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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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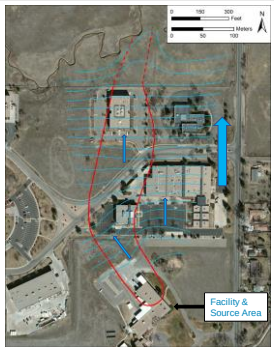
Solvent Contamination in Groundwater

- 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-dichloroethene (DCE)



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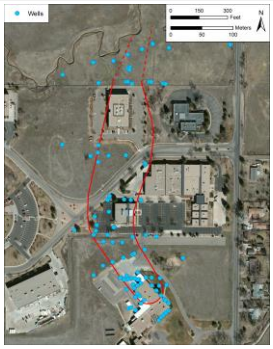
Background

- 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.



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2016 Conditions

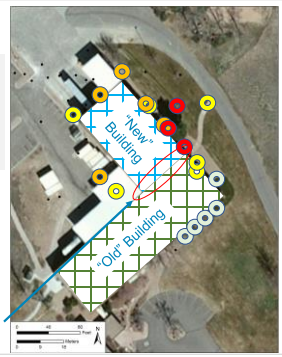
After more than ***22 years*** of remediation effort…

Contaminant concentrations were still above regulatory limits.

1,1-DCE Concentrations (µg/L)

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

Suspected Source Area



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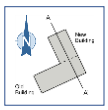
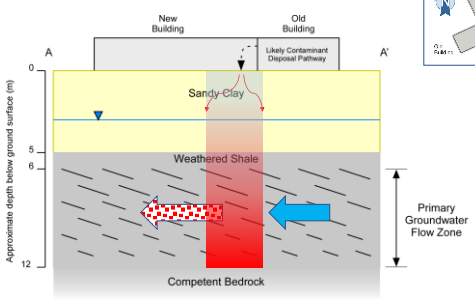
Conceptualization





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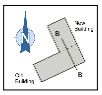
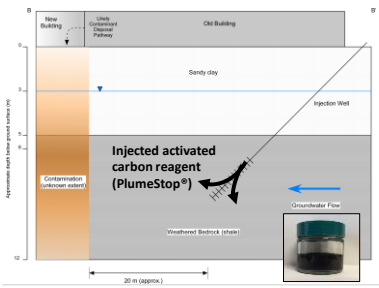
Remediation Plan





Inclined Boreholes (x 7)
Plus 4 other vertical wells

- Liquid colloidal reagent injected upgradient
- Move with flow of groundwater into the contamination source area
- Manually monitor downgradient wells for effectiveness

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Uncertainties – Conceptual and Practical

Conceptualization

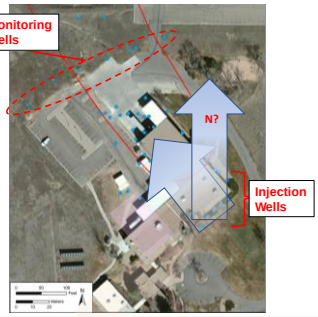
- ***Groundwater flow*** is north-westwards
- ***Travel time*** is 6 months to 1 year to reach monitoring wells NW of source area.

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



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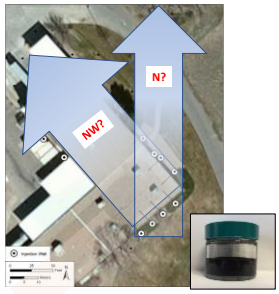
Alternative Real Time Monitoring Strategy

- **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



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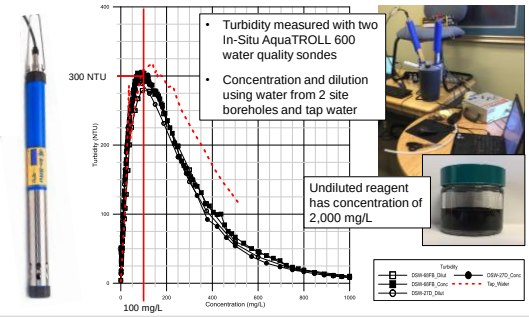
Turbidity Response – Bench Scale Test



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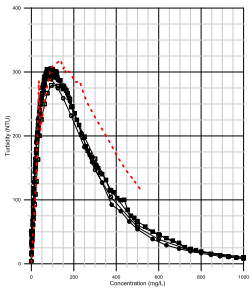
Bench Scale Test Conclusions

- **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)*



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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 (380 L) of clean flush water added per well

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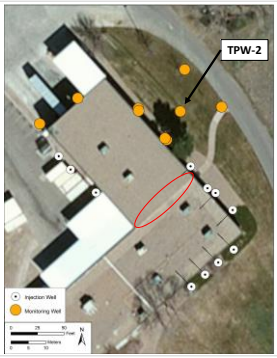
Real Time Monitoring

- **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



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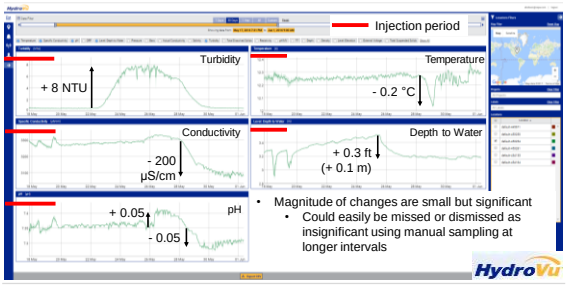
Real Time Monitoring Data (TPW-2)

(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

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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.

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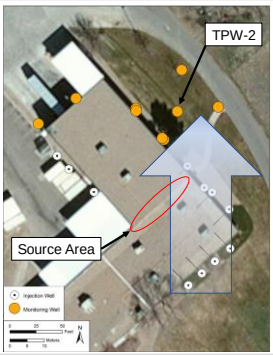
Field Test Conclusions

- 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***



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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.