



ISCO Treatment Program: O&G Superfund Site

Site

- O&G Superfund Drum Reconditioning Site; Kingston, New Hampshire.

Contaminants of Concern

- VOCs, primarily - BTEX, PCE, TCE, 1,1-DCA, & 1,4-Dioxane.
- VOC levels as high as 20,000 ug/l.

Geology/ Hydrology

- Site geology consists of fine to medium sand, some silt, and trace gravel with bedrock encountered at ~18-35 ft bgs.
- Depth to water is approximately 3-6 ft bgs with flow in the southeastern direction.

ISCO Treatment Program

- Multiple ISCO technologies including (ALK-ASP) as the primary oxidant; and MFR as a secondary alternate oxidant treatment.
- ALK-ASP concentration between 15-18%, and a MFR oxidant concentration between 8-12%.
- Two treatment areas; Area A (~17,400 sq. ft) & Area B (~1,800 sq. ft).
- Permanent injection wells (IWs) utilized.
- Two injection events (Events II and III) as part of a larger overall treatment program.
- Event II utilized a total of 112 IWs to inject 111,600 gallons of ALK-ASP, 350 gallons of MFR and 1,800 gallons of hydrogen peroxide. Event III utilized a total of 63 IWs to inject 33,000 gallons of ALK-ASP, 26,390 gallons of MFR and 9,425 gallons of hydrogen peroxide.
- Following Event III, most areas are below site clean-up levels for primary COCs with remaining areas in acceptable range for monitored natural attenuation (MNA).
- No further injections are scheduled to take place at the site.

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ISOTEC Case Study No. 67

ISCO TREATMENT PROGRAM: IMPACTED GROUNDWATER TREATMENT UTILIZING ACTIVATED SODIUM PERSULFATE

Ottati & Goss Superfund Site
Kingston, New Hampshire

INTRODUCTION

ISOTEC was retained to implement an in-situ chemical oxidation (ISCO) treatment program at a former drum reconditioning superfund site in Kingston, New Hampshire to address impacted soil and groundwater. Three separate treatment areas referred to as Area A, Area B and Area C were designated for treatment. Primary contaminants of concern (COCs) at the site include benzene, toluene, ethylbenzene, total xylenes (BTEX), tetrachloroethene (PCE), trichloroethene (TCE), 1,1-dichloroethane (1,1-DCA) and 1,4-Dioxane. The ISCO remedy chosen for the site consisted of sodium hydroxide activated sodium persulfate (ALK-ASP) as the primary oxidant and ISOTEC's patented modified Fenton's reagent (MFR) as a secondary oxidant. Historical VOC levels in groundwater have been as high as 20,000 micrograms per liter (ug/l) in Area B and were more recently measured to be as high as 7,600 ug/l in Area A prior to conducting the full-scale treatment program. Historical levels of 1,4-Dioxane were as high as 200 ug/l in Area B and 32 ug/l in Area C. Soil concentrations in discrete locations were found to be as high as 6,060 micrograms per kilogram (ug/kg) for toluene, 294,000 ug/kg for ethylbenzene and 780,000 ug/kg for total xylenes.

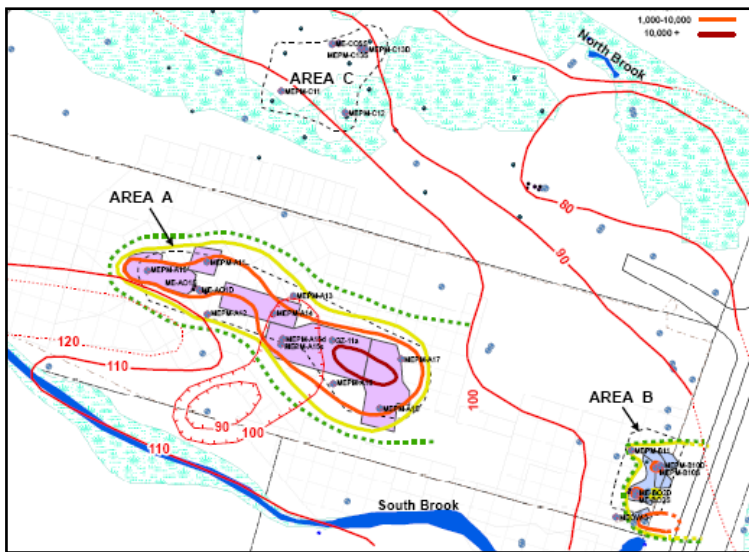
This case study pertains to treatment in Areas A and B only during the last two treatment events (Events II and III) conducted in 2009 and 2010.



SITE BACKGROUND/GEOLOGY

Past business operations at the site have resulted in soil and groundwater impacts with COCs including BTEX, PCE, TCE, 1,1-DCA and 1,4-Dioxane. The site is currently an unoccupied area owned by the state. Three separate areas referred to as Area A, Area B and Area C were designated for treatment. Permitting for the treatment program was governed by the New Hampshire Department of Environmental Services (NHDES) and United States Environmental Protection Agency (US EPA) guidelines.

General subsurface geology consists of fine to medium sand, some silt, and trace gravel with bedrock encountered at approximately 18-35 feet below ground surface (bgs). Depth to groundwater is approximately 3-6 feet (ft) bgs and generally flows in the southeastern direction.



ISCO TREATMENT PROGRAM AND IMPLEMENTATION

The ISCO treatment program consisted of an initial pilot study program in 2007-2008; and the full-scale treatment program which consisted of three treatment events in 2008, 2009 and 2010, respectively. The pilot program and Event I of the full-scale treatment targeted all three treatment areas. They were completed by another party and will not be discussed in this case study. Events II and III of the full-scale treatment targeted only Area A and Area B. The injection pathway utilized consisted of permanent injection wells.

Area A was approximately 17,400 square feet (ft²) in size consisting of as many as five (5) treatment parcels referred to as A-11 through A-15. The target vertical treatment zone covers the 7-26 ft bgs interval with the treatment zone thickness varying for each treatment parcel. Area B was approximately 1,800 ft² in size consisting of as many as three (3) treatment parcels referred to as B-11, B-12 and B-13. The target vertical treatment zone covers the 5-29 ft bgs interval with the treatment zone thickness varying for each treatment parcel.

Event II Treatment

Event II of the treatment program was conducted over a 30 day period (26 days of injections) in 2009. Treatment targeted the entire 17,400 ft² area in Area A utilizing 64 injection wells within all five (5) treatment parcels. A total of 97,200 gallons of ALK-ASP (~18% concentration) were injected in Area A. At the conclusion

of Event II in Area A, 1,800 gallons of hydrogen peroxide (~10% concentration) were injected into 10 wells to initiate continued activation of residual sodium persulfate in the area. The hydrogen peroxide injections targeted wells in the most contaminated portion of Area A where the pH was shown to have dropped to below the required pH needed for alkali activation of the sodium persulfate.

Treatment in Area B targeted parcels B-11 and B-12 (approximately 1,550 ft²), and parcel B-13 (approximately 250 ft²). A total of 14,400 gallons of ALK-ASP were injected in Area B into 30 injection wells, mostly within parcels B-11 and B-12. Injection in parcel B-13 consisted of MFR treatment (~12% oxidant concentration) into 8 wells. MFR was chosen in this area as an alternative oxidant to ALK-ASP to limit migration of the oxidant into a nearby brook. A total of 350 gallons of MFR were injected into Parcel B-13.

Event III Treatment

Event III of the treatment program was conducted over a 24 day period (22 days of injections) in 2010. Event III targeted a smaller area than Event II and focused treatment in areas where there were significant exceedances of groundwater levels that were not likely to attenuate on their own. Event III consisted of three separate injection phases. Phase I consisted of hydrogen peroxide (~8% concentration) injections in areas with the highest residual remaining COC concentrations; Phase II consisted of ALK-ASP (~15% concentration) injections; and Phase III consisted of MFR (~8% oxidant concentration) injections. Phases II and III targeted all Event III injection well locations.



Treatment in Area A was focused on parcels A-11, A-14 and A-15. A total of 7,350 gallons of hydrogen peroxide were injected into 13 wells (Phase I), 25,800 gallons of ALK-ASP were injected into 35 wells (Phase II), and 22,990 gallons of MFR were injected into 34 wells (Phase III).

Treatment in Area B was focused on parcels B-11, B-12 and B-13. A total of 2,075 gallons of hydrogen peroxide were injected into 10 wells (Phase I), 7,200 gallons of ALK-ASP were injected into 28 wells (Phase II), and 3,400 gallons of MFR were injected into 24 wells (Phase III).

A total of 253,000 lbs of sodium persulfate were injected into Areas A & B over Events II and III. At the time of completing Event III in 2010, this was one of largest sodium persulfate (in terms of lbs of oxidant) projects completed to date.

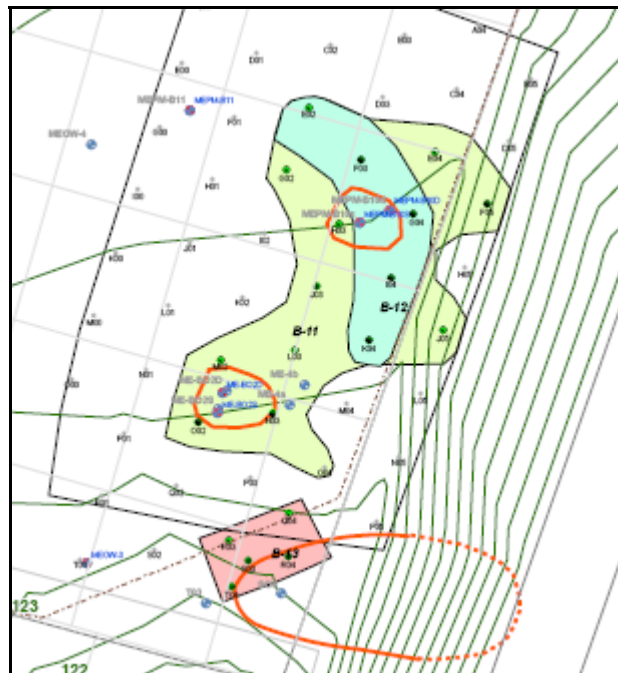
CURRENT PROJECT STATUS

The overall objective of the ISCO treatment program was to achieve significant destruction of COCs in groundwater to meet the Groundwater Interim Cleanup Levels (ICLs) set forth for the site. Following Event III of the treatment program, most of the ISCO target treatment areas were below site cleanup levels for majority of primary COCs with concentrations in the remaining areas in acceptable range to transition to monitored natural attenuation (MNA).

Site Map – Treatment Area A Injection Well Locations



Site Map – Treatment Area B Injection Well Locations



Performance Monitoring Wells (Areas A and B)

<p>Spring 2007</p>	<p>Baseline</p>
<p>Spring 2009</p>	<p>Post Event I</p>
<p>Spring 2009</p>	<p>Post Event II</p>
<p>Spring 2011</p>	<p>Post Event III</p>