



Tsunami Evacuation Planning in Washington State

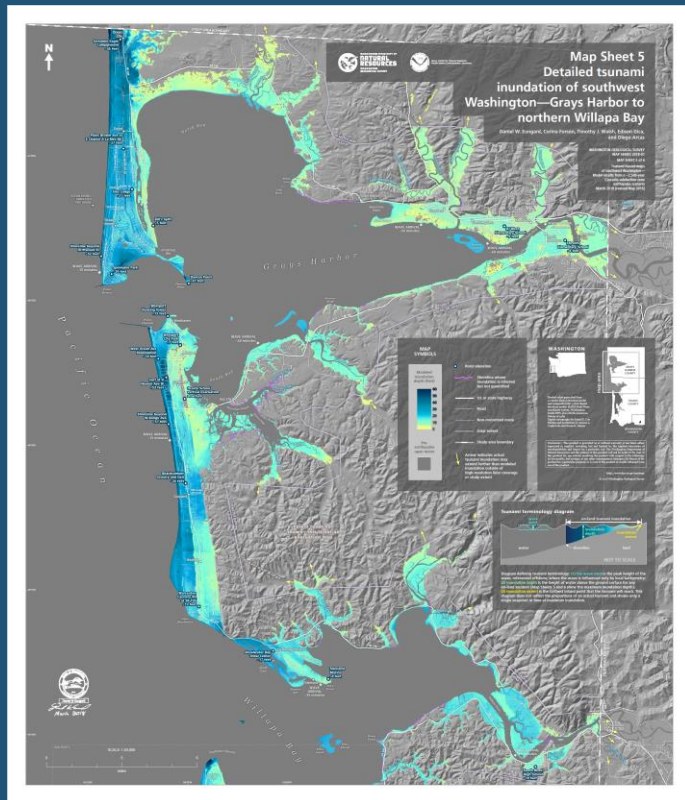


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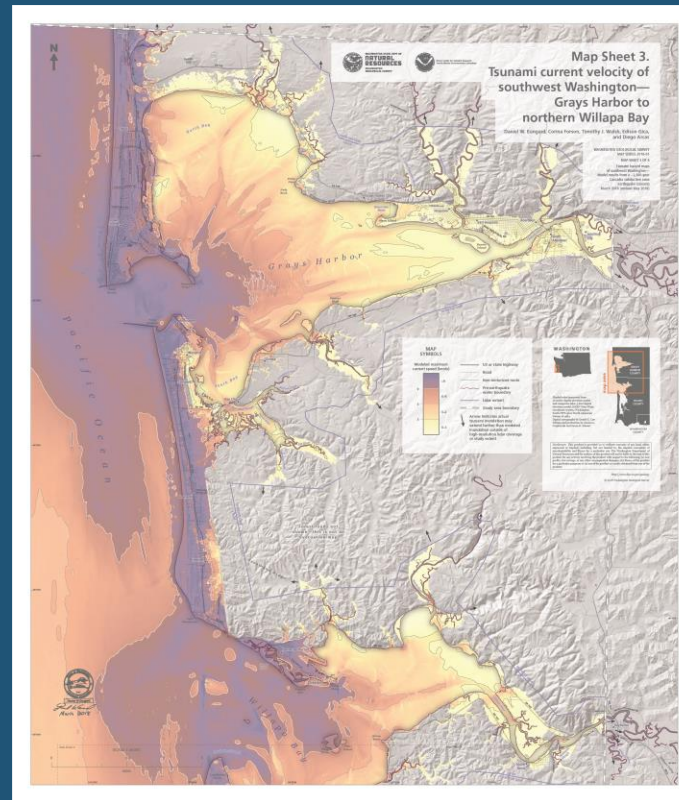


Tsunami Modeling in Washington



Tsunami inundation maps

CSZ L1, Seattle Fault Zone, Alaska Aleutian Subduction Zone scenarios



Tsunami current velocity maps

CSZ L1, Seattle Fault Zone, Alaska Aleutian Subduction Zone scenarios

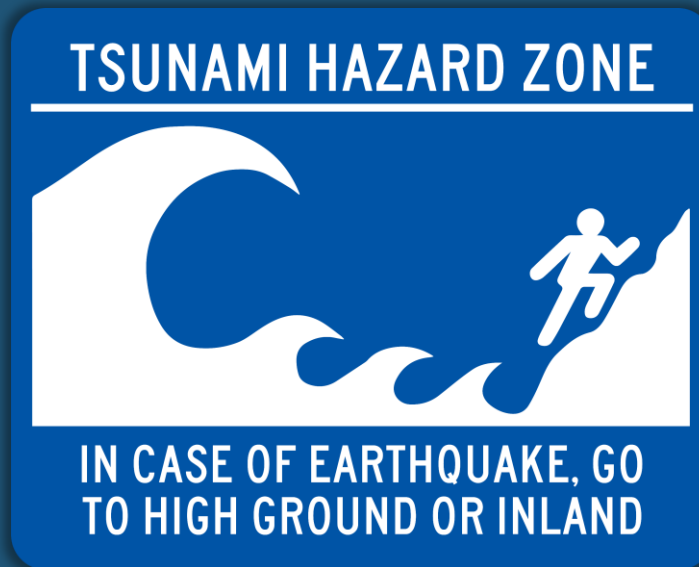


Tsunami evacuation walk maps

CSZ L1 scenario



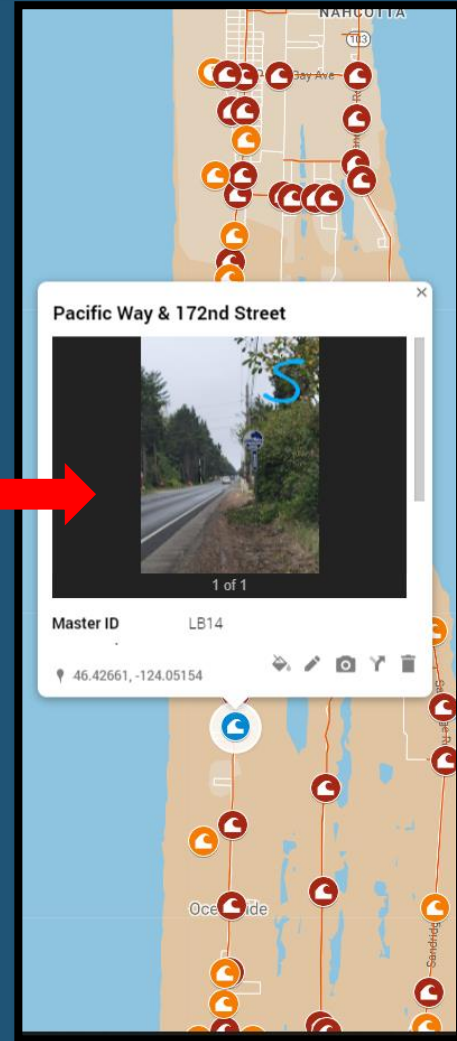
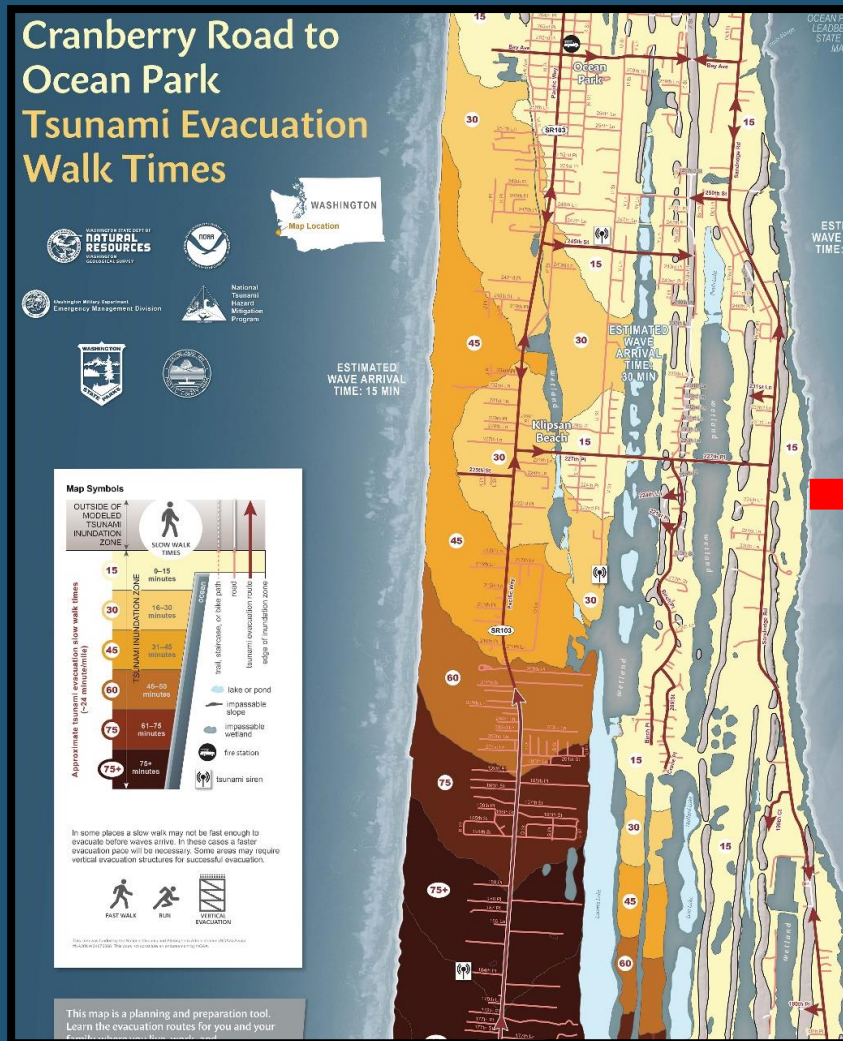
Tsunami Evacuation Route Wayfinding Signs





Tsunami Evacuation Route Wayfinding Assessment

- Covered all locations with tsunami pedestrian evacuation walk maps as of 2022; **28 communities** and **1,055+ miles of evacuation routes total**
- University of Washington students captured location data, took pictures, and documented condition of signs and paths
- Recommended new signs to fill line-of-sight for all routes
- Data organized by sign type and priority and compiled into Google MyMaps





Evacuation Route Wayfinding Project Findings



Damaged



Graffiti



Private property

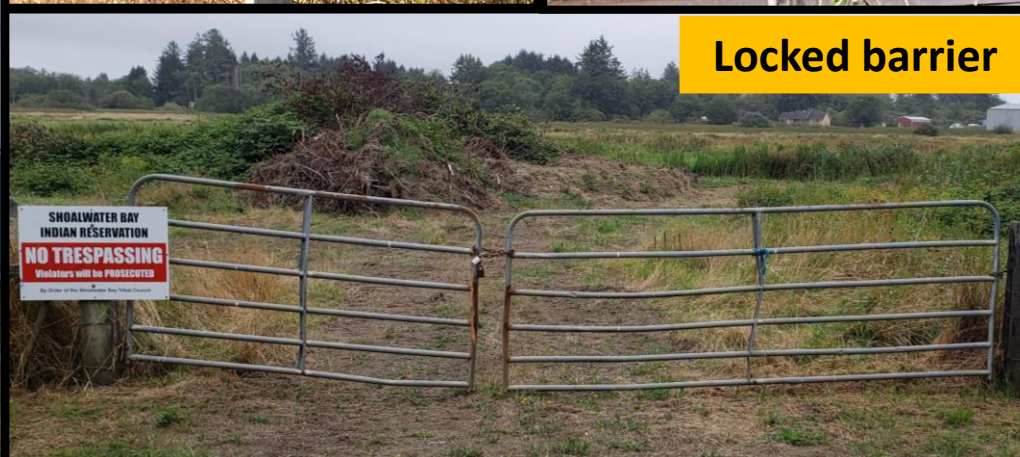


Confusing

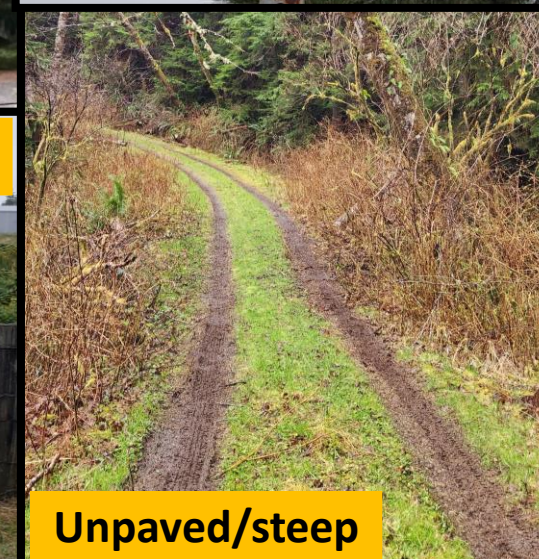


Inaccurate

Wrong direction



Locked barrier



Unpaved/steep



Washed out



Wayfinding Project Results and Deliverables

- In total, **more than 1,700 new signs were recommended** in the assessed communities for robust, effective tsunami evacuation along our coasts
- Each community received the created Google MyMaps for their respective jurisdictions and all associated data
- WA EMD provides tsunami signs free of charge to local jurisdictions as funding allows
- **Wayfinding methodology document in progress**
 - Provides a proven step-by-step process for approaching tsunami wayfinding within your community
 - Draws on best practices from this project and from other US states and territories





Getting Creative with Signage

★ YOU ARE IN A TSUNAMI ZONE
The Gladys Valley Marine Studies Building is engineered to survive a magnitude 9.0+ earthquake and resulting tsunami.

GREEN: High ground safety zone.

YELLOW: Evacuation zone for a local tsunami that can reach shore 10 to 20 minutes after an earthquake close to the Oregon coast. General shaking in your city warning, move on foot quickly to high ground.

ORANGE: Evacuation zone for a distant tsunami that will reach the shore 4 or more hours after an earthquake far away from the Oregon coast. You will not feel an earthquake and there will be an official evacuation warning.

IN CASE OF AN EARTHQUAKE, FOLLOW THE EVACUATION SIGNS TO HIGH GROUND. A TSUNAMI IS ON ITS WAY.

★ THE MARINE STUDIES BUILDING
The Marine Studies Building was specially designed to resist earthquake and tsunami forces. In the event of an earthquake, the Marine Studies Building rooftop provides high ground that allows people to evacuate above the level of tsunami inundation. It is an official assembly area for anyone who works, lives, or plays around the IMSC campus. The rooftop assembly area has a community disaster cache filled with basic survival supplies to support 500 people for two days. The elevated walkway on the outside of the building is the most obvious of three rooftop access points, designed to be seen and its purpose clear. Visitors are welcome to walk up the ramp and enjoy the view from the top. Go over and check it out!

Evacuation zone maps were developed by DOGAMI



TSUNAMI EVACUATION MAP
CANNON BEACH AND ARCH CAPE AREAS, OREGON

IF YOU FEEL AN EARTHQUAKE:

- Drop, cover and hold.
- Move immediately inland to higher ground.
- Do not wait for an official warning.

SENYIRA EL TEBELGOR:

- Bajar, cubrirse y agarrarse.
- Moverse de inmediato a un lugar más alto que el nivel del mar.
- No esperar por un aviso oficial.

LOCAL CASCAEDA EARTHQUAKE AND TSUNAMI: Evacuation zone for local tsunami that can reach shore 10 to 20 minutes after an earthquake close to the Oregon coast.

MAREMOTO LOCAL: Zona de evacuación de tsunami que puede alcanzar la costa de Oregon 10 a 20 minutos después de un terremoto cercano a la costa de Oregon.

DISTANT TSUNAMI: Evacuation zone for a distant tsunami that will reach the shore 4 or more hours after an earthquake far away from the Oregon coast.

MAREMOTO DISTANTE: Zona de evacuación de tsunami que puede alcanzar la costa de Oregon 4 o más horas después de un terremoto lejano de la costa de Oregon.

MAP SYMBOLS / SIMBOLOS DEL MAPA

- Evacuation route / Ruta de la evacuación
- Assembly area / Área de concentración
- Tsunami warning sirens / Sonido de advertencia de tsunami
- School/Escuela
- City Hall/Cabildo pueblo
- Fire Dept./Parque de bomberos
- Police/Policia

SCALE
0 0.5 mile / 0 0.5 km



DOWNTOWN

TRANSFORMATION

CITY OF FORT LAUDERDALE



Cranberry Road to Ocean Park Tsunami Evacuation Walk Times



ESTIMATED WAVE ARRIVAL TIME: 15 MIN




ESTIMATED WAVE ARRIVAL TIME: 1 HOUR




But what if evacuation out of the inundation zone before the first waves of a local tsunami arrive simply isn't possible for a community?



In some places a slow walk may not be fast enough to evacuate before waves arrive. In these cases a faster evacuation pace will be necessary. Some areas may require vertical evacuation structures for successful evacuation.



FAST WALK

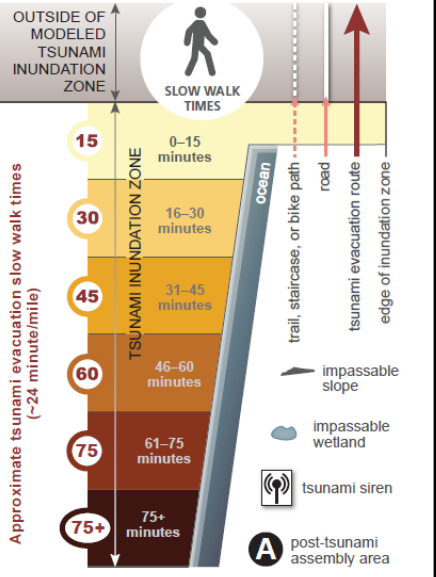


RUN

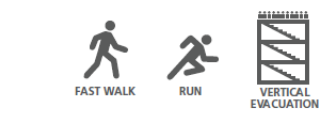


VERTICAL EVACUATION

Map Symbols



In some places a slow walk may not be fast enough to evacuate before waves arrive. In these cases a faster evacuation pace will be necessary. Some areas may require vertical evacuation structures for successful evacuation.





WA State Vertical Evacuation Needs Assessment

- Completed in 2021, built off Project Safe Haven begun in 2009
- Based on 2010 census population, does not include daytime visitors or tourists
- Scenario: M9.0 CSZ earthquake and tsunami with 5-6 minutes of shaking. People will have 15 minutes or less to get to high ground.
- Discovered almost half of Pacific and Grays Harbor Counties' populations within the inundation zone are not within 15 minutes of high ground (over 32,000 people)
- Determined **Washington needs between 58 and 80+ additional VES to support its permanent population**



Study Area Summary Tables, by Option: 1-4

[total estimated population in tsunami zone = ~71,186]

Based on 2010 census data; does not account for tourists or other visitors



OPTION 1

# of VES	Minimum VES Capacity Need	% of People Within 15 Minutes to High Ground or VES	# of People Within 15 Minutes to High Ground or VES	% of People <u>Not</u> Within 15 Minutes to High Ground or VES	# of People <u>Not</u> Within 15 Minutes of High Ground or VES	% of People Within 25 Minutes to High Ground or VES	# of People Within 25 Minutes to High Ground or VES
N/A	N/A	54.9%	39,115	45.1%	32,073	66.4%	47,282

OPTION 3

# of VES	Minimum VES Capacity Need	% of People Within 15 Minutes to High Ground or VES	# of People Within 15 Minutes to High Ground or VES	% of People <u>Not</u> Within 15 Minutes to High Ground or VES	# of People <u>Not</u> Within 15 Minutes of High Ground or VES	% of People Within 25 Minutes to High Ground or VES	# of People Within 25 Minutes to High Ground or VES
82	22,804	87.0%	61,959	13.0%	9,227	99.2%	70,603

OPTION 4

# of VES	Minimum VES Capacity Need	% of People Within 15 Minutes to High Ground or VES	# of People Within 15 Minutes to High Ground or VES	% of People <u>Not</u> Within 15 Minutes to High Ground or VES	# of People <u>Not</u> Within 15 Minutes of High Ground or VES	% of People Within 25 Minutes to High Ground or VES	# of People Within 25 Minutes to High Ground or VES
58	21,049	86.3%	61,441	13.7%	9,747	98.4%	70,013



Current and Pending VES in Washington

Ocosta Elementary

- Completed in 2016
- First VES in North America
- Funded through school bond approved by 70% of voters

Shoalwater Bay Tower

- Completed in 2022
- Second VES in WA; first standalone tower design in US
- First Tribal VES, first federally funded VES

Ocean Shores, WA

- Funding awarded, in progress

Westport, WA

- Funding awarded, in progress





Funding VES: The Biggest Hurdle

BRIC (Building Resilient Infrastructure and Communities)

- Pass-thru and reimbursement-based grant program from FEMA for government entities and special purpose districts with FEMA-approved Hazard Mitigation Plans

OSPI School Seismic Safety Grant Program

- For full funding or to cover local match for FEMA grants
- Focused on K-12 public schools needing earthquake retrofits, vertical evacuation, and/or complete rebuilding

OSPI School Construction Assistance Program

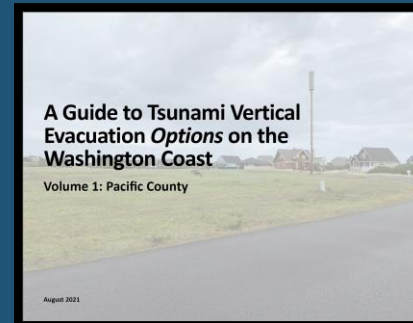
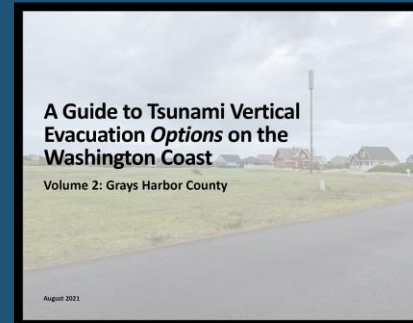
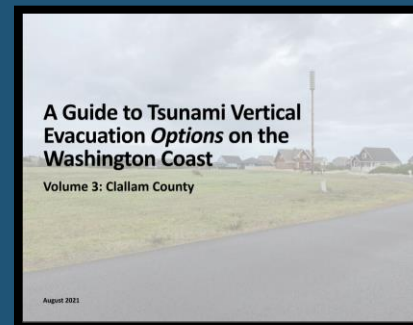
- Potential avenue for VES funding, could also supplement a school VES project by covering other costs



Tsunami VES Resources

[Mil.wa.gov/tsunami](https://www.mil.wa.gov/tsunami)

- New 2024 edition of the Manual for Tsunami Vertical Evacuation Structures
- 8 Phases Process Checklist
- PowerPoint Presentation
- VES gap assessments for Grays Harbor County, Pacific County, and Clallam County
- Historical Project Safe Haven documents



Manual for Tsunami Vertical Evacuation Structures

2nd Edition, September 2024



Tsunami Maritime Response and Mitigation Strategies

Ongoing work – WA EMD and WGS produce one grant-funded strategy per year

- Completed: Port of Bellingham, Westport Marina (Port of Grays Harbor), Port of Neah Bay
- In progress: Eagle Harbor (Bainbridge Island), Port of Port Angeles

Best practices – built on work consolidated through the National Tsunami Hazard Mitigation Program and collaboration with the US Coast Guard

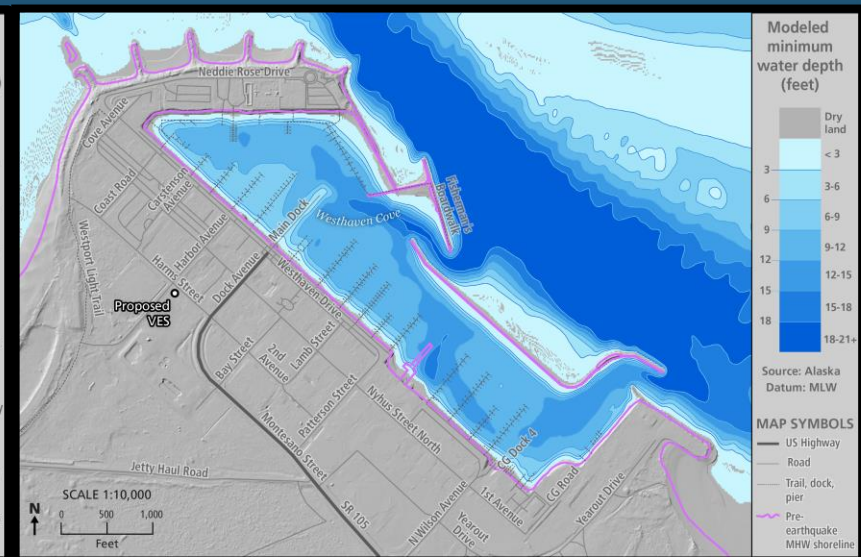
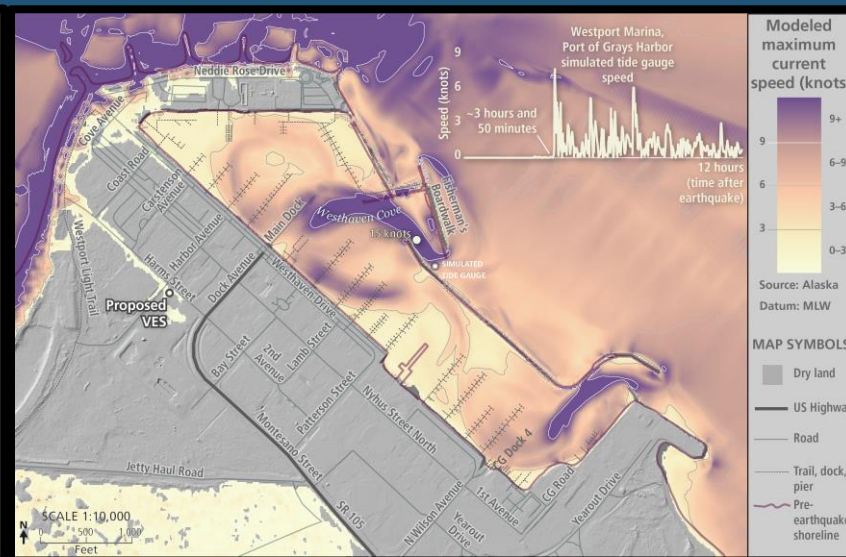
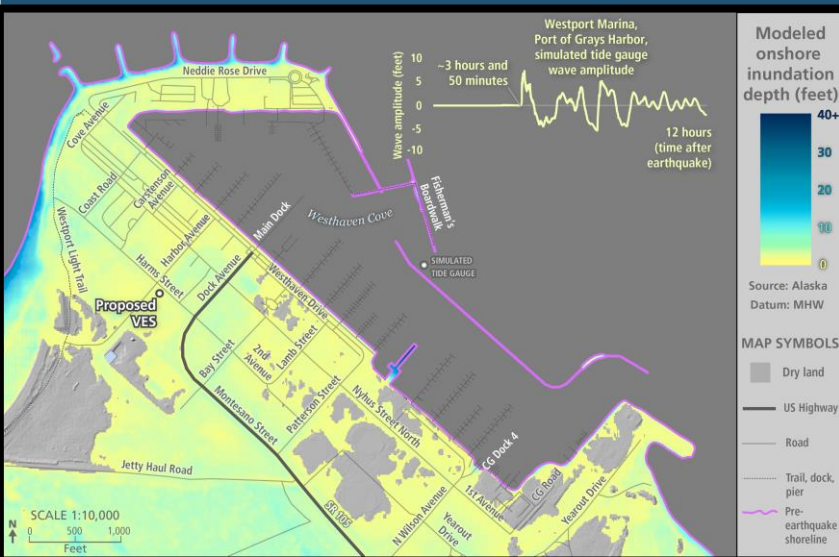
Comprehensive – Includes sections on tsunami maritime risk, tsunami alerts, protective action guidance for boaters, and recommended tsunami maritime response and mitigation actions

Multi-hazard approach – Emphasis on other coastal hazard tie-ins (sea level rise, storm surge, king tides, etc), especially for funding purposes



Tsunami Maritime Response and Mitigation Strategies

- Include higher resolution modeling for highest-risk tsunami scenarios
 - Site-specific maps of local waterways (inundation, current velocity, drawdown)
 - Graphs with estimated wave arrival times, timing of largest waves and largest drawdown
 - Current velocity and modeled water depth over time





Thank you!



Institute for
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Resilient and Safe Communities

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Check us out!

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