Managing Contaminated Dredged Material

PIANC's Technical Brief about the management of contaminated dredged material within the navigation community.

International Navigation Association

Association Internationale de Navigation

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PIANC is the acronym for the International Navigation Association. It is an international scientific and technical non-political and non-profit-making association. Since its foundation in 1885, PIANC has been the international leader in the development and improvement of inland and maritime navigation and its infrastructure.
PIANC's mission is to promote sustainable development of all kinds of waterborne navigation throughout the world by providing international, professionally sound, and impartial data, and appropriate assistance and advice via a comprehensive network of international navigation and port professionals and other stakeholders.

FOREWORD

The International Navigation Association (PIANC) has decided to broaden its technical activities by launching a new initiative to provide technical guidance on a variety of subjects affecting international navigation. This new initiative has been implemented through a series of technical briefs that will convey PIANC's technical position and observations relevant to the subject matter being presented. The technical brief is written for a broad readership (e.g., problem owners and solvers, decision-makers, governmental authorities, professionals and technicians, permitting bodies, press, general public, and other stakeholders). This technical brief is the first in the series and it focuses on how to manage contaminated dredged material (CDM). It updates the recommendations and conclusions of earlier working group reports on the subject and is intended to assist with the decision-making process for managing CDM. Key subject matter contacts can be accessed via the referenced PIANC Web site. These key contacts will direct inquirers to sources of published information and technical guidance, as appropriate, on behalf of PIANC. They will not represent PIANC in any commercial projects and/or litigation.

PIANC General Secretariat

Eric Van den Eede, President

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INTRODUCTION

The management of dredged material from inland waterways was addressed by the Inland Commission (InCom (formerly PTC I)) Working Group No. 7 in 1990. This working group concluded that . . .

> *…the majority of dredged materials are considered acceptable for a wide range of disposal alternatives. However, contaminant levels in some sediments have produced concern that dredged material disposal, especially in open waters and wetlands, may adversely affect water quality and aquatic life.*
>
> *Since many inland waterways are located in industrial and urban areas, sediment may become contaminated with toxicants and other pollutants. In rural areas, sediment may be contaminated with herbicides, pesticides, and other agrichemicals. These sediments require special consideration and handling when placed in aquatic (subaqueous), upland, and/or wetland environments.*

The international navigation community, working through PIANC, has developed a comprehensive, yet simplified, approach to the identification, development, evaluation, and selection of environmentally, economically, and socially preferable alternatives for the handling and treatment of CDM from ports and inland waterways. The technical framework for CDM is consistent with the London Convention's technical approach to management of dredged material placed in marine environments. InCom Working Group No. 17 in 1998 published its two-volume final report on CD-ROM that contains information needed to assess and develop alternatives for the survey, dredging, transport, placement, treatment, and monitoring of CDM. A major conclusion of the InCom Working Group No. 17 report was that "contaminant controls and treatment will be required in the future unless the sources of contamination of the sediments are eliminated or greatly reduced." In early 2002, the Environmental Commission (EnviCom) Working Group No. 5 will publish technical requirements for the design of confined placement of CDM in aquatic, upland, and wetland environments.

DEFINING CDM

Definitions:

- CDM – any sediment that is removed by dredging and that contains contaminants at levels and availability that can make the material environmentally unacceptable for unrestricted use.
- Contaminant – a chemical or biological substance in a form that can be incorporated into, onto, or be ingested by and harm organisms, consumers of organisms, or users of the environment.

PIANC's Technical Position: In many countries throughout the world, there are urgent problems concerning the contamination of sediment in canals, navigable inland waterways, and ports. New techniques have been developed for the management of contaminated materials, and methods are continuing to be evaluated and improved. Because of the nature and variety of the contamination sources and sediment types to be dredged, the assessment, treatment, and management of contaminated dredged material (CDM) require a variety of techniques. There is no universally developed and available panacea to solve this complex problem. In order to manage CDM, the case-by-case approach is more appropriate than a rigid classification system. Without proper control of the sources of contamination to the waterways, today's suspended material will become tomorrow's CDM.

For additional information on this subject, you may access PIANC contacts via the following Web site: *www.pianc-aipcn.org/technicalbriefs/cdm*.

RISKS

Background: The CDM project manager must often use “best professional judgment” to weigh multiple and sometimes conflicting lines of evidence to reach a decision. Environmental risk assessment provides an organized and consistent framework to navigate the integration of complex information to obtain quantifiable estimates of risk, including uncertainty.

Risk Components in CDM Projects: The risk of managing CDM is distributed throughout the entire process, from the initial survey of the sediments to dredging, transport, treatment, and final disposition of the dredged material. Risk does not go away; rather, it is distributed or changes from one type to another. Each step in the dredging process includes risk.

PIANC’s Technical Position: PIANC is currently answering a series of questions regarding the use of risk assessment in the management of CDM associated with navigation projects. Key questions being addressed include:

- What is risk assessment, characterization, and management?
- When should the project manager consider applying risk assessment?
- Will the use of risk assessment require expensive data collection?
- What is the role of risk assessment in the risk management process?
- What is the relationship between ecological and human health risk assessment?
- What is the relationship between actual risk and the presence of contaminants?
- What tools are available or under development?

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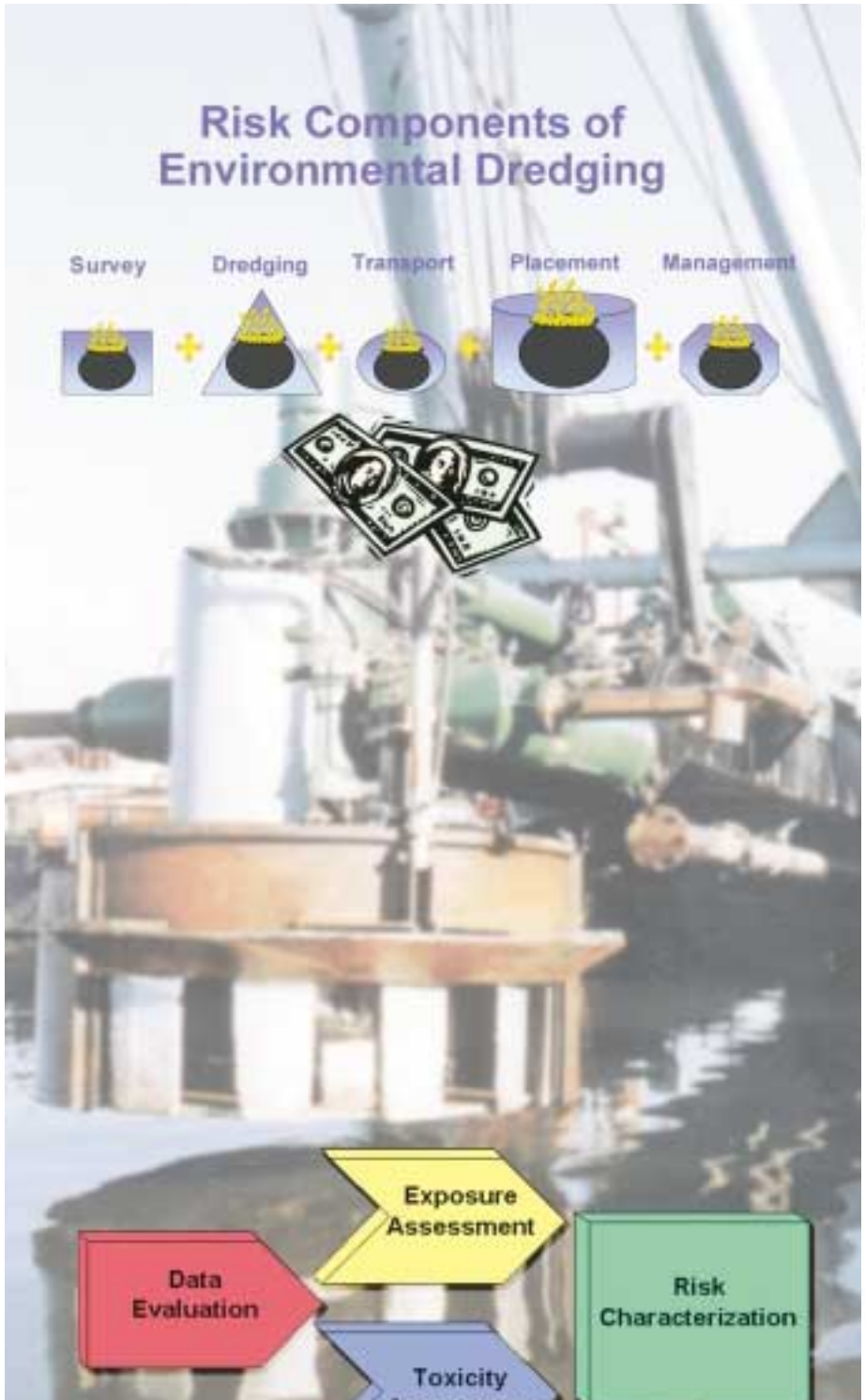
Risk Components of
Environmental Dredging
Survey
Dredging
Transport
Placement
Management
Exposure
Assessment
Data
Evaluation
Risk
Characterization
Toxicity

RISKS

CHEMICAL CHARACTERISTICS AND SOURCES

Four Major Classes of Contaminants:

- Nutrients (e.g., phosphorous and nitrogen compounds like ammonium).
- Metals (e.g., cadmium, lead, zinc, copper, chromium, nickel, mercury, arsenic).
- Organics (e.g., polycyclic aromatic hydrocarbons (PAHs); polychlorinated biphenyls (PCBs); pesticides, aldrin, dieldrin, endrin, DDT and its derivatives; dioxins and furanes, etc.).
- Radioactive materials.

Sources:

- Effluent discharges from industrial production.
- Contaminated sites of historic dumps or production units.
- Military installations and military wastes.
- Agricultural and horticultural land uses.
- Atmospheric precipitation (acid rain, dust deposition, etc.).
- Handling of contaminants (storage, transshipment, transport).

PIANC's Technical Position: The physical and chemical characteristics of dredged material and the prevailing conditions during handling of CDM can influence its properties and will impact dredging and CDM management plans. The handling, treatment, and disposal of CDM cannot be evaluated in a reasonable and efficient manner without considering fundamental knowledge about the physical, chemical, and biological composition and characteristics of the dredged material. Identification of sources of contamination is essential to developing a good characterization plan.

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CHEMICAL CHARACTERISTICS AND SOURCES

IDENTIFYING, ASSESSING, AND SELECTING OPTIONS

Contaminated Dredged Material Technical Framework:

CDMTF is an "international road map" for nations to follow when developing and evaluating the appropriate options for dredging and management of CDM in ports and inland waterways. The CDMTF:

- Is based on case-by-case assessment.
- Evaluates the environmental, engineering, and economic acceptability of the full continuum of CDM management alternatives using a consistent technical approach.
- Enhances consistency and coordination among various agencies responsible for decision-making.
- Is consistent with the Dredged Material Assessment Framework (DMAF) that is the implementing guideline for the London Convention.

PIANC's Technical Position:

Prior to the development of the CDMTF, there was no overall, consistent approach to the development of a preferred alternative for the handling and treatment of CDM from international ports and waterways. The CDMTF has been developed for international use and allows for a case-by-case approach to the assessment and selection of handling and treatment options for CDM. The CDMTF can be applied within the context of any nation's navigation and environmental regulatory programs. Flexibility is the key to its conception and use. Thus, it should be treated as a technical guide to evaluate the commonly important factors to be considered in managing CDM. PIANC, through its working groups, is expanding the technical framework to greater levels of detail and decision-making assistance.

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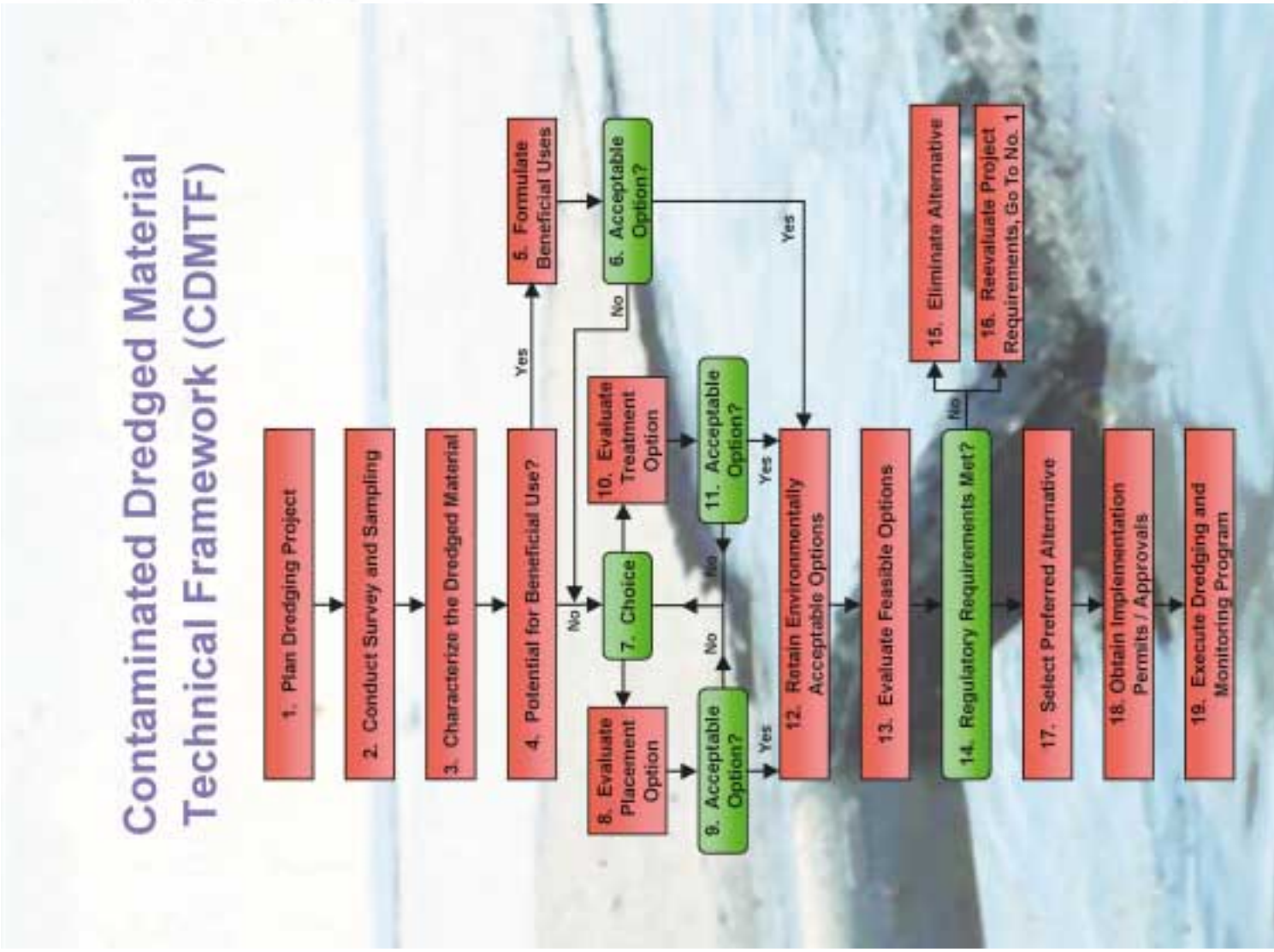

Contaminated Dredged Material
Technical Framework (CDMTF)
1. Plan Dredging Project
2. Conduct Survey and Sampling
3. Characterize the Dredged Material
4. Potential for Beneficial Use?
Yes
No
5. Formulate Beneficial Uses
6. Acceptable Option?
No
Yes
7. Choice
8. Evaluate Placement Option
9. Acceptable Option?
No
Yes
10. Evaluate Treatment Option
11. Acceptable Option?
No
Yes
12. Retain Environmentally Acceptable Options
13. Evaluate Feasible Options
14. Regulatory Requirements Met?
No
15. Eliminate Alternative
16. Reevaluate Project Requirements, Go To No. 1
17. Select Preferred Alternative
18. Obtain Implementation Permits / Approvals
19. Execute Dredging and Monitoring Program

PLANNING CDM PROJECTS

Types of Plans: Planning for the removal, handling, treatment, and ultimate disposition of CDM is crucially important to the success of the project and to the proper estimation of costs. Some key areas of planning common to all CDM projects are:

- Consultation with stakeholders and the public, which is very important. Providing them adequate information and involving them from an early stage can be mutually beneficial. The consultation process is continuous throughout the life of the facility. This consultation can be organized with a communication plan.
- A health and safety plan that covers protections from both the physical and chemical injury of CDM.
- A monitoring plan to assess project success to include sampling and analyses.
- An operations and management plan that covers all aspects and linkages to project execution.

Guidelines Available: PIANC has developed a checklist of possible planning documents and tasks for CDM removal, treatment, and disposal projects. An example flowchart for planning the timing and physical linkages between project parts has also been developed.

PIANC's Technical Position:

- The presence of CDM can have adverse consequences on plans for the development of navigation worldwide.
- Proper planning of the dredging projects for CDM is essential to attaining successful project goals.
- While every project will have its own planning needs, all CDM projects require that the following elements be considered: project safety, approvals, communications, project monitoring, operations, timing, and costs.
- The goal of monitoring CDM projects is to produce information that is useful in making management decisions and to assess the attainment of project goals.
- The planning requirement for CDM should never be underestimated.
- Management of costs throughout the project is a task that has to be planned with as much care as any other task.

For additional information on this subject, you may access PIANC contacts via the following Web site: *www.pianc-aipcn.org/technicalbriefs/cdm*.

PLANNING CDM PROJECTS

STATE-OF-THE-ART TECHNOLOGIES

Components of a CDM Project:

- **Survey** – generation of the project history and data needed to assess and evaluate alternatives for managing CDM.
- Hydrographic measurements.
- Sediment sampling.
- Sediment testing.
- **Dredging** – excavation of CDM by mechanical or hydraulic equipment that has the objectives of removal of the contaminated sediment and reduction of the overall environmental risk.
- Mechanical.
- Hydraulic.
- Pneumatic.
- Specialty.
- **Transport** – method of conveying dredged material to handling and treatment systems. Transport by:
- Barge.
- Pipeline.
- Truck.
- **Placement** – the engineered control of CDM in the aquatic, wetland, and upland environments. Placement options:
- Confined upland, nearshore, or aquatic.
- Beneficial use.
- **Treatment** – the permanent modification or alteration of the physical, chemical, and biological characteristics of the CDM. Treatment classes:
- Pretreatment – goal is to reduce volume and improve handling characteristics.
- Biological – use of microorganisms to degrade organic compounds.
- Chemical – use of chemicals to achieve sorption, oxidation, or reduction, and chemical ion exchange of organics and metals.
- Thermal – application of heat to volatilize and remove organic contaminants and some metals. Some processes like incineration will destroy the contaminants at high temperature.
- Immobilization – the use of additives such as cement and fly ash to prevent contaminants from moving out of the solid matrix.
- Water treatment – physical, chemical, and biological treatment of excess water from CDM handling and treatment processes.
- **Monitoring** – the sampling and analysis that is done during the operational phases of the project. Monitoring of CDM projects should include:
- Dredge site.
- Transport systems.
- Placement site.
- Treatment systems.
- Post-project monitoring of the same locations.

STATE-OF-THE-ART TECHNOLOGIES

PIANC's Technical Position:

- Technologies exist to survey, dredge, transport, place, and treat CDM in an environmentally responsible manner.
- The choice of particular technologies for CDM is very site-specific and varies within and among countries.
- One universally accepted fact is that a reliable and comprehensive survey is essential to the successful handling and treatment of CDM at a minimal cost.
- Accuracy and precision of survey methods for determining amount and distribution of CDM are critical.
- Internationally uniform sampling methods for characterizing CDM are needed.
- Universal numerical standards for CDM management are scientifically invalid and should not be used.
- The entire range of CDM particle sizes affects handling and treatment of CDM.
- Evaluation of suitable handling and treatment alternatives will continue to rely on effects-based approaches.
- Confined disposal facilities (CDFs) are effective and commonly used management options for CDM worldwide—on land, in water, and under water; each type has its own advantages and disadvantages, and one is not to be preferred over the other.
- Contaminants associated with dredged material remain tightly bound to sediment particles. Consolidation within CDFs reduces permeability of the dredged material and results in self-sealing.
- CDFs are containment sites and can be engineered and managed in the long term to control contaminant releases.
- Adequately trained personnel and appropriate equipment are needed for proper operation of a CDM project. A variety of equipment and techniques are available for the handling and placement of dredged material in CDFs.
- The need for CDFs and treatment will continue in the future unless sources of contamination to the sediments are controlled.
- One type of treatment may work well for one site, but may not work at all at the next site.
- Materials placed in CDFs should be placed in such a way that allows for them to be removed for beneficial use in the future, where appropriate.
- The CDM must be compatible with the intended beneficial use.
- Waterfront revitalization projects may provide an opportunity to manage CDM in an environmentally, economically, technically, and socially sensible manner.
- Costs for CDM projects vary considerably depending upon the type of project, the options chosen, and the site-specific conditions.
- Project sponsors are generally not prepared to accept large increases in costs to deal with CDM in navigation projects.

Each dredging project involving CDM is a unique situation that demands a "custom-fitted" solution. For each site, the optimal combination of techniques must be determined by weighing technical, economic, and environmental aspects. Not all projects provide a cost-effective opportunity for beneficial uses of CDM.

For additional information on this subject, you may access PIANC contacts via the following Web site: *www.pianc-aipcn.org/technicalbriefs/cdm*.

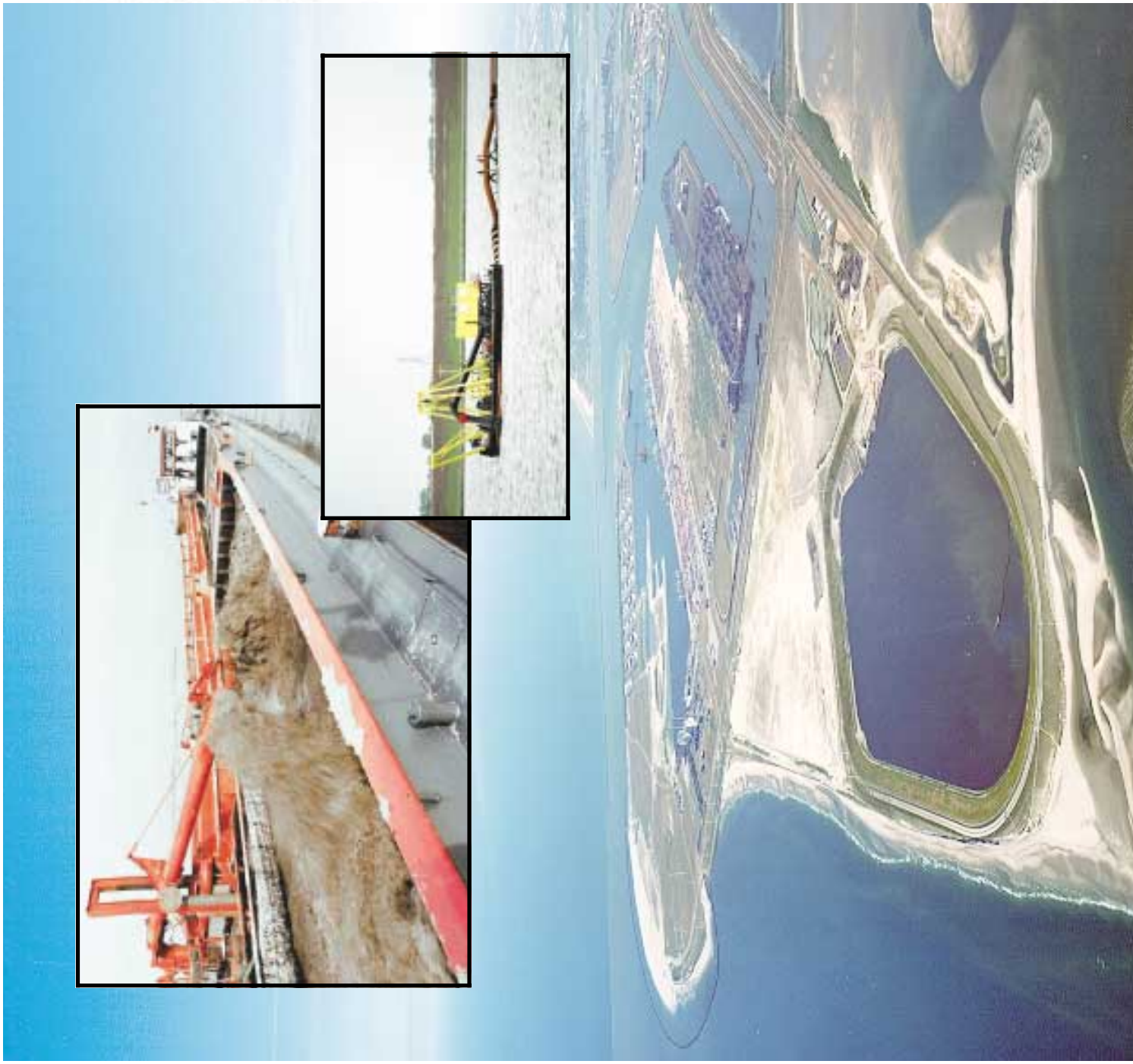
DOCUMENTING RESULTS WITH CASE STUDIES

Key Working Group Reports:

- **Inland Commission (PTC 1) - INCOM WG-17.** Volume 2 of the WG report contains 18 case studies from 8 different countries. These are:
  - **Belgium** - Underwater disposal of dredged material in the Port of Antwerp.
  - **Canada** - Pilot-scale remediation, Hamilton Harbor; CDM dredging and treatment, Welland River.
  - **Germany** - Management of dredged material from the Port of Bremen-City; Remediation of the Harbour Elburg; Dredged material management in the Port of Hamburg; Upland disposal of slightly contaminated dredged material from the River of Saar, at "Harliner Bogen"; Restoration of the Teltow Canal in Berlin.
  - **Italy** - Placement of dredged material to rebuild eroded salt marshes (Barene) in the Venice Lagoon.
  - **Japan** - Minamata Bay remediation project from mercury contamination.
  - **The Netherlands** - Slufter Disposal Site.
  - **United Kingdom** - Environmental dredging on the Birmingham Canals; Glasgow Garden Festival.
  - **USA** - Bayou Bonfouca sediment remediation, Slidell, Louisiana; Vertical strip drains to increase storage capacity in CDF at Craney Island; Eagle Harbor capping of contaminated sediments; Marathon Battery Superfund dredging and disposal; Sediment washing potential at CDFs – Erie Pier and Saginaw Bay Demonstrations.

- **Environmental Commission - ENVICOM WG-5.** Report contains 20 case studies on confined disposal from 10 different countries.
  - **Belgium** - Cellenproject Waaslandhaven (subaquatic CDF); Fasiver, Ghent (upland CDF).
  - **Canada** - Liverpoole (nearshore CDF); Mission Bay (subaquatic CDF).
  - **Denmark** - Copenhagen Lynette (nearshore CDF).
  - **France** - Armentieres (upland CDF).
  - **Germany** - Bremen Siltmound, Seehausen (upland CDF); Hamburg Siltmound, Feldhofe (upland CDF), Hamburg Rodewisch (subaquatic CDF); Lüssen Gravelpit (subaquatic CDF).
  - **Japan** - Minamata Bay (capped subaquatic CDF); Takamatsu Harbour (subaquatic CDF).
  - **The Netherlands** - Ijsseloog (nearshore CDF); Rotterdam Parrotsbeak (upland CDF); Slufter (nearshore CDF),
  - **Spain** - Huelva Left Bank (nearshore CDF).
  - **Sweden** - Helsingborg (subaquatic CDF); Göteborg Torviken (nearshore CDF).
  - **USA** - Boston Harbor (subaquatic CDF); Norfolk Craney Island (nearshore CDF).

DOCUMENTING RESULTS WITH CASE STUDIES



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Useful or related sources of information

- PIANC - Management of Aquatic Disposal of Dredged Material. Report of PIANC PEC Working Group 1, 1998
- PIANC - Handling and Treatment of Contaminated Dredged Material from Ports and Inland Waterways, Report of PIANC PTC I Working Group No. 17, 1995
- PIANC Dredged Material Management Guide, PIANC PEC Special Report Supplement to PIANC Bulletin No. 96, 1997
- PIANC - Beneficial Uses of Dredged Material. A Practical Guide. Report of PIANC PTC II Working Group 19, 1992
- CEDA/IADC. Environmental Aspects of Dredging. CEDA/IADC series of Guides 1997-1999
- IADC - International Association of Dredging Companies - *www.iadc-dredging.com*
- IAPH - International Association of Ports and Harbors - *http://www.iaphworldports.org*
- WODA - World Organization of Dredging Associations - *www.woda.org*
- EADA - Eastern Dredging Association
- CEDA - Central Dredging Association - *www.dredging.org*
- WEDA - Western Dredging Association - *www.wesda.org*
- U.S. Army Corps of Engineers Dredging Operations Technical Support *www.wes.army.mil/el.dots/dots.html/*
- U.S. Army Corps of Engineers Center for Contaminated Sediments *www.wes.army.mil/el/dots/ces/index.html*
- U.S. Environmental Protection Agency Great Lakes Contaminated Sediments Program *www.epa.gov/glnpo/sediments.html*
- Contaminated Sediments - Web References, Assessment of Contaminated Sediments *http://www.pca.state.mn.us/water/sediments/links-assessment.html*
- U.S. Environmental Protection Agency Office of Water - Contaminated Sediments *http://www.epa.gov/waterscience/cs/aboutcs/*
- Sediments Research Web - *http://www.sediments.org/*
- Development Programme Treatment Processes, Institute for Inland Water Management and Waste Water Treatment, Dutch, Ministry of Transport Watermanagement and Public Works, The Netherlands
- Environmental Guidelines for Aquatic, Nearshore, and Upland Confined Disposal Facilities for Contaminated Dredged Material, Report of ENVICOM Working Group 5 (publication scheduled for 2002)