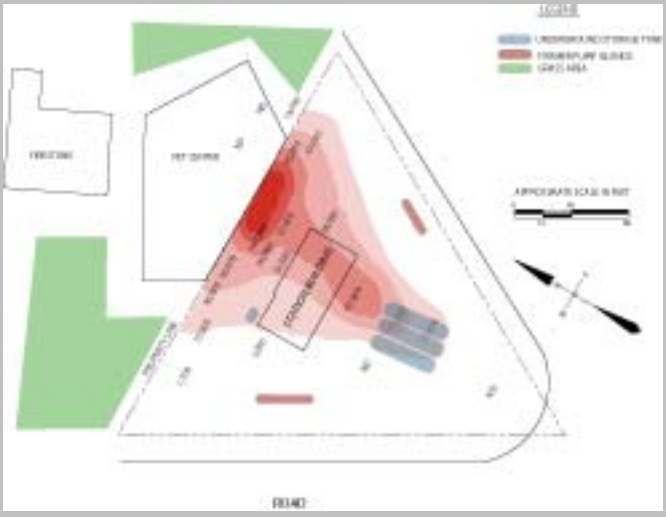
ADVANCED OXIDATION- OZONE SPARGE REMEDIATION
Former Service Station Site Southeastern, Pennsylvania

BLUE **L**IGHTNING **U**NDERGROUND **E**NTERPRISES (BLUE)
Moorestown, New Jersey 08057, U.S.A.

INTRODUCTION
The subject site was the location of an out-of-service, former, retail petroleum service station. Environmental assessment activities at the site, following gasoline, underground storage tank removal activities revealed the presence of separate phase hydrocarbons on the water table beneath the site, and high residual concentrations of petroleum hydrocarbons in soil and groundwater. Targeted compounds, exceeding the PADEP cleanup standards included benzene, toluene, ethylbenzene, xylenes, naphthalene, and MTBE.



BACKGROUND
The subject property was undergoing a real estate transaction, as part of the site divestiture. As such, the client required that the site be remediated within a nine-month period, to facilitate sale of the property. The remedial goal for the site was to remove separate phase hydrocarbons (SPH) from the subsurface, and reduce adsorbed and dissolved phase hydrocarbons to levels that would allow natural attenuation of remaining contaminants to represent a viable long-term approach to site cleanup.

REMEDIATION:
DESIGN, CONSTRUCTION & OPERATION
The timeline for cleanup of this property was the driving factor for site remediation. It was possible to expedite design, permitting and construction of the remediation system, through effective regulatory negotiation and communication. The remediation system was designed, permitted, constructed and started within three months of project inception. The remediation system was operated from April 1998 through November 1998. Post-remedial soil sampling and four groundwater monitoring events were conducted between January and June 1999 to demonstrate remedial effectiveness.

To ensure that the aggressive timeline would be met for the remediation project, in-situ advanced oxidation was selected as the primary remedial technology to be employed at this site. Ozone sparging was conducted at the site through a series of nested, sparge points at the site to affect chemical oxidation of the hydrocarbon compounds in groundwater and both the saturated and unsaturated soils. The ozone sparge system was augmented with soil vapor and groundwater extraction using total phase extraction technology and traditional groundwater pumping. Extracted and treated groundwater was re-injected to the subsurface, up gradient of the impacted area to further enhance remedial effectiveness by flushing the contaminated area with clean water.

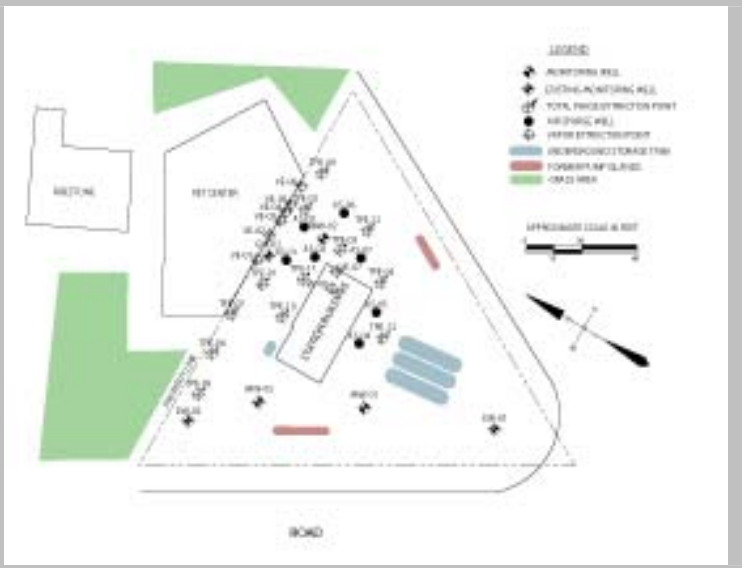
RESULTS

The remedial effort at this project site vastly exceeded the design goals. The objective for the remediation system was to remove SPH, reduce soil concentrations to an acceptable risk level, and to reduce dissolved phase concentrations to the low parts-per-million (ppm) range to allow natural attenuation to further remediate the site. Based on post-remedial site monitoring and sampling, SPH was removed from the site, and soil and groundwater concentrations at the site were all found to be below the PADEP statewide cleanup standards required for unconditional site closure.

SUMMARY & CONCLUSIONS

The PADEP approved post-remedial sampling plan documented the effectiveness of the remediation system at the site, and demonstrated compliance with the PADEP cleanup standards for the project. As such, in July 1999 an unconditional No Further Action, and PADEP ACT 2 release from liability was issued by the PADEP for this property.

Total BTEX concentrations in groundwater were reduced between 86% and 99% across the site. MTBE was reduced between 97% and 98%, and naphthalene was reduced between 52% and 97% site-wide.



Additionally, groundwater concentrations continued to decrease during the post-remedial monitoring events, indicating that the source area was effectively remediated and that concentrations will not rebound.