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

NUCLEAR WASTE TECHNICAL REVIEW BOARD
FULL BOARD MEETING

SUBJECT: GEOHYDROLOGY TECHNICAL GUIDELINE

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Geohydrology Technical Guideline

Significance:

Dissolution and transport in moving ground water is considered to be the primary means for releasing radionuclides from the repository to the accessible environment.

Geohydrology Technical Guideline

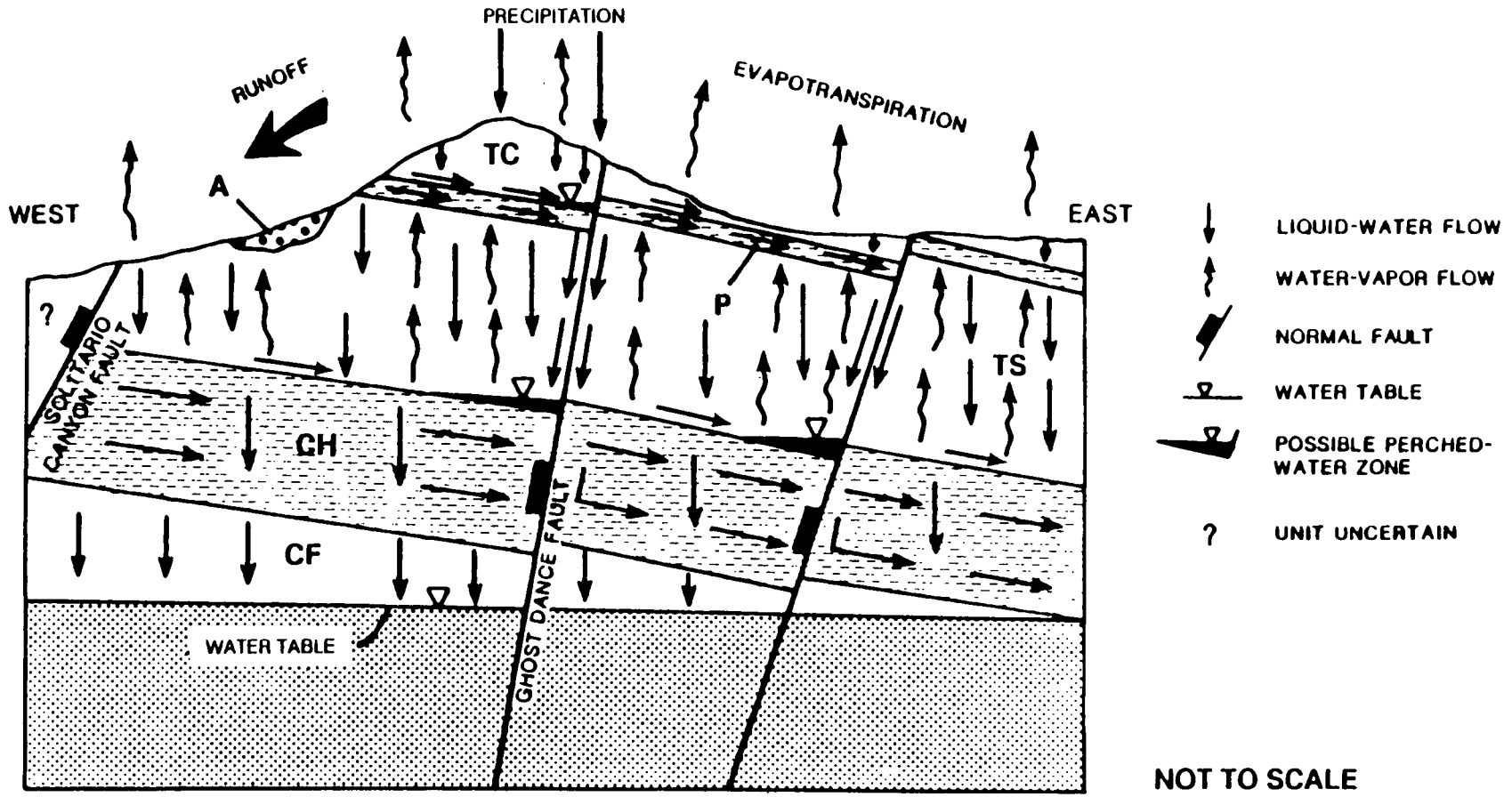
Context: Geohydrologic setting

- Site unsaturated-zone (UZ) system
- Site saturated-zone (SZ) system
- Regional ground-water flow system

Site Unsaturated-Zone System

- **Boundaries**
  - Upper: Land surface
  - Lower: Water table
- **Geohydrologic units**
  - Fractured welded tuffs
  - Unfractured nonwelded tuffs
- **Moisture-balance processes**
  - Downward infiltration/percolation of liquid water in matrix and fractures
  - Upward advective transport of water vapor in fractures
  - Lateral redistribution in nonwelded tuff units

UNSATURATED ZONE
CONCEPTUAL MODEL OF FLOW

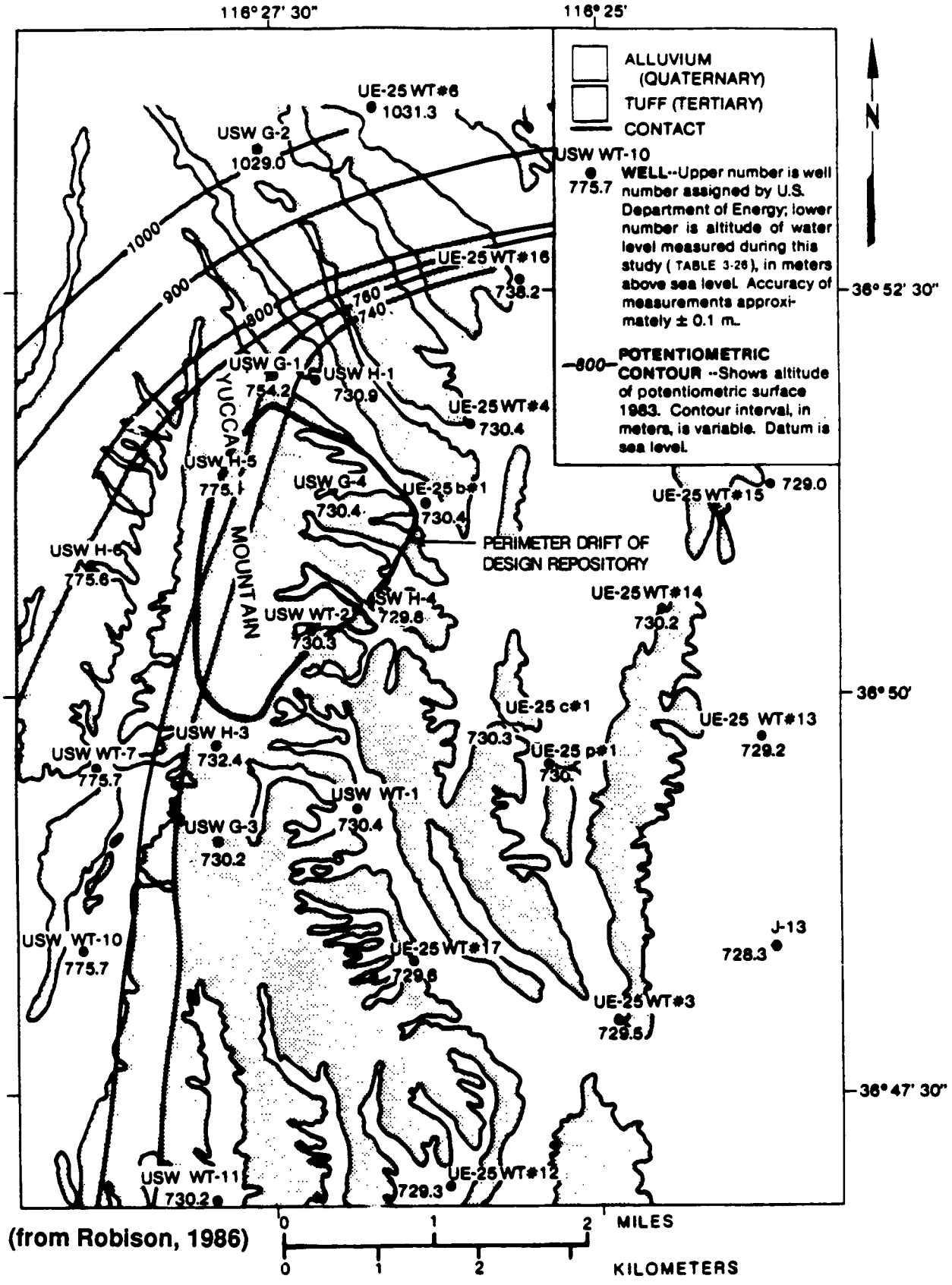


A	ALLUVIUM	TS	TOPOPAH SPRING WELDED UNIT		WELDED UNIT
TC	TIVA CANYON WELDED UNIT	CH	CALICO HILLS NONWELDED UNIT		NONWELDED UNIT
P	PAINTBRUSH NONWELDED UNIT	CF	CRATER FLAT UNIT (Undifferentiated)		SATURATED ZONE

Site Saturated-Zone System

- **Water-table configuration**
  - Low-gradient region to the south
  - Large-gradient zone to the north
- **Aquifers**
  - Welded tuffs
  - Paleozoic carbonates
- **Lateral flow direction and rates**
- **Vertical flow direction and rates**

Preliminary Composite Potentiometric-Surface Map of the Saturated Zone



(from Robison, 1986)

Large-Hydraulic-Gradient Zone

- **Models**

  - **Dam:** Permeability contrast due to fault, intrusion, rock-fabric change, rock alteration
  - **Drain:** Buried fault zone providing access to deep Paleozoic carbonate-rock aquifer

- **Consequences**
  Little or no expected adverse impact on waste containment and isolation

Regional Ground-Water Flow System

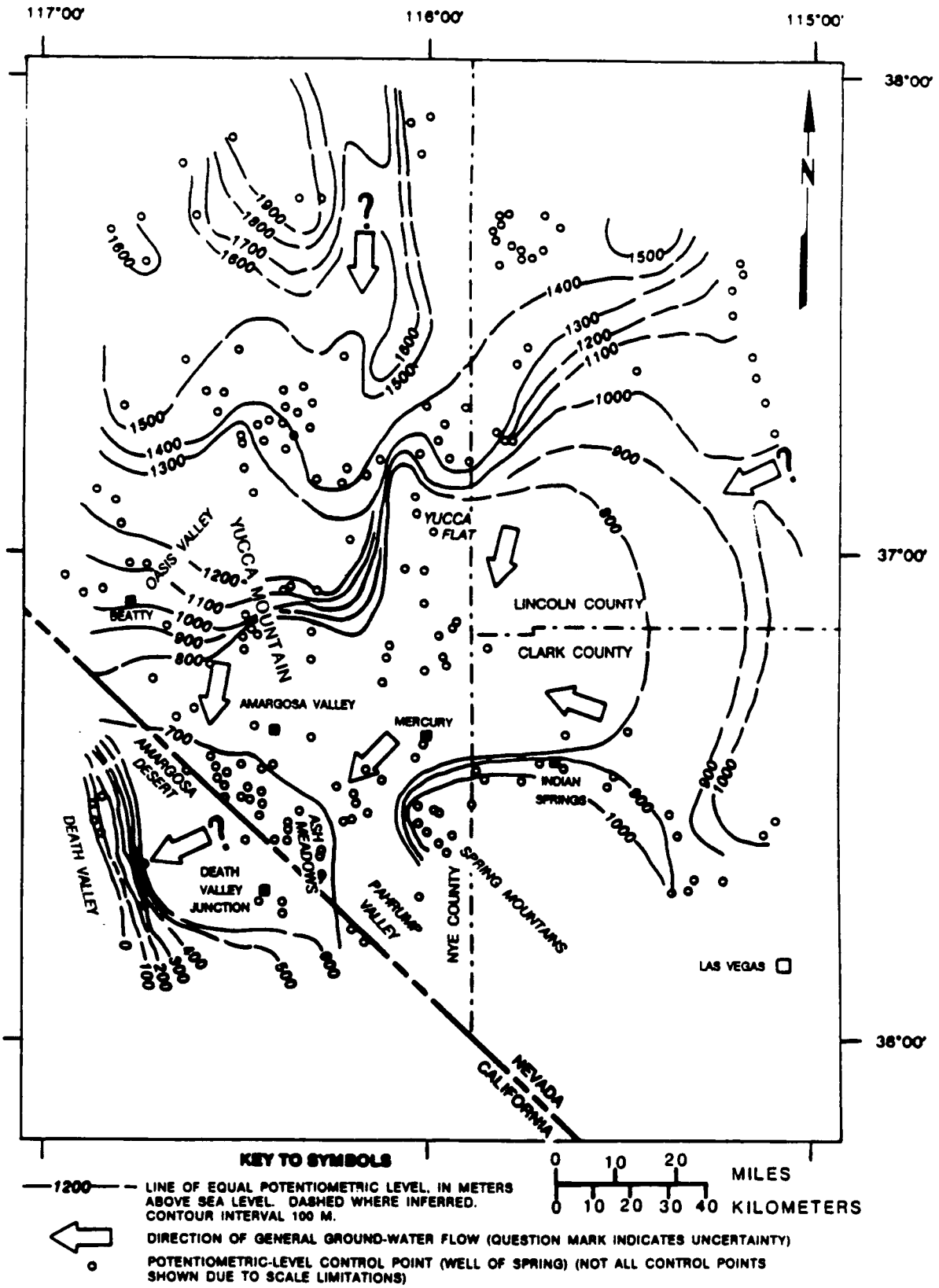
- **Water-table configuration (≈ potentiometric surface)**

- **Recharge areas:**
  - **Upland areas with mean annual precipitation >200mm**

- **Discharge sites:**
  - **Ash Meadows**
  - **Franklin Lake Playa**
  - **Death Valley**

- **Aquifers:**
  - **Valley fill**
  - **Volcanic rock**
  - **Upper carbonate**
  - **Lower carbonate**

Regional Ground-water Flow Paths



(from Waddell et al., 1984)

ESSE Evaluation of the Geohydrology Technical Guideline

- Qualifying condition
- Disqualifying condition

Qualifying Condition [10 CFR 960.4-2-1 (a)]:

"The present and expected geohydrologic setting of the site shall be compatible with waste containment and isolation."

Specifically:

- **Comply with EPA release limits to accessible environment**
- **Satisfy 10 CFR 60.113 requirements for allowable radionuclide releases from the engineered barrier system**

Disqualifying Condition [10 CFR 960.4-2-1 (d)]:

"A site shall be disqualified if the pre-waste-emplacement groundwater travel time from the disturbed zone to the accessible environment is expected to be less than 1,000 years along any pathway of likely and significant radionuclide travel."

Site Unsuitability

A site is unsuitable if

- **a qualifying condition cannot be satisfied**
- **a disqualifying condition is present**

ESSE Evaluation Process

1. Define specific, addressible technical issues

2. Identify information and actions needed to address technical issues

3. Summarize EA information and findings

4. Review available information obtained since EA

5. Assess present status of issues

6. Develop subsequent conclusions and recommendations

ESSE Geohydrology Technical Issues

1. Conditions for sustained flow: occurrence of preferential pathways capable of sustaining sufficient ground-water flow to affect waste containment and isolation.

2. Expected travel time: presence of conditions that could cause the site to fail to satisfy the ground-water travel-time requirement.

Technical Issue 1:
Conditions for Sustained Flow

- Presence of preferential flow and transport pathways through the unsaturated zone (e.g., faults, fractures, permeability contrasts, saturation anomalies)

- Spatial distribution and capacity of pathways (e.g., to repository, from repository)

- Activation of pathways (e.g., future climate change; diversion of water into faults and fractures)

- Consequences for waste containment and isolation

Technical Issue 2: Expected Travel Time

- Ambiguities (e.g., "distrubed zone," "expected," "likely and significant")
- Deterministic versus stochastic approach

ESSE Conclusions

Lower-level suitability findings continue to be supported for the geohydrology qualifying and disqualifying conditions

ESSE Recommendations

- Identify and characterize potential pathways in the unsaturated zone
- Characterize processes that may attenuate and redistribute ground-water flow in the unsaturated zone
- Quantify ambient hydrologic and hydrochemical conditions in the unsaturated zone
- Conduct hydrologic and tracer tests in the saturated zone
- Develop reliable models for flow and transport in the unsaturated and saturated zones