ABSTRACT

Located in an urbanised industrial setting in Miami, Florida, USA, the Miami River had not been dredged in 70 years, since its construction in 1934. In 2004 the US Army Corps of Engineers awarded a maintenance contract to the Joint Venture of Weston Solutions / Bean Environmental to execute the dredging, transportation, and processing of approximately 721,000 cubic yards of contaminated materials from a 5.5 mile long shipping channel in the river. To deal with the range of material types and significant debris encountered over this relatively narrow and crowded waterway, the latest generation of equipment for dredging, sediment processing and de-watering was implemented. This included a newly designed and built precision backhoe dredger Barredor del Rio. In addition, Boskalis Dolman, a subsidiary of Bean’s partner Stuyvesant, built and operated a “portable” sediment processing system, the Mobile Soil Washing Plant (MSWP), alongside the Miami River. The processing of the sediment with this on-site installation reduced the amounts of contaminated sediment to be disposed, provided clean sand for beneficial reuse, and significantly lessened the cost of the operation.

INTRODUCTION

The Miami River corridor was home to early Native American settlements, and in the early 1900s it was dredged in order to assist in draining the Everglades, the subtropical marshland in southern Florida. As the city of Miami developed, the river became a major outlet for storm water and untreated sewage. With the US Army Corps of Engineers (USACE) deepening of the river to 15 feet in 1934, the river became the fourth largest port area in the United States with US$ 4M in trade annually. During World War II, the port became a manufacturing center for the Navy’s PT Boats in WWII.

In 1990 the USACE recommended that maintenance dredging be done to remove sediments impacting navigation. Impacted sediments from storm water run-off from 69 square miles of urban and industrialised areas complicated and delayed this recommended maintenance dredging. The sediments were contaminated with heavy metals, pesticides, sewage and petroleum products which were clearly unsuitable for ocean disposal. In 1998 the Miami River Commission (MRC) was established and charged with focusing on areas including dredging, greenways, the redevelopment of areas adjoining the river and storm-water retrofitting. The MRC also targeted the contaminated sediments degrading the mouth of the Miami River which flows into Biscayne Bay. Soon after a Dredging Work Group was established as a Sub-Committee to MRC and they negotiated a plan which shared the financial responsibility for the project dividing it into 80% for the Federal government and 20% non-Federal costs.

PROJECT OVERVIEW

The aim of the Miami River project was to restore the navigation channel to a depth of 15 ft. This involved the removal of a total of about 750,000 cubic yards of contaminated sediments. The approach decided upon was to transport the dredged contaminated sediment to an interim disposal and processing area. At the processing area the contaminated sediment would be separated, washed and dewatered, creating a high percentage of clean sand. Thereafter the clean sand and residue would be transported to a

Above, Figure 1. The site of the Miami River Project with the sediment processing plant on the left.
permanent disposal area in a legal and responsible manner (Figure 1).

In 2004 the US Army Corps of Engineers awarded a maintenance contract to the Joint Venture of Weston Solutions / Bean Environmental to execute the dredging, transportation, and processing of approximately 721,000 cubic yards of contaminated materials from a 5.5 mile long section of the river. The contract was awarded on a basis of Best Value, with technical proposals, past performance, and price being primary evaluation factors. The total original budget available for project execution was US$ 74 million, which included funding from the Federal, State, City and County governments.

SITE REQUIREMENTS

Marine traffic control was an essential element in planning the project as the Miami River is an extremely narrow waterway, with an active freight and pleasure boat traffic. Prior to the start of work, clear lines of communication had to be established with the shipping companies and local pilots.

Traffic control also had to be established on land, as the management and control of land traffic was crucial to the safe disposal of the dredged material. Approximately 2500 tonnes of dewatered sediment and debris per day were transported by truck to disposal facilities. A well-executed land traffic plan, managed by Weston Solutions, included:
- advance planning for traffic control prior to the start of work;
- clearly designated truck (lorry) hauling routes;
- specified types and sizes of the truck (lorry) fleet;
- clear signage and flagmen for en route; and
- requisite manifests and bills of lading.

ENVIRONMENTAL PROTECTION

Environmental protection was a top priority at the Miami River and covered a wide variety of issues. Water quality was an important consideration, and monitoring was performed for turbidity, dissolved oxygen, lead, arsenic, copper arsenic and copper throughout construction. The presence of animals which are listed as “Endangered Species”, such as the manatees, are of great concern in Florida and their protection is mandated. In addition, submerged archeological resources needed to be safeguarded. And last, but certainly not least, air quality while dredging had to be monitored for noise, odor, air emissions and the effects on birds.
EXECUTION OF THE PROJECT AND THE MOBILE SOIL WASHING PLANT

In order to meet the demands of the Miami River clean-up project, Bean designed and built the new precision backhoe dredger, Barredor del Rio (Figures 2 and 3). The Barredor del Rio is equipped with RTK-GPS and Bean’s in-house Crane Monitoring System (CMS) to provide real-time, heads up display to the operator of the precise dredger and bucket location in relation to the dredge plan and target elevation. The measured system dredging accuracy is better than 6 inches in X, Y, and Z planes.

Another essential part of the clean-up operation was the Mobile Soil Washing Plant (MSWP), built and operated by Boskalis Dolman. This is a “portable” high capacity sediment processing system which was sited within the project area along the banks of Miami River. Boskalis Dolman had become involved in the Miami River project before the tender procedure was initiated, during which time the dredging and sediment processing was studied as an Integrated Approach, to define the most appropriate and cost-effective method.

The Boskalis Dolman soil washing operations were developed in the 1980s in response to stricter environmental regulations and the need to find solutions for the disposal of contaminated soil and sediment. They have been used in the Netherlands at both temporary and permanent locations for over twenty years. The concept of the “portable” high capacity plant is a recent development. It allows the processing plant to be delivered to project sites anywhere in the world, rather than the client needing to bring the contaminated sediment to the plant. And it also eliminates the need to deal with the low processing capacity that normally comes with a portable plant.
In the case of this project, the MSWP was being used in southeastern England when the need arose for the Miami River project. Upon completion of the UK project, the MSWP was disassembled, packed up and mobilised by ship across the Atlantic. During mobilisation several adjustments were made to increase plant capacity from 100 up to 150 tonnes per hour, in order to meet the demands of the US job, that is, to be able to process more than 10,000 m$^3$ situ sediment per week. This required additional plant which was transported by Antonov airplane from the Netherlands to the Miami site (Figure 4). Within three weeks, this MSWP was reassembled along the banks of the Miami River and was up and running (Figure 5).

Figure 4. Additional components of the Mobile Soil Washing Plant were shipped by Antonov airplane, shown here at Miami International Airport.

Figure 5. The sediment processing Mobile Soil Washing Plant and transloading operations were situated along the banks of the river. The sand separation unit (hydrocyclones and counter current washer) is in the middle.
PRIMARY SYSTEM COMPONENTS

The MSWP combines coarse fraction separation via a stationary grizzly screen, rotating sieve drums, vibrating shaker screens and hydrocyclones, and mechanical de-watering of the fine fraction through a pre-thickener tank and a series of belt filter presses (Figures 6 and 7). Different types and sizes of debris require different treatment. Oversized debris, including car bodies, motorcycles, boats and heavy industrial debris were removed and separated out over a stationary Input Grizzly. The coarse debris, composed of rock, trash and rocks with a particle size of from 1 m to 3 cm, passed the grizzly and was placed in a rotating wash and sieve drum (Figure 8). This fraction will typically be over 90 percent dry solids content. The passing fine debris (Figure 9), that is particles of less than a centimetre, also typically over 90 percent dry solids content, are then placed through vibrating shaker screens. Another processing step can be added as necessary.

At this point the sand separation process begins using hydrocyclones and counter-current washing. The sand particles (Figure 10) are 3 mm to 63 µm, with a dry solids content typically over 70 percent. The de-sanded sediment is then put through a mechanical de-watering process where flow and density measurements are conducted and automated polymer dosing occurs. This results in the pre-conditioning of fines of 20 percent dry solids in a pre-thickener tank. The mechanical de-watering table uses belt filter presses which reduces the remaining dry solids content by about 50 percent. The MSWP utilised the 2 metre Andritz CPF 2200 S8 belt filter presses. The final design of these presses was done in-house with special safety features engineered into the press design.
The MSWP has a fully automated programmable logic control (PLC) with which all fluid levels and flows are monitored and controlled. The MSWP also has a built-in maintenance schedule, and technical support can be achieved by telemetry. This permits the plant to be operated efficiently with limited personnel: two process operators control the plant and to check the results, one loader operator and two deckhands for housekeeping responsibilities (Figure 11).

The production capacity on most fixed installation soil processing plants are typically 40 to 50 tonnes per hour. The MSWP can realise up to 140 tonnes per hour or over 2200 m³ per day. During the Miami River operation the average production rate was approximately 1300 m³ per day.

The production capacities of the dredging and processing operations were well balanced on the project and resulted in the breakdown of fractionated products as shown in Table I.

More than 50 percent of the dredged sediment was processed clean (coarse) fractions which could be beneficially used in the community at little to no cost to the project; and around one quarter was dewatered filtered cake which was transported by truck for ultimate disposal at one of three licenced landfills.

Table I. Breakdown of fractionated products.

<table>
<thead>
<tr>
<th>Product</th>
<th>Size</th>
<th>Material</th>
<th>Mass Balance</th>
<th>Dry Solid Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trommel</td>
<td>Coarse material</td>
<td>30 cm – 20 mm</td>
<td>Rock, trash</td>
<td>19%</td>
</tr>
<tr>
<td>Shaker Screen</td>
<td>Fine material</td>
<td>20 mm – 3 mm</td>
<td>Fine gravel</td>
<td>5%</td>
</tr>
<tr>
<td>Hydro-cyclone</td>
<td>Sand</td>
<td>3 mm – 63 μm</td>
<td>Sand</td>
<td>52%</td>
</tr>
<tr>
<td>Hydro-cyclone</td>
<td>Fines (sludge)</td>
<td>&lt;63 μm</td>
<td>Fines to be dewatered on belt filter presses</td>
<td>24% up to 54% after dewatering with belt filter presses</td>
</tr>
</tbody>
</table>
CONCLUSIONS

The challenges of dredging the Miami River are derived primarily from the presence of a constant stream of water-based transportation, the need to proceed under strict ecological guidelines, and specific environmental legislation regarding the disposal of contaminated dredged materials.

The high production levels of the Mobile Sand Washing Plant coupled with the need for a limited number of operators made the operation extremely cost-efficient. In addition, the processed clean (course) fractions could be beneficially used in the community at little to no cost to the project. The tremendous decrease in contaminated volume achieved through implementation of the MSWP offered an environmentally sound practice for dredging in difficult contaminated waters.

Figure 10. Separated sand output.

Figure 11. Right, operator in the control room of the MSWP. Below, close-up of one of the control screens.