



## **REPORT OF THE NICOLE WORKSHOP**

**Cost-effective clean-up technology; quality assurance and acceptance**

**17-18 May 2001**

**hosted by TotalFinaElf, Paris, France**

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**NICOLE (*Network for Contaminated Land in Europe*) was set up in 1995 as a result of the CEFIC “SUSTECH” programme which promotes co-operation between industry and academia on the development of sustainable technologies. NICOLE is the principal forum that European business uses to develop and influence the state of the art in contaminated land management in Europe. NICOLE was created to bring together problem holders and researchers throughout Europe who are interested in all aspects of contaminated land. It is open to public and private sector organisations. NICOLE was initiated as a Concerted Action within the European Commission’s Environment and Climate RTD Programme in 1996. It has been self-funding since February 1999.**

NICOLE’s overall objectives are to:

- Provide a European forum for the dissemination and exchange of knowledge and ideas about contaminated land arising from industrial and commercial activities;
- Identify research needs and promote collaborative research that will enable European industry to identify, assess and manage contaminated sites more efficiently and cost-effectively; and
- Collaborate with other international networks inside and outside Europe and encompass the views of a wide a range of interest groups and stakeholders (for example, land developers, local/regional authorities and the insurance/financial investment community).

NICOLE currently has 143 members. Membership fees are used to support and further the aims of the network, including: technical exchanges, network conferences, special interest meetings, brokerage of research and research contacts and information dissemination via a web site, newsletter and journal publications. NICOLE includes an Industry Subgroup (ISG) – with 29 members; a Service Providers Subgroup (SPG) with 28 members, 70 individual members from the academic sector/research community and 16 members from other organisations, including research planners, non-profit making organisations, other networks, funding organisations. Note some members are involved in both the ISG and the SPG. For further general information, further meeting reports, network information and links to contaminated land related web sites, please visit NICOLE's web site: [www.nicole.org](http://www.nicole.org)

Membership fees are currently 3,500 EURO per year for companies, and 150 EURO per year for academic institutions. For membership requests please contact:

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# 1 Introduction

NICOLE initiated a meeting about brownfields remediation and redevelopment as part of its ongoing conference series, which is outlined in Table 1. The focus of the workshop was to explore cost and benefits of land remediation from the perspectives of different stakeholders, and in particular to explore how the wider economic, environmental and social values of remediation work might be assessed and balanced to provide a sound basis for decision making and sustainable development.

The programme included a series of presentations and parallel sessions:

- Session on cost effectiveness, cost and benefits appraisal and communication strategy
- Problem holders / service providers perspective on the use and acceptance of remediation technologies from France, Belgium and Italy
- Case Studies: parallel sessions introducing problem sites from France, the Netherlands and Germany, comparing the views of the workshop on best approach with what actually took place
- Regulator perspectives on the use and acceptance of remediation technologies from France, Belgium and Italy
- Session on quality assurance

This meeting report includes summaries of the presentations and reports of parallel session analyses. It also includes *discussion* sections, where the key points made during workshop exchanges between delegates are summarised.

This meeting was the first NICOLE conference for 2001. Further information about NICOLE's workshops and publications is available on [www.nicole.org](http://www.nicole.org). This report provides an outline of the discussions and presentations which took place in this workshop.

**Table 1: Recent and Forthcoming NICOLE Events and Publications**

<b>Date</b>	<b>Event / Report</b>
14-15 November 2001	Workshop on ICT/Computing applied to contaminated land characterisation/remediation, Rotterdam, the Netherlands (Port of Rotterdam) in conjunction with the Network on Natural Attenuation in Groundwater and Soil (NNAGS).
17-18 May 2001	Workshop: <i>Cost-effective clean-up technology; quality assurance and acceptance</i> , Paris, France
January 2001	Special Issue of <i>Land Contamination and Reclamation</i> , outlining NICOLE and CLARINET work, <a href="http://www.nicole.org">www.nicole.org</a> and <a href="http://www.btinternet.com/~epppublications/">www.btinternet.com/~epppublications/</a>
9 and 10 November 2000	<b>Report of the NICOLE workshop <i>Brownfields: How to Change a Potential Threat into an Asset</i>, IJmuiden, The Netherlands, <a href="http://www.nicole.org">www.nicole.org</a></b>
October 2000	NICOLE News, Web link: <a href="http://www.nicole.org">www.nicole.org</a> Information gateway: NICOLE News Service – Announcement 120
September 2000	Joint Statement of NICOLE, CLARINET, ETCA and SENSPOL: Sustainable Management of Contaminated Land for the Protection of Water Resources, Web link: <a href="http://www.nicole.org">www.nicole.org</a> Information gateway: NICOLE News Service – Announcement 112
21-23 June 2000	EU Workshop on The Protection of European Water, Resources, Contaminated Sites, Landfills and Sediments, Venice. Web link: <a href="http://www.etcenet.org/">www.etcenet.org/</a>
22-23 May 2000	<b>Report of the NICOLE Workshop on <i>Source Management</i>, Helsinki, Web link: <a href="http://www.nicole.org">www.nicole.org</a> Information gateway: NICOLE News Service – Announcement 121</b>

## 2 Proceedings

### 2.1 Session on Cost Effectiveness, Cost and Benefits Appraisal and Communication Strategy

#### Remedial Effectiveness in a European Context, Joop Okx, TAUW, the Netherlands

Arriving at sustainable (soil remediation) alternatives involves a decision process. Tools can support some of the routines within the decision process. Decision support exists to help those who have to take decisions deal with the complex and wide-ranging information involved in contaminated land management. Decision support can be provided as written guidance (flow sheets, model procedures) and/or software. It aims not only to facilitate decision making but to help ensure that the process is transparent, documented, reproducible and hopefully robust, providing a coherent framework to explore the options available. Decision support codifies specialist expertise in a way that allows its reproducible use by many. It integrates specific information about a site and general information such as legislation, guidelines and know-how, to produce decision-making knowledge in a way that is transparent consistent and reproducible. Support, however, is not the same as taking a decision. The actual deciding is not provided by a tool, but remains the shared responsibility of the stakeholders.

The decision making process for any problem usually encompasses:

1. An identification phase in which the problem is identified
2. A development phase in which possible solutions are identified and developed
3. A selection phase in which the solution to be implemented is chosen.

Decision processes can be seen as goal-oriented systems. The informationless paradigm - giving it a try - is the least powerful in achieving a high performance. The feedback paradigm performs better since it allows learning from experience. The feed-forward paradigm allows anticipation. The full-information paradigm combines the benefits of both the feedback and the feed-forward paradigm. Although projects necessarily focus on the decision making process in advance, attention should be stretched to the resulting remedial actions and feed-backs and feed-forwards should consequently enable those involved to anticipate and learn from the results of the actions. Different stakeholders often have different objectives and, thus, their preference for remedial alternatives may differ. Nevertheless multi-attribute models are useful tools when trying to make a decision. A number of decision support tools are discussed in terms of their role in the decision process, the way they allow for feedback and feed-forward, and, the way they support decision making in a multi-objective setting.

REC is a decision support tool developed in the Netherlands. The aim of REC is to support the choice of the most effective and efficient strategy for soil remediation for the site concerned. REC is the acronym of Risk reduction, Environmental merit and Costs, which are the three perspectives used in the system. Its aim is to seek an optimal balance between Risk reduction, Environmental merit and costs. Further information on REC is available from: [www.vu.nl/ivm/research/rmk](http://www.vu.nl/ivm/research/rmk).

A detailed review of decision support tools, including a copy of the full paper, is available in: United States Environmental Protection Agency (2000) NATO Committee on Challenges to Modern Society: NATO/CCMS Pilot Study Evaluation of Demonstrated and Emerging Technologies for the Treatment and Clean Up of Contaminated Land and Groundwater. Phase III 1999 Special Session Decision Support. . NATO/CCMS Report No 245. EPA Report: 542-R-00-011 (Editors Bardos, R.P and Sullivan, T.) A download is provided on [www.clu-in.org](http://www.clu-in.org)

CLARINET Working Group 2 has finished a study on decision support issues in 16 European countries. Its final report will be available from [www.clarinet.at](http://www.clarinet.at) from October 2001.

**A Methodology for Assessing the Full Costs and Benefits of Groundwater Remediation, Paul Hardisty, Komex, UK.**

The term **cost and benefit analysis (CBA)** is often used to cover a broad range of methods that have been developed to enable decision-makers to meet the aims above in an objective, transparent, and consistent manner. The traditional approach to CBA can be simply defined as “*the formal assessment of the costs and benefits of implementing an action A compared with an alternative option, action B, to achieve defined objectives.*” The costs include not only any financial expenditure but also a measure of the impact of a particular approach. In order for the positive and negative aspects for each option to be compared directly they are often converted to common units. In traditional CBA the common unit is money.

Hardisty's talk focused on how economic analysis can be used to compare the real overall costs of pollution, including private costs (to the problem holder) and external costs (to society), and the benefits accruing from remediation and the avoidance of future damages. Overall decisions on the required level of remediation can thus be made with an understanding of the full economic ramifications, including the wider implications for the environment and society as a whole. Recognising the need to take account of the likely costs and benefits in enforcing groundwater remediation (Environment Act, 1995), the Environment Agency in England and Wales has recently published a framework for assessing groundwater remediation alternatives.

*Environment Agency. (2000) Costs and Benefits Associated with Remediation of Contaminated Groundwater: Framework for Assessment. R&D Technical Report P279. Prepared by Komex Clarke Bond & EFTEC Ltd., Available from: WRc plc, Swindon, UK.*

Hardisty argued that for aquifer remediation an appraisal of costs and benefits was necessary during the decision making about whether remediation should take place, and if so what goals should be set. His view was that CBA for selecting a remedial technique, once these goals had been set, was a relatively trivial exercise. He further pointed out that, while consultants generally have a good ability to determine what the costs of particular remedial techniques are, their ability to value its benefits and possible impacts was rather limited. His argument was that the overarching value of the remediation effect desired compared with the likely costs of achieving it should be the fundamental decision making criterion for aquifer restoration. As an example he pointed out how attempting to restore groundwater at a site in an area of many diffuse pollution inputs might not only be expensive, but might also have only a very limited value to society as a whole.

CBA methodology is linked directly to existing UK guidance on risk assessment for contaminated sites. This approach is iterative, starting with high level analysis of the likely costs and benefits of remedial objective options and the technical approaches, which are best suited for reaching those objectives. The benefits analysis includes both private benefits, and if possible wider external benefits (often described as the value of damage averted by taking action). Valuation of external benefits of remediation is not straightforward, and can include the value of damaged resources, option values, and intrinsic worth (existence and bequest values). Often, only partial monetisation of some benefits can be practically achieved. However, benefits can be compared with expected annualised costs for achieving overall specific remedial objectives, allowing a preliminary identification of the economically optimal objective. The framework provides a tool that allows a regulator to 'take account of likely costs and benefits' in exercising its statutory powers, and with which firms and regulators can negotiate a position that balances their respective concerns (social optimum against private optimum). Once the remedial objective has been set, and with it the most economically attractive approach, technology selection becomes merely a least-cost analysis. In many cases, the hidden costs of certain remedial objectives and approaches are revealed.

## Trends and developments in groundwater restoration: EPA site Programme, Jim Cummings, EPA, USA

There is now a general realisation in the USA that pump and treat is at best a protracted containment

### Description of Pump and Treat

*Groundwater and/or free product abstraction followed by above ground treatment and return to aquifer. Discharge to sewer rather than treatment may also be an option. Pump and treat is also a containment strategy to prevent the plume spreading. In both cases pumping is required at rates that cause all water in a contaminant plume to enter the well rather than continue travelling through the subsurface. Conventional pump and treat (P&T) cleans groundwater rather than soil, although may have the effect of reducing contaminant concentration in the soil by a flushing effect. It treats the plume rather than the source and separate treatment for the source may be required. P & T can also be used to apply agents for soil flushing and/or in situ bioremediation in the source as well as the plume area. P&T does not treat NAPLs or adsorbed phase contamination in saturated zone and capillary fringe resulting in subsequent rebound. LNAPLs may be recovered separately but DNAPLs are a major source of rebound. Above ground treatment is designed to treat the contaminants present. Examples of technologies used to treat recovered groundwater are air stripping, carbon adsorption, chemical oxidation, biodegradation, precipitation, adsorption, reverse osmosis, steam stripping. Several technologies may be used together as a treatment train.*

**Taken from:** Nathanail *et al* (2001) Contaminated Land Management Ready Reference, Available from EPP Publications Limited: 52 Kings Road, Richmond, TW10 6EP, UK. E-mail: enquiries@eppublications.com

remedy. This means that those envisaging a pump and treat project need to consider providing for operations and maintenance costs over decades if not centuries. Cummings argued against the use of net present value (NPV) in project costings for Public Sector remediation projects. Using an NPV basis may be applicable in the corporate world where money is borrowed, however, he argued, for public funds payment is almost always on a "pay as you go basis. For example, future costs

cannot be discounted for P&T projects being paid for by the Public Purse, they will always be a burden on tax-payers.

The current debate about aquifer remediation in the USA is about how the risk reduction achieved by a project should be valued. On the one hand there is a point of view that the risk reduction achieved only has a value when the risk based remediation targets are met. Another point of view is that some credit should be given, even when these targets have not been met, if a substantial amount of the contaminant mass has been removed. Aside from pump and treat, Cummings outlined two broad approaches to aquifer remediation as perceived in the USA: monitored natural attenuation (MNA) and extraction based *in situ* technologies, and their interdependence. USA policy on MNA is outlined in U.S. EPA Directive 9234.2-25, which states that MNA is "appropriate when used in conjunction with other remediation measures (e.g. source control, groundwater extraction), or as a follow-up to active remediation measures that have already been implemented". There is a strong emphasis on source control in the USA. U.S. EPA Directive 9234.2-25 states that "sources should be located and treated or removed when feasible, and where significant risk reduction will result, regardless of whether the EPA has determined that groundwater restoration is technically impractical."

Current extractive approaches to source control have significant technical limitations, which are related to the mobility of contamination at ambient temperatures, subsurface heterogeneity and low permeabilities. Cummings advocated *in situ* thermal treatment technologies (see below) as being able to overcome some of these limitations. Cummings likened the current state of the art in remediation to surgery in the 1940's: "you don't know how bad the problem is till you open the patient up". He argued for better approaches to assessing and identifying problems *in situ* in real time. He felt that decision support development should focus on real time dynamic systems able to augment field data and day to day operational decision making for remediation projects, as well as the "advance planning" decision support, which he saw REC to be an example of.

***In Situ Thermal Treatment Technologies (Cummings, US EPA)***

Recently developed in situ thermal remediation technologies offer the potential to address a variety of contamination problems. These technologies can be deployed to enhance traditional remediation approaches - e.g., soil vapour extraction (SVE). They can also be used to address problems for which solutions are currently lacking e.g., free product contamination at depth and/or in the saturated zone, contamination sequestered in low permeability strata, and semi- and non-volatile contaminants. These robust technologies offer the potential to actually restore groundwater - either alone or in conjunction with other less aggressive tools - in contrast to the limited containment goal of most systems involving pumping and treating large quantities of groundwater.

Methods of increasing subsurface temperature to enhance contaminant destruction and/or recovery include Steam Enhanced Extraction, Electrical Resistive Heating and Thermal Conductive Heating. In situ thermal approaches achieve contaminant recovery/destruction via a variety of physical and chemical processes including increased volatility, reduced viscosity and in situ hydrous pyrolysis oxidation. Contaminants may be destroyed in situ or recovered in aqueous, vapour and free product phases.

Further information is available from: [www.clu-in.org/thermal](http://www.clu-in.org/thermal)

**Communication strategies in relation with large pollution problems, E. Eeckman, PRP Belgium**

Good communications with stakeholders such as affected communities and responsible authorities can reduce the complications and problems that result from contaminated land problems. Good communications will help to minimise the hindrance to remediation procedures that may arise from negative perceptions held by those affected by the problem. Communication strategies are not necessarily a short term approach. It may take some time for a strategy to take effect especially if the company credibility has been damaged and needs to be restored.

Key elements in communication strategy are: improving the image of the problem holder, taking immediate local action, planning longer term actions, and ensuring that the company is adequately prepared to deal with issues, complaints and questions as they arise. These points were illustrated on the basis of a case study - see text box "*Case Study Background*".

*Image perception:* Create a positive image of the company at the national level. (For example, in this case a profile was created of the company as a leader in waste management technologies.)

*Immediate local action*

- Inform the local community that the problem is limited and that action is being taken. (So in this case, the company used press releases, mail shots etc to convey the facts – that they were responsible for a fraction of the problem, that they were investing money in new equipment to prevent the problem in the future etc.)
- Address issues of regular expression of blame where this is a factual error. (On each occasion that the company was blamed for a smell that was not their responsibility, they would ensure that the local community and press were informed.)
- Avoid discussion where the other side is firmly entrenched – this is a waste of time. (In this case dialogue was impossible, and remained so, with the nearest neighbours.)

*Long-term local actions*

- Continue to communicate pro-actively and openly, avoiding technical arrogance and industry jargon. Initiate communications using plain simple language that is easily understood.
- Develop long term relationships with the media and target groups – communications are easier if you know the people with whom you are communicating, or to whom you are trying to convey a message.

- Maintain efficient internal communication. (The workers lived in the local community – communicating the facts to the workers means that they were better able to defend the company when challenged.)
- Take voluntary initiatives to improve the environment – and tell people about it, for example, when a new piece of equipment is planned, purchased or installed etc.

*Be prepared:* Provide arguments for organisations (such as replies to Frequently Asked Questions). Try and use visual messages: a picture is worth a thousand words, and stays in the mind much longer. Use photographs that present a positive image, such as clean processing equipment, graphs of reductions in emissions.

#### *Communications Case study background*

The illustrative case study used for this presentation was that of a company on a small industrial estate. One of the company's waste management processes produced a very unpleasant smell (albeit non-toxic) which had been causing a real nuisance for its residential neighbours over a two year period. Lack of effective communications with local residents had led to a situation that had seriously deteriorated. Oral complaints about smells to the company were followed by complaints to the police and then public demonstrations. The residents were becoming increasingly hostile towards the company.

Local authorities and neighbours had developed what Eeckman described as an emotional response to the problem. For example, all complaints about unpleasant smells were blamed on this company although they were only responsible for some of the escaping odours. The company maintained that they were doing all they could to minimise smells escaping, for example by investing in new plant and ongoing research to prevent malodorous emissions. Studies had showed that nuisance levels of odour emission from the plant were only a problem for 2% of the time, and were mainly concentrated in a zone 110m – 260m from the plant. However, the local perception of odour problems from the plant was that they were much more frequent and more widespread.

The company had developed what Eeckman described as a "logical" response, i.e. one that took a strict legal and technical standpoint. They had only communicated and consulted where required with the regulatory authorities. Their perspective was that they were undertaking a legitimate production activity and that the problem was minor. There was no consultation with the site's neighbours and local community. However, the company subsequently realised that local engagement was going to be necessary to find a solution to the and so employed communication consultants.

An effective message for problem holders to convey, from both their own perspective and that of other stakeholders, is that: they wish to find a solution to the problem; they have already taken action and will take more; and that they have nothing to hide. Clearly it is also useful to be able to say that the problem of concern is not a health and safety risk. For this message to be effective it has to be conveyed. Table 2 summarises typical approaches used to communication and interaction.

Even with an effective message and a clear communication strategy, it is prudent to be prepared for the possibility of a crisis, for example a further incidence of the problem (in the case study that might be a large odour emission), or an unexpected change in campaigning by other stakeholders. Effective crisis management requires preparation in advance, and includes the following strategies.

- Have a crisis manual of procedures and contacts, listing the procedures that should take place in the event of a crisis, a list of contacts with relevant parties.

- Ensure that your staff/spokesperson has been trained in handling public meetings, dealing with awkward people and questions, and communicating effectively with the media.
- Issue a position paper – a detailed document to explain the history of the situation, what’s happened and why, how the situation is being handled now, how it will be handled in the future, what the prognosis is for the future.
- A corporate leaflet with a description of all of the company’s activities can help to explain the processes involved and dispel any myths about what the company actually does.
- Prepare a Question and Answer manual with all of the worst possible questions that could be asked, with their answers.

<b>Table 2 Typical approaches to communication and interaction</b>
Press releases – issue press releases regularly, and at least as often as events occur.
Press file – maintain a press file with short articles written in journalistic style. These ‘stories’ are then available for the media to use
Information letters – use mail shots to send out letters of information about procedures, for example, what happened, how it happened, how it’s being dealt with.
Individual contacts – it’s a good idea to cultivate personal relationships with your media contacts. If you have a working relationship with the press/local groups/authorities, you are far more likely to be taken seriously than an anonymous official.
Appoint a spokesperson – it is helpful for all concerned if there is consistency in delivering the message, rather than a different person each time.
Appoint an independent ombudsman to deal with complaints. Someone who can be seen to be impartial will be taken more seriously than a company representative.
Create a ‘guidance’ group to influence public opinion

Eeckman concluded with the following summary of essential activities to achieving good communications. The first step is to address the problem, that is, to realise that there is a problem and plan how it should be tackled. Then it is important to commence proactive communication, to be seen to be offering information before it is required, rather than reacting to a situation or a demand for information. It is important to recognise the emotional nature of the issue - people often have an emotional response to circumstances that may affect their well being, especially contaminated land issues, whether or not it is a rational response to have. Engage in meaningful dialogue with those who may not understand, or even oppose your actions - by listening to their concerns and showing that you understand them, your communications will be taken more seriously. Become an honest and credible information source by consistently providing accurate communications – this will stand you in good stead in the long term. Provide a rapid response, move quickly to provide information, dispel fears, and counteract negative rumours.

## **2.2 The use and acceptance of remediation technologies from France, Belgium and Italy**

### **2.2.1 Problem holders / service providers Perspectives**

#### **France (Pierre Colin, GESTER)**

There is a "college" or association of companies in France working as engineers for contractors (UPDS), performing audits, risk assessments and remediation. Their combined turnover has doubled in the last five years, to €2 million, as a direct result of increasing regulation in France. For example, risk assessment legislation was introduced last year; this uses target limit values instead of the fixed limit values that were previously in use.

In addition other organisations had a turnover of €2 million, thus the total turnover in France in 2000 was €34 million. Approximately half of this expenditure is on site studies and half on remediation works.

The market in France has evolved in three phases:

- Phase 1 - remediation of service stations, gas plants and dealing with emergencies
- Phase 2 - closure of chemical and metallurgical plants, and remediation of orphan sites (funded by ADEME – €30 million have been spent by ADEME)
- Phase 3- transfer of properties and re-use of brownfield sites.

Recent changes in the remediation market in France include techniques being selected more on an end use basis, thus containment and monitoring are on the increase. Pressures on time and space mean that techniques such as biopiling are not used frequently. There is an increasing amount of remediation of sites contaminated with metallic compounds, solvents and non-volatile hydrocarbons. Approximately 50% of remediation is based on removal off site and 30% includes on site and *in situ* options. On site thermal treatments are now well established and there is a steady market for these treatments. Excavation and removal continues to be a growing market, as well as soil washing, soil venting, air-sparging, dual extraction and biological treatments.

#### **Belgium (Bart Vandervelppe, Envico)**

Contaminated land legislation in Belgium is recent – it dates from 1995 in the north (Flanders) where the legislation covers all sites and from 2000 in the south (Walloon) where the legislation only covers special sites and service stations.

Currently, the majority of technologies selected are off site. Pump and treat is the most commonly used *in situ* treatment. Conventional technologies are frequently chosen because, at the moment, 80 - 90% of soil remediation projects are at small sites such as service stations, where 'dig and dump' is the quickest and easiest option. Clean up values and costs are the criteria used to select the soil remediation technique. Industries want solutions with limited financial risks, so innovative techniques are not required; they require a rapid solution to the contamination problem. In addition, small industrial sites are being used as 'training sites' to gain practise in using technologies; large sites are still being investigated.

In the future on site (mostly bio-piling or soil washing) and *in situ* (venting, sparging, monitoring) technologies will become more important. This will be because of the increase in the number of soil remediation projects at larger, more complicated, former industrial sites (brownfields) which will mean long term planning for soil remediation – hence there will be more time and more scope to try out newer techniques. Risk based clean up values, costs and proven efficiency will be the criteria to

select a soil remediation technique, using site specific models. Industry will search for solutions with a perfect balance between environmental, technical and financial risks.

### **Italy (Claudio Mariotti, Aquater)**

Contaminated land management in Italy is rather complex. Before 16<sup>th</sup> December 1999 regional legislation existed in five regions and one province in northern Italy (the more industrialised region). This had a common approach to site remediation derived from Dutch, USA, and European approaches. A site characterisation would compare contaminant concentrations with the reference values. If this indicated that there was no pollution, the procedure finished. If the site characterisation indicated that the site was polluted then the polluter/site owner/responsible person had two options – remediate to obtain concentration equal to or lower than the reference values, or, perform a risk analysis to verify the real risk and plan a remediation project, maybe with new target concentrations. Dig and dump, and containment were the preferred options carried out by the seven main service providers, followed by soil vapour extraction, soil venting, bio-venting, *in situ* bioremediation, and air sparging.

After 16<sup>th</sup> December 1999, DM 471/99 came into force, with three levels of action - survey, planning (preliminary and final) and clean up execution. There are various levels of clean up execution indicated under DM 471/99. ‘Safety intervention’ can be emergency (to control a situation) or permanent (to maintain a situation below limits). ‘Safety measures’ prevent new contamination or delimit the site boundary. ‘Environmental restoration’ returns the site to its original landscape.

There are different types of reference and target values defined by DM 471/99. A table of values (background, residual and reference) for soils and groundwater are used as screening/target values to determine whether or not a site is polluted, and to determine the main goal of the remediation project. The source of these tabular values is not openly available and there are some doubts about the use of risk assessment for their derivation. A common opinion of some experts is that for some contaminants they maybe could be lower.

- Background levels defined as the levels of the contaminants which are naturally occurring in the site and its surroundings; yet in reality backgrounds may be higher than the tabular values.
- Acceptable residual levels are the minimum goal to be reached if the tabular values cannot be obtained, even if the best available remediation technologies at bearable costs are applied – they are determined from the risk analysis results.
- The reference levels are new target levels which may be set by local authorities when particular site conditions require a more precautionary approach. These could be lower than the tabular values and therefore cause conflicting criteria to be applied to a site.

Risk assessments are now not used to plan target concentrations. They are used at the end of the remedial process if it has not been possible to reach target concentrations to determine whether or not there is a risk to human health. If a risk to human health still exists, then additional safety measures would be undertaken. This ‘Remediation with safety measures’ entails additional costs of works and monitoring; it is not in most cases economically sustainable, for their long term application (with great uncertainty about the duration) and a consequent losses of site value and/or re-use.

There are other problems with the risk assessments, for example, the probabilities to be used in the calculations are not defined - a range of  $10^{-4}$  to  $10^{-6}$  is indicated. In addition the database or reference to be used for the chemical and toxicological features of the pollutants is not indicated, and neither are the exposure scenarios, intake parameters, basic formulas, models defined. These uncertainties create problems for service providers, as public administrations cannot judge the value of the risk assessment, and so often will not accept its results, leading to extended negotiations.

## Discussion

**French target values.** A question was asked about how the target values are set in France and what would happen if the targets were not achieved. (The service providers provide the experience to determine the target values, if they were not achieved they would go back to the regulator and site owner and set new target levels determined by a risk assessment (the service provider would choose the risk assessment method). P Colin reported that if these target levels were not then achieved, a new risk assessment would be carried out to find new targets and reach agreement. However, a representative of Gaz de France disagreed with this scenario, in his opinion those responsible for the site wouldn't accept re-negotiation of targets; but he added that it could depend on the owner. For example it may be possible to renegotiate targets for sites managed by ADEME or where the state is the owner<sup>1</sup>. Renegotiations of the target values would not affect the cost of the remediation plan as the costs are agreed at the outset and are fixed.

Determination of the acceptable risk value depends on site use,  $10^{-5}$  risk is considered to be safe for normal sites (sites where children may be exposed), with a higher acceptable risk of  $10^{-4}$  for industrial sites. Confinement and isolation may be used to limit risks to humans and groundwater, but if so then future use must be ensured. If there were a change of use then the situation should be reassessed.

**Progress in dealing with contaminated sites** France has started to deal with the large, urban sites and brownfields. Italy is currently concerned with large sites, such as former industrial areas and local authority controlled sites. They are administered differently but the approach is the same. It would be possible for some sites to be managed differently, by agreement with the Ministry of the Environment, but no one has yet done this. Belgium has made good progress with soil remediation at service stations, and legislation is in preparation for other sites. The legislation will have the same approach as current practice, i.e., for Historic Pollution the owner must remediate when there is a risk to human health, for Recent Pollution, the owner must remediate when trigger values are exceeded, a risk based approach will not be accepted.

**Technology available in Belgium** Technologies made available depend upon the consultant. Industry is interested in investing in new technologies and OVAM is interested in better understanding new technologies, the consultants select the remediation technology. Because off-site washing is inexpensive and a proven technology it is often the selected technology; there is currently little incentive to try out new methods.

### 2.2.2 Regulator Perspectives

#### Belgium - Flemish Region (Victor Dries, OVAM)

Contaminated land legislation in Flanders dates from 1995. A distinction is made between "historic" and "new" contamination. For sites contaminated in the past, decision making is based on the principles of risk management. For new contamination incidents decision making is based on "Soil Remediation Standards" - SRS - which set the goals for restoration. Most of the sites being treated in Flanders are relatively small, and OVAM try to encourage treatment in general to a high quality:

- if possible to background levels,
- if background levels are not possible to SRS
- if SRS are not possible so that risks are reduced to an acceptable level.

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<sup>1</sup> The regulatory situation in France is in reality more complex, with a greater degree of flexibility. For example, the process of setting remediation targets is iterative. Local authorities often ask for feasibility studies before setting definitive remediation goals. Discussions are possible before signature by the Prefet of the *Arrete Prefectoral*, but not after (Darmendrail 2001. Pers. Comm.)

Treatment methods themselves should be selected on the BATNEEC principle: best available technique not entailing excessive cost.

Different remediation approaches vary in the acceptability and use in Flanders. Excavation is almost always followed by treatment as landfill taxes are high (resulting in a total landfill price of more than 100 EURO per tonne). Excavation and off site treatment is often used, particularly on relatively small sites. It is seen as easy and fast, and has a high degree of acceptability to site owners, consultants and regulators. It is anticipated that a professional association of off site soil treatment contractors (OVB) will be able to give consultants advice on off site treatment options in a single document, rather than consultants having to make many individual approaches to individual contractors.

On site treatment following excavation is not very popular in Flanders. It can take up a lot of space (e.g. biopiling), and is highly visible, leading to objections from neighbours to the site. Its use is generally restricted to large sites. On site thermal treatment is now entering the Flanders market and is seeing acceptance from regulators, providing that strict control of emissions and effluents can be demonstrated.

*In situ* techniques are applied at sites in Flanders, although Dries is personally sceptical about the ability of current techniques to offer complete solutions to his satisfaction as a regulator. Pump and treat (P&T) solutions are generally accepted by regulators, but with the proviso that the chances of P & T offering a complete solution are not high. Dries also pointed out that poor site investigation work was limited P&T effectiveness. Hydrogeological containment is used for managing active waste sites, but is not popular as a remediation approach.

Soil venting and bioventing are popular technologies, and air sparging is growing in importance as a remedial technique, all are well accepted by regulators. However, a recent study on emissions from these processes indicates that the emissions control is of limited effectiveness, with significant transfer of volatile organic compounds from soil to atmosphere.

MNA is accepted as a polishing technique only. Regulators will require demonstration of a sound knowledge of the aquifer in question, and the implementation of a detailed monitoring programme. Financial guarantees to maintain site management and monitoring may also be required.

Containment using barrier systems are a popular remedial option for large sites (Dries called this "wrap and dump". It is seen as a temporary measure, with a likely lifetime of 20 to 40 years. It is also seen as a costly approach owing to the monitoring required for it. Active containment techniques, such as use of permeable reactive barriers, is an emerging concept in Flanders, and as such is not readily accepted by regulators.

Dries concluded by reiterating that risk management is a sound basis for decision making, particularly for prioritising actions. However, risk reduction is not the sole criterion for setting remediation goals, in particular for new contamination incidents. He suggested that remediation to risk based goals for particular end uses implies a need for on going site monitoring, and in the future the possible need to "re-remediate" the site in question. It is important to consider the "risks" of the remediation process itself when determining future actions, for example to consider to what extent the remediation is simply transferring contamination from, say, soil to air and water. He also remarked that the approaches favoured by standards and legislation may not necessarily be the best technical approach according to the contemporary state of the art. Finally, he saw a need for a stronger emphasis on the management of the site overall, with remediation work being just one component of that management activity.

### **France (Dominique Darmendrail, BRGM)**

There are four basic principles underlying the regulation of contaminated land management in France:

- The precautionary principle
- Proportionality
- Specificity
- Transparency.

The precautionary principle is widely used by countries and says that action may be necessary, even if a hazard is suspected rather than being definitely proven. Proportionality is that the costs and impacts of the solution to any problem must not themselves be excessive. Transparency means that the reasons for decisions made should be clear to all stakeholders. Specificity describes how remediation goals should be set. Goals should be set on the basis of site specific risk assessment, considering four main receptors: human health, water systems, ecosystems and buildings. There are no general remediation treatment levels. Rehabilitation must take into account both future and current site use and the wider environment. Site specific risk assessments are based on  $10^{-5}$  acceptability levels for carcinogens. Variations in likely risk across space and time must be considered in the assessment. The typical processes for contaminated site management are: preliminary visits, an initial diagnosis, a simplified risk assessment, and detailed diagnosis and a detailed risk assessment. All processes are supported by standards from AFNOR (the French Standards Agency).

As well as risk management several other criteria are important for decision making about site remediation, in particular: the costs of implementing remediation (both initial and ongoing), the views of the local community ("psycho-sociological" criteria) and practical constraints such as available time and space.

No preferences for particular remediation techniques by regulators were reported. All techniques are potentially applicable, providing that they comply with the general French regulatory framework for contaminated site management.

### **Italy (Francesca Quercia, ANPA)**

Contaminated land regulations in Italy are administered on a regional basis, although the Ministry of the Environment administers 41 large sites of several hundred hectares or more in size. The 15 largest sites account for 330,000 ha of land and water. Taken together they represent more than 1% of the area of Italy. The provisional total of suspected problem sites identifies by the regional authority inventories is 11,000. The inventories of Piedmont and Lombardy are considered the most reliable, of 770 and 2,650 sites, respectively.

The national framework for contaminated legislation, enacted by the regions is contained in:

- DM 185 (1989) - provisional remediation plans
- D Lg vo 22 (1997)- the Waste Act (*Decreto Ronchi*)
- L420 (1998) and L388 (2000) the draft decree and national plan for sites of national interest (the 41 sites mentioned above)
- DM471 (1999) first national legislation dealing specifically with polluted sites remediation

Administrative experience of the 1999 act is still rather limited, and difficulties are occurring (as discussed above by Mariotti). A further difficulty is the status of materials taken off site for treatment. All soil materials taken off site must be considered as waste. They can only be re-used if they meet stringent clean-up" levels, which are not seen as feasible with current treatment technologies. These limit values are not risk based. Their intention is to discourage the transportation of soils from their sites of origin.

Hence there is little off site treatment plant in Italy, aside from three plants producing materials for re-use in roads. One off site treatment plant based on incineration, and one based on biological treatment are also in operation. So while the 1999 decree states that disposal of site materials to landfill should be discouraged, the reverse seems to be happening.

While the 1999 decree is based on risk management, risk based decision making for groundwater remediation is complicated because no clear quality objectives are set for groundwater.

Remediation work on the sites of national interest for soils has seen containment and off site disposal as the most frequent actions taken, as emergency and permanent responses, respectively. Groundwater measures have been largely barriers, pump and treat and hydraulic control.

Information on the remediation works in Piedmont and Lombardy is as follows. Contaminated soils are mainly dealt with by removal or containment. Process technologies have been applied in a number of instances, including: soil venting, biopiles, soil washing and thermal desorption. Phytoremediation is being tested at field scale. In most cases groundwater remediation has been based on P & T, often using air stripping as the above ground treatment. There have been a few cases of use of MNA and permeable reactive barriers.

### **2.2.3 Discussion**

A question was asked about the impacts public inventories of problem sites had on land values, in particular the impacts on neighbouring "innocent" parties. The reply from the Belgian regulator was that this possibility of blight was recognised in Belgium. Their experience was that its impact could be a reduction in local land values of 10 to 15%. However, they also found the effect was temporary, and diminished over a period of several years.

It is clear that understanding of benefits and wider impacts of remediation work are only imperfectly understood, and are hard to factor into current approaches to cost benefit or cost effectiveness analyses. While risk management remains the principal goal of contaminated land management, better tools are necessary for overall sustainability appraisal. Existing tools are perceived as being perhaps too rigid, and narrow in the range of their considerations. In addition, decision making tools which are more transparent to lay-people would be a welcome development.

There are problem areas where none of the remediation tools available offer an adequate or sustainable solution for the scale of the problem. Two examples given were mine tailings consisting of millions of tonnes of material in Sweden, and the contamination that has arisen from aerial deposition from Smelters in Belgium. There are also more localised problems where existing treatment methods have very limited effectiveness, most notably for the removal of DNAPL sources from aquifers. It is not clear to what extent particular treatments are effecting a cure, since only very small amounts of residual DNAPL can cause continued problems. Indeed in some cases the cure may be worse than the problem, with activity to remove some of the DNAPL, resulting in a wider dispersion of the residual DNAPL. If firm evidence is available that a remediation is unlikely to be effective or will not be sustainable development, then the regulators present at this meeting suggested they would be likely to agree that these remediation works should not be undertaken. However, they will almost certainly require ongoing monitoring of the site, and a watching brief on technological developments, so that when an effective solution is found, remedial action is undertaken.

For some sites this may be the only "management solution", even although it is not necessarily an environmental solution. However, often a containment approach is adopted as an interim solution. Containment may also offer the potential for site re-use. However this re-use is usually subject to the provisos that continued site monitoring is necessary, and that the containment is not seen as a permanent solution.

More detailed information on the regulatory framework and decision making issues in Europe is available from the CLARINET web site ([www.clarinet.at](http://www.clarinet.at)) and a survey of decision making issues across Europe will be published in the Final Report of CLARINET Working Group 2 at the end of October 2001. This will also be made available on [www.clarinet.at](http://www.clarinet.at).

## 2.3 Case studies

The case study section of the workshop consisted of parallel sessions introducing problem sites from France, the Netherlands and Germany. The objective of exploring these case studies was to see what the consensus approach would be from delegates had they been responsible for site management. These views would then be compared with the activities actually carried out or planned. These case studies are reported below in four sections: a site description, the conclusions of the workshop syndicate for that case study's parallel session, an outline of the actual approach taken and the subsequent workshop discussion of that case study.

### Case 1. The Netherlands (I. Croese, Arcadis)

#### *Site Description*

DSM Geleen is a large chemical plant (c 600 ha) still operating and producing fertilisers (since 1950) and petrochemicals (since 1960); it is situated on a former coal mining area (1920 – 1960). The site is surrounded by residential areas of the city of Geleen and smaller villages. The site is situated on a former river terrace with 5 – 8 m of loam overlying coarse gravels and sands. The groundwater (12 – 25 m depth) flows to the nearby river Maas. Extensive investigations have been carried out over the past 14 years and are stored in a database for future remediation plans. Historical investigations showed that there are over 200 sources of soil pollution and more than 25 groundwater plumes of organic and inorganic compounds. The plumes are large (3 – 4 km long) and are underneath adjacent villages; the pollutants are likely to reach the river in 3 – 4 years. Additional site investigation on 50 contaminated locations and potential source areas showed that 23 source areas have contaminant levels above Intervention Values (aromates, TPH (total petroleum hydrocarbons), chlorinated hydrocarbons, cyanides and some exotics). Most of these plumes have spread across property boundaries; several plumes are shrinking due to natural attenuation and depletion of the source area. The risk assessment showed that the risk to humans from mobile and immobile contaminants is below MTR (maximum tolerable risk), risks to the ecology are at or below an acceptable level, HC50 (Hazardous Concentration 50%). The local population perceived that there were large problems of contamination from DSM although the risk assessment had shown that they were low.

#### *Syndicate Conclusion*

The syndicate approached its discussion with the view point of trying to find a compromise that might be acceptable to the various stakeholders concerned. The following potential risks to a successful remediation strategy were identified.

*Unknown factors* One set of unknown factors was described as 'Time bombs' - for example finding previously undiscovered source areas could considerably alter the course of an remediation strategy. In addition, it is assumed that the plumes will continue to shrink, although it is quite possible that the shrinking process could halt or slow down, and that the plumes could remain the same size or even grow.

*Changes* Legislative interpretation changes, for example changes in the interpretation of EU directives for List ‘A’ substances, could mean that stricter rules might be emplaced. Land use changes, including off site changes, could affect the strategy if more stringent controls on land conditions were imposed. Similarly, the groundwater is not currently used, but it could become a resource such as drinking water, in which case stricter controls would apply to its condition and lower levels of contaminants may be applicable.

*Misjudgement* If the site investigation results were inaccurate and/or if the interpretation of the site data were faulty then the contamination on site could be a bigger problem than it is.

The following Stakeholders were identified, who should be kept informed of ongoing progress with the remediation activity.

- River boards
- Regulators
- Municipalities
- Neighbours
- Staff
- NGOs
- Journalists
- Banks and Insurers

Five remedial solutions were identified. The workshop split into 4 groups and ranked these 5 options:

	Ranking group 1	Ranking group 2	Ranking group 3	Ranking group 4
MNA	1	3	1	3
Plume interception	2	2	2	2
Source Removal	3	1	3	1
Risk perception	4	4	4	4
Change of use	5	5	5	5

There was no overall agreement on the ranking, and thus the optimal strategy. The options of MNA and Source Removal both had two, “1” rankings (albeit with two “3” rankings), followed by Plume Interception with 4 “2” rankings. There was some discussion in the plenary session over whether this indicated that Plume Interception should be the better choice, as it had no “3” scores.

#### *Actual Approach Taken*

A cost-benefit based approach was taken for remediation decision making. The topsoil was mapped according to its quality. It was found that overall the topsoil was less contaminated than had been thought, so topsoil liberated by construction works could be re-used on site where the contaminant levels were at or below Intervention Values; in the hotspot areas (above Intervention Values) it was cleaned or removed. (Topsoil that was not disturbed by construction work could be left on site, whatever its quality).

It was decided to deal with the plumes as a group. A barrier was emplaced to protect a threatened well (plume interception), which left the 23 active sources to be tackled. A multi-criteria analysis considering: risk reduction, environmental merit, costs, O&M (operation and management) and environmental impact, was used to look at the relative contribution of the source areas to the total mass flux of the mobile contaminants. Relative costs were calculated for the remediation of each source area (and thus the cost effectiveness of their remediation) in order to prioritise remediation areas.

Using the source area data, the total mass of contamination was calculated, then the flux of the contamination was calculated, and then the flux was normalised to Intervention Values - thus calculating the remediation cost per source area. Finally the cumulative flux reduction of source areas was calculated – this showed that 6 or 7 locations had 95% of the total contaminant mass.

The following strategy was established:

1. Tackle the major 6 source areas in the first 5 years
2. Tackle all source areas over 25 years
3. Evaluate the groundwater spread every 5 years
4. Recalculate the flux to revise the approach to the site and, if appropriate,
5. Re-prioritise the source areas to be tackled.

This plan greatly reduced the original estimated costs (initially estimated as about €400m). Environmental monitoring is a big part of this strategy.

The case study presenter has commented further as follows. Human risks should be brought down to at least below MTR-level. Further decrease of the level of risks was to be realised on the basis of ALARA. Since the MTR level was not exceeded, remedial action should be based on ALARA only. To be able to quantify the R (risk) of ALARA and cost efficiency the above mentioned exercise using normalised relative flux and costs per source area was carried out.

#### *Case Study Discussion*

Several comments were made about the type of cost-benefit approach outlined above. The method doesn't take into consideration mobility of the plumes - it assumes that the plumes are static, which is an unrealistic assumption. It ignores the geometry of the sources and the rate of dissolution, since above a certain size the scale of the source does not increase contamination further because the groundwater is already saturated – hence the source mass alone might not be the best approach for the prioritisation for action.

The costs of removal are different for different contaminants – for example the costs of removing 1kg of chlorobenzene, and 1kg of sulphate are very different. It was suggested that this approach only considers mass not toxicity, which again varies greatly between different contaminants, but the service provider noted that the data had been normalised to relative toxicity.

It was suggested that the impact on the groundwater body must be assessed and that source removal should be considered, because the authorities like source removal (even if monitored natural attenuation (MNA) is more cost effective in the long term). Although it was noted that there is still free product in plume area so MNA will take a very long time. It is planned to use finger-printing technique to discern whether or not degradation is actually taking place.

Several delegates suggested that a more thorough risk based decision-making approach would have reduced costs further. Mr Croese replied that the owners felt they had to be seen to be doing a more than a risk based approach to be credible to the regulators; they felt they had to demonstrate a desire to treat the contamination – hence the source removal scheme.

#### **Case 2. Germany (T. Ertel, UW Umweltwirtschaft GmbH)**

##### *Site description*

The German site is a former industrial site in a town near a river with hydrocarbon contamination in fractured bedrock. The site is an industrial area, and was formerly a mineral oil works and then a solvent recycling plant. The contamination problem is a plume of petroleum hydrocarbons, PAH and

chlorinated solvents, about 120m length as free phase, which is impacting the River Neckar (600m). There may be a DNAPL in the subjacent aquifer. Other receptors include protected mineral springs (800m) and residents in housing 20-30m uphill from the industrial area (no noisy, smelly remediation works would be acceptable). The site is now owned by the municipality and is due for redevelopment for industrial use. Drainage systems for underground car parks have already recovered 40 tonnes of free product.

The objectives of the remediation strategy are to protect the River Neckar (in Germany the river quality should be maintained to drinking water standards), to protect the groundwater and to protect the mineral springs (traces of chlorinated hydrocarbons, CHCs, have been found in the mineral springs). In addition there is an objective not to increase the size of the plume. Health risks to humans (workers and other site users) from polyaromatic hydrocarbons (PAHs) and benzene should be minimised. Solutions to the problem which have been proposed to the municipality include removing the source (pump and treat, or dig and dump) and placing a barrier between the source and the receptor such as a permeable reactive barrier (PRB) or slurry walls.

#### *Syndicate Conclusion*

Workshop delegates spent most of the discussion time asking questions about the site history and conditions, and discussing the pros and cons of remedial methods. For example, P&T is an established technology that could be used to treat the source, but it could draw in contaminants from adjacent sites. Thermal desorption (steam injection) could be used to mobilise the DNAPLs. Capping and other containment measures were discussed for the plume – but they were considered to be expensive. Costs versus time were discussed, although there was no information on the timescales allowed for the remediation. The source/plume boundary and the speed of the plume migration were large uncertainties, which caused concern, and led to much debate over the approach to be taken. The only stakeholder considered was the owner (the municipality).

After the discussion each participant proposed his or her favoured solution(s). The most frequently proposed solution for the source was excavation to landfill, and/or thermal treatment. Other solutions proposed included controlled digging, i.e., digging out the most contaminated areas (with back up solutions to control the plume), pump and treat, jet-pumping (a sophisticated pump and treat method using an intensive network of small pipes), electric heating to immobilise the contaminants, and capping.

The most frequently proposed solutions for the plume were either MNA and/or a reactive or hydrogeological barrier. In addition, actions to reduce the plume proposed including pump and treat, possibly using dual-phase vapour extraction (DVE), and installation of a deep drainage system.

The workshop concluded that the source should be removed, as this would be the best option for the site, and would gain public support. Opinion was more divided on the best method of dealing with the plume; more characterisation data was needed – but MNA and use of a barrier were the most popular choices with the information to hand.

#### *Actual approach taken:*

More investigations were undertaken. The source was removed (dig and dump, or dig, treat and dump), and the space was used to create an underground carpark with a drainage system for ongoing removal and treatment. The existing drainage system was extended to enable Pump and Treat to be carried out down stream from the source. The plume was better defined.

Monitored Natural attenuation was used to deal with the plume (it is a MNA model site in Germany and linked to a 3 year research project).

Future work includes looking at plume-source relationships, identifying and verifying the nature of the source (there may be other polluting industries on the industrial estate), employing forensic geochemistry such as GCMS fingerprinting and isotopic shift ( $C^{13}$ ) variations or statistical cluster analysis. It is planned to distinguish between the changes in isotopic composition caused by plume mixing and by natural degradation processes (to determine whether MNA is actually working) following the steps outlined below.

1. Remove the source
2. Measure residual mass flux
3. Calculate MNA time frame
4. Therefore establish if MNA is working
5. Decide whether other intervention is required.

Finger-printing techniques show that degradation of free product in the plume is already taking place. Matching the GCMS fingerprints with the measurement of the isotopic shift will elucidate the mixing/degradation processes in the plume.

### **Case 3. France (F. Karg, HPC Envirotec)**

#### *Site description*

A former military and industrial site (178 ha) with serious contamination from explosives and chemical warfare material (WW2), posing serious health threats. . Farmers have been hospitalised with serious illnesses related to organo-arsenic poisoning. It is an orphan site.

In 1939 this site was a French military camp, and then a German military site for pyrotechnics and chemical weapons production. After the war a private company produced explosives, propellants and tear gas. The site was used for munitions recycling and disposal until 1968, including burial of chemical weapons from WWII, and explosives were buried or exploded. The area was re-occupied by farmers when this company went bankrupt (from 1968 to the present day), with some out of bounds sections fenced off. Karg reported that these types of sites are everywhere, and often secret (military), however, the seriousness of the contamination at this site is shocking. Farmers, the original owners of the land, want the pollution to be remediated and the roped off areas returned for farming. There has been much wrangling between civil companies, local authorities and the military authorities over responsibility for remediation. The problem here is acute and difficult as no one has accepted responsibility for the site, there is also only limited information about the site's history, which makes the site investigation difficult. In addition special labs are required for the sample analyses.

#### *Syndicate Conclusion*

The key point the syndicate made was that the owners and regulators have to be persuaded to take responsibility for taking action! The syndicate and the workshop were amazed that such a toxic site was not being immediately investigated further and that it was still in use for agriculture. The current situation is that little is being done. This approach was described by the syndicate as: "Do nothing and hope for the best". The ideal way forward would be to abatement of the contamination problems in a systematic manner. This phased approach would consider objectives related to: liability, health issues, agricultural product quality, impacts on drinking water supplies. An early task would be a stakeholder analysis to determine who has what problems and what needs for action, and how funding might be obtained. The site is large, complex, and clearly hazardous to health in parts. Remediation needs to be planned on a dynamic basis, and even although its owners are keen to continue agricultural use, some changes in site use and possibly closing of parts or all of the site during remediation seem unavoidable.

*Actual approach taken*

The site has had a “Phase 1 Risk Assessment” under the French system, as described earlier. This found it to be a “Class 1” site, which is the most serious category. The site should now be the subject of a detailed risk assessment but no funding is currently available. Main contaminants found include: organo-arsenic compounds, organonitrates, organophosphates and the nerve agent *Adamsite*. The consultant for the site has recommended further site investigation in detail and detailed risk assessment to set risk management goals, see Table 3.

A number of immediate actions were also recommended:

- 20m minimum security perimeter
- Forbid access to areas with barrels, drums and highly contaminated soils
- Identify the chemical nature of the contamination
- Forbid farming at least until the site has been more thoroughly investigated
- Monitor the drinking water quality

**Table 3: Summary Consultants Recommendations for Detailed Site Investigation and Risk Assessment, for the French case Study.**

<ul style="list-style-type: none"> <li>• Geophysics and geomagnetic surveys to establish position of munitions</li> <li>• Soundings</li> <li>• Soil sampling and analysis</li> <li>• Analysis of contaminant loading in foodstuffs grown on site</li> <li>• Pieziometers</li> <li>• Analysis of contaminant loading in groundwater</li> </ul>	<ul style="list-style-type: none"> <li>• Drinking water monitoring</li> <li>• Monitoring of groundwater and river water quality</li> <li>• Modelling of groundwater data to predict impact on agricultural and drinking water wells</li> <li>• Epidemiological study to evaluate the extent of the health problems</li> <li>• Risk Assessment following French procedures for Class 1 sites</li> </ul>
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**Discussion and Conclusions of the Exercise**

The attitudes of the different stakeholders involved in particular projects have a profound influence on the management of contaminated sites. The three case studies illustrated this in a dramatic fashion. The problems illustrated by the case studies were large, a Dutch petrochemical complex and former coal mining site of some 800 ha, a DNAPL plume in a German industrial area with dispersion of free product as far as 120 m from the source, and a grossly contaminated site in France, still in use for agricultural purposes.

- The workshop felt that the site owner in the Netherlands and his consultants appear to be over-designing the system, as regards removal of potential source zones, in part because they perceive a need to be seen to be acting by other stakeholders (the public and regulators) and spending an appropriate amount of money on dealing with problem. The workshop's approach of choice would have been a stronger focus on understanding the risk management needs for the aquifer.
- The aquifer restoration project in Germany is attempting to demonstrate control of a large DNAPL spill in an industrial area, where sources from other sites are also contributing to the pollution load on the aquifer. A research project has been commissioned to try to determine where these sources might be, and to separate those effects from the degradation of the plume from the DNAPL spill being treated.

- Site investigation and remediation work on the site in France appears to have stalled because the local regulator and the site owners are not prepared to face up to the problems posed by the site, despite direct evidence of hazards to those using the site. In part this is because the site owners or occupiers depend on it for their agricultural livelihood, and have a strong political influence on the local authority.

The workshop recognised that professionals in contaminated land management do not always communicate well with lay people, and that this lack of engagement means that solutions may not always be optimal, or perceived as optimal by all stakeholders. There are two facets to this problem. One is that while risk based decision making is now generally accepted as the most appropriate means of contaminated land management, this is not accepted by all stakeholders. Furthermore, a lack of engagement with lay people means that the advantages of this management approach in prioritising and directing resources to tackling the most pressing problems are not being exploited in all cases. The second, and opposing facet, is that in some situations contaminated land professionals must accept that stakeholders may legitimately desire a solution that is over-designed (and so suboptimal) from a risk management perspective. Contaminated land professionals are aware that communications with all stakeholders is not carried out as well as it should be, yet poor communication remains a problem and an impediment to optimising contaminated land management.

## 2.4 Quality Assurance Session

### Quality assurance system for remediation companies (S d'Haene, Dec, Belgium)

The aim of quality assurance (QA) is to demonstrate to clients that remediation work has been carried out satisfactorily. To operate in Flanders, civil engineering contractors are required to carry accreditation for their specific field of activities (for example: earth moving works, water treatment installations). Accreditation is managed by an independent commission. Furthermore all civil engineering works have to be executed according to a set of standard specifications.

OVAM, the regulators in Flanders, have a requirement for remediation consultants to be accredited. However, as yet there are no standard specifications for remediation works as these are normally tailor-made on a site by site basis. For this reason OVB (OndernemersVereniging Bodemsanering - the Federation of Soil Remediation Contractors in Flanders) and OVAM have taken the initiative to write a protocol for execution of remedial works: the *Achilles Protocol*.

The Achilles Protocol is a code of good practice that has been taken on by the industry on a voluntary basis. It is an integrated quality assurance system including safety and environment. Its aim is to control adverse effects from remedial works, encompassing:

- nuisance
- health and safety issues and
- environmental emissions.

The specifications consist of the following basic elements:

- Guidelines for a risk analysis to identify the critical elements of the remediation works
- Guidelines for project files to be maintained by the contractor to document how the elements of the assurance system have been effected
- Codes of good practice describing minimum operational conditions.

The risk analysis is the essential point and basis for the quality assurance system. This is based on the concept of *loss control*. This attaches nominal costs to different preventable outcomes from remediation works in three categories: human impact; environmental impact, financial impact. An economic rule of thumb is that for every Belgian Franc (BF) that is spent in injury compensation an

additional 5-50 BF will have been spent on the consequence to the project of the injury, and a further 1 to 3 BF will have been lost as a result of loss of time. A further rule of thumb is that for every severe accident that takes place in civil engineering works, there will have been 600 near misses. The aim of the QA system is to reduce the number of near misses, and so the financial impact of poor practice. The Achilles Protocol includes a set of procedures, based on civil engineering experience, to guide operational management to control the direct causes of losses. In the codes of good practice, a set of preventive measures per remediation technique is described, based on the risk analysis. These codes can be seen as a set of minimum criteria. The techniques described are Best Available Technologies.

### **Quality assurance on the complete process; from pollution detection up to final remediation (W. de Koning, SIKB, The Netherlands)**

A new network has been created for both public and private parties to work together to continuously and structurally enhance the standards of activities relating to soil management in The Netherlands. In the spring of 2000 the network was formally launched as the Foundation Infrastructure for Quality Assurance of Soil Management (SIKB).

Explicit incorporation of quality assurance requirements for remediation work, both in corporate business and in public institutions, is increasingly taking place in the Netherlands. Past performance indicates a clear need for quality management. A survey of the authorisations for Dutch remediation projects has found that at between 50 and 75 % of sites the actual remediation results differ from earlier investigation predictions and from the work the public authority has authorised on the basis of the original plan. Indeed the original remediation targets are not met at 45 to 75 % of these sites, and where variations take place, the reasons for these changes are not listed in public records in many as 25% of cases.

De Koning argues that these variations are largely caused by technical errors, and that similar errors are being repeated over and over again. He contrasts the situation of soil analyses, where many standards and norms exist, with that for remediation and record keeping where there are few. He points out that every case which deviates from the original plan poses risks for the client, as well as for participating parties and the relevant authorities, in particular financial risks. He emphasises that he is not saying that soil management is in a bad state, but can and must be made efforts more efficient and effective.

SIKB's vision for quality assurance is based on five basic tenets:

- achieving an adequate soil quality is a shared responsibility of all parties concerned
- quality assurance for critical parts of the process
- unity within the structure and with existing structures
- quality assurance can only succeed with adequate enforcement
- prioritisation should be on the basis of practical needs

These principles are to be applied by SIKB to the entire chain of activities in soil management. Over 2001 to 2006 this work will consist of the following elements:

- quality assurance strategy development for process elements, people and products
- a coherent and widely accepted set of instruments, including a working enforcement system
- continuous attention to opportunities for improvement
- co-ordination with international developments.

SIKB recognises the importance of the Public Sector in contaminated site management, and is working to encourage a situation where the Public Sector *as client* has demonstrably moved towards formulating requirements on quality assurance for its contractors. Where *as policy and decision making authority* it has demonstrably moved towards a situation in which it uses intermediary services

with a quality assurance system only, linking with the development of enforcement regulations. Where *as enforcing* authority the Public Sector demonstrably moved towards effective enforcement of the legal rules on soil management, and has introduced its own internal working quality assurance system.

Four products are expected from the five year SIKB programme: a research programme, standards, auditing criteria, and audit reports. The programme will focus on:

- development of standards where they are still lacking: to prevent errors and ambiguous agreements where possible
- professional competence: defining needed skills more clearly should lead to educational programmes that fit demand better
- stimulation of use of existing standards: many rules and standards exist already, and rationalisation where there are excessive and potentially confusing standards and guidance,
- construction of the network: quality assurance can seem like the panacea for everything that's wrong. QA will only work when the inspections by the certifying institutions work well, and when improper use of certification logos is adequately punished.

Further information is available on the SIKB web site: [www.sikb.nl](http://www.sikb.nl).

## **Discussion**

Both speakers agreed that quality assurance is only a part of "total" quality management. Quality assurance is able to manage how well a job is done, but cannot change the facts if the job itself is fundamentally flawed. Setting minimum standards, for example of reliability for site investigation sampling is an equally important, but distinct activity. OVAM see easier auditing of site management as one of the fundamental advantages of QA.

Delegates were not convinced that QA alone was sufficient to reduce the apparent uncertainty in site investigation information to more acceptable levels. For example QA systems do not necessarily "force" a client to collect the *volume* of information that might be necessary for a good model of a contaminated site. In some countries there could be a downward quality spiral, as clients demand ever price competitive quotes from what is a low margin business. The only consultancies able to stay in business will then ultimately be those willing to provide a lower than desirable information base. As this becomes the norm, so the spiral downwards deepens. In these circumstances, perhaps QA is evidence only that a bad job has been done well. This was not the only point of view. Several delegates countered that "fitness for purpose" must form part of quality assurance systems. It was also pointed out that Professional Indemnity insurance was being used as a surrogate QA approach in some countries, where clients hoped that inadequate work would leave their consultants open to legal action. In the UK, for instance, a client may sue a service provider for being professionally negligent if a project they are responsible for does not meet targets. In practice this is a very hit and miss strategy, given the inherent difficulties in proving professional negligence. Nonetheless successful claims have been made.

### 3 Workshop Findings

The concluding discussion of this workshop is as follows.

NICOLE sees cost effectiveness and risk management as closely inter-related, in that risk management not only ensures that receptors are adequately protected, but also helps avoid the over-design of remedial solutions. The industry and regulator presentations and the case studies in this workshop all demonstrated the importance in Europe of risk management as a basis for contaminated land decision making. However, countries do differ in *how* risk management is applied at a regulatory and policy level. For example, the pragmatic approach of the German case study meant that the cost burden of the remediation was alleviated to a significant extent. This type of decision making approach would not have been possible, for example, in Italy, where a more prescriptive approach to risk based decision making is taken. Differences in regulatory and policy approach are not the only reasons that remediation work may be “over-designed”. The Dutch case study showed how a business’ concerns over how it was perceived led it to take a possibly more expensive, remedial approach to what might have been a pure risk management approach. Note “over-design” is very much a subjective comment and reflects the views expressed through the meeting, rather than any kind of validated or verified critique.

Contaminated land professionals need not just to be aware of the need for better communication of technical matters to all stakeholders in a project, but to take action to ensure this communication takes place. In particular technical people need to be sensitive to the legitimate interests of lay-people who have their own knowledge and perspective to bring to discussions.

There is clear concern about the quality of technical work in contaminated land management across NICOLE countries. The level of technical competence is seen as generally high, and the practical results of most remediation work overall are certainly sufficient. What is less clear is the effectiveness of individual projects. There is increasing interest in developing quality assurance systems as a means of enhancing service quality. However, delegates were sceptical that QA systems alone would provide answer to total quality issues. Clients also need to bear in mind the need for an adequate level of investment in site information for good site management. The contaminated land industry as a whole is somewhat polarised between service providers who are looking for reasonable levels of investment in information, and problem holders who are looking for opportunities for cost reduction.

The discussion about quality is part of a broader debate about understanding what is cost effective in remediation, and what constitutes sustainable development. Proponents of formal cost benefit analysis argue that this is the best route for determining both what is most cost effective and what is most sustainable for a site, although there are limitations to current approaches to attaching monetary values to some wider benefits and impacts. However, not all delegates were convinced that CBA alone was adequate for *sustainability appraisal*. Several concerns were expressed: (1) the reliability and reproducibility of valuations of broader benefits and impacts, such as landscape, nuisance and amenity, (2) the credibility of these valuation methods to all stakeholders (3) the complexity of the methods and the difficulty in communicating its findings to all stakeholders - even although the concept of money is universally grasped the valuation process may not be; and (4) there was a fundamental disquiet about reducing the broad range of sustainable development issues to a single index, even if that was money.

Those involved in contaminated land management recognise that the actions that are finally agreed are the result of a process of negotiation, effectively bargaining, which weighs the interests of different stakeholders. It is perhaps this bargaining process that could be made a little more guided, a little more transparent and a little more explicit.

The discussion finished on an optimistic note. The current debate about quality and overall value in a holistic sense is really the concluding stage in a progression of thinking across Europe. Initially contaminated land management in many countries was regulated on the basis of rather absolute concepts like "multi-functionality", and limit values whose provenance was not always clear. Nowadays there is a wide technical consensus that risk management is the most appropriate basis for decision making. Contaminated land professionals are now in the process of communicating this technical consensus to the wider society. The current technical debate is now related to the following issues: cost effectiveness, understanding "sustainability", stakeholder inclusion and quality management. This debate has emerged, and is emerging, independently in different countries throughout Europe. NICOLE sees an important role for itself in fostering this debate, and providing opportunities for its issues to be discussed by a wide range of stakeholders from the different countries of Europe.

## Annex 1 Delegate List

Mrs M. (Meri) Barbafieri	National Research Council of Italy	Italy
Mr R.P. (Paul) Bardos	R3 Environmental Technology Ltd.	UK
Ms Ch. (Charlotte) Beillouin	Corus UK Ltd.	UK
Mr J. (Jonny) Bergman	MB Envirotech AB	Sweden
Mr S. (Simon) Bluestone	Montgomery Watson Spa	Italy
Mrs P. (Patricia) de Bruycker	Solvay S.A.	Belgium
Mr C.E.H.M. (Cees) Buijs	HBG	NL
Mr R. (Ruud) Busink	Corus Iron IJmuiden	NL
Mr C. (Claudio) Carlon	Consorzio Venezia Ricerche	Italy
Mr J. (Jacques) Chevalier	UCB	Belgium
Mr P. (Pierre) Colin	GESTER/UPDS	France
Mr P. (Paolo) Cortesi	ENI S.p.A.	Italy
Mr R.L. (Rae) Crawford	ExxonMobil	UK
Mr I. (Ido) Croese	Arcadis Heidemij Advise	NL
Mr J. (Jim) Cummings	US-EPA	USA
Mrs D. (Dominique) Darmendrail	BRGM	France
Mr P.J. (Peter) van Driel	Fugro Milieu Consult BV	NL
Mr L. (Luc) Demoulin	Gaz de France	France
Mr S. (Siegfried) D'Haene	DEC Deme Environmental Contractors	Belgium
Mr L. (Ludo) Diels	VITO	Belgium
Mr G. (Giacomo) Donini	URS Dames & Moore	Italy
Mr V. (Victor) Dries	OVAM	Belgium
Mr D. (David) Edwards	VHE Holdings plc.	UK
Mr E. (Edgard) Eeckman	PRP	Belgium
Mr C. (Christer) Egelstig	JM AB	Sweden
Mr Th. (Thomas) Ertel	UW Umweltwirtschaft GmbH	Germany
Mrs M. (Marjan) Euser	NICOLE Secretariat	NL
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Mr J. (Johan) De Fraye	Montgomery Watson	Belgium
Mr P. (Philippe) Freyssinet	BRGM	France
Mr L. (Lars) Gärtner	Norsk Hydro AS	Norway
Mr W. (Wouter) Gevaerts	Gedas NV	België
Mr F. (Frédéric) Goldschmidt	CNRSSP	France
Mr B. (Bertil) Grundfelt	KemaktaKonsult AB	Sweden
Mr J. (Jérôme) Guézou	Gaz de France	France
Mr P.E. (Paul) Hardisty	Komex International Ltd.	Cyprus
Mr I. (Ian) Heasman	Taylor Woodrow	UK
Mr T.J. (Timo) Heimovaara	IWACO BV	NL
Mr M. (Mark) Hoff	ERM Lahmeyer International GmbH	Germany
Mr R. (Rüdiger) Hotten	Hochtief Umwelt GmbH	Germany
Mr T. (Thierry) Imbert	Ophrys	France
Mr R. (Roger) Jacquet	Solvay S.A.	Belgium
Mr J. (John) Janse	BioSoil BV	NL
Mr J. (Jan) Japenga	Alterra	NL
Mr F. (Frank) Karg	HPC Envirotec	France
Mr H. (Harald) Kasamas	Clarinet	Austria
Mr J.M. (John) Kidd	Shell Global Solutions	UK
Mr J. (Jouko) Kinnunen	Dynea Chemicals Oy	Finland
Mr B. (Ben) Klinck	BGS	UK
Mr W. (Walter) de Koning	SIKB	NL
Mr J.G. (Dick) Kruisweg	Akzo Nobel NV	NL

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