



In-situ and on-site bioremediation of large scale and complex contaminated sites

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Martin Slooijer

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Topics

- Introduction
- Case 1: In-situ remediation of complex creosote contamination
- Case 2: On-site remediation of an oil contamination caused by exploration and oil production.
- Case 3: On-site remediation of a large oil contaminated site

Introduction BioSoil:

- All round remediation company, highly specialised and experienced in aerobic and anaerobic biodegradation
- World wide solutions for soil and groundwater contaminations, e.g. Chile, Japan, Germany, Italy, Canada etc.
- Clients various multinationals, Shell, Philips, VOPAK etc.
- BioSoil will take on remediation projects risk based with a guaranteed end result.
- R&D department, about 10% of personnel

Biological degradation process (aerobic)

- Micro organism
- Carbon source
- Nutrients (Nitrogen, Phosphorus)
- Oxygen

Two applications

- On-site, landfarming
- In-situ

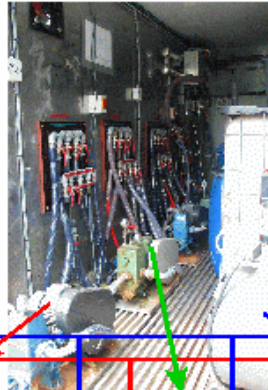


In-situ remediation, the soil is the bioreactor

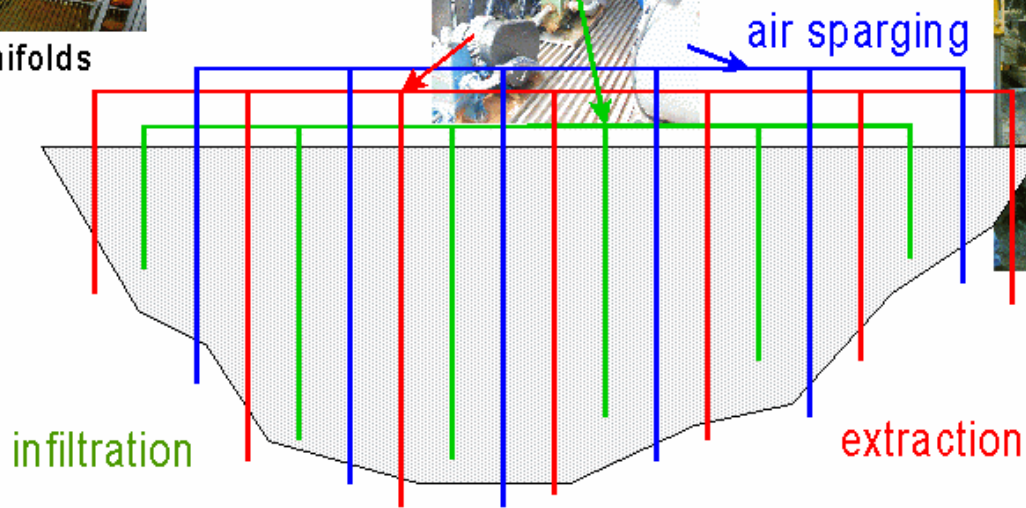
groundwater purification, dosing of nutrients, electron donor, etc.



manifolds



drilling



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Case 1:

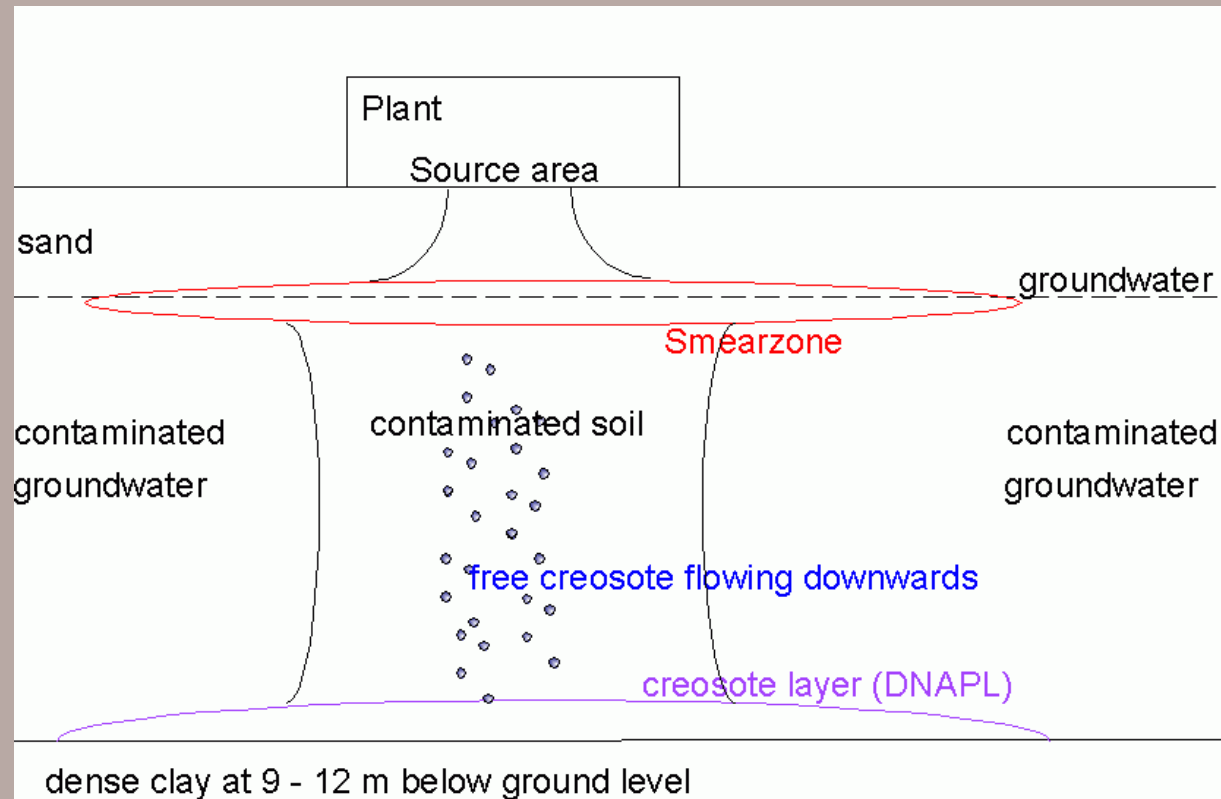
In-situ remediation Oostdijk



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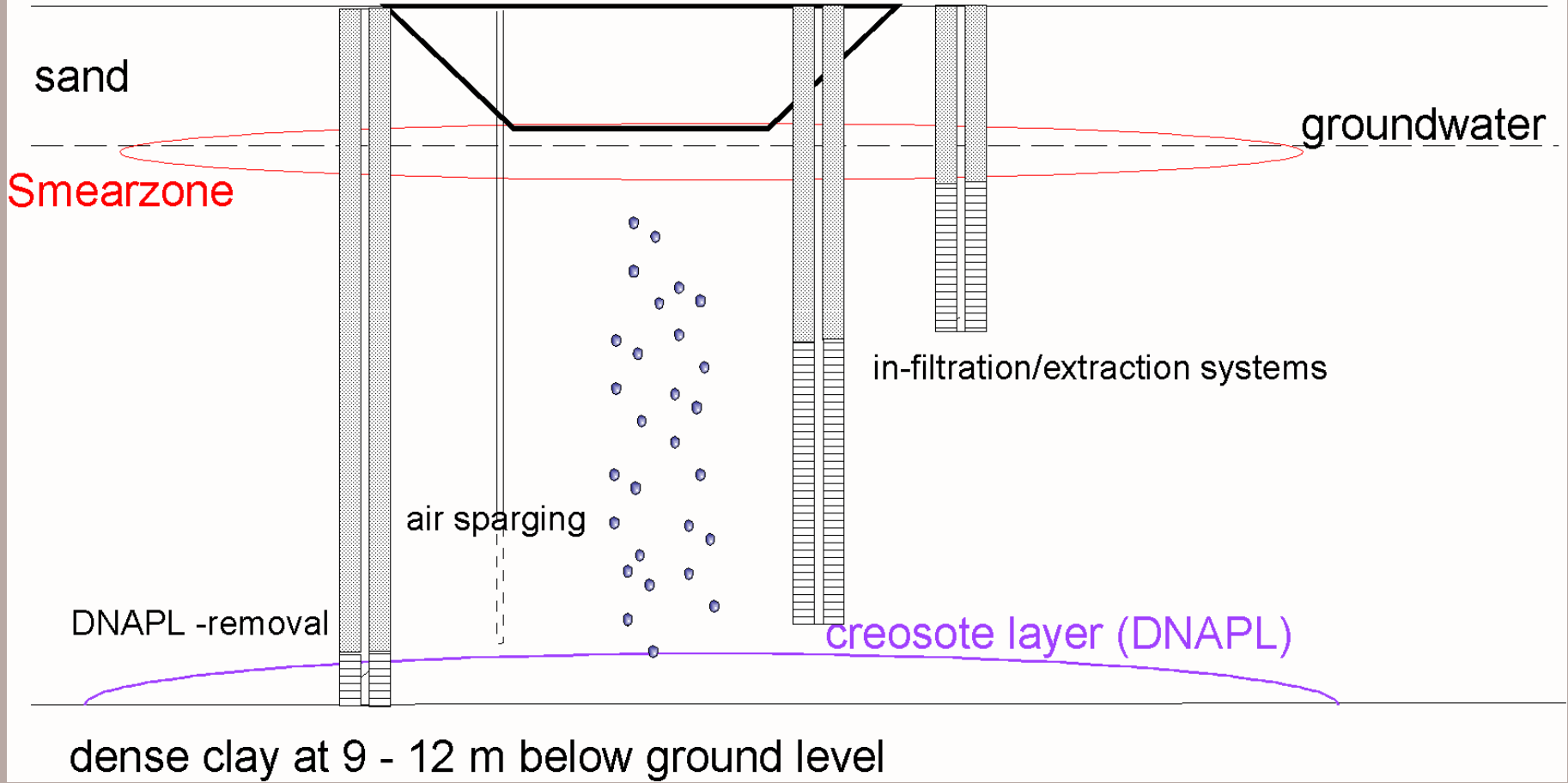
Location

- 60 long years: impregnation of wood with creosote
- (PAH, phenols, mineral oil, creosote as DNAPL's, smear zone, ...)



Decontamination approach

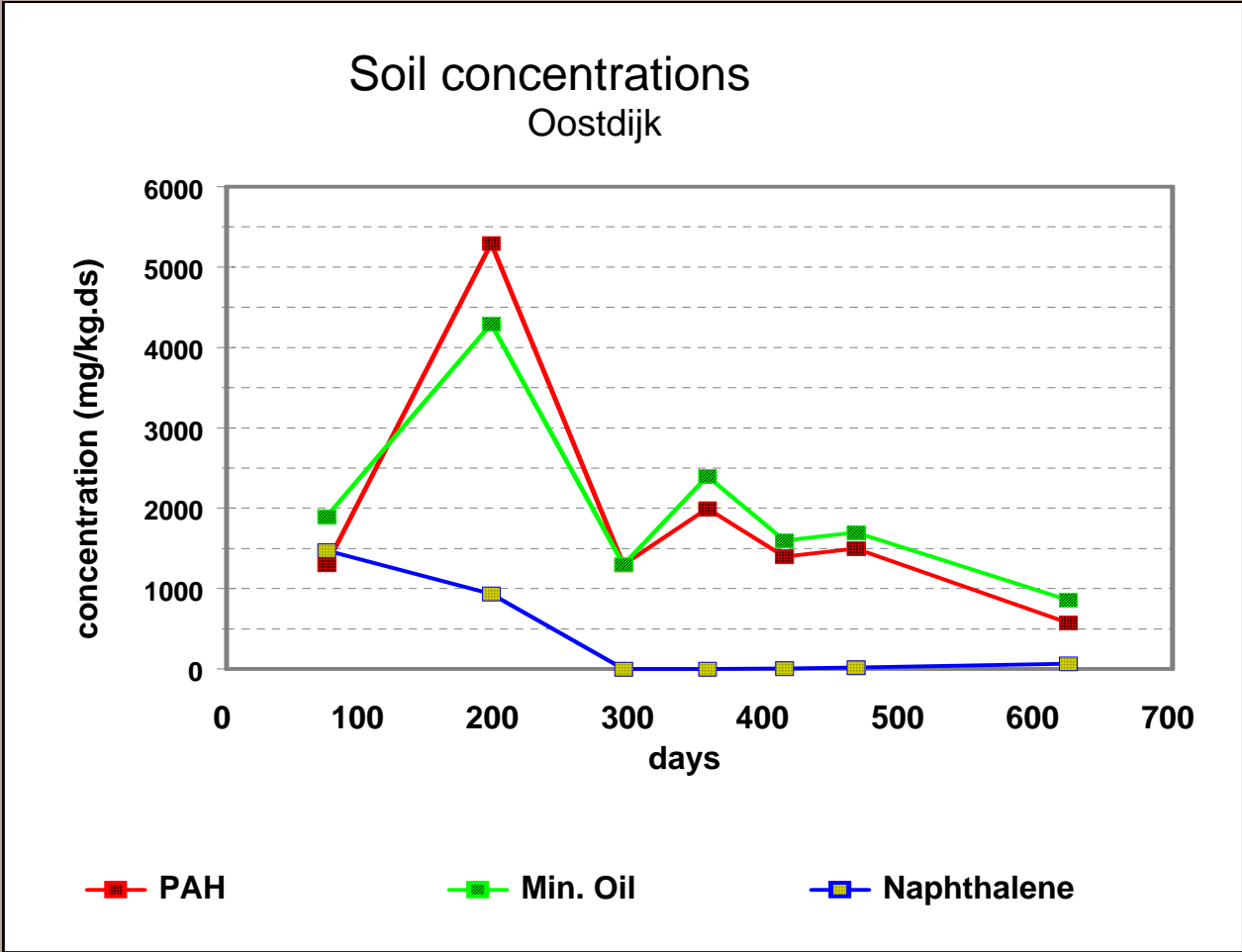
excavation of the source area



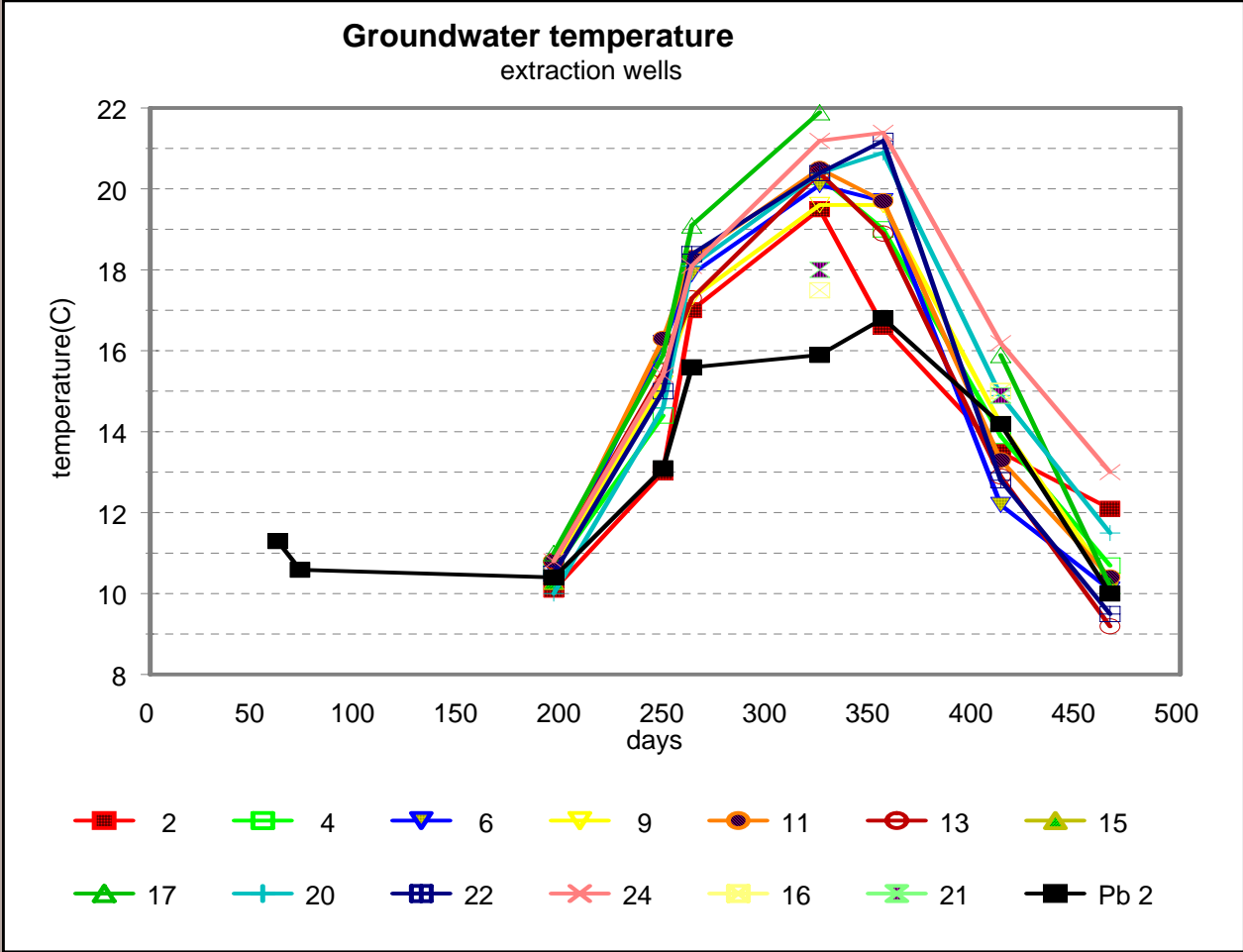
Results Laboratory test

SOIL	TEST PERIOD (days)	Levels before degradation (mg/kg)		Levels after degradation (mg/kg)	
		PAH's	mineral oil	PAH's	mineral oil
Oostdijk A	392/374	3300	5900	89/84	140/330
Oostdijk B	392/188	5000	15000	77/110	430/760
Oostdijk C	441/441	9700	18000	43/33	250/210

Results pilot



Results pilot



Summary Pilot results

- Temperature rise
- 5 tons of product extracted
- Decrease in soil concentrations
- Groundwater during pilot down to $\mu\text{g/l}$ level (source area)

Project targets:

- Below intervention levels for groundwater
- No target levels for soil.

Pilot test / Full scale

- Size 400 m² / 15.000 m²
- Depth 10 - 12 m-gl
- Duration 2 years / 7 years
- System
 - extraction / infiltration at two depth
 - aeration (sparging) at two depth
 - spacing 5 m / 5 - 15 m
 - product extraction system at 10 - 12 m-gl

Results until now

- App. 40 ton DNAPL removed
- 15.000 m² reduced to 1000 m²
- Partly developed as residential area

Successful approach: Laboratory, Pilot and full scale



Case 2:

On-site remediation Chile Fireland

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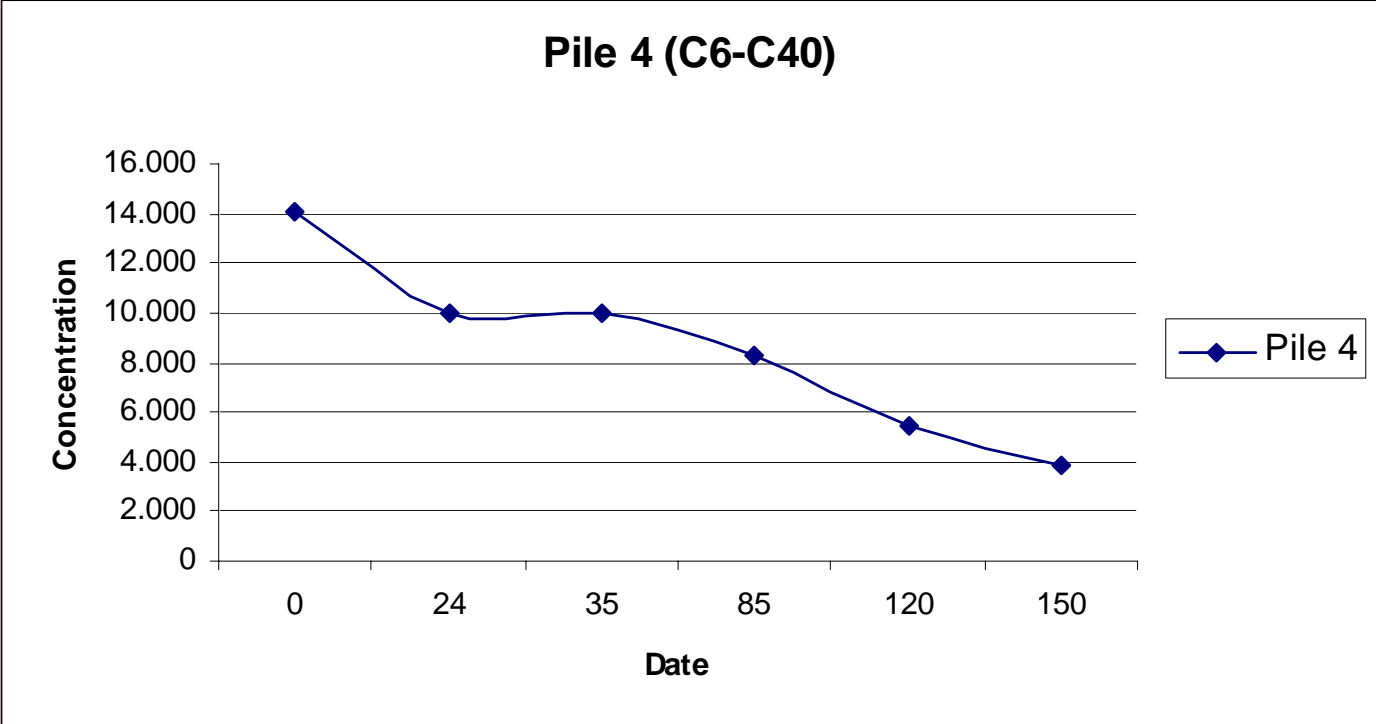
Project

- Many years of exploration and oil / gas production
- Over 1,000 locations contaminated
- Very remote areas
- Difficult climate, cold and windy

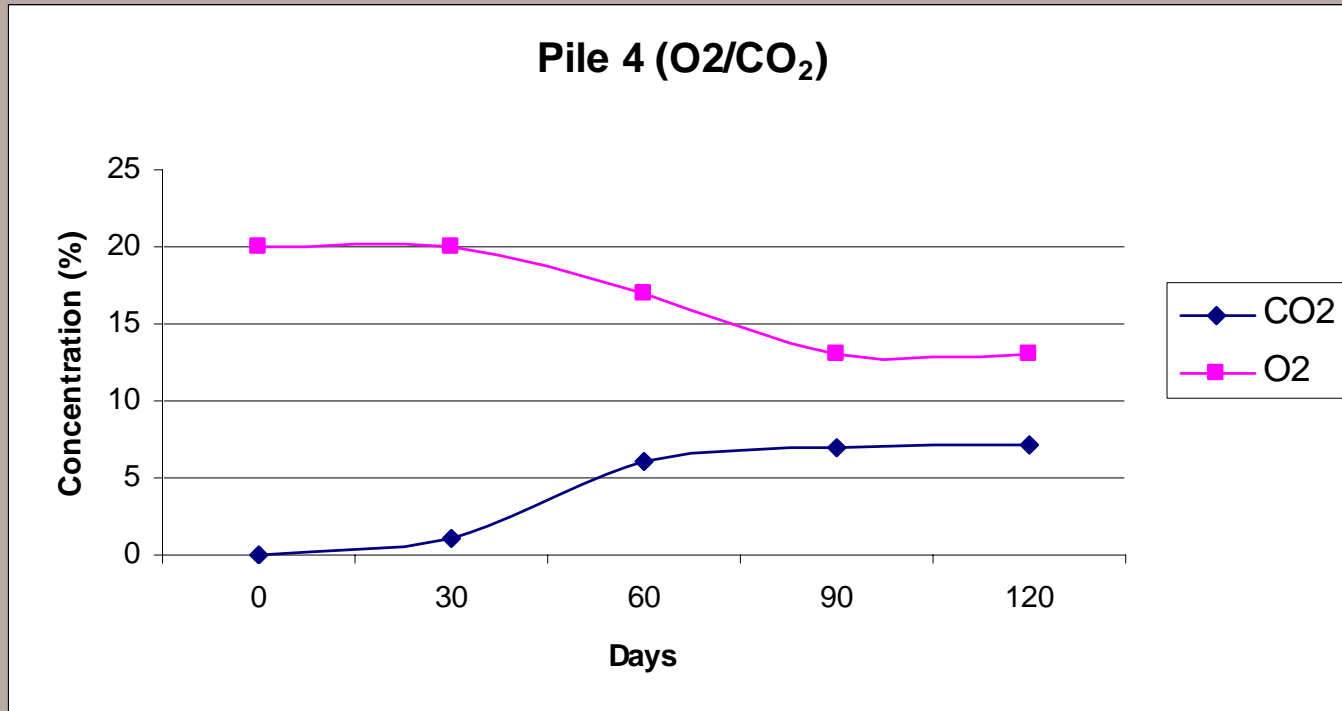
Approach:

- First a laboratory study
- Pilot test

Pilot results



Pilot Results O₂/CO₂



Case 3:

On-site remediation VOPAK



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Project characteristics

- Removal of subsurface structures
- Soil contamination of about 100,000 tons
- Groundwater contamination of about 20,000 m³.
- Strict time schedule:
 - total time available 1.5 year
 - for 20,000 tons soil only 3 months
- Objective soil: 1,000 mg/kg
- Objective groundwater: 350 µg/l

Remediation approach

- On-site biological decontamination of all the contaminated soil (intense mixing of the soil and use of forced aeration system)
- Pump and Treat for the groundwater remediation, using a horizontal drainage system.



Results

- The work is finished within the set timeframe, no contaminated soil needs to be removed of site.
- During soil remediation, temperature over 30°C (winter)
- Groundwater remediation took about 1/3 of the estimated time.
- Costs for on-site remediation over € 15.00 per ton cheaper than conventional way (dig & dump).



On-site treatment:

- Re-use of “waste” material
- No clean sand needs to be supplied.
- Significantly less transport movements around the site
- Combination with redevelopment
- Treatment time is hardly an issue
- Much lower costs