

HIP in the Netherlands:

Integrated approach towards optimized use of In-Situ Remediation Techniques

Bottlenecks for the wide application of in-situ remediation techniques

Despite the many advantages of in-situ remediation techniques, their wide market introduction is hampered by two main factors:

1. Insufficient demonstration optimization and verification of the application of in-situ technologies in “real-life” projects.
2. Current policies and operational and decision-making processes are not fitted for the application of in-situ technologies.

The HIP-program

The goal of the HIP-program is to remove those two bottlenecks through demonstration and validation of capabilities and limitations of in-situ remediation technologies in “real-life” contaminated sites. The focus is to frame the uncertainties of innovative approaches such as separated source-plume targeting in comparison to the conventional pump and treat approach, to

A major obstacle to redevelopment of contaminated sites is frequently thought to be the great effort and substantial cost associated with conventional soil remediation. The Netherlands has about 15,000 sites, urgently in need of remediation within the next 10 years. In 2005, a critical report of The Netherlands Court of Audit concluded that the rate of remediation strongly lagged behind this target. The new policy of the Ministry of Housing, Spatial Planning and the Environment is to increase the remediation rate from 900 to 2000-3000 a year. This can only be achieved through the wider application of in-situ technologies. In the years to come, several industries have to perform a branch-wide remediation, involving hundreds of companies. The will for cost reduction drives a strong need for standardized remediation concepts of in-situ remediation techniques in particular.

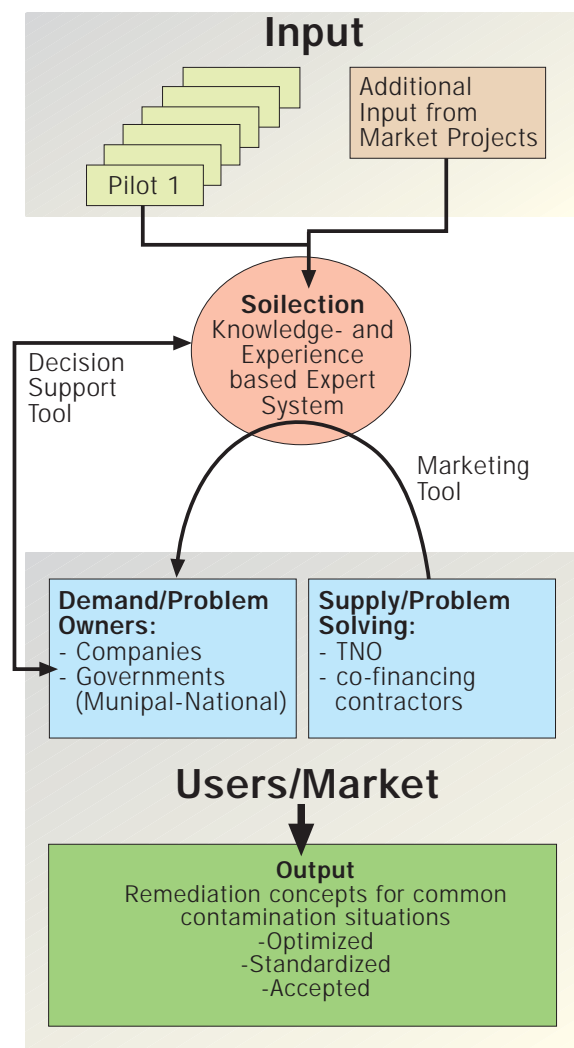


Figure 1. Schematic layout of the HIP program for carrying out in-situ remediation demonstration pilots to stimulate the application of in-situ technologies.

bring the uncertainties to a more acceptable level. This includes the uncertainties towards remediation targets, such as risk reduction versus contaminant concentration or discharge reduction and the concept of a stable end situation.

To reach these objectives the HIP-program (Figure 1) runs demonstration projects from 2006 to 2009 on 24 contaminated sites.

The sites are selected using site archetypes (based on the type of risk-driving contaminants at the site, differences in geo-hydrological conditions (shallow vs. deep, clay vs. sand) and land use (residential, commercial vs. industrial). In addition, SOILECTION, a web-based tool, is developed which comprises of a case-based reasoning instrument and a marketing tool.

SOILECTION incorporates the experience in 110 additional cases. In a separate, operational track of the HIP program the second, non technological, bottleneck is analyzed. In the HIP-program remediation contractors (80-90% of the market), branch organizations, site owners and authorities are jointly involved, making sure all the stakeholders work towards the common goal of standardized and reliable use of accepted in-situ-technologies.

Implementation:

Validation: Can it work?

Most of the existing in-situ remediation techniques have shown a proof of concept under idealized laboratory conditions. Many have also been validated in the field. Whether or not an in-situ technology is useful at a particular site depends on the total set of site characteristics, such as those shown in Table 1. One of the HIP-pilots that is in this validation state involves the potential of mobilization oil contamination from soil through the use of acoustic waves.

Technology Requirements:

Showing when it works, knowing when it doesn't

Under some conditions a particular in-situ technology may not be able to deliver the desired results. For this scenario, another,

Table 1. Common contaminated site characteristics in the Netherlands.

Site Characteristics			Occurrence (% of total)
Contaminant type (C)	C.1	Chlorinated Hydrocarbons	45
	C.2	Aromatics/Oil/MTBE/Cyanide	45
	C.3	Other	10
Geo-hydrology (G)	G.1	Permeable (sandy)	45
	G.2	Layered, permeable and impermeable layers	45
	G.3	Other	10
Built Environment (B)	B.1	Urban	70
	B.2	Industrial	25
	B.3	Other	5

Table 2. Matrix of contaminated site archetypes based on common combinations of contaminant type (C), Geohydrologic conditions (G) and Land Use in the Netherlands.

Pilot Archetype Group 1 2500 sites		Pilot Archetype Group 2 2500 sites	
C.1	Chlorinated Hydrocarbons	C.1	Chlorinated Hydrocarbons
G.1	Permeable soil	G.2	Layered, permeable and impermeable layers
B.1	Built Environment (urban)	B.1	Built Environment (urban)

Pilot Archetype Group 3 5000 sites		Pilot Archetype Group 4 3500 sites	
C.2	Aromatics/Oil/MTBE/Cyanide	C.1	and/or C.2
G.1	Permeable soil	G.1	and/or C.2
B.1	Built Environment (urban)	B.2	Built Environment (industrial)

better suited, in-situ technology might be available. Alternatively, in-situ technologies may be combined (in space or time) to yield the desired result. The pilots in the HIP program serve to provide in-sight into the potential of an in-situ technology as well as its requirements. In addition the HIP pilots serve as tests for broadening the application of in-situ technologies such as chemical oxidation and (enhanced) natural attenuation, towards conditions different (contaminant and soil type and heterogeneity) than under which commonly applied.

Knowledge transfer: Decreasing uncertainties

The large number of and wide range in types of in-situ remediation techniques, combined with the many site variables (hydrogeological, chemical, social, operational etc.) hampers the understanding of the in-situ remediation potential on the side of problem owners and legislators. Despite the variability, most contaminated sites in the Netherlands can be grouped based on very general site characteristics (Table 2). By demonstrating the use of in-situ technologies at sites that belong to these pilot groups, knowledge transfer occurs on whether and when a particular in-situ technology or combination thereof, works. This will allow the building of a confidence base amongst the problem owners and legislators.

Discussion:

Acceptance (do we want to use it?)

Whether or not an in-situ remediation approach is followed will firstly depend on the level of trust that a problem owner has in a proposed in-situ methodology. The demonstration projects in the HIP program are input to the SOLECTION knowledge- and experience based expert system (Figure 1). This will function as a webbased decision support tool, i.e. the past experience from similar contaminated sites is available as a base to support decisions in choosing whether and which in-situ remediation concept is most suitable. The remaining level of uncertainty is caused by unique site-specific aspects that should be mapped out in detail to minimize risks towards cost and time overruns. The centralized access to available knowledge and experience allows better founded decision whether to use in-situ technologies and consequently reduce risks, while optimizing the definition of alternative scenarios and milestones during project operation.

Use (will we use it?)

Ultimately, whether or not in-situ technologies are used, will depend on governmental policies and legislative framework. This should not only provide the need for remedial action, but also present clear, verifiable remediation goals. The shift

in government policy from concentration-based towards riskbased remediation standards with the future land use function in mind will aid in the development of site-specific, attainable remediation goals.

Research Pilots within the HIP program

The individual pilots of the HIP program are R&D “addons” to commercial remediation to facilitate optimal knowledge transfer to the Dutch remediation market which the overall HIP program aims to stimulate. The research focus of the individual pilots within the HIP program is therefore driven by bottlenecks in the market, these can be technology specific or pertain to more general knowledge gaps such as how to determine whether a stable contaminant status has been reached after remediation. To achieve a stable end situation and to underpin the termination of after care can be difficult. In a pilot with Biosoil, innovative monitoring methods like isotope analysis are being used as a solution to those difficulties. For in-situ chemical oxidation (ISCO) technologies, an important factor in determining their remediation effectiveness is the natural oxidant demand by the sediment phase. However, little is known on how sediment heterogeneity affects the oxidant demand for the various oxidant applications, such as ozone, peroxide or persulfate. In a HIP pilot with contractor SITA Remediation the research focus is on optimizing the ISCO application of permanganate and Fenton's reagents in a heterogeneous sandy aquifer contaminated with chlorinated solvents. With the help of stable carbon isotope measurements to track the oxidation reactions the optimal use of the selected ISCO treatments is determined.

