Large-Scale Remediation in a Complex Environment: Some Key Points

- 6.5 km of river dredging
- Coordinate sediment slurry dewatering & water-treatment
- Biological treatment of impacted sediments
- Formation of a parkland
General Project Process Diagram

- **Dredging package**
- **Retention lagoon**
- **Dewatering**
- **Old ponds excavation**
- **Pre-mixing**
- **Pre-treatment**
- **Bio piles**
- **Civil engineering works**
- **Foul air treatment**
- **Water treatment**
- **Project management, administration & logistics**
- **Site scientist**
- **Project monitoring & testing**

**Control/validation**

D: Diesel
E: Electricity
A: Additives
Ch: Chemicals
N: Nutrients
Over 70,000 m³ of Earthworks including the Lagoons

Over 3.5 km of Roads Constructed with Geotextile protection

Density Tests every 200 mm layer plus 2 layers of Geogrid

42,000 m² of HDPE to complete ‘waterproofing’ of the site
IMS 7012 Dredge, 900 m³/hr at 40 m head

4 No. 900 m³/hr Flowserve Booster Pumps with 12” floating pipes

9,000 m³ Slurry per day, 1,350 m³ dry solids

In-let screen with 2 No. 450 m³ discharge pumps
De-Watering

- 6,000 m³ Retention Lagoon with 4 Mixers & 2 Slurry Pumps
- 250 m³ Settlement Tank and associated Flocculent / Coagulant dosing tanks
- 4 No. Dewatering Centrifuges
- Conveyors for Dewatered Sediments
Liquid Processing Plant

11,000 m³
LPP Lagoon
with 4 Mixers

Aerobic
nitrification
Zone
(Ammonia to
Nitrates)
followed by
anaerobic
denitrification
(nitrates to
Nitrogen)

Biomass and
phosphoric
acid addition
in the aerobic
zone. Carbon
source
addition in the
anoxic zone.

Constant in-
line
Monitoring
for TN
(20mg/l),
Ammonical
N (5 mg/l),
TSS (100
mg/l), pH (6-8)

Mixing & Bioremediation

Mixing Plant with 3 hoppers, mixer and conveyor

Capacity of 100 m³/hr sediments and 130 m³/hr total including organic and inorganic admixtures

Additional bioremediation option with windrow method

Biopiles with air extraction utilising EnGlobe’s P95 system and foul air treatment
Infrastructure

4,000 m of Pipework installed

2,500 m of electrical cabling

Over 500 m$^3$ of concrete poured

500 m of control cabling
Offices & HMI

Operations controlled from Management Offices

And from Engineers Offices in the South Camp

With control information routed via the Main Control Centre

And displayed by HMI software
Dredging

- IMS 7012 dredger on site and in the water
- Licensed
- Connected to pipework and Operational Qualification OQ passed
6 Km of riverbed; Started dredging in June; So far through areas of ‘low’ contamination
Dredged Sediment Slurry pumped into a 8,000 m³ retention pond:
To maintain a sediment suspension & 24-hour LPP
Initial Slurry Pumping Rates:
- 400 m³ of slurry/hour
- Gradually optimizing
- High sediment variability encountered

Inlet Filters:
1. Screen oversize to < 6mm
2. Hydrocyclone de-sanders removing particles to 0.5 mm
LPP & De-sanding Unit
Dewatering performance

- Yields >500 m³ cake/day

Dewatering includes 4 large centrifuges

- Continuous optimization of polymers and flocculants
- Extension of operating times to increase production
Water Treatment Operation

The centrate water is sent to a treatment lagoon where the water is subjected to a 2-stage biological treatment to remove nitrogen:

- Ammonium – Nitrate (aerobic)
- Nitrate – Nitrogen gas (anaerobic)
To date achieving:

- 0.9 mg/l Ammoniacal N (<5 mg/l)
- 9 mg/l total N (<20 mg/l)
- 60 mg/L TSS (100 av; 200 max)
Additive Mixing Plant  Mix sediments with organic and inorganic additives
Contamination profile:

- Average impacts: 6,000 mg/kg
- Generally C_{16}-C_{24} range
- Criteria: 1,560 mg/kg (C_{8}-C_{32})
- Windrow initial treatment
Environmental Monitoring (Summarised)

Air Monitoring
- Dust
- VOCs
- Noise
- Odour

Water Monitoring
- Solids content (SS) & Turbidity in vicinity of dredging
- Control monitoring of LPP
- Monitoring of water discharge (TSS, N, metals, etc)

Process Control & Validation Monitoring
- Solids sampling and analysis
- Includes TPH, VOCs, SVOCs, PAHS, metals, etc
Health & Safety & Environmental Monitoring

Coordinates

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EnGlobe Remediation team

- 7 expats from Canada, UK and Netherlands
- 15 local employees
  - Dredging
  - Dewatering
  - Bioremediation
  - Lab operation
  - Landscaped hills
Key Risks:

- High volume of site traffic throughout the site.
- Heavy plant at dynamic locations.
- High numbers of staff site wide.
- Prevention of unauthorised access.
Englobe has a dedicated monitoring team, together with fully equipped and staffed onsite laboratory.

**Team Interaction**

**Monitoring Team**
- 3 Environmental Samplers trained in all aspects of the Kishon Project. All employed in Israel by Englobe.
- The team is lead by a Monitoring Manager with over 7 years experience within Englobe.

**Laboratory Team**
- Experienced and trained team members. All also employed in Israel by Englobe.
- The team is lead by an independent Site Scientist from Jones Laboratory in the UK.

**Team Interaction**
- Both teams work together to: Monitor, Sample, Analyse, Report.
- Ensuring accurate, reliable current data to enable real time responses in a dynamic environment.
The primary health risks to receptors both on and off site are:

- **TPH (Total Petroleum Hydrocarbons)** – The principal contaminant in the material to be dredged and bioremediated.
- **Metals** – Present in varying quantities throughout the project.
Site ‘Set-Up’ & associated permits was fully completed in May 2014

Dredging started in June 2014, starting at the remediation site

From initial dredging – gradual (careful) increasing of production rates

Treatment results to date are very limited but positive