Improved Monitoring for Remediation Effectiveness with Water Quality Sondes

Using Real-Time Monitoring to Rapidly Assess the Effectiveness of a Remediation Tactic

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Solvent Contamination in Groundwater

- Operational manufacturing facility since 1971
- Uncontrolled disposal of degreasing solvents from 1970s to 1980s (<1000 gallons)
- Multiple sources

Primary Contaminants:
- 1,1,1-trichloroethane (TCA)
- 1,4-dioxane
- 1,1-dichloroethylene (DCE)

Background

- Early 1990s – Site investigation
- 1994 – Remedial actions begin
- 1995 – Site sold
- Previous owners retain liability and responsibility for cleanup.
- Since 1994, SSP&A has provided oversight of investigation & remedial activities on behalf of the current property owner.

2016 Conditions

After more than 22 years of remediation effort…

Contaminant concentrations were still above regulatory limits.

1,1-DCE Concentrations (μg/L)

- ND (not detected)
- > 1
- > 10
- > 100

Suspected Source Area

Conceptualization

Remediation Plan

Inclined Boreholes (x 7)
- Liquid colloidal reagent injected upgradient
- Move with flow of groundwater into the contamination source area
- Manually monitor downgradient wells for effectiveness
Uncertainties – Conceptual and Practical

Conceptualization
- Groundwater flow is north-westwards.
- Travel time is 6 months to 1 year to reach monitoring wells NW of source area.

Validation Monitoring
- > 1.5 years of manual groundwater sampling & analysis

BUT...
- Could the groundwater flow direction be wrong?
- Could the reagent miss some or all of the source zone?
- The effectiveness monitoring and assessment will take a long time and cost more money

Alternative Real Time Monitoring Strategy

- Tracer test prior to injection requested
- Demonstrate flow direction REJECTED
- Proposed parallel real-time monitoring
  - Discern direction and velocity of colloidal reagent following injection.
  - Turbidity to be used as the primary indicator

Turbidity Response – Bench Scale Test

- Turbidity measured with two In-Situ AquaTROLL 600 water quality sondes
- Concentration and dilution using water from 2 site boreholes and tap water
- Undiluted reagent has concentration of 2,000 mg/L

Bench Scale Test Conclusions

- Presence or absence of reagent can be measured by turbidity using the AT600
- Relative concentration cannot be reliably estimated (due to duality of reagent concentration for each value of turbidity)

Baseline Monitoring and Injection Schedule

- Baseline – 3 weeks (25 April)
  - Installed sondes and telemetry units in 5 wells around site prior to injection
- Injection – 4 days (16 to 19 May)
  - Injected reagent sequentially into 11 wells
  - 700 gal (2650 L) of reagent + 300 gal (80 L) of clean flush water added per well

Real Time Monitoring

- Monitoring Locations
  - 9 groundwater monitoring wells
  - 5 sondes moved between wells in response to early monitoring results
- Real Time Monitoring – 60 days (16 May to 15 July)
  - Turbidity plus pH, EC, Temp, Water Level
  - Measurements every 15 minutes
  - Data transmitted several times per day to HydroVu cloud platform and remotely viewed at least daily
Real Time Monitoring Data (TPW-2)
(18 May to 1 June)

- Magnitude of changes are small but significant
- Could easily be missed or dismissed as insignificant using manual sampling at longer intervals

Field Test
Conclusions
• Reagent presence confirmed at one location (TPW-2)
• Flow direction and velocity conceptualization is wrong – Main flow is northwards and in the order of 9 times faster than anticipated.
• Reagent may not have reached a large part of the target source area

Turbidity Monitoring Results

- One well clearly records turbidity indicative of the reagent
- Two wells show uncertain trace responses at very low concentrations (< 2 NTU range)
- No response in any other wells.

Project Conclusions
• Remediation project stopped after discussions between stakeholders.
• Alternative remediation strategies implemented.
• Real-time, high resolution monitoring allowed decisions to be made over 1 year earlier (90% reduction) than would have been possible by using a manual monitoring strategy
• Significant savings made in project life-cycle time and costs with a cost savings to investment ratio of 2:1.