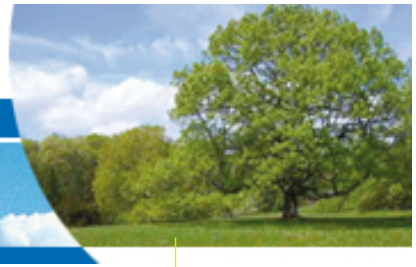
MIXIS® the association of Soil Mixing and Chemical Treatment

A new approach for in-situ source zone remediation

Tuesday 23th of october
Christophe Chêne

La dépollution sur mesure

The MIXIS® concept



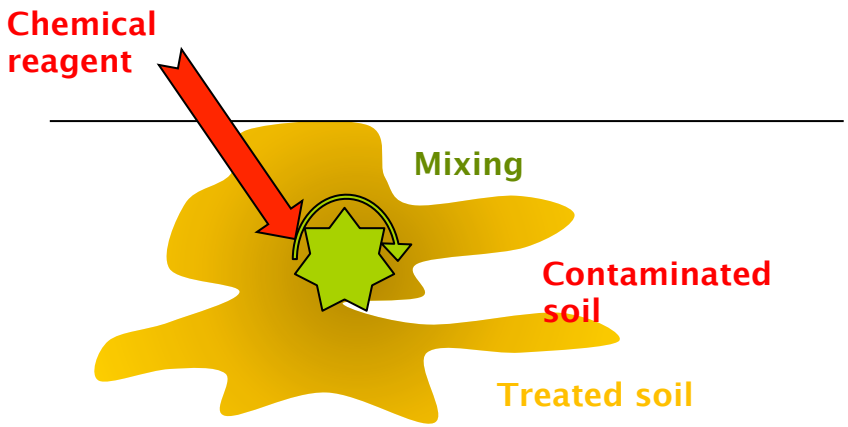
MIXIS® is a new way to carry out chemical In-Situ treatment for soil or groundwater remediation

- Until now, in-situ chemical treatment is carrying out via direct injections or recirculation
- In laboratory, chemicals treatments such as oxidation or reduction are fast and efficient
- The problem, on the filed, is the contact between the reagent and the pollutant in the soil
  - Problems of heterogeneity;
  - Problems of accessibility;
  - Rebound effect …

One solution is coupling soil mixing and chemical treatment

=> MIXIS Concept

MIXIS® how it works ?



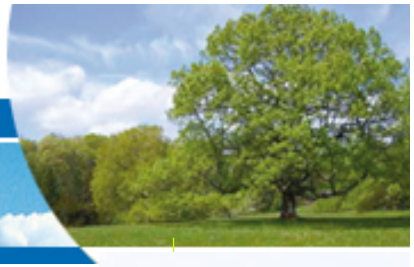
Easy !

Not so easy :

It's the mix of 2 know how :

- The soil mixing, specially for deep mixing
- The chemical treatment

A double innovation



Soil Mixing added to chemical treatment

1. Innovation by the use of this technic for soil remediation

   Soil mixing is a technic used in special foundation and

   soil stabilisation

2. Development of advanced chemical reagents for soil remediation

   •Strong reductive reagent based on zero valent iron, with several adjuvants depend on the contaminant

   For VOHC, heavy metal, pesticides, PCBs, …

   •Oxidant

   For hydrocarbons, BTEX, some PAH, …

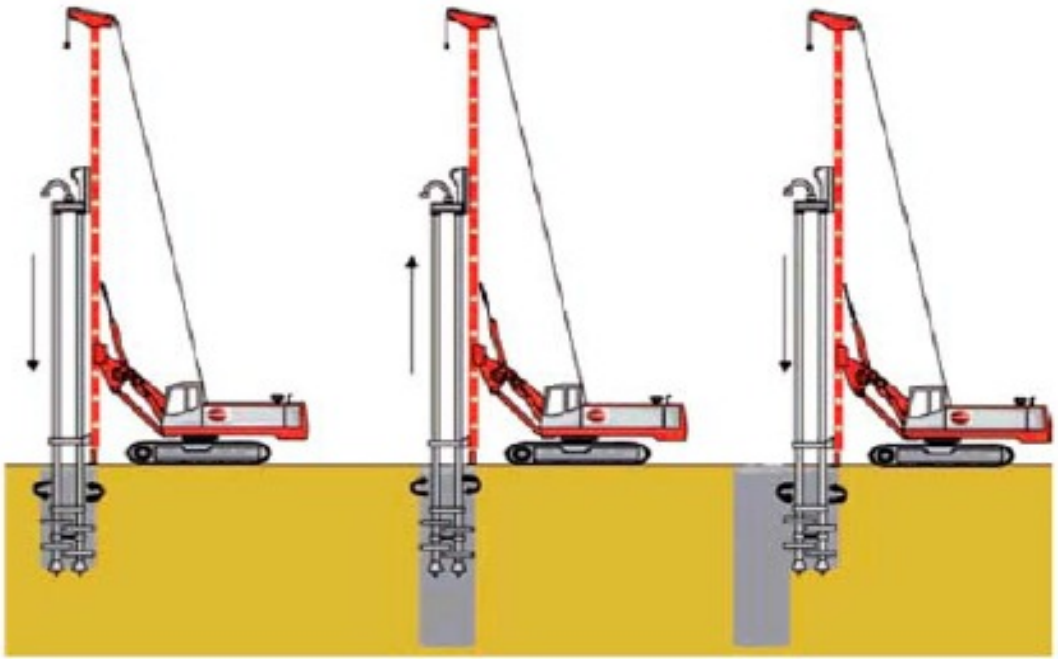
The soil mixing

Shallow soil mixing

Soléo Services tools

Deep soil mixing

A lot of development and innovation



- Geotechnical issue
- Delivery issue – chirurgical treatment
- A Partner for deep soil mixing

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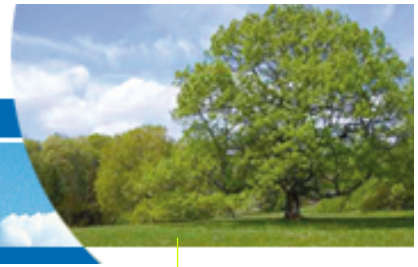
The chemical treatment



2 main ways : Oxidation & Reduction

Oxydation => **MIXIS®-Ox**

- Use of oxidant from the market : hydrogen peroxyde, permanganate, persulfate, …
- Specific formulation => Soléo Services development

Aliphatic Hydrocarbons, BTEX, some PAHs, mixt of contaminant, …

Reduction => **MIXIS®-Red**

Strong reagent based on zero valent iron, with several adjuvants depend on the contaminant => specific Soleo Services formulation + research & development wit LRGP (Nancy – F)

For VOHCs, heavy metals, pesticides, PCBs, …

Delivery unit specially developed for MIXIS®-Red

Adjustment of the formulation

–Laboratory test and field pilot test :

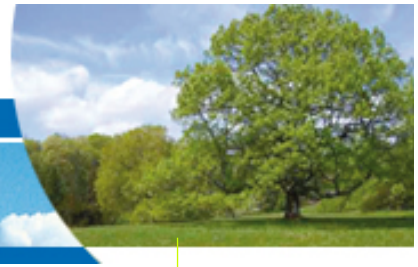
–Specific formulation depend on :

Contamination, geology, delivery issue

–On site reagent synthesis

For a better efficiency

The MIXIS® market place



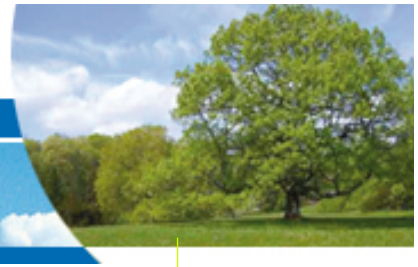
- MIXIS® is more expensive than classical in-situ treatment but cheaper than excavation and off site disposal

- MIXIS® is much more efficient and faster than classical in-situ treatment, due to a better homogeneity of the treatment

  The time treatment & the efficiency is comparable to dig & dump and ISTD

- MIXIS® is an ideal technic to treat localised source zones contaminated by recalcitrant compounds with high level of contamination => LNAPL – DNAPL

MIXIS® is in concurrence with excavation and in-situ thermal desorption from, price, efficiency and time remediation, point of view



Advantages and drawbacks

Advantages

- → No problem for deep soil treatment (> 10 m) without important cost evolution (the price is proportional to the volume and not to the depth)
- → Great efficiency of the treatment
- → No problem of off-gas unlike dig & dump
- → Short time treatment
- → Limited material mobilisation => low nuisance (sound, visual, olfactory)
- → Able to treat cramped area
- → The injected reactive is able to improve the quality of the soil and the groundwater around the treated area => compatible with biological treatment for polishing

⇒ MIXIS® is perfect for urban area applications

⇒ It's the way to work in small area and to avoid soil movement (trucking), dust, and undesirable smells, specially for volatile compounds, that can generate some health and safety hazards.

Drauwbacks

- → Soil destructuration, sloss of soil bearing

⇒ Many ways for soil reconstruction => speciality of our Partı

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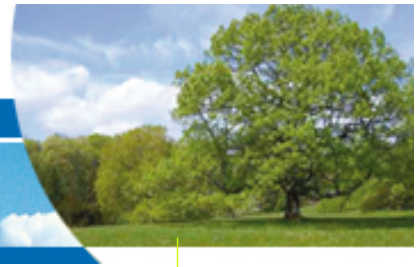

MIXIS®-Red : case study 1

2010 – Site in Grenoble (F-38) area – More than 2 years of feed back

Contamination due to the use of TCE in the process of the former factory

Groundwater TCE concentration up to 2g/l (pure product) in the source zone area + daughter product such as DCE & VC

Decreasing concentration around and downstream of the source area

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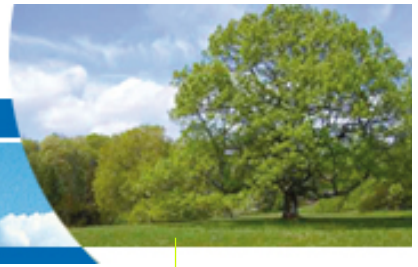

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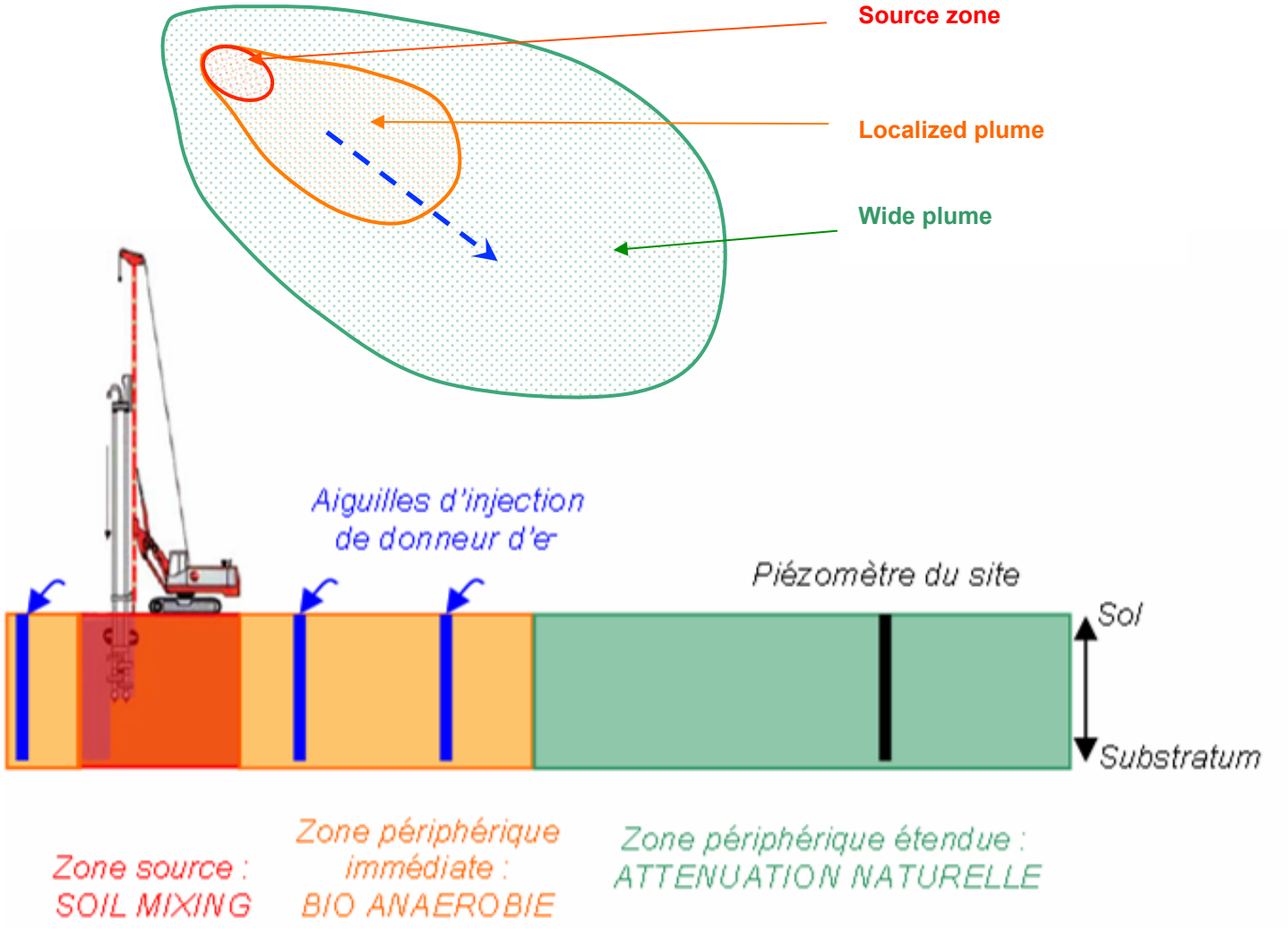


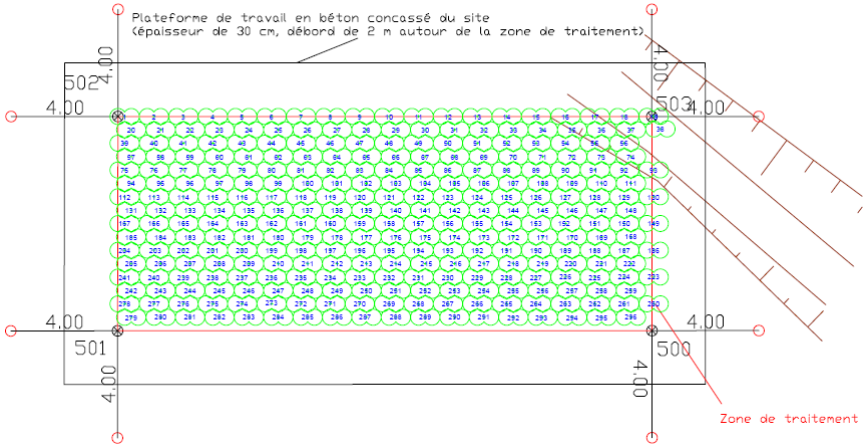
MIXIS®-Red : case study 1

2010 – Site in Grenoble (F-38) area – More than 2 years of feed back

Finaly ~ 300 drillings,

1050 m³ of treated soil

2,5 weeks



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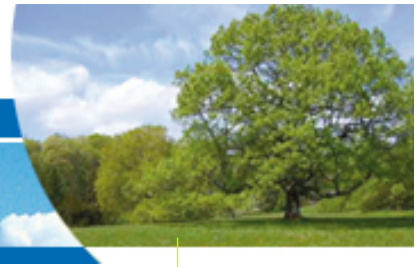
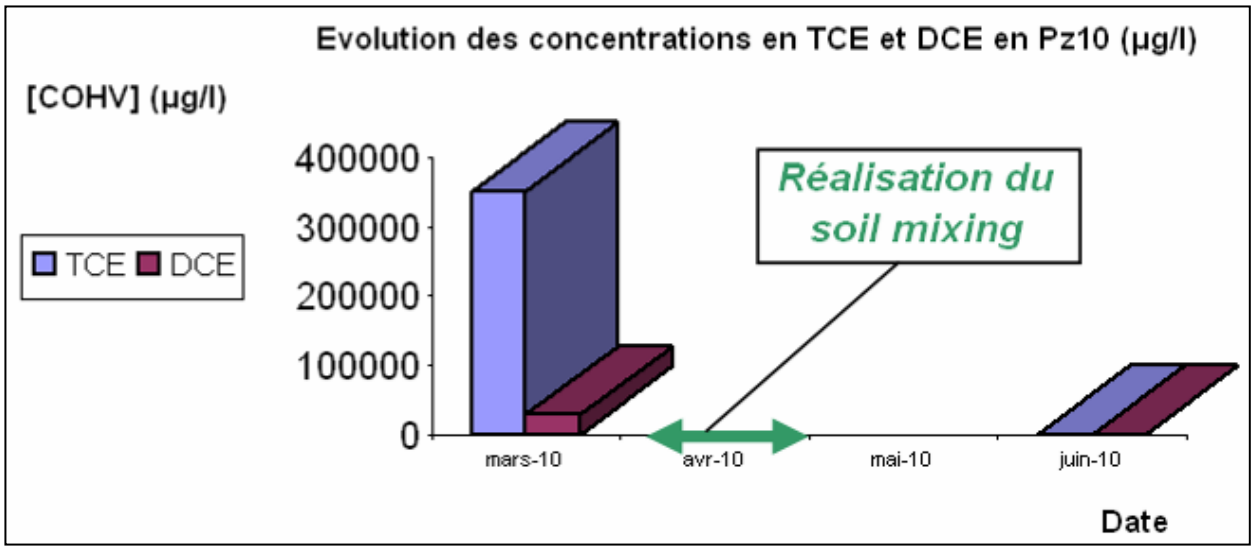


2010 – Site in Grenoble (F-38) area – More than 2 years of feed back

Drilling of a new monitoring well in the heart of the source zone, one month after the treatment

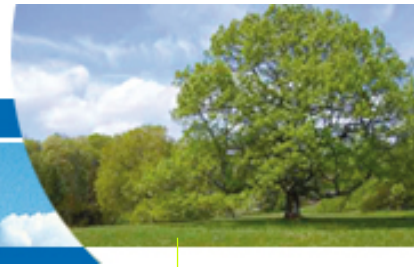
[TCE] : 350000µg/l → 49µg/l / [DCE] : 29000µg/l → 160µg/l



VOHCs decreasing of 99,9% one month later

Redox potential of -600mV favourable to anaerobic treatment

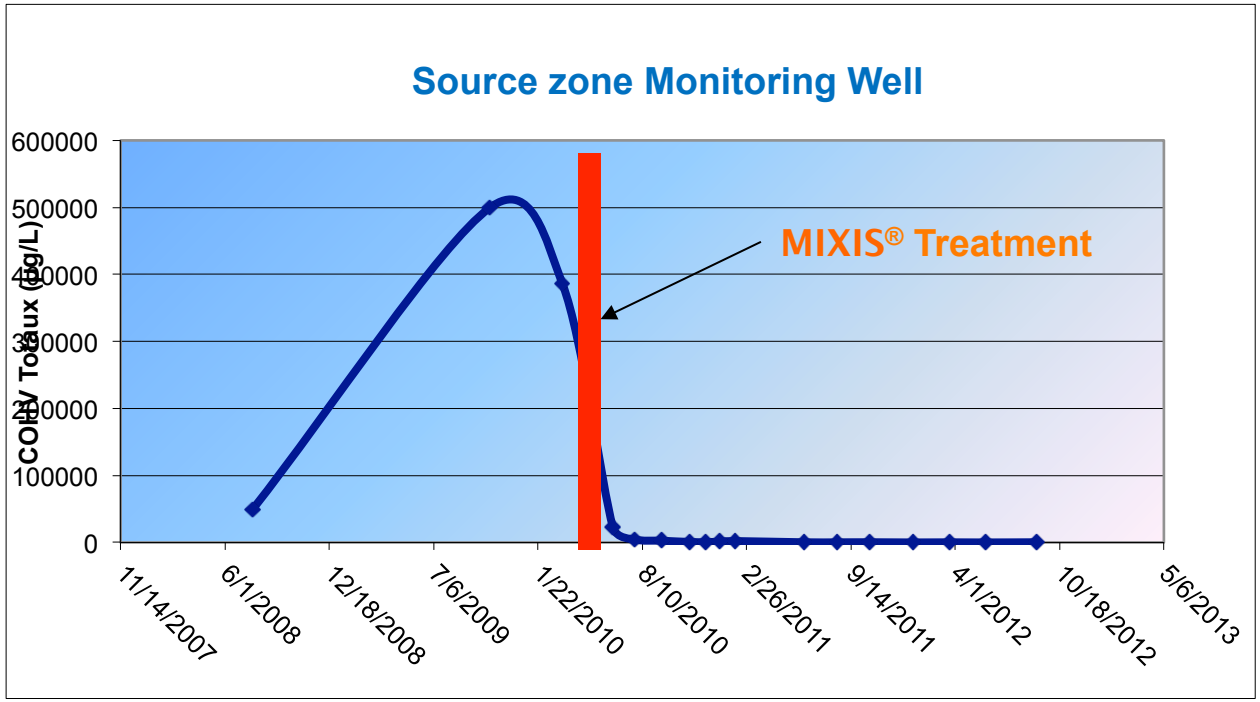
MIXIS®-Red : case study 1



2010 – Site in Grenoble (F-38) area – More than 2 years of feed back

Evolution of the VOHCs concentration in the monitoring well set up in the heart of the source zone:

Spectacular results and no rebound effect since 2 years



Curent concentrations	Drinking standards
TCE = 4 µg/l	10 µg/l (F)
DCE = 17 µg/l	50µg/l (OMS)
CV = 14 µg/l	0,5 µg/l (F)

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MIXIS®-Red : case study 2

2012 – Site in Orleans area (F-45) – Deep soil mixing => 13 m

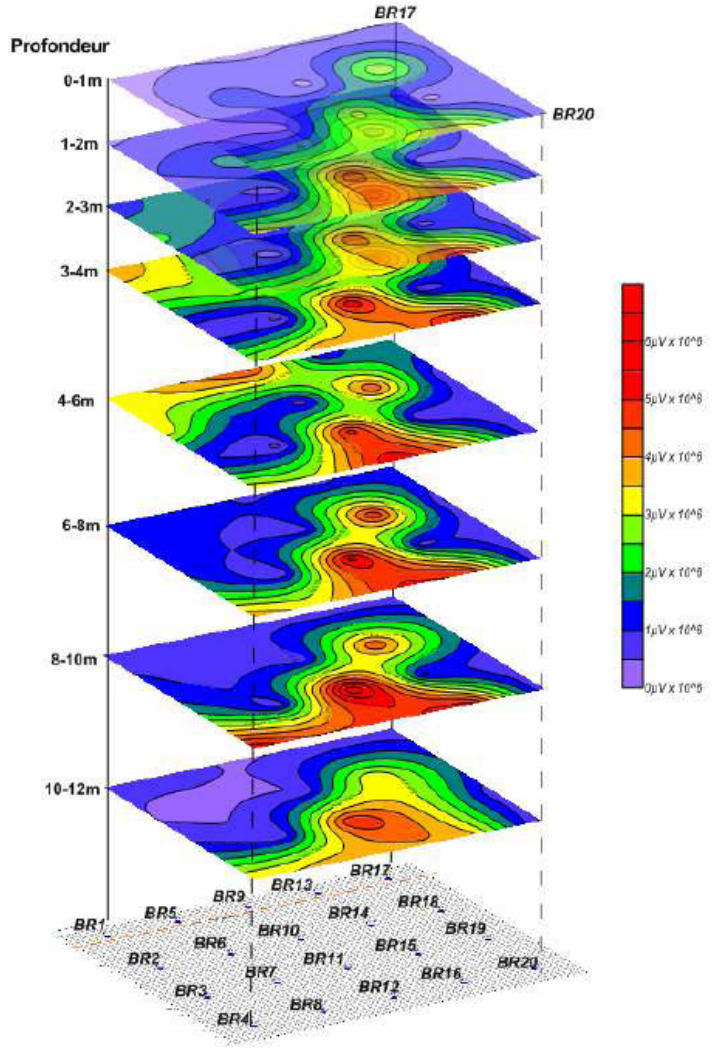
Contamination due to chlorinated solvents storage & handling

Treatment of 10 m of non saturated zone + 3 m of saturated zone

Soil chlorinated solvent concentration up to 28 g/kg: evidence of pure product in non saturated zone

In the groundwater:

PCE + TCE = 250 mg/l



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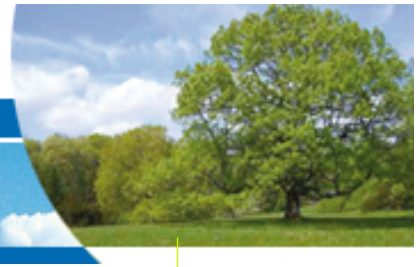
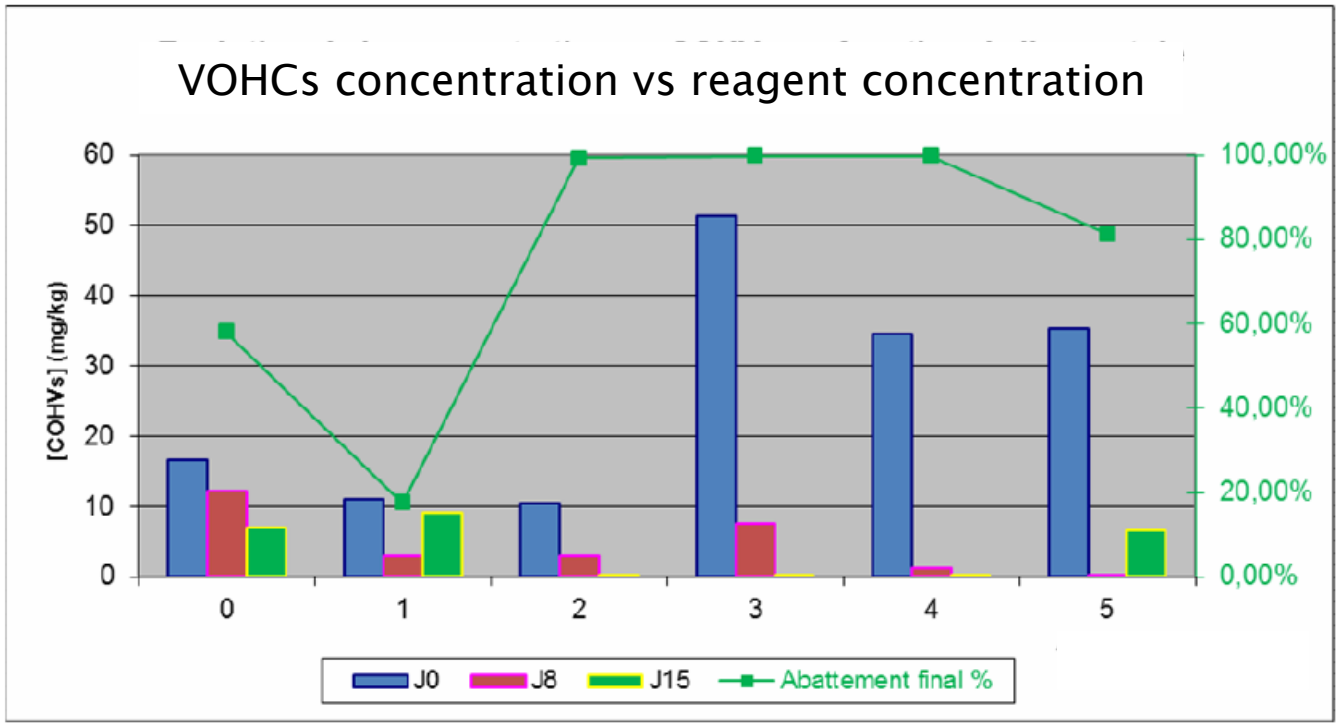


2012 – Site in Orleans area (F-45) – Deep soil mixing => 13 m

Laboratory test for the design of the reagent



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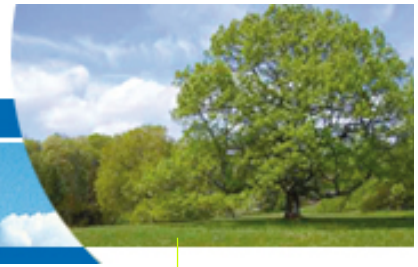

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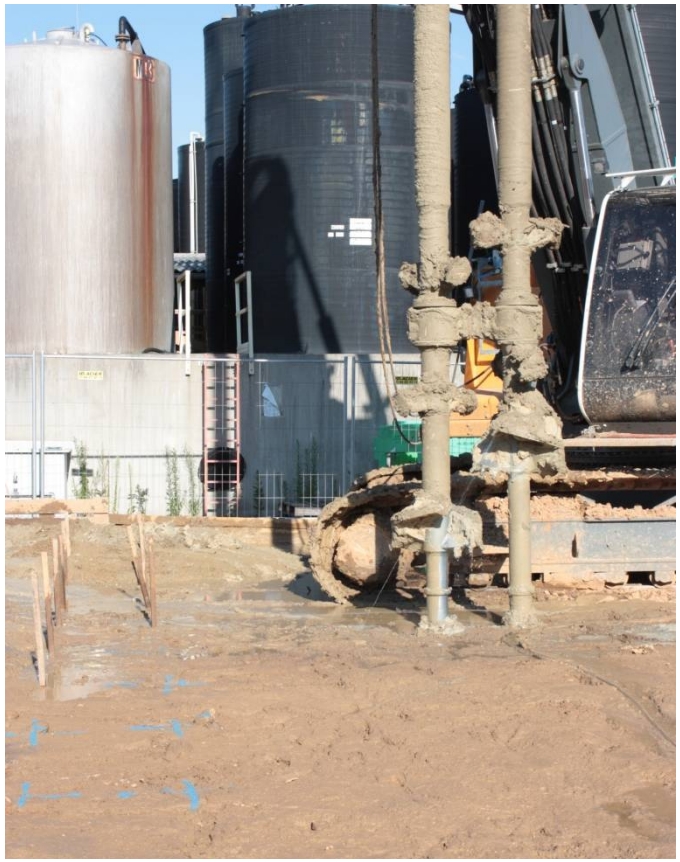

Results expected in december 2012

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MIXIS®-Ox : case study

2011 – Site in Rouen area (F-76) – Shallow soil mix

Contamination due to chlorinated and not chlorinated solvents storage & handling

Treatment of non saturated zone by excavation and on-site treatment (biopile)

Vadoze zone and groundwater contaminated by a mix of aliphatic hydrocarbons, BTEX, VOHCs, …

Hydraulic barrier down stream to avoid plume extension

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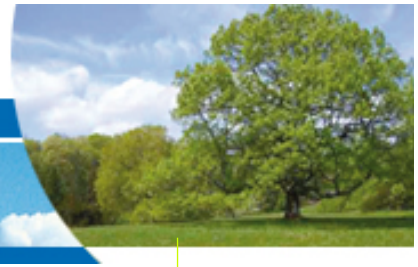
MIXIS®-Ox : case study



2011 – Site in Rouen area (F-76) – Shallow soil mixing

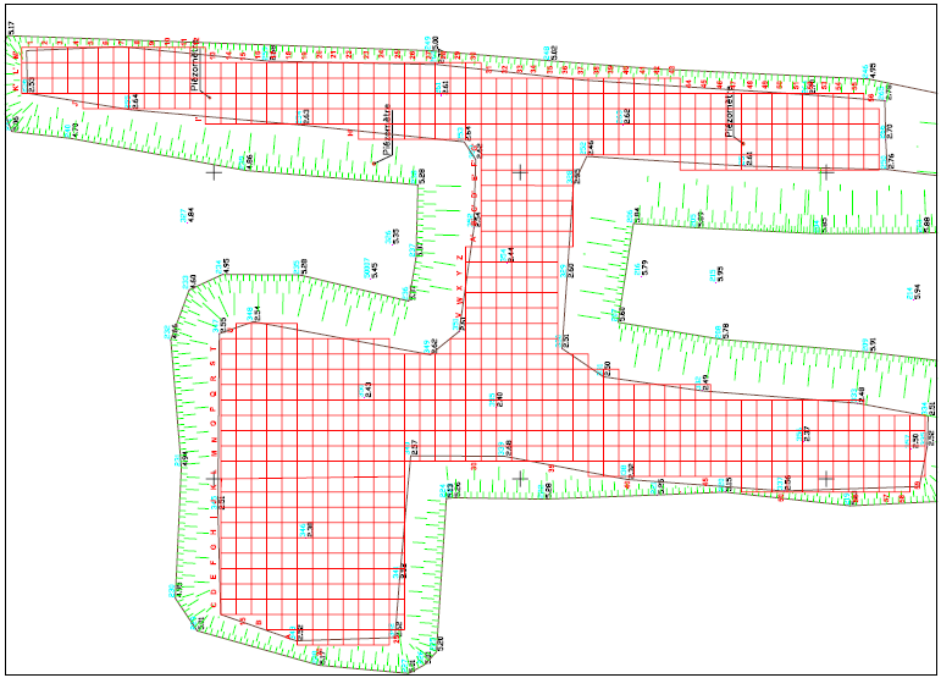
T38 14000 µg/L	T39 14000 µg/L	T40 8400 µg/L	T41 8400 µg/L	T42 5200 µg/L	T43 5200 µg/L	T44 29000 µg/L	T45 29000 µg/L	T46 61000 µg/L	T47 61000 µg/L	T48 2800 µg/L	T49 2800 µg/L
						T30 16000 µg/L	T31 16000 µg/L				
T13 120000 µg/L	T14 120000 µg/L	T15 24000 µg/L	T16 24000 µg/L	T17 1500000 µg/L	T18 15.10^5 µg/L	T19 < 20 µg/L	T20 < 20 µg/L	T21 100 µg/L	T22 100 µg/L		
T4 72000 µg/L	T5 72000 µg/L	T6 72000 µg/L									

< 1000 µg/L

1000 < C < 10000 µg/L

> 10000 µg/L

- Laboratory test
- 1350 m³ of contaminated soil treated in 1 week
- 1 month of standby
- Then reception and backfilling



MIXIS®-Ox : case study

2011 – Site in Rouen area (F-76) – Shallow soil mixing

MIXIS®-Ox : case study

2011 – Site in Rouen area (F-76) – Shallow soil mixing

Schématisation des concentrations finales des eaux en hydrocarbures (C10-C40) :

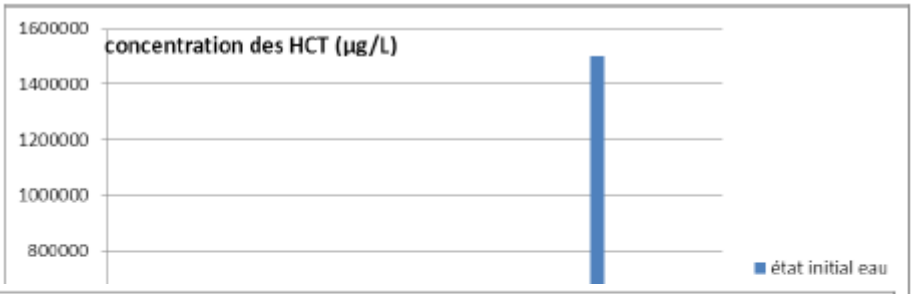
T38 170 µg/L	T39 170 µg/L	T40 430 µg/L	T41 430 µg/L	T42 170 µg/L	T43 170 µg/L	T44 1400 µg/L	T45 1400 µg/L	T46 490 µg/L	T47 490 µg/L	T48 140 µg/L	T49 140 µg/L
						T30 780 µg/L	T31 780 µg/L				
			T13 1700 µg/L	T14 1700 µg/L	T15 1300 µg/L	T16 1300 µg/L	T17 450 µg/L	T18 450 µg/L	T19 90 µg/L	T20 µg/	
			T4 1700 µg/L	T5 1700 µg/L	T6 1700 µg/L						

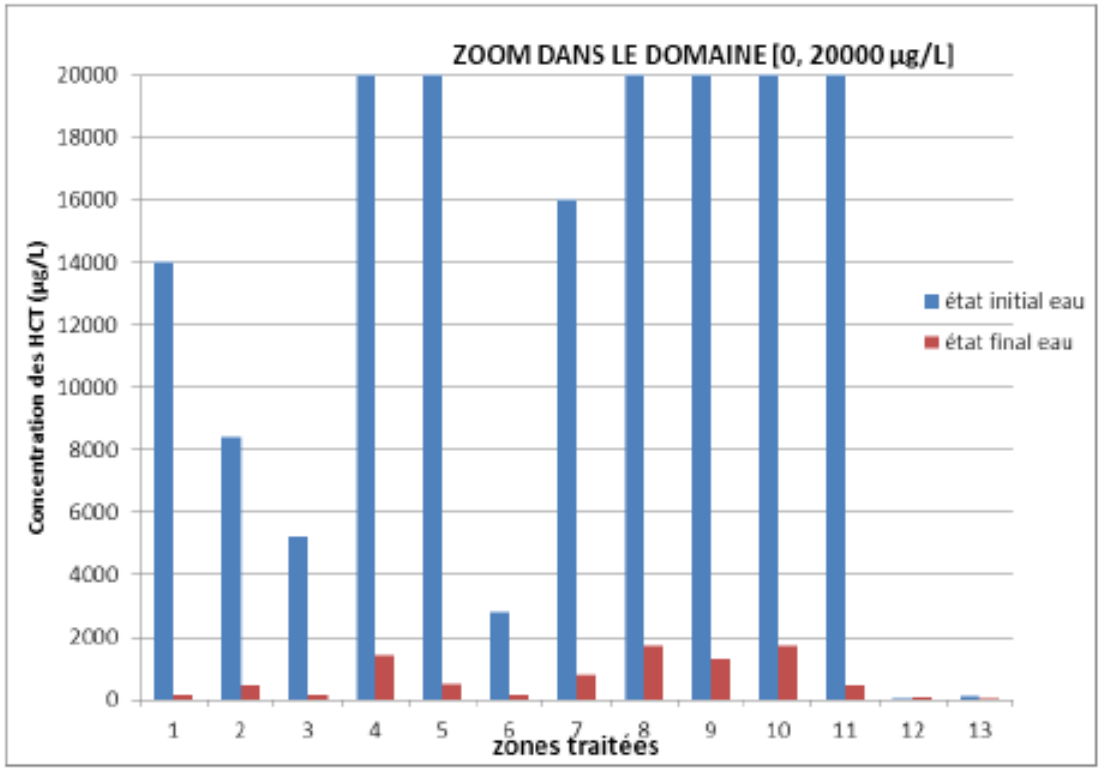
< 1000 µg/L

1000 < C < 10000 µg/L

> 10000 µg/L

HCT final state





1 month after treatment
Average concentration decreasing = 99,5 %

MIXIS®-Ox : case study

2011 – Site in Rouen area (F-76) – Shallow soil mixing

Schématisation des concentrations initiales des eaux en PCE :

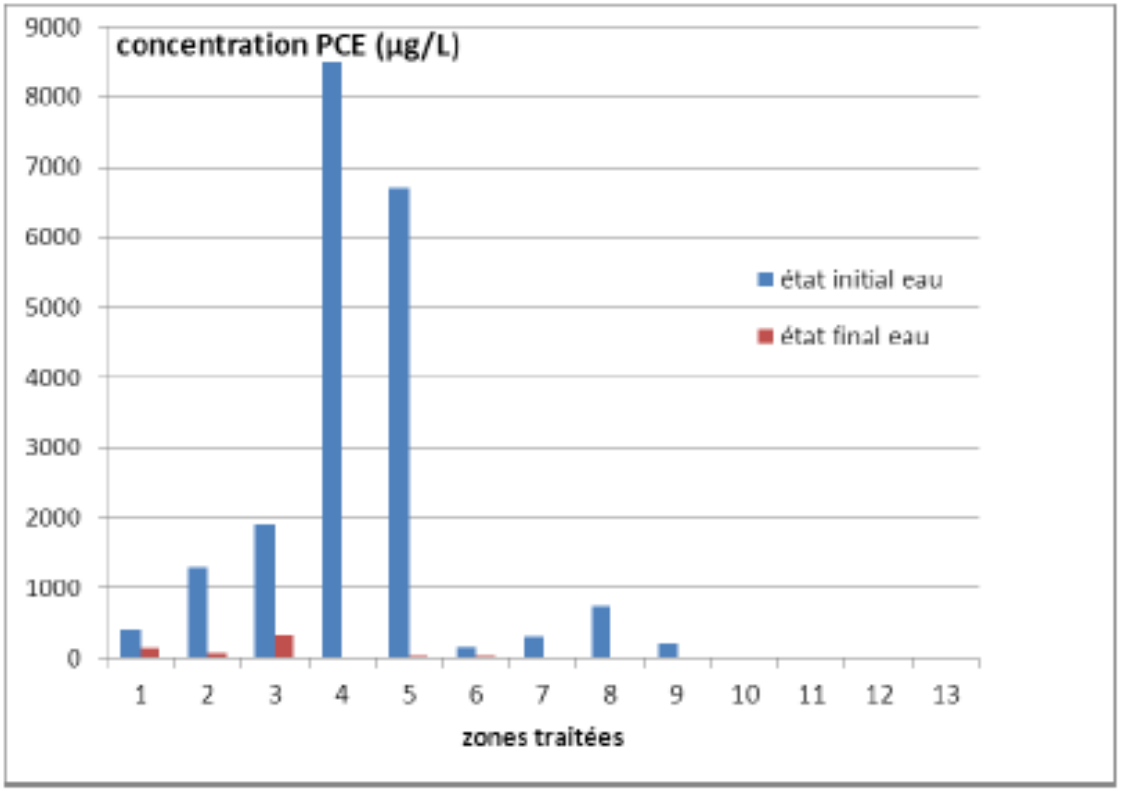
T38 410 µg/L	T39 410 µg/L	T40 1300 µg/L	T41 1300 µg/L	T42 1900 µg/L	T43 1900 µg/L	T44 8500 µg/L	T45 8500 µg/L	T46 6700 µg/L	T47 6700 µg/L	T48 160 µg/L	T49 160 µg/L
						T30 320 µg/L	T31 320 µg/L				
			T13 760 µg/L	T14 760 µg/L	T15 220 µg/L	T16 220 µg/L	T17 < 10 µg/L	T18 < 10 µg/L			
			T4 < 10 µg/L	T5 < 10 µg/L	T6 < 10 µg/L						

< 40 µg/L

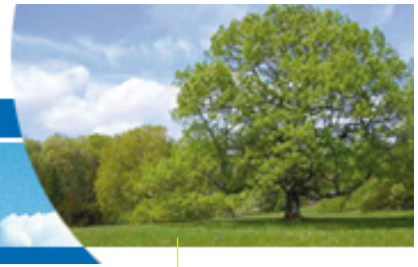
40 < C < 400 µg/L

> 400 µg/L

1 month after treatment
Average concentration decreasing = 97 %



PCE Initial state



MIXIS®-Ox : case study

2011 – Site in Rouen area (F-76) – Shallow soil mixing

Good Job !

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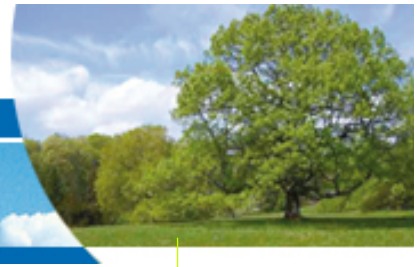
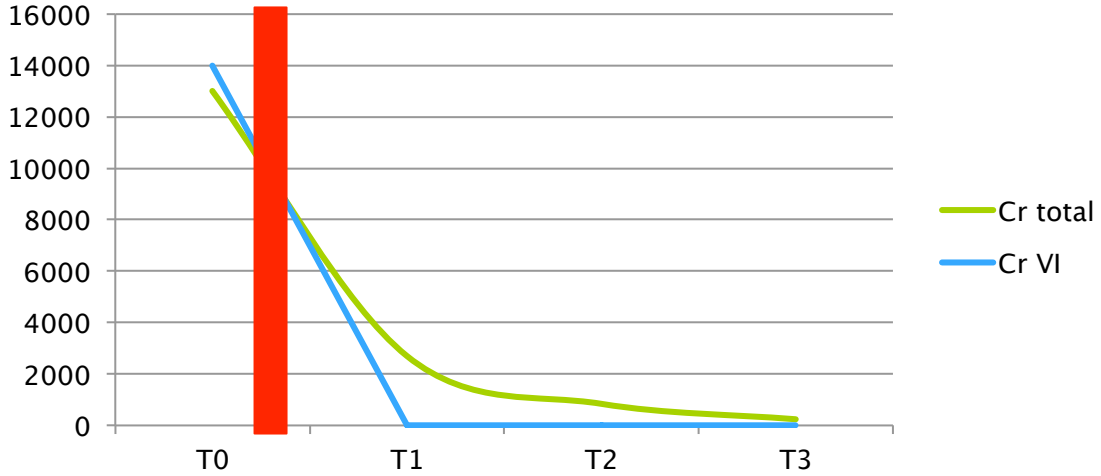
MIXIS® New development



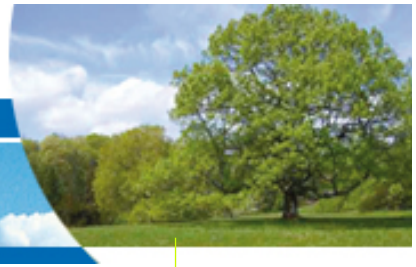
Development of a reagent for hexavalent chromium stabilisation

- First application using direct injection



Development of a reagent for the treatment of heavy hydrocarbons in adsorbed phase

- In laboratory : 30 000 => 140 mg/kg
- Concentration decreasing > 99 %



Thank you for attention

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