Neptune's Progress on the West Valley Probabilistic Performance Assessment (PPA)

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NEPTUNE AND COMPANY

Presentation Outline

- Process for PPA Development
- Features, Events, Processes, and Scenarios (FEPS)
- Conceptual Site Model (CSM) Overview
  - Contaminated Facilities
  - Erosion
  - Surface Water
  - Groundwater
  - Climate Change
  - Human Exposure
- GoldSim Model Development

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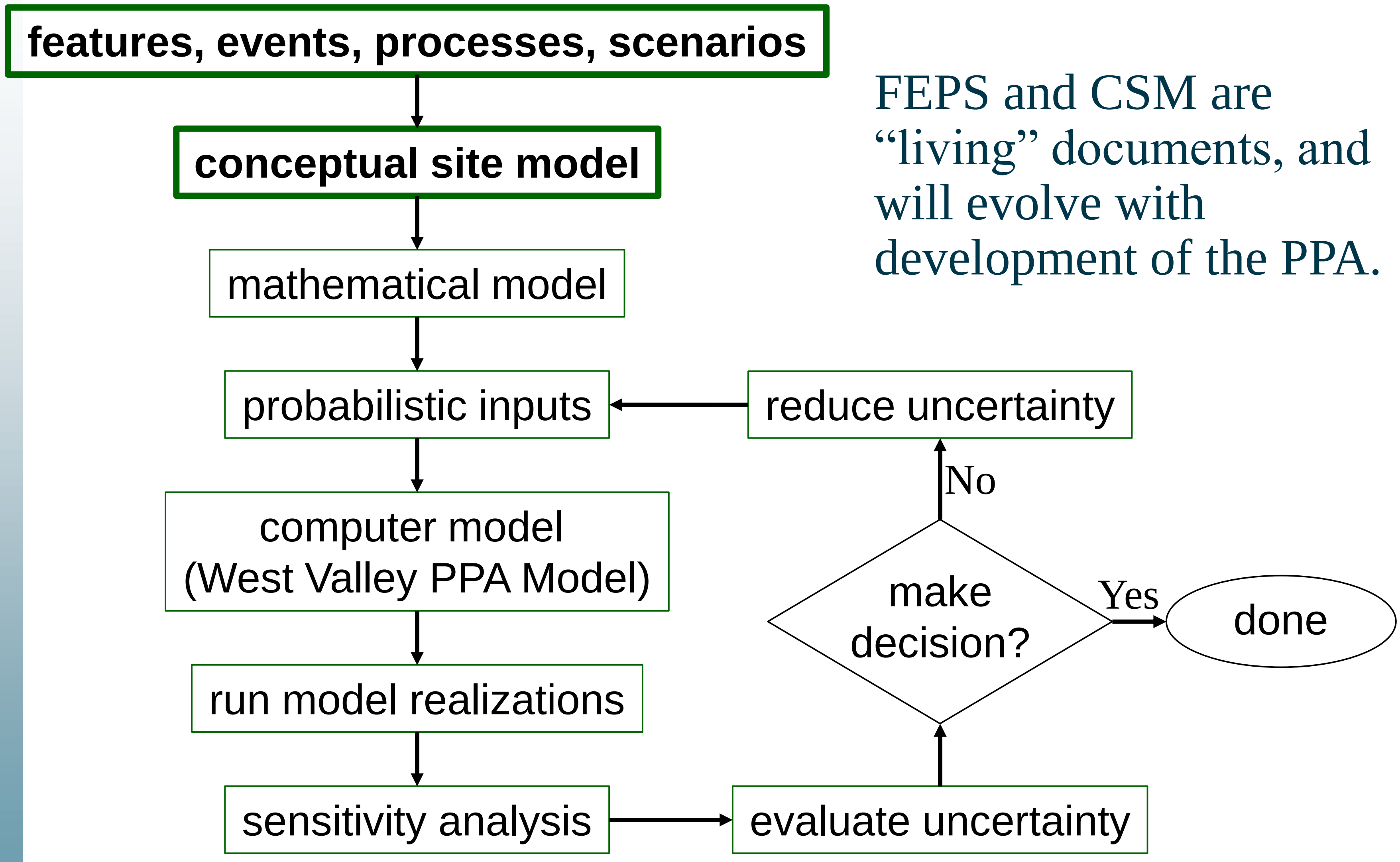
Process for PPA Development



FEPS and CSM are "living" documents, and will evolve with development of the PPA.

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What are FEPS?

Performance Assessment starts with identification of Features, Events, Processes, and exposure Scenarios:

- natural and engineered ***features*** of the environment
- ***events*** that would influence contaminant transport
- natural ***processes*** that move contaminants from source locations (contaminant transport mechanisms)
- ***scenarios*** of human activities that would result in exposure to radionuclides and hazardous chemicals

The FEPS Analysis Process

- *FEPS identification:*

  An initial list of more than 1300 FEPS comes from a review of previous PAs, plus site-specific considerations.

- *Remove duplication:*

  The initial list is reduced to about 600 after combining duplicate and similarly-worded FEPS.

- *FEPS screening:*

  After screening out FEPS that do not apply to West Valley Site, about 430 FEPS are retained for consideration in the Conceptual Site Model (CSM).

- Some FEPS will require further evaluation.

Natural and Engineered Features

- location and inventory of disposed waste and residual contamination
- waste form and containerization
- engineered barriers
- properties of porous media (soils, sediments and rocks that water flows through)
- surface water features (seeps, creeks, etc.)
- trees, grasses, and other plants
- burrowing animals

Events

- natural events such as large storms
- erosion events, such as:
  - landslides
  - slumps
  - gully formation
- excavation into waste or contaminated areas
- loss of institutional control, followed by site occupation and development

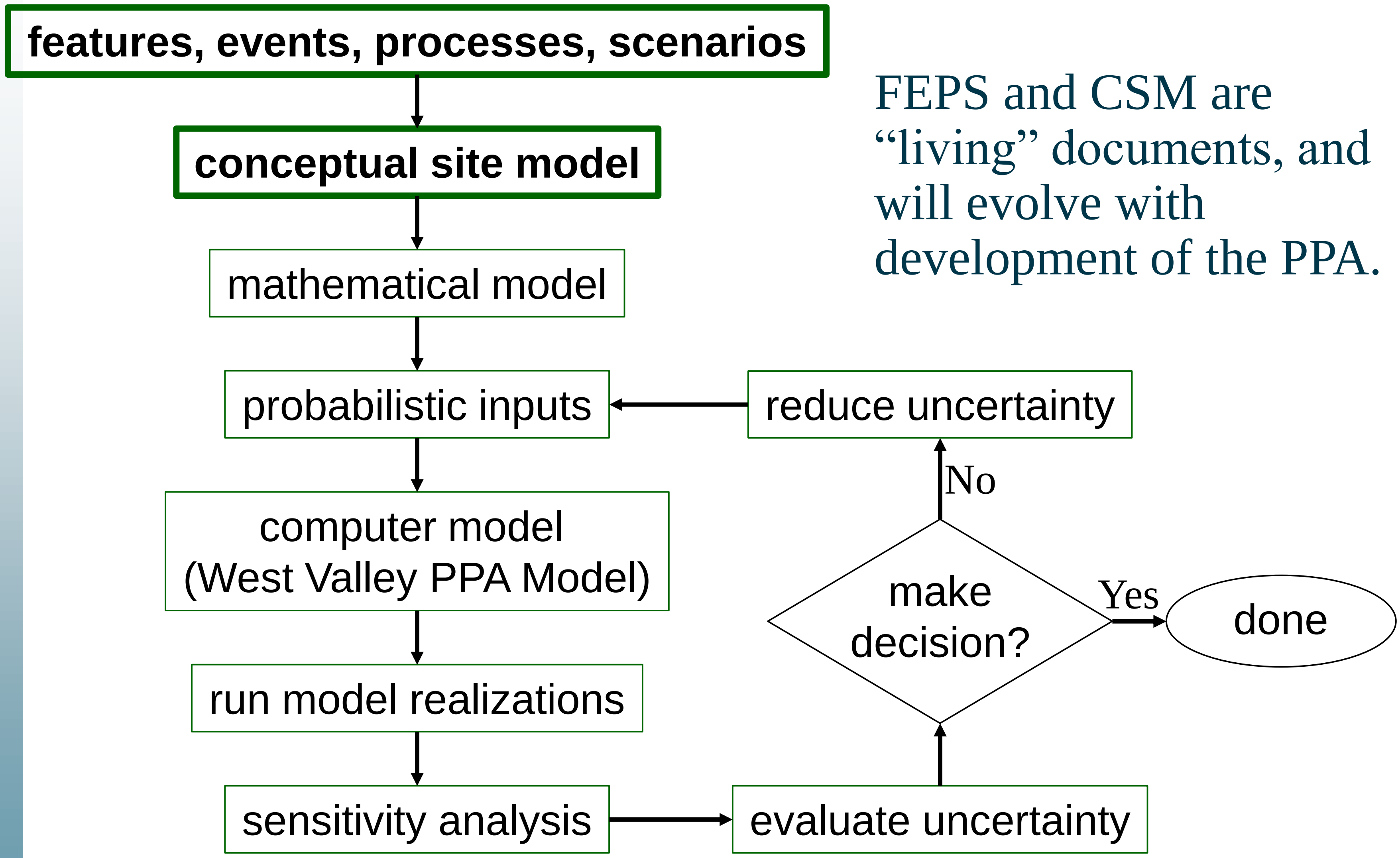
Natural Processes

- radioactive decay and ingrowth
- groundwater and surface water processes: water and sediment contaminant transport
- diffusion of contaminants in pore air and water and dispersion into the atmosphere
- location and type of erosion processes
- redistribution of contaminants to the ground surface by plant uptake and burrowing animals
- effects of long-term climate change

Exposure Scenarios

- human activities typical of the region, such as constructing and living in a dwelling, farming, hunting, fishing, and hiking
- other activities found in the region, such as
  - quarrying
  - drilling for petroleum products
  - drilling for water
- cultural uses of the environment by Native Americans (e.g. Seneca Nation of Indians)
- large scale water intakes downstream

Process for PPA Development



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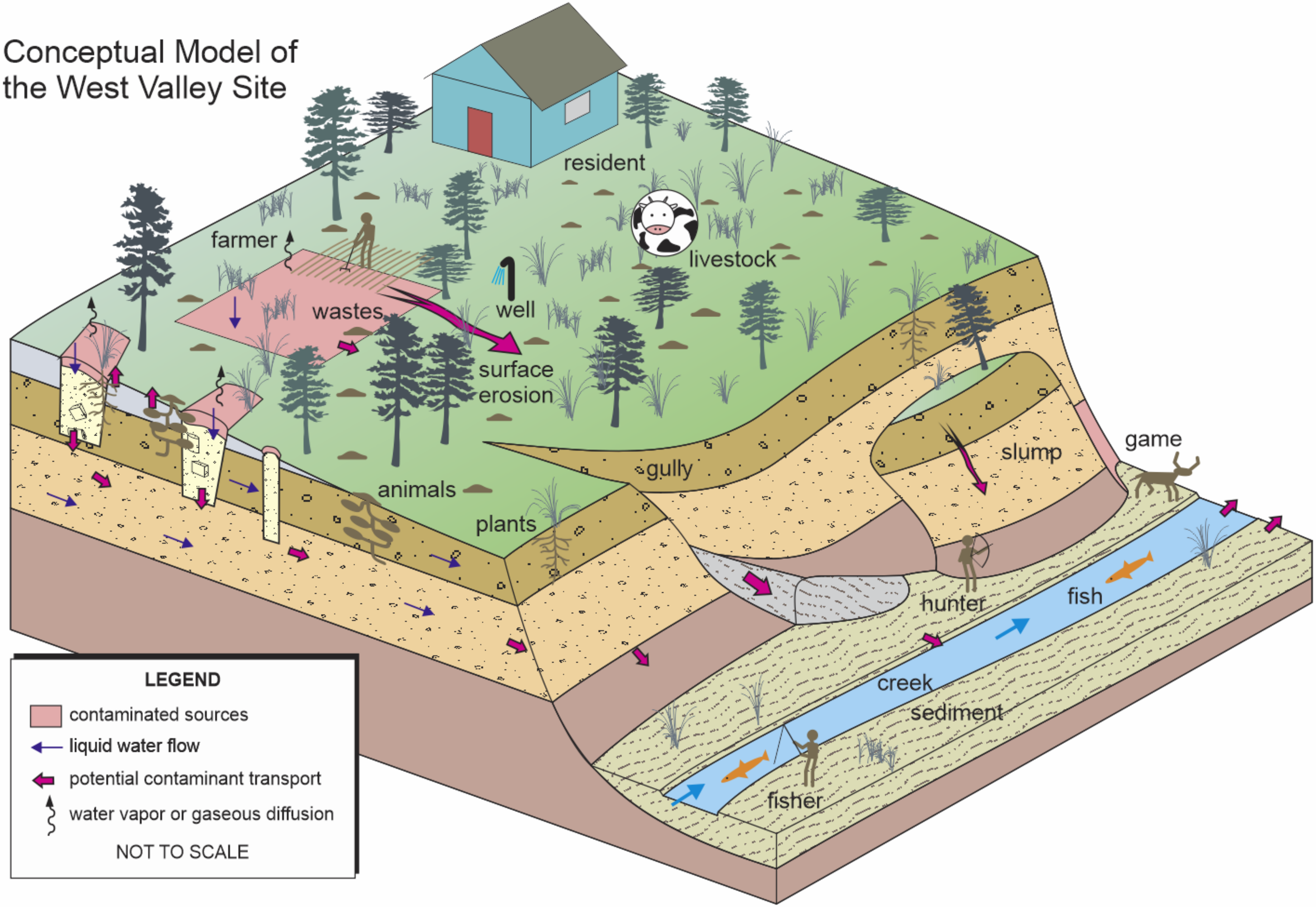
Conceptual Model of the West Valley Site



LEGEND

- contaminated sources
- liquid water flow
- potential contaminant transport
- water vapor or gaseous diffusion

NOT TO SCALE

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Contaminated Facilities

Contaminated facilities to be modeled includes:

- Phase 1 residual contamination (following cleanup)
  - Residual contamination is included as separate source areas in each Waste Management Area (WMA) since these still contribute to risks.
- Facilities remaining after completion of Phase 1 Decommissioning
  - Waste Tank Farm, NDA, SDA, non-source area of the North Plateau Plume, contaminated soil and sediment

NDA – (United States) Nuclear Regulatory Commission-licensed Disposal Area

SDA – (New York) State-licensed Disposal Area

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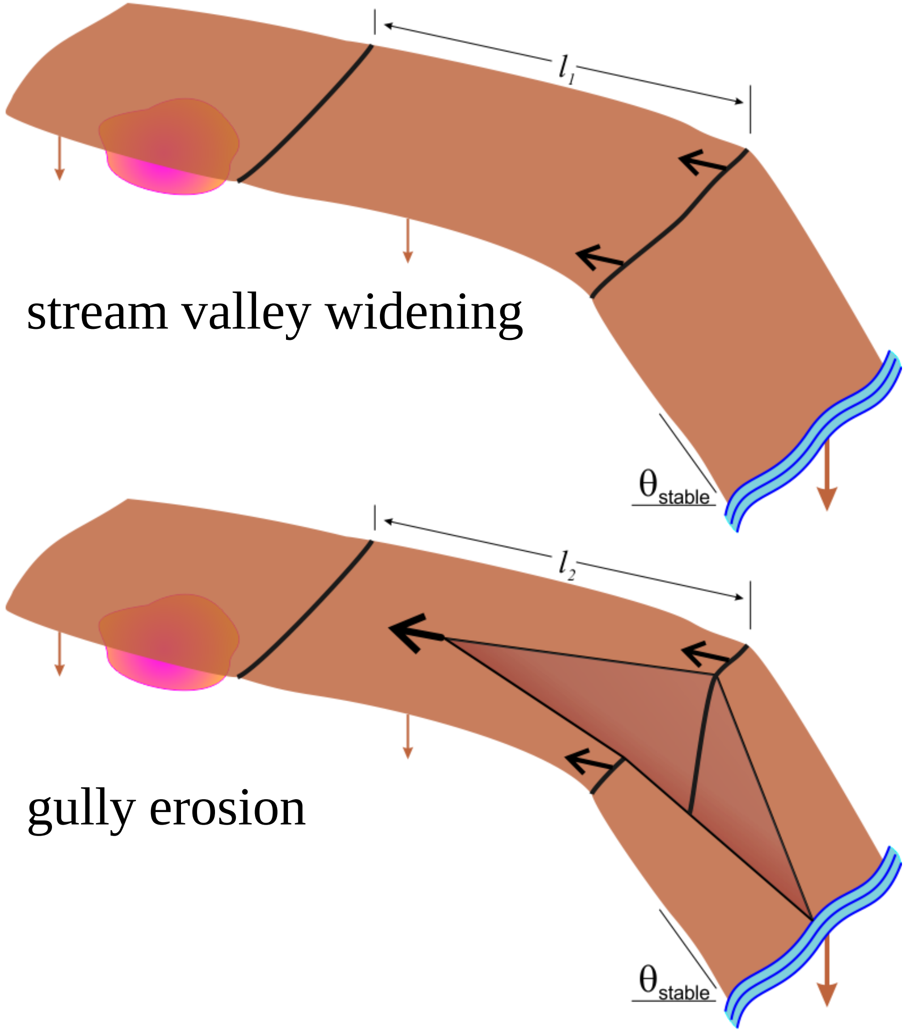
Potential Erosion Pathways



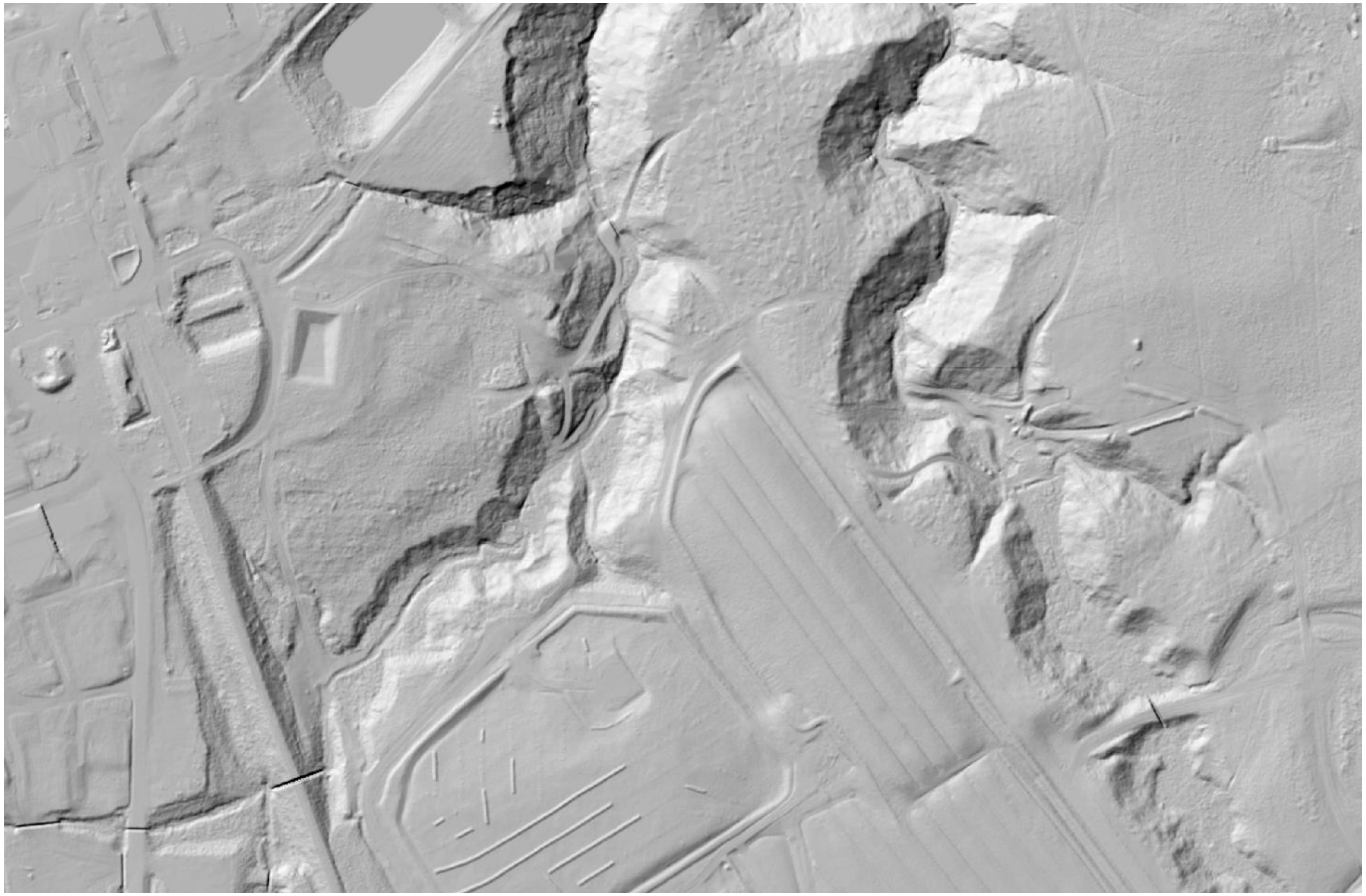
A source area may have multiple surface water flow paths described by:

- distance between waste and the top of the stream valley (path length)
- rates of erosion

Example: Northern SDA Trenches

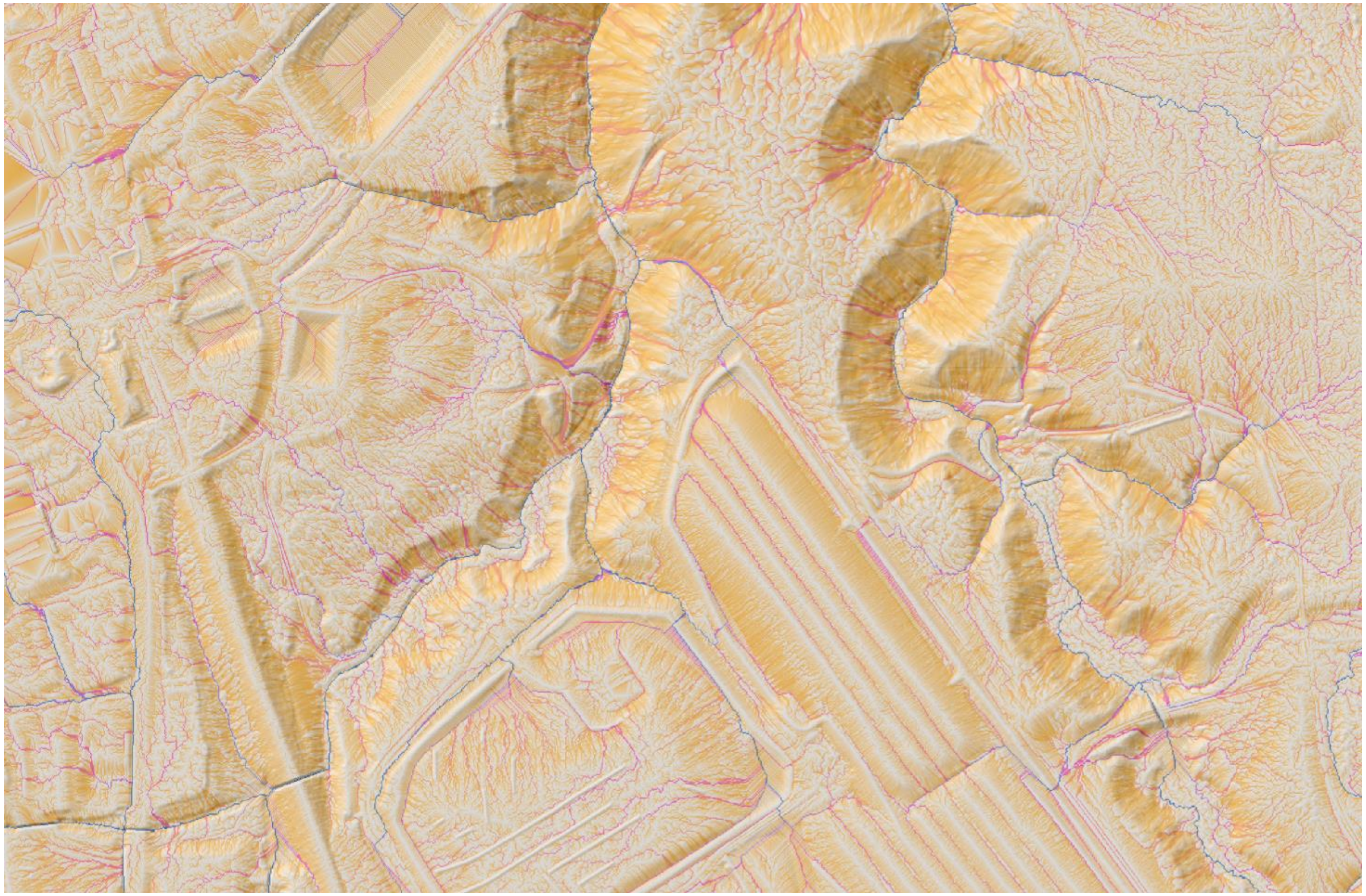
2015 orthoimage
courtesy NYSERDA

Example: Northern SDA Trenches



2015 LiDAR topography
courtesy NYSERDA

Example: Northern SDA Trenches



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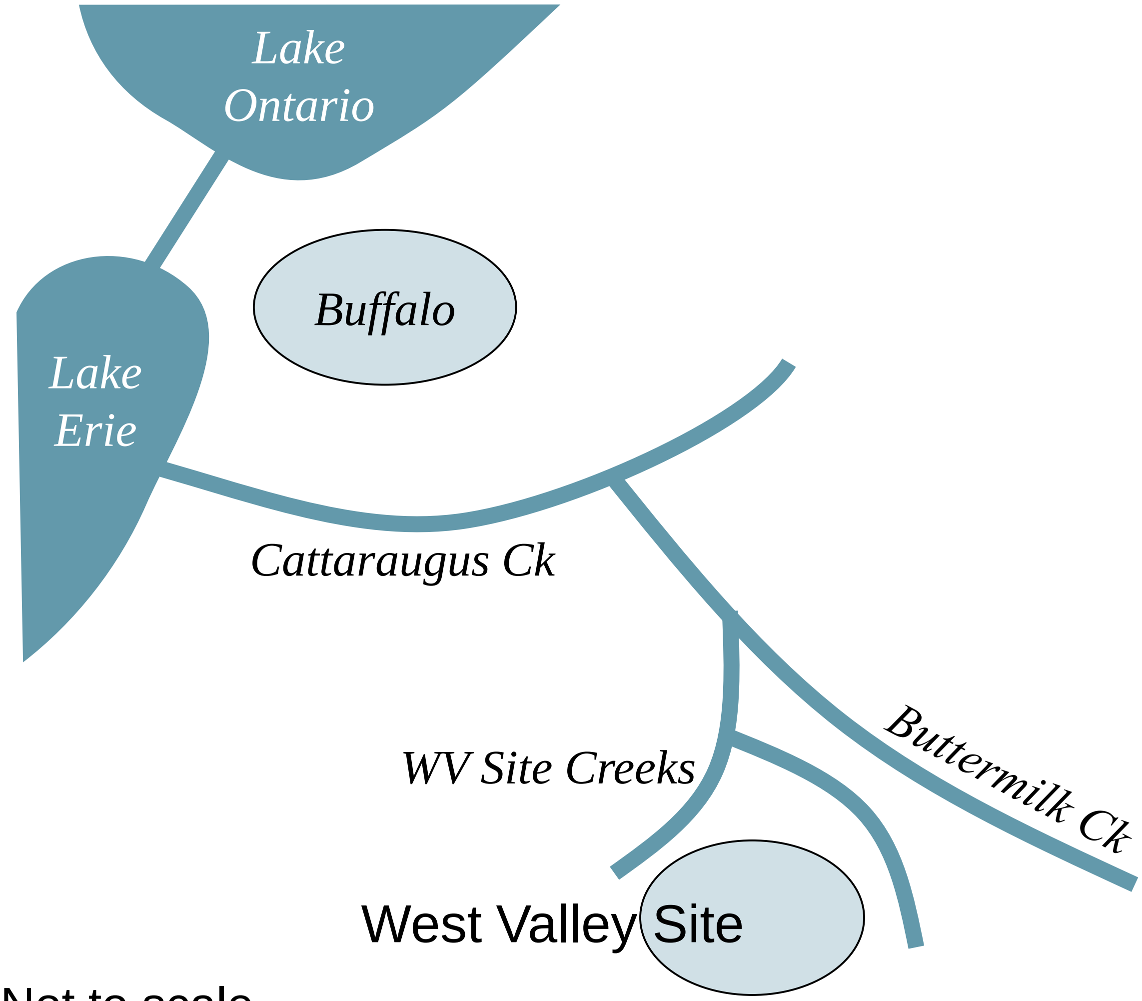
Surface Water and Sediment



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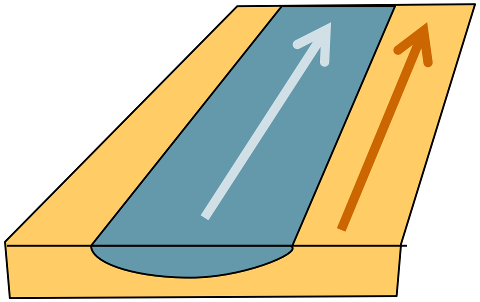

Both contaminated surface water and sediments move downstream.

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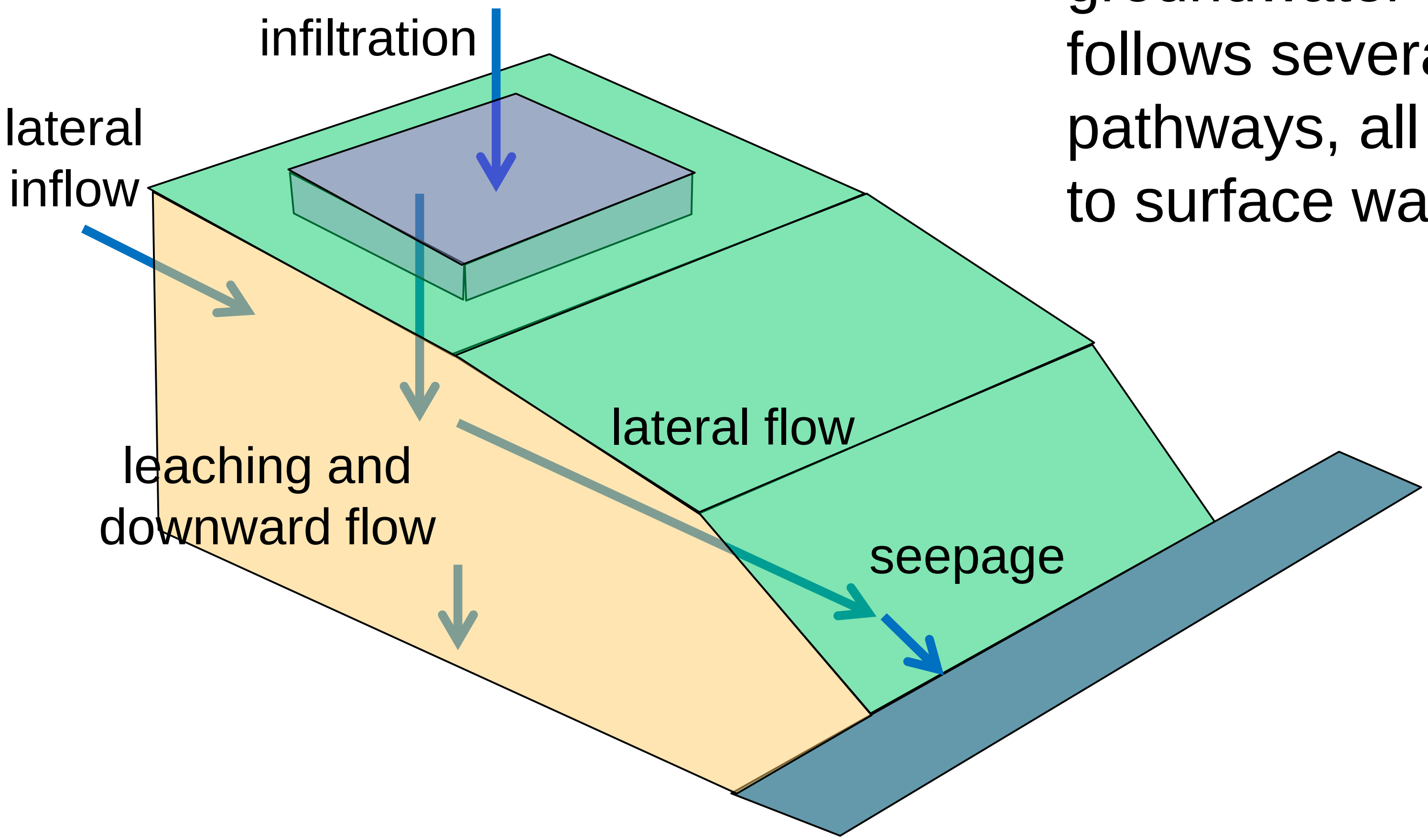
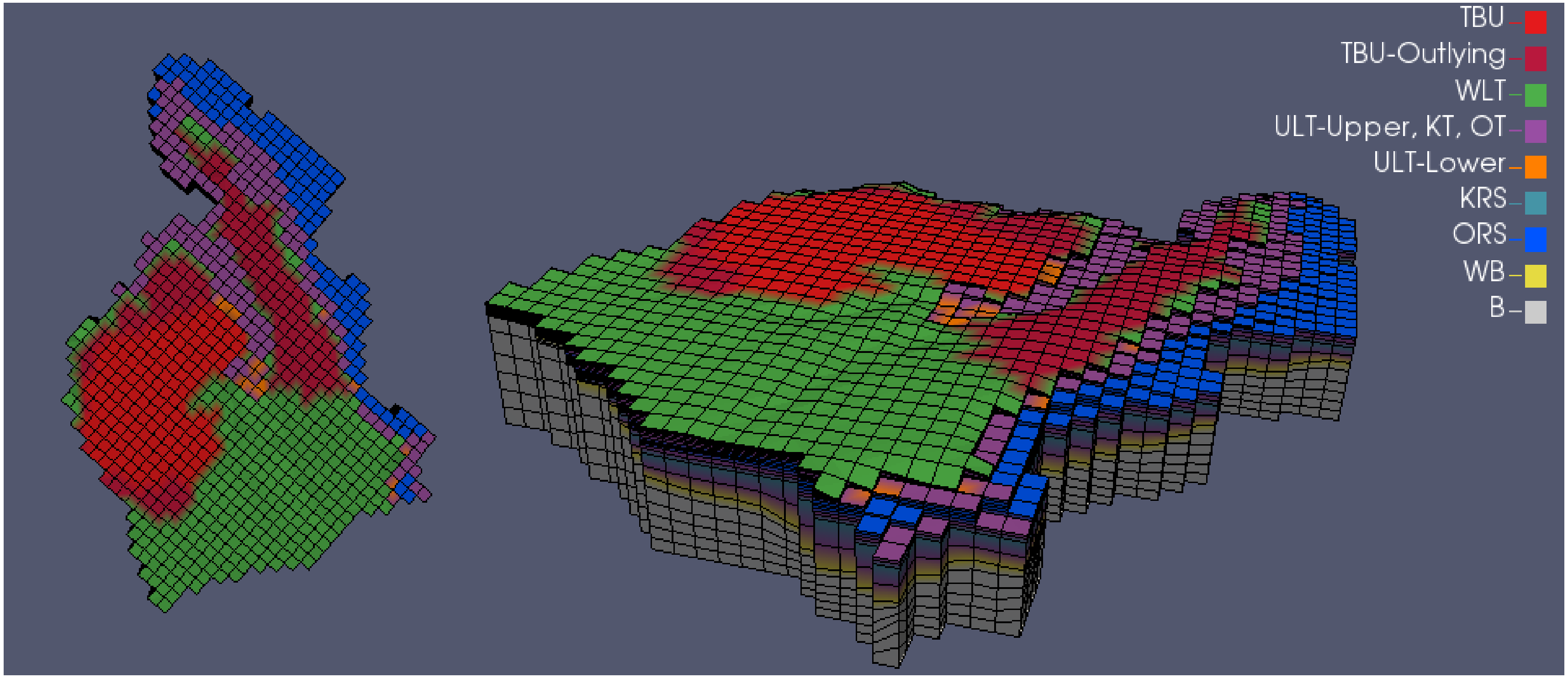
Groundwater Modeling



Infiltration and groundwater flow follows several pathways, all leading to surface water.

Groundwater Modeling

Groundwater modeling of the site will use a detailed grid, similar to this one, but with more detail in order to capture the effects of engineered control alternatives.



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Future Climate State

- Intergovernmental Panel on Climate Change (IPCC):
  Start of a glacial period is not expected in the next 50,000 years.

This conclusion is strongly supported by climate modeling studies using Earth System Models. These models indicate:

- the transition to glacial conditions is not possible while atmospheric CO_2 (carbon dioxide) concentrations are > 300 ppm (they are currently > 400 ppm)
- CO_2 remains in the atmosphere for a long time, and
- a return to pre-industrial CO_2 concentrations (280 ppm) may take hundreds of thousands of years.

*The most likely future climate at the WNYNSC is **a continuation of the current interglacial climate** under conditions of variable but progressive global warming.*

What Does a Warming Interglacial Climate Mean?

Current site meteorological conditions are ***not representative*** of future climate patterns, since warming is expected.

Global warming is likely to increase atmospheric moisture and increase storm frequency and intensity.

- Slower moving, more intense storms from jet-stream modifications
- Consequences of changes in the strength and stability of the circulation in the Atlantic Ocean

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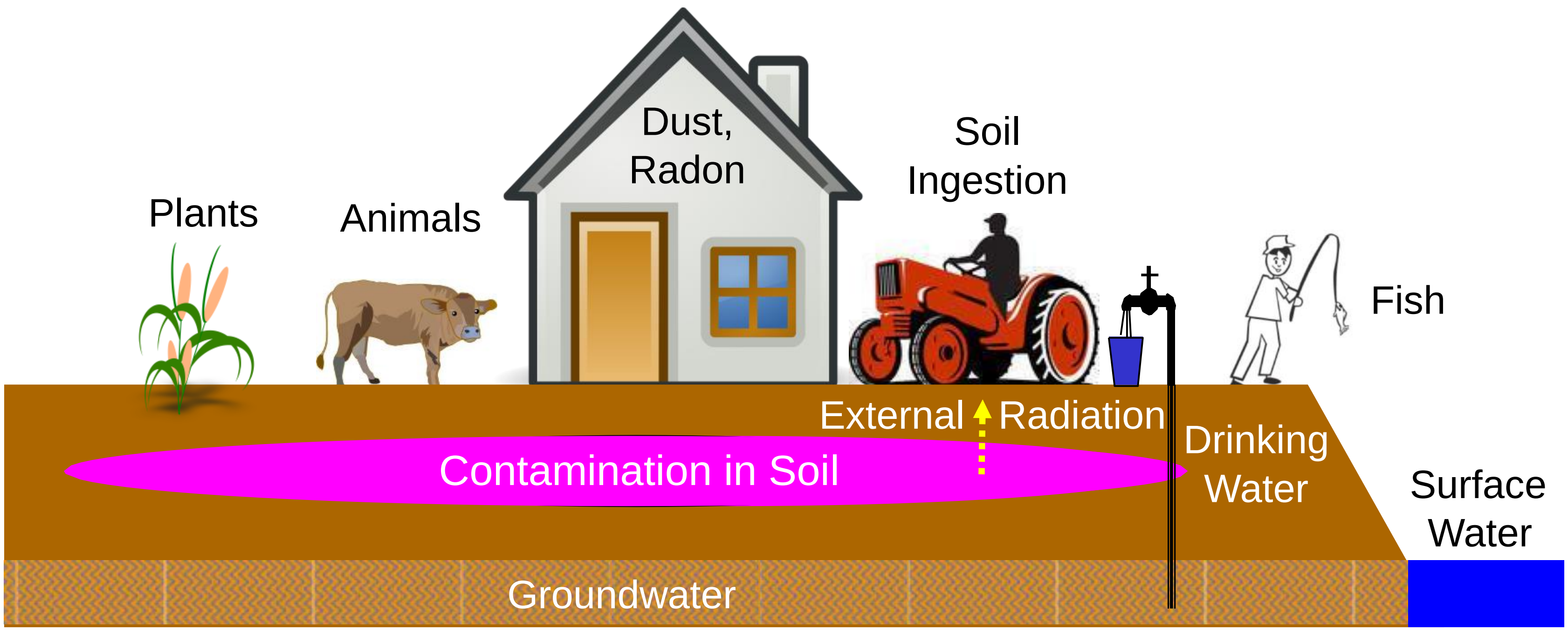
Human Exposure Scenarios

Example Scenario: Farmer exposed to radiation or chemical contamination



Exposure Scenarios

- Human and ecological (animals and plants) exposures will be evaluated.
- Examples for people include farming (including living on the site), recreational (e.g., fishing, hunting, hiking), etc.
- Ecological exposure scenarios include terrestrial and aquatic organisms.

Exposure Pathways

As an example, exposure pathways for farming include:

- Ingestion of
  - incidental soil, sediment, and dust
  - groundwater
  - fruits and vegetables (produce or wild plants)
  - animal products: milk, poultry, and eggs
- Inhalation of
  - radioactive and volatile chemical gases
  - suspended dust
- Skin absorption from soils, surface waters, and sediment
- External exposure from soils and sediment

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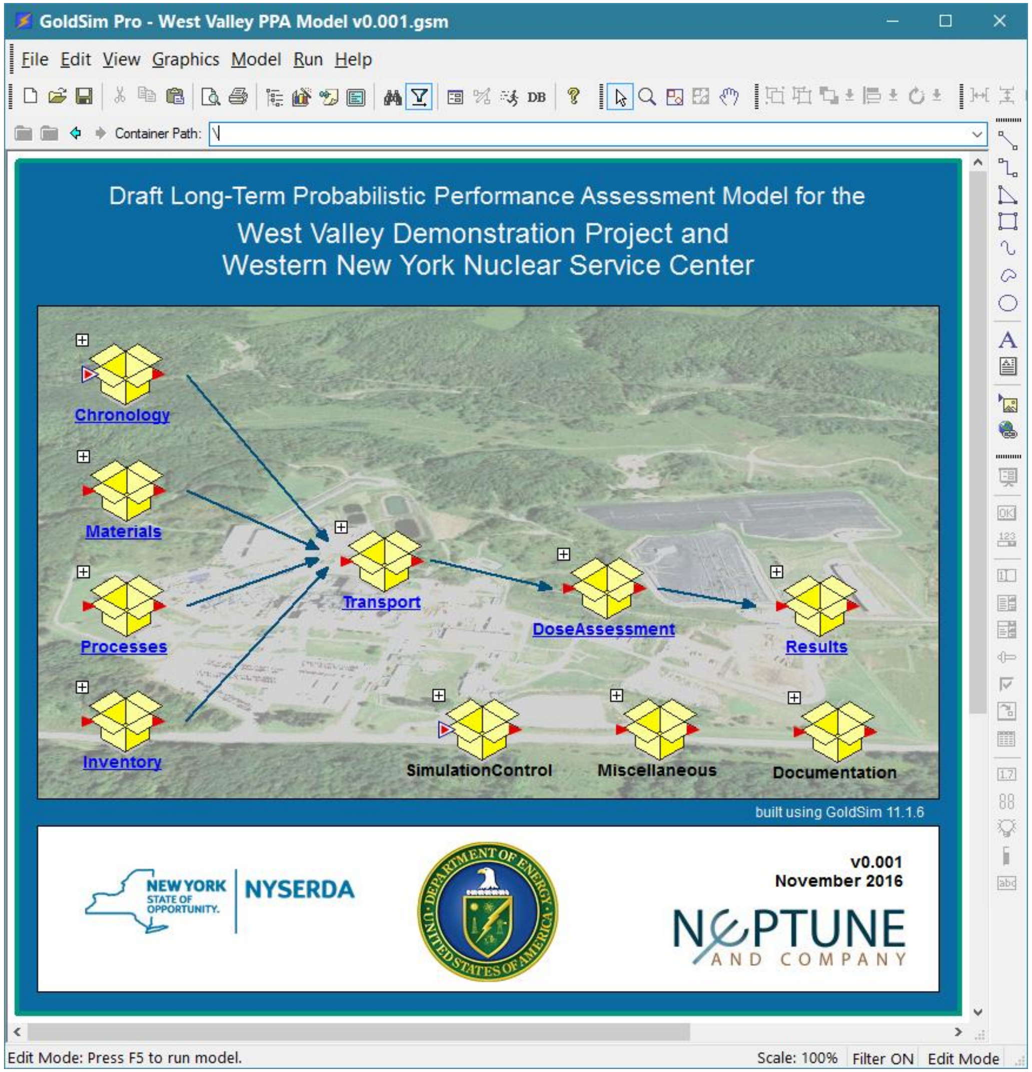
PPA Model Development

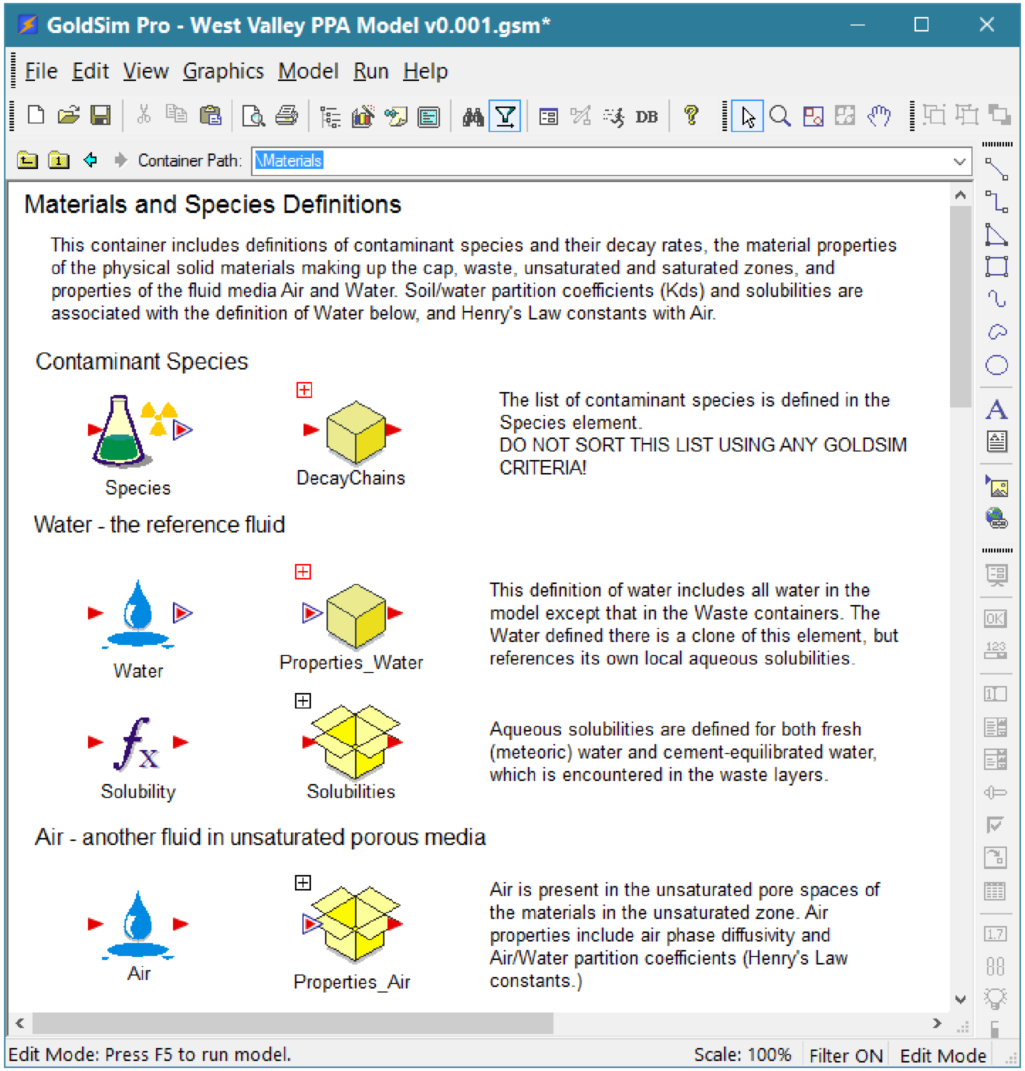


We are in the initial stage of model development.

The PPA is built using the GoldSim system modeling platform (under Windows). Player versions of GoldSim are available, so anyone can explore and run the model.

www.goldsim.com

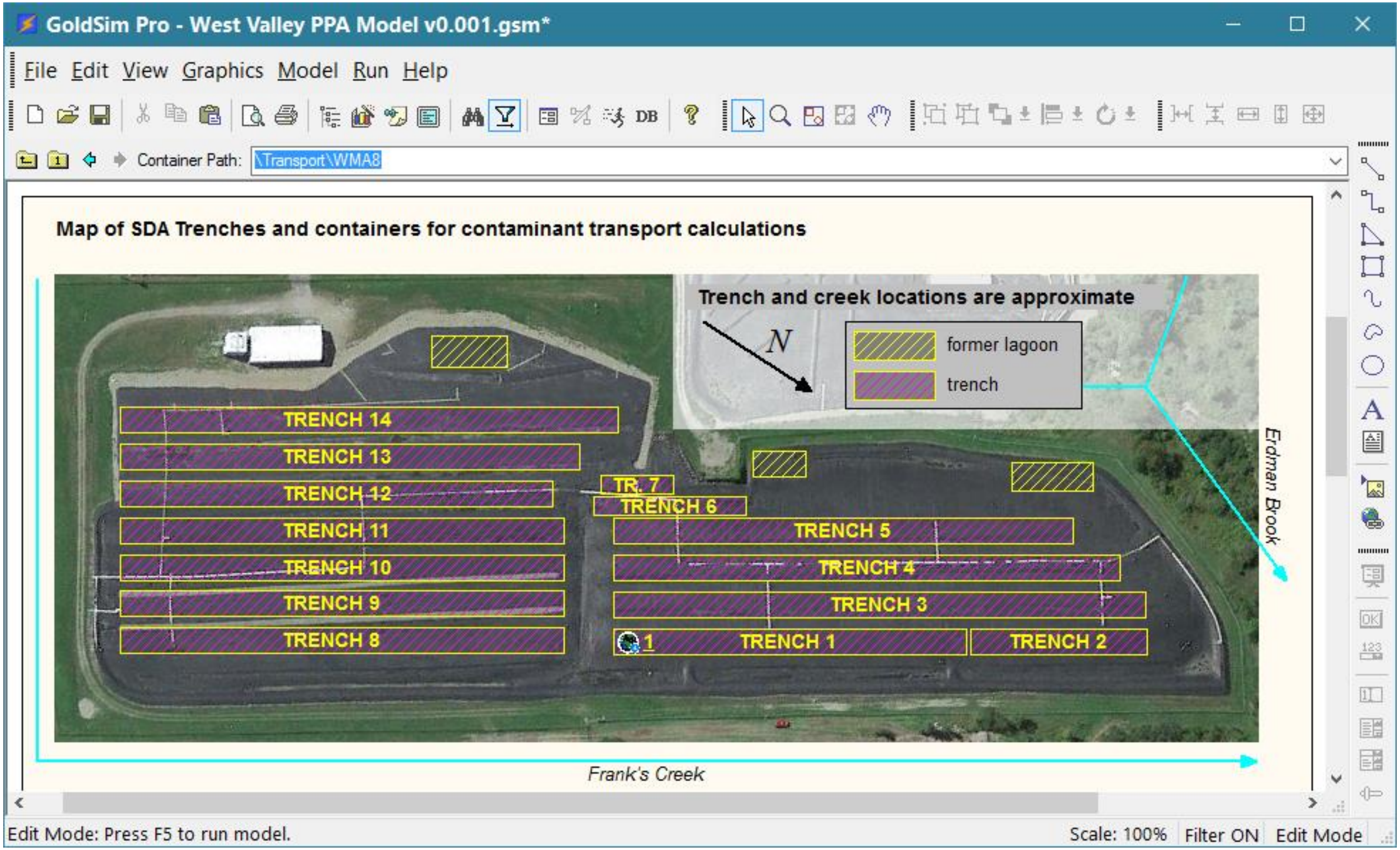
Basic Structure



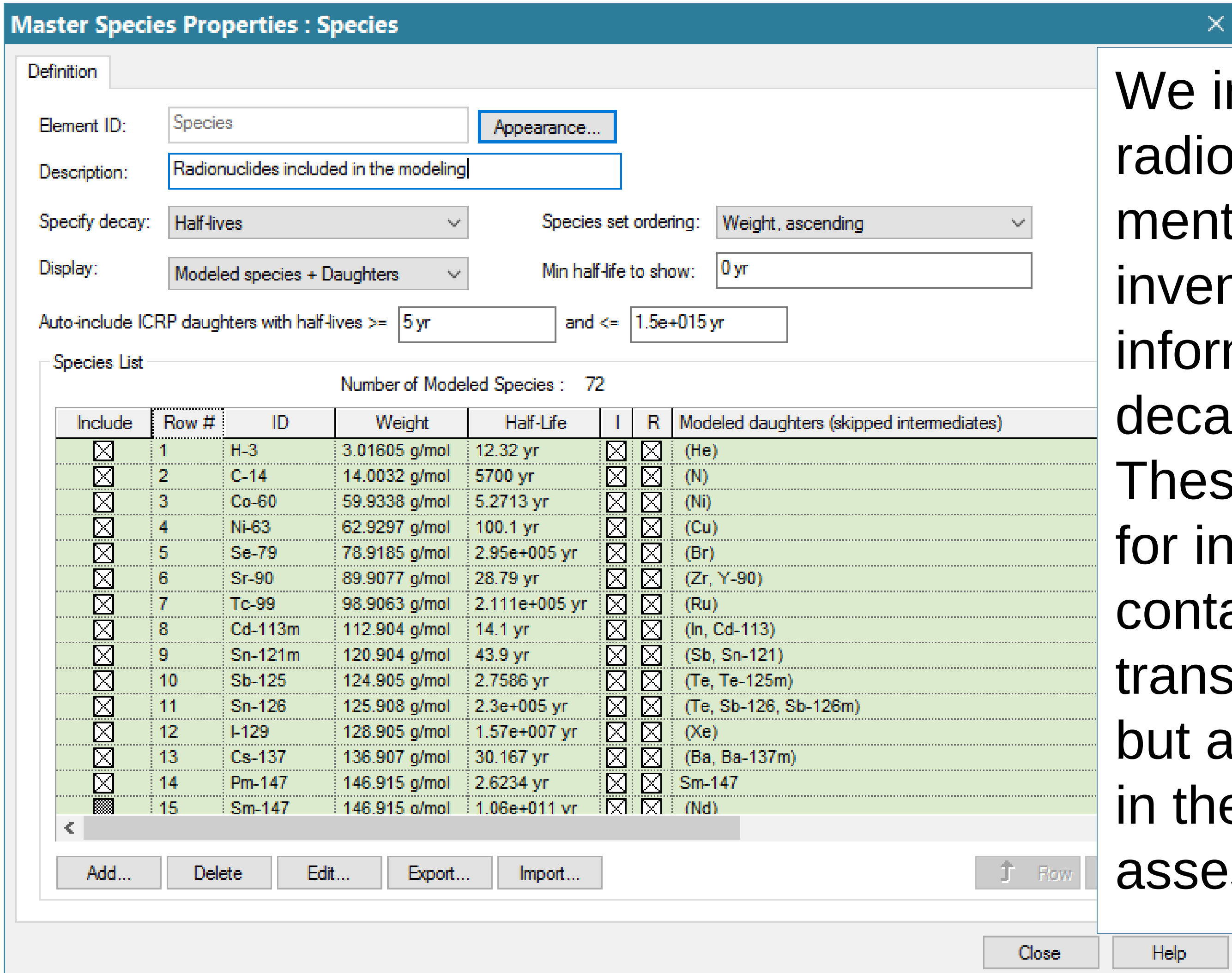
We have begun adding information for:

- modeled Species
- definition and properties of Water, Air, and several Solid media

Inventory Development by WMA



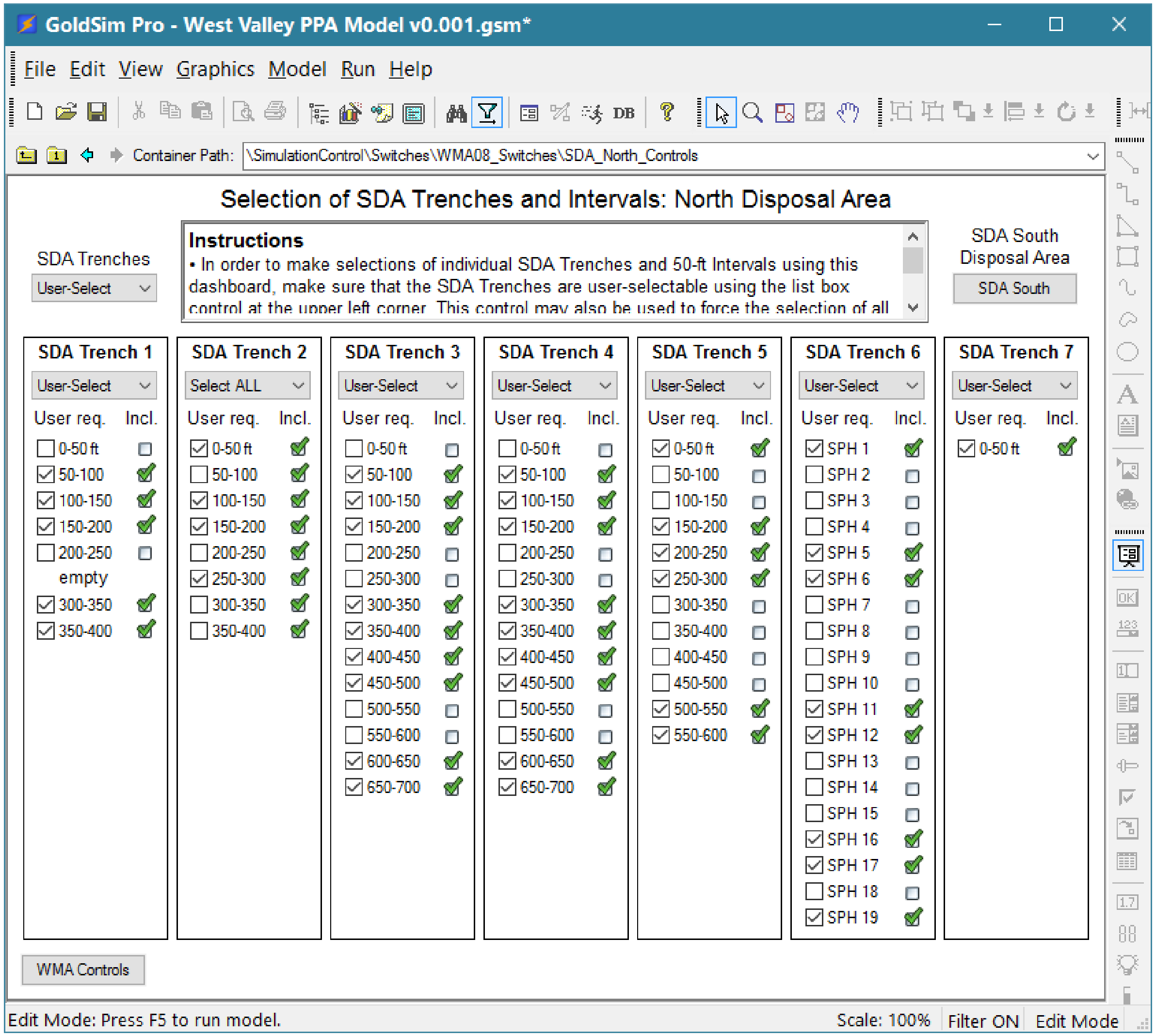
Radionuclide Species



Include	Row #	ID	Weight	Half-Life	I	R	Modeled daughters (skipped intermediates)
☒	1	H-3	3.01605 g/mol	12.32 yr	☒	☒	(He)
☒	2	C-14	14.0032 g/mol	5700 yr	☒	☒	(N)
☒	3	Co-60	59.9338 g/mol	5.2713 yr	☒	☒	(Ni)
☒	4	Ni-63	62.9297 g/mol	100.1 yr	☒	☒	(Cu)
☒	5	Se-79	78.9185 g/mol	2.95e+005 yr	☒	☒	(Br)
☒	6	Sr-90	89.9077 g/mol	28.79 yr	☒	☒	(Zr, Y-90)
☒	7	Tc-99	98.9063 g/mol	2.111e+005 yr	☒	☒	(Ru)
☒	8	Cd-113m	112.904 g/mol	14.1 yr	☒	☒	(In, Cd-113)
☒	9	Sn-121m	120.904 g/mol	43.9 yr	☒	☒	(Sb, Sn-121)
☒	10	Sb-125	124.905 g/mol	2.7586 yr	☒	☒	(Te, Te-125m)
☒	11	Sn-126	125.908 g/mol	2.3e+005 yr	☒	☒	(Te, Sb-126, Sb-126m)
☒	12	I-129	128.905 g/mol	1.57e+007 yr	☒	☒	(Xe)
☒	13	Cs-137	136.907 g/mol	30.167 yr	☒	☒	(Ba, Ba-137m)
☒	14	Pm-147	146.915 g/mol	2.6234 yr	☒	☒	Sm-147
	15	Sm-147	146.915 g/mol	1.06e+011 yr	☒	☒	(Nd)

We include every radionuclide mentioned in all inventory information, plus decay products. These are screened for inclusion in the contaminant transport models, but all are included in the dose assessment.

Fine-Scale Inventory Control



The model user can include or exclude specific WMAs.

Example:

SDA trenches, or even 15-m (50-ft) sections that are considered for excavation and removal.

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Questions?