CONFIDENTIAL

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SUSTAINABLE PROCESSING AND DISPOSAL OF PEATY SEDIMENTS

REQUIREMENTS ASSESSMENT

Headquarters

Hogenakkerhoekstraat 21
9150 Kruibeke – België
DV.A214075

Tel: +32 (0)3 250 19 00
Fax: +32 (0)3 254 10 08
www.verhaert.com
info@verhaert.com

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ABBREVIATION	FULL	DESCRIPTION
N/A		

1 REQUIREMENTS ASSESSMENT

1.1 STAKEHOLDERS' OBJECTIVES WITHIN THE PROJECT

1.1.1 FLEMISH DEPARTMENT OF MOBILITY AND PUBLIC WORKS, MARITIME ACCESS AND SOIL BALANCE DIVISION

Maritime Access (aMT) ensures the Scheldt is always smoothly navigable through maintenance dredging, the widening of the navigation channel, wreck storage and silt treatment from the coast to beyond Antwerp. Secondly, Maritime Access maintains the roads and land owned by the Flemish Region in the port areas. As a third important task, aMT builds and renovates the infrastructure that keeps the ports accessible to shipping, such as locks. It also subsidises other infrastructure in the port, such as the construction of docks or quay walls.

Within the latter core task, the collaboration between aMT and Port of Antwerp-Bruges (POAB) fits within the Complex Project Extra Container Capacity Antwerp (CP ECA). Container handling in the Antwerp port area records high figures year after year. To cope with the expected growth in container traffic until 2030, the Flemish government wants to provide additional container handling capacity in the Antwerp port area. This complex project includes the construction of a new dock, the Second Tidal Dock ('Tweedegetijdendock'). The construction of this new dock entails a major earthmoving operation and optimisation of the soil balance is quite a challenge.

1.1.2 PORT OF ANTWERP-BRUGES

With a total throughput of 289 million tonnes per year, POAB is a major hub in global trade and industry. The port is a crucial link for container handling, general cargo traffic and vehicle transfer. POAB is the home base to 1,400 companies and houses the largest integrated chemical cluster in Europe. The port provides, directly and indirectly, a total of 164,000 jobs and added value of EUR 21 billion.

POAB has a clear ambition: to become the first world port that reconciles economy, people and climate. The port not only wants to continue its growth trajectory sustainably, but also to use its unique position as a logistics, maritime and industrial platform to take the lead in the transition to a circular and low-carbon economy. Together with the port community, customers and other partners, POAB will actively seek innovative solutions for a sustainable future.

The construction of the Second Tidal Dock is part of a bigger picture where additional container capacity will be created in the Antwerp port area. As mentioned earlier, the construction of the dock will involve the release of large quantities of sediments, including peaty material. AMT and POAB are working closely together to work out the soil balance of this project in a sustainable way.

1.2 REQUIREMENTS ASSESSMENT

1.2.1 CHALLENGES AND PROBLEM DEFINITION

The expansion of the port of Antwerp requires the excavation of 35 million m³ of dredging, of which about 6 million m³ consist of clay and peat in the soil layers. Of these 6 million m³, there is an estimated 2.5 million m³ of peaty sediment. Especially for the peaty portion, aMT and POAB face the challenge of processing and/or storing it without oxidising the stored carbon. In addition, it is also important that the intended operation itself minimises CO_2 emissions and can be done as cost-efficiently as possible.

1.2.2 PROCESS STEPS AND NEEDS

1.2.2.1 DESCRIPTION OF THE BASIC PROCESS

The basic process of sediment processing can be categorised into two different phases, each with its components, namely a preparation phase and an elaboration phase. In the preparation phase, all research elements are provided that are necessary to properly carry out the works in the elaboration phase. In the preparation phase, we distinguish two parts, namely the **soil analysis** in which the characteristics of the sediment are mapped and the determination of the **excavation and processing techniques**. In the elaboration phase, we distinguish three components. The first part is the actual excavation and possible pre-processing. The second component is the transport of the dredging. The third and last part is the application at the final destination and post-processing. These phases are illustrated visually below:

PREPARATION PHASE

1. Soil analysis
2. Determination of the excavation and processing techniques

ELABORATION PHASE

1. Excavation and possible pre-processing
2. Transport
3. Application to final destination and post-processing

Different needs can be identified for each process step. These needs are discussed in more detail below.

1.2.2.2 PREPARATION PHASE

1.2.2.2.1. SOIL ANALYSIS

In the soil analysis phase, the main aim is to build up knowledge around the sediment through soil analyses and to properly characterise it. It is very important to have a good understanding of the characteristics of the sediment, at different locations and depths of the working zone. Among other things, we want to find out through sampling how fast the peat will oxidise when excavated, how it will behave under water, how many silt particles the peat consists of, etc. Based on this information, an estimate is made of the soil type (peat, clay, sandy ...), the volume of the package and the thickness of each layer in preparation for further works. The table below identifies the needs for these soil analyses and links them to a rationale or soil idea.

Need	Rationale
Determination of the properties of the sediment	Through sampling, we mainly want to investigate the properties of the sediment that are necessary for the elaboration of a possible solution. Characteristics may include oxidation rate, behaviour under water, percentage of peat, clay, sand, volume of the package, thickness of the layer, etc.
Amount of samples	How many samples must be taken to determine the necessary properties of the sediment? In what way should these samples be taken? The cost-benefit must be weighed up, as taking and analysing samples also involves a cost and lead time.

1.2.2.2.2. Determination of excavation techniques

As part of the implementation planning, it will be necessary to determine which techniques will be required during the excavation of the peaty sediment. It is expected that the technology selected will be site- and soil type-dependent. Besides the choice of excavation technique (e.g. mechanical or hydraulic dredging), any pre- and post-processing of the peaty sediment should also be considered to minimise oxidation of the carbon stored in the peaty sediment.

Need	Rationale
Activation speed of the technology	The selected technique must be ready to be operational by the time it is needed.
Reliability	The technology must be able to withstand the environmental conditions (e.g. excavation under water, etc.) and guarantee continuity.
Suitability for the volume	The chosen technique should be consistent with the intended processing speed. The maximum speed is limited by: • Pace of other operations • Availability of transport

Suitability for the environment	Depending on the depth of the excavation zone, whether it is below or above the water level and the immediate surroundings of the zone, certain techniques will be preferred (mechanical versus hydraulic ...)
Alignment of excavation and processing techniques	The destination of the excavated sediments will impose constraints on the excavation technique. For example, hydraulic dredging will result in a higher water volume, which has a negative impact on transport (higher total volume) but possibly a positive effect on the oxidation rate (the dredged material remains in an oxygen-poor environment).
Impact of possible contaminants	Any contamination could limit the possible final destination of the material in question. It is therefore important to identify the extent of contamination.
Alignment with general planning and requirements of other stakeholders	The above needs should be in line with the requirements of overall project planning.
Availability of technique data	Information on positive (processing speed, low cost...) and negative (emissions, low reliability...) characteristics of the chosen technology must be available to correctly make the choice of process/technology type.

1.2.2.3 ELABORATION PHASE

1.2.2.3.1. Excavation and possible pre-processing

Using the techniques determined in the previous step, excavation of the project will take place according to the implementation schedule. In addition to excavation, there may also be pre-processing of the dredged material, for example to minimise emissions or the amount of water present in the excavated volume.

Need	Rationale
Processing speed	The excavation and pre-processing rate should be in line with the overall project schedule. **Figure 1** shows a preliminary order of magnitude estimate of the quantity of peat per quarter.
Minimisation of (CO2 and methane) emissions	To be in line with the European Effort Sharing Regulation guidelines, greenhouse gas emissions must be minimised. This involves both emissions from oxidation of the peat, and emissions associated with the processes and techniques used.
Compatibility while maintaining composition	The technique must be capable of handling the sediment in question, which can occur in varying degrees of 'purity' (pure peat versus mixture of peat and other soil types) and consistency (watery, soft material versus drier material)
Minimisation of costs	The selected technique should provide a cost-effective solution. One yardstick that can be used here is the cost of storage at a landfill for mono depot, for which 40 €/m³ should be charged, excluding excavation or dredging.

A possible scenario of the course of the excavations was drawn up by Tractebel (P016898_2GD_RAP-A-2005) with the starting point being to aim for maximum reuse of materials in the project area. The excavation, storage and replenishment of the various materials was mapped in a soil balance (P016898_2GD_RAP-G-2303). The graph below is a representation of the volume of peaty sediments released during the construction of the Second Tidal Dock and to be stored or processed (Note: it assumes expansion versus the excavated volume as indicated in Tractebel's calculations). As project phases were expressed in periods of 6, 9, 12 or 18 months, the graph is visualised per quarter, assuming that the volume is released evenly throughout the phase of operation.

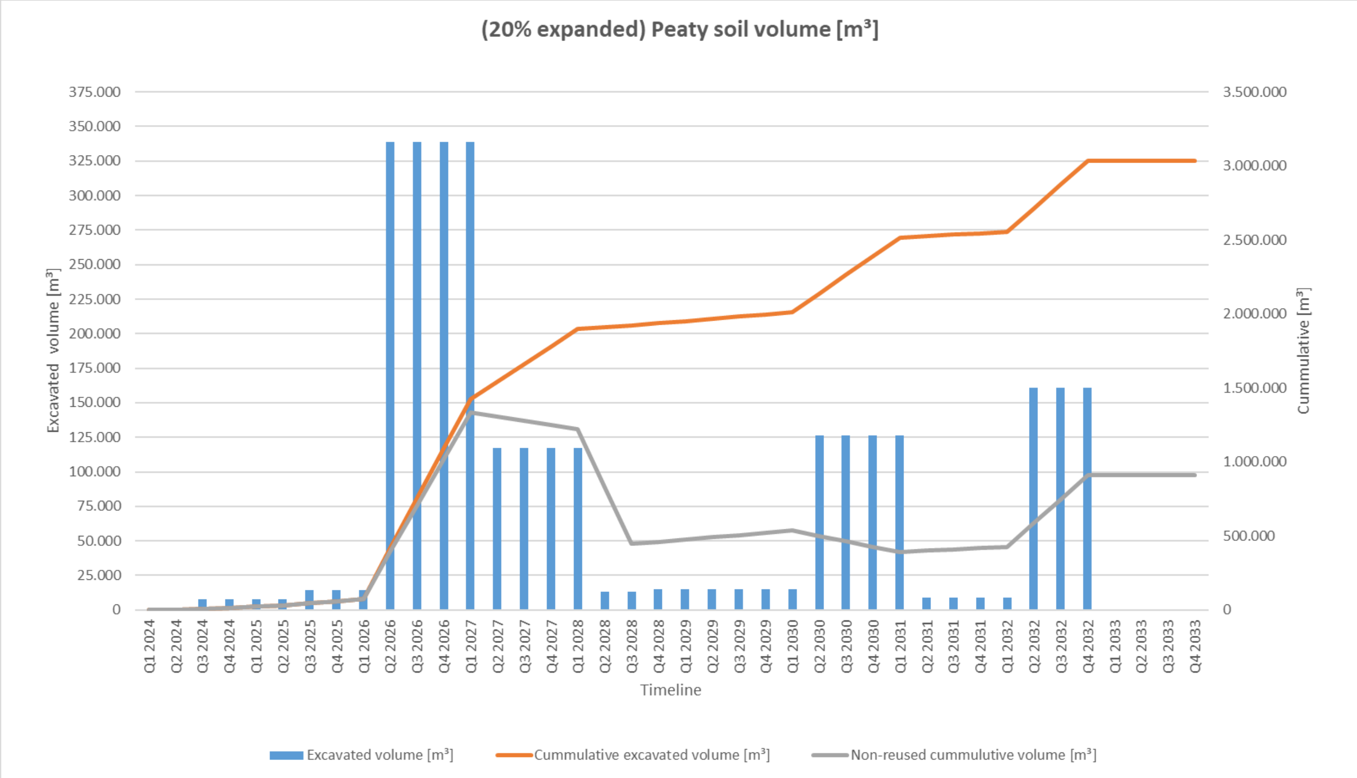

Figure 1

1.2.2.3.2. Transport

The volume of peaty sediments that cannot be reused on site will have to be transported. This transport involves a cost and an amount of (greenhouse) gas emissions and is also limited by practical aspects: for example, the use of trucks must be limited given the burden on the road network, and ship transport is only possible to locations where the waterways allow it..

Neede	Rationale
Minimisation of costs	The selected method of transportation should ensure a cost-effective solution. This is impacted by: • Type of transport (truck versus train versus ship) • Total volume (amount of soil that cannot be reused, amount of water present in the sediment) • Total distance
Minimasation of emissions	To be in line with the European Effort Sharing Regulation guidelines, greenhouse gas emissions must be minimised. This is impacted by: • Type of transport (truck versus train versus ship) • Total volume (amount of soil that cannot be reused, amount of water present in the sediment) • Total distance
Volume suitability	The chosen type of transport must be capable of carrying the volumes of peaty soil according to the rate of processing.
Availability and reliability	Transport must be available throughout the period of the works.
Minimisation of pressure on road and water networks	The selection of transport method must take into account the impact on the pressure on the road and/or water network.

1.2.2.3.3. Application to final destination and post-processing

The remaining volume of peat will have to be processed and/or stored. There are several options for this, see also the **identified solutions**, each with their own boundary conditions.

Need	Rationale
Kosten minimaliseren	Processing and/or stocking should be as cost-efficient as possible.
Minimisation of (CO2 and methane) emissions	To be in line with the European Effort Sharing Regulation guidelines, greenhouse gas emissions must be minimised. This involves both emissions from oxidation of the peat, and emissions associated with the processes and techniques used.
Suitability of volume	The final destination(s) must be able to process and/or store the total volume of peat
Purity of emissions (pure CO2 versus methane, ...)	Depending on the final destination, the purity of the emissions will be important. This is particularly applicable when the emissions would be captured for further use.

2 IDENTIFIED SOLUTIONS

This project is the first of its kind that will seek to avoid emissions from oxidation of carbon stored in peaty soil. It will therefore be a flagship project for large public yards.

The market consultation will present **three different solution approaches** that were investigated during the first phase of this PIO project. These include solutions that seek to avoid oxidation, solutions that allow peat to oxidise under controlled conditions and solutions that process the peaty soil into or into another material. The market consultation will gauge the feasibility of the various realisation scenarios, the innovative nature of the priority functionalities, preconditions, risks and a rough estimate of the development costs of the solution directions. The market consultation will be via an online survey and an online conference due to its international nature. An overview of the three solution directions is given below.

2.1 SOLUTION DIRECTION 1: AVOID OXIDATION

- Storage below groundwater level
    - Replenishment of natural areas
    - 'Deep earth sequestration'
    - Carbon farming (incorporation into soil by farmers)
- Slow down oxidation (clay-peat complex…)
- Avoid degradation fo phenols (pH…)
- Covering layer of driving slabs, clay or other material to limit contact surface with air

2.2 SOLUTION DIRECTION 2: CONTROLLED OXIDATION

- Accelerated oxidation and on-site emission capturing
    - Sulphate als accelerator
    - Pumping air through the soil
    - Spreading open to increase contact with air
- Oxidation and capturing of emissions at final destination
- Minimisation of methane emissions in favour of CO_2

2.3 SOLUTION DIRECTION 3: PROCESSING IN OR INTO OTHER MATERIAL

- Bacterial action to chance peat properties so they can be used for other applications.
- Processing into BioChar
- Hydro thermal carbonisation into soil improver.