TBT - TREATMENT AND DISPOSAL
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DEFINING THE PROBLEM
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1. Why is TBT a problem?
2. When is TBT a problem?
3. TBT Clean
4. Case study: Falmouth
1. Why is TBT a problem?

Licensing of disposal of dredged material at sea:
- Food & Environment Protection Act 1985
- Protection of the environment and human health
- Case by case assessment of licence applications
- Weight of evidence approach
- TBT = one of many potential contaminants

TBT is:
- Highly toxic, particularly to marine organisms such as molluscs, even at low concentrations
2. When is TBT a disposal problem?

Defining TBT contamination for disposal at sea:
- Action Level 1 = 0.1mg/kg
- Action Level 2 = 1.0 mg/kg

Interpreting TBT contamination:
- <0.1mg/kg = disposal at sea likely
- 0.1 to 1.0mg/kg = disposal at sea possible
- >1.0mg/kg = disposal at sea unlikely
2. When is TBT a treatment problem?

Some factors affecting viability of treatment:

- Volume of contaminated dredged material
- Nature of the TBT contamination:
  1. diffuse contamination absorbed to sediment particles
  2. paint particles and flakes present in sediment matrix
- TBT distribution across sediment particle sizes
- TBT removal efficiency / target concentration
- Availability of treatment facility
- Cost
3. Treatment options – TBT Clean

TBT Clean:
- EU LIFE funded project - Antwerp Port Authority
- “Development of an integrated approach for the removal of tributyltin from harbours and waterways: prevention, treatment and reuse of TBT-contaminated sediments”
- www.portofantwerp.be/tbtclean/

Research topics:
- Screening of technologies
- Sediment characterisation
- Remediation, including dredged material
- Reuse of cleaned sediment
- Cost-benefit analysis
3. Treatment options – TBT Clean

Pre-treatment options:
- Fraction separation (e.g. hydrocycloning) to obtain sand for further treatment (e.g. density separation / floatation)

Remediation options:
- Thermal treatment for highly contaminated sediment (i.e. >10mg/kg TBT)
- Bioremediation for moderately contaminated sediment (i.e. 1-10mg/kg TBT)
- Other options generally not technically and/or economically feasible
TBT removal efficiencies:

- Lagooning (dewatering) + biomediation = c.50-70% removal of TBT at 1-10mg/kg
- Mechanical dewatering + thermal treatment = c.90+% removal of TBT at >10mg/kg
- Hydrocyclonning + mechanical washing (of sand fraction) + thermal treatment = c.90+% removal of TBT at 1-10mg/kg
3. Treatment options – TBT Clean

Costs (based on 10,000 tonnes dry sediment):

- Lagooning and biomediation = 80 euros / tonne
- Mechanical dewatering + thermal treatment = 180 euros / tonne
- Hydrocycloning + mechanical washing + thermal treatment = 140 euros / tonne

Above costs exclude:

- Transport of dredged material to/from treatment facility
- Additional treatment for other contaminants (if necessary)
- Subsequent disposal
3. Treatment options – TBT Clean

Conclusions:

- TBT is thermally unstable, so heat used to volatilise organic content = TBT degradation to DBT, MBT and inorganic tin
- At 450°C, degradation from 72.6mg/kg to 0.29mg/kg (TBT removal = 99%) takes up to 15 minutes
- Higher temperatures = higher TBT removal
- Thermal treatment is only feasible remediation technique for highly TBT contaminated sediments, with a high removal efficiency
- Thermal treatment also degrades other organic contaminants (e.g. PAHs)
- Thermal treatment does not degrade metal contaminants, but leaves a solid residue needing further treatment (e.g. stabilisation)
4. Case study - Falmouth

Location: Falmouth, Cornwall
Objective: navigation of larger cruise vessels and tankers
4. Case study - Falmouth

Proposed capital dredge:
- Approaches to -8.3mCD
- Berths to -9.5mCD
4. Case study - Falmouth

Predicted volume of dredged material:

- Area 1 = 57,900m³
- Area 2 = 9,000m³
- Area 3 = 112,960m³
- Area 4 = 480,680m³
- Total = 660,540m³
4. Case study - Falmouth

TBT concentrations: 2004 survey

- Min. <0.002mg/kg
- Max. 18.5mg/kg
4. Case study - Falmouth

TBT concentrations: 2007 survey
- Min. <0.001mg/kg
- Max. 12.3mg/kg
4. Case study - Falmouth

Scale of contamination: sediment unacceptable for disposal at sea following initial advice from Cefas, based on 2004 survey:

- Area 1 = unacceptable to 1m below seabed
- Area 2 = unacceptable to 2m below seabed
- Area 3 = unacceptable to 1.5m below seabed
- Area 4 = no sediment unacceptable
Predicted volume of TBT contaminated dredged material:

- Area 1 = 29,340 m$^3$
- Area 2 = 6,540 m$^3$
- Area 3 = 102,090 m$^3$
- Area 4 = 0 m$^3$
- Total = 137,970 m$^3$
4. Case study - Falmouth

Treatment to remediate TBT contaminated sediment?

Risks re findings of TBT Clean:

- Insufficient removal of TBT (to achieve <0.1mg/kg)
- Insufficient removal of metals
- Remediation not proven for large volumes of dredged material
- Availability / location of remediation facility (may be overseas)
- High costs associated with thermal treatment
- Disposal at sea may not be possible, even after after treatment
4. Case study - Falmouth

Disposal options?

Option 1 - Disposal to a purpose built confined disposal facility within the docks estate:
- Initial chemical stabilisation and physical solidification (S/S) using cement to immobilise TBT and other contaminants (i.e. prevent leaching)
- Disposal to containment site
- e.g. Mylor Yacht Harbour and Newlyn

Option 2 - Disposal to confined disposal facility in sea:
- Disposal on sea bed
- Followed by capping
- e.g. River Tyne trial