YUCCA MOUNTAIN PROJECT

Studies

Assessment of Geosphere Performance Issues in TSPA-VA

Presented to:
Nuclear Waste Technical Review Board

Presented by:
Abraham Van Luik
U.S. Department of Energy
Yucca Mountain Site Characterization Office
Las Vegas, Nevada

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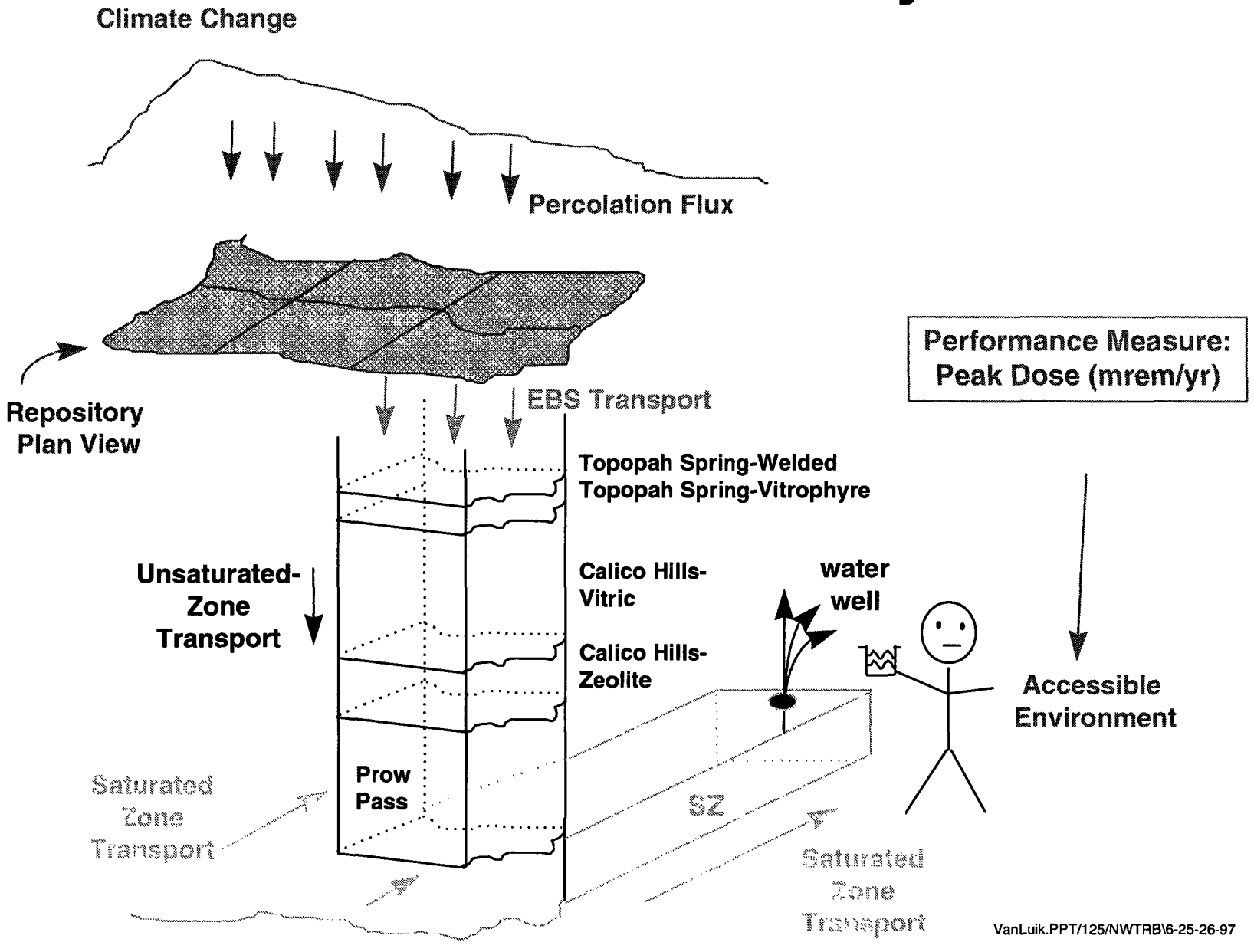
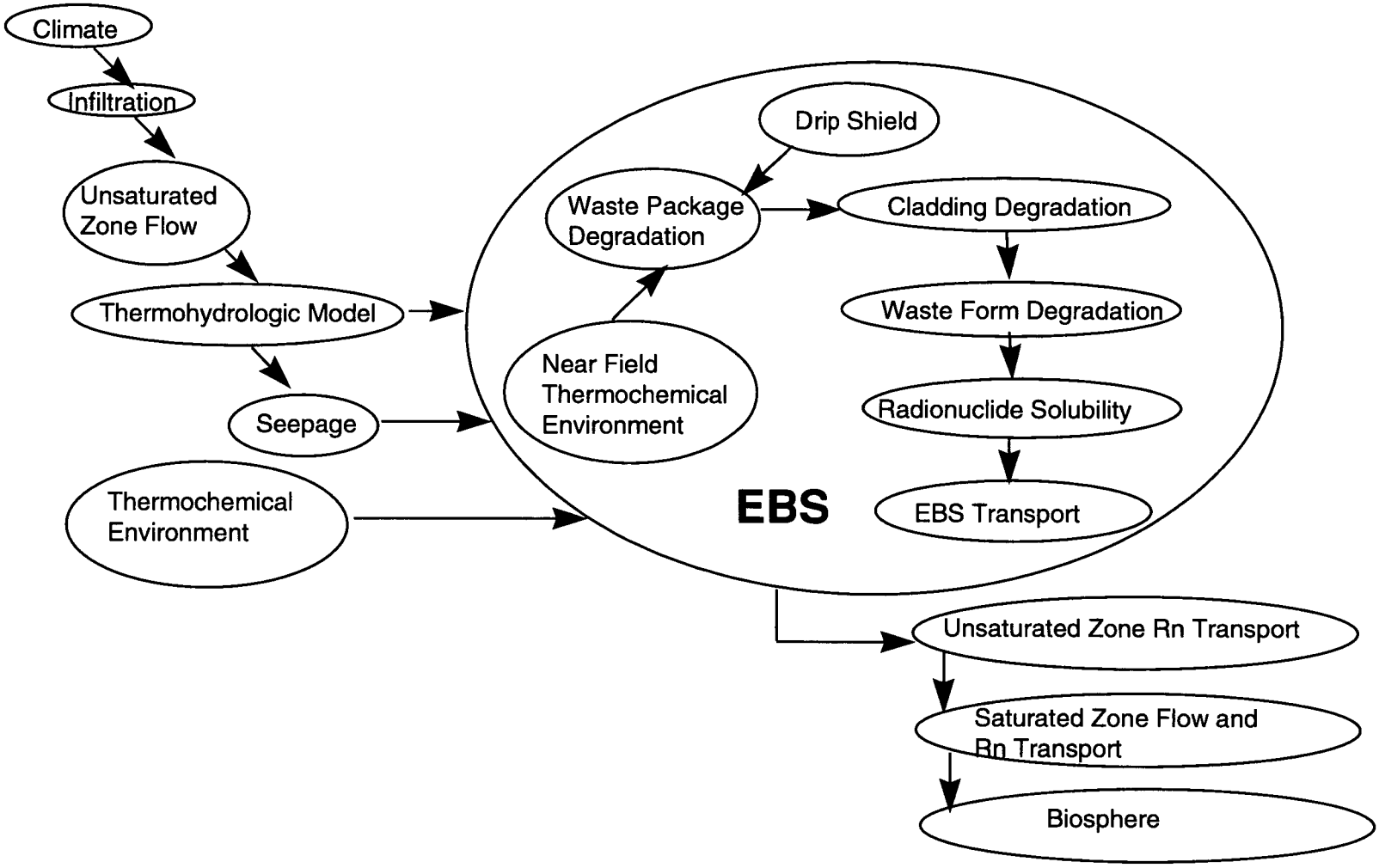
Outline

- Schematic of Geosphere in TSPA-VA
- Components of Geosphere
- Role of Geosphere in Waste Containment and Isolation Strategy
- Key Information Required from Geosphere Models
- Key Issues Associated with Geosphere Models
- Approach to Address Key Geosphere Model Issues in TSPA-VA
- Conclusion

Schematic of Natural System




Climate
Infiltration
Unsaturated Zone Flow
Thermohydrologic Model
Seepage
Thermochemical Environment
Drip Shield
Waste Package Degradation
Cladding Degradation
Waste Form Degradation
Radionuclide Solubility
EBS Transport
Near Field Thermochemical Environment
EBS
Unsaturated Zone Rn Transport
Saturated Zone Flow and Rn Transport
Biosphere

Key Site Components Affecting Predictions of Long-Term Waste Containment and Isolation

	Significance	KTI	WCIS
• Infiltration	●	✓	✓
• Unsaturated Zone Percolation Flux	●	✓	✓
• Seepage into Drifts	●	✓	✓
• Changes in Aqueous Flow: Thermal/Climate	●	✓	✓
• Unsaturated Zone Rn Transport	●	✓	✓
• Saturated Zone Rn Transport	●	✓	✓
• Biosphere	●		
• Disruptive Processes - Volcanism	●	✓	✓
• Disruptive Processes - Seismicity	●	✓	✓

Role of Natural Barrier System in Waste Containment and Isolation Strategy

- Provides controlled environment within which behavior of engineered components can be evaluated
- Provides remoteness from variability in surficial processes
- Provides remoteness from biosphere
- Provides reduction (by dispersion, dilution, retardation) and delay in arrival of any released radionuclides from engineered components

Key Information Required from Geosphere Models

Model	Key Information
Unsaturated Zone Flow	Percolation flux spatial/ temporal variability Fracture-matrix flux distribution Seepage flux spatial/ temporal variability
Thermohydrology	Seepage flux spatial/temporal variability Average "edge" vs "center" waste package groups In-drift relative humidity, temperature, liquid saturation

Key Information Required from Geosphere Models

(Continued)

Model	Key Information
Thermochemistry	Ambient key geochemical constituents Changed refluxing aqueous geochemistry due to thermal effects Thermally induced alteration of mineralogy
Unsaturated Zone Transport	Advective velocity distribution Mass breakthrough at the water table

Key Information Required from Geosphere Models

(Continued)

Model	Key Information
Saturated Zone Flow and Transport	Advective velocity distribution Dilution/mixing along flow path Mass breakthrough at potential receptors

Unsaturated Zone Flow Model Issues

Issues	Approach to Address
Infiltration rate	Use alternate maps including uncertainty; expert elicitation
Variability in infiltration rate	Sensitivity study to propagate surface variability to variability at depth
Effect of climate change	Derived from multiple "calibrated" UZ flow models with alternate climate/infiltration scenarios

Unsaturated Zone Flow Model Issues

(Continued)

Issues	Approach to Address
Seepage flux	Derived from drift-scale models evaluating a reasonable range of conceptual and parameter uncertainty; expert elicitation
Variability Seepage flux	Derived from drift-scale model results combined with expert elicitation

Unsaturated Zone Transport Model Issues

Issues	Approach to Address
Unsaturated zone flow model	Range of infiltration rates (best estimate and reasonable range from expert elicitation) combined with appropriate range of conceptual models and properties
Fracture-matrix coupling, matrix diffusion, fracture continuity, and fracture porosity	Sensitivity analyses to identify most significant parameters within range of calibrated models

Unsaturated Zone Transport Model Issues

(Continued)

Issues	Approach to Address
Changes in flow/transport properties by thermal/ chemical alteration	Sensitivity study to identify applicable range of effects to consider in TSPA
Retardation within fractures and matrix	Reasonable values based on mineralogic abundance. Small-scale effects tested by sensitivity study

Saturated Zone Flow and Transport Model Issues

Issues	Approach to Address
Darcy flux distribution including variability (esp. major structural features)	Incorporate alternative heterogeneous properties in sensitivity analysis
Alternative conceptual models of fracture-matrix interaction and range of effective transport properties (dispersivity, fracture/ matrix sorption, matrix diffusion, and effective fracture porosity)	Sensitivity analyses combined with expert elicitation to identify applicable range of most significant parameters to include in TSPA
Effect of climate change	Identify range of changes in flow rates and water table elevations based on regional flow model

Saturated Zone Flow and Transport Model Issues

(Continued)

Issues	Approach to Address
Effective transport properties of scale of km to 10s of km (including regional aquifer mixing)	Use regional and local scale inference to other analog systems, including natural geochemical tracers combined with expert elicitation
Mixing in well withdrawal scenarios	Alternative scenarios treated for 5-km biosphere; not an issue at 30 km due to transition from tuff to alluvial aquifer

Disruptive Features, Events, and Process Model: Signficant Issues

Issues	Approach to Address
Probability of direct volcanic eruption	Use PDF of volcanic event frequency derived from expert elicitation. Scale frequency for indirect effects
Effects and consequences of direct volcanic eruption	Review CNWRA model and incorporate reasonable ranges of effects based on expert judgment
Effects and consequences of indirect volcanic event	Develop bounded effects based on expert judgment and conduct sensitivity analyses on range of consequences

Disruptive Features, Events, and Process Model: Signficant Issues

(Continued)

Issues	Approach to Address
Probability and effects of seismic/tectonic event	Use PDFs for likeihood of occurrence derived from expert elicitation. Conduct sensitivity analyses on range of consequences
Probability and effect of human intrusion	Conduct stylized human intrusion analyses as recommended by NAS

Conclusions

- Significant issues exist regarding the confidence in models (and therefore predictions based on these models)
- Approaches have been implemented to address these issues within the TSPA for the Viability Assessment
- Additional testing and model development and substantiation will occur between VA and LA