Expedited In-Situ Hydraulic Oil LNAPL Removal – Utilizing Biosolvents and Surfactants

EcoVac Services

May 23, 2012

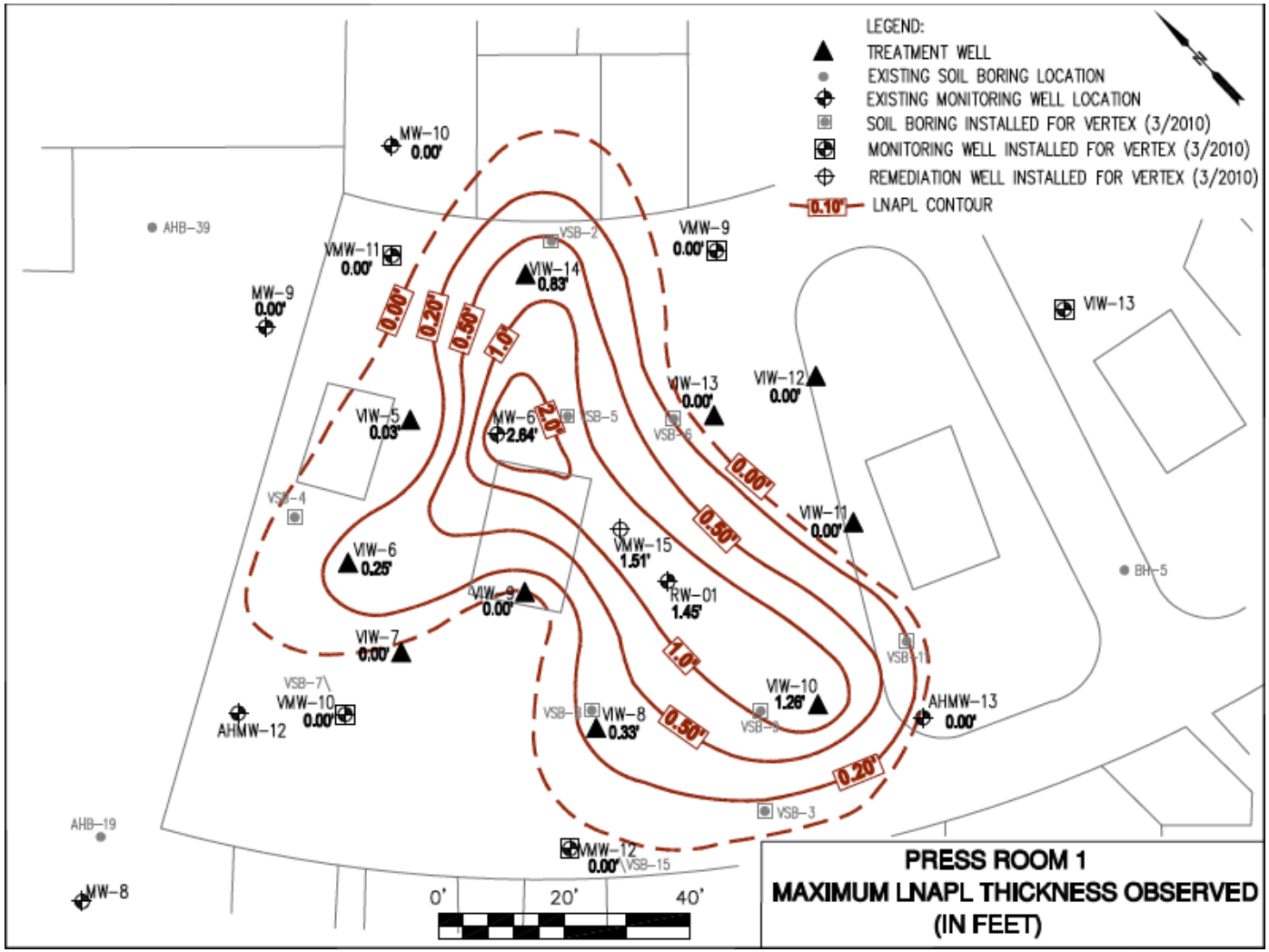
INNOVATIVE REMEDIAL SOLUTIONS

Site Background

- *Two hydraulic oil LNAPL plumes* existed beneath two buildings at a former manufacturing facility in eastern Ohio
- The hydraulic oil emanated from recently decommissioned hydraulic presses
- Occupied by industrial facilities since the *late 1880s* that have included a *railroad maintenance yard and metal fabrication*

Site Aerial

Maximum LNAPL Thickness (Press Room #1)



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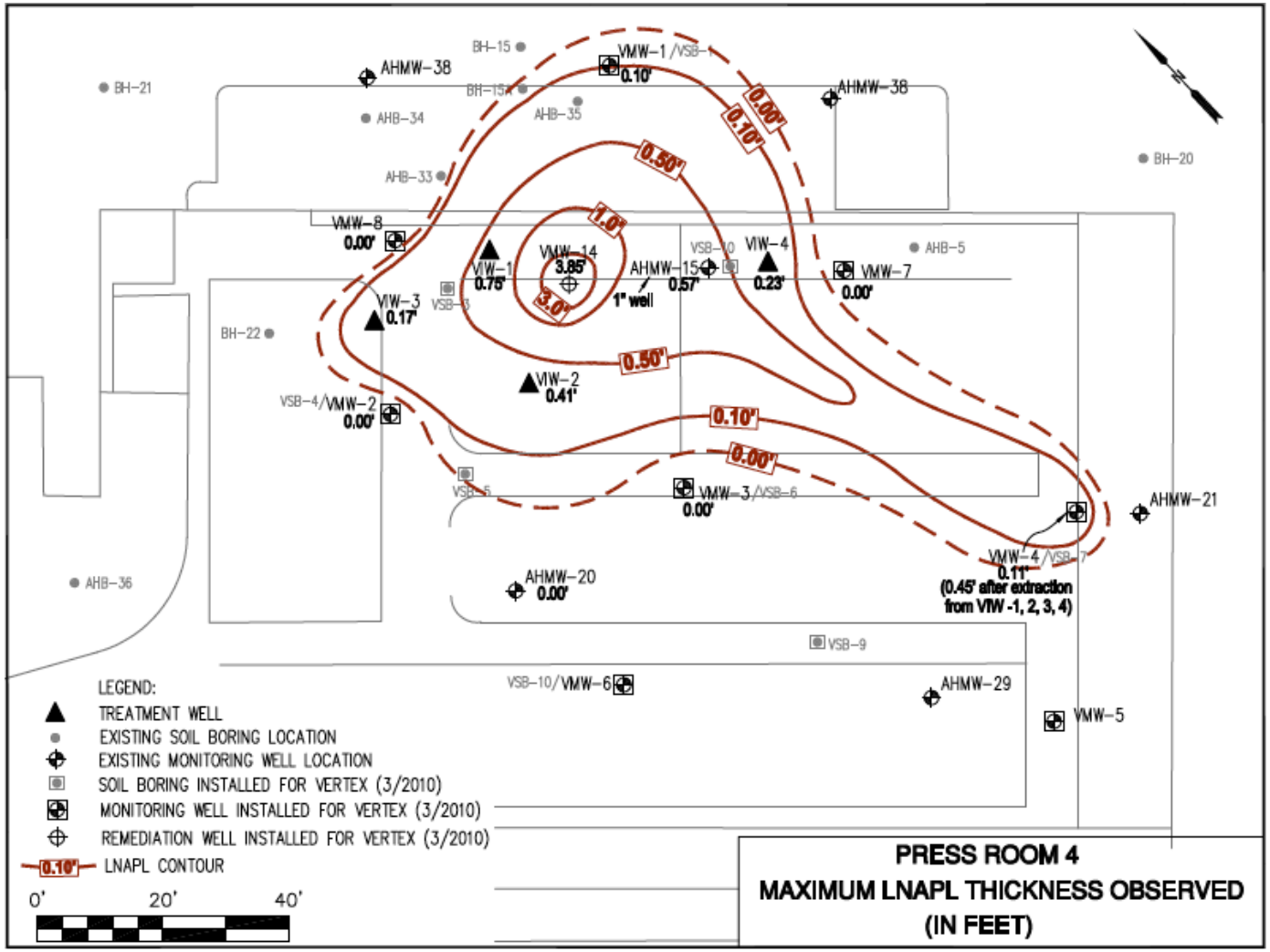
Maximum LNAPL Thickness (Press Room #4)



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Remedial Process

- The property owner was interested in an *expedited cleanup to remove environmental encumbrances* that might impact the ability to transfer the property

- Selected was a cost-effective in-situ mobile remedial system employing a *treatment train* approach utilizing *biosolvents and surfactants* (**SOLV-IT**) to remove hydraulic oil LNAPL

- The process included *field/aquifer testing*, *treatability testing*, *additional treatment well installation*, *pilot testing*, *and field implementation*

- The mobile system was implemented during an approximate 30-field days time period, which resulted in *significant LNAPL removal*

Phase 1 – Field/Aquifer Testing

- Quantification of total VOC removal rate and total removal
- Flow rates from the subsurface
- Extraction well vacuum pressures (relative intrinsic permeability)
- Offgas concentrations (total VOC's)
- Groundwater recovery rates and volumes
- Vacuum influence
- Groundwater level drawdown data
- Determine the ideal placement/well construction details for additional treatment wells
- Assess site constraints
- Assess the LNAPL reduction effected by the dual-phase/multi-phase extraction process

Phase 2 – Treatability Testing

- Laboratory treatability testing consisted of *viscosity reduction assessment*, *surfactant selection*, *surfactant compatibility*, and *one-dimensional column testing*

- **Viscosity Reduction**

  - The LNAPL was *too viscous* (406 cp at 15° C)
  - Therefore, a *vegetable-based cosolvent* was amended to reduce the LNAPL viscosity to 23 cp (at 15° C), a *94% viscosity reduction*

- **Surfactant Selection**

  - The study concluded that proprietary surfactant EFS-A™ (*2.31% solution with 1.80% electrolyte concentration*) was capable of achieving maximum LNAPL mobilization and recovery

Phase 2 – Treatability Testing

- **<u>Surfactant Compatibility</u>**
  - *No adverse reactions* (e.g. precipitation / phase separation) were observed between the surfactant formulation and site groundwater

- One-dimensional column testing – *98% soil TPH reduction recorded*

Column Study Effluent Images

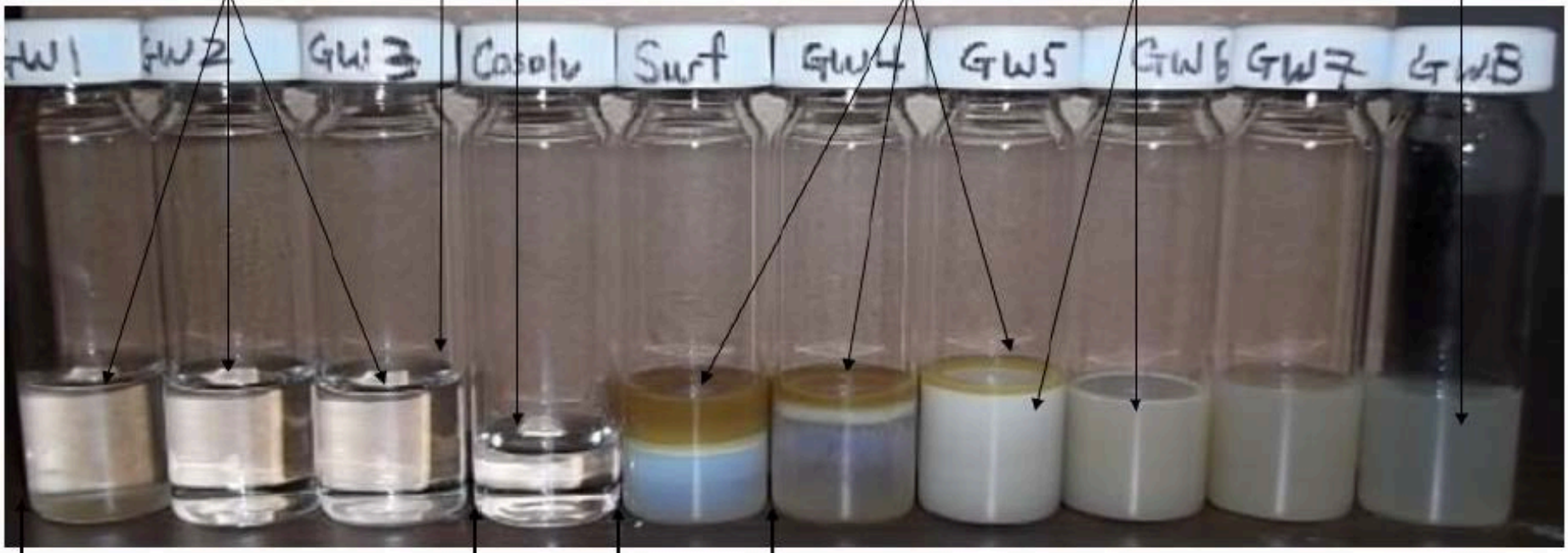
No NAPL elution was observed prior to cosolvent/surfactant application. 3 PVs of groundwater was applied.

During the ½ PV of cosolvent application, no NAPL mobilization was observed.

Large amount of NAPL mobilization was observed.

Large amount of solubilized NAPL was collected.

Effluent was getting clear out.



2 ml NAPL was injected. Injection fluid was groundwater.

0.5 PV cosolvent was injected.

1 PV surfactant was injected.

5 PVs post-surfactant groundwater application was started.

Phase 3 – Pilot Testing

- Conducted *October 24-28, 2011*
- Measureable LNAPL, ranging in thicknesses from *0.01 to 2.92 feet*, was *present in sixteen wells* (including in nine of the 14 newly installed treatment wells)
- The distribution of LNAPL in the wells *yielded an alternate interpretation* of the SPH plume.
  - It is noted that SPH is not entirely delineated in Press Room #1, notably south of VIW-10 and northeast from VIW-14

Phase 3 – Pilot Testing

- Maximum differential pressures, ranging from *-0.03 to -2.40 inches of water*, were detected in surrounding monitor wells during extraction up to *distances of approximately 39 feet*

- Groundwater drawdown, ranging from *+0.01 to -6.75 feet*, was also detected in surrounding monitor wells during extraction up to *distances of approximately 80 feet*

- VOC (vapor) ranged from 880 to 4,200 PPM
- Air flow rates ranged from 29 to 294 CFM
- Aquifer yields 0.6 to 7.3 GPM

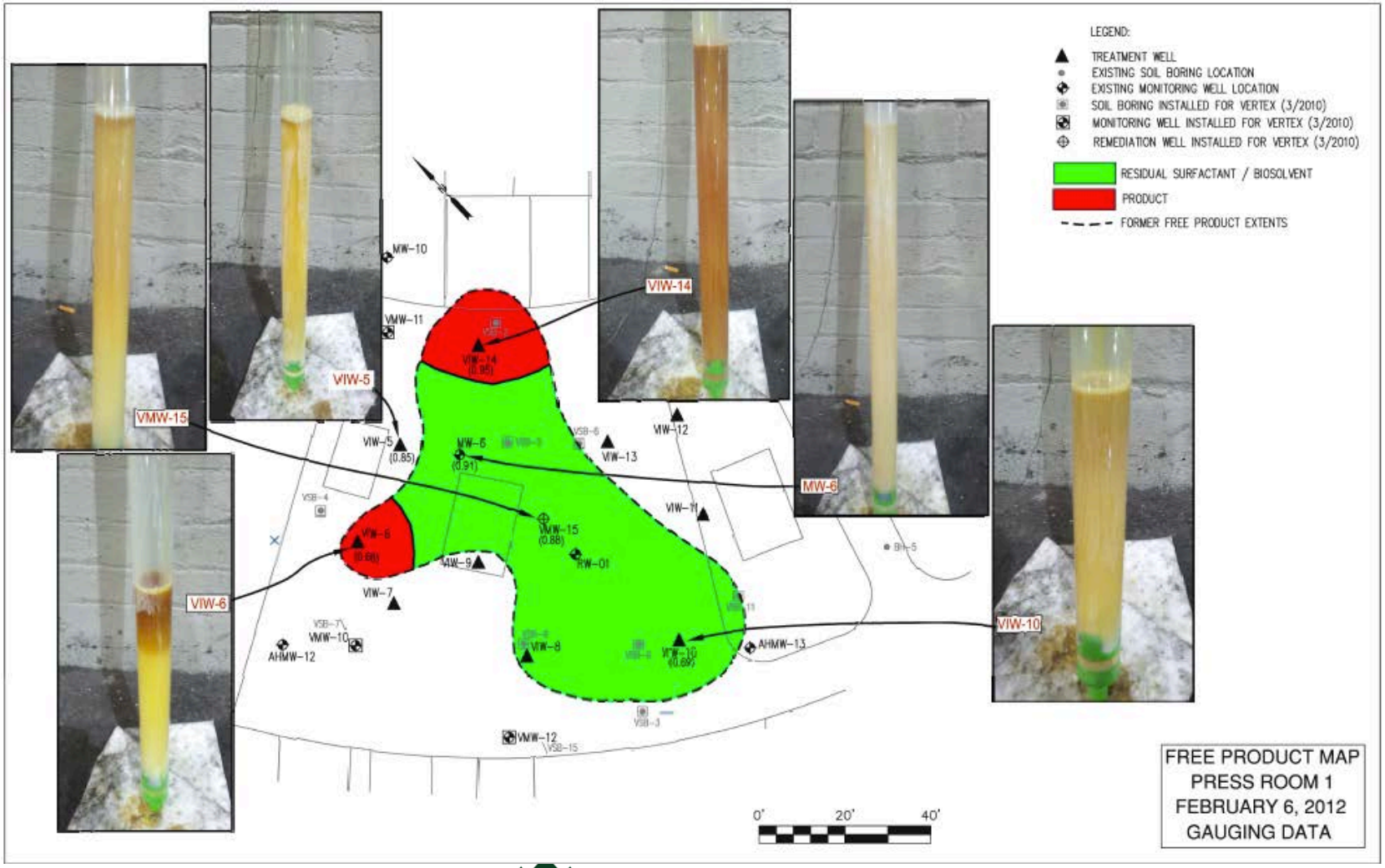
Phase 4 – SOLV-IT® Implementation

- *SOLV-IT®* was performed during *30 field days* - November 28 and December 30, 2011 (16 field days) and January 23 to February 10, 2012 (14 field days)

- A total of *3,905 gallons of cosolvent solution* was injected, followed by *6,750 gallons of (diluted) surfactant mixture*

- The viscosity of the hydraulic oil NAPL was *reduced from 406 cp prior to injection to 69 cp* (after cosolvent injection) and then to 11 cp (following surfactant injection)
  - This viscosity reduction *exceeded the value predicted* during the treatability study (23 cp)

February 6, 2012 LNAPL Plume (Press Room #1)



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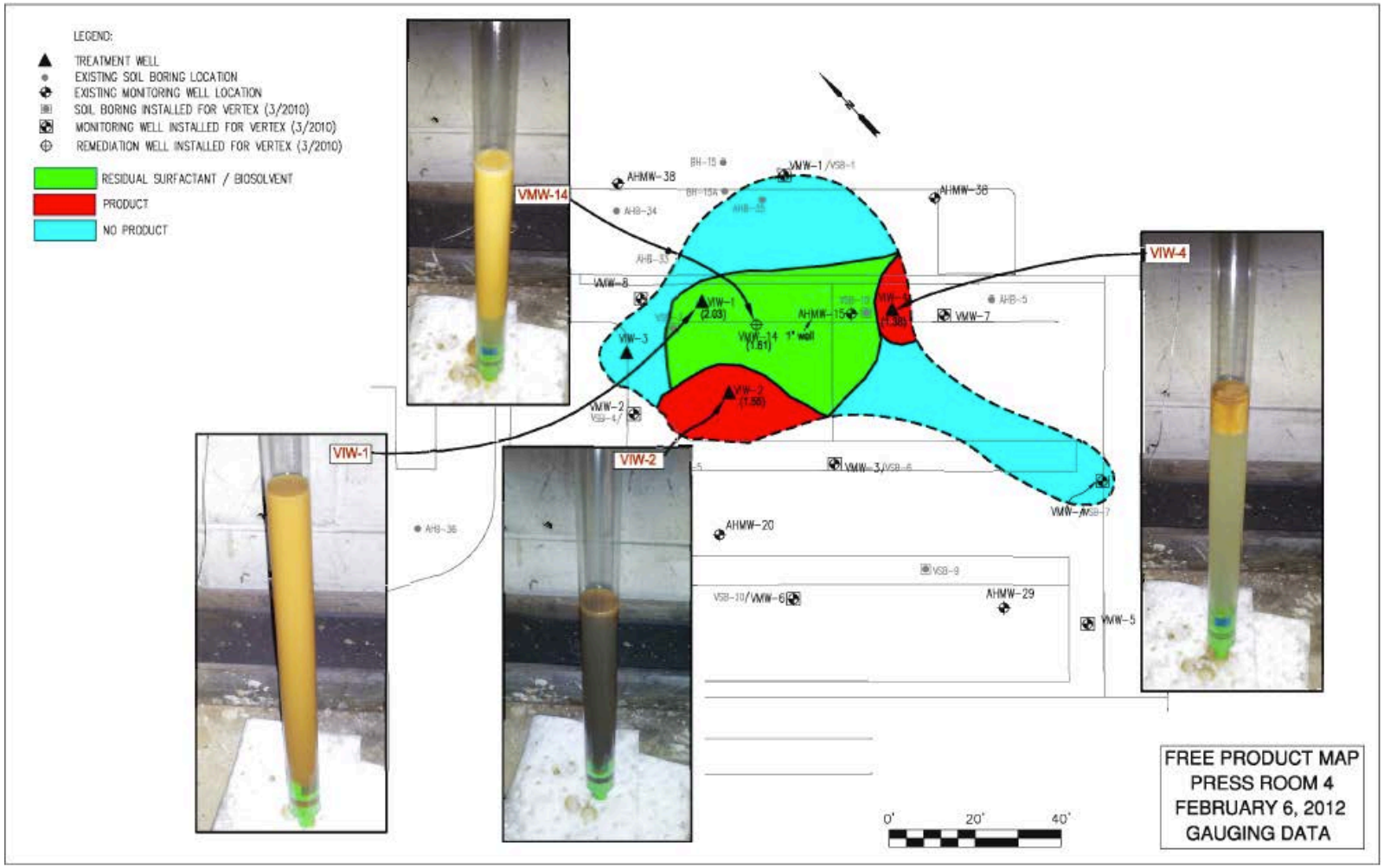
February 6, 2012 LNAPL Plume (Press Room #4)



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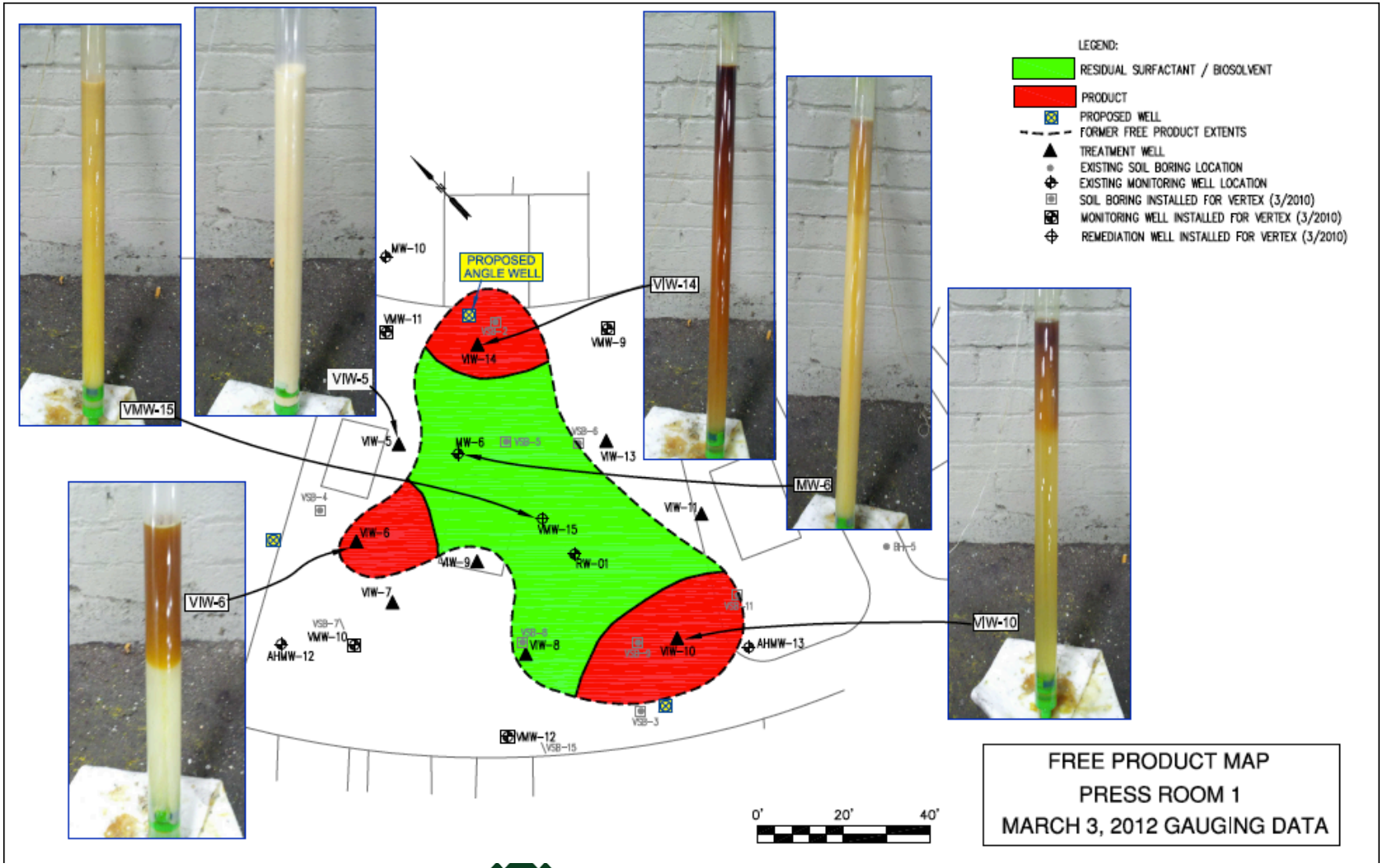
March 3, 2012 LNAPL Plume (Press Room #1)



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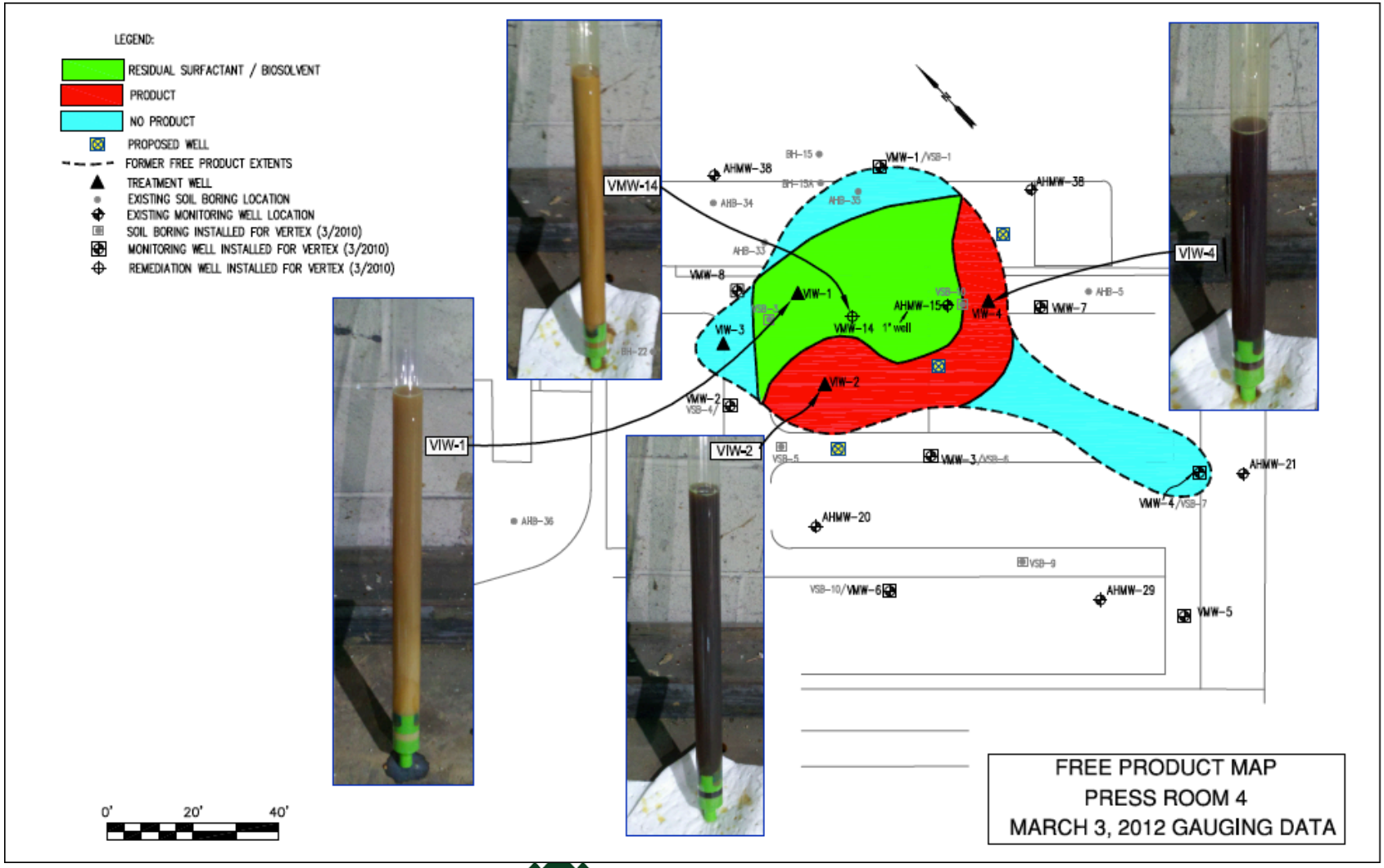
March 3, 2012 LNAPL Plume (Press Room #4)



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Results and Conclusions

- *Cosolvent injection decreased the viscosity to enable movement (flow) of the hydraulic oil using a surfactant*
- *The selected surfactant was effective in decreasing the interfacial tension and removing the hydraulic oil from the subsurface*
- *Additional capture is necessary to complete removal of all injected cosolvent and surfactant, and the remaining residual hydraulic oil*
- *The injection sequence can influence the recovery rate and efficiency of the injected cosolvent and surfactant*
- *The "Treatment Train" using cosolvents and surfactants is effective in removing viscous NAPLs from the subsurface.*

Lessons Learned

- Always fully delineate!
- Every site is unique, and outliers can exist
- Treatability studies, when properly conducted, can provide helpful information and provide a “blueprint” for field implementation

Questions?

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