SUSTAINABLE SEDIMENT SOLUTIONS: STABILIZATION OF CONTAMINATED SEDIMENT

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Technical Session 1C – Sediment Management

RAMBOLL Bright ideas. Sustainable change.

OBG Part of Ramboll

SOLIDIFICATION VS STABILIZATION

- **Solidification**: Contaminated materials are encapsulated "physically trapped" to form a solid material that restricts contaminant leaching by:
  - *Reduces permeability*
  - *Increases compressive strength and durability*

- **Stabilization**: Chemical reaction between reagents and contaminated materials - designed to reduce leachability of target contaminants
  - *Binds free liquids*
  - *Immobilizes and transforms contaminants*
  - *Reduces solubility of COC's*

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WHY SOLIDIFICATION / STABILIZATION?

- Reduces contamination migration and exposure risks
- Readily supplements other sediment management technologies
- Provides beneficial use opportunities
- Improves sustainability by minimizing energy use and off-shore disposal space
- Provides a stable construction material for redevelopment

MEASURING PERFORMANCE

- Typical Performance Requirements
  - Unconfined Compressive Strength (UCS)
  - Hydraulic Conductivity (HC) lower than baseline
  - Leachability Reduction (% reduction? gw goal?)
- Explore optimal mixtures
- Test industrial by-products (e.g., fly ash, slag)
- Optimize mixes and cost

Quantifiable metrics that demonstrate remedial goals can be achieved

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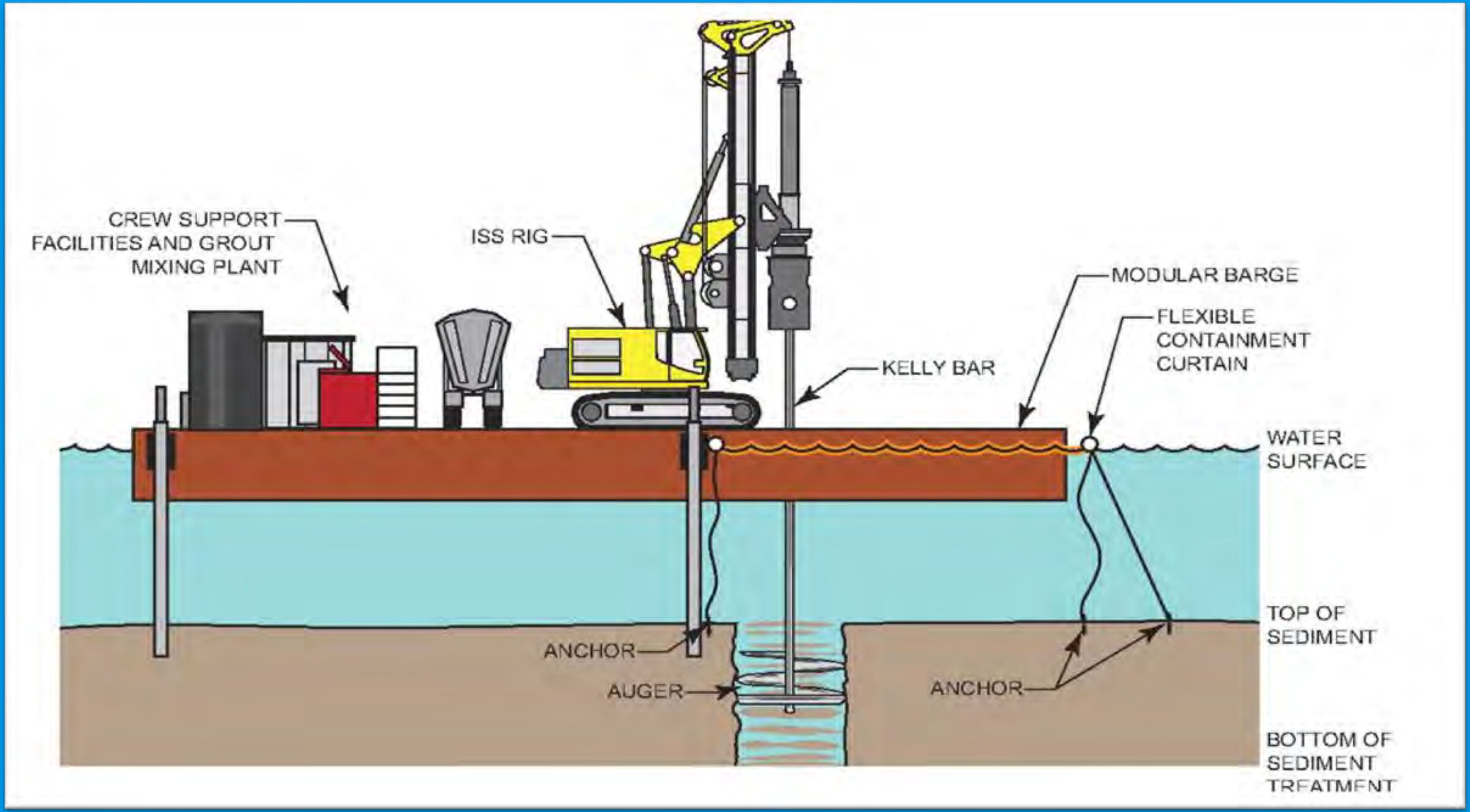
Failure Mode of Sample

IN-SITU

- Treat sediment in place
- Minimize short term impacts by reducing remediation time
- Minimize infrastructure upgrades and shoring required to remove deep impacts
- Reduce environmental footprint – less transport, less landfill disposal
- Improve habitat



- On-water work adds complexity
- Must contend with subsurface debris

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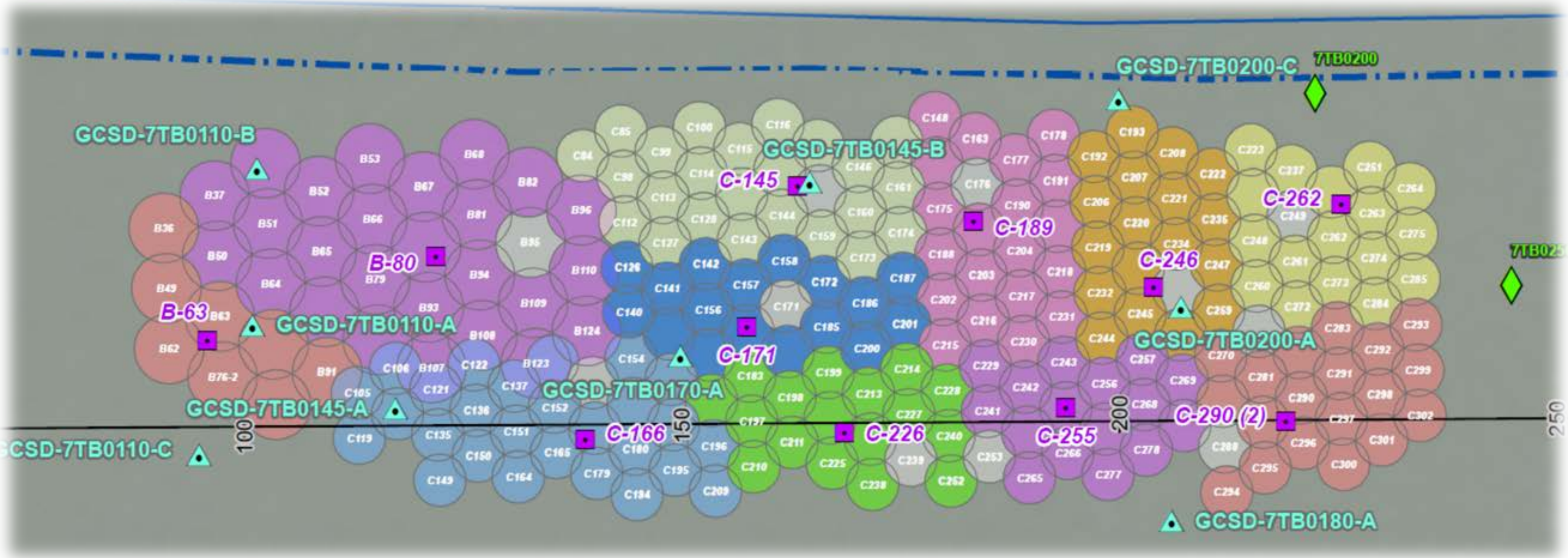
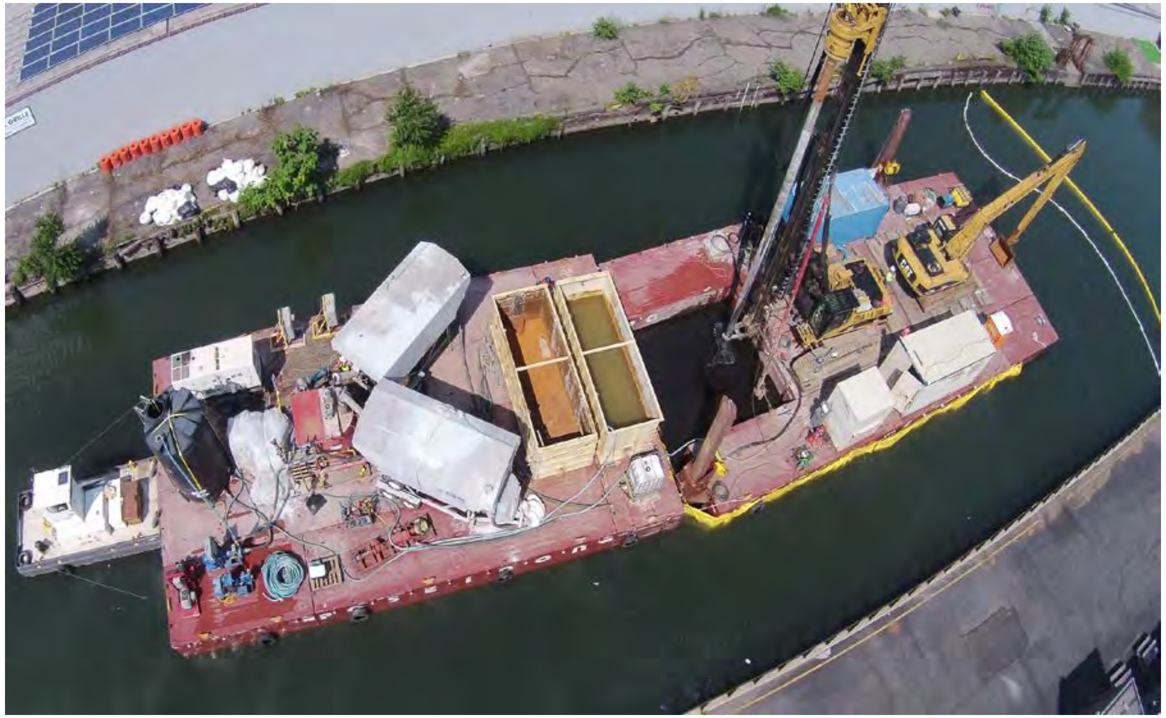
IN-SITU



GCSD-7TB0110-B
GCSD-7TB0145-B
GCSD-7TB0200-C
7TB0200
C-145
C-189
C-262
C-246
B-80
B-63
GCSD-7TB0110-A
C-171
GCSD-7TB0200-A
GCSD-7TB0170-A
GCSD-7TB0145-A
CSD-7TB0110-C
C-166
C-226
C-255
C-290 (2)
GCSD-7TB0180-A
100
150
200
250



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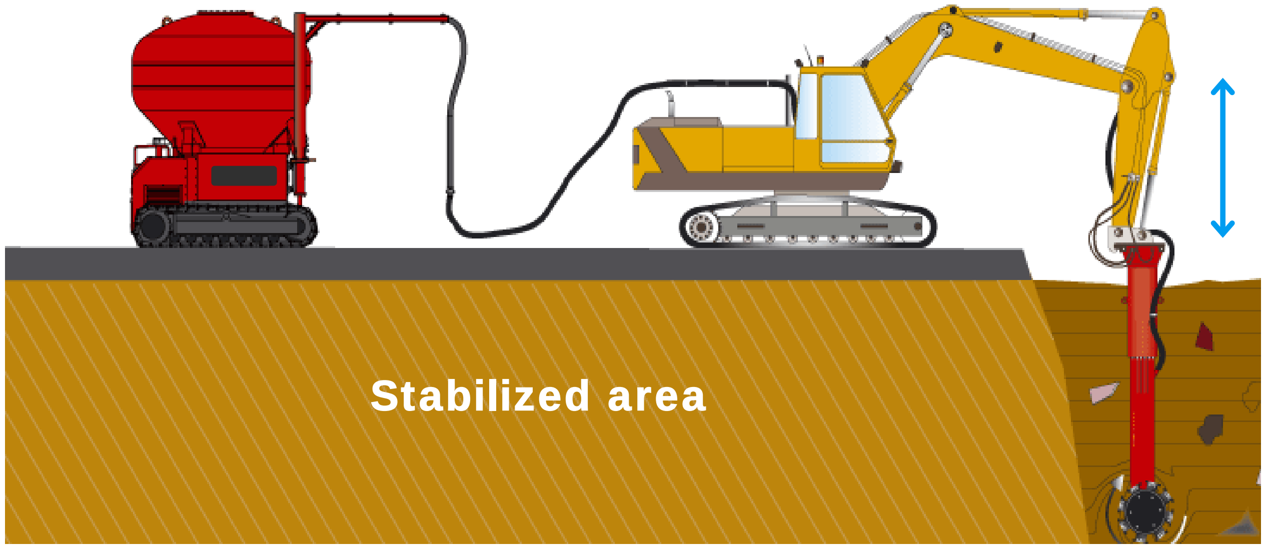
EX SITU MASS STABILIZATION (ISS)

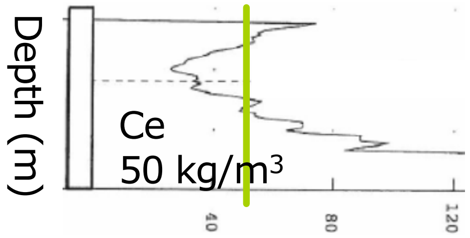
- Removes sediment from water body
- Treat Dredge Soils in upland area for beneficial use on or off site
- Reduce environmental footprint – less trucks, less landfill disposal

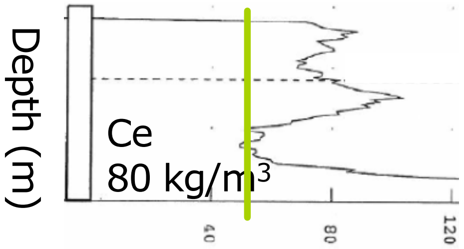


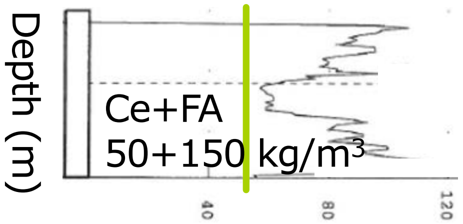
EXAMPLE FOR EX-SITU TREATMENT AND REUSE
JÄTKÄSAARI HARBOUR, FINLAND
MAY 2013

- Urban renewal project: 2011 to present
- Historic port to modern residential area
- Dredged contaminated sediment
- Basin stabilization
- Produce usable construction materials

OPTIMIZING MIX DESIGN







Mix	Relative Quality	Relative Binder Cost
Ce 50 kg/m3	Poor	60 %
Ce 80 kg/m3	Good	100 %
Ce+FA 50+150 kg/m3	Very Good	70 %
OSA5 (Oil Shale Ash) 150 kg/m3	(Too) Good	20 %

Ce = Cement
FA = Fly ash
OSA5 = Oil Shale Ash

WATER PERMEABILITY LABORATORY TESTS RESULTS
WEST HARBOUR PHASE III

Binder	Binder amount (kg/m³)	Water permeability (cm/s)
Ce+FA	50+150	1.1×10^{-7}
Ce+FA	50+150	7.4×10^{-7}
Ce+FA	50+150	1.7×10^{-7}
Ce+FA+FGD	50+150	1.1×10^{-7}
LC 3:7+FA	50+150	1.2×10^{-7}
LC 3:7+FA+FGD	50+75+75	1.1×10^{-7}
OSA8	150	8.2×10^{-7}

Max Target value 1×10^{-6} cm/s.

Binders:

Ce = Cement
FA = Fly ash
LC = Lime + Cement 1:1
FGD = Flue gas desulphurisation agent
OSA8 = Oil Shale ash

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LEACHING TEST RESULTS
WEST HARBOUR PHASE III

Element	Limit value (mg/m²)*	Test results 64 d (mg/m²)
Arsenic, As	58 →	0.4 – 0.6
Barium, Ba	2800 →	4.0 – 9.3
Cadmium, Cd	2.1 →	0.04 – 0.06
Cobalt, Co	280 →	0.21 – 0.25
Copper, Cu	250 →	0.7 – 3.3
Mercury, Hg	1.6 →	0.04 – 0.14
Molybdenum, Mo	70 →	3.6 – 22.9
Nickel, Ni	270 →	0.4 – 2.7

Element	Limit value (mg/m²)*	Test results 64 d (mg/m²)
Lead, Pb	210 →	0.2 – 0.3
Antimony, Sb	36 →	0.8 – 16.8
Selenium, Se	14 →	0.5 – 1.9
Tin, Sn	280 →	1.5 – 6.5
Vanadinium V	700 →	0.7 – 4.7
Zinc, Zn	330 →	2.4 – 4.0
Fluoride, F	2800 →	105 - 124

Limit values presented in the environmental permit application of Sepänmäki noise barrier.

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Modified test according to standard NEN 7375:2004

FIELD TESTING OF MASS STABILIZATION IN JÄTKÄSAARI

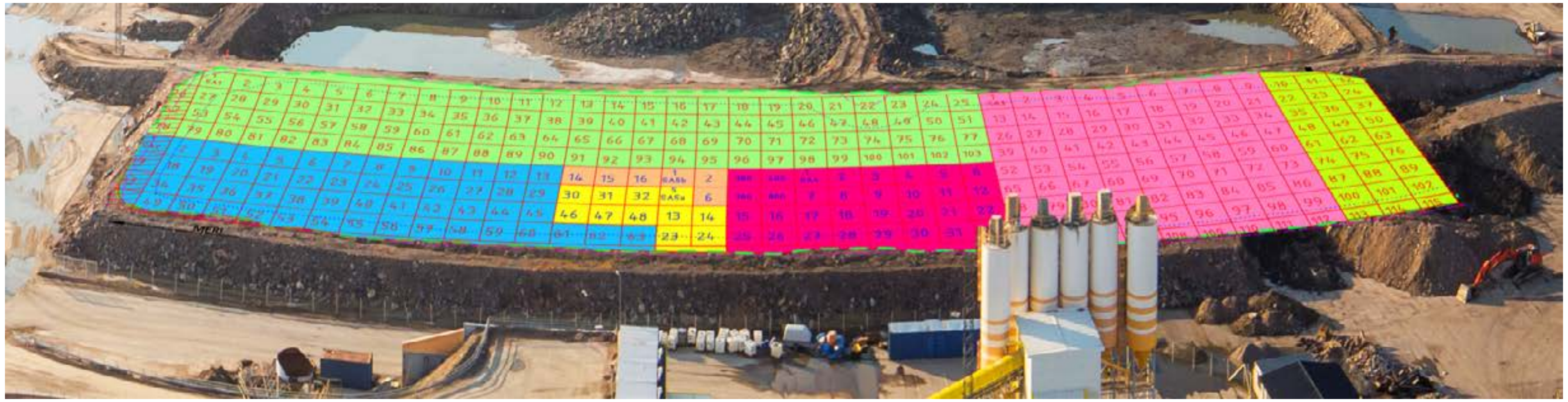
Binder Mixes

Cement

Cement and fly ash

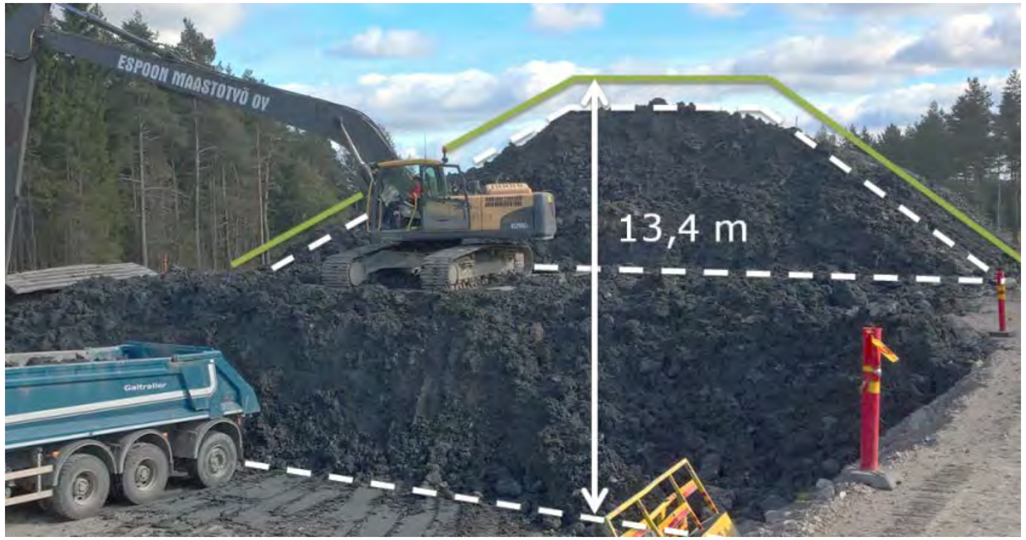
Cement and bio-reactive fly ash

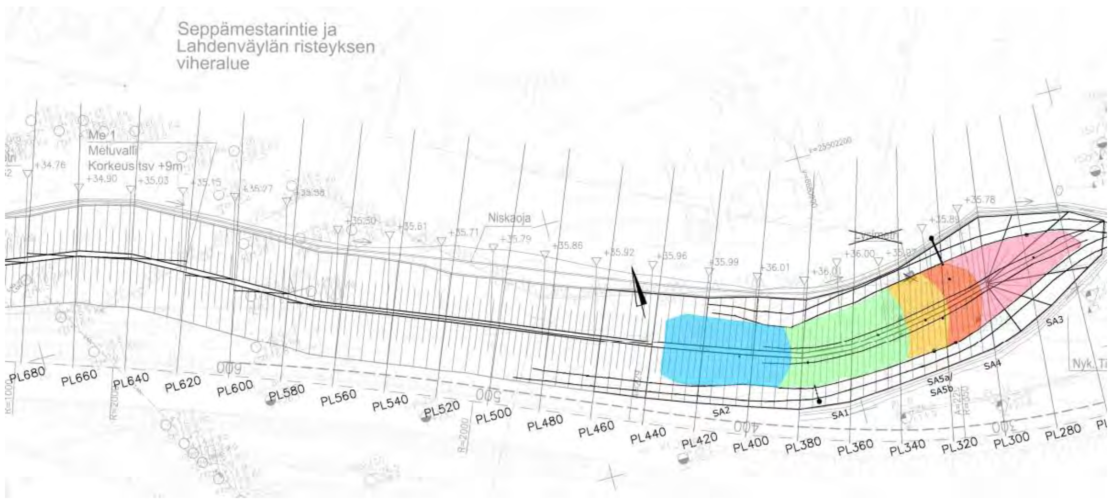
Oil shale ash

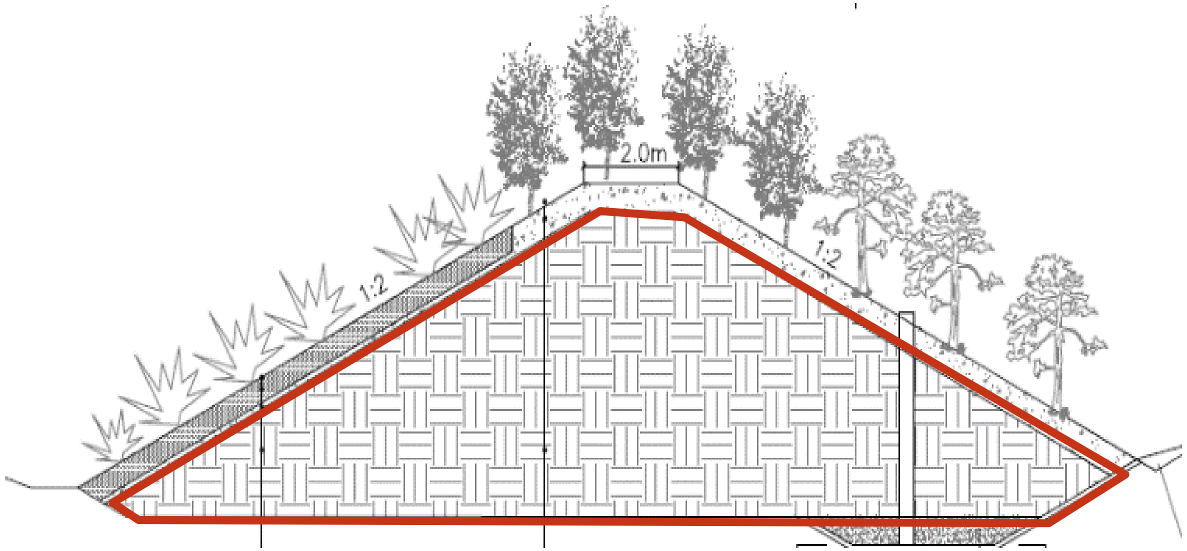


DIFFERENT BINDER RECIPES

REUSE - SEPÄNMÄKI NOISE BARRIER







- Constructed April to October 2016
- 2893 truckloads of stabilized sediment
- 29,540 cubic meters transported and placed 12 km from West Harbor
- Design height at 5-13 m

OTHER RE-USE EXAMPLES IN THE HELSINKI REGION

- Landfill cap structure and intermediate storage area in Vuosaari, **120 000 m³**, 2010-2015
- Alakivenpuisto park, **34 000 m³**, 2014-2015
- Road noise wall, **29 000 m³**, 2016
- Hyväntoivonpuisto park, **5 000 m³**, 2011
- Ida Aalberg park, **100 m³**, 2013

POST STABILIZATION NATURAL RECOERY

- Wisconsin, USA
  - MGP impacted soils
  - 1.6 hectare ISS effort
  - 61,000 m^3 of impacted soils
  - 60 cm clean fill over solidified soil

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POST ISS HABITAT EVALUATION

EXAMPLE OF POST ISS NATURAL RECOVERY

- Solidified area now submerged due to rising Great Lakes water levels
- Clean backfill resembles aquatic environment
- Assessed post ISS benthic community
  - Sediment concentrations do not present risk to benthic invertebrates
  - Benthic invertebrate HBI scores similar between ISS and reference areas
  - Benthic community indicative of early succession stage

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KEY CONSIDERATIONS FOR BENEFICIAL USE

CHALLENGES

- Public Perception of contaminated material – “not in my backyard”
- Site Management – potential long-term commitments to monitoring
- Testing – each site is unique and should be tested for strength and contaminant leaching potential

STRATEGIES

- Present in context of sustainability and net environmental benefit
- Integrate materials into brownfield, port development, coastal resiliency, and ecological improvement projects
- Proactive discussions with stakeholders

➢ ***Change perceptions for sediment use***

THANK YOU!

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