



**SITE:** FORMER PESTICIDE MANUFACTURING FACILITY

**Project:** Pilot-Scale Deep In Situ DARAMEND Injection for Source Zone Reduction of Chlorinated Pesticides

**Client:** Confidential

### BACKGROUND

ADVENTUS conducted a laboratory study to demonstrate the effectiveness of deep in-situ DARAMEND™ bioremediation of soil contaminated with volatile organic compounds (VOCs) and organochlorine pesticides (OCPs). A pilot-scale demonstration project is also currently proceeding on site.

The bench-scale work evaluated many DARAMEND treatment scenarios, using numerous DARAMEND products, as well as straight anoxic conditions, versus aerobic-anoxic cycling. The studies were performed in sealed columns to simulate in-situ conditions and prevent contact with the atmosphere. The best treatment consisted of the addition of DARAMEND 2002/6390Fe20, which seamlessly integrates fibrous organic matter with micro-scale zero-valent iron. This treatment reduced the total OCPs from 46.9 mg/g to 1.1 mg/g after 117 days of treatment, representing greater than 97% reduction in total OCPs. During this same period, the VOCs, primarily xylene and ethylbenzene, were reduced by over 99%.

### PILOT-SCALE DEMONSTRATION

Given the success of this treatment technology at bench-scale, a pilot-scale demonstration project was initiated in October of 2003. The goal of the project was to reduce source zone soil concentrations of OCPs and VOCs through the deep in-situ injection of DARAMEND into the source area. A series of four applications of 1% DARAMEND by weight with respect to the mass of soil in the contaminated area was designed for. The applications were to occur at intervals of 14 to 21 days.

The targeted zone of contamination was a highly weathered limestone, at depths of 31' to 37'. The injection method consisted of driving rods to these depths using a Geoprobe rig, followed by hydraulic fracturing and injection of DARAMEND. Four locations were chosen for injection, with two to three depths per location. At each location, a total of approximately 2,800 pounds of DARAMEND were injected (i.e. 1,400 pounds per injection at locations with 2 depths, and 930 pounds per injection at locations with 3 depths).



**Fig. 1 From top to bottom:  
DARAMEND bag, injection hose,  
and jar of DARAMEND.**



**Fig. 2** Creation of DARAMEND and guar mixture.



**Fig. 3** DARAMEND layer injected between clay and weathered limestone.

The DARAMEND was delivered to the site in 25 kg bags for ease of handling, and the material was handled with negligible dust creation (**Figure 1**). The DARAMEND product can be delivered in any size of bag required for the project. To inject the product, it was placed in a hopper, and mixed in-line with a guar solution for delivery to the subsurface (**Figure 2**). To enhance groundwater movement through the DARAMEND fractures, sand was introduced in some fractures, at ratios of 1:2 and 1:1 sand to DARAMEND by mass. The product was successfully injected in each of these scenarios.

Sampling of the subsurface to determine the aerial and vertical extend of the DARAMEND injections was performed using Geoprobe sampling equipment. The DARAMEND layers were easily visible from the cores, whether the fracture was a hairline fracture near the tip of the fracture, or whether it was a few inches in thickness closer to the injection location (**Figure 3**).

### Results

Soil concentrations of Toxaphene and total OCPs were measured in June of 2004. Given the fact that OCPs bind strongly to the soil, the concentrations vary widely from one location to the next. For samples that were taken from as close to the same location and depth as possible, and for samples that showed a decrease in concentration between November 2003 and June 2004, the results are tabulated in Table 1. Four out of twelve samples showed an increase between these sampling dates, however the median concentrations of those increases were 9 µg/g and 12 µg/g for Toxaphene and total OCPs respectively.

These data show that the soil concentrations of Toxaphene and total OCPs decreased significantly between the dates shown. The decrease in the average concentration of both Toxaphene and total OCPs was 93%.

**Table 1. Influence of in-situ DARAMEND on average Toxaphene and total OCP concentrations between November 2003 and June 2004 for selected samples.**

	Toxaphene (µg/g)	Total OCPs (µg/g)
Average Nov 2003 Value	127.7	169.1
Average June 2004 Value	8.7	11.8
Decrease in Average Concentration	93.2%	93.0%

**Future Work**

Given the success of the treatment to date, preliminary plans are being made for further injections on site, to target a second hot spot.

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