



# **CHLORINATED SOLVENTS IN A COMPLEX MATRIX: AGREED PLAN OF MANAGEMENT, WITH NATURAL ATTENUATION, AFTER *IN SITU* REMEDIATION**

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## A LONG HISTORY

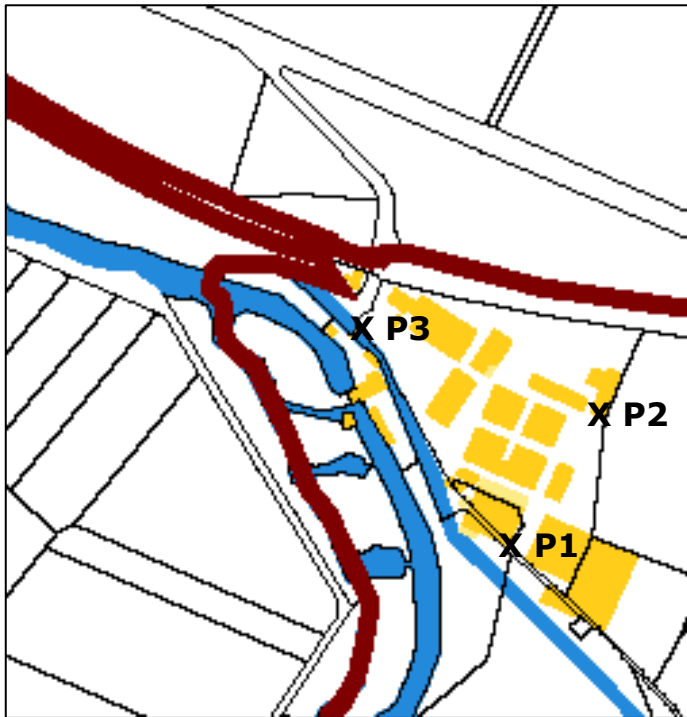
- Industrial activity upon the site since the 30's
- Activities of metal treatment & coating
  - surface cleaning, sanding, varnish and painting
- Pollution by mostly liquid wastes
  - degreasing, used solvents, oils, used bath solutions
- Sources: tanks, load/unload areas...
- Primary sources were dismantled

## A COMPLEX SOIL MATRIX

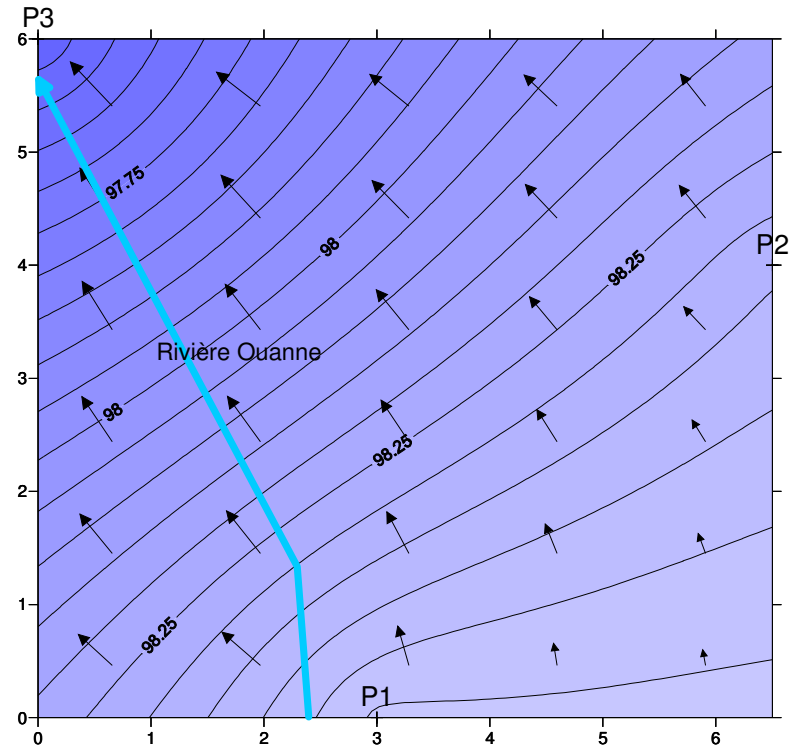
- Surrounding a former mill, the site is settled close to the river bed in a valley grabbed in the Senonian's chalk
- Upper layer (5m) is made of recent alluvium and a matrix of clay around chalky blocks or flints
- Up to at least 18 m (as deepest known), chalk and clay alternate in a pile of layers

- Regionally, they are 2 major aquifers: river's one (upper) and chalk's one (deeper)
- Locally, at least 3 aquifers were identified
- This made works more complex than expected:
  - Investigation, diagnostic, as well as treatment and performance's following

# RIVER'S AQUIFER



Site map



River's aquifer modelling

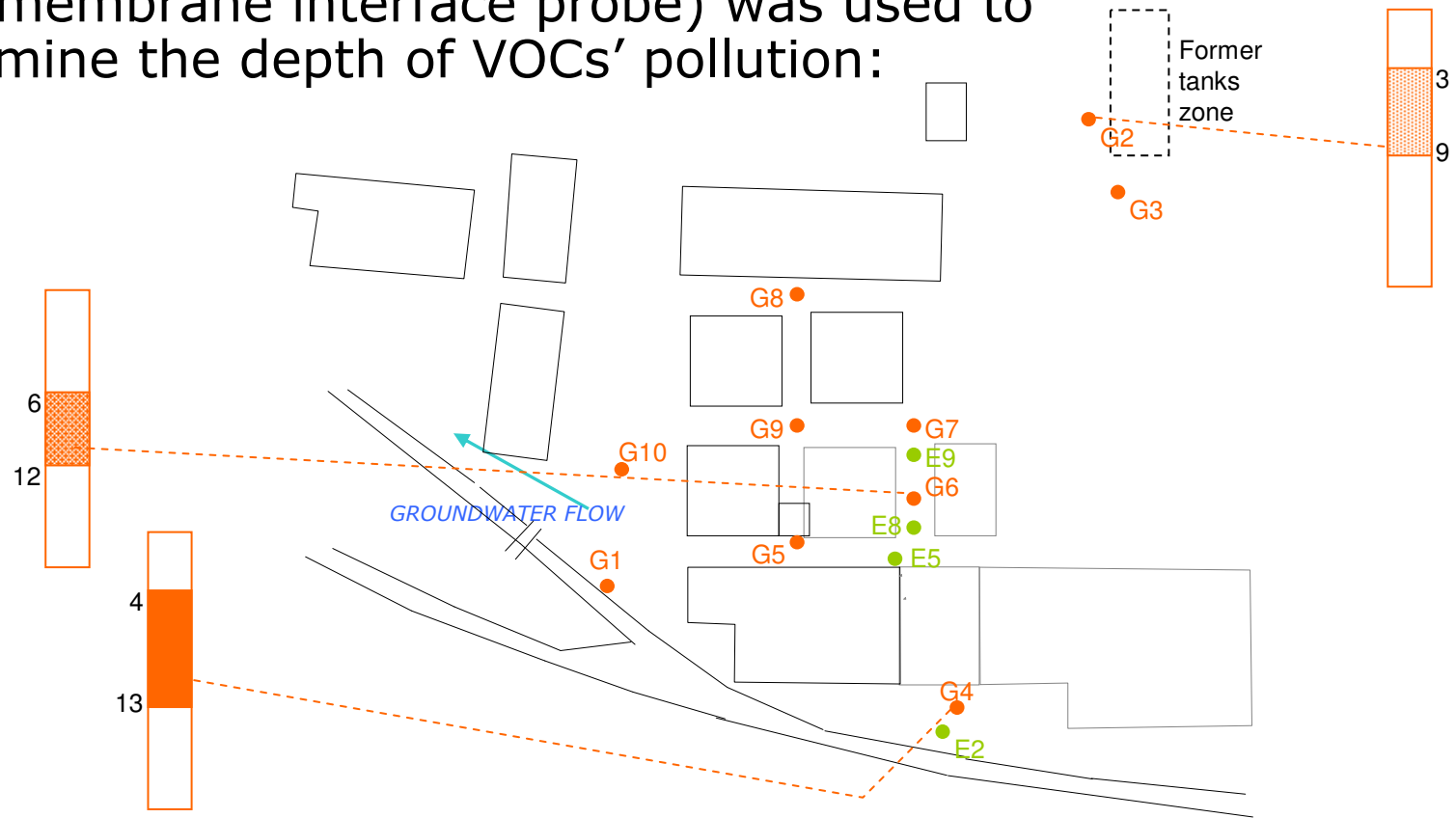
- First investigations, in 2004, found 2 pollution sources:
  - The TPH source was purged out
  - The PCE source (5,5 mg/kg) was kept in place (P2)
  - HVOC were the major contaminants in groundwater
  - The whole degradation panel of chlorinated compounds was found: PCE (up to 91,2 mg/L in P1), TCE (up to 23 mg/L), cis-1,2-dichloroethylene (20,2 mg/L) and vinyl chloride (up to 0,68 mg/l).
- Later investigations, after site's closure, showed that plumes migrate, following groundwater major stream, with the risk of impacting a potable well 2.5 km downstream

## STEP 0 : STUDIES 04/05

- A diagnostic, with deep piezos (P4 at 18 m below ground level=chalk ground water)
- A detailed risk study, in March 2005, showed that:
  - sanitary risk by inhalation was suitable
  - the ingestion risk of potable water wasn't suitable with future foreseen uses of the site.
- Therefore, the study allowed to calculate residual concentration in the upper groundwater layer, to meet an acceptable risk, for a redeployment of the zone with restriction of use:
  - DCE : 850µg/L,
  - PCE : 600µg/L,
  - TCE : 600µg/L
  - VC : 20µg/L
- in other terms, meet those values after treatment produce an acceptable risk for determined targets.

# STEP 0 : STUDIES 04/05

- MIP (membrane interface probe) was used to determine the depth of VOCs' pollution:



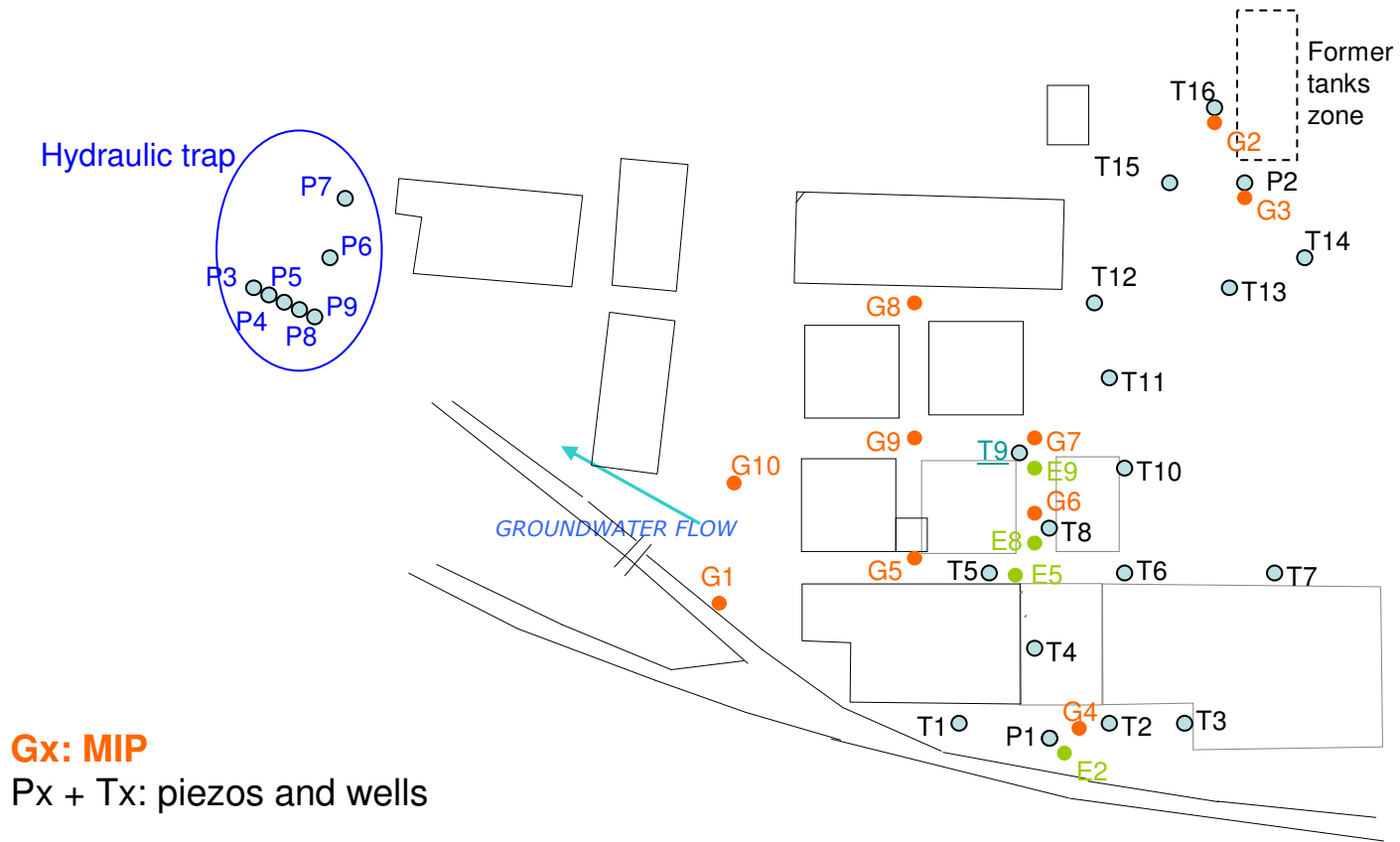
- The chalk's groundwater seems not to be impacted by HCOVs related with the former plant.



## **WORKS STEP 1 : PUMP & TREAT**

- Punctually polluted places (TPH spot in point G10), soils were excavated and off-site treated
- Due to high HVOCs level in water and local hydrological pattern, pump & treat was performed on all polluted points (T1 to T16), connected together to the unit
- Furthermore, an hydraulic barrier was placed to prevent downstream well contamination

# STEP 0 : STUDIES 04/05



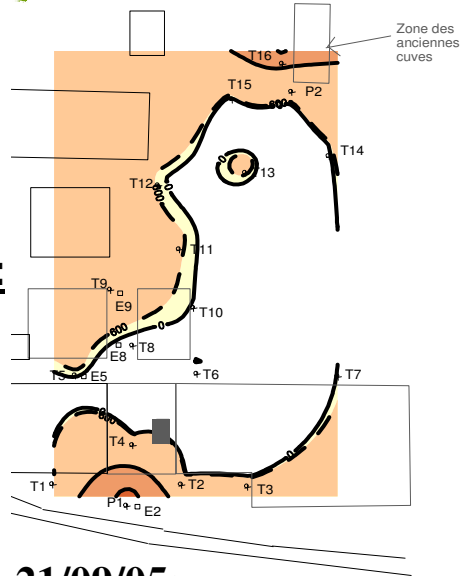


## WORKS STEP 1 : PUMP & TREAT

- After 7 months of treatment, an average decay (all chlorinated components) of 70% of pollution's peak
- In December 2005, the polluted zones close to the river (P1) and painting cabin (T9, T5) present lower amounts of all the chlorinated compounds.
- The only tank zone (T16) keeps remaining high levels for PCE.

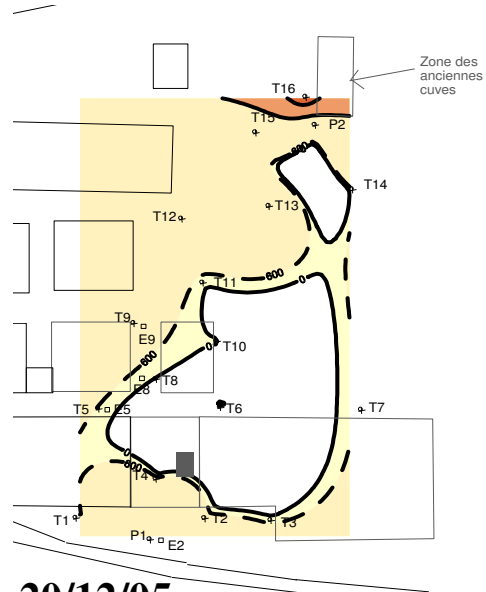
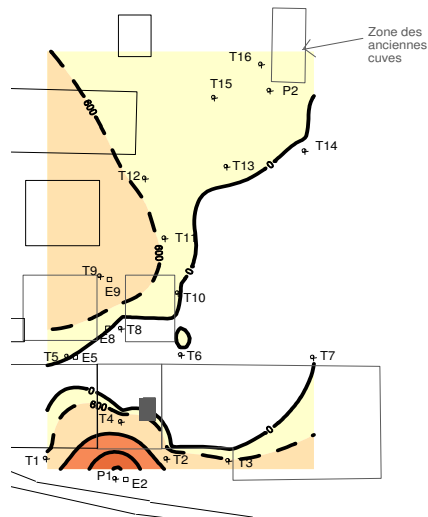
# WORKS STEP 1 : PUMP & TREAT

## PCE contamination:

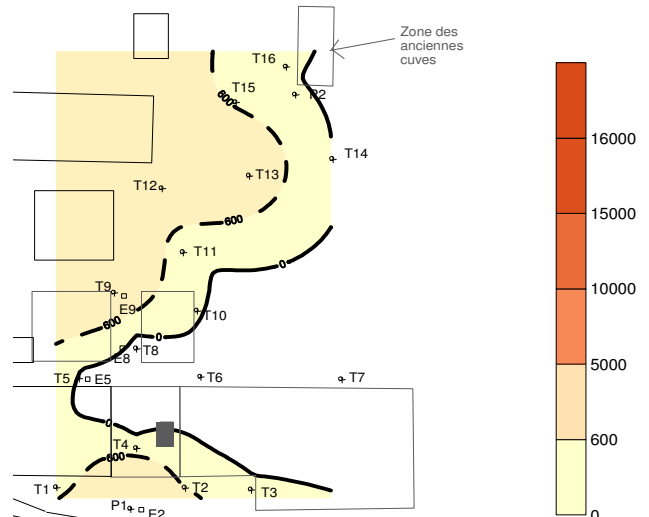


**21/09/05:**

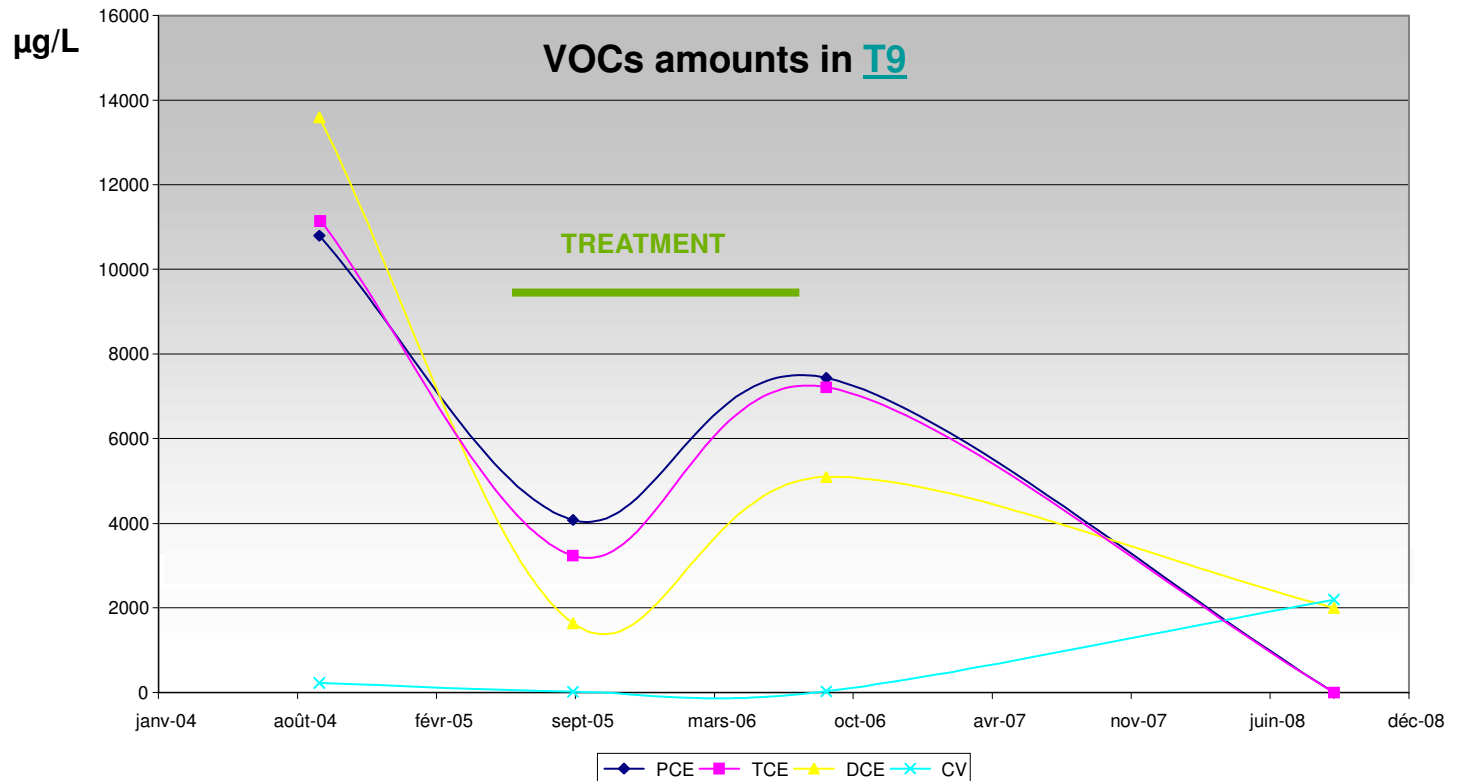
## TCE contamination:



**20/12/05**



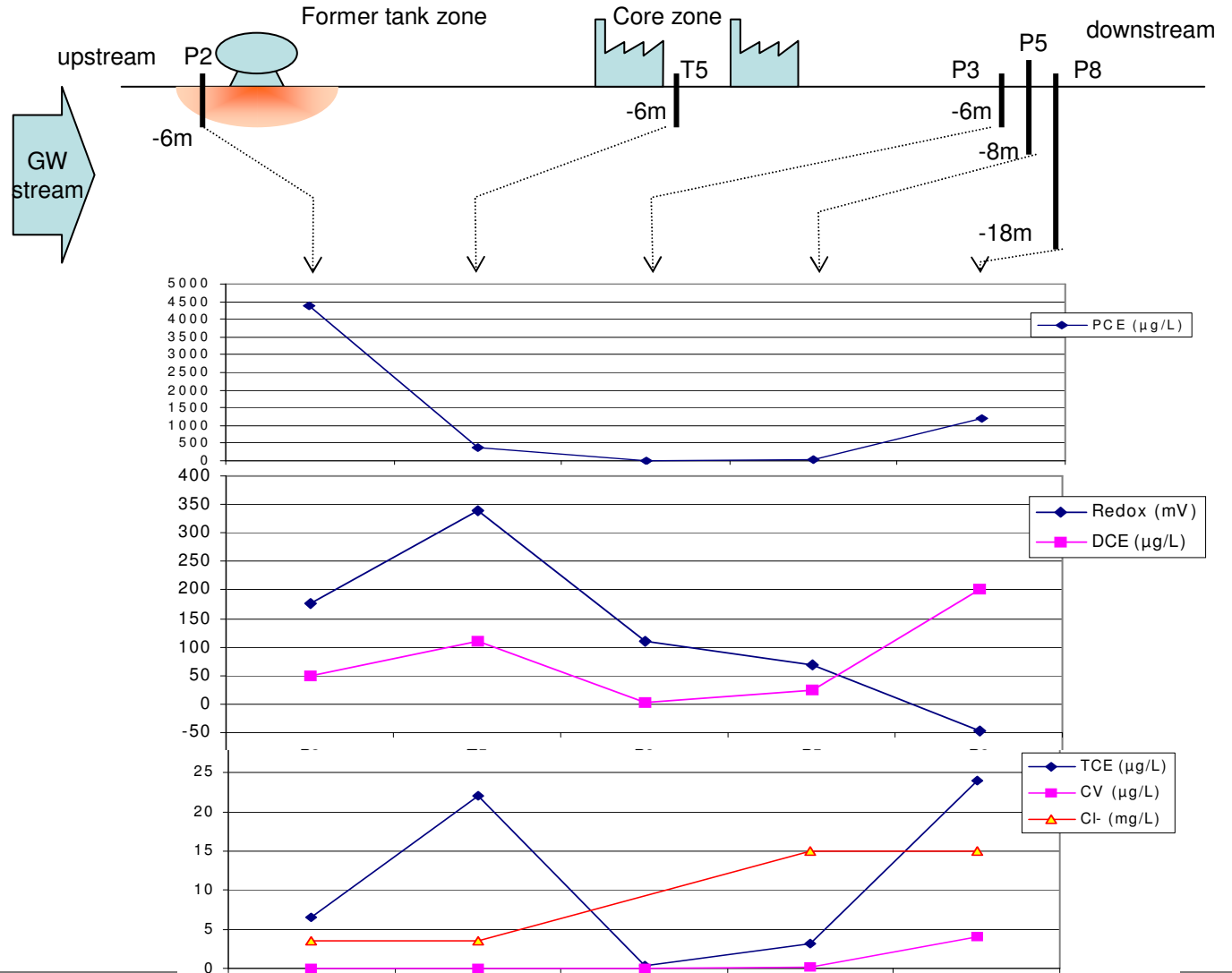
## WORKS STEP 2 : NATURAL ATTENUATION



- Last measurements showed drastic breakdowns in VOCs amounts since the treatment stopped
- Beside the decay of highly chlorinated molecules, degradation products are rising (CV, Cl-).

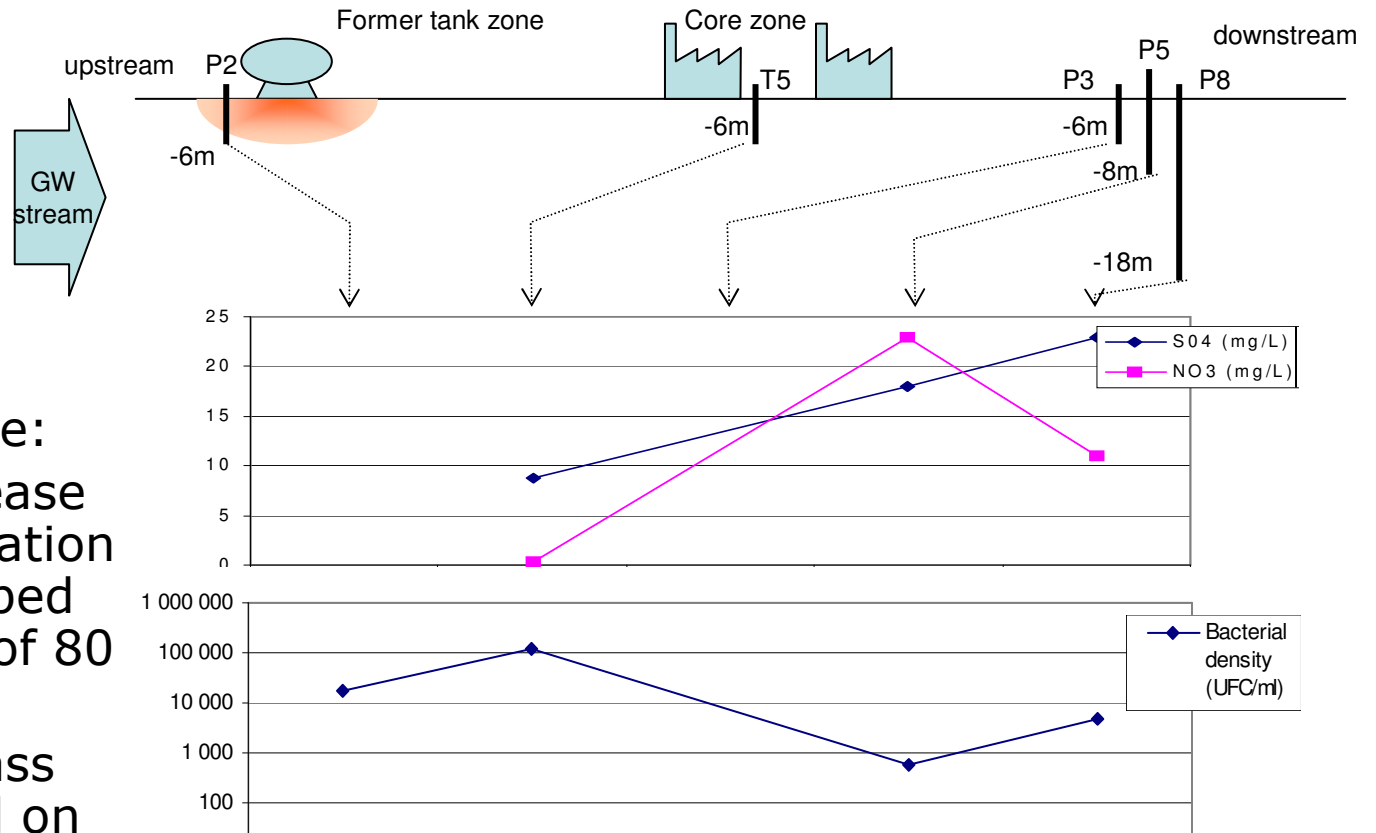
# WORKS STEP 2 : NATURAL ATTENUATION

Furthermore, several hints demonstrate the effectiveness of biodegradation, as presented to the DRIRE (2008):



Measures: in situ, the 21/08/08

# WORKS STEP 2 : NATURAL ATTENUATION



Measures: in situ, the 21/08/08

Data compilation allowed to conclude:

- Significant decrease of whole contamination since activity stopped (from an average of 80 to 2 mg/L)
- low pollutant mass export (g/d, based on groundwater speed and thickness)
- Evidence of biodegradation mechanisms, aerobic (peripheral zone), as anaerobic (deep and core zone)



## PLAN OF MANAGEMENT

- Regarding the whole data collected:
- The file notifying the stop of the plant's activity
- The potable water well, 2,6km downstream,
- The evidence of groundwater contamination by chlorinated compounds, in site's underground and downstream
- The Detailed Risk Study (EDR) made by LISEC France (03/05), which results show that sanitary risk by inhalation is acceptable, but the risk by swallowing water isn't acceptable
- The remediation works made during 2005 and 2006 (pumping + stripping) by LISEC France,
- The demonstration driven by VALGO about « Natural attenuation under the site – proposal for a rehabilitation procedure », including last dated rules about polluted sites (circ. 8 Feb. 07),
- And the global agreement of all the stakeholders, from former, present and future owners, to public authorities, inc. the DRIRE;



## PLAN OF MANAGEMENT

- Furthermore, regarding,
- Soils and water analysis results showing the low residual contamination level and evidences of microbial activity demonstrating the effectiveness of natural attenuation
- The favorable notification from the DRIRE to use this alternative solution, but completed with restriction in future uses of the site
- The need to protect sensible targets and, thus, to fulfill our knowledge about plume extension in time and space scale, particularly in the direction of the water spring
- The first draft of the plan of management, based upon natural controlled attenuation with evaluation of the exposure's level of all the recipients, and submitted, for information, to authorities.
- The need to rule an easement for public utility (SUP), bound to the future site's use, as described in rehabilitation projects, and to a restriction in groundwater uses, in the concerned area;

## **PLAN OF MANAGEMENT**

- Based on the above elements, a plan of management is proposed, aiming:
- To realize air analysis studies in the kept building, to assess the sanitary risk
- To give a precise description of the rehabilitation project, with the localization of buildings allowed to receive public (ERP) and proposal of fittings, regarding the results of air analysis and residual risk analysis
- To characterize soils right to the buildings to demolish to fit the rehabilitation project and in the future embankments
- To propose a plan of survey of the groundwater, determining piezos to be controlled in and out of the site
- To realize a study of environmental vulnerability to identify targets and ways of transfer
- To obtain a modelling of pollutants' plume out of the site, with the help of simulations of the dispersion, including all the specificities of the area.

# PLAN OF MANAGEMENT



Rehabilitation Plan