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Agenda item 7: Technical Guidelines and related Assessments

Updated Guidelines on Management of Dredged Materials

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UNEP/MAP
Athens, 2017

Explanatory Note by the Secretariat

1. The Contracting Parties to the Barcelona Convention at their 19th meeting in Athens, Greece, in 2016 requested the Secretariat to undertake a review of the implementation of the technical guidelines adopted by COP13 under Articles 5 and 6 of the Dumping Protocol to the Barcelona Convention.

2. In view of ensuring synergies, where appropriate, with the London Dumping Protocol which recently issued new/updated generic and specific guidelines, COP19 also requested the Secretariat to update the respective guidelines taking into account the specificities of the Mediterranean region, the status of the implementation of the Dumping Protocol to the Barcelona Convention as well as the need to ensure a full streamlining of GES and its targets based on the ecosystem approach.

3. In this respect, the Secretariat (MED POL Programme) has worked in two main directions

a) to undertake a simple assessment of dumping activities in the Mediterranean based on the information provided by the Contracting Parties in their reports on measures taken for the implementation of the Dumping Protocol (2005-2013)
b) to draft an updated version of the 1999 MAP/MED POL guidelines on the management of dredged materials

4. The updated guidelines composed of two parts A and B consist of the following:

a) Part A, addressing assessment and management of dredged material, has 7 sections.

b) Sections 1,2,3,4, and 5 have some textual changes aiming to take into consideration and streamline relevant developments in the MAP legal framework namely the roadmap for implementing the ecosystem approach, the operational objectives, GES definitions and related targets, as well as the Regional Plan on the Management of Marine Litter in the Mediterranean adopted by Decision IG.21/7 COP 18, 2013[1]. The decision-making process has been updated to integrate the basic concept of these updated guidelines which is favoring beneficial use before granting a dumping permit.

c) Section 6 is new, and includes issues to be taken into consideration before taking any decision to grant a dumping permit, addressing beneficial uses of dredged materials which aim to facilitate the application of the provisions of Dumping Protocol considering a new approach to reduce the contamination of the marine ecosystem by dumping of dredged material. In this respect, the updated guidelines recommend the Contracting Parties to limit, as much as possible dumping activities and give priority to beneficial use of dredged materials. The information provided, in this context, is collected and streamlined from different sources which are all cited in the references chapter. Section 6 also integrated the Sections 6 and 7 of the original guidelines, with some additions.

d) Section 7 is a new section providing information on the treatment options for dredged material, including confined disposal and other treatment technologies.
d) Section 8 is an amended and enriched text of Annex III and IV of the original guidelines addressing Best Environmental Practices (BEP) of dumping of dredged material. In the same spirit of section 6 and in view of limiting as much as possible the contamination of marine environment from dumping, this section provides exhaustive information on BEP's to reduce the contaminants prior to their dumping.

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[1] The sciences of physical and chemical characterization of marine sediments did not exhibit drastic changes except for the instrumental technology used to analyse the sediments, therefore sections 4 and 5 were not subject to major updating. It has also to be noted that the Contracting Parties since 1999 have acquired the knowledge and the know-how related to characterization and normalization procedures and other analytical techniques.

e) Part B, addressing monitoring of dredged materials dumping operations, is almost the same as Part B of the original guidelines. This part is defining the outline for the development of national monitoring programmes for dumping sites before and after dumping in the framework of IMAP and MEDPOL Monitoring Programme in line with IMAP Decision (IG 22/7, COP 19, 2016) as well as the outline for the assessment of the validity of impact hypothesis.

5. It should be noted that the technical annexes 1 and 2 to the previous Guidelines for the Management of Dredged Material (UNEP(OCA)/MED IG.12/4) are maintained.

6. The Secretariat has also prepared an issue paper as an information document on the possibility to consider complementary approaches to enhance environmental protection from dumping activities. The issue paper introduces the concept of adopting at regional level Upper Thresholds Values, National List of contaminants and National Action Levels for selected trace metals and persistent organic pollutants for dredged materials subject to re suspension, dumping, and relocation with proposed associated national action levels of concentration.

7. The version of the Guidelines presented in the document takes into consideration comments and revisions made during the Regional Meeting of Experts to review the Draft Desalination and Dumping Protocol Guidelines, held in Loutraki, Greece, on 4-6 April 2017, as well as comments and inputs of the MED POL Focal Points, submitted to the Secretariat after the Meeting of Experts.

8. With regards to the comments received from the MED POL Focal Points after the Meeting of Experts (Loutraki, 4-6 April 2017), the Secretariat reviewed them, accepted those that were in line with the discussions held during the Meeting and included in the text in square brackets with an explanatory footnote, those changes/proposals that go beyond the issues discussed by and agreed upon during the Meeting for the consideration of the MED POL Focal Points meeting in May 2017.

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List of Abbreviations / Acronyms

BEP	Best Environmental Practice
Cd	Cadmium
CDF	Confined Disposal Facility
COP	Conference of the Parties
Cu	Copper
Cr	Chromium
DGPS	Differential Global Positioning System
EIA	Environmental Impact Assessment
GES	Good Environmental Status
Hg	Mercury
IMAP	Integrated Monitoring and Assessment Programme
MAP	Mediterranean Action Plan
MED POL	Programme for the Assessment and Control of Marine Pollution in the Mediterranean Sea
MPA	Marine Protected Area
Ni	Nickel
PAH	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PCBs	Polychlorobiphenyls
Sn	Tin
SPAMI	Specially Protected Areas of Mediterranean Importance
Zn	Zinc

Introduction

1. Dredging activities are an essential part of port and harbour activities. Two main dredging categories can be distinguished:

a) Capital dredging, mainly for navigational purposes, to enlarge or deepen existing channel and port areas, or to create new ones; this type of dredging activity also includes some technical activities on the seabed such as trenches for pipes or cables, tunneling, removal of material unsuitable for foundations, or removal of overburden for aggregate extractions;

b) Maintenance dredging, to ensure that channels, berths or construction works are maintained at their designed dimensions.

In addition, other dredging operations such as:

c) Dredging to support coastal protection or management: relocation of sediments for activities such as beach nourishment and construction of levees, dykes, jetties, etc.

d) Environmental dredging: to remove contaminated sediment for the purpose of reducing risks to human health and the environment; construction of confined aquatic disposal cells to hold contaminated sediments.

e) Restoration dredging: to restore or create environmental features or habitats in order to establish ecosystem functions, benefits, and services, e.g. wetlands creation, island habitat construction and nourishment, construction of offshore reefs, and topographic features for fisheries enhancement, etc.;

f) Dredging to support local and regional sediment processes: includes engineering to reduce sedimentation (e.g. construction of sediment traps), retaining sediment within the natural sediment system to support sediment-based habitats, shorelines and infrastructure.

2. All these activities may produce large quantities of material that have to be managed in an environmentally sound manner including their beneficial use, disposal, confinement or treatment. In the case of disposal at sea, it should be ensured that adverse impacts on the marine and coastal ecosystems of the Mediterranean do not occur.

3. It must be also recognised that dredging operations as such may harm the marine environment, especially when they take place in the open sea close to sensitive areas (key habitats, SPAMIs, Marine Protected Areas (MPAs), aquaculture areas, recreational areas, etc.). This is the case in particular when dredging operations have a physical impact (increased turbidity) or lead to the re-suspension or the re-releasing of major pollutants (heavy metals, organic or bacterial pollutants and nutrients).

4. Dredging operations may result in the re-mobilization of pollutants contained in the sediments and their suspension, which may, at certain levels, have an adverse impact on the environment, either at sea during dredging or capping when these sediments are submerged, or on land when these sediments are stored. Dredging can also result in hydromorphological, sedimentologic and hydrographic changes to dredged areas and have a more global impact on disposal sites or onshore management.

5. In the above context, the Contracting Parties are urged to exercise control over dredging operations in parallel with that exercised over dumping. Beneficial uses and use of Best Environmental Practices (BEP) for dredging activities are essential pre-condition for dumping, in order to dispose on land and/or minimise the quantity of material that has to be dredged and the impact of the dredging and dumping activities in the maritime area.

6. On the other hand, un-polluted dredged material can have positive environmental effects and externalities. In fact, dredged materials can be integrated, under certain conditions and subject to the existence of a local market, into treatment systems allowing their exploitation, in particular in building materials. They can also be used for beach nourishment in the fight against erosion of the coastline and thus come as an alternative to other more harmful disposal methods. Finally, in the case of sediment pollution, dredging can be a removal solution that decontaminates the marine environment, but with the risk of transferring the problem to the land or being re-dumped to another sea area.

7. The basic principle of these updated Guidelines is that dumping or re-suspension of dredging sediments in the coastal zone of the Mediterranean should be minimized as much as possible, in order to avoid the deterioration of the Good Environmental Status and/or maintain its good status in relation to a number of relevant MAP ecosystem approach based Ecological Objectives and related Operational Objectives and GES targets (1, 2, 2.1, 2.2, 5.1,5.2, 7.1, 7.2, 7.3, 8.1, 9.1,9.2,9.4,10.2) as adopted in 2013 by COP 18 (Decicion IG.21/3). Therefore **beneficial uses and land management should be primarily and ultimately considered before any decision on dumping at sea**.

8. The updated guidelines also provide ample information and links related to land disposal and low cost treatment and disposal options[2].

I. SCOPE OF THE APPLICATION OF THE GUIDELINES

9. Several Articles of the Dumping Protocol[3] provide ground base for the development of the guidelines. Under Article 4.1 of the Protocol, the dumping of waste and other matter is prohibited. Nevertheless, pursuant to Article 4.2 (a) of the Protocol, this principle may be waived and the dumping of dredged material authorized under certain conditions. Under Article 5, dumping requires a prior special permit from the competent national authorities.

10. Furthermore, in accordance with Article 6 of the Protocol, the permit referred to in Article 5 shall be issued only after careful consideration of the factors set forth in the Annex to the Protocol. Article 6.2 provides that the Contracting Parties shall draw up and adopt criteria, guidelines and procedures for the dumping of wastes or other matter listed in Article 4.2 so as to prevent, abate and eliminate pollution. In addition, the Protocol recognizes the importance of on land beneficial uses and BEPs as important steps before granting a dumping permit by relevant authorities.

11. In accordance with Article 9 (8) of the Regional Plan on the Management of the Marine Litter in the Mediterranean, the Contracting Parties should apply by the year 2020 the cost effective measures to prevent any marine littering from dredging activities taking into account the relevant guidelines adopted in the framework of Dumping Protocol of the Barcelona Convention.

12. In this context, the updated Guidelines for the Management of Dredged Materials, provide guidance to the Contracting Parties on the fulfilment of their obligations related to:

(a) the issue of permits for the dumping of dredged material in accordance with the provisions of the Protocol; and Article 9 (8) of the Regional Plan on the Management of the Marine Litter in the Mediterranean
(b) monitoring, sampling and assessment methods consistent with IMAP Decision
(c) transmission to the Secretariat of reliable data on the inputs of contaminants by the dumping of dredged material and other harmful impacts on marine and coastal ecosystems, in line with reporting under the MAP Barcelona Convention.

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[2] In this respect advice is available from a number of international organisations, including the Permanent International Association of Navigation Congresses (PIANC) 1986: Disposal of Dredged Material at Sea (LDC/SG9/2/1). Through its Environmental Policy Framework and close links with industry in developing Cleaner Industrial Production Technologies, the United National Industrial Development Organisation (UNIDO) is able to offer expert advice and training to enhance capabilities to develop an integrated management plan for dredged material.
[3] Amended text of 1995

(d) good dredging, best available practices and equipment
(e) data as regards thresholds and contaminant concentrations in the dredged material

13. The updated guidelines are designed to allow Contracting Parties to manage dredged material without polluting the marine environment. In accordance with Article 4.2 (a) of the Dumping Protocol, these updated guidelines relate specifically to the dumping of dredged material from ships and aircraft. They do not concern either dredging operations or the disposal of dredged material by methods other than dumping.

14. The updated guidelines are presented in two parts. Part A deals with the assessment and management of dredged material, while part B provides guidance on the design and conduct of monitoring of marine dumping sites.

15. The updated guidelines commences with a guidance on the conditions under which permits might be issued. Sections 4, 6 and 7 address the relevant considerations related to the characteristics, composition of the dredged material and priority is given to beneficial uses and low cost treatment of dredged material (part A). In case dumping at sea is to be considered, guidance on the monitoring of the dumping site is provided in part B. The references provide extensive information, among others, on analytical techniques and normalization procedures which could be used by national authorities to implement these updated Guidelines. In addition, the updated Guidelines have three Annexes on:

a) Analytical requirements for the assessment of dredged materials

b) Normalization techniques for studies on the spatial distribution of contaminants

c) Contaminant action levels and thresholds

II. DEFINITION OF TERMS

16. For the purpose of these updated guidelines the following definition of terms apply:

Action levels	Guidance values used to trigger action
Benthic	Relating to, or occurring at the bottom of a body of water.
Bioaccumulation	Accumulation of environmental contaminants in living tissue.
Bioassay	Tests in which organisms are exposed to dredged materials to determine their biological effects or toxicity.
Biological testing	Testing via bioassays.
Biota	Living organisms.
Capital dredging	Capital dredging includes geological material dredged from previously unexposed layers beneath the seabed and surface material from areas not recently dredged.
Clay	Sedimentary mineral particles 0.2 to 2.0 μm in size, usually with a negative charge (anion); the size and charge have profound implications for sediment chemistry and other physical interactions.
Contaminated Dredged Material	Dredged material not meeting national assessment criteria (e.g. exceeding upper action levels).

Dredged material Management	An overarching term describing a variety of handling methods of dredged materials including, inter alia: dumping (deliberate disposal), re-use, beneficial use, re-location, placement, confinement and treatment.
Eco-toxicological Testing	Biological testing via bioassays.
Fractions	Categories of sediments using grain size.
Harbour	Harbours include enclosed and semi-enclosed docks, docks entrances, marinas, wharves and unloading jetties
Maintenance Dredging	Maintenance dredging is the dredging required to maintain berths and navigation channels at advertised depth. It includes material dredged from recently deposited by sedimentation processes in harbour or sea areas
National Action List	List or inventory of dredged material contaminants that Contracting Parties might consider in the permitting process and decision.
National Action Levels	Levels for a particular contaminant concentration below which there would be little concern (lower NALs), or above which there would be concern due to increased risk or increased probability of effects (upper NALs).
Sediment	Naturally occurring material that is produced through the processes of weathering and erosion of rocks, and is subsequently transported by the action of fluids such as wind, water, or ice, and/or by the force of gravity acting on the particle itself.
Σ PAH9	anthracene; benzo[a]anthracene; benzo[ghi]perylene; benzo[a]pyrene; chrysene; fluoranthene; indeno[1,2,3-cd]pyrene; pyrene; phenanthrene
Σ PAH16	acenaphthene, acenaphthylene, anthracene, benzo[a]anthracene, benzo[b]fluoranthene, benzo[k]flouranthene, benzo[a]pyrene, benzo[ghi]perylene, chrysene, dibenz(ah)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene and pyrene

III. CONDITIONS UNDER WHICH PERMITS FOR DUMPING OF DREDGED MATERIAL MAY BE ISSUED

PART A ASSESSMENT AND MANAGEMENT OF DREDGED MATERIAL[4]

1. Characterization of dredged material

17. For the purpose of these updated guidelines, the following definition[s] apply[ies]:
"dredged material" means any sedimentary formation (clay, silt, sand, gravel, rocks, and any indigenous parent rock material) removed from areas that are normally or regularly covered by sea water, by using dredging or other excavation equipment; For any other relevant definition, the text of Art. 3 of the Dumping Protocol, applies.

2. Disposal of dredged material

18. In the vast majority of cases, dumping harms the natural environment so before taking any decision to grant a dumping permit other methods of management should be considered. In particular, all possible beneficial uses of dredged material should be primarily and ultimately assessed and (see section 6) considered before granting dumping at sea permit.

3. Decision making process

General Introduction

19. In case where, after exploring all possibilities of beneficial use of dredged materials according to section 6 of part A of these updated guidelines, dumping operations at sea should be considered, it is recommended to select proper dumping sites to maintain GES for the Mediterranean Sea and to minimise the impact on commercial areas, MPA's, SPAMI's, key habitats, estuaries, and recreational fishery areas. This approach is a major consideration in resource protection and is covered in greater detail in Part C of the Annex to the Dumping Protocol.

20. In order to define the conditions under which permits for the dumping of dredged material may be issued, the Contracting Parties should develop on a national and/or regional basis, as appropriate, a decision-making process (Fig .1) for evaluating the properties of the material and its constituents, having regard to the protection of human health and the marine environment.

Criteria for Decision Making Process

21. The decision-making process, for dumping at sea of dredged materials, is based on a set of criteria developed on a national and/or regional basis, as appropriate, which meet the provisions of Articles 4, 5, and 6 of the Protocol and are applicable to specific substances. These criteria should take into consideration the experience acquired on the potential effects on human health and the marine environment.

22. These criteria may be described in the following terms:
   (a) physical, chemical and geochemical characteristics (e.g. sediment quality criteria);
   (b) application of beneficial use decision-making approach as mentioned in section 6 of part A of these guidelines;
   (c) biological effects of the products of the dumping activity (impact on marine ecosystems and estuary systems);

[4] Egypt pointed out that according to their point of view, the order of the Sections under Part A, should be different, as follows: (1) Characterization of dredged material; (2) Assessment of the characteristics and composition of the dredged material; (3) Disposal of dredged material; (4) Decision making process

(d) reference data linked to particular methods of dumping and to dumping sites;
(e) environmental effects that are specific to dumping of dredged material and are considered undesirable outside and/or in close proximity to the designated dumping sites;
(f) the contribution of dumping to already-existing local contaminant fluxes (flux criteria);
(g) mitigation measures during dumping operations

23. Criteria should be derived from studies of sediments that have similar geochemical properties to those to be dredged and/or to those of the receiving system. Depending upon the natural variation in sediment geochemistry, it may be deemed necessary to develop individual sets of criteria for each area in which dredging or dumping is conducted.

24. The decision-making process, with respect to the background natural baseline reference levels and to some specified contaminants or biological responses and with the aim to maintain GES as adopted in 2013, may lay down a national upper and a lower reference threshold **[and action level]**[5], giving rise to three possibilities:

(a) material which contains specified contaminants or which causes biological responses in excess of the relevant upper threshold should generally be considered as unsuitable for dumping at sea, subject to confinement or/and treatment;
(b) material which contains specified contaminants or which causes biological responses below the relevant lower threshold should generally be considered of low environmental concern for dumping at sea;
(c) material of intermediate quality should be subject to more detailed assessment before suitability for dumping at sea can be determined.

25. Data related to threshold levels from Mediterranean countries are provided in Annex III to the updated Guidelines for information purposes with the view to guide as appropriate the competent national authorities in the process of setting national threshold level values. It is recommended to review this Annex on a regular basis to take into account global, regional and national relevant developments and adjust it accordingly

26. When the criteria and the associated regulatory limits cannot be met (case (a) above), a Contracting Party should not issue a permit unless detailed consideration in accordance with Part C of the Annex to the Protocol indicates that dumping at sea is, nonetheless, the least detrimental option, compared with other management techniques. If such a conclusion is reached, the Contracting Party should:

(a) implement a programme for the reduction at source of pollution entering the dredged area, where there is a source that can be reduced by such a programme, with a view to meeting the established criteria;
(b) take all practical steps to mitigate the impact of the dumping operation on the marine environment including, for example, the use of confinement (capping or CDF) or treatment methods;
(c) prepare a detailed marine environment impact hypothesis;
(d) initiate monitoring (follow-up activity) designed to verify any predicted adverse effects of dumping, in particular with respect to the marine environment impact hypothesis;
(e) issue a specific permit for each specific operation;
(f) report to the Organisation on the dumping which has been carried out, outlining the reasons for which the dumping permit was issued.

[5] Insertion in square brackets proposed by Egypt

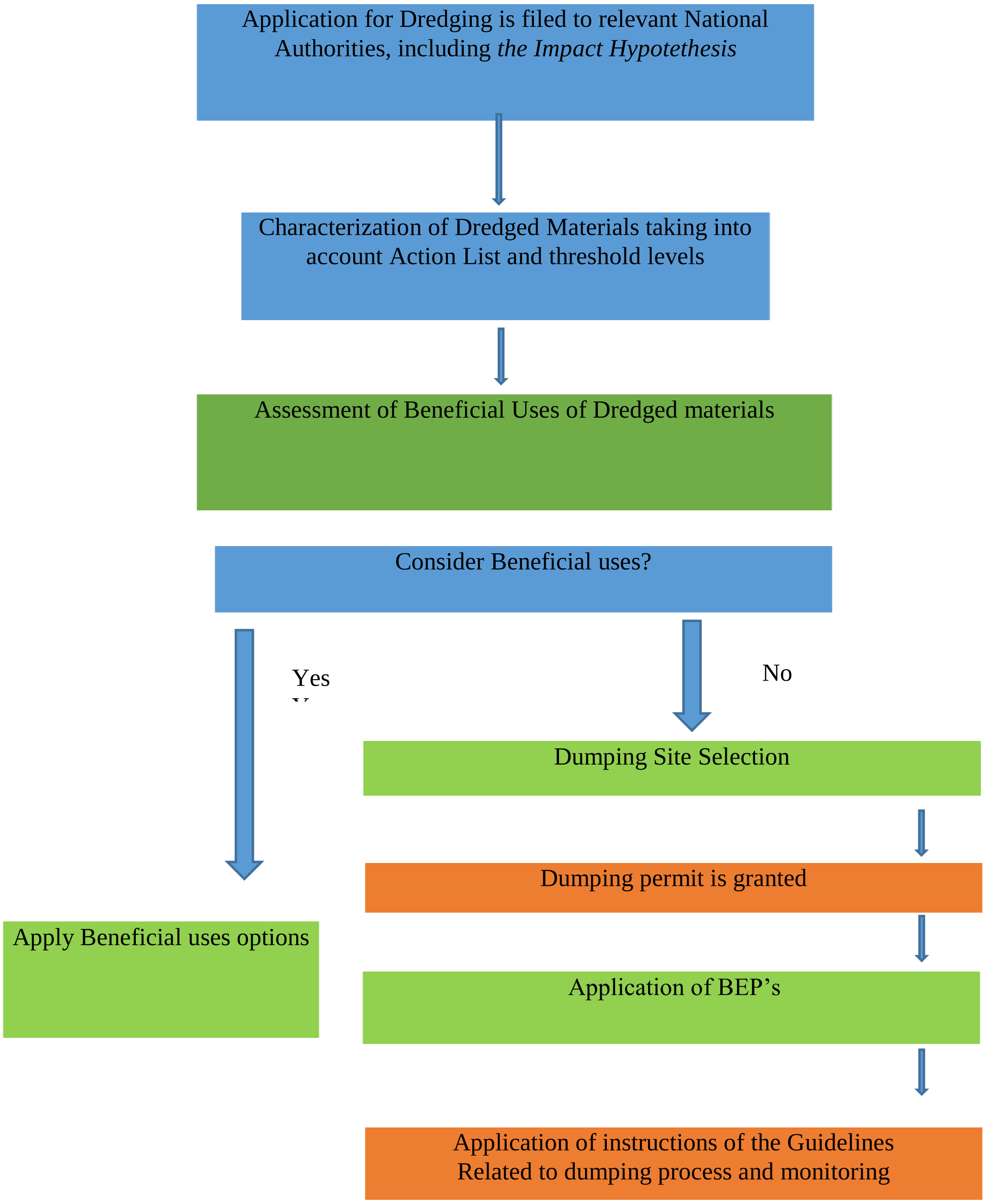

Figure 1. Decision making process of the updated guidelines[6]

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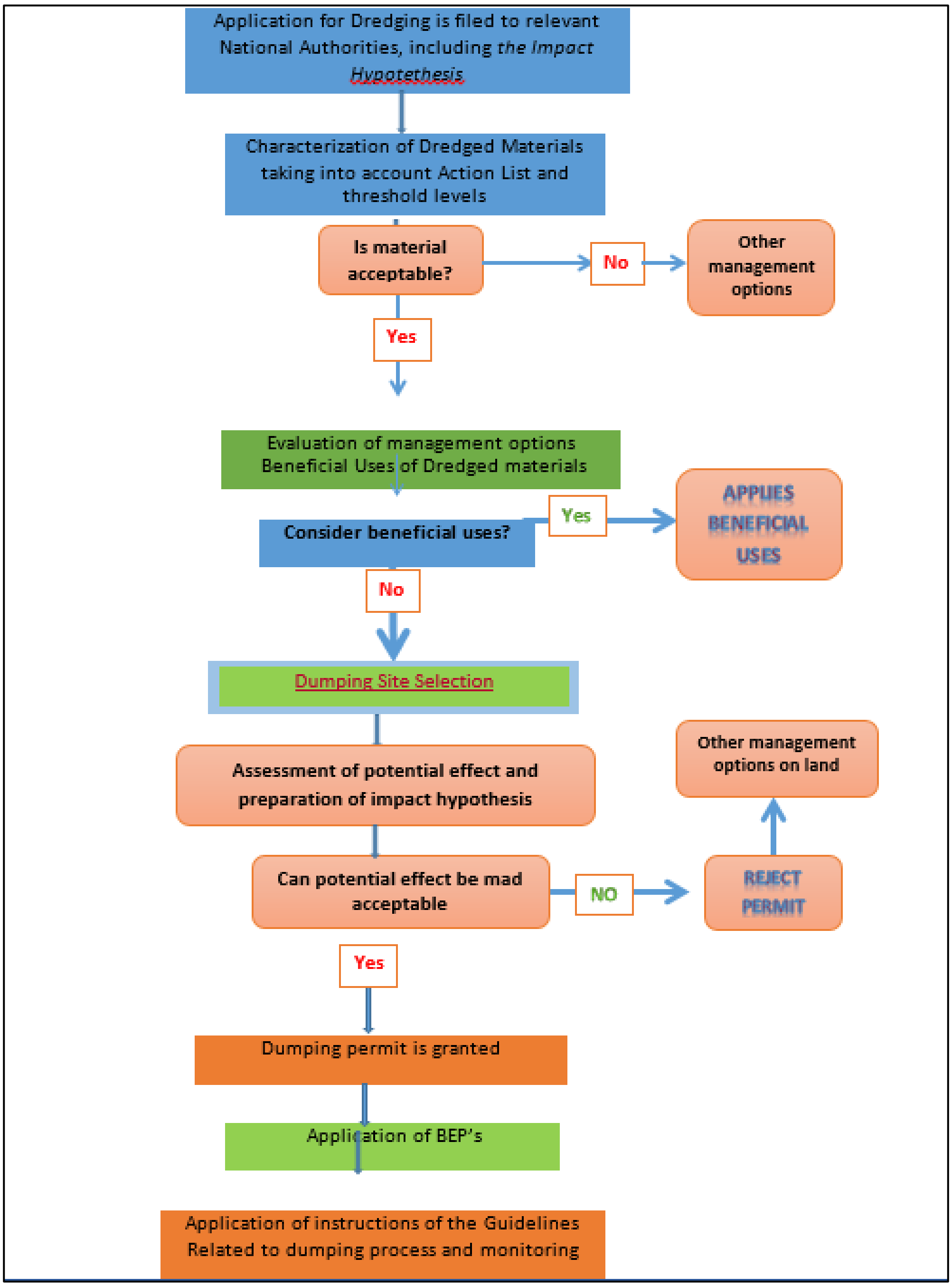
[6] France requested additional information on the Impact Hypothesis and Action List.
Egypt proposed to change the diagram in line with the OSPAR guidelines and paragraph 92 of the present updated guidelines. The modified diagram is presented as an alternative

[Alternative Proposal by Egypt][7]



Additional Criteria for Decision Making Process

27. Additional criteria for evaluating the need for dumping and alternatives to dumping are provided herewith to assist the national authorities in the decision making process. They are therefore to be evaluated, if applicable, for each proposed dumping on an individual basis using information included in these updated guidelines.

[7] Revised diagram proposed by Egypt in line with the OSPAR guidelines and paragraph 91 of the present updated guidelines

28. The need for dumping at sea is to be determined by evaluation of the following factors:

(a) Amount of dredged material;
(b) Degree of treatment -useful and feasible- for the dredged materials to be dumped and whether or not it has been or will be treated to this degree before dumping;
(c) The relative environmental risks, impact and cost for dumping as opposed to other feasible alternatives as mentioned in section 6 of part A of these updated Guidelines.
(d) Irreversible or irretrievable consequences of the use of alternatives to dumping.

Beneficial Use

29. A need for dumping is considered to have been demonstrated when a thorough evaluation of the factors listed above has been made, and the relevant authorities, as the case may be, have determined that the following conditions exist, where applicable:

(a) There are no practicable improvements which can be made in process technology or in overall possible treatment to reduce the adverse impacts of the dredged materials on the marine ecosystems;
(b) There are no practicable beneficial use alternatives which have less adverse environmental impacts or potential risk than dumping.
(c) Treatment alternatives or improvements in processes and alternative methods of disposal are practicable when they are available at reasonable incremental cost and energy expenditures, which need to be competitive with the costs of dumping, taking into account the environmental benefits derived from such activity, including the relative adverse environmental impacts associated with the use of alternatives to dumping.

Aesthetic, Recreational and Economic Values

30. Impacts of the Proposed Dredging or Dumping operations on Aesthetic, Recreational and Economic Values are determined on an individual basis, taking into account the uses and activities in the area and using the following considerations:
(a) Potential for affecting recreational use and values of sea waters, inshore waters, beaches, or shorelines;
(b) Potential for affecting the recreational and commercial values of living marine resources;
(c) Nature and extent of present and potential recreational and commercial use of areas which might be affected by the proposed dumping;
(d) Existing water quality, and nature and extent of disposal activities, in the areas which might be affected by the proposed dumping;
(e) Applicable GES's values and its targets and assessment criteria;
(f) Macroscopic [or organoleptic] characteristics of the materials (e.g. color, suspended particulates) which result in an unacceptable aesthetic nuisance in recreational areas;
(g) Presence in the material of pathogenic organisms which may cause a public health hazard either directly or through contamination of fisheries or shellfisheries;
(h) Presence in the material of toxic chemical constituents released in volumes which may affect humans directly;
(i) Presence in the material of chemical constituents/heavy metals which may be bioaccumulated or persistent and may have an adverse effect on humans directly or through food chain interactions; [reference to Annex I of these updated Guidelines]
(j) Presence in the material of any constituents which might significantly affect living marine resources of recreational or commercial value.

31. For all proposed dumping, full consideration will be given to such non quantifiable aspects of aesthetic, recreational and economic impact, such as:

(a) Public consultation of the proposed dumping and dredging sites;
(b) Consequences of not authorizing the dumping including without limitation, on aesthetic, recreational and economic values with respect to the municipalities and industries involved.

4. Assessment of the characteristics and composition of the dredged material

a) Physical characterization

32. For all dredged material to be dumped at sea, the following information should be obtained:
(a) quantity of dredged material (gross wet tonnage);
(b) method of dredging (mechanical dredging, hydraulic dredging, pneumatic dredging, and application of BEP's);
(c) rough preliminary determination of sediment characteristics (i.e. clay/silt/sand/gravel/rock).

b) Chemical and biological characterization

33. In order to assess the capacity of the site to receive dredged material, both the total amount of material and the anticipated or actual loading rate at the dumping site should be taken into consideration. Chemical and biological characterization is also needed to fully assess the potential impact. Information may be available from existing sources, for example from field observations on the impact of similar material at similar sites, or from previous test data on similar material tested not more than five years previously, and from knowledge of local discharges or other sources of pollution, supported by a selective analysis. In such cases, it may be unnecessary to measure again the potential effects of similar material in the vicinity.

34. Chemical, and as appropriate biological, characterization will be necessary as a first step in order to estimate gross loading of contaminants, especially for new dredging operations. The requirements for the elements and compounds to be analyzed are set out in Section 5. The purpose of testing under this section is to establish whether the dumping at sea of dredged material containing contaminants might cause undesirable effects, especially the possibility of chronic or acute toxic effects on marine organisms or human health, whether or not arising from their bioaccumulation in marine organisms and especially in food species.

35. The following biological test procedures might not be necessary if the previous physical and chemical characterization of the dredged material and of the receiving area, and the available biological information, allows an assessment of the environmental impact on an adequate scientific basis.

36. However, suitable biological test procedures should be applied if:

(a) the previous analysis of the material shows the presence of contaminants in quantities exceeding the upper reference threshold in paragraph 24 (a) above or of substances whose biological effects are not understood,
(b) there is concern for the antagonistic or synergistic effects of more than one substance,
(c) there is any doubt as to the exact composition or properties of the material, it is necessary to apply suitable biological test procedures.

37. These procedures, which should involve bio-indicators species may include the following:

(a) acute toxicity tests;
(b) chronic toxicity tests capable of evaluating long-term sub-lethal effects, such as bioassays covering an entire life cycle;
(c) tests to determine the potential for bioaccumulation of the substance of concern;
(d) tests to determine the potential for alteration of the substance of concern.

38. Substances in dredged material may undergo physical, chemical and biochemical changes when deposited in the marine environment. The susceptibility of dredged material to such changes should be considered in the light of the eventual fate and potential effects of the dredged material. This may be reflected in the impact hypothesis and also in the monitoring programme. [8]

c) Exemptions

39. Dredged material may be exempted from the testing referred to in paragraphs 33 to 37 of these guidelines if it meets one of the criteria listed below; in such cases, the provisions of the Parts B and C of the Annex to the Protocol (see Sections 6 and 7 below) should be taken into account, provided that they are not contaminated.

(a) It is composed of previously undisturbed geological material;
(b) It is composed almost exclusively of sand, gravel or rock;
(c) It is suitable for beneficial uses and is composed predominantly of sand, gravel or shell, with particle sizes compatible with information included in section 6-part A of these updated guidelines.

40. In the case of Capital dredging projects national authorities may, taking into account the nature of the material to be dumped at sea, exempt part of that material from the provisions of these guidelines, after representative sampling. However, Capital dredging in areas which may contain contaminated sediments should be subject to characterization in accordance with these guidelines, notably paragraph 34.

5. Guidelines on dredged material sampling and analysis

a) Sampling for the purpose of issuing a dumping permit

41. For dredged material which requires detailed analysis (i.e. which is not exempted under paragraph 39 above), the following guidelines indicate how sufficient analytical information may be obtained for the purpose of issuing a permit. Judgment and knowledge of local conditions will be essential in the application of these guidelines to any particular operation (see paragraphs 51 and 52).

42. An in situ survey of the area to be dredged should be carried out. The distribution and depth of sampling should reflect the size of the area to be dredged, the amount to be dredged and the expected variability in the horizontal and vertical distribution of contaminants. In order to evaluate the number of samples to be analyzed, different approaches might be retained.

43. The table that follows gives an indication of the number of sample sites to be used in relation to the number of m3 to be dredged in order to obtain representative results, assuming a reasonably uniform sediment in the area to be dredged.

Amount dredged (m3 in situ)	Number of stations
Up to 25000	3

[8] Egypt proposed to add the following new paragraph after paragraph 38, in line with OSPAR Guidelines: “39. Action List. The Action List is used as a screening mechanism for assessing properties and constituents of dredged material with a set of criteria for specific substances. It should be used for dredged material management decisions, including the identification and development of source control measures. The criteria should reflect experience gained relating to the potential effects on human health or the marine environment. Action List levels should be developed on a national or regional basis and might be set on the basis of concentration limits, biological responses, environmental quality standards, flux considerations or other reference values. They should be derived from studies of sediments that have similar geochemical properties to those from the ones to be dredged and/or to those of the receiving system. Thus, depending upon natural variation in sediment geochemistry, it may be necessary to develop individual sets of criteria for each area in which dredging or deposit is conducted. With a view to evaluating the possibilities (Annex III)

from 25 000 to 100 000	4-6
from 100 000 to 500 000	7-15
from 500 000 to 2 000 000	16-30
> 2 000 000	extra 10 per million m3

44. Core samples should be taken where the depth of dredging and the expected vertical distribution of contaminants warrant; otherwise a grab sample is considered appropriate. Sampling from the dredger is not acceptable.

45. Normally, the samples from each sampling site should be analyzed separately. However, if the sediment is clearly homogeneous with respect to sediment features (grain-size fractions and organic matter load) and expected level of contamination, it may be possible to analyze composite samples from adjacent locations, two or more at a time, provided care has been taken to ensure that the results give a justified mean value for the contaminants. The original samples should be retained until the procedure for the issue of a permit has been completed, in case the results indicate that further analysis is necessary.

b) Sampling in the case of the renewal of a dumping permit

46. If a survey indicates that the material is essentially below the lower reference threshold in paragraph 24 (b) above and no new events of pollution have taken place indicating that the quality of the material has deteriorated, surveys need not be repeated.

47. If the dredging activity involves material with a contaminant content between the upper and lower reference thresholds in paragraph 24 (a) and (b) above, it may be possible, on the basis of the initial survey, to reduce either the number of sampling stations or the number of parameters to be measured. However, sufficient information must be provided to confirm the initial analysis for the purpose of issuing a permit. If such a reduced sampling programme does not confirm the earlier analysis, the full survey should be repeated.

48. However, in areas where there is a tendency for sediments to show high levels of contamination, or where contaminant distribution changes rapidly in response to varying environmental factors, analysis of the relevant contaminants should be frequent and linked to the permit renewal procedure.

c) Provision of Input Data

49. The sampling scheme described above provides information for the purpose of issuing permits. However, the scheme can at the same time provide a suitable basis for estimating of total inputs and, for the time being in the current situation, can be considered the most accurate approach available for this purpose. In this context it is assumed that materials exempt from analysis represent insignificant inputs of contaminants and therefore it is not necessary to calculate or to report contaminant loads.

d) Parameters and methods

50. Since contaminants concentrate mainly in the fine fraction (< 2 mm) and even more specifically in the clay fraction (> 2 µm), analysis should normally be carried out on the non-coarse fraction sample (< 2 mm). It will also be necessary, in order to assess the likely impact of contaminant levels to provide information on:

(a) grain size fractions (% sand, silt, clay);
(b) load of organic matter;
(c) dry matter (% solids).

Information on the normalization procedure is provided in Annex II of the updated Guidelines.

51. In those cases where analysis is required, it should be mandatory for primary metal substances [and arsenic][9]. With respect to organochlorines, polychlorobiphenyls (PCBs) should be analysed on a case-by-case basis in non-exempt sediments because they remain a significant persistent environmental contaminant. Other organohalogens should also be measured if they are likely to be present as a result of local inputs as indicated in the Action List Threshold Levels contained in Annex III of the updated Guidelines.

52. In addition, the authority responsible for issuing permits should carefully consider specific local inputs, including the likelihood of contamination by arsenic, polycyclic aromatic hydrocarbons (PAH) and organotin compounds as indicated in Annex I to the updated Guidelines. The authority should make provision for the analysis of these substances as necessary.

[Alternative text proposed by Spain[10]

52. In addition, the authority responsible for issuing permits should carefully consider specific local inputs, including the likelihood of contamination by PCB, PAH and TBT, as indicated in Annex I to the updated Guidelines. The authority should make provision for the analysis of these substances as necessary.]

53. In applying paragraphs 51 and 52, the following should be taken into account :

(a) potential routes by which contaminants could reasonably have been introduced into the sediments;
(b) probability of contamination from agricultural and urban surface run-off;
(c) spills of contaminants in the area to be dredged, in particular as a result of port activities;
(d) industrial and municipal waste discharges (past and present);

54. Further guidance on the selection of determinants and methods of contaminant analysis under local conditions, and on procedures to be used for harmonization and quality assessment purposes, will be found in the Annex I to the updated Guidelines as adopted, and updated periodically, by the Contracting Parties.

55. National relevant authorities are the ultimate responsible for the application of national normalized and standardized methods for sampling and analysis of determinants. References include information that could be consider in this matter.

6. Considerations before taking any decision to grant a dumping permit

6.1 Dredging Operations

56. Dredging operations may result in the re-mobilization of contaminants contained in the sediments and their suspension, which may, at certain levels, have an adverse impact on the environment, either at sea during dredging or clapping when these sediments are settled, or on land when these sediments are stored. Dredging can also result in hydromorphological and hydrographic changes to dredged areas and have a more global impact on disposal sites or onshore management.

57. On the other hand, dredging can have positive environmental effects and externalities. In fact, dredged materials can be integrated, under certain conditions and subject to the existence of a local

[9] Proposed by Spain to ensure consistency with Annex I to the present Guidelines
[10] Spain proposed to include in this paragraph the PCB, PAH, TBT for which measurements could not be necessary, according to the Annex I to the present Guidelines

market, into treatment systems allowing their exploitation, in particular in building materials. They can also be used to beaches nourishment in the fight against erosion of the coastline, and thus come as an alternative to more structural solutions. Finally, in the case of sediment pollution, dredging can be a removal solution that decontaminates the marine environment, but transfers the problem to the land.

58. It is important, while assessing the value of sediment as a resource, to consider opportunities for beneficial uses of dredged material, taking into account the physical, chemical and biological characteristics of the material. Generally, a characterization carried out in accordance with part A of these updated Guidelines will be sufficient to match a material to possible beneficial uses in water, at the shoreline and on land.

6.2 Physical Classifications of Dredged materials

a) Rock

59. Rock may vary from soft marl via weak rocks (for example, sandstone and coral) to hard rocks (such as granite and basalt). Rock may also vary in size from large to small, depending on the dredging equipment used and the type of material. Rock may also result from blasting, cutting, or ripping and is seldom of only one material type. Whether the rock can be used economically depends on its quantity and size. Rock is a valuable construction material and may be used for both terrestrial and aquatic projects. Usually, dredged rock is not contaminated.

b) Gravel and Sand

60. Gravel and sand (granular) are generally considered the most valuable materials derived from a dredging project. Gravel and sand are suitable for most engineering uses without processing. Some additional processing (such as freshwater washing) may be needed for certain agricultural or product uses. Granular material can be used for beach nourishment, parks, turtle nesting beaches, bird nesting islands, wetlands restoration and establishment, and many other applications. Granular material is usually not contaminated.

c) Consolidated Clay

61. Consolidated clay varies from hard to soft clay and is material obtained from capital dredging. The material may occur as lumps or as a homogeneous mixture of water and clay, depending on the material type and the dredging equipment used. If the water content is high, dredged clay may have to be dewatered before being transported. Possible uses of consolidated clay range from forming industrial products, such as bricks and ceramics, to building erosion control structures, such as dikes and berms. Consolidated clay is not usually contaminated.

d) Silt/Soft Clay

62. Silt and soft clay are the most common materials acquired from maintenance dredging in rivers, canals, and ports. These materials are most suitable for agricultural purposes (such as topsoil) and all forms of wildlife habitat development. Depending on national regulations and laws, mildly contaminated silt and soft clay may be used for some engineered uses or product uses such as bricks, tiles, and ceramics and cap layer for aquatical confinement of polluted material. Because of the high water content, silt and soft clay must be dewatered for any product use. Dewatering can require months or years and, depending on the draining process used, can require temporary storage.

e) Mixture (rock/sand/silt/soft clay)

63. Capital dredged material usually occurs in layers as deposited from some past hydraulic process and may require the use of different dredging methods. Maintenance dredged material is usually a mixture of materials such as boulders, lumps of clay, gravel, organic matter, and shells, with varying

densities. Even though engineered and product uses will be somewhat restricted because of the mixture, mixed material may be used for a wide range of beneficial uses, such as land reclamation, habitat improvement, and landfill capping, filling materials in harbour facilities.

6.3 Beneficial uses

64. « Beneficial use of sediments includes making use of opportunities for retaining clean sediment within natural sediment processes and cycles that support aquatic, estuarine, and marine systems. »

(a) In water :

◦ *Habitat restoration and development* using direct placement of dredged sediments for enhancement or restoration of ecosystem habitat associated with wetlands, other nearshore habitats, coastal features, offshore reefs, fisheries enhancement, etc.

◦ *Sustainable relocation* by retaining sediment within the natural sediment system to support sediment-based habitats, shorelines and infrastructure.

(b) At the shoreline :

◦ *Beach Nourishment*

◦ *Shoreline Stabilization and Protection* on land[11]

65. Operational feasibility, that is, the availability of suitable material in the required amount at a particular time, is a crucial aspect of many beneficial uses.

a) Beach Nourishments

66. The influences of waves and tidal currents keep beach material in continuous motion. Where the prevailing wave direction is at an angle to the beach of less than 90 degrees, some material will be moved along the beach or foreshore or even offshore in a process called littoral transport. This movement is most rapid under storm conditions. If the moved material is not replaced, the beach and eventually the shoreline will erode. If lost beach material is not replaced naturally, beach nourishment may be necessary to enhance the beach profile and moderate the wave climate at the shoreline. In addition to the improvement of beaches for coast protection, improvement may also be required for recreation beaches. Recreation beaches may be improved or new beaches may be created. Dredging can supply the required large quantities of sand and gravel-sized material for beach nourishment. A life span of 10 years is a common design target for many beach nourishment schemes but a shorter life may be acceptable, particularly where the cost of nourishment material is low.

Recommended materials: Gravel and Sand.

b) Berm Creation

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[11] France suggested to consider beneficial uses on land as a separate point (c) with the following beneficial uses:
- Engineered Capping of soils or waste materials, e.g. landfill covers or remediation of former mining sites. (This form of beneficial use also applies to capping of contaminated sediments in aquatic environments.)
- Aquaculture, Agriculture, Forestry, and Horticulture involving direct placement of dredged material to create or maintain an aquaculture facility, replace eroded topsoil, elevate an area for improved site use, or otherwise enhance the physical and chemical characteristics of land.
- Recreational Development through direct placement of dredged material for the foundation of parks and recreational facilities; for example, waterside parks providing such amenities as swimming, camping, or boating.
- Commercial Land Development (also known as reclamation) using direct placement of dredged sediments to support commercial or industrial development activities, including "brownfield" redevelopment, as well as marine port, airport, and residential developments. These activities typically occur near navigational channe ls by expanding the land footprint or providing bank stabilization material.
- Commercial Product Development involving the use of dredged material to create marketable products such as construction materials, e.g. bricks, aggregate, cement, top soil, etc.

67. Dredged material may be used for creating berms or embankments to modify shoreline wave climate and thus improve beach stability. The berm may also be designed to alter wave direction and modify the rate or direction of local sediment transport. Generally, the berm is aligned roughly parallel to the beach, but the optimum alignment at a specific site will be determined by the direction of the most destructive wave climate.

68. The formation of berms may provide a particularly attractive use for a wide range of dredged material. Because the berm is generally a submerged formation, most or all of the formation usually can be created by the bottom discharge of dredged material from hoppers. Berms may gradually erode and be dispersed, but the dispersed material will probably benefit the local coastal regime, either through beach feeding or by increasing foreshore levels.

69. Modification of the wave climate by berms may also improve recreational opportunities for surfing, swimming, sailing, and other activities. Care must be taken in placement of the berm to avoid interference with other users such as fisheries, ports, harbours, outfalls, and intakes.

Recommended Sediment Types: rock,gravel and sand, consolidated clay and mixture

c) Capping **[Cover material for capping sites]**[12]

70. Capping involves the placement of clean dredged material over a deposit of contaminated dredged material in open-water or upland locations as a means of isolating the contaminated sediment from the surrounding environment. Open-water caps provide a wave-and current-resistant layer on top of previously deposited contaminated materials. Sand, clay, or mixed materials may be used for open-water capping, whereas clay is usually most suitable for upland locations.

d) Land Creation

71. Land creation using dredged material includes filling, raising, and protecting an area that is otherwise periodically or permanently submerged. The creation of coastal land may also involve constructing a perimeter enclosure for protection against erosion by waves and currents. This may not be necessary in estuarine waters or in other sheltered coastal locations that have a small tidal range. Coarse or fine dredged material may be used in land creation. The suitability of a particular dredged material for land creation will depend largely on the intended use of the land. Material from maintenance dredging is usually silt or sand, while material from capital dredging may be of almost any kind or may be mixed. Sometimes the fine-grained material may be separated from the coarse material and the two resulting materials used in different ways.

72. Fine material will require a long time to drain and consolidate; therefore, the strength achieved may be low. Land created using these fine-grained materials may be limited to recreational uses, such as parks, or uses where the imposed loads will be small. If land must be created rapidly, material from capital dredging are primarily used. Where longer development times are acceptable, materials from maintenance dredging may also be used. Land created for industrial development or to accommodate roads or railways normally requires only sand or coarser material. Often the constraints of time and the availability of suitable material limit the use of dredged material in land creation. Such constraints may be overcome by long-term planning, which provides for land creation over extended periods. Land creation may also be constrained by compelling environmental considerations.

Recommended Sediment Types: rock, gravel and sand, consolidated clay, silt/soft clay, mixture

[12] Spain proposed to replace the current title of point (c) “capping” with the title included in square brackets “cover material for capping sites”, in line with the idea that the beneficial use if the use of clean dredged material to cover the polluted one

e) Land Improvement

73. Dredged material may be used for land improvement when the quality of existing land is not adequate for a planned use or where the elevation of the land is too low to prevent occasional flooding. As with land creation, the suitability of a particular dredged material for land improvement will depend largely on the intended use of the improved land.

74. Proven methods have been developed for land improvement by filling with the fine material, such as silts and clays, produced by maintenance dredging. Various dewatering techniques may be utilized, such as: subdividing the placement area to allow filling to a limited depth on a rotational basis; reworking the filled area with low ground-pressure agricultural or earth-moving equipment; and mixing coarse-grained material with the fine-grained upper layer.

75. Dredged material of fluvial origin is primarily eroded top soils and organic matter that may be used on land of poor agricultural quality to improve the soil structure. Even material dredged from a saline environment may, after treatment, be suitable for use as topsoil. Mildly contaminated soils can be used for non-consumptive land uses. Land improved using fine material is generally of lower strength than land improved using coarse-grained material. Potential applications include dairy and arable farming, recreation areas, playing fields, golf course, parks, light residential development or light commercial storage areas.

Recommended Sediment Types: rock, gravel and sand, consolidated clay, silt/soft clay, mixture.

f) Replacement Fill

76. Dredged material may be used as a replacement fill when the physical qualities are superior to soils near the dredging site. In industrial fill sites, peat and clayish soils are usually removed and replaced by sand or other granular dredged material to improve physical properties needed to meet building requirements. Weak soils may be replaced with sand from construction of tunnels, bridges, fairways, and ports. Fine-grained soils do not have the necessary physical properties for industrial fill in most civil works projects; however, green areas or parks may be suitable applications. Some examples of replacement fills include:

(a) Filling holes in the landscape left from gravel or clay mining.
(b) Removal of soft layers so that an area is reclaimed with dredged sand.
(c) Trenching peat or soft clay and filling with sand to get a more stable layer of soil; for example, for abutments, tunnels, roads, and railways.
(d) Filling obsolete canals and docks to improve the use of the land.

Recommended Sediment Types: rock, gravel and sand, mixture

g) ***Aquaculture***

77. Aquaculture of coastal fish, shellfish, and other species is a rapidly expanding worldwide industry. The expansion of aquaculture has led to a shortage of suitable sites in many areas, especially coastal sites. Lack of access, legal constraints, competing land uses, and high land costs have limited aquaculture development for many locations. One way these constraints may be overcome is to use maintenance dredged material containment areas for aquaculture.

78. Aquaculture is a promising beneficial use because aquaculture ponds and dredged material containment areas share many design characteristics. Common features include perimeter levees to retain water, construction on relatively impervious soils, and control structures for water discharge and drainage. Both types of facilities have similar regulatory and permitting requirements for construction and operation, and both types of facilities include locations adjacent to waterways in coastal areas, often on large tracts of land and near transportation routes and major markets.

Recommended Sediment Types: Consolidated clay; Silt/soft clay; Mixture

h) Shore Protection

79. Shore protection methods include dike construction as well as beach nourishment and underwater berms, which were discussed earlier. Dike construction may use dredged material in the form of a pumped sand, directly dredged clay material, or rock. Rock produced by dredging may be used as riprap slope protection, armor stone, groins, or breakwater core material. Dredging does not usually produce large quantities of rock, but where it does, a range of useful engineering applications exists.

Recommended Sediment Types: rock, gravel and sand, consolidated clay.

i) Construction Materials

80. Some dredged material can be used as construction material. In some parts of the world, dredging to obtain construction material is a common practice. Because of the growing demand for construction materials and dwindling inland resources, this may be an important beneficial use. In many cases, dredged material consists of a mixture of sand and clay fractions, which requires some type of separation process. Dewatering may also be required because of high water content.

81. Depending on the sediment type and processing requirements, dredged material may be used as: concrete aggregates (sand and gravel); backfill material or in the production of bituminous mixtures and mortar (sand); raw material for brick manufacturing (clay with less than 30 per cent sand); ceramics, such as tile (clay) pellets for insulation or lightweight backfill or aggregate (clay); raw material for the production of riprap or blocks for the protection of dikes and slopes against erosion (rock, mixture); and raw material for the production of compressed blocks for security walls at military installations and for gated communities and home subdivisions.

Recommended Sediment Types: rock, gravel, sand, silt, clay, mixture

j) Decorative Landscaping Products

82. Dredged material can be blended with recycled residual materials such as glass, gypsum, plastic bottles, and automobile interiors, etc. to manufacture statues, figures, garden benches, stepping patio pavers, plant vases, artificial rocks and water fountains. These products can be used to landscape gardens, backyards, swimming pool environments, monument stones, miniature golf courses, highway rest areas, tourist welcoming centers, zoos, and theme parks such as Disney World.

Recommended Sediment Types: sand, silt, clay, mixtures

k) Topsoil

83. Maintenance dredging in harbours, access channels, and rivers produce mixtures of sand silt, clay and organic matter that can be excellent ingredients for topsoil. Some dredged materials may be excellent topsoil as they are. Other dredged material may require blending with other residual materials such as organic matter (yard waste, wastepaper, storm debris, etc.) and bio-solids (human sewage sludge or animal manure) to manufacture enhanced fertile topsoil. The dredged material may be used to improve soil structure for agricultural purposes. For production of food, uncontaminated material must be used. For other uses, the allowed contaminant level will depend on the use of the topsoil. In some cases, suitable material may be placed in a thin layer directly by pumping. After dewatering, the material is suitable topsoil for seeding and planting.

84. Dewatering may require several years, depending on the granular texture of the dredged material and is influenced by additional substances or by the type of dewatering process. Dredged material

from coastal or tidal areas will require special attention to salinity, since most agricultural species cannot tolerate and grow in salty soil. Salinity may be reduced naturally by rain or by the dewatering process. Other uses of topsoil might include using dredged material to cap poor soils or to cover a fill of coarse material (e.g., urban or industrial waste sites). Dredged material can also be used in the manufacture of blended artificial topsoil products. The blended topsoil can be used for athletic fields such as sport fields and ball fields, home landscaping, golf courses, parks, brownfield redevelopment, etc. Required topsoil specifications for a specific use can be met through blending appropriate materials together in specific amounts.

Recommended Sediment Types: sand, silt, clay, mixtures

l) Fish and Wildlife Habitats

85. Dredged material can be used beneficially to enhance or create various wildlife habitats. This may be either incidental to the project purpose or planned. For example, nesting meadows and habitat for large and small mammals and songbirds have been developed on upland or floodplain (seasonally flooded) dredged material placement sites. Numerous examples are available where dredged material has been used to create nesting islands for water birds and waterfowl.

86. Many technical and legal considerations are necessary for the creation of nesting islands. An island can be built where none existed, and vegetation states (bare ground versus sparse herb cover versus tree/shrub habitat) can be managed using periodic dredged material applications. The types of dredged material can be manipulated to provide proper substrates for nests; in that view, softer silts and clays can be capped with sand, shell, and cobbles. The placement of the dredged material can be manipulated to provide the most acceptable habitat characteristics.

87. Upland wildlife habitats are typically dredged material containment areas that are no longer used or have long periods between maintenance dredged material placement. This allows native vegetation to grow and provide food and cover for wildlife. Site management is minimal, but can be intensified to provide special food crops, overwintering waterfowl feeding areas, and numerous other natural resource opportunities.

Recommended Sediment Types: rock, gravel and sand, consolidated clay, silt/soft clay, mixture

m) Fisheries Improvement

88. Appropriate placement of dredged material can improve ecological functions of fishery habitat. Fishery resource improvement can be demonstrated in several ways. Bottom relief created by mounding of dredged material may provide refuge habitat for fish. Fine-grained sediment transport can be stabilized by planting seagrasses or capping with shell or other coarse dredged material. The seagrasses or shell caps additionally improve fishery habitat.

Recommended Sediment Types: rock, gravel and sand, consolidated clay, silt/soft clay, mixture

n) Wetland Restoration

89. Dredged material has been extensively used to restore and establish wetlands. Where proper sites can be located, wetlands restoration is a relatively common and technically feasible use of dredged material. Wetlands restoration or rehabilitation using dredged material is usually a more acceptable alternative to creation of a new wetland. Many of the natural wetlands in the Mediterranean region are degraded or impacted, or have been destroyed, and the recovery of these wetlands is more important than the creation of new ones. Most former wetlands still have hydric soils, even though the hydrologic characteristics of the site may have been altered. When a new wetland is created, hydric soil conditions, appropriate hydrologic conditions, and wetland vegetation must all be introduced to the site. Creation of a new wetland would also mean replacing one habitat type with another, which is

not always desirable. Long-term planning, design, maintenance, and management are necessary to maintain a created wetland.

90. Wetland restoration using dredged material can be accomplished in several ways. [For example, dredged material can be applied in thin layers to bring degraded wetlands up to an intertidal elevation, as has been done extensively in the Mediterranean]. Dewatered dredged material can be used in wind and wave barriers to allow native vegetation to regrow and restore the viability of a wetland. Dredged material sediment can be used to stabilize eroding natural wetland shorelines or nourish subsiding wetlands. Dewatered dredged material can also be used to construct erosion barriers and other structures that aid in restoring a degraded or impacted wetland.

Recommended Sediment Types: consolidated clay, silt/soft clay, mixture

6.5 Decision process for beneficial uses

a) *Contaminant Status of Materials*

91. Evaluating the contaminant status of the dredged material is the first step to determine if the material is acceptable for beneficial use. In general, highly contaminated sediments will not normally be suitable for most proposed beneficial use applications and particularly for proposed wildlife habitat development projects. However, after appropriate examination, testing, and treatment, the material may be classified as suitable. Dredged material from ongoing activities (maintenance dredging) should be re-evaluated periodically to ensure that the sediment contamination level has not worsened since the last dredging cycle. These updated Guidelines provide information related to the assessment of the level of contamination of dredged materials.

b) *Site Selection*

92. Selecting a placement site and choosing a beneficial use are interdependent decision processes. Dredged material may have multiple beneficial use options and there may be several different potential placement sites. Often, the characteristics of the sediments determine or limit the types of sites that may be selected and the beneficial uses that can be achieved. Once a potential use and site have been identified, various implications should be assessed such as technical feasibility, environmental acceptability, cost/benefits, and legal constraints.

c) *Technical Feasibility*

93. The technical feasibility of implementing a particular beneficial use at a designated site must be evaluated. Various constraints must be considered, such as pumping distance, water depth, access, etc. If technical feasibility constraints will not allow the proposed beneficial use and/or selected site, then alternate beneficial uses or disposal options must be pursued.

d) *Environmental Acceptability*

94. Before any substantial work can be undertaken, the environmental impact prior, during, and subsequent to construction of the proposed project must be investigated. An Environmental Impact Assessment (EIA) and/or impacts hypothesis should be performed on all projects. The chosen beneficial use options may be pursued if it is concluded that the environmental effects will not be significantly harmful. Permission to undertake the dredged material placement may be denied if the proposed work is likely to have any significant adverse environmental effects.

e) *Cost/Benefit*

95. After one or more potential beneficial use options have been identified and the engineering methods have been defined, estimated costs and benefits should be analysed. The costs are usually

estimated by standard methods. Options for beneficial use may lower the cost for disposal of dredged material in many instances, but increase costs in other scenarios. Costs are frequently lower when distances from dredging site to placement site are reduced. In cases with higher costs, the increase may be more than offset by the value of the benefits. Although difficult to quantify, intangible benefits should always be taken into account when assessing overall costs and benefits. These benefits may include improved habitat, aesthetic enhancement, a more viable local community, and other benefits.

f) *Legal Constraints*

96. Early and concentrated coordination between relevant authorities, e.g. local interest groups, and environmental protection agencies is mandatory. Some beneficial use options or sites selected may be prohibited or rendered inappropriate by law or regulation.

6.6. Characteristics of the dumping site and method of deposit

97. The selection of a site for dumping at sea does not only involve the consideration of environmental parameters, but also economic and operational feasibility.

98. In order to be able to assess a new dumping site, basic information on the characteristics of the dumping site have to be considered by national authorities at a very early stage of the decision-making process.

99. For the purpose of studying the impact, this information should include the geographical coordinates of the dumping area (latitude, longitude), the distance to the nearest coastline as well as proximity of the dumping area to the following:

a) recreational areas;
b) spawning, recruitment and nursery areas of fish, crustaceans and molluscs;
c) known migration routes of fish or marine mammals;
d) commercial and sport fishing areas;
e) mariculture areas;
f) areas of natural beauty or significant cultural or historical importance;
g) areas of special scientific, biological or ecological importance;
h) shipping lanes;
i) military exclusion zones;
j) engineering uses of the seafloor (e.g. potential or ongoing seabed mining, undersea cables, desalination or energy [conversion] [production][13] sites).

100. The dumping of dredged material should not interfere with nor devalue legitimate commercial and economic uses of the marine environment. The selection of dumping sites should take into account the nature and extent of both commercial and recreational fishing, as well as the presence of aquaculture areas, spawning, nursery and feeding areas.

[Insertion proposed by Spain[14]
In selecting dumping sites, the habitats of rare, vulnerable or endangered species must be avoided, taking into account the preservation of the biodiversity.]

101. In view of uncertainties regarding in the diffusion of marine contaminants giving rise to transboundary pollution, dumping of dredged material in the open sea should be prohibited.

[13] Both options are included in square brackets for review by the MED POL Focal Points Meeting
[14] Spain proposed to move here the paragraph 109 of the current version, related to biodiversity preservation considerations in dumping site selection

102. For dredged materials, the only data to be considered for this purpose should include information on:
- disposal method (e.g. vessels, hopper discharge; and other controlled methods);
- dredging method (e.g. hydraulic or mechanical), having regard to Best Environmental Practice (BEP).

103. For the evaluation of dispersal characteristics, the use of mathematical diffusion models requires the collection of certain meteorological, hydrodynamic and oceanographic data. In addition, data on the speed of the vessel dumping the material and the rate of dumping should also be made available.

104. The basic assessment of a site, whether a new or existing includes the consideration of possible effects that might arise due to the increase in certain constituents or to interaction (e.g. synergistic effects) with other substances introduced in the area, either through other dumping, input from rivers, discharges from coastal areas, exploitation areas, maritime transport, or through the atmosphere.
105. The existing stress on biological communities as a result of such activities should be evaluated before any new or additional dumping operations are conducted.

106. The possible future uses of resources and amenities in the sea receiving area should be kept in mind.

107. Information from baseline and monitoring studies at existing dumping sites will be important in the evaluation of any new dumping activity at the same site or nearby.

6.7. General considerations and conditions: Nature, prevention and minimization of the impact of disposal of dredged material

108. Particular attention should be given to dredged material contaminated by hydrocarbons and containing substances that have a tendency to float following re-suspension in the water column. Such materials should not be dumped in a manner or at a location which may interfere with fishing, shipping, amenities or other ~~beneficial uses of the marine environment~~ **[legitimate uses of the sea]**[15].

109. [In selecting dumping sites, the habitats of rare, vulnerable or endangered species must be avoided, taking into account the preservation of the biodiversity.][16]

110. In addition to toxicological effects and bioaccumulation of the constituents of dredged material, other potential impacts on marine life should be considered, such as:

a) alteration of the sensorial and physiological capacities and the behaviour of fish in particular in respect of natural predators;
b) nutrient enrichment;
c) oxygen depletion;
d) increased turbidity;
e) modification of the sediment composition and blanketing of the sea floor.

Physical impact

111. All dredged materials, whether or not contaminated, have a significant physical impact at the point of disposal. This impact includes covering of the seabed and a localised increase in the levels of suspended solids.

[15] It was agreed during the Regional Meeting of Experts to review the Draft Desalination and Dumping Protocol Guidelines, to ensure consistency with the wording of UNCLOS referring to “legitimate uses of the sea”
[16] Spain proposed to maintain this paragraph but move it to the section *6.6. Characteristics of the dumping site and method of deposit.* Spain recommends to place the paragraph after the paragraph 100

112. The physical impact may also extend to zones outside the dumping zone as such, resulting from the forward movement of the dumped material due to wave and tidal action and residual current movements, especially in the case of fine fractions.

113. In relatively enclosed waters, oxygen-consuming sediments (e.g. organic carbon-rich) could adversely affect the oxygen regime of receiving systems. In the same way, dumping of sediments with high levels of nutrients may significantly affect the nutrient fluxes and, subsequently, in extreme cases, contribute significantly to the eutrophication of the receiving zone.

Chemical impact

114. The chemical impact of dredged material disposal on the marine water quality and the marine biota, is mainly from the dispersion of pollutants in association with suspended particles, and the release of pollutants from the dumpsite sediments.

115. The binding capacity of contaminants may vary considerably. Contaminant mobility is dependent upon several factors among which are chemical form of contaminant, contaminant partitioning, type of matrix, physical state of the system (e.g. pH ,TE), waterflow, suspended matter (organic matter), physico-chemical state of the system, type of interactive processes, such as sorption/desorption - or precipitation/dissolution - mechanisms, and biological activities.

Bacteriological impact

116. Bacteriologically, dredging activities and dumping of dredged material may involve a resuspension, of sedimentary microorganisms, particularly faecal bacteria, which are trapped in the sediment. Studies carried out show that, in particularly on dredging sites, there is a significant correlation between turbidity and concentrations of germs tested (faecal coliforms, faecal streptococci).

Biological impact

117. The immediate biological consequence of this physical impact includes smothering of benthic flora and fauna in the dumping area.

118. Nevertheless, in some instances, after dumping activities stop, there may be a modification of the ecosystem, in particular when the physical characteristics of the sediments in the dredged material are very different to those in the receiving zone.

119. In certain special circumstances, disposal may interfere with migration of fish or crustaceans (e.g. if dumping is in the coastal migration path of crabs).

120. In other respects, the chemical pollution impact resulting from the dispersion of pollutants associated with suspended matter, and from the contaminants "relargage" from the sediments which are accumulated on the dumping site, can induce a change in the composition, biodiversity and abundance of benthic communities.

Economic impact

121. An important consequence of the physical presence of dumping of dredged material is interference with fishing activities and, in some instances, with navigation and recreation. The former concerns both the smothering of areas that may be used for fishing and interference with fixed fishing gear; shoaling following dumping can lead to navigational hazards and clay or silt deposition may be harmful in recreational areas. These problems can be aggravated if the spoil is contaminated with bulky harbour debris such as wooden beams, scrap metal, pieces of cable etc. that according the

Regional Plan for the Marine Litter Management in the Mediterranean should be retired prior disposal at sea.

Approaches to management

122. This section deals only with management techniques to minimise the physical effects of disposal of dredged material. Measures to control the contamination of dredged materials are covered in other sections of these guidelines.

123. The key to management lies in careful site selection and assessment of the conflict between marine resources, the marine environment and activities. These notes are intended to supplement these considerations.

124. To avoid excessive use of the seabed, the number of sites should be limited as far as possible and each site should be used to the maximum extent possible without interfering with navigation (sand-shoals formation).

125. All measures should be taken to allow recolonization to take place once deposition stops.

126. Effects can be reduced by ensuring as far as possible that the sediments in the dredged material and receiving area are similar. Locally, the biological impact may be further reduced if the sedimentation area is naturally subject to physical disturbance (horizontal and vertical currents). Where this is not possible, and the materials are clean and fine, a deliberately dispersive style of dumping should be utilised so as to limit blanketing to a small site.

127. With capital and maintenance dredging, the material may be different in character to the sediments at the receiving site and re-colonisation may be affected. Where bulky material such as rock and clay are deposited, there may be interference with fishing activity, even in the long term.

128. Temporal restrictions on dumping activities may have to be imposed (for example tidal and seasonal restrictions). Interference with fish or crustacean migration or spawning or with seasonal fishing activities may be avoided by imposing a calendar for dumping operations. Trench digging and refilling activities may also interfere with migratory patterns and similar restriction measures are needed.

129. Where appropriate, disposal vessels should be equipped with accurate positioning systems for example, satellite systems. Disposal vessels should be inspected and operations controlled regularly to ensure that the conditions of the dumping permit are being observed and that the crew is aware of its responsibilities under the permit. Ships' records and automatic monitoring and display devices (e.g. black-boxes), where these have been fitted, should be inspected to ensure that dumping is taking place at the specified dumping site.

130. Where solid waste is a problem, it may be necessary to specify that the disposal vessel (or dredger) is fitted with a grid to facilitate removal for disposal (or recovery) on land, rather than being dumped at sea.

131. Monitoring is an essential component of management action (see Part B).

7. Treatment of dredged material[17]

(a) Confined disposal

132. [Confined disposal means that the dredged material is placed in an engineered containment structure, that is, within dikes or bunds, or in natural or constructed pits, or borrow pits. This isolates the material from surrounding waters or soils during and after disposal. Other terms used in the literature for this type of disposal include [“confined aquatic disposal or capping” (CAD)][18] “confined disposal facility" (CDF), “diked disposal site” and “containment area”. CDFs may be constructed in open waters (known as island CDFs), at near-shore sites or on land. The function of CDFs is to retain the dredged material solids whilst releasing the carrier water. For facilities receiving contaminated material, an additional objective is to provide the efficient isolation of contaminants from the surrounding area. To achieve this, depending on the degree of intended isolation, CDFs may be equipped with a complex system of control measures such as surface covers and liners, treatment of effluent, surface runoff and leachate.] [19]

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[17] Egypt proposed to change the order of paragraphs in the section 7, in order to put definition before the treatment technologies. The proposed text following this change is quoted below:
Definition
132. Treatment is defined as the processing of contaminated dredged material to reduce its quantity or to reduce the contamination. Treatment generally refers to removed dredged material, since treatment in situ is not usually an option. The quality of the sediment defines whether a treatment is feasible or not. In most cases the content of heavy metal and organic contaminants is primarily related to grain size. In general the finer the particles and the higher the content of organic matter are in the sediment, the higher the potential for contamination is. It is important to find realistic solutions for treating dredged material based on site- specific conditions and type of dredged material.
Treatment technologies
133. The main treatment technologies available include separation, dewatering, thermal immobilisation and bioremediation. Simple technologies such as sand separation, land farming, ripening and stabilisation can be applied if the material is not heavily contaminated. More advanced technologies such as immobilisation may be required to treat heavily contaminated sediments. Technology is available for all kinds of treatment processes, however treatment costs should be considered within the cost- benefit analysis of each case, in particular when there is contamination, which requires stabilisation or removal that increases its costs.
More detailed information on treatment technologies can be found at www.PIANC.org]
(b) Confined disposal
134. Confined disposal means that the dredged material is placed in an engineered containment structure, that is, within dikes or bunds, or in natural or constructed pits, or borrow pits. This isolates the material from surrounding waters or soils during and after disposal. Other terms used in the literature for this type of disposal include “confined disposal facility" (CDF), “diked disposal site” and “containment area”. CDFs may be constructed in open waters (known as island CDFs), at near-shore sites or on land. The function of CDFs is to retain the dredged material solids whilst releasing the carrier water. For facilities receiving contaminated material, an additional objective is to provide the efficient isolation of contaminants from the surrounding area. To achieve this, depending on the degree of intended isolation, CDFs may be equipped with a complex system of control measures such as surface covers and liners, treatment of effluent, surface runoff and leachate

[18] Insertion proposed by Spain

[19] The meeting of the Regional Meeting of Experts to review the Draft Desalination and Dumping Protocol Guidelines (Loutraki, 4-6 April 2017) agreed with the proposed content of the paragraph on confinement and cleared it from the technical point of view. It decided to leave this paragraph in square brackets for further discussion by the MED POL Focal Points meeting in May 2017 following the submission by the Secretariat of a legal analysis whether a dumping permit should be issued for this activity and whether it is a placement or a dumping related activity. The meeting recommended to the Secretariat to take into consideration best relevant global, regional and national practices on this matter.

[(b) Other treatment technologies [20]

133. Treatment is defined as the processing of contaminated dredged material to reduce its quantity or to reduce the contamination. Treatment generally refers to removed dredged material, since treatment in situ is not usually an option. The quality of the sediment defines whether a treatment is feasible or not. In most cases the content of heavy metal and organic contaminants is primarily related to grain size. In general the finer the particles and the higher the content of organic matter are in the sediment, the higher the potential for contamination is. It is important to find realistic solutions for treating dredged material based on site- specific conditions and type of dredged material.

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More detailed information on treatment technologies can be found at www.PIANC.org]

8. Best Environmental Practices for dredging and dredged material management

[Introduction [21]

135. A dredger is a piece of equipment which can dig, transport and dump a certain amount of underwater laying soil in a certain time. Dredging equipment can be divided in Mechanical and Hydraulic Dredgers, depending on the way that the soil is excavated.

(a) Digging
Hydraulic digging make use of the erosive working of a water flow. For instance, a water flow generated by a dredge pump is lead via suction mouth over a sand bed. The flow will erode the sand bed and forms a sand-water mixture before it enters the suction pipe. Hydraulic digging is mostly done with special water jets. Hydraulic digging is mostly done in cohesionless soils such as silt, sand and gravel. **[Mechanical dredges are characterized by the use of some form of bucket to excavate and raise the bottom material. Mechanical dredges may be classified into two subgroups by how their buckets are connected to the dredge: wire rope-connected (clamshell or dragline) and structurally connected (a backhoe).]**[22] Mechanical digging [~~by knives, teeth or cutting edges of dredging equipment~~][23] is apply to cohesive soils.

(b) Transport
The transport of the dredged soil can be also done hydraulically or mechanically, either continuously or discontinuously.

(c) Deposition
Deposition of soil can be done in simple ways by opening the grab, turning the bucket or opening the bottom doors in a ship. Hydraulic deposition happens when the mixture is flowing over the reclamation area. The sand will settle while the water flows back to sea or river.

[20] This paragraph in square brackets was added by the Secretariat following the discussions held during the Regional Meeting of Experts to review the Draft Desalination and Dumping Protocol Guidelines (Loutraki, 4-6 April 2017), which requested the Secretariat to provide information on other available treatment technologies.
[21] This section in square brackets was added by the Secretariat following the discussions held during the Regional Meeting of Experts to review the Draft Desalination and Dumping Protocol Guidelines (Loutraki, 4-6 April 2017), which requested the Secretariat to provide information on dredger operation technology.
[22] Insertion proposed by Spain
[23] Deletion proposed by Spain

136. Dredgers can have the aforementioned three functions integrated or separated. The choice of the dredger for executing a dredging operation depends not only on the above mentioned functions but also from other conditions such as the accessibility to the site, weather and wave conditions, anchoring conditions, required accuracy etc.

More detailed information on dredgers can be found at http://www.dredging.org/media/ceda/org/documents/resources/othersonline/vlasblom1-introduction-to-dredging-equipment.pdf]

Best Environmental Practices

137. The applicability of BEPs is generally varying according to the particular circumstances of each dredging operation and it is clear that different approaches may then be appropriate. Generally, the objectives of BEPs are to:

(a) Minimize the impacts of dredging operation on the marine ecosystems
(b) Minimize the effects caused by the deposit of dredging materials
(c) Optimize the quantities for deposit
(d) Improve sediment quality

138. Optimization of the quantities for deposit:

A. Minimize the impacts of dredging

Minimizing the impacts in reducing the increase in turbidity and minimizing oxygen depletion

Proposed BEP:
(a) use excavation tools /dredger heads appropriate to minimize turbidity
(b) use silt screens/shields
(c) minimize overflow by e.g. recirculation of overflow water
(d) use specially designed dredgers to dredge contaminated sediments
(e) avoid the use of dredgers which introduce large amounts of suspended sediments into the water column where this may lead to problems with oxygen depletion or contamination e.g. agitation dredgers
(f) avoid periods when dredging induced turbidity will lead to unacceptable reductions in oxygen levels due to high temperatures.

B. Keep volume of dredged material minimal

To this aim, operators would consider the following:

a. Minimize need for dredging such as:

i. *in fluid mud areas: introduce the concept of Navigable depth based on:*
(a) physical and chemical evaluation of the sediment (including rheometry and densitometry)
(b) full scale trials

Proposed BEP:
Dredging only the amount of material required for maintaining a particular density level to allow navigation. This may require e.g. continuous underway measurement of sediment density by using a nuclear transmission gauge or measurement of shear forces.

ii. in areas with sandy waves.

Proposed BEP:
Selective dredging of sand waves and other mobile sand structures

iii. hydraulic engineering

Proposed BEP:
Use of hydraulic structures to reduce sedimentation
iv. *accurate monitoring of dredged depths at an appropriate frequency*

Proposed BEP:
Accurate positioning systems e.g.:
(a) microwave systems
(b) radio wave technology
(c) differential Global Positioning System (DGPS)
(d) apply rapid survey equipment
(e) continuous measurement systems
(f) echo sounders
(g) swath/multi beam systems

C. Optimization of dredging operations management through accurate survey systems

i. *availability of survey data on board*

Proposed BEP:
(a) online visualization of updated bathymetric charts, including topographic data, coastlines, deposit areas, dredge position, dredge head position
(b) tidal information

ii. *process evaluation*

Proposed BEP:
(a) visualization/evaluation of dredged tracks/profiles/zones
(b) dredging intensity chart
(c) in case of muddy material, sand and gravel: establish optimum overflow time by analysis of load diagrams

B. Improve dredging process, through

i. *effective dredging process control*

Proposed BEP:
(a) Continuous on-line measurements and presentation e.g. of area, heading, speed of the dredgers and position of the suction head/buckets/cutter/backhoe/grab/ wheel/...
(b) measurement of mixture velocity and concentration
(c) measurement of macro production (load diagram)
(d) hopper-measurement system monitoring the filling process

ii. *output improving techniques*

Proposed BEP:
(a) best suited suction head/cutters wheel/ backhoe/buckets
(b) submerged dredge-pumps
(c) degassing installations

iii. *selective dredging techniques*

Proposed BEP:

(a) selective dredging to e.g. separate contaminated material

D. Improve sediment quality

Improvement of sediment quality through an in situ operation before dredging and after deposit and improvement of physical aspects (cohesion, consistency, density) of dredged material

Proposed BEP in situ before dredging:

(a) where relevant, increase sediment density by physical means e.g. vibration or mechanical separation

Proposed BEP during the dredging process:

(a) hydro cyclones for separation of granulometric fractions
(b) flotation
(c) dewatering (under development) (consider potential problems with process water and associated contaminants e.g. re- circulation will reduce problems)

PART B MONITORING OF DREDGED MATERIAL DUMPING OPERATIONS

1. Definition

139. In the context of assessing and regulating the environmental and human health impacts of dredged material dumping operations, monitoring is defined as all measures whose purpose is to determine, from the repeated measurement of a contaminant or an effect, whether direct or indirect, of the introduction of this contaminant into the marine environment, the spatial and temporal modifications undergone by the receiving zone as a result of the activity under consideration.

140. It should be noted that the provisions of Part B cover all dredged material operations at sea.

2. Rationale

141. Monitoring of dredged material dumping operations is generally undertaken for the following reasons:

(a) to establish whether the dumping permit conditions have been respected - compliance monitoring - and consequently have, as intended, prevented adverse effects on the receiving area as a consequence of dumping;
(b) to improve the basis on which permit applications are assessed by improving knowledge of the field effects of major discharges which cannot be directly estimated by a laboratory evaluation or from the literature;
(c) to provide the necessary evidence to demonstrate that within the framework of the Protocol the monitoring measures applied are sufficient to ensure that the dispersive and assimilative capacities of the marine environment are not exceeded, and so dumping operations do not cause damage to the environment and deteriorate GES.

3. Objectives

142. The purposes of monitoring are to determine contaminant levels in all sediments above the lower reference threshold in paragraph 24(b) of the guidelines and in bio-indicator organisms, and the biological effects and consequences for the marine environment of the dumping of dredged material and, ultimately, to help managers to combat exposure of organisms to dredged materials and associated contaminants.

143. Whenever possible, the monitoring programme should be aligned with the current MEDPOL monitoring programmes for the Ecological Objectives 5, 8, 9, and 10, in line with the Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria set out in Decision IG. 22/7 of the COP 19.

4. Strategy

144. Monitoring operations are expensive since they require considerable resources both to carry out measurement and sampling programmes at sea and the subsequent analytical work on the samples. In order to approach the monitoring programme in a resource-effective manner, it is essential that the programme has clearly defined objectives, that the measurements made can meet those objectives, and that the results are reviewed at regular intervals in relation to the objectives.

145. Since the effects of dredged material dumping are likely to be similar in many areas, there appears to be little justification for monitoring all sites, particularly those receiving small quantities of dredged material. It would be more effective to carry out more detailed investigations at a few carefully chosen sites based on risk-based approach e.g. those subject to large inputs of dredged material) in order to obtain a better understanding of the processes and effects involved.

146. This is particularly the case for zones which present the same physical, chemical and biological characteristics, or nearly the same characteristics, for which there is strong presumptive evidence that the effects of dredged material dumping are similar, and it is very difficult to justify monitoring of all sites on scientific and economic grounds, particularly for those receiving small quantities of dredged material (e.g. less than 25,000 tons per year).

5. Impact Hypothesis

147. In order to establish such objectives, it is first necessary to derive an impact hypothesis describing predicted effects on the physical, chemical and biological characteristics both of the dumping zone and of the surrounding zones. The impact hypothesis forms the basis for defining the field monitoring programme.

148. The aim of an impact hypothesis is to provide, on the basis of the available information, a concise scientific analysis of the potential effects of the proposed operation on human health, living resources, marine life, amenities and other legitimate uses of the sea. For this purpose, an impact hypothesis should incorporate information on the characteristics of the dredged material and on conditions at the proposed dumping site. It should encompass both temporal and spatial scales of potential effects.

149. One of the main requirements of the impact hypothesis is to produce criteria which describe the specific environmental effects of dumping activities, taking into account the fact that such effects have to be avoided outside the designated dredging and dumping zones (see Part A, Section 3).

6. Preliminary Evaluation

150. The preliminary evaluation should be as comprehensive as possible. The primary areas of potential impact should be identified as well as those considered to have the most serious consequences for human health and the environment. Alterations to the physical environment, risks to human health, devaluation of marine resources, and interference with other legitimate uses of the sea are often seen as priorities in this regard.

151. The expected consequences of dumping could be described in terms of the habitats, processes, species, communities and uses affected by the dumping in line with GES definitions and targets. The precise nature of the predicted change, response, or interference (effect) could then be described. The GES and the effect should be described (quantified) together in sufficient detail to eliminate any doubt as to the parameters to be measured during post-operational field monitoring. In the latter context, it might be essential to determine "where" and "when" the impacts can be expected.

7. Reference Baseline

152. In order to develop an impact hypothesis, it may be necessary to conduct a baseline survey and checking the GES's values which describe not only the environmental characteristics, but also the variability of the environment. It may also be helpful to develop sediment transport, hydrodynamic and other mathematical models, to determine the possible effects of dumping.

153. Where either physical or chemical effects at the seabed are expected, it will be necessary to examine the benthic community structure in areas where the dredged material disperses. In the case of chemical effects, it may also be necessary to examine the chemical quality of the sediments and the biota (including fish), in particular the major pollutant contents.

154. In order to assess the impact of the proposed activity on the surrounding environment, it will be necessary to compare the physical, chemical and biological quality of the affected areas with reference sites located away from dredged material dumping pathways and with similar physical and biological

characteristics with the affected areas. Such areas can be identified during the early stages of the impact assessment.

8. Impact Hypothesis Verification: Defining the Monitoring Programme

155. The measurement programme should be designed to ascertain that physical, chemical and biological changes in the receiving environment are within baseline survey values and don't affect adversely the achievement or maintenance of GES.

156. The measurement programme should be designed to determine:
(a) whether the zone of impact differs from that projected; and,
(b) whether the extent of changes outside the zone of direct impact is within the scale predicted.

157. The first question can be answered by designing a sequence of measurements in space and time that circumscribe the projected zone of impact to ensure that the projected spatial scale of change is not exceeded.

158. The second question can be answered by making physical, chemical and biological measurements that provide information on the extent of change that occurs outside the zone of impact, after the dumping operation takes place (verification of a null hypothesis). Then, before any programme is drawn up and any measurements are made, the following questions should be addressed:

(a) what testable hypothesis can be derived from the impact hypothesis?
(b) what exactly should be measured to test these impact hypotheses?
(c) in what compartment or at which locations can measurements most effectively be made?
(d) for how long should measurements continue to be made to meet the original aim?
(e) what should be the temporal and spatial scale of the measurements made?
(f) how should the data be processed and interpreted?

159. It is recommended that the choice of contaminants to be monitored should depend primarily on the ultimate purposes of monitoring. It is definitely not necessary to monitor regularly all contaminants at all sites and it should not be necessary to use more than one substrate or effect to meet each aim.

9. Monitoring

160. The dumping of dredged material has its primary impact at the seabed. Thus although a consideration of water column effects cannot be discounted in the early stages of monitoring planning, it is often possible to restrict subsequent monitoring to the seabed.

161. Where it is considered that effects will be largely physical, monitoring may be based on remote methods such as side-scan sonar, to identify changes in the characteristics of the seabed, and bathymetric techniques (e.g. echo sounding) to identify areas of dredged material accumulation. Both these techniques will require a certain amount of sediment sampling to establish ground-truth. In addition, multispectral scanning can be used for monitoring the dispersion of suspended material (plumes, etc.) during the disposal operations.

162. Tracers may also be proved useful in following the dispersal of the dredged material and assessing any minor accumulation of material not detected by bathymetric surveys. Where, in relation to the impact hypothesis, either physical or chemical effects at the seabed is expected, it will be necessary to examine the benthic community structure in areas where the dredged material disperses. In the case of chemical effects, it may also be necessary to analyse the possible bio accumulation of pollutants (including fish).

163. The spatial extent of sampling will need to take into account the size of the area designated for dumping, the mobility of the dumped dredged material and water movements which determine the direction and extent of sediment transport. It should be possible to limit sampling within the dumping site itself if effects in this area are considered to be acceptable and their detailed definition unnecessary. However, some sampling should be carried out to aid the identification of the type of effect which may be expected in other areas and for scientific purposes.

164. The frequency of surveying will depend on a number of factors. Where a dumping operation has been going on for several years, it may be possible to establish the effect at a steady state of input and repeated surveys would only be necessary if changes are made to the operation (quantities or type of dredged material dumped, method of disposal, etc.). If it is decided to monitor the recovery of an area which is no longer used for dumping dredged material, more frequent measurements might be needed.

10. Notification

The Contracting Parties should inform the Organization of their monitoring activities. Concise reports on monitoring activities should be prepared and transmitted to the Organization as soon as they are available, in conformity with Article 26 of the Barcelona Convention and the Integrated Monitoring and Assessment Programme adopted by COP 19 (Decision IG22/7).

11. Feedback

165. Information gained from field monitoring (and/or other related research) can be used to:

(a) modify or, in the best of cases, terminate the field monitoring programme;
(b) modify or revoke the permit;
(c) serve as a basis to improve the permitting system refine the basis on which applications for permits are assessed.

ANNEX I
ANALYTICAL REQUIREMENTS FOR THE ASSESSMENT OF DREDGED MATERIAL

Analytical Requirements for the Assessment of Dredged Material

1. This Annex amplifies the analytical requirements set out in paragraphs 50-52 of the Updated Guidelines on Management of Dredged Material.

2. An integrated approach is essential. It includes a tiered approach under which the following are assessed in sequence:

[Alternative proposal by Italy:[24]
2. Evaluations of dredged material are most efficiently conducted following a tiered process that begins with collecting existing relevant information, sediment chemistry data, and results from simple screening approaches. The evaluation then progresses, as needed, to more detailed assessments where information from multiple lines of evidence is collected to reach conclusions about contaminant exposure, effects and, ultimately, the risks posed by the disposal of dredged material into the sea (PIANC 2006). The term line of evidence is commonly used to refer to broadly-defined categories of information, physical, chemical and biological data, e.g. sediment chemistry, toxicity test data, and benthic community survey results.
The recommended sequence of tiers is as follows:]

- the physical properties;
- the chemical properties;
- the biological properties and effects.

3. At each tier it will have to be determined whether there is sufficient information to allow a management decision to be taken or whether further analysis is required. Further information determined by local circumstances can be added at each tier.

4. As a preliminary to the tiered analysis scheme, information required under Part A Section 4 (par. 32) of the guidelines will be available. In the absence of appreciable pollution sources and if the visual determination of sediment characteristics leads to the conclusion that the dredged material meets one of the exemption criteria under paragraphs 39-40 of the guidelines, the material will not require further analysis.

5. It is important that, at each stage, the assessment procedure takes account of the method of analysis.

6. Analysis should be carried out on the non-coarse fraction sediment (less than 2 mm).

Tier I: PHYSICAL PROPERTIES

7. In addition to the preliminary assessment of the characteristics of the sediments required by paragraph 32 of these guidelines, it is strongly recommended that the following be determined:

- distribution of grain size (% of sand, silt, clay);
- [~~humidity ratio (%);~~**density/specific gravity;**][25]
- amount of organic matter.

[24] Italy proposed to replace the sentence "An integrated approach is essential. It includes a tiered approach under which the following are assessed in sequence" with the sentence added in the text in square brackets, in line with the wording of the LC/LP 2017 Guidelines.
[25] Spain proposed to replace the "humidity ratio (%)" with "density/specific gravity"

[Alternative proposal by Italy for paragraph 7 [26]

7. In addition to the preliminary assessment of the characteristics of the sediments required by paragraph 32 of these guidelines, the basic physical characteristics required are the amount of material, particle size distribution and other geotechnical attributes of the sediment (e.g. specific gravity of solids).
It is strongly recommended that the following determinations be carried out:
• grain size analysis (by laser or sieving methods)
• percentage of solids (dry matter)
• density/specific gravity
• organic matter (as total organic carbon)]

Tier II: CHEMICAL PROPERTIES

Primary group determinants [list[27]]:

8. In all cases where chemical analysis is required, the concentrations of the following trace metals [elements[28]] should be determined:

Arsenic (As)
Cadmium (Cd)
Chromium (Cr)
Copper (Cu)
Lead (Pb)
Mercury (Hg)
Nickel (Ni)
Zinc (Zn)

9. In certain cases, the analysis may also include other pollutants. In the case of mercury, special attention should be paid to speciation.

10. [Where dry matter analysis is required, the ratio of fresh weight/dry weight has to be considered, and the analysis has to be made on the intertitial water.][29]

11. When examining the toxicity of contaminated dredged sediment, the analysis should also include [be carried out also on[30]] the water phase. Lastly, the total organic carbon should be measured.

12. With regard to organic pollutants, the sum of PCB congeners IUPAC numbers 28, 52, 101, 118, 138, 153 and 180, should be analyzed. If local circumstances so require, the analysis should be extended to other congeners.

13. The polycyclic aromatic hydrocarbons (PAH) (sum of 9 or sum of 16) and the tributyltin compounds (TBT) and their degradation products should also be measured.

[Alternative proposal by Italy for par.13 [31]

[26] Italy proposed to replace the paragraph 7 of Annex I with the text put in square brackets
[27] Italy proposed to replace the “group determinants” with “list”
[28] Italy proposed to replace the word “metals” with the word “elements”
[29] Spain proposed to delete the paragraph 10 of Annex I, included in square brackets. Italy also suggested that this paragraph is unclear
[30] Italy proposed to replace the “also include” with “be carried out also on”
[31] Italy proposed an alternative text for the paragraph 13, put in square brackets

13. The polycyclic aromatic hydrocarbons (PAH) (sum of 16PAH or sum of 9 as a subgroup including at least the following, but not limited to: anthracene; benzo[a]anthracene; benzo[ghi]perylene;benzo[a]pyrene;chrysene; fluoranthene; indeno[1,2,3-cd]pyrene; pyrene; phenanthrene)) and the tri-butyl tin compounds (TBT) and their degradation products should also be measured.
As a minimum requirement, national action levels need to be established for the primary list above.]

14. The measurement of PCB, [PAH] and TBT will not be necessary when:

- sufficient information from previous investigations indicates the absence of contamination ;
- there are no known sources (point or diffuse) of contamination nor historic inputs;
- the sediments are predominantly coarse; and
- the levels of total organic carbon are low.

Secondary group determinants [list][32]:

15. Based upon local information on sources of contamination (point or diffuse sources) or historic inputs, other determinants may need to be measured for instance: organophosphorus pesticides; organochlorine pesticides; polychlorinated dibenzodioxins (PCDD); polychlorinated dibenzofurans (PCDF).

[Alternative proposal by Italy for par. 15[33]

15. Based upon local information on sources of contamination (point or diffuse sources) or historic inputs, other determinants may need to be measured for instance:
Other chlorobiphenyls
organophosphorus pesticides;
organochlorine pesticides;
polychlorinated dibenzodioxins (PCDD);
polychlorinated dibenzofurans (PCDF);
Petroleum hydrocarbons
Phthalates (DEHP and optionally - DBP/BBP)
Tri-phenyl tin (TPhT)
Other anti-fouling agents

In deciding which additional individual organic contaminants to determine, reference should be made to existing priority substance lists, such as those prepared by the EU (as applicable).]

[**Tier III: BIOLOGICAL PROPERTIES AND EFFECTS**[34]

16. In a significant number of cases the physical and chemical properties do not allow the biological impact to be measured directly. Moreover, they do not adequately identify all the physical disturbances nor constituents associated with sediments present in the dredged material.

17. If the potential impact of the dredged material to be dumped cannot be adequately assessed on the basis of chemical and physical characteristics, biological measurements should be made.

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[32] Italy proposed to replace the "group determinants" with "list"
[33] Italy proposed an alternative text for the paragraph 15, put in square brackets
[34] The Secretariat was requested to include in the updated Guidelines the Annexes 1 and 2 of the current Guidelines adopted in 1999. The Meeting already reviewed the first part of the Annex I (tiers I and II) and is therefore provided as clear text. The rest is included into square brackets for further review by the MED POL Focal Points, in line with the Meeting conclusions and recommendations.

1. Toxicity bioassays

18. The primary purposes of the biological bioassays is to provide direct measures of effects of all sediment constituents acting together, taking into account their bioavailability. For ranking and classifying the acute toxicity of harbour sediments prior to maintenance dredging, short term bioassays may often suffice as screening tool :

- To evaluate the effects of the dredged material, bioassays for acute toxicity can be carried out with pore water, on elutriate or the whole sediment. In general, a set of 2-4 bioassays is recommended with organisms from different taxonomic groups (e. g. crustaceans, molluscs, polychaetes, bacteria, echinoderms), [**using species that are considered appropriately sensitive and ecologically relevant and methods have been standardized and validated;**][35]
- In most bioassays, survival of the test species is used as an endpoint. Chronic bioassays with sub-lethal endpoint (growth, reproduction, etc.) covering a significant part of the test species life cycle may provide a more accurate prediction of potential impacts of dredging operations,. [~~However, standard test procedures are still under developments.~~ **thus are recommended**[36]**.**]

19. The outcome of sediment bioassays can be unduly influenced by factors other than sediment associated chemicals. Confounding factors like ammonia, hydrogen sulphide, grain size, oxygen content and pH should therefore be determined during the bioassays.

20. Guidance on the selection of appropriate test organisms, use and interpretation of sediment bioassays is given by e.g. EPA/CE (1991/1994) and IADC/CEDA (1997) [**or PIANC (2006)**][37] while guidance on sampling of sediments for toxicological testing is given by e.g. ASTM (1994).

2. Biomarkers

21. Biomarkers may provide early warning of more subtle (biochemical) effects at low and sustained levels of contamination. Most biomarkers are still under development but some are already applicable for routine application on dredged material (e.g. one which measures the presence of dioxin-like compounds - Murk et al., 1997) or organisms collected in the field (e.g. DNA strand/breaks in flat fish).

3. Microcosm experiments

22. There are short-term microcosm tests available to measure the toxicant tolerance of the community e.g. Pollution Induced Community Tolerance (PICT) (Gustavson and Wangberg, 1995).

4. Mesocosm experiments

23. Because of the costs and time involved these experiments cannot be used for issuing permits but are useful in cases where the extrapolation of laboratory testing to field conditions is complicated or when environmental conditions are very variable and hinder the identification of toxic effects as such. The results of these experiments would be then available for future decisions on permits.

5. Field observations of benthic communities

24. In situ monitoring of benthic communities (fish, benthic invertebrates) in the area of the disposal site can provide important indications of the condition of marine sediments. Field observations give an insight into the combined impact of physical disturbance and chemical

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[35] Inclusion proposed by both Spain and Italy
[36] Italy proposed to delete the sentence “However, standard test procedures are still under developments” and replace it with the sentence “thus are recommended, put in square brackets.
[37] Inclusion proposed by Spain

contamination. Guidelines on the monitoring of benthic communities are provided by e.g. the Paris Convention, 1992, ICES.

6. Other biological properties

25. Where appropriate, other biological measurements can be applied in order to determine, for example, the potential for bioaccumulation and for tainting.

SUPPLEMENTARY INFORMATION

26. The need for this information will be determined by local circumstances and may form an essential part of the management decision. Appropriate data might include: redox potential, sediment oxygen demand, total nitrogen, total phosphorus, iron, manganese, mineralogical information or parameters for normalising trace metal data (e.g. aluminium, lithium, scandium).]

ANNEX II
NORMALISATION TECHNIQUES FOR STUDIES ON THE SPATIAL DISTRIBUTION OF CONTAMINANTS[38] [39]

[38] Extract from 1989 ACMP Report (Section 14) ICES Coop. Res. Rep. 167, pp. 68-75

[39] The Secretariat was requested to include in the updated Guidelines the Annexes 1 and 2 of the current Guidelines adopted in 1999. The Meeting already reviewed the first part of the Annex I (tiers I and II) and is therefore provided as clear text. The rest is included into square brackets for further review by the MED POL Focal Points, in line with the Meeting conclusions and recommendations.

NORMALISATION TECHNIQUES FOR STUDIES ON THE SPATIAL DISTRIBUTION OF CONTAMINANTS[40] [41]

[Alternative title proposed by Spain [42]

Annex II. CHEMICAL ANALYTICAL METHODS AND NORMALISATION TECHNIQUES FOR STUDIES ON THE SPATIAL DISTRIBUTION OF CONTAMINANTS]

1. Introduction

1. Normalisation in this discussion is defined as a procedure to compensate for the influence of natural processes on the measured variability of the concentration of contaminants in sediments. Most contaminants (metals, pesticides, hydrocarbons) show high affinity to particulate matter and are, consequently, enriched in bottom sediments of estuaries and coastal areas. In practice, natural and anthropogenic substances entering the marine system are subjected to a variety of biogeochemical processes.

[Alternative proposal by Italy for par.1 [43]

Normalisation is defined here as a procedure to correct contaminant concentrations for the influence of thenatural variability in sediment composition (grain size, organic matter and mineralogy). Most contaminants (metals and organic contaminants) show high affinity to particulate matter and are, consequently, enriched in bottom sediments of estuaries and coastal areas. In practice, natural and anthropogenic substances entering the marine system are subjected to a variety of biogeochemical processes.]

2. As a result, they become associated with fine-grained suspended solids and colloidal organic and inorganic particles. The ultimate fate of these substances is determined, to a large extent, by particulate dynamics. They therefore tend to accumulate in areas of low hydrodynamic energy, where fine material is preferentially deposited. In areas of higher energy, these substances are "diluted" by coarser sediments of natural origin and low contaminant content.

3. It is obvious that the grain size is one of the most important factors controlling the distribution of natural and anthropogenic components in the sediments. It is, therefore, essential to normalise for the effects of grain size in order to provide a basis for meaningful comparisons of the occurrence of substances in sediments of various granulometry and texture within individual areas or among areas. Excess levels, above normalised background values, could then be used to establish sediment quality.

4. For any study of sediments, a basic amount of information on their physical and chemical characteristics is required before an assessment can be made on the presence or absence of anomalous contaminant concentrations. The concentration at which contamination can be detected depends on the sampling strategy and the number of physical and chemical variables that are determined in individual samples.

5. The various granulometric and geochemical approaches used for the normalisation of trace elements data as well as the identification of contaminated sediments in coastal sediments has been

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[40] Extract from 1989 ACMP Report (Section 14) ICES Coop. Res. Rep. 167, pp. 68-75
[41] The Secretariat was requested to include in the updated Guidelines the Annexes 1 and 2 of the current Guidelines adopted in 1999. The Meeting already reviewed the first part of the Annex I (tiers I and II) and is therefore provided as clear text. The rest is included into square brackets for further review by the MED POL Focal Points, in line with the Meeting conclusions and recommendations.
[42] Spain proposed to change the title of the Annex, since its content have a broader scope than merely the normalization techniques and it covers also chemical analytical methods
[43] Italy proposed an alternative text for the paragraph 1 of Annex II, put in square brackets

extensively reviewed by Loring (1988). Two normalisation approaches widely used in oceanography and in atmospheric sciences have been selected here. The first is purely physical and consists of characterising the sediment by measuring its content of fine material.

6. The second approach is chemical in nature and is based on the fact that the small size fraction is usually rich in clay minerals, iron and manganese oxi-hydroxides and organic matter. Furthermore, these components often exhibit a high affinity for organic and inorganic contaminants and are responsible for their enrichment in the fine fraction. Chemical parameters (e.g., Al, Sc, Li) representative of these components may thus be used to characterise the small size fraction under natural conditions.

7. It is strongly suggested that several parameters be used in the evaluation of the quality of sediments. The types of information that can be gained by the utilisation of these various parameters are often complementary and extremely useful considering the complexity and diversity of situations encountered in the sedimentary environment. Furthermore, measurements of the normalising parameters selected here are rather simple and inexpensive. This annex presents general guidelines for sample preparation, analytical procedures, and interpretation of physical and chemical parameters used for the normalisation of geochemical data. Its purpose is to demonstrate how to collect sufficient data to normalise for the grain-size effect and to allow detection, at various levels, of anomalous concentrations of contaminants within coastal sediments.

2. Sampling Strategy[44]

8. Ideally, a sampling strategy should be based on a knowledge of the source of contaminants, the transport pathways of suspended matter and the rates of accumulation of sediments in the region of interest. However, existing data are often too limited to define the ideal sampling scheme. Since contaminants concentrate mainly in the fine fraction, sampling priority should be given to areas containing fine material that usually correspond to zones of deposition.

9. The high variability in the physical, chemical and biological properties of sediments implies that an evaluation of sediment quality in a given area must be based on a sufficient number of samples. This number can be evaluated by an appropriate statistical analysis of the variance within and between samples. To test the representativity of a single sediment specimen at a given locality, several samples at one or two stations should be taken.

10. The methodology of sampling and analysis should follow the recommendations outlined in the "Guidelines for the Use of Sediments as a Monitoring Tool for Contaminants in the Marine Environment" (ICES 1987). In most cases, the uppermost layer of sediments collected with a tightly closing grab sampler (Level I in the Guidelines) is sufficient to provide the information concerning the contamination of the sediments of a given area compared to sediments of uncontaminated locations or other reference material.

11. Another significant advantage of using sediments as monitoring devices is that they have recorded the historical evolution of the composition of the suspended matter deposited in the area of interest. Under favourable conditions, the degree of contamination may be estimated by comparison of surface sediments with deeper samples, taken below the biological mixing zone. The concentrations of trace elements in the deeper sediment may represent the natural background level in the area in question and can be defined as baseline values, **[taking into account the fact that it some cases it may also be historical pollution]**[45]. This approach requires sampling with a box-corer or a gravity corer (Levels II and III in the Guidelines).

3. Analytical Procedures

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[44] Spain suggested that there is no need to include in the Annex a sampling strategy for normalization
[45] The sentence in square brackets was added based on comments received from France

12. Typical analytical procedures to be followed are outlined in Figure 1. The number of steps that are selected will depend on the nature and extent of the investigation.

3.1 Grain size fractionation

13. It is recommended that at least the amount of material <63 μm, corresponding to the sand/silt classification limit, be determined. The sieving of the sample at 63 μm is, however, often not sufficient, especially when sediments are predominantly fine grained. In such cases, it is better to normalise with lower size thresholds since the contaminants are mainly concentrated in the fraction <20 μm, and even more specifically in the clay fraction (> 2 μm).

14. It is thus proposed that a determination be made, on a sub-sample, of the weight fraction < 20 μm and that > 2 μm with the aid of a sedimentation pipette or by elutriation. Several laboratories are already reporting their results relative to the content of fine fractions of various sizes and these results may be useful for comparison among areas.

3.2 Analysis of contaminants

15. It is essential to analyse the total content of contaminants in sediments if quality assessment is the goal of the study, and it is thus recommended that the unfractionated sample (< 2 mm) be analysed in its entirety. The total content of elements can be determined either by non-destructive methods, such as X-ray fluorescence or neutron activation, or by a complete digestion of the sediments (involving the use of hydrofluoric acid (HF)) followed by methods such as atomic absorption spectrophotometry or emission spectroscopy. In the same way, organic contaminants should be extracted with the appropriate organic solvent from the total sediment.

16. An individual size fraction of the total sediment may be used for subsequent analysis, if required, to determine the absolute concentrations of contaminants in that fraction, providing that its contribution to the total is kept in perspective when interpreting the data. Such size fraction information might be useful in tracing the regional dispersal of metals associated with specific grain-size fractions, when the provenance of the material remains the same. However, sample fractionation is a tedious procedure that introduces considerable risk of contamination and potential losses of contaminants due to leaching. The applicability of this approach is thus limited.

4. Normalisation Procedures

4.1 Granulometric normalization

17. Since contaminants tend to concentrate in the fine fraction of sediments, correlations between total concentrations of contaminants and the weight percent of the fine fraction, determined separately on a sub-sample of the sediment by sieving or gravity settling, constitute a simple but powerful method of normalisation. Linear relationships between the concentration and the weight percentage of the fine fraction are often found and it is then possible to extrapolate the relationships to 100% of the fraction studied, or to characterise the size dependence by the slope of the regression line.

4.2 Geochemical normalisation

18. Granulometric normalisation alone is inadequate to explain all the natural trace variability in the sediments. In order to interpret better the compositional variability of sediments, it is also necessary to attempt to distinguish the sedimentary components with which the contaminants are associated throughout the grain-size spectrum. Since effective separation and analysis of individual components of sediments is extremely difficult, such associations must rest on indirect evidence of these relationships.

19. Since contaminants are mainly associated with the clay minerals, iron and manganese oxi-hydroxides and organic matter abundant in the fine fraction of the sediments, more information can be obtained by measuring the concentrations of elements representative of these components in the samples.

20. An inert element such as aluminium, a major constituent of clay minerals, may be selected as an indicator of that fraction. Normalised concentrations of trace elements with respect to aluminium are commonly used to characterise various sedimentary particulate materials (see below). It may be considered as a conservative major element that is not affected significantly by, for instance, early diagenetic processes and strong redox effects observed in sediments.

21. In the case of sediments derived from the glacial erosion of igneous rocks, it has beenfound that contaminant/Al ratios are not suitable for normalising for granular variability (Loring, 1988). Lithium, however, appears to be an ideal element to normalise for the grain size effect in this case and has the additional advantage of being equally applicable to non-glacial sediments.

22. In addition to the clay minerals, Mn and Fe compounds are often present in the fine fraction, where they exhibit adsorption properties strongly favoring the incorporation of various contaminants. Mn and Fe are easily analyzed by flame atomic absorption spectrometry and their measurement may provide insight into the behavior of contaminants.

23. Organic matter also plays an important role as scavenger of contaminants and controls, to a major degree, the redox characteristics of the sedimentary environment.

24. Finally, the carbonate content of sediments is easy to determine and provides additional information on the origin and the geochemical characteristics of the sediments. Carbonates usually contain insignificant amounts of trace metals and act mainly as a diluent. Under certain circumstances, however, carbonates can fix contaminants such as cadmium and copper. A summary of the normalization factors is given in Table 1.

4.3 Interpretation of the data

25. The simplest approach in the geochemical normalization of substances in sediments is to express the ratio of the concentration of a given substance to that of the normalizing factor.

26. Normalization of the concentration of trace elements with respect to aluminium (or scandium) has been used widely and reference values on a global scale have been established for trace elements in various compartments: crustal rocks, soils, atmospheric particles, riverborne material, marine clays and marine suspended matter (cf., e.g., Martin and Whitfield, 1983; Buat-Menard and Chesselet, 1979).

27. This normalization also allows the definition of an enrichment factor for a given element with respect to a given compartment. The most commonly used reference level of composition is the mean global normalized abundance of the element in crustal rock (Clarke value). The enrichment factor EF is given by:

$$EF\ crust = (X/Al)\ sed / (X/Al)\ crust$$

where X/Al refers to the ratio of the concentration of element X to that of Al in the given compartment.

28. However, estimates of the degree of contamination and time trends of contamination at each sampling location can be improved upon by making a comparison with metal levels in sediments equivalent in origin and texture.

29. These values can be compared to the normalized values obtained for the sediments of a given area. Large departures from these mean values indicate either contamination of the sediment or local mineralization anomalies.

30. When other variables (Fe, Mn, organic matter and carbonates) are used to characterize the sediment, regression analysis of the contaminant concentrations with these parameters often yields useful information on the source of contamination and on the mineralogical phase associated with the contaminant.

31. A linear relationship between the concentration of trace constituents and that of the normalization factor has often been observed (Windom et al., 1989). In this case and if the natural geochemical population of a given element in relation to the normalizing factor can be defined, samples with anomalous normalized concentrations are easily detected and may indicate anthropogenic inputs.

32. According to this method, the slope of the linear regression equation can be used to distinguish the degree of contamination of the sediments in a given area. This method can also be used to show the change of contaminant load in an area if the method is used on samples taken over intervals of some years (Cato, 1986).

33. A multi-element/component study in which the major and trace metals, along with grain size and organic carbon contents, have been measured allows the interrelationships between the variables to be established in the form of a correlation matrix. From such a matrix, the most significant ratio between trace metal and relevant parameter(s) can be determined and used for identification of metal carriers, normalization and detection of anomalous trace metal values. Factor analyses can sort all the variables into groups (factors) that are associations of highly correlated variables, so that specific and/or non-specific textural, mineralogical, and chemical factors controlling the trace metal variability may be inferred from the data set.

34. Natural background levels can also be evaluated on a local scale by examining the vertical distribution of the components of interest in the sedimentary column. This approach requires, however, that several favourable conditions are met: steady composition of the natural uncontaminated sediments; knowledge of the physical and biological mixing processes within the sediments; absence of diagenetic processes affecting the vertical distribution of the component of interest. In such cases, grain-size and geochemical normalization permits compensation for the local and temporal variability of the sedimentation processes.

5. Conclusions

35. The use of the granulometric measurements and of component/reference element ratios are useful approaches towards complete normalization of granular and mineralogical variations, and identification of anomalous concentrations of contaminants in sediments. Their use requires that a large amount of good analytical data be collected and specific geochemical conditions be met before all the natural variability is accounted for, and the anomalous contaminant levels can be detected. Anomalous metal levels, however, may not always be attributed to contamination, but rather could easily be a reflection of differences in sediment provenance.

36. Geochemical studies that involve the determination of the major and trace metals, organic contaminants, grain size parameters, organic matter, carbonate, and mineralogical composition in the sediments are more suitable for determining the factors that control the contaminant distribution than the measurement of absolute concentrations in specific size fractions or the use of potential contaminant/reference metal ratios alone. They are thus more suitable for distinguishing between uncontaminated and contaminated sediments. This is because such studies can identify the factors that control the variability of the concentration of contaminants in the sediments.]

Figure 1. A typical approach for the determination of physical and chemical parameters in marine sediments

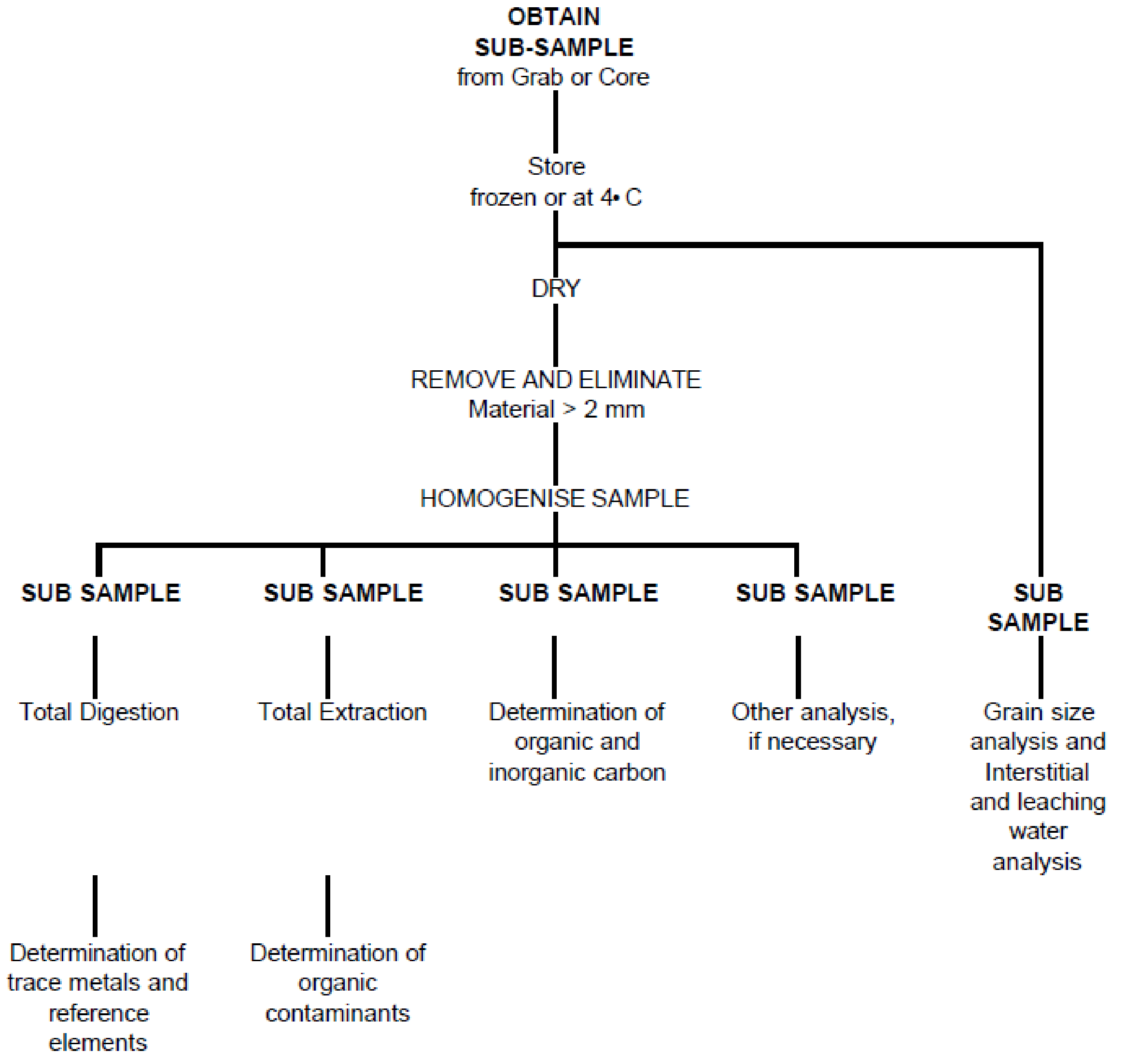

Table 1. Summary of normalisation factors

NORMALISATION FACTOR	GRAIN SIZE (Fm)	INDICATOR	ROLE
Textural			Determines physical sorting and depositional pattern of metals
Sand	2000 to 63	Coarse-grained metal-poor minerals / compounds	Usually diluent of trace metal concentrations
Mud	<63	Silt and clay size metalbearing minerals / compounds	Usually overall concentrator of trace metals
Clay	<2	Metal-rich clay minerals	Usually fine-grained accumulator of trace metals
Chemical			
Si		Amount and distribution of metal-poor quartz	Coarse-grained diluter of contaminants
Al		All silicates but used to account for granular variations of metal-rich fine silt and clay size Al-silicates	Chemical tracer of Alsilicates, particularly the clay minerals
Li, Sc		Structurally combined in clay minerals and micas	Tracer of clay minerals, particularly in sediments containing Al-silicates in all size fractions
Organic carbon		Fine-grained organic matter	Tracer of organic contaminants. Sometimes accumulator of trace metals like Hg and Cd.
Fe, Mn		Metal-rich silt and clay size Fe-bearing clay minerals. Ferich heavy minerals and hydrous Fe and Mn oxides	Chemical tracer for Fe-rich clay fraction. High absorption capacity of organic and inorganic contaminants
Carbonates		Biogenic marine sediments	Diluter of contaminants. Sometimes accumulate trace metals like Cd and Cu.

ANNEX III
CONTAMINANT ACTION LEVELS AND THRESHOLDS

Lower and Upper threshold levels adopted by Italy
IMO- LC/SG 40/INF.30 ,17 February 2017,

	L1	L2
Trace elements	**[mg kg-1] dry weight**	
Arsenic	12	20
Cadmium	0.3	0.8
Chromium	50	150
Chromium VI	2	2
Copper	40	52
Mercury	0.3	0.8
Nickel	30	75
Lead	30	70
Zinc	100	150
Organic contaminants	**[µg kg-1] dry weight**	
Organotin compounds	5 (TBT)	72 (MBT, DBT, TBT)
Σ PCB*	8	60
Σ 2,4′-4,4' DDD	0.8	7.8
Σ 2,4′-4,4' DDE	1.8	3.7
Σ 2,4′-4,4' DDT	1.0	4.8
Chlordane	2.3	4.8
Aldrin	0.2	10
Dieldrin	0.7	4.3
Endrin	2.7	10
a-HCH	0.2	10
b-HCH	0.2	10
γ-HCH (Lindane)	0.2	1.0
Heptachlor epoxide	0.6	2.7
HCB	0.4	50
Petroleum Hydrocarbon C>12	Not available	50000
ΣPAHs16	900	4000
Anthracene	24	245
Benzo[a]anthracene	75	500
Benzo[a]pyrene	30	100
Benzo[b]fluoranthene	40	500
Benzo[k]fluoranthene	20	500
Benzo[g,h,i]perylene	55	100
Crysene	108	846
Indenopyrene	70	100
Phenantrene	87	544
Fluorene	21	144
Fluoranthene	110	1494
Naphtalene	35	391
Pyrene	153	1398
T.E. PCDD,PCDF and Dioxin Like PCBs	2 x 10-3	1 x 10-2

Sum of CB: 28, 52, 77, 81, 101, 118, 126, 128, 138, 153, 156, 169, 180.

Chemical Levels L1 and L2 are elaborated by specifically developed weighted criteria, which allow abandoning the pass-to-fail approach. The chemical classification is based on the development of a Chemical Hazard Quotient (HQ_C) which considers the typology and number of parameters exceeding limits of L1 and L2, the magnitude of such exceedances and type of contaminant (priority or priority hazardous substances, according to Annex II of Directive 2008/105/EC). The sediment quality classification is the integration of chemical and ecotoxicological Hazard Quotients. In general, above

L2, dumping at sea is never allowed.

Lower and Upper threshold levels adopted by Spain

ACTION LEVELS (DW)

CONTAMINANT	N.A. A (Action level A) Limit for disposal at sea in restricted areas	N.A. B (Action level B) Limit for disposal at sea in case that bioassays are not conducted	N.A. C (Action level C) Limit for conducting bioassays
Hg (mg/kg)	0.35	0.71	2.84
Cd (mg/kg)	1.20	2.40	9.60
Pb (mg/kg)	80	218	600
Cu (mg/kg)	70	168	675
Zn (mg/kg)	205	410	1640
Cr (mg/kg)	140	340	1000
Ni (mg/kg)	30	63	234
As (mg/kg)	35	70	280
Σ 7 PCBs (mg/kg) (1)	0.05	0.18	0.54
Σ 9 PAHs (mg/kg) (2)	1.88	3.76	18.80
TBT(3) (mg Sn/kg)	0.05	0.20	1.0

(1) Sum of IUPAC congeners 28, 52, 101, 118, 138, 153 and 180.
(2) Sum of Anthracene, Benzo(a)anthracene, Benzo(ghi)perylene, Benzo(a)pyrene, Chrysene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Pyrene and Phenanthrene).
(3) TBT and their degradation products (DBT and MBT).
According the chemical (and biological characterization if it is done) the dredged material is classified in 3 classes:

- Class A: The concentration of all pollutants below action level A.
- Class B: The concentration of all pollutants below action level B or action level C (only in the case that biological characterization is conducted and the results indicate a negative toxicity).
- Class C: The concentration of one or more pollutants is above action level C or action level B in the case that biological characterization is conducted and the results indicate a positive toxicity). This material is not allow to be dumped and sub be subject to confinement, treatment or management on land.

Lower and Upper threshold levels adopted by France
http://www.ifremer.fr/cycleau/cycleau/reglementation/dragages.htm

- Under N1,the potential impact is considerable as neutral and negligible.Au-dessous du NIVEAU N1, l'impact potentiel est jugé neutre ou négligeable, les valeurs observées se révélant comparables aux bruits de fond environnementaux.
- Entre les NIVEAUX N1 et N2, une investigation complémentaire peut s'avérer nécessaire en fonction du projet considéré et du degré de dépassement du NIVEAU 1. Des tests sont alors pratiqués pour évaluer la toxicité globale des sédiments.
- Au-delà du NIVEAU N2, une investigation complémentaire est généralement nécessaire car des indices peuvent laisser présager un impact potentiel de l'opération. En fonction des résultats obtenus, l'immersion est susceptible d'être interdite et la mise en place de solutions alternatives encouragées. Une étude d'impact approfondie est alors jugée indispensable.

Contaminant (mg/kg-1 S.S.)	**Niveau N1**	**Niveau N2**
Arsenic (As)	**25**	**50**
Cadmium (Cd)	**1.2**	**2.4**
Chrome (Cr)	**90**	**180**
Cuivre (Cu)	**45**	**90**
Mercure (Hg)	**0.4**	**0.8**
Nickel (Ni)	**37**	**74**
Plomb (Pb)	**100**	**200**
Zinc (Zn)	**276**	**552**

Valeurs guides des niveaux 1 et 2 pour les métaux (mg/kg-^{1}de sédiment sec) retenues par la France (Arrêté du ~~14/06/2000~~ **[09/08/2006]**)[46].

Contaminant (mg/kg-1 de S.S.)	**Niveau N1**	**Niveau N2**
PCB totaux	**0.5**	**1**
PCB congénère 28	**0.025**	**0.05**
PCB congénère 52	**0.025**	**0.05**
PCB congénère 101	**0.05**	**0.1**
PCB congénère 118	**0.025**	**0.05**
PCB congénère 138	**0.05**	**0.1**
PCB congénère 153	**0.05**	**0.1**
PCB congénère 180	**0.025**	**0.05**

Valeurs guides des niveaux 1 et 2 pour les congénères de polychlorobiphényles (mg/kg-^{1} de sédiment sec) retenues par la France (Arrêté du 14/06/2000).

Dans le cadre du projet de recherche PNETOX (Programme National EcoTOXicologie), la détermination des valeurs guides a été étendue à des substances organiques toxiques présentes dans les sédiments des zones portuaires confinées. Les figures 6 et 7 présentent respectivement les niveaux guides proposés pour les hydrocarbures aromatiques polycycliques (HAP) prioritaires et pour le Tributylétain (TBT).

Contaminant (mg/kg-^{1} de S.S.)	**Niveau N1**	**Niveau N2**
Fluoranthène	**0.40**	**5**
Benzo(b)fluoranthène	**0.30**	**3**
Benzo(k)fluoranthène	**0.20**	**2**
Benzo(a)pyrène	**0.20**	**1**
Benzo(ghi)pérylène	**0.20**	**1**
Indéno(1,2,3cd)pyrène	**0.20**	**1**

Niveaux de référence (mg/kg-^{1} de sédiment sec) retenues pour les hydrocarbures aromatiques polycycliques ([1]).

Niveaux	**mg/kg-^{1}**	**Proposition**
1	**0 à <100**	**Immersion autorisée, sans condition particulière**
2	**100 à <400**	**Immersion autorisée sous réserve : Bio-essais & étude locale d'impact**
3	**^{3}400**	**Immersion autorisée sous réserve : Etude d'impact approfondie**

Niveaux de référence proposés pour le Tributylétain (mg/kg-^{1}de sédiment sec) ([1]).

[46] France will submit the most recent values as adopted by the Arrêté of 09/08/2006

ANNEX IV
REFERENCES

References

Brofjordens bottensediment 1984, samt förändringar efter 1972. / Heavy metals and petrogenic hydrocarbons in the sediments of Brofjorden in 1984, and changes after 1972. / University of Göteborg, Dep. of Marine Geology, Report No. 3, 95 p. (English summary)

Buat-Menard, P. and R. Chesselet (1979), Variable influence of atmospheric flux on the trace metal chemistry of oceanic suspended matter. Earth Planet.Sc.Lett., 42:399-411

Cato, I., J. Mattsson and A. Lindskog (1986), Tungmetaller och petrogena kolväten I

CEDA & IADC, 2008: Environmental Aspects of Dredging, Edited by R. N. Bray. Taylor and Francis. ISBN 978-0-415-45080-5

Columbia University at New York (2001) beneficial use of dredged materials.

EPA, Office of Water, 2001. Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual EPA-823-F-01-023.

EPA/CE, 1991. Evaluation of Dredged Material Proposed for Ocean Disposal: Testing Manual

EPA/CE, 1998. Evaluation of Dredged Material Proposed for discharge in Waters of the US. Testing Manual(Draft): Inland Testing Manual EPA – 823-B-98-004.

EPA-503/8-91/001. US-EPA Office of Water (WH-556F).

Gustavson, K. and S.A. Wangberg (1995), Tolerance induction and succession in microalgae communities exposed to copper and atrazine. Aquat.Toxicol., 32:283-302

Handling (QUASH) - Inter-laboratory study on sieving and normalisation of geographically different sediments; QUASH round 5 (sponsored by the EU Standards, Measurements and Testing Programme) 36 of 39 OSPAR Commission Agreement 2014- 06

ICES (1987), Report of the ICES Advisory Committee on Marine Pollution, 1986. ICES Coop.Res. Report No. 142, pp.72-75

ICES (1987), Report of the ICES Advisory Committee on Marine Pollution, 1986. ICES Coop. Res. Report No. 142, pp.72-75

IMO 2015, Guidelines on Low Cost, Low Technology Assessment of Dredged Material

International Maritime Organization (IMO) 2003. Waste Assessment Guidance - Selection and analysis of physical and chemical parameters for the assessment of dredged material quality, Report of the Scientific Group of the LONDON Convention.

IOC - UNEP - IMO, 2000. Global Investigation of Pollution in the Marine Environment (GIPME 2000): Guidance on Assessment of Sediment Quality, Pub. No. 439/00.

JAMP Guidelines for Monitoring Contaminants in Sediments (Agreement 2002-16)

Loring, D.H. (1988), Normalization of trace metal data. Report of the ICES Working Group on Marine Sediments in Relation to Pollution. ICES, Doc. C.M.1988/E:25, Annex 3

Loring, D.H. (1988), Normalization of trace metal data. Report of the ICES Working Group on Marine Sediments in Relation to Pollution. ICES, Doc. C.M.1988/E:25, Annex 3

Martin, J.M. and M. Whitfield (1983), River input of chemical elements to the ocean. In: Trace Metals in Sea-Water, edited by C.S. Wong, E. Boyle, K.W. Bruland, J.D. Burton and E.D. Goldberg. Plenum Press, New York and London. pp.265-296

Maryland dredged materials management programme (2007) Innovative

OSPAR Guidelines for the Management of Dredged Material at Sea (Agreement 2014-06)

PIANC 2006 Biological assessment guidance for dredged material, EnviCom report of WG 8 Rees, H.L., C.

QUASH (1999) Sediment Sieving Techniques, QUASH Project Office, FRS Marine Laboratory, PO Box 101, Victoria Road, Aberdeen, AB11 9DB, Scotland

Reuse of Dredged Materials

Smedes, F. (1997) Grain size Correction Procedures, Report of the ICES Working Group on Marine Sediments in Relation to Pollution. ICES CM 1997/Env:4, Ref. E, Annex 6.

Smedes, F. Davies, I.M., Wells, D., Allan, A., Besada, V. (2000): Quality Assurance of Sampling and Sample

Smedes, F., Lourens, J., and Wezel, van A. (1997) “Zand, Slib en Zeven, Standardisation of contaminant contents in marine sediments, Report RIKZ-96.043 (Dutch), ISSN 0927-3980, RIKZ, PO Box 20907, 2500 EX, The Hague.

Waste Assessment Guidelines under the London Convention and Protocol: 2014 edition

Windom, H.L., S.T. Schropp, F.D. Calder, J.D. Ryan, R.G. Smith Jr., L.C. Burney, F.G. Lewis, and C.H. Rawlinson (1989), Natural trace metal concentrations in estuarine and coastal marine sediments of the southeastern United States. Environ.Sci.Tech., 23:314-320