A Comparison of RESRAD and GoldSim Models for Assessing Radiological Dose for a RCRA Landfill

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Presentation Outline

- Overview of USEI RCRA Subtitle C landfill near Grandview, ID
- Key differences between GoldSim and the RESRAD-Onsite computer code
- Comparison of transport and exposure pathways in the GoldSim and RESRAD models
- Comparison of radon flux calculations
- Comparison of all-pathways dose results

Neptune Modeling Philosophy

- Keep it simple but not too simple
- Probabilistic system allows full global Sensitivity Analysis to be performed
  - Identifies inputs that are the primary drivers for the results
  - Reduce uncertainty in decision
  - Optimize site performance
- Technically defensible, transparent, open, traceable

Grand View Site

- Location: about an hour south of Boise, Idaho.

Problem Statement

- Improve previous site performance modeling and waste acceptance criteria by
  - greater site-specific representation
  - use of appropriate environmental transport and exposure pathways.
- Use GoldSim modeling platform instead of RESRAD-Onsite to improve estimates of site performance and to investigate acceptance of new waste streams.

RESRAD-Onsite vs GoldSim

- RESRAD-Onsite is a purpose-built model for calculating dose and dose-based soil guidelines.
  - Well-tested and relatively simple to use, but limited to on-site exposure from a single, homogeneously-contaminated soil source.
- GoldSim is a general probabilistic modeling platform, with tools for radionuclide transport.
  - Flexibility to address any transport pathways, waste geometry, and engineered systems

GoldSim can be used for a variety of applications (environmental, business, engineered) to support decision-making and risk analysis.

Pathways Comparison

Transport pathway (Exposure route)	**RESRAD**	**CSM**
Infiltration to groundwater	×	–
Drinking water	×	–
Garden irrigation and livestock	×	–
Irrigation → soil (ext, soil ing, produce, dust inh)	×	–
Cover erosion—sheet and rill erosion	×	×
Reduced cap thickness (radon inh)	×	×
Cover erosion—gully erosion		–
Exposed waste (ext); locally enhanced infiltration		–
Gas-phase diffusion	×	×
Radon inhalation	×	×
Deposition of ^{222}Rn decay products in cover (ext, soil ing, produce, dust inh)		×
Water-phase diffusion		×
Radionuclides in cover (ext, soil ing, produce, dust inh)		×

ext: external radiation

ing: ingestion

inh: inhalation

– intentionally not included

(blank) not available to include

Pathways Comparison

Transport pathway (Exposure route)	**RESRAD**	**CSM**
Plant root uptake by native plants		×
Deposition on ground surface (ext, soil ing, produce, dust inh)		×
Ingestion by cattle (meat ing)		×
Animal burrowing		×
Mixing of cover material (ext, soil ing, produce, dust inh)		×
Human intrusion (Cell 16: drilling of a water well)		×
Cuttings on surface or in mud pit (ext, soil ing, produce, dust inh)		×
Human intrusion (Cell 16: excavation for a residence)		×
Direct exposure to waste; subsequent exposure to excavated cap material (ext, soil ing, dust inh)		×

ext: external radiation

ing: ingestion

inh: inhalation

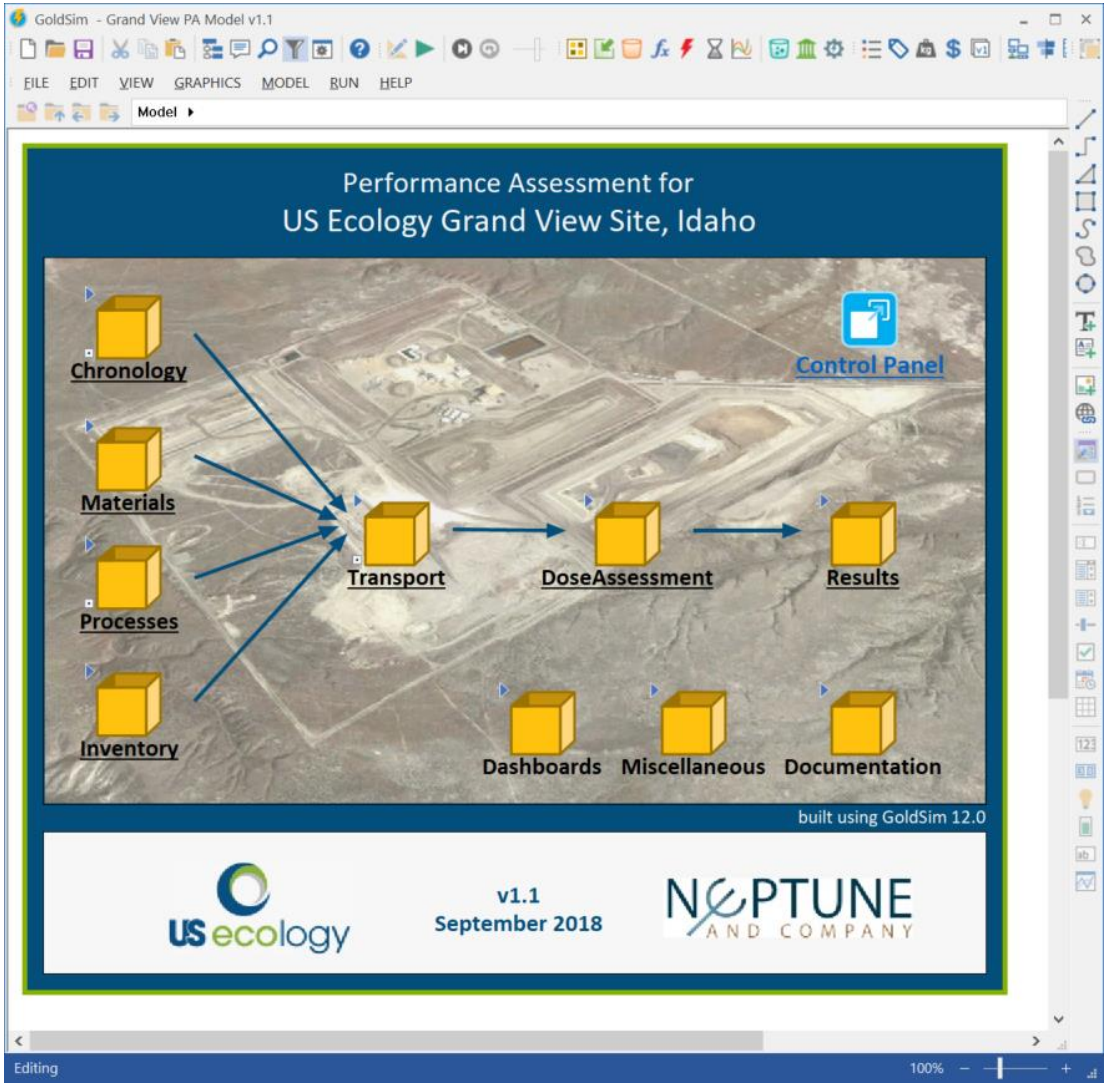
– intentionally not included

(blank) not available to include

Key Differences in Modeling Assumptions

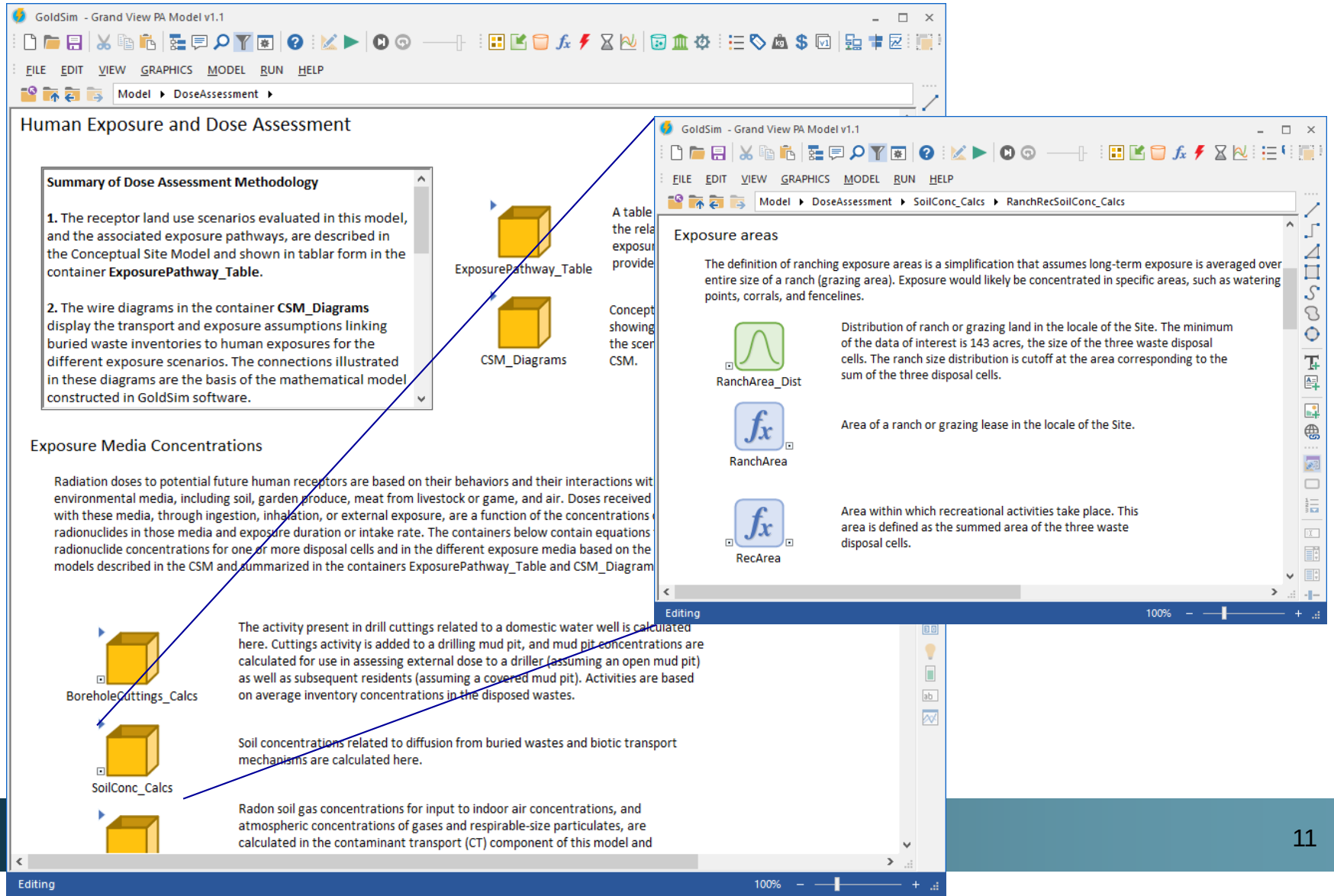
Topic	RESRAD-Onsite	GoldSim PA
Exposure and source area assumptions	Small area - approximately half of the size of Cell 14.	Actual disposal cell dimensions. Exposure is defined for individual on combined disposal cells.
Cover assumptions	The cover is perpetually "clean" and evolves over time only by uniform sheet erosion at a very slow rate.	The cover becomes contaminated over time from: radon diffusion/deposition of Pb210, plant uptake, and animal burrowing. Erosion - realistically evaluated.
Land use assumptions	RESRAD default assumptions and values for agricultural land use.	Realistic site-specific future land uses and activities applicable to the tops of the disposal cells.
Infiltration assumptions	Irrigation of 0.2 m/yr is assumed to occur over the source area. Evapotranspiration coefficient set at 0.75. Default runoff coefficient.	Site-specific feasibility of irrigation evaluated. Site-specific measurements/models for infiltration rate and vadose zone transport time.
Groundwater pathways assumptions	All RESRAD irrigation-driven agricultural pathways (garden, beef cattle and milk cows) and the drinking water pathway are active.	Considers actual potential well yields for feasibility of a domestic well. Did not include radionuclide migration to groundwater based on site-specific info.

Grand View GoldSim Model



The *Grand View GoldSim PA Model* is used to inform site licensing and waste acceptance criteria decisions.

Grand View GoldSim Model
Dose Assessment Container



Comparison of RESRAD and GoldSim PA ^{222}Rn Flux Results

- Cells 14 and 15 path length is the same as the RESRAD model virtual cell – GoldSim flux is about 3x larger than the RESRAD flux.
- RCRA cover geomembrane not accounted for, and could reduce flux.

	^{222}Rn flux (pCi/m^2-s)		
disposal cell	mean	median (50th %ile)	95th %ile
Cell 14	0.33	0.25	0.88
Cell 15	0.33	0.25	0.88
Cell 16	7.4×10^{-3}	3.1×10^{-3}	0.023
virtual disposal cell - RESRAD		0.094*	

* RESRAD model result is for a deterministic run only.

Statistical summary of GoldSim PA Model Peak ^{222}Rn flux, 10,000 realizations

Comparison of All-Pathways Results

- RESRAD model peak dose of 9.8 mrem/yr with the virtual disposal cell.
- Lower doses with GoldSim model (10,000 realizations).

	Peak Dose (mrem in a yr) within 1,000 yr		
disposal cell	mean	median (50^{th} %ile)	95^{th} %ile
recreationist	3.9×10^{-3}	8.9×10^{-4}	0.013
rancher	0.19	0.028	0.62
driller – Cell 14	0.017	0.017	0.025
driller – Cell 15	0.017	0.017	0.025
driller – Cell 16	0.016	0.016	0.023
construction	0.099	2.8×10^{-3}	0.15
on-site resident – Cell 16	0.68	0.21	1.8

Modeling Differences Summary

- CSM pathway differences
  - cover contamination, biotic, human intrusion, groundwater
- Resident calculation differences
  - on Cell 16
- Radon transport integrated in GoldSim
- Alpha resident for indoor air radon

Summary

Compared to RESRAD, GoldSim supports:

- Evaluation of all potential site-specific pathways
- More flexible probabilistic analysis
- Optimization of long-term decision making, including future disposal, closure, and stewardship
- Within-model documentation
  - Technical defensibility, transparency, and traceability