

THE XXVIII INTERNATIONAL BALTIC ROAD CONFERENCE,  
26.–28. OCTOBER 2013

EXPERIENCES OF UTILISING MASS  
STABILISED LOW-QUALITY SOILS FOR  
INFRASTRUCTURE CONSTRUCTION IN THE  
CAPITAL REGION OF FINLAND – CASE  
ABSOILS PROJECT  
LIFE09 ENV/FI/000575

26.8.2013

JUHA FORSMAN / RAMBOLL FINLAND  
KATA KREFT-BURMAN / RAMBOLL FINLAND  
NOORA LINDROOS / RAMBOLL FINLAND  
HEIKKI HÄMÄLÄINEN / RAMBOLL FINLAND  
VILLE NIUTANEN / LEMMINKÄINEN (BIOMAA)  
KATJA LEHTONEN / RUDUS

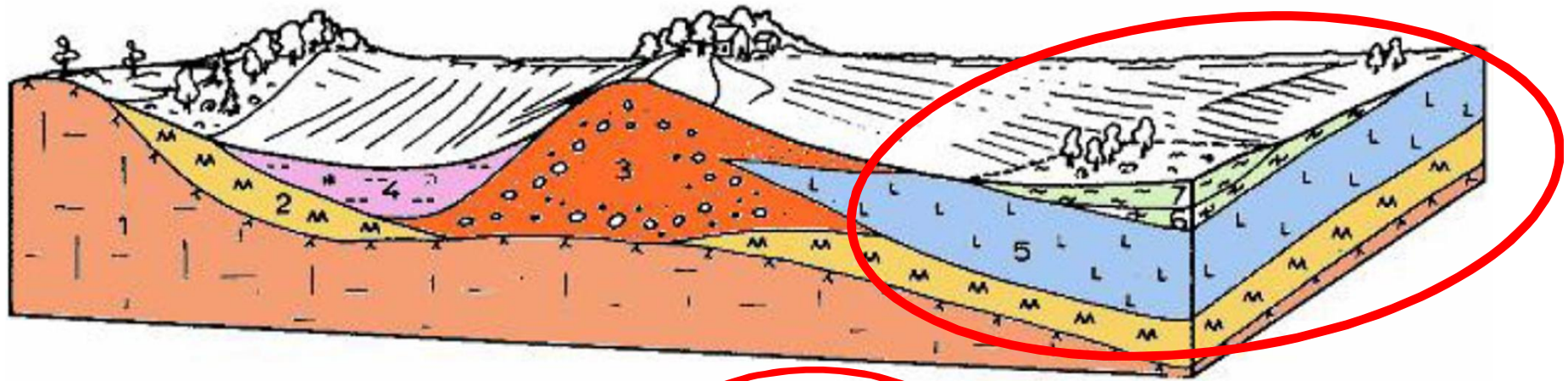
RAMBOLL

# EXPERIENCES OF UTILISING MASS STABILISED LOW-QUALITY SOILS FOR INFRASTRUCTURE CONSTRUCTION IN THE CAPITAL REGION OF FINLAND – CASE ABSOILS PROJECT

1. BACKGROUND AND CHALLENGES:  
FINNISH GEOLOGY AND SURPLUS SOFT LOW-QUALITY SOILS
2. SOLUTION: THE MASS STABILISATION METHOD
3. DEMONSTRATION: CASE PERKKA DOG PARK
4. LESSONS LEARNED



# 1. FINNISH GEOLOGY – TYPICAL FORMATIONS



- 1 Kallio - Rock
- 2 Moreeni - Moraine
- 3 Hiekka ja sora - Sand and gravel
- 4 Siltti - Silt

- 5 Savi - Clay
- 6 Lieju - Mud
- 7 Turve - Peat

## Clay...Mud...Peat (postglacial):

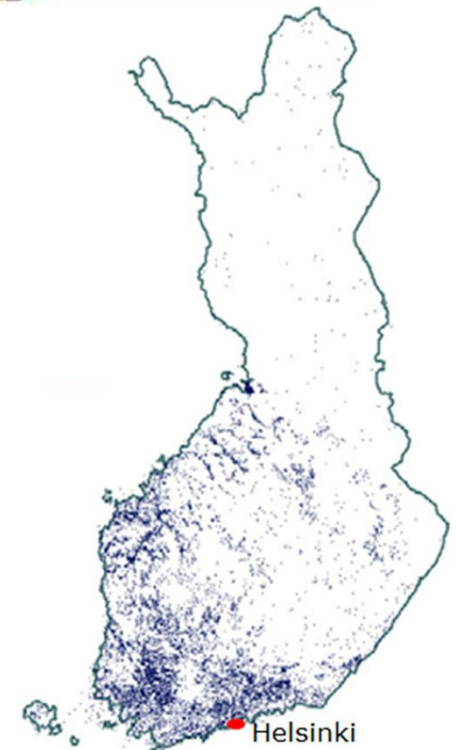
$w_o = 50 \dots 2000 \%$  (from dry weight)

$\tau_o = 1 \dots 25 \text{ kPa}$

Organic content = 0...97 %

Bearing capacity = no capacity ... low

**RAMBOLL**



# 1. THE USE OF AGGREGATES AND THE SITUATION WITH SURPLUS SOILS IN THE HELSINKI REGION

1. 17 MILLION TONNES OF AGGREGATES ARE ANNUALLY USED FOR CONSTRUCTION IN THE CAPITAL REGION OF FINLAND

2. ABOUT 3 MILLION TONNES OF SURPLUS SOILS ARE ANNUALLY TRANSPORTED TO LANDFILLS IN THE CAPITAL REGION OF FINLAND

3. 70% OF THE LANDFILLED SURPLUS SOILS ARE ESTIMATED TO BE OF POOR QUALITY: ABOUT 2,5 MILLION TONNES OF **SILT, CLAY AND MUD** ANNUALLY

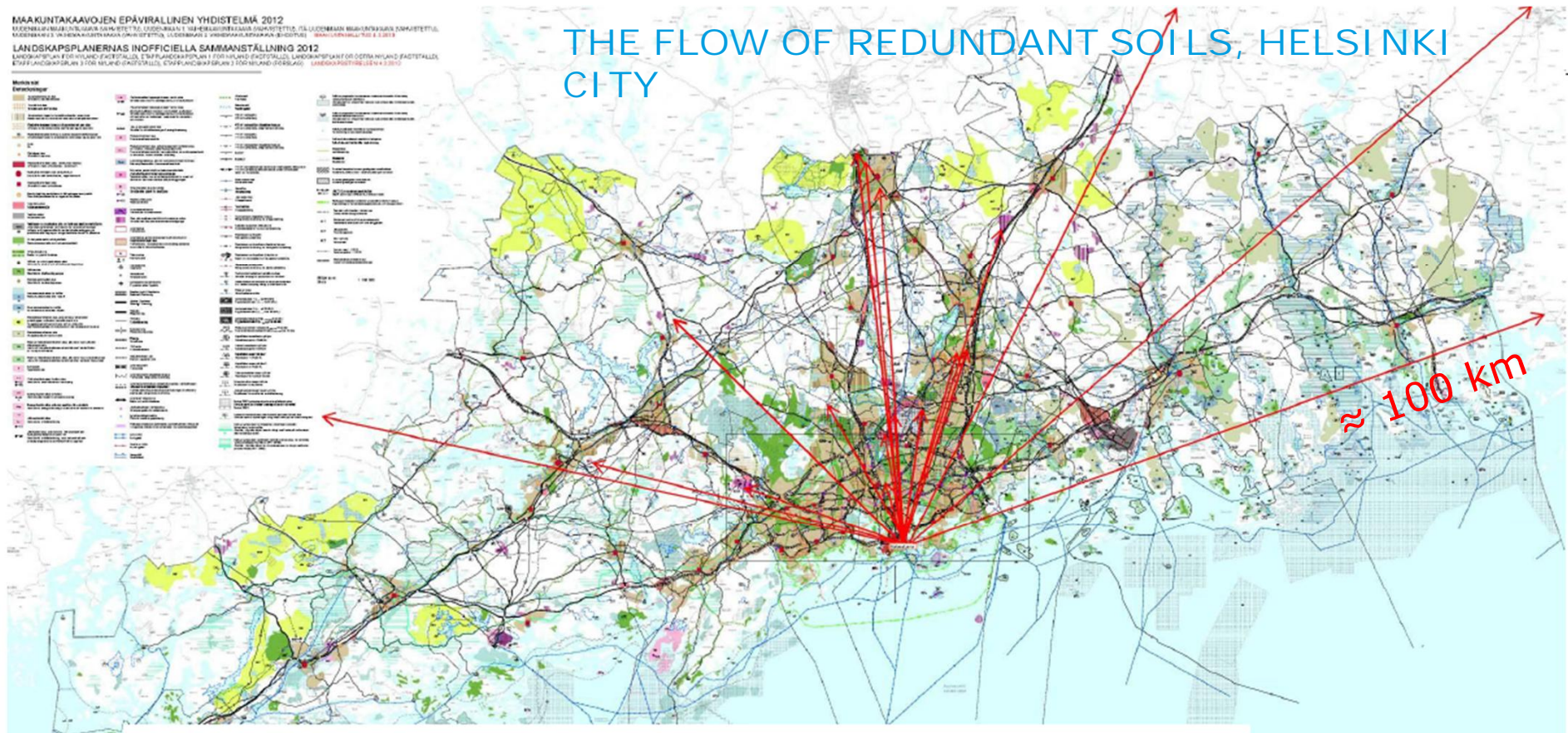
4. "SURPLUS POOR QUALITY" IS DEFINED AS SOIL REMOVED FROM THE CONSTRUCTION SITE AND AS SUCH UNSUITABLE FOR CONSTRUCTION PURPOSES





# 1. SURPLUS SOILS IN THE HELSINKI REGION – CHALLENGES

5. CURRENTLY THE CITY OF HELSINKI HAS NO LANDFILLS FOR SURPLUS SOILS => THE TRANSPORTATION DISTANCE OF SURPLUS SOFT SOILS IS ABOUT 50...100 KM!



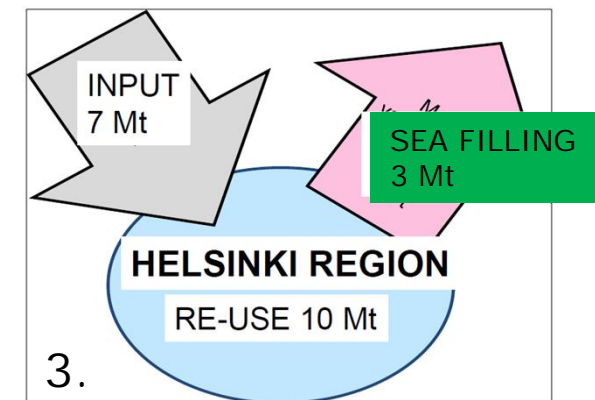
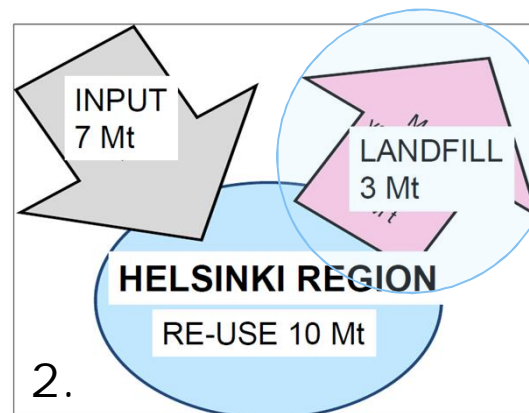
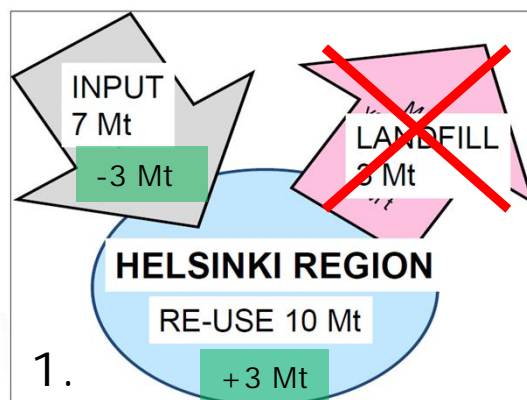
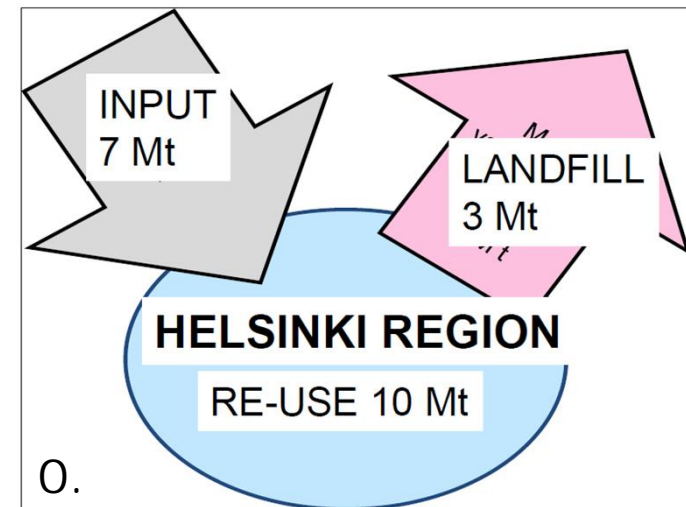
*From Mikko Suominen / City of Helsinki*

# 1. STRATEGY FOR THE RE-USE AND DEPOSIT OF SURPLUS SOILS IN THE HELSINKI REGION

## POSSIBILITIES:

### 0. CURRENT SITUATION

1. 100% RE-USE
2. LANDFILL SITES
3. SEA FILLING



# 1. STRATEGY FOR THE RE-USE AND DEPOSIT OF SURPLUS SOILS IN THE HELSINKI REGION

## STRATEGY FOR RE-USE AND DEPOSIT OF SOILS

### POSSIBILITIES

~~0. CURRENT SITUATION~~

1. 100 % RE-USE

2. LANDFILL SITES

3. SEA FILLING

(COMBINATION)



LIFE09 ENV/FI/000575

ABS OILS





LIFE + 2009 ENVIRONMENT POLICY AND GOVERNANCE  
STRAND

LIFE09 ENV/FI/575

Sustainable methods and processes to convert  
abandoned low-quality soils into construction  
materials. Demonstration project in Finland.  
(ABSOILS)





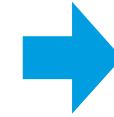
## 2. SOLUTION: STABILISATION OF SOFT SOIL



clay



binder



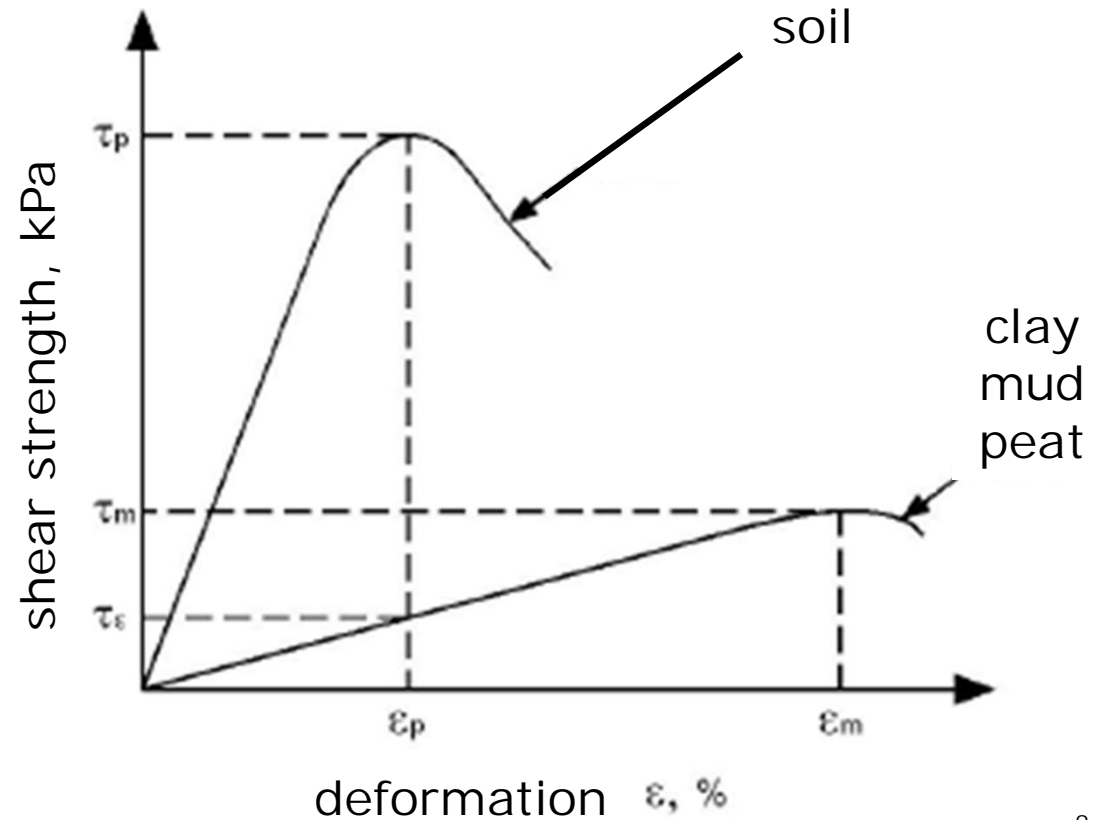
stabilised soil



mud



peat



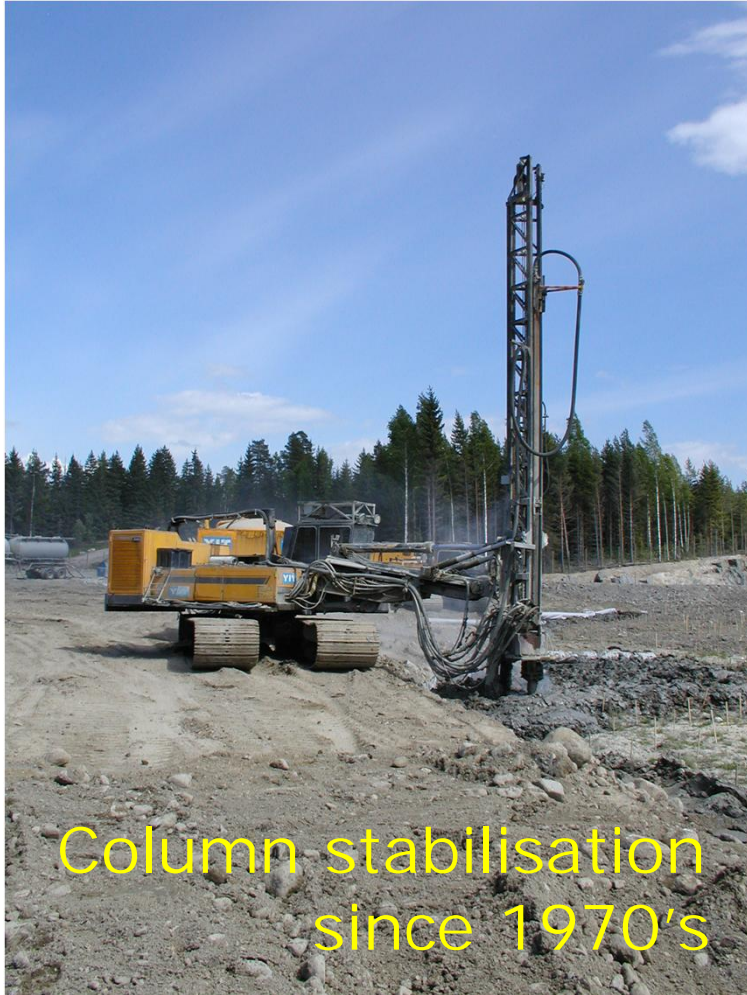
## 2. POTENTIAL BINDERS IN STABILISATION

- “Traditional” binders Cement and Lime
- BY PRODUCTS IN FINLAND:
  - Fly ash from coal burning (0,6 Mt/a)
  - Fly ash from biofuel incineration (0,35 t/a)
  - Industrial gypsum (1,5 Mt/a)
- BY PRODUCTS IN ESTONIA:
  - Oil shale ash as a potential binder in stabilisation of soft soils: contains a lot of lime which gives the material good strength development properties (5...7 Mt/a)
- CHALLENGES: ENVIRONMENTAL PERMIT REQUIRED FOR BY-PRODUCTS TO BE USED AS BINDERS OR BINDER MIXTURE COMPONENT

## 2. APPLICATIONS OF THE MASS STABILISATION METHOD

1. Settlement reduction (embankments, structures, ...)
2. Improvement of stability
3. Support of slopes and excavations
4. Improvement of bearing capacity
5. Immobilisation and/or confinement of waste deposits or polluted soils
6. Reduction of vibrations

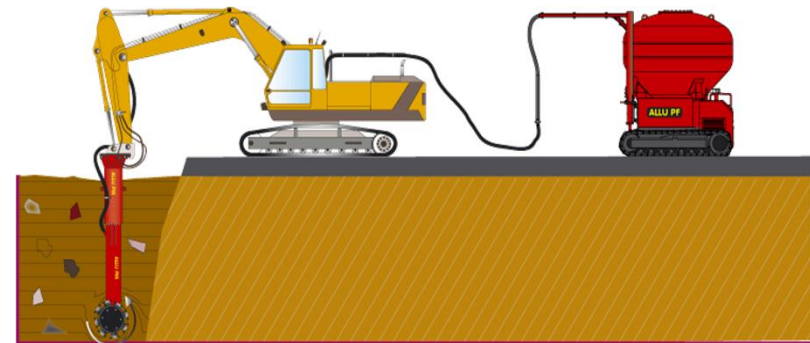
## 2. NORDIC DEEP STABILISATION METHODS (IN-SITU)



Column stabilisation since 1970's



Mass stabilisation since 1990's



Mixing tool installed on an excavator machine and a binder storage tank <sup>12</sup>



## 2. MASS STABILISATION METHODS (EX-SITU)



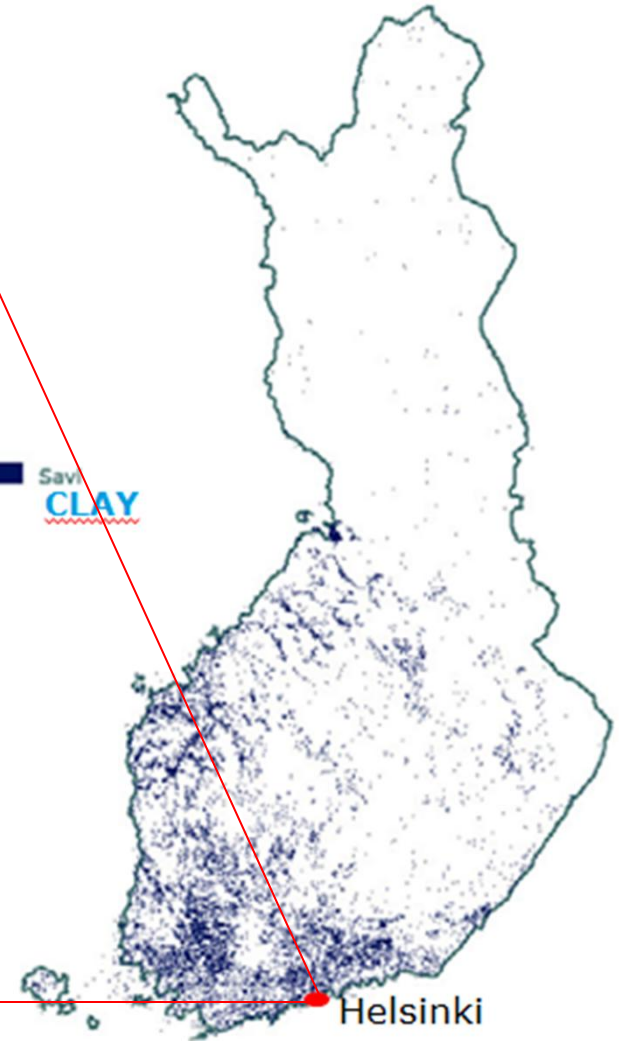
Windrow turner



Screener crusher

Process stabilisation

# 3. ABSOILS PROJECT DEMONSTRATION ON PILOT: CASE PERKKA DOG PARK

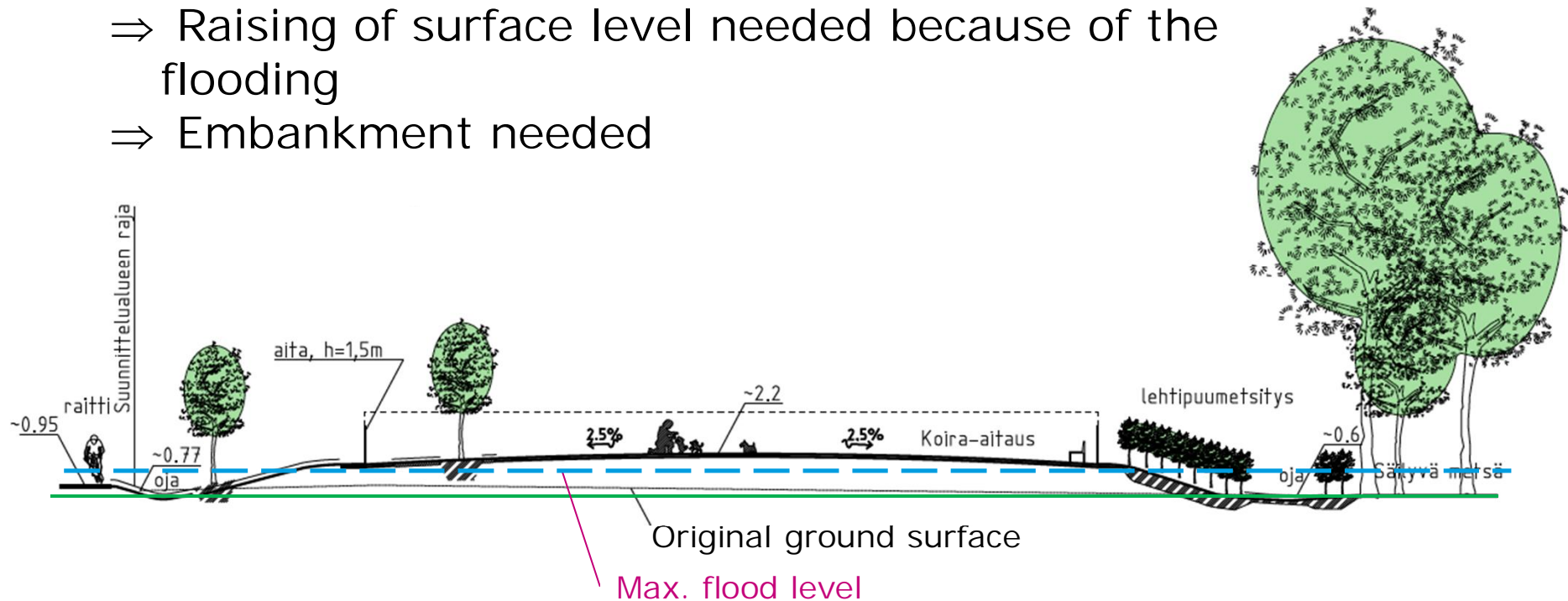




### 3. DEMONSTRATION: CASE PERKKA DOG PARK

⇒ 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 %

RAMBOLL

Traditional aggregate embankment:

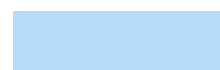
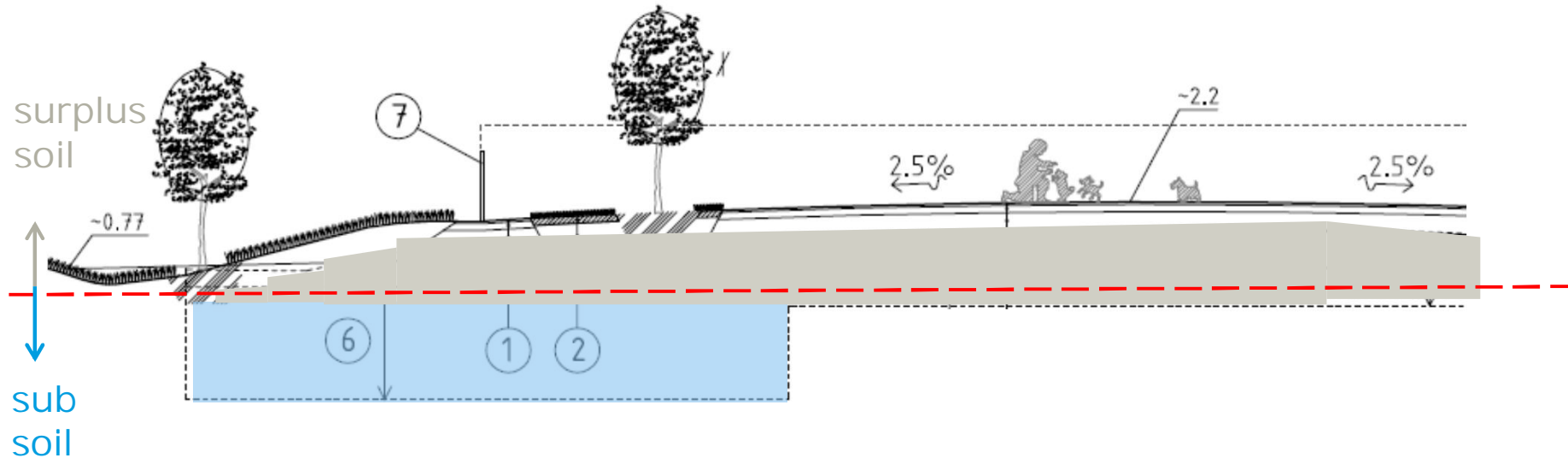
⇒ stability  $<< 1,5$

⇒ settlement 1 m

⇒ not acceptable

⇒ innovative and low-priced solution needed

### 3. "INNOVATIVE SOLUTION"



mass stabilised subsoil (clay and mud)



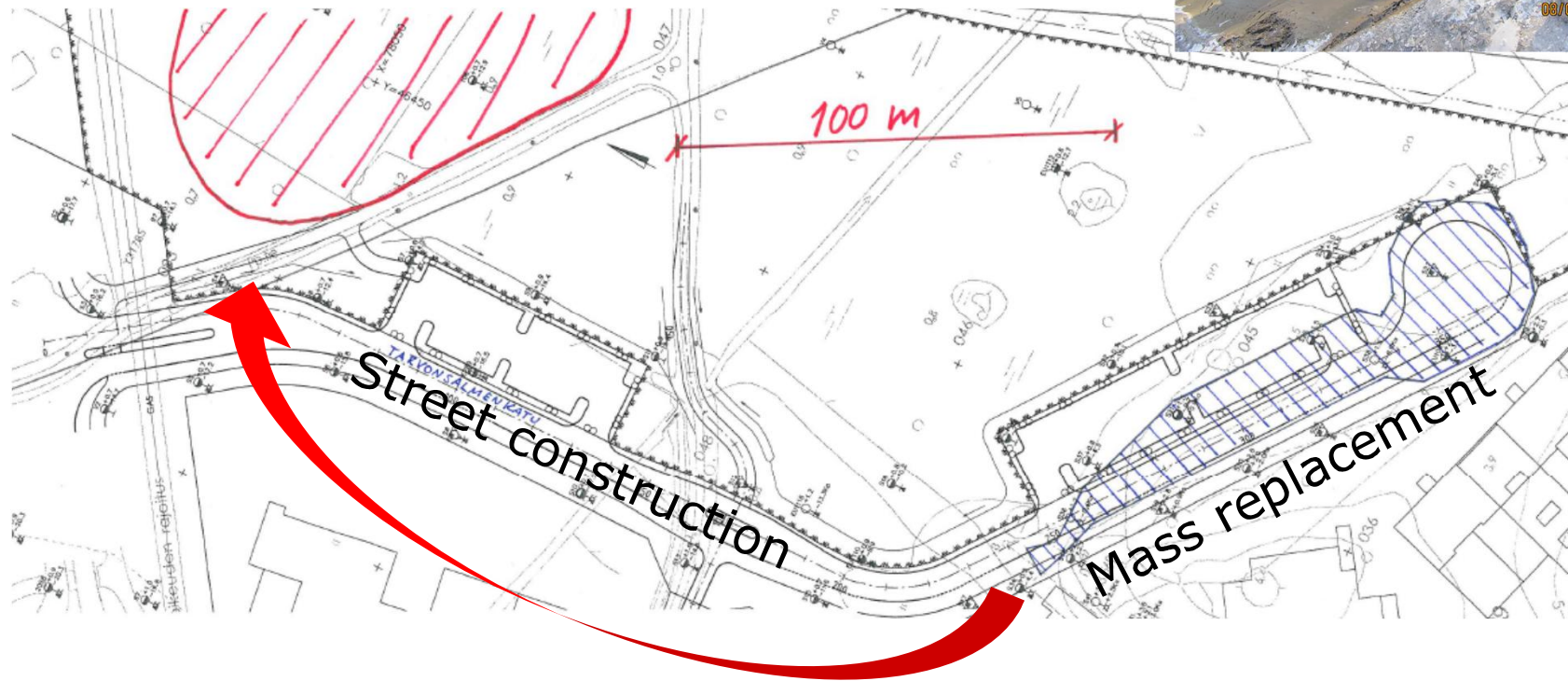
excavated clay from the neighbouring street construction project

Mass stabilisation binder = a mixture of cement and fly ash from coal combustion from Helsinki Energy



### 3. "INNOVATIVE SOLUTION"

Dog Park  
Embankment



3000 m<sup>3</sup> of soft clays transported 0,2...0,4 km to a neighbouring construction site instead of 25 km to landfill

=> 75 000 ton km less transport on public roads!

=> 3000 m<sup>3</sup> less soft clay on public landfill!

**RAMBOLL**

=> 3000 m<sup>3</sup> less aggregates to Dog Park embankment

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

# 3. CONSTRUCTION PHASES

CLEARING AND HARROWING 01/2012

TRANSPORT OF SOFT CLAY FROM NEIGHBOUR CONSTRUCTION SITE 01...02/2012

MASS STABILISATION 01...02/2013

QUALITY CONTROL OF MASS STABILISATED LAYER 01...05/2103

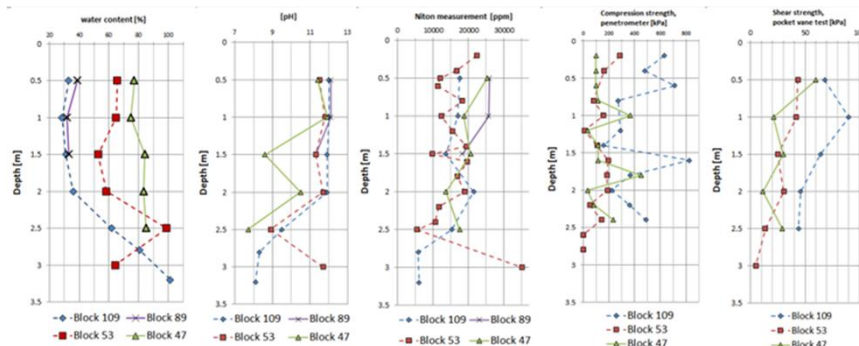
INSTALLATION OF LYSIMETERS 02/2013 (SAMPLING AND LEACHATE TESTS 2013... )

INSTALLATION OF SETTLEMENT PLATES 02/2012 (MEASURING 2013...2017)

CONSTRUCTION OF UPPER LAYERS 08...10/2013 (?)

ANALYSING AND REPORTING OF THE TEST RESULTS 2013...2015

OPENING OT THE NEW DOG PARK 2014... (?)



Visual comments made during the test pit excavations:

**BLOCK 53:** The excavation pit held form until 2,5 m depth. In depth 1,2 - 1,4 m material was more soft but still. In 2,0 m the material was sometimes so hard that vane shear apparatus couldn't penetrate the material. A bad slope failure came when excavating in depth of 3,0 meters. In 2,5 meters the sample in the grab contained a stream of binder. The sampling done in depth 2,5 - 3,0 m is inaccurate. Here it was impossible to keep track of exact layers of materials due to uncontrolled mixing.

**BLOCK 109:** Every 0,5 meters until 2,5 meters the material can be categorized "hard" throughout the depth layer. Once the material was so hard that vane shear apparatus didn't penetrate the material. The first slope failures were detected in level 2,5 m. Stabilization ended about 2,6 m deep.

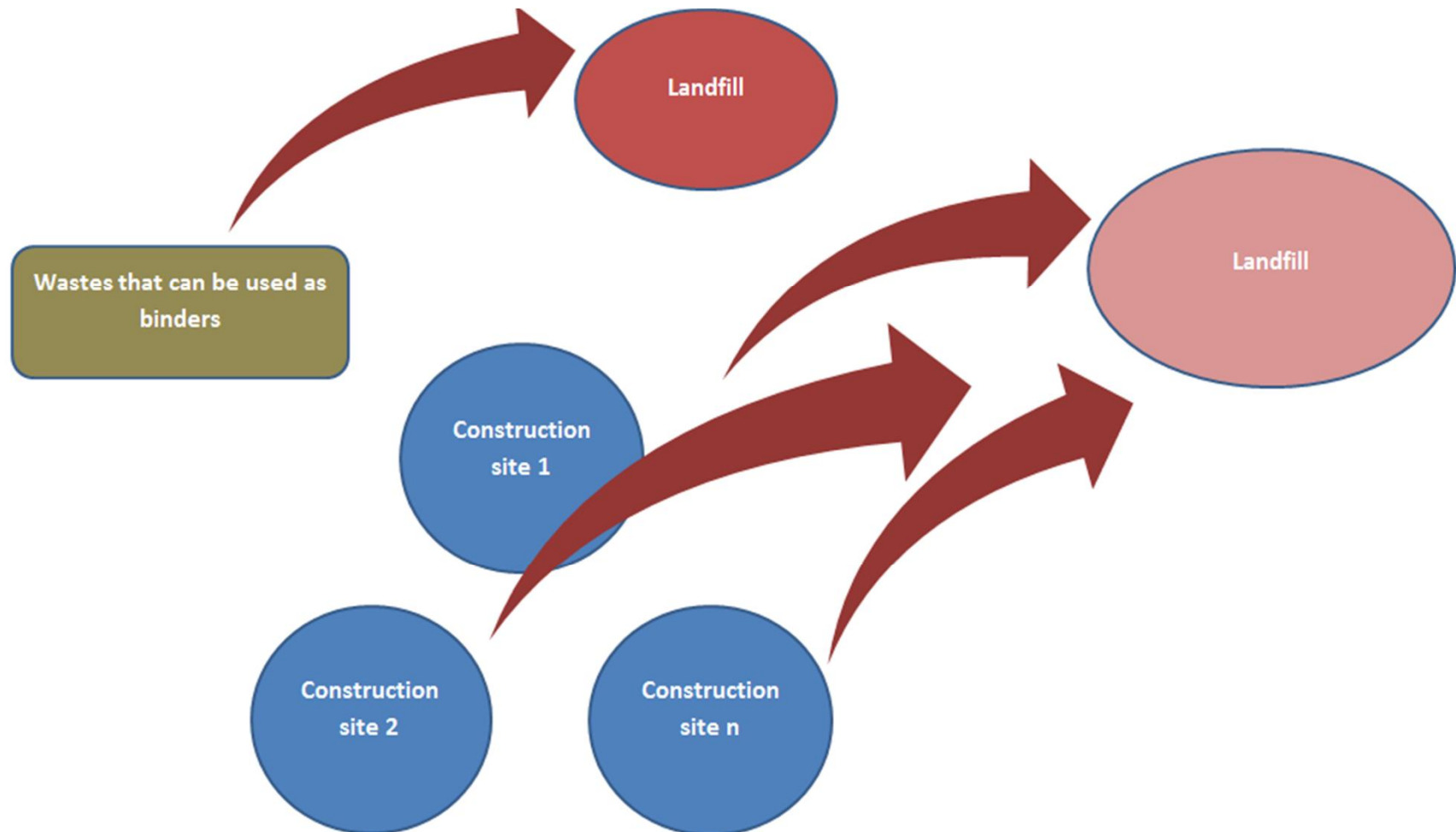
**BLOCK 47:** In the depth of 1,0 the material was once so hard that vane shear apparatus didn't penetrate the material. In general the material was coarse and seemed more stabilized. In depth 1,0 m were very hard pieces of stabilized material. A clear odour of stabilization was present. In 1,5 m the material was more sticky. It was hard to make evened surface for penetrometer or vane shear apparatus. The last sample was taken in the depth of 2,5 m since it was clearly seen that the earth pressure was very high.

**BLOCK 89:** Samples were taken from the test pit. No vane shear or penetrometer testing was able to be made in the test field due to practical reasons. The material however was stabilized and proper.



## 4. LESSONS LEARNED 1/3

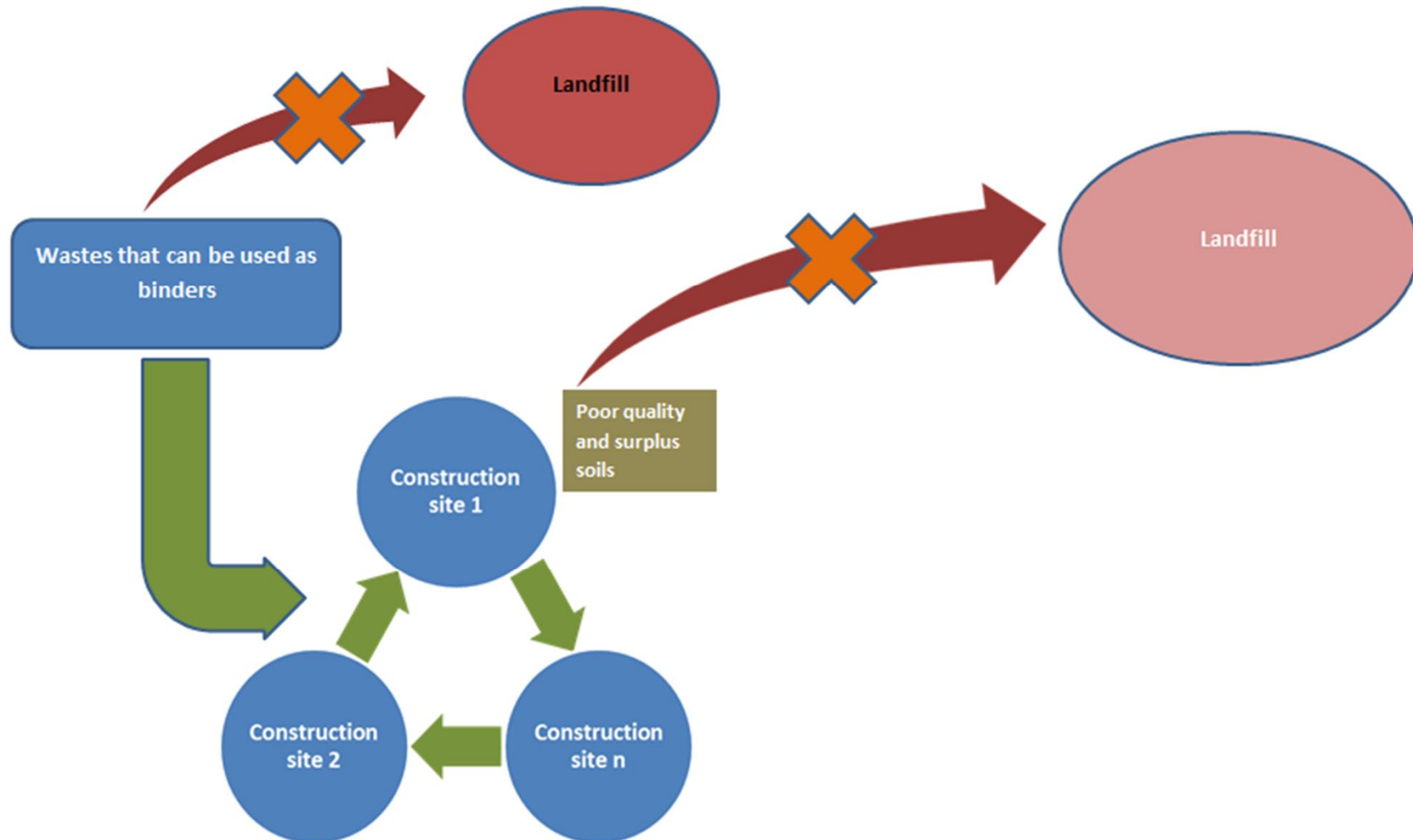
THE PERKKA DOG PARK PROJECT DEMONSTRATED THAT THE CURRENT WAY TO TRANSPORT LOW QUALITY SURPLUS SOILS AND BY PRODUCTS TO LANDFILL IS NOT THE BEST PRACTICE ...





## 4. LESSONS LEARNED 2/3

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!





## 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!

RAMBOLL

[Some useful www-pages:](#)

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

<http://simmccities.com/>

<http://uuma2.fi/>

# Thank You

