

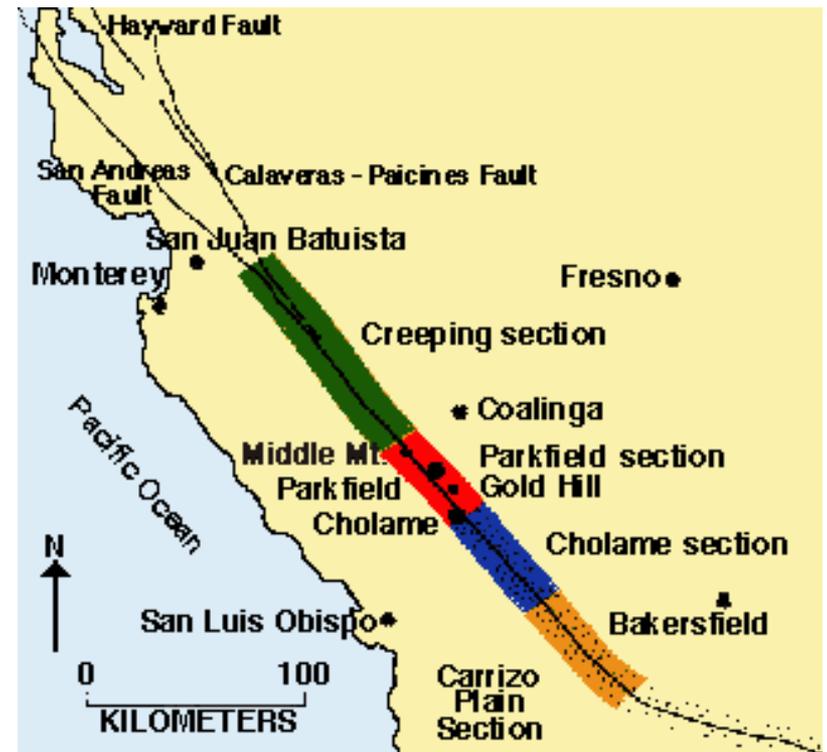
# California's Earthquake Legislation

# California's Earthquake Legislation

- Generally follows every earthquake
- Attempts to alleviate problem observed

# Legislation, Paso Robles Earthquake

- Associated with M6 and M5 eqs in late September
- Paso Robles, 2003-\$250,000 in damage
- Unreinforced brick bldgs must post signs
- Encourages the retrofitting of unreinforced brick by not requiring other non-seismic improvements



# 1933 Long Beach Earthquake

- Collapse of URM
- Schools collapsed
- Recognition that lateral forces caused building collapse



# Collapse of Unreinforced Masonry School

- 5 teachers killed
- Field Act passed
- Gave the state authority to supervise structures built for schools

# Earthquake Codes

- $F = CW$
- $F = \text{force}$
- $C = \text{constant depending on building material, earth material, and number of building stories}$
- $W = \text{weight of building}$
- **Recognition of lateral forces: acceleration**

# 1933 Long Beach Earthquake

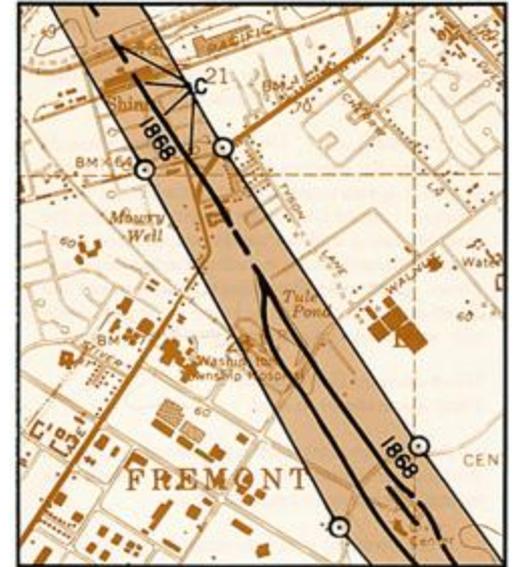
- Building response
  - Un-reinforced masonry
- Field Act: legislation
- Seismic Element Code (F=CW)
- First acceleration records
- Expertise and classification of “structural engineer” developed

# 1971 San Fernando earthquake

- “Hidden thrust”
- Hospital structure response
- Alquist- Priolo Act-ground rupture
- Dam safety act
- Ground accelerations  $> 1g$
- Performance of hydraulic fill structures
- Infra-structure: roads, power, water supply

# Alquist-Priolo Act

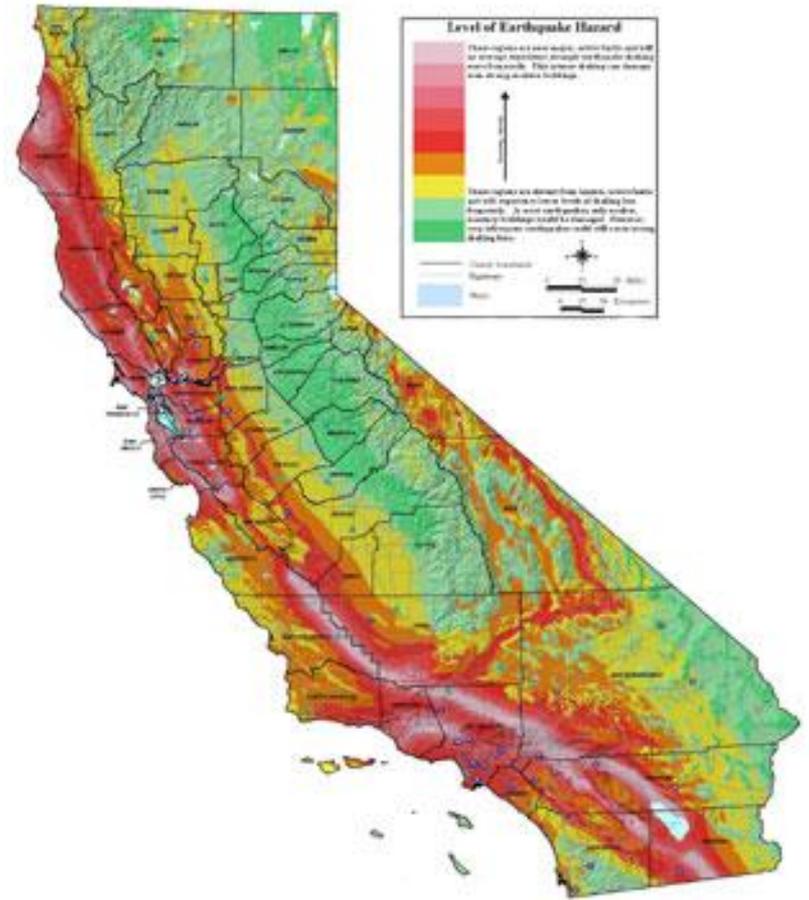
- Prohibits building structures for human occupancy on active faults



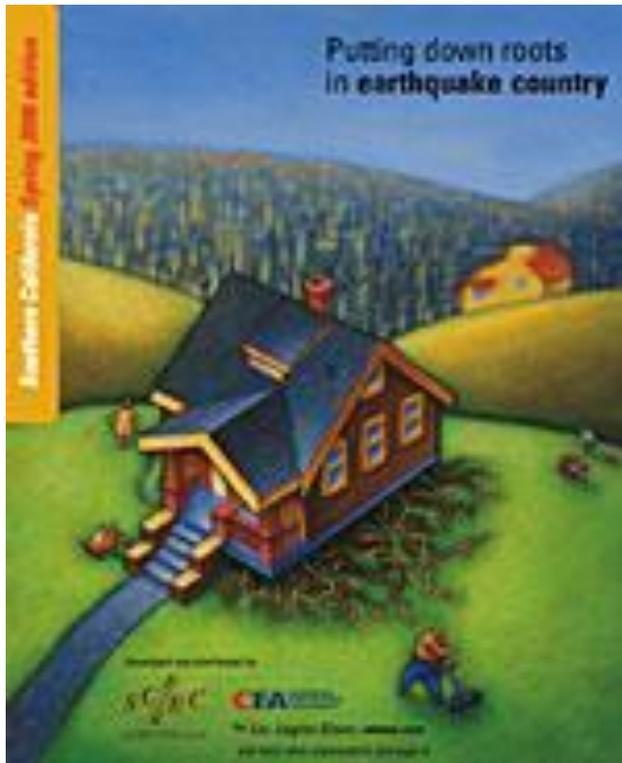
1989, Loma Prieta Earthquake

# Seismic Hazard Mapping Act

- This act addresses the fact that areas tend to respond the same during an earthquake
- Maps indicate areas that are most likely to experience, ground shaking, liquefaction and landslides
- Maps are used by cities and counties for guidance



# Education



American Red Cross, Bay Area Chapter

Association of Bay Area Governments

California Earthquake Authority

California Geological Survey

Earthquake Engineering Research Institute

Governor's Office of Emergency Services

San Francisco Office of Emergency Services  
and Homeland Security

Southern California Earthquake Center

Structural Engineers Association of Northern  
California

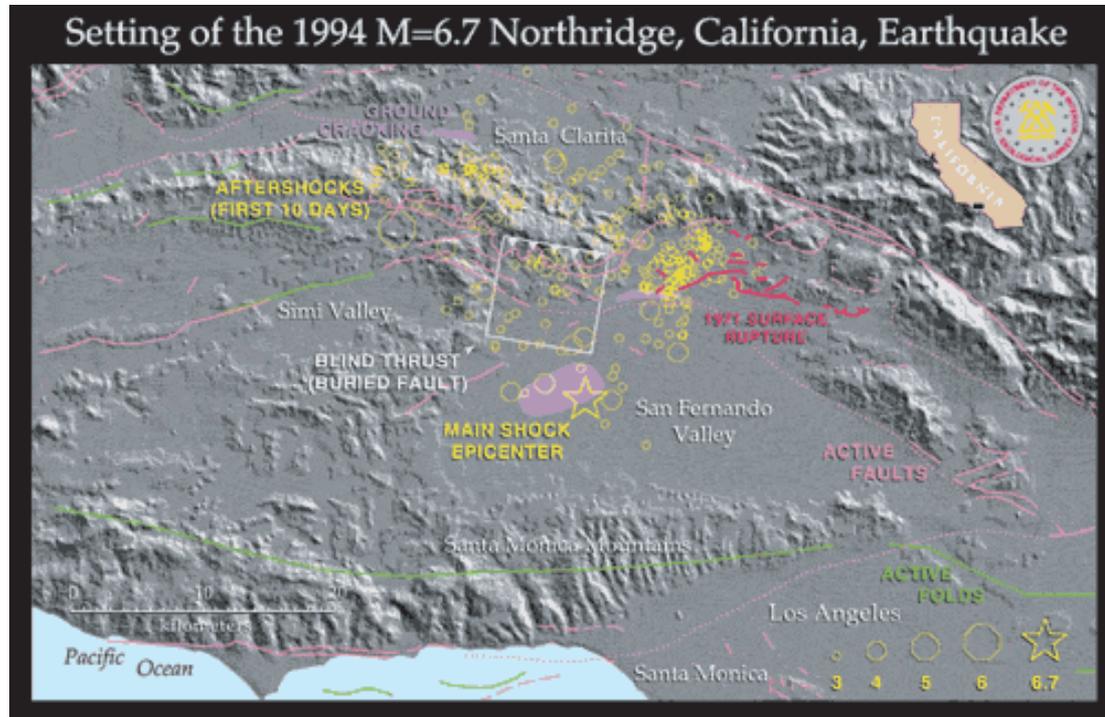
University of California Berkeley

U.S. Department of Homeland Security,  
Federal Emergency Management Agency

U.S. Geological Survey

# The Northridge Earthquake

# Northridge Earthquake



The mountains are the surface expression of the fault.  
This fault was unknown before this earthquake.

# California Earthquake Authority

- 1994, Northridge, 12.5 billion dollars damage
- 1995-private companies restrict or refuse to write earthquake insurance
- 1996-California Earthquake Authority

# California Earthquake Authority

- privately financed, publicly managed
- sell to homeowners, mobile home owners, condominium owners, and renters

# California Earthquake Insurance

Post-Northridge Earthquake- **Chuck Quakenbush**  
the California Insurance Commissioner

- Refused to punish insurance companies who mishandled claims associated with the Northridge earthquake
- Currently lives in Hawaii

# California Earthquake Insurance

- Instead of forcing insurance companies to pay large sums of money to earthquake victims whose claims were mishandled
- Collected 11.6 million dollars in donation to grants and non-profit corporations created by Quakenbush
- Some of the funds were used in his campaign

# CEA

- Rates are developed depending on
- 1.
- 2.
- 3.
- 4.
- 5

# CEA: rate criteria

- Rates are developed depending on
- 1. proximity to active fault
- 2. earth material
- 3. special study zones
- 4. building materials
- 5. age of structure
- 6. ?

# California Earthquake Insurance

- Coverage shall be in accordance to the rules of insurer
- up to the current building code
  - bolted to foundation
  - bracing for cripple wall
  - strapping of water heaters

# California Earthquake Insurance

- Rates vary from \$1.10 to \$5.25 per 1000 dollars

# California Earthquake Insurance

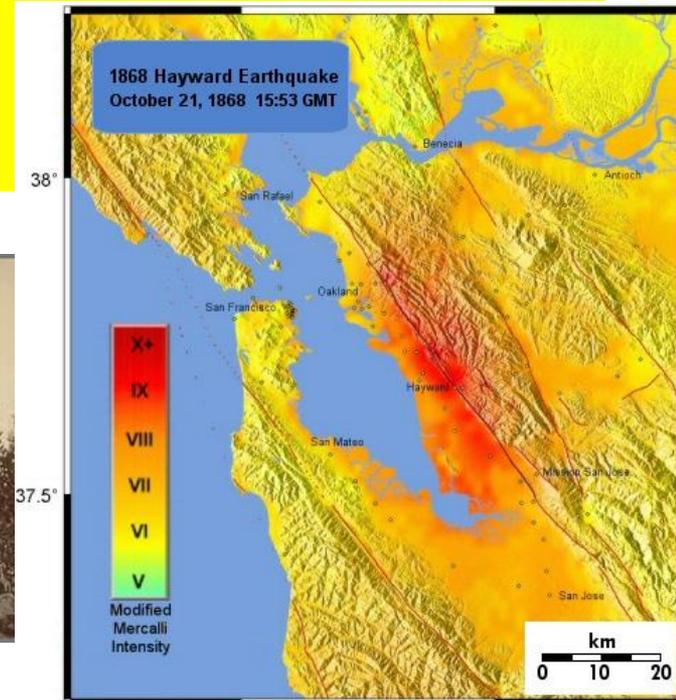
- 60 days of renewal or issuance of insurance
- authorized insurer (by the state)
- disclosure of discounts or surcharges
- dwelling not including:
  - outbuildings,
  - swimming pools
  - masonry fences and walls
  - masonry chimneys

# California Earthquake Insurance

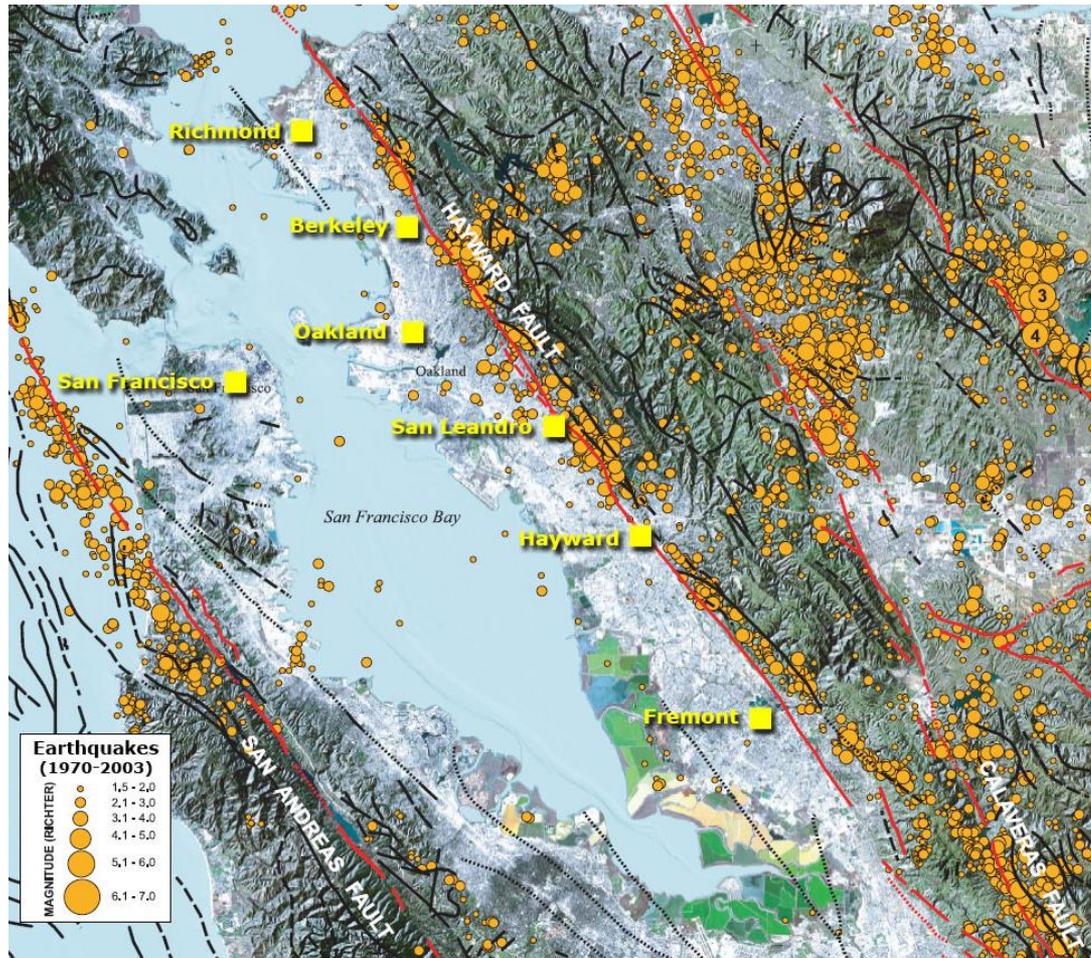
- **Base-limits earthquake coverage**
- **Coverage A-Dwelling:** the structure is equal to the amount of homeowners policy
- **Coverage B-Deductible, 10-15%**
- **Coverage C-Contents:** \$5,000 -100,000
- **Coverage D-Loss of use:** \$1500 -15,000
- **Coverage E-Limited building upgrade:**  
\$20,000 limit

# Bay Area Earthquake

- Hayward Fault: M 6.8
- \$112-122 billion in economic loss
- < 15 % covered by insurance



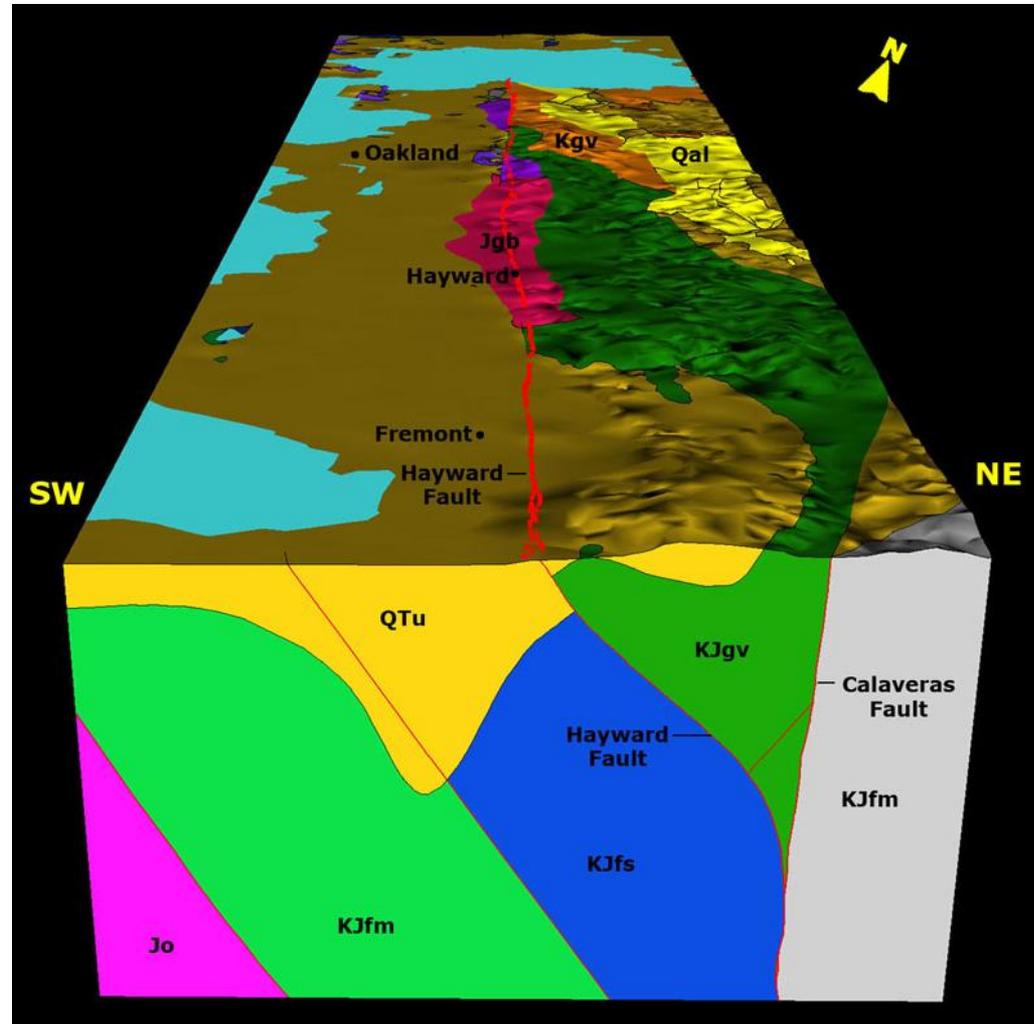
# Hayward Fault



# Hayward Fault Earthquake, 20??



# Geological Cross-section



# Earthquake Prediction and Probability

- 1868 earthquake
- Hayward fault
- Damage is equated to the Modified Mercalli Scale, then a Richter Magnitude is assigned
- County Court House
- Cripple wall damage
- Have we fixed this problem?

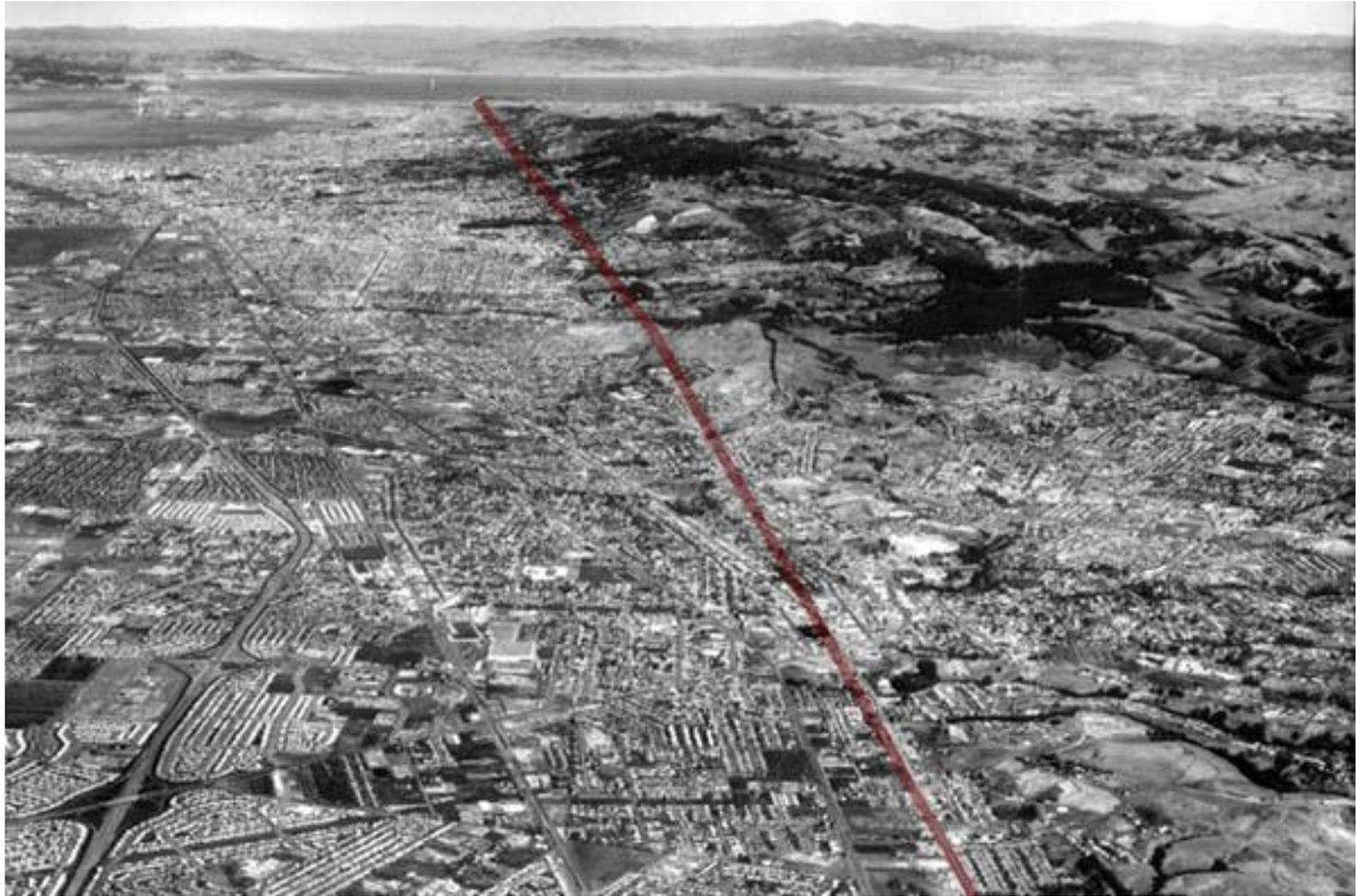


# Scenario for a M 7 earthquake on the Hayward Fault

- Moves at about 9mm per year
- 12-13KM at depth
- Extends from Fremont, Hayward, San Leandro, Berkeley to El Cerrito
- At the surface and below 12 KM it is creeping
- The intermediate portion is locked since 1868

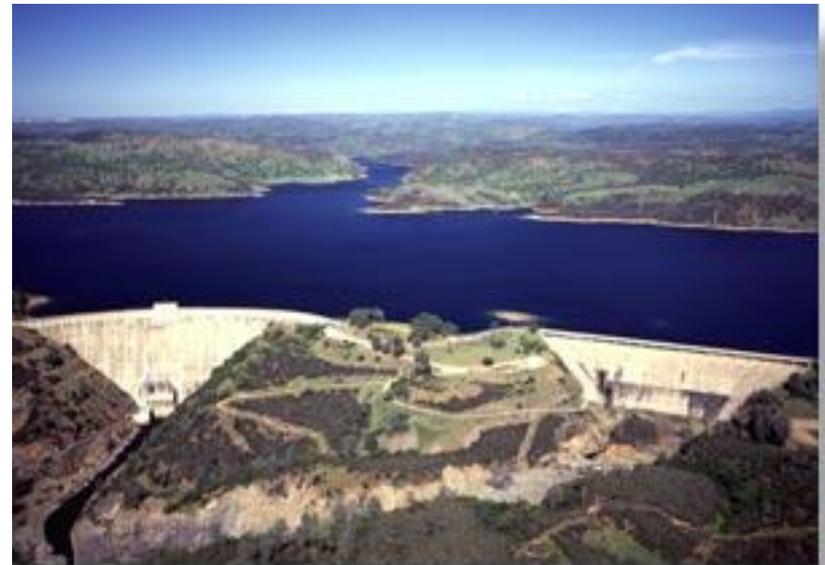


# Quake 2003 Scenario

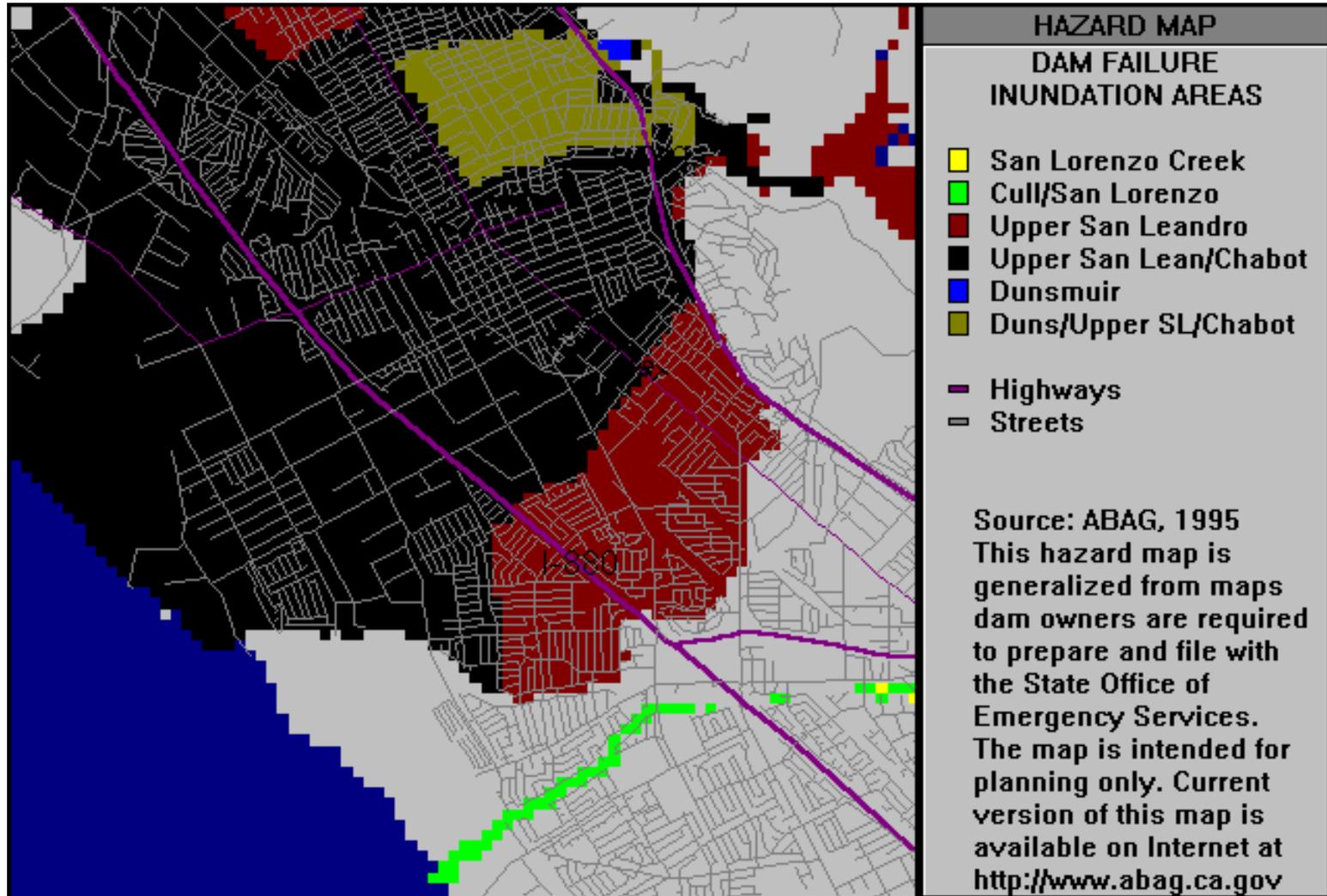


# Hayward fault earthquake

- Water and sewer delivery will be halted
- Liquefaction and ground shaking
- Breaking of pipes
- 60% of customers out of service
- 75% will not have service if reservoirs run dry



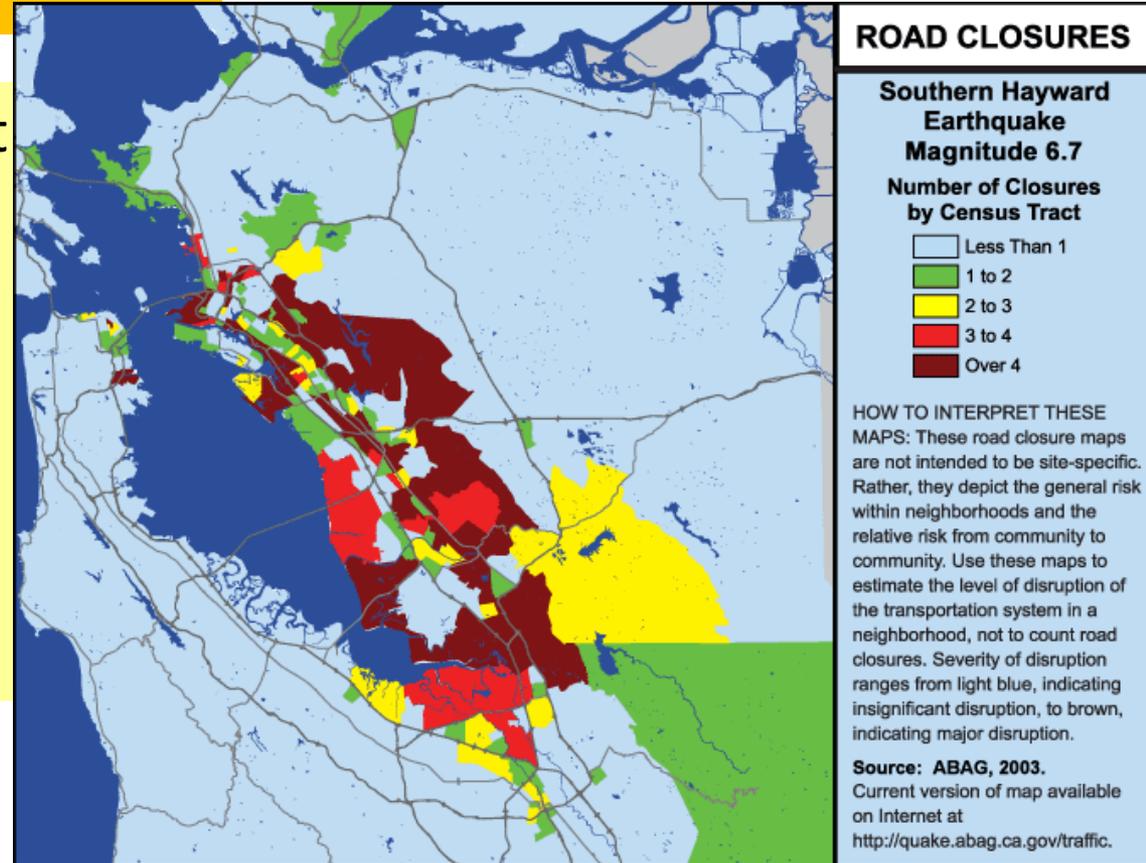
# Dam Failure



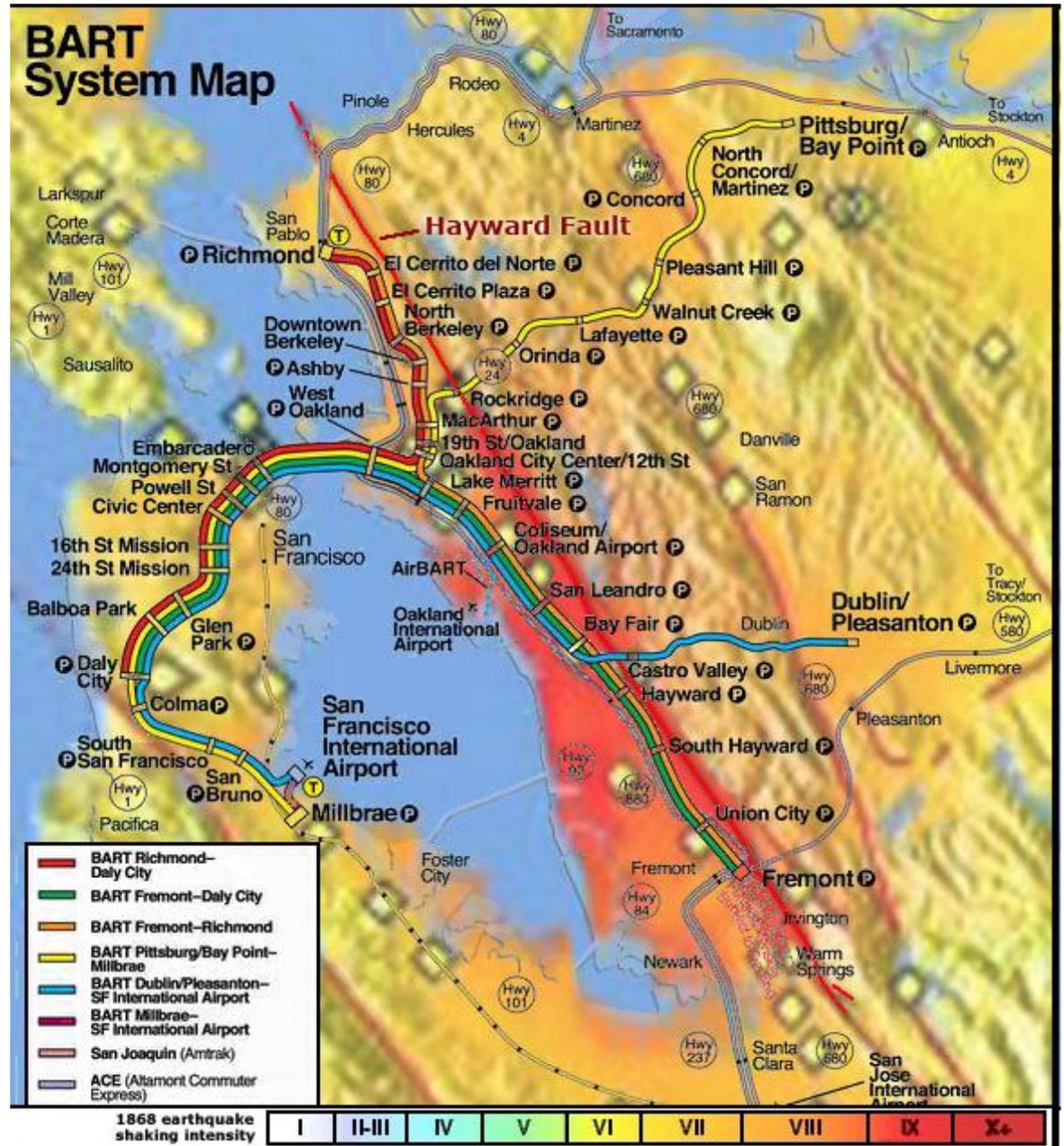


# Transportation

- 1989- 300 feet of runway lost at Oakland airport
- Damages to bridges- 0.05-.1g of lateral force
- San Mateo Bridge- retrofitted
- New Antioch bridge



- **BART** crosses the Hayward fault-Orinda Tunnel
- 238
- crosses 580

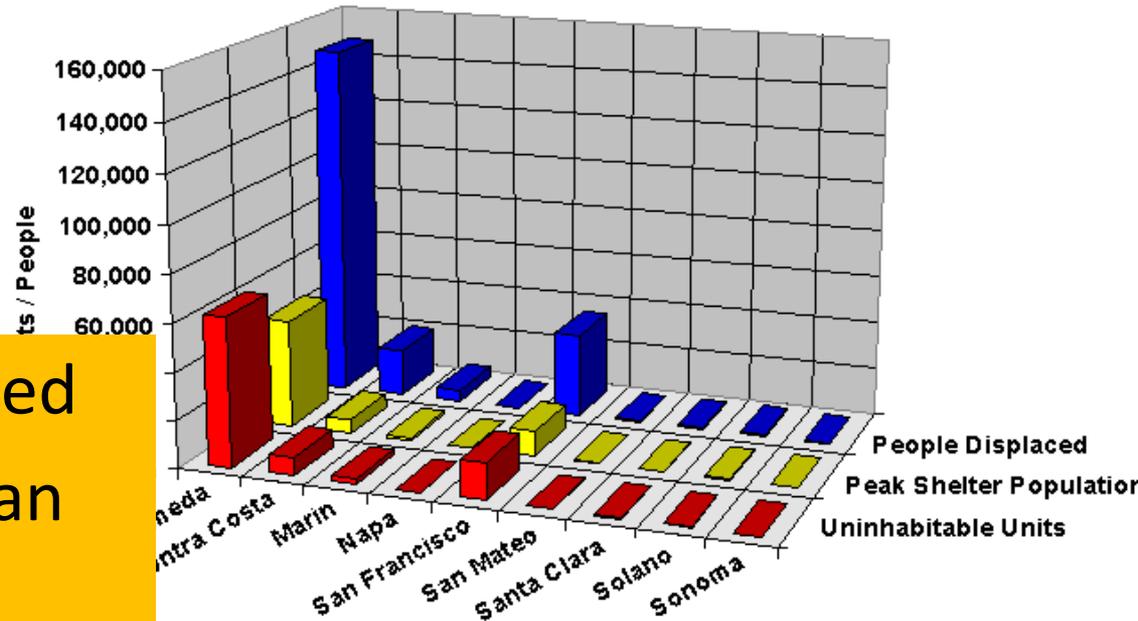


# Structures

- Industrial and light commercial buildings- 500 red-tagged in Alameda and Contra Costa Counties
- Unreinforced masonry buildings- 500
- Residential buildings-7000

# Housing

HOUSING IMPACTS OF AN EARTHQUAKE ON THE NORTHERN HAYWARD FAULT



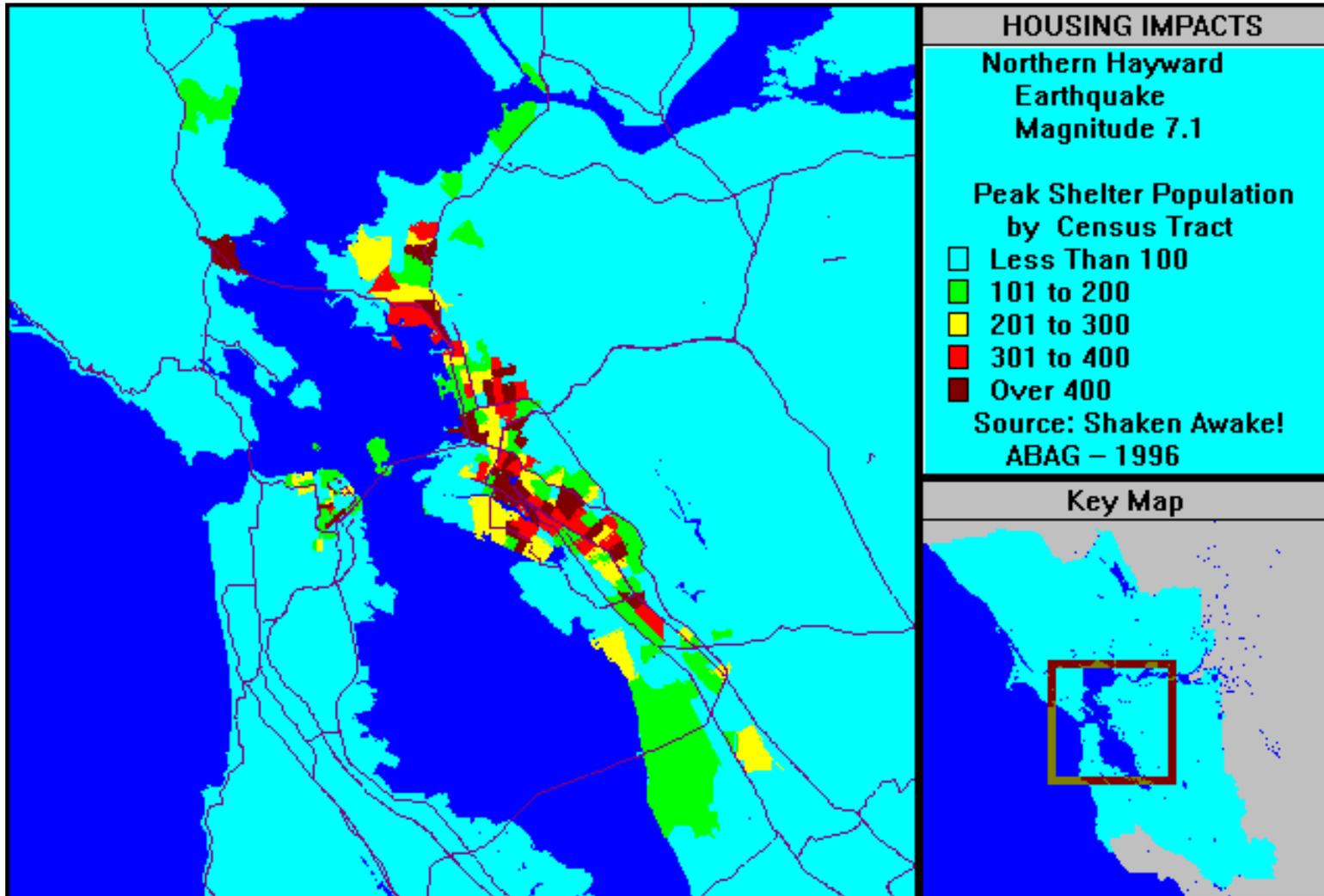
- 370,000 people displaced
- 95% in Alameda and San Francisco Counties
- 16% in Bay Area-loss of multi-family housing
- Unreinforced masonry
  - 92% loss in Alameda County
  - 55% in Bay Area

# Hospitals

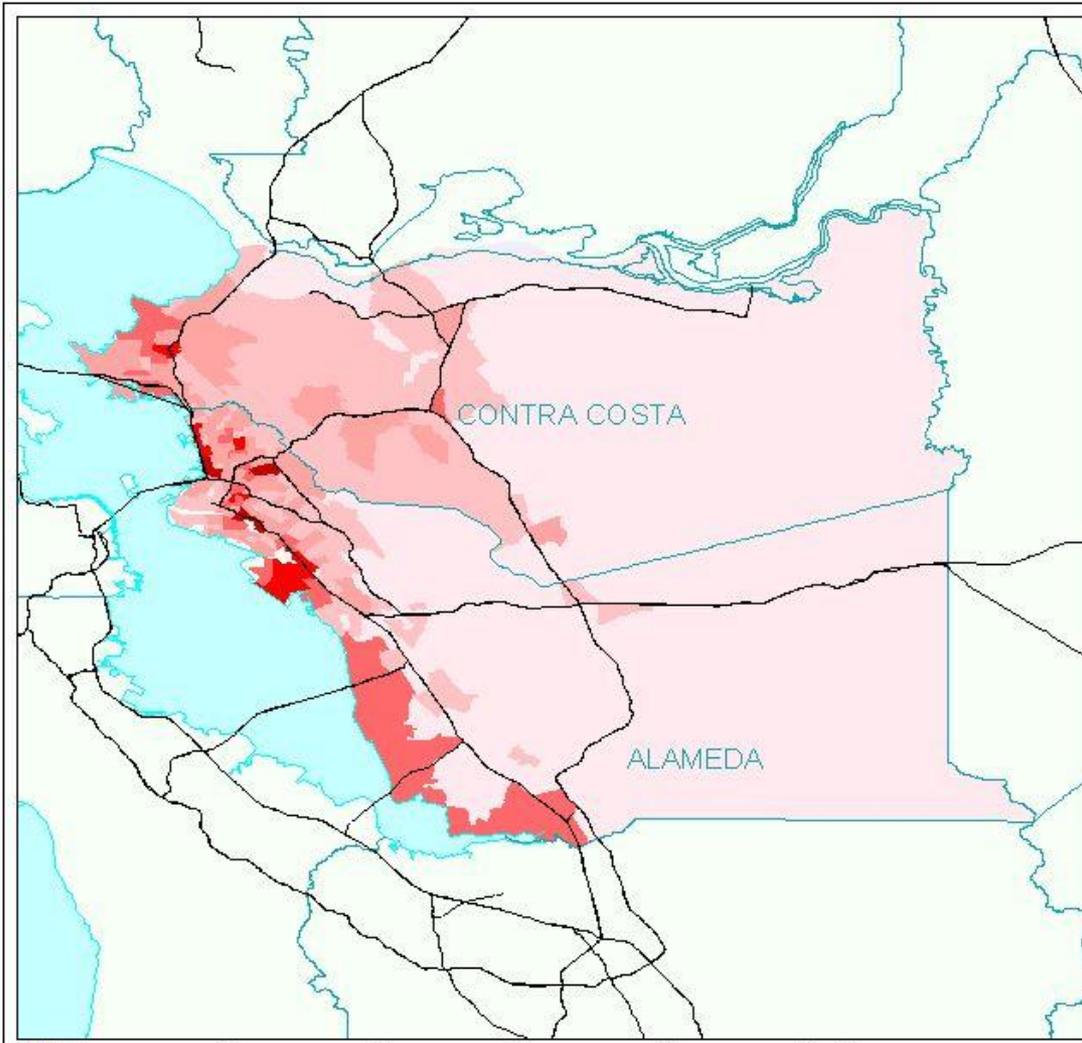
- 20% of the beds are in good location
- 50% in marginal buildings
- 30% in bad buildings
- 2008-retrofit poorly designed structures
- 2030- all structures should be to code



# Shelter Population







# Economic Loss

HAZUS MODEL RUN

\*\*\*\*\*

**North Hayward Event  
Magnitude 6.5  
March 25, 2003**

- Interstate
- County Boundary
- Economic Loss by Census Tract**
  - \$1,000,000,000 - \$2,000,000,000
  - \$500,000,000 - \$999,999,000
  - \$100,000,000 - \$499,999,000
  - \$50,000,000 - \$99,999,000
  - \$30,000,000 - \$49,999,000
  - \$15,000,000 - \$29,999,000
  - \$5,000,000 - \$14,999,000
  - \$1,000 - \$4,999,000
  - No Economic loss
  - Area Outside Study Region

## Economic Loss Per County

Alameda	\$4,070,813,000
Contra Costa	\$1,546,983,000

**Study Region Total: \$5,616,796,000**

Created by:  
CA OES GIS Unit  
J. Perton



# Bay Area Earthquake (1906 magnitude)

- 122-150 billion dollars in direct loss
- Fire, transportation, water, housing
- Up to 1800 fatalities; 8,000 injured (night)
- 3400 fatalities; 10,0000 injured (day)
- Commercial buildings: 40%-SF; 79% SCC
  - 15% overall