Development of Input Distributions for Performance Assessment

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Overview

- General Guidelines for Establishing Parameter Distributions
- Potential Problems
  - Use of generic datasets
  - Representativeness
  - Risk dilution

Developing Parameter Distributions

- Why? – To evaluate the impact of uncertainty and variability
- How? – Various approaches, no standard approach is a applied to PA's
- When? – The earlier in the PA development process, the better

Data Uncertainty and Variability

- Type of uncertainty - important implications for PA analysis
- Uncertainty types - epistemic and aleatoric
- Most PA's do not explicitly represent the uncertainty types differently

General Guidelines (Distributions)

- Site specific data is preferred, all things equal
- Data quality should be ensured
- Comparison of site specific data to generic data should be performed
- Need to understand what the data represents
  - Is your data representing a model? (more on this)
  - Is your data spatially and temporally variable?
- Need basis for all data but amount of support can be risk-informed

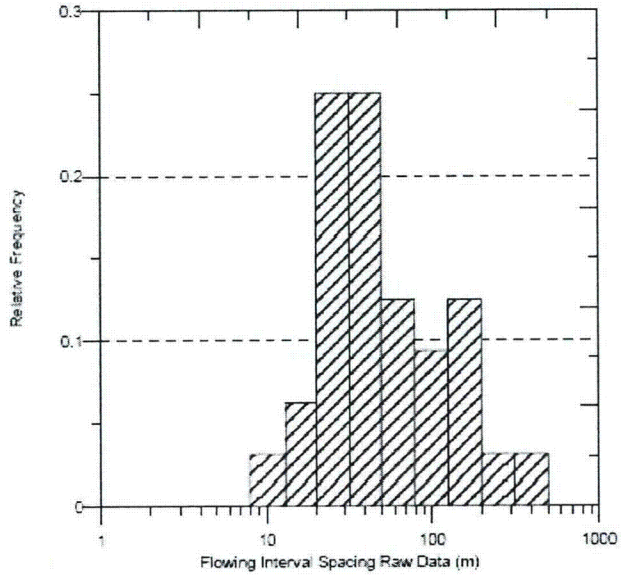
Establishing Parameter Distributions

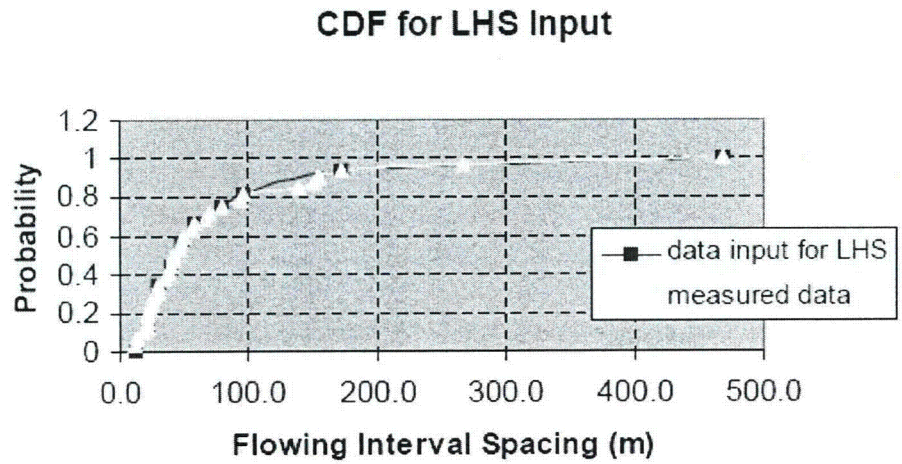
- A lot of data – use statistical methods
- Show comparison of data to distribution
- Limited data:
  - Initially use maximum entropy approaches
  - Refine distributions by collection of more data
  - May need to truncate distributions that impact timing of dose impacts using conservative bias

Guidelines – Use of generic data

- Initially, use the full range of the distribution
- Evaluate the range of results compared to the decision metric
- Evaluate the impact of changes to the range of the distributions on the results. If significant:
  - Collect more information
  - Make technical arguments for conservative decision (conservatism must be demonstrated at the system-level)

Establishing Parameter Distributions



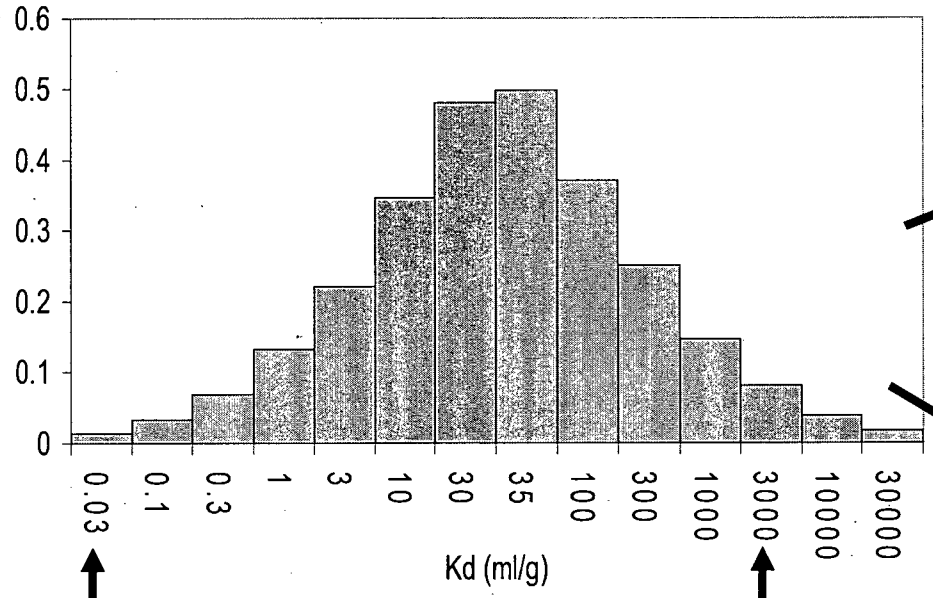


ANL-NBS-MD-000003 Rev 01 September 2004 – Probability Distribution for Flowing Interval Spacing

Problems

- Use (misuse) of generic data
- Assumed representativeness
- Risk Dilution

Problems – Use of generic data



Range of Uranium Kd for Sand from Sheppard and Thibault is 0.03 ml/g to 2200 ml/g for 24 samples

Variables (some):

Grain size

% not sand

pH

Eh

Pore fluid chemistry

Biologic agents

Variables (some):

Oxidation/reduction

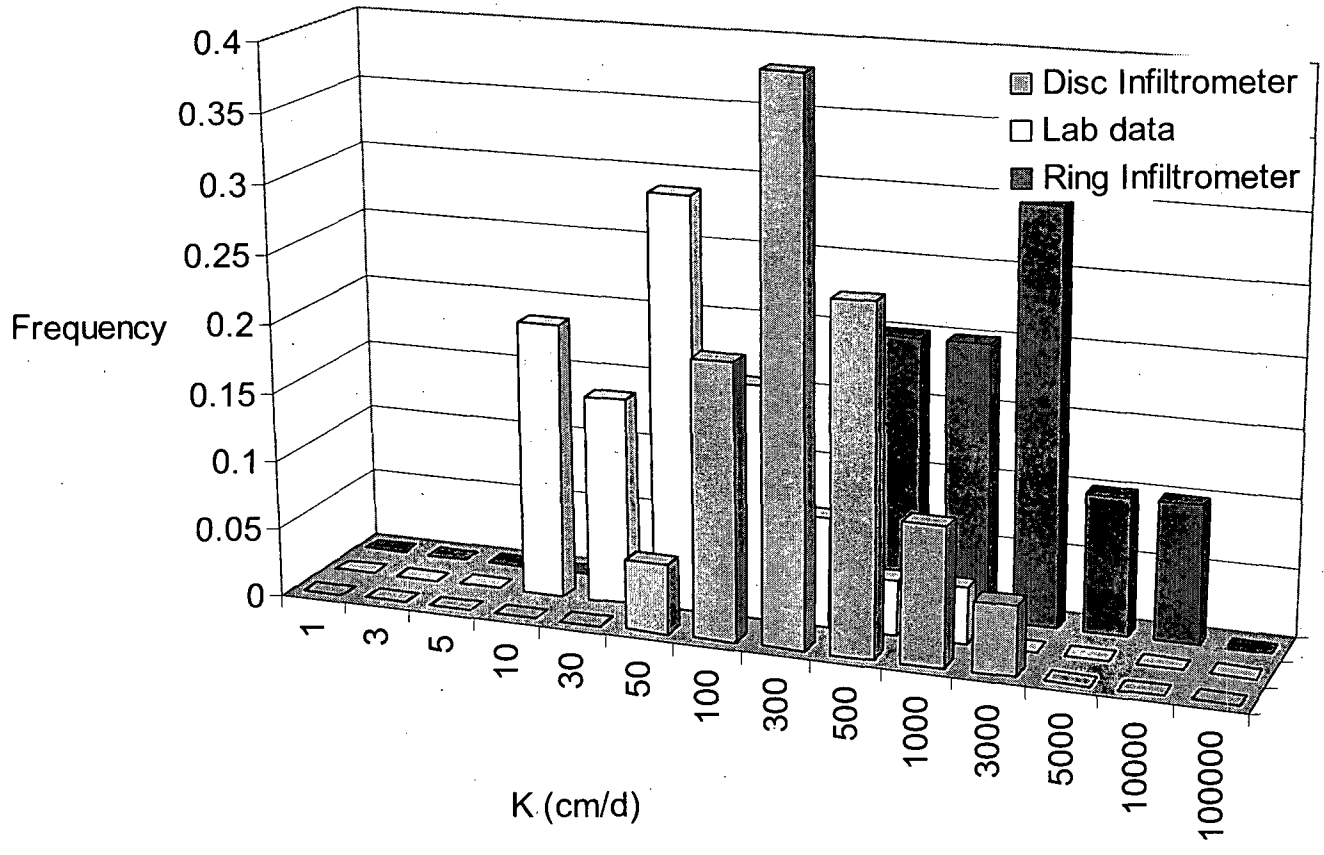
Speciation (solubility)

Adsorption

Problems – Use of generic data

- Sheppard and Thibault data represents a lot of different things
  - What is 'conservative'?
- In many PA's, results could be significantly different if the U Kd was 0.03, 35, or 2200 ml/g
- Your specific site may have much more narrow range of values
  - Example: Hanford U Kd's ~ (0.2 to 4 ml/g) [Krupka and Serne]

Using Data – Representative Data Example



Data generated for this example.

Problems – Risk Dilution

- 'Risk dilution' occurs when overly broad parameter distributions are used in the analysis
- Parameter distributions that affect the timing of dose will move the time of peak dose from realization to realization
- If the peak of the mean is the performance objective (as for NRC probabilistic analysis), the magnitude of the peak of the mean is lowered (with less certainty in the time of peak dose)
- Lack of knowledge should not <u>benefit</u> a safety decision

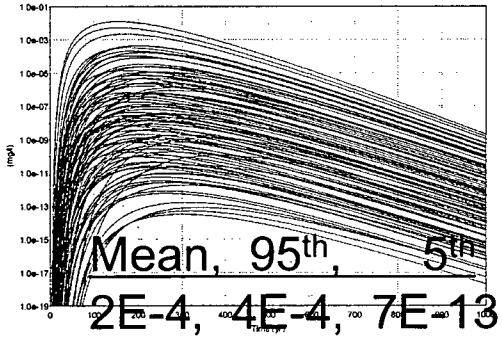
Example – Risk Dilution

- Contaminated soil (Cs-137) distributed in a 10 m by 10 m area, 1 m thick
- Transport with sorption through a 5 m thick vadose zone
- Estimate the drinking water concentrations (dose)
- Uncertainty in sorption coefficient, infiltration rates, liquid saturation
- What is the risk?

Example – Risk Dilution

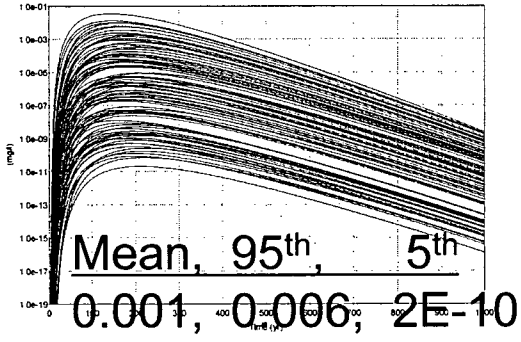
Base:

- Infiltration, uniform [0.001 m/yr to 0.1 m/yr]
- Liquid saturation, uniform [0.1 to 0.6]
- Cs Kd, log-normal, GM = 50 ml/g, GSD = 1.8



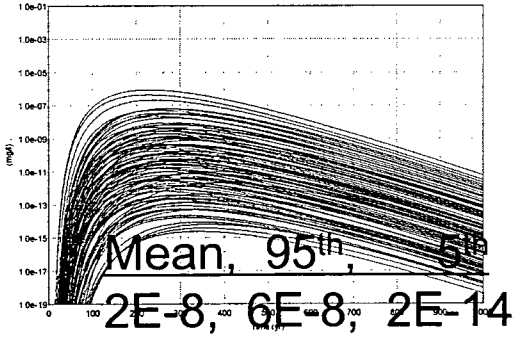
Wetter, less sorptive:

- Infiltration, uniform [0.03 m/yr to 0.1 m/yr]
- Liquid saturation, uniform [0.3 to 0.6]
- Cs Kd, log-normal, GM = 23 ml/g, GSD = 1.4



Drier, more sorptive:

- Infiltration, uniform [0.001 m/yr to 0.03 m/yr]
- Liquid saturation, uniform [0.1 to 0.3]
- Cs Kd, log-normal, GM = 100 ml/g, GSD = 1.4



Conclusions

- Guidelines for development of parameter distributions were presented.
  - Use quality, site-specific data
  - Present data compared to distributions
  - Provide risk-informed basis for parameter distributions
- Problems, particularly when data is limited, include misinterpretation of generic data and risk dilution.