEWÄSSER-EXPERTEN!) Tanja Pottgiesser (umweltbüro essen Bolle und Partner GbR) Dr. Andreas Müller (chromgruen Planungs- und Beratungs-GmbH & Co. KG)
Expert support and editing	Stefan Behrens, Dr. Armin Münzinger (chairman), Dr. Karin Schäfer, Ann-Kristin Schulze (all North Rhine-Westphalia Office of Nature, Environment and Consumer Protection)
Layout	Ingo Nienhaus (DIE GEWÄSSER-EXPERTEN!) Andrea Mense, Claudia Brinkmann (North Rhine-Westphalia Office of Nature, Environment and Consumer Protection)
Translated from German	Dr. Georg Gellert, Dr. Armin Münzinger
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Preface

For centuries people have built constructions in and on watercourses for example to drive mill wheels or to irrigate the land. Usually, constructions have been built perpendicular or diagonal to the flow direction of the river. They have an influence on water flow, migration of organisms and bed-load transport. Thus, the continuity of rivers is limited or is non-existent.

The European Water Framework Directive (WFD) sees river continuity as mandatory to achieve the good ecological status. The directive “Infrastructure for Spacial Information in Europe” (INSPIRE) regards river constructions as an inventory of water management activities and obliges member states to publish the corresponding spatial data.

The present document of North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection enables a standardised and digital survey of constructions in and on rivers for the first time in German-speaking regions. The term “construction” describes here selected technical installations which can directly affect river morphology, discharge dynamics, water flow, sediment transport and organisms’ migration as well as indirectly influence water quality, for instance oxygen content and temperature balance.

The described procedure is based on experiences and knowledge gained since the statewide survey of river morphology in the years 2011 to 2013. Detailed knowledge of the assignment of constructions to the various categories, groups of types and construction types is not required. Rather, a dichotomous decision tree based on measurable parameters, clearly visible in the field, leads the surveyor to the respective construction type. Each type is described in the annex and the variety of forms is documented with numerous photos.

A survey of river constructions performed according to the present method can be carried out simultaneously with a river morphology survey or separately. Using the software BEACH, the recorded data can be stored and used together in a database, for example for

- localisation of technical installations in and on rivers
- an overview of constructions to evaluate river continuity
- the derivation of the extension of living space by eliminating constructions
- the success monitoring and efficiency certificate of realised construction removals and
- the historicisation of single constructions

My thanks goes to all participants, which have participated in the development of the procedure for a standardised and digital survey and mapping of constructions in and on rivers

Thomas Delschen

Dr. Thomas Delschen
President of the North Rhine-Westphalia State Agency
for Nature, Environment and Consumer Protection

Preamble

The document „Gewässer-Bauwerke in Nordrhein-Westfalen – Anleitung zur Erhebung an kleinen bis großen Fließgewässern“ is a unique procedure in Central Europe which for the first time in German-speaking countries describes and differentiates the most relevant constructions in and on rivers. It was published with numerous photos in 2018 www.lanuv.nrw.de/kl/publikationen/arbeitsblatt38 and is now translated into English „Guide for the field survey of constructions in rivers“, making it accessible to a wider group of experts in Europe.

North Rhine- Westphalia shares several transboundary catchments basins, e.g. Rhine, Maas and Ems with other EU-Memberstates, e.g.France, Belgium and the Netherlands. The present guide in English can be used to share and improve common understanding and interpretation of data on river morphology or river continuity and ease discussions between experts while preparing reports in line with the EU Water Framework Directive. In addition the document may contribute to relevant CIS working groups of the EU Commission.

A working team within LANUV revised the commissioned drafted English version to stay as close as possible to technical terms, preset and used in official documents in the context of the EU Water Framework Directive. Available experiences in publishing articles in international journals and membership in international working groups could not overcome the lack of native speakers and missing familiarity with specific administrative or technical English terms. Therefore readers are invited to correct linguistic inconsistencies or technical terms. Correction and suggestions can be sent to Fachbereich54@lanuv.nrw.de or Landesamt für Umwelt, Natur und Verbraucherschutz, Postfach 101052, 45610 Recklinghausen, Germany.

List of selected German technical terms and their translations into English

German	Englisch
Absturz	bedfall
Altdaten	legacy data
ankreuzen	tick
aufgeständert	elevated
Abflussquerschnitt	discharge cross section
Ausleitung	diversion
Ausleitungsgerinne	diversion channel
Ausleitungsstrecke	diversion stretch
Ausprägung	specification
Auswahl der Bauwerksart	determination of the construction category
Baumaßnahmen	construction works
Bauwerk (in bzw. an Fließgewässern)	river construction
Bauwerkart	construction category
Bauwerkstyp	construction type
Bauwerkstypgruppe	construction type group
Bewegliches Wehr	movable weir
Beweglicher Verschluss	movable closure
Bewerten	evaluate
Betretungsverbot	no entry
Dammbalken	bulkheads
Datum der Begehung	date of survey
Düker	inverted siphon
Durchlass	culvert
Einfachregistrierung	Single registration
entfällt	not applicable
erheben; erfassen (analog oder digital)	record
erheben; untersuchen, beurteilen	assess
Erhebungs-/Kartierbogen	mapping sheet
Fehler	error
Fischaufstieg	fish pass
Fischaufstiegsanlage	fish migration facility, upstream
freitragend	self-supporting
Gewässer	river
Gewässername	river name
Gewässerstruktur	river morphology
Gewässerunterhaltung	maintenance of rivers
Gleite (Sohlgleite)	sliding
größter Stufenabstand	widest step distance
Grünabfall	green waste
Hinweis	practical advice
Kartierabschnitt	survey unit
Kartierabschnittslänge	survey unit length
Kartieranleitung	(mapping) procedure
kartieren (mit Kartierbogen)	map
Kartierfehler	mapping error
Kartierstatus	Status of survey
Lage des Gewässers	location of the river

Lage (des Gewässers) weicht ab	watercourse relocated
Lauf verändert	watercourse changed
Lichte Höhe	clear height
Lichte Breite	clear width
Merkmal	feature
Nachbereitung	post processing
Name des Kartierenden	name of cartographer
nicht einschätzbar	not assessable
Oberwasser	head water
Pumpwerk/Schöpfwerk	pumping station
Querbauwerk	transverse construction
Rückstau	backwater
Schlauchwehr	inflatable rubber dam
Schütz/Schütztafel	gate/dam board
Schwelle (Sohlschwelle)	ground sill
Segment (Verschlusstyp)	radial gate
Siel	sluice
Staustrecke	storage stretch
Sockel	pedestal
Sohlbeschaffenheit	river bed substrates
Technischer Fischaufstieg	technical device for upstream fish migration
Tragekonstruktion	carrying construction
Umgehungsgerinne	bypass channel
Unterwasser	tail water
Untersuchung (incl. Beurteilung)	assessment
Verfahren	procedure
Verrohrung/Überbauung	piping/overbuilding“
Verschluss (eines bewegl.) Wehres	lock
Walze	roller
Wasserkraftanlage	hydro power plant
Wildes Bauwerke	unpermitted construction
zuordnen	assign

Gewässer-Bauwerke in Nordrhein-Westfalen – Anleitung zur Erhebung an kleinen bis großen Fließgewässern	River constructions in North Rhine-Westfalia – Guide for the field survey of river constructions

Content

1 Introduction

The European Water Framework Directive (WFD) demands the assessment of hydromorphology as a supporting element for the ecological status of rivers, which is evaluated by biological quality components. Hydromorphology is sectionned into morphological conditions, river continuity and hydrological regime.

Constructions in and on rivers play a significant role with regard to river continuity. Their assessment requires on-site inspection. So far, there is no standardised field survey procedure for these constructions.

The present document describes an **innovative procedure** for the survey and mapping of constructions in and on rivers in North Rhine-Westphalia (NRW). It has the following characteristics:

- Data acquisition is performed by **standardised forms** (in NRW implemented by the software BEACH). It is applicable in the open field as well as in built-up areas. It is designed to **record constructions in rivers of all sizes** from mouth to source.
- The term “construction” describes selected technical installations that can have direct influence on **river morphology, water flow, continuity of sediments and organisms as well as indirect influence on water quality, inter alia the oxygen- and temperature balance**. In addition to the most frequently occuring constructions, which are described in detail here, there are further constructions in and on rivers which are not recorded, as they are of lower relevance for river continuity, for instance, supply- and waste discharges or bed- and bank fixation which are considered by the LANUV-Arbeitsblatt 18 (2018).
- Based on the experiences and findings from the comprehensive quality control, within the framework of the statewide recorded data from the river morphology survey and river constructions, carried out by the North Rhine-Westphalia Office of Nature, Environment and Consumer Protection in the period from 2011 to 2013, for the present guide only those parameters have been chosen which can be easily identified in the field.
- Initially, a **decision tree** must be run through which leads the cartographers to the correct construction by targeted decisional questions and therefore to the parameter set which must be used. The cartographer does no longer determine the construction type him- or herself. Thereby, further sources of errors are excluded.
- The procedure **for mapping river constructions can be carried independently or as part of the river morphology survey** (see LANUV - AB 18, 2018). In the latter case, the data from the construction mapping are considered in the different single parameters of the river morphology survey, when the mapping software BEACH has been used.

The results of the data recorded according to the present guide for the field survey of constructions in rivers serve for planning aid and decision support, for instance for river restoration, for river development planning or for the assessment of river development measures as well as data basis for different purposes like

- Overview of the river constructions for the assessment of the river passabilty for organisms (e. g., fishes, invertebrates) or sediments,
- Implementation of the concept for the return of degraded rivers by using positive impacts from near-natural river sections (Strahlwirkungs- und Trittsteinkonzept in der Planungs in der Planungspraxis, LANUV Arbeitsblatt 18, 2011),
- Derivation of the extension of habitat by dismantling of river constructions (Lebensraumgewinn durch Rückbau von Querbauwerken, LANUV 2017)
- Evaluation of planned river engineering measures, river maintenance works, compensatory measures and other interventions.

The present guide for the field survey of constructions in small to large rivers consists of five chapters and an annex. Initially, it describes the procedure in a general form. It presents and explains the technical basis, requirements and further indications for the recording as well as the data entry forms. Finally, it indicates possible sources of errors and ways to avoid them.

The annex of the present survey describes and illustrates the considered river constructions with numerous photos and figures.

2 Procedure description

2.1 Procedure overview

Four categories of constructions are considered:
- Hydro power plant
- Transverse construction
- Fish migration facilities, upstream
- Other constructions

Two categories are then subdivided into **construction types**:
- Transverse constructions into the types “movable weirs”, “dam”, “ground sill” and a group consisting of “bed fall”, “ramp” and “slide”.
- Other constructions into the types “sluice”, “pumping station” and “inverted siphon” and a group consisting of “bridge”, ”culvert”, piping/overbuilding”.

This guide does not apply to the following river constructions: bed fixation and bank protection, fords, supply- and discharge pipelines crossing above ground, port facilities, flood control reservoirs without permanent backwater and reservoirs conform to the State Water Act of North Rhine-Westfalia. Also excluded are raking systems and staff gauges, although technical structures of other water gauges are registered according to the abovementioned types. Recording and documentation of technical installations that are not mentioned here can be regulated within the scope of individual terms of service.

The survey is performed on-site and data are recorded in paper forms or with the digital mapping software BEACH. Only measurable or countable parameters are recorded. The correct and precise measurement of features forms the core of the procedure. Photos supplement data acquisition.

However, the evaluation of recorded data is not part of this procedure

For the various categories or types different parameters are to be recorded. The decision which parameter must be recorded for a specific construction is not within the cartographer’s responsibility, but is determined by a decision tree (see chapter 2.3). This decision tree uses clearly defined and distinguishable criteria. This simplifies the identification of the construction types in the field notably and enables traceability in each case.

In case of the categories “hydro power plant” and “fish migration facility, upstream” no further decisions have to be made. For the categories “transverse constructions” and “other constructions” at most three decisions must be made until the correct parameter set is identified.

River constructions can be mapped independently or combined with a river morphology mapping according to the LANUV-Arbeitsblatt 18 (LANUV 2018). In the latter case when using the mapping software BEACH, data of the river constructions mapping are automatically transfered to the relevant parameters of the river morphology survey.

To link the recorded river construction data and the data of the river morphology mapping, the localisation of hydraulic structures must always be based on survey units of the river morphology survey.

The described procedure usually allows an unambiguous mapping of constructions in and on rivers. However, in specific cases it is possible that constructions **cannot be clearly assigned** by the presented mapping instructions (some special cases are described in this guide).

If the decision tree cannot be applied adequately, cartographers must decide the allocation of the construction by themselves. This must be documented using photos (see mapping sheet “comments). This documentation also ensures that river constructions not to be mapped (e.g., rake installations) or wrongly allocated constructions can be deleted or corrected afterwards in the database.

The current water level has a decisive influence on the mapping process and the features to be measured. To assess these data correctly the use of this procedure is limited to mean water level or below.

2.2 Definition of terms

For a general and common understanding, it is necessary to define the terms being used in the following text. Definitions applicable in the context of this guide may differ from other relevant definitions, e. g., in DIN-guidelines, because these guidelines primarily consider constructional aspects and are not suitable for the mapping of river constructions as described here.

The following definitions apply to this procedure:

The term **construction** describes all artificial installations in and on rivers, which are built in the riverbed and extend perpendiculary or diagonally to the flow direction across the whole river width. In addition to installations in the riverbed, within the framework of the present procedure, also constructions at the embankment (e. g., bridges) are understood as ”construction“.

The term **parameter** describes a key figure to be mapped, e. g., ”actual water level difference“.

The term **feature** describes the different specifications or values of a parameter. Features are either recorded in the form of numeric quantities (e. g., in the case of the parameter ”water level difference“: ”1.3 m“) or selected from a fixed set list. For the parameter ”riverbed structure“ for example, one of the following features „bed with sediment“, “bed without sediment“ or ”bed not visible“ has to be selected.

The term **decision tree** describes the system that guides the cartographer to a correct parameter set for the mapping of a construction. It is extensively described in chapter 2.3.

The term **decision-making level** describes the specific questions in the decision tree. By answering them, the cartographers are guided to a correct mapping parameter set for a construction.

The term **construction category** determines four different kinds of construction:

Hydro power plant	**Transverse construction**	**Fish migration facility, upstream**	**Other construction**

The term **construction type** describes constructions of a construction category, which are assessed by the same parameter set because of their functional or technical similarity. Furthermore, there are construction types for which no parameters are to be assessed as the result of the run through the decision tree. This concerns e. g., the construction type ”ground sill“. The assignement of a construction to a construction type is usually based on the determination of the construction category and of the following processing on the decision-making levels.

For bed falls, ramps and slidings (construction category ”transverse construction“) and bridges, culverts and pipings/overbuildings (construction category ”other constructions“), the same parameters are to be assessed, even if they are addressed in other contexts as separate construction types. For this reason they are designated as ”**construction type groups**“.

Construction types within a construction type group can be differentiated on basis of the charateristic features; changes can be made in the database, if necessary.

The construction category ”**transverse construction**“ divides as follows:

Transverse construction

Construction type **Movable weir**	Construction type group **Bed fall, ramp, sliding**	Construction type **Ground sill**	Construction type **Dam**

For the construction types bed fall, ramp, and sliding respectively the same parameters must be assessed. Therefore, they are combined to a contruction groups

The construction category ”**other construction**“ divides as follows:

Other construction

Construction type **Inverted siphon**	Construction type group **Pumping station**	Construction type **Sluice**	Constructional group **Bridge, culvert, piping/overbuilding**

For the construction types bridge, culvert, piping/overbuilding respectively the same parameters are to be assessed. Therefore, they are combined to a construction type group.

2.3 Assessment procedure

This chapter contains the overview of the decision tree, describes the successive mapping of a construction in the field and demonstrates the fundamental principles of this procedure.

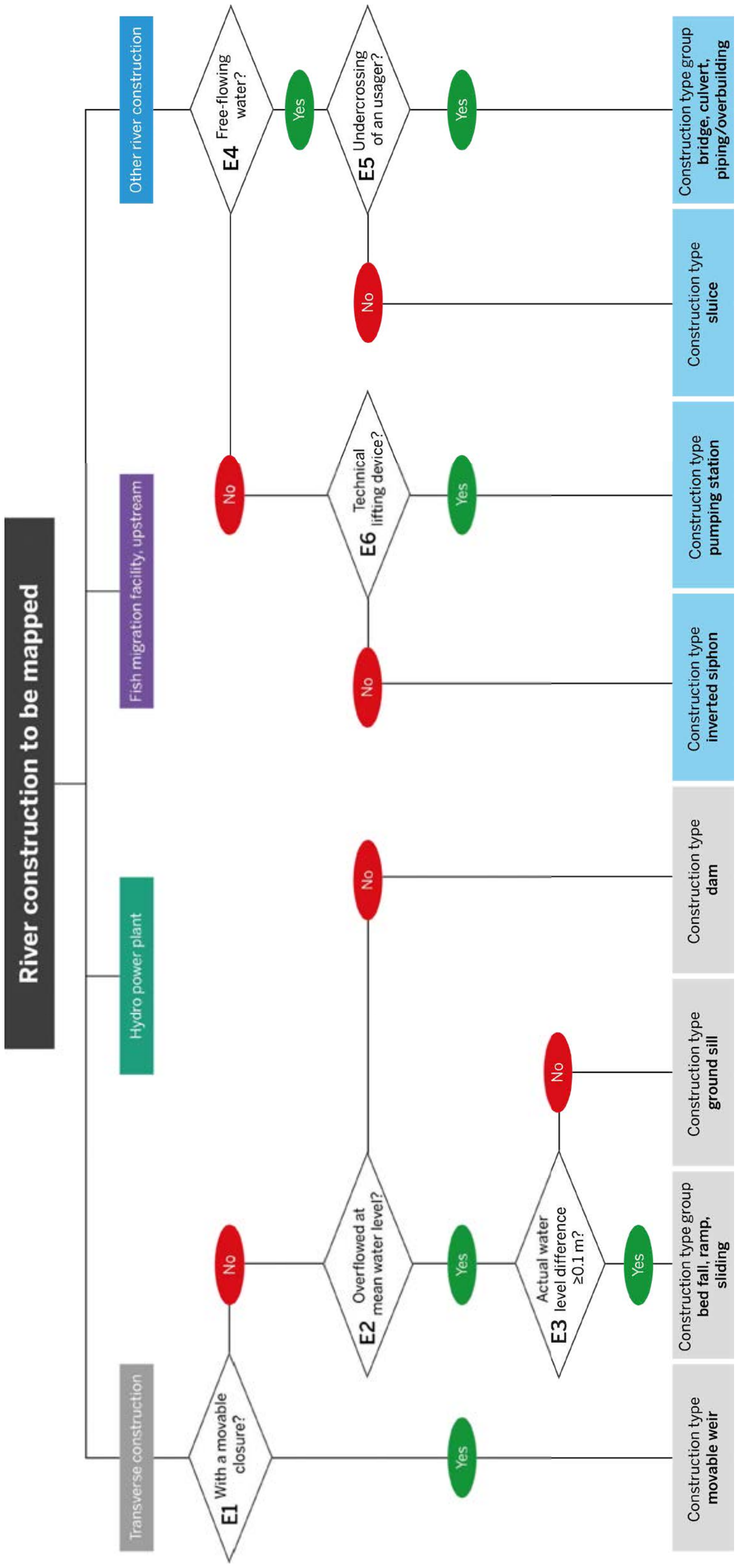


Figure: Decision tree of the river construction field survey

Step 1:

At the beginning of the present procedure for mapping river constructions, decision has to be taken, if the found technical installation can be mapped in the context of the present procedure. The Annexe describes how the construction categories can be distinguished and which construction can be assigned to which construction category.

If the found technical installation does not correspond to one of the four construction categories, then this construction is not to be mapped according to this procedure.

Furthermore, constructions are not to be mapped, which are neither completely nor partially in a water body, on a river bank or across a 200 m wide corridor (for each river side 100 m) along the river. This case normally is only relevant for a large viaduct.

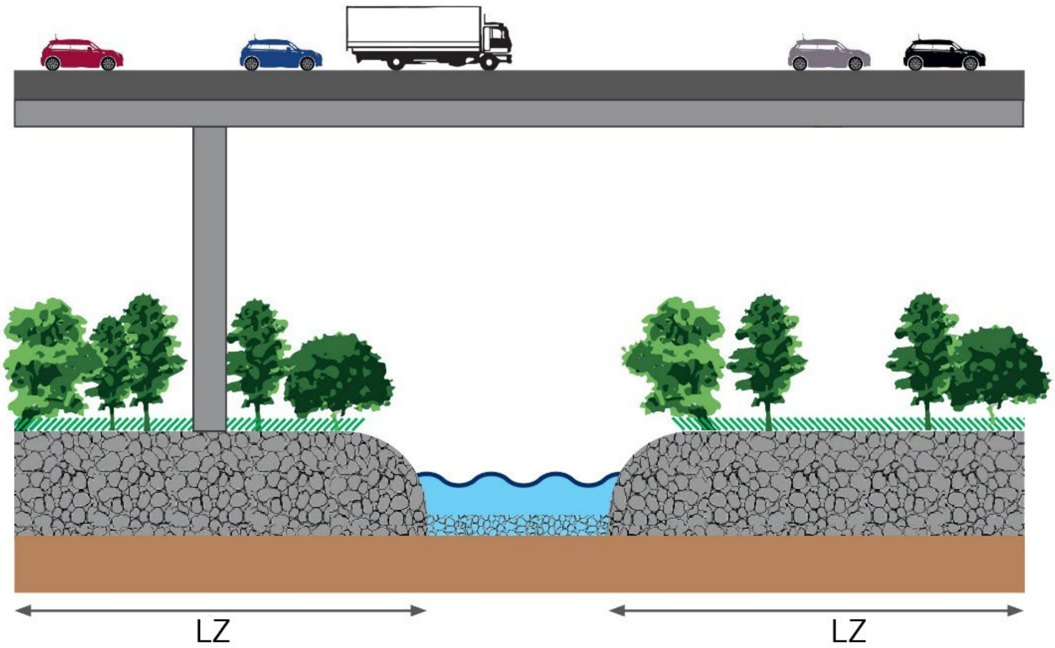


Figure: Bridge in the cross section to be mapped, as one of the bridge piers is located in a 200 m wide corridor (LZ = land zone)

Subsequently, the technical installation to be mapped is determined by assigning it to one of the four kinds of construction:

- Hydro power plant
- Transverse construction
- Fish migration facility, upstream
- Other construction

Basis prerequisite for the application of this procedure is a good knowledge for the assignment of technical installations to the corresponding construction category.

Construction category "Hydro power plant"

Hydro power plants are river constructions which transform kinetic energy of the water in mechanical or electrical energy (e. g., water wheel or turbine) and make it useable for humans.

Construction category ”transverse construction“

The construction category ”transverse construction“ includes different construction types and one construction type group which usually serves for riverbed fixation, water flow regulation or for damming purposes at mean water level. Within the scope of this procedure, a distinction is made between the following “construction types” or “construction type groups”:

- Movable weir
- Dam
- Ground sill
- Bed fall, ramp, sliding (construction type group)

Construction category ” fish migration facility, upstream“

Facilities for fish migration, upstream are technical installations in rivers that allows fishes and invertebrates to migrate upstream or to bypass a construction which impedes migration (continuity barrier) in a river.

Construction category ”other construction“

The construction category ”other construction“ includes different construction types and a construction type group which especially serve as ”crossing constructions“, but also have other different functions (e. g., the lifting of water on a higher terrain level). Within the scope of this procedure, a distinction is made between the following construction types or a construction type group:

- Bridge, culvert, piping/overbuilding (construction type group)
- Sluice
- Pumping station
- Inverted siphon

Provided the construction to be mapped shows characteristics of more than one of the four construction categories and/or uncertainties exist concerning the correct determination of the construction category, the technical installation must be assigned to a construction category nevertheless. The cartographers must take a decision on the assignement of a construction. This must be documented in detail with photos, so that a subsequent correction is possible if necessary.

Step 2:

For each river construction, following information is always to be recorded which serve for their identification:

- Master data like river name and river identification number, servey unit-ID, location (coordinates), stationing within the survey unit,
- Data for the mapping like cartographers‘ name, date of field work,
- Information on the mapping status (e. g., existent, not mappable, non-existent),
- Information on the survey unit length at which the construction is located

If necessary, corrections regarding the location or the construction type have been made, detailed explanations must be given. Furthermore, for the mapping status of the construction it must be indicated if it is still existing or not, due to deconstruction measures or other reasons. This is important in the event of deviations from existing legacy data. A detailed description of these paramaters is given in chapter 4.1.

Step 3:

For each construction the following general parameters must be recorded:

- Length of the backwater
- Diversion existing
- Position of the diversion channel (if applicable)
- Length of the diversion stretch (if applicable)
- Unpermitted construction
- Fish migration facility upstream existing or present or available
- Water level

A detailed description of these parameters is given in chapter 4.2

Step 4:

For construction categories „transverse construction“ and „other construction“ identified in step 1, the determination of the construction type is done by running through further decision levels according to a dichotomous decision making pattern. Subsequently, for each construction type different parameters are to be recorded.

Construction category ”transverse construction“

For the construction category ”transverse construction“ it must be analysed at first if the construction has at least one movable lock (decision level E1). If yes, then it leads to the parameter set for the **construction type ”movable weir“**. A detailed description of this construction type is given in chapter A.2.2 of the annexe.

For a transverse construction without a movable lock it must be decided if the transverse construction is overflowed at mean water level (decision level E2). For transverse constructions without movable locks which are not overflowed at mean water level, the parameter set of the **construction type ”dam“** must be chosen. A detailed description of the construction type ”dam“ is given in chapter A.2.3 of the annexe.

For transverse constructions without movable locks which are overflowed at mean water level, the actual water level difference is determined (decision level E3).

If the actual water level difference is higher than 0.1 m, then a standadised parameter set is used for the **construction type group ”bed fall, ramp, sliding“**. Recorded constructions of this construction type group can be assigned, after the recording of all data, to a construction type (calculated by the ratio between the current difference in water levels and construction length).

Table: Construction type depending on the inclination

Inclination	Construction type	Details of construction type
1:0 to 1:3	Bed fall	Chapter A.2.4
<1:3 to 1:10	Ramp	Chapter 0
<1:10 to 1:30	Sliding	Chapter A.2.6

A differentiation of the construction types within this constructional group is not relevant under this procedure. However, it may be relevant in other contexts (e. g., during a survey of river morphology). If the current difference in the water levels is lower than 0.1 m or not visible, then the parameter set of the **construction type “ground sill**“ is used. A detailed description of the **construction type „ground sill“** is given in chapter A.2.1 of the annexe.

Construction category ”other construction“
For the construction category ”other construction“ it must be assessed at first, whether the river flows in a free gradient through the construction (decision level E4).

If the construction is flown through in a free gradient, then the next step will be to examine if the construction serves for a use or for the crossing of a river (decision level E5). If yes, it leads to the parameter set for **the constructional type group ”bridge, culvert, piping/overbuilding“**. After recording all relevant parameters of the assessed constructions of this construction type group, then the following criterion will be applied:

Table: Construction type depending on the construction design

Criterion	Construction type	Details on the construction type
Self-supporting, elevated and clear width >=2 m	Bridge	Chapter A.4.4
Length <10 % of the survey units‘ length	Culvert	Chapter A.4.5
Length >=10 % of the survey units‘ length	Piping	Chapter A.4.6

A differentiation of the construction types within this construction type group is not relevant under this procedure. However, it may be relevant in other contexts (e. g., during a survey of river morphology).

If the answer on the decsision level E5 is”no“ and consequently the construction does not serve for a use or for the crossing of a river, the parameter set of the **construction type ”sluice“** must be taken. A detailed description of the construction type ”sluice“ is given in chapter A.4.1 of the annexe.

If the construction is not flown through in a free gradient, then it must be examined as next step if there is a technical lifting device (decision level E6).

If a technical lifting device exists, then the parameter set of the **construction type ”pumping station“** must be taken. A detailed description of the construction type ”pumping station“ is given in chapter A.4.2 of the annexe.

If there is no technical lifting device, then the parameter set of the **construction type ”inverted siphon“** must be taken. A detailed description of the construction type ”inverted siphon“ is given in chapter A.4.3 of the annex.

All parameters for recording constructions are described in chapter 4.

3 Instruction for the assessment of river constructions

3.1 Professional requirements of the cartographers

In principle, different professional requirements are necessary to ensure the quality of the recorded data within the assessment of river constructions.

Methodological knowledge

The quality of the assessment depends considerably on the knowledge and experience of the cartographers. For carrying out mappings an intensive preparation of field works and good methodological knowledge are crucial conditions (see chapter 3.3). In the description of services, the requirements of the qualification of the cartographers must be described in detail.

Mapping experience

A basic requirement for the cartographers is the knowledge of the four construction categories and their fundamental functions for the correct assignement of technical installations, met in the field.

Prior to start the assessment, the cartographers should have mapped, the different technical installations on different water courses according to this procedure. If necessary, also on a trial basis.

Objective mapping

The analogue or digital mapping sheet must be filled in conformity with the requirements of the present procedure for the survey of constructions in rivers. Personal impressions, special skills and subjective preferences must be ignored. Different cartographers must get to the same results independently of each other (cross mapping of technical installations in the field)

Detection of the water level

The cartographers must be able to classify the current water level within the overall runoff behaviour of a river (for instance mean flow or low flow conditions). Where appropriate, the available data of current water levels, especially of major rivers, should be queried from water gauge stations. In North Rhine-Westphalia for instance, the specialised information system **ELWAS-WEB** or **HYGON** are set up on the internet for this purpose.

3.2 Data basis

State-of-the-art for the preliminary preparation of mapping work is the use of a geographic information system (GIS) including Web Map Serices (WMS). High-resolution remote sensing data cannot replace the mapping of river constructions, but support the preliminary works and especially for larger rivers and in rough terrain provide further information. Actual aerial photos or high resolution satellite images especially come into question here. Following map basis and tools are needed in their respective current version:

- Topographic maps (especially DTK 10 or DTK 5, where appropiate, overview maps for the orientation,
- Aerial photos (preferably coloured, if appropiate, black-and-white, georeferenced orthophotos),
- Digital terrain model (DTM),
- Stationed watercourse on the basis on the DTK 10 or alternatively scale 1:25,000

Further helpful data basis are:

- Map of the river types (LUA-Merkblatt 36, 2002),
- Photos, oblique images, videos e. g. taken by multicopters

Furthermore, the following information from the competent authorities for the mapping of river constructions, especially on large rivers or waterways can be helpful:

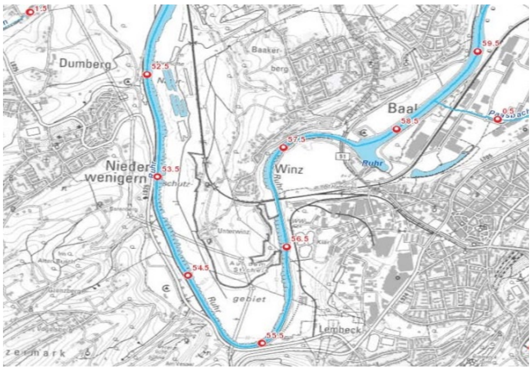
- Head of the reservoir and backwater length, e.g., from FLYS (river hydrological web-service of the Federal Institute of Hydrology, Bundesamt für Gewässerkunde, Koblenz)
- Location, purpose and impact of constructions,
- Sediment freight in pipings, overbuildings and culverts

If older data of constructions are to be checked in the field, the existing data are needed for the comparison with data from repeated mapping actions.

Data basis

Stationed water course

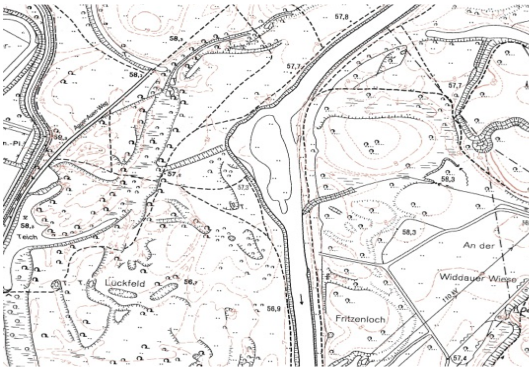
- Digital river stationing map with information on diversions or bifurcations



Source: © State NRW 2018

German basic map with contour lines (DTK 5 H)

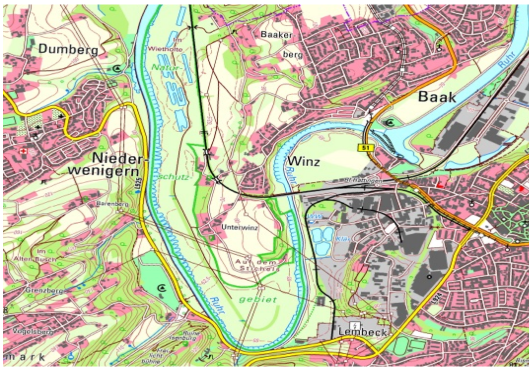
- Overview of the location of constructions in and on the river and the width of the water surface upstream of the construction.



Source: LUA 2002

Topographic map TK 25 (1:25,000)

- Overview of the location of the constructions in and on the river and the location of diversions and bifurcations.



Source: © State NRW 2018

(Detail)aerial photo

- Coloured aerial photo in a perpendicular axis: overview of the location and length of the construction (in flow direction), angle of a construction to the river axis, width of the water surface upstream of the construction, length of the backwater, location of diversions and bifurcations.
- The aerial photo can also serve for orientation purposes in the field, as potentially unrecorded paths are recognisable here.

Source: © State NRW 2018

3.3 Preliminary works

Prior to the mapping of river constructions in the field, a series of preliminary works in the office are **absolutely** necessary.

Technical preparation
If there is already information on the constructions to be mapped, this should be supplied by the customer before the survey starts. The cartographer should view and analyse the information and consider them for the work planning.

Detection of diversions
For this parameter a **careful preparation** is needed. In the River Stationing Map NRW an own identification number has been assigned to all known diversion channels. Thus, they can be presented cartographically. Bifurcations are marked in the River Stationing Map NRW as well. The information on diversions and bifurcations must be verified in the field.

Determination of survey units
The use of survey units for the survey of river constructions is required, as on one hand the location of the constructions is realised by the survey units. On the other hand, the use of the software BEACH enables the takeover of results in corresponding single parameters in a parallel-performed river morphology survey.

The survey units are normally predefined and are based on the respective edition of the river stationing map (Gewässerstationierungskarte=GSK) of the State NRW. Each survey unit is clearly identified not only by the survey unit ID, but also by a River Identification Number (Gewässerkennzahl=GEWKZ), by the edition of the GSK and by stationing values of the starting and end points (specification in metres).

If there are no survey units based on the actual river stationing map, then the river is continuously subdivided, based on the DTK 10, in 100-m survey units along the midline of the river, from the mouth upstream. For the new defined survey units, the eastings and the northings of the starting and endpoints are determined.

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

The boundaries of survey units are marked and consecutively numbered from the mouth upstream. If rivers exist as digital vector topic (e. g., ATKIS Basis-DLM), then the boundaries of survey units can be performed semi-automatically in GIS. The structure of the survey unit boundaries and -numbering is also consecutively performed for longer piped river sections.

The length of the survey units is given (see LANUV-Arbeitsblatt 18, 2018, chapter 3.1). If necessary, a deviating survey unit length can be determined in the field. Local narrowing or widenings of the river are not taken into consideration. An initially selected river unit length can not be undercut in the further water course (looking in flow direction), even if the river, e. g., due to constructions, shows a smaller actual width downstream than upstream within a near-natural unit. By this approach it is avoided that the survey unit lengths often vary.

If the water course in the field deviates significantly from the water course by the prescribed survey units shown on the map, then **new survey units** must be created from the last not affected survey unit until the next not affected survey unit. This is the case, irrespective of whether the real river length might be shorter, longer or equal. A geographic referencing of survey units, which are replaced by new survey units is not needed.

Significant spatial deviations of river sections are sections that lie outside a corridor of 200 m of width (respectively 100 to the left and to the right of the river) from the given survey units or where changes in section length result in more than 50 % for the survey units (channel lengthening, -shortening). They also include changed drainage systems (e. g., changes with regard to the river mouth), changed determinations of the main water course (e. g., mill races) as consequence of river branchings and extended upper reaches.

In cases of minor spatial deviations or changes in length than mentioned above, no new survey units should be created, but appropiate informations in the comment field should be given.

For the new survey units, the beginning and the end of the survey unit must be documented by UTM-coordinates (by GPS or by map). Newly created survey units get a clear ID. This will be created by the attachment of a further numerical digit to the ID of the first concerned survey unit which will increase for each new survey unit until the next not concerned survey unit.

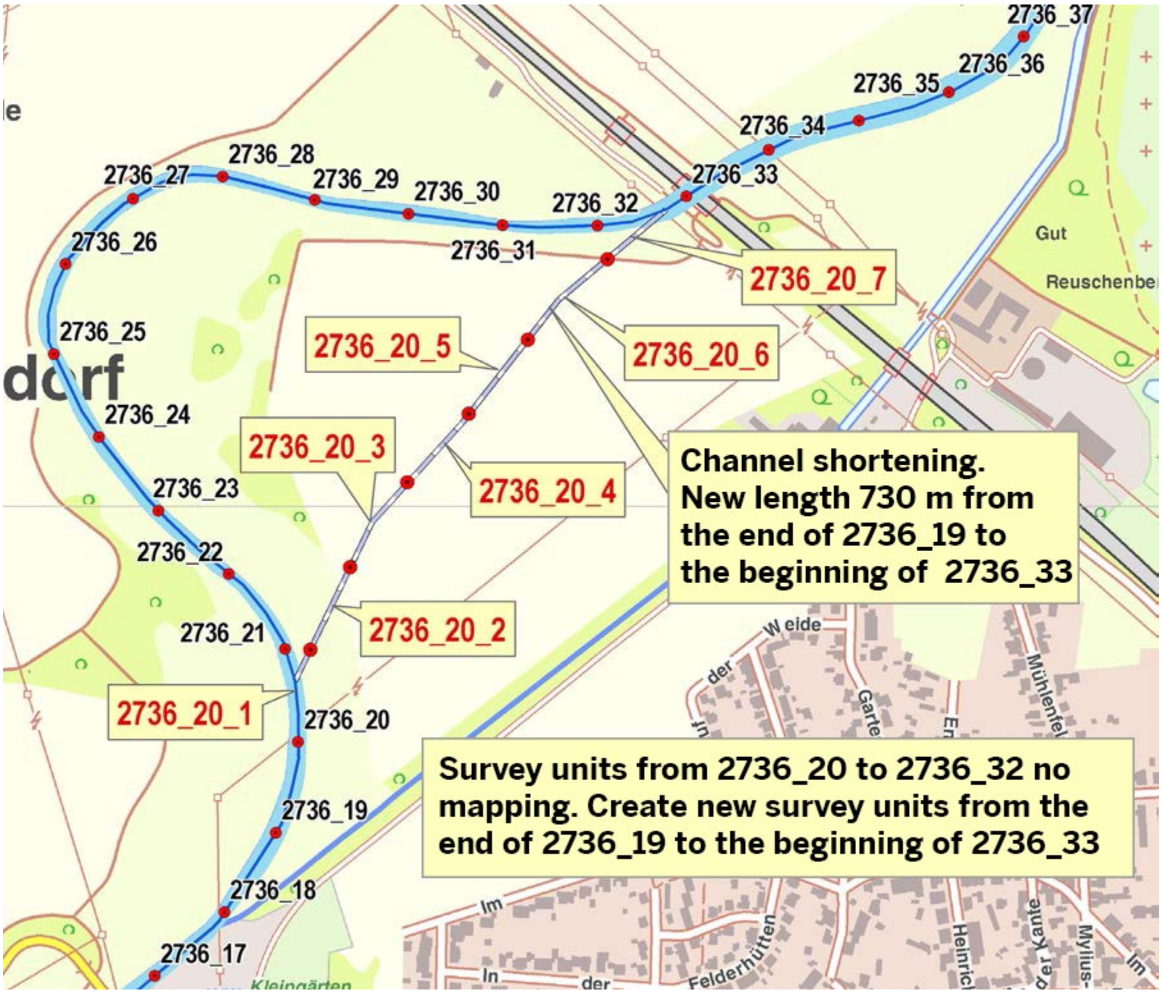


Figure: Designation of newly created survey units (LANUV 2012)

Example

On a river to be mapped, a section of the channel course has been changed, here channel shortening. The first survey unit affected by the channel change has the ID ”2736_20“. Due to this channel change seven new survey units must be created until a survey unit has been reached whose stationed channel corresponds to the water course in the field again (e. g., survey unit ”2736_33“).

The newly created survey units get the IDs ”2736_20_1“, ”2736_20_2“, ”2736_20_3“, ”2736_20_4“, ”2736_20_5“, ”2736_20_6“, ”2736_20_7“.

3.4 Field work

The field work must be organised intensively like the planning of the daily`s route. The necessary (technical) equipment of the cartographers for the field work is also to be provided.

Equipment
To simplify the mapping of river constructions, to speed up the electronic data processing and to guarantee the quality of the data, the cartographers should carry the following equipment items.

Guide for the field survey of river constructions	The guide should be carried along during the survey on the rivers in a digital and/or in a printed form.
Mapping sheet, clipboard, pen	For recording in the mapping sheets a clipboard and a water-resistant pen (preferably a soft pencil) should be carried along as well as a sufficient number of mapping sheets.
Mobile device, tablet-shell, replacement batteries	When using mobile devices for the data record the transmission of the mapping sheets in a data base is omitted. Mobile devices should be suitable for the outdoor use (for instance protected according to German Norm IP 67). A waterproof protective cover for the mobil device should be as robust as possible und should protect against rain. Care has to be taken on an acceptable battery autonomy (>8 h continuous operation). Ideally, the possibility should be given to change discharged batteries.
Digital camera, spare batteries	Digital cameras must be used, optionally equipped with GPS and compass to facilitate the allocation of digital photos to the survey units. Ideally, the possibility should be given to change discharged batteries.
Ranging rod	For the asessment of some parameters and features a ranging rod has been proven useful. It can be used for size estimations, for the exploration or the examination of overgrown construction components.
Laser-measuring device, folding rule	For the determination of distances and dimensions, laser-measuring devices have been proven useful. Useful are devices with different measuring ranges which work between few centimetres and at least 100 m. Alternatively, also a folding rule can be used.
GPS device	For the most exact determination of the location of constructions and for the general orientation a GPS-device must be carried along to identify the respective coordinates.

Binoculars	Binoculars should be taken along during the mapping of river constructions on major rivers for the verification of parameters and features from the dyke or maintenance way.
Topographic overview maps	It is recommended for the orientation in the field to produce and to carry along topographic overview maps at a scale of 1:25,000 or 1:10,000 with an actual river stationing.
Mobile phone	For health and safety reasons a mobile phone should be absolutely taken along, as usually the mapping is carried out alone (see chapter 3.7).
Authorisation proof	The customer should provide an authorisation proof according to the State Water Act (Landeswassergesetzt, NRW) which authorises the accessing of private land in order to record the basics of the water management according to the State Water Act.

Time

Principally, the mapping can be carried out all year long under the condition that the water level lies at mean water level or below.

Generally, the time between November and April is favorable, as in the remaining time of the year the vegetation impedes the view at river constructions or their inspection, measuring parameters and features or taking informative photos. This must be considered in the time planning.

Day route

Depending on the available preliminary information, on the terrain situation and on the number of constructions per kilometre, widely variying daily outputs must be expected. The day route must be carefully planned before mapping.

Orientation in the open field

Before starting fieldwork, the cartographers should familiarize themselves with the localities of the river and its constructions to be mapped by studying the topographic map and available aerial photos.

The use of digital mapping devices makes a GPS-function available for the orientation in the field. However, topographic circumstances may lead this device to malfunction or deliver only inaccurate site information.

The location of already known constructions can be varified by their GPS-coordinates and the digital map material. Probably, existing striking landmarks and structures in close proximity to river constructions can be compared with digital photos and additionally provide support for the identification of the construction.

Direction of on-site inspections

It is recommended to map the contructions from the river mouth to the source.
In the cases ”Rhine“ and ”Weser“ the direction is reversed. This corresponds to the Guide for the Survey of River Morphology.

It should be noted that the position specifications ”left“ and ”right“ are always related to the viewing direction ”in the direction of flow“.

Joint mapping operations of river constructions and river morphology

The use of the mapping software BEACH allows to transfer autoimatically the characteristics and geometrics of the recorded river constructions to the corresponding single parameters (SP 2.1 ”transverse and special structures“, SP ”2.2 „piping/overbuildings“ or 4.5 ”culvert/bridge“) of the River Morphology Survey.

Therefore, it is recommended that the mapping of river constructions should be carried out before mapping river morphology in each survey unit. This ensures that the evaluation of river morphology includes all constructions within a survey unit.

Photo documentation

The pictures should clearly show the construction with its specific parameters and features and ideally its location in the river and on the terrain. Attention must be paid to a good picture quality. Backlit shooting should be avoided and an appropiate depth of focus should be achieved. The photos must be **immediately verified in the field** for their quality and, if needed, new pictures must be taken.

Basically, each river construction must be documented by **at least** three photos.

One photo is taken

- from upstream of a construction (in flow direction)
- from downstream of a construction (against flow direction)
- in side view (position in the river or on the terrain)

Data protection issues have to be considered by taking photos. This means, no person, signs or licence plates can be recognized on the photos. If this is unavoidable, then they must be made unrecognisable afterwards.

The photos should allow the proof for constructional modifications of an already mapped construction (e. g., modification of construction type “bed fall” in “sliding”).

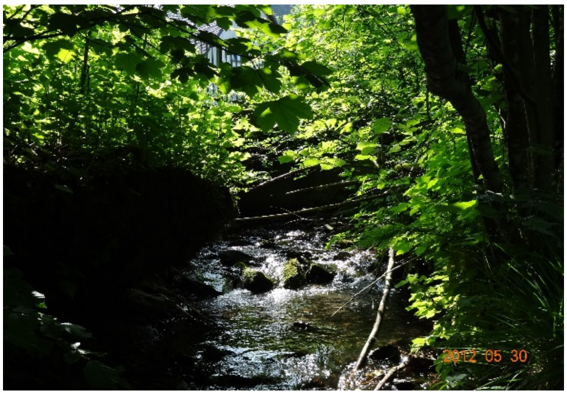
If in rare cases, none or not sufficiently significant photos of a construction could be taken (e. g., no entry), then this must be documented in the field ”comments“ of the mapping sheet.

Photodocumentation


Good photo: construction and river recognisable


Bad photo: blurred and concealed


Good photo: difference in water levels can be clearly seen



Bad photo: photo too dark


Good photo: the construction can be clearly seen


Bad photo: the vegetation covers the construction


Good photo: The construction can be clearly seen


Bad photo: the horizon is tilted

3.5 Postprocessing

The postprocessing should be done on the same day of the on-site mapping if possible.

Postprocessing includes the following tasks:
- Check for completeness
- Allocation of photos
- Plausibility check

Check for completeness
Mapping sheets have to be checked if they are completed for all recorded river constructions and that for all constructions exist at least three photos. Constructions, which do not meet both criteria, a corresponding justification should be given.

Allocation of photos
The photos must be allocated to the river construction in the respective survey unit and must be named according to the specifications of the customer. In North Rhine-Westfalia the software ”BEACH GS 3 Foto-Manager“ is available for this purpose. If there are several constructions within a survey unit, then the allocation of the photos must be done with particular care.

Plausibility check
All recorded data should be checked for plausibilty. In the program ”BEACH GS 3 Desktop“ used in North Rhine-Westfalia, a series of plausibility checks is realised which automatically can be used for whole data sets (e. g., recognisable features must fit the identified construction).

Verification of nonexistent constructions
Aerial photos or other geographical data combined with adjacent constructions mapped as ”existent“ should be used to verify again locations of river constructions mapped as ”nonexistent“. In this verification, also newly identified constructions must be included.

3.6 Specific hints for the mapping of river constructions in the field

The correct and complete recording of the geometrics of a construction is a point of emphasis in the procedure to map river constructions, besides a good photo documentation. Therefore, the calibration of geometrics is pointed out in particular:

3.6.1 The procedure of measuring features

Normally, laser distance measuring devices have the function to select between a measurement from the rear or from the front edge of the instrument. A measurement from the rear edge is recommended as the instrument calculates its own length automatically during the measurement. Thus, the laser distance measuring device (e. g., during a measurement of the features “clear width“ or for the determination of the number of closures at the construction side) can be positioned flush against the supporting element of a construction on one river side and the distance to the next supporting element (usually on the other river side) can be measured. Correct instrument setting is fundamental and therefore to be checked in order to avoide false measurements. ,

For the vertical measurement of heights, like differences in water levels and the maximal retention height, it is useful to aim alternatively at laser target objects with laser points, as measuring aid. This can be, depending on the situation at the construction, for instance the foaming water surface, stranded flotsam, the foot of the embankment, stones or fixations at the level of the water surface downstream. It is important to aim at the level of the water surface with the laser device and not at the river bed.

If it is not possible to approach a construction in the open field at a sufficient distance (e. g., no entry, fence), then the respective measurement can be performed on another point. Thus, for the determination of the clear height of a footbridge with a hand hold, the distance can be measured from the hand hold vertically to the bottom edge of the superstructure, before the whole distance from the hand hold to the water surface is measured. The difference of both measured values results in the clear height of the crossway construction.

There are several possibilities for the measurement of lengths, e.g., construction length, length of a diversion channel or backwater. In case of short distances, the stretch can be comfortably measured at corresponding construction elements (or, if needed, replacing laser objectives like tree trunks or stones). In case of longer distances, it can be useful to determine the length by walking with an incremental jog and convert the result into metres.

Hint: to determine the incremental jog, a range of at least 10 m in a normal speed and step length should be run. The steps are counted and the stretch (10 m) subsequently divided in the required step number.

If a measurement is not possible, the present data basis (detailed aerial photos) but also further satellite images (e.g., Google Maps) can be involved. Here, usually the constructions and their angle to the river axis, their width upstream, their diversion channels, their backwater- and construction lengths can be clearly seen and estimated or subsequent to these actions can even be measured (see also chapter 3.3).

A laser measurement should be preferably done in shaded areas of a construction. In very bright surroundings or in direct sunlight and in the case of longer distances, the detection of the laser point is difficult. For this reason, it also makes sense, depending on the position of the sun, to change your own position or the side of the river if possible, to measure the parameters and the features free from interferences. However, if measuring is not possible (the instrument reapetedly shows error messages), then a folding rule must be used.

3.6.2 Identification of the water level

The actual water level for each river construction to be mapped is recorded in the identification block of the mapping sheet below the parameters that are independent of the construction category. The information on the water level is used for the plausibility and tracability of the recorded parameters and features of river constructions of different mappings at different times with possibly different water levels.

Within the framework of the presented guide, it is strongly recommended to perform the mapping of river constructions only at mean water level. However, a mapping may be carried out at water levels below mean water and in the period of desiccation, after consultation of the customer.

At water levels higher than mean water mapping activities must be suspended, as the parameters and features can not be measured correctly or constructions may not be detected. For instance, the actual difference in water levels can result in a value too small. A possible consequence is that a bed fall can be interpreted as ground sill or it lies completely under the water surface and is therefore overlooked by the cartographers.

If constructions with water gauge systems and continuous logging of the water level are to be mapped in or on rivers, cartographers should inform themselve within the framework of the preliminary works about the actual water level. The assessment of the parameter ”water level“ is based on the respective water level of a river on the day of mapping. The water level can be derived from the average waterline which is recognisable by the vegetation, erosion, discoloration of rocks, and fixations.

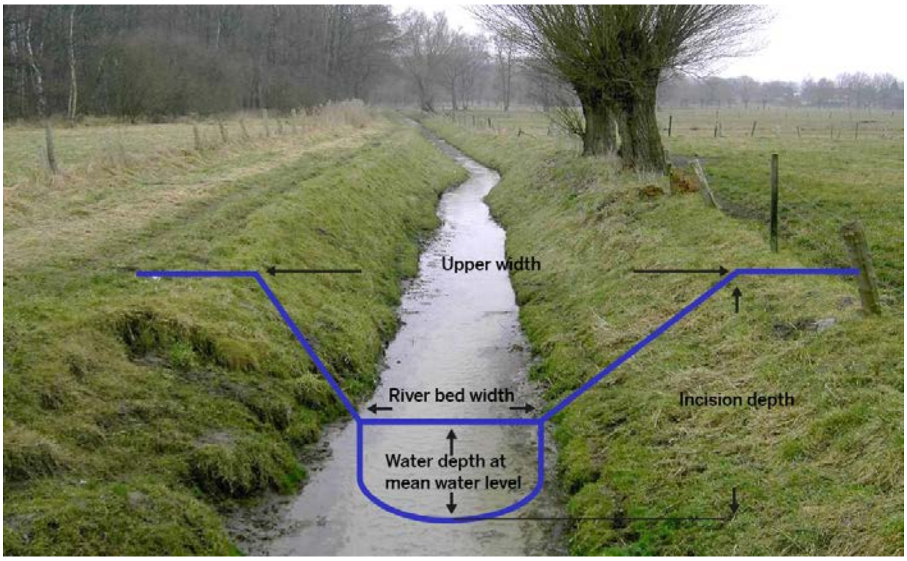


Figure: Geometrics in cross profile view

Before mapping river constructions, it must be fundamentally coordinated with the customer how to proceed with **dried out rivers**. In the field ”comments“ the status of the river must be noted. If a river has fallen dry and its features are nevertheless to be assessed, certain parameters and features can be ascertained using an assumed mean water level and thus estimated. The mean water level is normally recognisable by the vegetation, erosion, discoloration of rocks, and fixations.

Information on the width (e.g., upstream water surface width) are performed by an assumed mean water line.

Identification of the water level

Water level low, mapped as rough ramp (compare right)

Mean water level, no construction mapped (compare left)

Water level low, mapped as rough sliding (compare right)

Mean water level, no construction mapped (compare left)

Waterlevel low, mapped as ground sill (compare right)

Mean water level, no construction mapped (compare left)

3.6.3 Repetitive mapping

When verifying data on river constructions, which have been mapped at an earlier date or which have been extracted from a database, the allocation of constructions found in the field to old data can be difficult: If for instance there is more than one construction within a survey unit or various constructions are close together or the locations of the constructions have been measured too inaccurate in the past.

If there are differences for single parameters to be recorded in comparison with an earlier mapping of this construction, then the actual decision must be documented so carefully that it is transparent without a renewed mapping (e. g., by additional photos, comments, etc). Possibly, this even leads to the assignment to a new construction type.

3.6.4 Mapping on large rivers

The mapping of river constructions on large rivers shall be intensively prepared by the analysis of available data (see chapter 3.2), especially by actual aerial photos. These data can be complemented by a request to the competent authorities and river maintenance agencies. Especially for waterways, the information is kept ready for usage in the geo-basis- and specialist services of the Federal Waterways and Shipping Administration (WSV) or its regional offices.

For each mapping, the used basics or data should be documented as accurately as possible (minimum information: editor, title or object name, source of supply, publication date). It is recommended to create a tabular report in which the sources (with information on the actuality) and if needed, methods of analysis (e.g., photogrammetry, GIS-evaluation) are mentioned. If under certain circumstances different sources of information are used, then this must be properly noted. The detail level of the report must be agreed between the customer and the contractor.

Specifications of parameters and features which are taken from maps, aerial photos or other information sources must be primarily verified in the field. All accessible and walkable bridges should be used for the recording of the parameters and features. Both riversides should be inspected separately whenever possible to detect potential diversion channels and facilities for upstream fish migration. Supporting preliminary works by aerial photos or terrain maps are helpful.

The method for the mapping of river constructions (on-sight inspection, inspection by boat, use of multicopters) should be specified.

Especially on large rivers, the accessibility to constructions is limited, so that a detailed on-site inspection on a river is not possible because of the work safety (see chapter 3.7). Then the parameters must be estimated (if needed, from the opposite riverside) or they cannot be recorded. If the information is based on estimations, then this must be documented in the comment field of the construction.

3.6.5 Dealing with constructions composed of different categories or -types

If a construction is composed of different categories or construction-types, then these elements are assessed corresponding to their construction category or - type as separate constructions. This applies with regard to side-by-side or consecutively arranged elements. For side-by-side arrangements all constructions must be indicated by the same stationing.

Examples are:

- Bed fall with ramp downstream,
- Bed fall >1 m and next to it arranged rough ramp,
- Bed fall underneath a bridge

Constructions composed of different construction category and - types


Two constructions to be mapped: movable weir and bridge


Two constructions to be mapped: movable weir and sliding


Two constructions to be mapped: bridge and ramp


Two constructions to be mapped: movable weir and hydro-power station


Three constructions to be mapped: movable weir, sliding and bed fall


Three constructions to be mapped: ramp, bed fall and movable weir

3.7 Safety at work

Each employee in Germany is insured 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 professional association (Berufsgenossenschaftlich, Verordnung A 1 "Grundsätze der Prävention") defines fundamental requirements on the protection of employees, for instance:

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

Especially four features characterise the specific hazards which are linked to the work "mapping of river constructions":

- Working along rivers
- Working in changing localities
- Working alone
- Working outdoors

Mapping of river constructions is working along rivers

For a thorough mapping operation of constructions in and on rivers, the cartographer must permanently stay in close proximity to the rivers. This leads to diverse risks (e. g., slipping, hypothermia because of wet clothes, drowning because of falling in the river or a flood wafe (e.g. hydropeaking of rain overflow basins), sinking into mud). This risk analysis must be taken into account by the contractor.

Mapping of river constructions is working in changing localities

Mappings of river constructions are often performed in areas, which are unknown for the cartographers. There is an additional risk in comparison with stationary workplaces because the personal must adapted themselves to new situations. Therefore, the contractor must verify the risk assessment for each new mission and if necessary, further protective measures must be taken.

Mapping of river constructions is often working alone

If a single person is not within a calling distance and outside of the visual range of others, then this is called "working alone". This must not be a disadvantage in the event of an accident. Working alone is usual practice in mapping river constructions. It is necessary to guarantee a quick intervention in case of an accident.

A constant reachability and a good knowledge of the current location 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. On river streches far distant from settlements, in dead spots, or under adverse circumstances (weather condition, impassability, dense wood, narrow valeys, etc.) it is appropriate to employ several cartographers on the same river (e.g., in a distance of a daily output) or at least in the same catchment area. At the end of the mapping, a feedback should be given. It is also recommended to train all cartographers in first aid.

Mapping of river constructions is working outdoors

When working outdoors, the following aspects in particular must be taken into account:

- Protective measures in cold and wet weather: Weatherproof clothing according to DIN EN 343. Working at temperatures below -5 C°: protective clothes against cold according to DIN EN 342.
- Protective measures on sunny days: Although it is recommended to map during winter (outside the growing season) mapping works are also possible in summer (e.g., because of project delays). For the protection against solar radiation: tight clothing, head covering, effective sunscreen and sunglasses. For the protection against ozone and high heat: avoid longer periods of physical activities at noon and early afternoon. These works ought to be shifted 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 risky areas, a prophylactic vaccination is recommended. Special caution is needed in marshy areas and rough terrain.

Special case ”self-employed“

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

Legal provisions which also include self-employed-persons are for instance the German building site regulation: ”Guaranteeing the safety and health of the workforce at work, also the **contractors working on a construction site without employees** must comply with the workplace safety regulations. They have to follow the indications of the coordinator and the safety and health plans”. The Subsections 1 and 2 also applies to contractors, who work on the construction site themselves (§6 Baustellen Verordnung).

Besides, self-employed-persons may obtain insurance voluntarily 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 engaged themselves are responsables for their own health protection.

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

4 Description of the mapping sheet

The structure of the mapping sheet is shown in the table below.

Table: Structure of the mapping sheet

Block	Description
Identification (see chapter 4.1)	• Master data relating to the river construction • Information on mapping • Correction of location (if applicable) • Reason for the change of the construction type (if applicable) • Mapping status • Length of the survey unit
General parameters (see chapter 4.2)	• Backwater • Diversion • Unpermitted construction • Fish migration facility, upstream, existent • Water level • Selection of the construction category
Construction category ”transverse construction“ (see chapter 4.3)	• Determination of the construction type or - type group (decision level E1 to E3) • Parameter set of the respective construction type or - type group
Construction category FMF ” fish migration facility, upstream“ (see chapter 4.4)	• Design of the fish migration facility, upstream • Allocated construction
Construction category ”other construction“ (see chapter 4.5)	• Determination of the construction type or - type group (decision level E4 to E6) • Parameter set of the respective construction type or - type group
Documentation (see chapter 4.6)	• Photos • Comments

In the block **”identification“** the master data of the river construction are recorded which serve for the unique identification and documentation of the mapping status.

The block **”general parameters“** contains parameters which must be equally recorded for all constructions. In addition, here the construction is assigned to a ”construction category“.

For the construction category “hydro power plant “ no further infomation is recorded. For the other construction categories ”transverse constructions“, ”fish migration facility, upstream“ and ”other constructions“ a further record of parameters is followed in the corresponding described blocks.

The block **”documentation“** is relevant for all categories of construction.

The **recording of the parameters** and of their features is done in the appropiate fields. Regarding the manner of mapping it can be differentiated:

- Filling of text- and number fields
- Ticking the feature (=single registration)
- Counting of features

Filling of text- and number fields
The respective parameters must be filled with text and numeric values. This concerns for instance the features ”river name“ and/or ”river identificaton number“. Dimensions are recorded as a number, specified as an integer or with one decimal digit, depending on the parameter.

Single registration
Corresponding to the information sign (👍) only one feature is to be selected for the respective parameter.

Counting of features
For parameters with the information sign (✍) each occuring feature must be recorded by a measured or an estimated value or the number recorded.

Field survey of river constructions

Mapping sheet according to LANUV-Arbeitsblatt 38 (2018) - p. 1/2

Identification

Master data of the river construction

River name
River identification number
Survey unit-ID -
Edition of stationing map
Construction-ID
Previous construction-ID
Location of constr. (e32/n32)
Stat. within survey unit (m)

Information on the suvey

Name of the cartographer
Institution
Mapping date . .

Correction of location (if applicable)

Position deviates ≥10 - 20 m
Position deviates >20 - 50 m
Water course changed/location deviates >50 m

Reason for the change of construction type

Reconstructed/In a state of decay
Mapping error
Water level
Unknown reason

Mapping status

Existent
Not mappable, safety at work
Not mappable, no entry
Non-existent, change of construction type
Non-existent, natural structure
Non-existent, deconstructed
Non-existent, water level
Non-existent, unknown reason
Not within the survey unit
Not at the river to be mapped

Length of the survey unit

100 m
500 m
1,000 m

General parameters

Technical backwater

Length of the backwater (m)

Diversion

No diversion
Location of the diversion channel, left
Location of the diversion channel, right

Lenght of the diversion stretch (m)

Unpermitted construction

yes
no

Fish migration facility, upstream, existent

yes
no

Water level

Mean water
Lower than mean water
Dried up

Selection of the construction category

Hydro power plant	No further recording
Transverse construction	Ground sill, bed fall, ramp, sliding, dam, movable weir
Fish migration facility, upstream	Facility for upstream fish migration
Other construction	Bridge, inverted siphon, piping/overbuilding, pumping station, sluice, culvert

Transverse construction

Determination of the construction type or of the construction type group

E1: Transverse construction with movable closure

yes → **Movable weir**
no → **E2**

E2: Transverse construction overflowed at mean water

yes → **E3**
no → **Dam**

E3: Actual water level difference >0.1 m

yes → **Bed fall, ramp, sliding**
no → **Ground sill, no further recording**

Movable weir

Type of closure

Gate/dam board
Bulkheads
Roller
Segment
Tube
Flap
Needle
Postcard

Proportion mov. closures in construction width

<25 %
25 - 50 %
>50 - 75 %
>75 %

Water level difference (WLD)

Actual water level difference (m) ,
Minimal water level difference (m) ,
Maximal water level difference (m) ,

Stilling basin

Existent
Non-existent
Not visible

Construction conditions

Intact
In a state of decay
Not assessable

Dam

Maximal retention height (m) ,

Field survey of river constructions

Mapping sheet according to LANUV-Arbeitsblatt 38 (2018) - p. 2/2

Construction-ID ______ Mapping date __ . __ . ____

Transverse construction

Bed fall, ramp, sliding

Dimensions of the construction (enter value)

Actual water level difference (m)	,
Construction length (m)	,
Number of steps	
Maximal water level difference between steps (m)	,
Maximal step distance (m)	,
Clearly structurally connected (m)	yes ☐ no ☐

Reference

Inclinat.: act. WLD-difference/construction length

≥1:3	→ **Bed fall**
<1:3 - ≥1:10	→ **Ramp**
<1:10 - 1:30	→ **Sliding**

Stilling basin (single registration)

- Existent ☐
- Non-existent ☐
- Not visible ☐

Angles to river axis (single registration)

- <45° ☐
- ≥45° ☐

Riverbed condition (single registration)

- Rough ☐
- Smooth ☐
- Not applicable (in case of bed fall) ☐

FMF

Construction category fish migration facility, upstream

Design of the facility (single registration)

- Technical device for upstream fish migration ☐
- Bypass channel ☐

Assigned construction (enter value)

Construction-ID ______

Other constructions

Determination of the construction type or of the construction type group

E4: Free-flowing water

- yes ☐ → **E5**
- no ☐ → **E6**

E5: Under-crossing of an usage

- yes ☐ → **Bridge, Culvert, Piping/Overbuilding**
- no ☐ → **Sluice,** no further recording

E6: Technical lifting device existent

- yes ☐ → **Pumping station,** no further recording
- no ☐ → **Inverted siphon,** no further recording

Bridge, Culvert, Piping/Overbuilding

Construction self-supporting or elevated, clear width ≥2 m

- yes ☐ → **Bridge**
- no ☐ → **Culvert, Piping/Overbuilding**

Dimensions of the construction (enter value)

Clear width (m)	,
Clear height (m)	,
Construction length (m)	,

Berm (single registration)

	le	ri
Existent	☐	☐
Non-existent	☐	☐

Water level (enter value)

Act. water level difference, upstream (m)	,
Act. water level difference, downstream (m)	,
Act. water table width upstream (m)	,
Act. water table width in the construction (m)	,

Riverbed condition (single registration)

- Riverbed with sediment ☐
- Riverbed without sediment ☐
- Riverbed not visible ☐

Construction elements in the river (single registration)

- yes ☐
- no ☐

Unprotected bank, interrupted (single registration)

- yes ☐
- no ☐

Documentation

Photos (enter value)

In flow direction ______ Against flow direction ______ Without flow direction ______

Comments (enter value)

______

Legend/List of abbreviations

(hand symbol)	Single registration
(pen symbol)	Enter value (measure, counting)
☐	Number field > Integer number
☐ ,	Number field with commas > Survey result with one decimal digit
☐ . .	Date field With format dd.mm.yyyy

le	In flow direction left
ri	In flow direction right
Act.	Actual
Mov.	Movable
D	Decision level
FMF	Fish migration facility, upstream
m	Metre
Stat.	Stationing
WLD	Water level difference

4.1 Identification

For the clear identification of the river construction, master data of the construction, information on the mapping, location correction, reason for the construction change, status of mapping, and the length of the survey unit are recorded.

Master data of the river construction

The master data of the constructions are text fields, which partly must be filled out at the desk in advance of the mapping.

River name

The current name of the river is entered, shown on the currently valid stationing map. Any other names, which can be possibly found in topographic maps, should not be used. The discrepancy should be filled in the field "comments" of the mapping sheet.

In case of a digital mapping the already known data are not queried.

River identification number

The river identification number is entered shown on the currently valid stationing map.

In case of a digital mapping, the already known data are not queried.

Survey unit-ID

The survey unit ID is derived from the currently valid river stationing map and is usually predefined. It is used for the clear allocation of river constructions to a river survey unit of the river morphology survey.

Edition of stationing map

The edition of the stationing map, which has been used is entered. In case of a digital survey, the already known data are not queried.

Master data of the river construction

Construction-ID

The construction-ID is used for the clear identification of the construction.

For constructions that already exist in databases, the construction-ID is given. It is composed of the abbreviation (”qbw“, ”sob“, ”wka“, ”faa“) and a consecutive number. Each construction-ID exists in the central database of the State NRW only once.

This system cannot be used to map new constructions that do not exist in the database, as for instance in parallel performed mappings identic values could be assigned.

Therefore, the construction-ID is assigned by the system as follows:

Q_river identification number_survey unit_consectutive number

Previous construction-ID

The previous construction-ID is only relevant for constructions, which exist in the database. Only in special cases, an entry is needed here.

These cases are described in **”mapping status“**.

Location of the constr.

(e32/n32)

The location of the construction must be determined by coordinates (ETRS89/UTM-Zone 32N). Only the easting (e32) and the northing (n32) are recorded. The location of a construction is measured in principle at the end of a construction in flow direction (e.g., outlet structure of a piping, the end of a ramp).

In case of the usage of the mapping sheet, the UTM-coordinates (e32/n32) are measured by a GPS-device on the lower edge of a construction.

In case of the usage of the mapping software BEACH, the UTM-coordinates (e32/n32) are taken from the map of the mapping software. In this case, the point must be set on the river line.

Stat. within survey unit (m)

The indication of the stationing within a survey unit is of great importance, if a localisation is not possible for technical reasons or if the constructions follow each other so closely that a differentiation by GPS-coordinates is not possible.

By stationing also the relative sequence of the constructions within a survey unit is derived, e. g., if a localisation by GPS-coordinates is not possible.

Master data of the river construction

The stationing must be determined from the actual river stationing map with regard to the lower section boundary of the survey unit. It is determined or estimated against the flow direction and registered as integer in metres. In the case of 100 m long survey unit, the stationing can have values between 0 and 99, in the case of 500 m long survey units, values between 0 and 499 and in the case of 1,000 m long survey units, the stationing amounts to values between 0 and 999.

Constructions located on the riverbed side-by side must be recorded with the same stationing.

Information on the survey

Name of the cartographer	The name of the cartographer
Institution	The office of the cartographer
Mapping date	The date on which the mapping of river constructions has been performed in the field

Correction of location (if applicable)

Definition

If during a repetitive mapping the entered coordinates (see location of the construction) show deviations of more than 10 m from the original values, then one of the following features must be selected. Thereby the cartographer documents that there really is an error in legacy data.

Information on mapping

With a single registration (☝) one of the following features must be recorded.

Location deviates ≥10 - 20 m	The measured location deviates from a previous mapping by more than 10 to 20 m. An explanation in the field ”comments“ is not necessary, as measurement inaccuracies are asumed in the previous mapping.
Location deviates >20 - 50 m	The measured location deviates from a previous mapping by more than 20 to 50 m. The location correction must be described in the field ”comments“.
Watercourse changed / location deviates >50 m	The measured location deviates from a previous mapping by more than 50 m or a watercourse change must be assumed. The location correction must be described in the field ”comments“.

Reason for the change of the construction type (if applicable)

Definition

If the construction type of a repetitive mapping does not correspond to the construction type of the corresponding legacy data, then the reason of the construction type change shall be indicated (using photos of the constructions from the existing data pool). The above also applies if during a repetitive mapping a difference has been noted to the data pool or to the construction category.

Information on the mapping

With a single registration ( ) one of the following features must be recorded.

Reconstructed/in a state of decay The construction from the data pool has been modified by technical measures or by a natural decay so that it does not correspond any more to the previously registered construction type of legacy data.

Mapping error The construction type from legacy data is the result of an incorrect recording.

Water level The construction type from the legacy data was incorrectly recorded due to the water level according to the comparison of photos from the actual mapping.

Unknown reason It cannot be assessed with a degree of certainty why the construction type has been provided by the existing data pool.

Mapping status

Definition
With the mapping status of a construction, fundamental informations on the mapping are noted. Thus, especially in cases of repetitive mappings it is documented if or which deviations from previous data are detected.

Information on mapping
The mapping status of a construction is recorded by a simple registration (✍).

existent	For a new construction to be mapped, the mapping status is always set to ”existent“. If the software BEACH is used, then this information is automatically preset. In cases of repetitive mappings this information confirmes that the construction with the corresponding construction category or -type is still existent in the survey unit (see ”location of the construction“) of the supplied data set.
not mappable, safety at work	Fieldwork cannot be guaranteeded in compliance with the safety at work, e.g., due to a steep terrain, too smooth surfaces, marshy areas, etc. The construction to be mapped must be recorded as ”not-mappable“.
not mappable, no entry	There is a prohibtion of the property access, e.g., military area, industrial area, private property or the construction is not visible for other reasons. The construction to be mapped must be recorded as ”not-mappable“.
non-existent, change of construction type	Constructions existing in a database can be recorded as ”not-existent“ for various reasons. Due to the characteristics of the recorded parameters, the result is a different construction type than in legacy data. In this case, for this construction no further data are recorded. However, it is necessary to create a new data set or mapping sheet in which the construction type with its correct features (and thus also the correct construction type) and with a new construction-ID is recorded. In the field ”**previous construction-ID**“ of the ”new“ data set the construction-ID of the prvious construction is entered. In the field” **change of construction type**“ an assessment for the reason should be given.

Mapping status

The change of the construction category always requires a change of the construction type.

non-existent, natural structure

Constructions existing in a database can be recorded in the field for various reasons as ”non-existent“.

The construction given in the database is not a construction in accordance with this procedure but it is a natural structure. This can be a natural step in the rock, a beaver dam or a deadwood accumulation.

non-existent, deconstructed

Constructions existing in a database can be recorded in the field for various reasons as ”non-existent“.

The construction given in the database is no longer existent, only construction remains are visible (e.g., on the embankment),

non-existent, water level

Constructions existing in a database can be recorded in the field for various reasons as ”non-existent“.

Due to the actual water level no construction is visible. However, it cannot be excluded that at lower water levels the conditions for the mapping of a construction are given.

non-existent, unknown reason

Constructions existing in a database can be recorded in the field for various reasons as ”non-existent“.

In the field neither a construction nor remains of a construction can be determined.

Also in side channels and in adjacent survey units of the same river there is no construction with the parameters and features stored in the database.

not within the survey unit

The construction existing in a database is not located in the prescribed survey unit but it is found in another survey unit of the same river.

For the existing construction no further data are recorded.

Mapping status

A new mapping sheet must be created and filled out for the construction with corresponding information on its location, features and parameters. The construction-ID of the new data set is created by placing of the adjective ”MOVE_“ before the original construction-ID.

In the field ”**previous construction-ID**“ of the ”new“ data set, the construction-ID of the original construction must be entered.

not at the river to be mapped

A construction existing in the database is neither found in the prescribed survey unit nor in another survey unit of the same river. However, it can be found in a side channel, which has not been mapped or in a diversion channel.

For the prescribed construction no further data are recorded and no new dataset is created (or no new mapping sheet).

If the construction is located on another river to be mapped, then the entry ”**not at the river to be mapped“** must be selected and it must be proceeded how it is described there.

Length of the survey unit

Definition

The length of the survey unit of the river morphology survey in which the construction is located is entered.

Information on mapping

With a single registration (👍) one of the following features must be recorded.

100 m	The survey unit is 100 m long.
500 m	The survey unit is 500 m long.
1,000 m	The survey unit is 1,000 m long.

4.2 General parameters

Technical backwater

Definition
A "technical backwater" is defined as a clear visible lower flow velocity on the water surface over the whole river width at mean water level (flow pattern smooth) due to a construction in comparison with the flow velocity in the free flowing river sections. Essential for the comparison is the medium flow velocity on the water surface in the middle of the river or in the river line upstream of the construction (head water) and downstream of the construction (tail water).

Information on mapping
The recorded length of the backwater should be in proportion of the causing construction, the construction and river size and the gradient of the river. Usually, e.g. ground sills, slidings or ramps do not lead to a long backwater in the watercourse. For rivers in lowlands with low gradients must be considered, that the transition from a backwater area to a naturally smooth flow pattern is possibly difficult to notice.

Provided a construction has no backwater, the length of the backwater must be indicated as 0 m.

Length of the backwater (m)	The length of the backwater is recorded in integer metres in the corresponding field.

Technical backwater

Technical backwater <10 m

Technical backwater 10 – 50 m

Technical backwater 10 – 50 m

Technical backwater 50 – 100 m

Natural backwater <10 m, beaver dam

Natural backwater >100 m, beaver dam

Diversion

Definition

A diversion is the permanent or temporal drain of water from the riverbed in a diversion channel. The drained water is returned to the main watercourse at the end of the channel.
A special form of diversion is the bifurcation: here, the drained water is not returned to the main water course of the extracted river but it is transferred into a second river (with a new river identification number).

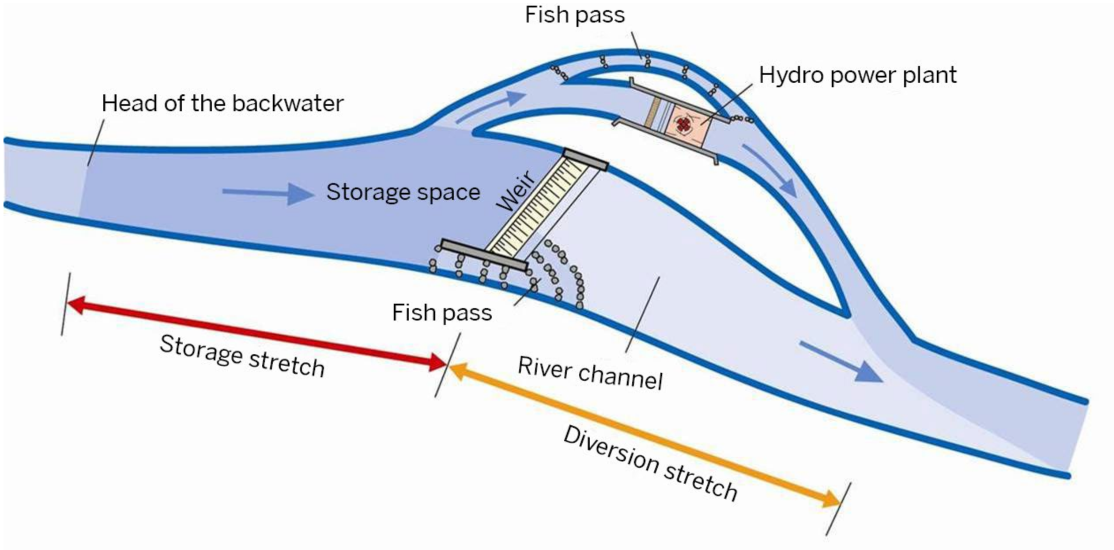


Figure: Construction with diversion (MUNLV 2005). The **diversion channel** is located left in flow direction and leads to the hydropower station; the river section between the weir and the re-confluence of the diversion channel is described as diversion stretch.

If, after a bifurcation, a larger river (tributary river) flows into the main watercourse, then the diversion channel ends at the mouth of the tributary river. A ”larger river“ comprises a watercourse, which discharge -as far as it is visibly assessable- is at least in the same magnitude as the river to be mapped.

Practical advice on mapping

Records for diversion channels are their existence, their location on which river side the diversion is located and the length of the affected river section (”diversion stretch“).

As mapping along the watercourse is performed against flow direction, it must be considered that the confluence of a diversion channel may occur relatively far downstream of the associated construction. In the course of mapping, the confluence will occur temporally or spatially before the construction for the diversion.

During the preparation of the mapping, particular attention must be paid to the confluence of diversion channels.

In the case of bifurcations, the length of the diversion channel to the mouth of the river or to the confluence of a larger side river must be recorded (as described above).

Diversion

Diversion stretches of bifurcations in larger rivers may have a length of several thousand metres. Usually, bifurcations are marked in the actual river stationing map. Therefore, during the preparation of the mapping, particular attention must be paid to bifurcations.

The following features are recorded:

No diversion	At the river construction to be mapped there is no diversion from the main riverbed into a diversion channel or into an artificial river.
Location of the diversion channel, left	At the construction to be mapped there is a diversion from the main riverbed into a diversion channel or into an artificial river that is located on the left side of the river in flow direction.
Location of the diversion channel, right	At the construction to be mapped there is a diversion from the main riverbed into a diversion channel or into an artificial river that is located on the right side of the river in the flow direction.
Length of the diversion stretch (m)	The length of the diversion stretch is measured in integer metres, and recorded in the designated field. It corresponds to the river section between the diversion and confluence of the diversion channel with the main river or until the mouth of a larger tributary into the main river or watercourse.

Diversion


Diversion channel; water course = diversion stretch in the direction of the arrow


Diversion channel, almost 80 % of the water; diversion stretch in the direction of the arrow


Diversion stretch with residual water


Diversion channel; diversion stretch in the direction of the arrow


Diversion channel recognisable in the background


Diversion channel; diversion section in the direction of the arrow

Unpermitted construction

Definition
Unpermitted constructions are structures or technical installations which have not been created within an organised process of hydrological engineering (e.g., plan approval procedure) and therefore not approved in all probability.

Practical advice on mapping
The classification of a construction as ”unpermitted construction“ is based on the cartographer´s estimation.

With a single registration (👍) one of the following features must be recorded.

Yes	Due to the workmanship of the construction, this has possibly not been created within an organised process of hydrological engineering.
No	Due to the workmanship of the construction, this has been created within an organised process of hydrological engineering.

Unpermitted construction


Unpermitted construction, movable weir


Unpermitted construction, bed fall


Unpermitted construction, dam


Unpermitted construction, ramp


Unpermitted construction, dam


Unpermitted construction, dam


Unpermitted construction, bed fall


Unpermitted construction, bed fall

Fish migration facility, upstream, existent

Definition

A fish migration facility, upstream, is a structural device to enable the fish up- and downstream migration which is negatively affected by a construction. This may be a technical fish pass or a near-natural created bypass channel. Further differentiations according to DWA Merkblatt -M 509 are not provided.

Further information on decision-making, whether it is a fish migration facility, upstream or not, can be taken from chapter 4.4 and chapter A.3 in the annexe.

Practical advice on mapping

Fish migration facility, upstream are recorded as a separate construction category. As fish migration facility, upstream, can be directly or indirectly allocated to a construction, a link to the associated construction of the facility for fish migration,upstream, is created in the context of the ”general parameters“.

With a single registration (👍) one of the following features must be recorded.

Yes	At the construction, there is a technical fish migration facility, upstream, or a bypass channel. A separate mapping sheet and additional dataset must be created for the fish migration facility, upstream.
No	At the construction, there is neither a technical fish migration facility, upstream, nor a bypass channel.

Water level

Definition

The water level is defined as the height of the water surface with regard to the average waterline. Usually this is recognisable by the bank vegetation, erosion phenomena, discoloration of stones or by the boundary of a bank protection.

Practical hint on mapping

The water level has a decisive influence on the identification of river constructions and on measuring parameters exactly. At distinct increased water levels there is the risk that specific parameters (e.g., the actual difference in water levels) are recorded with a too low value or constructions cannot be detected. Constructions, like ground sills (≤0.1 m), are normally better visible at lower water levels than at mean water level, while they are not clearly visible at higher water levels.

Basically, river constructions can also be mapped in dried up rivers. However, a special care is needed and some parameters can only be estimated, like differences in water levels or backwater.

With a single registration (👍) one of the following features must be recorded.

Mean water — The riverbed is normally completely covered by water. Any bank features are clearly visible, also if they have been completely dried up.

Lower than mean water — The riverbed is not completely covered by water. It shows clear dried up bank areas. In addition, bank features can be dried up.

Dried up — The riverbed is completely dried up or only residual water pools exist.

Water level

Clearly more water than at mean flow level

Clearly more water than at mean flow level

Clearly more water than at mean flow level

Clearly more water than at mean flow level

Mean water level

Mean water level

Watercourse dried up

Watercourse dried up

Determination of the construction category

Definition
Four determined constructions categories with an effect on river continuity are to be distinguished for this guide.

Practical advice on mapping
There is a single registration (👍) of the construction category.

Hydro power plant

Hydro power plants serve for the conversion of kinetic energy into mechanical or electrical energy. The detailied recording of attributes in conjunction with hydro power plants is not required by the presented guide (background is e.g. the limited or lacking accessibility of constructions of this category).

Transverse construction

River constructions of the category ”transverse construction“, especially in comparison with the construction category ”other construction“, usually perform the function of a bed fixation, a flow regulation and/or a damming up of the river at mean water level. To this construction category belong the construction types ”ground sill“, ”movable weir“, ”dam“ and the construction type group ”bed fall, ramp, sliding“.

Earth bodies (e.g., dams, dykes) which have no barrier effect at mean water level are not recorded as constructions. This also applies to possible existing closure devices.

Fish migration facility, upstream

These technical constructions serve for the upstream migration of fishes, which is negatively affected by constructions. Usually, they are in connection with at least one other construction to be mapped separately. It is differentiated between technical and near-natural designed bypasses. The detailed recording of attributes of fish migration facilities, upstream is not covered by this guide (background is e.g. the limited or lacking accessibility of constructions of this category).

Other construction

Constructions of the category ”other construction“ fulfil very different functions in a river.

The construction category ”other construction“ includes different construction types which especially serve as crossway constructions but also may have other different functions (e.g., lifting of water to a higher level).

Determination of the construction category

To this construction category belong the construction type group ”culvert, bridge, piping/oberbuilding” and the construction types ”sluice”, “pumping station” and “inverted siphons“ “

The construction type group ”culvert, bridge, piping/overbuilding“ includes also crossway constructions in earth bodies which do not lead to backwater.

Cuts in earth bodies of flood control reservoirs which are equipped with closures but are not operated as permanently backwater are not recorded.

Overview construction categories and construction types

Transverse construction – ground sill

Transverse construction – movable weir

Transverse construction – movable weir

Transverse construction – dam

Transverse construction – bed fall

Transverse construction – ramp

Transverse construction – sliding

Fish migration facility, upstream

Overview of construction categories and -types


Hydro power plant


Other construction – sluice


Other construction – pumping station


Other construction – inverted siphon


Other construction – bridge


Other construction – piping/overbuilding


Other construction – culvert


Other construction – piping/overbuilding in a earth body

No construction to be mapped within this guide

Reservoir, not to be mapped

Temporary footbridge, not to be mapped as bridge

Pipe bridge, not to be mapped as bridge

Gas pipeline, not to be mapped as inverted siphon

Cut in a earth body of a flood control reservoir, not to be mapped

Ford, not to be mapped as sliding or ramp

Watering place for animals, not to be mapped

Staff gauge, not to be mapped as construction

No construction to be mapped within this guide


Water abstraction, not to be mapped as construction


Water abstraction, not to be mapped as construction


Water level measuring device, not to be mapped as construction


Pump for water abstraction, not to be mapped as construction


Unpermitted installation, not to be mapped as construction


Animal trap, not to be mapped as bridge


Technical installation for the retention of floatsam, not to be mapped as construction


Scientific measuring instruments, not to be mapped as construction

4.3 Construction category ”transverse construction“

4.3.1 Determination of the construction type or construction type group

For the construction category ”transverse construction“ the decision levels E1 to E3 must be run through to detemine the corresponding construction type and construction type group. On each decision level a yes/no-question must be answered. After finishing the decision tree, the construction type or the construction type group is determined, for which a standardised parameter set is used.

For individual construction types or for the construction type group (see chapter 4.3.2 to 4.3.4) further parameters must be recorded.

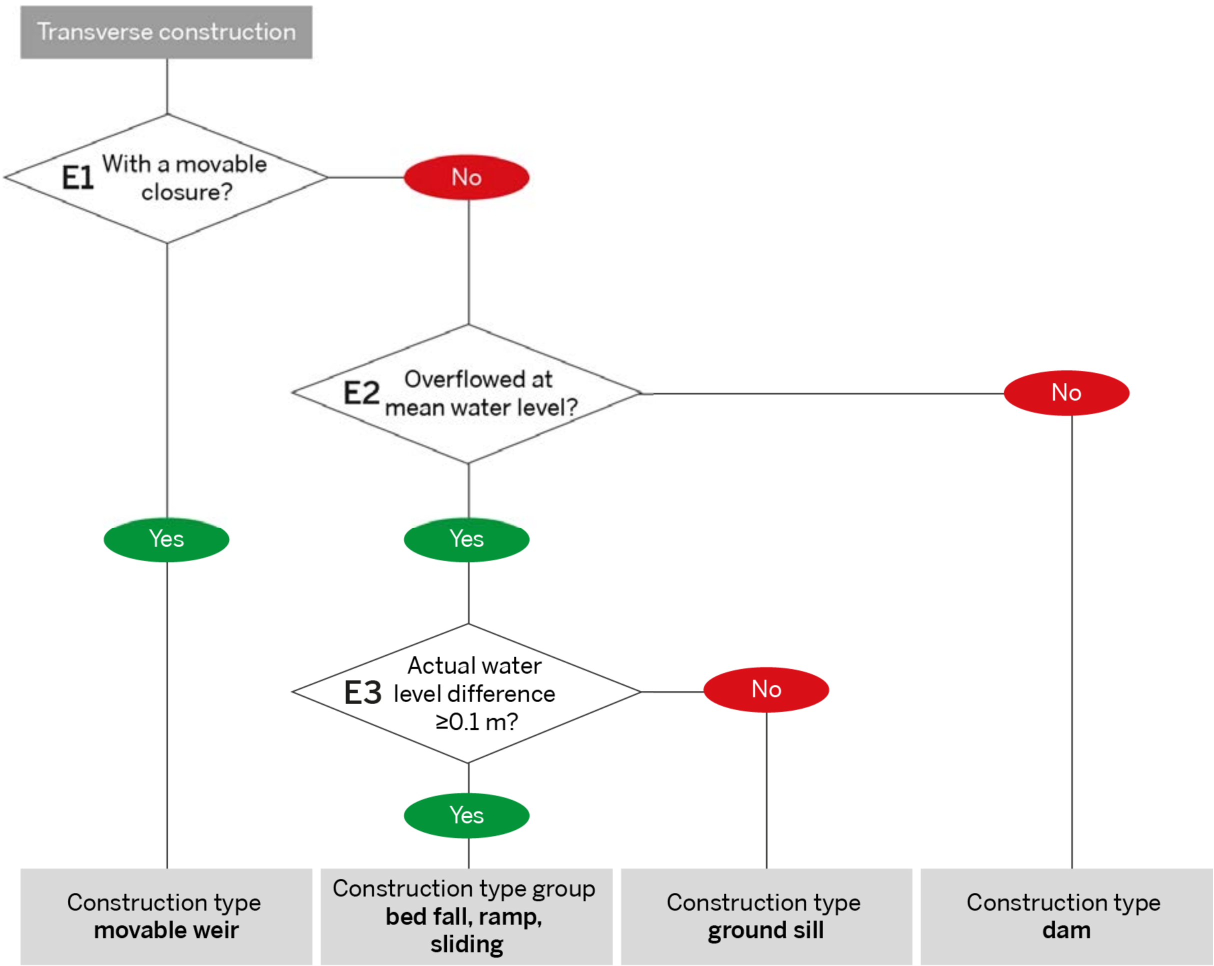


Figure: Extract of the decision tree for the construction category ”transverse construction“

E1: Transverse construction with movable closure

It must be decided, if at least one movable closure is fixed to the construction. A closure is the mobile part of a weir, which serves for the regulation of the water flow at mean water level. A movable closure must be recorded, too, if on the day of the field mapping no closure but rails, grooves or other structural components are visible which are able to hold a closure.

Constructions in earth bodies which are fitted with a movable closure, only closed in the case of flooding (e.g., flood control reservoirs) are not classificated as constructions with movable closure. As the survey is normally carried out at mean water level, the movable closures are found open at the time of mapping.

With a single registration (👍) one of the following features must be recorded.

Yes	The construction to be mapped shows at least a movable closure or a functional device to hold a closure. See: construction type ”**movable weir**“ in chapter 4.3.2 and chapter A.3.1 in the annex.
No	The construction to be mapped shows neither a movable closure nor a functional device to hold a closure. Continue to **decision level E2**

E2: Transverse construction overflowed at mean water

It must be decided, if a construction without a movable closure is overflowed at mean water level or not. If the mapping is performed below the mean water level, then it must be estimated if the construction could be overflowed at mean water level.

With a single registration (👍) one of the following features must be recorded.

Yes

The transverse construction without movable closure is overflowed at mean water level.

Continue to **decision level E3**.

No

The transverse construction without movable closure is not overflowed at mean water level.

Look: construction type "**dam**" in chapter 4.3.3 and chapter A.2.3 in the annex.

E3: Actual water level difference >0.1 m

It must be decided, if the actual difference in water levels at the overflowed transverse construction without movable closure is higher or lower than 0.1 m on the date of the mapping. The height difference between the water levels upstream (head water) and downstream of a construction (tail water) is measured as water level difference.

With a single registration (👍) one of the folowing features must be recorded.

Yes	The height difference between the water levels of head water and tail water at the construction is more than 0.1 m. See: constructional type group ”**bed fall, ramp, sliding**“ in chapter 4.3.4 and chapter A.2.4 and A.2.6 in the annex.
No	The height difference between the water levels of head water and tail water is less than 0.1 m. See: construction type ”**ground sill**“ in chapter A.3.6 in the annex.

4.3.2 Construction type “movable weir“

Type of Closure

Definition

The closure of a movable weir in rivers serves for the regulation of the water flow. Closures can be available in different designs, so-called closure types. Closure types are distinguished by deciding if the water flows in the open position above or below the closure. Therefore, they are called over- and under flowing closure types. A movable weir may have a single closure or several closures, set next to one another with usually separately adjustable closures (possibly different closure types) which may be made of different materials (e.g., wood, metal, concrete).

Information on mapping

A distinction is made between the following described closure types. The number of closures per construction is counted (✍) and the number recorded.

Gate/dam board

A movable weir with the closure type ”gate/dam board“ usually consists of a foundation in the riverbed and lateral walls made of e.g. concrete or brickwork. The lateral walls carry the guides or brackets (e.g. metal rails or grooves made of concrete) and can protrude the top of the embankment.

A simple gate consists of one or several connected rectangular wooden boards or metal plates, which surface stands vertically and blocks the cross profile of a river in the cases they are lowered to the riverbed or to a base.

By mechanical lifting of the gate a discharge below the gate is possible.

Bulkheads

A movable weir with the closure type ”bulkheads“ usually consists of a foundation on the riverbed and of lateral guidance elements (e.g. concrete, brickwork, metal) to hold beams. The beams/planks made of wood or metal are fitted vertically in the lateral guidance elements individually or on top of each other to regulate the outflow. They are usually manually inserted or removed.

Roller

A movable weir with the closure type ”roller“ normally consists, depending on the width of the river, of two or more weir pillars made of concrete or brickwork, in the flanks of which the rollers can be pivoted and adjusted vertically and rotatably by a chain drive. The movable closure (roller) can be lifted out of the water to be underflown.

Type of Closure

Segment

A movable weir with the closure type ”segment“ consists of a weir body with one opening. This can be opened or closed by a shield, attached to a rotatable supporting structure (Segment) by lifting or lowering.

Tube

A movable weir with the closure type ”tube“ consists of a tube filled with water and/or air which is fixed on a concrete foundation in the riverbed and on the lateral walls. By releasing the water and/or air, the water level in the river can be regulated.

Flap

A movable weir with the closure type ”flap“ consists of a movable flap, wich is installed on a foundation on the riverbed to regulate the water level. Usually, the flap is moved hydraulically or by a rack-and-pinion gear. If the weir with flap is completely open, then the mobile closure is overflowed by water. At mid-sized to large rivers the movable weirs predominantly are found in the form of fish-bellied flaps. These are curved or graded flaps, which often are fixed by hinges on the foundation of the box shaped weir. Roof weirs are recorded as special form of the movable weir with flap.

Needle

A movable weir with the closure type ”needle“ consists of a vertical row of wooden planks or round logs (needles). This construction consists of a threshold with stop fixed on the riverbed and a catwalk above the waterline to hold the needles by hydraulic pressure.

By taking away or by adding single needles the flow rate or backwater is regulated.

Postcard

A movable weir with the closure type ”postcard“ consists of wooden panels (postcards) which turn around a vertical axis to one side and by this way are opened or closed. By opening and closing the wooden panels, the water level of a backwater is regulated.

Type of Closure

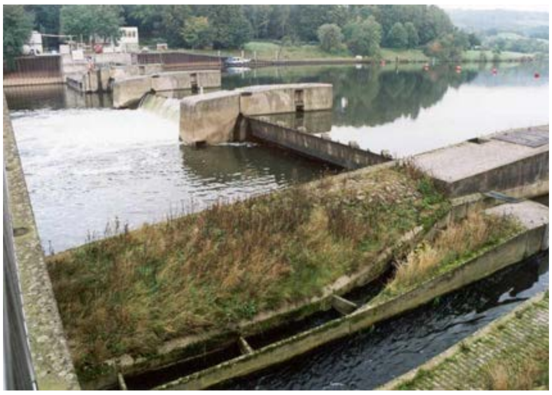

Gate/dam board


Bulkheads


Roller


Segment


Tube


Flap, half opened


Needle, partially removed


Postcard

Stilling basin

Definition
A stilling basin (SB) is a technically installed pool in the tail water (TW) of a construction in which the kinetic energy of the water is dissipated in a controlled way.

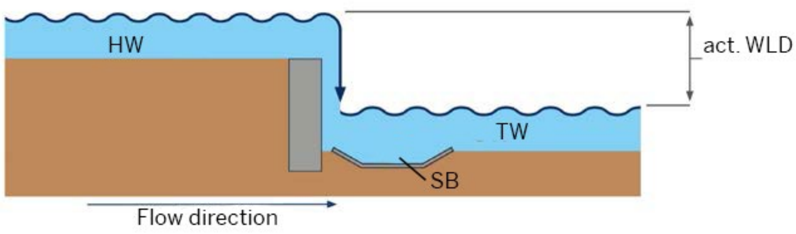


Figure: Construction with a stilling basin in longitudinal section

Practical advice on mapping
A concrete sleeper or big natural stones in the tail water of a construction can be a sign for a stilling basin.

With a single registration (☝) one of the following features must be recorded.

Existent	A stilling basin exists.
Non-existent	A stilling basin does not exist.
Not visible	At the time of the mapping, it is not recognisable, if a stilling basis exits or not.

Stilling basin


Stilling basin


Stilling basin

Proportion of movable closures in construction width

Definition

A movable weir consists of fixed and mobile components (closures). The proportion of movable closures on the construction width enables an estimation of the maximum discharge width.

Practical advice on mapping

The percentage of movable closures on the construction width of a movable weir is indicated. If there are several closures (also with different closure types) at a movable weir, then the widths of all closures are added and brought into relation with the construction width.

With a single registration (👍) one of the following features must be recorded.

<25 %	The proportion of movable closures covers less than 25 % of the whole construction width.
25 – 50 %	The proportion of movable closures covers between 25 % and 50 % of the whole construction width.
>50 – 75 %	The proportion of movable closures covers between 50 % and 75 % of the whole construction width.
>75 %	The proportion of movable closures covers more than 75 % of the whole construction width.

Proportion of movable closures in construction width

Proportion of movable closures <25 %

Proportion of movable closures <25 %

Proportion of movable closures 25 – 50 %

Proporttion of moable closures >50 – 75 %

Proportion of movable closures >75 %

Proportion of movable closures >75 %

Water level difference

Definition

The height difference between the water levels upstream (head water) and downstream of a construction (tail water) is measured as water level difference.)

Practical advice on mapping

Measuring the difference in water levels, the general information on the procedure of measuring must be considered (see chapter 3.6.1).

The actual water level difference (act. WLD), the minimal water level difference (min. WLD) and the maximal water level difference (max. WLD) are measured in metres with one digit behind the decimal point. The minimal water level difference can only be larger than 0.0 m for movable weirs with a solid concrete pedestal. If there is no pedestal, then “0.0“ is entered.

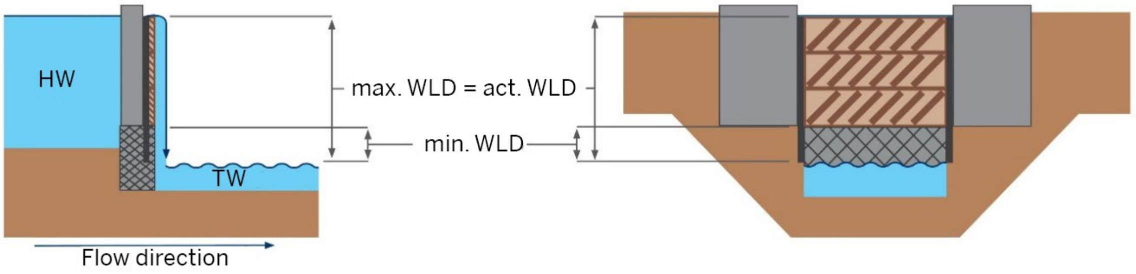


Figure: **Movable weir** in a longitudinal- and in a cross section, closure closed with pedestal - the maximal water level difference corresponds to the actual difference in water levels

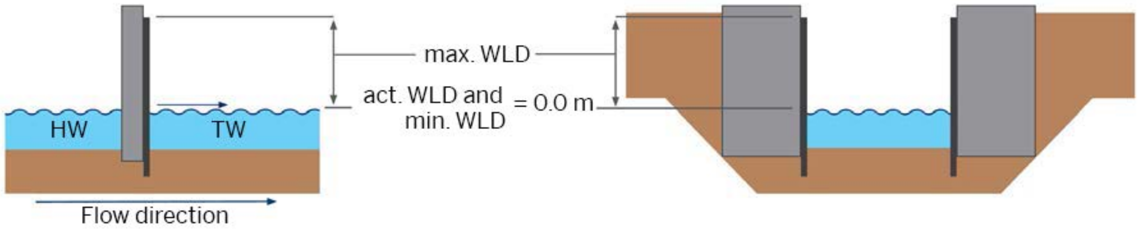


Figure: **Movable weir** in a longitudinal- and in a cross section. Closure opened or removed, no pedestal - the actual water level difference corresponds to the minimal difference in water levels and is equal to zero

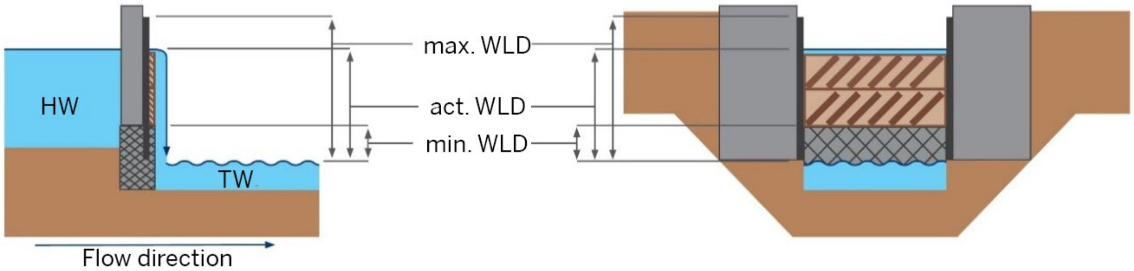


Figure: **Movable weir** in a longitudinal- and in a cross section. Closure partially closed, pedestal is existent - the minimal, the actual and the maximal difference in water levels have different values

Water level difference

Actual water level difference (m) The actual water level difference specifies the difference in water levels between head water and tail water for a movable weir at the time of mapping.

Minimal water level difference (m) The minimal water level difference shows the expected smallest difference in water levels between head water and tail water for a movable weir. The minimal water level difference only exists when the closure is completely open. It can be greater than zero if a solid pedestal protrudes the water level.

Maximal water level difference (m) The maximal water level difference shows the greatest difference in water levels between head water and tail water for a movable weir. The maximal water level difference only exists when the closure is completely closed . It can be limited by the top of rail tracks or the closure or by the river bank, depending on the design-related construction and the closure type,

Water level difference

Minimal and actual water level difference 0.0 m

Minimal and actual water level difference 0.0 m

Actual and maximal water level difference are identical

Maximal water level difference is larger than the actual

Minimal water level difference corresponds to the pedestal height

Actual = maximal water level difference, minimal corresponds to the pedestal

Construction conditions

Definition

The condition of the construction permits conclusions about the maintenance conditions of the river construction and gives information on the expected future development of a movable weir.

Practical advice on mapping

The cartographers have to assess, if a construction is to be identified as ”intact“ or as ”in a state of decay“. If the condition is ”not assessable“, then this can be noted by the cartographers.

With a single registration (☝) one of the following features must be recorded.

Intact

The function of a movable weir is not affected at mean water level. This also applies to movable weirs, where only small pieces have been broken off, for instance at the pedestal, riverbed or on the bank protection.

In a state of decay

Components relevant for function of the river construction, like pedestal, lateral walls, guide rails or movable closures are lacking or are damaged or destroyed.

Not assessable

Most of the movable weir is, e.g. below water surface or cannot be seen because of other reasons.

Construction conditions

Intact

In a state of decay

Not assessable

In a state of decay

In a state of decay

In a state of decay

In a state of decay

In a state of decay

4.3.3 Construction type "dam"

Maximal retention height

Definition
The maximal retention height (RH) is a measure of the storage capacity of dams that are not overflowed at mean water level.

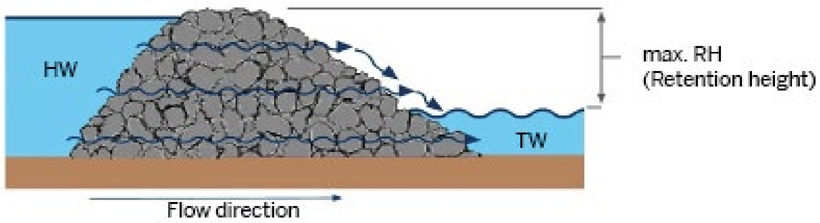


Figure: Filled dam in longitudinal section

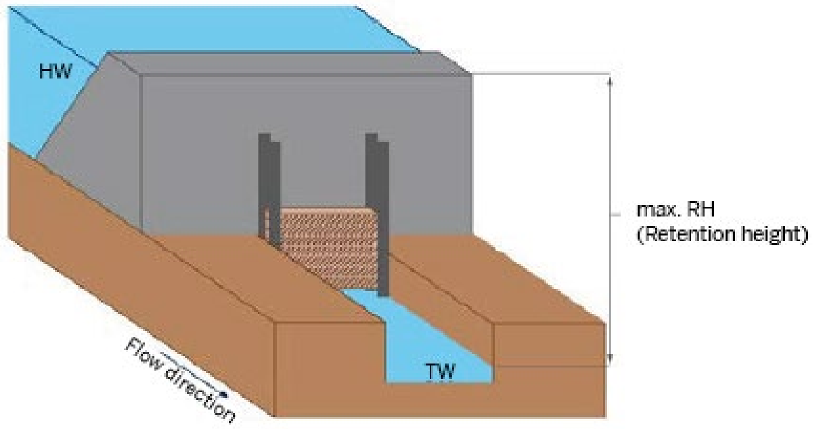


Figure: Construction type "dam" in cross section made of concrete structurally connected to the movable closure

Practical advice on mapping
The cartographers have to measure the maximal retention height. The general information on the procedure of measuring must be considered (see chapter 3.6.1).

The maximal retention height is measured from the water level of the tail water to the water level of the completely filled reservoir at the upper edge of the dam. The level of the filled reservoir normally is the overflow threshold of the spillway.

For larger constructions, information on the maximal retention height can be required from operators: e.g. digital dam plans documentations or information boards.

Further informations on the construction type "**dam**" can be taken from the chapter A.2.3 in the annex.

Maximal retention height (m)	The maximal retention height is measured in metres and noted with one digit behind the decimal point.

4.3.4 Construction type group ”bed fall, ramp, sliding“

Dimensions of the construction

Definition

Dimensions of a river construction are parameters, which are of particular importance for hydromorphological and ecological evaluations of this construction type group. In addition, the parameters are recorded here to differentiate between the construction types of this group.

Practical advice on mapping

The cartographers have to measure the construction dimensions. The general information on the procedure of measuring must be considered (see chapter 3.6.1). The measuring is peformed in metres and is recorded with one digit behind the decimal point.

Actual water level difference (m)

The actual water level difference (act. WLD) specifies at the time of the mapping operation the level difference at a construction between head water (HW) and tail water (TW) in metres and is recorded with one digit behind the decimal point.

Construction length (m)

The construction length (L) is defined as the horizontal distance between the upper edge of a construction (the end of the head water, HW) and the beginning of the tail water (TW). It serves for the determination of the inclination and is measured in metres with one digit behind the decimal point.

Stilling basins, bed fixations for ramps and slidings are not included in the construction length.

A bed fall with an inclination of 1:0 may show a construction length of 0.0 m.

If the construction length cannot be measured (accessibility, safety at work), then a sufficiently precise estimation must be carried out.

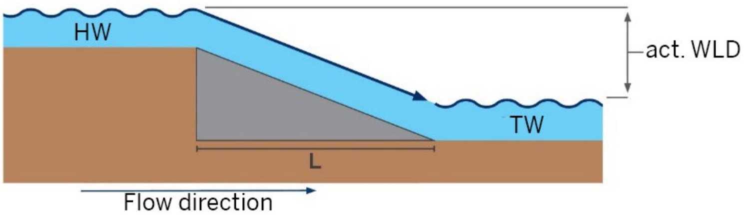


Figure: Construction length

Length within the section (m)

The “length within the section” shows how large the proportion of the construction length is within the river section, the construction is assigned to. If a construction is completely located within a survey unit, then the value is identical with the construction length.

Dimensions of the construction

Number of steps

The number of steps of a construction is given, if there is more than one. The number of steps with an actual water level difference (act. WLD) of minimal 0.1 is counted and recorded in integers.

The maximal distance between two consecutive steps (max. SD <2 m) should not exceed 2 m or a clear constructional connection is given (see below: parameter "clearly constructional connected").

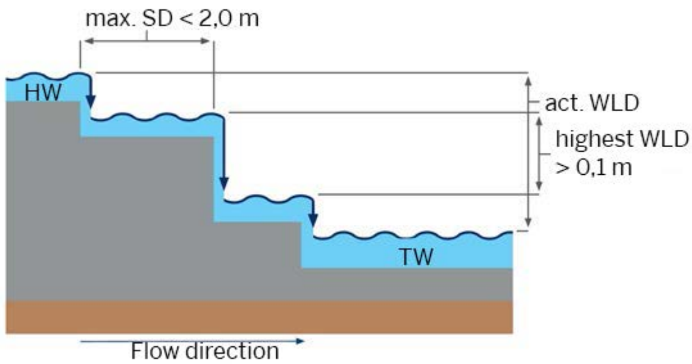


Figure: Construction type "bed fall",designed as cascade in longitudinal section

Maximal water level between steps (m)

The maximal water level difference (max. WLD in the figure above) between two single steps within the construction is recorded in metres with one digit behind the decimal point, if the construction has more than one step.

Maximal step distance (SD) (m)

The maximal step spacing (max. SD<2 m) between two single steps inside a construction is measured in metres and recorded with one digit behind the decimal point, if the construction has more than one step.

Clearly structurally connected

The steps of the construction show a similar inclination, so that they belong to the same construction type and the structural connection can be clearly identified.

There is a single registration (yes/no).

Stilling basin

Definition

A stilling basin (SB) is a technically installed pool in the tail water (TW) of a construction in which the kinetic energy of the water is dissipated in a controlled way.

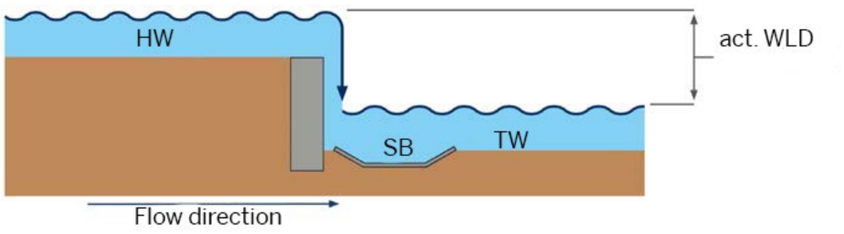


Figure: Construction with a stilling basin in a longitudinal section

Practical advice on mapping

A concrete sleeper or big natural stones in the tail water of a construction can be a sign for a stilling basin.

With a single registration () one of the following features must be recorded.

Existent	A stilling basin exists.
Non-existent	A stillng basin does not exist.
Not visible	At the time of the mapping, it is not recognisable, if a stilling basin exists or not.

Stilling basin


Stilling basin


Stilling basin

Angle to the river axis

Definition

The angle to the river axis describes the orientation of a construction in relation to the river axis. It serves in combination with the recording of diversions (channels) for the identification of **prank weirs**.

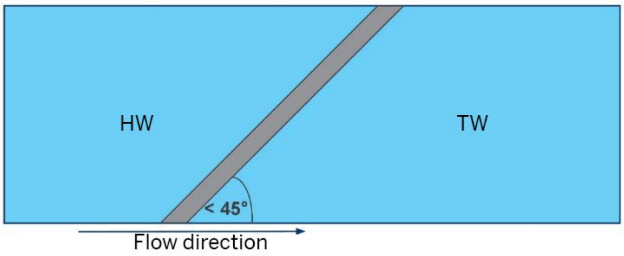


Figure: Angle to the river axis

Practical advice on mapping

The angle must lie between 0 and 90 degrees. Always the smaller angle to the river axis is used.

With a single registration (👍) one of the folowing features must be recorded.

< 45 degree	The construction forms an angle to the river axis which is smaller than 45 degree.
≥ 45 degree	The construction forms an angle to the river axis which is larger than 45 degree.

Angle to the river axis


Angle to the river axis <45°


Angle to the river axis <45°


Angle to the river axis <45°


Angle to the river axis ≥45°


Angle to the river axis ≥45°


Angle to the river axis <45°

Riverbed condition

Definition

The riverbed condition describes the riverbed surface of the construction types ”ramp“ and ”sliding“.

Practical advice on mapping

With a single registration (👍) one of the following features must be recorded.

Rough	The riverbed surface of the construction is made of riprap by stones or blocks. The flow is uneven and turbulent.
Smooth	The riverbed surface of the construction consists of smooth concrete or grouted brickwork. The flow is even over a smooth bed.
Not applicable (in case of bed fall)	For bed falls (inclination ≥1:3) the feature ”not applicable“ must be recorded.

Riverbed condition

Rough

Smooth

Rough

Smooth

4.4 Construction category ”fish migration facility, upstream“

Design of the facility

Definition

The fish migration facility, upstream, can be designed as technical device for upstream fish migration (e.g., pond system or vertical slot) or as bypass channel.

Practical advice on mapping

The detailed recording and differentiation of technical upstream fish migration facilities (e.g., according to DWA-M 509) for the assessment of the fish passability is not part of this guide. Besides an unrestricted accessibility, an extensive ichthiological expertise is needed for the assessment and evaluation of the functionality of a fish migration facility, upstream.

If there is a combination of both designs, then the major part is to be estimated and appropiately recorded.

Further information on upstream fish migration facilities can be taken from chapter A.3 and from the corresponding panels in the annex.

With a single registration (👍) one of the following features must be recorded.

Technical device for upstream fish migration	There is a technical device for upstream fish migration (e.g., pond system). It can be a component of a river construction or it is directly structurally associated with a construction.
Bypass channel	There is an artificially created or natural watercourse (e.g., reactivated former riverbed) used as bypass channel which is fed with water from the main river channel and serves to bypass a construction

Design of a fish migration facility, upstream


Technical device for upstream fish migration

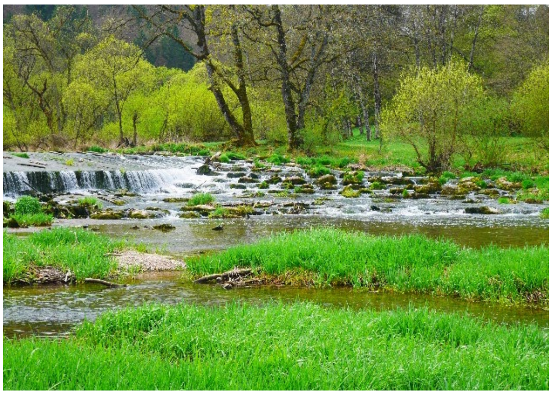

Bypass channel


Technical device for upstream fish migration


Bypass channel


Technical device for upstream fish migration


Bypass channel, newly created


Technical device for upstream fish migration


Bypass channel

Assigned construction

Definition
A river construction with negativ effects on fish migration, where passability should be improvced or restored by a fish migration facility, upstream.

Practical advice on mapping
If recognisable, the river construction to which the fish migration facility, upstream, is assigned, should be registered here. In this context, the construction-ID must be recorded.

This field remains empty, if it is not recognisable to which construction the fish migration facility, upstream, is assigned.

It is important to ensure that to each construction with the feature ”yes“ in the general parameter ”fish migration facility, upstream, is existent“ a construction category ”fish migration facility, upstream“ must be recorded and the construction-ID of the concerned construction has to be recorded in the field ”assigned construction“.

Construction-ID	The clear identification of the assigned construction is recorded.

4.5 Construction category ”other construction “

4.5.1 Determination of the construction type or construction type group

For the construction category ”other construction“ the decision levels E4 to E6 must be run through to determine the corresponding construction type and -type group. On each decision level one question, arranged in a dichotous sequence, must be answered with yes/no. At the end of a run through the decision tree, the construction type or -type group, and thus the parameter set of the construction to be mapped is determined.

For the construction type group ”bridge, culvert, piping/overbuilding“ (see chapter 4.5.2) further parameters must be recorded.

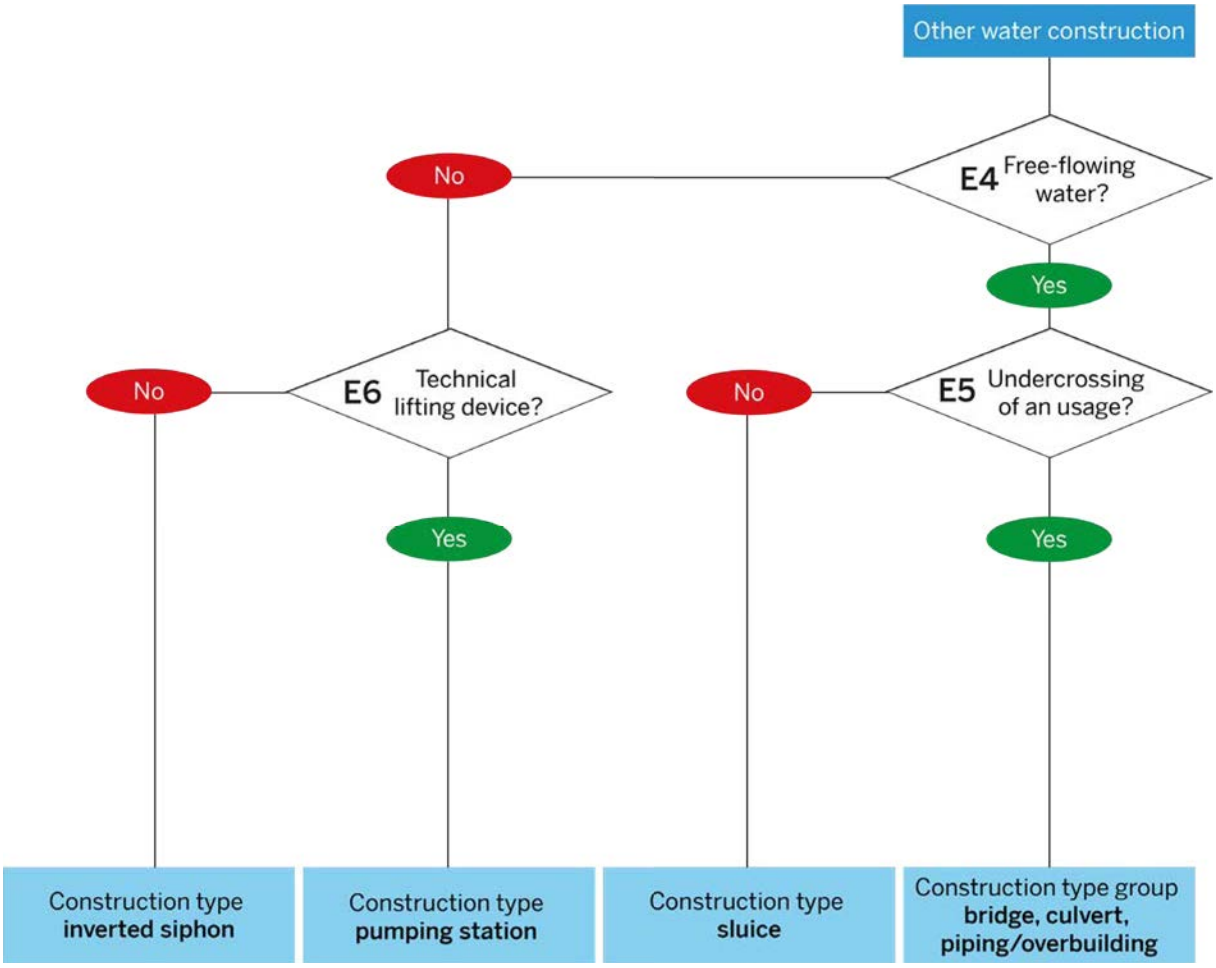


Figure: Extract of the decision tree for the construction category ”other construction“

E4: Free-flowing water

The decision level ”free-flowing water“ determines, if a river flows through the construction with a free water level and without pressure. A free water level occurs, if there is a space beween the surface of the water level and the covering construction (clear height >0 m).

It must be decided, if the river flows through or crosses under a construction with a free water level and without pressure or if the river disappears in the construction or in the underground. If water flows freely in or under a construction, then this can be followed usually over the entire length or at least over a longer distance.

This is valid for all ”other constructions“ with the exception of ”inverted siphon“ and ”pumping station“.

Rivers can be passed below roads or other rivers (e.g., waterways) with pressure. A free water level is not recognisable. At the pumping station, the water is elevated to a higher terrain level.

With a single registration (👍) one of the following features must be recorded.

Yes	The water flows with a free water level and without pressure through or below the construction Continue to **decision level E5**.
No	The water is either passed with internal pressure through the construction or there is a technical lifting device. Continue to **decision level E6**.

E5: Under-crossing of an usage

The river crosses on a lower level an usage (e. g. traffic routes, agricultural fields, or settlements) or under an earth body which does not cause a backwater at mean or lower water level.

Decision must be taken, whether the river crosses a construction with the above-described usages or not. In this context, pipeline- or other pipework bridges are not defined as usage.

With a single registration (☝) one of the following features must be recorded.

Yes	An usage is crossed under. The construction belongs to the construction type group ”bridge, culvert, piping/overbuilding“. See: construction type group ”**bridge, culvert, piping/overbuild-ing**“ in chapter 4.5.2 and chapter A.4.4 to A.4.6 in the annex.
No	No usage is crossed under. The construction corresponds to the -type ”sluice“. See: construction type ”**sluice**“ in chapter A.4.1 in the annex.

E6: Technical lifting device existent

A river or the predominant discharge of a river is elevated by a technical lifting device from a lower to a higher terrain level.
If there is a technical device, then the river usually ends at a rake, inflow or in an unaccessible operation building.

With a single registration (👍) one of the following features must be recorded.

Yes

A technical lifting device in the shape of a pumping station exists, no further mapping actions.

See: Construction type "**pumping station**" in chapter A.4.2 in the annex.

No

There is a technical lifting device, the construction corresponds to the construction type "inverted siphon", no further mapping actions.

See: Construction type "**inverted siphon**" in chapter A.4.3 in the annex.

4.5.2 Construction type group ”bridge, culvert, piping/overbuilding“

Construction self-supporting or elevated, clear width ≥2 m

Definition

A construction is considered as self-supporting, if it has an own carrying structure based on abutments.

A construction is elevated, if it is built on pillars or columns.

The clear width is the widest position in the horizontal profile cross-section inside the construction (distance between the lateral limits).

Practical advice on mapping

First, it must be checked, if the clear width is at least 2 m or more. If this is the case, then the carrying structure must be looked at in more detail.

With a single registration (☝) one of the following features must be recorded.

Yes	The construction is self-supporting or elevated and has a clear width of ≥2 m. See: construction type ”**bridge**“ in chapter A.4.4 in the annex.
No	The construction is either not self-supporting or elevated or its clear width is <2 m. See: construction type ”**culvert**“ in chapter A.4.5 and ”**piping/overbuilding**“ in chapter A.4.6.

Construction self-supporting or elevated, clear width ≥2 m


Elevated on pillars


Self-supporting


Elevated on pillars


Self-supporting


Elevated on pillars


Clear width >2 m


Clear width >2 m, not self-supporting or elevated


Bridge with abutments

Dimensions of a construction

Definition

Dimensions of a construction are the parameters, which are of particular importance for the hydromorphological and ecological evaluation. In addition, these data are recorded, as they are needed for the differentiation of the individual construction types within this group.

Practical advice on mapping

During the recording of construction dimensions, the special information for the procedure of measuring must be considered (see chapter 3.6.1).

All features are measured and recorded in metres with one digit behind the decimal point.

Clear width (m)

The clear width is measured at the broadest position in the horizontal cross profile inside of the construction.

If there are pillars or columns in the river, then the individual widths of the interspaces are summed up to the clear width.

If there are two or more pipes in parallel in the river (e.g., in the case of a culvert), then the clear width is determined as sum of the width of each pipe.

Clear height (m)

The clear height is measured at the highest point in the vertical profile cross-section inside of a construction from the water surface to the bottom edge of the construction.

Care must be taken, that it is measured from the water surface and not from the riverbed.

Construction length (m)

The construction length corresponds to the river section which is covered by the construction in flow directon. It is measured along the flow direction at the longest extension.

Water level difference

Definition

Water level diffence describes differences in altitude of two water tables: upstream and within the construction or within and downstream of a construction. The actual water table width corresponds to the head water recorded as riverbed widths upstream and the actual water table width in the construction.

Practical advice on mapping

During the recording of construction dimensions, the special information for the procedure of measuring must be considered (see chapter **Fehler! Verweisquelle konnte nicht gefunden werden.**).

All features are measured and recorded in metres with one digit behind the decimal point.

Act. water level difference, upstream (m)

The actual difference in water levels upstream is the difference in altitude of the head water level and the water level within the construction directly at the inflow at the time of measuring.

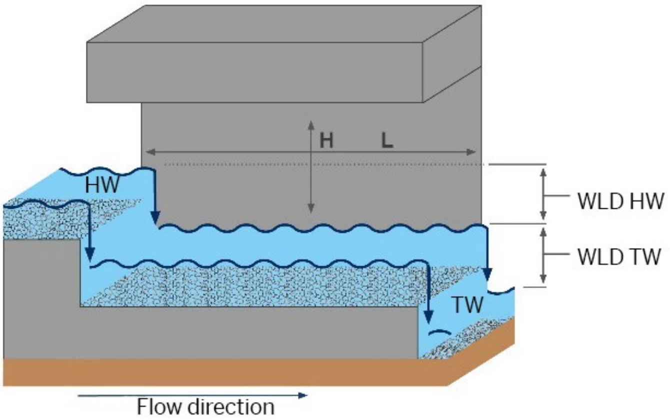


Figure: Construction with a water level difference head water (HW) and tail water (TW) in a longitudinal section

Act. water level difference, downstream (m)

The actual difference in water levels downstream describes the difference in height of the water level within the construction directly at the outflow and the tail water level at the time of measuring.

Act. water table width upstream (m)

The actual water table width upstream is the average width of the riverbed in the range of up to 50 m above the construction at the time of mapping. It is measured from shoreline to shoreline.

Water level difference

Act. water table width in the construction (m)

The actual water table width within the construction is the average width of the riverbed within the construction. In case of insufficient visibility it is measured at the in- or outflow, alternatively. If widths differ at the in- and outflow, the respective lower value is noted.

If there are pillars or columns in the river, then the individual widths of the interspaces are summed up to the actual water table width.

If there are two or more parallel pipes in the river (e.g., in the case of a culvert), then the actual water table width corresponds to the sum of the single pipe widths.

Berm

Definition
The berm is defined as a passable strip of land (natural or artificial) of at least 0.3 m of width on one or on both banks inside or below the construction. A berm enables animals (e.g. otters) to migrate through or to cross a construction.

Practical hint on mapping
With a single registration (👍) one of the following features is recorded separately for the left and the right river bank (in flow direction).

Existent — A continuous land strip of at least 0.3 m of width exists inside or below the construction.

Non-existent — There is no continous land strip of at least 0.3 m of width inside or below the construction.

Berm


Berm existent


Berm non-existent


Berm existent


Berm non-existent


Berm existent


Berm non-existent


Berm existent


Berm non-existent

Riverbed condition

Definition
The riverbed condition describes the natural or artificial riverbed surface inside the construction.

Practical hint on mapping
For survey units with a length of 100 m, the sediment layer must completely cover the artificial riverbed and must be at least 0.1 m thick.

For survey units with a length of at least 500 m or 1,000 m, sediment layer must completely cover the artificial riverbed and must be at least 0.2 m thick.

For reasons of safety at work it is expressly forbidden to enter pipings/overbuildings or culverts.

With a single registration (👍) one of the following features must be recorded.

Riverbed with sediment

The riverbed inside a construction is completely un-fixed (natural) or it is fixed (artificially), but has a sediment layer of the thickness indicated above.

If the riverbed inside the construction is insufficiently visible but either at the in- or outflow of the construction, a sediment layer of the thickness indicated above is given over the entire width, then ”riverbed with sediment“ must be recorded, too.

Riverbed without sediment

The riverbed inside a construction consists of massive concrete, concrete elements or other bed fixations. It can be partially covered by sediment. The sediment layer does not cover completely the whole area und does not correspond to the thickness, indicated above.

If the construction is insufficiently visible inside and at the in- and outflow of the construction there is no sediment layer of the thickness, indicated above, then ”riverbed without sediment“ must be recorded.

Riverbed not visible

In cases of very deep and/or strongly turbid rivers or because of lacking accessibility, it is not possible to see if the riverbed is covered with sediment or not.

Riverbed condition

Riverbed with sediment

Riverbed without sediment

Riverbed with sediment

Riverbed without sediment

Riverbed with sediment

Riverbed without sediment

Riverbed not visible

Riverbed not visible

Construction elements in the river

Definition
The construction shows not only carrying structures in the bank- or land zone but there are additionally one or several supporting pillars or other construction elements directly in the riverbed.

Practical hint on mapping
Supporting structures in the bank zone that partially extend into the river are not recorded here.

With a single registration (👍) one of the folowing features must be recorded.

Yes	One or several supporting pillars or something similar stand in the riverbed.
No	No elements of the construction are in the riverbed.

Construction elements in the river


No construction element in the river


Construction element in the river


No construction element in the river


Construction element in the river


No construction element in the river


Construction element in the river


No construction element in the river


Construction element in the river

Unprotected bank interrupted

Definition

In the area of a construction an “unprotected bank interrupted” can only exist if the bank in the area of the construction is massively protected by riprap, gabions, concrete or something similar. The river banks do not show any fixations or at most bioengineering measures outside the construction. If the river banks are massively fixed outside the construction, then the feature “unprotected bank interrupted“ is not given.

Practical hints on mapping

With a single registration (👍) one of the following featues must be recorded.

Yes	At least one river bank is massively protected in the area of the construction and there is no protection outside of the construction. Artificially installed, massively protected berms are also to be recorded here.
No	None of the river banks is massively protected in the area of the construction. If the river bank is already protected outside the construction, then there is not discontinuity of the natural bank.

Unprotected bank interrupted


Unprotected bank, interrupted


Unprotected bank, interrupted


Unprotected bank, interrupted


Unprotected bank, interrupted


Unprotected bank, not interrupted


Unprotected bank, not interrupted


Unprotected bank, not interrupted, special case protected


Unprotected bank, not interrupted

4.6 Documentation

Photos

Definition

The numbers or filenames of the taken photos are noted with the information in the viewing direction.

Practical advice on mapping

The viewing direction is noted in relation to the flow direction, thus

- in flow direction
- against flow direction
- without flow direction (more or less transversely to the flow direction)

Comments

Definition

Important informations are noted which cannot be considered by the recorded data.

Practical advice on mapping

This especially concerns explanations

- in case of uncertainties to determine a construction category,
- in case of differences between the determined construction type according to the decision tree and the judgement of the cartographer or
- further information on a possible change of the construction type.

5 Error prevention during the assessment of river constructions

Basic requirement for the field survey of river constructions is the reliable identification of construction categories and construction types. Nevertheless, it is possible that during the assessment the cartographers make errors despite having a good knowledge.

Possible sources of errors are, while:

- applying the decision tree,
- distinguishing between technical installations and natural structures,
- distinguishing between similar constructions types.

5.1 Error sources while applying the decision tree

During the application of the decision tree, errors may occur. Some of these cases are described as examples in the following table:

Table: Possible errors on the decision levels E1 to E3

Decision level	Possible errors
E1: Transverse construction with a movable closure	• In case of lacking closures (flap, board, etc.) functional devices for the installation of closures are not detected, e.g., due to vegetation, difficult accessiblity or small size. • A not-functioning device for the hold of closures is assessed as functioning. • Other devices are interpreted as devices for the hold of closures. • A sluice (sluice flap) is classified as movable weir. • The sealing construction of a flood control reservoir is classified as movable weir.
E2: Transverse construction overflowed at mean water level	• The mapping of river constructions is performed at a water level deviating from the mean water level; the mean water level is under- or overestimated.
E3: Actual difference in water levels	• Incorrect measurement lead to the classification of bed falls, ramps or slidings as ground sills.

Table: Possible mistakes on the decision level E4 to E6

Decision level	Possible errors
E4: Free flowing water	• Because of a large difference in water levels at the inflow of a construction, it cannot be detected whether water flows freely inside the construction. • In dammed rivers, it cannot be assessed if water flows freely inside the construction because there is no difference between the water table of the head water of the construction and the bottom edge of the construction.
E6: Technical lifting device existent	• The construction installed with the technical lifting device is located away from the river or covered by vegetation.

5.2 Error sources while distinguishing between technical installations and natural structures

Depending on the river type and river size, natural structures like transverse bars, rapids, river bottom steps or pool sequences may occur. These are usually easy to identify in the hydromorphological context. For instance, in rivers at bottlenecks it often occurs that roots of opposite bank vegetation are connected to a homogeneous root network which creates a natural difference in water levels.

Rock face edges and sinterings, debris accumulations, deadwood accumulations, fallen trees, and beaver dams can also be confused with ground sills, bed falls, bed fall stairs, or ramps. A high tide channel or spillways may resemble a diversion channel or a bypass channel.

Natural structures are not recorded as constructions. This concerns:

- Natural rapids and bed falls,
- Beaver dams and deadwood accumulations,
- Transverse features which resemble natural transverse bars (e. g., autochthonous material like placed stones or flow control elements).

Natural features


Natural bed substrate, no sliding


Natural bed substrate, no sliding


Natural substrate, no bed fall


Natural substrate, no bed fall


Natural feature, no dam


Natural feature, no diversion


Natural feature, no dam (beaver dam)


Natural feature, no dam (beaver dam)

5.3 Error sources while distinguishing similar construction types

Characteristic properties of construction types of the categories ”transverse construction“ and ”other construction“ which can be easiliy confused are presented below.

Possibilities for confusion with the construction type ”ground sill“
The construction type ”ground sill“ (actual difference in water levels ≤0.1 m) can be confused with the following construction types, in case of an imprecise measuring:

Table: Confusion with the construction type ”ground sill“

Construction type	Characteristic parameter and features
Bed fall	actual difference in water levels >0.1 m.
Ramp	actual difference in water levels >0.1 m.
Sliding	actual difference in water levels >0.1 m.

Possibilities for confusion with the construction type ”bed fall“
The construction type ”bed fall“ (actual difference in water levels >0.1 m, inclination 1:0 to 1:3, no movable components) can be confused with the following construction types in consequence of erroneous measurements:

Table: Confusion with the construction type ”bed fall“

Constructional type group	Characteristic parameters and features
Ground sill	actual water level difference ≤0.1 m.
Ramp	Construction length and -height result in an inclination flatter than 1:3 but steeper than 1:10.
Sliding	Construction length and -height result in an inclination flatter than 1:10 upto 1:30.
Movable weir	Movable construction elements or rather for this purpose needed guide rails exist.
Bridge, culvert, piping/overbuilding	A potentially existing difference in water levels for this construction type is recorded under ”actual water level difference (m) “.

Possibilities for confusions with the construction types “ramp” or “sliding”:
Due to errors made during the measurement of features, there are, especially in the interface of the inclination, possibilities of confusion with other construction types. That means, a ramp with an inclination of less than 1:10 can be easliy confused with a sliding (inclination <1:10 – 1:30) and vice versa. Furthermore, there is a possibility of confusion with the following construction types:

Table: Confusion with the construction type ”ramp“ or ”sliding“

Construction type	Characteristic parameters and features
Ground sill	actual water level difference ≤0.1 m.
Bed fall	Construction length results in an inclination steeper than 1:3.

Possibilities for confusions with the construction type ”movable weir“
If movable components do not or any more exist or the function for the regulation of a ”movable weir“ can not be seen in the field, then confusions with othe construction types are possible. Even if movable elements like beams or gates do not exist at the time of the survey, under certain circumstances rails, grooves or other components exist nevertheless which indicate that this is a movable weir.

Table: Confusion with the construction type ”movable weir“

<table>
<tr><th>Construction type</th><th>Characteristic parameters and features</th></tr>
<tr><td>Ground sill</td><td rowspan="4">Construction without movable elements (or rails, grooves or other components on which a closure can be installed)</td></tr>
<tr><td>Bed fall</td></tr>
<tr><td>Ramp</td></tr>
<tr><td>Sliding</td></tr>
</table>

Confusion of constructions / not registerd


No construction, supply line not to be mapped


No inverted siphon, mapped as bridge


No construction, supply line not to be mapped


No construction, ford not to be mapped


No construction, gas pipeline not to be mapped


No construction, footbridge not to be mapped


No construction, footbridge not to be mapped


No construction, footbridge not to be mapped

Confusion of constructions / not registerd


No construction, footbridge not to be mapped


No construction, oil barrier not to be mapped


No construction, pasture fence


No construction, flotsam


No facility for fish migration upstream, flow around


No facility for fish migration upstream, armour stones and erosion


No construction, natural bottom step


No construction, deadwood accumulation

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Map basis:

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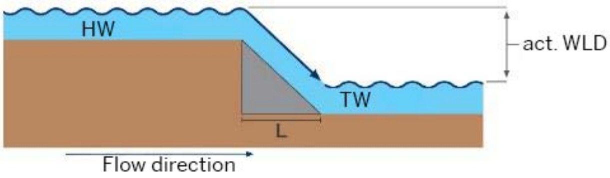
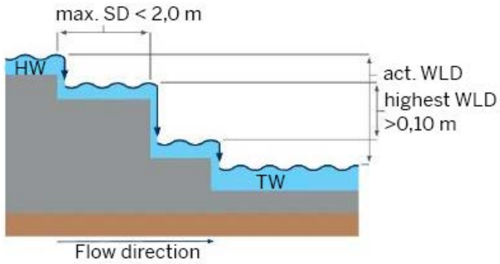
List of symbol- and abbreviations

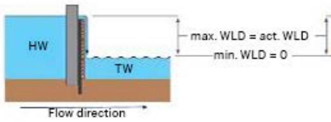
☝	Single registration
✍	Record a value (measure, counting)
✓	Affirmation (checkbox)
akt.	actual
ATKIS	Official topographic-cartographic information system
B	clear width
BaustellV	Baustellenverordnung (Construction site regulation)
BG	Berufsgenossenschaft (Professional association)
BL	Berm to the left
BR	Berm to the right
DGK	Deutsche Grundkarte (German basic map)
DGM	Digitales Gelände Modell (Digital terrain model)
DIN	Deutsches Institut für Normung (German Institute for Standardisation)
DTK	Digitale Topografische Karte (Digital topographic map)
DWA	Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (German association for Water, Wastewater, and Waste)
e32	Easting of ETRS89/UTM-Zone 32 N
E1 – E6	Decision levels E1 to E6
ELWAS	Elektronisches wasserwirtschaftliches Verbundsystem für die Wasserwirtschaftsverwaltung NRW (Electronic water management network for the water management authority North Rhine-Westfalia)
EP	Einzelparameter (Single parameter of the river morphology survey)
ETRS89	European Terrestrial Refewrence System 1989
GEWKZ	Gewässerkennzahl (River identification number)
GPS	Global positioning system
GSK	Gewässerstationierungskarte (River stationing map)
LZ	Gewässerumfeld (Land zone)
H	clear heigth
HRB	Hochwasserrückhaltebecken (Flood control reservoir)
ID	Identifier
L	Construction length
LAWA	Bund/Länder-Arbeitsgemeinscaft Wasser (Government/States Water Working Group)
max.	maximal
min.	minimal
n32	Northing of ETRS89/UTM-Zone 32 N
HW	Oberwasser (Head water)
SD	Stufenabstand (Maximal Step distance)
RH	Stauhöhe (Maximal retention height)
SB	Tosbecken (Stilling basin)
TK	Topografische Karte (Topographic map)
UTM	Universal Transverse Mercator System
TW	Unterwasser (Tail water)
WRRL	Wasserrahmenrichtliinie (Waterframework directive)
WLD	Wasserspiegeldifference (Water level difference)
WSV	Wasser und Schiffahrtesverwaltung des Bundes (Federal Waterways and Shipping Administration

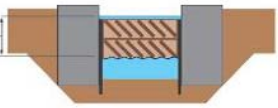
Legend to figures

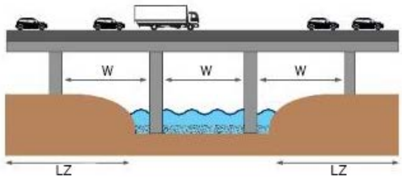
Examples:











Legend

- Soil
- Construction
- Pedestal
- Closure types
- Water body
- River bed structure
- Rails
- Riprap
- Berm

Act.	actual
Bl	Berm left
Br	Berm right
H	Clear height
L	Construction length
LZ	Land zone
m	Metre
Max.	maximal
Min.	minimal
HW	Headwater
RH	Retention height
SB	Stilling basin
SD	Step distance
TW	Tailwater
W	Clear width
WLD	Water level difference

Annex

A.1 Construction category „hydro power plant”

A hydro power plant is a construction that converts the energy of water into mechanical or electrical energy (e.g., water wheel or turbine) and makes it usable for humans.

The operation of a conventional hydro power plant usually requires the presence of one or more interdependent constructions, which guarantee the needed height difference between two water levels. Either the hydro power plant is located, in the watercourse (hydraulic power station) or on diversion channels which are supplied with water from the river by other constructions (diversion hydro power plant).

A hydro power plant with the associated constructions forms a functional unit, which is important for the assessment of river continuity according to the WFD-criteria. The associated constructions might be various kilometers away from each other.

At the power plant building, water wheels or hydrodynamic screws can be clearly identified from the outside. In the field, less recognisable are the enclosed hydro power plants and inside-lying turbines. The back of the power plant building has an outlet opening for the water after it has passed through the turbine.

For most of the power plants buildings, an upstream installed raking system is a further clearly identifiable constructional element. It serves to keep foliage, wood, or other flotsam away from the power plant.

The construction category ”hydro power plant“ is not further differentiated.

Hydro power plant

Hydro power plant with an upstream raking system

Hydro power plant with a hydrodynamic screw

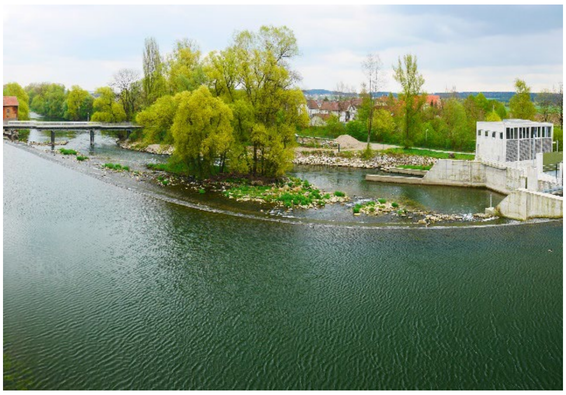
Hydro power plant

Hydro power plant with an upstream raking system

Hydro power plant with an upstream raking system

Hydro power plant with a water wheel

Hydro power plant with an upstream raking system



Hydro power plant in combination with a construction

A.2 Construction category ”transverse construction“

The construction category ”transverse construction“ includes different construction types and a constructional type group which usually serves for bed fixation, outflow regulation or damming at mean water level. In the context of this procedure, the following construction types are differentiated:

- Ground sill
- Movable weir
- Dam
- Bed fall, ramp, sliding

A.2.1 Construction type “ground sill“

A ground sill is a construction in rivers across the whole river width which does not show movable components and which is overflowed at mean water level. Ground sills do not change the riverbed slope (their inclination normally is 0 degree). The top edge of the ground sill does not protrude, or only a little above the riverbed, so that there is no backwater and therefore water level difference is smaller or equal to 0.1 m. A ground sill is also recorded as construction, if the construction does not create a water level difference.

Ground sills can be built of different materials (e.g., wood, metal, concrete, brickwork, natural stones) and can be constructed in different ways (e.g., type 1; type 2; type 3). They usually serve as local riverbed fixations. Further information on the design of sills is given in Handbuch Querbauwerke (MUNLV 2005). A differentiation of the differently constructed sills is not carried out in the context of this guide as this is often not possible in the field.

Pedestals of former, no longer functional movable weirs or remaining relics of other construction types in rivers are also recorded as ground sill, if they cause a water level difference of ≤0.1 m.

Ground sills which are embedded in the riverbed and do not creat a difference in water levels are recorded as construction type ”ground sill“ as well.

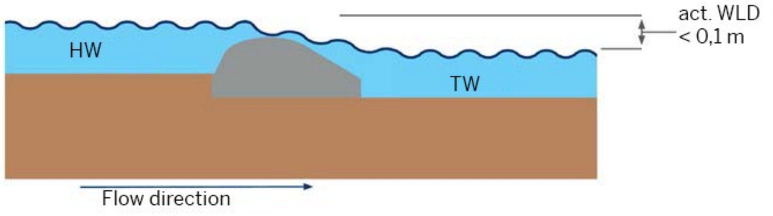


Figure: Construction type ”ground sill”, type 1 in longitudinal section with a small difference in water levels

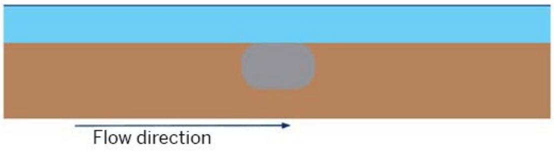


Figure: Construction type ”ground sill”, type 2 in longitudinal section without difference in water levels

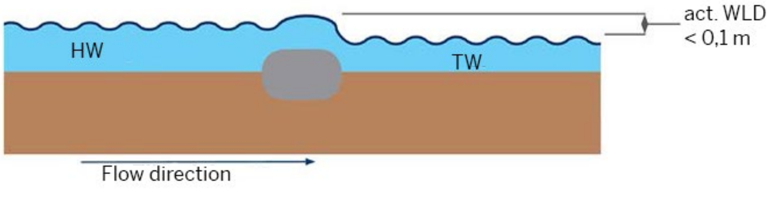


Figure: Construction type ”ground sill”, type 3 in longitudinal section with a small difference in water levels

Ground sill


Ground sill


Ground sill


Ground sill


Ground sill


Ground sill


Ground sill


Ground sill


Ground sill

A.2.2 Construction type "movable weir"

The construction type "**movable weir**" is a construction in a river with devices for the installation and fixing of at least one movable closure which enables the temporal or permanent regulation of the water flow.

A movable weir may show one or more closures being exposed side by side, which can usually be separately adjusted. If necessary, the closures of all movable weirs can be completely or partially pulled up, laid down or removed.

The closures of a movable weir may vary in construction and material – even at the same construction. Depending on the closure type (different closure types see chapter 4.3.2), a movable weir is over- or underflowed in the open position.

In case of a movable weir with an overflowed closure, the movable components are laid down on the riverbed and overflowed in the open position. In addition to these under- or overflowed closure types, there are also so-called needles.

The closure can rest on the riverbed or on a pedestal (component of the construction). Thereby, the pedestal of a movable weir can create a permanent water level difference and/or a permanent backwater and be formed as a bed fall, ramp or sliding.

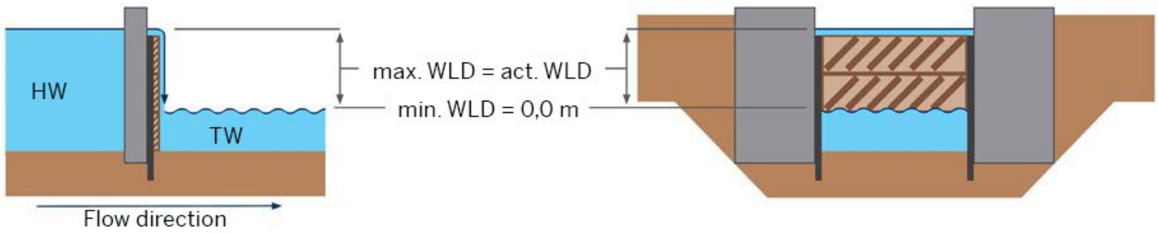


Figure: Longitudinal- and cross section (view from downstream) of a movable weir without a pedestal

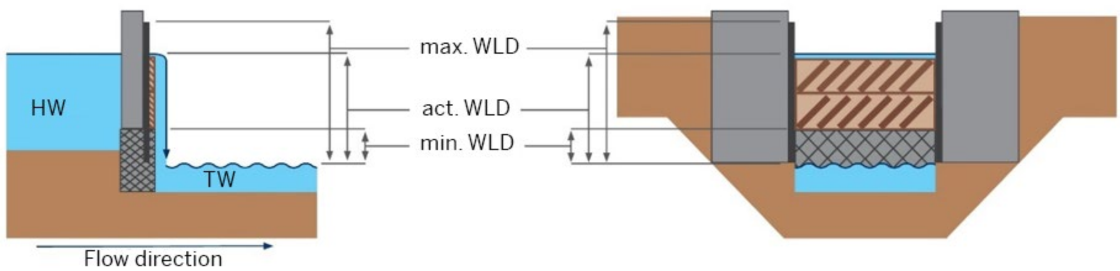


Figure: Longitudinal- and cross section (view from downstream) of a movable weir with a pedestal

”Movable weirs“ usually serve for the damming and/or diversion of water. The dammed water is often diverted into an artificial diversion channel and conducted to different uses (e.g. for the drive of a mill, of a sawmill, for the generation of electric power or for fish farming).

They also are used for the saisonal irrigation of agricultural areas and for raising groundwater level. Especially in the winter time they are often found in an open position (without closure or damming effect).

Movable weirs are different from sluices (see chapter A 4.1) as they are not located inside or part of a dam.

Movable weirs

Closure type “gate“

Four gates

Closure type ”flap“ (laid down)

Closure type ”gate“ (with pedestal)

Closure type ”tube“ (with pedestal)

Closure type ”gate“ (without pedestal)

Closure type “bulkheads“

Closure type “roll“

Movable weirs


Closure type ”gate“ (with pedestal)


Closure type “gate“


Closure type “segment“


Closure type “postcard“


Closure type ”needle“ (with pedestal)


Closure type ”bulheads“, additionally unpermitted construction


Closure type ”gate“, additionally unpermitted construction


Closure type “flap“

Movable weirs


Without closure, yet to be recorded


Without closure, yet to be recorded


Without closure, yet to be recorded


Without closure, yet to be recorded

A.2.3 Construction type “dam“

A dam is a crosswise or diagonal to the flow direction established construction in rivers without movable components, not overflowed at mean water level. It clearly protrudes above the riverbed and causes a permanent backwater at mean water level. In comparison to the river width or to the water level upstream of the dam, both the river width and the water surface are smaller downstream of the dam.

Building materials are for instance armour or natural stones, brickwork or concrete (if necessary, covered by soil). A dam is essentially used to dam up a river.

It can be assumed that there is an out- or overflow on the dam and/or that the construction material is permeable. Out- and overflows, for instance for the spillway, are constructional components of the dam and therefore not recorded separately, even if they are adjustable by movable closures.

Dams e.g., made of stone heaps, which have been built by children in the riverbed, are recorded as dams as well, because of the induced backwater and additionally they have the characteristic of a ”unpermitted construction“.

A dam of a flood control reservoir that does not exercise a barrier effect at mean water level is not recorded as dam. Movable, usually open closures that serve for a barrier effect and a regulated water release at high watermark also remain unconsidered. However, if there is an overflowed transverse construction crosswise or diagonal to flow direction at mean water level with an actual difference in water levels at a flood control reservoir, then this must be recorded.

Dams of reservoirs and auxiliary dams with constructionally connected overflow structures are also not recorded in the framework of this guide, as for these constructions there are sufficient data from licensing documents.

Beaver dams are natural structures in rivers and not recorded as constructions.

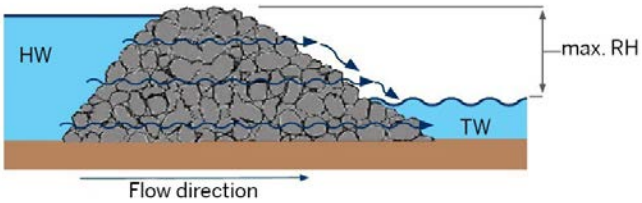


Figure: Backfilled dam in longitudinal section

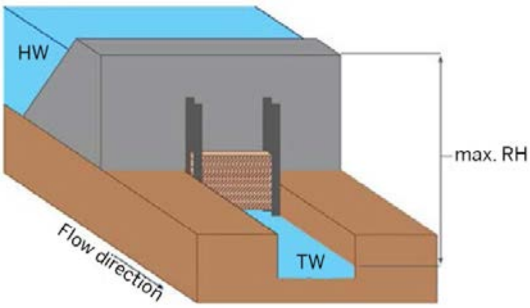


Figure: Dam made of concrete in cross section with constructionally connected closures

Dam


Dam, stonewalled


Dam, built with stone


Dam, water surface behind the construction invisible


Dam, with outflow construction


Dam, riprap


Dam, riprap


No dam, but piping


No dam, reservoir with an overflow spillway

A.2.4 Construction type "bed fall"

A bed fall usually is a construction with a vertical or a steeply inclined crash wall (inclination 1:0 to 1:3) which is located crosswise or diagonally to the flow direction in the river and extends over the whole river width.

This construction has no movable components and is overflowed at mean water level. The upper edge of the construction lies in the tail water visibly above the river bottom. In exceptional cases, in the head water, due to the accumulation of sediments, the upper edge of the bed fall can be flush with the river bottom.

A bed fall can be made of different materials like wood, armour- or natural stones, metal concrete or brick-work. A bed fall serves to overcome a difference in altitude on the river bed or to dam a river. Occasionally it is designed in the shape of a cascade. The latter corresponds to several successive bed falls following each other in a maximal distance of 2 m or they are clearly constructionally interconnected (overall construction).

Solid weirs, pedestals of former, no longer functional, movable weirs and relics of other construction types remaining in the river must also be recorded as bed fall, provided that at the time of mapping the difference in water levels is at least 0.1 m.

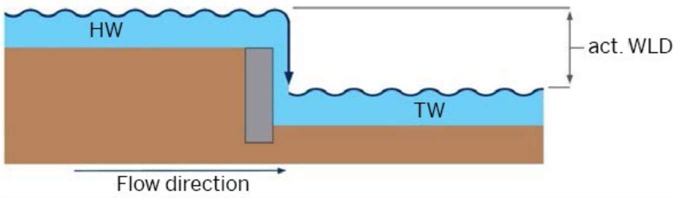


Figure: Construction type "bed fall" in longitudinal section with an inclination of 1:0 **(vertical)**

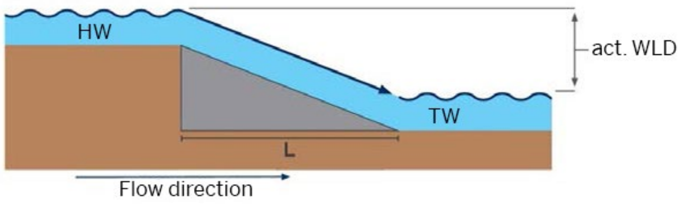


Figure: Construction type "bed fall" in longitudinal section with an inclination of 1:3 **(steep)**, no ramp

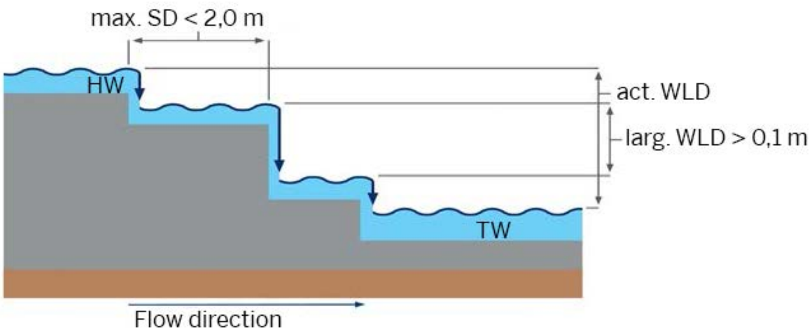


Figure: Construction type "bed fall", designed as cascade, in longitudinal section

Bed fall


Inclination 1:0


Inclination 1:0


Inclination 1:0


Inclination 1:0


Inclination 1:0


Inclination 1:1


Inclination 1:0, additionally unpermitted construction


Inclination 1:3, additionally unpermitted construction

Bed fall


Cascade, number of steps at least 11


Cascade, number of steps = 4


Cascade, number of steps = 4


Cascade, number of steps = 6

A.2.5 Construction type “ramp“

A ramp is a construction in rivers without movable components which extends across the whole river bed and is overflowed at mean water level. The inclination of a ramp lies between <1:3 and 1:10 and lies clearly above the natural gradient of the river up- and downstream of the construction. The difference in water levels between the upper and the lower end of the construction is more than 0.1 m.

The bottom of a ramp can be rough (e.g., riprap) or smooth (e.g., concrete). In the case of rough ramps, the uniform gradient in the river is interrupted by disruptive bodies in the form of stone set or riprap with stones or boulders. Concrete sleepers, wooden beams or rows of piles, which are located across the river bed may additionally protect the construction. The flow is uneven and turbulent.
In the case of smooth ramps, the surface consists of smooth concrete or grouted brickwork. The flow is uniform.
Solid weirs, pedestals of former, no longer functional movable weirs and relicts of other construction types remained in the river are also recorded as ramps, provided that they fulfil the mentioned conditions.

Ramps differ from slidings and bed falls by their inclination.

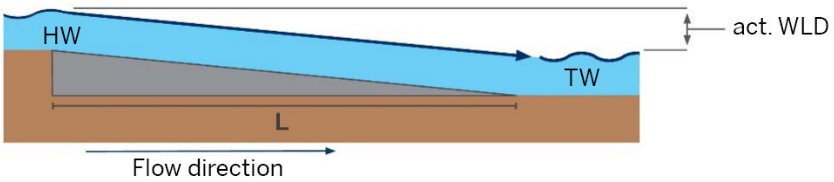


Figure: Construction type ”ramp“ in longitudinal section, inclination 1:10

Ramp


Rough


Smooth


Rough


Smooth


Rough


Smooth


Rough


Smooth

A.2.6 Construction type “sliding“

A sliding is a construction in rivers without movable components which extends across the whole river bed and is overflowed at mean water level. The inclination of a sliding is between <1:10 and 1:30 and therefore lies above the natural river gradient up- and downstream of the construction. The difference in water levels between the upper and the lower end of the construction is more than 0.1 m. The bottom of a sliding can be rough (e. g., riprap) or smooth (e. g., concrete).

In the case of rough slidings, the uniform gradient in the river is interrupted by disruptive bodies in the form of stone set or riprap with stones or boulders. Concrete sleepers, wooden beams or rows of piles which are located across the riverbed may additionally protect the construction. The flow is uneven and turbulent.

In the case of smooth slidings, the surface consists of smooth concrete or jointing brickwork. The flow is uniform.

Solid weirs, pedestals of former, no longer functional movable weirs and relics of other construction types remained in the river are also recorded as slidings, provided that they fulfil the above mentioned conditions.

Slidings differ from ramps and bed falls by their inclination.

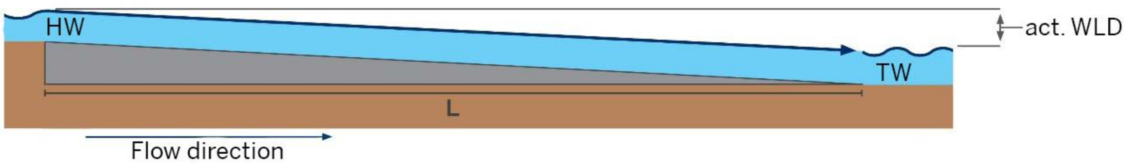


Figure: Construction type ”sliding“ in longitudinal section, inclination 1:20

Sliding


Rough


Smooth


Rough


Smooth


Rough


Smooth


Rough


Smooth

A.3 Construction type ”fish migration facility, upstream“

Fish migration facilities, upstream, are technical constructions in rivers to enable the upstream migration of fishes and invertebrates or the bypassing of a not passable construction (migratory obstacle) in a river.

A fish migration facility, upstream, is either an independent construction, installed in or part of another construction (technical fish pass) or a bypass channel, which spaciously flows around a construction.

This guide does not provide for a detailed recording of parameters of technical facilities for upstream fish migration or bypass channels. The assessment and evaluation of geometric features of different facilities for upstream fish migration to determine the passability for fishes require special ichthyiological expertise according to the different fish river types.

For a further distinction and description of the different kinds of construction of technical fish migration facilities, bypass channels or their mixed or intermediate forms, reference is made to the relevant literature (e.g., DWA Merkblatt – M 509, 2016).

Therefore, the construction category ”fish migration facility, upstream,“ is not further differentiated.

Fish migration facility, upstream

Technical fish pass

Bypass channel

Technical fish pass

Bypass channel

Technical fish pass

Bypass channel

Technical fish pass

Bypass channel

A.4 Construction category ”other construction"

The construction category ”other construction“ includes different construction types which in particular serve for crossing constructions but also have further different functions (e. g., raising of water to a higher terrain level). In this guide the following construction types are differentiated:

- Sluice
- Pumping station
- Inverted siphon
- Bridge
- Culvert
- Piping/overbuilding

A.4.1 Construction type “sluice“

A sluice is an open incision in a dam, through which a river is conducted and lockable by means of flaps, gates or similar closures. It is possible that this incision was bridged afterwards. The closing device usually closes mechanically by the water pressure if the open/outside water at the dam (main water-course) is raising higher than the water level of the tributary watercourse in the embankment hinterland (e.g., at high watermark). It opens automatically, when the water level in the main watercourse has fallen enough.

The impacts of a sluice on the flow rate and continuity of a river are very limited in time, as they are only closed at flood events.

Incisions in earth bodies of flood control reservoirs with sealing constructions, which do not operate for permant water storage, are not recorded as sluices in this procedure.

In principle, two kinds of sluices can be differentiated:
- Flap sluices have top hung flaps (made of wood, or metal) which are hanging in the water.
- The larger gate sluices normally have two laterally suspended swing doors.

Sluices are to be distinguished from movable weirs, which usually do not lie in or at a dam.

Sluice


Gate sluice


Gate sluice


Gate sluice


Gate sluice


Flap sluice


Flap sluice

A.4.2 Construction type “pumping station“

A pumping station is a technical plant that transports river water to a higher terrain level. This is done by a lifting device (water drawing device) or by using pumps (pumping station). The technical devices required for this purpose are usually installed and not accessible, which complicates the distinction of both tecniques during field work.

These water pumping systems may serve for irrigation or drainage: the water is lifted from a lower level to a higher level and subsequently flows by gravity (e.g., for irrigation of agriculturally used areas) or with the help of pump pressure into the nearest river to ensure the run-off (e.g., in regions of mining subsidence).

With this type of construction, the flowing water or the predominant discharge of a river usually ends at a rake, inlet or an inaccessible operation building. After passing through a pumping station, it is not always possible to see a watercourse above ground at a different terrain level.

Pumping station


Inlet in a pumping station


Pumping station (underground) with a rake


Pumping station


Water drawing device


Pumping station

A.4.3 Construction type“inverted siphon“

An inverted siphon is a crossing in which two water courses cross on different terrain levels (e.g., overground river and water way). Usually it consists of an inlet- and an outlet construction each made of concrete and the intermediate inverted siphon pipe that is not visible.

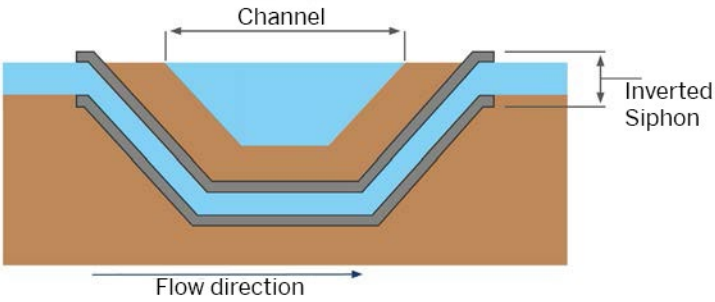


Figure: Invered siphon in longitudinal section

In contrast to a bridge for two crossing rivers, an inverted siphon is a constraint point for the river on a low terrain level, as its water does not flow on the surface in free fall but by hydrostatic pressure underground in pipes to discharge after the passage of the inverted siphon and to flow on the previous terrain height.

Waterbridges in which the river is not passed through by hydrostatic pressure are not recorded as inverted siphons but as bridges (see chapter A.4.4).

Inverted siphon

Inverted siphon

Inverted siphon

Inverted siphon

Inverted siphon

Inverted siphon

No inverted siphon, bridge

No inverted siphon according to of this guide, pipe bridge

No inverted siphon according to this guide, gas pipeline

A.4.4 Construction type “bridge“

A bridge is a technical construction in and on rivers which is used to cross a river (crossway construction), for instance for traffic routes such as roads, railway lines, foot- and cycle paths. The river flows with a free water surface under and through the construction.

A bridge can also be a construction used to cross two watercourses on different levels (water bridge). A water bridge is only recorded as a construction if the river to be mapped flows underneath this bridge.

A bridge is an elevated or self-supporting construction. Usually the riverbed can be seen and the discharge cross section is not or only marginally restricted. A bridge has a clear width of more than 2 m and can have a strip of land of at least 0.3 m on one or on both river banks inside or beneath the contruction (berm, see chapter 4.5.2). Bridges can be made of different construction materials, e.g. ferroconcrete, steel or wood.

Bridges are recorded if at least one bridge pier is located in the river, on the embankment, in the riparian zone or landside in a corridor of 100 m width per river side.

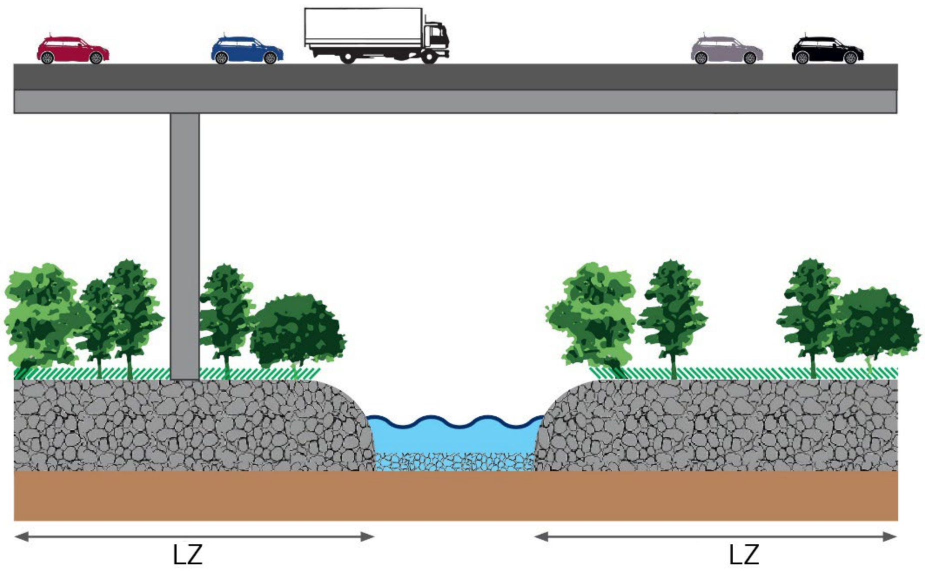


Figure: Construction type bridge in the cross section, as one of the bridge pier is in the adjacent land zone (LZ - 200 m-corridor)

Bridge


Unprotected river bank, interrupted


Unprotected river bank, not interrupted, self-supporting


Unprotected river bank, interrupted


Berm to the left and right side


Elevated


Elevated


Berm protected, to the left and right side


Unprotected river bank on the right side, interrupted (in flow direction)

Bridge


Berm existent


Elevated


Bridge only for the lower river section


No bridge, temporary footpath


No bridge, temporary footbridge


No bridge, pipe bridge

A.4.5 Construction type “culvert“

A culvert is a technical construction in or on rivers which is used to cross a river (crossing construction), for instance for traffic routes like agricultural and forestry lanes, streets, property driveways or railway lines. Like the construction type ”bridge“ the river flows with a free water surface under and through the construction. However the river is crossed with a body of earth, established transversely to the flow direction of the river, which includes an opening (culvert) for the river to pass.
River constructions in earth bodies, which do not cause backwater at mean water level are recorded as culverts as well.

In a culvert the discharge cross section may be considerably restricted; the clear width (horizontal profile cross-section) is less than 2 m. However the construction method of the cross profile (e. g., round, angular) is insignificant. Culverts usually are constructions vaulting completely the riverbed. They can be made of different materials (e.g. brickwork, concrete, metal, plastic). Profile shapes (e. g., pipe, cover, box) are very versatile, too.

The delimitation to the construction type ”piping/overbuilding“ is made by the length of the construction within the framework of this guide. The length of culverts is amaximum of 10 % of the respective survey unit length, which is dependent on the size of the river:

Survey unit 100 m	Construction length ≤10 m
Survey unit 500 m	Construction length ≤50 m
Survey unit 1,000 m	Construction length ≤100 m

In the case of a length of more than 10 % of the respective survey unit, the construction is classified as piping/overbuilding.

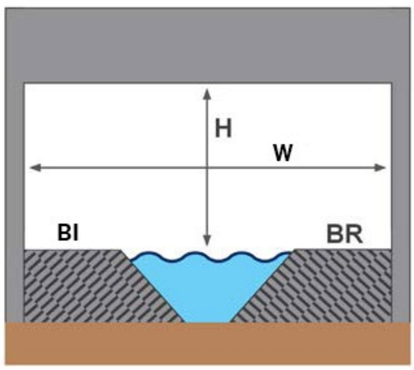


Figure: Culvert in cross section with berm

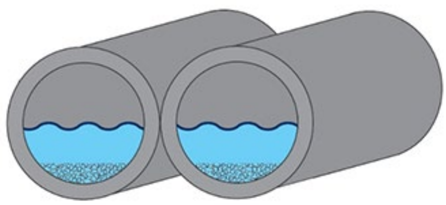


Figure: Culvert in cross section, consisting of two adjacent tubes

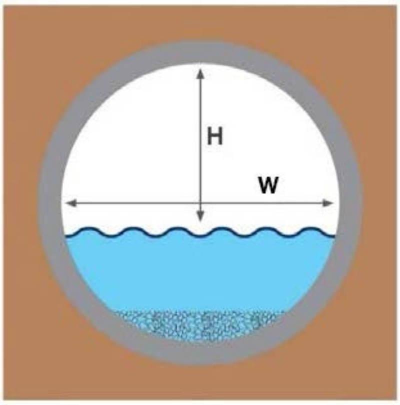


Figure: Culvert in cross section without berm

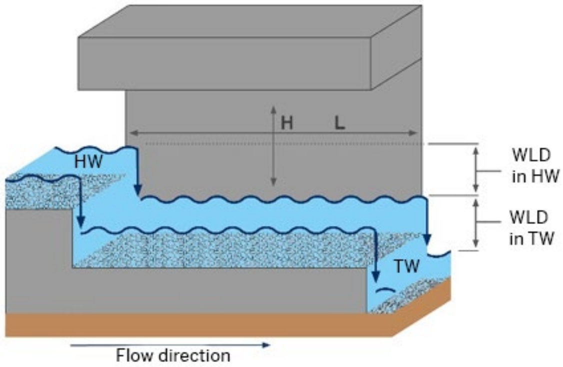


Figure: Culvert in longitudinal section with a difference in water levels up- and downstream

Culvert


Culvert, without berm


Difference in water levels in tailwaters


Culvert, without sediment


Culvert


Riverbed invisible


Riverbed invisible


Difference in water levels in tailwaters


Culvert

Culvert

Culvert

Culvert

Culvert

Culvert without sediment

No construction

No construction, pipeline

A.4.6 Construction type “piping/overbuilding“

A piping/overbuilding is a construction which leads a river under extensive obstacles (e.g., agricultural and forestry areas; inner-city areas or earth bodies). The water normally flows freely without pressure or a technical lifting device. The discharge cross section can be considerably narrowed.

Pipings/overbuildings can be made of different material (e.g., brickwork, concrete, metal, plastic). Profile shapes (e.g., pipe, box) are very versatile, too.

The delimitation to the construction type ”culvert“ is made by the length of the construction within the framework of this guide. The length of pipings/overbuildings amounts more than 10 % of the respective survey unit length, which is dependent on the size of the river:

Survey unit 100 m	Construction length >10 m
Survey unit 500 m	Construction length >50 m
Survey unit 1,000 m	Construction length >100 m

In case of a shorter length the construction is classified as culvert.

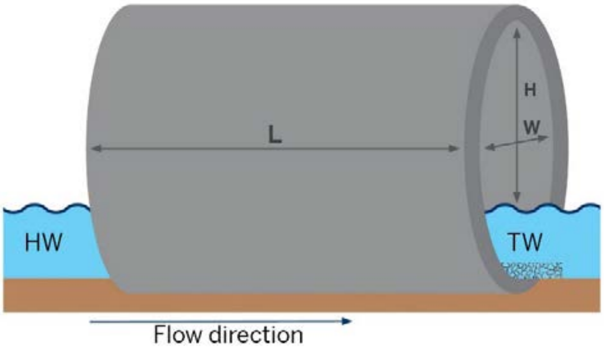


Figure: Perspective view of a piping

Piping/Overbuilding

Piping/Overbuilding

Piping/Overbuilding

Piping/Overbuilding

Piping/Overbuilding

Piping/Overbuilding

Piping/Overbuilding

Piping/Overbuilding

North Rhine-Westphalia Office of Nature,
Environment and Consumer Protection

Leibnizstraße 10
45659 Recklinghausen
Germany
Telephone +49 2361 305-0
poststelle@lanuv.nrw.de

www.lanuv.nrw.de