Probabilistic Performance Assessment Modeling at the West Valley Site

Quarterly Public Meeting May 2019

NEPTUNE AND COMPANY

What is Performance Assessment?

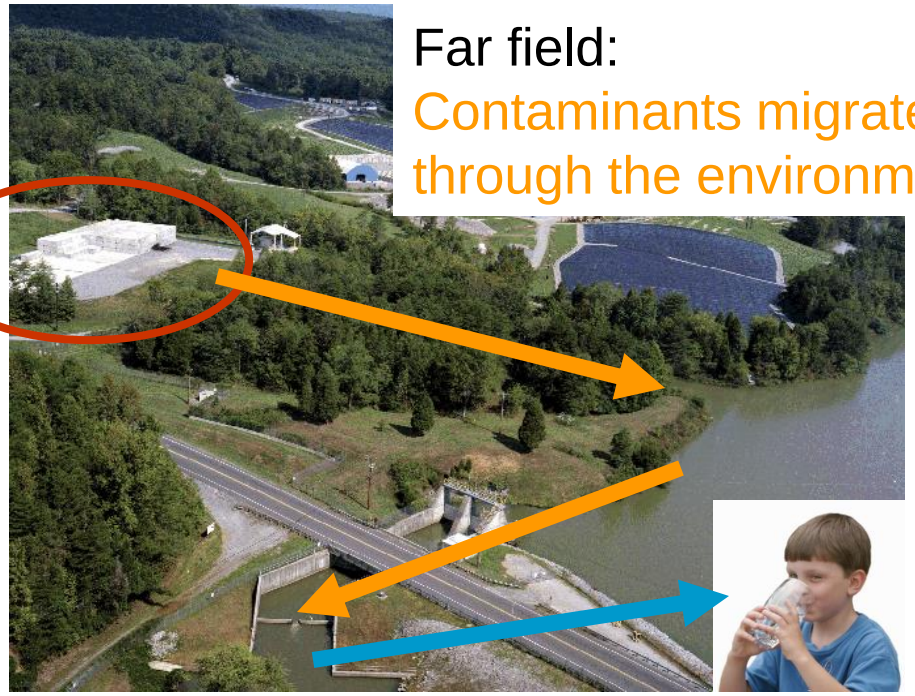
Performance Assessment is an analysis of the release of a radionuclides (and other contaminants) from a contaminated site, and an estimation of the exposure to future humans and other biota to these contaminants, for a specific set of future site scenarios that are based on expected future land use.

PAs are generally intended to evaluate whether or not performance objectives are met.

Modeling the System

Example: Human and ecological health effects arise from exposure to contaminants transported through an engineered (near field) and natural (far field) environment to a biological (physiological) environment

Near field:
Radiological materials leak out of buried wastes.



Far field:
Contaminants migrate through the environment.

Physiological exposure:
Humans and ecological receptors are exposed by several pathways.

a radioactive waste disposal facility in Tennessee USA

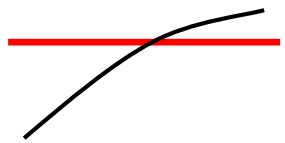
Why Performance Assessment?

- Federal agencies (EPA, NRC, and DOE) all require site-specific performance assessments (PAs) at radiologically-contaminated sites.
- NRC's Final Policy Statement identified its License Termination Rule as the decommissioning criteria for the WVDP.
- A PA is supported by a science model that emulates the release, transport, and future exposure to contaminants.
- Deterministic and Probabilistic

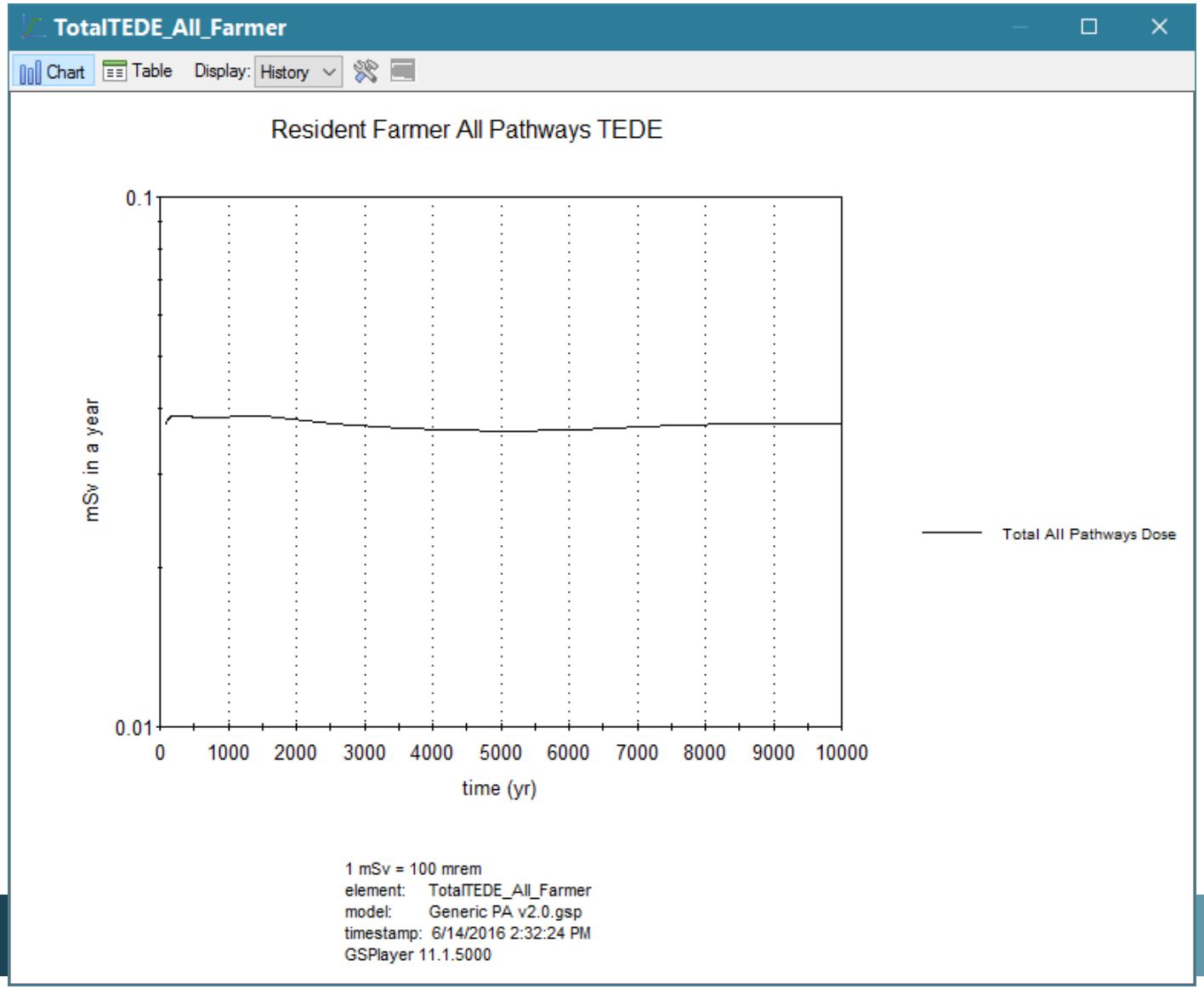
Deterministic Modeling

Deterministic models…

- Utilize a single set of input parameters (inventory, hydraulic conductivity, K_d, etc.)
- Produce single-valued output with no uncertainty
- Are easy to compare to deterministic performance objectives



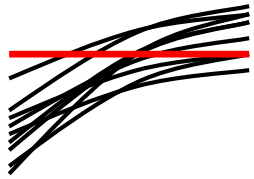
A single run (deterministic) simulation will generate a single time history of dose.



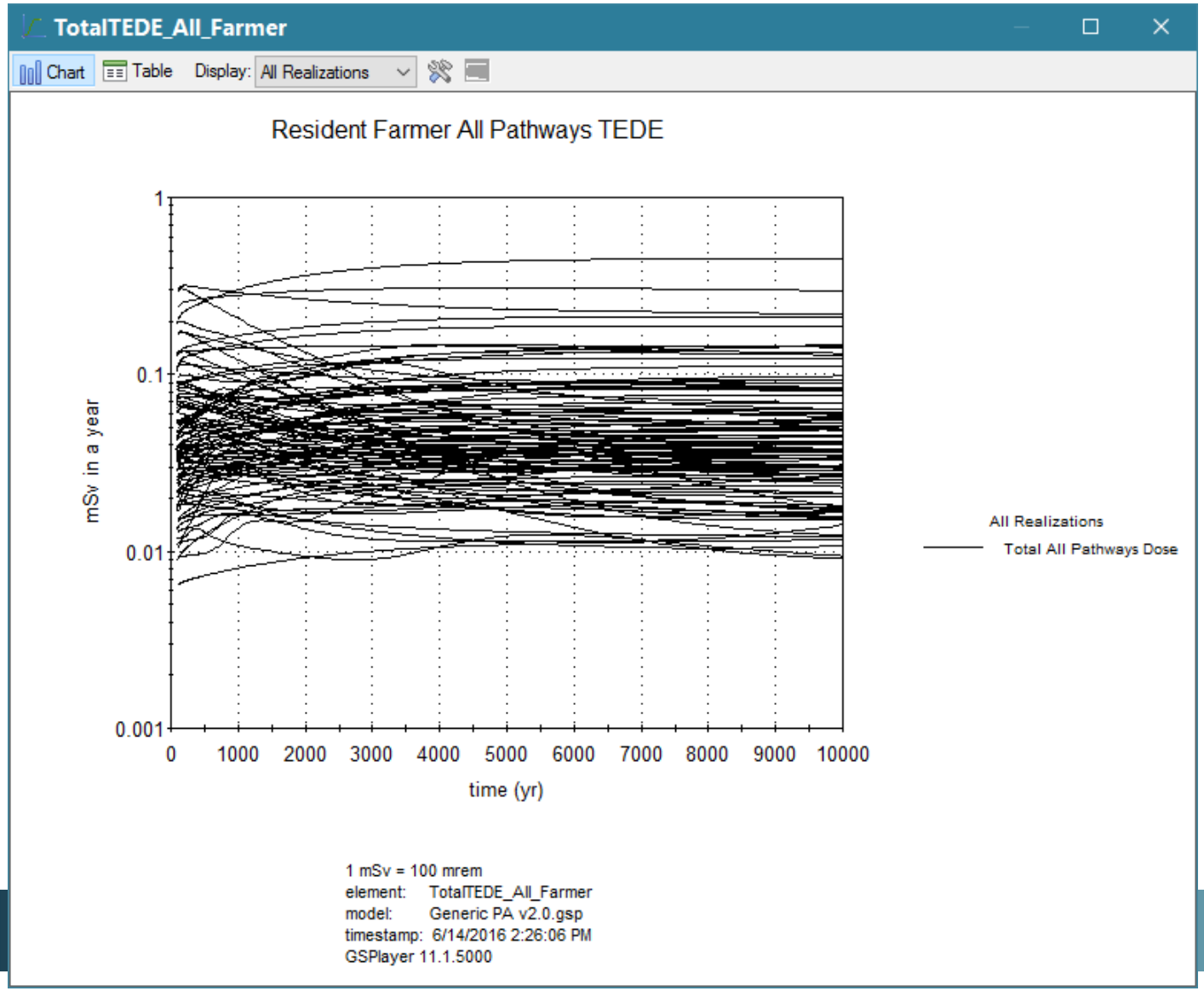
Probabilistic Modeling

Probabilistic models

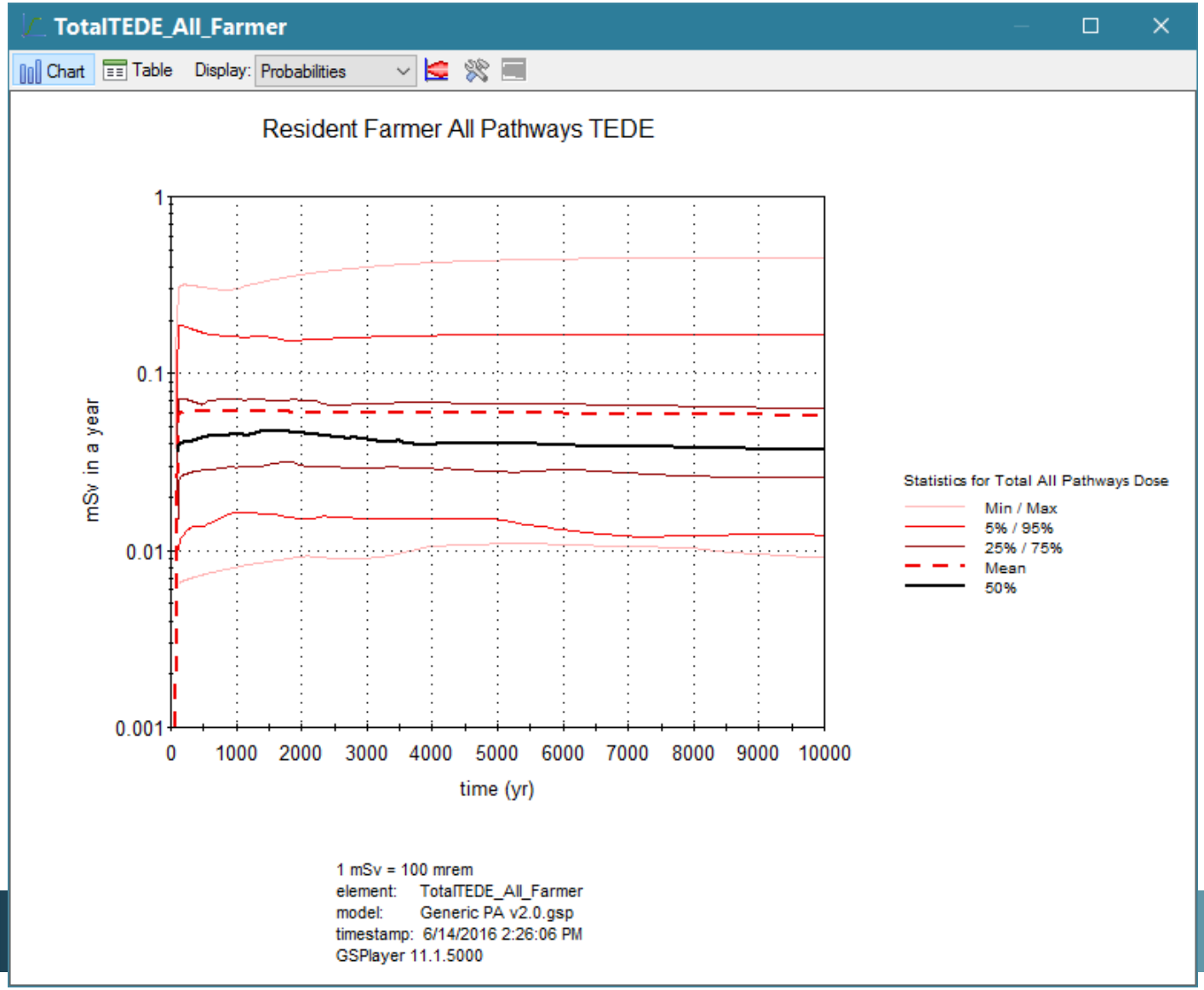
- Utilize a range of input parameters (inventory, hydraulic conductivity, K_d, etc.).
- Designed to account for *inherent uncertainties* in assumptions, parameter values, and in the models themselves.
- Model is run many times with different randomly selected values for inputs.
- Model outputs are collections of values (distributions) for endpoints of interest.



A probabilistic simulation will generate several time histories of dose, showing uncertainty.

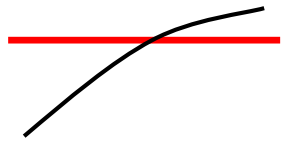


A probabilistic simulation can also be shown using a statistical summary.



Deterministic Modeling

- We often say “It’s ok to make conservative decisions. It’s not ok to try to build conservative models”.
- Conservativism is subjective and it obscures model interpretation.
- Another fundamental issue with the philosophy of deterministic models is they assume the model structure is correct.



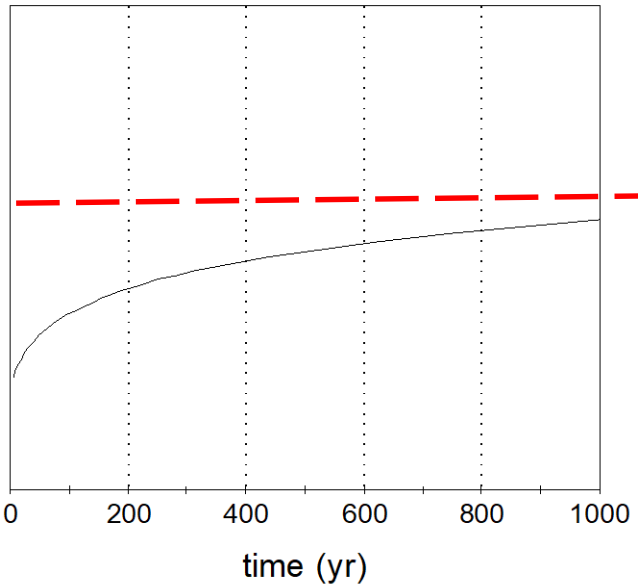
Probabilistic Modeling

Probabilistic models

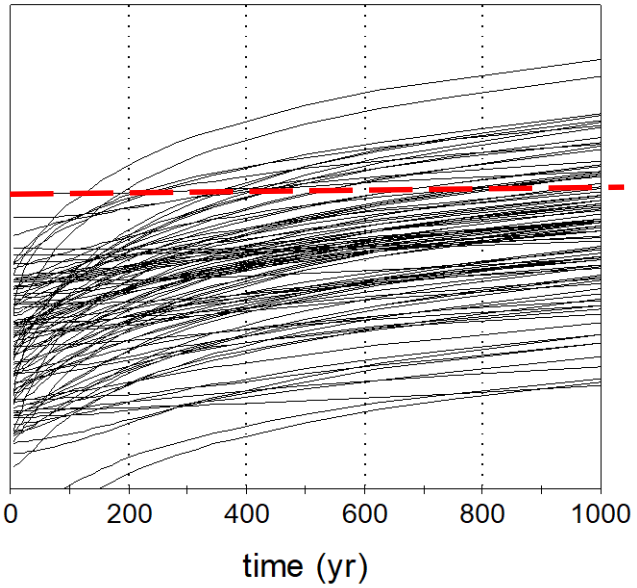
- Strive to be realistic (not conservative)
- Represent uncertainty using many values for model parameters
- Allow for identification of input parameters that are most important
- Allows for iterative model development and identification of data gaps

Model Output

Single deterministic answer



Many probabilistic answers



- Does not represent uncertainty
- Limited results for decision making

- Reflects uncertainty clearly
- Decision maker has to evaluate comfort level

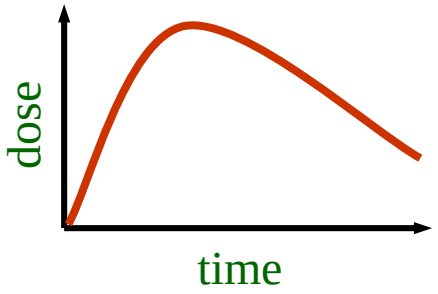
Deterministic *vs* Probabilistic

	pro	con
deterministic analysis	• May be appropriate for simple compliance demonstration • If so, then simple for decision makers and public	• Uncertainties are unspecified • What is “conservative” may not be known • No global SA possible
probabilistic analysis	• Better represents state of knowledge • Requires development of input distributions • Facilitates global SA and uncertainty analysis	• Requires more computer time (perhaps)

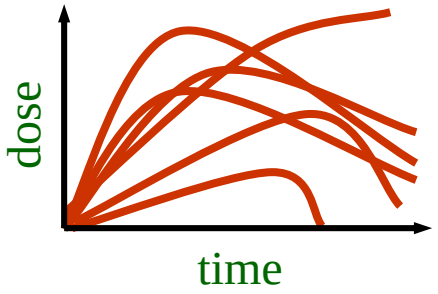
Managing Uncertainty

- We know that our knowledge is incomplete.
- How can we account for imperfect knowledge?
- Each modeling parameter and process has inherent uncertainty and variability.
  - Inputs are based on what we think we know (expectation) and how unsure we are (uncertainty).
  - Therefore the results must also be uncertain.

no single answer is correct



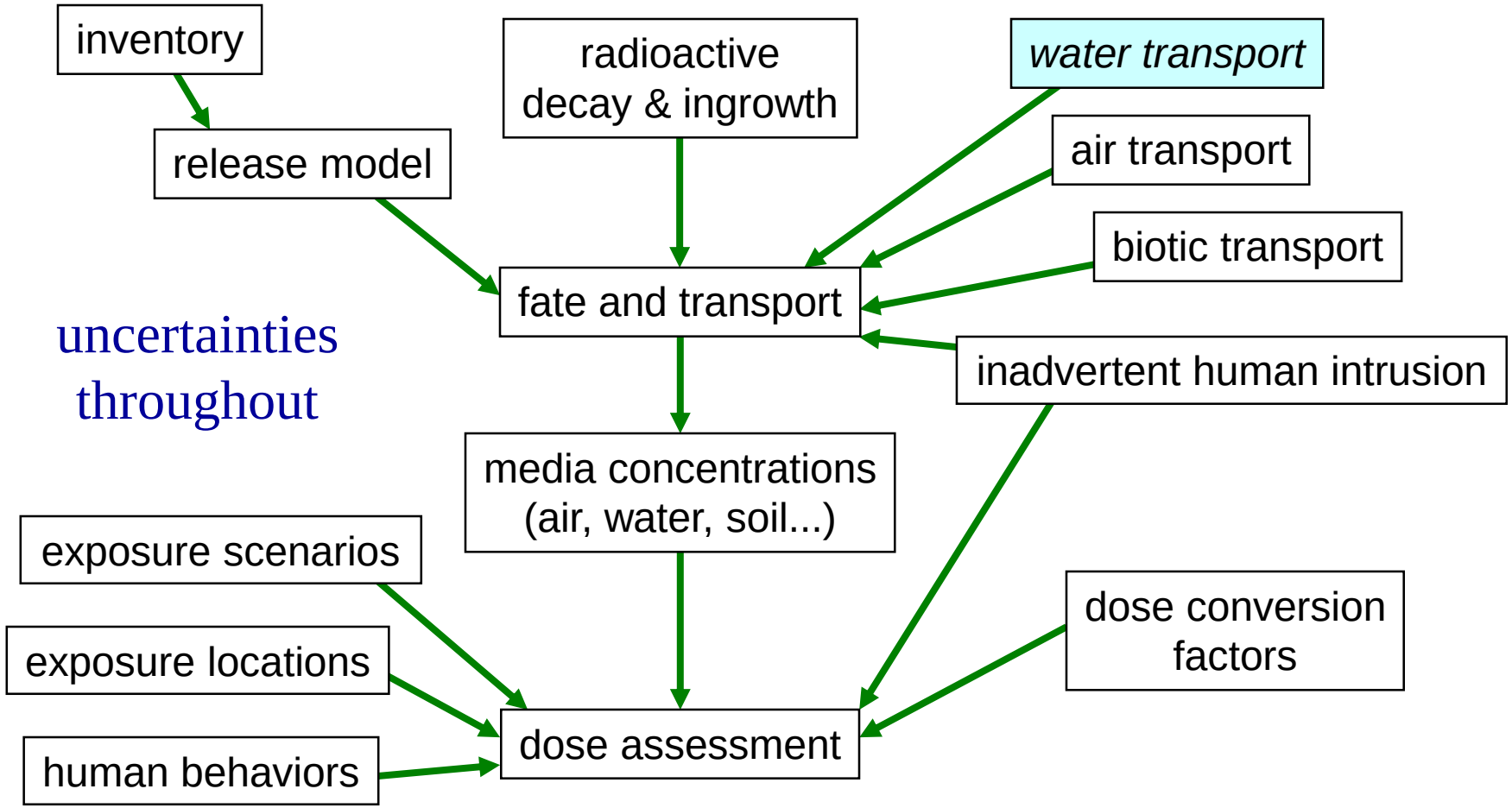
a collection of answers reflects our knowledge



Probabilistic Modeling

- Model preparation
  - Gather pertinent information
  - Develop conceptual model
- Model structure
  - Variables (parameters) and relationships
  - Include alternative models, scenarios
- Model specification
  - Probability distributions, correlations
  - Costs, value judgments

A PA Influence Diagram



System Modeling

model input parameters

modeled processes

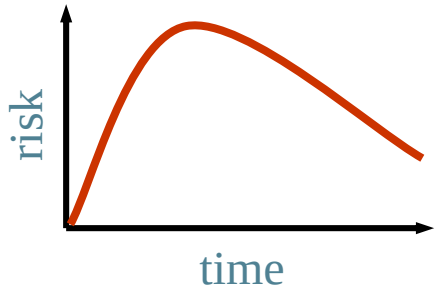
modeling results

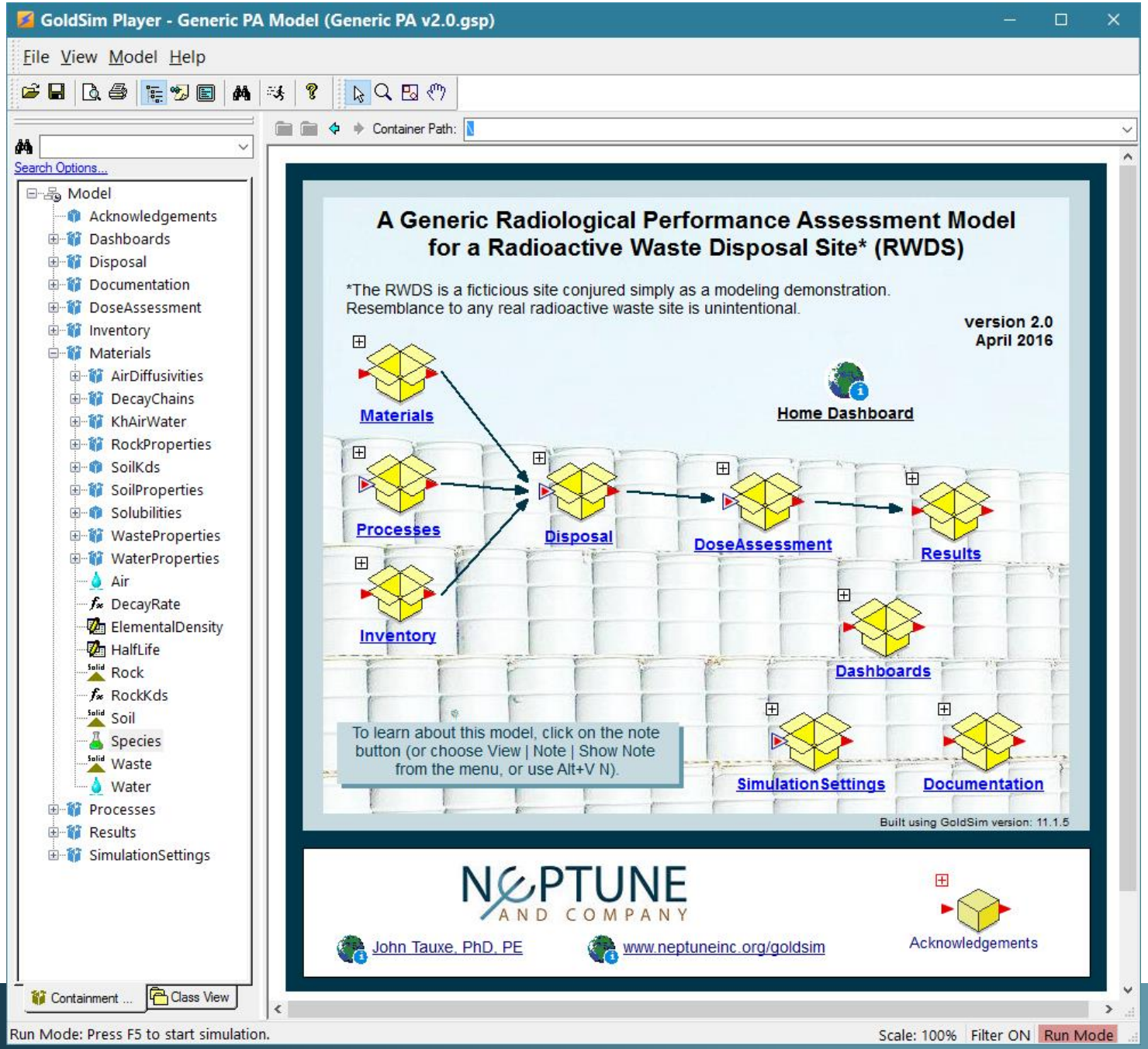
examples:

average annual precipitation
= N(μ=55 cm, σ=35 cm)

water movement
follows Darcy's Law:

$$v_x = \frac{K}{n} \nabla h$$




GoldSim Player - Generic PA Model (Generic PA v2.0.gsp)
File View Model Help
Container Path:
Search Options...
Model
Acknowledgements
Dashboards
Disposal
Documentation
DoseAssessment
Inventory
Materials
AirDiffusivities
DecayChains
KhAirWater
RockProperties
SoilKds
SoilProperties
Solubilities
WasteProperties
WaterProperties
Air
DecayRate
ElementalDensity
HalfLife
Rock
RockKds
Soil
Species
Waste
Water
Processes
Results
SimulationSettings
Containment ...
Class View
A Generic Radiological Performance Assessment Model for a Radioactive Waste Disposal Site* (RWDS)
*The RWDS is a ficticious site conjured simply as a modeling demonstration. Resemblance to any real radioactive waste site is unintentional.
version 2.0
April 2016
Materials
Home Dashboard
Processes
Disposal
DoseAssessment
Results
Inventory
Dashboards
To learn about this model, click on the note button (or choose View | Note | Show Note from the menu, or use Alt+V N).
SimulationSettings
Documentation
Built using GoldSim version: 11.1.5
NEPTUNE AND COMPANY
John Tauxe, PhD, PE
www.neptuneinc.org/goldsim
Acknowledgements
Run Mode: Press F5 to start simulation.
Scale: 100%
Filter ON
Run Mode

Long-term Probabilistic PA Summary

- Alternatives focused
- Probabilistic system allows full global Sensitivity Analysis to be performed.
  - Identifies inputs that are the primary drivers for the results
  - Can perform SA over the decision options
- Technically defensible, transparent, open, traceable

Support for the SEIS

- Modeling results will be available for the SEIS – the cross-over should be straightforward in principle.
- The SEIS process may require modifications and additions to the West Valley PPA Model in order to accommodate several alternatives.