



# CEI Hub Mitigation Strategies

## Increasing Fuel Resilience to Survive Cascadia

OSSPAC Publication 19-01  
December 31, 2019

THE STATE OF OREGON  
Mike Harryman, State Resilience Officer



## Oregon Seismic Safety Policy Advisory Commission

After the Loma Prieta earthquake in 1989, Oregon residents demanded that the State of Oregon better address earthquake hazards throughout the state. The state legislature established the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) in 1991 through Senate Bill 96. The Commission is a group of eighteen individuals appointed by the Governor. They represent a variety of interests regarding public policy and earthquakes and include representatives of many state agencies a member each from the Oregon House and Senate, representatives of important stakeholder groups, and members of the public. The OSSPAC mission is to positively influence decisions and policies regarding pre-disaster mitigation of earthquake and tsunami hazards; increase public understanding of hazard, risk, exposure and vulnerability through education; and be responsive to new studies or issues raised around earthquakes and tsunamis.

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**OREGON SEISMIC SAFETY POLICY ADVISORY COMMISSION**  
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# preface

In June of 2018, the Oregon Seismic Policy Advisory Safety Commission (OSSPAC) was tasked by the Governor and the State Resilience Officer to conduct a 15-month study on Oregon’s Critical Energy Infrastructure (CEI) Hub located in NW Portland. The Commission was asked to focus on the following:

- Conduct an analysis of state and federal guidance on the regulatory authority for seismic upgrades to structures, pipelines and include land mitigation.
- Determine if a current state agency has statutory authority to develop long-term mitigation efforts and if not, recommend which state agency would be best suited for this new authority.

- Work in conjunction with Oregon Solutions to develop public-private partnerships and determine incentives that focus on hardening current infrastructure.
- Showcase the Earthquake Early Warning system to encourage seismic awareness in the private sector.

In gathering input for this report, the CEI Hub Working Group of OSSPAC consulted with the State Resilience Officer and engaged other state and local government officials. Four small task forces were created, each dedicated to one of the topics above. In addition, special meetings of the full Commission were held bi-monthly to develop the data and deliberate recommendations included in this report. Testimony was gathered from representatives of non-governmental organizations, state and federal agencies, and members of the public. In addition, interviews were conducted by teams of Commission members with several state agency representatives.

OSSPAC received organizational support from the Office of Emergency Management (OEM) and special assistance from the Oregon Department of Energy (ODOE), the Oregon State Fire Marshal (OSFM), and the Department of Environmental Quality (DEQ). OSSPAC gratefully acknowledges the financial support of the Department of Consumer and Business Services (DCBS), the Oregon Health Authority (OHA), and the Office of Emergency Management (OEM).

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# executive summary

In 2018, the Oregon Seismic Policy Advisory Safety Commission (OSSPAC) was tasked by the Governor and the State Resilience Officer to conduct a 15-month study on Oregon's Critical Energy Infrastructure (CEI) Hub located in NW Portland. The Commission was asked to focus on the following: existing regulatory authority for seismic upgrades to liquid fuel tank infrastructure, developing public-private partnerships and incentives, showcasing Earthquake Early Warning, and recommending a current state agency to be given statutory authority to develop long-term mitigation efforts. Through meetings and testimony with experts, agencies, and interested stakeholders, OSSPAC has investigated these matters as well as the broader issue of fuel diversity and its impact on Oregon's resilience in the face of a Cascadia earthquake. The commission's major finding and recommendations are detailed in this executive summary.



## Major Finding

- A. **The Critical Energy Infrastructure Hub is a major threat to safety, environment, and recovery after a Cascadia Subduction Zone earthquake on par with the 2011 Fukushima nuclear meltdown in Japan. Owners of privately-owned liquid fuel tanks at the Hub need to be compelled to seismically strengthen their infrastructure. No state agency is a perfect fit to be designated as the regulatory authority over these facilities.** While several agencies are tangentially involved with elements of the Hub, none have the expertise or capacity to regulate all of its elements. A few that are most promising are involved with specific safety-related tasks such as fire or environmental spills, but these do not involve seismic hazards at present. In addition, it is difficult to regulate privately-owned tanks which are grandfathered by the building code. Finally, the CEI Hub is governed more by local entities rather than those of the state and federal governments.



## Recommendations

- A. **Enact legislation to assign regulatory oversight of liquid fuel facilities at the CEI Hub to the Oregon Department of Environmental Quality.**
- B. **Direct the Oregon Department of Environmental Quality to establish a regulatory program parallel to their existing below-ground tank program, extending it to above-ground liquid fuel tanks in Oregon.** The program should include the regular inspection of above-ground liquid fuel tanks over 10,000 gallons. If a tank is found to be out of compliance, its use should be restricted until it is brought into compliance. The current program should be expanded to include additional inspectors and administrative staff, as needed. The new program should include a similar funding mechanism through a yearly fee on liquid fuel tanks over 10,000 gallons. This will provide stable, ongoing funding for vehicles, staff, and equipment for emergency response.
- C. **Direct Oregon DEQ with assistance from DOGAMI, OSFM, and ODOE to develop a set of Oregon Administrative Rules that govern the safety of above-ground liquid fuel tanks.** DEQ should develop new tools for above-ground tank inspectors to use in their evaluations. Evaluations should include normal issues such as proper valving and corrosion, as well as seismic and soil-stability issues. They should develop timelines for remediation of above-ground liquid fuel tanks that don't meet current standards.



- D. **Direct Oregon Solutions to manage a project that develops a small-scale CEI Hub at an alternate site.** Oregon Solutions should identify a location, determine the size, identify which companies would relocate, what types of fuel they would store, and how the new small-scale facility would operate in conjunction with the existing Hub. The new small-scale fuel hub site should ideally be near existing pipeline, waterway, and railway infrastructure, but it should be placed on land that is not susceptible to liquefaction. The design of the new tanks and pipelines should employ the latest state-of-the-art seismic design to ensure post-earthquake functionality. The cost of such a project is unknown and largely dependent on the size and cost of the land, number of tanks installed and infrastructure needs. This effort should involve support from and funding for both ODOE and DOGAMI.
- E. **Direct the Oregon Department of Energy to develop a long-term program to increase the geographic diversity of fuel storage capacity throughout the state.** A robust program should include a complete assessment of the seismic resilience of existing facilities throughout the state. Strategies could include increased storage on public-owned land, such as ODOT maintenance yards, airports, county public works yards, fleet services, and motor pools. The program should investigate ways to mitigate barriers to implementing a geographically distributed fuel network throughout the state.
- F. **Enact legislation to increase the Oregon State Fire Marshal’s gas transfer fee to support Oregon DEQ, OEM, ODOE, and DOGAMI in providing technical assistance for fuel industry resilience planning.** The fund could be used for large-scale emergency response exercises, training, and technical assistance for fuel companies to develop their retrofit programs, which will be required by the new DEQ regulations of above-ground liquid fuel tanks.
- G. **Enact legislation to provide funding to Oregon universities and agencies to research new seismic mitigation strategies.** Provide \$2M–\$4M per biennium in direct funding or matching grants. The funding or grants should be available to any university or state agency in Oregon. Strategies should build on previous work by DOGAMI and others and should include new liquefaction mitigation methodologies, economical seismic retrofit solutions for ground-supported liquid fuel tanks, new isolation strategies for above- and below-ground fuel piping, and other technologies that increase fuel system resilience.
- H. **Enact legislation to provide authority and adequate funding to the Oregon Department of Energy to continue progress on the Oregon Fuel Action Plan.** This recurring funding should provide for a

0.5 FTE position. ODOE should work with fuel terminal companies to train once every other year to respond to a Cascadia event scenario; work with the Oregon Fuel Association to build county and regional distribution plans; work with the Western State Petroleum Association to ensure alternate bulk fuel resources to support post-earthquake emergency response and recovery; and work with the Department of Administrative Services to establish pre-disaster fuel contracts, as appropriate. It should also include conducting a comprehensive statewide assessment on consumption by fuel type both during normal conditions and post-disaster response.

- I. **Direct Oregon Solutions to implement the recommendations of their 2018 report, including developing effective incentives for CEI Hub owners.** Oregon Solutions should continue to engage critical parties, collect information about Hub operations and constraints, convene an education-focused collaborative table, and identify a model for implementing and administering a non-monetary incentive program. They should hand off the responsibility to other appropriate state agencies as the process develops. Qualified researchers and analysts should collect information on the scale of an incentive program.
- J. **Enact legislation to provide funding for the Office of the State Fire Marshal to increase their response capabilities for spills and fires on land and water at the CEI Hub.**
- K. **Enact legislation to fully fund the implementation of ShakeAlert in Oregon.** Approve a one-time funding request of \$7.5M for the University of Oregon to cover funds for the installation of seismic sensors and the telecommunication infrastructure to deliver data to processing centers. Approve a recurring funding request of \$500k/year (\$1M per biennium) for OEM/DOGAMI for a dedicated Earthquake Early Warning coordinator and related staff. This effort includes policy development, education and outreach to local communities and business partners, marketing, and technical support, including coordination with the CEI Hub and other major storage facilities throughout the state.
- L. **Enact legislation to incentivize a pilot project to implement ShakeAlert at the CEI Hub.** Provide support and funding for ShakeAlert personnel to work with CEI Hub stakeholders and to develop and implement a plan. Until the seismic and telecommunications network is complete, ShakeAlert would be used to implement a manual response for shutting down pumps and other rotating equipment, as well as to secure infrastructure used for energy transfers between facilities. Incentivize stakeholders to participate in the pilot project via fast-track permitting, tax breaks, or other measures.



# chapter one

## Major Threats to Safety, Environment, and Resilience

Oregon's Critical Energy Infrastructure (CEI) Hub is a six-mile stretch of facilities on the west bank of the Willamette River in Northwest Portland (Figure 1.1). The majority of Oregon's liquid fuel infrastructure, as well as a portion of its electrical and natural gas infrastructure, resides in the CEI Hub. More specifically, the CEI Hub contains:

- Over 90% of the state's liquid fuel supply and 100% of the jet fuel for PDX airport.
- Hundreds of tanks holding various forms of liquid products that have a potential storage capacity of over 8.6 million barrels.
- 46 large above-ground liquid fuel tanks.
- All of Oregon's major liquid fuel port terminals.



*Figure 1.1: Outline of the Critical Energy Infrastructure (CEI) Hub on the west bank of the Lower Willamette River area in northwest Portland, Oregon. The CEI Hub, outlined in yellow, stretches for six miles. Aerial photo: Google Maps, 2019*

In addition, the CEI Hub contains liquid fuel and natural gas pipelines and transfer stations, and a liquefied natural gas storage facility. To support the fuel infrastructure, high voltage electrical substation and transmission lines are located on the same property.

A dozen different companies own facilities in the CEI Hub. These include private companies BP, Chevron Corporation, Kinder Morgan Energy Partners, McCall Oil and Chemical Corporation, NuStar Energy, Shell, Pacific Terminal Services, Phillips 66, Arc Logistics, NW Natural, Portland General Electric, and PacifiCorp. It also includes some government-owned facilities for the Bonneville Power Administration (BPA).

### The Risk to the CEI Hub from Cascadia

The Cascadia Subduction Zone is a massive geological fault off Oregon's coast. It stretches 600 miles from northern California to southern Canada. When it ruptures, it creates massive M8-9 earthquakes and tsunamis that permanently alter the landscape of the Pacific Northwest. The last Cascadia event was in January 1700, far before modern infrastructure covered the landscape. According to leading experts, the likelihood of the next Cascadia event occurring in the next 50 years is 37% (Goldfinger and others, 2012). Additionally, there are three major earthquake faults very near the Hub: the Oatfield Fault, the Portland Hills Fault, and the East Bank Fault. The Portland Hills Fault is immediately adjacent to the Hub.

Facilities like those at the CEI Hub have been damaged or destroyed in past earthquakes. Past tanks have sustained partial and total failure resulting in oil leakage, fire, and damage to nearby facilities. Some fuel tanks at the CEI Hub are more than 100 years old, and the majority were built 50 or more years ago.

### During a major earthquake, the CEI Hub will experience:

- Severe ground shaking
- Liquefaction—water-saturated soils lose strength
- Lateral spreading
- Landslides from adjacent slope
- Co-seismic settlement—ground is permanently lowered
- Bearing capacity failures
- Potential seiches—oscillating waves in water

*"The CEI Hub is adjacent to the Willamette River and has extensive deposits of highly liquefiable soils. These soils (made of sands, silts, gravels, and clays) have been deposited both by natural river activity and by human activities, such as the hydraulic placement of material dredged from the river or debris deposited as landfill." (Wang and others, 2013; Oregon Resilience Plan, 2013)*

They were constructed before anyone understood the region's earthquake risk, and before we understood that the soil beneath the CEI Hub is highly susceptible to liquefaction and lateral spreading (Wang and others, 2013).

The vast majority of CEI Hub tanks, piers, pipelines, and wharves were built to older codes, and they are not required to be updated to current codes. The building code only requires structures to be updated if the gravity or lateral systems are modified in a way that increases stresses by more than 5% and 10%, respectively.

In January of 2019, the State Building Codes Division (BCD) issued a code interpretation regarding the state's authority to regulate the construction of external tanks. It limits the state code regulations for the design and anchorage of tanks to those that are exclusively located inside or attached to buildings. This has implications for the CEI Hub since none of its tanks would fall under the regulation of the state building code for new, replacement or retrofit tanks. Local jurisdictions, however, are allowed to adopt their own standards.

## Our Fukushima

If a Cascadia earthquake were to occur today, the two most destructive results would be the tsunami along the coast and the disaster created by the CEI Hub. According to testimony, the CEI Hub aftereffects would be as devastating as the 2011 Fukushima nuclear meltdowns in Japan.

- **Fire and Airborne Toxins.** According to Richard Franklin with the EPA, CEI Hub storage tanks contain primarily refined petroleum fuel products and crude oils, as well as gases and fuel additives. If these chemicals spill—or worse, mix—they can ignite and release toxic chemicals into the air. In addition, some tanks contain non-petroleum hazardous chemicals such as ammonia and chlorine that are lethal if released. Those working at or near the CEI Hub will likely be in grave danger. The Hub sits adjacent to Forest Park (a wildland urban interface) and the community of Linnton. The North Portland peninsula and neighborhood of St. Johns is due east, and Portland's Northwest Industrial area is just to the south.
- **Environmental Disaster.** A release of just a small portion of the liquid fuels at the CEI Hub would cause a spill of national significance larger than any previous oil spill in US history. Hazardous materials would release into the air and soil, as well as into the Willamette and Columbia Rivers, which flow into the Pacific Ocean. The environmental devastation would cover a huge area of waterway and take

decades and tens of millions of dollars to clean up. This toxic flow will have significantly negative and long-lasting impacts on riparian and aquatic habitats and on the aquatic, riparian, terrestrial, and avian species that depend on these habitats.

- **Impaired Response.** Meanwhile, other large-scale catastrophes would be unfolding throughout the City and region. Emergency response personnel would struggle to address the disaster occurring at the CEI Hub because roads, bridges, utilities, and communication systems would be damaged or destroyed. And recovery vehicles would be unable to access and use the very fuel that spills from the CEI Hub's tanks.
- **Delayed Recovery.** According to Oregon's State Resilience Officer, Mike Harryman, fuel is our Achilles' heel. The CEI Hub contains a 3-5-day supply of fuel. Every drop of that fuel, and more, will be needed for the recovery process.

## Compounded Economic Losses

A Cascadia event would devastate the region's petroleum supply and distribution system. Restoring the region's petroleum infrastructure would likely take months, if not longer. In addition, the Olympic Pipeline that transports most of the gasoline, diesel, and jet fuel to Oregon is projected to sustain as many as 250 breaks and 82 leaks. Oregon can expect to lose most of its normal incoming supply of fuel.

The damage at the CEI Hub will have unprecedented impacts on Oregon's economy for many years. A study of the interdependence between the energy sector of Oregon's economy and the larger state economy found that for every dollar lost in petroleum and natural gas energy sales, Oregon's economy loses an additional \$0.30 to \$0.36 (Miles and Blue, 2013). In 2016, energy expenditures by Oregonians on transportation fuels and direct use fuels—the energy sources that flow through the Hub—accounted for approximately \$7.6 billion (ODOE, 2018). Combining this statistic with the results above, we estimate the lost economic output attributed to missing energy sales at approximately \$10 billion per year of lost Hub output. These impacts will persist at some level during the time it takes to return energy sales to the level that would have existed if the quake had not happened.

And these impacts are specific to only the energy sector of Oregon's economy. Other sectors of the state's economy—including construction, tourism, and transportation—would likely suffer significant economic loss without access to the energy supplies that flow through the Hub. The estimate above does not include these additional losses.

## This Report

In the past decade, multiple reports have discussed the CEI Hub, including those produced by the [Department of Geology and Mineral Industries](#) (2012; 2013), [OSSPAC](#) (2013), the [City Club](#) (2017), [Oregon Solutions](#) (2019), and [Portland State University](#) (2019). This report seeks to deepen the discussion and provide clear and actionable recommendations for the Governor and Legislature on how to address the extraordinary risk the CEI Hub poses to our state.





# chapter two

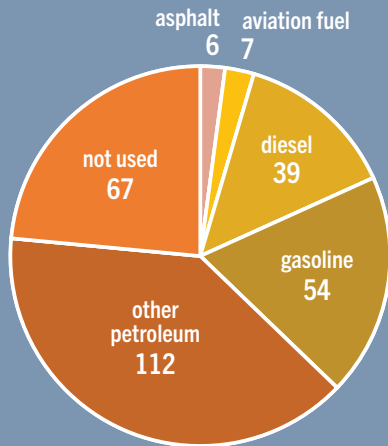
## Regulating Liquid Fuel Tanks

In Oregon, fuel tank owners are not required to assess or mitigate their infrastructure for seismic risk. Private industry is unlikely to do so without being compelled through regulation. Similar regulation has proven challenging in the case of Portland's old unreinforced masonry buildings (URMs). Like fuel tanks, URMs are grandfathered by the building code as long as they have not been modified. Recent attempts to require mandatory URM retrofits have been resisted by private owners.

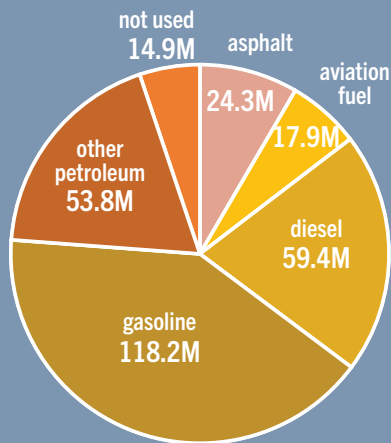
The 2019 [Senate Bill 95](#) would have required owners and operators of bulk petroleum terminals to conduct and submit seismic vulnerability assessments to the Department of Environmental Quality. This would have been an important first step toward regulating mitigation efforts, but it did not pass.

## Above-Ground Storage Tanks

Contents by Number of Tanks at the CEI Hub



Contents by Volume (Gallons) at the CEI Hub



Source: OPB Tony Schick; data from 2015 and not updated to 2019; contains data for some but not all CEI Hub terminals.

Currently, many local, state, and federal agencies are tangentially involved with particular aspects of the CEI Hub. OSSPAC interviewed several of these agencies to explore their potential for regulating the Hub.

### Local Authority

The CEI Hub resides in the City of Portland and Multnomah County. Those jurisdictions have more direct control over the Hub than the state, but to date they have not used their authority to include seismic mitigation enforcement or require retrofits.

In exploring current oversight roles in the City of Portland, OSSPAC determined that the Bureau of Development Services can review new tank designs if it decides to adopt its own standards. Portland Fire & Rescue inspects existing fuel tanks for fire safety. The Portland Bureau of Emergency Management is responsible for disaster planning and coordinating emergency response. Currently, none of these agencies regulates the seismic performance of existing structures or compels mandatory seismic mitigation.

### State Authority

#### Oregon Department of Environmental Quality (DEQ)

Oregon DEQ does not currently have direct authority over above-ground fuel tanks. However, they do maintain the Oil Spill Prevention Program and the Tanks Program (see sidebar, p. 10), which oversee in-ground tanks, pipelines, and transportation of fuel over water. Through these programs, DEQ works with industry to reduce the risk of spills and respond to them in a way that minimizes damage to human health and the environment. Facilities are required to conduct preventive maintenance, which is evaluated and approved by a professional engineer. The

1992 requirements do not address seismic resilience. DEQ also conducts oil spill contingency planning drills with tank operators, but these are single tank scenarios aimed at preventing spills on water. They do not address seismic considerations or multi-tank conditions on the scale of what is possible with a Cascadia event.

### Oregon Department of Energy (ODOE)

ODOE's role is to monitor the region's fuel outlook for possible impacts to the state's supply. They maintain the [Oregon Fuel Action Plan](#), which includes the state-wide fuel allocation program. ODOE works with industry to ensure that even in a severe or long-term fuel disruption or shortage, adequate fuel supplies would be provided to the state's emergency and essential service providers to save lives, protect public health and safety, and restore critical lifelines and services.

The Oregon Fuel Action Plan identifies nine priority actions that ODOE would take to address impacts to the current fuel infrastructure's significant vulnerabilities. This includes securing and delivering a bulk fuel supply from outside the region to support the state's ongoing emergency response and recovery activities in the aftermath of a catastrophic earthquake.

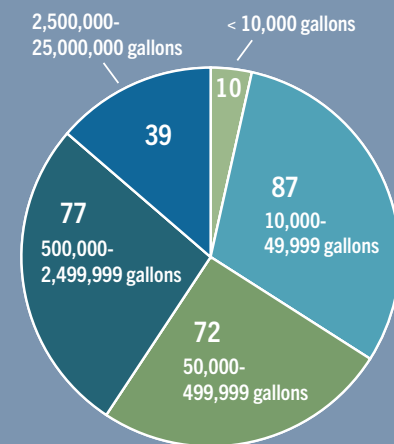
ODOE has broad planning authority to work with all partners, including authority to develop contracts or mechanisms necessary to bring fuel into the state. The ODOE director has broad subpoena power to obtain all necessary information from owners in the CEI Hub. ODOE is required to ensure that proprietary information provided remains confidential, but the data can be aggregated for statistics.

### Oregon Department of Agriculture (ODA)

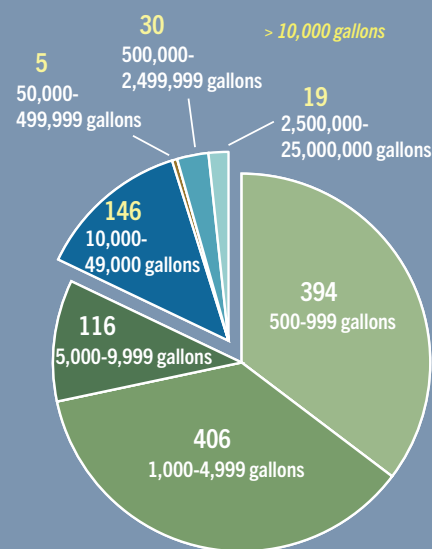
ODA is responsible for inspection of petroleum facility meters and scales. This includes distribution terminals in Portland, Eugene,

## Above-Ground Storage Tanks

Distribution by Capacity at the CEI Hub



Distribution of GASOLINE Tanks by Capacity Statewide in Oregon



Source: OPB Tony Schick; data from 2015 and not updated to 2019; contains data for some but not all CEI Hub terminals. Other data on gasoline tanks from Oregon State Fire Marshal Hazardous Materials database.

## Oregon Tanks Program

Oregon DEQ administers the Tanks Program, which licenses in-ground tanks for gas, fuel oil, aviation fuel, kerosene, and waste oil. Tank owners must pay an annual fee to allow them to receive fuel. Fees pay for administration and inspectors. Six inspectors (totaling 3.5 FTE) serve the entire state. As of July 2019, there were 1,621 facilities with operating permits for 4,969 regulated underground tanks.

The 2019-21 budget request for leak-prevention work was:  
Permit Fees: \$4,264,657;  
License Fees: \$83,600; Federal Grants: \$865,997. Fees are not based on volume, as this would interfere with highway funds.

If a tank leaks, cleanup is done by state staff. The program taps federal trust funds to pay for initial response and then tries to recover costs of cleanup from owners.

and Umatilla, as well as distributors (card locks), jobbers (tanker trucks with measuring devices), and gas pumps at retail stations. ODA also oversees motor fuel quality. They perform annual audits of nearly 55,000 gasoline and diesel fuel locations to screen for octane in the fuel.

### **Oregon State Fire Marshal's Office (OSFM)**

OSFM regulates the dispensing of gasoline and liquefied petroleum gas. Therefore, above-ground tanks fall within their jurisdiction. They review designs for new fuel tanks and inspect existing tanks for fire risk. However, their authority lies within jurisdictions without building departments. In the City of Portland, the Bureau of Planning and Sustainability reviews new tank designs, and the Portland Fire Bureau inspects existing fuel tanks.

OSFM maintains a “community right to know” database that lists material quantities stored at each hazardous materials site, though it is not necessarily specific to individual tanks. OSFM also serves as a repository for all data regarding fire-fighting events and incidents in the State of Oregon—all agencies report to their office and they report nationally. These are useful tools that can be leveraged in regulatory planning.

OSFM's Regional Hazardous Materials Response Team responds when a spill or plume extends beyond a facility's fence and local resources have been exhausted. However, it would take some time to reach the CEI Hub immediately following a Cascadia event. The closest Hazmat team would be at Portland's Fire Station #7, which is located at SE 122nd Avenue. The next closest teams are in Tualatin and Gresham.

### **Oregon Department of Transportation (ODOT)**

ODOT is responsible for implementing the Oregon Fuels Tax Program, which requires fuel dealers and sellers to submit tax

reports. Reports must identify the number of gallons of motor vehicle fuel or aircraft fuel sold, distributed, or used in Oregon.

## Federal Authority

At the federal level, the Department of Transportation, the Environmental Protection Agency, the Pipeline and Hazardous Materials Safety Administration (PHMSA) and the Coast Guard oversee elements of safety at the CEI Hub. But none of them oversee seismic risk. OSSPAC recommends focusing on providing authority to a state agency under the Oregon Legislature's control.

## No One Perfect Agency

Ideally, one agency would regulate the CEI Hub, ensuring that all facilities be subject to seismic mitigation work. This would cover the entire CEI Hub, including tanks, piers, wharves, control buildings, piping, loading racks, and containment structures. OSSPAC determined that there is currently no single state agency that has the expertise or capacity to regulate all elements of the Hub, but that it is important to start with something and develop additional capabilities over time.

OSSPAC recommends focusing first on regulatory authority of above-ground liquid fuel tanks of more than 10,000 gallons, which are of primary concern in terms of limiting threats to safety, environment, and recovery. Tanks of this size constitute the bulk of liquid fuel stored in the state, and this size exempts smaller tanks located at farms, schools or fire stations. Oregon DEQ's experience regulating in-ground tanks makes it a logical candidate for regulating above-ground liquid fuel tanks. Because the DEQ does not currently have seismic expertise, they will need to collaborate with partners at DOGAMI, OEM, and Oregon universities to develop standards and build the necessary expertise as the program evolves.

## Possible Mitigation at the CEI Hub to Limit Spills and Improve Fuel Resilience

- Conduct facility-wide seismic vulnerability assessment and develop mitigation plans
- Harden soils to reduce liquefaction hazards
- Install flexible connections, shut-off valves at pipe fittings, and spill containment walls
- Structural mitigation (e.g., strengthening foundations and tank walls, and replacing piles at piers)



## Chapter 2 Recommendations

**Enact legislation to assign regulatory oversight of liquid fuel facilities at the CEI Hub to the Oregon Department of Environmental Quality.**

**Direct the Oregon Department of Environmental Quality to establish a regulatory program parallel to their existing below-ground tank program, extending it to above-ground liquid fuel tanks in Oregon.** The program should include the regular inspection of above-ground liquid fuel tanks over 10,000 gallons. If a tank is found to be out of compliance, its use should be restricted until it is brought into compliance. The current program should be expanded to include additional inspectors and administrative staff, as needed. The new program should include a similar funding mechanism through a yearly fee on liquid fuel tanks over 10,000 gallons. This will provide stable, ongoing funding for vehicles, staff, and equipment for emergency response.

**Direct Oregon DEQ with assistance from DOGAMI, OSFM, and ODOE to develop a set of Oregon Administrative Rules that govern the safety of above-ground liquid fuel tanks.** DEQ should develop new tools for above-ground tank inspectors to use in their evaluations. Evaluations should include normal issues such as proper valving and corrosion, as well as seismic and soil-stability issues. They should develop timelines for remediation of above-ground liquid fuel tanks that don't meet current standards.

**Enact legislation to increase the Oregon State Fire Marshal's gas transfer fee to support Oregon DEQ, OEM, ODOE, and DOGAMI in providing technical assistance for fuel industry resilience planning.** The fund could be used for large-scale emergency response exercises, training, and technical assistance for fuel companies to develop their retrofit programs, which will be required by the new DEQ regulations of above-ground liquid fuel tanks.

**Enact legislation to provide funding to Oregon universities and agencies to research new seismic mitigation strategies.** Provide \$2M–\$4M per biennium in direct funding or matching grants. The funding or grants should be available to any university or state agency in Oregon. Strategies should build on previous work by DOGAMI and others and should include new liquefaction mitigation methodologies, economical seismic retrofit solutions for ground-supported liquid fuel tanks, new isolation strategies for above- and below-ground fuel piping, and other technologies that increase fuel system resilience.



# chapter three

## Ensuring Fuel Resilience

The petroleum industry exercises a “just-in-time” business strategy. Refineries and distribution terminals maintain adequate supplies to meet expected demands under normal conditions. The CEI Hub terminals are on a six-day refueling cycle. This means at any given time, Oregon has less than one week’s supply of reserves on hand.

Supply and distribution problems do occur routinely, and the refineries and distribution terminals are extremely resilient at handling short-term disruptions. For example, unexpected damage to concrete structures at the Bonneville navigational lock shut down Columbia River traffic for three weeks in early September 2019. All fuel barge traffic came to a halt. Industry put fuel in tanker trucks for delivery on Interstate 84 to eastern Oregon until the Bonneville lock was reopened for river traffic at the end of the month. No fuel shortages occurred as a result of this incident.

However, this was a single, short-lived event. Viable infrastructure was in place to support modified operations and deliveries. This would not be the case after a Cascadia event. The entire Pacific Northwest petroleum infrastructure would be impacted, and there would be wide-spread damage to the transportation, communications, and electrical systems. Industry would not be able to recover without government intervention.

### Limitations of Hardening the CEI Hub

It is possible to harden the CEI Hub in various ways, but it would be difficult, expensive, and disruptive. For example, soils susceptible to liquefaction can be improved with methods such as jet grouting. This would make the soil more stable and limit the movement of above-ground fuel storage tanks. It would not eliminate liquefaction, but it would significantly lessen its impact. Based on data from a recent study by Dr. Peter Drusika, a professor at Portland State University (PSU), the cost to mitigate the soil of just the largest tanks at the CEI Hub (those greater than 25 feet in diameter) would exceed \$225M.

Similarly, older tanks can be retrofit. Due to the very large number of tanks and the array of different owners, it is unlikely that all the tanks could get upgraded or ideally replaced in any reasonable time frame. While anchoring older tanks could be done at a reasonable cost and would not be very disruptive, more significant retrofitting work such as fixing those tanks with floating roofs could take the tanks out of service for a significant length of time. Based on the same PSU report, the cost of retrofitting the tanks could be another \$60M.

Alternatively, a second location could be established for a smaller-scale CEI Hub. This would reduce negative impacts from damage to the current CEI Hub during a Cascadia event. Such a site should ideally be near existing pipeline, waterway, and railway infrastructure. However, the smaller-scale alternate site should be far enough from the river and on soil that is not subject to liquefaction, landslides, lateral spreading, or other geological seismic hazards. New tanks and pipelines built at the alternate site should utilize the latest state-of-the-art seismic design and be designed to higher standards to ensure post-earthquake functionality. Even with retrofitting, existing tanks at the old site would still likely have damage that newer tanks would not experience.



## Geographic Diversification of Fuel Throughout Oregon

The greatest fuel-related challenge after a Cascadia event will be to deliver fuel into impacted communities without viable roadway, waterway, and rail transportation systems. Widespread islanding is anticipated in smaller communities—downed bridges and landslides will prevent access to many areas of the state and isolate the populations in these islands. In some areas of the state, it may take months to get fuel delivered due to the lack of access.

With most of the state’s bulk fuel supplies concentrated at the CEI Hub, geographically diversifying the state’s fuel supplies and increasing fuel storage capacity at designated locations around Oregon becomes critical to the state’s overall ability to recover from a Cascadia event. At the very least, it would bridge the gap between a community running out of fuel and the state being able to coordinate that first delivery into the impact zone to resupply the area. Ways to diversify in-state fuel supplies include:

- Adopt [Oregon Fuel Action Plan](#) criteria for pre-designated “Fuel Points of Distribution” for receiving emergency fuel supplies at selected fuel diversification sites.
- Store fuel on publicly-owned land with existing capability to store and dispense unleaded, diesel, and aviation fuel. Examples include ODOT maintenance yards, airports, county public works yards, fleet services, and motor pools.
- Partner with private-sector companies to build fuel storage capacity throughout the state. Potential private-sector companies are those that provide an emergency or essential service mission to save or sustain life and/or support the restoration of critical lifelines and services in support of the state’s overall response and recovery effort.
- Adopt the Oregon Health Authority and DOGAMI’s fuel readiness guidance for the 11 coastal hospitals and for all hospitals and other critical facilities statewide. This requires proper installation of seismically-certified generators, adequate storage capacity, and fuel onsite to power backup generators so that operations can be maintained after a Cascadia event. The entire state will experience fuel shortages even though eastern Oregon will not be directly impacted by strong earthquake shaking.

## Current Fuel Resilience Work

- **Governor's 2025 Resiliency Vision** (October 2018)  
Called for OEM and DEQ to commission a study to evaluate potential release from the CEI Hub into the Columbia and Willamette Rivers following a major earthquake and mitigation measures to ensure rapid containment.
- **Seismic Assessment of Liquid Storage Tank Inventory** (May 2019)  
The City of Portland commissioned a study to assess potential impacts of fuel storage tank failures in the CEI Hub from a major earthquake.
- **PSU Liquefaction Mitigation Research** (currently underway). NSF has sponsored research at PSU to use microorganisms to produce gas bubbles that reduce soil saturation to levels below the threshold needed for liquefaction.

## Need Continued Support for Oregon Fuel Action Plan

The [Oregon Fuel Action Plan](#), written and established by the Oregon Department of Energy, aims to ensure the state is ready to respond to any situation or emergency that threatens Oregon's fuel supply and distribution system. The plan identifies nine priority actions the agency would take to acquire and deliver fuel in support of the state's response and recovery efforts in times of crisis. It creates a framework for coordinating response to petroleum shortages or disruptions among all levels of government, the military, and the petroleum industry.

In a Cascadia event or other major disaster, the Oregon Fuel Action Plan establishes new temporary fuel supply chains into Oregon. It also identifies viable delivery systems to move fuel into impacted communities to assist emergency and essential service providers to save lives, restore critical lifelines services, and protect public health and safety. While the plan is designed to address a Cascadia event, all strategies in the plan are flexible and can be scaled down in response to a wide range of events with potential impacts to Oregon's fuel supply and distribution system like winter storms, fire season, industry accidents, and special events like the solar eclipse.

The Oregon Fuel Action Plan is a working document and will be updated as needed to ensure that all response strategies remain current and in sync with those of our federal, military, state, local, and tribal partners. As ODOE continues to refine the Fuel Action Plan, the agency will work closely with its private partners to integrate industries' resources and capabilities into the state's response strategies to enhance and strengthen Oregon's overall fuel planning and response efforts. This includes furthering its fuel planning work with the Western States Petroleum Association, Oregon Fuels Association, and Pacific Propane Gas Association.

Of course, this plan still has many facets that need to be written, expanded, or improved. This will take additional work and resources to complete. OSSPAC recommends additional staff be assigned to the ODOE by the Legislature to assist with this task.

## Lack of Data on State Fuel Consumption

If we don't know how much fuel the state uses today and we don't know what we'll need in five years, we won't know what we will need for response and recovery after a Cascadia event. The City of Portland has consumption data included in its long-range plan, but it was last tallied in 2007 and does not include the entire state. Data is needed about consumption by type of fuel during normal conditions as well as the spike in consumption under post-disaster conditions in order to better plan and understand how much diversification is needed throughout the various Oregon regions and geographies. In addition, it will be important to know the trends of fuel consumption including the continued use of electric vehicles and the use of alternate fuels. This data is critical to enabling other programs such as the long-term fuel diversification program and the alternate small scale CEI Hub. OSSPAC recommends that this data be collected by the ODOE as part of its ongoing work on the Oregon Fuel Action Plan.

## Reduce Dependence on Fossil Fuels

Strategies to harden existing fuel facilities and increase storage capacity around the state are important actions to increase seismic resilience. However, these strategies are ultimately limited in their effectiveness because a Cascadia event would likely impact refineries and pipelines in other states. The availability of fuel and the capacity to transport it could still be constrained even if Oregon's fuel infrastructure were improved.

Adopting transportation modes that are not dependent on fossil fuels reduces our need to store and distribute fuel and supports the important goal of curbing the state's carbon emissions to reduce the impact of future climate conditions. These modes could include electric, compressed natural gas, or biofuel buses in the public sector and electric cars, bicycles, and scooters for residents. TriMet, the state's largest public transit agency, has already committed to being diesel-free by 2040. The State of Oregon has also committed to 50% of electrical energy consumption coming from renewable sources by 2040. More work needs to be done in this area.

Alternate fuel sources have separate distribution networks outside of the CEI Hub that may be more resilient than the current liquid petroleum infrastructure. Use of these fuels would preserve limited liquid petroleum resources for the heavy machinery needed to rebuild after a seismic event. At the same time, however, shifting to alternate energy sources has different challenges to resilience. An issue with the widespread use of electric vehicles, for example, is that they are dependent on an extensive generation and distribution system that will likely be inoperable after Cascadia. Liquid fuel is much easier to store and transport, which will be essential to early recovery efforts. In the future, local microgrids and battery storage may help meet essential energy needs in a more resilient way.

Decreased reliance on fossil fuels also helps the state by reducing the amount of gas and diesel that will be spilled following a Cascadia event. Gas stations can contaminate local groundwater when they leak, and the CEI Hub itself could massively pollute the Willamette and Columbia, further harming salmon populations, the tribes that depend on them, and the communities that rely on commercial fishing.

### Greenhouse Gas Emissions Trend

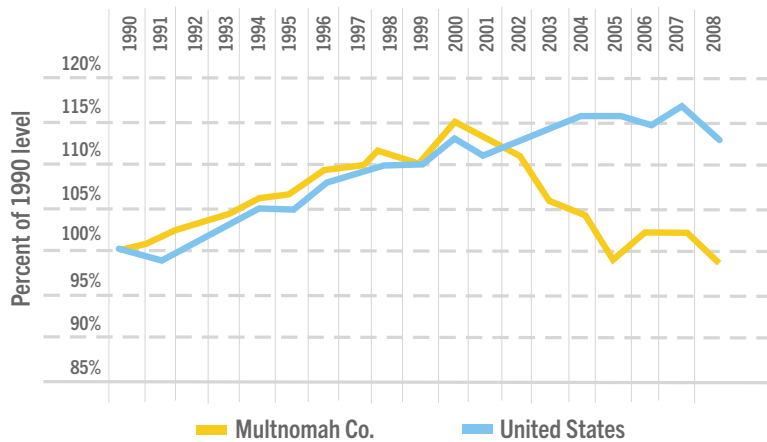


Figure 3.1: Greenhouse gas emissions trend for Multnomah County as compared to the United States, shown as a percent of 1990 levels. (Figure after Portland Plan—Energy, Figure 5.)



## Chapter 3 Recommendations

**Direct Oregon Solutions to manage a project that develops a small-scale CEI Hub at an alternate site.**

Oregon Solutions should identify a location, determine the size, identify which companies would relocate, what types of fuel they would store, and how the new small-scale facility would operate in conjunction with the existing Hub. The new small-scale fuel hub site should ideally be near existing pipeline, waterway, and railway infrastructure, but it should be placed on land that is not susceptible to liquefaction. The design of the new tanks and pipelines should employ the latest state-of-the-art seismic design to ensure post-earthquake functionality. The cost of such a project is unknown and largely dependent on the size and cost of the land, number of tanks installed and infrastructure needs. This effort should involve support from and funding for both ODOE and DOGAMI.

**Direct the Oregon Department of Energy to develop a long-term program to increase the geographic diversity of fuel storage capacity throughout the state.**

A robust program should include a complete assessment of the seismic resilience of existing facilities throughout the state. Strategies could include increased storage on public-owned land, such as ODOT maintenance yards, airports, county public works yards, fleet services, and motor pools. The program should investigate ways to mitigate barriers to implementing a geographically distributed fuel network throughout the state.

**Enact legislation to provide authority and adequate funding to the Oregon Department of Energy to continue progress on the Oregon Fuel Action Plan.**

This recurring funding should provide for a 0.5 FTE position. ODOE should work with fuel terminal companies to train once every other year to respond to a Cascadia event scenario; work with the Oregon Fuel Association to build county and regional distribution plans; work with the Western State Petroleum Association to ensure alternate bulk fuel resources to support post-earthquake emergency response and recovery; and work with the Department of Administrative Services to establish pre-disaster fuel contracts, as appropriate. It should also include conducting a comprehensive statewide assessment on consumption by fuel type both during normal conditions and post-disaster response.

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# chapter four

## Partnerships and Incentives to Encourage Mitigation

A great deal of mitigation work is necessary to the tanks and infrastructure of the CEI Hub in order to increase its resilience to a major earthquake. This will take time, expertise, and significant investment. It will also take the willing participation of the private entities that own most of the assets that Oregon will count on to supply fuel to restart our economy.

It is unrealistic to assume that the state should cover the cost of this extensive mitigation of private assets on private land. At the same time, the state needs to partner with the tank owners because the fuel that is stored at the CEI Hub is critical to our post-Cascadia recovery effort. Private-public partnerships are one way to help pay for this effort. Another possibility is offering state-sponsored incentives through measures other than direct financial assistance.

## No One-Size-Fits-All Incentive

As noted in the 2019 Oregon Solutions report, operators and owners of the fuel terminals at the CEI Hub function independently and not as a monolith. Each company has market goals and constraints specific to their operations. These differences may matter when it comes to designing incentive programs that garner buy-in from the Hub operators. Information on the companies' varied operations, goals, and constraints would help provide a solid foundation upon which to build an effective incentive program.

The Oregon Solutions report lists a range of possible incentives to harden Hub infrastructure. These fall into two broad categories:

### Financial-Based Incentives

- Direct financing
- Tax credits
- Fuel or business license taxes (cost recovery)
- Expansion of the Oregon Department of State Land's moorage fees
- Seismic resiliency fund through Business Oregon
- Financial incentives to store caches of fuel around the state

### Regulatory-Based Incentives

- Permit fast-tracking or other actions that help reduce the time, uncertainty, and cost of mitigation
- Public-private partnerships to share responsibilities

## Considerations for Financial Incentive Programs

Developing an effective incentive program requires collecting information on a range of issues, including:

- **The overall cost of hardening investments.** Dr. Peter Dusicka of Portland State University recently completed a report that describes a “high level” estimate of the cost to harden the Hub’s oil storage tanks. This estimated cost exceeds \$300 million. (This estimate excludes the costs of hardening other CEI Hub infrastructure, such as pipelines, pumps, and electrical supplies.)



- **The factors used to rank investments over time.** For example, the factors used to identify the investments considered most critical given the risks of tank or infrastructure failure.
- **The distribution of existing tanks and infrastructure regarding the estimated end of their useful lives over the next 20, 30, or 50 years.** At a certain point in time, older tanks will likely be replaced and reconstructed under current code requirements.
- **The marginal increase in construction costs for new tanks and infrastructure versus the cost of earthquake hardening and the losses of not hardening.**
- **Developing a sustainable source of funds that supports the financial incentives.** The range of possible sources include: a fuel-delivery fee paid by all residents and businesses that purchase or use petroleum products that flow through the CEI Hub; appropriations from the state’s general fund; private investments recouped through increasing market prices; or a mix of these and other funding sources.
- **Identifying the entity that will implement and manage a financial incentive program.** The range of possible models includes: a public agency, a public/private partnership, or a nonprofit agency.

### Other Incentive Programs for Oil Tank Cleanup

Several states have programs that incentivize private owners of oil storage tanks to take actions that reduce the threat of pollution from leaks. These programs generally operate as a fund that provides reimbursements to tank operators for qualified expenditures. Funding generally comes from tax payments per tank or per quantity of petroleum products that flow through the tanks. The examples we studied (see sidebar) are specific to underground storage tanks (USTs) typically found at gas stations. We found no information on programs designed for large, above-ground tanks such as those at the CEI Hub.

### Other State Programs to Encourage Oil Tank Mitigation

- **Minnesota’s Petroleum Tank Release Cleanup Fund** reimburses up to 90% of “reasonable and necessary” costs incurred in responding to petroleum tank leaks. Gasoline distributors pay a fee of \$20 per 1,000 gallons.
- **California’s Underground Storage Tank Cleanup Fund** reimburses for corrective actions taken to stop or clean up leaking USTs. Owners pay a fee based on tank volume.
- **Colorado’s Petroleum Storage Tank Fund** reimburses costs related to assessment and cleanup of sites contaminated by petroleum products by applying a surcharge.
- **Washington State’s Pollution Liability Agency’s** recent study concluded that a revolving loan program would provide the best incentive for UST owners to remove, replace, or upgrade tanks and clean up contamination.

## Relationship Building is Needed

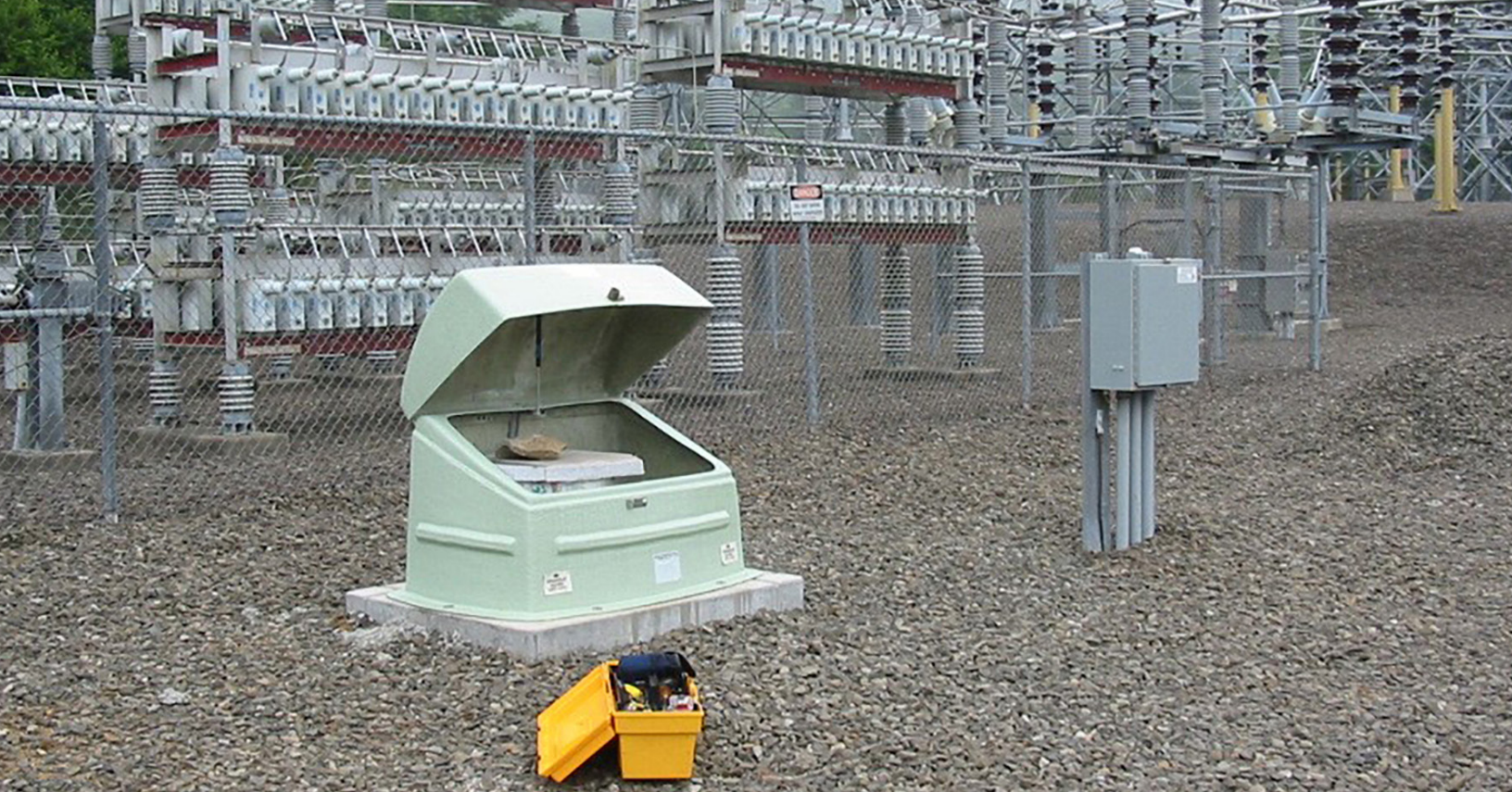
OSSPAC has concluded that it is too early to propose incentive programs for the CEI Hub. According to the 2019 Oregon Solutions report, additional communication, trust building, collaboration, and information collection is needed *prior to* developing the specifics of an incentive program. This should include representatives of the CEI Hub companies and other interested and affected parties. Defining the specifics of an incentive program before taking these steps risks alienating CEI Hub companies and limiting their participation for a variety of reasons including operational needs and constraints, perceived business risks, and cost concerns.



## Chapter 4 Recommendations

**Direct Oregon Solutions to implement the recommendations of their 2018 report, including developing effective incentives for CEI Hub owners.** Oregon Solutions should continue to engage critical parties, collect information about Hub operations and constraints, convene an education-focused collaborative table, and identify a model for implementing and administering a financial incentive program. They should hand off the responsibility to other appropriate state agencies as the process develops. Qualified researchers and analysts should collect information on the scale of an incentive program.

**Enact legislation to provide funding for the Office of the State Fire Marshal to increase their response capabilities for spills and fires on land and water at the CEI Hub.**



# chapter five

## Utilizing ShakeAlert

[ShakeAlert](#) is an Earthquake Early Warning (EEW) system developed by the U.S. Geological Survey (USGS) along with a coalition of state and university partners, including the University of Oregon. It detects earthquakes so quickly that alerts can be received before the onset of strong ground shaking. Alerts are sent to the public via wireless alerts and cellphone apps, allowing them to take protective action, thereby reducing injuries and casualties.

Alerts are also sent to institutions and commercial service providers to trigger automated protective actions and secure critical infrastructure. For example, companies within the CEI Hub could slow and stop distribution of liquid fuels, disconnect barges from fuel supply hoses, and retain fuel supply for immediate use in recovery efforts. The amount of warning is from seconds to many tens of seconds depending on

the location of the source relative to where the alert is ultimately received. During this time, trains can be slowed or stopped, equipment can be automatically shut down, and the public can be warned to drop, cover, and hold.

The ShakeAlert system utilizes an extensive array of ground-based seismic sensors throughout California, Oregon, and Washington. These stations deliver continuous data in real time to three west coast data centers. This information is then processed by special software to determine the earthquake's location and magnitude and if above a predetermined threshold, the system sends alerts to the community and to machines that are programmed to receive the alerts. During a large event, ShakeAlert updates the predictions as the earthquake progresses. See Figure 5.1.

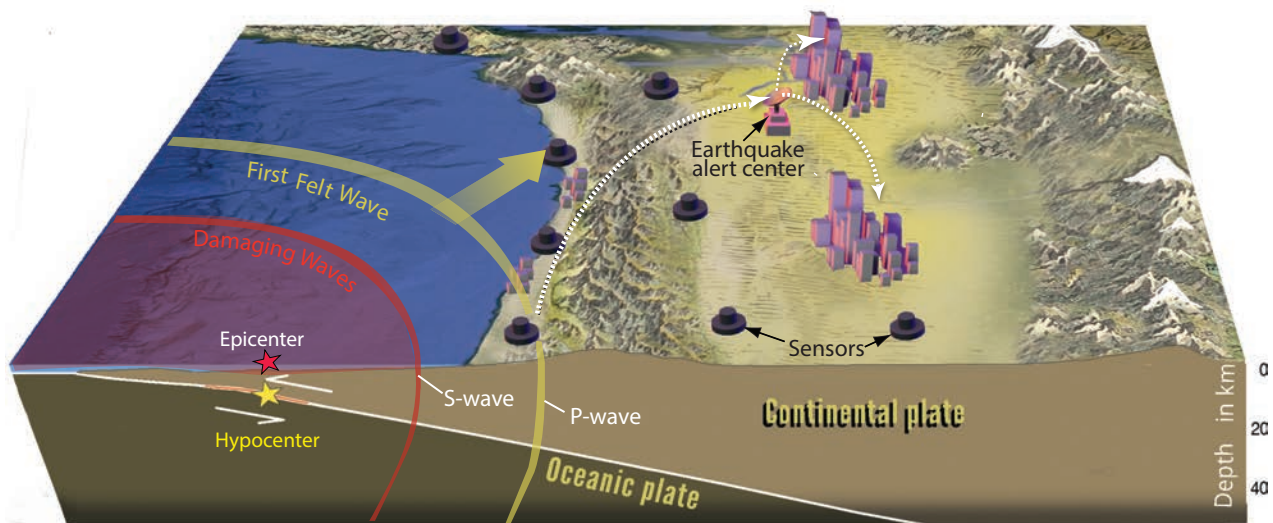


Figure 5.1: The ShakeAlert Earthquake Early Warning System, in development by the U.S. Geological Survey and its partners. This simplified image illustrates these concepts: earthquake shaking can be measured by sensors, and P waves (generally less damaging) travel faster than S waves, which are the more damaging waves. ShakeAlert is designed to provide advance warning -- for a Cascadia earthquake, the warning would be in terms of seconds to many tens of seconds depending on the actual earthquake and the person (or location) receiving warning. Image modified from USGS Fact Sheet 2014-3083 by Jenda Johnson. More information at: <https://www.shakealert.org>.

## Potential CEI Pilot Projects

Implementing ShakeAlert pilot projects in the CEI Hub would have significant benefits. While it is unlikely that *all* facilities can be secured, safeguarding even a fraction of them would help. Every gallon of fuel kept contained is one less gallon to feed fires, destroy our environment, and delay response and recovery.

Direct communication with stakeholders in the CEI Hub (e.g., Kinder Morgan Energy Partners, Nustar, McCall Oil and Chemical Corporation, and Chevron Corporation) indicates that successful ShakeAlert pilot projects are possible. Organizations have already expressed interest in using their internal communication systems to deliver alerts to employees, so they can take protective actions to reduce injuries. Regarding built infrastructure, they prefer to investigate the use of manual responses, as opposed to automated. There is valid concern about using automated responses until ShakeAlert capabilities are better understood and the system itself is more robustly implemented throughout the state.

Defining good candidates for a CEI Hub pilot project would require repeated engagement by ShakeAlert's Technical Users Engagement Group at the University of Oregon over a period of months and potentially several years. This sustained engagement is necessary to develop familiarity and trust with the ShakeAlert products and to implement technological solutions.

## Oregon's Alert System Lags Others

California began issuing statewide alerts in October 2019, and Washington's system is likely to go public in October 2020. Both states have invested capital and recurring funds to construct their seismic network, strengthen monitoring, and conduct public

## Countries that Already Have an Earthquake Early Warning System:

- Mexico City (1993)
- Japan (1995)
- Taiwan (1999)
- Turkey (1999)
- China (2008)

Many of these systems have been tested during subsequent earthquakes and have worked well. After the 2011 Tohoku earthquake, most of the country received alerts on their cell phone and computers and no trains derailed. Before the 2017 Tehuantepec earthquake off the southern coast of Mexico, residents were given over 2 minutes of warning before the earthquake arrived. Unfortunately, in every one of these countries, the system was implemented after a major damaging earthquake occurred killing tens of thousands of people. The objective for the United States is to implement a system before a major earthquake strikes the West Coast.

outreach. The density of stations in both our neighboring states is far beyond what is in Oregon at present.

Based on testimony from the director of EEW, Oregon's ShakeAlert system is currently 51% complete. The system needs telemetry infrastructure upgrades and 83 additional seismic stations. The total capital outlay needed to finish the network in Oregon is \$7.5M. Right now, alerts are possible. But the lack of density of the stations and the latency in the telemetry transmission means that the system alerts are less reliable and cannot be delivered in time.

If we do not invest in ShakeAlert infrastructure in Oregon, we run the risk of not alerting the public while our neighboring states do. If investments had been made during Oregon's 2019 legislative session, the state would be in line with both California and Washington. As it stands, we are in the unenviable position of being last to deliver public alerts.

### **Hardware Is Important, But People Are Essential**

Having all the hardware in place to sense an oncoming earthquake is important, but it takes people to run the network and educate local communities about what to do when an alert is received.

Washington provides recurring funds of \$600K/year to support seismic network personnel and end-user engagement. California provides \$1.2M/year of recurring funds to their statewide network, with money distributed evenly between the northern and southern networks. With support from the Washington legislature (\$500K in current biennium), Washington's Emergency Management Division established a new Earthquake Early Warning (EEW) Coordinator.

Oregon has never provided recurring funds to support seismic network personnel or an education and outreach team. Oregon should support a dedicated EEW coordinator at a state agency. A dedicated EEW state coordinator is particularly important in the runup to public rollout. Such a role would spearhead policy development, education, and outreach to local communities and business partners and provide marketing and technical support for EEW in Oregon. Funding of \$500k/year should be dedicated to this effort.

The EEW Coordinator would direct staff to engage interested state partners, coordinate with public safety and emergency management officials on earthquake early warning, and partner with existing preparedness efforts such as the national Great ShakeOut drill. The program must also develop critically

needed Oregon-specific earthquake early warning preparedness education and training materials to ensure the public understands the importance of “drop, cover, and hold on” as a protective action when an earthquake occurs.



## Chapter 5 Recommendations

**Enact legislation to fully fund the implementation of ShakeAlert in Oregon.** Approve a one-time funding request of \$7.5M for the University of Oregon to cover funds for the installation of seismic sensors and the telecommunication infrastructure to deliver data to processing centers. Approve a recurring funding request of \$500k/year (\$1M per biennium) for OEM/DOGAMI for a dedicated Earthquake Early Warning coordinator and related staff. This effort includes policy development, education and outreach to local communities and business partners, marketing, and technical support, including coordination with the CEI Hub and other major storage facilities throughout the state.

**Enact legislation to incentivize a pilot project to implement ShakeAlert at the CEI Hub.** Provide support and funding for ShakeAlert personnel to work with CEI Hub stakeholders and to develop and implement a plan. Until the seismic and telecommunications network is complete, ShakeAlert would be used to implement a manual response for shutting down pumps and other rotating equipment, as well as to secure infrastructure used for energy transfers between facilities. Incentivize stakeholders to participate in the pilot project via fast-track permitting, tax breaks, or other measures.

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# references

- California State Water Resources Control Board. (2008). [Underground Storage Tank Cleanup Fund Program Summary](#).
- City Club of Portland. (2017). [Big Steps Before the Big One: How the Portland area can bounce back after a major earthquake](#). City Club of Portland Bulletin: Vol. 99, No. 2.
- Clague, J., Atwater, B.F., Wang, K., Wang Y., and Wong, I. (2000). Geological Society of America Penrose Conference: Great Cascadia Earthquake Tricentennial, held in Seaside, Oregon, Oregon Department of Geology and Mineral Industries: Special Paper 33, 156 pages.
- Colorado Department of Labor and Employment. (2018). [2018 Incentive Program](#). Petroleum Storage Tank Fund, Division of Oil and Public Safety, Petroleum Program.
- Dusicka, P. and Norton, G. (2019). [Liquid Storage Tanks at the Critical Energy Infrastructure \(CEI\) Hub; Seismic Assessment of Tank Inventory](#). Report prepared for the City of Portland's Bureau of Emergency Management.

- Fore, K. and Mills, M. (2019). [Oregon Solutions CEI Hub Assessment Findings](#).
- Given, D. D., Allen, R., Baltay, A., Bodin, P., Cochran, E., Creager, K., ... (2018). [Revised technical implementation plan for the ShakeAlert system—An earthquake early warning system for the West Coast of the United States](#). Open-File Report 2018-1155.
- Goldfinger, C., Nelson, C. H., Morey, A. E., Johnson, J. E., Patton, J., Karabanov, E., ... (2012). [Turbidite event history—methods and implications for Holocene paleoseismicity of the Cascadia subduction zone](#). U.S. Geological Survey Professional Paper 1661–F, 170 p.
- Integrated Economics, LLC and Sound Resource Economics. (2016). [Economic Report on Petroleum Storage Tanks in Washington](#). Prepared for the Washington State Pollution Liability Insurance Agency.
- Miles, S. and Blue, A. (2012). Oregon Economic Interdependency Assessment of the Energy Sector, Appendix A in Wang, Y., Bartlett, S. and Miles, S. (2012). [Earthquake Risk Study for Oregon’s Critical Energy Infrastructure Hub](#). Oregon Department of Geology and Mineral Industries, Open-File Report 0-13-09.
- Minnesota Commerce Department. (2018). [Petrofund](#); Minnesota Office of the Revisor of Statutes. [2018 Minnesota Statutes. 115C.08 Petroleum Tank Fund](#).
- Oregon Department of Energy. (2017). [Oregon Fuel Action Plan](#).
- Oregon Department of Energy. (2018). [2018 Biennial Energy Report](#).
- Oregon Department of Environmental Quality (2016). Regulation of Aboveground Storage Tanks Storing Hazardous Substances in Oregon.
- Oregon Seismic Safety Policy Advisory Commission. (2013). [The Oregon Resilience Plan: Reducing Risk and Improving Recovery for the Next Cascadia Earthquake and Tsunami](#). Report to 77th Legislative Assembly.
- Papaefthimiou, J. (2019). [City of Portland & Critical Energy Infrastructure Hub](#). OSSPAC Testimony.
- Tetra Tech. (2016). 2016 [Critical Energy Infrastructure Hub Study](#). Appendix to Natural Hazards Reduction Plan prepared for Portland Bureau of Emergency Management. pp. 127-148.
- Wang, Y., Bartlett, S., & Miles, S. (2013). [Earthquake Risk Study for the Critical Energy Infrastructure Hub in Oregon](#). Oregon Department of Geology and Mineral Industries, Open File Report 0-13-9.



# appendix a

## List of Stakeholders

### Attendees of at least one Workgroup Meeting between April 2019 and December 2019

Tiffany Brown	OSSPAC	Joe Karney	OSSPAC
Matt Crall	OSSPAC, DLCD	Christina Leclerc	OSSPAC, ODOT
Greg Ek-Collins	OSSPAC, ODOT	Ed MacMullan	OSSPAC
Karmen Fore	Oregon Solutions	Bonnie Magura	OSSPAC
Dacia Grayber	OSSPAC	Walter McMonies	OSSPAC
Laura Hall	Regional Disaster Preparedness Organization	Trent Nagele	OSSPAC
Mike Harryman	State Resilience Officer	Leland O'Driscoll	University of Oregon
Deanna Henry	Oregon Department of Energy	Jonna Papaefthimiou	Portland Bureau of Emergency Management
Emily Hooft	University of Oregon	Adam Pushkas	OSSPAC
Tyler Janzen	Chief of Staff—Representative David Gomberg	Jay Raskin	OSSPAC
		Althea Rizzo	OSSPAC, OEM
		Scott Smith	Oregon Department of Environmental Quality

*(Attendees of at least one Workgroup Meeting  
between April 2019 and December 2019, continued)*

Jeff Soulages           OSSPAC  
Nate Takara           Portland Fire and Rescue  
Susan Romanski       OSSPAC  
Aeron Teverbaugh    OSSPAC, DCBS  
Doug Toomey          University of Oregon  
Yumei Wong           OSSPAC, DOGAMI

**Testimony to OSSPAC — November 13, 2018**

Yumei Wang           Oregon Department of Minerals and Industry  
Scott Smith           Oregon Department of Environmental Quality  
Karmen Fore          Oregon Solutions  
Doug Toomey          University of Oregon  
Lucy Walsh            University of Oregon

**Testimony to OSSPAC — January 8, 2019**

Deanna Henry         Oregon Department of Energy  
Lori Koho             Public Utilities Commission  
Barnes Ellis          City Club of Portland  
Jonna Papaefthimiou Portland Bureau of Emergency Management  
Terry Whitehill       City of Portland, Bureau of Development  
                              Services  
Tom Armstrong        City of Portland, Bureau of Planning

**Testimony to OSSPAC — March 12, 2019**

Mike Heffner         Oregon Office of State Fire Marshal  
Karmen Fore          Oregon Solutions

**Testimony to OSSPAC — May 14, 2019**

Elizabeth King       Washington State Energy Office  
Nate Takara           City of Portland, Fire Marshall  
Ed MacMullan         Economist

**Testimony to OSSPAC — July 9, 2019**

Jonna Papaefthimiou Portland Bureau of Emergency Management  
Scott Porter          Washington County  
Arash Khosravifar    Portland State University

**Testimony to OSSPAC — November 12, 2019**

Jay Wilson            Clackamas County Disaster Management  
Richard Franklin      US Environmental Protection Agency

**Interview — August 27, 2019**

Deanna Henry         Oregon Department of Energy  
Ken Niles             Oregon Department of Energy

**Interview — August 27, 2019**

Michael Heffner      Oregon Office of State Fire Marshal

**Interview — September 6, 2019**

Lidia Emer            Oregon Department of Environmental Quality  
Michael Zollitsch     Oregon Department of Environmental Quality

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