ASSOCIATION FOR LEARNING ENVIRONMENTS

Resilient Design: The Expanding Evolution of Sustainable Design Methodologies

05.03.18

Seattle Public Schools Eric Becker, AIA, LEED AP
PCS Structural Solutions Craig Stauffer, SE
Bassetti Architects Dan Miles, DBIA, AIA + Kristian Kicinski, AIA, WELL AP, LEED AP BD+C

re·sil·ience

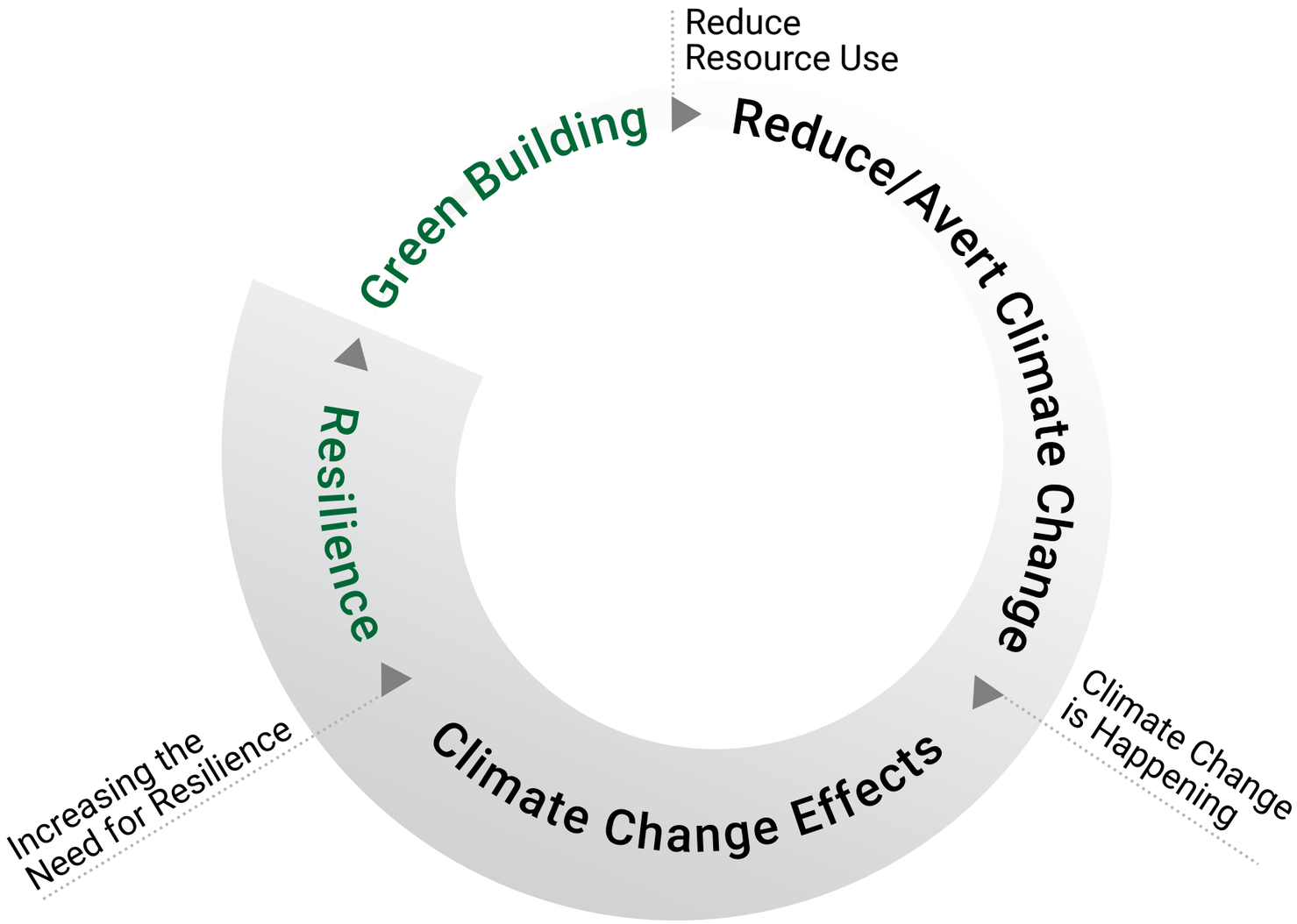
[rə̀zilyəns]

1. **Plan or prepare for the hazard or event by anticipating the risk, which can include addressing risk and mitigating risk**
2. **Adapt to changing conditions**
3. **Withstand, absorb, or limit the impact while preferably maintaining functionality during the event**
4. **Recover (preferably rapidly) and regain functionality after the event**

*Definition Source: *Defining Resilience,* Martha G. VanGeem

*Image Source: World Business Council for Sustainable Development, *Shared Resilience: Working Together to Manage Climate Risk*

Evolution of Awareness



"Resilience is the natural evolution of sustainability. Events like Hurricane Katrina and Superstorm Sandy have made it painfully clear that it is not enough for our buildings to be a low impact on the environment – the environment must also have a low impact on our buildings" (Feis et al., 2016)

Evolution of Awareness

Setting the "Ideal" as the Indicator of Success

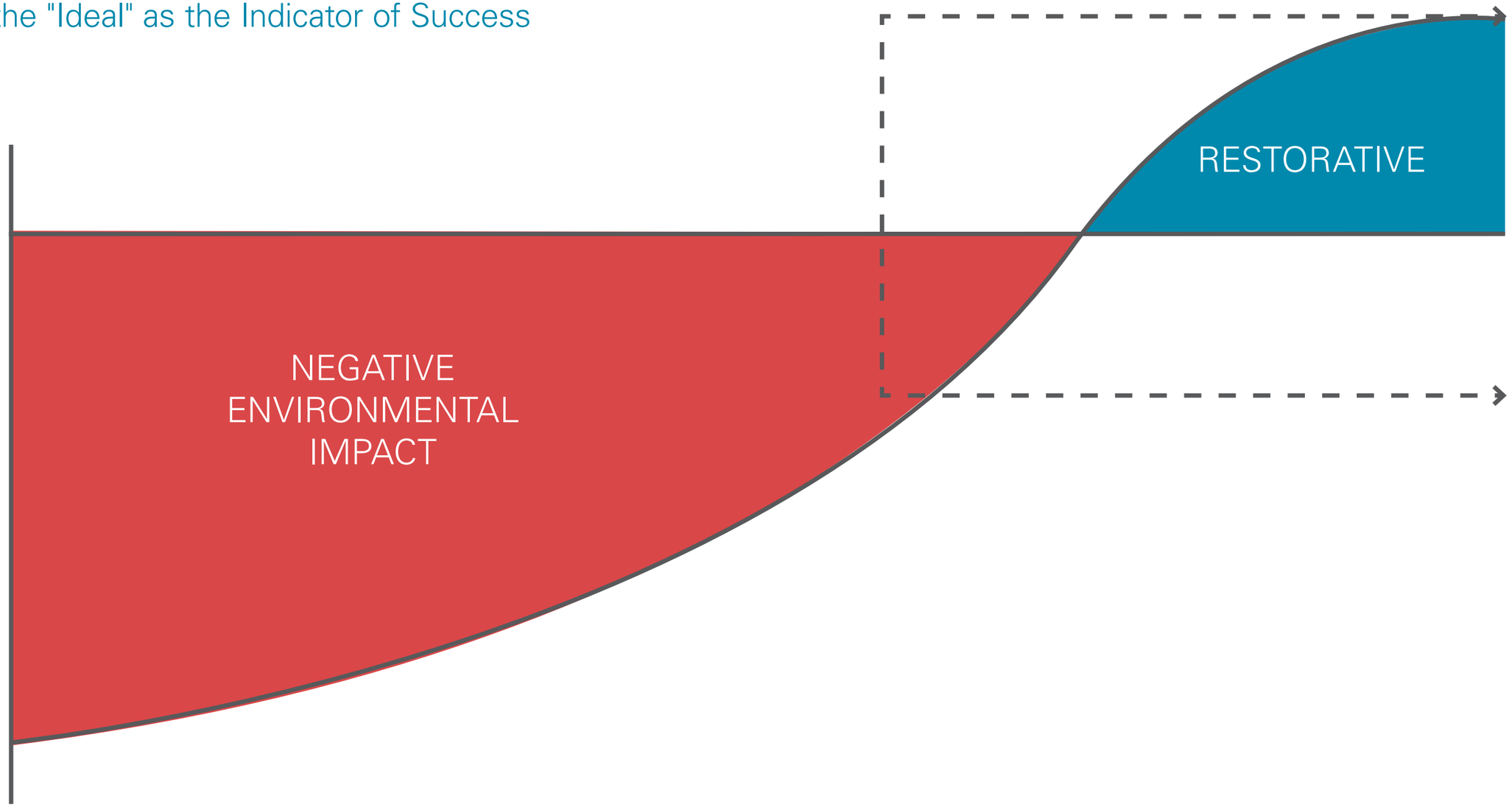
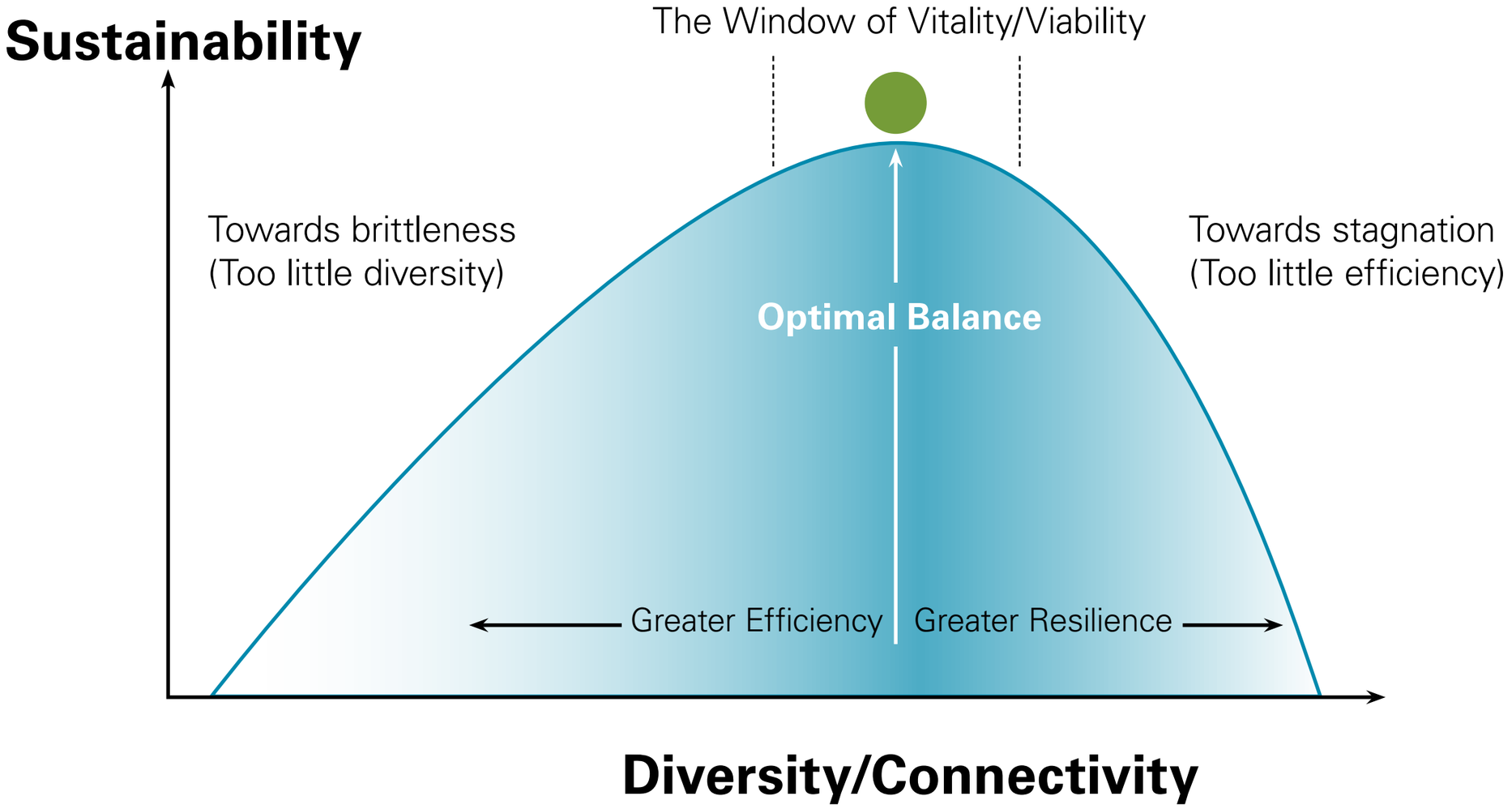


*Image source: Inhabitat

Evolution of Awareness

Sustainability as a function of efficiency and resilience



Potential Hazards

- Earthquake
- Tsunami
- Wildfire
- Flood
- Eruption
- Hurricane
- Tornado

Mount Saint Helens | Photograph by Jim Hill

Case Study – Japan

THE PROGRAM FOR EARTHQUAKE-RESISTANT SCHOOL BUILDINGS

STEPS OF THE PROGRAM		RESPONSIBLE LEVEL
Program Design	• Provision of Technical Guideline • Technical Support • Financial Support • Monitoring	National Government (MEXT)
Program Implementation – Planning	Step 1: Establishment of Investigative Organization	Local Government (Municipalities)
	Step 2: Implementation of Basic Survey	
	Step 3: Prioritization of Vulnerable Buildings for Seismic Retrofitting	
	Step 4: Vulnerability Assessment	
	Step 5: Implementation of Seismic Diagnosis	
	Step 6: Determination on Urgency of the Projects	
Program Implementation – Implementation	Step 7: Formulation of Annual Plan	
	Step 8: Formulation of Reinforcement Plan	
	Step 9: Preparation of Design Drawings	
	Step 10: Implementation of Construction Works	

*Graphic based on: *Making Schools Resilient at Scale: the Case of Japan*

KOBE, JAPAN – HYOGO-KEN NANBU EARTHQUAKE, 1995

- Redefined shelter needs in dense urban areas
- Of Kobe's 1.4 million people 320,000 needed shelter
- Every school served as living quarters for the first 2–3 weeks
- 6.9 magnitude
- Even moderate earthquakes in densely populated areas can displace thousands of people

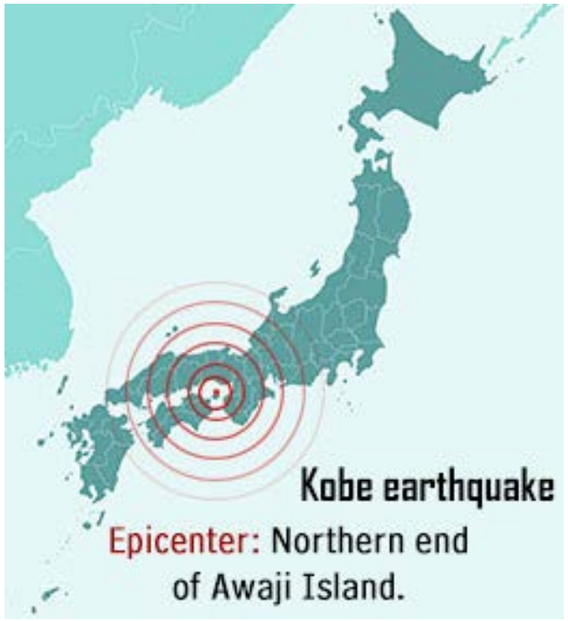


*Image Source: Japan America Society of Greater Philadelphia

Case Study – Lincoln School District

SCHOOL SHELTERING GUIDELINES

Sheltering Students

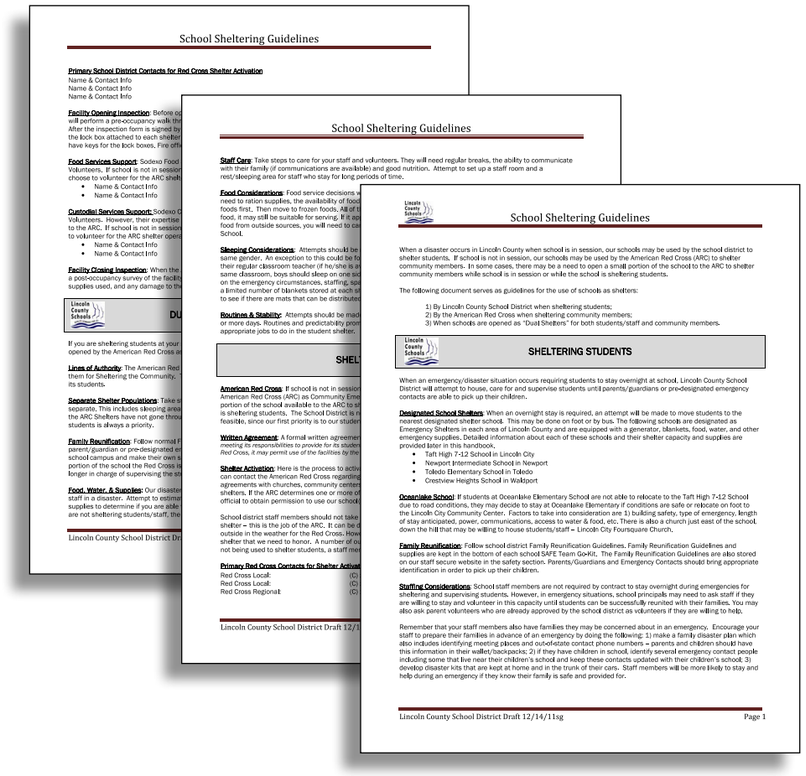
- Designated School Shelters
- Family Reunification
- Staffing Considerations
- Staff Care
- Food Considerations
- Sleeping Considerations
- Routines & Stability

Sheltering the Community

- American Red Cross
- Written Agreement
- Shelter Activation
- Primary Red Cross Contacts for Shelter Activation
- Primary School District Contacts for Red Cross Shelter Activation
- Food Services Support
- Custodial Services Support
- Facility Closing Inspection

Dual Sheltering Considerations

- Lines of Authority
- Separate Shelter Populations
- Family Reunification
- Food, Water, & Supplies



Case Study – California

City officials in California are advised to plan for sheltering **20**% of their total population – nearly every school will be needed for public shelter

Spontaneous Community Convergence

- Large numbers of tents and campers in the athletic fields
- Sanitation issues
- Safety issues

Sheltering Students

- Need to provide shelter, food, and medical attention
- Electricity, water, and phone lines were down
- Sanitation issues

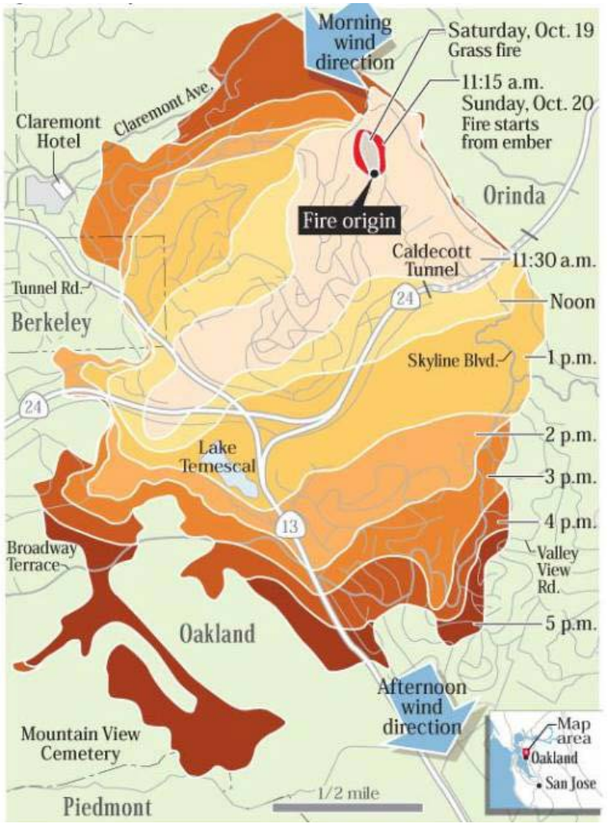
Coordination with the Red Cross

- Communication issues (unable to locate any school district personnel listed as contacts for the Red Cross)
- Unable to turn on the ventilation system or give access to the locked off food service area

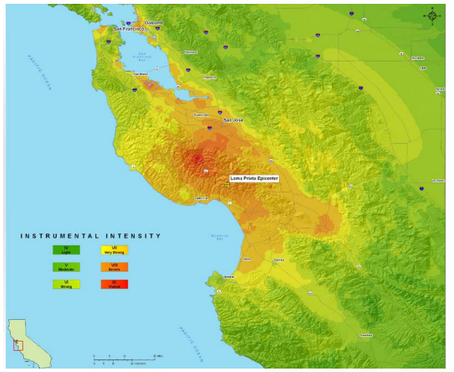
Long-Term Community Sheltering

- Concerted effort to keep students separate at all times
- Parents were concerned that their children were being exposed to drugs, alcohol, disease, and violent behaviors- which drew news media attention
- Transients did not leave following immediate post-disaster period

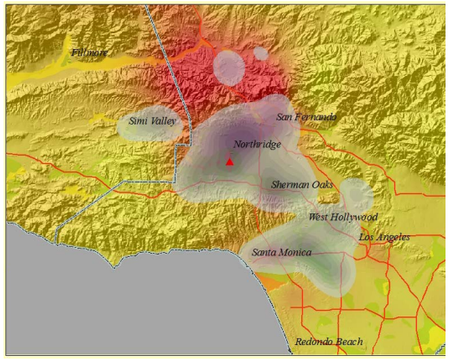
OAKLAND HILLS FIRE



LOMA PRIETA EARTHQUAKE



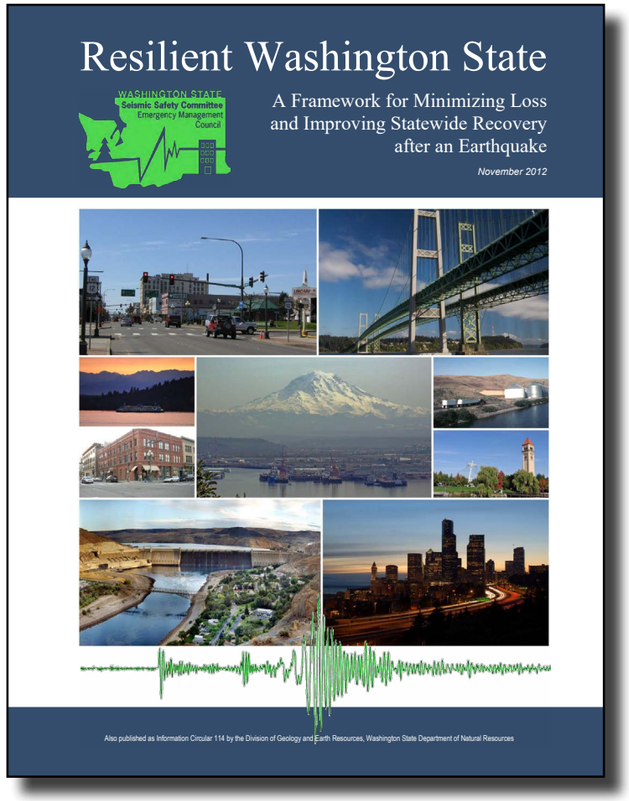
NORTHRIDGE EARTHQUAKE



*Clockwise left to right: Oakland Hills Fire - Oakland Fire Department; Loma Prieta Earthquake - Digital Mapping Solutions; Northridge Earthquake - University of West Florida

Washington State – School Plan Suggestions

RECOMMENDATION **1. Make schools resilient: structurally, socially, and educationally**	
PRIORITY ACTIONS	**RECOMMENDED ORGANIZATIONS**
1a. Perform assessments of school buildings to prioritize seismic risk of the state's schools **Short-term:** Complete assessments by year 8 **Mid-to long-term:** Repair or replace schools as outlined in the plan	**OSPI (lead); DNR**
1b. Enact legislation that requires school districts to conduct safety drills **Short-term:** Draft and enact legislation **Long-term:** Track metrics related to progress	**State Legislature (lead); OSPI; EMD**
1c. Enact legislation that requires school districts to develop mitigation plans **Short-term:** Develop mitigation plans to make them eligible for federal funding **Long-term:** Districts maintain hazard mitigation plans by regularly revising and updating them	**State Legislature (lead); School Districts; Cities; Counties; EMD**
1d. Enact legislation that requires school districts to develop and maintain comprehensive continuity of operation plans **Short-term:** School districts develop continuity operations plans **Long-term:** Schools and districts maintain plans through regular training, updates and exercises	**OSPI (lead); State Legislature; School Districts**



*__Washington State Seismic Committee__
Emergency Management Council
Resilient Washington State: *A Framework for Minimizing Loss and Improving Statewide Recovery after an Earthquake*

Considerations/Priorities – Seattle Public Schools planning

- Get back to business within three days of an event
- Be prepared to provide resources on location
- Consider the vulnerable populations
- Prevention/Mitigation, Preparedness, Response, Recover

Considerations/Priorities – Seattle planning

NEIGHBORHOOD SCHOOLS AS RECOVERY RESOURCES

Seattle Office of Emergency Management

- With schools used a portion of the day, **other community activities focused on recovery could be collocated** on the property

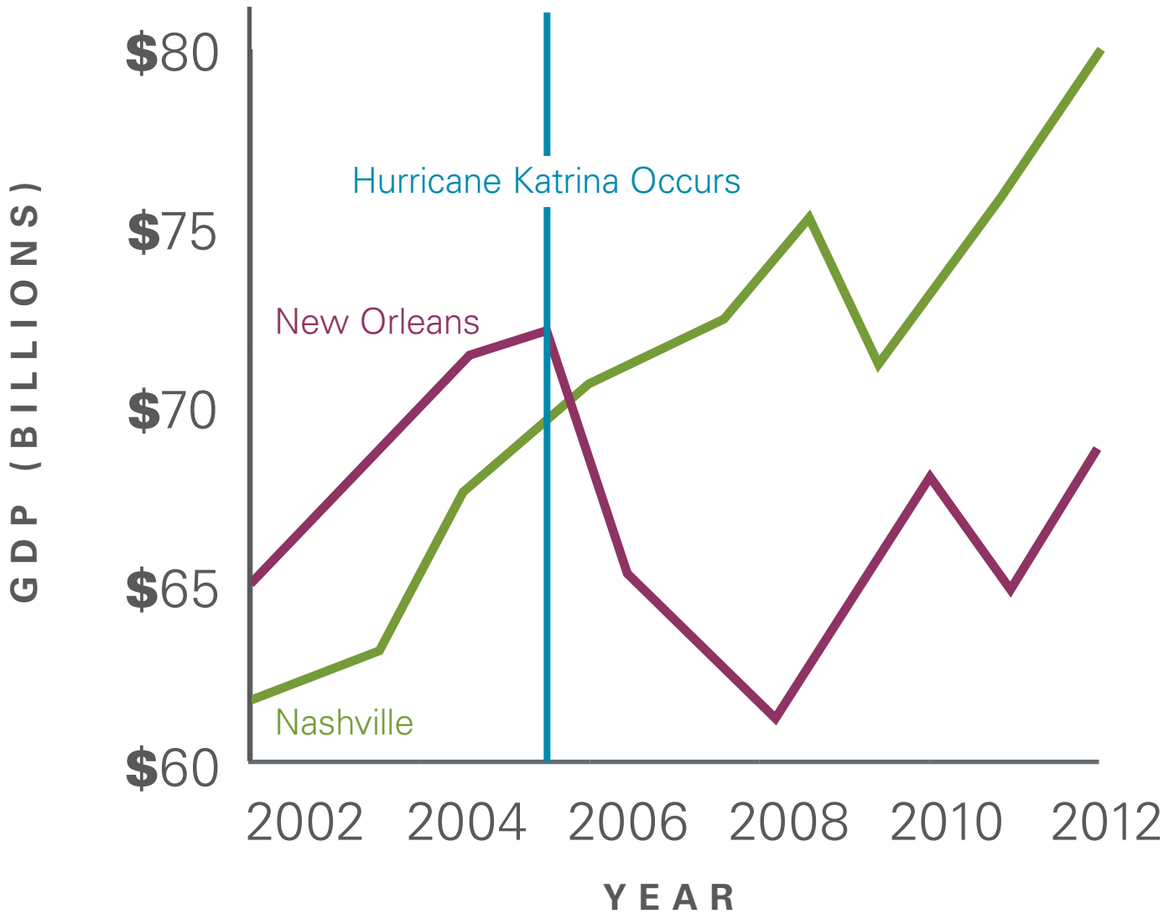
- The driving need to **collocate services** with schools is the anticipated inability to move around the city because of transportation disruptions due to an earthquake

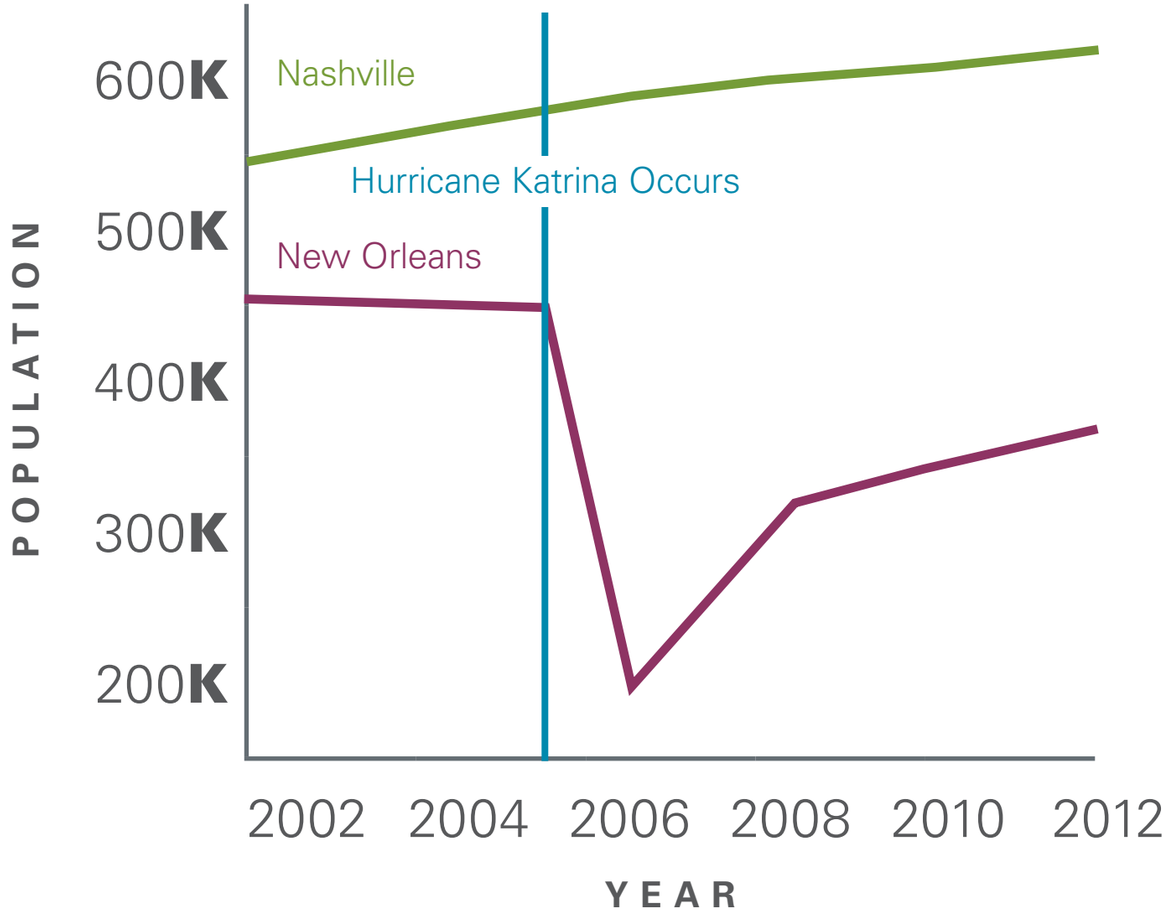
- **Leverage schools as a physical neighborhood resource** for "wrap around services" for children and families: space, resources (locating complementary services, e.g., childcare, family support, medical, mental health) and access to information

**Seattle Disaster Recovery Framework*

Importance of Recovery

HURRICANE KATRINA





Importance of Mitigations

- Based upon 23 years of past federal grants from FEMA, HUD, and EDA
- These grants funded the retrofitting of mostly public buildings, such as schools or wastewater treatment plants
- Every $1 spent, approximately $6 is saved

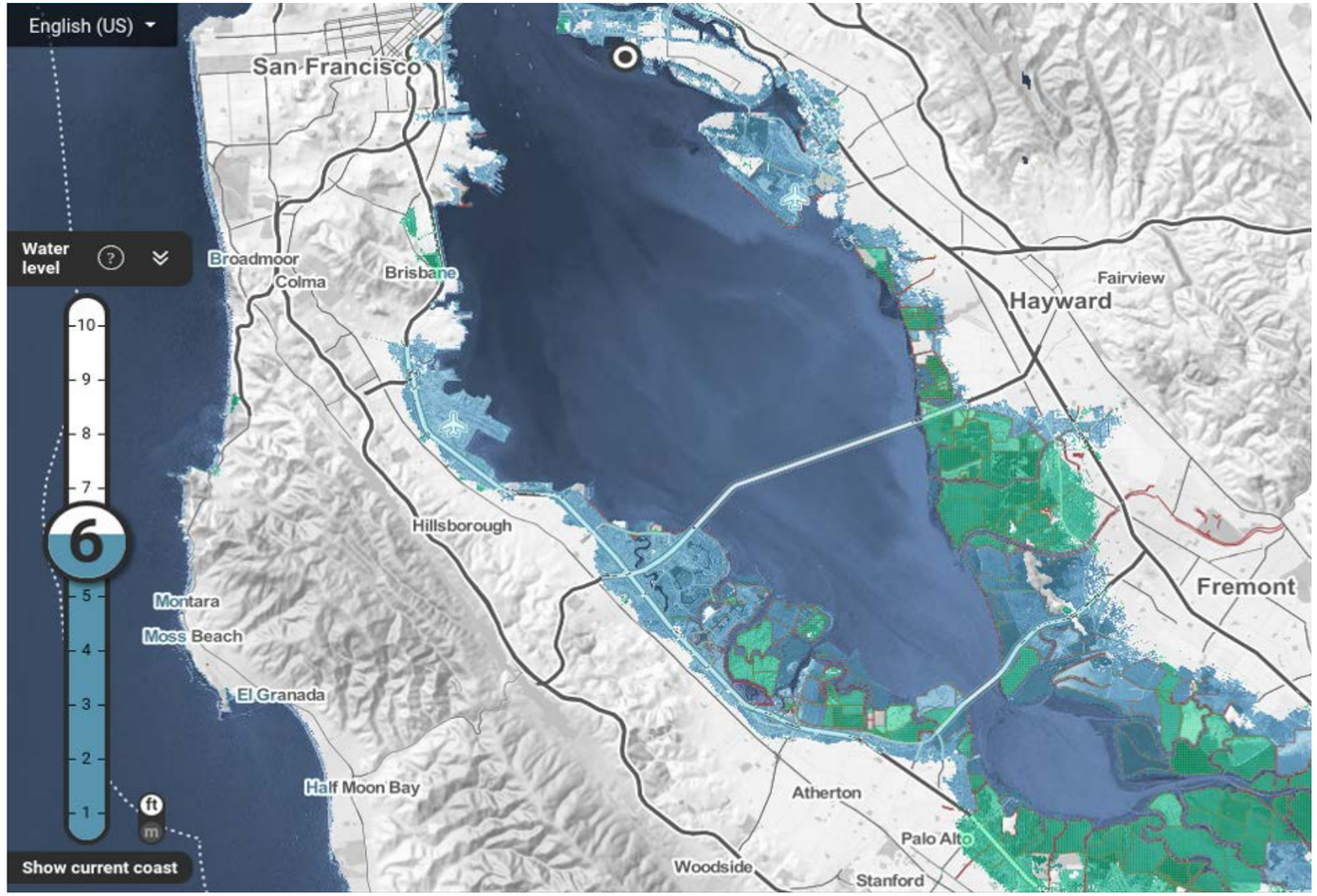
BENEFIT-COST RATIO BY HAZARD AND MITIGATION MEASURE

	FEDERALLY FUNDED COST PER DOLLAR SAVED
Riverline Flood	**7**:1
Hurricane Flood	**Too few grants**
Wind	**5**:1
Earthquake	**3**:1
Wildland-Urban Interface Fire	**3**:1
OVERALL HAZARD BENEFIT-COST RATIO	**6**:1

* *Invest Now, Spend Less Later* - Nancy Eve Cohen | Diagram information from the National Institute of Building Sciences (NIBS)

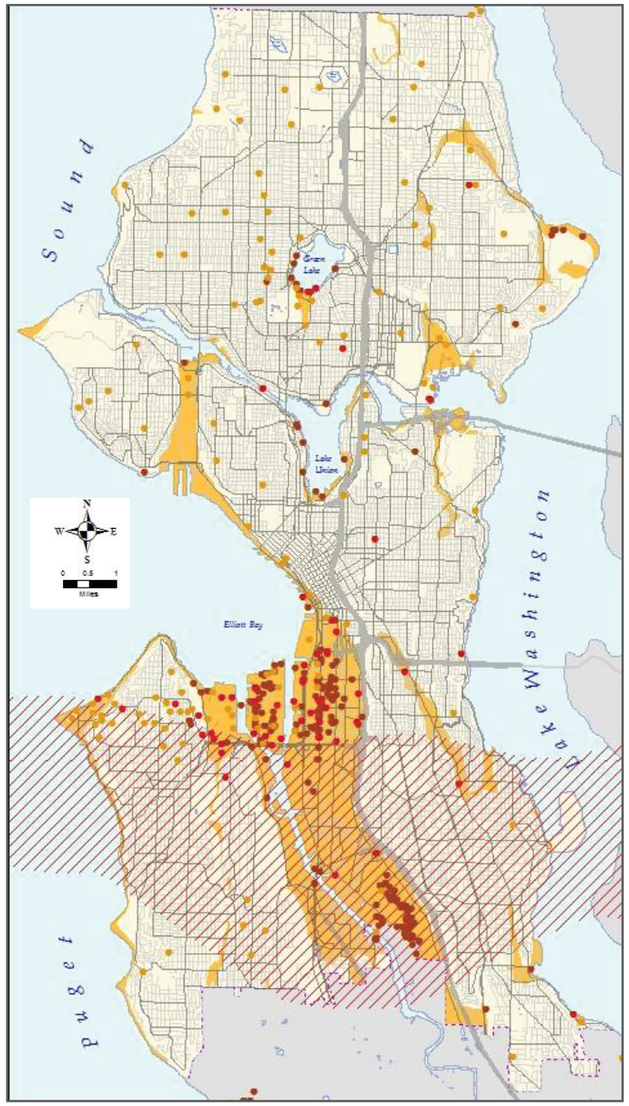
Considerations/Priorities – Site

San Francisco Surge Zone Map



*Map source:Climate Central

Seattle Fault Zone, Liquefaction Areas, and Ground Failures



Ground Failure

- 1949
- 1965
- 2001
- Seattle Fault Zone
- Liquefaction Prone Areas

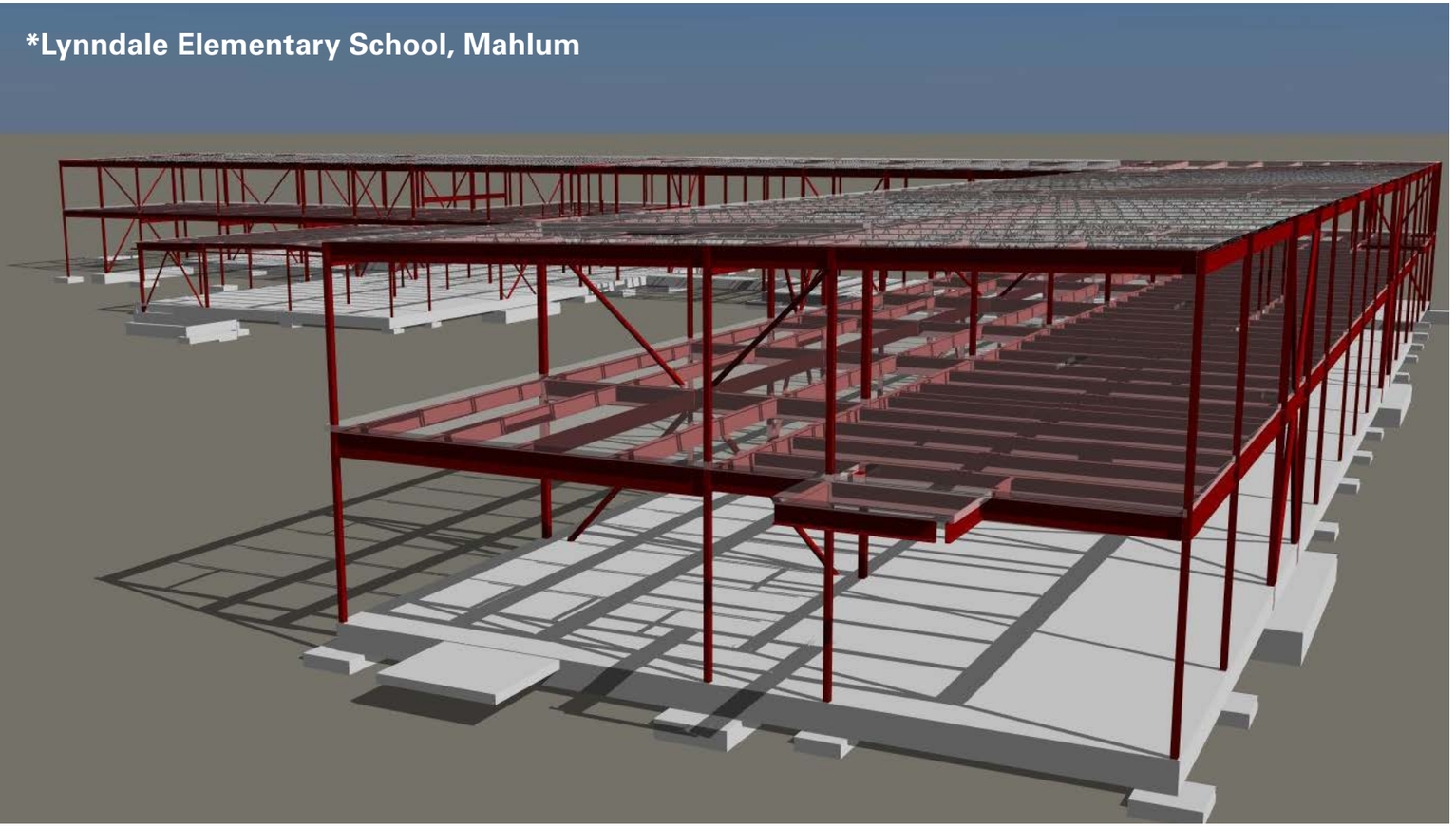
*Map source: Seattle Office of Emergency Management *Seattle Hazard Identification and Vulnerability Analysis*

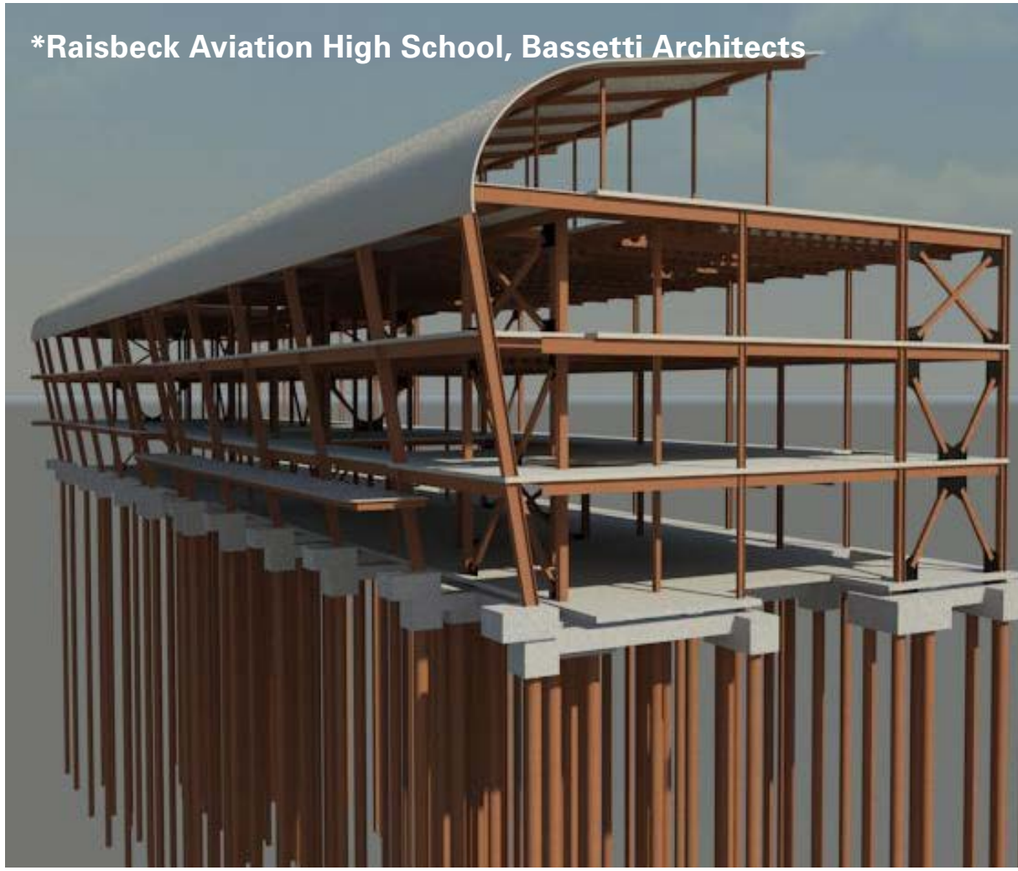
Considerations/Priorities – Structure


*Lynndale Elementary School, Mahlum

*Raisbeck Aviation High School, Bassetti Architects

Considerations/Priorities – Structure

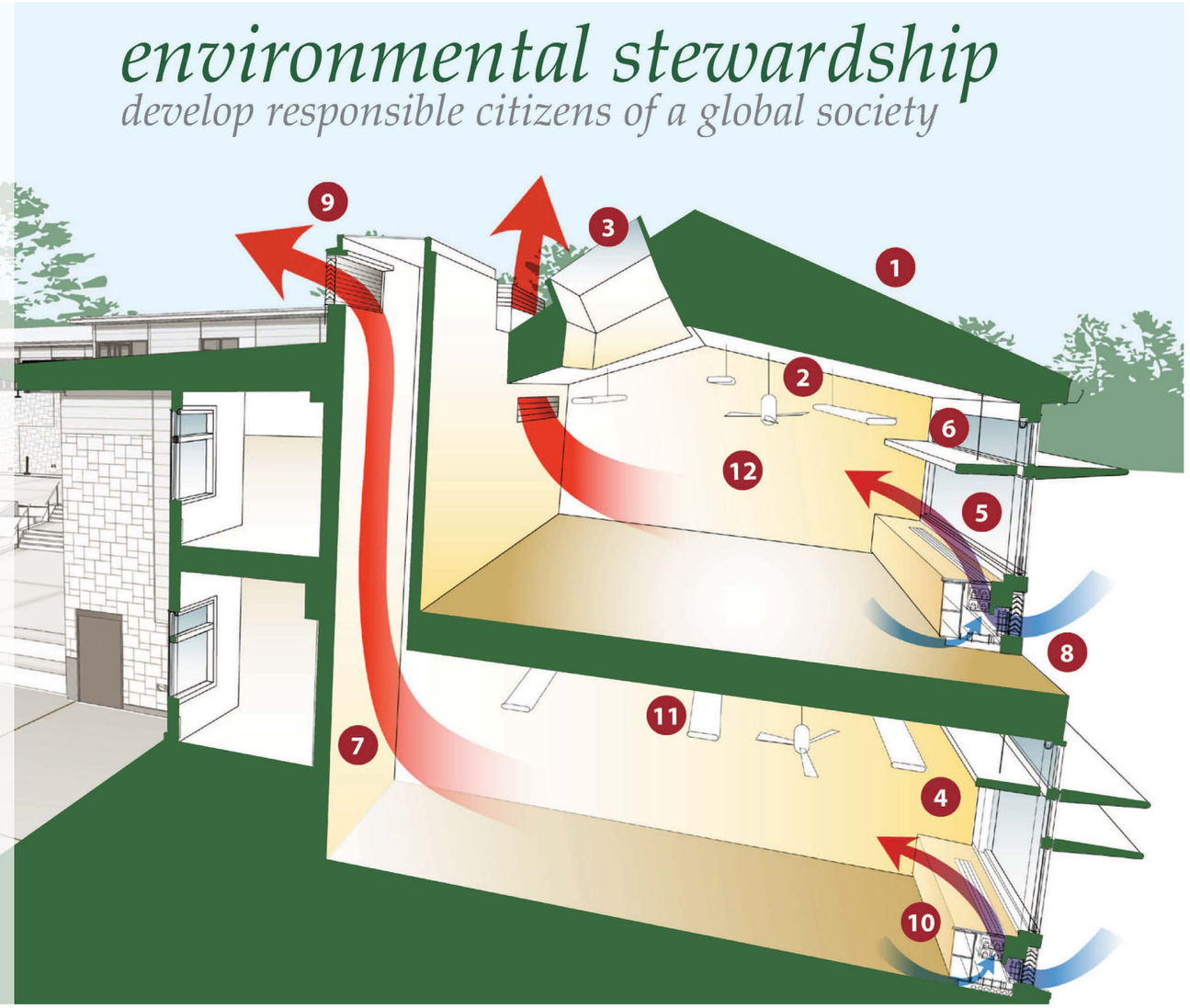




Considerations/Priorities – High Performance Strategies

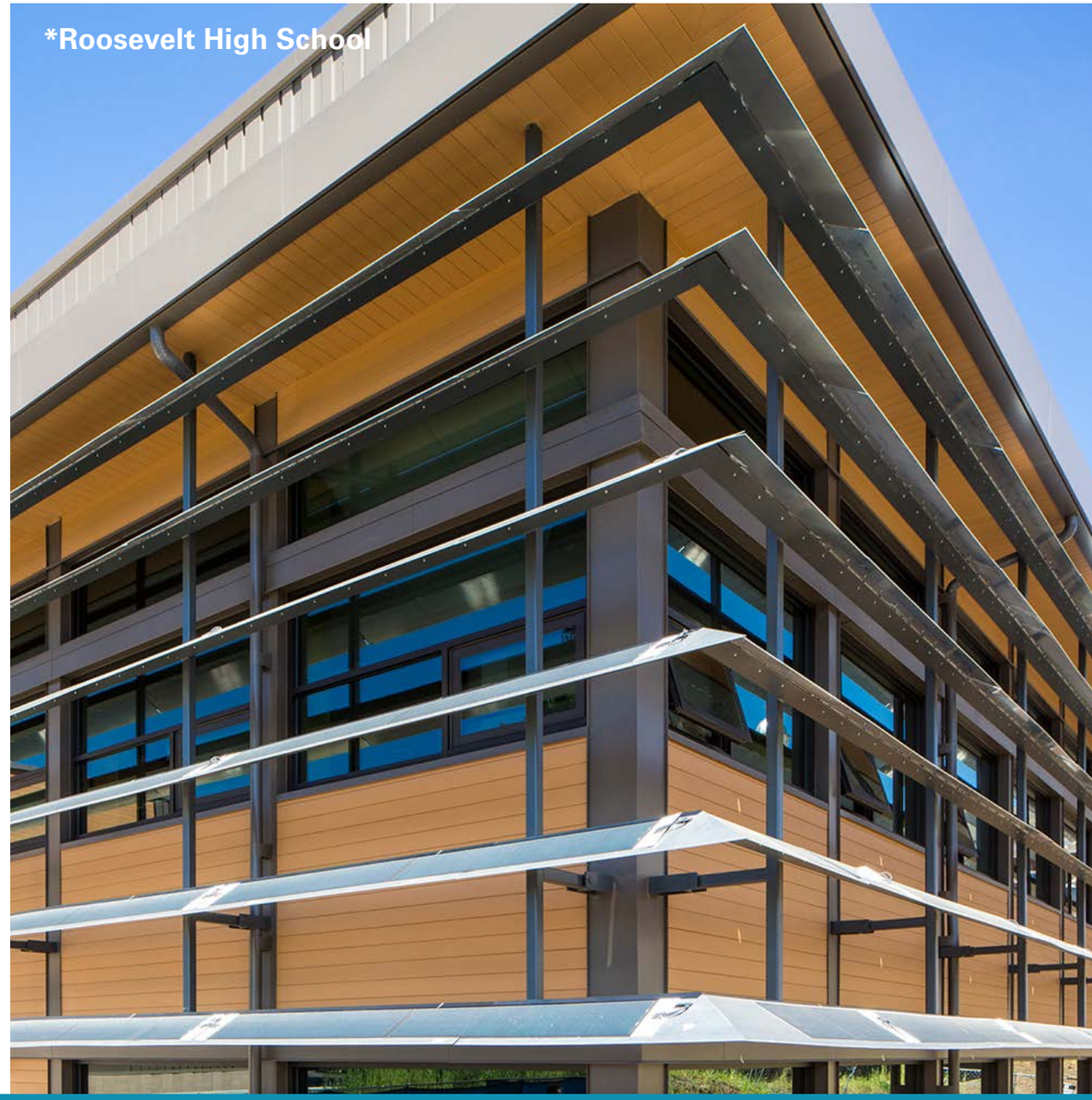
- Natural Ventilation
- Operable Windows
- Water Collection
- Solar Panels
- Photo Voltaics
- Harvesting Daylight

*St. Thomas School



1. ENERGY STAR cool roofs reduce urban heat island effect.
2. Fabric ceiling panels distribute daylight and improve acoustic performance
3. Insulated fiberglass skylights provide diffuse light with reduced heat energy loss
4. High R-value (R-26) walls with rigid insulation reduce thermal bridging
5. Operable windows provide user control of fresh air and temperature
6. High windows bring daylight deep into the classroom
7. Daylight shafts bring light to the back of rooms on the lower floor
8. Automatic dampers control the passive intake of fresh air
9. Automatic dampers control the passive exhaust of heated air
10. High efficiency finned tube radiators heat the incoming air and the recirculating indoor air
11. Photocells save energy by controlling high efficiency, indirect lighting
12. Temperature and CO2 sensors control the intake and exhaust dampers

Considerations/Priorities – High Performance Strategies



Key Questions to Start the Conversation in your Community

1. **How do I know if a building is resilient?**
2. **What are our most resilient buildings right now?**
3. **Are my schools expected to prioritize getting students back to school or sheltering the community?**
4. **What are the various entities who will plan what happens to my school in the event of a disaster?**
5. **Should some areas and/or systems of our schools be more resilient than others?**
6. **What can be done now to improve resiliency of facilities in my community with the least amount of cost and institutional change?**
7. **What are the plans that are currently in place that would affect resiliency?**

*

Image Source: Jeffrey Loehr, *Demystifying Climate Change*

Resources

Seattle Emergency Management Plans
http://www.seattle.gov/emergency-management/plans

SHIVA – The Seattle Hazard Identification & Vulnerability Analysis
http://www.seattle.gov/Documents/Departments/Emergency/PlansOEM/SHIVA/SHIVAv6.3Final.pdf

Resilient Washington State – Emergency Management Division
http://mil.wa.gov/emergency-management-division/resilient-washington-subcabinet

Disaster and Emergency Preparedness: Guidance for Schools
https://www.ifc.org/wps/wcm/connect/8b796b004970c0199a7ada336b93d75f/DisERHandbook.pdf?MOD=AJPERES

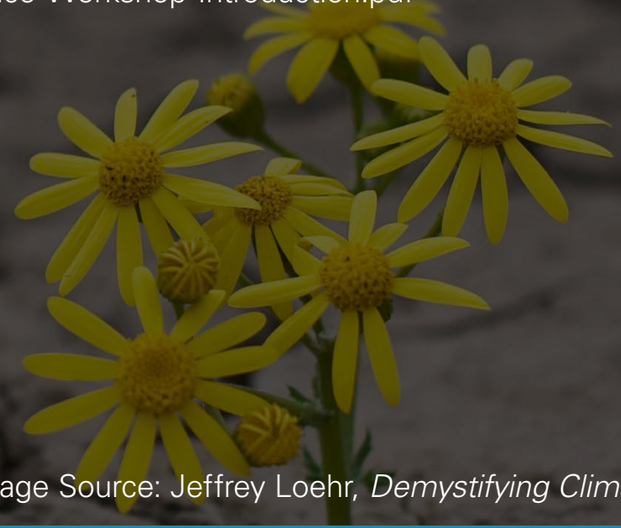
Making Schools Resilient at Scale: the Case of Japan
https://www.gfdrr.org/sites/default/files/publication/110216drmhubtokyoMakingSchoolsResilientatScale.pdf

The National Resilience Initiative Annual Report
https://www.aia.org/resources/86176-the-national-resilience-initiative-annual-re

US Resiliency Council | Building Rating System for Earthquakes
http://usrc.org/files/technicalresource/USRC-Architects_Brochure%20-%20071117%20%5b3-page%5d.pdf

USGBC RELi Standard
http://c3livingdesign.org

NST Community Resilience Program – Third Stakeholder Workshop
https://www.nist.gov/sites/default/files/documents/el/building_materials/resilience/3rd-Disaster-Resilience-Workshop-Introduction.pdf



* Image Source: Jeffrey Loehr, *Demystifying Climate Change*