



PROJECT

Project Bioremediation of Soil Containing Organic Explosives

Site: Joliet Army Ammunition Plant (JAAP) Wilmington, Illinois, USA

SUMMARY

DARAMEND® bioremediation effectively reduced the concentrations of TNT, DNT and Tetryl during two separate pilot-scale demonstrations on contaminated soil from the JAAP. DARAMEND bioremediation was also effectively applied during a full-scale (3,000 ton) demonstration of the technology at the same site on TNT impacted soil.

CHALLENGE

The challenge for each of the pilots and the full-scale demonstration differed. The first pilot-scale demonstration was conducted by Plexus Environmental, under contract from the US Army Environmental Center (AEC). In this case, DARAMEND bioremediation was one of five technologies evaluated for their effectiveness on TNT and Tetryl contaminated soils. The hypothetical remedial goals for TNT and tetryl were 150 mg/kg and 20 mg/kg, respectively.

The second pilot-scale demonstration was conducted on soils contaminated with TNT, Tetryl and DNT. During this demonstration the technology was applied using a windrow application, rather than a land-farm application as had been used in the first pilot, this demonstration compared DARAMEND technology with composting. For the purposes of this demonstration the remedial goals for tetryl, TNT, 2,4-DNT, and 2,6-DNT were established at 14 mg/kg, 15 mg/kg, 8 mg/kg, and 8 mg/kg, respectively.

The third demonstration aimed to prove that DARAMEND could be effectively applied at large-scale using windrow application.

SOLUTION

The first pilot-scale demonstration was conducted by an independent third party (Plexus Environmental) under contract from the US AEC with the intent of evaluating five potentially innovative biological treatment technologies for use on organic explosive compounds. The official report evaluating DARAMEND and the other four technologies is available through the US AEC web page.

During this demonstration two 10-ton bioremediation cells were constructed by Plexus Environmental, and DARAMEND bioremediation was applied according to protocols. One treatment cell contained TNT impacted soil, and the other contained tetryl impacted soil. The entire demonstration was scheduled to last 120 days, regardless of the analytical results; therefore twelve, 10-day treatment cycles were applied to each soil.



Each cycle consisted of the application of 1% (w/w) DARAMEND organic amendments and 0.1% (w/w) powdered zero valent iron. Following amendment application the moisture content was increased to about 80% of the soil water holding capacity. During the second pilot-scale demonstration, DARAMEND was applied to two 150-ton windrows. In this case, six 7-day treatment cycles were applied to soils impacted with Tetryl, TNT and DNT. A K-W windrow turner was used to incorporate amendments and aerate the soil when necessary. Again, each cycle involved the application of DARAMEND organic amendments (1%(w/w)), powdered iron (0.1%(w/w)), and moisture (up to 80% of soil WHC).

The third demonstration, applied at full-scale, was primarily intended to demonstrate the applicability of this technology, using windrows at full-scale. In this case, two windrows containing approximately 1,500 tons of TNT impacted soil were treated using DARAMEND bioremediation. Three treatment cycles similar to those described above, were applied to these windrows.

RESULTS

Interestingly, the conclusions drawn by Plexus during the AEC biotechnology comparison indicated that DARAMEND bioremediation was the only technology evaluated capable of reaching the remedial goals for tetryl impacted soil, and was forecast to be the cheapest for TNT impacted soils.

TNT concentrations were reduced from an initial value of about 5,900 mg/kg to less than 150 mg/kg after 48 days of treatment. The concentration decreased to 114 mg/kg through the end of the demonstration. The concentration of tetryl was reduced from about 6,000 mg/kg to less than 20 mg/kg after only 36 days of treatment. The concentration remained under 20 mg/kg for the remainder of the demonstration.

Results from the second pilot demonstration were also favorable, although initial concentrations were not as high. Tetryl, TNT, and DNT concentrations were reduced from 314 mg/kg, 122 mg/kg, and 62 mg/kg, to 8.3 mg/kg, 2.1 mg/kg, and 2.1 mg/kg, respectively, after six treatment cycles (50 days).

During the full-scale demonstration DARAMEND bioremediation was successfully applied to two 1,500 ton windrows. Unfortunately the initial concentration of TNT in these soils was so low that it was well below the remedial standard and we were not able to demonstrate effective treatment. Nevertheless we did demonstrate that DARAMEND bioremediation could be effectively applied at full-scale using windrow protocols.

COST

Cost estimates generated from the AEC demonstration were extrapolated directly from 10-ton pilots and do not reflect accurately the actual full-scale costs; nevertheless, *DARAMEND was determined to be the most cost effective technology evaluated for both TNT and tetryl impacted soils.* Based on the second pilot demonstration full-scale treatment costs were estimated at approximately \$45 to \$75/ton depending on the initial contaminant concentrations.



The cost to apply DARAMEND at full-scale during the third demonstration was approximately \$45/ton.

TIMELINE

As discussed above the first demonstration lasted for 120 days, although the hypothetical remedial goals established for the demonstration were attained after 48 days for TNT impacted soils, and 36 days for tetryl impacted soils. During the second demonstration remedial goals for tetryl, TNT, 2,4-DNT, and 2,6-DNT were achieved following 14 days of treatment (2 cycles). For obvious reasons a timeline for the full-scale demonstration is irrelevant.