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**Agenda item 2 (b): Correlation tool on ELV and EQS**

**UNEP/MAP ELV – EQS tool – user guidance document**

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# Contents

<b>1 Introduction</b>	<b>3</b>
1.1 Emission Limit Values (ELV)	4
1.2 Environmental Quality Standards (EQS)	4
1.3 ELV and EQS	4
1.4 Acknowledgements	6
<b>2 Is the ELV-EQS tool suitable for me?</b>	<b>6</b>
2.1 Conceptual limitations	6
2.2 Data availability	7
2.3 Disclaimer	7
<b>3 Providing input to the ELV-EQS tool</b>	<b>8</b>
3.1 Schematic representation of the receiving marine waters	8
3.2 Definition of the receiving environment (geometry)	11
3.3 Definition of the discharge	15
3.3.1 Position of the discharge	15
3.3.2 Quantity and quality of the discharge	15
3.4 Definition of the substance of concern	16
3.5 Definition of the hydrological, meteorological and environmental conditions	18
<b>4 Running the ELV-EQS tool and interpreting the output</b>	<b>21</b>
4.1 Running the ELV-EQS tool	21
4.2 Interpreting the output	21
 <b>Appendices</b>	
<b>A Substance decay rates</b>	<b>A-1</b>
A.1 Definition	A-1
A.2 Recommended values of decay rate for specific pollutants	A-1
A.3 Unit conversion	A-3
<b>B Substance partition coefficients</b>	<b>B-3</b>
B.1 Definition	B-3
B.2 Recommended values for specific pollutants	B-3
B.3 Unit conversion	B-4
<b>C Environmental parameters</b>	<b>C-4</b>
C.1 Unit conversion	C-4



## Introduction

The ELV-EQS tool has the objective to provide a bridge between the ecosystem approach and the UNEP/MAP Barcelona Convention Protocol on Land Based Sources. As such, it establishes a relation between environmental quality standards (EQS) and emission limit values (ELV) following a combined, precautionary approach. It uses the concept of a mixing zone as defined in the related EC Guidance Document (EC, 2010). The relation between the EQS and the ELV depends on the characteristics of the discharge, on the characteristics of the substance of concern and on the characteristics of the receiving water body. Mathematical water quality modelling is an accepted and often applied way of quantifying the relation between the EQS and the ELV, taking into account all of these factors.

The ELV-EQS tool offers a rapid assessment tool to establish the relation between the EQS and the ELV for a single discharge. It has been set up based on the findings of the project “*Testing of a modelling system to assess the variations of EQSs with ELVs for nitrogen and mercury in Gulf de Lion and Izmir Bay*” (Deltares, 2012) funded by UNEP/MAP.

The web-based ELV-EQS tool has been set up in line with the recommendations formulated in this report. The ELV-EQS tool uses a simplified representation of the characteristics of the receiving water body. This obviously leads to a loss of accuracy, but it allows for easy application and offers a generic, coherent and harmonized approach. The method includes sufficient site specific information to allow application to the variety of coastal environments encountered in the Mediterranean. It produces credible and site-specific results which can be applied relatively easy to a large amount of sites.

This User Guidance Document helps to use the web-based ELV-EQS tool. The use of this tool involves the following steps, which will be discussed in the next chapters of this document:

- To decide if the ELV-EQS tool is useful, Chapter 2 provides guidance to find out if the tool is suitable for the case at hand.
- To provide input to the ELV-EQS tool, Chapter 3 discusses the input items one-by-one.
- To run the tool and to interpret the output from the ELV-EQS tool, Chapter 4 provides the necessary guidance.

This guidance provides relevant concepts and background information. The ELV-EQS tool can be accessed via the internet:

<a href="http://ol-ws003.xtr.deltares.nl/elveqs">http://ol-ws003.xtr.deltares.nl/elveqs</a>
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## 1.1 Emission Limit Values (ELV)

The Mediterranean Countries are co-operating already many years under the flag of the Mediterranean Action Plan (MAP). Among many other activities, a Land Based Sources Protocol has been established. As a part of this protocol to control the inputs of pollutants into the marine ecosystem of the Mediterranean, the countries adopted advanced regional policies and tools for pollution reduction from the urban and industrial sector based on setting Effluent Limit Values (ELVs), basically applying to individual discharge points.

The MAP Land Based Sources (LBS) Protocol defines an ELV as

*“the maximum allowable concentration measured as a “composite” sample, of a pollutant in an effluent discharged to the environment”*

In the remainder of this report, we will denote such an ELV as a “c-ELV” where the letter “c” indicates that the ELV is expressed as an effluent concentration (e.g.  $\text{g}\cdot\text{m}^{-3}$ ). Alternatively, we will use “m-ELV” to indicate the maximum allowable discharged mass of a substance of concern to the environment, expressed as a flux (e.g. in  $\text{g}\cdot\text{s}^{-1}$ ). The relation between the c-ELV and the m-ELV is as follows:

$$m\text{-ELV} = c\text{-ELV} * Q_e$$

where  $Q_e$  represents the effluent flow expressed as a volume flux (e.g.  $\text{m}^3\cdot\text{s}^{-1}$ ).

## 1.2 Environmental Quality Standards (EQS)

At the same time, the co-operating countries are in a process of establishing Environmental Quality Standards (EQSs) as an element of an ecosystem approach. An Environmental Quality Standard means:

*“the concentration of a particular pollutant or group of pollutants in water, sediment (any material transported by water and settled to the bottom) or biota (all living organisms of an area) which should not be exceeded in order to protect human health and the environment.”*

## 1.3 Mixing zone

In view of the two supplementary policy lines discussed above, one dealing with ELVs and one dealing with EQSs, establishing the relation between ELVs on one hand and EQSs on the other hand is essential. In this respect, the concept of a mixing zone as defined in the related EC Guidance Document (EC, 2010) plays a crucial role:

*“a mixing zone is an area around a discharge point where the concentration of a substance may locally exceed the EQS”*

This implicitly determines the highest acceptable emission or the ELV: if the EQS is given, the ELV follows from the requirement that the EQS is satisfied at the edge of the designated mixing zone.

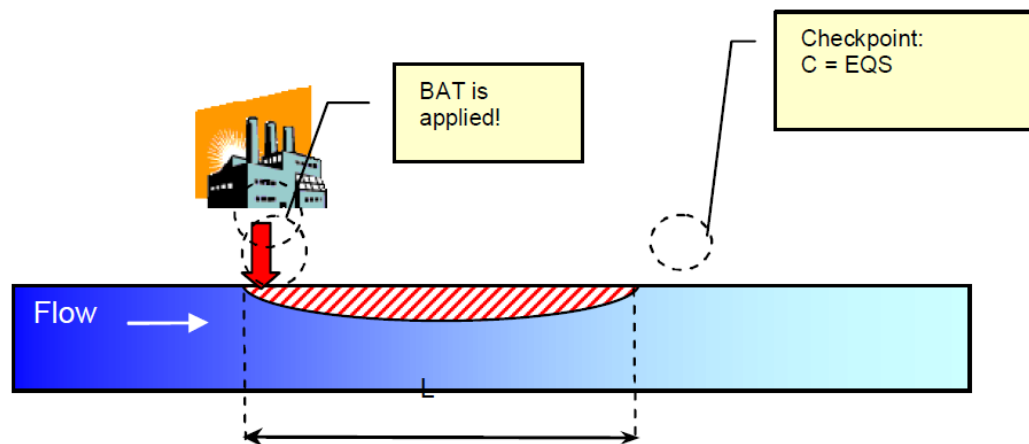


Figure 0.1 Illustration of a mixing zone in flowing waters, showing the “checkpoint” located at a distance “L” downstream of a pollution source where the EQS needs to be satisfied (Source: EC, 2010). BAT refers to “Best Available Technology”.

#### 1.4 Substance(s) of Concern

The assessment by the ELV-EQS tool proceeds on the basis of individual substances. The effects of combinations of substances (mixtures) are neglected. Individual substances should be assessed:

- If an EQS has been defined; and
- If the substance is present in the discharge.

In the remainder of this document we will refer to the substance under study as the “substance of concern”. The ELV-EQS tool should be used for all relevant substances of concern individually. Depending on the concentrations of these substances in the discharge, on the background concentration and on the EQS, one substance will turn out to be the most restrictive. If there are many substances of concern, it may be useful to have some rules of thumb to find the candidates for the most restrictive substances beforehand.

If there is a so-called Maximum Allowable Concentration (MAC) EQS defined and if the mixing zone for the MAC-EQS is less than 100m (see Section 3.4 for an explanation), you look for the substance with the maximum value of the following indicator:

- ratio between the effluent concentration  $C_e$  and the MAC-EQS:  $\frac{C_e}{MAC\ EQS}$

If there is an Annually Averaged (AA) EQS defined and if the mixing zone for the AA-EQS is more than 500m (see Section 3.4 for an explanation), you look for the substance with the maximum value of the following indicator:

- ratio between the effluent concentration  $C_e$  and the difference between the AA-EQS and the background concentration  $C_b$ :  $\frac{C_e}{AA\ EQS - C_b}$

In other cases, a combination of both indicators may lead you to the most restrictive substance.

## 1.5 Acknowledgements

This work was funded by the UNOPS Project Office and technically facilitated by the UNEP-MAP Secretariat in Athens. We gratefully acknowledge the support from the UNOPS project office staff and the UNEP-MAP secretariat staff.

## 2 Is the ELV-EQS tool suitable for me?

The ELV-EQS tool has been set up to be for a wide range of coastal discharges. There are however, certain limitations to its applicability. Below, you will find guidance to decide if the tool is suitable for the case at hand. If one or more of the following conditions apply, the ELV-EQS is not intended to be used for your case.

### 2.1 Conceptual limitations

- The discharge is outside the Mediterranean.

The ELV-EQS tool focuses on those physical processes that are dominant and neglects processes that are insignificant in the Mediterranean, in particular tidal motion. In other areas than the Mediterranean these assumptions may not be valid, and the tool should not be used.

- The volume of the discharge significantly exceeds  $1 \text{ m}^3 \cdot \text{s}^{-1}$  (or  $3600 \text{ m}^3 \cdot \text{h}^{-1}$ ).

The ELV-EQS tool neglects the impact of the discharge volume on the water circulation in the receiving marine environment. This may not be valid for large volume discharges, and therefore the tool should not be used for such discharges.

- There are two or more discharges close to each other

The ELV-EQS tool deals with one individual discharge at a time. If there are multiple discharges, and if they are far enough apart from each other (at least about 2000m), the discharges can be treated separately. The impact from other discharges can be accounted for in the ELV-EQS tool by specifying a background concentration. If the discharges are very close to each other (less than about 200m), you can consider them as one larger discharge in the ELV-EQS tool, as long as you do not specify a mixing zone less than about 500m. For cases with two discharges at a distance between about 200-2000m, the ELV-EQS tool cannot be used. However, if one of the two discharges is much smaller than the other, it could simply be neglected.

- The study area cannot be simplified according to the available options in the ELV-EQS tool.

The ELV-EQS uses a simplified representation of the receiving marine waters, see Section 3.1. If you find that these simplifications are too restrictive for your case, you cannot use the ELV-EQS tool.

- The discharge has a complex, multiport diffusor.

The computation method used to represent the discharge in the ELV-EQS tool does not account for multiport diffusors. You can still try to use the tool, but the results obtained close to the discharge point will probably be too conservative.

- The discharge is below the pycnocline of a stratified water body.

If the receiving water body shows stratification (see 3.2 for an explanation) and if the discharge is in the lower part of the water column, below the so-called pycnocline (see 3.2 for an explanation), the ELV-EQS tool cannot be applied.

## 2.2 Data availability

If one of the following data items is not available, it does not make sense to use the ELV-EQS tool, simply because you do not have sufficient data.

- Co-ordinates of the discharge.
- Depth below the water surface of the discharge.
- The discharge quantity (m<sup>3</sup>/h).
- The concentration of the substance(s) of concern in the discharge.
- An Environmental Quality Standard for the substance(s) of concern.
- An (approximate) water depth of the receiving waters.
- An (approximate) strength of the marine currents in the receiving waters.

The remaining input data items could be replaced by defaults to obtain at least a first indication of the acceptability of the discharge. We recommend using a higher safety factor of 3 to 5 (see Section 3.6) if you feel that data availability is poor.

If you find that the concentration of the substance(s) of concern in the discharge is always lower than the relevant Environmental Quality Standard(s) for the substance(s) of concern, the discharge is always acceptable, and there is no need to use the ELV-EQS tool.

## 2.3 Disclaimer

The website (having the URL including any software-application(s) offered or functioning thereon or forming part thereof, and any and all information, documentation, data contained on, or produced or generated by the said website (hereinafter all collectively referred to as the "Website"), has been developed by Stichting Deltares, established in Delft, The Netherlands ("Deltares") in cooperation with, and specifically for the United Nations Office for Project Services ("UNOPS") and the United Nations Environment Programme Mediterranean Action Plan ("UNEP-MAP"). Use of the Website, for whatever purpose, is at all times for the sole responsibility and risk of the person using the Website ("User").

The User accepts and agrees that:

- (i) the User shall at all times remain solely responsible for the use of the Website and the interpretation and use of the results obtained by the User with or from the Website, and for any and all consequences that (might) arise from using these results;
- (ii) UNEP-MAP, UNOPS and Deltares shall not be responsible for, and shall not assume any liability in relation to losses, damages, claims or other disadvantage or harm suffered by the User or by third parties as a result of, or related to the use of this Website and/or the interpretation and/or the use of the results generated by the Website. This includes without limitation losses or damages in relation to, the result of or connected with:
  - a. defects in or malfunctions of the Website;
  - b. the temporary or permanent inability to use the Website, partly or completely; or
  - c. alleged or legally proven infringements of any rights of third parties as a consequence of the use of the website by User.



## 3 Providing input to the ELV-EQS tool

This section discussed the input items one-by-one.

### 3.1 Schematic representation of the receiving marine waters

Typically, the ELV-EQS tool considers a part of the receiving marine waters with a surface area of at most 5000m x 5000m. It is not impossible to include larger areas, but the most interesting and the most reliable results are obtained at a rather close distance to the discharge point. The ELV-EQS tool does not use an exact representation of the area of interest, but uses a simplified rectangular approximate representation. There are two types of simplified rectangular representations available:

- Case 1: an “open” environment with a straight coastline and three open water sides (for an example: see Figure 3.1);
- Case 2: a “semi-enclosed” environment with just one open water side (for an example: see Figure 3.2).

You have to choose which case is the most appropriate for the discharge under study. We note that the “semi-enclosed” environment will provide a more conservative result than the open environment.

Input item	Unit	Default
Type of environment (“open” or “semi-enclosed”)	-	open

Case 1: open environment

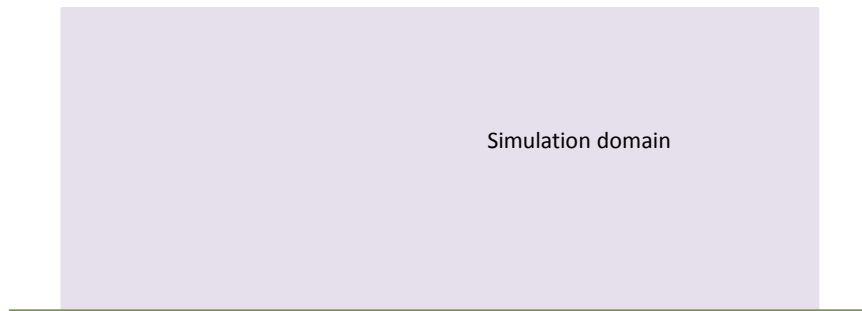
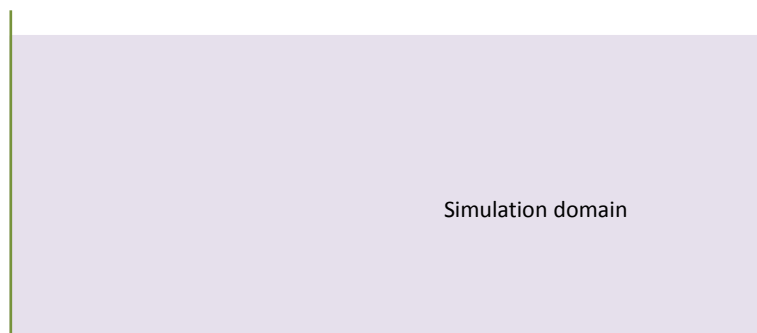


Figure 3.1 Top view of a simplified rectangular representation of an “open” environment; example of an “open” environment for the Gulf of Lions (Deltares, 2012)

Case 2: semi-enclosed environment



# Deltares

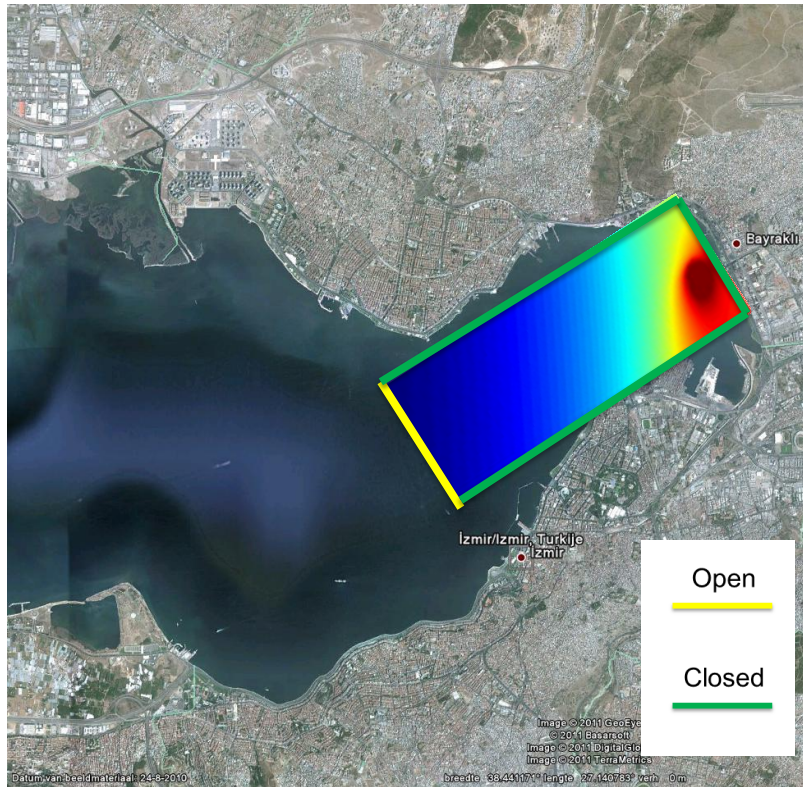


Figure 3.2 Top view of a simplified rectangular representation of a “semi-enclosed” environment; example of a “semi-enclosed” environment for Izmir Bay (Deltares, 2012)

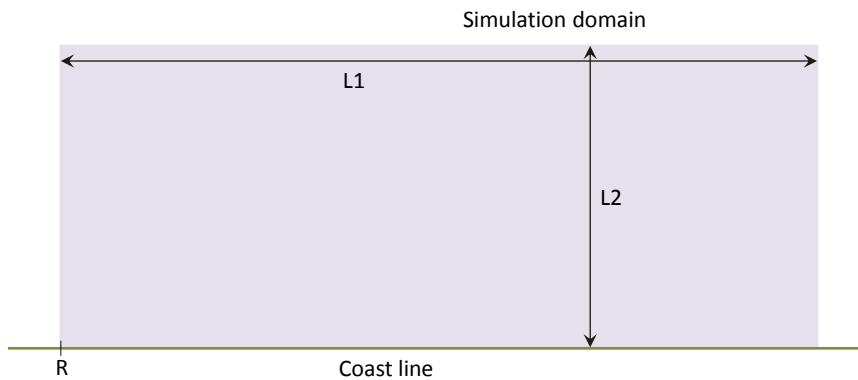
### 3.2 Definition of the receiving environment (geometry)

#### 3.2.1 Size of the domain

The size of the simulation domain within the receiving environment is defined by a length L1 parallel to the (inner) coastline and a length L2 perpendicular to the (inner) coastline; see Figure 3.3 for a definition.

Input item	Unit	Default
Size of simulation domain L1 along the coast	m	5000
Size of simulation domain L2 perpendicular to the coast	m	2000

Case 1: open environment



Case 2: semi-enclosed environment

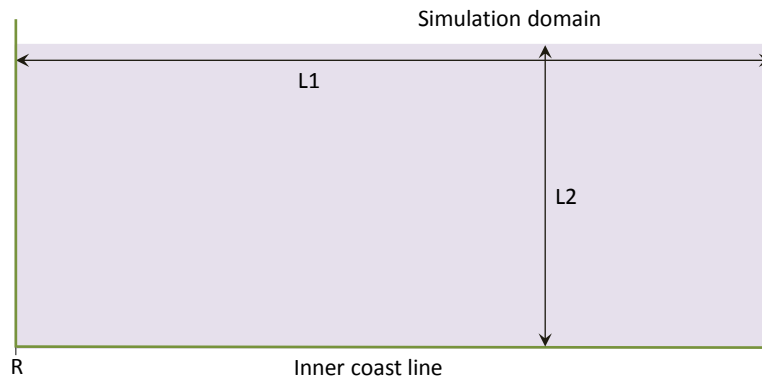


Figure 3.3 Top view of the simulation domain for an open and a semi-enclosed environment, showing the horizontal dimensions L1 and L2.

## 3.2.2 Water depth

The water depth in the simulation domain is defined immediately adjacent to the (inner) coastline, see Figure 3.4. Optionally, you can define the slope of the bottom, towards the open sea boundary of the domain.

Input item	Unit	Default
Water depth near-shore / depth of pycnocline	m	
Bottom slope (optional)	m/m	0

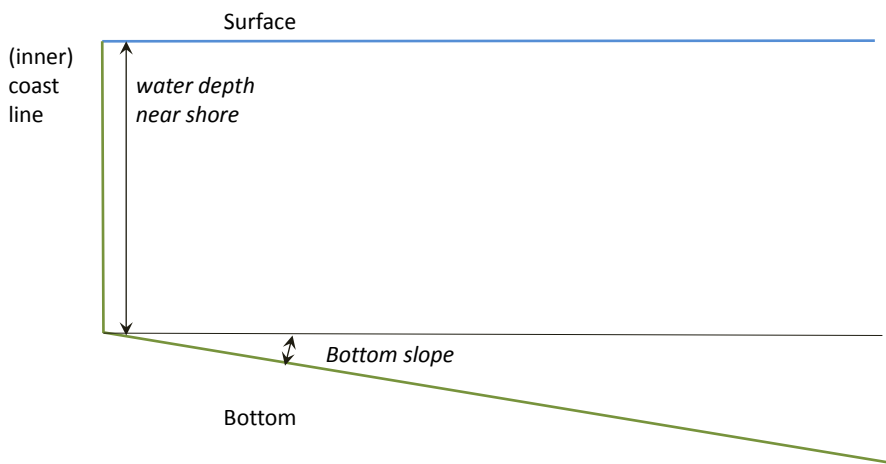
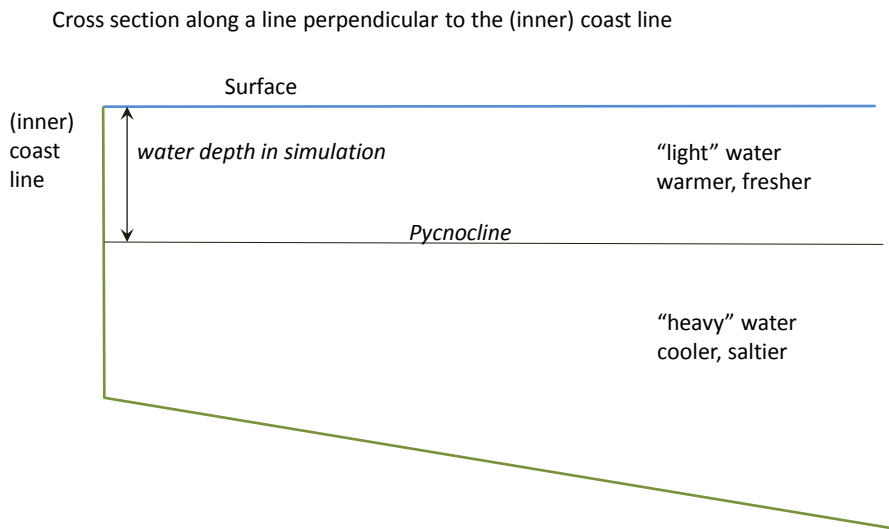


Figure 3.4 Cross section along a line perpendicular to the (inner) coast line, defining the water depth near shore and the bottom slope

If the inner coast line is a sandy beach, we recommend specifying a water depth near shore of 1m, and to use the bottom slope of not higher than about 0.1. A bottom slope of 0.1 m/m means that moving away from the coastline the water depth increases with 1m for every 10 meter of horizontal distance.

### 3.2.3 Water depth in case of stratification

In some cases, the receiving marine environment shows “stratification”: the water column shows several layers of water with a different temperature and salinity. This causes differences in the water density: a layer of “light” water floats on a layer of “heavy” water. The separation between two layers is called “pycnocline”, see Figure 3.5.



*Figure 3.5 Cross section along a line perpendicular to the (inner) coast line, defining the water depth near shore in the case of stratification.*

Due to the density difference between the water on both sides of the pycnocline, there is only limited mixing of water. The ELV-EQS tool only deals with discharges in the top layer of a stratified water body. Adopting a conservative (“worst case”) approach, we neglect the mixing of waters over the pycnocline. As a consequence, you need to specify the water depth equal to the thickness of the top layer and a zero slope, as shown in Figure 3.5.

# Deltares

## 3.2.4 Orientation of the study area

It is also necessary to define the orientation of the study area, relative to the North, see Figure 3.6.

Input item	Unit	Default
Orientation of study area relative to North	°	0

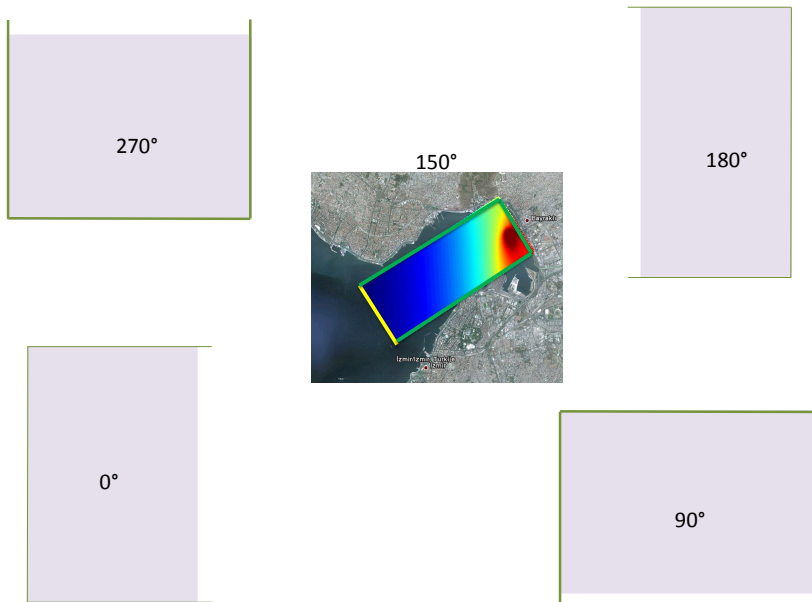
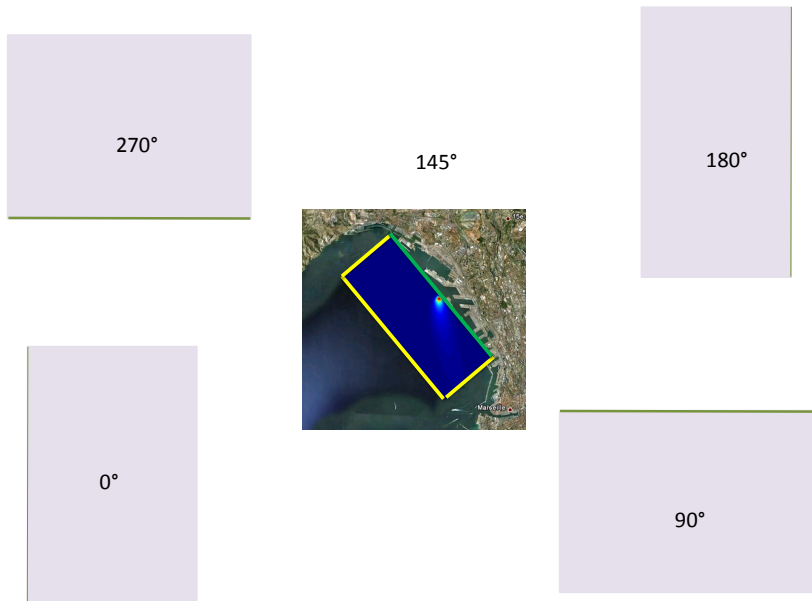


Figure 3.6 Top view of the study area with different orientation. Top: open environment, including the Gulf of Lions example; bottom: semi-enclosed environment, including the Izmir Bay example.

### 3.3 Definition of the discharge

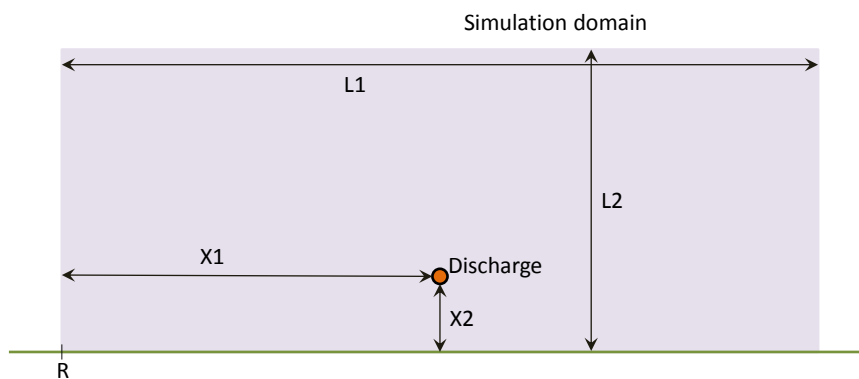
#### 3.3.1 Position of the discharge

Presumably, you know the co-ordinates of the discharge point (for example longitude and latitude), and the depth of the discharge point. To use the ELV-EQS tool you need to indicate the relative position of the discharge within the area of interest. To define the horizontal and vertical position of the discharge, relative to the receiving environment, the following quantities must be defined:

Input item	Unit	Default
Position of discharge: distance X1 along the coast, relative to point R, see Figure 3.7	m	
Position of discharge: distance X2 from the coast, see Figure 3.7	m	
Position of discharge: depth from water surface	m	0 (surface)

Normally, X1 should be selected in the middle of the simulation domain, so that the discharge plume can move in all directions. Also, we recommend making the distance between the discharge location and any open boundary at least two mixing zone distances (see Section 3.4).

Case 1: open environment



Case 2: semi-enclosed environment

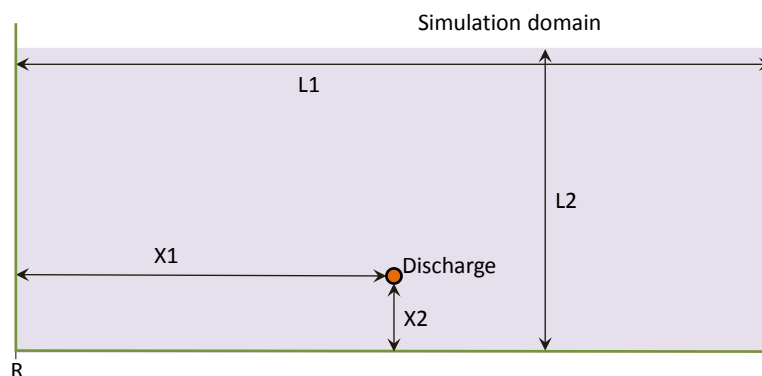


Figure 3.7 Definition of simulation domain and location of discharge

#### 3.3.2 Quantity and quality of the discharge

To define the quantity and the quality of the discharge, the following must be specified:



Input item	Unit	Default
Discharge flow rate ( $Q_e$ )	m <sup>3</sup> /h	
Discharge temperature (optional)	°C	20
Discharge salinity (optional)	ppt	37
Discharge pipe opening diameter (D)	m	0.3
Discharge concentration	g/m <sup>3</sup>	

The discharge flow rate, together with the discharge pipe opening diameter will determine the mean velocity of the outflow jet  $U_e$  (m/s). If only the velocity of the jet and the pipe opening diameter are known, the discharge flow rate can be computed as follows:

$$Q_e = U_e \pi \left(\frac{D}{2}\right)^2 3600$$

If only the discharge flow rate and the mean velocity are known, the pipe diameter can be calculated as follows:

$$D = 2 \sqrt{\frac{Q_e}{3600 U_e \pi}}$$

It is important to specify the discharge salinity and temperature if these deviate from the receiving water (e.g. a fresh water discharge in the marine environment). Such differences affect the density of the discharged water and may cause the discharge plume to rise to the surface or sink to the bottom. In particular, for a fresh water discharge you specify a salinity of 0. Appendix C.2 provides some unit conversion rules.

In the case of a variable discharge volume, we recommend the use of a maximum value obtained after calculating a 6-hour running mean of the discharge volume.

### 3.4 Definition of the substance of concern

To define the substance of concern, the following quantities must be specified:

Input item	Unit	Default
Name	-	
Substance decay rate	1/d	0
Substance partition coefficient	m <sup>3</sup> /kg	0
Background concentration	g/m <sup>3</sup>	0
EQS (MAC, maximum allowable concentration)	g/m <sup>3</sup>	
mixing zone (MAC)	m	500
EQS (AA, annually averaged concentration)	g/m <sup>3</sup>	
mixing zone (AA)	m	500

#### 3.4.1 Substance decay rate

The substance decay rate represents a range of biochemical and physical processes, such as hydrolysis, photolysis and biodegradation. Appendix A provides background information and references to estimate the decay rate. In case of doubt, we recommend using a low end estimate of the decay rate, or a value of 0. This will provide a conservative result, and will avoid underestimating the impacts of a discharge.

The substance decay rate is specified in  $d^{-1}$ . Appendix A.2 explains how to derive values in  $d^{-1}$  from values in other units, and provides conversion tables.

The substance decay rate may be dependent on the environmental conditions (pH, temperature, water transparency, solar radiation, presence of organic particles). To account for such dependencies in detail goes beyond the scope of the ELV-EQS tool.

#### 3.4.2 Substance partition coefficient

The substance partition coefficient determines the distribution of the substance over a truly dissolved fraction and a fraction attached to suspended particles in the water. This distribution is important because the truly dissolved fraction is generally considered to impose the highest level of risk to aquatic life (it is more “bio-available”). For this reason, sometimes EQS’s are defined for the dissolved fraction only (e.g. for Mercury).

In the ELV-EQS tool, a partition coefficient should be specified *if the relevant EQS is defined for the dissolved fraction of the substance only*. In all other cases, a partition coefficient equal to 0 should be defined. Appendix B provides background information and references to estimate the substance partition coefficient.

We note that the fraction attached to particles may settle to the seafloor together with the particles. This has been neglected in the ELV-EQS tool, because of the typical high water transparency and low particle concentration of the Mediterranean waters.

The partition coefficient is specified in  $m^3.kg^{-1}$ . Appendix B.2 explains how to derive values in  $m^3.kg^{-1}$  from values in other units, and provides conversion tables.

#### 3.4.3 Mixing zones and environmental quality standards (EQS) - MEDPOL

The definition of Environmental Quality Standards (EQS) as well as the establishment of designated mixing zones for individual discharges relevant to derive Emission Limit Values, are basically policy decisions. Any relevant recent developments in this respect would need to be included in this section. We kindly request the UNEP-MAP Secretariat to provide the necessary input.

#### 3.4.4 Mixing zones and environmental quality standards (EQS) – EU legislation

The Water Framework Directive (WFD) 2000/60/EC of 23 October 2000 calls for “good ecological status” of all European water bodies and establishes a framework for community action in the field of water policy. Its daughter Directive 2008/105/EC of 16 December 2008 (EC, 2008) formulates environmental quality standards in the field of water policy. It encompasses the pre-existing Directives 82/176/EEC on Mercury discharges by industry, 83/513/EEC on Cadmium discharges, 84/156/EEC on Mercury discharges by industry, 84/491/EEC on HCH discharges and 86/280/EEC on discharges of dangerous substances (defined in Dir. 76/464).

The WFD defines two types of EQS:

Maximum Allowable Concentration EQS (MAC-EQS), which may never be exceeded, and which is protecting against acute effects.

Annually Averaged EQS (AA-EQS), which may not be exceeded on an annually averaged basis, and which is protecting against chronic effects.

For some substances, only the AA-EQS or only the MAC-EQS is defined.

For most substances the EQS refers to the “total” concentration (the result of the analysis of an unfiltered sample). For some substances (e.g. cadmium and mercury) the EQS refers to the dissolved concentration (the result of the analysis of a filtered sample).

The establishment of designated mixing zones for individual discharges under the WFD is explained in the relevant EU Guidance Document (EC, 2010). We note that this Guidance asks for explicit consideration of separate “MAC-EQS” and “AA-EQS” mixing zones (particular if a MAC-EQS is defined). This implies that the acceptable area of exceedance of the AA-EQS may be different than the acceptable area of exceedance of the MAC-EQS. In some European countries, the MAC-EQS mixing zone is much smaller than the AA-EQS mixing zone.

Note that Appendix C.2 provides unit conversion rules for EQS.

### 3.4.5 Substance background concentration

If the receiving water already shows concentrations higher than zero of the substance of concern, the ELV-EQS tool can take this into account. You have to ascertain that the field data used to derive the background concentration are from samples taken far enough from the discharge under study (typically at least 2-5 km). The use of a background condition can be a way to account for the presence of other discharges in the vicinity of the discharge under study, and to arrive at a cumulative assessment, see also Section 2.

If the background concentration already exceeds the EQS(s), then the ELV-EQS tool will always show that the discharge is not acceptable. Evidently, in such cases running the ELV-EQS tool is not useful.

## 3.5 Definition of the hydrological, meteorological and environmental conditions

The transport of the discharged substances away from the discharge point into the receiving marine environment is controlled by the meteorological conditions (wind) and by the hydrological conditions (currents). These are often variable. The ELV-EQS allows you to specify up to 10 different sets of wind and currents conditions. For each of these conditions, you need to indicate the frequency of occurrence (in %). The sum of the frequencies of occurrence of all defined conditions, needs to be exactly equal to 100%. On top, some parameters, like the water temperature, the salinity and the concentration of suspended matter can also vary, most probably affected by the variability of the wind and the currents. Consequently, you need to specify for each of the conditions:

Input item	Unit	Default
Frequency of occurrence	%	
Wind speed at 10 m above water surface	m/s	5
Wind direction relative to north	°	0
Current speed	m/s	0.05
Suspended solids concentration	g/m <sup>3</sup>	0
Salinity (above pycnocline) (optional)	ppt	37
Temperature (above pycnocline) (optional)	°C	20

### 3.5.1 Wind

The wind speed is defined at 10 m above the water surface. This is a common definition in the meteorology, so if you find numbers without any specification you can assume them valid at 10 m above the surface. The wind direction is defined as in Figure 3.8.

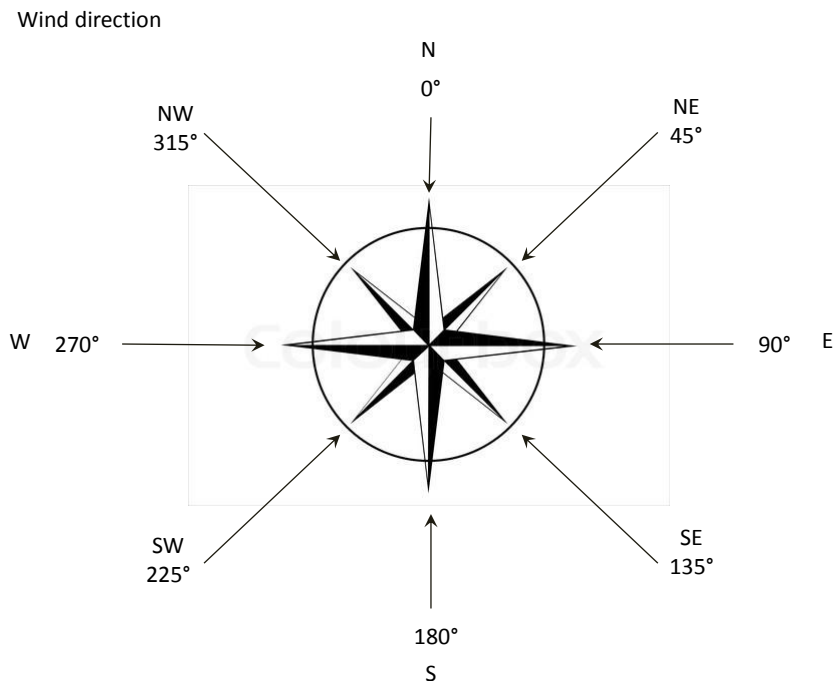
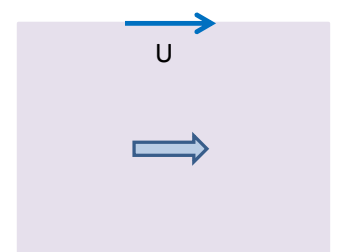


Figure 3.8 Definition of wind directions

### 3.5.2 Currents

The current speed is defined in a simplified manner. In the “open” environment the current is parallel to the coast; in the semi-enclosed environment, there is a circular current, see Figure 3.9. The current is defined at the open sea boundary of the simulation domain; see the symbol “U” in Figure 3.9. In the open environment, a positive value of U means a current from left to right (standing at the seaside looking towards the sea). A negative value of U means a current from right to left. In the semi-enclosed environment, a positive value of U means a counter-clockwise current, while a negative value of U means a clockwise current.

Case 1: open environment



Case 2: semi-enclosed environment

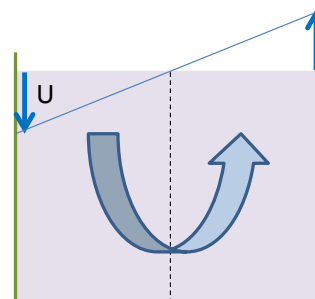


Figure 3.9 Definition of currents, and their direction if a positive value is specified

For the definition of the salinity and the concentration of suspended solids, appendix C.2 provides guidance and some unit conversion rules.

## 3.6 Safety factor

The ELV-EQS tool is a so-called “rapid assessment tool”. It uses certain simplifications to allow the user to obtain credible and site-specific results, without the need to collect a large volume of data and to perform complex and expensive 3D modelling. In a tiered risk-based approach (as recommended by EC, 2010), the ELV-EQS tool is a relatively simple assessment step, that can be carried out before a much more and costly detailed site-specific assessment. The tiered approach implies that if the ELV-EQS tool indicates that the discharge can be accepted, the assessment stops, and a detailed site-specific assessment is not required. If the ELV-EQS tool indicates that the discharge cannot be accepted, the assessment moves to the next level.

In this perspective, the ELV-EQS should adopt a worst-case approach: the simplifications of the tool should never lead to the acceptance of a discharge that would have been rejected in a more detailed assessment.

For this reason, the underlying technical report (Deltares, 2012) recommends using a safety factor. Based on the test results obtained for the Izmir Bay and the Gulf of Lions, a value of 2 was recommended for this safety factor.

Input item	Unit	Default
Safety factor for fate and transport calculation	-	2

We note that Deltares (2012) recommends that UNEP discusses with the stakeholders whether or not the 2012 study provides a sufficient picture of the uncertainties connected to the use of the ELV-EQS tool. If not, then additional validation studies are recommended like the 2012 study, for other locations and/or for other substances. Such studies should then lead to a better understanding of the uncertainties related to the use of the ELV-EQS tool, and to an updated recommended value for the safety factor.

Many EQSs have been derived using a safety factor as well. This is another kind of safety factor, and it should not be confused with the safety factor discussed above. The EQS safety factor accounts for the uncertainty related to the amount of toxicity tests available as a basis for deriving an EQS.

## 4 Running the ELV-EQS tool and interpreting the output

### 4.1 Running the ELV-EQS tool

For details on using the website we refer to the user documentation (Deltares 2014). This document gives details on how to use the website, and to interpret the feedback messages (if any) that occur after the calculation was started by the user.

If all input is correct the calculation succeeds and the user sees the results.

### 4.2 Interpreting the output

The ELV-EQS tool produces a table showing the maximum and mean concentrations calculated as a function of the distance from the discharge, see Figure 4.1.

Figure 4.1 Sample output screen

Distance from pipe	Maximum concentration	Mean concentration
m	g/m <sup>3</sup>	g/m <sup>3</sup>
0	0.4	0.4
10	6.03E-02	6.86E-02
20	3.30E-02	3.46E-02
30	2.45E-02	2.70E-02
40	1.98E-02	2.21E-02
50	1.75E-02	1.99E-02
60	1.55E-02	1.78E-02
70	1.41E-02	1.62E-02
80	1.29E-02	1.49E-02
90	1.20E-02	1.39E-02
100	1.42E-03	3.22E-03
200	9.97E-04	2.14E-03
300	7.69E-04	1.75E-03
400	6.21E-04	1.46E-03
500	5.14E-04	1.22E-03
600	4.45E-04	1.05E-03
700	4.24E-04	1.02E-03
800	4.02E-04	9.72E-04
900	3.79E-04	9.22E-04
1000	3.56E-04	8.69E-04
1200	3.10E-04	7.60E-04
1400	2.67E-04	6.57E-04
1600	2.29E-04	5.65E-04
1800	1.96E-04	4.84E-04
2000	1.68E-04	4.16E-04
EQS	...	...
allowable mixing zone	...	...
field mixing zone	from table	from table
discharge permitted?	YES/NO	YES/NO

We note:

- The results include the background concentration (if specified).
- The results include the safety factor.
- The results refer to the total concentration if the substance partition coefficient = 0.
- The results refer to the dissolved concentration if the substance partition coefficient > 0.

Below the table you will find some additional information:

- The EQS (if specified) for the maximum allowable concentration (MAC-EQS) and for the average concentration (AA-EQS) (if specified in the input).
- The allowed mixing zone for the evaluation of the MAC-EQS and the AA-EQS respectively (if specified in the input).
- The “field mixing zone”: the distance from the pipe where the relevant concentration (maximum – mean) equals the EQS (MAC-AA).
- An evaluation if the discharge is permitted. Only if the field mixing zone is smaller than or equal to the allowable mixing zone, the discharge is permitted.

If the discharge is not permitted, you can repeat the assessment with a modified discharge volume or discharge concentration, to determine the acceptable discharge.

## 5 References

- Deltares, 2012. Testing of a modelling system to assess the variations of EQSs with ELVs for nitrogen and mercury in Gulf de Lion and Izmir Bay. Report 1201869-000-ZKS-0016 by Deltares for UNEP-MAP, January 2012.*
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- EC, 2005: Common Implementation Strategy for the Water Framework Directive Environmental Quality Standards (EQS) Substance Data Sheet, according to Manual of the Methodological Framework Used to Derive Environmental Quality Standards for Priority Substances of the Water Framework Directive. Peter Lepper, Fraunhofer-Institute Molecular Biology and Applied Ecology, 15 November 2004. Available at the internet-site of the European Commission: [http://europa.eu.int/comm/environment/water/water-dangersub/pri\\_substances.htm](http://europa.eu.int/comm/environment/water/water-dangersub/pri_substances.htm).*
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- Sabljić A and Güsten H (1995). QSARs for soil sorption. In: Overview of Structure-Activity Relationships for Environmental Endpoints. Hermens JLM (ed.), Report prepared within the framework of the project "QSAR for Prediction of Fate and Effects of Chemicals in the Environment", an international project of the Environmental Technologies RTD Programme (DG XII/D-1) of the European Commission under contract number EV5V-CT92-0211.*
- Thomann, R.V. and J.A. Mueller, 1987. Principles of Surface Water Quality Modelling and Control, Harper & Row Publ., New York.*
- Van Gils, J., Prognosis of WFD chemical status in the coastal waters of The Netherlands Part 1: Update and validation of the Scremotox model. Report Z4441 by Deltares, Prepared for: RWS Waterdienst, Delft, The Netherlands, October 2008 (<http://www.deltares.nl/product/22647>).*





## A Substance decay rates

### A.1 Definition

In the ELV-EQS tool “decay” is defined as the total of all processes that make the substance of concern disappear from the water column. This includes decay induced by microbial activity (biodegradation), by solar radiation (photolysis) or by chemical reactions (hydrolysis). It also includes processes that make the substance of concern move to the atmosphere (volatilisation) or to the marine sediments (settling). Depending on the nature of the substance of concern, some of the abovementioned processes are relevant.

For use in the ELV-EQS tool, the total of all “decay” processes, needs to be expressed as a first order decay rate  $k$  ( $d^{-1}$ ), which causes the substance of concern to disappear at a rate which is proportional to the concentration:

$$\frac{\partial C}{\partial t} = -kC$$

where  $C$  is the concentration of the substance of concern, and  $t$  is time. The determination of this parameter requires some experience and may involve a literature study. The section below provides recommended values for some key substances.

In general, we recommend being conservative while specifying the decay rate, and using the lowest values encountered in the literature. If no information is available, we recommend using a value  $k = 0$ .

### A.2 Recommended values of decay rate for specific pollutants

Substance	Recommended value ( $d^{-1}$ )	Note
BOD (untreated, after settling)	0.30	1
BOD (treated discharge)	0.15	1
Total nitrogen	0.03	2
Total phosphorus	0.0	3
Mercury	0.0	4
Chromium	0.0	4
Cadmium	0.0	4
Lead	0.0	4
PHA / PAH (naphthalene, anthracene)	0.1	5
PHA / PAH (all other)	0.0	5
Phenols	0.0	6

Notes:

- 1 EPA (1985) provide values from different case studies. The recommended decay rate is the result of expert judgement, using in particular the estuarine and marine examples from this reference. Low end values are recommended from the perspective of using a conservative approach. It is commonly accepted that treated waste waters show a lower decay rate in the environment (Thomann & Mueller, 1987).
- 2 For nitrogen, we consider denitrification as a process which effectively removes nitrogen from the aquatic environment, see Deltares (2012) for a further discussion and references.
- 3 For phosphorus, there are no processes which effectively remove it from the aquatic environment. For reasons explained in section 3.4.2, we recommend neglecting the settling of particulate phosphorus. Therefore, the recommended decay rate is 0.0.

- 4 Metals are not undergoing any decay. For reasons explained in section 3.4.2, we recommend neglecting the settling of the particulate fraction. Therefore, the recommended decay rate is 0.0.
- 5 PHA / PAH indicates a group of substances called *Polycyclic aromatic hydrocarbons*, a class of chemical compounds that consist of fused aromatic rings.

The substances in this group are for example:

	<b>US EPA</b> Priority pollutants (16 PAHs)	<b>IARC</b> Probable or possible human carcinogens (6 PAHs)	<b>Borneff</b> (6 PAHs)	<b>UNECE POPs</b> <b>Protocol</b> Indicators for the purposes of emissions inventories (4 PAHs)
Naphthalene	✓			
Acenaphthylene	✓			
Acenaphthene	✓			
Fluorene	✓			
Anthracene	✓			
Phenanthrene	✓			
Fluoranthene	✓		✓	
Pyrene	✓			
Benz[a]anthracene	✓	✓		
Chrysene	✓			
Benzo[b]fluoranthene	✓	✓	✓	✓
Benzo[k]fluoranthene	✓	✓	✓	✓
Benzo[a]pyrene	✓	✓	✓	✓
Dibenz[ah]anthracene	✓			
Indeno[123cd]pyrene	✓	✓	✓	✓
Benzo[ghi]perylene	✓		✓	

The properties of this substance group are variable. Substances like anthracene and naphthalene show decay rates around  $0.005 \text{ d}^{-1}$  (EC, 2005), while most others are reported to show no decay. Apart from decay, some PAHs are removed from the water column by volatilisation (transfer between the water column and the atmosphere). Again, substances like anthracene and naphthalene show much higher volatilisation than other PAHs. For reasons explained in section 3.4.2, we recommend neglecting the settling of the particulate fraction of these substances.

Based on formulas and substance parameters reported by van Gils (2008), we estimated the decay rates, including volatilisation, for a series of PAHs, for environmental conditions representing Mediterranean coastal waters (a water depth of 10 m, a water temperature of  $20^{\circ}\text{C}$ , a suspended solids concentration of 5 mg/L with an organic fraction of 10%). Under such conditions, only anthracene and naphthalene show a noticeable decay. For all other PAHs, the decay is effectively zero.

- 6 Phenols are a class of chemical compounds consisting of a hydroxyl group ( $-\text{OH}$ ) bonded directly to an aromatic hydrocarbon group. The simplest of the class is phenol. Phenolic compounds are classified as simple phenols or polyphenols based on the number of phenol units in the molecule. This group of substances is diverse. Consequently, it is hard to estimate a common decay rate. For individual compounds, literature values can be used.

### A.3 Unit conversion

Original quantity/unit	Scale factor / conversion	Target quantity/unit
Decay rate k (s <sup>-1</sup> )	86400	Decay rate k (d <sup>-1</sup> )
Half-life time T <sub>50</sub> (d)	$k = \frac{\ln 2}{T_{50}}$	Decay rate k (d <sup>-1</sup> )

## B Substance partition coefficients

### B.1 Definition

The partition coefficient  $K_d$  expresses the distribution of a substance of concern over the dissolved phase and the suspended particles. In the ELV-EQS tool, we represent the particles phase by their total dry weight. The partition coefficient  $K_d$  then represents:

$$K_d = \frac{C_s}{C_d}$$

where  $C_d$  is the dissolved concentration (g.m<sup>-3</sup>) and  $C_s$  is the concentration in particles (g.kgDW<sup>-1</sup>, DW = dry weight). The partition coefficient  $K_d$  is expressed in the unit m<sup>3</sup>.kg<sup>-1</sup>. The section below provides recommended values for some key substances.

The ELV-EQS tool uses the partition coefficient only to derive a dissolved concentration of the substance of concern, in the case that the EQS refers to a dissolved concentration. This is typically the case for metals. In the case that the EQS refers to a total concentration, a value  $K_d = 0$  needs to be used.

### B.2 Recommended values for specific pollutants

Below, we mention recommended values for the substance partition coefficient, expressed as m<sup>3</sup>.kgDW<sup>-1</sup>, where DW represents the dry weight of the suspended matter. These values should ONLY be used if the EQS is specified as a dissolved concentration.

Substance	Recommended value (m <sup>3</sup> .kg <sup>-1</sup> )	Note/reference
BOD	0.0	1
Total nitrogen	0.0	1
Total phosphorus	0.0	1
Mercury	437	Deltares, 2012
Chromium	290	Krop et al. 1995
Cadmium	40	Krop et al. 1995
Lead	420	Krop et al. 1995
PHA / PAH (naphthalene, anthracene)	1	2
PHA / PAH (all other)	100	2
Phenols	0.0	3

Notes:

- 1 No partition coefficient used, since EQS values are commonly expressed as "total concentrations" (concentrations in the unfiltered sample).
- 2 Using the same data and making the same assumptions as those mentioned in Appendix A.2, typical values for the partition coefficient have been determined for Mediterranean coastal waters.

- 3 Phenols are a class of chemical compounds consisting of a hydroxyl group (—OH) bonded directly to an aromatic hydrocarbon group. This group of substances typically has a high solubility in water and consequently, no tendency to be in the particular phase.

## B.3 Unit conversion

Original quantity/unit	Scale factor / conversion	Target quantity/unit
(dry matter based) partition coefficient $K_d$ ( $m^3 \cdot g^{-1}$ )	1000	Partition coefficient $K_d$ ( $m^3 \cdot kg^{-1}$ )
(dry matter based) partition coefficient $K_d$ ( $l \cdot kg^{-1}$ )	0.001	Partition coefficient $K_d$ ( $m^3 \cdot kg^{-1}$ )
(organic carbon based) partition coefficient $K_{OC}$ ( $l \cdot kg^{-1}$ )	0.001 $f_{OC}$ (mass fraction of organic carbon in suspended particles)	Partition coefficient $K_d$ ( $m^3 \cdot kg^{-1}$ )
octanol – water partition coefficient $K_{OW}$ ( $l \cdot kg^{-1}$ )	$\log(K_{OC}) = 0.81 \log(K_{OW}) + 0.1$ (Sabljić and Güsten, 1995)	(organic carbon based) partition coefficient $K_{OC}$ ( $l \cdot kg^{-1}$ )

## C Environmental parameters

### C.1 Unit conversion

Original quantity/unit	Scale factor / conversion	Target quantity/unit
Total dissolved solids (mg/l)	$\approx 0.001$	Salinity (ppt or g/kg)
Suspended solids (g/l)	1000	Suspended solids (mg/l)
Any substance (pg/l)	$10^{-9}$	Any substance (mg/l)
Any substance (ng/l)	$10^{-6}$	Any substance (mg/l)
Any substance ( $\mu g/l$ )	$10^{-3}$	Any substance (mg/l)