



NICOLE NEWS

Network for Industrially Contaminated Land in Europe

Latest on NICOLE projects, reports, meetings and working groups

Distributed free to all NICOLE members

NICOLE: Past and Present

This year NICOLE News celebrates 10 years of NICOLE, looking back at past successes and forward to future challenges. Here, Lida Schelwald van der Kley talks to past chairs of NICOLE about the history, achievements and future of the organisation.

Welcome to this special edition of NICOLE news. It is special since NICOLE is celebrating its 10 year

NICOLE from its early days into the important group it is today.

How it all started...

Who better to ask about the development of NICOLE than one of its founding fathers, Martin Bell of ICI? "At the time there was a need for European Industry, as one of the main owners of the contaminated land problem, to become

first inaugural meeting in 1996 in Hanover and started with EU support."

Martin believes that the last aim (a credible voice for industry) has been achieved. The other aims are partly achieved. "There are more economic technologies available now, but there is still a long way to go. Risk assessment is now much more accepted, but there are still some EU countries where it is only



Some famous faces from 10 years of NICOLE (clockwise from top left) Terry Walden, Cees Buijs, Bill Hafker, Wouter Gevaerts, Martin Bell, Steve Wallace, Bertil Grundfelt, Paolo Cortesi, Rae Crawford, Divyesh Trivedi, Marjan Euser and Mike Summersgill

anniversary this year. At the NICOLE workshop in Leuven this October we will look back at those memorable first 10 years and also look forward. To look back and assess the impact of NICOLE, we invited all the former chairs of the network and the Industry and Service Providers Subgroups. They have all played a major role in defining and accomplishing NICOLE's goals on Contaminated Land Management and leading NICOLE to where it is today. We will be having an interview session with them as part of the forthcoming workshop. As a preview, we have dedicated this article to the opinions of three key figures in the development of

better informed about methods for identifying, assessing and managing its solution. Existing technologies were expensive and inadequate and we needed to stimulate the development of new cost-effective technologies and enable leveraged collaborations. Our further view was that risk assessment was not properly understood or accepted as a process for managing contaminated land. For industry contaminated land was not a competitive issue. These reasons and the benefit for industry of being able to talk with credibility to regulators and academics without being seen as a lobbying group made it worthwhile trying to form NICOLE. So we had our

permitted as a last resort. These aims are therefore still valid".

Start-up of ISG

Shortly after the NICOLE Inaugural meeting it was decided to form a subgroup within NICOLE for companies actively addressing contaminated land problems within their own land holdings. The idea was that this Industry Subgroup (ISG) would provide a forum to exchange views and share experiences with fellow colleagues and also identify research needs from an industry point of view. Cees Buijs, working at the time for

Continued on page 3

• Workshop Reports: Page 4 • NICOLE Working Groups: Page 5 • Full Contents on Page 2 •

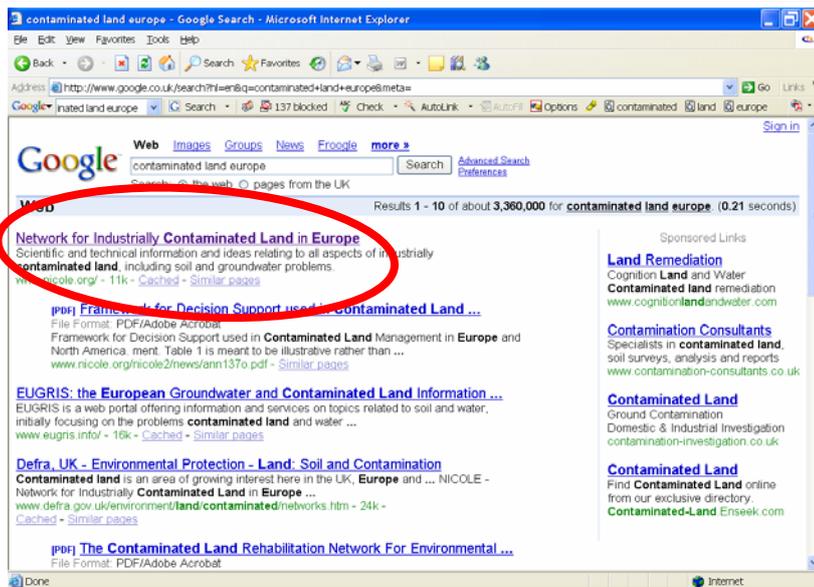
CONTENTS

Page

Forthcoming Events

NICOLE Past and Present	1 & 3	EURODEMO - paving the way to innovation in remediation technology: November 9-11 2006. More information at http://www.eurodemo.info [part of EcoMondo 2006]
NICOLE events	2	LINK BIOREMEDIATION DISSEMINATION EVENT - November 23 rd 2006 To register for this free event email tina.hunt@lgc.co.uk .
General information	2	WHAT DOES THE FUTURE HOLD FOR LARGE METAL-POLLUTED SITES? - Difpolmine Conference, Montpellier, France: December 12-14 December 2006 Contact: difpolmine@ademe.fr http://www.difpolmine.org
NICOLE Workshop Reports	4	
NICOLE Working Groups	5	
Working Group Reports	6 & 7	Johan De Fraye steps down as SPG Chair
NICOLE Project updates	8	After two years as the Chair of the Service Providers Group, Johan De Fraye is stepping down. As he is also moving to an industry position with Honeywell, he will not follow the traditional path of becoming the senior SPG representative on the Steering Group, a role that will remain with Wouter Gevaerts. Johan's place in SPG will be taken by Bertil Grundfelt. We would like to thank Johan for all his work and wish him all the best in his new career.
EU groundwater legislation	9	
SG/ISG/SPG updates	10	See the SPG report on page 10
ERA: an update	11	
10 years of solid delivery	12	

www.nicole.org is number 1 in Europe!



As an example of the increasing presence and value of the NICOLE website, a search on Google reveals that NICOLE is the number one response to a search string of 'contaminated-land-Europe'. The NICOLE web site was visited 180,301 times over the past 12 months. A total of 28.89GB of information was downloaded. This demonstrates that www.nicole.org is an important place to begin a search for information and contacts in the contaminated land sector. The combination of valuable publications and meeting reports, a large knowledge base of information, pictures, news, conference announcements and comment makes the NICOLE website a valuable resource.

Contact Paul Bardos,
paul@r3environmental.co.uk

A selection of key NICOLE publications over 10 years

- 16 detailed Workshop Reports from 1999 to present covering all aspects of contaminated land management, held in countries right across Europe, and eight NICOLE Workshop Summary Reports from the Framework 5 project (1996-1998).
- Guidance, training and project reports covering a range of CLM topics from 1999 to present, particular highlights include: risk management, MNA and risk communication and more recently a review of soil and waste legislation across ten Member States.
- Joint Statements: NICOLE / CARACAS - October 1997, *Towards a Better Future: Establishing Fitness for Use and Sustainable Development of Contaminated Land in Europe*, revised May 1998; NICOLE / CLARINET - October 1998 *Better Decision Making Now: The use of Risk Assessment and Risk Management*; NICOLE, CLARINET, ETCA and SENSPOL - 2000 *Sustainable Management of Contaminated Land for the Protection of Water Resources*.
- NICOLE Opinion on Contaminated Land Research, August 1997 (for Framework 6 Programme).
- CLARINET and NICOLE Special Edition of Land Contamination and Reclamation: The Sustainable Management and Remediation of Contaminated Land Management and Remediation of Contaminated Land (*Land Contamination and Reclamation* 9 (1) 47-174).
- 2001 Discussion Paper on the Need for Sustainable Land Management. Role of a Risk assessment Based Approach (in six languages).

Nearly all of these outputs can be found on www.nicole.org. Where reports are not on the web site they generally can be purchased from the secretariat, contact Marjan Euser: marjan.euser@tno.nl

Useful Web Links

Environment Agency ERA page:

<http://www.environment-agency.gov.uk/subjects/landquality/113813/887579/887584/>

EU Thematic Strategy on soil home page:

<http://ec.europa.eu/environment/soil/index.htm>

EU Groundwater Daughter Directive home page:

<http://ec.europa.eu/environment/water/water-framework/groundwater.html>

NICOLE: Past and Present

Continued from page 1

the Port of Rotterdam, became the first chairman of the ISG. The first meeting of the ISG proved very constructive and was well attended, many of those present going on to play a very significant role within NICOLE. Cees recalls: “the inspiration from Dale Laidler and Martin Bell (ICI), the enthusiasm from Johan van Veen (TNO) and warm support of Patricia de Bruycker of Solvay. Quite some time was spent discussing ISG targets and activities, like promoting strategies, sharing best practices, technology evaluation and knowledge transfer. With some sadness I handed over the chairmanship of the ISG after a few years to my successor Bill Hafker (Exxon Mobil).”

Consolidation and expansion

Our next NICOLE chairman was Paolo Cortesi of ENI, Italy. During his chairmanship the main goal for NICOLE was to make risk assessment the basis for sound policy making on contaminated land. “This goal was pursued in a number of ways. One was the strengthening of the cooperation with other networks acting on related issues, such as CLARINET and the Common Forum, which represented the regulators, SedNet (sediments) and CABERNET (Brownfields). We organised workshops and wrote position papers on risk assessment and related issues such as risk communication, source management and MNA to disseminate the Risk Management concept, including active participation in CONSOIL. There was also active participation in DGXII workshops, projects and panels to drive the definition of our research topics in the framework programmes. Eastern European countries were also involved in order to put their new legislation on the right track and to facilitate the business of the NICOLE member companies working in or expanding to these countries. Last but not least, we collaboratively financed research projects aiming to provide scientific support to some key principles of the NICOLE strategy (for example the MNA project)”.

Friendly and fruitful co-operation

Paolo continues: “Looking back on my experience in NICOLE, I have to emphasise the great amount of good quality work that can be delivered by a

small group of “volunteers” with a high sense of self-responsibility operating in a friendly atmosphere. I am honoured to have contributed to the development of this network that symbolises a remarkable example of fruitful cooperation among different stakeholders for the good of European business and people”.

NICOLE continues self-supported

The year 1999 marked a transition period for NICOLE. The 3 year contract with the EU had ended and NICOLE continued as a network solely supported by its fee-paying members, who at that stage numbered over 100.

An important success for NICOLE at this stage had been the development of a platform of mutual trust and collaboration between its diverse range of members. NICOLE also had an expanding portfolio of projects and its scope was expanding to include other topics such as brownfields, sustainability and the demonstration of innovative technologies.

Launch of the SPG

The value of service providers was now fully recognised and an important landmark was the Launch of the Service Providers Group (SPG) at the beginning of 2000 initiated by Cees Buijs who was by that time employed at HBG. Mike Summersgill of VHE and Wouter Gevaerts of Tauw became its first chairmen, with the support of Elze-Lia Visser-Westerweele as the secretariat. Mike summarised the early days: “The SPG membership at that time comprised several firms who had formal or informal ties to Industry members, being ‘in-house’ consultants. This formed a natural consensus about the kind of problems that industrial landowners in the network had, and helped define a ‘technical’ direction that the Group wanted to adopt. One of the fundamental things we decided to do immediately was to formulate a matrix of company capabilities, so that we could see our strengths as a group and also make this information clear to other Network members. When the topics of the workshops started to become technology and cost-related, rather than technical-research related, that was when the subtle shift towards harnessing the experience of Service Providers

occurred. Recognising that these firms had worked across the industrial base (and in several European countries) drove the SPG into its current phase (read more about this on page 10).

More chairs

Over the years more chairpersons steered NICOLE energetically and successfully in the new era of contaminated land management today, supported by an efficient TNO secretariat (Marjan Euser), and a professional information manager (Paul Bardos / r3) who developed the NICOLE website further. To mention a few of those who have contributed over the years: Bill Hafker and Rae Crawford, both ExxonMobil (ISG and SG), Karen Cerneaz, Shell (SG), Steve Wallace, National Grid (SG), Terry Walden, BP (ISG) Wouter Gevaerts (SPG), Thierry Imbert, Tauw (SPG) and Johan De Fraye, MWH (SPG). Most of them will be present to give their views at the interview session at the NICOLE workshop in Leuven.

NICOLE today

Nowadays NICOLE is a self-sustaining, vibrant network that supports safe and cost-effective solutions for industrially contaminated land management. Much has been achieved in the 10 years since NICOLE was formed, but in the view of our current chair, Divyesh Trivedi (Nexia Solutions) still more needs to be done. A NICOLE forward strategy study was carried out in 2005 to re-align the network to newer priority areas and to ensure that the network continues to deliver real value and benefits to its members. NICOLE members agreed unanimously that the most important issue affecting contaminated land is recent and upcoming EU legislation, as demonstrated by the recent NICOLE report on soil and water legislation in ten EU countries (see page 8). Members support the network providing technical input on key legislative issues. The good contacts enjoyed by both the organisation and its individual members at EU level already ensure that our input, which reflects the views of our membership, is appreciated and adopted.

Lida Schelwald van der Kley is secretariat of the ISG. More thoughts on the development of the ISG are reported on page 10.

A review of the development and practical contribution of NICOLE to contaminated land management can be found on page 12.

NICOLE Workshop Reports

The Impact of EU Directives on the Management of Contaminated Land. Cagliari, Sardinia, Italy, December 2005

Over the last few years several EU policy developments, including new and revised Directives, have been initiated, which could potentially have a significant impact on contaminated land management in the future. The “Van der Walle-case” is an example of how Directives can dramatically influence the way that contaminated land is dealt with. NICOLE members have highlighted the importance for their organisations of being both informed and able to contribute to such developments. The workshop aimed to:

- inform and explain to the participants of the workshop what a range of existing and proposed EC Directives might mean to the management of contaminated land (Figure 1).
- create an opportunity for dialogue between stakeholders and regulators.

A degree of parallel working in Directives and thematic strategies for waste, soil, water and environmental liability was apparent from the Workshop presentations - perhaps not surprising, given that each initiative has its own timescale, complexities and terminology. Even small differences in approach and terminology can have major consequences for both the regulated community and those involved in the implementation of Directives in Member States. The workshop called for better liaison between the different EC policy areas, particularly to ensure consistent use of definitions, terms and over-arching guiding principles. The workshop also concluded that a risk based approach to environmental decision-making has a lot to offer in terms of prioritising environmental problems across all policy areas. This would help ensure effective use of limited economic resources, and that the consequential effects of actions required by regulation were not excessive in terms of their wider environmental, economic and social impacts. Risk based environmental decision making is an effective route to sustainable development. NICOLE members participate in working groups for a number of these policy developments.

NICOLE will consider carefully how it can develop this platform with other networks, particularly the Common Forum, to support a more consistent use of terms and principles, and to demonstrate the advantages of risk-based decision making processes.

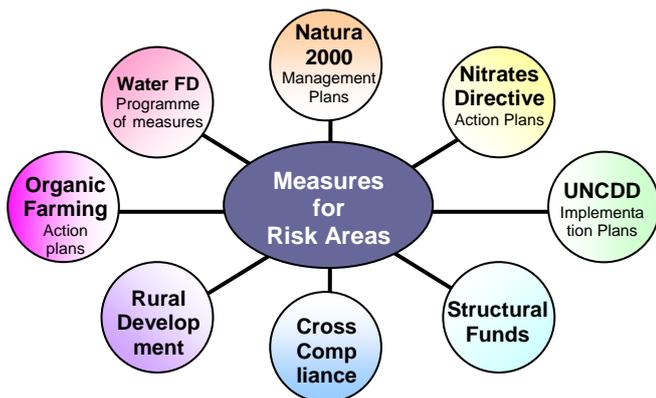


Figure 1 Linkage of EC initiatives with soil protection

Data Acquisition for a Good Conceptual Site Model, Carcassonne, France, May 2006

The core of such a risk-based approach is the development and elaboration of a site conceptual model; this is the first and most essential step to ensure that there is a robust and defensible basis for contaminated land management. Data acquisition was first highlighted as a key step towards deriving a conceptual model by the 2002 NICOLE meeting in Pisa, which focused on cost-effective site characterization methods. The invited papers at the 2006 workshop presented examples from real contaminated land case studies highlighting the importance of good quality data acquisition for the development of robust and appropriate conceptual site models, combining information on the geology, biology and the chemistry of the subsoil. The emphasis was on innovative, productive and cost effective data collection methods supporting site management decision making processes rather than “wanting to know what is in the soil”.

However, it was clear both from the meeting and subsequent comments that the use of appropriate technology is essential to successful and cost-effective site investigation and monitoring, despite the fact that an appropriate selection mechanism that industry can use is not available at present. To achieve such a mechanism, emerging technologies may need to be compared in the context of a verification project or programme, in a similar manner to the independent remediation technology verification protocols that are currently being developed by EU projects such as PROMOTE (Figure 2). Better approaches are also needed for selecting the most appropriate technology. Despite the potential opportunities for more effective site characterisation that seem possible, in some presentations the extent of use and the degree of acceptability to regulatory authorities was not immediately apparent. Understanding and defining the barriers that prevent the wide scale uptake of innovative technologies and the advantages that they possess, along with guidelines for the appropriate use of such technology, would be a significant assistance in its adoption on a large scale by industry. It was suggested that improved dialogue between consultants, researchers, industry and regulators regarding a mechanism to move new technology from development through to acceptance on an industry-wide scale should be a vital step in any process aimed at evaluating new technology.

The executive summary, full meeting report, and copies of presentations for both workshops can be viewed and/or downloaded from www.nicole.org

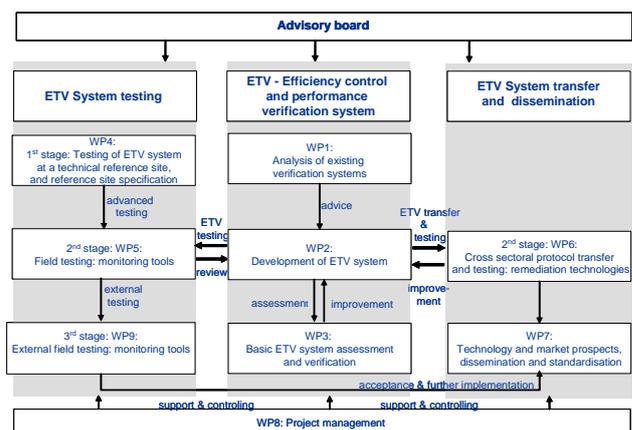


Figure 2 Structure of the PROMOTE project

NICOLE and the Working Group initiatives

Divyesh Trivedi, Nexia, UK NICOLE Chairman

If you recall, during 2004 and 2005 NICOLE undertook a major review of the function, scope, direction and operation of the network: the NICOLE Strategic Review. We published the outcome of this review in the 2005 NICOLE News. A key recommendation from the review was that NICOLE would be much more effective if working groups (WGs) composed of interested, knowledgeable and enthusiastic members were formed that led and managed activities to address key issues of importance to our members.

We took this very seriously in the Steering Group (SG), Industry Sub Group (ISG) and Service Providers Subgroup (SPG). The first such working group was formed during 2005 and concerned the Groundwater Daughter Directive. Led by Wouter Gevaerts from Arcadis, this group ensures that a NICOLE viewpoint is included in the direct and indirect inputs working technical committee which Wouter chairs. It also ensures that any information about new developments concerning the Groundwater Daughter Directive is communicated to NICOLE members. You may have picked up several pieces of information from this WG through the monthly NICOLE

emailed to members by Marjan Euser.

We have been fortunate in having such a successful “bench mark”. This working group includes ISG and SPG members who have played an active part in regular discussions (mostly by teleconferencing to save time and travel costs).

More recently the Steering Group reviewed and endorsed requests for several new working groups. The scope and operation of these working groups was discussed at the joint ISG/SPG meeting prior to the Carcassonne Workshop in May 2006. At this workshop several new groups were formed and NICOLE members given the opportunity to sign up to them. Very briefly below is an outline of the scope of activities of the working group together with the name of the person leading the group:

Waste Directive: Ian Heasman, (Taylor Woodrow)

To lead NICOLE development of waste issues in relation to contaminated soils management, covering the Waste Directive, European Court of Justice rulings etc.

MNA: Roger Jacquet (Solvay)

To continue the long-standing work by NICOLE to gain acceptance for MNA as an important option to manage contaminated land.

Soil Strategy: Johan de Fraye (Honeywell)

To lead the NICOLE input into the developing Soil Framework Directive.

Ecological Risk: Bertil Grundfelt (Kemakta)

To develop the issues raised by the Stockholm 2005 workshop and lead on NICOLE ecological risk input into EU Directives and framework programmes such as Heracles.

Encouragingly, these groups are already very heavily subscribed. It is important to emphasise that, like many of NICOLE’s activities, participation is on a voluntary basis. We regard these working groups as one of the major vehicles that will take NICOLE forward; propagating its viewpoints and promoting cost-effective solutions to contaminated land management on industrial sites to the benefit of its members.

NICOLE encourages members who have ideas for a working group on an issue that would greatly benefit NICOLE members to contact the NICOLE Secretariat (marjan.euser@tno.nl). She can also arrange contact with existing working group leaders.

The background to and aims of each of the working groups are described in more detail below and on the following pages.

NICOLE Working Group on the Waste Directive

Ian Heasman, Taylor Woodrow, UK

NICOLE research^[1] shows that European countries agree that excavated contaminated soil is waste, in line with the Waste Framework Directive (WFD). It is explicit in the WFD that once a material is waste it can only be either 'recovered' or 'disposed of'; and that both of these activities require a Waste Framework Directive permit (or an exemption). Many European Countries have their own views and practical approach to this.

The 2004 Van Der Walle European Court of Justice ruling not only defined escaped hydrocarbon from a petrol station as waste, but it also defined the associated polluted soil and groundwater as waste. The far-reaching consequences of this decision could include that contaminated land needs further

licensing under waste legislation, that further clean up is mandatory and that this would be driven by waste regulatory requirements. There is also potential for an undermining of the risk-based approach to contaminated land, replacing it with the hazard-based approach enshrined in waste legislation. Help is potentially on the way through the Thematic Strategy on Waste Prevention and Recycling, which aims to turn Europe into a recycling society that seeks to avoid waste and uses waste as a resource. It will streamline and clarify waste legislation including a revision of the 1975 WFD, and set recycling standards. The Thematic Strategy on the Sustainable Use of Resources, with its emphasis on resource productivity and eco-efficiency, should also encourage sustainable use of contaminated soil.

There is a role for NICOLE to inform these initiatives. The objectives of the Waste Directive WG are to encourage the development of the Waste Strategy and Waste Directive in a way that:

- Supports risk based land remediation, the heart of the NICOLE mission
- Supports the reuse, recycling and recovery of contaminated soils and related materials
- Clarifies when contaminated soil and related materials are waste and when they cease to be waste
- Supports proportionate risk based permitting and exemptions
- Supports breaking the linkage between treated contaminated soils and their classification as waste earlier in the chain of custody
- Encourages the development of risk based fit-for-purpose protocols to achieve non-waste status
- Resolves the Van Der Walle issue

[1] The Interaction Between Soil and Waste Legislation in Ten European Countries, NICOLE, December 2005

NICOLE Working Groups

NICOLE Working Group on Contaminated Soil

Johan De Fraye, Honeywell

As part of the initiative to play an influential part in the upcoming legislation and European policy on contaminated land, NICOLE has launched several working groups (WG). One of those working groups is the WG Contaminated Soil (WGCS). It was established when it became known that the European Commission was working on a draft framework directive dealing with impacts on soil. The WGCS is still in its infancy; an introduction to its programme formed part of the joint ISG-SPG session in Carcassonne, France in May 2006.

The schedule for the implementation of the new Soil Directive is shown below.

2002: *Decision 1600/2002/EC laying down 6th Community Environment Action Programme: protect natural resources and promote sustainable use of soil; Communication COM(2002) 179 "Towards a Thematic Strategy on Soil Protection"*

2003: *Open stakeholder consultation with Advisory Forum and five Working Groups (including contamination)*

2004: *Stakeholder consultation ends with reports containing recommendations*

2005: *Internet public consultation; Impact assessment of new legislation*

2006: *Draft proposal for a Soil Framework Directive*

2008: *Final Directive (?)*

The draft proposal for the Directive is currently in circulation within the European Commission. Once finalised it will be sent to the European Parliament for review. At that point it will become a public domain document on which the WGCS can work. However, the headline information within the section of the Directive related to contamination is already known. This is summarised below, beginning with some definitions as taken up in the draft proposal:

"soil": *top layer of the earth's crust formed by mineral particles, organic matter, water, air and living organisms; interface between earth, air and water, in continuous evolution*

"contaminated site": *Site with confirmed presence, caused by man, of dangerous substances in such a level that they pose a risk to human health and the environment*

"potential soil polluting activities": *Parts 1 & 2 of Annex I in Directive 2003/105/EC (Seveso II); Annex I in Directive 96/61/EC (IPPC); Airports; Harbours; Former military sites; Petrol and filling stations; Dry cleaners; Mining installations excluded from Seveso II and including their waste installations; Landfills; Waste water treatment installations; Pipelines for dangerous substances*

Some of the main concepts relating to soil contamination are listed below:

The **prevention of soil contamination** equates to the appropriate and proportionate measures to limit the introduction of dangerous substances.

An **Inventory of Contaminated Sites** could be established using the following procedure: locate the sites where potential soil polluting activities take place or have taken place; soil investigations and risk assessment. The first assessment should be within 5 years after transposition date and renewed every 5 years.

A **National Remediation Strategy** should be in place within seven years of transposition, identifying specific targets, prioritisation of actions (including MNA and containment), allocation of means to achieve targets and a timetable for implementation.

If a potentially soil polluting activity is undertaken at a site, a **Land Status Report**, issued by an authorised body, should be provided by the current landowner to both the prospective buyer and the competent authority as part of the sale. The report should include information on site history, chemical analyses and trigger values for on-site investigation.

The WGCS' aims are:

- To influence development of Soil Directive and its implementation
- To keep NICOLE members informed of progress
- To identify key players in the Commission that should be approached either by NICOLE or its members or member organisations
- To provide analysis of the key issues in the proposed directive
- To organise/coordinate contacts with national regulators

NICOLE Working Group on the Groundwater Daughter Directive

Wouter Gevaerts,
Arcadis, Belgium

The Groundwater Daughter Directive (GWDD) is an extension of the Water Framework Directive, which aims to expand the original role of the WFD by aiming to achieve good chemical status of groundwater, reverse upward trends of pollutants in groundwater and develop requirements to prevent and limit inputs of pollutants into the groundwater. The Common Implementation Strategy (CIS) aims to improve the transformation of the WFD and GWDD from legislation into reality by, amongst other things, developing technical guidance on common approaches and methodologies. Stakeholders, NGOs and the research community are involved in this joint process as well as Candidate Countries in order to facilitate the cohesion process. The NICOLE Working Group is closely associated with CIS Working Group C (groundwater), which has around 80 participants representing environment ministries and agencies of the EU, stakeholder organisations, NGOs and the scientific community. NICOLE is represented by Wouter Gevaerts and Lucia Buvé and has been closely involved in the preparation of the "prevent and limit" guidance document. Due to a delay in the approval of the GWDD, it is not yet clear what the position will be on historical contamination, therefore the guidance document is yet to be finished. However it is at an advanced stage and is due to be released by the end of the year.

The NICOLE Working Group has the following aims:

- To have an influential role in the development and implementation of the Directive
- To spread the knowledge of the Nicole network on risk assessment and groundwater contamination
- To continue making a contribution to the CIS through drafting and preparation of material
- To be a semi-independent forum for comment and analysis related to the Directive
- To inform NICOLE members of progress in the GWDD

NICOLE Working Groups

NICOLE Working Group on Ecological Risk Assessment

**Bertil Grundfelt,
Kemakta, Sweden**

In conjunction with the NICOLE workshop in Cagliari (see page 4), the NICOLE Steering Group decided to initiate working groups to address legislative and policy-oriented issues that need forward action and for which there is active support from both Industry Subgroup and Service Providers Subgroup members. One of the originally proposed topics for a WG is Ecological Risk Assessment (ERA). The WG on ERA has just got started. It aims to follow up on the conclusions from the Stockholm Workshop in June 2005 and produce a proposed NICOLE position/action plan regarding the ERA topic for presentation to the Steering Group.

ERA is an area that is still under development compared to other areas of risk assessment. Issues that need to be resolved, in order to clarify the role of ERA, include:

- What is an acceptable level of disturbance to the ecosystem?
- What are the criteria that enable one to define when an assessment shows that there is no problem?
- How do we use the results of an ERA?

The acceptance of risk-based land management of contaminated land (RBLM) was an early priority of NICOLE. The advantages of RBLM are that it is systematic and objective, it

provides a consistent basis for dealing with issues such as uncertainties and decision making and it leads to solutions appropriate to the risks posed by contamination. The assessment of these risks has previously focused primarily on risks to human health and water. Ecological risk assessment has only recently become a more regular part of contaminated land management. In countries which have, or are establishing ERA frameworks, several common principles are already apparent, such as the use of a tiered approach and "weight of evidence".

A major problem in carrying out ecological risk assessment is a paucity of technical data and an inadequate consideration of existing information by some models. Consequently, there are significant uncertainties in the execution of ERA as well as in its role.

A question implied by ERA is: can we do anything with its findings? i.e. how do we manage ecological risks? The idea of "ecological risk management" would seem to be a natural consequence of the use of ERA, but has scarcely begun as a discipline. It has been argued that any requirements for ecological risk management should be proportional, taking into account the geographical and urban context of a site and the ongoing land use. The context of many contaminated sites is that they are located in industrial or urban areas, both of which are already highly disturbed from an ecological point of view. Hence, if the implication of ecological risk assessment is that there is a problem

arising from a contaminated site that needs to be put right, the next question is what is the desired end-point of the "putting right" actions? Even if it could be determined what the original status of an ecosystem was, is it appropriate to expend resources to restore an ecosystem that does not exist elsewhere in the site's local environment?

At the conclusion of the Stockholm workshop a list of prioritised or ranked issues related to ERA was produced. The issues had been formulated during group discussions in the workshop. The issues were sorted under the headings:

- Legislation/regulation
- Data needs
- Modelling/assessment methods

This list of issues, which is included in the proceedings from the Stockholm workshop, will be revisited during the discussions in the working group.

After its announcement, and in particular in conjunction with the Carcassonne workshop in May 2006, the membership in the ERA WG has evolved strongly showing that there is a great interest in the topic among NICOLE members. The Working Group currently consists of 20 members, out of which 12 are service providers, 4 are industrial members and 4 are individual members (academics/regulators). A proposed agenda for the WG has been distributed for comments. A first meeting with the WG is scheduled to coincide with the workshop in Leuven, Belgium in October. The aim is to present a proposed position/action plan to the Steering Group in spring 2007.

NICOLE Working Group on Natural Attenuation

Roger Jacquet, Solvay, Belgium

NICOLE activities in the field of Natural Attenuation (NA) started in 1998 with a review of the existing Monitored Natural Attenuation (MNA) protocols published in 1999. It was followed by the MNA demonstration project run on 8 sites throughout Europe and completed in 2005.

Since the first NICOLE initiative in 1999, the perception of NA in different countries or regions has evolved and protocols or guidelines for the application of Natural Attenuation as a remedial strategy have been published (England & Wales 2000, Flanders 2003) and some initiatives are going on in

Germany at federal level, while in France NA is considered in the "re-writing" of the legal texts related to contaminated soil management. We hope that the NICOLE activities on NA have had some impact on the recent legislation developments on MNA.

The NICOLE MNA demonstration project made clear that the proposed methodology based on the line of evidence is broadly accepted and considered very useful and that acceptance is facilitated by a structured argument, a conceptual model and a comprehensive data set.

The time has come for promoting the implementation of MNA as well as the concept. Indeed, if it is accepted that MNA has a potential for the management of contaminated soil projects, then it

should systematically be considered among all other management options before selecting a particular solution.

The WG aims to promote the acceptance of MNA, now focusing on its implementation throughout Europe.

The main activities will be to collect MNA case studies to be posted (anonymously) via a NA NICOLE web page. The NICOLE community, site owner as well as service provider, are asked to provide cases where MNA has been accepted by the authorities as stand alone or as part of a treatment train in managing option of contaminated land. A second activity is the follow up of new legislative development regarding MNA. The list of relevant links will be updated as new developments appear.

NICOLE Project Updates

Sustainability of the Natural Attenuation of Aromatics (BTEX)

Previous NICOLE projects [1,2] have shown that industry, regulators and scientists recognise Natural Attenuation (NA) as an interesting process that results in loss of contamination and prevention of plume migration. To prevent future plume migration, the sustainability of NA processes is important. None of the existing protocols considers this element, but this information is essential to give a reliable extrapolation of plume behaviour in the future and to determine the applicability of NA at a site. Within this project, a protocol to determine the sustainability of NA of BTEX was developed.

Naturally occurring degradation processes can mean that active remediation measures might not be necessary, or can be reduced, so a more cost-effective remediation strategy can be implemented. Most protocols that are available to determine the occurrence of NA mainly focus on monitoring of processes that indicate whether degradation has occurred in the past. The information obtained is then extrapolated to predict plume development in the future, for instance using modelling. However, when predicting plume behaviour in the future, the sustainability (i.e. durability) of NA is important. Will the required NA processes also occur in the future? Are estimations and expectations used in modelling still valid in, for instance, 5 or 10 years from now? These uncertainties are mainly caused by a lack of understanding and detailed

information about the underlying mechanisms of NA processes. Also, a structured argument with a conceptual model and a comprehensive data set is necessary to get MNA approved and to take away possible doubts of site owners and regulatory authorities [1].

Together with Dutch governmental and industrial parties a new systematic protocol to determine the sustainability of NA of chlorinated ethenes was developed [3]. This protocol helps industry, governments and consultants to get a reliable picture of the NA processes and the sustainability of NA and is used as a management tool to make decisions and to optimise monitoring activities in the case of NA processes for chlorinated ethenes. Besides chlorinated ethenes, aromatic hydrocarbons (BTEX) form an important group of contaminants in industry that are frequently detected in groundwater plume areas for which natural attenuation is considered. The objective of this NICOLE project was to develop a protocol to evaluate the occurrence and to determine the sustainability of NA of BTEX. Recent knowledge about (anaerobic) BTEX degradation was collected and recent research results were integrated. Specific measurements and/or tests with samples from sites of the participants and other samples were performed (anaerobic bench scale feasibility tests, isotopic analyses, bioavailable iron (III) tests, molecular analyses). The results confirmed BTEX degradation under various conditions.

Together with the knowledge and experiences gained with the new protocol for chlorinated ethenes, a new protocol to

determine the sustainability of NA of BTEX was developed. This protocol provides information about the mechanisms of and prerequisites for NA of BTEX. It includes (analytical) tools to determine the occurrence of BTEX degradation at a site and a systematic approach to determine the sustainability of the process in the future.

The recently developed protocols provide the required structured approach to determine the feasibility of MNA as stand-alone option or as a cost-effective addition to active measures and help to take away possible doubts of site owners and regulatory authorities. The protocols consider the most important groups of mobile contaminants in the groundwater (chlorinated ethenes and BTEX). The protocol for chlorinated ethenes is available via the website of SKB (www.skbodem.nl). The protocol for BTEX will be available via the website of NICOLE (www.nicole.org) soon.

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The Interaction between Soil and Waste Legislation in Ten European Union Countries

This project was a direct result of the NICOLE workshop in Sofia in November 2004, which identified that national and European legislation related to contaminated land management was a key issue affecting NICOLE members. A further complication is the variation between EU member states over the definition of waste and interpretation of legislation. Against this background a one year study was undertaken to investigate the inter-relationships between soil and water legislation in a range of EU member states. NICOLE members in each of the ten countries

were invited to review the legislative situation in their country. The review was structured around ten questions in three categories (legislation, the relationship between soil and waste and soil reuse) in order to allow some degree of comparison between the reviews. Each review was reviewed by a second NICOLE partner. The general conclusions were that comprehensive legislation was present in many of the countries investigated, but that it was generally a very recent innovation; in cases where comprehensive legislation didn't exist, cases were generally examined on a case-by-case basis. Nonetheless, in either situation there were clear limitations to the legislation and opportunities for confusion,

particularly over the interpretation of waste as related to soil reuse. A full report and a summary report were published in December 2005 [1].

The publication of these documents has stimulated a significant amount of comment [2, 3]. Clearly the subject is of concern to a variety of groups and it is hoped that the debate produced through this project will help to bring a legal resolution to the problems highlighted.

1 Available at <http://www.nicole.org>

2 EU study finds "legal vacuum" on reuse of polluted soil in ENDS edition, January 2006 www.endsreport.com

3 Clean and Pleasant Land; The changing world of land remediation in July/August 2006 issue of waste management world www.waste-management-world.com

EU groundwater legislative framework

Phillipe Quevauviller

European Commission, DG Environment, Brussels

Difficulty in locating and quantifying pollution in groundwater can result in a lack of awareness and/or evidence of the scale of risks and pressures on aquifers. A groundwater policy framework was developed in the 1970s (Directive 80/68/EEC) that is now evolving in line with Directive 2000/60/EC, the Water Framework Directive (WFD). This article summarises existing groundwater legislation and related activities.

Directive 80/68/EEC [1] protects groundwater by preventing the introduction of high priority pollutants (List I) and limiting the introduction of List II pollutants into groundwater. Direct discharges of List I substances are prohibited and indirect discharges must be prevented, while direct and indirect discharges of List II substances must be limited. Derogation clauses exist for domestic effluents from isolated dwellings; discharges into groundwater unsuitable for use; re-injection of water used for geothermal purposes and water pumped out of mines, quarries or for civil engineering works. Artificial recharges for management are subject to authorisation on a case-by-case basis if there is no risk of pollution. The Directive will be repealed in 2013 [2], when it will be replaced by the WFD and the Groundwater Daughter Directive, GWDD [3]. The WFD provides a protection framework for both groundwater quantity and quality. Member States must prevent or limit inputs of pollutants to groundwater, prevent deterioration of all groundwater and ensure a balance between abstraction and recharge to achieve good groundwater status by 2015. Under the WFD, Member States have to:

- Delineate groundwater bodies within River Basin Districts (RBD) and characterise the pressures on them and the impacts of human activity on groundwater status to identify groundwater bodies at risk of not achieving WFD objectives.
- Establish registers of protected areas within each RBD, such as Drinking Water Protected Areas, for example.
- Set up a monitoring network based on characterisation, providing a comprehensive overview of groundwater chemical and quantitative status, to be operational by 2007.
- Set up a river basin management plan (RBMP) for each RBD, the first one being scheduled at the end of 2009. A review is planned in 2015, and every six years thereafter.
- With regard to the economic analysis conducted via the WFD and in line with the polluter pays principle, take account of the recovery of costs for water services by 2010.
- Establish a programme to achieve WFD objectives by the end of 2009. This will be operational by 2013, reviewed and, if necessary, updated by 2015 and every six years thereafter.

While quantitative status for groundwater is covered by the WFD, it does not provide specific criteria regarding chemical status (quality objectives). Varied approaches to groundwater protection justified a request to the Commission (under Article 17 of the WFD) to propose specific measures for groundwater pollution. This was adopted on 19th September 2003 (COM(2003)550 final) [3]. It has three pillars:

1. Establish criteria linked to chemical status, based on existing EU standards (nitrates and biocides for example) and threshold values for pollutants of risk to groundwater bodies. These will be established by Member States and will account for scale, hydrogeological conditions, soil vulnerability and specific pressures and so on. They will be reported to the Commission and will be used as future quality objectives.

2. Establish criteria to identify upward pollution trends in groundwater (measurements and requirements for reversals).
3. Determine requirements for the prevention/limitation of inputs of pollutants to groundwater, ensuring continuity with the existing Directive.

Groundwater protection policy is also affected by directives such as the Nitrates Directive, the Plant Protection Products and Biocide Directives, the Integrated Pollution Prevention and Control (IPPC) Directive and the Landfill Directive [4]. Further directives (e.g. sewage sludge) are also indirectly relevant.

The characterisation of groundwater and the design of a monitoring programme and a subsequent programme of measures are closely linked to scientific inputs. Legislation must consider the latest research. Improvements to the implementation of the GWDD are ongoing through projects such as BRIDGE, which develops a common methodology to establish groundwater threshold values. Further EU-funded projects of interest to groundwater policy are in development or are in their starting phase [4]. A Common Implementation Strategy (CIS) is being developed to facilitate understanding, elaborate technical guidance, share experiences and resources and avoid duplication of effort. Stakeholders, NGOs, the research community and Candidate Countries are all involved

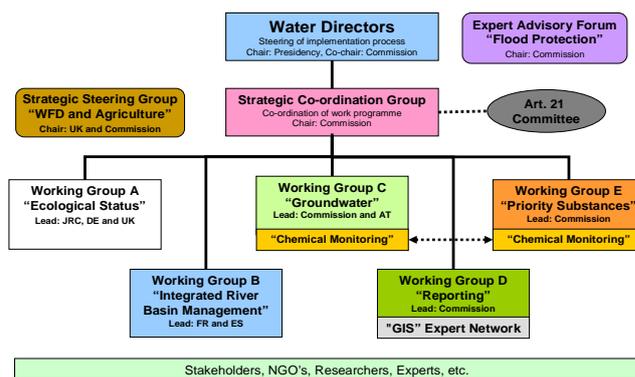


Figure 1 WFD Common implementation strategy (2005-2006)

(see Figure 1). Working Group C (groundwater) has around 80 participants from environment ministries and EU agencies, stakeholder organisations, NGOs and the scientific community. Technical guidance documents on monitoring, protected areas and prevention/limitation provisions are being drafted. A fourth group will draft a guide on compliance and trend assessment. The documents on monitoring and protected areas are finished. Due to delays in the approval of the GWDD, the prevention and limitation document will be delayed until early 2007.

The new Groundwater Directive will generate a wide range of implementation-related activities under the umbrella of the CIS Working Group, which is a unique opportunity to develop an iterative, scientifically-sound, groundwater protection regime based on the WFD milestones in the coming years.

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3. Proposal for a Directive of the European Parliament and of the Council on the protection of groundwater against pollution, COM(2003)550 final.
4. Ph. Quevauviller, *J. Environ. Monitor.* 7 (2005) 89-102.

References 1-3 are available at <http://ec.europa.eu/environment/water>

SPG/ISG/SG Updates

Steering Group

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One of the activities of our network is maintaining interfaces with other stakeholder groups. The Steering Group reviewed the list of interfaces that can be regarded as having greatest importance to NICOLE. The list was slightly adapted and is now as follows:

Common Forum, CEFIC, CONCAWE, Eurometaux, Eurodemo, Heracles, PERF and SedNet.

Volunteers of the Industry Subgroup and Service Providers Subgroup stay in regular contact with these groups. Of course many links from NICOLE members to other groups exist too – and if relevant information pops up it is disseminated within the network.

The lunch session at the SG meeting in Spring was attended once again by representatives of DG Environment and DG Research. Our contact with the DG's has an open and informal character. The SG was updated about the preliminary

ideas for DG Research's FP 7. The first Call for Proposals is expected to be available in 2007. Further, the Steering Group is developing a network communication strategy, both for internal and for external purposes. Lida Schelwald wrote a draft-report which was reviewed by the SG members and by Paul Bardos, the NICOLE Information Manager. The next step will be to select actions that need to be followed up.

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10 years of Industry Subgroup

Lida Schelwald van der Kley
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In 1996, in the Delta Hotel Vlaardingen, the NICOLE Industrial Subgroup was started. Cees Buijs (Port of Rotterdam) had organised the event and became the first chairman of the ISG. The general message of this productive first meeting was: *'How to challenge in a constructive manner'*. After a few years, Cees handed over the chair of the ISG to Bill Hafker (Exxon Mobil). He made the ISG a successful platform for discussing the interests of industry with regard to the management of contaminated industrial sites. His focus was promoting risk based land management in Europe. Together with NICOLE's sister network CLARINET, two joint statements were prepared that still hold their value today, helping to advance the understanding of the potential of RBLM. The fact that NICOLE still works together with the regulatory community is a legacy of cooperative success and continued sense

of shared opportunities. Like Cees, Bill believed that prevention should be a top priority for industrial land management. He draws a parallel with the well known waste hierarchy: "Over time people first tended to dig and dump contaminated land; that is, make the waste and dispose of it. Efforts towards Risk Based Land Management are in effect a 'recycle and reuse' strategy allowing us to re-use land many might previously have seen as in need of 'disposal'. The challenge for the future is to achieve a situation where existing sites are managed for successful reuse, while not creating new contaminated sites." Bill's successor, Rae Crawford, explains that the ISG's topics and focus changed over the years. New topics emerged, like brownfield utilization and sustainability, and industry moved from problem identification to solution generation. This resulted in many new co-funded projects. Where possible the ISG tried to work closely with the Service Providers Subgroup and academics on these projects and tried to maintain an open

dialogue with stakeholders, particularly the regulators, to enhance confidence in risk based solutions for managing contaminated sites. However, according to another former chair, Terry Walden (BP) the true success of NICOLE lies in the opportunities it provides in gaining a wider understanding of what is happening in Europe. This is something which is often overlooked, but is an enduring benefit of NICOLE membership. Enthusiasm seems to be a common characteristic of all of our ISG chairs, including our current chair, Anja Sinke (BP). This enthusiasm seems to be contagious, as many of our ISG members pro-actively engage in projects and working groups. NICOLE and its members have built up an impressive track record of applying cost effective and technically sound risk based management solutions, although evolving legislation and pressure on re-use of industrial land means there is still work to be done.

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Service Providers Subgroup

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The NICOLE Service Providers Subgroup is steadily growing with new members from Sweden, Italy, the UK and Belgium from both contractor and consultancy companies. All SPG members together form a large "body of knowledge". In the open atmosphere of the NICOLE network this knowledge is disseminated. The workshops are the best example of sharing this knowledge and experience. This was clearly the case during the workshop in Carcassonne on site characterisation and the role of the site conceptual model. In organising field activities the SPG members are bringing their practices into the network. During the workshop in December 2005



From left to right: Johan De Fraye (Honeywell), former SPG chairman, Bertil Grundfelt (Kemakta, Sweden), SPG chairman, Laurent Bakker (Tauw, Netherlands), SPG vice chairman.

in Sardinia one of the members showed the network his brand new high tech soil washing plant. The Carcassonne visit in cooperation with the French Adème showed very large scale remediation measures of a mining area. In June 2006 the network was offered a visit to a steam

injection pilot plant in Belgium.

In the SPG meeting of June 2006 Johan De Fraye was thanked for his chairmanship over the last 2 years and went home with the SPG gold medal for being our chairman. Bertil Grundfelt (Kemakta, Sweden) succeeds Johan as SPG chairman and in his opening words emphasised the role of SPG in the dissemination of knowledge in the NICOLE network. Laurent Bakker (Tauw, Netherlands) was voted to become the new vice chairman of the SPG, seeing his role in the continuity of the NICOLE network and to position NICOLE as a stakeholder on soil related topics. Both Bertil and Laurent will take a seat in the Steering Group of NICOLE.

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ERA: an update

**Samantha Fishwick,
Environment Agency, UK &
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Shell Global Solutions, UK**

This article provides an update on the development of an ecological risk assessment (ERA) framework for soil contamination, describing how the draft framework is being improved using feedback from three consultations, namely a public consultation, road-testing with industry and a workshop with UK stakeholders.

The framework was designed using the best available science, based on reviews of other risk frameworks, environmental standards and ecotoxicology tests. Then, with the aim of judging practicality, UK industries carried out ERAs on their own sites. Industry partners (members of SAGTA, Energy Institute and NICOLE) tested a variety of potential pollutant linkages, reporting their findings tier-by-tier. We will jointly publish case studies from this work in the future. In March 2006, UK practitioners discussed the framework in light of the road tests. Feedback from the consultations is summarised below: full details, with EA responses, will be published in 2006.

Feedback from industry

Strengths of the draft framework are its tiered nature and early development of a conceptual site model (CSM). A good CSM backed up with supporting evidence can mean that assessors may exit the framework early on where a pollutant linkage is unlikely. Partners considered the draft soil screening values (SSVs) to be too conservative for practical use. The tools used to measure biological effects received particular criticism. Problems included difficulty distinguishing between effects due to the physical properties of the soil and the contaminants; some current tests being inappropriate for use in made ground; high variability both in some of the tests compounded by varying contaminant concentration; little correlation between organism response and contaminant concentration in many tests; risk of underestimating effects due to sorption of organics onto test media, loss of volatiles during preparation and long incubation times in some tests. Finally, most sites are contaminated by a number of chemicals, but UK legislation requires linkages to be made to specific contaminants. These issues made data interpretation difficult in terms of

ecological risk. Industry partners felt justifying remediation expenditure based on these data would be difficult.

Feedback from the workshop

A workshop attended by about 40 UK-based practitioners (e.g. conservation bodies, Government, regulators, industry, consultants, and academia) discussed the draft framework and findings from the road-testing programme. Key messages from the workshop are presented in the Table below. Most practitioners agreed on the principles of ERA but often conflicted over its practical application.

Activities to improve the framework

Feedback is directing activities to improve the framework, such as:

Linking the framework to UK regulations:

In conjunction with conservation agencies and Government we are improving links between the operational translation and the legal definitions of "harm". We are identifying all potential protection goals in the legislation, then advocating assessments relevant to measurable endpoints.

Decision-making principles: Having clear regulatory protection goals helps build a logical decision-making process. Although flexibility is needed, it is essential to have criteria that can be applied at least as defaults. Together with

conservation agencies we are developing criteria that are not too onerous but give reasonable protection. Principles set out in the problem formulation stage of ERA could be used to modify default criteria.

Guidance for applying ERA tools:

- Process for refining measurements of metal concentrations in soils for more realistic comparison with SSVs. Funds are being sought to compare SSVs with background values in UK soil databases
- Developing 'operating windows' and a decision-support tool for assessors to select and deploy appropriate bioassays.
- Improvements to bioassay methods.
- Guidance on ecological assessment and simple ecological exposure assessment screening models is being discussed with industry and conservation bodies.

The Environment Agency continues to work with practitioners to address the problems encountered so far to ensure that the final framework is fit for purpose. A strong message from the workshop was that even once it is agreed the framework should be flexible, so improvements can be made as ERA becomes better understood. Most see the value of end users and regulators working together, welcoming the openness with which the framework is being developed.

Headline messages from contaminated land practitioners (March 2006 workshop)	
Headline agreement	Headline points where clarification is required
<p>The framework</p> <ul style="list-style-type: none"> ▪ a tiered ERA framework with increasing activity through the tiers ▪ use of weight-of-evidence in decision-making ▪ application of quantitative criteria/thresholds; use of statistics ▪ CSMs drive the identification of potential pollutant linkages ▪ on-site unaffected (by contamination) location is the preferred baseline/reference condition for site-specific ERA <p>Assessment tools</p> <ul style="list-style-type: none"> ▪ use of SSVs as a screening tool - consideration of background concentrations - ability to modify field measured concentrations (PEC) ▪ use of bioassays where appropriate ▪ use of ecological assessment and increase the 'ecology' emphasis in the framework ▪ use of screening tools ▪ these are 'tools in a toolbox', it isn't always necessary to use the full suite 	<p>The framework</p> <ul style="list-style-type: none"> ▪ the linkage between measurement endpoints and the legal definitions of "harm". For example, do the operational translations relate to species of interest, their habitat or all organisms in an ecosystem? ▪ community resilience and redundancy; how are these measured or judged? ▪ The potential risk must justify the effort involved <p>More guidance needed for ...</p> <ul style="list-style-type: none"> ▪ CSMs; their development and presentation in the tiered framework ▪ sampling strategies ▪ weighing of evidence - how? ▪ applying SSVs ▪ bioassays - what to use (relevance), when (operating window) and their interpretation ▪ use of ecological assessment

NICOLE: 10 Years of Solid Delivery

**Paul Bardos and
Hans-Peter Koschitzky**



When the ideas for NICOLE as network first emerged in CEFIC over 1995, contaminated land management (CLM) was very much a fractured discipline across Europe. There were substantial differences in approach between countries. There were virtual fault-lines between different interest groups. Beyond the discussion needed on an individual project there was little concerted dialogue occurring between industry, service providers, regulators and researchers. There was not even a “soils department” in the European Commission. National approaches varied between “multi-functional” and strictly end-use related, and there was little consensus on how environmental quality objectives for soil and groundwater should be set. Attitudes between industry and regulators were polarised, and research projects often had little if any end-user input. So in consequence, research results often did not find the applications or the acceptance that they might have done. Service provision was highly variable in how far it took account of the developing state of the art in contaminated land management practice.

A NATO initiative, the Committee for Challenges to Modern Society, was the catalyst that led to the rapid development of contaminated land management networking in Europe and the now much more harmonious relationships between different stakeholders and national interests in Europe. The CCMS

supported a “Pilot Study” that focused on remediation technologies which included among its participants regulators, site holders, technology developers and researchers from the various NATO countries. Among its participants were two individuals who would play an important role in the development of CLM networking across Europe: Johan van Veen and Harald Kasamas.

When CEFIC initiated discussions on sustainable technology across the chemical industry in Europe there was great interest in CLM as many industries foresaw that it would have a major impact on the management of contaminated sites into the future. A number of key research organisations and researchers were invited to these discussions, including Dale Laidler who with Martin Bell (both ICI) quickly came to the conclusion that some form of network for industry to share know-how on a non competitive basis could bring mutual advantage. Other industrial companies, like the Port of Rotterdam and Solvay, also saw this advantage and they were enthusiastic to join. Together with Dale Laidler and Johan van Veen they prepared a successful proposal for the 4th EU Framework Program. Thus the NICOLE project was born, leading to the inauguration of the network in 1996, funded as a concerted action by the Framework 4 Programme.

In the meantime Harald Kasamas had also been busy and a technical network was born from the regulatory community across Europe, who had already been meeting on an informal basis since 1993 (again catalysed by the CCMS Pilot Study). This was also a Framework 4 project: CARACAS (Concerted Action on Risk Assessment for Contaminated Sites in the European Union). Paul can recall that the two networks greeted each other with some surprise and mutual incomprehension, and the first meeting between their steering groups in a room at a Consoil conference had some

moments of high drama. Yet this first meeting concluded positively, and began a fruitful collaboration between the two networks that gradually led to an increasingly common approach to the technical basis for contaminated land management: i.e. risk based decision making, and a common interest and involvement in research and development projects to bring to bear and end-user perspective. Over time relationships have matured further.

As projects such as CLARINET (Contaminated Land Rehabilitation Network for Environmental Technologies) have come and gone, NICOLE has evolved into a self-funding network. There is now a consensus for risk based land management, with NICOLE taking a leading role in encouraging best practice among industry and service providers and encouraging relevant and well designed research from the academic community. NICOLE and the regulators’ network (the Common Forum) now work together to influence policy and regulation at a European level to try and ensure a balanced approach for CLM across the Member States.

From a technical point of view NICOLE and its projects have been influential in the development of risk based decision making for CLM across Europe, and for the adoption of and guidance for the use of monitored natural attenuation (MNA). Both of these subjects are well represented in NICOLE’s publications archive, a selection of which is listed on page 2.



Johan van Veen (left) and Harald Kasamas (right)

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