REGENESIS®

Report

Environmental Industry Chlorinated Solvent Market Survey Response

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Early in 2024, REGENESIS surveyed a cohort of over 300 environmental remediation professionals to determine the state of the market for remediating chlorinated volatile organic compounds (CVOCs) in groundwater. Based on the survey results, REGENESIS has published the following overview, offering a current look at the market while outlining potential future trends for remediating sites impacted by CVOCs.

The Remediation Market

> *How many chlorinated solvent remediation projects do you project to move forward this year? And which chlorinated site types does your team work on?*

Results

70%

of respondents have five or fewer chlorinated remediation projects ready to move forward in 2024

About 70% of respondents have five or fewer chlorinated remediation projects ready to move forward in 2024 while 56% have a similar number of projects as in the past. The number of people who responded with fewer projects more than doubled those with more projects (21% to 9% respectively). The top three categories of chlorinated solvent sites are industrial manufacturing, dry cleaners, and commercial real estate (i.e., strip malls), which may generally reflect the population of active chlorinated sites.

Future Trend

As Chlorinated Solvent Sites Are Closed, Remaining Sites Will Be More Challenging

These results indicate a relatively stable chlorinated remediation market, with a potential slight downward trend. This would be the expected trend as the pool of chlorinated sites shrinks due to more sites achieving regulatory closure. Over time, the remaining chlorinated solvent sites are expected to become more challenging to remediate.

Remediation Technology Selections

> *Please rank order your "Go-To" technology used for treating chlorinated contaminants in groundwater within a low-to-moderate-concentration plume, and within a moderate-to-high-concentration plume:*

Results

On an individual basis, ISCO was the most frequently selected technology for both low-to-moderate-concentration (Low-C) and moderate-to-high concentration (High-C) plumes. ISCO received less first-place selections (n=54) than ERD (59) for Low-C plumes but received the highest number of first-place selections as a 'Go-To' technology for High-C plumes by over 50% (82 to 54).

Enhanced reductive dechlorination (ERD) was the most selected technology when including multi-technology approaches. ERD and ERD combinations, including ERD/ISCR and ERD/Carbon-Sorption, were selected more than twice as much (n=603) as ISCO (253) for Low-C plumes. When only the top three technology selections are considered, remedies containing an ERD component were selected approximately 56% more than those selecting ISCO (246 to 158).

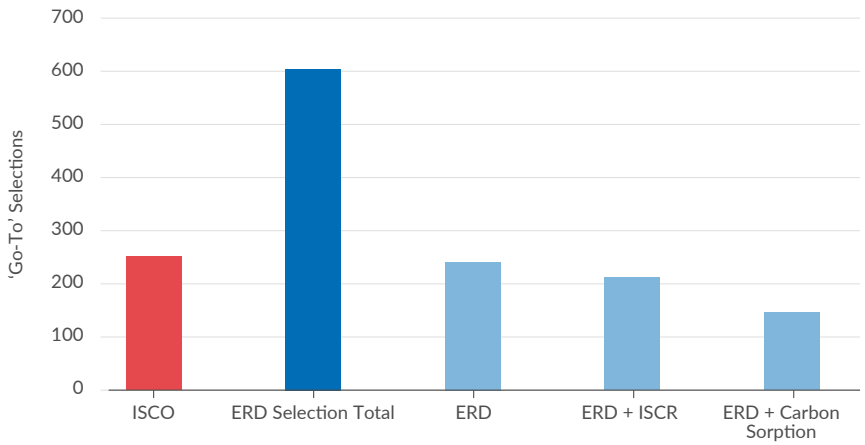
For High-C plumes, ERD or ERD-combinations were selected 17% more than ISCO. ISCR and ISCR combinations were selected 11% more based on the Top-3 'Go-To' selections.

Beyond ERD, ISCR, and ISCO technologies, Natural Attenuation placed highest as a 'Go-To' option for Low-C plumes. As a single technology, it ties ERD with the most first-place selections. Excavation approaches also ranked high on High-C sites (tied for 2nd-place as the top 'Go-To' selection), presumably implemented for 'hot-spot' removal.

Figure 1

ISCO vs. ERD 'Go-To' Selections

Chart showing the total number of technology selections for ISCO and ERD, including ERD combinations. Dark blue indicates all selections where ERD was included. Light blue bars show the individual technology choices.



Future Trends

Multi-Technology Approaches Using ERD and ISCR Will Continue to Increase

ERD, ISCR, and carbon-sorption technologies are often co-applied, creating synergistic effects that improve remedial outcomes.

> For example, applying ISCR creates a reducing environment that is also favorable for facilitating anaerobic bioremediation of chlorinated solvents. Carbon sorption increases CVOC retardation, dramatically shrinking the time and space needed for ERD and ISCR reactions to degrade CVOCs fully.

These benefits are realized from co-applying multiple technologies to optimize remediation progress are anticipated to become more important over time, compared to the past where single technology approaches that relied on one destruction mechanism were more prevalent.

ISCO Will Remain a Primary Tool for Remediating Chlorinated Solvents

ISCO is expected to remain an important tool for quickly reducing chlorinated solvent mass in source areas. It can also be used for achieving closure criteria where treatment goals are not as stringent. The sequential use of ISCO and ERD/ISCR is likely to remain a common approach.

Reliance on Monitored Natural Attenuation (MNA) Remedies Expected to Increase

Monitored natural attenuation (MNA), a key approach for addressing the potential risk due to chlorinated solvent plumes in groundwater, will likely increase as a 'Go-To' approach for qualifying sites as companies look to reduce environmental costs in the wake of recent PFAS (per- and polyfluoroalkyl substances) regulations.

Using Mechanical Approaches Like Pump & Treat and Air Sparge Will Decrease

As *in situ* remediation technologies and MNA approaches continue to gain favor, mechanical technologies such as pump & treat (P&T) and air sparging (AS) are likely to decrease, continuing a decades-long steady decline.

Working With Technology Providers

> *Who is responsible for developing a remedial design for your chlorinated solvent groundwater remediation projects (in-house or technology provider)? And how does your office like to work with a remediation technology provider?*

Results

60%

of respondents preferred to collaborate with technology providers and in-house staff

Using in-house staff to recommend or specify the remedial approach and then collaborating with a technology provider on an application design was selected almost 60% of the time, 3x more than developing the design in-house and 10x more than outsourcing the design and remedy selection. Additionally, respondents prefer to retain some management of the remediation projects vs. outsourcing the remediation project fully (i.e., turn-key).

Future Trend

Consultants will continue to rely on technology providers for design support while retaining control over the general remedial approach and technology selection. This collaborative approach will likely remain steady or increase as sites become more complex and technology offerings/combinations more diversified. The increasing site complexity could also lead to rising requests for turn-key services and more remedy selection input from technology providers.

Remediation Project Drivers

> *Top three factors driving your groundwater remediation technology choice*

85%

of respondents chose cost as a leading factor for technology selection

Cost is the leading factor for technology selection at 85%, followed by previous experience with a technology (72%), and speed/time required to meet a regulatory target (71%).

Future Trend

Cost and Speed (Time and Money) Will Remain Primary Considerations in Selecting Remediation Technologies

Unsurprisingly, cost is the #1 factor in deciding a remediation technology. The speed/time required to meet regulatory targets ranks almost as high. In remediation, cost and time are inseparable as reducing the project lifecycle is the best method to control costs. Cost and speed to closure will remain dominant factors. However, even if they purport these benefits, new remedial technologies may struggle to gain traction due to the high value placed on prior experience.

Greenhouse Gases (GHGs)

> *Have greenhouse gas emissions (GHG) entered your conversations with clients relating to current remediation projects? Does it influence the current selection of groundwater remediation approach? And do you foresee GHG emissions data having greater importance to your clients in the future?*

66%

of respondents state that GHG emissions are becoming more or somewhat more important

Two-thirds of survey respondents state that GHG emissions are becoming more or somewhat more important.

Future Trend

The Importance Placed on GHG Emissions Will Slowly Increase

Since the 1990s, *in situ* remediation has been seen as a way to eliminate unnecessary energy consumption and attendant generation of GHGs by P&T systems. This benefit of *in situ* approaches that do not waste energy by pumping water will become more appreciated in the coming years, particularly as new remediation sustainability models, that quantify GHG emissions (i.e., carbon footprints) for remediation technologies become more widely used throughout the industry.

Conclusion

Adapting Remediation Strategies to Evolving CVOC Site Challenges and Sustainability Goals

A slowly declining pool of CVOC-contaminated sites means that the remaining sites will likely be more challenging to remediate. This will continue to fuel the demand for synergistic, multi-technology approaches that can be flexibly applied to different areas in a CVOC plume. ERD, ISCR, and carbon-sorption technologies that can be coapplied will become even more integral to achieving site closures. ISCO will continue to be important for reducing CVOC source mass in stubborn hotspot areas.

Plume-wide MNA approaches for achieving closure are likely to increase, in some cases enhanced by chemical adsorption of CVOCs in barriers to retard the contaminants, allowing natural attenuation to be more effective in preventing CVOC plume expansion.

A collaborative approach where the consultant leads remedial decision-making and the selection of technologies, with technical input from the technology provider on their application, will likely continue to be the preferred approach moving forward. Cost and time-to-closure will drive remedial technology selections for the foreseeable future along with personal experience with proven technologies.

The consideration of GHG emissions is likely to increase over time in selecting remedial approaches, especially in states like New York, where sustainability is factored into remediation decision-making at the regulatory level. This will result in fewer mechanical (P&T and AS) approaches implemented over time.

REGENESIS will continue to lead the global groundwater remediation market by developing innovative and synergistic remediation solutions for the CVOC market that rapidly reach site goals, with the lowest life-cycle costs. REGENESIS will prioritize methods that reduce greenhouse gases (GHGs) and will collaborate closely with environmental consulting firms to optimize remedial decision making.