



Horizontal Remediation Wells (HRW): Transferring Effective Technologies From the Oil Industry to Environmental Remediation

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Mike Sequino

Directional Drilling Technologies Began In The Oil Fields



- From “Whip-Stocks” to Steerable “Bottom Hole Assemblies”
- Demand grew steadily as EOR methods advanced
- River crossing technique developed from the need to lay pipe lines under shipping channels
- HRW wells resulted from marriage of both



The first HRW installations



- The first HRW were installed and subsidized at large government sites and chemical plants beginning in the 1980's
- Some were groundwater recovery wells in clay, in lieu of excavation
- First Air Sparge (AS)/Soil Vapor Extraction (SVE) pair was completed for Department Of Energy
- The wells were expensive and yet effective but at that time HRWs were not thought of as a viable alternative for most projects due to cost

1993 Installation of HRW at JFK Airport was the Pivot Point



- JFK was the largest airport in USA in 1993
- Marriage of oilfield know-how with utility rig nimbleness and efficiency spawned success
- Using smaller drill rigs dramatically reduced the HRW installation cost
- Today there are miles of HRW under JFK airport



For the Next 20 Years, HRW Continue to Advance

HRW had growing pains finding the best match of materials, field conditions, and cleanup objectives:



- Completion materials
- Well screen design
- Well development
- Filter pack (natural or artificial?)
- Drilling fluid management (recycling is good)

Today HRW Technology Allows:



- No obstruction of business
- Get to the source, horizontal well placement at the core of the problem
- Lower cost per volume of treated soil
- More efficient delivery and recovery
- Multiple uses: HRW treatment train

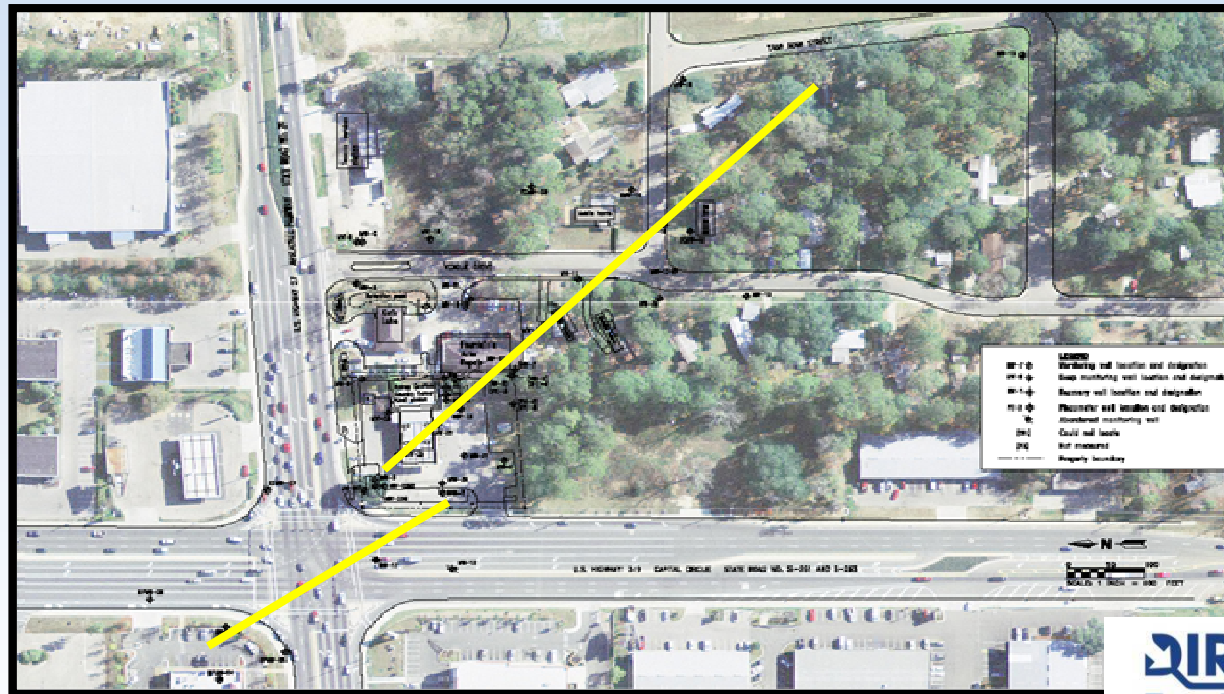
Rebuild a Commercial Intersection



- Major intersection in Tallahassee surrounded by with businesses and residential areas
- Historically challenged site in Tallahassee
 - No progress after 10 years and a lot of money spent
- HRW system installed to access plume under residential neighborhood
 - Site closed after 18 months of HRW operation

Case Study Continued:

- Hydraulic divide send plume in opposite directions
- Drilled diagonally under intersection without blocking road
- No interruption of fast food kitchen and drive-thru

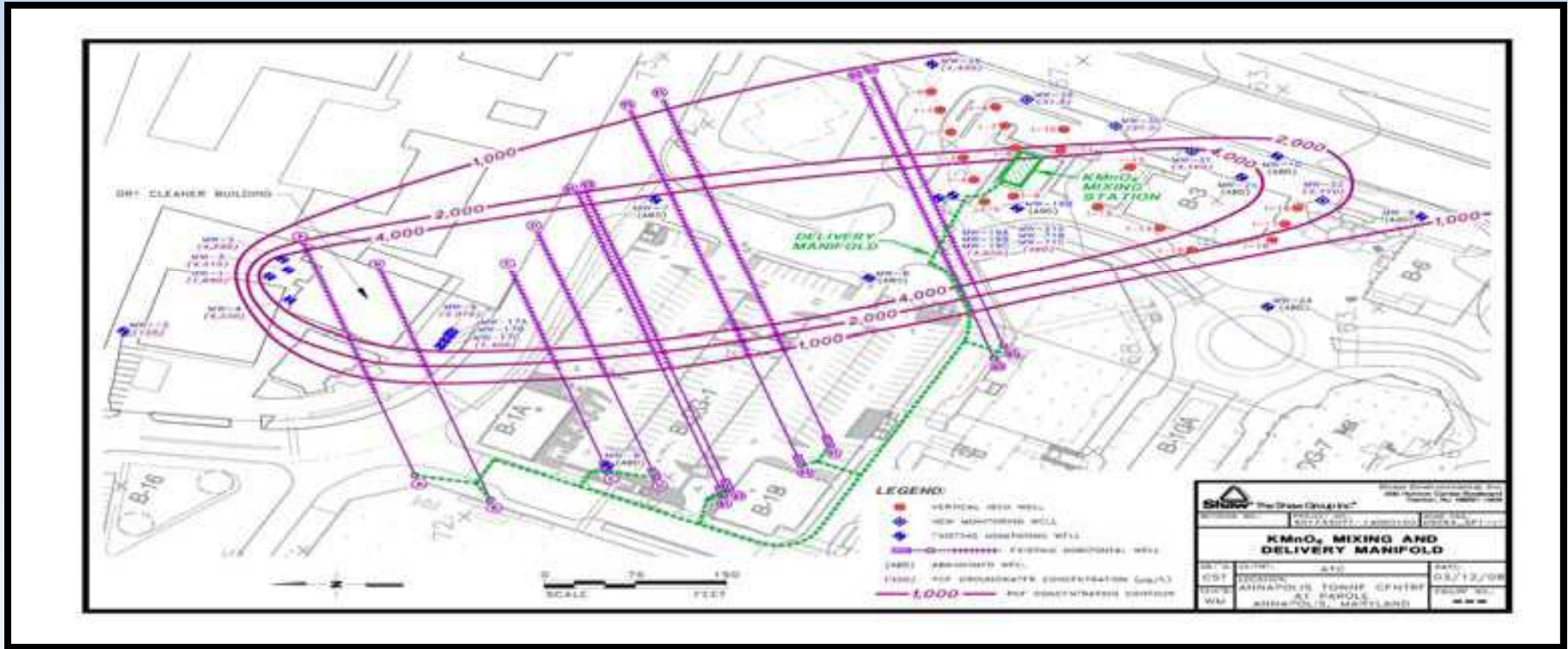


Develop a City Block



- Entire city block in Annapolis receiving big box retail, bank and high-rise residential
- Potassium permanganate injection
- Drilling alongside heavy construction
- Developer insisted on fast paced remediation construction
- Injected 1,000,000 gallons KMnO₄

Site Map



Rebuild a Whole Neighborhood



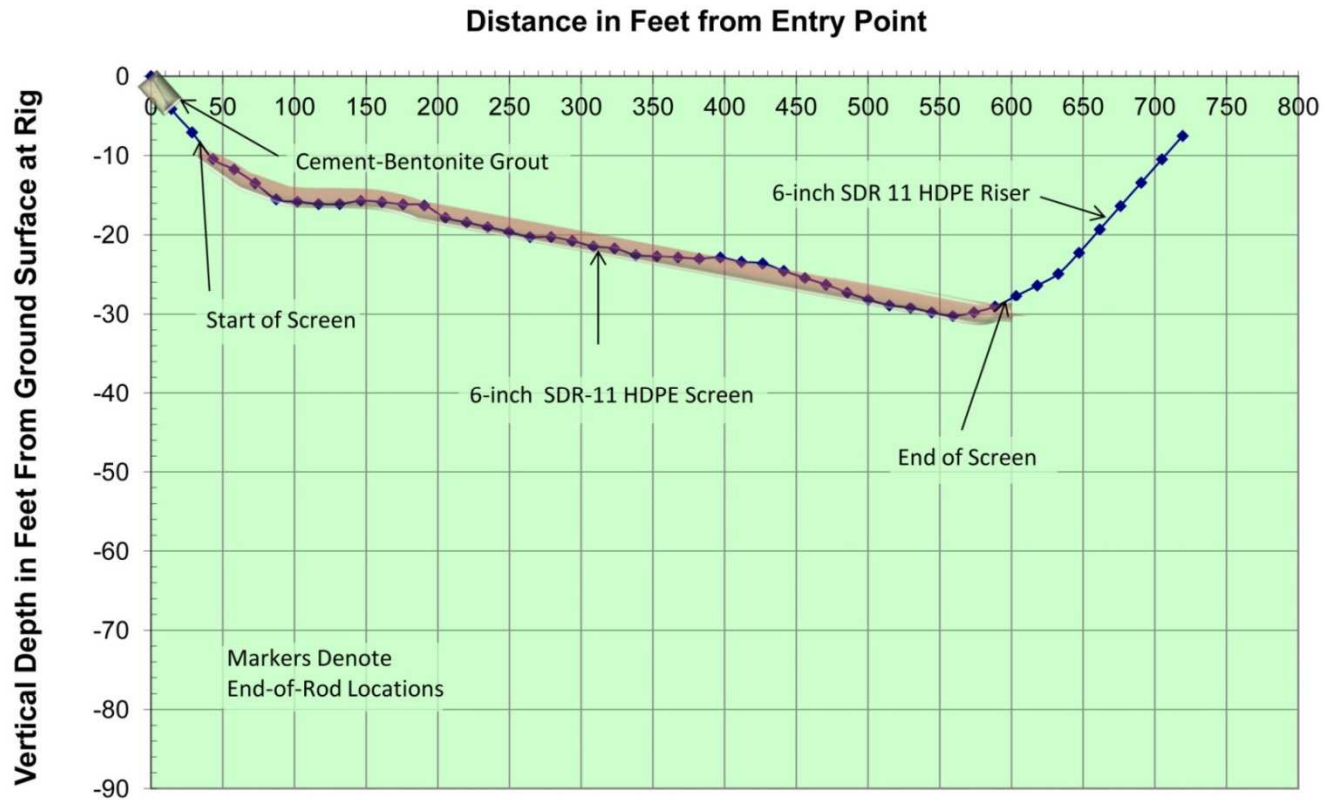
- Historically impacted rail yard on banks of Han River on prime real estate
- Demolition and reconstruction put MPE installation on fast track to reduce worker exposure risk during excavation
- Partnered with local firms to execute project
- Free product clearly evident in exit pits

HRW save the Olive Groves



- Farm threatened by neighboring oil recycling facility
- 300 meter long hydraulic barrier installed within 1 m thick sand lens
- Horizontal Remediation Well followed irregular grade of target zone
- Smooth trough of depression along entire property boundary

Horizontal Well Profile



HRW for Characterization

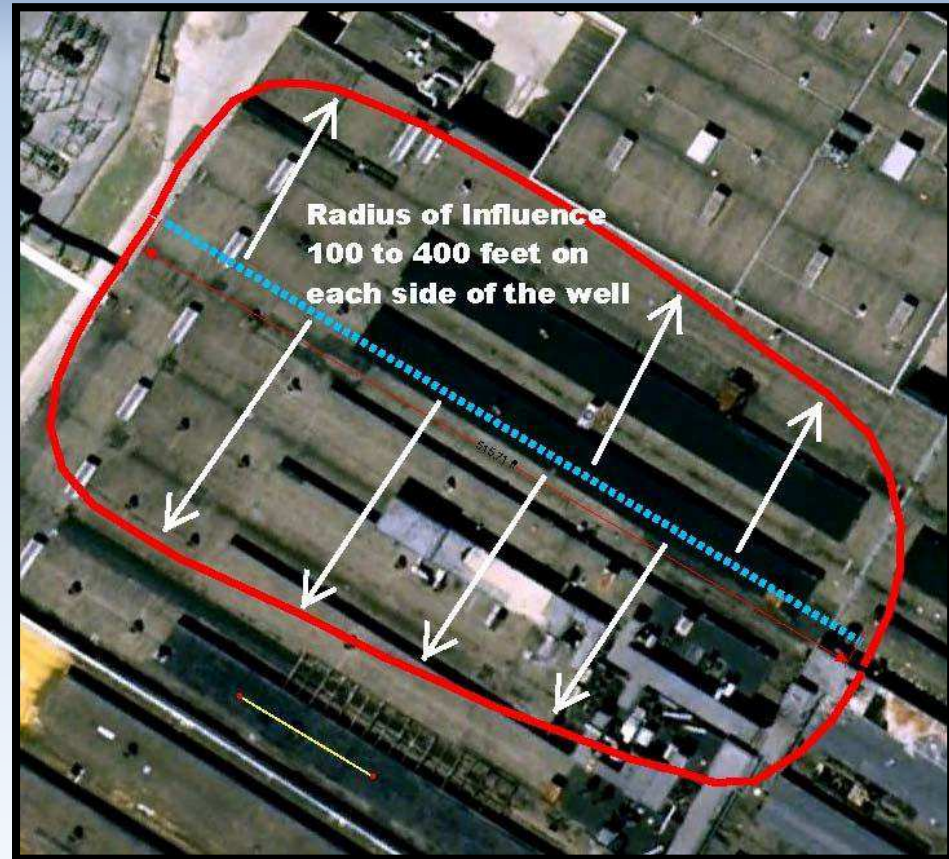


- Collect soil samples under large buildings or tanks overlying LNAPL
- Confirm source of vapor intrusion
- Detect leaking sewers acting as preferential pathways



Expand your Zone of Influence

- Horizontal wells develop larger zone of influence than vertical wells
- Over 20 meters for horizontal sparge wells
- Over 40 meter and higher for soil vapor extraction (SVE)



Creative Project Designs



- Dual purpose remediation/mitigation horizontal wells
 - SVE and subslab depressurization in one horizontal well
 - SVE and Injection horizontal well designed as one
- Combine ERH electrodes with SVE
 - Two technologies in one horizontal well

Engineered Horizontal Well Screens



- Achieve even flow distribution for any horizontal well screen length
- Match flow rates, pressures, pipe diameter, slot configuration, and formation characteristics



The Technology Continues to Develop



- Expanding range of remediation applications
 - First ever horizontal Electrical Resistance Heating project in New Jersey
 - Various proprietary passive remediation methods using horizontal wells (California and elsewhere)
- The environmental industry will benefit from the demands from pipeline industry to transfer even more oil field technology. Cost efficient sophisticated instrumentations are being developed.

What Will the Future Bring?



- As the technology becomes even more efficient, projects will also become more cost efficient.
- Down-hole logging tools
- Hydraulic/pneumatic fracturing methods
- Soil, groundwater and vapor horizontal sampling

Conclusion



- As with the current uses of HRW we are only limited by our imagination.
- The growth and development of HRW are again only limited by our imaginations
- The growth and development of HRW will continue because this technology is a powerful and proven remediation tool.
- We encourage you to help us discover new uses and implementations for this technology.

DIRECTIONAL
Technologies, Inc
Horizontal Directional Drilling Services

Horizontal Remediation Wells

Horizontal Remediation Technologies • Installation • Design • Engineered Well Screens • Services

Questions?

Founded in 1992, Directional Technologies, Inc. has installed over 1,000 horizontal remediation wells thru out the world.

Corporate Headquarters in Wallingford, CT
Branches offices in Philadelphia, PA; Ashby, MA; Tallahassee, FL



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www.directionaltech.com | mike@directionaltech.com