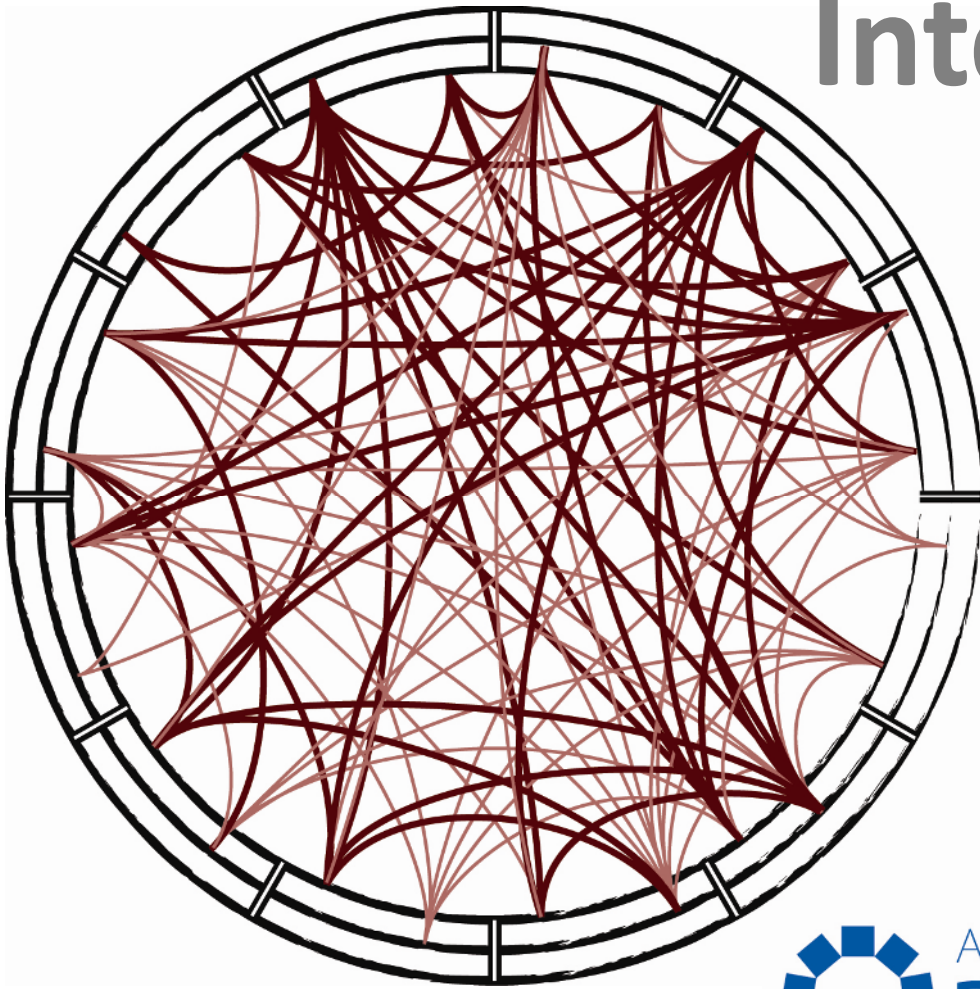


Infrastructure Vulnerability & Interdependencies Study



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Michael Germeraad

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michaelg@abag.ca.gov



ASSOCIATION OF BAY AREA GOVERNMENTS
RESILIENCE PROGRAM

PROJECT FUNDERS



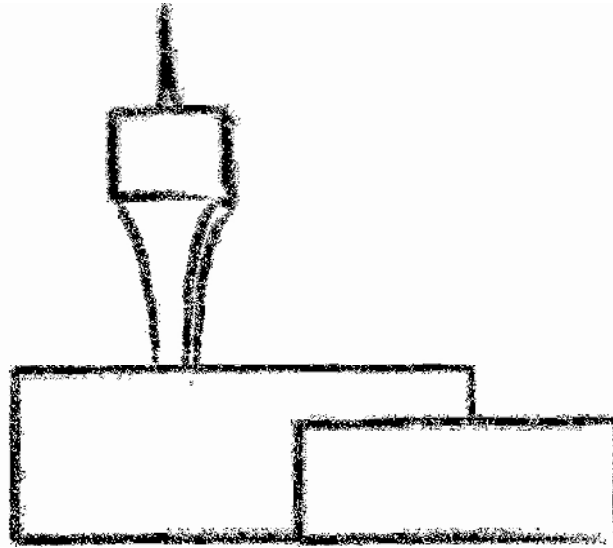
Colette Armao

(Associate Aviation Planner)

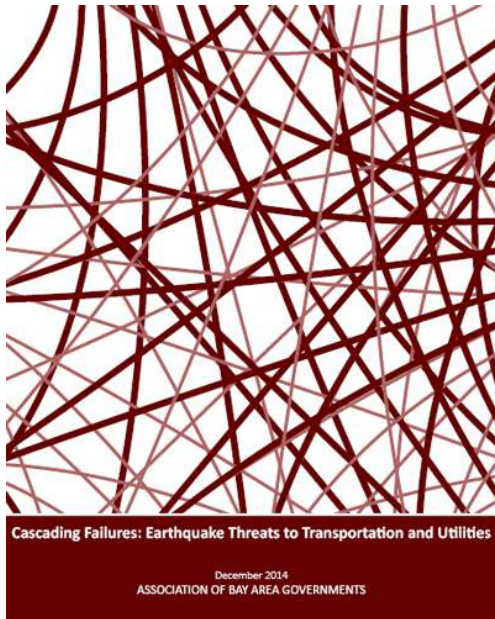
colette.armao@dot.ca.gov

“Sometimes you go in for bird seed,
and you walk out with a dog.”

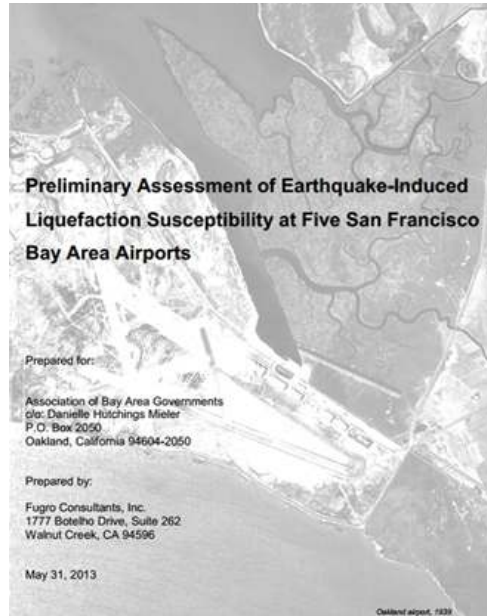
AIRPORT IS
DEPENDENT ON



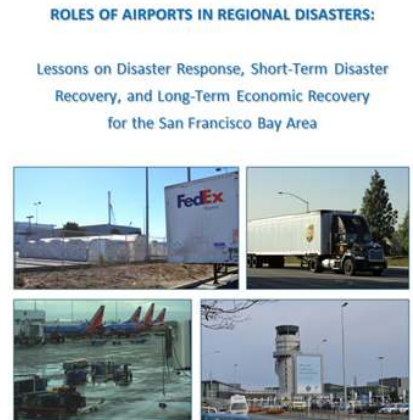
DEPENDENT ON
AIRPORT



**Infrastructure Vulnerability
& Interdependencies Study**

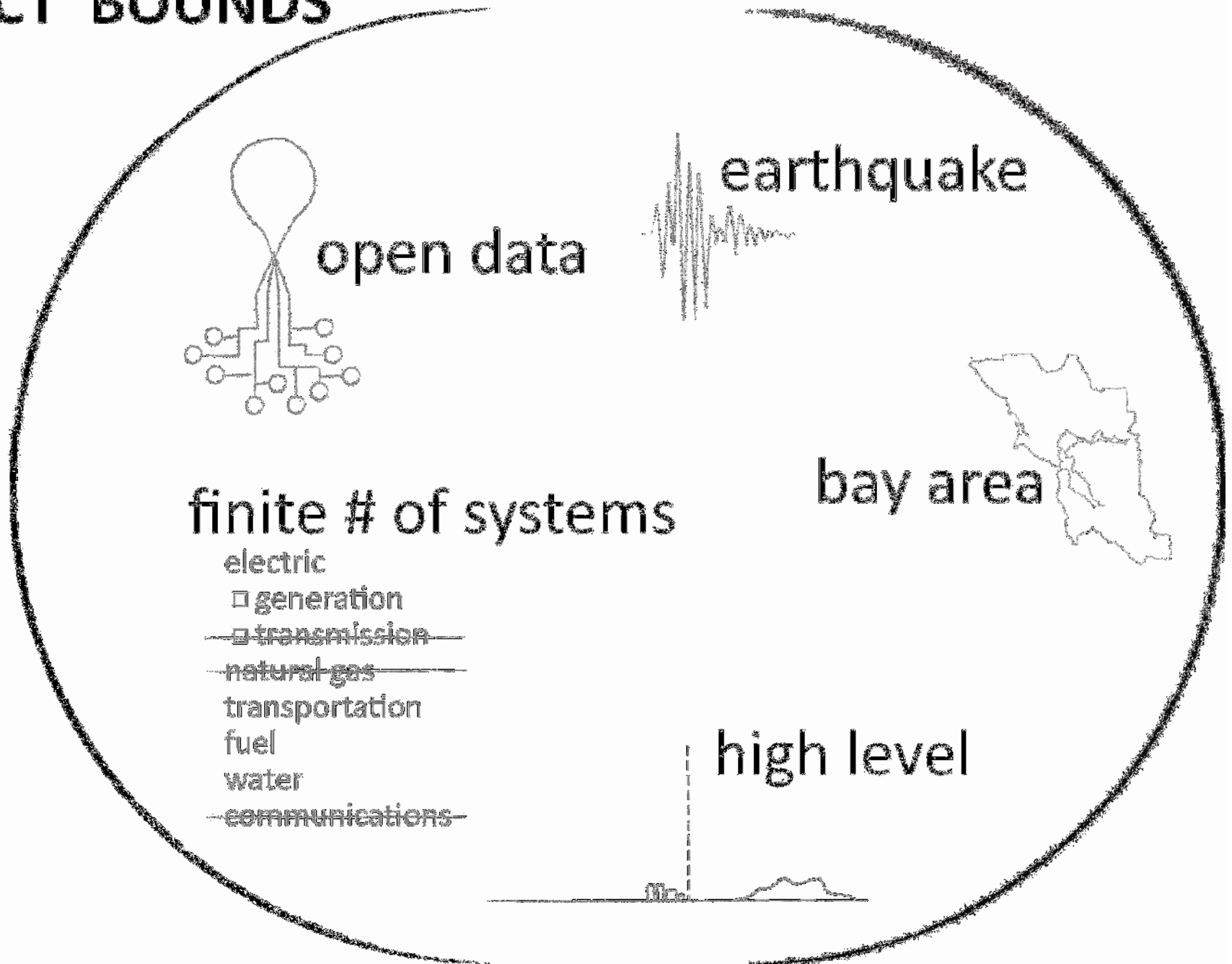


**Airport Liquefaction
Susceptibility Analysis**



**Roles of Airports in
Regional Disasters**

PROJECT BOUNDS



METHODOLOGICAL PRINCIPLES

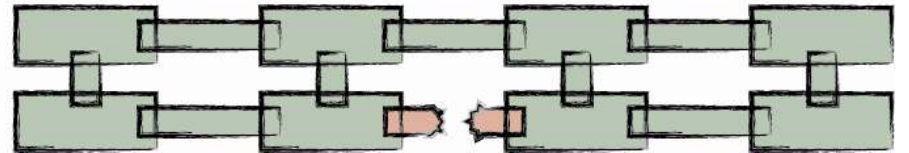
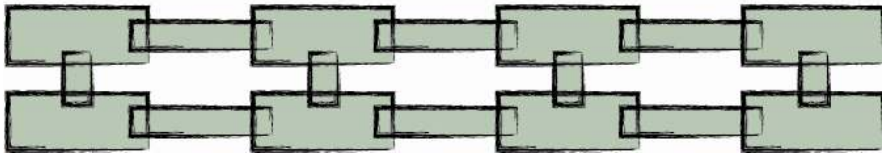
- System structure
 - Map system (geographic & operation)
- Component fragility
 - Research & reconnaissance reports.
- Scenario based
 - Explore risk in discrete events.
- Four dimensions of restoration
 - Time, space, quantity, quality
- Equal priority on consequence
 - Risk = (probability of failure) x (consequence)

SYSTEM STRUCTURE

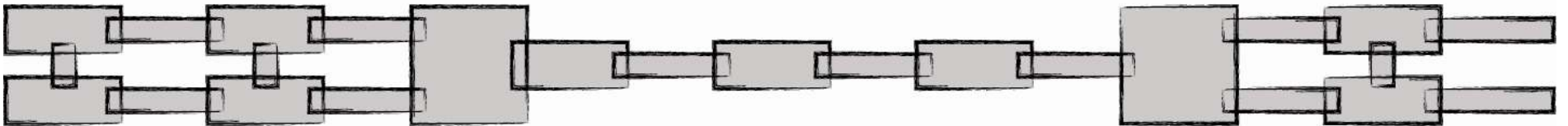
Series System



Parallel System



General System



COMPONENT FRAGILITY

Chile Earthquake of 2010 *Lifeline Performance*

PREPARED BY
Earthquake Investigation Committee of the Technical Council of
Lifeline Earthquake Engineering

EDITED BY
Alex K. Tang, P.E., P.Eng., C.Eng., F.ASCE
John M. Eidinger, P.E., M.ASCE

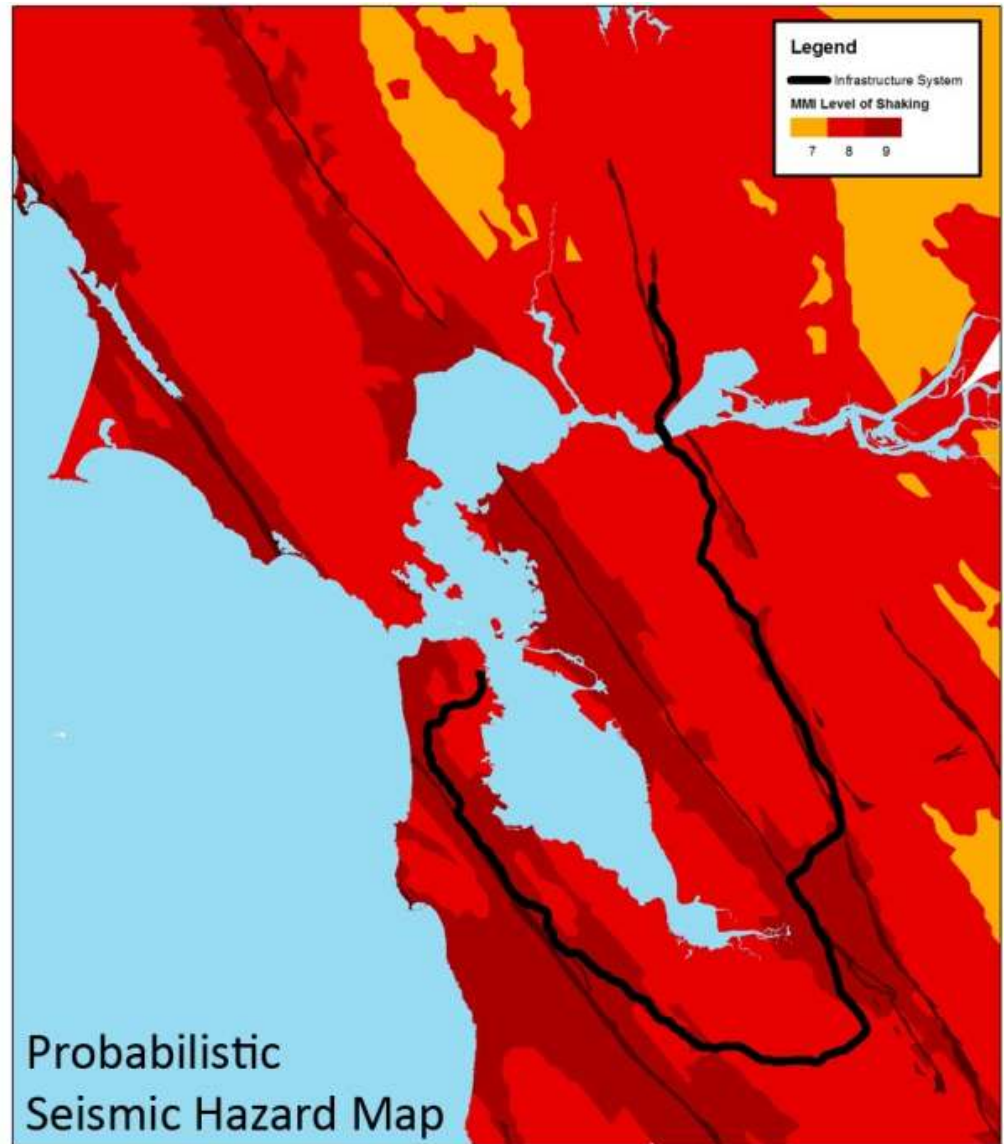
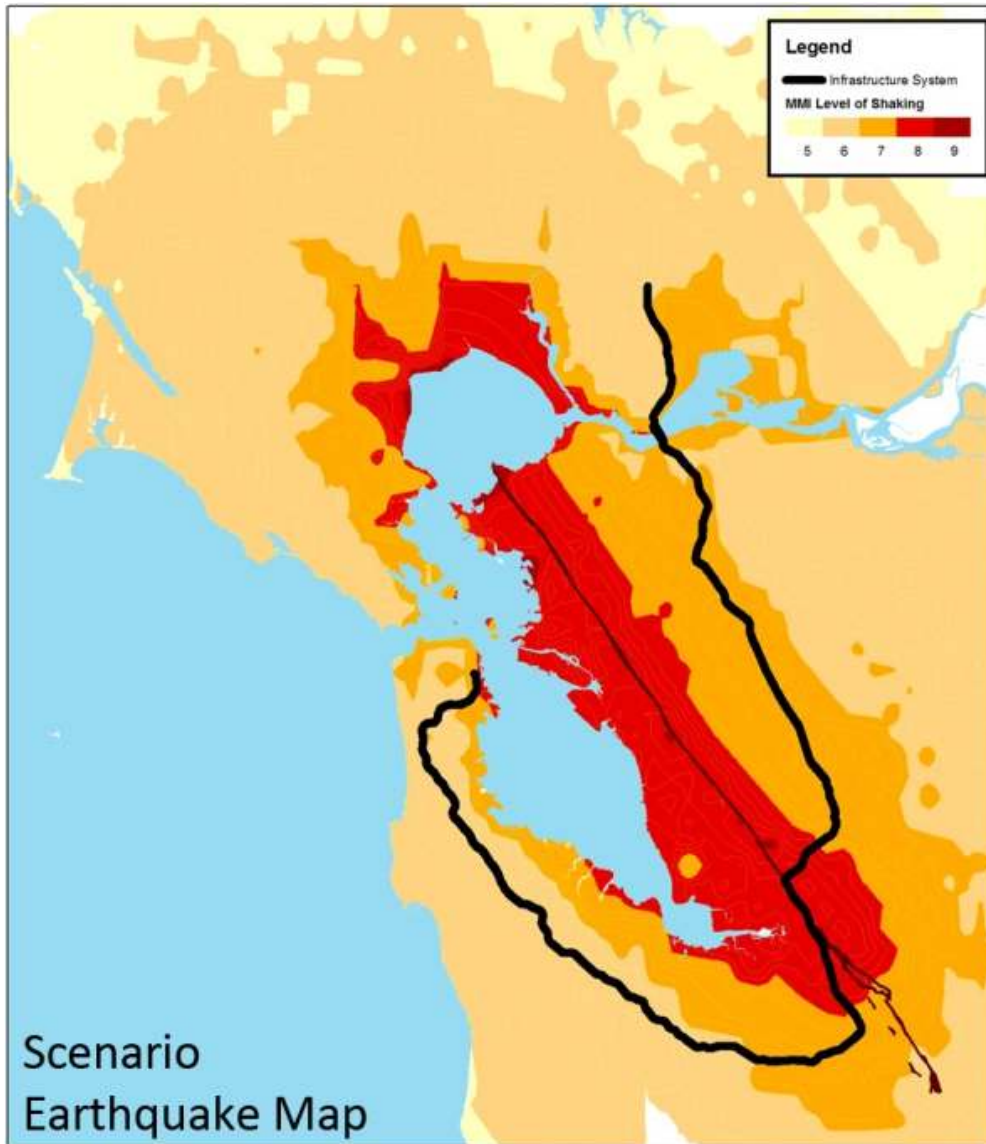
SPONSORED BY
Technical Council on Lifeline Earthquake Engineering
Monograph No. 36

ASCE

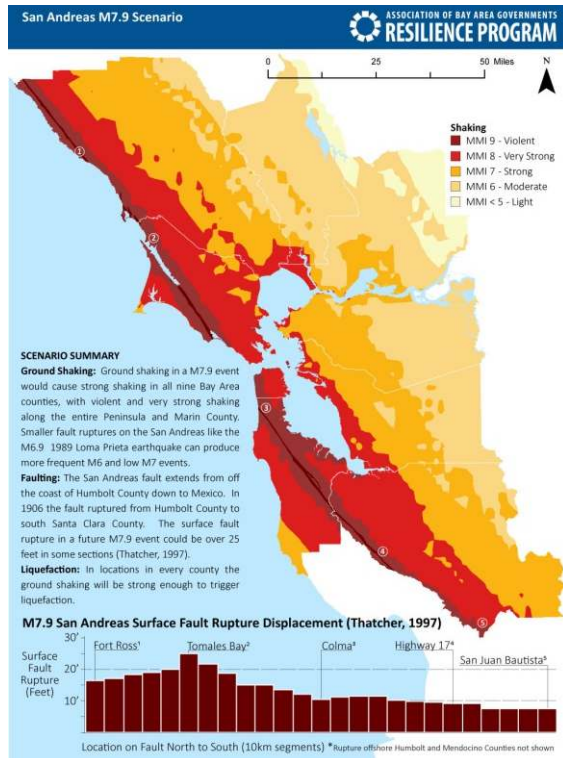
Published by the American Society of Civil Engineers



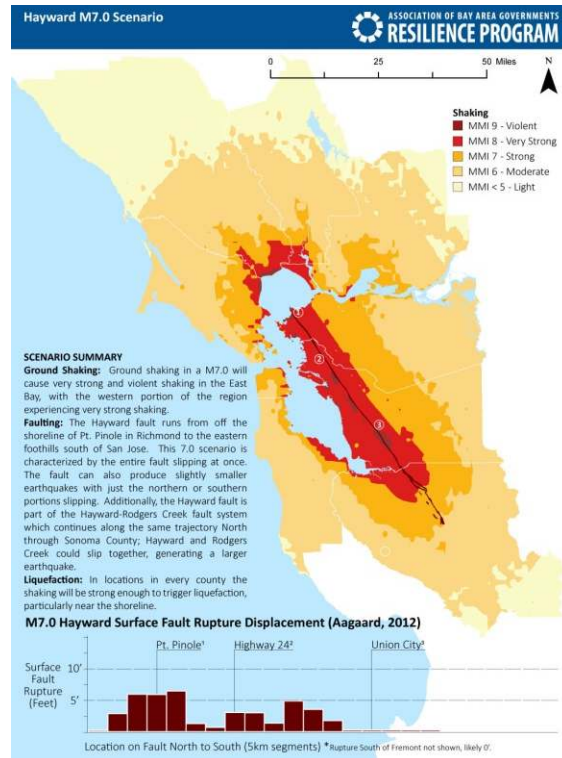
SCENARIO BASED



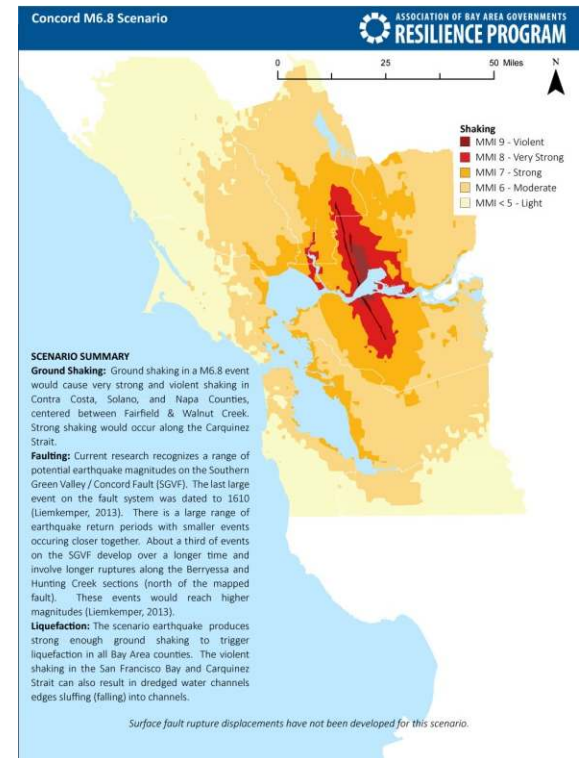
SCENARIO BASED



San Andreas M7.9



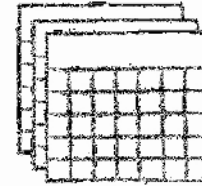
Hayward M7.0



Concord SGV M6.8

FOUR DIMENSIONS OF RESTORATION

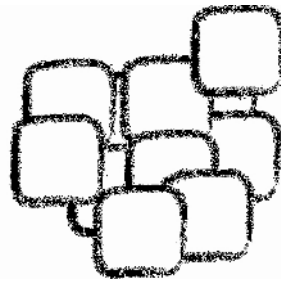
Time



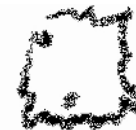
Space



Quantity



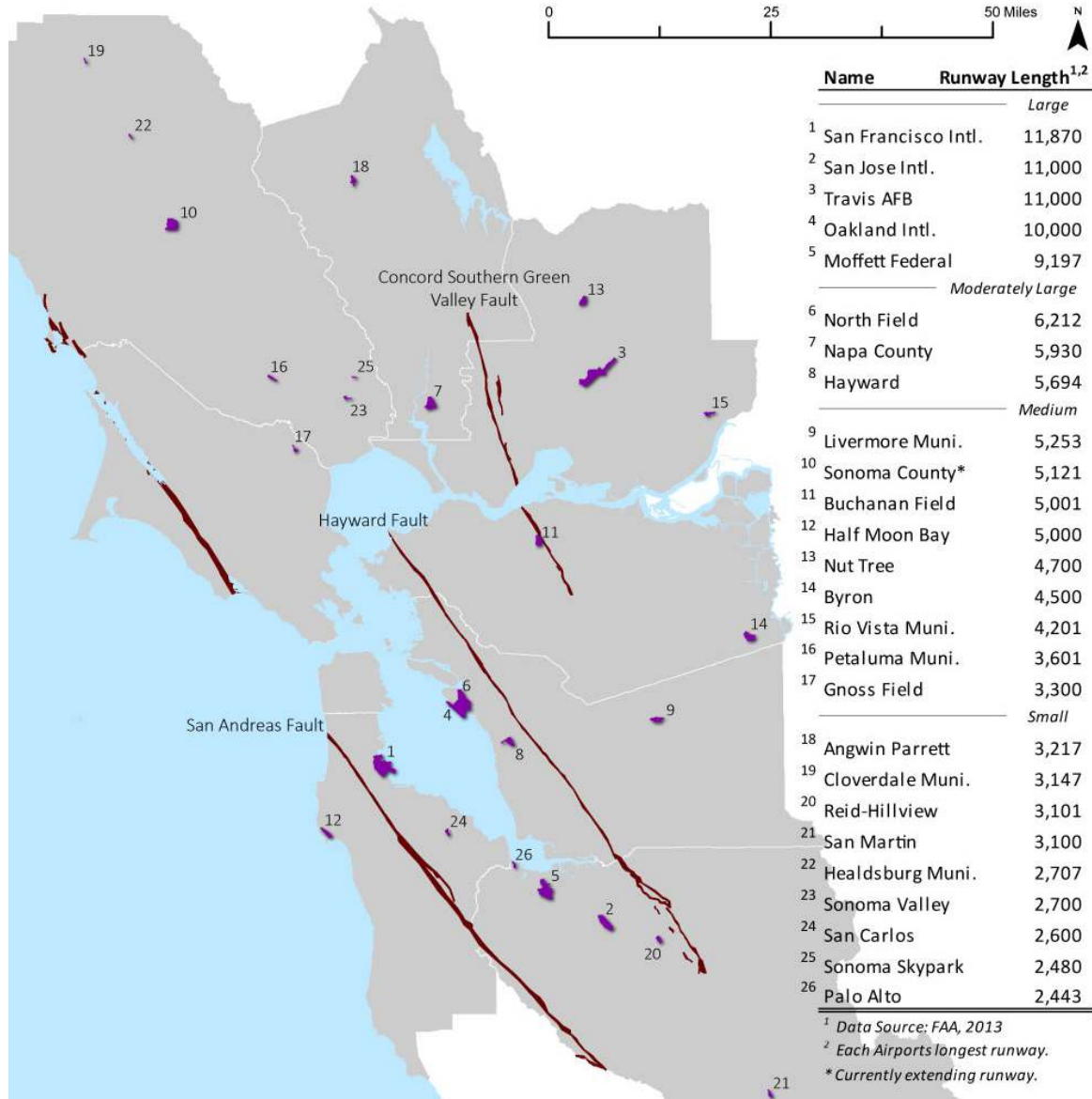
Quality



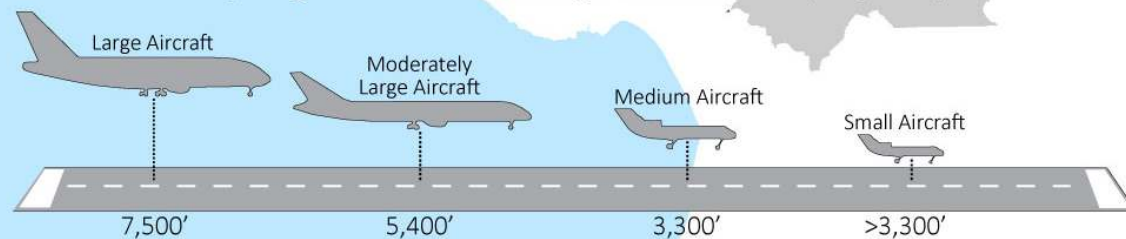
EQUAL WEIGHT TO CONSEQUENCES

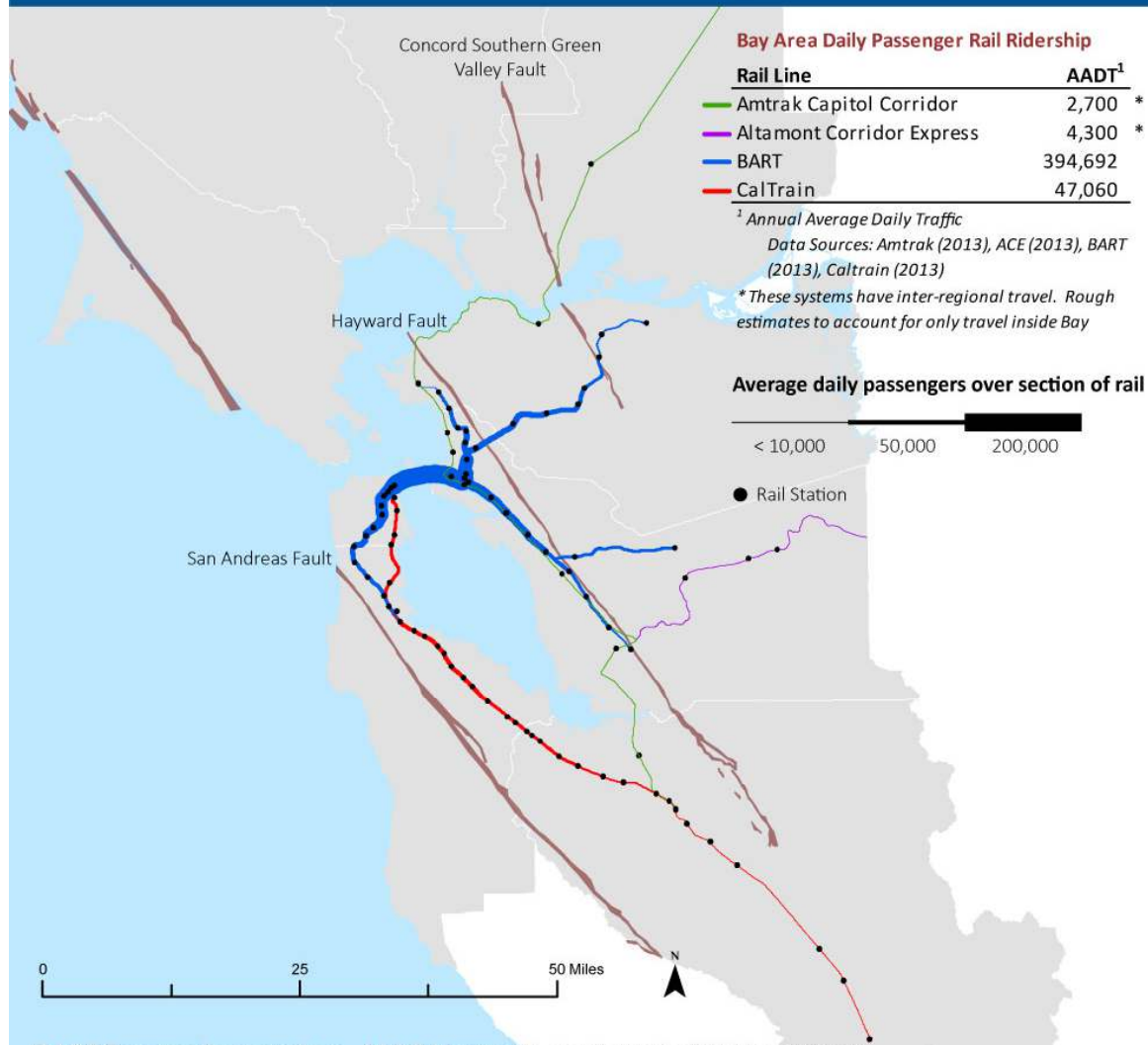


SYSTEM EXPLORATION



Minimum Runway Length Needed to Land Single Wheel Aircraft (FAA, 2013)





Bay Area Daily Passenger Rail Ridership

Rail Line	AADT ¹
Amtrak Capitol Corridor	2,700 *
Altamont Corridor Express	4,300 *
BART	394,692
CalTrain	47,060

¹ Annual Average Daily Traffic
Data Sources: Amtrak (2013), ACE (2013), BART (2013), Caltrain (2013)

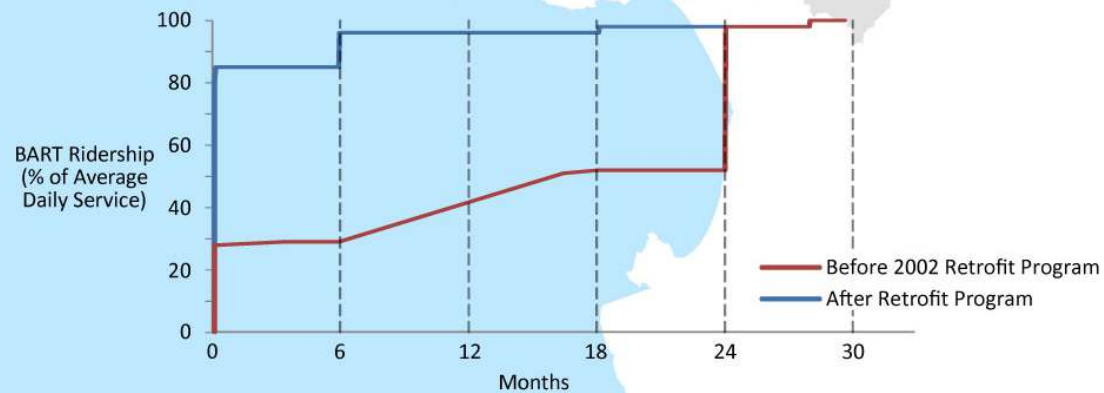
* These systems have inter-regional travel. Rough estimates to account for only travel inside Bay

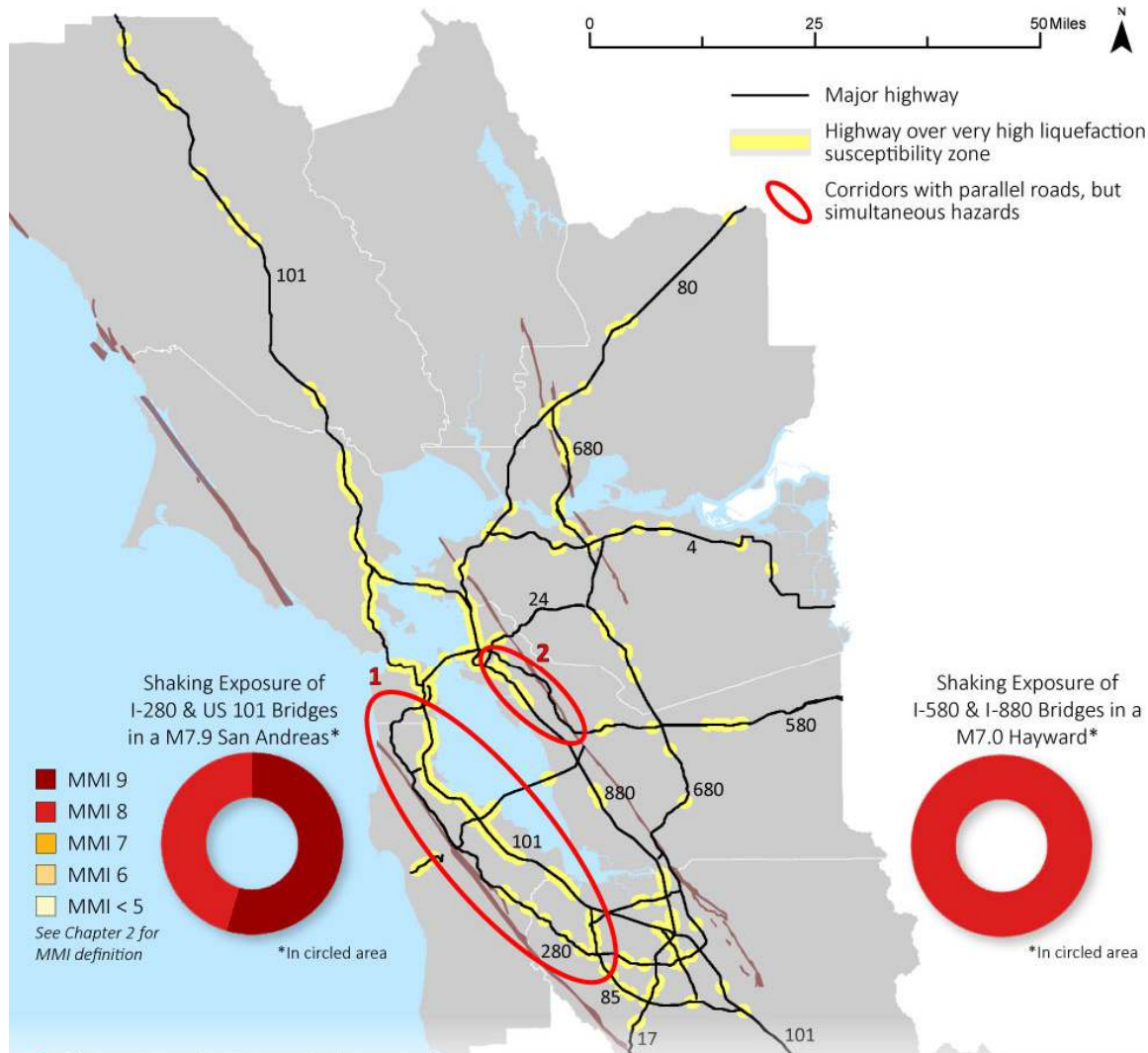
Average daily passengers over section of rail



● Rail Station

BART Service Restoration - M7.0 Hayward Earthquake (BART, 2002a)





1. The US 101 and I-280 corridor between their San Francisco interchange and the Hwy 85 interchange is exposed to multiple hazards in a M7.9 San Andreas scenario. Over this stretch of I-280 there are 86 bridges, over half of which experience MMI 9 severe shaking. Along this same stretch, over half of the length of US 101 is in a very high liquefaction zone. All bridges along this portion of US 101 experience MMI 8 or 9 as well. Each of these highways have portions that carry over 250,000 daily passengers, with most of US 101 carrying 200,000 daily passengers, and I-280 carrying between 100,000 and 150,000 passengers over this section. In a future San Andreas earthquake, this parallel section of roadway will experience multiple hazards across parallel links.

2. The I-880 and I-580 corridor between the 980 and 238 interchange is exposed to multiple hazards in a M7.0 Hayward scenario. Over this stretch of I-580 there are 44 bridges, all of which will experience MMI 8, very strong shaking. In addition to strong ground shaking, along this stretch of I-580, the road crosses the Hayward fault three times. Along this same stretch, I-880 crosses over many sections of very high liquefaction susceptibility, with all bridges along this portion of the freeway also experiencing MMI 8, very strong shaking. Each of these highways average between 175,000 and 200,000 average daily passengers. In a future Hayward earthquake the parallel section of roadway will experience multiple hazards across parallel links.

California Fuel Production and Use, and the Bay Area's Fuel Profile

CA Gasoline Production	Millions of gallons ¹
Southern California	8,545
Northern California	6,173
Bakersfield & Santa Maria	1,256
Total³	15,974

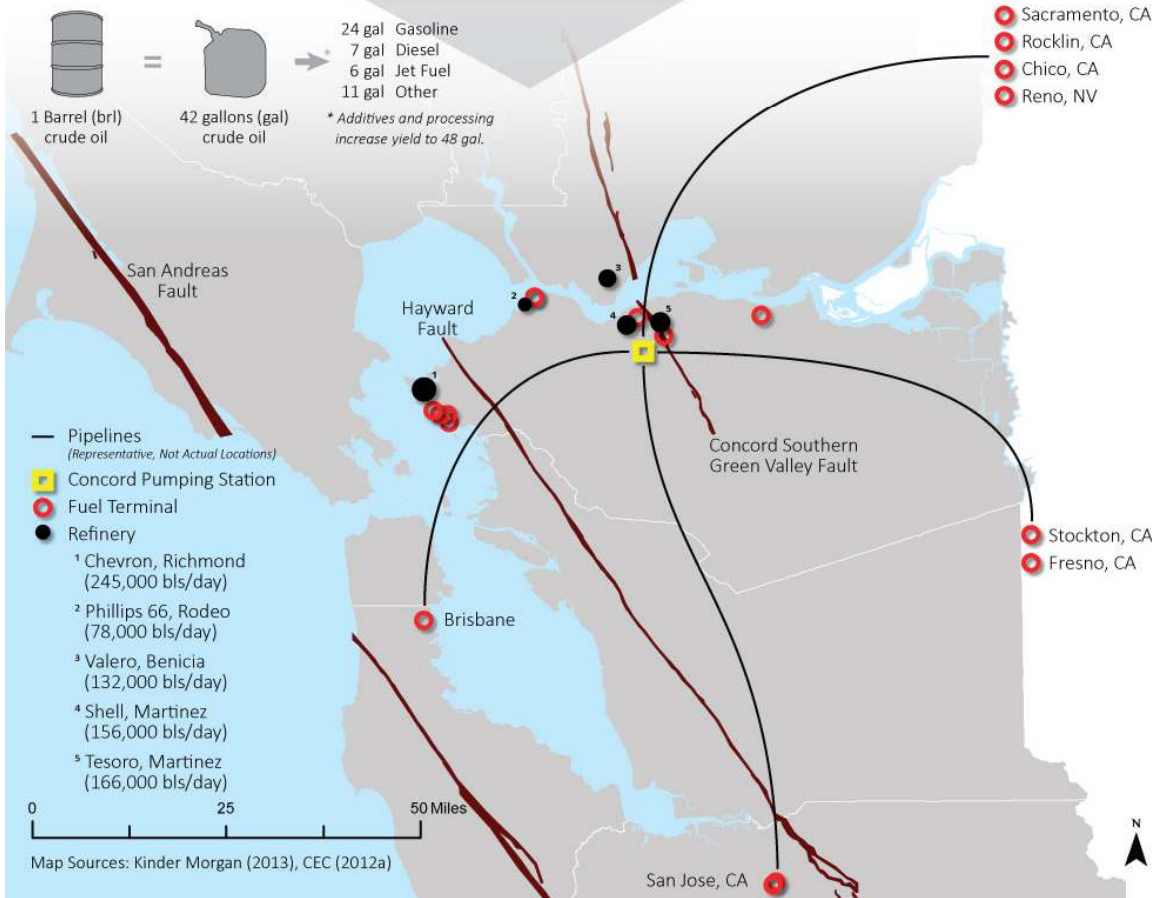
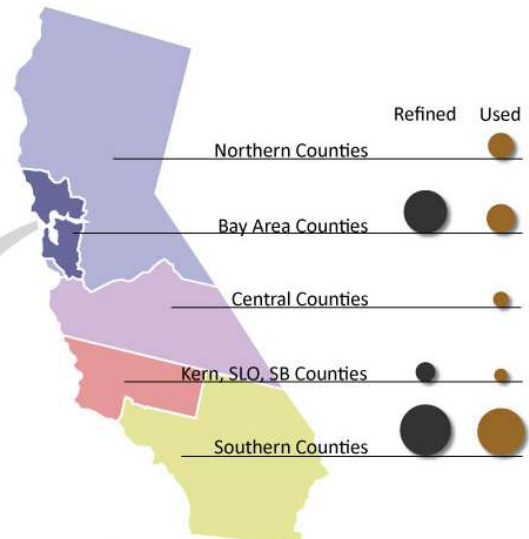
¹ Calculated by multiplying the regional share² by the State total³

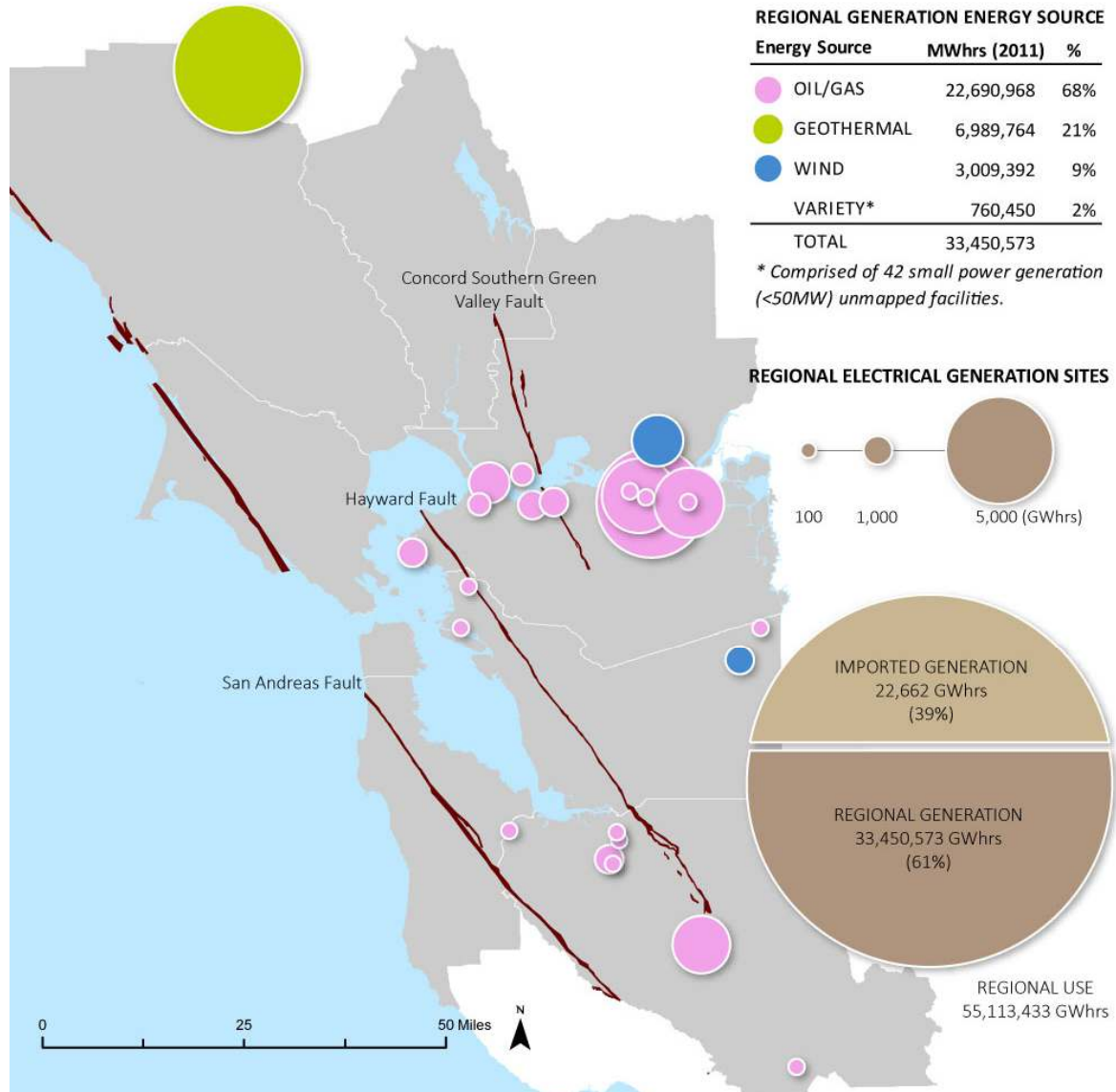
² CEC (2012a)

³ CEC (2012b)

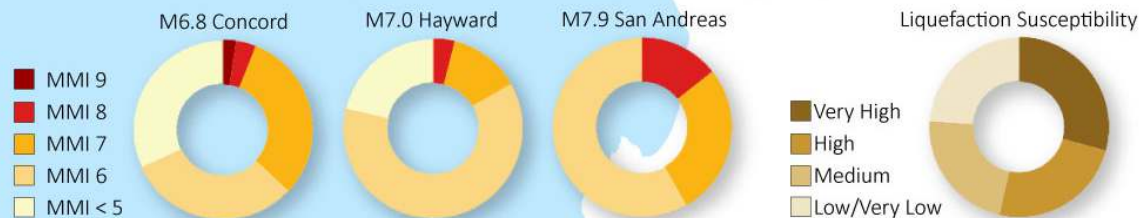
CA Gasoline Use	Millions of gallons ¹
Southern Counties	7,247
Bay Area Counties	2,641
Northern Counties	2,151
Central Counties	772
Kern, SLO, SB Counties	572
Total	13,383

¹ CEC (2012c)



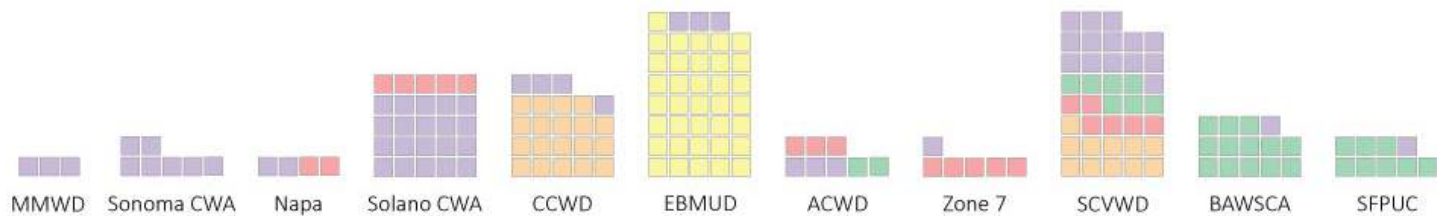
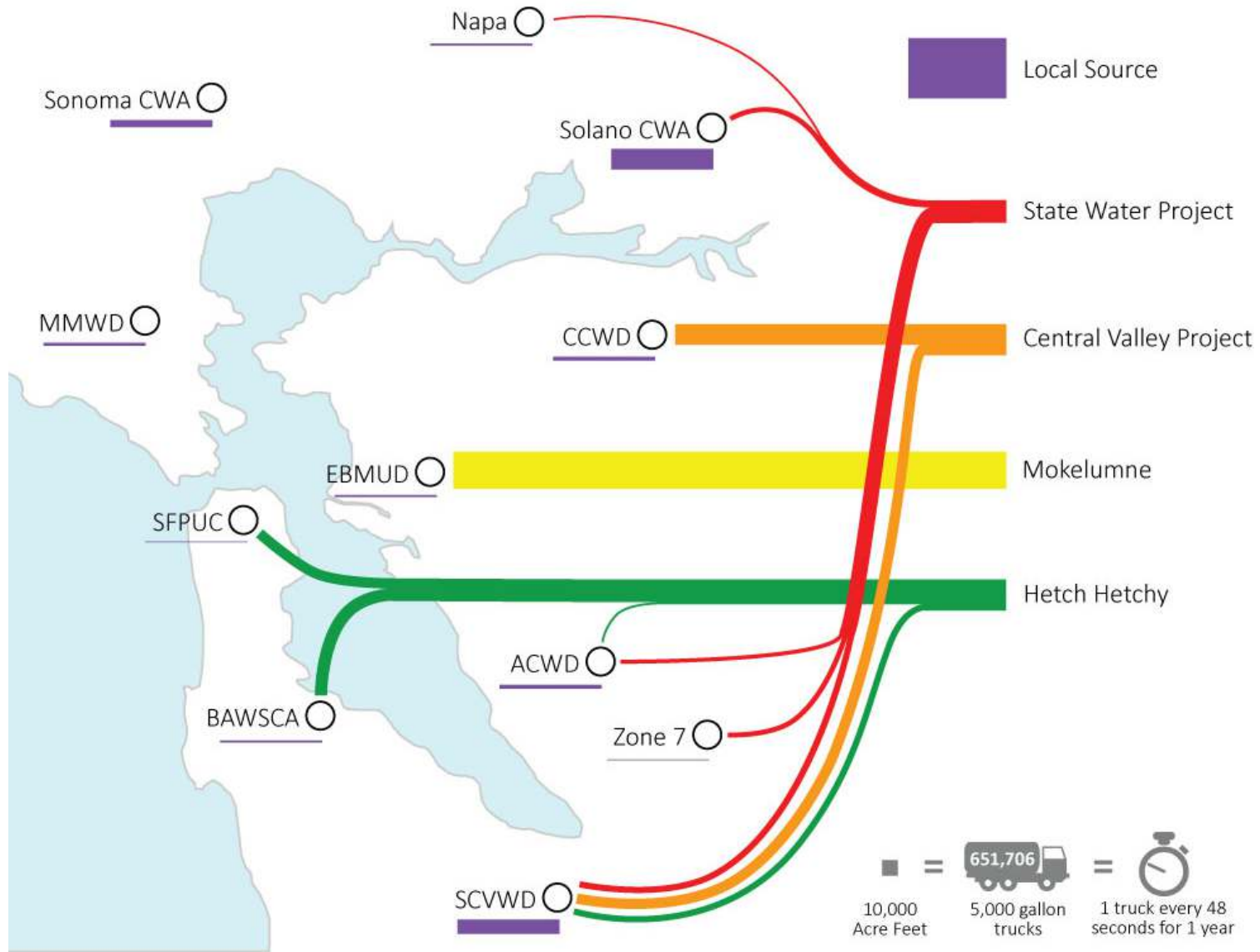


Regionally Generated Power Exposed in Scenario Earthquake Shaking & Liquefaction Zones (MWhrs)



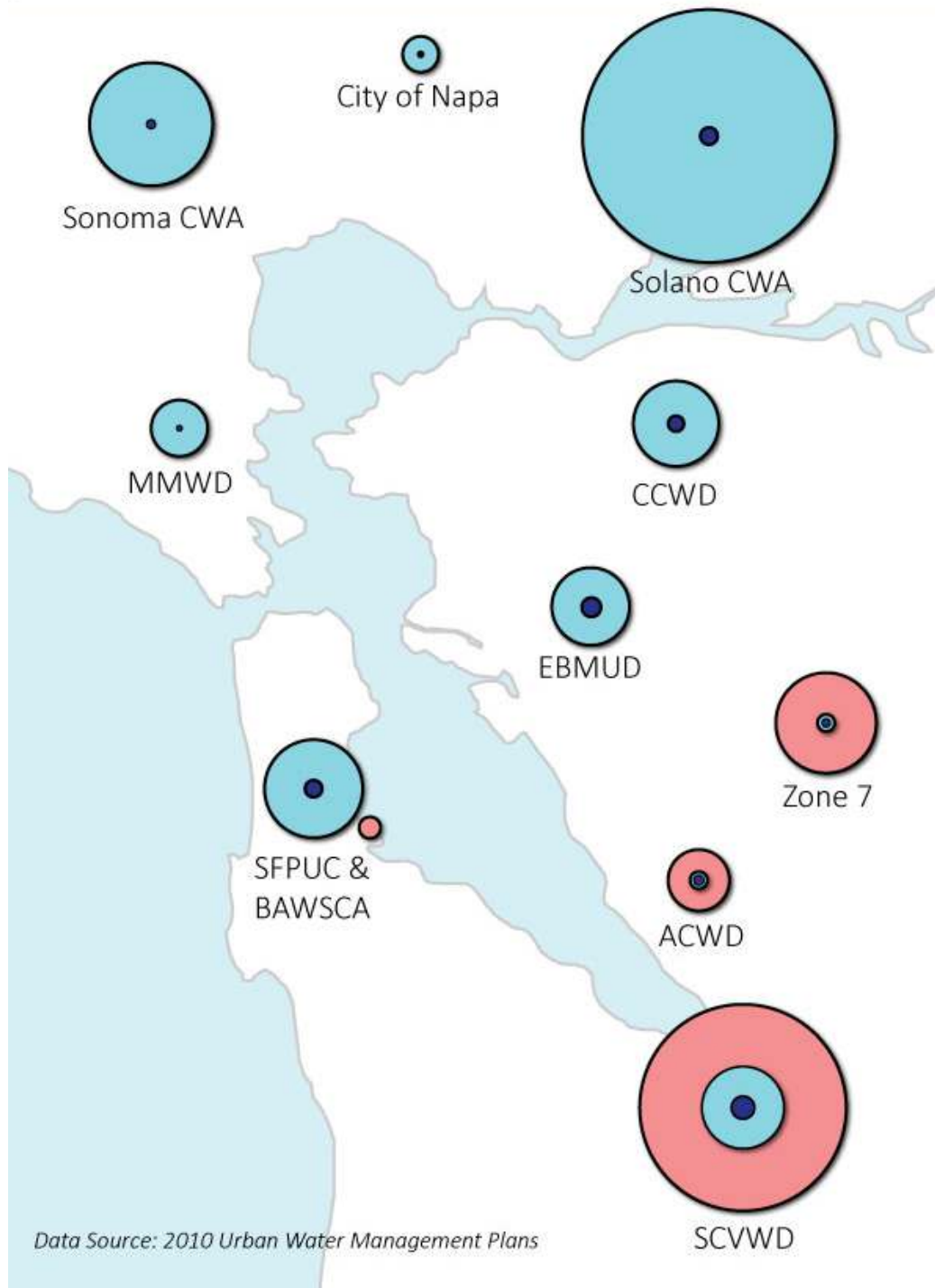
see Chapter 2 for MMI definitions

Water System Source Portfolio (11 Largest Bay Area Water Districts) & Annual Normal Supply

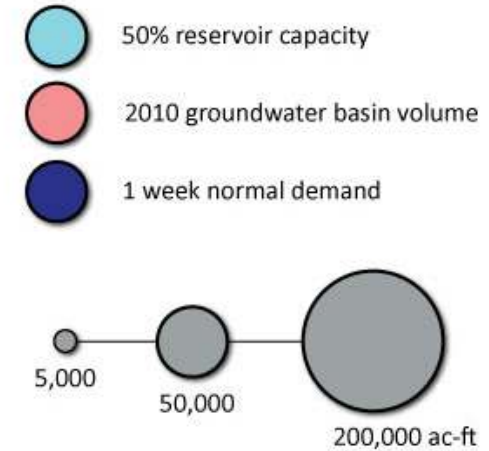


Data Source: 2010 Urban Water Management Plans

Water Storage Within 9 County Region, and Normal Water Demand



LEGEND



INTERTIES DESCRIBED IN 2010 URBAN WATER MGMT. PLANS

Agencies Linked	Sharing Capacity (acft/day)
SFPUC, SCVWD	123
EBMUD, Hayward, SFPUC	92
EBMUD, Hayward	33 ¹
EBMUD, DSRSD	6 ¹
EBMUD, CCWD	25 ¹
ACWD, Hayward	unknown ²
ACWD, Milpitas	unknown ²
EBMUD, CCWD	307 ³
SFPUC, State Water Project	unknown ³
Sonoma CWA to MMWD	systems connected ⁴
SFPUC to BAWSCA, ACWD, SCVWD	systems connected ⁴

¹ Multiple stations contribute to intertie capacity.

² Distribution pipes between jurisdictions are connected.

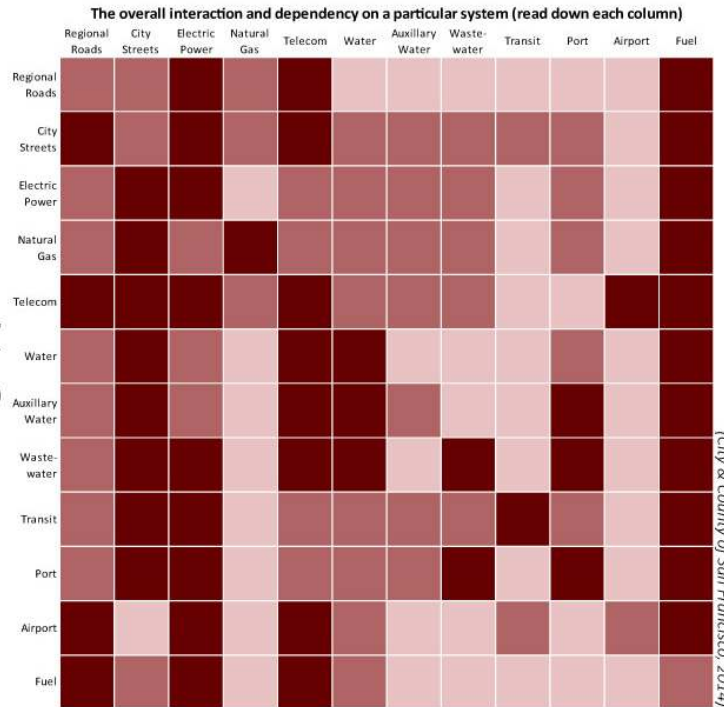
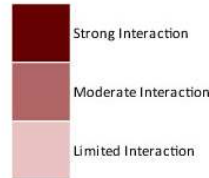
³ Intertie where regional systems collocate.

⁴ First system wholesales water to listed districts.

Reading the matrix from left-to-right shows which systems the designated operator relies on. For example, Airports have a strong interaction with regional roads, but a limited interaction with natural gas.

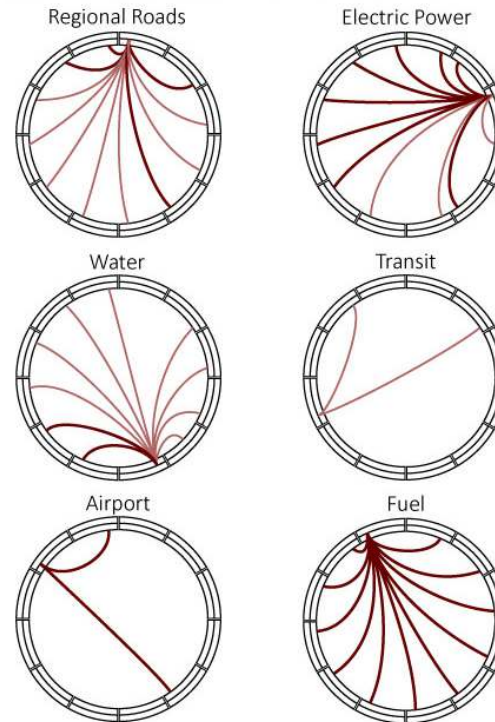
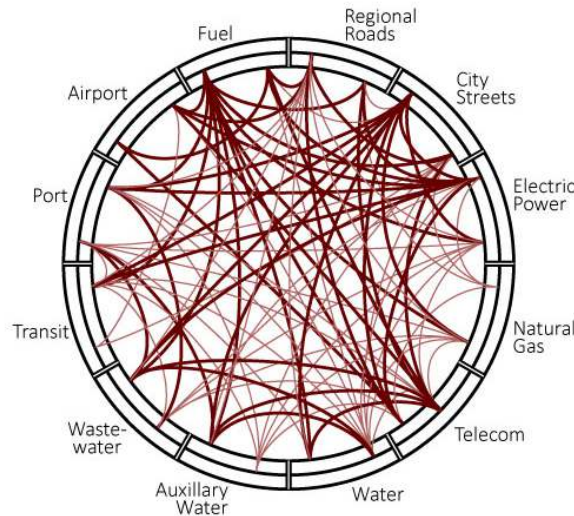
Reading the matrix from top-to-bottom shows which systems rely on the designated operator. For example, all systems have a strong interaction with the fuel system.

The lifeline operators' dependency on other lifeline systems (read across each row)



Matrix Information Displayed as Scallop Diagram.

The graphic below shows all moderate and strong interactions between systems. The individual systems to the right show which systems rely on the designated operator (same as reading the matrix from top-to-bottom).



WHERE WE GO FROM HERE...

- State | regional lifelines council
 - Modeled by City | County of San Francisco
- Curate ongoing lifelines studies
 - Lots of great work... keep track of it all.
 - Explore the 4 dimensions of restoration to help understand what level of performance is needed.
- Develop strategies from users side.
 - Resilience can be improved by making stakeholders less reliant on system.

Featured Projects



Stronger Housing, Safer Communities

An ABAG and BCDC report on vulnerability of housing and communities to earthquakes and flooding and strategies to address them



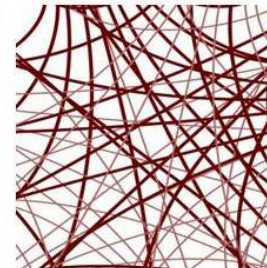
Mitigation and Adaptation Plans

ABAG and BCDC are supporting jurisdictions to update and develop local hazard mitigation and climate adaptation plans



Policy Implementation Assistance

ABAG is providing assistance to develop policy implementation tools and guidance.



Cascading Failures

An ABAG report on earthquake threats to interdependent transportation and utility systems.

Upcoming Events



04.16.15 Community Engagement Workshop (Redwood City)

This workshop is designed to support local mitigation and adaptation planning process. [Learn more »](#)

04.29.15 Community Engagement Workshop (Napa)

This workshop is designed to support local mitigation and adaptation planning process. [Learn more »](#)

[Past events »](#)

In the News

Do you rent or own a home or apartment in Oakland? [Learn more about programs to improve the seismic safety of Oakland housing.](#) Posted on 01.14.15

L.A. mayor calls for mandatory earthquake retrofitting for thousands of buildings | LA Times, December 8, 2014

Posted on 12.09.14

Preparedness, early warning system top agenda at quake symposium | ABC 7 News, October 16, 2014

[Preparedness, early warning system top agenda at quake symposium](#)



Posted on 10.17.14

ABAG Website

<http://resilience.abag.ca.gov/>

Project Website

http://resilience.abag.ca.gov/projects/transportation_utilities_2014/

