ABSOILS EU LIFE+: UTILISING SURPLUS CLAYS IN INFRASTRUCTURE CONSTRUCTION

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MASS STABILISATION CONFERENCE 2015

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SIBELIUS HALL, LAHTI, FINLAND

LIFE09 ENV/FI/000575

ABSOILS PROJECT IN A NUTSHELL

- Start: September 2010/ end: June 2015
- Co-ordinated by Ramboll Finland
- Project partners: Lemminkäinen and Rudus
- Supported by the Finnish Ministry of the Environment and the Uusimaa cities - Helsinki, Espoo and Vantaa
- Co-financed by the EU LIFE+ Environmental Policy & Governance programme (LIFE09 ENV/FI/000575)

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MILJÖMINISTERIET
MINISTRY OF THE ENVIRONMENT

ABSOILS OBJECTIVES

- To provide technical, environmental and methodological data and information on materials, materials mixtures and additives, storage, treatment and transports of materials as well as the diverse stages of construction

- Piloting action to demonstrate the practical implementation of four challenging types of civil-engineering applications in full-scale pilots based on the use of redundant soft soils: e.g. flood barriers, noise barriers, supporting banks and landscape construction.

- To create and demonstrate a Model for Sustainable Regional Material Service System (RMSS) for the Uusimaa region. The RMSS will direct the use of regionally produced and generated materials and aggregates to the short-term and long-term infrastructure construction projects with the assistance of practical logistics and Internet operated database.

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UTILISING LOW-QUALITY SOILS FOR INFRASTRUCTURE CONSTRUCTION (ABSOILS)

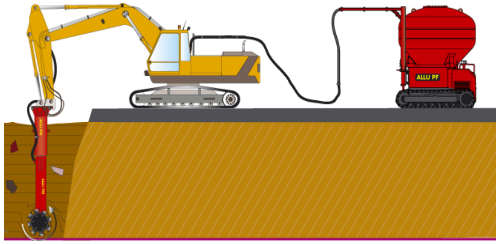
"Surplus soil type"	Project	Purpose of use
Dry crust clay as it is	Pirttiranta, Vantaa	Flood embankment
Column stabilised surplus soil (from pipeline trench)	Haltiala, Helsinki	Filling and landscaping
Mass stabilised clay and mud	Perkkaa dog park, Espoo Arcada II, Helsinki	Embankment, "light weight" filling
Mass stabilised dredged sediments	Jätkäsaari I, II, III and IV, Helsinki	Noise barrier, landscaping, …
Screened topsoil	Ida Aalberg Park, Helsinki	Topsoil

MASS STABILISATION METHODS IN ABSOILS

Column stabilisation (in-situ)

”Process stabilisation” - screener crusher (ex-situ)

Mass stabilisation (in-situ & ex-situ)



USED BINDERS IN ABSOILS

Site	Stabilised material	Used binder	Principle of stabilisation	Conducted investigations
Arcada 2, Helsinki	Surplus Clay	CEM (100 kg/m^3)	MS ex situ	ST, QCS
Perkkaa dogpark, Espoo	Surplus Clay	CEM; FA; FGD; gyp; LC (80…160 kg/m^3)	MS ex situ	ST, QCS, lysimeter tests, …
Jätkäsaari I, Helsinki	w ≈ 70…100 %, Hh ≈ 3…4 %	CEM (60 kg/m^3)	MS ex situ	ST, QCS, leaching tests
Jätkäsaari II, Helsinki	w ≈ 26…159 %, Hh ≈ 1,5…8,7 %	CEM ; FA (40…500 kg/m^3)	MS ex situ	ST, QCS, PLT, settlement plates, …
Jätkäsaari III, Helsinki	w ≈ 58…100 %, Hh ≈ 2,6…4,0 %	CEM, LC, FA, FGD, OSA5, OSA8 (150…200 kg/m^3)	MS, SC, ex situ	ST, QCS, PLT, settlement plates, water permeability, leaching tests …
Jätkäsaari IV, Helsinki	w ≈ 58…100 %, Hh ≈ 2,6…4,0 %	CEM; FA (200 kg/m^3)	SC, ex situ (Jätkä III)	QCS, PLT, settlement plates, …

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 Crusher CS = Column Stabilisation	ST = stabilisation tests QCS = quality control soundings PLT = Plate Load Test

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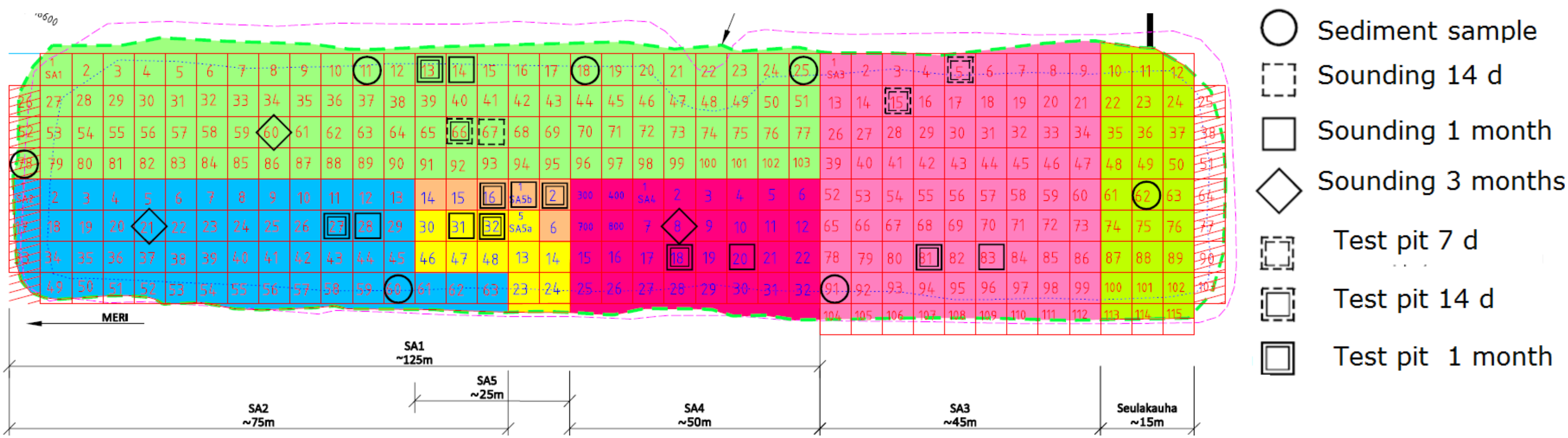
BINDERS IN FIELD (JÄTKÄSAARI PHASE III)

Area	Binder mix	binder amount [kg/m^3]
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

Quality control soundings, test pits and laboratory analysis to validate the suitability of binder mix **(in total 15 different tests)**



BINDER COSTS (JÄTKÄSAARI III)

Binder mix	binder amount (kg/m³)	compression strength in laboratory 28 d (kPa)	binder cost €/m³ (VAT. 0 %)	Compared to average commercial binder cost
CEM + OSA	10+100	144	5,1	**55 %**
CEM + Hana FA + OSA	30+50+50	136	5,2	**56 %**
LC 3:7 + Hana FA	50+100	187	6,4	**69 %**
CEM + Hana FA	50+100	166	5,3	**57 %**
Oil shale ash OSA8	150	164	6,0	**64 %**
CEM + HanaFA + FDG	50+50+50	155	5,3	**57 %**

➡ **55…69 % lower binder costs!**

Commercial binders	binder amount (kg/m³)	compression strength 28 d (kPa)	binder cost €/m³ (VAT. 0 %)
CEM	75	350	7,9
LC 3:7	75	235	9,6
CEM	100	663	10,5
	Average binder cost =		**9,3 €/m³**

Binder (Jätkäsaari III)	€/t
CEM	105
Lime Cement	128
Fly Ash	0
Oil Shale ash type8	40
Flue gas desulphu-risation gas	0

EXAMPLES OF LOW-QUALITY SOILS MATERIALS FLOW IN INFRASTRUCTURE CONSTRUCTION

Three types of material flow in low-quality soils:

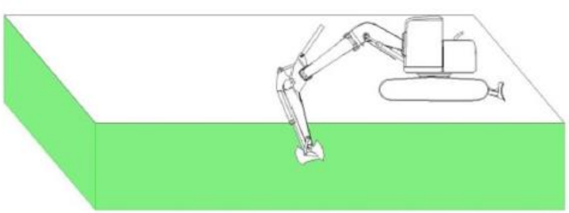
CASE 1. Construction site “**produces”** low-quality “surplus” soils

CASE 2. Construction site “**utilises”** low-quality “surplus” soils

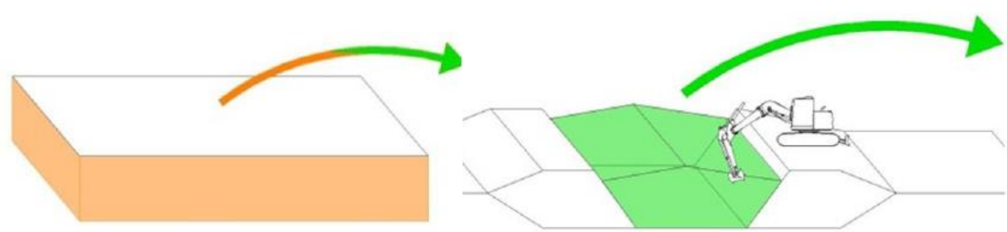
CASE 3. Construction site “**produces and utilises”** “surplus” low-quality soils

in-situ and/or ex-situ stabilisation

in-situ



ex-situ



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CASE 1. JÄTKÄSAARI (PRODUCES & EX-SITU) - DREDGING SEDIMENTS

PROBLEM
Contaminated sediments

Dredging

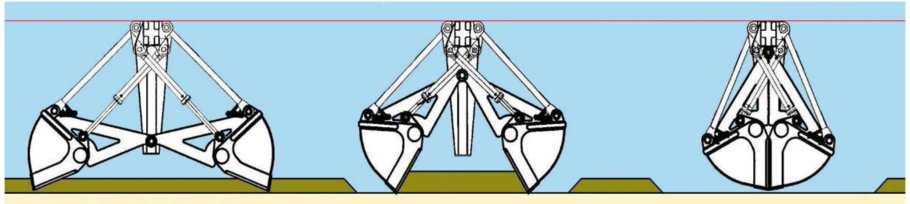
Clean sediments

Deposit to sea

Deposit to stabilisation basins

Mass stabilisation

Utilisation as earth construction material



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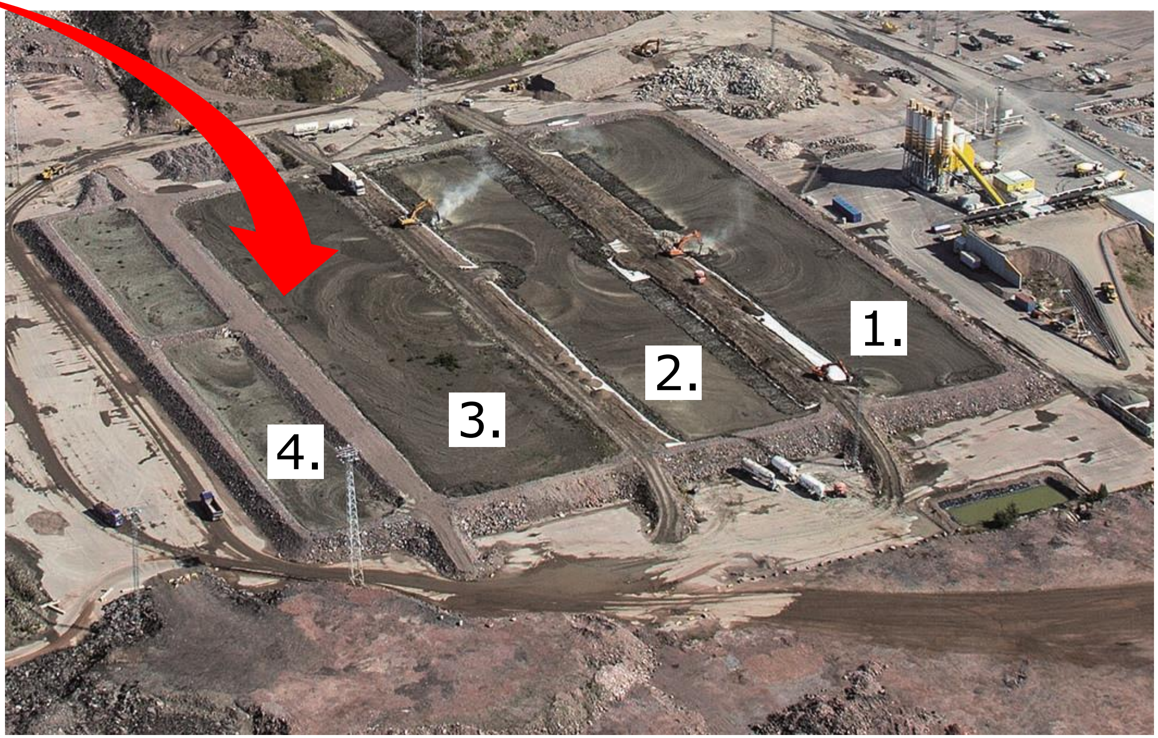
CASE 1. JÄTKÄSAARI (PRODUCES & EX-SITU) - DREDGING SEDIMENTS

The overall volume of these four stabilisation basins is about 90 000 m^3



Dredged sediments

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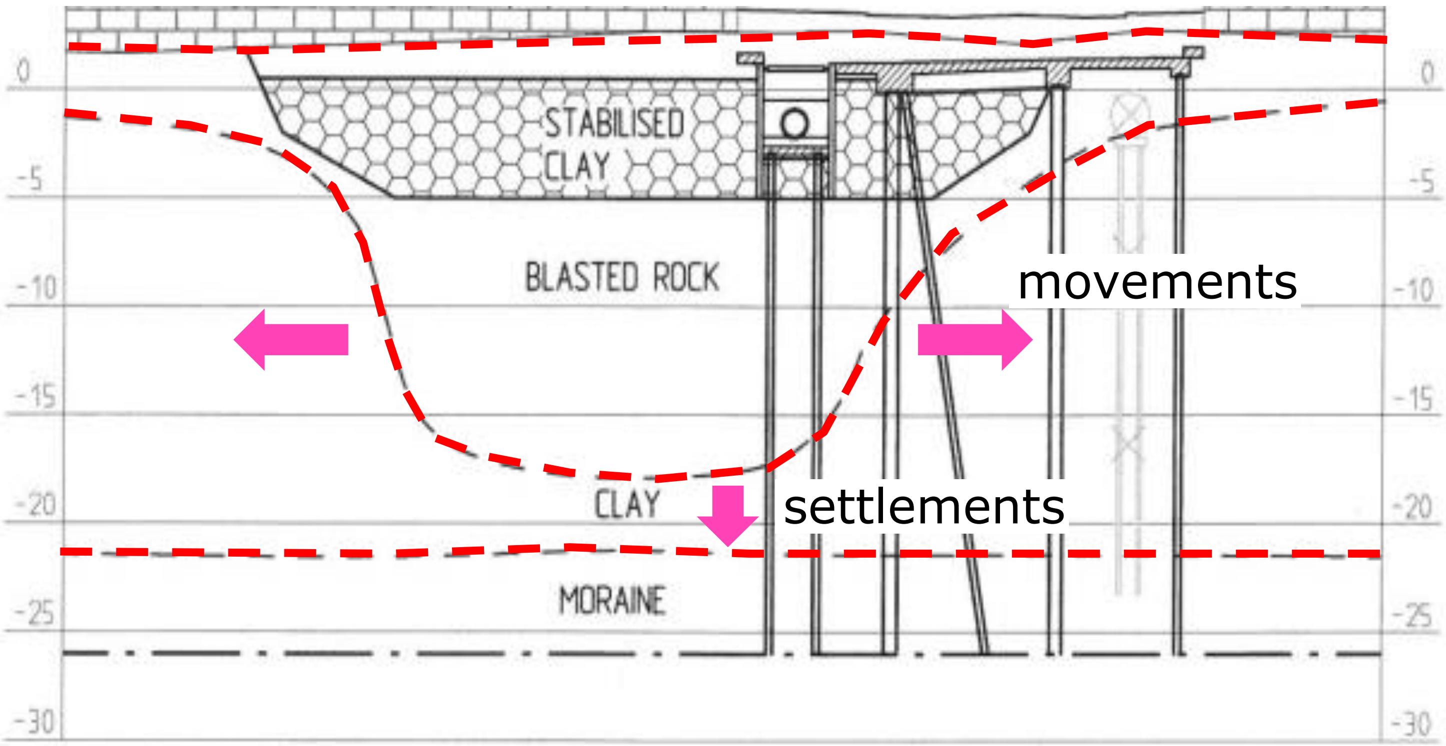
CASE 2. KYLÄSAARI: LIGHTENING OF OLD EMBANKMENTS (EX-SITU & UTILISATION)

Filled from the sea in 1960's => mass replacement failed leaving the blasted rock to float on top of the soft clay layer => movements, settlements, ... + dumping of contaminated soil, oils, etc. => 2010’s construction of the area



History = red lines

Designed / Constructed 2010…2012= black line

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CASE 2. KYLÄSAARI: LIGHTENING OF OLD EMBANKMENTS (EX-SITU & UTILISATION)

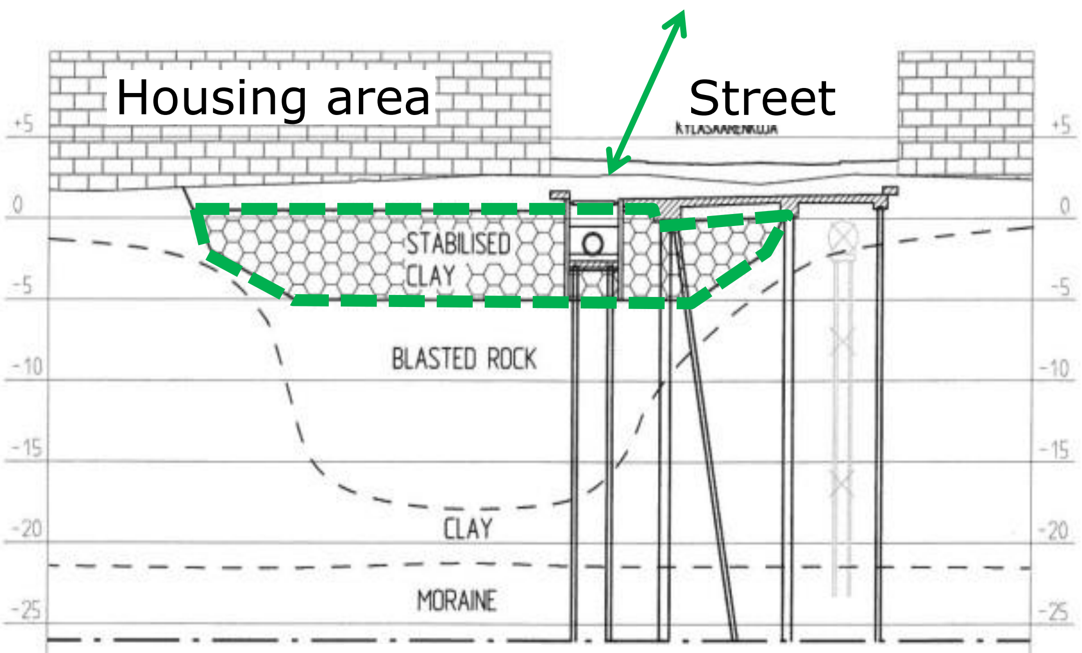
Solution:

Digging contaminated blasted rock away

⇒ Filling with surplus clay to level -5 and mass stabilisation of the clay

⇒ Pile driving (d=400…700 mm steal piles / Ruukki)

=> stabilised clay as a "light weight" filling



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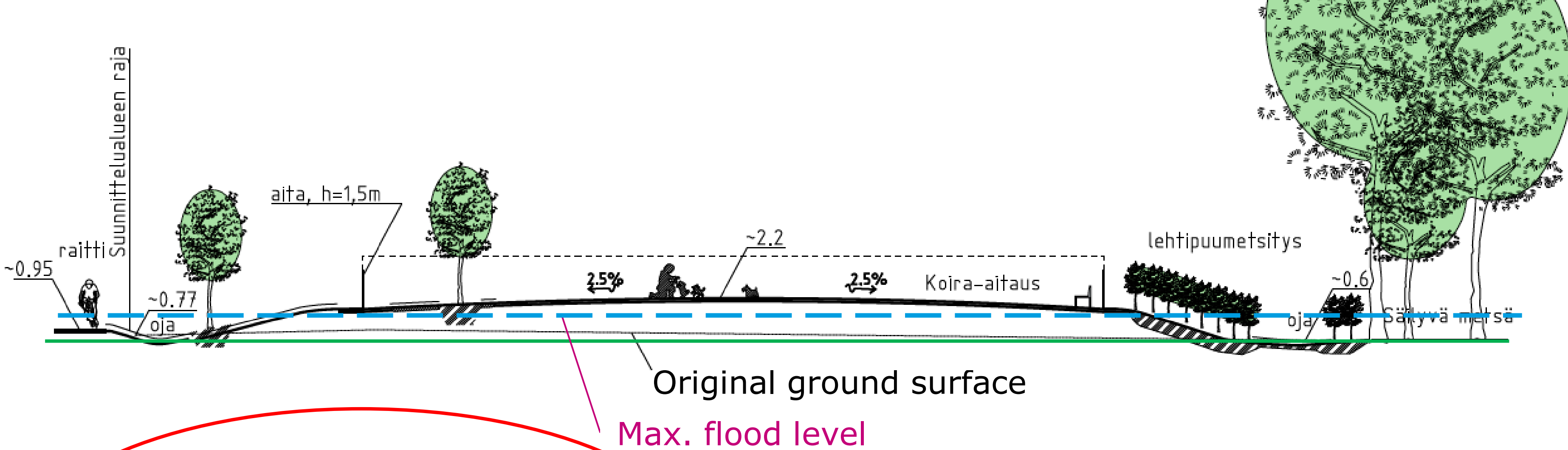
CASE 3. PERKKAA DOG PARK (IN-SITU & EX-SITU)

⇒ Raising of surface level needed because of the flooding

⇒ Embankment needed



Sub soil:
- thickness of clay 11 … 14 m
- shear strength 5…10 kPa
- water content 80…130 %

Traditional aggregate embankment:

⇒ stability << 1,5 (nearby gas pipe)

⇒ Settlement ≈ 1 m

⇒ not acceptable

⇒ **innovative and low-price solution needed**

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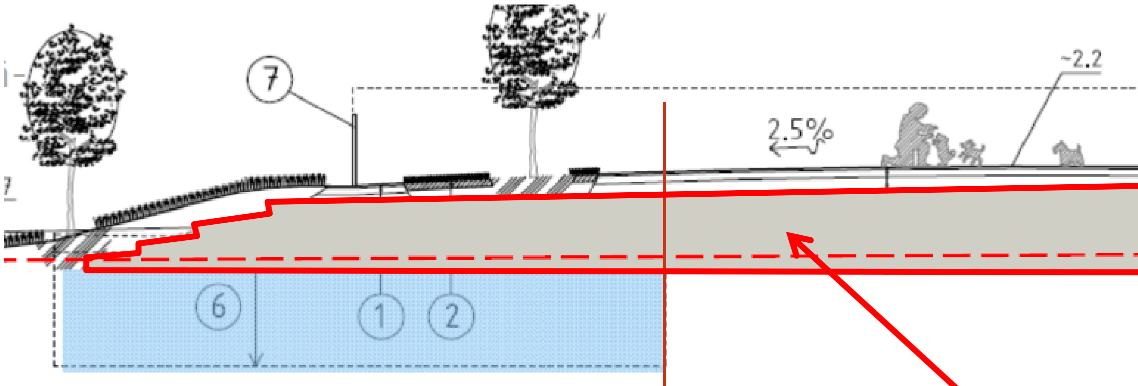
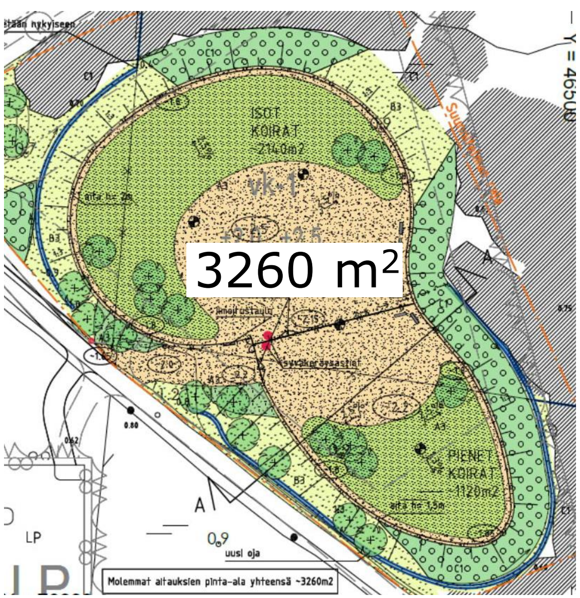
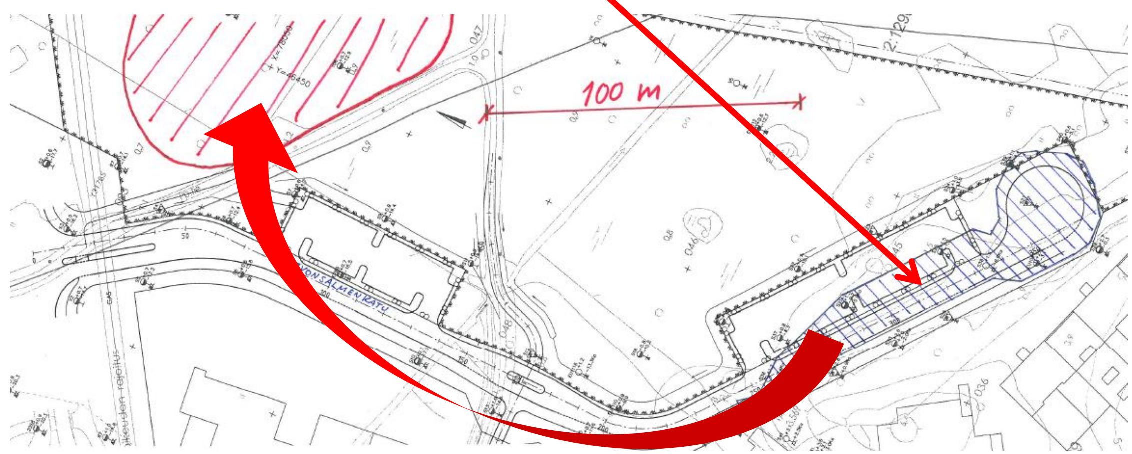
CASE 3. PERKKAA DOG PARK (IN-SITU & EX-SITU)



Surplus clays obtained from an adjacent construction

Mass stabilised subsoil





CASE 3. PERKKAA DOG PARK (IN-SITU & EX-SITU)

Lessons learned in Dog Park

3000 m^3 of soft clays transported 0,2…0,4 km to a neighbouring construction site instead of 22 km to landfill

=> 75 000 ton km less transport on public roads

=> 3000 m^3 less soft clay transported to public landfill

=> 3000 m^3 less aggregates used for embankment

=> "100% RE-USE" OF SOFT SURPLUS CLAY

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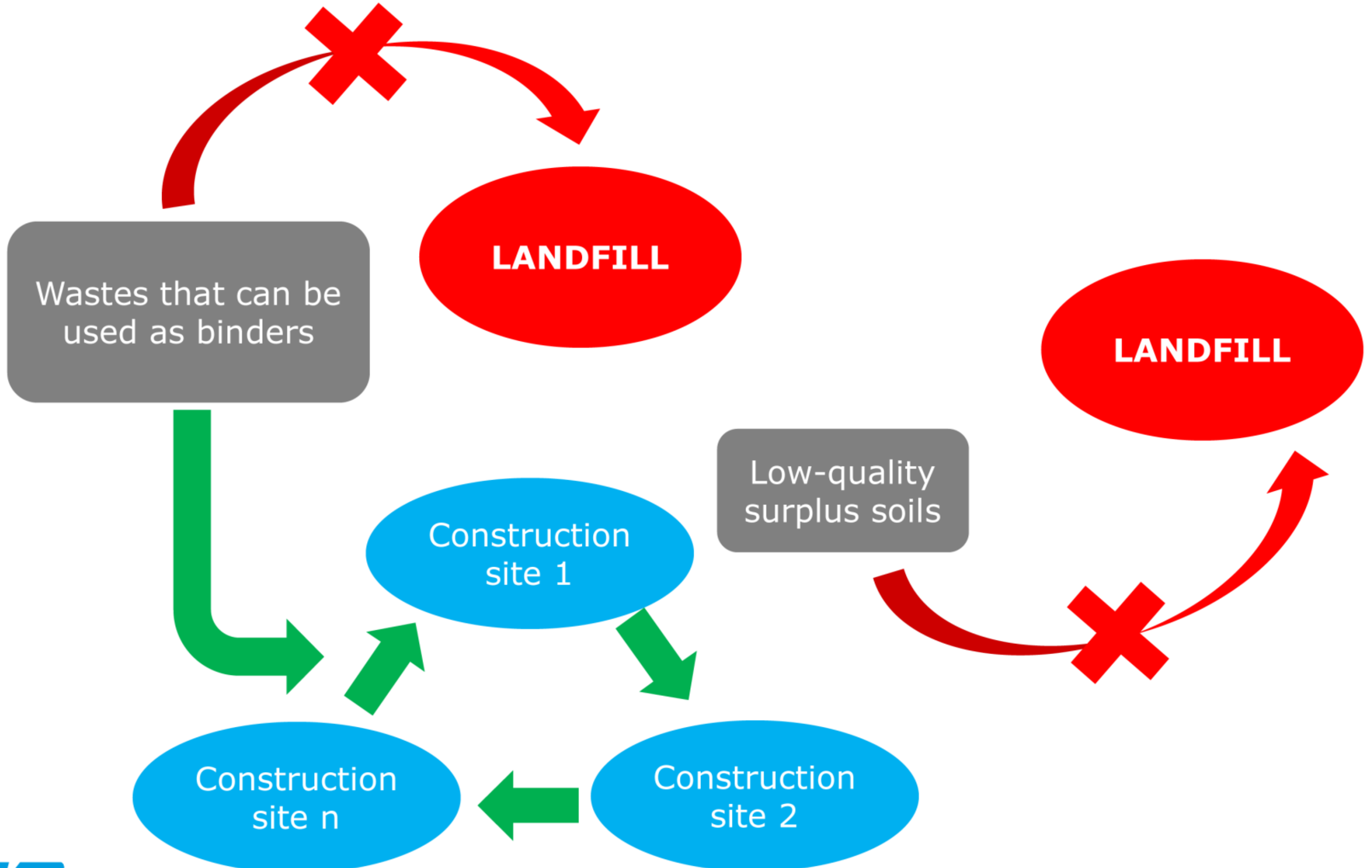
LESSONS LEARNED

There is a more sustainable way to do – surplus low-quality soils and wastes from energy production can be processed with mass stabilisation method into construction material



LESSONS LEARNED

Mass stabilised soft soil is a suitable construction material for embankments, landscape fillings, sealings, noise barriers, harbour fillings, …

before

after

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THANK YOU

HTTP://PROJEKTIT.RAMBOLL.FI/LIFE/ABSOILS/
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