



Exploration & Production

GENERAL SPECIFICATION

CIVIL WORKS

GS EP CIV 102

Dredging and filling up

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1. Scope

This specification covers studies relative to dredging and filling-in works, and is more specially meant for use by Engineering CONTRACTORS.

General specifications stipulate the COMPANY minimum requirements. However, some works may present particular problems. In this case the COMPANY reserves the right to modify or complete general specifications by particular specifications.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

When local national standards, regulations and codes exist, all design, engineering, materials and construction shall conform to their latest requirements, which complete or modify the present specifications.

In case of lack of obligatory local national standards, international norms and standards will be applied.

In case of lack of international norms and standards, national norms and standards listed hereafter will be applied.

In all cases the system adopted shall be coherent, i.e. the various texts shall present no incompatibility. Any dispute shall be resolved by basing works on the most stringent text for the CONTRACTOR and at his expense.

The list of specifications and norms quoted is not exhaustive: the CONTRACTOR shall respect the secondary standards and regulations, which cover the works described in the present specification.

Certain specifications and norms may be indicated with an issue date. This is for information only and on the understanding that the most recent issue shall be used.

Correctly speaking, standards, which are specifically applicable to dredging works, do not exist. Standards, which are applicable to hydraulic filling-in works, are the same as those used for earth filling-in, and are given in specification [GS EP CIV 101](#).

Standards

Reference	Title
ISO 8385 – 1999	International standards and codes Ships and Marine Technology – Dredgers – Classification
Eurocode 7	European standards and codes Calcul géotechnique, Partie 1 : Règles générales (Geotechnical design, Part 1 : general rules)
Fascicule n° 2 du CCTG	French standards and codes Terrassements Généraux (General Earthworks) – 14 mars 1979 (Ministère de l'Environnement et du Cadre de vie, Ministère des transports)

Reference	Title
NFP 11-300	Classification des matériaux utilisables dans la construction des remblais et des couches de forme d'infrastructures routières (Classification of usable materials in construction of filling-in and base course of roads)
	American standards
ASTM D 420 – 98	Guide to Site Characterisation for Engineering, Design, and Construction Purposes
ASTM D 421 – 85 (1998)	Practice for Dry Preparation of Soil Samples for Particle-size Analysis and Determination of Soil Constants
ASTM D 422 – 63 (1998)	Test Method for Particle-Size Analysis of Soils
ASTM D 854 – 00	Test Methods for Specific Gravity of Soil Solids by Water Pycnometer
ASTM D 1556 – 00	Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557 – 00	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2,700 kNm/m ³))
ASTM D 1883 – 99	Test Method for CBR (California Bearing Ratio) of Laboratory – Compacted Soils
ASTM D 2167 – 94	Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2216 – 98	Laboratory Determination for Water (Moisture) Content of Soil and Rock by Mass
ASTM D 2487 – 00	Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2845 – 00	Test Method for Laboratory Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock
ASTM D 2922 – 96e1	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D 2937 – 00	Test Method for Density of Soil in Place by the Drive-Cylinder Method
ASTM D 3017 – 96e1	Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D 3155 – 98	Test Method for Lime Content of Uncured Soil-Lime Mixtures
ASTM D 3213 – 91 (1997)	Practices for Handling, Storing, and Preparing Soft Undisturbed Marine Soil
ASTM D 3282 – 93 (1997)e1	Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
ASTM 4253 – 00	Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table

Reference	Title
ASTM D 4254 – 00	Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D 4318 – 00	Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soil
ASTM D 4428 – 00	Test Methods for Crosshole Seismic Testing
British standards and codes	
BS 6031 – 1981	Code of Practice for Earthworks
BS 812	Testing Aggregates
BS 1377 – 1990	Methods of Test for Soils for Civil Engineering Purposes
BS 5930 – 1999	Code of Practice for Site Investigations
BS 6349 – 5 – 1991	Maritime Structures. Code of Practice for Dredging and Land Reclamation
BS 7370 – 5 – 1998	Grounds Maintenance. Recommendations for the Maintenance of Water Areas
BS 7473 – 1991	Glossary of Terms for Dredgers

Professional Documents

Reference	Title
PIANC Bulletin 47, 1984	Classification of soils and rocks to be dredged

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS EP CIV 101	General earthworks
GS EP ENV 121	Environmental impact assessment onshore activities
GS EP GEO 102	Onshore geotechnical soil survey

3. Materials to be dredged

3.1 General

In the absence of any scientific classification of dredging degrees, the COMPANY requests the use of the report published by the International Navigation Association (PIANC). This report was published in 1984 in the PIANC bulletin.

3.2 Description of materials to be dredged or excavated

All call for bid for dredging or excavation works shall include a description as faithful as possible of the materials to be dredged (refer to [GS EP GEO 102](#))

3.2.1 Description of soils to be dredged

For the description of soils to be dredged, the Engineering CONTRACTOR shall refer to Table 1 in appendix, drawn up by the PIANC Maritime Navigation Commission. He shall be as precise as possible in his description (nature, consistency, colour, etc.).

The identification shall moreover include an indication of the soil physical characteristics:

- Structure (resistance to penetration, compactness)
- Granular soil: sieve analysis and description of grains
- Cohesive soil: consistency (shear breaking resistance)
- Smell and colour.

3.2.2 Description of rocks to be dredged or excavated

Drilling diagrams shall be completed by the following elements:

- The descriptive section shall start with a geological classification of rock types. This classification shall be simple but precise
- Drilling parameter characteristics:
 - Coring characteristics (diameter, method, equipment used)
 - Percentage of intact sample cores
 - Percentage of cores with a length of more than 10 cm
 - Progress speeds.
- Sedimentary rocks: indication of inclination and thickness of layers

- Qualitative information:
 - Colour
 - Particle sizes (fine or glassy particles) and texture
 - Strength
 - Bed, joint, crack or geological fault, discontinuity including orientation, etc.
 - Degree of weathering.

In appendix, table 2, drawn up by the PIANC Maritime Navigation commission, groups together the elements required for the identification and classification of rocks to be dredged or excavated.

3.3 In situ and laboratory tests

The Engineering CONTRACTOR shall find in appendix, tables 3 to 7 drawn up by the PIANC, the list of tests to be carried out:

- Table 3, relative to methods to be used on site, as well as in laboratories to identify the soils to be dredged
- Table 4, relative to testing procedures for soil
- Table 5, relative to methods to be used for testing rocks
- Table 6, relative to surface survey used in situ, to obtain sound information on soils and rocks.

Laboratory testing must be undertaken on fresh samples and great care must be taken so that samples are fully representative.

Representative soil samples shall be kept in sealed containers so that more detailed analysis may be carried out at a later date.

3.4 General considerations

Consideration of tables 1 to 7 aim at giving the elements required to define, for the Construction CONTRACTOR, the problems involved in dredging.

4. Equipment and techniques

4.1 General

The Engineering CONTRACTOR shall submit the equipment characteristics and the techniques that he intends to suggest, for COMPANY approval.

4.1.1 Choice of machine types

The Engineering CONTRACTOR shall take the following factors into consideration (this list is not exhaustive):

- Nature of materials to be dredged
- Quantity of materials to be dredged
- Dredging depth

- Distance between dredging site and deposit or fill-in area
- Site access
- Physical environment of site
- Pollution from dredged materials.

Table 7 shown in appendix may be used for a preliminary determination of machine types that can be used.

4.1.2 Work phases

The Engineering CONTRACTOR shall make clear the various work phases involved in dredging operations:

- Excavation
- Transport
- Deposit.

The study shall show the different functions, either under combined form regrouping the overall functions, or on the contrary, under dredging train form, including:

- Extraction machine: the dredging machine
- Transport equipment: barges, trucks, piping
- Unloading and setting down device: bucket elevator or other device.

4.2 Types of dredging machines

In compliance with paragraph 4.1.1, the Engineering CONTRACTOR shall study the type of the dredging machines and in his instructions he shall perfectly define the type of machine to be used, with characteristics and limits. These instructions shall be submitted to the COMPANY for approval.

4.3 Machines and methods used in excavation

Depending on the nature of rocks found, the Engineering CONTRACTOR might have to define excavation methods for rocks. The recommended methods shall be submitted to the COMPANY for approval.

4.4 Deposit or filled-in

Deposit or filled-in shall be defined in particular specifications.

The Engineering CONTRACTOR shall study the problem of deposits for excavated materials and submit his findings for COMPANY approval:

- Deposit area (hydraulic disposal at sea, onshore earth deposit)
- Deposit techniques
- Transportation of materials.

This study shall take into account the type of dredged material, as well as site access constraints.

5. General technical conditions - Environment of sites

5.1 General information and description of works

The Engineering CONTRACTOR shall provide information concerning the dredging project (see Sections 3 and 4).

5.1.1 General project scope

Dredging, excavation, deposit and filling-in works are generally part of overall complex offshore and onshore installations. It shall therefore be necessary, at bid stage, to correctly inform potential Construction CONTRACTORS on these overall works so that they may make an adequate estimation of the work involved. A presentation shall be made of these works and associated constraints in the particular specifications.

5.1.2 Description of works

Dredging, excavation, deposit and filling-in works to be carried out shall be described in a detailed manner. This description shall naturally be backed up by drawings, survey results and materials descriptions, in order to obtain a correct understanding of the problems to be solved and to judge what sort of equipment will be the most suitable.

5.2 Particular constraints

5.2.1 Offshore and onshore access conditions

These conditions define what sort of equipment shall be used and the methods for site supply. It is therefore necessary at bid stage to imagine what shall be the Construction CONTRACTOR requirements (forwarding of equipment, spare parts, miscellaneous supplies and personnel), and to reply in advance to the questions that may arise, via the edition of a proposal in order to meet these requirements.

In any case, it will be made mandatory for the Construction CONTRACTOR to comply with the local regulations.

5.2.2 Nautical and meteorological conditions

These natural conditions have an implication on the performance of the works. It shall therefore be necessary to inform Construction CONTRACTORS with respect to the following elements:

- Tides
- Wave (registered or forecast in all site areas)
- Currents (registered or forecast, particularly in estuaries)
- Meteorological conditions (wind, rain, fog, etc.)
- Hydrographic chart.

Detailed data on these conditions will allow the Construction CONTRACTOR to define the working sequence in order to comply with the overall schedule of the works.

5.2.3 Constraints resulting from existing installations

A particular document, with instructions adapted to each case, shall be made up for each one of the following situations:

- Construction of a structure within a port
- Other companies working on the same site or in a neighbouring area.

Recommendations shall be made concerning the following points (non-exhaustive list):

5.2.3.1 Port use

Onshore: Keeping in use road system circulation, lay-bys, railways, laying of temporary pipes and cables, clearing of some areas.

Offshore: Particular requirements for mooring or navigation in the dredging work area or in deposit areas, as well as underway from one to the other.

In some particular cases (open navigation channels), it may be added that the Construction CONTRACTOR Representative shall consult with the harbour master before starting the next days work.

5.2.3.2 Other companies

Particular specifications shall define the Construction CONTRACTOR obligations relative to sites used by other companies in the same area or surrounding areas.

This document shall also mention maintenance requirements for neighbouring industries and installations. Should these requirements be important, they might be treated in a specific separate document.

The Construction CONTRACTOR shall not take advantage of the following in order to escape from his obligations and make claims:

- Normal daily operation of the harbour
- Performance of simultaneous works by other companies.

5.2.4 Use of explosives

A particular clause shall always determine conditions under which explosives may be used in site areas.

The Construction CONTRACTOR shall take all the necessary precautions when using explosives in order to ensure that their use represents no danger to personnel or third parties and no damage to navigation and neighbouring installations.

In all cases, the Construction CONTRACTOR shall act in compliance with local regulations relative to explosives and he shall obtain all required administrative permits, particularly concerning their storage, handling and use.

Particular specifications shall define, if necessary, the areas in which the use of explosives shall be subject to restrictions or prohibited. However, in all cases, the Construction CONTRACTOR shall limit the use of explosives depending on the inconveniences that may result for the installation to be built, considering its destined use and nature.

5.3 Site environment

5.3.1 Area reserved for the Construction CONTRACTOR

The specification relative to this issue shall generally indicate:

- Whether there is a fee for this area
- Whether the Construction CONTRACTOR will have the right to erect a fence around this area
- Construction CONTRACTOR obligation to restore the area on completion of his works and to remove all his belongings
- The date of this restoration (temporary or final acceptance for instance) and the fact that the acceptance of works shall depend upon the restoration of the area that was made available
- Condition of the restored area.

5.3.2 Site installations

Having stipulated what areas shall be made available for the Construction CONTRACTOR, particular specification shall aim at formulating instructions or obligations for site installations:

- Access and service roads that exist or are to be made
- Water, electricity supply, telephone lines
- Precautions to be taken about existing installation foundations
- Fence and security
- Storage of materials and equipment
- Constraints for circulation around site installations or annoyances to neighbours (noise, dust, etc.).

Particular specifications may define dates for the completion and operational use of site installations.

Large site installations may have partial dates (and corresponding acceptances), along with penalties and premiums.

5.3.3 Layout, topographic and hydrographic marks

Before any work starts, the Engineering CONTRACTOR shall have altimetric, planimetric and hydrographic marks established. The dredging shall be based on these marks.

Lining up of the works and marking measurements shall be reproduced on a drawing, which shall be given to the Construction CONTRACTOR. The latter will be granted a ten-day delay to make any comment.

Staking out, laying out and maintenance of markings shall be ensured by the Construction CONTRACTOR and at his expense.

As the works progress, the Construction CONTRACTOR shall also ensure, under his own responsibility, all the staking out and laying out that are required to perform the works, in compliance with methods that have been approved by the Engineering CONTRACTOR and in the latter's presence.

This specification shall moreover indicate:

- The levelling system referred to in the file
- Possibly, the vertical offset of this system, in comparison to other systems used in the region (for instance hydrographic zero in comparison with general levelling zero)
- Sea level variations with respect to this levelling system
- Level markings that may be used for the works.

5.3.4 Onshore and offshore site lighting

Generally speaking the following shall be provided:

- For onshore sites, road signs and site markings shall be provided by the Construction CONTRACTOR and at his expense to avoid any road accidents. Markings shall be illuminated at night
- For offshore sites near shipping lines, the Construction CONTRACTOR shall provide beacon buoys for the work site and advise the local navigation authorities in adequate advance to enable circulation of the information.

In all cases, the Construction CONTRACTOR shall act in compliance with the administrative authority which is responsible for the area in which works are being carried out (road police, harbour officials, etc.).

5.3.5 Dredging influence on the environment

The Engineering CONTRACTOR shall inform himself as to the problems involved with dredging operations:

- Alteration to coastal or river morphology, e.g. enhancement or loss of amenity, addition or reduction of wildlife habitat, etc.
- Alteration of water currents and wave climate, which might affect navigation, coastal defence, etc.
- Reduction or improvement of water quality, affecting fauna
- Removal of polluted materials and their relocation to safe, contained areas
- Suspended sediments due to the dredging process.

When harmful environmental effects cannot be avoided, the Engineering CONTRACTOR shall assess the ecological damage. He shall make a comparison of the dredging methods in order to minimise this impact.

The impact file shall be in compliance with specification **GS EP ENV 121**.

5.4 Documents to be established by the Engineering CONTRACTOR

Apart from classical bid documents, the Engineering CONTRACTOR shall establish the following:

- Particular specifications
- List of unit prices
- Estimated price

- Drawings
- List of recommended equipment
- Forecast schedule for works.

This list is not exhaustive and shall be subject to COMPANY approval.

6. Method for the execution of works

6.1 Schedule and drawings

6.1.1 Schedule for the execution of works

A detailed time schedule shall be requested from the Construction CONTRACTOR.

- Firstly, as an appendix to his bid
- Secondly, within a month delay after the contract approval, following detailed discussion of the said contract clauses.

In all cases, periodical updating shall be requested from the Construction CONTRACTOR throughout the duration of the works.

The schedules shall comply with the COMPANY requirements.

6.1.2 Drawings

The particular specifications shall define exactly the Engineering and the Construction CONTRACTORS scope of works.

6.2 Dredging gradient slopes

The particular specifications shall define the gradient slopes to be respected for dredging works. Those slopes shall depend upon the nature of the dredging material and the location of structures to be built.

The Engineering CONTRACTOR may modify slopes during the works if it appears that the planned gradients lead to instability.

6.3 Materials

6.3.1 Definition of materials to be dredged

In addition to chapter 3, the following adjustments should be made:

- As the criteria for the division of dredged materials into categories depend partly on dredging machine capacity, the category may be modified with the agreement of the Construction CONTRACTOR at the time of contract signature.

The determination of relevant categories shall be based on the results obtained from soil investigation and geotechnical surveys. So that this determination may be of use, it is necessary that:

- Geotechnical surveys are sufficient in quantity, especially in a varying environment
- The results from tests may be interpreted in terms of dredging difficulties.

If the test results are not sufficient, they shall be completed by complementary investigations carried out during the works. The Engineering CONTRACTOR shall prescribe the tests to be carried out, so that the results may be directly used to determine the boundaries that separate the material categories.

- There is no use in selecting too many categories of materials to be dredged even in varying environment.

A limited number of categories shall be pre-selected (three for instance, five at the most). Their determination will depend on:

- Nature of material (mud, sand, rock, etc.)
- Geotechnical characteristics, for instance cohesion
- Capacity of dredging machine
- Previous excavation before dredging by means of special machines.

As many details as possible shall be provided in order to avoid any ambiguity that may lead to dispute.

- During the estimation of dredged material categories, the Engineering CONTRACTOR shall pay particular attention to the estimation relative to the hardest categories of material.

The particular specifications shall stipulate in all cases that the quantitative division of materials into categories has only an indicative value and that the Construction CONTRACTOR may not base any claim on the fact that the definitive division is different from that forecast.

6.3.2 Filling-in material

A particular specification shall apply to the origin and the quality of fill-in by dry or hydraulic methods.

A detailed technical study shall be made on the fill-in material. On the one hand, settling down of overloads and on the other hand, the importance of quantities to be used shall be studied.

In case of materials not coming from project dredging, the Engineering CONTRACTOR shall submit a technical file for COMPANY approval. The said file shall include:

- Borrowing and quarry areas
- Deposit areas
- Geotechnical surveys
- Sample analyses
- Possible proportions of different materials to be mixed to obtain satisfactory particle sizing
- Elimination of too large or too fine materials (by decantation for instance), with certain tolerances for both limits.

Materials studies shall be based on some of the following tests:

- Soil:
 - Permeability
 - Particle sizing

- Cleanliness, amount of organic material, impurities, tolerances
- Sand equivalent
- Chemical and mineralogical nature
- Density.
- Rock:
 - Particle sizing
 - Particle shape
 - Cleanliness of particles, tolerated impurities
 - Cohesion and hardness
 - Density, porosity
 - Liability to decay.

The upper fill-in layers that may be used as road foundation layers shall be in compliance with road work quality requirements (CBR test, Proctor test, Atterberg limits, grading curves imposed by the COMPANY, etc.).

When materials come from deep dredging, the Engineering CONTRACTOR shall determine the conditions for their use. Moreover a clause shall enable the COMPANY to refuse the use of some dredged material for fill-in works. It shall therefore be necessary to provide deposit areas for dredged material that cannot be reused.

In all cases where fill-in is made with fine material which risk passing through a mass made up of much larger elements, or through a quay wall, a filter shall be laid, particularly in the following cases:

- Between sand fill-in and rock mass (whether back shoulder of quay, or spoil bank)
- Between sand fill-in and free joints of a structure in contact with water (crest girder on quay for example) or pile wall.

Filter characteristics shall be determined by the Engineering CONTRACTOR and submitted for COMPANY approval.

6.4 Definition of equipment to be used by the Construction CONTRACTOR

6.4.1 General

The definition of the type of equipment to be used, provided by the Engineering CONTRACTOR shall be used only on indicative basis.

The methods proposed by the Construction CONTRACTOR shall be one of the essential elements involved in the assessment of his proposal.

It shall therefore be necessary, in all cases, to request that Construction CONTRACTOR issues a special file, giving the characteristics of each piece of large equipment that he intends to use for the execution of the works.

6.4.2 Instructions for the bid

Instructive information concerning the following equipment possibilities shall be provided:

- Destination of dredged products

- Capacities suggested for the following elements:
 - Necessity to dredge a fixed volume within a fixed delay
 - Nature of material categories to be dredged, with the proportion of each category in the total volume
 - Transport distance for dredged products (offshore or onshore distance, sea distance for rejected products).
- Technical possibilities of equipment:
 - Minimum dredging possibilities. This is determined by the deepest basin or quay foundation dredged, taking a margin into account which depends upon the uncertainty of the quality of foundation material
 - Dredging aptitude under wave and current effects
 - Equipment possibilities concerning material of very special consistency and very hard material, excavation of rock before dredging or breaking up by dredging alone
 - Special equipment required for dredging: for example, flow rate measurement device to enable control of quantities and ratings, etc.
- Particular local problems:
 - Nautical conditions, meteorological conditions, sea state
 - Constraints for harbour running which do not involve hindering navigation in certain areas
 - Obstacles that may be encountered: debris, wrecks, etc.

6.5 Execution of dredging and rock excavation

6.5.1 Deposit area for dredged products

The Engineering CONTRACTOR shall define deposit areas for dredged and excavated products. He shall make sure that deposits are not likely to be swept away by currents into dredged areas or areas in the process of being dredged.

In case dredging leads to fill-in, the Engineering CONTRACTOR shall provide an initial survey of the deposit area.

Particular specifications shall indicate any special arrangement relative to the existing neighbouring structures in the deposit zone (protective dykes to be made, etc.).

For underwater deposit areas the maximum deposit volumes shall be stipulated (level not to be exceeded).

6.5.2 Removal of wrecks

The Engineering CONTRACTOR shall indicate to what extent the removal of any wreck or heavy object is included in the Construction CONTRACTOR scope of work. He shall:

- Define what is the nature, size or weight above which an object unexpectedly discovered in a dredging zone may be considered as justifying supplementary payment
- Provide the procedure to be used when the Construction CONTRACTOR has to remove objects that exceed the limits previously mentioned

- Provide the way to assess stoppage of works and any damage caused to equipment, as well as the method of payment for removal of these objects (cost plus contract or special estimate).

6.5.3 Control of results and execution tolerances

The controls of results shall be either in line with dredging or fill-ins.

6.5.3.1 Dredging

The Engineering CONTRACTOR shall prescribe the contour surveys according to design axis and following the prescribed pattern.

It shall be necessary to prescribe certain tolerances relative to overdepth and underdepth.

- **Overdepth:** Overdepth tolerance shall depend on the one hand, on sea condition and on the other hand, on the sedimentation speed at the point in question. All quantities in excess to these tolerances shall not be paid
- **Underdepth:** Underdepth may be accepted where the precision for dredging ceiling is not given for a specific objective and where depths equal themselves out. They shall be excluded in all other cases.

Where material to be dredged is of a varying nature, tolerances may be given for each type.

6.5.3.2 Fill-ins

Particular specifications shall define levels.

The control methods shall be the same as for onshore soil fill-ins. Stipulation shall be made for the settling down delay before measuring definitive results.

If hydraulic fill-in is completed by machine operations, the tolerances shall be those of onshore fill-ins.

The Construction CONTRACTOR shall give all facilities to the Engineering CONTRACTOR in order to carry out the necessary controls during and after execution. Particular specifications shall stipulate the equipment and the personnel that the Construction CONTRACTOR shall make available for the Engineering CONTRACTOR to this effect.

6.5.4 Control methods

The Engineering CONTRACTOR shall define the methods to be used to ensure position controls for machines, surveys, etc.

6.6 Execution of hydraulic fill-ins

6.6.1 Fill-ins

The particular specifications shall:

- Stipulate conditions for enclosing dykes (characteristics, maintenance, characteristics and location of overflows)
- Define decantation and/or evacuation conditions for fine or mud soils contained in the fill-in materials
- Prohibit pockets of doubtful soil materials within the fill-in

- Provide arrangements to take into consideration installations and structures that already exist in the areas or surrounding deposit areas (to avoid flooding, changing layout of cables and piping, etc.)
- Provide arrangements required for settling
- Recommend method for back filling of quays.

6.6.2 Preloading of hydraulic fills

The particular specifications shall define:

- Location and value of overload
- Delay for maintaining overload
- Evacuation conditions for the overload.

7. Acceptance

7.1 Determination of dredged volumes

Dredged volumes shall be determined by dredging sections, fill-in sections or exceptionally by the carrying machine.

7.1.1 Dredging section

An initial cross-examination of seabed shall be made before works start. The crosschecks shall be made following a control point drawing provided by the COMPANY, with a determined pattern relying on determined axis. Measurement density shall depend upon the nature of the soil. The measurements shall be converted to planimetric and altimetric scale markings.

If several partial acceptances are to take place, these acceptances shall involve further surveys.

Periodical surveys may be provided, either to estimate silting up of the dredged basin (one month period for example) and discover underdepths, or to control work progress and possibility to calculate dredging rating capacity (24 hour period for example).

Surveys shall be made either by using ultra-sonic equipment, or rods. Ultra-sonic equipment shall be regularly calibrated at the stem rod. The measurements shall be converted to prescribed levels and axis, and shall take into account water level variations. In the case of mud beds the stem rod shall include at its lower end a horizontal flat surface, several centimetres square. This surface shall remain constant throughout the works. By definition, the soil refusal measurement taken when pushing the rod equipped as described above shall be considered as the soil measurement.

It should be noted that the Construction CONTRACTOR may not argue about natural sedimentation, which is produced in dredged sections, to contest the dredged volumes for payment, due to the difference between measurements taken before and after dredging (to be stipulated in price quotations).

7.1.2 Fill-in section

The instructions are the same as for onshore filling-in, by measuring sections before and after fill-in. The settling delay shall be stipulated, after which section measurements shall be made.

It shall also be stipulated that account shall not be made in the take-off for any subsidence of the ground to be filled-in, due to an overload effect from the fill-in. The Construction CONTRACTOR shall have considered this in his price (to be stipulated in price list quotation).

7.1.3 Carrying machine

Volume determination shall be made by gauge scale readings in the machine compartments. The machine shall be equipped in consequence and its volumetric characteristics shall be known. Gauge tables shall be established with cross checks and used for the determination of volumes. In the case of mud a rod survey system, similar to that described in paragraph 7.1.1 hereabove, shall be used.

7.2 Acceptance of the works

General conditions for acceptance of works naturally apply to dredging works. However, in their case, certain particularities shall be considered.

7.2.1 Materials added during dredging

Supplementary materials may be added to the beds through different circumstances (lie of the land, currents, nature of soil, proximity of deposit areas, manner in which dredging is carried out in the various zones, etc.).

The particular specifications shall stipulate to what extent the Construction CONTRACTOR shall clean up, at his expense, the surplus found in dredged areas and within what delay.

7.2.2 Acceptance

Conditions for acceptance shall be:

- Completion of dredging to the prescribed dimensions, taking tolerances into account
- Removal of added surplus in dredged areas and possibly of wreck
- Control of results.

Global acceptance may be given for the whole of the works, or several partial acceptances, relative to several zones, if so stipulated within particular specifications.

Appendix 1

**Table 1 - General basis for identification and classification of soils⁽¹⁾
for dredging purposes**

Main soil type	Particle size identification Range of size (mm)	Identification	Particle nature and plasticity	Strength and structural characteristics
Boulders	Larger than 200 mm	Visual examination and measurement ⁽⁴⁾	Particle shape : Rounded Irregular Angular Flaky Elongated Flaky and elongated	N.A.
Cobbles	Between 200-60 mm			
Gravels	Coarse 60-20 mm Medium 20-6 mm Fine 6-2 mm	Easily identifiable by visual examination	Texture : Rough Smooth Polished	Possible to find cemented beds of gravel, which resemble weak conglomerate rock. Hard-packed gravels may exist intermixed with sand
Sands ⁽⁵⁾	Coarse 2-0.6 mm Medium 0.6-0.2 mm Fine 0.2-0.06 mm	All particles visible to the naked eye. Very little cohesion when dry		Deposits will vary in strength (packing) between loose, dense and cemented. Structure may be homogeneous or stratified. Intermixture with silt or clay may produce hard-packed sands
Silts ⁽⁵⁾	Coarse 0.06-0.02 mm Medium 0.02-0.006 mm Fine 0.006-0.002 mm	Generally particles are invisible and only grains of coarse silt may just be seen with the naked eye. Best determination is to test dilatancy ⁽²⁾ . Material may have some plasticity but silt can easily be dusted off fingers after drying and dry lumps powdered by finger pressure.	Non-plastic or low plasticity	Essentially non-plastic but characteristics may be similar to sands if predominantly coarse or sandy in nature. If fine will approximate to clay with plastic character. Very often intermixed or interleaved with fine sands or clays. May be homogeneous or stratified. The consistency may vary from fluid silt through stiff silt into "siltstone"
Clays	Below 0.002 mm Distinction between silt and clay should not be based on particle size alone since the more important physical properties of silt and clay are only related indirectly to particle size	Clay exhibits strong cohesion and plasticity without dilatancy. Moist sample sticks to fingers and has a smooth, greasy touch. Dry lumps do not powder, shrinking and cracking during drying process with high and dry strength	Intermediate plasticity (Lean clay) High plasticity (Fat clay)	Strength Shear strength⁽³⁾ V.soft May be squeezed easily between fingers Less 20 kN/m² Soft Easily moulded by fingers 20-40 kN/m² Firm Requires strong pressure to mould by fingers 40-75 kN/m² Stiff Cannot be moulded by fingers, indented by thumb 75-150 kN/m² Hard Tough, indented with difficulty by thumb nail Above 150 kN/m² Structure may be fissured, intact, homogeneous, stratified or weathered
Peats and organic soils	Varies	Generally identified by black or brown colour, often with strong organic smell, presence of fibrous or woody material		May be firm or spongy in nature. Strength may vary considerably in horizontal and vertical directions. Presence of gas should be noted

Notes:

N.A.: Not applicable

- Soil may be defined in the engineering sense as any naturally occurring loose or soft deposit forming part of the earth crust. The term should not be confused with "pedological soil" which includes only the topsoil capable of supporting plant growth, as considered in agriculture.
- Dilatancy is the property exhibited by silt as a reaction to shaking. If a moistened sample is placed in an open hand and shaken, water will appear on the surface of the sample giving a glossy appearance. A plastic clay gives no reaction.
- Defined as the undrained (or immediate) shear strength ascertained by the applicable in situ or laboratory test procedure.
- Though only visual examination and measurement are possible an indication should be given with respect to the particles as well as the percentages of different sizes.
- "Sands" and "Silts" are terms denoting a particle size. Sands are not necessarily restricted to quartz sands but may include lime sands, iron ores, etc. Also silts denote a grain size, not a consistency. Therefore consistency terms such as "fresh harbour silts, muds", etc. should not be used.

**Table 2 - General basis for identification and Classification of Rocks⁽¹⁾
for dredging purposes**

Group	Examples of rock type	Origin	Identification	Remarks
I. Igneous	Granite Dolerite Basalt etc.	Formed by the solidification (crystallisation) of original molten material (magma) extruded from within the earth's crust	All exhibit a crystalline form although the individual crystals may be invisible to the naked eye. Complex system of rocks. All igneous rocks are hard although may be altered by various natural causes such as weathering. Because of stress rocks may possess systems of joints and fissures	Full identification of rocks may be complex. Hand examination will give approximate classification based on rock type name. Laboratory examination may be required using rock slices to confirm the more difficult cases Engineering properties of rock for dredging purposes requires generally to be carried out in laboratory using Test Procedures suggested in Table 6
II. Sedimentary	Sandstone Limestone Marls Chalk Corals Conglomerates etc.	Derived from pre-existing formations by weathering and disintegration, often being reconsolidated in hard strata. Occurring as sequence of deposits in beds	Often recognisable by bedded structure. In general terms the older the formation; the harder the rock although a considerable variation in hardness, colour and other characteristics is likely. In many sedimentary rocks the individual particles forming the body of the material may be seen (e.g. sandstone) and a rough grading given in description	Whilst for practical purposes it may not be necessary to identify a rock by name, it is of inestimable value in analysing the project as a whole Degree of weathering in rock is of extreme importance and will alter the engineering properties of even the hardest igneous rocks
III. Metamorphic	Gneiss Marble etc.	Includes an igneous or sedimentary rock which has been altered by heat or pressure	Wide range in degree of metamorphism with some rocks still close to original condition, other rocks completely recrystallised so that original structure obscured. Rock is normally very hard with glassy surface	

Note:

- (1) Rock may be defined in the engineering sense as the hard and rigid deposits forming part of the earth crust as opposed to deposits classified as soil. Geological rock embraces both soft and hard naturally occurring deposits, excluding topsoil.

Table 3 - Classification of soils for dredging purposes by in situ and laboratory testing⁽¹⁾

Main soil type	Particle size distribution	Particle Shape	In situ density or bulk density	Specific gravity of the solid particles	Compactness (in situ)	Natural Moisture content	Plastic and liquid wastes	Shear strength	Lime content	Organic content
(2) Boulders Cobbles	Visual in field	Visual inspection	N.A.	Lab. Test (on fragments)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Gravel	Lab. test	Lab. test	N.A.	Lab. test	In situ test	N.A.	N.A.	N.A.	(3) Lab. test	N.A.
Sands	Lab. test	Lab. test	(4) Lab. test on undisturbed samples	Lab. test	In situ test	Lab. test	N.A.	N.A.	Lab. test	Lab. test
(5) Silts	Lab. test	Lab. test	Lab. test on undisturbed samples	Lab. test	In situ test or lab. test on undisturbed samples	(6) Lab. test	Lab. test	Lab. test	Lab. test	Lab. test
Clays	(7) Lab. test	N.A.	Lab. test on undisturbed samples	N.A.	In situ test or lab. test on undisturbed samples	(6) Lab. test	Lab. test	(8) In situ and/or Lab. test	N.A.	Lab. test
Peats and organic soils	N.A.	N.A.	Lab. test on undisturbed samples	N.A.	In situ test	Lab. test	Lab. test	In situ and/or Lab. test	N.A.	Lab. test

Notes:

N.A. : Not Applicable

Tests heavily outlined in the table are considered to be of first priority for assessment of soil characteristics for dredging purposes; lightly outlined tests are of second priority. Non-outlined tests can be restricted to a few representative samples of each soil type.

(1) For testing procedures see Table 4.

(2) To be tested as rock.

(3) Applicable to dredged aggregates for construction purposes.

(4) Determination of max./min. dry density is also recommended.

(5) Silts often contain an appreciable amount of clay particles which have a strong influence on the soil characteristics. In such cases the tests for silts as well as for clays should be performed.

(6) Tests should be performed on samples in natural condition by preference using undisturbed samples.

(7) It may be useful to carry out particle size distribution on any sand/silt fraction within the clay sample but also expressing the percentages relative to the total sample.

(8) Tests should include sensitivity performed on representative samples.

Table 4 - In situ and laboratory testing procedures of soils for dredging purposes

Soil properties or characteristics	In situ test	Laboratory test (site or central laboratory)	References (British standards or equivalent) ⁽¹⁾
Particle size analysis	N.A.	Sieving on granular soils. Sedimentation on cohesive soils. Combination on composite soils such as sandy clays. A rough evaluation by comparison with standard soil samples by microscope or with grid counter	BS 1377 (1990)
Particle shape	N.A.	Comparison with standard samples and photographs.	BS 812 - 105.1 (1989), BS 812 - 105.2 (1990)
Bulk density or in situ density	N.A. except for measurement of boulders and cobbles	The unit weight of soil as found in situ and expressed as the ratio between total weight and total volume of soil.	BS 1377 (1990)
Specific gravity of the solid particles	N.A.	S.G. determined as the ratio between unit weight of solid particles and unit weight of water.	BS 1377 (1990)
Compactness (in situ)	May employ several in situ tests, e.g. (i) Standard penetration test (ii) Dutch penetrometer (sounding) (iii) Other penetrometers based on standardised test procedures	N.A.	(i) BS 1377 (1975) p. 103 et seq. (ii) The penetrometer and Soil Exploration (Sanglerat) (iii) Elsevier Publishing Co., Amsterdam (1979)
Moisture content	(ii) Radio active meter method	(i) Moisture content determination	(i) BS 1377 (1990) (ii) Meigh, A.C. and Skipp, B.O. "Gammaray and neutron methods of measuring soil density and moisture". Geotechnique, X (1960), 3 June, pp 110-126
Plasticity	N.A.	Determination of liquid and plastic Limits	BS 1377 (1990)
Shear strength	May employ several in situ test e.g. (i) Hand penetrometer (ii) Vane tests (iii) Dutch penetrometer (iv) Other penetrometers based on standardized test procedures	(i) Torvane (v) Hand penetrometer (vi) Unconfined compression apparatus (vii) Triaxial compression (viii) Cell apparatus (ix) Fall cone	(i) Item manufactured by "Soiltest" Inc. Evanston, Ill., U.S.A (ii) BS 1377 (1990) (iii) See references given above for "compactness" (iv) See references given above for "compactness" (v) See reference given above (vi) BS 1377 (1990) (vii) BS 1377 (1990) or for more advanced study: The measurement of soil properties in the Triaxial Test (Bishop, AW & Henkel, D.J.) Arnold, London (1962). (viii) Gauze, E.C.W.A and Tan Tjong Kio "The shearing properties of soils" Part I : The cell-test procedure Part II : Comparison of triaxial and cell-test results Geotechnique II (1950), 2 December, pages 141-261 (ix) A new approach to the determination Shear Strength of clay by the Fall cone test (Hansbo). Royal Swedish Geotech. Inst. Stockholm (1957), Proceedings n° 14.
Lime content	N.A.	(i) Measurement of carbonate content (ii) Visual test by applying hydrochloric acid (HCl) to specimen to indicate effervescence	(i) A.S.T.M. D 3155 (1998) or "Soil mechanics for Road Engineers", HMSO London (1952)
Organic content	N.A.	Determination of organic content	BS 1377 (1990)

Notes:

(1) It should be emphasised that other international or national standards exist which may be equally appropriate for use.

Table 5 - In situ and laboratory testing procedures of rocks for dredging purposes

Name of test	Purpose of test	Remarks	Lab (L) or in situ (S)	References
Visual inspection	Assessment of rock mass.	Indicates in situ state of rock mass. (1)	S or L	BS 5930 (1999)
Thin section	Identification.	Aid to mineral composition.	L	Geological Textbooks
Bulk density	Volume/weight relationship.	Wet and dry test.	L	International Journal for Rock Mechanics and Mining Sciences (1979) 16, 141-156
Porosity	Measure of pores expressed as percentage ratio voids/total volume.	To be calculated directly from wet and dry bulk density.	L	Ditto
Carbonate content	Measurement of lime content.	Useful for identification of limestone, chalks, etc.	L	ASTM D 3155 (1998)
Surface hardness	Determination of hardness	Graded according to Mohs hardness scale from 1 (talca) to 10 (diamond)	L	Reference set commercially obtainable
Uniaxial compression	Ultimate strength under uniaxial stress.	Test to be done on fully saturated samples. Dimensions of testpiece and direction of stratification relevant to stress direction are to be stated. Recommend 1:2 length/diameter ratio for cylindrical specimens.	L	International Society for Rock Mechanics Commission Committee on Lab. Tests, Publication 135 (Sept. 1978)
Brazilian split	Tensile strength (derived from uniaxial testing).	Ditto except length/diameter ratio recommendation	L	Ditto, Doc. No. 8 (Mar. 1977)
Point Load test	Strength indication	Easy and fast test but should be matched with uniaxial compressive strength test.	L	Int. Journal for Rock Mech. Min. Sci. (1972) 9, 669-697
Protodiakonov	Indication of crushing resistance under dynamic load.	Test has been devised for the harder type of rocks. Care should be taken with the execution and interpretation of test results on soft rocks, especially coarse-grained conglomerates.	L	See notes (2)
Standard penetration test	Strength indication.	Applies to corals and highly weathered rocks.	S	BS 1377 (1990)
Seismic velocity	Indication of stratigraphy and fracturing of rock mass.	Useful in extrapolating laboratory and field tests to rock mass behaviour.	S	ASTM D 4428 (2000)
Ultrasonic velocity	Longitudinal velocity.	Tests on saturated core samples.	L	ASTM D 2845 (2000)
Static modulus of elasticity	Stress/strain rate.	Gives an indication of brittleness.	L	Ditto
Drillability	Assessment of the rock mass.	Measurement of drilling parameters including penetration rate, torque, feed force fluid pressure etc. and statement of drill specification and technique	S	
Angularity	Determination of particle shape.	May be visual examination compared to standard specimens	L	BS 812

Notes:

- (1) Colour photography for record purposes can be very useful.
- (2) Concise references are not available for this test. A reference which gives a slight modification of the test procedure (in order to overcome some of disadvantages of the original method such as rebonding of pulverised material) is: *The Strength, Fracture and Workability of coal*, Evans I and Pomeroy CD, Pergamon Press (1966).
 - (a) "Professor M.M. Protodiakonov's Strength Coefficient of Rocks". Translation by the Foreign Technology Division of the Air Force Systems Command, Ohio, U.S.A. (translation 1981).
 - (b) "Methods for the Evaluation of the Fissurization and Strength of a Rock Mass" by M.M. Protodiakonov. Translation by the Council for Scientific and Industrial Research, Pretoria (1965).
 - (c) "Methods of Evaluating the Cracked Stage and Strength of Rock In Situ" by MM. Protodiakonov, Department of Mines and Technical Surveys, Ottawa, Canada (1965).
 - (d) "A critical appraisal of the Protodiakonov index", Misra, G.B. and Paithankar, A.G. Technical note International Journal of Rock Mechanics, Min. Sciences and Geomech. Abstracts, Vol. 13, PP. 249-251 (1976).

Table 6 - Sampling and investigation procedures for dredging purposes

Rock or Soil Type	Rotary Drilling (1)	Shell & Auger Boring	Underwater (sea bed) Devices	Undisturbed Sampling (2)	Disturbed Representative Samples (2)	Dynamic Penetration Test (3)	Static Penetration Test (e.g. Dutch, Swedish)	In situ Vane testing	Geophysical methods
Rocks	Best method of obtaining core samples of intact rocks in in situ conditions for examination and test	N.A.	Useful for obtaining core samples of limited penetration	Cores represent undisturbed samples of intrinsic rock	Cutting in drill fluid may be used for identification of non-recovered layers	Used only in soft or weathered rock and in corals	N.A.	N.A.	Useful to establish the likely geology over a large area. Will assist both to 'set out' a borehole grid and to 'fill in' detail between borings and drillings. However, note should be taken that such methods still require careful interpretation. Very useful where relatively simple soil/rock conditions exist (i.e. soft alluvium over rock). Where only slight changes in strata density occur great care needed in interpretation
Boulders Cobbles	May be used to penetrate and obtain core samples	Chiselling required to penetrate strata	N.A.	Cobbles retained as undisturbed samples	N.A.	N.A.	N.A.	N.A.	
Gravels	N.A.	Method employed for site investigation in order to obtain representative and undisturbed samples and to carry out field (in situ) tests.	N.A.	Not practicable to retain gravel as an undisturbed sample unless in cemented condition	Obtained from borings in tins or bags. Must be "representative" (i.e. only from a single horizon or stratum).	Used with cone gives reasonable in situ compactness estimate	Very difficult to penetrate coarse gravel	N.A.	
Sands	N.A.		Various devices are available to obtain representative samples, but generally of limited penetration	Patent samplers available, difficult to sample in undisturbed condition	Essential for identification of various strata,	Useful for in situ compactness estimate at the same time as sample is obtained	Useful method for determining in situ properties and "hard" strata levels. In areas with wide soil variation may be useful to supplement borehole information	N.A.	
Silts	N.A.			If cohesive in nature can use clay undisturbed core samplers, otherwise see Sands		Can very well be used, but interpret with care		Used for estimate of shear strength but great care needed in interpretation	
Clays	N.A.			Variety of undisturbed core samplers available				Very useful for shear strength evaluation in alluvial clays	
Peats, etc.	N.A.			Variety of undisturbed core samplers available				Used for estimate of shear strength but great care needed in interpretation	

Notes:

N.A.: Not applicable

- (1) Normally 55 mm (mx or equivalent) core size commonly used in massive rocks and a minimum of 70 mm is normally recommended for weak, weathered or fractured rocks. It is, however, suggested that 100-150 mm will give improved results.
- (2) Care should be observed in handling and preserving samples. Samples of rock should be retained where possible in conditions approximating to the in situ state. Undisturbed and disturbed samples of soil, particularly core samples of cohesive materials, should be protected from loss of natural moisture. Care in labelling samples is of paramount importance.
- (3) Reference is for the "Standard Penetration Test" (see also table 4).

Test dredging: There may be some projects on which the complexity of the geology or other special circumstances warrant the use of test dredging or even make test dredging desirable. In other cases the results of previous dredging contracts might be useful. In all cases details of all relevant circumstances should be provided, including quantitative and qualitative examination of the spoil and where appropriate a description of the dredger previously used. Great care should be taken by the COMPANY in providing reliable information and by the CONTRACTOR in interpreting this information.

Table 7 - General characteristics of soils and rocks for dredging purposes (rocks unweathered* and unblasted)

Rock/Soil type	Excavation characteristics						Suitable as reclamation material	Suitability to pipeline transportation	Often observed bulk density before excavation
	Dipper dredger	Bucket dredger	Suction dredger	Cutter dredger	Trailer dredger	Grab dredger			
Rock*									
I. Igneous	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.0-2.8
II Sedimentary	Possible in soft rock but difficult	Possible in soft rock but difficult	N.A.	Difficult to fair in softer rocks	N.A.	Possible in softer rocks but very difficult	Very good	Fair, large fragments may block pipes	1.9-2.5
III. Metamorphic	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	2.0-2.8
* Weathering of rocks will alter from and strength considerably and may allow direct dredging without blasting, etc.									
Boulders	Fair	Very slow, may require slinging	N.A.	N.A.	N.A.	Difficult but large units cope	Not acceptable	N.A.	N.A.
Cobbles or cobbles with gravel	Fair	Fair	Difficult	Difficult	Difficult	Fair	Bad to good	Poor	N.A.
Gravel	Easy	Fair	Difficult to fair	Fair	Difficult to fair	Fair	Good	Fair	1.75-2.2
Sandy gravel	Easy	Fair to easy	Fair	Fair to easy	Fair to easy	Fair to easy	Very good	Fair to good	2.0-2.3
Medium sand	Easy but low production	Easy	Easy	Easy	Fair to easy but high overflow losses likely	Easy	Very good	Good	1.7-2.3
Fine sand		Easy	Easy	Easy		Easy	Good	Very good	
Extra fine sand		Easy	Easy	Easy		Easy	Good	Very good	
Silty fine sand		Easy	Fair	Easy		Easy	Good	Very good	
Cemented fine sand	Fair	Fair	N.A.	Fair to easy	Difficult	Difficult	Good	Bad to good	1.7-2.3
Silt	N.A.	Easy	Difficult to fair	Easy	Fair to easy but high overflow losses	Fair	Bad	Very good	1.6-2.0
Firm or stiff gravelly or sandy clays (i.e. boulder clays)	Fair	Difficult to fair	N.A.	Difficult to fair	N.A.	Difficult to fair	Good	Only possible after disintegration	1.8-2.4
Soft silty clays (i.e. alluvial clays)	N.A.	Fair to easy	N.A.	Easy	Fair	Easy	Bad	Fair	1.2-1.8 (fresh harbour sediment 1.15-1.6)
Firm or stiff Silty clays	Fair to easy	Easy	N.A.	Fair to easy	Difficult to fair	Fair	Bad to fair	Only possible after disintegration	1.5-2.1
Peats	N.A.	Easy	N.A.	Easy if no gas encountered	Fair	Easy	Unacceptable	Very good	0.9-1.7

N.A.: Not applicable

Note: This table only gives a **rough indication** and should be used **with caution**.

The feasibility to use a certain type of dredging equipment depends not only on the soil type, but also on site conditions, the size, strength of construction and power supply of that piece of equipment, etc.

The qualification used above (i.e. bad, poor, fair, easy, very good, etc.) are meant to show the degree of suitability but should not be related to the output or even less as indicative on the cost per excavated unit.