United States Nuclear Regulatory Commission

Regulatory Perspective on Performance Assessment

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What is Performance Assessment (PA)?

- Performance assessment is a tool that can be used for understanding how the natural and engineered features of a site retain radioactive materials.

- Thoroughly examines:
  - what can happen,
  - how likely it is, and
  - what can result.

What Performance Assessment is Not

- PA is not a subjective process to produce a result supporting a predetermined decision (e.g., a site is safe).
- PA is not a substitute for a lack of key data.

How is a PA conducted?

- Collect data
- Develop conceptual models
- Develop and test computer codes
- Analyze results

A team of experts typically repeats these steps many times, refining and improving the models if needed.

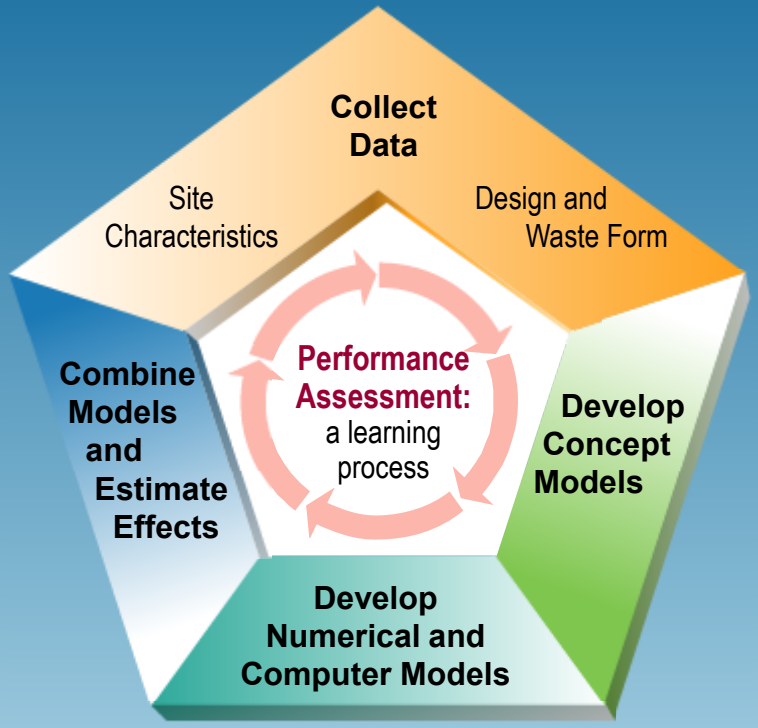
Overview of Performance Assessment

What is Performance Assessment?

- Systematic analysis of what could happen at a site

Why use it?

- Complex system
- Systematic way to evaluate data
- Internationally accepted approach



What is assessed?

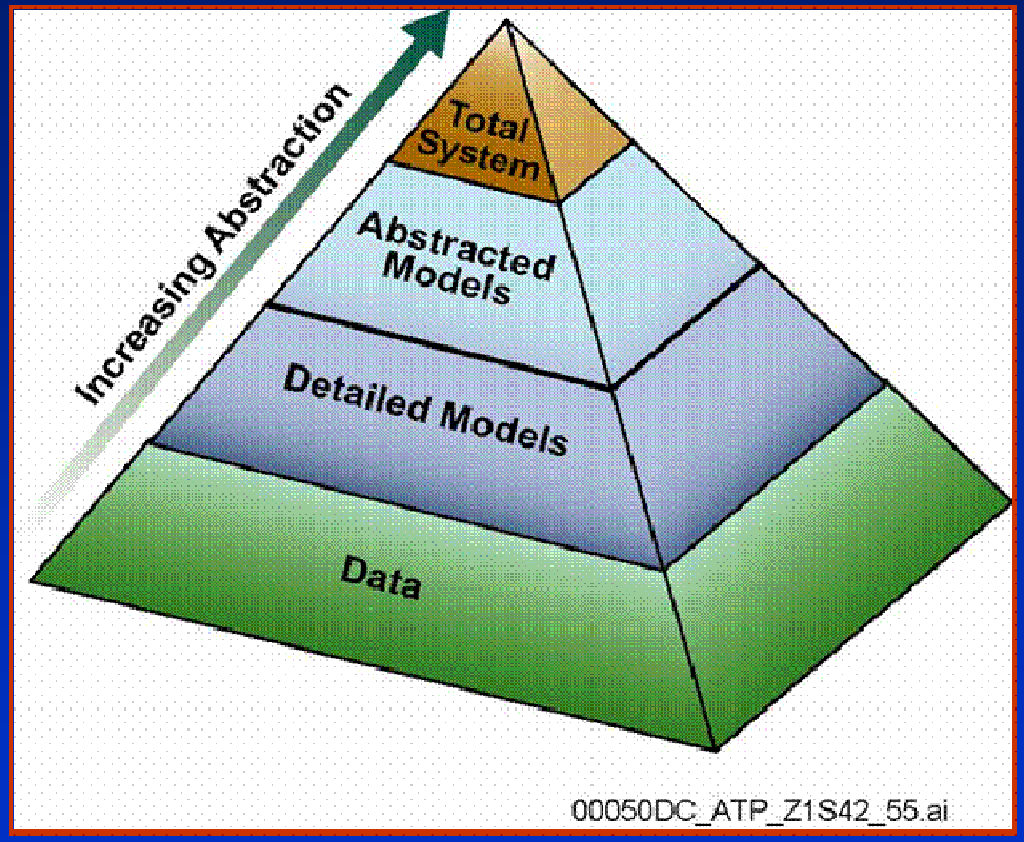
- What can happen?
- How likely is it?
- What can result?

How is it conducted?

- Collect data
- Develop scientific models
- Develop computer code
- Analyze results

NRC would require a Performance Assessment to:

- Provide site and design data
- Describe barriers that isolate waste
- Evaluate features, events, and processes that affect safety
- Provide technical basis for models and inputs
- Account for variability and uncertainty
- Evaluate results from alternative models, as needed


Increasing Abstraction
Total System
Abstracted Models
Detailed Models
Data
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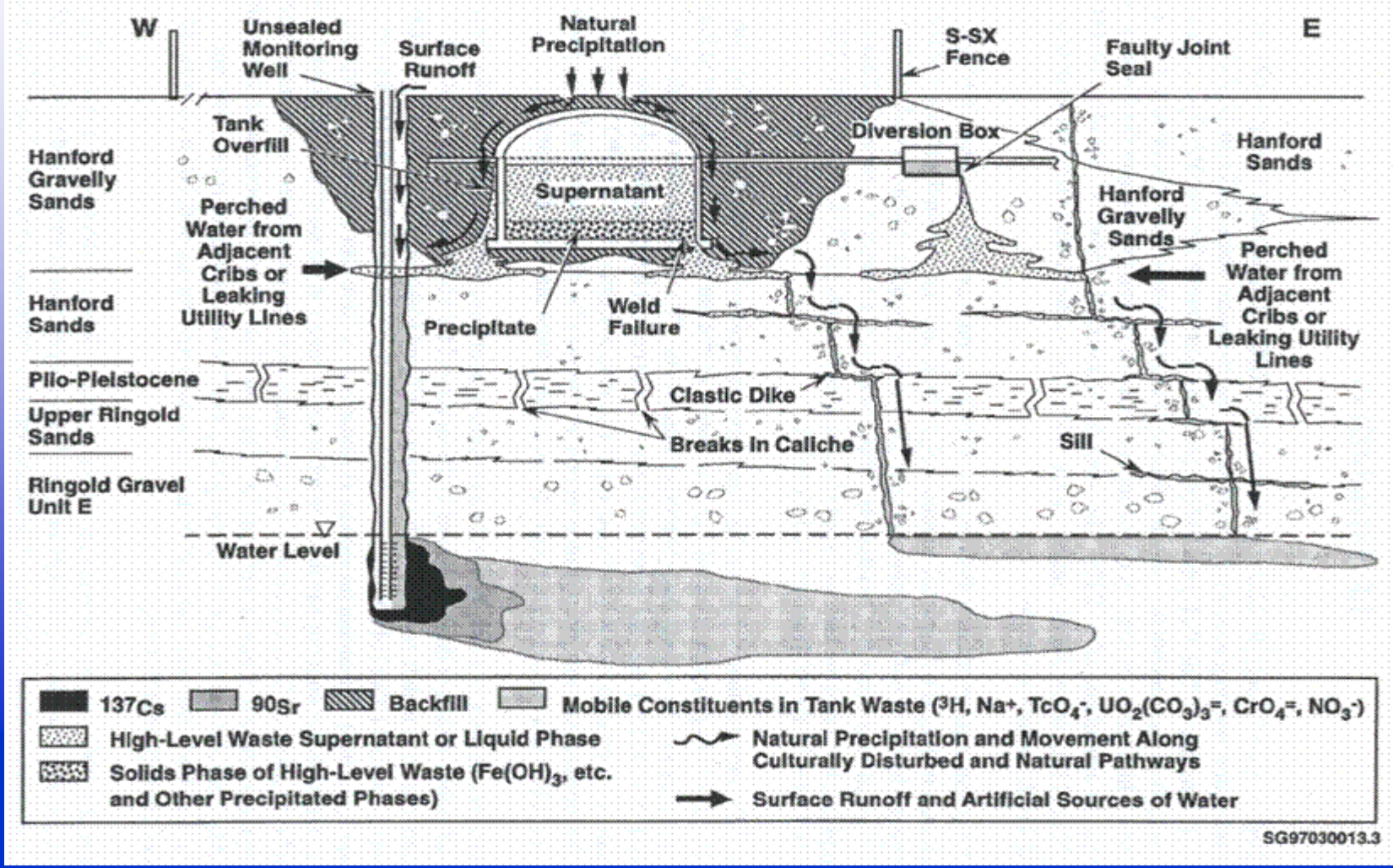
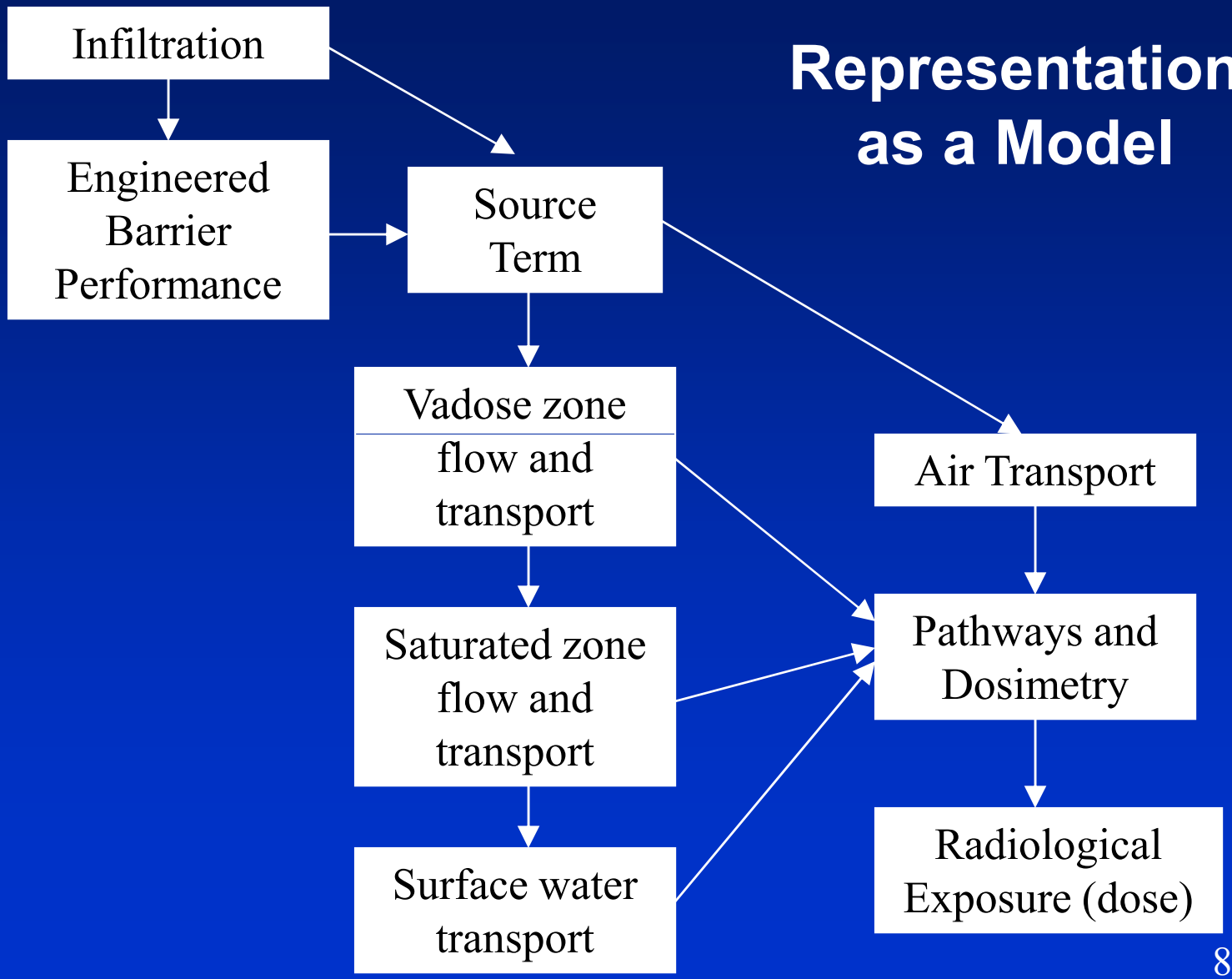
Example of a complex site



Source: PNNL-12114

Representation as a Model



How is a PA used?

- To estimate radionuclide release and transport, and potential exposure to an average member of a critical group.
- To estimate important parameters and models.
- To evaluate the effects of uncertainty and variability.
- To provide information to decision makers.

Uncertainty and Variability

- Uncertainty and variability - example
- The impact of uncertainty and variability must be factored into decision making.
- Uncertainty and variability can be managed through:
  - Probabilistic assessment (e.g., Monte Carlo)
  - Deterministic analyses with sensitivity analysis
  - Collection of more data
  - Use of conservatism

Uncertainty and Variability - continued

- The NRC does not prescribe whether analyses should be deterministic or probabilistic.
- Each has advantages and disadvantages.

Example - deterministic approach

Estimate values of parameters

↓

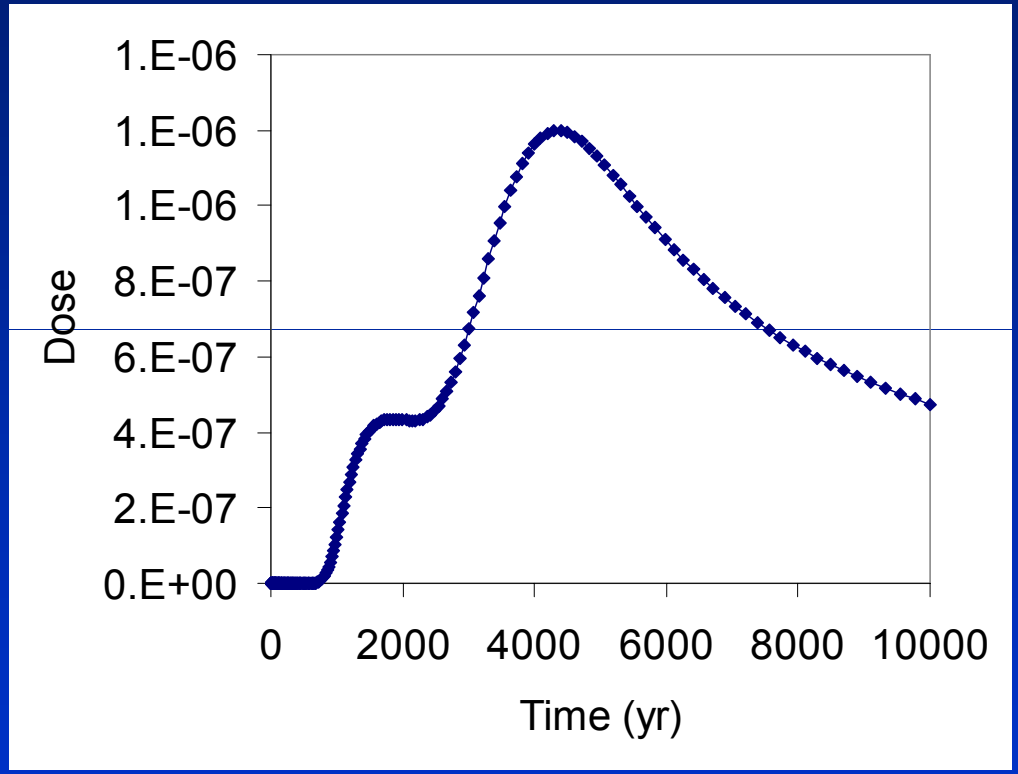
X, Y, Z

↓

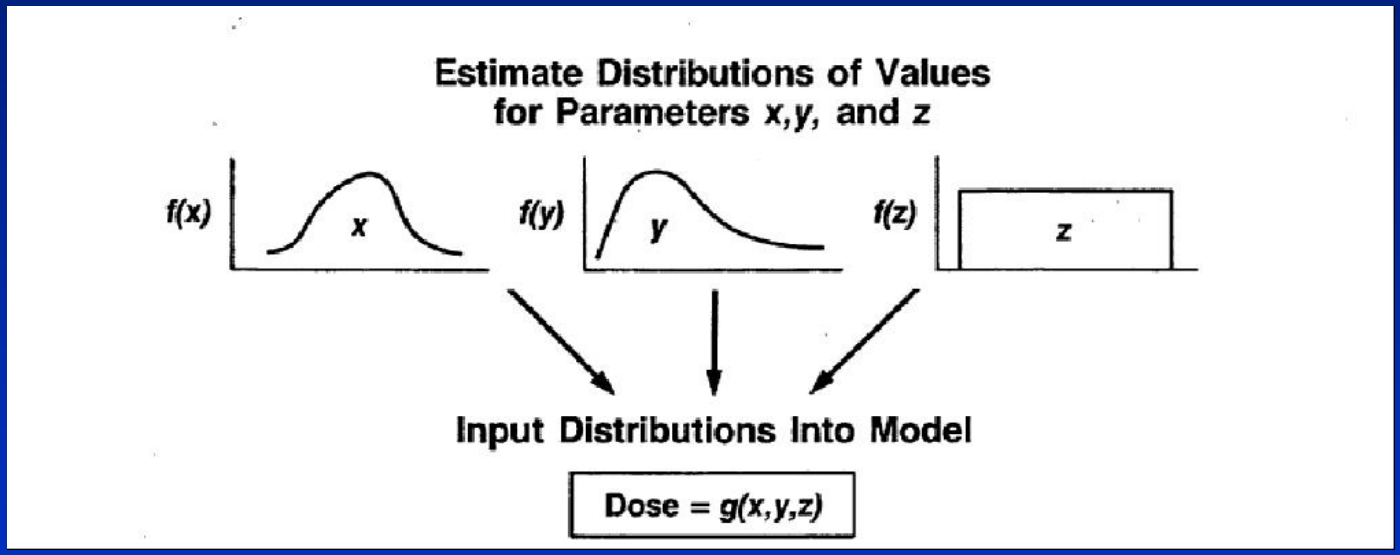
Input parameters into a model

↓

Dose = g(X,Y,Z)



Example of probabilistic approach



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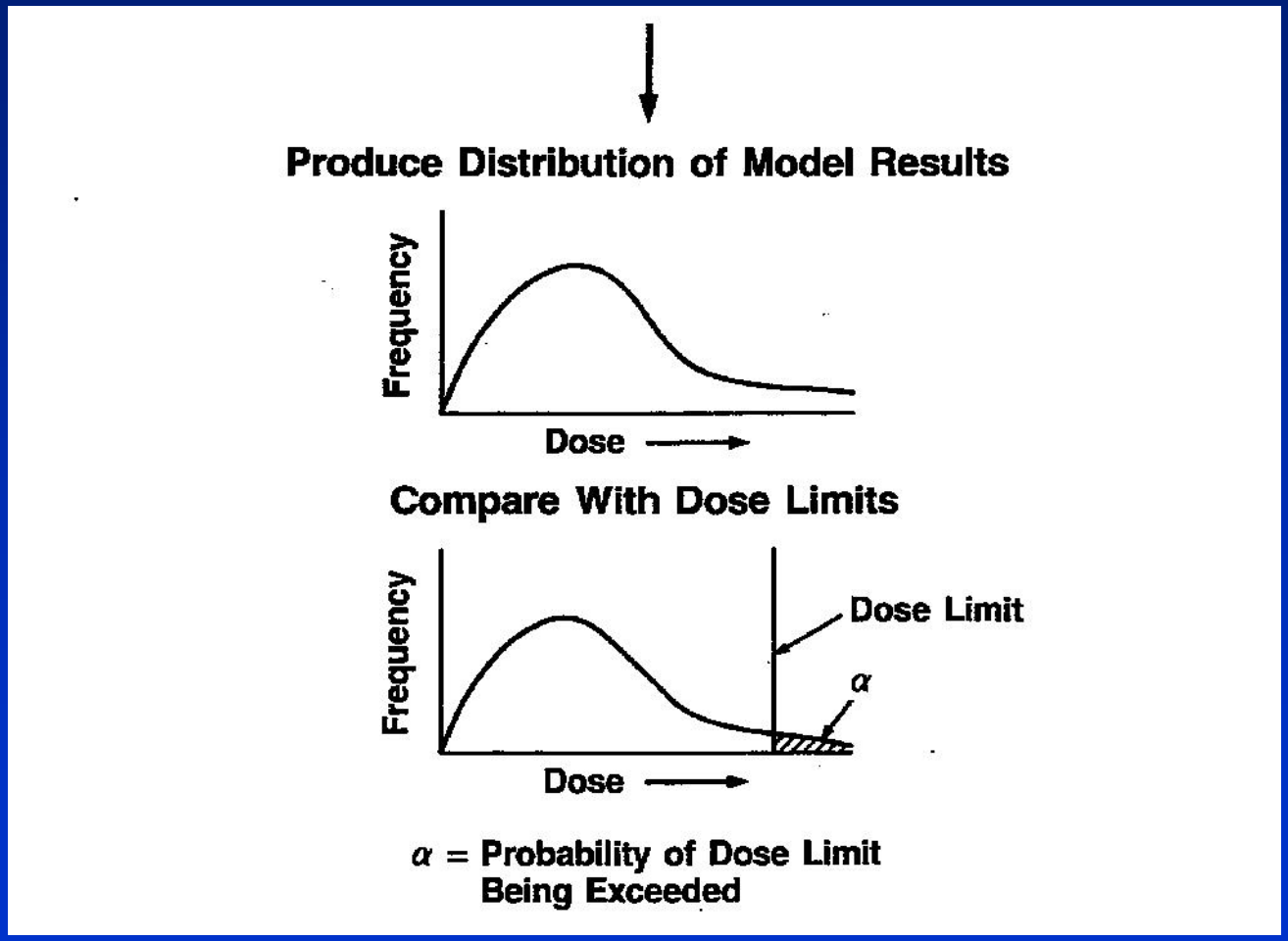
Example of probabilistic approach - continued



Probabilistic vs. Deterministic

- Deterministic
  - Easier to understand
  - Simpler to explain
  - More straightforward to implement
  - Treatment of uncertainty can be difficult
- Probabilistic
  - More rigorous treatment of uncertainty
  - Can be used to identify important data
  - More complicated
  - More difficult to implement

Confidence in PA Results

- Confidence building very important

- Confidence developed via:
  - Technical checking and review
  - Quality assurance
  - Hand calculations
  - Comparison to other models
  - Comparison to site observations
  - Comparison to comparable sites (e.g., analogs)

Potentially Affected Populations

- Potentially affected populations are site-specific.
- Pathway analysis should result in the determination of the total intake of radionuclides by the average member of the critical group.
- Receptors are individuals who can potentially be exposed to radiation.
- Critical group – *group of individuals reasonably expected to receive the greatest exposure to residual radioactivity for any applicable set of circumstances.*

Potentially Affected Populations - continued

- The average member of the critical group is that individual who is assumed to represent the most likely exposure situation, based on cautious but reasonable exposure assumptions and parameter values.
- For example, in a rural environment, a family farm adjacent to a contaminated site may be the reasonably conservative selection for the critical group.

Conclusions

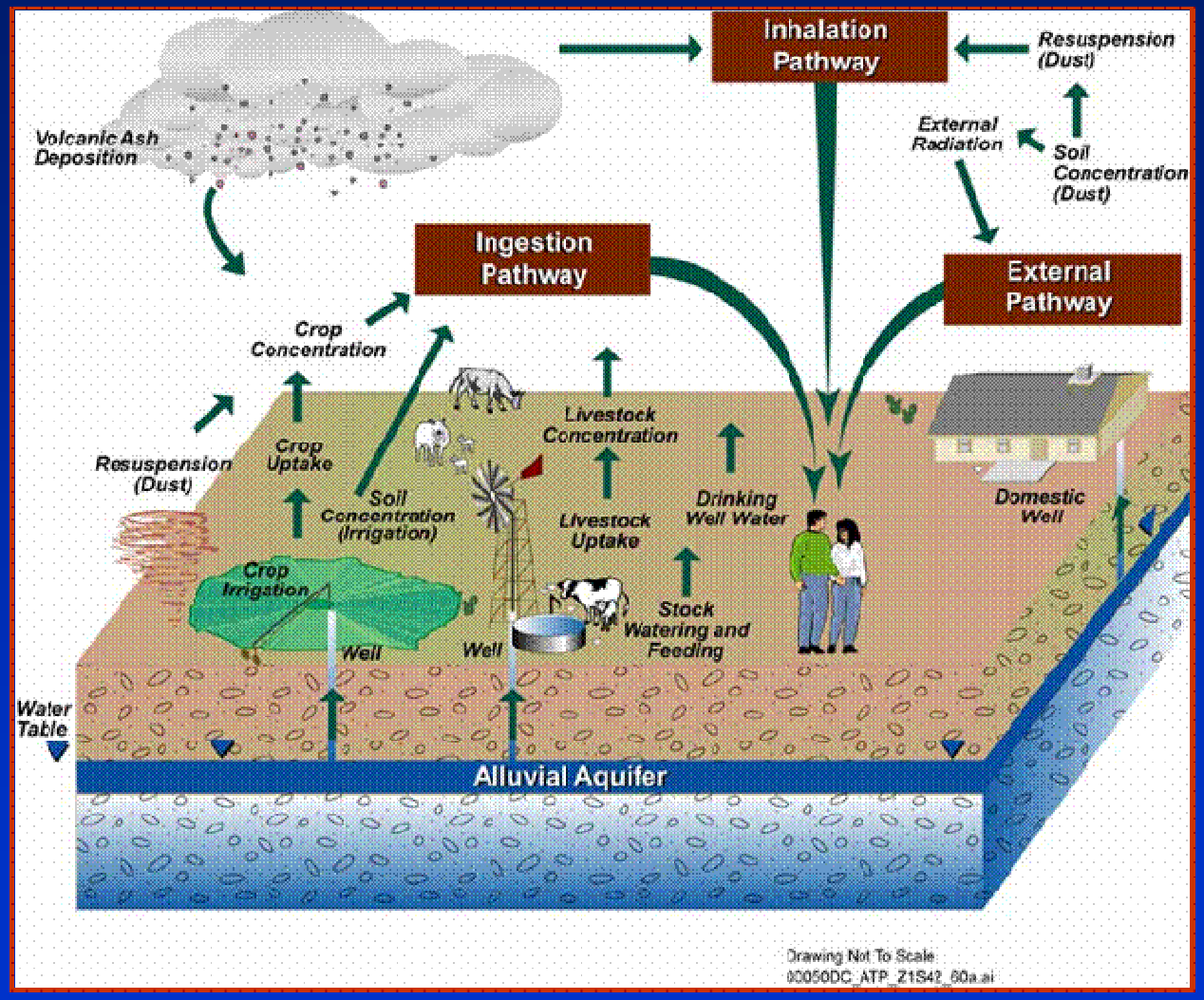
- Performance assessment is a widely accepted process.
- Performance assessment is intended to be an objective process for assessing risks and the associated impact of uncertainties in order to inform decision makers.
- Performance assessment is intended to increase understanding.

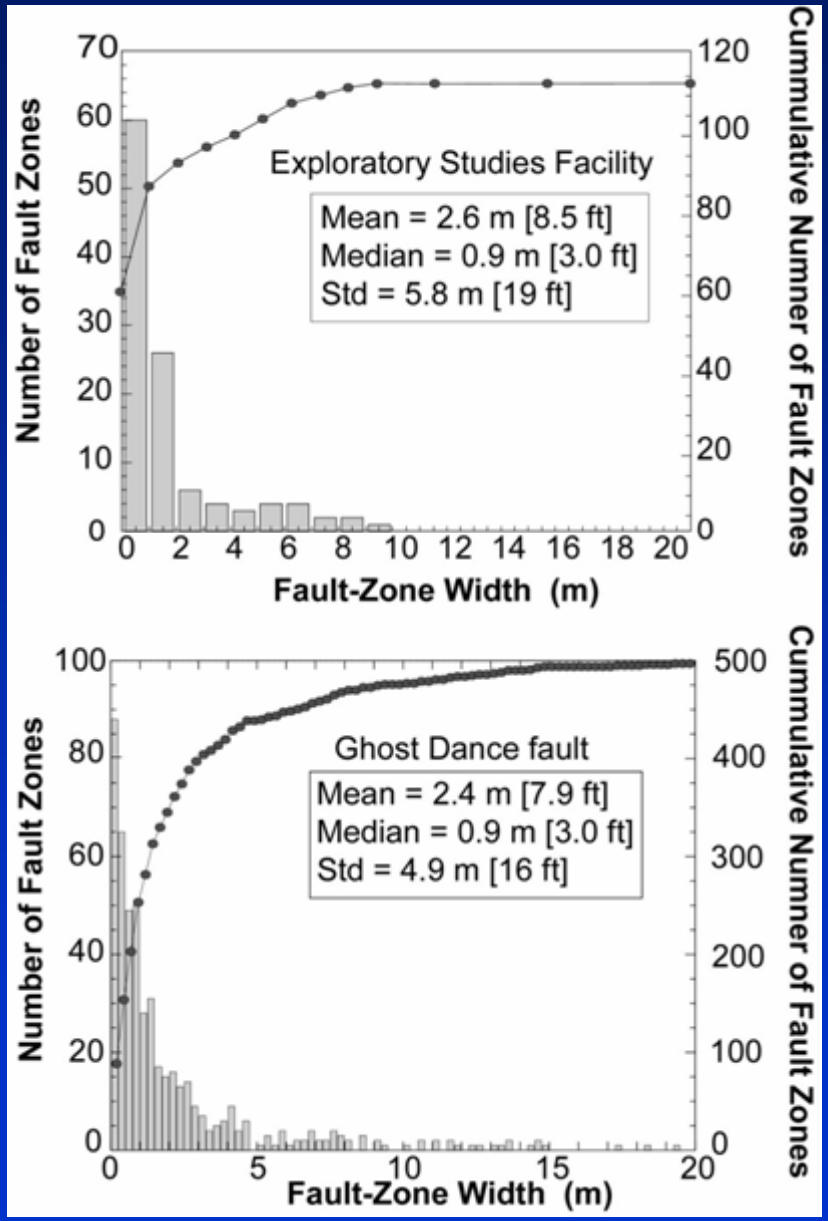
Reference

NUREG-1573 'A Performance Assessment Methodology for Low-Level Radioactive Waste Disposal Facilities, Recommendations of NRC's Performance Assessment Working Group', US Nuclear Regulatory Commission, Washington, DC, October 2000.

Backup Slides

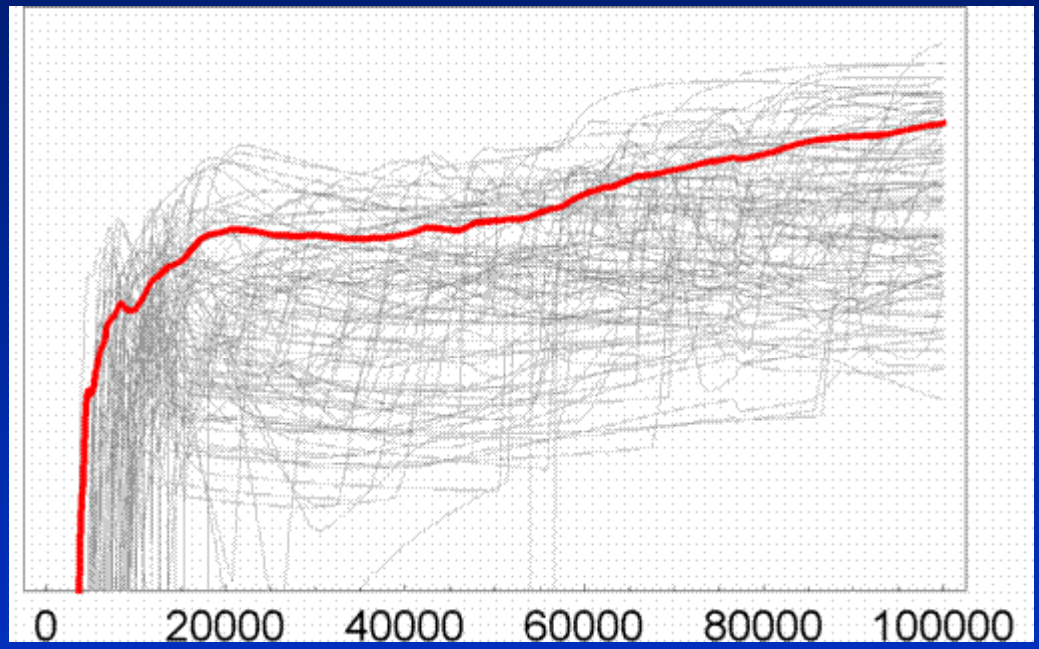
Example of potential exposure pathways



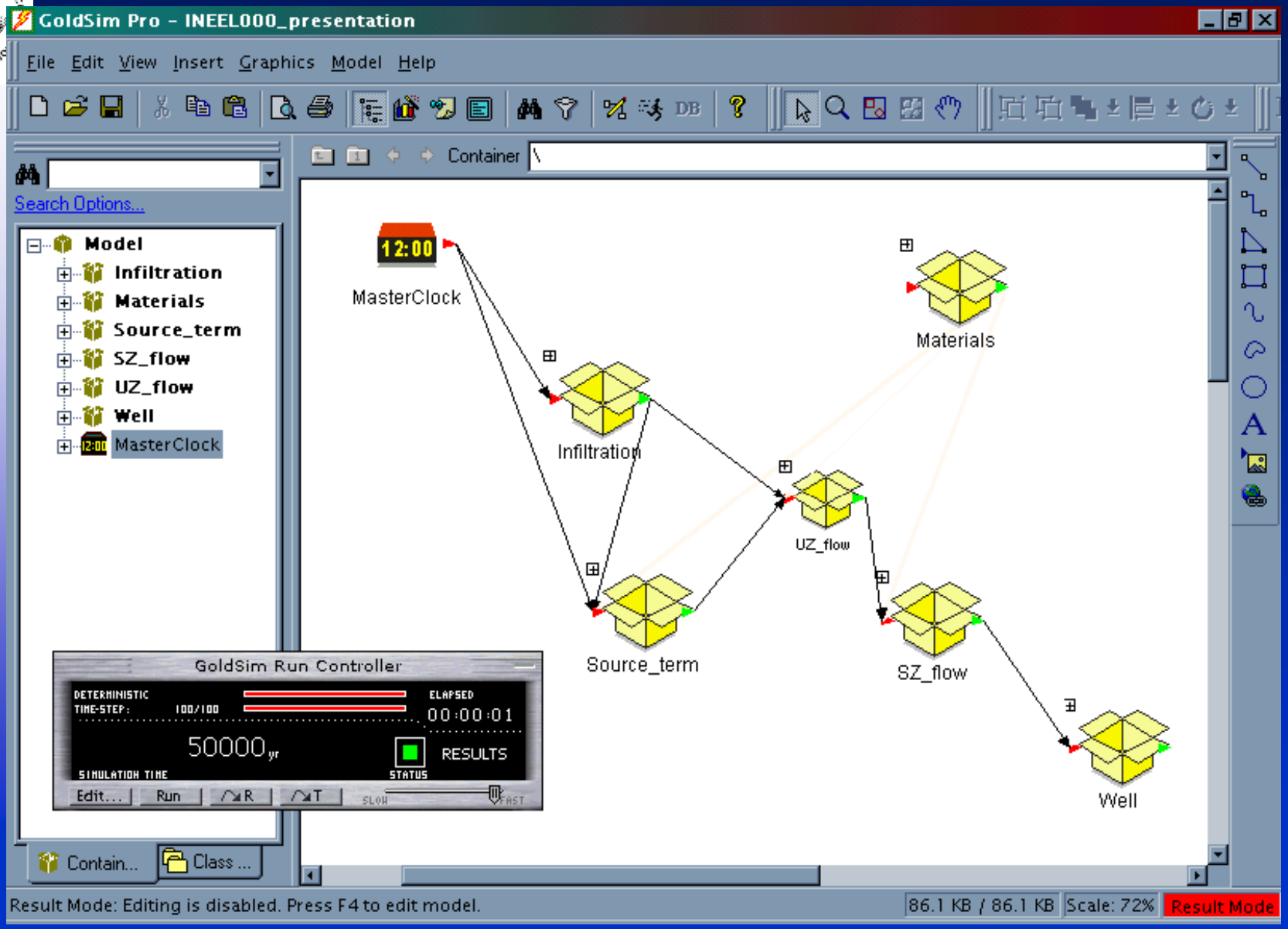


Example of data showing natural variability.

A numerical distribution can be used to fit the observed data.



Example of a horsetail plot from a probabilistic assessment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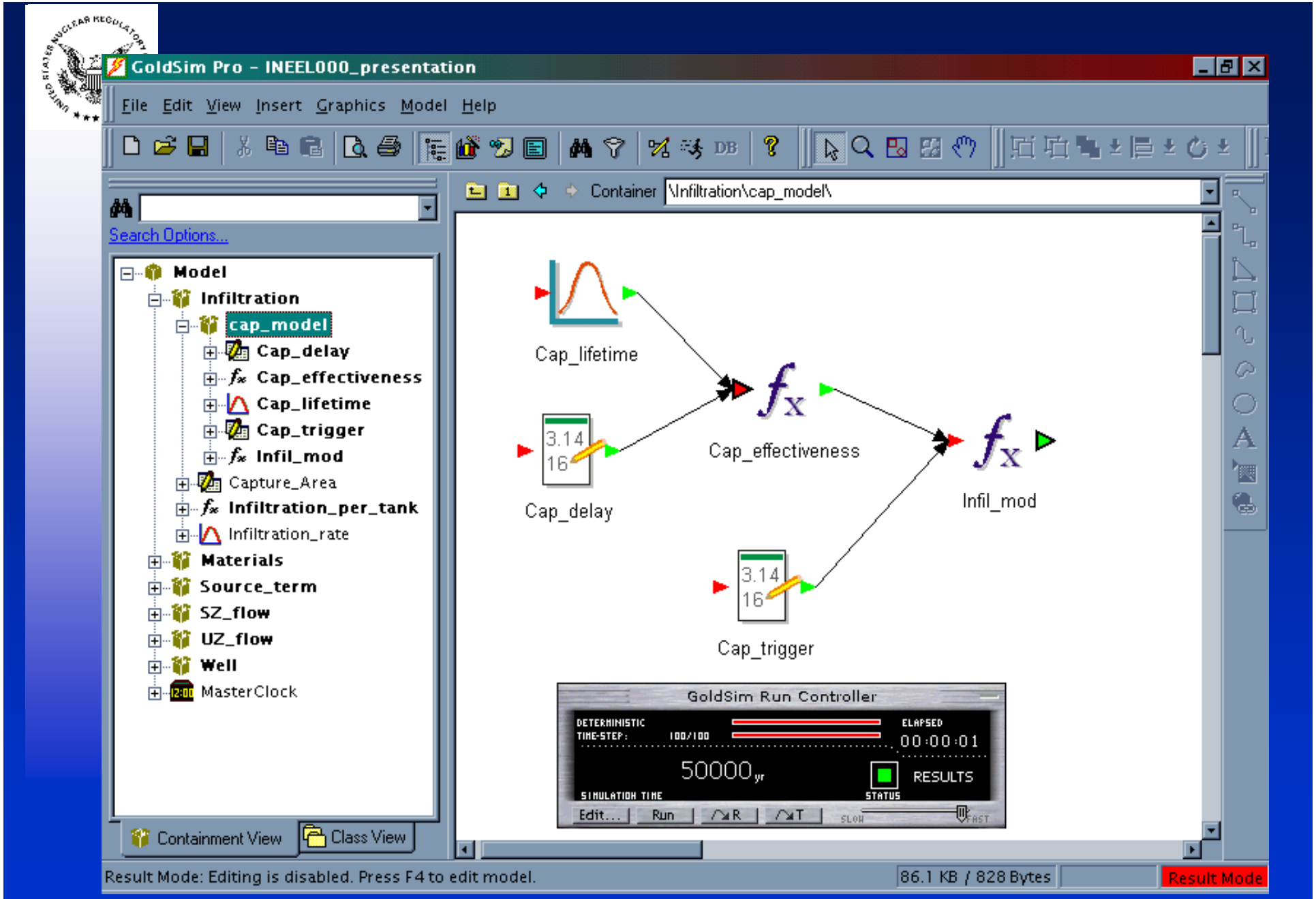
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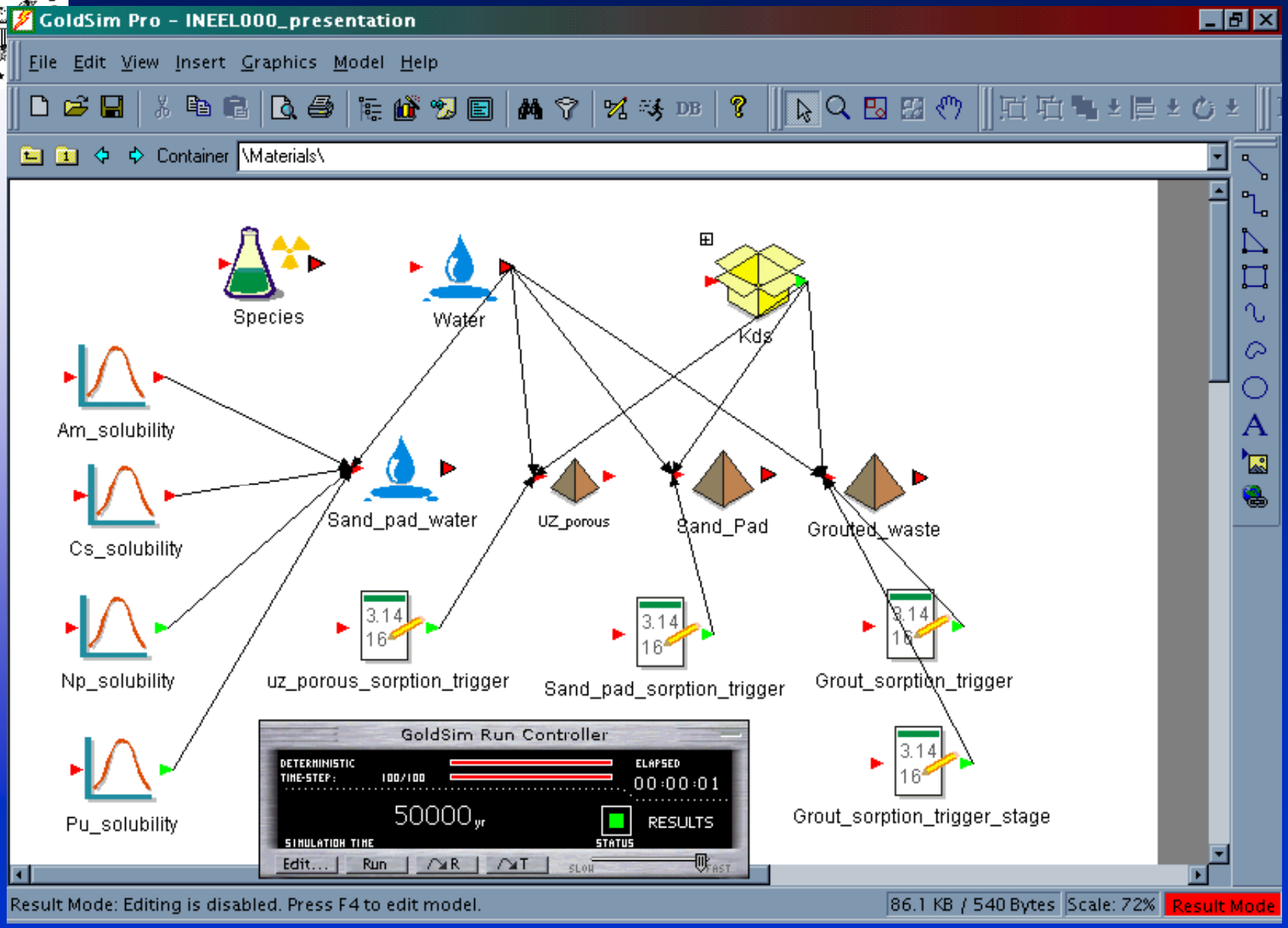
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