

## 10 Years of In Situ Chemical Reduction in Tropical Environments: Lessons Learned and Conclusions So Far

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**Background/Objectives.** Since 2007 SGW has been using ISCR for chlorinated solvents and heavy metals contaminations in more than 25 successful projects in Brazil. During these 10 years of experience with technology, SGW has injected more than 715,000 kg of remediation product, distributed at around 1,500 injection points and 22,500 meters of drilling. Although targets were achieved in all the projects, several “rules” and “assumptions” had to be redesigned through the years and new understanding arose from project to project. From specific formulations to amendments performance and longevity, several changes and learnings were made in order to reach a high performance. Faster and complete reactions, better amendments distribution, longer reactivity, clay / temperature / biological / geologic issues.

**Approach/Activities.** Initially, our first challenge was to inject the ISCR amendment into the subsurface with the equipment available in Brazil, and then how to deliver the amendment in correct location concerning the distribution and influence radius. With this step covered, we started focusing in quantities and efficiency. After the first project results exceeding the expectations, we started tracking the reactions and learning the key aspects that allowed higher performance. Then we went to the amendment formulation step, adjusting the formulation and the ingredients based on the site characteristics and targets. Finally, we learned how to improve our injections, using pneumatic and hydraulic fracturing, controlling pressure and flowrate during injections, adding anti-methanogenic reagents, combining technologies and being able to remediate more complex sites on shorter time and lower costs, always without rebound effects. In the beginning our amendment mixture was prepared by hand and the pumps adapted from other applications. Once the projects and amendments volume has increased significantly we introduced automatic mixers to reach efficiency and exchange the injection pumps to avoid breaks and excessive maintenance.

**Results/Lessons Learned.** The results were achieved in all the projects but, with the learning curve, the newer projects were always more effective than the older ones, as well more cost effective. Formulations were adjusted to our specific geologic / climate / biological conditions, resulting in custom made amendments. Equipment was developed and adapted based on technology transfer and site-specific conditions, this way allowing higher performance, lower costs and guessing process. The most challenging projects were those that presented heterogeneous lithology conditions with different layers intercalation in which conditioned the fate and transport of contaminants and consequently influence to the right injection design. Today we use specific self-developed equipment and injection systems, customized formulation for each site, considering the site contamination, specificity and targets.