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

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: **TSPA FOR YUCCA MOUNTAIN: SANDIA NATIONAL LABORATORIES SECOND ITERATION (TSPA-93)**

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

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

PRESENTER'S TELEPHONE NUMBER: (505) 848-0730

ARLINGTON, VIRGINIA
JANUARY 12, 1994

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Approach

- Determine important processes and parameters from TSPA-91
- Incorporate design features and issues
  - Thermal loading studies
  - Multiple waste-package concepts
- Develop framework for assessing dose effects

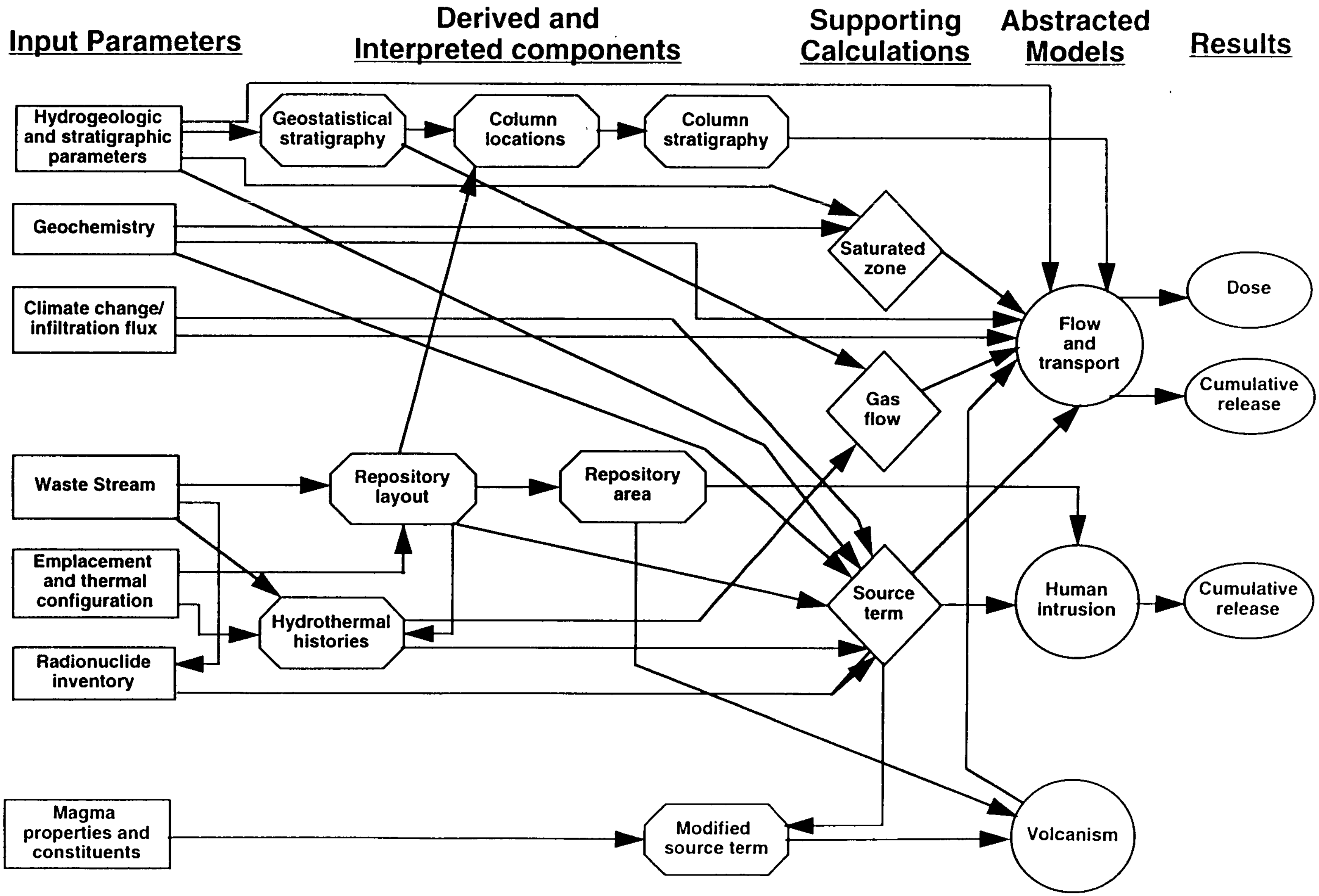
Guiding Elements *for prioritizing TSPA efforts*

- Site characterization prioritization
- Design requirements
- Regulation assessment

Important Processes and Parameters Identified from TSPA-91

- Aqueous flow
  - Composite porosity: percolation flux, source term
  - Weeps: fracture aperture, episodicity
- Gaseous flow: bulk permeability, retardation, source term
- Direct releases: probability of occurrence, source term

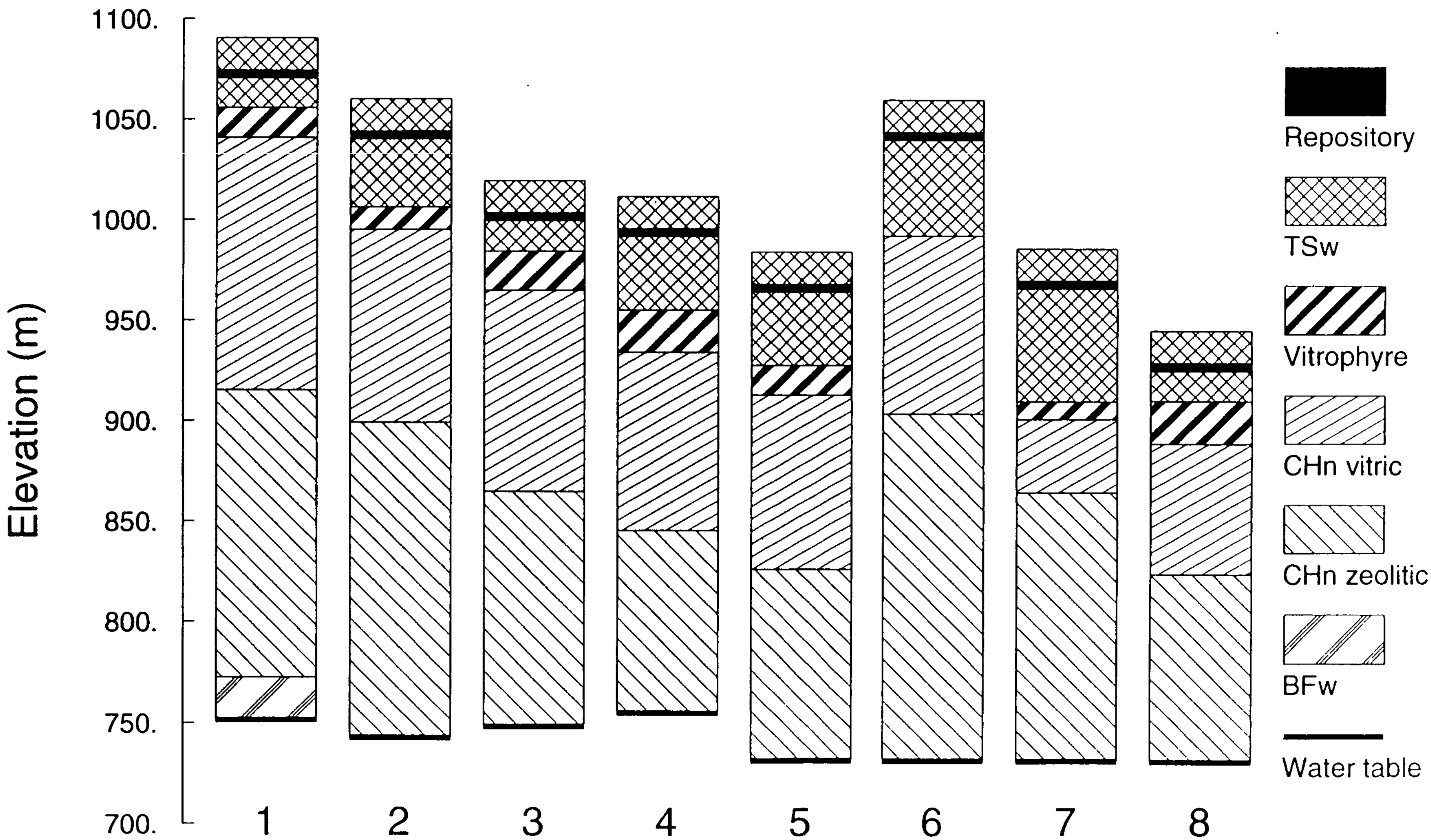
Elements in Sandia National Laboratories TSPA-93



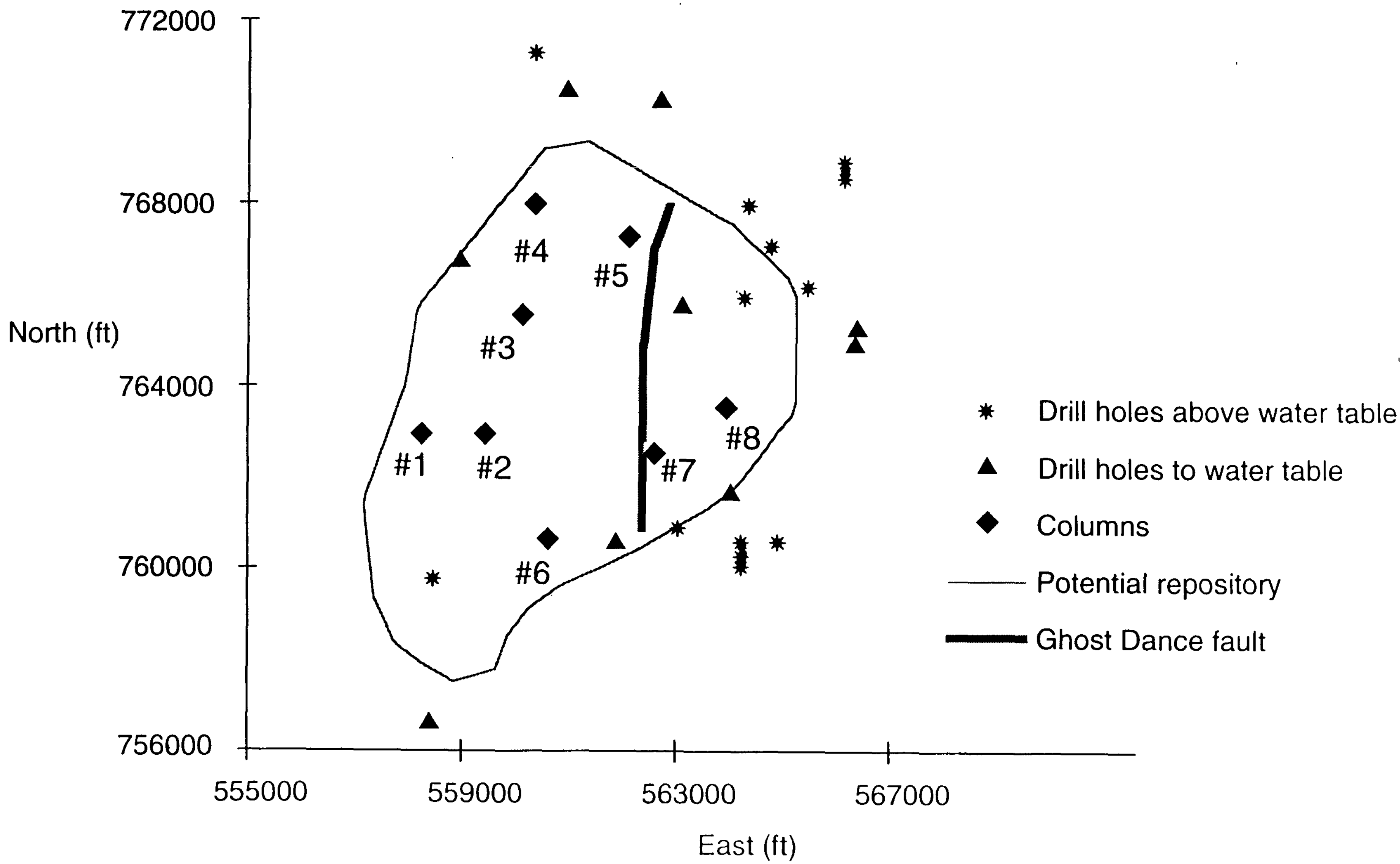
Information Sources for Sandia National Laboratories TSPA-93

Component	Contributors	
Stratigraphy and Hydrogeologic Parameters	LBL	(Wittwer, Bodvarsson)
	USGS	(Flint, Flint, Spengler, Weeks, Luckey, Geldon, Appel, Hoxie)
Climate Change	USGS	(Flint, Flint, Hobson, Forrester, Peterman)
	WIPP	(Swift)
Geochemistry	LANL	(Triay, Morris, Meijer, Ebinger)
Thermal Effects	LLNL	(Johnson, Buscheck)
	B&W Fuel	(King)
Saturated Zone	USGS	(Dick Luckey) - [illegible] & review model
Gas Flow	DSI	(Ross, Lu)
Source Term and EBS Processes	LLNL	(Lamont, Gansemer, Halsey, Lewis, Stout, McCright)
	ORNL	(Croff)
	Iowa State University	(Bullen)
	B&WFuel	(Doering, Baheny)

Three-Dimensional Stratigraphy



Drillhole and Stratigraphic Column Locations



Hydrogeologic Parameters

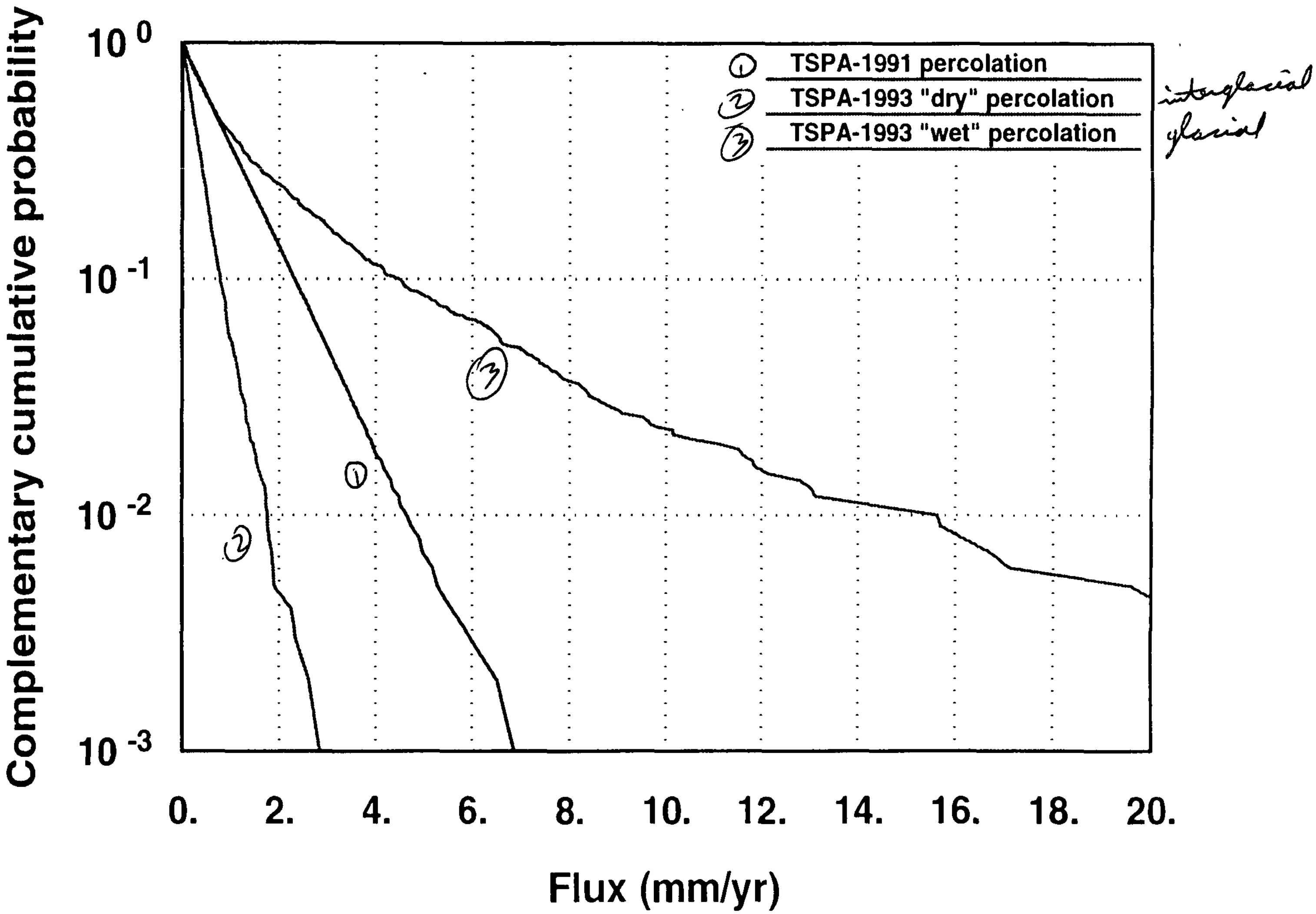
Matrix Parameters

Parameter	TSPA-91	TSPA-93
Porosity	X	1277
Bulk Density	X	2801
Saturated Hydraulic Conductivity	X	272
Air Entry	X	211
Saturation/ Desaturation	X	211
Residual Degree of Saturation	X	211

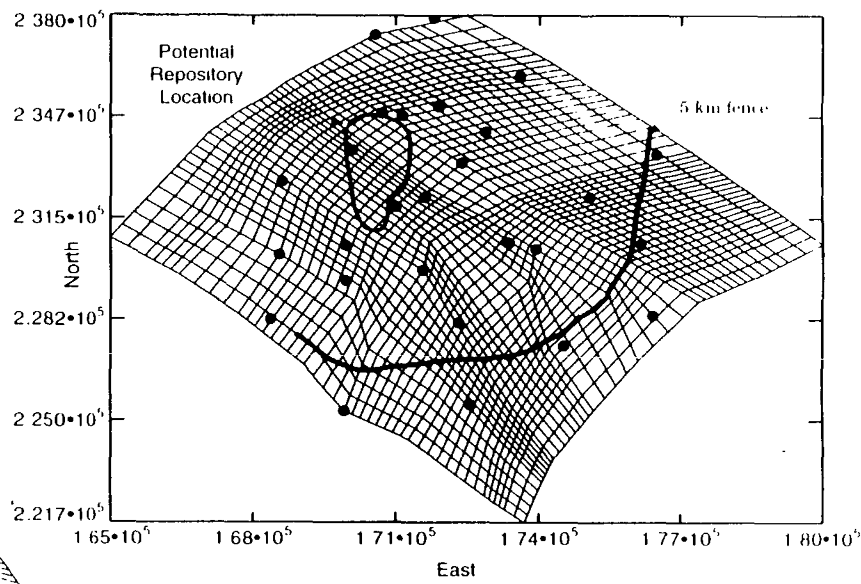
Fracture Parameters

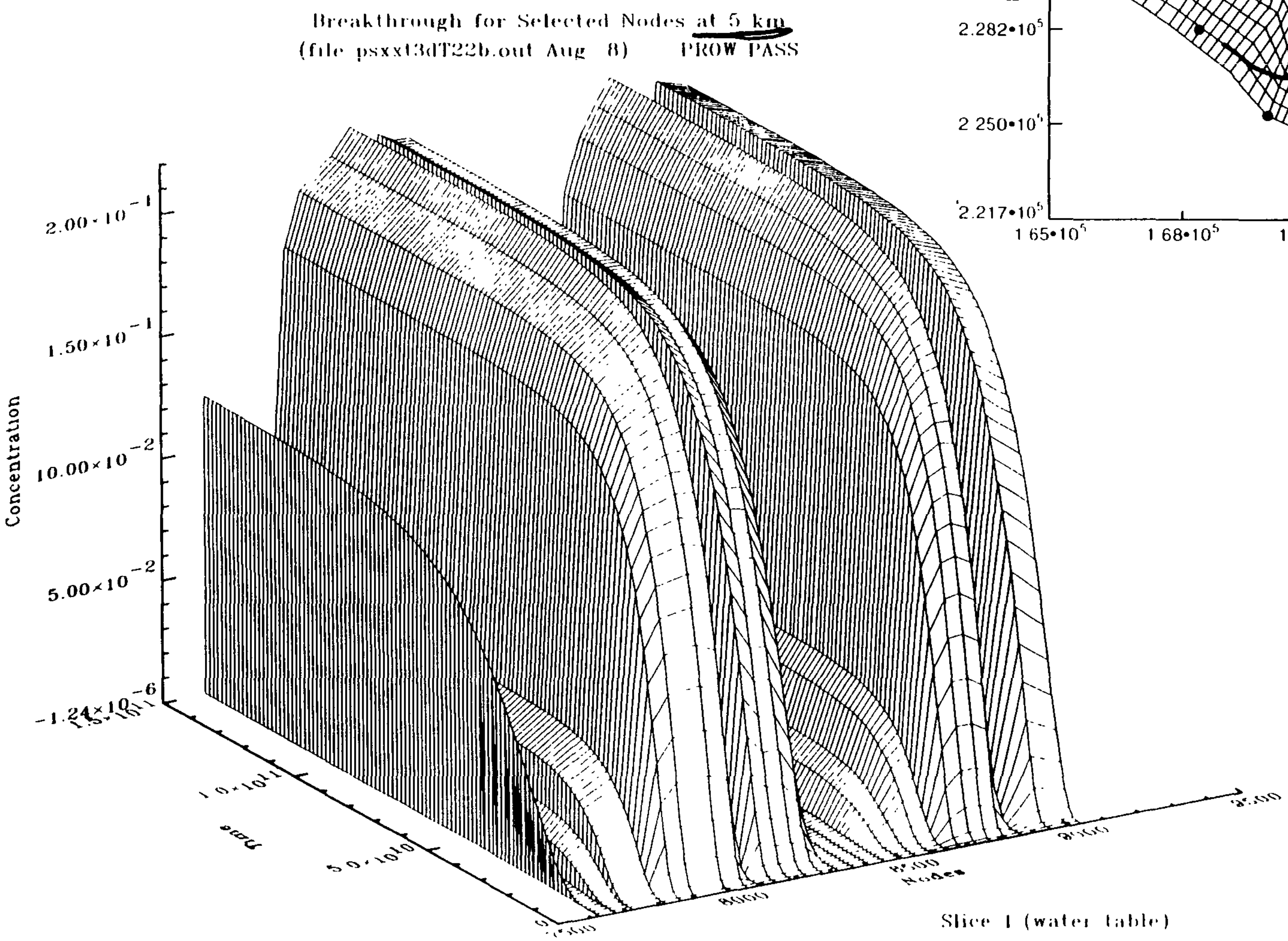
Parameter	TSPA-91	TSPA-93
Frequency	-	768
Orientation	-	2957
Spacing	Representative	Derived
Density	Representative	-
Hydraulic Aperture	Estimated	Derived
Aperture Porosity		Derived
Hydraulic Conductivity	Sand	Derived
Air Entry	Sand	Derived
Desaturation	Sand	Derived
Residual Degree of Saturation	Sand	Derived
Saturated Volumetric Water Content	Sand	Derived

Percolation Flux Distributions



Saturated-Zone Contaminant Plume





Geochemical Parameters

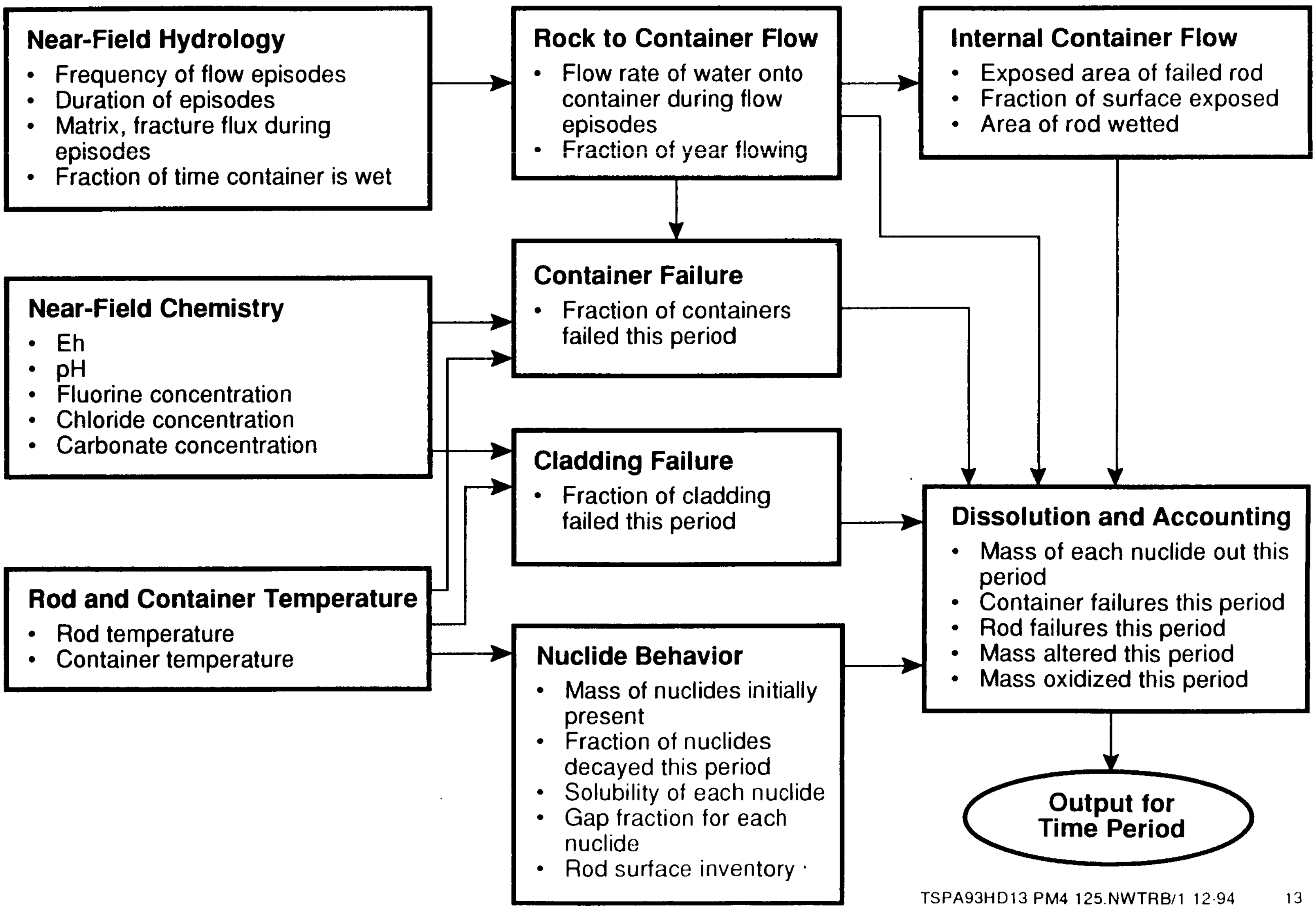
Solubilities

Element	Min	Max	E[x]	cv	Distribution Type
Am	10^{-10}	10^{-6}			uniform
Pu	10^{-10}	10^{-6}			uniform
Np	-8	-2	-4	0.20	log beta
Ni	-6	-1	-2.75	0.25	log beta
Sr	-6	-3	-4	0.12	log beta
Sm	-10^{-10}	10^{-6}			uniform
Zr	-12	-7			log uniform
Nb	-9	-7			log uniform

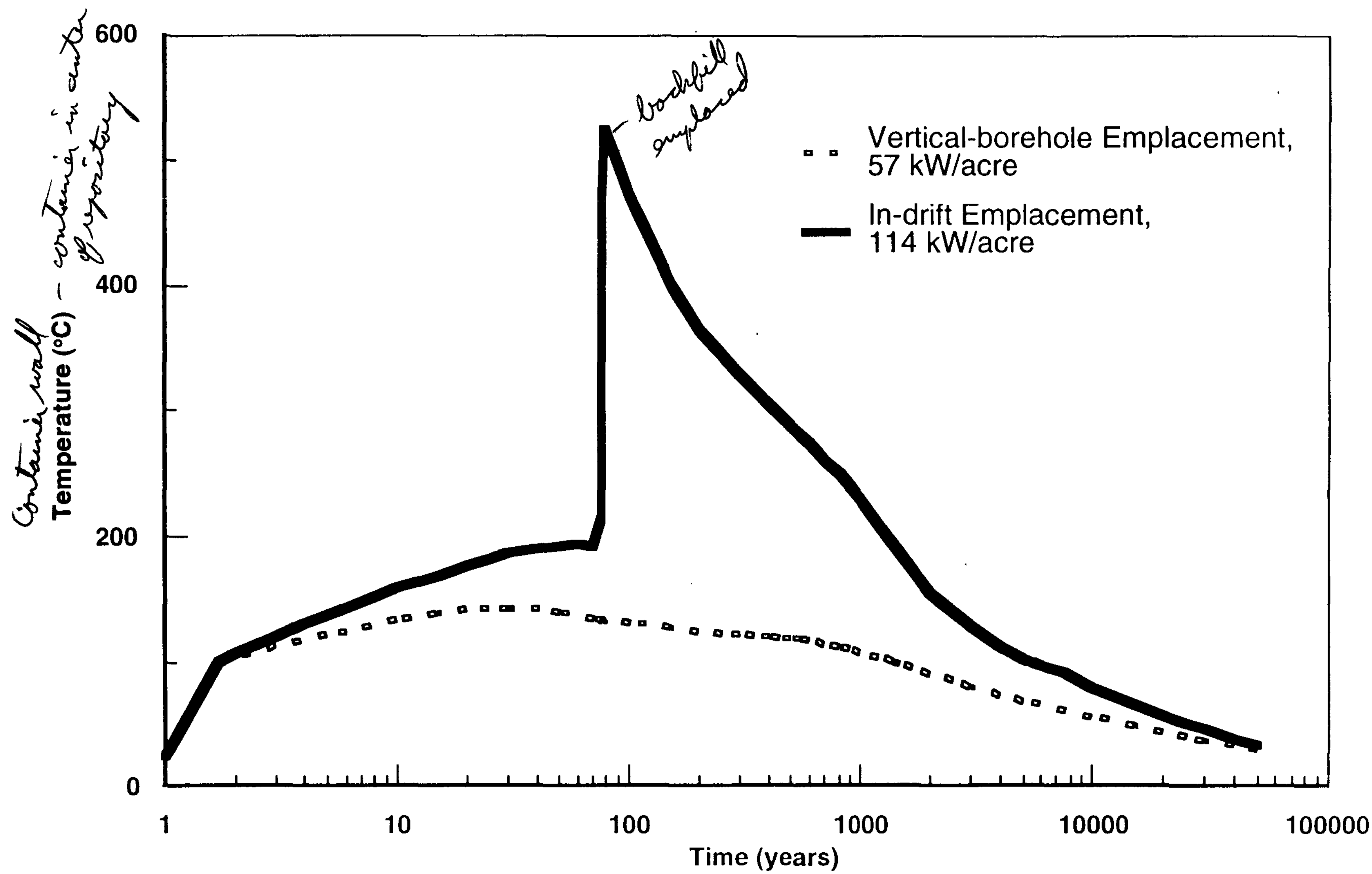
Sorption-coefficient Distributions

Element	Rock Type	Min	Max	E[x]	cv	Distribution Type
Am	D	100	2000			uniform
	V	100	1000	400	0.20	beta
	Z	100	1000			uniform
	Fe	1000	5000			uniform
Pu	D	50	200	100	0.25	beta
	V	50	200	100	0.25	beta
	Z	30	70	40	0.15	beta
	Fe	1000	5000			uniform
U	D	0	5			uniform
	V	0	4			uniform
	Z	5	20	10	0.30	beta
	Fe	100	1000			uniform

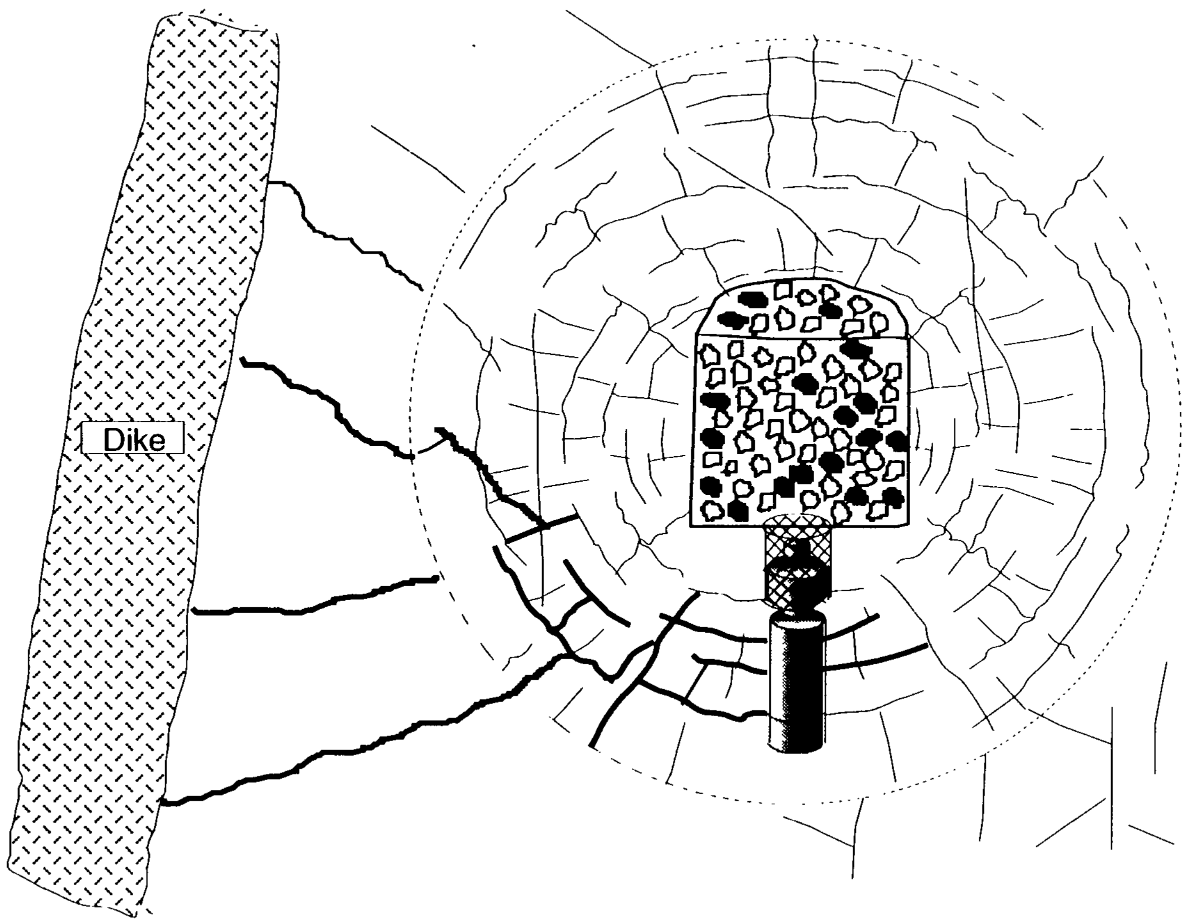
Lawrence Livermore National Laboratories YMIM Source Model



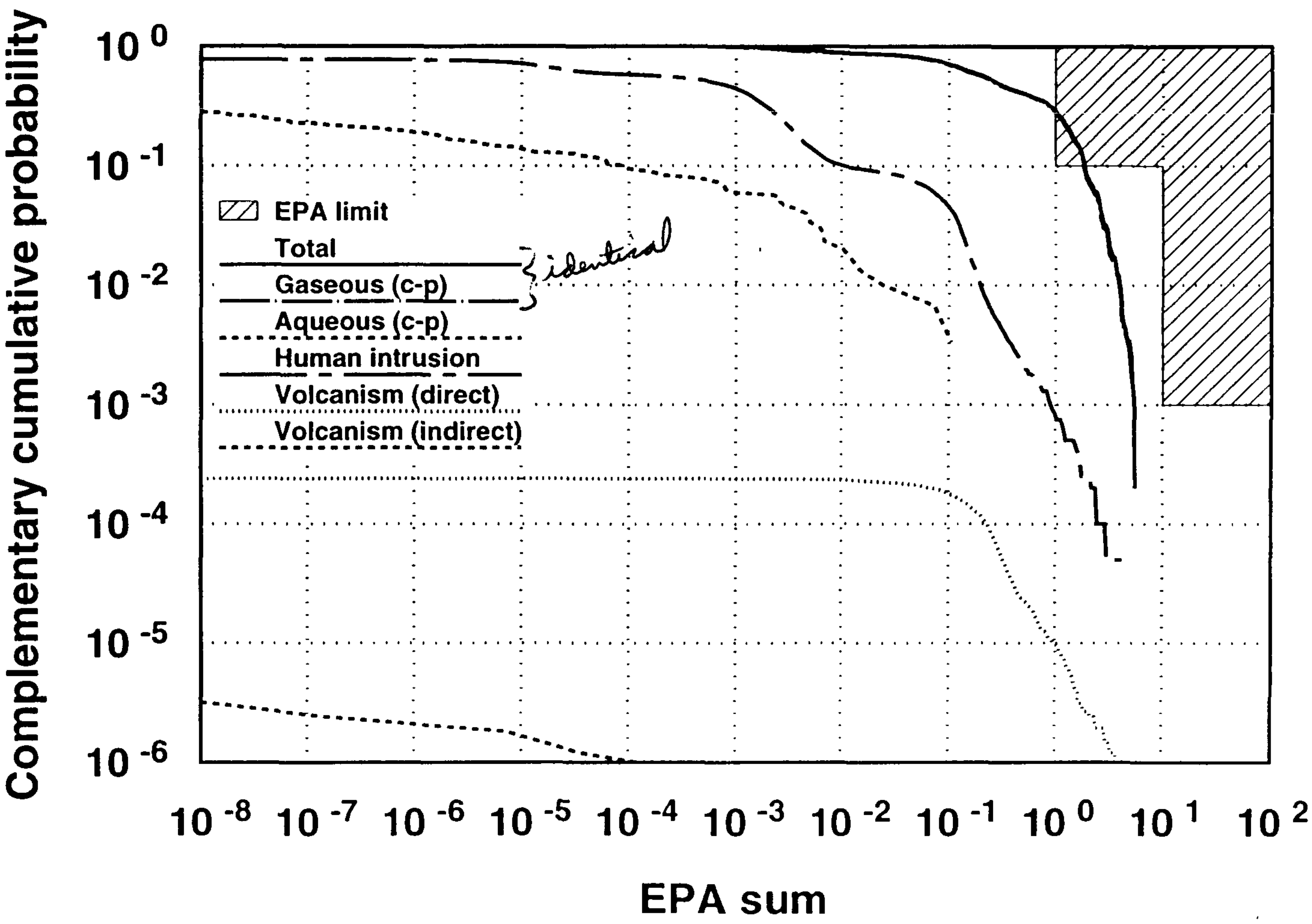
Thermal Loading



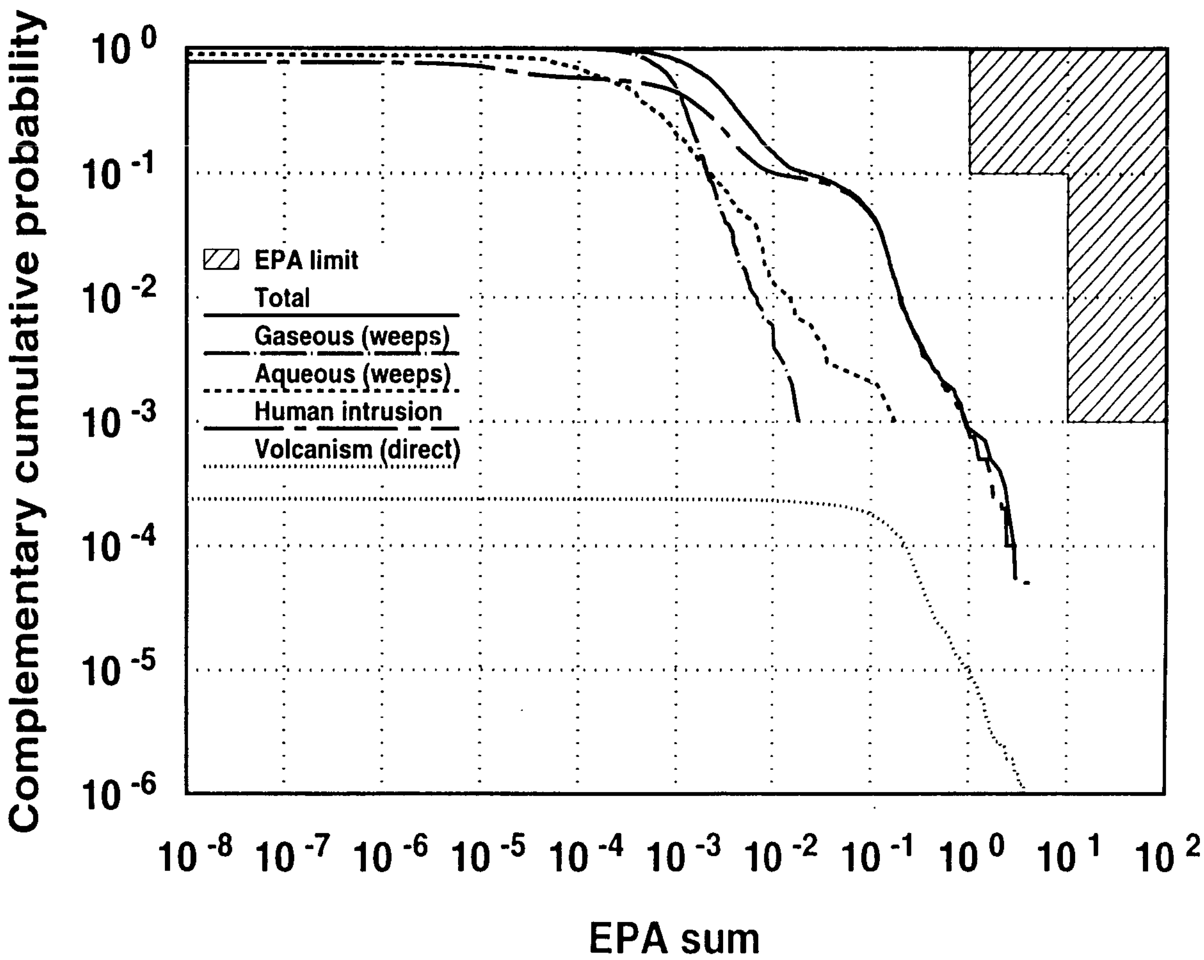
Magmatic Effects



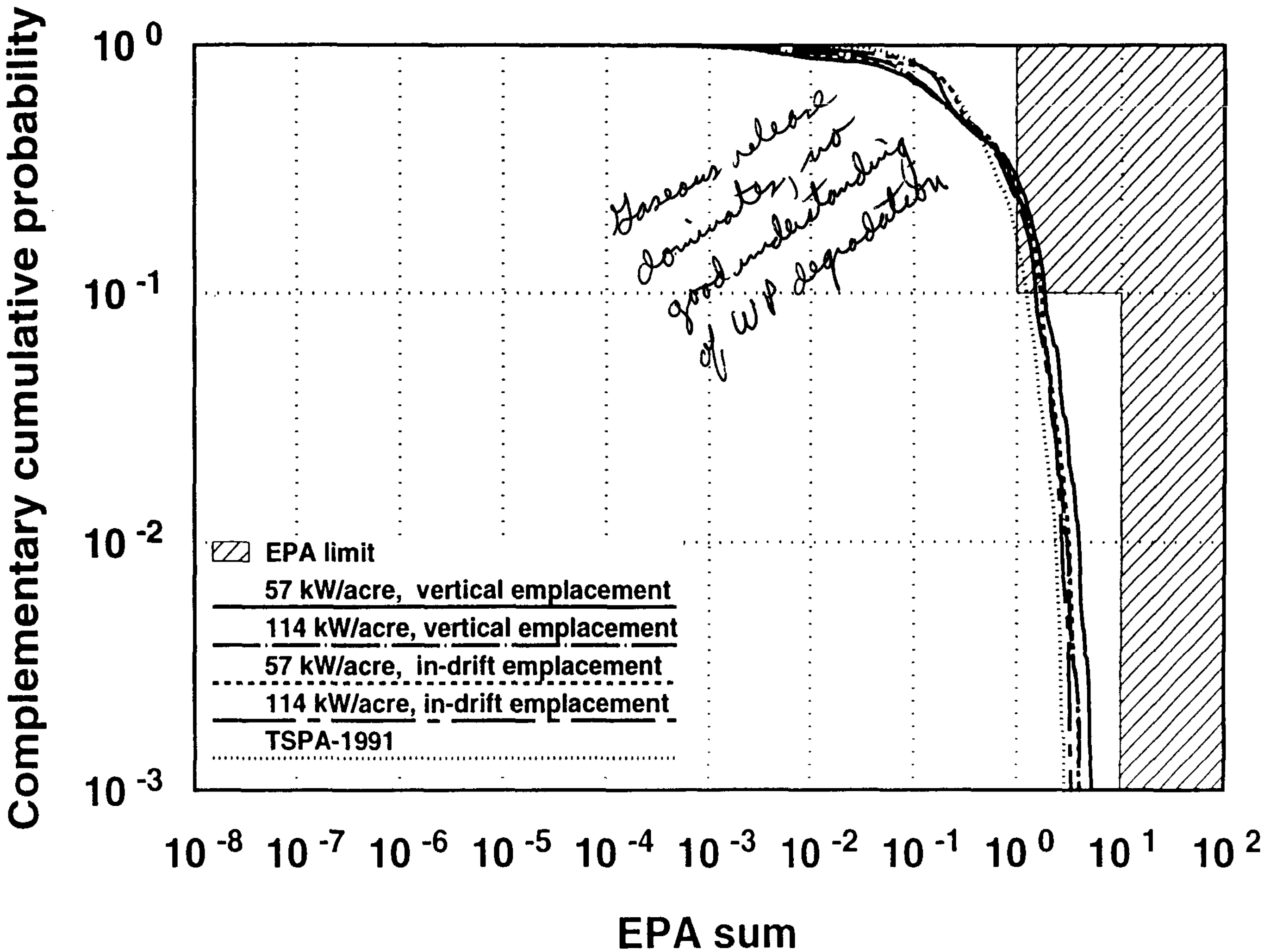
CCDF: Composite-Porosity Model, 10,000 Years, 57 kW/Acre, Borehole Emplacement



CCDF: Weeps Model, 10,000 Years, 57 kW/Acre, Borehole Emplacement

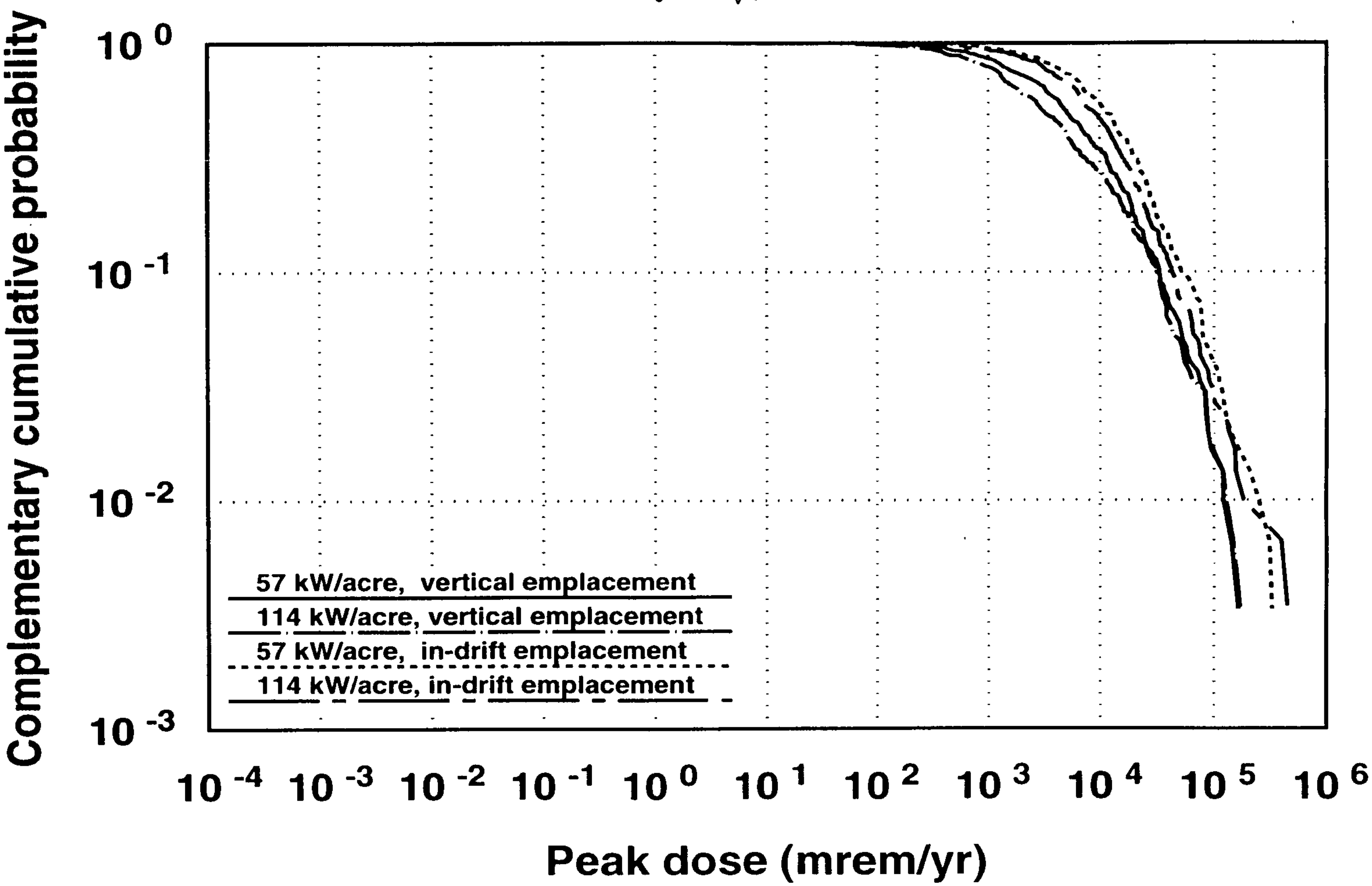


Cumulative Releases to the Accessible Environment: Composite-Porosity Model, 10,000 Years



Peak Individual Doses from Drinking Water: Composite-Porosity Model, 1,000,000 Years

Most of peak doses occur w/in 10^4 years



Conclusions from Sandia National Laboratories TSPA-93

- For the composite-porosity model:
  - CCDFs are dominated by gaseous releases
  - Aqueous releases similar for all emplacement configurations and slightly lower than TSPA-91
  - Highest sensitivity still to percolation flux
  - Human intrusion and volcanism not major contributors to release

- For the weeps model:
  - Human intrusion and aqueous and gaseous flow all contribute significantly to the CCDF
  - More sensitivity to thermal load
  - Sensitive parameters include container lifetime; number; episodicity and size of weeps, retardation in saturated zone

Conclusions from Sandia National Laboratories TSPA-93

(Continued)

- Waste-package model:
  - Waste-package failure strongly dependent on coupled processes
  - Little differentiation seen in corrosion-resistance of various designs
  - Larger containers show poorer performance for weeps and human intrusion models
- Little difference in releases observed for two thermal loads (may be due to simplifications and conservative assumptions)
- Improved saturated zone representation shows much structure in contaminant plumes not seen in 2D models

Limitations

- Exclusion of barrier effects from cladding may be very conservative
- Near-field geochemistry not explicitly modeled
- No diffusive releases from waste package
- Abstraction of hydrothermal properties may be too simplistic
- Waste-form alteration resulting from interaction with magmatic constituents not included in model

Guidance for Site Characterization

- Obtain information to help differentiate among possible flow models
  - Evidence of weeps
  - Size, connectivity, frequency, duration of flow in weeps
- Refine understanding of gas flow and retardation
- Characterize percolation flux Need a lot more info
- Characterize saturated zone flow, dilution, and unsaturated zone coupling
- Expand understanding where simplifications may have masked importance:
  - Colloids
  - Matrix/fracture coupling
  - Temporal persistence of flow paths

Guidance for Site Characterization

(Continued)

Increased data completeness

- Obtain more information on southern and western portions of potential repository area
- Determine scaling properties
- Obtain more information on spatial correlations and cross-correlations
- Investigate Ue25a#1 saturated hydraulic conductivities
- Obtain information on hydraulic characterization of unsaturated zone fractures and rock matrix

Guidance for Site Characterization

(Continued)

For near field:

- Perform integrated testing on waste package for water contact under saturated and unsaturated conditions
- Investigate near-field coupled thermal-mechanical-hydrologic-geochemical processes
- Characterize the interaction of natural and man-made components
- Obtain much more information on container corrosion and waste-form alteration processes

Guidance for Design

- Characterize thermal and hydraulic properties of any potential backfill materials
- Examine true benefits of horizontal vs. vertical emplacement
- Pursue emplacement design to minimize water contact
- Evaluate the possible enhanced performance from cladding and the contribution of the waste-package temperature to cladding failure
- Evaluate feasibility of maintaining long-term reducing environment (to reduce Np solubility)

Issues of Interest to Regulation Assessment

- Dose calculations require more information :
  - Saturated zone information must be more detailed
  - Characterization of a larger area may be necessary
  - Additional information must be gathered on the biosphere
  - For very long time-periods, radionuclide travel time not important to peak dose
- Longer time periods introduce even more uncertainty

Future TSPA Work

- Maintain effort to:
  - Work on larger suite of scenarios
  - Validate TSPA abstractions
  - Update parameter distributions and process models with new information
  - Study effects of heterogeneity
- Perform additional detailed modeling and abstraction for hydrothermal effects
- Develop models for coupled effects in the near field and on the waste package and waste form
- Improve aqueous and gaseous modeling capability by incorporating information on fracture/matrix coupling, parameter scaling, climate change, hydrothermal effects, etc.