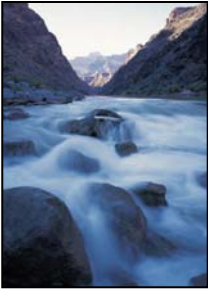


# Stabilization of Zinc in Soil and Groundwater

*using in situ techniques for developed properties*

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A recent remediation project focused on *reducing leachable zinc concentrations in soil and groundwater*. The zinc sources were from historical industrial operations at the site, which were partially remediated prior to site redevelopment. Continued exceedances of zinc in surface water discharges resulted in the need for further zinc remediation following the construction of an apartment complex on the site.

Since the site was redeveloped, remediation alternatives were limited to injection technologies. Several chemistries were evaluated for injection and long-term stability of zinc in soil and groundwater. The selected approach achieved leachable zinc concentrations below the remediation goal of 2.0 mg/L. Testing to demonstrate long-term leaching showed that the selected approach would maintain the required site conditions for stabilizing leachable zinc for over a 400-year period.

## Zinc in the Environment

Zinc is naturally occurring in the environment, and is an essential nutrient in humans, plants and animals. In larger doses, *zinc can become a potential toxicity hazard and an environmental threat*. Aquatic organisms are especially sensitive to zinc, therefore the concerns at this site were due to the groundwater discharge to surface water.

Zinc in several forms has many uses in a variety of industries. Metallic zinc is often mixed with other metals to form alloys such as brass and bronze. Zinc can combine with other chemicals to form salts. Most naturally-occurring zinc is found as a zinc sulfide mineral. Zinc salts are used to make white paints, ceramics and rubber. Zinc is also used in preserving wood, and manufacturing and dyeing fabrics.

## Site Background

A 21-acre parcel in the Mid-Atlantic United States hosted several industrial operations from 1907 to 1982. Groundwater at a pH of 5 SU and containing as much as 30 mg/L of zinc discharges to a small stream on one edge of the facility. The site surface was remediated and redeveloped into an apartment complex. Groundwater remediation to a goal of 2.0 mg/L zinc was deferred until after the apartment complex was built. *In situ* stabilization technologies that could be applied with minimal interference with site use were evaluated and implemented to achieve the remediation goal.



## Remediation Approach

The remediation had to reduce aqueous zinc concentrations using reagents that were amenable to injection. Two approaches were considered:

1. **Zinc Hydroxide.** Zinc sequestration as a hydroxide [Zn(OH)<sub>2</sub>] can achieve the necessary concentration reductions with an increase of pH from the acidic site conditions to pH values in the range of 8 to 10 SU. A magnesium hydroxide [Mg(OH)<sub>2</sub>] slurry was selected as a pH buffer for zinc stabilization.
2. **Zinc Sulfide.** Zinc can also be sequestered as a zinc sulfide mineral [ZnS] to low aqueous concentrations. Sulfide application is commonly used in waste water treatment systems as calcium polysulfides [CaS<sub>x</sub>]. The material has a very high pH and has the potential to create hydrogen sulfide odors. A slurry consisting of native sulfur and a pH buffer that would produce polysulfides after injection (and thereby mitigate potential odor issues) was also evaluated.

**Treatment Trials.** During treatment trials, the untreated soil leached with groundwater produced 14.7 mg/L of zinc. Addition of all reagents produced comparable results, with leachable zinc concentrations reduced by more than 99.9 percent. The remediation goal of 2.0 mg/L was achieved by a factor of about 200. The magnesium hydroxide approach was cost-effective and carried none of the potential nuisance concerns associated with sulfur applications. A series of multiple extract tests using magnesium hydroxide-treated soil leached by site groundwater demonstrated that the remediation goal would be maintained for a period of over 400 years.

**Pilot Test.** A pilot test was completed to demonstrate the in-field application of the injection process and efficacy of the remedy. Zinc concentrations in groundwater downgradient of the injections fell from 21.2 mg/L to less than 1.0 mg/L within 7 months following the injections.

**Full-Scale.** A total of 45,000 gallons of magnesium hydroxide slurry was injected into 63 borings to form treatment barriers along the downgradient side of the site. Approximately 3 weeks were required to complete the injections. Downgradient monitoring wells will be sampled periodically to assess the full-scale performance of the remedy.

## About ReSolution Partners, LLC

ReSolution Partners delivers environmental solutions designed to meet our client's objectives. Our staff combines cost-effective environmental strategies with customized remedies to alleviate an environmental liability.

For additional details regarding this project or metals stabilization, contact Bernd Rehm at 608.669.1249 or at [brehm@resolutionpartnersllc.net](mailto:brehm@resolutionpartnersllc.net).