



Surfactant Enhanced Recovery of Separate-Phase Petroleum Hydrocarbons

Sunnyside Yard, Queens, New York

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Site History

- Located in Sunnyside Yard, Queens, New York
- Over 100 years of service
- State Superfund Site
- Six Operable Units (OUs)
- 130 acre Site
- OU-3 LNAPL and PCB Plume

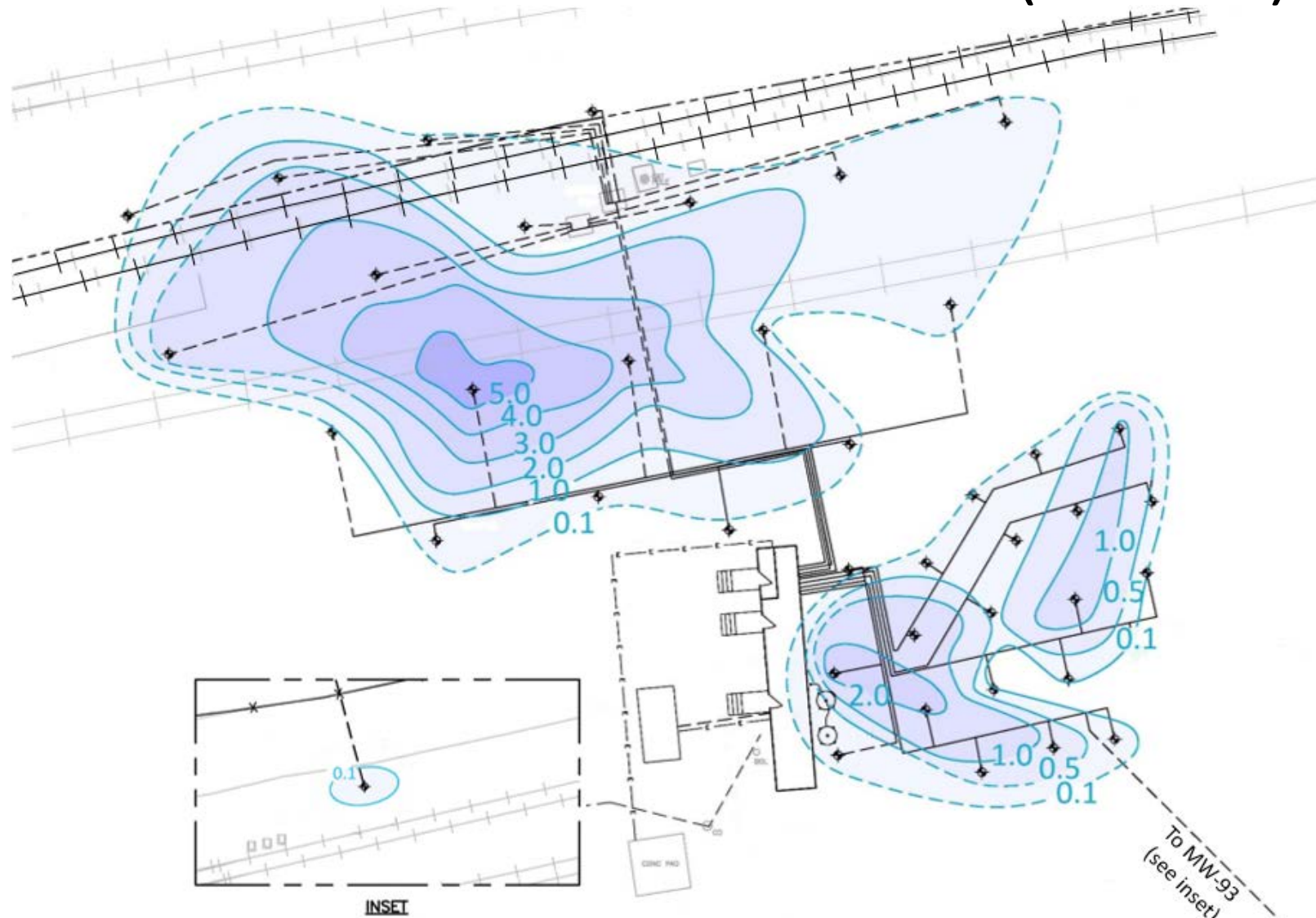


OU-3 Record of Decision

Cleanup Standards

- PCBs < 25ppm
- Lead < 3,900 ppm
- cPAHs < 25 ppm (total of 7 compounds)
- SVOCs < 500 ppm
- LNAPL thickness < 0.1 foot

Dual Phase Vacuum Extraction (DPVE) System



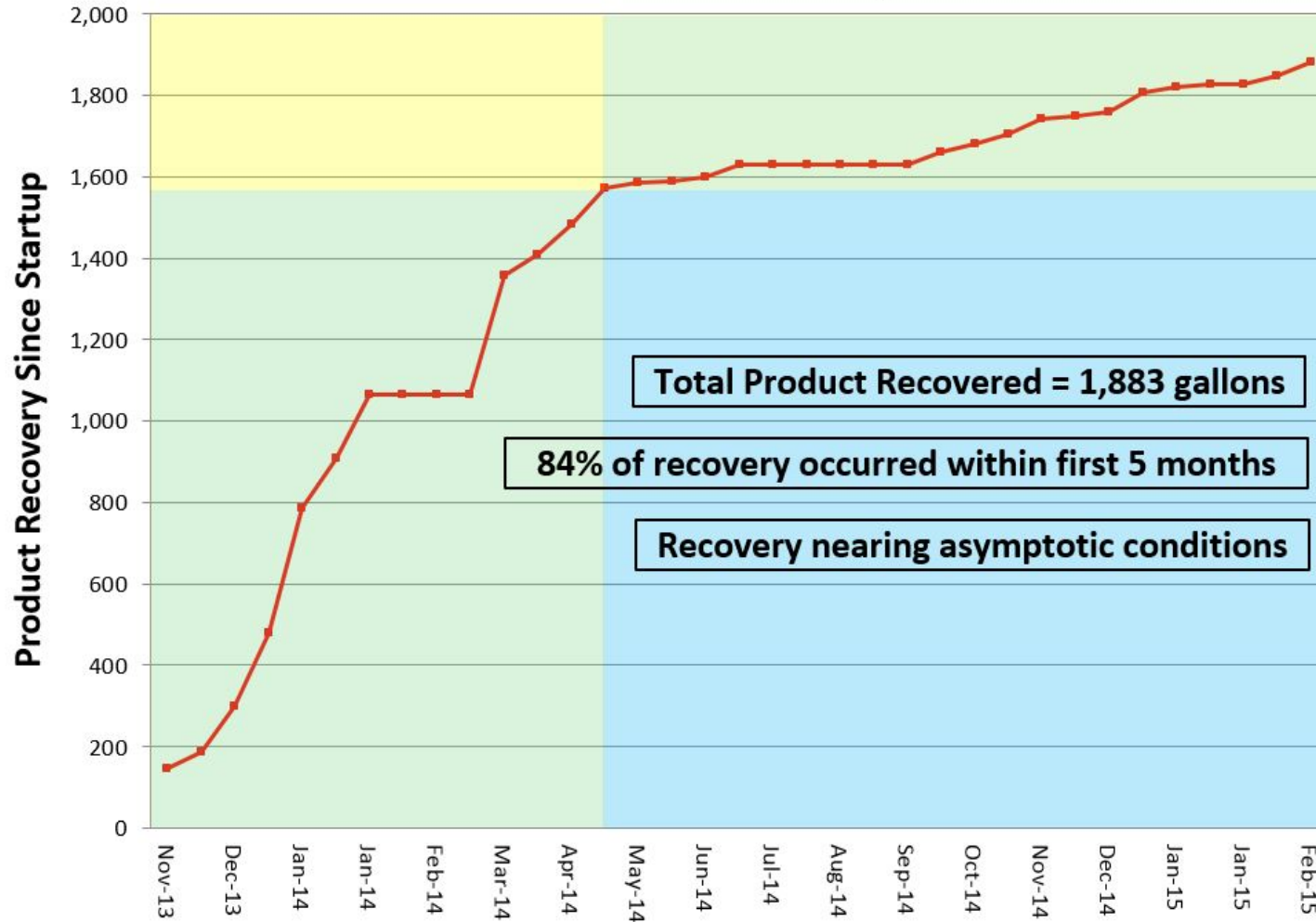
June 2013

Dual Phase Vacuum Extraction (DPVE) System

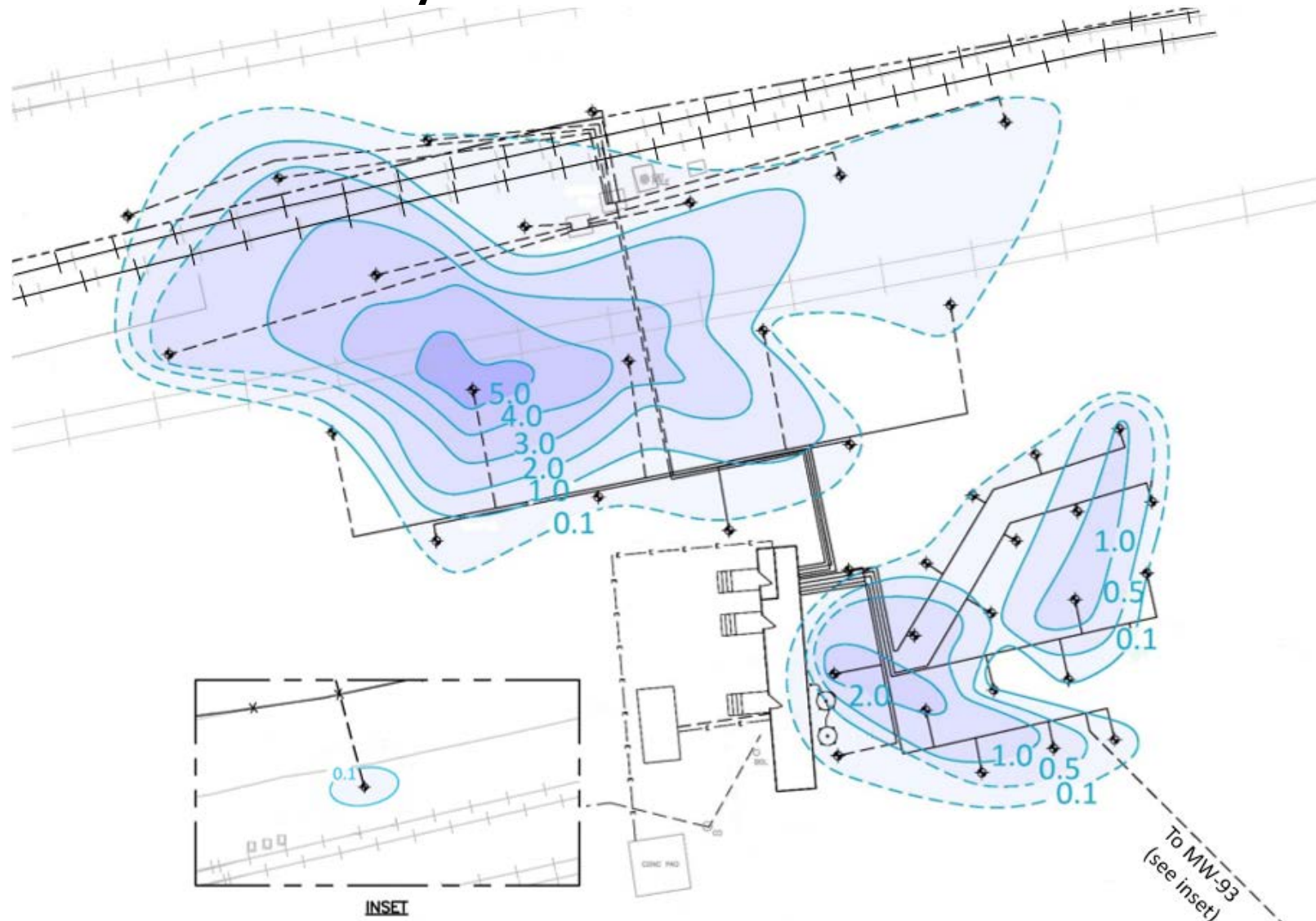


DPVE System Performance

Cumulative Product Recovery Over Time

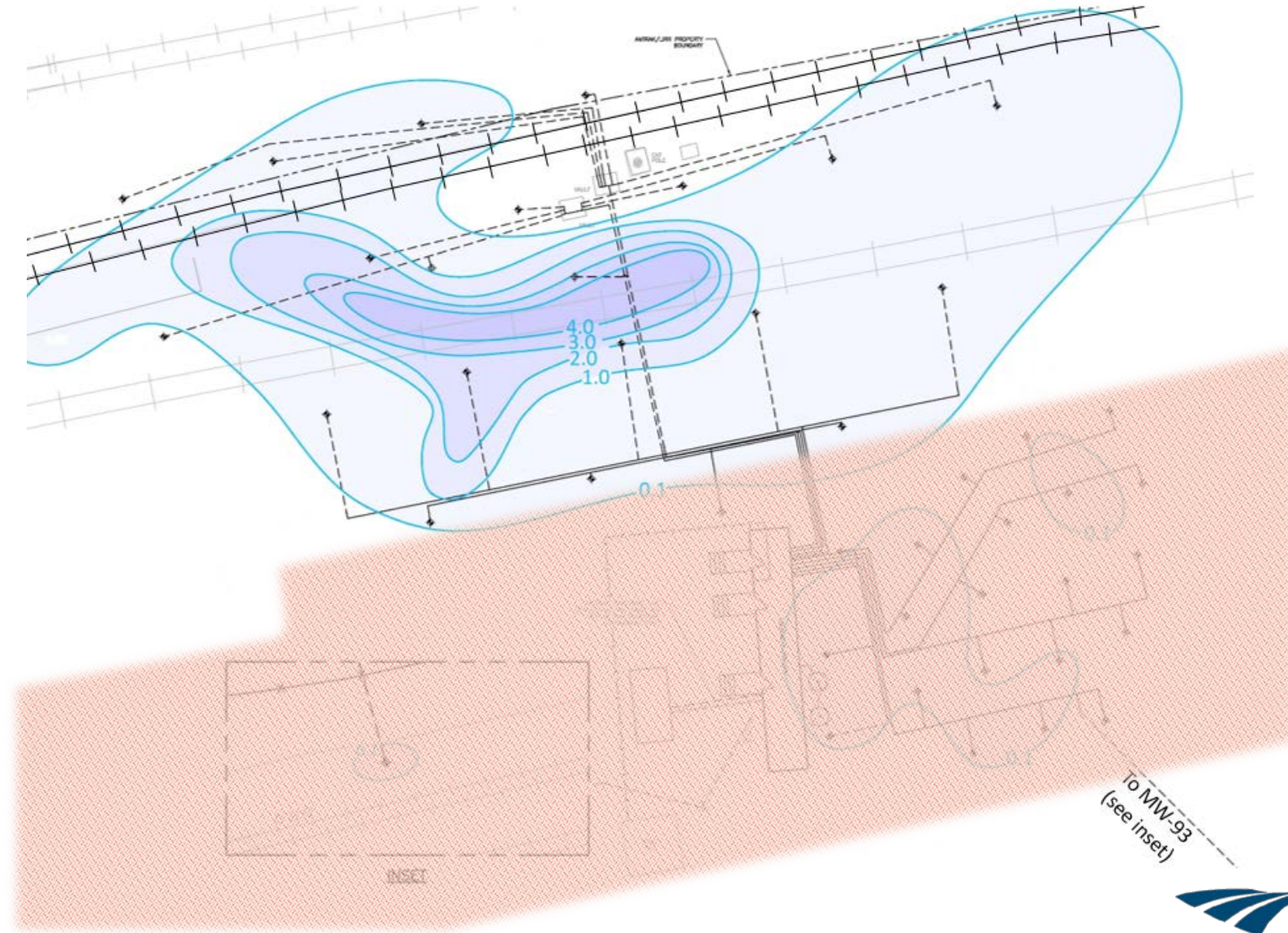


DPVE System Performance



June 2013

High Speed Rail Building Design



High Speed Rail Building Design



Evaluate Technologies to Accelerate Remediation

- Source zone excavation
- Activated persulfate injections
- Catalyzed hydrogen peroxide injections
- Surfactant injections
- Thermal enhancement



Ivey-sol[®] Surfactant Technology

- Composition
 - Several patented non-ionic surfactant formulations
- Applications
 - Desorb and liberate free-phase LNAPL and/or sorbed petroleum hydrocarbons
- Mechanism
 - Makes the contaminants more miscible in the aqueous phase, increasing the “physical availability”
- Additional Uses
 - Enhances bioremediation

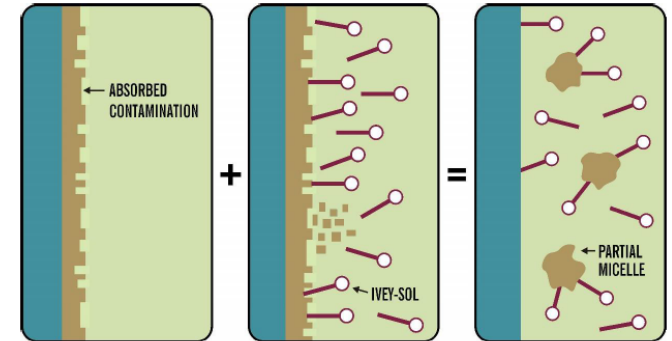
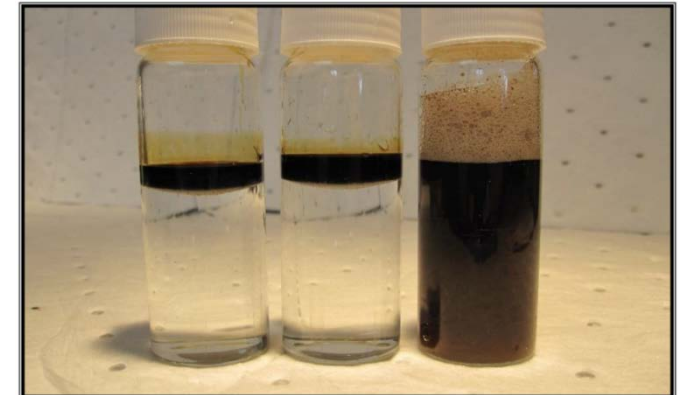
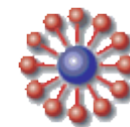


Figure 2-2: Ivey-sol[®] desorbing contamination off the soil surfaces, or NAPL layer making it more 'Available' for in-situ or ex-situ remediation.



Photograph 2-2: Pre-post Ivey-sol[®] Free NAPL Product Remediation



Ivey International Inc.

“Today's Environmental Solutions For A Better Tomorrow”™

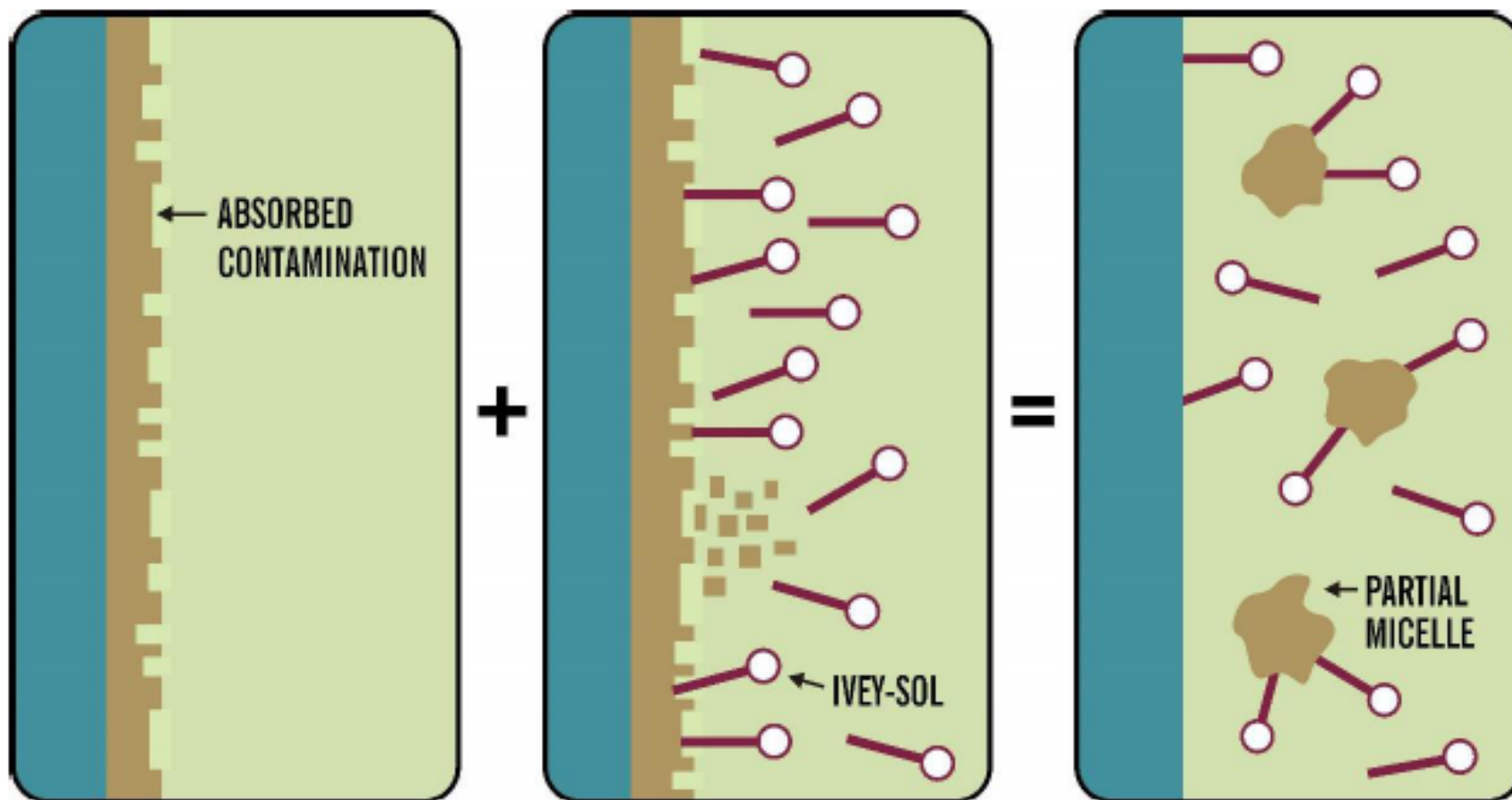
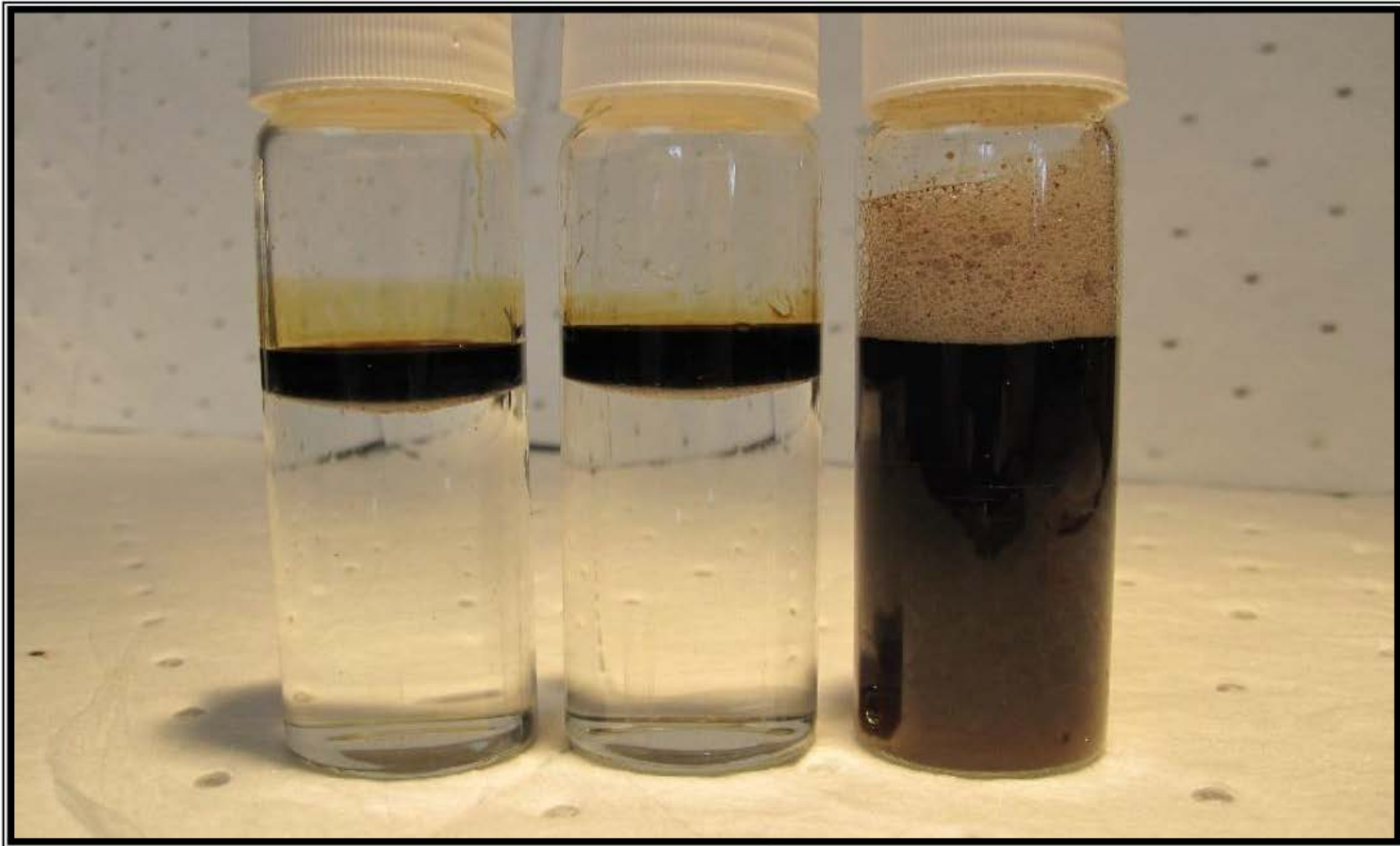


Figure 2-2: Ivey-sol[®] desorbing contamination off the soil surfaces, or NAPL layer making it more 'Available' for in-situ or ex-situ remediation.



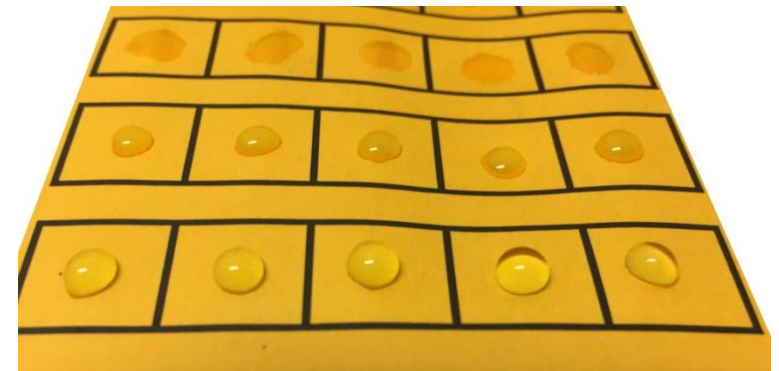
Photograph 2-2: Pre-post Ivey-sol[®] Free NAPL Product Remediation

Injection Areas



Pilot Study Methods

1. Injection (gravity fed/geoprobe)
 - Experimented with surfactant to water ratios
 - Experimented with volumes of total mixture
2. Extraction (DPVE system)
 - Removed at least 3x the injection volume
 - Continued extraction until no surfactant was present
3. Extract from injection point or nearby extraction well

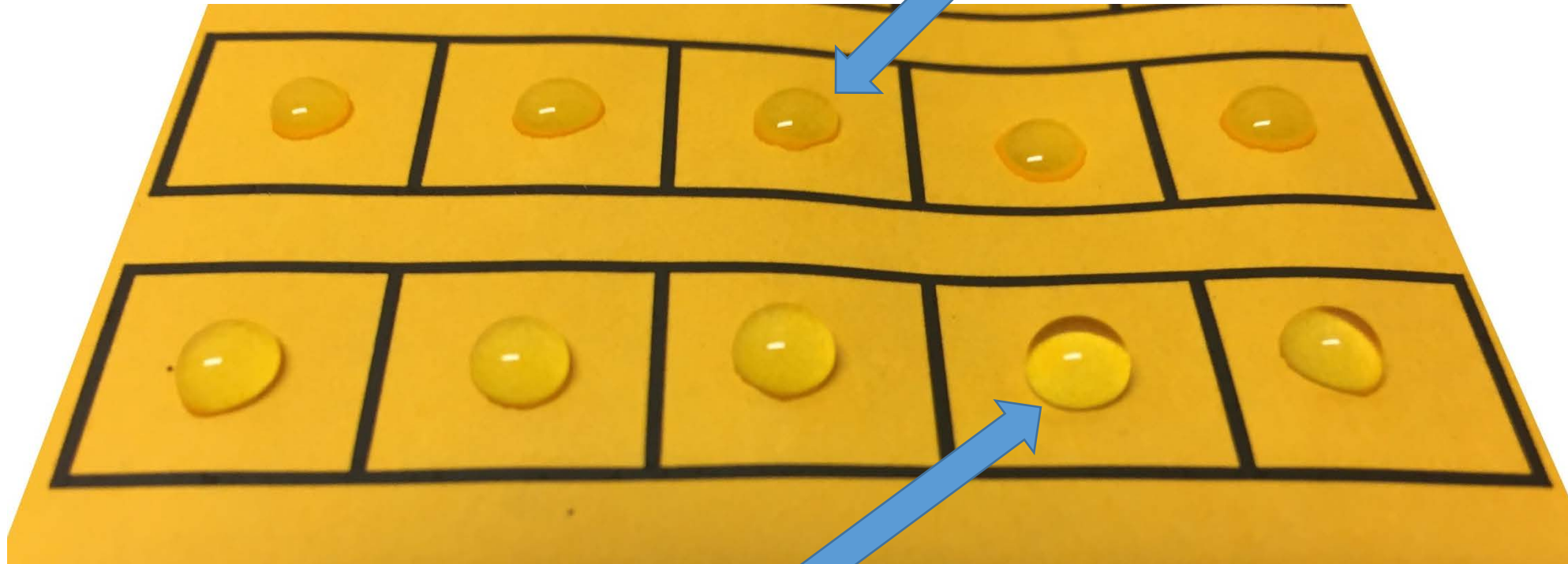


Water mixed with Surfactant

Irregular edges

Loses its beading

Absorbed by the paper



Water free of Surfactant

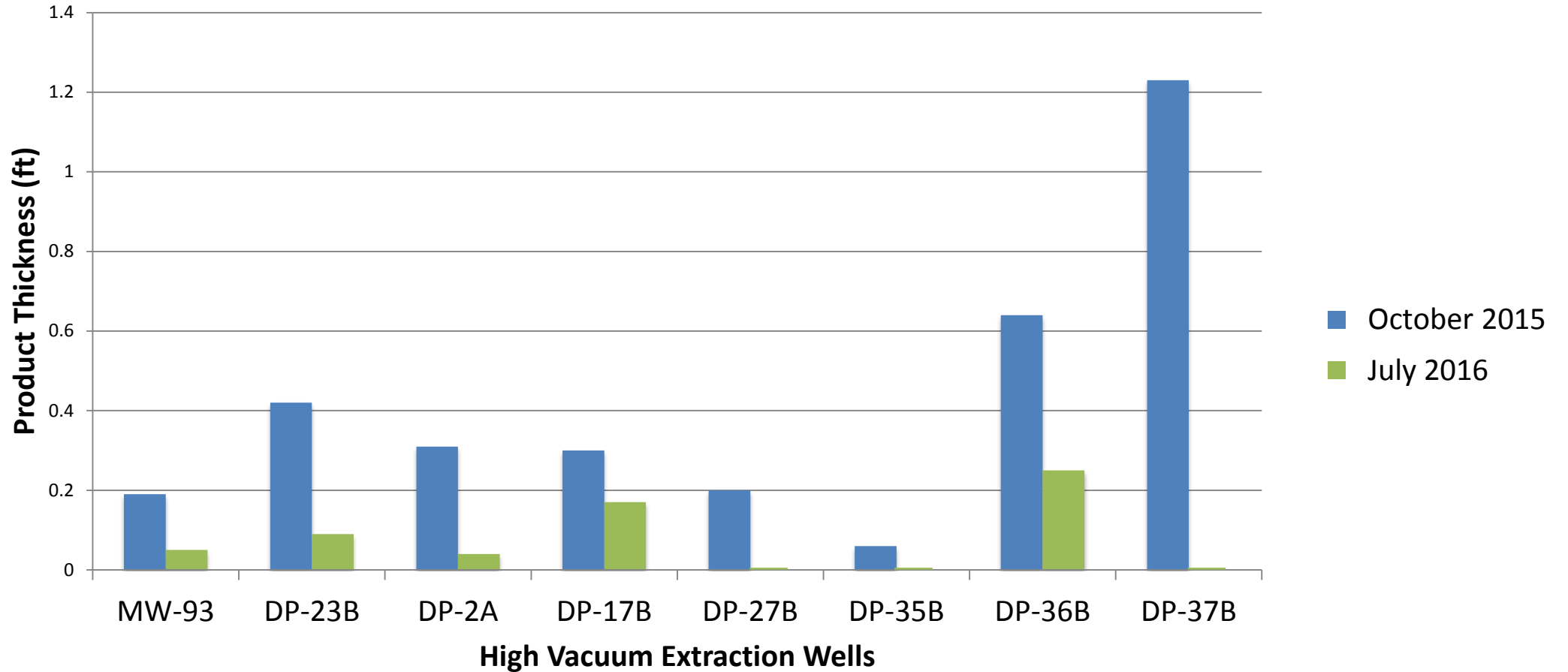
Forms near-perfect circles

Retains its beading

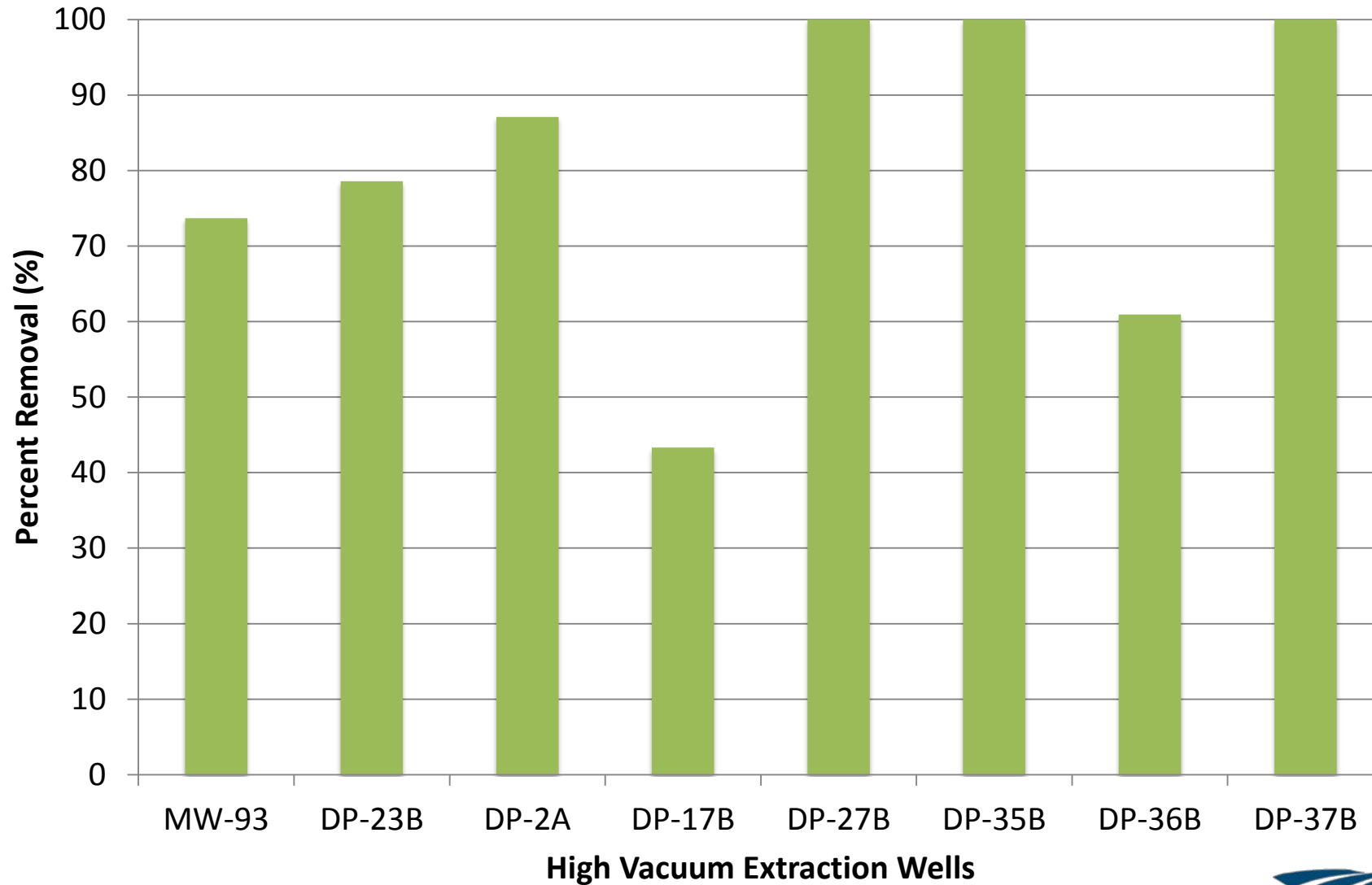
Does not absorb into the paper

Pilot Study Results

Product Thickness, Before and After



SPH Percent Removal



Conclusions

- SHP recovery was enhanced by the increase of SPH solubility
- Free product was not observed in the extracted groundwater
- Reduction of SPH thickness was usually observed within 24 hours of surfactant injection and persisted for several weeks or longer
- Low concentration ratios of surfactant (1:20) are effective and higher concentrations do not increase effectiveness
- Low injection volumes or injection rates were generally needed in OU-3 due to the low permeability soil conditions and high groundwater table

Recommendations

- Future applications of surfactant should be aimed at treating areas exterior of the proposed excavation but impacted by measurable impacts of SPH > 0.1 foot
- A Geoprobe[®] should be used to facilitate injections of a surfactant solution using a 5% Ivey-sol[®] to potable water ratio (i.e., 10:200 v/v or similar) under pressure
- Extraction should commence approximately 48 hours after injection and expect to conclude after removing 30 to 70 times the injection volume.

Questions