PROCESSING CONTAMINATED SEDIMENT FROM THE MIAMI RIVER

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ABSTRACT

In the period from June 1 to October 20, 2005, a Mobile Soil Washing Plant was used to process a total of 135,000 situ m^3 (250,000 tonnes) contaminated sediment from the Miami River. After separating the material into coarse and fine gravel, sand and filter cake, approximately 75% was suitable for beneficial use. The average plant capacity was calculated at 1.512 m^3 per day, 15% above the guaranteed production capacity. Converted to mass, the top weekly production was as high as 24,000 tonnes, giving an average of approximately 150 tonnes per hour.

Keywords: Soil washing, beneficial use, sediment processing.

INTRODUCTION

Early in 2005, Boskalis Dolman was awarded a contract for the processing and dewatering of dredged sediments from the Miami River, Florida, USA. The Joint Venture Weston-Bean had won the main contract from the US Army Corps of Engineers (Jacksonville District), aiming at deepening the Miami River back to its original depth. The relatively narrow and crowded waterway had never been dredged since the deepening of the river to 15 ft in 1934. The sediments were contaminated with heavy metals, pesticides, sewage and petroleum products and unsuitable for ocean disposal. Apart from the chemical contamination, a lot of debris was to be expected.

Boskalis Dolman's assignment involved the processing of an expected total of 550,000 m^3 of contaminated sediment from a stretch of the Miami River from Biscayne Bay up to NW 36th Street, about 8,9 kilometers upstream. Boskalis Dolman was involved from the pre-tender phase and followed its proven Integrated Project Approach on Waterbed Remediation. This approach focuses on overall cost reduction by optimizing the combined dredging, processing and disposal operations and by finding beneficial use for the dredged sediments

TREATABILITY STUDY AND PLANT DESIGN

Relevant to the Integrated Project Approach is a thorough understanding of the physical and chemical properties of the sediment as well as of the sediment behavior during the several possible dredging and processing options. Furthermore it is necessary to develop insight into the variations of the sediment characteristics over the length of the river and over the thickness of the sediment layer to be removed.

Boskalis Dolman specialists studied various treatment options and its Environmental and Geotechnical Laboratory conducted two sediment sampling campaigns and several Treatability Studies. Early testing showed a high sand content and very good dewatering characteristics and proved that recovered and washed sand, gravel and rock would meet the standards for beneficial use. Based on this information, two potential treatment options were selected: Mechanical Dewatering after Sand Separation and Stabilization/Solidification.

Biggest advantage of Mechanical Dewatering after Sand separation appeared to be the relatively high volume of reusable material and the large reduction in disposal volume and costs. At the same time, the technology is relatively robust and, if well designed, not very sensitive to changes in sediment water content.

The first sampling campaign was necessary to develop sufficient insight into the changing sediment characteristics over the full stretch of the Miami River. A total of 21 borings was used and 25 samples were analyzed. The gathered information was, together with the information available in the public tender documents, used to develop a Digital

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Terrain Model. A second sampling campaign was performed to fill in remaining gaps in the available information and to further detail the chosen project approach.

Table 1. Variations in sediment characteristics over the Miami River.

Borehole number	Dry matter content	Organic matter content	Fraction < 63 micron
1	44%	10.7%	64.6%
5	58%	5.1%	29.3%
9	63%	6.6%	23.4%
12	42%	11.3%	63.4%
19	62%	2.5%	12.4%
21	72%	5.4%	18.7%

To enable the design team to describe and model the sediment characteristics for each section of the Miami River, 4 main sediment types were defined based on differentiations in especially dry matter content and percentage of fines (fraction < 63 micron). All sediment information was grouped and the characteristics of the 4 different sediment types were calculated as averages of the per sediment type available numbers.

Table 2. Defined Sediment types.

Sediment type	1	2	3	4
Fines (< 63 micron)	13,6%	32,8%	49,1%	67,2%
Dry matter content	70%	58%	50%	43%
Organic matter content	3,5%	6,5%	8,5%	10,5%
Density (tonnes per m^3)	1,77	1,54	1,41	1,33

Per river section, a detailed description was made of the expected volumes per different type of sediment. Expected daily volumes were detailed and the expected production of debris, sand and residue was calculated per section, based on using a Sand Separation and Dewatering Plant. This to get detailed insight into the necessary dredging and processing capacity as well as in the production of the different output materials (sand and filter cake) per river section.

Table 3. Expected variations in dredge capacities and productions.

Dredging capacity	950 – 1,500	m^3 per day
Plant Load	1,300 – 2,700	tonnes per day
Debris production	350 – 900	tonnes per day
Sand production	250 – 1,400	tonnes per day
Residue production	650 – 1,200	tonnes per day

At the end of the described pre-investigation phase, the necessary capacity for a Separation and Dewatering Plant was defined at 9,200 m^3 per week or 1,300 m^3 per day (working 24/7), taking into account a daily maximum of 1,500 m^3.Maximal Plant design load was set at 2,700 tonnes sediment per day. The Desanding Unit design load was set at 1,400 tonnes dry solid per day. The Dewatering Unit design load was set at 575 tonnes dry solids per day.

SEDIMENT PROCESSING

To comply with the above design characteristics, Boskalis Dolman decided to mobilize its newest Mobile Soil Washing Plant (MSWP) from Europe to Miami for installation on a designated project site alongside the Miami River.

The MSWP is a Boskalis Dolman in-house development, based on extensive experience with soil washing technology. First drawings for the plant were made as a direct result of the Miami River project tender procedure

and demands, as a high processing capacity was foreseen and the plant would have to be installed in a relatively short time frame.

For the MSWP, standardized 20ft and 40ft container modules are used, to facilitate quick and easy transport and installation. By incorporating the latest technical developments, the use of fuel and additives is minimized and plant uptime and efficiency is optimized. The MSWP design is extremely robust and the capacity of the plant is much higher than comparable mobile plants and even than most fixed soil washing plants.

As the Miami River project got delayed in early 2004, the decision to actually build the MSWP was made for use on several soil and sediment remediation projects in Europe. A first project was started in September 2004 and dealt with approximately 100,000 tonnes contaminated soil at a jobsite near the city of Alkmaar in The Netherlands. At the moment the Miami River Sediment Processing contract was awarded to Boskalis Dolman, the MSWP was processing contaminated sediment at a jobsite near Plymouth in the United Kingdom.

Figure 1. MSWP at Miami River project site.

It was mobilized from there to Port Everglades, Florida, on board of a chartered vessel. Meanwhile, the MSWP was partially modified for its new task: the processing capacity was further increased, an option that was foreseen and prepared during MSWP development in 2004. This is to comply with the necessary capacity of 9,200 m^3 of sediments per week. The complete mobilization operation of this unique plant included transportation of several newly-built components by sea from the Port of Rotterdam and even by air, using an Antonov cargo carrier. In total, 38 container units were mobilized to Miami.

During mobilization of the plant, the project site was prepared by the installation of concrete foundations for placing an offloading excavator and a settlement tank. A water tight asphalt floor with a one foot high bund wall and sewer pits was installed, to cope with leakage, spillages, cleaning water and possible contaminated rain water. Conform normal procedure, all water collected in the sewer pits is pumped into the processing plant and treated before discharge.

In the sediment treatment process, the MSWP combines fraction separation via a stationary grizzly screen, a rotating sieve drum, a vibrating screen, hydrocyclones and a counter current washer. The separated materials (debris, rock and sand) are stockpiled using conveyor belts. Subsequently, the separated fine materials are mechanically

dewatered through a pre-thickener tank and a series of up to 4 belt filter presses. Polymers are added at two locations in the process for optimum dewatering, in very precise doses, based on flow and density measurements. The MSWP is equipped with a fully automated PLC control system, to monitor and control all levels and flows, while technical support can be arranged by telemetry if necessary.

The plant is operated by two specialist operators and a loader operator. During daytime, extra personnel is used for housekeeping activities. Plant design is based on minimal contact risk of the workes with the contaminated sediments, using automized systems and CCTV where possible. For all personnel and visitors, sufficient safety clothing is available, including boots, cover-alls and gloves.

PLANT PRODUCTIONS AND OUTPUT

On 1 June 2005 the MSWP started processing Miami River sediments, fed from barges by an offloading excavator. It was the start of phase 1 of this challenging project: During a period of 142 days, material was processed from the first six of a total of fifteen distinguished dredge areas.

The production had to be suspended several times, amongst other things due to the hurricanes Katrina, Rita and Wilma. Downtime was also caused by a blocked bridge and due to necessary dredge repair works. During approximately 37.5% of the 142 day period (equivalent to 53 days), sediment processing was not feasible due to downtime that was not caused by the MSWP. The remaining MSWP operating time was therefore limited to 89 days.

Problems with the MSWP loader excavator, blockage of the rotating sieve drum and general plant maintenance and repair resulted in 11% downtime of the available processing time (equivalent to 10 days). The resulting net uptime for both the dredging and processing was 55.6%, equivalent to 79 days (or 1,896 production hrs).

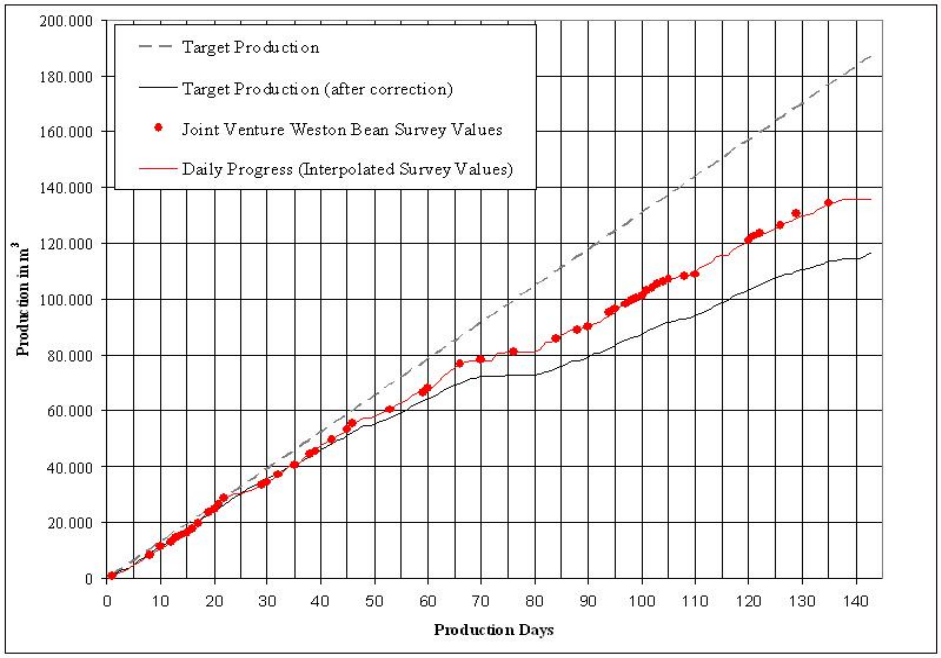

Figure 2. Progress chart.

A total of 135,000 situ m^3 (176,000 situ cubic yard; 250,000 tonnes) was dredged and processed into approximately 66,000 tonnes coarse and fine gravel, 135,000 tonnes sand and 62,000 tonnes filter cake. The soil washing

technology used proved to be an adequate treatment approach, as all sand and gravel, together representing 75% of the plant output, appeared to be clean and could be beneficially used at little to no cost to the project.

The filter cake was mechanically de-watered up to a 54% dry solid content. Dewatering productions ranged from 10 to 26 tonnes dry solid per hour and could easily be handled using the available 3 belt filter presses. This relatively highly contaminated material was trucked to a nearby confined disposal facility.

Overall, the average production is calculated at 950 m^3 per day, well below the project target of 1,300 m^3 per day. However, when taking into account the net available MSWP production time, a production of 1,500 m^3 per day is calculated, 15% above the target production.

Table 4. Produced output materials.

Product	Size	Mass Balance	Remark
Coarse screened fraction	+ 20 mm	19%	Rock, gravel and trash
Fine screened fraction	3 mm – 20 mm	5%	Gravel
Sand	63 micron – 3 mm	52%	
Filter Cake	< 63 micron	24%	Up to 54% dry solids

Maximal productions were established in the 3rd and 16th week of production: 12,400 m^3 (16,200 cubic yard) and 12,700 m^3 (16,600 cubic yard) respectively, approximately 35% above target. Converted to mass, the production over these two weeks was as high as 24,000 metric tonnes, giving an average of approximately 150 tonnes per hour.

CONCLUSIONS

A thorough pre-investigation to define the expected sediment characteristics resulted into a sand separation and dewatering plant design capable of handling large variations in sand and residue content. The Mobile Soil Washing Plant used on the job was adapted to cope with the defined variations and its high uptime resulted into a maximum weekly capacity of approximately 12,500 m^3 per week, 35% above design load. The sand separation approach resulted into a high disposal mass reduction: only 25% of the products from the processing plant were to be disposed.

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