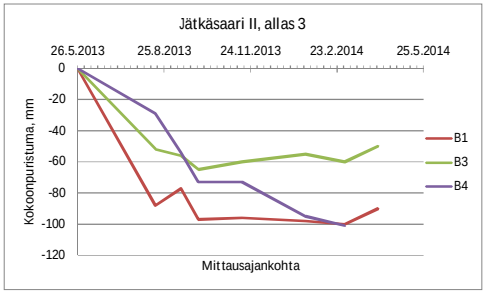
SIMM CENTER / ABSOILS CONFERENCE
10.–11. SEPTEMBER 2014

MASS STABILISED DREDGED SEDIMENTS AS CONSTRUCTION MATERIAL – JÄTKÄSAARI PILOT CASE

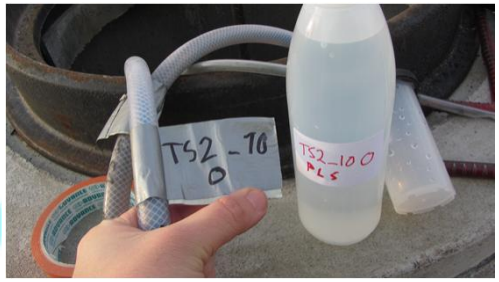


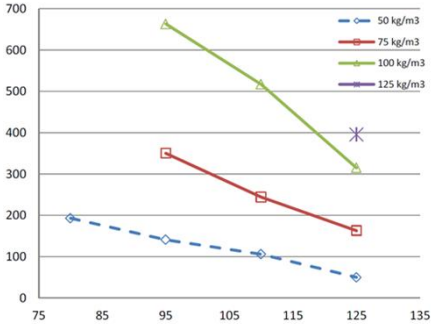
ABSOILS PROJECT
Life09 env/fi/000575

Taavi Dettenborn

Juha Forsman

RAMBØLL



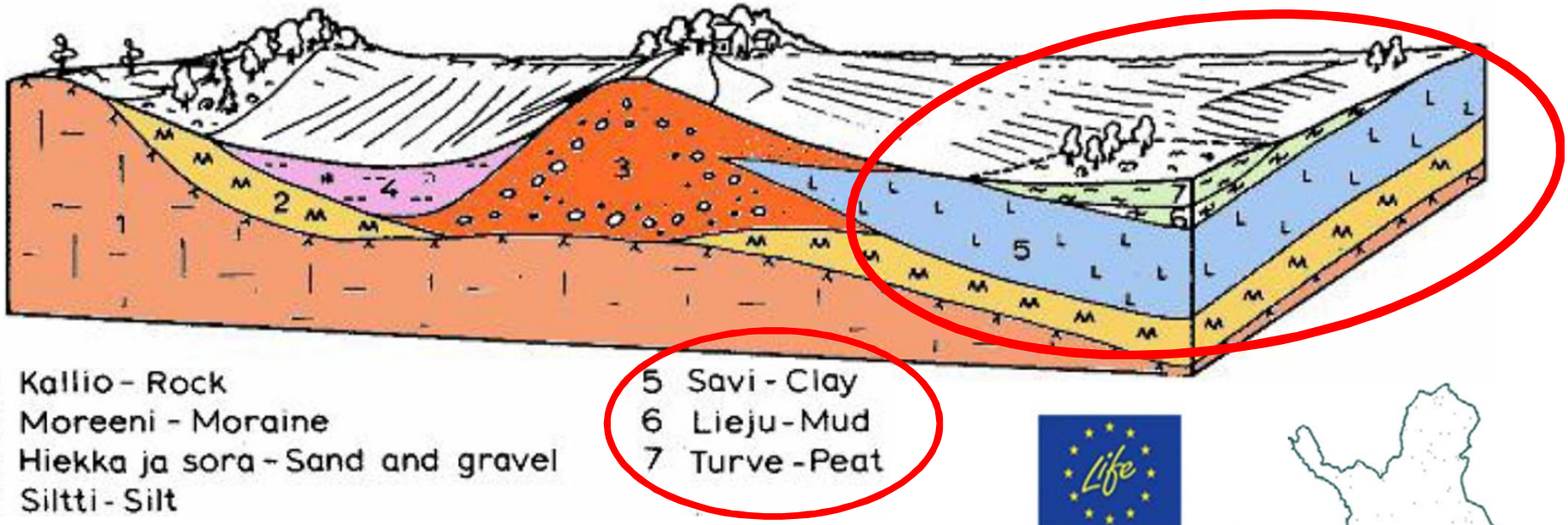


MASS STABILISED DREDGED SEDIMENTS AS CONSTRUCTION MATERIAL – JÄTKÄSAARI PILOT CASE

1. FINNISH GEOLOGY, SURPLUS SOILS
2. MASS STABILISATION METHOD
3. DEMONSTRATION CASES OF ABSOILS
4. CASE JÄTKÄSAARI I, II AND III
5. LESSONS LEARNED

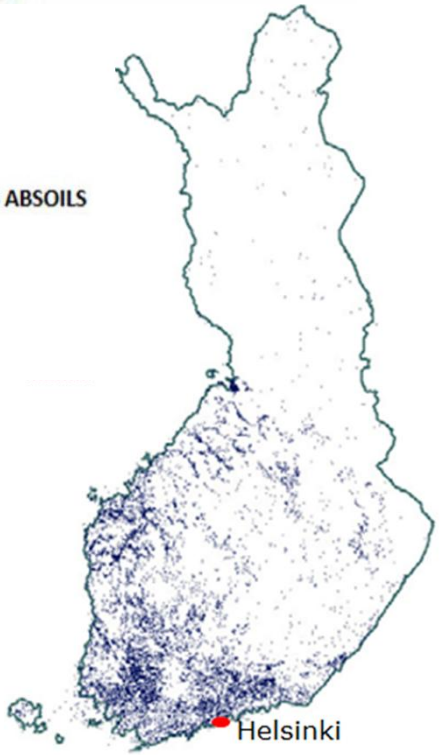
LIFE09 ENV/FI/000575

1. FINNISH GEOLOGY – AND SURPLUS SOILS



LIFE09 ENV/FI/575 ABSOILS

Clay...Mud...Peat:
w_o = 50 ... 1500 %
τ_o = 1 ... 25 kPa
Organic content = 0...97 %
Bearing capacity = not at all ... low



SURPLUS SOILS

- surplus soils are transported to landfills in the capital region of Finland
- 70% of the landfilled surplus soils are estimated to be of poor quality

1. SOLUTION: STABILISATION OF SOFT SOIL

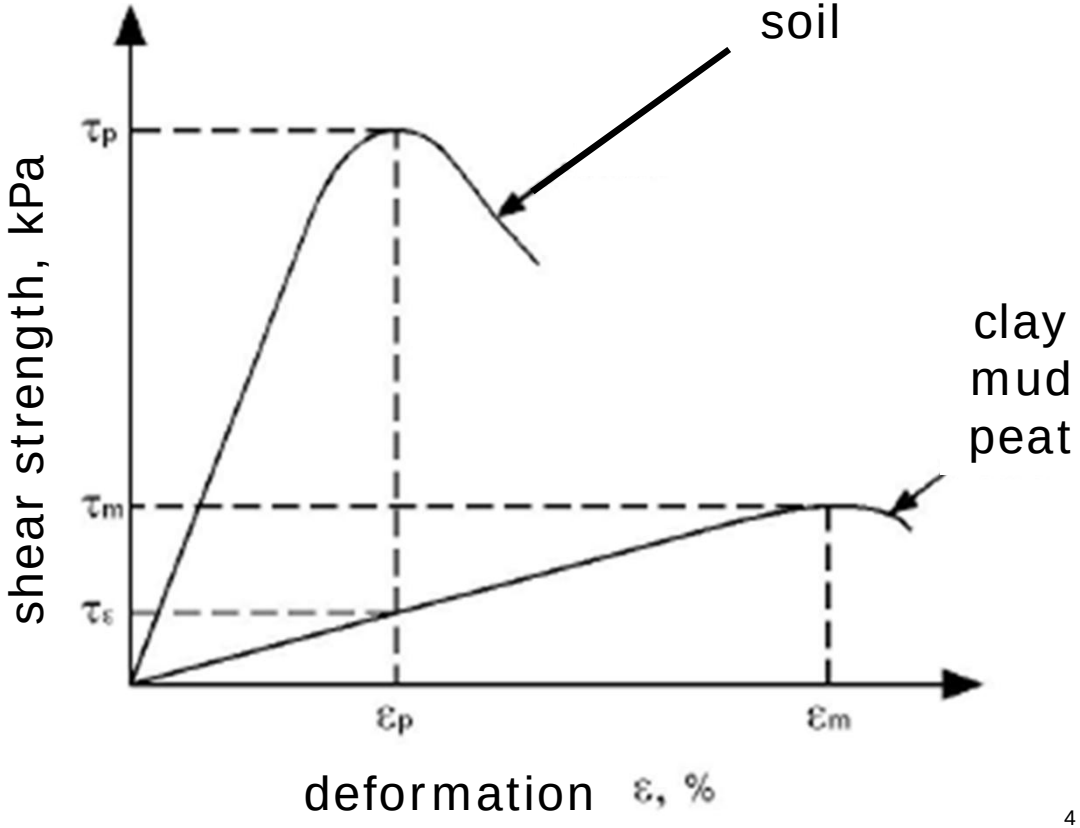
clay

binder

stabilised soil

mud

peat



3. DEMONSTRATION CASES OF ABSOILS

		Site	Volume [m^3]	Year
PILOTS	1	Arcada 2, Helsinki	35.000	2011
	2	Perkkaa dogpark, Espoo	13.000	2012-2013
	3.1	Jätkäsaari I, Helsinki	20.000	2011
	3.2	Jätkäsaari II, Helsinki	90.000	2012
	3.3	Jätkäsaari III, Helsinki	21.000	2014
	4	Jätkäsaari IV, Helsinki	1.800	2014 (?)
	5	Honkasuo, Helsinki	5.000 (?)	2015 (?)

OTHER	1	Haltiala, Potmäki, Helsinki	4.000	2011
	2	Pirttiranta, Vantaa	4.000	2011
	3	Ida Aalbergs park, Helsinki	7.800	2012-2013

3. DEMONSTRATION CASES OF ABSOILS

		Site	Stabilized material	Used binder	Purpose of use of surplus soil	Principle of stabilisation	Conducted investigations
PILOTS	1	Arcada 2, Helsinki	Surplus Clay	CEM	Lightening material	MS ex situ	stabilization tests, quality control soundings
	2	Perkkaa dogpark, Espoo	Surplus Clay	CEM; FA; FGD; gyp; LC	Embankment material	MS ex situ	stabilization tests, quality control soundings, lysimeter tests, ...
	3.1	Jätkäsaari I, Helsinki	*w ≈ 70...100 %, Hh ≈ 3...4 %	CEM	Landscaping	MS ex situ	stabilization tests, quality control soundings, leaching tests
	3.2	Jätkäsaari II, Helsinki	w ≈ 26...159 %, Hh ≈ 1,5...8,7 %	CEM ; FA	Landscaping ; Flood embankment	MS ex situ	-stabilization tests, quality control soundings, plate load tests, settlement plates, ...
	3.3	Jätkäsaari III, Helsinki	w ≈ 58...100 %, Hh ≈ 2,6...4,0 %	CEM, LC, FA, FGD, OSA5, OSA8	Noise barrier (Sepänmäki?)	MS, SC, ex situ	stabilization tests, quality control soundings, plate load tests, settlement plates, water permeability, leaching tests ...
	4	Jätkäsaari IV, Helsinki	w ≈ 58...100 %, Hh ≈ 2,6...4,0 %	CEM; FA	Noise barrier, test embankment	SC, ex situ (Jätkä III)	quality controll soundings, settlement plates, plate load tests, ...
	5	Honkasuo, Helsinki	Peat and surplus clay	Not known yet	Soil improvement	MS, in situ (peat), ex situ (clay)	stabilisation tests, ... (?)
OTHER	1	Haltiala, Potmäki, Helsinki	Column stabilized excavated surplus clay	Not known, in situ - stabilised material from many sites	Landscaping "hill"	CS, in situ and utilisation ex situ	no tests, digging at autumn 2014
	2	Pirttiranta, Vantaa	Dry crust clay, w≈ 35...50 %	No stabilization	Flood embankment	no stabilisation	no tests
	3	Ida Aalbergs park, Helsinki	Clay, substrate (humus)	Mass stabilised dredged clay from Jätkä II (800 m^3) and from other sites (7000 m^3)	Landscaping, embankemnt	MS, ex situ (Jätkä II)	no tests at site (Jätkä III material)

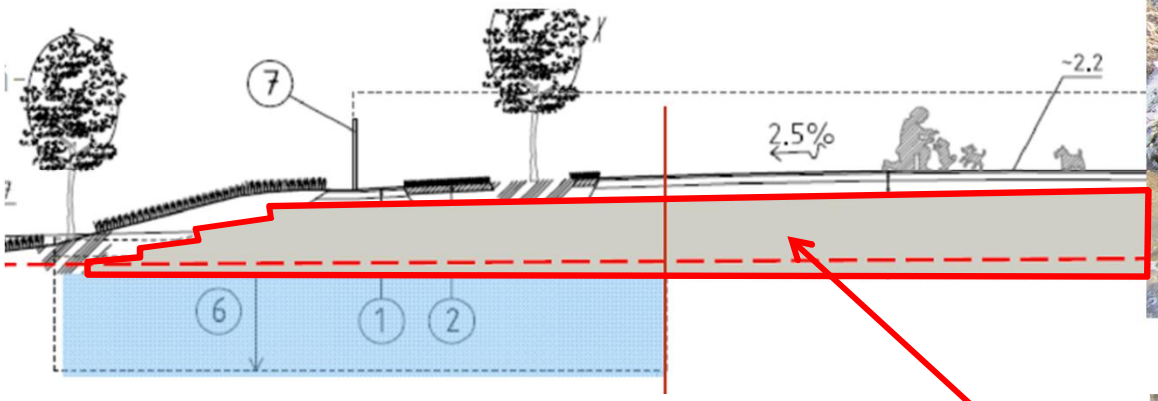
CEM = CEM II/B-M (S-LL) 42,5 N
LC = Lime-cement
FA = Fly ash

OSA = Oil shale ash
FGD = Flue gas desulphurisation gas
Gyp = Gypsum

MS = mass stabilisation
SC = Screener Crushes
CS = Column stabilistaion

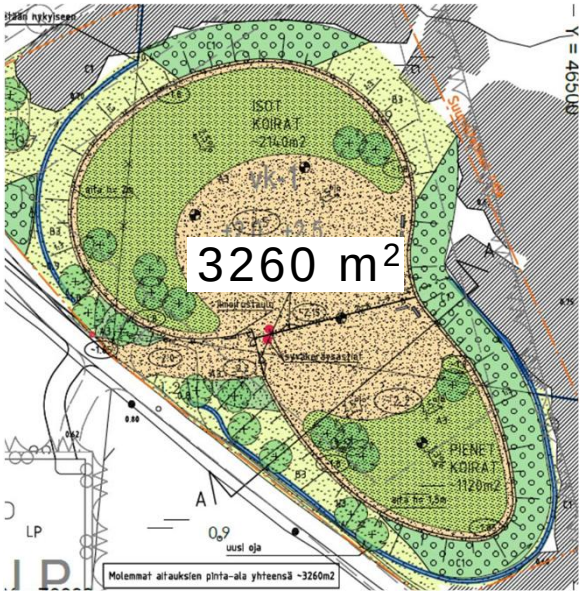
3. CASE: PERKKAA DOG PARK 1 / 2

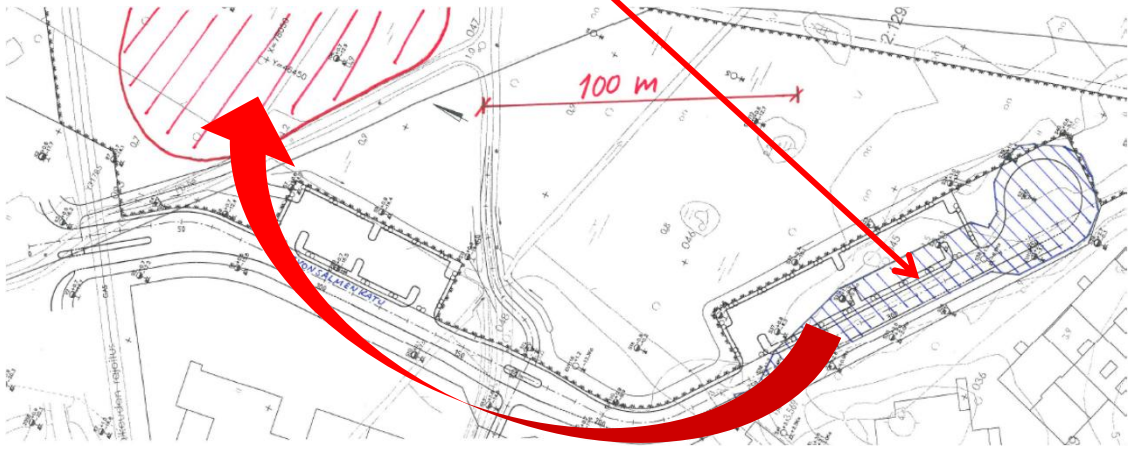
LIFE09 ENV/FI/575 ABSOILS



Surplus clays obtained from an adjacent construction

Mass stabilized subsoil



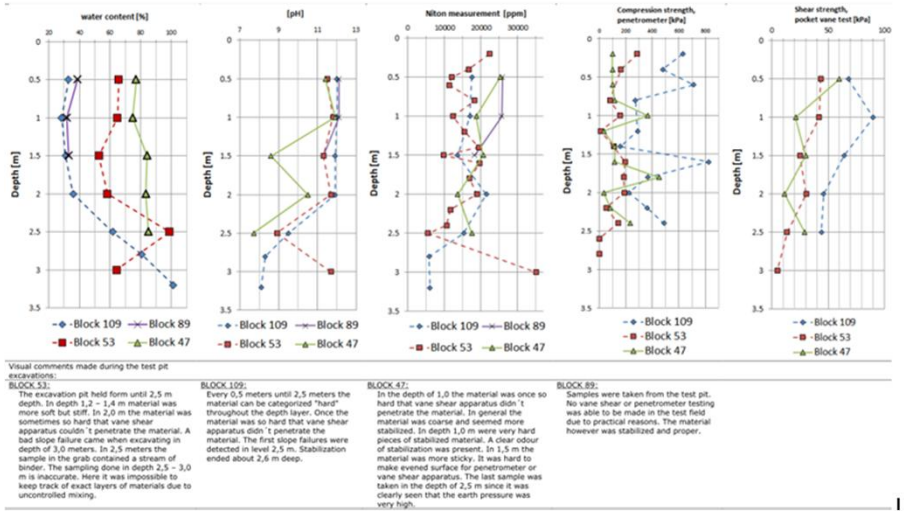


3. CASE: PERKKAA DOG PARK 2 / 2

LIFE09 ENV/FI/575 ABSOILS

Mass stabilisation 15.01.2013

Quality control 2013

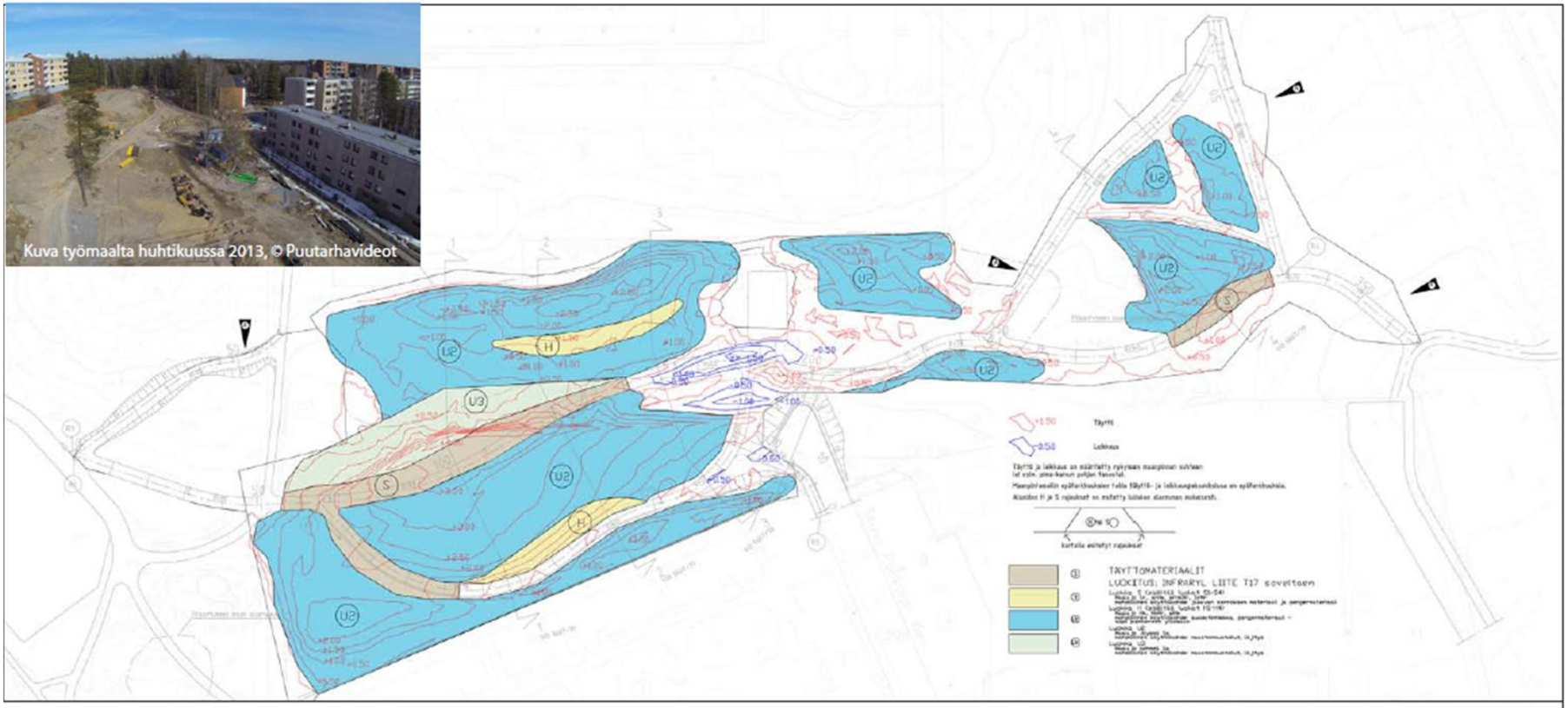


Installing lysimeters 11.2.2013

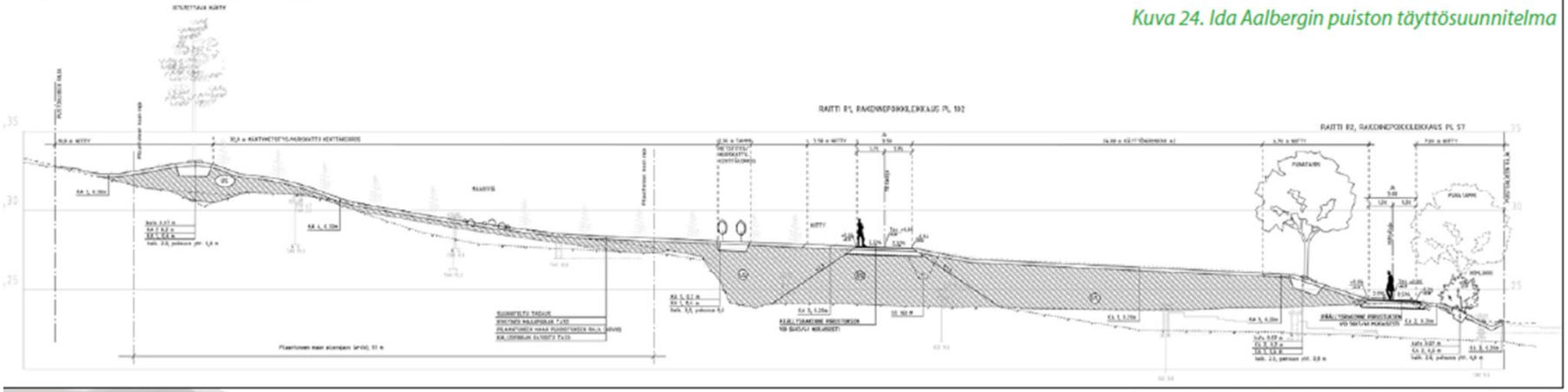
Measuring lysimeter in ready Dog Park 12.2.2012

3. IDA AALBERG PARK

DI-työ Aino-Kaisa Nuotio



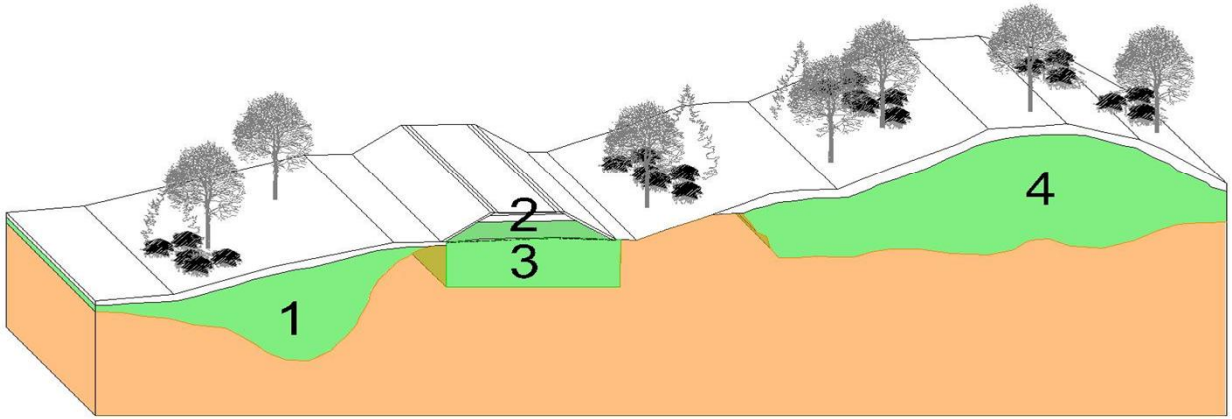
Kuva 24. Ida Aalbergin puiston täyttösuunnitelma



Kuva 25. Ida Aalbergin puiston rakenneleikkauksia

3. IDA AALBERG PARK

LIFE09 ENV/FI/575 ABSOILS



3. CASE: PIRTTIMÄKI, VANTAA, FLOOD EMBANKMENT (SURPLUS CLAY)

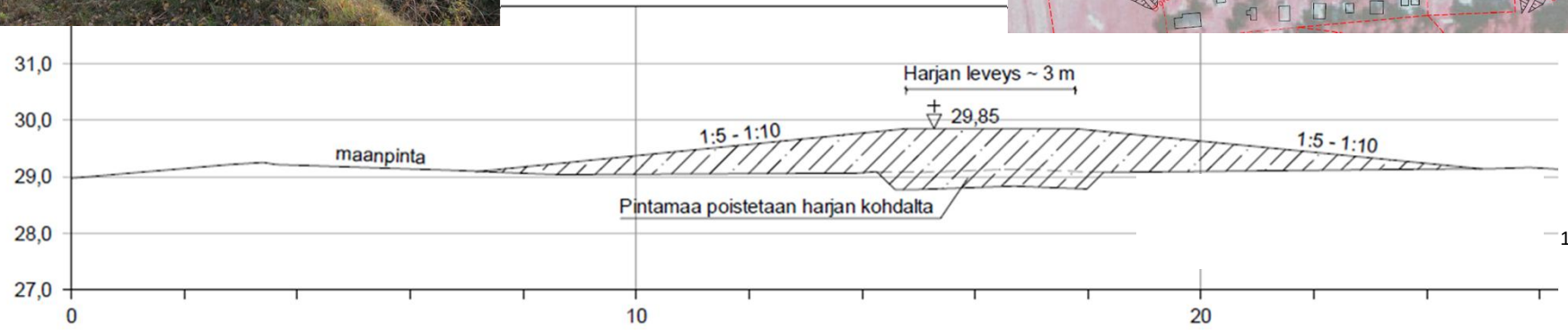
LIFE09 ENV/FI/575 ABSOILS

PROBLEM

Spring flood 1966

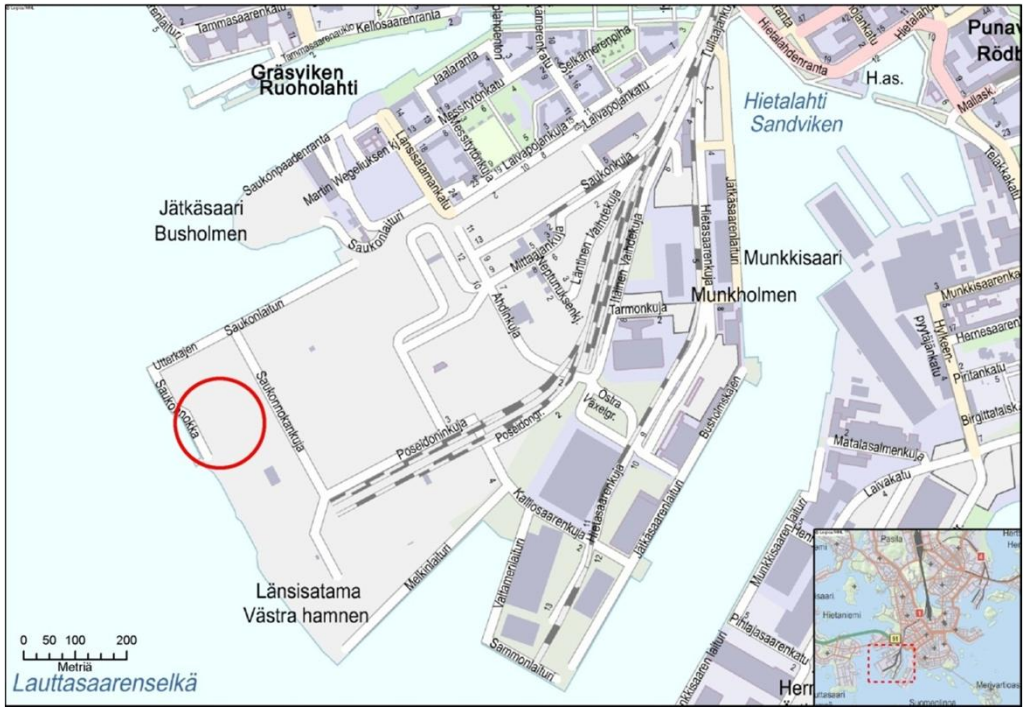
Summer flood 2004

SOLUTION



4. JÄTKÄSAARI I, II AND III MASS STABILATION OF DREDGED SEDIMENTS

LIFE09 ENV/FI/575 ABSOILS



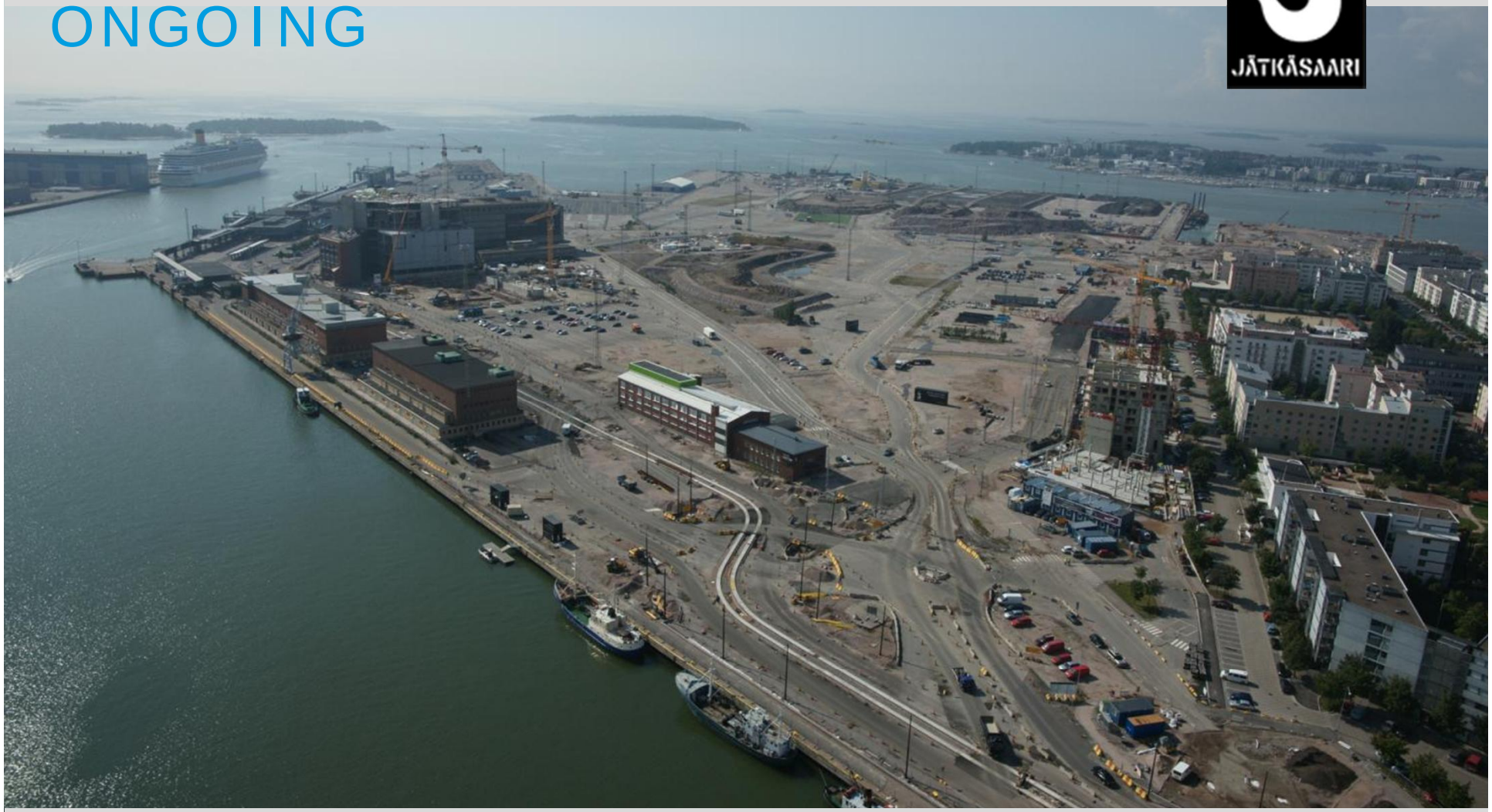
RAMBØLL

WEST HARBOUR NEW HOUSING DISTRICT IN 2030

CITY OF HELSINKI - Introducing Major Urban Development Projects

WEST HARBOUR NEW HOUSING DISTRICT, CONSTRUCTION ONGOING

JÄTKÄSAARI



Helsingin kaupunki

http://www.uuttahelsinkia.fi/jatkasaari/perustiedot/webcam-jatkasaareen

JÄTKÄSAARI I, II AND III

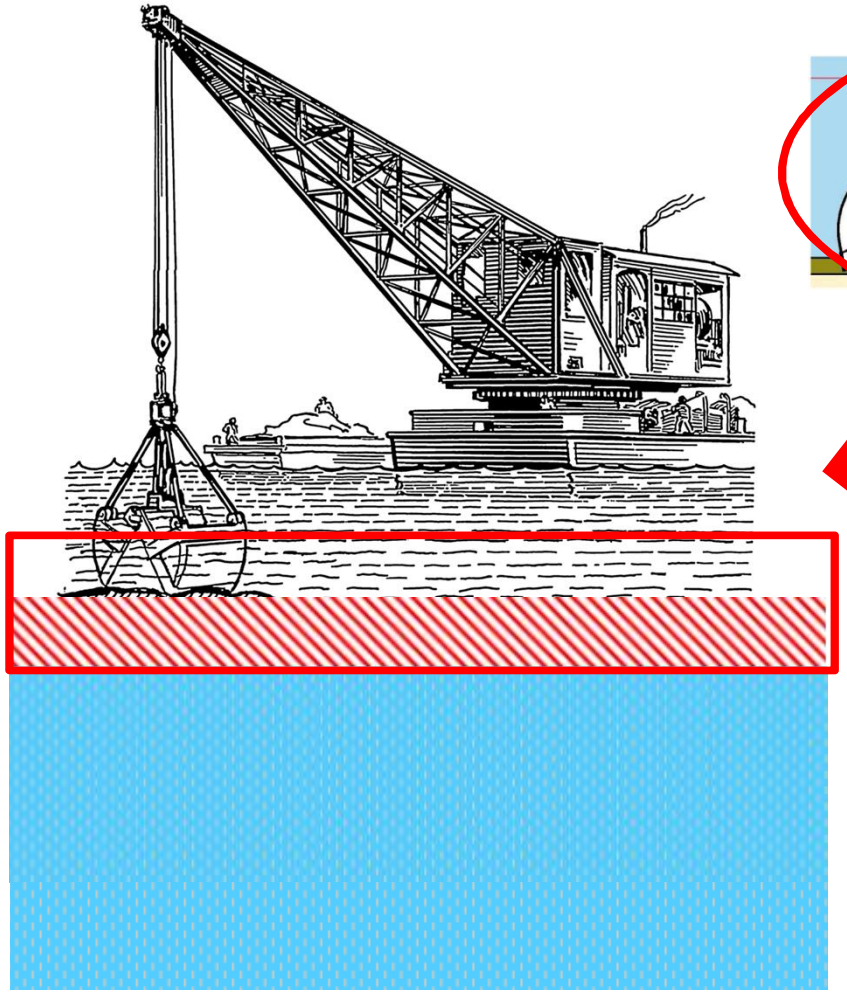
MASS STABILIZATION OF SOFT SOILS AT THE SITE

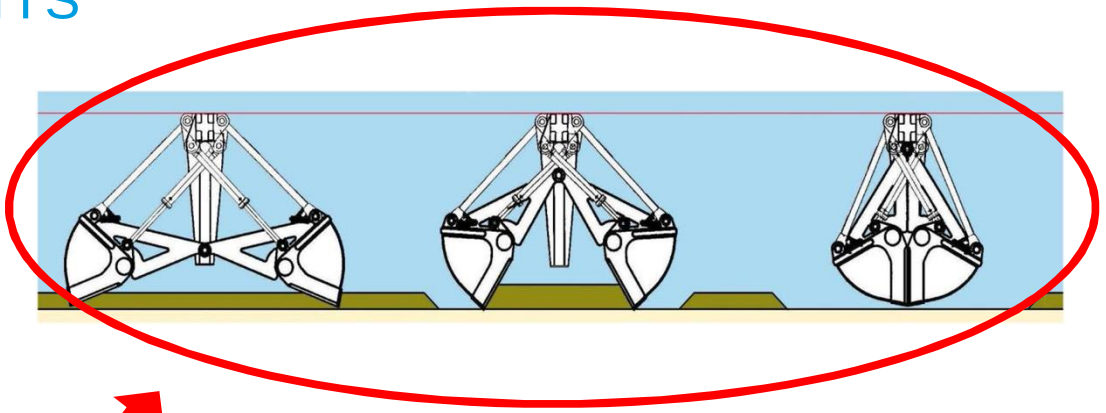
LIFE09 ENV/FI/575 ABSOILS

RAMBØLL

4. JÄTKÄSAARI

- DREDGING SEDIMENTS





PROBLEM

Contaminated sediments

Mass stabilization

Utilization as earth construction material

Clean sediments

Deposit to sea

RAMBØLL

LIFE09 ENV/FI/575 ABSOILS

4. JÄTKÄSAARI
- 3 PHASES (I, II AND III)

Phase	Volume m³	
Jätkäsaari I	20.000	Spring 2011
Jätkäsaari II	80.000	Autumn 2012
Jätkäsaari III	21.000	Winter 2014

Dredeg 06/2013

Mass and screener crusher stabilization spring 2014

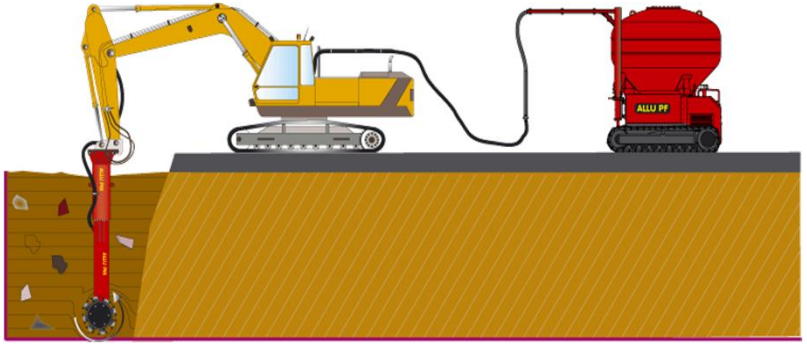
Binders:

- Fly ash
- Lime Cement
- Flue gas desulphurisation gas
- CEM II/B-M (S-LL) 42,5 N
- Oil Shale ash

RAMBØLL

LIFE09 ENV/FI/575 ABSOILS

4. JÄTKÄSAARI - MASS STABILISATION METHODS

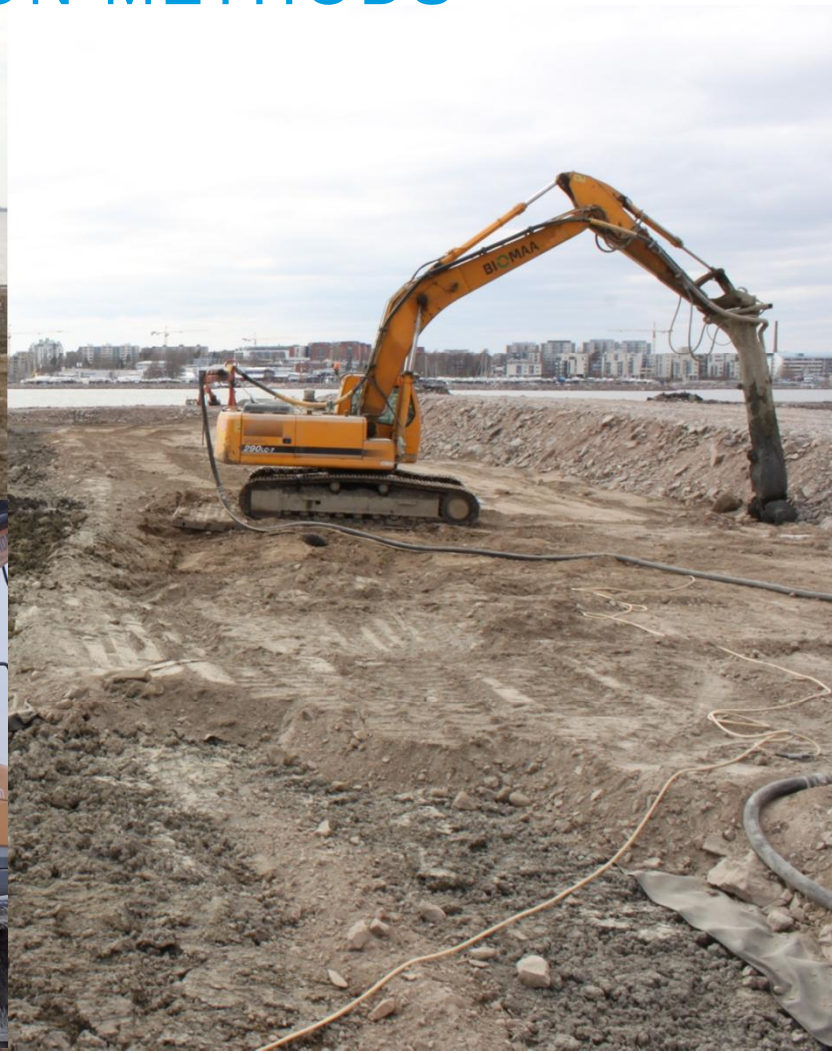


Mixing tool installed on an excavator machine and a binder storage tank

RAMBØLL

LIFE09 ENV/FI/575 ABSOILS

4. JÄTKÄSAARI III
- MASS STABILISATION METHODS

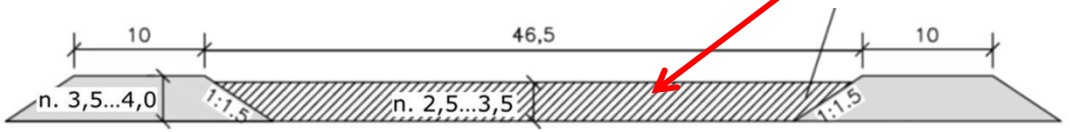


RAMBØLL

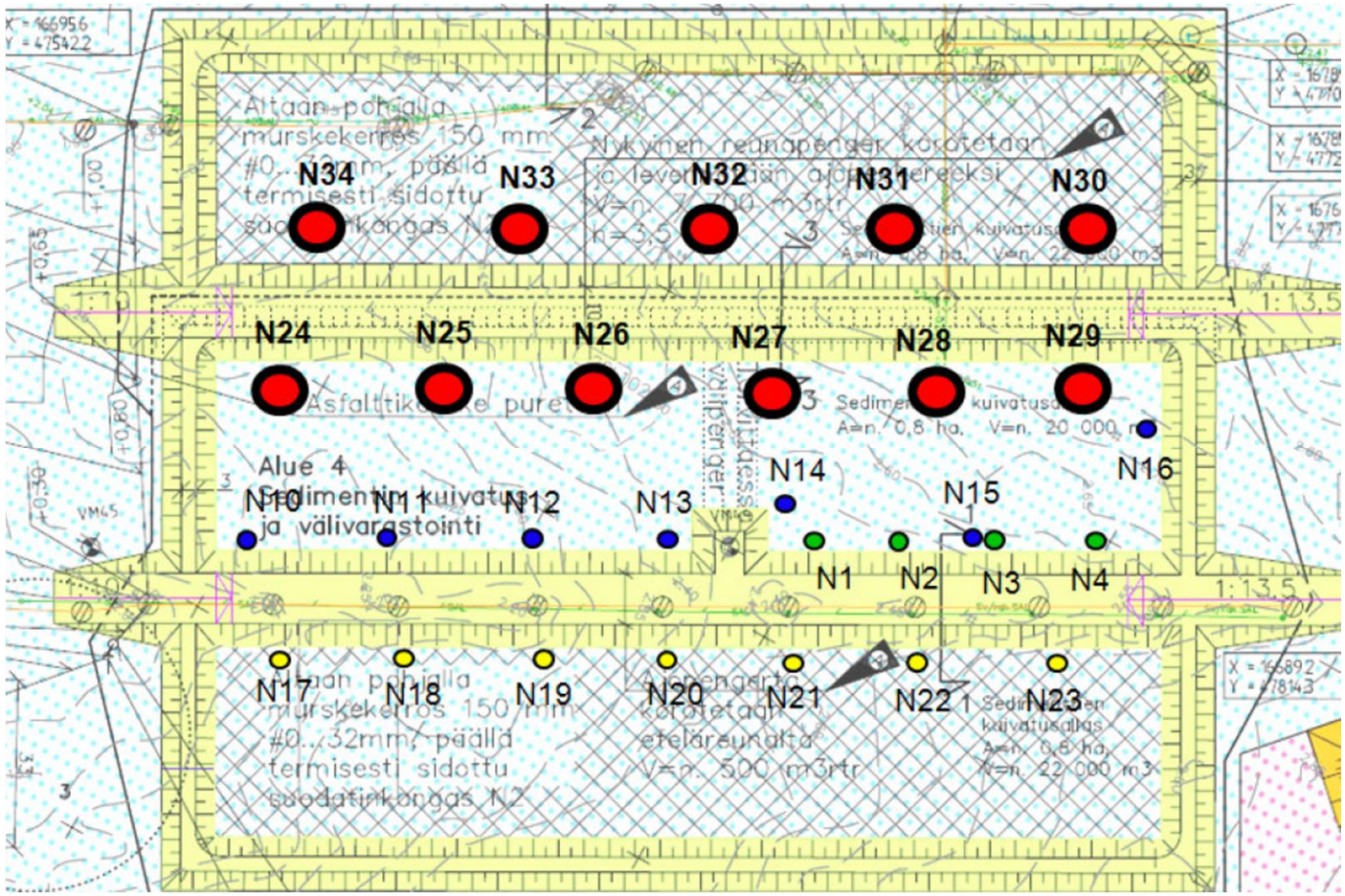
LIFE09 ENV/FI/575 ABSOILS

4. JÄTKÄSAARI - PRELIMINARY TESTS FROM STAGE I

Cross section



View from top

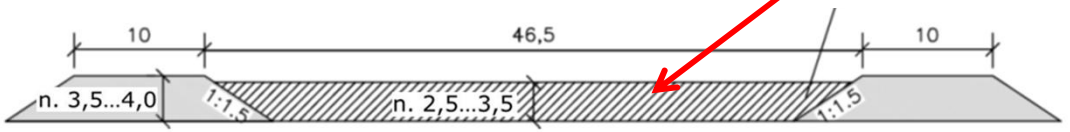


LIFE09 ENV/FI/575 ABSOILS

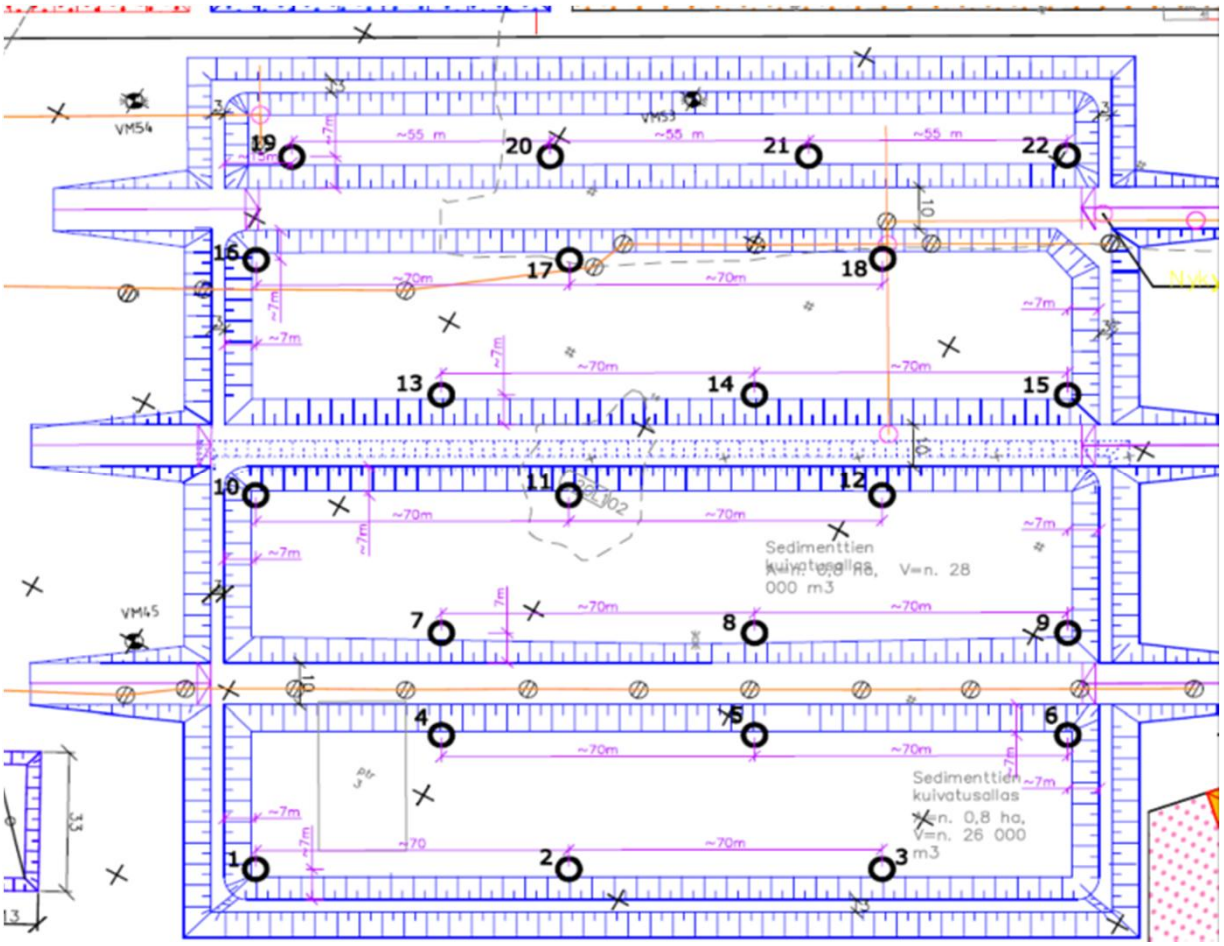
RAMBØLL

4. JÄTKÄSAARI - PRELIMINARY TESTS FROM STAGE II

Cross section



View from top

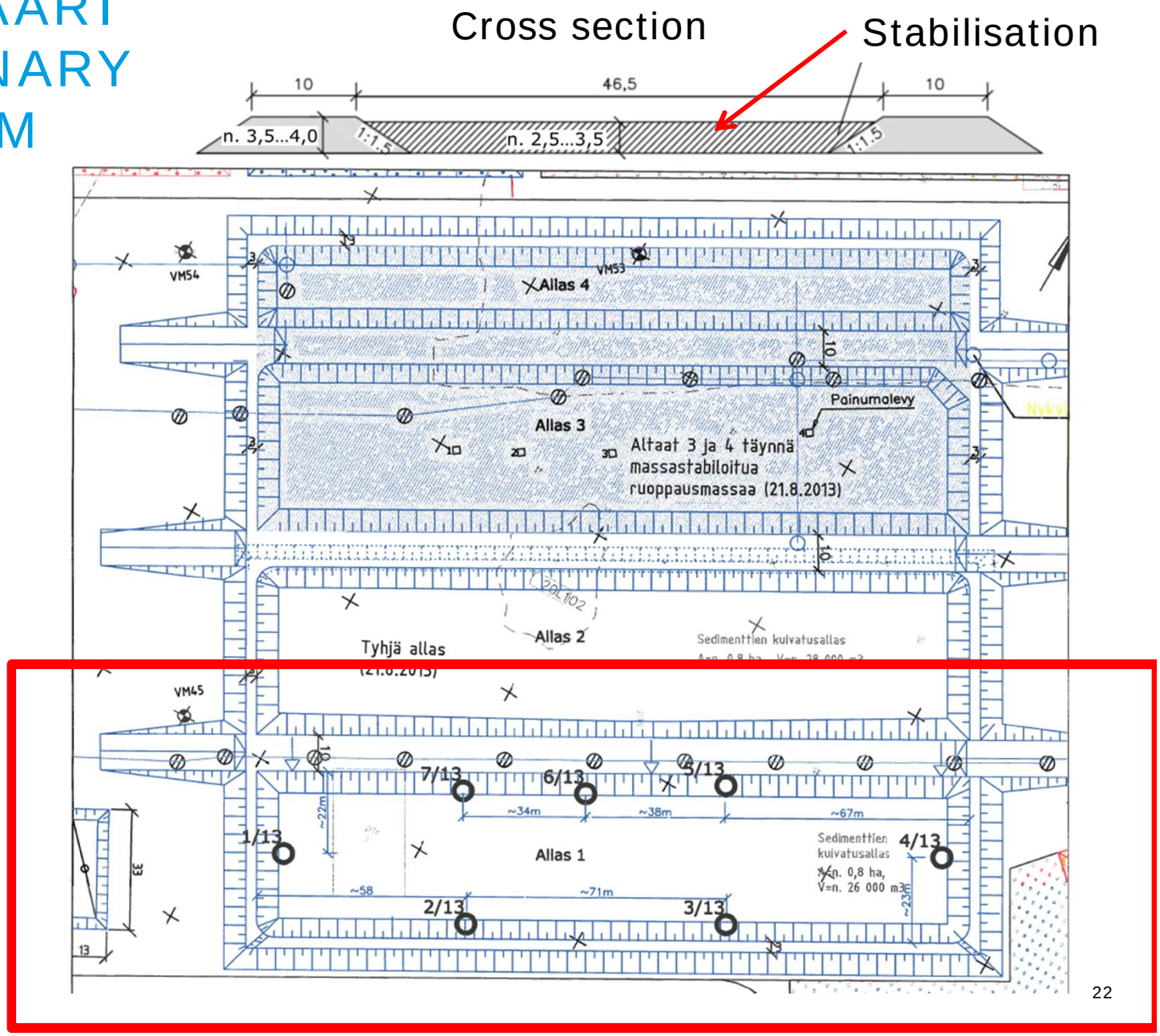


LIFE09 ENV/FI/575 ABSOILS

RAMBØLL

4. JÄTKÄSAARI - PRELIMINARY TESTS FROM STAGE III

View from top

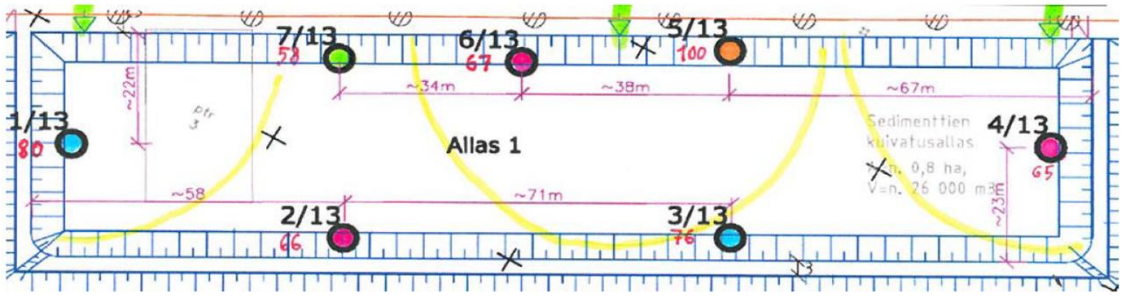


LIFE09 ENV/FI/575 ABSOILS

RAMBØLL

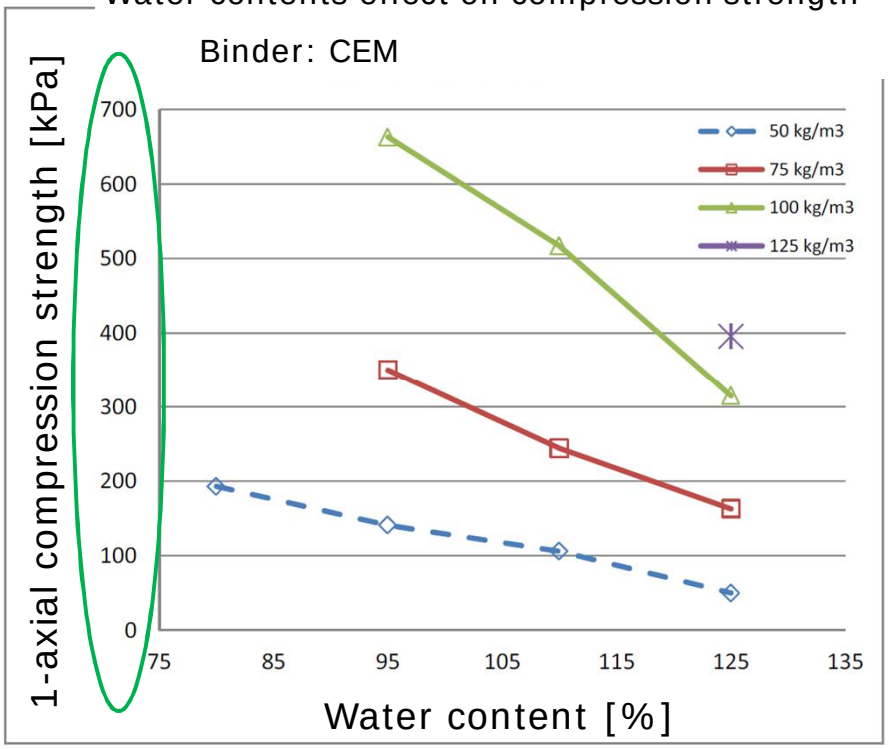
4. JÄTKÄSAARI III
- SOME LABORATORY RESULTS

LIFE09 ENV/FI/575 ABSOILS



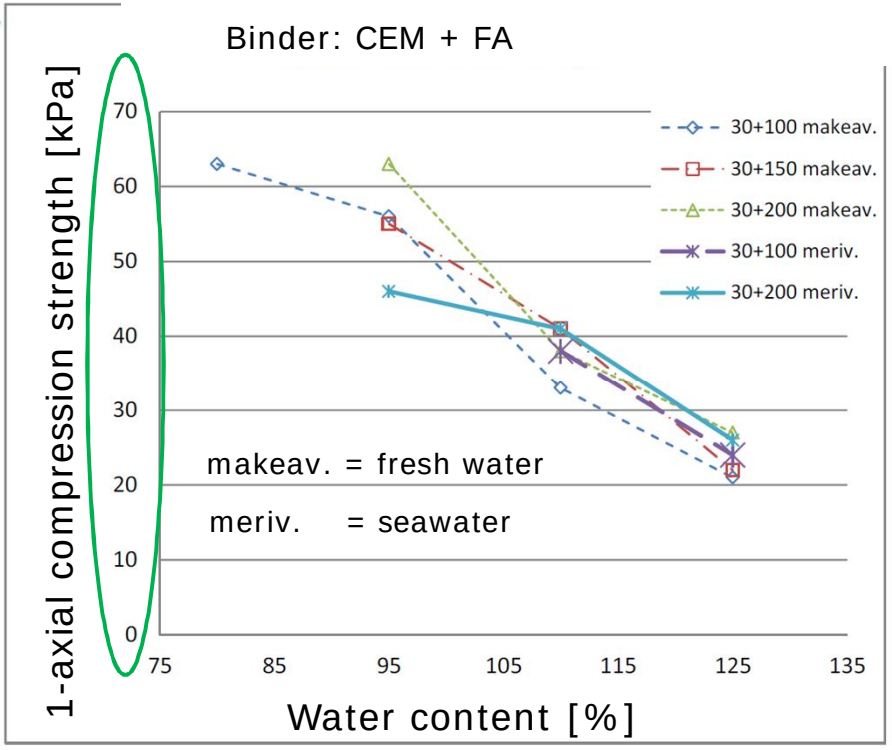
Water contents effect on compression strength

Binder: CEM



Water contents effect on compression strength

Binder: CEM + FA



4. JÄTKÄSAARI III
- SOME LABORATORY RESULTS

LIFE09 ENV/FI/575 ABSOILS

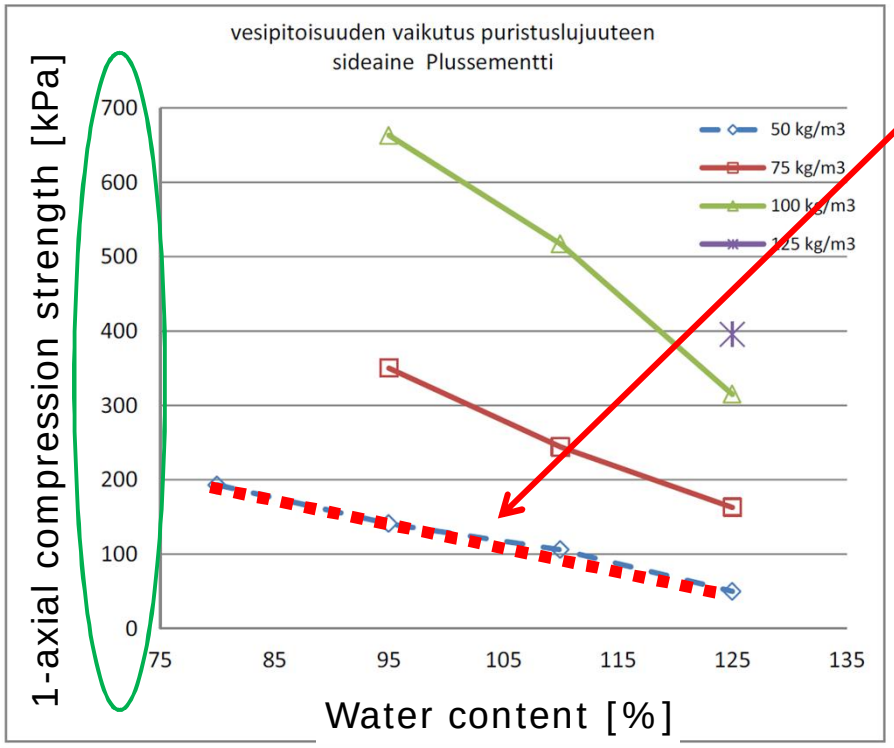
RESULT:

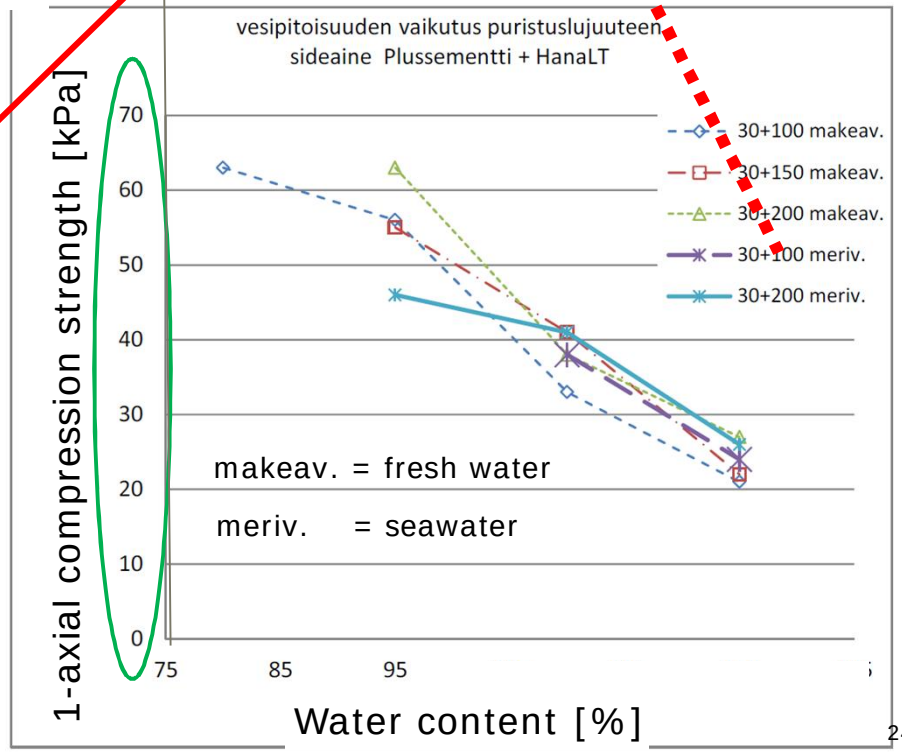
- CEM binder sensitive to water content

- Adding FA to binder mix → More tolerance to water contetnt changes

150 kPa

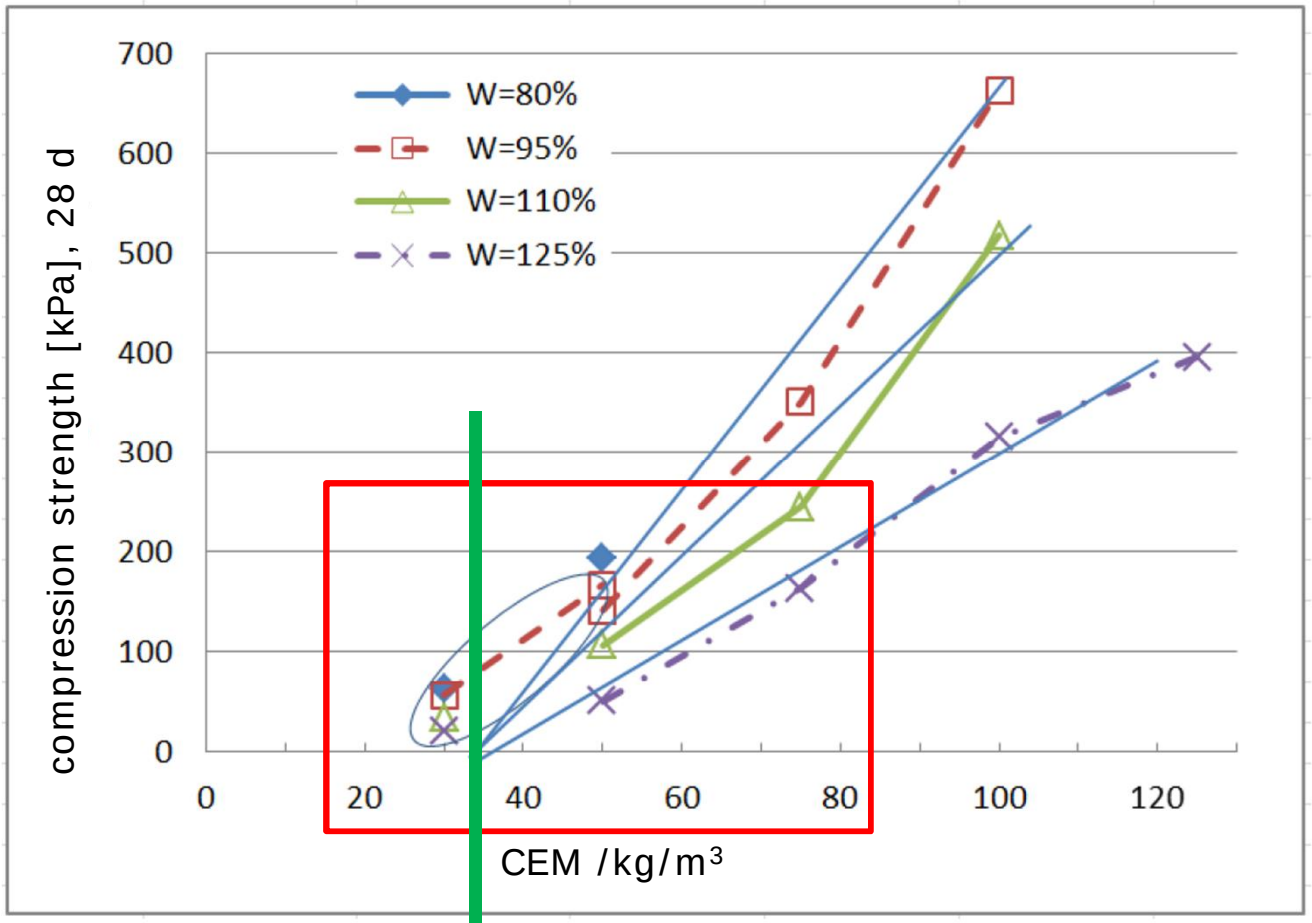
100 kPa





4. JÄTKÄSAARI III
- SOME LABORATORY RESULTS

LIFE09 ENV/FI/575 ABSOILS



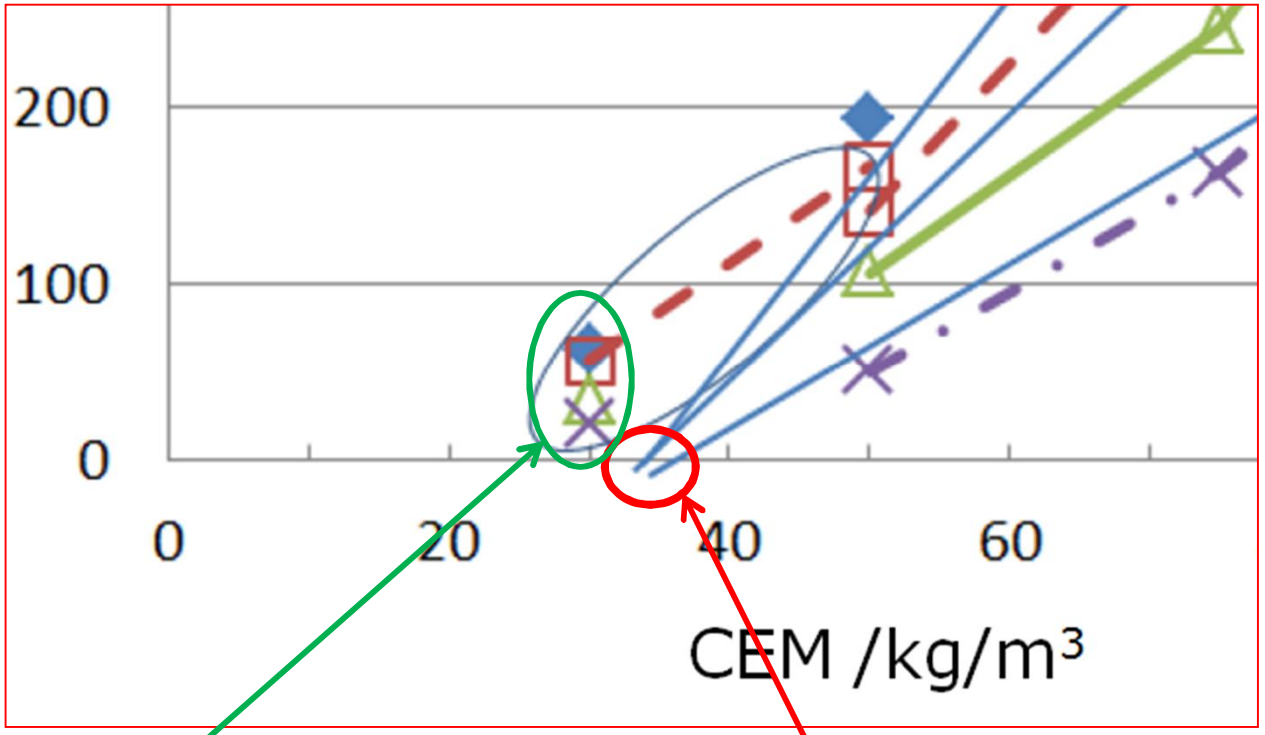
Binder mix: CEM30 + FA100

Only binder is CEM

RAMBOLL

4. JÄTKÄSAARI III
- SOME LABORATORY RESULTS

LIFE09 ENV/FI/575 ABSOILS



Adding FA to binder mix →
Min. amount of CEM could be lower than using only CEM, however, gained strength is lower

Only CEM binder →
Min. amount of CEM 40…50 kg/m3

4. JÄTKÄSAARI III / BINDERS PLANNED AND REALIZED AMOUNTS

LIFE09 ENV/FI/575 ABSOILS

Area	Binder mix	binder amount [kg/m³]	Volume [m³]
SA1	LC+FA	50+150	8000 / **7025**
SA2	LC+FA+FDG	50+75+75	6000 / **3163**
SA3	CEM+FA	50+150	3400 / **5310**
SA4	CEM+FA+FDG	50+75+75	2600 / **2338**
SA5a	OSA B8	150	500 / **900**
SA5b	OSA B5	150	500 / **500**
SA3	CEM+FA	50+150	2500 / **1760**
			23 500 / **20995**

FA = Fly ash
LC = Lime Cement
FDG = Flue gas desulphurisation gas
CEM = CEM II/B-M (S-LL) 42,5 N
OSA = Oil Shale ash

Planned / Realized

Binder	Total amount
CEM	471 t
Lime Cement	509 t
Fly Ash	2527 t
Oil Shale ash	210 t
Flue gas desulphurisation gas	413 t

RAMBØLL

4. JÄTKÄSAARI III - BINDER COSTS

Binder mix	binder amout (kg/m³)	compression strenght 28 d (kPa)	binder cost €/m³ (VAT. 0 %)
CEM + OSA	10+100	144	5,1
CEM + HanaFA + OSA	30+50+50	136	5,2
LC 3:7 + HanaFA	50+100	187	6,4
CEM + HanaFA	50+100	166	5,3
Oil shale ash OSA (=OSA8)	150	164	6,0
CEM + HanaFA + FDG	50+50+50	155	5,3

Binder	€/t
CEM	105
Lime Cement	128
Fly Ash	0
Oil Shale ash (=OSA8)	40
Flue gas desulphu-risation gas	0

Comercial binders	binder amout (kg/m³)	compression strenght 28 d (kPa)	binder cost €/m³ (VAT. 0 %)
CEM	75	350	7,9
CEM	100	663	10,5
LC 3:7	75	235	9,6

RAMBOLL

LIFE09 ENV/FI/575 ABSOILS

4. JÄTKÄSAARI III - QUALITY CONTROL

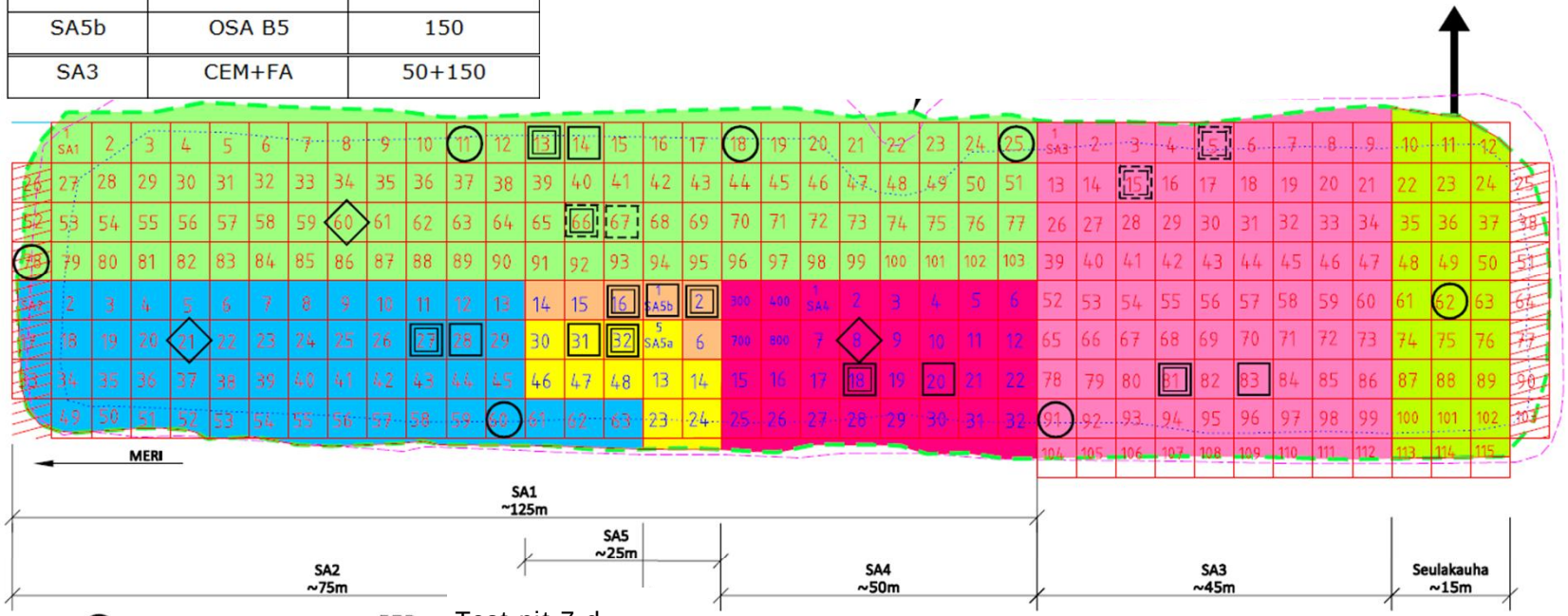
- SOUNDINGS, TEST PITS, SEDIMENT SAMPLES / BINDER AREAS

Area	Binder mix	binder amount [kg/m³]
SA1	LC+FA	50+150
SA2	LC+FA+FDG	50+75+75
SA3	CEM+FA	50+150
SA4	CEM+FA+FDG	50+75+75
SA5a	OSA B8	150
SA5b	OSA B5	150
SA3	CEM+FA	50+150

FA = Fly ash
LC = Lime Cement
FDG = Flue gas desulphurisation gas
CEM = CEM II/B-M (S-LL) 42,5 N
OSA = Oil Shale ash

LIFE09 ENV/FI/575 ABSOILS

Screener crusher
stabilised sediment

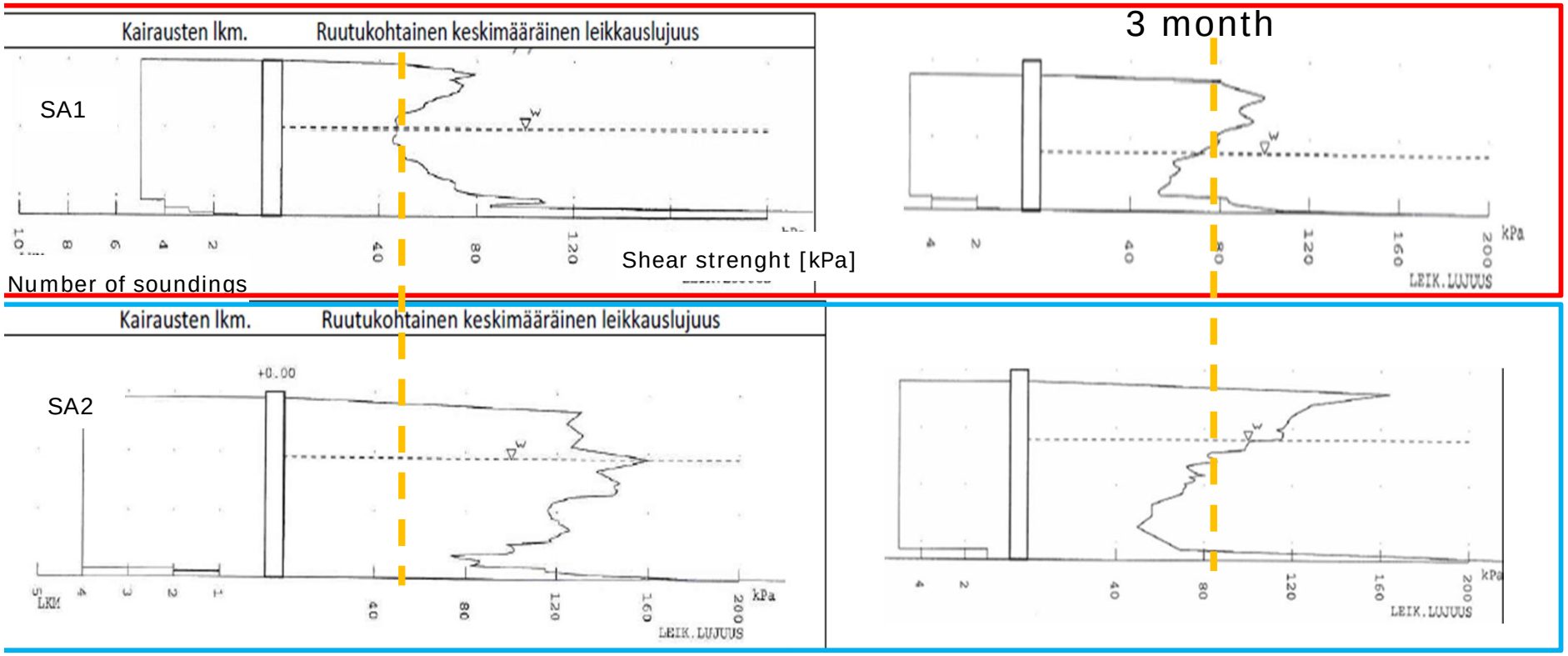


Sediment sample
Sounding 14 d
Sounding 1 month
Sounding 3 months
Test pit 7 d
Test pit 14 d
Test pit 1 month

Jätkäsaari
Yliäämämalden sta
Alas 1
Helsinki
RAMBOLL
GEO 1510004948
30.4.2014

4. JÄTKÄSAARI III - QUALITY CONTROL SOUNDINGS

1 month



SA1	KC+LT	50+150
SA2	KC+LT+RPT	50+75+75
SA3	PlusSe+LT	50+150
SA4	PlusSe+LT+RPT	50+75+75
SA5a	PKT B8	150
SA5b	PKT B5	150
SA3	PlusSe+LT	50+150

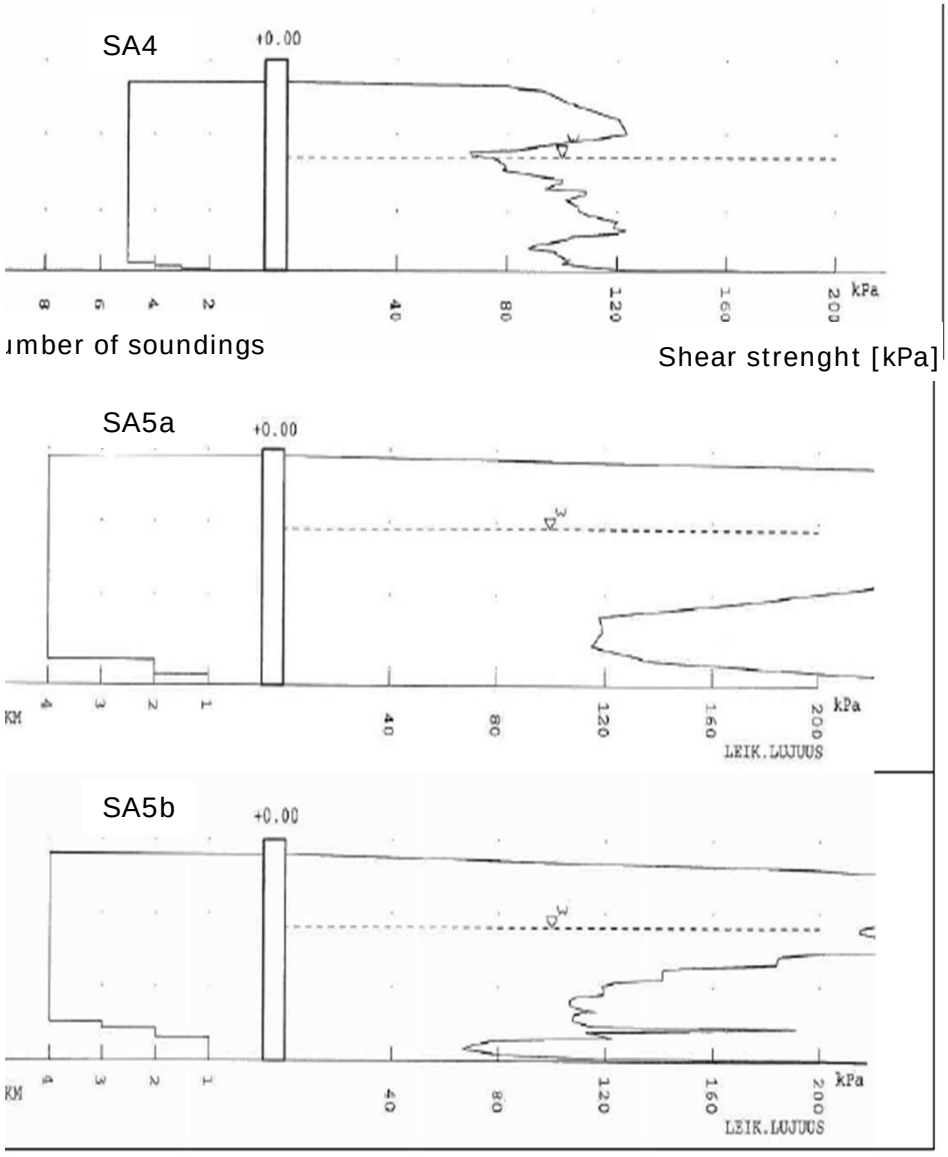
= 200 kg/m3
= 200 kg/m3

LT = Fly ash
KC = Lime Cement
RPT = Flue gas desulphurisation gas
PLusSe = CEM II/B-M (S-LL) 42,5 N
PKT = Oil Shale ash

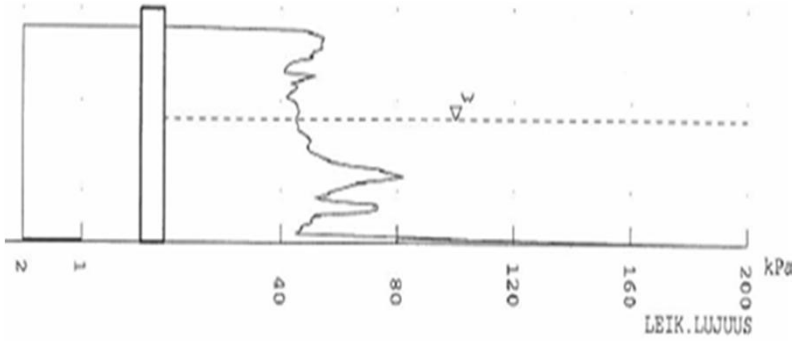
LIFE09 ENV/FI/575 ABSOILS

4. JÄTKÄSAARI III - QUALITY CONTROL SOUNDINGS

1 month



3 month

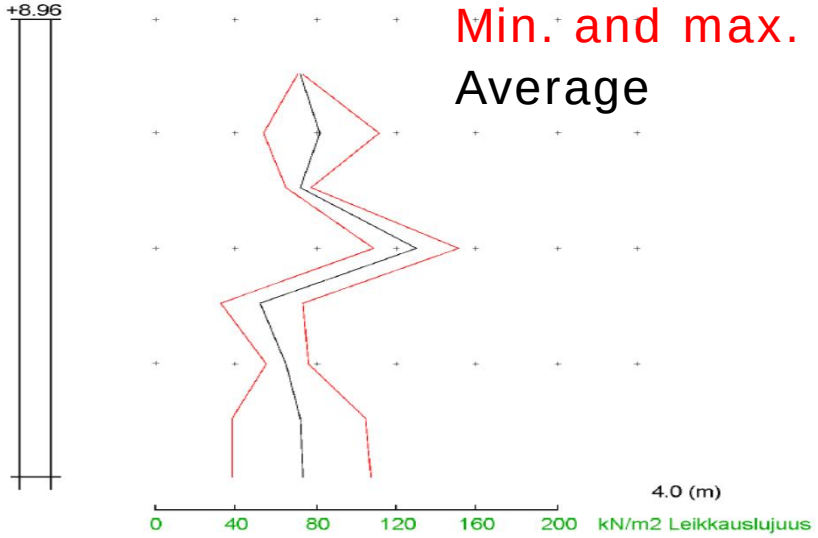


Area	Binder mix	binder amount [kg/m³]
SA1	LC+FA	50+150
SA2	LC+FA+FDG	50+75+75
SA3	CEM+FA	50+150
SA4	CEM+FA+FDG	50+75+75
SA5a	OSA B8	150
SA5b	OSA B5	150
SA3	CEM+FA	50+150

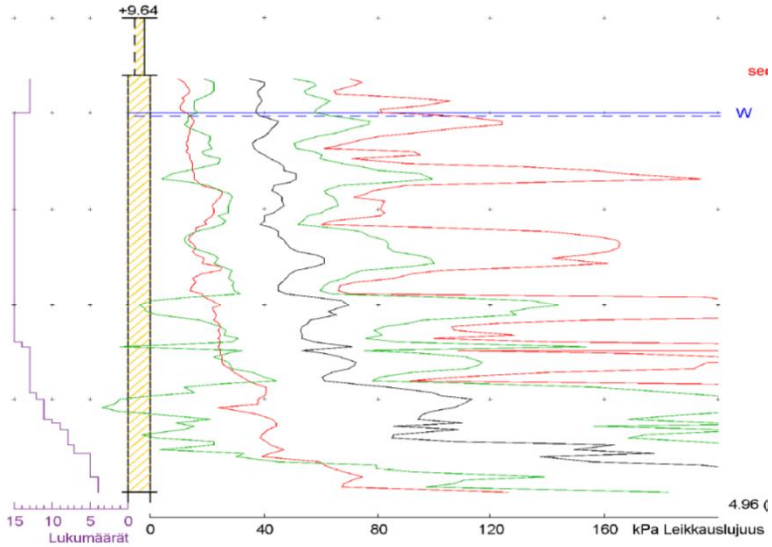
LIFE09 ENV/FI/575 ABSOILS

4. JÄTKÄSAARI I, HELSINKI – 2011, 20 000 M^3

LIFE09 ENV/FI/575 ABSOILS

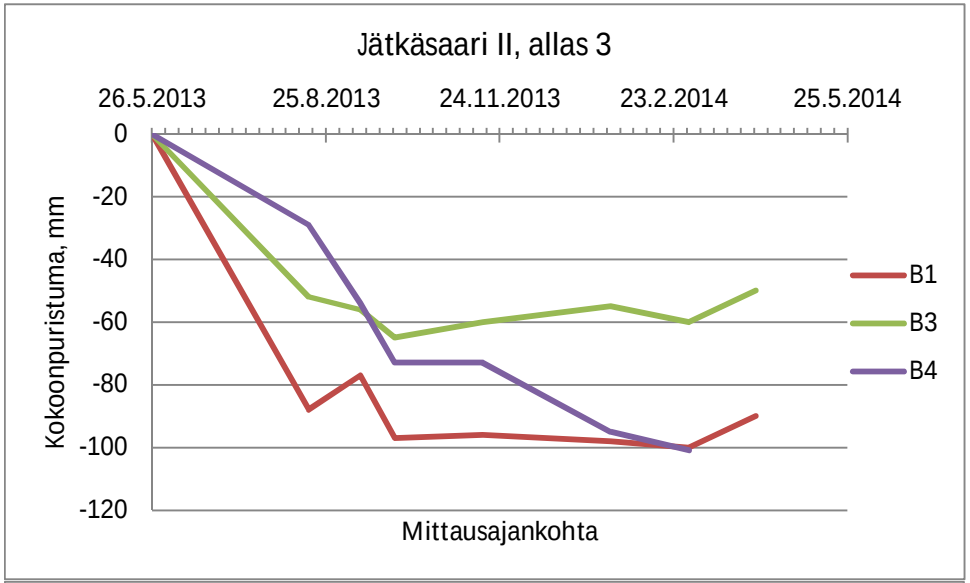


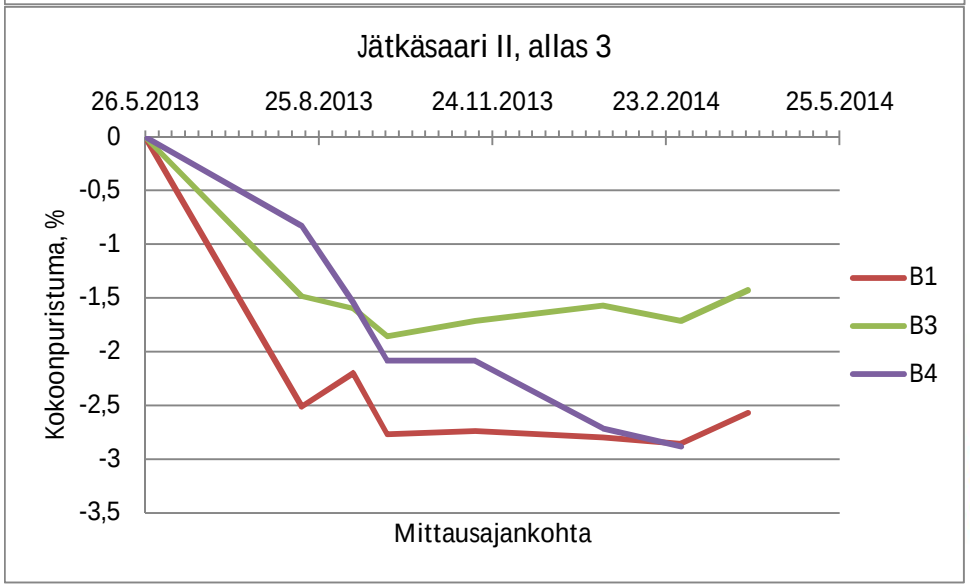
Stabilized material on stockpile

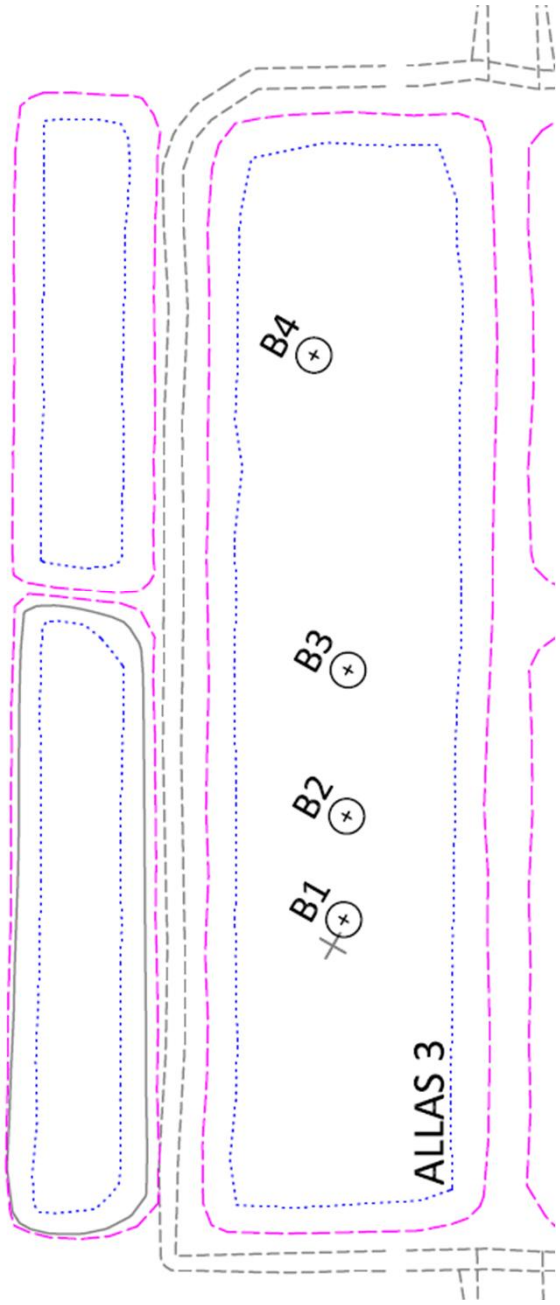


Sounding results from stockpile

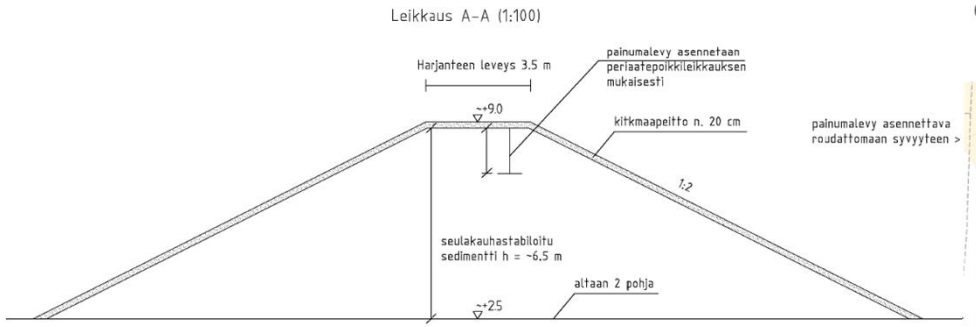
4. JÄTKÄSAARI II – SETTLEMENT PLATES ON TOP OF MASS STABILIZATION

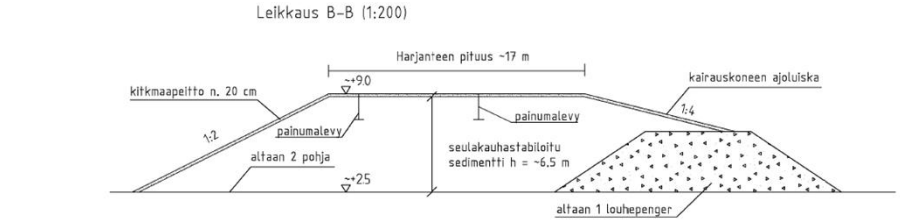


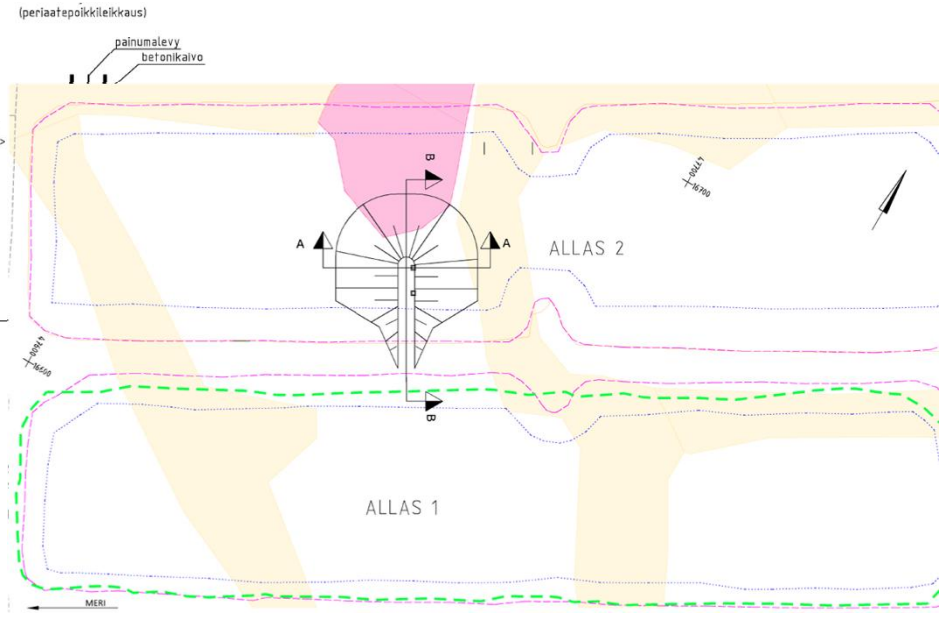




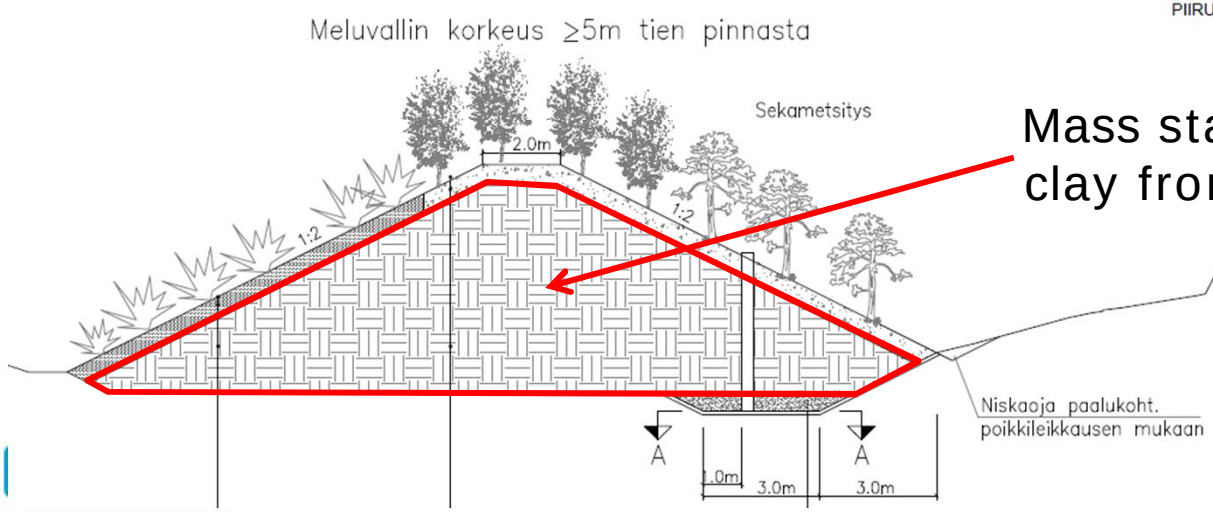
4. JÄTKÄSAARI IV – NOISE BARRIER 2014 (?)







PIIRUSTUS 3

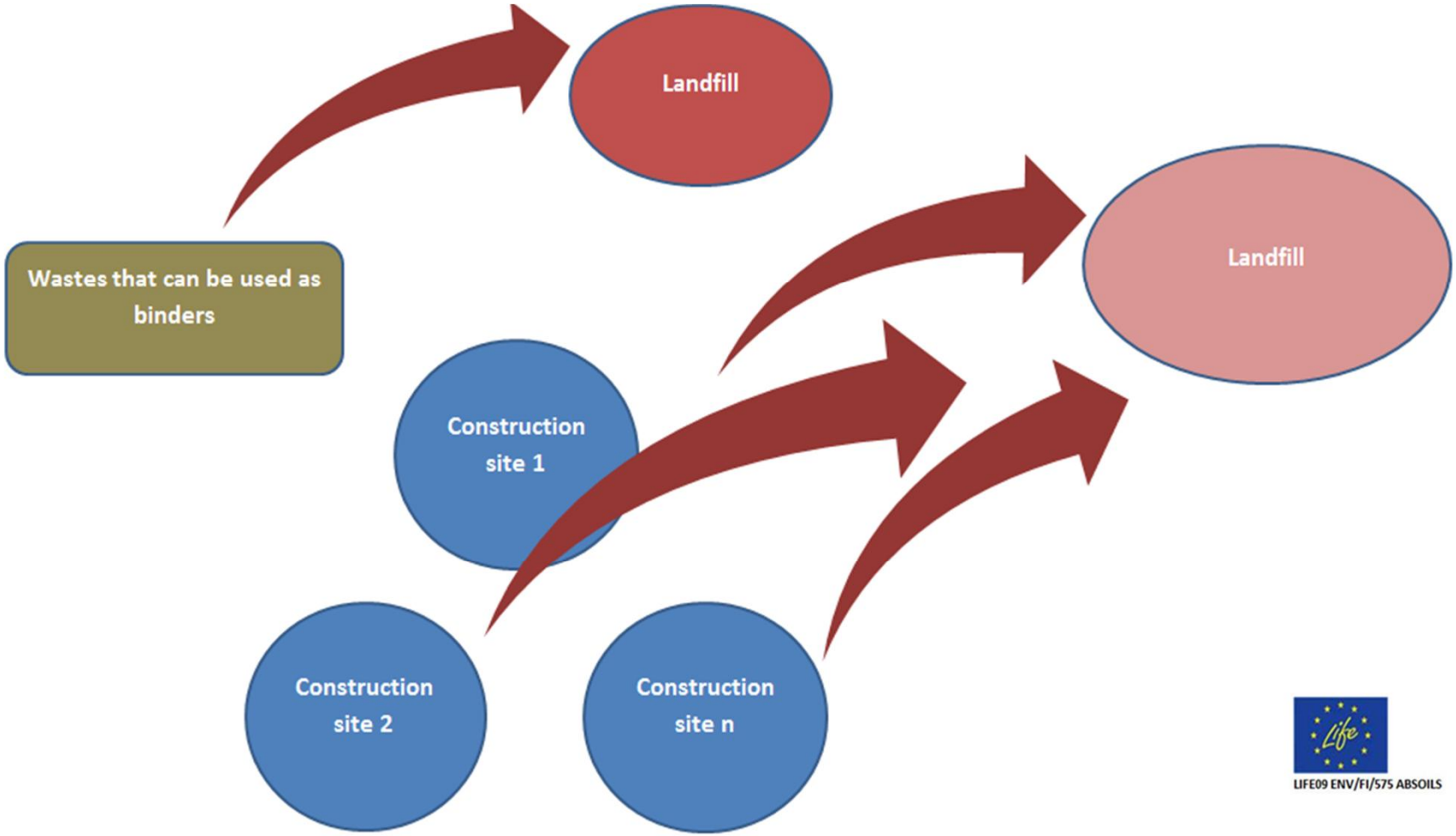


Mass stabilized surplus clay from Jätkäsaari III

LIFE09 ENV/FI/575 ABSOILS

4. LESSONS LEARNED 1 / 3

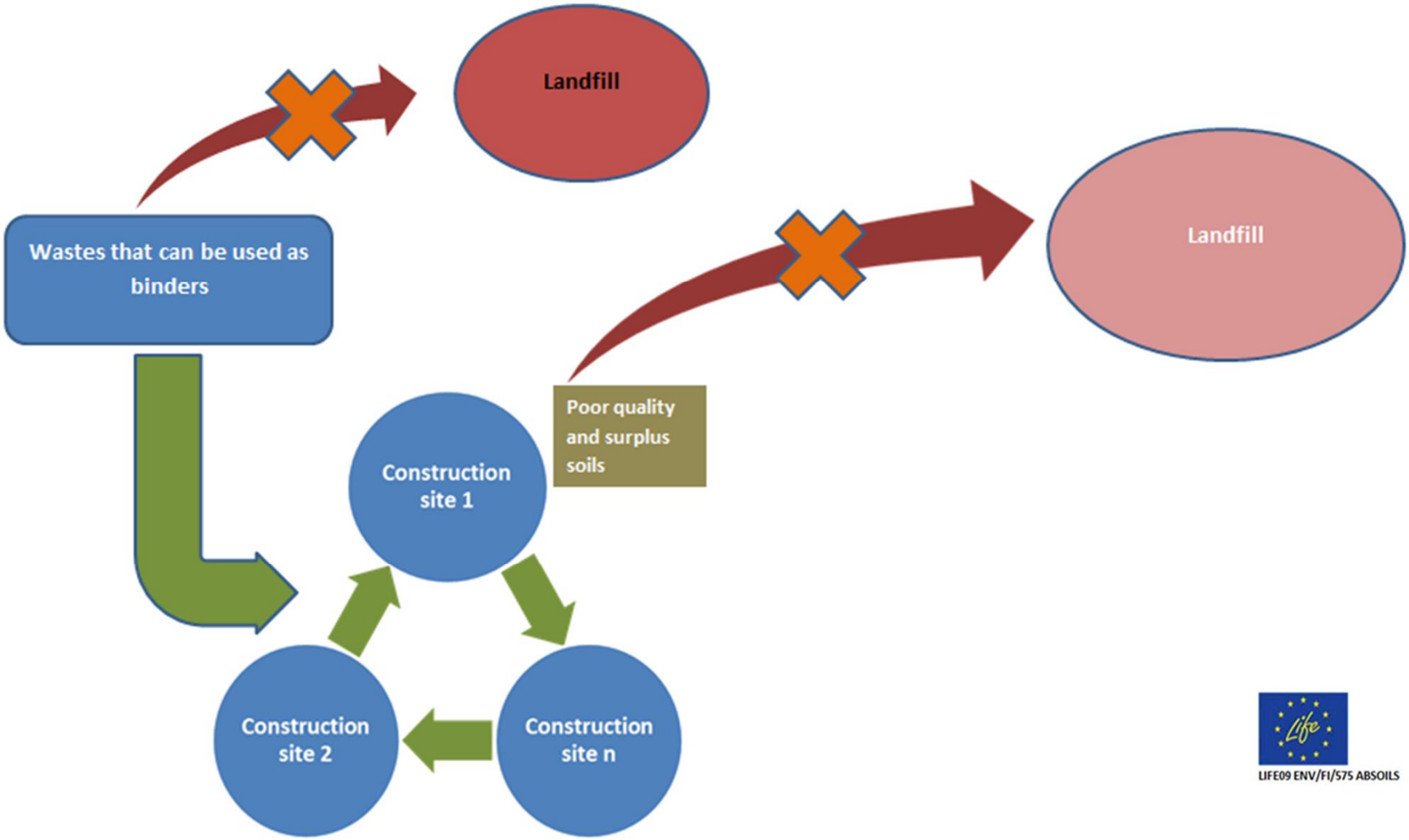
THE PERKKAA DOG PARK PROJECT DEMONSTRATED THAT THE CURRENT WAY TO TRANSPORT LOW QUALITY SURPLUS SOILS AND BY PRODUCTS TO LANDFILL IS NOT THE BEST PRACTICE ...



LIFE09 ENV/FI/575 ABSOILS

4. LESSONS LEARNED 2 / 3

THERE IS A MORE SUSTAINABLE WAY TO DO – SURPLUS LOW-QUALITY SOILS AND WASTES FROM ENERGY PRODUCTION CAN BE PSOCESSED WITH MASS STABILISATION METHOD INTO CONSTRUCTION MATERIAL!



LIFE09 ENV/FI/575 ABSOILS

4. LESSONS LEARNED 3 / 3

MASS STABILISED SOFT SOIL IS A SUITABLE CONSTRUCTION MATERIAL FOR EMBANKMENTS, LANDSCAPE FILLINGS, SEALINGS, NOISE BARRIERS, HARBOUR FILLINGS, ...

before

after

Thank You!

RAMBØLL

LIFE09 ENV/FI/575 ABSOILS

Some useful www-pages:

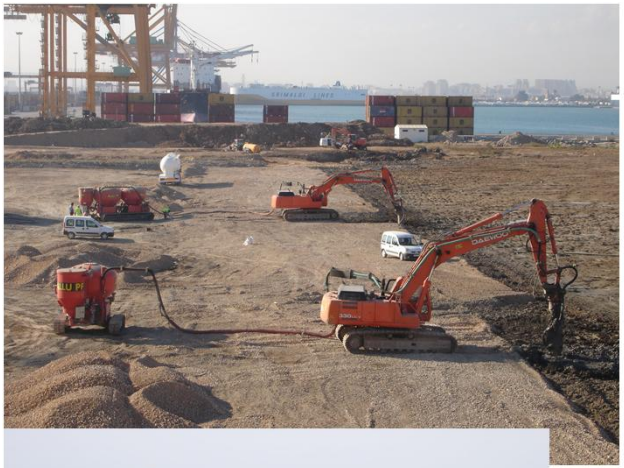
http://projektit.ramboll.fi/life/absoils/

http://simmccities.com/

http://uuma2.fi/

Thank You

LIFE09 ENV/FI/575 ABSOILS









RAMBØLL