Stanford Water System Earthquake Issues

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EERI
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John Eidinger

- 1954 - 1971: A youth in Canada
- 1971 - 1975: B.S. MIT
- 1975 - 1984: M.Eng, M.S., M.B.A. Berkeley
- 1978 - 1990: ABB
- 1991 - 2023: G&E
- P.E. S.E.

John Eidinger

- 100 water utilities
- 60 power plants
- 4,000 electric substations
- 4 Books
- 100 Papers
- Lifelines: Electric Power, Water, Wastewater, Natural Gas, Trains
- Many documents free at www.geEngineeringSystems.com

Agenda

- Is the Stanford Water System "Reliable" After Earthquakes?
- Some pictures to give you an idea

Today's Quiz. Given a nearby San Andreas M 7.9, how long will the water be out on Campus? (Days)

Person	Days
Student 1	
Student 2	
Student 3	
Student 4	
Student 5	
Student 6	
Student 7	
Student 8	
Student 9	

What You Should Take Away

- What's seismically weak in the water grid?
- Is it worthwhile to seismically upgrade the water grid?
- What can we (you) do about this?

What is the Most Common Type of Pipe that Delivers Water on Campus?


9/7/1999


9/7/1999

Stanford Water System

- Demand ~ 2 - 4 Million Gallons per Day (winter - summer)
- Supply: Normally 100% from Hetch Hetchy (SFPUC) (Since 1956). Pre-1956: local wells. Now, the wells are for emergency operations
- Pipes: About 50 miles (6" - 24")
- Most Common Pipe: Asbestos Cement
- Other Pipes: Ductile Iron, PVC, Cast Iron
- Local Storage: 8 Million Gallons

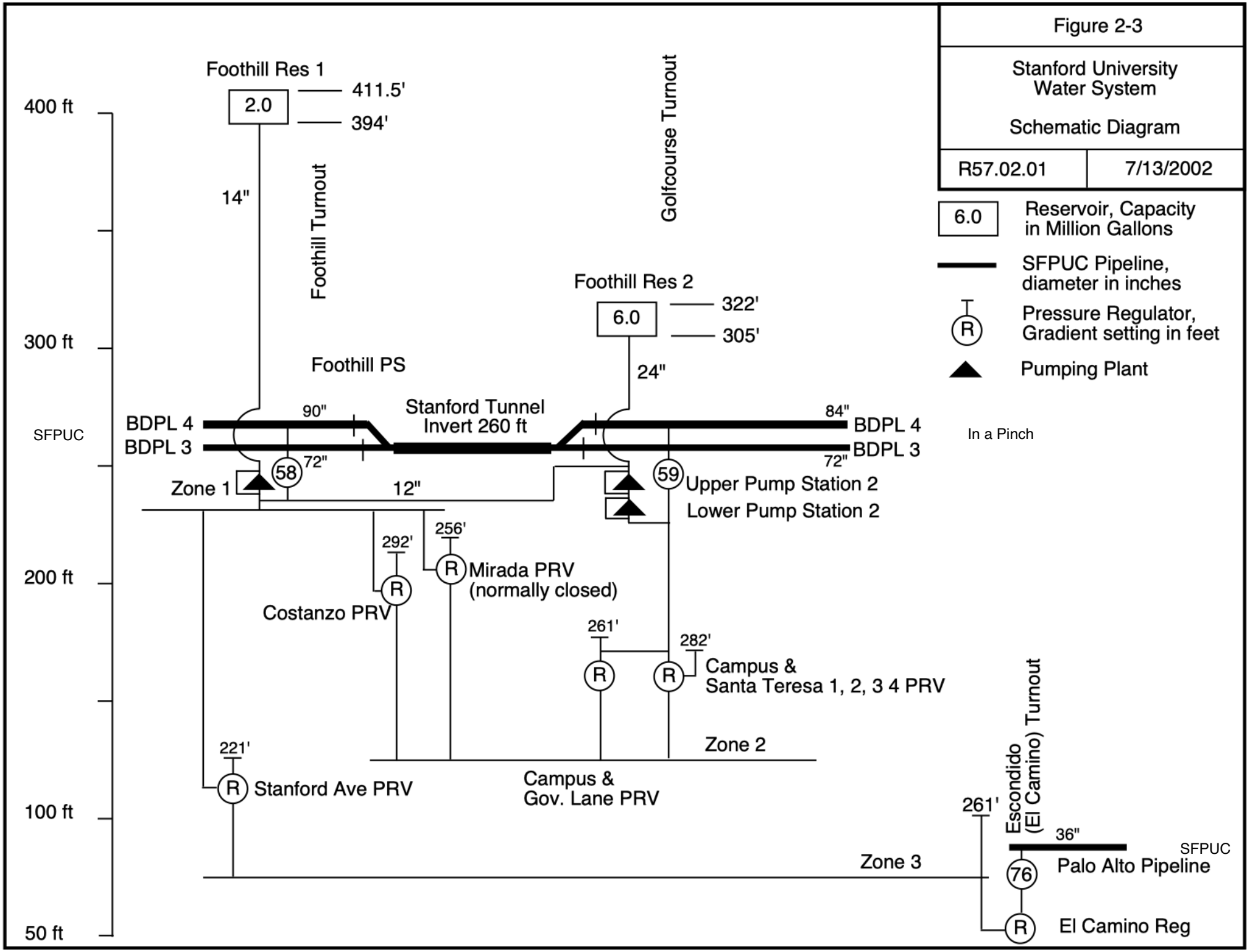
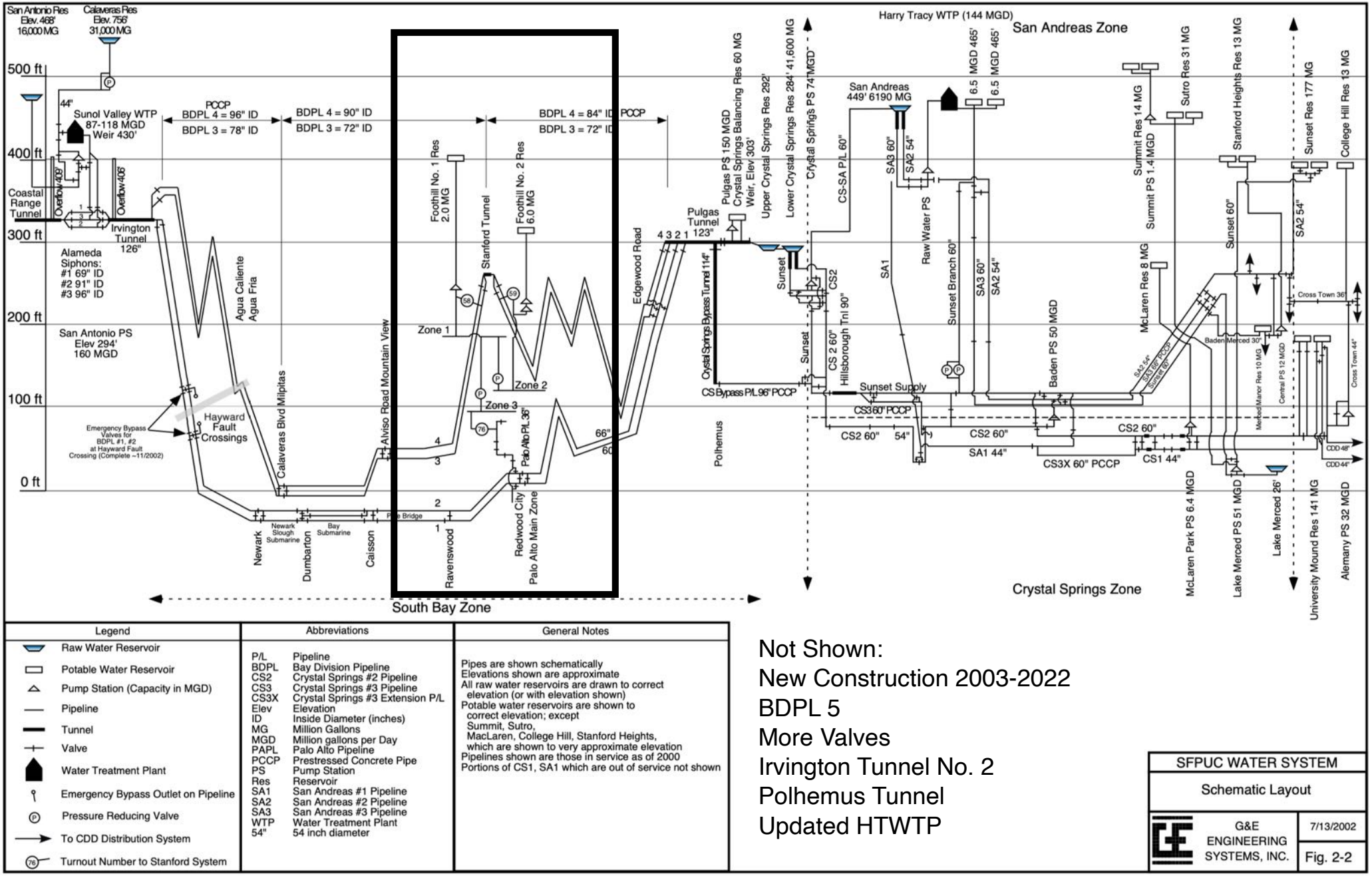


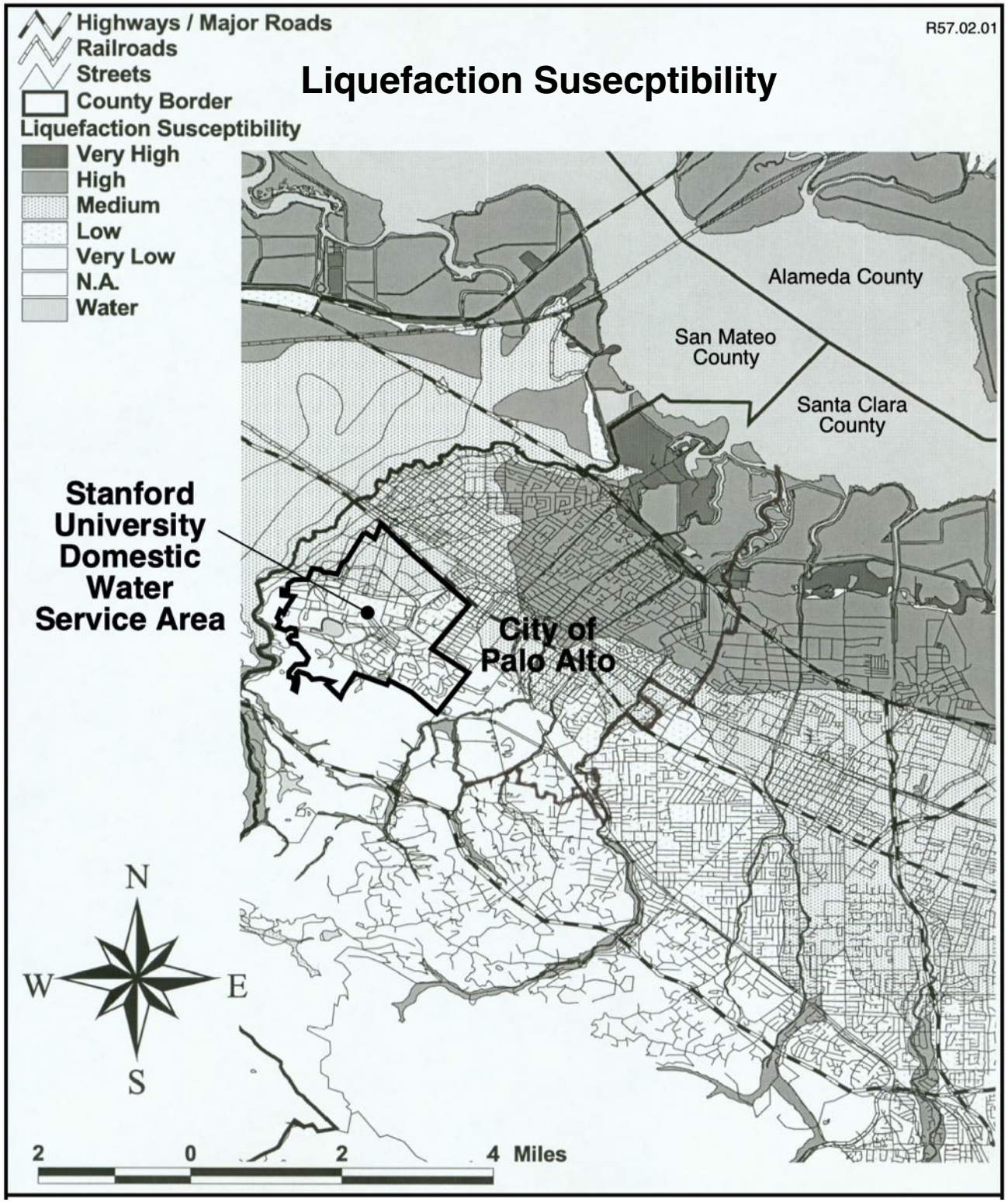
Figure 2-3
Stanford University Water System
Schematic Diagram
R57.02.01
7/13/2002
6.0 Reservoir, Capacity in Million Gallons
SFPUC Pipeline, diameter in inches
R Pressure Regulator, Gradient setting in feet
Pumping Plant
In a Pinch
400 ft
300 ft
200 ft
100 ft
50 ft
Foothill Res 1
2.0
411.5'
394'
14"
Foothill Turnout
Golfcourse Turnout
Foothill Res 2
6.0
322'
305'
24"
Foothill PS
SFPUC
BDPL 4
BDPL 3
90"
Stanford Tunnel
Invert 260 ft
84"
72"
58
59
Zone 1
12"
Upper Pump Station 2
Lower Pump Station 2
292'
256'
Costanzo PRV
Mirada PRV
(normally closed)
261'
282'
Campus &
Santa Teresa 1, 2, 3 4 PRV
Zone 2
221'
Stanford Ave PRV
Campus &
Gov. Lane PRV
Zone 3
261'
Escondido
(El Camino) Turnout
36"
SFPUC
76
Palo Alto Pipeline
El Camino Reg



Legend	Abbreviations		General Notes
Raw Water Reservoir	P/L	Pipeline	Pipes are shown schematically
Potable Water Reservoir	BDPL	Bay Division Pipeline	Elevations shown are approximate
Pump Station (Capacity in MGD)	CS2	Crystal Springs #2 Pipeline	All raw water reservoirs are drawn to correct elevation (or with elevation shown)
Pipeline	CS3	Crystal Springs #3 Pipeline	Potable water reservoirs are shown to correct elevation; except Summit, Sutro, MacLaren, College Hill, Stanford Heights, which are shown to very approximate elevation
Tunnel	CS3X	Crystal Springs #3 Extension P/L	Pipelines shown are those in service as of 2000
Valve	Elev	Elevation	Portions of CS1, SA1 which are out of service not shown
Water Treatment Plant	ID	Inside Diameter (inches)	
Emergency Bypass Outlet on Pipeline	MG	Million Gallons	
Pressure Reducing Valve	MGD	Million gallons per Day	
To CDD Distribution System	PAPL	Palo Alto Pipeline	
Turnout Number to Stanford System	PCCP	Prestressed Concrete Pipe	
	PS	Pump Station	
	Res	Reservoir	
	SA1	San Andreas #1 Pipeline	
	SA2	San Andreas #2 Pipeline	
	SA3	San Andreas #3 Pipeline	
	WTP	Water Treatment Plant	
	54"	54 inch diameter	

Not Shown:
New Construction 2003-2022
BDPL 5
More Valves
Irvington Tunnel No. 2
Polhemus Tunnel
Updated HTWTP

SFPUC WATER SYSTEM
Schematic Layout
G&E ENGINEERING SYSTEMS, INC.
7/13/2002
Fig. 2-2


Highways / Major Roads
Railroads
Streets
County Border
Liquefaction Susceptibility
Very High
High
Medium
Low
Very Low
N.A.
Water
R57.02.01
Liquefaction Susecptibility
Alameda County
San Mateo County
Santa Clara County
Stanford University Domestic Water Service Area
City of Palo Alto
N
W
E
S
2 0 2 4 Miles

Forecast Pipe Damage, Stanford, Given a M 7.9 Earthquake on the San Andreas Fault

Pressure Zone	Pipes 16" and Larger	Pipes 12" to 14"	Pipes 10" and Smaller	Total, all Diameters
Zone 3	0.00	0.00	1.40	**1.40**
Zone 2 Lower	0.08	0.50	1.78	**2.35**
Zone 2 Upper	0.09	0.44	1.64	**2.17**
Zone 1	0.02	0.33	0.98	**1.34**
Total, all Zones	**0.19**	**1.27**	**5.80**	**7.26**

The 2 local reservoirs may drain in 15 hours (assuming no fires and quick operator action)

The 2 local reservoirs may drain in 48 hours (assuming no fires and no operator action)

The 3 local wells will likely work once Stanford / PG&E restore power

The SFPUC Supply System will likely be lost for up to 24 hours, or until SFPUC turns valves to isolate damage in their system

BDPL 1 & 2 Retrofit
Looking East

BDPL 1 Crossing Hayward Fault
Construction as of Jan 29, 2003
Designer: G&E Engineering Systems Inc.

Can We Do Better?

- Option 1. Replace 50 miles of pipe with earthquake-resistant water pipe. Cost: $170,000,000 (or about $10,000 per student)
    - Benefit: 99%+ no water outage for first 2 days post-earthquake. Perhaps increase tuition ~$1,000 per year.
- Option 2. Spend $4.6 Billion to Upgrade Hetch Hetchy System (Done. Water rates increase 300%).
- Option 3. Do nothing. Beat Cal ?

Where your water comes from:

Yosemite National Park (1895)

President Teddy Roosevelt
and John Muir
were against it (1904).
Teddy at al vetoed it multiple times

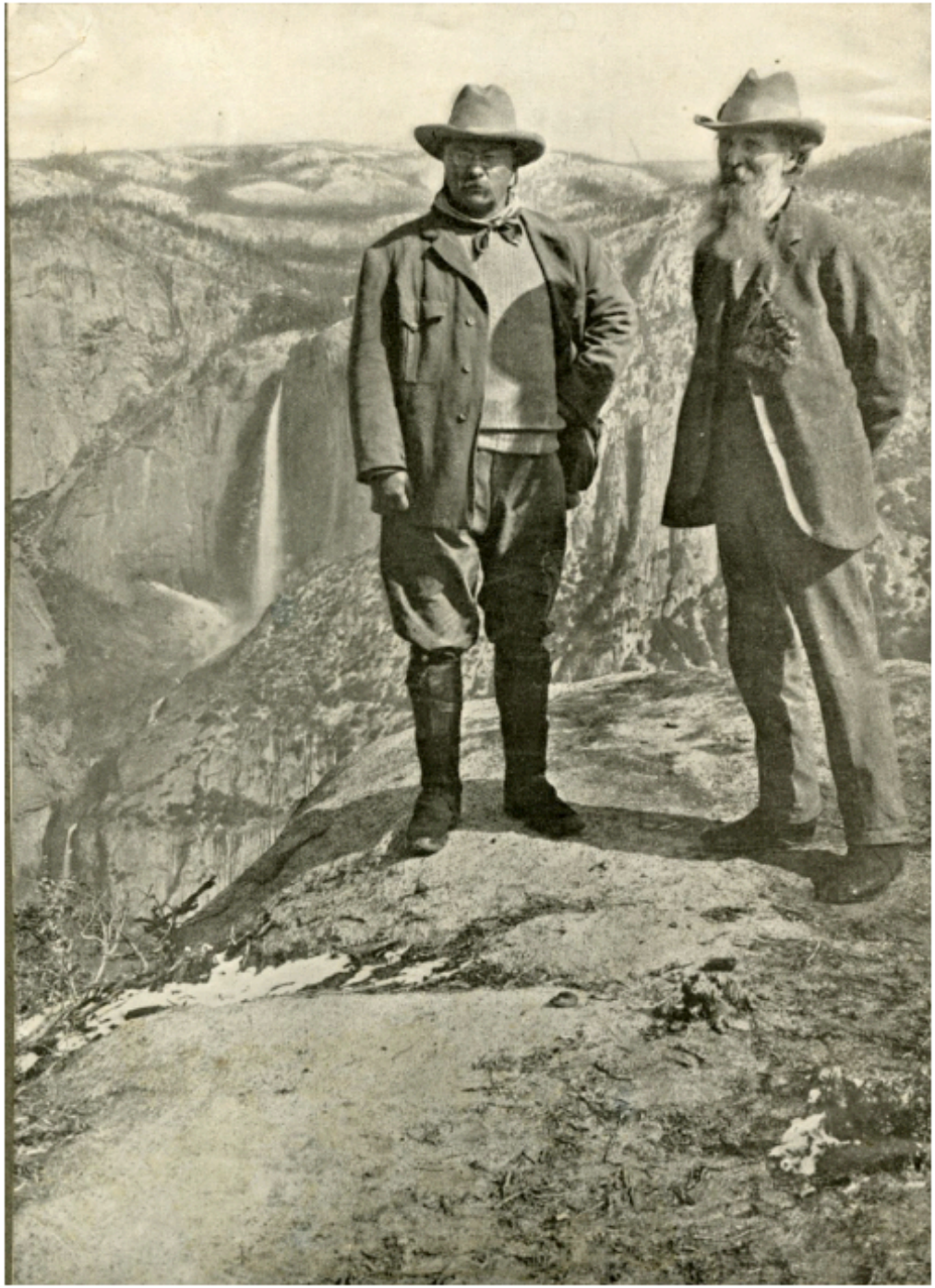
The Great San Francisco Earthquake
And Fire
changed people's minds (1906)

Hetch Hetchy Designed by
John Freeman, MIT (1912)

Congress Approved it and
President Woodrow Wilson
Signed the Conversion
of a National Park into
a Water Supply (1913)

First Water Delivery to
San Francisco (1934)

First Water Delivery to
Stanford (1956)



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AX STOLEN!

Classes Will Be Excused At 10 o'Clock

Chairman Names Freshmen to Be Custodians of 'C'

Bear Crews Will Depart For Seattle

Women in Law Discussed During Guidance Meeting

Ancient Ax Rivalry Climaxed by Successful Stanford Raid on Guards of Armored Car; Highways Filled by Avenging Californians