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The use of Passive Flux Meters and Design Verification Program - Lessons Learned from Pre-Application Assessments at In Situ Remediation Sites

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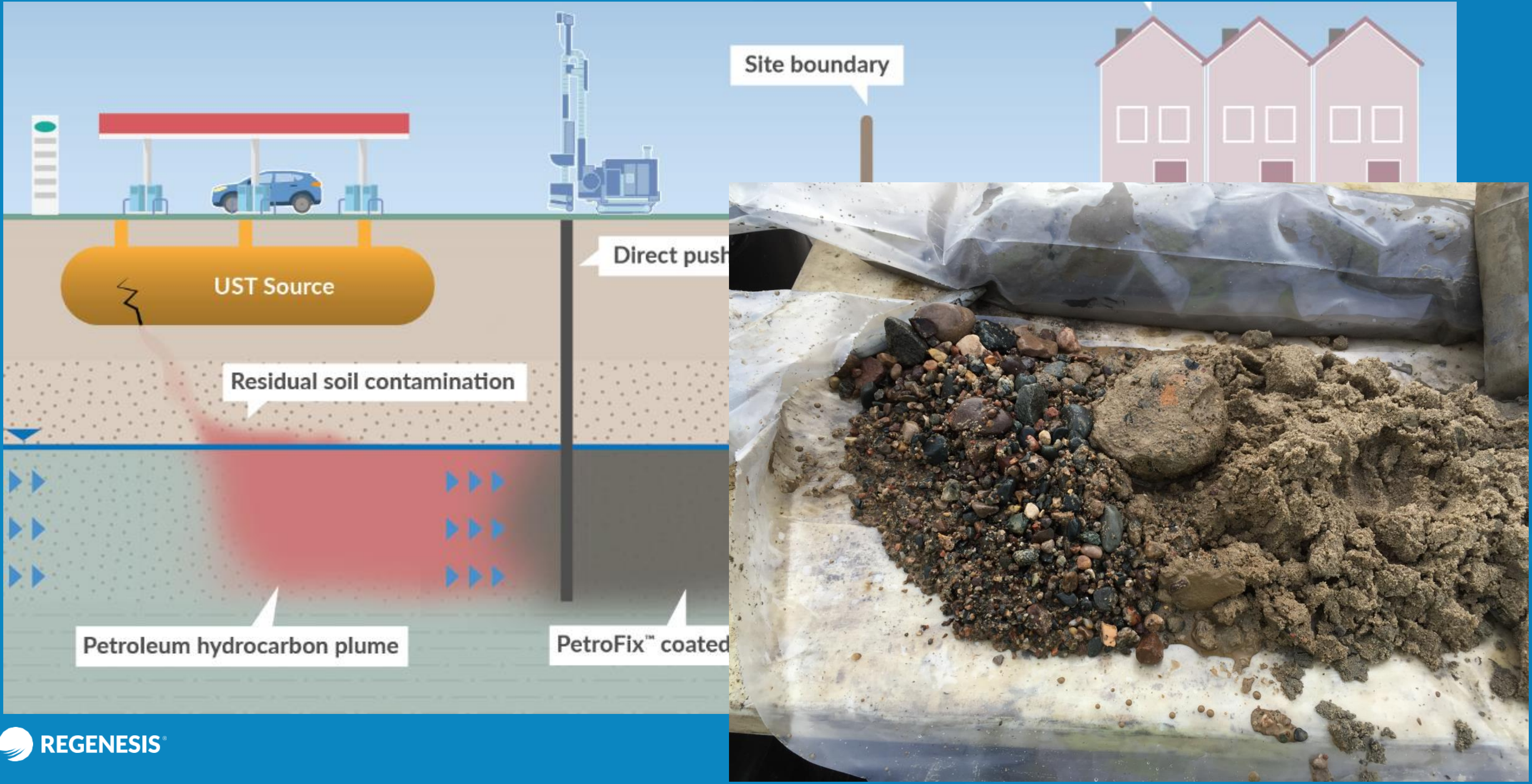
RemTech 2019

Introduction



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Design Verification Testing (DVT): What is it?

- **Design Verification Tests** (**DVTs**):
  - A process of data collection and analysis
    - to verify design assumptions of a site's
    - chemical and geological conditions and
    - the viability of *in-situ* injection(s).
- **Focus on remedial design parameters**
  - Not necessarily Site Investigation parameters
- **High density sampling**
- **Data collection of concern varies site to site**
- **Performed 4-6 weeks prior to an application**:
  - Allow time for analysis and modification

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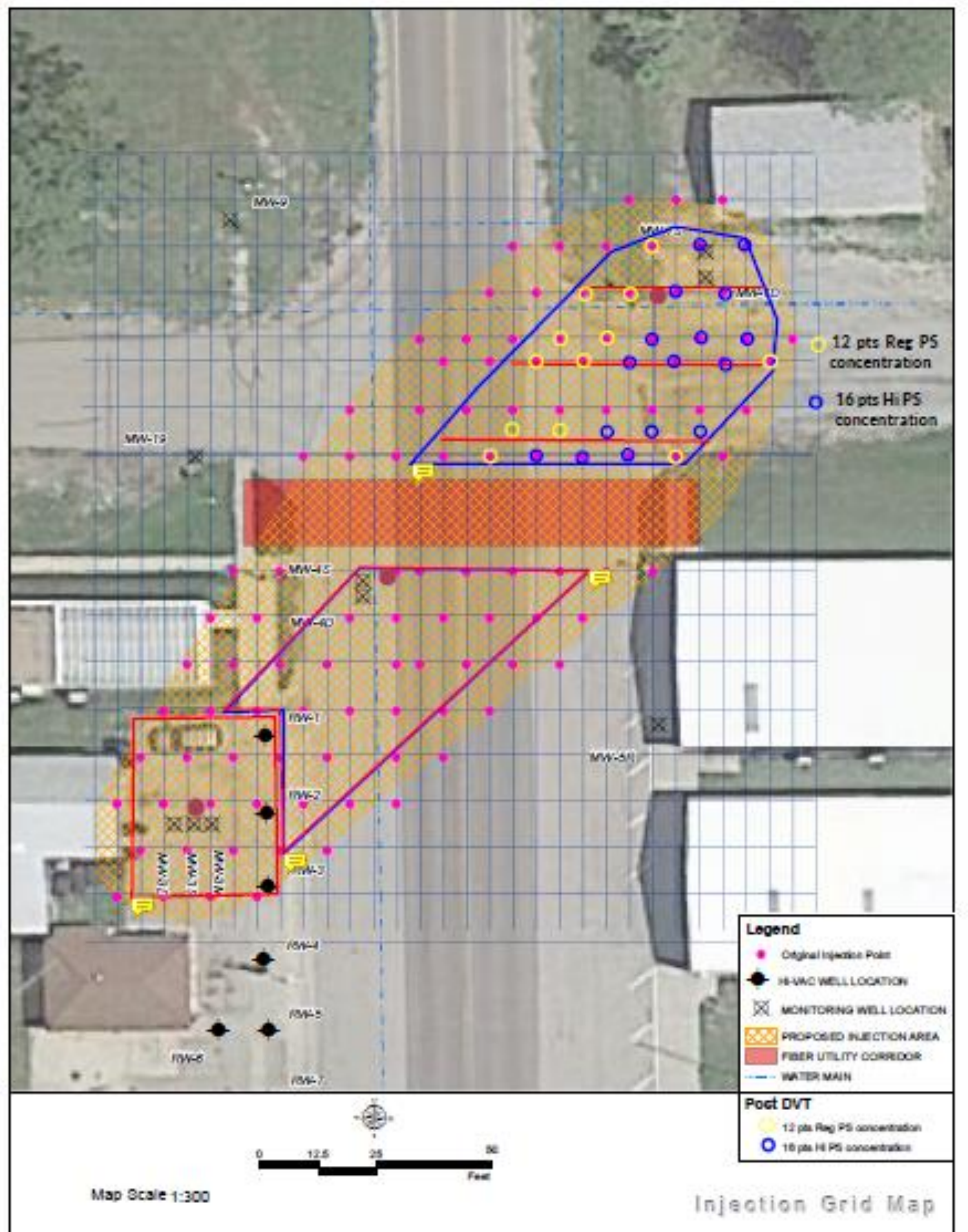
Design Verification Testing (DVT): Why do it?

Focus

- Site investigations typically focus on liability and risk assessment
  - Emphasis on contaminant identification, plume dimensions and pathways
  - This isn't a criticism!

- Design verification focuses on efficient reagent-contaminant contact
  - Emphasis on identification of principal impacted units, contaminant mass distribution and reagent delivery



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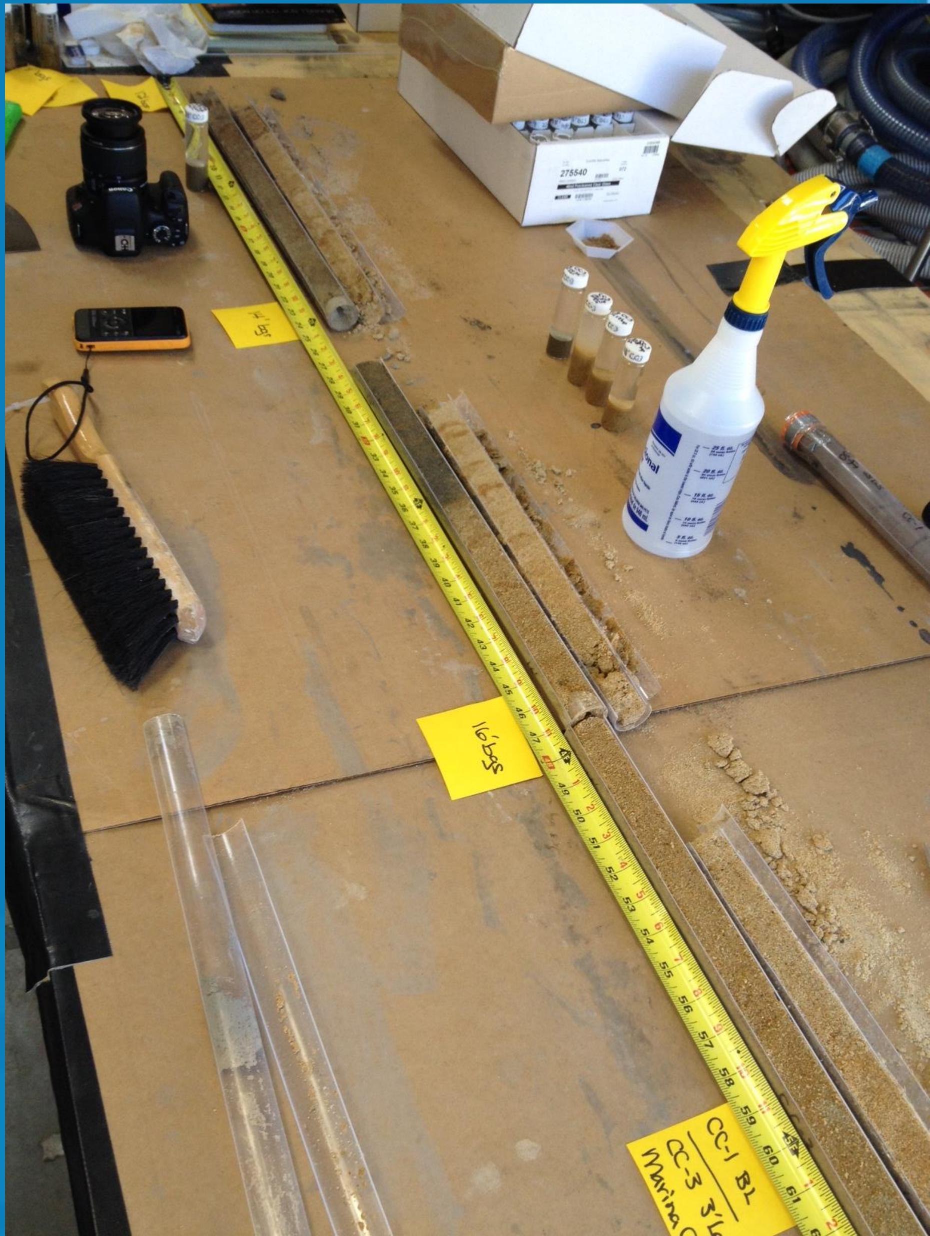
Design Verification Testing (DVT): Why do it?

Advantages

- Identify technical blind spots/gap analysis
- Refines design assumptions
- Calibrate Reagent Design
  - Contaminant mass vs reagent volume/mass
  - Consider competing compounds
  - Can we fit reagent volumes in the target zone
  - Reagent selection
  - Improves contact with contaminant:
    - Improves efficacy
  - Improves accuracy of dose and application
    - Make most cost effective application
  - Proof of concept

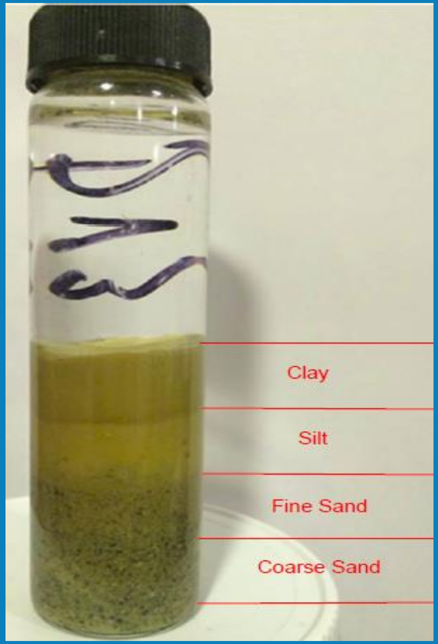


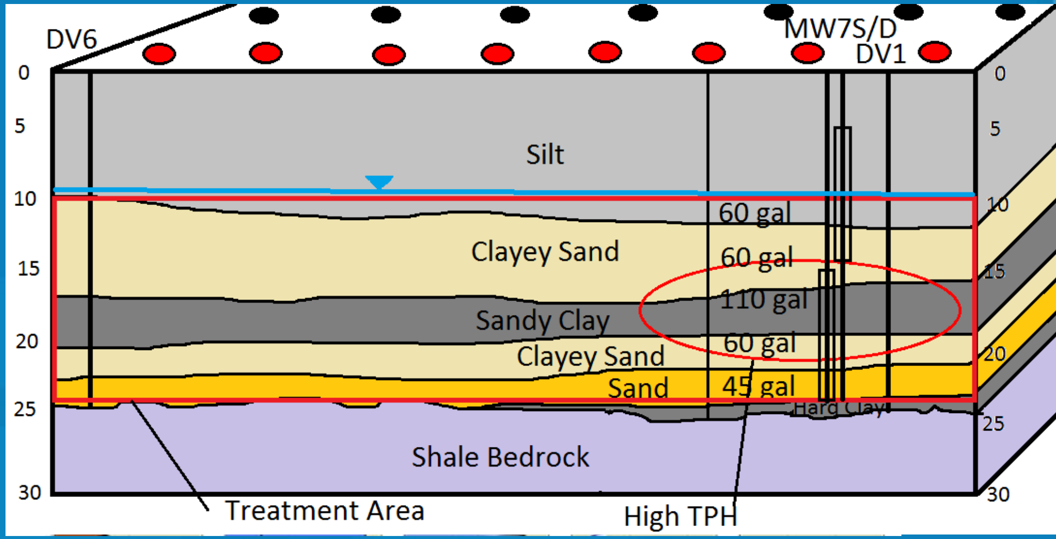
Design Verification Testing (DVT): Components

- Confirmation of geology in treatment zone
  - Continuous soil core logging
  - Settling tubes

- Identification of flux zones
  - Sampling as above
  - Passive flux meter
  - Hydraulic Profile Testing

- Contaminant concentrations in flux zones
  - 'Real' contaminant concentrations to be addressed
  - MIP
  - Multi-level sampling
  - Passive flux meter



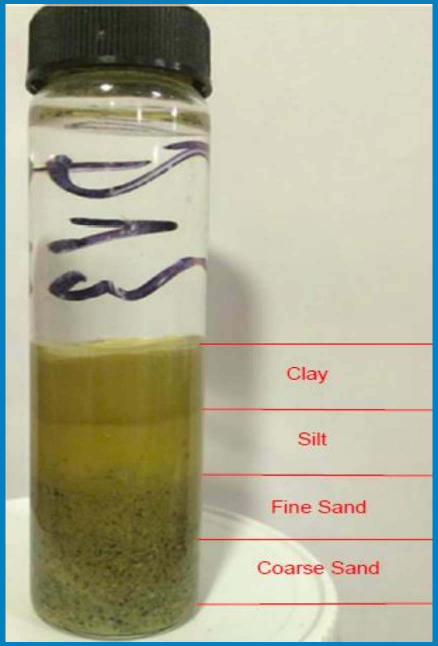


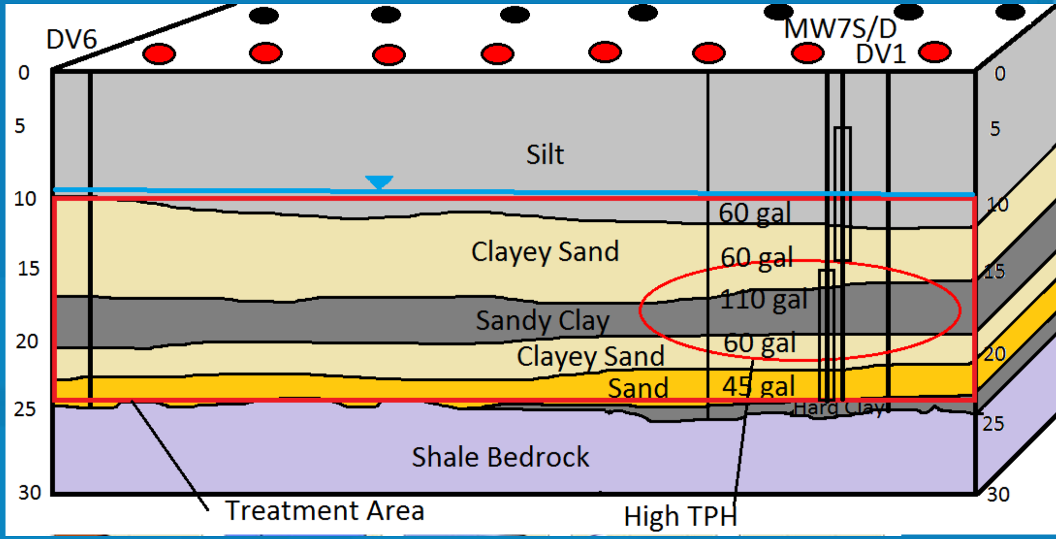
Design Verification Testing (DVT): Components

- Geochemical confirmation
  - Competing contaminants
  - Competing organics e.g. DOC = competitive sorption

- Clear water Injection
  - Test aquifer and application parameters

- Pilot injection
  - Test emplacement as well as efficacy





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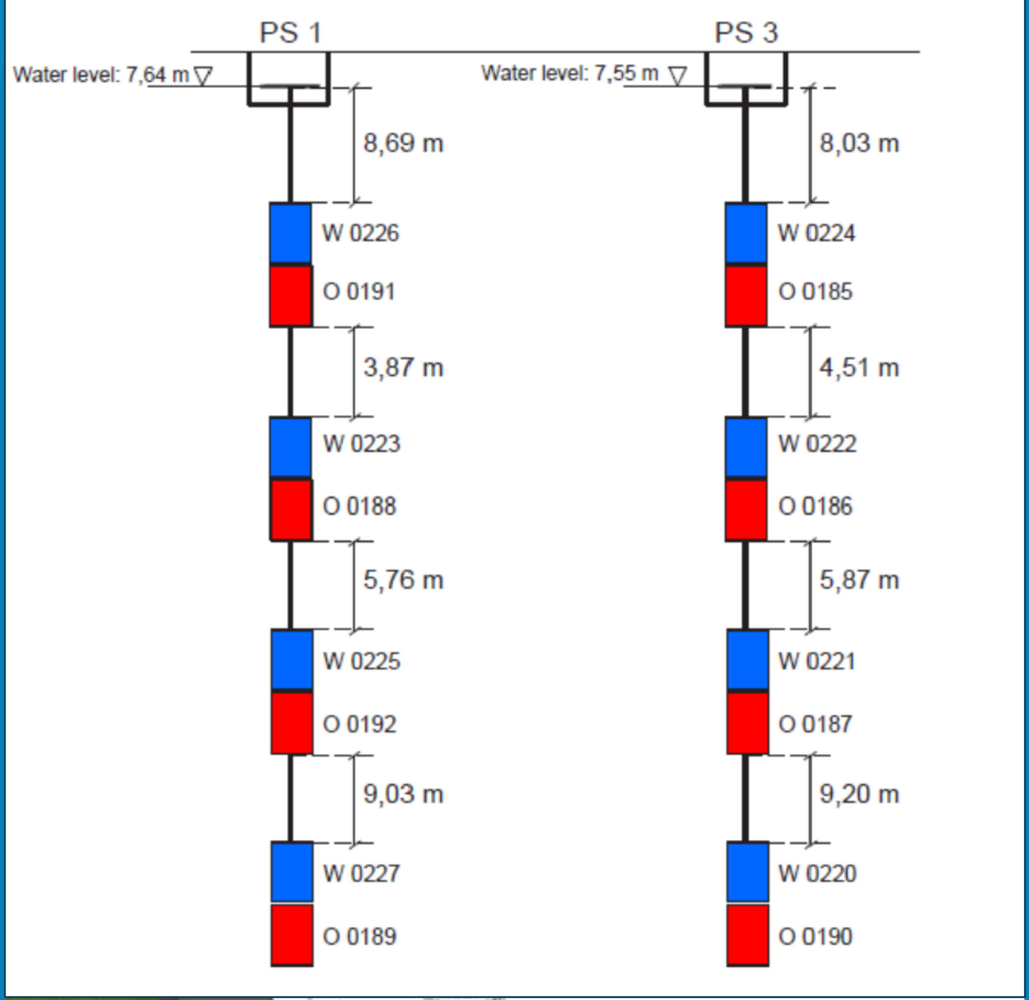
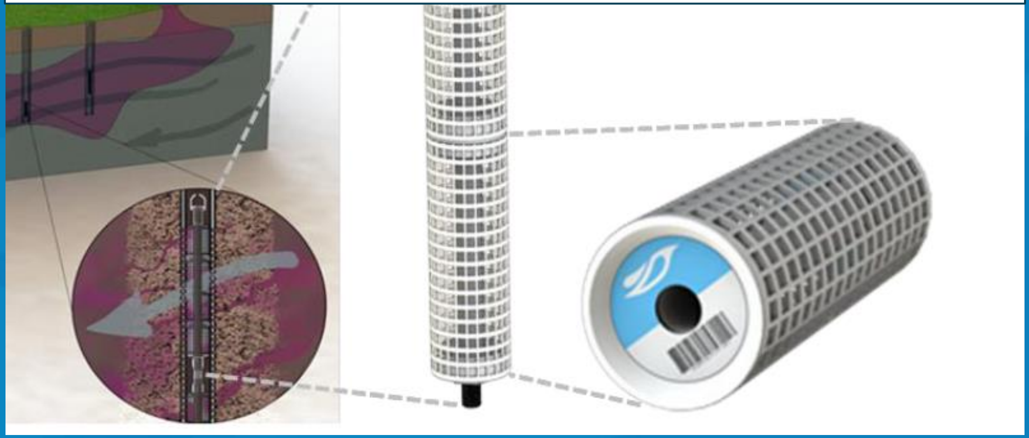
Focus on passive flux meters

- Petroleum hydrocarbon plume, up to 1000ug/L
- Sands and gravels
- 1km (partially active) pump and treat barrier
- Concept was to replace with a colloidal activated carbon barrier

- DVT to define treatment thickness and contaminant mass at barrier location
- Including Passive Flux Meter (I-Flux)
  - 2 wells
  - Multi-level sampling
    - At each:
      - 1 cartridge for groundwater flow
      - 1 cartridge for contaminant flux





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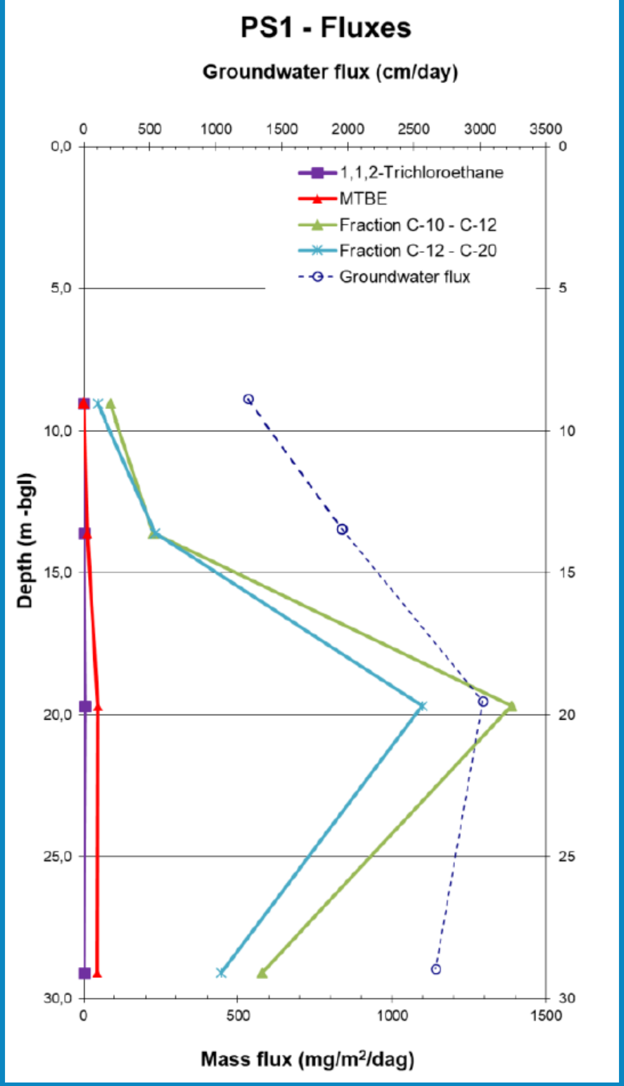
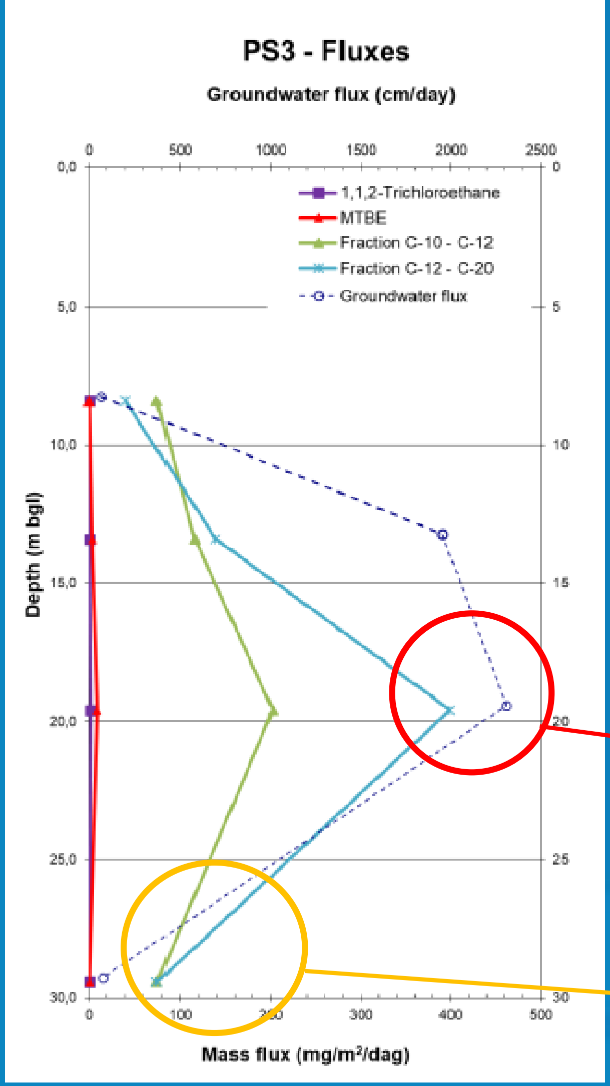
Focus on passive flux meters





- Very high groundwater flow rate (10-30 m/DAY at approx. 20mBGL
- Corresponding to Pump and Treat
- Low contaminant concentrations
- Vertical extent more than expected

Result:

- Barrier needs to be deeper
- Need to test with pumps off
- Review design to allow for higher flow
- Pilot in the right area?

Depth of boundary pump

Low flow velocity corresponding to a fine soil layer in log

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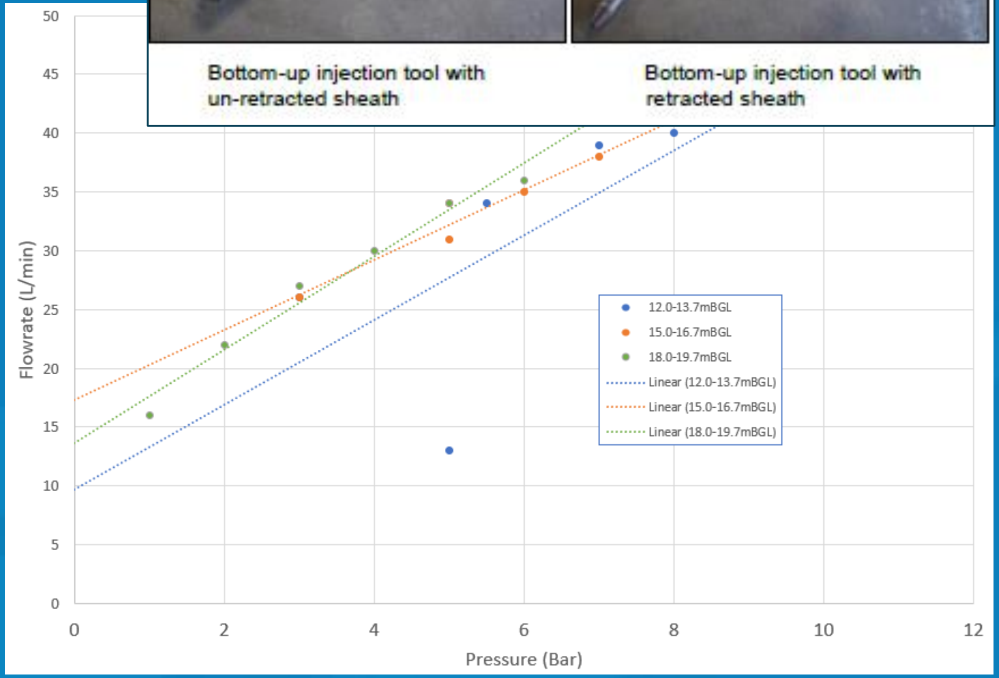
Design Verification: Clear Water Injection Test

- Injection of clean water to test:
  - Total volume accepted by the aquifer
  - Flowrates accepted
  - Pressure required
    - Minimum and ‘maximum’ (without fracturing)
  - Documents acceptance rates and volumes vertically

- Assists in application decisions
  - High or low volume substrate?
  - Direct Push Injection
    - Top-down vs Bottom-up
  - Injection wells
    - Screened Intervals
  - Balance of low pressure vs radius of influence

Bottom-up injection tool with un-retracted sheath

Bottom-up injection tool with retracted sheath



Pilot injection example

- Generally flat, slight slope downward toward the south
- Superficial geology: sand and gravel
- Non-continuous clay layer at ~ 8m bgs
- 2nd deeper clay layer in some areas at ~15-20 m bgs
- GW at ~ 6 mbgs and flows south toward Au Sable River, ~1km away

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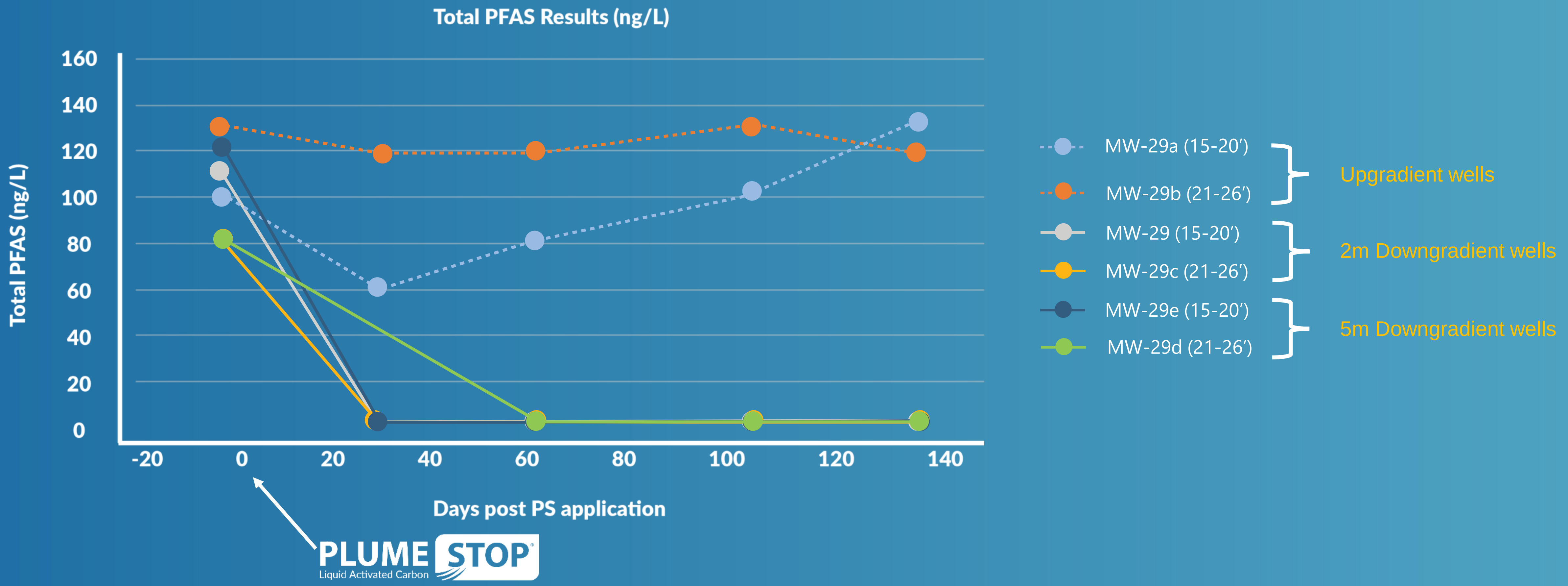
Total PFAS Results:
132 Days Post-application



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Design verification testing: analysis

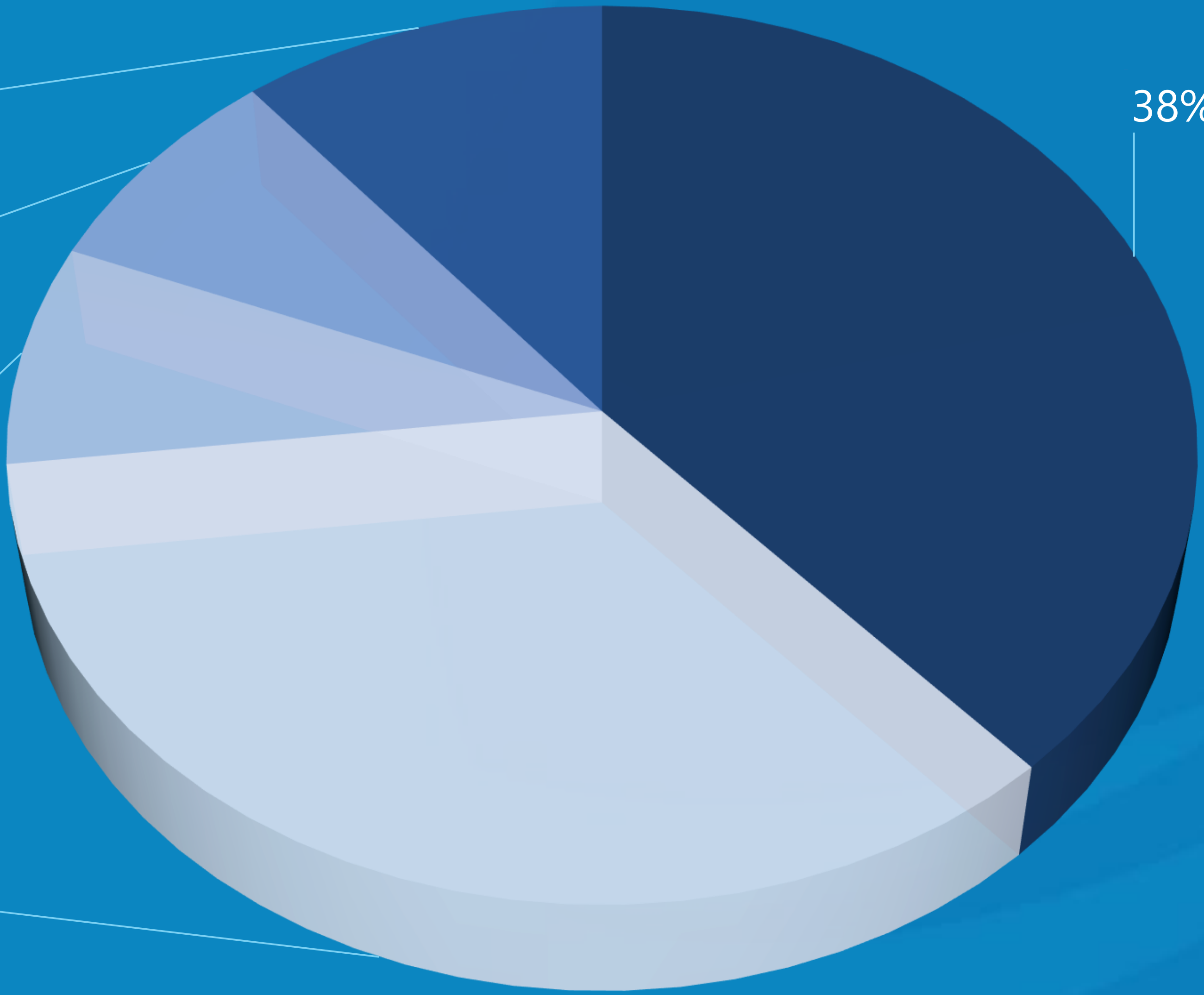
- Multiple site study:
  - 43 Sites

- Project Design Approach
  - 33 % source areas
  - 67 % mid- to distal- plume

- Contaminant Type
  - 35% Petroleum
  - 61% CVOC's
  - 4% Comingled

- General Soil Type
  - 50% Fine grained (Clays & Silts)
  - 50% Coarse grained (Sand & Gravel)

Design Verification Testing - Results



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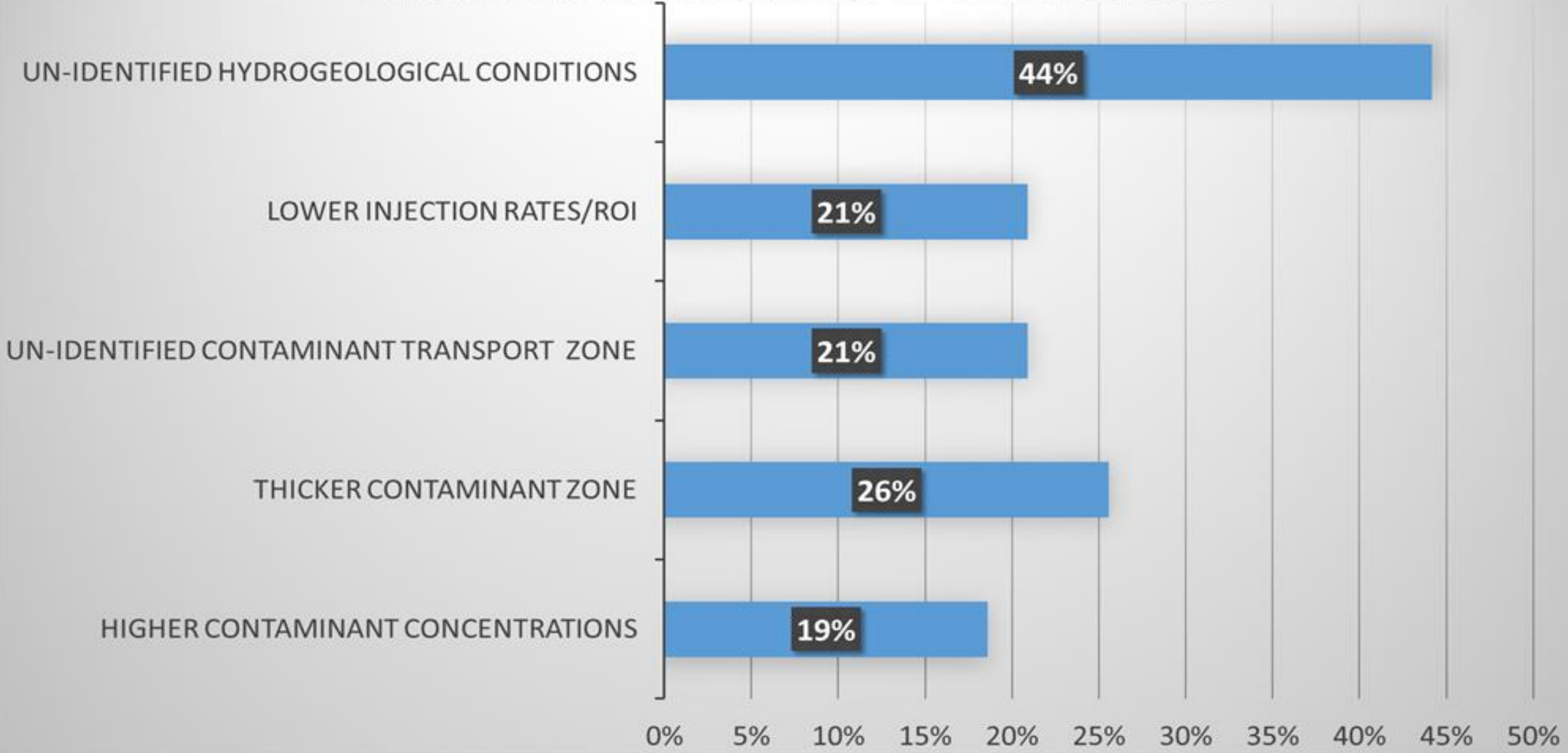
ANALYSIS OF TECHNICAL BLIND SPOTS



Conclusions

- Enhances knowledge of treatment location/zone
- Improves accuracy and granularity of data on which the design is based
- Allows gap analysis of knowledge
- Tests assumptions of the design
- Produces data directly relevant to the application
- Improves confidence
- Avoids errors
- Reduces overall costs
- Increases overall success of the project

Thank you

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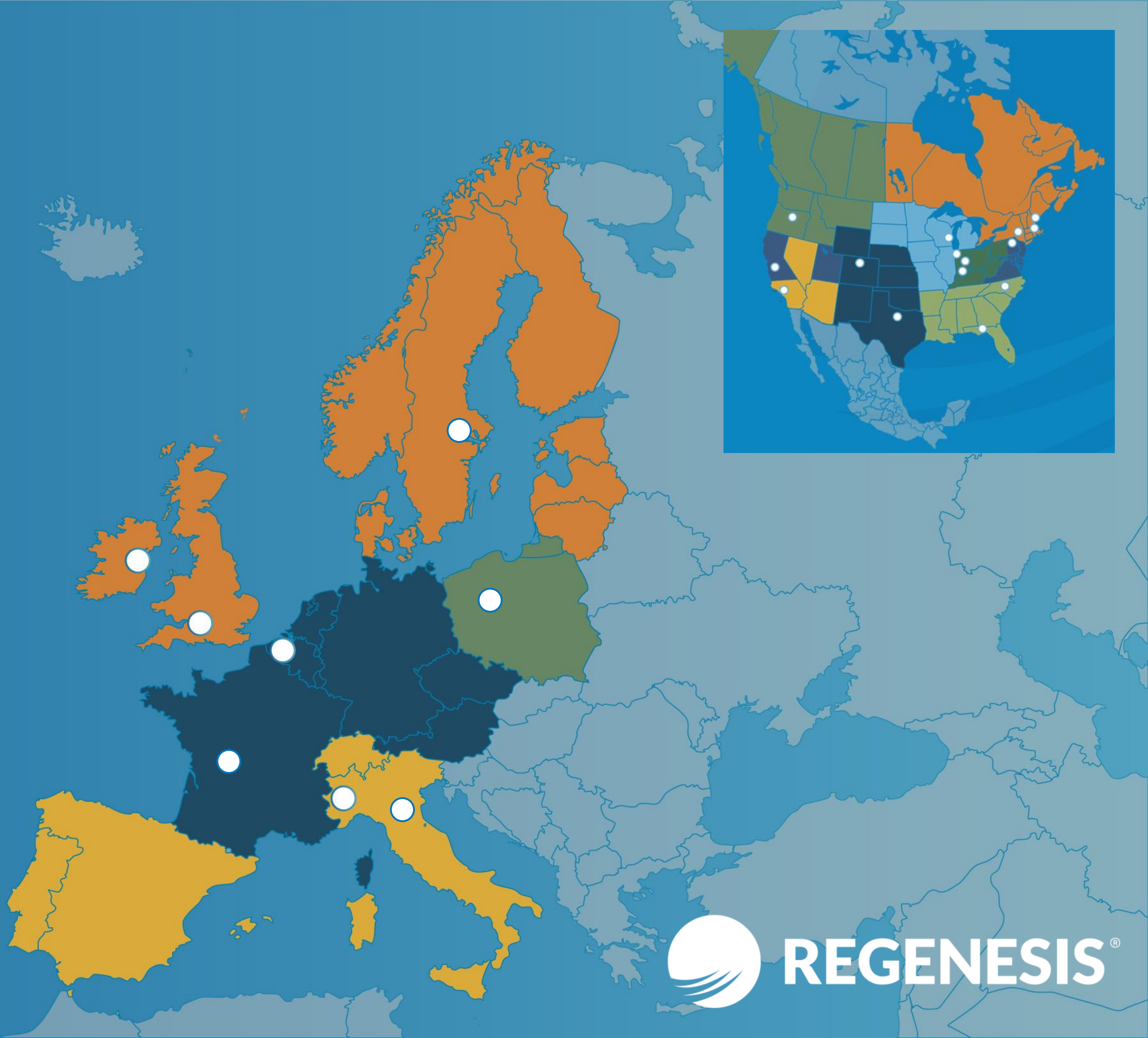

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