APPENDIX A

TERMS OF REFERENCE

COMMISSIONED RESEARCH ES 702. PROJECT BRIEF

CAPITAL AND MAINTENANCE DREDGING - A PILOT CASE STUDY TO REVIEW THE POTENTIAL BENEFITS FOR NATURE CONSERVATION

Capital and maintenance dredging comprise the most frequently undertaken dredging activity in England. Maintenance dredging occurs on a regular basis in order to keep shipping lanes and harbour channels open and navigable. Capital dredging represents the working of previously un-dredged areas be it for docks, marina construction, or a new navigation channel.

The dredged spoil, of which it is estimated that 200 million tonnes per year are derived from maintenance dredging alone (Nunney and Chillingworth, 1986), is deposited elsewhere in either terrestrial or marine dump sites, sold as aggregate and occasionally utilised in coast based schemes.

The potential benefits to nature conservation that could accrue from retaining the dredged material within the near-shore system, or on environmentally beneficial land based schemes, are in need of investigation, as are methods of mitigating the effects of potential interruptions to natural coastal sediment systems and knock-on coastal erosion problems.

The project aims through the example of a case study, to investigate these areas and provide a methodological framework for future environmental appraisals of capital and maintenance dredging on a country scale.

Specific project requirements

1) How much material is currently removed annually, where from, and what are the future demands?

2) What coastal geomorphological systems are currently interrupted or disturbed by dredging activities and what, if any, may be the apparent shoreline response?

3) How and where is the dredged material presently disposed of?

4) How might dredged material be put to an environmentally beneficial use. Areas requiring examination are:-

1. Levels of toxicity and methods of reduction.

2. Suitability for beach feed in terms of physical and chemical composition and economic comparison with current sources.

3. Suitability for near-shore injection for trickle feeding of mudflat/saltmarsh complexes.

4. Terrestrial uses, with specific reference to the use of dredged material for raising land levels to the height required to accept saltmarsh.

5. What are the merits of sediment by-pass schemes where a dredged channel crosses a longshore drift route?

Where possible recommendations should be supported by examples from other U.K. or international localities.

A specific aim of the project is to rehearse the methodology for the production of environmental appraisals for capital and maintenance dredging that could be applicable throughout England and the U.K.

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29 August 1991

ANNEX A

CAPITAL AND MAINTENANCE DREDGING - A PILOT CASE STUDY TO REVIEW THE POTENTIAL BENEFITS FOR NATURE CONSERVATION

Case Study Area - Poole Harbour

Site specific project requirements

1. How much material is currently removed annually, where from, and what are the future demands?

2. What is currently known about the geomorphological system within and outside the harbour? Is there a shore line response? What future research is required to give a full knowledge of natural processes in and around Poole Harbour?

3. How and where is the dredged material presently disposed of?

4. How might dredged material be put to an environmentally beneficial use. Areas requiring examination are:

   a. Levels of toxicity and methods of reduction. With particular reference to the south east corner of Holes Bay. Is this material suitable for habitual recreation. What are the levels of toxicity in the area, how might they be reduced and how might the sediment be transported?

   b. Suitability for beach feed in terms of physical and chemical composition and economic comparison with current sources. Illustrated with the example of Bournemouth Borough Councils use of Harbour material for beach feed, what is the potential for expansion of this scheme?

   c. Suitability for near-shore injection for trickle feeding of mudflat/saltmarsh complexes. What dredging vessel is most suitable for such a practise?

   d. Terrestrial uses, with specific reference to the use of dredged material for raising land levels to the height required to accept saltmarsh.

   e. What are the merits of sediment by-pass schemes where a dredged channel crosses a longshore drift route?

Where possible recommendations should be supported by examples from other UK or international localities, particularly the USA.

Project Outputs

The project output will be in the form of a written report, 5 copies of which should be prefaced with an Executive Summary and received by 29 February 1992. A brief interim report giving details of progress will be required by 13 December 1991.

APPENDIX B

LEGISLATION RELEVANT TO EACH PORT WITH RESPECT TO THE LIMIT OF POWERS THE PORT AUTHORITIES HAVE TO CARRY OUT WORKS

Appendix B

Legislation relevant to each port with respect to the limit of powers the Port Authorities have to carry out works including dredging is outlined below:-

- Each Port has its own Act(s) of Parliament. The Port is free to undertake any construction works as long as they are within the terms of its Act(s).

- Local Acts of Parliament or Orders under the Harbour Act 1964 made by the Department of Transport specifically provide a particular power, within the terms of the Act or Order, to the Port Authority to carry out construction work.

- Only these Orders/Acts give the Port Authority immunity from inquiries, planning permissions, etc.

- A Port may need another Parliamentary Bill to revise its Act(s). This can be done without an inquiry but in Parliament the Bill may be subject to objections from MPs.

- If a Port is not covered by a Harbour Act. (ie. it isn't an established Port) then development needs to go through the normal planning procedure. This is the case with most of the Wharves on the Thames.

- A Port Authority will have to apply for a Harbour Revision Order if the Ancillary Works Limit needs to be extended. There is no need for an Inquiry. However, it is subject to objections from Parliamentary Members.

APPENDIX C

KEY ECOLOGICAL AND MANAGEMENT FACTORS IN THE EVALUATION OF HABITAT CREATION

Appendix C Key Ecological and Management Factors in the Evaluation of Habitat Creation Options for a Particular Site Using Dredged Material

CRITERION	EXPLANATION	APPLICATION TO HABITAT CREATION/USING DREDGED MATERIAL
Existing nature conservation interest	Sites of existing importance (e.g. assessed in relation to NCR criteria).	Established habitats of importance should not be lost to habitat creation/restoration unless it can clearly be demonstrated beyond reasonable doubt that what is likely to replace it will be of significantly higher conservation value.
Technical Viability	The creation/restoration options which are technically feasible at a given site.	The range of options needs to be reviewed alongside the corresponding likelihood of success in terms of physical, chemical and biological characteristics.
Proximity to dredging location (the site for potential habitat creation).	Is the site which is potentially to be used for habitat creation close to the area of dredging.	This will affect both the cost of the scheme, as transportation of material can be prohibitively expensive, and the technical feasibility of pumping dredged material onto the site.
Water quality	Pollutants in the water will eventually accumulate in the sediment.	The water which enters the site must be of high enough quality to ensure the site does not deteriorate.
Effect on coastal processes	Impact on hydrological regime.	Placement of dredge material at the chosen site may interrupt sediment transport pathways and cause knock-on effects on coastal stability. An increase in turbidity may cause disruption to nearshore communities.
Sustainability of created/restored habitats.	Capacity for survival and regeneration. Coastal habitats are dynamic not static. Change is an important element of survival.	To minimise management costs in the long-term, sites and habitats involved should be persistent and self-sustaining. Selection of habitats for creation/restoration should also consider natural succession and the sensitivity of the habitat to storms, etc.

CRITERION	EXPLANATION	APPLICATION TO HABITAT CREATION/USING DREDGED MATERIAL
Site size.	Larger habitats are likely to be more valuable for nature conservation.	Site size should be maximised to help ensure greatest sustainability and to accommodate species with larger range requirements. Management resources should, however, be sufficient to adequately cover the site.
Site suitability	Present chemical, biological and physical characteristics of the site in its present state.	Consideration of past land-use should determine the need for any site preparation.
Time-scale of dredging activity	Is it a continuous process whereby material becomes available on a cyclical basis or is it a single operation for a maintenance or capital dredging scheme?	This will affect the habitat which is likely to occur as the continuous application of material prevents the successional development of the habitat.
Resource Implications of habitat creation/restoration	The cost in staff time, capital and maintenance works, and management.	Resource implications of managing the site from construction to maintenance must be fully considered and an appropriate long-term management framework identified and put in place.
Source of colonising flora and fauna	Vital for initial colonisation and long term sustainability.	Habitats which colonise naturally may have a greater chance of survival in the long term than those planted artificially. Natural colonisation may therefore be desirable for some habitat types.
Vulnerability to disturbance	Some habitats/species are more tolerant of disturbance than others.	Those habitats and species vulnerable to disturbance must be identified and protected by effective management of access. Where human disturbance cannot be excluded, careful selection of habitats for creation/restoration is essential. Screening using vegetation (e.g. reeds) or embankments could be considered; visitor management should ensure that habitats are not damaged by trampling, etc.

CRITERION	EXPLANATION	APPLICATION TO HABITAT CREATION/USING DREDGED MATERIAL
Seasonal restrictions	Determination of the time of year to place material on a site to cause minimum disturbance to flora and fauna.	Due to the spawning characteristics of aquatic organisms, the time of year during which material can be placed in the shallow subtidal and intertidal zones may be restricted in certain areas.
Degree of control over influencing factors.	Ability to control physical and human influences.	Factors which might affect the site's ecology, including drainage and pollution, need to be under the control of site managers.
Naturalness	Natural appearance of coastline contributes to overall value.	The large open vistas of the coastal zone invoke a feeling of wilderness. Habitat creation/restoration may provide an opportunity to remove artificial features which can impede this feeling. Natural plants and habitat should also be encouraged, notably those native to the U.K. or to the particular region.
Long term trends	Recorded changes in habitat composition, species numbers, etc.	Habitat creation/restoration should accommodate desirable trends in species population growth, etc. and may also be used to counter undesirable changes (See Note 1).
Diversity	Diversity of habitat types increases the range of species present at a site.	Site management can be used to improve habitat diversity and hence opportunities for wildlife observation and research into intra-species interaction. However, care must be taken to ensure that each habitat unit remains an ecologically viable size.
Wildlife corridor	Linking areas of similar habitat.	Reduces isolation, improves species mobility and hence chance of survival. Opportunities to create/restore such corridors may therefore be important particularly if existing or created sites are small.

CRITERION	EXPLANATION	APPLICATION TO HABITAT CREATION/USING DREDGED MATERIAL
Rarity	Rare habitats or habitats supporting rare species.	The reason for initial rarity must be understood. Re-establishing viable populations of rare species can be a lengthy, costly and ecologically difficult process.
Education and research potential	Important at certain sites (e.g. Local Nature Reserves, near centres of population, research establishments, etc.).	Careful habitat selection required to maximise educational value and usefulness for research.
Position on migration route	Particularly relevant to habitats for birds.	Identifying and restoring/creating habitats suitable for migratory species.
Amenity and recreation value	Leisure use may encourage the public to develop an interest in conservation.	Access and safety issues may be important. With careful management, it may be possible to combine nature conservation objectives with activities such as fishing, cycling or wildfowling.

NOTES:

1. A number of long term monitoring programmes operate for coastal species, enabling trends in species to be identified. Relevant examples include the Birds of Estuary Enquiry (BTO), National Wildfowl Count (WWT), Seabird Colony Register (NCC), and the Reedbed Survey (RSPB).

* Source: Adapted from Posford Duvivier 1991

APPENDIX D

EXAMPLES OF HABITAT CREATION OR RESTORATION INITIATIVES USING DREDGED MATERIAL

Appendix D **Examples of Habitat Creation or Restoration Initiatives Using Dredged Material Adapted from: Posford Duvivier, 1991)**

D.1 **Marsh Habitat**

Location/Habitat	Brief Description	Cost	Success	Reference
Texas, USA. Saltmarsh	Developed marsh on dredged material in moderate to high wave-energy environments. Breakwater was used to protect the planted marsh sprigs. Erosion control mats and plant-rolls were also used.	Planting techniques ranged from \$48 to \$242 per linear metre for a marsh 20m wide in 1988.	Still experimental.	U.S. Army Corps of Engineers (1988)
Lower Mississippi River, Louisiana, USA. Saltmarsh	Unconfined dredged material placement to elevate shallow bay bottoms to allow natural growth of emergent marsh.	\$1.50 to \$3.00/cu. m (1987).	Resulted in the development of 2000 ha of man-made intertidal marsh.	Landin et al (1989)
Galveston, Texas, USA. Marsh.	Site protected with temporary sandbag breakwater to protect young plants.		After 10 years, breakwater began to fail. Structure has now gone but a healthy marsh remains.	Personal Commun-ication; Philip Williams Associates, San Francisco; 1990
Altamaha River, Georgia, USA. Brackish marsh.	3 acre brackish water marsh was established on sandy dredged material.	\$10,000 per acre planted in experimental plots. If mechanically planted cost would be more in the region of \$5-6000 per acre.	Cordgrass formed a dense lush mass of vegetation and visually the marsh was identical to other marshes in the vicinity.	Landin et al (1989) Saucier et al (1978)

Location/Habitat	Brief Description	Cost	Success	Reference
Bolivar Peninsula, Galveston Bay, Texas, USA. Saltmarsh	9 acre saltmarsh established on sandy dredged material, with severe to moderate erosion. The dredged material was dewatered and shaved down with a bulldozer. There was a 26 mile fetch so there was a need for breakwaters, therefore more money was spent on this project.	$12,000	Sandbags, breakwaters and erosion control matting proved to be effective methods in protecting the marsh. Smooth cordgrass survived at intertidal elevations while saltmarsh cordgrass invaded the upland site.	Landin et al (1989) Saucier et al (1978)
South San Francisco Bay, California, USA. Saltmarsh	Marsh was developed in an old 10 acre salt pond on confined dredged material.	$10,000 per acre. Costs - dredging - breaching - dyke and channel digging.	The site was planted with Pacific cordgrass, Pacific glasswort and pickleweed. It took 11 years to achieve total plant cover.	Landin et al (1989) Saucier et al (1978)
Apalachicola, Florida, USA. Saltmarsh.	A small marsh development project on poorly consolidated fine grained marine sediments in an area subject to long wind fetches. Spartina sp. were planted.	$1.50 per cubic yard used local employment centre $2000 per acre.	Spartina sp. is stabilising. The saltmarsh, fish populations and other estuarine habitats have been improved by the formation of tidal channels and tidal pond.	Landin et al (1989) Saucier et al (1978)
Shooters Island, New York, USA. Marsh.	Breakwater created out of rubble, dredged fill placed behind breakwater. Partially completed.	$10 per cubic yard	Significant habitat improvement in dredged and badly eroded location.	Personal Commun-ication; U.S. Army Corps of Engineers; (1990)

Location/Habitat	Brief Description	Cost	Success	Reference
South-East USA. Saltmarsh	Planting of Spartina sp. on dredged material to create saltmarsh habitat.		Both Spartina species showed a very good response in terms of marsh establishment.	Reinhold (1976)
North Carolina, USA. Saltmarsh.	The stabilisation of dredge spoil and the establishment of a new tidal marsh on the North Carolina coast.		Spartina marsh developed from seed and from transplanted seedlings to give complete cover within two growing seasons.	Wood-house et al (1972)
Muzzi Marsh, San Francisco, USA. Saltmarsh	Mitigation work for dredging ship channel and constructing Larkspur Ferry Terminal. Breached the dyke and flooded dredged spoil disposal area behind.		Successful growth of small plants. Work was completed in 1981. By 1987 the site was densely vegetated but only following extensive regrading exercise.	San Francisco Bay Conser-vation and Develop-ment Commiss-ion (1988)
Royal Portisbury Docks, Avon Saltmarsh	Maintenance dredgings (silty sediment) has been dumped into a silt lagoon which is open to tidal influence.		This area has naturally colonised with saltmarsh vegetation.	Personal communic ation English Nature 1992.

Location/Habitat	Brief Description	Cost	Success	Reference
Lymington, Hampshire.	Following increasing Saltmarsh erosion it was considered necessary to initiate an investigation to understand the saltmarsh system. It has been recommended that brushwood groynes and redistribution of local dredged material be investigated in this study.		Still experimental.	Personal commun-ication. New Forest District Council, 1992.
Farlington Marshes, Hampshire	Thick Reno mattresses were laid at a slope of 1 in 5, and covered in mud dredged from in front of the embankment. The project was initiated for a sea defence scheme.		Saltmarsh plant communities developed on the site and provided a successful sea defence.	Lewis and Williams (1984)

D.2 Dredged Material Islands

Location/Habitat	Brief Description	Cost	Success	Reference
North Carolina, USA. Island for Birds.	Construction of two islands out of dredged material for sea birds and aquatic biota. Planting of smooth and saltmarsh cordgrass. Similar islands have been developed in Alabama, Florida, Maryland, Texas and Louisiana.	$2 per cubic yard. Temporary breakwater $5-6000.	A marsh developed and benthic organisms thrived. Terns and skimmers nest on the islands.	U.S. Army Corps of Engineers (1988)
Gaillard Island, Alabama, USA. Island from dredged material.	Island of silty and dredged material; interior containment pond of 250-300 ha of shallow water.	10-15 million dollars for planting. This cost was minor compound with the cost of habitat creation of the 1300 acre site which was $10,000 per acre.	Seabirds and pelicans nest successfully on the island. Naturally colonised.	Landin et al (1989)
North Carolina, USA. Island Habitats.	Dredged material islands provide isolated, relatively predator-free habitats which are heavily used by colonies of nesting seabirds and wading birds.		It was reported that approx. 83% of the colonial sea birds nesting in North Carolina in 1973 used dredged material islands.	Smith (1976)
Florida, USA. Spoil islands.	Tampa Bay, Florida. Proposed construction of spoil islands using maintenance dredgings.		Not known.	Limoges (1976)

Location/Habitat	Brief Description	Cost	Success	Reference
Oregon, USA. Clam flats.	Dredged material disposal site developed as commercial Clam Bed. Involved creating correct elevation and capping with gravel/rock.	$3-4 per cubic yard.	Habitat suitable for clams has been inadvertently produced by the disposal of dredged material.	Smith (1976a)
Florida, USA. Mangrove	Three mangrove species have been naturally and artificially propagated on disturbed soils including dredged material.			Smith (1976a)
Dorset, U.K. Artificial islands.	Poole Bay, Dorset. BP proposal to build artificial island for offshore oil exploration using dredged fill material.	£150-200 million		Smith (1990)

D.3 Other Intertidal/Subtidal Habitats

Location/Habitat	Brief Description	Cost	Success	Reference
North East, USA. Intertidal mudflats.	Pumped dredged material onto rocky beach, creating intertidal flats. Elevation work involved.	$3-4 per cubic yard.	Commercial clam and worm beds established naturally. Colonised naturally.	Personal Commun-ication; U.S. Army Corps of Engineers (1990)
Le Havre, France. Mudflats.	Proposed creation of artificial mudflats along channel sides to provide fish, shellfish and bird habitat and a natural water purification facility.	6.45 million French Francs (1989)	Not known.	Cellule de Suivi du Littoral Haut Normand, (1989)
Cheasapeake Bay, USA. Oyster Beds.	2500m^3 dredged material placed subtidally, capped with dead oyster shells for lining to settle on. Open water disposal.	$3-4 per cubic yard.	Good settlement rate. Oysters harvestable in third year.	Personal Commun-ication; U.S. Army Corps of Engineers (1990)
Foulton Hall Point; Stone Point; and Horsey Island; Essex.	Beach recharge, using dredged material, to reduce or even reverse saltmarsh loss.		Project was successful in terms of recharge of beach. Benthos was monitored for any change.	NRA Report, 1992.

APPENDIX E

U.K., U.S. AND DUTCH GUIDELINES FOR THE TERRESTRIAL AND AQUATIC DISPOSAL OF CONTAMINATED DREDGED MATERIAL

INTERDEPARTMENTAL COMMITTEE ON THE REDEVELOPMENT OF CONTAMINATED LAND

Recommended threshold and action values for assessing and redeveloping contaminated land.

ICRCL Guidance Note 59/83, Second Edition, 1987

TABLE 3 TENTATIVE "TRIGGER CONCENTRATIONS" FOR SELECTED INORGANIC CONTAMINANTS

CONDITIONS

1. This Table is invalid if reproduced without the conditions and footnotes.

2. All values are for concentrations determined on "spot" samples based on an adequate site investigation carried out prior to development. They do not apply to analysis of averaged, bulked or composited samples, nor to sites which have already been developed. All proposed values are tentative.

3. The lower values in Group A are similar to the limits for metal content of sewage sludge applied to agricultural land. The values in Group B are those above which phytotoxicity is possible.

4. If all sample values are below the threshold concentrations then the site may be regarded as uncontaminated as far as the hazards from these contaminants are concerned and development may proceed. Above these concentrations, remedial action may be needed, especially if the contamination is still continuing. Above the action concentration, remedial action will be required or the form of development changed.

Contaminants	Planned Uses	Trigger Concentrations (mg/kg air-dried soil) Threshold	Action
Group A: Contaminants which may pose hazards to health			
Arsenic	Domestic gardens, allotments.	10	*
	Parks, playing fields, open space.	40	*
Cadmium	Domestic gardens, allotments.	3	*
	Parks, playing fields, open space.	15	*
Chromium (hexavalent) (1)	Domestic Gardens, allotments.	25	*
	Parks, playing fields, open space.		
Chromium (total)	Domestic gardens, allotments.	600	*
	Parks, playing fields, open space.	1,000	*
Lead	Domestic gardens, allotments.	500	*
	Parks, playing fields, open space.	2,000	*
Mercury	Domestic gardens, allotments.	1	*
	Parks, playing fields, open space.	20	*
Selenium	Domestic gardens, allotments.	3	*
	Parks, playing fields, open space.	6	*
Group B: Contaminants which are phytotoxic but not normally hazards to health			
Boron (water-soluble) (3)	Any uses where plants are to be grown (2, 6)	3	*
Copper (4, 5)	Any uses where plants are to be grown (2, 6)	130	*
Nickel (4, 5)	Any uses where plants are to be grown (2, 6)	70	*
Zinc (4, 5)	Any uses where plants are to be grown (2, 6)	300	*

NOTES:

* Action concentrations will be specified in the next edition of ICRCL 59/83.

1. Soluble hexavalent chromium extracted by 0.1M HCl at 37°C; solution adjusted to pH 1.0 if alkaline substances present.

2. The soil pH value is assumed to be about 6.5 and should be maintained at this value. If the pH falls, the toxic effects and the uptake of these elements will be increased.

3. Determined by standard ADAS method (soluble in hot water).

4. Total concentration (extractable by $HNO_3/HClO_4$).

5. The phytotoxic effects of copper, nickel and zinc may be additive. The trigger values given here are those applicable to the 'worst-case': phytotoxic effects may occur at these concentrations in acid, sandy soils. In neutral or alkaline soils phytotoxic effects are unlikely at these concentrations.

6. Grass is more resistant to phytotoxic effects than are most other plants and its growth may not be adversely affected at these concentrations.

TABLE 4: TENTATIVE "TRIGGER CONCENTRATIONS" FOR CONTAMINANTS ASSOCIATED WITH FORMER COAL CARBONISATION SITES

CONDITIONS

1. This Table is invalid if reproduced without the conditions and footnotes.

2. All values are for concentrations determined on "spot" samples based on an adequate site investigation carried out prior to development. They do not apply to analysis of averaged, bulked or composited samples, nor to sites which have already been developed.

3. Many of these values are preliminary and will require regular updating. They should not be applied without reference to the current edition of the report "Problems Arising from the Redevelopment of Gas Works and Similar Sites". (1)

4. If all sample values are below the threshold concentrations then the site may be regarded as uncontaminated as far as the hazards from these contaminants are concerned, and development may proceed. Above these concentrations, remedial action may be needed, especially if the contamination is still continuing. Above the action concentrations, remedial action will be required or the form of development changed.

Contaminants	Proposed Uses	Trigger Concentrations (mg/kg air-dried soil)	
		Threshold	Action
Polyaromatic hydrocarbons(1,2)	Domestic gardens, allotments, play areas.	50	500
	Landscaped areas, buildings, hard cover.	1000	10000
Phenols	Domestic gardens, allotments.	5	200
	Landscaped areas, buildings, hard cover.	5	1000
Free cyanide	Domestic gardens, allotments landscaped areas.	25	500
	Buildings, hard cover.	100	500
Complex cyanides	Domestic gardens, allotments.	250	1000
	Landscaped areas.	250	5000
	Buildings, hard cover.	250	NL
Thiocyanate(2)	All proposed uses.	50	NL
Sulphate	Domestic gardens, allotments, landscaped areas.	2000	10000
	Buildings(3).	2000(3)	50000(3)
	Hard cover.	2000	NL
Sulphide	All proposed uses.	250	1000
Sulphur	All proposed uses.	5000	20000
Acidity (pH less than)	Domestic gardens, allotments, landscaped areas.	pH5	pH3
	Buildings, hard cover.	NL	NL

NOTES

NL: No limit set as the contaminant does not pose a particular hazard for this use.

(1): Used here as a marker for coal tar, for analytical reasons. See "Problems Arising from the Redevelopment of Gas works and Similar Sites" Annex A1. (1).

(2): See "Problems Arising from the Redevelopment of Gas Works and Similar Sites" for details of analytical methods. (1).

(3): See also BRE Digest 250: Concrete in sulphate-bearing soils and groundwater. (4).

Dutch guidelines on the freshwater disposal of contaminated dredged material

Table 1 - Quality standards

	A	B	C	D	E
Cd	2	7,5	30	50	3,5
Hg	0,5	1,6	15	50	0,8
Cu	35	90	400	5 000	55
Ni	35	45	200	5 000	40
Pb	530	530	1 000	5 000	100
Zn	480	1 000	2 500	20 000	340
Cr	480	480	1 000	5 000	100
As	85	85	150	50	30
Oil (mineral)	1 000	3 000	5 000	5 000	1 050
EOX	*)	7	20	20)2	7
- PAH (6 Borneff)	0,6	4,5	17	15	*)
- PCB)1	*)	0,2	0,4	3,5	*)
DDT, DDE, DDD	0,01	0,02	0,5	1,0)3	0,1)4
HCH	0,001	0,02	0,5	1,0	*)

- Concentrations mg/kg, deducted to standard soil (10% organic content and 25% lutum).

A : Provisional quality goal year 2 000, fresh water bottom-sediments.
B : Provisional (temporary) threshold value below which dispersion of dredged material in fresh water is accepted, provided that the quality of receiving (sedimentation) areas is not worsened.
C : Provisional threshold value for fresh water bottom-sediments, exceedance urge direct research into the risks for the environment and public health and urges in principle restoration of the sediments.
D : Threshold value for dredged material quality, exceedance leads to disposal in Papegaaiebek disposal site.
E : Provisional threshold value for unconfined disposal of dredged material in the North Sea and adjacent estuaries.

- Not all substances are listed, for a complete review reference is made to the bibliography.

1) TCB : IUPAC −28, −52, −101, −118, −138, −153, −180.
2) Threshold value, only indicating necessity for futher research,
3) Threshold value for individual parameters.
4) Threshold value for DDE and DDD.
*) No threshold value or sum-parameter determined.

Source: Proceedings of the International Seminar on the Environmental Aspects of Dredging Activities.

Quality Standards for Dredged Materials in the Netherlands

QUALITY STANDARDS FOR DREDGED MATERIALS IN THE NETHERLANDS

N a m e (mg/kg dry matter)	Reference Value	Testing Value	Signalling Value	
Chromium	100	480	1000	
Nickel	35	45	200	
Copper	36	90	400	
Zinc	140	1000	2500	
Cadmium	0.8	7.5	30	
Mercury	0.3	1.6	15	
Lead	85	530	1000	
Arsenic	29	85	150	
Naphthalene	0.01			(*)
Chrysene	0.01	0.8	3	0.2
Phenanthrene	0.1	0.8	3	0.2
Anthracene	0.1	0.8	3	0.2
Fluoranthene	0.1	2.0	7	1.2
Benzo(a) pyrene	0.1	0.8	3	0.2
Benzo(a) anthracene **	1	0.8	3	0.2
Benzo(k) fluoranthene **	10	0.8	3	0.6
Indeno (1,2,3cd) pyrene **	10	0.8	3	0.2
Benzo (ghi) perylene **	10	0.8	3	0.2
Mineral Oil Total	50	3000	5000	
Octane, Heptane	1			
Pentachlorophenol	0.1	0.3	0.5	
Hexachlorobenzene	0.001	0.02	0.5	
PCB IUPAC-number:				
28	0.01	0.03	0.1	
52	0.01	0.03	0.1	
101	0.01	0.03	0.1	
118	0.01	0.03	0.1	
138	0.01	0.03	0.1	
153	0.01	0.03	0.1	
180		0.03	0.1	
Hexachlorocyclohexane	0.001	0.02	0.5	
Aldrin	0.01	0.04	0.5	
Dieldrin	0.01			
Endrin	0.001	0.04	0.5	
DDE	0.01	0.02	0.5	
Endosulphan	0.01	0.02	0.5	
Chlordane	0.01			
Heptachlorepoxide	0.01	0.02	0.5	
Hexachlorbutadiene	0.01	0.02	0.5	

NOTE: (*) General sediment environmental quality: current quality of sediments in relatively unpolluted regions.

** We believe this may a printing error as it doesn't appear consistent.

Source: World Bank Technical Paper Number 126.

US Federal Recommended Maximum Limits for Metal Content in Digested Sewage Sludges

Recommended Maximum Limits for
Metal Content in Digested Sewage Sludges*

Element	Domestic Sludge Concentration, ppm
Zinc	2,000
Copper	1,000
Nickel	200
Cadmium	15 or 1.0% of Zinc
Boron	100
Lead	1,000
Mercury	10
Chromium	1,000

* Typical sludge from communities without excessive industrial waste inputs or with adequate abatement.

Source: US ACE, date unknown "Beneficial uses of dredged material".

APPENDIX F

SITE SURVEY ANALYSIS RESULTS

SITE 1

PARTICLE SIZE	WEIGHT	% DRY WEIGHT
> 2.00 mm	2.3844	4.0
1.00 - 2.00 mm	2.3580	3.9
0.60 - 1.00 mm	3.3934	5.7
0.212 - 0.60 mm	4.3520	7.3
0.106 - 0.212 mm	10.1931	17.0
0.063 - 0.106 mm	14.6782	24.5
0.038 - 0.063 mm	10.4030	17.3
< 0.038 mm	13.2882	22.2
TOTAL	59.9865	

SITE 2

PARTICLE SIZE	WEIGHT	% DRY WEIGHT
> 2.00 mm	3.6580	5.4
1.00 - 2.00 mm	2.1431	3.2
0.60 - 1.00 mm	2.3462	3.5
0.212 - 0.60 mm	5.6123	8.3
0.106 - 0.212 mm	9.1432	13.5
0.063 - 0.106 mm	13.1653	19.4
0.038 - 0.063 mm	17.5142	25.9
< 0.038 mm	17.1232	20.9
TOTAL	67.7054	

SITE 3

PARTICLE SIZE	WEIGHT	% DRY WEIGHT
> 2.00 mm	1.5230	2.6
1.00 - 2.00 mm	2.6141	4.5
0.60 - 1.00 mm	3.6124	6.2
0.212 - 0.60 mm	2.3126	3.9
0.106 - 0.212 mm	7.4612	12.7
0.063 - 0.106 mm	12.1789	20.1
0.038 - 0.063 mm	16.5613	28.2
< 0.038 mm	12.3741	21.1
TOTAL	58.6376	

SITE 4

PARTICLE SIZE	WEIGHT	% DRY WEIGHT
> 2.00 mm	4.6126	4.7
1.00 - 2.00 mm	3.1236	3.2
0.60 - 1.00 mm	3.6132	3.7
0.212 - 0.60 mm	8.7124	8.9
0.106 - 0.212 mm	13.4161	13.6
0.063 - 0.106 mm	21.1236	21.4
0.038 - 0.063 mm	26.4718	26.8
< 0.038 mm	17.6384	17.8
TOTAL	98.7117	

SITE	MERCURY (μg/kg)	ZINC (μg/g)	COPPER (μg/g)	NICKEL (μg/g)	IRON (mg/g)	MANGANESE (μg/g)
1	43	82	33	37	13.06	130
2	18	107	34	33	9.50	128
3	26	95	32	27	9.32	100
4	32	43	14	13	3.14	66

SITE	pH	ORGANIC CONTENT (% DRY WT)	SULPHIDE (μg/g)	CARBONATE (% DRY WT)	BORON (μg/g)
1	7.86	3.58	< 1	5.43	15
2	7.59	5.10	< 1	4.84	10
3	7.80	4.26	< 1	6.04	18
4	7.96	3.81	< 1	4.87	6

PHYLUM	CLASS	ORDER/FAMILY	SPECIES	SITE 1	SITE 2	SITE 3	SITE 4
Mollusca	Gastropoda	Mesogastropoda	*Littorina littorea*	89	89	0	0
			Hydrobia ulvae	0	266	0	0
	Bivalvia		*Scrobicularia plana*	89	0	0	0
Cnidaria	Anthozoa	Actinaria	*Peachia hastata*	0	89	0	0
			Actinia equina	0	622	356	89
Nemertini			*Nemertopsis flavida*	0	89	0	0
Annelida	Polychaeta	Nereidae	*Perinereis cultrifera*	89	0	89	89
Arthropoda	Crustacea	Amphipoda	*Corophium volutator*	0	89	266	89

Analyte (µg/kg)		Site 1	Site 2	Site 3	Site 4
Phenols		< 10	< 10	< 10	< 10
PCB's		< 10	< 10	< 10	< 10
DDT		< 10	< 10	< 10	< 10
'Drins		< 10	< 10	< 10	< 10
PAH's	Phenanthrene	10	< 10	< 10	120
	Anthracene	< 10	< 10	< 10	51
	Fluoranthene	60	45	51	870
	Pyrene	60	52	48	590
	Benzo(a)anthracene	24	17	19	96
	Chrysene	18	21	24	130
	Benzo(b)fluoranthene	25	34	28	240
	Benzo(k)fluoranthene	15	21	12	140
	Benzo(a)pyrene	15	21	11	140
	Indeno(123cd)pyrene	< 10	< 10	< 10	24
	Bibenz(ah)anthracene	< 10	< 10	< 10	11
	Benzo(ghi)perylene	< 10	< 10	< 10	24

Appendix F

Table **Redox Potential Readings from Holes Bay Sediment Samples**

Samples	Redox Potential (mV)
1	-44
2	-125
3	-260
4	-318