Las Vegas Earthquake Hazard and Seismic Vulnerabilities

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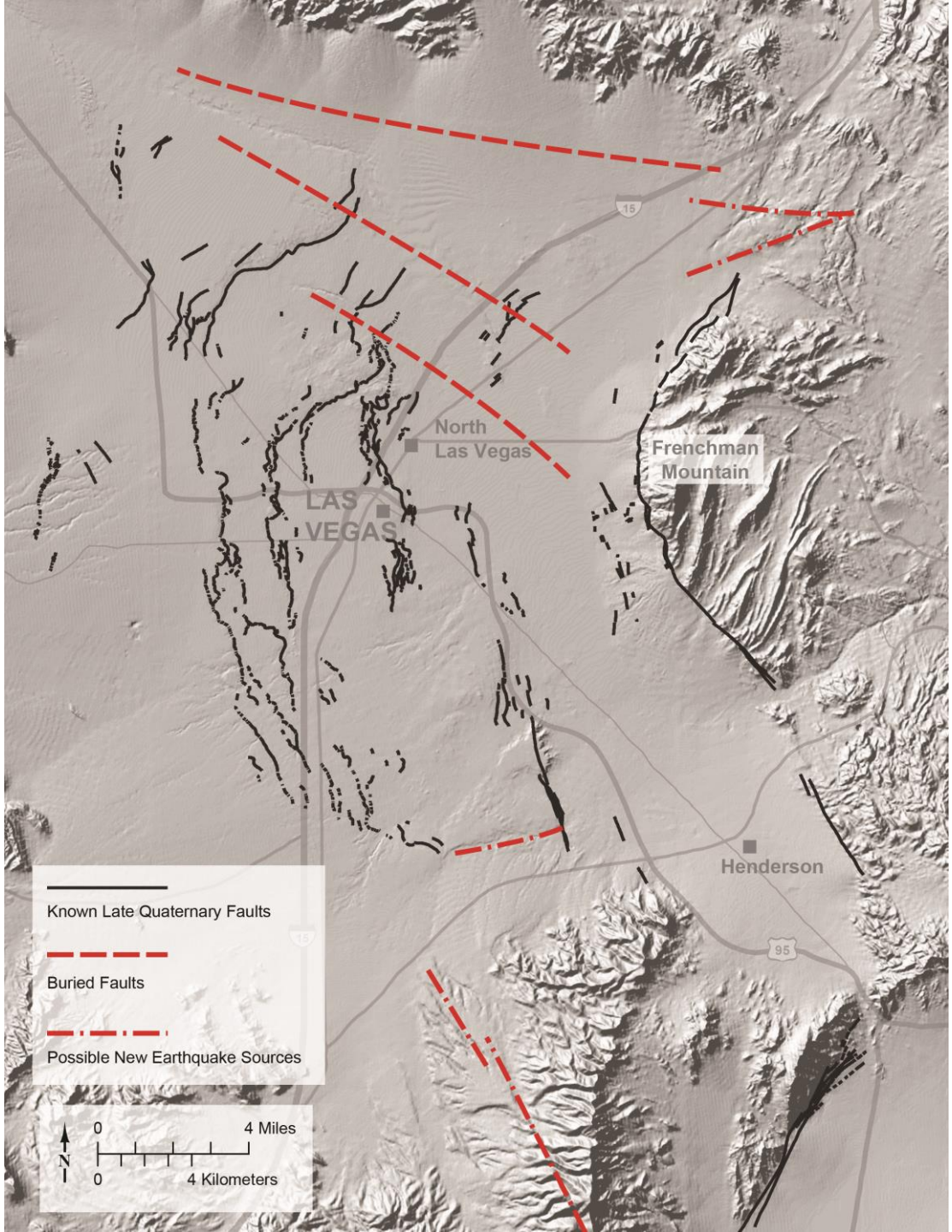
Nevada Bureau of Mines and Geology



Las Vegas Valley Fault System

Eglington scarp. View towards the north. Photograph taken by John Bell of the Nevada Bureau of Mines and Geology.

Bonanza Road fault scarp – Cashman Field fault zone

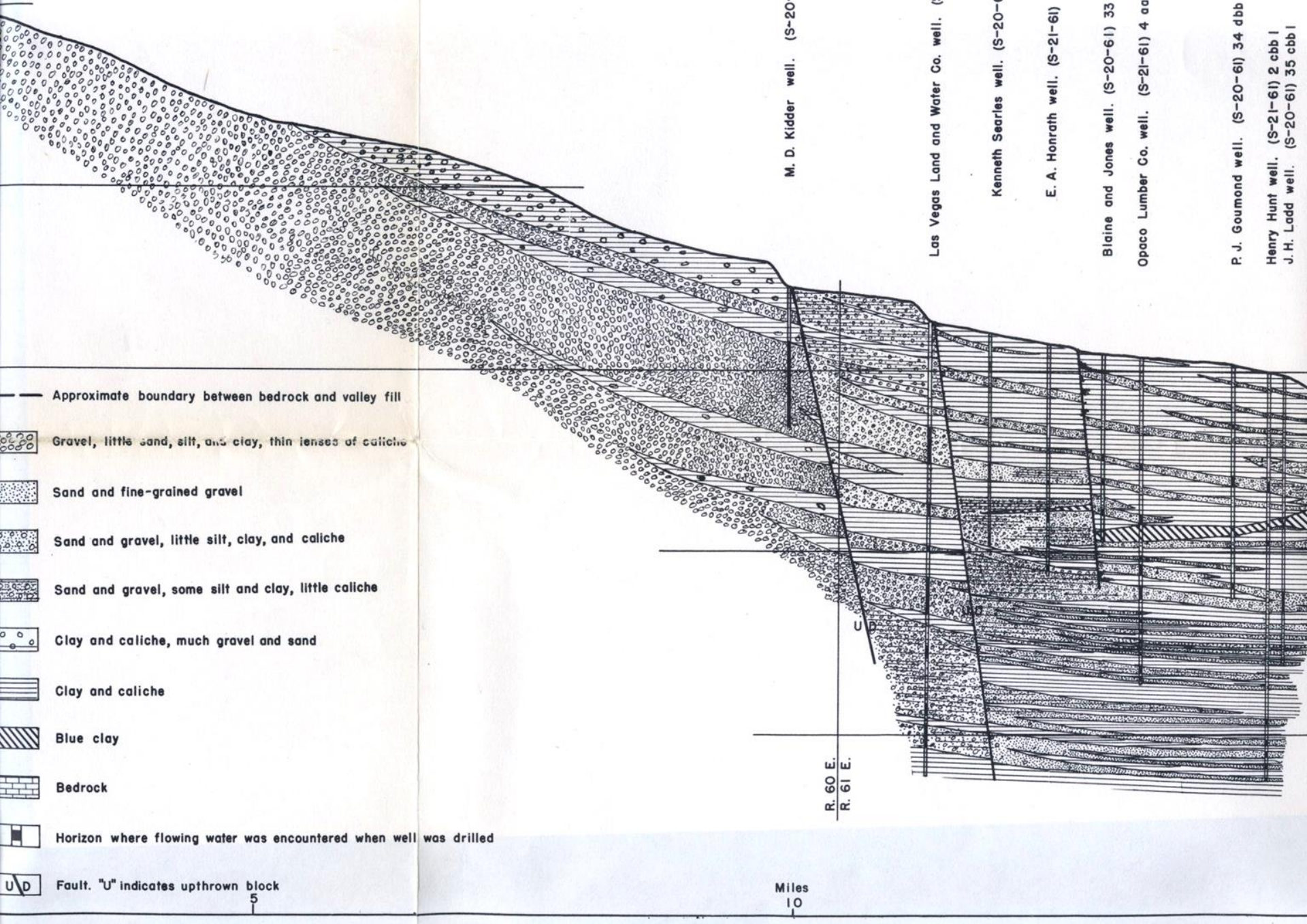
Whitney Mesa fault zone

Photograph by Lindsey in 1980

Set back from fault along the Whitney Mesa fault zone

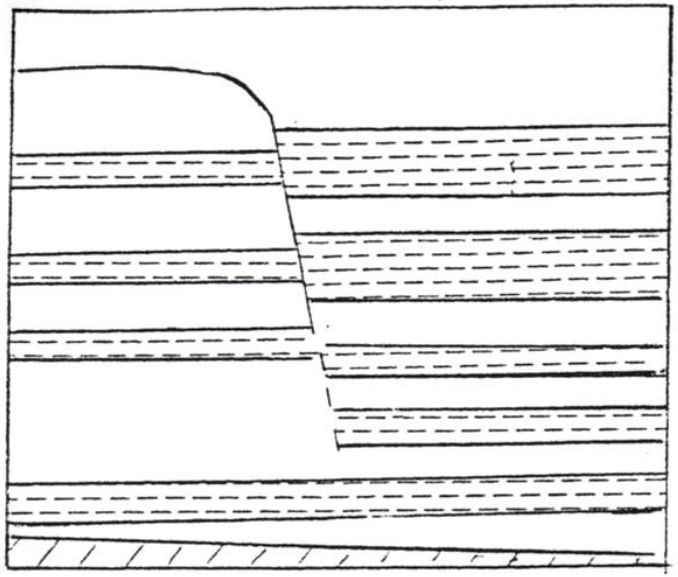
Many Decades of Debate about the Earthquake Threat in Las Vegas Valley

- Maxey and Jameson (1948): hydro-compaction (non-tectonic) origin to fault scarps,
- Mindling (1965): first mention of poss. tectonic origin,
- Bell (1981): found several inconsistencies with hydro-compaction origin and suggested a tectonic component,
- 1996 Southern NV seismic hazard conference: tectonic component favored,
- National Seismic Hazard Maps: faults set in their own category, below any impact on hazard,
- Lamichhane and others (2014) UNLV study demonstrates importance of local faults to seismic hazard,
- dePolo and Taylor (in prep.): strongly advocate an earthquake threat from these faults, develop preliminary hazard values.

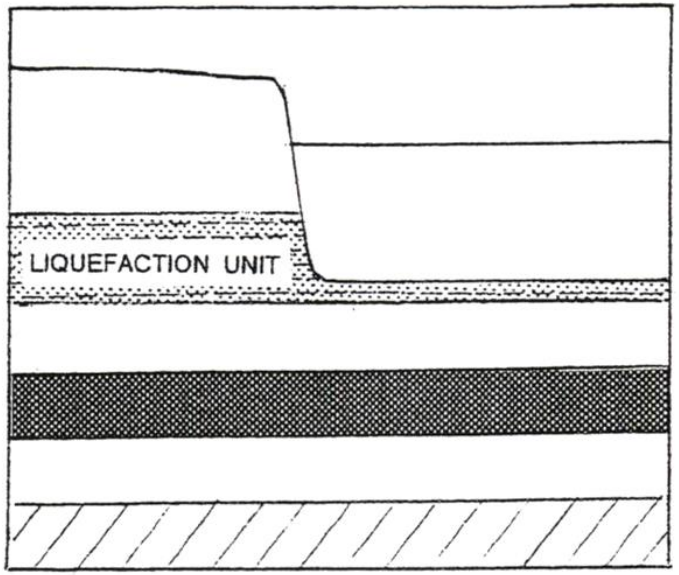


Maxey and Jameson (1948)

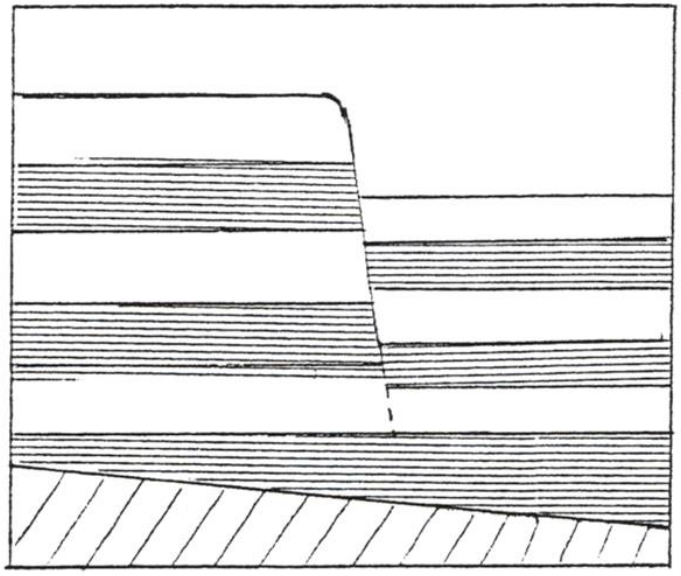
COMPACTION MODEL



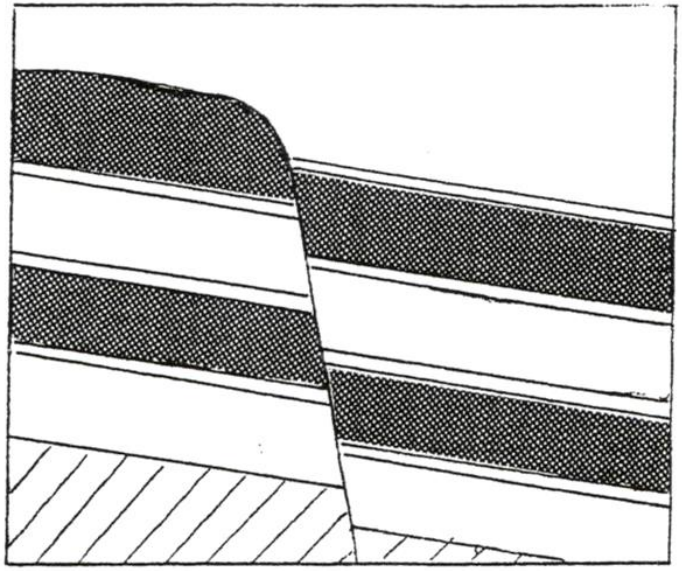
LIQUEFACTION MODEL



SOLUTION MODEL (DISTRIBUTED)



TECTONIC FAULT MODEL



The Case for an Earthquake Hazard in Las Vegas

- Earthquakes occur in and around the valley.
- At least one local fault, Frenchman Mountain fault, is considered to be 100% tectonic.
- Basement appears to be offset below faults and they appear to be forming the basin (so at least a tectonic origin).
- Evidence of rapid surface offsets appear to have been from paleoearthquakes.

1/8/89 M3.5

2/3/01 M3.5

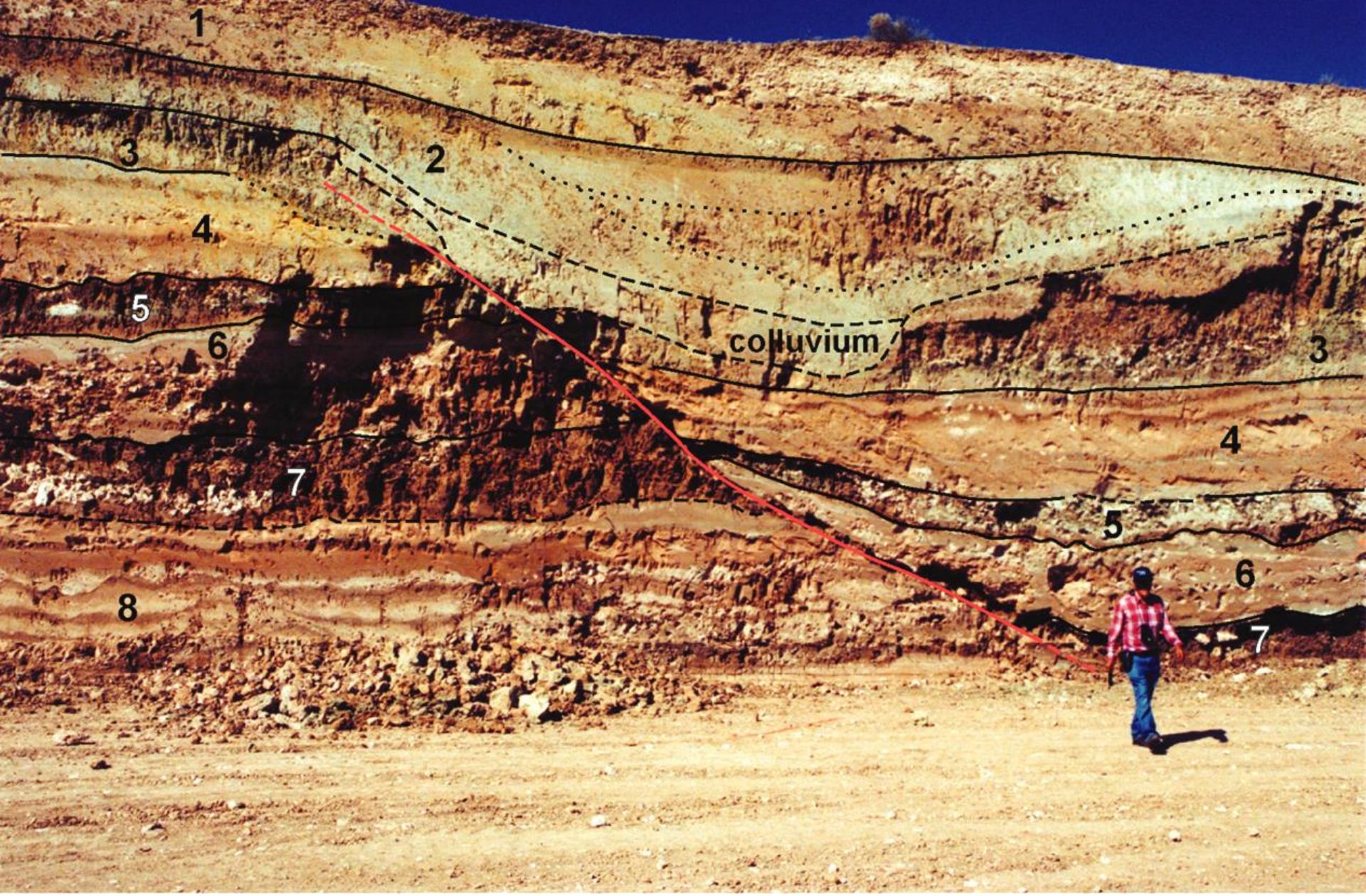
10/5/14 M3.6

Earthquake Activity around Las Vegas

dePolo and dePolo, 2012

Recent Event Strike-Slip Displacement

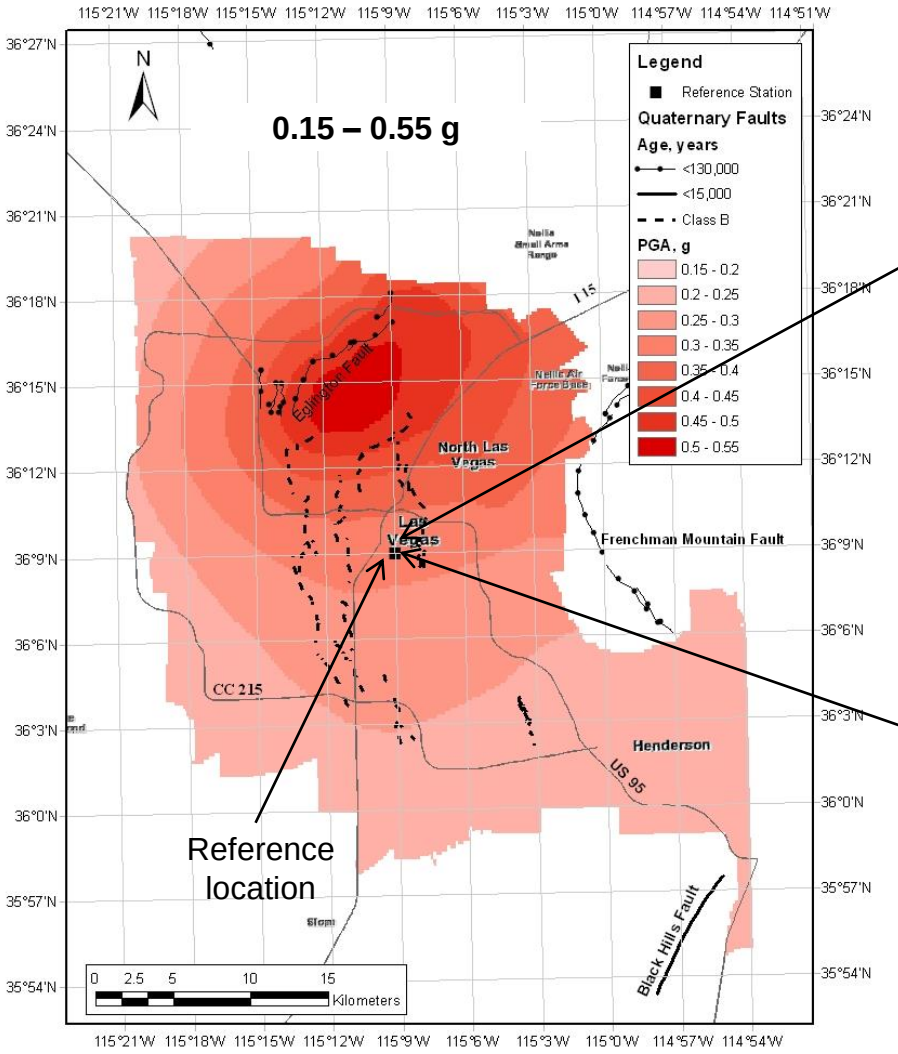
- Common for small Las Vegas earthquakes to be strike-slip,
- Older faults within basin has strike-slip motion in the geologic past,
- Geodetic modeling suggests shear deformation,
- Larger strike-slip earthquakes are a possibility.


1
2
3
4
5
6
7
8
colluvium
3
4
5
6
7

Lamichhane et al. (2014)
UNLV Seismic Hazard Study

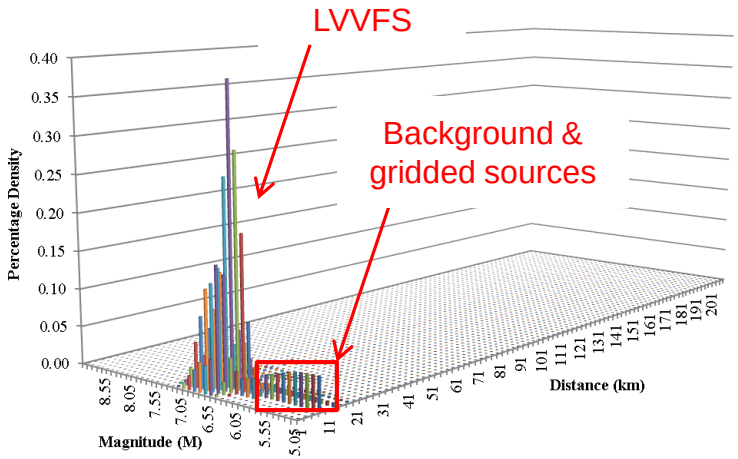
441 locations, ~ 3 km grid

PGA

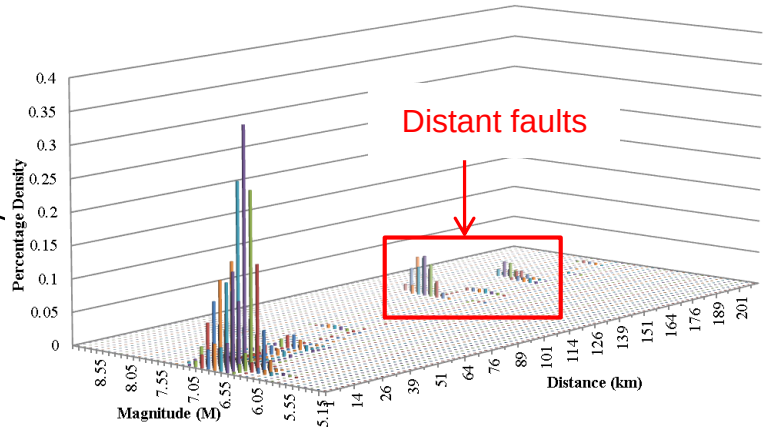


2% PE in 50 years

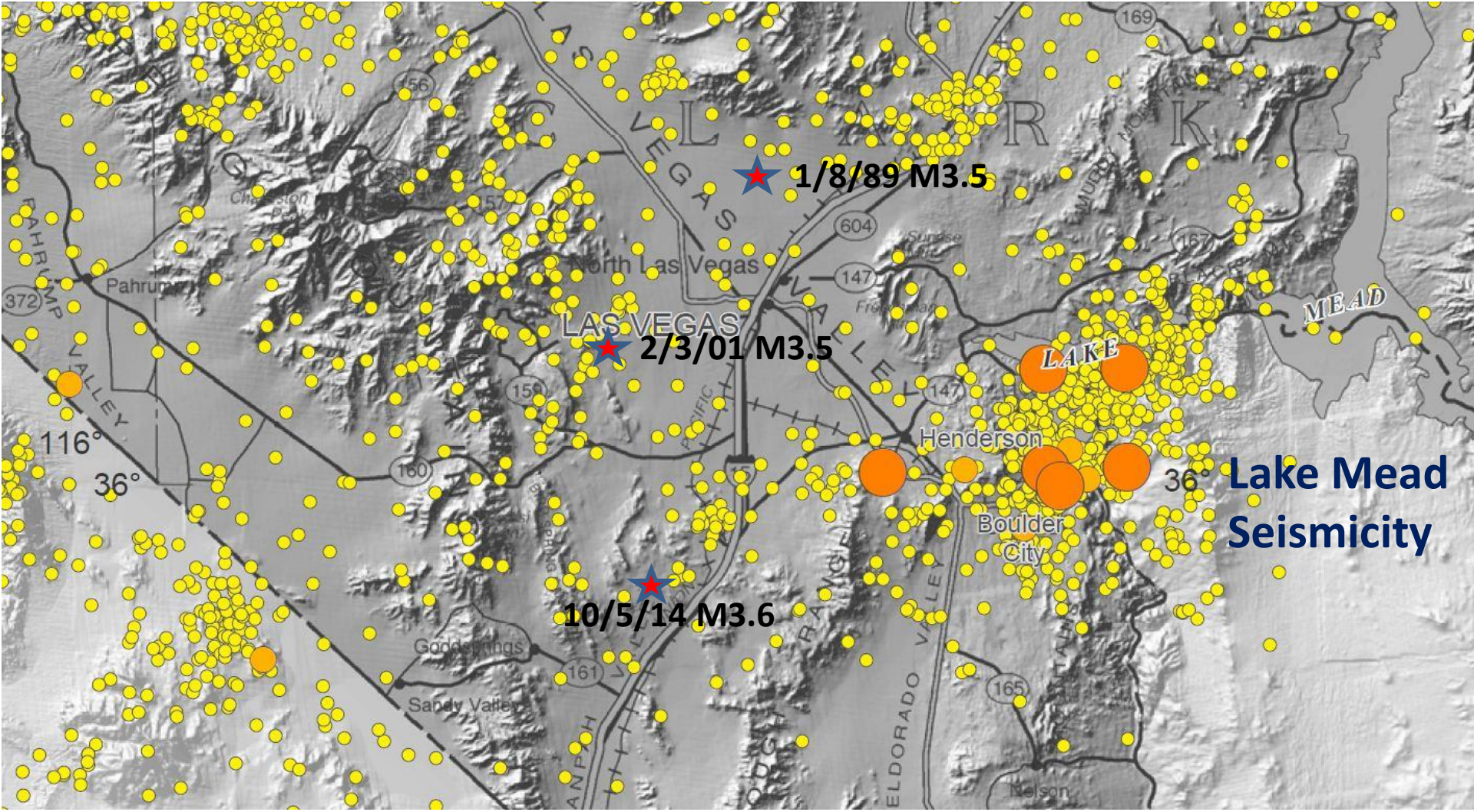
Deaggregations



Peak ground acceleration



Long period (4 s)



dePolo and dePolo, 2012

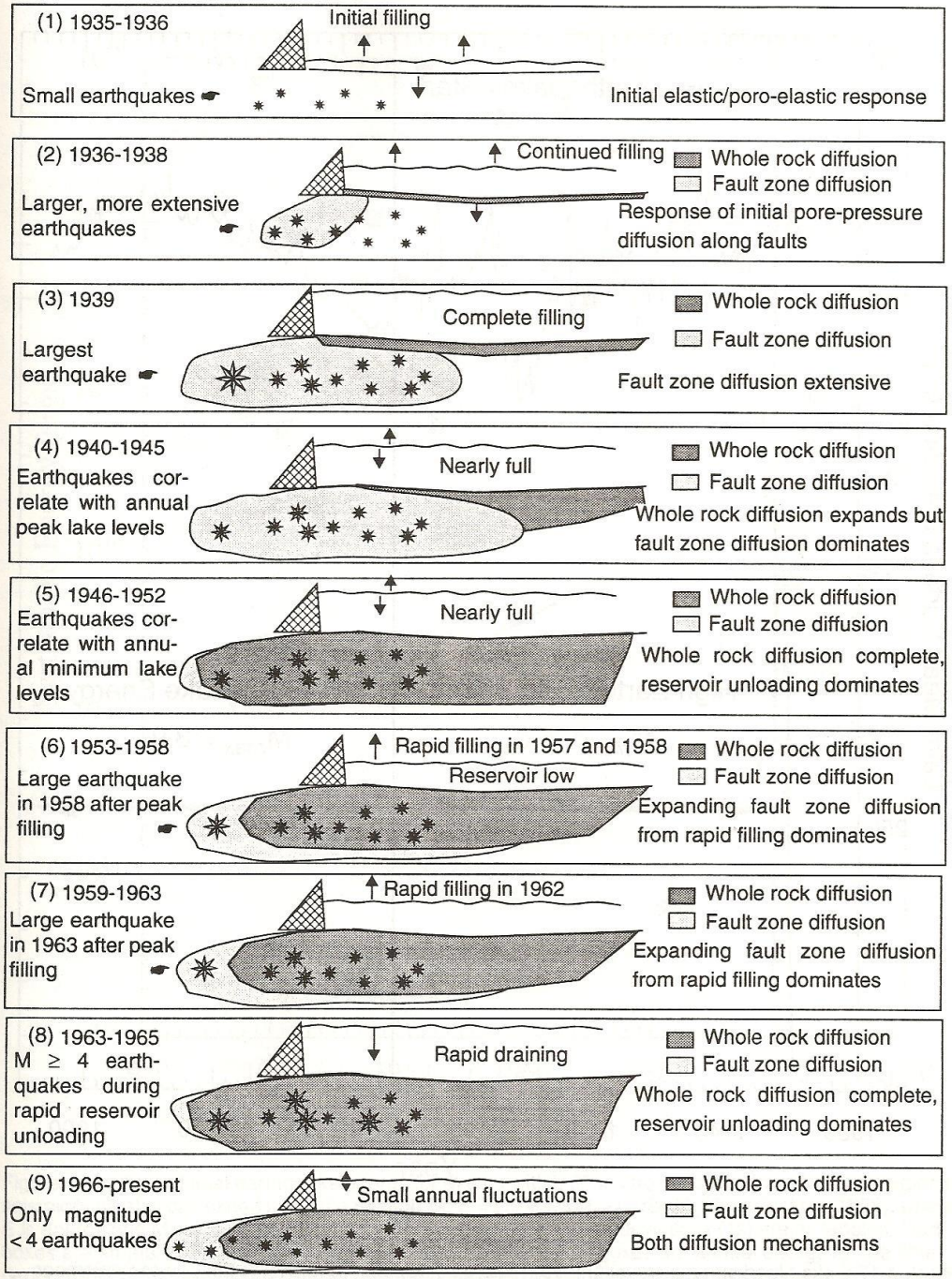


Figure 4-16. Schematic diagram of the time evolution of reservoir-induced seismicity near Hoover Dam.

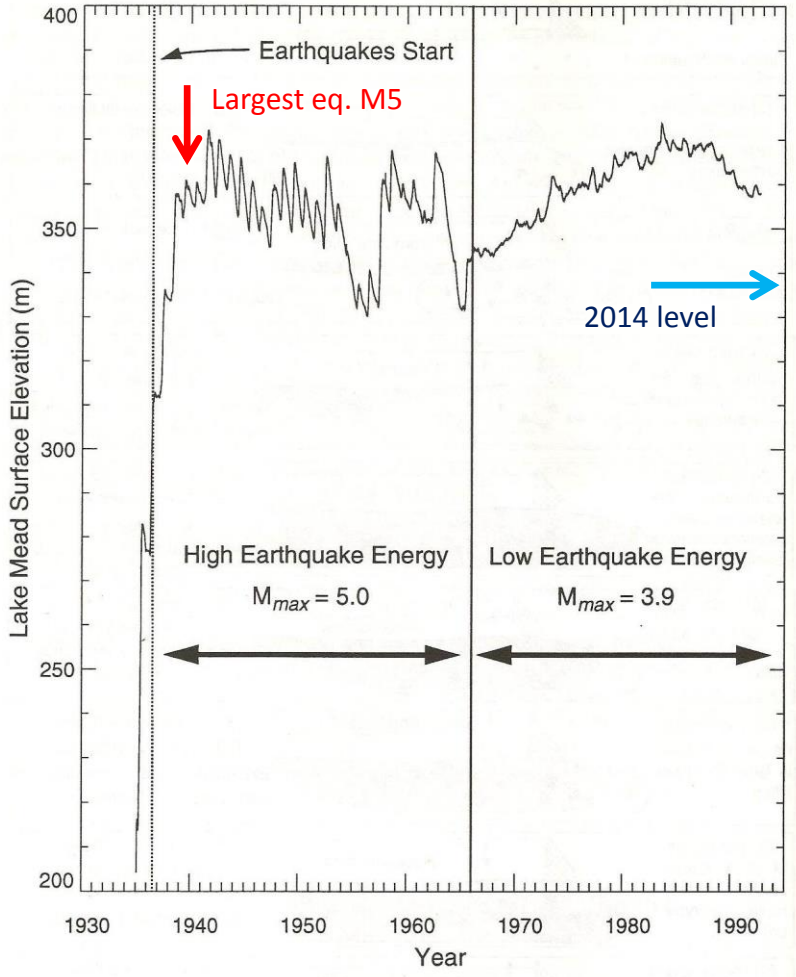
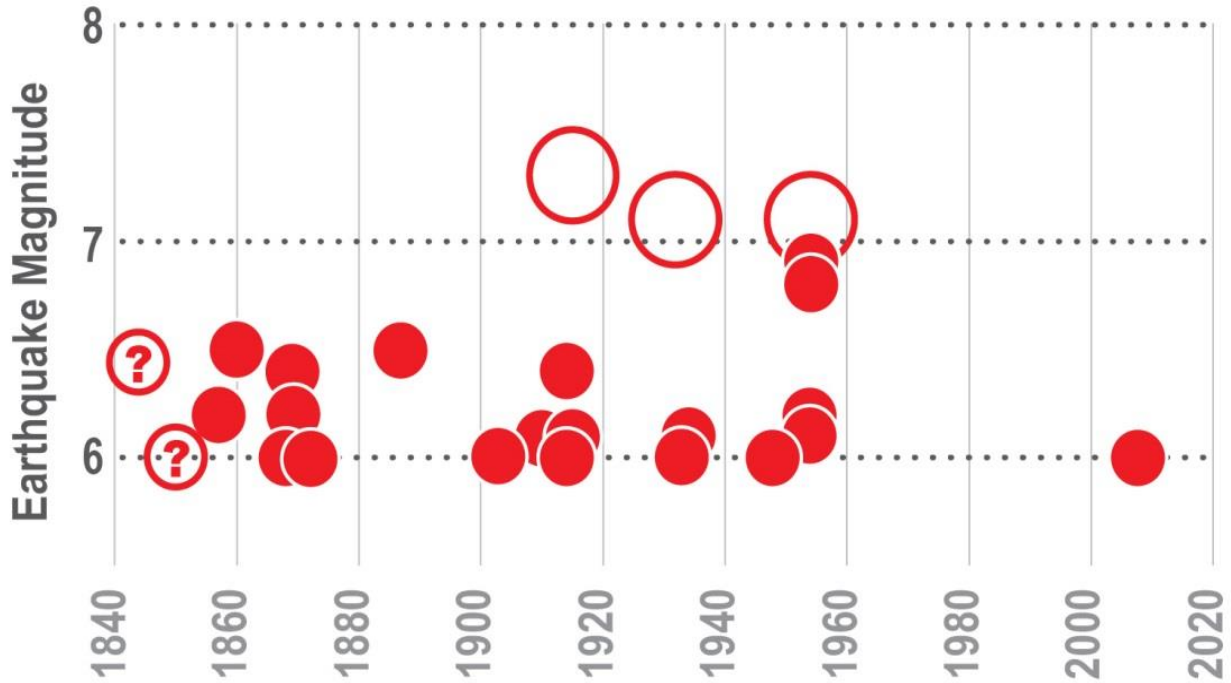


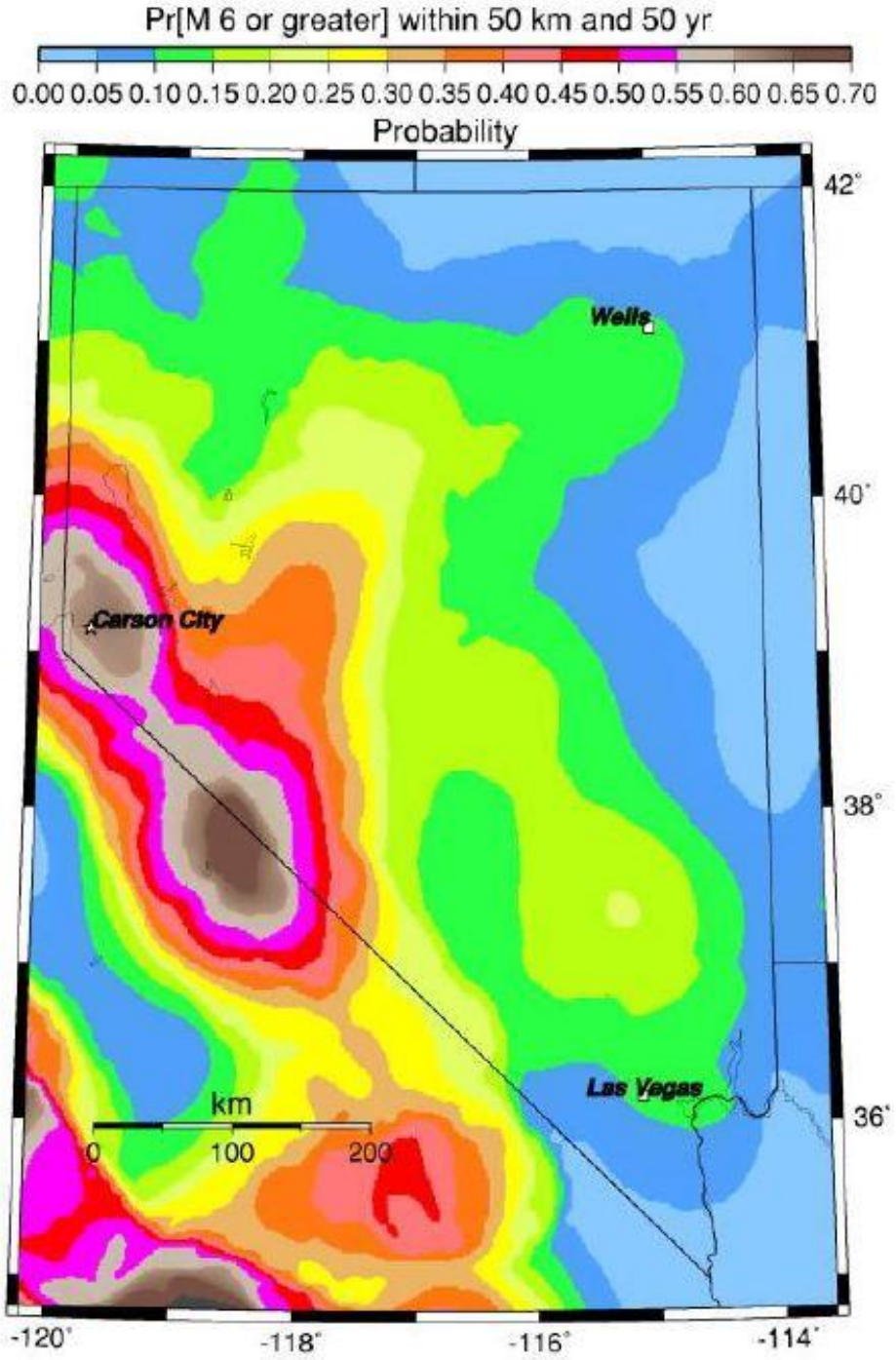
Figure 4-17. Lake Mead surface elevations from February 1935 (initial filling) to the end of September 1992. See Fig. 4-18 for annual earthquake energy for the same time period.

Reservoir-Induced Earthquakes

U.S. Bureau of Reclamation (1993)



Nevada's Major Earthquake History



Wells 12% chance

M6 earthquake occurred Feb. 21, 2008

Earthquakes are about consequences,
not probabilities of occurrence.

HAZUS Earthquake Loss Modeling

- **M 6** near Las Vegas had modeled losses of about **$3B***.

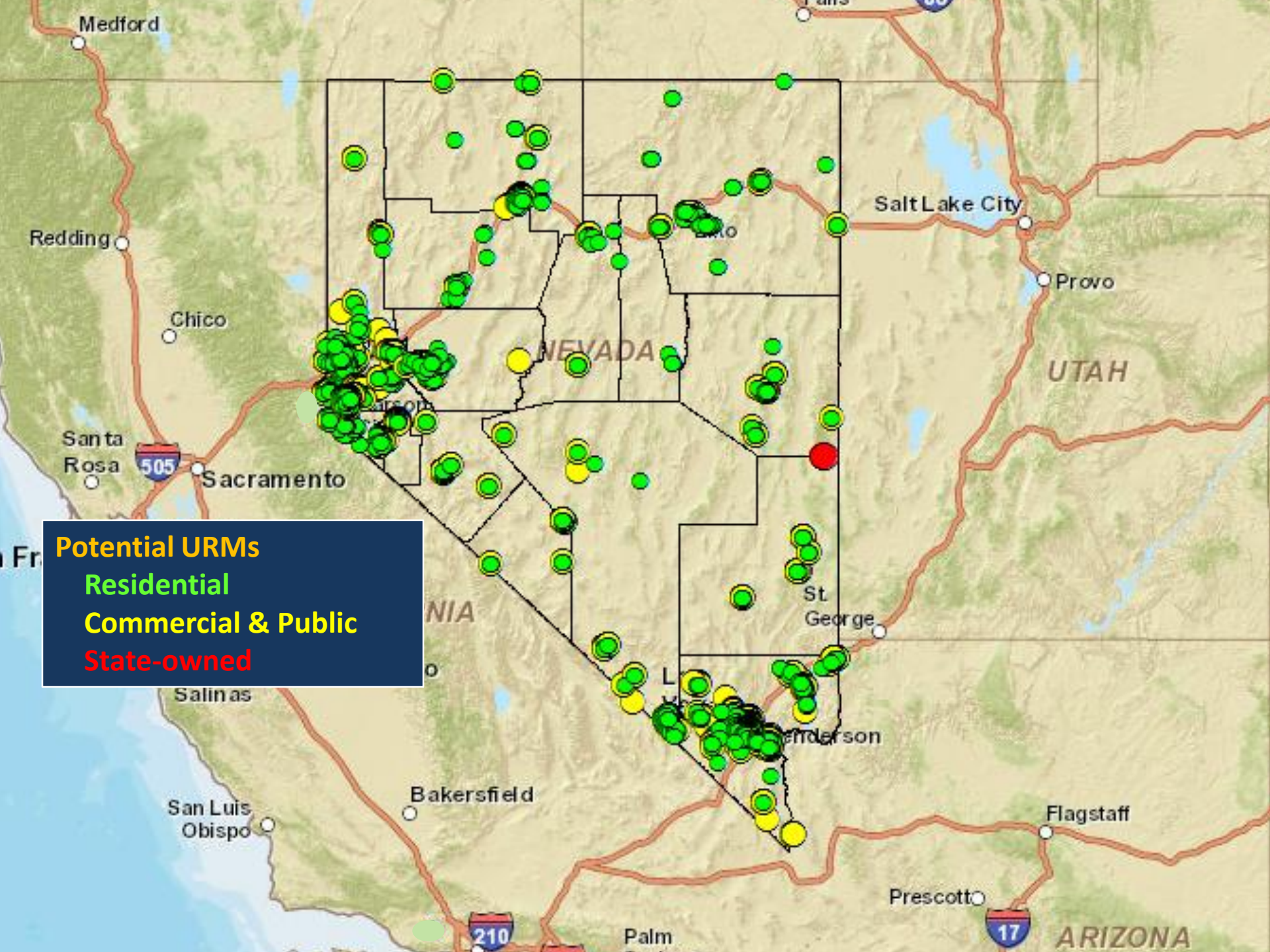
- **M 7** near Las Vegas had modeled losses of about **$21B***.

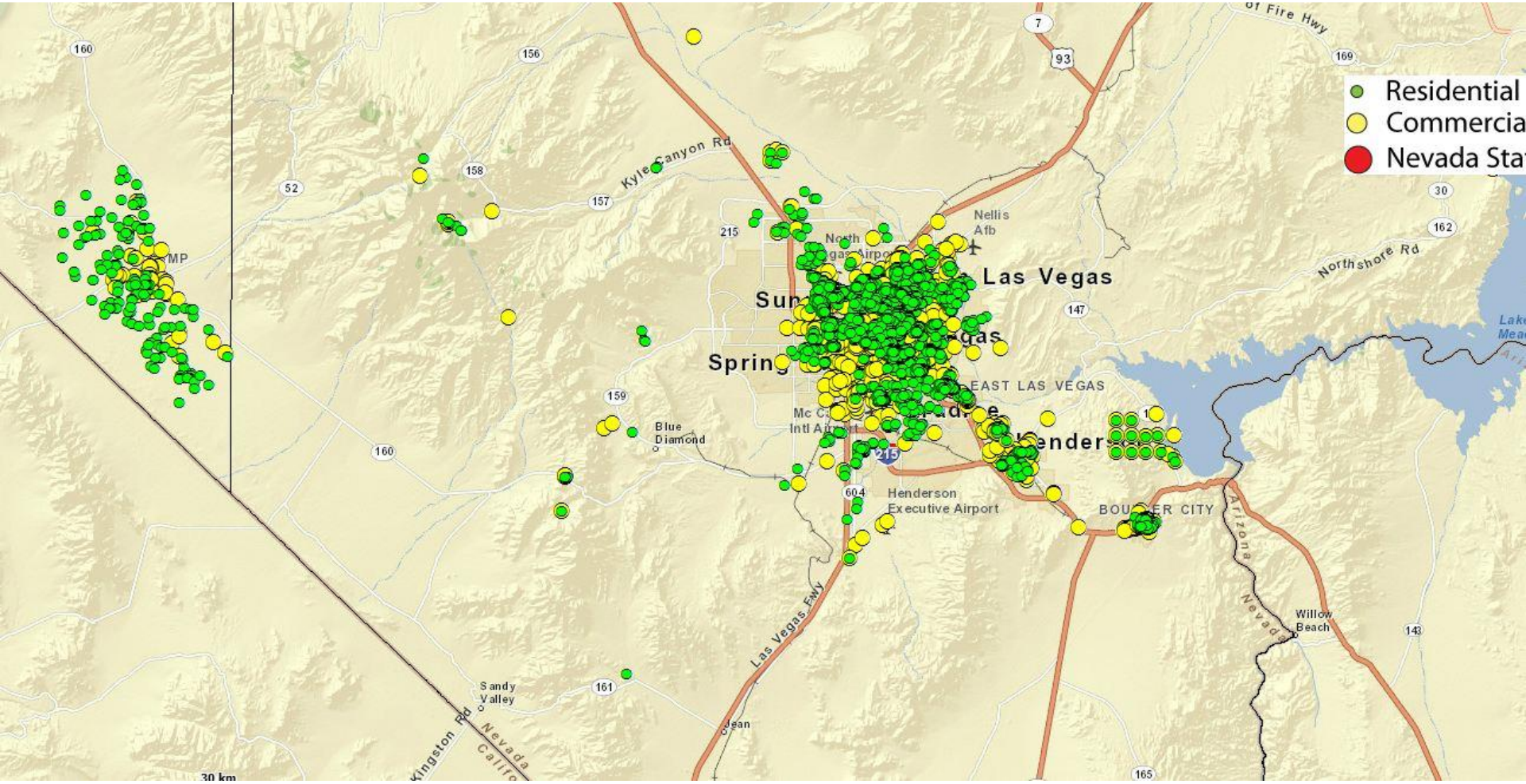
* *Estimates are +/- a factor of 10*

Potential Unreinforced Masonry Buildings in Nevada*:

7,354	Residential
16,145	Commercial & Public (city & county)
98	State-owned
23,597	TOTAL*

* The total does not include buildings owned by the federal government.


Potential URMs
Residential
Commercial & Public
State-owned
Medford
Redding
Chico
Santa Rosa
505
Sacramento
Salinas
San Luis Obispo
Bakersfield
Palm
210
NEVADA
UTAH
ARIZONA
Salt Lake City
Provo
St. George
Flagstaff
Prescott
17


Residential
Commercia
Nevada Sta
Las Vegas
Nellis
Afb
North
Las Vegas
Airport
Mc C
Intl Airport
EAST LAS VEGAS
Henderson
Executive Airport
BOULDER CITY
Blue
Diamond
Sandy
Valley
Jean
Willow
Beach
Kyle Canyon Rd
Northshore Rd
Las Vegas Fwy
Arizona
Nevada
Nevada
Calif
Kingston Rd
30 km
MP
160
156
158
52
157
215
159
160
604
161
7
93
169
30
162
147
143
165

Strategy to Deal with URMs a Challenge

- Economically very difficult to impossible,
- Life-safety rehabilitation can still lead to a post-earthquake loss of the building (limited benefit to cost breadth),
- We are currently accepting the risk.

Many, Many Good Buildings in Las Vegas – Contents and Nonstructural Threats

- **Safety needs to be considered**
  - during the event (preventing injuries)
  - immediate post-event
  - emergency response
- **Value/costs need to be considered**
  - protecting valued items

Earthquake Disaster Response Plan and Capability

- Generally good response and mitigation plans,
- Good familiarity with and practice of plans,
- Some enhanced resources in communities,
- Generally good personnel training,
- Strategies are in place to periodically enhance plans,
- **Detailed earthquake planning scenario** could enhance response plans.

Recovery Plan Critical

- **Response and handling of visitors – first PR for recovery.** Will the visitor exodus be coordinated to minimize response impedance, visitor suffering, and other negative impacts?

- **Can people/businesses get reestablished?** Information, inspections, physical help, trash bins, advise, utilities, reconstruction loans.

Recovery Plan Critical

- **Post-earthquake environment difficult to plan in and recovery has to happen as quickly as possible.** Helps people feel they are getting back in control; minimize business interruption; pre-strategize recovery resources and needs.

- Engage as soon as emergency response needs wind down – **need pre-event recovery plan**.

Some Conclusions

- Definite earthquake disaster potential in Las Vegas that needs to be seriously prepared for,
- Detailed earthquake disaster planning scenario excellent tool for visualizing situations and potential actions, and motivating preparedness,
- Have a detailed recovery plan ready before the next disastrous earthquake.