On-Line Calculators for Site Assessment Calculations

Jim Weaver
Hydrologist

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The OnSite On-Line Site Evaluation Tools

- Aid to planning site assessment
  - "What is the travel time to the next proposed downgradient receptor well?"
- Review of modeling reports
  - "Should they really have used 10 as the retardation factor for benzene?"
- Enhance contaminant transport knowledge
  - "How does aquifer recharge affect contaminant plumes?"

On-Line Calculators & Web-Enabled Models

- http://www.epa.gov/athens/onsite
  - Formulas
  - Models
  - Unit Conversions
  - Scientific Demos
- On the web since 1999
- As many as 30k hits/month
- Modeling Course on Web also

Calculators -- Formulas

- Hydraulic gradient (2,3, or more points)
- Vertical Gradients
- Moisture Content
- Retardation Factor
- Henry's Law Coefficients
- Longitudinal Dispersivity
- Diffusion Coefficients
- Darcy's Law, Seepage Velocity
- Effective Solubility from Mixtures

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Calculators -- Models

- Plume Diving
- Steady State Plume Length
- Transport from continuing or fuel source
- Concentration Uncertainty
- Domenico Analytical Solutions
- Johnson-Ettinger Vapor Intrusion

Calculators – Unit Conversions

- Flow Rates, Hydraulic Conductivity
- Half Lives/Rate Constants
- Henry's Law Coefficients
- Dates to sequential time
- Lat-Long to distance
- Fahrenheit to Celsius

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Calculators -- Demos

- Borehole Concentration Averaging
- Flow in a Laboratory Column
- Unsteady Mass Balance
- Flow in a one-dimensional aquifer

Transport of Contaminants in Ground Water

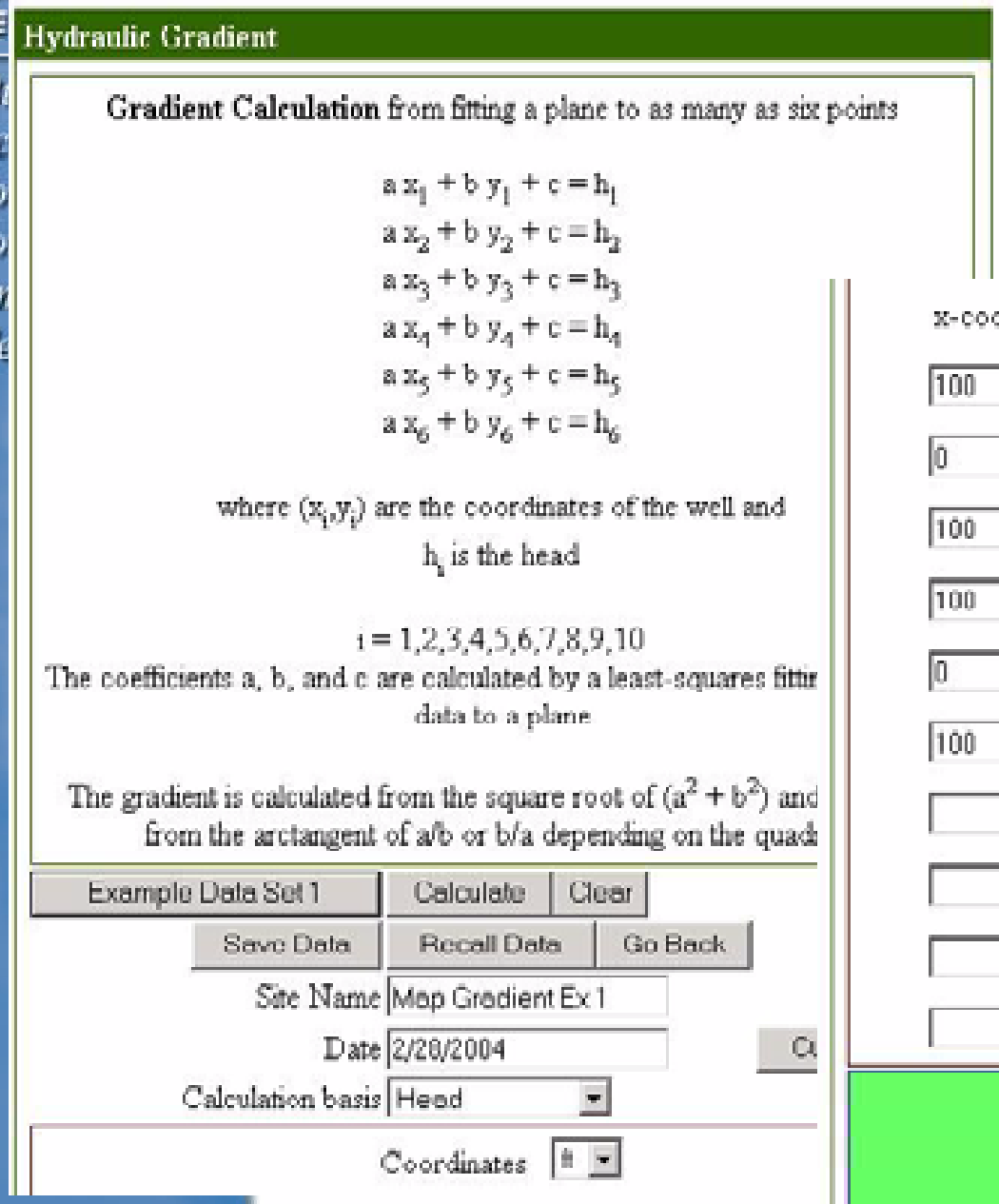
- Parameters:
  - 1 Ground water velocity
  - 2 Retardation
  - 3 Dispersion
  - 4 Decay
- Source – Forcing Function:
  - Concentration
  - Duration

Calculators

- Parameters:
  1 Ground water velocity, gradient calculation
  2 Retardation Factor
  3 Dispersivity Estimates
  4 Decay-rate estimation, conversions
- Forcing Function (Source)
  - Concentration
  - Duration

1 Gradient

- Ground water flow
  - Gradient
  - Direction
- Established from 3 or more wells
- Likely to vary over time



x-coordinate	y-coordinate	head ft
100	0	20.00
0	100	20.00
100	100	19.75
100	0	20.00
0	100	20.00
100	100	19.75
		0.
		0.
		0.
		0.

Number of Points in Calculation: 6

Gradient Magnitude (i): 0.003536

Degrees from North (+ y axis): 45.00

2 Retardation Factor

- Sorption of Organics to Aquifer Materials
- Dependent Upon
  - Organic Carbon Content
  - Chemical Properties
    - Should be well-known constants …
    - Many States have preferred/required values
      - Benzene K_{oc} = 38, 65, 83, 97, 106 L/kg

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Retardation Factor Calculator

Retardation Factor $R = 1 + \rho_b k_d / \theta$

R = retardation factor

ρ_b = bulk density = $\rho_s(1-\theta)$

ρ_s = solids density

θ = porosity

k_d = (soil) distribution coefficient = $f_{oc} K_{oc}$

f_{oc} = fraction organic carbon

K_{oc} = organic carbon/water partition coefficient

Example Data | Calculate | Clear

Save Data | Recall Data | Go Back

Site Name: Example

Date: 2/28/2004 — Current Date

Porosity (θ): 0.25 (Try 0.25)

Fraction Organic Carbon (f_{oc}): 0.0001 (Try 0.0001)

Chemical Data Source: District of Columbia Underground Storage Tank Division

Note: District of Columbia Underground Storage Tank Regulations, District of Columbia Risk Based Corrective Action (DCRBCA)/Risk Based Decision Making

Data revision date: October 1, 1999

Chemical: benzene

Solids Density (ρ_s): 2.65 Default

K_{oc} value: 66.1 L/kg

Bulk Density (ρ_b): 1.99 g/cm^3

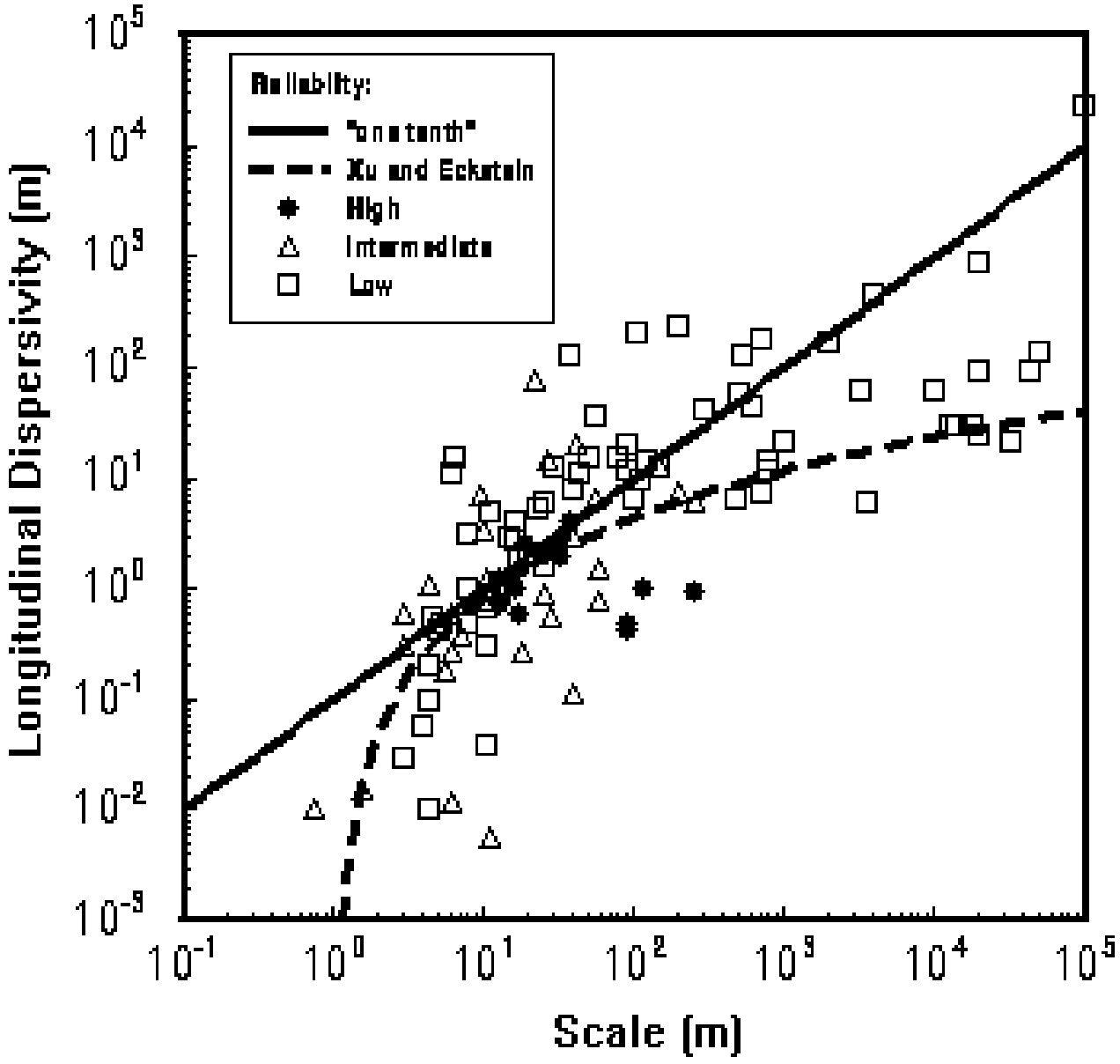
k_d: 0.006610 L/kg

Retardation Factor: 1.1

3 Dispersivity

- Apparent dilution with distance from source
  - Not measured at LUST sites
  - Two choices
    - "Rules-of-thumb"
      - e.g.: 1/10 or 1/20 plume length
    - Curve fitting

Gelhar, Welty and Rehfeldt (1992) Dispersivity Data



4 Decay

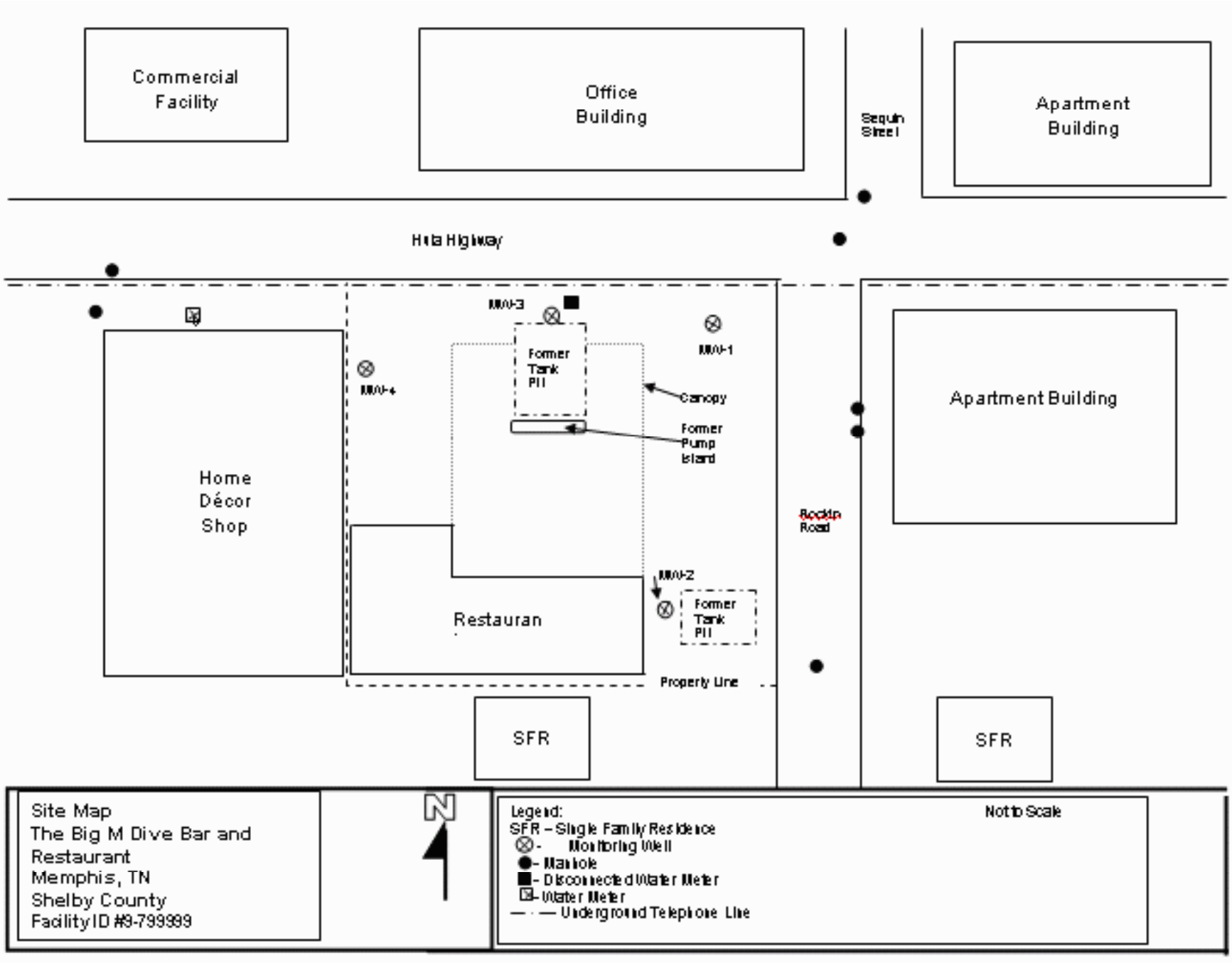
- Estimate from
  - Literature Studies
  - Field Data
    - Calculator coming soon

Uncertainties

- Which parameters are known exactly? -- none
- Is the release known – date, amount? – usually not
- Do model assumptions exactly match site conditions? – no

Scenario

- Site Assessment Data from a LUST in Tennessee
  - Two sets of data:
    - June 1991 to March 1994
    - October 1995 to October 2000
  - Questions concerning
    - Sufficiency of data for closing site
    - Costs as limiting factors in assessment
    - Differences between fund-ineligible and fund-eligible sites


Commercial Facility
Office Building
Sequin Street
Apartment Building
Hwy Highway
MW-3
MW-1
Former Tank Pit
MW-4
Canopy
Former Pump Island
Home Décor Shop
Apartment Building
Rocklin Road
MW-2
Former Tank Pit
Restauran
Property Line
SFR
SFR
Site Map
The Big M Dive Bar and Restaurant
Memphis, TN
Shelby County
Facility ID #9-799999
N
Legend:
SFR – Single Family Residence
- Monitoring Well
- Manhole
- Disconnected Water Meter
- Water Meter
— · — Underground Telephone Line
Not to Scale

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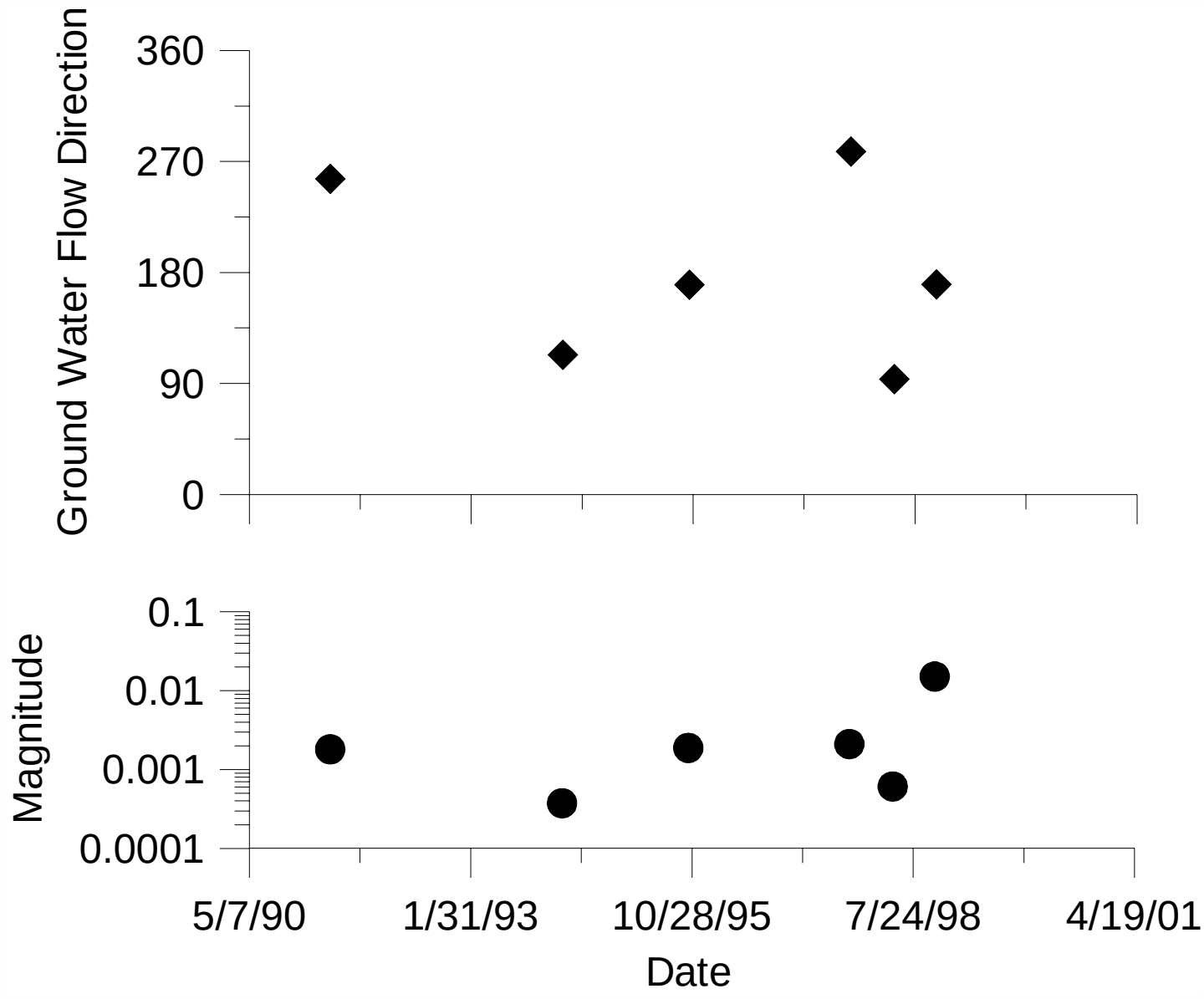
Magnitude and Direction of Ground Water Flow



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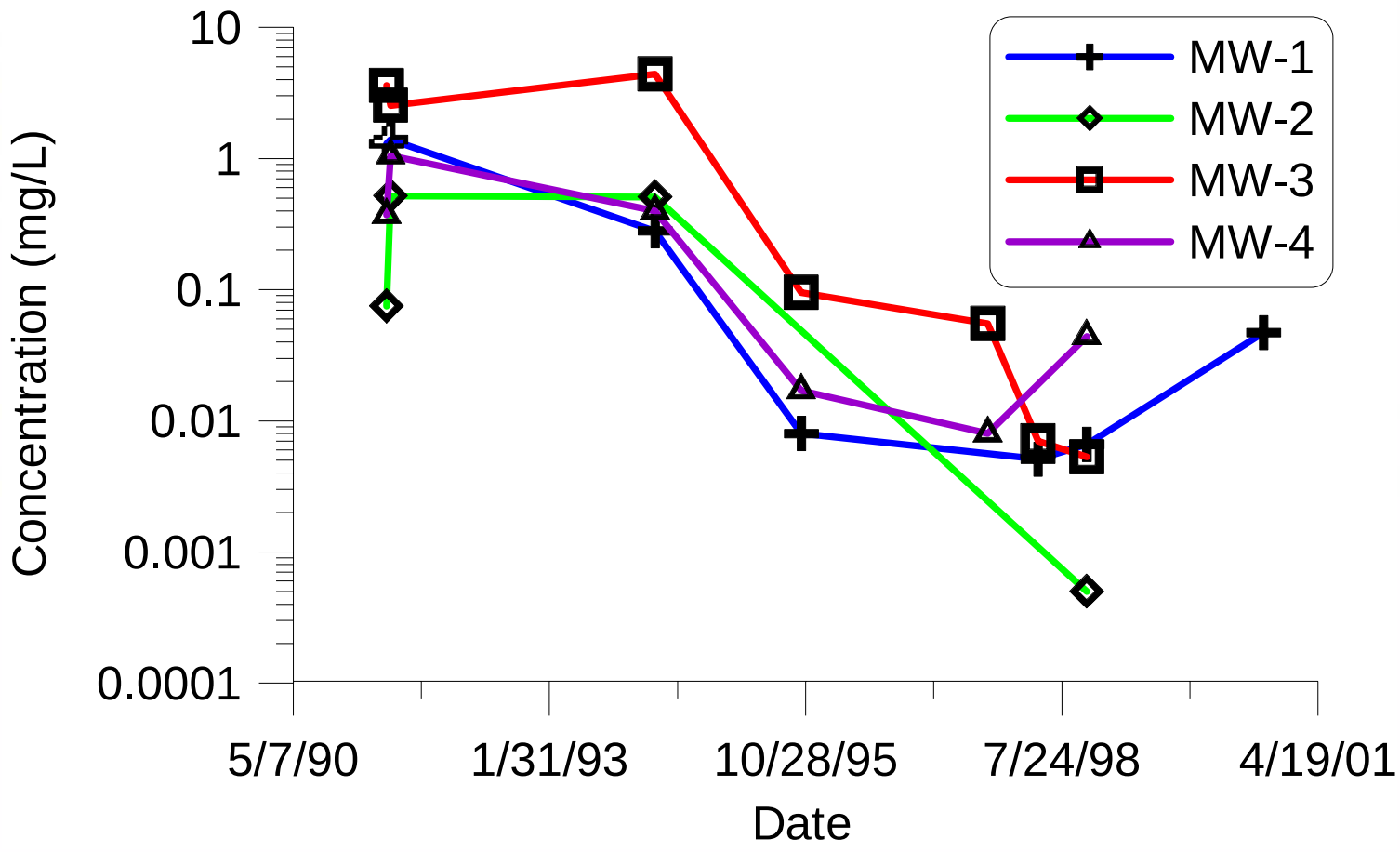
Benzene



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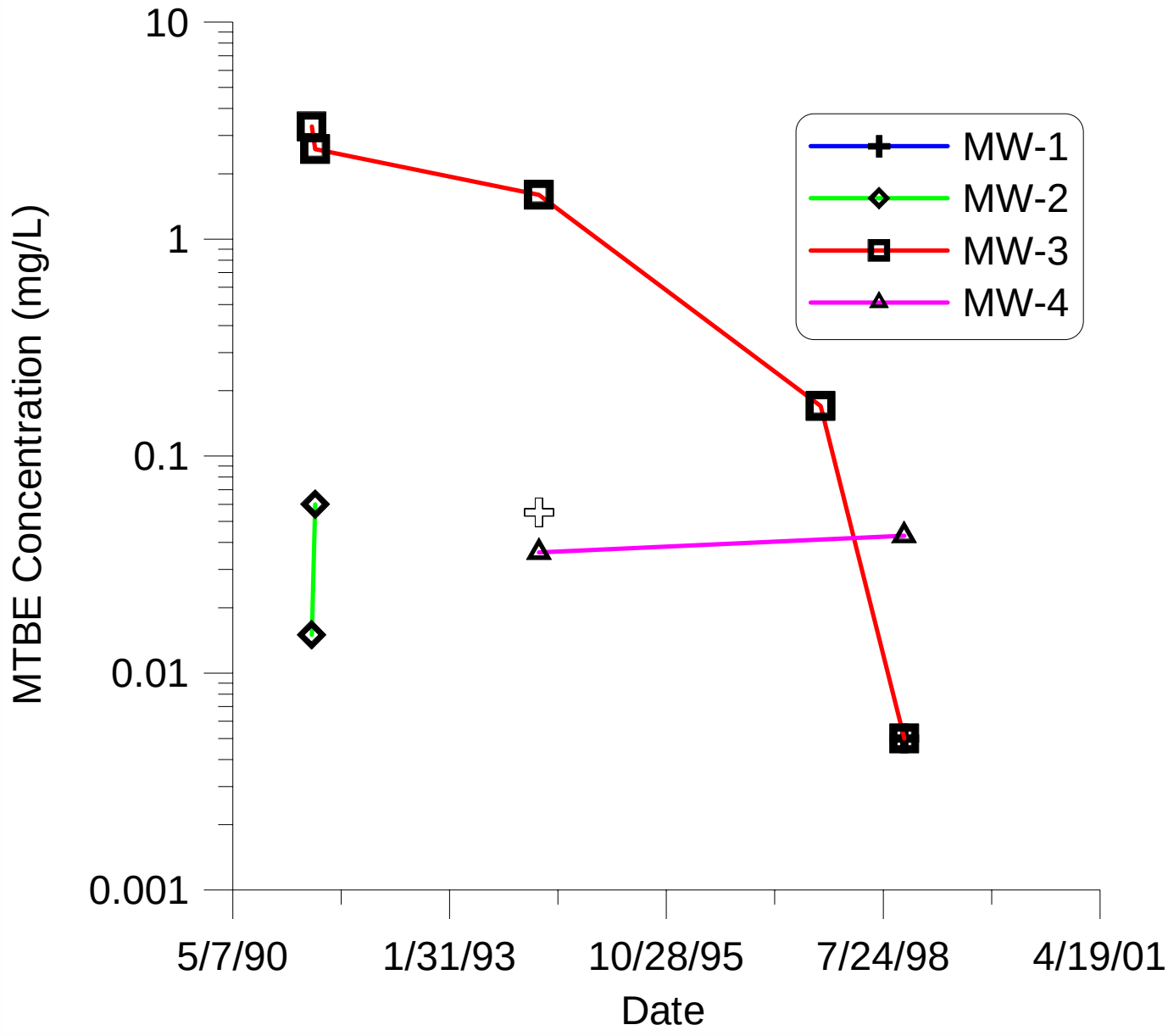

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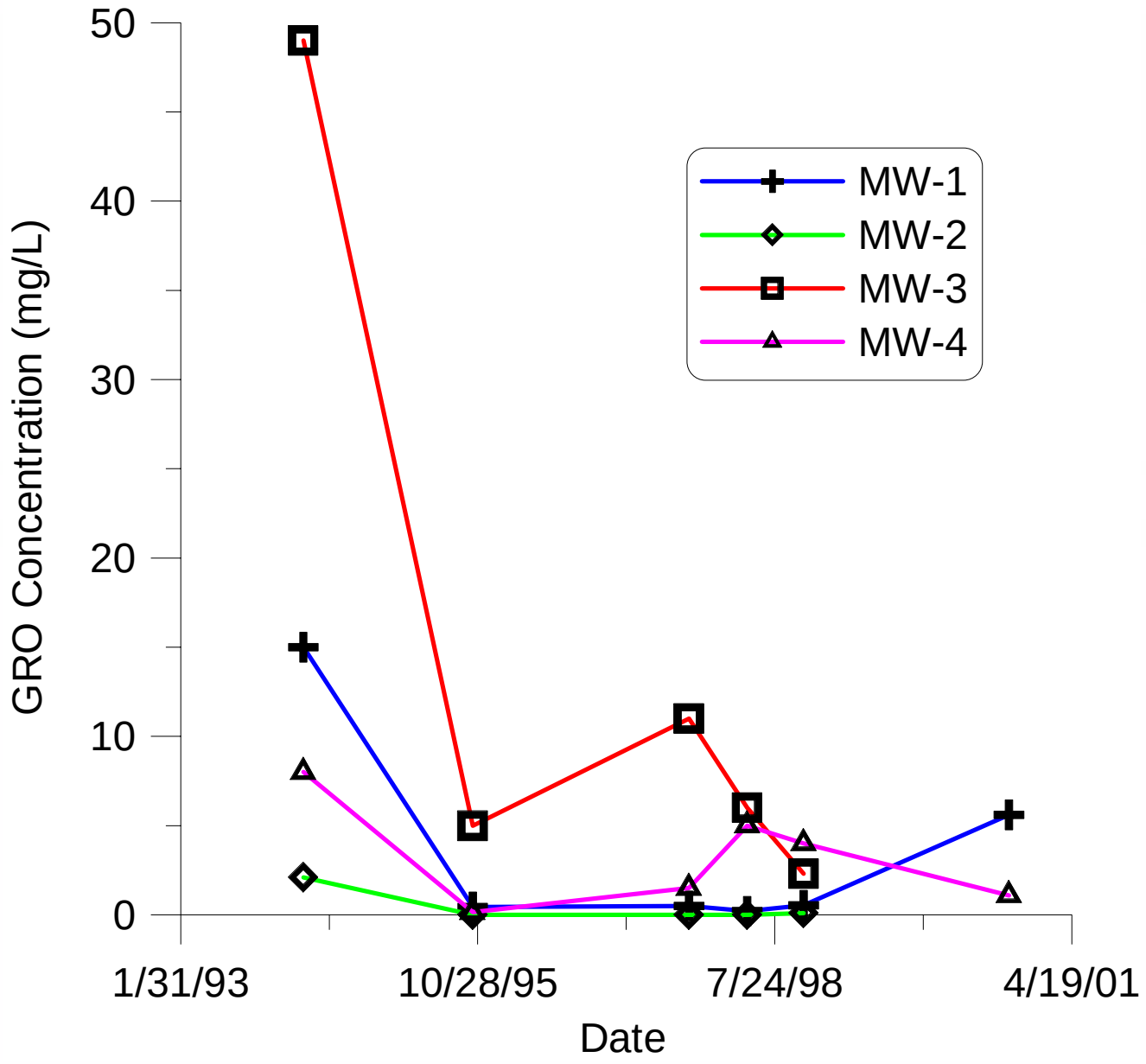


Transport Simulation

- Use “Concentration Uncertainty” calculator to estimate plume extent
  - Consider uncertainty in all inputs
  - Simulate transport from MW-3
  - Flow to the west
    - From topography
- Calculate ranges of all outcomes
  - 9 inputs →  simulations

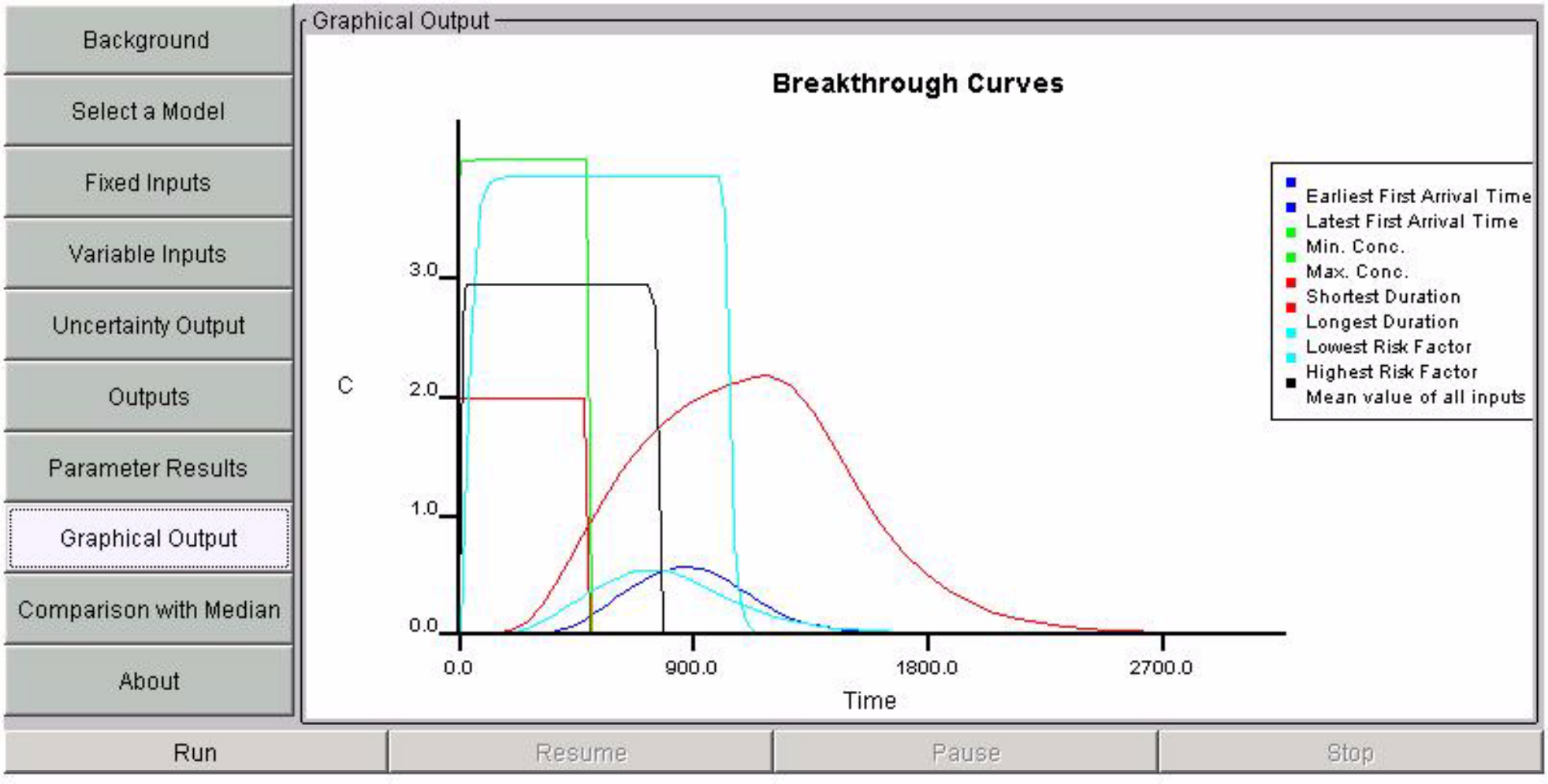
Benzene Uncertainty Simulation

- Hydraulic Conductivity: 20 to 200 ft/d
- Gradient: 0.001 to 0.015
- Organic Carbon Partition Coefficient, K_{oc}: 38 to 107
- Fraction Organic Carbon 0.00005 to 0.00015
- Half Life < 365 to 730 days
- Dispersivity range from data tabulation

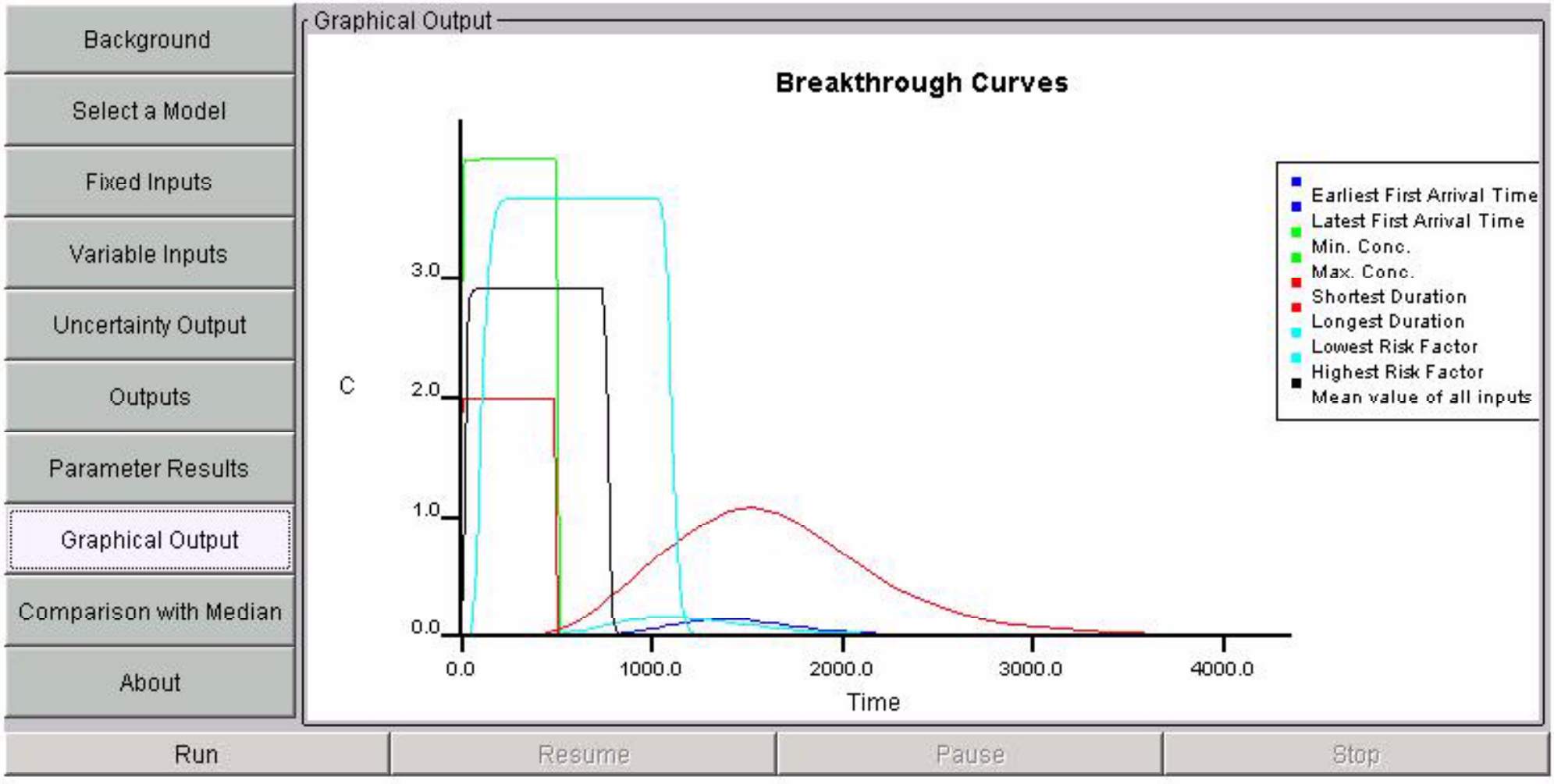
Benzene Uncertainty Simulation

- Data from MW-3 defining the source:
  - Concentration -- 2 mg/l to 4 mg/l
  - Duration – 500 days to 1000 days

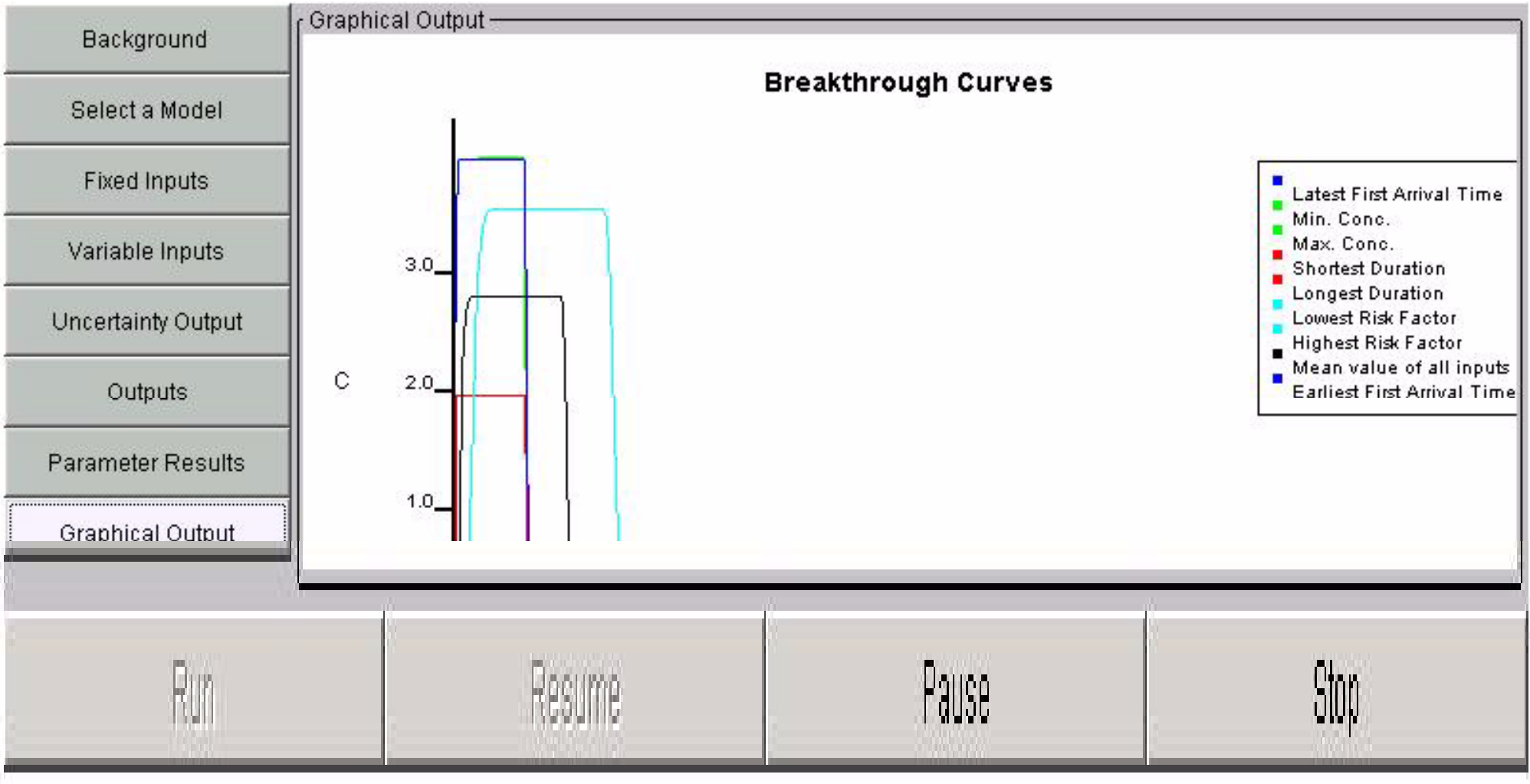
Bounding curves for Receptor 50 feet from MW-3



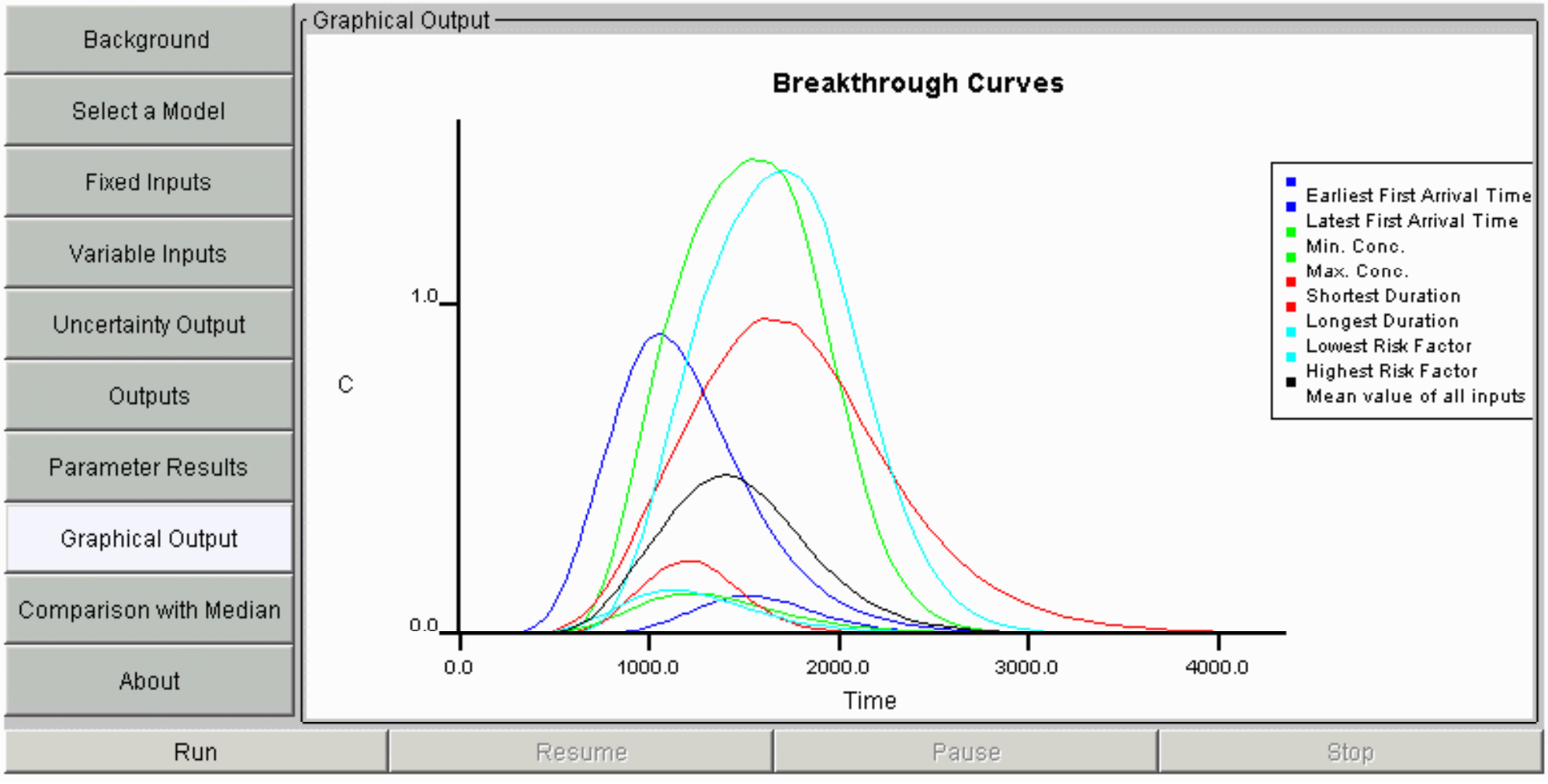
Bounding curves for Receptor 100 feet from MW-3



Bounding curves for Receptor 215 feet from MW-3



Receptor at 215 feet, lower ground water velocity



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Vertical Well Screen Placement

- Calculate expected plume diving due to recharge
- Estimate vertical placement of well screens

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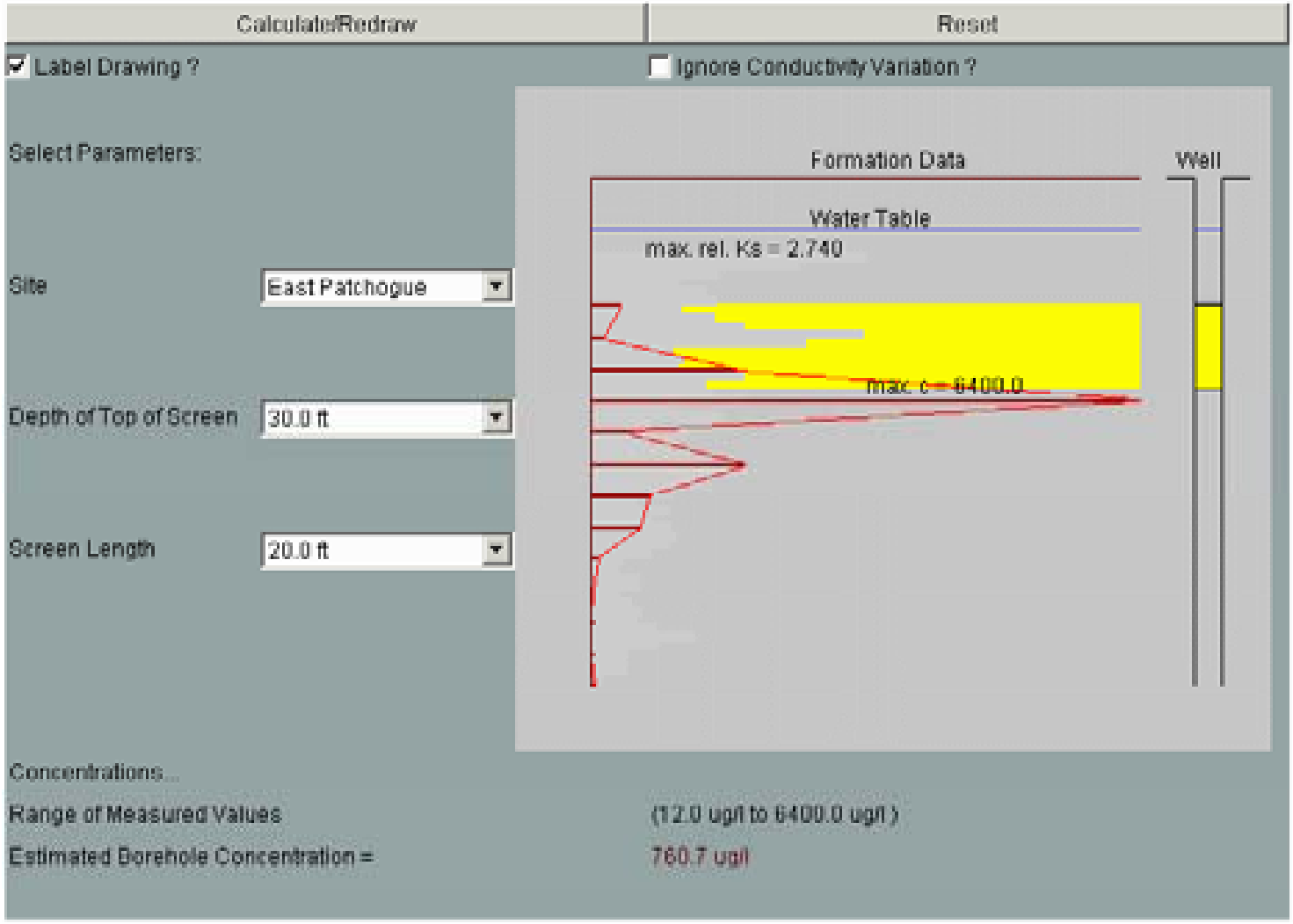


Calculate/Redraw | Reset

☑ Draw Watertable ?

☑ Draw UpperBound of Plume ?

☑ Vertical Exaggeration ?

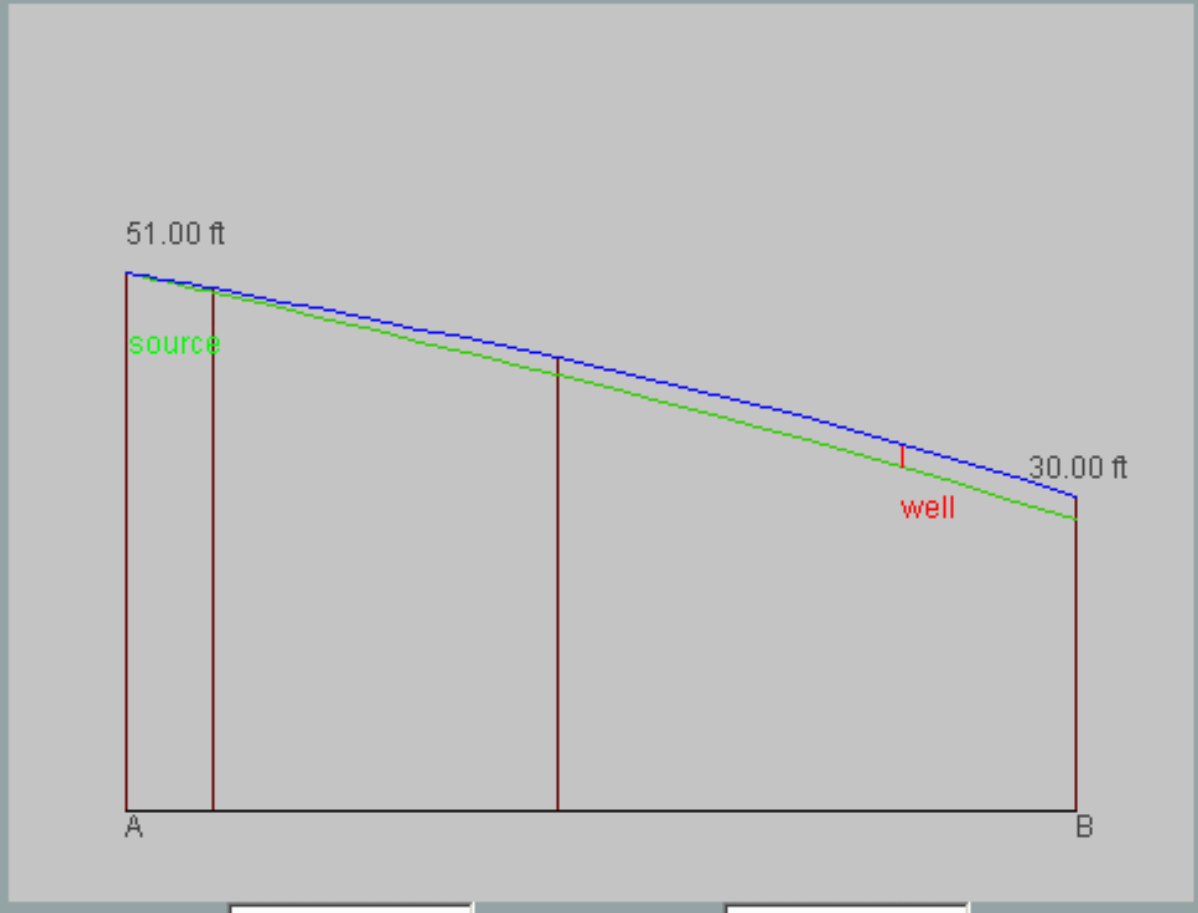
☑ Label Drawing ?

Upgradient Head (at A)	51	ft
Downgradient Head (at B)	30	ft
Source Location	1.0	ft
Well Location	450.0	ft
Vertical Exaggeration	8.088	
Plume Depth at Well	2.257	
% Mass Balance Error	-1.040e-13	

Results...calculated for:

Source Location at 1.0

Well Location at 449.99999



Hydraulic Conductivity	20	ft/d	20.0	ft/d	20.0	ft/d
Segment Length	50.0	ft	200.0	ft	300.0	ft
Recharge	20	in/yr	20	in/yr	20	in/yr

Results

- With high conductivity and gradient quick transport to receptors up to 500 feet away
  - Obtaining data on conductivity and better gradient data would reduce uncertainty
- Simulations with lower transport rates have diminished concentrations 200 plus feet away
- Other examples on web site

New/Updated

- Temperature – dependent Henry's Law Coefficients
- On-line Johnson/Ettinger model
- Expanded contaminant data
- On-line modeling training course
- http://www.epa.gov/athens/learn2mo

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Further Information

- Calculators: www.epa.gov/athens/onsite
- Training Course: www.epa.gov/athens/learn2model
- Listserve for news
- Although this work was reviewed by EPA and approved for presentation, it may not necessarily reflect official Agency policy.