INNOVATIVE COMBINED IN-SITU SOIL MIXING AND CHEMICAL OXIDATION TO IMPROVE DELIVERY IN CLOSE QUARTERS

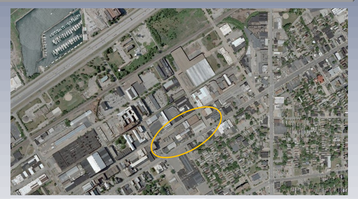
Background / Information

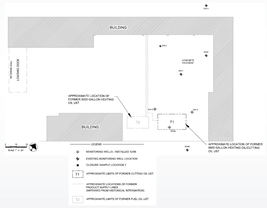
Overview. The use of an innovative soil mixing approach to oxidant delivery at a manufacturing site was successfully implemented to provide for the efficient and cost-effective remediation of a courtyard area of the facility that was closely bounded by existing buildings and an adjacent public street. The ability to mix the impacted soils and groundwater within close quarters, avoided the need to drive sheet piling, dewater the impacted area, and the completion of a deep subsurface excavation to remove the impacted materials. The innovative remedy approach provided for relatively easy implementation, as well as improved remedial efficiency. Additionally, due to the reduced time to complete the initial implementation another area of the site was treated with similar results. The successful design, implementation and performance monitoring of the targeted treatment areas, with limited additional hotspot treatment, resulted in the attainment of required clean-up standards and no further action within nine months of the remedy implementation.

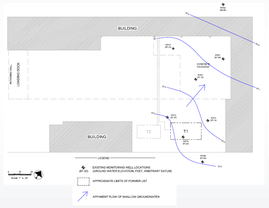
Background/Objectives. Operations at a gear manufacturing facility have been ongoing for approximately 100 years. Day-to-day operations resulted in soil and groundwater impacts from cutting oil in the courtyard area of the site, and a former gasoline station was incorporated into another area of the site where BTEX impacts were identified. As part of the overall site remedial efforts under the Voluntary Action Program (VAP), Bureau of Underground Storage Tank Regulation (BUSTR) standards needed to be attained within the two areas of the facility.

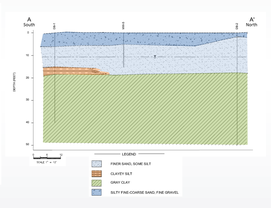
Approach/Activities. The implemented remedial technology within the courtyard treatment area was combined soil mixing and in-situ chemical oxidation (ISCO) along with an associated post-ISCO performance monitoring program. The innovative combination of these technologies provided for the completion of the project within a limited operating area without impeding daily site operations. The primary constituent of concern was total petroleum hydrocarbons (TPH) associated with underground storage tanks of cutting oil. Within the former gas station treatment area, BTEX was the primary constituents of concern. ISCO treatment was applied using an injection lance. Noted soil and groundwater impacts were observed at depths ranging from ~ 8 to 18 feet below ground surface (ft-bgs). The overall courtyard treatment area was ~7,500 ft^2, and the former gas station area was approximately 1,500 ft^2.

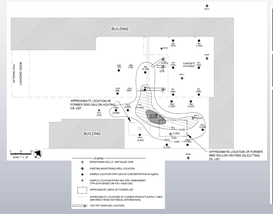
Results/Lessons Learned. Over an approximate nine months of post-ISCO performance monitoring period both TPH and BTEX concentrations were reduced to below BUSTR standards with greater than 90% concentration reduction observed. At the end of the performance monitoring period no further action (NFA) letters were received for each of the sites and the project realized significant cost and sustainability benefits as compared to other evaluated alternatives.







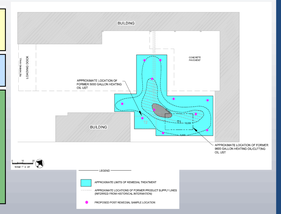


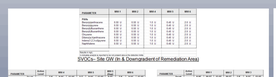


Site Geology
- **Fill:** 0 to 2 feet below ground surface (ft-bgs)
- **Sand (fine to coarse):** 2 to 18 ft-bgs
- **Clay:** ~18 ft-bgs

Site Hydrogeology
- **Depth to GW:** ~10-11 ft-bgs
- **GW Flow Direction:** North / Northwest

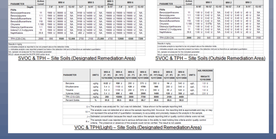
Contaminant Information
- Two (2) former USTs (T2-fuel oil, T1-fuel oil converted to cutting oil)
- Both USTs closed by client circa 1990
- T2 not regulated (consumptive use); T1 is regulated by BUSTR
- Soils are primary concern for gaining BUSTR approval for No Further Action (NFA)
- GW impacts not part of BUSTR remediation
- TPH(CD-C34) is of concern at site; from T1 cutting oil releases
- BUSTR TPH cleanup criteria is **5000** mg/kg in soils
- TPH up to 23,000 mg/kg in area of former T2
- TPH and soil impacts to be addressed between 10-18 ft-bgs
- **NFA** desired by client
- (See attached site map and analytical data)




VOCs - Site GW (In & Downgradient of Remediation Area)

SVOC & TPH – Site Soils (Designated Remediation Area)


SVOC & TPH – Site Soils (Outside Remediation Area)


VOC & TPH-Light – Site Soils (Designated Remediation Area)

Proposed Remedial Approaches

- ***Alternative 1***
  - Sheet pile around perimeter of designated remediation area
    - ~350 lineal ft to depth of ~25 to 30 ft-bgs
  - Excavate and remove soils from ground surface to 18 ft-bgs
    - ~2800 yds soil
  - Segregate clean soils from ground surface to ~8 ft-bgs
    - ~1200 yds
  - T&D soils from 8-18 ft-bgs
    - ~1600 yds
  - Confirmatory sampling / backfill excavation / restore grounds

- ***Alternative 2***
  - Complete in-situ chemical oxidation (ISCO) throughout designated remediation area
    - ~50 injection points on assumed 10-ft centers
  - ISCO application focused on impacted soils from 8-18 ft-bgs
    - ~1600 yds soil
  - Bottom-up treatment approach
  - Performance monitoring (3 events with analytical)
  - Re-treat limited areas, if necessary
  - Final confirmatory sampling / reporting

Acknowledgements

Mike McKim & Steve Tompkins - Cleveland, OH

Bill Lundy - Deep Earth Technologies, Inc.

Soil Mixing/ISCO Process and Fieldwork Photos

Contact Information

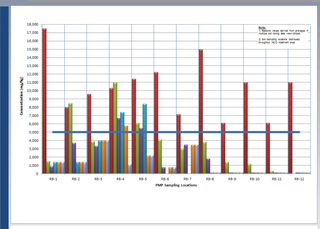
Doug Gray— URS Corporation

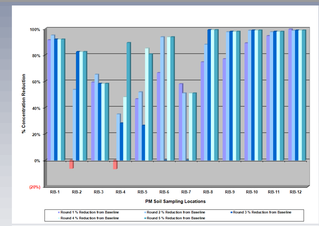
1375 Euclid Avenue, Suite 600

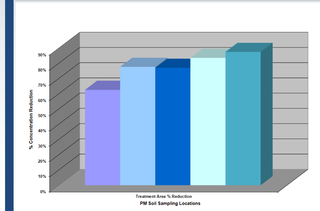
Cleveland, OH 44115

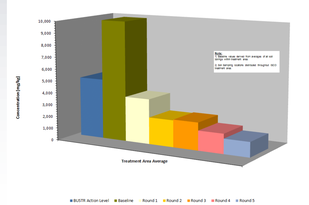
Phone: 216.622.2283 E-mail: doug.gray@urs.com

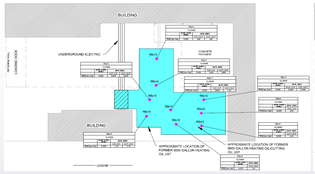
Results / Conclusions

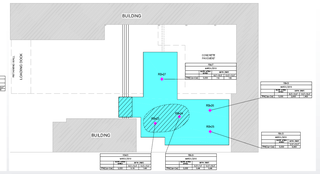


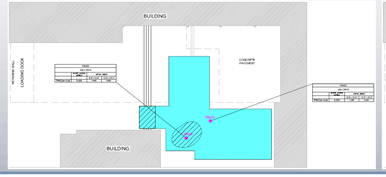


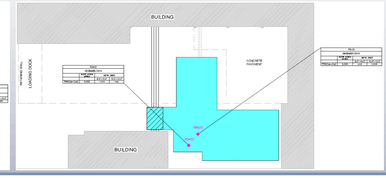












Observations and Conclusions

⇒ Excavation/Disposal with Sheet pile & Dewatering (Alt.1) estimated at ~$800K due to limited work area and proximity to buildings/foundations

⇒ Innovative Soil Mixing/ISCO (Alt.2) total cost of ~$350K, including Performance Monitoring

⇒ Overall cost savings = **$450K**

⇒ Total field time was 5 days from mob to demob to treat 7,500 ft^2 from 3-18 ft-bgs (i.e., ~4,200 yds)

⇒ ~23,000 gallons of ISCO Amendment was injected during the soil mixing (i.e., Between 600 –1200 gallons per cell)

⇒ No disruption to ongoing operations at the site

⇒ No damage to foundation or structures from soil mixing/ISCO application, despite tight quarters and limited site mobility

⇒ No mobilization of contaminants from soil to groundwater based on ongoing groundwater sampling

⇒ Two small areas ~20ft x 20ft and 10ft x 10ft required additional direct push ISCO application

⇒ Approximately 9 months of performance monitoring to attain clean-up criteria

⇒ Average concentration reduction of ~90%

⇒ No Further Action (NFA) approved in December 2010

⇒ Overall the use of innovative soil mixing/ISCO approach was very cost effective and provided for attainment of NFA in an expedited fashion