Environmental Dredging Equipment

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Project Chain

Administrative initiation -> Project consultancy

Dredging operation

Soil treatment
DDE Products
Site investigation

Survey

Core samples

Particle size

Bottom profile

Cone penetration test

Contamination tests
Project Plan Drafting

- Compose remediation plan
- Select equipment required for dredging
dewatering and separation
- Select positioning and measuring equipment
- Select dilution monitoring equipment to meet
government regulations
- Prepare operational risk analysis
Selective layer removal

Selective removal:
• To minimise disturbance
• To minimise dredge volume
• To reduce treated volume
• To reduce transport and dumping costs
• Enables reuse of clean top layer
Design Criteria for environmental dredging equipment

- Economic handling of dredged materials.
- Capacity of dredging equipment depending on storage or de-watering capacities.
- Resistant to debris.
- Capable of handling organic gasses.
- High accuracy positioning system required.
- Minimal dilution of the polluted dredged materials.
- Minimal spillage.
- Minimal turbidity during the dredging action.
- Manoeuvrability and dredge pattern.
- Availability of protocols for field measurement of sediment release from dredgers.
Environmental Dredging Concepts

- Auger dredge (+DDE)
- Bottom disc cutter (+DDE)
- Modified bucket chain dredge
- Sweep dredge

- Closed clam shell dredge
- Penetration dredging (+DDE)

Ketelmeer dredge tests

Other concepts
Ketelmeer clean-up project
Auger dredge ‘HAM 291’

- Thin layer dredging
- Minimal spill
- Minimal turbidity
- High transport density
- 6 Degrees of freedom
- Flexible dredge patterns
- High position accuracy
Bottom Disc Cutter ‘Vecht’

- Controllable flow
- Minimal spill
- Minimal turbidity
- High transport density
- 6 Degrees of freedom
- Flexible dredge patterns
- High position accuracy
Bucket Chain Dredge ‘Aalscholver’

- Minimal spill
- Minimal turbidity
- In situ transport density
- High position accuracy
- Resistant for debris
Sweep dredge ‘Vlaanderen XV’

- Thin layer dredging
- Minimal spill
- Minimal turbidity
- High transport density
- High position accuracy
<table>
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Clamshell Bucket

Disadvantages:
• No selective removal
• Requires silt screens
Penetration Dredge

Feature: polluted sediment remains in place
Mode of bottom removal
Auger collection
Spill composition of an auger
Auger with trailing shoe
Auger/Pump Characteristics

- Capable of pumping in situ density mixture
- Capable of handling organic gas
- Resistant to debris
- Minimal dilution
- Minimal spillage

- Low transport / dumping costs
Remaining Boundary Conditions

- High accuracy positioning system required.
- Manoeuvrability and dredge pattern.
- Availability of protocols for field measurement of sediment release from dredgers. (HR Wallingford)
DGPS-Receiver with own reference station

GPS

CSI Power Max.

Ref. signal

NAVGuARD

Ref. Station
Required instrumentation

- Echo sounder
- Tidal receiver
- DGPS antenna
- Motion sensor
Flow & Density control for treatment plant
Large scale to small scale
DOP® Pump features

- Normal dredge dump
- Mechanical seal
- Hydraulic/electric drive
- Protective casing
- Suction pipe
- Sand production head
- Discharge pipe
- Jet water pipe
Combining Augers and DOP’s
Auger head for DOP® pump
Experience gained in practice

Units build:

- Auger dredge HAM291 – Van Oord
- DOP1815 with auger – Dutch Dredging
- DOP2320 with auger – Golder Associates
- DOP2320 with auger – Kystverket
- DOP2320 with auger – D.E.M.E
- Disc cutter – Boskalis
- DOP1815 with auger – Deco Diving
- DOP1815 Beaudredge – Boskalis

Example cases
HAM291 (Ketelmeer/Slufter)
Ketelmeer results

- Total volume: 15 million m³
- Total area: 2800 ha
- Project duration: 2 years
- Dredging and construction: 113.45 million Euro
- Accuracy: vertical 5 cm, horizontal 10 cm
Slufter Results

- Total volume: 1.1 million m³
- Average in situ density
- Transport distance (with boosters): 12 km
- Highly toxic!
de Boer (the Netherlands)
In situ mixture density
De Boer features

- Typical soft soil project
- Attached on a manipulator of an excavator
- 6 Degrees of freedom
- Very accurate positioning

- Contaminated silt removed
- Minimal dilution
- Reduced handling, dewatering and storage costs
- Remaining sediment very clean
Golder dredging site (Canada)
Golder results

- Production ranged from 200 to 6,500 m$^3$/week
- Average production of 2,800 m$^3$/week
- 50,000 m$^3$ of contaminated sediments dredged
- All hazardous waste and industrial fill removed
- Costs of permitting, monitoring, removal, water treatment and disposal are high
- Segregation of different classifications results in large savings on disposal costs
- Turbidity increase during operations: very low to none
Heavy-duty auger Kystverket (Norway)

- Arctic environment
- Stiff glacial clay
- Raking motion
- Heavy-duty frame
- Debris collector
Debris in protective grating
Kystverket results

- Low turbidity
- Accurate removal of contaminated layers
- Minimal environment disturbance
Dedicated portable DOP® auger dredge (DEME Sweden)
Dedicated portable DOP® auger dredge (DEME Sweden)
DEME results

- Pollution by traditional paper industry
- High percentages of PCB's, Cadmium and Mercury
- In situ dry material was only 8%, dredging 5% and pumping 4-4.5%
- Total quantity of 260,000 m³
- Normal duration: 3-5 years

Now: Only one summer season!
Conclusions

- Excellent real life dredging laboratory Ketelmeer
- Vast amount of knowledge gained
- Understanding of processes
- Applicable in wide range of projects

- In situ removal: low transport and storage costs
- Minimal disturbance of good sediment
- Targeted treatment of polluted soil possible

- Best possible delivery to treatment plant
Treatment of Dredged Materials
Miami River Project Overview
Miami River Project Diagram

Sediment

- Grizzly
- Stationary Screen
  - Rotary filter drum
  - Vibrating Filter
  - Upstream tower
  - Upstream tower
- Hydro cyclone
- Settling tank
  - Settling tank
  - Filter belt press
  - Filter belt press
- Collecting tank

Debris
- Coarse Sand
- Fine Sand
- Filter cake
Miami River Project Details

- Start June 1, 2005; Duration 5 months
- 250,000 cubic meter
- 10,000 cubic meter per week
- 38 Standard 20’ and 40’ containers
- 5000 square meter footprint
- Survived hurricanes Katrina, Rita and Wilma
- Dewater of fines up to 55% dry solid content
- 100% Process water recycling
- 125,000 cubic meter of clean sand produced
- Product directly by truck to customer