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GUIDANCE DOCUMENT

ON ANALYSIS OF PRESSURES AND IMPACTS AND ASSESSMENT OF RISKS APPLICABLE FOR GEORGIA

USAID GOVERNING FOR GROWTH (G4G) IN GEORGIA

08 AUGUST 2017

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USAID GOVERNING FOR GROWTH (G4G) IN GEORGIA

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ACRONYMS

AA	Association Agreement with European Union
BOD	Biological Oxygen Demand
CIS	Common Implementation Strategy
COD	Chemical Oxygen Demand
COMMPS	Combined Monitoring-Based and Modelling-Based Priority Setting
DEM	Digital Elevation Model
DPSIR	Driver, Pressure, State, Impact Response Approach
EQS	Environmental Quality Standards
EU	European Union
EURAM	European Risk Assessment Methodology
G4G	Governing for Growth in Georgia
HMWB	Heavily Modified Water Bodies
HVS	High Volume Substances
IMPRESS	Impact Pressure Working Group
LOQ	Limit of Quantification
LVS	Low Volume Substances
PE	Population Equivalent
QN5	5%ile of the Natural Annual Flow
QN50	50%ile of the Natural Annual Flow
QN70	70%ile of the Natural Annual Flow
QN95	95%ile of the Natural Annual Flow
RBMP	River Basin Management Plan
TSS	Total Suspended Solids
USAID	United States Agency for International Development
UWWT	Urban Waste Water Treatment Directive
WFD	Water Framework Directive
WWTP	Waste Water Treatment Plant

CONTENTS

DEFINITIONS

Environmental objective of the Water Framework Directive (WFD)

- Protecting, enhancing and restoring all natural surface water bodies with the aim of achieving good ecological status and surface water chemical status;
- Protecting and enhancing all artificial surface water bodies with the aim of achieving good ecological potential and good surface water chemical status;
- Protecting and enhancing the status of wetlands directly depending on aquatic ecosystems;
- Preventing deterioration of water bodies from one status class to another;
- Achieving compliance with any water-related standards and objectives for Protected Areas.

Driver-Pressure-State-Impact-Response (DPSIR), methodology that supports the identification and understanding of human pressures, the assessment on their significance and their possible adverse impacts, on water bodies.

Driver: A human activity that may have an environmental effect.

Pressure: The proximate cause of any human-induced alterations to the morphological conditions needed to support the biological quality elements

State: The conditions of the riverine water reach resulting from both natural factors and also human pressures.

Impact: The environmental effect of the pressure.

Response: The mitigation measures that are taken to improve the state the impacted water reach.

Example

Driver: Urbanization; Pressure: Sewage disposal; State: Increased levels of nutrients, ammonia, metals and priority substance; changed chemistry; Impact: Eutrophication, other changes to taxonomic composition and productivity of aquatic biota; Response: Consultation with planning and legislative authorities on best practice regarding development and enforcement of appropriate license conditions.

Significant pressure - A pressure that on its own or in combination with other pressures and in the absence of suitable measures, including existing controls, is liable to cause a failure to achieve one or more of the Directive’s environmental objectives.

Risk assessment - To identify thresholds in relation to (i) the magnitude of a pressure and (ii) observed or predicted changes in both physicochemical and hydromorphological conditions for helping to decide if water bodies, or groups of water bodies, should be identified as being at risk of failing to achieve the WFD’s environmental objectives.

Note

Good Status = Good Chemical Status plus Good Ecological Status. Ecological Status comprises the following elements: biological elements; chemical and physico-chemical elements supporting the biological elements, hydromorphological elements supporting the biological elements.

EXECUTIVE SUMMARY

As part of a review of the impact of human activity on the status of waters (the pressures and impacts analysis), Article 5 and Annex II of the Water Framework Directive (WFD) require to:

- Collect and maintain information on the type and magnitude of the significant pressures to which surface water and groundwater bodies in each River Basin District are liable to be subject,
- Carry out an assessment of the risk that these bodies will fail to meet the Directive's environmental objectives.

There are currently substantial differences in the scope, quality and quantity of data and information available in Georgia for use in the pressures and impacts analysis. Therefore this Daft Guidance Document on Analysis of Pressures and Impacts, and Assessment of Risks applicable for Georgia on Analysis of Pressure and Impacts and Assessment of Risks Applicable for Georgia was developed. In the document threshold values and criteria to grade water bodies into risk categories "Not at risk", "Possibly at risk" and "At risk" were established. This Guidance Document is based on the requirements and principles of WFD and IMPRESS (Impact/Pressure) Working Group Guidance Document.

Both hydromorphological alterations and physico-chemical pollutants entering from point and diffuse sources into surface waters are included in the document. Furthermore, method for identification of specific pollutants required by WFD is introduced along with risk assessment scheme.

CHAPTER 1: INTRODUCTION

In 2000, the European Union (EU) adopted the WFD introducing new legislative approaches for managing and protecting water based on geographical and hydrological boundaries – River Basins. The WFD mainly targets to achieve good status of water through implementation of river basin management plans (RBMP). One of the core activities for the RBM planning is an analysis of the pressures and impacts for the surface and groundwater. The implementation of a Pressure and Impact Analysis is required under Article 5 (1) of the WFD. It has to be undertaken for each river basin district, aiming to "review the impact of human activity on the status of surface waters and on ground waters".

To facilitate implementation of the Water Framework Directive the EU Member States and the Commission agreed on a Common Implementation Strategy (CIS), resulting in creating a working groups and developing guidance documents on technical aspects.

The working group "IMPRESS" has prepared a guidance document on Pressure and Impact Analysis within the CIS framework. The guidance document for Georgia is based on the guidance document developed for the WFD as well as it integrates results from the EU projects in the Caucasus Region to fully capture national priorities and adapt it to local needs.

PURPOSE OF THE GUIDANCE DOCUMENT

The aim of this guidance document is:

- To identify/overview the pressures that lead to potential pollution (general parameters and other specific pollutants) and describe hydromorphological alterations to the surface water bodies;
- To describe the methodology applied for the risk assessment.

This document is intended for the use of decision-makers (policy makers, water managers) and surface water monitoring experts to analyse pressures and impacts in the river basins according to the EU Water Framework Directive. This guidance is tailored to local needs against stakeholders' feedback and specific national context.

This document is focused on an analysis of pressure and impact for the surface water bodies applying most effective pressure indicators, parameters and coherent criteria. Chapter 1 presents an outline of the overall scope and detailed objectives of this guidance document.

The detailed objectives of this document are to:

- Guide the experts involved in the RBMPs for the analysis of pressures and impacts regarding hydromorphology and physico-chemistry (general parameters and other specific pollutants);
- Outline the basic principles of a Pressure and Impact Analysis according to the EU WFD;
- Propose a specific approach, indicators and criteria to analyse pressures and impacts for river water bodies to be integral part of the RBMPs;
- Propose criteria to analyse significant pressures and impacts that exclusively focus on (i) hydromorphology and (ii) general physico-chemistry considering point and diffuse pollution sources;
- Design the approach in a concise way focusing on key indicators and criteria.

Chapter 2 describes legal frame for pressure and impact analysis and risk assessment in accordance to EU WFD and IMPRESS Guidance Document.

In Chapter 3 methods and threshold values are established to be used for risk assessment and grading pressures both hydromorphological and physico-chemical parameters.

Chapter 4 is dedicated to methodology for identification of other specific pollutants for Georgia as listed in WFD, Annex VIII see annex 2 of this document.

In Chapter 5 further readings and references are included.

> The pressures and impacts analysis utilized existing information, to identify areas that were at risk of failing to meet the required standard of "good ecological status". This required a practical analysis of existing land use patterns, physical/topographical relationships, and water quality data (quality and quantity), to make some general assumptions on where risk to water lay from pollutants ascribed to particular land use.

CHAPTER 2: BACKGROUND

Approaches for pressure impact analysis come out from legislative and conceptual requirements. Government of Georgia has signed in 2014 Association Agreement (AA) with the European Union. One part of this AA is related to transposition and implementation of the EU water policy into the national legislation and practice, where WFD have a key role.

THE WATER FRAMEWORK REQUIREMENTS

Article 5 of the Water Framework Directive requires, inter alia, a review of the impact of human activity on the status of surface waters and groundwater.

> ***Note:*** *This requirement is already transposed to the Draft Law on Water Resources in Georgia and several drafts of sub-laws were also developed.*

The review must be undertaken in accordance with Annex II of the WFD (Due to fact that this Guidance Document is focusing on surface water bodies only part 1.4 – 1.5 is taking into account (Separate Guidance Document will be developed for ground waters). This review requires an assessment of the likelihood that water bodies in river basin districts will fail to meet the Directive's environmental objectives. In order to support experts to determine if water bodies are at risk to fail the environmental objectives the Guidance Document No. 3 on the Analysis of Pressures and Impacts (2001) has been developed under the Common Implementation Strategy.

Annex II requires:

- To collect and maintain information on the type and magnitude of the significant pressures to which surface water and groundwater bodies in each River Basin District are liable to be subject;
- To carry out an assessment of the risk that these water bodies will fail to meet the Directive's environmental objectives.

Furthermore, the WFD requires, that all pollutants "identified as being discharged in significant quantities" into bodies of surface water have to be set at national level and for each pollutant Environmental Quality Standard (EQS) should be established in accordance with the procedure laid out in Annex V, 1.2.6. (An Indicative List of the main pollutants is provided in Annex VIII (see Annex 2. of the document)). Principles of the risk assessment are defined as substance specific, that means each specific pollutant identified relevant for Georgia should be tested (acute and chronic ecotoxicological tests) by taxa listed in WFD Annex V, 1.2.6 individually to establish EQS. Therefore, this guidance document also contains approach to identify the other specific pollutants (individual substances, not grouped parameters).

The impact assessment should use both information from the review of pressures, and any other information, for example environmental monitoring data, to determine the likelihood that the surface water body will fail to meet its environmental quality objectives (see Definition of this document).

THE ANALYTICAL FRAMEWORK OF PRESSURE AND IMPACT

It is clear from the WFD that the impacts are the results of pressures. On the other hand, these terms are not defined in WFD. Therefore, for common understanding of such terms around the EU Member States, widely used approach based on analytical framework of the Driver-Pressure-State-Impact-Response (DPSIR) was used in Guidance Document No. 3 and is also applied in this Guidance Document. This approach supports the identification and understanding of human pressures, the assessment on their significance and their possible adverse impacts that might cause the failure to achieve good water status.

The DPSIR system enables a holistic analysis on the function of aquatic ecosystems and its water status, how it can be impacted by pressures and in consequence mitigated through the implementation of measures. Fig. 1 outlines some examples to support the understanding of the DPSIR principle.

Figure 1: Examples for the DPSIR principle linking drivers and possible impacts on water bodies

DRIVERS	PRESSURES	STATE	IMPACT
Agriculture Aquaculture Hydropower Water abstraction (supply service) Flood protection Mining Industry Urban development Tourism	Point sources of pollution Diffuse sources of pollution Hydromorphological alterations (river continuity, water abstraction and hydrological regime changes, dredging, etc.)	Increased river pollution Increased nutrient input Changed river flow regime Increased loss of species Changed biodiversity	Moderate/Bad water status Eutrophication Reduced biodiversity

RESPONSE

Design of monitoring programme; Tailor made programme of measures; Improvement of water resources management and assessment methods; Water protection awareness raising, etc.

According to DPSIR a pressure is the direct effect from a human activity (=driver; e.g. infrastructure development) that can negatively impact on ecosystems of surface waters and in consequence on water status. These relations are presented in example below for hydromorphological pressure.

An example of the DPSIR model relevant to hydromorphological pressures is:

Driver:	Infrastructure development (e.g. routes, buildings)
Pressure:	Dredging of a water body substrate
State:	Altered depth, and alteration to quantity, structure and substrate of the bed
Impact:	Changes to taxonomic composition and productivity of aquatic biota
Response:	Initiating a programme of dredging regulation (or substrate reinstatement)

MAIN STEPS IN ANALYSIS OF PRESSURES AND IMPACTS

While the previous sub-chapter described the scope and purpose of the WFD, and general requirements to be considered while analysing pressures and impacts, this sub-chapter is dedicated to general approach that can be applied in accordance with water body type and data availability.

The main steps of the general approach for pressures and impact analysis are presented by the WFD and they are as follows (see Fig. 2):

- Identifying driving forces and pressures;
- Identifying the significant pressures;
- Assessing the impacts;
- Evaluating the likelihood of failing to meet the objectives.

Figure 2: Basic scheme of the Pressure/Impact Analysis and Risk

Identification of anthropogenic drivers for causing pressure on rivers → **Identification of significant pressures** that may impact on the riverine environment/status

Impact Analysis
Impact of significant pressure on water bodies

Risk Assessment
Estimation of water bodies at risk to fail the WFD environmental objectives

These four steps have to be supported by *the description of the water body and its catchment area* (e.g. such information as climate, hydrology, geology, soil and land use). *Data from the monitoring programmes and surveys* that are relevant for the water body can be introduced during the process when assessing impacts. Important element of the analysis is to know *the environmental objectives* that will be compared with the data from pressures screening and such comparison can give knowledge where pressures are likely to cause a failure of the objectives.

Important assumption:

It is expected that before starting of the Pressure Impact Analysis and Risk Assessment, typology of surface water categories will be conducted. Analysis will be done for each River Basin District in Georgia as delineated in previous steps of the WFD implementation process. Risk assessment will contribute to more detailed typology of surface water bodies. For example, some of the water bodies can be grouped based on the type of pressure, or on the other hand one water body can be subdivided due to existing pressure in the substantial area of water body.

IDENTIFYING DRIVING FORCES AND PRESSURES

The essential step of the pressures and impacts analysis is to identify the driving forces that may cause pressures on the water body. The list of driving forces is presented in for example in Fig. 1. The complete list of driving forces is presented in chapter 3, where given pressures are described, quantified and risk on water body is assessed.

In general driving forces are activities (sectors) that may produce a series of pressures through point sources, diffuse sources of pollution or from hydromorphological alterations. Driving forces are quantified by aggregated data, simple to obtain (e.g. hectares of arable land, number of livestock, population density, and density of infrastructure for the given area). Comparison of these data with monitoring information allows to assess of the likelihood that the driving force is related to environmental pressure.

Due to fact, that an activity can cause a pressure on a number of downstream water bodies, data would be collected on the basis of river basins, or river basin districts.

IDENTIFYING OF SIGNIFICANT PRESSURES

In previous step large number of pressures can be identified that have no, or little impact on the water body. Therefore, WFD requires that only “significant pressure” to be assessed and it means that pressure has impact causing failure of the environmental objective. This categorisation requires to understand the character of the impact that may result from the pressure and to use appropriate method to assess the relationships between pressure and impact, as well. Such methods are described in the chapter 3 for 4 pressure categories.

The WFD requires information to be collected and maintained on the type and magnitude of significant anthropogenic pressures, and indicates a broad categorisation of the pressures into:

- Point source pollution;
- Diffuse source pollution;
- Hydromorphological alterations;
- Effects of modifying the flow regime through abstraction or regulation (hydrological pressures).

In chapter 3, steps and simple methods to identify the significant pressures and quantify their magnitudes by using thresholds and criteria are described.

ASSESSING THE IMPACTS

The assessment of impacts of given pressures will be dependent on what data are available. Both observed data (monitoring programmes, surveys, etc.) and/or calculated data from simple or more complex models and data from analogues sites can be used in the analysis. For example, if effluent is discharged to a river can cause at least a local change in the water quality. This change may be estimated by using method as indicated in the Georgia Technical Regulation (see References), or by using simple conservative mixing model, if more appropriate.

In case, where data are available for the water body itself, it may be possible to make a direct assessment of the impact. There is a wide variety of data types (including, for example physical, biological and chemical data) to be integrated into a coherent understanding of the system.

In situations with no observed data, one possible means to evaluate status is to use a similar analogous site for which data are available, and to assume that the assessment made from the observed data can be applied validly to both sites. A key concern in considering whether a site with data can be taken as analogous to the study site is the importance of proximity. Proximity in itself often indicates that many features of the two catchments will be similar (e.g. ecology, topography, geology, climate, channel characteristics and land use). The assessment of similarity is probably best made on the basis of expert judgement on the general characteristics that will be used in the impact assessment.

EVALUATING THE LIKELIHOOD OF FALING TO MEET OBJECTIVES (RISK ASSESSMENT)

The implementation of the risk criteria results in the allocation to three risk classes that indicate if a water body is ‘At Risk’, ‘Possibly at Risk’ or ‘Not at Risk’ to fail the EU WFD environmental objectives (see Table 1). Results will be illustrated in thematic GIS maps, clearly showing what water bodies are at risk to fail the objectives. This finding enables the design operational monitoring addressing the relevant biological, hydromorphological and/or chemical elements that can best assess the estimated impact. In chapter 3 threshold values and risk criteria for given pressures are defined.

Table 1: Three risk categories to indicate the possible failure of the EU WFD environmental objectives

Risk Category	Risk Category Name
1	Water body **at risk** to fail the EU WFD environmental objective (=criteria exceeded)
2	Water body **possibly at risk** to fail the EU WFD environmental objective (= unclear if criteria are exceed or not; insufficient data)
3	Water body **not at risk** to fail the EU WFD environmental objective (=criteria not exceeded)

CHAPTER 3: PRESSURE AND IMPACT ANALYSIS, RISK ASSESSMENT AND RELATED CRITERIA

Hydromorphology and general physico-chemistry take a specific role within the WFD and the assessment of water status. This role is briefly outlined here to also better understand the role of Hydromorphology and general physico-chemistry within a Pressure and Impact Analysis and Risk Assessment. Both hydromorphology and general physico-chemistry of water bodies do take a crucial role when assessing pressures and impacts as their alteration can impact on water status in consequence. This means, that both pressures on hydromorphological and general physico-chemical elements can consecutively impact on biological quality elements and, hence, alter the related water status.

In the above context, altered hydromorphological and general physico-chemical parameters and impacts from significant human pressures on them serve as excellent indicators to estimate if a water body is at risk to fail the good water status before and/or besides undertaking any monitoring activities.

In this chapter, risk criteria and/or thresholds regarding hydromorphological and general physico-chemical elements will be introduced to assess significant pressures and impacts on water status. The following pressures are taken into account:

- Effects of modifying the flow regime through abstraction or regulation (hydrological pressures);
- Hydromorphological alterations;
- Point source pollution;
- Diffuse source pollution.

INFORMATION NEEDS AND DATA SOURCES

The description approach for pressures and impacts analysis and risk assessment requires many types of data. The type of data, which has to be collected, shall at first consist of data about the water body (type, morphology, geographical and meteorological terms, biological and physico-chemical conditions), because this is the starting point for an analysis of pressures and impacts. In addition data about the existing uses (data about pressures from urban, industrial and agricultural point and diffuse sources, about water abstractions, water flow regulation, morphology and land use) and about the state of a water body are necessary.

To assess the risk of failing the environmental objectives, the ecological status and therefore the biological and chemical status and the vulnerability of a water body must be evaluated. Data must be collected which provide a description of the water body and its catchment, an identification of the anthropogenic pressures and an estimation of the impacts on the basis of monitored biology, chemistry and physical habitat conditions.

Information and data needed are described in detailed form for each pressure type below, where appropriate.

PRESSURE AND IMPACT ANALYSIS AND RISK ASSESSMENT FOR HYDROMORPHOLOGICAL ALTERATIONS AND HYDROLOGICAL PRESSURES

The hydromorphological pressure types were subdivided into three groups covering hydrological regime changes, river continuity and river morphology (see Table 2) and for those types also pressure and risk criteria were developed.

Table 2: Pressure types for which criteria are identified to determine if water bodies are at risk to fail the WFD environmental objectives

Pressure Group	Pressure Type *including the indication of drivers*
Hydrological flow changes	**2. Water abstraction** – River stretches impacted by in-sufficient ecological flow. Drivers: Irrigation; hydropower; drinking water reservoirs; other barriers;
	3. Impoundments/Reservoir Effects/Back water: River stretches impacted by altered flow conditions upstream of (i) artificial barriers (change of river like to lake like character) and (ii) due to dredged river bed materials. Drivers: Irrigation dams; hydropower; drinking water reservoirs; other barriers;

	4. Hydropeaking: River stretches impacted by altered flow conditions downstream of artificial barriers/hydropower schemes and that are effected by regular artificial flood pulses Drivers: hydropower; drinking water reservoirs; other barriers;
Longitudinal river and habitat continuity interruption	**1. Interruption of river continuity and fish migration routes** Drivers: Irrigation; hydropower; drinking water reservoirs; other barriers;
Morphological alterations *(only feasible if survey information in 5 classes for entire river reaches are available)*	**5. Changes in overall nature-like morphological condition of rivers.** Drivers: broad set of human water uses including agriculture flood protection, urban settlements, industry, hydropower, navigation, etc.

The guidance for the approach on Pressure-Impact Analysis and Risk Assessment for hydro -morphological pressures takes into account the present situation in data availability in Georgia. When data and information are insufficient or not available, the assessment may be based on expert judgement (e.g. using simple mathematical models, knowledge of local experts, transfer information from other similar river basins, etc.).

RIVER SIZE CATEGORIES

Hydromorphological pressures have impact on the river depending on the size of the river or its catchment area. Different methodologies are applied taking into account stream order rankings, catchment area size categories or river typologies. In this guidance document to simplify its implementation, three river size categories are proposed (based on typology) and these categories reflect natural conditions in Georgia. Risk criteria are proposed for each of three size groups, which are outlined below.

River size category	Channel width	Catchment Area Sizes	Description of River Type
Small	< 10 m	10 km^2 – 100 km^2	Mountain 'gravel' river type
Medium	10 – 30 m	100 km^2 – 1000 km^2	Semi-Mountain 'gravel' river type
Large	> 30 m	> 1000 km^2	Lowland/Plain river type

RISK CATEGORIES ONE-OUT-ALL-OUT PRINCIPLE

Based on the criteria, outcomes will enable the allocation of water bodies to three risk categories (see Table 3). As for physico-chemical elements, the WFD compliant One-Out-All-Out Principle shall be applied. This means, even if only one of the criteria is rated 'At Risk' but the others not, this puts the water body at risk.

Table 3: Three risk categories for hydromorphology to indicate the possible failure of the EU WFD environmental objectives

Risk Category #	Risk Category Name
1	**Water body at risk to fail the EU WFD environmental objective** One or more significant (see risk criteria in Tables below in Chapers 3.2 and 3.3) hydromorphological alterations are assessed (barriers, impoundments, water abstraction, hydropeaking) River morphology (if available) is "extensively modified or severely modified'. Water bodies of this group should be considered as heavily modified (HMWB).
2	**Water body possibly at risk to fail the EU WFD environmental objective** Data sets are insufficient to apply criteria and gaps need to be filled. OR No significant (see **risk criteria**) hydromorphological alterations (barriers, impoundments, water abstraction, hydropeaking) are assessed. However, river morphology (if available) is "moderately modified". This group is temporary, because decision whether these water bodies should belong to category "provisional HMWB" cannot be done and needs additional data and investigation.
3	**Water body not at risk to fail the EU WFD environmental objective** No significant (see **risk criteria**) hydromorphological alterations (barriers, impoundments, water abstraction, hydropeaking) are assessed. River morphology is "near-natural" or "slightly modified". Water bodies of this group should be considered as natural river water bodies regarding hydromorphology. However, other pressures may be assessed.

The hydrology risk assessment, along with the assessment of morphological alterations, is important in characterising Heavily Modified Water Bodies (HMWBs). The hydrology and morphology risk assessments served as a screening step for the provisional identification of HMWBs.

HYDROLOGICAL FLOW CHANGES

For pressure and impact analysis and hydrological risk assessment collection of following data should be necessary:

- To undertake the assessment of risk appropriate to the pressures acting upon and, the ecological sensitivity of, a water body;
- To estimate the natural flow at a fluvial site, or level change regime;
- To assess the change from the natural condition due to the pressures.

Specific data descriptors that may be used to support hydrological pressure identification process and the risk assessment are described in Tab.4. All pressure should relate to specific points or areas, with coordinates (location) referenced to the Georgia Grid.

Table 4: Descriptors of the hydrological pressures

Subject	Data Form/Requirements
Natural flows	• Relate to reaches or water bodies; • Measured at some point upstream or downstream and extrapolated to the point of interest; • Derived by modelling long-term catchment characteristics which may include calibration by comparison with an analogous catchment or short-term monitoring; • Derived by more advanced modelling techniques e.g. rainfall-runoff modelling, or flow naturalisation by decomposition.
Abstraction	• The peak rate; • Maximum daily and maximum annual rate of abstraction; • Indication of the pattern of usage (including seasonality); • Use to which the abstracted water is put (potable water, agriculture, industry).
Impoundments	• Location referenced to the Georgia National Grid; • Nature of the structure (dam/weir, etc.); • Describe the quantity and pattern of any artificially-controlled releases from the structure; • An estimated rate of abstraction and variability of the level (where known); • Define the point of intended discharge from the impoundment; • Identify the presence of any fish pass and or other means of maintaining the ecological and sedimentological continuum.
Discharge data	• The permit limits (where the discharge is controlled) or best estimate of the rate of flow; • A measure of total annual quantity; • Pattern (including seasonality) of the discharge.

SCREENING OF THE HYDROLOGICAL RISK CATEGORIES

The purpose of screening is to characterise water bodies (or groups of waterbodies) into one of three risk categories "Not at Risk", "Probably at Risk" and "At Risk" based on the combined hydrological effect of all abstraction, discharge and flow regulation pressures. Several methods and tools are available to put water bodies into "Risk Categories". In this guidance document three steps concept is described.

Step 1: Preparation phase for screening

1.1 Conceptualise the catchment

- Mapping of provisional water bodies, typology and the location of known pressures;
- If necessary, conceptual modelling of interactions between groundwater, surface water and wetland areas.

1.2 Determine scale and sites for screening assessments taking into account

- Probable hydrological impact;
- Water bodies to be assessed (size, individual/group assessment, types of pressures);
- Group smaller water bodies of the same category and type with similar scale of pressures;
- Define location of points on a river system where impacts are assessed;
- Assessment sites may be appropriate:

  a) Downstream of major abstractions or flow regulation structures;

  b) At gauging stations.

Step 2: Initial screening of water bodies into "Risk Categories"

2.1 Define whether due to the combined hydrological effect of all abstraction, discharge and flow regulation pressures the waterbody is:

- Not at Risk on the basis of available information;
- Probably at Risk; or
- At Risk using pressure thresholds for rivers (see Table 5),

2.2 Produce the Initial lists of water bodies broadly characterised with associated pressures identified.

Step 3: Screening of water bodies in "Probably at Risk" category

3.1 Screen "Probably at Risk" list of water bodies (or groups of water bodies) from Step 2.1 against thresholds for "significant hydrological change" (Tab. 5) for rivers (hydrological impact relative to natural flow). These thresholds will be estimated (set) from the hydrological flow data time series (historical data), from the national hydrological monitoring programme (as percentiles) see Tab.5). However, if ecological flow values are established, those values will be taken as threshold values to assign water bodies to risk categories.

3.2 Identify and document significant abstraction and flow regulation pressures and assess level of confidence in data.

3.3 Review need for further information or investigations.

Further investigations may be required depending on:

- Risk due to other pressures acting in combination on the ecology of the water body;
- Sensitivity of the water body to abstraction/flow regulation pressures.

3.4 Assign a final risk category to water bodies, based on individual screening assessments and pressures acting in combination. Final list of water bodies categorised as "Not at Risk" (on the basis of available information), "Probably at Risk" (where still data are needed after screening process) and "At Risk" with support of confidence levels (there is sufficient evidence on the impact of pressure). Such list will be final product.

PROVISIONAL THRESHOLDS FOR IDENTIFICATION OF SIGNIFICANT ABSTRACTION AND FLOW REGULATION PRESSURES

Thresholds for category "Not at Risk" (on the basis of available information) and for "At Risk" category will be set (see Tab. 5). After such initial screening water bodies in category "Probably at Risk" due to hydrological changes will be established. There is likely to be a large number of water bodies that fall between these two categories, but for which further information will be needed to make sure this view is correct.

The thresholds that will be applied are designed to assess pressures quickly but measurably, in the main drawing on expert opinion and local knowledge.

Table 5: Thresholds for hydrological pressures on water body

Water Body	Threshold (provisional)	When	Note
Thresholds for where pressures do not present a Risk			
Combined abstraction and flow regulation pressures			
River	Hydrological change relative to natural flow conditions is for example <10% (However, different % value can be used. Hydrologists will make decision).	At all times	Expert opinion
Flow regulation pressures from Impoundments			
Any water body affected by an impoundment	Hydrological thresholds above (e.g. <10%) are not crossed		
Thresholds for where pressures place a waterbody at Risk			
Combined abstraction and flow regulation pressures			
River	Percentage of hydrological change relative to natural low flow conditions (e.g. >40% from 95%-ile flow)	Crossed defined percentiles*	Based on Risk Assessment method**
Flow regulation pressures from Impoundments			
Any water body directly above or below an impoundment	Flow regulation presents a Risk unless the physical alterations are too minor for the water body to be considered as heavily modified.		

Any water body lying between a cascade of linked impoundments	Flow regulation presents a Risk unless the physical alterations are too minor for the water body to be considered as heavily modified		

** Local decisions will be needed as to which percentile or combination of percentiles is appropriate for a specific river system and the pressures on it (as for example a % of QN95, QN70, QN50, and QN5).*

*** Risk Assessment Method will be based on the ecological flow objective.*

HYDROMORPHOLOGICAL ALTERATIONS

Pressures on river morphology are human activities that have adverse consequences on the features or processes of water bodies, rather than the artificial structures that are often used in association with the activities. For example, pressures on river morphology include impounding and bank reinforcement, the former using structures such as sluices, weirs or dams, the latter using materials such as wood, sheet piling or concrete. Specific pressures for river morphology in Georgia are estimated as presented in Tab. 6 below.

Table 6: Specific pressures on the morphology of rivers

Pressure	Description
Cannelisation (including straightening)	Straightening, widening, and deepening of channels; removal of substrate from a river channel includes dredging sand and gravel as building materials, creating ponds for fisheries, etc.
Dredging	Removal of substrate from a river channel includes dredging sand and gravel as building materials, creating ponds for fisheries, etc.
Flood protection and bank reinforcement	Strengthening of river beds for various purposes (e.g. erosion control); flood protection using flood walls, embankments; bank protection using gabion baskets, boulders, geotextiles, etc.
Water regulation	Structures for redirecting pattern of water flow
Impounding	Backing-up of water through the construction of dams, weirs, sluices, etc.
Intensive Land Use	Grazing, removal of riparian vegetation, management of riparian vegetation, erosion, etc.
Floodplain modification	Construction of flood banks limiting channel and floodplain interactions

Note: These thresholds for flow regulation do not take into account the effects of other major pressures on a water body. It is recognised that:

Abstraction pressure may contribute to failure of a chemical or ecological objective combined with other pressures on a water body. Particularly, pressures from point source pollution and diffuse pollution may act in combination with abstraction and flow regulation pressures. Pressures that cause morphological change may also act in combination with hydrological pressures on surface waters (For example, these could be flood-protection structures, weir structures or an activity such as dredging).

RISK ASSESSMENT FROM MORPHOLOGICAL ALTERATIONS

Techniques for describing and assessing surface water morphology are not well developed in Georgia. However, there are data and information available from the river habitat surveys conducted under several national and international projects. Additionally, the relationships between specific morphological features and their associated biota are not well understood. This means that determining the effect that a specific pressure on morphology will have on “biological elements” inevitably relies to a large extent on expert judgement.

Datasets and information sources

To undertake the Morphological Risk Assessment, datasets and information relevant to the pressures described in the Table 6 above are required.

It was found that data availability relating to the extent of morphological alterations to surface waters in Georgia was limited at the time of developing this guidance document, therefore, determining the effect that specific morphological pressures have on biological elements, relied heavily on expert judgement.

In Tab. 7 data and information sources for assessing surface water morphology are presented.

Table 7: Datasets and data sources for morphological assessment

Pressure	Description
Cannelisation (including straightening)	Maps, aerial photographs, river habitat surveys and infrastructure plans from the bodies through which the Central Government of Georgia conducts its statutory responsibilities in respect of river drainage and flood relief.
Dredging	Maps, aerial photographs, river habitat surveys

Flood protection and bank reinforcement	Data and information as Catchment Flood Risk Assessment and Management Studies, maps aerial photographs, from the bodies through which the Central Government of Georgia conducts its statutory responsibilities in respect of flood relief and protection.
Water regulation	Data from licences on water regulation, national hydrological monitoring, case studies and EIA from the HPP, weirs and locks, etc.
Impounding	Data on impoundments for power generation (licenses and EIA studies) and information from local water management authority. Furthermore, maps and aerial photographs of the rivers and reservoirs.
Intensive Land Use	GIS maps on Land Use and vegetation cover, aerial photogrpaths, data from surveys (biodiversity), etc.
Floodplain modification	Riparian and floodplain topographic data; Location of flood defence assets for maintenance/management;

Risk assessment thresholds for morphological alterations

The assessment framework provides sets of rules and threshold criteria for use in interpreting available data and knowledge on morphological alterations to surface water bodies. This methodology covered hydromorphological elements that are presented in Tab.8 along with thresholds values for assessment of morphologcal alterations (see Table 9). The “Methodology for describing and assessing surface water hydromorphology” is presented in Annex 1 of this guidance document[1].

Table 8: Morphological quality elements and indicative parameters

Quality Elements	Sub-Elements	Indicative Parameters
Continuity		Number, location and possibility to cross barriers Accessibility/connectivity for fish
Morphological conditions	Variation of depth and width of the river	River course Cross section and degree of naturalness
	Structure and substrate of the river bed	Presence of artificial river bed Degree of naturalness in substrate composition of the river bed Erosion/sedimentation structures
	Structure of the riparian zone	Presence of embankment zone Land use of embankments Land use of flood plain/river valley Possibility for entirely natural inundation Possibility for entirely natural meandering

Results from the assement can be used in preliminary classification of the hydromorphological elements status using so called *Hydromorphological Quality Score* system that is presented in Tab.9.

Table 9: Preliminary boundaries of the hydromorphological quality classes (SHMI, 2004)

Hydromorphological quality class		Limit values	Colour*
1	High	1,0 – 1,7	
2	Good	1,8 – 2,5	
3	Moderate	2,6 – 3,4	
4	Poor	3,5 – 4,2	
5	Bad	4,3 – 5,0	

** Colour are defined by WFD in Annex V (1.4.2) to present the ecological status and potential*

Such approach allows to make classification of water bodies (or groups of water bodies) into “Risk Categories” due to morphological alterations (Continuity, cannelisation (including straightening) and dredging, flood protection and bank reinforcement, water regulation, impounding, intensive land use and floodplain modification). Due to fact that such approach was already tested with suitable results in Georgia (the Adjaritskali/Choroki Pilot River basin), this guidance document use these threshold values to the assessment of the risks from morphological alterations to river water bodies. The following Tables 10 to 13 list the risk criteria for each hydromorphological pressure types as outlined in Table 2.

[1] The “Methodology for describing and assessing surface water hydromorphology” have been developed and used in the Adjaristskali/Chorokhi pilot river basin in Georgia under the EU EPIRB project

Table 10: Thresholds regarding the pressure "River and Habitat Continuity Interruption" (adopted from EU EPIRB, 2013).

River Size	Not At Risk	Possibly At Risk	At Risk
Small & Medium	No artificial barrier Or barrier that is equipped with a functioning fish bypass facility/fish migration aid	No sufficient information is available if fish bypass facility/fish migration aid is functioning;	One or several artificial barrier in place that hinder fish migration and interrupt habitats
Large	No artificial barrier Or barrier that is equipped with a functioning fish bypass facility/fish migration aid	No sufficient information is available if fish bypass facility/fish migration aid is functioning;	One or several artificial barrier in place that hinder fish migration and interrupt habitats

Table 11: Thresholds regarding the pressure "Impoundment" (adopted from EU EPIRB, 2013)

River Size	Not At Risk	Possibly At Risk	At Risk
Small & Medium	No impoundment No impoundment >500m upstream effect and the water body affected is impounded < 10% in relation to its overall length	No sufficient information is available; Individual Impoundment 500 – 1,000 m **OR** several impoundments are in place and affect 10-30% of the overall water body length	Individual Impoundment >1,000 m **OR** several impoundments are in place and affect >30% of the overall water body length
Large	No impoundment >500m upstream effect **and** the water body affected is impounded < 10% in relation to its overall length	No sufficient information is available; Individual Impoundment 500 – 2,000 m **OR** several impoundments are in place **and** affect 10-30% of the overall water body length	Individual Impoundment >1,000 m **OR** several impoundments are in place and affect >30% of the overall water body length

Table 12: Thresholds regarding the pressure "River Morphology" (result in 5 quality classes are in annex 1 of this document)

River Size	Not At Risk	Possibly At Risk	At Risk
Small & Medium & Large	The surveyed river reach is assessed with 'high quality': Morphological Quality Class 1 **OR** <30% of overall water body length is allocated to Morphological Quality Class 3-5	No sufficient information is available; **OR** <70% of overall water body length is allocated to Morphological Quality Class 3-5 **and** <30% of WB length Morphological Quality Class 4-5	>70% of overall water body length is allocated to Morphological Quality Class 3-5 **OR** >30% of overall water body length is allocated to Morphological Quality Class 4-5

Specific pressure on river morphology in Georgia is "dredging and removal of natural material" from the river bed. Threshold values that can be used for risk assessment are presented in Tab. 13.

Table 13: Thresholds regarding the pressure "Dredging and Removal of Natural Material

River Size	Not At Risk	Possibly At Risk	At Risk
Small & Medium & Large	No dredging	<15% of surveyed river reach affected	>30% of surveyed river reach affected

In addition to the morphological risk assessment, it should be noted that morphological alterations are also important in characterising Heavily Modified Water Bodies. The Morphological and Hydrological Risk Assessment exercises combined comprise the screening steps for the designation process. Water bodies considered to be at significant risk of failing to reach the objectives of the WFD in defined time period (good ecological and chemical status) (i.e. “At Risk” category), were considered further under the identification and designation of HMWB. The methodology for the identification and designation of HMWB will be covered by separate guidance.

PRESSURE AND IMPACT ANALYSIS AND RISK ASSESSMENT FOR PHYSICO-CHEMICAL ELEMENTS

This chapter focuses on the analysis pressures and impacts that may put a water body at risk of failing environmental objectives due to pollution from point and diffuse sources.

Point source pollution results when the contaminants come from a single location into the surface water.

Diffuse (non-point) source pollution results when contaminants are introduced into the environment over a large, widespread area and later entered into the surface water body.

The methods described in this document provide thresholds for grading water bodies into three “Risk categories” (“At Risk, “Possibly at Risk” and “Not at Risk”) according to pressure magnitudes, identified from the best available information and datasets, to determine the degree to which they placed the water body at risk of not achieving Good Ecological Status. The thresholds proposed were adapted from existing WFD guidance and other sources such as relevant Pressure and Impact Analysis in EU Member states, also using expert judgement.

The determination of risk category for a water body comprises of two stages.

Stage 1: Identification of the pressures from both point and diffuse sources of pollution.

Stage 2: In a second stage, for each of the identified pressures a corresponding threshold value is proposed to determine, if a water body is at risk of failing the environmental objectives, and their magnitudes of impacts.

Determination of risk categories can be summarized in the following scheme:

Indicator (pressure or water quality) → **Threshold** → **Risk Criterion**

APPROACH FOR PRESSURE-IMPACT ANALYSIS AND RISK ASSESSMENT FOR POINT SOURCES OF POLLUTION

This subsection serves a brief description of the approach for Pressure-Impact Analysis and Risk Assessment for point sources of pollution of surface water.

Pressures

The pressures on surface water are related to:

- Urban waste water discharges;
- Industrial waste water discharges;
- Other discharges into the surface water recipient as for example (such as mining; landfill contaminated land; agriculture point (slurry, silage and other feeds, sheep dip use and disposal, manure depots, farm chemicals, agricultural fuel oils); waste management and aquaculture.

Urban Waste Water Discharges

Risk assessment for Urban Waste Water Treatment Plants (WWTPs)

The risk assessment for Urban Waste Water Treatment Plants is undertaken by assessing compliance with discharge standards and compliance with monitoring requirements, as stipulated in national legislation. Threshold of Population Equivalent (PE) should be defined for point source risk assessment (e. g. more than 2000 PE).

Data Requirements

Following data and information will be collected for the risk assessment of the waste water treatment plants

- WWTP Name;
- Population Equivalent;

- Discharge Location;
- Self-Monitoring Frequency;
- Sampling Type;
- Influent and Effluent measurements;
- Date of sample and measured quality elements:

  a) Biological Oxygen Demand (BOD_5);
  b) Chemical Oxygen Demand (COD);
  c) Total suspended solids (TSS;
  d) Total Phosphorus;
  e) Total Nitrogen.

Threshold values

The required discharge standards are applied as threshold values for risk assessment of the urban waste water treatment plants. Discharge standards will be defined by the related national regulation in Georgia. For illustration threshold values as allowable concentrations, are summarised in Tab. 14.

Table 14: Discharge standards for the urban waste waters (based on the EU Directive 91/271/EEC on urban waste water treatment)

Parameter	Concentration mg/l	Absolute fail if concentration >mg/l
BOD_5	25	>50
COD	125	>250
TSS	35	>87.5

For the purpose of the risk assessment, it is assumed that the sample fails if any of the relevant parameters fail to conform or are not recorded.

In the risk assessment it is also necessary to take into account "requirements for discharges from urban waste water treatment plants to sensitive areas" (sensitive areas are defined by the EU Urban Waste Water Treatment (UWWT) Directive 91/271/EEC) as they are presented in Tab. 15. One or both parameters may be applied depending on the local situation. The application of one or both parameters is determined by expert judgement.

Table 15: Additional discharge standards if water body is designated as sensitive area

Parameter	Concentration mg/l	Note
Total Phosphorus	2	10,000-100,000 PE
	1	>100,000 PE
Total Nitrogen	15	10,000-100,000 PE
	10	>100,000 PE

Risk Assessment of WWTP

The risk assessment of the urban waste water treatment plant is summarised in the Table 16 below.

Table 16: Risk Assessment for UWWTP

Not at risk	Possibly at risk	At risk
Complies with discharge standards and is self-monitoring compliant.	Does not comply with discharge standards and is self-monitoring compliant.	Does not comply with discharge standards and is self-monitoring non-compliant.

A WWTP is considered **compliant with the discharge standards** if number of samples from self-monitoring failing the concentration limits set out in Tab. 15 and 16 or in national regulation is less than the maximum permitted number of samples which fail to conform (permitted number of samples which fail to conform should be defined by National Regulation). Furthermore, the degree of failure is less than the allowable deviation set out in Regulation.

A WWTP is considered **compliant with the self-monitoring requirements** if the stipulated number of samples is taken using flow-proportional or time-based 24 hour samples. Grab sampling is not considered sufficient to comply with the UWWTP. Number of samples and sampling procedure should be defined by the National Regulation and included in the permit of the waste water producer.

Risk assessment for untreated wastewater from settlements

This pressure indicator describes the untreated wastewater load (from the settlements (villages, cities) where canalisation is built without waste water treatment plant) in relation to the annual minimum flow. D_{ww} expresses the dilution of wastewater in a river water body. The pressure indicator helps to categorise the (raw) wastewater loads and rank them according to the magnitude of the expected impact on water status. Priority ranking and the classification of hot spots may be based on this indicator combined with information on the size of the impacted river stretch and magnitude of the pressure.

1. **The indicator can be calculated to analyse pressures according to the following equation** (EU EPIRB, 2013):

$$D_{ww} = L/Q_{min,r}$$

Description of used variables:

D_{ww}: Specific waste water discharge into the respective river water body (dimensionless)

L: Total (dimensionless) load equivalent originating from waste water discharge into the river in terms of:

- Organic matter as BOD_5 or COD; or
- Nutrient load, in terms of N_{tot} or P_{tot}; or
- Number of inhabitants connected to the sewer system.

Qmin,r: Minimum annual flow of the river [l/s]

The load equivalent (L) is discharged at a distinct location (point source) to the river. The total load equivalent shall be expressed as calculated dimensionless number L, using either the number of connected inhabitants or – in case loads are given - population equivalents, based on the figures provided below as examples:

Example 1

1 PE BOD5 = 60 g/day, 1PE COD=120 g/day, 1PE Ntot = 11 g/day, 1 PE Ptot=1,5-2 g/day and 1PE = 1 person connected to the sewer system. An agglomeration with 3,500 inhabitants (can be Dmanisi) discharges the entire wastewater to the Mashavera River with a long-term minimum annual flow of 1,64 m3/s (1640 /s). The following calculation shall be made:

L = number of PE (3.500); Qmin,r = 1640 l/s

➔ Dww = L/ Qmin,r = 3500/1640 l/s = 2,13.

Example 2

If for instance, it is known that a small industrial source (food company) discharges another 100 kg BOD per day through the same sewer system the calculation would have to be adapted as follows:

Ltotal = Lmunicipal + Lindustrial = 3500+100000 [g BOD]/60 [g BOD]=3500+1666,7=5166,7 ➔Dww = L/ Qmin,r = 5166,7/1640 l/s=3,15

Example 3

If, data volume of waste water discharge are available in terms of m3, the load equivalent can be calculated using a unit discharge of 120 l/ (inhabitant per day). When it is known that a discharge of 100 m3 waste water with municipal origin, a load equivalent can be calculated as follows:

L = 100,000 l/120 = 833

➔Dww = L/ Qmin,r = 833/1640=0,51

The sum of all load equivalents including direct and indirect industrial discharges. If available these load equivalents can be introduced for organic matter and nutrients. For municipal waste water this will not yield additional information but it is useful to introduce these numbers when significant load contributions from industrial waste waters are of concern.

In some cases existing treatment plants can be found only partly operated. However, in case of discharges of treated wastewater this indicator may be adapted in the following form.

$$Dww = (L*(1-\eta))/ Qmin,r$$

L: Load equivalents (either for organic matter, nutrients or quantity)

η: Treatment efficiency. Treatment efficiency can be selected according to the knowledge on the performance of the treatment plant. Usually the following figures in Tab. 18 can be assumed as an approximation.

Table 17: Values for the treatment efficiency of different wastewater treatment schemes.

		η [-] : Treatment Efficiency (%)		
	Settling Tank	Primary	Secondary	Advanced (nutrient removal)
Organic matter BOD	20	85	90	95
Organic matter COD		70	75	80
TSS	50	>90	>90-	>90
NH4		<25	>90	
Ntot				75
Ptot				80

Example 4

It is known that settlement produce 100 m3 per day and only primary treatment step is functioning. The load equivalent can be calculated as follows by using a unit discharge of 120 l/(inhabitant per day) and η - value (treatment efficiency) from Table 18 for NH4 (due to worst case scenario) as 0,25:

L= (100,000 l/120 l)x(1 - 0,25)= 625

➔*Dww = L/ Qmin,r = 625/1640=0,38*

When compared with results of example 3 (Dww = 0,51), it is visible that even partly treated waste water can lead to decrease the impact from waste water.

The indicator assumes the discharge of untreated wastewater as a worst case scenario.

Risk Assessment of urban untreated waste water

Criteria to assess the risk regarding an identified pressure untreated waste water **($D_{ww} = (L*(1-\eta))/ Q_{min,r}$)**

Risk Category	Risk Criteria
At Risk	$D_{ww}>1.5$
Possibly at Risk	$1< D_{ww} <1.5$
Not at Risk	$D_{ww}<1$

INDUSTRIAL WASTE WATER DISCHARGES

The risk assessment for discharges to surface waters from industrial waste water treatment plants is undertaken in a similar manner to UWWTPs.

It is important to note that the data is provided only for the purpose of risk assessment, which will in turn be used to target a monitoring programme. Where the data on compliance with discharge standards and monitoring is incomplete, expert judgement should be applied following consultation with the water inspection. The risk assessment is summarised in Tab. 18.

Table 18: Risk Assessment for Industrial WWTP

Not at risk	Possibly at risk	At risk
Complies with discharge standards and is self-monitoring compliant.	Does not comply with discharge standards and is self-monitoring compliant.	Does not comply with discharge standards and is self-monitoring non-compliant.

OTHER POINT SOURCE DISCHARGE

The risk assessment for point source discharges to surface waters (direct discharge is expected, seepage and infiltration into ground water is not taken into account) from other sources and activities identified in the IMPRESS guidelines (such as mining, landfill contaminated land, agriculture point (slurry, silage and other feeds, manure depots, farm chemicals, agricultural fuel), waste management and aquaculture), will be undertaken using expert judgement.

In this assessment following guidelines can be used: “A water is at risk at such point sources if there is a record of occasional incidents of pollution from these sources (e.g. one per year on average) that are sufficient to warrant serious attention in terms of established systems for the classification of incidents.” Classification of incidents (sudden deterioration of the surface water quality) would be defined by the National Regulation and should set criteria to assess changes of the water quality as for example fish killing, strong odour and changed colour of water, high concentration of suspended solids (muddy water).

TOTAL SHARE OF WASTE WATER IN THE RIVER

This indicator describes the total share of waste water that has been discharged to river from its source. It does not specifically show the expected impact on general physico-chemical parameters, but before all it indicates the likelihood of contamination with conservative substances and substances that tend to accumulate in sediment and biota.

The indicator can be calculated to analyse pressures according to the following equation:

$Sww = \sum Qww/MQr$

Description of equation:

- Sww: Total share of waste water in a river at a given cross section along the river
- Qww: Total of all (current/future) upstream waste water discharges into the river (m^3/s)
- MQr: Mean annual flow of the river (m^3/s)

Risk Assessment of Total waste water discharge into river

Criteria to assess the risk regarding an identified pressure Total Share of Waste water in River

- **($S_{ww} = \sum Q_{ww}/MQ_r$)**

Risk Category	Risk Criteria
At Risk	$S_{ww} > 0.1$
Possibly at Risk	$0.05 < S_{ww} < 0.1$
Not at Risk	$S_{ww} < 0.05$

APPROACH FOR PRESSURE-IMPACT ANALYSIS AND RISK ASSESSMENT FOR DIFFUSE SOURCES OF POLLUTION

Lack of data to represent many pressures and impacts of the diffuse source of pollution is an issue in many regions including Caucasus. This fact was determining the selection of the methods for risk assessment from the diffuse sources in this guidance document.

Drivers with the potential for causing pressures from diffuse pollution of rivers include:

- Agriculture;
- Rural drainage (septic tanks).

Some of the main effects of activities considered as part of the risk tests are shown in Tab. 19.

Table 19: Diffuse pollution risk to surface water

Driver/Pressure	Description of quality elements
Agriculture/ Crop production, animal live stocking, grazing	Nutrients, pesticides, etc.
Rural drainage/untreated waste water runoff	Nutrients, organic substances and bacterial loading

Datasets and information sources

To undertake the diffuse pollution to surface water Risk Assessment, datasets and information relevant to the pressures are required. Following sources of data can be used:

- Digital Elevation Model (DEM);
- GIS land use maps;
- Map of river basins and sub-basin boundaries;
- Geological map;
- Data and maps of meteorological and hydrological parameters (annual precipitation, mean annual river flows, air temperature, etc.);
- Statistics on the fertilizers application, animal live stocking for the river basin (if not available, also average values on national level can be used as default values);
- Census data on the inhabitants and settlements;
- Others.

Some of the datasets are available from existing databases of the organisations with related competencies. However, some of the maps will be developed when Pressure and Impact Analysis will be initiated in Georgia.

AGRICULTURE

Two pressure indicators for diffuse agricultural pollution sources are used to grade the water bodies into risk categories "Not at risk", "Possibly at Risk" and "At Risk". During the EU EPIRB project guidance document addressing hydromorphology and physico-chemistry for a Pressure-Impact Analysis/Risk Assessment according to the EU WFD (EU EPIRB, 2013)" have been developed and tested in the Adjaritskali/Chorokhi pilot river basin in Georgia. This assessment framework provides sets of rules and threshold criteria for use in interpreting available data and knowledge on diffuse sources of pollution on surface water bodies. Due to fact that pressure indicators and testing of that methods provided realistic results and also data and information for risk assessment are avalable, this approach was modified and used in this guidance document.

Pressure agricultural crop (plant) production

Indicator 1: Likelihood for diffuse pollution (EU EPIRB, 2013)

This indicator describes the likelihood of diffuse pollution including typical agricultural contaminants, such as nutrients from fertilizers, pesticides and other plant protection products. The indicator uses a general variable for the quantification of agricultural activities. Therefore not only general physica-chemical influences are covered but also other impacts that may go along with agriculture, such as pollution with agriculture related priority substances.

The indicator can be calculated to analyse pressures according to the following equation:

Sagri = Aagri/AWB

Description of equation:

- Sagri : Share of agricultural area in a given water body catchment [-];
- AWB: Catchment area of the respective water body [km^2];
- Aagri: Area used for intensive/industrial agriculture in the respective catchment If possible experts should provide a preliminary definition and/or identification method for agricultural area, depending on the availability of data (GIS layers on land use and soil types, other sources) [km^2]. For example, Aagri can cover arable, intensive grassland and also urban area.

Pressure Animal live stocking

Indicator 2: Likelihood for diffuse pollution (EU EPIRB, 2013)

This indicator describes the likelihood of diffuse pollution with typical pollutants stemming from animal live stocking, such as nutrients (with potentially toxic (e.g. NH_4) or chronic effects (e.g. PO_4) that can impact on biological quality elements and organic matter with potentially negative effects on riverine oxygen regime).

The indicator can be calculated to analyse pressures according to the following equation:

Ihus = Ue/AWB

Description of equation:

- Ihus: Indicator for animal livestock [LU/ha];
- Ue: Animal livestock unit for grazing livestock and others (e.g. pigs, different poultry species), that is calculated as livestock unit (LU) multiplied by animals number averaged over the whole year for the water body;
- AWB: Catchment area of the respective water body [ha].

LU usual figures e.g. under:
http://adlib.everysite.co.uk/adlib/defra/content.aspx?id=000IL3890W.198AWLDOHJ69F3

LU is based on the feed requirements of different livestock (from research projects). These values would not differ from country to country.

Animals	Livestock Unit (adopted from above web side)
Cows	1,0
Beef cows	0,75
Ewes (diary sheep)	0,11
Lamb	0,08
Pigs	0,35

Risk assessment of the pressures from agriculture

Example 5:

It is known that water body has area (AWB) 2000 ha, estimated number of beef cows is 1000 (expert judgement taking into account that one household has approximately 2 heads of cattle), LU unit is 0,75 (from above table).

Then Ihus (indicator of animal live stocking) is calculated as follows:

*Ihus = Ue/AWB = 1000 (beef cows)*0,75 (LU for cows)/2000 ha = 0,38*

0.75. In this case. water bodv will be "Possiblv at Risk" (see table below).

The assessment framework provided sets of rules and threshold criteria for use in interpreting readily available national datasets.

1. **Criteria to assess the risk regarding an identified pressure Likelihood Diffuse Pollution (Agriculture crop production - Sagri = Aagri/AWB)** (EU EPIRB, 2013)

Risk Category	Risk Criteria
At Risk	$S_{agri} > 0.4$
Possibly at Risk	$0,2 < S_{agri} < 0.4$
Not at Risk	$S_{agri} < 0.2$

2. **Criteria to assess the risk regarding an identified pressure Likelihood Diffuse Pollution (Animal livestocking - Ihus = Ue/AWB)** (EU EPIRB, 2013)

Risk Category	Risk Criteria
At Risk	$I_{hus} > 1$
Possibly at Risk	$0,3 < I_{hus} < 1$
Not at Risk	$0 < I_{hus} < 0.3$

RURAL DRAINAGE

This pressure is related to small municipalities where no sewer (canalisation) for waste water sanitation is built. In majority smaller than 1,000 PE villages are involved in this category.

Pressure: Diffuse pollution from un-sewered area.

Household cluster is identified with no sewerage connections (e.g. septic tanks). This is likely to represent an un-sewered cluster.

Risk assessment

This process will be conducted in four stages.

Stage 1: The development of GIS Map "Urban and built areas".

Stage 2: Link GIS Map with data on population dataset (Census) and on sewered households and septic tank households.

Stage 3: Identify household clusters (in villages) which may not be sewered.

Stage 4: Consult with relevant Local Authorities concerning the sewer facilities within the identified candidate sites.

Table 20: Values for the treatment efficiency of different wastewater treatment schemes.

Risk score	Not at risk	Possibly at risk	At risk*
Presence of "un-sewered" cluster points	Water body contains no "un-sewered" cluster point	Water body contains one or more "un-sewered" cluster points	-

** Data on waste water discharges from un-sewered cluster point (septic tanks) to surface water is not available and in many cases water from septic tanks penetrate to the ground water. Therefore, investigation will be needed to categorize water body "At Risk" due to such pressure.*

CHAPTER 4: METHODOLOGY OF SELECTION SPECIFIC POLLUTANTS RELEVANT FOR GEORGIA

PRESSURE AND IMPACT ANALYSIS AND RISK ASSESSMENT FOR PHYSICO-CHEMICAL ELEMENTS

Whereas the “priority substances” are clearly identified in WFD Annex X, one key question in the context of the analysis of pressures and impacts is the selection of specific pollutants (other than priority substances) for which data on pressures must be collected in order to assess whether there are impacts for the different water bodies in a river basin (district). This List of the main pollutants discharged in significant quantities is provided by WFD (Annex VIII) as is enclosed as Annex 2 of this guidance document.

Priority substances means substances identified in accordance with Article 16(2) and listed in Annex X of the WFD.
Specific pollutant means any substance liable to cause pollution, in particular those listed in Annex VIII of the WFD and also in Annex of this document.

The first step in selection of specific pollutants relevant for Georgia is collection of all specific pollutants from available data and information. Substances involved in industrial waste waters and also for plant protection (further pesticides) will be collected. On the other hand, industrial substances and pesticides will be assessed by different selection criteria (due to different behaviour and potential risk for the aquatic environment).

The following sources of information will be taken into account:

- List II of the main pollutants discharged in significant quantities is provided in WFD (Annex VIII and for more details see “Assessment of programmes under Article 7 of Council Directive 76/464/EEC”);
- List of 139 substances elaborated by European Commission;
- Data on the pesticides registered and used in Georgia;
- Data on the high-volume substances (HVS) used in Georgia (HVS > 1,000 t/year) and on the low-volume substances (LVS) (LVS >10 t/year a < 1,000 t/year);
- Data from the national water quality programmes (surface water, groundwater and sediments and discharged waste water);
- Data from the surveys conducted under the international projects (EU, UNDP, etc.).

CRITERIA FOR SELECTION OF THE SPECIFIC POLLUTANTS

The purpose of this chapter is to propose an iterative approach. It is composed from two steps.

The first step is to collect all data and information on the chemical substances that can occur in the surface water from their production and use on the territory of Georgia. The first step will finish with so called “Overall List of Specific Pollutants (may be also called as “List of Candidate Specific Pollutants) where all available information on chemical substances in Georgia will be used. There will be combination of data from legislation, data on use/production of particular substances in Georgia, data from national monitoring and survey and expert judgement (estimation), where necessary.

Note: To create the Overall List of Specific Pollutants is necessary to be aware that data and information is needed from several sectors. The multi-sectorial cooperation will be needed. At least following data and information would be used:

- *Chemical substances data from sector of industries (amount of chemicals used produced (volume categories are presented below), their properties and behaviour in the environment (toxicity, bioaccumulation, degradation));*
- *Agriculture sector would provide data on the application of the pesticides;*
- *Data from the surface water monitoring programme and surveys;*
- *Data from the permitting and control of the waste water discharges;*
- *International databases with studies of the chemical substances, etc.*

The second step is to dedicated to down the Overall Long List of Specific Pollutants to a manageable number of pollutants in a pragmatic and targeted step-by-step way (“from coarse to fine”). This way consists from using selection criteria to subdivide specific pollutants from the Overall List into groups of **relevant, potentially relevant and irrelevant specific pollutants** in Georgia. For this purpose, chemical substances were subdivided into three volume categories:

- HVS when used > 1,000 t.year-^{1};
- LVS when used in range 10 < 1,000 t.year^{-1};
- Category when used in amount from 0 < 10 t .year^{-1}.

Important criterion is whether specific pollutant on the Overall List is monitored or not and if there is already EQS established for pollutant. These criteria are composed into the selection scheme that is presented below.

CRITERIA FOR RELEVANT SPECIFIC POLLUTANTS IN GEORGIA

In selection of substances on the List of Relevant Specific Pollutants (other than pesticides) for Georgia, it is proposed to use criteria as follows:

Substances will fall into the group of **"relevant"** if:

a) If the chemical substance is already monitored (national surface water monitoring programme), EQS for the substance is available, and substance occurring in surface waters is found in concentration exceeding the EQS (substances from all 3 volume categories);
b) If the chemical substance is already monitored (national surface water monitoring programme), EQS for the substance is not available, and the substance was identified in more than 5 % of sampling locations (all 3 volume categories as in a)). Furthermore, substances that were identified by the monitoring in amount less than 5 % locations, however its production/use exceeds the volume of 1,000 ton/year.

Note: If EQS has not been determined yet for given substance, the selection will be based on frequency of occurrence (5 %) of chemical substance in aquatic environment above limit of quantification (LOQ).

CRITERIA FOR POTENTIALLY RELEVANT SPECIFIC POLLUTANTS IN GEORGIA

In selection of substances on the List of Potentially Relevant Specific Pollutants (not pesticides) for Georgia, it is proposed to use criteria as follows:

Substances will fall into group of "**potentially relevant**" if:

a) The substance is monitored (national surface water monitoring programme) and the Environmental Quality Standard (EQS) for the substance is available, the substance occurs in surface waters in concentration less than its EQS, but its production/use exceeds the volume of 10 ton.year^{-1};
b) If the substance is monitored (national surface water monitoring programme) and the EQS is not available, and the substance was identified in less than 5% of sampling locations, if its production/use is less than 1,000 ton.year^{-1};

Note: If EQS has not been determined yet for given substance, the selection will be based on frequency of occurrence (5 %) of chemical substance in aquatic environment above LOQ.

c) If the substance is monitored but its EQS for surface water is less than limit of quantification of used analytical method;
d) If the substance is not monitored, and volume of its production/use is above 1,000 ton.year-1;
e) If the substance was not monitored, and volume of its production/use moves from 10 to 1,000 ton.year^{-1}.

CRITERIA FOR IRRELEVANT SPECIFIC POLLUTANTS

In selection of substances on the List of Irrelevant Specific Pollutants (not pesticides), it is proposed to use criteria as follows:

Substances will fall into group of "irrelevant" if:

a) If the chemical substance is monitored (national surface water monitoring programme) and Environmental Quality Standard is available, and the substance occurs in surface waters in concentrations less than its EQS and its production/use is less 10 ton.year^{-1};
b) If the chemical substance is not monitored, and the volume of production/use is less than 10 tons.year^{-1}.

Scheme of selection process of the relevant specific pollutants is presented in the Tab. 21.

Table 21: Scheme of selection process of substance into the group of relevant, potentially relevant and irrelevant

			(i) Data on volume of substance production/use		
			High-volume substance (> 1,000 t.year^{-1})	**Low-volume substance (10 – 1,000 t.year^{-1})**	**No production/use, or in amount < 10 t.year^{-1*}**
Results from national monitoring/surveys	**EQS for the substance is determined**	**>EQS**	Relevant	Relevant	Relevant
		LOQ>EQS	Potentially relevant	Potentially relevant	Potentially relevant
		<EQS	Potentially relevant	Potentially relevant	Irrelevant
	EQS for the substance is not determined	**Frequency of substance occurrence over LOQ>5%**	Relevant	Relevant	Relevant
		Frequency of substance occurrence over LOQ<5%	Relevant	Potentially relevant	Potentially relevant
No data from national monitoring/surveys			Potentially relevant	Potentially relevant	Irrelevant

** In this category there might occur chemical substances that were not determined yet in the framework of inventory;*

LOQ means limit of quantification; EQS means Environmental Quality Standard.

Important note: If such data and information as required by the previous approach, it is possible to use European Risk Assessment Methodology (EURAM) that is proposed for the pesticides in chapter 3.3, as alternative.

CRITERIA FOR PESTICIDES SELECTION

Pesticides are classified in a different way as it was in the case of industrial chemical substances. It is based on the fact that pesticides enter the water environment primarily by processes like their washing out and soil erosion. In this case, therefore is reasonable to make selection of the pesticides into above mentioned groups according to their application into soil.

Proposed selection process may be summarised into steps as follows:

a) From the group of all pesticides used in Georgia there will be included into List of relevant dangerous substances the most used pesticides. The criterion for selection is 1 ton produced, sold and/or used annually. Active substances presented in the Overall List of dangerous substances relevant for Georgia will be a base for further selection;

b) For each active substance from the Overall List, there will be calculated *so called Index of Exposition (I_EXP)* separately for the River Basin Districts (or if decided for the overall territory of Georgia);

The *I_EXP* was developed by the European Chemicals Bureau in accordance with EURAM approach that includes three factors: emission, distribution in aquatic environment and degradation.

I_EXP as part of the Combined Monitoring-based and Modelling-based Priority Settings (COMMPS) approach is used for determination of dangerous substances in aquatic environment on European Union level. This index is calculated with following formula:

I_EXP= 1.37*log(EEXV) + 1.301

*Where, EEXV= Emission*Distribution*Degradation*

Emission

This factor is calculated by multiplying of production and or imported amount particular chemical substance by coefficient connected to the use of this substance. This coefficient is in range from 0.01 used in close system – 1 wide dispersive use).

Distribution

Distribution in the environment is calculated by using Model Mackay I Level (range of coefficient is from 1 to 5 depending of the % of the substance in water). For more details see further readings and references (*Mackay, Donald (1991); EQC Model Software for Mackay Level I)*.

Degradation

Degradation is represented by the multiplication factor from 0,1 to 1 in relation to three classes of degradability (ready biodegradable, inherent biodegradable and persistent).

Next step is to determine so called “Effect Index (I_EEF) that is calculated as sum of Direct.

Effect Score, Indirect Effect Score and Human Effect Score:

I_EEF = EFSd + EFSi + EFSh

This step will continue with calculation of the Priority Index (I_PRIO) by the formula as follows:

I_PRIO = I_EXP* I_EEF (maximum score for each index is 10 and the substances with score 100 is the most hazardous for the aquatic environment).

c) After this calculations, there will be active substances selected into the groups as follows:

“Relevant” chemical substances:

- Whose active substances that calculated ***I_PRIO*** is higher than 50, although the substance was not detected in the framework of national monitoring/surveys of surface water (in this case it is considered that particular pesticides are applied in different seasons and surveys made 1 or 2 times annually might not record those substances).

“Potentially Relevant”chemical substances:

- Whose substances that calculated ***I_PRIO*** are in the range 15 – 49 score.

“Irrelevant” chemical substances:

- All other pesticides.

EXAMPLE OF THE LIST OF SPECIFIC POLLUTANTS

The process of the selection relevant specific pollutants for the country is long-term and need to include as much as information and data from different sectors. As example, the List of relevant specific pollutants for Slovakia is presented in Tab. 22. It lasted one and half year to gather data and information from databases on chemical substances (production, import, uses) application of pesticides, EU and national legislation, monitoring programmes and investigative surveys. Later, for each relevant specific pollutant on the List, the EQS was derived (if not existed) and the Pollution Reduction Programme for Slovakia was developed. In this Programme, for each substance sources of pollution and measure to eliminate and/or reduce the discharge into the recipient were identified. The information was presented in the form of table for each specific pollutant as illustrated below:

Table 22: List of relevant specific pollutants for Slovakia

CAS No.	Name	Source of pollution (locality)	Amount (t/year)	Description of use
1330-20-7	Xylenes (isomers)	CHEMOLAK Slovakia s.r.o. Sereď; Slovnaft VÚRUP, a.s. Bratislava; U.S. Steel Košice, s.r.o. Košice	11 1,300 690	Solution agent in the laquer and stain industry
1071-83-6	Glyphosate (an herbicide)	Western part of Slovakia	0.2	Orchards, strawberry, potatoes and vineyards

To collect such information, it was necessary to create working group with representatives from Ministry of Environment (including water monitoring institution and inspection), Ministry of Agriculture (including Central Office for Control of Use Pesticides), Ministry of Economy (due to chemical substances use by industries), Ministry of Health (due to data on effects of chemical substances on human beings), and experts from research institutes.

Table 23: List of relevant dangerous substances\ for Slovakia (Pollution Reduction Programme, 2004)

CAS No.	Name of chemical substance
107-06-2	1,2-Dichloroethane
128-37-0	4-methyl-2,6-di-tert butylphenol (butylhydroxytoluene)
62-53-3	Aniline
7440-38-2	Arsenic and its compounds

98-10-2	Benzene sulphonamid
50-32-8	Benzo(a)pyrene
205-99-2	Benzo(b)fluorantene
207-08-9	Benzo(k)fluorantene
95-16-9	Benzothiazole
191-24-2	Benzo[ghi]perylene
92-52-4	Bifenyl (phenylbenzene)
25068-38-6	Bisphenol A
117-81-7	bis(2-ethylhexyl)-phtalate
1702-17-6	Clopyralid
108-94-1	Cyclohexanone
13684-56-5	Desmedipham
84-74-2	Dibutylphtalate
122-39-4	Diphenylamine
26225-79-6	Ethofumesate
85-01-8	Phenanthrene
206-44-0	Fluoranthrene
50-00-0	Formaldehyde
1071-83-6	Glyphosate
118-74-1	Hexachlorobenzene
2921-88-2	Chlorpyrifos
1071-83-6	Chlorpyrifos- metyl
7440-47-3	Chrome and its compounds
193-39-5	indeno(1,2,3-c,d)pyrene
34123-59-6	Isoproturone
57-12-5	Cyanides
58-89-9	Lindane, gamma-isomer
3653-48-3	MPCA
7440-50-8	Copper and its compounds
91-20-3	Naphtalene
7440-02-0	Nickel and its compounds
104-40-5	4-(para)-nonyl phenyl
40487-42-1	Pendimethalin
1806-26-4	Octylphenyls
140-66-9	4-tert-octylphenyl
1336-36-3	PCB and its congenerates
127-18-4	Tetrachlorethylene
108-88-3	Toluene
79-01-6	Trichloroethylene
100-42-5	Vinylbenzene (styrene)
1330-20-7	Xylenes (isomers)
7440-66-6	Zinc

RISK ASSESSMENT OF SPECIFIC POLLUTANTS

The risk assessment from the relevant specific pollutants is based on applying a set of thresholds to each substance presented on the List of Relevant Specific Pollutants. In theory, evaluating the risk of failing objectives should be a straightforward comparison of the state of the water body with threshold values that define the objective. The used quality objectives should be taken from EU legislation and/or estimated Environmental Quality Standards in accordance with the procedure set out in WFD Annex V, conducted on the national level. The risk assessment approach of relevant specific pollutants is presented in Fig. 4 below and consists from several steps as follows:

Step 1: Deriving the List of Relevant Specific Pollutants. Process is described in the chapter 4.2 and 4.3);

Step 2: Test of relevance. Step 1 deals only with the identification of pollutants being discharged into water bodies. On the other hand, step 2 selects from these those pollutants that are likely to cause, or to already be causing, harm to the aquatic environment. This will depend on the intrinsic properties of the pollutants, their fate and behaviour in the environment and the magnitude of their discharges;

Step 3: Obtaining data on concentrations in, and loads to surface water bodies. Monitoring and/or estimated data (obtained by models varying from simple calculations to complex models) for the water bodies;

Step 4: Comparing concentrations with Environmental Quality Standards (EQS). EQSs are supposed to reflect the good status condition of a water body. They must be derived from ecotoxicological data. Exceeding EQS-values will be considered as harmful to the aquatic environment. Monitored or estimated concentrations will be compared with the appropriate EQS only for those specific pollutants from the List that are expected to occur in the surface water body;

Step 5: The final product – final product will be a list of water bodies “At Risk” due to relevant specific pollutants in the river basin districts and can be presented as GIS Map.

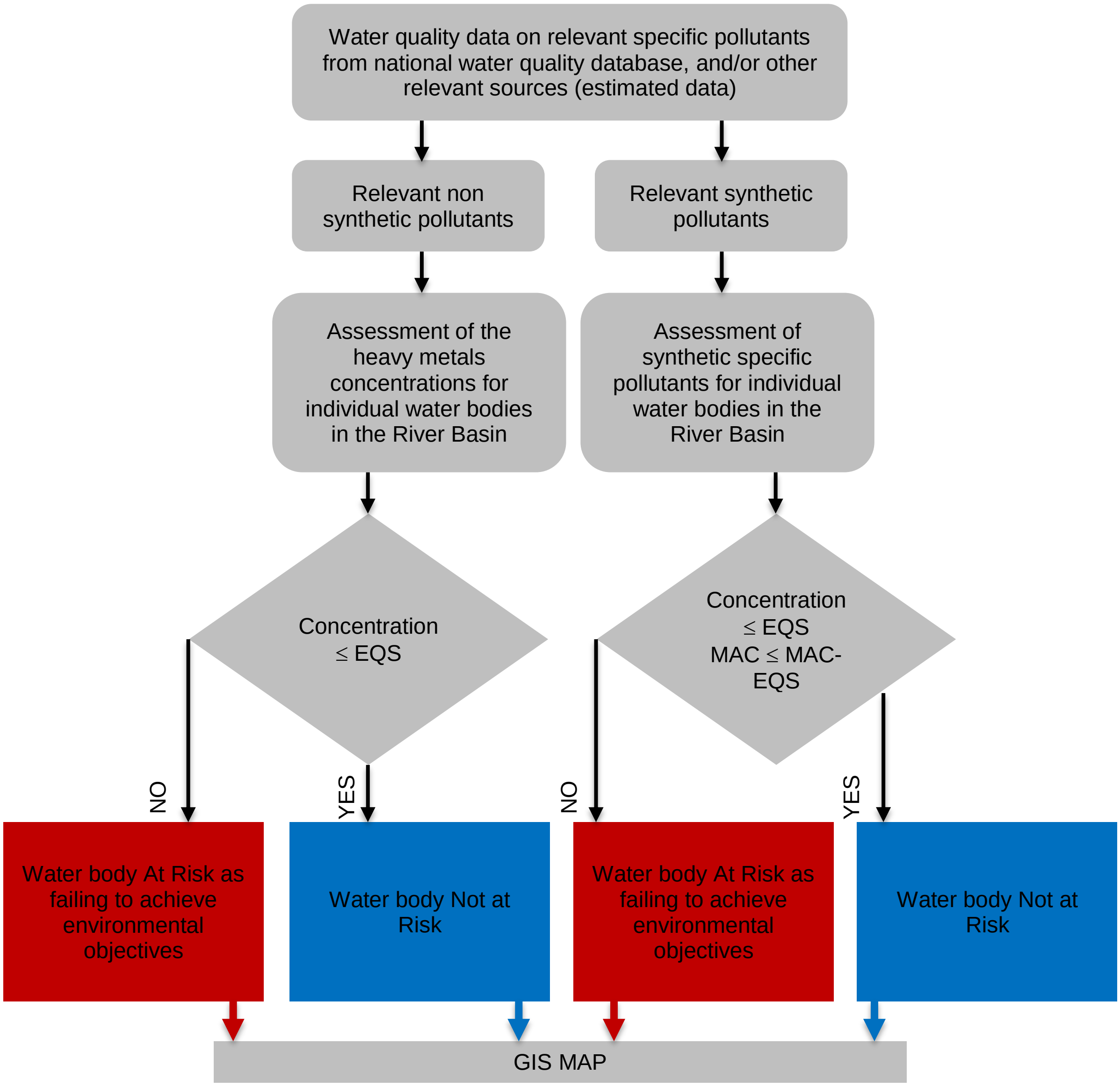
UNCERTAINTIES

When assessing specific pollutants and their harmful impact on the aquatic environment, it is necessary to know the potential uncertainties that may be in the data and information. It is useful to know information as for example:

- How the EQSs were derived (The best estimate for the EQS should be used based on the most recent ecotoxicological data.)?
- Limit of detection (or quantification) for the specific pollutants included in the monitoring programme;
- Behaviour and properties of specific pollutants in the environment (accumulation in biota and sediments, etc.);
- Potentially additive effects of specific pollutants with similar mode of toxic action;
- How identified discharges of specific pollutants are controlled and monitored?

Responses on those items should be known for the risk assessors before Pressure Impact Analysis.

Figure 3: Scheme for evaluating the risk of failing environmental objectives for specific pollutants



CHAPTER 5: FURTHER READINGS AND REFERENCES

EU Directive 2000/60/EC establishing a framework for Community action in the field of water policy (Water Framework Directive).

The Common Implementation Strategy (C.I.S.) "Guidance Document No.3 – Analysis of Pressures and Impacts".

Directive 2013/39/EU amending Directives 2000/60/EC and 2008/105/EC as regards priority substances in the field of water policy.

Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment).

EU EPIRB, 2013. Guidance Document addressing hydromorphology and physico-chemistry for a Pressure-Impact Analysis/Risk Assessment according to the EU WFD.

Mackay, Donald (1991) "Multimedia Environmental Models: The Fugacity Approach" Lewis Publ., CRC Press, Boca Raton, FL.

EQC Model Software for Mackay Level I (see: following web site http://www.trentu.ca/academic/aminss/envmodel/models/EQC2.html).

LIST OF FIGURES AND TABLES

ANNEX 1. METHODOLOGY FOR DESCRIBING AND ASSESSING SURFACE WATER HYDROMORPHOLOGY

INSTRUCTION FOR HYDROMORPHOLOGICAL ASSESSMENT PROTOCOL

How to fill up the assessment protocol

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

1. Channel plan form parameters

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

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

The Channel planform score (CPS) is calculated as the average of the scores given for channel sinuosity, channel type and channel shortening: CPS = (1.1 + 1.2 + 1.3)/3

<u>1.1 Channel sinuosity</u>

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

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

The SI values from the historic map and the new map are compared and the score is found from Table 1.

Figure 1: Two examples showing calculation of SI and sinuosity. The blue line is the river and the red line is the straight line along the river valley

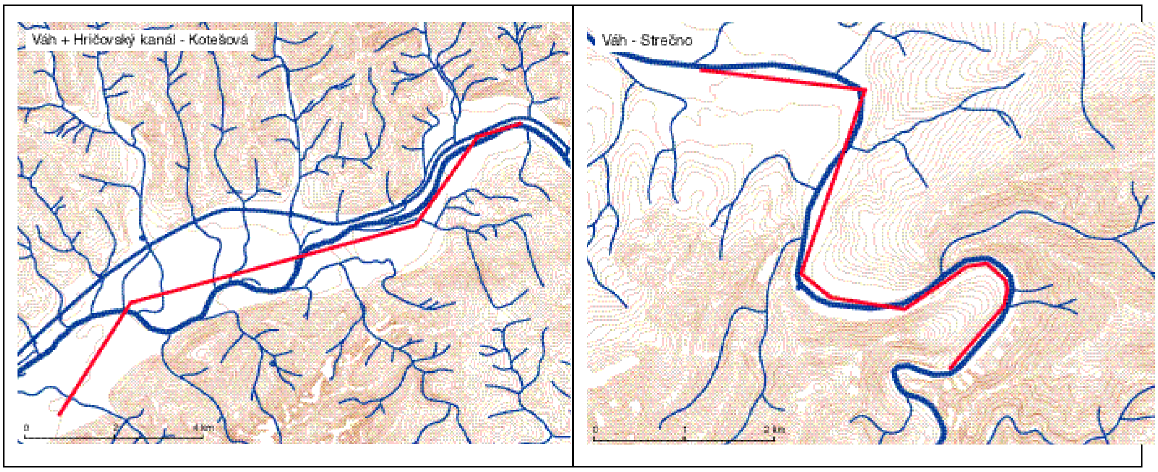


Table 1: Table for evaluating parameter 1.1. Channel sinuosity

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

1.2 Channel type

The channel type is identified using the following definitions:

Single thread	Single channel river. If there are gravel bars or islands, the channel is no wider than the respective channel without bars or islands.
Parallel channels	Anastomosing and anabranching rivers, where the channel is split into two or more persistent branches.
Braided	River divided by gravel bars that are wider than the average width of the unbraided channel or where there are three or more overlapping bars.

The score is found from Table 2.

Table 2: Table for evaluating parameter 1.2 Channel type

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

If there are no historic maps, the natural type has to be estimated from the literature using information on geology and geomorphology. Alternatively remnants of the old channels in the flood plain can potentially be identified on aerial photos and the historic channel type can thus be estimated.

1.3 Channel shortening

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

Table 3: Table for evaluating parameter 1.3 Channel shortening

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

2. In-stream features

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

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

2.1 Bed elements

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

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

The score for each SSU is determined from Table 4.

Table 4: Table for evaluating parameter 2.1 Bed elements

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

Figure 2: Bed elements

Bar

Island

Riffle	Rapid
	
Rocks	Step pool sequence
	

2.2 Bed substrates

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

The different substrate types considered are:

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

Figure 3: Bed substrate types

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

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

Table 5: Table for evaluating parameter 2.2 Bed substrates.

Number of substrate types	Score
1	4
2	3
3	2

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

2.3 Variation in width

Variation in width is defined as the largest channel wetted width divided by the smallest channel wetted width in the SU at the time of the survey. The width is the distance from the right bank to the left bank perpendicular to the current, independent of whether islands occur in the cross-section. For large rivers, the value is found from topographic maps (scale 1:10,000 or 1:25,000) or on aerial photographs. Man-made structures such as port entries, etc., and small-scale protrusions are not taken into account. For smaller rivers the variation of width is measured in the field. The smallest and largest river widths are measured in each SSU and added to the assessment form. The ratio between the largest and the smallest width considering all measurements within all the SSUs is calculated. The score is found from Table 6.

Table 6: Table for evaluating parameter 2.3. Variation in width

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

2.4 Flow types

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

Freefall (FF) The flow separates clearly from the back wall of a distinct vertical feature. Generally associated with waterfalls.

Chute (CH) A low curving fall with substantial flow contact with the substratum. There may be multiple chutes in a short distance often over boulders or bedrock outcrops. Associated with cascades.

Chaotic (CA) No clearly distinctive flow patterns when more than one flow type are occurring close together.

Broken standing waves (BS) Mostly associated with rapids and riffles. White water tumbling wave is present.

Unbroken standing wave (US) Often associated with riffles. This flow type has a disturbed surface with upstream facing wavelets.

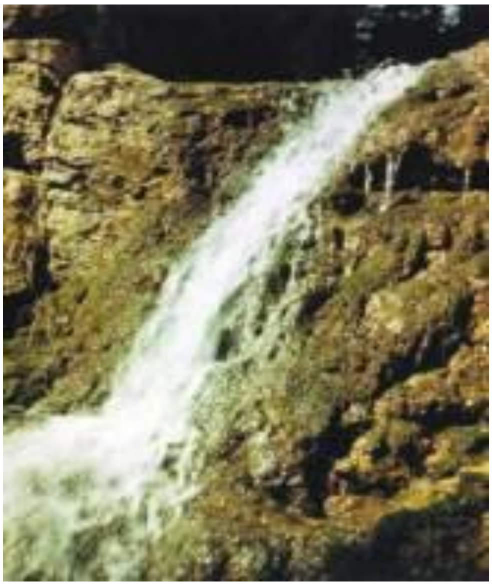
Rippled (RP) No coherent pattern in the flow direction and no waves. Wavelike ripples are asymmetrical and only a centimetre or so in height. Be aware that wind can affect the assessment as it can create a rippled surface (and in a few cases standing waves).

Upwelling (UP) Occurs where the water surfaces ‘heave’ as upwelling reach the surface, e.g. at tight bends or below cascades and behind in-stream vegetation.

Smooth (SM) Moving water without a disturbed surface. Associated with glides.

No perceptible flow (NO) Associated with pools and ponded reaches. No overall movement of the water is visible.

Figure 4: Flow types.

Freefall 	Chute 
Chaotic 	Broken standing waves 
Unbroken standing waves 	Rippled 

Upwelling	Smooth
	
No perceptible flow 	

Each flow type should cover > 5% of the surface area to be scored with the exception of flow types free fall and chute which only have to be present. On the assessment form all substrate types that are present in the amounts needed for scoring are circled and subsequently counted and the score for each SSU is determined from Table 7. The score for the SU is determined as the average of the five SSU scores.

Table 7: Table for evaluating parameter 2.4 Flow types

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

2.5 Large woody debris

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

LWD is recorded for the each SSU and the value is scaled to represent the number of LWD per km reach. The score is determined from Table 8. Note that if the LWD is smaller than the limit set here, it should be assessed as CPOM substrate and thus count in the bed substrate assessment, if coverage exceeds 5% in total (2.2).

Table 8: Table for evaluating parameter 2.5 Large woody debris

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

2.6 Artificial bed features

This covers constructions such as fairway, bed reinforcement, parallel structures, groynes, ground sills, pipeline crossing and colmatage. Artificial bed features are always made of artificial materials that are not endemic to the stream / river. The score is given according to the length of the affected river, see Table 9.

Table 9: Table for evaluating parameter 2.6 Artificial bed features

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

3. Bank / Riparian zone parameters

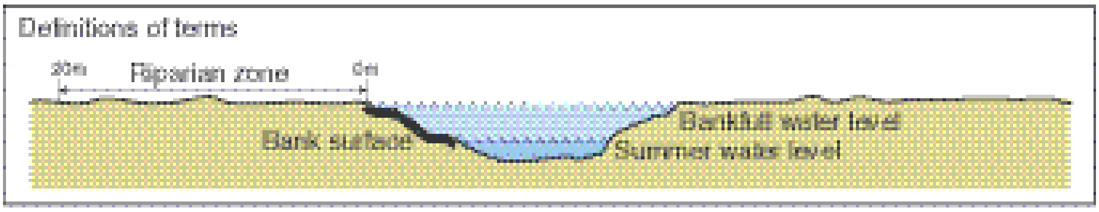
Bank and riparian parameters are assessed separately for the left and the right side of the stream in each SSU. The scores for each parameter are first averaged for all SSU and then bank and riparian score (BRS) is calculated as the average of the three bank and riparian parameters.

BRS = (3.1 + 3.2 + 3.3)/3

3.1 Natural riparian vegetation

This includes vegetation in the riparian zone along both channel banks. The riparian zone is here defined as a 20-metre strip with the lower boundary at bankfull level (Fig. 5). Islands are not included in the survey. Note that in the case of trees it is the projected area of the canopy that is used for the coverage and not the stem of the tree.

Figure 5: Identification of the riparian zone where vegetation is assessed



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

Natural riparian vegetation:

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

Other vegetation types:

Herbs, tall herbs and shrubs, meadow, pasture, non-native trees.

Managed land:

Arable land, parkland, gardens, golf courses etc.

Artificial structures:

Roads, rail, urban, industrial etc.

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

Natural: >90% natural vegetation. Rest: other vegetation types. No artificial structures or managed land.

Near natural: 25% - 90% natural vegetation. Rest: other vegetation types. No artificial structures or managed land.

Semi-natural: <25% artificial structures or <50% managed land

Modified: 25-50% artificial structures or 50-75% managed land

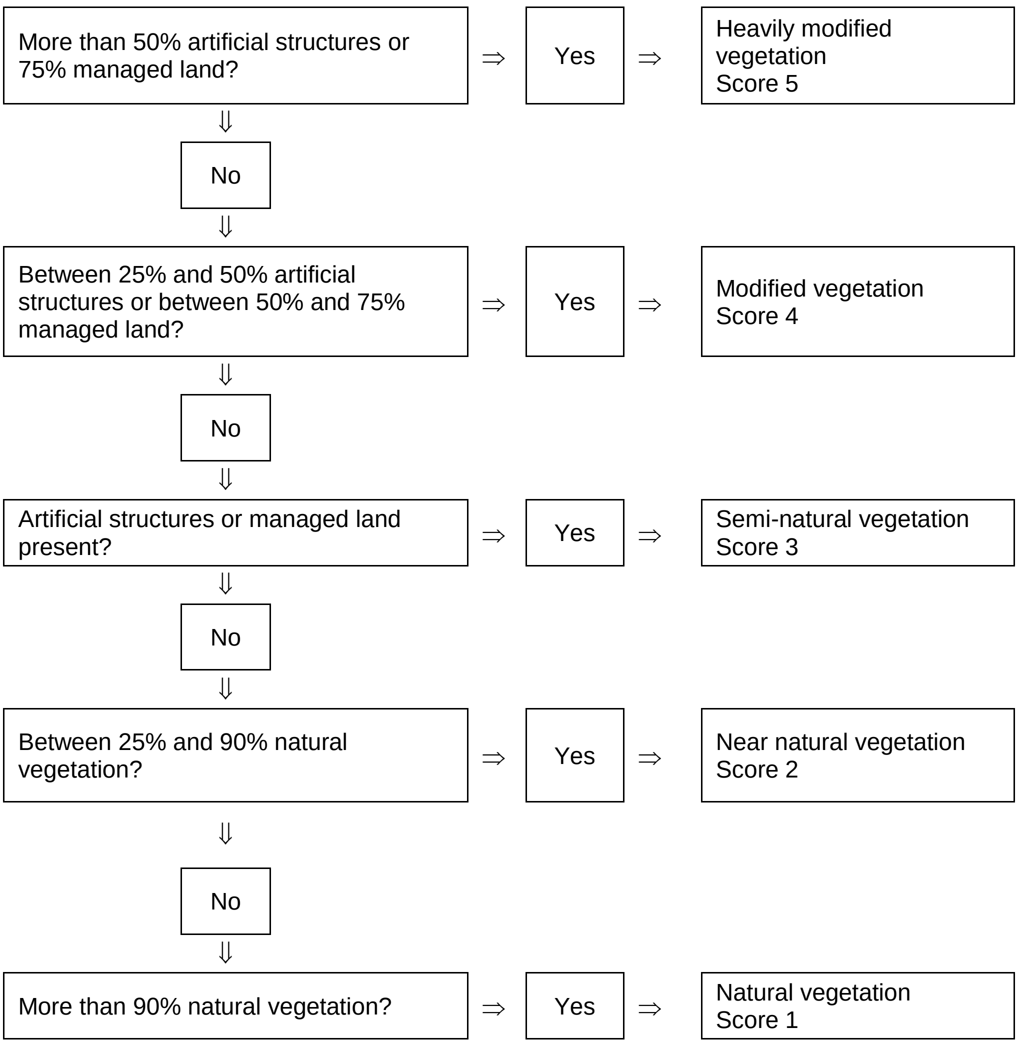
Heavily modified: >50% artificial structures or >75% managed land

Table 9: Table for evaluating parameter 3.1 natural riparian vegetation

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

The flow diagram in Figure 6 can be used to determine the vegetation quality class and the score for the riparian vegetation.

Figure 6: Flow diagram for determining the vegetation on the riparian areas



3.2 Bank stabilisation

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

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

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

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

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

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

Table 10. Table for evaluating parameter 3.2 Bank stabilisation

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

3.3 Bank profile

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

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

Artificial bank structures

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

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

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

Boulders, brickwork (unbroken): Cobble, set rubble stones, bricks, walls, concrete surfaces.

In case of modified banks only the predominant type is to be taken into account. If boulders are occasionally added to the bank, the profile for the reach is set to semi natural.

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

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

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

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

Table 11: Table for evaluating parameter 3.3 bank profile

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

Floodplain parameters

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

FPS = (4.1 + 4.2)/2

The field survey/assessment involves two parameters:

Size (percentage) of present natural floodplain area compared to potential (historical)

Land use / natural vegetation in floodplain

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

<u>4.1 Flooded area</u>

The flooded area is here defined as that part of the floodplain that has the potential of being flooded.

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

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

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

Guiding/summer dykes: All dykes located within the inundated floodplain (e.g. summer dykes, remainder of old dykes or road dykes) that affect flooding. The presence of such structures in relation to the section length of the river axis is not included in the score but has to be registered in the site protocol. The score is given from Table 12.

Table 12: Table for evaluating parameter 4.1 Floodplain area

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

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

4.2 Natural vegetation / land use on floodplain

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

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

The percentage of the actual floodplain covered by natural vegetation is estimated for each bank of the sub-unit, and the score is set according to Table 13. The arithmetic mean of the 5 assessments from each side of the in sub-unit is used as the final score. The final score is subsequently included as a decimal value in the assessment.

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

Table 13: Table for evaluating parameter 4.2 Natural vegetation / land use on floodplain area

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

5. Hydrological regime assessment

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

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

The hydrological regime score (HRS) is calculated as the average of the scores given for mean flow, low flow, water level range and frequent flow fluctuations:

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

5.1 Mean flow

The score is based on the reduction in mean flow from the mean flow in the reference state (Table 14).

Table 14: Table for evaluating parameter 5.1 Mean flow

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

5.2 Low flow

The score is evaluated based on the reduction in low flow from the low flow in the reference state (Table 15). If hydrological records are available, Q_{355} can be used. Otherwise the low flow is the typical flow during low flow periods.

Table 15: Table for evaluating parameter 5.2 Low flow

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

5.3 Water level range

The range in water level is defined as (Hc / Hr) x 100, where Hc is the current difference between the mean annual maximum water level and the mean annual minimum water level, and Hr is the difference between the mean annual maximum water level and the mean annual minimum water level in the reference condition.

The score is based on the change in water level range from the reference state (Table 16)

Table 16: Table for evaluating parameter 5.3 Water level range

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

5.4 Frequent flow fluctuations

Frequent flow fluctuations occur typically below hydropower plants where the operation of the turbines changes on a short-term (often daily) basis. The score is based on the magnitude of the frequent flow fluctuations, which is assessed as minor, moderate or major (Table 17).

Table 17: Table for evaluating parameter 5.4 Frequent flow fluctuations

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

ASSESSMENT FORM – Structural features

Stream / River name: Site name: Date:
Surveyor: Surveyor Cert. No.:

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

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

ASSESSMENT FORM – Hydrological features

Stream / River name: Site name: Date:
Surveyor: Surveyor Cert. No.:

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

ANNEX 2. INDICATIVE LIST OF THE MAIN POLLUTANTS ACCORDING TO WFD ANNEX VIII

1. Organohalogen compounds and substances which may form such compounds in the aquatic environment;
2. Organophosphorous compounds;
3. Organotin compounds;
4. Substances and preparations, or the breakdown products of such, which have been proved to possess carcinogenic or mutagenic properties or properties which may affect steroidogenic, thyroid, reproduction or other endocrine-related functions in or via the aquatic environment;
5. Persistent hydrocarbons and persistent and bioaccumulable organic toxic substances;
6. Cyanides;
7. Metals and their compounds;
8. Arsenic and its compounds;
9. Biocides and plant protection products;
10. Materials in suspension;
11. Substances which contribute to eutrophication (in particular, nitrates and phosphates);
12. Substances which have an unfavourable influence on the oxygen balance (and can be measured using parameters such as BOD, COD, etc.

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