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SERIES 5 Maritime and port works in the surroundings of the coastal area

RECOMMENDATIONS FOR MARITIME WORKS

ROM 5.1-05

Quality of coastal waters in port areas

GOBIERNO DE ESPAÑA
MINISTERIO DE FOMENTO
Puertos del Estado

RECOMMENDATIONS FOR MARITIME WORKS **SERIES 5**

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Prologue

The necessity of establishing standard actuation protocols in the field of maritime engineering has led to the development of the **ROM** (Recomendaciones para Obras Marítimas) **programme, Recommendations for Maritime Works.** With the formation of the Technical Commission responsible for its development in 1987, the writing of a set of Technical Norms establishing the procedures, methods and execution criteria of the maritime and port works carried out in the Spanish National Port Administration was initiated.

The broad range of issues to be dealt with by the Recommendations made it necessary to structure them in a series of seven subject areas:

- **Series 0:** Description and characterization of the factors of projects of maritime and port works.
- **Series 1:** Works for shielding against the oscillations of the sea.
- **Series 2:** Works inside port areas.
- **Series 3:** Planning, management and exploitation of port areas.
- **Series 4:** Superstructures and installations on land within port areas.
- **Series 5:** Maritime and port works in the surroundings of the coastal area.
- **Series 6:** Technical, administrative and legal principles.

Series 5, **Maritime and port works in the surroundings of the coastal area,** includes the Recommendations concerning the Environmental Impact assessment (ROM 5.0), Maritime and Port Works in the Coastal Area (ROM 5.2), Dredging and Filling (ROM 5.3), and those developed in this document: ROM 5.1. Quality of the Coastal Waters in Port Areas. In this working framework, the ROM 5.1 approaches the problems of the quality of port waters, reflecting the spirit and the principles established by the Water Framework Directive (2000/60/EC): "to establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater", all bearing in mind that the aspects and activities of the ports must be taken into account both in the general approach and in the way of tackling the problems and management of the aquatic systems.

The ROM 5.1 has been edited by the Spanish National Port Administration, under the responsibility of the Technical Direction of Infrastructures and Port Services, with the participation of the following persons:

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The aim of these Recommendations, including aspects of norms, methodologies and technologies, is to act as a documental basis for the planning and development of systems of management of port water quality.

The **ROM 5.1** is structured in four large blocks of work: 1) Article, 2) Technical and Legal Fundamentals, 3) Technical Methods and Applications and 4) Data, each one of which develops specific aspects related to the application of the proposed methodology. In order to aid understanding of the document and to facilitate its implantation, the aspects and contents dealt with in each block are indicated next.

The **Article** is the central block of the Recommendation, establishing the philosophical line and the application methodology of each one of the four basic aspects making up the document: characterization of water bodies programme in the geographical area of jurisdiction, environmental risks assessment and management programme, the programme of environmental monitoring and the programme of contaminant events management.

As a complement to the application methodology, the **Technical and Legal Fundamentals** justify the proposed procedures, setting them in the communitary and state legal framework and developing the scientific and technical theoretical aspects most relevant to the Article.

The block related to **Technical Methodology and Applications** includes a detailed explanation of the different techniques and methods proposed in the Article.

The document is completed with a block detailing possible sources for consultation of **Data.**

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Part I

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ARTICLE AND TECHNICAL SPECIFICATIONS

Part I

1. INTRODUCTION

In recent years, different Administrations and Organisms, both in the national and international scope have chosen to promote policies for protecting the environment with the aim of establishing a common strategy for sustainable development. The protection of aquatic ecosystems has not been an exception in this tendency.

These policies are giving rise to the existence of an emerging set of legislation and norms, huge and enormously complex to follow and correlate, which in many cases is applicable to coastal marine waters in general and, thus, also to port area waters. International, European, national and regional norms have an impact on this matter, and norms regulating general aspects of environmental policy coexist with others that specifically regulate marine waters and their quality requirements. Of course, there are other norms which impact indirectly, such as, those regulating the ports and their activities, those relating to the supervision of natural, specially protected spaces, to coasts or to the development of fishing activities.

Simultaneously and not unrelated to these tendencies, the Spanish Ports, along with the rest of the ports of the European Union, have been working since the start of the 90s in the port environment field. The aim of this involvement was to contribute to the sustainability of the transport, harmonizing the environmental policies and the development of tools enabling the identification and reduction of the port environment impacts, better prevention, control and management of the environmental risks, in short, a more flexible adaptation of the ports to the demands and requirements of the extensive environmental regulation that is being introduced.

In this context the recent approval of the Directive 2000/60/EC of the European Parliament and Council 23rd October 2000 should be highlighted, known as the Water Framework Directive (WFD), through which a Community-wide framework in the water policy area is established. This is a legislative step that limits the development of the norms for the protection of the European aquatic ecosystems, whether continental, coastal or transitional, and which therefore has direct effects on port area waters. The effects of this Directive, whose adoption into Spanish legislation took place through the Spanish Law 62/2003 on Tax, Administrative and Social Order law, will be translated into new conceptual, normative, political and social changes directed at going deeper into integral management of the water systems with the aim of enabling their sustainable use, protecting their quality and preventing their deterioration.

1.1. Effects of the approval of the water framework directive on ports

Ports are obviously within the scope of application of the Water Framework Directive as maritime coastal and transitional waters are within their objectives of protection, without prejudicing their legal designation, of the distinct responsibility areas and the specific legislation applicable to them.

To these effects, ports are completely incorporated into the spatial scope denominated "River basin district", a figure established as the basic unit of administration of water systems for which the so-called Water Council or Committee of Authorities was created. This organism for cooperation among the distinct administrations that has concurring responsibilities in matters and spaces related to management of waters within the River basin district, and of which the Port Authorities are part, has been given the informative and consultative responsibilities in the planning process and in all the aspects related to the protection of waters, with the main aim of guaranteeing adequate coordination in the application of the existing norms in this field.

With the incorporation of the port areas in the scope of application of the Water Framework Directive, a reference water quality system must also be established in them, which is homogeneous and standardised, and from which the so-called "chemical quality" and "ecological status" of water bodies can be evaluated, taking into account the repercussions and impact on the human activity within these water bodies.

In this sense, in contrast to the general demands that water bodies are subject to, the Directive contemplates the possibility that many port water areas can under certain circumstances be considered as "modified water bodies"; a definition that can grant these waters exceptional conditions through which their environmental demands can be reduced, while maintaining their objectives of protection and improvement necessary in order to achieve a good ecological potential and good chemical quality.

1.2. Objectives of this recommendation

The responsibility for "water quality" in port areas is shared among the different environmental administrations at local, regional and national level, and the Port Authorities with their role of regulating the activity taking place in the geographical area of jurisdiction.

The port administrations are currently responsible for the following aspects related to the management of the quality of port waters:

- Evaluation of the effects of investments in infrastructures and, if there are, of the port director plans for the environmental impact assessment in order to submit for approval by the environmental authorities.
- Requiring the concessionary activities and the services and port operations to fulfil the applicable environmental norms through their inclusion in the regulatory framework of these activities: regulations of services and police, regulatory specifications and concessionary contracts.
- Sanitation of the water layer.
- Collaboration with the competent administrations in the prevention and control of the emergencies due to accidental contamination in the geographical area of jurisdiction.

In this situation of concurring responsibilities, accentuated because of the complete inclusion of the port waters within the scope of application of the Water Framework Directive,in which diverse administrations have competences both in regulation and in the management and control of the port area water quality, it is essential not only to have inter-administration coordination instruments such as the Water Council or the Committee of Competent Authorities in each River basin district, but also to have objective technical and methodological tools. These tools, agreed on by the competent authorities, should allow them to approach, with common criteria and in an easy and complete way, the integral management of port water quality in accordance with the underlying principles of the Water Framework Directive and with all the current international, national, regional and local regulations, independently of the competences assigned to each Administration. Without these tools, integrated environmental management would be impossible within the port waters.

For these reasons and with the aim and interest in efficiently exploring sustainable development in the port areas in terms of protection and improvement of the aquatic environment, Spanish National Port Administration considered it beneficial to develop, within its programme of Recommendations for Maritime Works (ROM) and with the denomination "ROM 5.1. Quality of Coastal Waters in Port Areas", a first methodological and technical tool for the integral management of port water bodies, with direct impact both on the design, evaluation and environmental monitoring of the infrastructural works and on the activities and operations of the port, without which it is very difficult to approach these aspects.

This general aim can be detailed in the following specific objectives:

- Establishment of methods and procedures to delimit the uses and characterization of the port water bodies.
- Establishment of the system of indicators of port water quality.
- Establishment of the programme of risk assessment in the port water bodies.
- Establishment of the programme of preventive and corrective measures.

- Establishment of a system of measurement, follow-up and environmental monitoring of the water quality.
- Establishment of the best practices for environmental management of the port waters.

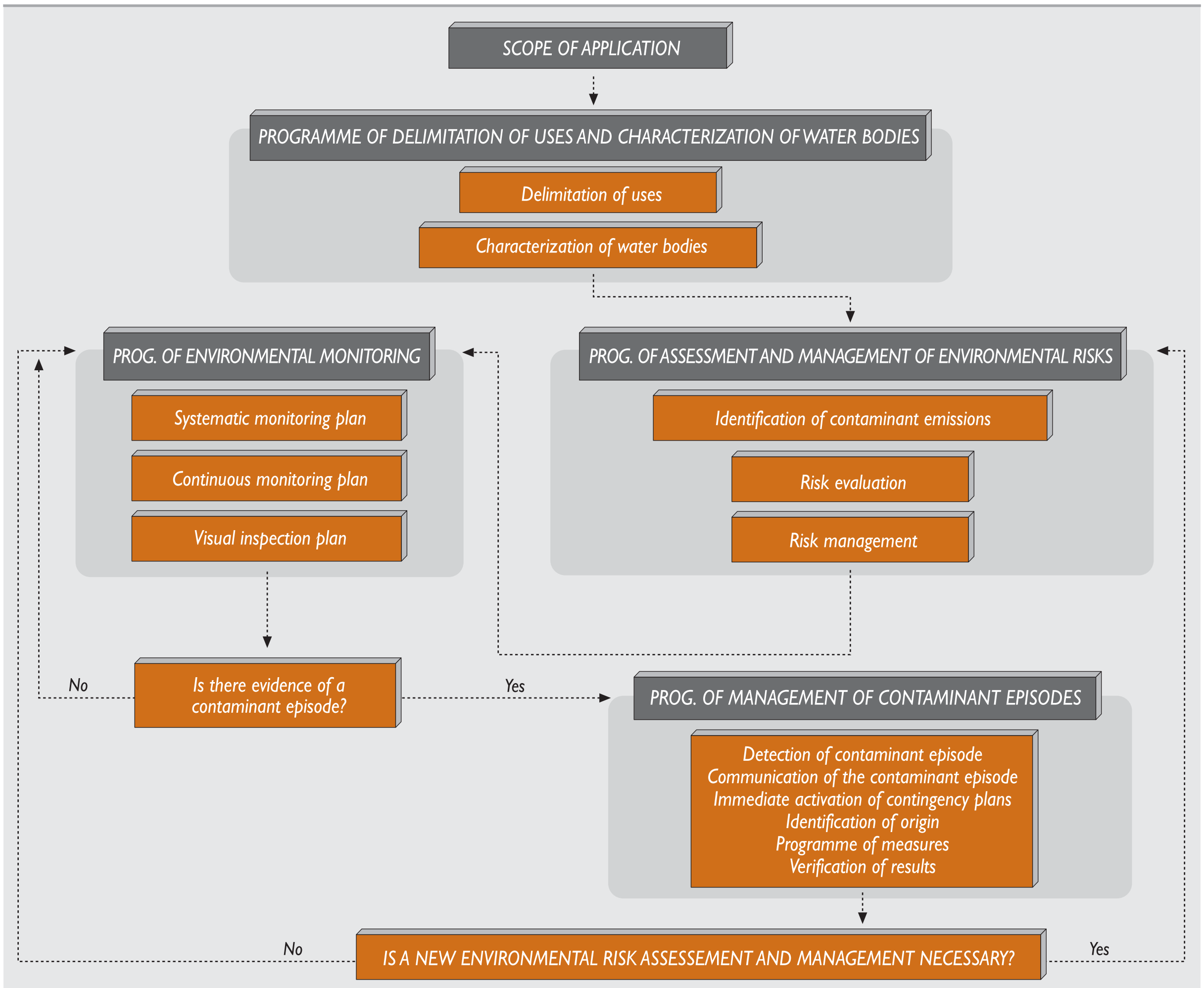
Therefore, this Recommendation represents only a first proposal for a methodological system to approach integral environmental management of the port waters, and do not establish new responsibilities beyond those legally binding ones or obligation to carry out any of the programmes. The aim is, firstly, to help the port administrations to be objective about environmental management and, secondly, to provide a future common technical reference framework agreed on by the administrations that share competences in the management of port area water quality.

Now, there is a need to discuss and later improve and develop through comparison with the criteria of the above-mentioned Administrations and the whole scientific/technical community with interest and knowledge in this field, as a means of achieving the aims.

2. CONCEPTUAL SCHEME FOR THE APPLICATION OF ROM 5.1

Given the diversity of the aspects dealt with in this Recommendation, it starts with the aim of facilitating their future application, attempting to provide an overview of the basic concepts and different procedures and relations that it contains, as is indicated in Figure 2.1. The sequence of development of these activities depends on each specific situation to be approached:

Figure 2.1.I. **Diagram for application of the ROM 5.1**



- The initial application of the ROM in existing port installations.
- The design and project of new works, installations and activities, in existing ports.
- The design and project of new ports.

According to the diagram, the application of the ROM 5.1 is structured in four large working areas: the characterization of water bodies programme, the environmental risks assessment and management programme, the programme of environmental monitoring and the programme of contaminant events management.

The detailed development of the specific procedures referring to each one of these constitutes the central body of the Recommendation Document.

Logically, the performance of all these tasks must be based on an exhaustive compilation of all the existing information about the natural, economic and social media, with the aim of optimizing the resources required in the application of the ROM. In this sense, it should be noted that although the principal basis for the application of this methodological scheme rests on the existing information, it will normally be necessary to carry out campaigns and other activities (modelling, etc) to obtain complementary information.

The basic aspects, in which these working areas are structured, as well as the general process for their application, are introduced in the following subsections.

A. Characterization of water bodies programme

The management of water quality in a specific port environment requires the establishment of methods and procedures for delimitation and characterization of its different water bodies. In the application of the ROM, this programme is based on the following tasks:

- Delimitation of uses of the aquatic environment.
- Establishment of categories of the water bodies.
- Assignment of types to the water bodies.

This programme of activities is carried out at the time of implementing the Recommendation and when there are changes in the uses and structures.

B. Environmental risks assessment and management programme

The quality of the waters in the geographical area of jurisdiction will be conditioned by the set of interactions of the activities, both of the Port Authorities and of others, which coincide in this space. Therefore, an important aim of the ROM is to establish procedures enabling the evaluation of the environmental risks associated with the different contaminant emissions impacting on the geographical area of jurisdiction.

The assessment and management of environmental risks is a preventive instrument that is applied with the objective of introducing measures aimed at minimizing the environmental repercussions of these contaminant emissions. The following procedure has been designed for this purpose:

- Risk evalaution.
- Risk management.

This programme of activities is always carried out after the application of the characterization of water bodies programme (either after its initial application or when the uses or the water bodies undergo a variation), as well as when changes are produced in the number, type or characteristics of the contaminant emissions.

C. Environmental monitoring programme

The programme of environmental monitoring is the tool through which the evolution of the chemical quality and ecological status can be evaluated (or of the ecological potential, in that case) of the different water bodies. Its application enables the proof of reduction in quality of the water bodies, the failure and omissions of the environmental risks assessment and management programme and the activation of the programme of contaminant events management.

The development of this programme includes the following plans:

- Systematic monitoring plan.
- Continuous monitoring plan.
- Visual inspection plan.

This programme of activities is initiated once the previous programmes are developed and remains active continuously in time.

D. Programme of contaminant events management

The programme of contaminant events management is the procedure leading to the mitigation of the quality deficits detected in the water bodies by the programme of environmental monitoring. Its development is based on the following working steps:

- Identification of origin.
- Adoption of preventive and corrective measures.
- Verification of the results.

The aim of this programme will be to reduce the adverse effects of contaminant events through the application of corrective measures.

3. APPLICATION SCOPE

As has already been indicated, the scope of application of ROM 5.1. corresponds to the **geographical area of jurisdiction** legally established by each Port Authority.

The Spanish law 48/2003, of 26th November, on Economic Conditions and Provision of Services in the Ports of General Interest, defines the geographical area of jurisdiction as those "spaces of land and water necessary for the development of the port uses and the reserve spaces that guarantee the possible development of the port activity". In this sense, the port uses are "commercial uses (…), fishing, nautical-sports and the complementary or auxiliary uses for the previously mentioned ones, including those related to logistic activities and storage and those corresponding to industries or businesses (…)". In the same way, the uses considered as non port uses are cultural and recreational facilities.

Within the aquatic environment of the geographical area of jurisdiction, the above-mentioned Law distinguishes among the following areas:

- ZONE I: Made up of the Port's interior waters shielded naturally or artificially, including the docks destined to loading and unloading, transfer of goods, embarkation and disembarkation of passengers, ship building and refitting, as well as the areas necessary for the manoeuvres of docking and the water spaces within the breakwaters.

- ZONE II: Surface making up the rest of the port waters and whose main use is for access and anchorage.

Notwithstanding, the competences in the scope of application defined, collaboration with other competent administrations is recommended to improve the characterization of the natural environment in the zones bordering on the port areas. Therefore, knowledge of the environmental characteristics of the exterior boundary, beyond the scope of responsibility and jurisdiction of the port, can provide an essential support when managing the water quality in the port area.

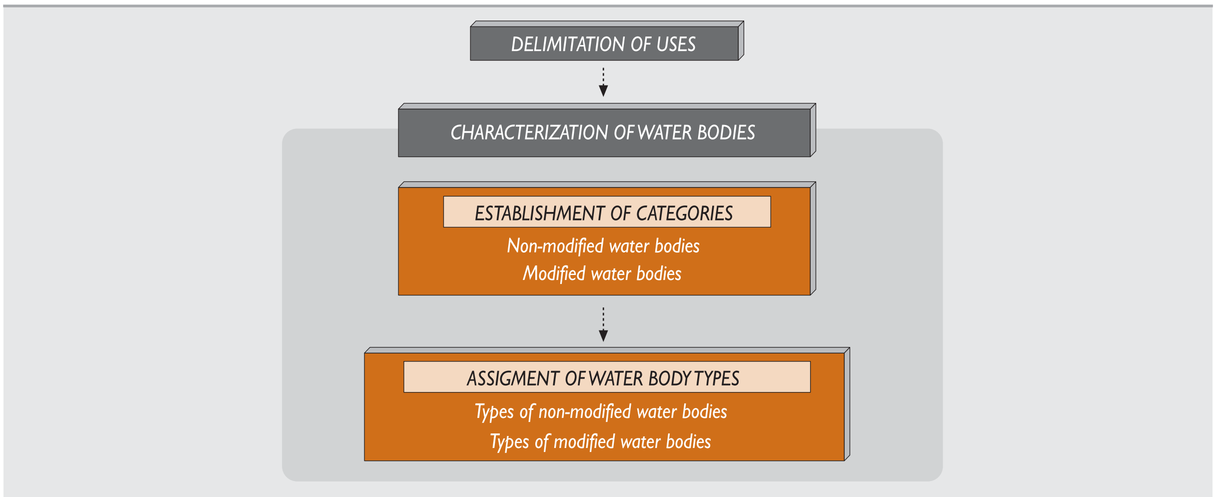
4. CHARACTERIZATION OF WATER BODIES PROGRAMME

The characterization of water bodies programme is the instrument for management of the environment in the geographical area of jurisdiction. These water bodies make up the basic units for management of their quality.

This programme of activities is developed at the same time as the ROM is implemented and when changes are introduced in the configuration of the aquatic environment of the geographical area of jurisdiction (enlargement of the port facilities, variation in the use of the aquatic environment, etc.).

In general terms, its application is according to the methodological scheme shown in Figure 4.1.

Figure 4.1.I. Activities included in the characterization of water bodies programme



4.1. Delimitation of uses in the aquatic environment

Given that the limits of the different water bodies within the geographical area of jurisdiction are based on the uses and activities of the aquatic environment recognized in it, a delimitation must be made of uses and activities in this environment starting from the characteristics of the physical, economic and cultural area in which the port is integrated.

Therefore, for the development of this zonification of uses and activities of the aquatic environment, all the existing normative basis, related to socio-economic activities in the port area, enabling a detailed knowledge of the natural and cultural heritage, must be integrated. In principle, two types of generic uses are considered; the port ones and the non-port ones.

A. Port Activities and Uses

- Port Uses in accordance with the contents of Title IV of the Spanish Law 48/2003 of Economic Conditions and Provision of Services in the ports of general interest, whether commercial (basic port services), fishing, nautical-sports and auxiliaries for the previously mentioned ones.

B. Non-port Activities and Uses

- Existence of protected areas in the context of the WFD, among which the following should be remarked:
    - Areas designated for the protection of economically significant aquatic species (areas for producing molluscs and other invertebrates and areas destined to fishing and fish farming) in the framework of the Spanish Law 3/2001 of Maritime Fishing in Spain, of the Spanish Law 23/1984 of marine cultivation and the Order of the Ministry of Agriculture, Fisheries and Food 1029/2003.
    - Bodies of water designated as recreational waters, including areas designated as bathing waters under Directive 76/160/EEC.
    - Nutrient-sensitive areas, including areas designated as vulnerable zones under Directive 91/676/EEC and areas designated as sensitive areas under Directive 91/271/EEC.
    - Areas designated for the protection of habitats or species where the maintenance or improvement of the status of waters is an important factor in their protection, including relevant Natura 2000 sites designated underDirective 79/409/EEC.
- Other areas not protected in the context of the WFD.

4.2. Characterization of water bodies

The characterization of water bodies is the process by which the aquatic environment of the geographical area of jurisdiction, previously zoned depending on the uses and activities, is classified into different homogenous types with the aim of being able to assess their quality. The characterization process takes place in two distinct steps: establishment of categories and assignment of types. In the first, each water body defined is assigned a category (modified or non-modified) depending on the degree of hydromorphological or physical alteration it has undergone. The second step is the fragmentation of each one of these categories into different types, enabling the peculiarities and variability of the aquatic environment to be reflected.

This characterization process of the water bodies of the geographical area of jurisdiction follows the steps indicated in Figure 4.1. It should be noted that the water body concept includes both the water column and the seabeds.

4.2.1. Establishment of categories

The establishment of the categories to the port waters enables a first recognition of three water bodies. Adopting the system of characterization of water bodies proposed in the WFD, the following are considered:

- **Non-modified Transitional water bodies.** "Surface water bodies in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows".

- **Non-modified Coastal waters.** "The surface waters situated close to land from a line all of whose points are at a distance of one nautical mile towards the sea from the closest point of the baseline that is used to measure the width of territorial waters and which extend until the outer limit of the transition waters".

- **Modified water bodies.**

  A surface water body of the geographical area of jurisdiction is classified as modified when the changes in the hydromorphological characteristics that must be made to achieve a good ecological status, involve considerable negative repercussions for the port activity and traffic. Furthermore, the water body can be considered as modified when the benefits derived from such consideration in carrying out the foreseen activities cannot be achieved (due to technical impossibility or disproportionate costs) by other means that provide a significantly better environmental option.

  As far as the ROM 5.1 is concerned, in principle, all the waters of the geographical area of jurisdiction confined, for example in docks, are considered as modified water bodies. Furthermore, all those waters in which, after application of specific studies, it is demonstrated that they have undergone a substantial change in their physical or hydromorphological conditions, will also be classified as modified water bodies. (Block III. Method 1).

4.2.2. Assignment of types to water bodies

Due to the peculiarities of the aquatic environment, it is necessary to fragment the categories of water bodies and assign each one with a type depending on its characteristics. This assignment is done differentiating between non-modified and modified waters, as is indicated in the following.

4.2.2.1. Types of non-modified water bodies

Depending on the characteristics of the substrate (physical descriptor) and on the categories, four different types of non-modified water bodies have been defined, as indicated in Chart 4.1.

Chart 4.1. *Types of non-modified water bodies*

Categories:
Transitional waters.
Coastal waters.

Substrate type:
Hard-bottom: > 50% of rocky surface.
Soft-bottom: ≤ 50% of rocky surface.

The result of the joint application of the two characterizations is four types of non-modified water bodies.

Categories	Substrate type	
	Hard-bottom	Soft-bottom
Transitional waters	N1	N2
Coastal waters	N3	N4

For each of the two categories defined for non-modified water bodies (transitional and coastal) two substrate types are established, with the following criteria: hard-bottom (rock making up more than 50% of the surface) and soft-bottom (sediment making up more than 50% of the surface).

4.2.2.2. Types of modified water bodies

Depending on the flushing time of the water bodies (hydromorphological descriptor) and on the characteristics of the substrate (physical descriptor) four different types of modified water bodies have been defined, as indicated in Chart 4.2.

The flushing time of a water body is defined as the average time to change all the water in a domain. Flushing time is estimated as the time necessary for a uniformly distributed conservative tracer to reduce its average concentration over its whole volume by 90%. This value must be evaluated using numerical modelling taking into account the average values of the most significant dispersive agents (Block III: Method 3).

With the aim of normalizing the evaluation conditions of the flushing time, the following hydrodynamic modelling conditions are used:

- Tide: Estimate the two main harmonics of the tide initiating the simulation in phase quadrature.
- Wind: Annual average wind regime.
- Tributaries: Annual average flow.

Chart 4.2. ***Types of modified water bodies***

Flushing time:
Low renewal: > 7 days.
Acceptable renewal: ≤ 7 days.

Substrate type:
Criterion: The integration of substrate type is carried out using the levels and ranges specified for the non-modified water bodies (Chart 4.1.).

The result of the joint application of the two characterizations is four types of non-modified water bodies:

Flushing time	Substrate type	
	Hard-bottom	Soft-bottom
Low renewal	M1	M2
Acceptable renewal	M3	M4

Once the different water bodies of the geographical area of jurisdiction are classified, those corresponding to the same type of water body can be grouped together in a single water body, if they share boundaries.

5. PORT WATER QUALITY INDICATORS

The analysis of chemical quality and ecological status of the water bodies of the geographical area of jurisdiction requires the selection of biological, physical and chemical indicators whose status or variation informs us of the existence of effects on the environment.

For a better understanding of the technical indications contained in the environmental risks assessment and management programme and in the programme of environmental monitoring (Chapters 6 and 7), next the chemical quality indicators and ecological status and ecological potential indicators are introduced. The former come from the current norms, the latter have been adopted from the existing scientific information.

5.1. Indicators of chemical quality

The indicators of chemical quality (Table 5.1.) of each of the water bodies of the geographical area of jurisdiction will be those priority substances (Annex X of the WFD) that can be present in the scope of application of ROM 5.1. The quality criteria of each one of these priority substances are shown in Table 7.1.

5.2. Indicators of ecological status or ecological potential

For the analysis of the ecological status or the ecological potential of a water body, the pelagic and benthic environments will be considered using the indicators shown in Table 5.2. The integration of these quality indices, along with their assessment systems, is explained in Section 7.1.2.3.

Table 5.1.I. ***Indicators of chemical quality***

Priority Substances
HEAVY METALS: Cadmium, Lead, Mercury and Nickel
HIDROCARBUROS AROMÁTICOS POLICÍCLICOS: Anthracene, Fluoranthene, Naphthalene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(g,h,i)perylene, Benzo(k)fluoranthene and Indeno(1,2,3-cd)pyrene
PHENOLS: Nonylphenols (4-(para)-nonylphenol), Octylphenols (para-tert-octylphenol) and Pentachlorophenol
CHLORATED ORGANIC COMPOUNDS: Alachlor, Atrazine, C10-13 Chloroalkanes, Chlorfenvinphos, Chlorpyrifos, 1,2-dichloroethane, Dichloromethane, Endosulfan (alpha-endosulfan), Hexachlorobenzene, Hexachlorobutadiene, Hexachlorocyclohexane (lindane), Diuron, Pentachlorobenzene, Trichlorobenzenes (1,2,4-trichlorobenzene) and Trichloromethane (chloroform)
OTHERS: Trifluralin, Benzene, Brominated diphenylethers, Di(2-etylhexyl)phthalate (DEHP), Isoproturon, Simazine and Compounds of tributyltin (tributyltin cation)

Table 5.2.I. ***Indicators of ecological status and ecological potential***

Indicators
PELAGIC ENVIRONMENT: Oxygen saturation (%); Turbidity; Total hydrocarbons; Detergents and Chlorophyll “a”
BENTHIC ENVIRONMENT: Total Organic Carbon (TOC); Kjeldahl Nitrogen (KNT); Total Phosphorus (TP); Heavy metals: Hg, Cd, Pb, Cu, Zn, Ni, As, Cr; PCB; PAH and Hard-bottom Communities Characteristic

6. ENVIRONMENTAL RISKS ASSESSMENT AND MANAGEMENT PROGRAMME

The environmental risks assessment and management programme is the procedure which brings to light the effect of each contaminant emission, whether it is caused by ordinary activities or by accidents, on the quality of port waters. To this end, the risk attributable to each emission is evaluated on the basis of the likelihood of its occurring, the ensuing consequences and the vulnerability of the waters potentially affected. Where necessary, depending upon the tolerability of the emission, the appropriate preventive and corrective measures are applied with a view to achieving acceptable levels.

In addition, this programme provides the information required to optimize the design of the programme of environmental monitoring.

As previously explained, this programme will always be implemented after the characterization of water bodies programme has been applied to the relevant waters. Once the initial environmental risk evaluation has been carried out, subsequent evaluations will only be required in the following circumstances:

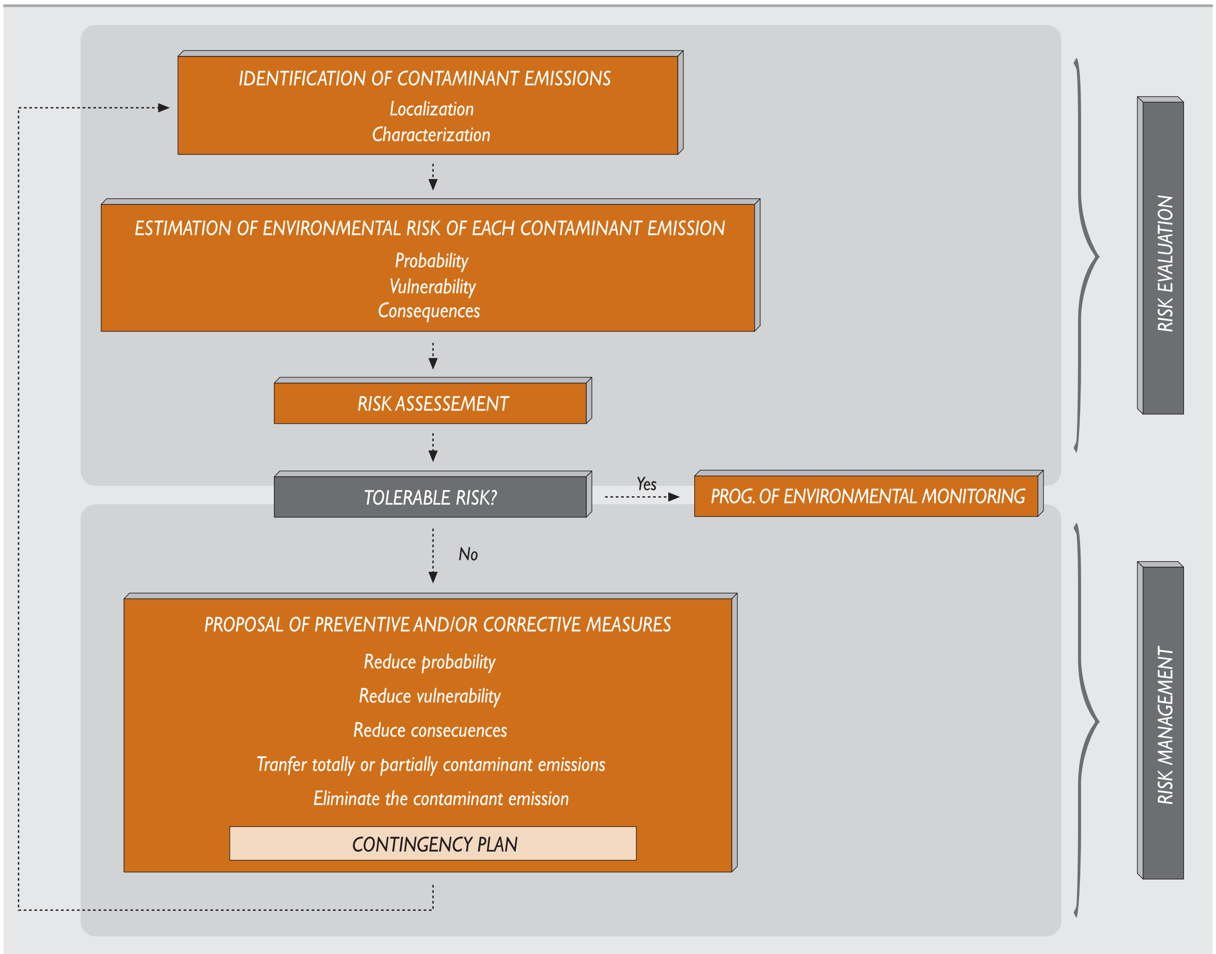
- If alterations to the delimitation of use and characterization of port waters (modification of port facilities and infrastructure, extension of docks, etc) take place or are planned.

- If there are changes in the number, type or characteristics of contaminant emissions (due to new activities, new port traffic, the construction of new terminals, changes of use, alterations to conditions of use in different port areas, etc).

- If new environmental legislation relevant to the content of this programme is passed.

The methodology for implementation of this programme is shown in Figure 6.1.

Figura 6.1.I. ***Process of the programme of assessment and management of environmental risk***



6.1. Identification of contaminant emissions

The target of this phase is to locate and characterize contaminant emissions produced either by ordinary activities or by accidents. In this context, a contaminant emission is understood to be the discharge into the port water environment of substances or energies which alter the quality of the waters which receive them. Depending upon the manner in which the contaminant emission is discharged into the water, it shall be classified as point or diffuse (Table 6.1).

Table 6.1.I. ***Characterization of the contaminant emissions***

Type	Definition
POINT	Emission of contaminant substances through fixed and predefined points (channelled run-off, storm relief, etc.)
DIFFUSE	Unchanneled emission of contaminant substances (Filtrations dredging, etc.)

Figure 6.2.I. **Matrix of situations susceptible to cause diffuse contaminant emissions**

Identification of infraestructures, equipment and uses susceptible to being sources of contaminant emissions	Situations susceptible to causing contaminant emissions									
	Run-off in basin	Run-off in Service Zone	Intentional or uncontrolled unloading and discharge	Leakage and spillage	Filtrations	Accidents and breakages	Resuspension or dispersion of sediments	Manipulation losses	Dredging	Breakage of machinery
RECEPTION AND MANAGEMENT OF WASTE GENERATED BY THE SHIPS AND RESIDUES OF THE CARGOS										
Operations of collection and transport of waste and residues										
Storage and treatment										
SHIP-PORT INTERPHASE										
Maritime transport										
Abandoned ships										
Ship services: docking and mooring										
Fixed or floating installaations for supplying fuel to ships										
Equipment and installations for handling and transporting cargo										
Loading and unloading operations										
Residues of loads in docks and manoeuvring zones										
Manipulation of dangerous or contaminant cargos: hydrocarbons, chemical and petrochemical products, etc.										
CARGO TERMINALS										
System of storage and distribution (exterior)										
Systems of storage and distribution (interior): shed, tanks and silos										
Conductions, belts and rails for transport of cargos										
Residues of the cargos										
Parking and land traffic										
PASSENGER TERMINAL										
Parking and land traffic										
FISHERY INSTALLATIONS										
Organic residues of fishery activity										
URBAN ACTIVITIES										
Storage of urban residues										
Construction and demolitions										
INDUSTRIAL ACTIVITIES										
Storage of industrial residues										
Storage of raw materials and industrials products										
Contaminated surfaces or sediments										
AGRICULTURAL AND FISHERY ACTIVITIES										
Storage of agricultural and livestock farming residues										
Treatment with fertilizers and/or pesticides										
MARITIME ACTIVITIES										
Maritime transport										
Cleaning of bilge and ballast water										
Waste and residues from ships										
Fish farm and shell fishing residues										
Extractive activity										

Within the geographical area of jurisdiction there may be a wide range of easily identifiable point emissions (industrial, urban, storm tank overflows, etc.) However, identifying diffuse contaminant emissions which may affect these waters requires systematic methods such as the matrix shown in Figure 6.2, which will enable every port to identify situations liable to cause these diffuse contaminant emissions.

This matrix associates different types of diffuse contaminant emissions with their likely sources in terms of equipment and infrastructure.

Given the purpose of this Recommendation, identifying contaminant emissions in Zone I of the geographical area of jurisdiction constitutes one of the fundamental tasks in this section. Nevertheless, an exhaustive knowledge of all emissions in the geographical area of jurisdiction, regardless of their origin, is considered essential. Similarly, it is recommendable that all emissions in the outer areas of the port which may affect the geographical area of jurisdiction should also be known of.

6.1.1. Localization of the emissions

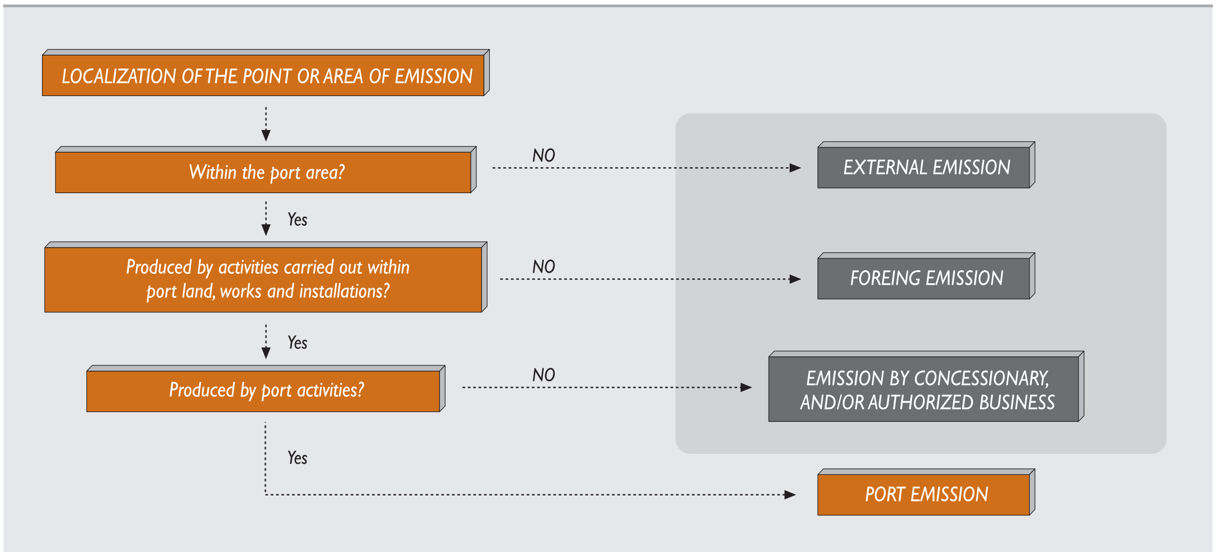
The purpose of this action will be to inventory and classify any emissions which may affect the quality of port waters.

In the case of permitted point emissions, with discharge points within or outside the geographical area of jurisdiction, all of the information should be available in the corresponding Effluent discharge permit, which requires the exact location of the point of discharge or deposit of waste substances or waters to be specified, (R. D. 606/2003). It should be remembered that, according to Article 57 of the Spanish Law 22/1988 (of coasts, 28th July), the competence to authorise the emission into the sea rests with the Coastal Authority of the relevant regional government. In order to obtain a complete picture, steps should also be taken to identify any illegal dumping points.

In the case of diffuse emissions, matrices such as that in Figure 6.2 should be used in order to locate the areas which produce or may produce emissions liable to affect the quality of the waters in the geographical area of jurisdiction.

Once each emission has been located, it should be classified according to its point or area of emission and its origin, as shown in Figure 6.3.

Figure 6.3. Characterization of contaminant emissions



6.1.2. Characterization of the emissions

The purpose of characterizing emissions is to know what contaminant substances they contain and the range of variation in concentration and discharge flow.

All port emissions, as well as those of its concessionaries, should be studied in detail, as they directly affect water quality in the geographical area of jurisdiction.

It is also essential to characterize in as much detail as possible emissions from other sources which are within the geographical area of jurisdiction.

The characterization given to external diffuse or point emissions will depend upon the effect which, as a result of the hydrodynamics of the environment, they may have on the quality of the waters in the geographical area of jurisdiction.

6.1.2.1. Characterization of point emissions

The correct characterization of these emissions will also require an analysis of the different activities and processes which may produce the contaminant substances which then converge on the points of emission.

In order to establish which discharged substances are to be considered contaminants, the following regulations should first of all be taken into account, as well as any later ones which may be published:

- Priority substances as classified in Decision 2455/2001/EEC.
- Priority hazardous substances, as classified in the above Decision.
- Other hazardous substances not included in the above, but listed in the European Pollutant Emission Register (EPER), published in Decision 2000/479/EC.
- Substances which may affect the quality of protected areas, including nutrients, oxygen-consuming substances, biological contaminants, etc.

The concentration and flow of contaminants in emissions can be estimated in accordance with the following procedures:

- Collection of information from various sources: effluent discharge permit, EPER, etc.
- Analysis of the processes giving rise to the emissions, applying tried and tested emissions models and standards.
- Specific data collection campaigns.

In Block III: Method 2, each of the above procedures is described in detail.

6.1.2.2. Characterization of diffuse emissions

Some of the activities of the port and its concessionaries which are liable to produce diffuse contaminant emissions are as follows: receipt and management of ships' waste and loading waste, ship-port interface operations, operations in terminals and building/repair work, emissions caused by run-off, discharges and deliberate spillages, leakage, spillage, seepage, accidents, breaches and losses (Figure 6.2).

For this reason, the characterization of diffuse emissions should be carried out according to the same criteria and for the same substances as those established above for point emissions (Section 6.1.2.1), in addition to the list of substances defined as hazardous goods in the applicable legislation (Spanish norm, R.D. 145/1989, which approves the National Regulations for the Admission, Handling and Storage of Hazardous Goods in Ports).

Contaminant concentrations in diffuse emissions caused by goods handling should be estimated on the basis of the total quantities handled during all of the activities identified, and by applying factors enabling percentage loss to be estimated according to the methods, equipment and facilities used. As for the other causes of diffuse emissions (run-off, leakage, spillage, seepage, accidents and breaches, resuspension or dispersion of sediments, etc), tried and tested standards should be applied (see Block III: Method 2).

6.2. Estimation of environmental risk

Once all contaminant emissions with the potential to affect geographical area of jurisdiction waters have been identified, a risk assessment will be carried out for each of them. For this purpose, various scenarios will be considered, ranging from the accepted or authorised situation to that of maximum accident impact.

In the case of point emissions, the effluent discharge permit, as the relevant regulatory document, implicitly requires that the quality of the receiving waters be maintained within "acceptable" limits. The risk assessment associated with these point emissions relates to the non-fulfilment of the emissions requirements established in this Effluent discharge permit (accidents, breaches, etc.).

Diffuse emission risk assessments, however, are directly associated with the occurrence of a situation or event which may give rise to an unacceptable contaminant emission. These should be carried out for each port, taking into account the activities with the potential to cause emissions there.

The methodology employed in the environmental risk estimation is based on the following formula:

$$R_i = P_i \times V_i \times C_i$$

where:
R_i: Risk value of contaminant emission "i".
P_i: Probability factor of contaminant emission "i".
V_i: Vulnerability factor of the waters in respect of contaminant emission "i".
C_i: Consequence magnitude factor of contaminant emission "i".

This formula, in accordance with what has been discussed above, enables the risk of each emission identified to be estimated prior to analysing its tolerability (Section 6.3.) and drawing up measures to prevent, correct or eliminate it (Section 6.4).

Given that any risk estimation involves significant uncertainty due to various factors (limitations to scientific knowledge, scarcity of sources of information, varying and, at times, contradictory perception of existing risks and their seriousness, etc.), any opinions given and sources of information used should be properly documented so that they may be correctly interpreted.

The following sections indicate a basic methodology for a standardized, homogeneous estimation of the risk factor. Nevertheless, it should also be stated that, where sufficient accurate information is available, quantitative assessment methods such as risk probability assessment (statistical, probabilistic methods, etc.) may also be employed if so desired.

6.2.1. Estimation of the probability factor corresponding to the risk of a contaminant emission (P_i)

Assessment of this factor will be based on an exhaustive collection of information on activities with the potential to generate unacceptable contaminant emissions, whether they are point or diffuse. In assessing impact, a realistic figure for the *probability factor* should be determined by means of a tried, tested and preferably well-documented methodology.

As specified above, the probability factor $\mathbf{P_i}$ associated with the contaminant emission "i" should be deduced, in the case of point emissions, from an analysis of possible instances of non-fulfilment of the discharge conditions established in the corresponding effluent discharge permit (accidents, breaches, etc.). However, for diffuse emissions the probability factor applied will be related to frequency of occurrence, based on an analysis of situations liable to cause contaminant emissions (Figure 6.2).

Information sources which may be consulted in order to estimate frequency of occurrence of diffuse emissions or non-compliance with the limits set out in the effluent discharge permit for point emissions include companies' historical data (incident and accident logs, etc.), rainfall data, specific databases, data published in the specialist literature, and, finally, the expert's own opinion.

If the above analysis cannot be performed, the $\mathbf{P_i}$ figure may be calculated by means of the basic estimation method described below.

Table 6.2.I. Criteria for assessment of the probability factor

Probability factor (P_i)	Time elapsed between contaminant emissions	Examples of situations susceptible to cause contaminant emissions
4	< 1 month	Run-off
		Handling losses
3	between 1 month and 1 year	Filtrations
		Leakage and spillage
2	between 1 year and 7 years	Non-compliance with discharge permit
		Discharges
1	> 7 years	Run-off with long return period
		Accidents and breaches

Any one of these processes will give a *probability factor* ($\mathbf{P_i}$) for each contaminant emission.

6.2.2. Estimation of the vulnerability factor of the water bodies to a contaminant emission (V_i)

The *vulnerability factor* of the waters affected by an emission is assessed on the basis of their susceptibility, the existence of control, defence and alarm systems, and the efficiency of the working procedures in place.

The vulnerability factor should be determined by considering the above criteria in accordance with the following formula:

$$V_i = \frac{1}{10}\left[5 \cdot F_s + 3 \cdot F_a + 2 \cdot F_e\right]$$

where:

$\mathbf{F_s}$: Susceptibility of the waters to the contaminant emission.
$\mathbf{F_a}$: Accessibility of the contaminant emission.
$\mathbf{F_e}$: Efficiency of the working procedures.

6.2.2.1. Susceptibility of the water bodies (F_S)

Susceptibility evaluates the effects of a contaminant emission given the status of conservation of the water bodies affected.

To this effect, water bodies will be considered to be affected by a contaminant emission when its extent affects at least 10% of their surface area.

The extent of the contaminant emission will be deemed to be the water surface in which at least one of the following criteria applies:

- Non-fulfilment of any of the quality guidelines laid down for the contaminant (conservative contaminants).
- A fall in the average daily concentration of dissolved oxygen in the water column to below 50% saturation in more than 5% of the days of the year (oxygen-consuming contaminants).
- Non-fulfilment of bacteriological water quality criteria in bathing and mollusc-production waters, as established in the corresponding regulations (bacteriological contaminants).

Fulfilment of these criteria will not be evaluated in the "mixing area" of each contaminant emission. This area should be defined on the basis of the specific conditions of the environment into which the emission takes place.

In the evaluation of the extent, only those substances contained in the emission will be modelled (Section 6.1.2). In the case of contaminants, only those with specific quality guidelines will be considered. Similarly, dissolved oxygen-reducing and bacteriological pollution-spreading processes will only be modelled when the characterization of the contaminant emission establishes that reactive or bacteriological substances are involved.

The information which must be collected for modelling is that pertaining to the characteristics of the contaminant emission (location, concentration, reactivity of substances, discharge laws, etc.), environmental characteristics (hydrodynamic, meteorological, etc.) and the preventive measures in place. Initially the modelling should be carried out in the same hydrodynamic conditions (tide, wind, tributary waters) as were established for the calculation of flushing time (Section 4.2.2.2). At all events, the random components of the different phenomena modelled, as well as the probabilistic analysis of the results obtained (Block III: Method 3), should be taken into account where appropriate.

The susceptibility of the waters should be evaluated on a scale of 1 – 4, depending upon the water bodies affected by the contaminant emission, in accordance with the criteria in Table 6.3.

Table 6.3.I. Criteria for assessment of the susceptibility term of the water bodies

Susceptibility of water bodies (F_s)	Type of water body affected by the contaminant emission
4	Protected natural areas; Sites of Community Importance (SCIs); bathing, fishing, shell fishing or aquicultural zones Sensitive zones, (91/271/EEC); waters associated with vulnerable zones (91/676/EEC) and water bodies with good or very good ecological quality
3	Other non-modified water bodies
2	Modified water bodies
1	Any type of water body affected by the contaminant emission without non-compliance of any of the established guidelines

Should different bodies of water be affected by the contaminant emission, the *susceptibility factor* value adopted for the emission should be that of the most susceptible water body.

6.2.2.2. Accessibility of the contaminant emission (F_a)

The *accessibility of the contaminant emission* to the water bodies quantifies the existence or the establishment of detection or control, defence and alarm systems to prevent contaminant emissions from reaching the water bodies. An emission is considered to have less accessibility the more control, defence and alarm systems there are.

The *accessibility of the contaminant emission* should be evaluated on a scale of 1 – 4, depending upon the number of control, defence and alarm systems which exist, in accordance with the criteria in Table 6.4.

Table 6.4.I. Criteria for assessment of the accessibility term of the contaminant emission

Accessibility of the contaminant emission (F_a)	Level of the system of control and defence against the possibility of contaminant emissions
4	Non-existence of systems of control and defence against the possibility of contaminants emissions, or existence of these in a permanently non-operational state
3	Existence of permanently operational systems of defence against the possibility of contaminant emissions but with no control systems
2	Existence of permanently operational contaminant emission control systems, as well as defence systems. Absence of alarm systems
1	Existence of permanently operational contaminant emission control systems, as well as defence systems. Existence of alarm systems

6.2.2.3. Efficiency of the working procedures (F_e)

Efficiency of the working procedures quantifies the possibility that the preventive and corrective measures taken against the contaminant emission will achieve their objectives.

The Port Authority's working procedures describe, in the appropriate detail for each case: who, how, where, why and with what resources a particular activity should be carried out. Their aim is to standardize working practices, avoiding any uncertainty and improvisation which might cause problems or shortcomings when carrying out each task.

The *efficiency of the working procedures* should be evaluated on a scale of 1 – 4, depending upon the ability of the working procedures to counter the causes or effects of the contaminant emission, in accordance with the criteria in Table 6.5.

Table 6.5. Criteria for assessment of the efficiency term of the working procedures

Efficiency of the working procedures (F_e)	Level of the working procedures established to combat the cause or to reduce the effects of the contaminant emission
4	Non-availability of working procedures to combat the cause or reduce the effects of the contaminant emission
3	Availability of generic working procedures that, although not established specifically to reduce the cause and effects of a contaminant emission, provide some coverage
2	Availability of specific working procedures to combat the cause or reduce the effects of the contaminant emission, but without periodic simulations and other activities associated with the state of maintenance and training of the corresponding human teams and materials
1	Availability of specific working procedures to combat the cause or reduce the effects of the contaminant emission, with periodic simulations and other activities associated with the state of maintenance and training of the corresponding human teams and materials

6.2.3. Estimation of the magnitude factor of the consequences produced by a contaminant emission (C_i)

After evaluating the probability of each contaminant emission and the vulnerability of the water bodies, the consequences must also be evaluated. The *consequence magnitude factor* is based on three elements: how hazardous the substances are, the extent of the area of impact in each of the water bodies, and how easily they can be restored. Depending upon the social repercussion of a contaminant emission, a multiplier may be incorporated to increase the final value of the consequence magnitude factor.

This factor should be evaluated by considering the above criteria in accordance with the following formula:

$$C_i = \frac{1}{4}\left[2 \cdot F_p + F_g + F_r\right] \cdot F_c$$

where:

F_p: Hazard posed by the contaminant emission.
F_g: Extent of the contaminant emission.
F_r: Recovery potential of the water bodies following the contaminant emission.
F_c: Social repercussion of the contaminant emission.

6.2.3.1. Hazard posed by the contaminant emission (F_p)

The *hazard posed by the contaminant emission* is understood to be its potential to affect the chemical and ecological quality of the environment, human health or established usage.

It should be evaluated according to the substances present in the emission, taking into account the priority groups of substances listed in Annex X of the Water Framework Directive (Decision 2455/2001/EC), in the European Contaminant Emissions Register (EPER: Decision 2000/479/EC), in the National Regulations for the Admission, Handling and Storage of Hazardous Goods in Ports (Spanish Norm, R. D. 145/1989), in the Directives concerning the management of bathing water (76/160/EEC and 2006/7/EC) and in Directive 79/923/EEC on the protection of shellfish waters. Table 6.6. lists the specific substances contained in the above legislation.

The hazard posed by the contaminant emission should be evaluated on a scale of 1 – 4, in accordance with the criteria in Table 6.7.

Should various specific substances be involved in the contaminant emission, the **F_p** value adopted for the emission should be that of the most hazardous substance.

6.2.3.2. Degree of extent of the contaminant emission (F_g)

The *degree of extent of the contaminant emission* refers to the percentage of surface area of the water bodies affected by the emission.

The percentage of surface area affected by the contaminant emission should be obtained by referring to the result of the evaluation of the extent of each contaminant emission (Section 6.2.2.1.), calculated by means of the dispersion and transportation models (Block III: Method 3). The value for the extent of the contaminant emission is obtained by overlaying the geographical area affected. The percentage of each water body affected may then be established by comparing the known extent of emission of each indicator with the known surface area of the water body.

This concept should be evaluated for each water body on a scale of 1 – 4, reflecting the percentage of surface area affected by the emission, in accordance with the criteria in Table 6.8. For each water body, the figure entered as the percentage affected by the contaminant emission will be taken to be the highest percentage calculated for any type of contaminant (conservative, oxygen-consuming and bacteriological).

Table 6.6. Criteria for assessment of the hazard

4	C_{10-13} Chloroalkanes Tributylin compounds *(Tributiltin cation)*	Nonilphenols *(4-(para)-nonilphenol)* Mercury and its compounds	Polyaromatic hydrocarbons *(Benzo(a)pirene)* *(Benzo(b)fluorantene)*
4	1,2-Dichloroethane Alachlorine Anthracene (1) Atrazine (1)	Simazine (1) Trichlorobenzenes (1) *(1,2,4-triclorobenzene)* Trichloromethane (cloroform)	Chlorfenvinphos Cloropirifos (1) Di(2-ethylhexil)phthalate (1) Dichloromethane
3	Arsenic BTEX	Cianides Chlorides	Zinc Fluorides
3	Radioctive substances of low specific activity (LSA) (3)	Deplenished iron oxide and iron sponge (3)	Ammonia nitrate fertilizer-type B (3)
3	Aluminium silicate in powder (uncovered) (3)	Lead nitrate (3)	Ammonia nitrate fertilizer-type A (A1) (3)
3	Raw Ammonia wastes with humidity over 7% (3)	Magnesium nitrate (3)	Ammonia nitrate fertilizer-type A (A2) (3)
3	Zinc ash (3)	Barium nitrate (3)	Ammonia nitrate fertilizer-type A (A3) (3)
3	Antimony mineral and waste (antimonite) (3)	Mixed Sodium nitrate and potassium nitrate (potassium nitrate from Chile) (3)	Ammonia nitrate fertilizer-type A (A4) (3)
3	Sulphur. In blocks or large granuled powder (3)	Sodium nitrate (nitrate from Chile) (3)	Fertilizer wastes with more than 8% humidity (3)
3	Aluminium Ironsilicate in powder (3)	Potassium nitrate (3)	Dry copra (3)
2	Intestinal enterococos	*Escherichia coli*	Minerals oils
2	Concentrated minerals (2)	Iron phosphoirus (2)	Petroleum coke (calcinated) (2)
2	Aluminium (run-off) (2)	Vanadium mineral (2)	Granulated tar (2)
2	Fluorite (Calcium fluoride) (2)	Sawdust (2)	Wood in sticks (2)
2	Wastes (containing more than 8% humidity) (2)	Dry prereduced irons, with high iron contents, in briquettes and pellets (2)	Petroleum coke (uncalcinated) (2)
1	Other substances emitted		

(1): Priority substances that may be classed as hazardous priority substances in the future.
(2): M.H.B.: Materials potentially Hazardous in Bulk according to Spanish Norm, R.D. 145/1989.
(3): Hazardous products according to Spanish Norm, R.D. 145/1989. Term in italics: Groups of subsstances represented.

Table 6.7. Criteria for the assessment of the danger of the contaminant emission

Hazard posed by contaminant emission (F_P)	Group of substances included in the contaminant emission
4	Substances defined as "priority hazardous substances" in Annex X of the WFD (Decision 2455/2001/EC) Substances defined as "priority substances" in Annex X of the WFD (Decisión 2455/2001/CEE)
3	Substances appearing as contaminant in Annex A1 of the European inventory of contaminant emissions (EPER), published through Decision 2000/479/EC, but which have not been considered at previous levels Substances defined as hazardous merchandise in the applicable legislation (Spanish Norm. R.D. 145/1989)
2	Substances or bacteriological indicators considered in the Directives 76/160, 2006/7 and 79/923, which have not been considered in previous levels Substances defined as potentially hazardous merchandise in the applicable legislation (Spanish Norm. R.D. 145/1989)
1	Other emitted substances

<table>
<tr><td>(Benzo(g,h,i)perilene)
(Indeno(1,2,3-cd)pirene)
(Benzo(k)fluoroantene)</td><td>Pentachlorobenzene
Hexachlorobutadiene
Pentabromobiphenileter</td><td>Cadmium and its compounds
Hexaclorocyclohexane
(gamma isomer-lindane)
Hexaclorobenzene</td></tr>
<tr><td>Endosulphane [1]
(alpha-endosulphane)
Fluorantene
Isoproturon [1]</td><td>Octilphenols [1]
(para-ter-octilphenol)
Pentachlorophenol [1]
Nickel and its compounds</td><td>Benzene
Trifluoralene [1]
Diuron [1]
Naphthalene [1]
Lead and its compounds [1]</td></tr>
<tr><td>Halogenated organic compounds
Copper</td><td>Chrome VI
Phenols</td><td>Total nitrogen
Total phosphorus</td></tr>
<tr><td colspan="3">Iron bars or steel, from drilling, off-cuts, perforations, sandings, scrapings, lathing of ferrous metals [3]</td></tr>
<tr><td colspan="3">Seed cakes with vegetable oil content, mechanically pressed seed wastes, with more than 10% oil or more then 20% combined oil and humidity [3]</td></tr>
<tr><td colspan="3">Seed cakes with vegetable oil content, wastes from extraction of oil from seeds with solvents or by pressing that contain less than 10% oil, or with humidity greater than 10% but less 20% oil and humidity combined [3]</td></tr>
<tr><td colspan="3">Seed cakes with vegetable oil contents (wastes from the extraction of oil from seeds with solvents, with less than 1.5% oil and 11% humidity) [3]</td></tr>
<tr><td colspan="2">Flour and wastes of fish (with antioxidant treatment):
fat content 18% by weight [3]</td><td>Flour and wastes of fish (with antioxidant treatment):
humidity content 5-11% by weight [3]</td></tr>
<tr><td colspan="2">Flour and wastes of fish: fat content 12%
by weight [3]</td><td>Frour and wastes of fish: humidity content 6-12%
by weight [3]</td></tr>
<tr><td colspan="2">Ironsilicate, 30-90% silicate [3]</td><td>Inactive charcoal [3]</td></tr>
<tr><td>Wastes and floating material [3]</td><td></td><td></td></tr>
<tr><td>Gluten in granules [2]</td><td>Broken rice [2]</td><td>Bran [2] Toasted flours [2]</td></tr>
<tr><td>Flours [2]</td><td>Coal [2]</td><td>Corn [2] Granulated alfalfa [2]</td></tr>
<tr><td>Rice Husk [2]</td><td>Chrome mineral [2]</td><td>Citrus pulp [2]</td></tr>
<tr><td>Wood pulp in pellets [2]</td><td>Charcoal
briquettes [2]</td><td>Barley malt in granules [2]</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

Table 6.8. Criteria for assessment of the degree of extent of the contaminant emission

Degree of extent of the effects of the contmainant emission (Fg)	Percentage of the water body affected by the contaminant emission, measured Superficially
4	> 50%
3	Between 30 and 50%
2	Between 10 and 30%
1	< 10%

Should various water bodies be affected by the contaminant emission, the extent value adopted should be that of the water body with the highest percentage.

6.2.3.3 Recovery potential of the water body with respect to the contaminant emission (F_r)

The *recovery potential of the water body* quantifies the time which needs to pass before the waters recover the environmental quality which they had prior to the contaminant emission, if this is possible.

The recovery potential should be evaluated on a scale of 1 – 4, depending upon the recovery time following the contaminant emission, in accordance with the criteria in Table 6.9.

Table 6.9. Criteria for assessment of the recovery potential of a water body with respect to a contaminant emission

Recoveryof the water body respect to the contaminant emission (F_r)	Time limit of recovery of the water body with respect to the effects caused by the contaminant emission
4	Irreversible situation or recovery period of more than 7 years
3	Reversible situation, either naturally or with the adoption of available measures, with a time limit of recovery of the water body between 1 and 7 years
2	Reversible situation, either naturally or with the adoption of available measures, with a time limit of recovery of the water body between 6 months and 1 year
1	Reversible situation, either naturally or with the adoption of available measures, with a time of recovery of the water body of less than 6 months

Should various bodies of water be affected by the contaminant emission, the *recovery potential of the water body* value adopted for that contaminant emission should be that of the highest evaluation of all of the water bodies and of all of the types of contaminants.

6.2.3.4. Social repercussions of the contaminant emission (F_c)

To conclude the process of risk estimation and obtain the R_i value for each contaminant emission identified, social repercussion will be evaluated within the consequence factor. This parameter will reflect the social alarm which the contaminant emission might create.

The evaluation criteria for this value are included in Table 6.10.

Table 6.10. Criteria for assessment of the social repercussions of a contaminant emission

Social repersussion of the contaminant emission (Fc)	Level of social alarm generated by the contaminant emission
1.25	High level of social alarm
1.10	Significant level of social alarm
1	No indications of social alarm

6.3. Risk assessment of a contaminant emission

This evaluation consists of the comparison between the results of the risk assessment for each emission analysed and the risk tolerability criteria below.

Each contaminant emission may be classified as:

- ***Unacceptable contaminant emissions: R_i >20.***

  Emissions which require the immediate adoption of the necessary preventive and corrective measures.

- ***Correctable contaminant emissions:*** $15 \leq R_i \leq 20$

  Emissions which require a study to be carried out on the issues associated with the risk in order to establish, as a matter of urgency, what preventive and corrective action is needed to reduce it.

- ***Acceptable contaminant emissions:*** $R_i < 15$

  These are emissions which require no special action, but which must be included in the programme of environmental monitoring.

6.4. Proposal of preventive and corrective measures

Those contaminant emissions which pose an unacceptable or correctable environmental risk will require the establishment of preventive and corrective action to reduce the various factors involved in the risk estimation to acceptable levels.

The preventive and corrective measures should:

- Be based on the most appropriate technology and the best environmental practices available.
- Be appropriate both to the type of emission to be corrected and to the existing ambient conditions.
- Offer certain guarantees of success without causing subsequent indirect harm; the benefits of the measures taken should be subsequently verified.

These measures are intended to:

- Avoid the risk, either by deciding not to proceed with the risk or by reducing it to levels permitted by the quality objectives.
- Reduce probability by avoiding the most common situations likely to cause contaminant emissions, deploying new infrastructure, facilities and equipment in conjunction with environmental best practice (suitable goods handling equipment, leakage and loss control, etc.).
- Reduce either the vulnerability factor of the waters or the consequent magnitude factor of the emission.
- Partially or wholly relocate the emission, whilst ensuring that this actually reduces the risk.

Some examples of courses of action to reduce the risk from contaminant emissions are as follows:

- Eliminate the origin: take action against the source of the contamination itself.
- Protect the protected areas, using containment barriers and similar methods.
- Predict emission development: the numerical models employed to analyse the susceptibility of the water bodies (Section 6.2.2.1.) can be used to predict how the contaminant emission will evolve, enabling the choice of corrective measures to be optimised.
- Containment of the contaminant emission, using containment barriers, suitable mechanical collection systems, auxiliary service vessels to deploy barriers and mechanically remove spillages, dispersants, etc.
- Regeneration of affected elements: experimentation with different techniques to restore the ecosystems of the geographical area of jurisdiction.

Of all the possible preventive measures, the only compulsory one is the Contingency Plan for Accidental Marine Contamination. Article 129 of the Spanish Law 48/200 obliges Port Authorities to draw up a Port Contingency Plan to prevent and combat contamination in the Public Domain of the Port. This Plan, incorporating the contingency plans for all of the commercial and industrial facilities in the port, will detail the resources required to prevent and combat accidental contamination. Should any of these facilities not have such a plan, the Port must require them to produce one in accordance with the criteria contained in the current Legislation, which sets out the Contingency Plan for accidental marine contamination. The following is a summary of its contents:

a. *Scope of the plan,* which identifies the facilities included.

b. *Response levels* in an event which causes, or might cause, accidental marine contamination. The human and material resources to be deployed at each level of seriousness are here described.

c. *Make-up and functions of the plan's response and management team.*

d. *Procedures to be carried out during the contingency: plan activation procedure,* describing the established systems to activate each level of emergency alert and identifying those responsible for the activation; *notification procedure,* describing the procedure for notifying the relevant maritime, port or regional authority of any incident, and identifying the person or department responsible for the notification; *coordination procedure* to coordinate with the national and corresponding regional plans; *action*, describing the general norms to be activated in case of emergency, depending upon the response level as described in Section (b) above; and *end of emergency procedure,* describing the conditions in which the emergency situation may be considered to have finished.

e. *Inventory and maintenance of available resources,* describing the material resources available to contain and recover from a spillage of contaminants, and specifying those responsible for their safekeeping and maintenance, the periodicity of inspection and the maintenance work to be carried out in accordance with the manufacturer's instructions in each case.

f. *Update programme*, specifying the theory training courses to be given to the contamination-fighting personnel, the periodicity and different levels of practical training exercises to be carried out, and the conditions and timing of periodical reviews of the plan.

If the establishment of preventive or corrective measures is insufficient to bring the risk down to acceptable levels, the option of extending the action beyond the geographical area of jurisdiction, and even that of avoiding the emission, should be considered.

The procedure to estimate the risk following the application of preventive or corrective measures will be the same as that described in Section 6.2. This process must be repeated, applying the same criteria and operational procedures, until the case in question reaches levels considered acceptable.

The list of preventive and corrective measures set out in this section will form the basis of the action plans applied when the anticipated risk from one of the contaminant emissions materialises in a contaminant event (Section 8).

Block IV: Data gives a list, though not exhaustive, of documents containing the preventive and corrective measures applied at certain ports. These measures could be adapted to certain port activities in order to prevent and correct contamination of the water bodies.

7. PROGRAMME OF ENVIRONMENTAL MONITORING

The programme of environmental monitoring is the tool which makes it possible to verify the status and evolution of the quality of water bodies in the geographical area of jurisdiction, to pinpoint the deficiencies in the environmental risks assessment and management programme and to activate the programme of management of contaminant events, without having any detrimental effects on the competences and responsibilities of the various authorities in the supervision and control of the waters.

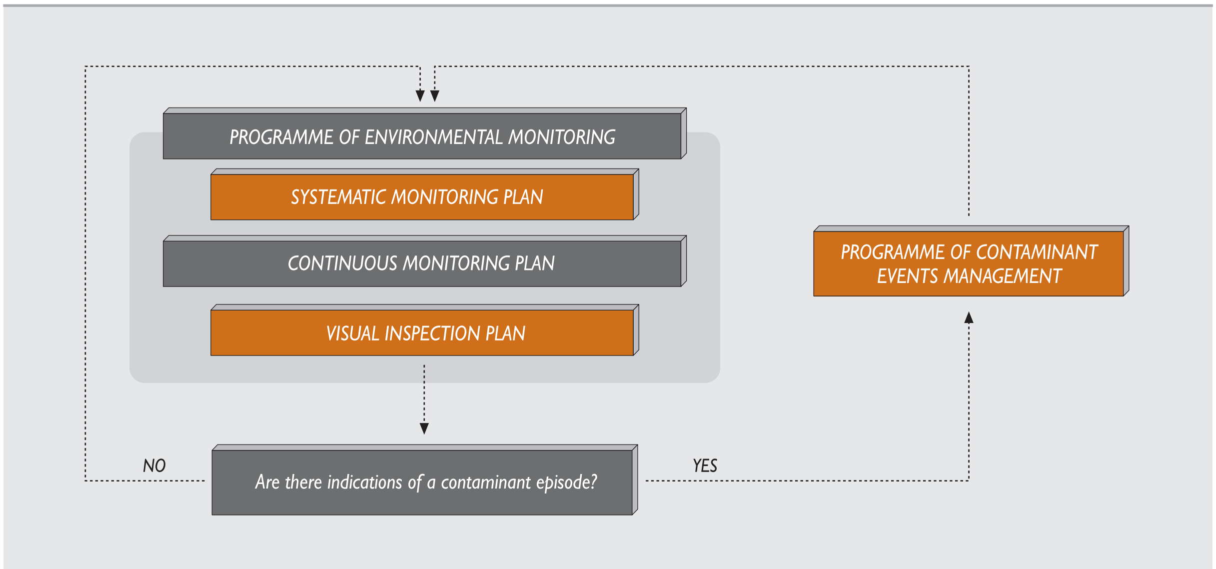
This programme will come into force after its uses have been delimited and the water bodies characterized and after the environmental risks of the contaminant emissions of the geographical area of jurisdiction have been assessed.

This programme will be implemented by means of the following activities or plans:

- Systematic monitoring plan.
- Continuous monitoring plan.
- Visual inspection plan.

The development of this programme is reflected in the diagram in Figure 7.1.

Figure 7.1. ***Actuations of the programme of environmental monitoring***



7.1. Systematic monitoring plan

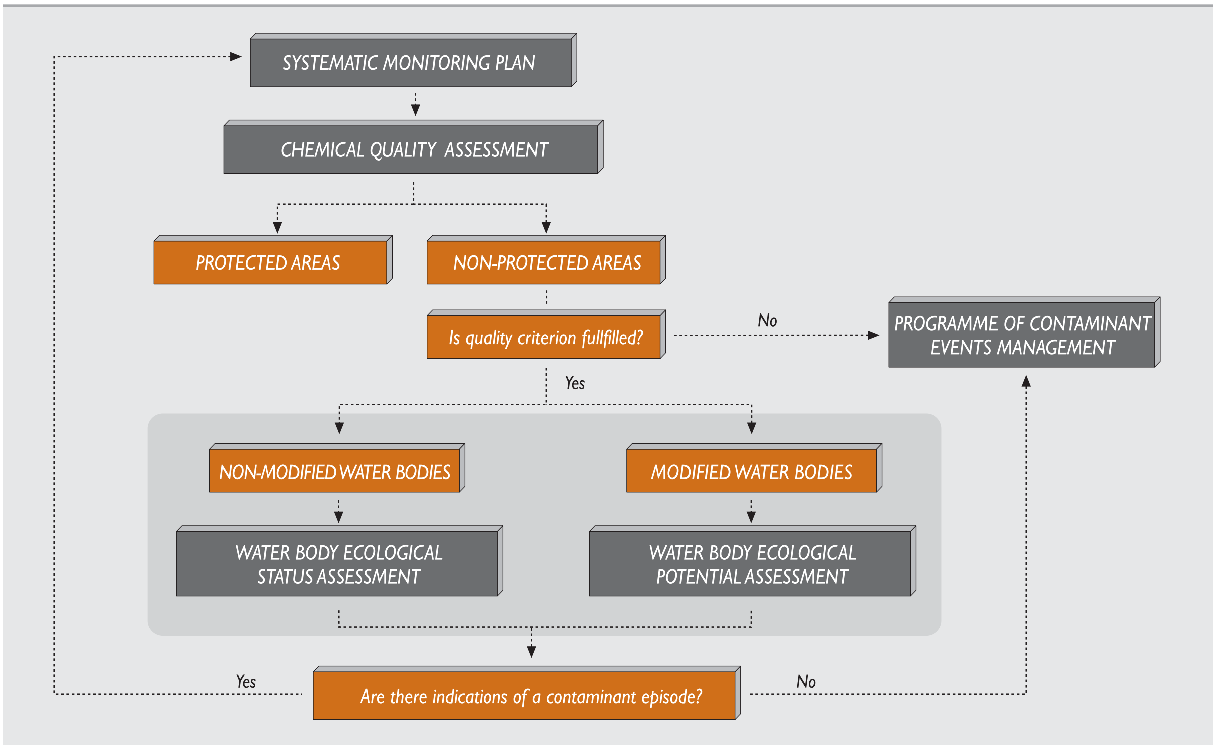
The systematic monitoring plan constitutes the cornerstone of the programme of environmental monitoring, as it is the tool used for assessing the quality of the water bodies. This plan is based on an uninterrupted measuring process and a periodic, systematic and standardised analysis of the quality of the water column (pelagic environment) and of the seabeds (benthic environment), as shown in the flow diagram in Figure 7.2.

As can be observed in this diagram, the fulfilment of the quality guidelines established for the chemical quality of water bodies is a prior and essential requirement for the achievement of a good quality of the water bodies.

The specific objectives established for this plan are as follows:

- Analysis of the chemical quality of the water bodies in the geographical area of jurisdiction.
- Analysis of the ecological status or ecological potential of the water bodies in the geographical area of jurisdiction.

Figure 7.2. **Diagram for water body quality assessment**



In all of these analysis procedures, there are three distinct stages:

- Selection of biological, physical and chemical quality indicators.
- Measurement of selected indicators.
- Quality assessment.

In any case, one of the main design characteristics of the systematic monitoring plan must be flexibility. Thus, aspects such as the variation in the number of points, sampling frequency or even the variables analyzed will have to be subjected to a process of revision and updating, depending on the prior information from the results obtained or on possible modifications of the initial conditions (maintenance or improvement of the water quality, new port activities, reiteration of specific contaminant events, enforcement of new norms, etc), as outlined in Section 7.4. However, such modifications should take into account the maintenance of the historical series of the records obtained previously.

The importance of the first quality assessment carried out for the implementation of ROM 5.1.should be stressed, as this allows an initial diagnosis to be made of the problem of port water bodies.

7.1.1. Analysis of chemical quality of water bodies

7.1.1.1. Selection of chemical quality indicators

The selection of indicators intended for the assessment of the chemical quality of water and the sea-beds takes as a starting point the list of priority substances of Annex X of Directive 2000/60/EC (Table 7.1.). On the basis of this, the indicators selected to assess the chemical value of a water body will be those whose presence has been detected in some contaminant emission (Section. 6.2.2.1: susceptibility of water bodies).

7.1.1.2. Measurement of chemical quality indicators

The measurement of the chemical quality indicators selected will be carried out taking into account the number of points, distribution, depth and frequency required to obtain representative results. For the purposes of the application of this Recommendation, a minimum number of three measurement points is generally advised for water bodies affected by the discharge of priority substances, with a three-monthly measurement frequency in the pelagic environment and an annual frequency in the benthic environment. Nevertheless, this geographic and temporal sampling intensity may be substantially reduced depending on the uniformity and permanence of the results available from the data and knowledge at hand, as well as the risk level assessed for the emissions that might affect it (see Section 7.4).

The methodological requirements for the measurement of each indicator (sampling method, type of sample, sampling volume, technical analysis, etc.) are described in Block III: Method 4.

In each water body, the value of an indicator of the chemical quality of the water column or the seabeds is defined as the average value of the set of measurements of an indicator taken at the different points in the water body throughout the year.

If there were any possibility that some contaminant emission might give rise to the bioaccumulation of priority substances in the organisms, the possibility of establishing a monitoring programme would be evaluated.

7.1.1.3. Chemical quality assessment of water bodies

The assessment of the ***chemical quality of the water column*** is performed by means of the comparison of the average annual values of the indicators established in Section 7.1.1.2. with the reference values established in the standard (quality guidelines) for the priority substances. In the absence of quality guidelines for some of these substances, the objectives proposed by organisms of acknowledged prestige can be applied (US Environmental Protection Agency, USEPA; Environmental European Agency, EEA; National Oceanographic and Atmospheric Administration, NOAA; Canadian Environment Agency, CEA). Table 7.1 shows these guidelines for all of the substances defined as priority substances in Annex X of the Water Framework Directive.

Similarly, for the assessment of the ***chemical quality of sediments***, the Standstill Principle will be applied, according to which the concentration of these priority substances should not increase significantly in time, ‘significant’ being understood as an increase in the average annual value of concentration of the substance of over 50% of the value obtained in the first measurement campaign.

It is considered that a water body fulfils the chemical quality requirements when each and every one of the indicators selected is within the established limits of acceptability.

7.1.2. Analysis of the ecological status and the ecological potential of water bodies

7.1.2.1. Selection of ecological status and ecological potential indicators

The indicators to be used in the assessment of the ecological status (non-modified waters) and ecological potential (modified waters) of water bodies are specific to the environment which is to be quantified (pelagic and benthic) and include physical-chemical and biological variables. Within this type of indicators, a distinction is made between status indicators and pressure indicators (Table 7.2). The objective of the former is to foresee damaging

Table 7.1. Chemical quality guidelines for water column for priority substances listed in the WFD(CEQG: Canadian Environmental Quality Guidelines. EPA: Environmental Protection Agency. U.K: United Kingdom).This table will be subject to the revisions established in Article 16 of Directive 2000/60/EC.

Priority Substances	Quality Objectives	Reference Standard
HEAVY METALS		
Cadmium (µg/l) (*)	5 - 2.5	DIR 83/513/EEC
Lead (µg/l)	8.1	EPA
Mercury (µg/l) (*)	0.5 - 0.3	DIR 82/176/EEC
Nickel (µg/l)	74	EPA
POLYCYCLIC AROMATIC HYDROCARBONS		
Anthracene (µg/l) (**)	0.012	CEQG
Fluoranthene (µg/l) (**)	0.04	CEQG
Naphthalene (µg/l)	1.4	CEQG
Benzo(a)pyrene (µg/l) (**)	0.015	CEQG
Benzo(b)fluoranthene (***)		
Benzo(g,h,i)perylene (***)		
Benzo(k)fluoranthene (***)		
Indeno(1,2,3-cd)pyrene (**)		
PHENOLS		
4-(para)-nonilphenol (***)		
Para-ter-octylphenols (***)		
Pentachlorophenol (µg/l)	2	DIR 86/280/EEC
CHLORATED ORGANIC COMPOUNDS		
Alachlor (***)		
Atrazine (µg/l)	17	EPA
C10-13 Chloroalkanes (****)		
Chlorfenvinphos (***)		
Chlorpyrifos (µg/l)	0.002	CEQG
1,2-dichloroethane (µg/l)	10	DIR 90/415/EEC
Dichloromethane (µg/l) (**)	98.1	CEQG
Alpha-endosulfan (µg/l)	0.02	CEQG
Hexachlorobenzene (µg/l)	0.03	DIR 88/347/EEC
Hexachlorobutadiene	0.1	DIR 88/347/EEC
Hexachlorocyclohexane (lindane) (µg/l)	0.02	DIR 84/491/EEC
Diuron (***)		
Pentachlorobenzene (µg/l) (**)	6.0	CEQG
1,2,4-trichlorobenzine (µg/l)	0.4	DIR 90/415/EEC
Trichloromethane (chloroform) (µg/l)	12	DIR 88/347/EEC
OTHERS		
Trifluoraline (µg/l) (**)	0.2	CEQG
Benzine (µg/l)	110	CEQG
Bromated Diphenylethers (****)		
Di(2-ethylhexy)phthalate (DEHP) (µg/l) (**)	16	CEQG
Isoproturon (***)		
Simazine (µg/l)	2	UK
Tributyltin (TBT) (µg/l)	0.001	CEQG

(*) Quality guidelines corresponding to coastal and transition waters, respectively.
(**) Quality guidelines proposed by the Canadian Environmental Quality Guidelines (CEQG) for fresh waters.
(***) Substance which does not have any quality criteria for the marine environment.
(****) Decision 2455/2001 (Annex WFD) indicates that these groups of substances normally including a considerable number of individual compounds for which it is not posible at present to establish the appropriate indicative parameters.

Table 7.2. ***Indicators of the ecological status and of the ecological potential***

				Indicators
Pelagic Environment	**All substrate types**	Physical-chemical	Status	Oxygen Saturation (%)
				Turbidity
			Pressure	Total Hydrocarbons
				Detergents
		Biological	Status	Chlorophyll "a"
Benthic Environment	**Soft-bottom**	Physical-chemical	Status	Total Organic Carbon
				Kjeldahl Nitrogen
				Total Phosphorus
			Pressure	Heavy Metals: Hg, Cd, Pb, Cu, Zn, Ni, As, Cr
				PCB (1)
				HAP (2)
	Hard-bottom	Biological	Status	Characteristic communities

(1): ∑ 7 PCB (**Polychlorinated biphenyls):** PCB 28 (2,4,`4'-trichlorobiphenyls), PCB 52 (2,2',5,5'-tetrachlorobiphenyl), PCB 101 (2,2',4,5,5'-pentachlorobiphenyl), PCB 118 (2,3',4,4',5-pentachloro biphenyl), PCB 138 (2,2',3,4,4',5'-hexachlorobiphenyl), PCB 153 (2,2',4,4',5,5'-hexachlorobiphenyl), PCB 180 (2,2',3,4,4',5,5'-heptachlorobiphenyl).
(2): ∑ 10PAH (**Polycyclic Aromatic Hydrocarbons**): naphthalene, anthracene, phenanthrene, fluoranthene, benzo(a)anthracene, chrysene, benzo(a)pyrene. Benzo(g,h,i)perylene, benzo(k)fluoranthene, Indeno1,2,3-(cd)pyrene.

effects (e.g. chlorophyll, turbidity, etc.) or to define the extent of the contamination (e.g. oxygen saturation, TOC, etc.). The mission of the pressure indicators is to characterise the influence of external agents on the ecosystems (e.g. PAH, PCB, etc.).

7.1.2.2. Measurement of ecological status and of ecological potential

The measurement of the indicators selected for each environment (pelagic and benthic) will be carried out in each water body over a yearly cycle, as in the case of chemicalquality, over the number of points, distribution, depth and frequency required in order to obtainrepresentative results. For the purposes of the application of this Recommendation, and in the absence of any prior information, a monthly frequency is proposed for the first measurement campaign for the pelagic environment and an annual frequency for the benthic environment.

However, as has been pointed out in the case of chemical quality, this geographical and temporal sampling intensity can also be modified according to the uniformity and stability shown by the available results and data, and to the level of risk assessed for the emissions that may affect it. (see Section 7.4).

The methodological requirements for the measurement of each indicator (sampling method, sample type, sampling volume, analytical technique, etc.) are described in Block III: Method 5.

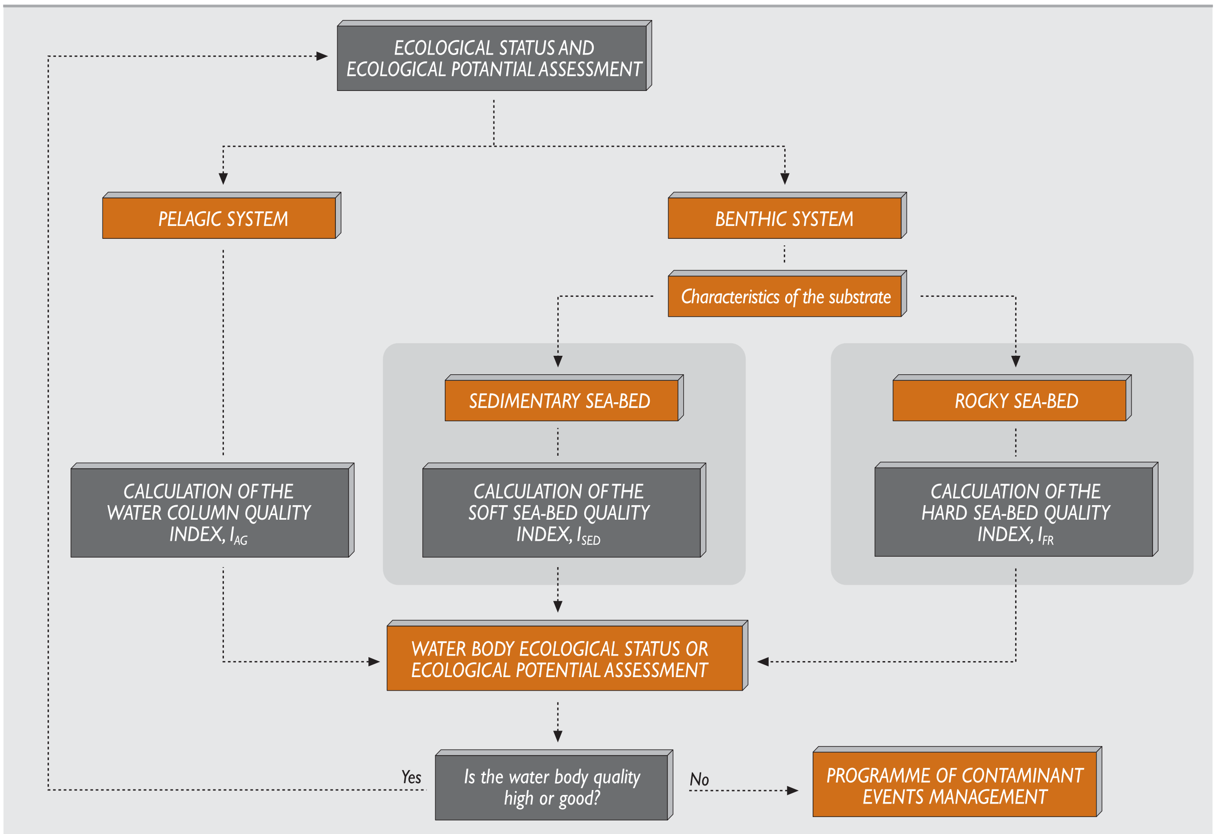
The value of an indicator is defined for each water body as the average annual value of the set of measurements made in a water body.

7.1.2.3. Assessment of ecological status and ecological potential

The assessment of the ecological status of non-modified water bodies and of the ecological potential of modified water bodies is performed using quality indices which are specific for the pelagic (water column) and benthic systems (seabeds) included in the schema shown in Figure 7.3.

These indices integrate the indicators established in Section 7.1.2.1. using the formulations described in the following sections.

Figure 7.3. **Assessment of ecological status and ecological potential of a water body**



7.1.2.3.1. Calculation of the quality of a water column (I_{AG})

The quality of a water column is assessed using the following index:

$$I_{AG} = \frac{\left(3.5C_{SAT} + 3C_{TURB} + 3.5C_{CLA}\right) \cdot C_{HT} \cdot C_{DET}}{10}$$

where:

I_{AG}: Quality index of water column.
C_{SAT}: Standardised value of percentage of average annual dissolved oxygen saturation in water column.
C_{TURB}: Standardised value of average annual turbidity in water column.
C_{CLA}: Standardised value of average annual concentration of chlorophyll 'a' in the water column.
C_{HT}: Standardised value of average annual concentration of total hydrocarbon on the surface of the water body.
C_{DET}: Standardised value of average annual concentration of detergents on the surface of a water body.

These values are obtained by transforming the average annual of each indicator calculated for the water body, using the standardisation tables shown in Tables 7.1.A and 7.1.B. for the non-modified and modified water bodies, respectively.These tables can be substituted by others devised on the basis of more accurate local information.

7.1.2.3.2. Calculation of the quality of soft-bottoms (I_{SED})

The procedure for the calculation of the quality of the soft-bottoms will be performed using an overall soft-bottom quality index (I_{SED}) integrating two specific indices to estimate its chemical contamination and its organic contamination.

$$I_{SED} = I_{CQ} + I_{CO}$$

where:

I_{SED}: Soft-bottom quality index.
I_{CQ}: Chemical contamination index.
I_{CO}: Organic contamination index.

The ***chemical contamination index*** is calculated using the following index:

$$I_{CQ} = \frac{C_{MP} + C_{PCB} + C_{HAP}}{6}$$

where:

I_{CQ}: Chemical contaminant index of the sediments.
C_{MP}: Standardised value of the average annual concentration of heavy metals in the fine fraction of the dry sediment (<63mm).
C_{PCB}: Standardised value of the average annual concentration of Polychlorinated Biphenyls (PCB) in the total fraction of the dry sediment at environmental temperature.
C_{HAP}: Standardised value of the average annual concentration of Polycyclic Aromatic Hydrocarbons (PAH) in the total fraction of the dry sediment at environmental temperature.

These standardised values are obtained from the values of each indicator (average annual value) using the standardisation tables shown in Table 7.2.A. for non-modified water bodies and in Table 7.2.B. for modified water bodies. These tables may be substituted by others devised on the basis of more accurate local information.

The ***organic contamination index*** will be calculated using the following expression:

$$I_{CO} = \frac{C_{COT} + C_{NTK} + C_{PT}}{2}$$

where:

I_{CO}: Organic contamination index of the sediments.
C_{COT}: Standardised value of the average annual percentage of Total Organic Carbon in the fine fraction of the dry sediment (<63mm).
C_{NTK}: Standardised value of the average annual concentration of Total Kjeldahl Nitrogen in the fine fraction of the dry sediment (<63mm).
C_{PT}: Standardised value of the average annual concentration of Total Phosphorus in the fine fraction of the dry sediment (<63mm).

These standardised values are assessed on the basis of the average annual concentration of the indicators measured in the sampling campaigns, as specified in Table 7.3.A. for non-modified water bodies and Table 7.3.B. for modified water bodies. As for the indices described previously, these tables can be substituted by others devised on the basis of more accurate local information.

7.1.2.3.3. Calculation of the quality of hard-bottoms (I_{FR})

The quality of the hard-botoms will be calculated using the assessment of the characteristic communities present using the following index:

$$I_{FR} = \frac{\sum_{i=1}^{i=n} C_{COB_i}}{n}$$

where:

I_{FR}: Quality index of hard-bottom communities.
C_{OB_i}: Standardised value of percentage of rocky surface covered by flora and fauna communities characteristic of a level of depth 'i'.
n: Number of levels of depth analysed.

The calculation of the quality of the hard-bottom communities is made over a series of cross-sections on the seabed (profiles). By direct observation of these, the coverage is evaluated in the following ranges of depth: intertidal, 0-5, 5-15, 15-30 and >30 metres.

Table 7.1.A. ***Water quality index for non-modified water bodies***

$$I_{AG} = \frac{\left(3.5C_{SAT} + 3C_{TURB} + 3.5C_{CLA}\right) \cdot C_{HT} \cdot C_{DET}}{10}$$

The standardised value of the indicators is obtained by substitution of the value of 'x' by the value calculated by each indicator (average annual concentration) in the standardisation tables below, according to the type of water body in question.

Transition waters

Detergents (mg/l)	C_{DET}
$x \geq 1$	0.2
$0.3 \leq x < 1$	0.6
$0.1 \leq x < 0.3$	0.8
$x < 0.1$	1

Total Hydrocarbons (mg/l)	C_{HT}
$x \geq 1$	0.2
$0.7 \leq x < 1$	0.6
$0.3 \leq x < 0.7$	0.8
$x < 0.3$	1

Oxygen Saturation (%)	C_{SAT}
$x > 90$	10
$70 < x \leq 90$	8
$30 < x \leq 70$	5
$10 < x \leq 30$	2
$x \leq 10$	0

Chlorophyll "a" (µg/l)	C_{CLA}
$x < 2$	10
$2 \leq x < 4$	8
$4 \leq x < 7$	5
$7 \leq x < 13$	2
$x \geq 13$	0

Turbidity (NTU)	C_{TURB}
$x < 4$	10
$4 \leq x < 7$	8
$7 \leq x < 12$	5
$12 \leq x < 20$	2
$x \geq 20$	0

Coastal waters

Detergents (mg/l)	C_{DET}
$x \geq 1$	0.2
$0.3 \leq x < 1$	0.6
$0.1 \leq x < 0.3$	0.8
$x < 0.1$	1

Total Hydrocarbons (mg/l)	C_{HT}
$x \geq 1$	0.2
$0.7 \leq x < 1$	0.6
$0.3 \leq x < 0.7$	0.8
$x < 0.3$	1

Oxygen Saturation (%)	C_{SAT}
$x > 90$	10
$70 < x \leq 90$	8
$40 < x \leq 70$	5
$20 < x \leq 40$	2
$x \leq 20$	0

Chlorophyll "a" (µg/l)	C_{CLA}
$x < 1.5$	10
$1.5 \leq x < 2.5$	8
$2.5 \leq x < 5$	5
$5 \leq x < 8$	2
$x \geq 8$	0

Turbidity (NTU)	C_{TURB}
$x < 2$	10
$2 \leq x < 6$	8
$6 \leq x < 9$	5
$9 \leq x < 12$	2
$x \geq 12$	0

The standardisation of the data obtained in the non-modified and modified water bodies is shown in Tables 7.4.A. and 7.4.B., respectively. As in the indices outlined above, the tables can be substituted by others devised on the basis of any local information available.

7.1.3. *Analysis of protected zones*

Given the peculiarity of these zones acknowledged by the Water Framework Directive itself, it is not considered necessary to carry out their monitoring. However, use may be made of the public information corresponding to the program of environmental monitoring developed in accordance with the corresponding sector norms.

Table 7.1.B. Water quality index for modiffied water bodies

$$I_{AG} = \frac{\left(3.5C_{SAT} + 3C_{TURB} + 3.5C_{CLA}\right)\cdot C_{HT}\cdot C_{DET}}{10}$$

The standardised value of the indicators is obtained by substitution of the value of 'x' by the value calculated by each indicators (average annual concentration) in the standardisation tables below, according to the type of water body in question.

Acceptable residence

Detergents (mg/l)	C_{DET}
x ≥ 1	0.2
0.3 ≤ x < 1	0.6
0.1 ≤ x < 0.3	0.8
x < 0.1	1

Total Hydrocarbons (mg/l)	C_{HT}
x ≥ 1	0.2
0.7 ≤ x < 1	0.6
0.3 ≤ x < 0.7	0.8
x < 0.3	1

Oxygen Saturation (%)	C_{SAT}
x > 90	10
70 < x ≤ 90	8
30 < x ≤ 70	5
10 < x ≤ 30	2
x ≤ 10	0

Chlorophyll "a" (µg/l)	C_{CLA}
x < 2	10
2 ≤ x < 4	8
4 ≤ x < 7	5
7 ≤ x < 13	2
x ≥ 13	0

Turbidity (NTU)	C_{TURB}
x < 4	10
4 ≤ x < 7	8
7 ≤ x < 12	5
12 ≤ x < 20	2
x ≥ 20	0

Low residence

Detergents (mg/l)	C_{DET}
x ≥ 1	0.2
0.3 ≤ x < 1	0.6
0.1 ≤ x < 0.3	0.8
x < 0.1	1

Total Hydrocarbons (mg/l)	C_{HT}
x ≥ 1	0.2
0.9 ≤ x < 1	0.6
0.5 ≤ x < 0.9	0.8
x < 0.5	1

Oxygen Saturation (%)	C_{SAT}
x > 70	10
50 < x ≤ 70	8
20 < x ≤ 50	5
10 < x ≤ 20	2
x ≤ 10	0

Chlorophyll "a" (µg/l)	C_{CLA}
x < 3	10
3 ≤ x < 5	8
5 ≤ x < 10	5
10 ≤ x < 14	2
x ≥ 14	0

Turbidity (NTU)	C_{TURB}
x < 4	10
4 ≤ x < 7	8
7 ≤ x < 12	5
12 ≤ x < 20	2
x ≥ 20	0

Table 7.2.A. Chemical contamination index of non-modified water body sediments

$$I_{CQ} = \frac{C_{MP} + C_{PCB} + C_{HAP}}{6}$$

The standardised value of the indicators is obtained by substitution of the value of 'x' by the value calculated by each indicator (average annual concentration) in the following standardisation tables:

PCB (mg/kg)	C_{PCB}
$x < 0.01$	10
$0.01 \leq x < 0.02$	8
$0.02 \leq x < 0.08$	5
$0.08 \leq x < 0.2$	2
$x \geq 0.2$	0

PAH (mg/kg)	C_{HAP}
$x < 0.4$	10
$0.4 \leq x < 0.8$	8
$0.8 \leq x < 30$	5
$30 \leq x < 200$	2
$x \geq 200$	0

Mercury (Hg) (mg/kg)	C_{Hg}
$x < 0.2$	10
$0.2 \leq x < 0.4$	8
$0.4 \leq x < 2.0$	5
$2.0 \leq x < 15$	2
$x \geq 15$	0

Cadmium (Cd) (mg/kg)	C_{Cd}
$x < 0.4$	10
$0.4 \leq x < 0.8$	8
$0.8 \leq x < 4.0$	5
$4.0 \leq x < 30$	2
$x \geq 30$	0

Lead (Pb) (mg/kg)	C_{Pb}
$x < 40$	10
$40 \leq x < 80$	8
$80 \leq x < 400$	5
$400 \leq x < 3500$	2
$x \geq 3500$	0

Copper (Cu) (mg/kg)	C_{Cu}
$x < 40$	10
$40 \leq x < 80$	8
$80 \leq x < 320$	5
$320 \leq x < 2800$	2
$x \geq 2800$	0

Zinc (Zn) (mg/kg)	C_{Zn}
$x < 150$	10
$150 \leq x < 400$	8
$400 \leq x < 2000$	5
$2000 \leq x < 15000$	2
$x \geq 15000$	0

Chromium (Cr) (mg/kg)	C_{Cr}
$x < 80$	10
$80 \leq x < 160$	8
$160 \leq x < 700$	5
$700 \leq x < 7000$	2
$x \geq 7000$	0

Arsenic (As) (mg/kg)	C_{As}
$x < 30$	10
$30 \leq x < 60$	8
$60 \leq x < 180$	5
$180 \leq x < 1000$	2
$x \geq 1000$	0

Nickel (Ni) (mg/kg)	C_{Ni}
$x < 40$	10
$40 \leq x < 80$	8
$80 \leq x < 320$	5
$320 \leq x < 2800$	2
$x \geq 2800$	0

Once the standardized value of the average annual concentration is calculated for each of the eight heavy metals (Hg, Cd, Pb, Cu, Zn, Cr, As and Ni), the term C_{MP} is obtained by applying the following criteria:

Standardisation	C_{HM}
All metals = 10	10
All metals ≥ 8	8
1-3 Metals with values 2 or 5	5
More than 3 Metals with values 2 or 5	2
Any metal with value 0	0

Table 7.2.B. **Chemical contamination index of modified water body sediments**

$$I_{CQ} = \frac{C_{MP} + C_{PCB} + C_{HAP}}{6}$$

The standardised value of the indicators is obtained by substitution of the value of 'x' by the value calculated by each indicator (average annual concentration) in the following standardisation tables:

PCB (mg/kg)	C_{PCB}
x < 0.01	10
0.01 ≤ x < 0.03	8
0.03 ≤ x < 0.1	5
0.1 ≤ x < 0.8	2
x ≥ 0.8	0

PAH (mg/kg)	C_{HAP}
x < 0.5	10
0.5 ≤ x < 1.0	8
1.0 ≤ x < 40	5
40 ≤ x < 320	2
x ≥ 320	0

Mercury (Hg) (mg/kg)	C_{Hg}
x < 0.3	10
0.3 ≤ x < 0.6	8
0.6 ≤ x < 3.0	5
3.0 ≤ x < 24	2
x ≥ 24	0

Cadmium (Cd) (mg/kg)	C_{Cd}
x < 0.5	10
0.5 ≤ x < 1.0	8
1.0 ≤ x < 5.0	5
5.0 ≤ x < 40	2
x ≥ 40	0

Lead (Pb) (mg/kg)	C_{Pb}
x < 60	10
60 ≤ x < 120	8
120 ≤ x < 600	5
600 ≤ x < 4800	2
x ≥ 4800	0

Copper (Cu) (mg/kg)	C_{Cu}
x < 50	10
50 ≤ x < 100	8
100 ≤ x < 400	5
400 ≤ x < 3200	2
x ≥ 3200	0

Zinc (Zn) (mg/kg)	C_{Zn}
x < 250	10
250 ≤ x < 500	8
500 ≤ x < 3000	5
3000 ≤ x < 24000	2
x ≥ 24000	0

Chromium (Cr) (mg/kg)	C_{Cr}
x < 100	10
100 ≤ x < 200	8
200 ≤ x < 1000	5
1000 ≤ x < 8000	2
x ≥ 8000	0

Arsenic (As) (mg/kg)	C_{As}
x < 40	10
40 ≤ x < 80	8
80 ≤ x < 200	5
200 ≤ x < 1200	2
x ≥ 1200	0

Nickel (Ni) (mg/kg)	C_{Ni}
x < 50	10
50 ≤ x < 100	8
100 ≤ x < 400	5
400 ≤ x < 3200	2
x ≥ 3200	0

Once the standardized value of the average annual concentration is calculated for each of the eight heavy metals (Hg, Cd, Pb, Cu, Zn, Cr, As and Ni), the term C_{MP} is obtained by applying the following criteria:

Standardisation	C_{HM}
All metals = 10	10
All metals ≥ 8	8
1-3 Metals with values 2 or 5	5
More than 3 Metals with values 2 or 5	2
Any metal with value 0	0

Table 7.3.A. Organic contamination index of non-modified water body sediments

$$I_{CO} = \frac{C_{COT} + C_{NTK} + C_{PT}}{2}$$

The standardised value of the indicators is obtained by substitution of the value of 'x' by the value calculated by each indicator (average annual concentration) in the standardisation tables below, according to the type of water body in question.

Coastal water bodies

Total Organic Carbon (%)		Kjedahl Nitrogen (mg/kg)		Total Phosphorus (mg/kg)	
Values	C_{COT}	Values	C_{NTK}	Values	C_{PT}
x < 0.5	4	x < 540	3	x < 450	3
0.5 ≤ x < 2.1	3	540 ≤ x < 1900	2	450 ≤ x < 720	2
2.1 ≤ x < 3.6	2	1900 ≤ x < 3200	1	720 ≤ x < 1100	1
3.6 ≤ x < 5.2	1	x ≥ 3200	0	x ≥ 1100	0
x ≥ 5.2	0				

Transition water bodies

Total Organic Carbon (%)		Kjedahl Nitrogen (mg/kg)		Total Phosphorus (mg/kg)	
Values	C_{COT}	Values	C_{NTK}	Values	C_{PT}
x < 0.6	4	x < 600	3	x < 500	3
0.6 ≤ x < 2.3	3	600 ≤ x < 2100	2	500 ≤ x < 800	2
2.3 ≤ x < 4.0	2	2100 ≤ x < 3600	1	800 ≤ x < 1200	1
4.0 ≤ x < 5.8	1	x ≥ 3600	0	x ≥ 1200	0
x ≥ 5.8	0				

Table 7.3.B. Organic contamination index of modified water body sediments

$$I_{CO} = \frac{C_{COT} + C_{NTK} + C_{PT}}{2}$$

To determine the value of the indicators, the average value of each indicators is calculated in the sediments of a water body and is substituted by value of 'x' in the corresponding standardisation table

Total Organic Carbon (%)		Kjedahl Nitrogen (mg/kg)		Total Phosphorus (mg/kg)	
Values	C_{COT}	Values	C_{NTK}	Values	C_{PT}
x < 0.6	4	x < 600	3	x < 500	3
0.6 ≤ x < 2.3	3	600 ≤ x < 2100	2	500 ≤ x < 800	2
2.3 ≤ x < 4.0	2	2100 ≤ x < 3600	1	800 ≤ x < 1200	1
4.0 ≤ x < 5.8	1	x ≥ 3600	0	x ≥ 1200	0
x ≥ 5.8	0				

Table 7.4.A. Quality index of hard-bottom communities in non-modified water bodies

$$I_{FR} = \frac{\sum_{i=1}^{i=n} C_{COB_i}}{n}$$

The standardized value of the indicator is obtained by the substitution of the value 'x' in the standardisation table by the value of the indicator calculated for the quality of the seabeds (coverage) estimated at each range of depth.

% Rocky surface covered by characteristics communities (coverage)	Value C_{COB}
80 > x	10
60 < x ≤ 80	8
30 < x ≤ 60	6
10 < x ≤ 30	2
x ≤ 10	0

Cuadro 7.4.B. Quality index of hard-bottom communities in modified water bodies

$$I_{FR} = \frac{\sum_{i=1}^{i=n} C_{COB_i}}{n}$$

The standardized value of the indicator is obtained by the substitution of the value 'x' in the standardisation table by the value of the indicator calculated for the quality of the seabeds (coverage) estimated at each range of depth.

% Rocky surface covered by characteristics communities (coverage)	Value C_{COB}
70 > x	10
50 < x ≤ 70	8
20 < x ≤ 50	6
5 < x ≤ 20	2
x ≤ 5	0

Table 7.4. System of assessment of ecological status and ecological potential of a water body

		Quality of pelagic environment (I_{AG})									
		10	9	8	7	6	5	4	3	2	1
Quality of benthic envirinment (I_{SED}; I_{FR})	10	100	90	80	70	60	50	40	30	20	10
	9	90	81	72	63	54	45	36	27	18	9
	8	80	72	64	56	48	40	32	24	16	8
	7	70	63	56	49	42	35	28	21	14	7
	6	60	54	48	42	36	30	24	18	12	6
	5	50	45	40	35	30	25	20	15	10	5
	4	40	36	32	28	24	20	16	12	8	4
	3	30	27	24	21	18	15	12	9	6	3
	2	20	18	16	14	12	10	8	6	4	2
	1	10	9	8	7	6	5	4	3	2	1

- Very good ecolgical status or ecological potential.
- Good ecological status or ecological potential.
- Insufficient ecological status or ecological potential.
- Deficient ecological status or ecological potential.
- Bad ecological status or ecological potential.

7.2. Continuous monitoring plan

For the continuous monitoring of specific points of the water bodies subjected to the greatest pressure of port activities, the incorporation of "measurement in real time" systems may be considered. The information obtained thus will complement that of the systematic monitoring plan.

The location and number of specific continuous monitoring points will depend on the configuration of the port environment, and on the hydrodynamic conditions and the extension and homogeneity of the water bodies acknowledged in it.

7.3. Visual inspection plan

The visual inspection plan integrates the set of activities intended to detect in advance any possible damaging effects for the quality of the water bodies due to the introduction of unforeseeable contaminant loads.

This plan will be effected by means of the visual monitoring of the contaminant emissions coming from Zone I (port emissions and those of leasing and authorised companies) and of the effects of all contaminant emissions coming from the rest of the geographical area of jurisdiction, whether local or widespread.

7.4. Actions derived from the programme of environmental monitoring

The programme of environmental monitoring can be revised after the first water body quality assessment, fitting its design (number of sampling points, frequency, variables, etc) to the results obtained in this programme and in the environmental risks assessment and management programme.

As a result of the continuous process of water body quality assessment corresponding to a specific programme of environmental monitoring, the following two possible lines of action are derived:

- When it is verified that the ecological status or ecological potential of the water bodies is good or very good, the programme of environmental monitoring will be continued in the terms established. However, if the results show uniformity and permanence, the scale and contents of the programme may be revised every three years.

- When the programme reveals evidence that there has been a contaminant events, the programme of contaminant events management (Section 8) will be activated.

8. PROGRAMME OF CONTAMINANT EVENTS MANAGEMENT

Without infringing on the competences, responsibilities and functions established by the various contingency and emergency plans, the present programme of contaminant events management represents the methodological procedure which allows any possible deterioration in the quality of the water bodies of the geographical area of jurisdiction, detected by the programme of environmental monitoring or by any other method, to be addressed.

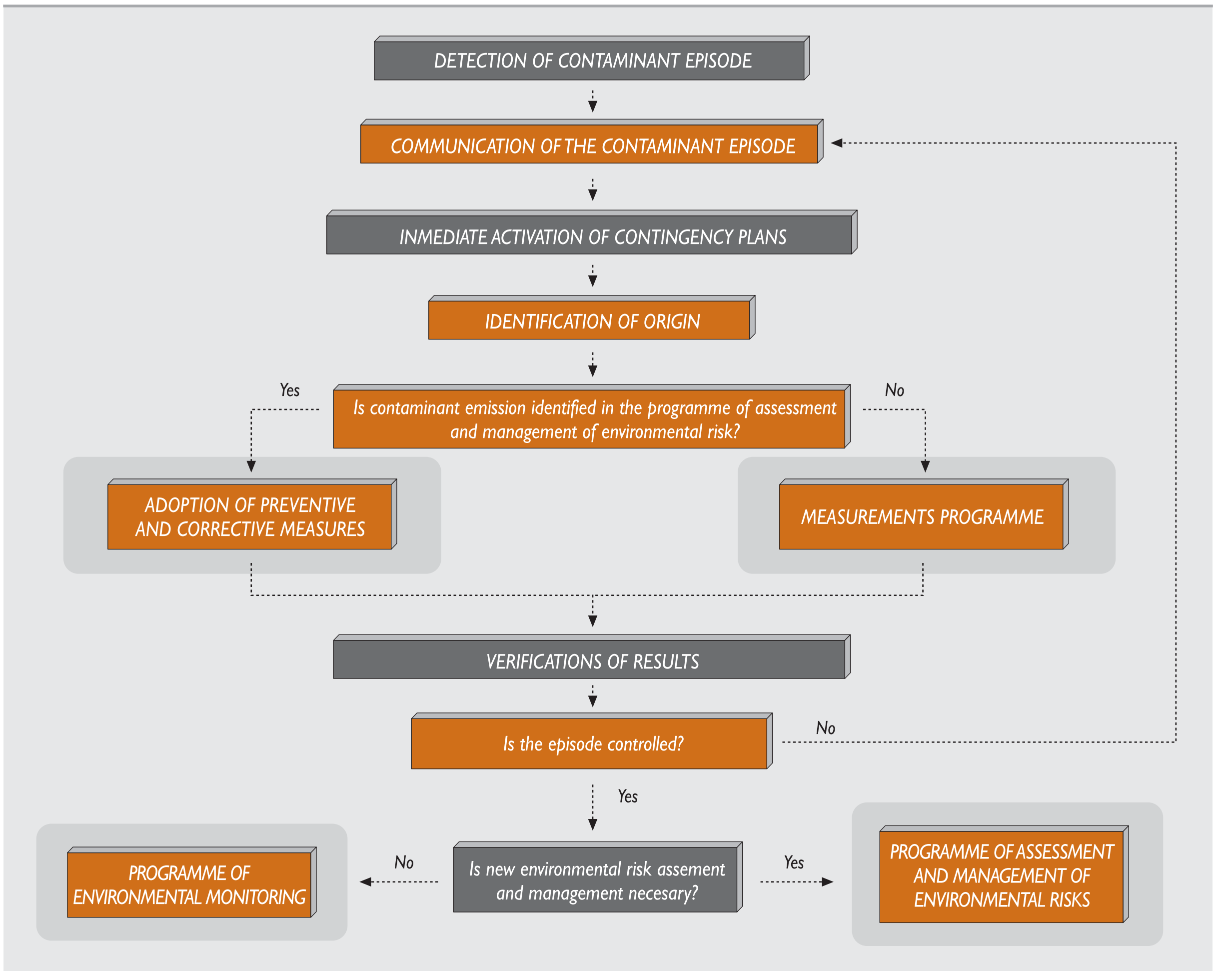
The methodology for implementing this programme fits the diagram shown in Figure 8.1.

The lines below describe the procedure of action against a contaminant event.

A. Detection of contaminant event

The detection of the contaminant events may be made through the reports of any sector of the population, through the alert of the parties responsible for the event or through any of the three plans that make up the programme of contaminant events management:

Figure 8.1. **Programme of contaminant events management**



- Systematic monitoring plan: Detection of contaminant event due to a reduction in the assessment of the ecological status of a water body, or the continued recording of low standardised values of any indicator.
- Continuous monitoring plan: Detection of the contaminant event through the continued recording of low standardised values of any indicator.
- Visual inspection plan: Visual detection of the effects derived from the introduction of contaminants in the port water environment.

In order to adapt the response to the magnitude of the contaminant event, a first assessment of the importance of the event will be made at the time of detection.

B. Communication of the contaminant event

Once the contaminant event is detected, the information concerning this event will be communicated to the corresponding authorities and, in all cases, to the Port Authority.

All of the information obtained in the detection of the event and all of its effects will be passed on.

C. Immediate activation of contingency plans

When a contaminant event occurs, whether or not its origin has been identified and in order to put an end to it and minimise its consequences for the environment, the procedures of activation, coordination and implementation of the Contingency Plans will be enacted immediately.

D. Identification of origin

Once the existence of a contaminant event in the geographical area of jurisdiction becomes evident, the identification of its origin will be initiated, as well as the search for the causes that produced it (cracks or leaks in pipelines, accidental discharges, cleaning operations, chronic contamination, etc.).

In the case where the contaminant event has been detected in the systematic monitoring plan or in the continuous monitoring plan, its origin can be determined thanks to the information handled in the process of locating and characterising the contaminant emissions performed in the environmental risks assessment and management programme (Section 6.1).

If the contaminant event is detected by the visual inspection plan or through the official complaints of private individuals, its origin can easily be determined, provided that there is sufficient evidence of the point or area where the event arises. In these cases, the causes can be determined by studying the effects, making it possible then to determine also the origin.

Finally, the most favourable case will be the one where the persons responsible for the contaminant event report its existence to the corresponding authorities or to the Port Authority. When this occurs, detailed information on the event will allow the most appropriate corrective measures to be taken.

E.1. Adoption of preventive and corrective measures

When the contaminant event is related with one of the emissions identified in the environmental risks assessment and management programme, the preventive and correcting measures proposed for that emission will be applied (Section 6.4).

E.2. Measurements programme

When the contaminant event is not related to any of these emissions (e.g. residual contamination of sediments) the programme of basic and complementary measures defined by the Water Framework Directive will be applied (Annex VI).

The basic measures will be those derived from the Community environmental legislation, such as the prohibition of the entry of contaminants in the water, prior authorisation of localised or extended emissions, etc.

The complementary measures will be those conceived and applied as a supplement to the basic measures in order to achieve the established environmental objectives (good or very good ecological status). When these objectives cannot be reached, the Directive proposes, among other measures, the development of research projects, the application of codes of good environmental practice, or the examination and revision of the corresponding permits and authorisations.

F. Verification of results

After applying these measures, a verification of their efficiency will be made, taking into account the results obtained, in order to determine whether the event has been controlled.

When the results are satisfactory, this will be detected through the programme of environmental monitoring. Otherwise, if the results are not as hoped for, the programme of contaminant events management will have to be revised until the event is controlled and its effects minimised and suppressed.

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Part II

Technical foundations

TECHNICAL AND LEGAL FOUNDATIONS

Part II

1. TECHNICAL FOUNDATIONS

1.1. Introduction

In accordance with the environmental policies currently implemented by the international community, integral environmental management and sustainable development are, at present, the basic lynchpins of coastal zone management. In the context of the European Community and pursuing the same line of action, The European Union has based its proposals of control and protection of the marine environment on a greater knowledge of the status of the marine environment, of the real threat derived from human activity and of the efficiency of the measures enforced.

As for the ports, the complexity and diversity of the problem of the environment is determined by the specific peculiarities of each port. Aspects such as their location, the type of activities pursued and the interactions arising from the confluence of these with other uses developed in and around them determine the type of actions required to halt their environmental deterioration. In any case, from an economic, social and environmental point of view, ports nowadays are integrated in population centres from whose influence they cannot free themselves. Recent years have seen a tendency to rearrange the spaces occupied by the ports so that, at the same time as they attempt to intensify their activity, they also take pains to minimise any conflicts of uses or interference with the environment which might arise. In short, they attempt to adapt to the requirements of society as regards the conservation of the environment and the aims of sustainable development.

This marriage of uses of the port environment has led to an intense pressure on the marine environment which must be managed using the appropriate tools adapted to its own peculiarities. The current reference framework for water management in the European Union and, therefore, the one with direct implications for ports, is Directive 2000/60/EC of the European Parliament and its Council, of October 23, 2000, (Water Framework Directive) which establishes "a framework for the protection of continental surface waters, transition waters, coastal waters and subterranean waters", which prevents their deterioration and promotes sustainable use.

This policy of protection of the marine environment was consolidated that same year with the publication of Decision 2850/2000, which establishes a framework for cooperation within the community in the area of accidental or deliberate marine pollution. This Decision aims to support and complement the work of the member states on a local, regional and national level for the protection of the marine environment and the coastline and to contribute to the improvement of the capacity of response of the member states in cases of accidents related with hazardous substances.

Reaching a target of this scope involves a total restructuring of concepts and procedures which, though complex, is necessary if a balance is to be attained between the uses of the marine environment and its sustainability.

Hence, the final objective of this new approach is to establish a reference framework common to all Community water bodies, using it to standardise water system quality assessment procedures.

Given that the Water Framework Directive is the most important water system management tool; this Recommendation should fit in with the guidelines of this Directive both from a conceptual and a methodological viewpoint. This intention is reflected in ROM 5.1, "Coastal Water Quality in Port Areas", which deals with the integrated quality management of port water systems, combining the requirements for the assessment of its ecological and chemical quality, both in the water column and in the seabeds, bearing in mind that risk assessment is likely to alter this management.

1.2. Delimitation of uses and characterization of water bodies

The current models of water system management establish as their minimum units of management ***water bodies***, significant bodies of water, clearly differentiated and perfectly delimited, including both the water column and the seabeds.

Also, since the areas defined by the zonification of uses and activities of the marine environment are characterised by being units subjected to the same type of pressure, the conditions prevailing in these areas may be considered homogenous. Thus, for the purposes of this Recommendation, and in accordance with the peculiarities associated with port areas, the limits of the water bodies will be established on the basis of the uses of the marine environment and the most relevant physical and physiographical peculiarities.

These uses to which the water systems are subjected are pressure factors which, eventually, generate impacts on the marine habitats. This circumstance highlights the real incidence that human activity has on the quality of water systems and thus also underlines the need to adjust the environmental objectives for these systems to the external conditions to which they are subjected. This working philosophy coincides fully with the strategy proposed by the European Commission for the protection and conservation of the marine environment, according to which this protection must take as its starting point the identification of the pressure factors which act on this environment.

The application of the above to ROM 5.1 has thus implied the need to pay special attention to the so-called ***modified water bodies,*** bodies which "as a consequence of physical alterations arising from human activity, have undergone a substantial change in their nature and cannot attain a good ecological status". The acknowledgement of this figure has made it possible to reduce the environmental objectives for water bodies subjected to uses of special economic and social relevance to objectives which are more coherent with their hydromorphological characteristics, with their current uses and with the impacts produced by these uses.

In order that, as well as being suitable for the uses, the environmental objectives contemplate objectively the natural variability which characterises water systems in physical, chemical and hydromorphological terms, the characterization of water bodies attempts to reduce the heterogeneity of the marine environment by means of the fragmentation of surface waters into a series of ***types*** of water bodies. For this purpose, the so-called ***descriptors,*** defining and discriminating variables of these characteristics are introduced in the description process.

The requirement that port water bodies should dispose of an environmental classification and assessment procedure making the maintenance of their quality compatible with port activities in itself justifies the need to establish suitable descriptors for this purpose.

Studies in this field have asserted that while the variability in the medium should be represented by a combination of biological, physical and chemical descriptors, it is the physical descriptors which best reflect the complexity and heterogeneity typical of port areas. The direct consequence of this has been the generic use of the dominant class of the substrate (hard or soft) for the characterization of all water body categories (non- modified and modified). With this, a significant part of the functional and structural variability of the benthic systems found in port water bodies can be reflected, although the singularity of these systems means that it is advisable to complete this characterization with a second specific descriptor.

In non-modified water bodies, the descriptor selected is the influence of continental waters on the structure and distribution of marine communities, differentiating between zones of a clearly coastal nature and those of a clearly estuarine nature.

In contrast, in order to underline the peculiarities associated with modified water bodies, a hydromorphological descriptor has been selected. This is the flushing time, a factor representative of transfer processes, directly related to water body eutrophication processes.

The fragmentation of water bodies responds to the need to work with smaller management units. However, this Recommendation has been at pains to leave it to the Port Authorities to design their own management system in accordance with their needs and requirements. Thus, adjoining water bodies, classified within the same typology, can be grouped together to constitute a single water body.

1.3. Assessment and management of environmental risks

The quality of coastal water bodies in port areas is a consequence of the activities and uses developed in its environment. The interaction of all of the possible influences often makes it difficult to identify accurately, and thus to resolve, the environmental dangers found in the marine environment of the geographical area of jurisdiction. It is necessary therefore to implement an assessment procedure which can distinguish as accurately as possible between the origins and effects of the various dangers so as to proceed to a more efficient management.

At present, the environmental risks and the liabilities associated to them are a subject of growing interest for all kinds of organisations and institutions. In the international arena, The ISO/TC 207 "Environmental Management" Technical Committee is working on a future standard of assessment for locations and entities which includes the concept of environmental risk.

In the European context, environmental risk is addressed in the White Paper on Environmental Liability. Also, in the Council's Directive 96/61/CE, on Integrated Pollution Prevention and Control (IPPC), the concept of environmental risk is important when it comes to authorising new activities. Other norms to be applied are Council Regulation (EEC) No 793/93 of 23 March 1993 on the evaluation and control of the risks of existing substances and Commission Directive 93/67/EEC of 20 July 1993 laying down the principles for assessment of risks to man and the environment of substances notified in accordance with Council Directive 67/548/EEC are established, both for the human being and for the environment.

As a consequence of this growing interest in environmental risk, June 2000 saw the publication of Standard UNE 150008 EX, on "Analysis and Assessment of Environmental Risks", which presented a general methodology for identifying, analysing and assessing the risk of the various industrial and commercial activities.

The objective of **risk assessment** is to estimate the possibility of a physical or chemical danger and to determine the vulnerability to, and the consequences for the environment of, this danger in order to predict the relation between the dangers and the ecological effects in a way which will be useful for environmental managers.

Environmental risk assessment is composed of two main stages: identification of risks dangers and estimation of risk or analysis and evaluation of the risks. Risk analysis is the process by means of which **the dangers are identified** and their risk is estimated. In the identification process, their existence is acknowledged and their characteristics are defined. Risk estimation, meanwhile**,** involves the description of the nature and magnitude of these dangers through the determination of their probability of occurrence, the vulnerability of the environment and the consequences that may arise from the materialisation of a risk. To do this, the information gathered in the previous stage is integrated together with the characteristics of the environment or the ecological system affected by the danger. The estimation of risk of the distinct dangers is reported in a comprehensible way to the managers so that they can decide on what measures to take.

The methods used for the estimation of the risk are classified in two categories, depending on the results which may be obtained from them: qualitative methods and quantitative methods. The application of qualitative methods allows the dangers to be identified and the risks to be estimated thus making it possible to adopt preventive or corrective measures. Quantitative methods, however, also allow more precise solutions and facilitate more efficiently the selection of the most adequate solutions. The process of standardisation was initiated for both methodologies with the publication of the Standard UNE 150008-EX. This Recommendation proposes a quantitative method based on the above standard.

Risk Assessment establishes the criteria of tolerability and is a task which must take as its starting point the results obtained in the process of estimation, through the use of a previously defined scale. The risk assessment of the various dangers is communicated in comprehensible terms to the managers so that these can decide on the measures to be taken.

After the risk assessment has been completed, the process of **risk management** is initiated, in which the preventive and corrective measures to be applied in order to reduce these risks are proposed. For each of the measures applicable to the correction of the various risks, a detailed study must be made in order to evaluate them since the adoption of these measures must be justified, both in connection with their cost and with their special characteristics. Finally, after making an evaluation of all of these measures, an order of priority is established among all of the measures to be applied.

1.4. Environmental monitoring

Current theories on ecological communities consider that, while an ecosystem normally tends towards a state of equilibrium, this equilibrium is not achieved when the speed at which the perturbations (natural or anthropic) occur is faster than the speed at which the system recovers. Given that the natural behaviour of marine ecosystems is altered by the uses made of them and by the pressures associated to these uses, the increase in human activity leads to deterioration in the quality of the water systems which must, in all cases, be quantified and assessed. Thus, monitoring of the status of conservation must be a priority in the management of these systems.

Monitoring, understood as the continuous and systematic observation of the various components of the marine ecosystems is, in the final instance, the founding stone on which water quality management is based. If this information is obtained over periods of time long enough to determine the ranges of variation and the tendencies of the indicators, it will provide essential data for any decision-making process.

In the European context, monitoring has been a widely used tool in the successive environmental standards. However, the specificity of the objectives established in the successive standards (microbiological quality, heavy metal control, works monitoring etc) has meant that the activities associated to this monitoring have not managed to offer a global view of the quality of Community waters. The concept of an integrated monitoring of water systems was introduced for the first time by the Water Framework Directive, a standard which, in order to obtain a complete picture of the status of the waters, speaks of the need to perform a "monitoring of the status of surface waters, the status of the subterranean waters and of protected zones".

Thus, the action plan for the Environmental Monitoring of port water bodies must be adapted to fit in with this new policy of protection and sustainable development of the marine environment in order to verify the "status of the surface waters" through the analysis both of the chemical and the ecological quality of the water bodies.

These new approaches in the area of the environment on a Community level have transformed the classical concept of norms in the sector (bathing waters, mollusc production areas, discharges…) and specific assessment parameters (bacteriological, physical and chemical), into asingle term which, while taking in the same contents, also incorporates quality assessment in its definition. This has come to be known as "ecological potential" or "ecological status" depending on whether it is modified or non-modified status, respectively, that are being dealt with. This has endowed environmental management with a global picture of the water systems (surface waters, subterranean waters, transition waters and coastal waters) and biological, physical and chemical dimensions have been incorporated into the concept of water quality in the form of indicators and quality criteria.

To this should be added the no less important inclusion of the status of the flora and fauna communities (composition and abundance), and the consideration of the pelagic and benthic environments in the assessment of the quality of the ecosystem or the ecological status of the water bodies. This means that, for the first time, all of the different marine organisms are taken into account in the integrated analysis of the system's quality.

Thus, Environmental Monitoring has become a continuous, uninterrupted process of control of the water bodies of geographical areas of jurisdiction and, as such, constitutes a tool of vital importance in the development of this Recommendation.

1.4.1. Chemical quality of water bodies

The Directive which was the precursor to Community policy on pollution caused by industrial activity was Directive 76/464/EEC of the Council of May 4, 1976, on pollution caused by hazardous substances discharged into the water medium. The certainty that industrial pollution was responsible for environmental problems was reflected in this Directive, which not only lays the foundations for the management of the discharges into the marine environment but also establishes a classification procedure for these substances according to their dangerousness. This was the first initiative to establish a hierarchical system of chemical substances by applying criteria related to their effects on humans and on the environment.

This standard, however, failed to provide a satisfactory degree of protection. Thus, in 2001, the Commission published the White Paper on chemical substances and preparations, a document which clearly marked orientation to be pursued in the near future by European policies on this matter.

That same year Decision 2455/2001 was published, by which Annex X of the WFD was modified. Through this standard, The European Parliament and the Commission passed the list of priority substances, substances with a significant risk for the water medium, and that of priority hazardous substances, those whose discharges the Directive intends to eliminate completely in the mid term. This list was drawn up by means of the application of a combined monitoring-based and modelling-based priority setting scheme (CMMPSS) based on the risk assessment of potentially contaminant substances. To do this, the assessment of each substance was hierarchised in five stages: 1) selection of candidate substances, 2) calculation of exposure rates 3) calculation of effect rate, 4) computation of risk based on priority rate and 5) assessment by experts of the lists obtained.

The final results from this procedure and their subsequent analysis by the Scientific Committee on Toxicity, Ecotoxicity and the Environment (SCTEE) led to the list of 33 priority substances, either synthetic or natural, responsible for defining the chemical quality of water bodies, which is today the only standard reference in this matter.

1.4.2. Ecological potential or ecological status of water bodies

The selection of systems for assessing the ecological quality of water bodies should be based on the application of specific rates which can express the variability of the medium with a limited number of variables. Despite the complexity associated with the implementation of this type of assessment system, the need for an increased knowledge of the port marine environment and of the pressures to which it is subjected in order to establish whether the causes of the environmental problems are internal or external, was the driving force behind this Recommendation's objectives of drawing up its own port water body assessment system.

The ecological quality assessment system developed by this ROM, comprised of the assessment of both the pelagic (water column) and the benthic environment (seabeds), required the formulation of specific quality rates to reflect the importance and weight assigned to each indicator and award the water body a standardised quality value.

Given that this assessment is a reflection of the structure and functioning of the marine ecosystems associated to surface waters, the selection of the indicators that make up the water quality and water depth rates was determined both by the relevance of the information provided by each of them and by the representativeness of this information.

Bearing in mind the above, the selection of the variables to be used as indicators of the ecological quality of port aquatic environments took as its starting point the exhaustive analysis of the existing scientific studies and publications, the recommendations of international organisms and governments and the knowledge contributed by the experts involved in the elaboration of this Recommendation.

The pressure of the uses and activities on the water column has an effect which, though specific, can be detected immediately. Thus, acknowledging that the port activity itself leads to a minimal development of the communities of the pelagic environment, the quality assessment system has been based on the application of one single synthetic index made up of indicators representative of the physical and chemical characteristics of the port water environment.

Unlike that described for the pelagic environment, the response of the seabeds to the various pressures is determined by the fact that the most toxic and persistent contaminants (PCBS, PAHs, heavy metals, etc) and organic compounds (organic material, nutrients) accumulate or are retained in the sediment particles, being subjected, under certain conditions, to the dynamics of adsorption of the aquatic organisms which, in the medium or long term, show their effects. The consequence of this process of gradual contamination has been the degradation, to a lesser or greater extent, of the benthic communities.

Under these conditions, the sediment quality assessment systems could be addressed either through the analysis of the effects of this pressure on the status of the benthic communities or through an evaluation of the degree of contamination of the sediments in terms of toxicity, chemical or physical pollution, etc. However, as is indicated in the literature specialising in port environments, the information provided by the combination of the rates of organic pollution and the chemical pollution of the sediment, may be equally as representative as that obtained from the application of biological rates.

In the light of this statement, the quality assessment of the port seabeds has taken as its starting point the contamination of its sediments.

1.5. Management of contaminant events

A contaminant event is associated with any contaminant emission which produces a reduction in the quality of a water body, whether this reduction is sudden or gradual.

Contaminating emissions which reduce quality drastically are classified as part of what is known as accidental marine pollution. The potential risk that events of accidental marine pollution might occur in the various activities (port and non-port) carried out in the Ports (loading and unloading operations, freight transfer and handling on board the vessels and in the terminals, damage to installations, etc) makes it necessary to have available means of combating this pollution which will, on the one hand, minimise the risks of spillage and, on the other, guarantee fast and effective levels of response.

The recognition of the high level of risk associated with accidental spillages of certain hazardous substances was ratified by means of the signing, in the year 1990, of the International Convention on cooperation, preparation and fighting against pollution by hydrocarbons. This document introduced for the first time the advisability of developing a National Contingency Plan, complemented by specific Contingency Plans for vessels, offshore companies, handling installations, etc, aimed at preventing pollution by hydrocarbons and evaluating the nature, magnitude and consequences of recorded contaminant events.

The ratification of this Convention by the Spanish state, in the year 1993, was materialised in the publication of two specific norms: the Order of February 23, 2001, which defined the National Contingency Plan and Royal Decree 253/2004, which established the measures for prevention and fighting against contamination in loading and unloading operations and in the handling of hydrocarbons in marine and port environments.

The former norm defined the National Contingency Plan for marine accidents of any nature and established the main lines of action of the so-called internal contingency plan, applicable to contaminant events in installations of potentially contaminant products, and of the Territorial Contingency Plan, applicable to contaminant events in specific zones of the coastline or in installations which do not dispose of means to combat spills.

Later, Spanish Royal Decree 253/2004 defined the contents of the Internal Contingency Plans to be imposed on authorities and companies responsible for sea ports, shipyards, oil platforms, breaking yards, installations dealing with hydrocarbon waste or any other marine installation handling large quantities of hydrocarbon.

While contaminant events that are accidental are those that have the greatest social repercussions, it is the emissions of small magnitude but which are constant in time which eventually cause the most chronic pollution in the medium.

Thus, the latter should also be considered as contaminant events. Although there are as yet no norms, conventions or specific legislation for this type of event, certain standards have appeared since the publication of the Water Framework Directive which, directly or indirectly, advocate the prevention and, if necessary, correction of this type of pollution emission. In the year 2000, Decision 2850/2000/EC was published, establishing a Community framework for cooperation in the area of accidental or deliberate marine pollution. The starting point for its application is a Community system for the rapid and effective exchange of information to allow for preparation and intervention in the case of "(…) discharge of hazardous substances into the marine medium, whatever its origin (…)".

The management of contaminant events was completed with the subsequent publication of Directive 2004/35/EC, a norm which establishes the framework of environmental liability. Based on the principle of 'the polluter pays', the main objective of this Directive is the prevention and repair of any environmental damage that leads to significant adverse effects on the chemical quality or on the ecological status or ecological potential of the water bodies.

2. LEGAL FOUNDATIONS

The set of legal norms to be applied in port waters and in sea waters in general is huge. There are norms which come from the international arena and the European Community, and numerous state and autonomous norms. Among these can be distinguished those that directly regulate aspects of the waters from others which have an indirect incidence on them such as those that regulate the ports and the activities practised in them, those relating to the monitoring of natural spaces with a special protection status, those that regulate the coasts, fishing activities etc.

Consequently, the list below is not intended to cover the whole spectrum of the legislation applicable in this area. It should be regarded rather as an outline of the legislation currently applicable to seawaters, which is regularly complemented and updated. Thus, the following sections focus mainly on the international arena, gathering the international treaties in which Spain participates and the European Community legislation on the waters, most of which has been adequately incorporated into Spanish state legislation. Similarly, reference is made to the secondary legislation, that is, the legislation which, while it does not directly regulate water quality, does affect it.

International Legislation applicable to waters

The regulation of sea waters and their quality has been the object of numerous international conventions. Below are some of the most important of these, which are of compulsory application in the Spanish state, since they have been signed and ratified by it (and published in full in the corresponding BOE, or Official State Bulletin, which is also indicated). As can be observed in the list, The European Community also participates in several of these International Conventions.

- United Nations Convention on the Law of the Sea, 1982, Instrument of Ratification of United Nations Convention on the Law of the Sea made in Montego Bay on 10 December 1982. Parts 1-X BOE of 14-02-97 (and Instrument of Ratification of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982, made in New York on 28 of July 1994). BOE of 13-02-97.

- Instrument of Ratification of the Agreement on the application of the provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 concerning the conservation and management of transzonal fish populations and highly migratory fish populations, made in New York on 4 August 1995. BOE 175, of 21-07-04.

- Instrument of Ratification on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area, made in Monaco on 24 of November 1996 (ACCOBAMS). BOE 150, of 23-06-01.

- Agreement on the Protection of the Mediterranean Sea against Pollution, made in Barcelona on 16 of February 1976, and contiguous Protocols (cooperation in case of hydrocarbon discharge emergencies;

and prevention and elimination of discharges from vessels). Instrument of Ratification of 17 of December 1976, BOE 44, of 21-02-78. Amendments have since been made to this Convention, which shall forthwith be referred to as the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean Sea, made in Barcelona on 10 June 1995, published in BOE 173, of 19-07-04. The amendments also affect the protocol on the prevention of discharges from vessels and aeroplanes. A new Protocol was approved in 1995 on specially protected areas and biological diversity in the Mediterranean. BOE 18-12-1999.

- Instrument of Ratification of the Convention (OSPAR) for the Protection of the Marine Environment of the North-East Atlantic, made in Paris on 22 September 1992, BOE150, of 24-06-98. Instrument of acceptance by Spain of Annex V and Appendix 3 of theConvention for the Protection of the Marine Environment of the North-East Atlantic (Paris, 22 September 1992, published in the BOE of 24 June 1998), adopted in Sintra (Portugal)on 23 July 1998. BOEof 21-02-01.

- Instrument of Ratification by Spain of the second additional protocol of the Convention of 29 May 1968 between Spain and Portugal to regulate the use and hydraulic exploitation of the international stretches of the Rivers Miño, Limia, Tagus, Guadiana and Chanza and tributaries in the case of the hydraulic exploitation of the River Miño, signed in Guarda, on 12 February 1976. BOE 140, of 13-06-77.

- Instrument of Ratification of the Convention on the Protection and Use of Transboundary Watercourses and International Lakes, made in Helsinki on 17 March 1992. BOE of 4-04-2000.

- Instruments of Ratification of the RAMSAR Convention, of 2 February 1971, ratified by the Instrument of 18 March 1982, concerning wetlands of international importance, especially as habitats of sea birds. BOE of 20-08-82.

- Oslo Convention for the prevention of sea pollution caused by discharges from ships and aircraft, of 15 February 1972 (with Amendments Protocol on 2 March 1983). BOE of 25-04-74.

- London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, of 29 December 1972 (with amendments protocol on 2 March 1983). BOE of 25-04-74.

- International Convention for the Prevention of Pollution by Vessels, of 2 November 1973.MARPOL Convention (with London Protocol on 17 February 1978 and subsequent amendments). Correction of errors of amendments of 2001 in annex of protocol of 1978 concerning the International Convention for the Prevention of Pollution by Vessels, 1973 (BOE of 17 and 18 October 1984, and 6 March 1991) (Amendments to rule 13G of Annex I of the MARPOL 73/78 and to the Supplement of the IOPP Certificate), adopted on 27 April 2001, through the MERO 95(46) Resolution .BOE 52, of 01-03-03. The State of Vessel Assessment Plan, adopted on 27 April, 2001, by Resolution MEPC 94(46). BOE of 16-07-2003.

- European Agreement on the limitation of use of certain detergents in washing and clearing products, made in Strasburg on 16 September 1968 (Instrument of Ratification of 29 July 1975) and Amendment Protocol of 25October 1983 (Instrument of Ratification of 13 November 1987) BOE259, of 29-10-75. BOE 28, of 02-02-88.

- Stockholm Convention on Persistent Organic Pollutants of 22 May 2001. BOE of 23-06-04.

- Convention on the prevention of seawater pollution by hydrocarbons, of 12 May 1954. With amendments in 1962 and 21 October 1969. (Instrument of Ratification of 13 January 1976). BOE23, of 27-01-78.

- International Convention on civil liability for damage due to sweater pollution by hydrocarbons, made in Brussels on 29 November 1969 (Instrument of Ratification of 15 November 1975) BOE58, of 08-03-76.Instrument of adhesion to the protocol of 1992 which amends the Convention, published in the BOE of 20 September 1995. Amendments to the degree of limitation subsequently published in the BOE of 03-10-02.

- International Convention on cooperation, preparation and combating pollution by hydrocarbons, London on November 1990 (Ratified on 3 December 1993). BOE133, de 05-06-95.

- International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971, amended in London on 27 November 1992, BOE 244, of 11-11-97. Provisional Application of the Agreement between Spain and the Internacional Fund for Compensation for Oil Pollution Damage, made in London on 2 of June 2000, published in BOE 174, of21-07-00. Entry in force of Agreement between Spain and the International Fund for Compensation for Oil Pollution Damage, made in London on 2 of June 2000, BOE 224, of 18-09-01. Amendment to limits of compensation of the Convention. BOE of 12-11-2002.

- Instrument of Adhesion of Spain to the London Protocol on intervention on the high seas in cases of sea pollution by substances other than oil, of 2 November 1973. BOE of 11-05-94.

- International Convention on the Safety of Life at Sea (SOLAS), 1974, made in London on 1 November 1974 (BOE of 16 to 18 June, and 3 September 1980 and 17 March 1983). Amendments of 1998 to the International Convention on the Safety of Life at Sea, adopted on 18 May 1998, published in the BOE on 1-12-02. The amendments made in 1999 were published in the BOE of 14 September 2001. On 5 December 2000, through Resolution MSC 99 (73) the Amendments of 2000 were adopted, published in BOE 302, of 18-12-02. The Council of Ministers of 23 July were notified of the Amendments of 2001 and 2002.

- International Code for the Protection of vessels and port installations, adopted on 12 December 2002 through Resolution 2 of the Conference of contracting governments to the International Convention on the Safety of Life at Sea, (SOLAS) 1974. BOE 202, of 21-08-04.

- International Maritime Code on Dangerous Goods (IMDG) makes up chapterVII of the International Convention on the Safety of Life at Sea, 1974 (BOE of 18 June 1980). Amendment 31-02 applicable from 1 January 2004, adopted in London on 24 May 2002. BOE 291, of 05-12-03.

- Basle Convention on the control of transboundary movements of hazardous waste and its elimination; Basle 22 March 1989. BOE of 22-09-94.

- Resolution MSC.87 (71) International Code for the Safe Carriage of Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Wastes in Flasks on Board Ships(CNI code), Resolution MSC.88 (71), approved on 27 May 1999. BOE 221, of 14-09-01.

- International Code for the Construction and Equipment of Ships Carrying. Hazardous Chemicals in Bulk (CIQ Code), adopted on 5 December 2000 through Resolution MSC 102(73), and amendments in BOE 16 December 2002 andBOE, of 04-03-03. International Code for the Construction and Equipment of Ships carrying liquid gases in bulk (CIQ Code), adopted on 5 December 2000 through Resolution MSC 103(73). BOE of 16-12-02.

2.1. European community legal framework

2.1.1. Legal Framework

Below is a list of the most important norms for the sector under study. However, given that virtually all of the norms mentioned have already been incorporated into Spanish legislation, as well as the list of Community legislation outlined below, it is recommended as a general rule to refer directly to the state and autonomous legislation.

- Council Directive 75/440/EEC, of 16 June 1975, concerning the quality required for surface waters intended for the production of drinking water in the member states DOCE 194/L, of 25-07-75 (modified by Directive 79/869/EEC of the Council, on 9 October 1979; Directive 90/656/EEC of the Council, of 4 December of 1990; and Directive 91/692/EEC of the Council, of 23 December 1991).

- Council Directive 76/160/EEC, of 8 December 1975, concerning the Quality of Bathing Waters. DOCE 31/L, of 05-02-76 (modified by Directive 90/656/EEC of the Council, of 4 December 1990; Directive 91/692/EEC of the Council, of 23 December 1991).

- Council Directive 76/464/EEC, of 4 May 1976, concerning the Pollution caused by certain Hazardous Substances discharged into the Community Water Environment DOCE 129/L, of 18-05-76.

- Council Directive 78/659/EEC, of 18 July 1978, on the quality of fresh waters needing protection or improvement in order to support fish life, DOCE 222/L, of 14-08-78. (Modified by Council Directive 90/656/EEC, of 4 December 1990 and Council Directive 91/692/EEC, of 23 December 1991).

- Council Directive 79/869/EEC, of 9 October 1979, concerning the methods of measurement and frequencies of sampling and analysis of surface water intended for the abstraction of drinking water in the Member States, DOCE 271/L, of 29-10-79(modified by Council Directive 81/855/EEC, of 19 October 1981, Council Directive 90/656/EEC, of 4 December 1990, Council Directive 91/692/EEC, of 23 December 1991).

- Council Directive 79/923/EEC, of 30 October 1979, on the quality required of waters intended for the breeding of molluscs, DOCE 281/L, of 10-11-79 (Modified by Council Directive 91/692/EEC, of 23 December 1991).

- Council Directive 80/778/EEC, of 15 July 1980, on the Quality of Waters intended for Human Consumption, DOCE 229/L, of 30-08-80 (Directive 80/778/EEC is repealed and replaced by Directive 98/83/CE, as from 25 December 2003).

- Council Directive 80/68/EEC, of 17 December 1979, on the protection of groundwater against pollution caused by certain hazardous substances,DOCE 20/L, 26-01-80 (Modified by Council Directive 90/656/EEC, of 4 December 1990; Council Directive 91/692/EEC, of 23 December 1991).

- Council Directive 82/176/EEC, of 22 March 1982, on limit values and quality objectives for mercury discharges by sectors other than the chlor-alkali electrolysis industry, DOCE 81/L, of 27-03-81(Modified by Council Directives90/656/EEC and 91/692/EEC).

- Council Directive 83/513/EEC, of 26 September 1983, on limit values and quality objectives for cadmium discharges, DOCE 291/L, of 24-10-83 (Modified by Council Directives 90/656/EEC and 91/692/EEC.

- Council Directive 84/156/EEC on limit values and quality objectives for mercury discharges by sectors other than the chlor-alkali electrolysis industry. (DOCE L 74 of 17.03.1984).(modified by Directives 90/656/EEC and 91/692/EEC).

- Council Directive 84/491/EEC, of 9 October 1984, on limit values and quality objectives for discharges of hexachlorocyclohexane DOCE 274/L, of 17-10-84 (modified by Council Directives 90/656/EEC and 91/692/EEC).

- Council Directive 86/280/EEC on limit values and quality objectives for discharges of certain hazardous substances included in List I of the Annex to Directive 76/464/EEC (Official Journal L 181 of 04.07.1986). (modified by Directives 90/656/EEC and 91/692/EEC and by the following measures: Directive 88/347/EEC, Official Journal L 158 of 25.06.1988; Directive 90/415/EEC, Official Journal L 219 of 14.08.1990.

- Council Directive 91/271/EEC, of 21 May 1991, on the treatment of urban waste water, DOCE 135/L, of 30-05-91. Commission Directive 98/15/CEof 27 February of 1998 which modifies Council Directive 91/271/EEC on certain requirements established in its annex I DOCE 67/L, of 07-03-98.

- Council Directive 91/676/EEC, of 12 December 1991, concerning the protection of waters against pollution caused by nitrates from agricultural sources, DOCE 375/L, of 31-12-91.

- Council Directive 98/83/EC, of 3 November 1998, on the quality of waters intended for human consumption DOCE 330/L, of 05-12-98.

- Directive 2000/60/EC of the European Parliament and the Council, of 23 October 2000 establishing a framework for Community action in the field of water policy, DOCE 327/L, of 22-12-00. Decision n° 2455/2001/CE of the European Parliament and the Council, of 20 November 2001, approving the list of priority substances in the field of water policy and modifying Directive 2000/60/CEOfficial Journal n° L 331 of 15/12/2001 p. 0001 – 0005.

- *7 years after* the entry in force of the Directive, the following norms will be repealed: Directive 75/440/EEC; Decision 77/795/EEC; Directive 79/869/EEC.

- *13 years after* the entry in force of the Directive, the following Directives will be repealed: Directive 78/659/EEC; Directive 79/923/EEC; Directive 89/68/EEC; Directive 76/464/EEC, except for clause 6, which will be repealed on the date of entry in force.

- Regulation (EC) n°. 2099/2002establishing a Committee on Safe Seas and the Prevention of Pollution from Ships (COSS) and amending the Regulations on maritime safety and the prevention of pollution from ships, DOCE 324/ of 29-11-02.

- Directive 2002/84/EC of the European Parliament and The Council, of 5 November, amending the Directives on maritime safety and the prevention of pollution from ships, DOCE 324/L, of 29-11-02.

- Regulation (EC) n° 648/2004 of the European Parliament and The Council, of 31 March 2004, on detergents, DOCE L 104, of 8-4-2004.

2.1.2. Actions in the International Arena

- Council Decision 94/156/EC, of 21 February 1994, on the adhesion of the Community to the Convention on the protection of the marine environment of the Baltic Sea zone (Helsinki Convention 1974) DOCE 73/L, of 16-03-94.

- Council Decision 95/308/EC, of 24 July 1995, on the conclusion, on behalf of the Community, of the Convention on the protection and use of transboundary watercourses and international lakes (Helsinki Convention) [DOCE L 186 of 05.08.1995].

- Council Decision 98/249/EC, of 7 October 1997, on the conclusion of the Convention for the protection of the marine environment of the north-east Atlantic (Paris Convention) (DOCE L 104 of 03/04/1998).

- Instrument of Ratification of 10 July 1990 of the European Convention-Framework of 21 May 1980 on transboundary cooperation between territorial communities or authorities, made in Madrid.BOE 248, of 16-10-90.

- Council Decision 77/585/EEC, of 25 July 1977, concluding the Convention for the protection of the Mediterranean Sea against pollution and the Protocol for the prevention of the pollution of the Mediterranean Sea by dumping from ships and aircraft (DOCEL 240 of 19/09/1977).

- Council Decision 81/420/EEC, of 19 May 1981, on the conclusion of the Protocol concerning cooperation in combating pollution of the Mediterranean Sea by oil and other harmful substances in cases of emergency (DOCE L 162 of 19/06/1981).

- Council Decision 83/101/EEC, of 28 February 1983, concluding the Protocol for the protection of the Mediterranean Sea against pollution from land-based sources (DOCE L 067 of 12/03/1983).
- Council Decision 84/132/EEC, of 1 March 1984, on the conclusion of the Protocol on specially protected zones of the Mediterranean (DOCE L 068 of 10/03/1984).
- Council Decision, of 29 April 2004, on the conclusion, on behalf of the European Community, of the Protocol on cooperation to prevent pollution by ships and, in cases of emergency, to combat pollution in the Mediterranean Sea, of the Barcelona Convention for the Protection of the Mediterranean Sea against pollution (DOCE L 261, of 6/08/2004).
- Decision n° 2850/2000/EC of the European Parliament and the Council, of 20 December 2000, establishing a Community framework of cooperation in the field of accidental or deliberate marine pollution (DOCE L 332 of 28/12/2000).
- Protocol on cooperation to prevent pollution by ships and, in cases of emergency, to combat pollution in the Mediterranean Sea (DOCE L 261, of 6/08/2004).

2.1.3. Other Documents of Interest

- Council Decision 77/795/EEC, of 12 December 1977, establishing a common procedure for the exchange of information on the quality of surface fresh water in the Community. Official Journal n° L 334 de 24/12/1977 p. 0029 - 0036.
- Council Decision 86/85/EEC, of 6 March 1986, establishing a Community information system for the control and reduction of pollution caused by the spillage of hydrocarbons and other harmful substances at sea or in inland waters. DOCE 77/L, of 22-03-86.
- Council Decision 88/346/EEC, of 16 June 1988 amending Decision 86/85/EEC establishing a Community information system for the control and reduction of pollution caused by the spillage of hydrocarbons and other harmful substances at sea DOCE 158/L, of 25-06-88.
- Commission Decision 92/446/EEC of 27 July 1992, on questionnaires on water directives, Official JournalL 247 of 27.08.1992.
- Special Report n° 3/98 on the application by the Commission of the policies and actions of the European Union in the field of water pollution, accompanied by the replies of the Commission. DOCE 191/C, de 18-06-98.
- EEC Council Resolution, of 7 February 1983, on combating water pollution. DOCE 46/C, of 17-02-83.
- Commission Report of 21 February 1996, on Community water policy (COM(96) 59 final).
- Commission Report to the European Parliament and the Economic and Social Committee on the Billing Policy and the Sustainable Use of Water Resources COM (2000) 477 final, made in Brussels on 26-07-00.
- Call for proposals in the field of Community cooperation against accidental or deliberate marine pollution DOCE 105/C, of 05-04-01.
- Council Directive 96/61/CE, of 24 September 1996, on the integrated prevention and control of pollution [Official Journal L 257 of 10.10.1996].
- Commission report to the European Council and Parliament, of 2 October 2002, «Towards a strategy of protection and conservation of the marine environment» [COM (2002) 539 final, not published in the Official Journal].

2.1.4. Proposals

- Proposal by the European Parliament and Council Directive on the Protection of groundwaters against pollution (Codecision Procedure (COD/2003/0210)constitutes a directive derived from the framework directive and substitutes Directive 80/68/CE).
- Amended Proposal by the European Parliament and Council of Directive on the quality of bathing waters (substituting Directive 76/160CE) COM/2004/0245 final - COD 2002/0254.
- Proposal by the European Parliament and Council of Directive on the quality of fresh waters needing protection or improvement in order to support fish life (Coded version)COM/2004/0019 final - COD 2004/0002.

2.2. Related Legislation

As mentioned above, in addition to the legislation directly concerning the waters, attention should also be drawn to the state and regional legislation of other sectors whose practical application also affects these spaces. Below are some of the most relevant of these.

- Environmental Impact Assessment of Projects.
- Environmental Assessment of Plans and Programmes (Strategic Assessment).
- Natural Protected Spaces, Flora and Fauna.
- Fishing.
- Coasts.
- Town Planning/Coastal Planning/Integrated management of coastal zones.
- Waste from Ships.
- Management of Material from dredging.
- Atmosphere.

Part III

Technical methods and applications

TECHNICAL METHODS AND APPLICATIONS

Part III

1. INTRODUCTION

The Technical Methods and Applications Block has been approached as a working tool to complement the application procedures introduced in the ROM 5.1.

Given the heterogeneity which characterises port systems and the diversity of analytical methods and procedures, this document is intended to be a basically orientative tool, whose only aim is to define the technical specifications of each of the methods proposed and to establish the minimum criteria to be fulfilled in the implementation of this Recommendation.

For this purpose, the present document is structured around the five elements of the ROM 5.1 that require some kind of analysis or calculation: the characterization of modified water bodies, the characterization of contaminant emissions, the calculation of the flushing time of the water bodies and the extension of the contaminant emissions, the chemical quality analysis and the ecological status and ecological potential analysis.

Each chapter of the document addresses specific methods of analysis applicable to each of the aspects outlined above.

2. CHARACTERIZATION OF MODIFIED WATER BODIES

In order to highlight the magnitude of the physical alterations to which the port waters are subjected, the concept of heavily modified water body is understood as that defined in the Water Framework Directive as: "a body of surface water which as a result of physical alterations by human activity is substantially changed in character", and which thus cannot attain a good ecological status. Water bodies classified as modified will see their quality objectives lowered to what is termed **good ecological potential.**

Given the consequences that the classification of a water body as modified can have, this process requires a detailed analysis of its hydromorphological characteristics and of the repercussions that these can have on its ecological status.

As indicated in the WFD itself, the condition of modified can be recognised for a water body subjected to uses with a special economic and social relevance, as is the case of port waters. On this subject, the saidDirective establishes that: "member states may designate a body of surface water body as artificial or heavily modified when the changes to the hydromorphological characteristics of that body which would be necessary for achieving good ecological status would have significant adverse effects on navigation, including port facilities" and when "the beneficial objectives served by the artificial or modified characteristics of the water body cannot, for reasons of technical feasibility or disproportionate costs, reasonably be achieved by other means, which are a significantly better environmental option.

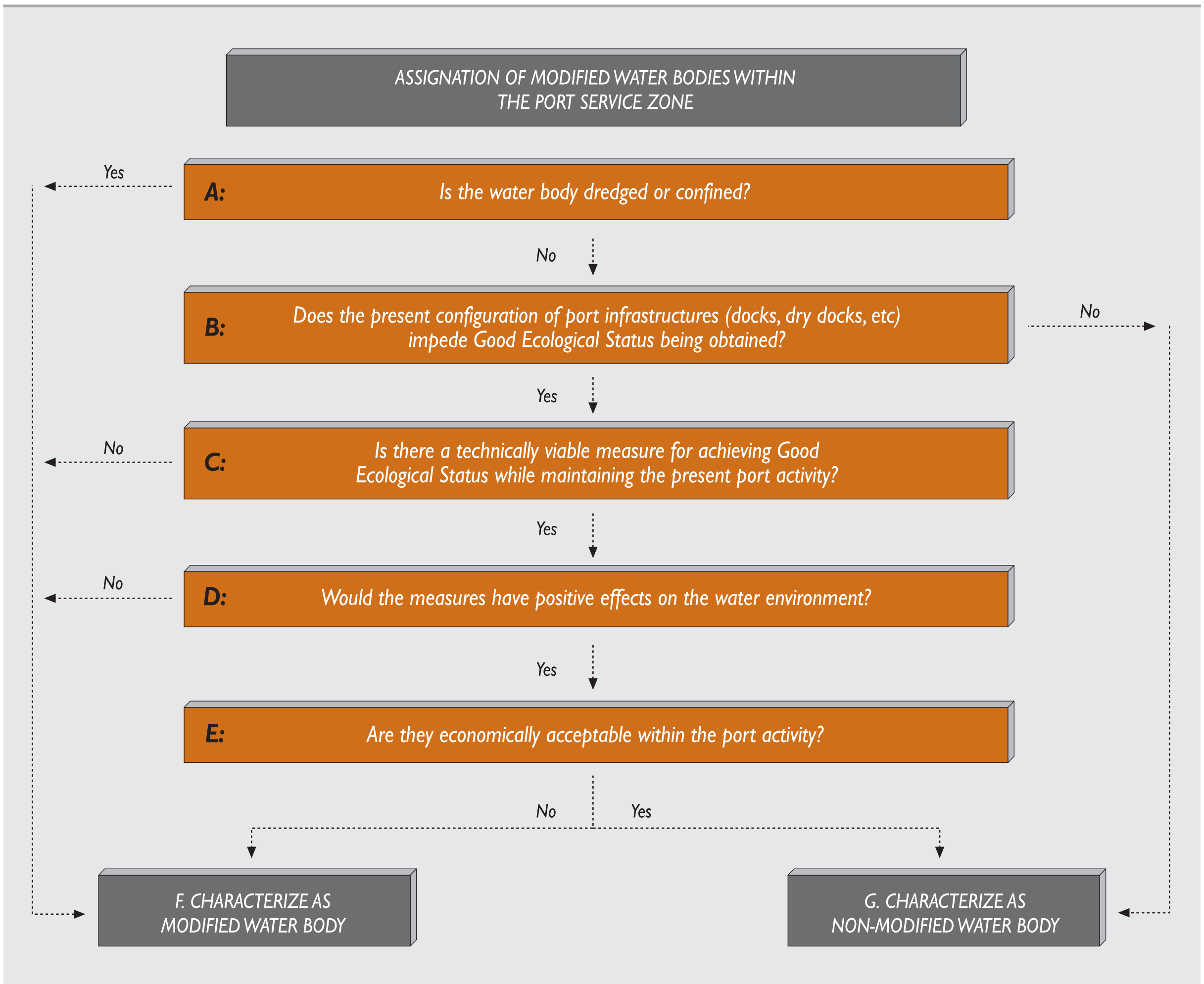
For this purpose, a method is proposed here for the characterization of this type of water body, adapted to the peculiarities of port zones.

Method 2.A. Characterization of Modified Water bodies

For the process of characterization of modified water bodies, bearing in mind that the very existence of the port may bring with it physical alterations which make it difficult to reach the good ecological status in the Port Service Zone, the possibility of applying measures to reduce the effects of these bodies and thus attain the good ecological status should be contemplated. Otherwise, these water bodies can be classified as modified bodies according to the methodological schema in Figure 2.1.

The procedures required to answer each of the five questions which make up this method for determining modified port water bodies are outlined below:

Figure 2.1.III. **Method for the characterization of modified port water bodies**



A. Is the water body confined or is it subjected to dredging?

Given that the definition of modified water body points directly to physical alterations as being responsible for the non-fulfilment of the environmental objectives required to reach the good ecological status, the primary objective of the characterization of port water bodies must be the identification of these physical alterations.

The main physical alterations that can be recognised within the Geographical area of jurisdiction are the confinements of the water bodies in port docks, dredging, dykes and sailing channels.

In the first two cases, the water bodies are prevented from reaching the good ecological status, the only applicable measure being the disappearance of these alterations.

Consequently the waters affected by these will be classified as modified water bodies.

In contrast, in the case of dykes and sailing channels, the modified nature of the water bodies affected will be determined once it has been assessed whether the impacts they produce are responsible for not reaching the good ecological status.

B. Does the current configuration of port infrastructures prevent the good ecological status from being reached?

The responsibility for preventing port water bodies from reaching the good ecological status may lie both with the port infrastructures themselves (dykes) and with the port activities and uses.

In order to determine whether the physical alterations are responsible for not reaching the good ecological status in a water body, it is necessary to evaluate their impact on the water environment, bearing in mind the susceptibility of its quality to these alterations. In any case, it will have to be considered whether the risk of not reaching the good ecological status is due to the hydromorphological changes produced by the physical alterations and not by external pressures (e.g. discharge of toxic substances).

C. Is there any technically feasible method for attaining the good ecological status while maintaining current levels of port activity?

Given that the water bodies are subjected to the impact of a wide variety of hydromorphological pressures or changes, any proposal for corrective measures aimed at reaching the good ecological status of the water bodies must contemplate the following options:

- Measures for changing the hydromorphological conditions.
- Measures for improving the physical or chemical status.
- Measures for improving the biological status.

D. Will the measures have positive overall effects on the water environment?

In most cases, the corrective measures will have effects on the environment in one way or another. Thus, rather than assessing the existence of effects (positive or negative), it will be necessary to assess whether the negative effects are greater than the benefits obtained from the improvement in the ecological status of the water body.

Independently of the above, these measures must always be coherent with the Community legislation on environmental issues (Habitats Directive, Birds Directive, etc). If this were not so, it would be considered that the measures had significant adverse effects on the environment.

E. Are these measures economically viable for the port activity?

As well as being technically feasible, the measures must be economically viable.

A cost is considered to be viable when it does not modify the port activity beyond its standard short-term range of variation. A non-viable cost, in contrast, is one which compromises standard port activity in the long term.

F. Characterization of modified water body

Once the characterization process is completed, the modified water body will have to reach the "best ecological and chemical status possible bearing in mind the repercussions which it has not reasonably been possible to avoid due to the nature of the port activity or pollution". Continuing with the methodological and conceptual schema of the WFD, these water bodies are required to reach a good or very good ecological potential.

G. Characterization of non-modified water body

Similarly, water bodies classified as non-modified will have to reach the best ecological and chemical status possible.

The application of this method must be subjected to future decisions which are adopted, on a state or Community level, concerning the characterization of port water bodies.

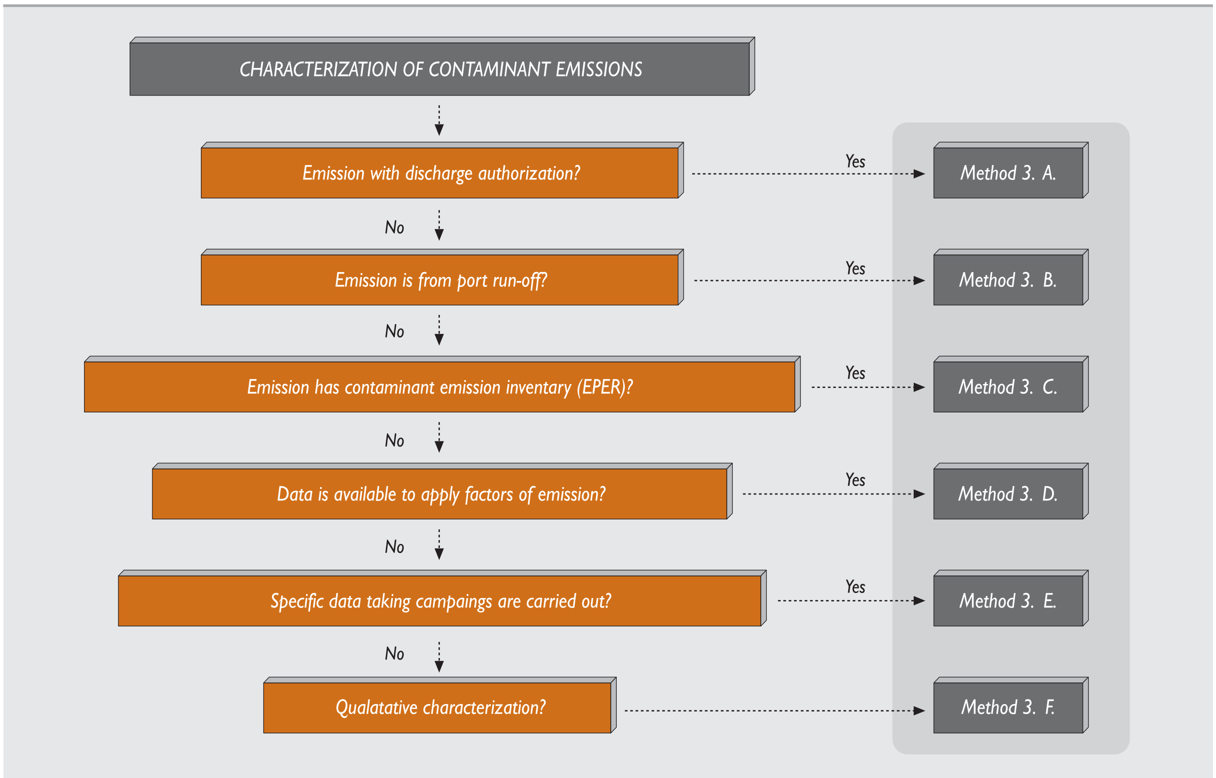
3. CHARACTERIZATION OF CONTAMINANT EMISSIONS

Assessment and management of environmental risks is based on a prior characterization of the situations which might generate disturbances in the quality of the water environment. For this purpose, all of the contaminant emissions located in the geographical area of jurisdiction must be considered for study, 'contaminant emission' being understood as the introduction in the port water environment of substances or energies which might alter the quality of the receiving water bodies.

The general aim of this characterization is to provide sufficient information for estimating the environmental risk of each contaminant emission and to act against those which constitute a risk which is unacceptable for the system.

Figure 3.1 shows a methodological schema which might be used for the characterization of contaminant emissions in the geographical area of jurisdiction. Given the complexity associated with obtaining the information required for this characterization (identification of substances emitted, concentration of substances, volume of emission, etc) six action procedures have been formulated. The type of information available and the needs of the port will determine, in each case, the procedure to be used.

Figure 3.1. Methodological schema of the characterization of contaminant emissions



Method 3.A. Authorisation of Discharge

A.1. Direct Discharges

In the case of direct discharges, the main source of data on a contaminant emission will be the effluent discharge permit itself, a document which must contain, among other data, all the information on the qualitative and quantitative characteristics of the discharge. It should be noted that the appropriacy of this action is approved in Directive 2003/4/EC, on public access to information on the environment in the hands of the corresponding public Authorities.

A.2. Indirect Discharges

The characterization of indirect emissions, that is, of those which, while being discharged at a specific point, are the result of the grouping together of several effluents, will be performed through the authorisations or permits corresponding to each of these. Depending on their origin, these may be included in some of the following types:

- Urban wastewater discharge: the party responsible for which (town council, sewage system management entity, etc) must be in possession of the authorisation of the discharge.

- Industrial wastewater discharge: must be in possession of the effluent discharge permit issued by the sewage system management entity (Town Council, etc), in which the general characteristics of the discharge must be exposed in detail.

Method 3.B. Characterization of port run-off flows

In the case where the port run-offs are not subjected to a process of discharge authorisation, their effects on the quality of the port waters must be considered. For this purpose, a procedure of characterization of these run-offs may be developed, which must take into account aspects such as the concentration of contaminant substances, of bacteriological contaminants, of oxygen-consuming substances and of materials which may generate an increase in the turbidity of the environment.

Method 3.C. Consultation of the inventory of contaminant emissions (EPER)

The Decision of the Commission 2000/479/EC in the amendment to Article 15 of Directive 96/61/EC, concerning integrated pollution prevention and control (IPPC), requires the member states to take inventory and supply the Commission with data on the main contaminant emissions arising in their waters.

This legal precept is transferred to the state legislation through Article 8 of Spanish Law 16/2002, which compels the parties responsible for the installations listed in its Annex I to notify the Regional Communities in which they are located about the data on emissions at least once a year. This is how the so-called EPER register is generated. The organism in charge of distributing this information on a Community level is the European Commission *(www.eper.cec.eu.int)*, on a state level the Ministry of the Environment (www.eper-es.com) and on a Regional Community level the Environment Councils.

Method 3.D. Quantitative Characterization

In the absence of any specific information on the existing effluent discharges, the analysis of the processes responsible for their generation may eventually enable the quantification of the emissions. For this, it is necessary to use nationally or internationally accepted estimation methods or representative emission factors from the productive sector.

The use of emission factors is a very useful tool for determining the concentrations in which substances are emitted. Although their use has traditionally been closely related to atmospheric emissions, it is also possible to find, in the specialist technical bibliography, examples of their use for contaminant emissions originated in various activities or installations.

Method 3. E. Specific data-taking campaigns

Specific data-taking campaigns are based on the analysis of the contaminant substances of the emission in locations close to the point of emission. In the design of this characterization process (sampling type, number, size and frequency of sampling), the peculiarities of each of the discharges analysed should be taken into account, such as their volume, uniformity, variability, randomness, toxic potential of the substances, etc. The following list of standards lay down the standardised procedures for performing this design:

- ISO 5667-1: 1980. Water Quality. Sampling Part 1: Guidance on the design of sampling programmes.

Table 3.1. ***List of activities of different contaminant sources with type of emission generated***

	MATRIX FOR THE ASSIGNMENT OF THE *EPER* REGISTERED SUBSTANCES (D.2000/479/CE) TO EACH GENERATOR ACTIVITY OF CONTAMINANT EMISSIONS
Combustion Installations	With a rated thermal input exceeding >50MW
	Minera oil and gas refineries
	Coke ovens
	Coal gasification and liquefication plants
Production and processing of metals	Metal ore (including sulphide ore) roasting or sintering installations
	Installations for the production of pig iron or steels (primary or secondary fusion), including continuous casting, with a capacity exceeding > 2.5tonnes/hour
	Installations for the processing of ferrous metals: hot-rolling mills with a capacity exceeding > 20 tonnes of crude steel per hour
	Installations for the processing of ferrous metals: smitheries with hammers the energy of which exceeds 50 kilojoule per hammer, where the calorific power exceeds 20 MW
	Installations for the processing of ferrous metals: application of protective fused metal coats with an input exceeding 2 tonnes of crude steel per hour
	Ferrous metal foundries with a production capacity exceeding 20 tonnes per day
	Installations for the production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes
	Installations for the smelting, including the alloyage, of non-ferrous metals, including recovered products, (refining, foundry casting, etc) with a melting capacity exceeding 4 tonnes per day for lead and cadmium or 20 tonnes per day for all other metals
	Installations for surface treatment of metals and plastic materials using an electrolytic or chemical process where the volume of the treatment vats exceeds 30 m^3
Mineral Industries	Installations for the production of cement clinker in rotary kilns with a production capacity exceeding 500 tonnes per day or lime in rotary kilns with a production capacity exceeding 50 tonnes per day or in other furnaces with a production capacity exceeding 50 tonnes per day
	Installations for the production of abestos and the manufacture of abestos-based products
	Installations for the manufacture of glass including glass fibre with a melting capacity exceeding 20 tonnes per day
	Installations for melting mineral substances including the production of mineral fibres with a melting capacity exceeding 20 tonnes per day
	Installations for the manufacture of ceramic products by firing, in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain, with a production capacity exceeding 75 tonnes per day, and/or with a kiln capacity exceeding $4m^3$ and with a setting density per kiln exceeding $300Kg/m^3$
Indistria quimica	Chemical installations for the production of basic organic chemicals, such as simple hydrocarbons (linear or cyclic, satured or unsatured, aliphatic or aromatic)

- ISO 5667-2: 1991. Water Quality. Sampling Part 2: Guidance on sampling techniques.
- ISO5667-3: 2003. Water Quality. Sampling Part 3: Guidance on the preservation and handling of water samples.

Método 3.F. Qualitative Characterization

The qualitative characterization can be obtained from a matrix such as that shown in Table 3.1. Which lists the activities generating contaminant emissions with the substances considered in the EPER inventory (Decision 2000/479/EC) intervening in them. The procedure includes the identification of the activities which can produce contaminant emissions and the allocation of the substances emitted for each activity.

For this, the activities are grouped together in specific sector subtasks, whose aim is to serve as a guideline for the ports in the identification of the contaminants which may foreseeably be emitted. Next, the identification of the contaminants by category of activity is initiated on the basis of the experience acquired with the existing contaminant emissions.

Nutrients		Metal and their compounds								Organic-halogenous compounds							Other organic compounds						Inorganic C.			Number of contaminants
Total Nitrogen	Total Phosphorus	Arsenic	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc	Dichloroethane	Dichloromethane	Chloroalcanes	Hexachlorobenzine	Hexachlorobutadene	Hexachlorocilohexane	Halogenous organic compounds	BTEX	Organic-stanic compounds	Polycyclic aromatic hydrocabons	Phenols	Diphenyletherbromate	Total organic carbons	Chlorides	Cyanides	Fluorides	
x	x		x	x	x	x	x	x	x								x		x			x	x		x	14
x		x	x	x	x	x	x	x	x							x	x		x	x		x	x	x	x	17
x	x																		x	x		x		x		6
x																			x	x		x				4
			x	x	x	x	x	x	x									x	x			x	x	x	x	13
x	x		x	x	x			x	x									x	x			x	x	x	x	13
x	x		x	x	x			x	x									x	x			x	x	x	x	13
			x			x		x	x									x	x			x	x		x	9
			x			x		x	x									x	x			x	x		x	9
	x	x	x	x	x		x	x	x							x		x	x	x		x	x	x	x	16
		x	x	x	x	x	x	x	x							x		x	x			x	x	x	x	15
		x	x	x	x	x	x	x	x							x		x	x			x	x	x	x	15
x	x	x	x	x	x		x	x	x							x		x	x			x	x	x	x	16
																										0
				x												x						x				3
		x					x	x														x			x	5
x	x		x	x	x	x	x	x	x								x					x			x	12
x	x		x	x	x	x	x	x	x								x					x			x	12
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x	x	24

(Continued)

Table 3.1. List of activities of different contaminant sources with type of emission generated

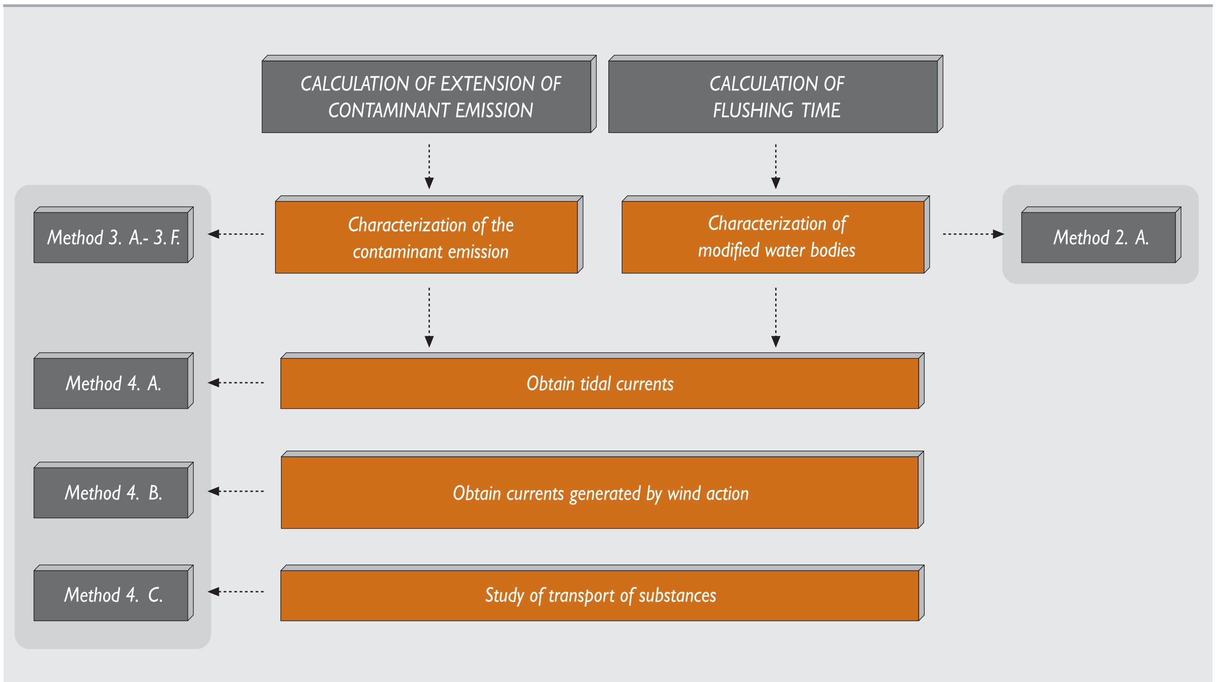
	MATRIX FOR THE ASSIGNMENT OF THE *EPER* REGISTERED SUBSTANCES (D.2000/479/CE) TO EACH GENERATOR ACTIVITY OF CONTAMINANT EMISSIONS
Chemical Industry	Chemical installations for the production of basic organic chemicals, such as oxygen-containing hydrocarbons such as alcohols, aldehydes, ketones, carboxylic acids, esters, acetates, ethers, peroxides, epoxy resin
	Chemical installations for the production of basic organic chemicals, such as sulphurous hydrocarbons
	Chemical installations for the production of basic organic chemicals, such as phosphorous hydrocarbons
	Chemical installations for the production of basic organic chemicals, such as halogenic hydrocarbons
	Manufacturing of organic chemical products such as metallic organic compounds
	Chemical installations for the production of basic organic chemicals, such as basic plastic materials (polymers synthetic fibres and cellulose-based fibres)
	Chemical installations for the production of basic organic chemicals, such as synthetic rubbers
	Chemical installations for the production of basic organic chemicals, such as dyes and pigments
	Chemical installations for the production of basic organic chemicals, such as surface-active agents and surfactants
	Chemical installations for the production of basic inorganic chemicals (gases), such as: ammonia, chlorine or hydrogen chloride, fluorine or hydrogen fluoride, carbon oxides, sulphur compounds, nitrogen oxides, hydrogen, sulphur dioxide, carbonyl chloride
	Chemical installations for the production of basic inorganic chemicals, such as acids, such as chromic acid, hydrofluoric acid, phosphoric acid, nitric acid, hydrochloric acid, sulphuric acid, oleum, sulphurous acids
	Chemical installations for the production of basic inorganic chemicals, such as bases, such as ammonium hydroxide, potassium hydroxide, sodium hydroxide
	Chemical installations for the production of basic inorganic chemicals, such as salts, such as ammonium chloride, potassium chlorate, potassium carbonate, sodium carbonate, perborate, silver nitrate
	Chemical installations for the production of basic inorganic chemicals, such as non-metals, metal oxides or other inorganic compounds such as calcium carbide, silicon, silicon carbide
	Chemical installations for the production of phosphorous-, nitrogen- or potassium-based fertilizers (simple or compound fertilizers)
	Chemical installations for the production of basic plant health products and of biocides
	Installations using a chemical or biological process for the production of basic pharmaceutical products
	Chemical installations for the production of explosives
Paper and Cardboard Inductry	Industrial plants for the production of pulp from timber or other fibrous materials
	Industrial plants for the production of paper and board with a production capacity exceeding 20 tonnes per day
	Production and treatment of cellulose with a capacity of > 20t/day
Textile Ind.	Plants for the pre-treatment (operations such as washing, bleaching, mercerization) or dyeing of fibres or textiles where the treatment capacity exceeds 10 tonnes/day
Leather Ind.	Plants for the tanning of hides and skins where the treatment capacity exceeds 12 tonnes of finished products per day
Coal Industry	Installations for the production of carbon (hard-burnt coal) or electrographite by means of incineration or graphitization
Consumption of organic dissolvents	Installations for the surface treatment of substances, objects or products using organic solvents, in particular for dressing, printing, coating, degreasing, waterproofing, sizing, painting, cleaning or impregnating, with a consumption capacity of more than 150 kg per hour or more than 200 tonnes per year
Waste management	Installations for the disposal or recovery of hazardous waste as defined in the list referred to in Article 1 of Directive 91/689/EEC, as defined in Annexes II A and II B (operations R1, R5, R6, R8 and R9) to Directive 75/442/EEC and in Council Directive 75/439/EEC of 16 June 1975 on the disposal of waste oils, with a capacity exceeding 10 tonnes per day
	Installations for the incineration of municipal waste as defined in Council Directive 89/369/EEC of 8 June 1989 on the prevention of air pollution from new municipal waste incineration plants and Council Directive 89/429/EEC of 21 June 1989 on the reduction of air pollution from existing municipal waste-incineration plants with a capacity exceeding 3 tonnes per hour
	Installations for thee disposal of non-hazardous waste as defined in Annex II A to Directive 75/442/EEC under headings D8 and D9, with a capacity exceeding 50 tonnes per day
	Landfills receiving more than 10 tonnes per day or with a total capacity exceeding 25 000 tonnes, excluding landfills of inert waste
Agro-alimentery industries and cattle exploitations	Slaughterhouses with a carcase production capacity greater than 50 tonnes per day
	Treatment and processing intended for the production of food products from animal raw materials (other than milk) with a finished product production capacity greater than 75 tonnes per day or vegetable raw materials with a finished product production capacity greater than 300 tonnes per day (average value on a quarterly basis)
	Treatment and processing of milk, the quantity of milk received being greater than 200 tonnes per day (average value on an annual basis)
	Installations for the disposal or recycling of animal carcases and animal waste with a treatment capacity exceeding 10 tonnes per day
	Installations for the intensive rearing of poultry with more than 40 000 places for poultry
	Installations for the intensive rearing of pigs with more than 2 000 places for production pigs (over 30 kg)
	Installations for the intensive rearing of sows with more than 750 places for sows

Nutrients		Metal and their compounds								Organic-halogenous compounds							Other organic compounds						Inorganic C.			
Total Nitrogen	Total Phosphorus	Arsenic	Cadmium	Chromium	Copper	Mercury	Nickel	Lead	Zinc	Dichloroethane	Dichloromethane	Chloroalcanes	Hexachlorobenzine	Hexachlorobutadene	Hexachlorocilohexane	Halogenous organic compounds	BTEX	Organic-stannic compounds	Polycyclic aromatic hydrocabons	Phenols	Diphenyletherbromate	Total organic carbons	Chlorides	Cyanides	Fluorides	Number of contaminants
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x	x	24
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x	x	24
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x	x	24
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x	x	24
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x	x	24
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x	x	24
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x	x	24
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x	x	24
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x	x	24
x	x		x	x	x	x	x	x	x							x	x		x					x	x	14
x	x		x	x	x	x	x	x	x							x	x		x					x	x	14
x	x		x	x	x	x	x	x	x							x	x		x					x	x	14
x	x		x	x	x	x	x	x	x							x	x		x					x	x	14
x	x		x	x	x	x	x	x	x							x	x		x					x	x	14
x	x		x			x		x														x		x	x	8
x	x	x	x	x	x	x	x	x	x						x	x	x	x		x		x				16
x	x								x							x	x			x		x				7
x	x	x	x	x	x	x	x	x	x						x	x		x		x		x				15
x	x		x	x	x	x	x	x	x							x		x				x				12
x	x		x	x	x	x	x	x	x							x		x				x				12
x	x		x	x	x	x	x	x	x							x	x		x		x	x	x			15
x	x		x	x	x	x	x	x	x							x	x		x	x	x	x	x			16
x	x	x		x	x											x						x	x			6
																						x	x			2
x	x	x	x	x	x		x	x	x		x	x				x		x	x	x		x		x	x	18
x	x	x	x	x	x	x	x	x	x							x			x			x	x	x		15
x	x	x	x	x	x	x	x	x	x							x			x			x	x		x	15
x	x	x	x	x	x	x	x	x	x							x						x	x	x		14
x	x		x	x	x	x	x	x	x							x						x		x		12
x	x																					x	x			4
x	x																					x	x			4
x	x																					x	x			4
x	x			x	x				x							x						x				7
x	x				x				x													x				5
x	x				x				x													x				5
x	x				x				x													x				5

4. CALCULATION OF FLUSHING TIME OF WATER BODIES AND OF EXTENSION OF CONTAMINANT EMISSIONS

For the calculation of the flushing time of the modified water bodies (Section. 4.2.2.2) and the extension of a contaminant emission (Section 6.2.2.1, 6.2.3.2), the starting point is the results obtained from the characterization of the contaminant emissions (methods 3.A.-3.F.) and from the characterization of the modified water bodies (method 2.A.). This information will form the basis of the numerical models used for the calculation of both variables (Figure 4.1.III.).

Figure 4.1.III. ***Methods of calculation of extension of the contaminant emission and flushing time of water body***



Although the use of numerical models is, at present, common practice and several of these are available, both in commercial versions and in some which are freely available on the web, the specific conditions that normally concur in the water environment of port zones enable the introduction of some hypotheses on their hydrodynamic behaviour, allowing the simplest versions to be used successfully.

There are two hypotheses which can, as a general rule, be accepted, related to the effects of the tide and the wind as the generators of the main dispersive currents. In the first case, it will be assumed that the tidal currents can be considered to be two-dimensional in depth, so that the depth-averaged hydrodynamic models (H2D models) will provide a sufficiently approximate solution. In the second case, it will be assumed that the effects of the wind are transmitted in the depths, in agreement with a parabolic, and thus non-uniform, law (H2DZ, quasi-three-dimensional models).

The hypothesis of two-dimensionality of the tidal currents is perfectly justified since these have a barotropic effect which affects the entire water column.

The assumption that the currents produced by the wind have a flat trajectory is based on the shallowness (depth normally less than 30 m) of the sea in port zones, thus allowing the three-dimensional Ekman effects to be discarded. Also, the assumption of a constant in-depth value of the eddy viscosity together with the consideration of the average value of the wind in the studies referenced in this ROM 5.1 provide sufficient evidence of the hypothesis of parabolic distribution of the velocity of these currents down to the seabed.

Only in the case where in the measurement campaigns thermoclines or picnoclines can be appreciated in the water bodies can the use of three-dimensional hydrodynamics models be justified.

As regards substance transport models, it is normally possible to turn to the advection-diffusion equation (conservation of the substance mass) in its two-dimensional version. Only in the case of studies on the evolution of the dissolved oxygen concentration with a great sediment oxygen depth demand, or also in the presence of permanent picnoclines might the use of this equation in three dimensions be considered. Thus, the models which can generally be used are those whose scientific foundations respond at least to the concepts outlined in the following sections.

Method 4.A. Obtaining the tidal currents

The two-dimensional hydrodynamic numerical model (H2D) is derived from the Navier-Stokes equations which govern the movement of a fluid and the continuity equations which, for the case of an incomprehensible fluid, are:

- Equation of conservation of quantity of movement.

$$\rho\left[\frac{Du}{Dt}\right] = -\nabla p + \rho g + \left[\frac{\partial \tau_{ij}}{\partial x_j}\right]$$

- Equation of continuity:

$$\nabla u = 0$$

where:

ρ = fluid density.
u = velocity vector (u, v, w).
p = pressure.
g = acceleration of gravity.
τ_{ij} = tangential tension in the directioni on the plane j.
D/Dt = material derivative.
∇ = gradient.
$\frac{\partial}{\partial x_j}$ = Partial derivative

The integration in vertical for long waves of the quantity of movement and continuity equations leads to the following equations:

- Conservation of quality of movement:
  InX)

$$\frac{\partial \bar{u}H}{\partial t} + \frac{\partial(\bar{u}^2 H)}{\partial x} + \frac{\partial(\bar{u}\bar{v}H)}{\partial y} - f\bar{v}H = -gH\frac{\partial \eta}{\partial x} - \frac{gH^2}{2\rho_0}\cdot\frac{\partial \rho_0}{\partial x} +$$
$$\frac{1}{\rho_0}\left[\tau_{xz}(\eta) - \tau_{xz}(-h)\right] + HN_h\left[\frac{\partial^2 \bar{u}}{\partial x^2} + \frac{\partial^2 \bar{u}}{\partial y^2}\right] + 2H\frac{\partial N_h}{\partial x}\frac{\partial \bar{u}}{\partial x} + H\frac{\partial N_h}{\partial y}\left[\frac{\partial \bar{u}}{\partial y} + \frac{\partial \bar{v}}{\partial x}\right]$$

In Y)

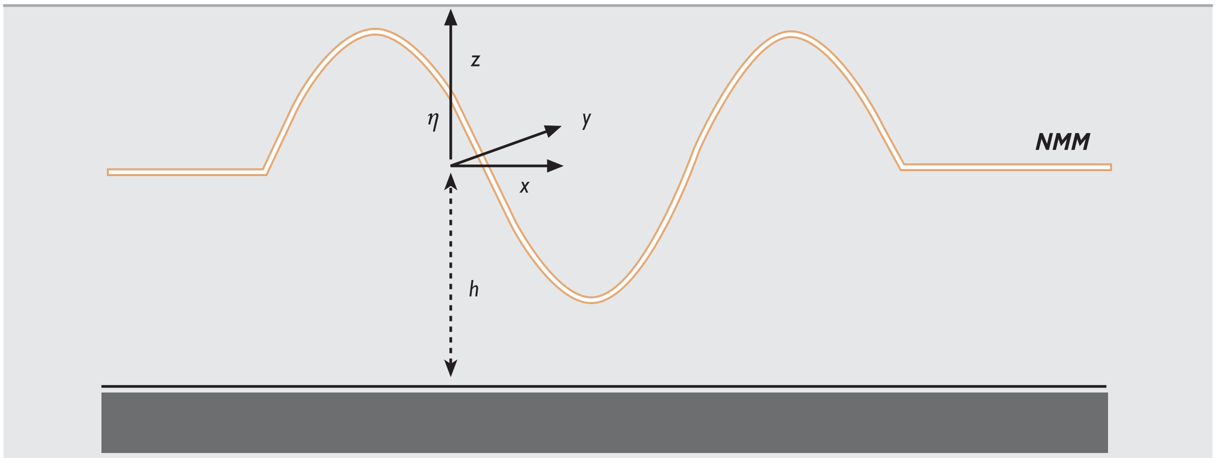
$$\frac{\partial \bar{v}H}{\partial t}+\frac{\partial(\bar{u}\bar{v}H)}{\partial x}+\frac{\partial(\bar{v}^2H)}{\partial y}+f\bar{u}H=-gH\frac{\partial \eta}{\partial y}-\frac{gH^2}{2\rho_0}\cdot\frac{\partial \rho_0}{\partial y}+$$
$$\frac{1}{\rho_0}\left[\tau_{yz}(\eta)-\tau_{yz}(-h)\right]+HN_h\left[\frac{\partial^2\bar{v}}{\partial x^2}+\frac{\partial^2\bar{v}}{\partial y^2}\right]+2H\frac{\partial N_h}{\partial y}\frac{\partial \bar{v}}{\partial y}+H\frac{\partial N_h}{\partial x}\left[\frac{\partial \bar{u}}{\partial y}+\frac{\partial \bar{v}}{\partial x}\right]$$

- Continuity equation:

$$\frac{\partial \bar{u}H}{\partial x}+\frac{\partial \bar{v}H}{\partial x}+\frac{\partial H}{\partial t}=0$$

The dependent variables of the problem are $\eta, \bar{u}, \bar{v}$ and ρ_o which represent the elevation of the free surface over the reference level (Figure 4.2), the average velocities in vertical in the directions x and y respectively and the average density at each calculation point.

Figure 4.2. **Reference System**



The rest of the terms of the equation are:

H	=	height of water ($H = h + \eta$).
f	=	Coriolis parameter $\Rightarrow f = 2\,\Omega\,\text{sen}\phi$
Ω	=	angular velocity of the earth = $7.29\ 10^{-5}\ s^{-1}$
ϕ	=	latitude.
N_h	=	horizontal eddy viscosity coefficient.
$\tau_{xz}(\eta)$, $\tau_{yz}(\eta)$	=	tangential tensions on the free surface in directions x and y.
$\tau_{xz}(-h)$, $\tau_{yz}(-h)$	=	tangential tensions on the seabed in directions x and y.

For example, in the case of the wind, the tensions generated can be expressed as follows:

$$\frac{\tau_{xz}(\eta)}{\rho_0}=C_a\frac{\rho_a}{\rho_0}W_x\sqrt{W_x^2+W_y^2}$$
$$\frac{\tau_{yz}(\eta)}{\rho_0}=C_a\frac{\rho_a}{\rho_0}W_y\sqrt{W_x^2+W_y^2}$$

where:

C_a = coefficient of friction by wind.
W_x and W_y = wind velocities in directions x and y at 10 m on the free surface.
ρ_a = air density.

The friction on the sea-bed can be expressed as a variable dependent on depth, using the Colebrook formula:

$$C = 18 * \log\left(\frac{12 * H}{k_s}\right)$$

where:

C = Chezy friction coefficient.
k_s = Nikuradse roughness.

Thus, the tensions on the seabed can be expressed as:

$$\frac{\tau_{xz}(h)}{\rho_0} = \frac{g\bar{u}\sqrt{\bar{u}^2 + \bar{v}^2}}{C^2}$$
$$\frac{\tau_{yz}(h)}{\rho_0} = \frac{g\bar{v}\sqrt{\bar{u}^2 + \bar{v}^2}}{C^2}$$

Method 4.B. Obtaining the currents generated by the action of the wind

It can be considered that the velocities generated by the effects of the wind constitute a movement with a flat trajectory (thus making it possible to discard three-dimensional effects), whose field of induced velocity is variable in depth. For this reason, a quasi-three dimensional model (H2DZ) will be used.

The following hypotheses are accepted:

- Stationary field of velocity.
- Horizontal gradients of velocity components negligible.
- Vertical velocity component negligible.
- Hydrostatic distribution of pressures.
- For these hypotheses, a parabolic distribution of velocity can be adopted:

$$u(z) = \alpha z^2 + \beta z + y$$
$$v(z) = \alpha' z^2 + \beta' z + y'$$

The coefficients of these expressions are determined with the contour conditions on the free surface and on the seabed. For this, the non-slip condition is considered on the seabed and the tangential tension value on the surface is considered to be equal to that produced by the wind, which is assumed to be proportional to the square of its velocity.

The equations for the vertical distribution of velocity are as follows:

$$u(z)=\left[\frac{3}{4}a-\frac{3}{2}\bar{u}\right]\left[\left(\frac{z}{h}\right)^2-1\right]+a\left(\frac{z}{h}+1\right)$$

$$v(z)=\left[\frac{3}{4}b-\frac{3}{2}\bar{v}\right]\left[\left(\frac{z}{h}\right)^2-1\right]+b\left(\frac{z}{h}+1\right)$$

$$\text{where}\quad a=\frac{\tau_{sx}H}{\rho N}\quad y\quad b=\frac{\tau_{sy}H}{\rho N}$$

Where N is the eddy viscosity on the surface and τ_s is the tangential tension due to the wind ($\tau_s = cw^2$) of components τ_{sx} and τ_{sy}.

For this case, the averaging of the quantity of movement and continuity equations leads to the following expressions:

- Quantity of movement equations
  In X)

$$\frac{\partial\bar{u}}{\partial t}+\bar{u}\frac{\partial\bar{u}}{\partial x}+\bar{v}\frac{\partial\bar{u}}{\partial y}+\left(0.2\bar{u}+\frac{a}{40}\right)\frac{\partial\bar{u}}{\partial x}+\left(0.2\bar{v}+\frac{b}{40}\right)\frac{\partial\bar{u}}{\partial y}=-g\frac{\partial\eta}{\partial x}+f\bar{v}+\frac{\tau_{sx}}{\rho_0 H}-\left(0.18\frac{\bar{u}}{H}\sqrt{\frac{\tau_s}{\rho_0}}-0.5\frac{\tau_{sx}}{\rho_0 H}\right)$$

  In Y)

$$\frac{\partial\bar{v}}{\partial t}+\bar{u}\frac{\partial\bar{v}}{\partial x}+\bar{v}\frac{\partial\bar{v}}{\partial y}+\left(0.2\bar{u}+\frac{a}{40}\right)\frac{\partial\bar{v}}{\partial x}+\left(0.2\bar{v}+\frac{b}{40}\right)\frac{\partial\bar{v}}{\partial y}=-g\frac{\partial\eta}{\partial y}+f\bar{u}+\frac{\tau_{sy}}{\rho_0 H}-\left(0.18\frac{\bar{v}}{H}\sqrt{\frac{\tau_s}{\rho_0}}-0.5\frac{\tau_{sy}}{\rho_0 H}\right)$$

- Continuity equation

Method 4.C. Study of transport of substances

For the calculation of the extension reached by the contaminant emission, only those substances or processes present in it will be modelled. For this purpose, the first step is to classify these into conservative, reactive and bacteriological. As has been established in this ROM 5.1, the processes of dispersion of conservative substances which have specific quality criteria, of reduction of dissolved oxygen and of evolution of bacteriological pollution will be modelled when appropriate.

The numerical transport model is based on the equation of conservation of the quantity of mass of a substance present in the water column of the coastal environment. This equation expresses the fact that the local variation of the concentration in the time unit is originated as a consequence of three transport processes: advection (or transport by the existing hydrodynamic currents), diffusion through the effects of turbulent phenomena and their reaction or interaction with other substances or organisms present in the water environment. In three-dimensional form, this equation corresponds to the following expression:

$$\frac{\partial c}{\partial t}+\frac{\partial u_i c}{\partial x_i}=\frac{\partial}{\partial x_i}\left(D_{x_i}\frac{\partial c}{\partial x_i}\right)+S-Kc$$

where:

c = concentration of substance.
u_i = velocity-vector components.
D_{xi} = turbulent diffusion coefficients

S = quantity of substance introduced in the environment.
K = rate of reaction or degradation.

The assumption of a practically horizontal mass transport flow is valid outside the zone of injection of the substance. In the near field, the phenomenon may have a three-dimensional form, while in the far field the horizontal movement may be considered to prevail over the vertical.

The transport equation in its two-dimensional form is expressed as:

$$\frac{\partial H\bar{c}}{\partial t}+\frac{\partial \bar{u}H\bar{c}}{\partial x}+\frac{\partial \bar{v}H\bar{c}}{\partial y}=\frac{\partial}{dx}\left(HD_{xx}\frac{\partial \bar{c}}{\partial x}\right)+\frac{\partial}{\partial x}\left(HD_{xy}\frac{\partial \bar{c}}{\partial y}\right)+\frac{\partial}{\partial y}\left(HD_{yy}\frac{\partial \bar{c}}{\partial y}\right)+\frac{\partial}{\partial y}\left(HD_{yx}\frac{\partial \bar{c}}{\partial x}\right)+S-KH\bar{c}$$

where

H = height of water ($H = h + \eta$).
$\bar{c}$ = average vertical concentration of water column.
$\bar{u}, \bar{v}$ = average horizontal velocities.
D_{xx}, D_{xy}, D_{yx}, D_{yy} = dispersion coefficients.

The dispersion coefficients in the directions x and y are defined using the following expressions:

$$D_{xx}=\frac{(k_l\bar{u}^2+k_t\bar{v}^2)H\sqrt{g}}{\sqrt{\bar{u}^2+\bar{v}^2}C}$$

$$D_{yy}=\frac{(k_l\bar{v}^2+k_t\bar{u}^2)H\sqrt{g}}{\sqrt{\bar{u}^2+\bar{v}^2}C}$$

$$D_{xy}=D_{yx}=\frac{(k_l-k_t)\bar{u}\bar{v}H\sqrt{g}}{\sqrt{\bar{u}^2+\bar{v}^2}C}$$

In the above formulas, k_l represents the dispersion coefficient parallel to the flow, while k_t is the dispersion coefficient perpendicular to the flow. It is common, in the case of two-dimensional transport, to assume an isotropic movement, ($k_l=k_t$), as there is no predominant flow direction, so that the two-dimensional transport equation can be expressed as:

5. CHEMICAL QUALITY ANALYSIS

The chemical quality analysis is an uninterrupted, periodic, systematic and standardised process of quality measurement and assessment of the pelagic (water) and benthic (soft beds) environment, which will be carried out through the analysis of the fulfilment of the quality objectives established for each of the selected indicators for this purpose. These will be those substances of Table 7.1 of the ROM 5.1 whose presence has been detected in some of the contaminant emissions directly discharged on the water body.

The methods used in the supervision of the water body quality indicators must conform to the national and international standards which guarantee, on the one hand, the supply of quality information and, on the other hand, the scientific comparability of the results. On this basis, the analysis of the chemical quality of the water bodies will be based on the standards produced as a modification of Annex X of the Water Framework Directive and, failing this, on that established by the ISO standards. When a priority substance is not accounted for in any of the above cases, any of the techniques recommended in the last edition of the Standard Methods (APHA, 2004) may be used. The chemical quality analysis in the water column and in the water body beds will be structured around two clearly distinct aspects, the design of the data-taking campaigns (Section 5.1) and the analysis of the indicators (Section 5.2).

5.1. Method for the design of chemical quality data-taking campaigns

Method 5.A. Design of data-taking campaigns

The design of data-taking campaigns can be carried out following the specifications laid down in the three ISO standards on water quality concerning sampling.

- ISO 5667-1:1980. Water Quality. Sampling. Part 1. Guidance on the design of sampling programmes.
- ISO 5667-2:1991. Water Quality. Sampling. Part 2. Guidance on sampling techniques.
- ISO 5667-3:2003. Water Quality. Sampling. Part 3. Guidance on preservation and handling of water samples.

However, due to the need for objective and standardised data-taking campaigns applicable both to the pelagic environment (water) samples and to those of the benthic environment (sediment), the design of campaigns specifically adapted to the requirements of ROM 5.1 will be adopted, according to the following specifications:

DESIGN OF SAMPLING CAMPAIGNS

SAMPLING STRATEGY
Layered and deliberate, locating the sampling points in the area adjacent to the outer edge of the mixing zone of each emission point.

NUMBER OF SAMPLES
As a general rule, three sampling points are recommended per water body.

TYPE OF SAMPLES
- *Pelagic environment:* Samples from points at two depths, taken using oceanographic bottles such as the Niskin bottle or equivalent.
- *Benthic environment:* Samples from points on the surface (0-30 cm) obtained with corer.

SIZE OF SAMPLE
The total size of the sample will depend on the number and type of indicators to be analysed.

SAMPLING FREQUENCY
- *Pelagic environment:* A three-monthly minimum sampling frequency will be established.
- *Benthic environment:* An annual frequency will be established.

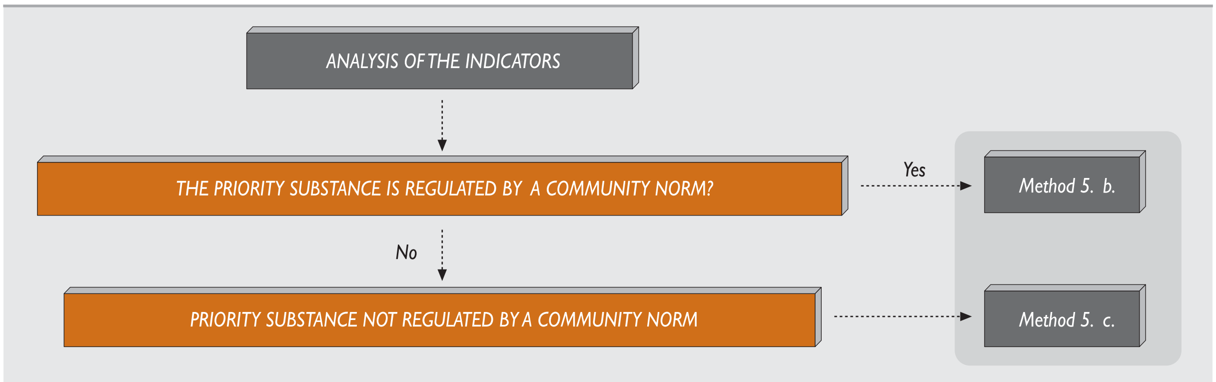
However, this geographic and temporal intensity of the sampling could be considerably reduced depending on the uniformity and stability of the data presented and the information available.

CONSERVATION
For the conservation of the water and sediment samples, the specifications of the Standard ISO 5667-3 Water Quality. Sampling. Part 3 Guidance on preservation and handling of water samples may be referred to.

5.2. Methods for the analysis of the chemical quality indicators

The methods for the analysis of the chemical quality indicators of the water column and the depths of the water bodies will fit the methodological schema shown in Figure 5.2.

Figure 5.1. **Methodological steps in the analysis of chemical quality indicators**



METHOD 5.B. ANALYSIS OF PRIORITY SUBSTANCES REGULATED BY COMMUNITY STANDARDS

The analysis of priority substances regulated by Community standards will be carried out in accordance with the methods of analysis established by these standards for the water and soft bed samples (Table 5.1.III).

METHOD 5.C. ANALYSIS OF PRIORITY SUBSTANCES NOT REGULATED BY COMMUNITY STANDARDS

In the absence of any legal regulations, the internationally recognised standards corresponding to the various analytical techniques applicable to each priority substance may be applied. Some of the most important of these are the ISO standards, the analytical methods established in the last edition of the "Standard Methods" (APHA, 2004), and the analytical methods of the U.S. Environmental Protection Agency (U.S. EPA) listed in Table 5.2.III.

Table 5.1.III. **Substances with quality objectives established as Community standards**

Priority substances	Directives	Analytical Technique	Detection Limit of (*) Water	Detection Limit of (*): Sediment
Cadmium	83/513/EC	Atomic absorption Spectrophotometry		
Mercury	82/176/EC	Atomic absorption Spectrophotometry without flame		0.05 mg/kg
Pentachlorophenol	86/280/EC	Chromatography in liquid phase at hight pressure or gaseous chromatography	0.1 µg/l	1 µg/ kg
1,2-dichoroetane	90/415/EC	Purging and trap-chromatography in gaseous phase	1 µg/l	
Hexachlorobenzene	88/347/EC	Chromatography in gaseous phase	1-10 µg/l	1-10 µgkg
Hexachlorobutadine	88/347/EC	Chromatography in gaseous phase	1-10 µg/l	1-10 µgkg
Hexachlorocyclohexane	84/491/EC	Chromatography in gaseous phase	Estuaries territorial waters: 0.004 µg/ l(1)	1 µg/kg PS
1,2,4-trichlorobenzene	90/415/EC	Chromatography in gaseous phase	10 µg/l	1 µg/kg PS
Trichloromethane	88/347/EC	Chromatography in gaseous phase	Conc< 0.5mg/l: 0.1µg/l Conc> 0.5mg/l: 0.1 mg/l	

(*): Detection limit *xg* of a given substance is the smallest determinable quantity of a sample using a given work procedure which can still be distinguished from zero.
(1): Value corresponding to 1/5 of the quality objective of Hexachlorocyclohexane (0.02 µg/l).

Table 5.2.III. Analytical techniques established by the ISO standards, the Standard Methods and the EPA for the analysis of the concentration of priority substances in water

Priority Substances	Método 5.C	
	ISO Standards	Standard Methods
Lead	ISO 11885:1998. Water quality. Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy	Method 3113, 311-B, 3111-C. Absorption spectrometry.
		Method3500-Pb D. Atomic Ditizona
		Method 3120. emission spectrometry with plasma fitted inductively
Nickel	ISO 11885:1998. Water quality. Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy	Method 3113, 311-B, 3111-C. Atomic absorption spectrometry
		Method 3120. Emission spectrometry with plasma fitted inductively
Antracene	ISO 17993:2002. Water quality. Determination of 15 polycyclic aromatic hydrocarbons (PAH) in water by HPLC with fluorescence detection after liquid-liquid extraction	Method 6630 B, 6630 C. Gas chromotography
Fluorantene	ISO 17993:2002. Water quality - Determination of 15 polycyclic aromatic hydrocarbons (PAH) in water by HPLC with fluorescence detection after liquid-liquid extraction	Method 6410 B. Gas chromotography. Mass spectrometry
Naphthalene	ISO 17993:2002. Water quality - Determination of 15 polycyclic aromatic hydrocarbons (PAH) in water by HPLC with fluorescence detection after liquid-liquid extraction	
	ISO 15680:2003. Water quality — Gas-chromatographic determination of a number of monocyclic aromatic hydrocarbons, naphthalene and several chlorinated compounds using purge-and-trap and thermal desorption	
Benzo(a)pirene	ISO 17993:2002. Water quality - Determination of 15 polycyclic aromatic hydrocarbons (PAH) in water by HPLC with fluorescence detection after liquid-liquid extraction	
Benzo(b)fluorantene	ISO 17993:2002. Water quality - Determination of 15 polycyclic aromatic hydrocarbons (PAH) in water by HPLC with fluorescence detection after liquid-liquid extraction	
Benzo(g,h,i)perilene	ISO 17993:2002. Water quality - Determination of 15 polycyclic aromatic hydrocarbons (PAH) in water by HPLC with fluorescence detection after liquid-liquid extraction	
Benzo(k)fluorantene	ISO 17993:2002. Water quality - Determination of 15 polycyclic aromatic hydrocarbons (PAH) in water by HPLC with fluorescence detection after liquid-liquid extraction	
Indeno(1,2,3-cd)pirene	ISO 17993:2002. Water quality - Determination of 15 polycyclic aromatic hydrocarbons (PAH) in water by HPLC with fluorescence detection after liquid-liquid extraction	
4-(para)-nonilphenol Para-ter-octilphenols Alachloride	Method 505, 507, 525.2, 508.1, 551.1	
Atrazine	ISO 10695:2000. Water quality — Determination of selected organic nitrogen and phosphorus compounds — Gas chromatographic methods	
C10-13 Chloroalkanes Chlorfenvinphos Clorpyriphos	Method 8141.A	
Dichloromethane	ISO 10301:1997. Water quality — Determination of highly volatile halogenated hydrocarbons — Gas-chromatographic methods	
	ISO 15680:2003. Water quality — Gas-chromatographic determination of a number of monocyclic aromatic hydrocarbons, naphthalene and several chlorinated compounds using purge-and-trap and thermal desorption	
Alfa-endosulfan		Method 6630 B, 6630 C. Gas chromotography. Method 6410 B. Gas chromotography. Mass spectrometry.

Table 5.2.III. Analytical techniques established by the ISO standards, the Standard Methods and the EPA for the analysis of the concentration of priority substances in water

Priority Substances	Método 5.C	
	ISO Standards	Standard Methods
Lead	ISO 11885:1998. Water quality. Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy	Method 3113, 311-B, 3111-C. Absorption spectrometry.
		Method3500-Pb D. Atomic Ditizona
		Method 3120. emission spectrometry with plasma fitted inductively
Diuron		
Pentachlorobenzene	ISO 6468:1996. Water quality — Determination of certain organochlorine insecticides, polychlorinated biphenyls and chlorobenzenes — Gas chromatographic method after liquid-liquid extraction	
Trifluraline	ISO 10695:2000. Water quality — Determination of selected organic nitrogen and phosphorus compounds — Gas chromatographic methods	Method 6630 B. Gas chromotography
Benzene	ISO 15680:2003. Water quality — Gas-chromatographic determination of a number of monocyclic aromatic hydrocarbons, naphthalene and several chlorinated compounds using purge-and-trap and thermal desorption	Method 6210 B, 6210 C. Purging and trapping in a packed column withn Gas chromotography. Mass spectrometry
		Method 6220 B, 6220 C. Purging and trappingwith Gas chromotography
		Method 6210 D. Purging and trapping in capillary column with Gas chromotography. Mass spectrometry
		Method 6410 B. Gas chromotography. Mass spectrometry
Diphenylether bromates Di(2-ethylhexel)phtalate (DEHP) Isoproturon	Method 506, 525.2	
Simazine Tributiltín (TBT)	ISO 10695:2000. Water quality — Determination of selected organic nitrogen and phosphorus compounds — Gas chromatographic methods	

As in the case of priority substances regulated by Community standards, in the absence of any specific standard, the characterization of the concentration of the priority substances in the sediment beds will be performed adopting the analytical technique established for water samples.

6. ANALYSIS OF ECOLOGICAL STATUS AND ECOLOGICAL POTENTIAL

The analysis of the ecological status and ecological potential of the water bodies is, like the chemical quality assessment, a process of continuous and systematic observation, measurement and analysis of each of the two environmental compartments of the water bodies: the pelagic environment and the benthic environment.

In order that this analysis is objective, homogenous and adequate for the needs of this Recommendation, this document draws on the methods of analysis of each of the indicators selected by ROM 5.1 to assess the ecological status and ecological potential of water bodies (Table 7.2 of the main document).

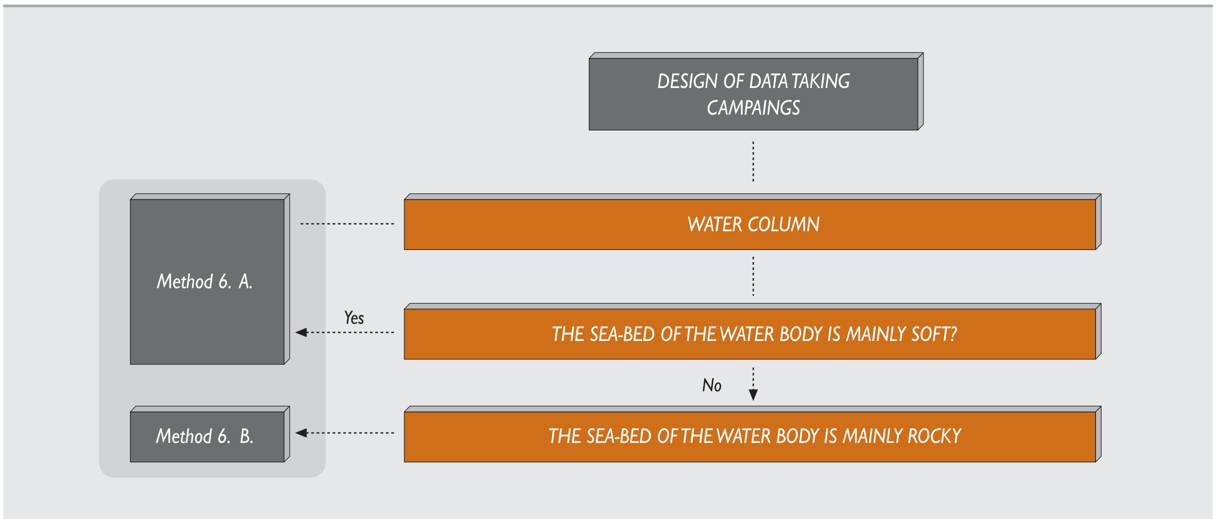
As in the case of the chemical quality analysis, the methods used in the assessment of the water body quality indicators must be based on standards that guarantee the quality of the data measured and the comparability of the results. In this respect, there are standards which have established analytical techniques for the assessment of some of the indicators included in this Recommendation, as is the case for dissolved oxygen (Directives 76/160, 78/659, 79/923) or total hydrocarbons (Directive 80/778). In the absence of these, the methods of analysis defined in the ISO standards, or in other internationally recognised handbooks (APHA, 2004, USEPA) will again be adopted.

The analysis of the ecological status and ecological potential of water bodies is made up of two clearly distinct aspects: the design of data-taking campaigns (Section 6.1) and the analysis of the indicators (Section 6.2).

6.1. Method for design of data-taking campaing for ecological status and ecological potential

In order to systematise the selection of data-taking methods, it is proposed that the diagram in Figure 6.1.III. should be followed.

Figure 6.1.III. Methodological stages in the design of data-taking campaings



METHOD 6.A. DATA-TAKING CAMPAIGNS: WATER COLUMNS AND SOFT-BOTTOM

The design of the data-taking campaigns will again be based on the philosophy defined in the three ISO water quality norms concerning sampling.

- ISO 5667-1 Water quality. Sampling. Part 1. Guidance on the design of sampling programmes.
- ISO 5667-2 Water quality. Sampling. Part 2. Guidance on sampling techniques.
- ISO 5667-3 Water quality. Sampling. Part 3. Guidancee on preservation and handling of water samples.

However, given the need to design objective, standardised data-taking campaigns, applicable both to pelagic environment (water) and benthic environment (sediment) sampling, the campaign design will be specifically adapted to the requirements of ROM 5.1, following the outline below:

SAMPLING CAMPAIGN DESIGN

SAMPLING STRATEGY

Systematic, using a regular net situated on the water body under study.

NUMBER OF SAMPLES

The number of sampling points for each water body will be the number required to obtain representative results.

TYPE OF SAMPLES

- *Pelagic environment:*
  Samples at points taken directly from the surface for the determination of total hydrocarbons and detergents.
  Continuous measurements along a vertical profile with a multiparametric dissolved oxygen probe, chlorophyll 'a', turbidity, temperature and salinity, these last two for the calculation of the percentage of saturation.
- *Benthic environment:* Samples from points on the surface (0-30 cm) obtained with Corer.

SAMPLE SIZE

- *Pelagic environment:*
  The size of the samples will be 1litre for total hydrocarbons and 500 ml for the analysis of the detergents.
- *Benthic environment:*
  For the set of measurements to be made, a sediment quantity of 500 g (dry weight at room temperature) will be required.
  In the case of sediments with a low content of finematerial (<0.063 mm) this quantity will be increased in order to ensure a sufficient quantity of thismaterial for the analysis of heavy metals.

SAMPLING FREQUENCY

- *Pelagic environment:*
  For the first data-taking campaign, a minimum monthly frequency is established.
- *Benthic environment:*
  For the first data-taking campaign, a minimum yearly frequency is established.

Nevertheless, this geographic and temporal sampling intensity may be substantially reduced depending on the uniformity and stability of the available data and knowledge.

CONSERVATION

For the conservation of the water and sediment samples, Table 6.1.III. may be referred to.

METHOD 6.B. DESIGN OF DATA-TAKING TECHNIQUES: HARD-BOTTOM

Unlike the case of soft soft-bottoms in which the sampling takes place at points, the sampling in the case of hard-bottoms is carried out at cross-sections (longitudinal stretches). The general characteristics of these campaigns will fit the following outline:

DESIGN OF SAMPLING CAMPAIGN

SAMPLING STRATEGY

Stratified, at depth levels: intertidal, 0-5, 5-15, 15-30, >30 metres.

NUMBER OF SAMPLES

At least one transection will be made for each water body, an increase in this number being possible, depending on the size of the water body.

TYPE OF SAMPLES

At each depth level, the selected indicators will be assessed in a range of 50 m x 3 m.

FREQUENCY

The sampling will be performed once a year, preferably at the end of spring.

Table 6.1.III. Synthesis of water and sediment sample conservation conditions

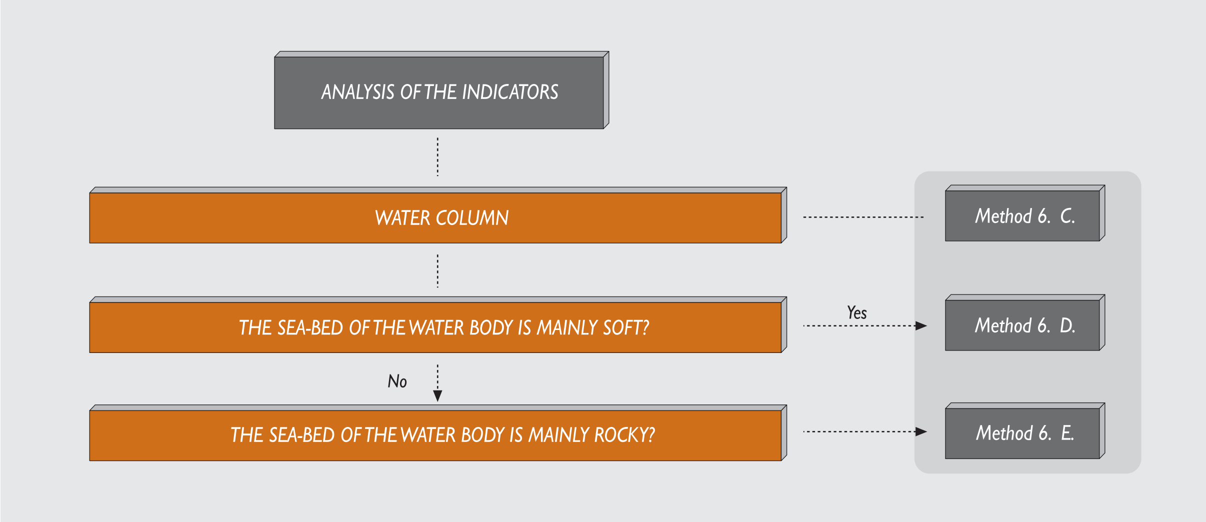
Indicators	Type of recipient (1)	Conservation Technique	Maximum conservation time recommended before analysis
WATER COLUMN INDICATORS			
Oxygen saturation (*)	V	Set the oxigen *in situ* and store in dark	4 days maximum
Turbidity (*)	P or V	Refrigeration between 2 and 5°C	24 h
Chlorophyll 'a' (*)	P or V	Refrigeration at 4°C	24 h
		Filtering and freezing of filters	3 weeks
Detergents	V	Refrigeration	48 h
Total Hydrocarbons	Glass recipient washed with dissolvent (for example, pentane) used for the extraction	–	2 h
	V	Acidification at pH < 2 with hydrochloric acid and refrigeration between 2 and 5°C.	28 days
SOFT BED INDICATORS			
Total organic carbon	P or V	Freezing at (–20°C)	28 days
Kjeldahl Nitrogen	P or V	Freezing at (–20°C)	28 days
Total phosphorous	V	Freezing at (–20°C)	28 days
Mercury	P or V	Refrigeration (4°C) or freezing up to (-18°C).	28 days
Heavy Metals (except mercury)	P or V	Refrigeration (4°C) or freezing up to (–18°C)	Up to 6 months refrigeration, up to 2 years freezing
PAH	V	Refrigeration at 4°C	28 days
PCB	V	Freezing at (–20°C)	7 days
		Extraction and refrigeration of the extract at 4°C	40 days

(1): P: Plastic (Polyethylene PTFE, PVC, PET); V: Glass; VB= Borosilicate Glass. Source: Standard ISO 5667-3: 2003
(*): When requiring sampling at points for the calibration of measuring techniques *in situ*.

6.2. Method for the analysis of ecological status and ecological potential indicators

The method of analysis of the ecological status and ecological potential indicators of the water bodies will be established on the basis of the following diagram.

Figure 6.2.III. ***Methodological stages in the analysis of the ecological status and ecological potential indicators***



METHOD 6.C. ANALYSIS OF THE ECOLOGICAL STATUS AND ECOLOGICAL POTENTIAL INDICATORS OF THE WATER COLUMN

For the analysis of the ecological status and ecological potential indicators of the water column, the method of analysis established in the Community Directives on the quality of the water environment can be used as a reference. Table 6.2.III. includes some of these Directives.

Table 6.2.III. ***Analytical Techniques established by Community Directives***

Ecological status and ecological potential indicators	Community Directives (*)	Method of analysis
Oxygen saturation	76/160/EC, 79/923/EC 78/659/EC, 80/778/EC	Electro-chemical Method Calibration with Winkler Method
Turbidity	–	–
Chlorophyll 'a'	–	–
Detergents (surfactants)	76/160/EC	Absorption Spectrophotometry with methylene blue
Total Hydrocarbons (dissolved or emulsioned)	80/778/EC	Infrared Absorption Spectrophotometry

(*): Council Directive 76/160/EC, of 8 December, 1975, on quality of bathing waters.
Council Directive 78/659/EC, of 18 July, 1978, on quality of continental waters requiring protection or improvement to be apt for fish life.
Council Directive 79/923/EC, of 30 October, 1979 on quality required of waters for the breeding of molluscs.
Council Directive 80/778/EC of 15 July, 1980, on the quality of waters intended for human consumption.

As a complement to the above methods, other internationally recognised standards establishing specific methods of analysis may be used (ISO, Standard Methods, U.S. EPA) (Table 6.3.III.).

Table 6.3.III. Analytical techniques established by ISO standards and by the Standard Methods for the analysis in water of the ecological status and ecological potential indicators

Ecological status and ecological potential Indicators	Method 6.C	
	ISO Standards	Standard Methods
Turbidity	ISO. 7027: 1999. Water quality. Determination of turbidity	Method 2130 B. Nephelometric Method
Chlorophyll 'a'		Method 10200 H. Espectrometric Method of ultraviolet-visible molecular absorption
		Method 10200 H. Fluorometric Method

METHOD 6.D. ANALYSIS OF ECOLOGICAL STATUS AND ECOLOGICAL POTENTIAL INDICATORS OF SOFT BOTTOMS

Table 6.4.III. shows the ISO standards and the method of the last version of the "Standard Methods" proposed for carrying out the determinations required in the present Recommendation.

Tabla 6.4.III. Analytical techniques established by ISO standards and Standard Methods for the analysis in water and in sediments of ecological status and ecological potential indicators. PCB: Polychloride biphenyls. PAH: Polycyclic Aromatic Hydrocarbons.

Ecological status and ecological potential Indicators	Method 6.D	
	ISO Standards	Standard Methods
Total Organic Carbon	ISO 10694:1995. Soil quality – Determination of organic and total carbon after dry combustion (elementary analysis)	Method 5310 D. Wet combustion Method.
Total Kjeldahl Nitrogen	ISO 11261:1995. Soil quality – Determination of total nitrogen – Modified Kjeldahl method	Method 4500 Norg B.Kjeldahl Method
Total Phosphorous		Method 4500 P. Automised reduction Method with ascorbic acid
Heavy Metals	ISO 11047:1998. Title: Soil quality – Determination of cadmium, chromium, cobalt, copper, lead, manganese, nickel and zinc - Flame and electrothermal atomic absorption spectrometric methods ISO	*Metals*: Method3111 B, 3111 C. Atomic absorption Spectrometry Method
		Arsenic: Method 3500 As B. Atomic absorption Spectrometry Method with electrothermal atomisation
		Mercury: Method 3112. Atomic absorption Spectrometry Method using cold steam
PCB		Method 6431 B. Solid-liquid extraction Method. Gas Chromatography
PAH HPLC/GC-MS	ISO 18287:2006. Soil quality — Determination of polycyclic aromatic hydrocarbons (PAH) – Gas chromatographic method with mass spectrometric detection (GC-MS).	Method 6440 B. Solid-liquid extraction Method. High Performance Liquid Chromatography (HPLC)

METHOD 6.E. ANALYSIS OF THE ECOLOGICAL STATUS AND ECOLOGICAL POTENTIAL INDICATORS OF HARD-BOTTOMS

Given the lack of any standards for the assessment of this indicator, a standardised method is proposed which is summarised in the following stages:

1. Establish the characteristic communities of the various depth levels of the cross-section for the species in question. To do this, the scientific information available on each biogeographical region should be revised or experts on the subject should be consulted.
2. Define the extension of the sections representative of each depth level, establishing a location system (GPS, submerged buoys…) for successive assessments.
3. Go along each section, either on foot (intertidal) or using divers (subtidal), making note of the coverages corresponding to each of the characteristic communities present, and the total coverage of the section.

Part IV

Data Sources and References of Interest

DATA SOURCES AND REFERENCES OF INTEREST

Part IV

1. DATA SOURCES AND REFERENCES OF INTEREST

The following sections detail, for each programme proposed in the ROM, some of the most important data sources for its application, as well as a set of relevant Scientific/Technological references.

1.1. Characterization of the water bodies programme

1.1.1. Delimitation of uses in aquatic environment

SOURCES FOR PORT USES. INSTRUMENTS FOR REGULATION OF THE USE OF PORT AREAS

- Spanish Law 48/2003, of 26th November, of the economic regime and provision of services in ports of general interest. (Spanish Official State Bulletin (BOE) Nº 284 of 27/11/2003).
- Plan of Use of Port Areas (or equivalent instrument).
- Special Regulation Plan of the geographical area of jurisdiction (or equivalent instrument).

SOURCES FOR NON-PORT USES

- Coastal Regulation Plan (or equivalent instrument).
- Designated zones for protection of economically significant species.
  - APA/1029/2003, of 23rd of April, for publishing the new designation of mollusc and marine invertebrate production zones on the Spanish coast. (BOE Nº 103 of 30/04/2003).
  - The Ministry of Agriculture, Fisheries and Food, as well as the competent regional authorities for each Autonomous Community, have all the information relating to the fishing zones and shell fish production zones around the Spanish coast.
- Conservation of habitats or species (Site of Community Importance – Special Protection Area, etc).
  - Decision of the Commission of 28th of December 2001, approving the list of areas of Communitarian importance with regard to the Micronesia biogeographical region, in application of the Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (DOCE Nº 5 of 9/01/2002).
  - Decision of the Commission of 7th December of 2004 approving, in accordance with the Directive 92/43/EEC of the Council, the list of areas of communitarian importance of the Atlantic biogeographical region (DOCE Nº 387 of 29/12/2004).
  - The Ministry of the Environment has a database of nature which lists the Spanish nature areas whose characteristics have deserved the protected status. Information is available in the Ministry's Web Page.
  - The Ministry of Agriculture, Fisheries and Food has a list of the marine Reserves on the Spanish coast.
- Sensitive zones with relation to the Directive 91/271/EEC. (Concerning urban wastewater treatment).
- Vulnerable zones with relation to the Directive 91/676/EEC. (On nitrates from agricultural sources).
- Recreational zones. (Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality).

- The Ministry of the Environment has developed a "Guide to Spanish beaches" (available on its Web Page) which lists all the beaches on the Spanish coast.

1.1.2. *Characterization of water bodies*

Geophysical Sources

- Hydrographical Institute of the Navy. 1999. Nautical charts. Ministry of Defence.
- General Coastal Administration. Marine Geophysical Studies carried out in Spain. Ministry of the Environment.

Meteorological Sources

- National Meteorological Institute. Ministry of the Environment.
- Spanish State Ports. 1991. ROM 0.3-91. Atlas of Maritime Climate on the Spanish coast. Ministry for Development.
- Spanish State Ports. 1995. ROM 0.4-95. Climatic Actions II. Wind. Ministry for Development, 249 pp.
- Spanish State Ports Oceanographic database. Network of port meteorology REMPOR.
- NCDC, NCAR, ERL. 1954-1992. COADS. Comprehensive Ocean Atmosphere Data Set.
- U. S. Navy. 1969-1984. World Marine Climatological Atlas.
- UK Meteorological Office. From 1986. Winds UKMO.
- FNOC Fleet Numerical Oceanography Center. 1946-1994. Winds, pressures and temperatures.
- NODC-NOAA. 1900-1990. Temporal Series of Oceanographic Stations and Campaigns.
- NODC-NOAA. Global Climatological Atlas, Seasonal and Annual Analyses. Levitus.
- Isemer & Hasse, Institut für Meereskunde, Kiel University. BUNKER Climatological Atlas of the Atlantic Ocean.

Oceanographic Sources

- Spanish State Ports. REMRO coastal wave network. Ministry for Development.
- Spanish State Ports. Deep-water wave network. Ministry for Development.
- Spanish State Ports. Radar network. Ministry for Development.
- Spanish State Ports. Current meter network. Ministry for Development.
- Spanish State Ports. REDMAR. Tidal graph network. Ministry for Development.
- Sea levels. TOGA Sea Level Center. Ministry for Development.

Bathymetric Sources

- Hydrographical Institute of the Navy. 1999. Nautical charts. Ministry of Defence.
- General Coastal Administration. Marine Geophysical Studies carried out in Spain. Ministry of the Environment.
- NGDC-NOA. Global bathymetry with a resolution of 5 minutes.

1.2. Environmental risks assessment and management programme

1.2.1. Characterization of contaminant emissions

Public Information sources

- Ministry of the Environment. State register of pollutant emissions and sources.
- OSPAR. Data Report on the Comprehensive Study of Riverine Inputs and Direct Discharges (RID).
- Discharge permits.

Sources for quantitative characterization

- AINIA Agriculture/Food Technology Institute. Best available techniques for different types of industry.
- European Commission. Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques.
- General Environmental Administration. 2000. Document for orienting the performance of the EPER. European Commission. 103 pp.
- EPA. Chemical Specific Guidance Documents. Documents relating to different types of chemical substances.
- EPA. Industry Specific Guidance Documents. Documents relating to industrial processes.
- EPA. 2001. Guidance for Reporting Releases and Other Waste Management, Quantities of Toxic Chemicals: Lead and Lead Compounds. 216 pp.
- "Entorno" Foundation. Technological guides. List of documents relating to distinct industrial processes.
- HELCOM. 1999. Guidelines for the fourth Baltic Sea Pollution Load Compilation (PLC-4). Baltic Marine Environment Protection Commission.
- Ministry of the Environment. 2003. Guide to Available Technical Improvements in Cement Manufacture in Spain. 129pp.
- National Pollutant Inventory. Australian Government. List of documents relating to industrial manufacturing activities.
- OSPAR. Norwegian Pollution Control Authority. Documents quantifying the pollution by chemical substances.

- Pollution Inventory Report, 2004. Combustion Activities Guidance Note. Environmental Agency Pollution. 38 pp.

- Pollution Inventory Report, 2004. Guidance for landfill operators. Environmental Agency Pollution. 6 pp.

- Pollution Inventory Report, 2004. Guidance for operators carrying out chemical treatment of waste, including waste oil. Environmental Agency Pollution. 6 pp.

- Pollution Inventory Reporting. 2004. Guidance for operators of waste transfer stations. Environmental Agency Pollution. 11 pp.

- Spanish State Register of Pollutant Emissions and Sources. Orientation document for the Glass Sector. Ministry of the Environment. 94 pp.

- Spanish State Register of Pollutant Emissions and Sources. Orientation document for the Paste and Paper Sector. Ministry of the Environment. 94 pp.

- Spanish State Register of Pollutant Emissions and Sources. Orientation documents for calculating emissions on farms. Ministry of the Environment. 4 pp.

- V. Uloth, R. van Heek, P. George. 2002. Dioxin and Furan Emission Factors for Combustion Operations in Pulp Mills. Canadian Environmental Protection. 25 pp.

- V. Uloth, T. Whithford, R. van Heek, P. George. 2002. Dioxin and Furan Emission Factors for Wood Waste Incinerators. Canadian Environmental Protection. 32 pp.

- World Bank Group. Pollution Prevention and Abatement Handbook. Project guidelines. Industry sector guidelines. Documents relating to different industrial activities.

Sources for the specific data-taking campaigns

- European commission. 2002. Integrated Pollution Prevention and Control (IPPC) Reference Document on the General Principles of Monitoring. 123 pp.

- Spanish State Register of Pollutant Emissions and Sources. Ministry of the Environment Measurement methods for chemical and Physical chemical variables in water.

Sources of the flow rates of agricultural run-off

- OSPAR. Guideline HARP. Documents for quantification of Nitrogen and Phosphorous.

1.2.2. Sources for the proposal of preventive and corrective measures

Community Norms

- Order of 18th of December 2001, establishing the instructions for presentation of the loading manifest for maritime traffic.

- Order FOM 3056/2002, of 29th November, establishing the integrated procedure for docking of ships in ports of general interest.

- Spanish Law 995/2003, of 25th July, establishing the combined requisites and procedures for the loading and unloading operations of grain carrying ships.

- Spanish Law 1249/2003, of 3rd of October, about information formalities required from merchant ships arriving at or leaving from Spanish ports.
- Directive 2004/35/EC CE of the European Parliament and of the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage.

Documents of interest

- ABP mer. 1999. Good practice guidelines for ports and harbours operating within or near UK European Marine sites. 184 pp.
- American Association of Port Authorities (AAPA). Environmental Management Handbook. Documents about best environmental practice in different types of activities.
- CIRIA. 1999. Safety in ports ship-to-shore links and walkways. A guide to procurement, operation and maintenance.
- European commission. 1999. European Code of Conduct for Coastal Zones. 98 pp.
- Department of the Environment, Food and Rural Affairs. 2002. Safeguarding our seas. A strategy for the conservation and sustainable development of our marine environment. United Kingdom Government. 82 pp.
- Department of Transport-Ports. 2003. A guide to good practice on port marine operations. United Kingdom Government. 93 pp.
- Department of Transport-Ports. 2003. Modern Ports- A UK policy. United Kingdom Government. 49 pp.
- Department of Transport-Ports. 2004. Port Marine Safety Code. United Kingdom Government. 37 pp.
- Public Company of Ports of Andalucia. 1995. Regulations of Police, Regulations and Services of the Ports of the Autonomous Community of Andalusia. 15 pp.
- European Sea Ports Organisation. 2003. Environmental code of practice. 36 pp.
- European Sea Ports Organisation. 2004. Overview of EU & international environmental rules & policies which affect the port sector. Annex to the Environmental Code of Practice of ESPO (European Sea Ports Organisation). 27 pp.
- IMO. 2003. Code of practice of safety for loading and restraining of loads. 118 pp.
- Maritime and Coastguard Agency. 2003. Port waste management planning-A guide to good practice. 15 pp.
- NetRegs. Construction work at harbours and docks. Environment Agency.
- UK Marine SACs Project. 1999. Good practice guidelines for ports and harbours operating within or near UK European marine sites. Joint Nature Conservation Committee, 218 pp.
- Wallingford Ltd & Ports. 1996. Guidelines for the beneficial use of dredged material.
- Wallingford Ltd & Ports. 1999. Environmental aspects of aggregate dredging: refined source terms for plume dispersion studies.
- Wallingford Ltd & Ports. 1999. Feasibility of decontaminating dredged materials.
- Wallingford Ltd & Ports. 1999. Guidelines for Port Environmental Management.

1.3. Programme of environmental monitoring

1.3.1. Measurement of the indicators of chemical quality and ecological status and ecological potential

Sampling Techniques

- Australian Government. 2000. Monitoring and assessment. In: Australian and New Zealand Guidelines for Fresh and Marine Water Quality. The Guidelines. Vol. 1. Chap.7. 42 pp.
- A.D McIntyre, J.M Elliot, D.V. Ellis. 1984. Introduction: Design of sampling programmes. In: Methods for the study of marine benthos. Blackwell Scientific publications. 1-27 pp.
- A.R.O. Chapman. 1986. Population and ecology of seaweeds. In: Advances in Marine Biology. Academic Press, 1-161 pp.
- European Environmental Agency. 1999. Surface water quality monitoring. National Environment Research Institute, Denmark.
- U.S. EPA. 2001. National Coastal Assessment. Field Operations Manual. 77 pp.
- U.S. EPA. 1997. Recommended guidelines for sampling marine sediment, water column, and tissue in Puget Sound.
- U.S. EPA. 2002. Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. 32 pp.
- Green, R.H. 1979. Sampling design and statistical methods for environmental biologists. Wiley. New York.
- HELCOM. 2001. General Aspects. In: Manual for marine monitoring in the Combined Programme of HELCOM.
- HELCOM. 2001. Programme of monitoring of contaminants and the effects of contaminants. In: Manual for marine monitoring in the Combined Programme of HELCOM.
- HELCOM. 2001. Programme of monitoring of eutrophication and its effects. In: Manual for marine monitoring in the Combined Programme of HELCOM.
- Marine Biodiversity Monitoring Committee. 1999. Protocol for monitoring of seaweeds. In: Marine and Estuarine Biodiversity Monitoring Protocols. 31 pp.
- Norm ISO 5667-1:1980. Water quality. Sampling. Part 1. Guidance on the design of Sampling Programmes
- Norm ISO 5667-2:1995. Water quality. Sampling. Part 2. Guidance on Sampling Techniques.
- Norm ISO 5667-3:2003. Water quality. Sampling. Part 3. Guidance on the preservation and handling of water samples.
- Norm ISO/TR 13530:1997. Water quality. Guide to analytical quality control for water analysis.
- OSPAR. 1997. JAMP (Joint Assessment and Monitoring Programme) eutrophication monitoring guidelines: Nutrients, Oxygen, Chlorophyll 'a'.
- OSPAR. 2002. Guidelines for monitoring contaminants in sediments.
- Phycological Society of America. 1985. Competition among macroalgae. In: Hand book of phycological methods. Ecological field methods: macroalgae. Cambridge University Press. 511-530 pp.

- Phycological Society of America. 1985. Remote sensing and mapping. In: Hand book of phycological methods. Ecological field methods: macroalgae. Cambridge University Press. 177-197 pp.

- Salm, R.V. and J.R. Clark. 1984. Marine and Coastal Protected Areas: a guide for planners and managers. IUCN. Gland. Switzerland. 302 pp.

- UK Marine SACs Project. 2001. Marine Monitoring Handbook. Joint Nature Conservation Committee, 405 pp.

- World Bank Group. 1998. Pollution Prevention and Abatement Handbook. Monitoring Environmental Quality, 7 pp.

- World Bank Group. 1998. Pollution Prevention and Abatement Handbook. Part II Implementing policies in practice: Indicators of Pollution Management, 11 pp.

Analytical Techniques

- APHA, AWWA, WEF. 2000. Standard Methods for the Examination of Water and Wastewater: 5540-C, 5520-F, 10200-H, 2130, 4500-O, 4500-P F, 6431. 6630 B, 3030. 3120. 3111 B. 3112 B. 3113.

- EPA. 1995. Environmental monitoring and assessment program (EMAP) laboratory methods manual. Estuaries. Volume 1 - biological and physical analyses. 128 pp.

- EPA Drinking Water Methods for Chemical Contaminants. Methods: 550, 550.1, 180.1. Rev 2.0.

- HELCOM. 2001. General guidelines on quality assurance for monitoring in the Baltic Sea. In: Manual for marine monitoring in the Combined Program of HELCOM.

- K.J.M. Kramer, U.H. Brockmann, R.M. Warwick. 1994. Tidal estuaries. Manual of sampling and analytical procedures. A.A. Balkema/Rótterdam/Brookfield, pp 87,145, 163, 167, 169.

- Norm ISO 11047:1998. Title: Soil quality. Determination of cadmium, chromium, cobalt, copper, lead, manganese, nickel and zinc. Flame and electrothermal atomic absorption spectrometric methods.

- Norm ISO 11261:1995. Soil quality. Determination of total nitrogen. Modified Kjeldahl method.

- Norm ISO 18287:2006. Soil quality. Determination of polycyclic aromatic hydrocarbons (PAH). Gas chromatographic method with mass spectrometric detection (GC-MS).

- Norm ISO 10694:1995. Soil quality. Determination of organic and total carbon after dry combustion (elementary analysis).

- Norm ISO 5813:1983. Water quality. Determination of dissolved oxygen. Iodometric method.

- Norm ISO 5814:1990. Water quality. Determination of dissolved oxygen. Electrochemical probe method.

- Norm ISO 10695:2000. Water quality. Determination of selected organic nitrogen and phosphorus compounds. Gas chromatographic methods.

- Norm ISO 11885:1998. Water quality. Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy.

- Norm ISO 7875-1:1996. Water quality. Determination of surfactants. Part 1: Determination of anionic surfactants by measurement of the methylene blue index (MBAS).

- Norm ISO 10301:1997. Water quality. Determination of highly volatile halogenated hydrocarbons. Gas-chromatographic methods.

- Norm ISO 15680:2003. Water quality. Gas-chromatographic determination of a number of monocyclic aromatic hydrocarbons, naphthalene and several chlorinated compounds using purge-and-trap and thermal desorption.

- Norm ISO 7027:1999. Water quality. Determination of turbidity.

- Norm ISO 6468:1996. Water quality. Determination of certain organochlorine insecticides, polychlorinated biphenyls and chlorobenzenes. Gas chromatographic method after liquid-liquid extraction.

- Norm ISO 17993:2002. Water quality. Determination of 15 polycyclic aromatic hydrocarbons (PAH) in water by HPLC with fluorescence detection after liquid-liquid extraction.

1.3.2. Analysis of chemical quality, ecological status and ecological potential

- Community Norms

  - Decision Nº 2455/2001/EC of the European Parliament and of the Council of 20 November 2001 establishing the list of priority substances in the field of water policy and amending Directive 2000/60/EC (Text with EEA relevance).

  - Council Directive 86/280/EEC of 12 June 1986 on limit values and quality objectives for discharges of certain dangerous substances included in List I of the Annex to Directive 76/464/EEC.

  - Council Directive 83/513/EEC of 26 September 1983 on limit values and quality objectives for cadmium discharges. Council Directive 84/491/EEC of 9 October 1984 on limit values and quality objectives for discharges of hexachlorocyclohexane.

  - Council Directive 84/156/EEC of 8 March 1984 on limit values and quality objectives for mercury discharges by sectors other than the chlor-alkali electrolysis industry.

  - Council Directive 82/176/EEC of 22 March 1982 on limit values and quality objectives for mercury discharges by the chlor-alkali electrolysis.

  - Council Directive 88/347/EEC of 16 June 1988 amending Annex II to Directive 86/280/EEC on limit values and quality objectives for discharges of certain dangerous substances included in List I of the Annex to Directive 76/464/EEC.

  - Council Directive 90/415/EEC of 27 July 1990 amending Annex II to Directive 86/280/EEC on limit values and quality objectives for discharges of certain dangerous substances included in list I of the Annex to Directive 76/464/EEC.

- International Norms

  - Canadian Council of Ministers of the Environment. 2002. Summary of Existing Environmental Quality Guidelines.

  - OSPAR. 1997. Agreed background/reference concentrations for contaminants in sea water, biota and sediment.

  - EPA. 2002. National Recommended Water Quality Criteria.

- UK Marine SACs Project. 1997. Environmental Quality Guidelines. Joint Nature Conservation Committee.

Quality criteria for the analysis of the ecological status and ecological potential

- Australian Government. 2000. Sediment quality guidelines. In: Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Aquatic ecosystems. Vol. 2. Chap. 8.4. 30 pp.
- Australian Government. 2000. Toxicants. In: Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Aquatic ecosystems. Vol. 2. Chap. 8.3. 100 pp.
- California Environmental Protection Agency. 2001. Water quality control plan.
- Canadian Council of Ministers of the Environment. 2002. Summary of Existing Environmental Quality Guidelines.
- CEDEX. 1994. Recommendations for the Management of dredged material in Spanish ports. Ministry for Public Works, Transport and the Environment.
- Council Directive 76/160/EEC of 8 December 1975 concerning the quality of bathing water.
- Council Directive 79/923/EEC of 30 October 1979 on the quality required of shellfish waters.
- EPA. 2003. Screening Values for Chemicals. In: National Sediment Quality Survey. 19 pp.
- EPA. 2000. Ambient Aquatic Life Water Quality Criteria for Dissolved Oxygen (Saltwater): Cape Cod to Cape Hatteras. 55 pp.
- Ministry of Supply and Services of Canada. 1992. Guidelines for Canadian recreational water quality.
- Ministry of water, land and air protection. Government of British Columbia. Water Quality Guidelines. Quality criteria of distinct chemical and physical-chemical variables.
- Netherlands Ministry of Housing, Spatial Planning and Environmental. Directorate-General for Environmental Protection. 1994. Circular on intervention values for soil remediation.
- NOAA. 1999. Sediment quality guidelines developed for the national status and trends program. 12 pp.
- NOAA. 1999. United States national estuarine eutrophication assessment.
- UK Marine SACs Project. 1997. Environmental Quality Guidelines. Joint Nature Conservation Committee.

Data sources

- Community Organisms
  - European Environmental Agency. European Environment Information and Observation Network (EIONET).
    - WATERBASE database. Information related to the quality and quantity of continental and marine waters.
    - EUROWATERNET Programme. Programme of data collection and validation of the Member States.
    - EUNIS. European system of information about spaces and species.
    - WASTEBASE Database. Information about wastewaters and their management.
  - European Sediment Research Network. SedNet.

- State Organs
  - National Sediment Knowledge Exchange, Intersed, REN2002-11937-E.
  - European Pollutant Emissions Register (EPER). 2001. Ministry of the Environment.
  - Júcar Water Management Board. Júcar River Basin. Pilot Project of the European Water Directive Framework.

Information Documents

- EPA. 2002. Research Strategy Environmental Monitoring and Assessment Program. 77pp.
- IAPH. 1991. Guidelines for Environmental Planning and Management in Ports and Coastal Area Developments. The International Association of Ports and Harbours, Tokyo, Japan. 89 pp.
- PIANC. 1999. Environmental management framework for ports and related industries.
- PIANC. 2003. Ecological and engineering guidelines for wetlands restoration in relation to the development and maintenance of navigation. 57 pp.
- PIANC.1999. Environmental management framework for ports and related industries.
- UK Marine SACs Project. 1999. Guidelines for managing water quality impacts within UK European marine sites. Joint Nature Conservation Committee, 443 pp.
- UK Marine SACs Project. 1999. Guidelines for managing water quality impacts within UK European marine sites. Joint Nature Conservation Committee, 443 pp.
- UK Marine SACs Project. 2001. Natura 2000. European Marine Sites - ecological sensitivity and management requirements. Joint Nature Conservation Committee.
- UK Marine SACs Project. 2001. Natura 2000. European Marine Sites - ecological sensitivity and management requirements. Joint Nature Conservation Committee.

1.3.3. Protected zones

- **Recreational Zones.** The Ministry of Health makes available publicly the results of the analysis of bathing water quality carried out in the Spanish beach areas in 2001. The raw data can be obtained from the Department of Health of each Regional Community.
- **Zones designated for the protection of aquatic species of economic relevance.** The Ministry of Agriculture, Fisheries, as well as the competent departments of each regional community can provide the information collected in the Monitoring and Control Programmes carried out in the zones used for fishing, or production or extraction of aquatic species.
- **Sensitive/vulnerable Zones.** The Ministry of the Environment and the competent Departments of each regional community can provide the information relating to the zones catalogued as sensitive to urban waste discharges and vulnerable to the contamination produced by nitrates used in agriculture.
- **Conservation of habitats or species.** The Ministry of the Environment and the autonomous communities are competent in the control and follow-up in the Protected Zones.

1.4. Programme of contaminant events management

- IMO. 1988. Hydrocarbon pollution manual IV: Combating hydrocarbon spills. 216 pp.
- IMO. 1995. Manual on oil pollutants section II. Contingency planning. 70 pp.
- IMO. 2000. OPRC-HNS. Protocol on preparedness, response and co-operation to pollution incidents by hazardous and noxious substances. 26 pp.
- IMO. 2003. Guidelines for the elaboration of on-board emergency plans against contamination of the sea. 58 pp.
- Maritime and Coastguard Agency. 2002. Contingency Planning for Marine Pollution Preparedness and Response. Guidelines for Ports. 72 pp.
- P. Nelson. Australia's National Plan to combat pollution of the sea by oil and other noxious and hazardous substances- Overview and current issues. Spill Science & Technology Bulletin 6, 3-11.
- Port of Tilbury London. 2002. Oil spill contingency plan.
- Port of Tilbury London. 2002. Port waste management plan. 71 pp.

1.5. References of interest

- Norm UNE 150008:2000. Analysis and assessment of environmental risks. Spanish Association for Norms and Certification.
- Norm UNE 150103:2004. Environmental Management Systems. Guide for the implementation of environmental management systems in accordance with UNE-EN ISO 14001 in port environments and additional requisites for the registry in the EMAS regulation.