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Sludge Treatment Centre Fasiver: Sanitation and Redesign of the Site “Eilandje” at Zwijnaarde (Belgium)

Abstract

In general, there is a lack of disposal sites and/or alternative treatment techniques for beneficial reuse of contaminated dredged material in the Flemish region of Belgium. On the other hand there are several sites in this region that, owing to former industrial activities, are contaminated and no longer have a commercial or industrial use. Some even have a negative value as a result of the present contamination and the needed sanitation before any further use. On top of this there is an urgent shortage of industrial areas in the Ghent region for the expansion of high technology oriented businesses and small- to medium-sized organisations.

In the late 1990s governmental organisations in the Ghent region were urgently seeking economical solutions for the disposal of contaminated dredged material. Several maintenance dredging operations were postponed because of a lack of disposal possibilities. Eventually several governmental organisations and private partners combined their expertise and developed the “Fasiver Project” which includes the sanitation of a black-point (surface of about 7 ha) and the redesign of a 42 ha large site by means of a sludge treatment centre (dewatering lagoons) and a confined disposal facility for contaminated dredged material. The final destination of the site is industrial area (approximately 30 ha) and a greenbelt (approximately 10 ha) on top of the sanitised black-point. The profits made by the selling of the grounds in the industrial area should cover the costs made for the sanitation of the black-point.

The site is located in the Ghent region, on the crossing of highways E17 and E40 and the waterways Upper Scheldt and a ring canal around Ghent. The installation and exploitation of the sludge treatment centre and the confined disposal facility are regulated and controlled by the Flemish Government. All necessary environmental and building permits are yet available. The design of the treatment centre and the confined disposal facility is in accordance with Flemish and European regulations, which means amongst other things that a double mineral liner or equivalent is installed at the bottom; several drainage layers are installed in order to collect the percolate and to control the impermeable liner; an isolating top layer minimises environmental impacts in the future. After filling the disposal site the area shall be used as an industrial site. The total capacity of the confined disposal site is estimated to 1.3 million cubic metres.

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Introduction

In general, a lack of disposal sites and/or alternative treatment techniques for beneficial reuse of contaminated dredged material exists in the Flemish region of Belgium. On the other hand there are several sites in this region that, owing to former industrial activities, are contaminated and no longer have a commercial or industrial use. Some even have a negative value as a result of the present contamination and the needed sanitation before any further use.
On top of this there is an urgent shortage of industrial area in the Ghent region for the expansion of high technology oriented businesses and small- to medium-sized organisations.

In the late 1990s governmental organisations in the Ghent region were urgently seeking economical solutions for the disposal of contaminated dredged material. Several maintenance dredging operations were postponed because of a lack of disposal possibilities. There was even a restriction on the draught in the ring canal around Ghent. Where the canal was designed for vessels with a draught of up to 3 metres, at the end of the year 2000 the maximal draught was limited to 2.5 metres.

Eventually several governmental organisations, including the Province of East-Flanders and the City of Ghent, and private partners, including Domo Service Gent NV and DEC NV, combined their expertise and developed the “Fasiver Project” which includes the sanitation of a black-point (surface of about 7 ha) and the redesign of a 42 ha large site by means of a sludge treatment centre (dewatering lagoons) and a confined disposal facility for contaminated dredged material. The net capacity for dewatered dredged material of the confined disposal facility is estimated to 1.3 million cubic metres.

The final destination of the site is industrial area (approximately 30 ha) and a greenbelt (approximately 10 ha) on top of the sanitised black-point and around the industrial area. The profits that will be made by the selling of the grounds in the industrial area should cover the costs for the sanitation of the black-point.

The Fasiver Project has provided a solution for the three problems mentioned above:

- An historical black-point with a great risk for the environment and human health is sanitised and controlled in an economical and environmentally safe way.
- Maintenance dredging operations in the Ghent region are restarted and can continue for over 10 years.
- An industrial area is created on a very favourable location near two major highways and waterways, so the needed expansion of the industry in the Ghent region can continue without developing new sites in residential parts of the city.

Situation

The site in question is located in the Ghent region, at the crossing of highways E17 and E40 and the waterways Upper Scheldt and the ring canal around Ghent (see Figures 1, 2 and 3).

Public Private Partnership

At first sight, public and private partners have contradictory interests. The private partner wants to reduce risks (insecurity of public policy and changing regulations) and increase financial return related to the investment, whereas the public partner wants to diminish financial risks and the financing volume and increase efficiency in execution. Through a public private partnership these opposing interests can be shared in common cooperation.

This common cooperation between public and private interests can be illustrated taking the redevelopment of a “brownfield” site as an example.

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Figure 1. Location of Fasiver site in Europe (in Belgium).

Figure 2. Detailed location of Fasiver site in Belgium, at crossing of Highways E17 and E40.

Figure 3. Aerial view of Fasiver site.

1. Know-how
The private partner has to take the technical risks (e.g. using new techniques, applying existing methodologies on a larger scale or under different conditions). The public partner is responsible for the planning and permit risks (e.g. delays in planning procedure, negative environmental impact assessment, failure to obtain construction permits).

2. Efficiency
While the private partner takes responsibility for the schedule risks (delays in execution, flexibility), the public partner is responsible for the regulatory risks (changing rules, political risks, expropriation).

3. Finance
Here, the private partner takes care of the commercial risks (cost calculation, budget control) and can pre-finance the project. The public partner has to take the final budget risk based on revenues from the brownfield site: the contamination cost has to be lower than the revenues.

During the study period of the Fasiver Project the following public and private partners combined their interests:

– Domo Service Gent as main owner of the site, including the black-point;
– DEC as environmental contractor for the sanitation of the black point and the exploitation of a sludge treatment centre and disposal facility;
– Vlaamse Milieuholding (VMH) as initiator of the project, in execution of the Flemish Government policy to prevent and recycle waste;
– The City of Ghent and the province of East Flanders as partners interested in the potential value of the site.

Through the use of a pull-out option, the public partners (VMH, City of Ghent and province of East Flanders) left the public private partnership after the study period, so that the private partners (owner and contractor) had to take the exploitation risks on their own. By giving a pre-purchase option (to the City of Ghent and the province of East Flanders), the public partners nevertheless remain involved with the project.

Principle of Sanitation

Formulation of the problem
A part of the site in question was formerly used as a disposal site for waste products coming from the production of viscose fibres on the other side of the Scheldt canal. In that time there was practically no legislation, knowledge or concern about the environmental impact of such activities. This way about 175,000 m^3 of organic viscose sludge was dumped in five basins without any lining or control measures.

For over 50 years no measures were taken to minimise the threat to the environment of the present sludge basins. Due to the lixiviation of heavy metals and other contaminants present in the sludge the groundwater in the surrounding area is contaminated and forms a possible risk to the adjacent residential area on the southeast of the site.

Because of the historical character of the problem, the present owner of the site is a so-called ‘innocent owner’ and has no obligation whatsoever in order to sanitise this black-point. On the other hand due to the presence of the black-point the site has a negative value and cannot be sold or used. Only a global project – a so-called “brownfield” development – including a risk-based sanitation of the black-point and an economical revalorisation of the site, can supply a solution. Figure 4 shows an overview of the black-point.

Proposed solution

Because of the large volume of contaminated viscose sludge, excavation and ex-situ treatment and disposal of the treated sludge was not an economically viable solution. Therefore preference was given to in-situ stabilisation and isolation of the sludge basins, combined with in-situ groundwater remediation of the contaminated hot spots around the sludge basins.

For the stabilisation and immobilisation of the contaminated viscose sludge a series of laboratory tests was undertaken in order to define the best-suited recipe. Several binding agents and granulated materials were tested.

As the viscose sludge is a fluid-like, fibrous, organic material with practically no mechanical structure, a granulated additive is necessary in order to improve the structure and the ground mechanical characteristics of this material. Based on the laboratory tests, the use of steel slag as granulated material showed the best results. As the steel slag is a secondary by-product it is also an economically and environmentally good alternative for the use of raw materials. A second advantage of the use of steel slag is the presence of approximately 10% lime in this material, which ameliorates the immobilisation of the contaminants present in the viscose sludge. As binding agent a purpose-made additive mainly consisting of cement showed the best results, economically and mechanically.

The final tests showed that with this recipe, a shear strength of 10 kPa was easily attainable, already after seven days. Control measurements on site affirm these results. Figure 5 shows an overview of the stabilisation of the different basins on site.

On site the different additives (steel slag and binding agents) are first mixed in predefined quantities in a semi-mobile mixing plant. Then this mixture is transported to the different sludge basins where a long reach excavator equipped with a specially designed mixing bucket spreads and mixes the additives and the viscose sludge. Because of the presence of large parts of wood, bricks, concrete, steel, etc. in the sludge basin, a mixing technique without any rotating parts was deliberately chosen.

Figure 4. Overview of the black-point.

Figure 5. Overview of the stabilisation of the different basins.

The actual isolation of the contaminated sludge volume will be performed by means of an impermeable cement-bentonite wall around the different basins. This cement-bentonite wall will be 30 metres deep below ground level and will reach a natural underlying impermeable clay layer. On top of the stabilised viscose sludge comes first a gas-drainage and second an impermeable HDPE-liner of 2.5 mm thick.

Finally the isolated area will be covered with over 2 metres of mould and arranged as a green area as buffer near the industrial zone.

Health and Safety

Because of the organic character of the viscose sludge and the presence and continuous production of H_2S gas in the sludge, many problems were expected during the handling of this type of sludge. An extensive safety plan was made, including personal H_2S gas detectors for all personnel working near the sludge basins. All the material that was used in the stabilisation operations was equipped with positive pressure cabins. An emergency plan was set up in order to evacuate the site in case of calamities.

During the laboratory tests – for the determination of the right recipe for stabilisation – also the H_2S gas concentration above the sludge surface was measured. There was even a pilot study on site where the H_2S concentration and odour production were measured during a simulation of the proposed stabilisation technique.

During these tests a few cases near the sludge surface (within a few centimetres) were measured with concentrations of up to 500 ppm. The MAC-value for H_2S gas is 10 ppm. Nevertheless because of the distribution in open air and the chemical reaction in the sludge (increase of pH) owing to the addition of cement, it seemed that concentrations within a few metres of the surface were limited below 10 ppm. Continuous measuring on site during the stabilisation operations confirmed these results.

Also the odour production because of the stabilisation operations stayed within the "normal" concentrations observed before the beginning of the project. Depending on the weather conditions, the typical odour of the viscose sludge could be observed in a perimeter of about 500 metres around the basins.
During the stabilisation operations this perimeter is not significantly wider. A specialised panel of noses (a research group of the University of Ghent) is responsible for the follow up of the odour concentration around the sludge basins.

Once the viscose sludge is stabilised – and thus the pH increased – the H_2S gas in the sludge is actually immobilised and all the risks or inconveniences that go with the presence of H_2S gas disappear.

Sludge Treatment Centre

Next to the sanitation of the black-point, a large treatment centre for contaminated dredged material was installed on the site. About ten hectares of

Figure 6. Sludge Treatment Centre Fasiver.

dewatering fields have been installed around and up the sanitised black-point (Figure 6).

Finally the whole area will be arranged as a disposal site for contaminated dredged material. In this way the level of the area is brought from between +6 and +8 m TAW to a level of +13 m TAW, which is the level of the highway E40 along the site.

Quay wall
In order to maximise the supply by water, first a quay wall was installed along the Scheldt canal. The installed quay wall is 120 m long and consists of sheet piles and anchors (Figure 7).

Figure 7. The quay wall at the Fasiver site.

All the drainage sand, gravel and about half of the construction sand needed for the installation of the dewatering fields and disposal site is brought over water. Naturally all the contaminated dredged material that will be treated on site is also brought over water.

Installation of dewatering field and disposal site
Figure 8 shows the structure of the dewatering fields and disposal site. The natural top layer at the site is a clay layer of about 3 metres thick. The presence of this layer and the permeability are examined in detail before the installation of the dewatering fields or disposal site is started. On these locations where the permeability is greater than 10^{-9} m/s or the natural clay layer is less than 3 metres thick an additional mineral liner is added.

This additional mineral liner consists of a layer of non-contaminated dredged material of about 30 cm thick and a permeability of maximum 10^{-10} m/s or a “sand-bentonite-polymer liner” (Trisoplast®) of 7 cm thick with a permeability of maximum 10^{-11} m/s.

On top of the mineral liner comes a drainage layer of about 20 cm thick. This drainage layer will function as a control drainage layer in order to evaluate the isolating capacities of the upper impermeable liner. The impermeable liner on top of the control drainage is a layer of compacted, dewatered, non-contaminated dredged material with a permeability of maximum 10^{-9} m/s. Upon that comes then the percolate drainage layer. This drainage layer consists of several types of drainage sand, gravel and a network of drainage pipes.

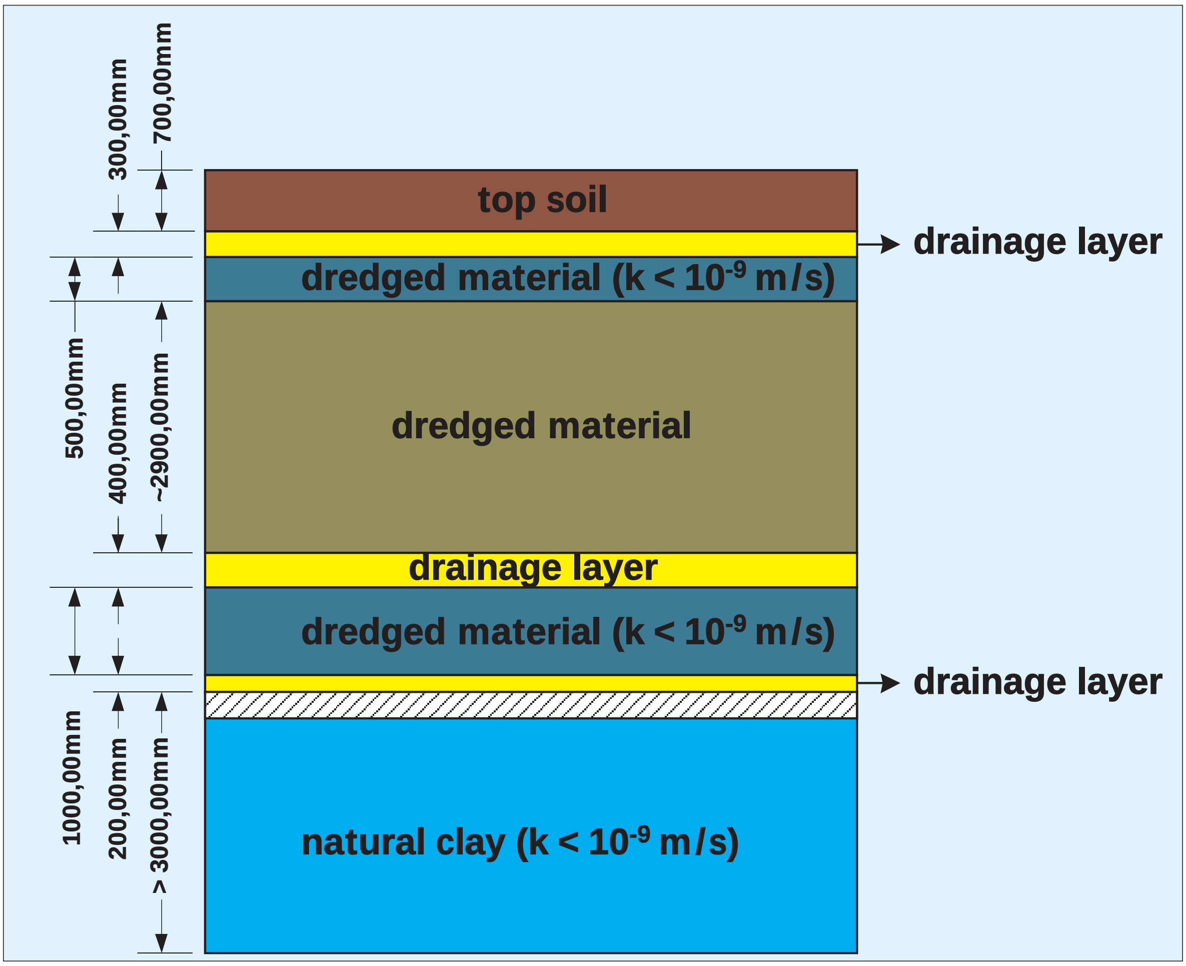

Figure 8. Structure of the dewatering fields and disposal site.

The layer functions first as a collector during the dewatering phase and evolves to the percolate drainage layer for the disposed contaminated dredged material.

At the top of the disposed dredged material again a mineral liner is installed in order to isolate the whole site. This mineral liner will consist of a layer of non-contaminated dredged material of about 50 cm thick and a permeability of maximum 10^{-9} m/s. Finally the site is completed with a draining layer of about 30 cm and a soil layer of about 70 cm.

The capacity of the disposal site is estimated to be 1.3 million cubic metres. Within the first two years (2001 and 2002) of exploitation, 450,000 m^3 of dewatered dredged material will be disposed of.

Exploitation of dewatering fields

Once the dewatering fields are installed the supply of dredged material can start. Prior to the dredging operations the physical and chemical quality of the dredged material is tested in situ. Depending on the results the dredged material is divided in several categories:

– material that can be used as mineral liner;
– contaminated material;
– material that can be used as top soil, and so on.

Depending on the category the dredged material is simply dewatered or treated to minimise the concentrations of contaminating substances.

First the dredged material is loaded in dumper trucks specially designed for the transportation of liquid material. In this way the dredged material is transported to the proper dewatering field.

In the dewatering field a continuous turning of the dredged material stimulates the evaporation and maximises the draining capacity of the bottom layer. The material is then placed in rigs. This allows the surface exposed to sun and wind to be maximised and rainfall can flow directly in the drainage layer. In a period of three to six months the dry matter content of the dredged material is brought from less than 40% (g/100 g) to over 65% (g/100 g). Figure 9 illustrates this dewatering process.

Depending on the chemical quality of the dredged material after the dewatering bioremediation and/or physical-chemical treatment of the material takes place. In order to minimise organic contaminants biodegradation is stimulated by adding proper nutrients and compost and a continuous aeration by turning the

Figure 9. Accelerated natural dewatering of dredged material.

dredged material with special turning machines. Altering the pH in the dredged material (by adding compost for example) can eliminate heavy metals and other inorganic contaminants.

All the water (process water and rainfall) collected in the drainage layer of the dewatering fields is directed to a large buffer basin. The water runs then through a water purification plant, consisting of a sand filtration and an active carbon filter. Finally the water is discharged to the Scheldt canal.

Final Destination

The final destination of the site is an industrial area for high technology oriented businesses or small- to medium-sized organizations. On top of the sanitised black-point and within a strip of about 100 metres along the Upper-Scheldt, a green belt will function as a buffer between the industrial area and the adjacent residential area on the other side of the Upper Scheldt.

According to the planning the first 10 hectares of industrial area will be sold in 2004.

Conclusion

The combined expertise of the public partners, the Province of East-Flanders and the City of Ghent, and the public partners, Domo Service Gent NV and DEC NV, offered the solution to the several problems of the different partners.

Three major problems were solved: A historical black-point with a great risk for the environment and human health is being sanitised and controlled in an economical and environmentally safe way.

Maintenance dredging operations in the Ghent region of Belgium are restarted and can continue for over 10 years.

An industrial area is being created on a very favourable location near two major highways and waterways, so the needed expansion of the industry in the Ghent region can continue without developing new sites in residential parts of the city.