



Use of Fly ash from KKAB, Sweden

Sealing a landfill and stabilizing hazardous waste

M.Sc.Civ.Eng Kristina Hargelius, Environmental consultant in Ramböll Sweden AB

RAMBÖLL

Recycled paper – gives us perfect fly ash



RAMBOLL

Production of fly ash – 20 000 ton a year



Fly ash and bottom ash.

The fly ash is a non hazardous product – includes metals

- SiO₂
- CaO
- Al₂O₃
- K₂O

Similar substances as in cement.



The bottom ash contains heavy metals

RAMBOLL



Chemical contents of the KKAB fly ash is similar to puzzolana cement

SiO ₂	22	% TS
Al ₂ O ₃	11	% TS
CaO	56	% TS
Fe ₂ O ₃	2	% TS
K ₂ O	0,8	% TS
MgO	1,6	% TS
MnO	0,095	% TS
Na ₂ O	0,4	% TS
P ₂ O ₅	0,3	% TS
TiO ₂	0,3	% TS
Sum	95	% TS

	Limit for inert material		Average for KKABs Fly ash	
	L/S 0,1	L/S 10	L/S 0,1	L/S 10
	mg/l	mg/kg TS	mg/l	mg/kg TS
As	0,06	0,5	0,001	0,01
Ba	4	20	1,0	61,5
Cd	0,02	0,04	0,000	0,001
Cr	0,1	0,5	0,072	0,138
Cu	0,6	2	0,005	0,043
Hg	0,002	0,01	0,000	0,000
Mo	0,2	0,5	0,278	0,155
Ni	0,12	0,4	0,000	0,005
Pb	0,15	0,5	0,015	0,644
Sb	0,1	0,06	0,000	0,003
Se	0,04	0,1	0,001	0,002
Zn	1,2	4	0,016	0,438
Cl	460	800	32	321
SO ₄	1500	1000	62	55
F	2,5	10	1,7	28
DOC	160	500	7,8	38

Mixing high contaminated bottom ash with the fly ash

- The bottom ash contains high levels of
 - Lead
 - Zink
 - Copper
 - Arsenic
- The leach test after mixing the ashes and two days hardening. The levels of heavy metals decreased with **90 – 98%**.

Geotechnical and chemical tests of the fly ash



There were no good results at the laboratories.

Drilling in ash layers from nearly ten years of ash deposing to find the groundwater table

- No water found
- The ash was powder dry down to a depth of 10 m below surface
- Some fly ash was left behind in an airtight sampling bag
- 5 days later the ash was hard as concrete



The ash mine of Rome. 3000 – 2000 years ago they began to use Pozzolana ash.



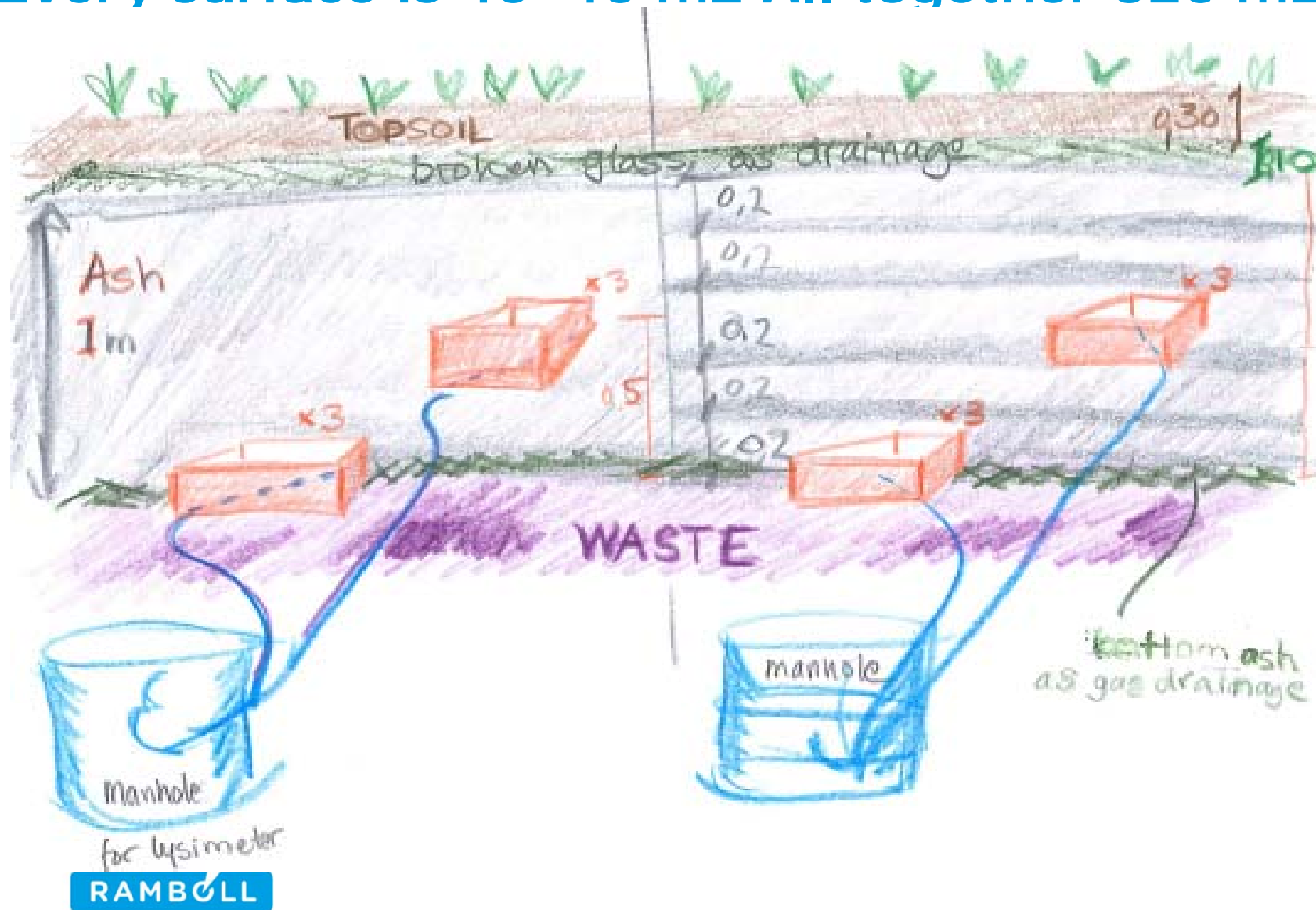
RAMBOLL

Puzzolana ash has been used for more than 2000 years – Pantheon temple in Rome



Pilot surfaces – 2 different construction methods

Every surface is 40*40 m² All together 320 m²



Lysimeters – to collect leachate. We had 12 lysimeters in 2 levels



A pilot surface was established as a terracing surface with **crushed glass** as gas drainage



Lysimeters filled with macadam (gravel) and sand.





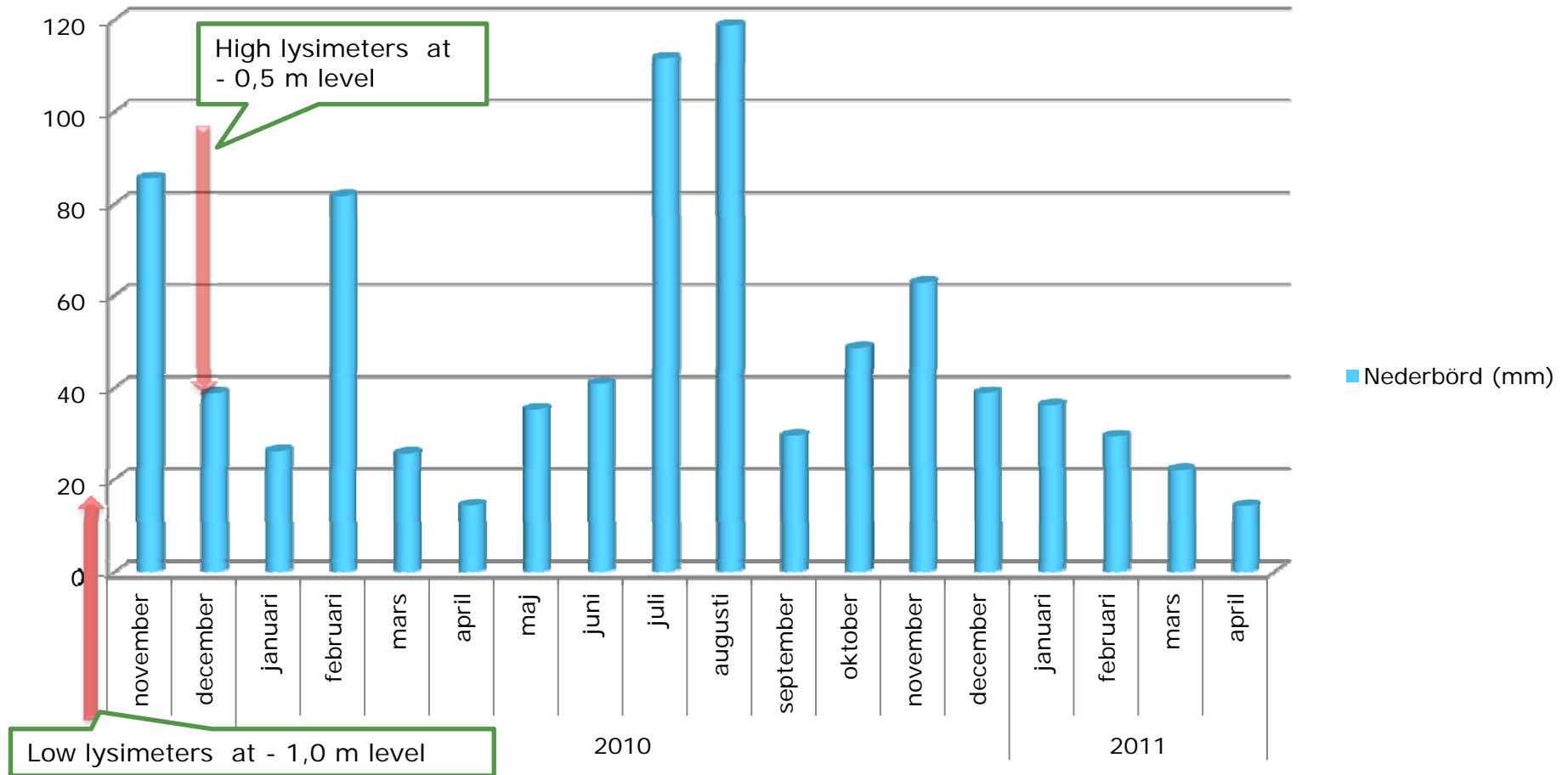
Precipitation in the form of snow can be moved away



The last layer Top soil



Rainfall nov 2009 to april 2011



Pumping water from the lysimeters

- During 1,5 years the 12 lysimeters has collected 4,2 litres all together
- Every lysimeters surface is 0,2 m²
- The permeability is approx. 1,2 l/m² a year
- During the last test, water was only collected by one of the lysimeters.



Results during 1,5 year

Dates for sampling of water from the lysimeters	(The first test) 2010-04-21	2010-10-25	2011-05-09	2011-09-15
Total volume (l) from 12 lysimeters	3,75	0,3	0,05	0,15
Equivalent to liter/m ² a year	6,25	0,50	0,09	0,25

- The guidelines concerning sealing is following
 - A landfill for non hazardous waste - max permeability 50 l/m² a year
 - A landfill for hazardous waste - max permeability 5 l/m² a year

Testing the function of the lysimeters – Was it too good to be true?? No! It was true😊

Peristaltic
pump



We pumped water into the dry lysimeters, to be sure that nothing was broken.

What is the next step? Reclassification

- The whole landfill will be sealed with the fly ash.
- The waste classification is now “Non-hazardous” and we are applying for a reclassification to “Inert waste”.
- The case is in the process
- The preliminary decision is that the fly ash will be reclassified

