S.S. Papadopulos & Associates, Inc.

Natural Gradient Tracer Test to Support Transport Analysis of a Detached MtBE Plume

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Introduction

SSP&A designed and analyzed the results of a natural gradient tracer test performed by EAR on Long Island, New York where a detached plume of MtBE discharged to a river.

The objectives of the tracer test are:

-to support site characterization and the refinement of the site conceptual model
-provide data suitable for recalibration of the groundwater flow-and-transport model

Tracers

Bromide

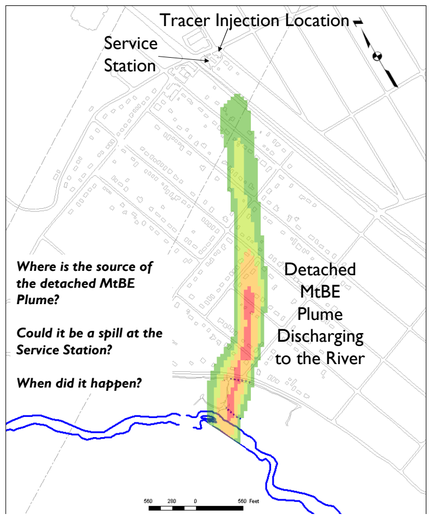
- Conservative groundwater tracer
- Relatively low concentrations using inexpensive portable equipment

Sulfur Hexafluoride (SF6)

- Inert gas that is detectable over a wide range of concentrations
- Recently gained acceptance as a conservative tracer in ground water

Rhodamine WT

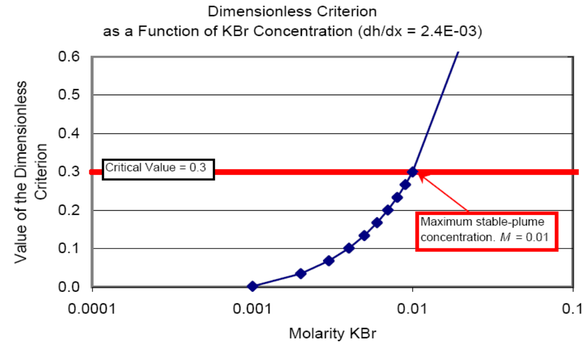
- Ease of monitoring and the good potential for detection, especially at the low range of concentrations
- Can undergo significant sorption on mineral surfaces or degradation due to exposure to oxygen



Design

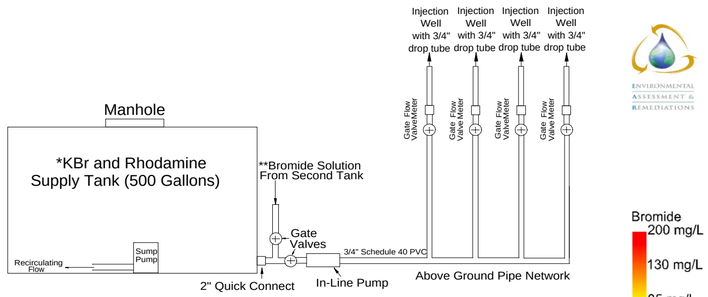
SSP&A provided design parameters (tracer input concentration, and injection flow rate) to:

-maximize the detection range of the tracer
-minimize disruption to the flow field
-minimize density effects

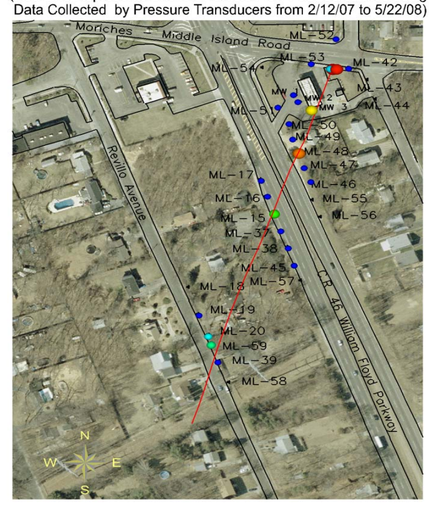


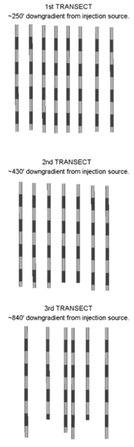
Injection and Monitoring

EAR performed the injection and the monitoring of the 3 tracers over a dense monitoring network. The brominde injection system is shown below:



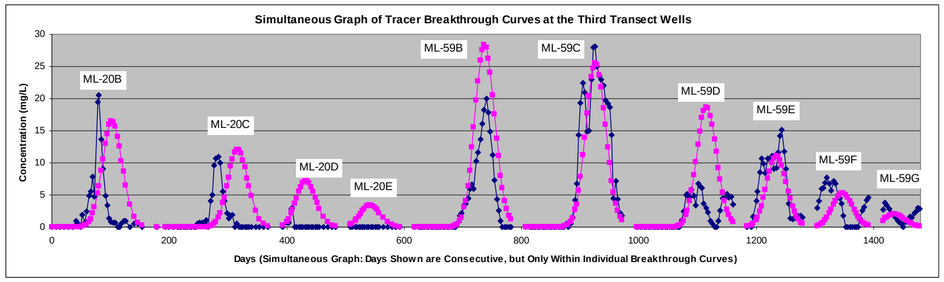
Maximum Historical Groundwater Bromide Results
(Red Line Represents Shallow Particle Flow Path Calculated using Data Collected by Pressure Transducers from 2/12/07 to 5/22/08)





Analysis-Analytical Model

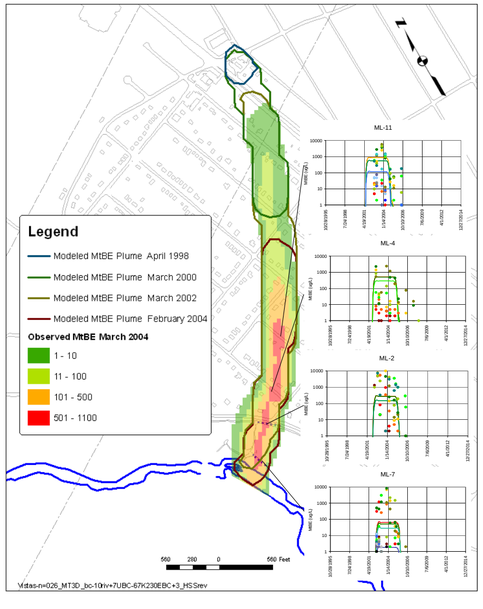
Parameter estimation runs with PEST (Doherty, 2004) using ATRANs (Neville, 1998)
Simulate KBr transport and determine a set of parameter values providing a best fit between simulated and observed concentrations.
The final manual adjustments provided the opportunity to adjust breakthrough curves fit based on expert insight that could not be simply incorporated into PEST



Model Parameter	Range (value used on figure)
Velocity (ft/day)	2.01 - 2.15 (2)
Longitudinal dispersivity (ft)	0.57 - 1.50 (0.7)
Horizontal transverse dispersivity (ft)	0.20 - 1.50 (0.3)
Vertical transverse dispersivity (ft)	0.045 - 0.10 (0.06)

Analysis-Numerical Model

- Flow Model update to simulate groundwater flow (Modflow)
- Transport Model updated to reproduce the results of the tracer test (MT3D)
- Transport model to simulate MtBE transport using MT3D and the Hydrocarbon Spill Screening Model Interface (HSS)



Conclusion

-Bromide was the easiest tracer to release and analyze
-ATRANS was very useful to analyze the tracer test results and match arrival times and concentration magnitudes
-Numerical modeling, based on the observed tracer and MtBE concentrations allowed to conclude that:

- A release of MtBE at the Service Station would discharge into the River, as observed.
- Travel time within the subsurface between the Service Station and the River is approximately 4 years
- Calibration of the timing of the observed MtBE concentrations at the site between February 2002 and May 2008 indicates that the most recent release(s) at the site occurred as early as during the Winter of 1998.