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TERRA ET AQUA

INTERNATIONAL ASSOCIATION OF DREDGING COMPANIES

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Front cover:
These dewatering lagoons, located in the vicinity of the harbour of Antwerp, Belgium, are part of a pilot programme to stimulate the natural dewatering process thus reducing the required surface for on-land disposal of dredged materials (see page 3).

IADC
P.J.A. Hamburger, *Secretary General*
Duinweg 21
2585 JV The Hague, The Netherlands
Tel. 31 (70) 352 3334, Fax 31 (70) 351 2654
E-mail: info@iadc-dredging.com
http://www.iadc-dredging.com

International Association of Dredging Companies

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TERRA ET AQUA

Editorial

As we seek to increase awareness of dredging and its beneficial aspects, time and again we are confronted with the facts: Dredging has a ‘dirty’connotation. Unjustly. To turn this image around takes a great deal of effort by all of us. So although the IADC specifically represents and promotes the private dredging industry, its goals often find a common denominator with other branches of the industry. In pursuit of these common goals, a representative of the IADC sits on the PIANC-PEC and the IADC has often joined forces with other maritime organisations.

In the last year, on many occasions, IADC has brought forth the idea of united public relations effort to explain dredging to a wider public. This spring the first of these joint effort has come to fruition with the publication of a new booklet, *Dredging The Facts,* prepared in a cooperative effort with CEDA, PIANC and the IAPH. As you will see it is truly a joint effort to explain dredging and its positive effects to the public at large. More information about *Dredging The Facts* can be found on page 28.

In addition, the IADC website has been growing: the last few issues of *Terra et Aqua* are now available via the net with a listing of the back issues still available. And an elaborate source of dredging information is now being developed and will be accessible through www.dredgeline.net. This site will be linked to other important dredging-related sites, such as the USACE web pages, CEDA and so on. Though most of us have too little time to do too much, it may be useful to take a break and surf the net to explore the many sources of information about dredging that are now available.

Speaking of cooperation, it should be mentioned that IADC’s International Seminar on Dredging and Reclamation – being held in Buenos Aires, Argentina from November 8-12 (see page 32) – coincides with Expo Marítima Mercosur. Both the IADC and the organisers of Expo Marítima Mercosur are working together to give added impact to these outstanding events. Two good reasons to visit Argentina this autumn.

Marsha R. Cohen
Editor

J. Van Mieghem, F. Aerts, G.J.L. Thues, H. De Vlieger and S. Vandycke

Building on Soft Soils

Abstract

The disposal of fine-grained contaminated sediments inherent to maintenance dredging activities is an increasing problem. For various reasons, new disposal sites are no longer the obvious solution. Therefore, the yet-available storage capacity must be used as efficiently as possible. Besides leading to the development of more advanced environmental dredging techniques, this results in improved dewatering techniques for soft material and in-situ techniques that ameliorate the mechanical soil characteristics.

The Belgian-based DEME Group, together with the Flemish Ministry of Public Works and the Port Authorities of Antwerp, invest in the development of innovative techniques, which opens new options for the management of fine-grained material disposal sites and for the reuse of areas otherwise difficult to access.

Since 1990 large-scale testing on dewatering lagoons has taken place. Today, results show that the needed storage capacity for dredged materials can be reduced by half, owing to the consolidation achieved in dewatering lagoons. Vacuum consolidation with horizontal drains has been developed and applied for dewatering silt stored underwater. Storage capacity, up to 20% of the already-stored volume, can be gained. The installation of gravel piles, in combination with vertical drainage and vacuum consolidation, ensured the stability of the bedding for a railway link through a sludge disposal site. A load of 3.8 tonne/m^2 for several days induced a mere 3 cm settling.

Soft Soil Improvement, an in-situ sanitation and stabilisation technique designed to improve the mechanical characteristics of very soft soil, stabilises soft soil and immobilises the heavy metals and other soil contaminants. The stabilisation and immobilisation is realised by mixing the soft soil with cement and certain additives. After treatment, no appreciable lixiviation is present and a modulus of compressibility of up to 100 MPa is realisable.

This paper was originally published in the WODCON XV Proceedings, *Dredging into the 21st Century (Volume 1),* Las Vegas, Nevada, June 28 through July 2 1998 and is reproduced here in a slightly revised form with permission.

Introduction

The volume of the maritime cargo traffic through the Port of Antwerp is steadily growing. In the last year alone more than 110 million tonnes were handled. One of the fastest growing areas is container traffic (12% per year), obliging the Port Authority to create space for installing new container terminals at a rather high rate of several tens of hectares per year.

On the other hand, this same Port Authority has to face a constantly growing number of regulations about land use, not the least of which is an obligation to keep the port activity within borders already defined in 1980. Many efforts to increase the productivity in tonnes per square metre and per year have a positive result, but have to be accompanied by systematic and thorough actions to enhance the optimal use of the available space. Space has thus become one of the most valuable commodities in the further development and survival of the port.

For this reason, it became necessary, and even inevitable, to spend rather large amounts of money in order to reuse the sites allocated for depositing sediments which were the product of maintenance dredging. After making an inventory of all the available techniques able to improve the soil mechanical characteristics of this difficult material, i.e. silt, a short list of possible solutions provided the technical basis for a call for tender for this out-of-the-ordinary job.

Dewatering Lagoons

One of the most important problems in the storage of fine-grained material and sediments in storage basins on land, is the very long natural dewatering and consolidation period, even when the layer thickness is limited and there are long time intervals between the successive filling up operations. Therefore, when only a natural process of dewatering is applied, very large surfaces are required for on-land disposal. This presents a problem as at the moment these surfaces are no longer available within the Antwerp region.

The situation urgently demands techniques that stimulate the dewatering process, thus reducing the required

Joris Van Mieghem

Joris Van Mieghem graduated in 1971 with a MSc in Civil Engineering from the University of Ghent, Belgium. Since then he has worked at the Flemish Ministry of Infrastructure where he is presenlty Chief Engineer-Director of the Department Sea Schledt, responsible for dredging and reclamation works on the Left Bank harbour extension of Antwerp.

Freddy Aerts

Freddy Aerts graduated in 1982 with a MSc in Civil Engineering and Transport Mechanics from the Royal Military Academy of Brussels, Belgium. He then worked as a project engineer in the Ministry of Defence. In 1993 he joined the Flemish Ministry of Infrastructure where he is responsible for large infrastructural works in the Port of Antwerp.

Gerard Thues

Gerard Thues has a degree in Elecro-Mechanical Engineering from the Free University of Brussels, Belgium. He has held a variety of positions with the Port Authority of Antwerp over the course of 40 years and is presently CEO of the APEC-Antwerp/Flanders Port Training Center.

Hugo De Vlieger

Hugo De Vlieger started his career with the Belgian-based DEME Group in 1973. He has coordinated dredging operations in Zeebrugge, as well as inMalaysia, Singapore and Venezuela. In May 1989 as Managing Director he started up SILT NV. Since July 1993 he has been General Manager at SILT.

Stefaan Vandycke

Stefaan Vandycke graduated with a degree in Elecro-Mechanical Engineering from the University of Leuven, Belgium in 1988. After working at Pauwels Industrial and De Cloedt, in 1993 he joined Dredging International, where he is presently with the Department of Innovating Technologies.

surface for on-land disposal. This has led the Antwerp Port Authorities and the Flemish Ministry of Public Works to support pilot projects and test programmes concerning the development of new techniques.
Since 1990, a large-scale testing and study programme has been operating. The aim is to increase the natural settling and consolidation phenomena as much as possible in specially designed dewatering fields, until a stable clay like material is obtained, which then can be used for beneficial applications, such as landscape projects, and such.

Preliminary study

A preliminary study was done to define the main aspects of interest for a pilot programme. An initial theoretical evaluation of different possible techniques was made with the mathematical simulation model CONSOL. This evaluation demonstrated three main dewatering methods useful for consolidation, namely:

– the under drainage techniques;
– the surface drainage techniques; and
– the evaporation enhancement techniques.

Dewatering fields and in situ consolidation

A pilot plant for the dewatering of fine-grained dredged material, a so-called dewatering lagoon, was installed in the harbour area of Antwerp, on the left bank of the River Scheldt. The project was realised by a joint venture of Dredging International NV, NV Ondernemingen Jan De Nul and NV Baggerwerken De Cloedt en Zoon on behalf of the Flemish Government of Public Works.

Different combinations of drainage and surface dewatering systems were applied to enhance the natural consolidation process (Table I). The dewatering fields were filled in successive layers with dredged material from the River Scheldt (Table II). Approximately 286,000 m3 equivalent to 157,000 tonne dry solids (TDS) was dredged with a small cutter dredger.
A general view of the silt level variations during the filling period and the consolidation period in a dewatering field is given in the Figure 1.

A continuous follow up of the silt layer thickness in the dewatering fields was executed during the consolidation process. Periodic detailed campaigns of in-situ density measurements were executed during the first four months.

Results of the consolidation monitoring

The consolidation of the material in the deposit was monitored daily during the dredging operations and afterwards on a weekly basis. The results illustrate the quicker consolidation in fields L1, L2 and L5, where under drainage techniques were applied. During the first four months the thickness in the drained fields was reduced by 35%, whereas the reduction in the other fields was limited to 25%.

Using the results of the density profiles combined with the evolution of the mud thickness (Table III), the total amount of dry solids in the fields was checked for each survey, resulting on average in 155,000 TDS to be compared to the estimated initial dredged quantity of 157,000 TDS. The variation of the average density in the fields is shown in Table IV.

After four months mechanical techniques were applied to further enhance the dewatering process. First an amphirol was deployed, with poor results. Later ditches were dug with traditional earth-moving equipment to generate horizontal pressure gradients which enhance the drainage. The improvement of the evaporation by vegetation was obtained by sowing a mixture of grass species in fields L2 and L3. This operation was done after three months of consolidation (beginning of autumn). During the first (winter) months the effect was limited but in spring, owing to the natural plant growth on the consolidating mud, the vegetation improved dramatically (Figure 2).

Further research and conclusions

For a further evaluation and examination of the different dewatering techniques, last year another pilot dewatering lagoon was installed in the Antwerp harbour area. Considering the results of the former pilot project, under drainage was provided over the whole area of the dewatering field. The lagoon was filled in May 1997 with fine-grained dredged material from the River Scheldt (17,000 TDS). The average density of the stored silt was 1.23 t/m3, with a layer thickness of about 1.8 m.

Within four months of consolidation an average density of 1.35 t/m^3 was achieved. Within eight months, thanks to the utilisation of different mechanical techniques and improved surface drainage, a density of 1.50 t/m^3 was realised.

The field tests illustrate the effectiveness of a well-planned and adequately realised treatment method for the acceleration of the dewatering and consolidation of fine- grained dredged material on a large scale.

Table I. Applied drainage techniques in the dewatering fields.

Field nr.	Under drainage	Evaporation enhancement
L1	gravitational	ditches, dug with traditional earth-moving equipment
L2	drains and vacuum	vegetation (after 3 months)
L3	no	+ vegetation (after 3 months)
L4	no	+ amphirol and discuswheel (after 4 months)
L5	gravitational	+ amphirol and discuswheel (after 4 months)

Table II. Filling characteristics in the fields.

Field nr.	Surface (m^2)	# of fill operations	Height (m) after the last filling operation and water evacuation
L1	42612	7	1.64
L2	42612	6	1.75
L3	40216	6	2.09
L4	64056	6	1.93
L5	44160	7	1.74

Figure 1. Layer thickness in a dewatering field.

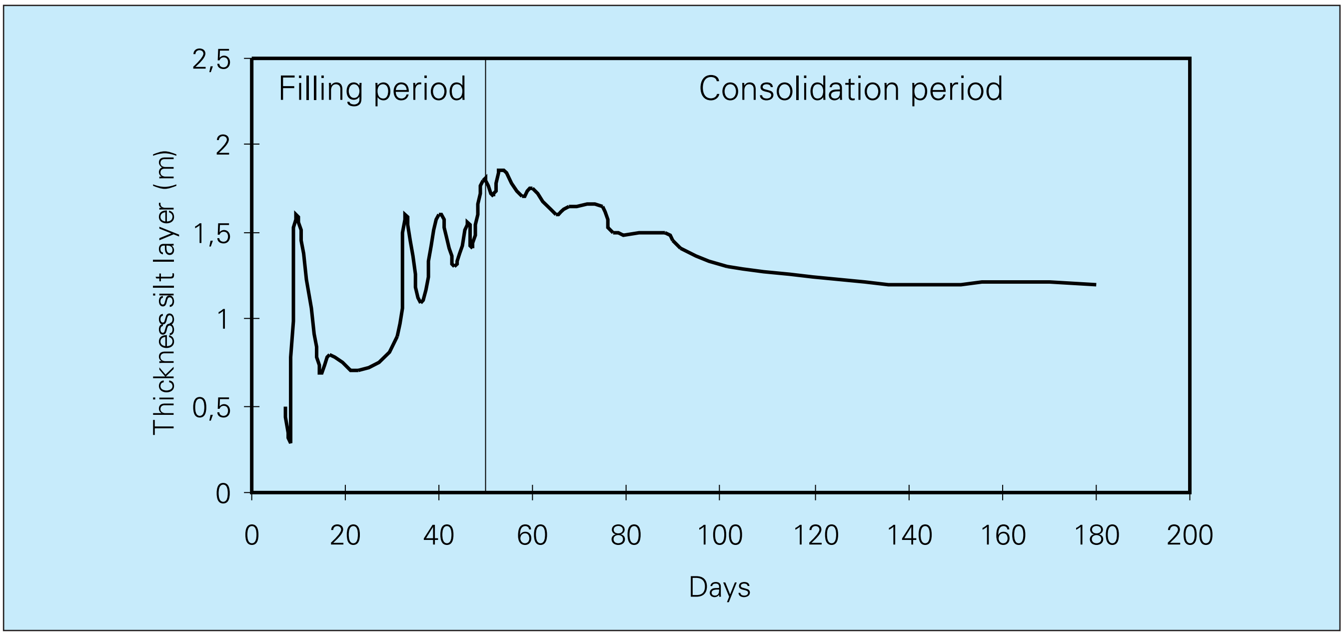


Table III. Evolution of the mud thickness.

Field nr.	Initial height	Height (m) after n days				Reduction
	(m)	30	75	90	120	(%)
L1	1.64	1.33	1.10	1.07	1.07	35
L2	1.75	1.33	1.18	1.16	1.15	35
L3	2.09	1.86	1.61	1.58	1.58	24
L4	1.93	1.66	1.47	1.47	1.45	25
L5	1.74	1.30	1.11	1.10	1.09	36

Table IV. Evolution of the mud density.

Field	Initial density	Density (t/m^3) after n days			
	(t/m^3)	30	75	90	120
Average	1.223	1.272	1.314	1.318	1.318
Drainage	1.223	1.285	1.333	1.345	1.345
No drainage	1.223	1.255	1.290	1.293	1.295

The volume can be reduced by 35% within four months and by up to 50% in less than nine months. This means that the consolidation process in a dewatering lagoon, inclusive the filling and emptying, can be repeated on a yearly base.

Important details of such a treatment method are the following:

- The installation of a solid under drainage system is essential when creating a dewatering lagoon.
- The under drainage system has to facilitate the dewatering of the lowest silt layer.
- During the dewatering process, special attention needs to be paid to the daily evacuation of rain and rising interstitial water, by means of ditches in the silt surface and canals along the surrounding dike.
- For the same reason, the width of the dewatering lagoons must be kept within 100 m, while the length may be 500 m or more.
- Furthermore, in order to minimalise the consolidation period, the initial density of the dredged material must be as high as possible.
- Improved dredging techniques, already make it possible to fill up a dewatering lagoon with silt at a density of up to 1.30 t/m3.

Strategy for the future

The installation of dewatering lagoons is an important, though intermediate step, towards a global solution of the problems of ports where a shortage of reclamation areas exists, especially for fine-grained material. Additionally it is necessary to look for projects where the obtained product (soft clay) can be applied. Different solutions can be suggested, such as the utilisation as fill material for landscaping projects or as a raw material for the construction industry.

The policy of the Flemish Government consists in the installation of about 2 km^2 of dewatering lagoons. The next few years, the annual production of consolidated dredged material will be very important. Therefore, large-scale utilisation projects will be required.

Vacuum Consolidation with Horizontal Drains

General description

This technique was developed for the extraction of water from silt, stored under water (Figure 3). When the water is extracted the density of the silt increases and the volume decreases. This results in a gain in storage capacity and a better stability of the soft soil.

Since it is impossible to put a surcharge on the silt, pressure has to be created in another way. By inserting a horizontal drain network in the silt layer and connecting the network to a vacuum installation, an underpressure is created inside the drain network. The difference in pressure between a drain and the silt makes the water flow towards the drain. This way a large amount of water is gradually drawn out of the silt, in an area around the drain tube.

When executing this technique, special attention is paid to the following two points. First, the drains have to be tested on clogging and pore size. When a drain starts to clog, further extraction of water is impossible and when the pore size is too big, silt is drawn into the drain tube. Secondly, the drain tubes have to be inserted at least 1.0 m underneath the top of the silt to assure a minimum of leaks (water from above the silt, drawn into the drain tube).

To determine the possible gain in volume and the rise in density, some samples are taken. From these samples, soil mechanical facts are determined and from these results the theoretical gain can be calculated. This makes it possible to determine the most effective number of drains to insert, the period the vacuum has to be maintained and the friction, while inserting the drains.

The advantage of using horizontal drains lays in the fact that no cover is needed on top of the silt. The top layer of 0.5 m to 1 m silt provides a cover and seal from the water above. This makes the technique easier to execute and less expensive than the use of vertical drains.

Technical execution

To insert the drains in the silt a special construction was designed, which can be used in water depths varying from 1 m to 25 m. For the pilot project this

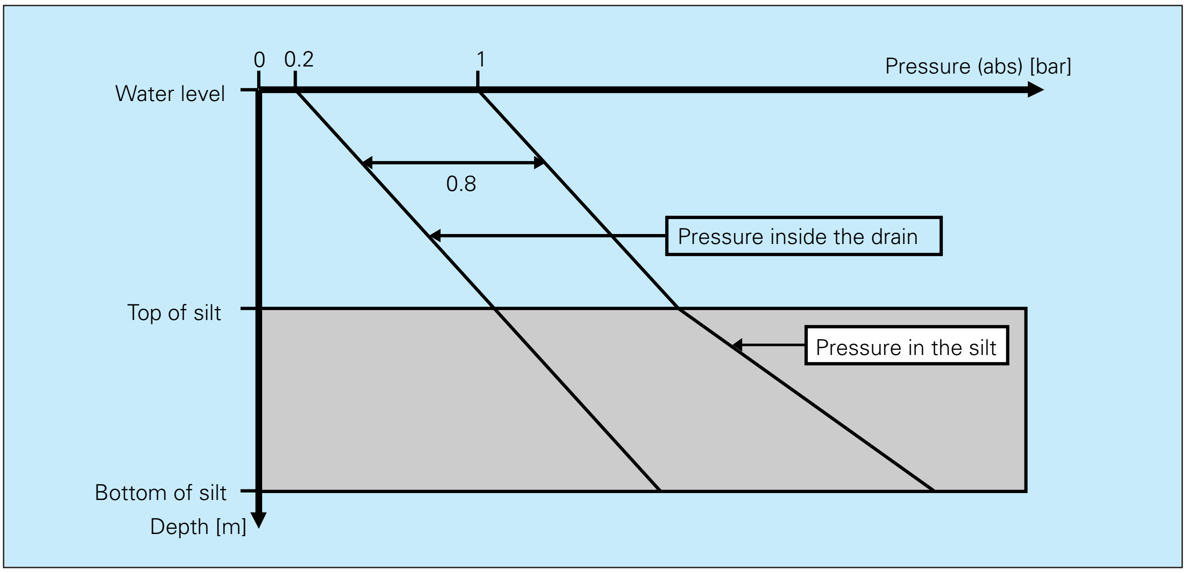
Figure 2. Layout of the dewatering fields.

construction was mounted on the ladder of a converted bucket dredge, while the top of the silt layer was situated 19.5 m under the water level.
The number of drains to insert, is a factor which determines the speed and the degree of consolidation that can be reached. Therefore, before executing the project a cost-benefit analyses must be made to determine the most economical combination of drains to insert. In this particular case a grid of 2 m x 2 m was maintained for inserting the drains. A first drain was inserted 1 to 1.5 m below the silt surface and a second one 3 to 3.5 m below the silt surface. This was taken into account when designing the plough construction.

The plough construction

The construction consists of several parts. The plough construction is the part mounted at the end of the ladder. It consists of two hollow blade constructions, which are pushed into the silt by the weight of the ladder. Through each plough two drain tubes are

Figure 3. Principle of vacuum consolidation.



guided, which exit the plough at a different depth. This way four drains are inserted simultaneously, with a distance of two metres between them. This construction can be rotated around the end of the ladder so at every depth, it is always in the right position. When passing through harder soil layers, the jet nozzles at the cutting edge can be used to limit the cutting and friction forces.

The drain drums

The drains are guided through four separate tubes over the ladder coming from four drums mounted on the ladder at the same height of the main deck, which makes them easy accessible.

Inserting the drains

When inserting the drains the following actions take place:

- The lay-barge is positioned on the starting line. As the installation of the drains must be very accurate (every 2 m) an accurate positioning system has to be used.
- After the positioning the drains are inserted through the plough construction and connected with the shore.
- Then the ladder is lowered and the plough is inserted in the silt.
- By pulling on the back-winch the lay-barge is pulled on one line to the other side. The barge is kept on line by using the side wires.
- At ca. 40 m before the end of the track the drains are cut.
- The barge is pulled further to the end to make sure that all drains are out of the plough and the ladder is hoisted.
- The lay-barge moves back to the start line for the next track.

Collector tubes

On the shore all the drain tubes are connected to a collector tube (Figure 4). For monitoring reasons the upper and the lower drains are collected separately. The two collectors are then connected to the pump installation. On every collector a flow meter is installed to measure the amount of water pumped. The collector tubes are hard PVC tubes, which can resist the underpressure in the system and which are easily connected with glue.

The vacuum pump installation

The vacuum pump installation (Figure 5) must create a maximal underpressure (80 to 90%) in the drain network and pump away the water that is extracted. The vacuum has to be as high as possible to provide a maximal extraction. The pump capacity has to be sufficient to pump away all the water.

The pump installation is built up as follows. First, a tank, which is put under vacuum by a vacuum pump. In the drum, a submerged pump is installed, to pump away the water that is extracted. An automatic control system controls the water level and the vacuum inside the tank.

Results

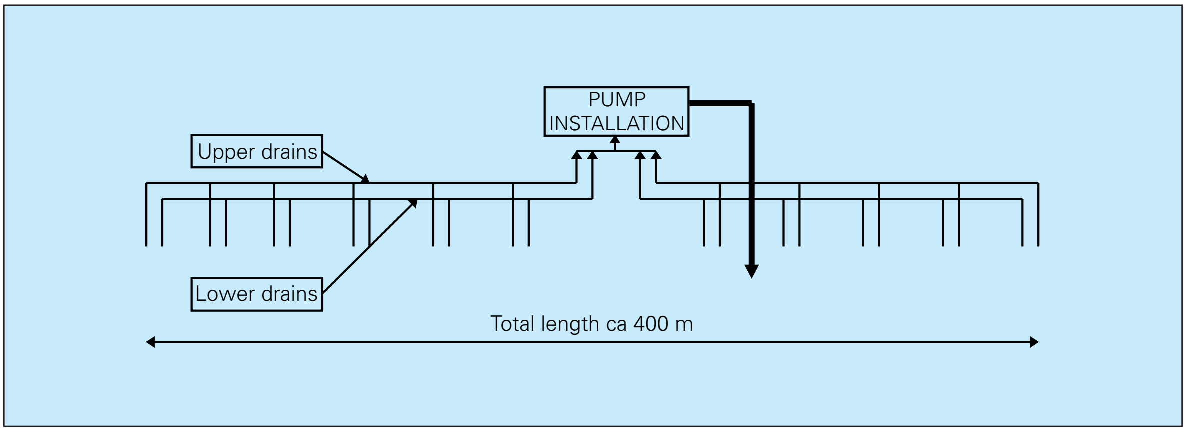
As the project has just come to an end a further analysis of the results has to be executed. This means taking samples of silt for further tests to determine water contents and other soil mechanical parameters. A further analysis of the amount of water pumped during these six month will show us the evolution of the flow of water extracted from the silt and a constant flow which gives us an idea of the leak that occurred.

In the pilot project the thickness of the silt layer was about 5.2 m. As the expected efficient radius is about 1 m around the drain, this results in only a 4 m thick layer that is treated. The other 1.2 m is treated much less efficient owing to border effects. On thicker layers, the border effects would become less important.

Gain in storage capacity

The storage used for the pilot project has completely been filled since 1991 and contained about 600,000 m^3

Figure 4. The collector tubes and pump installation.



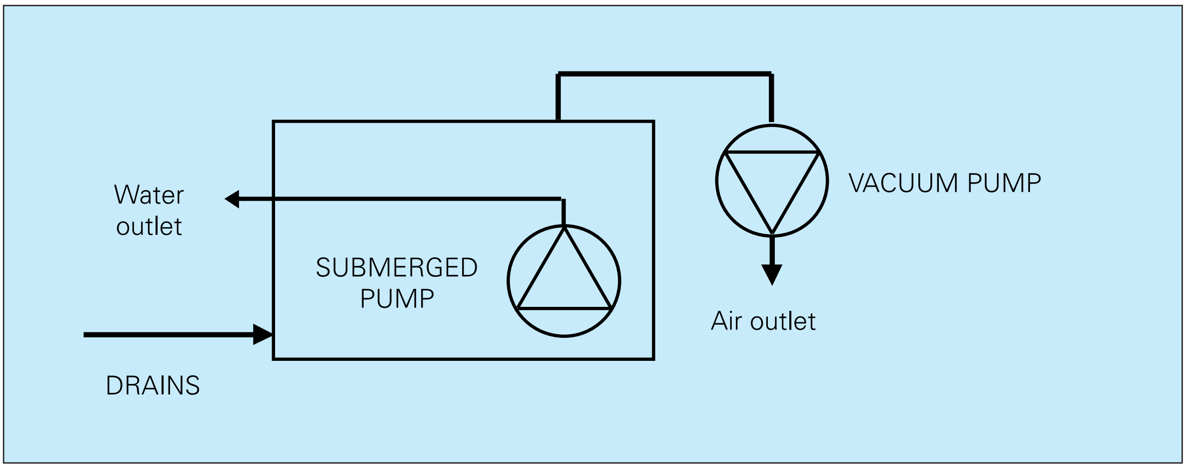


Figure 5. Working principle of the vacuum pump installation

of silt. The size of the underwater storage is 300 m wide, 400 m long and 5 m deep.
During a period of six months pumping, several soundings were executed. In this period the level of the silt dropped about 0.8 m. As only 4 metres was efficiently treated, we can assume the decrease of 0.8 m on a layer of 4 m thick, which is about 20%, without removing any silt. The area that was covered with drains was about 120,000 m^2, so the total gain in storage capacity was about 100,000 m^3.

Gain in density
The treated silt has been dumped there since 1991. Presumably it has reached a natural consolidation level in the period of five years proceeding the test project. Before inserting the drains some samples were taken over the complete thickness of the layer. The density of the silt varied from 1.25 t/m^3 at the top, to 1.35 t/m^3 at the bottom of the silt layer. When assuming an average density of 1.30 t/m^3 at the start and taking into account the gain in storage capacity, an increase in density up to 1.37 t/m^3 after consolidation is calculated. This will be controlled on the samples taken after consolidation.

Features and advantages
The use of the vacuum consolidation technique to realise a fast dewatering of soft soil has several advantages. The dewatering results in a reduction of the volume and an increase of the density and stability of the soft soil. No surcharge is needed, as the water is extracted from the soil, creating an underpressure in the drain. Neither is a sealing foil needed, as the seal is created by the soil itself. The technique can be used in almost every location, even submerged.

The use of horizontal drains, rather than vertical drains, results in several advantages, especially when used together with the vacuum technique. When the right tools are used the time of inserting the horizontal drains is much less than the time needed to insert vertical drains.

This technique has the possibility to insert a drain-network in a silt storage after the storage has been filled. This means that every existing storage facility for silt can maximise its capacity by using this vacuum consolidation technique.

Construction of a Railway Through a Sludge Disposal Site

To keep its competitive position in the container traffic, the construction of a new container quay along the River Scheldt was a necessary and urgent investment for the Port of Antwerp. The location of the terminal was chosen taking into account the fact that good hinterland connections are essential for the operation of the terminal. Therefore, a new inland navigation terminal also had to be built in the harbour docks near the sea terminal. A good connection to the European highway network was already available, but extra railway infrastructure had to be installed. To make this possible a part of a very difficult to access disposal site for dredged materials near the North Sea terminal had to be stabilised.

The execution of the work was granted to a joint venture of the Belgian contractors SILT NV and Dredging International NV. The stabilisation of a surface of 67,000 m^2 had to be realised in a time span of six months.

Description of the site
The depot has been used since 1975 for the storage of fine-grained sediments coming from the harbour docks on the right bank of the River Scheldt. The depot was installed starting on the "Polder" level +2.50 TAW and is now reaching a level of +10.00 TAW in the part where the job was done. The railway bedding however had to be installed on the level +7.64 TAW. A stable dike needed to be constructed to bridge the difference in height between the bedding and the rest of the disposal site. The dike had to be strong enough to allow the depot to be filled up to the level +11.50 TAW.

Soil investigation programme

For this type of project knowledge of the subsoil is essential. To this end the Geotechnics Division of the Environment and Infrastructure Department was commissioned and they implemented a programme of borings and cone penetration tests. All the investigations were carried out with light portable equipment as the site was very difficult to access. Most of the investigations were done from a small dike, which was placed between the actual depot in use and the zone that had to be stabilised. This small dike prevented fresh sludge from entering the working zone in the six months proceeding the actual stabilisation.

The geological profile which was built up from this campaign was as follows:

– on top a layer of recent reclamation (harbour sludge), with a thickness of about 8 m;
– then a layer of soft "Polder" clay, whose thickness varied as it had filled all underlying creeks in recent history;
– a more sandy layer, with clay inclusions, called "Stroomzand" (natural sand), with a thickness of about 2 m and absent in certain areas;
– below this, a layer of peat and soft clay with a thickness from zero to some 5 m with an average of 3 m; and
– finally, old quaternary sands containing clay.

The working area was divided into three zones, depending on the topography and the availability of the natural sand layer (Stroomzand) underneath the sludge. The fact that this sand layer was not present in one part of the working area, resulted in the application of two different techniques to stabilise the site.

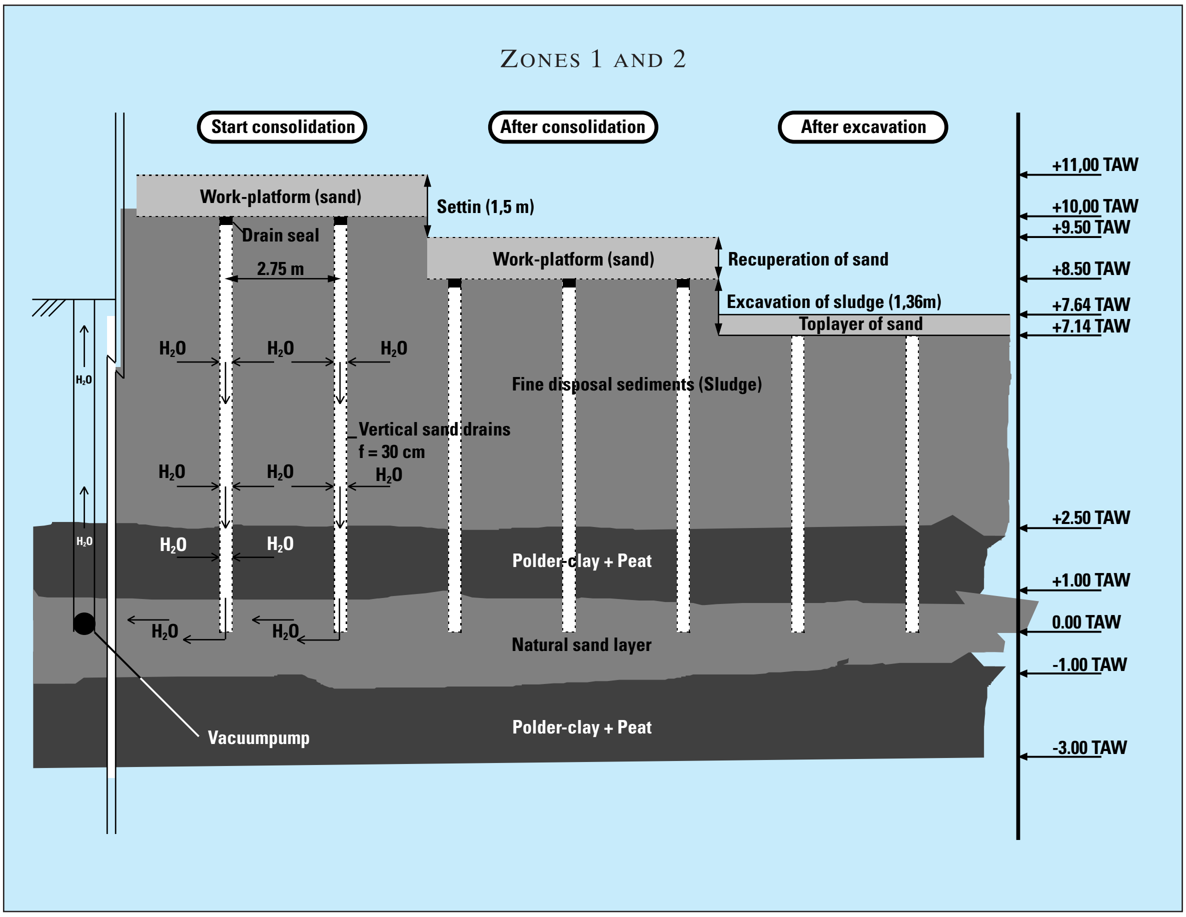
Description of the works

Zones 1 and 2

Before the real stabilisation started a hydraulic fill with sand in a layer of about 2 m thick took place. The sand came from the dredging activities to clear the new quay and served as a working platform on the site. It brought in place the sand needed for the work with a minimum of costs and thanks to this overload, the consolidation process already started slowly (Figure 6).

The actual stabilisation started with the construction of a stable dike between the future railway and the rest of the disposal site (also in zone 3). This was done with sand on which the dynamic consolidation method "Menard" was applied. The method consists of dropping several times a heavy weight (15,000 kg) from a height of about 15 m. As the sand went down into the

Figure 6. Stabilisation by vacuum consolidation (zones 1 and 2).



sludge, consequently the foundation characteristics of the soil underneath the dike construction were ameliorated. In some, more wet areas, sand drains were added under the dike.

In the meantime the work on the future railway bed took place. Vertical sand drains (Ø 30 cm, length 12 m) with a spacing of 2.70 m were drilled in from the working platform, reaching the sand layer of "Stroomzand". The drilling holes were sealed with clay and silt.

Two rows of vacuum pumps were installed along the future railway bedding, lowering the water level in the Stroomzand from +6.50 TAW to +1.00 TAW. Through this forced vertical drainage (50 km of vertical sand drains), a settlement of 1.5 m of the sludge took place (dry matter > 55%). Afterwards a layer of 1.3 m of consolidated sludge was excavated and a top layer of sand (0.5 m thick) was compacted. This brought the railway bed to its finished design level of +7.64 TAW.

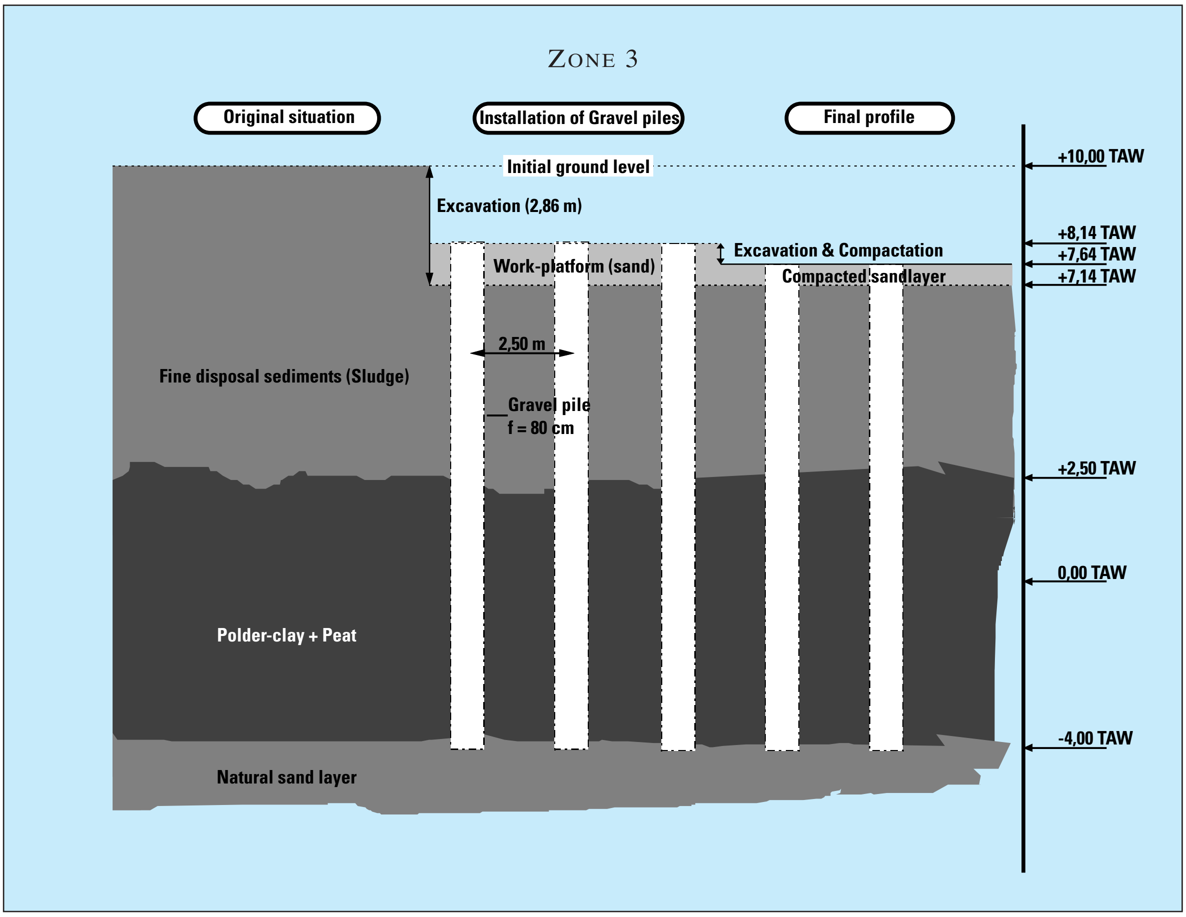
Zone 3

Here a layer of 2.9 m of sludge was excavated and a 1.0 m thick layer of sand was put on the remaining sludge to serve as a working platform. The whole operation still required a sludge transport of about 125,000 m^3 (zones 1, 2 and 3) to the adjacent disposal site where, by the use of bulldozers, it was stored below +11.5 TAW. From the sand platform, in zone 3, the stabilisation of the railway bedding was done with gravel piles (Ø 80 cm, length 7.5 to 12 m) with a spacing of 2.50 m. The imposed short time span for execution and the lack of additional material sets, obliged the use of two different techniques for installation of gravel piles, both giving sufficient results (Figure 7).

With the first technique, thanks to its own weight and an additional vertical force, a cylindrical vibrator was brought into the sludge until it reached a sand layer with sufficient bearing capacity. Then the vibrator was lifted for 0.5 m and while the shaft was kept open with compressed air, gravel was added under pressure and forced into the sludge until saturation was achieved. Then the vibrator was lifted again and again, doing the same operation until the surface was reached.

The other technique consisted of vibrating a hollow tube (ø 80 cm) into the sludge, using a vibrohammer. The tube had a certain overlength and a valve at the bottom that was closed when reaching down and opened when the tube was pulled up. Once the foundation level was reached, the tube was filled with gravel. While lifting the tube, using the vibrohammer, the gravel stayed in place, creating a gravel pile.

Figure 7. Stabilisation with gravel piles (zone 3).



Testing

After the stabilisation, the site was transferred to the National Railway Company for the installation of the track. The requirements they had for the area were a modulus of compressibility of more than 17 MPa and differential settlements of less than 50 mm on a distance of 10 m. Every 1500 m^2 of the railway bedding was tested with a plate loading test (750 cm^2) with good results.

The standard test method for bearing capacity gives information on the soil only to a depth equal to about two times the diameter of the bearing plate. The standard bearing plates are varying in diameter from 305 to 762 mm, so the bearing capacity could only be estimated to a depth of 1.50 m. As the railway track was to be used quite intensively and heavy loads were to be expected another test was added.

The tender document asked for testing of the bearing capacity on six different locations, spread across the entire area, by constructing a 40 cm thick reinforced concrete slab with a width of 4.5 m and a length of 10 m (this equalled a load of 10 kPa). Each slab had to be loaded with 28 kPa for several days, while the settlements on the edge of the slab had to stay less than 50 mm. The six tests were successfully executed.

The installation of the concrete slab (with a total weight of 45 tonnes) caused, in all cases, a settling of less than 15 mm, after 20 days. The additional load of 28 kPa (an additional weight of 126 tonnes) was installed and caused, in all cases, an additional settling of maximal 15 mm, within the first day. After three days a steady state was achieved and over the entire area the total settling stayed well beyond the prescribed 50 mm.

Nowadays the treated part of the disposal site is bearing the weight of freight container trains heading for the Scheldt container terminal.

Soft Soil Improvement

The properties of soft soil, such as large deformation, low strength, high water content and, recently, contamination by human activity are often responsible for the problems that occur in modern building projects. Soft Soil Improvement is an in-situ technique, invented, developed and patented within the DEME Group, that can help to overcome these problems.

Primarily the technique was designed for soil stabilisation in relation to dredging activities. In a further field of application SSI can also be used for the immobilisation of heavy metals or other contaminants in the soft soil and even to enhance bio-remediation in contaminated soil layers.

The technique

The SSI set (Figure 8) incorporates three main units:

– first, a computerised grout mixing unit, with storage facilities for binding agents, and such;
– then, a high pressure pump unit;
– and finally, a computerised injection unit mounted on a swamp crane (the swamp excavator).

For all the units of the SSI set conventional equipment was used; only the technology and the mixing blades are protected by knowhow and world-wide patents.

The three units of the SSI set and the storage facilities are fully transportable by containers. A surface of about 300 m^2 (12 m x 24 m) is required for the installation. In three days time, with a minimum of auxiliary equipment, the mobile plant is installed. The SSI set can be erected and operated by a maximum of three workers.

The mixing unit prepares the grout mixture to be injected. Up to four different products can be mixed in predefined quantities through a controlled measuring system. According to the required object, different types of agents can be used, such as cement, bentonite, fly ashes, lime polymers and so on. The mixing process is executed according to a preconceived recipe, after which the grout mixture is delivered ready for use to the production line. The control of the mixing unit is fully automated and computerised, but it can also be used manually.

After that a high pressure pump sends the prepared mixture with a pressure of up to 400 bar to the injection unit. In order to control the production and the quality of injection, a flow meter has been placed on the production line. The computerised injection unit controls and registers all the injection parameters: injection time, operational depth of the mixing blade, torque for the rotation of the mixing blade, down/up speed, rotation speed and the flow of the injected mixture. All those data are collected on a memory card (PCMCIA standard) and at the end of the week they are transmitted to a standard PC with memory card reader to write the production report. Data for every single executed column is recorded separately.

The injection unit is mounted on a crane, equipped with a large and floating undercarriage (the swamp excavator), which allows the unit to work on the very soft soil particular conditions for which the equipment was designed.

A homogeneous mixture of grout, binding agents and the soft soil, is created in a mechanical way by the mixing blades and in a hydraulic way by the turbulence of the very high pressure injection. The mixing blade itself is prepared in relation to the type of soil to be treated. The blades can have a different length according to the consistency of the soft soil. They are equip-

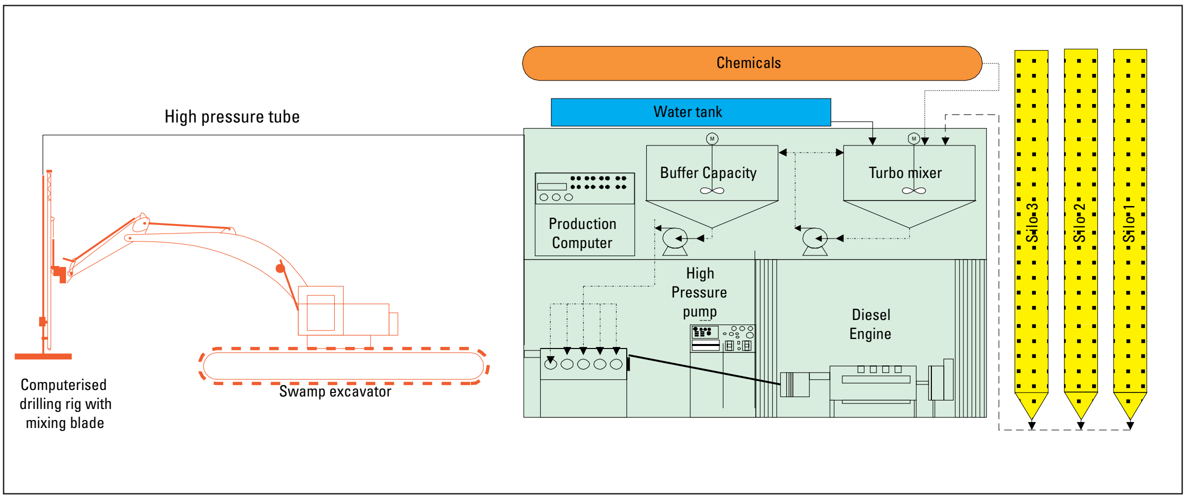


Figure 8. The Soft Soil Improvement set.

ped with injection nozzles of different diameters which can be oriented in different directions. The injectors fulfil two specific goals. When put in a vertical position, they will literally cut the soil, and thus facilitate the penetration of the mixing blades. Secondly in a more horizontal position, they will create a deeper penetration of the injected grout mixture into the soft soil and thus create a more homogeneous mixture.

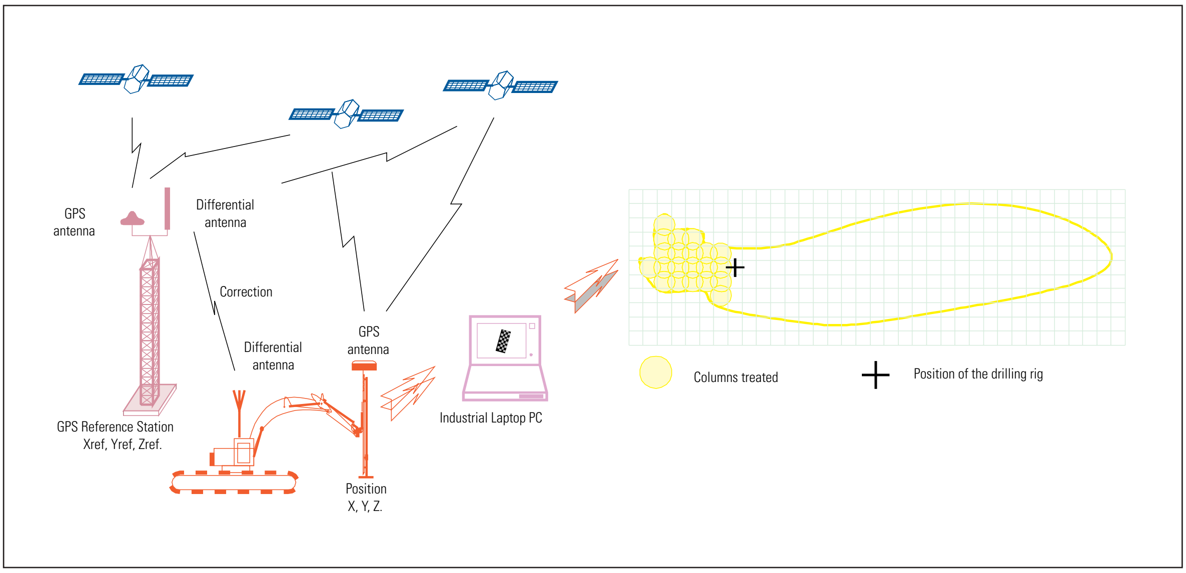
By orienting the injection nozzles more horizontally, a wider spread of the grout mixture is achieved and thus a column with a bigger diameter (up to 60%, according to the consistency of the soil) than the length of the mixing blade is realised. The mixing blade also can be divided into high and low pressure sections, where high pressure sections fulfil above-mentioned specific goals and low pressure sections allow us to vary the volume of the injected grout in a wide range according to the requirements of the contract.

So executed, the blades create a column of treated soil. A computer registers the precise position of the column by using the data from the K.A.R.T.-D.G.P.S. The Kinematic Accuracy Real Time Differential Global Positioning System is a satellite system which allows the operator to position the drilling rig with a very high accuracy. Each column realised is marked on a laptop screen to distinguish the performed work (Figure 9).

Fields of application

By varying the binding agents, their concentrations and the column configuration, different objectives can be achieved. To stabilise soft soils, a mixture, consisting mainly of cement, is injected. The columns can be placed following a predefined configuration according to the expected load on the soft soil. Soils, which can practically resist no load, show an acceptable stability after treatment. The technique has already been tested with this purpose.

Figure 9. The K.A.R.T.-D.G.P.S. system.



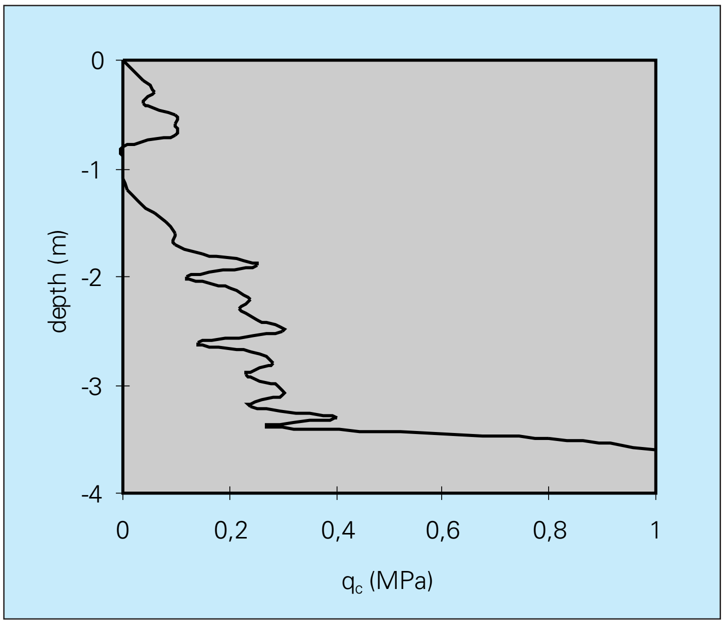


Figure 10. A cone penetration test.

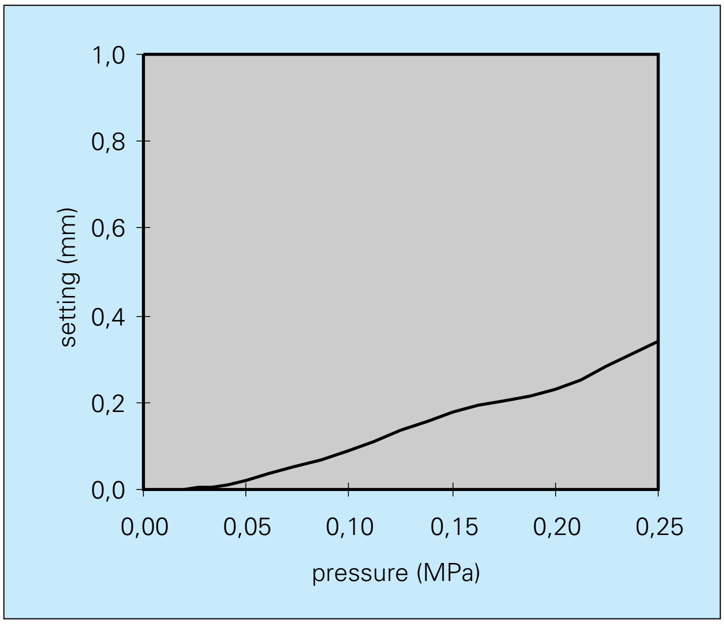


Figure 11. A plate loading test.

Before treatment, the stability of the soil layer to be treated was determined by means of cone penetration tests (Figure 10). This choice was made, taking into account that a plate loading test is practically not executable with such soft soil (Figure 11). The cone penetration tests showed that the sludge layer offered practically no resistance ($q_c < 0.4$ MPa) to the penetration of the cone. After treatment, a cone penetration test was no longer executable, thus the stability was tested with plate loading tests (200 cm^2), with a good result (Modulus of compressibility = 99.75 MPa).

For the immobilisation of heavy metals or other contaminants in soft soil, agents such as bentonite are used. The diameter of each column is calculated so that each of them interacts with its neighbours. In this way, the entire volume of soft soil is treated and thus the method prevents any lixiviation of contaminants.
The technique has already been tested with the purpose of immobilising heavy metals in river sediments.

Some analyses were performed before and after applying the technique in order to evaluate the lixiviation of heavy metals in the river sediments. Four heavy metals (As, Cd, Hg, Pb) were determined. The results show explicitly the binding of the four metals into the sludge, owing to the reaction of the particular binding agents (Figure 12).

The method described before can also be used to create a vertical shield to isolate contaminated sediments from the environment. The columns are placed in one line and each of them intersects with its neighbours.

For yet another field of application, the unit can easily be used to insert a consortium of bacteria into contaminated soft soils. The technique stays the same, but instead of using a mixture of cement and binding agents, bacteria are implemented to enhance bioactivities for degradation or immobilisation of contaminants.

Features and advantages

Soft Soil Improvement is an in-situ technique, so in contrast to classic sand replacement methods practically no contaminated material need be transported to other locations. This results in a reduction of time and money. Furthermore, the environment is preserved because no disposal site is required for excavated silt.

Owing to the easy transportation and installation of the equipment and the mobility of the swamp crane on the very soft soil, no site is inaccessible for the technique. And owing to the automated control systems, the execution of the technique is not complicated.

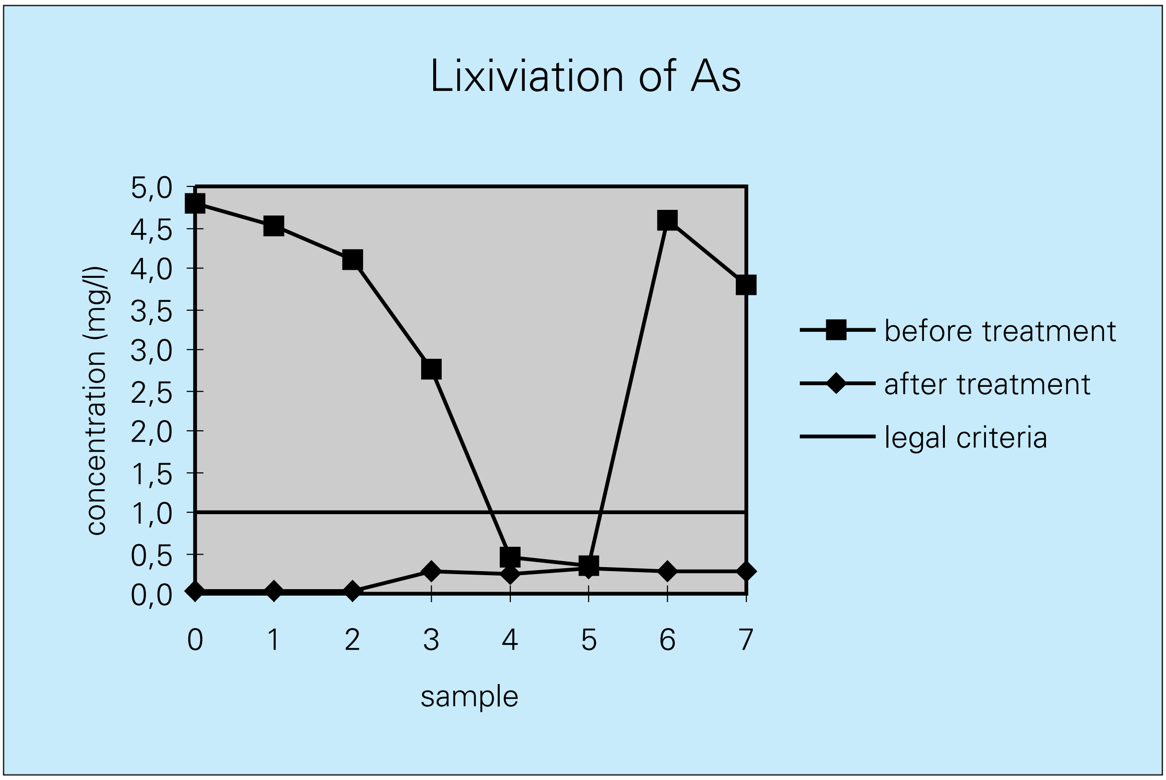


Figure 12. Immobilisation with Soft Soil Improvement.

Furthermore, the fact that the whole installation consists of conventional, easy to install equipment, makes the technique, even in very small projects, profitable.

By using primarily the cutting force of the fluid injected at a high pressure the wearing of cutting tools and total installed power is reduced.

In varying the agents and the column configuration every objective can be achieved. This makes the technique far more flexible than the classic methods for stabilising soft soil.

The in-situ sanitation of contaminated soft soil, using the described technique, offers a durable and stable solution.

Conclusions

- Large-scale pilot projects on dewatering lagoons confirm that, on a yearly basis, this technique results in a 50% volume reduction in the finally needed storage capacity for fine-grained dredged material.
- Vacuum consolidation of silt, stored underwater, creates a large amount of new storage capacity. The technique, tested in the harbour of Antwerp, showed a gain in storage capacity of 20%.
- For the construction of a bedding, through a fine-grained sediments disposal site for the railway link to Antwerp's new container terminal, two different techniques for stabilisation were applied. One zone was stabilised by vacuum consolidation with vertical sand drains; an other zone was stabilised with gravel piles.
- Soft soil, contaminated with heavy metals or other pollutants, can be treated by an in- situ, high pressure mixing of the soft soil with cement and certain additives (Soft Soil Improvement). Soil, initially resisting practically no load, shows after treatment a modulus of compressibility of 100 MPa. The lixiviation of heavy metals can be reduced easily to a minimum, far beyond the legal criteria.

All these results demonstrate that the recently developed techniques, or a combination of these, can bring a solution to the actual problems encountered by the Antwerp Port Authorities and the Flemish Government.

The Role of Dredging in Port Development: A Seminar

January 30 - February 8 1999
Ismailia, Egypt

In November 1995, the European Union (EU) and the twelve Mediterranean Partners issued a declaration concerning a new European-Mediterranean Partnership. Their aim: To create a framework for political, economic, and social and cultural ties between these two groups of nations. One of the key areas stressed was "the importance of developing and improving infrastructures through the establishment of an efficient transport system".

This declaration eventually evolved into a concrete idea to present a seminar on "the role of dredging in port development". The European Dredging Association (EuDA), which represents the European dredging industry, was asked to organise the event, and they, in turn, sought out the International Association of Dredging Companies (IADC), well-known for its series of international seminars conducted in cooperation with universities.

Based on on their week-long course, which is presented annually in Delft (The Netherlands), Singapore and Buenos Aires (Argentina), the IADC provided an expanded ten-day seminar for this occasion. Aimed at personnel and future decision-makers of port managment and public works authorities, the seminar highlighted, amongst other things, how dredging and reclamation can play a crucial role in the development of new ports and the maintenance of exisiting ports.

In addition to the their own expert lecturers, the IADC invited several outside parties, who offered information on a variety of dredging related subjects:

– Mr P. van der Kluit, a representative of the IAPH, spoke on "The role of ports";
– Mr T. Neville Burt, a Senior Consultant at HR Wallingford Ltd., addressed the licensing process, legal and environmental aspects, and beneficial uses and disposal of dredged material;
– Prof. Dr. Gamal El-Din Nassar, representing FIDIC, lectured on the "FIDIC (Iinternational) Forms of Contract Conditions for Engineering Projects;
– Mr M. Audigé of The World Bank, a Senior Port's Specialist in the African region, gave the view of The World Bank as related to procurement of works, goods and services and environmental safeguards;

Participants, lecturers and sponsors pose in front of the venue of the special seminar on "The Role of Dredging in Port Development" held in Ismailia, Egypt earlier this year.

– Mr K. Klaver, a Senior Consultant at ECT International BV, spoke on "Port and container terminal development"; and
– Mrs Fourcassies of the Port of Bordeaux presented three modules of port hydrography.

The course consisted of two types of presentations: lectures by these various professionals, and workshops, some of which were conducted on-site in order to give the "students" hands-on experience.

Amongst the subjects covered were:
– the development of new ports and maintenance of existing ports;
– project phasing (identification, investigation, feasibility studies, design, construction, maintenance);
– descriptions of types of dredging equipment and boundary conditions for their use;
– state-of-the-art dredging techniques including environmentally sound techniques for dredging and disposal of dredged materials;
– pre-dredging investigations, designing and estimating from the contractor's view;
– costing of projects and types of contracts such as charter, unit rates, lump sum and risk- sharing agreements.

The participants, who came not only from Egypt, but also from Algeria, Cyprus, Israel, Jordan, Lebanon, Malta, Morocco, Tunisia and Turkey, were also treated to a site visit at the Suez Canal. This gave them the opportunity to see dredging equipment in action and to gain a better understanding of the extent of a dredging activity.

As part of the seminar each person received a comprehensive course book which includes both the course work and a reference list of relevant literature in the field. At week's end all participants were presented with a Certificate of Achievement in recognition of their completion of the course. A reception held for the students, lecturers and other representatives provided an amicable close to an intensive learning experience.

Other Seminars in 1999

Although the seminar in Egypt was special in the sense that it represented the cooperation of a variety of international dredging and related experts, it was quite traditional in that it reflects the IADC's long-standing commitment to education, to encouraging people to enter the field of dredging, and to improving communications and understanding about dredging throughout the world.

The underlying principle of all IADC seminars is that a well-executed dredging project has positive effects on an area's economy, its environment and the quality of

Site visits take participants out of the classrooom and into the practical world. Seen here, the entire group is on board a pendulum ship to view the dredging works at the Suez Canal.

life of its residents. To optimise the chances of the successful completion of a project, it is important that from the start contracting parties fully understand the requirements of a dredging project.

As has been the case for many years, the IADC presented its seminar at the International Institute of Hydraulic and Environmental Engineering (IHE) in Delft, The Netherlands in March 1999. Each year the course seems to grow in popularity and this year some thirty IHE students attended the week-long dredging and reclamation seminar. These post-graduate students represented a great variety of nationalities, and work for both public agencies as well as private industry.

At the close of each seminar, the group of participants is divided into teams who are then asked to submit a tender based on the information they have acquired during the course. The effort and enthusiasm displayed during this procedure is quite evident. As one of the winners of the tender commented, "This week is so different than a normal university course where you just sit in your chair and listen. In this course you have to really pay attention and then act upon what you've been taught. I knew very little about dredging before this week, and now our group has been awarded the first prize for the best tender. It has truly been a learning experience."

Continuing the tradition in South America, the International Seminar on Dredging and Reclamation will once again be presented in Buenos Aires, Argentina, in November 1999. An application form for this event can be found on the last page of the magazine.

For further information about the venues for any of these courses in 1999 or 2000 please contact the IADC Secretariat in The Hague.

Eleni Paipai

The Need for Harmonisation in European Practices on the Disposal and Reuse of Dredged Material

Eleni Paipai

Eleni Paipai received a Higher National Diploma in Applied Biology from Brighton College, UK, a BSc (Hons) in Environmental Sciences from the University of East Anglia (UK), and a MSc in Environmental Pollution Control from Manchester University (UK). After working in Greece as an environmental scientist, she joined Wimpey Environmental in the UK. In 1990 she was employed by Posford Duvivier Environment. In 1995, she went to HR Wallingford, Ltd. and is presently a Principal Environmental Scientist in the Ports and Estuaries Group.

Abstract

The European Union (EU) Directive on Waste has introduced a new definition of waste with a legal connotation. When first introduced, however, the EU Directive on Waste and the UK 1994 Waste Management Licensing Regulations (WMLR), which adopted the Directive, gave rise to more questions than answers, particularly for dredged material which could be exempt from the Regulations if a beneficial use could be found.

For dredged material to be increasingly regarded, and subsequently used, as a useful commodity rather than waste in an EU-wide context, there is a need to identify a harmonised approach in disposing and reusing dredged material. This paper was originally published in the WODCON XV Proceedings, Dredging into the 21st Century (Volume 2), Las Vegas, Nevada, June 28 through July 2 1998 and is reproduced here with permission in a slightly revised form.

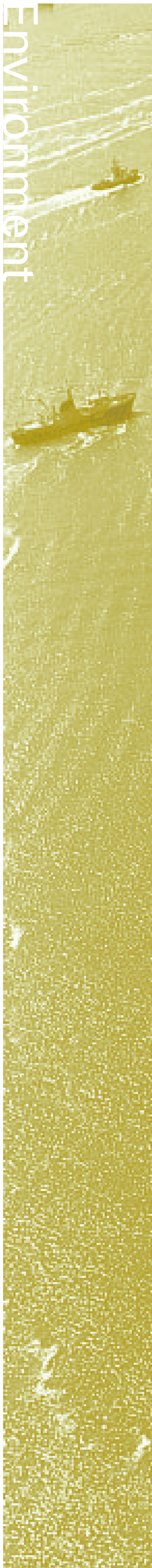
Introduction

The European Union (EU) Directive on Waste has introduced a new definition of waste with a legal connotation. "Waste" legally means any substance which the producer or holder intends to, or is required to, discard. In practice this means substances for which no use for their present form has been identified. Under this Directive, a waste operator, who cannot demonstrate the usefulness of a substance or mixture of substances and subsequently find a use for it, should obtain a waste disposal permit.

When first introduced, the EU Directive on Waste and the UK 1994 Waste Management Licensing Regulations (WMLR), which adopted the Directive, gave rise to more questions than answers, particularly for dredged material which could be exempt from the Regulations if a beneficial use could be found. Different waste regulation authorities offered different interpretations with regard to the exempt beneficial uses of dredged material. Similarly, in some of the other EU countries which adopted the EU Directive on Waste in their national legislation, different or inconsistent interpretation of the definition of waste and waste handling by the appropriate regulatory authorities caused further difficulties in the management and reuse of dredged material.

For dredged material to be increasingly regarded and subsequently used as a useful commodity rather than waste in an EU-wide context, there is a need to identify a harmonised approach in disposing and reusing dredged material.

This paper examines why there is a need to harmonise, as practically as possible, the approach to disposal and reuse of dredged material, and how this harmonisation can be realised. The paper concentrates on the land disposal of dredged material because the offshore disposal of dredged material is well governed by international conventions such as the London Convention 1972.



The EC Directive and Its Implications for Dredged Material Reuse or Disposal

The main requirement of the EC Directive is the need to obtain a permit to handle, transport, store (including temporary stockpiling) and dispose of a waste in a licensed disposal site. In the UK, the EC Directive on Waste is adopted by the 1994 Waste Management Licensing Regulations (WMLR).Where a beneficial use of a substance can be demonstrated, this substance is exempt from the 1994 Regulations, and thus there is no need to obtain a permit. However, there is still a need to register the substance(s) and intended use with the appropriate regulatory authority. The thinking behind the requirement for such registration is that there is still a need to prove that the intended beneficial use will have no impacts on the environmental resources (e.g. soil, aquifers, fisheries).

Dredged material is exempt from these Regulations if it can be used beneficially for agricultural, ecological or land improvement or flood protection purposes (Figure 1). Although exempt, there is still a need to demonstrate that any one of these beneficial uses on land, as identified in the Regulations, will not have significant environmental implications.

In the UK this is achieved by registering the dredged material and its intended beneficial use with the appropriate licensing authority, which may require evidence or justification on grounds of environmental acceptability.

Figure 1. At Kallo in Belgium, dewatered and treated silt is being placed at a test site.

UK Case Study

In 1994, coinciding with the new legal requirement to comply with the 1994 WMLR, a two-year study was initiated by the UK Construction Industry Research and Information Association (CIRIA) aiming at producing guidance on the safe, economical and effective disposal on land of material arising from dredging for navigation or flood defence. From the start of the study, however, it became obvious that most of the guidance could also apply to material arising from remedial dredging.

The study aimed to assist the dredging industry in the UK, particularly the inland dredging industry, and the UK Regulators in the wake of the 1994 WMLR. It is worth noting that the study coincided with the interpretation of the EC Directive on Waste by the UK legal system. The study therefore experienced firsthand some of the pains that both regulators and dredging practitioners went through in understanding and adopting the EC Directive within the UK reality.

Code of practice

The study found out that, in order to assess the potential for impacts on environmental resources of the disposal of dredged material on land for beneficial uses, the contaminant load of the dredged material is compared with the code of practice on sewage sludge being spread onto agricultural land or with regulatory standards derived solely for the remediation or end use of contaminated land. This code of practice is set out by the UK Department of Environment, Transport and the Regions (DETR) and reflects the EC Directive on the protection of groundwater.

Table I. Criteria for sludges applied to agricultural lands for selected countries.

Parameter (kg/Ha)	UK	Netherlands	Germany	France	United States	Canada	Canada (Ontario)
Antimony (At)							
Arsenic	10	2	–	–	–	15	14
Beryllium							
Cadmium	5	2.0	8.4	5.4	5-20	4	1.6
Chromium	1000	100	210	360	–	–	210
Copper	280	120	210	210	125-500	–	150
Iron							
Lead	1000	100	–	210	500-2000	100	90
Mercury	2.0	2.0	5.7	2.7	50-200	1.0	0.8
Nickel	70	20	60	60	–	36	32
Selenium	5	–	–	–	–	2.8	2.4
Silver							
Thallium							
Zinc	560	400	750	750	250-1000	370	330

Similar sorts of codes of practice exist in other EU Member Countries, although the actual numerical standards vary from country to country (see Table I) (IADC/CEDA, 1997). Dredged material is, therefore, regarded either as sewage or as contaminated soil.

The aim of this comparison is to limit, as much as possible, the contaminant load entering the soil and subsequently any surface and underground water resource, and the human food chain at large. However, it still stigmatises all dredged material as already containing as large quantities of available heavy metals as sewage sludge does.

This comparison, however, overlooks the fact that dredged material is high in metal sulphides. These have a high potential of depleting oxygen sources and of resulting in a flux of heavy metals entering the interstitial water and later on other surface or underground water bodies – unless properly handled, disposed of and managed. In addition, the code of practice for the application of sewage sludge onto land does not include parameters, such as polychlorinated biphenyls and tributyl tin, which are typically present in dredged material from heavily industrialised waterways and ports.

The study also highlighted the need to identify early on the properties of the material to be dredged and their potential for contamination of the receiving site. In the UK reality, this characterisation means chemical analyses and sometimes an elutriate/leaching test.
Very rarely does a project budget allow for a comprehensive risk assessment to identify the possible contaminant pathways in the receiving site or the eco-

Figure 2. At this dry sediment treatment plant in Rotterdam's Maasvlakte, contaminated sediment is washed and dewatered. The processed clean sand can be reused for construction projects.

toxicological properties of the dredged material. Yet these two approaches can give an as-accurate-as-possible contamination risk assessment for the receiving site and form the basis of most cost-effective precautionary measures. In some other European countries, as well in the USA and Canada, it is the elutriate and eco-toxicological test, which form the basis of decision-making policies on the management of dredged material.

Dredged Material Management Across the EU Countries

The way in which dredged material disposal on land is legislated in most of the European countries is rather peripheral and inconsistent. For instance, as mentioned above, the EU Directive on the protection of groundwater primarily reflects pollution control from application of sewage sludge on land and industrial discharges on land and in surface waters. Dredged materials, however, have characteristics which make them neither an industrial nor a domestic waste and, furthermore, they can have beneficial uses.

German approach
In 1996, HR Wallingford carried out an international review on the codes, conditions and practices of land disposal of dredged material on behalf of IADC/CEDA. In brief, the study identified that in Germany the approach to managing the application of dredged material to land is similar to the British approach.

That is, in order to decide on the feasibility of disposing dredged material to land, the contaminants load in the dredged material is compared with the standard values for contaminants in sewage sludge subject to application onto agricultural land (IADC/CEDA, 1997). In addition, the German LAGA classification excludes dredged material from their regulations governing the beneficial uses of residual products from mining activities, and the highest limit of ignition loss for landfilled waste is still lower than the expected ignition loss value for wet and highly polluted dredged material (Köthe, 1997).

Dutch approach
By contrast, The Netherlands approach to disposal of dredged material to land is more tailored to the chemical properties of dredged material. Their three-tier classification system was initially designed to characterise contaminated soil, but it is now extended to include dredged material and it is based on eco-toxicological studies.

An overall EU approach
With the exception of the Dutch classification system for land disposal, which recognises the specific properties of dredged material, there appears to be no piece of environmental legislation in most of the European countries which reflects the properties of dredged material in both in situ and after dredging. The physical and chemical characteristics of dredged material and the prevailing conditions during their handling, from dredging to disposal, can influence their properties, and may have implications for disposal plans. Equally, however, proper handling and management can provide opportunities for beneficial uses of dredged material (Figure 3).

Figure 3. An experiment in growing vegetation on treated dredged material in the USA.

In addition, across the EU dredged material management is characterised by inconsistencies, such as the following:

- Dredged material has characteristics, which make it neither an industrial nor a domestic waste, yet the peripheral legislation that applies to its disposal, particularly on land, does not recognise the potential for reuse either before or after cleaning-up of dredged material.
- The approach to managing the on-land disposal of dredged material is either case- specific or subject to strict nationwide standard values, and varies from country to country and region to region in the same country.

During the various studies referred to above, consultation with dredging and disposal practitioners highlighted the difficulties and frustration, which they face when they deal with inconsistent approaches in the management of dredged material. They feel that a more harmonised approach should eliminate time-consuming obstacles and help in the identification and implementation of beneficial use schemes for dredged material.

Staged Approach Solution

Given that the prevailing consensus with regard to identifying disposal solutions is that each disposal problem should be judged on its own merits, harmonisation in the European disposal practices should perhaps be a staged approach. Such an approach should start at the local level and move up through the regional to the national and finally to the EU level. Nevertheless, such a staged approach can take time and add to the frustration already experienced by those who are keen to see dredged material used beneficially more often and in a wider context.

The lack of harmonisation in handling dredged material can also lead to a situation where different interested organisations operate in an ad-hoc way, thus resulting in misleading statements or policies or recommendations.

In their recommendations for the handling and management of dredged material, particularly contaminated dredged material, the PIANC Working Group I-17 has highlighted the need for an enhanced consistency and coordination among various agencies responsible for decision-making processes on the handling and disposal of contaminated dredged material (PIANC, 1996). PIANC emphasises the benefits of following an integrated, systematic and logical approach in identifying disposal options for dredged material, preferably with a beneficial use attached to them, with or without treatment. The thinking behind this recommendation is that by managing and using dredged material beneficially, smaller volumes of highly contaminated material end up in landfill sites, which are costly to prepare and control even after their closure. This is a view shared by many in the field of managing dredged material, particularly those who are faced with the realities of identifying and planning for the best disposal option on grounds of environmental acceptability.

In other words, lack of harmonisation in handling dredged material can result in loss of opportunities for cost savings and environmental enhancement projects. Furthermore, understanding and seeking harmonisation, at whatever level from the local to international, should eventually assist policy makers to formulate policies and regulations which are practical and useful to dredging and disposal practitioners.

The aquatic disposal of dredged material in the North Sea region is addressed in a harmonised way via the London Convention 1972. It should be possible to follow this example and identify ways and actions to mirror-image the harmonised approach of the aquatic disposal in the legislation applicable to land disposal, including disposal to inland waters. The first step towards identifying ways of harmonising handling of dredged material and its potential for beneficial uses, may be a review of all direct and peripheral EU legislation with the aim to compare and contrast the pieces of legislation which affect handling of dredged material, and to highlight ways of clearer regulatory procedures, legislative requirements and best practice.

Conclusions

When evalutating the benefits of a harmonised approach, no one can and should underestimate the difficult route that lies between the inception of a beneficial use of dredged material and its materialisation.

In the close knit community of the EU, the difficulties and experiences of one country can benefit another, as long as there is a common denominator in the approach to managing dredged material. First of all, however, for the beneficial uses of dredged material, with or without treatment, to have a future in Europe, there is a need for a mutual understanding, between the EU nations, of the environmental advantages associated with the beneficial use of dredged material. This mutual understanding will facilitate a harmonised approach in the management of dredged material across the European countries, and further assist in overcoming the difficulties in assessing the most feasible disposal option.

A harmonised approach should also assist in bridging the gap between water and sediment quality policies, and reflect the integrated nature of the environment. In turn, a harmonised approach should encourage more beneficial use schemes and facilitate an exchange of experience, tips and lessons learned between the European countries.

References

Construction Industry Research and Information Association (CIRIA), UK.
Report 157: Guidance on the Disposal of Dredged Material to Land.

IADC/CEDA 1997.
Guide 2b: *Conventions, Codes and Conditions:* Land Disposal.

Köthe H. F. 1997.
"Management of Dredged Material in Germany: A Compromise between Economy and Ecology".
Terra et Aqua, No. 67, June 1997.

PIANC 1996.
Handling and Treatment of Contaminated Dredged Material from Ports and Inland Waterways "CDM". PTC I Report of Working Group no. 17, Supplement to Bulletin no. 89, 1996.

Environmental Aspects of Dredging
Guide 5: Reuse, Recycle or Relocate

In this fifth guide in the series "Environmental Aspects of Dredging", Anna Csiti, General Manager of the Central Dredging Association, and T. Neville Burt, Principal Engineer at HR Wallingford, have collaborated to address the question, "What should be done with removed sediment?". Based on a comprehensive review of the literature in the field covering all types of dredged material – both clean and contaminated – they have assembled clear and in-depth answers. As they make clear in this book, fortunately "dredged material is increasingly regarded as a resource rather than a waste".

Reuse, Recycle or Relocate reflects the concern of the public and the industry with the destination of the millions of cubic metres of dredged sediments which arise each year. These sediments derive from dredging projects of all sorts, be it for the maintenance of existing ports and navigation channels and/or the development of new ones. As the authors point out, "More than 90% of the sediment from navigation dredging is unpolluted, natural, undisturbed sediments and is considered acceptable for a wide range of uses or placement alternatives". It is the remaining 10%, which are mildly or heavily contaminated as a result of industrial, municipal and agricultural activities, that demand most of our attention for finding ways to reuse, recycle or relocate the materials and it is this issue to which this Guide devotes itself.

Chapter 1 presents the basic management alternatives – beneficial use, open-water disposal confined disposal and treatment – which forms the basis for the rest of the book. Chapter 2 presents a decision-making procedure for the environmental evaluation of these four alternatives. Chapter 3 reviews the physical, chemical, biological and engineering properties of dredged material. Chapters 4, 5 and 6 describe in more detail the beneficial uses, open-water disposal and confined disposal alternatives, respectively. And lastly, Chapter 7 discusses sediment treatment, including physcio-chemical, biological, thermal, electrokinetic and immobilisation methods.
Given the fact that a plan for the disposal of dredged material has become a crucial part of almost any dredging operation, this Guide provides invaluable information to the industry. The book is completed by a very extensive reference list, which should help readers to track down any further information they need on this subject.

Other Books in the Series

Though Guide 5 is written as a stand-alone document, it is best used in conjunction with the other Guides in the series. The series, which will comprise seven books at its completion, is a joint effort of the International Association of Dredging Companies (IADC) and the Central Dredging Association (CEDA), and an Editorial Board comprising members from both associations have been actively involved in the development of the concept. Other books in the series already available are:

Guide 1: Players, Processes and Perspectives, written by Jan Bouwman and Hans Noppen of AVECO bv, is an analysis of the players involved in reaching a decision to dredge and creates a system for assisting these decision-makers.

Guide 2: Conventions, Codes and Conditions; Marine Disposal and Land Disposal, written by Elena Paipai, T. Neville Burt and Carolyn Fletcher of HR Wallingford, presents the international conventions governing disposal of dredged materials and examines how various national legislation complies with this.

Guide 3: Investigation, Interpretation, and Impact, written by Richard K. Peddicord and Thomas M. Dillon, independent consultants, describes pre-dredging investigations for material chracterisation. This includes field surveys, sampling and laboratory testing for physical, chemical and biological characteristics of dredged materials.

Guide 4: Machines, Mitigation and Monitoring, written by Jos Smits, General Manager of International Marine & Dredging Consultants NV, discusses dredging equipment, mitigating measures and the monitoring and control of the dredging process.

Guide 6: Effects, Ecology and Economy, which will give a review of environmental and socio- economic impacts of dredging projects, is scheduled to be published in autumn 1999. *Guide 7: Frameworks, Philosophy and the Future* rounding out the series should be published in early 2000.

All books in the series may be ordered from the IADC Secretariat in The Hague. ***Reuse, Recycle or Relocate*** *(104 pp. Illus. NLG 30.00) will be available in spring 1999.*

Eddy Declercq

The Concept of Public-Private Partnerships: A New Approach To Transport Infrastructure Financing?

Dr Eddy Declercq

Dr Declercq has received two Masters from the Free University Brussels, Belgium in Communications Science (1988) and Industrial Location and Development (1992). In 1997 he received his PhD in Business Management from La Salle University, New Orleans, Louisiana, USA. He has worked in a variety of positions as a special advisor to the Belgian Government, the European Commission, the European Dredging Association and other organisations. He is presently Managing Director of Strategic and Economic Research Corporation (STRATECO), Director of the Centre for Intermodal Research (CIR), both in Belgium, and Senior Advisor at PriceWaterhouseCoopers in The Netherlands.

Abstract

Implementation of a trans-European transport network is of the highest priority in the European Union. Since inter-European dredging projects are essential to the realisation of a trans-European transport network, the European Dredging Association (EuDA), with the co-operation of Directorate General VII, Transport, sponsored a study to determine the feasibility and form of utilising public-private partnerships. This article is based on the study commissioned by the EuDA and executed by the Centre for Intermodal Research (CIR).

Introduction

In view of the stringent budgetary constraints in Europe and considering the urgent need to realise many projects for the trans-European transport network, the possibility to combine public and private financing has received renewed interest. The idea of Public-Private Partnerships (PPP) has been studied within the European Union (1997) with the objective to see how they could contribute to the implementation of the trans-European transport network.

The Concept of Public-Private Partnerships

Comparing the various approaches to private sector co-financing (World Bank, EU, EIB,...), it is suggested that there are fundamentally common views, as demonstrated in Figure 1, but that perspectives differ from public and private partners.

The *private partner* has a predominantly commercial perspective. Their first interest in participating in PPP's is to obtain an acceptable return on investment.
At present, the risk for the private partner is substantially higher than in traditional public works contracts. The risks are not only related to the financial return (which could eventually be guaranteed by the public authorities), but also to the insecurity of public policy and changing regulations. Both substantially increase the uncertainty/risk of the project and gradually rise in relation to the duration of the project. In many cases, the private sector still shies away from PPPs because the uncertainties (and thus risks) are still too high compared to traditional collaboration forms between the public and private sectors (co-operation).

The *public-partner* prioritises societal needs (e.g., cohesion and integration). Public authorities have a high interest in establishing PPPs to reduce the (financial) risks in large infrastructure projects as well as public

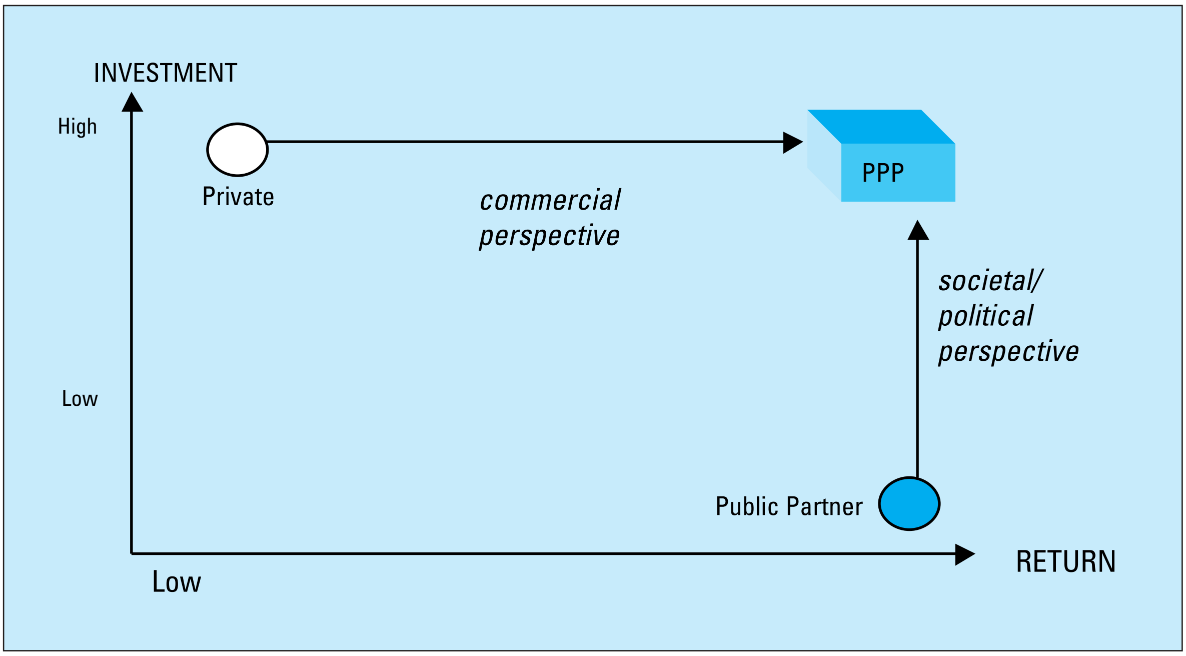


Figure 1. Public-Private Partnership (PPP): Perspectives.

financing volume. The objective of public authorities of PPP is therefore to allocate risk between the public and the private sectors according to each party's ability to manage and bear each risk. This means that a PPP should be flexible in distributing risks, including the problem of project ownership where private participation can be in other structures than taking partial or total ownership of projects, e.g., via a participation in the capital investment programmes or by sharing in the cost risk and/or the revenue risk.

The following definition for Public-Private Partnership is proposed: "The Public-Private Partnership is a form of collaboration between a public and a private partner for a well-defined period of time and related to one or more specific phases of a planned project. The responsibilities of both the private and public partners are explicitly defined in the Partnership Agreement, including punitive damages for both partners in case of non-compliance with the terms of the contract".

The key factor is that the project risks must be allocated to the public and private sectors, respectively, according to each party's ability to manage such risks without destroying the economic balance of the project. It is emphasised that this definition is rather restrictive. Others tend to take a pragmatic view and define all forms of collaboration between the public and private sectors as partnerships.

Structure of Co-operation Agreement vs Partnership

The allocation of project risk and responsibility between partners clearly differs according to the type of public-private collaboration. Based on both factors, two main groups of public-private collaboration can be identified, namely the co-operation and the partnership (see Figure 2). Each of these variants originates from the principle that the public sector transfers to the private sector a number of responsibilities related to a traditionally public activity. Both the public-private co-operation and the public-private partnership include a contract between the public and the private partners of a project. The difference between both is the content and structure of the agreement.

Co-operation agreement

The co-operation agreement defines the contribution of the private partner(s), the period of the time of the contracts the financial contributions of both parties and other conditions. In many cases, the co-operation agreement specifies penalties for the private partner in case of non-compliance to the conditions of the contract. What is generally missing in the co-operation agreement is the well-defined and written description of the engagement of the public partner. A public-private co-operation that includes also a description of possible penalties for the public partner in case of non-compliance differentiates the public-private partnership from the co-operation. This aspect is directly related to the risk assessment of public-private collaboration.

Risk Assessment

Two main types of risk can be identified in relation to the collaboration between public and private partners. The first is the *project risk* related to realising large infrastructure projects. Under project risks one can distinguish:

- Technical risks (using new techniques or applying existing methodologies at a larger scale or under

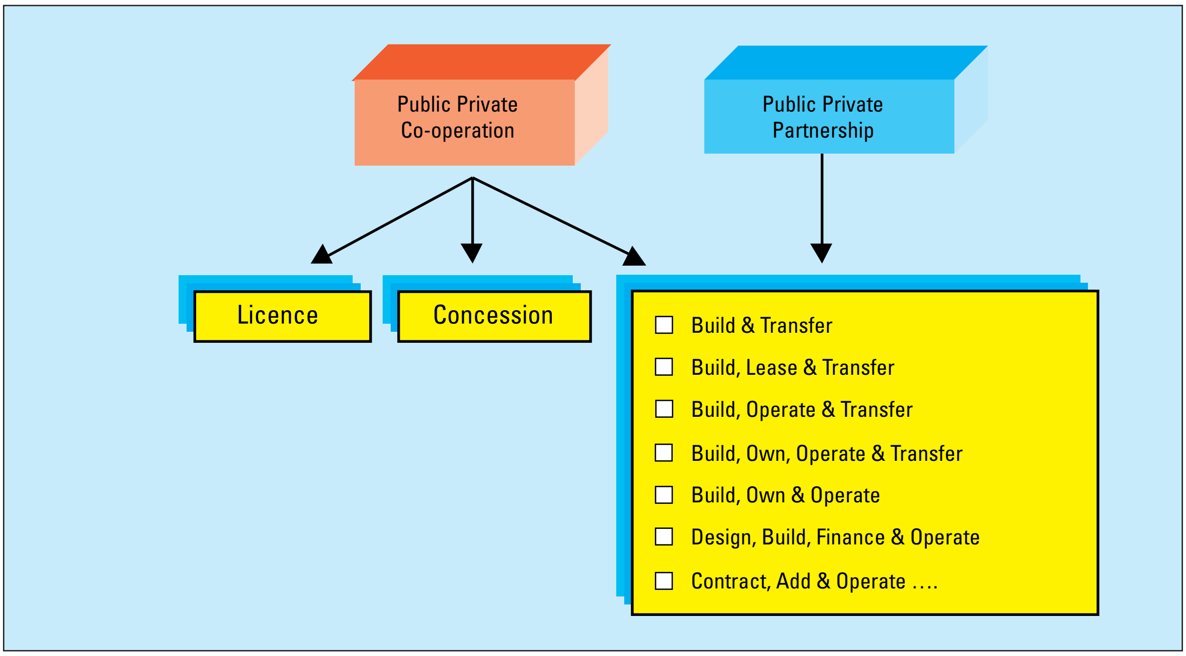


Figure 2. Structures of Public-Private Collaboration.

different conditions, and such);
- Schedule risk (delays in execution);
- Commercial risks (cost escalation, budget control, and such).

Most if not all of these risks can be borne by the private sector.

There are however other categories of risk or uncertainty, in particular for transport infrastructure, that are outside the control of the private sector. These risks can be described as *structural risks* and they cannot be shifted to the private sector, in particular in view of the public character of the risks. Such risks should therefore be carried by the public sector to guarantee minimum conditions for project success.

Structural risks include:
- Planning and permits risk (e.g. delays in planning procedure, negative environmental impact assessment, not granting construction permits...)
- Political risk (new government changes plans, ...)
- Regulatory risk (the design rules are changed, ...)

Commitment as a Differentiating Factor

The difference between traditional co-operation and public-private partnership should be sought in other domains than the role and contribution of each partner. Most studies do not explicitly define and qualify the commitment of both partners sharing the risks and responsibilities. In particular these elements differentiate the PPP from traditional forms of 'co-operation' as demonstrated in Figure 3.

Types of PPP
Three different types of PPP can be distinguished, based upon the participation level of the four stakeholders.

The first type is the 'basic PPP' where the public and private partners team up for operating a specific project and outsource all non-core activities to outsiders.
The second is the 'controlled PPP' where the provider of the financial resources is formally included in the project and is able to participate in the decision-making process and therewith in the controlling of the project's risks.
Finally, the third type of PPP incorporates all stakeholders during the life cycle and can be considered an 'integrated PPP'.

The basic PPP is the cleanest form and enables the public-private partnership to scan the market to find the best available option in terms of investor(s) and contractor(s).
The controlled PPP is the strongest form of collaboration given that the investor is a partner in the PPP and will constantly monitor the project in order to secure its expected return on investment. The investor will act as a continuous auditor.
The integrated PPP incorporates also the constructor(s) as a partner. An important question here is the level of involvement during the project life cycle.

The well-defined distribution of risks (and benefits) between the public and private partners is undoubtedly the key element for a successful PPP. The level of participation of the stakeholders is the crucial factor. The risks for each partner vary according to the structure of the PPP (basic, controlled or integrated PPP).

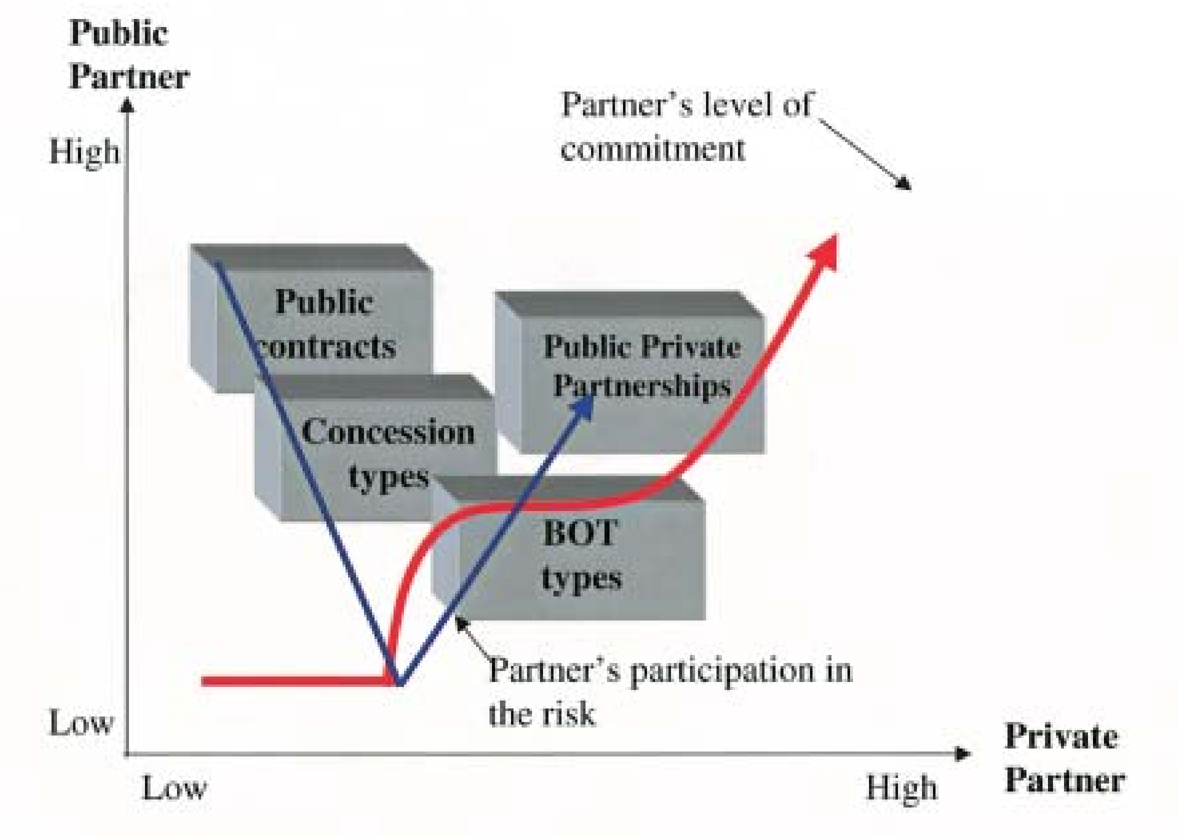


Figure 3. Commitment in public-private collaboration.

The other partners predominantly confront the public partner with a possible non-compliance with the stipulations of the PPP contract.

Public partners
Depending on the type of partnership, the level of risk for the public partner could be reduced to an acceptable level. The controlled or the integrated PPP is the optimal selection for the public partner, given that the participation from the start of the project of the investor(s) and contractor(s) will increase the (financial) stability of the project.

Private partners
It is logical that the private partner will carefully assess the commercial viability of a project before engaging in such a venture. For the private partner, however, structural risks come on top of the project risk. For the private partner, the participation of the investor in the controlled PPP increases stability and consequently reduces the project risks, both in financial as in political terms. For private partners in PPP's, the risk is the deciding factor for a participation.

The greatest risks could well be run by the investors, or equity provider, whether they are a partner in the PPP or outsiders. The best option for the investor is also the early participation in the project, either in the controlled or the integrated PPP. However, even as a partner, the fact remains that the investor provides the financial resources and therefore is the most vulnerable partner to possible changes.

Finally, there is the contractor. The risks for contractors are generally limited as long as they remain outsiders from the project. In this case, the period of their involvement is confined to the beginning of the project, when risks both political and commercial remain limited. In case of a partnership (integrated PPP), the constructor increases risks but will at the same time increase long-term expected revenues from the project.

Conclusions

The overall project risks can never be fully eliminated for companies and public bodies participating in a transport infrastructure investment. The selection of the optimal PPP structure will remain a project-based decision for which no general assessment rules exist. Careful preparation of a PPP is an important success factor. The key factor is that the project risks must be allocated to the public and private sectors, respectively, according to each party's ability to manage such risks without destroying the economic balance of the - project.

Charles W. Hummer, Jr.

Books/ Periodicals Reviewed

Dredging: The Facts
Published jointly by the International Association of Dredging Companies, International Association of Ports and Harbors, International Navigation Association and the World Organization of Dredging Associations
The Hague, The Netherlands, 1999
Pamphlet, 8 pp., A4, illustrated, colour
Edited by members of the PIANC-PEC

Dredging as a process plays a tremendously important role in local, national, regional and international economies. This importance is often poorly understood by those who benefit from it, both the population-at-large and governments at the national and international levels. This short but comprehensive booklet fills the large gap for an easily understood and distributed information pamphlet on dredging.

This booklet fulfills this need and does so in a manner that should find ready acceptance and understanding. The cover aptly highlights the "facts" as the title denotes:

– Dredging is vital to social and economic development.
– Dredging is vital to construction and maintenance of much of the infrastructure upon which our economic prosperity and social well-being depend.
– When and why do we dredge?

The composition of the booklet is presented in a very logical format that is suitable for the broad audience it is designed to reach. The first section takes up the basic question of "Why we dredge?" The one-page answer to that basic premise covers dredging for navigation, dredging for construction, reclamation and mining and, finally, dredging for the environment.

The next section addresses in a few short paragraphs, the dredging process. Following this section is "Types of dredgers". In a few short paragraphs, accompanied by some relevant photographs, the reader gets an effective nutshell view of the types of dredgers.

The following section addresses "Dredged material management alternatives". This short section fulfills a complementary need for understanding and appreciating that there are more solutions to the disposal of dredged material than are often thought. The section talks to the regulatory aspects, beneficial uses of dredged material and treatment of dredged material. The latter subject makes mention that contaminated sediments can be dredged (removed from the ecosystem) and treated to reduce the contamination before it is disposed or otherwise beneficially used.

Finally, the booklet presents a section on the environmental issues related to dredging. Covering the dredging process itself as well as the various disposal options, this section is also effectively illustrated and simply stated.

The last segment of the publication addresses one of the true basics of dealing with the issue of contamina-

(continued on page 31)

Seminars/ Conferences/ Events

Coastal Structures '99

Royal Palace of the Magdalena,
Santander, Spain
June 7-10 1999

Puertos del Estado (State Ports of Spain) and the Universidad de Cantabria are organising a conference co-sponsored by the American Society of Civil Engineers (ASCE). Presentations will run in three parallel sessions from June 7-9 and contain papers on all aspects of the design, construction and maintenance of coastal structures, such as: functionality, stability and reliability; wave and structure interaction; geotechnical aspects; physical modelling and field monitoring; environmental problems associated with structures, and so on. The last day will be a visit to the port of Bilbao and the Guggenheim Museum.

For further information check the homepage:
http//www.omniasc.es/aforo/coastal99 or
Conference Bureau Aforo, S.L.
C/Magallanes, 36, 39007 Santander, Spain
tel. +34 942 23 06 27, fax +34 942 233 10 58
email at: aforo@omniasc.es

International Ports Congress

De Vere Grand Harbour Hotel,
Southampton, UK
June 14-15 1999

Co-sponsored by the International Assoociation of Ports and Harbours (IAPH) and International Navigation Association (PIANC), the Institution of Civil Engineers (ICE) is hosting a two-day congress to offer up-to-date information about recent developments in the design and construction of ports. Topics will include: the rapidly changing environment; effects of new legislation; developments in cargo handling; how ports may diversify to best use land resources; and integration with other modes of transport.

For further information contact:
Rachel Cooninx, Thomas Telford Conferences,
The Institution of Civil Engineers, One Great George Street, London SWIP 3 AA, UK
tel. +44 171 662314, fax +44 171 233 1743
email: coninx_r@ice.org.uk
http://www.t-telford.co.uk/co/conflist.html

POAC '99

Helsinki University of Technology,
Espoo, Finland
August 23-27 1999

The 15th International Conference on Port and Ocean Engineering under Arctic Conditions is being organised under the auspices of the POAC International Committee. It will especially address the new developments in the offshore industry together with winter and Arctic navigation. Special emphasis will be given to the progress in the theortetical and physical modelling of ice problems. Technical tours will be arranged to the icebreakers of the Finnish Board of Navigation and to the shipyard and Arctic Technology Centre (MARC) of Kvaerner Masa-Yards.

For further information contact:
POAC '99 Conference
c/o TSG-Congress Ltd.
Kaisaniemenkatu 3 B 12
FIN-00100 Helsinki, Finland
tel. +358 9 628 044, fax +358 9 667 675
email: info@tsgcongress.fi

Offshore Europe 99

Aberdeen, Scotland
September 7-10 1999

Offshore Europe 99, an Oil and Gas Exhibition and Conference, will examine the offshore industry on the brink of the 21st century. This biennial event attracts industry professionals from the countries involved in exploration and production, including the UK, Norway, The Netherlands and Denmark on the Northwest EuropeanContinental Shelf, France and Italy in the Mediterranean, and Spain in the Atlantic. The enormous technological expertise represented by these and surrounding countries will be demonstrated at this conference.

For further information contact:
Offshore Europe Partnership
Ocean House, 50 Kingston Road
New Malden, Surrey KT3 3LZ, UK
tel. +44 181 949 9222, fax +44 181 949 8186/8193
email: oe99@spearhead.co.uk
http://www.offshore-europe.co.uk

Val Johnston-Jones
Society of Petroleum Engineers
Empire House, 4th Floor, 175 Piccadilly
London W1V 9DB, UK
tel. +44 171 408 4466, fax +44 171 408 2299
email: vjohnston-jones@london.spe.org

12th International Harbour Congress

Technological Institute,
Antwerp, Belgium
September 12-16 1999

The Royal Flemish Society of Engineers, Section on Harbour Techniques, is organising a 4-day congress to be held together with the 9th International Harbour Exhibition. The topics will include: Port planning; port infrastructure design; port construction; and port access in offshore, coastal and non-coastal harbours. There will also be a workshop on "Information Data Network - Vessel Traffic System". The congress will be followed by the 4th International CATS Congress from September 15-17, 1999 on the Characterisation and Treatment of Sediments.

For further information contact:
12th International Harbour Congress,
Att: Ms Rita Peys, c/o Technologisch Instituut vzw
Desguinlei 214, B-2018 Antwerp, Belgium
tel. +32 3 216 0996/ fax +32 3 216 0689
email: have@conferences.ti.kviv.be
http://www.ti.kviv.be/conf/have.hmt

CATS 4

Technological Institute,
Antwerp, Belgium
September 15-17 1999

The Fourth Congress on Characteristation and Treatment of Sediments (CATS 4) is organised by the Technological Institute of the Royal Flemish Society of Engineers, Sections on Environmental Technology and Harbour Techniques. The congress will be preceded by the 12th International Harbour Congress (September 12-16).

Topics will include: Sediment and dredged material characterisation; source control and sediment management; dredging technology, focussing on contaminated sediments; sustainable relocation and beneficial use; treatment and disposal technologies; environmental risk and environmental merits analysis; impact assessment, management and control; and strategies for sustainable management.

For further information contact:
CATS 4, Att: Ms Rita Peys
c/o Technologisch Instituut vzw
Desguinlei 214, B-2018 Antwerp, Belgium
tel. +32 3 216 0996/ fax +32 3 216 0689
email: cats@conferences.ti.kviv.be
http://www.ti.kviv.be/conf/cats.hmt

Expo Maritima Mercosur/PescAL

Centro Costa Saiguero,
Buenos Aires, Argentina
November 11-13, 1999

The Expo Maritima Mercosur/PescAL are being organised by Diversfield Business Communications, a world leader in the commercial marine publishing and trade show industries. This event focusses on the economic opportunities in the Mercosur - the free trade zonde developed by Argentina, Brazil, Paraguay, Uruguay and associate members Chile and Bolivia.
It spotlights the construction of the Hidrovia, the inland waterway system linking the Mercosur countries, and reflects the accelerated investment and commercial interest in port development in this area.

In addition, the Expo coincides with IADC's International Seminar on Dredging and Reclamation being held in Buenos Aires from November 8-12 (see page 32), and the IADC and the organisers of Expo Maritima Mercosur are working together to give an added impact to both these outstanding events.

For further information contact
Diverified Business Communications
PO Box 3280.
Boston, MA 02441-3280 USA
fax +207 842 5503

Diversified Business Communications
Uruguay 1134 3^0 Piso
1016 Buenos Aires, Argentina
tel. +54 11 4813 1814/fax +54 11 4813 6143

Europort 99

RAI Exhibition Centre,
Amsterdam, The Netherlands
November 16-20, 1999

Europort is the world-wide marketplace for the maritime industry, featuring exhibitions on: ship design and construction; ship maintenance, repair and conversion; ship equipment; engine and propulsion systems; navigation and communication; safety equipment;

environmental protection; cargo handling and containers; ports and waterways; and offshore and marine technology. CEDA Dredging Days, organised by the Central Dredging Association, will be held simultaneously on November 18 and 19.

For further information contact:
Europort 99, Amsterdam RAI
PO Box 77777, 1070 MS Amsterdam, The Netherlands
tel. +31 20 549 1212, fax +31 20 646 4469
email: europort@rai.nl
http://www.europort.nl

CEDA Dredging Days

RAI Exhibition Centre,
Amsterdam, The Netherlands
November 18-19, 1999

In association with the Europort 99 Exhibition, held from November 16-20 1999, the 29th International Maritime and 11th International Inland Shipping Exhibitions, CEDA Dredging Days will be divided into two very specific topics:
– dredging for immersed tunnels, pipelines and outfalls; and
– agitation dredging, water injection dredging and sidecasting.

Because of the demands of the community for less expensive yet environmentally acceptable methods of construction and maintenance of trenches and channels, the conference wishes to focus attention on these specialised areas.

For further information contact:
CEDA Secretariat, PO Box 488, 2600 AL Delft,
The Netherlands
tel. +31 15 278 3145, fax +31 15 278 7104
email: ceda@dredging.org

Books/ Periodicals Reviewed

(continued from page 28)

ted sediments: the need to control the source of contaminants before they reach the waterways and marine and fresh water environments where they can be so detrimental. This issue is one that is often ignored by local, regional and national regulators who have historically tended to address the end process of dredging and disposal rather than source control.

The booklet also gives a short but very relevant listing of pertinent publications that readers may wish to utilise in broadening their knowledge further.

The collaboration of the international parties who sponsored this publication is as important at the booklet itself. They represent the major players in the navigation and dredging fields and this project shows an increasing maturity and responsibility for education and environmental awareness. The booklet should be very effective in providing a simple but clearly articulated source or primer on dredging and disposal issues. The audiences for which this booklet will be particularly useful are: educational institutions at all levels; and policy-making groups such as The World Bank, European Investment Bank and the regional development banks for Asia and Latin American.
Likewise; the international business and financial media should find this a ready source for reference in dealing with matters related to dredging. Finally, most legislators who are flooded with complex matters of all descriptions should find this short volume a means to fill in a void in their knowledge base.

This booklet is the first effort by all of these collaborating groups. The intent is to continue this effort with further publications to promote understanding and awareness as it relates to dredging matters.

The booklet can be acquired from any one of the following organisations:
International Association of Dredging Companies
Duinweg 21, 2585 JV The Hague, The Netherlands
Email: info@iadc-dredging.com

International Association of Ports and Harbours
IAPH Secretariat, Kono Building
1-23-9 Nishi-Shimbasi, Minato-ku, Tokyo 105, Japan
Email: iaph@msn.com

International Navigation Association
PIANC Secretariat, Graff de Ferraris, 11ème étage,
Boîte 3 Bld., Emile Jacqmain 156
B-1000 Brussels, Belgium
Email: navigation-aipcn-pianc@tornado.be

World Organization of Dredging Associations
WODA/EADA Secretariat
GPO Box 388, Hamilton Central
Queensland 4007, Australia

CEDA Secretariat
P.O. Box 488
2600 AL Delft, The Netherlands
Email: ceda@dredging.org

WEDA Executive Offices
P.O. Box 5797, Vancouver,
Washington 98668-5797, USA
Email: weda@juno.com

International Seminar on Dredging and Reclamation

Place: Buenos Aires, Argentina
Date: November 8-12, 1999

In cooperation with the Universidad Nacional de La Plata and Estudio de Ingenieria Hidraulica S.A., the International Association of Dredging Companies is pleased to organise for the first time in Buenos Aires an intensive, one week seminar on dredging and reclamation, This seminar has been succesfully presented for many years both in Delft, The Netherlands with the International Institute for Hydraulic Engineering, and in Singapore with the National University of Singapore and the Applied Research Corporation.
The costs are US$ 3250, which include six nights accommodation at the conference hotel, breakfast and lunch daily, one special participants dinner, and a general insurance for the week.

The seminar includes workshops and a site visit to a dredging project. Highlights of the programme are:

Day 1: Why Dredging?
The Need for Dredging/Project Phasing
Day 2: What is Dredging?
Dredging Equipment/Survey Systems (includes a Site Visit)
Day 3: How Dredging?
Dredging Projects
Day 4: Preparation of Dredging Contract
Day 5: Cost/Pricing and Contracts

Representatives of port authorities, companies, and individuals interested in attending are requested to complete the preliminary registration form below as soon as possible and prior to October 1, 1999, and return to:
IADC Secretariat, Duinweg 21,
2585 JV The Hague, The Netherlands
tel. +31 70 352 3334, fax +31 70 351 2654
e-mail: info@iadc-dredging.com

(please print)

Name ....
Title ....
Company ....
Address ....
....
Tel. .... Fax ....
E-mail ....

Please send this form and your deposit by cheque or credit card for US$ 500 in order to guarantee your place at the seminar. Upon receipt of this form and your deposit your place in the seminar is confirmed. We will then send you further detailed information, final registration forms, and an invoice for the correct amount.

Without your deposit we cannot guarantee your place and accommodations at the seminar.

☐ A Cheque is enclosed.
☐ Please charge my credit card:
☐ American Express ☐ Eurocard/Master Card ☐ Diners Club

Account no.: |_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|_|

Expiry date: |_|_|_|_|_|_|

Signature .... Date ....

VISIT EXPO MARITIMA MERCOSUR, BUENOS AIRES, NOV. 11-13 1999

Membership List IADC 1999

Through their regional branches or through representatives, members of IADC operate directly at all locations worldwide.

Africa

Boskalis South Africa (Pty.) Ltd., Capetown, South Africa
Boskalis Togo Sarl., Lomé, Togo
Boskalis Westminster Cameroun Sarl., Douala, Cameroun
Boskalis Zinkcon (Nigeria) Ltd., Lagos, Nigeria
Dredging International Services Nigeria Ltd., Lagos, Nigeria
HAM Dredging (Nigeria) Ltd., Ikeja, Nigeria
Nigerian Dredging and Marine Ltd., Apapa, Nigeria
Westminster Dredging (Nigeria) Ltd., Lagos, Nigeria

The Americas

ACZ Marine Contractors Ltd., Brampton, Ont., Canada
Beaver Dredging Company Ltd., Calgary, Alta., Canada
Dragamex SA de CV, Coatzacoalcos, Mexico
Gulf Coast Trailing Company, New Orleans, LA, USA
HAM Caribbean Office, Curaçao, NA
Norham/Dragagens, Rio de Janeiro, Brazil
Stuyvesant Dredging Company, Metairie, LA, USA
Uscodi, Wilmington, DE, USA

Asia

Ballast Nedam Malaysia Ltd., Kuala Lumpur, Malaysia
Ballast Nedam Dredging, Hong Kong Branch, Hong Kong
Boskalis International BV., Hong Kong
Boskalis International Far East, Singapore
Boskalis Taiwan Ltd., Hualien, Taiwan
Dredging International Asia Pacific (Pte) Ltd., Singapore
Dredging International N.V., Hong Kong
Dredging International N.V., Singapore
Far East Dredging Ltd., Hong Kong
HAM Dredging (M) Sdn Bhd, Kuala Lumpur, Malaysia
HAM East Asia Pacific Branch, Taipei, Taiwan
HAM Hong Kong Office, Wanchai, Hong Kong
HAM Philippines, Metro Manila, Philippines
HAM Singapore Branch, Singapore
HAM Thai Ltd., Bangkok, Thailand
Jan De Nul Singapore Pte. Ltd., Singapore
Mumbai Project Office, Mumbai, India
PT Penkonindo, Jakarta, Indonesia
Tideway DI Sdn. Bhd., Selangor, Malaysia
Van Oord ACZ B.V., Dhaka, Bangladesh
Van Oord ACZ B.V., Hong Kong
Van Oord ACZ B.V., Singapore
Van Oord ACZ Overseas B.V., Karachi, Pakistan
Zinkcon Marine Malaysia Sdn. Bhd., Kuala Lumpur, Malaysia
Zinkcon Marine Singapore Pte. Ltd., Singapore

Middle East

Boskalis Westminster Al Rushaid Ltd., Dhahran, Saudi Arabia
Boskalis Westminster M.E. Ltd., Abu Dhabi, UAE
Dredging International N.V., Middle East, Dubai
Dredging International N.V., Tehran Branch, Tehran, Iran
Gulf Cobla (Limited Liability Company), Dubai, UAE
HAM Dredging Company, Abu Dhabi, UAE
HAM Saudi Arabia Ltd., Damman, Saudi Arabia
Jan De Nul Dredging, Abu Dhabi, UAE
Van Oord ACZ Overseas BV., Abu Dhabi, UAE

Australia

Condreco Pty. Ltd., Milton, QLD., Australia
Dredeco Pty. Ltd., Brisbane, QLD., Australia
New Zealand Dredging & General Works Ltd., Wellington
Van Oord ACZ B.V., Victoria, Australia
WestHam Dredging Co. Pty. Ltd., Sydney, NSW, Australia

Europe

ACZ Ingeniører & Entreprenører A/S, Copenhagen, Denmark
Anglo-Dutch Dredging Company Ltd., Beaconsfield, United Kingdom
A/S Jebsens ACZ, Bergen, Norway
Atlantique Dragage S.A., Nanterre, France
Baggermaatschappij Boskalis B.V., Papendrecht, Netherlands
Baggermaatschappij Breejenbout B.V., Rotterdam, Netherlands
Ballast Nedam Bau- und Bagger GmbH, Hamburg, Germany
Ballast Nedam Dredging, Zeist, Netherlands
Ballast Nedam Dragage, Paris, France
Boskalis Dolman B.V., Dordrecht, Netherlands
Boskalis International B.V., Papendrecht, Netherlands
Boskalis B.V., Rotterdam, Netherlands
Boskalis Westminster Aannemers N.V., Antwerp, Belgium
Boskalis Westminster Dredging B.V., Papendrecht, Netherlands
Boskalis Westminster Dredging & Contracting Ltd., Cyprus
Boskalis Zinkcon B.V., Papendrecht, Netherlands
Brewaba Wasserbaugesellschaft Bremen mbH, Bremen, Germany
CEI Construct NV, Afdeling Bagger- en Grondwerken, Zele, Belgium
Delta G.m.b.H., Bremen, Germany
Draflumar SA., Neuville Les Dieppe, France
Dragados y Construcciones S.A., Madrid, Spain
Dravo S.A., Madrid, Spain
Dredging International N.V., Madrid, Spain
Dredging International N.V., Zwijndrecht, Belgium
Dredging International Scandinavia NS, Copenhagen, Denmark
Dredging International (UK), Ltd., Weybridge, United Kingdom
Enka-Boskalis, Istanbul, Turkey
Espadraga, Los Alcázares (Murcia), Spain
HAM Dredging Ltd., Camberley, United Kingdom
HAM, dredging and marine contractors, Capelle a/d IJssel, Netherlands
HAM-Van Oord Werkendam B.V., Werkendam, Netherlands
Heinrich Hirdes G.m.b.H., Hamburg, Germany
Holland Dredging Company, Papendrecht, Netherlands
Jan De Nul N.V., Aalst, Belgium
Jan De Nul Dredging N.V., Aalst, Belgium
Jan De Nul (U.K.) Ltd., Ascot, United Kingdom
Nordsee Nassbagger- und Tiefbau GmbH, Wilhelmshaven,Germany
N.V. Baggerwerken Decloedt & Zoon, Brussels, Belgium
S.A. Overseas Decloedt & Fils, Brussels, Belgium
Sider-Almagià S.p.A., Rome, Italy
Skanska Dredging AB, Gothenborg, Sweden
Sociedade Portuguesa de Dragagens Lda., Lisbon, Portugal
Sociedad Española de Dragados SA., Madrid, Spain
Società Italiana Dragaggi SpA. "SIDRA", Rome, Italy
Société de Dragage International "S.D.I." S.A., Marly le Roi, France
Sodranord SARL, Paris, France
Tideway B.V., Breda, Netherlands
Van Oord ACZ B.V., Gorinchem, Netherlands
Van Oord ACZ Ltd., Newbury, United Kingdom
Wasserbau ACZ GmbH, Bremen, Germany
Westminster Dredging Co. Ltd., Fareham, United Kingdom
Zanen Verstoep B.V., Papendrecht, Netherlands
Zinkcon Contractors Ltd., Fareham, United Kingdom
Zinkcon Dekker B.V., Rotterdam, Netherlands
Zinkcon Dekker Wasserbau GmbH, Bremen, Germany

INTERNATIONAL ASSOCIATION OF DREDGING COMPANIES
Duinweg 21 - 2585 JV The Hague - The Netherlands