Case study: This document presents one example of information to be collected from real case in order to realise LCA.

Slufter deposit description for LCA

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CEAMaS

Civil Engineering Applications for Marine Sediments

Table

Qualitative description

Location and capacity

The case study for the sludge deposit Slufter (http://www.portofrotterdam.com/nl/Over-de-haven/Haven-in-beeld/video/Pages/default.aspx?videoId=29).The Slufter is owned by Port Port of Rotterdam and exploited by Boskalis (including acceptance of sediment and maintenance). The reported capacity of the Slufter is 150 mln. m^3. This is the capacity for dredged sediment, recalculated to the capacity of the Slufter after consolidation (dewatering) of the sediment. This consolidation corrected volume is in line with the claimed capacity method for the underwater cell "Put van Cromstrijen" (see the memo from 24-11-2014).

(*) The capacity is a volume capacity based on the in-situ sediment density (1.240 kg/m^3), the actual deposit volume is 82 mln. m^3. The difference is due to consolidation, assuming a consolidated density of 1,850 kg/m^3 with a mineral density of 2,350 kg/m^3. Therefore, the consolidated solid weight per m3 is 1,480 kg/m3, **well above the 1 ton sediment (dry weight)/m3**.

The location is mainly used for the environmental and capital dredging for Port of Rotterdam, but since all historic urgent sites have been dredged in the years 1986 - (+/-) 2005, the current yearly amount of sediment stored in the Slufter declined from 20% to less than 1% of the total dredged material for the port (**).

(**) The total yearly dredged amount of sediment for the port is 20 mln m^3. Therefore the amount of sediment from the port going to the Slufter has declined from 4 mln. m^3 a year (average for 1986 – 2005) to <0,2 mln. m^3 a year (average for 2008 – 2014).

Origin of material

The Slufter is designed to store the sediment of Port of Rotterdam. The length of the harbour (from the Slufter at the Maasvlakte to the Erasmus bridge) is 40 km. Most contaminants are present in the older, inner city harbours, which are at 40 km of the Slufter (***).

(***) While there are no docks, the harbour length translates into a salinity gradient, with marine water coming +/- 20 km into the harbour. The harbours with most contaminants are in the brackish/fresh water part of the harbour and contain almost no material from marine origin (only river sediments).

In the initial filling phase the quality of the sediments accepted in the Slufter was bound by strict legislation. Now that the Slufter is filled with >25 m of sediment, the deposit is well isolation towards groundwater (and return water is monitored). This translates to less sediment quality restrictions on the remaining capacity (+/- 33%). In practise all sediments which do not have an oil phase are accepted.

Distance to location

On average the transport of the sediment:

- Most sediment (+/- 90%) is transported by ship. Due to the fact that most contaminated are in the inner city harbours, most dredging will be done with a "beun" ship (average 1.500 tonnes)
  - A small fraction (+/- 10%) is transported by truck. This will be mainly small waterways and some top soils from the harbour area; we assume the same distance from the Slufter.
- Will be dredged **40 km** from the deposit.
- Will be dredged with a hydraulic crane (small volumes, high accuracy (cm's), minimal spill, undiluted), with some hoppers for the bulk. On average the density of the dredged material is **1.240 kg/m³**.
- Unloading is done with a **barge-unloading suction dredger & hydraulic pumping** from the unloading site, Loswalkade/Hartelhaven. The distance of the unloading site to the Slufter is **2 km**
- The Slufter is 200 ha in surface area, adding a pipe length of **1 km** for the disposal inside the deposit.

Figure 1 Slufter (right of the wind mills) with desanding basins on the left of the mills (no longer used). Unloading is in the bend of the harbour (Hartelhaven), 2 km from the Slufter.

Figure 2 View from the unloading point (Hartelhaven) towards the Slufter.

Cost for the Slufter

Construction

The cost during construction (1986-1987) is not published. The Slufter is part of the Landfill location "Maasvlakte 1". Due to the need to use sand for the landfill, the Slufter has been used as a sand quarry during construction. Also for the construction of the dikes (sea dikes) for the Slufter, sand was needed.

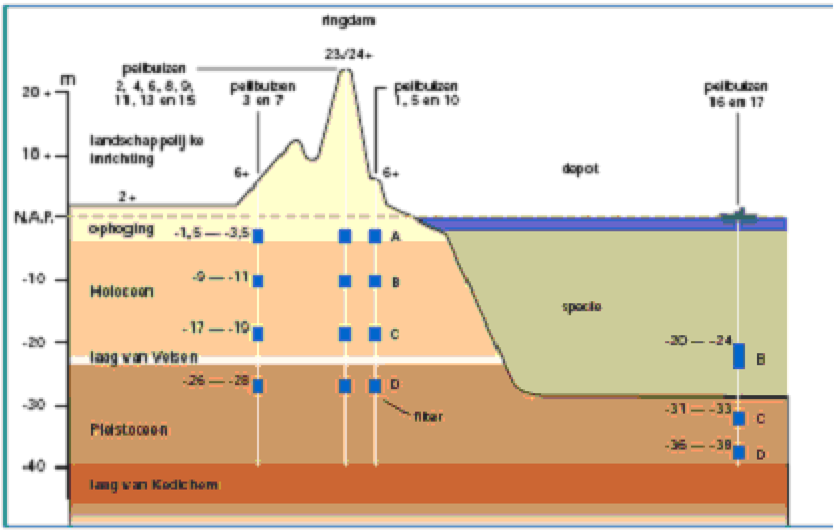

Figure 3 Slufter subsurface: Holocene is a sandy aquifer

A direct costing is therefore hard to make due to the benefits for the overall construction of the Maasvlakte. Doubling the cost for a deposit with $^{1}/_{3}{}^{th}$ of the volume (IJsseloog), the initial construction cost will be +/- 100 mln. euro in 1986, translating into **170 mln. euro (+)** at the price level in 2014 (with a 3% interest rate).

(+) Tweede Kamer der Staten-Generaal , Nr 144 – 2009/2010 - 27 625 : Total investments on all state owned deposits with a remaining capacity of 55 mln m3 is 237 mln. euro (price index 2009). 170 mln. direct initial cost for a deposit of 150 mln. m3 therefore seems to be on the low site.

The cost (1.13 euro/ton) consists of:

- Excavation of the site (including sand mining)
- Construction of dikes, including use of rubble-mound (dike protection sea site)
- Piping and pumps
- Monitoring network

Yearly operational cost

The cost are not published, but the state (Tweede Kamer der Staten-Generaal , Nr 144 – 2009/2010 - 27 625) published an average cost covering rate of 11,43 euro per m3 in situ sediment, excluding VAT. Including VAT, based on the price level 2014, and subtracting the investment cost, this would translate to **14.8 euro/m3** (in situ density, 1,240 kg/m3 or 418 kg dry sediment weight per m3) for operation cost. This cost includes the cost for pumping, replacement of pipes, maintenance and monitoring.

The **on-site electrical energy cost** within this operational cost for pumping (electric pumps) for a comparable deposit (IJsseloog) are 19% of the total exploitation cost per year. Based on an energy price of 0.12 euro/kW, this translates into **4.700 MW** for the current filling scenario (200.000 m3 a year).

For the LCA, please notice that the current windmill capacity for the dike of the Slufter is 25.5 MW (0,5% of the energy total use). Since the wind capacity is low compared with the total energy cost, I would advise a Dutch average energy mix for the depot.

Fuel consumption (diesel)

- See the aquatic cell report; most transport will be by ship.
- The average distance of 40 km is double the distance for Put van Cromstrijen, the calculation has been corrected for the distance
- The dumping is now replaced by the pumping from the unloading site. This has been left out (no diesel consumption).

Table 1 Overview of fuel consumption (litre) dredging, and transport for deposit “De Slufter”

	dredging (litre/ton dry weight)	transport per km	40 km	dumping (litre/ton dry weight)	Total fuel (litre/ton dry weight)
Fuel cost	0.24	0.0040	0.159	0.0000	0.40
contribution (%)	61%		39%	0%	

Step by step input

1) Preparation work for creating the deposit:
    a. € 170 mln initial cost
2) Dredging, transport by ship (see distance to location) and unloading:
    a. Average distance from sediment site to deposit is 40 km
    b. Total fuel consumption: 0.40 litre/ton dry weight
3) Transport (terrestrial): +/- 10% (not considered separately)
4) Work on site:
    a. Yearly energy use 4,700 MW for 200,000 m3 sediment (418 kg dry sed./m3)
    b. In total: 3 km of pipes
5) Maintenance:
    a. Wear on pumps and pipes
    b. yearly survey with side scan sonar
    c. monitoring of turbidity (automated sensor)
    d. groundwater monitoring (divers and water quality samples)
6) Close down scenario:capping with 1 meter of ‘living layer’.
7) Land use before: none (sea)
8) Land use after filling: Undecided
    a. Scenario 1: nature conservation area,
        i. No additional income
    b. Scenario 2, use as industrial site, commercial value 5 euro/(m2.year)
        i. Potential lease of 10 mln. euro/year

In short

The deposit The Slufter is an active managed location with a current (2014) capacity for 50 mln. m^3 sediment. The sediment comes from an average distance of 40 km. Sediment quality parameters are hardly relevant, there is no direct exposure to organisms, leakage ground and surface water is controlled. After filling and capping the reuse is either a nature conservation area or an industrial area.

The relative cost for The Slufter compared to other solutions is given in Table 2.

Table 2 Cost comparison of sediment treatment (top) and sediment storage sites (bottom)

Verwerkingstechniek	Zandig	Matig zandig	Kleiïg	Venig
Verspreiden op land	€ 0,-	€ 0,-	€ 0,-	€ 0,-
Op de kant zetten	€ 0,-	€ 0,-	€ 0,-	€ 0,-
Verspreiden in zout water	€ 0,-	€ 0,-	€ 0,-	€ 0,-
Verspreiden in zoet water	€ 0,-	€ 0,-	€ 0,-	€ 0,-
Direct toepassen in werk	€ 3,63	€ 3,63	€ 3,63	€ 3,63
Rijpen	€ 13,07	€ 19,64	€ 34,11	n.v.t.
Landfarmen	€ 18,99	€ 28,52	€ 49,55	n.v.t.
Sedimentatiebekken / nat storten slib	€ 13,38	€ 18,53	n.v.t.	n.v.t.
Sedimentatiebekken / droog storten slib	€ 23,31	€ 42,96	n.v.t.	n.v.t.
Sed.bekken/hydrocycl. / nat storten slib	€ 23,72	€ 35,27	n.v.t.	n.v.t.
Hydrocyclonage / droog storten slib	€ 25,81	€ 46,75	n.v.t.	n.v.t.
Koude immobilisatie	€ 34,06	€ 51,70	€ 63,50	n.v.t.
Omrekeningsfactor tds/m3 ex situ	1	0,7	0,4	0,3

Bron: MKBA Waterbodems.

Het verspreiden van baggerspecie en het direct toepassen is uiteraard het goedkoopst omdat hier nauwelijks verwerkingskosten worden gemaakt. Het eenvoudig verwerken (rijpen, landfarmen en zandscheiden door sedimentatie) en nat storten van baggerspecie zitten qua verwerkingskosten in de middenmoot. Zandscheiden door hydrocyclonage, ontwateren en immobilisatie gemiddeld genomen de duurste bestemmingen.

De tarieven voor reguliere stortplaatsen liggen tussen de € 30 en 60 per ton droge stof (exclusief BTW). Voor de natte stort is in het MKBA uitgegaan van de volgende storttarieven.

Depot	Mm3 restcapaciteit per 01/01/2005	Kosten per m3 ex situ (€)
Slufter	93,3	8,30
Hollandsch Diep	10	13,61
Seaport Groningen	1,5	22,69
Averijhaven	1,9	13,61
Drempt	0,72	24,50
IJsseloog	22,8	13,61
Cromstrijen	11	6,81
Amerikahaven	12	12,60
Kwaliwaal	4	20,42

Bron: MKBA Waterbodems.

CEAMaS brings together eight partners from Belgium, France, Ireland and the Netherlands in order to develop knowledge and consensus to raise new solutions for reuse of marine sediments applicable to all of Europe. The project aims to promote the beneficial re-use of marine sediments in civil engineering applications, in a sustainable, economical and socially acceptable manner. The partnership expertise covers civil engineering, geosciences, coastal and maritime engineering, dredging and sediment management, geography, sustainable construction and environmental monitoring.

www.ceamas.eu

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Investing in Opportunities

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