ASSOCIATION FOR LEARNING ENVIRONMENTS

Resilient Design: The Expanding Evolution of Sustainable Design Methodologies

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Seattle Public Schools
PCS Structural Solutions
Bassetti Architects

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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

"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

NEGATIVE ENVIRONMENTAL IMPACT

RESTORATIVE

*Image source: Inhabitat
Evolution of Awareness
Sustainability as a function of efficiency and resilience

Sustainability

The Window of Vitality/Viability

Towards brittleness (Too little diversity)

Towards stagnation (Too little efficiency)

Optimal Balance

Greater Efficiency

Greater Resilience

Diversity/Connectivity
Potential Hazards

- Earthquake
- Tsunami
- Wildfire
- Flood
- Eruption
- Hurricane
- Tornado
## Case Study – Japan

### The Program for Earthquake-Resistant School Buildings

<table>
<thead>
<tr>
<th>Steps of the Program</th>
<th>Responsible Level</th>
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<tbody>
<tr>
<td>Program Design</td>
<td>National Government (MEXT)</td>
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<td></td>
<td>Local Government (Municipalities)</td>
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<tr>
<td>Program Implementation</td>
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<tr>
<td>Planning</td>
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<tr>
<td>Implementation</td>
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</table>

- **Program Design**
  - Provision of Technical Guideline
  - Technical Support
  - Financial Support
  - Monitoring

- **Program Implementation**
  1. Establishment of Investigative Organization
  2. Implementation of Basic Survey
  3. Prioritization of Vulnerable Buildings for Seismic Retrofitting
  4. Vulnerability Assessment
  5. Implementation of Seismic Diagnosis
  6. Determination on Urgency of the Projects
  7. Formulation of Annual Plan
  8. Formulation of Reinforcement Plan
  9. Preparation of Design Drawings
  10. Implementation of Construction Works

### 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*

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

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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

*Clockwise left to right: Oakland Hills Fire - Oakland Fire Department; Loma Prieta Earthquake - Digital Mapping Solutions; Northridge Earthquake - University of West Florida
## RECOMMENDATION 1. Make schools resilient: structurally, socially, and educationally

<table>
<thead>
<tr>
<th>PRIORITY ACTIONS</th>
<th>RECOMMENDED ORGANIZATIONS</th>
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<tbody>
<tr>
<td><strong>1a. Perform assessments of school buildings to prioritize seismic risk of the state’s schools</strong></td>
<td>OSPI (lead); DNR</td>
</tr>
<tr>
<td>Short-term: Complete assessments by year 8</td>
<td></td>
</tr>
<tr>
<td>Mid-to long-term: Repair or replace schools as outlined in the plan</td>
<td></td>
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<tr>
<td><strong>1b. Enact legislation that requires school districts to conduct safety drills</strong></td>
<td>State Legislature (lead); OSPI; EMD</td>
</tr>
<tr>
<td>Short-term: Draft and enact legislation</td>
<td></td>
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<tr>
<td>Long-term: Track metrics related to progress</td>
<td></td>
</tr>
<tr>
<td><strong>1c. Enact legislation that requires school districts to develop mitigation plans</strong></td>
<td>State Legislature (lead); School Districts; Cities; Counties; EMD</td>
</tr>
<tr>
<td>Short-term: Develop mitigation plans to make them eligible for federal funding</td>
<td></td>
</tr>
<tr>
<td>Long-term: Districts maintain hazard mitigation plans by regularly revising and updating them</td>
<td></td>
</tr>
<tr>
<td><strong>1d. Enact legislation that requires school districts to develop and maintain comprehensive continuity of operation plans</strong></td>
<td>OSPI (lead); State Legislature; School Districts</td>
</tr>
<tr>
<td>Short-term: School districts develop continuity operations plans</td>
<td></td>
</tr>
<tr>
<td>Long-term: Schools and districts maintain plans through regular training, updates and exercises</td>
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</tbody>
</table>
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
NEIGHBORHOOD SCHOOLS AS RECOVERY RESOURCES

• 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**

- **GDP (Billions)**
  - Nashville
  - New Orleans

- **Population**
  - Nashville
  - New Orleans

Hurricane Katrina Occurs in 2005.
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

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Benefit-Cost Ratio</th>
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<tbody>
<tr>
<td>Riverline Flood</td>
<td>7:1</td>
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<tr>
<td>Hurricane Flood</td>
<td>Too few grants</td>
</tr>
<tr>
<td>Wind</td>
<td>5:1</td>
</tr>
<tr>
<td>Earthquake</td>
<td>3:1</td>
</tr>
<tr>
<td>Wildland-Urban Interface Fire</td>
<td>3:1</td>
</tr>
</tbody>
</table>

**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

Seattle Fault Zone, Liquefaction Areas, and Ground Failures

Seattle Office of Emergency Management
Seattle Hazard Identification and Vulnerability Analysis

Figure 4. 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
Considerations/Priorities – Structure

*Lynndale Elementary School, Mahlum

*Raisbeck Aviation High School, Bassetti Architects
Considerations/Priorities – High Performance Strategies

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

*St. Thomas School

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Considerations/Priorities – High Performance Strategies

*Federal Way Public Schools Support Services Center

*Roosevelt High School

*Lakota Middle School
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

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

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%5b6b3-page%5d.pdf

USGBC RELi Standard
http://c3livingdesign.org

NST Community Resilience Program – Third Stakeholder Workshop

* Image Source: Jeffrey Loehr, Demystifying Climate Change