



Remediation project 'Dellen Wuyts'

Field experiences & results

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Turn key, Design & Construct project



Remediation project 'Dellen Wuyts'

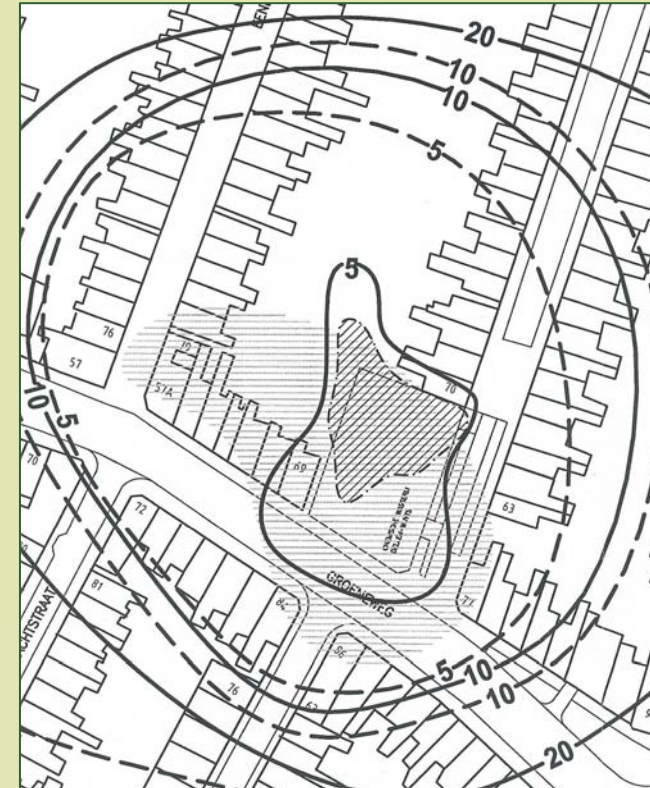
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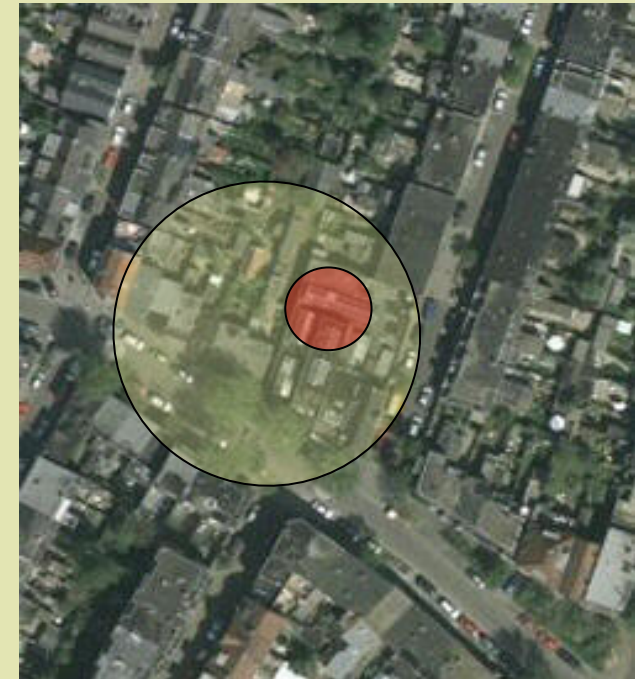
Site Characteristics

- Former dry cleaner
- Urban environment
- Soil type: sand, silty. Water table at ca. 2,5 m-bs
- Estimation: >5.000 kg product
- Max. 20-30.000 $\mu\text{g/l}$
- Horizontal distribution: ca. 10.000 m^2
- Vertical distribution: ca. 70 m
- Sanitation goals:
 - PCE 20 $\mu\text{g/ltr}$
 - TCE 250 $\mu\text{g/ltr}$
 - DCE 10 $\mu\text{g/ltr}$
 - VC 2,5 $\mu\text{g/ltr}$
- Sanitation depth until 10 m-bs



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Side Characteristics - photo impression



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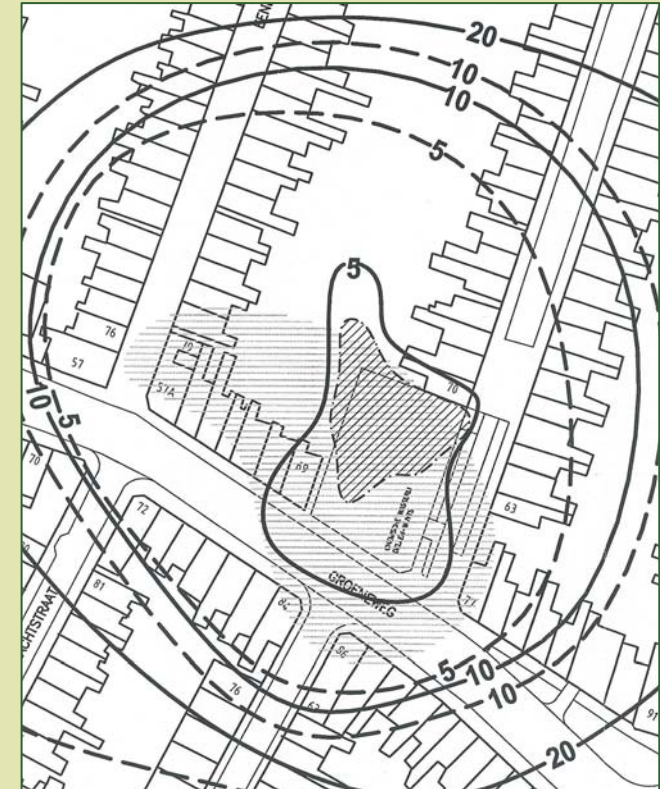
Combination of remediation techniques

Source area:

- Excavation unsaturated zone - source area
- Soil vapour extraction
- Chemical oxidation - Fenton's reagents

Plume & remaining source area

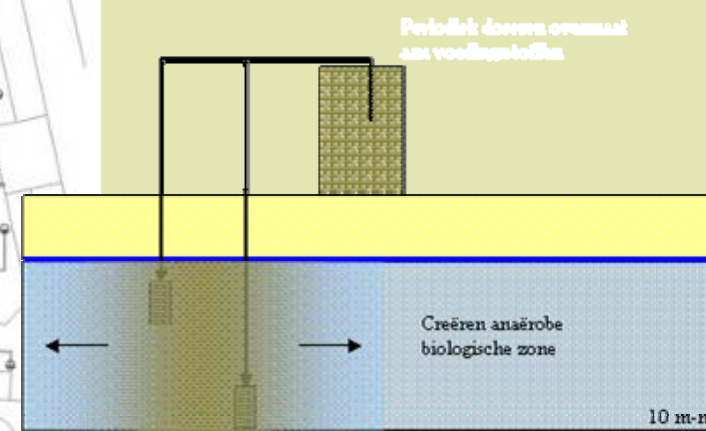
- Stimulation of natural degradation





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Excavation & filter plan bioremediation





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Filter plan chemical oxidation & soil vapour extraction





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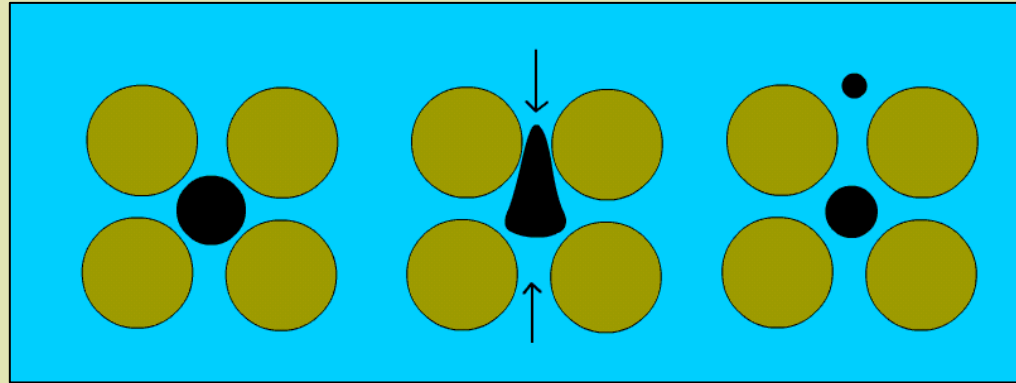
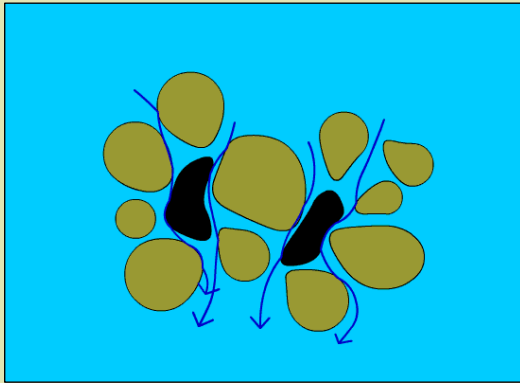
Acoustic, sonic Effects?

- After placing of ca. 70 ISCO filters
- Placed by Sonic Drilling
- Unexpected, worrying results
- Increase in concentration: factor 7-12

| Effects Acoestic remediation Dellen Wuyts | | | | | |
|---|----------------------|---|--------|---|--|
| filter | actualisation survey | after acoustic enhancement * after 3th injection round | | | |
| 7 | 12.000 | n.b. | 61.000 | * | |
| 9 | 1.350 | n.b. | 5.060 | * | |
| 10 | 39.700 | n.b. | 81.500 | * | |
| 11 | 24.300 | n.b. | 5.300 | * | |
| 201 | | 150.000 | | | |
| 201 | | 150.000 | | | |
| 204 | | 240.000 | | | |
| 205 | | 140.000 | | | |
| 208 | | 240.000 | | | |
| 401 | | 170.000 | | | |
| 403 | | 160.000 | | | |
| 408 | | 190.000 | | | |
| 410 | | 53.000 | | | |
| 502 | | 50.000 | | | |
| 602 | | 130.000 | | | |
| 604 | | 100.000 | | | |
| 606 | | 88.000 | | | |
| 612 | | 2.200 | | | |
| 701 | | 210.000 | | | |
| 801 | | 200.000 | | | |
| 809 | | 120.000 | | | |
| 810 | | 210.000 | | | |
| average: | 19.338 | 144.622 | | | |
| av. increasement (factor): | | 7 | | | |
| max. increasement (factor): | | 12 | | | |
| n.s. not analysed | | | | | |

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Acoustic, sonic Effects?



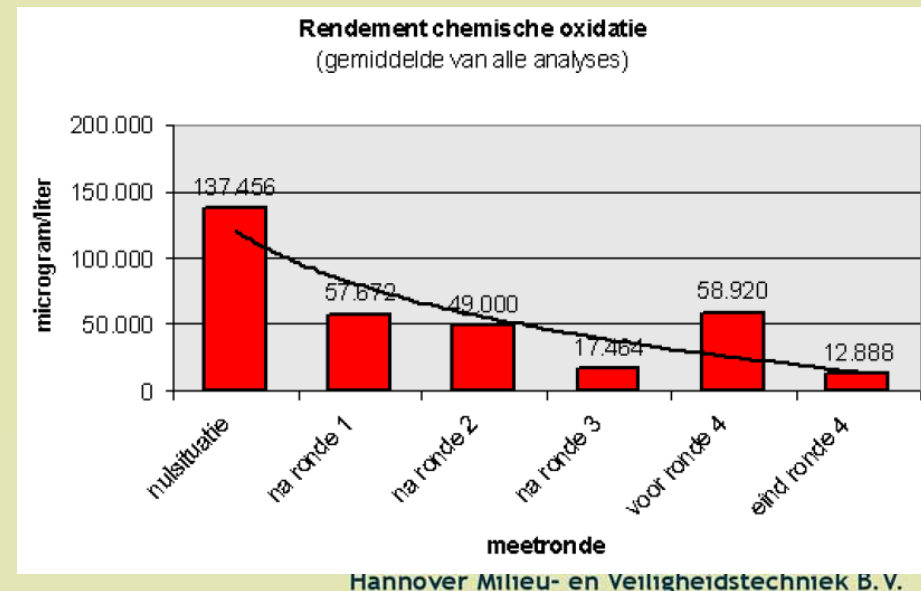
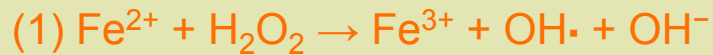
Results:

- To meet sanitation goals: need for a much more intensive source area treatment
- A much higher remediation result / efficiency
- Start of further 'acoustic' pilot studies, together with TNO (Dutch Research Institute)

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Chemical oxidation in source area

- Using Fenton's Reagents
- Four oxidation rounds - dec '03 - sept '04 (in stead of two)
- Results: >90% reduction



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Chemical oxidation in source area

- Natural gas condensates (Oosterhout - Netherlands)
- Other volatile oils (Antwerp - Belgium)
- Btex (Roermond - Netherlands)
- Chloride compounds (Saint Pazanne - France)



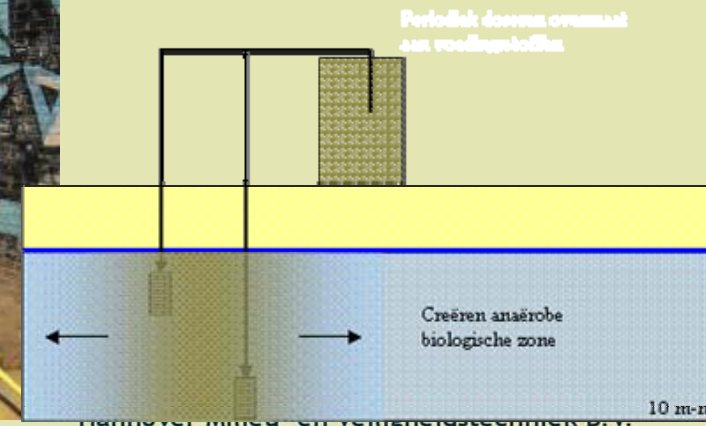


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Enhancement biological degradation

- Remaining source area & plume area
- 1st Shock load injection of molasses (Jan '05)
- Including 'enting the site with water from an other site with high concentrations of dehalogenating bacteria
- 2nd Shock load injection of ENNA (June '05)

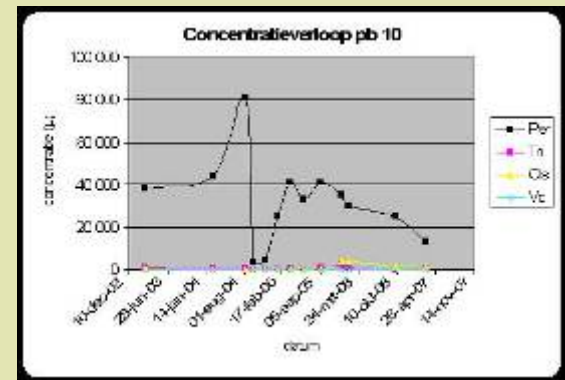
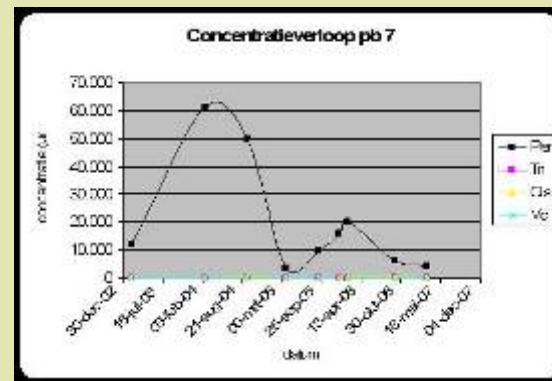
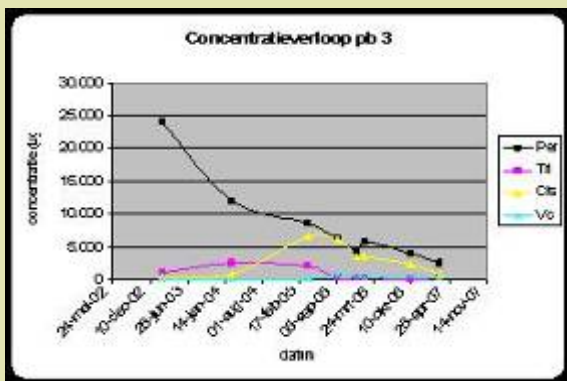
ENNA: very fine emulsion of Soya-oil (long lasting carbon source)



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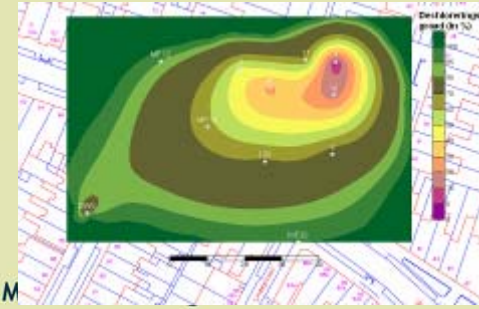
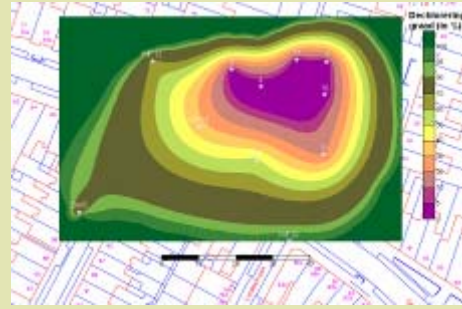
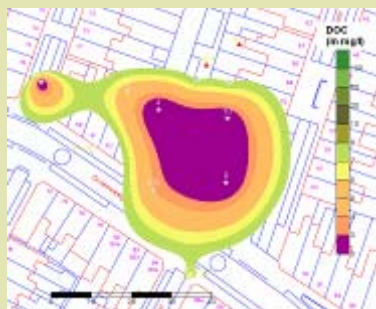
Enhancement biological degradation - results

- Clear improvement of 'degradation environment' (DOC)
- Clear increase in harmless rest products (ethene, ethane)
- Spreading of pollutants is stabilized



DOC after ISCO and after shock load

Dechlorination index after ISCO & stimulation NA





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Thanks for your attention !

Klaas de Jong

Questions?