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Southern California Earthquake Scenario and Overview of the November 2008 ShakeOut Exercise

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Threat to Lifelines: M_w 7.8 on the Southern San Andreas Fault

May 11, 2007 (slides revised 5/12/07)

Caltech Earthquake Research Affiliates Meeting

U.S. Department of the Interior
U.S. Geological Survey

SoSAFE
Southern San Andreas Fault Evaluation

FEMA

SCEC

CGS California Geological Survey

M_w7.8 'ShakeOut' Scenario *(Nov. 2008)*

- San Andreas 'Really Big One' simulated earthquake
- Initiation near Bombay Beach (unilateral rupture to the NW)
- Slip of 4.5 meters at Cajon Pass (I-15); disruption of critical lifeline infrastructure (freeway, internet, power and gas lines)
- Basic description sent out via OES statewide and announced at SoSAFE workshop Jan. 9, 2007
- Developments needed:
  - Earthquake Early Warning
    - Zipper array along fault
    - Lifeline crossings
  - Building Damage Assessment
    - DamageMap

Credit: Nitin Gupta, OpenSHA & Ned Field, USGS

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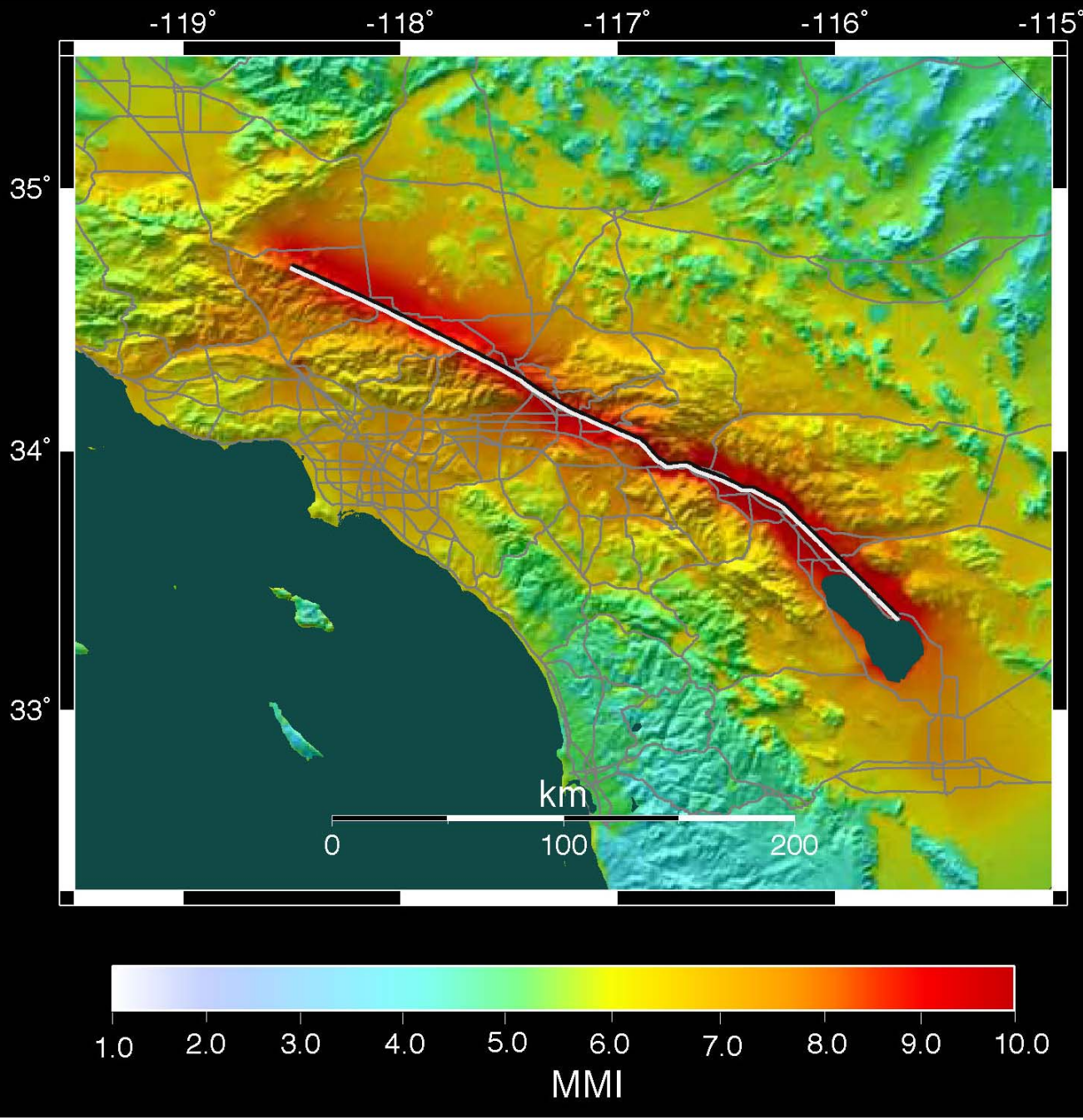
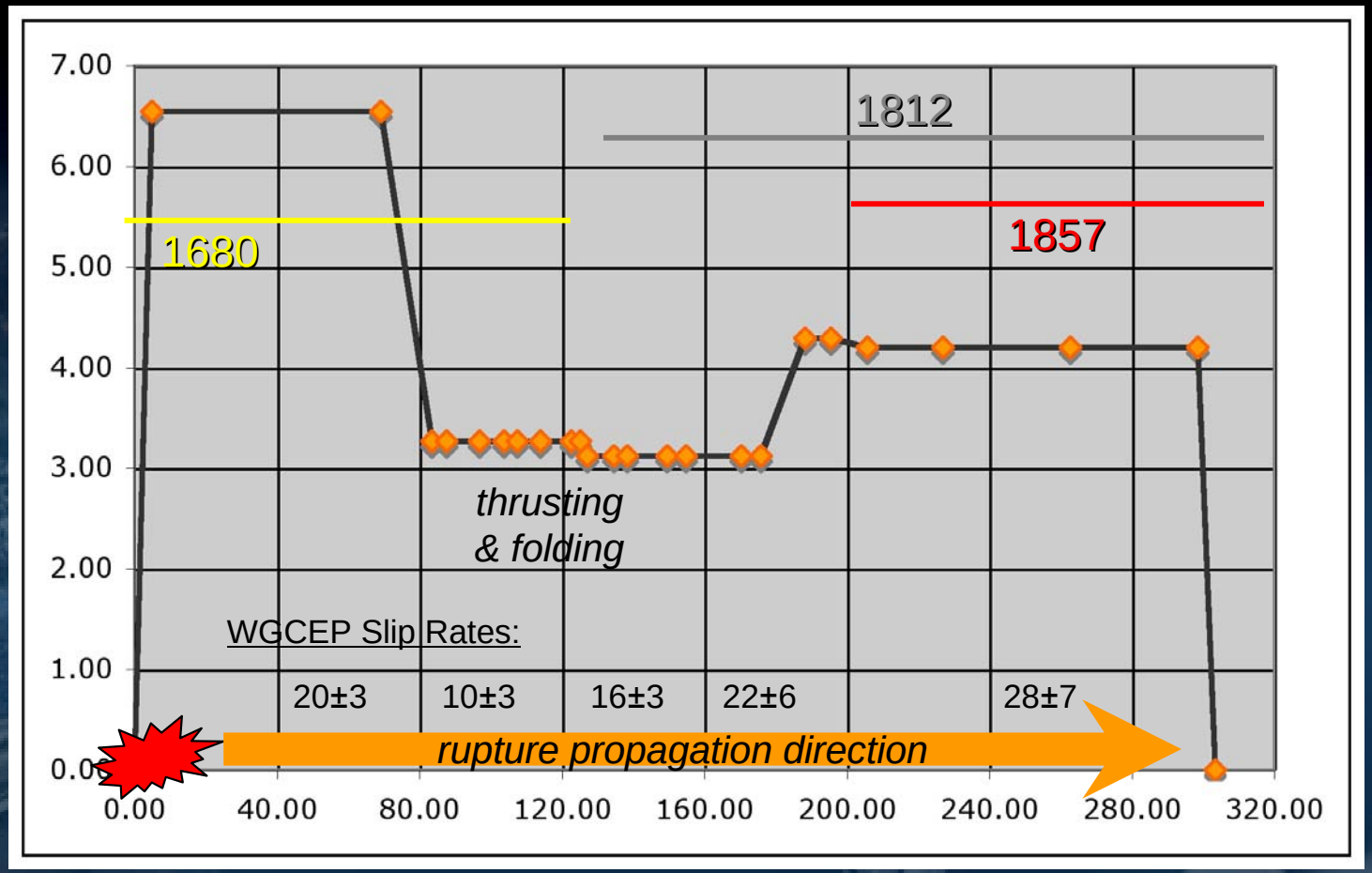
SCEC



Earthquake Scenario at 3 Levels of Detail

- Basic Rupture Description:
  - Mw 7.8, unilateral rupture starting at Bombay Beach
    - SE endpoint (Bombay Beach): 33.35009, -115.71192
    - NW endpoint (Lake Hughes): 34.698495, -118.508948
- Static Rupture Description
  - 23 points along-strike (from SCEC CFM-R)
  - Slip predictable model to construct slip distribution along-strike
  - Slip rates, dips and depths for all sections of the San Andreas from the WGCEP, Appendix A. by Wills, Weldon and Bryant (March 1, 2007 - draft version)
- Kinematic Rupture Description (v 1.1.0 as of 5/12/07)
  - Uses the SCEC CFM triangular surface representation in full detail (rather than the CFM-R). The above Static Rupture Description slip distribution formed the 'background' model during construction of the Kinematic Rupture Description as follows; a 30 km wavelength random slip function was convolved with the background slip. Then, scaling criteria were applied to the slip distribution to generate the rise time and rupture speed. From this, contours showing the rupture front at one-second intervals were also computed.
- Available with documentation at --- http://urbanearth.usgs.gov

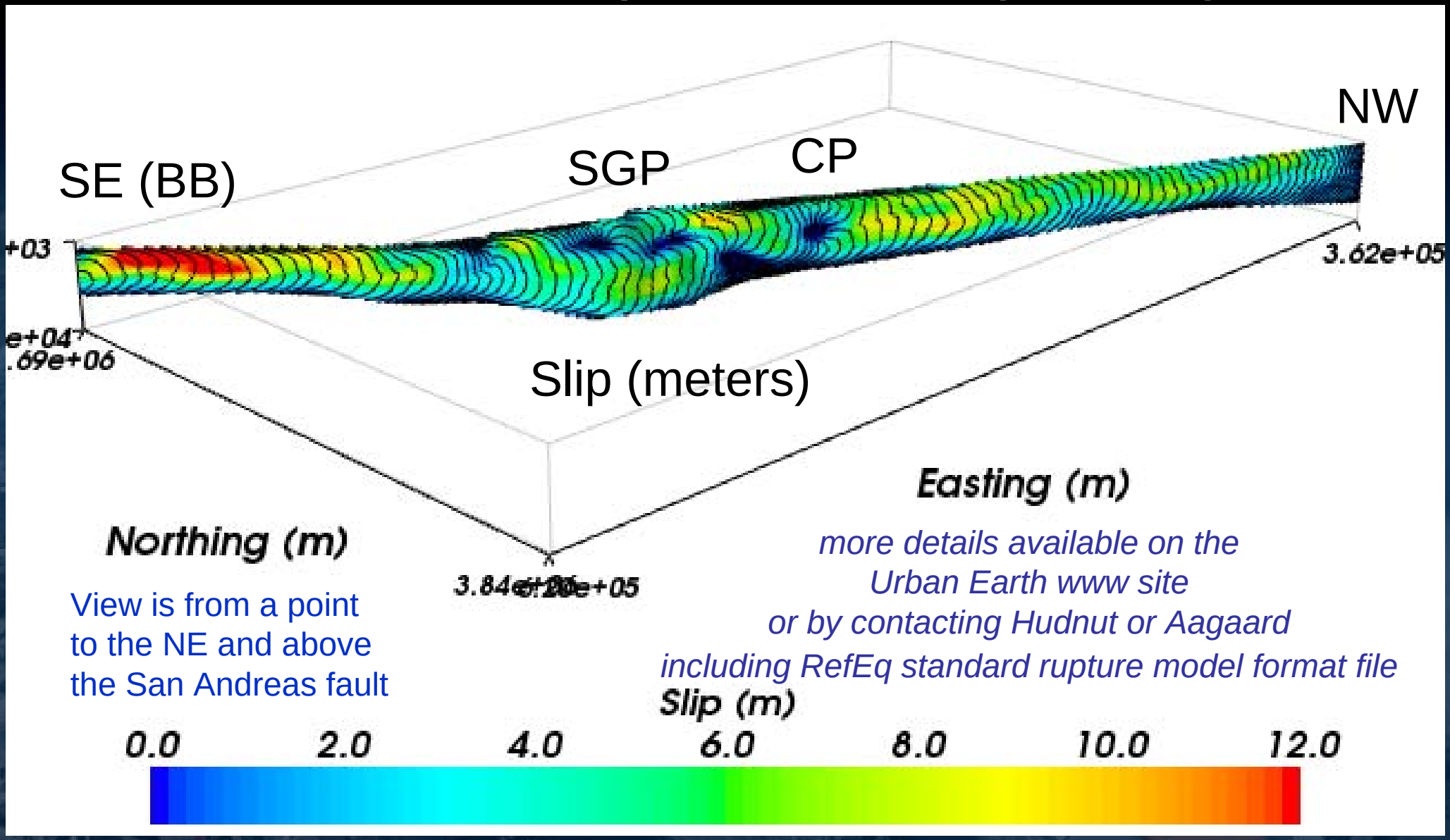
ShakeOut - Static Rupture Description



SE end
Bombay
Beach

NW end
Lake
Hughes

Kinematic Rupture Model (v 1.1.0)

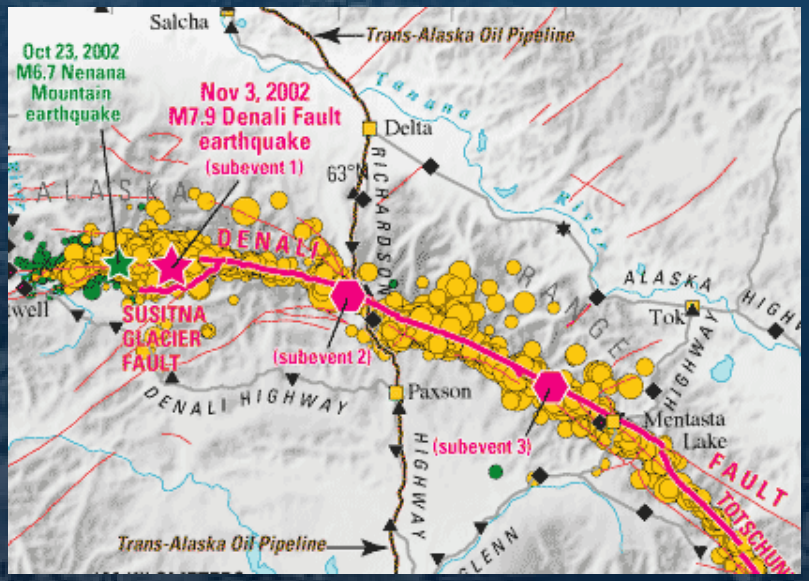


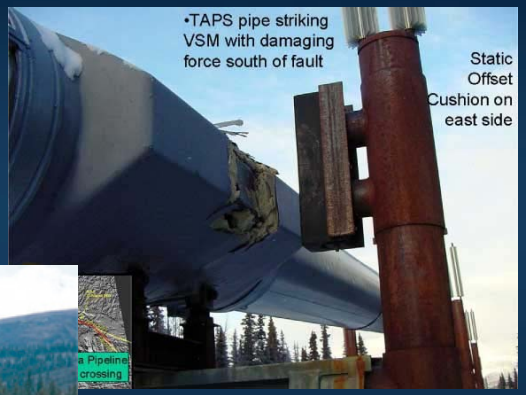
"Good science, when applied in the way that the people of Alaska have done, made the difference between an emergency and a tragedy."

Charles Groat, Director, United States Geological Survey

Each day, the Trans-Alaska oil pipeline carries one million barrels of oil, about 17% of the domestic oil supply for the United States, valued at about $25 million. If the pipeline had ruptured during the 2002 Denali earthquake, the lost revenue and cost of repair and environmental cleanup would have been incalculable.

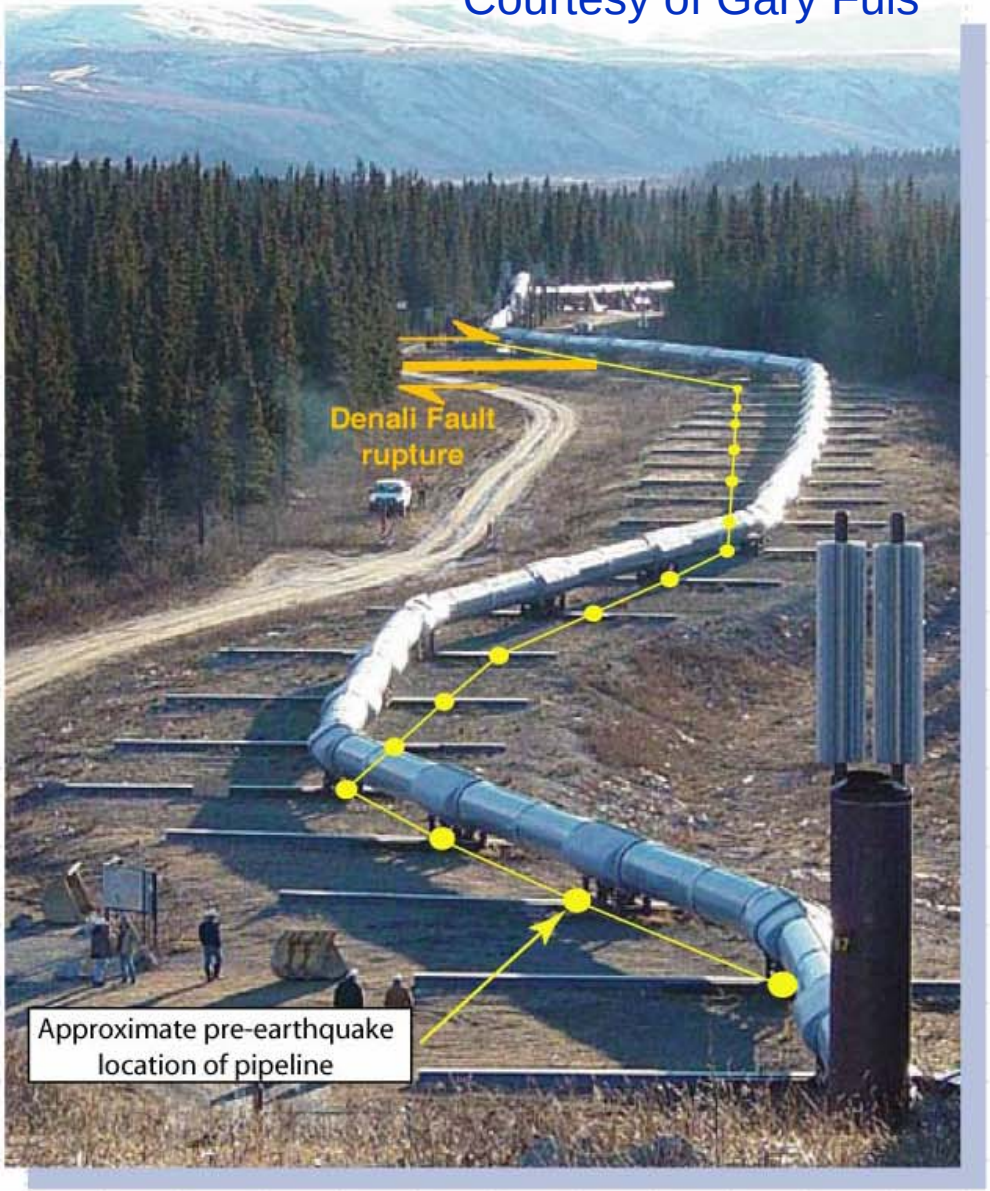
M 7.9 - similar to the anticipated San Andreas fault 'Big One'





Denali Fault Crossing (Before and After)

Courtesy of Gary Fuis

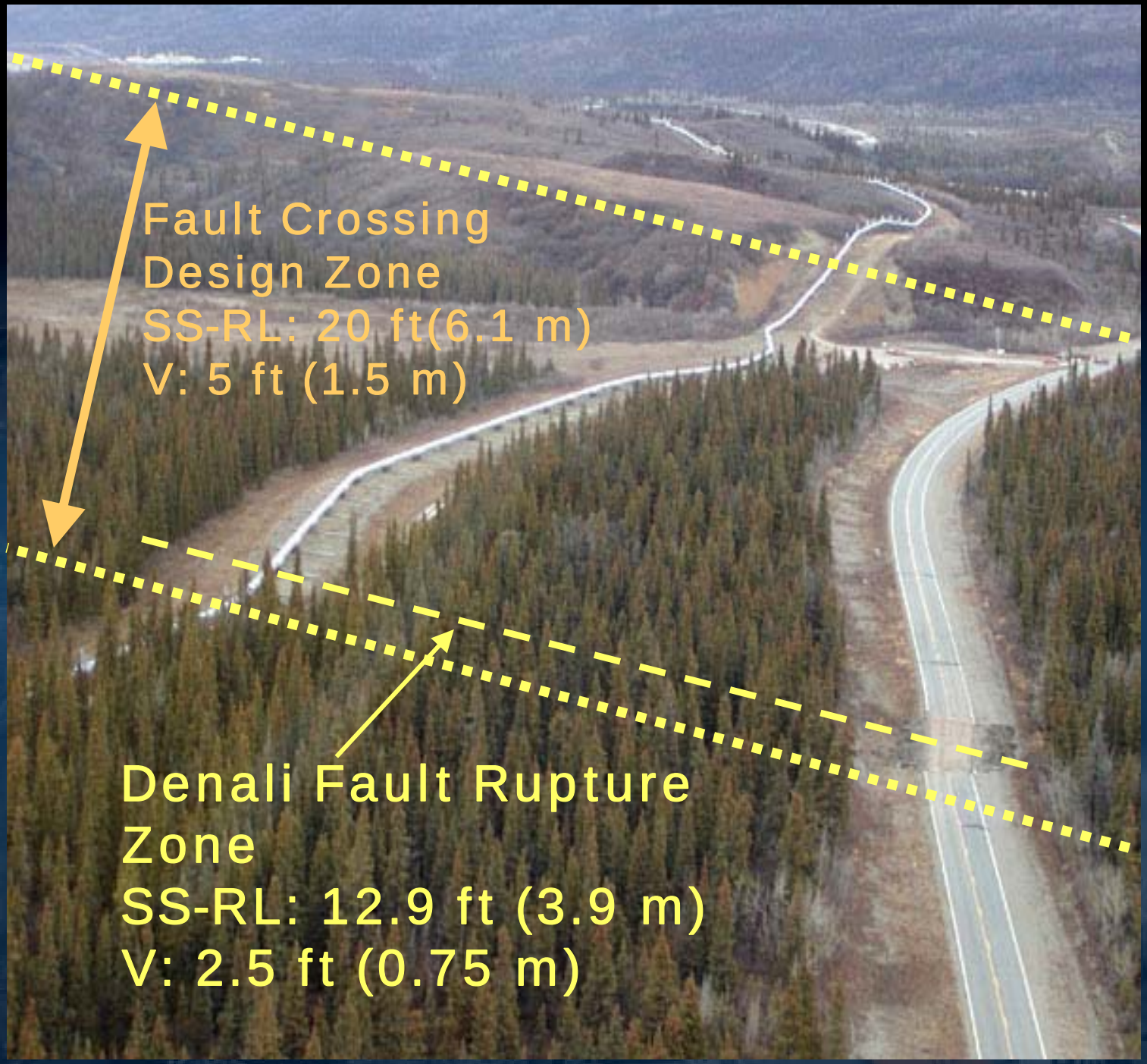


TAPS Pipeline

Denali Fault Crossing

and

Richardson Highway



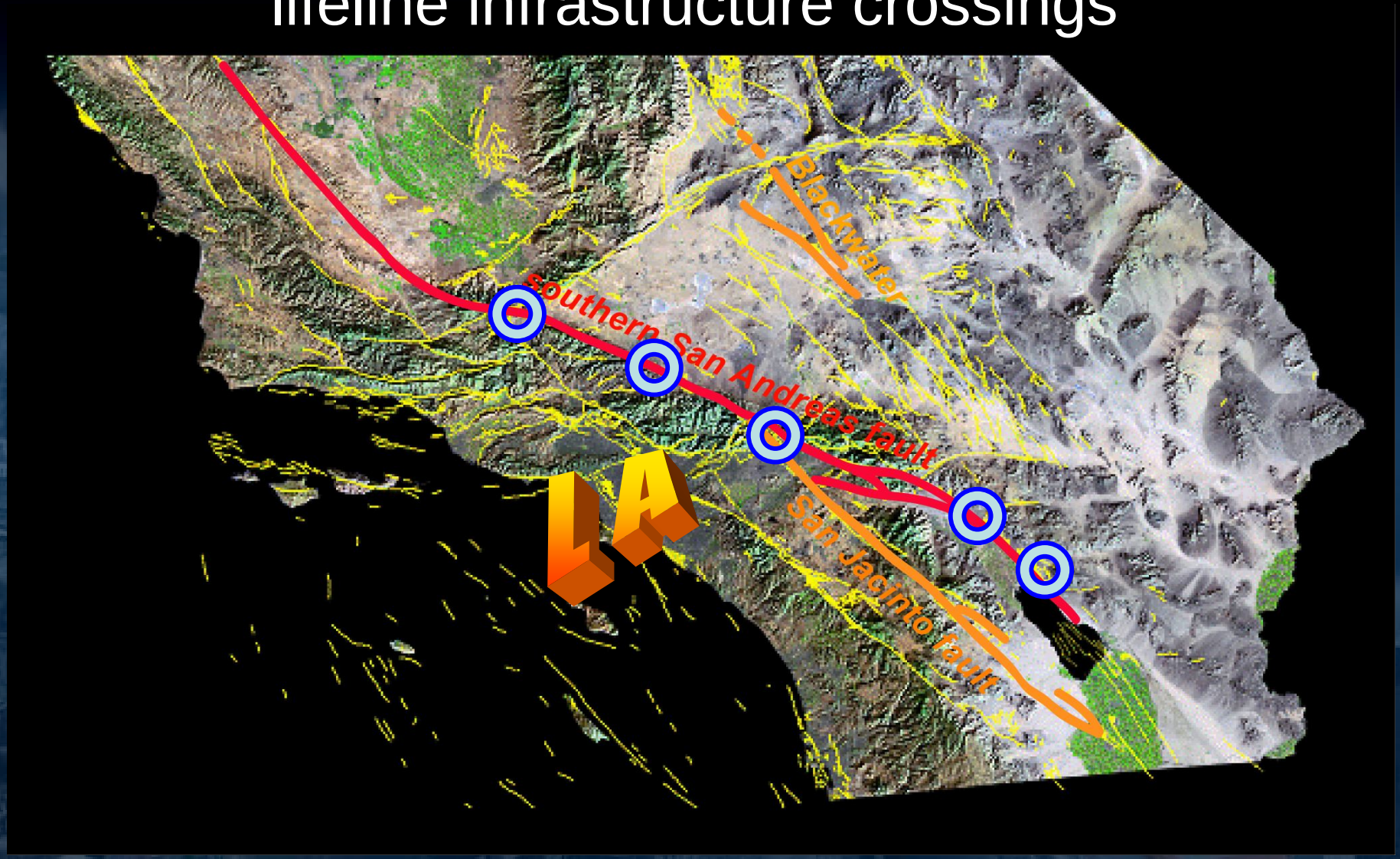
Courtesy of Cluff & Slemmons

Bucky Tart

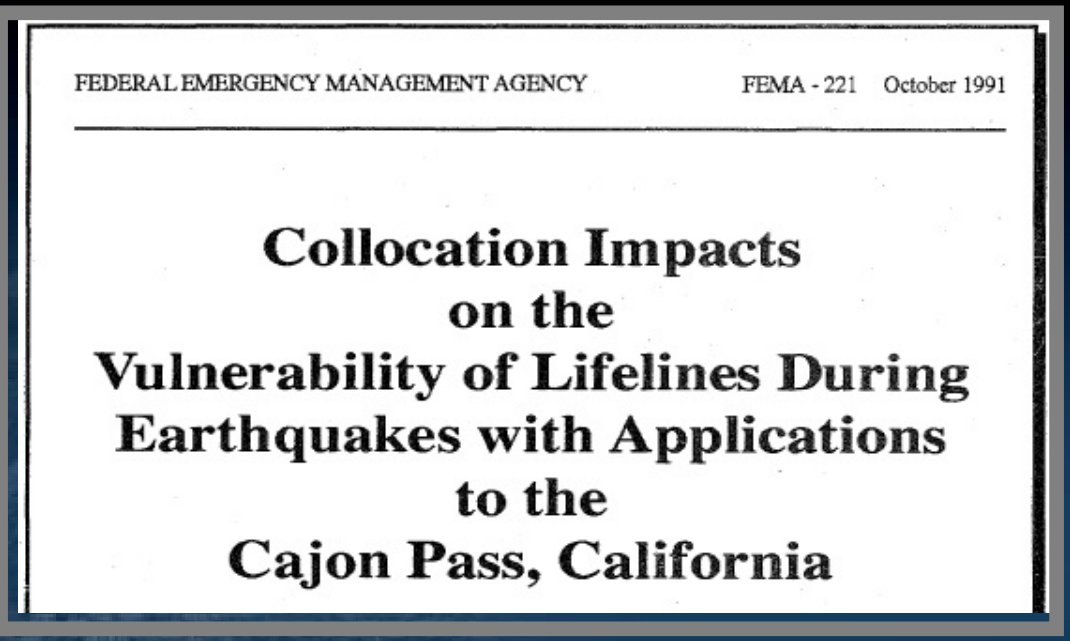
Courtesy of Gary Fuis

Courtesy of Gary Fuis

San Andreas - need to instrument major lifeline infrastructure crossings



FEMA report series (1991-1992)



FEDERAL EMERGENCY MANAGEMENT AGENCY FEMA - 221 October 1991

Collocation Impacts on the Vulnerability of Lifelines During Earthquakes with Applications to the Cajon Pass, California

disruption without yet considering collocation impact!

Lifeline	Minimum Additional Delay Before Temporary Service is Restored, days
Fiber Optic Telephone Communication	61
High Voltage Electric Power Transmission	19
Natural Gas Bulk Transmission	25
Petroleum Products Transmission	41
Interstate Highway Traffic	35
Railroad Service	17

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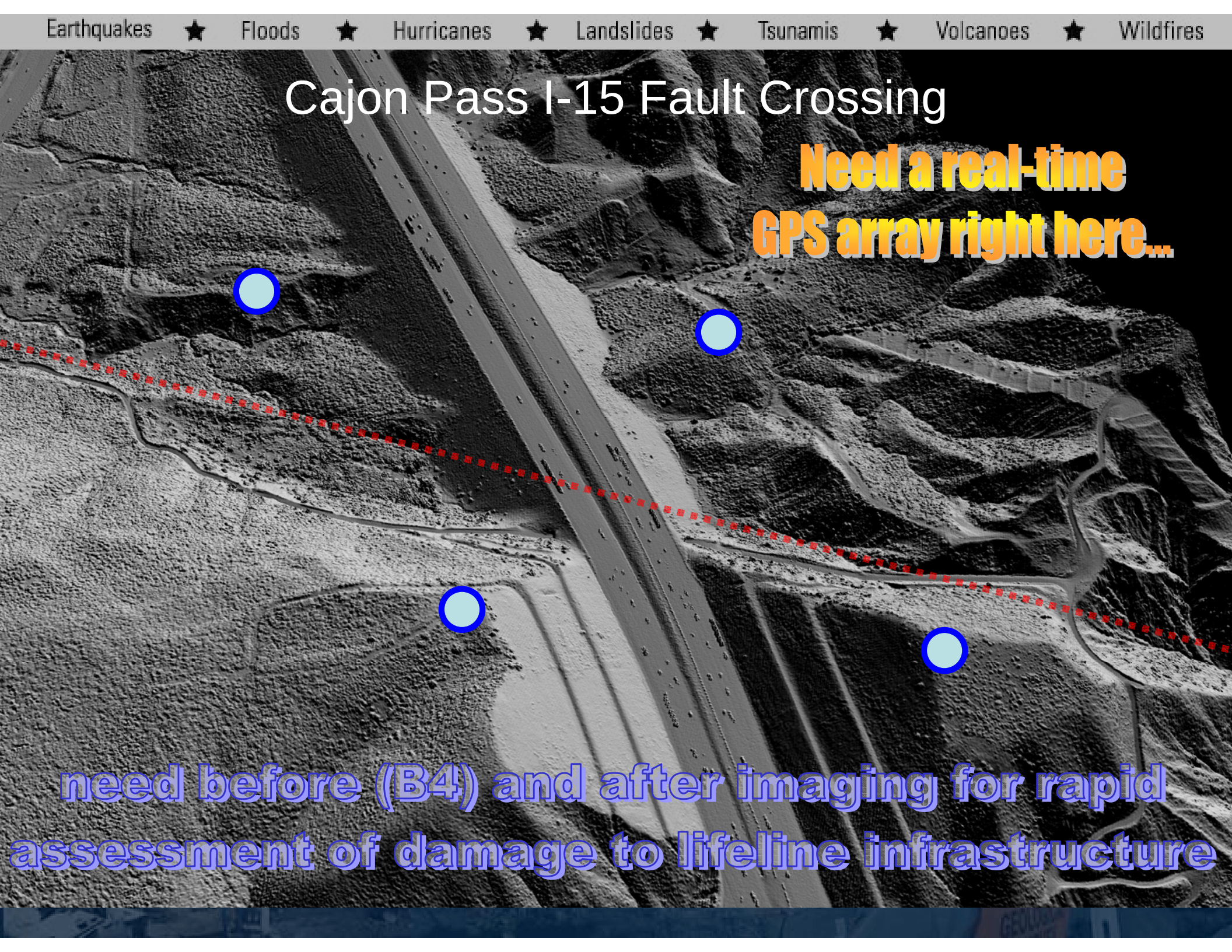
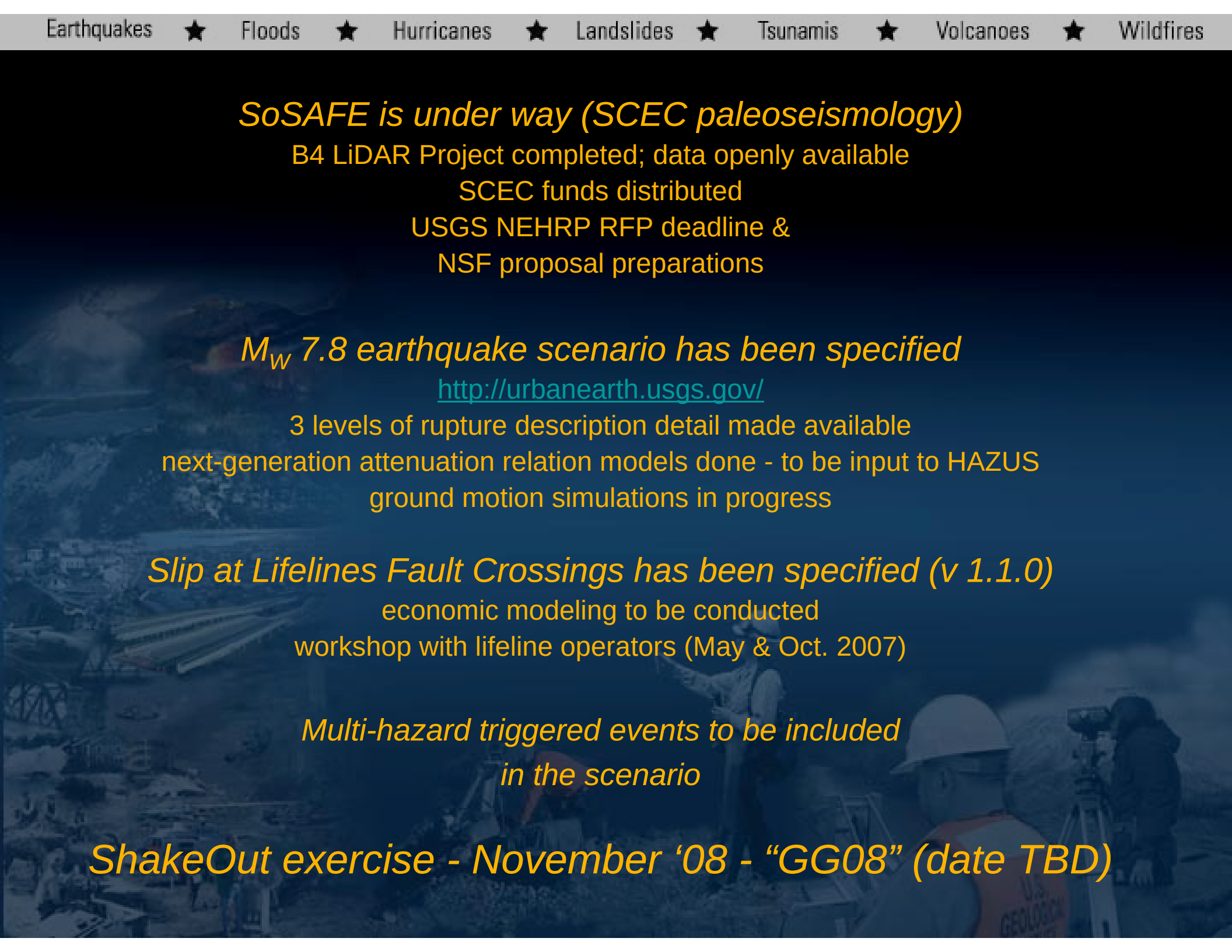
B4 data at work for SoSAFE & ShakeOut

ShakeOut M_w 7.8 Surface Offsets

SUBJECT TO REVISION (KMD v. 1.1.0; 5/12/07)

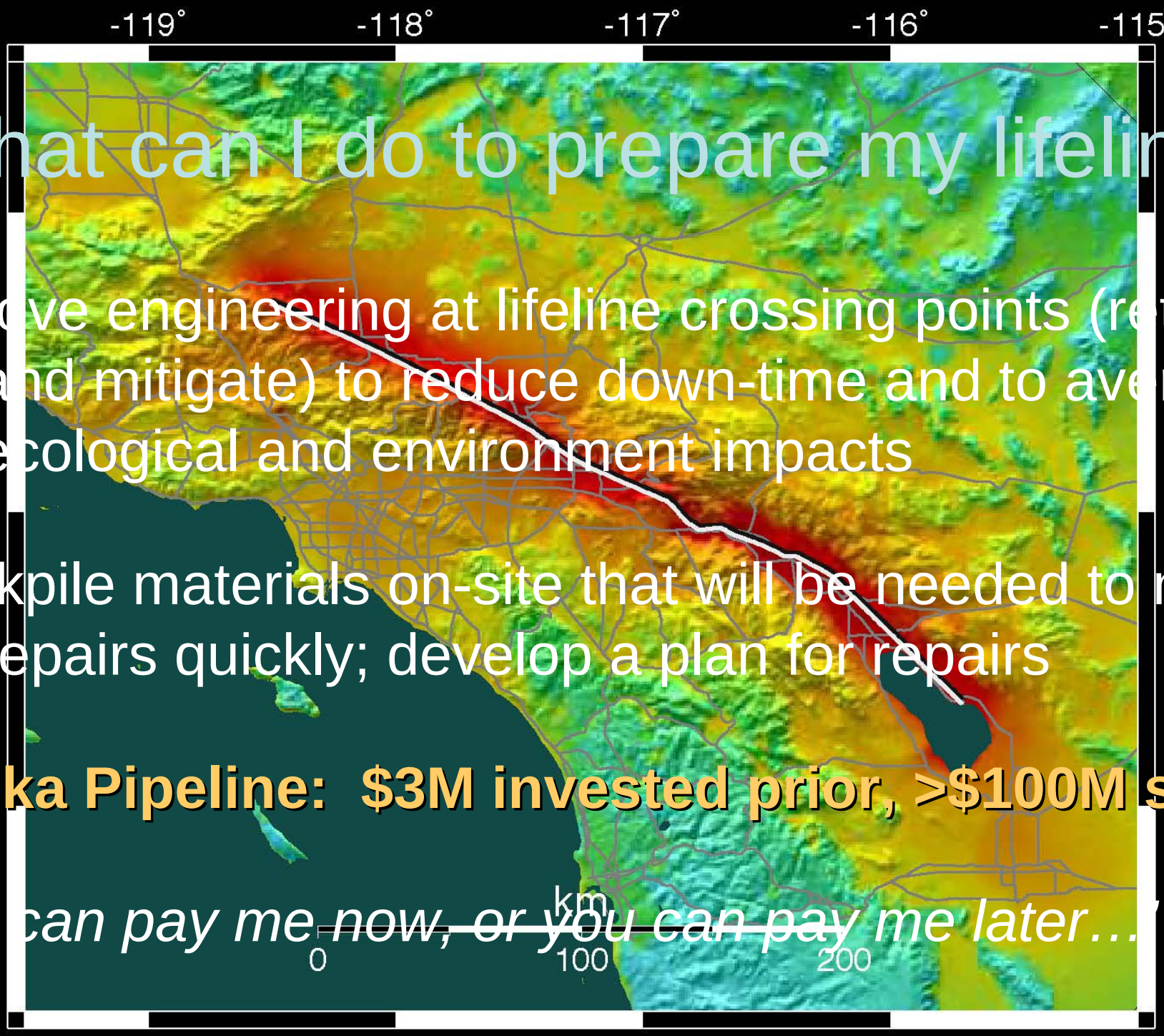
Lifeline Crossing:	Fault Slip (meters)	Duration of Disruption (days)
Gorman (I-5)	0 (landslide - Pyramid)	15
Palmdale (Route 14)	2.6	10
Cajon Pass (I-15)	4.4 (low end of range)	35 (FEMA, 1991)
Whitewater	1.7	5
Indio (I-10)	7.3	10


Earthquakes ★ Floods ★ Hurricanes ★ Landslides ★ Tsunamis ★ Volcanoes ★ Wildfires
Cajon Pass I-15 Fault Crossing
Need a real-time GPS array right here...
need before (B4) and after imaging for rapid assessment of damage to lifeline infrastructure


Earthquakes ★ Floods ★ Hurricanes ★ Landslides ★ Tsunamis ★ Volcanoes ★ Wildfires
SoSAFE is under way (SCEC paleoseismology)
B4 LiDAR Project completed; data openly available
SCEC funds distributed
USGS NEHRP RFP deadline &
NSF proposal preparations
M_W 7.8 earthquake scenario has been specified
http://urbanearth.usgs.gov/
3 levels of rupture description detail made available
next-generation attenuation relation models done - to be input to HAZUS
ground motion simulations in progress
Slip at Lifelines Fault Crossings has been specified (v 1.1.0)
economic modeling to be conducted
workshop with lifeline operators (May & Oct. 2007)
Multi-hazard triggered events to be included
in the scenario
ShakeOut exercise - November '08 - "GG08" (date TBD)

Earthquakes ★ Floods ★ Hurricanes ★ Landslides ★ Tsunamis ★ Volcanoes ★ Wildfires

What can I do to prepare my lifeline?



Improve engineering at lifeline crossing points (retrofit and mitigate) to reduce down-time and to avert ecological and environment impacts

Stockpile materials on-site that will be needed to make repairs quickly; develop a plan for repairs

Alaska Pipeline: $3M invested prior, >$100M saved

'You can pay me now, or you can pay me later…'