

IN SITU MASS STABILIZATION

Stabilization of Contaminated Sediment for Re-use
at the Port of Helsinki and Other Finland Sites

Michael Mengelt

RAMBOLL Bright ideas. Sustainable change.

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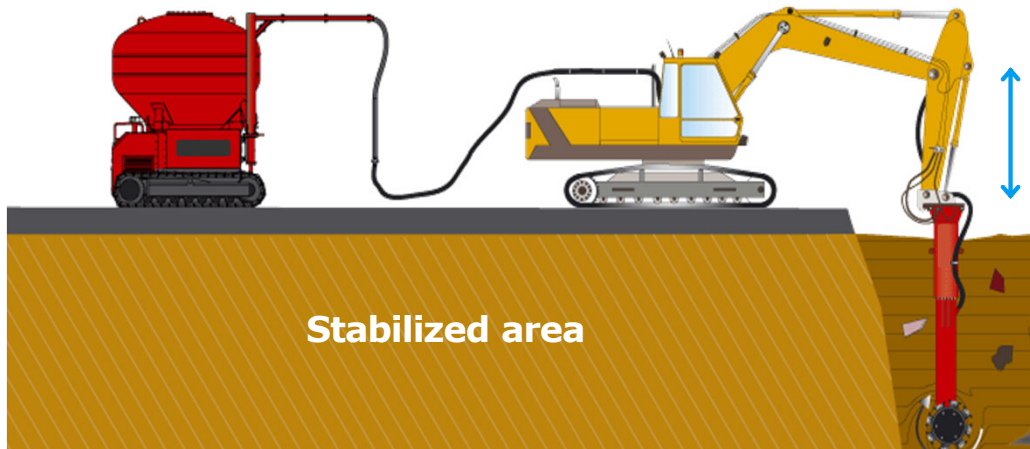
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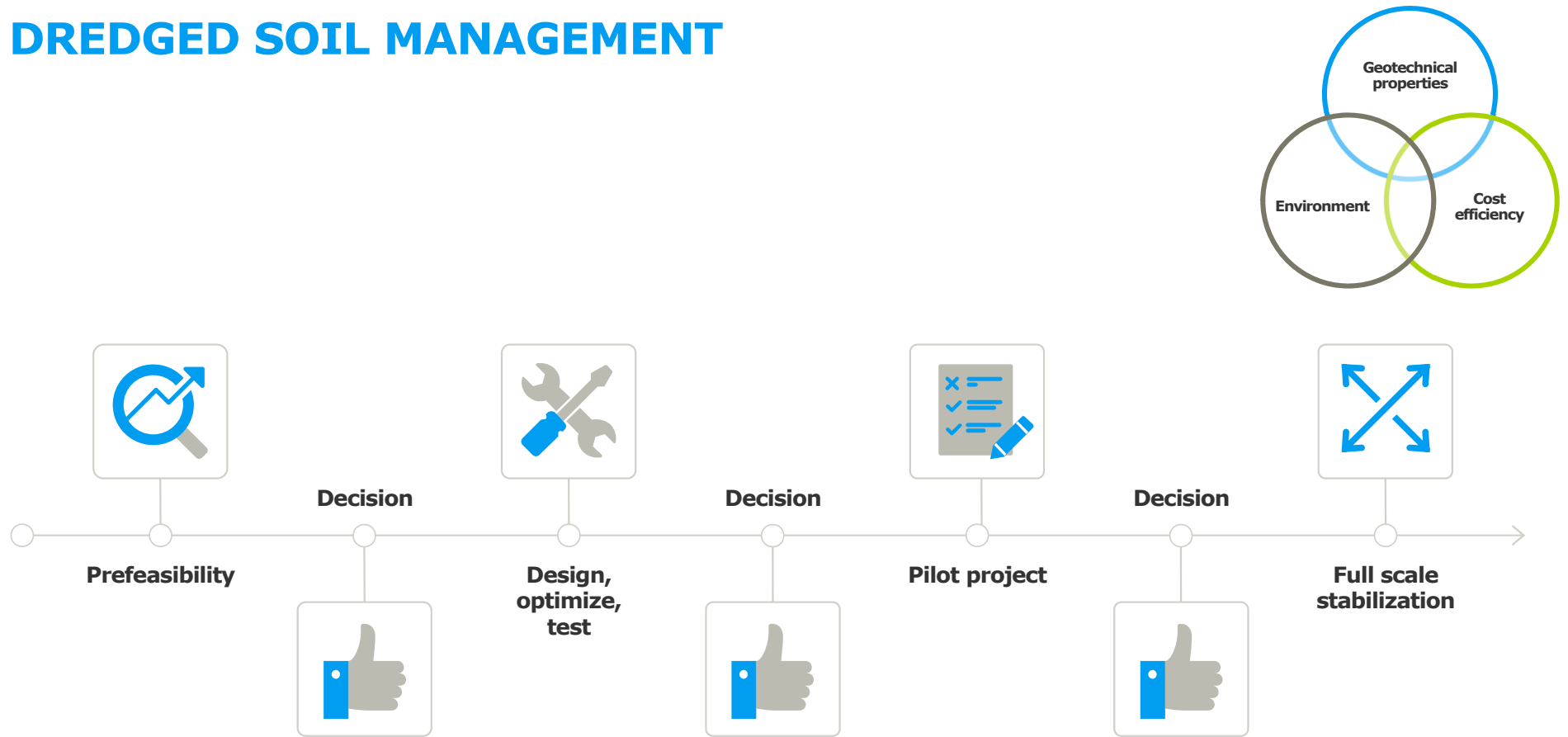
Bright ideas. Sustainable change.

MASS STABILIZATION (ISS)

- Dry mixing method
- *In situ* or *ex situ* stabilization
- Cost from 30–100 euro/m³
- Mixing cost 10 euro/m³
- Binder cost is the remainder of the price!



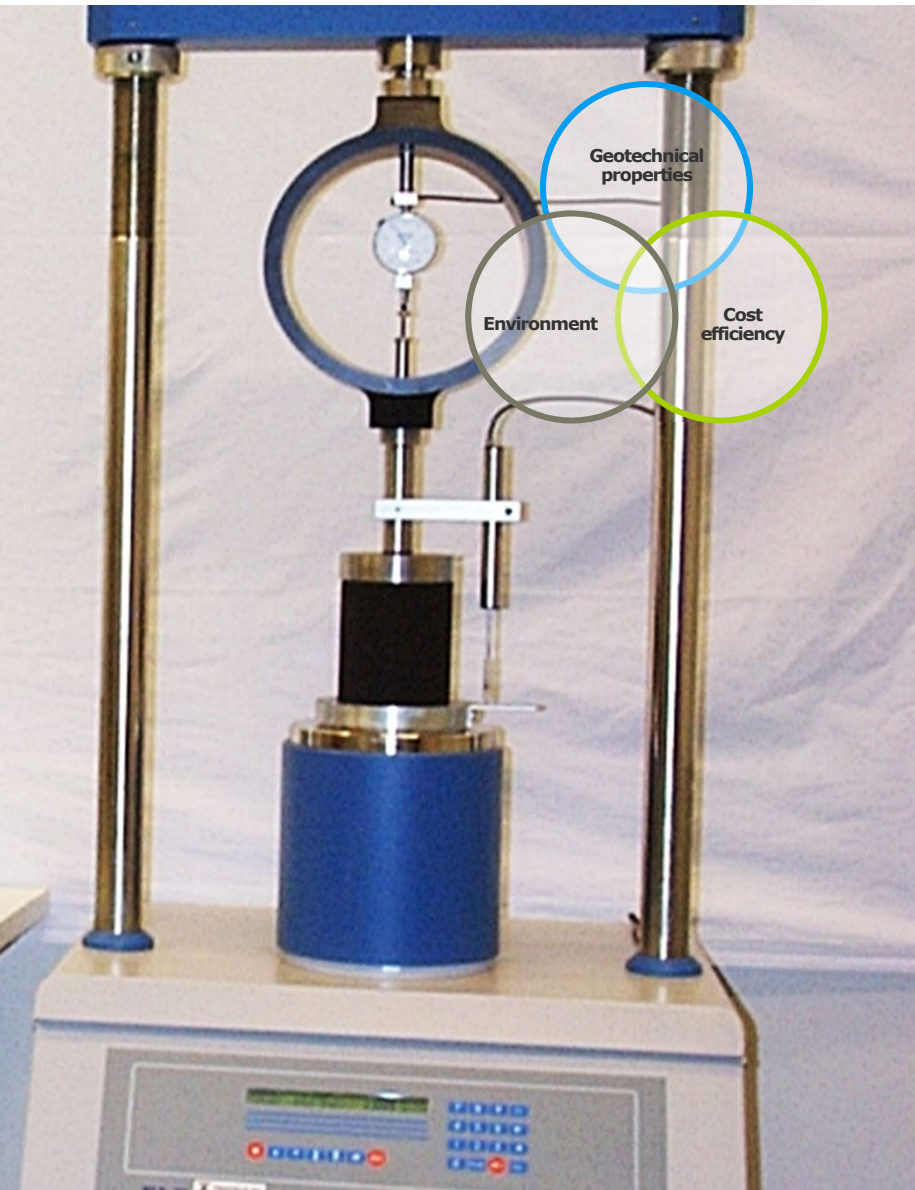
DREDGED SOIL MANAGEMENT



LABORATORY MIX EVALUATION

- Explore promising mixtures
- Exploit industrial by-products?
- Hydraulic conductivity
- Chemical compatibility and leaching
- Strength targets assurance
- Optimum cost-benefit determination

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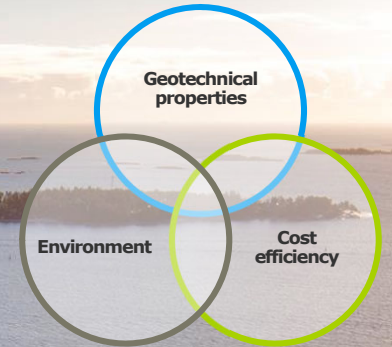
STABILIZATION CONSTRUCTION PHASE



- Full scale implementation!
- Pilot testing proves laboratory results
- Quality control is key to success
- Designer should be involved
 - On site modifications due to changing conditions
 - Lessons learned for future port work and site

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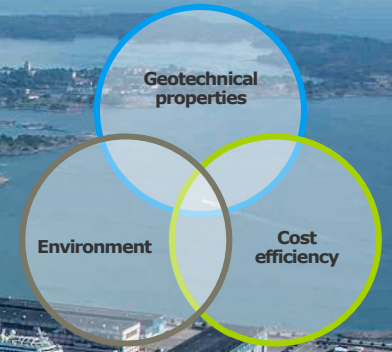
JÄTKÄSAARI HELSINKI



- Urban renewal project
- Historic port to modern residential area
- Ongoing 2011 to present
- Dredging contaminated sediment, basin stabilization
- Produce usable construction materials

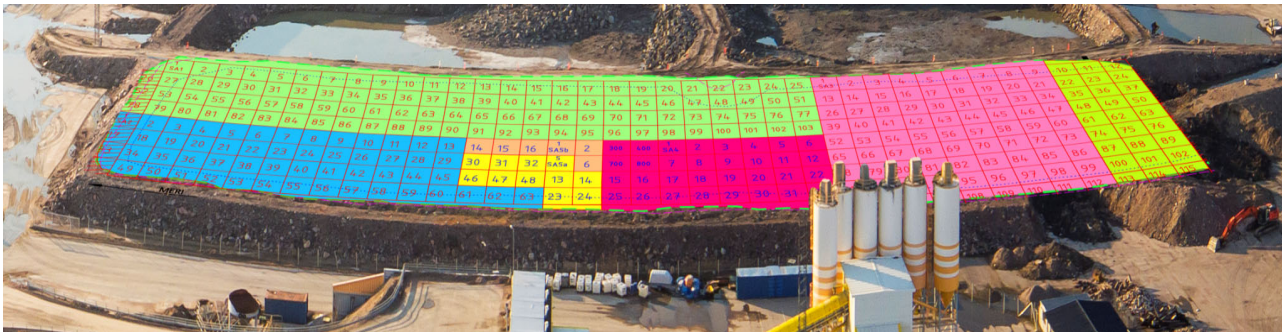
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JÄTKÄSAARI HARBOUR MAY 2013



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MASS STABILIZATION IN JÄTKÄSAARI



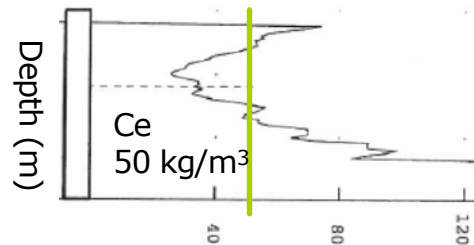
DIFFERENT BINDER RECIPES

Binders:

- Cement
- Lime cement
- Cement and fly ash
- Cement and bio-reactive fly ash
- Oil shale ash

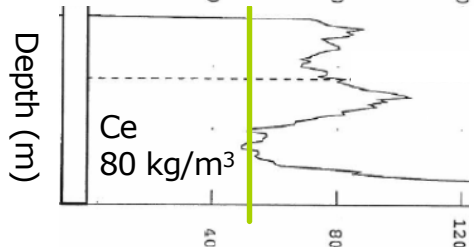
COLUMN SOUNDING TEST RESULTS

SOME EXAMPLES OF ASHES AS A BINDER, JÄTKÄSAARI

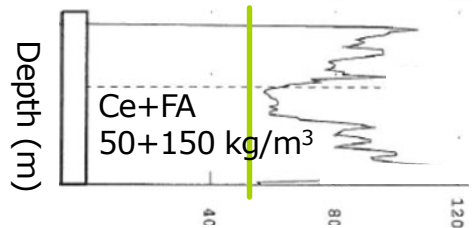


Quality

Poor



Good

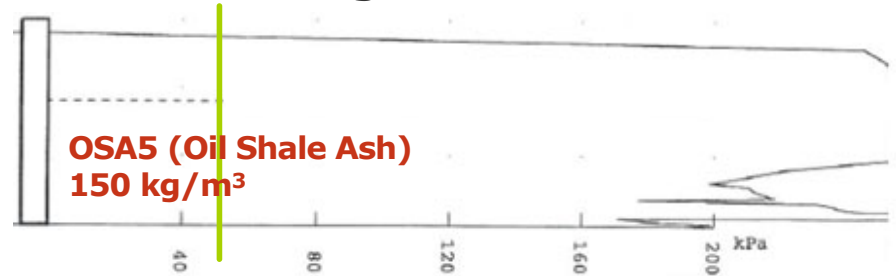


Very good

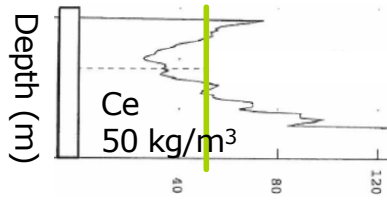
Shear strength (kPa)

Phase/year	Binders
I / 2011	Ce
II / 2012	Ce, Ce+FA
III / 2014	Ce+FA, LC+FA, Ce/LC+FA+FGD, OSA5, OSA8

"Overshoots target"



BINDER COSTS, SOME UNIT PRICE CALCULATIONS

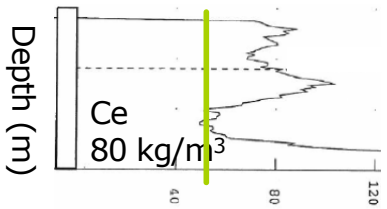


Quality

Poor

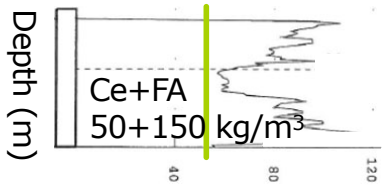
Relative Binder Cost

60%



Good

100%



Very good

70%

Ce+FA (reactive bio fly ash)
0+200 kg/m³

Good

20%

WATER PERMEABILITY LABORATORY TESTS RESULTS

WEST HARBOUR PHASE III

Binder	Binder amount [kg/m ³]	Water permeability [m/s]
Ce+FA	50+150	1,1 x 10 ⁻⁹
Ce+FA	50+150	7,4 x 10 ⁻⁹
Ce+FA	50+150	1,7 x 10 ⁻⁹
Ce+FA+FGD	50+150	1,1 x 10 ⁻⁹
LC 3:7+FA	50+150	1,2 x 10 ⁻⁹
LC 3:7+FA+FGD	50+75+75	1,1 x 10 ⁻⁹
OSA8	150	8,2 x 10 ⁻⁹

Binders:

Ce = Cement

FA = Fly ash

LC = Lime + Cement 1:1

FGD = Flue gas
desulphurisation agent

OSA5, OSA8 = Oil Shale ash

Limit values presented in the environmental permit application of Sepänmäki noise barrier, max. 1 x 10⁻⁸ m/s.

10⁻⁸ m/s > 1...8 x 10⁻⁹ m/s

LEACHING TEST RESULTS

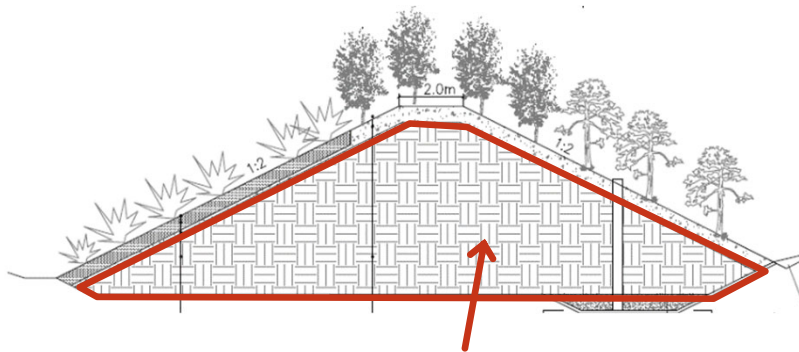
WEST HARBOUR PHASE III

Element	Limit value [mg/m ²]*	Test results** 64 d [mg/m ²]
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

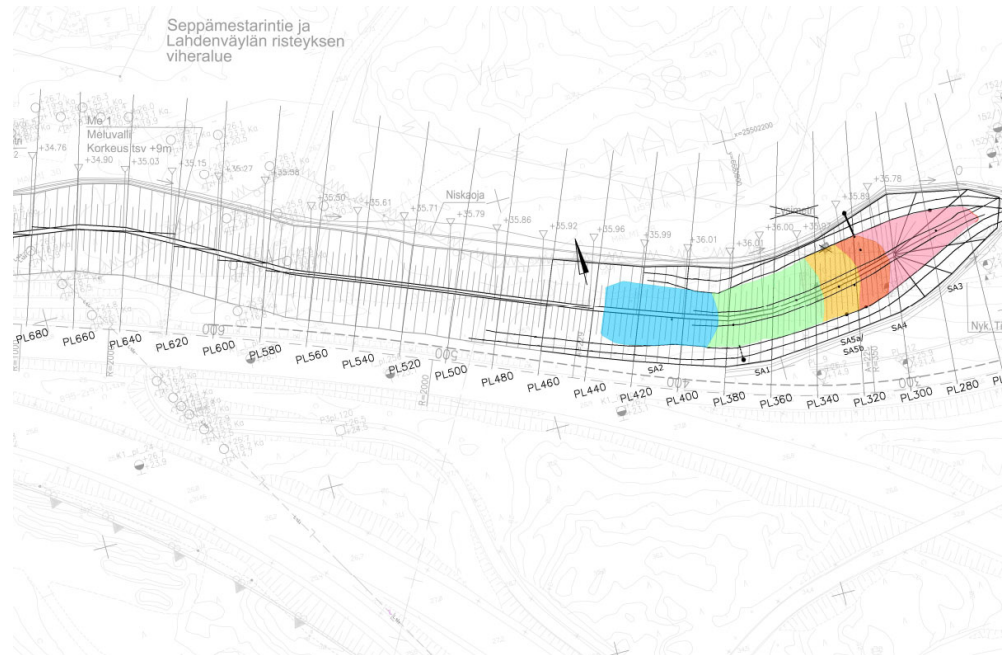
Element	Limit value [mg/m ²]*	Test results** 64 d [mg/m ²]
Lead, Pb	210 →	0.2 – 0.3
Antimony, Sb	36 →	0.8 – 16.8
Selenium, Se	14 →	0.5 – 1.9
Tin, Sn	280 →	1.5 – 6.5
Vanadium V	700 →	0.7 – 4.7
Zinc, Zn	330 →	2.4 – 4.0
Fluoride, F	2800 →	105 – 124

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

SEPÄNMÄKI NOISE BARRIER



MASS STABILIZED SURPLUS CLAY FROM WEST HARBOUR PHASE III (CONSTRUCTION IN 2016-2017)



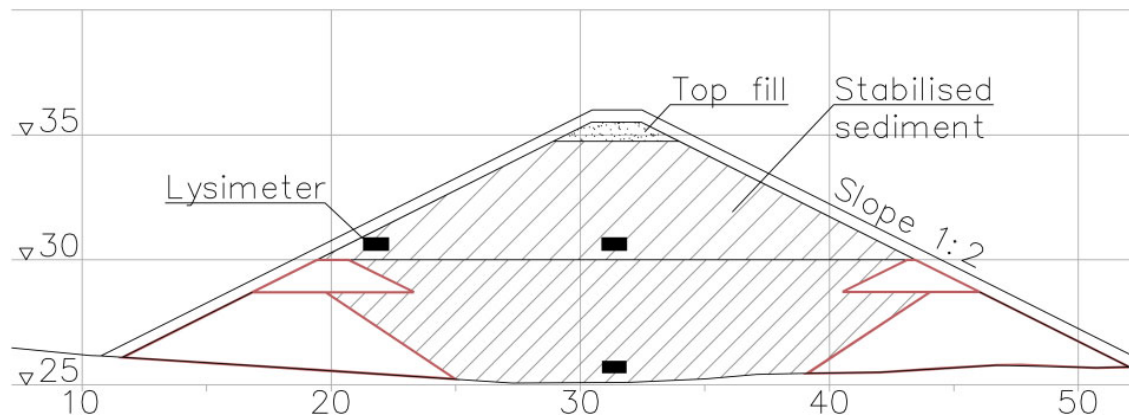
SEPÄNMÄKI NOISE BARRIER, DESIGNED H = 5-13 M

SEPÄNMÄKI NOISE BARRIER, HELSINKI

- Construction from April to October 2016
- 2893 truckloads of stabilized sediment (distance from West Harbour 12 km)
- A total of 29540 cubic meters (39,400 cu. Yd) transported and placed



SEPÄNMÄKI NOISE BARRIER INVESTIGATIONS



OTHER RE-USE EXAMPLES IN THE HELSINKI REGION

- Landfill cap structure and intermediate storage area in Vuosaari, Helsinki, **120 000 m³**, 2010-2015
- Alakivenpuisto park, Helsinki, **34 000 m³**, 2014-2015
- Road noise wall, Helsinki, **29 000 m³**, 2016
- Hyväntoivonpuisto park, Jätkäsaari, Helsinki, **5000 m³**, 2011
- Ida Aalberg park, Helsinki, **100 m³**, 2013

THANK YOU!