

## Remediation for Mercury Stabilization by In Situ Chemical Reduction (ISCR) in Groundwater (Brazil Site)

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**Background/Objectives.** An active paper plant, located in the São Paulo State (Brazil), presented mercury concentrations in groundwater up to 895 µg/L in August 2011. A remediation process was designed to protect the River located downstream of the site. The plume of contaminant extended through an area of 8000 m<sup>2</sup> with 8 m deep (from 5.00 to 13.00 meters above ground). The predominant lithology is composed of sandy sediments and it is estimated that the linear groundwater flow velocity is 0.077 m/s.

**Approach/Activities.** The remedial approach involves stabilization of mercury in situ via injection of EHC-Hg<sup>®</sup> amendments, which is composed of zero valence iron (ZVI), and a source of sodium sulfide to promote precipitation of mercury as HgS. In December 2011, a pilot test was conducted in an area measuring 36 m<sup>2</sup>, in the vicinity of a monitoring well with concentration of 420 µg/L of mercury. After 194 days, the results showed a reduction near 92% of mercury concentration. Geochemical data showed an increase in pH and a decrease of oxidation reduction potential (ORP), strong indicators of mercury stabilization as sulfide salts. Calculations showed a 2.5 m radius of influence, confirmed by soil samples collected equidistantly between two injection points. The large scale was executed in four steps throughout the years between 2012 and 2014. Each step injected 13 ton, 12.5 ton, 8.1 ton and 16.6 ton of EHC-Hg<sup>®</sup> diluted in water. During the third and fourth steps, a complementary assessment, mathematical flow and transport modeling, was performed that identified a new mass center of mercury with concentrations up to 1060 µg/L, besides confirming the River as the only superficial water body to be protected. Due to these conclusions, the fourth step was re-designed to act upon the identified mass center and address the hydrogeochemical and the diffusely distributed mercury uncertainties. The efficiency was accompanied during the injection steps, in addition to five campaigns of groundwater monitoring after the last injection.

**Results/Lessons Learned.** After the EHC-Hg<sup>®</sup> injection, a reduction of mercury concentrations on both mass centers was detected, with reduction of 94.12% in the dimension of superficial plume and 98.84% of estimated mercury mass dissolved in groundwater. Furthermore, no concentrations of mercury were observed in the wells located downstream of the electrolysis area, which implies that the plume did not reach the River. However, in spite of the favorable achieved status, the presence of an impenetrable layer in the new mass center, the scattered mercury distributions in the unsaturated soil and pH oscillation detected in some monitoring wells may disturb the equilibrium in the long term (> 30 years), so it is being recommended that total sealing of the area be completed to lower the partitioning of mercury from soil to water and measures are taken to control the leachate leakage and maintenance of annual groundwater monitoring.