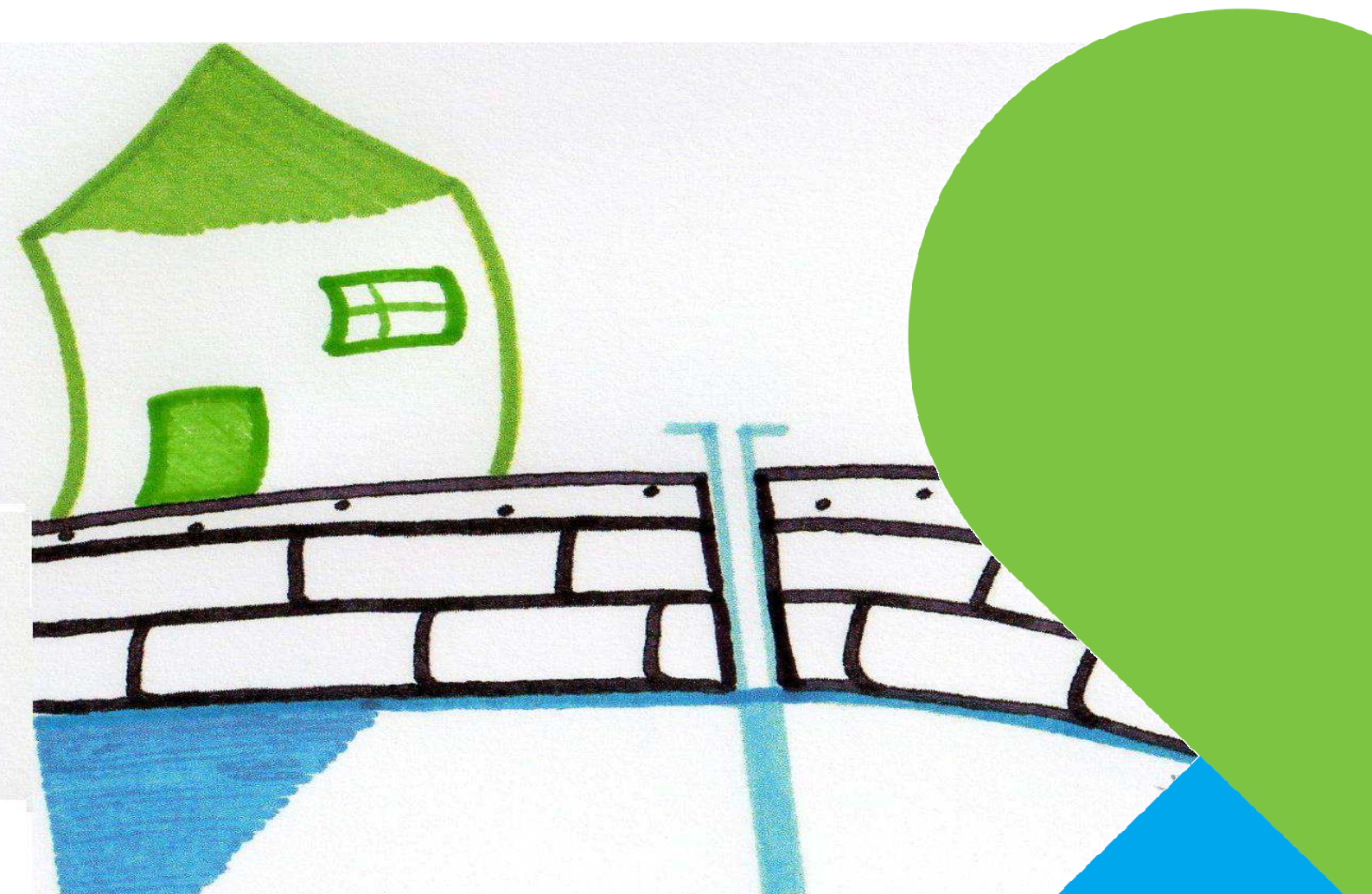


APPENDIX



Contents of Appendix

.....	2
APPENDIX I: Our approach	11
1. Why this study?	12
2. Means for this study	12
• Interviews with French actors	12
• Written testimonies	12
• Workshops	13
APPENDIX II: French situation viewed by some French actors	14
APPENDIX III: French methodology for “polluted sites”	32
APPENDIX IV: Some links to know more about French tools	35

French Landscape Research and Development

Project's name	Organism(s)	Summary	Project's status / Availability
Methodology guidelines for the technique selection and performance assessment (guidelines)	ADEME	Guidelines for preselection of "best available" soil remediation techniques. Part 1: Methodological guide :soil treatability (This guide's aim is to make decision-makers able to eliminate inadequate techniques thanks to simple parameters characterizing the site, the pollutant(s) and the soil, and to make them aware of parameters which are likely to limit techniques' feasibility and performances) (124p). Part 2: Specifications for pilot tests in order to check selected techniques (246p)	Available on : http://www.planetegagnante.fr/servlet/KBaseShow?sort=-1&cid=96&m=3&catid=10143
COMRISK : Involvement of populations in assessment and management of polluted sites or soils (state of the art / guidelines)	INERIS ADEME	State of the art and guidelines for communication tools used on polluted sites. Part 1: State of the art: survey of feedbacks from different actors, survey of perception from populations, inventory of knowledge and practices (2008, 364p). Part 2: Communication supports for risk assessment and polluted sites management: booklets and posters, transparencies, supports for events (2008, 107p). Part 3: Guidelines: fundaments, strategies, practical recommendations, Frequently Asked Questions (FAQ), involvement plan for populations and other supports for implementation (2008, 382p).	Available on : http://www.comrisk.fr/
Characterisation of microbial activities involved in chlorinated solvent biodegradation (innovative techniques)	ADEME/SERPOL /ENOVEO	The objective is to use DNA micro-array in order to control biological degradation and to improve decontamination process. Part 1: validation of q-PCR for monitoring biological decontamination and for dehalococoides bacterial amount assessment Part 2: optimisation of sampling method for bacterial community identification	On-going project
EvaSol - PRECodd (innovative techniques)	ADEME/Ecole Centrale Lyon/SITA	Development both continuous monitoring methods (biosensors) and microbial community analysis (micro-array) in order to improve polluted site remediation evaluation - these methods are developed to clearly demonstrate the bioremediation technics feasibility and efficiency.	On-going project

Biodegradation kinetics of chlorinated solvents on polluted sites (innovative techniques)	ADEME/ENOVEO /BURGEAP	Development of microbial community analysis (micro-array) in order to improve polluted site remediation evaluation.	On-going project
MACAOH (Modelling, Attenuation, and Characterization in Aquifers of OrganicHalogenated compounds) (guidelines)	ADEME	MACAOH's aims are, first, to help fill gaps in understanding and applied knowledge, and secondly, to produce three technical guides on the following themes: "Characterization of a source zone", "Natural attenuation", and "Modelling". Spanning a period of 5 years (2001-2006), it included experiments at the laboratory scale (batch, column) and pilot scale (SCERES basin), at two industrial sites, as well as modelling studies (such as performance tests of computational tools in the framework of an inter-comparison program associating MACAOH partners and 8 modelling teams). These guides, available for download on the ADEME web site, are also referenced by the French Ministry of Ecology, Energy, Sustainable Development and Town and Country Planning as technical tools for then management of contaminated sites. The MACAOH technical guides include a description of key concepts, methodologies, and protocols, as well as examples of applications. They are intended for both service providers (e.g., consulting companies, research organizations) and clients (industries, planners, communities, institutions).	Available on : http://www2.ademe.fr/servlet/KBaseShow?sort=-1&cid=96&m=3&catid=10143
BROWNFIELD REGENERATION (website)	ADEME	Methodology for urban brownfield regeneration - consideration of soil pollution in urban project - best practices - environmental and urban regulation - 2009	available on : http://www.developpement-durable.gouv.fr/amenagement-et-sites-pollues/
Best practice guidance for sustainable brownfield regeneration (guidelines)	ADEME	Author : RESCUE (Regeneration of European Sites in Cities and urban Environments) Part 1 to part 5 : guidance according to the urban project partners including best practices and tools Part 6 : RESCUE Tools : the VTC (Virtual Training Centre) and the SAT (Sustainability Assessment Tool) May 2005 - 144 p	available on : http://www.rescue-europe.com/download/reports/RESCUE%20Manual.pdf
Pollution Identification by Trees: use of Phytoscreening and dendrochemistry (PIT) (guidelines)	ADEME	Use of dendrochemistry for the characterisation of soil and groundwater pollution. The interest is to use trees as a non-invasive method, especially in urban areas. Pollutants to be investigated are organics such as HVOC, and inorganics. Two guidance documents are expected:- use of phytoscreening as an integrated tool for actual pollution identification, -use of dendrochronology for historical identification of pollution. Should start by the end of 2010 and will last until 2013. An American guidance document already existsfor HVOC and will be used as a basis.	On-going project

RECORD : isotopic (review)	ADEME	Literature review of the use of Isotopes for source's origin identification (including chlorinated solvents). On-going project should end en 2011.	On-going project
RECORD : bruit de fond (review)	ADEME	Literature review of background level in the environment (natural and anthropogenic). On-going project should end en 2011.	On-going project
GEOSIPOL (guidelines)	ADEME	Use of geostatistics for site characterisation and calculation of the volume of soil to be removed or the volume of water to be clean-up. On-going project. Should be finished in 2011.	On-going project
OPUSS (review)	ADEME	Scientific review of the various models on transport of pollutants between the vadose zone and the aquifer. Potential for their use on the urban area. On-going project. Should end in mid-2011.	On-going project
ATTENA	ADEME/INERIS/B RGM	ATTENA project: Field Tools Development for Monitored Natural Attenuation for certain pollutants as organohalogenated compounds.	On-going project
ETV SOL : Environment Technology Verification for Soil (state of the art)	ADEME	Systems called Environmental Technology Verification (ETV) have been developed in the USA or in Canada in order to accelerate the innovative technologies' entry on the market, by providing quality information to potential users thanks a web. Nowadays, there is no verification system for Europe but its effective implementation has been planned for 2010-2011. For now, the global frame of the European system isn't planned out. The purpose of this project is to draw the state of the art of ETV systems over the world then preparing European systems dedicated to polluted soils.	On-going project
SOLENV : Environmental Evaluation of Remediation Techniques (guidelines)	ADEME	The main objective of the SOLENV project is to develop a methodological basis dedicated to the assessment of the environmental benefits of the implementation of contaminated land remediation technologies, integrating the pressures on the environmental components such as air, water, soil, ecosystems and the impacts on the soil functions (degradation or restoration) according to the types of soil uses (agriculture, housing, raw materials resources). The methodology should eventually allow selecting for a given polluted site (geological and hydro-geological context, climate, nature and number of pollutants, presence of underground infrastructure ...) the best treatment technology according to the ratio environmental benefits / treatment efficiency or through a multi-criteria analysis.	On-going project

RHODANOS (innovative techniques)		<p>RHODANOS is a research programme including two project interesting in terms of water treatment :</p> <ul style="list-style-type: none"> - DETECTEUR: development of new integrating sensors detecting and measuring concentrations of pollutant (such as VOC) using material creeping properties of a polymer faced to such pollutant. This kind of probe will be easy to install in urban environment and will give information in real time for monitoring. - HYDROCARB: Development of an analysis tool (Software) which can measure concentration for the whole chlorinated family thanks to only one analyse (chromatography). 	On-going project
Groundwater samples' representativeness from control wells (demonstration / guidelines)	ADEME	<p>Research project aiming to ameliorate groundwater sampling practices. Pilot-tests and investigations on site were led simultaneously by several scientific partners. Sampling tools and procedures for draining, sampling, samplers conditioning, well equipment were accurately reviewed.</p> <p>Two protocols for sampling on control well are suggested and theirs pros and cons were weighted:</p> <ul style="list-style-type: none"> - A simplified protocol which cares above all about the notion of risk assessment - A scientific protocol which takes into account the notion of pollution diagnosis. <p>The last notion must help to understand the contamination status of the aquifer in its entire complexity ant its evolution. November 2006 – 149p.</p>	available via : http://www2.ademe.fr/servlet/getDoc?sort=-1&cid=96&m=3&id=40664&ref=12441&nocache=yes&p1=111
OPOPOP (Optimisation des Paramètres d'Ozonation en phase liquide des Polluants multiples de site Pollué) (demonstration / guidelines)	ADEME	<p>Ozonation of water is not really a new technique. It has been used for twenty years in order to fight again polluted sites. Until now, its main purpose was the treatment of organic matter by oxidation, eliminating any colour and odour. Innovative aspect is to try using such a method to treat other kinds of pollutants. That's why a new prototype in liquid phase will be installed on the ozonation site of LaSalle Beauvais, allowing tests on many pollutants' behaviour upon contact with ozone (e.g. : organohalogenated compounds absorbable or not). Some pollutant will be totally oxidized when others will be partially degraded. The main aims of this pilot-test are the determination of the most polyvalent ozonation parameters, of the non-attacked pollutants and finally of alternative solutions. This study of feasibility will give the basis for a further implementation on real site.</p>	On-going project

Use rate and costs of different techniques and procedures for remediation of polluted soils and groundwater in France (state of the art / survey)	ADEME	This study deals with the use rates and costs of the different treatment procedures of soils and groundwater treatment on French territory on 2006. January 2009-85p	available via : http://www2.ademe.fr/servlet/getDoc?sort=1&cid=96&m=3&id=60681&ref=12441&nocache=yes&p1=111
Comparatif ISCO – ENA sur un site industriel pollué par des Solvants chlorés (guidelines)	ADEME	Comparing between in-situ oxidation and « ameliorated » natural attenuation on a real pilot-site in order to define conditions for application and enhance a better remediation for similar polluted sites. If guidelines, separately dealing with ISCO and ENA already exist, the efficiency of these methods hardly succeeds in overtaking the 80%. Innovative approach of the project reside in two aspects: - accurate comparing between two techniques on the same site - define factors decreasing the efficiency rate or the techniques and fine solutions (injection technique, better characterization of the site) In parallel, microbiological and biochemical methods will be tested in order to characterize the dechlorination status and bacteria's activity. This tool will be used to study the effect of oxidation on dechlorinating bacteria.	
Development of optimized tools for the evaluation of VOC transfer from soil to indoor and outdoor air: state of the art (bibliographic report)	INERIS	Description of theoretical mechanisms, the measurements and the models: - part 1: transfer of VOC in the underground matrix, - part 2: transfer at the sol/air interface and dispersion. Published in September 2009 for the French National Agency for Research (163p).	Not yet available on line
Emission of gaseous pollutants in buildings from a contaminated soil: comparison between on site measurements and models (article)	INERIS	Presentation of some comparisons between measurements and results of modelling on real contaminated sites Published in the proceedings of the Second French National Conference on the Research on contaminated soils, 2009, Paris, France (9p)	
Feedback on the use of geomembrane to limit the intrusion of volatile substances flux in buildings (bibliographic report)	INERIS	Discussion about the use of geomembranes to minimize the intrusion of volatile substances in buildings: description of geomembrane, setting, durability, disadvantages Published in 2009 for the French Ministry of Environment (ref. DRC-09-103753-03795A)	Not yet available on line
Factsheet on modelling of volatile substances from soil to ambient air: Volasoil model (technical report)	INERIS	Presentation of the equations of the Volasoil model: assumptions, principles, parameters, limits, prospects Published in 2009 for the French Ministry of Environment (ref. DRC-09-103753-03796A)	Not yet available on line

Factsheet on modelling of volatile substances from soil to ambient air: Johnson & Ettinger model (technical report)	INERIS	Presentation of the equations of the Johnson & Ettinger model: assumptions, principles, parameters, limits, prospects Published in 2009 for the French Ministry of Environment (ref. DRC-09-103753-03794A)	Not yet available on line
Vapour emissions from contaminated soils into buildings : Developments of the volasoil model for multilayer soil (article)	INERIS	Presentation of the theoretical equations to extend the Volasoil model to a multilayer configuration, and application to a real case Published in the proceedings of the International Conference on Contaminated Soils, 2005, Bordeaux, France	
Vapour emissions from contaminated soils into buildings: comparison between predictions from transport models and field measurements (article)	INERIS	Presentation of some comparisons between measurements and results of modelling on real contaminated sites Published in the proceedings of the International Conference on Contaminated Soils, 2003, Gent, Belgium	
Method of measuring surface emissions of methane (article)	INERIS	Presentation of a method to measure surface emissions of a volatile substance Published in the proceedings of the International Conference on latest achievements in the field of mine ventilation, fire and methane hazard fighting, 1999, Szczyrk, Poland	
Development and validation of a method for measuring biogas emissions using a dynamic chamber (article)	INERIS	Presentation of a method to measure surface emissions of a volatile substance Published in the proceedings of the 5th International Landfills Conference, Sardinia, Cagliari, 1995	
Study of exposure models relative to contaminated soils: modelling of the transfers of volatile substances from basement or crawl space to indoor air (technical report)	INERIS	Translation and interpretation of a Dutch RIVM's report on the transfers of volatile substances in buildings depending of the nature of the foundations Published in 2005 for the French Ministry of Environment (ref. DRC-05-57278-DESP/R03a)	
Quelles techniques pour quels traitements BRGM		Guide presenting main available techniques for treatment of soils, groundwater and gases. Main in-situ, on-site and ex-situ techniques using all kinds of process (physic-chemical, biological, thermics) - 2010, 403p.	

Industrial brownfields folder: consequent environmental issue for Lille Metropole		Information mission from Municipality collectivities of Lille Metropole containing 53 recommendations to manage industrial brownfields. 2010, 180p.	
AFFSET thresholds for indoor air's TCE and PCE concentrations		The Afsset (French Agency for health security of Environment and Work) thresholds for PCE & TCE concerning indoor-air. 2010	
NANOFREZES - Nanoparticules de fer pour la remediation des eaux souterraines	INERIS (with SERPOL)	Nanofrezes project aims to improve fundamental knowledge on reactive mechanisms, transfers and toxicity of nanoparticles of iron (and/or catalysed) used in groundwater treatment.	

APPENDIX I: Our approach

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1. Why this study?

Main aim of this report, written in the frame of European CityChlor project, is to define and to assess French strengths and bottlenecks for remediation of urban sites polluted by chlorinated solvents.

This report is also a tool in order to describe French situation to other European partners of CityChlor project (Flanders, Germany, Netherlands). From this inventory work, also done by European partners, some work axes will be found out in order to build a common methodology for an integrated management of urban sites polluted by chlorinated solvents.

2. Means for this study

Following elements in this report have been collected by three different ways:

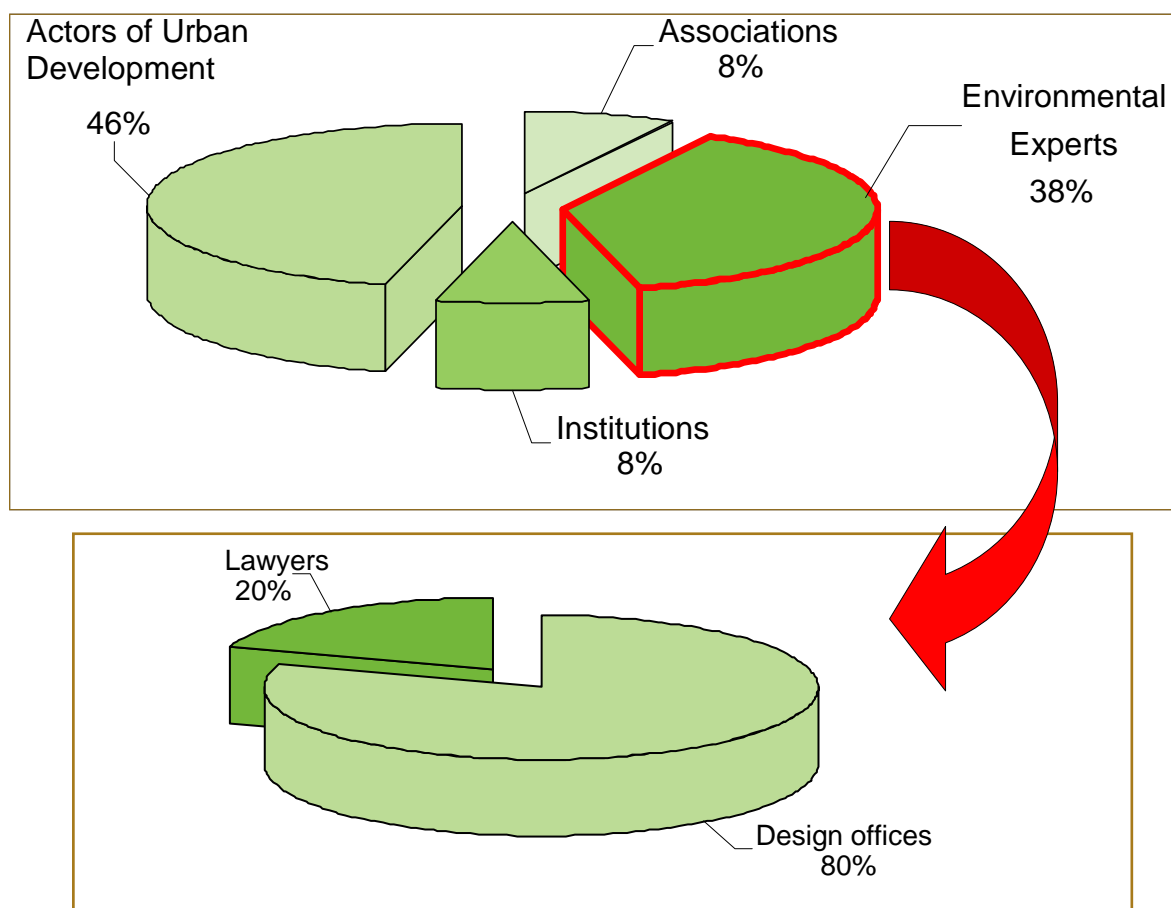
Interviews with French actors

Many contacts have been solicited in the frame of CityChlor French part. Then, different points of view have been collected and French actors gave their expectancies concerning management of urban sites polluted by chlorinated solvents. Although, some of these elements have been received by phone calls or meetings, we tried to traduce these key messages as loyally as possible in this document.

Written testimonies

Following report is based on different French actors' testimonies. These actors have different professional and personal backgrounds. These elements allowed the realization of a first document which has been presented during French regional CityChlor workshop on June 24th 2010 (available in line: <http://www2.ademe.fr/servlet/getDoc?id=69016&cid=96&m=3&p1=2&ref=17205>).

Figure 2 : Distribution of different contributors



Workshops

First French inventory, realized thanks to French contributors has been presented to French actors during the French Regional CityChlor workshop on June the 24th 2010. During this sharing day, some complementary elements have been collected from many attendees. They were able to share their idea and point of views during three thematic discussion-groups:

- 1- Technical solutions in urban environment;
- 2- Juridical responsibility, finances and urban planning;
- 3- Communication: from information to population involvement.

This document takes into account elements from contributions presented into French regional workshop attendee's folder and new elements collected during this workshop.

A second sharing session has been done, at a European level this time, on November the 16th 2010 in Paris. European actors shared their points of view on common topics. This workshop allowed sharing French points taken from first regional workshop at a European level.



Figure 3 : Photographs from French regional workshop



APPENDIX II: French situation viewed by some French actors



Pollution of former dry cleaner by PCE in an urban area

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During its operations the GTB industrial dry cleaner has leached perchloroethylene (PCE) into the subsurface. For many years, a poor indoor air quality has been observed in many houses located in the site vicinity, e.g. corrosion of boilers in some houses and odour intrusions notably after a rain event. After the company winding-up by decision of court beginning of 2005, ADEME was set in charge of taking up appropriate actions instead of the bankrupt operator.

BURGEAP has been mandated by ADEME since July 2007 to conduct the studies allowing:

- to identify 3 types of contaminated zones on site and outside the site limits, i.e. the “hot spots”, the “source zones”, and the “impact zones”. This definition differentiates the corrective actions to launch depending on the situation. Characterization methods were implemented following the recommendations of the MACAOH – source zone technical guide and included a screening step with the MIP probe, boreholes for soil cores collection, groundwater and soil air monitoring wells;
- to confirm the absence of PCE as a NAPL outside the site limits. PCE measured in surrounding houses is transferred from the site through vapour migration, mainly in the loose limestone thin layers, and / or from rain water infiltration;
- to quantify the mass of PCE present, roughly 2.5 tons in the “hot spots” (this estimation is uncertain due to highly heterogeneous soil concentrations);
- to propose a pollution management plan able to recover a good quality for indoor air in surrounding houses (concentrations below the WHO values), to treat PCE hot spots and source zones, to insure the durability of the performance of the remedial techniques by the means of a monitoring plan on site and in the surrounding houses, and to free the surrounding parcels of land from easements and restrictions of use after remediation in order to prevent financial depreciation of estates.

ADEME and INERIS began communication rounds towards population, set up protective measures for adjacent houses, i.e. improve air change and venting conditions, replace boilers, seal up subsurface concrete slabs. Indoor air contamination, namely PCE, concentrations are nevertheless still above WHO values in some houses. Today (May 2010), a general contractor has been selected to conduct remediation expected to start before the end of 2010. The remediation of hot spots and source zones is funded par ADEME and must insure the absence of added exposition of population during the remediation period.

Pollution of groundwater PCE (City of Avignon)			
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Perchloroethylene (PCE) has been frequently detected since 2005 in a groundwater pumping well located in an industrial zone in the city limit of Avignon, France, with concentrations measured between 22 and 33 µg/L (MCL = 10 µg/L). The city council launched a hydrogeological study in January 2009 which objectives are to delineate the PCE groundwater plume, to identify the source of pollution, and to evaluate its fate.

Mandated to realized the hydrogeological study, BURGEAP proceeded by iterative steps in order to determine the origin of the PCE contamination (screening step of the MACAOH – source zone protocol). Starting from the initial study area which was identified by the city services (this 1.5 km² area is located within the industrial zone of concern), 59 existing wells (6 m depth) and 8 new wells (between 16 to 28 m of depth) were sampled for groundwater head and quality measurements, thus characterizing the plume over a much larger zone of roughly 5 km².

These investigations concluded in:

- delineating the groundwater plume and the impact zones (10, 40 and 100 µg/L iso-concentration lines),
- identifying the site responsible for the contamination.

The study steering committee hence took the following corrective actions:

- communication towards the potentially exposed population (private wells used for drinking water) followed by edition of a decree restraining and forbidding the use of ground water,
- allotments made by the city to the groundwater sampling plan in the concerned private wells, and the distribution of bottled mineral water. The city technical services installed new drinking water network, when non-existing, to houses located above the groundwater plume,
- partial allotments made by the city to link all houses to the drinking water network, and when not possible, allotments made to install private water treatment devices,
- setting of a new steering committee to follow up the progress of new actions, i.e. the monitoring plan of potentially polluting activities and the study begun by the suspected company responsible for the groundwater contamination

Actions of CSTB: assessment of the impact from polluted soils to indoor air

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Presence of gaseous pollutant on ground could have a sanitary impact in indoor environment. Current technical tools to assess this impact seem to be insufficiently precise, in particular to deal with different typologies of building constructions. Effort should be done to develop such tools to manage these situations.

Means to prevent building from ingress of gaseous pollutant from ground should be develop and could be considered like complementary actions to manage potentially polluted ground.

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- "Estimation of Radon Concentration in House Using a Simple Ventilation Model." Collignan B., Millet J.R. Radon in the living environment. 19-23 April 1999 Athens workshop, Greece.

Organize interactions with populations during investigations and management of polluted sites

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Public participation is increasingly considered as a plain part of the assessment and the management of a contaminated site. It is also perceived as a difficult and sometimes risky challenge. In Europe, to our knowledge, beside academic virtual experiments on "test groups", feedback and recommendations on the subject are scarce and dispersed.

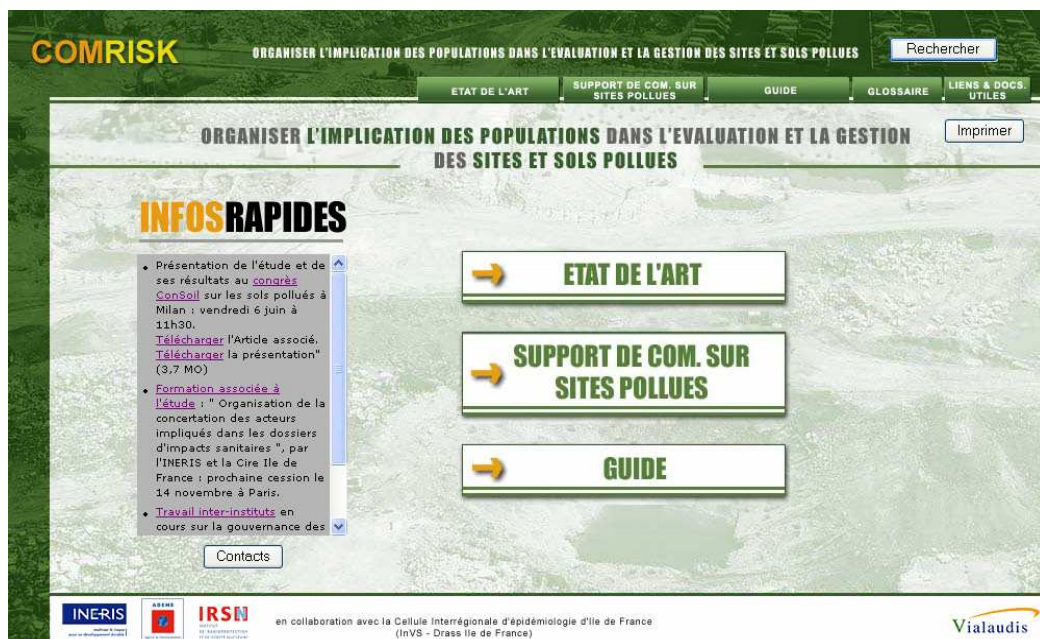
Following own experiences on real cases, INERIS and IRSN, in collaboration with the Cire Ile de France, have developed for ADEME a guide and a toolbox for organising public involvement in the assessment and the management of contaminated sites.

The guide and the toolbox are intended for all actors dealing with a contaminated site: public authorities, site owners, consultants, and representatives of the public (organisations, elected representatives, ...). They are available to all on a dedicated website (www.comrisk.com).

The guide is organised in a flexible set of files, each for a step or a specific point of the public involvement process. It also proposes separately a synthetic discussion of the rationale of the recommendations. The toolbox includes: a set of "event supports" for communicating on risks related to a contaminated site; several sets of slides and leaflets explaining risk-based site management for lay people; a FAQ review; and a frame for a "public involvement plan".

The guide and the toolbox are based on a comprehensive review of the state of the knowledge and of the praxis concerning risk perception, risk communication, and public involvement in risk assessment, with emphasis on local environmental and technological risks and more specifically on contaminated sites. The praxis review addressed national contexts, guidelines and tools, communication documents, and case studies. It considered mainly France, Germany, Switzerland and the European level, as well as the USA and Canada where community involvement belongs to everyday site management. Additionally, in order to fill in gaps in the available documentation, two *ad hoc* inquiries were conducted in France: a poll-study on perception of contaminated sites and related risks, conducted within communities concerned by contaminated sites; and a questionnaire-and-interview case study on cases of public Involvement in the assessment and management of contaminated sites and of some other local risks, conducted among public authorities, site owners, consultants, and representatives of the public.

A main conclusion of the whole study is that communication on a contaminated site should be integrated in a broad public involvement approach taking into account site-related concerns and expectations of all actors: health risks, but also property value, employment concerns, trust or mistrust between actors, former local conflicts, relation to the local environment and to the site, etc. Public involvement actually helps find the most adequate solution for the site, acceptable to all parties as "honest" if not consensual, and not necessarily more expensive. The guide helps analyse the site-specific context, define accordingly objectives and a strategy for the public involvement, and choose and adapt involvement tools.



MACAOH project – Modelling, Attenuation and Characterization in Aquifers of Halogenated Organic compounds

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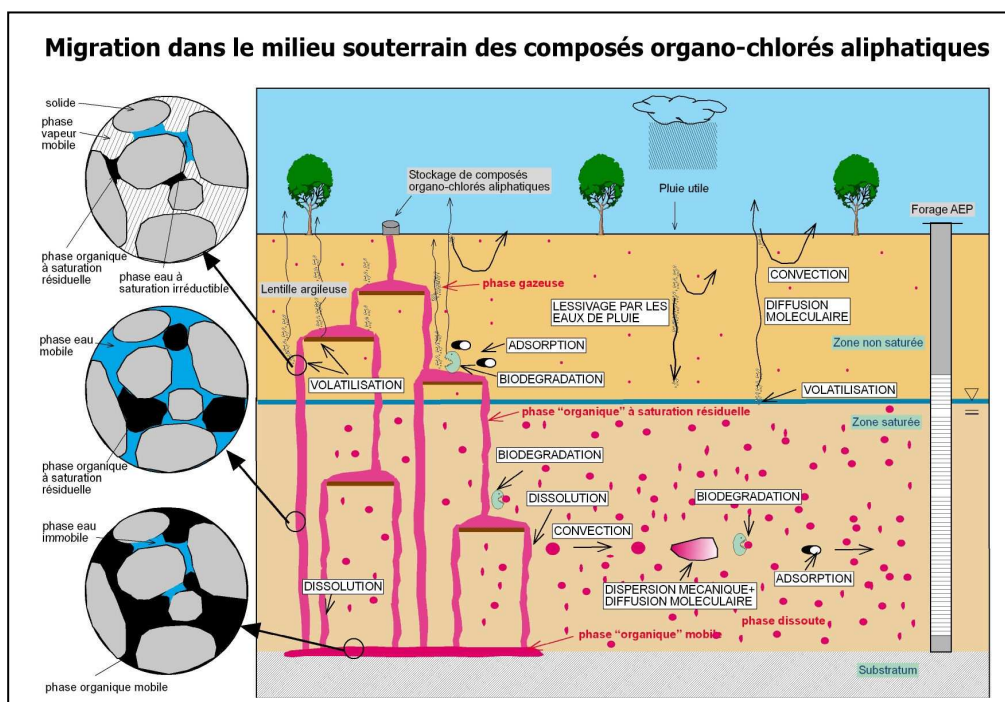
MACAOH is a R&D project initiated by ADEME (2001-2006) which main objectives are (i) to help fill gaps in understanding and applied knowledge, and, (ii) to produce **three technical guides** on the following themes: "**Characterization of a source zone**", "**Natural attenuation**", and "**Modelling**" of organochlorinated contaminants in aquifers. Structured around the three above-mentioned themes, it included experiments at the laboratory scale (batch, column) and pilot scale (SCERES basin), at two industrial sites, as well as modelling studies.

USEPA protocols are the industry standard documents but the MACAOH approach explicitly differs by:

- taking into account **the source zone** which governs, to a great extent, the fate of contaminant plumes (gaseous and aqueous). This means characterizing source zones (soil and groundwater concentrations revealing the presence of **NAPL**, composition of the NAPL, mass balance), and the existing Natural Attenuation (NA) processes (namely dissolution and volatilization of NAPL),
- proposing a **minimal list of parameters to measure** (in-situ parameters and laboratory analysis) in 7 wells at least (up-gradient, in the source zone, and down-gradient in the near

and the farther plume) in order to qualitatively evaluate the **biodegradation processes**. The “score” method is believed to oversimplify the complexity of a site,

- proposing a method to quantify the existing NA processes (in the source and the plumes) and their relative importance in order to set **a relevant criteria to select Monitored Natural Attenuation (MNA) as a remedial solution**,
- proposing recommendations to help users in **selecting the best suited computational tool** to the situation to be modelled and to insure “**good modelling practices**”, e.g. modelling NAPL within the source zone as the only way to represent accurately the decrease of groundwater concentrations with time in the near plume of gaseous or aqueous species. Modelling should be used in order to understand the behaviour of contaminants in the subsurface and to predict their fate in space and time (and thus to evaluate the feasibility of MNA as a remedial action).



Behaviour/Mechanism of VOCies in soils and groundwater

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<http://www.epa.gov/ada/download/reports/protocol.pdf>

USEPA, 2004. Performance Monitoring of MNA Remedies for VOCs in Ground Water, EPA/600/R-04/027, 78p.
http://www.epa.gov/ada/download/reports/600R04027/600R04027_fm.pdf

Phytoscreening and dendrochemistry for chlorinated solvents

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Trees are bio-indicators of their environment and can be used as proxy-recorders: chlorinated solvents present at rootball will be uptaken by roots and translocated by sap in the outermost rings. Micro cores, 5 mm diameter, 0,2 grams in weight, are enough sample to detect the different chlorinated compounds searched by CityChlor, using the same conventional and widely accepted analytical methods (headspace GC), with same detection limits of 10 ppb ;

The method has been tested at dozens of sites, in US, Europe, Canada, Israel, and has enabled the establishing of bio-accumulation factor (ratio of wood sample concentration to concentrations available to tree at rhizosphere –soil and groundwater-) for HVOCs, between 0,6 and 0,8. The micro-cores contamination can be assimilated to an integral of the contamination available at rootball, in both saturated and unsaturated zones. The correlation coefficient between concentrations in wood and bio available at rhizosphere varies from 0.9 at $p < 0,05$ to 0,98 at $p < 0,01$. One analysis only is enough to detect contamination.

Feasibility study takes a few minutes, by checking on Google Earth with site address.

The phytoscreening method avoids the costly wells and allow access, without nuisance, to populated areas, also to areas of difficult access. Method is also much cheaper than conventional methods, around 15 times less, and critically reduces environmental impacts: no waste, no water, no energy (just elbow grease) and thus has lowest possible carbon print.

The capacity to use portable would be a great plus, as making the method faster and even cheaper, with same headspace GC and same detection limits. Both phytoscreening and portable GC methods are accepted in the US.

Using the trees as proxy-recorders, cores sampled in old enough trees can help age date the release, with a precision by the year. 2 mm laths are made from the 10 mm cores, and line scanned using EDXRF (Energy Dispersive X-Ray Fluorescence). Chlorine anomalies related to HVOCs can be detected based on the uptaken and fixed chlorine and distinguished from other chlorine sources such as by the multi-elemental signature of road salt (where Cl is associated to K, Ca, and S). The age-dating of releases turns to be extremely important when there is dispute between two or more possible owners, over time of ownership, so with changes in insurance titles. Dendrochemical methods are capable of determining allocation of torts, would asynchronous releases be observed.

CIDISIR project – Quantification of dissolution kinetics on real sites (petroleum hydrocarbons and halogenated compounds)

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The CIDISIR R&D project aims at evaluating the dissolution rates of petroleum hydrocarbons and halogenated derivatives in subsurface porous media. The project is based on data measurement at 3 observations scales (laboratory scale, pilot scale, and industrial site scale) and is organized in 4 themes: development of a methodology for representative groundwater sampling and evaluation of a passive multi-level sampler, identification of laboratory tests for NAPL/water mass transfer performance, evaluation of NAPL/water mass transfer from site data, and development of a methodology for better modelling mass transfers to groundwater.

The main results relate to groundwater sampling tools and method developments:

- evaluation of a passive multi-level sampler based on passive diffusion of contaminants through a membrane (DMLS) and the development of a discrete point multi-level sampling device (PREMUNIX),
- development of a method to select existing laboratory tests for capable of quantifying NAPL/water mass transfer performance (NAPL/water contact, shaking flash method, percolate water through a contaminated column, Raoult's law application on NAPL composition),
- development of a method to model NAPL dissolution based on various criteria, such as the NAPL saturation and the scale of the heterogeneities of porous media properties and of contamination. Practical recommendations are given for characterizing the pollution, selecting the mass transfer models (local equilibrium, non equilibrium with a constant or a linear transfer coefficient), and selecting the best suited computational tool.

The practical outcomes of this work are summarized in a technical guide which aim is to help clients and consultants to quantify dissolution rates in the framework of contaminated site studies (impact studies, risks evaluation, remediation methods design ...).

References:

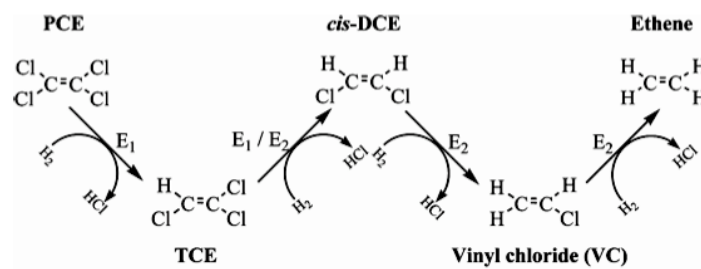
CÔME J.M, BURGHOFER P., DANQUIGNY C., EMONET-GAUTHIER A., GETTO D., HAESELER F., KASKASSIAN S., LE ROUX F., QUINTARD M., RAZAKARISOA O., SCHAEFER G., 2005. CIDISIR, Quantification des cinétiques de dissolution sur sites réels - hydrocarbures pétroliers et dérivés halogénés -, Guide méthodologique, Programme RITEAU/Ministère de la Recherche, 72 p.

http://www.sites-pollues.developpement-durable.gouv.fr/spip.php?page=document&id_article=606

Molecular biology to monitor and understand biodegrading mechanisms

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ENOVEO offers several innovative approaches for monitoring pollutant biodegradation, including chlorinated solvent dechlorination. Such approaches are based on molecular biology tools, which identify the microorganisms present (phylogenetic microarrays) and quantify the degradation activity of these organisms (qPCR). These techniques determine the presence of the pollutant degrading microorganisms and if the genes encoding the degradation of these pollutant are transcribed (i.e., active). This approach analyses the activity of microorganisms of interest directly and provides a new approach for managing contaminated sites. Indeed, these tests can determine the biodegradation potential of a site to help select the most appropriate treatment, thus avoiding the introduction of expensive pollution control systems. Moreover, these techniques can monitor the effectiveness of different treatment approaches by assessing the impact of direct injections of organic substrates on microorganisms and by quantifying the expression of genes responsible for biodegradation. Finally, this measure of activity could predict an accumulation of metabolites of degradation that can sometimes be more toxic than the pollutant initially observed on the site.



Reductive dechlorination of PCE in Ethene(Zhang and Bennett, 2005).

References : www.enoveo.fr

ISCR to EHC®, chemical in-situ reduction technology

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VALGO displays in France the unique combination of controlled-release carbon and zero valent iron (ZVI) developed by ADVENTUS, known as EHC®.

Following the placement of these materials into the environment, the Redox (Eh) potential dives in groundwater and stimulates direct chemical dechlorination. These physical, chemical and biological processes combine to create a strongly reducing (e.g., -600 mV Eh) environment that stimulates both direct mineralization of chlorinated solvents, organochlorine pesticides, and other persistent organic compounds.

Our ISCR reagents have been used at hundreds of sites around the world to treat over 3 million tons of soil/sediment and millions of gallons of groundwater impacted by energetics, organochlorine pesticides, chlorinated solvents and related compounds. The EHC reagents can be safely and easily applied to the environment by *in situ* injections. The ISCR technology was applied for the first time in a field project in FRANCE.

There exist a number of alternative accelerated anaerobic bioremediation technologies that purportedly offer responses similar to those described herein. However, these other materials consist of various sources of carbon-only; hence they cannot achieve the requisite Eh reductions to facilitate ISCR reactions. This presentation will also review factors which have been identified as technology differentiators and significant variables in effective remedial design. These include:

1. Short-term sequestration of targeted compounds as a primary removal mechanism;
2. Accumulation of catabolic intermediates and potential generation of secondary plumes;
3. Physical displacement of COIs via water flushing;
4. Constructability and ease of substrate emplacement;
5. Environmental longevity (EHC last at least 5 years in the subsurface environment)
6. Applicability to source areas, hot-spot treatment or permeable reactive barriers (PRBs);
7. Ability to immobilize heavy metals present as co-contaminants;
8. GMO issues (all soybean-based products from the North America will contain GMOs);
9. Made in the EU;
10. EHC costs €2.00/kg, (potential volume discounts may apply);
11. Patent and other legal issues.

Key words *in situ* chemical reduction (ISCR); DARAMEND EHC; chlorinated solvents; contaminated soil, sediment and groundwater; permeable reactive barrier (PRB).

References :

- sur la technique ISCR en général et l'EHC® : www.adventusgroup.com
- sur le retour d'expérience en France : ISCR™ : technologie de réduction chimique in situ, Critères et mise en œuvre, Laurent THANNBERGER, communication Intersol 2010

« FLUXOBAT » project : developing optimized tools to assess transfers of volatiles from source zone in soil to atmospheric and indoor air

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Health risk assessment related to the presence of volatile organic compounds in the subsurface are carried out under the pressure of regulations growing ever more aware to this issue. For such compounds, the main exposure pathway due to migration into indoor air is hard to estimate partly because of unrepresentative measurements and inappropriate modelling tools (many orders of magnitude are often observed between results of a model and on-site measured data). The complete deterministic description of the physics involved is hardly possible because of the coupling of multiphasic transfers in soil, concrete and air and because of the variability of space and time dependent parameters.

FLUXOBAT aims to overcome both technical (role of the convection, diffusion, scale effects...) and methodological limitations (accounting for heterogeneities, time and space variations, coupled mass transfer in a soil-concrete-building system). The project will be investigated through experimentations at three different scales (laboratory columns, experimental pilots, industrial site) in order to better understand the physics at stake and to improve measurement protocols as well as inadequate modelling tools.

Hence, the FLUXOBAT project consists in developing robust methodology for the assessment of volatiles organic compounds transfer (petroleum hydrocarbons, aliphatic chlorinated solvents...) from the subsurface to the indoor air.

The objective of the project is to propose methods and tools for a reliable assessment of transfers and health risks induced by volatile compounds coming from soils to the indoor air. This concerns thousands of sites in France. To secure such assessments should lead to an effective and sustainable management of soil contamination (in accordance with health risk criteria for indoor air and by reducing the excavated soil volumes and off site treatments).

The results of the project will be summarized in a methodological guide (processes to account for, measurement and modelling protocols, advices for data interpretation...) and a final report (state of the art and main results of the studies) that will be distributed to private and public stakeholders on polluted soils through websites, publications, conferences and partners network.

MAVENSOL : A NEW IN SITU VENTING PROCESS USING LARGE DIAMETER AUGER (LDA)

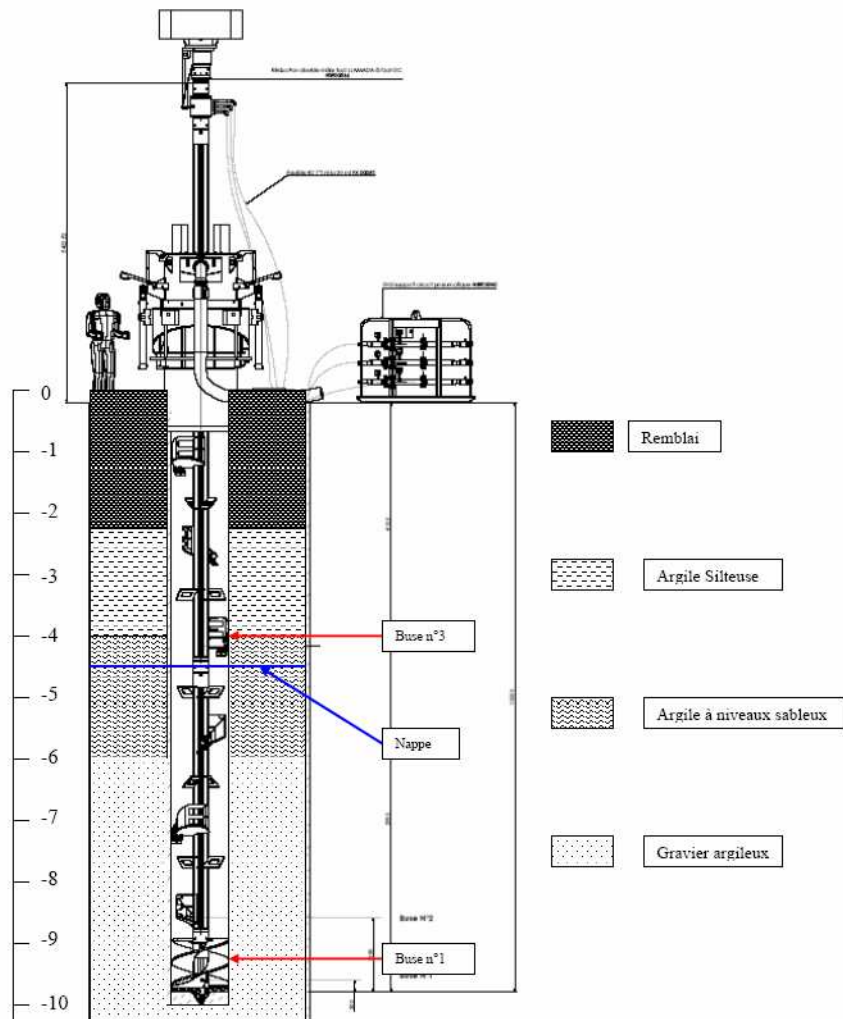
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Conventional industrial clean-up techniques used for the remediation of sites polluted by COVs are generally based on excavation + incineration for impacted soils, and pump-and-treat combined with adsorption on activated carbons for underground water treatment. Implementation of such techniques is very variable in cost, as it will depend on pollution depth, accessibility, cleaning criteria, permeability of soils, etc. The duration of remediation operation is generally in the order of 12 to 24 months, at the shortest.

A new process has been developed by SoletancheBachy and its subsidiary Sol Environment. It is based on a soil venting/air sparging process applied in situ, using a large diameter auger. This new process was first designed further to a laboratory Pilot study co-funded by the French Agency ADEME. During this first study, the main parameters controlling the efficiency of the treatment were identified, including the influence of mixing energy and mixing time. A specific tool was patented in 2008. It includes a specific auger shape, the distribution of ambient air through a series of nozzles placed along the hollow auger axis, and a special shroud for the collection of extracted air which can then be conveyed to an external treatment unit.

SoletancheBachy built its first prototype in 2008 within the scope of a collaborative Research project called Mavensis launched by the "Pôle de Compétitivité" AXELERA in Lyon (Fr) and co-funded by French Industry Minister.

This technology is thought to present a high application potentiality as it is very flexible and can be adapted to mixed pollutants. It can be applied to depth down to about 20 meters, in fine grained soils where conventional pump-and-treat techniques are not applicable. Full remediation can be obtained within a few weeks, which is a major advantage especially for the remediation of urban sites.



Principle scheme

References: www.solenvironment.com

In-situ chemical reduction and soil mixing for VOCies

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A brand new technology, combining chemical reduction and soil mixing, has been developed, by Soléo Services to treat in-situ chlorinated solvent contaminated soils and groundwater.

From a point of view of time and efficiency, this technology competes with excavation and off site disposal but avoid a lot of disadvantage that cause a lot of problem when operating in town centre: noise, off gas of volatile contaminant, trucks traffic...

The soil mixing is done using special design auger where the reactant is injected at the bottom. For a better reactivity, the chemical reactant is synthesised on site using a process developed and applied by Soléo services.

The efficiency of the reactant has been demonstrated in laboratory and show an efficiency never seen: the residual concentration of pollutant is below the detection limit in soil and groundwater.

This technology has been applied on a former industrial site in the heart of a town close to an hospital on a 150 m² area to 8 m deep. The field efficiency will be demonstrated before the CityChlor symposium by soil and groundwater sampling in the heart of the treated zone.

Communication during remediation in an urban site, Vernou (77)

Writer:	Organism:	Actor:	Contact:
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The successful remediation of a site is linked to good quality communication. It is not a question to communicate to communicate but to inform and get information (to establish confidence and serenity). This is connected with the step of quality: to say what one does, to do what one says ... and to prove it!

It is satisfactory to achieve good technical results, but the satisfaction is even greater when one is greeted with sympathy by the residents and local authorities for months or years after completion of remediation site.

Treatability of polluted sites: methodological guide for techniques selection and performance assessment

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The methodology guidelines are intended for the pre-selection of techniques by the decision maker, in view of discarding any clearly inappropriate techniques based on the knowledge of simple site, pollutant and soil-related parameters and to identify those parameters likely to limit the feasibility and performance of the techniques. These guidelines lead to the pre-selection of techniques that must then be subjected to additional treatment and characterisation tests in view of ascertaining their feasibility and ability to achieve the goals.

The pre-selection method must involve the following steps:

Preamble: minimum required knowledge - The decision maker must first ensure it possesses sufficient knowledge concerning the types of pollutant to treat, the boundaries of the polluted area to treat, the concentration levels encountered at various points within this area and its location relative to the saturated zone, the access conditions to this area of polluted soil to treat and finally, the desired treatment outcome goals.

Pre-selection of techniques - The procedure follows a logical tree path, starting from the general site properties, pollutant(s) to treat and soil matrix and leading to more specific properties requiring the analysis and testing of samples representative of the soil to treat. During this procedure, a number of parameters appear, some of which serve to exclude the feasibility of a given technique (exclusion parameters), while others (limiting parameters) render the applicability of a technique more complex or fastidious.

Summary of pre-selection results - The preselected techniques are compared with respect to the limiting parameters specific to each technique and to additional criteria concerning the technique's development status, frequency of use, order of magnitude and treatment duration and costs.

On completion of the pre-selection process, the decision maker may consult with service providers specialized in conducting treatment tests in view of ascertaining treatment feasibility according to the preselected techniques. For this, the characterisation and treatment tests must conform to the specifications defined for each of the techniques.

List of techniques taken into account in the guidelines are as follows:

- Biodegradation
- Bio-immobilisation
- Bioleaching
- In situ chemical oxidation
- Physical or physicochemical sorting operations
- Physicochemical stabilisation
- Phytoextraction
- Phytostabilisation
- Reduced pressure extraction and multi-phase extraction
- Thermal desorption
- Washing with chemical agents and surfactants

The decision support tool was developed by applying the treatment tests and characterisations, proposed by the programme partner teams, to 8 distinct soils collected from the following types of polluted sites:

- Former gasworks or coking plant
- Oil storage site
- Surface treatment activity
- Non-ferrous metal metallurgy activity
- Manufacture or use of wood treatment products
- Former mining sites
- Solvent regeneration activity
- Accidental PCB pollution

References:

Le guide "traitabilité des sols pollués" est disponible en téléchargement gratuit :

<http://www2.ademe.fr/servlet/KBaseShow?sort=-1&cid=96&m=3&catid=10143>

APPENDIX III: French methodology for “polluted sites”

Two different approaches:

French feedback and evolution of national policy concerning polluted sites allowed distinguishing two types of management situations as detailed in the ministerial note of February the 8th of 2007:

- For already urbanized and occupied sites: **the Media Quality Assessment approach (IEM)**. This approach consists in studying a “photograph” of middles’ status and uses. Main aim is here to make sure that status of concerned middles is compatible with defined uses. This approach enables to differentiate situations which allow plenty use of middles from other cases which are likely to pose a problem. IEM can be used in order to appreciate acceptability of extra-site impacts of classified installations or not. More information on <http://www.developpement-durable.gouv.fr/spip.php?article19744> (in French).
- For sites which are likely to be urbanized or rehabilitated in the future: the **Management Plan**. This approach is implemented when situation allows acting both on the site’s status (thanks to preventive building or remediation) and on the sites’ uses which can be chosen or adapted. This approach can be used for use changing projects on polluted sites (ruled by ICPE legislation or not). Moreover, Management Plan is also required on site necessitating authorization during activities ending or rehabilitation for a use similar or a different from last period of activity. use from use on a site. More information on <http://www.developpement-durable.gouv.fr/spip.php?article19744> (in French).

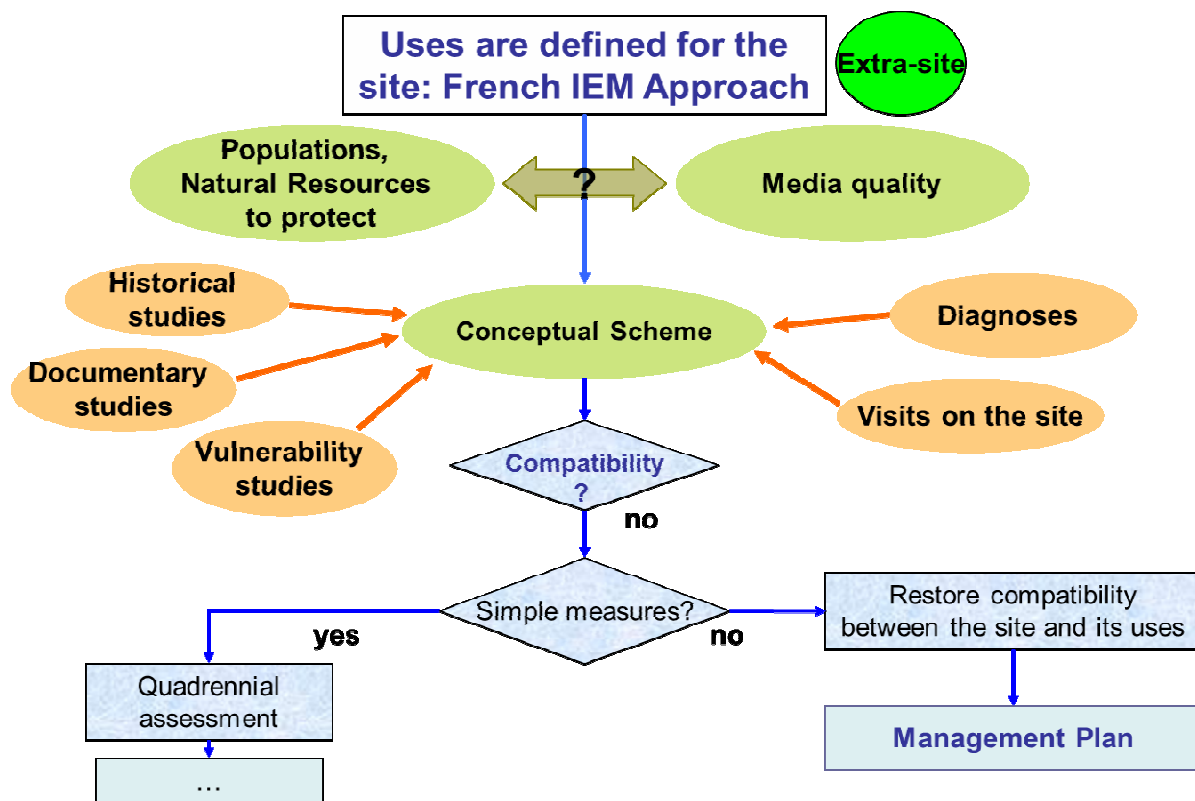


Figure 4: Use of the French IEM tool

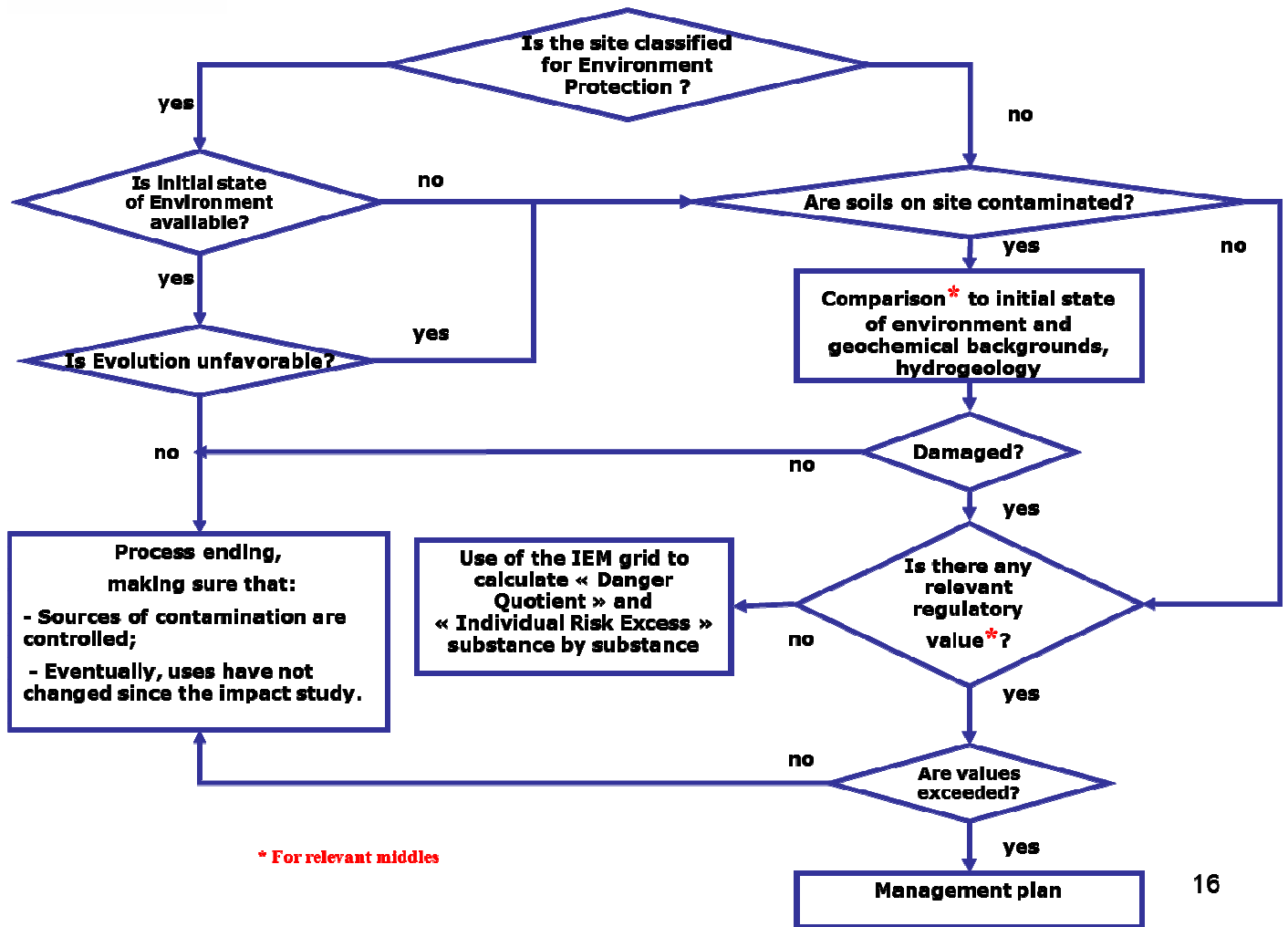


Figure 5: Realization of a Quantitative Sanitary Risk Assessment (EQRS)

APPENDIX IV: Some links to know more about French tools

Links to know more

Code of Urbanism:

 in French: <http://www.legifrance.gouv.fr/affichCode.do?cidTexte=LEGITEXT000006074075>

Code of Environment:

 in English: <http://195.83.177.9/code/liste.phtml?lang=uk&c=40>

 in French: <http://www.legifrance.gouv.fr/affichCode.do?cidTexte=LEGITEXT000006074220>


Labour code:


 In French: <http://www.legifrance.gouv.fr/affichCode.do?cidTexte=LEGITEXT000006072050>

Norms:

 **AFNOR:** Agence Française de Normalisation - Edition - Formation – Certification (*French Agency for Normalisation – Edition – Training – Certification*) - www.afnor.org

Databases / Inventories:

 **BASIAS:** Inventaire d'Anciens Sites Industriels et Activités de Service (*Inventory of Former Industrial sites and Service Activities*) – www.basias.brgm.fr

 **BASOL:** Base de données BASOL sur les sites et sols pollués (ou potentiellement pollués) appelant une action des pouvoirs publics, à titre préventif ou curatif (*Inventory of polluted sites and soils (or potentially polluted) requiring actions from public authorities*) – www.basol.ecologie.gouv.fr

 **RMQS:** Réseau de Mesures de la Qualité des Sols (*Network of Soils' Quality Measurements*) - www.gissol.fr/programme/rmq/rmq.php

About ADEME

The French Environment and Energy Management Agency (ADEME) is a public agency under the joint authority of the Ministry for Ecology, Sustainable Development, Transport and Housing, the Ministry for Higher Education and Research, and the Ministry for Economy, Finance and Industry.

ADEME provides expertise and advisory services to businesses, local authorities and communities, government bodies and the public at large, to enable them to establish and consolidate their environmental action. As part of this work the agency helps finance projects, from research to implementation, in the areas of waste management, soil conservation, energy efficiency and renewable energy, air quality and noise abatement.



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