Enhanced Seismic and Resilience Design for Beaverton School District's Mountainside High School

A case study of one high school construction project that applied the targeted standards proposed in HB 3486
(BSD 2014 construction bond program)

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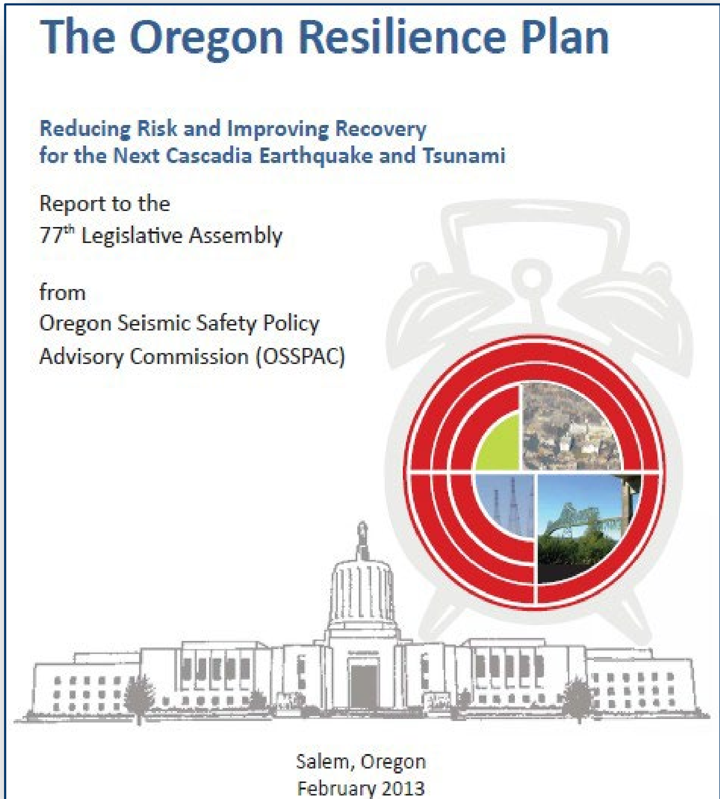
Former Executive Administrator for Facilities
Beaverton School District

March 2023

Seismic Risks Considered by BSD

The Oregon Resilience Plan (2013)


The Oregon Resilience Plan

Reducing Risk and Improving Recovery
for the Next Cascadia Earthquake and Tsunami

Report to the
77th Legislative Assembly

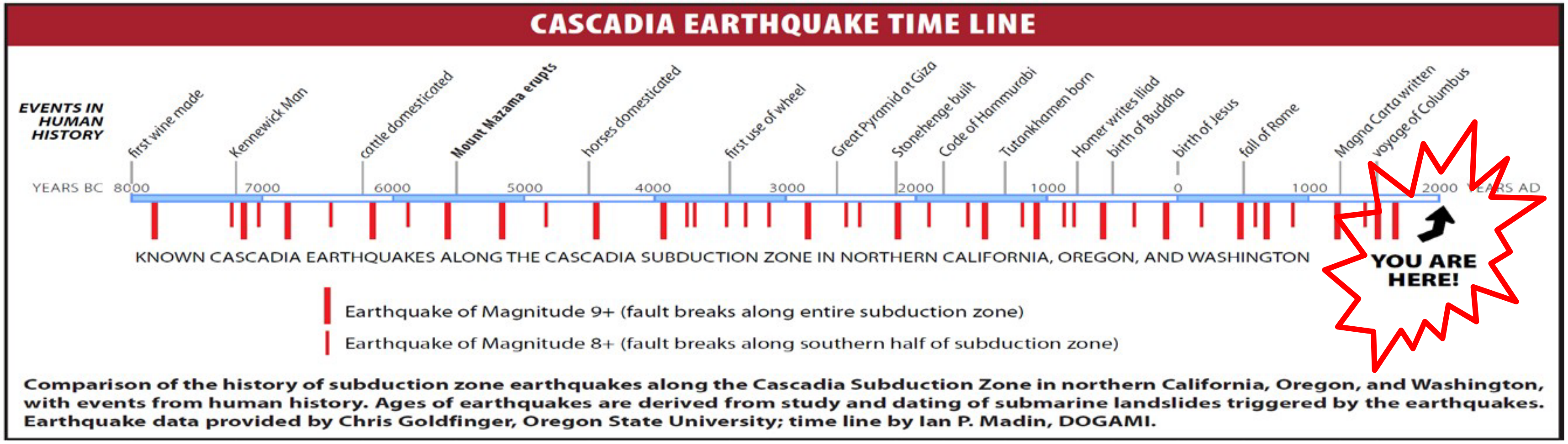
from
Oregon Seismic Safety Policy
Advisory Commission (OSSPAC)

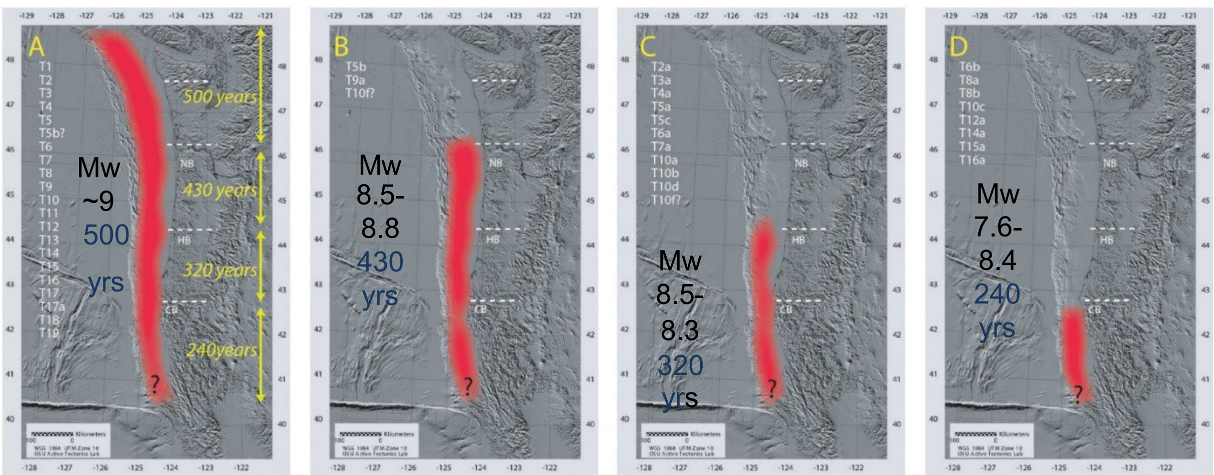
Salem, Oregon
February 2013

<u>50-year Comprehensive Plan</u>

- ❑ **Cascadia Earthquake Scenario**
- ❑ **Business/Workforce Continuity**
- ❑ **Coastal Communities**
- ❑ **Critical & Essential Buildings**
- ❑ **Transportation**
- ❑ **Energy**
- ❑ **Information and Communication**
- ❑ **Water & Wastewater**

Oregon Seismic Hazard
10,000 years of history





(Modified from Goldfinger et al. (in press) by adding magnitude estimates and some labels)

- 41 EQs > 8.0 magnitude
  - Recurrence = 240 years
  - Last one: Jan 25, 1700
  - We are OVERDUE!
- 19 EQs > 9.0 magnitude
- Last 9.0; 323 years ago
- 30% chance of 9.0 within 50 years*

* *Oregonian, June 2019*

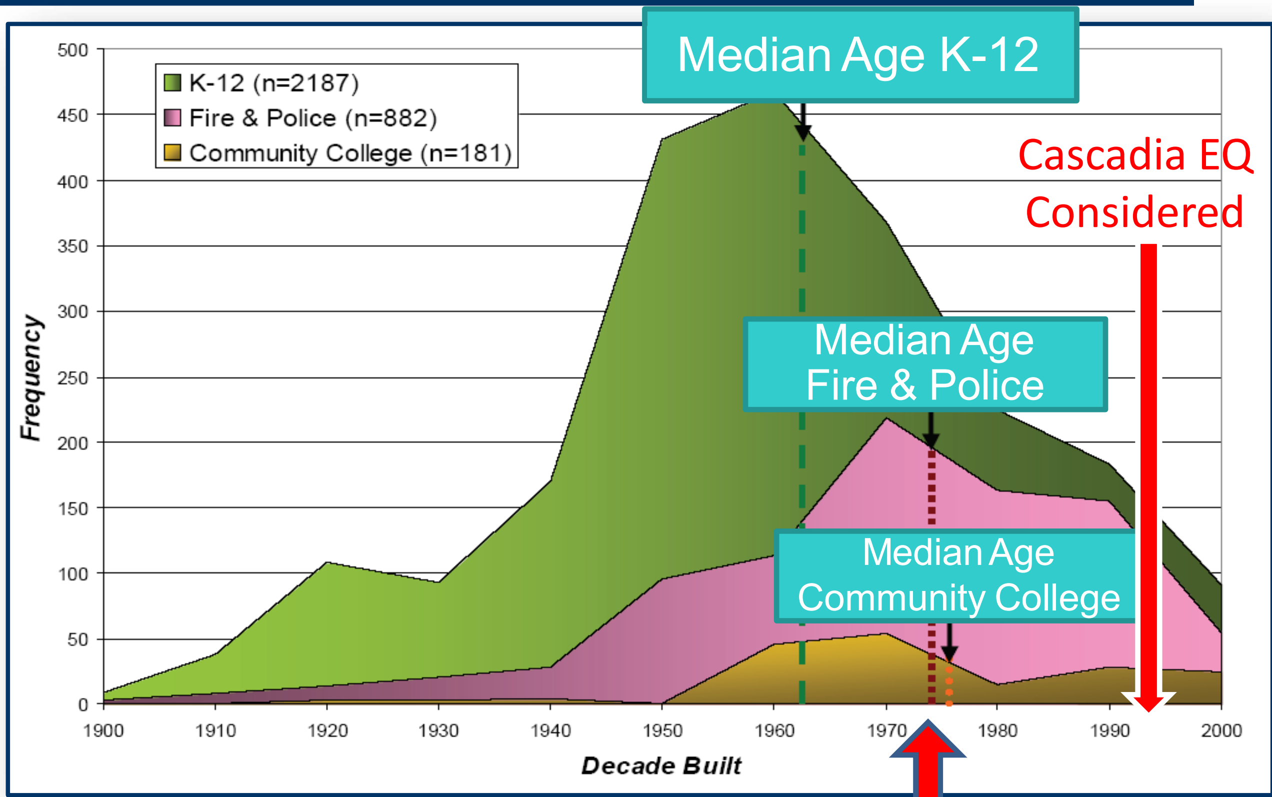
Current Recovery Challenges

** Oregon Resilience Plan 2013 Estimates*

Critical Services	Zone	Current Estimated Average Recovery Times *
Electricity	Valley	1 to 3 months
Drinking Water	Valley	6 months to 1 year
Sewer	Valley	1 to 3 years +
Top Priority Highways	Valley	6 to 12 months



Oregon Education & Emergency Facilities



1st Oregon Seismic Code

From: DOGAMI Open-File Report O-07-02; Statewide Seismic Needs Assessment

Seismic Risks Considered by BSD

Building Performance Gaps

Oregon Resilience Plan - 2013

Critical Building Category	Zone	Estimated Average Recovery Time	Resilience Target
Healthcare Facilities	Valley	18 months	Immediate
Police and Fire	Valley	2 to 4 months	Immediate
Emergency Shelter	Valley	18 months	72 hours
Schools	**Valley**	**18 months**	**30 days (60 days*)**
Housing	Valley	3 days**	72 hours

*   30-day timeframe is preferred but a 60-day is also acceptable.

** Underestimates recovery for older construction

<u>2016 FEMA estimate:</u>

Thousands of schools (OR & WA) will collapse or be uninhabitable

Factors BSD Considered in Selecting Targeted Resilience Design Features

- Seismic code based upon “Life Safety” standard
  - Building may not be economically repairable after earthquake*
    - * Pacific Earthquake Engineering Research Center Report
- Schools are distributed in neighborhoods & walkable
- Schools attract people needing emergency shelter
- New school buildings may be in inventory for ~100 years
- Probability of “The Big One” during service period is high

High School Resilience Features: the Building Structural System Strategy

- Risk Category IV – Structural / Seismic Design
  - Code requirement for schools – Category III
    - +25% EQ design loads above commercial building standard
  - Category IV: Immediate Occupancy Standard – whole building
    - +50% EQ design loads above commercial building standard
  - Insurance against total economic loss

- Non-Structural Components
  - Equipment (required to operate after EQ) seismically certified
  - Components required for use as shelter: Category IV seismic bracing
  - Others: Category III seismic bracing

High School Resilience Features: the Water & Wastewater Strategy

- Restrained pipe joints between city lines and building
  - Water and sewer lines on site
- Stub-out water connections for exterior tanker to supply:
  - Kitchen
  - Locker rooms & showers
  - Drinking fountains in common spaces
  - Restrooms serving dining / commons
- Seismic bracing of building plumbing per Category IV
- Sewer short term: Others to provide portable toilets

High School Resilience Features: the Electricity & HVAC Strategy

- Emergency Power
  - Emergency generator; with fuel storage for 96 hours
    - *Code standard: support emergency exiting*
  - Supplemented with solar PV system
  - Power for lighting and ventilation in shelter rooms

- Heating & Cooling
  - Assume no natural gas service
  - Natural ventilation: doors, windows, and exhaust fans

High School Resilience Features: the Natural Gas & Telecom Strategy

- Natural Gas
  - Seismic shut-off valve to reduce potential fire hazard
- Telecommunication
  - Emergency management agencies to bring in portable communication systems
  - Beaverton School District radio system

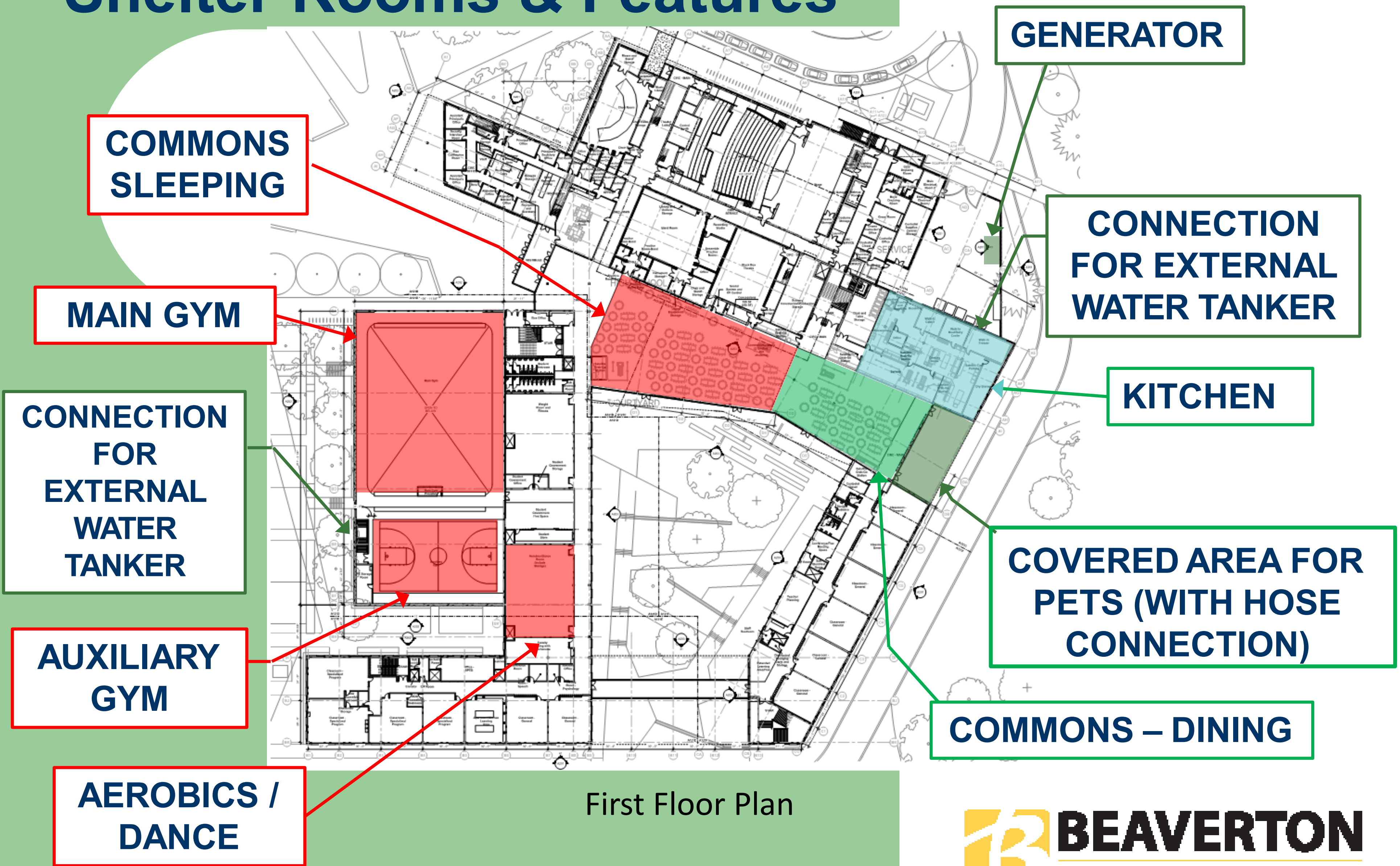
Case Study Details
Mountainside High School
Beaverton School District

Completed 2017

- **3-Stories plus partial basement**
- **342,000 SF**
- **40 acres**
- **2,200 students**
- **$100 million (building only)**

Mountainside High School
11:50 AM Sun Dec 5
87%
Mountainside
High School
2D
Google

Mountainside High School Shelter Rooms & Features



First Floor Plan

BEAVERTON SCHOOL DISTRICT

1%* Cost Impact
Mountainside High School

Resilience Feature	Cost Estimate
Category IV Structure	$500,000
Generator & Fuel Storage	$330,000
Electrical Wiring	$8,000
Water Service Sub-Outs	$15,000
Natural Gas Seismic Shut Off Valve	$5,000
Restrained Joints - Water & Sewer Lines	$108,000
Solar PV Interconnection	$80,000
Approximate Total	$1,046,000

** Calculated using pre-construction cost estimates for the building vs. the added cost for targeted resilience features. The building cost excludes project costs for site development and off-site improvements required by permitting jurisdictions.*

Benefits of Targeted Resilience Features

- Enhanced earthquake safety for students and staff
- Emergency shelter to support the community – all hazards
- Inexpensive insurance premium vs. total economic loss
- Addresses Oregon Resilience Plan target for early return to school operations

Original Construction: *(why now … ?)*

- ➢ Only opportunity to economically include these features
- ➢ BSD applied these features to all 7 new schools in its 2014 bond

ASCE News Article Recognized BSD's Resilience Designs

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Oregon ASCE Members Make Resiliency a Priority in School District

BY Ben Walpole
September 17, 2015 Infrastructure Resilience Division Oregon resilience

Project architects, community members and children join a ground-breaking for Beaverton's new resilient schools. PHOTO: Scott Johnson/Beaverton Project Manager-Facilities Development

It's not easy to face up to the frightening prospect of a major earthquake and tsunami striking your community.

Two years ago, the state of Oregon adopted a resilience plan with a 50-year strategy to address the threat posed by the Cascadia Subduction Zone. The plan takes a "not-if-but-when" approach to the next disaster, and it can make for scary reading.

But the Beaverton School District – led by several ASCE members – is not intimidated, seeing the state plan as a means to build a more resilient community. Seven new schools to be built over the next several years will all apply the resilience plan's recommendations.

"It was evident to the school district that we had this special opportunity at a key moment in time with the construction of these seven schools," said Dick Steinbrugge, P.E., M.ASCE, executive administrator for facilities at Beaverton. "It was sort of a call to action with regard to the Oregon Resilience Plan."

About the Channel

"ASCE News" – the news source for Society members – covers the activities of ASCE and its members, showcasing Society accomplishments and the many ways members can participate and benefit.

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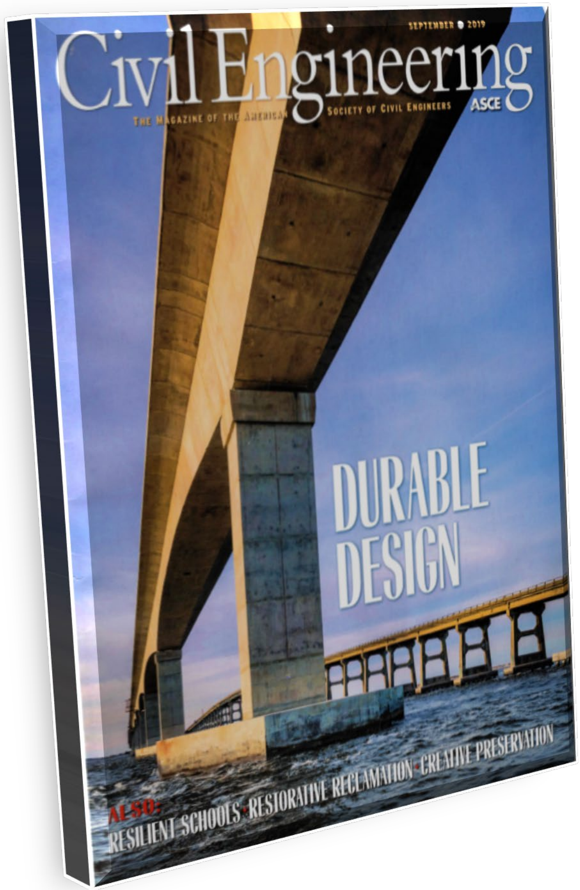
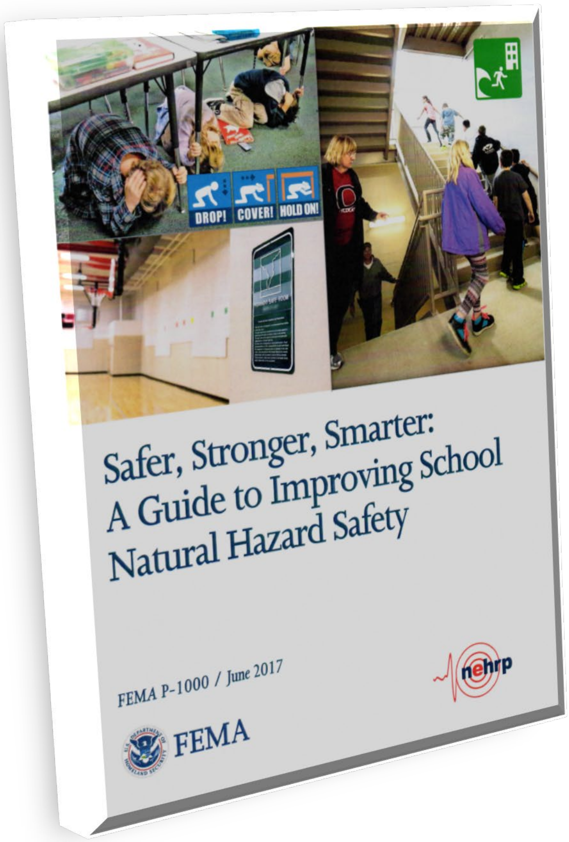
September 17, 2015

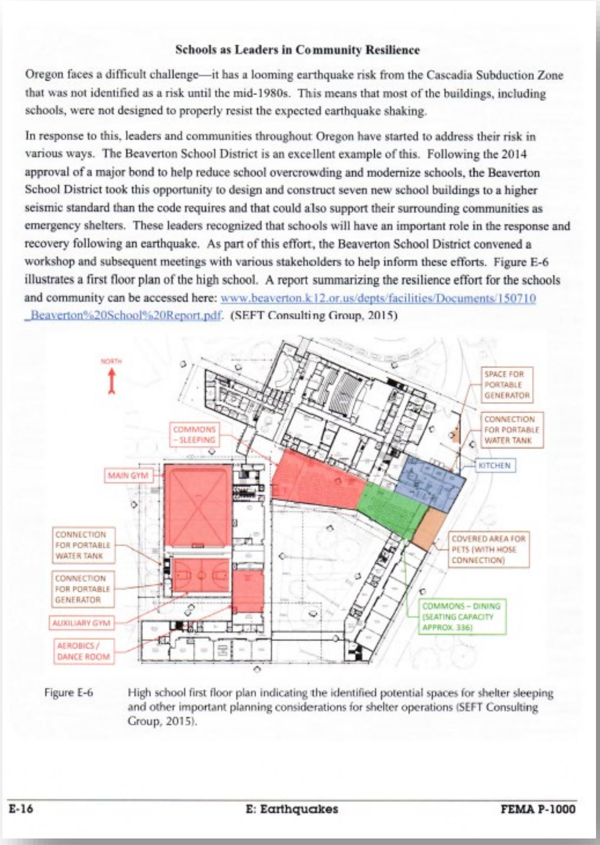
ASCE Civil Engineering Magazine Cited BSD's Resiliency Designs



September 2019 edition

Federal Emergency Management Agency – FEMA P-1000 / June 2017





Schools as Leaders in Community Resilience

Oregon faces a difficult challenge—it has a looming earthquake risk from the Cascadia Subduction Zone that was not identified as a risk until the mid-1980s. This means that most of the buildings, including schools, were not designed to properly resist the expected earthquake shaking.

In response to this, leaders and communities throughout Oregon have started to address their risk in various ways. The Beaverton School District is an excellent example of this. Following the 2014 approval of a major bond to help reduce school overcrowding and modernize schools, the Beaverton School District took this opportunity to design and construct seven new school buildings to a higher seismic standard than the code requires and that could also support their surrounding communities as emergency shelters. These leaders recognized that schools will have an important role in the response and recovery following an earthquake. As part of this effort, the Beaverton School District convened a workshop and subsequent meetings with various stakeholders to help inform these efforts. Figure E-6 illustrates a first floor plan of the high school. A report summarizing the resilience effort for the schools and community can be accessed here: www.beaverton.k12.or.us/depts/facilities/Documents/150710_Beaverton%20School%20Report.pdf. (SEFT Consulting Group, 2015)

Figure E-6 High school first floor plan indicating the identified potential spaces for shelter sleeping and other important planning considerations for shelter operations (SEFT Consulting Group, 2015).

E-16 E: Earthquakes FEMA P-1000

The Seattle Times – Noted BSD's Advanced Seismic Designs

The Seattle Times

Pacific NW Magazine

By [Sandi Doughton]

Seattle Times staff reporter

Nov. 21, 2021 at 7:00 am Updated Nov. 21, 2021 at 10:41 am

As Oregon outfits its schools for seismic safety, many in Washington remain highly vulnerable to earthquakes and tsunamis