

# **CHANCES AND LIMITATIONS of** **IN-SITU TREATMENT SYSTEMS**

## **MAIN ORGANIC CONTAMINANTS**

- Light Products      Gasoline  
                             Solvents  
                             BTEX  
                             MTBE  
                             Chlorinated Hydrocarbons
- Medium Products   Diesel / Heating oil  
                             Lubricants
- Heavy Products     Crude oil  
                             Heavy Oil

# TREATMENT OPTIONS FOR SOIL

- Excavation >>> mechanical treatment (ex-situ)
- No Excavation >>> treatment as found (in-situ)



IN SITU  
REMEDIALTION  
SYSTEMS



## USABLE EFFECTS

**contaminant is**

1. pumpable → pumping systems
2. adsorbent → adsorber systems
3. volatile → extraction/stripping systems
4. soluble → hydraulic systems
5. bio-degradable → bio-systems
6. chemo-oxidable → chemical systems

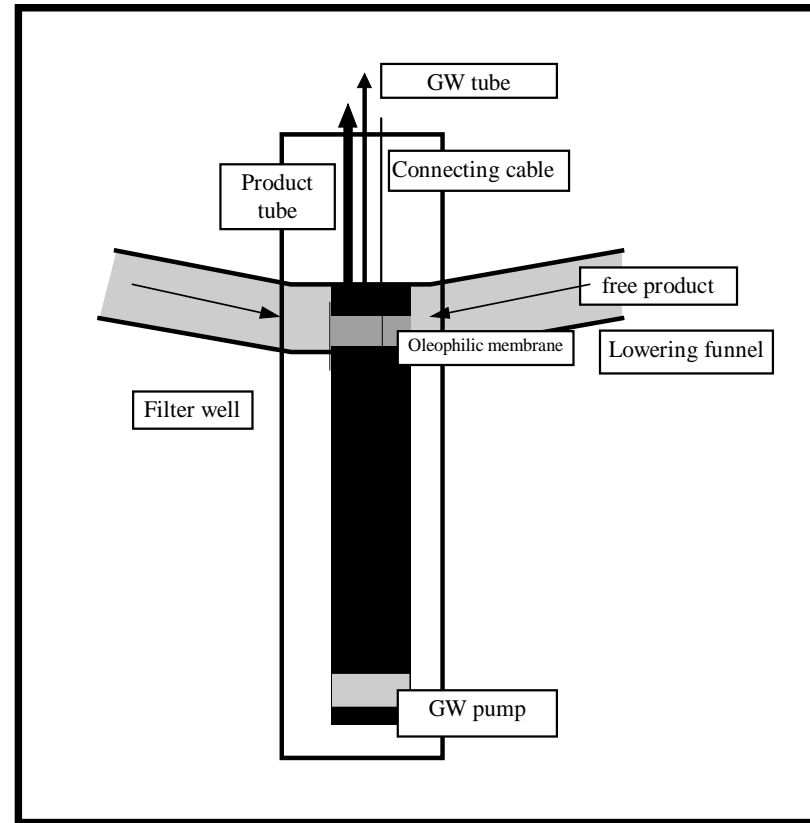
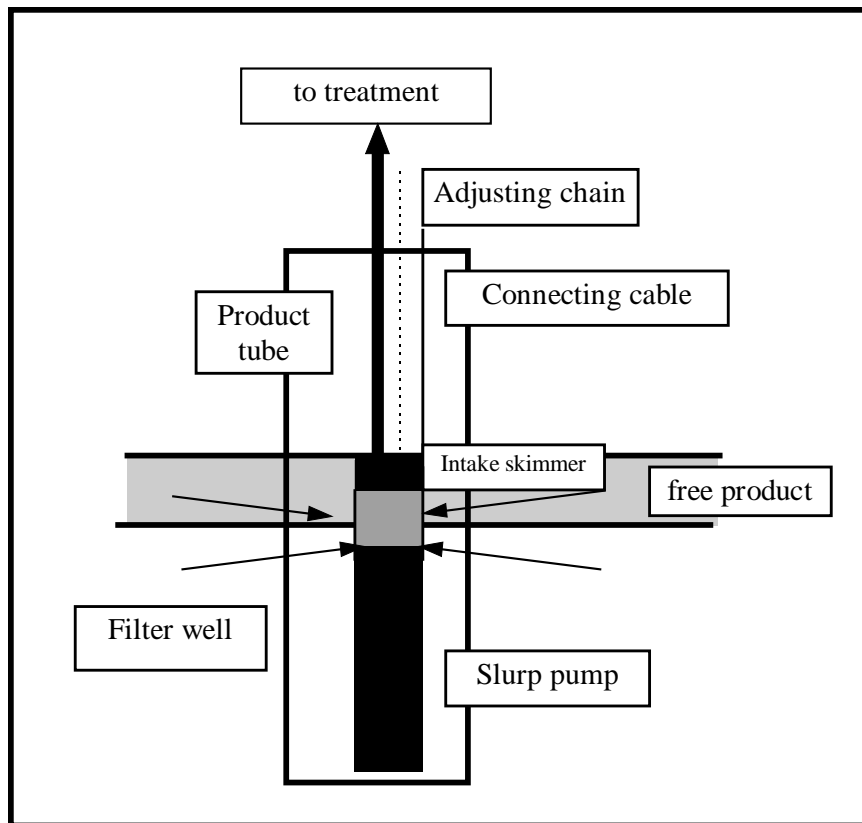
## **STATEMENT**

The number and the assembly of the subterranean installations are dominantly influencing the success of an in-situ treatment.

The battle is lost or won here and not in the water- and off gas plants.

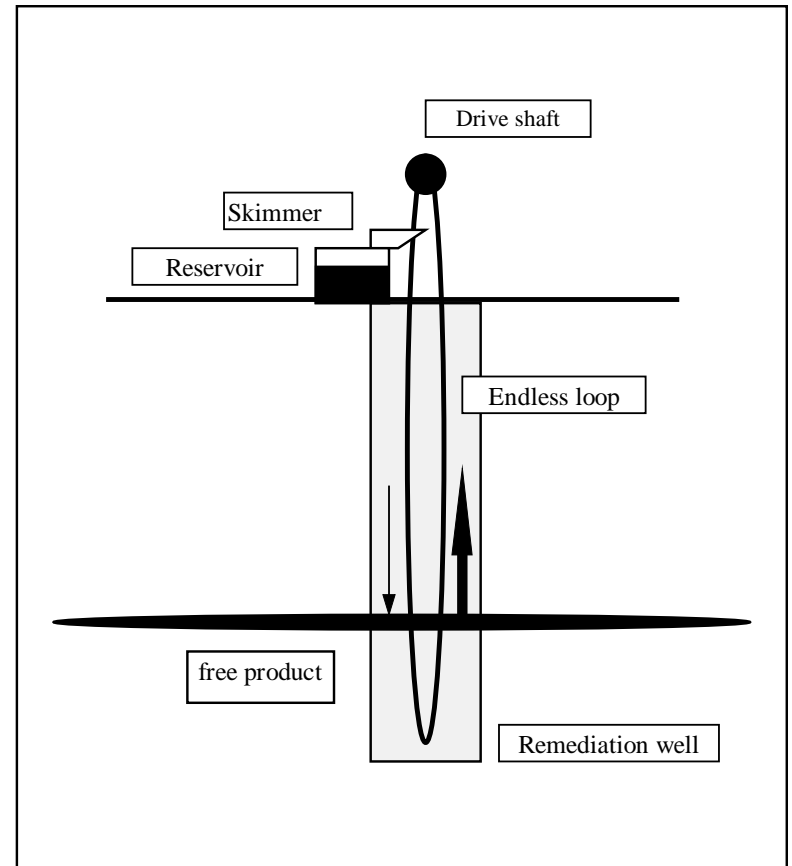
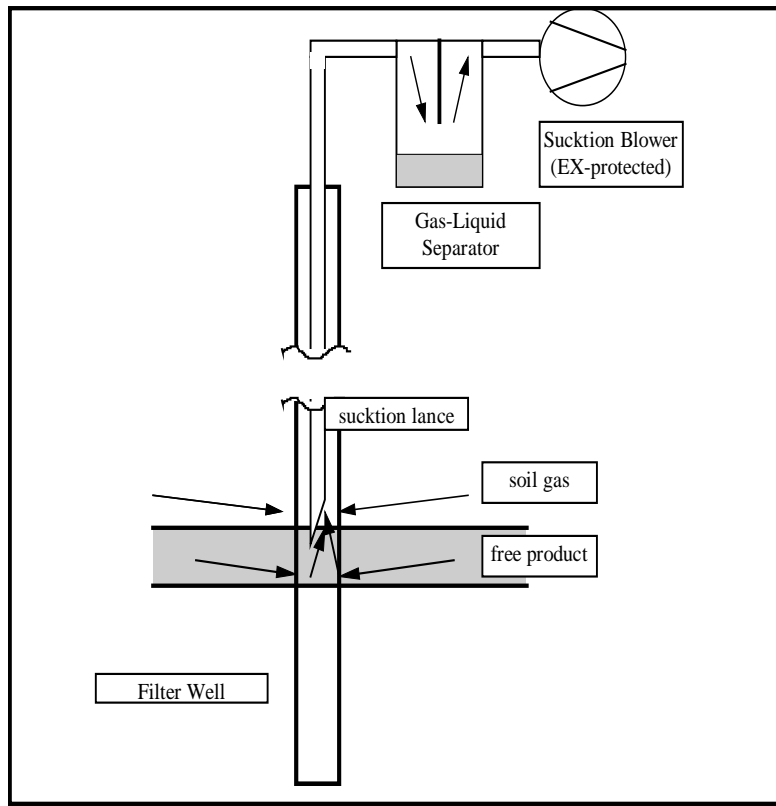
# **PRODUCT RECOVERY SYSTEMS**

- Removal of free product from
- Pre-treatment before excavation  
(to avoid soil pollution of uncontaminated soil)
- First step of in-situ remediation  
(best level in removal: kg HC/€)





# PRODUCT RECOVERY SYSTEMS



## **APPLICATION**

- Well diameter 2“ to 6“
- For Gasoline, Diesel / heating oil EL
- Product Thickness 1 mm to > 1 m
- Flow Rate > 100 ltr/h
- Duration 6 month and more

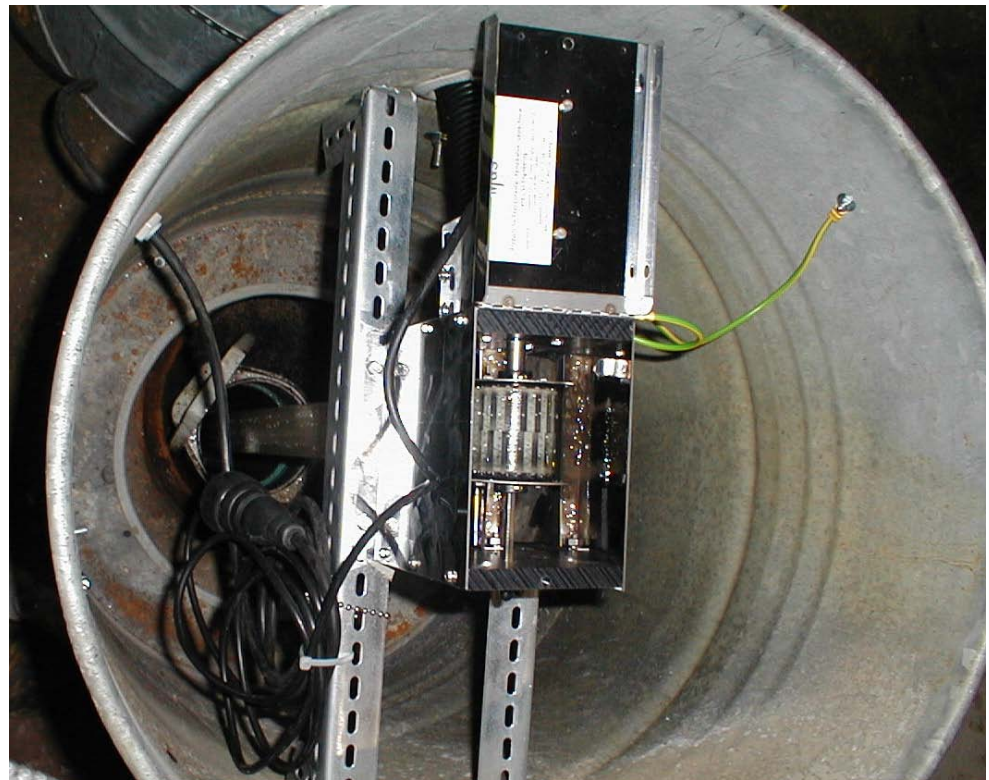
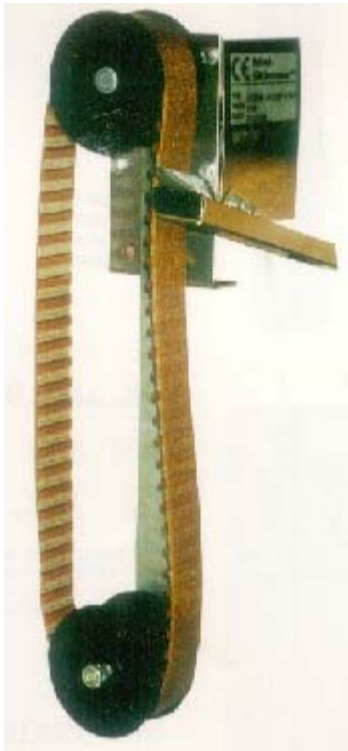
## **LIMITATIONS**

- Product entry into well
- Covering of product by floating groundwater
- Blocking of wells and membranes
- High viscosity products
- Processing of pumped water/product mixture

# RECOVERY SYSTEMS



# RECOVERY SYSTEMS





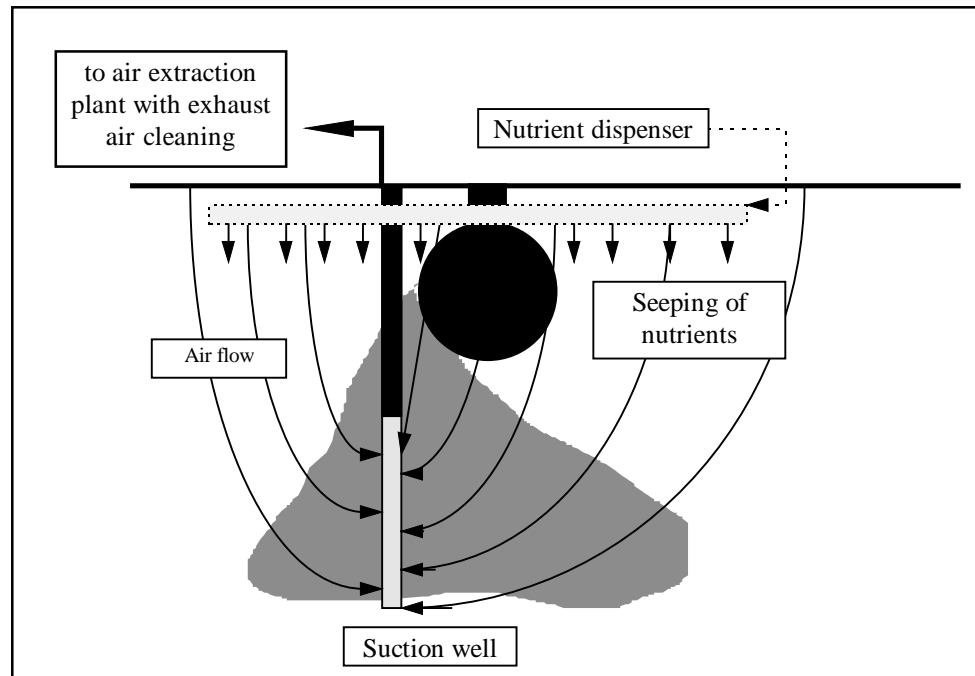
# RECOVERY SYSTEMS



## **SOIL GAS EXTRACTION**

- removal volatiles from unsaturated zone
- Pre-treatment before excavation  
(to avoid fire and explosions)
- Remediation to low residual values  
(instead of excavation)

# SOIL GAS EXTRACTION SYSTEMS



## **APPLICATION**

- Well Diameter 1,5“ to 4“
- For Gasoline (BTEX, MTBE)
- Air Flow per well 50-100 m<sup>3</sup>/h
- Duration up to 12 month



## **LIMITATIONS**

- Permeability of soil
- Volatility of products (Diesel: no !)
- Effective radius 5-60 m, interruption by ditches
- Effective soil gas treatment  
by Activated Carbon or Catalytic Combustion

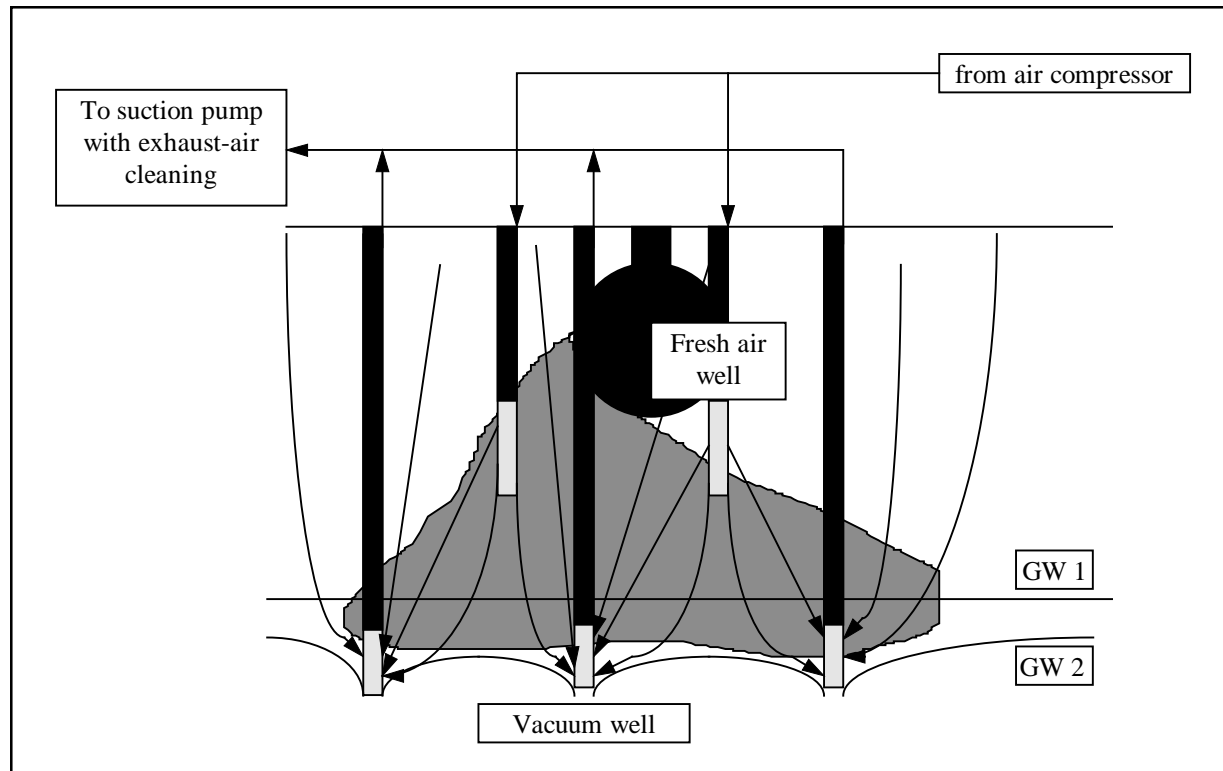
# SOIL GAS EXTRACTION INSTALLATIONS



# SOIL GAS TREATMENT INSTALLATIONS



# VACUUM EXTRACTION SYSTEM



# **BIOLOGICAL DEGRADATION**

- Well degradable Hydrocarbons
  - \* n-Alkanes from Gasoline and Diesel
  - \* BTEX
  - \* PAH from Diesel (max. 4 Rings)
- Slowly degradable Hydrocarbons
  - \* long chain a-Alkanes from lubricants
  - \* branched Alkanes (Iso-Alkanes)
  - \* biogenic Hydrocarbons
  - \* MTBE
  - \* CHC

# **BIOLOGICAL DEGRADATION**

- ➔ contamination dispersed in soil  
(no free flowing oil!)
- ➔ active micro organisms
- ➔ nutrients
- ➔ oxygen
- ➔ time

# **BIOLOGICAL DEGRADATION**

## **→ oxygen supply**

(air, techn.O <sub>2</sub> ,	O <sub>2</sub> in Water,	chem.-O <sub>2</sub> )
(21%, 98%,	10 mg/ltr,	4 to NO <sub>3</sub> /to oil)

## **→ temperature**

<< 10°C: ☹

11°-15°C: ☹

16°-28°C: ☺

# BIOLOGICAL DEGRADATION

## ➔ pH-value

< 5,0: ☹

5,1-6,0: ☹

6,1-8,5: ☺

> 8,6: ☹

## ➔ soil permeability (m/s)

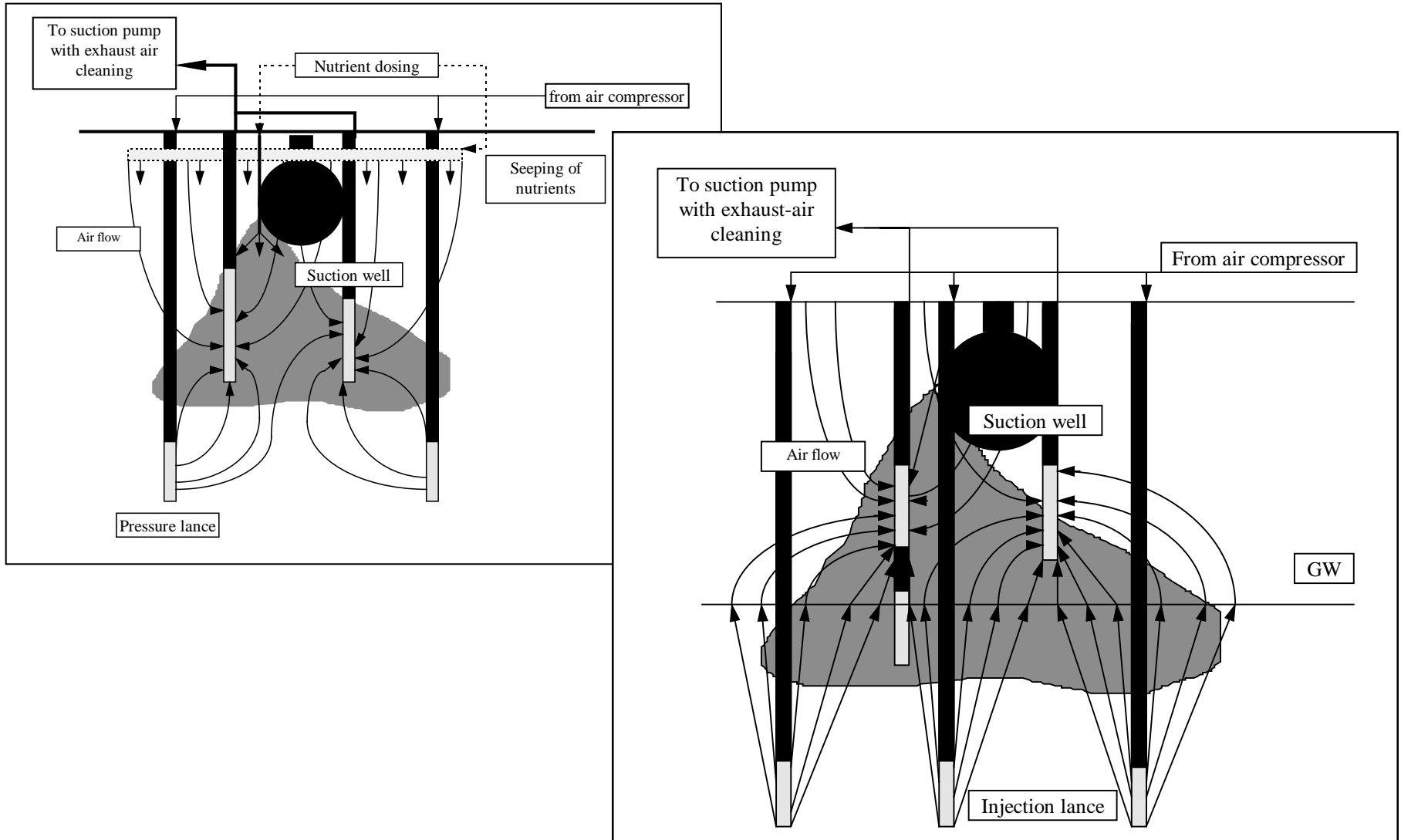
$k_f < 10^{-6}$ : ☹

$k_f = 10^{-5}$  : ☹

$> 10^{-4}$ : ☺



# BIO-TREATMENT SYSTEMS



# **BIOTREATMENT INSTALLATIONS**

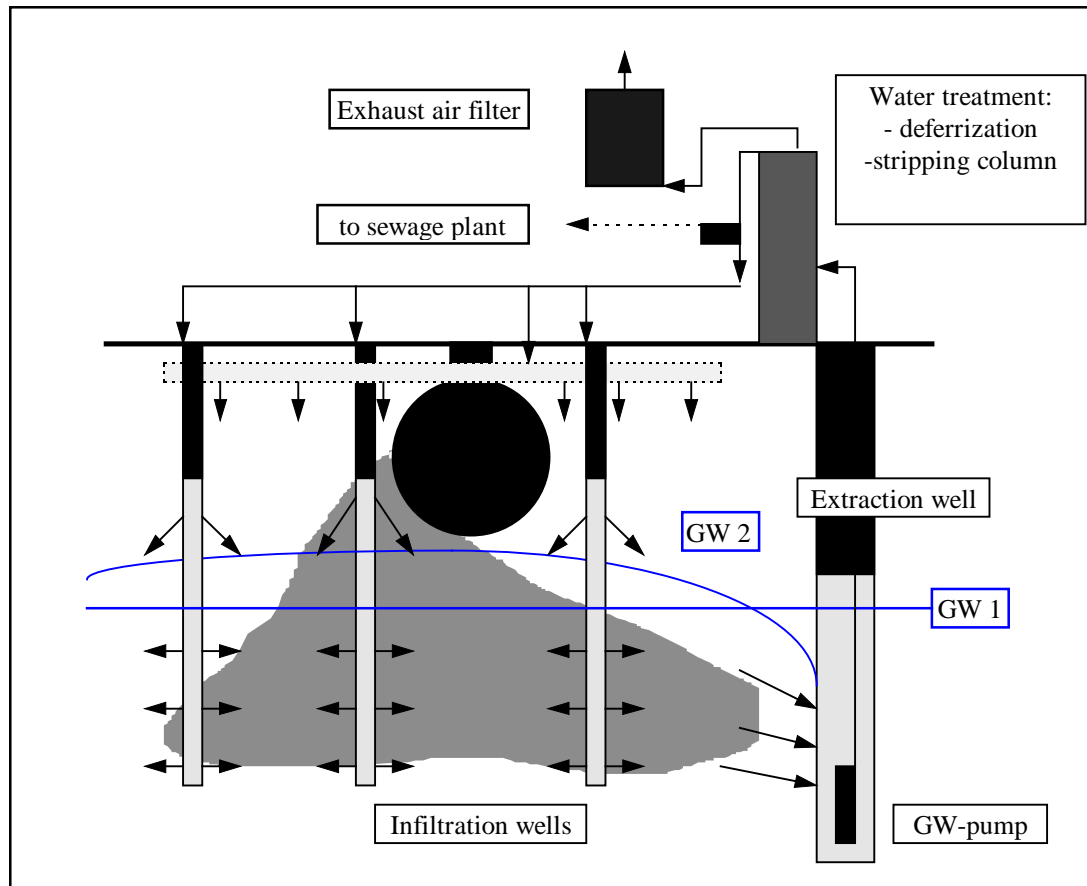


# GROUNDWATER TREATMENT SYSTEMS

## SOIL TREATMENT IN SATURATED ZONE



# PUMP AND TREAT SYSTEMS



# PUMP AND TREAT INSTALLATIONS

$> 50 \text{ m}^3/\text{h}$





# PUMP AND TREAT INSTALLATIONS

$< 5 \text{ m}^3/\text{h}$



## **APPLICATION**

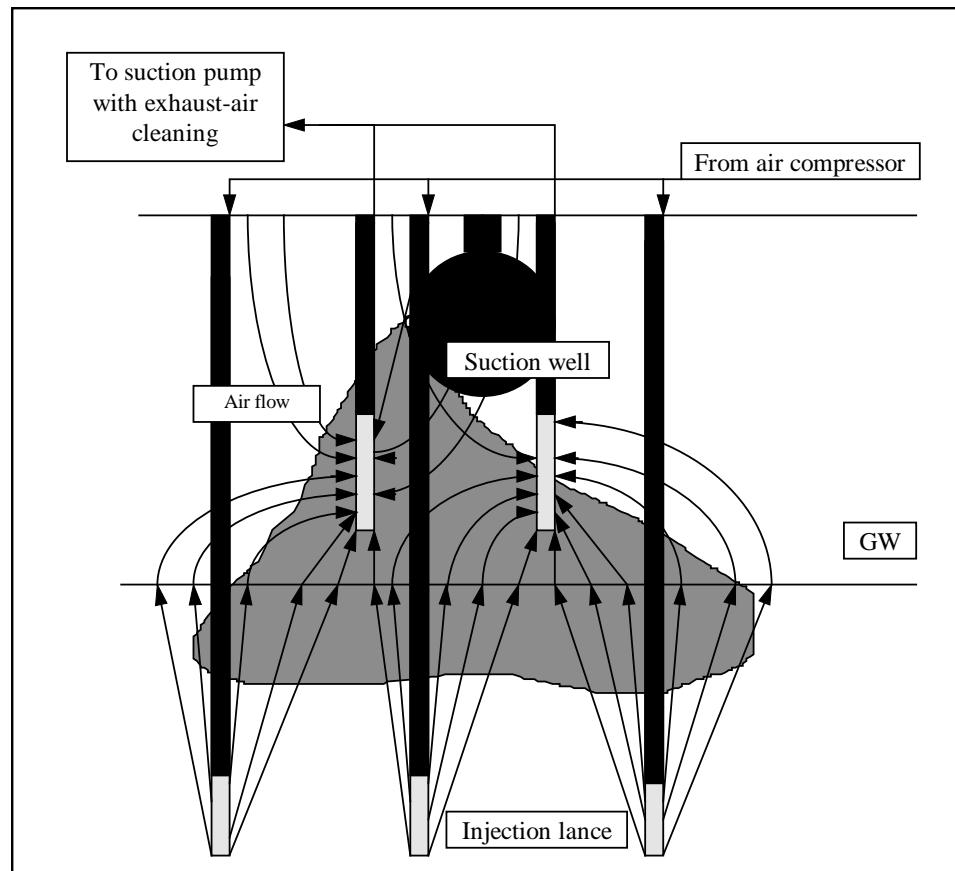
- Remediation of groundwater
- Groundwater lowering
- Downstream Protection
- Well Diameter 2" – 6"
- Total Water Flow 1-150 m<sup>3</sup>/h
- Duration .....

## **LIMITATIONS**

- Shrinking yield of contaminants
- Frequent maintenance
- Low oxygen transport into soil



# AIRSPARGING SYSTEMS

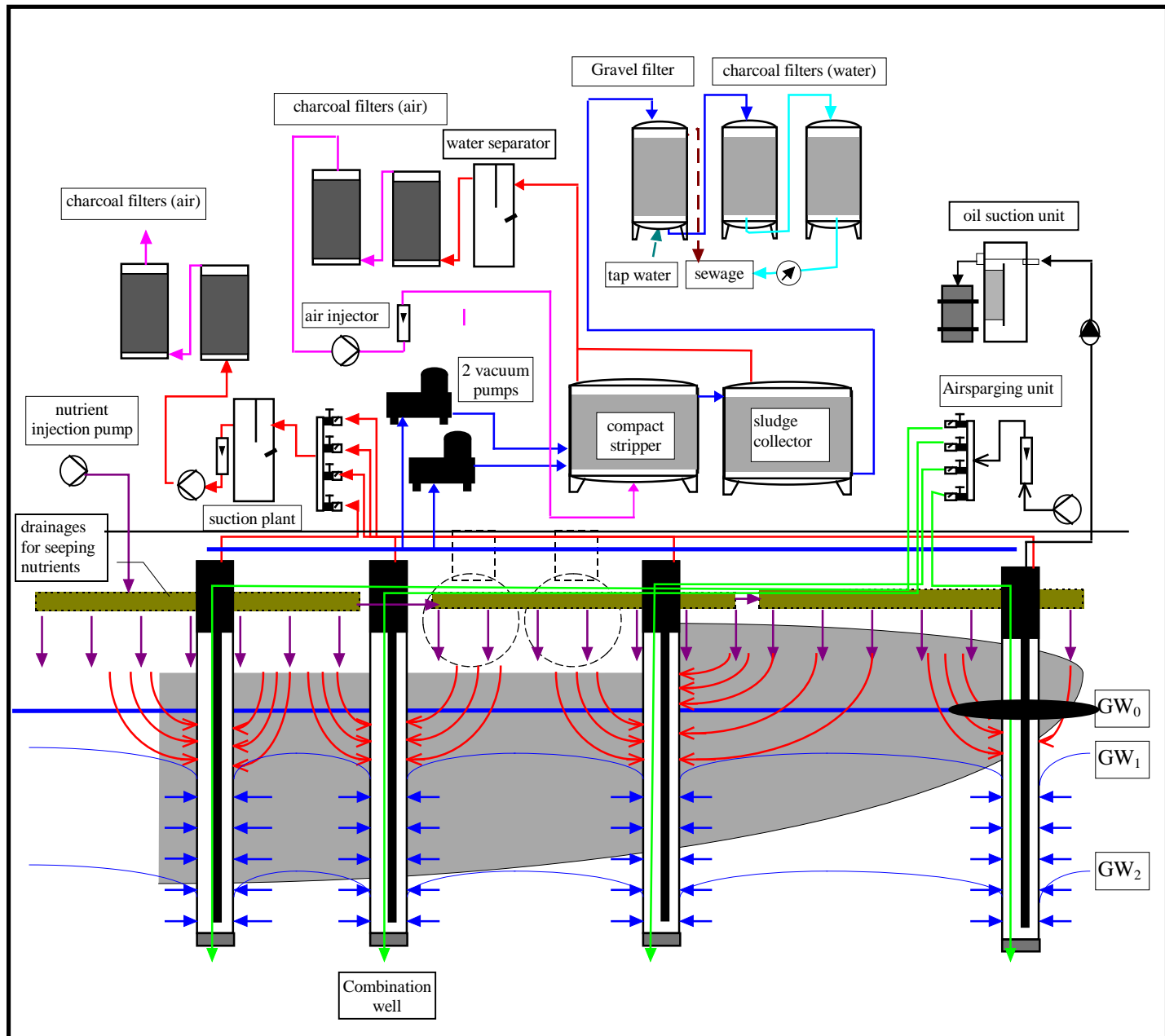


# AIRSPARGING INSTALLATIONS



## **COMBINED SYSTEMS**

- Soil gas extraction + vacuum extraction
- Airsparging + Pump & Treat + Soil gas extraction
- Product recovery + vacuum extraction
- MultiFunctionWell + Airsparging
- ...



## **SYSTEMS TO BE WARNED OF**

- Electric Degradation of Hydrocarbons
- „Turbo“ strains of bacteria
- Leaching or diluting liquids
- Immobilising liquids
- ANY BLACK BOX SYSTEM

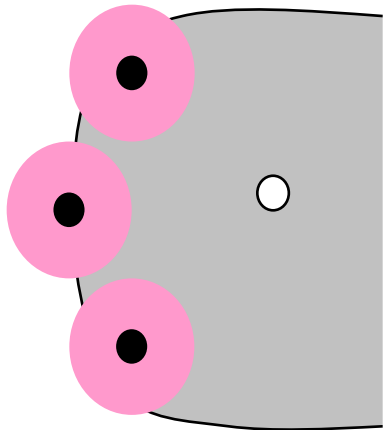
# **CHEMICAL OXIDATION**

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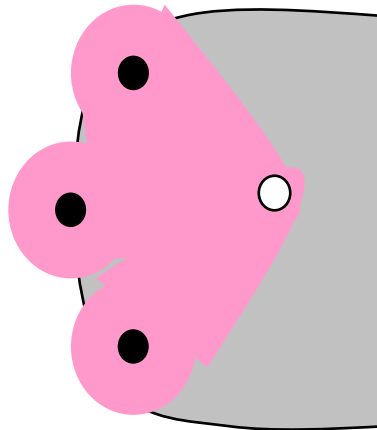
Injection of Oxidants

- Peroxide ( $\text{H}_2\text{O}_2$ )
- Permanganate ( $\text{KMnO}_4$ )
- other

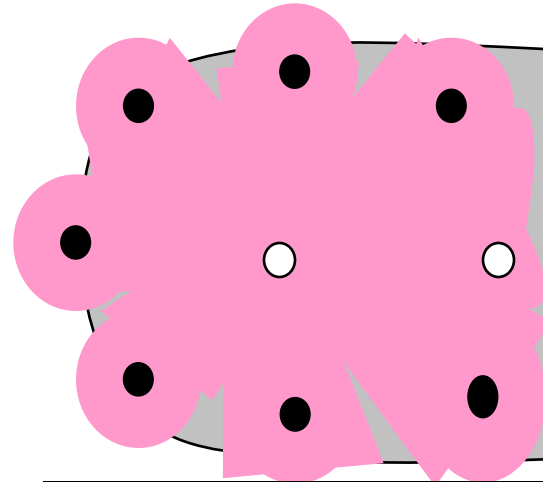
# SYSTEM



**1) Injection of  
Oxidant**



**2) Circulation of  
Oxidant**



**3) Site treatment by  
further lances**





## **LIMITATIONS**

- Degradation effect only where Oxidants are (short effective radius)
- Auto degradation of Oxidant (short reaction time)
- Frequent injection necessary
- Not for long chain hydrocarbons
- Mobile degradation products
- Destruction of natural organisms

Thats all folks

Thanks

