Klozur® SP
Case Study

Effective Soil Mixing Treatment of Diesel Range Organics in Vadose Zone Soil at the Base of Two Excavations

Site Closed Following a Single Application of Klozur® SP and Hydrated Lime

Summary

Following the excavation of contaminated soil from a source area, diesel range organic (DRO) levels remained above the remedial goal of 1,000 mg/kg at portions of the excavation base. It was determined that treating the remaining impacts *in situ* using chemical oxidation would provide significant cost savings compared to expanding the depth of the excavation. Trident Environmental performed a cost analyses of different treatment options and selected soil mixing with alkaline activated persulfate using an excavator. After a single three day soil mixing application, DRO in soil was reduced by 78 to 83% one month after the application. The site's remedial goals were met and the site has received a clean closure from the local regulators at the NMOCD.

Site Details & Goals

Two areas were targeted for treatment with the following baseline concentrations:

- Pit Excavation: 1,019 to 2,706 mg/kg (average of 1,657 mg/kg) at 15 ft bgs
- Vent Excavation: 1,670 mg/kg at 12 ft bgs

The remedial goal was to reduce DRO levels below 1,000 mg/kg.

Solution

Following a review of different technologies, alkaline activated persulfate (AAP) with Klozur® SP was selected for implementation via soil mixing. The persulfate dosing requirements were estimated based on the average baseline concentrations from each area and applying an estimated degradation ratio of 20 pounds of Klozur® SP per pound of DRO.

The addition of hydrated lime as an activator has several benefits in soil mixing applications with persulfate:

- Hydrated Lime is an efficient and low-cost option to generate alkaline conditions to promote activation of persulfate. Alkaline activation of persulfate results in the formation of both hydroxyl and sulfate radicals, two powerful oxidants aiding in the destruction of DRO.
- Hydrated lime serves to stabilize the soil following mixing and the amount could be varied to meet compressive soil strength targets.

Gilbert Van Deventer, PG - Trident Environmental:

"Performing the described ISCO method for the deeper less-impacted layer of contamination proved to be more cost effective than the usual dig-haul-disposal option we used for the much more highly contaminated soil overlying it. It also mitigated costs to otherwise haul in clean soil to replace what was hauled off."

Site Information

- Location: New Mexico
- Consultant: Trident Environmental
- Contaminant of Concern: DRO >1000mg/kg

Application

- Soil mixing strategy at the base of excavations

Remedial Approach

- Alkaline activated Klozur® SP with the use of hydrated lime

Results

- Remedial Goal was met. Site was closed.

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Implementation

The targeted treatment area dimensions and reagent additions are outlined in Table 1. The application was carried out in two steps. First, the dry reagents (Klozur SP and hydrated lime) were added and blended into the targeted interval, adding and blending one bulk sack at the time (Figures 1 and 2). Once the dry reagents were homogenized into the soil, water was added until the soil was almost saturated and blended again (Figures 3 and 4). The application was completed over a period of two days at the "pit excavation" and one day at the "vent excavation". Two weeks after the initial application, an additional 3,000 USG of water was added to bring the water content back up to ideal conditions. Maintaining adequate moisture content is critical during *in situ* treatment of vadose zone soil. Following successful performance monitoring, the excavations were filled in with clean soil taken from other parts of the site (Figure 5).

Table 1. Targeted Treatment Area Dimensions and Reagent Additions by Area

	Target Area (ft^2)	Treatment Interval (ft bgs)	Soil Mass (tons)	Klozur SP		Hydrated Lime		Addition Water	
				Mass (lbs)	Dose (g/kg)	Mass (lbs)	Dose (g/kg)	Volume (USG)	% Pore Fill
Pit Excavation	2,040	15 - 19	408	17,920	22	9,000	11	12,000	56%
Vent Excavation	750	12 - 16	150	4,480	15	3,500	12	3,000	38%

Figure 1. Adding Dry Reagents

Figure 2. Blending of Dry Reagents

Figure 3. Addition of Water

Figure 4. Vent Excavation after Completion of Wet Mixing

Figure 5. Panoramic View showing near Final Backfill of both Pit and Vent Excavations

Results

One month after the application, a five-point composite sample was collected from each area, showing a reduction in DRO of 78 to 83% compared to average baseline concentrations (Tables 2 and 3). A significant reduction in oil range organics (ORO) was also observed. BTEX and gasoline range organics (GRO) was not measured above the detection limit post treatment. A slightly higher percent reduction was observed in the pit excavation, which may be explained by the higher persulfate dosage applied in this area.

Both areas met the closure criteria of 1,000 mg/kg DRO and the excavations were filled in with clean soil taken from other parts of the site. Performing the described *in situ* chemical oxidation (ISCO) method for the deeper less-impacted layer of the impacted soil proved to be more cost effective than the usual dig-haul-disposal option that was used for the much more highly contaminated soil overlying it. It also mitigated costs to haul in clean soil to replace what otherwise would have been removed.

Table 2. Pit Excavation Reduction in Petroleum Hydrocarbons Relative Average Baseline Concentrations

	BTEX	GRO	DRO	ORO
Baseline (mg/Kg)	0.7	68	1,657	212
One month after treatment (mg/kg)	<0.001	<29	283	39
% Reduction	>99.9%	>57%	83%	82%

Table 3. Vent Excavation Reduction in Petroleum Hydrocarbons Relative Average Baseline Concentrations

	BTEX	GRO	DRO	ORO
Baseline (mg/Kg)	0.5	<50	1,670	157
One month after treatment (mg/kg)	<0.001	<29	321	52
% Reduction	>99.8%	-	78%	67%

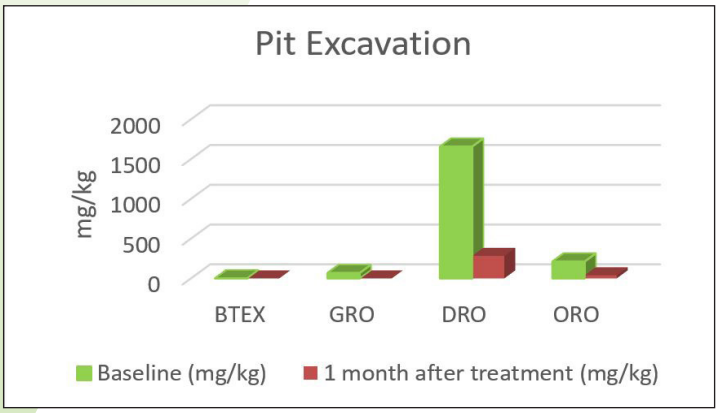

Figure 6. Baseline and Post Treatment Results Measured at the Pit Excavation

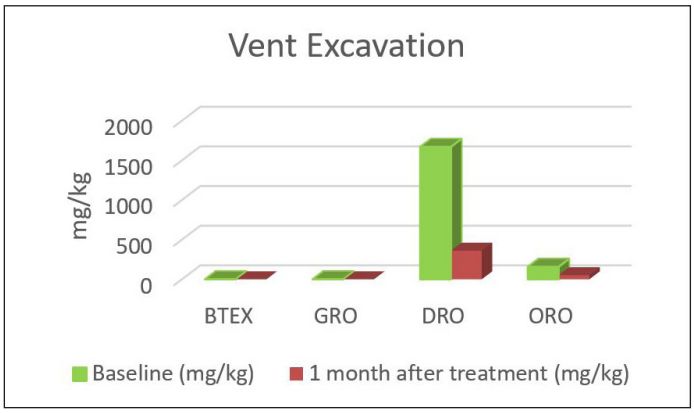

Figure 7. Baseline and Post Treatment Results Measured at the Vent Excavation