

**U.S. DEPARTMENT OF ENERGY  
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT**

**NUCLEAR WASTE TECHNICAL REVIEW BOARD  
FULL BOARD MEETING**

**SUBJECT: TOTAL SYSTEM PERFORMANCE  
ASSESSMENT (TSPA) II:  
ENHANCEMENTS TO TSPA-1991**

**PRESENTER: DR. HOLLY A. DOCKERY**

**PRESENTER'S TITLE  
AND ORGANIZATION: MANAGER,  
YUCCA MOUNTAIN PERFORMANCE ASSESSMENTS, DEPT. 6312  
SANDIA NATIONAL LABORATORIES  
ALBUQUERQUE, NEW MEXICO**

**PRESENTER'S  
TELEPHONE NUMBER: (505) 844-1756**

**DENVER, COLORADO  
JULY 13-14, 1993**

# Major TSPA II Objectives

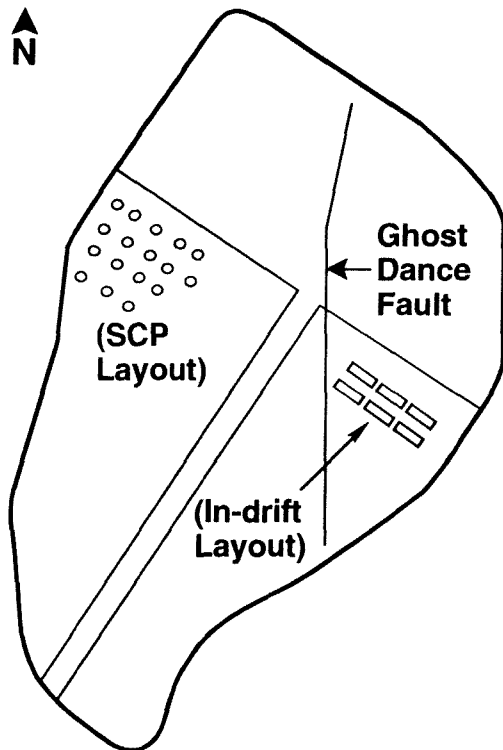
- **Evaluate effects of alternative**
  - **Thermal regimes**
  - **Emplacement modes**
  - **Waste-package designs**
- **Incorporate new site information**
- **Evaluate effects of alternative performance measures**
- **Conduct sensitivity/uncertainty analyses**

# TSPA II Source Term

- **Will couple hydrologic, thermal, and chemical effects**
- **Will include alternative emplacement and thermal-loading strategies**
- **Will use inventory based on current waste-stream estimates**
- **Inventory chosen for both release and dose effects**

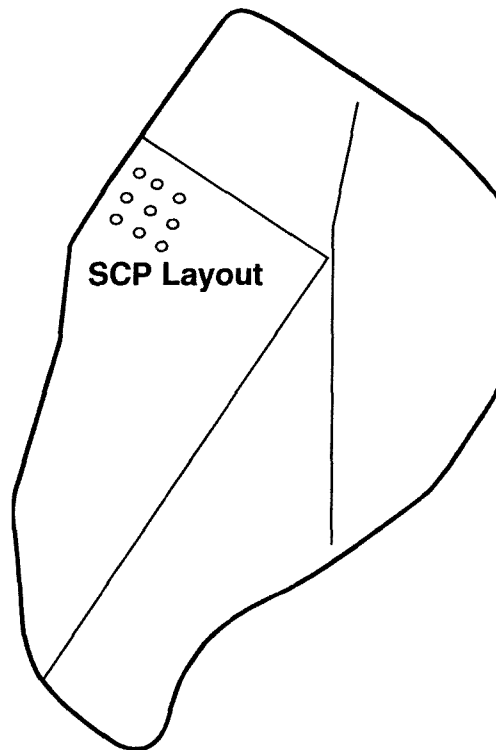
# Repository Areas Modeled for Alternative Emplacements and Thermal Loads

57 kW/Ac Thermal Loading



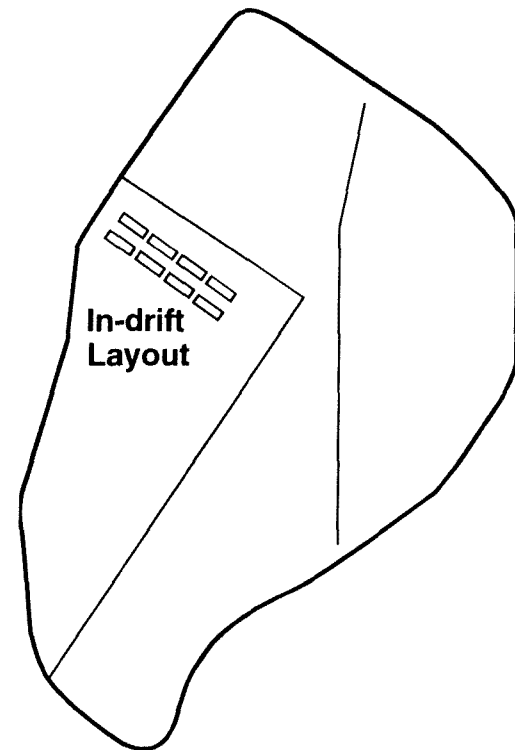
Area = ~820 acres

114 kW/Ac Thermal Loading



Area = ~480 acres

114 kW/Ac Thermal Loading



Area = ~410 acres

# Inventory Based on Current Waste-Stream Estimates

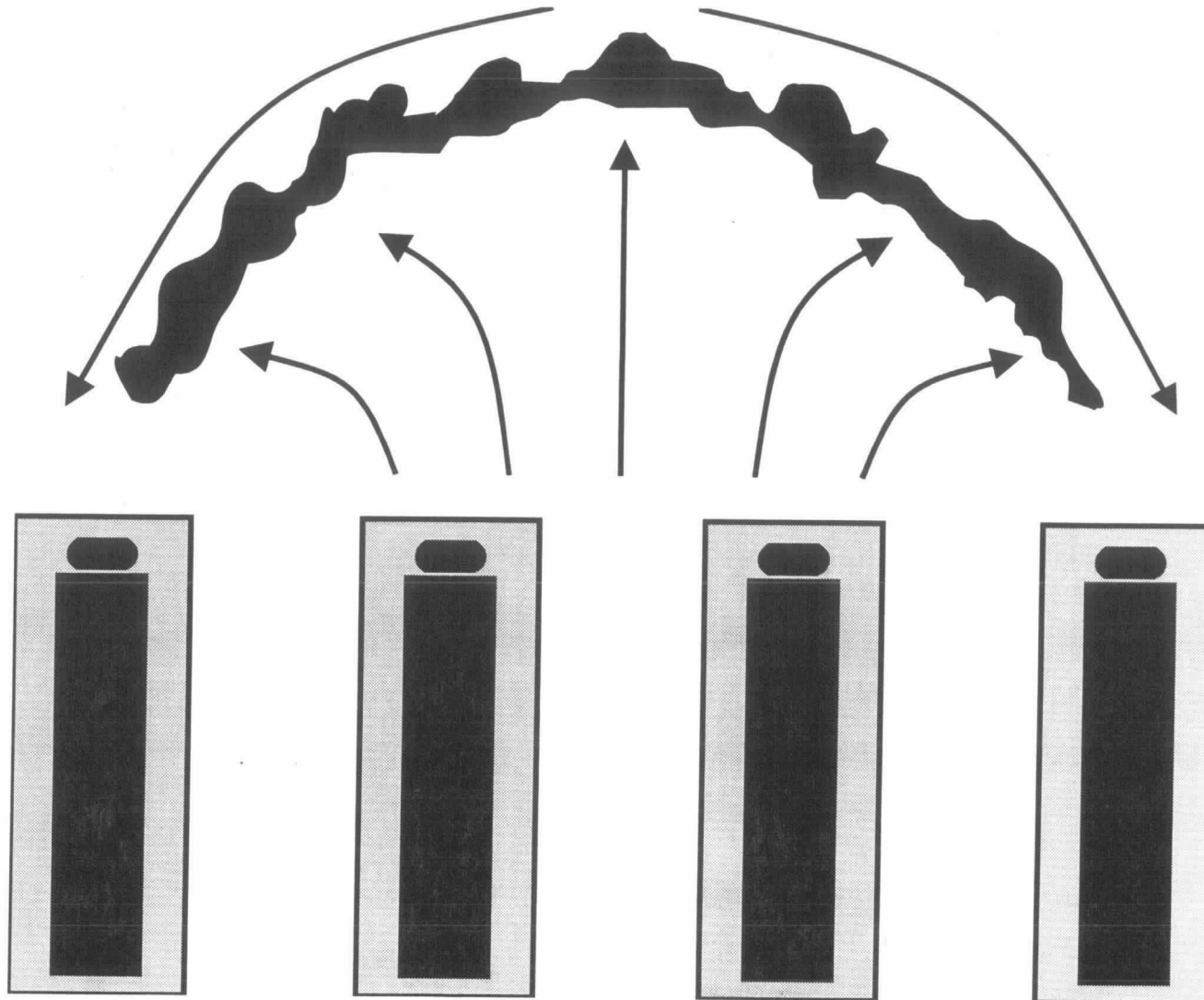
- **Spent fuel**
  - 25-year decay
  - 40 GWd/MTU (PWR), ~58% of total
  - 30 GWd/MTU (BWR), ~32% of total
- **Glassified high-level waste ~10% of total**

# **Source Term Module**

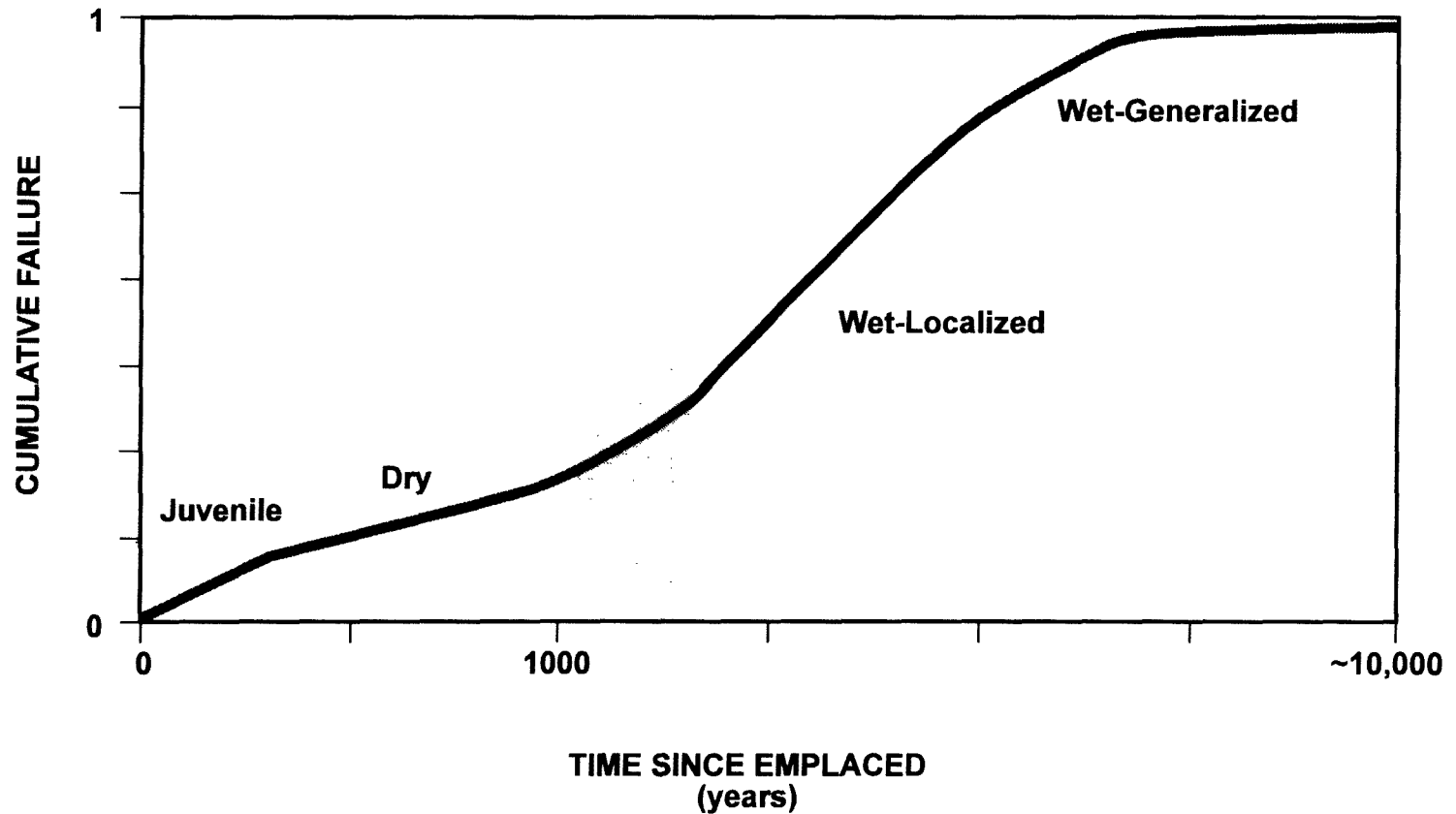
**(Developed in Cooperation with LLNL)**

- **Coupled thermal and hydrological processes**
  - **Boiling front, dryout, reflux**
- **Multiple barriers**
  - **Waste-package degradation processes**
    - **Pitting corrosion**
    - **General corrosion**
  - **Waste-form degradation**
    - **High-temperature oxidation**
    - **Aqueous alteration**
    - **Congruent leaching**

# Dryout and Reflux from Thermal Effects

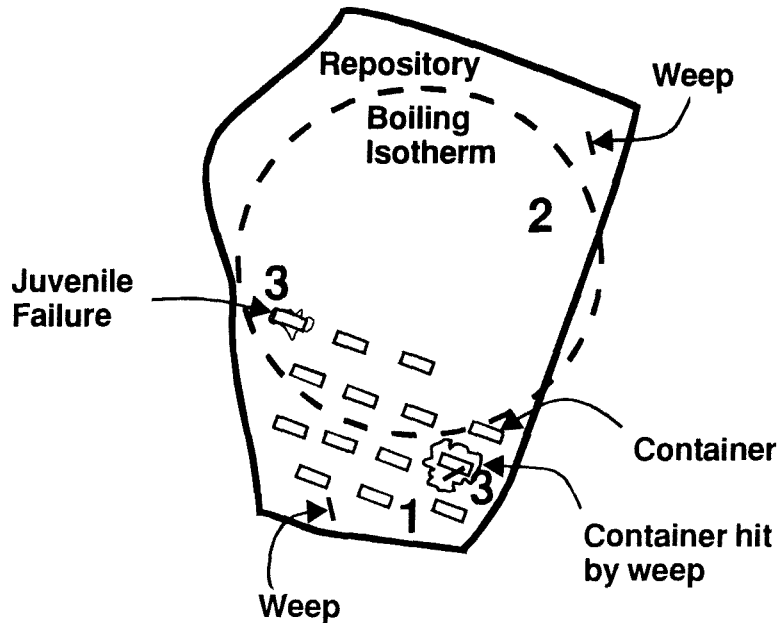
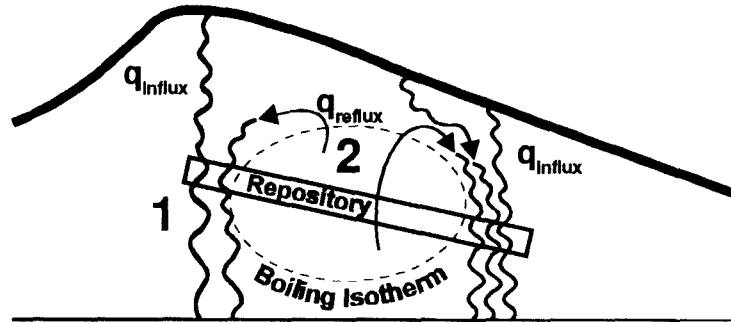


# Failure Distribution for all Waste Packages (as simulated by YMIM)



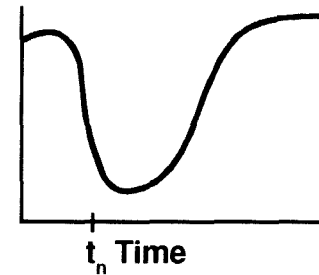


# Thermal Effects Incorporated in the Weeps Model

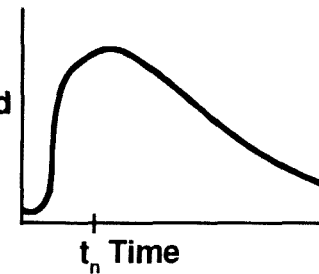


## Thermal Input Data

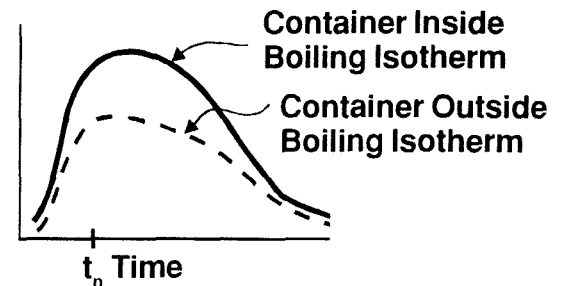
**1**  
Containers  
outside of  
Boiling  
Isotherm



**2**  
Volume  
encompassed  
by Boiling  
Isotherm



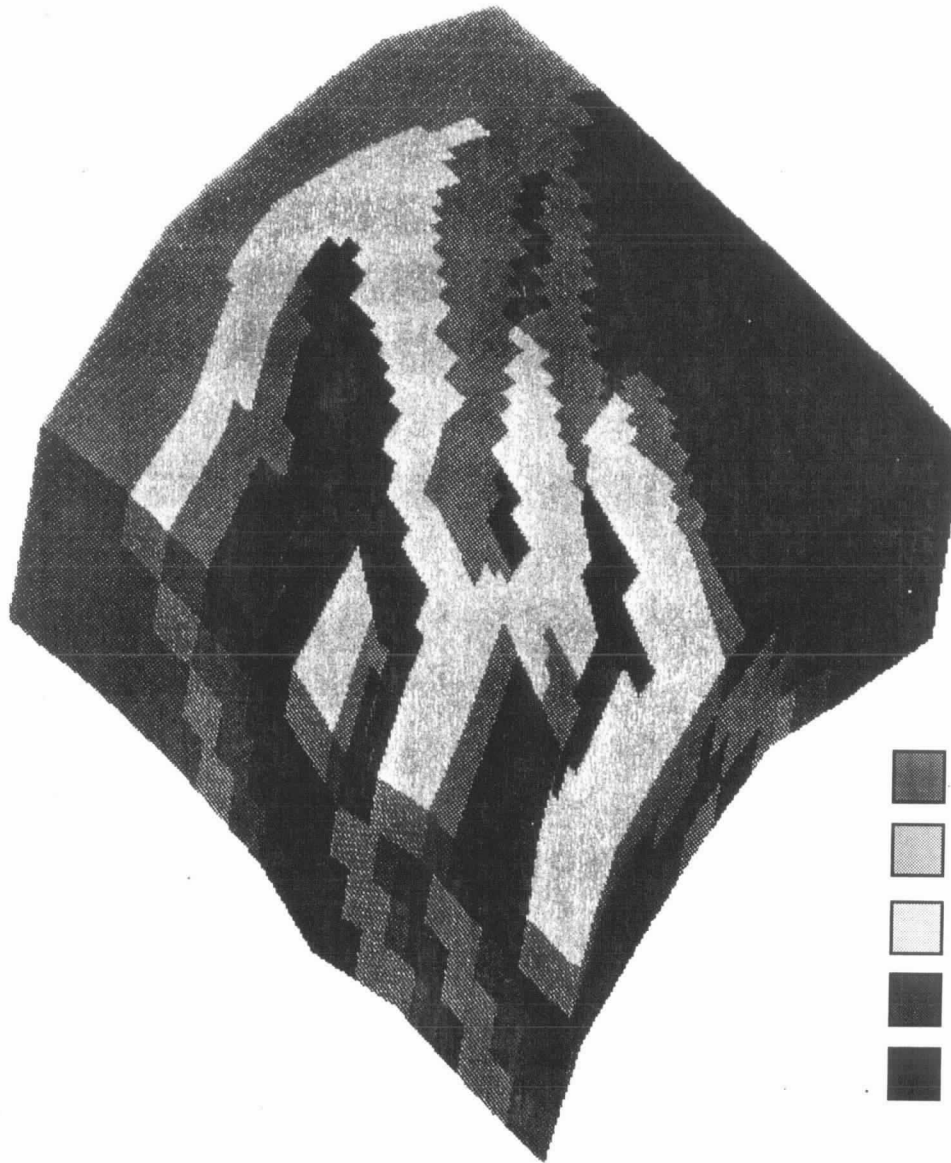
**3**  
Temperature  
of Container  
Wall



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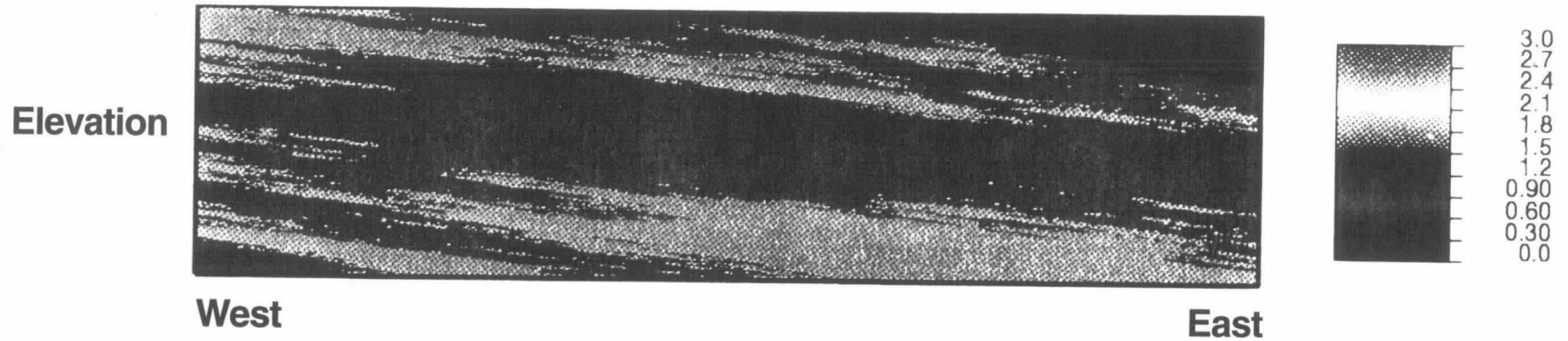
# 3-D Saturated-Zone Model



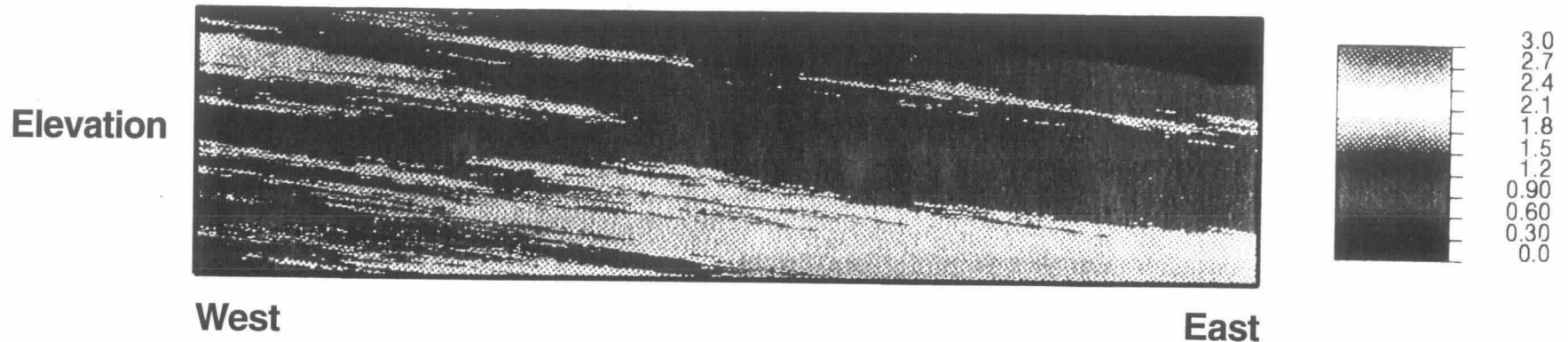
- Topopah Springs
- Calico Hills
- Prow Pass
- Bullfrog
- Tram

# East-West Transect Used to Generate Column 2

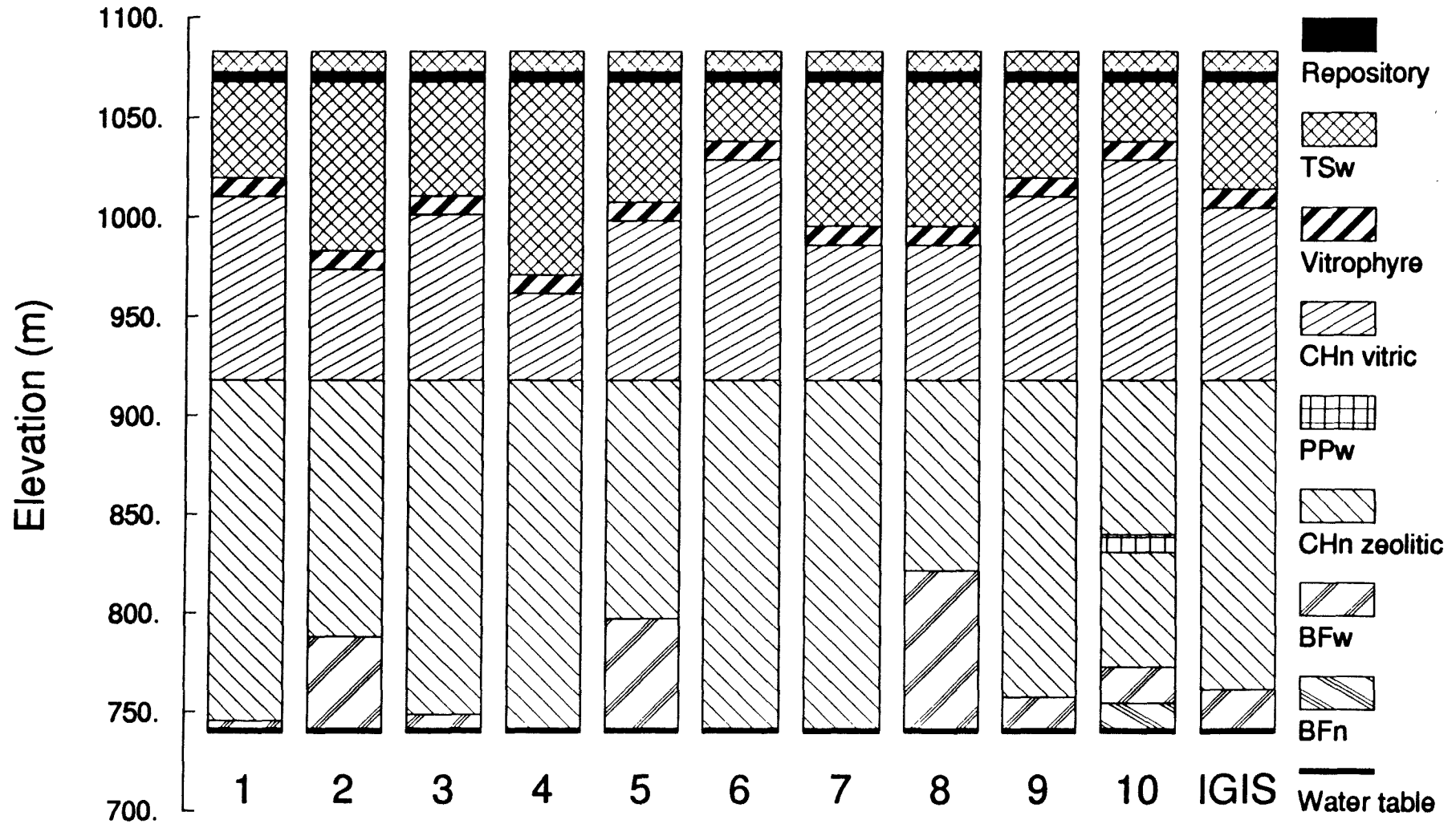
## Second Simulation



## Tenth Simulation



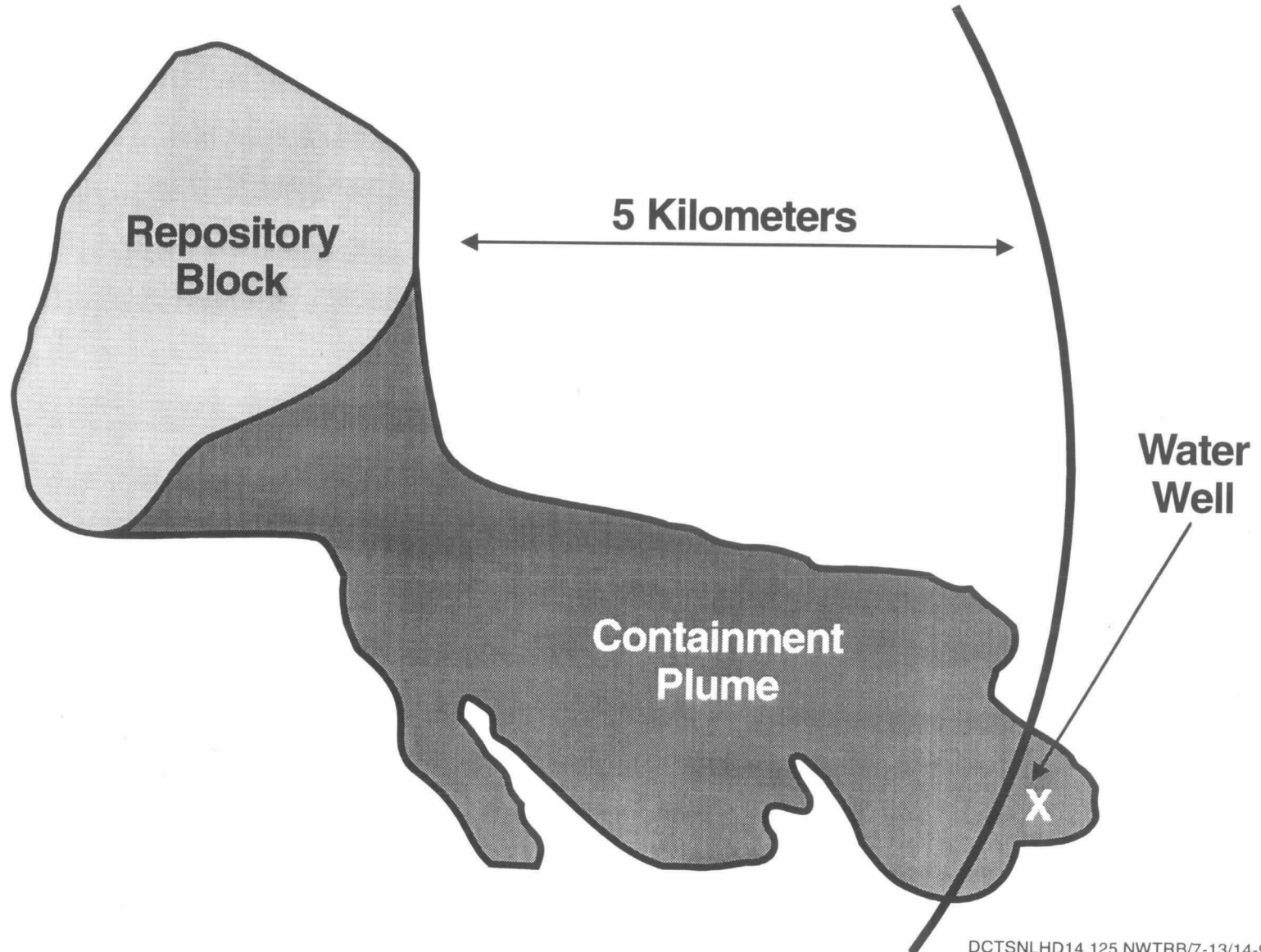
# TSPA Stratigraphic Realizations for Column 2



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# Dose Calculation Module



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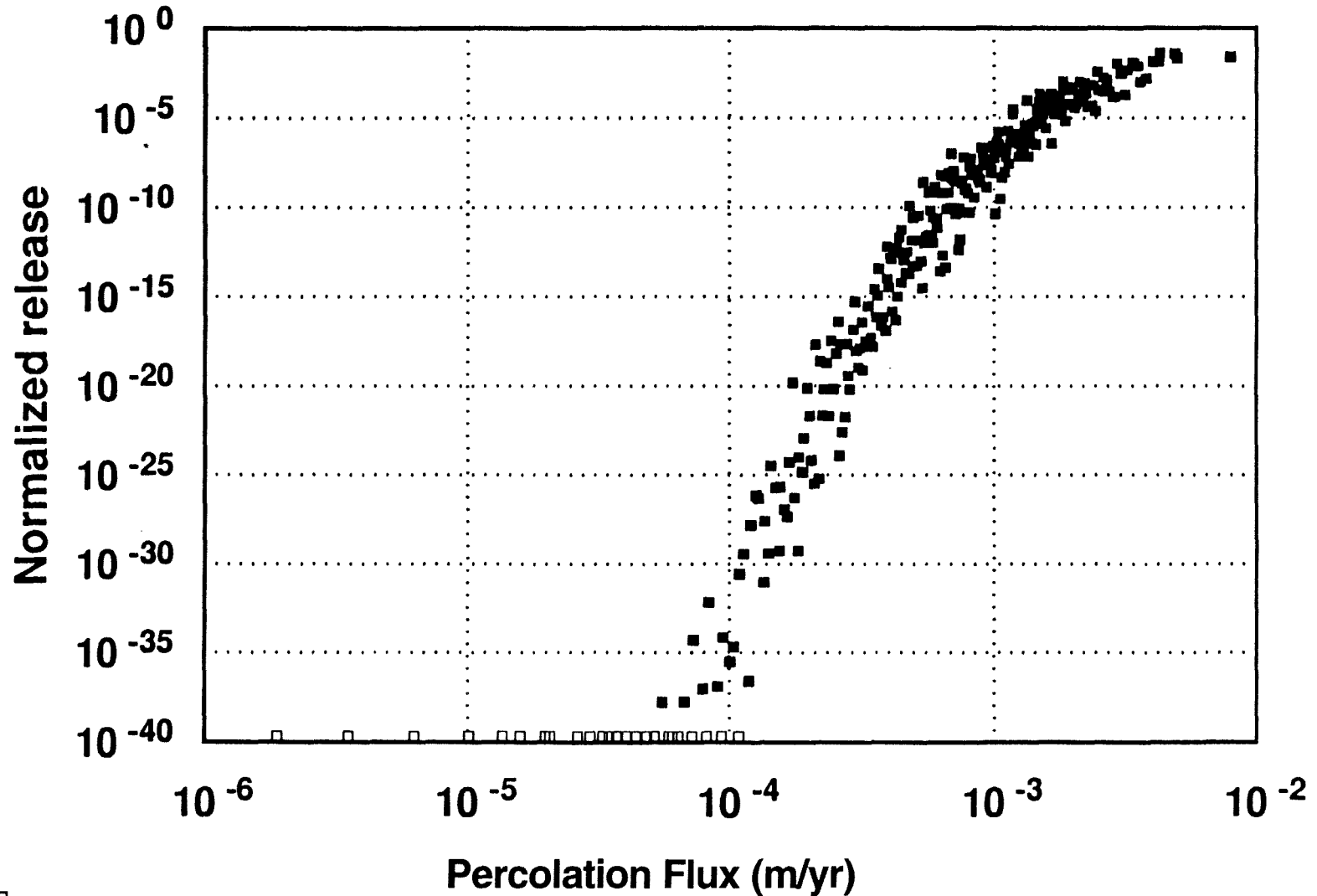
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# Sensitivity Analyses

- **Sensitivity studies performed on TSPA-91 aqueous release models**
- **Sensitivities highly dependent on conceptual model used**
  - **Composite porosity most sensitive to**
    - Percolation flux
    - Gaseous transport time
    - Container lifetime
    - Fuel matrix alteration rate
  - **Weeps Model most sensitive to**
    - Fracture aperture
    - Fracture connectivity
    - Infiltration (flux and number of episodes)

# Sensitivity of Aqueous Releases to Percolation Flux (Composite-Porosity Model)



□ = No Releases

# Summary of SNL TSPA-II Improvements on First Iteration

- **Coupled thermal/hydrologic processes**
- **More sophisticated source term**
- **Saturated zone model constructed using more site information**
- **Dose module**
- **Sensitivity studies**