



## Chemical Oxidation of Petroleum Hydrocarbons via In Situ Soil Mixing

### Summary

A former industrial facility in northern California contained two underground storage tanks (USTs) which were shown to be partially decayed during tank removal activities. Samples taken within the UST removal area indicated gasoline constituents benzene, toluene, ethylbenzene and xylenes (BTEX) at approximately 70 parts per million (ppm) in soil. Following soil and groundwater investigations, more than 2,100 tons of petroleum-impacted soil was excavated and transported off-site for disposal. An additional 8,000 cubic yards of soil was excavated and treated on-site. After excavation activities were completed, reassessment of the site was performed and resulted in a treatment area more extensive than previously investigated. Continued excavation was deemed too costly and a remedial strategy was sought to treat the remaining petroleum hydrocarbons on-site. A soil mixing design using RegenOx<sup>®</sup> in situ chemical oxidation and ORC Advanced<sup>®</sup> enhanced aerobic bioremediation was implemented.

Figure 1. Former Industrial Facility



Figure 2. RegenOx Material On-site



Figure 3. RegenOx Product Mixing



### Remedial Strategy

RegenOx was used to target high concentration soil while ORC Advanced was applied to accelerate the aerobic bioremediation of any remaining petroleum hydrocarbons. RegenOx and ORC Advanced were mixed together with water and applied using a dual axis remediation blender provided by Lang Tool Co. A treatment cell map was designed with approximate amounts of material applied in each cell (Figure 4).

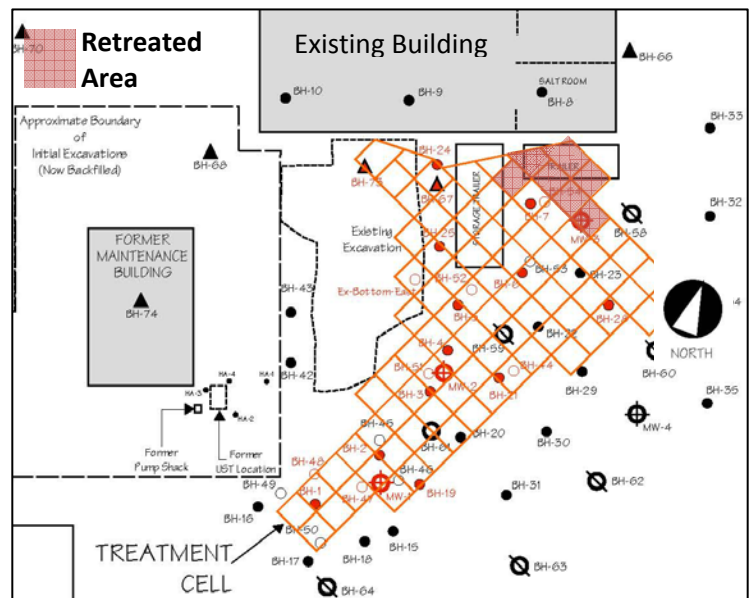


Figure 4. Treatment Cell Design and Retreated Area

- RegenOx – 79,620 lbs
- ORC Advanced – 4,800 lbs
- Soil Type – Silty clay
- 10ft x 10ft cells across 135,000 ft<sup>2</sup>

Table 1. Remedial Goals (ppm)	
TPHg	180
Benzene	0.27
Toluene	9.3
Ethylbenzene	4.7
Xylenes	11



Figure 5. Dual Axis Head



Figure 6. In Situ Mixing



Figure 7. In Situ Mixing

## Results

- Southern Area
  - TPHg declined by 2 orders of magnitude
  - BTEX reduced from 100 ppm to 2 ppm
  - Area remediated to below remedial goals
  - No groundwater was available to sample
- Northern Area
  - Retreatment of 7 cells (Figure 4)
  - Two cells remain elevated; highest concentrations at 440 ppm TPHg and 52 ppm BTEX
  - Groundwater TPHg concentrations declined by 80-90%
  - ORC Advanced anticipated to stimulate aerobic bioremediation of remaining contaminants

## Conclusion

In situ soil mixing using a dual axis remediation blender successfully delivered RegenOx and ORC Advanced to the vadose zone approximately 5 to 20 feet below ground surface. Nearly 80% of the soil treatment area was successfully remediated using a combined chemical oxidation and aerobic bioremediation method. Reductions of TPHg in groundwater were variable, however, in the Northern area a decrease by as much as 80% was observed.

