



NorthPestClean
Pesticide Remediation

“NorthPestClean”

“*IN SITU* alkaline hydrolysis of insecticides with various enhancement techniques, a large-scale demonstration project

CSME 2013

Amsterdam, 24-10-2013

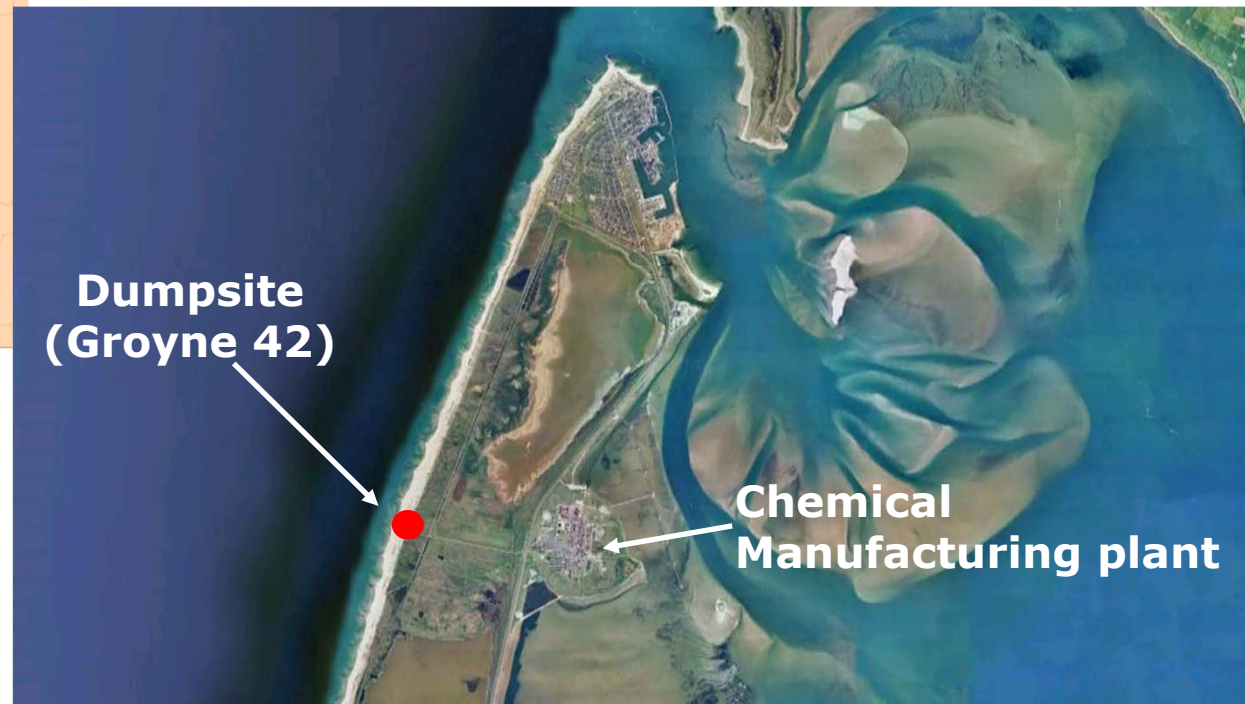
Boerge Hvidberg





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Chemical dumpsite 1953-1963





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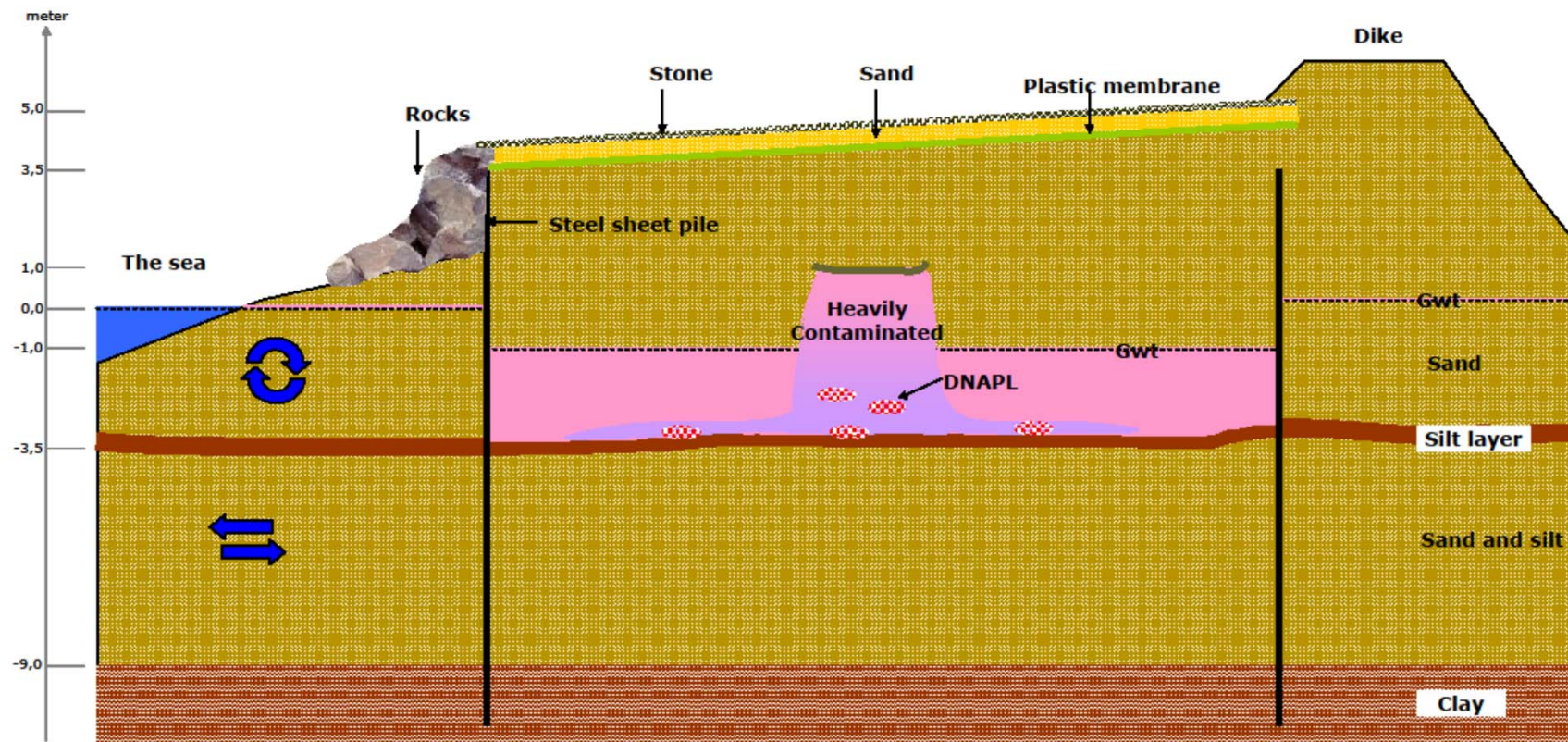
The contamination





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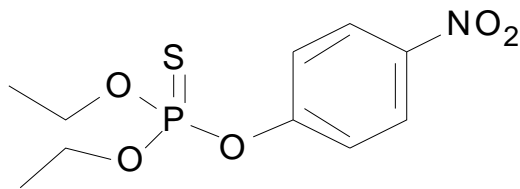
Principal sketch



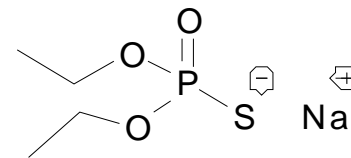
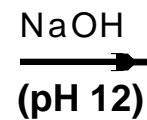


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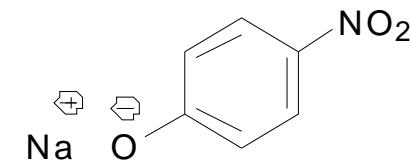
The principal of alkaline hydrolysis



Parathion



*O,O-diethyl phosphorothioate
EP2 -acid*



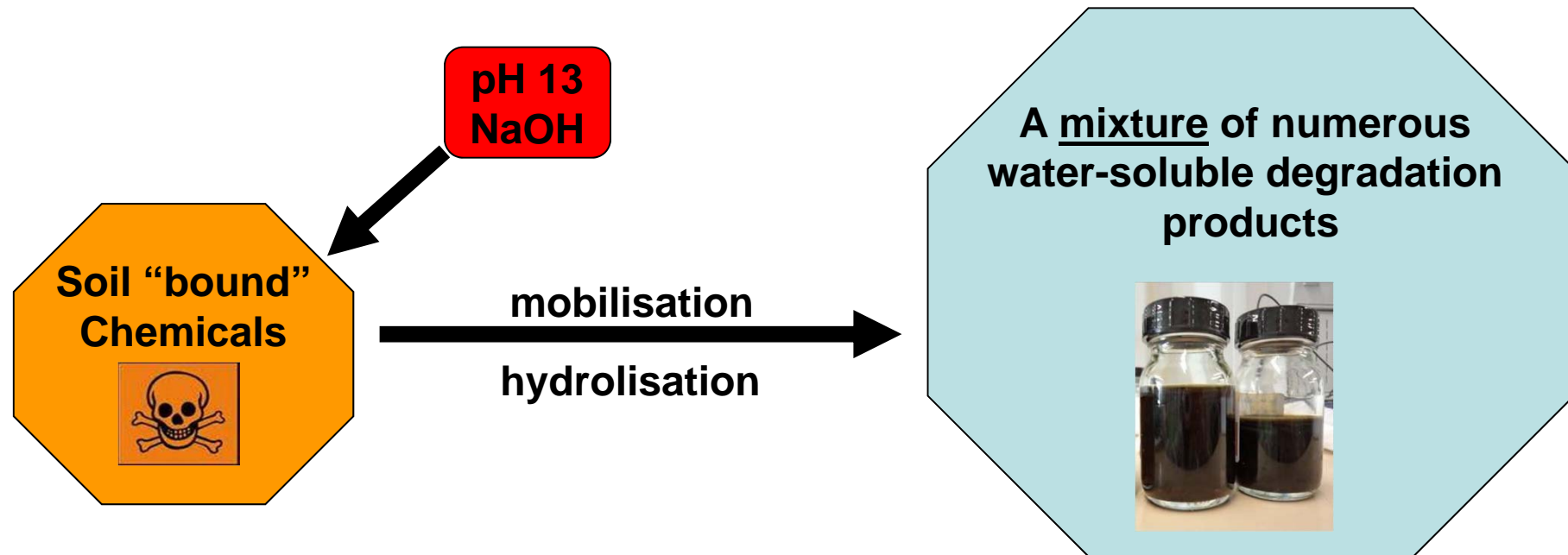
*para-nitrophenol
PNP*

"Water-soluble hydrolysis products"



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The “theory” of *in situ* alkaline hydrolysis

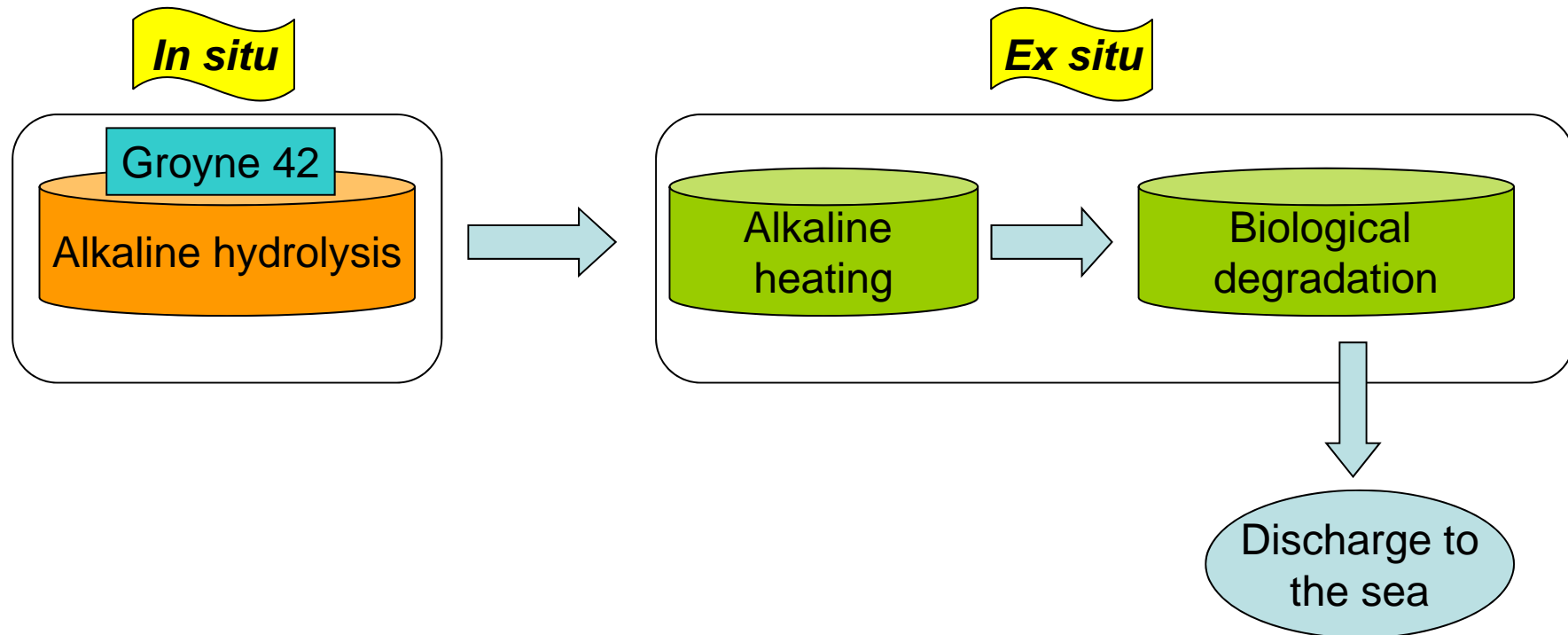




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Concept of remediation by alkaline hydrolysis

"Treat – Pump – Treat"





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"NorthPestClean" an EU-supported project

Objective:

- *In situ* alkaline hydrolysis – demonstrate efficiency
- Test of "**enhancement**" methods – increase efficiency



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The pilot test areas

3 test cells (10x10m)



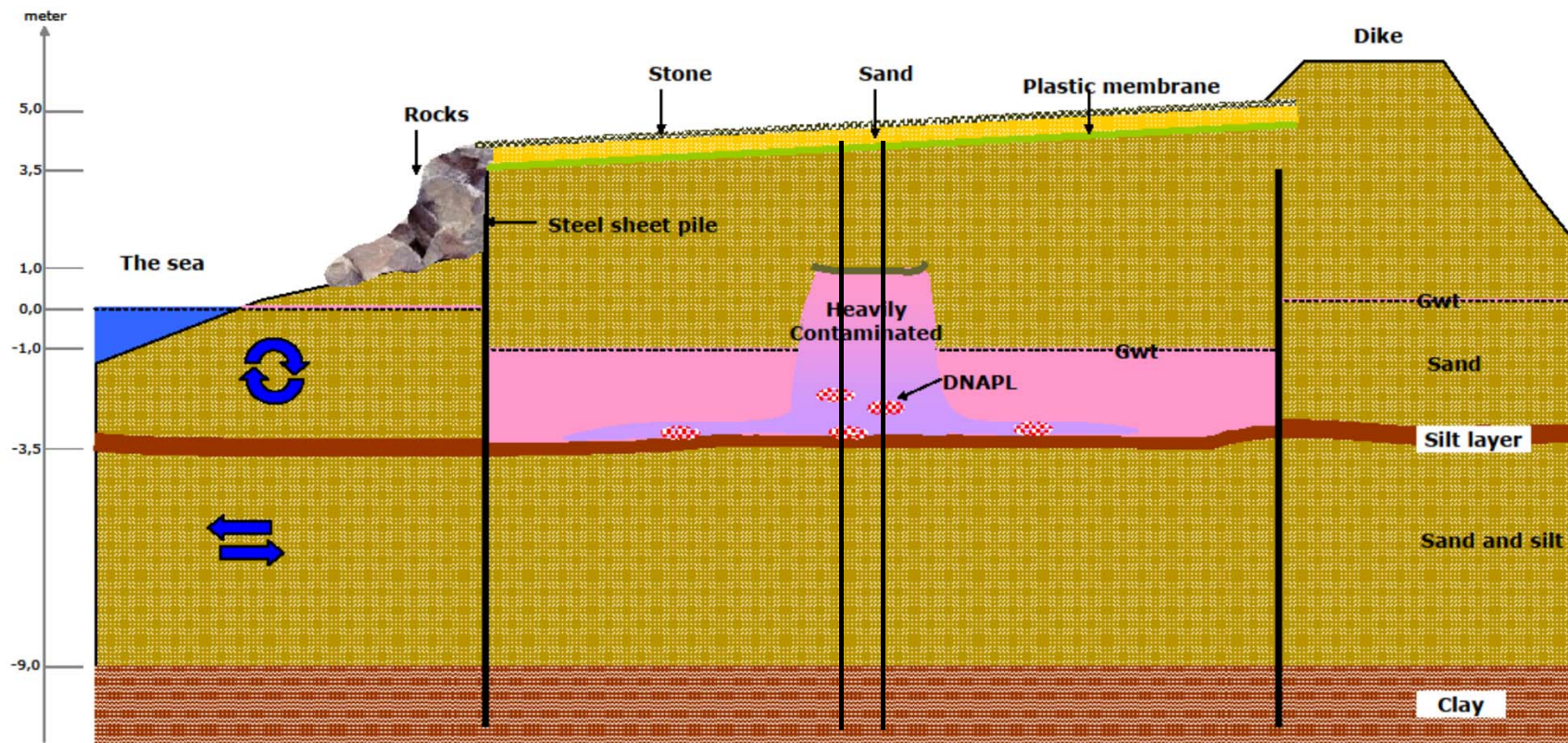
4 control test pipes





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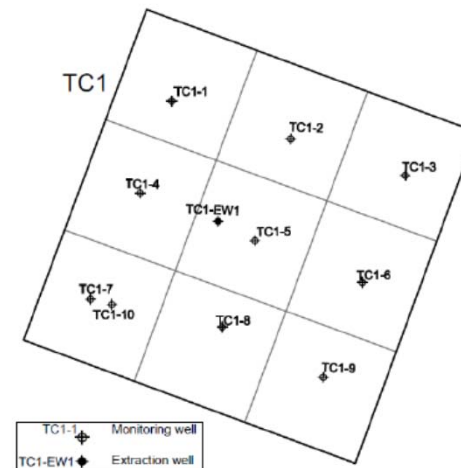
Principal sketch





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Initial characterization of test cells

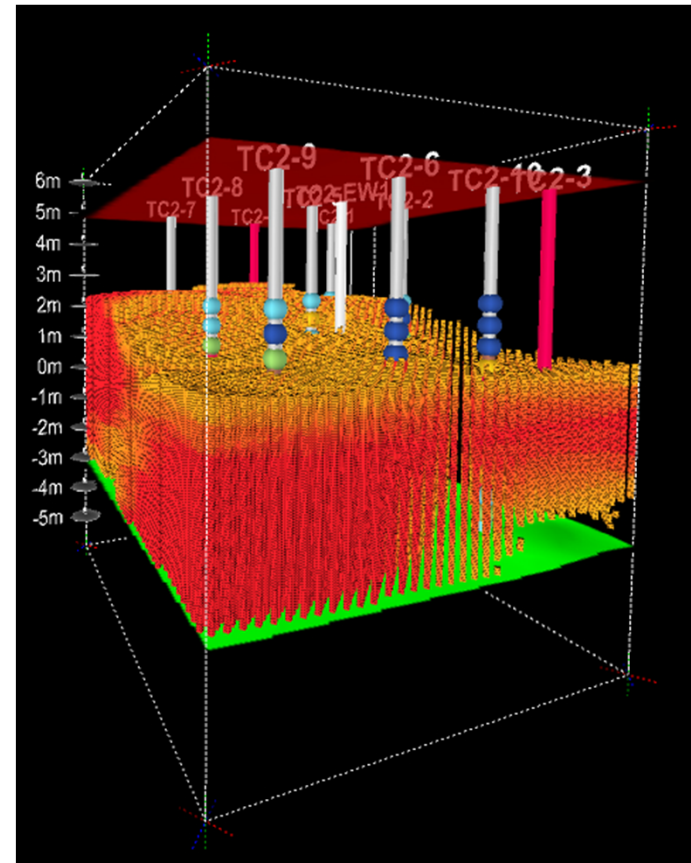




**“High resolution
site characterisation”**

Mass (kg) - test cells

	TC1	TC2	TC3
Parathion (EP3)	575	991	780
Methyl parathion	62	230	179
Malathion	32	135	198
Sulfotep	19	35	46
Hg	89	101	128





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Test of enhancement techniques in 3 cycles



- ➔ **Cycle 1 (2011): Drainage of the cells, replacing it with caustic soda**

- ➔ **Cycle 2 (2012): Drainage of the cells, replacing it with caustic soda + vibration (TC1)/recirkulation (TC2)/no enhancement (TC3)**

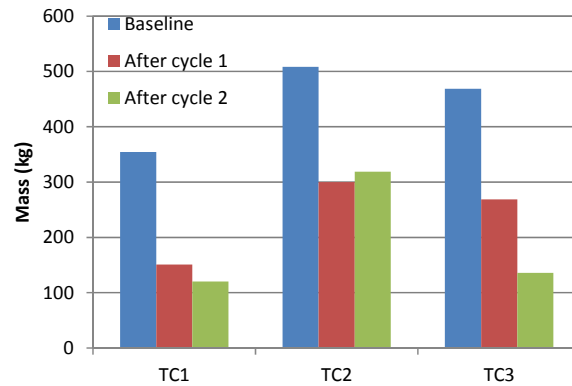
- ➔ **Cycle 3 (2013): No draining, vibration+air sparging (TC1)/recirkulation+surfactant (TC2)/no enhancement (TC3)**



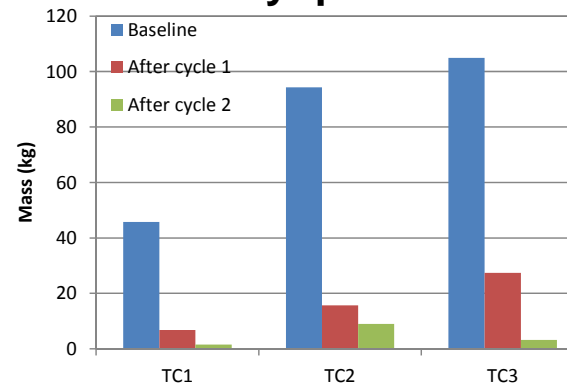
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Contaminated mass in soil (based on soil analysis)

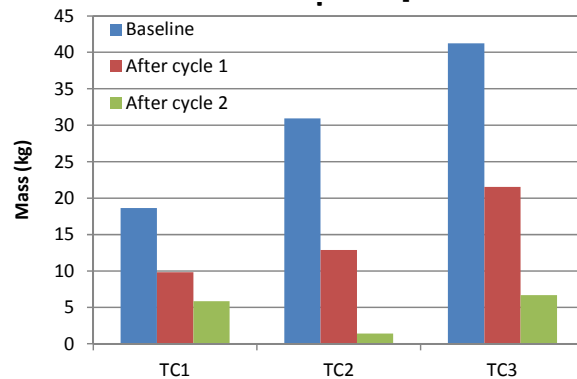
Parathion



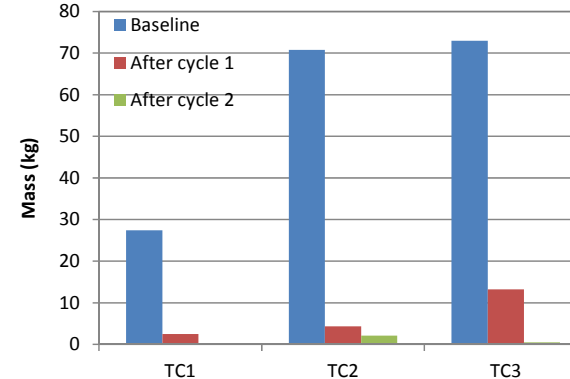
Methyl-parathion



E-sulfotep



Malathion



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Acknowledgements

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Central Denmark Region**

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Thank you for your attention!

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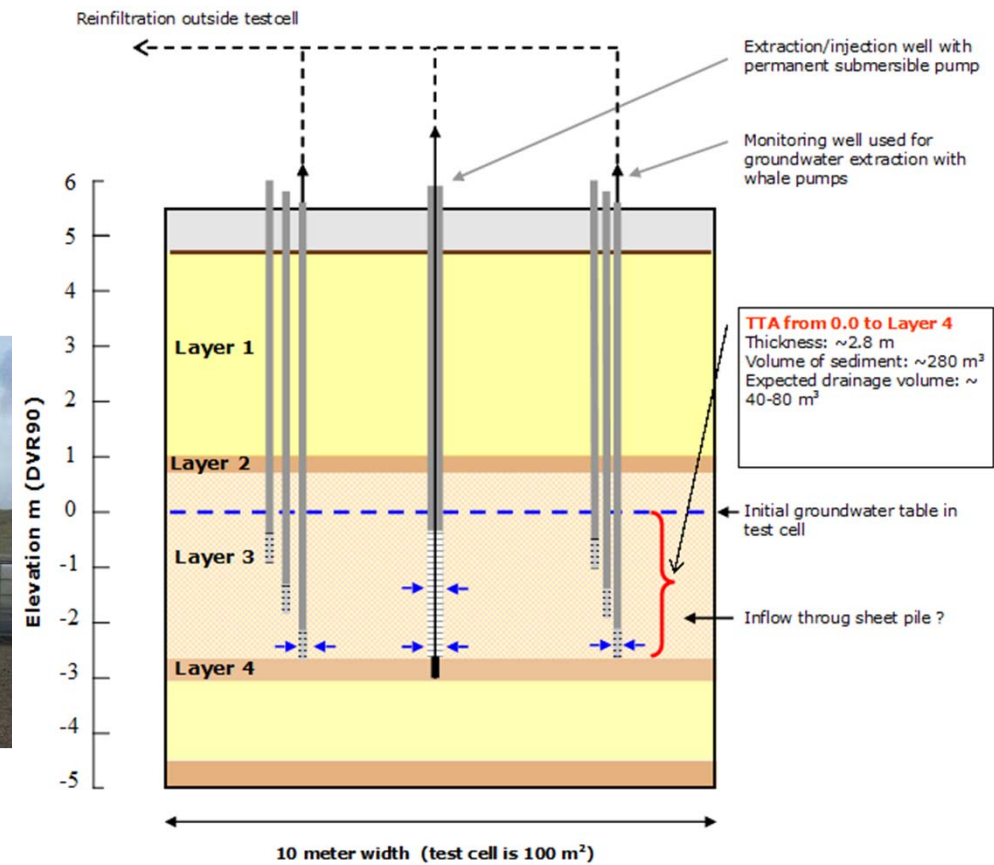
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Start of demonstration experiments

Draining the test cells





Caustic soda infiltration (pH 13)





Monitoring of hydrolysis progress

Water sampling



**pH13
treated**



**pH 6
untreated**



Enhancement metode 1 (cycle 2)

Acoustic vibration

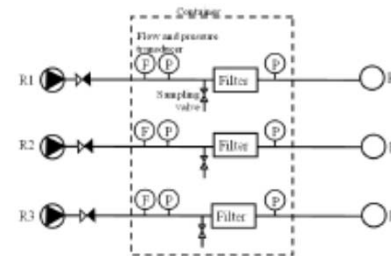
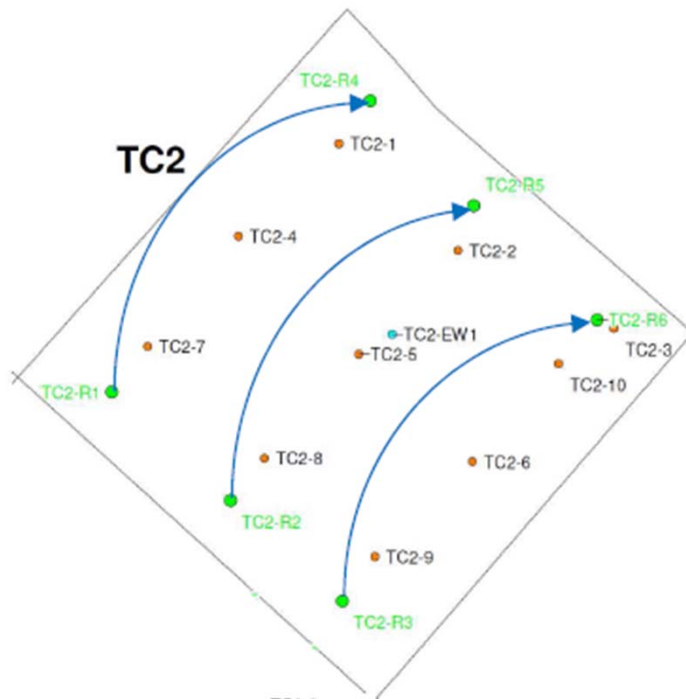


- 3000 kg
- 43 Hz
- 5 min pr. hour
- run 6-8 weeks
- evaluation of data (water samples)
- revise strategy



Enhancement metode 2 (cycle 2)

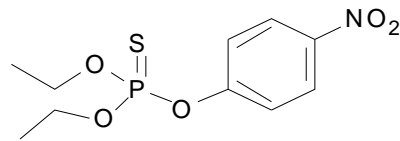
Recirkulation



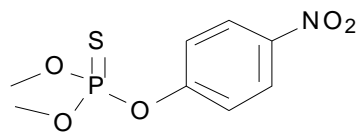


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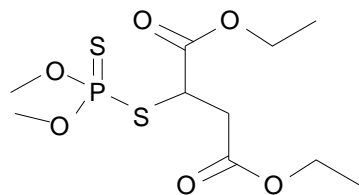
Primary contaminants, insecticides



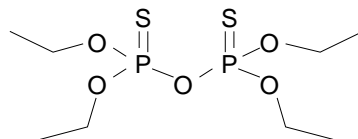
Parathion



Methyl-parathion



Malathion



Sulfotep



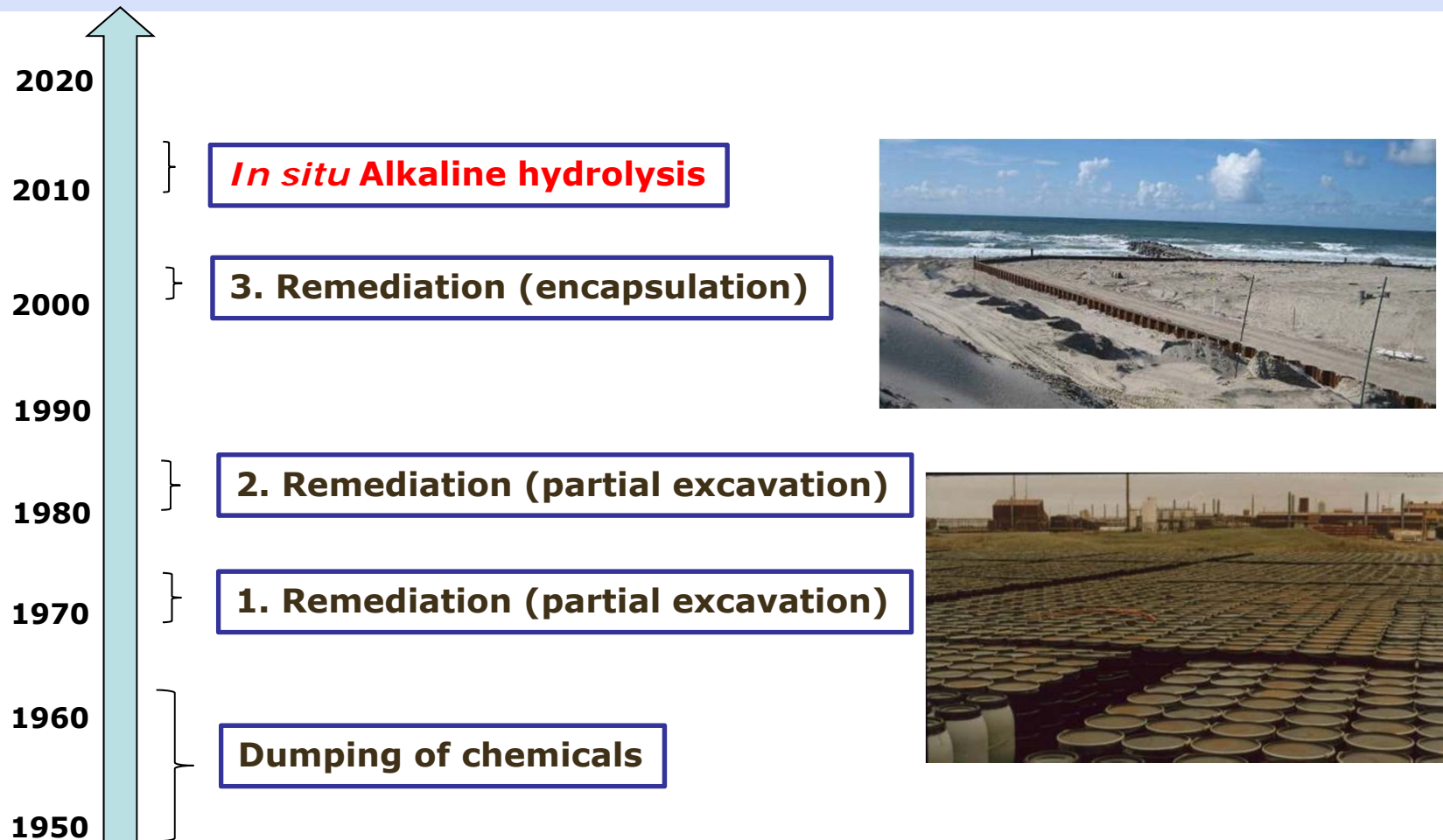
Photo 1958





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History





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Conclusions – in situ alkaline hydrolysis

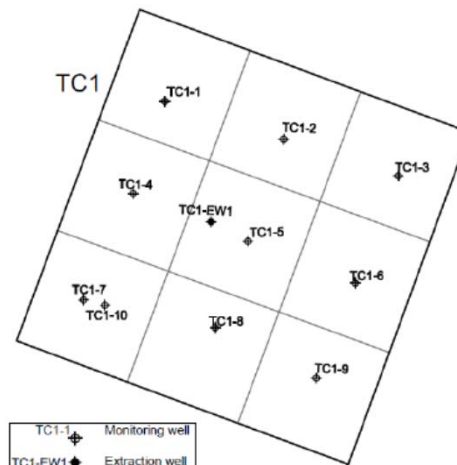
Conclusions after 1st round of NaOH treatment

- **30% of parathion degraded**
- **50% of methyl-parathion degraded**
- **75 % of malathion degraded**
- **The hydrolysis is underestimated in water samples**
- **Mercury is mobilised**
- **pH 11-13 is kept > 9 months**
- **Silicium mobilisation is a challenge**

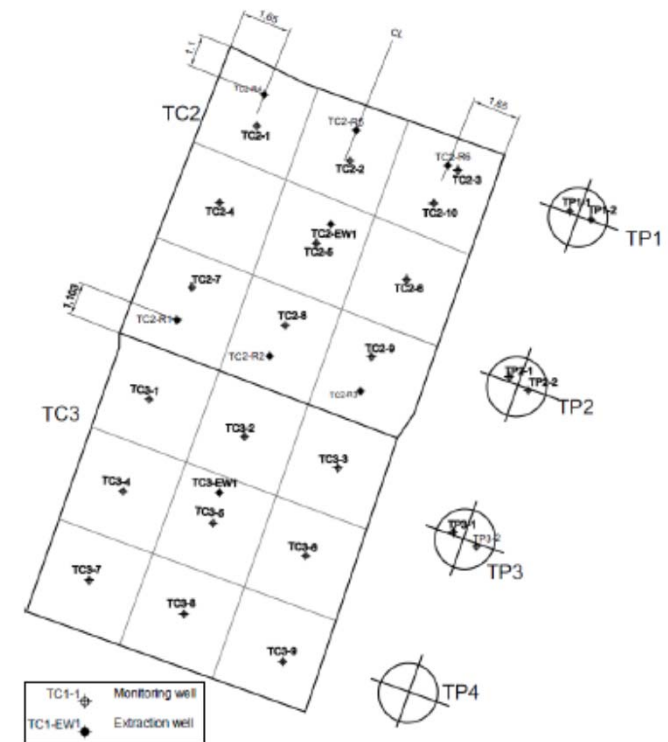


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Initial characterization of test cells



TC1-1 Monitoring well
TC1-EW1 Extraction well



TC1-1 Monitoring well
TC1-EW1 Extraction well



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Enhancement metode 3 (cyklus 3)

Surfactants

- **Laboratorieforsøg til identifikation af brugbare surfactanter (Aalborg University, Denmark and Surbec, USA)**
- **> 20 alternative surfactanter er blevet screenet**
- **Ecosurf EH-9 (alkohol ethoxylate) blev valgt**
- **Ecosurf EH-9 bliver testet i cyklus 3**



Composition in soil



Ethyl-parathion	63%
Methyl-parathion	13%
Malathion	10%
Sulfotep	3%

