FINDINGS OF RECENT RESEARCH ON IMPACTS OF MAJOR EVENTS, SUCH AS STORMS & EARTHQUAKES, FOR THE OPERATION OF CALIFORNIA DELTA INFRASTRUCTURES, INCLUDING LARGE WATER SUPPLIES, FLOOD PROTECTION SYSTEMS, ELECTRICITY GRIDS, & TRANSPORTATION

NATIONAL SCIENCE FOUNDATION RESEARCH ON BETTER RISK ASSESSMENT & MANAGEMENT (RAM) OF *INTERCONNECTED* CRITICAL INFRASTRUCTURES *SYSTEMS* (ICIS)

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MAY 19 2014

CASCADES? (LUIIJF ET AL 2008; VAN EETEN ET AL 2011)

CI Sector	Cascade initiating	Cascade resulting	Independent	Total	Sample size
Education	0	3	1	4	4
Energy	146	76	388	609	590
Financial services	1	26	33	60	60
Food	0	4	3	8	8
Government	2	40	26	68	67
Health	1	16	22	39	39
Industry	5	15	7	27	27
Internet	15	51	95	161	160
Postal Services	1	0	0	1	1
Telecommunications	69	125	114	308	295
Transport	19	128	276	423	422
Water	9	18	51	78	76
Total	268	501	1017	1786	1749

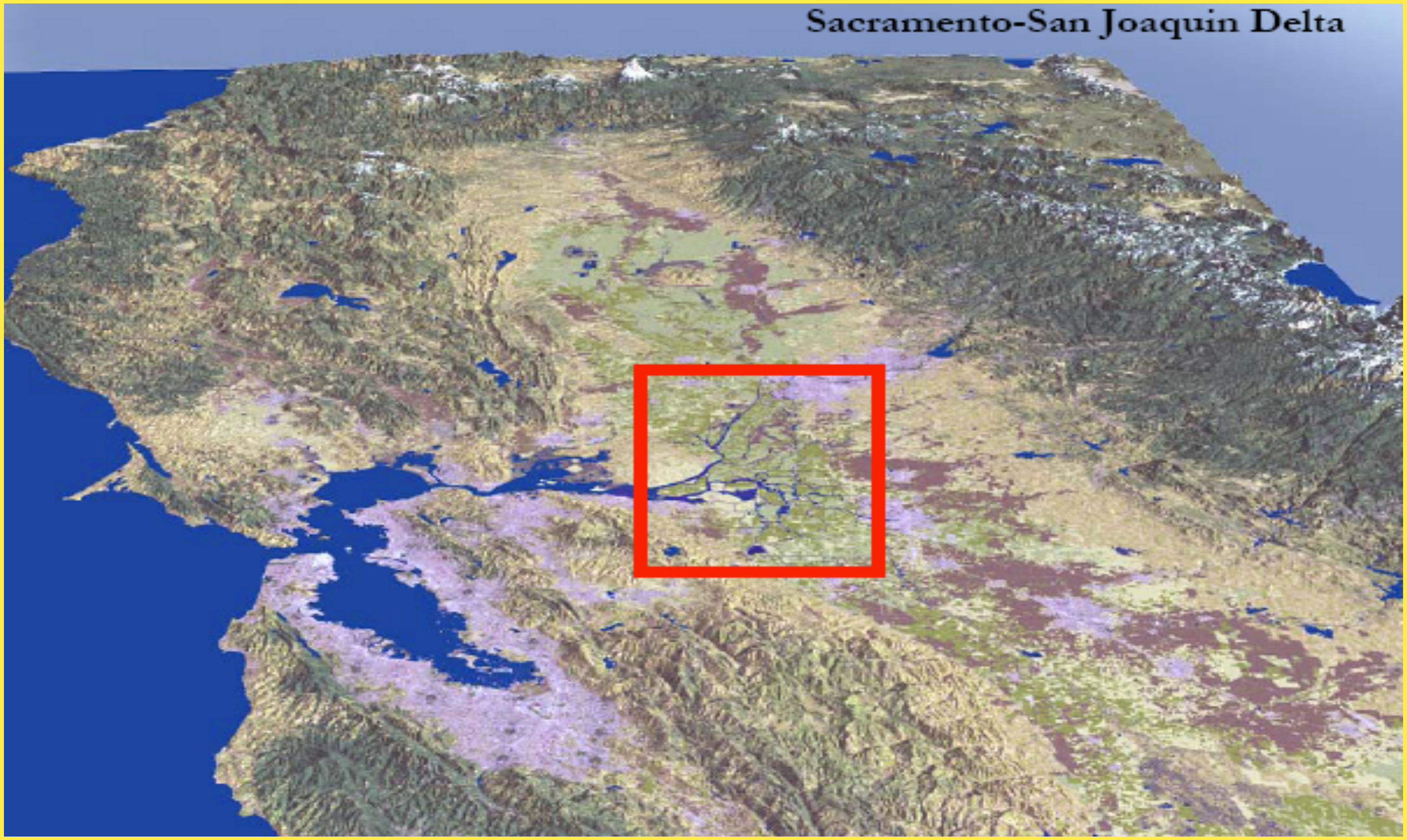
Table 1. Categorisation of number of CI disruption events (number of events).

TABLE 4 *Cascading events summed by affected infrastructure*

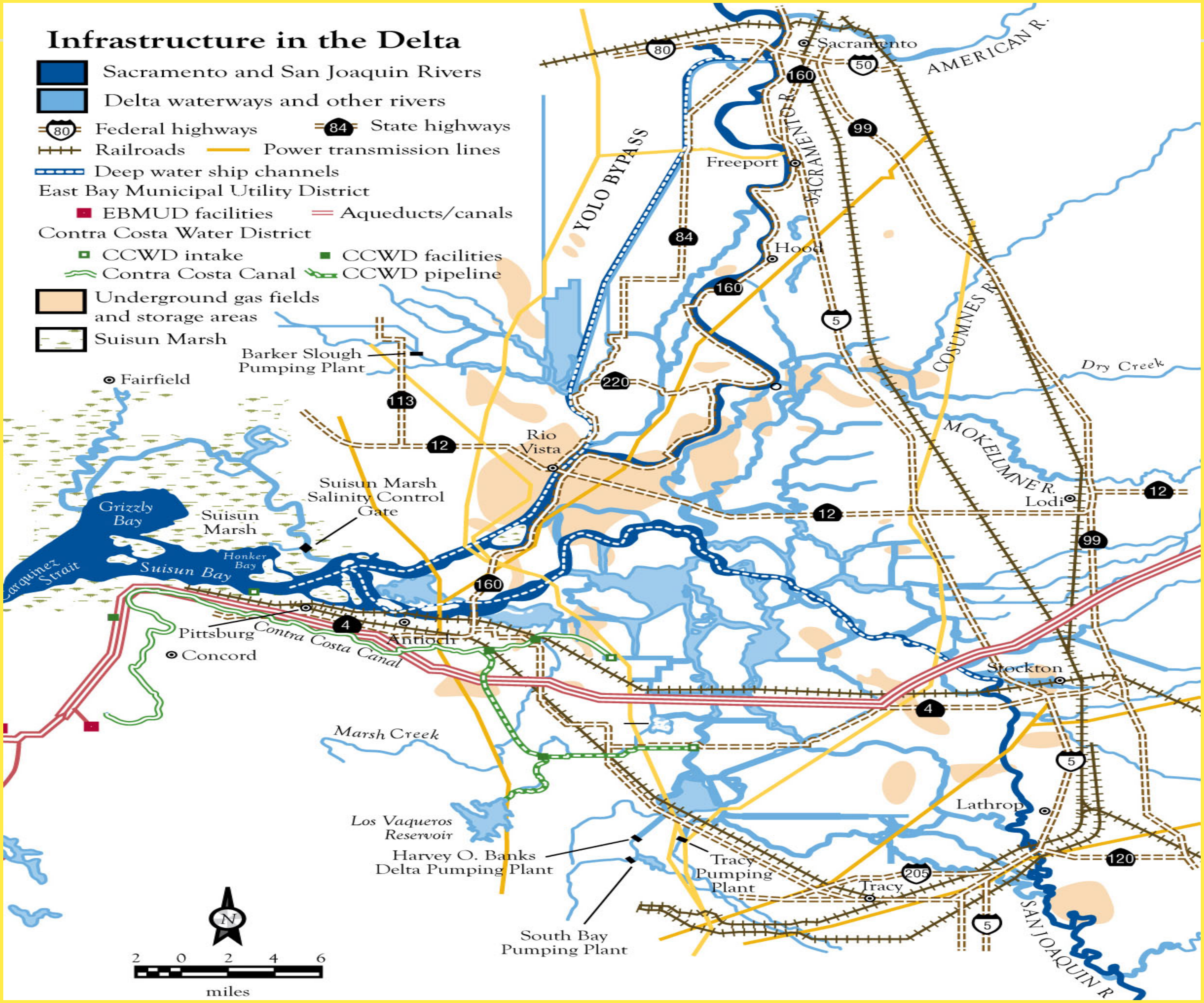
	Initiating sector									
	Energy	Financial Services	Government	Health	Industry	Internet	Telecom	Transport	Water	TOTAL
Affected sector	%	%	%	%	%	%	%	%	%	%
Education & research									100	100
Energy	100						0			100
Financial services	27	9				9	55			100
Food	*67*				33					100
Government	26		5	5		11	47	5		100
Health	50			25			13		13	100
Industry	83								17	100
Internet	15					25	60			100
Telecommunications	*48*						52			100
Transport	67				2		14	14	2	100
Water	80								20	100
TOTAL	***46.6***	**0.5**	**0.5**	**1.4**	**0.9**	**7.2**	***37.1***	**3.2**	**2.7**	**100**

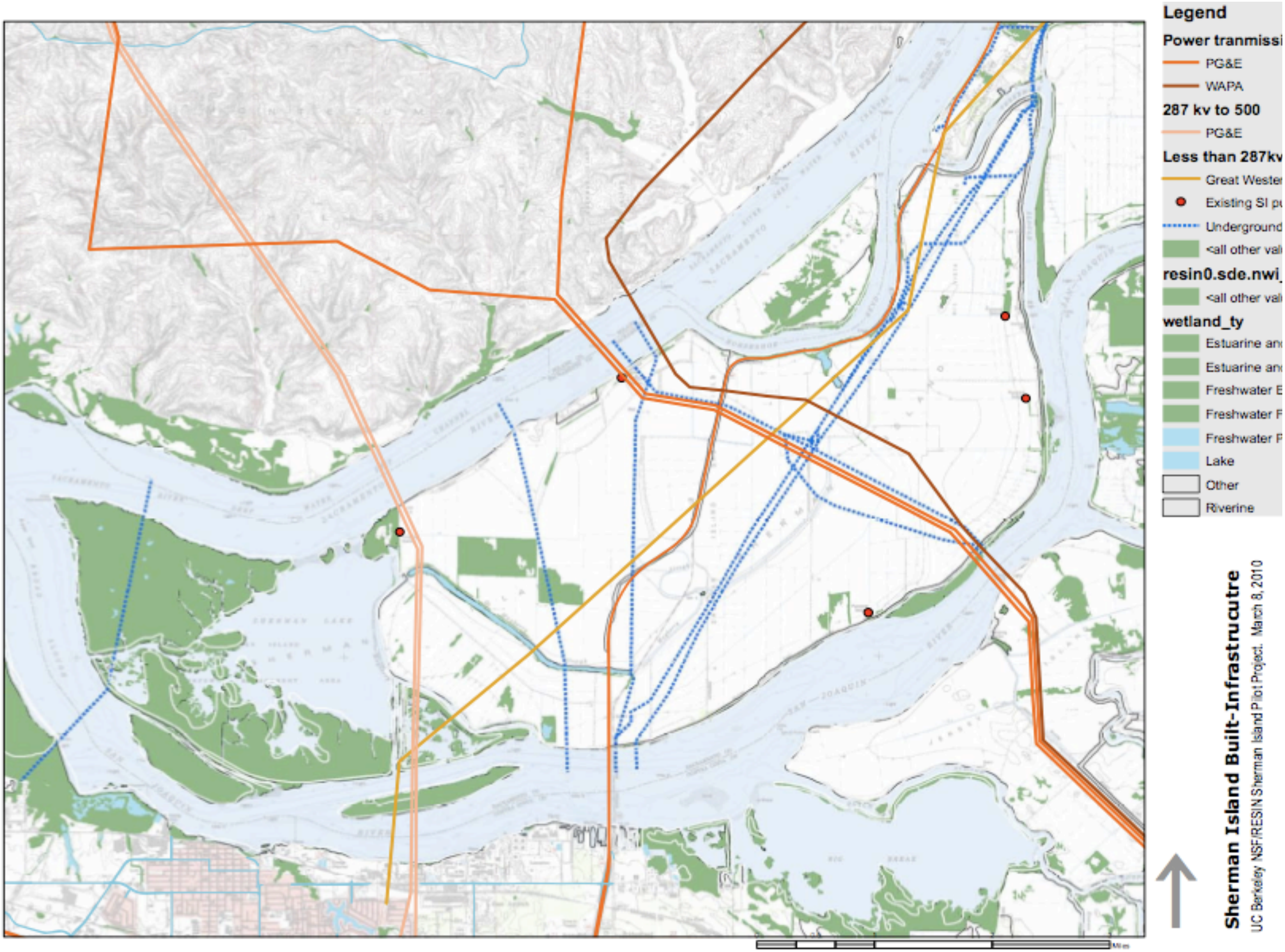
Note: figures in italics are referenced in the main text.

RESIN Resilient and Sustainable Infrastructure Networks



OUR RESIN RESEARCH AREA:





Sherman Island Built-Infrastrucutre
UC Berkeley NSF/RESIN Sherman Island Pilot Project. March 8, 2010

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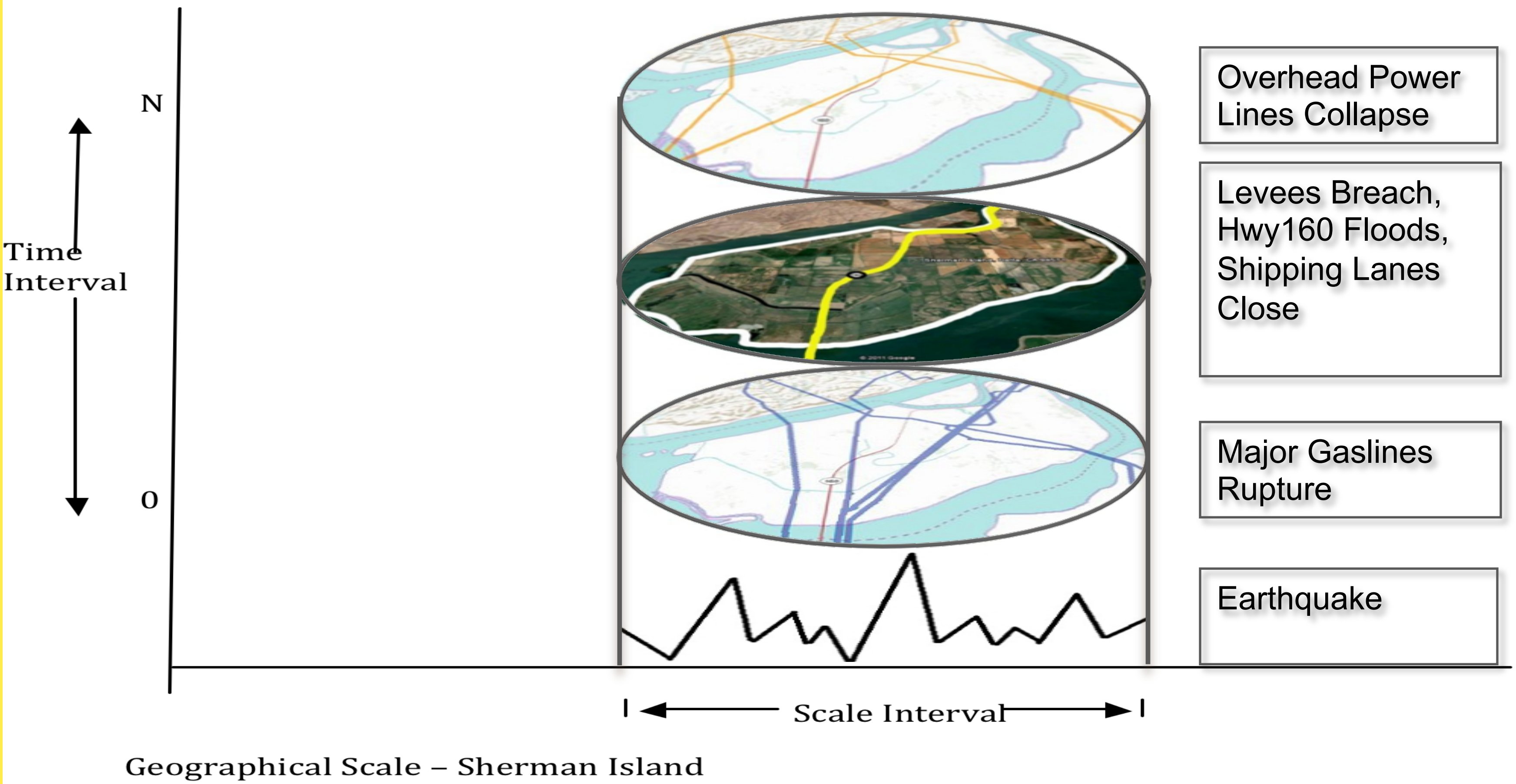
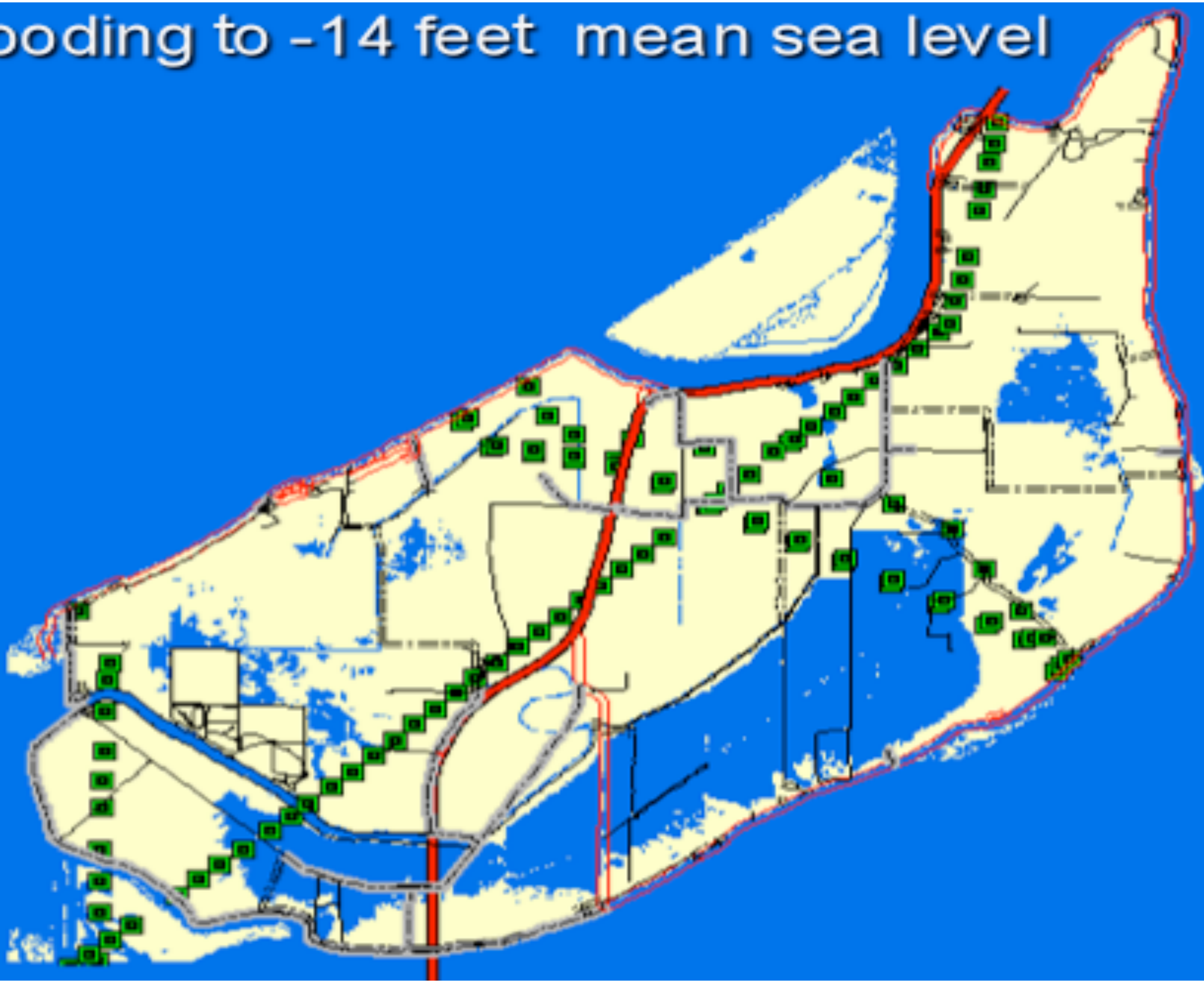
Figure 1 A Cylinder of Spatially Adjacent Infrastructure Elements – Sherman Island



Flooding to -14 feet mean sea level



Annual Pf

3 failure modes Sherman Island 2010

(Slope stability methods are Bishop and Spencer)

Failure Probabilities	$P_{f,\ Seepage}$	$P_{f,\ Overtopping}$	$P_{f,\ Slope\ stability}$
South Side	7.45%	6.60%	3.75% - 23.58% (Deep Failure)
North Side	7.08%	6.60%	5.05% - 29.01% (shallow Failure)

>7% Delta Risk Management Strategy [DRMS]

Mean annual probability of levee failure in the Delta Region from the combined risk of earthquakes, high water and dry-weather failures [2005 conditions]

Source: National Science Foundation, # EFRI-0836047

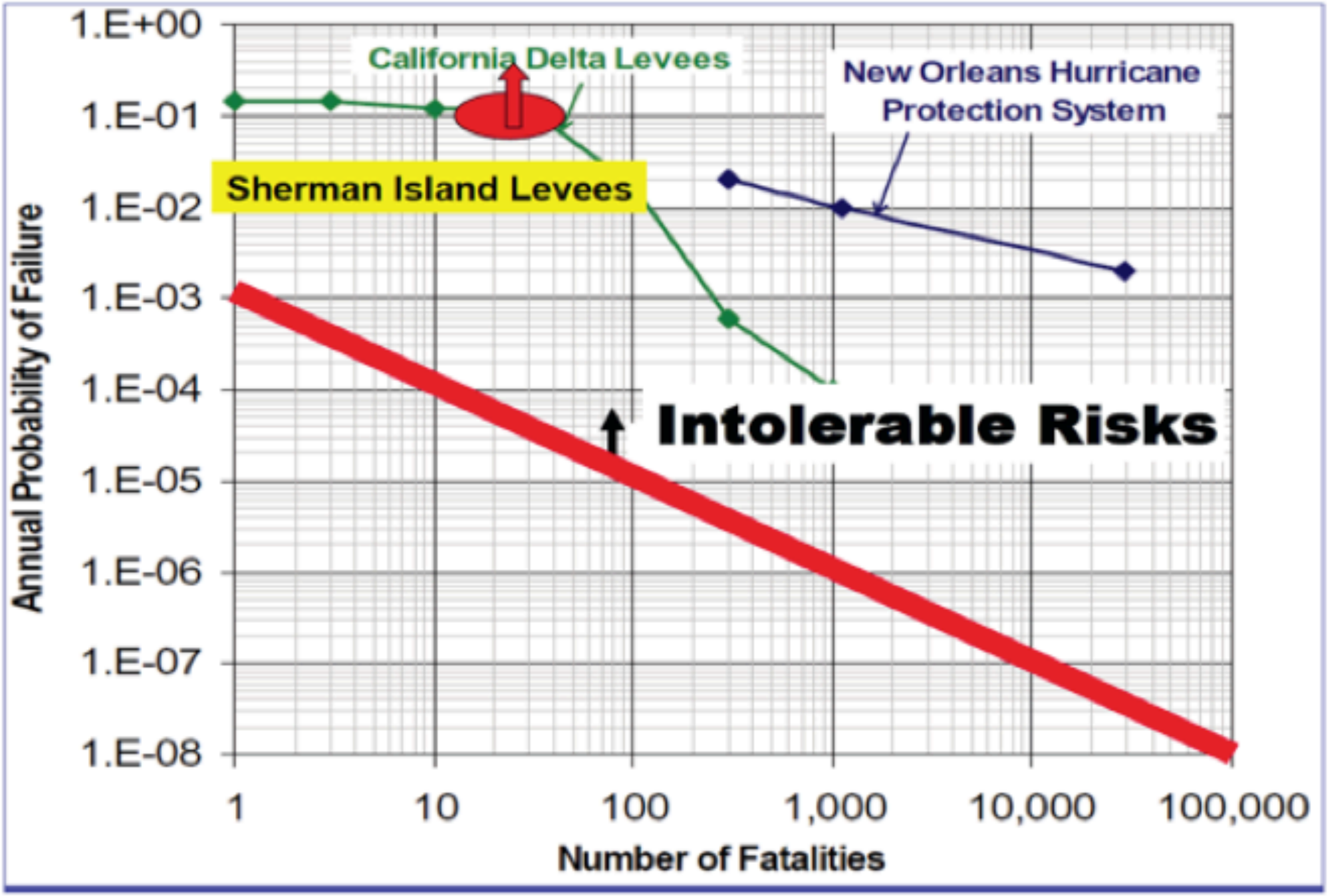


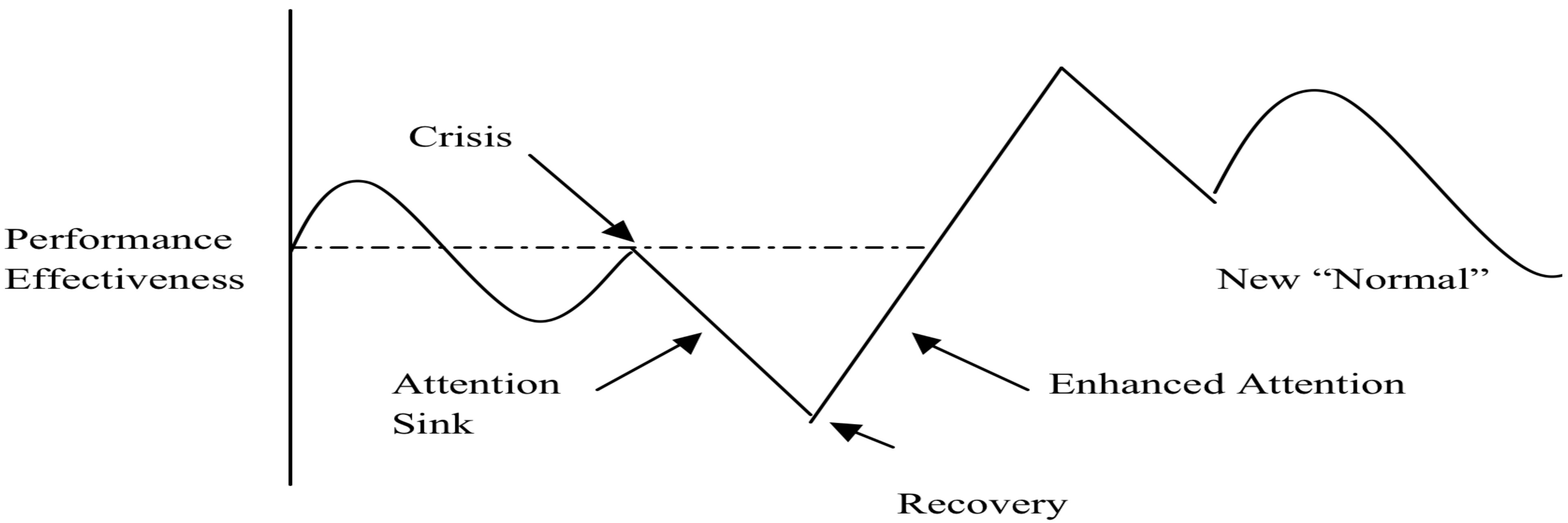
Figure. Assessments of risks associated with failure of water protection levees in the California Delta, in the Greater New Orleans Area, and at Sherman Island for exposure to current severe storm conditions compared with example U.S. risk acceptability guidelines (Roe et al forthcoming)

TEST QUESTION—
WHICH APPROACH: CYLINDER OR RESIN?

Whole-Cycle Approach to

Assessing and Managing Infrastructure Reliability:

Horizontal (infrastructural) and Vertical (interinfrastructural)



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Three Implications for the Delta Ecosystem

--Rethink system definitions, e.g., wetlands are not just an ecosystem but part of the system definition of adjacent levees those wetlands protect.

--Bring ecologists, biologists & renewable energy specialists into infrastructure control rooms to make real-time decisions, e.g., environmental dispatching on the transmission grid.

--Understand the full implications of the infrastructure control room as the only institutional & organizational formation we know for ensuring any kind of high reliability mandate—including those related to the co-equal goals of improved water supply reliability and enhanced ecosystem restoration.

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Thank You & Any Questions?

Further Reading Material

Emery Roe & Paul R. Schulman (2008). *High Reliability Management: Operating on the Edge.*

Emery Roe (2013). *Making the Most of Mess: Reliability and Policy in Today's Management Challenges.*

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