ERT newsletter
Let us do it together!
NR. 1 - OCTOBER 2008
European Remediation Technologies

Introduction ERT

Since three and a half years European Remediation Technologies (ERT) distinguishes o.s. on the European remediation market. ERT is a soil and groundwater remediation company specialised to deliver full services for in situ chemical oxidation (ISCO) and is the exclusive supplier of CAP18® and CAP18-ME® in Europe, refined vegetable oils suited for the anaerobic biodegradation of among other things chlorinated solvents.
Our device sounds 'LET US DO IT TOGETHER!', we are convinced that this approach is the key for mutual success!
If you have any question, don't hesitate to contact us. Always prepared for a meeting.

Kristof Van Vooren and Stijn Haghebaert

Kristof Van Vooren - Stijn Haghebaert

Delivered services *of* ERT

ISCO

ERT is concentrated as a niche player in the European market to design and execute ISCO projects. ERT is based in the centre of Europe (Belgium), so we are able to supply the whole European region. Together with our American partners ERT has experience with more than 100 executed ISCO projects.
In situ chemical oxidation is rapidly emerging as a viable remediation technology for mass reduction in source areas as well as for plume treatment. The oxidants most commonly employed to date include Fenton's (peroxide), permanganate, persulphate, and ozone systems, with subsurface delivery to groundwater by vertical or horizontal wells and sparge points, and to soil by lance injectors and hydraulic fracturing. The potential benefits of in situ oxidation include the rapid reactions with a wide range of chemicals of concern, applicability to many biorecalcitrant organics and a range of subsurface conditions, ability to tailor treatment to a site from locally available components and resources, and facilitation of property transfers and Brownfields development projects. Some potential limitations exist, including potential need for large quantities of oxidants due to the demand of non-target organics and other unproductive oxidant demands from the formation, resistance of some compounds to chemical oxidation, and potential for process-induced detrimental effects including gas evolution, permeability loss, and mobilization of redox sensitive and exchangeable metals. Full-scale deployment is accelerating, but care must be taken to avoid poor performance and unforeseen adverse effects.
Matching the oxidant and delivery system to the contaminants of concern and site conditions is the key to achieving performance goals.

Fenton's pilot injection equipment

CAP18® and CAP18-ME®

ERT is the exclusive supplier of CAP18® and CAP18-ME® in Europe. CAP18® and CAP18-ME® are slightly viscous liquids refined from natural vegetable oils, for the purpose of stimulating anaerobic biodegradation in groundwater. CAP18® is a food-grade, vegetable oil product that has been refined to concentrate what are known as C18 unsaturated fatty acids. The C18 unsaturated fatty acids provide a special benefit for groundwater remediation. CAP18-ME® is a modification of CAP18® that includes esters of fatty acids (which are themselves derived from CAP18®), which provide a more readily available source of carbon to stimulate anaerobic biodegradation. CAP18® and CAP18-ME® can be used for cost-effective, rapid treatment of chlorinated solvents, perchlorate, nitrate and explosives, found as contaminants in soil and groundwater. CAP18® and CAP18-ME® remediations are accomplished in-place without high capital costs, disruptive site activities or complex engineered delivery systems.

CAP18® and CAP18-ME® stimulates microbes living in the soil and aquifer to naturally degrade contaminants under anaerobic (oxygen-free) conditions. The long chain fatty acids are consumed via a process known as beta-oxidation, which establishes optimal anaerobic conditions for contaminant degradation and produces hydrogen over a sustained period of time (many months to years). The hydrogen is utilized by microbes to biologically destroy contaminants by stripping chlorine or nitrogen atoms from the molecule. Unlike many other bioremediation substrates, CAP18® and CAP18-ME® inhibits methanogenesis, thereby providing more hydrogen generation for reduction of target compounds rather than formation of undesirable methane. ***Compared to other bioremediation enhancements, CAP18® and CAP18-ME® are lower cost, more efficient, longer lasting and easier to apply.***

On www.e-r-t.net you can find a detailed description of the “Properties and mechanisms of CAP18®” and other info.

Below we reflect briefly what exactly is expected from a carbon source when stimulating the biodegradation, this following the expected evolution pattern :

1. Dissolved oxygen: The dissolved oxygen (DO) concentration is anticipated to decrease as the aquifer becomes progressively more anaerobic, with desired concentrations less than 1 mg/L.
2. Oxidation-Reduction Potential: The oxidation-reduction potential(ORP) is anticipated to decrease under progressively more anaerobic conditions. By values less than 100 to 150 mV (as measured with an Ag/AgCl electrode that is corrected to a standard hydrogen electrode) is conducive to anaerobic biodegradation.
3. Nitrate: If nitrate is present, nitrate concentration is also anticipated to decrease as the aquifer becomes progressively more anaerobic, with a desired concentration <1 mg/L.
4. Fe(+II): Under progressively more anaerobic conditions, ferric iron (Fe^{+3}) is biologically reduced to ferrous iron (Fe^{+2}), thus the concentration of Fe^{+2} is anticipated to increase with a desired concentration >1 mg/L.
5. Sulphate: Under progressively more anaerobic conditions, sulfate is biologically reduced to sulfide, thus the concentration of sulfate is anticipated to decrease. The desired concentrations are low, with <20 mg/L desired for an optimal treatment but not required because effective bioremediation also occurs at much higher concentrations.
6. VOC’s, ethene and ethane: Via an anaerobic pathway PCE will be converted to TCE, TCE to Cis, Cis to VC, to finally convert VC into the harmless ethene and ethane. When this complete cycle is observed, then we can speak of an optimal reductive dechlorination, at what the necessary DHE bacteria with certainty will be present.
7. Methane: Under very anaerobic conditions, methane is generated by reduction of carbon dioxide(which consumes hydrogen) and of acetate. Elevated methane concentrations are indicative of the strongly reducing conditions that benefit anaerobic bioremediation of chlorinated solvents, although methanogenic bacteria may also compete with dehalorespiring bacteria for available hydrogen. CAP18® and CAP18-ME® also inhibits methanogenic bacteria. Thus an increase in methane is anticipated, and concentrations >0.5 to >1 mg/L are generally considered to indicate redox conditions conducive to anaerobic biodegradation; however methane production at sites treated with CAP18® is likely to be lower than that produced by other substrates.
8. Total Organic Carbon: The total organic carbon(TOC) concentration is generally interpreted to reflect the distribution of the organic substrate. A TOC concentration in the range of approximately 20-50 mg/L is generally considered conducive to anaerobic biodegradation. Concentrations less than approximately 20 mg/L are also capable of supporting anaerobic biodegradation; however, lower TOC concentrations, coupled with evidence of accumulating intermediate breakdown products (such as cis-1,2-dichloroethene) or increasing concentrations of other electron acceptors (dissolved oxygen, nitrate, sulfate, etc.) indicate that additional substrate may be needed.

CAPISCO™

The CAPISCO™ process is a remediation model that is developed by ERT whereby the use of ISCO and CAP18® and/or CAP18-ME® are standing central as remediation technologies in the course of which remediation target values can be guaranteed.

Bioremediation partner: Carus Remediation Technologies *(formerly DBI)*

Carus Corporation (www.caruscorporation.com) announced that effective 29 April 2008 it has acquired the business and assets of DBI Remediation Products LLC, Fishers, IN, a leading manufacturer and marketer of bioremediation products. "This acquisition represents Carus' commitment to strengthen and expand the remediation technology offerings globally," stated Inga Carus, President and CEO of Carus Corporation.

Steven Irvin and Dan Bryant, founders and principal shareholders of DBI Remediation Products LLC, endorsed Carus' purchase of the business and their intentions to further strengthen its remediation product offerings. "The combined resources of Carus and DBI provide unparalleled support for our clients," added Steven Irvin and Dan Bryant.

Matt Dingens, Global Market Manager, Remediation Technologies., expressed great optimism for this purchase. "Most of our customers are currently combining in-situ chemical oxidation with some type of bioremediation at their sites. Our acquisition will now give our customers a single source for their remediation products. The combination of DBI's Innovative biostimulation products and Carus' established infrastructure will benefit Carus' and DBIs customers through expanded customer service, technical support, and sales representation".

DBI Remediation Products, LLC(DBI – www.dbiproducts.com) was formed in March 2003 with the objective of marketing CAP18®, an innovative, edible-oil based product for stimulating natural degradation of common environmental contaminants, such as chlorinated solvents (degreasers and dry cleaning fluids), perchlorate, and explosives.

$NaMnO_4$-injection equipment

As part of DBI's active product development program, two new products were launched in 2007. These products include CAP18-ME® and StimulOx™. CAP18-ME® was developed to shorten the time it takes to achieve anaerobic conditions at a site. StimulOx was developed to remediate petroleum products under aerobic conditions.
All of DBI's products are intended to empower the user to apply the product themselves, without the requirement for sophisticated and expensive equipment or training.

CAP18® & CAP18ME® injection equipment

Carus Corporation is the world's largest producer of permanganates, which are used mainly in environmental applications: to improve the quality of drinking water, to treat municipal and industrial wastewater, in air purification systems, and in groundwater remediation. Carus Corporation was founded in 1915 in LaSalle, Illinois, and is a member of the American Chemistry Council and an active participant in the industry's award-winning Responsible Care® initiative, working to make life better, healthier, and safer through chemistry.

CARUS®

Haute-Garonne (31) *France*

The CAP18®-injections at this French project where performed at the end of February 2008 via fixed injectors. Injection via 'direct push' wasn't feasible at this site due to the presence of boulders in the subsurface. The aquifer at the site has an extremely high groundwater velocity of 10 m/day. The groundwater velocity influences the radius of influence, and even on a short term good results can be achieved using CAP18®. Below the results from the pre-injection(baseline) monitoring, and 3 and 6 months after injection, are reflected in graphs. The results are given as an average of all monitoring wells(10 in total), which where sampled in the injected zone, except for the ORP and DO graphs at which all the monitoring wells both inside and outside the injection zone are shown. The location of the 10 fixed injectors(blue symbols with yellow contours) and monitoring wells are shown in 'Map 1'. A total of 9 IBCs(= 8.280 kg) of CAP18® was injected.

Evolution of the VOCs, ethene and ethane

After only 3 months we see already a complete reductive dechlorination, which was even more developed after 6 months. The PCE and TCE concentrations are under the target values in 9 of the 10 monitoring wells. The PCE and TCE are reduced to Cis and VC, respectively; therefore we expect and observe an intial increase in both parameters followed by their degradation as well. After 6 months there is already a Cis decrease. The most important conclusion is the that the dechlorination is complete to ethene and ethane, which are harmless end products. In other words there is no 'hang up' at Cis or VC, and after 6 months the increase of ethene and ethane is even more obvious.

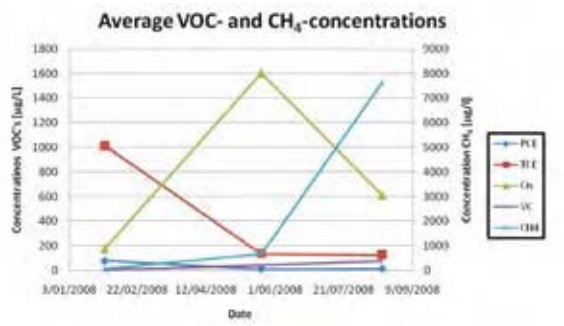


Figure 1

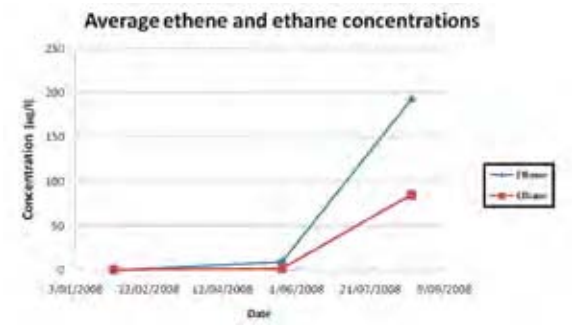


Figure 2

Evolution of Groundwater Redox Parameters

Analysis of parameters that reflect groundwater redox conditions also demonstrate that the aquifer is becoming more anaerobic. The ORP values in the injection zone are much lower then 150 mV, and the DO continuous to decrease after 6 months. There is a clear increase in TOC, which indicates good distribution and presence of CAP18®. Both nitrate and sulphate reduced, and the rising methane concentration also indicates more anaerobic conditions.

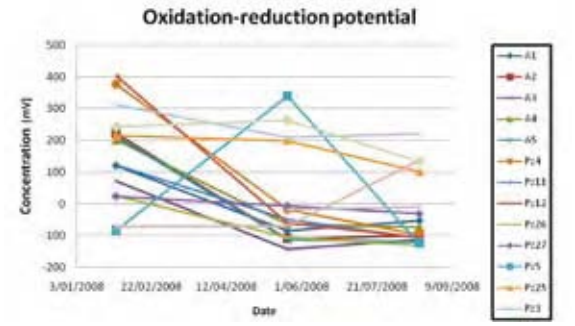


Figure 3

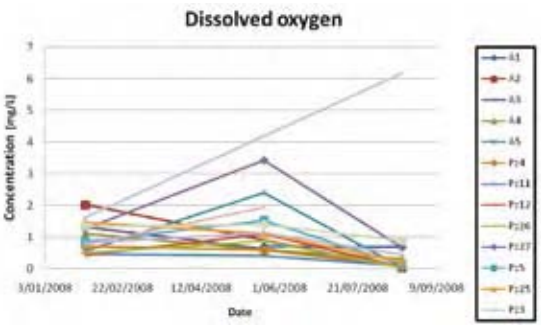


Figure 4

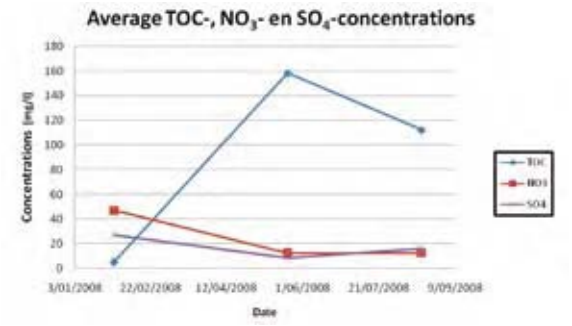


Figure 5

Presence of fatty acids

The concentrations of fatty acids is also monitored, because they are produced by metabolism of the CAP18® substrate. During the baseline(pre-injection) sampling event, fatty acids were not present. After 3 and 6 months they are present at elevated conditions, demonstrating the distribution and activity of the CAP18®.

Remark : After 6 months there is even noticed a CAP18® influence in 'Pz5', which is located approximately 25 m from the closest CAP18® injector. This can be seen in the ORP and DO graphs, namely for both a significant decrease which points out anaerobic conditions. The other parameters of 'Pz5'(VOCs, ethene, ethane, methane, TOC, NO3 ,SO4 and fatty acids), are not plotted in the graphs below, however the anaerobic CAP18® influence is noticeable in all of these analytes. The groundwater flow is determined from the west to the northeast and southeast across the site, what the CAP18® course is confirming at the moment.

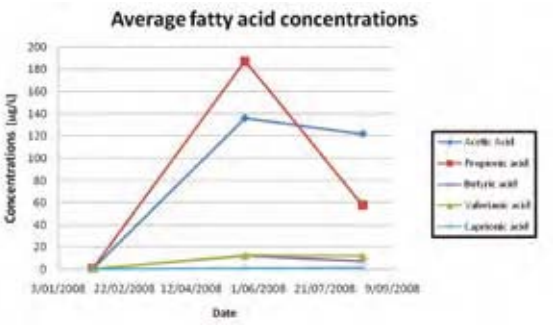
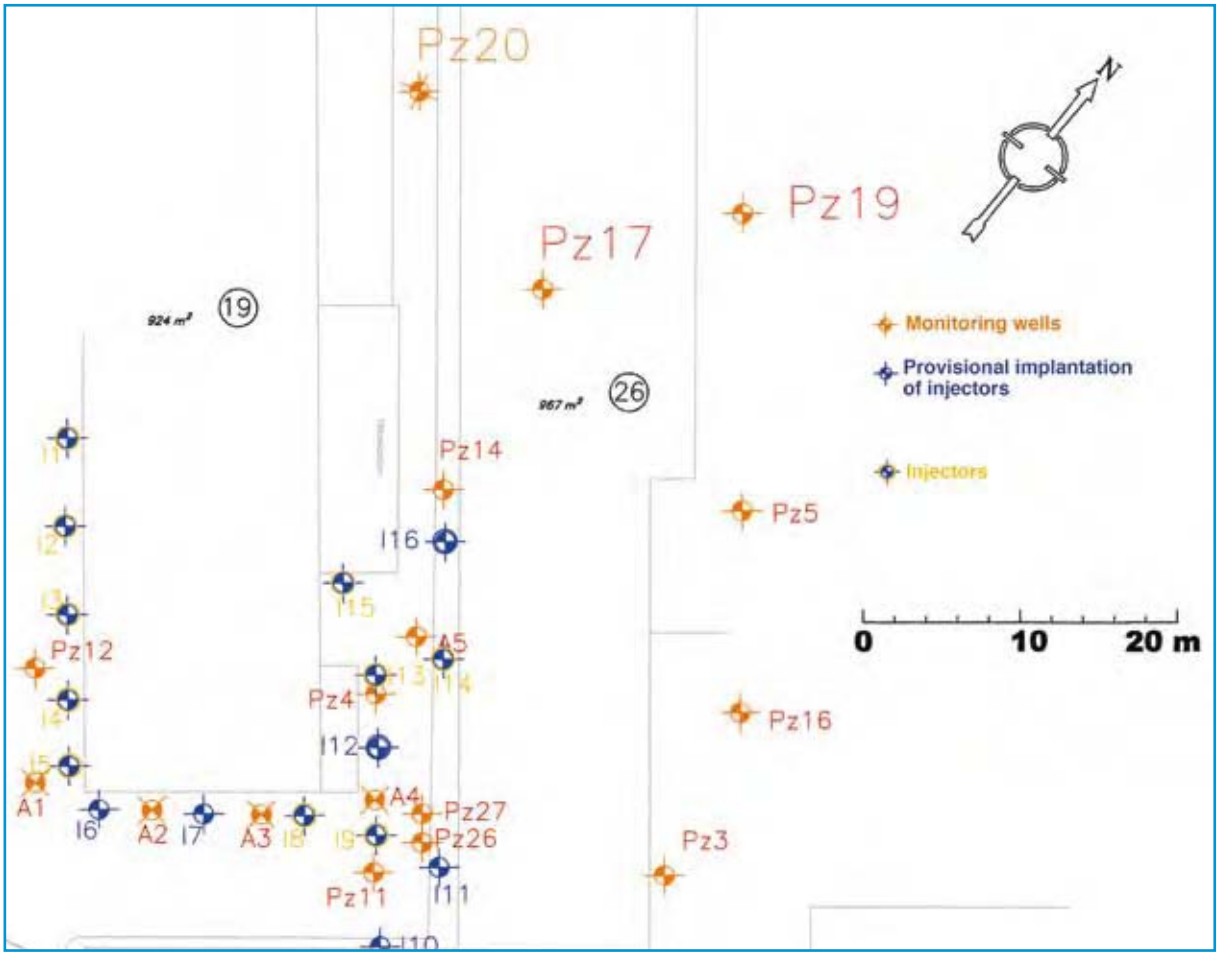


Figure 6



Map 1 : CAP18® fixed injectors & monitoring wells

Hoboken - Antwerp Region *(Belgium)*

After we had undertaken ISCO bench tests, an ISCO pilot with $NaMnO_4$ and CAP18® pilot in a former dry cleaning plant, the site was converted to implement the CAPISCO™ process. This process was developed by ERT to remove chlorinated solvents economically and accurately. In this CAPISCO™ project, the source (see 'Zone 1' in 'Map 2) is initially treated with permanganate and is subsequently treated with CAP18-ME® in order to achieve the required target values. The 'Zones 2&3' (see 'Map 2'), which contain dissolved VOCs that can be treated anaerobically via biological stimulation, and the downstream plume 'Zone 4' are treated with CAP18® and CAP18-ME®. The results of the baseline monitoring and the results after circa one year of treatment are given below. The depth to be treated is between 1 and 3 m-bg; below this level an impermeable clay layer is present.

Zone 1 : NaMnO4 injections

In August 2007 the first series of permanganate injections was made in which a total of 6.800 kg of $NaMnO_4$ 40% in diluted form was injected via circa 50 'direct push' injectors. In the light of the PCE and TCE results, the concentrations dropped insufficiently in some wells. For this reason a second series of permanganate injections were made in March 2008 in which 5.440 kg of 40% NaMnO4 was distributed in diluted form between about 100 'direct push' injectors.

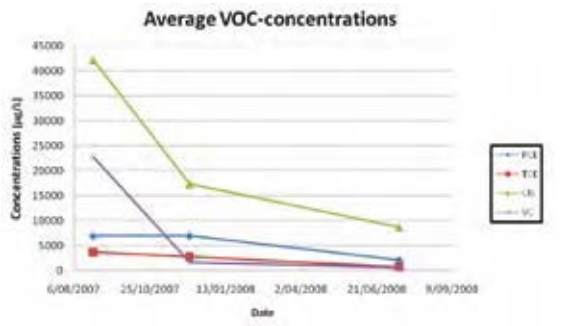


Figure 7

After the first series of injections (see 'Figure 7') a clear Cis and VC decrease was observed. Due to extra wells we monitored in the source, which were not part of the pre-injection monitoring, the average PCE and TCE concentrations were almost unchanged. After the permanganate of the second series of injections was exhausted, there was again an obvious decrease of CIS and VC but a clear drop of PCE and TCE was also observed. This in an acceptable low level such that the after-treatment with CAP18-ME® can be commenced. These injections were made in October 2008. In total 2.720 kg of CAP18-ME®(=3 IBCs) were injected, divided between 75 'direct push' injectors.

Zone 4 : CAP18® injections

6 IBCs(=5.520 kg) of CAP18® were injected in September 2007, divided between circa 150 'direct push' injectors. The graphs (see 'Figures 8, 9 & 10') show us the average results of six monitoring wells from the baseline monitoring, and 7 and 13 months after injection; the wells are located in 'Zone 4'.

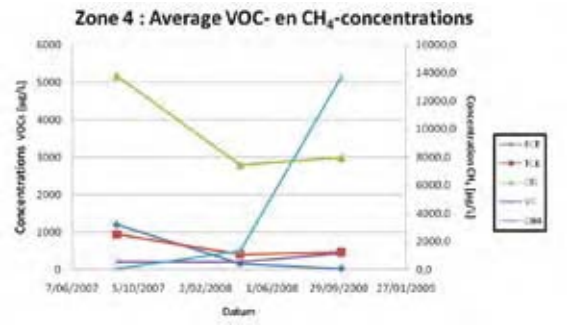


Figure 8

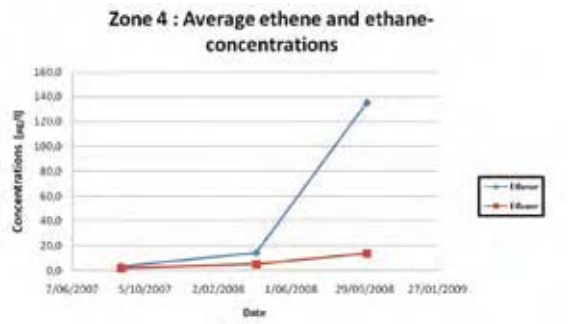


Figure 9

The decrease of PCE is obvious after 7 and 13 months; TCE and CIS is initially decreased and stays stable after one year, but in view of the gradual increase in VC and the obvious production of the harmless products ethene and ethane, we can suppose that the reductive dechlorination is complete. The anaerobic degradation is also shown through the changes in the groundwater redox parameters; nitrates have not been present since the beginning, but the reduction of sulphates and the production of ferrous iron and methane is clearly perceptible. In addition, the high TOC content indicates the presence of well distributed CAP18®.

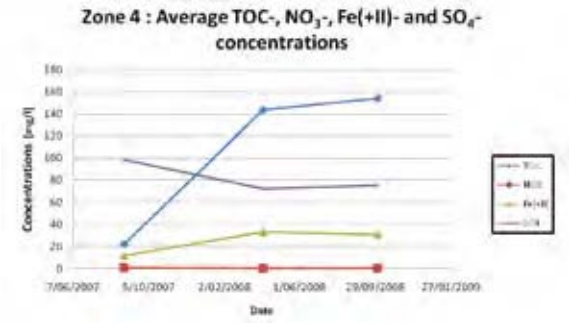


Figure 10

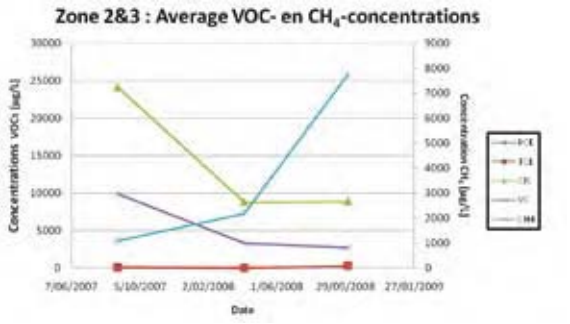


Figure 11

Zone 2&3 : CAP18-ME® injections

In mid January 2008 8 IBCs(=7.360 kg) of CAP18-ME®, distributed between 170 'direct push' injectors, were injected into 'Zone 2 and 3'. 'Figures 11, 12 & 13' show us the average results of 8 monitoring wells from the pre-injection monitoring, and 3 and 9 months after injection. The decrease of the VOCs after 3 months already clearly indicates that the ME does not miss the target. The PCE concentration is fairly low, but the increase of TCE after 9 months shows that the dechlorination is a fact. The decrease of CIS and VC and the clear increase of ethene and ethane indicates that the reductive dechlorination is complete. The groundwater redox parameters confirm this anaerobic change; nitrates and sulphates reduce further; the production of ferrous iron progresses and the production of methane is considerable. Although after 9 months the TOC is reduced compared to the value after 3 months, the average concentration spread out over the 9 months remains high. This indicates a good spread and presence of CAP18-ME®.

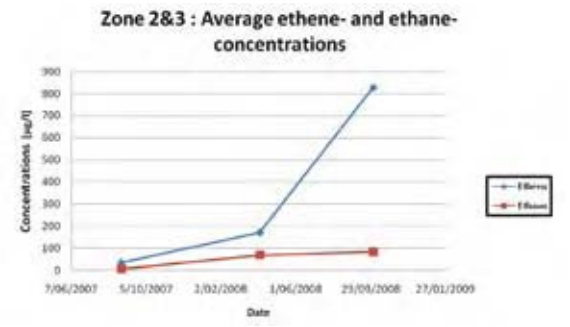


Figure 12

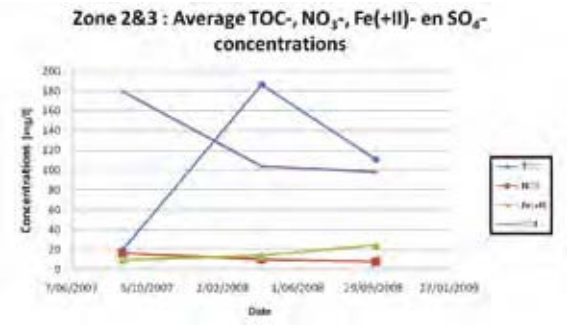
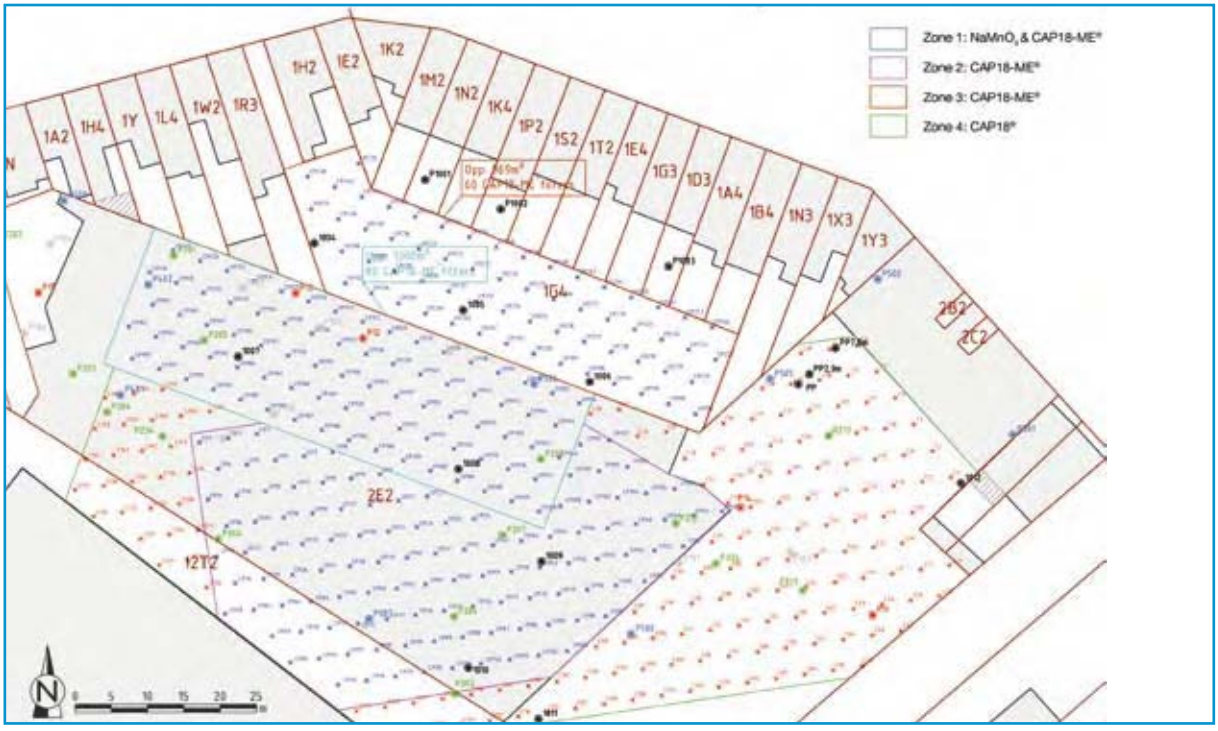


Figure 13



Map 2 : $NaMnO_4$ CAP18® & CAP18-ME® injection zones

Let us do it together!

European Remediation Technologies

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