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EPIRB Project Activity 2
Pilot Testing in EPIRB Project River Basins

Guidance Document

addressing hydromorphology and physico-chemistry for a Pressure-Impact Analysis/Risk Assessment according to the EU WFD

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1 INTRODUCTION

The development of River Basin Management Plans (RBMPs) according to the EU Water Framework Directive (2000/60/EC) requires many implementation steps that build upon each other. The ***Pressure and Impact Analysis*** according to the EU WFD's Article 5 and the corresponding Annex II is an essential component. It forms the basis for designing monitoring networks and programmes in specific the operational monitoring that responds to identified impacts. In addition, the *Pressure and Impact Analysis* supports the setting of tailor made and effective measures to achieve the required WFD environmental objectives.

The EPIRB Project aims at developing River Basin Management Plans and aligned Programmes of Measures. In this context a *Pressure and Impact Analysis* and the related risk assessment according to Article 5 has to be undertaken for each of the five selected pilot river basins. So far, river basin analyses have been developed for each pilot river basin, which also include a preliminary identification of pressures and impacts.

However, the methodologies that have been applied to assess possible impacts of anthropogenic pressures on water bodies show some shortcomings that partly include (i) lacking estimations if water bodies are at possible risk to fail the environmental objectives, (ii) coherent approaches regarding pressure types and corresponding impact/risk criteria as well as (iii) general assessment gaps can be identified. In any case, the findings and information from these previous assessments are a valuable basis of the upcoming *Pressure-Impact Analysis* and will be fully taken into account.

It should be noted here, that the previous identification of pressures and impacts within the EPIRB Project was done on a preliminary level and improvements have always been foreseen as part of the RBMP development and the upcoming Joint Field Surveys that will soon take place.

This document provides guidance to undertake an improved *Pressure and Impact Analysis* and *risk assessment* for surface water bodies applying most effective pressure indicators, parameters and coherent criteria. The overall scope and detailed objectives of this guidance document are outlined in **Chapter 2**.

Testing of the Approach of this Guidance Document

The experts are asked to test and implement the approach and its criteria (**Chapter 4**) through desk work (Step 1) before the 2nd EPIRB Project RBMP Workshop (16-17 June 2014, Batumi, Georgia).

In case a *Pressure-Impact Analysis* has already been undertaken that (i) delivered coherent results and that (ii) fits the related demands of this guidance document, focus of the testing should be given to the implementation of risk criteria and the estimation if a water body is at risk to fail the EU WFD objectives.

Any findings and shortcomings for adaptation and revision are supposed to be presented and to be discussed at the workshop towards optimisation. The testing will also enable targeted support to work on specific cases at the workshop and in follow

This document is a ***living document*** that can be extended and adapted to the conditions in the EPIRB Project pilot basins as well as to new policy requirements of the EPIRB Project beneficiary countries.

2 SCOPE, FOCUS AND OBJECTIVES OF THIS GUIDANCE DOCUMENT

2.1 Scope

The scope of this living guidance document is to support experts within the EPIRB Project to analyse pressures and impacts in the rivers of five pilot river basins according to the EU Water Framework Directive. Focus of the *Pressure and Impact Analysis* will be on hydromorphology and general physico-chemistry and it will support the estimation if river water bodies are at risk to fail the environmental objectives of the EU WFD.

2.2 Focus

The approach of the *Pressure and Impacts Analysis and risk assessment* addressed in this document

- is aligned to the requirements of the EU WFD and the CIS IMPRESS Guidance Document #3[1],
- addresses exclusively river surface water bodies,
- is based on previous EPIRB Project findings,
- proposes indicators and criteria to assess pressures and impacts regarding (i) general physico-chemical as well as (ii) hydromorphological parameters, and
- criteria regarding pressures and impacts on chemical water status will be proposed and applied by the respective EPIRB Project key expert.

2.3 Detailed Objectives

The detailed objectives of this study are to:

- **Guide the experts involved in the EPIRB Project** and the development of the RBMPs for the five pilot river basis regarding the analysis of pressures and impacts regarding hydromorphology and general physico-chemistry;
- **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 as part of the EPIRB Project** pilot river basins 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**;**
- Link the EPIRB Project Pressure-Impact Analysis through criteria to a **risk assessment** in order to estimate if river water bodies are at risk to fail the EU WFD objectives;
- Design the approach in a **concise way focusing on key indicators and criteria**,
- Base the approach **upon previous EPIRB Project** work, and
- Ensure easy and combined implementation through **desk work that will be supplemented for improvement by field assessments** during the upcoming Joint Filed Surveys.

[1]https://circabc.europa.eu/sd/a/7e01a7e0-9ccb-4f3d-8cec-aeef1335c2f7/Guidance%20No%203%20-%20pressures%20and%20impacts%20-%20IMPRESS%20(WG%202.1).pdf

3 IDENTIFICATION OF PRESSURES AND ASSESSMENT OF IMPACTS

3.1 EU WFD requirements as basis for the EPIRB Project

As stated above, the implementation of a *Pressure and Impact Analysis* is requested by EU WFD Article 5[2] and Annex II and respectively 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; and
- carry out an assessment of the risk that these water bodies 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 IMPRESS Guidance Document #3 on the *Analysis of Pressures and Impacts* (2001)[3] has been developed under the Common Implementation Strategy for the Water Framework Directive.

The (i) *Identification of Pressures* and (ii) the *Assessment of Impacts* is specifically addressed in the EU WFD Annex II (item 1.4. and 1.5) and consecutively follows-up previous implementation steps – that are listed below – as part of the basic characterisation of river basin districts/river basins:

- Characterisation of surface water body types (Annex II/1.2)
- Ecoregions and surface water body types (Annex II/1.3)
- Establishment of type-specific reference conditions for surface water body types.

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;
- Morphological alterations;
- Effects of modifying the flow regime through abstraction or regulation.

Basic Role of a Pressure and Impact Analysis according to the EU WFD

An EU WFD *Pressure and Impact Analysis* and the linked *risk assessment* aims to determine the likelihood that surface water bodies and groundwater bodies will fail to meet the environmental quality objectives. For water bodies at risk of failing their specified objectives, it is required to implement operational monitoring in order to validate estimated impacts and to set measures in that enable the achievement of good water status.

Within the EPIRB Project the findings of the *Pressure and Impact Analysis* and risk assessment will be used as basis (i) to design the operational monitoring programmes and network, (ii) identify measures as part of the PoM as well as (iii) to supplement eventual assessment gaps of water status assessment. The latter will be used to provide guidance to the beneficiaries by clearly indicating where future management efforts regarding monitoring improvement and setting of mitigation measures will be needed.

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[2] Characteristics of the river basin district, review of the environmental impact of human activity and economic anylsis of water use.

[3] http://ec.europa.eu/environment/water/water-framework/facts_figures/guidance_docs_en.htm

3.2 EU WFD Pressure and Impact Analysis for EPIRB Project implementation

3.2.1 The analytical framework of Driver-Pressure-State-Impact-Response (DPSIR)

The overall approach of the *Pressure and Impact Analysis* as described in the CIS IMPRESS Guidance and, hence, in this guidance document for the EPIRB Project follows the basic principle of cause and effect. This principle is based on the best practice analytical framework of the **DPSIR (Driver-Pressure-State-Impact-Response)** methodology that supports the identification and understanding of human pressures, the assessment on their significance and their possible adverse impacts these may have on riverine ecosystems and might cause the failure to achieve good water status.

According to DPSIR a ***pressure*** is the direct effect from a human activity (=driver; water use) that can negatively impact on ecosystems of surface waters and in consequence on water status.

The following **Figure 1** describes the basic DPSIR principle, defines its components and additionally presents an applied example for a better understanding (nutrient input – eutrophication).

Component(	Definition(
Driver(	A" human" activity" that" may" have" an" environmental" effect" (i.e." hydropower" generation,'industry,'agriculture,'etc.)"
Pressure(	The"direct"effect"stemming"from"a"driver"(i.e."an"effect"causing"a"change"of"the" riverine'flow'regime)"'
State(	The"condition"of"a"riverine"water"reach"resulting"form"both"natural"factors"but" also'human'pressures"
Impact(	The" environmental" effect" of" the" pressure" (i.e." degraded" water" quality;" fish" mortality)"
Response(	The"mitigation"measures"that"are"taken"to"improve"the"state"of"the"impacted" water'reach'(i.e.'minimising'water'abstraction;'reducing'pollution,'etc.)"

"

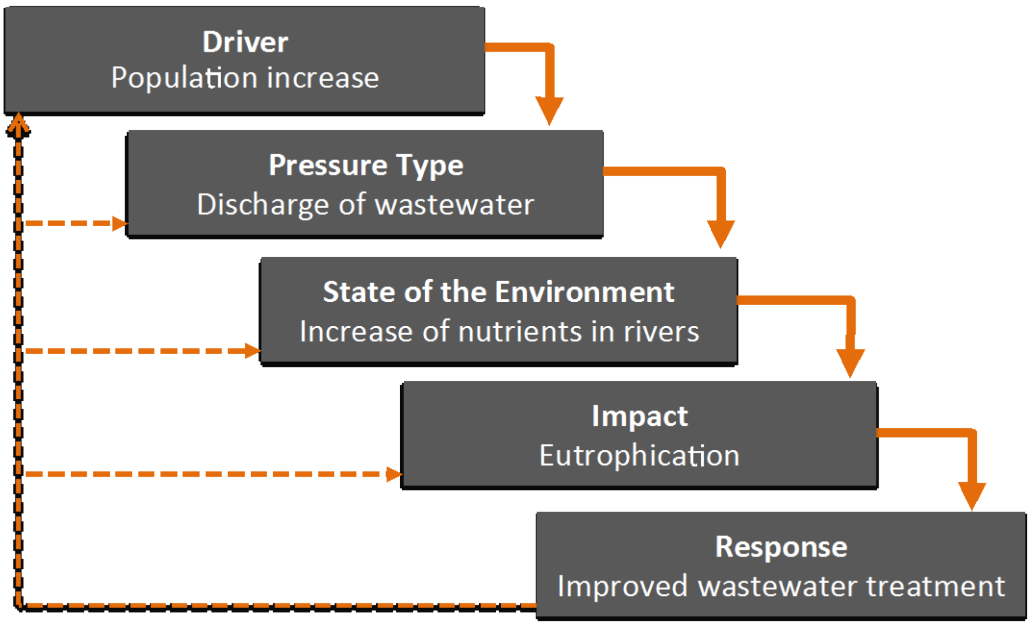

Figure 1: Basic principle of the analytical DPSIR methodology also presenting an applied example.

Figure 1 shows, a clear relation between impact and the state of the riverine environment. Whereas impacts are sometimes difficult or impossible to measure (e.g. in case of lacking monitoring programmes/networks), the state of the environment can be either measured/assessed (if sufficient monitoring data are available) or estimated through a /using criteria. The DPSIR system provides a general and interrelated analytical framework, which integrates dependant components with each other. It enables a holistic analysis on the function of aquatic ecosystems and its water status, how it can be impacted and in consequence mitigated through the implementation of measures. **Figure 2** outlines further examples to support the understanding of the DPSIR principle.

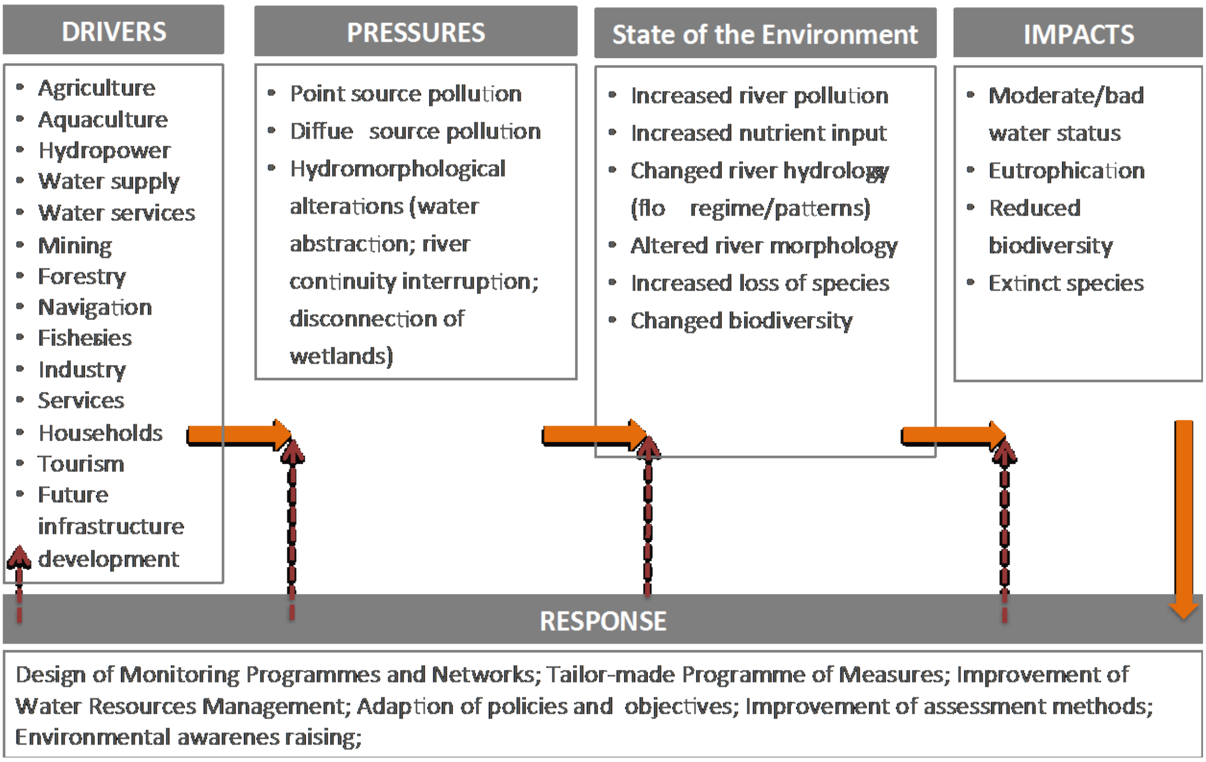

Figure 2: Further examples for the DPSIR principle linking drivers and possible impacts on water bodies.

3.2.2 Linking the Pressure and Impact Analysis with Risk Assessment

The analysis of pressure and impacts/risk assessment as proposed in this EPIRB Project guidance document is aligned to the DPSIR principle and is illustrated in **Figure 3** and also**,** more detailed, in **Figure 4**. Therefore, the *Pressure and Impact Analysis* starts with the identification of environmentally relevant drivers and pressures, followed by the assessment of significant pressures, hence, impacts and finally the estimation of possible risks of water bodies to fail the WFD environmental objectives.

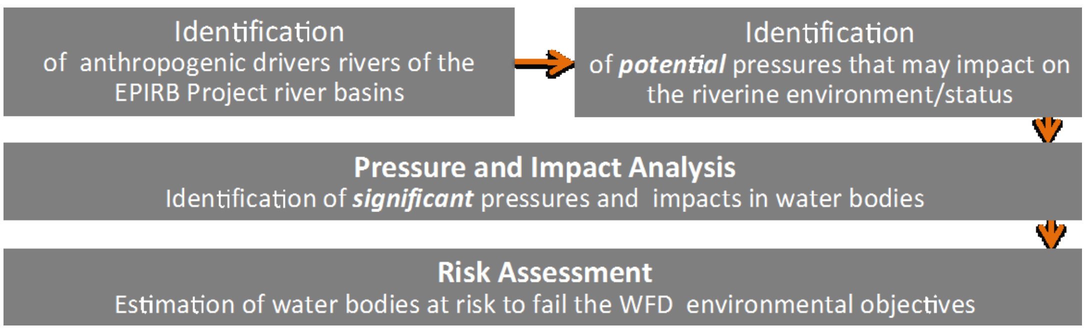

Figure 3: Basic scheme of the Pressure/Impact Analysis and risk assessment proposed in this guidance document for implementation in the EPIRB Project river basins.

The identification of relevant pressures (= significant pressure) that can affect river water bodies and the assessment of their actual impacts is an essential part of the *Pressure and Impact Analysis* to be undertaken. This means, in case a pressure is assessed as significant - via the application of defined criteria – it can impact negatively on the quality of rives and put the achievement of environmental objectives at risk.

Impacts and risks to fail objectives are assessed via the application of thresholds and/or criteria.

In follow-up to a *Pressure and Impact Analysis* and risk assessments, the factual impact of a pressure can be directly assessed and validated through operational monitoring. In addition, information gained through monitoring can also be used to adapt and improve the significance criteria to assess the significance of pressures.

Steps of the Pressure-Impact Analysis and Risk Assessment

In addition to **Figure 3**, the following **Figure 4** describes the three steps the *Pressure-Impact Analysis* and the link to the risk assessment in more detail for implementation within the EPIRB Project. **Step 1** of the assessment focuses on the identification of pressures that may negatively affect riverine systems. **Step 2** is dedicated to the definition of criteria to assess the impacts due to significant pressures. In case the defined significance criteria/thresholds for impacts are exceeded, the risk to fail the set environmental objectives will be automatically assumed (**Step 3**).

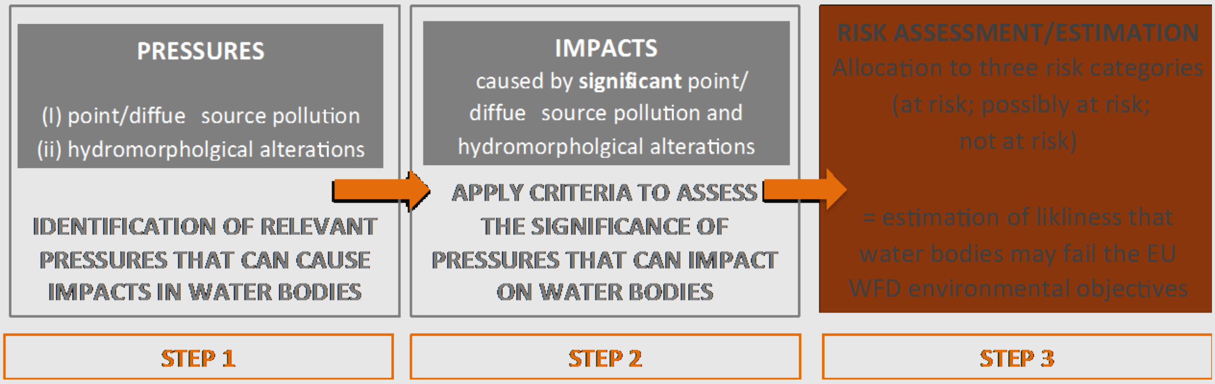

Figure 4: The three steps of the risk assessment addressing the assessment of the significance of pressures and impacts towards the estimation of the risk.

The implementation of the risk criteria results in the allocation to three risk classes that indicate if a water body is 1 - '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 and/or chemical elements that can best assess the estimated impact.

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)

EU WFD Consecutive Steps to the Pressure-Impact Analysis and Risk Assessment

The findings of the Pressure/Impact Analysis and risk assessment trigger the

(i) specification of the environmental objectives,

(ii) design of operational monitoring and

(iii) setting of effective measures to achieve the environmental objectives.

The operational monitoring serves the validation of estimated impacts as well as the assessment of the effect of measures towards the good water status.

4 EPIRB PROJECT PRESSURE-IMPACT ANALYSIS, RISK ASSESSMENT AND RELATED CRITERIA

4.1 Role of physico-chemical and hydropmorphological elements in the EU WFD

Hydromorphology and general physico-chemistry take a specific role within the EU 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*. **Annex 2** provides additional information on the role of hydromorphology and general physico-chemistry, specifically regarding status assessment.

According to the WFD, the elements used to determine a **high water status** are (i) biological quality elements, (ii) chemical quality elements, (iii) general physico-chemical quality elements, AND (iv) hydromorphological quality elements. This means that a water body can only have a high status if its hydromorphology as well as physico-chemistry shows a high status.

The elements used to determine a **good water status** are (i) biological quality elements, (ii) chemical quality elements and (iii) general physico-chemical quality elements. This means that a good status can be achieved in a water body even when the hydromorphological indicate a lower status.

Any assessment of a status lower than good which is **moderate, poor or bad status** is based exclusively on the assessment of (i) biological quality elements and (ii) chemical quality elements. Hydromorphological and physico-chemical elements take a supportive role.

However, 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.

The introduction and implementation of risk criteria and/or thresholds regarding hydromorphological and general physico-chemical elements can be used to assess significant pressures and impacts on water status.

Such criteria addressing hydromorphology and general physico-chemistry are proposed below to be implemented with the Pressure-Impact Analysis and risk assessment within the EPIRB Project.

4.2 Pressure-Impact Analysis/Risk Assessment for hydromorphological elements

Following the basic principles of **Chapter 3** and the WFD requirements, this chapter is specifically dedicated to the provide guidance in order to analyse pressures and impacts due to hydromorphological alterations of river surface water bodies in the EPIRB Project pilot basins. Specifically, criteria are proposed to estimate if a water body is at risk to fail the environmental objectives because of either anthropogenic hydrological or morphological pressures.

The provisions for hydromorphological elements and their EU WFD role are outline in the above Chapter 4.1. Transferred to the needs of the EPIRB Project this means that hydromorphological elements will be needed to identify reference sites in order to ensure the precondition to assess not only high water status. In addition, the elements will be needed to identify any possible impacts on water status and base (i) the design of operational monitoring as well as (ii) the Programme of Measures on these findings.

4.2.1 Background and available information

According to the Annex V, the EU WFD requires the assessment of the following hydromorphological elements to assess high, good and moderate status (**Table 2**). **Table 2** clearly shows that hydromorphological pressures are only assessed indirectly for good and moderate status. This becomes of special importance with the Pressure-Impact Analysis and risk assessment and, hence demands a representative approach for analysis, which is proposed here.

Table 2: **Definitions for high, good and moderate ecological status in rivers taking into account hydromorphological parameters (EU WFD Annex V).**

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

The assessment of hydromorphological conditions does not have a long tradition within water resources management. In fact, only some EU Member States had respective survey and assessment schemes in place before the EU WFD came into force. Today it can be said that most EU MS have systems in place and morphological assessments are available for entire national river networks. Based on this, *Pressure-Impact Analyses* have been undertaken towards the first RBMPs 2009 and as part of the river basin analyses 2004 & 2013, that concluded that hydromorphological alterations put a majority of river water bodies in Europe at risk. The types of hydromorphological alterations vary between EU MS but the interruption of river continuity and fish migration by artificial barriers is a common challenge. Aligned to the findings of the RBMPs, significant financial efforts need to be undertaken in future to restore the altered hydromorphological conditions of river water bodies to achieve the good status at the latest by 2027.

For the EPIRB beneficiary countries, shortcomings regarding hydromorphological surveys and assessments can be identified but efforts are certainly undertaken to fill gaps. The EPIRB Project identifies hydromorphological alterations as Significant Water Management Issues besides organic pollution, nutrient pollution and pollution caused by hazardous substances in. Hence, hydromorphological alterations are tackled in the EPIRB pilot river basins to be part of the RBMPs.

During the undertaken EPIRB Project Joint Field Surveys 2013 the following hydromorphological elements have been addressed aligned to the WFD requirements (see **Table 2**):

- Interruption of river and habitat continuity;
- Hydrological alterations;
- Modification of river morphology.

More specific parameters have been surveyed within the EPIRB Project include channel geometry, substrate composition, channel vegetation and organic debris, bank structure and related modification, flow conditions, interruption of longitudinal continuity by artificial structures, vegetation type, adjacent land use, and channel-floodplain interaction. Alteration of river morphology has been taken into account for a preliminary pressure analysis. Details for survey and assessments are part of **Annex 2.**

Although the above list of hydromorphological elements is extensive and WFD compliant, an assessment gap that hampers a complete *Pressure-Impact Analysis* so far is that the EPIRB Joint Field Surveys were exclusively implemented at selected spot checks and did not cover the *entire* length of the river network. The focus was rather on identifying reference site as basis for status assessment but did not necessarily focus on spot checks regarding pressures as well as impacts.

However, the collected information that has been carefully compiled so far by experienced experts within the EPIRB Project is considered as a very valuable basis to supplement and complete the analysis of pressures and impacts by this approach in this guidance document for integration into the EPIRB Project's RBMPs.

The approach to analyse pressures and impact as well as to undertake the risk assessment is described in the following **Chapter 4.2.2.**

4.2.2 Approach for Pressure-Impact Analysis and Risk Assessment for hydromorphological elements

The guidance for the approach on *Pressure-Impact Analysis and risk assessment* takes into account the precondition that are described in **Chapter 4.2.1** and is designed in such a way to fill the gaps in the best possible and effective way.

The assessment is based on expert judgement and planned to be implemented through a **2-step approach** that can be undertaken in parallel or consecutively for the five EPIRB Project pilot basins:

Step 1: Analysis if water bodies are at risk to fail objectives due to hydromorphological alterations by **implementing the proposed risk criteria through desk work** using**:**

- Previous EPIRB Project survey and assessment finding on hydromorphology and
- Existing national information on hydrology, eventually morphology and related pressures.

Both sources of information for the Analysis have to be compiled carefully to ensure success of Step 1. The approach is based on the implementation of expert judgement and assumes that the experts working in the pilot basin largely know the data sets, natural conditions and pressures in the basin as well as their respective combination during the risk assessment. Any knowledge gaps on pressures and impacts in the pilot basins need to be highlighted and located in order to be filled in the second EPIRB Project Joint Field Surveys via planned surveys.

Step 2: Analysis if water bodies are at risk to fail objectives due to hydromorphological alterations by **additional survey was part of the 2nd EPIRB Project Joint Field Survey:**

The surveys will be targeted as it is based on identified knowledge gaps that are identified during the desk work. The on-site surveys serve the collection of missing information on-site to fill gaps and to complete the *Pressure-Impact Analysis and risk assessment* in follow up.

As far as possible and feasible for key rivers, the expert are motivated to undertake hydromorphological assessments of entire river reaches applying the proposed criteria as this will automatically lead to complete risk assessments in the end.

Size categories:

As for other parameters, also when it comes to hydromorphology related anthropogenic pressures impact differently depending on the size of the river or its catchment area. When implementing a risk assessment this fact has to be taken into account, specifically when setting and applying risk criteria.

Different methodologies are in use regarding this challenge, e.g. taking into account stream order rankings, catchment area size categories or river typologies. To ease implementation, this approach will make use of river size categories that are based on typology and that have been used with in he EPIRB Project before. Risk criteria will be proposed for each of the three size groups which are outlined in **Table 3**.

Table 3: Three groups of river sizes for which risk criteria shall be applied.

River Size Category	Description of River Type	Proposed Catchment Area Sizes
Small	Mountain 'gravel' river type	10 km^2 – 100 km^2
Medium	Semi-Mountain 'gravel' river type	100 km^2 – 1000 km^2
Large	Lowland/Plain river type	> 1000 km^2

Types of Pressures

Based on experience regarding EU WFD risk assessments and in favour of effectives, the approach makes use of the most relevant ***hydromorphological pressure types*** instead of using the each element that is part of morphological surveys (see **Annex 1**).

For each of the ***five identified pressure types***, risk criteria are proposed in this guidance document that shall be implemented making use of readily available data and expert judgement to determine if water bodies are at risk due to hydromorphology according to the three risk categories.

As described above, filed surveys and assessments will exclusively serve the completion of the desk work and filling of data gaps. Hence, the detailed findings of survey and assessments of the EPIRB Project Joint Field Survey regarding hydromorphology will be a useful additional information to estimate the risk of the selected pressure types.

The list of pressure types can be supplemented if needed in the frame of the 2nd EPIRB Project RBMP Workshop (16-17 June 2014, Batumi, Georgia).

The five pressure types for which criteria are proposed are listed in the following **Table 4**.

Table 4: Pressure types for which criteria are identified (see Tables 6 – 10) to determine if water bodies are at risk to fail the WFD environmental objectives.

Pressure Group	**Pressure Type** *including the indication of drivers*
Longitudinal river and habitat continuity interruption	**1. Interruption of river continuity and fish migration routes** Drivers: Irrigation; hydropower; drinking water reservoirs; other barriers;
Hydrological alteration	**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;
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.

Risk categories and *One-Out-All-Out Principle*

Based on the criteria, outcomes will enable the allocation of water bodies to three risk categories (see **Table 5**). 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 5: 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) 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.

Testing

The experts are asked to test and implement the criteria through desk work (Step 1) before the 2nd EPIRB Project RBMP Workshop (16-17 June 2014, Batumi, Georgia). Any findings and shortcomings for adaptation and revision are supposed to be presented and to be discussed at the work shop towards optimisation. The testing will also enable targeted support to work on specific cases at the workshop and in follow-up.

4.2.3 Criteria to assess the risk of failing the environmental objectives

The following **Tables 6 to 10** list the risk criteria for each hydromorphological pressure types as outlined **in Table 4** in order to apply the *One-Out-All-Out Principle* in follow-up and to determine if a water body is at risk to fail the WFD environmental objectives. The criteria are outlined for (i) small, (ii) medium and (iii) large river types (see **Table 3**) and need to be implemented accordingly towards correct results.

Table 6: Risk criterion regarding the pressure type #1: *River and Habitat Continuity Interruption*.

River Size	Not At Risk	Possibly At Risk	At Risk
Small & Medium	Artificial 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 without functioning fish bypass facility and that hinder fish migration and interrupt habitats
Large	Artificial 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 without functioning fish bypass facility and that hinder fish migration and interrupt habitats

Table 7: Risk criterion regarding the pressure type #2: *Water Abstraction – Insufficient Ecological Flow*.

River Size	Not At Risk	Possibly At Risk	At Risk
Small & Medium	No water abstraction	No sufficient information is available	No water downstream abstraction site (full year or temporary) Aquatic ecosystem cannot be maintained below water abstraction; fish fauna/population can not migrate nor reproduce. $MQ_{eflow}<MJNQ_t$ or $NQ_{t\ nat}$ Water abstraction is located in a diversion reach
Large	No water abstraction	No sufficient information is available	No water downstream abstraction site (full year or temporary) Aquatic ecosystem cannot be maintained below water abstraction; fish fauna/population can not migrate nor reproduce.

Table 8: Risk criterion regarding the pressure type #3: *Impoundment / Reservoir Effect / Backwater*.

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 9: Risk criterion regarding the pressure type #4: *Hydropeaking*.

River Size	Not At Risk	Possibly At Risk	At Risk
Small & Medium	No hydropeaking Hydropeaking amplitude below dam < 1:3	Hydropeaking amplitude is unknown/Insufficient information Hydropeaking amplitude 1:3 up to 1:5	Hydropeaking amplitude below dam > 1:5
Large	No hydropeaking or Hydropeaking amplitude is very small/insignificant	Hydropeaking amplitude is unknown/Insufficient information	Any visible/significant hydropeaking

Table 10: Risk criterion regarding the pressure type #5: *River Morphology*
(only possible if survey result in 5 quality classes are available)

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

4.3 Pressure-Impact Analysis/Risk Assessment for physico-chemical elements

This chapter deals with the analysis pressures and impacts that may put a water body at risk of failing environmental objectives for general physico-chemical parameters as defined by the WFD. These general physico-chemical parameters according to the definition of the WFD are for rivers:

1. Thermal conditions
2. Oxygenation conditions
3. Salinity
4. Acidification status
5. Nutrient conditions

The physico-chemical parameter transparency is added for lakes.

As described in **Chapter 4.1**, the general physico-chemical parameters are used to support the interpretation of assessment results for biological quality elements and are not necessarily understood as a WFD quality element on their own. However, if there are contradictions between biological and general-physico-chemical quality elements these differences should be explained.

In the past, the first environmental quality standards for use oriented water quality objectives have been formulated for these general physico-chemical quality elements. Therefore, there is a high level of experience and information that has been used to develop this approach. Long time-series for these parameters are available for many regions of the world.

This long tradition results from the fact that this parameter group of physico-chemical elements indicates the most basic water quality problems, such as pollution stemming from municipal wastewater but also from certain industrial pollution sources and related quantitative problems that can impact on the thermal and oxygen regime of rivers.

4.3.1 Background and available information

No matter how detailed the data sets on a river basin are, the *Pressure-Impact Analysis and the risk assessment* is always limited by data availability. Therefore, all potential information sources have to be consulted and evaluated regarding their information content for implementing the risk assessment.

The objective of this *Pressure-Impact Analysis* is – under the condition of limited data availability - to make best possible use of all available information regarding physico-chemical elements, to select the most efficient way forward to improve the status of the water environment through effective monitoring and setting measures. For the EPIRB Project countries it is expected that a tiered approach will lead to several subsequent rounds of analysis and planning. This implies that in the future both, the methodology of the analysis as well as the data sources may be challenged, refined and improved from one implementation step to the next. Both methodology and data quality will play the crucial role for the success of the *Pressure-Impact Analysis* and informed decision making.

The EPIRB Project links past and future projects making use of its own data as well as of other projects. Therefore, it is important to carefully consider and describe the approach of this *Pressure-Impact Analysis* considering physico-chemical elements, to show clearly the gaps and provide a vision, where further assessments should go beyond EPIRB Project's boundaries.

The ultimate goal of a thorough *Pressure-Impact Analysis and risk assessment* would be to have an almost complete picture on the relevant pressures and impacts in river basin. A complete picture would include a mass balance of all "import", "export" and "transformation" processes of the river system under consideration. For this, information on pressures and emissions (in the case of general physico-chemical parameters) would need to be fully aligned with information on emissions to the river and the in-stream waters status.

As stated above, it is unrealistic that all information will be available for the EPIRB Project beneficiary countries in the near future. For the EPIRB Project's beneficiary countries the availability of information for this *Pressure-Impact Analysis* regarding general physico-chemical quality elements needs to be checked. In some EPIRB Project pilot basins / beneficiary countries the information on pressures will be more detailed than the information on environmental quality and vice versa. Data availability is an important restriction for the risk analysis.

4.3.2 Approach for Pressure-Impact Analysis and Risk Assessment for general physico-chemical elements

This subsection serves a brief description of the approach for Pressure-Impact Analysis and risk assessment for general physico-chemical elements.

Step 1:

In general, the approach regarding general physico-chemical elements is set up in a way offering a broad set of indicators to determine - in a first step of the analysis - which pressures are of relevance. The pressure indicators are based on the concept that either **(i) pressure information** or **(ii) water quality monitoring data** need to be available before assessing the risk of failing environmental objectives.

Pressure indicators: The approach of the *Pressure-Impact Analysis and risk assessment* proposes four indicators for pressures as well as which may impact general physico-chemical parameters[4].

Water quality indicators: For analysing the magnitude of impacts caused by pressures certain WFD compliant physico-chemical water quality parameters are proposed. The selection of the water quality parameters is based on data availability.

Step 2:

In a second step, for each of the identified pressures a corresponding risk criterion is proposed to determine if a water body is at risk of failing the environmental objectives. The pressure indicators are based on the concept that either (i) pressure information or (ii) water quality monitoring data need to be available before assessing the risk of failing environmental objectives.

Risk criteria: For each identified pressure, corresponding criteria are given to allocate results to

- three risk categories (water body 'no at risk', 'possibly at risk', 'at risk' to fail environmental objectives) in case of "pressure indicators" and
- two risk categories (water body 'no at risk', 'at risk' to fail environmental objectives) in case of "water quality indicators".

The following scheme describes the approach and links indicators, thresholds and risk criteria:

[4] No indicator is provided for industrial discharges (unless they are part of a municipal discharge) as they may be so diverse that is impossible to summarise them. Industrial discharges must be assessed on a case to case basis.

Risk categories and *One-Out-All-Out Principle*

All risk criteria are connected via an ***OR*** decision. In other words, if one of the identified pressures is assessed to cause an impact using the risk criteria then the water body is categorised to be at risk. This approach is fully in line with the ***WFD's one out, all out principle***.

Relating the estimated risk to water bodies

Relating local impacts (e.g. point source pollution) to entire water bodies regarding risk status is a challenging task. To address this task detailed information on a number of relevant conditions is needed. However, this level of detail is currently not available for the EPIRB beneficiary countries.

Therefore, it is recommended to select a precautionary approach to ensure that no significant pressure is neglected. This precautionary approach is based on the principle that each pressure that exceeds one of the risk criteria has an effect on the risk status of the entire water body. The entire affected water body needs to be put at risk to fail the environmental objectives in case a risk criterion is exceeded at a distinct location in a water body. This approach is recommended, in order to avoid neglecting any significant pressures in water bodies.

An alternative is to chose the risk category *'possibly at risk'* and describe in detail what information is lacking to implement a final risk allocation. This information would provide valuable input to water resource manager's and decision maker's considerations and it helps also to fill gaps in future.

In the following paragraphs the fundamental differences between these two types of indicators and their corresponding risk criteria are discussed taking into account (i) pressure indicators and related criteria, and (ii) water quality indicators and related risk criteria for physico-chemical elements.

(i) Pressure indicators and related risk criteria

Regarding relevant pressures, mainly information for the following two pollution sources plays a dominant role:

1. Medium to large population agglomerations[5] (and their wastewater management status);
2. Dominant diffuse pollution sources ;

A pressure indicator describes the type and magnitude of a pressure (e.g. a pollution load),while the risk criterion sets threshold levels to determine the risk of failing environmental objectives. If the pressure indicator violates the threshold of the risk criterion it is assumed that quality[5] objectives will be compromised and vice versa.

A risk criterion of this type links the magnitude and type of a pressure (e.g. a certain pollutant load) to the vulnerability/sensitivity of the river. The vulnerability/sensitivity of the river is described as far as possible by using available data on natural conditions, such as flow, catchment size and river typology that have been assessed within the work of the EPIRB Project.

The risk criterion tries to differentiate cases where the pressure is of minor importance for the river from cases where the pressure will lead to a significant degradation of environmental status.

[5] „Quality objectives" may have two meanings, either „water quality objective" in the sense of a desired chemical composition of the water or „environmental quality objective" in the sense that the whole water environment including biota should comply with certain standards

(ii) Water quality indicators and related risk criteria for general physico-chemical elements

The combined effect of the magnitude of a pressure and the susceptibility of the river to this pressure lead to a certain water quality. This water quality can also be directly measured/monitored, for instance in terms of general physico-chemical parameters. In this context, a second type of risk criteria is proposed here.

These criteria are threshold values for general physico-chemical parameters (quality standards). The *Pressure-Impact Analysis and risk assessment* analyses existing monitoring data to identify cases where these threshold values are violated.

Such quality standards have been very popular in the past. Usually related data are available almost everywhere and water managers are accustomed to work with such threshold values. These threshold values/criteria are adapted to the needs and paradigms of the WFD as they have a supportive role for the interpretation of the results for biological quality elements.

The following section outlines concrete pressure indicators and criteria that shall be implemented within the EPIRB Project.

4.3.3 Pressure indicators for implementation

In the following paragraphs four different indicators to analyse pressures are proposed. These indicators address the main pollutions sources:

- Two pressure indicators for pollution from municipal wastewater sources (including industrial wastewater sources as far as possible) and
- Two pressure indicators for diffuse agricultural pollution sources.

The data needed to calculate these indicators shall be easily available within the EPIRB Project and the result shall be as representative for the given situation as possible. Therefore, the indicators are always a compromise between simplicity and complexity or between theoretical data needs and practical availability of data.

The proposed indicators are adapted to the type and spatial resolution of information and may be modified once there is more/different/better information available.

Pressure Indicator 1: Untreated wastewater

This pressure indicator describes the untreated wastewater load in relation to the annual minimum flow[6]. 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.

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

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

Description of used variables:

- D_{ww} : Specific wastewater discharge into the respective river water body
- L : Total (dimensionless) load equivalent originating from wastewater discharge into the river in terms of
  - organic matter as BOD (ATH) or COD or
  - nutrient load, in terms of N_{tot} or P_{tot}, or
  - number of inhabitants connected to the sewerage system

This 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:

- 1 PE BOD = 60g/d, 1PE COD=120g/d, 1PE N_{tot} = 11g/d, 1 PE P_{tot}=1,5-2g/d or 1PE = 1 person[7] connected to the sewerage system
  e.g. An agglomeration with 3,500 inhabitants discharges the entire wastewater to a neighbouring river with an minimum annual flow of 2m^3/s, the following caculation shall be made: L = 3.500, $Q_{min, r}$ = 2.000L/s ➔ D_{ww}=3500/2000=**1.75**.
  If for instance it is known that an industrial source discharges another 100kg BOD through the same sewerage system the calculation would have to be adapted as follows: $L_{total} = L_{municipal} + L_{industrial}$= 3500+100,000[g BOD]/60[g BOD]=3500+1666.7=5166,7 ➔D_{ww}=5166,7/2000=**2,58**

- The sum of all load equivalents including direct and indirect industrial discharges (see also the list below, which proposes a number of industries which may be significant sources for pollution[8] with general physico-chemical parameters). If available these load equivalents can be introduced for organic matter and nutrients. For municipal wastewater this will not yield additional information but it is useful to introduce these numbers when significant load contributions from industrial wastewaters are of concern.

[6] If, for reasons of data availability other runoff indicators are to be used, a corresponding change must be made for the risk criterion.

[7] In case only wastewater discharge in terms of m^3 is available, the load equivalent can be calculated using a unit discharge of 120L/(inhabitant.day). A discharge of 100m^3 wastewater with municipal origin would result in a load equivalent of L=100,000L/120=833 [-] load equivalents

[8] The corresponding expectable loads per unit production need to be either measured or taken from literature and agreed upon within the project EPIRB team.

***$Q_{min,r}$* : Minimum annual flow of the river [L/s]**

The indicator assumes the discharge of untreated wastewater as a worst case scenario. In some of the EPIRB Project pilot river basin analyses/characterisations there were reports about missing treatment plants or existing treatment plants were not operated. However in case of discharges of treated wastewater this indicator may be adapted in the following form.

$D_{ww} = (L*(1-\eta))/ Q_{min,r}$

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 **Table 11** can be assumed as an approximation.

The following list proposes a list of industrial discharges that shall be included in the analysis of wastewater discharges. The list includes industries from which readily biodegradable wastewater can be expected (based on Annex III of 91/271/EC Council Directive on urban wastewater treatment:

Milk-processing	Production of alcohol and alcoholic beverages
Manufacture of fruit and vegetable products	Manufacture of animal feed from plant products
Manufacture and bottling of soft drinks	Manufacture of gelatine and of glue from hides, skin and bones
Potato-processing	Malt-houses
Meat industry	Fish-processing
Breweries	

Table 11: 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
NH_4		<25	>90	
N_{tot}				75
P_{tot}				80

Pressure Indicator 2: Likelihood for diffuse pollution (Driver: Agriculture)

This indicator describes the likelihood of diffuse pollution including typical agricultural contaminants, such as nutrients from fertilisers, pesticides and other plant protection products. The indicator uses a general variable for the quantification of agricultural activities. Therefore not only general physic-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:

$$S_{agri} = A_{agri} / A_{WB}$$

Description of equation:

- S_{agri} : Share of agricultural area in a given water body catchment [-]
- AWB : Catchment area of the respective water body [km2]
- A_{agri} : 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 (Corine like, GIS, other sources) [km^2]

Pressure Indicator 3: Likelihood for diffuse pollution (Driver: Animal livestock)

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:

$$I_{hus} = U_e / A_{WB}$$

Description of equation:

- I_{hus} : Indicator for animal livestock [LU/ha]
- U_e : Animal livestock unit[9]
- A_{WB} : Catchment area of the respective water body [ha]

Pressure Indicator 4: Total share of wastewater in the river

This indicator describes the total share of wastewater 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.

This pressure indicator gives an overall estimate for the potential contamination with micropollutants (such as priority substances and specific pollutants).

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

$$S_{ww} = \sum Q_{ww} / MQ_r$$

Description of equation:

- S_{ww} : Total share of wastewater in a river at a given cross section along the river
- Q_{ww} : Total of all (current/future) upstream wastewater discharges into the river [m^3/s]
- M_{Qr} : Mean annual flow of the river [m^3/s]

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

4.3.4 Water quality indicators for implementation

The EU WFD lists under the term general physico-chemical parameters the following indicators:

<u>“Thermal conditions” may be measures with the following parameters</u>

- Temperature – T [°C]
- Delta T (abrupt Temperature change/increase due to anthropogenic influence (cooling water, wastewater inlet, stagnation due to abstraction etc.)

<u>“Oxygenation conditions” may be measures with the following parameters</u>

- O_2 [mg/l]
- BOD-ATH, TOC, (COD) as indicators for organic matter, degradability and oxygen demand

<u>“Salinity” may be measures with the following parameters</u>

- Salinity or conductivity in [µS/cm]

<u>“Acidification status” may be measures with the following parameters</u>

- pH (to be discussed alkalinity and/or buffer capacity (only if data and references are available)

<u>“Nutrient conditions” may be measures with the following parameters</u>

- NH_4, NO_3
- PO_4

4.3.5 Criteria to assess the risk of failing the environmental objectives

According the methodology described above a risk criterion is a threshold value related to a certain pressure or water quality indicator. Two types of indicators have been introduced: (i) the first relates to the type and magnitude of a pressure as well as (ii) the second to resulting water quality for general physico-chemical parameters.

Risk criteria are applied by comparing existing information with the threshold values for a certain indicator. If the threshold is exceeded, it is assumed that the water body is at risk of failing environmental objectives related to general physico-chemical parameters at the given location.

For water quality indicators two risk categories are uses (at risk; not at risk). For pressure related risk criteria a third risk category is introduced, called “possibly at risk”. This category is introduced to express that there is an uncertainty. Hence, the risk criteria are an approximation and need to be validated by monitoring as described in the WFD Article 8 Annex V.

The subsequent list of risk criteria is based on the indicators described above. The list is divided according to the described division in (i) pressure and (ii) water quality related indicators.

Risk criteria for pressure indicators

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

Risk Category	Risk Criteria
At Risk	$D_{ww}>1,5$
Possibly at Risk	$1< D_{ww} <1,5$
Not at Risk	$D_{ww}<1$

Note: According to the UWWTD (91/271) and EU WFD (2000/60) any discharge of untreated wastewater of agglomerations>2,000 inhabitants puts a water body at risk and also <2,00o inhabitants if EQO may be compromised. However, given the situation of lacking wastewater treatment in the EPIRB Project beneficiary countries a less stringent criterion is proposed for implementation,

2. Criteria to assess the risk regarding an identified pressure Likelihood Diffuse Pollution *(Agriculture -* $S_{agri} = A_{agri} / A_{WB}$)

Risk Category	Risk Criteria
At Risk	$S_{agri} > 0,3$
Possibly at Risk	$0,1 < S_{agri} < 0,3$
Not at Risk	$S_{agri} <0,1$

3. Criteria to assess the risk regarding an identified pressure *Likelihood Diffuse Pollution (Animal live stocking -* $I_{hus} = U_e/ A_{WB}$)

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

4. Criteria to assess the risk regarding an identified pressure Total Share of Wastewater 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	$S_{ww} < 0,05$

Risk criteria for water quality indicators

For in-stream water quality indicators (in case data are available) the following risk criteria are proposed for implementation in the following **Table 12.** As for hydromorphology criteria are prosed for the three river size categories that are based on typology and that have been used with in he EPIRB Project before(small, medium, large). The exceedance of a threshold puts a water body at risk (except for Oxygen, here it is the contrary.

Table 12: Risk criteria for in-stream water quality indicators.

River Size****	Oxygen [% sat]*	BOD** (ATH inhibition)	NH_4**	NH_4***	PO_4***	pH	Delta T ***
Small	75	5	0,4	O,15	0,2	6,5-8,5	< 2
Medium	70	6	0,6	0,2	0,3		< 2
Large	60	7	0,8	0,3	0,4		< 3

*10% percentile (all seasons, comparable measurement conditions, at least 12 measurements)
**90% percentile (all seasons, representative flow conditions, at least 12 measurements)
***annual mean
**** see description of river sizes and types on Page 10 of this document.

For validation of the proposed risk criteria as part of the *Pressure-Impact Analysis* but also for consulting additional sources for the risk assessment threshold values for general physico-chemical parameters are provided in **Table 11**. These threshold values are understood as tentative approximations to the delimitation between good and moderate status. They may be understood as a working hypothesis that needs to be confirmed and validated. Also these threshold values are to be applied according to the one out all out principle.

The values in **Table 12** (i) are the result of expert judgement, (ii) are based on a compilation of different environmental quality standards from EU Member States and (iii) are based on previous EPIRB Project values that have been applied in the basin analysis 2013.

ANNEX 1: FURTHER OUTLINES ON THE ROLE OF HYDROMORPHOLOGICAL AND GENERAL PHYSICO-CHEMICAL ELEMENTS IN THE EU WFD

Hydromorphological quality elements and general physico-chemical parameters are first and foremost considered as parameters *supporting the biological quality elements*. Thus, they are not considered important per se, but because of the potential impact of certain hydromorphological and general physico-chemical condititions on aquatic organisms. The biological quality elements are critical for the ecological status/potential, an important part of the overall status of surface water bodies. 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.

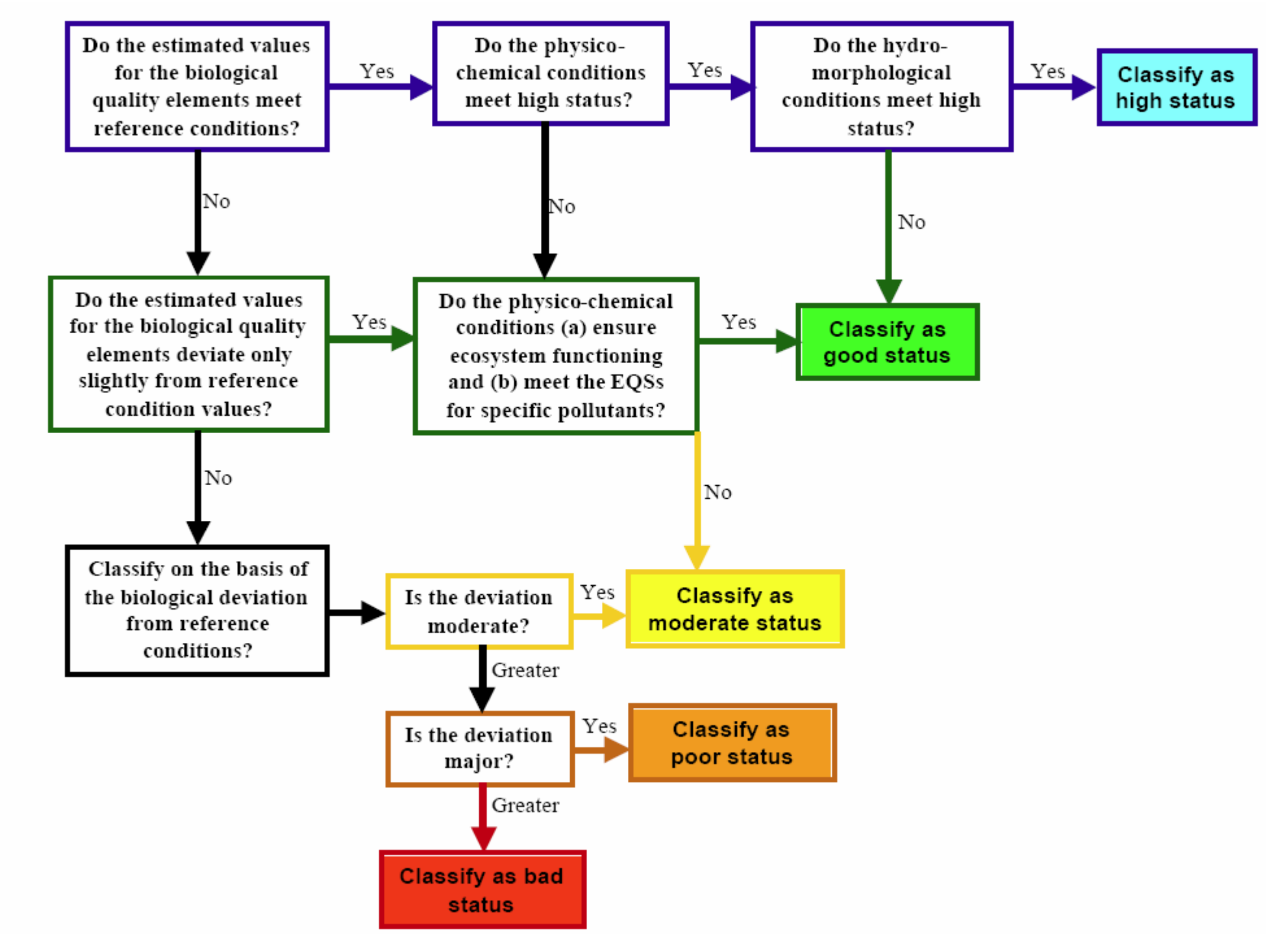

Figure: Indication of relative roles of biological, hydromorphological and physico-chemical quality elements in the ecological status classification[10].

[10] Adopted from WFD CIS Guidance Document No. 10: Rivers and Lakes – Typology, Reference Conditions and Classification Systems. https://circabc.europa.eu/sd/d/dce34c8d-6e3d-469a-a6f3-b733b829b691/Guidance%20No%2010%20-%20references%20conditions%20inland%20waters%20-%20REFCOND%20(WG%202.3).pdf

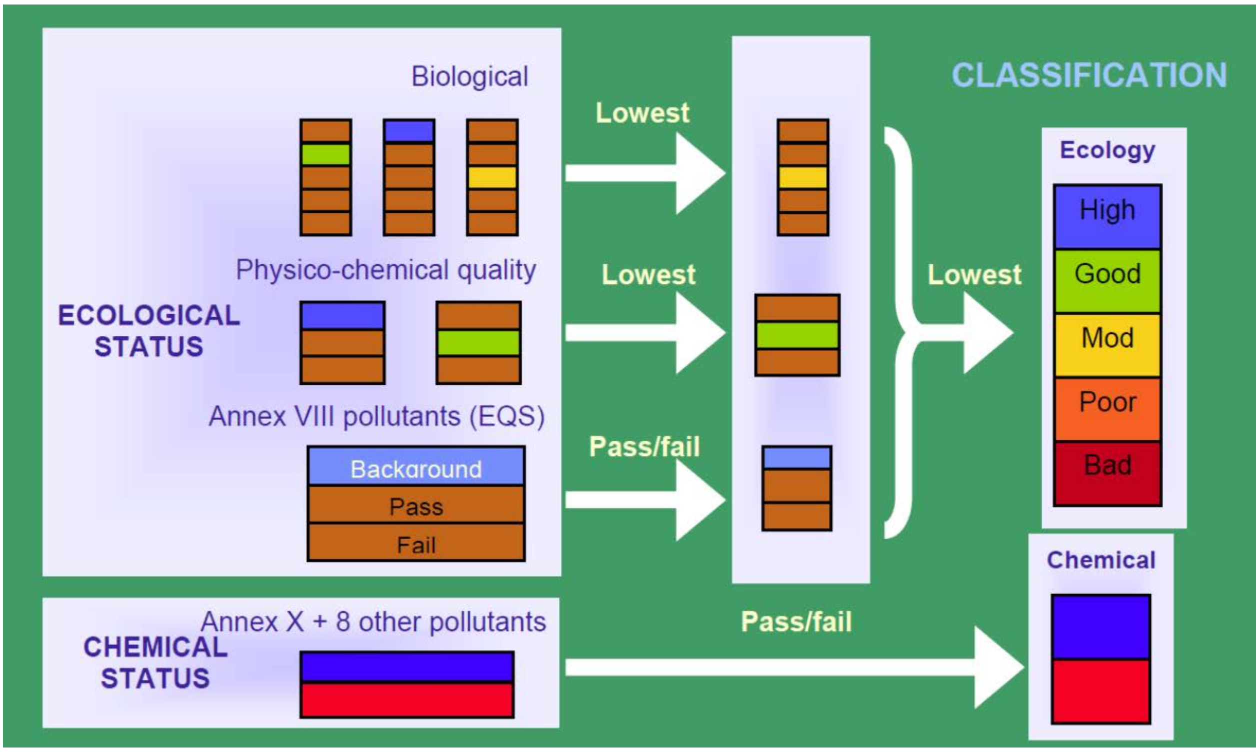

Figure: Indication of relative roles of biological, hydromorphological and physico-chemical quality elements in the ecological status classification11

[11] Adopted from WFD CIS Guidance Document No. 10: Rivers and Lakes – Typology, Reference Conditions and Classification Systems. https://circabc.europa.eu/sd/d/dce34c8d-6e3d-469a-a6f3-b733b829b691/Guidance%20No%2010%20-%20references%20conditions%20inland%20waters%20-%20REFCOND%20(WG%202.3).pdf

ANNEX 2: HYDROMORPHOLICAL ELEMENTS AS ASSESSED WITHIN THE EPIRB PROJECT

The assessment of modification of river morphology

The identification of hydromorphological "reference conditions" is an essential pre-requisite for assessing hydromorphological quality, and is a specific requirement of the EU WFD to enable classification of other levels of status. Reference conditions should be identified within each river type reflecting totally, or nearly totally, undisturbed conditions.

Hydromorphological alterations including modification of the river morphology were considered as significant water management issue apart from organic pollution, nutrient pollution and pollution caused by hazardous substances in the EPIRB pilot rive basins.

Modification of the river morphology is integrated pressure, which includes assessment of many man-caused changes as it presented in two assessment forms below.

Hydromorphology - Joint Field Surveys – KURA III

ASSESSMENT FORM – Structural features

Stream / River name: ___________________Site name:________________________Date: ________________

Surveyor:______________________________

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

Hydromorphology – Joint Field Surveys – KURA III

ASSESSMENT FORM – Hydrological features

Stream / River name: ___________ Site name: ________________Date: ____________

Surveyor: ____________________

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	