NanoFe™
Supported Zero-Valent Nanoiron

Insitu Groundwater Treatment Using Nanoiron: A Case Study

PARS Environmental Inc.
Outline

■ OVERVIEW OF PARS
■ INTRODUCTION
■ TECHNOLOGY OVERVIEW
■ CASE STUDY
■ SUMMARY
■ RECENT PROJECT EXPERIENCE
OVERVIEW OF PARS

- Established in 1984
- PARS focus is innovative technologies
- PARS provides engineering, environmental, and health & safety services
- New Jersey Technology Council selected PARS as “Environmental Technology Company of the Year” in May 2004
Introduction

- Nanoiron will remediate recalcitrant contaminants in soils and groundwater
- Sub-micron ($<10^{-6}$m) particles of $\text{Fe}^0$ with a noble metal catalyst
- Based on proven redox processes
- Very flexible and destroys contaminants rapidly *in-situ* or *ex-situ*
Treatable by Nanoiron Technology

- **Contaminants:**
  - Halogenated aliphatics (PCE, TCE, 1,1,1-TCA, 1,1,2,2-TeCA)
  - Halogenated aromatics
  - PCBs
  - Halogenated herbicides & pesticides
  - Nitroaromatics
  - Metals (e.g. Cr\(^{+6}\), As)

- **Geologic Conditions:**
  - Sand
  - Silt
  - Fractured rock
  - Landfills
  - Fill materials
  - Sediments
Nanoiron Dehalogenation Schematic

Noble Metals
- forms galvanic cells
- catalyze hydrogenation

Base Metal
- Electron donor

Noble Metal
(Pd, Pt, Ag, Ni, etc)

Base Metal
(Fe, Zn, Al, etc)

C₂Cl₄ → C₂H₆ + Cl⁻
NanoFe™

- Major process variables:
  - Fe⁰ surface area
    - BET Surface Area 30 m²/g
  - Presence of a noble metal catalyst
  - Nanoiron can be injected by gravity or under pressure
A Case Study

- Landfill site located adjacent to a Switchyard
- Soil and groundwater contaminated with chlorinated solvents (1,1,1-TCA, TCE, PCE, 1,1-DCE, 1,1-DCA) and metals (Al, Pb, Ni)
- >$1.0 million has been spent on natural attenuation
- Active remedy required
  - Excavate the Fill Area
  - Use Nanoiron technology to treat chlorinated solvent contaminants in ground water
Full-Scale Nanoiron Remediation

The remedial goal - inject Nanoiron slurry into the most contaminated portion of the plume to significantly reduce the contaminant concentrations

Nanoiron injection in two phases:
- Phase 1 - 3,000 pounds of Nanoiron were injected over 20 days
- Phase 2 – 1,500 pounds of Nanoiron were injected over 10 days

Nanoiron was applied in an injection grid
Schematic of Field Application Set-up

injection and transport of nanoparticles in aquifers

- Pump
- Metal Particle Suspension
- Monitoring Well
- Waste Well
- Injection Well
- In Situ Reactive Zone
- Control Volume
- Aquifer Solids
- Deposition
- Attachment
- Flow
- Detachment
The Field Application Set Up
NanoFe™ Application

NanoFe™ = Fe⁰ with Pd⁰ (catalyst)
Nanoiron Field Application
(Landfill Site, New Jersey) – CVOCs Trends

Chlorinated Compound Concentrations (ug/L)

Date

1st Nanoiron Injection

2nd Nanoiron Injection

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Nanoiron Field Application
(Landfill Site, New Jersey) – ORP and pH Trends
Nanoiron Field Application (Landfill Site, New Jersey) – Ethane and Ethene Trends

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Total VOCs Plume - Baseline
Total VOCs Plume – After First Nanoiron Application
Total VOCs Plume - After Second Nanoiron Application
Total VOCs Plume - Third Post-Injection Monitoring
Summary

- Dissolved chlorinated groundwater contaminants degraded significantly

- Positive remedial effects of the Nanoiron injection activities are still occurring throughout the Perched Water zone
Summary - Nanoiron Technology

- Treats dissolved plume and source area(s)
- No depth limitations
- Highly reactive – rapid degradation & no toxic intermediates
- Portable – low capital + O&M costs
- Easily injected, Nanoiron flows with groundwater
- Low Nanoiron /contaminant ratios required
# Recent Project Experience

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For further information, please contact:

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