Supplementary Information A: List of Project Partners

Below is a list of the Project Partners of the of the North Olympic Peninsula Resource Conservation and Development Council's project: *Planning for Climate Change on the North Olympic Peninsula*

Any local stakeholder that became engaged in the processes of this project, whether in participatory workshops or through other outreach efforts became **Project Partners,** who were invited to participate in all workshops, and who helped review and revise project materials prior to public distribution. For more information on this project's Collaborative Process see Section I.D. of the *Climate Change Preparedness Plan for the North Olympic Peninsula*.

Project Partners of the *Planning for Climate Change on the North Olympic Peninsula* project

Name	Organization		Name	Organization
Don Zimmerman	Naval Magazine Indian Island		Ross Goodwin	WA State DNR
Kevin Scott	Port Townsend Paper Mill		Tom Sandford	North Olympic Land Trust
Cindy Jayne	Local 2020 Climate Action Group		Jennifer Holderman	WA Dept of Ecology
Barney Burke	Commissioner, Jefferson County Public Utility District		Joe Holtrop	Clallam Conservation Districts
Bill Graham	Staff Rep, Jefferson County Public Utility District		Rebecca Benjamin	Exec Dir, North Olympic Salmon Coalition
Sissi Bruch	Lower Elwha Klallam Tribe		Coleman Byrnes	North Olympic Peninsula Lead Entity
Laura Tucker	Public Health - Jefferson County		Bill Baccus	Olympic National Park
Ashley Watkins	Jefferson County		Aaron Parker	Makah tribe
Bob Vreeland	Olympic Climate Action Group		Amanda Cronin	Washington Water Trust
Eric Toews	Port of Port Townsend		Bob Martin	Clallam County Public Works
Laura Lewis	WSU Jefferson County		Bob Phreaner	Streamkeepers
Clea Rome	WSU Clallam County		Cindy Kelly	Dry Creek Water Association
Scott Brewer	Hood Canal Coordinating Council		Dave Wilkinson	Climate Action Group
Charisse Deschenes	Planner, City of Sequim		David Garlington	City of Sequim
Ann Soule	Water Resources, City of Sequim		Geoff Hughes	Zoi Environment Network
David Sullivan	Jefferson County		George Bergner	Port Angles Business Association- Natural Resource Committee
Caroline Gibson	Northwest Straits		Glenn Gately	Jefferson County Conservation District
Owen Fairbank	Jefferson Land Trust		Glenn Wiggins	NOTAC (North Olympic Timber Action Committee)
Linda Herzog	Quilcene resident		Ian Jablonski	City of Port Townsend

Bill Dean	Port Ludlow resident		Jeff Marti	WA Dept of Ecology
Nikki Russel	Director of Development and Community Engagement- United Good Neighbors of Jefferson County		Jonathan Boehme	City of Port Angeles
Tami Pokorny	Jefferson County		Judy Larson	Protect the Peninsula Future
Gretchen Gaub	Puget Sound Partnership		Mike Kitz	PUD #1 of Clallam County
Josh Peters	WA Dept of Natural Resources		Richard Chambers	Port Angeles Business Association
Cathy Lear	Clallam MRC, Clallam County		Robert Sextro	Olympic Climate Action
Anna Bausher	Jefferson County, Assistant Planner - DCD		Ted Simpson	Clallam PUD
Glenn Gately	Jefferson County Conservation District		Dave Christensen	WA Dept of Ecology
Cheryl Lowe	Jefferson County MRC		Dana Eckelberger	Jefferson County Conservation District
Bob Bindschadler	Quilcene resident		Craig Fulton	PA Public Works
Kelly Stone	FEMA		Kenneth Clow	City of Port Townsend
Susan Porto	Jefferson County Public Health - Water Quantity/WRIA 17		Ross Tyler	Clallam Pub Works
Jared Keefer	Jefferson County Public Health, Env Health Director		Doug Nass	Gen Manager Clallam Co PUD
Mike Dawson	Jefferson County Public Health		Scott Chitwood	Jamestown S'Klallam Tribe- Natural Resources
Monte Reinders	Jefferson County Public Works		Doug Morrill	Manager, Fisheries Department, Lower Elwha Klallam Tribe
Kate Burke	Jefferson Health Care		Chris Byrnes	WA Department of Fish and Wildlife
Doug Frick	City of Port Townsend Planning Commission		Cheryl Baumann	North Olympic Lead Entity for Salmon
Nan Evans	City of Port Townsend Planning Commission		Ed Chadd	Streamkeepers
Viki Sonntag	QUUF Social Justice Committee		Bob Lynette	Olympic Climate Action
Rick Doherty	Local Food Interests		Cindy Kelly	Dry creek water
Connie Beauvais	Clallam Co Planning Commission		Dave Lasorsa	Clallam County Public Works
Carol Johnson	Executive Director of the North Olympic Timber Action Committee		George Kovich	WSDOT Olympic Region
Shawn Hines	Dungeness River Management Team		Haley Harguth	Hood Canal Coordinating Council
Jill Silver	Ten Thousand Years Institute		Jamye Wisecup	Clallam Co Emergency Management
Lorrie Mittmann	North Olympic Land Trust		Jane Hielman	Clallam Co Planning Commission
Chris Hugo	Director of Community Development, Sequim		Jeff Stewart	WA Dept of Ecology

Julie Black	Olympic Memorial Hospital, OMC Security/Safety Manager		Jesse Waknitz	Port of Port Angeles
Leanne Jenkins	Jamestown S'Klallam Tribe		Jon Fager	Port Angeles Business Association
Ruth Jenkins	North Olympic Land Trust		Leonard Denney, Jr. "Bud"	Makah Tribe
Steve Gray	Clallam County Planning Dept		Ray Cakir	WA State Dept of Natural Resources
Steven Humphrey	Sequim-Dungeness Valley Chamber of Commerce		Ken O'Hollaren	Port of Port Angeles
Mary Ellen Winborn	Clallam County -land use planner		Dick Stockment	Local 2020 Climate Adaptation
Nathan West	City of PA CED & Planning		Erik Pytlak	BPA Supervisory meteorologist
Sue Roberds	City of PA CED & Planning		Phil Lusk	PA City Light
Melissa Williams	Executive Director, Feiro Marine Life Center		Jim Parker	Jefferson County PUD GM
Tom Locke	Clallam County Director of Health		Kevin Dayton	Regional Transportation Planning Organization (RTOP)
Jessica Halofsky	Previously, US Forest service		Debbie Clemend	WSDOT
Charlie Comstock	PA Chamber of commerce		Lola Flores	Earth Economics
Corey Delikat	PA Director of Parks & Recreation		Bob Hamlin	Jefferson County Emergency Prep
Dave Robison	Fort Worden director of PDA		Penny Linterman	Clallam County Emergency Prep
Alan Cook	Icicle Seafoods		Carol Lee Roalkva	WSDOT Environmental Policy
Benoit Eudeline	Taylor Shellfish		Paul Perlwitz	Nippon Paper Mill
Darlene Schanfald	Olympic Environmental Council and Sierra Club		Richard Newman	PA Olympic Memorial Hospital, Head of HR
Dave Fuller	Port Gamble Sklallam Tribe		Ken Horvath	Jefferson County Hazard Mitigation Plan Update writer
Elton Homan	Olympic Climate Action		Paul Loubere	Climatologist
Eric Kingfisher	Jefferson Land Trust		Brian Grad	Olympic Climate Action
Jerry Clarke	Jefferson County Conservation District		Jamie Michel	Coastal Watershed Institute
Jessie McGrath	WA Department of Ecology		Mary Hunt	Local 2020 Climate Adaptation
Jim Gift	Olympic Peninsula Audubon Society		Nam Siu	Marine Surveys & Assessments
Ken Wiersema	Olympic Peninsula Audubon Society		Bernard W. Mills	US Coast Guard, AIRSTA?SFO Port Angeles
Kevin Clark	Climate adaptation committee of L2020		Morgan Goodrich	Port of Neah Bay
Michele Canale	North Olympic Land Trust		Bob Simmons	WSU Water Quality

Michelle McConnell	WA Department of Ecology		Andy Brastad	Clallam County Environmental Health
Paul McCollum	Port Gamble S'Klallam Tribe		Carol Creasey	Clallam County Env. Health
Randall McCoy	Lower Elwha SKlallam Tribe		Anne Shaffer	Coastal Watershed Institute
Richard Jahnke	L2020 Climate Adaptation		Bill Parkins	Neah Bay-Harbormaster
Janet Welch	Port Townsend Co-op board president		Zoe Ann Lamp	Jefferson County Public Works Transportation
Lara Gaasland	Jefferson County Intern		Katie Krueger	Quileute Natural Resources
Kia Armstrong	Nash's organic produce		Dana Ecelberger	Jefferson Conservation District
Patty McManus	Nash's Organic Produce		Lauren Turner	
Maureen Goff	Sound Science		Katherine Baril	Baril networks
Josha Crowley	STARR/ FEMA Contractor		Jeff Taylor	Citizen Action Training
Emily Whitehead	STARR/FEMA Contractor		Lance Bailey	City of Port Townsend
Jonathan Reanndeau	WSU Extension		Laura Dubois	City of Sequim
Bill Peach	Clallam County Commissioner		Donald Hatler	Clallam Conservation District
Jack Gillubert	Port Angeles property owner		Helle Andersen	Feiro Marine Life Center
Stephanie Noblin	Smart Awareness		Ashley Watkins	Jefferson County

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North Olympic Peninsula Resource Conservation & Development

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Department of Commerce

Innovation is in our nature.

Preparing for Climate Change on the North Olympic Peninsula

[speaker]

AGENDA

- Project Overview
- Brief Summary of Climate Change Projections for the North Olympic Peninsula
- Participatory Process & Vulnerability Assessment
- Priority Adaptation Strategies for each of the three focus areas:
  - Critical Infrastructure
  - Ecosystems
  - Water Supplies

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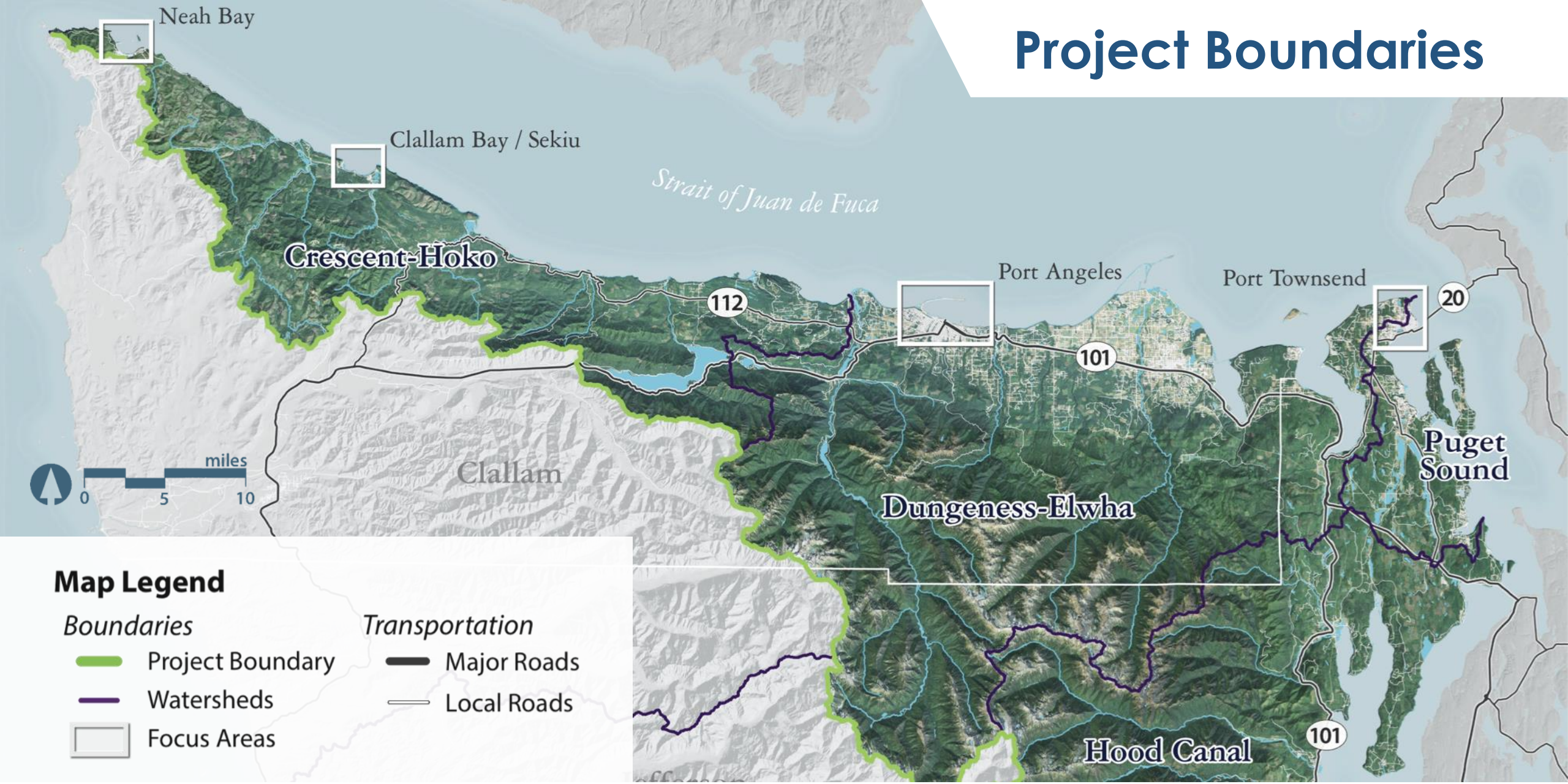
Project Boundaries



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Project Overview

- ***Create a Climate Change Preparation Plan for the North Olympic Peninsula that will inform the comprehensive and strategic planning processes of the area.***

  - Funded by Washington Department of Commerce
  - Recipient: North Olympic Development Council
  - Consultants:
    - Adaptation International
    - Washington Seagrant
  - Timeframe: June 2014 – October 2015

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Project Overview

- **Deliverables:**
  - **Climate Preparation Plan for the North Olympic Peninsula**
    - **Climate observations and projections**
    - **Key impacts**
    - **Adaptation (or Climate Change Preparedness) Strategies**
  - **A series of presentations** (such as this)
  - **Example Planning Language**
  - **Monitoring Plan**

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Project Process

Step 1:

Conduct a high level climate assessment that summarizes the observed trends and projected changes in the climate for the NOP

Step 2:

Identify Vulnerabilities and Priorities Through Workshops (Held November 2014)

Step 3:

Develop Adaptation Strategies Through Workshops (Held in April 2015)

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It is all about collaboration

It is the synthesis of the best available climate change projections and observations with local stakeholder expertise of vulnerable sectors and relevant adaptation strategies that makes this project unique.

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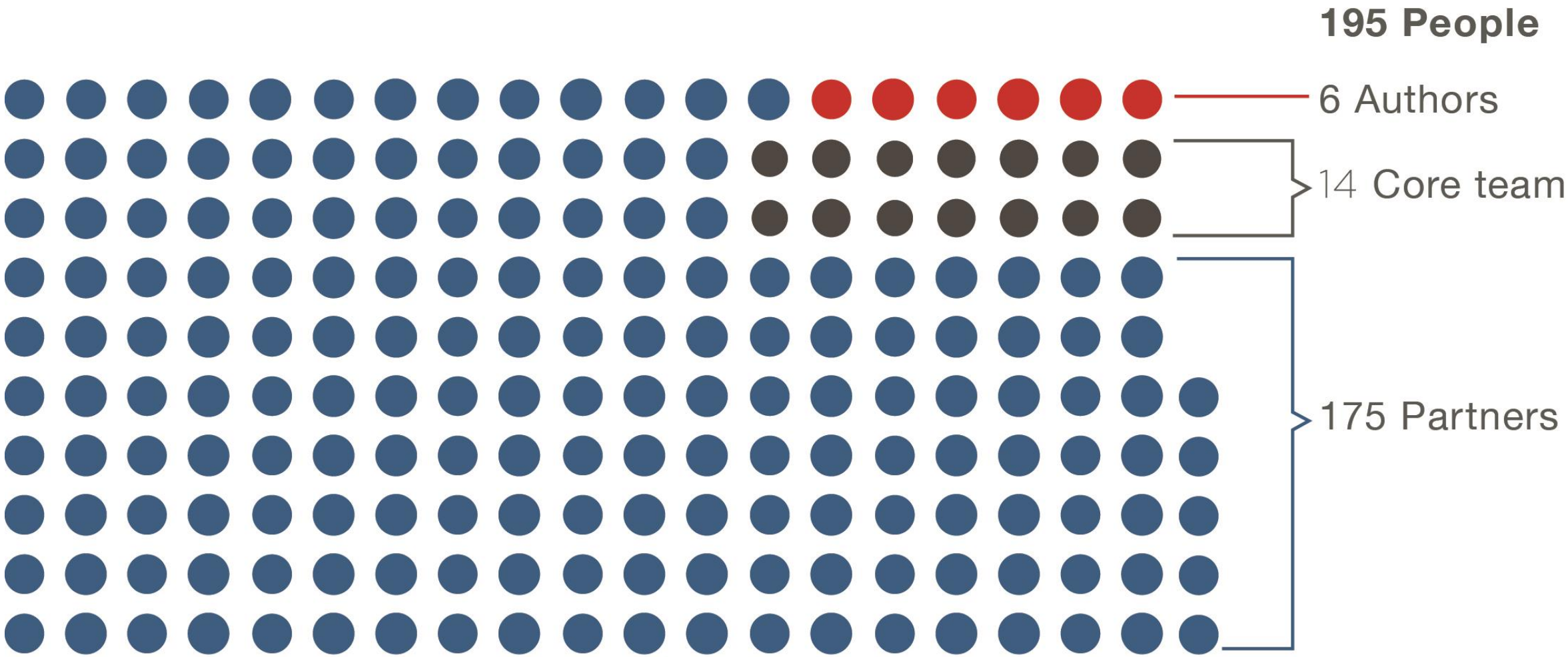
It is all about collaboration



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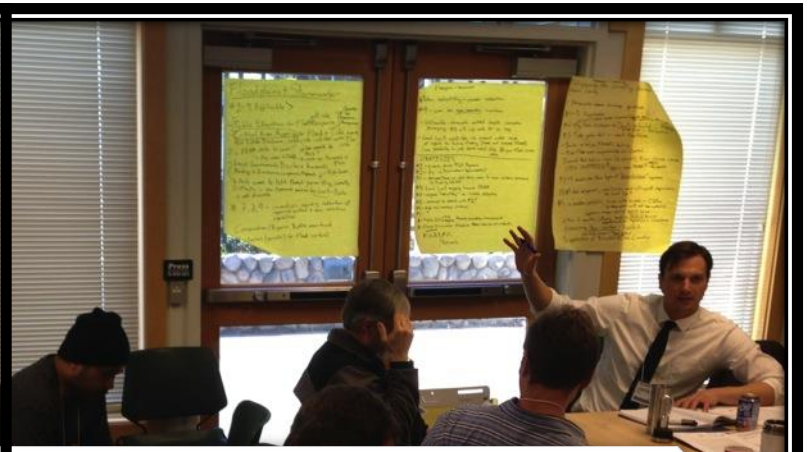

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Climate Change

Climate Change – National Climate Assessment - 2014

"Climate Change, once considered an issue for a distant future, has moved firmly into the present"

"Evidence for climate change abounds, from the top of the atmosphere to the depths of the oceans."

"Taken together, this evidence tells an unambiguous story: the planet is warming, and over the last half century, this warming has been driven primarily by human activity."

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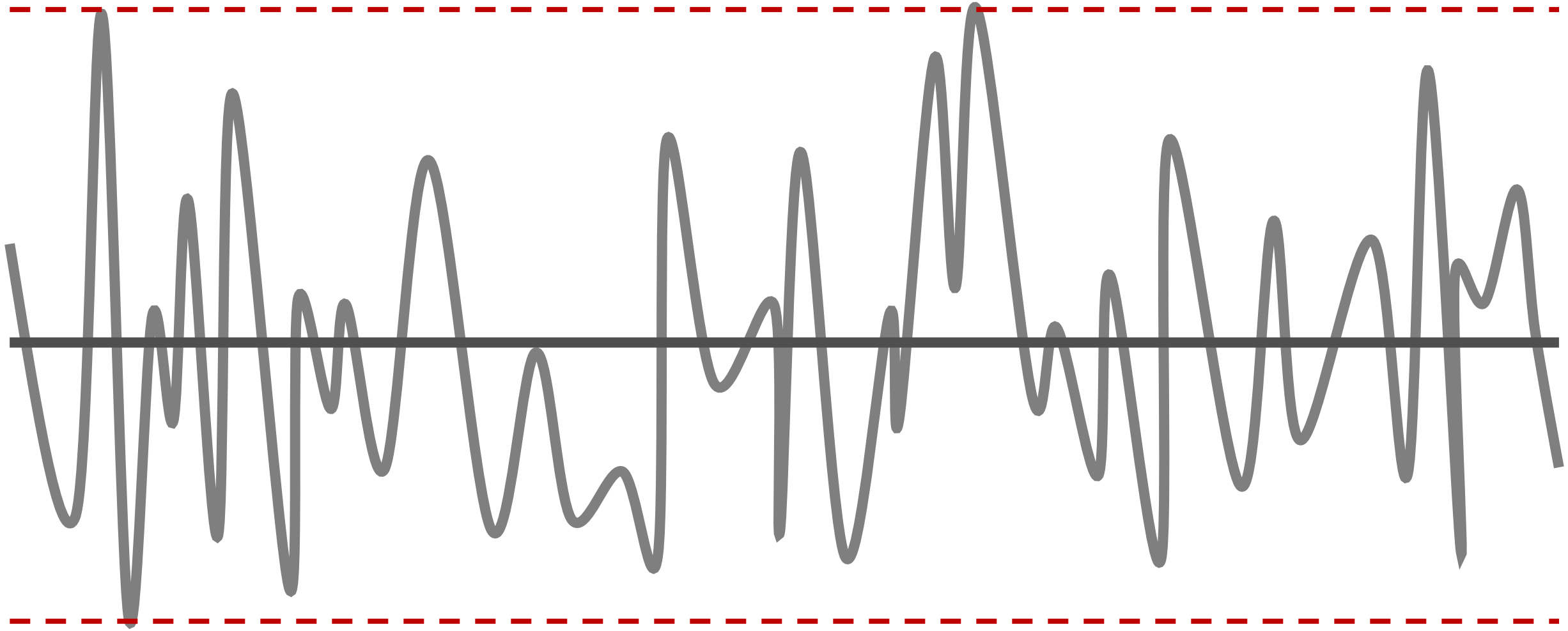
We assume that long-term climate is stable



Source: Hayhoe

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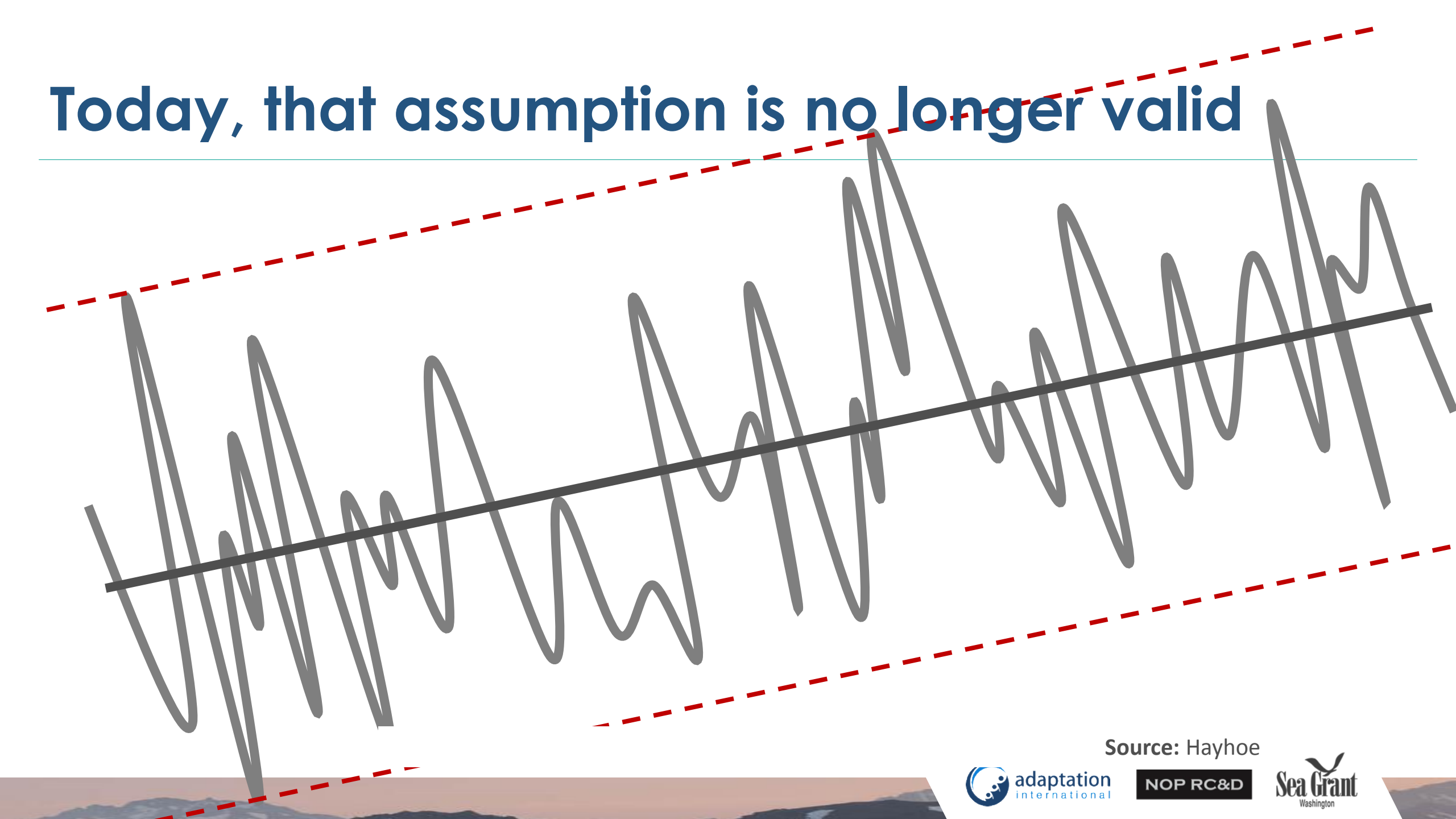
Today, that assumption is no longer valid



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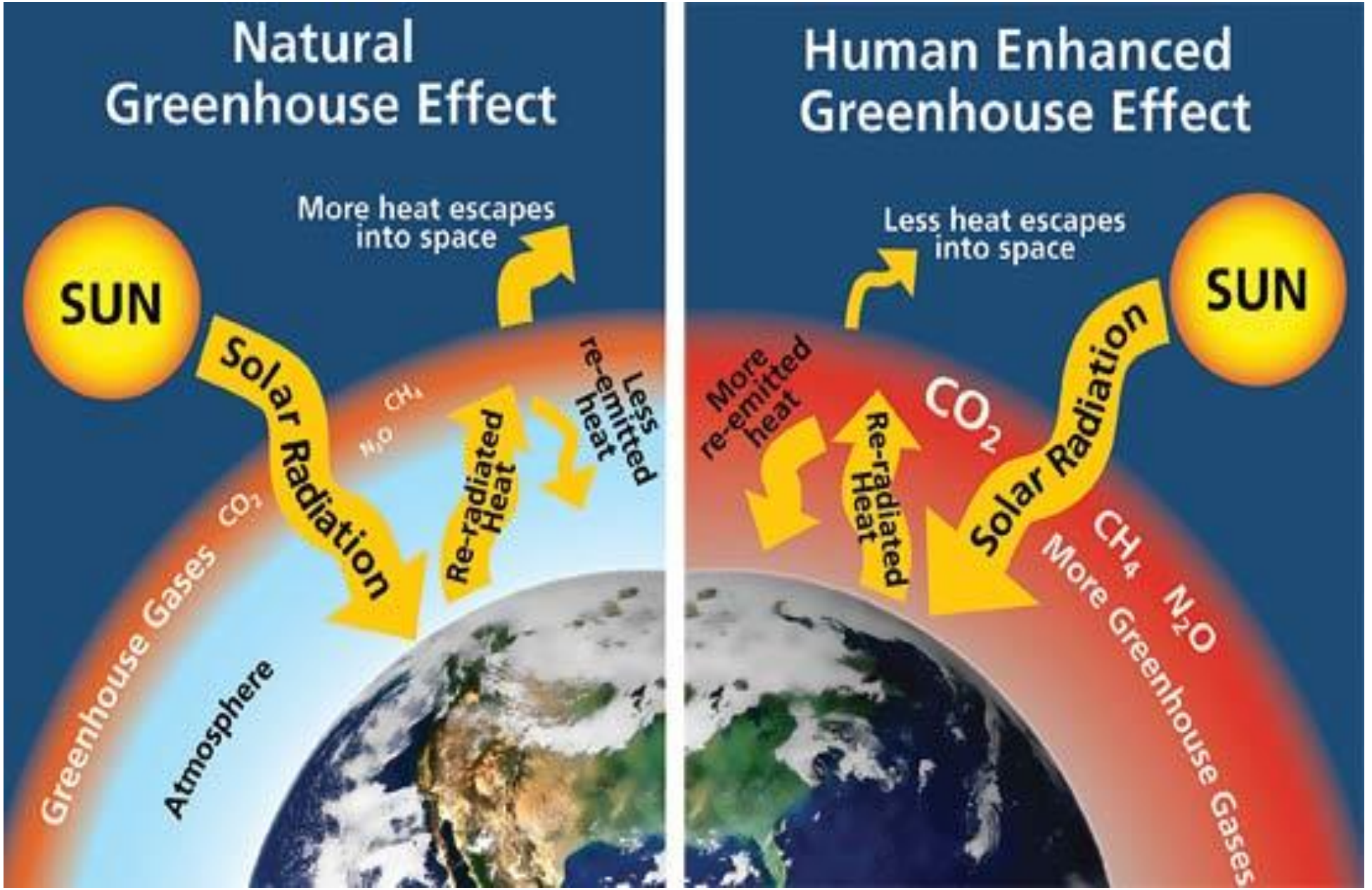

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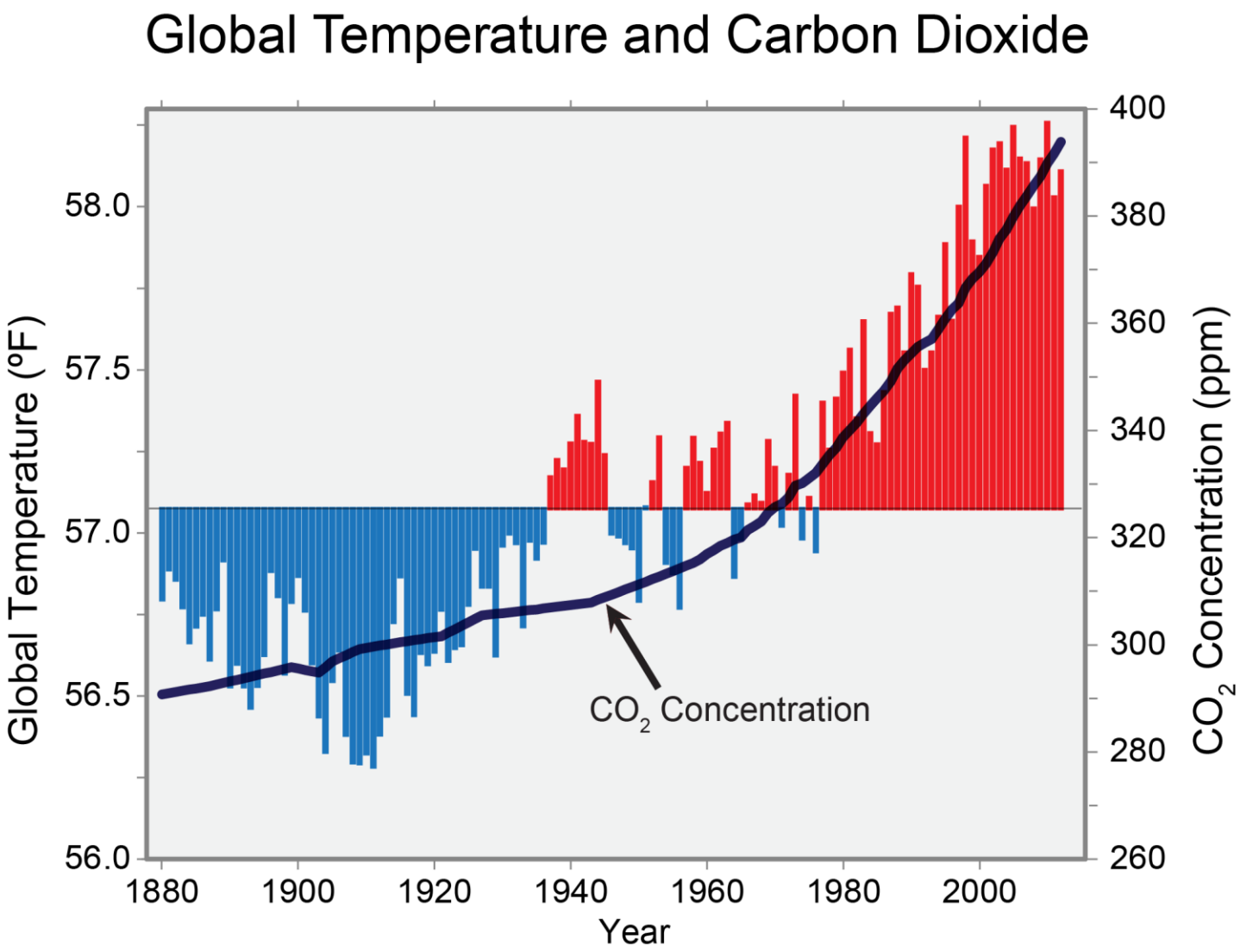
Historical Global Temperature and Carbon Dioxide



Source: U.S. National Climate Assessment 2014

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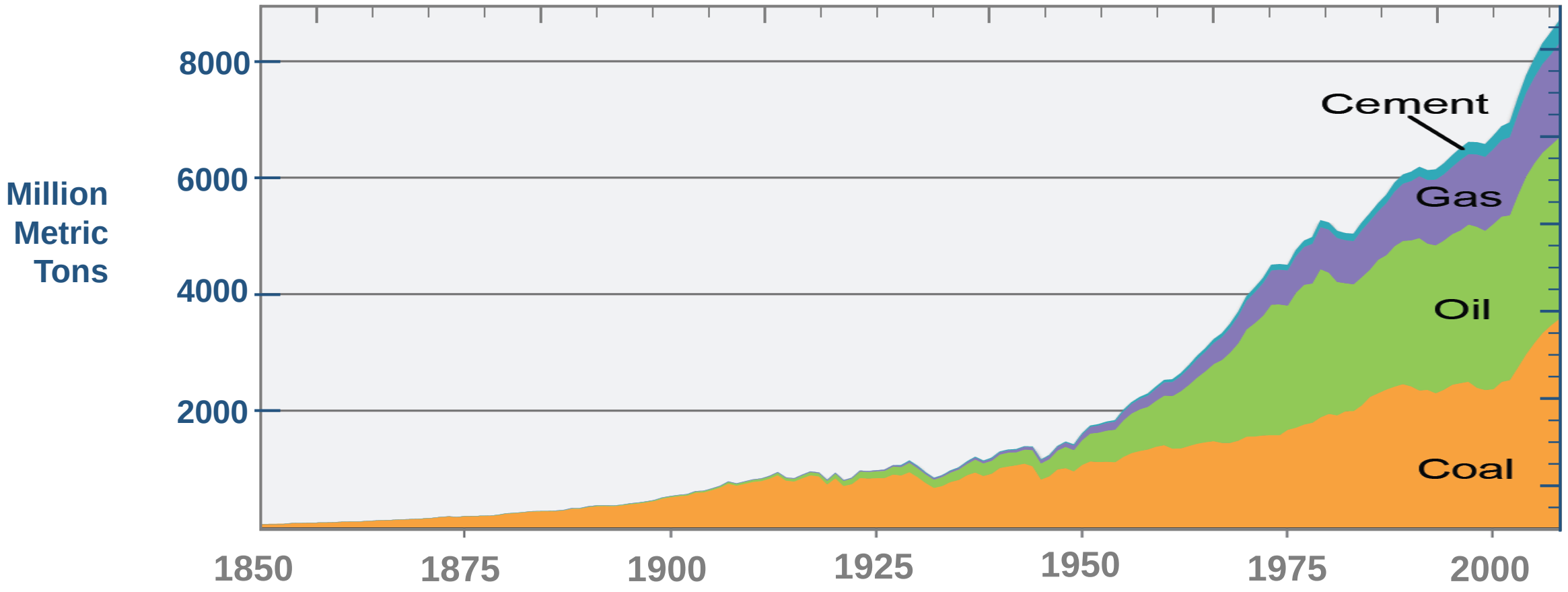
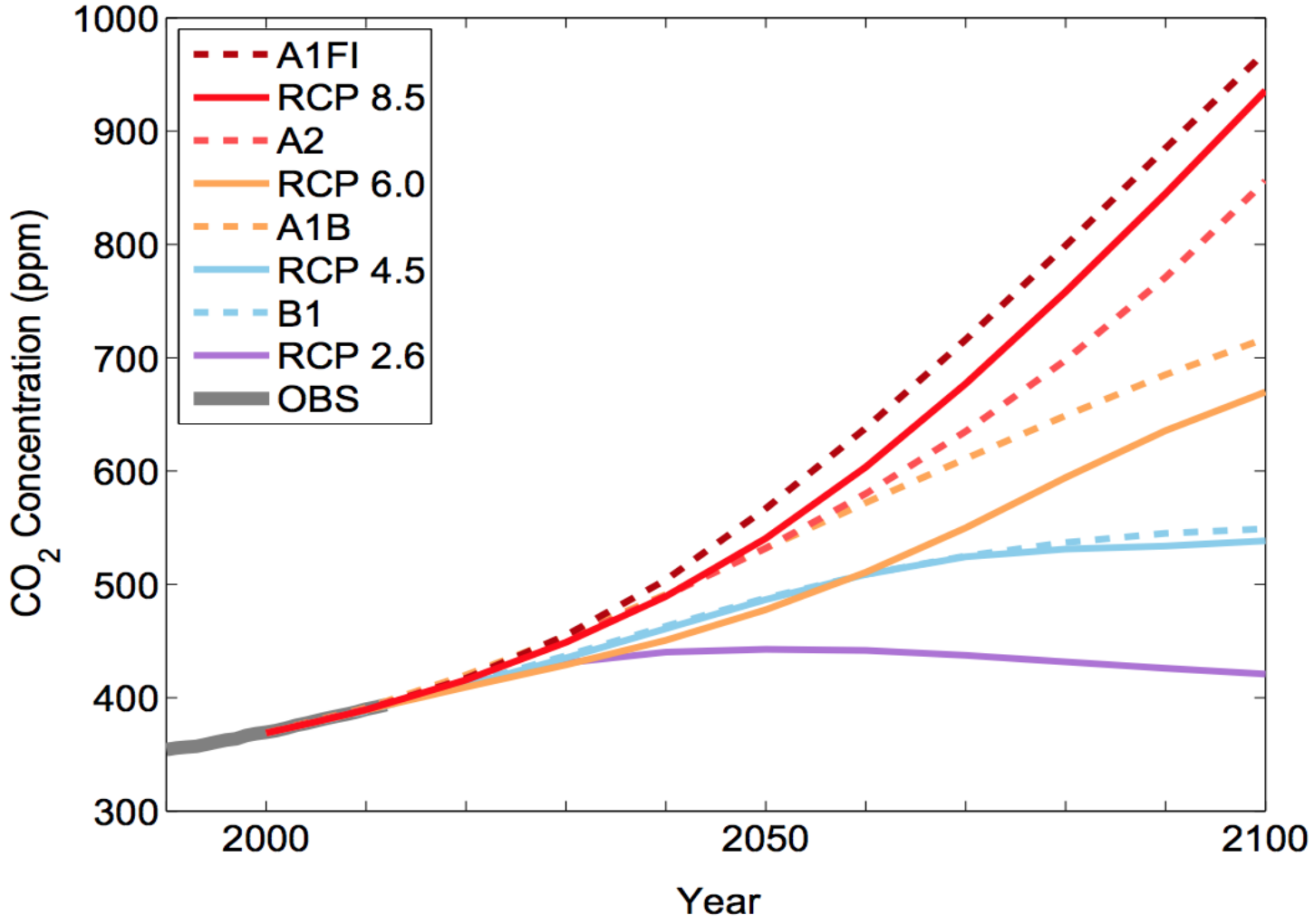
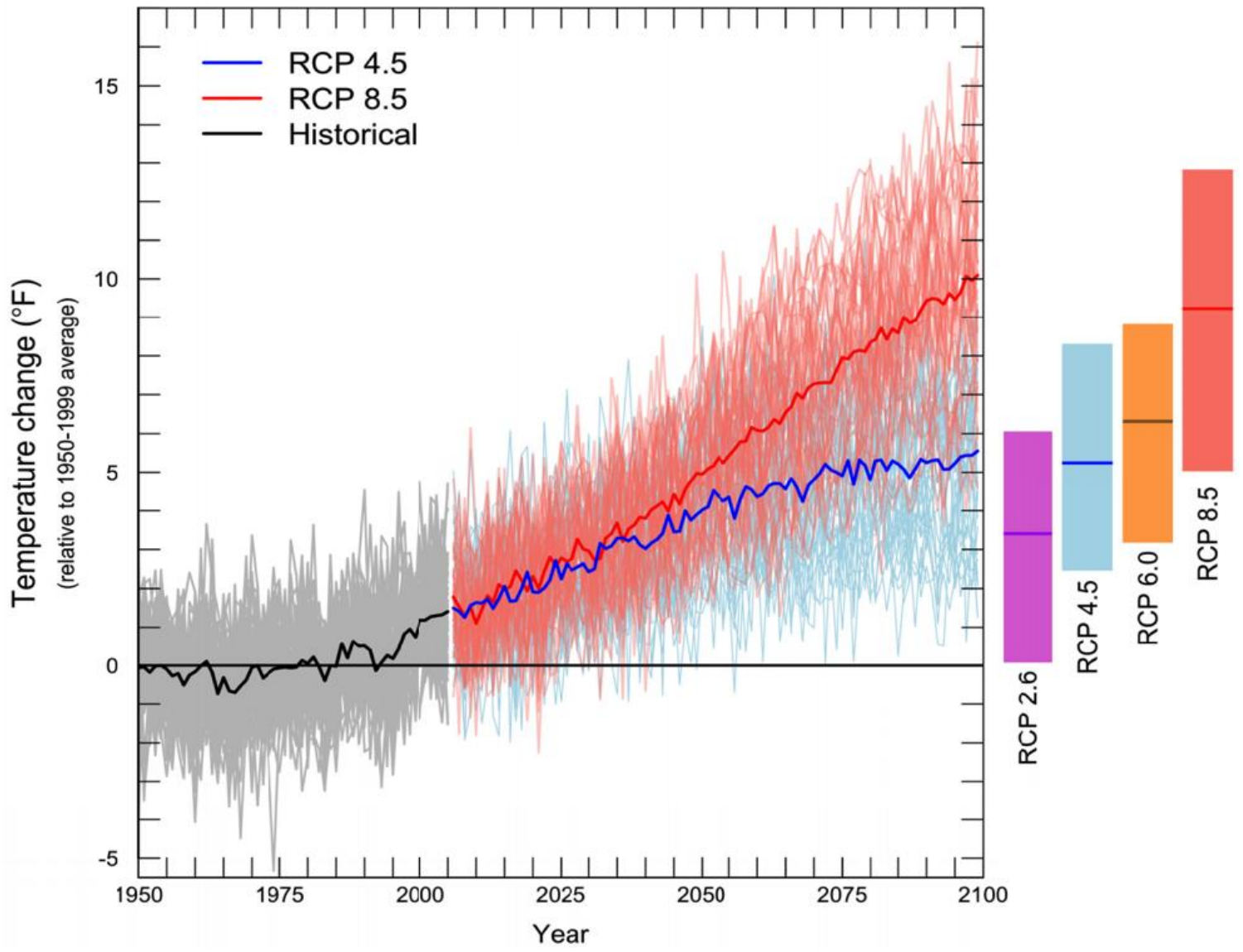
Carbon Emissions

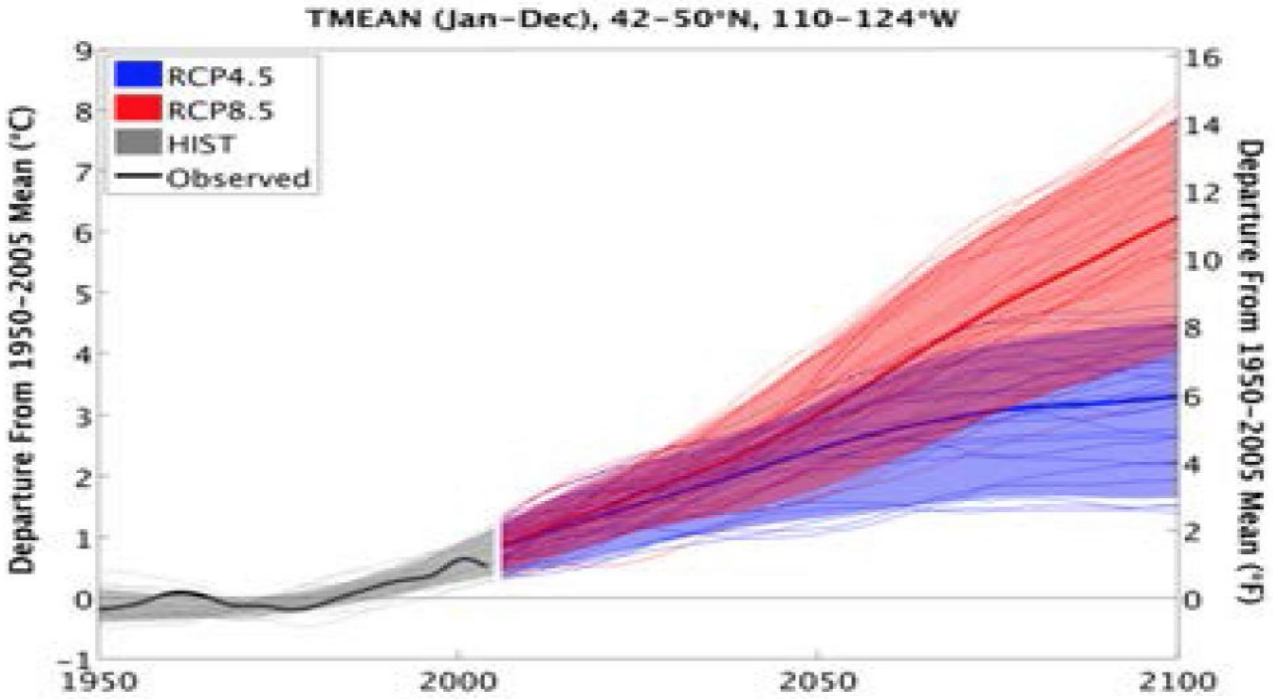


There are lots of potential futures



The future depends on our choices now



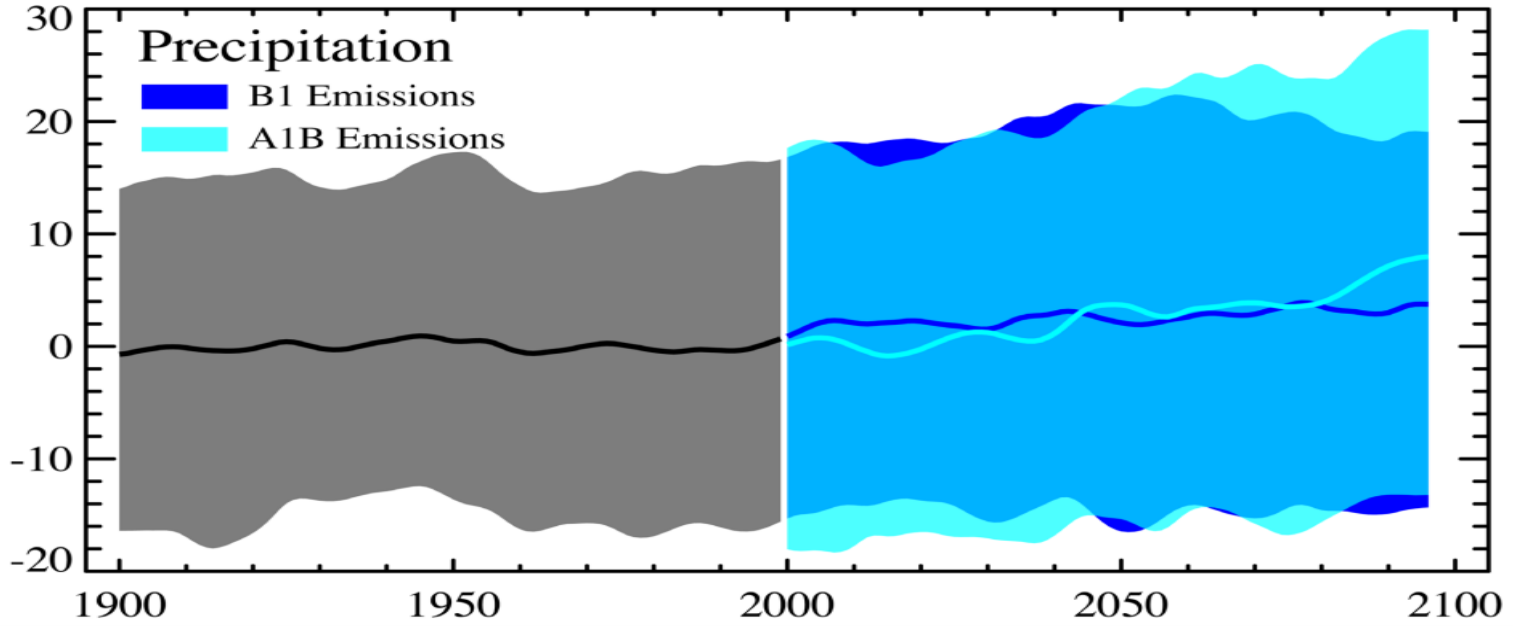


PNW Temperatures

- Warmed 1.3°F degrees over last century
- Projected 2.0°F – 8.5°F increase by 2050s
- 8 more days a year over 90°F degrees by 2050s
- 35 more freeze-free days by 2050s

PNW Precipitation

- No significant change in average annual precipitation
- Wetter Winters
- Drier Summers



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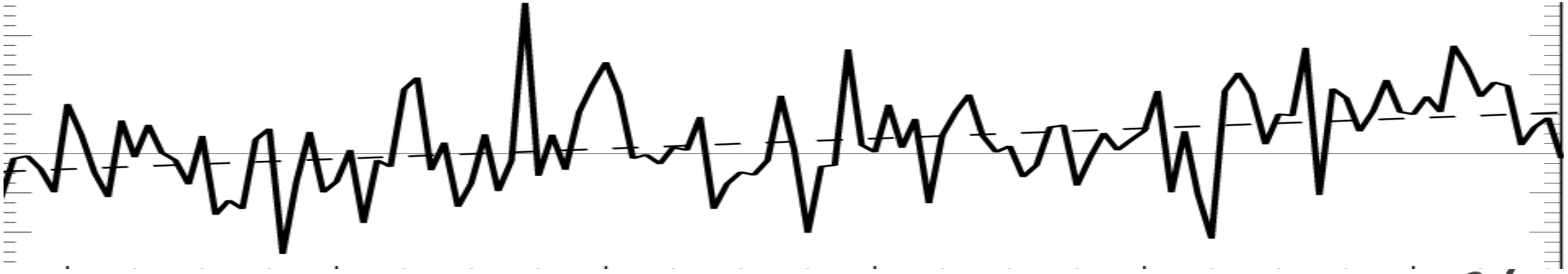
Temperatures

Regional Temperature Changes

	Observed Changes	Future Projections
Temperature Averages *(Pacific Northwest)*	Warmed 1.3°F (1895-2011)	By 2050's – between 4.3°-5.8°F average increase in all seasons.
Temperature Extremes	Increase in nighttime heat events.	Slight increase in days over 90°F (+8 days) for the Pacific Northwest (PNW), with negligible increase in days over 95°F on the Olympic Peninsula by the 2050s. Longer frost-free season (+ 35 days) across PNW by the 2050s.



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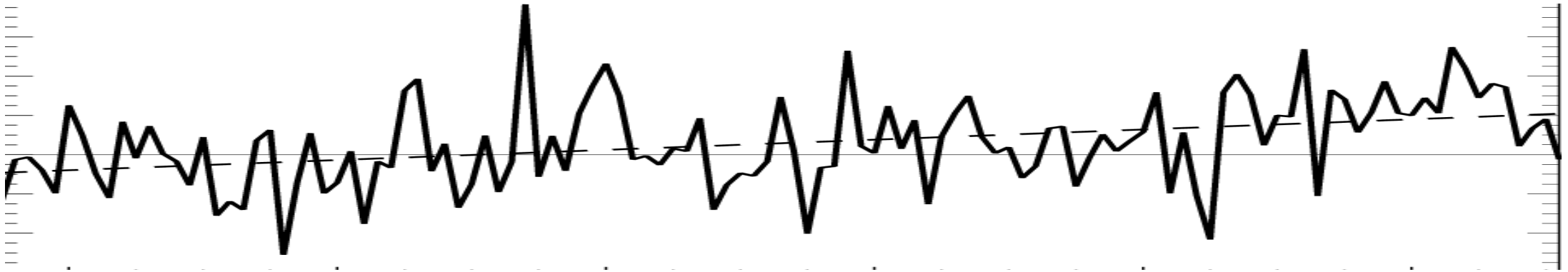
Temperature Changes in Jefferson and Clallam County

	Timeframe	Change to Average Monthly Max Temp (higher emissions)
Jefferson County	2050-2074	+8° in August, +5° in January
	2075-2099	+10° in August, +7° in January
Clallam County	2050-2074	+6° in August, +7° in January
	2075-2099	+9° in August, +9° in January



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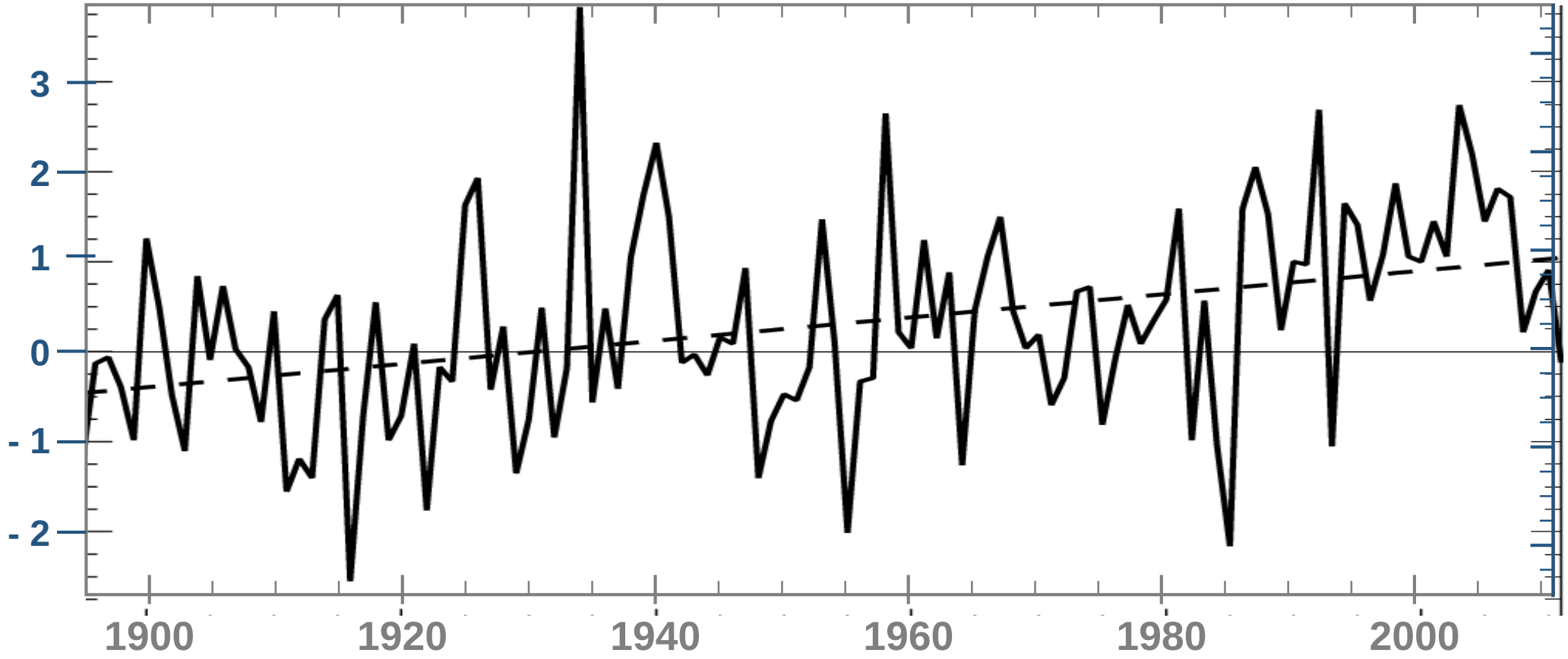
Observed Temperature

Temperature Anomaly (degrees Fahrenheit)



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Monthly Average Maximum Temperature

1950 – 2005

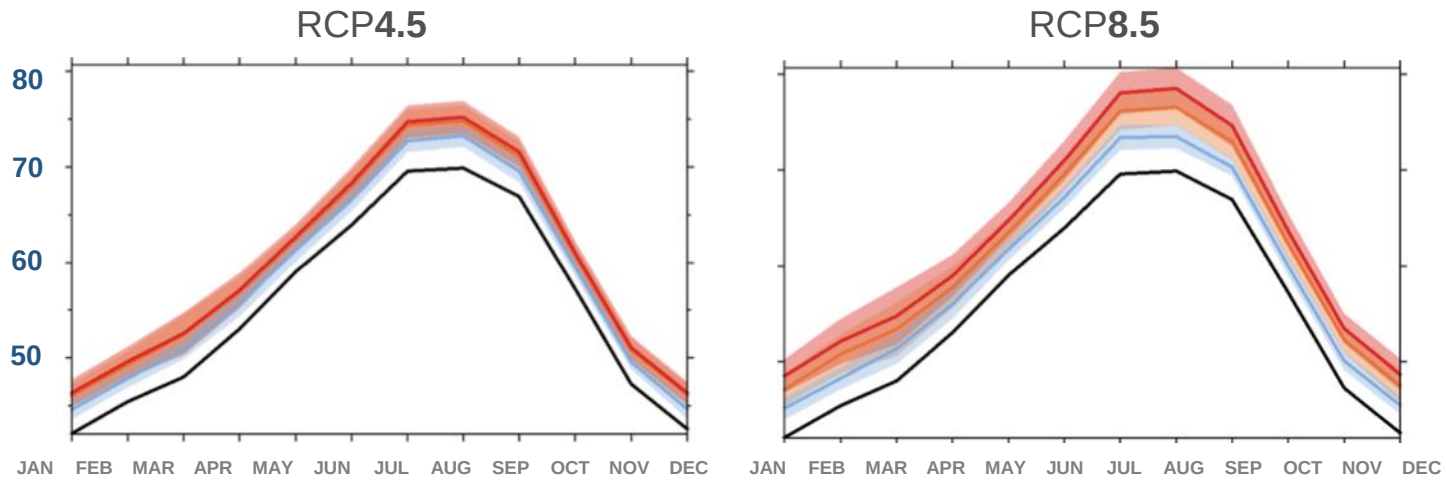
2025 – 2049

2050 – 2074

2075 – 2099

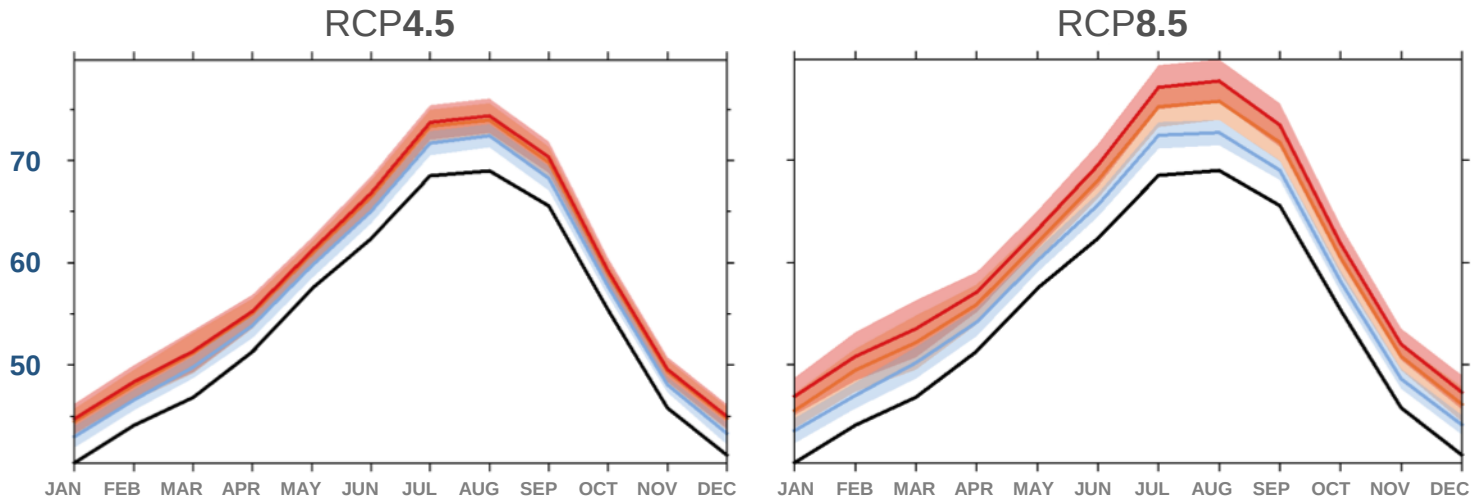
Clallam County

Monthly Avg. Max Temp (degrees Fahrenheit)



Jefferson County

Monthly Avg. Max Temp (degrees Fahrenheit)



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Monthly Average Minimum Temperature

1950 – 2005

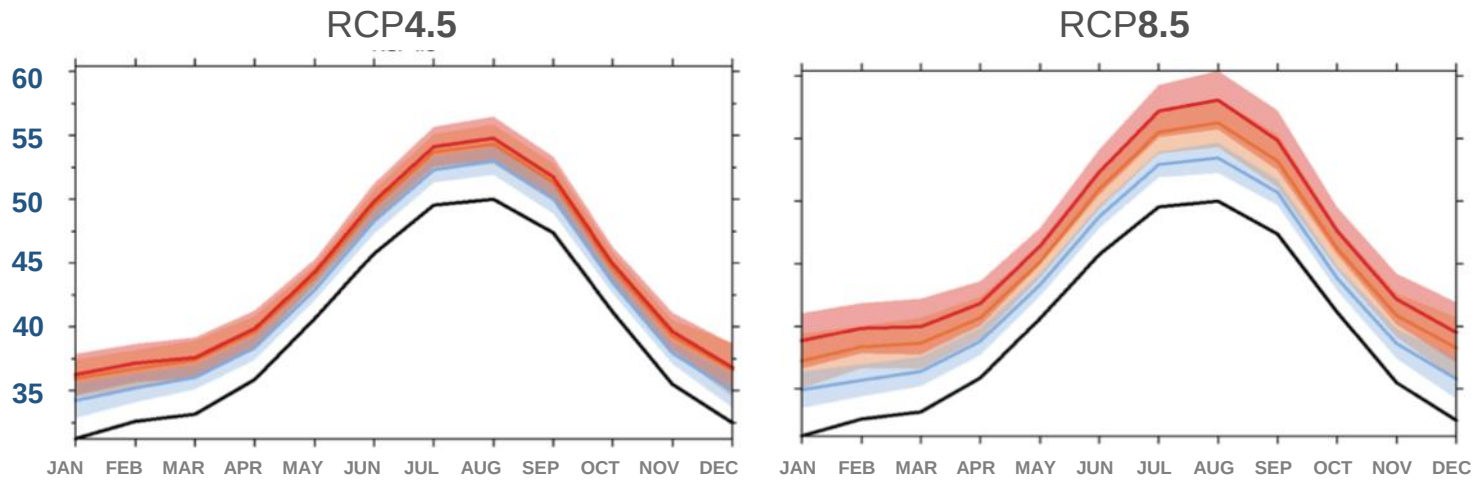
2025 – 2049

2050 – 2074

2075 – 2099

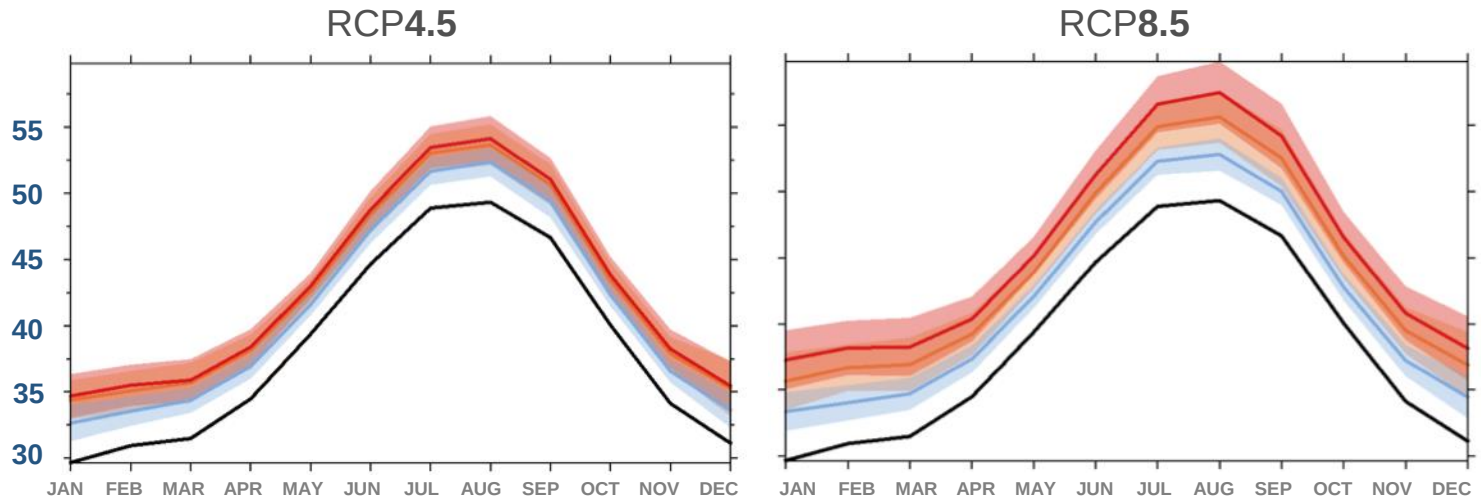
Clallam County

Monthly Avg. Minimum Temp
(degrees Fahrenheit)



Jefferson County

Monthly Avg. Minimum Temp
(degrees Fahrenheit)



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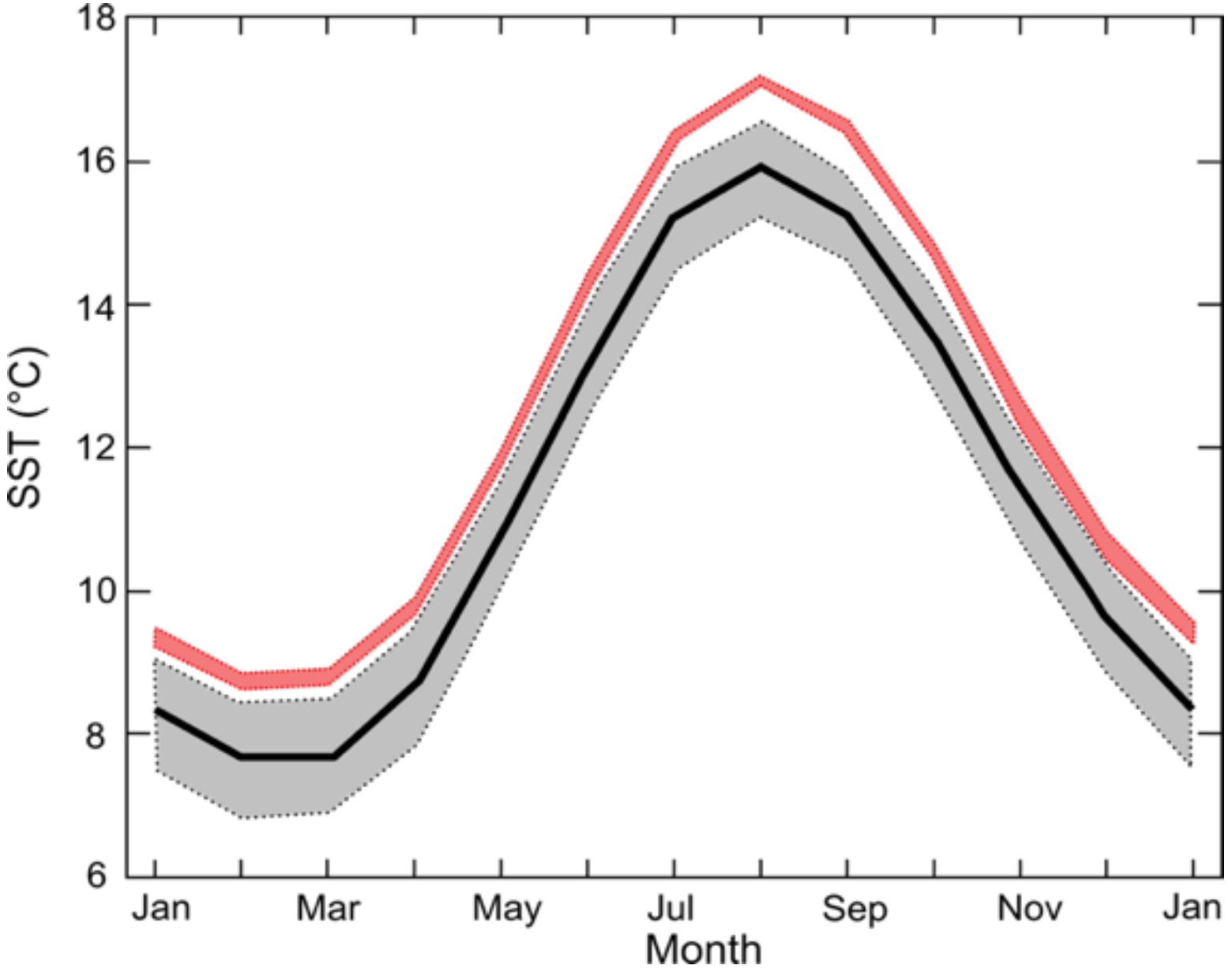
Sea Surface Temperature



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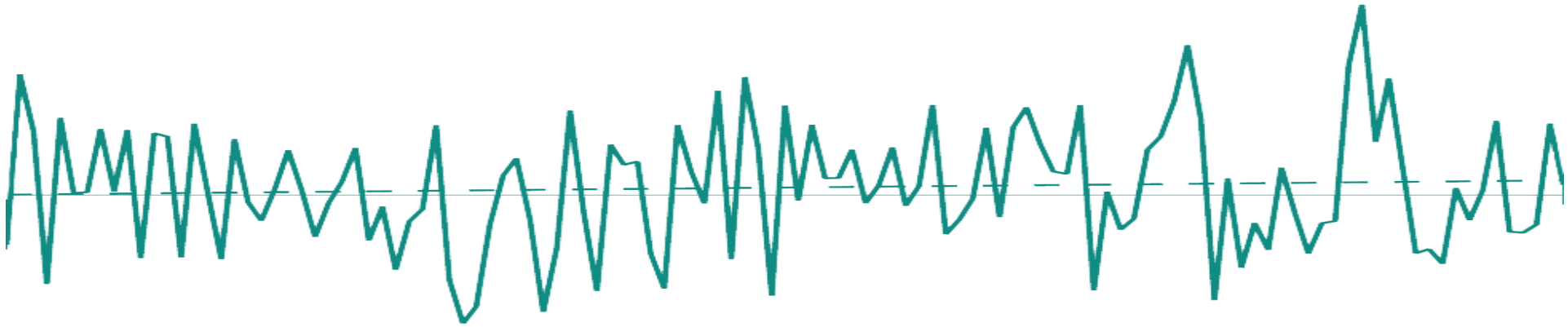
Precipitation

Regional Precipitation Change

	Observed Changes	Future Projections
Precipitation Averages *(for Pacific Northwest)*	No significant change in amount; region wide decrease in snowpack and glaciers.	Little average annual change – with drier summers (-6% to -8% average decrease) by the 2050s. Continued declining snowpack with a significant loss of snowpack in Olympics by 2080.
Precipitation Extremes	Ambiguous	More heavy rainfall events: 13% (+ 7%) increase in days with > 1 inch of rain by 2050s.



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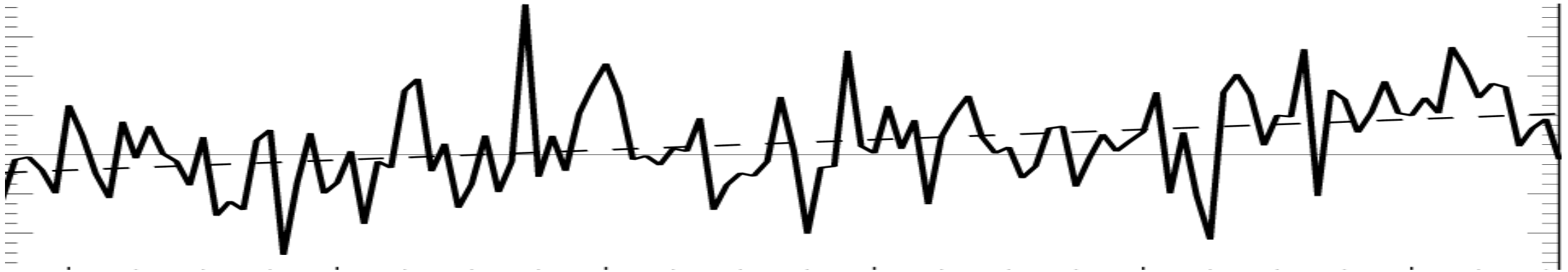
Precipitation Changes in Jefferson and Clallam County

	Timeframe	Change to Average Monthly Precipitation (higher emissions)
Jefferson County	2050-2074	-0.62 inches in August, +1.5 inches in November
	2075-2099	-0.62 inches in August, +1.8 Inches in November
Clallam County	2050-2074	-0.62 inches in August, +1.8 inches in November
	2075-2099	-0.93 inches in August, +1.8 inches in November



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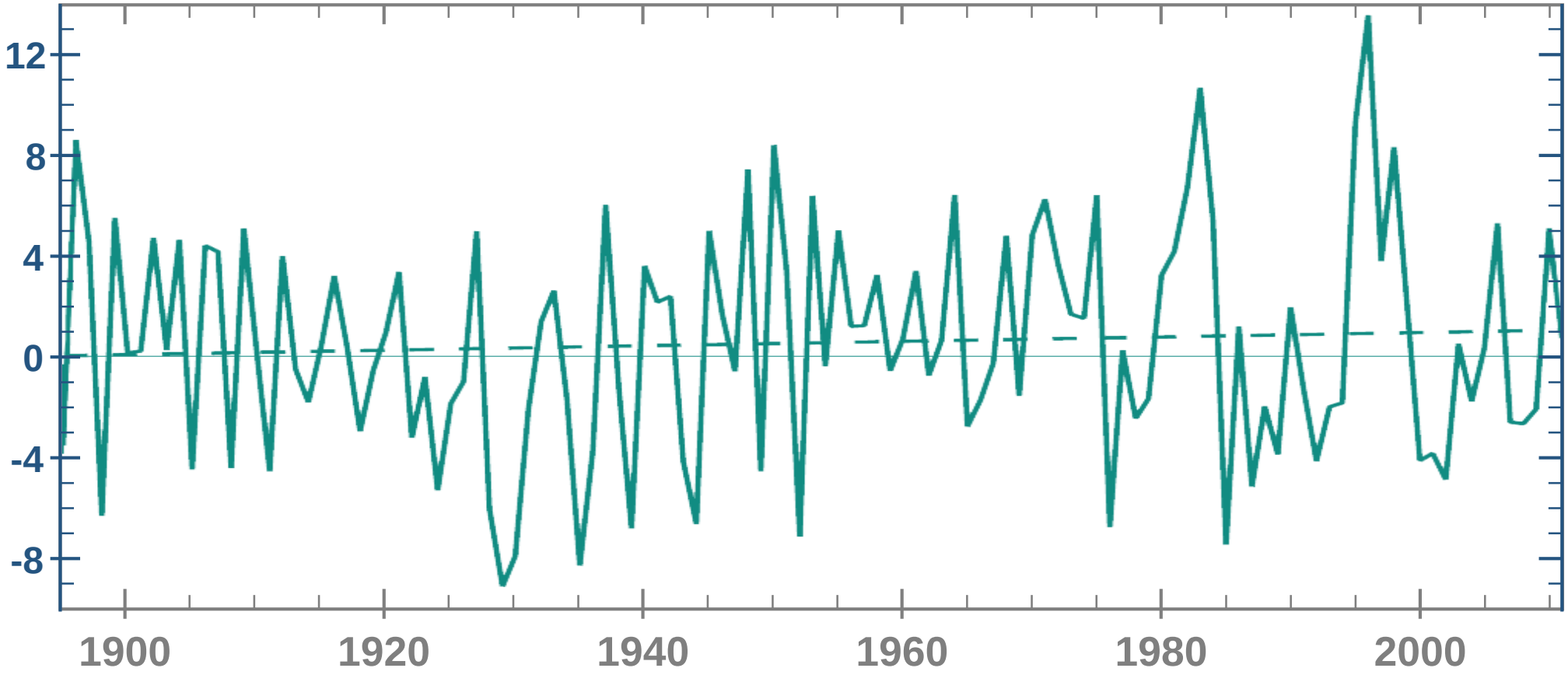
Observed Precipitation

Precipitation Anomaly (inches)



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Monthly Average Precipitation Projections

1950 – 2005

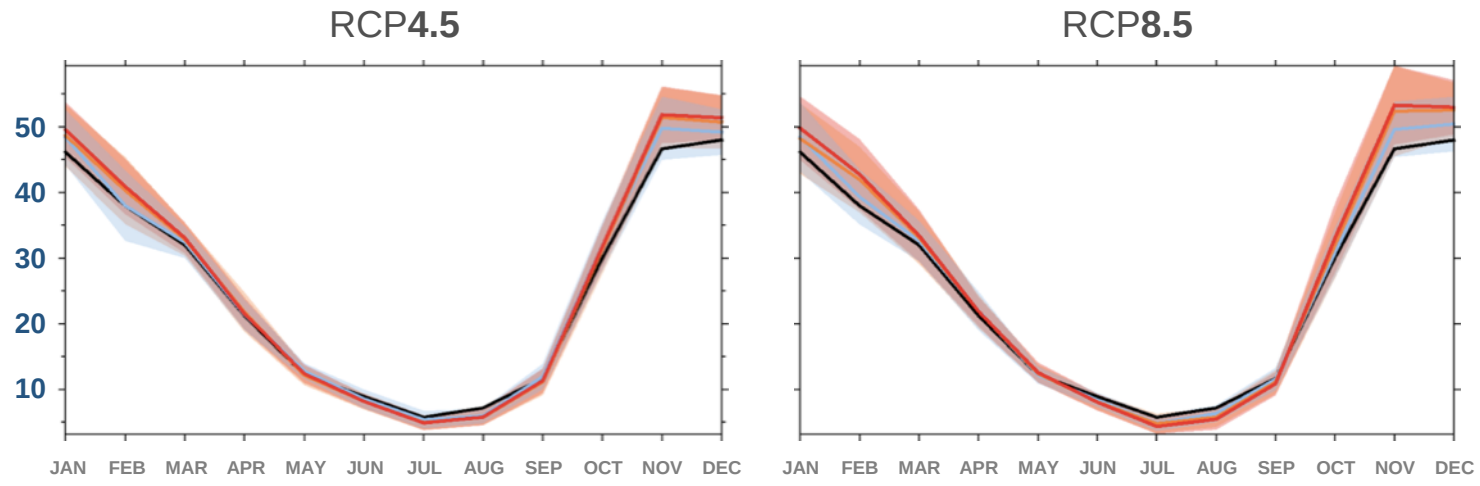
2025 – 2049

2050 – 2074

2075 – 2099

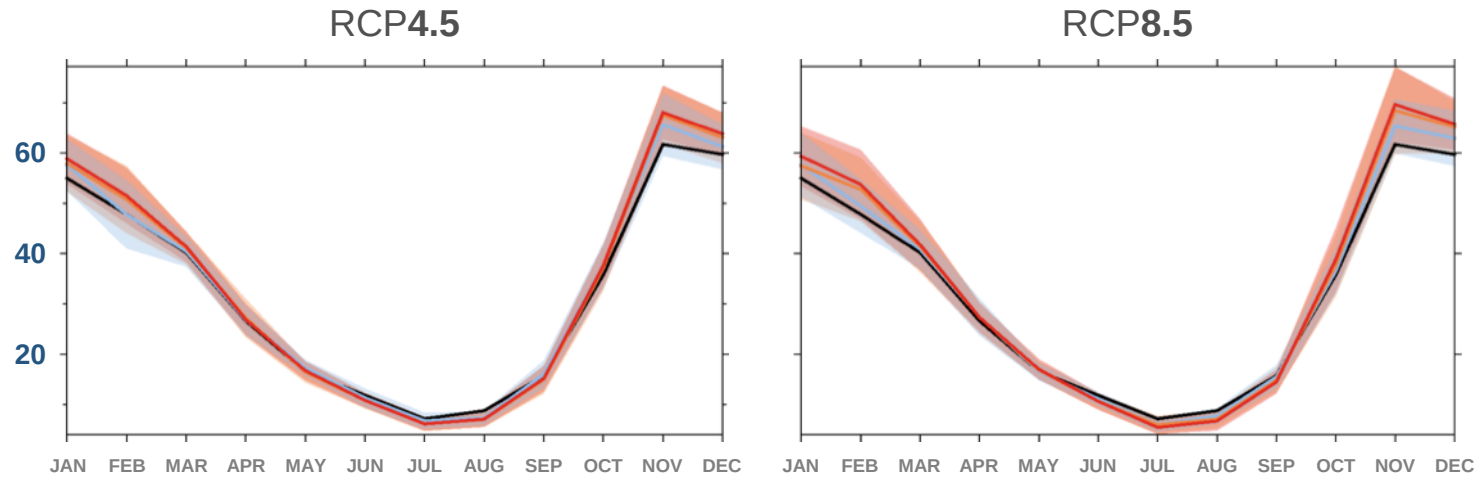
Clallam County

Precipitation
(in/day * 100)



Jefferson County

Precipitation
(in/day * 100)



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Monthly Average Runoff Projections

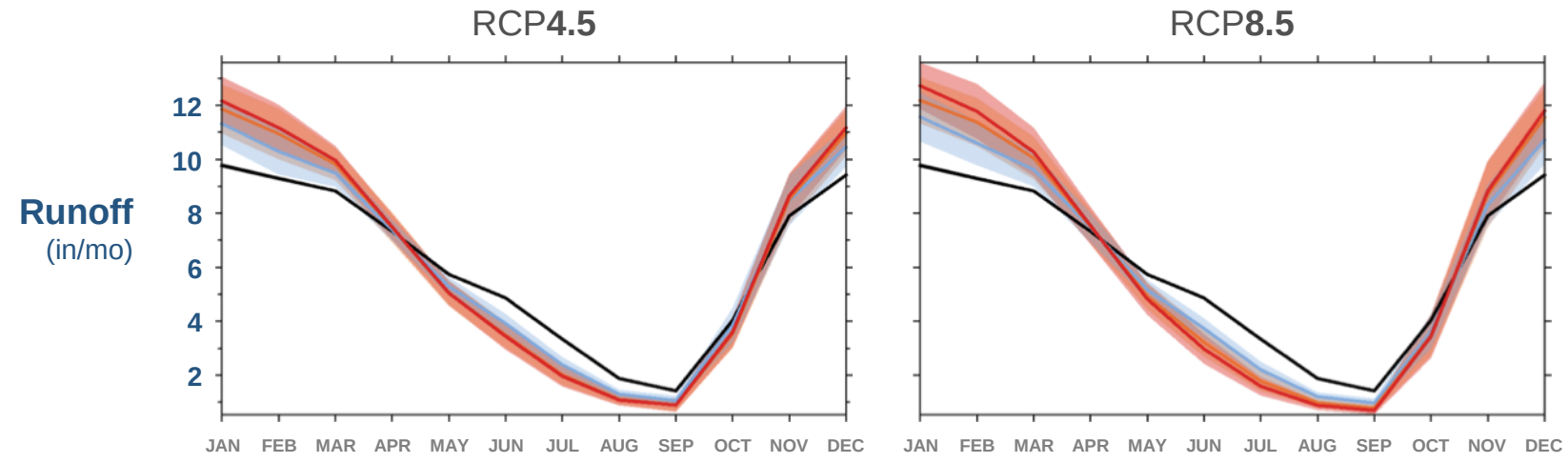
1950 – 2005

2025 – 2049

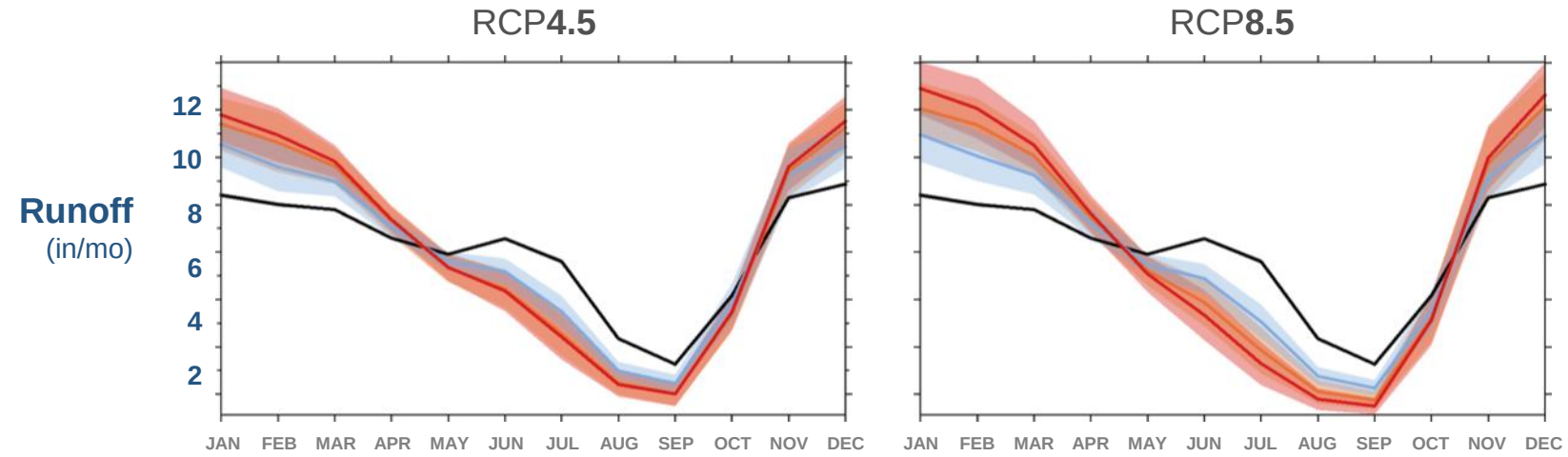
2050 – 2074

2075 – 2099

Clallam County



Jefferson County



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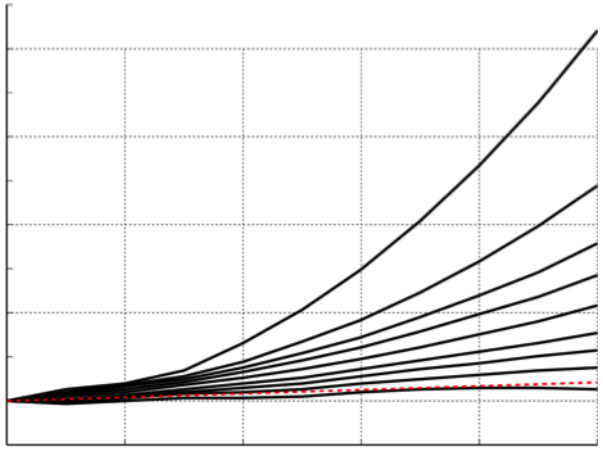
Rising Seas

Sea Level Rise

Future Sea Level Rise *(probability that mean sea level will reach or exceed ___ feet at a given year)*		
	Neah Bay	50% chance of ≥ 0.3 feet (2050) and ≥ 1.3 feet (2100) 5% chance of ≥ 0.7 feet (2050) and ≥ 2.7 feet (2100)
	Clallam Bay Sekiu	50% chance of ≥ 0.3 feet (2050) and ≥ 1.3 feet (2100) 5% chance of ≥ 0.7 feet (2050) and ≥ 2.7 feet (2100)
	Port Angeles	50% chance of ≥ 0.6 feet (2050) and ≥ 1.9 feet (2100) 5% chance of ≥ 0.9 feet (2050) and ≥ 3.3 feet (2100)
	Port Townsend	50% chance of ≥ 0.9 feet (2050) and ≥ 2.4 feet (2100) 5% chance of ≥ 1.2 feet (2050) and ≥ 3.9 feet (2100)



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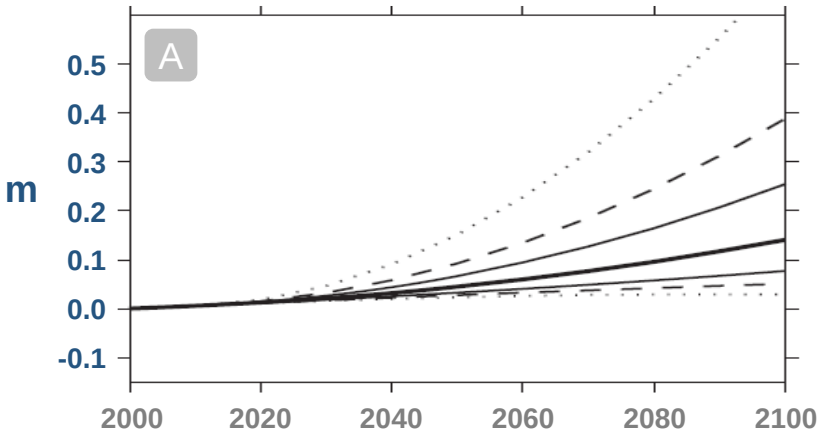
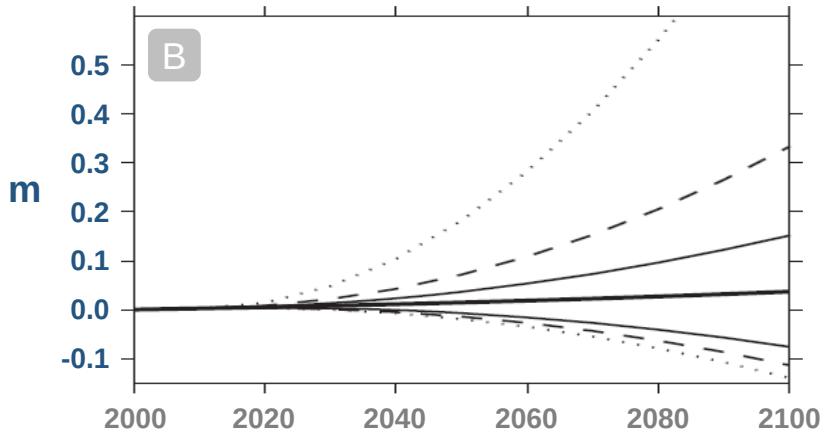
Global Probabilistic Sea Level Rise

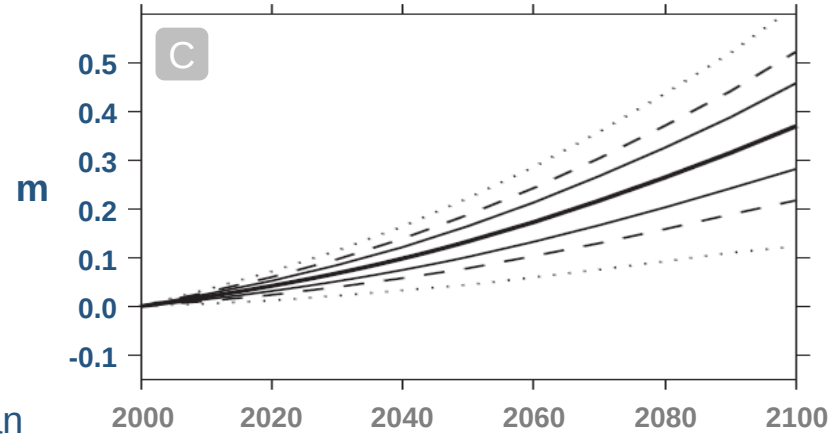
Greenland



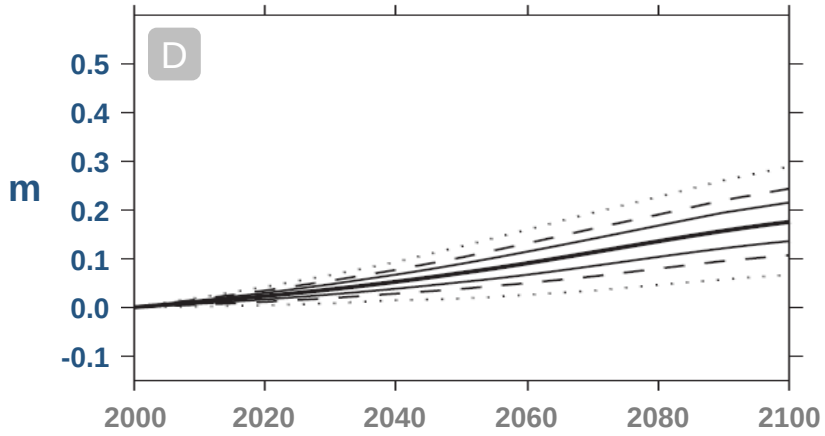
Antarctica



Thermal Expansion



Glaciers & Ice Caps



Center line = median
Dashed line = 95%
Dotted line = 99.5%

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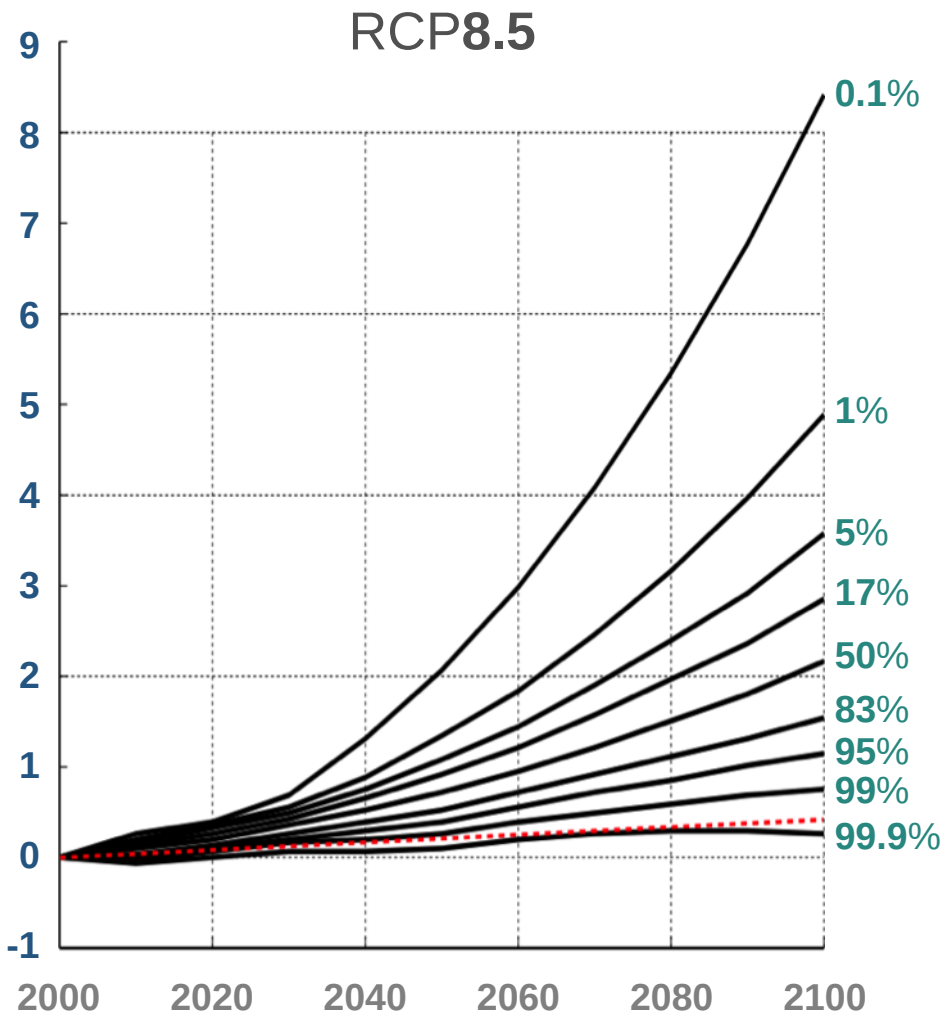
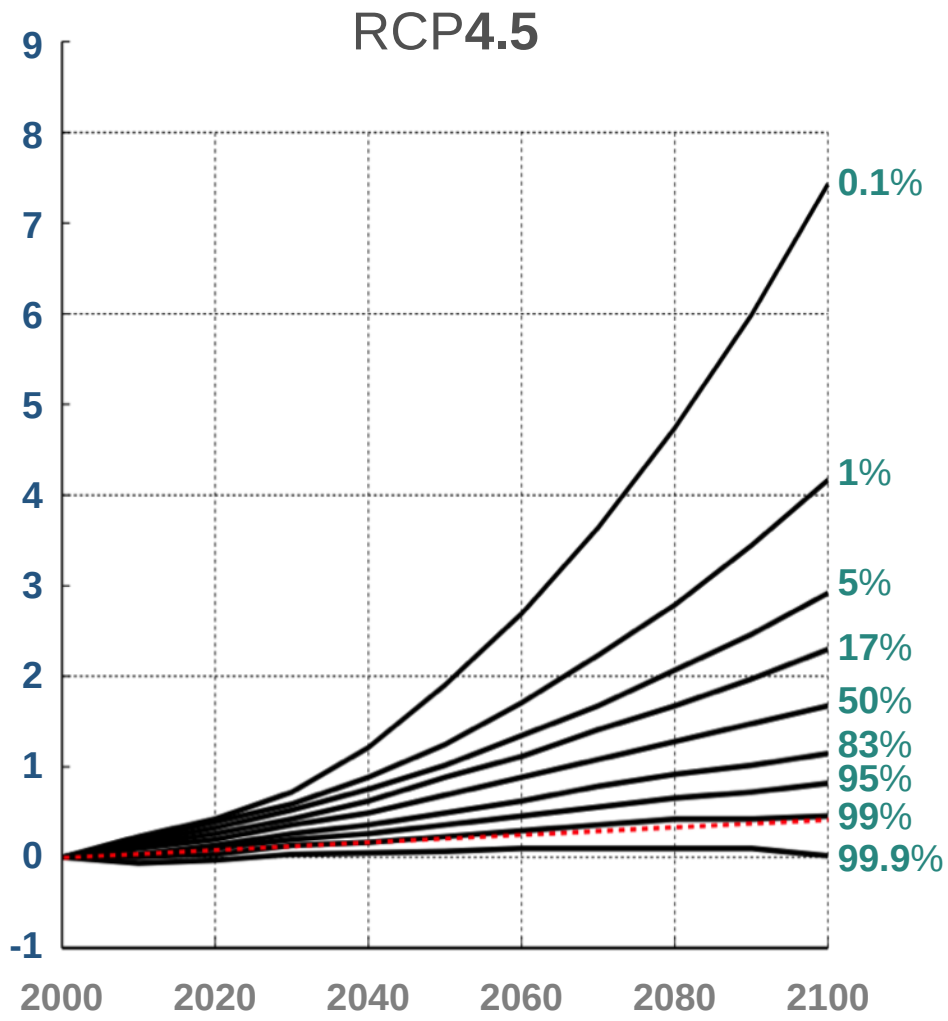
Probabilistic Sea Level Rise Projections

Feet Relative to Contemporary High Water Level
(Mean Higher High Water)





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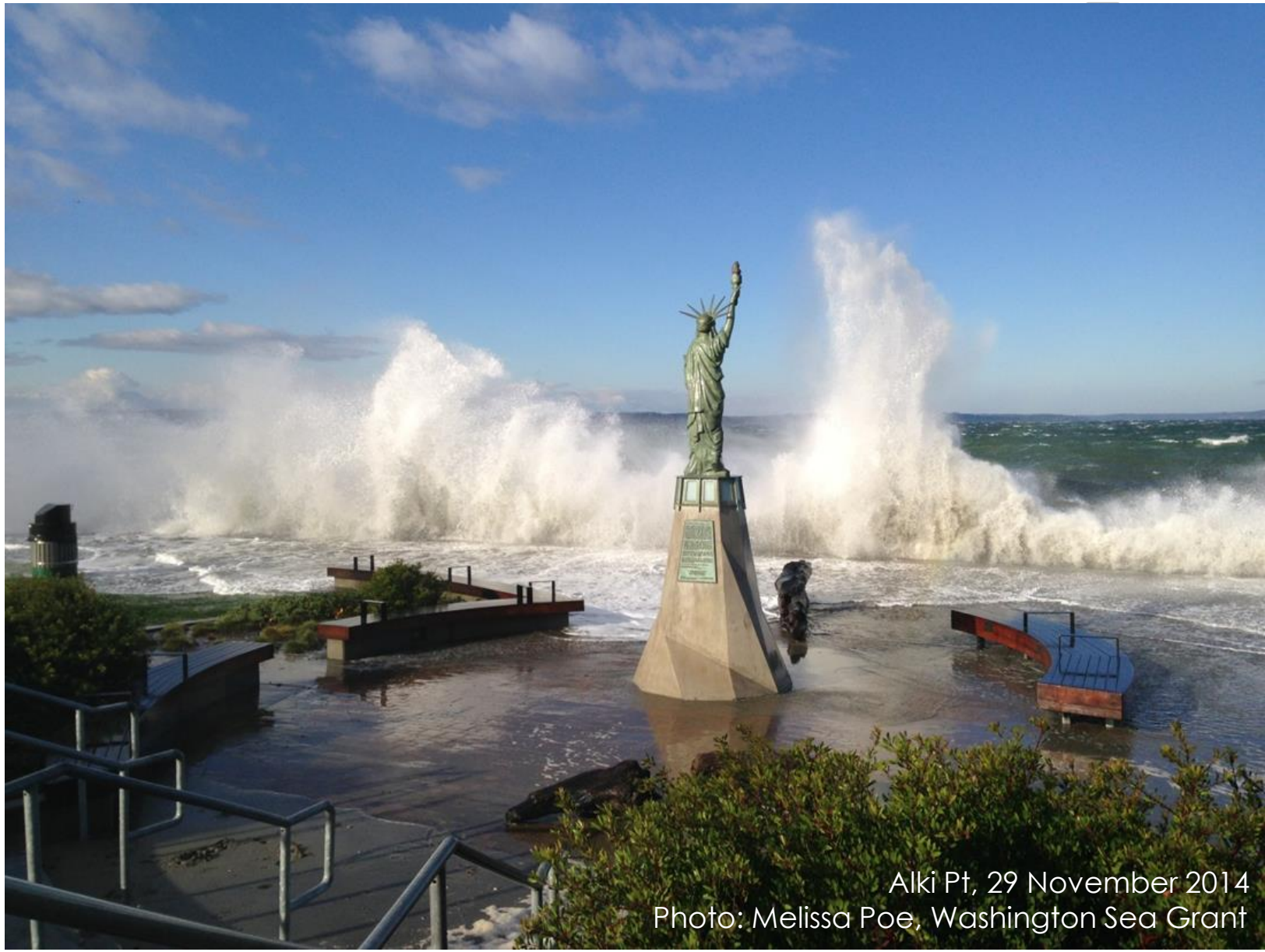
Relative sea level = level of the sea measured against the land. This is what tide gauges measure…and what matters from a hazards standpoint

Relative Sea Level = Vertical Land Movement + Eustatic Sea Level
(measured against "geocentric" reference)



Alki Pt, 29 November 2014
Photo: Melissa Poe, Washington Sea Grant

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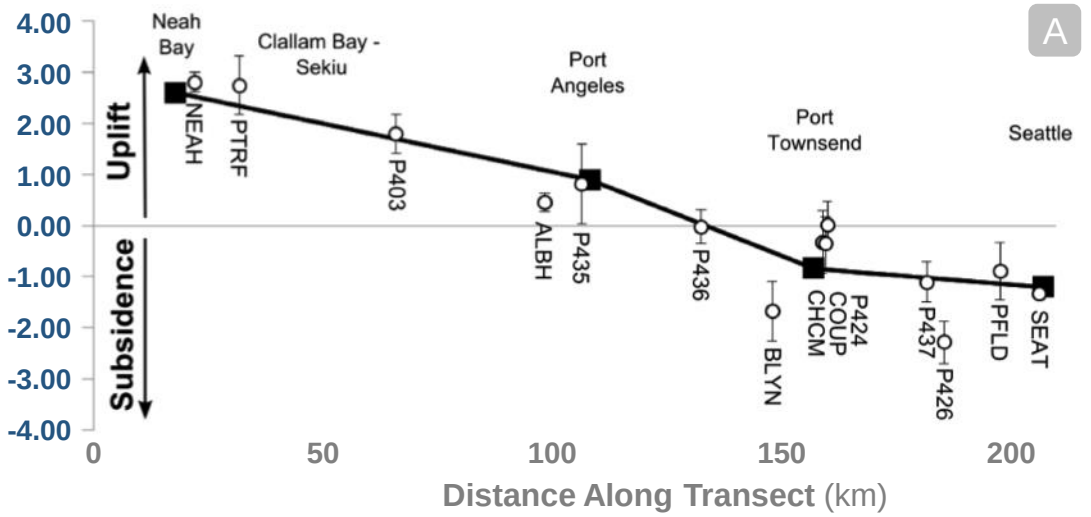
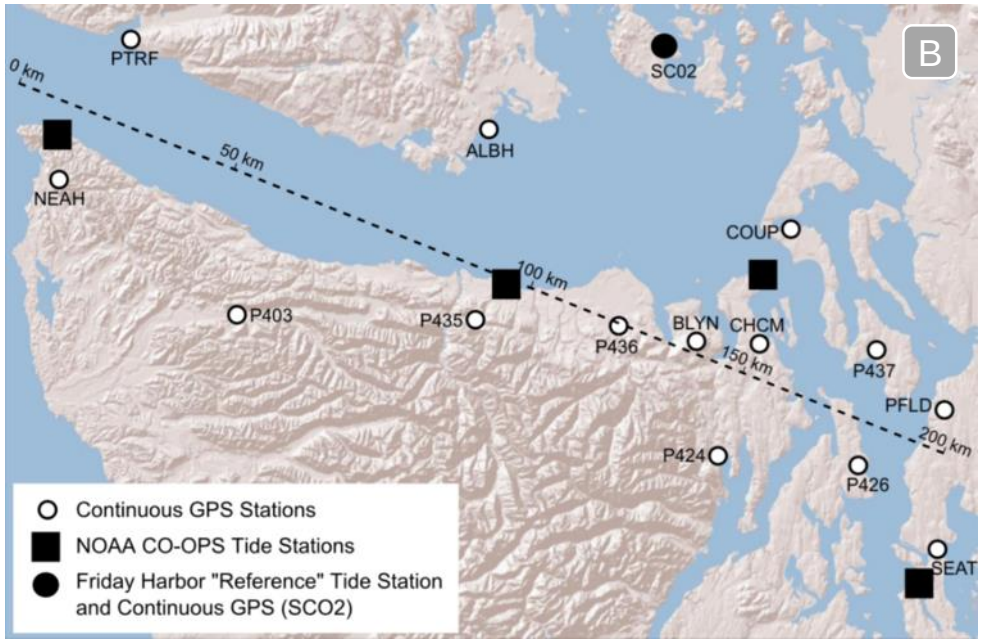
Vertical Land Movement

“Up” Velocity (mm/yr)





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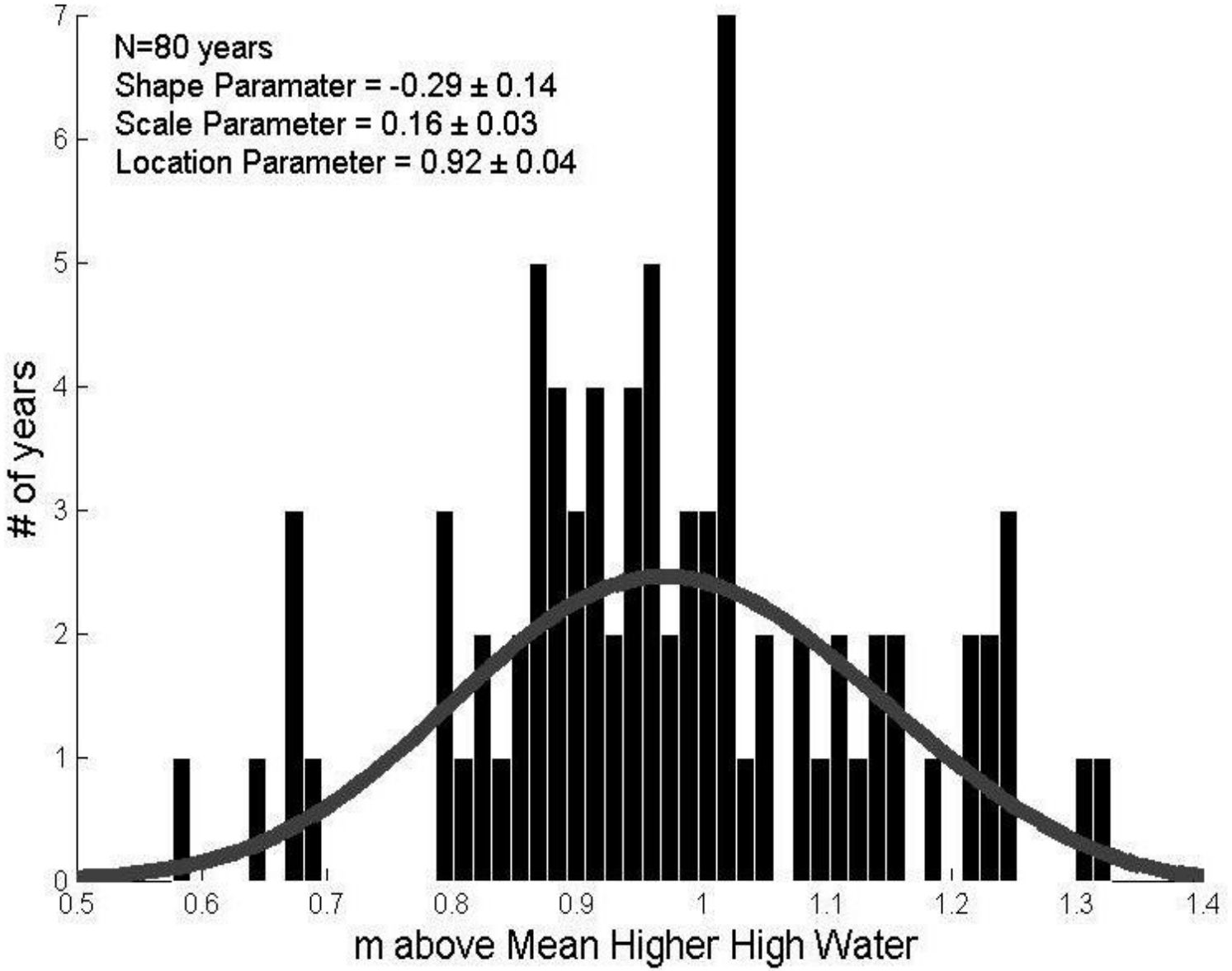
Best Fit Coastal Flood Probabilities



Local Relative Sea Level Rise & Coastal Flood Risk Tables

Location	Probability	… that mean sea level will reach or exceed ___ feet relative to current MHHW…			… and that the annual extreme coastal flood will reach ____ feet relative to current MHHW			
		2030	*2050*	*2100*	*Current*	*2030*	*2050*	*2100*
Neah Bay and Clallam Bay-Sekiu	99%	-0.1	-0.2	-0.1	2.0	2.1	2.2	2.6
	95%	-0.1	-0.0	0.3	2.4	2.4	2.6	3.1
	83%	0.0	0.1	0.7	2.7	2.9	3.0	3.7
	75%	0.0	0.2	0.9	2.8	2.9	3.1	3.9
	50%	0.1	0.3	1.3	3.2	3.3	3.5	4.5
	25%	0.1	0.5	1.8	3.6	3.6	3.9	5.1
	17%	0.2	0.5	2.0	3.7	3.8	4.0	5.4
	5%	0.2	0.7	2.7	4.1	4.1	4.4	6.2
	1%	0.3	0.9	4.0	4.3	4.4	4.8	7.5
Port Angeles	99%	0.1	0.1	0.5	1.1	1.4	1.6	2.2
	95%	0.1	0.2	0.9	1.4	1.6	1.9	2.7
	83%	0.2	0.4	1.2	1.6	1.9	2.2	3.2
	75%	0.2	0.4	1.4	1.8	2.0	2.3	3.4
	50%	0.3	0.6	1.9	2.1	2.3	2.6	3.9
	25%	0.3	0.7	2.3	2.4	2.6	3.0	4.5
	17%	0.3	0.8	2.6	2.5	2.8	3.2	4.8
	5%	0.4	0.9	3.3	2.8	3.1	3.5	5.5
	1%	0.5	1.2	4.6	3.1	3.4	3.9	6.8
Port Townsend	99%	0.2	0.4	1.0	1.1	1.5	1.9	2.8
	95%	0.3	0.5	1.4	1.3	1.8	2.2	3.3
	83%	0.3	0.7	1.8	1.6	2.1	2.5	3.8
	75%	0.4	0.7	2.0	1.8	2.2	2.6	4.0
	50%	0.4	0.9	2.4	2.1	2.5	2.9	4.5
	25%	0.5	1.0	2.9	2.4	2.8	3.3	5.1
	17%	0.5	1.1	3.1	2.5	2.9	3.5	5.3
	5%	0.6	1.2	3.9	2.8	3.3	3.8	6.1
	1%	0.6	1.5	5.2	3.1	3.6	4.1	7.3

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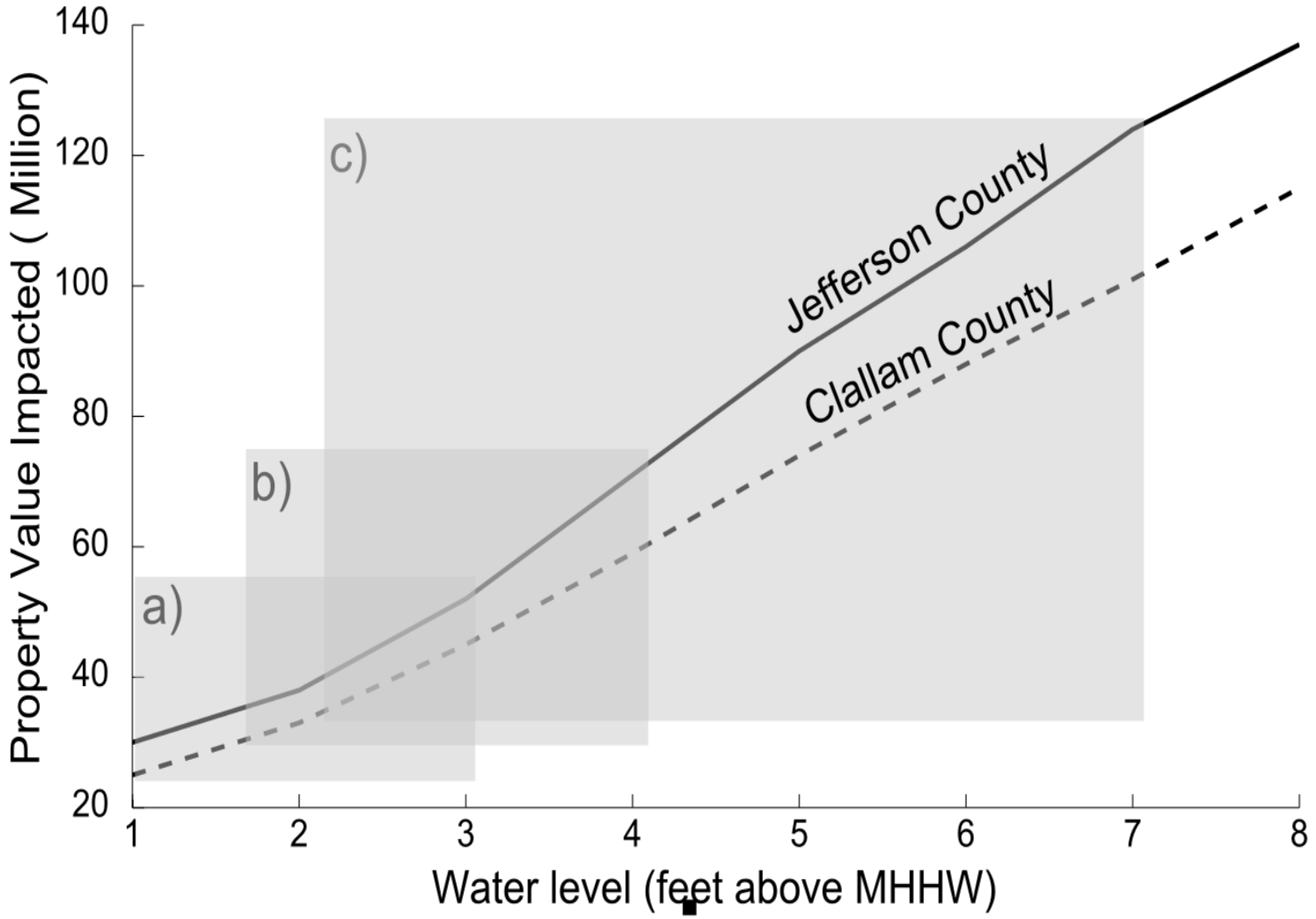
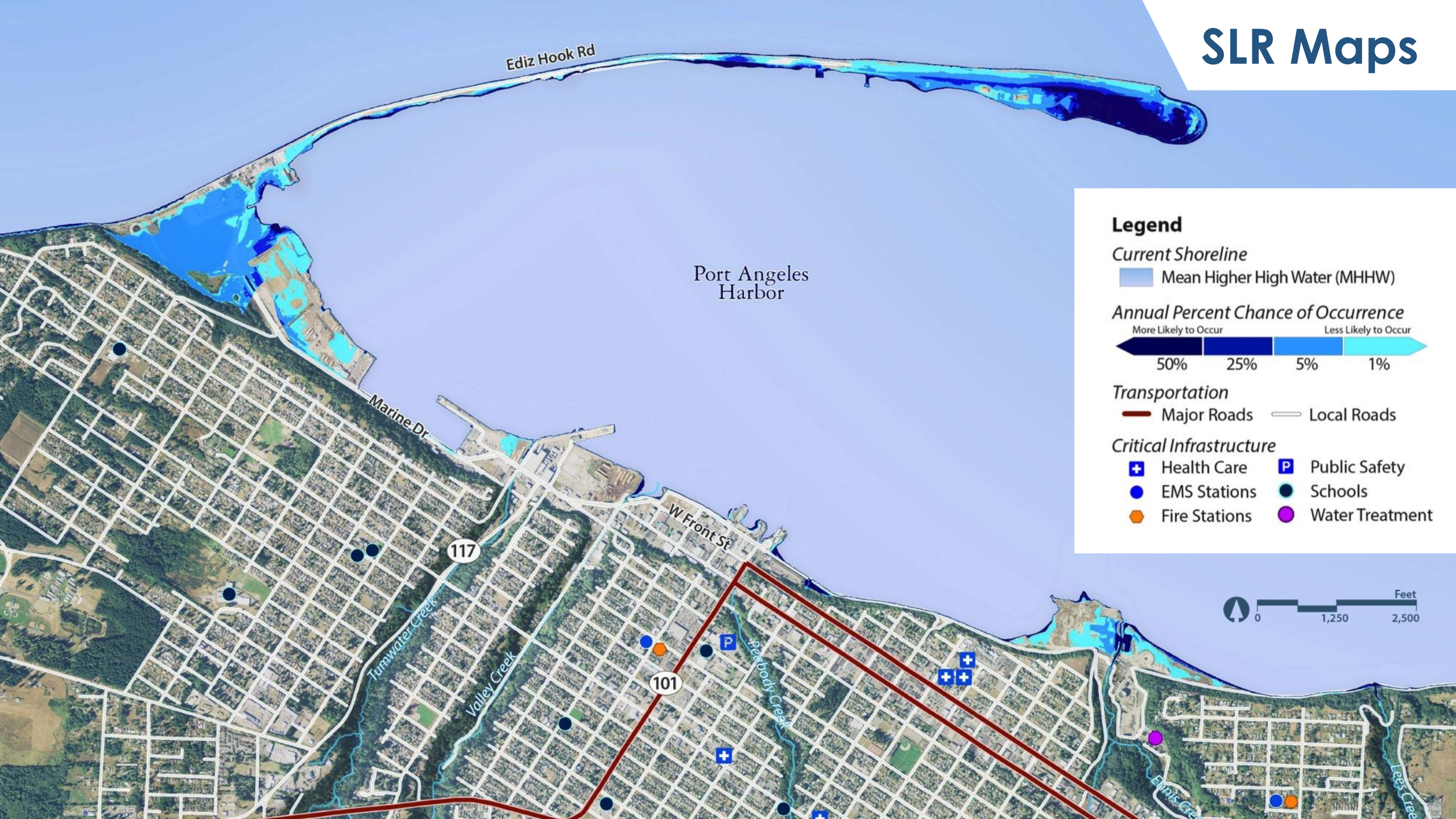
Value of Property at Risk

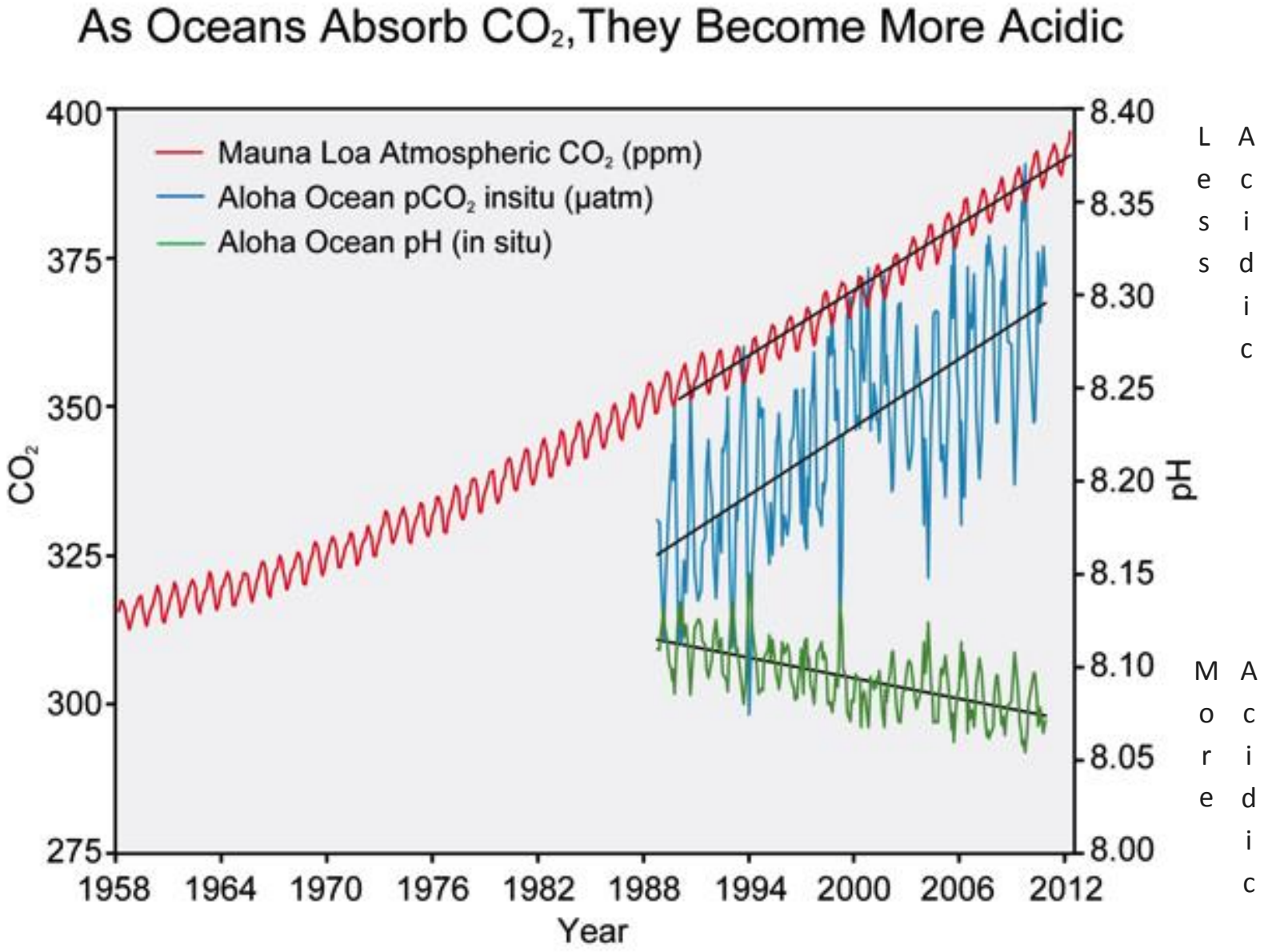


SLR Maps


Ediz Hook Rd
Port Angeles Harbor
Marine Dr
W Front St
117
101
Tumwater Creek
Valley Creek
Peabody Creek
Ennis Creek
Lees Creek
Legend
Current Shoreline
Mean Higher High Water (MHHW)
Annual Percent Chance of Occurrence
More Likely to Occur
Less Likely to Occur
50%
25%
5%
1%
Transportation
Major Roads
Local Roads
Critical Infrastructure
Health Care
Public Safety
EMS Stations
Schools
Fire Stations
Water Treatment
Feet
0
1,250
2,500

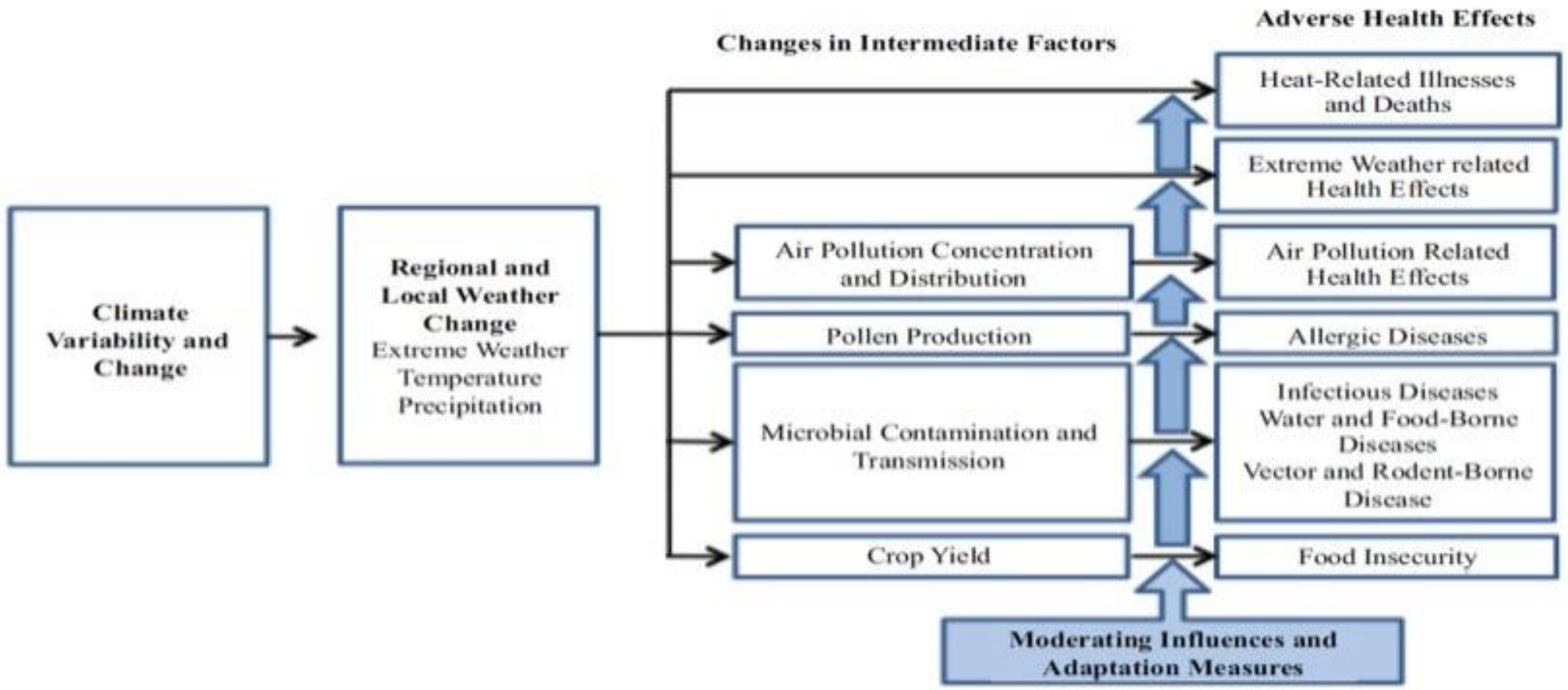
Ocean Acidification

- Occurring Sooner than expected in WA
- Affected by Coastal upwelling & Runoff
- Affecting marine organisms and food webs



Human Health and Livelihoods

Climate Change Impact to Human Health and Livelihoods



Climate Change Impact to Human Health and Livelihoods

Potential Health Effects Relevant to the NOP

- Accident & Injury in Extreme events
- Emerging Biotoxins/ Infectious Disease/ Allergies
- Heatwave Stress and Stroke
- Diminished Food Security

Many of these effects are moderated by function of our region's Ecosystems, Water Supplies, and Critical Infrastructure

And will Climate Change make people migrate TO the Pacific Northwest from more affected regions?


ENVIRONMENT

TUESDAY 16, SEPTEMBER 2014

Climate refugees are coming to the Pacific Northwest

by Knute Berger 28 Comments

?

?


Think Out Loud

Could The Pacific Northwest Become a Climate Change Migrant Mecca?

by Dave Miller OPB | Aug. 7, 2014 12:20 p.m. | Updated: April 2, 2015 6:49 a.m.


Scientist predicts mass exodus of climate change refugees to Pacific Northwest

By Negar Mojtahedi
Web Producer Global News

?

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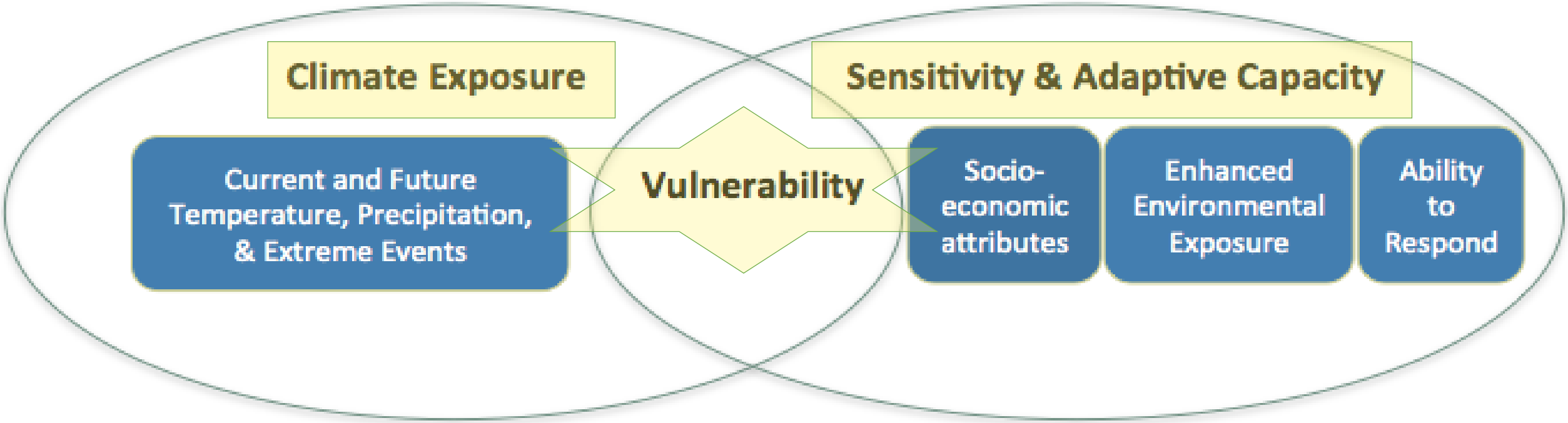
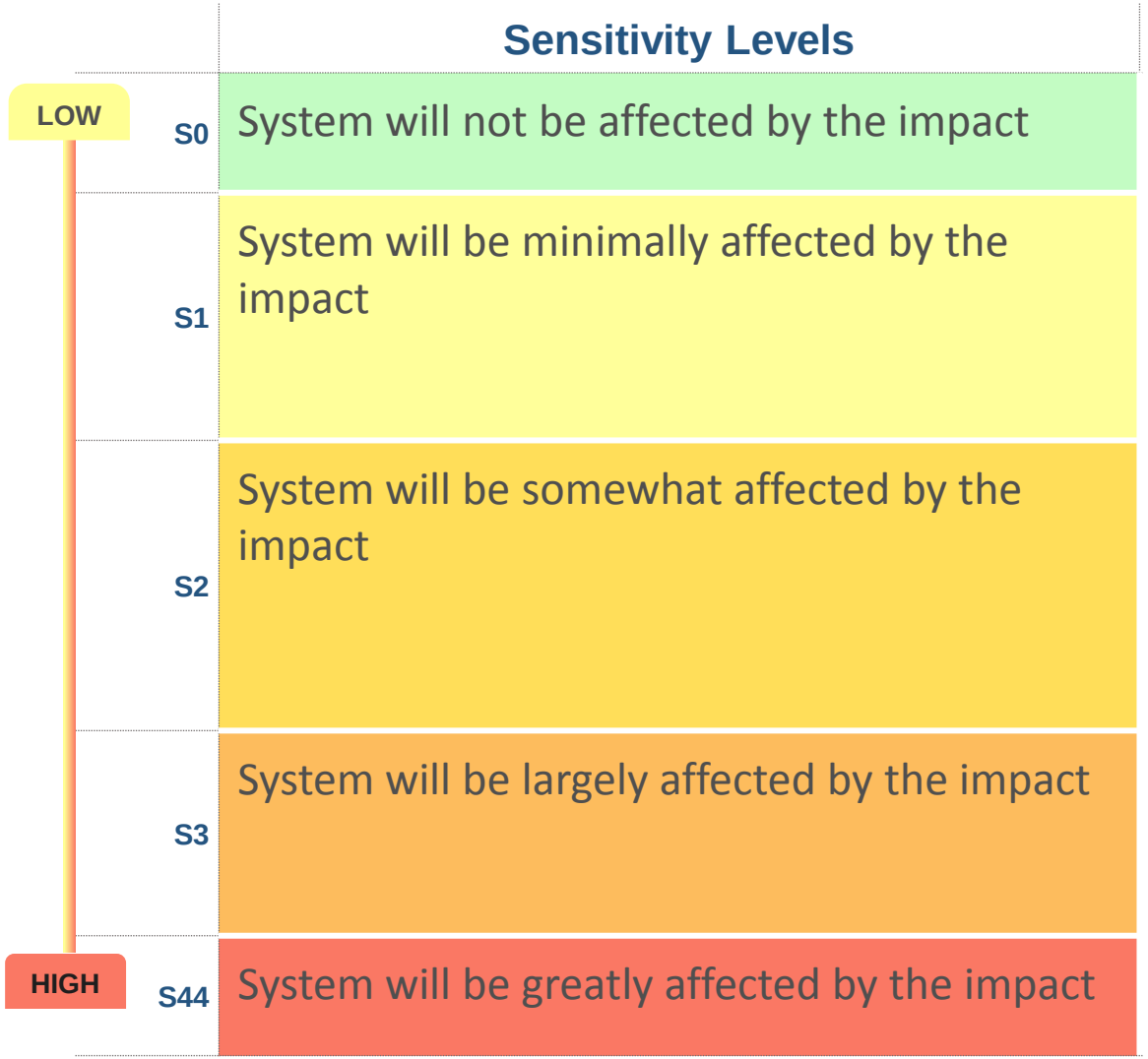
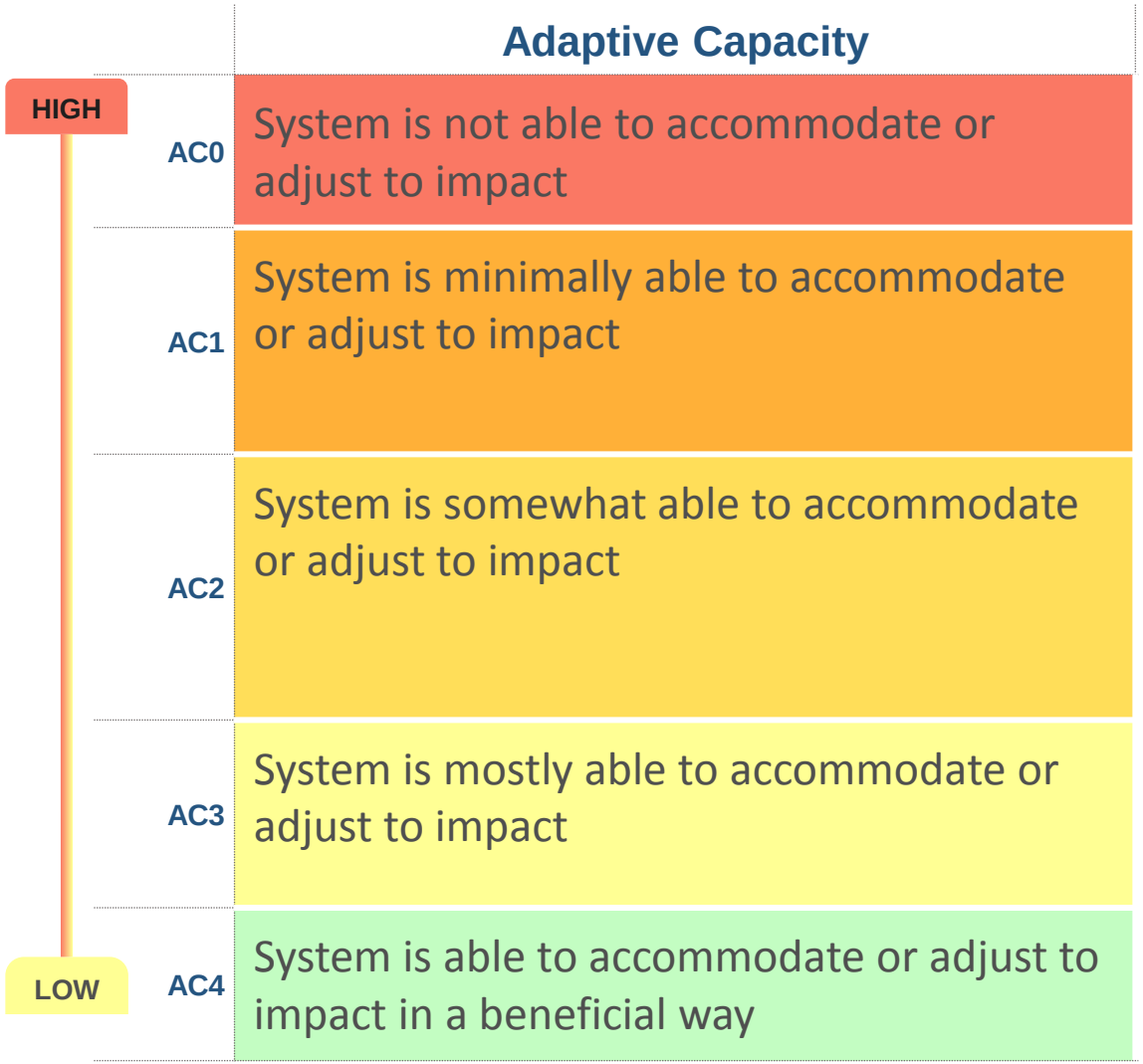
Vulnerability Assessment

Vulnerability Assessment Process



Vulnerability = Exposure, Sensitivity, & Ability to Adapt





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"Priority" Vulnerabilities identified by: Vulnerability Ranking and Action Planning Criteria

Vulnerability Ranking

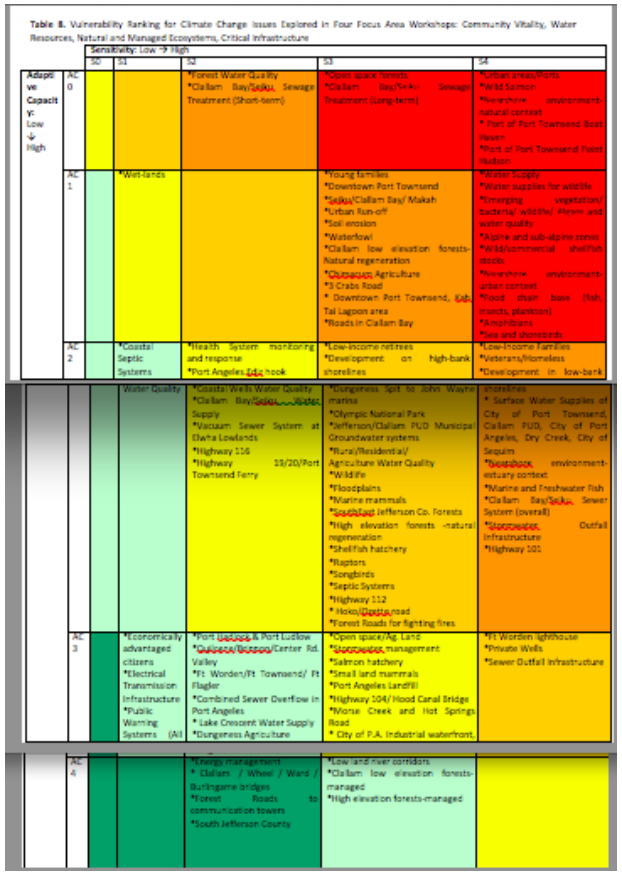

Table 8. Vulnerability Ranking for Climate Change Issues Explored in Four Focus Area Workshops: Community Vitality, Water Resources, Natural and Managed Ecosystems, Critical Infrastructure

Adaptive Capacity: Low → High	Sensitivity: Low → High				
	S0	S1	S2	S3	S4
AC 0			*Forest Water Quality *Clallam Bay/Sekiu Sewage Treatment (Short-term)	*Open space forests *Clallam Bay/Sekiu Sewage Treatment (Long-term)	*Urban areas/Ports *Wild Salmon *Nearshore environment-natural context * Port of Port Townsend Boat Haven *Port of Port Townsend Point Hudson
AC 1		*Wet-lands		*Young families *Downtown Port Townsend *Sekiu/Clallam Bay/ Makah *Urban Run-off *Soil erosion *Waterfowl *Clallam low elevation forests-Natural regeneration *Dungeness Agriculture *3 Crabs Road * Downtown Port Townsend, Kah Tai Lagoon area *Roads in Clallam Bay	*Water Supply *Water supplies for wildlife *Emerging vegetation/ bacteria/ wildlife/ Algae and water quality *Marine and sub-alpine zones *Wild/commercial shellfish stocks *Nearshore environment-urban context *Food chain base (fish, insects, plankton) *Amphibians *Sea and shorebirds
AC 2		*Coastal Septic Systems	*Health System monitoring and response *Port Angeles Ediz hook	*Development on high-bank shorelines	*Low-income families *Veterans/Homeless *Development in low-bank shorelines
		Water Quality	*Coastal Wells Water Quality *Clallam Bay/Sekiu Water Supply *Vacuum Sewer System at Elwha Lowlands *Highway 116 *Highway 19/20/Port Townsend Ferry	*Dungeness Spit to John Wayne marina *Olympic National Park *Jefferson/Clallam PUD Municipal Groundwater systems *Rural/Residential/ Agriculture Water Quality *Wildlife *Floodplains *Marine mammals *Sandy/Eastern Jefferson Co. Forests *High elevation forests -natural regeneration *Shellfish hatchery *Raptors *Songbirds *Septic Systems *Highway 112 * Hoko/Ozette road *Forest Roads for fighting fires	* Surface Water Supplies of City of Port Townsend, Clallam PUD, City of Port Angeles, Dry Creek, City of Sequim *Nearshore environment-estuary context *Marine and Freshwater fish *Clallam Bay/Sekiu Sewer System (overall) *Stormwater Outfall Infrastructure *Highway 101
AC 3		*Economically advantaged citizens *Electrical Transmission Infrastructure *Public Warning Systems (All	*Port Ludlow & Port Ludlow Quilcene/Brinnon/Center Rd. Valley *Ft Worden/Ft Townsend/ Ft Flagler *Combined Sewer Overflow in Port Angeles * Lake Crescent Water Supply *Dungeness Agriculture	*Open space/Ag. Land *Stormwater management *Salmon hatchery *Small land mammals *Port Angeles landfill *Highway 104/ Hood Canal Bridge *Morse Creek and Hot Springs Road * City of P.A. Industrial waterfront,	*Ft Worden lighthouse *Private Wells *Sewer Outfall Infrastructure
AC 4			*Energy management * Clallam / Wheel / Ward / Burlingame bridges *Forest Roads to communication towers *South Jefferson County	*Low land river corridors *Clallam low elevation forests-managed *High elevation forests-managed	

Action-Planning Criteria

- Resources available
- Project capacity and data gaps
- Relevance to both counties
- Informing decision-making
- Timing and magnitude of impacts

Criteria are specific to this Project's desired outcomes and included input from Core Team & Partners

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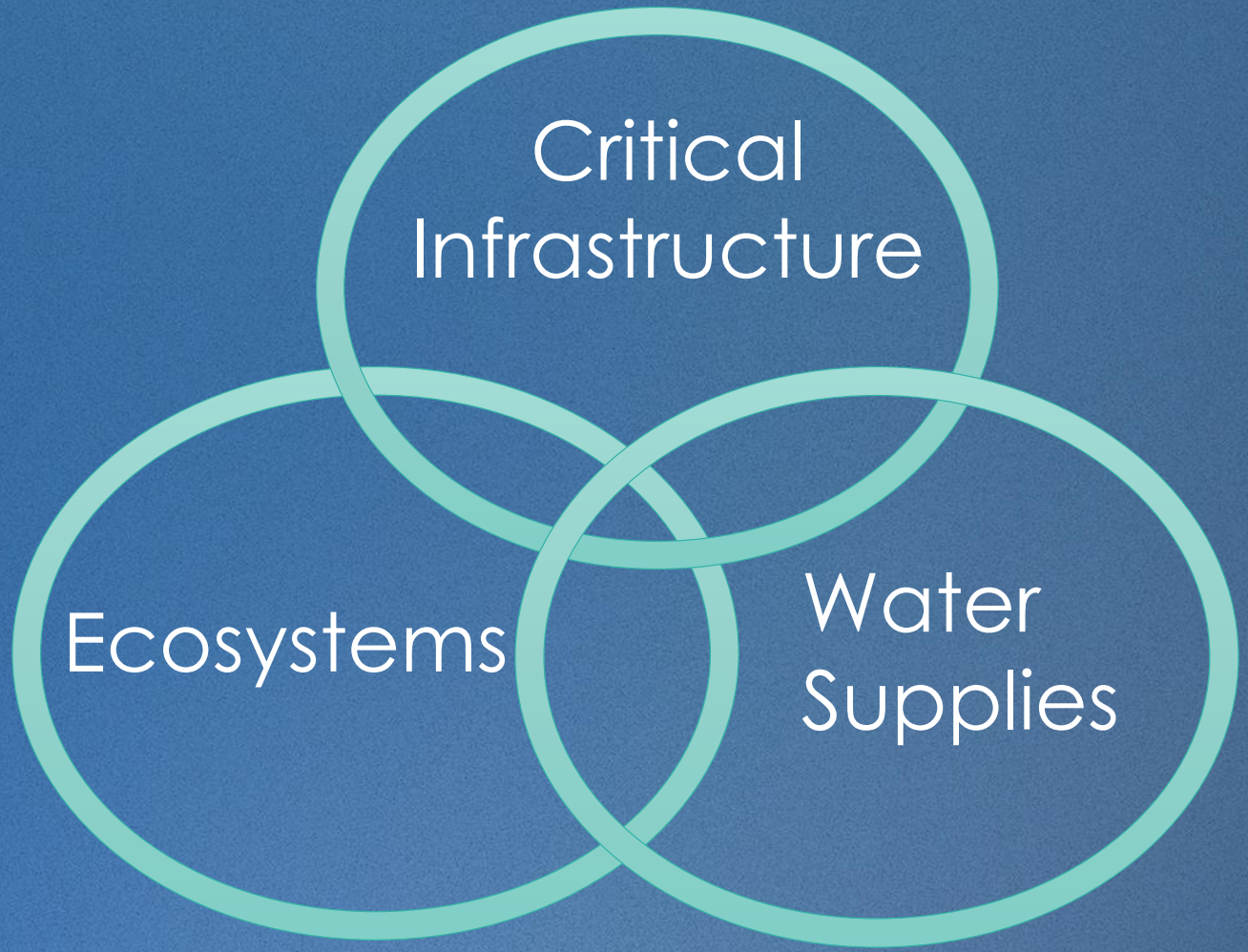
Evaluating Adaptation Actions

CRITERIA	DESCRIPTION
Timeframe for Implementation	The ideal timeframe for initiating implementation of the proposed action in order to be most effective. Actions requiring immediate action received higher scores.
Adaptive/Flexible	The proposed strategy allows for responding to uncertain outcomes or timing of climate change impacts.
Technical Feasibility	Current technology can be used and physically implemented to solve the problem it is meant to address.
Political & Social Feasibility	Action has political and social community support or, at a minimum, does not have political or community opposition. This also considers the “fundability” of an action.
Alignment with other Community Goals	The action has co-benefits for other community goals, plans, or actions, leads to increase in social resilience, if relevant; action is socially equitable.

Focus Areas:

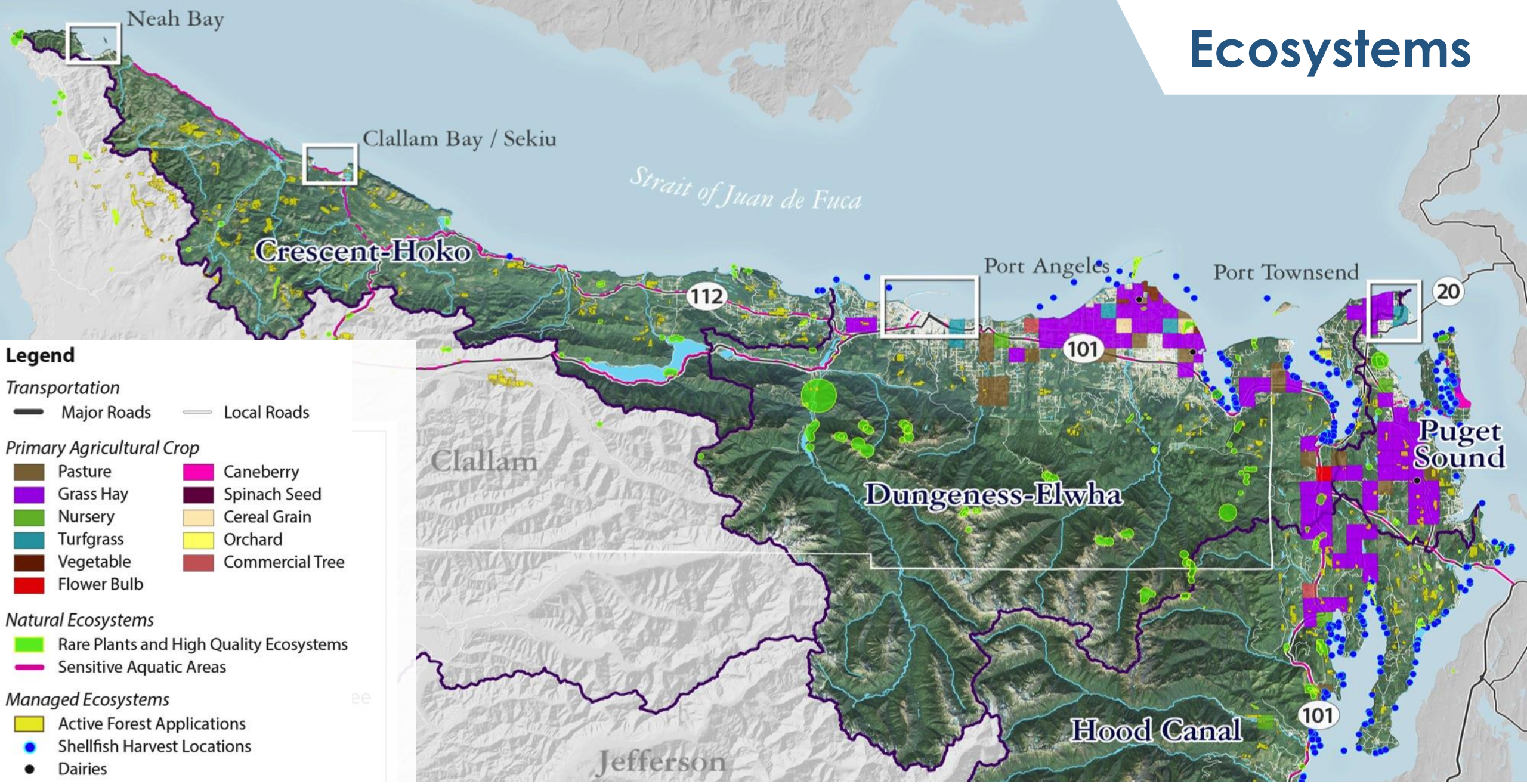


Ecosystems

Jeff Taylor

Port Townsend Marine Science Center

Ecosystems



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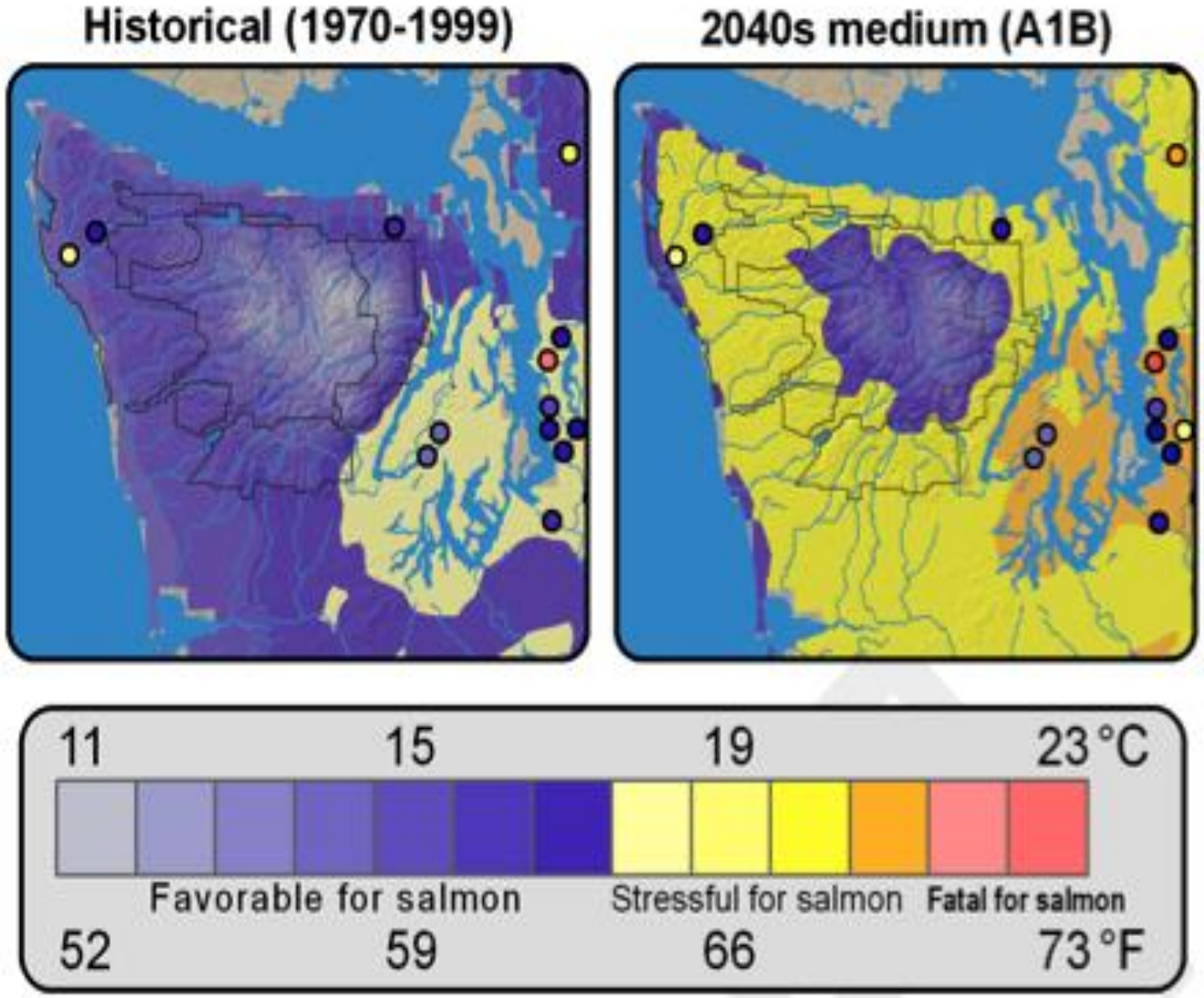
Critical Temperature Thresholds for Salmon



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Monthly Average Projections of Soil Water Storage

1950 – 2005

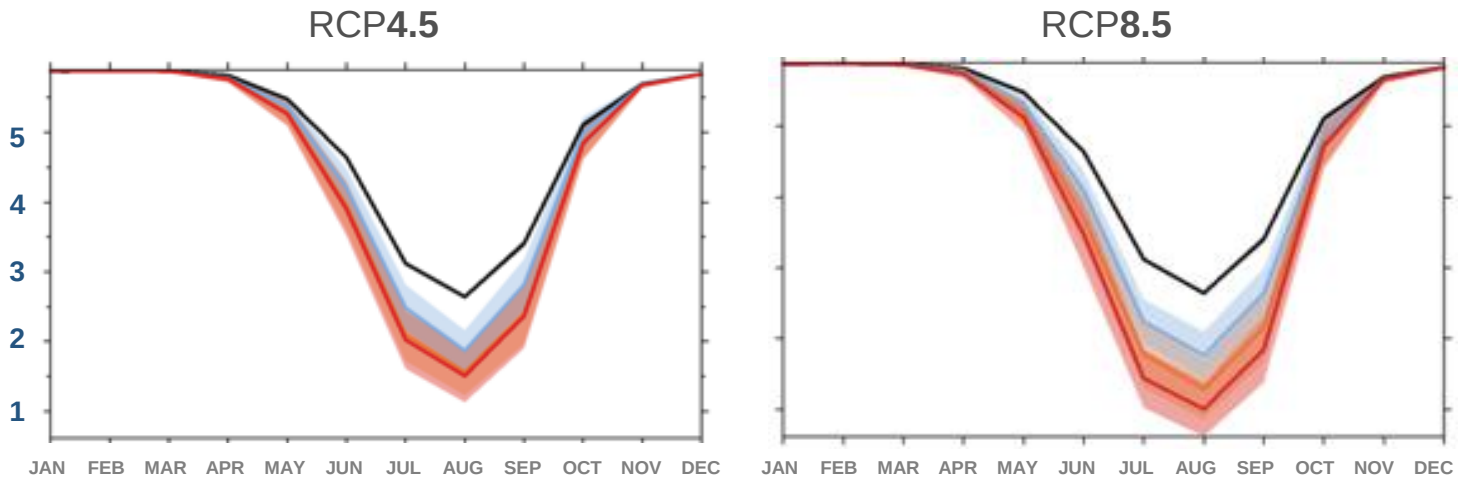
2025 – 2049

2050 – 2074

2075 – 2099

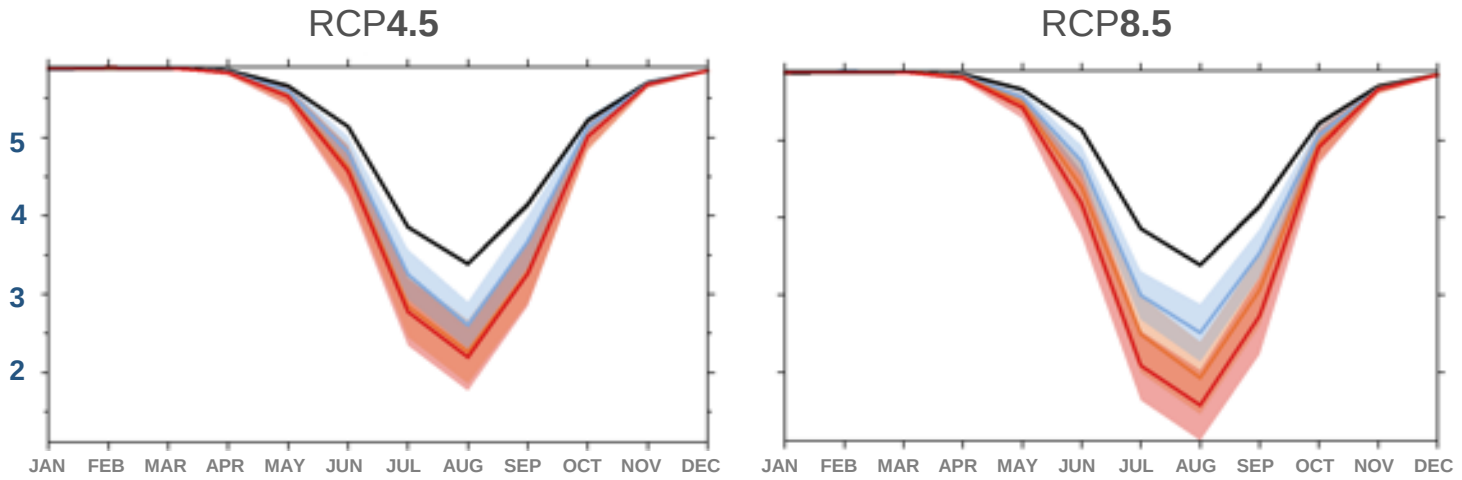
Clallam County

Soil water storage (inches)



Jefferson County

Soil water storage (inches)



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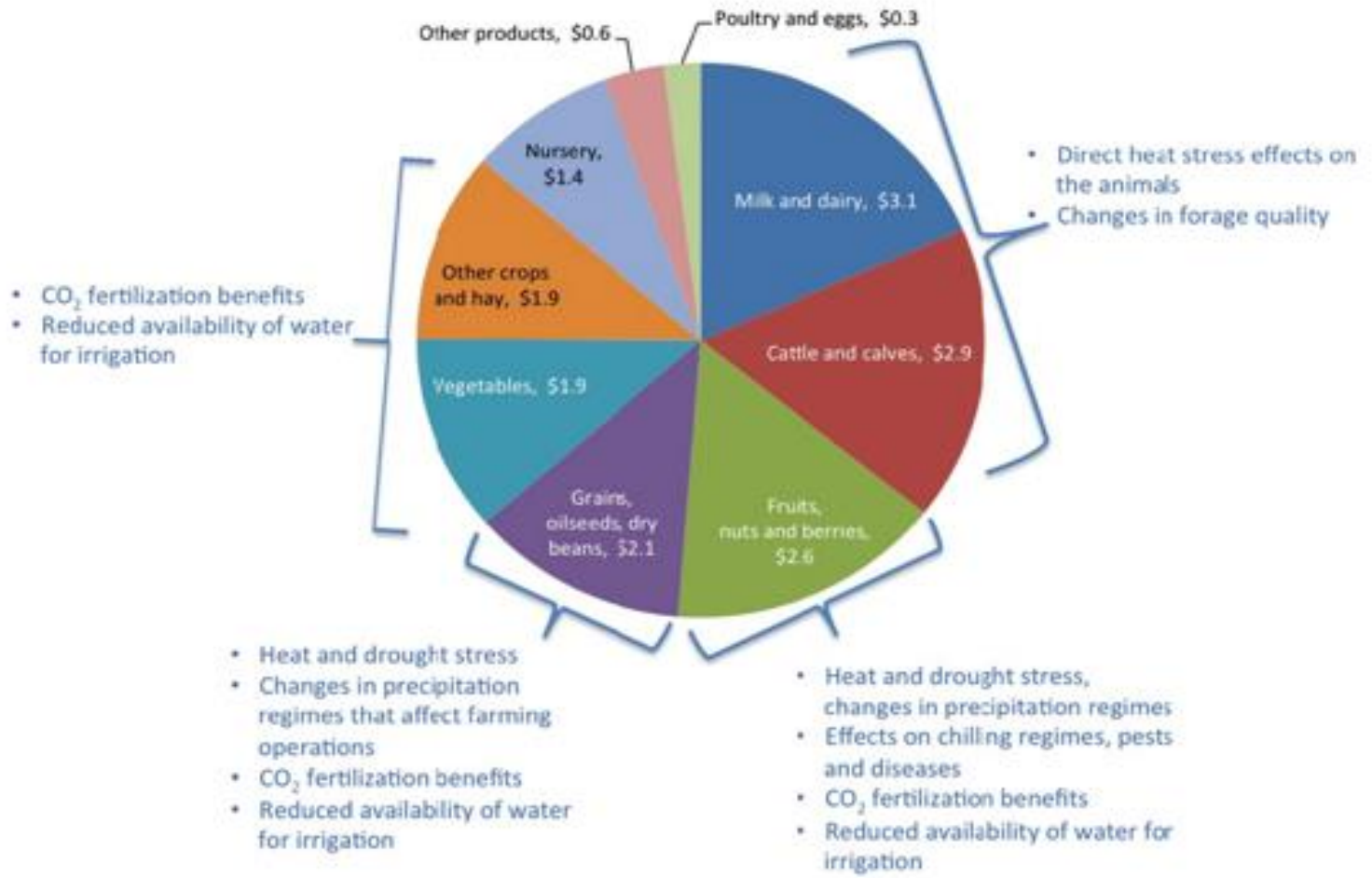
Agriculture product value for the Pacific Northwest



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Ecosystems "exposure" to climate change

Ecosystems Sub-sector	Exposure to climate change
Nearshore Environment and Watersheds	Sea level rise and storms surge, changes to the amount and timing of freshwater inputs, shifting erosion patterns, altered sediment delivery and transport, and increased opportunities for invasive plants and animals.
Forestry and Agriculture	Increases in mean summer temperatures, increases in mean cool-season temperatures, increases in length of growing season, increases in atmospheric CO_2 levels, increases in mean evapotranspiration, decreases in summer soil moisture, decreases in mean summer precipitation, reductions in summer/fall water availability due to decreases in snowpack, increases in mean winter precipitation, increased wildfire risk, changes in pest species.
Emerging Risks	Low average river flow, high water temperatures, and more intense flooding events with diminished water quality, more acidic ocean waters, shifting biodiversity patterns, shifting risk of Harmful Algal Blooms

SENSITIVITY: LOW → HIGH

ADAPTIVE CAPACITY: LOW → HIGH

	S0	S1	S2	S3	S4
AC0			• **Forest Water Quality**		• Wild Salmon • **Nearshore environment – *natural context***
AC1		• Wetlands		• Waterfowl • Clallam low elevation forests – *natural* • **Chimacum agriculture** • **Urban Run-off** • **Soil erosion**	• **Wild/commercial shellfish stocks** • **Nearshore environment – *urban context*** • Food chain base (fish, insects, plankton) • Amphibians • Sea and shorebirds • **Emerging vegetation/ bacteria/ wildlife/ algaes and water quality**
AC2				• Marine mammals • Southeast Jefferson Co. forests • High elevation forests • **Shellfish hatchery** • Raptors • Songbirds • **Low-income retirees** • **Development on high-bank shorelines** • **Floodplains**	• **Nearshore environment – *estuary context*** • Marine and freshwater fish • **Low-income families** • **Veterans/ homeless** • **Development in low-bank shorelines**
AC3			• **Dungeness agriculture** • Quilcene agriculture • Salmon aquaculture • Large land mammals	• **Salmon hatchery** • Small land mammals • **Open space/ Agricultural land**	
AC4				• Clallam low elevation forests – *managed* • High elevation forests – *managed*	

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TOP 10 **Strategies for Ecosystems**

WATER SUPPLIES

CRITICAL INFRASTRUCTURE

STRATEGY	SCORE	TYPE	LEAD GROUP(S)	CO-BENEFITS
Enhance efforts to encourage breeding and planting of drought tolerant, resilient plant species	20	AWARENESS	Agriculture/Forestry & Edu. Orgs	WATER SUPPLIES
Incorporate climate change more explicitly into comprehensive plans and Shoreline Master Programs (SMP)	19	PLANNING	Local Governments	CRITICAL INFRASTRUCTURE
Enhance promotion of agricultural best management practices to include future climate conditions	19	AWARENESS	Agriculture Sector and Edu. Orgs	
Update municipal codes to account for enhanced fire risk at forest/residential interface where needed	19	POLICY	Local Governments	CRITICAL INFRASTRUCTURE
Increase regional capacity for water storage *(preferable with natural systems)*	18	PLANNING	Multi-Stakeholder	WATER SUPPLIES
Encourage FEMA to incorporate climate change in rate maps and guidance	18	PLANNING	State and County Government	CRITICAL INFRASTRUCTURE
Develop graphic tool to illustrate climate impacts	17.5	PLANNING	Multi-Stakeholder	WATER SUPPLIES, CRITICAL INFRASTRUCTURE
Update financing policies for development in high risk areas	17	POLICY	Multi-Stakeholder	CRITICAL INFRASTRUCTURE
Enhance efforts to incentive use of native plants landscaping in residential, commercial, industrial settings	17	AWARENESS	Local Gov't and Private Sector	WATER SUPPLIES
Utilize low cost citizen science monitoring and analysis approaches and technologies	17	AWARENESS	Research Institutions and Citizens	

Ecosystem Adaptation Strategies - Detail

E-4: Update municipal codes to account for enhanced fire risk at forest/residential interface where needed					
Score	Type of Strategy	Timeframe for Implementation*	Lead Group(s)	Opportunities or Concerns	Focus Area Co-benefits
19	Policy	Near-term	Local Governments	*Highly adaptive, feasible, in line with political and social goals*	*Critical Infrastructure*

*Near-term (0-3 years), Medium-term (3-10 years), Long-term (>10 years)

Key Action Steps:

- Use education, incentives, and building codes to minimize fire risk, particularly in forest/residential interface.
- Enforce set-backs on building permits in forested areas.
- Update existing hazard analyses that incorporate historical climate variables (such as the Clallam County Community Wildfire Protection Program, 2009) with temperature and precipitation projections for a chosen climate change scenario.
- Review existing hazard analyses (such as the Clallam County Community Wildfire Protection Program, 2009) for strategies to mitigate the wildfire risk, and assess their continued viability with increased wildfire risk.

Water Supplies

Jeff Taylor

Barney Burke

Water Supplies

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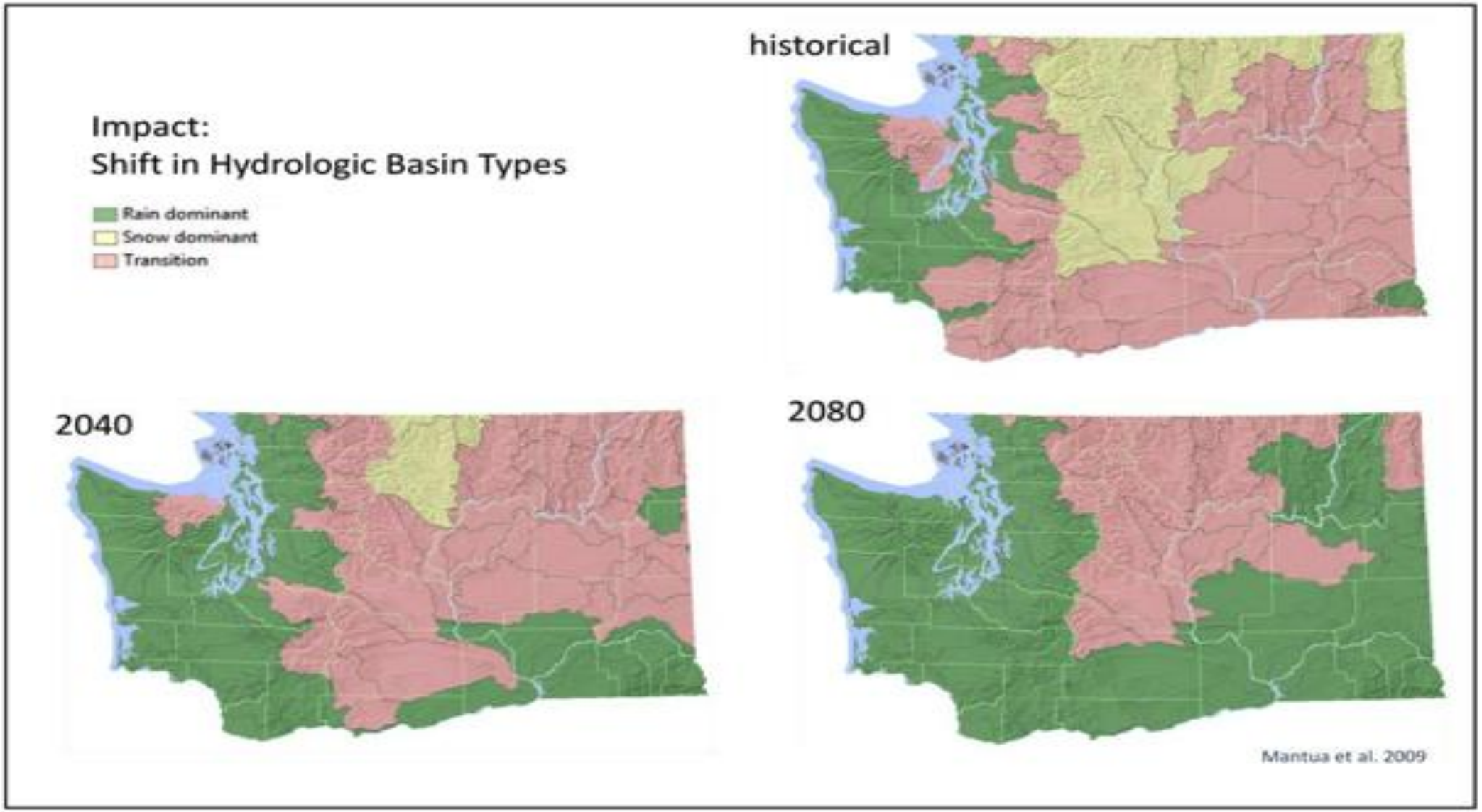
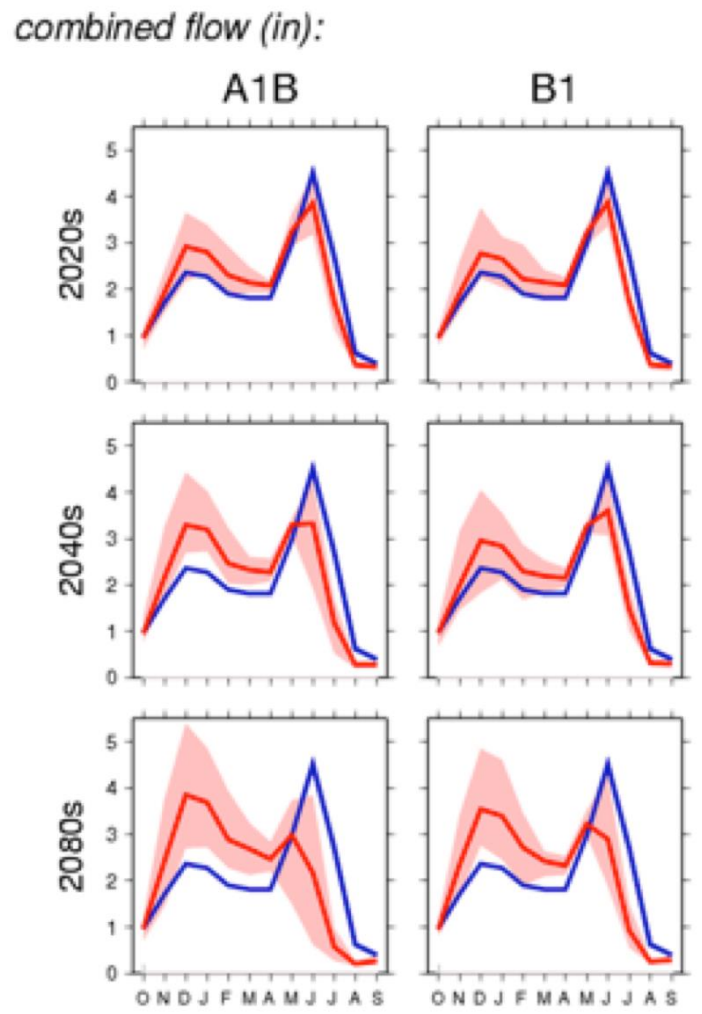
Shifts in Hydrological Basin Type

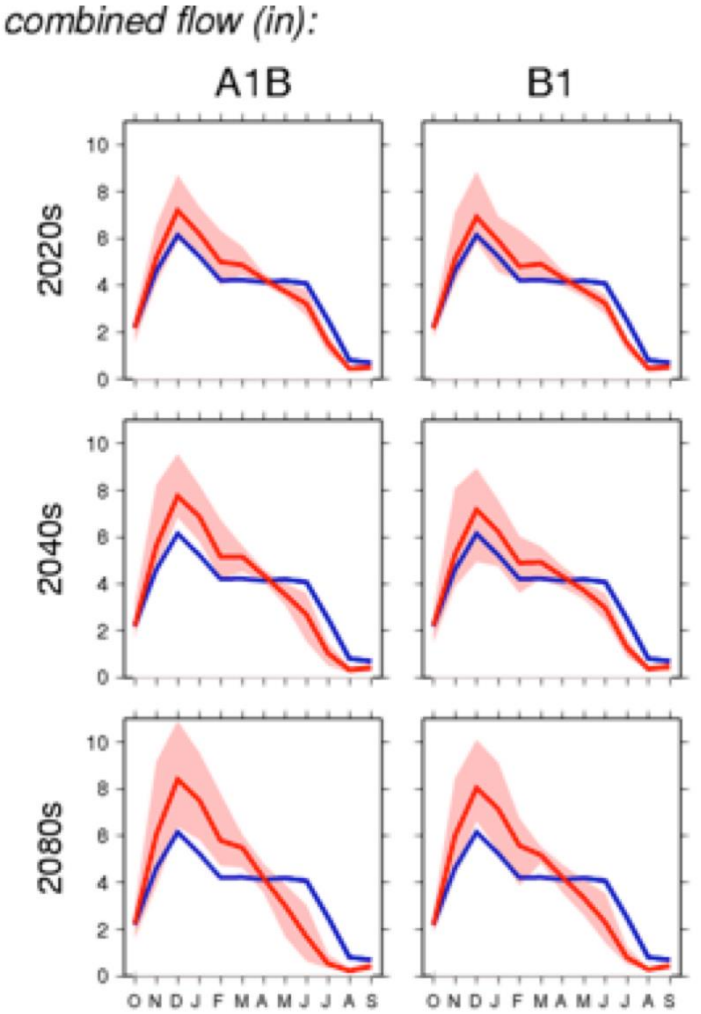


Shifts in Streamflow Patterns

Dungeness River Hydrograph
(near river outlet)



Elwha River Hydrograph *(near McDonald bridge near Port Angeles)*



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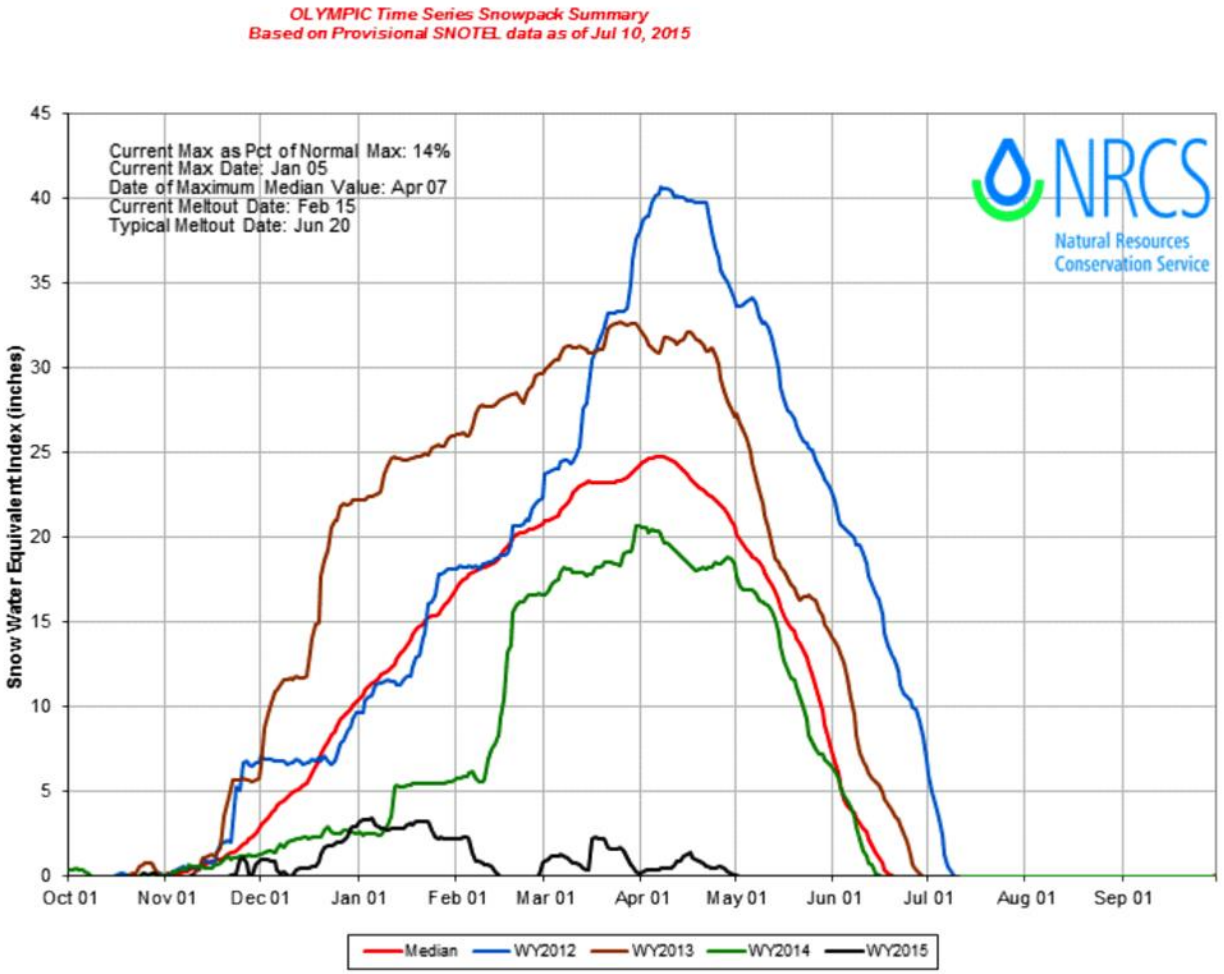
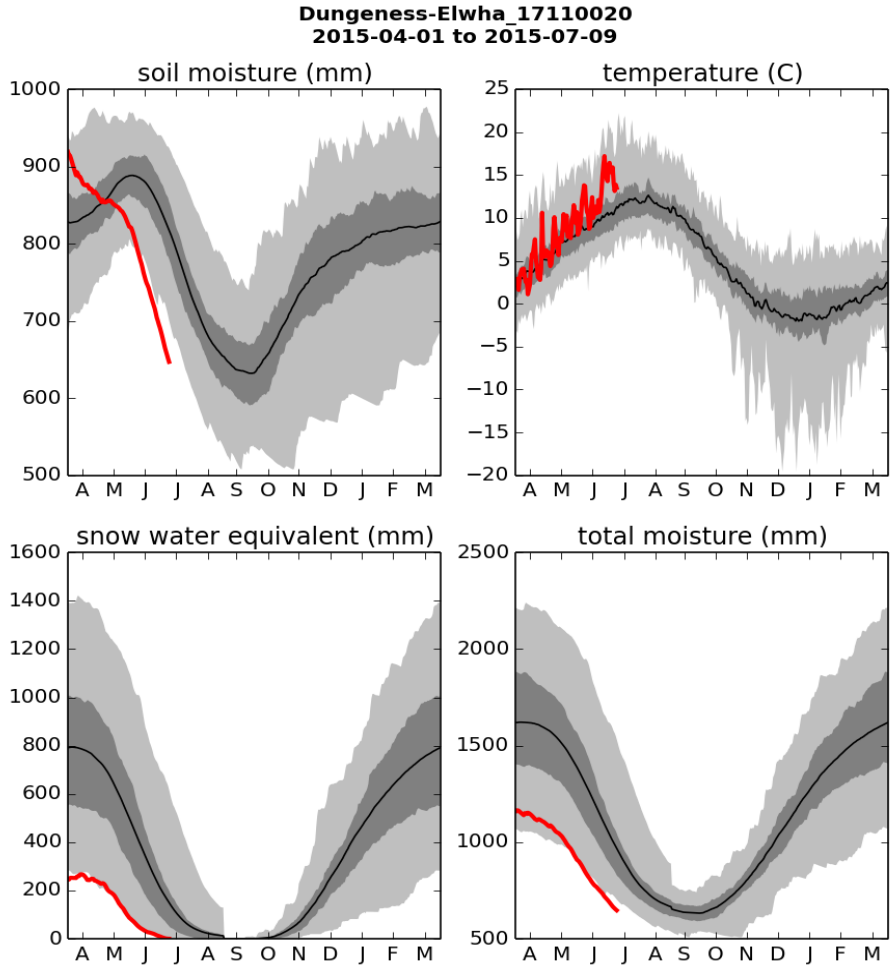
Drought in 2015 – low river flows and soil moisture





Water Supplies "exposure" to climate change

Water Supplies Sub-sector	Exposure to climate change
Surface Water Supplies	Seasonal changes to river flows and recharge rates, lower stream flows for extended periods especially during the summer and fall, more intense and frequent extreme precipitation events (increasing turbidity and hampering water treatment).
Groundwater Supplies	Altered precipitation intensity and timing along with decreases in snow pack that may decrease recharge rates, sea level rise that could drive salinization of coastal groundwater tables.
Water Quantity and Availability	Changing snowpack, frequent drought periods, and lower summer precipitation may decrease seasonal water supply and increase competition for water supplies, including increased water demands during heat events, longer growing seasons, increased wildfire fighting.

Vulnerability Rankings for Water Supplies

ADAPTIVE CAPACITY	SENSITIVITY: LOW → HIGH				
	S0	S1	S2	S3	S4
LOW — AC0			• Forest water quality		
AC1				• Run-off • Soil erosion • **Chimacum Agriculture**	• Water supplies for wildlife • Emerging risks – bacteria, algae, vegetation, and water quality issues • Alpine and sub-alpine zones
AC2		• Coastal septic systems water quality	• Coastal well water quality • **Clallam Bay/Sekiu – water supply**	• **Jefferson/Clallam PUD, Sequim, and other Municipal Groundwater systems** • Rural/residential/agriculture water quality • Wildlife • Floodplains • **Low-income retirees**	• **Surface water supplies of City of Port Townsend, Clallam PUD, City of Port Angeles, Dry Creek, City of Sequim** • **Low-income families** • **Veterans/ homeless**
AC3			• Combined sewer overflow in Port Angeles • Lake Crescent water supply • **Dungeness Agriculture**		• **Private Wells**
HIGH — AC4				• Clallam low elevation forests – *managed* • High elevation forests – *managed*	

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TOP 10 **Strategies for Water Supplies**

ECOSYSTEMS

CRITICAL INFRASTRUCTURE

STRATEGY	SCORE	TYPE	LEAD GROUP(S)	CO-BENEFITS
Enhance education on drought & water supplies issues for the peninsula	20	AWARENESS	Multi-Stakeholder	ECOSYSTEMS
Adopt new regulations requiring water-efficient appliances	20	POLICY	State Government	ECOSYSTEMS
Promote and incentivize smart irrigation technologies for agriculture	20	AWARENESS	Agricultural Sector	ECOSYSTEMS
Identify monitoring needs and enhance water supply monitoring	19	AWARENESS	Multi-Stakeholder	ECOSYSTEMS
Enhance efforts to educate home and business owners on the value of on-site water conservation, retention, and catchment	18	AWARENESS	Multi-Stakeholder	CRITICAL INFRASTRUCTURE
Continue to study ways to enhance water storage and groundwater recharge	18	PLANNING	Water Utility & Local Governments	
Encourage forestry practices promoting water retention within the watershed	18	AWARENESS	Forestry Sector	ECOSYSTEMS
Research or develop model to assess sea level rise and saltwater intrusion to groundwater	18	PLANNING	Local Governments	CRITICAL INFRASTRUCTURE
Improve forecasting for future water supply and demand	18	PLANNING	Water Utility Managers	
Map water retention values for ecosystems	18	PLANNING	Multi-Stakeholder	ECOSYSTEMS

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Water Supplies Adaptation Strategies - Detail

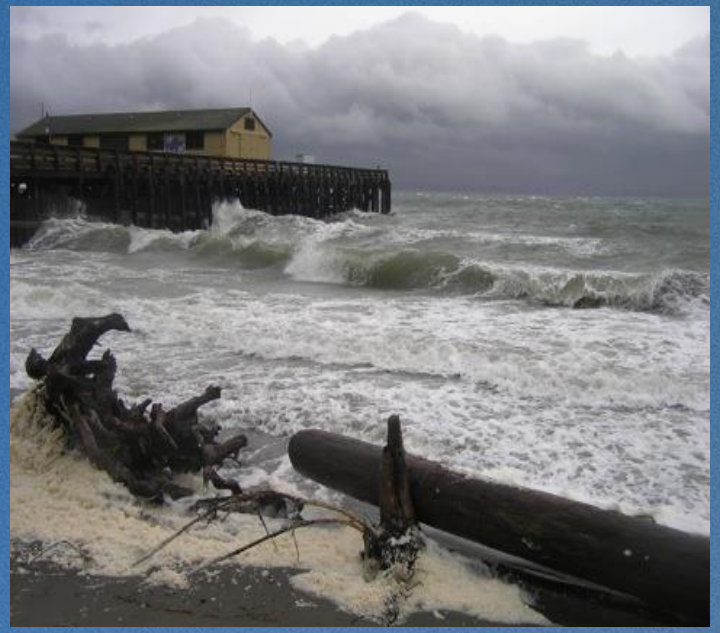
WS-3: Promote and incentivize smart irrigation technologies for agriculture					
Score	Type of Strategy	Timeframe for Implementation*	Lead Group(s)	Opportunities or Concerns	Focus Area Co-benefits
20	Awareness	Medium-term	Agriculture Sector	*High cost, technical and political feasibility*	

*Near-term (0-3 years), Medium-term (3-10 years), Long-term (>10 years)

Key Action Steps:

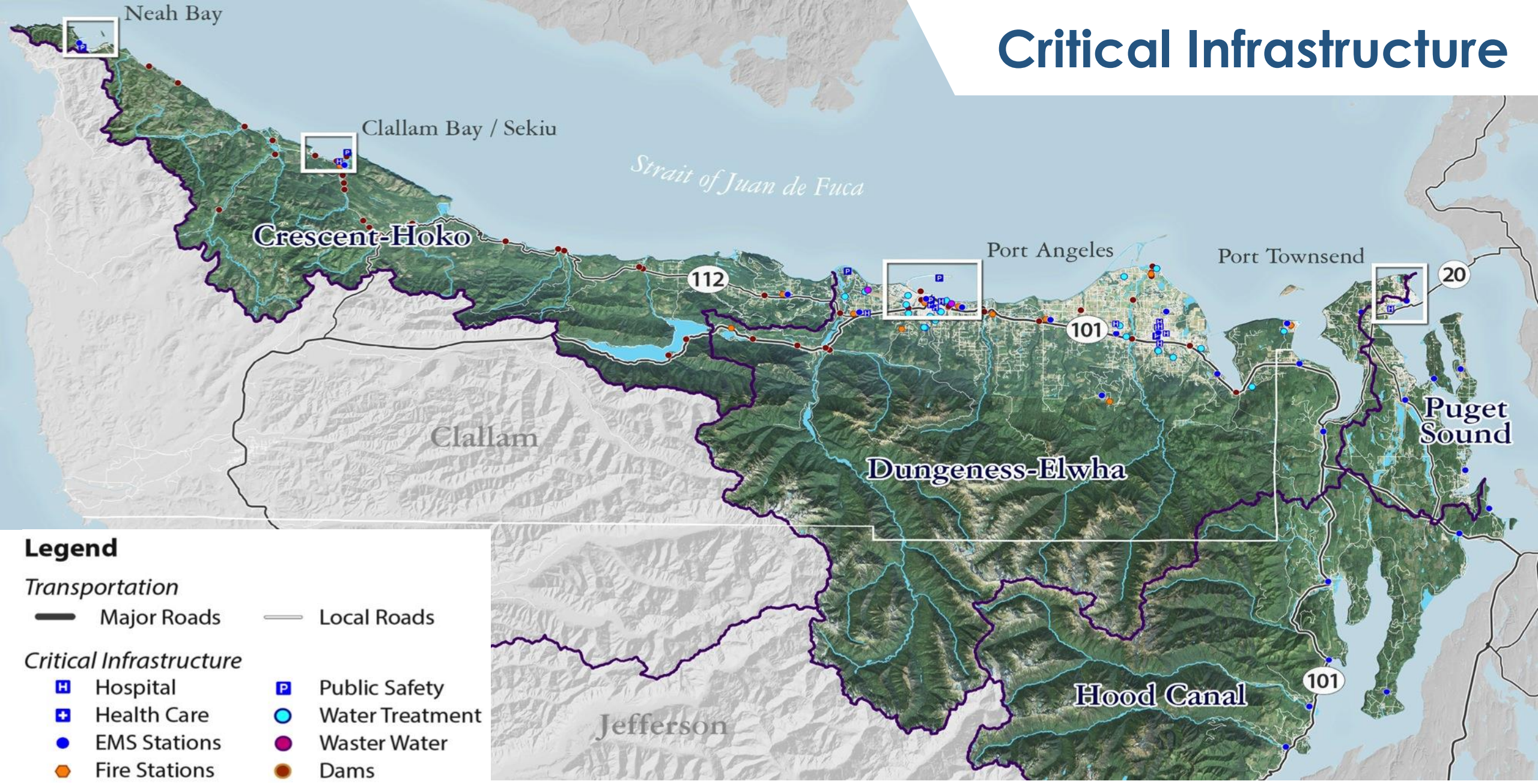
- Promote benefits of decreasing "consumptive use" of water.
- Utilize Washington State University's "CropSyst" software which, among other things, models cultivar water needs amount and timing (http://modeling.bsyse.wsu.edu/CS_Suite_4/CropSyst/index.html)
- Conduct assessment of existing irrigation issues: http://drought.wsu.edu/tools-resources/irrigation/
- Develop and distribute educational materials about smart irrigation technologies.
- Consider working with agricultural sector to host education workshop or meetings related to water conservation.

Critical Infrastructure



Port Townsend Marine Science Center

Critical Infrastructure



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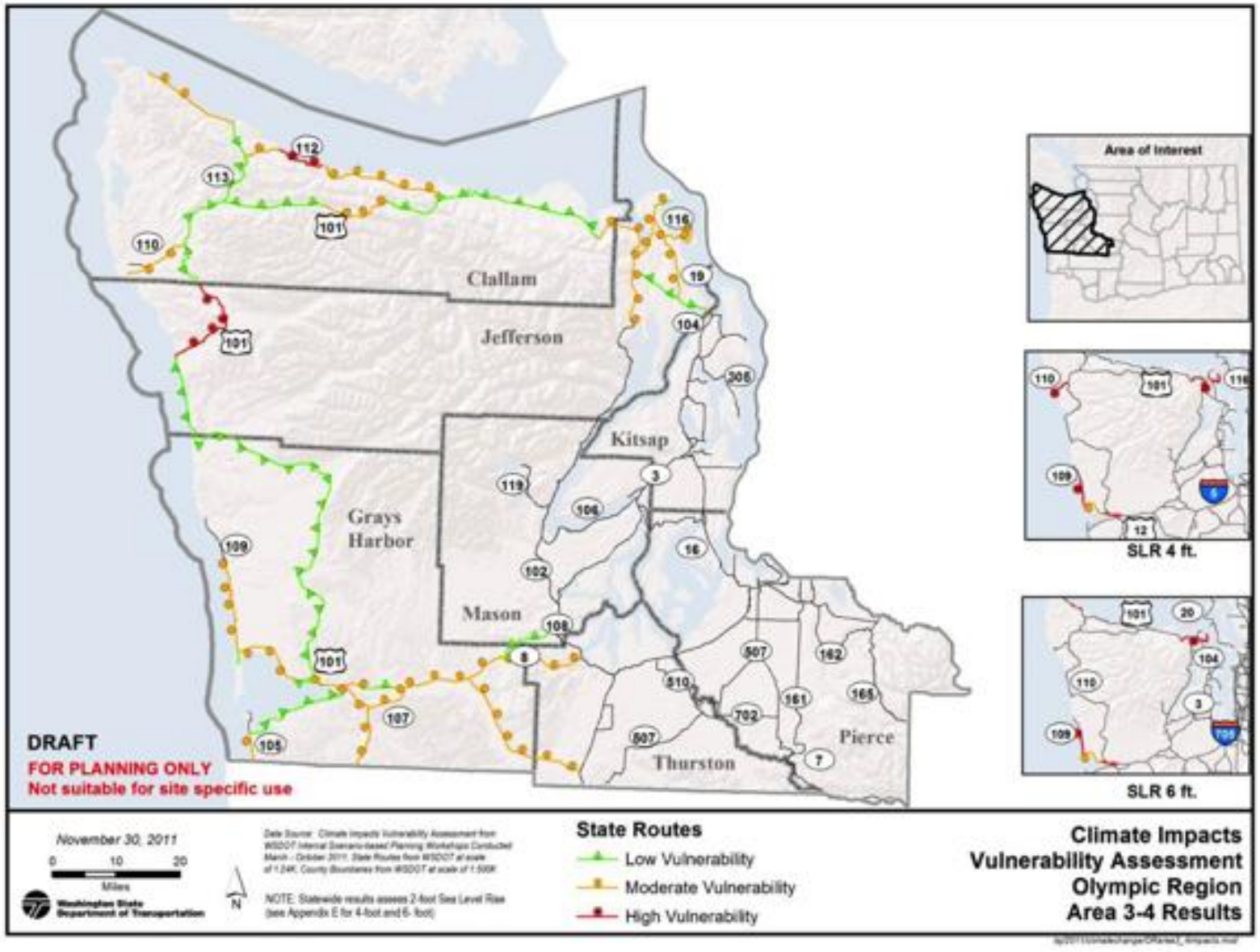
Critical Infrastructure "exposure" to climate change

Critical Infrastructure Sub-sector	Exposure to climate change
Downtown, Ports, Coastlines	Sea level rise, storm surge, and coastal flooding.
Floodplains and Stormwater	More intense and frequent extreme precipitation events bringing increased erosion, scouring, dispersion of more rocks and sediments, expanded flood zones, changes in side channel habitat.
Sewer and Septic Systems	Sea level rise, storm surge, and riverine flooding. Groundwater table alterations, shifting precipitation patterns, changes in evaporation rates (for mound septic systems).

Transportation corridor vulnerability



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Vulnerability Rankings for Critical Infrastructure

ADAPTIVE CAPACITY	SENSITIVITY: LOW → HIGH				
	S0	**S1**	**S2**	**S3**	**S4**
AC0 (LOW)			• **Clallam Bay/Sekiu sewage treatment *(short-term)***	• **Clallam Bay/Sekiu sewage treatment *(long-term)***	• **Port of Port Townsend Boat Haven** • **Port of Port Townsend Point Hudson** • **Urban Areas/ Ports**
AC1				• 3 Crabs Road • **Downtown Port Townsend and Kah Tai Lagoon** • Roads in Clallam Bay	
AC2		• **Coastal Septic Systems Water Quality**	• **Vacuum Sewer System at Elwha Lowlands** • Highway 116 • Highway 20 and the Port Townsend Ferry • **Port Angeles Ediz Hook**	• **Septic systems** • Highway 112 • Hoko/Ozette road • Forest roads for fighting fires • **Low-income retirees** • **Floodplains**	• **Stormwater outfall infrastructure** • Highway 101 • **Low-income families** • **Veterans/ Homeless** • **Clallam Bay/ Sekiu Sewer system (overall)**
AC3		• Electrical Transmission Infrastructure • Public Warning Systems *(All-Hazards)*	• Clallam/Wheel/Wart/Burlingame bridges • Forest Roads to communication towers • South Jefferson County	• Port Angeles Landfill • Highway 104/Hood Canal bridge • **City of Port Angeles industrial waterfront – Ediz Hook and Lower Elwha** • **Stormwater management**	• **Sewer outfall infrastructure**
AC4 (HIGH)					

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TOP 10 **Strategies for Critical Infrastructure**

WATER SUPPLIES ECOSYSTEMS

STRATEGY	SCORE	TYPE	LEAD GROUP(S)	CO-BENEFITS
Update Emergency management and response planning to include climate change where needed	20	PLANNING	Emergency Manager	
Reduce inflow and infiltration to wastewater systems	19.5	POLICY	Operations and Maintenance Dept.	
Update planning documents to incorporate sea level rise and flooding where needed	19	PLANNING	Multi-Stakeholder	
Do outreach and education on climate adaptation to build community support	19	AWARENESS	Multi-Stakeholder	
Develop and utilize decision making tools related to climate change risks	18	PLANNING	Local Governments	
Create critical area flood mapping beyond FEMA's historical flood data	17	PLANNING	Multi-Stakeholder	
Encourage soft defenses for shoreline infrastructure	16	POLICY	Local Government & Private Sector	
Improve on-site stormwater management practices	16	POLICY	Multi-Stakeholder	
Participate in FEMA's Community Rating System (CRS)	16	PLANNING	Multi-Stakeholder	
Enhance stormwater retention in upstream areas	16	POLICY	Multi-Stakeholder	

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Critical Infrastructure Adaptation Strategies - Detail

CI-3: Update planning documents for sea level rise and flooding where needed					
Score	Type of Strategy	Timeframe for Implementation*	Lead Group(s)	Opportunities or Concerns	Focus Area Co-benefits
19	Planning	Near Term	Multi-Stakeholder	*Medium and long-term issue where planning now can help reduce future costs*	*Ecosystems*

*Near-term (0-3 years), Medium-term (3-10 years), Long-term (>10 years)

Key Action Steps:

- Create a sea level risk district for inclusion in Comprehensive Plan and promulgate new codes and code changes associated with managing for sea level risk.
- Incorporate climate change and coastal hazard considerations into building codes by increasing freeboard requirements to two feet (three feet for critical projects) above the current 100-yr flood plain as buildings are redeveloped, developed, or renovated.
- See **Supplementary Information C** for more details.

Acknowledgements

The success of the project depended on the contributions of everyone involved. We are particularly grateful for the work of the Project Team, Core Team, and 175 partners that participated in the project.

The range of partners included cities, counties, tribes, environmental organizations, ports, public utility districts, Washington State University, WA State Department of Natural Resources and Ecology, WA Sate Department of Transportation, industry representatives, and business organizations.

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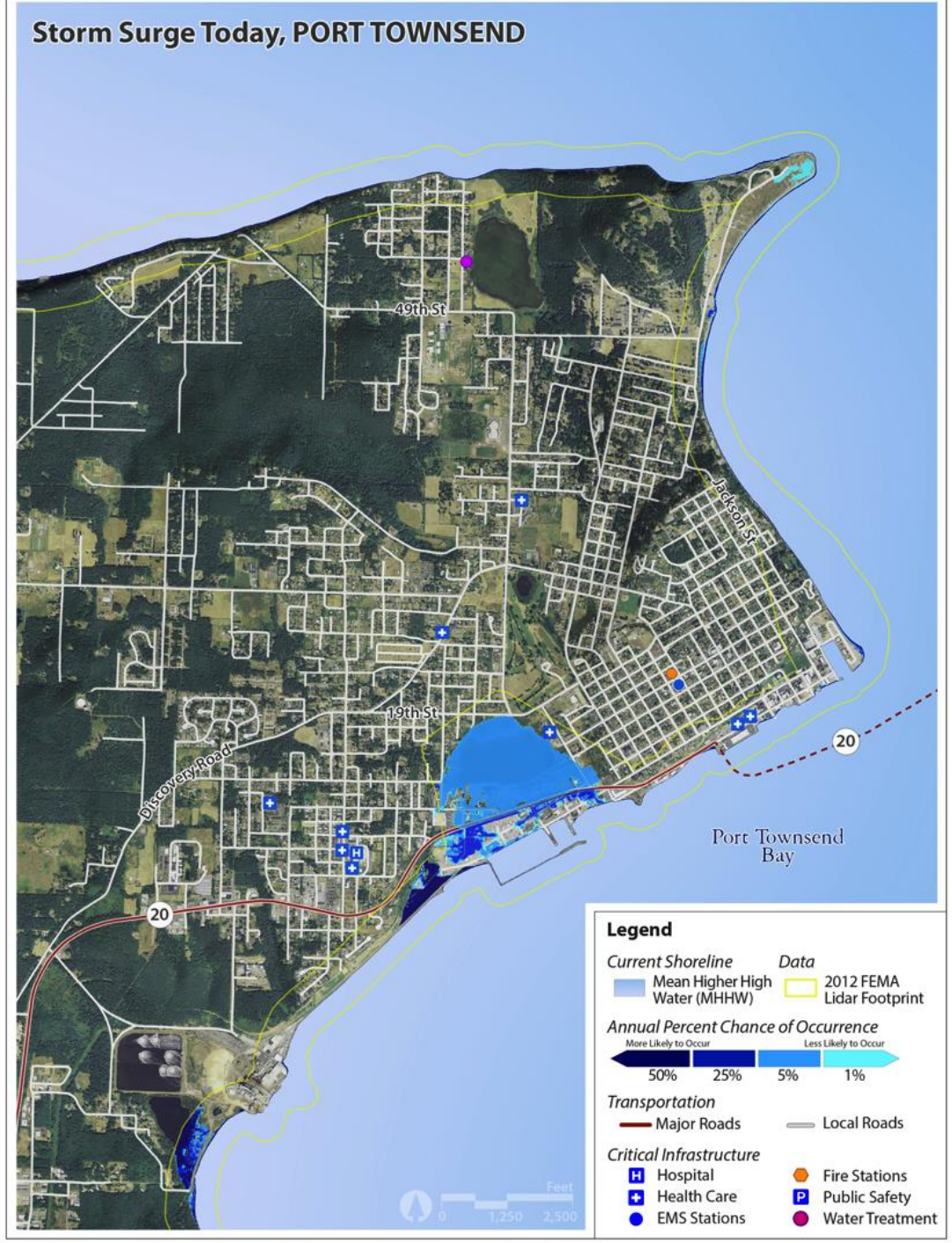
Thank You!

Full Report & Additional material available at:

www.noprcd.org

Sea Level Rise: Port Townsend



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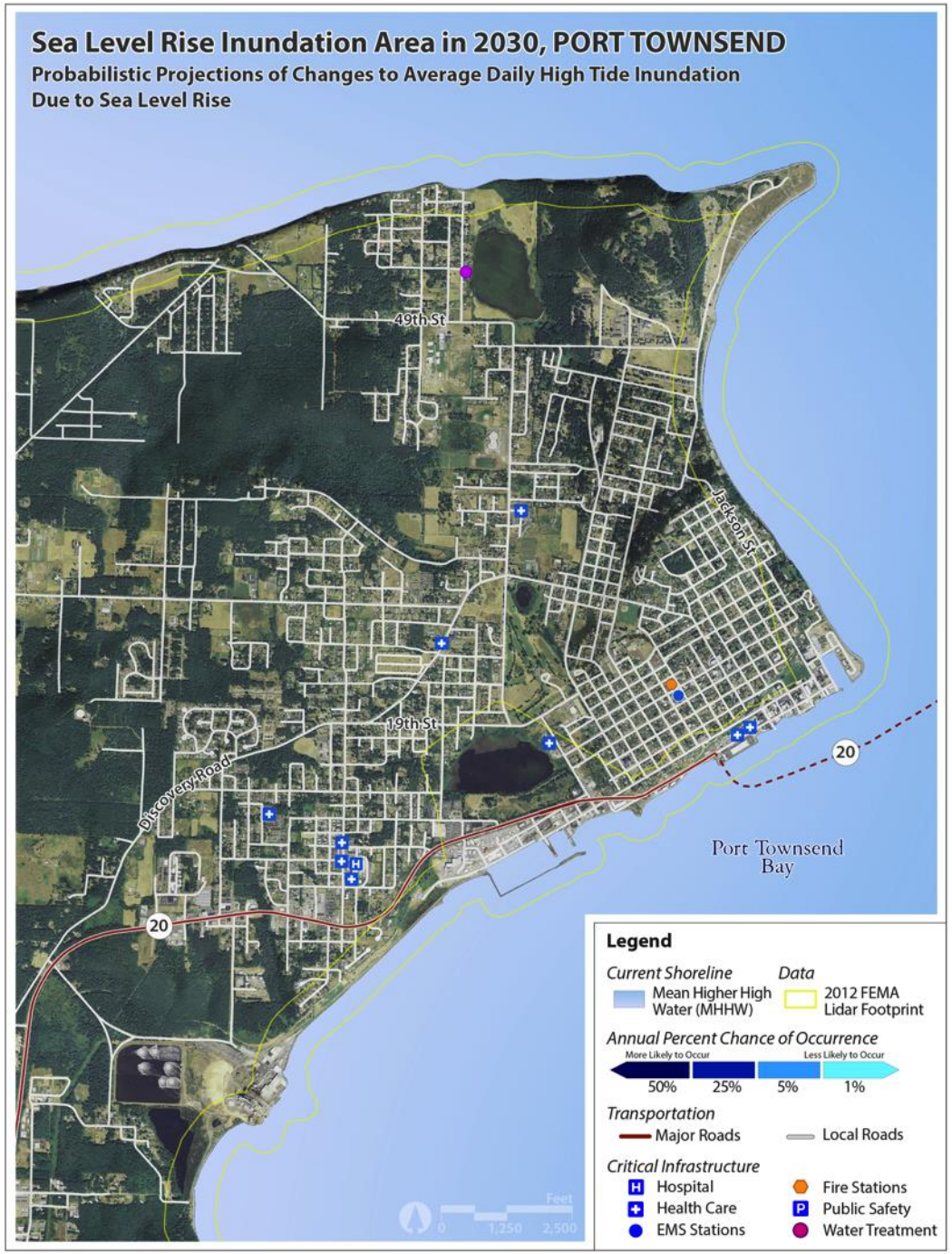
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Probabilistic Projections of Changes to Average Daily High Tide Inundation
Due to Sea Level Rise
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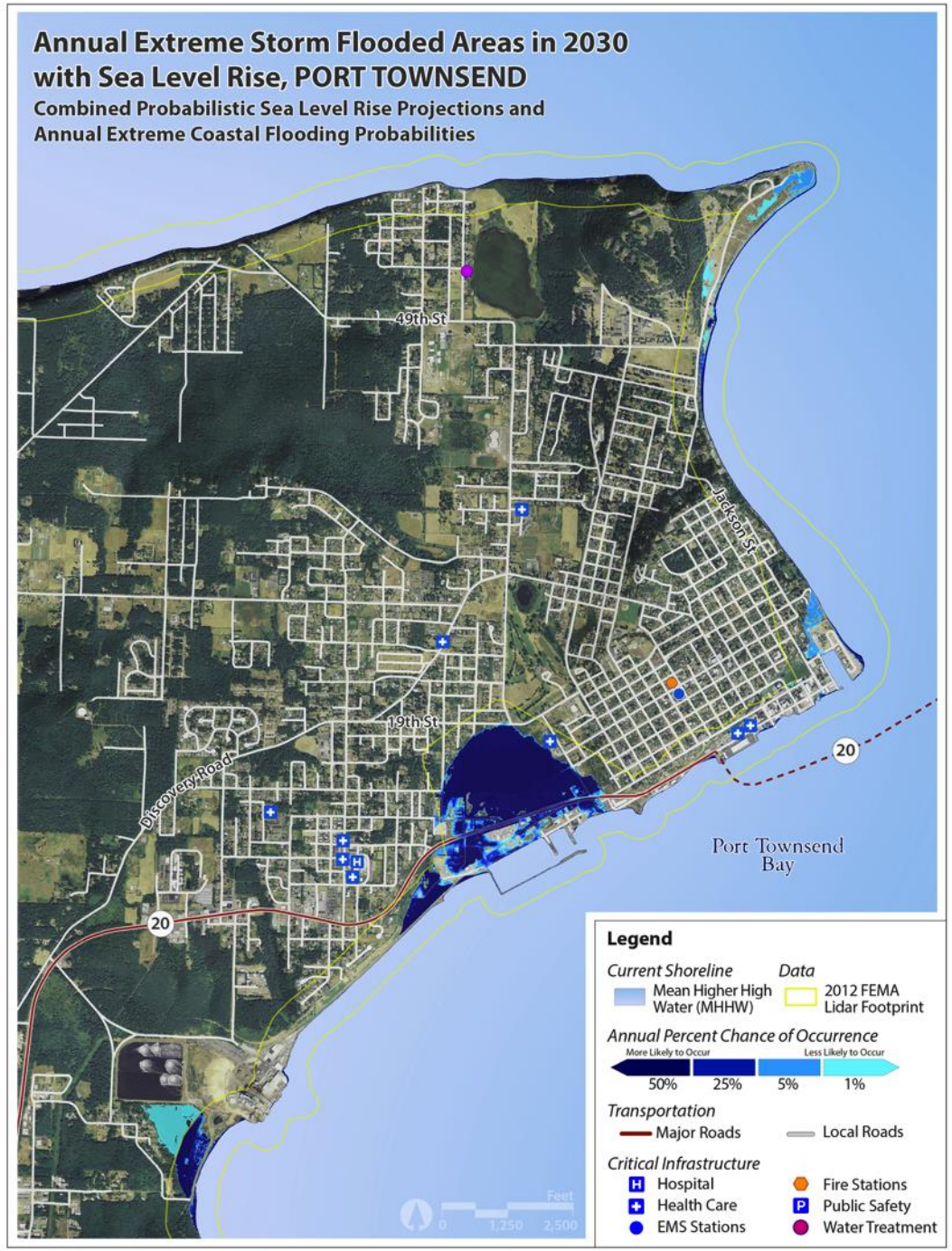
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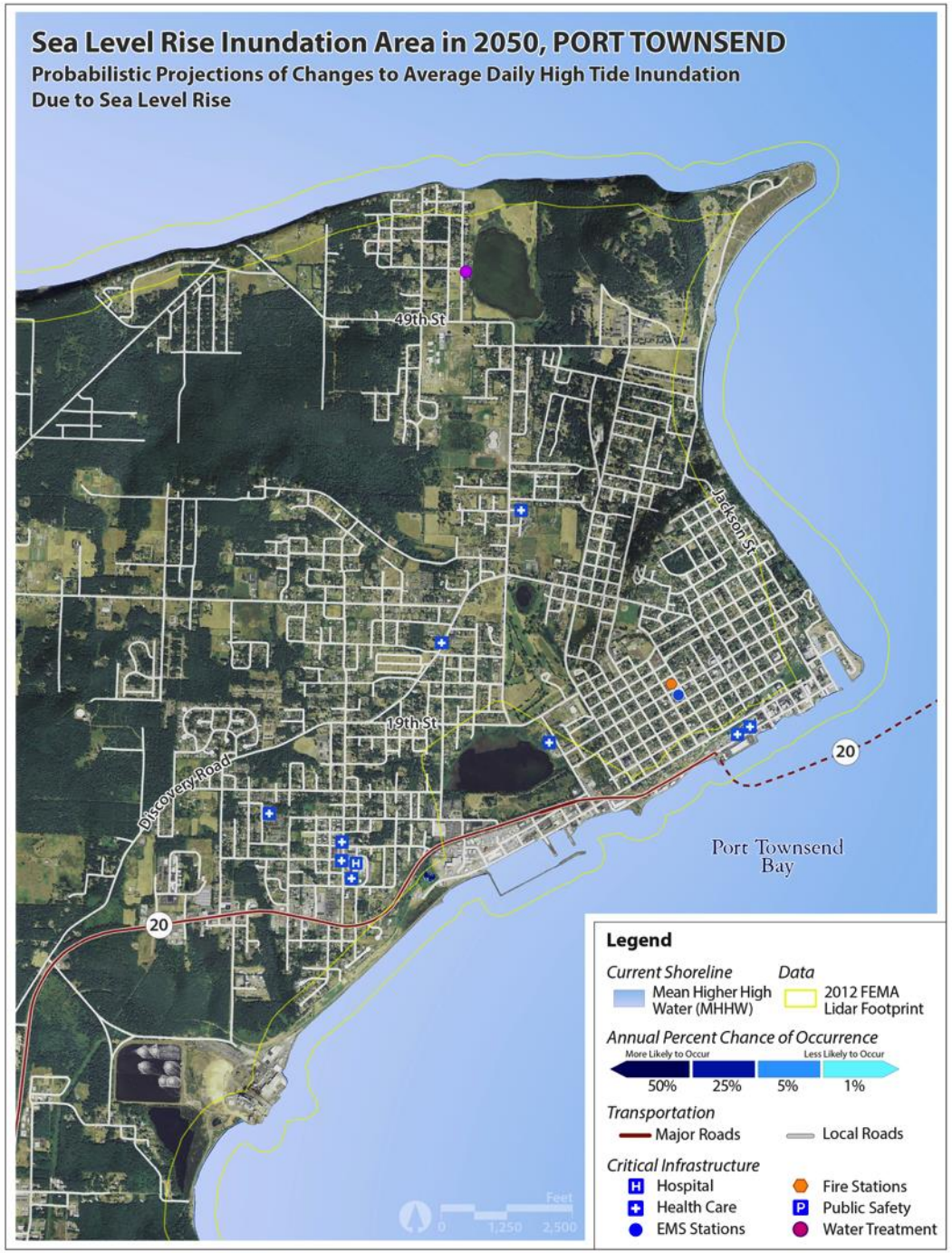
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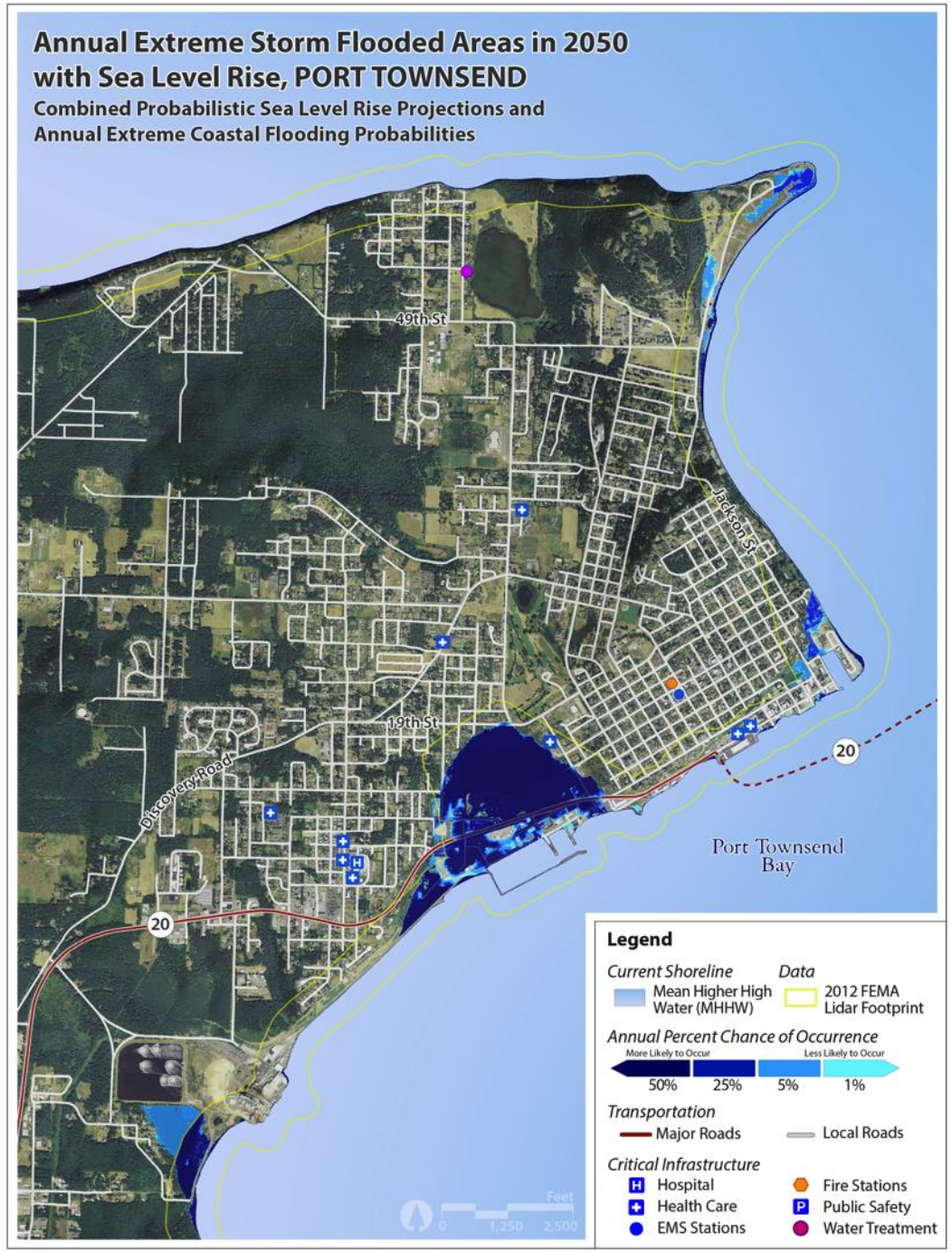
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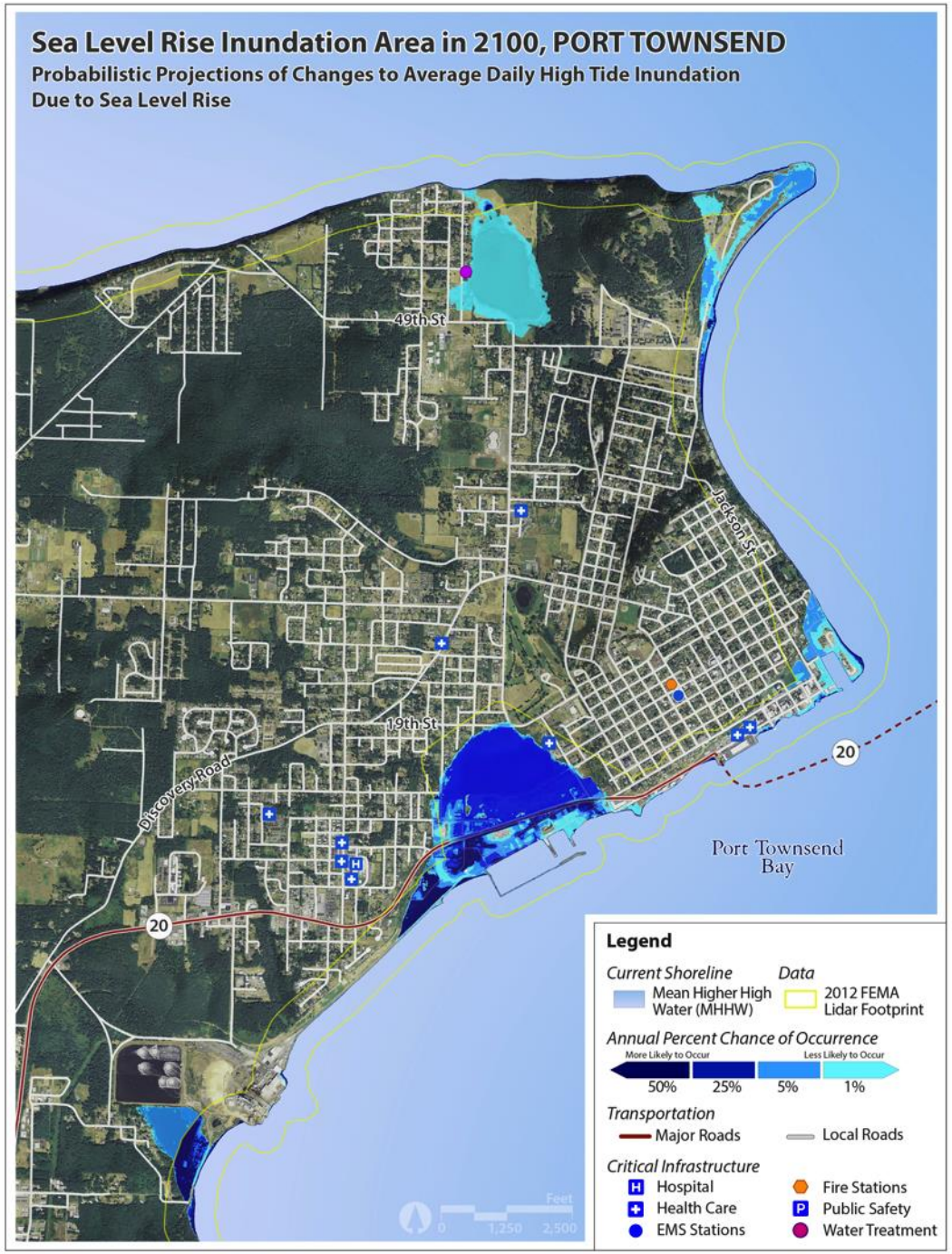
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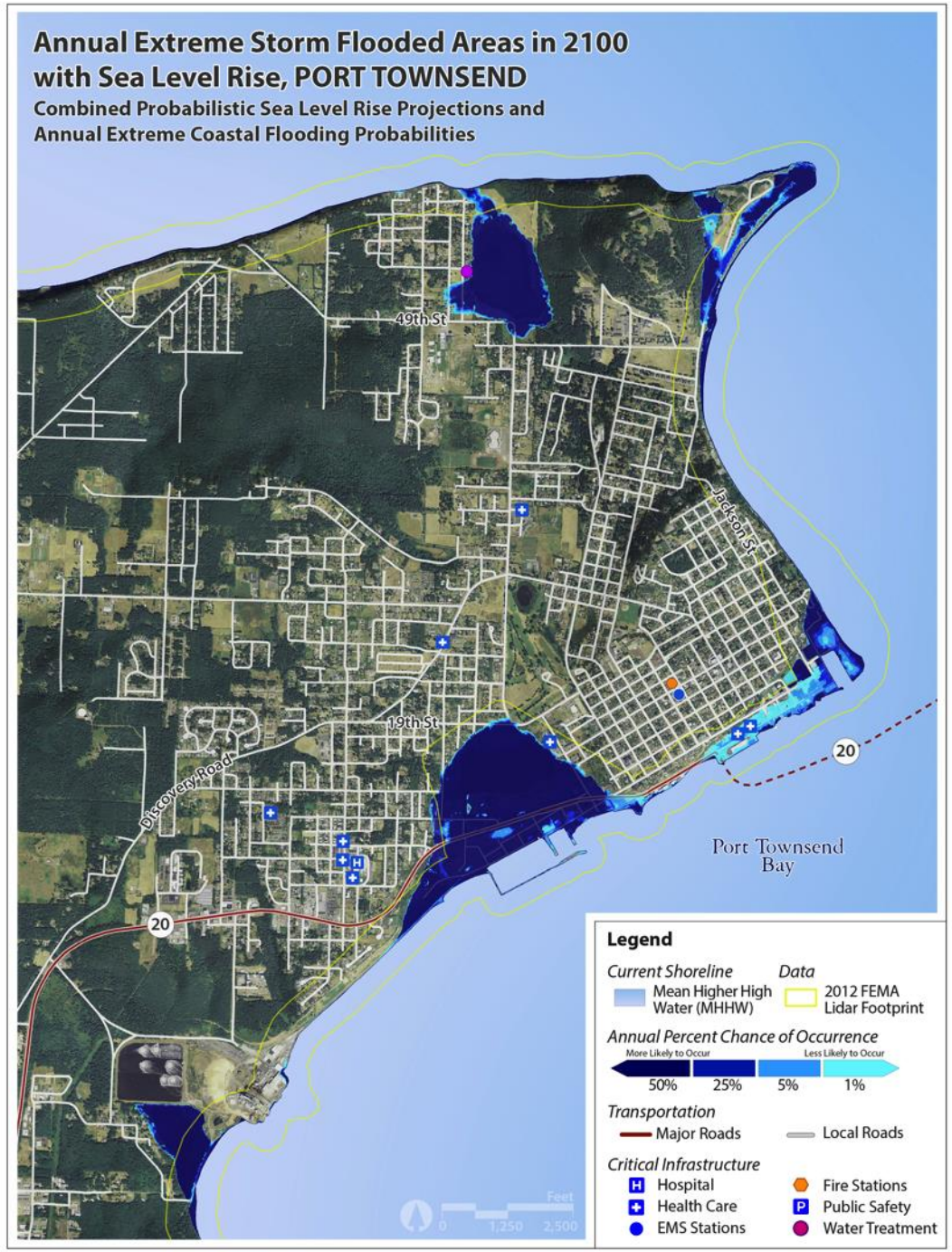
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Sea Level Rise: Port Angeles

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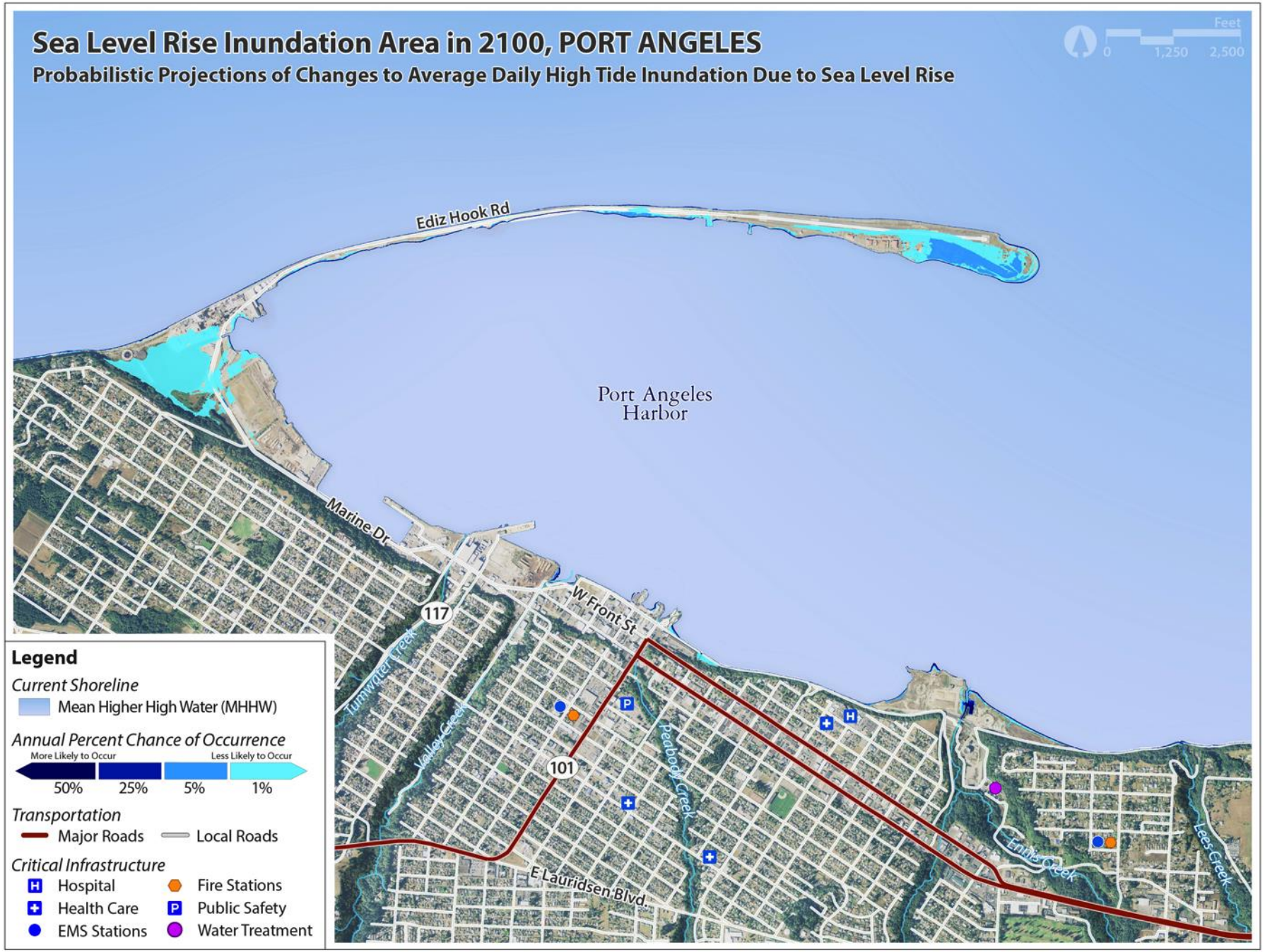
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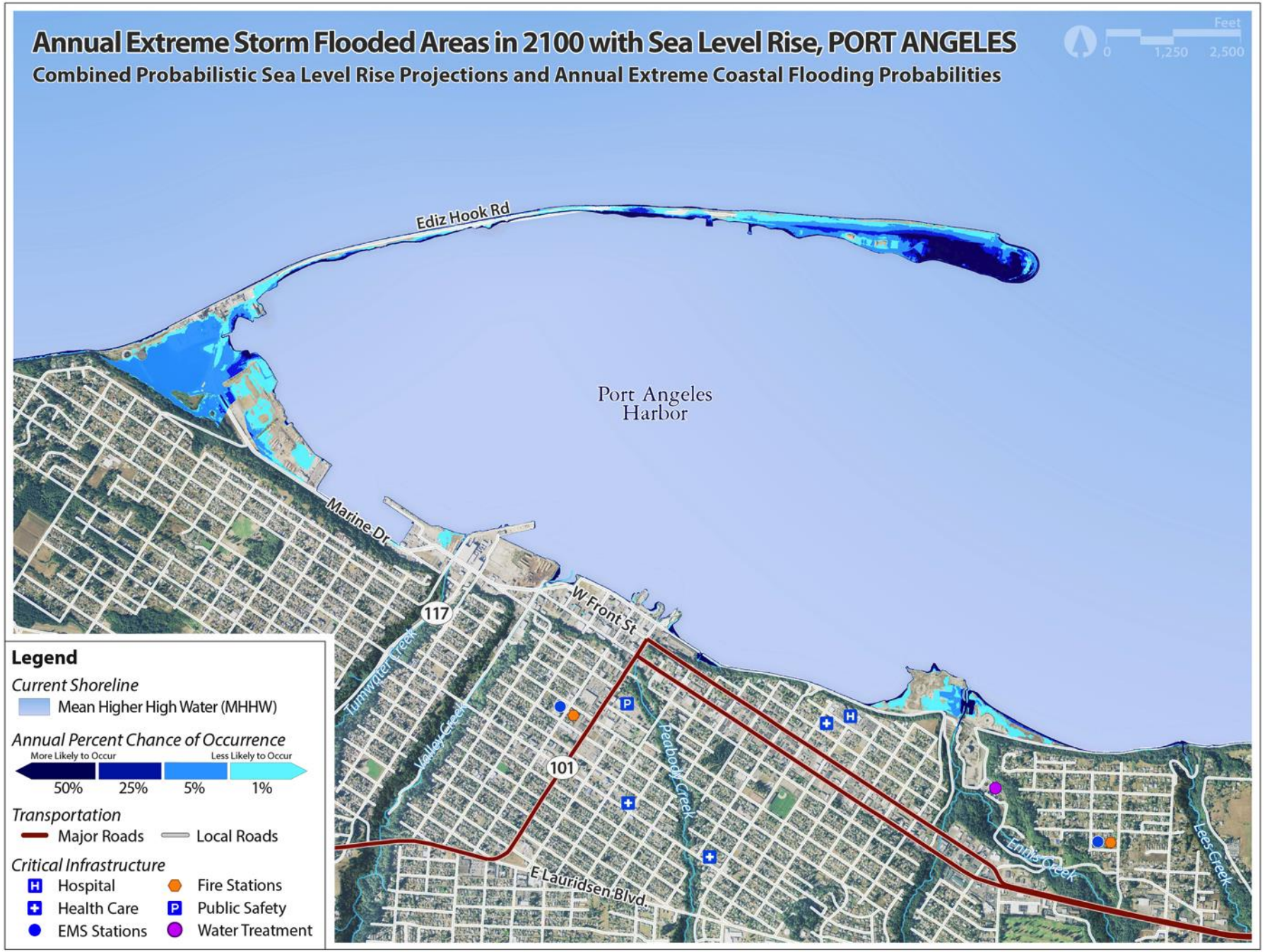
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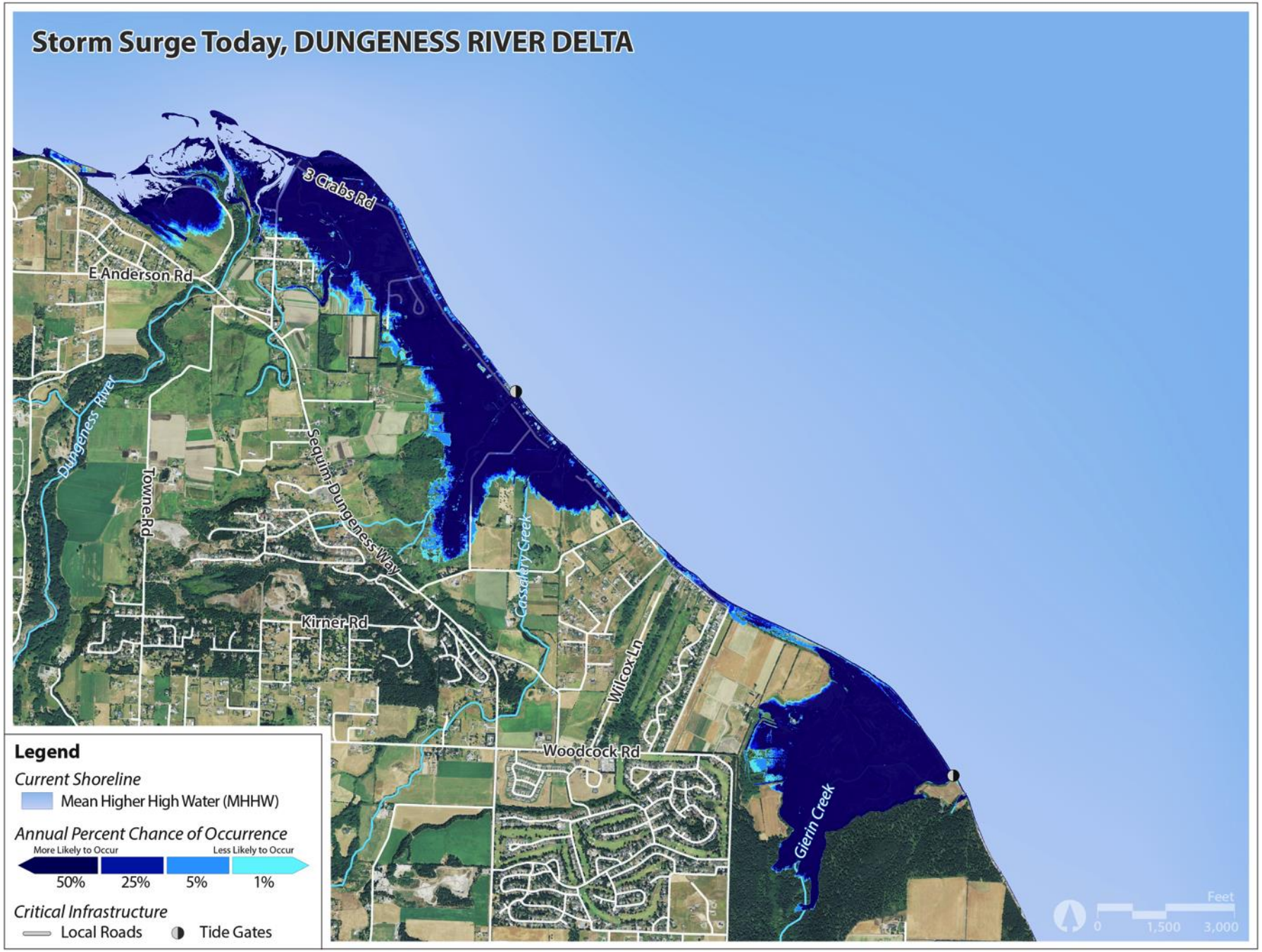
Sea Level Rise: Dungeness River Delta



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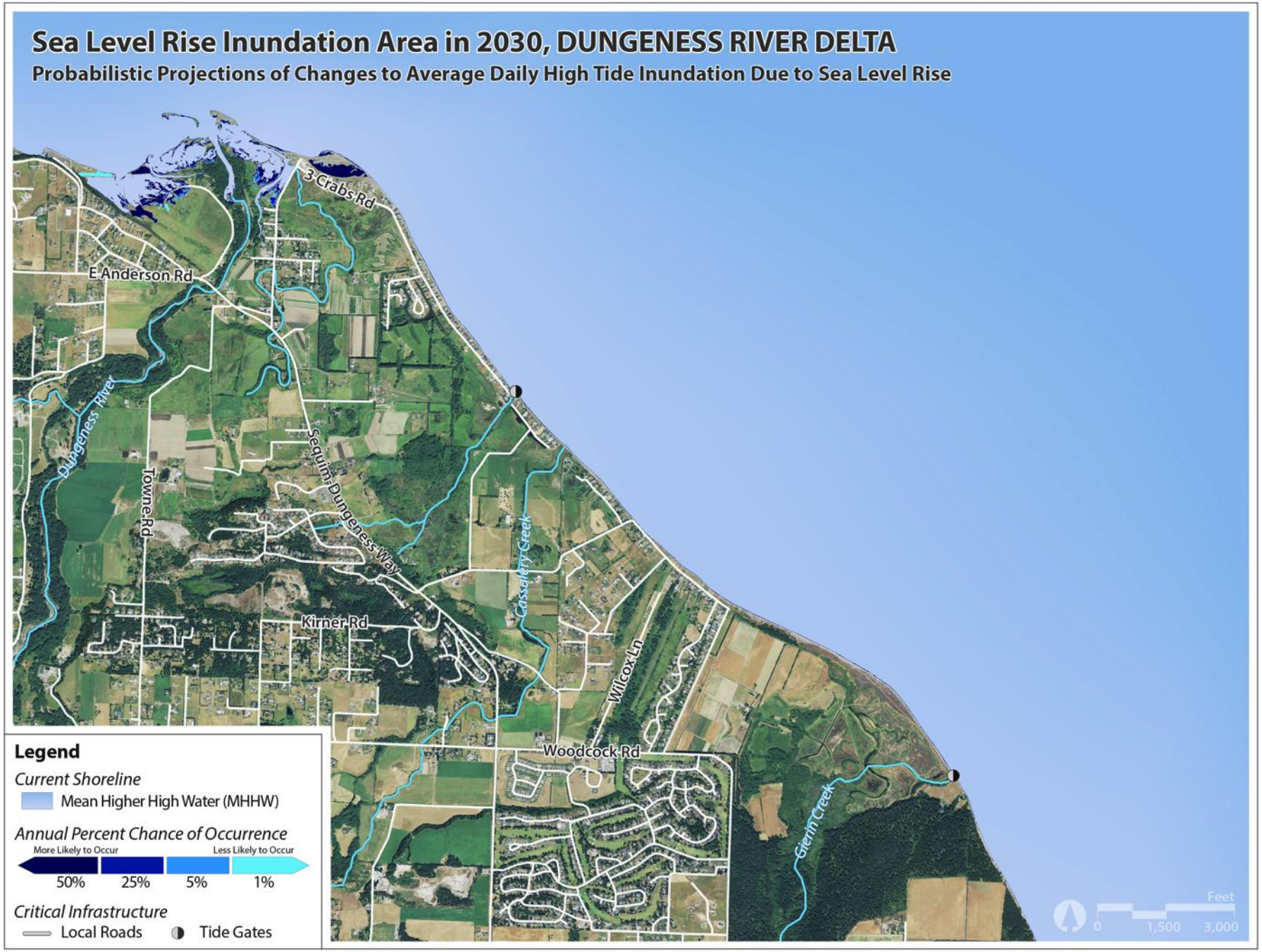

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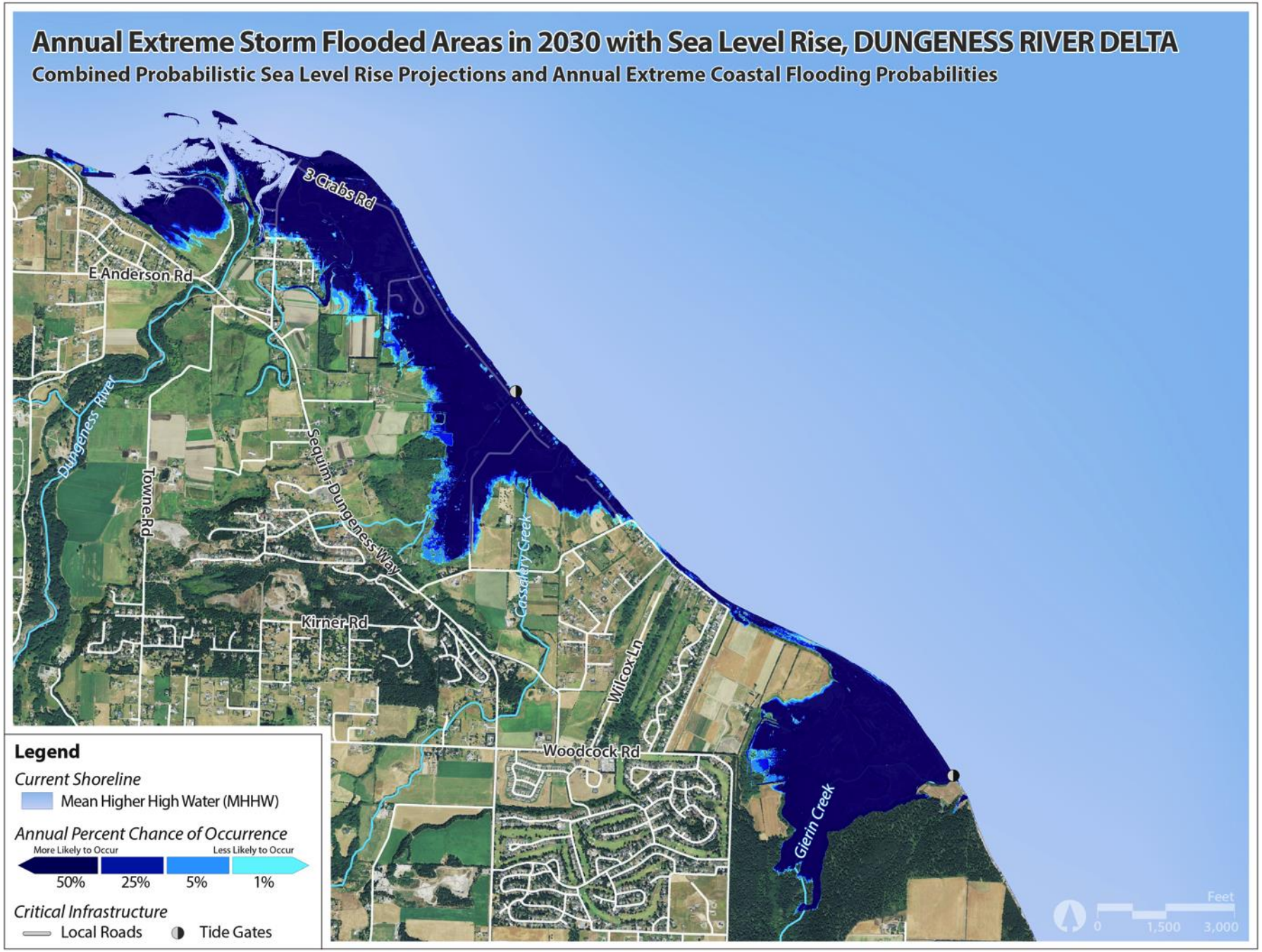

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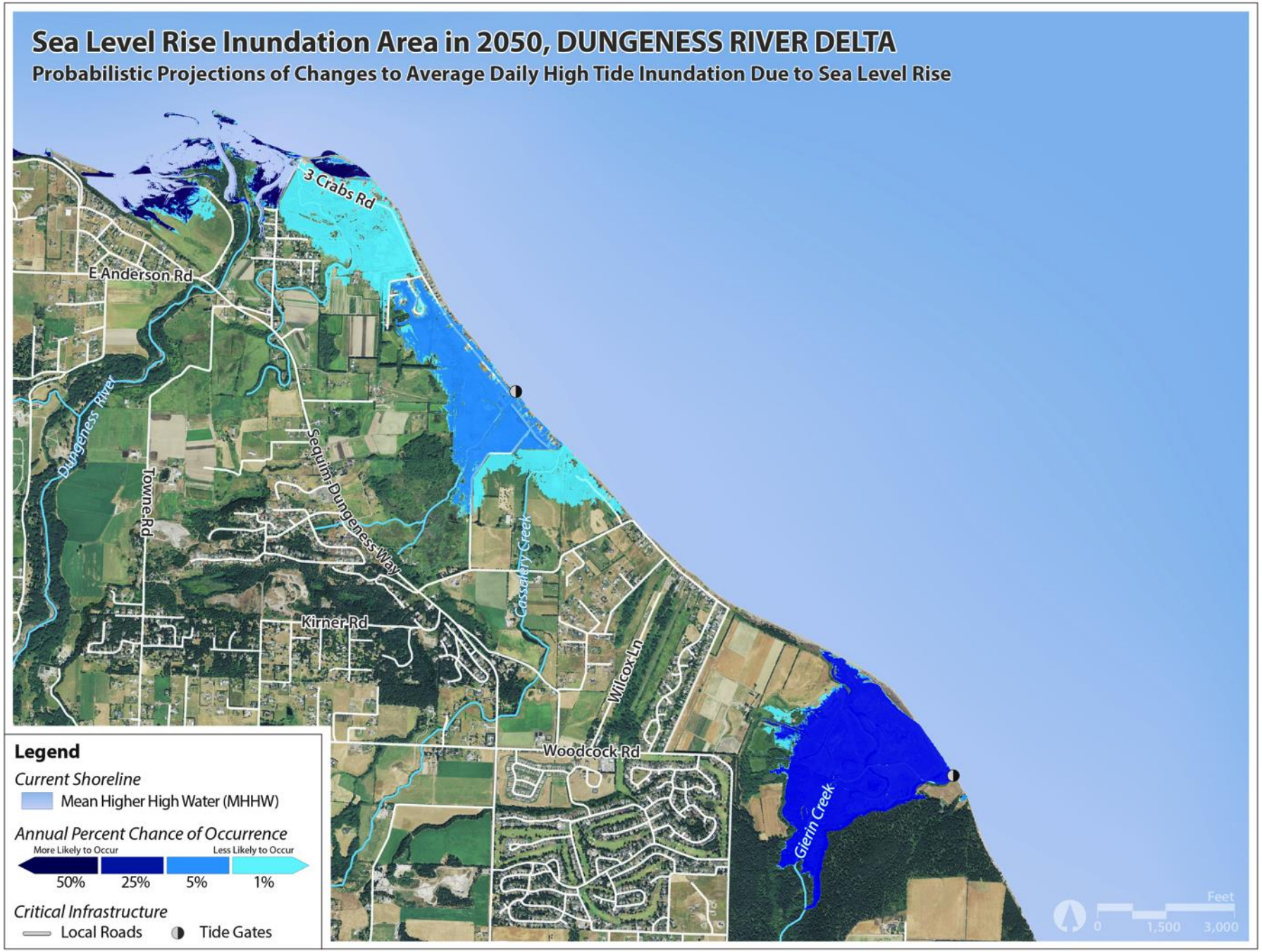

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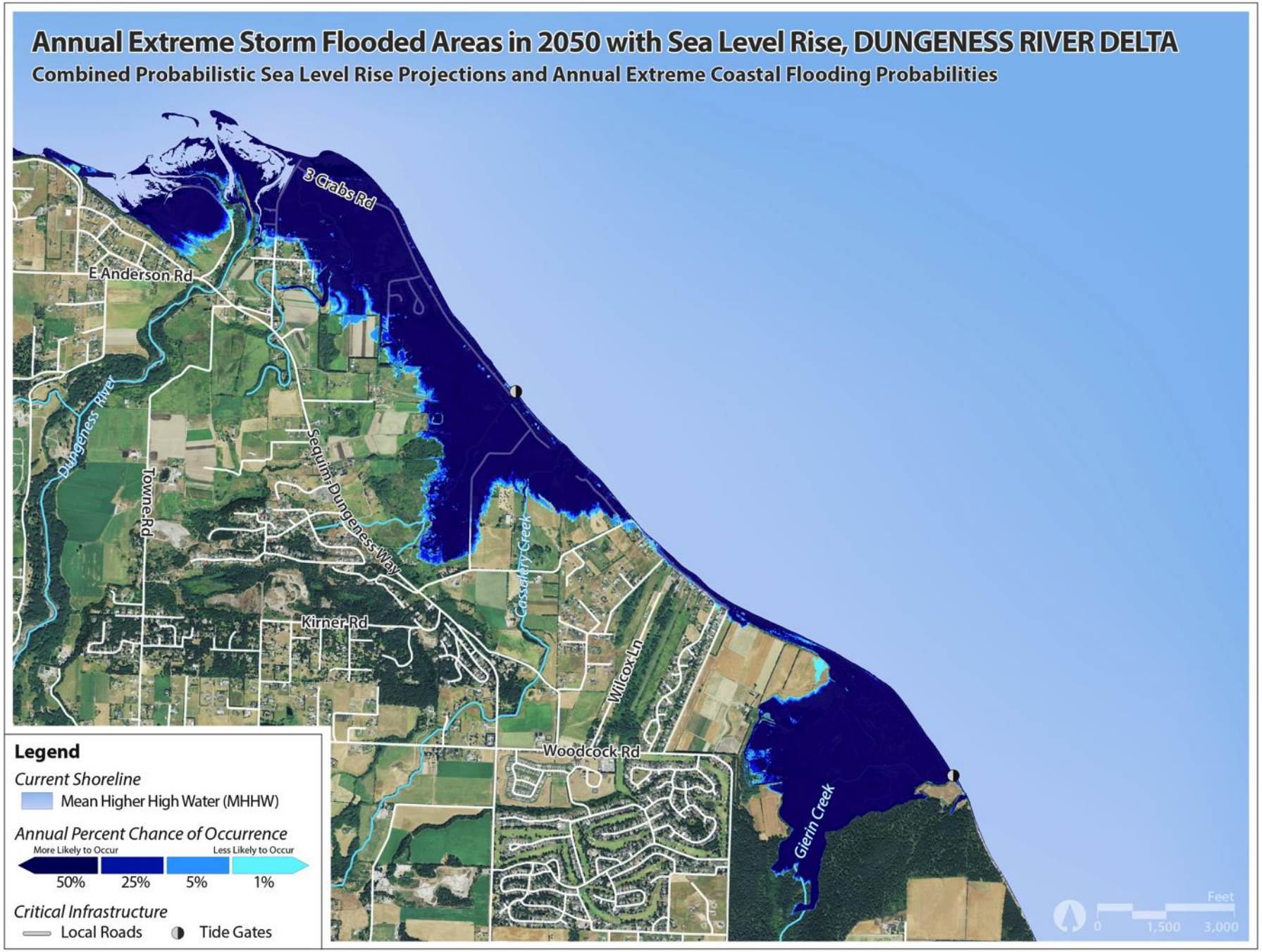

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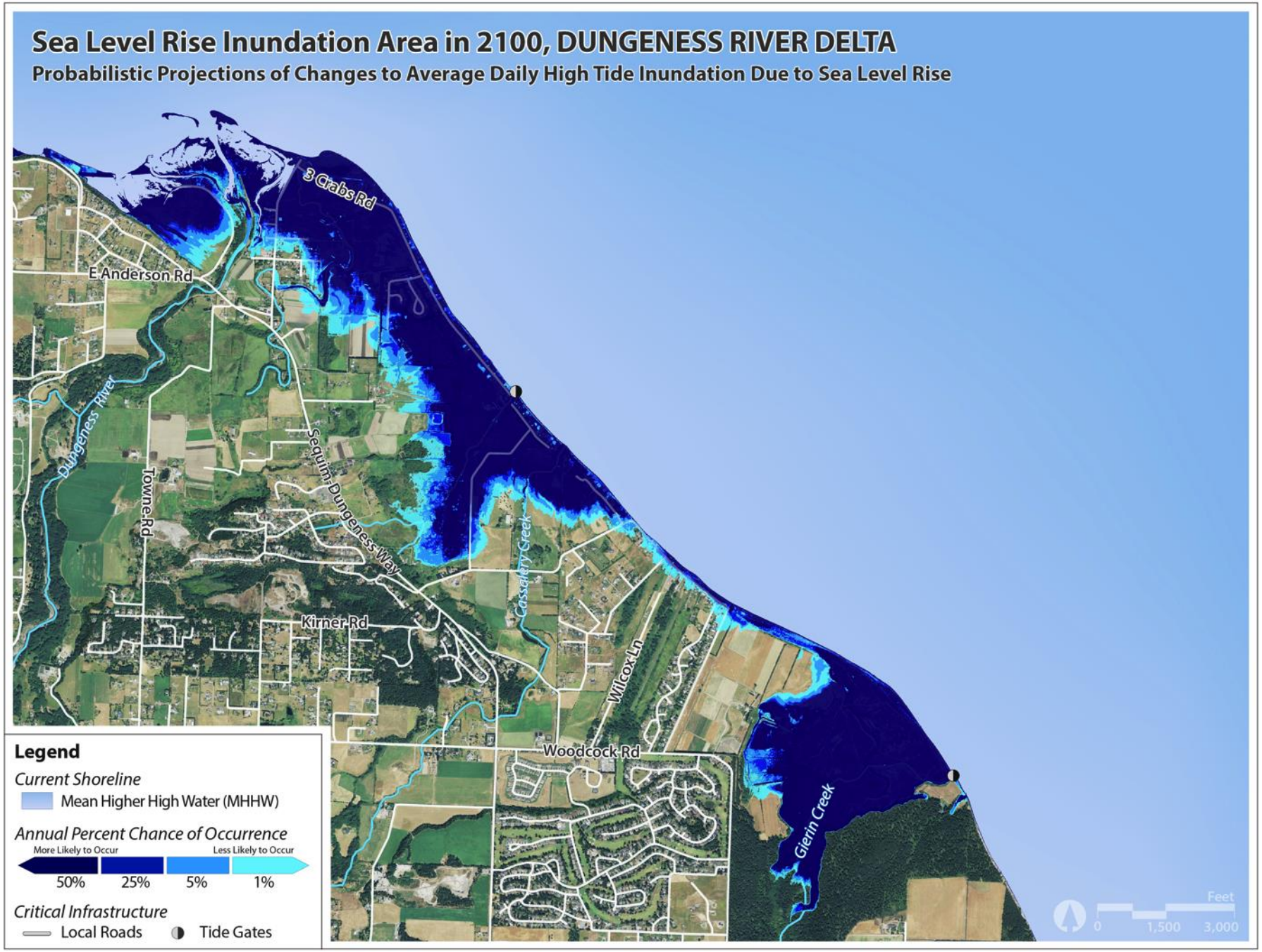

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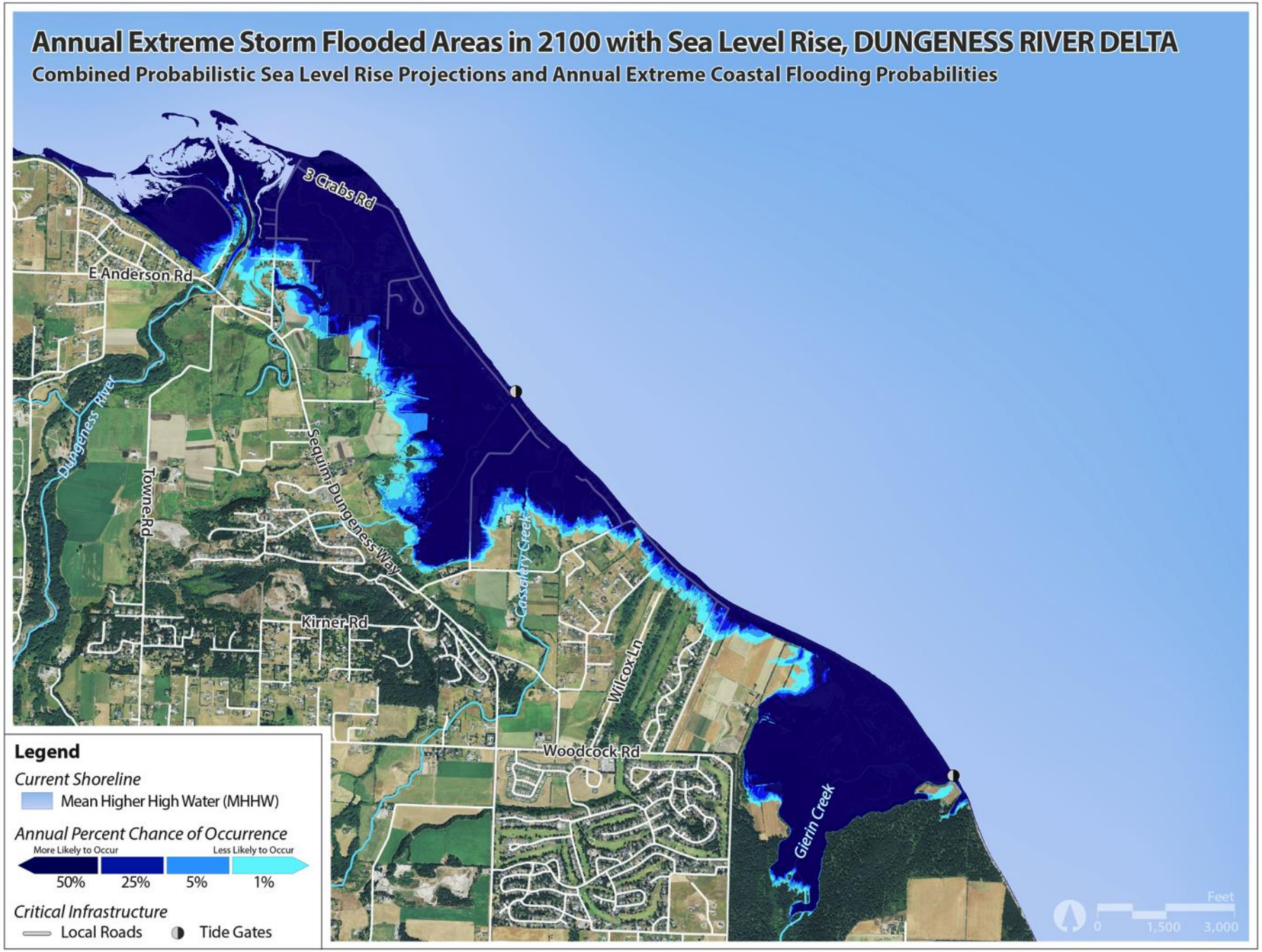

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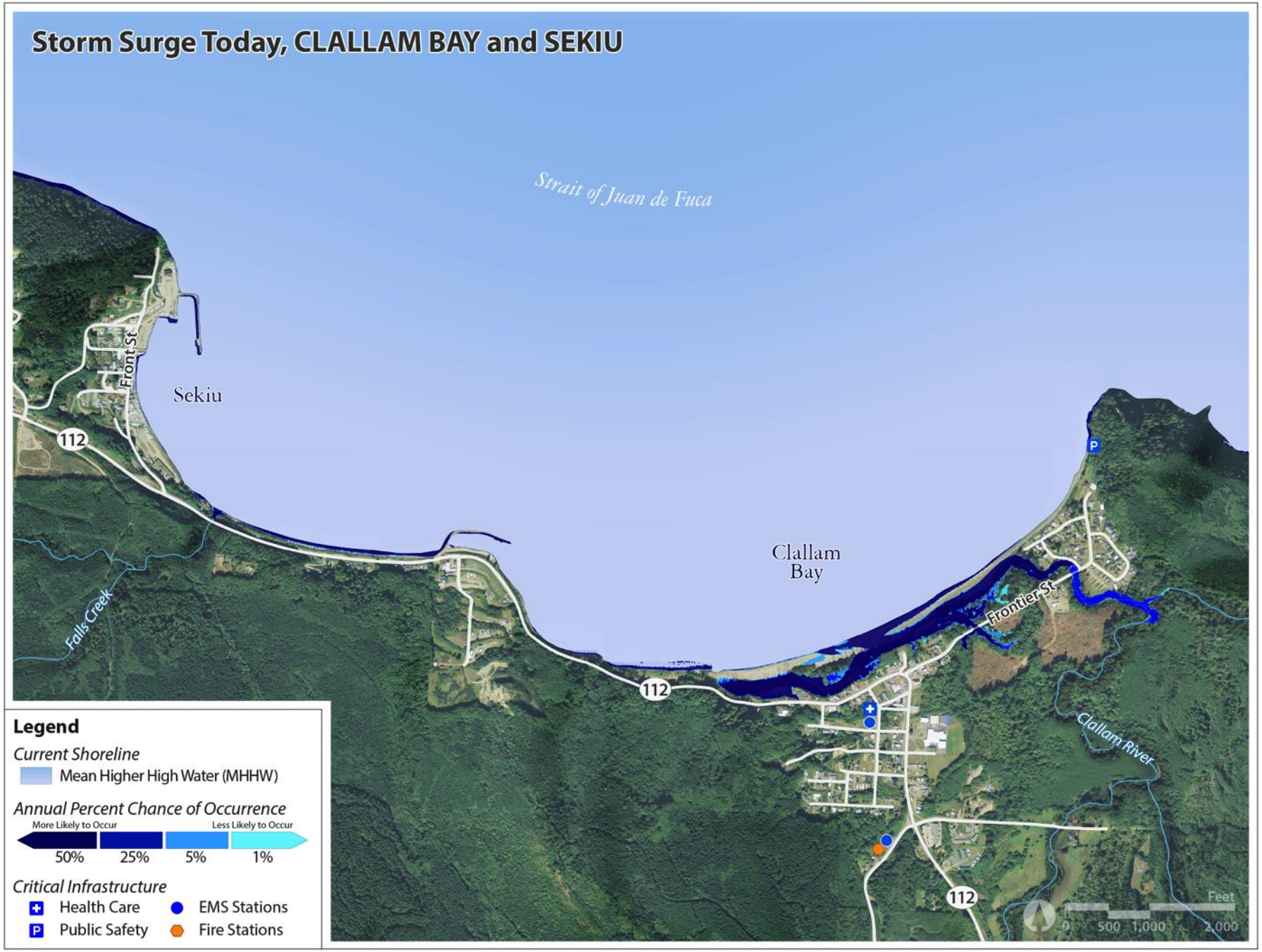
Sea Level Rise: Clallam Bay and Sekiu



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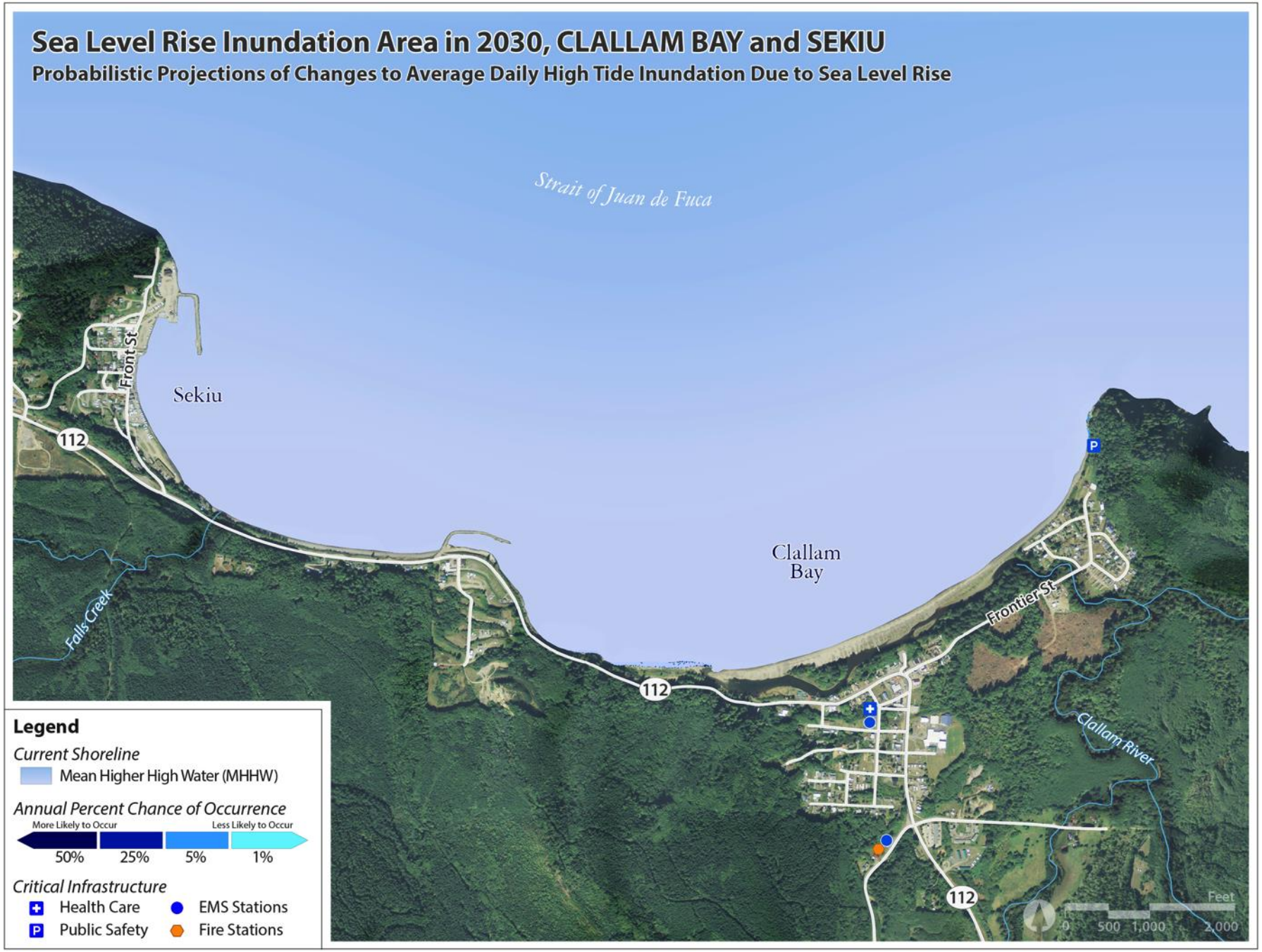
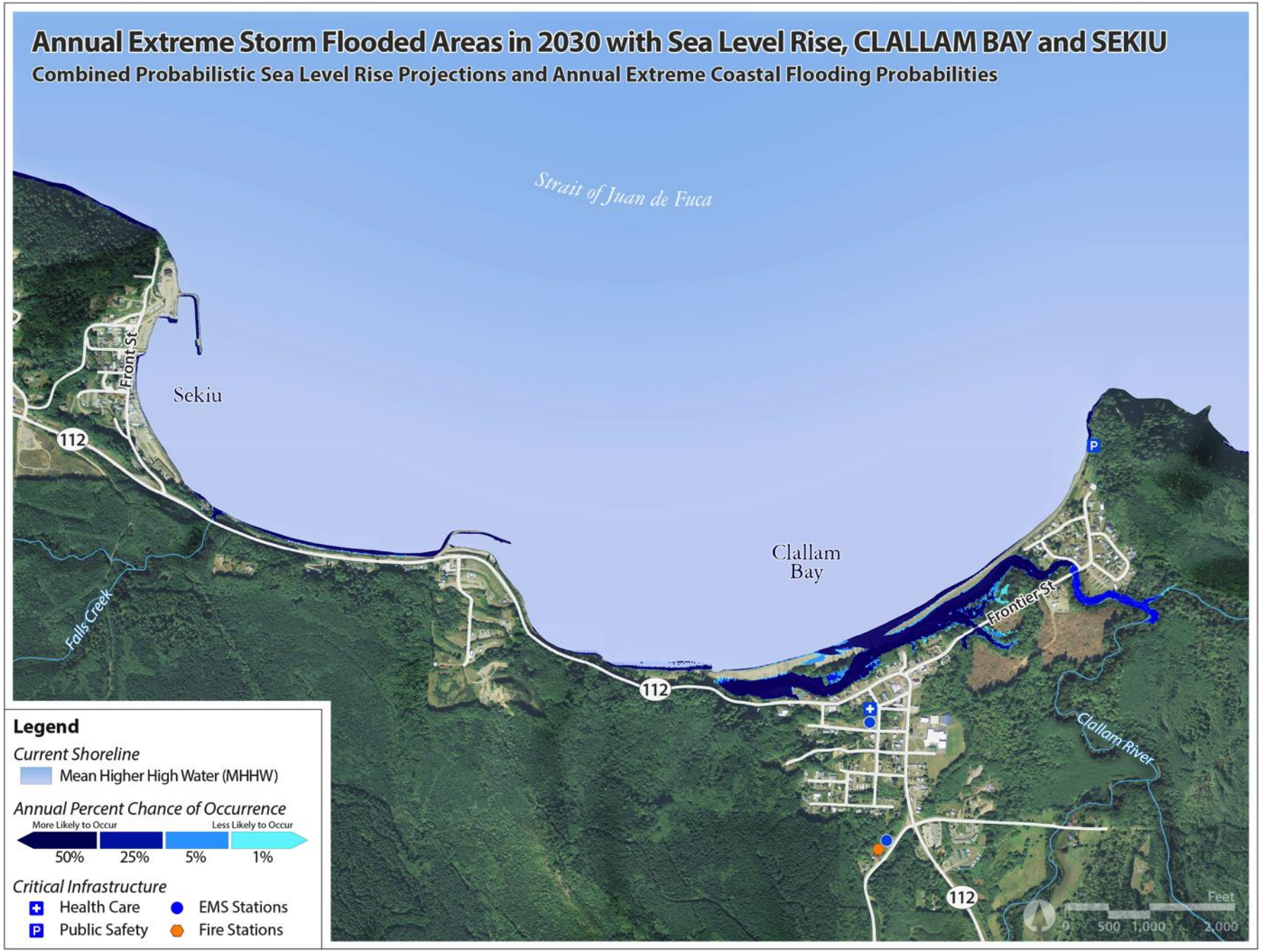


Sea Grant Washington



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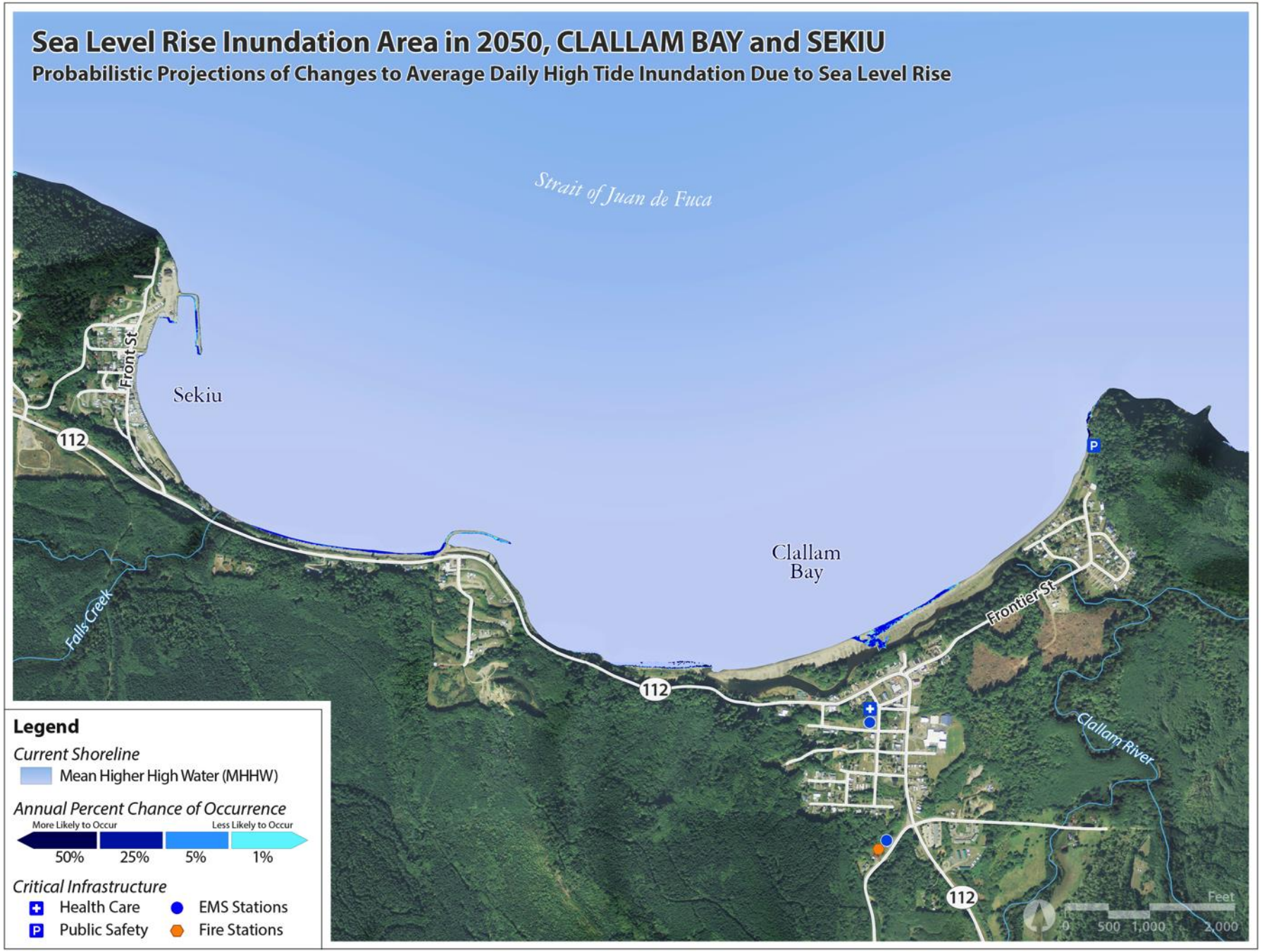
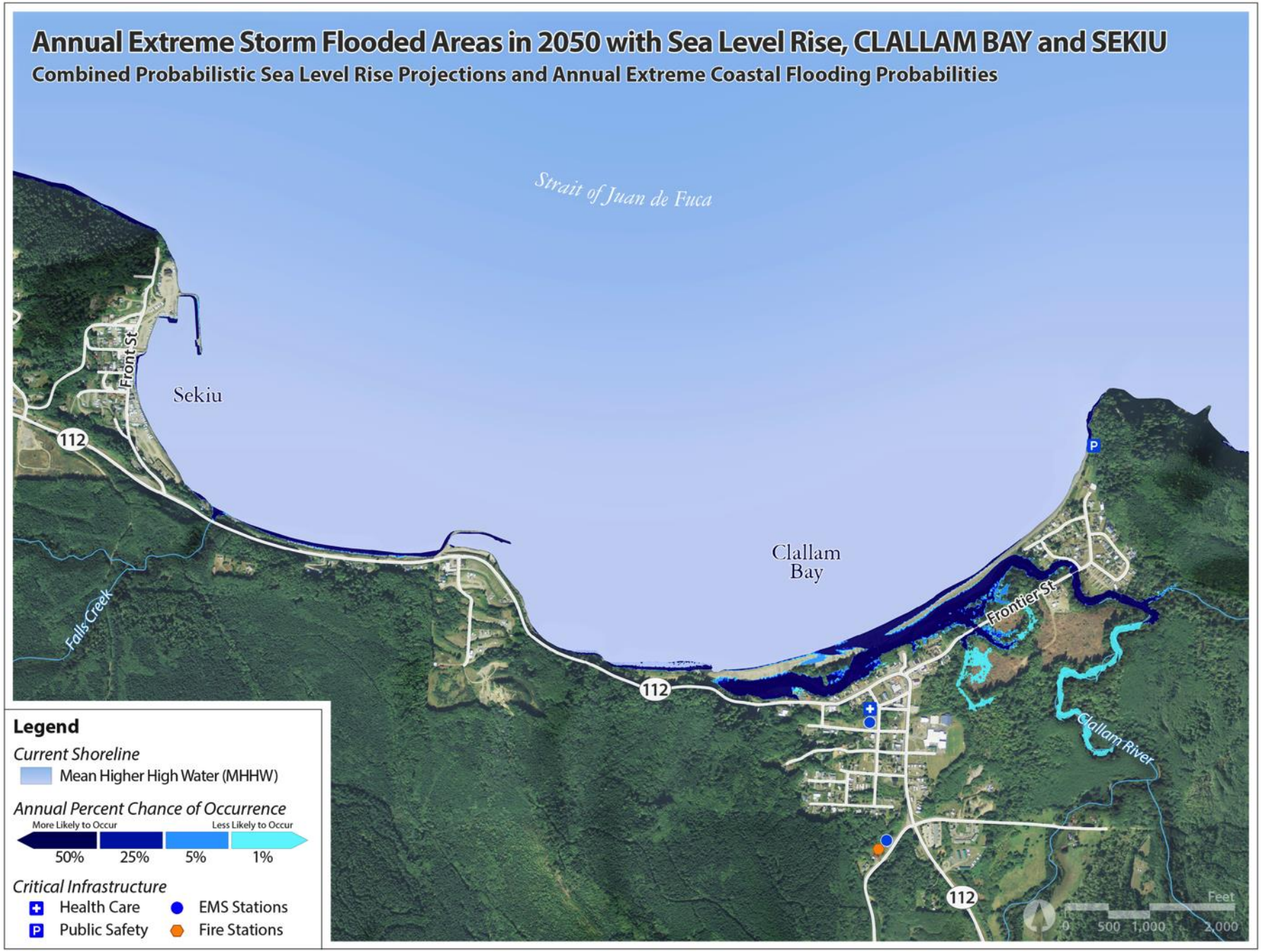


Sea Grant Washington



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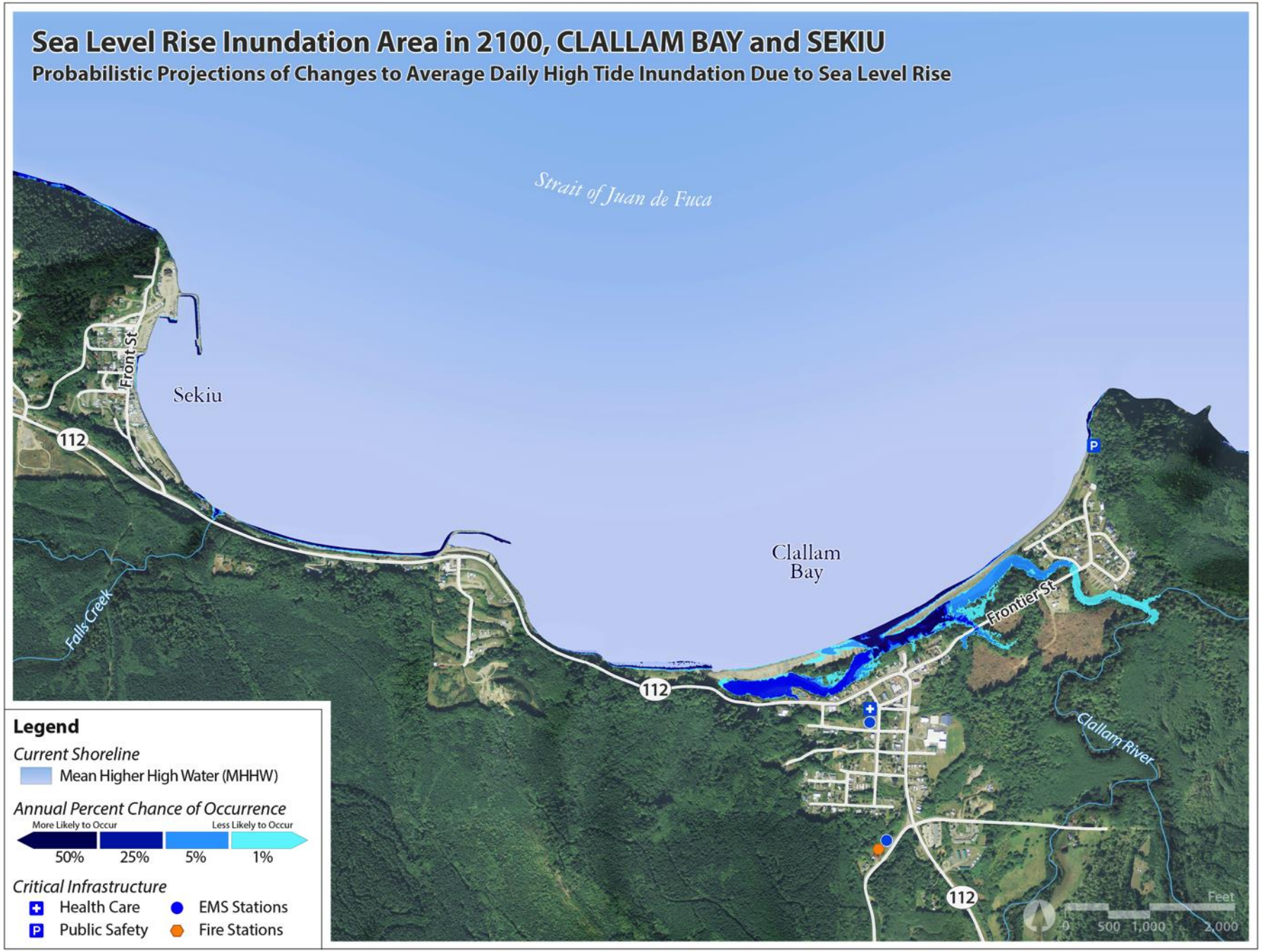

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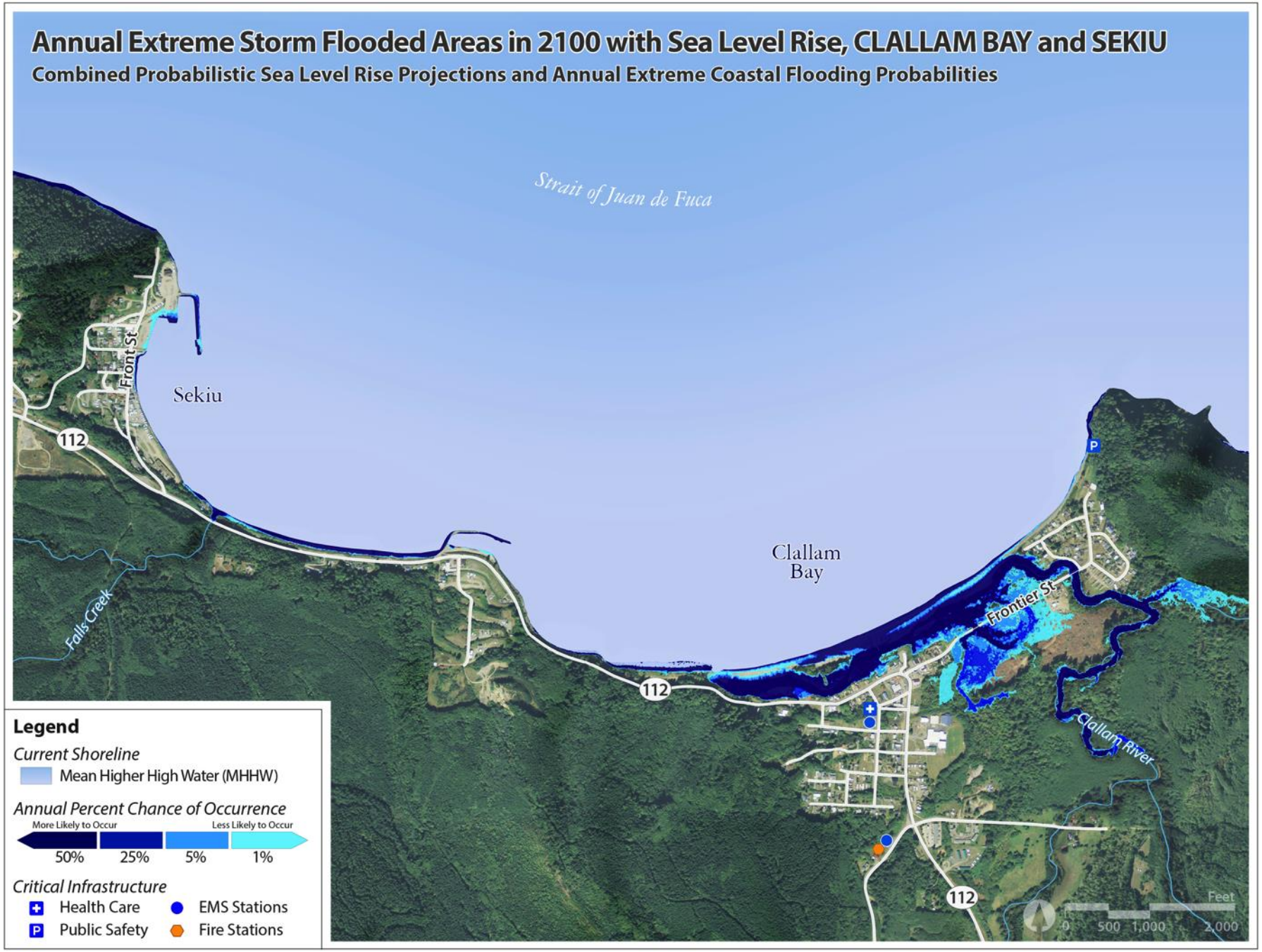
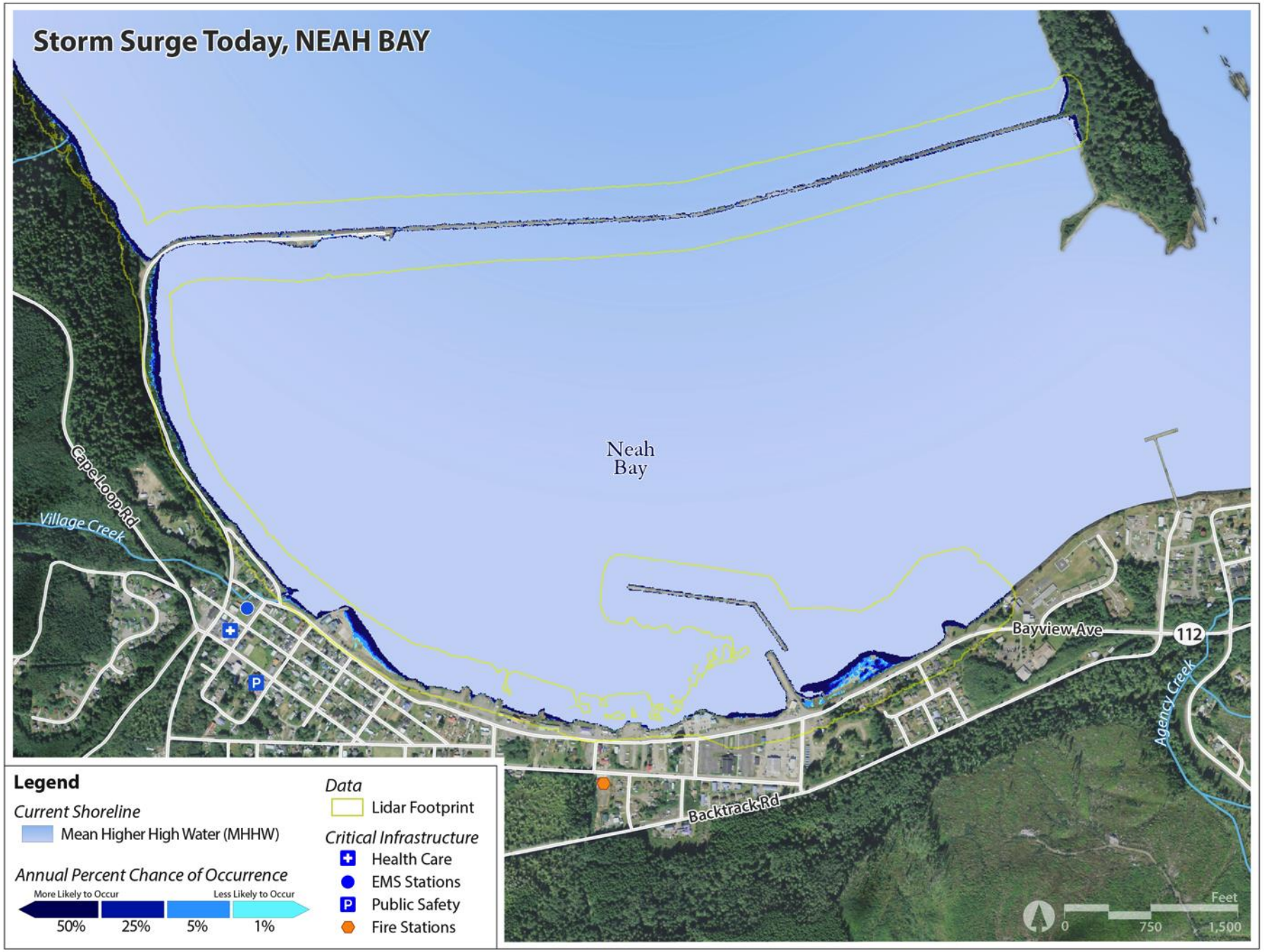


Sea Grant Washington

Sea Level Rise: Neah Bay



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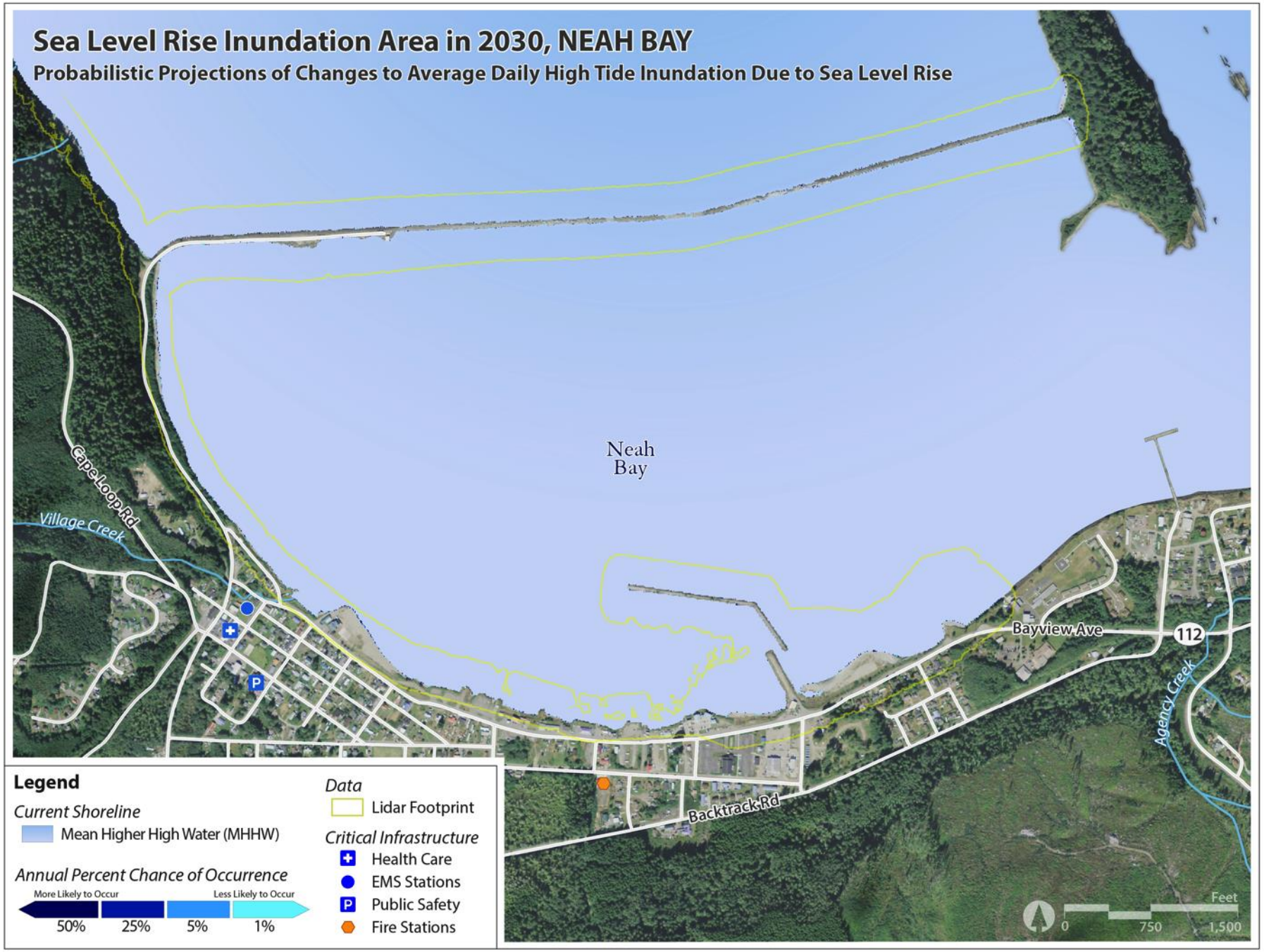
Sea Level Rise Inundation Area in 2030, NEAH BAY
Probabilistic Projections of Changes to Average Daily High Tide Inundation Due to Sea Level Rise
Neah Bay
Cape Loop Rd
Village Creek
Bayview Ave
112
Agency Creek
Backtrack Rd
Legend
Current Shoreline
Mean Higher High Water (MHHW)
Annual Percent Chance of Occurrence
More Likely to Occur
Less Likely to Occur
50%
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Critical Infrastructure
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EMS Stations
Public Safety
Fire Stations
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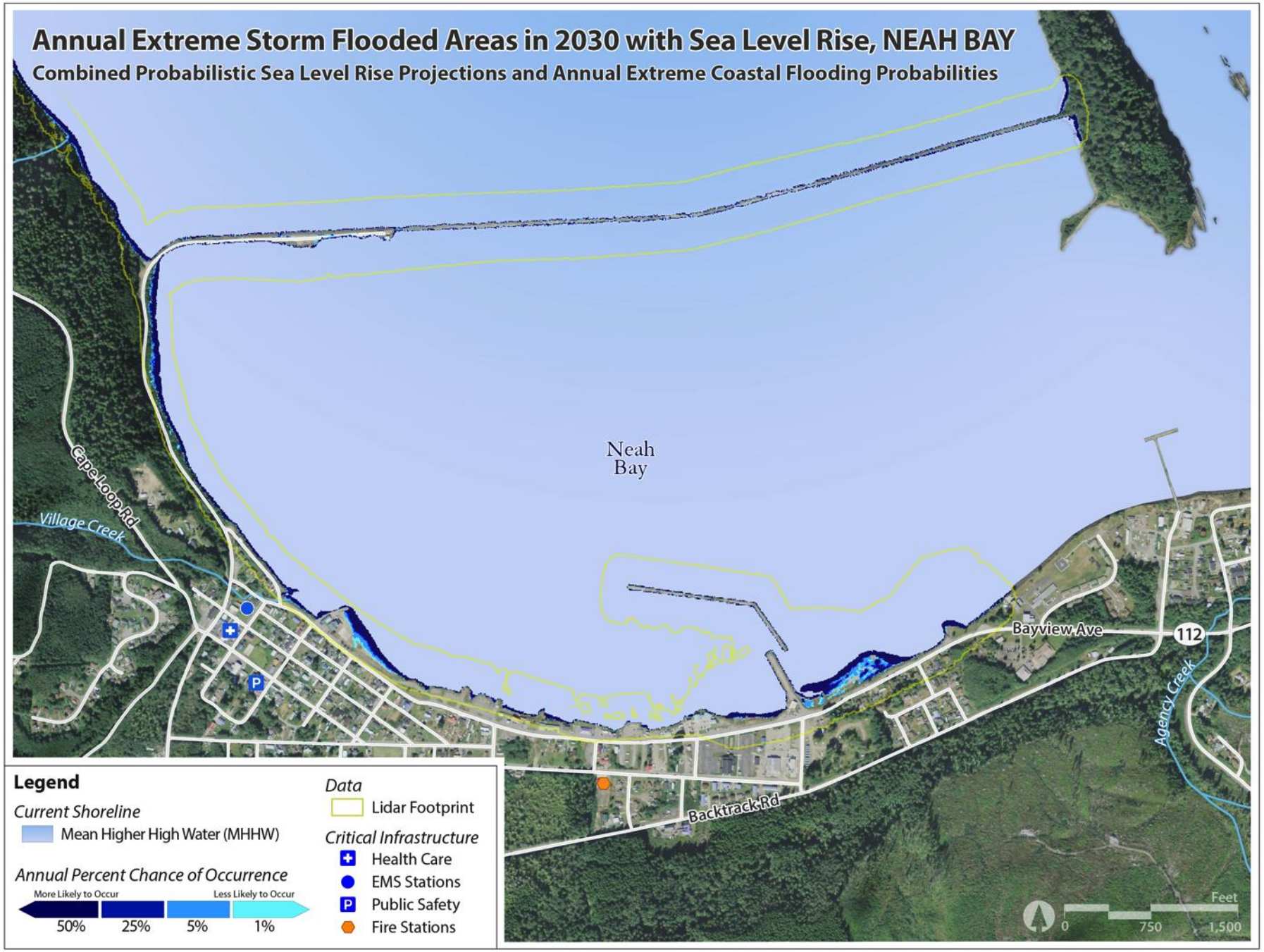
Annual Extreme Storm Flooded Areas in 2030 with Sea Level Rise, NEAH BAY
Combined Probabilistic Sea Level Rise Projections and Annual Extreme Coastal Flooding Probabilities
Neah Bay
Cape Loop Rd
Village Creek
Bayview Ave
112
Agency Creek
Backtrack Rd
Legend
Current Shoreline
Mean Higher High Water (MHHW)
Annual Percent Chance of Occurrence
More Likely to Occur
Less Likely to Occur
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Lidar Footprint
Critical Infrastructure
Health Care
EMS Stations
Public Safety
Fire Stations
Feet
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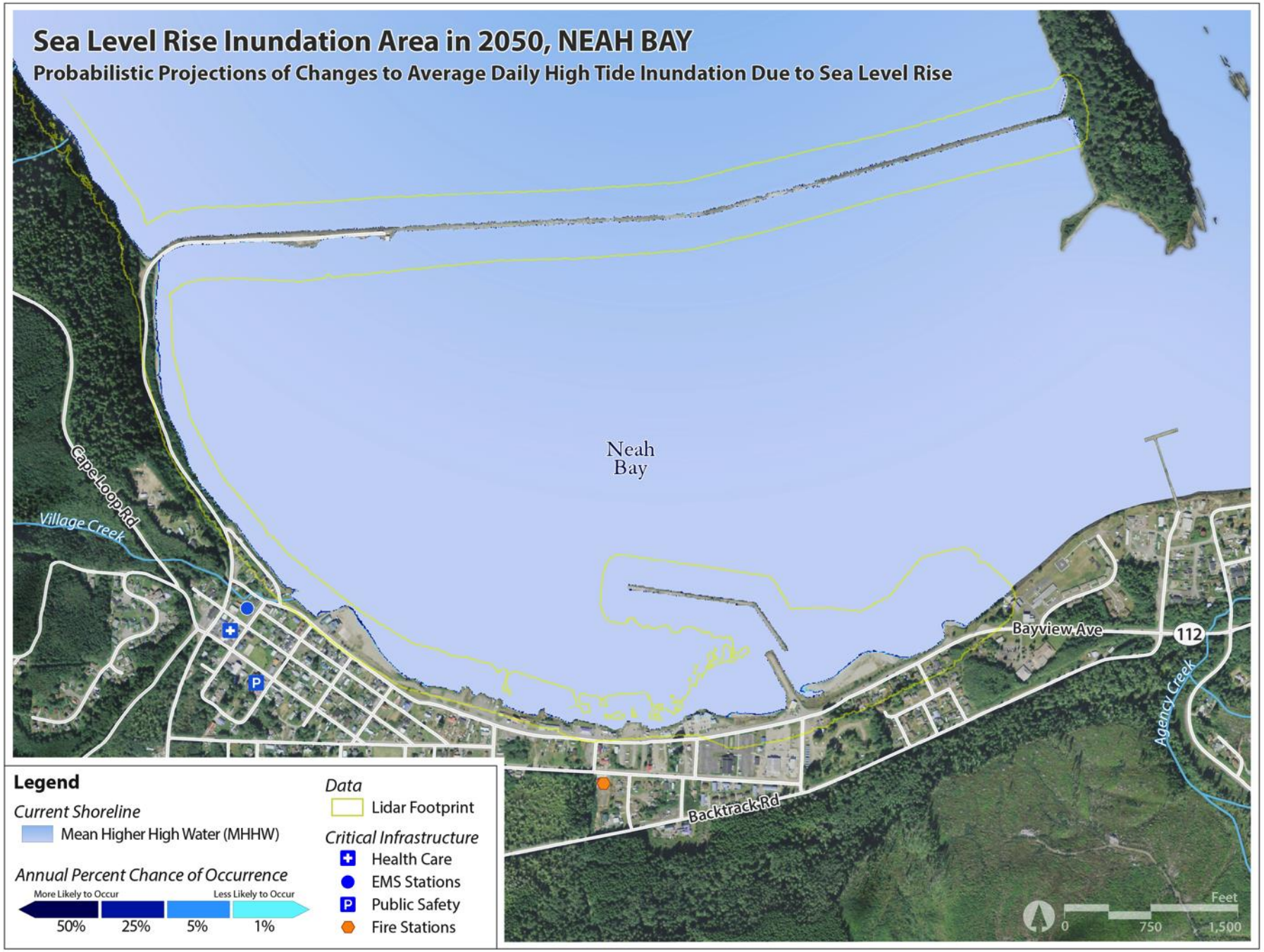
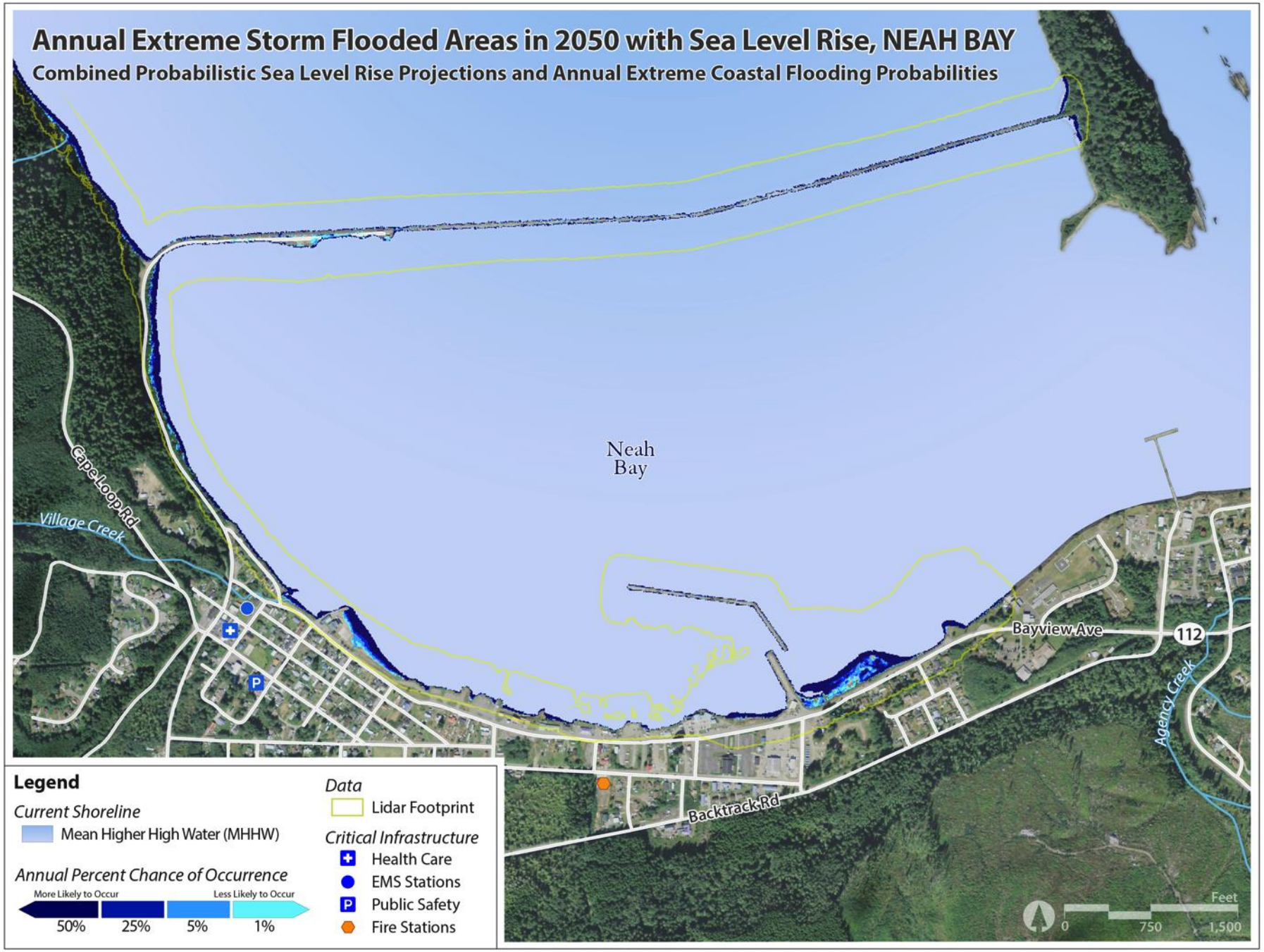
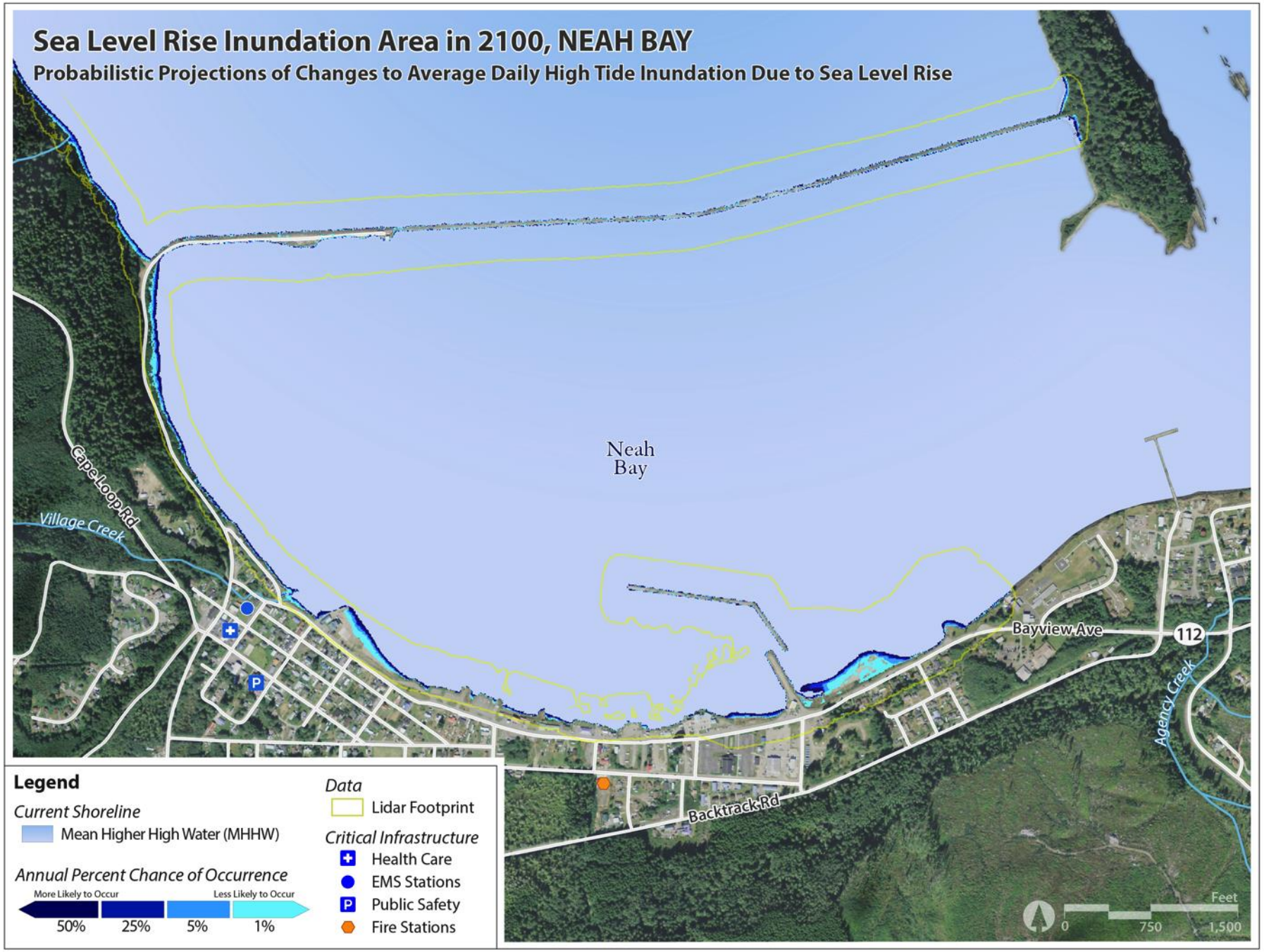
1,500

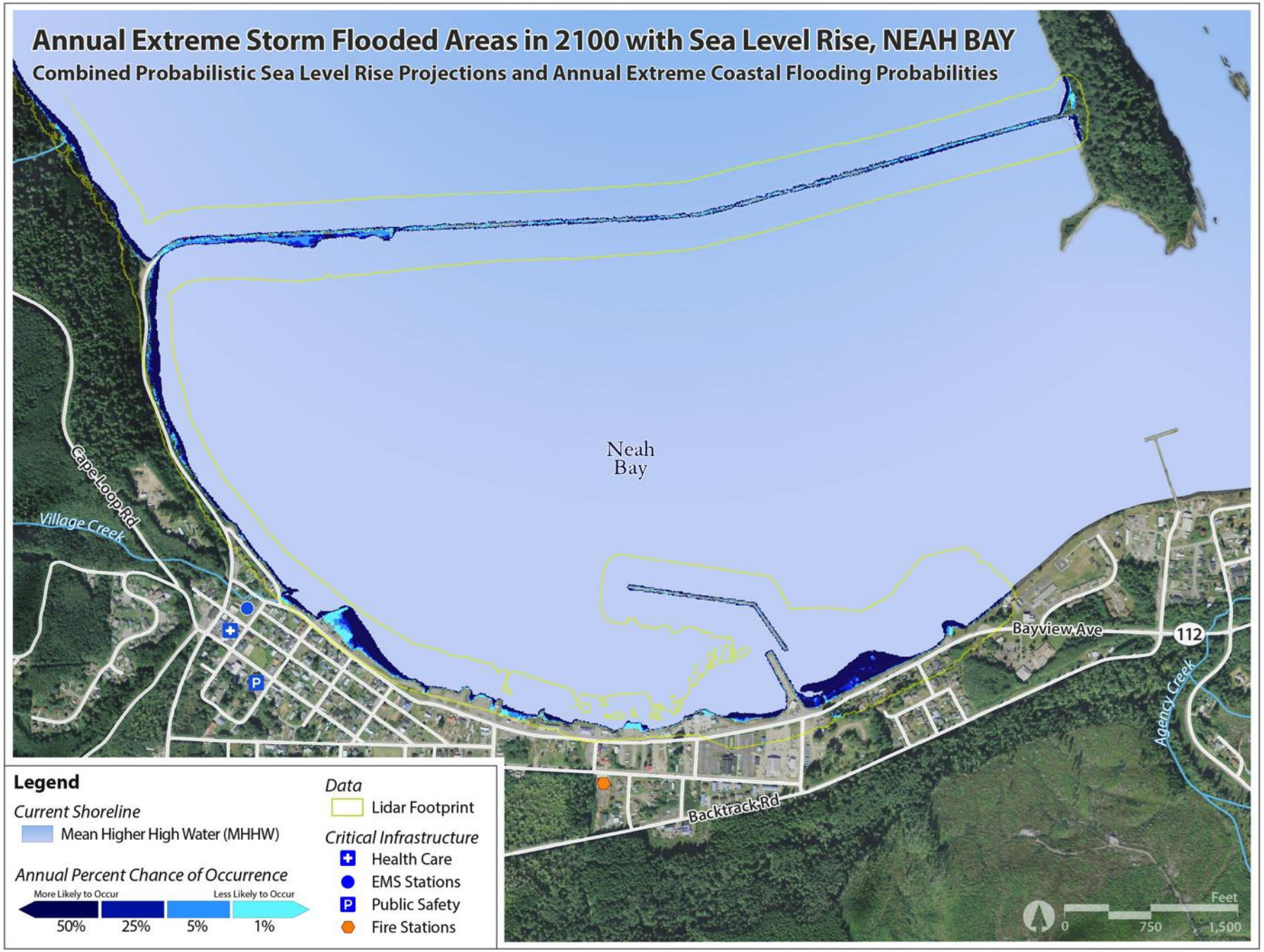


Sea Grant Washington


Annual Extreme Storm Flooded Areas in 2050 with Sea Level Rise, NEAH BAY
Combined Probabilistic Sea Level Rise Projections and Annual Extreme Coastal Flooding Probabilities
Neah Bay
Cape Loop Rd
Village Creek
Bayview Ave
112
Agency Creek
Backtrack Rd
Legend
Current Shoreline
Mean Higher High Water (MHHW)
Annual Percent Chance of Occurrence
More Likely to Occur
Less Likely to Occur
50%
25%
5%
1%
Data
Lidar Footprint
Critical Infrastructure
Health Care
EMS Stations
Public Safety
Fire Stations
Feet
0
750
1,500



Sea Grant Washington


Annual Extreme Storm Flooded Areas in 2100 with Sea Level Rise, NEAH BAY
Combined Probabilistic Sea Level Rise Projections and Annual Extreme Coastal Flooding Probabilities
Neah Bay
Cape Loop Rd
Village Creek
Bayview Ave
112
Agency Creek
Backtrack Rd
Legend
Current Shoreline
Mean Higher High Water (MHHW)
Annual Percent Chance of Occurrence
More Likely to Occur
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50%
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Critical Infrastructure
Health Care
EMS Stations
Public Safety
Fire Stations
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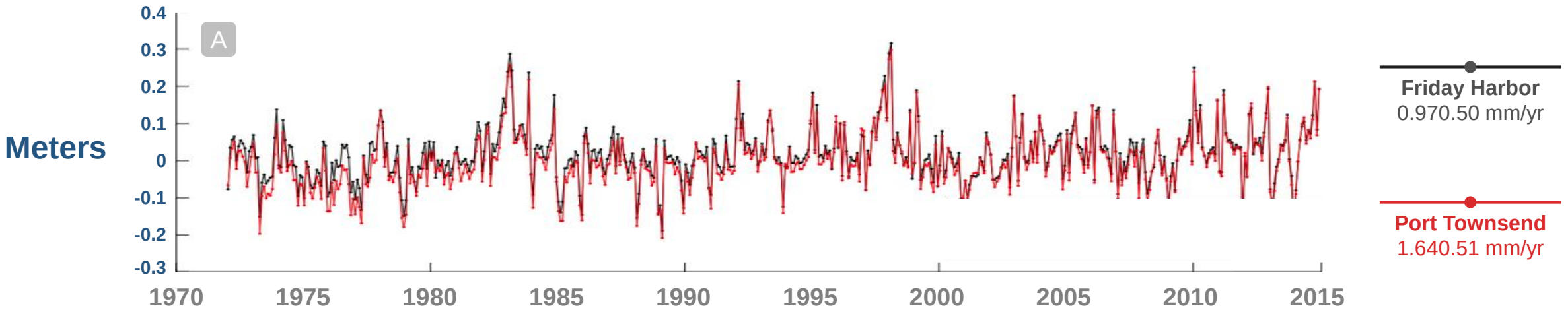
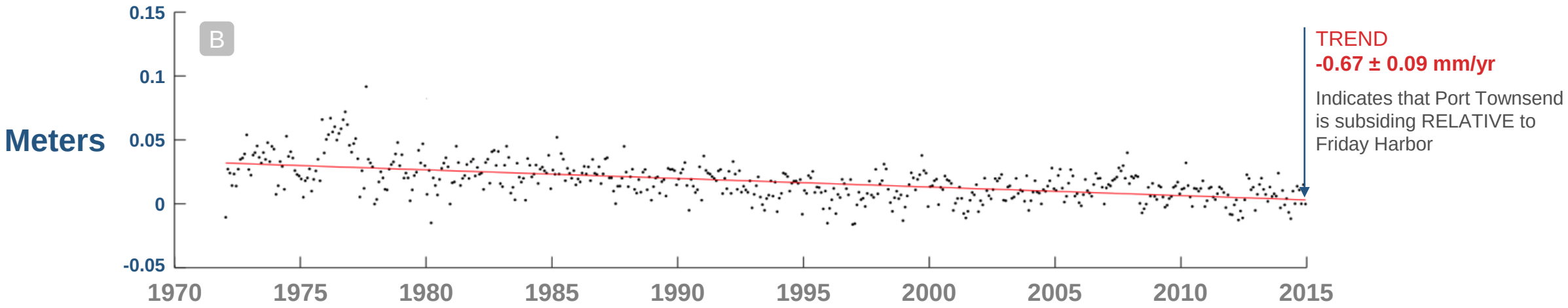
Double Differencing





adaptation international

NOP RC&D

Sea Grant Washington

Double Differencing

STATION	RELATIVE VERTICAL LAND MOVEMENT	ABSOLUTE VERTICAL LAND MOVEMENT
Friday Harbor	NA	-0.13 ± 0.19 mm/yr
Seattle	-1.04 ± 0.04 mm/yr	-1.17 ± 0.16 mm/yr
Port Townsend	-0.67 ± 0.09 mm/yr	-0.80 ± 0.18 mm/yr
Port Angeles	1.06 ± 0.13 mm/yr	0.93 ± 0.20 mm/yr
Neah Bay	2.76 ± 0.07 mm/yr	2.63 ± 0.17 mm/yr

Supplementary Information C:

Planning Language Examples for Climate Resiliency

TABLE OF CONTENTS

Introduction

The **Planning for Climate Change on the North Olympic Peninsula** project has collaboratively explored climate change impacts, vulnerabilities, and adaptation opportunities for the North Olympic Peninsula, to better inform the comprehensive and strategic planning processes of the cities, counties, tribes, Public Utility Districts and ports within the region. In the course of developing targeted adaptation strategies during the participatory spring workshops, a number of prioritized adaptation strategies were related to language in land use planning and ordinances. This document, part of the suite of final products of the project, summarizes references and examples for high level planning language as well as regulatory language to best mitigate the effects of climate change on the North Olympic Peninsula. The references and examples are organized by five key areas for adaptation for the region (collaboratively identified by over 150 stakeholders): **sea level rise, stormwater management, flooding, water supplies, and fire**. Note that the subheadings labeled "Comprehensive Planning Examples" could be utilized not only in Comprehensive Plans but also in strategic plans and other high level planning documents, and "Ordinance Examples" could also apply to lower level planning documents.

This document provides model language from other planning processes for North Olympic Peninsula jurisdictions to consider including in local planning efforts. The examples provided here will require tailoring to meet specific local needs and concerns. It is hoped that the strategies below stimulate discussion among decision-makers and planners in how to best prepare the region for the expected impacts, as outlined in the Planning for Climate Change Preparedness Plan for the North Olympic Peninsula report.

The project team recognizes there are considerable costs associated with the implementation of some of the strategies recommended here, for local governments, businesses and homeowners. These preventative expenses will need to be balanced against the potentially much greater cost of climate change impacts if no action is taken.

1. Sea Level Rise

During the course of the project, sea level rise was identified as a key climate impact for the North Olympic Peninsula. The Climate Change Preparedness Plan for the North Olympic Peninsula includes detailed sea level rise projections for the area. Four prioritized adaptation strategies and their relevant key action steps from the Preparedness Plan were specifically related to sea level rise and planning and regulatory documents (note: see Appendix A: Comprehensive List of Adaptation Strategies of the Climate Change Preparedness Plan for the North Olympic Peninsula for the full set of strategies and key action steps):

- **CI-3: Update planning documents for sea level rise and flooding where needed**.
  Key Action Steps:
  - Create a sea level risk district for inclusion in Comprehensive Plan and promulgate new codes and code changes associated with managing for sea level risk.
  - Incorporate climate change and coastal hazard considerations into building codes by increasing freeboard requirements to two feet (three feet for critical projects) above the current 100-yr flood plain as buildings are redeveloped, developed, or renovated.
- **CI-6: Create critical area flood mapping beyond FEMA's historical flood data**.

Key Action Steps:

- Cities and Counties should establish a climate change flood overlay as part of the critical area designations specific to their future flood concerns and use it to in addition to the FEMA flood maps which are constrained by only using historical data.

- **CI-17: Encourage relocation of infrastructure outside of coastal flood zone**

  Key Action Steps:

  - Create redevelopment restrictions, incentives for retreat, and building code changes with enhanced enforcement to move infrastructure from vulnerable locations.

A report prepared by the Land Use Law Center at Pace University School of Law for the Nature Conservancy titled "Local Land Use Response to Sea Level Rise" (PACE) does an excellent job at summarizing both high level planning examples and lower level regulatory language related to sea level rise, as well as other related areas including stormwater management, building regulations, and flooding. As stated in that report "This report summarizes selected local land use ordinances and regulations that include specific mention of sea level rise or that incorporate appropriate policy responses that may be used to address sea level rise." The 119 page report is a wonderful resource. Key excerpts from the report related to the adaptation strategies above are included below.

The report references the national framework for supporting preserving and protecting coastal resources, including the Coastal Zone Management Act, FEMA, the Disaster Mitigation Act, and the National Flood Insurance Program. It also references the state-level work done as part of The Coastal States Organization, *The Role of Coastal Zone Management Programs in Adaptation to Climate Change: Final Report of the CSO Climate Change Work Group* (September 2007). And for Washington State it notes:

> **Washington:** Under Washington's Shoreline Management Act, which implements the CZMA, local governments must establish shoreline management programs to protect shoreline Legislation on Climate Change—Mitigating Impacts adopted in 2007 identifies sea level rise as one of the threats to Washington's economy, environment, and communities. Executive Order 07-02 outlines strategies for addressing the impacts of climate change, focusing on greenhouse gases and energy issues.

Section VI of the document describes the processes local governments can use to incorporate consideration of sea level rise into land use planning, including Resolutions, Policy Statements, or Executive Orders, and Regional Land Use Plans. In VI.3 it covers how sea level rise can be incorporated into Comprehensive Plans, in VI.4 Shoreline Management Plans, and in VI.5 Hazard Mitigation Plans. For all options, it provides examples, including a few from Washington State, such as:

> "**City of Bainbridge Island, Washington: Environment Element**
>
> The City of Bainbridge Island, to the west of Seattle in Puget Sound, has explicitly addressed the potential for sea level rise in the Environment element of its comprehensive plan. Adopted in 2004, the plan recognizes that Bainbridge Island is potentially subject to flooding, erosion, landslides, seismic events, and soil subsidence. The overall goal of the Environment element is to avoid adverse impacts where possible; to minimize, reduce, or eliminate impacts over time; and to compensate for unavoidable impacts. The plan outlines protections for critical areas including transfer of and purchase of development rights; provides for the use of the City's

> Shoreline Management Master Program to address and protect marine fish and marine shoreline habitat; mandates no net loss of the city's remaining regulated aquatic resources; requires the maintenance of vegetated buffers between proposed development and aquatic resources; calls for the preservation of stream courses; and the protection or restoration of natural functions of riparian habitat.[142] "

Section VI.6 discusses types of land use regulations and best management practices for adaptation for sea level rise, including rolling easements, special area ordinances, habitat preservation, overlay zoning. As an example of overlay zoning, the document notes that in Tillamook, OR:

> "Beachfront protective structures—"riprap and other revetments"—are permitted only in Developed Beachfront Areas and Fore-dune Management Areas of the BD Zone [Beach and Dune Overlay] where development existed on January 1, 1977 or under exceptions to Goal 18. Proposals must demonstrate that there is the threat of ocean erosion or flooding; the development cannot be adequately protected by non-structural means; the protective structure will be placed as far landward as possible and will be angled into the bank to prevent flank erosion; that existing public access is preserved; and that specified construction standards are met."

It also includes an example of a Coastal Zone Management from Collier County, Florida:

> "The Resource Protection chapter of Collier County's Land Development Code includes specific requirements for Coastal Zone Management.[265] Among these is a mandatory sea-level-rise impact analysis for all shoreline development, including infrastructure. The analysis must show that the development will remain fully functional for its intended use after a six-inch rise in sea level.[266]"

Other types of land use regulations and best management practices for adaptation for sea level rise included in section VI.6 are: non-conformities; site capacity/performance standards; coastal wetland regulations; density restrictions/growth management; transfer of development rights; regulatory agreements; building standards, site plans and subdivision infrastructure; and floodplain management. An example of a tidal floodplain overlay from the town of Southampton, NY:

> "Southampton's Tidal Floodplain Overlay District establishes subdivision requirements for lot layout on the barrier beach to minimize damage from coastal storms. Setbacks are established for ocean beach water frontages in accordance with the town's Coastal Erosion Hazards ordinance. Structures on other water frontages must be set back at least 75 feet from the upper edge of the tidal wetland."

Part 2 of the document is "Local Planning and Regulatory Strategies for New York Municipalities." While focused on New York, it provides a summary of the overall phases a local government can use to move forward on sea-level rise planning, including policies, studies, citizen participation, moratorium, planning, and regulations and inter-municipal cooperation. Note that the studies aspect includes "The municipality may hire consultants to gather available data at the regional and local level ". Much of this effort has been completed as part of the Planning for Climate Change on the North Olympic Peninsula project, see the Climate Change Preparedness Plan for the North Olympic Peninsula for sea level rise projections and other specifics.

Part 2 Section V is titled "Sea Level Rise and Storm Hazard Mitigation Regulatory Approaches". Subsections of that chapter include: Create a New Zoning District(s) or Overlay District(s); Techniques and Standards that can be Included in New Districts; Subdivision Regulations and Site Plan Approvals; Adopt Local SEQRA Regulations; Avoid Regulatory Takings Challenges; Project Review Local Planning Board; Transfer of Development Rights; Establish Moratoria following future storm events (Post disaster moratoria); Intergovernmental Approaches.

For example, the section on "Techniques and Standards that can be included in New Districts"**,** has sub-sections that include: "no-build zone provision", "establish very limited build zones", and "permit conditions and standards"**.** An example under "permit conditions and standards" is:

> "Prohibit rebuilding in areas subject to a storm event unless certain standards are met: See Section VI.5 Town of Nags Head, North Carolina: General Use Standards for Redevelopment in Ocean Hazard Areas. Destroyed structures, major damaged structures, and minor damaged structures may not be reconstructed without an on-site inspection of the lot by zoning administrator, a septic improvements permit, and certain setbacks dependent on the extent of damage. For destroyed or major damaged structures town water must be restorable at street frontage of the lot, electrical service must be restorable to building site, and there must be direct, uninterrupted approved vehicular access to the lot." (Pages 89-90.)

Another valuable reference for sea level rise planning is "Addressing Sea Level Rise and Cumulative Ecological Impacts in San Juan County, Washington." It provides a nice summary of financial and tax incentives a jurisdiction could use to protect shorelines, including: conservation easements; preferential taxation; and public infrastructure (pages 54-55).

The Washington Department of Ecology has published a "Shoreline Master Programs Handbook" whose Chapter 15 covers "Shoreline Stabilization". This document discusses at length: the legal framework for shoreline management; the impacts of stabilization efforts; sea level rise; guidance for addressing stabilization in planning; demonstration of the need for stabilization and associated requirements; and soft shoreline stabilization techniques.

The Handbook provides specific thoughts on approaching the climate change driven threat of Sea Level Rise in shoreline stabilization efforts. On page 19 the report states:

> "The prospect of higher sea levels in future decades has ramifications for stabilization policy. Increased sea level will generally lead to higher rates of erosion and greater damage from coastal storms, which is anticipated to increase pressure to armor the coastline. At the same time, many of the existing impacts of armoring, such as loss of marsh and beach habitat, are expected to be exacerbated by higher sea levels."

> "The potential for sea level rise has implications for shoreline stabilization policies: • New development and redevelopment should be located and designed to reduce vulnerability and avoid the need for future stabilization measures. • Pressure to stabilize shorelines will be high, particularly following damaging storms. Communities may identify in advance those areas where armoring is an appropriate option and those where it is not. • Storm damage and failure of stabilization structures will be opportunities to relocate at-risk development and to adopt softer, more resilient stabilization. Communities will need to anticipate pressure to rebuild

existing development in increasingly vulnerable areas and should adopt strategies that enhance resilience to future coastal hazards. • Higher seawalls and stronger dikes require space and will impact existing waterfront development. Reserve space for future stabilization and drainage infrastructure along shorelines where engineering solutions are appropriate."

In instances where a shoreline is already experiencing erosion processes, the Department of Ecology recommends:

> "*Where erosion impacts a developed site, carefully assess the need for stabilization and whether there are more effective means of reducing the risk without recourse to conventional erosion control structures.*
>
> • Evaluate rates and mechanisms of erosion, and understand its causes, before selecting a stabilization method. Avoid short-term solutions that facilitate development of sites without addressing underlying hazards related to large landslides, channel migration, or sea level rise."

Cove Point, Massachusetts recognized in their "Community Flood Mitigation Plan" of 2014 that their historical flood planning zone depended on the historical 100 year floodplain with established base flood elevations of 4ft. Considering climate change, the community saw a need to integrate best and worst case sea level rise scenarios into their recommendations for increased freeboard on community structures.

The Maryland Department of Natural Resources Chesapeake and NOAA completed their own investigation into the feasibility of a Sea-level Rise Overlay Zone in a report titled; "A Model Sea-level Rise Overlay Zone for Maryland Local Governments" in 2011. The final outcomes of this process are described below:

> "The final deliverables include a model ordinance (Appendix A), a background report analyzing legal and policy considerations for implementing the ordinance, and roadmap for how the ordinance could be implemented in two Maryland jurisdictions, Anne Arundel County and the City of Annapolis (Appendix B). The model ordinance proposes revisions to existing floodplain ordinances: (1) to extend the floodplain boundaries to regulate in areas that will become at increasing risk of flooding as sea levels rise, and (2) to create different subdistricts within the floodplain district to allow local governments to tailor regulations based upon two adaption goals: accommodation (allow for continued development but require that it be more resilient to impacts), and retreat (gradually move development away from vulnerable areas to preserve valuable coastal resources). Each subdistrict employs different land-use tools to effectuate the goals of that district. In the accommodation district, the model requires increased setbacks, resilient design of structures and septic systems, and increased building elevations. In the conservation district (or retreat zone), the model uses downzoning, increased setbacks, and rebuilding restrictions. "

2. Stormwater

In the Planning for Climate Change project, three prioritized adaptation strategies and their relevant key action steps were specifically related to stormwater and planning documents:

- **CI-8: Improve on-site stormwater management practices**

Key Action Steps:

- Create monetary & non-monetary incentives for Stormwater Management or re-use, including within Low Impact Development (LID) projects. Applies to residential, industry, agriculture, and forestry sectors.

- **CI-10: Enhance stormwater retention in upstream areas**

  Key Action Steps:

  - Review other community policies aimed at stormwater retention.
  - Draft and pass policy that uses conservation of natural ecosystems, enhance riparian buffers and land management to increase stormwater retention.

A great resource for Stormwater Management planning is the Washington State Department of Ecology 2012 Stormwater Management Manual for Western Washington, amended in December 2014.

Comprehensive Planning Examples

An example from City of Olympia Comprehensive Plan, Environment Element (PN) and Utilities Element (PU):

- PN1.2 Coordinate critical areas ordinances and storm water management requirements regionally based on the best scientific information available
- PN1.6 Establish regulations and design standards for new developments that will minimize impacts to stormwater runoff, environmentally sensitive areas, wildlife habitat, and trees.
- PN1.9 Foster City partnerships with public, private, and non-profit agencies and groups and encourage them to help identify and evaluate new low impact development and green building approaches.
- PN1.10 Increase the use of low impact and green building development methods through education, technical assistance, incentives, regulations, and grants.
- PN 5.1 Reduce the rate of expansion of impervious surface in the community.
- PN5.2 Increase the use of permeable materials and environmentally-beneficial vegetation in construction projects.
- PN5.3 Retrofit existing infrastructure for stormwater treatment in areas with little or no treatment.
- PN5.4 Require prevention and treatment practices for businesses and land uses that have the potential to contaminate stormwater.
- PN5.5 Improve programs and management strategies designed to prevent and reduce contamination of street runoff and other sources of stormwater
- PU1.2 Require new developments to construct drinking water, wastewater and stormwater utilities in ways that meet the community development, environmental protection, and resource protection goals of this Plan, and that are consistent with adopted utility plans and extension policies.
- PU8.7 Separate combined wastewater/stormwater pipes in conjunction with stormwater and road improvements or residential repairs, when economically feasible.
- PU10.1 Improve stormwater systems in areas that are vulnerable to flooding.
- PU10.3 Evaluate the structural integrity of aging stormwater pipes and repair as needed.

- PU10.4 Inspect private and public stormwater systems to identify required maintenance and repairs.
- PU10.5 Inventory and inspect City-owned culverts and ditches and perform maintenance if needed.
- PU10.6 Ensure that private pipe and pond systems are maintained.

The PACE document described above also highlights some good examples for stormwater management, including the following:

> "**City of St. Pete, Florida: Coastal and Conservation Element (page 36)**
>
> The City of St. Pete is a barrier island community located on Florida's Treasure Coast, entirely within the Coastal High Hazard Area and the 100-year floodplain. The Coastal and Conservation element of the city's comprehensive plan establishes requirements for new development within the floodplain, including onsite retention of stormwater runoff, the minimization of impervious surfaces, and the cultivation of at least 25% native vegetation onsite. Policies to conserve wetlands and native vegetation encourage the removal of exotic invasive species, establish a preference for the use of native marine species in conservation and stabilization efforts, and require the adoption of land use regulations that protect environmental systems and habitat. Any project that produces changes in tidal circulation patterns requires hydrological analysis of the project's net environmental impact before approval. Intermunicipal cooperation is required to protect environmental functions of estuaries and other resources "on a system-wide basis regardless of political boundaries."

Other Stormwater examples can be found in the report from Keene NH: Adapting to Climate Change: Planning a Climate Resilient Community.

Ordinance Examples

An example from Whatcom County 2000-390:

> "20.80.633 Large Development stormwater controls.
>
> An engineered Stormwater Design Report must be submitted to the county engineer for any use covering more than 5,000 square feet with impervious surfacing…."

The Maryland Department of Natural Resources and NOAA explored the use of Critical Area Jurisdictions to implement climate change resilient stormwater strategies such as green infrastructure and on-site stormwater treatment. The report is titled, "A Local Framework for Coastal Resilience Strategies for Critical Area Jurisdictions" and was published in 2015. (Note: the report is not available on-line, but a presentation about it is available here.) The report specifically outlines recommended ordinance amendments, which may be instructive to proposing changes on the North Olympic Peninsula:

> "4.2 Ordinance Amendments

- Forest Program Alternatives and Developed Woodland Program Alternatives – COMAR 27.01.02.04 C (3) lays out the regulations for both forest and developed woodlands clearing and mitigation requirements in the section covering Limited Development Areas. The same

standards apply for Resource Conservation Areas. Suggested changes for forest and developed woodlands would be located in a community's section on standards for LDA and RCA.

- Buffer Program Alternatives - COMAR 27.01.09.01-2 provides details for mitigation and planting standards for approved Buffer activities, while COMAR 27.01.09.01-5 discusses FIL [Fee in Lieu] of Buffer mitigation. To make the transition from mitigation to FIL that would be used for green infrastructure, a community would amend their Buffer regulations to incorporate the suggested conversions.
- Modified Buffer Area (MBA) Program Alternatives – Generic regulations and guidelines for Modified Buffer Areas are discussed in COMAR 27.01.09.01-8. Each jurisdiction has a section in their Critical Area ordinance that details the regulations for their MBA in the IDA, LDA and RCA. This section is where the suggested amendments for defined planted buffer strips for specified activities and amounts of disturbance or lot coverage would be located and developed.
- Stormwater Program Alternatives – Critical Area policy for stormwater is described in the Maryland Chesapeake and Atlantic Coastal Bays' Critical Area 10% Rule Guidance Manual – "Developments that disturb less than 250 square feet of land are exempt, but those that disturb between 250 square feet and 5,000 square feet must comply with the 10% Rule. Those that disturb over 5,000 square feet must comply with both the 10% rule and the MDA Manual" (Section 7.0 (25) on page 7-9). In order to achieve the goal of treating small development projects that disturb less than 5,000 square feet, the town would amend their local Critical Area ordinance in the section for development standards in LDAs and RCAs to reflect the suggested changes, which entails using a chart to select a practice based on the amount of disturbance or development. No changes are necessary for IDA regulations because most new lot coverage or disturbance requires a 10% reduction in stormwater pollutants (COMAR 27.01.02 D (3))."

3. Flooding

In the Planning for Climate Change project, two prioritized adaptation strategies and their relevant key action steps were specifically related to flooding and planning documents:

- **CI-6: Create critical area flood mapping beyond FEMA's historical flood data**.
  Key Action Steps:
  - Cities and Counties should establish a climate change flood overlay as part of the critical area designations specific to their future flood concerns and use it to in addition to the FEMA flood maps which are constrained by only using historical data.
- **CI-8: Improve on-site stormwater management practices**
  Key Action Steps:
  - Create monetary & non-monetary incentives for Stormwater Management or re-use, including within Low Impact Development (LID) projects. Applies to residential, industry, agriculture, and forestry sectors.

Comprehensive Planning Examples

An example from Bainbridge Island - Comprehensive Plan Environment Element http://www.ci.bainbridge-isl.wa.us/DocumentCenter/View/1627:

- GOAL 1 - Protect the natural functions of frequently flooded areas.

○ Discussion: Frequently Flooded Areas are described in the Critical Areas Ordinance as those lands and floodplains adjacent to streams, lakes, coastal areas and wetlands with a 1% or greater chance of flooding in any given year (i.e. the 100-year floodplain), as determined by the Federal Emergency Management Agency (FEMA).

○ FL 1.1: Minimize public and private losses due to flood conditions by limiting development in frequently flooded areas as shown on the Flood Insurance Rate Maps.

○ FL 1.2: Limit the alteration of natural floodplains, stream channels, and natural protective barriers which help accommodate, dissipate, or channel floodwaters.

○ FL 1.3: Emphasize nonstructural methods, such as setbacks and vegetation, to prevent or minimize flood damage.

○ FL 1.4: Public facilities such as sewer and water lines should be located outside of frequently flooded areas, in order to minimize damage to both the public facility and the natural environment. Public facilities may be located within frequently flooded areas only if no environmentally preferable alternative exists to mitigate existing environmental concerns and additional development is not encouraged in frequently flooded areas

For more information on Green Streets, see the EPA document "Managing Wet Weather with Green Infrastructure - Municipal Handbook Green Streets."

Ordinance Examples

An example from the City of Baltimore Codes:

2-1. Establishment of district.

(a) City to establish. The City must establish a Floodplain District and an official floodplain map to include all areas subject to inundation by floodwaters.

(b) Bases.

(1) The bases of this delineation must be, at a minimum, the data contained in the most recent Flood Insurance Study for Baltimore City, and illustrated in the Flood Insurance Rate Map. The Flood Insurance Rate Map illustrates both the Special Flood Hazard Areas and that part of the tidal floodplain designated as "areas of 0.2% annual chance flood".

(2) The base-flood elevation, as determined in the Flood Insurance Study, is graphically delineated on the official floodplain map.

(3) Where field-surveyed topography or digital topography indicates that ground elevations are above the base-flood elevation in a Special Flood Hazard Area, then the area is considered in the Special Flood Hazard Area until FEMA issues a Letter of Map Change.

(4) Where field-surveyed topography or digital topography indicates that ground elevations are below the closest applicable design-flood elevation, even in areas not delineated on the FIRM as a Regulated Flood Hazard Area, the area is considered to be a Regulated Flood Hazard Area.

(c) District as overlay to zoning.
The Floodplain District is an overlay on any zoning district, as provided in the Zoning Code of Baltimore City.

§ 2-2. Subdistricts.

§ 3-1. In general.

(a) New construction and substantial improvements.

(1) In order to prevent excessive damage to structures, all new construction and substantial improvements to existing structures in the Floodplain District must comply with:

(i) the regulations and restrictions of this subtitle; and

(ii) except as otherwise provided in this Division I, the design and construction standards of:

(A) ASCE 24 {"Flood Resistant Design and Construction"}; and

(B) ASCE 7 {"Minimum Design Loads for Buildings and Other Structures"}, Chapter 5 {"Flood Loads"}.

(2) Where base-flood elevation data are used, the applicant must provide to the Planning Department:

(i) floodproofing elevations for all new construction and all substantial improvements to an existing structure; and

(ii) corresponding elevation certificates

Baltimore's Department of Planning has also initiated a unique planning approach that combines three previously separate planning processes and allows for ongoing alterations to required All Hazard Mitigation Plan updates. This effort is called the Disaster Preparedness and Planning Project (DP3) and is described by its creators as:

> "Baltimore's Disaster Preparedness and Planning Project (DP3) was created by the Department of Planning as an effort to address existing hazards while simultaneously preparing for predicted hazards due to climate change. This project develops a program that integrates hazards mitigation planning, floodplain mapping, and climate adaptation planning. DP3 links research, outreach, and actions to create a comprehensive and new risk-preparedness system for addressing existing and future impacts.
>
> Every five years the Federal Emergency Management Agency (FEMA) requires local governments to update their All Hazards Mitigation Plan (AHMP). In an effort to plan for existing hazards and prepare for predicted hazards due to climate change, the Office of Sustainability will develop and implement an integrated project to provide the City with a comprehensive

system for addressing existing and future impacts. The DP3 will assure that adaptation recommendations are included in future capital and operating budget decision making and prioritized within planning processes."

The PACE document noted above, pages 54-55, also provide an example of a Conservancy District Overlay that is used for areas subject to flooding:

Chatham, Massachusetts: Conservancy Districts Overlay

"The Town of Chatham's Conservancy Districts Overlay is intended to preserve groundwater, coastal waters, and habitat, and to "protect persons and property from the hazards of flood and tidal waters which may result from unsuitable development in or near swamps, ponds, bogs and marshes, along water courses or in areas subject to flooding, extreme high tides and the rising sea level." The Districts encompass "all the submerged lands along the coast of Town, and 55 areas subject to flooding," including the FEMA-designated 100-year floodplain. Permitted activities include beach nourishment except in salt marsh areas or shellfish tidal flats; dune nourishment; non-structural bank and dune stabilization; and approved coastal engineering structures. The construction of residential dwelling units is prohibited in the district and no building may be constructed in FEMA-designated V and V1-30 Zones. Pre-existing structures and uses are subject to the zoning ordinance's non-conforming use provisions."

4. Building Standards

In the Planning for Climate Change project, four prioritized adaptation strategies and their relevant key action steps were specifically related to building standards and planning documents (note that these are also referenced above in the Sea Level Rise section):

- **CI-3: Update planning documents for sea level rise and flooding where needed**.
  Key Action Steps:
  - Create a sea level risk district for inclusion in Comprehensive Plan and promulgate new codes and code changes associated with managing for sea level risk.
  - Incorporate climate change and coastal hazard considerations into building codes by increasing freeboard requirements to two feet (three feet for critical projects) above the current 100-yr flood plain as buildings are redeveloped, developed, or renovated.
- **CI-17: Encourage relocation of infrastructure outside of coastal flood zone**
  Key Action Steps:
  - Create redevelopment restrictions, incentives for retreat, and building code changes with enhanced enforcement to move infrastructure from vulnerable locations.

Comprehensive Planning Examples

An example from the Escambia County Florida Comprehensive Plan:

"OBJ COA 1.1 General Hazard Mitigation: Reduce the exposure of people and property to natural hazards. POLICIES COA 1.1.1 Building Code**.** Escambia County will, through adoption of the Florida Building Code, regulate the construction, alteration, use, maintenance and

other aspects of buildings and structures to minimize the exposure to wind, flood, fire and other hazards."

"OBJ COA 1.1.3 Flood Elevation**:** Escambia County will, as supported by federal emergency management regulations (Title 44, Code of Federal Regulations (CFR) 60.1) and the County's experience of significant flood hazard events, require additional height above the base flood elevation to more effectively reduce the exposure of people and property to losses from flood hazards."

Ordinance Examples

An example from the City of Malibu, CA Coastal Zone Shoreline and Bluff Ordinance and; Local Coastal Program Local Implementation Plan (page 73-74 of PACE document):

> "Development standards expressly require the consideration of sea level rise and mandate setbacks of a sufficient distance landward and elevations to a sufficient finished floor height, which will "eliminate or minimize to the maximum extent feasible hazards associated with anticipated sea level rise over the expected 100 year economic life of the structure."[255]"

See also the Sea Level Rise section above which includes coastal zoning examples, and see the example code from City of Baltimore in the Flooding section above, which includes Building Standards aspects.

An executive order by the Governor of Maryland in 2012 directed the Maryland Department of Natural Resources to provide "Coast Smart" construction guidance, including recommendations for the siting and design of State structures, as well as other infrastructure-based projects. The result was a report entitled "Climate Change and Coast Smart Construction infrastructure Siting and Design Guidelines" published in 2014. The report found that in light of changing environmental conditions influenced by climate change:

> "…the State should employ Coast Smart practices when constructing all new State structures, reconstructing or rehabilitating substantially damaged State structures, or making other major infrastructure improvements in Maryland's coastal zone, such as roads, bridges, sewer and water systems, drainage systems and essential public utilities. Similar measures should be applied to non-State structure or infrastructure projects if partially or fully funded by State agencies; and, to non-State projects located on State-owned lands. State agencies should take the necessary steps to incorporate the recommended Coast Smart practices into all appropriate architecture, engineering, construction and design manuals, State planning programs, regulatory programs, permitting and review processes, disaster planning and response, capital budgeting, and State grant and loan programs."

These recommendations are outlined in detail within the report.

5. Water Supplies

In the Planning for Climate Change project, sixteen prioritized adaptation strategies and their relevant key action steps were specifically related to water supplies and planning documents:

- **WS-2: Adopt new regulations requiring water-efficient appliances.**

Key Action Steps:
  - Work with state legislators to revise regulations.
- **WS-3: Promote and incentivize smart irrigation technologies for agriculture.** Key Action Steps:
- **WS-7: Encourage forestry practices promoting water retention within the watershed**
  Key Action Step:
  - Consider integrating water retention into forestry practices permits.
- **WS-11: Create an outreach, education, and incentive program for private well users.**
  Key Action Steps:
  - Develop general awareness / educational materials related to water use issues including what aquifer the wells pull from, appropriate conservation techniques for the region, relevant incentive programs.
- **WS-12: Develop or increase incentives for low-water use landscaping**
  Key Action Steps:
  - Develop outdoor planting incentives (rebates or grants) for native, drought tolerant plants, and rainwater-capturing landscapes.
- **WS-13: Adjust rate structure for water use to incentivize conservation where needed**
  Key Action Steps:
  - Create inverted block rate structure for water use, or support those rate structures already in place.
  - Consider developing time of use pricing.
  - Price water on a sliding scale thereby allowing differential charging for certain uses.
- **WS-14: Develop code and infrastructure for a municipal reclaimed water system**
  Key Action Steps:
  - Collaborate with WA Department of Ecology on their reclaimed water rules (accepting comments on new rule promoting reclaimed water in fall 2015).
  - Research codes used by other communities.
  - Draft code and develop infrastructure for municipal reclaimed water systems in the area.
- **WS-15: Enhance residential water conservation through incentives and outreach**.
  Key Action Steps:
  - Extend incentives (rebates or grants) to use of drip irrigation, rain barrels and cisterns, and other residential conservation methods.
- **WS-16: Encourage the State to lift restrictions or permit grey water reuse**
  Key Action Steps:
  - Investigate existing recommendations for grey water use by WA State Department of Health: http://www.doh.wa.gov/Portals/1/Documents/Pubs/337-016.pdf
  - Lobby government to make necessary changes (potentially revising building codes).
  - Create an outreach and incentive program encouraging grey water systems within a property.
- **WS-23: Research regulatory framework on water hauling/delivery.**
  Key Action Steps:
  - Research examples from other communities. One example is Chimacum, where they are already receiving water delivered to the area with no regulations in existence.
  - Identify the best practices and gauge how they would apply to the North Olympic Peninsula.
- **WS-25: Manage/enhance upstream watersheds** Key Action Steps:

- Consider increasing buffers and using bioswales so that it recharges into the soil.
- Identify, protect, and restore natural recharge areas including floodplains and wetlands.
- Minimize runoff through: Low Impact Development (LID), forest and vegetation management, floodplain management; and reestablishment of natural surface water off-stream retention ponds and storage areas. Retention ponds could be used for storing water for agriculture while also restoring important waterfowl habitat and increasing groundwater recharge.
- Create new wetlands or wetland banks for water storage and filtration purposes. Utilize historical ditches where appropriate. In the Dungeness area it was found that when some ditches were tight-lined (solid pipes were used to channel the water), the wells went dry, indicating the ditches were good sources for recharging the aquifer. Roadside ditches could be rerouted and widened to promote infiltration.

Comprehensive Planning Examples

An example from the City of Olympia Comprehensive Plan:

- "Environment Element: GN 5 - Ground and surface waters are protected from land uses and activities that harm water quality and quantity.
  - PN5.6 Limit or prohibit uses that pose a risk to water supplies in Drinking Water (Wellhead) protection areas based on the best scientific information available and the level of risk. Require restoration of any such areas that have been degraded.
- Utility Element: GU4 - Use Olympia's water resources efficiently to meet the needs of the community, reduce demand on facilities, and protect the natural environment.
  - PU4.1 Encourage and allow re-use techniques, including rainwater collection, greywater systems, and use of Class A reclaimed water as alternatives to use of potable water, in order to enhance stream flows or recharge aquifers, while also protecting water quality.
  - PU4.2 Develop specific targets for reducing potable water use.
  - PU4.3 Raise community awareness about why and how to conserve water.
  - PU4.4 Reduce water system leakage as much as possible, at a minimum below the Washington State limit of 10 percent of total water production.
  - PU4.5 Model best practices in our City operations and the Olympia Municipal Code.
  - PU4.6 Advance the use of reclaimed water as defined in Council-adopted policies.
- Utility Element: GU5 - Adequate supplies of clean drinking water are available for current and future generations and instream flows and aquifer capacity are protected.
  - PU5.1 Reserve water supply rights for at least 50 years in advance of need, so that supplies can be protected from contamination and they are not committed to lower priority uses.

- PU5.2 Develop and maintain multiple, geographically-dispersed sources of water supply to increase the reliability of the system.
- PU5.3 Monitor water levels in aquifers and maintain numerical groundwater models.
- PU5.4 Coordinate with Lacey, Tumwater, Thurston County and Public Utility District #1 to assure adequate water supplies throughout the City's Water Service Area, following the provisions of the Growth Management Act, Public Water System Coordination Act, and the Municipal Water Law.
- PU5.5 When practical, develop regionally consistent Critical Areas Ordinance regulations, Drainage Manual requirements, and other policies to ensure we are protecting groundwater quantity and quality across jurisdictional boundaries."

From Keene NH – Adapting to Climate Change: Planning a Climate Resilient Community:

"Opportunity: Wetlands and Sub-surface Waters Protection and Management

- Goal A: Increase the protection of existing and future wetlands to maintain the ability of these systems to naturally recharge aquifers and decrease stormwater run-off.
  - Target A: Develop a wetlands management strategy by 2010 that includes the identification of and recommendation to preserve key wetland areas in the City that will reduce the impact of a flooding event.
  - Target B: Develop a City-wide hydrologic study identifying the hydrologic areas, particularly those most susceptible to changes in climate and develop management plans, by 2010.
  - Target C: Incorporate wetland and sub-surface waters protection into the comprehensive master plan.
  - Target D: Update all relevant City standards to consistently support the protection of wetlands and sub-surface waters, whether during plan review, construction, or during operations."

An example from the Escambia County Florida Comprehensive plan:

"Area of Water Resource Concern: CP 10:7:
INF 4.1.12 Area of Water Resource Concern. An area of water resources concern may be established by the Northwest Florida Water Management District (NWFWMD) to protect the areas water resources from depletion, salt water intrusion, or contamination or from any other activity that may substantially affect the quality or quantity of the area's water resources. Within such area, the NWFWMD may establish lower permit thresholds, maximum and minimum levels, and stipulate any limiting conditions as necessary to monitor, manage, and control the use of water. Escambia County will cooperate with the NWFWMD in its enforcement of regulations if an area of water resources concern is established within Escambia County.

GOAL INF 5 AQUIFER RECHARGE PROTECTION

Escambia County will protect and provide for the rainfall recharge of the sand and gravel aquifer, the principal source of the County's potable water.
OBJ INF 5.1 Aquifer Protection Utilize LDC provisions, state funding, aquifer modeling, and other tools and resources to safeguard the long-term integrity of the sand and gravel aquifer.
OBJ CON 1.8 Water and Energy Conservation. The County will promote water and energy conservation strategies to support the protection of the County's natural resources."

Ordinance Examples

An example of a city adopting a water conservation goal: RESOLUTION NO. 2008-02 A RESOLUTION OF THE CITY OF ISSAQUAH ADOPTING A WATER CONSERVATION GOAL

> "1. The water conservation goal for the City of Issaquah is as follows: The City of Issaquah water utility shall develop conservation programs, capital investments and other strategies in order to achieve a water use savings of 51,000 gallons of water a day on an average annual basis and during the peak season 67,000 gallons of water a day by 2013.
>
> 2. The City of Issaquah, as a part of its Water System Plan update in 2008, shall assess its overall water conservation savings, water supply characteristics and demand projections in order to provide recommendations in order to update its water conservation goal."

An example of a city establishing a Water Efficiency Goal, from the City of Bremerton, WA, Resolution 3019:

> "1. Maintain water use per single family household to below 195 gallons per day on a three year average.
>
> 2. Keep maximum day demand less than twice the average day demand on a three year average."

An example of a reclaimed water ordinance from the City of Yelm, Ordinance No. 684:

- Section 2: "It is the policy of the City of Yelm to reclaim 100% of the wastewater generated by the City and that reclamined water shall be used within the jurisdiction wherever its use is economically justified, financialy and technically feasilble, and is consistent with legal requirements of RCW 90.46, for the preservation of public health, safety and welfare, and the protection of the environment."
- From Section 4: "Uses of Reclaimed Water: The Facilities Plan identified any use that meets the Standards for Class A Reclaimed Water as a planned or potential use of reclaimed water within the City's service area. Reclaimed water uses may include, but are not limited to, the irrigation of food and nonfood crops, landscape irrigation, impoundments, fish hatchery basins, decorative fountains, flushing of sanitary sewers, street cleaning, dust control, fire fighting and proteciton, toilet and urinal flushing, washing aggregate and concrete production, industrial cooling and industrial processes…."

6. Fire

In the Planning for Climate Change project, one prioritized adaptation strategy and its relevant key action steps were specifically related to fire and planning documents:

- **E-4: Update municipal codes to account for enhanced fire risk at forest/residential interface where needed**
  Key Action Steps:
  - Use education, incentives, and building codes to minimize fire risk, particularly in forest/residential interface.
  - Enforce setbacks on building permits in forested areas.
  - Update existing hazard analyses that incorporate historical climate variables (such as the Clallam County Community Wildfire Protection Program, 2009) with temperature and precipitation projections for a chosen climate change scenario.
  - Review existing hazard analyses (such as the Clallam County Community Wildfire Protection Program, 2009) for strategies to mitigate the wildfire risk, and assess their continued viability with increased wildfire risk.

A good resource for planning language related to fire is: http://www.firewise.org/wildfire-preparedness/regulations-and-plans.aspx. Some of the publications it lists include:

> Managing Fire in the Urban Wildland Interface, by Kenneth Blonski, Cheryl Miller and Carol Rice, $85.
>
> Planning for Wildfires (PAS 529/530) By Jim Schwab, Stuart Meck, and Jamie Simone:
> "Wildfires are both dangerous and costly, yet people continue to build in wildfire-prone areas. This poses challenges for governments and planners, who must decide whether to permit development in such areas and how best to design developments that are allowed. This report explores both issues, outlining how knowledge of wildfire risks can be incorporated into comprehensive planning and identifying best practices for development in at-risk areas." $15.

Comprehensive Planning Examples

From King County WA Comprehensive Plan:

> R-625 Structures within the FPD [Forest Production District] should be sited to maintain the productivity of the district. Site plan requirements should limit impervious surface, provide for fire control, protect domestic water supply and prevent conflicts with forest management.
>
> R-637 King County should encourage community fire planning so that residents are aware of the dangers of forest fires and take steps to make their properties less vulnerable. King County should support neighborhood-based efforts to manage forests to improve forest health and reduce the risk of wildfire.
>
> R-641 King County should consider climate change impacts and take steps to improve forest health and resilience to climate change impacts through its technical assistance to forest land owners, management of county-owned forest lands, and support of neighborhood-based efforts to reduce risks from wildfires.

Ordinance Examples

Section 4.2 of the Wildfire Planning Strategies For Community Design: A Guide For Southeastern Developers And Planners includes descriptions of model wildfire code ordinances. For example, it includes:

> "Communities are increasingly adopting or strengthening wildland fire ordinances to minimize wildfire damage. The majority of community wildland codes address 1) vegetative fuel clearance around structures, 2) vegetative maintenance, and 3) vehicular access requirements." (p. 5)

7. Other Resources

A few other planning resources related to climate change are:

- Washington State Department of Ecology Website on Climate Change: The site includes links to climate impact and adaptation reports for the state, as well as links to other relevant adaptation reports and planning resources.
- Municipal Research and Services Center: A Washington State non-profit "dedicated to proactively supporting the success of local governments state-wide by providing collaborative consultation and immediate access to a vast research and knowledge base." It has a great search tool that can be used to find example comprehensive plan and ordinance language on a variety of topics.
- Georgetown Climate Center's Adaptation Clearinghouse: this national clearinghouse is "a resource database and online community that seeks to assist state policymakers, resource managers, academics, and others who are working to help communities adapt to climate change."
- Climate Adaptation Knowledge Exchange: this site is a "shared knowledge base for managing natural and built systems in the face of rapid climate change", and includes examples from throughout the world.
- American Planning Association: a not-for-profit educational organization that provides resources for community planning. Note that their Washington State chapter has identified Climate Change as one of their 10 Big Ideas for Washington's Future, and there are working groups associated with each of the 10 ideas that will be working on related work products in 2015.
- Washington State Department of Commerce Climate Change and Energy website: this includes subpages on Climate Change Adaptation, which references other Adaptation resources, as well as a subpage on Climate Change Mitigation, with resources related to reducing greenhouse gases.
- Washington State Community Trade and Economic Development 2008 report on Planning for Climate Change: Addressing Climate Change through Comprehensive Planning under the Growth Management Act: this report discusses "how land use and transportation planning processes can be used to reduce greenhouse gas emissions." (Exec Summary, p. 4)

Supplementary Information D: Workshop 1 Results

This document provides a summary of the vulnerability rankings completed for each of the selected areas of concern by focus area workshop. **These sections provide an overview of the vulnerability rankings and a brief summary of the breakout session discussions for the potential vulnerabilities. It does not provide an exhaustive or comprehensive summary of the science or the discussion during the workshop.**

Each workshop followed a similar process and included a review of climate change science as well as the identification and evaluation of regional areas of concern. Overall vulnerability was determined for an area of concern based on its "sensitivity" to climate change impacts and "adaptive capacity" or ability to respond to these changes. This ranking is a method for prioritizing climate change adaptation planning across a diverse range of vulnerabilities. The ranking criteria for these two measures are listed below, along with the color-coded vulnerability categories that reference the tables in each workshop summary.

Sensitivity Levels		Adaptive Capacity Levels	
S0	System will not be affected by the impact	**AC0**	System is not able to accommodate or adjust to impact
S1	System will be minimally affected by the impact	**AC1**	System is minimally able to accommodate or adjust to impact
S2	System will be somewhat affected by the impact	**AC2**	System is somewhat able to accommodate or adjust to impact
S3	System will be largely affected by the impact	**AC3**	System is mostly able to accommodate or adjust to impact
S4	System will be greatly affected by the impact	**AC4**	System is able to accommodate or adjust to impact in a beneficial way

Vulnerability Ranking Table
Potential Opportunity
Low Vulnerability
Medium-Low Vulnerability
Medium Vulnerability
Medium-High Vulnerability
High Vulnerability

Community Vitality Workshop Results

On November 10th, 2014 a diverse range of stakeholders met in Sequim, WA to discuss Climate Change impacts relevant to issues of Community Vitality on the North Olympic Peninsula. Below is the vulnerability table drafted collaboratively through three breakout sessions at the workshop, covering issues of: *High-value Community Sites; Land-use Planning and Population Growth; Current and Future Demographics.* Each of the ranked vulnerabilities is described in more detail following the table in its given vulnerability category.

Table 1. Community Vitality Vulnerability Ranking Table

		Sensitivity: Low → High				
		S0	S1	S2	S3	S4
Adaptive Capacity: Low ↓ High	AC0				*Open space forestry	*Urban areas/Ports
	AC1				*Young families *Downtown Port Townsend *Sekiu/Clallam Bay/ Makah	*Water Supply
	AC2			*Health System monitoring and response *Port Angeles Ediz hook	*Low-income retirees *Development on high-bank shorelines *Dungeness; Spit to John Wayne marina *Olympic National Park	*Low-Income Families *Veterans/Homeless *Development in low-bank shorelines
	AC3		*Economically advantaged citizens	*Port Hadlock & Port Ludlow *Quilcene/Brinnon/Center Rd. Valley *Ft Worden/Ft Townsend/ Ft Flagler	*Open space/Ag. Land *Stormwater management	*Ft Worden lighthouse
	AC4			*Energy management	*Low land river corridors	

Community Vitality Vulnerability Ranking Descriptions:

High Vulnerability

Urban Areas/Ports: Many urban areas of the North Olympic Peninsula are found on low-bank waterfront sites and commercial districts in these areas are vulnerable to sea level rise, storm surge and wind damage. Climate change therefore presents a threat to both economic sustainability as well as the services provided in these urban and port districts. Some of the region's most important sectors are found in these regions: maritime industries, tourism, banking, government and retail.

Water Supply: Water supply is vulnerable to the projected decrease in precipitation during the warm and dry months of summer and current storage scenarios could be insufficient under drier conditions. Additionally, water delivery systems (sometimes piping for over 20 miles) are vulnerable to land slides and other extreme weather events. Because water is essential for all life on the Peninsula, sensitivity is perceived as very high.

Open Space Forestry: The group evaluated ecosystems of value to this community for the quality of life they offer (ecosystem services were covered in another workshop). For forestry, this included: recreation, views, foraging, and spiritual values. Forests were identified as sensitive to climate change due to increased likelihood of forest fire and drought, and their ability to adapt is low due to the long life cycles of dominant tree species.

Medium-High Vulnerability

Low-income Families: Although clearly not true for all families, many in this group often stretch budgets to cover utilities and reside in aging houses subject to extreme weather events (pests, wind, and rain). Climate change could impact their ability to maintain a healthy environment and access to affordable, healthy food (including subsistence). The group has existing support services helpful in adaptation (Habitat for Humanity, Goodwill, public transport, food banks), but they need access to healthy foods, education, and health care.

Young Families: Families in this group can be sensitive to utilities cost, recreational opportunities, cold and flu seasons, subsistence opportunities, lack of family wage jobs, drug and alcohol use, and have potentially very little resources for adaptation; needs improved education, family wage jobs.

Veterans/Homeless: Some members of this group experience exposure to outside environments (rainfall and temperatures), which could become more moderate; however, continued exposure to increased extreme events, zoonotic disease and bacterial exposure may have negative effects. There is also less access to housing for this group, and no Veteran's Affairs hospital. Some suffer depression, use drugs and/or alcohol, compete for limited resources, and find that personal transportation is expensive and often unobtainable. They do have access to shelters, food bank, and public transport, but need housing, medical, and drug and alcohol counseling.

Downtown Port Townsend: With changing climate conditions this area could see sea-level rise and an influx of climate refugees. Area has seen some flooding of basements and a high water table, business closures due to flooding, road issues, and the undermining of structures. Businesses in the area may have trouble getting insurance, securing financing, and face some regulatory issues. The area does enjoy a strong tourism base, strong community support, and has iconic value for the community and region. Needed investments include new, more flood tolerant infrastructure, roads and building enhancements, increased public awareness/education. Currently, many owners likely do not have money to invest in building improvements.

Sekiu/Clallam Bay/Makah: Currently, severe storms and droughts have impacted water supply in these areas. Changing climate conditions could limit transportation options; increased temperature/ocean acidification is projected, which will affect fish and shellfish harvests. Water supply will be an issue due to changes in snowpack, runoff and erosion, and sea-level rise. Challenges to adaptation include general remoteness, ongoing regulatory disputes, lack of public awareness and education, and funding. Strengths in adaptation include a resilient population with self-sufficiency including subsistence gathering.

Development in low-bank shorelines: Five areas in particular: Three Crabs Road, Dungeness, Hood Canal, Beckett Point, and Diamond Point, were identified as vulnerable communities due to high density of residences in areas with potential sea level rise, storm surge, and wind damage. They have very little adaptive capacity due to the proximity of buildings to the current high water mark. The workshop attendees were in agreement that future planning must prohibit building on parcels without significant set-back and acknowledged that many existing parcels may be unbuildable.

Medium Vulnerability

Low-income Retirees: Members of this group often stretch budgets to cover utilities and reside in aging houses more sensitive to extreme weather events (wind, rain). Climate Change could impact their ability to maintain a healthy environment and access to affordable, healthy food (including subsistence). This group has existing support services helpful in adaptation (Habitat for Humanity, Goodwill, public transport, food banks), but they need access to healthy foods, education, and health care.

Development on High Bank shorelines: Bluffs are popular for the building of homes with a view. These areas are extremely vulnerable to increased erosion due to landslides, sea level rise, storm surge, and high impact weather events. Feeder bluffs are particularly vulnerable. Recent Shoreline Management Plans address this concern better than previous planning efforts, but workshop attendees felt that greater set backs would be required to protect bluffs and homes from anticipated impacts.

Dungeness Spit to John Wayne Marina: With changing climate conditions this area could see more runoff, higher water temperatures, sea level rise, bluff and beach erosion affecting wildlife preserves, salt water intrusion to groundwater, flooding and inundation, fish/shellfish impacts with resulting impacts on cultural and recreational values. Currently, there is pollution and agricultural runoff in the area. Adaptation resources include highly resilient and resourceful communities with climate change awareness, political awareness of communities at risk, and some elevating or relocation of infrastructure (limited roads), but continued access to tidelands is important.

Olympic National Park: With changing climate conditions, the Park may see more forest fires, road damage due to flooding and associated erosion, forest impacts from pests and invasive species. Influential to adaptation options is the size of the park, constant oversight and federal funding, national significance/visibility, and the diversity of species. The Park may continue to see challenges in communicating with local municipalities, along with continued shortfalls in federal funding.

Ft. Worden Lighthouse: Sea level rise will likely worsen existing beach erosion and erosion of historic structures. There is some state funding available as well as historic preservation funding for adaptation response, but existing structures are old and fragile. Long-term preservation of the lighthouse may not be feasible.

Medium-Low Vulnerability

Health System Monitoring and Response: The system currently focuses mostly on care for retirees/elderly, but needs tools to better predict emergent climate change issues along with better infrastructure, stronger emergency response, infectious disease monitoring, and the ability to attract high quality medical professionals.

Port Angeles Ediz Hook: Ediz Hook is susceptible to sea level rise. Currently, the hook protects the inner Port Angeles harbor area except for East/Southeast storms. There is no current flooding but sea level rise could surpass flooding thresholds. There are adaptation challenges in the form of regulations and financing, though the removal of dams may help provide long-term reinforcement and stabilization of sediment. Prevailing winds are in favor of continued sediment building but the area will need more financing for additional armoring.

Open Space/Ag. Land: The workshop attendees evaluated ecosystems of value to this community for the quality of life they offer (ecosystem services were covered in another workshop). For agricultural lands, this included: the growing of food locally, the importance of agriculture to the region historically, recreation, and views. Agricultural lands are seen as relatively adaptable due to their ability to respond to extreme weather events, although flooding is a risk.

Stormwater Management: With increased precipitation during extreme weather events, stormwater systems are more likely to be more frequently overwhelmed by water volume as grasses and other pervious surfaces absorb less runoff and contaminants. This, in turn, results in poor water treatment and decreases in water quality

Low Vulnerability

Economically advantaged citizen: This group enjoys recreational opportunities, often live in lots with views (potentially higher hazard), area subject to climate changes to air quality (pollen), and has the financial and other resources for recreation. The group does have access to development strategies that are sustainable and support adaptation, but may need education and perhaps changes to regulation/enforcement.

Port Hadlock and Port Ludlow: These areas could see climate change impacts of sea level rise and summer drought. Piers and waterfront homes are particularly vulnerable. Changes in precipitation intensity could also impact the aquifer (covered further in Water Resources). These areas face ongoing issues with economic development and regulation, but benefit from a central location, location on somewhat higher ground, and strong communities. Existing infrastructure in the areas includes a sewage treatment plant, the Northwest School of Wooden Boat Building, and septic system infrastructure.

Quilcene/Brinnon/Center Rd. Valley: These areas may see more intense rainfall, sea level rise, and flooding during heavy rains from climate change. More intense rainfall could decrease effective drainage from septic fields. Ocean acidification could have impacts on businesses as the area already includes low-income population. The current population is used to waterfront access, needs flood control for road structures and septic systems. Funding may be available if roads are involved.

Fort Worden/Fort Townsend/Fort Flagler: With climate change, these areas could experience worsening of existing beach erosion due to sea level rise and potential erosion around historic structures. There is some state funding available as well as historic preservation funding for adaptation response, but existing structures are old and fragile. May need to be flexible in the management of other Fort amenities.

Low-land River corridors: The group evaluated ecosystems of value to this community for the quality of life they offer (ecosystem services were covered in another workshop). For low-land river corridors and flooding estuaries, this included: birding and other wildlife habitat, views, open space, and recreation. These areas are, by nature, adaptable to weather conditions and therefore rank low in vulnerability.

Water Resources Workshop Results

On November 12th, 2014 a diverse range of stakeholders met in Sequim, WA to discuss Climate Change and issues of Water Resources on the North Olympic Peninsula. Below is the vulnerability ranking table drafted collaboratively by three breakout sessions at the workshop, covering issues of: *Water Supplies; Water Quality; and Watersheds.* Each of the ranked vulnerabilities is described in more detail following the table in its given vulnerability category. This detailed information was gathered during workshop discussions of the ranking of each of the vulnerabilities, and includes aspects of both the sensitivity and adaptive capacity discussions.

Table 2. Water Resources Vulnerability Ranking Table

		Sensitivity: Low → High				
		S0	S1	S2	S3	S4
Adaptive Capacity: Low ↓ High	AC0			*Forest Water Quality		
	AC1				*Run-off *Soil erosion	*Water supplies for wildlife *Emerging vegetation/ bacteria/ wildlife/ Algae and water quality *Alpine and sub-alpine zones
	AC2		*Coastal Septic Systems Water Quality	*Coastal Wells Water Quality *Clallam Bay/Sekiu -Water Supply	*Jefferson/Clallam PUD Municipal Groundwater systems *Rural/Residential/ Agriculture Water Quality *Wildlife *Floodplains	* Surface Water Supplies of City of Port Townsend, Clallam PUD, City of Port Angeles, Dry Creek, City of Sequim
	AC3			*Combined Sewer Overflow in Port Angeles * Lake Crescent Water Supply		*Private Wells
	AC4					

Water Resources Vulnerability Ranking Descriptions:

High Vulnerability

Water Supplies for Wildlife: Climate change will likely decrease snow pack, change precipitation timing and intensity, lower stream flow in the summer, cause rain on snow events resulting in higher stream flows, increase forest fire risk, change stream morphology, raise stream temperatures, increase competition for water supplies. Ongoing restoration projects, development, road decommissioning, regulations, and water management for people, agriculture, and in-stream flows will all influence the extent of these impacts. Adaptation needs include protection of existing habitat, less development, maintaining existing watershed functions, active monitoring for stream blockages, and use of water that has not been allocated to maintain in-stream flows in late summer (some difference of opinion). There is a need to know how much water really is needed for fish and could the use of multipurpose storage be beneficial for both humans and fish. Most initial strategies suggested appear to be quite difficult to implement.

Emerging vegetation/ bacteria/ wildlife/ Algae & water quality: Existing issues include fecal coliform reproducing in rivers, harmful algal blooms (emerging diuretic shellfish poisoning), algae blooms in Anderson Lake (highly eutrophic), altered biodiversity, and increased macro-algae blooms (anthropogenic nitrogen is a direct influence). Climate change could influence windows of opportunity for growth and strength of proliferation of these organisms. Confounding issues include nutrient loading and the human introduction of non-native species.

Alpine and sub-alpine zones: Under climate change there areas will like see declines in snowpack and glaciers, increases to spring/winter/fall precipitation, declining summer precipitation, more frequent extreme events, and higher temperatures. Currently, these areas have experiences a historical warming of temperatures and changes in precipitation patterns. There also already appears to be stress on vegetation and forests, and a proclivity towards more non-native/invasive species. Climate changes may include drier summers and less rainfall that will increase forest fire risk along with heavier precipitation and potentially more flooding. These areas could see increased threat to disease and beetles, stress, and erosion. Adaptation success may depend on continued availability of water and cooler temperatures. The systems will likely adapt/change because they are protected in the Olympic National Park, but habitats will change.

Medium-High Vulnerability

Forest Water Quality: Pine bark beetles have already affected Forests on the peninsula and potential increase stream water temperatures due to lack of tree canopy. Logging and conversion of forestlands to agriculture or residential areas has increased eutrophication and lowered dissolved

oxygen in some streams, lakes, and nearshore habitats. The success of mandated buffers around streams will be important in improving water quality in these areas.

Run-off: Extreme precipitation has already led to increased turbidity and bacteria in some watershed, metals run off from roads, nutrient loading may lead to lower dissolved oxygen levels in nearshore habitats. The first large fall rain event washes summer accumulation of pollution and in some cases manure from agricultural sources into creeks. Lighter rain can drive contaminants into groundwater. Climate change could lengthen the dry season and increase contaminant loading during these more intense fall rain events, and may precipitation may be large enough to liberate contaminants that previously were too heavy for transport (e.g. metals on roads). Relevant to adaptation, are the existing state laws for septic systems, wells, and flood control. Currently, stormwater systems are in place but there may be a need for additional capacity and treatment, which are available but costly.

Soil Erosion: Increased erosion results in higher turbidity during extreme precipitation events. Examples include Johnson Creek and Matriotti Creek due to Agriculture influence. The Elwha river channel is largely incised because of high peak flows. The Chimacum River has experienced overflows. There is concern about logging in steep terrain and the related potential for erosion or landslides during rain events. Potential future alteration to plant species that stabilize banks (e.g. pine beetle related tree mortality) also influences increased peak flows and landslides. Other non-climate related influences include dam removal (Elwha River), flood plain control (Dungeness River) and agriculture influence (livestock eroding banks). Erosion is in some ways a natural process that can assist in adaptation (e.g. maintaining floodplains).

Surface Water Supplies of City of Port Townsend, Clallam PUD, City of Port Angeles, Dry Creek, City of Sequim: Climate change could affect the recharge rate for reservoirs and other water supplies through changes in precipitation intensity and timing (impact is not known currently, additional modeling or monitoring would be beneficial). Lower summer or fall stream flow will limit stream diversion to meet fish passage regulations. High water events or more barren slopes due to wildfire can cause turbidity issues. There is also the potential for increased competition for water resources and water is needed to fight wildfires fires, there is increased residential demand due to warmer temperatures and population growth, earlier and longer growing season increase demand for agricultural irrigation, and increased evaporation rates due to higher temperatures. For historical reference: in Port Townsend low snowpack has caused water supply issues; Clallam Public Utility District has seen low flow due to snowpack conditions and timing of rains; the Makah have had water supply issues; Beaver Creek and Lake Pleasant have also been impacted; and warming temperature have impacted water quality in Port Townsend. Generally, reduced snowpack decreases the refilling of reservoirs, though this doesn't affect the rain-dominate watersheds further west on the peninsula. Adaptation options could be tied to increasing storage capacity, enhancing conservation programs and water use efficiency laws, accurate data on how much water fish actually need, county infrastructure planning, interties with other water systems, conservation, and education. As in the past, there are expected some large political challenges to undertaking these actions.

Medium Vulnerability

Jefferson/Clallam Public Utility District Groundwater Water Supplies: These systems could see recharge rates altered by decreases in snow pack, changes in precipitation timing and intensity, lower stream flows, rain on snow events, increased forest fires, higher temperatures and evaporation, increased competition for resources (irrigation, population, fires). Jefferson Public Utility District has seen drought followed by rain, but the overall recharge rate was less than expected, perhaps due to rain coming when plants were actively growing. Historically, drought events correlate with drops in static water levels tied to timing and quantity of precipitation. Ongoing influences include pollution from septic systems and fertilizers. Adaptation opportunities could include increasing conservation, adjusting rate structures, alteration of storage methods, interties between water systems, and regulatory changes that support these actions.

Rural/Residential/Agriculture Water Quality: Currently, some manure lagoons overflow during extreme precipitation events. Though, it is not known if these overflows seep to groundwater. Other potential pollutants that affect water quality include pesticides, herbicides, fertilizer, and contaminants on hardscape (Marrowstone has cisterns). The capacity of manure lagoons may not be adequate given changing climate conditions as precipitation increase and shoreline and natural buffers potentially diminish. Existing processes relevant to adaptation include enforcement and education.

Private Wells: Sea level rise can cause salt-water intrusion into some wells. Shallow wells are highly sensitive to infiltration rates and may be affected by changes in precipitation intensity and timing and lower snowpack. Wells may also see increased demand due to warmer temperatures, earlier and longer growing season that increase demand for irrigation water, and increased demand from population growth due in part to climate refugees. In the past, the piping of leaky irrigation ditches reduced water table and some wells dried up. In the Elwha watershed five or six people have lost their wells (could be from dams but not sure, Laird's Corner and Lower valley). Clallam Public Utility District has previously had some shortages due to low stream flow and regulatory constraints. There has already been saltwater intrusion in Marrowstone and other Jefferson County areas. Confounding non-climate issues includes behavior (Marrowstone increased usage when Public Utility District water was brought in), water pricing, zoning, and regulation. Sea level rise may cause groundwater table to rise in coastal areas. Adaptation strategies include developing interties with existing water systems, enhanced reuse of grey water, or reclamation system for irrigation, smart water metering, installing cisterns or other rainwater catchment devices, education on conservation and planting of drought tolerant native plants, and changing regulations through comprehensive planning. There is substantial variation across systems, such as in Sequim where the users have agreements with irrigation companies and their water costs are low. These actions are not monetarily expensive but the challenge is gaining consensus from many individuals.

Wildlife: A changing climate will affect wildlife through extreme weather events, drought, and wildfires. Currently, the region has a moderate climate with diverse wildlife populations, though Elk populations remain low. Climate change could limit the quantity of food at higher elevations. This will cause increased stress and more interactions with humans if animals are driven from higher elevations and do not have food. Non-climate stressors for populations include more hunting, more fencing, more active management, more diseases affecting species and habitats (e.g. pine beetle affecting forests). Successful adaptation will require identifying key species, indicator species and enhancing monitoring to help guide response options. Habitat Management can involve: hunting/harvest, access to habitat and enhanced connectivity, population and habitat monitoring, more open space, and access to water.

Floodplains: Climate change will likely change the frequency of storm, rain, and drought events, which will affect river flood patterns. Because of this, there may be increases in erosion and scouring, more big cobbles, changes to upland sediment sources, increased flooding, changes in side channel habitat, property damage, increases in the flashiness of floods, impacts on estuaries, and intrusion or infiltration issues for groundwater. Currently, levees, bridges, diversions, upland land use practices, storm water discharge all affect the flood plains. The appropriateness of adaptation strategies will vary from place to place sometimes favoring unrestricted or natural flood plains and sometimes leaning toward more protection for property and infrastructure. There is an improving political/funding climate (as demonstrated by the current work on Dungeness). Many floodplain issues are already known and this makes it easier to map and then manage those impacts. Additional adaptation needs include more space for floodplains, improvement of regulations and enforcement of existing regulations, and public outreach. Political climate can be difficult as there are many privately owned lots with the floodplain.

Medium-Low Vulnerability

Coastal Wells Water Quality: The sensitivity of the wells depends on groundwater flow, recharge rates, and irrigation methods. Climate change could decrease or alter groundwater recharge rates, and raise the coastal water table in some areas as sea levels rise allowing for saltwater intrusion. Non-climate influences include coastal development.

Clallam Bay / Sekiu Water Supply: Both communities use groundwater-based system for water. They are currently as driven by snowpack as the systems further east, so the climate related impact might be a bit less.

Low Vulnerability

Coastal Septic System and Water Quality: Septic systems are already compromised at Golden Sands, Three Crabs, and Beckett Pt. Climate change could influence evaporation rates (for mound systems) and sea level rise could inundate coastal septic fields. Non-climate related issues are the limited enforcement and corrective actions taken on older or failing systems. The systems are supposed to be inspected each year. Actions developed to enhance resilience will need to be designed to address a large number of systems spread across a broad geographic area.

Combined Sewer Overflow in Port Angeles: Extreme precipitation events cause combined sewer overflow events in many communities across the country. Currently, they're about 100 overflow events a year in Port Angeles (tracking started in 2000) but with new system improvements (designed and funded) this should decrease to about one event a year by 2016. Climate change could increase the frequency large rain events and thus the frequency of overflow events where the impact is mostly to Port Angeles harbor. There is current work to upgrade conveyance of west Port Angeles to a treatment plant that will also have a storage tank to hold overflows.

Lake Crescent Water Supply: Currently, not as much snowpack-driven as for systems further east, so the impacts of climate change on this water system is likely a bit lower. There are currently no supply related issues and the adaptive capacity of the system is good.

Not Evaluated

The following items were discuss but not fully evaluated during the workshop, so they have not been assigned vulnerability rankings.

Shorelines/ Estuaries: With changing climate conditions, these areas could experience increased frequency and severity of severe storms, sea level rise, warmer waters, alteration to erosion patterns, and more frequent algal bloom events. These areas already face periodic flooding and salt water intrusion. Warming water trends stress the ecosystem, increase flora/fauna susceptibility to parasites, bacteria, and disease. Sea level rise could promote a higher incidence of salt-water intrusion in marshes/estuaries which would stress the plant community and alter the freshwater lens and thermocline due to changes in temperature and freshwater inputs. There is potential for increased estuary turbidity due to increased sediment loading from heavy precipitation events. Other non-climate related issues are the management difficulties of these areas (e.g. diverse property ownership), as well as development pressure, existing armoring, nutrient runoff from agriculture sources, and current large-scale restoration efforts (such as the Elwha estuary and Dungeness floodplain).

Wetland Function: Relevant climate change issues include water availability, drought, rates of inflow and outflow (due to changing precipitation patterns and snowmelt), flooding along with the potential increased heavy nutrient or sediment loads. The biggest current impact to this system comes from human society and some more limited animal influence (e.g. beavers). Climate change could lead to an overall disturbance of ecological balance, which may shift plants communities, nutrient loads, frequency of algae blooms, increase low oxygen levels, and change

invertebrate population. Wetlands are complex and affected in a variety of ways. They may become inundated if they can't keep up with rising sea levels or dry up if they are dependent on melt water from snowpack.

Native and non-native upland and riparian vegetation: Relevant climate change impacts include the potential for: higher winter and spring stream flows, lower summer stream flows, drought, wildfire, air temperature increases, and reduction in snowpack. Historically, these systems have been exposed to a moderate climate. Thus, changes in precipitation and hydrological extremes will not support same vegetation complex in same places and can stress existing species and encourage the growth of non-native species. Climate change could cause a loss of streamside vegetation (and the associated shade it provides the stream), streams may become wider and shallower, pine bark beetles and other pests could spread increasing forest disease and increasing wildfire risk. Non-climate related factors include higher management costs, more sedimentation, the use of more pesticides, surface and stream bank erosion, and a decline in forestry which remove roads and limits responder's ability to access areas during fires.

Population Growth and Development from Climate Refugees: Climate change could increase temperatures and reduced snow pack, building on the existing sunny Sequim effect – it's going to get even nicer. Regionally, Sequim and the other communities on the Eastern portion of the peninsula are attractive because of their climate and may become more so. However, existing national perception is this area is a gray, rainy place. If the region becomes more attractive due to climate change that equals more people, more development, more impervious surface (causing increases in stormwater runoff), more warming (from urban heat island effect), more habitat lost, an increased demand for water, and potential for fragmented habitat.

Surface Water and Groundwater: Changes in streamflow and precipitation patters may affect both surface and ground water. Droughts have meant both lower stream flows and lower ground water levels, while heavy precipitation events have meant increase run off and more flooding. Non-climate issues include increased groundwater withdrawals; surface water diversions, artificial recharge, stormwater infiltration and diversion for agricultural.

Homeowners: One of the main direct physical impacts of climate change to coastal homeowners comes from sea level rise and coastal flooding. Not directly climate related, other relevant issues include existing coastal armoring, the regulatory environment, and the desire many people have to build homes with views that are both more valuable and more exposed.

Natural and Managed Ecosystems Workshop Results

On November 13th, 2014 a diverse range of stakeholders met in Blyn, WA to discuss Climate Change impacts relevant to issues of Natural and Managed Ecosystems on the North Olympic Peninsula. Below is the vulnerability ranking table drafted collaboratively by three breakout sessions at the workshop, covering issues of: *Fisheries and Aquaculture; Agriculture and Forestry; Wildlife*. Each of the ranked vulnerabilities is described in more detail following the table in its given vulnerability category.

Table 3. Natural and Managed Ecosystems Vulnerability Ranking Table

		Sensitivity: Low → High				
		S0	S1	S2	S3	S4
Adaptive Capacity: Low ↓ High	AC0					*Wild Salmon *Nearshore environment-natural context
	AC1		*Wetlands		*Waterfowl *Clallam Low elevation forests - natural *Chimacum Agriculture	*Wild/commercial shellfish stocks *Nearshore environment-urban context *Food chain base (fish, insects, plankton) *Amphibians *Sea and shorebirds
	AC2				*Marine mammals *Southeast Jefferson Co. Forests *High elevation forests *Shellfish hatchery *Raptors *Songbirds	*Nearshore environment-estuary context *Marine and Freshwater Fish
	AC3			*Dungeness Agriculture *Quilcene Agriculture *Salmon aquaculture *Large land mammals	*Salmon hatchery *Small land mammals	
	AC4				*Clallam low elevation forests-managed *High elev forests-managed	

Natural and Managed Ecosystems Vulnerability Ranking Descriptions:

High Vulnerability

Wild Salmon: Juvenile salmon have a critical 2-3 month survival period in nearshore habitat, which can be affected by water temperature and hypoxia (low oxygen levels). Climate change may decrease summer stream flows, increase stress during staging alter run timing, and hatcheries may face depleted oxygen levels and need to move to higher flow sites. There is potential for increased plankton blooms and challenges to wild salmon feed sources. Existing non-climate stressors include mining of sand and gravel deposits near streams, which may affect water quality (a hatchery at Low Creek is pumping and filtering ground water for use in their facility instead of using streamflow due to poor seasonal water quality). Hatchery and Wild stocks have a certain degree of innate plasticity as colonizer fish that may help them adapt to these changes, but they are also already meeting existing environmental thresholds in some areas.

Nearshore Environment-natural context: These areas are affected by ocean chemistry, water and air temperatures, dissolved oxygen levels, dinoflagellate blooms, and mixing zones. Changing climate change could affect the timing of freshwater inputs, erosion, sediment transport, and degrading environmental conditions to allow invasive species to gain footholds. Other influential non-climate factors include runoff from non-point pollution, shoreline armoring, and the lack of riparian habitat. Conservation practices can help with adaptation in this environment and organisms in tidal zones have some capacity to adapt to rising sea levels.

Wild/commercial shellfish stocks: Both wild and seeded beds are seeing a lack of recruitment for pacific oyster (non-native), while native Hood Canal oysters are doing a little better in their habitat niche. Geoducks are also showing some resiliency to the current changing climate conditions but all these shellfish species are exposed to high water temperatures and more frequent algae blooms. It is expected that for the foreseeable future recent failures of oyster spat at hatcheries will continue. Hood canal oysters can deal with anoxic, high freshwater input environments and some hatcheries are already continuously monitoring and treating water inputs and outputs to their plants. For adaptation, wild/seeded stock may have some plasticity and ability to select species traits for survival. Non-native species seem to have a more efficient metabolism, but takes many years to acquire strains. Olympia oysters in estuary may have historically seen low pH (higher acidic) conditions but have a narrower preference for habitat and pacific oysters (non-native) are already highly dominant. Geoducks are all from native stock.

Nearshore environment-urban context: These areas are affected by ocean chemistry, water and air temperatures, dissolved oxygen levels, dinoflagellate blooms, and mixing zones. Changing climate change could affect the timing of freshwater inputs, erosion, sediment transport, and degrading environmental conditions to allow invasive species to gain footholds. Other influential non-climate factors include runoff from non-

point pollution, shoreline armoring, and the lack of riparian habitat. Conservation practices can help with adaptation in this environment and organisms in tidal zones have some capacity to adapt to rising sea levels.

Food chain base (fish, insects, plankton): Climate change will increase air and water temperatures, change the chemical composition of water, alter flow regimes, increased turbidity and scouring in streams, enhance erosion issues, potentially later population/development patterns, increase water usage during the summer, potentially affect the use of herbicides and fertilizers, rise sea level, make summer droughts more common, and continue declines in snow pack. Currently: upwelling brings nutrients and decrease pH (increases the acidity of the water and plankton are vulnerable to more acidic waters); drought has caused die off of salmon and other migrators in the past; flooding can increase the scouring of redds; turbidity in streams and rivers can impact forage fish and salmon; erosion and other debris flow from flood events scours the river bottoms affecting habitat, insects, freshwater plankton, and forage fish; sea level rise may alter coastal inundation patterns and affect the timing for salmon runs and forage fish; higher temperatures will affect insects; ocean acidification will affect plankton; higher water temperatures will increase the likelihood of algal and fungus blooms that decrease oxygen levels and can kill juvenile salmon and forage fish. Non-climate related stressors for the food chain base include the use of pesticides/herbicides/fertilizers; increasing water demand; and the release of micro-plastics impact on the ecosystems. The quick generational cycle for insects may allow them to adapt to some of these changes through natural selection; some species are migratory/mobile; some species have flexibility in what they eat (forage fish eat a variety of types of plankton); and some salmonids evolve relatively quickly. Nearshore restoration or protection can reduce these stressors and could introduce calcium and create conditions that enhance the natural function of food webs.

Amphibians: The issues of droughts and high flows of water; changes to humidity or moisture levels; microclimate changes; increases in overall air and water temperature; decreasing ocean/water pH; changing water chemistry such as dissolved oxygen levels; and habitat migration will all affect amphibians. Droughts as well as shifts in predatory/prey abundance and habitat loss due to floods and erosion have already been harmful to some amphibians. Increases in invasive species populations could displace existing native populations or increase predators or competition. The loss of food web species, loss or increase of habitat, drought associated reproductive issues, and susceptibility to diseases are all other climate and weather related issues affecting amphibians. Non-climate related issues include development that displaces habitat; increase pollution in the environment including plastics and herbicides. Adaptation of species will depend on genetic diversity, mobility, and human actions, but need education and political policy and will to drive action including assisted migration.

Sea and shorebirds: Changing water quality and increasing water temperature (which impacts food sources, and can increase the likelihood of harmful algae bloom which killed off surf scoters previously) will affect sea and shore birds. These bird move and feed with the ocean's and shoreline's food sources. As climate changes & ocean acidity increases, the birds will be pressured to adjust their feeding patterns and migration routes. Relocation of feeding flyways will likely make it difficult to find food and increase competition with resident species. Changing sea levels will modify and in some instances eliminate breeding grounds that are at, or near, sea level. Flooding of nesting areas can destroy nests and/or

increase exposure to predators. Other relevant issues include fishing bycatch, which traps fish-eating birds and overfishing that reduces their access to forage fish. Increased development of shorelines for business, industry, and homebuilding, reduces the space available for the birds to feed, rest, and nest. Forage fish declines due to over harvest, plus water contamination also adversely impact birds. These birds can fly, so can move away from affected areas and can shift their diets, but they will always need food and safe nesting areas.

Medium-High Vulnerability

Waterfowl: Climate change influence to this group could include: stream flow timing and volume, temperatures, storms, and storm surge. Coastal flooding due to storms and sea level rise may disrupt nesting. Waterfowl are habituated to specific nesting locations and earlier more intense weather shifts under climate change could devastate breeding if young are in nests or unable to swim and feed themselves. Both storms and rising water can disrupt migration and feeding between wintering site and breeding/nesting grounds. These species have the ability fly and swim, but need adequate safe water, marshlands to feed and nest as well as open flyways and good air and water quality.

Clallam low elevation forests-Natural regeneration: The group attending the workshop differentiated between naturally regenerated forests and managed forests since impacts such as drought and fire are more severe in wilderness areas versus managed or working forests. No forests are highly adaptable due to the slow life cycle of dominant tree species. The Clallam low elevation forests are susceptible to drought, fire, and heat stress.

Chimacum Agriculture: The Chimacum valley has very little water available for agriculture during the growing season, making it sensitive to drought and heat stress. There are adaptive measures that could mitigate some of this risk, but currently the basin has extremely limited access to new water use because of restriction from the Washington State Department of Ecology, limiting the ability of the agricultural system in the valley to adapt at this time. The valley is vulnerable to flooding, but has a historical precedence of seasonal flooding that is tolerated by current agricultural soils and cropping systems, reducing the sensitivity to these floods. This is Jefferson County's most productive farmland and highly valued for the community benefits it provides.

Nearshore environment-estuary context: These areas are affected by ocean chemistry, water and air temperatures, dissolved oxygen levels, dinoflagellate blooms, and mixing zones. Changing climate change could affect the timing of freshwater inputs, erosion, sediment transport, and degrading environmental conditions to allow invasive species to gain footholds. Other influential non-climate factors include runoff from non-point pollution, shoreline armoring, and the lack of riparian habitat. Conservation practices can help with adaptation in this environment and organisms in tidal zones have some capacity to adapt to rising sea levels.

Marine and Freshwater Fish: Relevant changing climate conditions include ocean acidification; sea level rise; riverine flow regimes and timing of freshwater input; water temperature increases, and potential increase in sediment. Currently, drought periods can create die offs of freshwater fish. These events are frequently tied to higher temperatures, low dissolved oxygen levels, high stress, and other food web impacts. Ocean acidification may decrease the abundance of food for marine and anadromous fish like salmon and estuaries may be impacted and less available with sea level rise. Salmon's ability to go upstream will be affected by not only streamflow but the availability of stream cover as cover might change if the trees the shade the streams and woody debris leaves system. Higher winter/spring streamflows and floods could scour beds and decrease availability of food. Non-climate related stressors include marine debris and micro-plastics in the environment; multiple sources and types of pollutant through stormwater, pesticides, insecticides; habitat loss, shoreline armoring; channel simplification; and fewer habitat structures. For adaptation, there is mobility within aquatic system, some ability to change food sources and the need some habitat diversity and refuge (food, cover, etc.) during the transition.

Medium Vulnerability

Marine mammals: Climate change can influence water temperature and clarity; increase the acidity of the ocean; create extreme precipitation events; and droughts. Food sources like salmon could be negatively impacted due to climate factors. This would reduce the food supply available to marine mammals. Non-climate related impacts already affecting marine mammals include toxins that bio accumulate through the food chain can affect their immune systems; sonar issues and boats; water temperature and clarity. These species can move to new areas in order to avoid some impacts; have endangered species protections; a suite of existing restoration projects; and fishing regulations. They will need access to good healthy food chains.

Southeast Jefferson Co. Forests: The forests in this area are vulnerable to many of the same threats as in other areas (drought, heat stress, fire, pest pressure) and are equally slow in adapting due to the long life of dominant species. However, this region receives more rain than the more northern rain shadow regions, likely providing it more of a buffer to these stressors. Managed forests will also be able to replant with species that are better adapted to expected increases in temperatures and develop other management techniques to help mitigate climate change impacts.

High elevation forests -natural regeneration: These forests are susceptible to increased risk of drought, heat stress, pest pressure and fire in an already inhospitable environment. Thin soils and slow growth make these forests especially vulnerable, and species are slow to adapt due to their long life cycles. However, these ecosystems are somewhat acclimated to harsh conditions and experience cooler temps in the heat of summer, providing them some potential resilience.

Shellfish hatchery: Hatcheries closest to ocean and upwelling see the greatest affects of ocean acidification and extreme variation in water chemistry. During upwelling events source water can be extremely hypoxic. When shellfish are moving from eggs to larva 80-90% of their weight is shell. In wild/seeded beds there has been a lack of recruitment for pacific oyster (non-native), native hood canal oysters doing a little better in their habitat niche, while Geoducks are also showing some resiliency. It is expected that for the foreseeable future failures at hatcheries like those already observed will continue. Hood canal oysters can deal with anoxic, high freshwater input environments and many hatcheries are already continuously monitoring and treating water inputs and outputs to their plants. Hatcheries do have the financial and technical capacity to adapt. They can treat water inputs and hang matrixes of algae and shellfish to improve water quality. Wild/seeded stock may have some plasticity, and ability to select species for survival, non-native species seem to have more efficient metabolism, but takes many years to acquire new traits. Olympia oysters in estuaries may have historically seen low pH (high acidic) water conditions but have a narrow preference for habitat and pacific oysters (non-native) are already highly dominant. Geoducks are all from native stock and have more efficient metabolism.

Raptors: Climate change could affect nesting location, territorial range, migration routes, and migration food sources. It could also alter the seasonal timing of nesting and affect food sources used for feeding young. This could increase stress on adult birds to find food and feed young. Also, declining habitat and declines in some food source bird, animal, and fish species may occur with climate change. These species do have ability to fly to move away from threats and can change prey base. As conditions change they will need to maintain some stability and access to habitat, food sources, and migratory routes.

Songbirds: Climate change could create seasonal shifts affecting migration patters, change food sources, affect the timing and availability of water, increase temperatures, and enhance storm surge. These changes could affect migration and breeding schedules. Warmer climates produce greater varieties of insects and food grains/berries. Birds depend on climate conditions and temperatures to produce the vegetation, which feeds them or shelters the insects they eat. Changes in timing are also critical as trees leafing out too early or too late for migrating birds could expose nests to predators, both aerial and terrestrial. As birds are forced to fly further north to find right breeding conditions, territorial competitions could develop between resident and migratory species. Non-climate issues include the development of tall buildings/structures in migratory flyways, many with lights that disorientate birds. Migratory songbirds fly at night to avoid heat and predators. As humans light the night, the birds are threatened. Many of these birds have the ability to fly and adapt diets but need safe areas to fly and appropriate habitat and food sources.

Medium-Low Vulnerability

Salmon hatchery: Juvenile salmon have a critical 2-3 month survival period in nearshore habitat, which can be affected by water temperature and hypoxia (low oxygen levels). Climate change may decrease summer stream flows, increase stress during staging alter run timing, and

hatcheries may face depleted oxygen levels and need to move to higher flow sites. There is potential for increased plankton blooms and challenges to wild salmon feed sources. Existing non-climate stressors include mining of sand and gravel deposits near streams, which may affect water quality (a hatchery at Low Creek is pumping and filtering ground water for use in their facility instead of using streamflow due to poor seasonal water quality). Hatchery and Wild stocks have a certain degree of innate plasticity as colonizer fish that may help them adapt to these changes, but they are also already meeting existing environmental thresholds in some areas.

Small land mammals: Relevant climate change conditions include changes to temperature, snowpack, wildfire and drought. Less snowpack can mean less insulation for marmots, more rain can flood burrows, subalpine areas dries out without snowpack, and wildfire could destroy habitat and displace animals. With changing conditions there may be less vegetation or new vegetation, other animal migrants, predators like coyotes may travel into high country more quickly and can kill off young; the availability of food may change due to drought; and both habitat and migration patterns may change. Currently, non-climate related impacts include by forest harvesting practices, invasive species, and human uses of the landscape. Large mammals have more flexibility in their food sources and more mobility than small mammals. Small mammals will wildlife corridors and healthy ecosystem to adapt to these changes.

Wetlands: Natural wetlands are subject to change with the climate due to changes in precipitation patterns, which could potentially dry up wetlands permanently or seasonally during drought conditions Conversely, wetlands could expand due to increased precipitation during wet months. The function and nature of wetlands is to absorb and hold water, providing them some resilience by design.

Low Vulnerability

Dungeness Agriculture: The Dungeness region has some of the finest agricultural soils on the Olympic Peninsula and water rights that support vibrant agriculture. These conditions also make the area attractive to development and increased development pressure due to population growth (and potentially climate related migration) puts agriculture in the Dungeness at risk. The area is also low-lying and subject to increased flood risk due to sea level rise. The open space and farmland in the area is well suited to absorbing seasonal fluctuations in precipitation and, since, agriculture is highly adaptable due to annual cropping cycles, this region is considered at a low risk.

Quilcene Agriculture: Similar to the Dungeness above, the Quilcene agricultural area, located primarily around the Little Quilcene fork, is fairly adaptable to expected impacts of climate change. Agriculture is able to adjust better than many industrial sectors due to annual cropping cycles and having open space to act as a buffer for increased precipitation events. This region also has strong water rights and enough water quantity to buffer it from the impacts of drought and heat stress. A dramatic drop in volume in the river would impact water availability over time.

Salmon aquaculture: With climate change and changing ocean conditions, some aquaculture sites may face depleted oxygen levels and need to move to higher flow sites. With higher water temperatures there is a higher likelihood for plankton blooms. Aquaculture has the ability to select certain species that are more tolerant to water condition and change dissolved oxygen levels around the sites (though both may have difficulty with rate of change). Feed technologies are improving and feed conversion ratios are generally improving, Australia is able to farm in warmer waters.

Large land mammals: Relevant climate change conditions include temperature, snowpack, wildfire, and drought. Less snowpack can mean subalpine areas dry out, and wildfire could destroy habitat and displace animals. There may be less vegetation available for food during drought periods. Other animals may migrate into new habitat areas and predators like coyotes will be able to move into the high country quicker and can kill off young. Current non-climate stressors include human use of the environment, population growth, forest harvesting practices. Large mammals have more flexibility in their food source and more mobility than small mammals though they need access to wildlife corridors and healthy ecosystems in general.

Clallam low elevation forests-managed: These forests are somewhat buffered from risks of drought, fire, pest pressures, and heat stress due to greater rainfall and temperatures moderated by proximity to the Straits and coast. Managed systems also allow for practices to mitigate risks, such as planting varieties better suited to heat and drought.

High elevation forests-managed: Managed forests offer more resilience, though the costliness of employing intensive management practices or tools may make it impractical. These forests will be sensitive to the same risks as others on the Peninsula: drought, heat stress, risk of fire, and pressure from pests. The thin soils and extreme conditions make this ecosystem less resilient than low elevation forests, though adaptive capacity may be increased due to acclimation to harsh conditions.

Critical Infrastructure Workshop Results

On November 14th, 2014 a diverse range of stakeholders met in Port Angeles, WA to discuss Climate Change impacts relevant to issues of Critical Infrastructure on the North Olympic Peninsula. Below is the vulnerability ranking table drafted collaboratively by three breakout sessions at the workshop, covering issues of: *Low-lying Infrastructure; Transportation Corridors and Emergency Management; Utilities, Sewer & Solid Waste*. Each of the ranked vulnerabilities is described in more detail following the table in its given vulnerability category.

Table 4. Critical Infrastructure Vulnerability Ranking Table

		Sensitivity: Low → High				
		S0	S1	S2	S3	S4
Adaptive Capacity: Low ↓ High	AC0			*Clallam Bay/Sekiu Sewage Treatment (Short-term)	*Clallam Bay/Sekiu Sewage Treatment (Long-term)	*Port of Port Townsend Boat Haven *Port of PT Point Hudson
	AC1				*3 Crabs Road * Downtown Port Townsend and Kah Tai Lagoon *Roads in Clallam Bay	
	AC2			*Vacuum Sewer System at Elwha Lowlands *Highway 116 *Highway 20 and the Port Townsend Ferry	*Septic Systems *Highway 112 * Hoko/Ozette road *Forest Roads for fighting fires	*Stormwater Outfall Infrastructure *Highway 101
	AC3		*Electrical Transmission Infrastructure *Public Warning Systems (All Hazards)	* Clallam / Wheel / Ward / Burlingame bridges *Forest Roads to communication towers *South Jefferson County	*Port Angeles Landfill *Highway 104/ Hood Canal Bridge *Morse Creek and Hot Springs Road * City of P.A. Industrial waterfront, Ediz Hook and Lower Elwha	*Sewer Outfall Infrastructure
	AC4					

Critical Infrastructure Vulnerability Ranking Descriptions:

High Vulnerability

Clallam Bay, Sekiu Sewage Treatment (Long-term): Currently, nuisance flooding during high flow events and climate change there might be some impact to the Clallam bay sewage treatment plant if river-flooding magnitude increases. The system has a good manager but it quite old. The prison nearby may present opportunities for sharing wastewater treatment resources. The surrounding vegetation (forestland) might also protect infrastructure. All of these adaptation options are potentially quite expensive.

Port of Port Townsend - Boat Haven: The Boat Haven is susceptible to sea level rise, storm surge, and coastal flood events. Currently, its stormwater outfall is near the maximum water level during storm events. Failure of the tide gate could lead damage the stormwater filter and would put the system out of operation. The secondary impacts could mean the yard permit is threatened (currently supports > 500 jobs). The Port does have some financial capacity and is a compact and localized system, which will increase its ability to adapt to these impacts. The tenants are resourceful and the maintenance staff has the skills to address engineering problems. However, the funding base for the Port is inadequate for a total system re-build and needs political will on part of port commissioners to increase port funding. Cost benefit analysis tools would be useful to guide investment decisions.

Port of Port Townsend - Point Hudson: Point Hudson will likely be affected by sea level rise, storm surge, and coastal flood events. Old Coast Guard station buildings on the sand spit are not well built and currently experience nuisance flooding during large rainfall events. Additional flooding is expected due to sea level rise and could compromise the buildings even more. Additionally, the jetty is old and failing and no money is available for upgrades. Point Hudson is an economic anchor for the community and protects the east end of downtown. The Port does have some financial capacity and is a compact and localized system, which will increase its ability to adapt to these impacts. Similar to above, the tenants are resourceful and the maintenance staff has the skills to address engineering problems. However, the funding base for the Port is inadequate for a total system re-build and needs political will on part of port commissioners to increase port funding. Cost benefit analysis tools would be useful to guide investment decisions.

Medium-High Vulnerability

Clallam Bay/Sekiu Sewage Treatment (short-term): Currently, nuisance flooding during high flow events and climate change there might be some impact to the Clallam bay sewage treatment plant if river-flooding magnitude increases. The system has a good manager but it quite old. The prison nearby may present opportunities for sharing wastewater treatment resources. The surrounding vegetation (forestland) might also

protect infrastructure. All of these adaptation options are potentially quite expensive. In the short-term, the system is likely able to accommodate the expected changes in rainfall and flood events and thus is less sensitive than over the long-term.

3 Crabs Road: This area is extremely likely to be affected by sea level rise and increased coastal flooding. The area was wetlands before the road was built in 1970 and currently experiences localized flooding around the 50 homes built along the road. Land-use policies do not limit construction in the area. It is possible to decrease the potential impacts of coastal flooding by opening up historic ponds and make drainage improvements (like the work being done by North Olympic Salmon Coalition at the very end of the road). In the long-term, there may not be many adaptation options as surrounding area is all low lying.

Downtown Port Townsend and Kah Tai Lagoon: Sea level rise and coastal flooding with likely exacerbate current bluff and beach erosion in this area. The existing wastewater treatment plant of wastewater outfall may be affected. There is a general lack of money for wastewater infrastructure upgrades as there is only have a small tax related income stream. Kah Tai Lagoon is largely an undeveloped park and more easily able to accommodate higher water levels. In the short-term, the downtown area will need enhancements to the water removal system for when the underground areas are flooded. In the long-term, the underground areas would likely need to be filled in to protect existing buildings and utilities might need to be elevated.

Roads in Clallam Bay: Increases in large rainfall events will likely increase the magnitude of flood in the Clallam River. This area already experiences minor flooding of homes and future flooding could block road that leads to the sheriff headquarters at slip point. There are also potential impacts to two bridges that cross the river, the river mouth position influences how the river floods and if the river mouth is unobstructed the river doesn't flood. There are options to decrease vulnerability in the area. Wheel Bridge is part of the Washington State Department of Natural Resources upgrade plan and could be raised or modified to clear log jams and two other bridges could be elevated. Generally, river mouth modifications are not popular but could be done to decrease blockage. Wheel Bridge and other bridges were also covered as part of a different breakout group.

Stormwater Outfall Infrastructure: Stormwater systems have diversified inputs and outputs and historically outfalls were not below the high tide line but that could change as sea levels rise and, depending on head pressure, could cause pushback up the pipe (in Port Angeles a primarily outflow is near Coho ferry terminal). Currently, the pump stations in Port Townsend are one to two feed above sea level and thus at risk from sea level rise. If all the stations three feet above current water levels were compromised, that would impact one-third of Port Townsend. There are a lot of adaptation choices including: increasing outfall pipe diameters, segmenting the system, use upland storage (Port Angeles is already building additional upland storage), or pump the outflow. Pumping treated effluent would be less expensive than building a plant. Wastewater pumping would be much more difficult because of the diverse inputs/outputs of the system. Large-scale precipitation events are currently not

treated as the water is assumed to be clean enough. Rain gardens are not necessarily a permanent fix as they require maintenance to continue to be effective.

Highway 101: The highway could be affected by see sea level rise, landslides, river flooding, and culverts that aren't big enough to handle stormwater flows. With sea level rise there may be increased flooding storm events; increases in river flooding; increases in landslides due to heavy precipitation that flow over or damage the road; the section of Highway 101 by Discovery Bay is defined by the Washington Department of Transportation as susceptible to impacts of four to six feet of sea level rise (other sections of Highway 101 are moderate or high impact in study). This corridor provides critical access to large parts of the North Olympic Peninsula, with no transportation alternatives aside from the ferry system. Actions to reduce vulnerability could center on culvert alteration or replacement and slope stabilization efforts. One supporting factor is the fact that the highway is identified as moderate/high vulnerability in State assessment and funding upgrades may be a higher priority. In the longer-term a detailed feasibility study will need to be conducted for Discovery Bay and implementation of upgrades or changes could still be quite difficult.

Medium Vulnerability

Septic Systems: Currently, elevation in the groundwater table can rise and flood out some septic system drain fields and some systems require mounds when they do not have adequately draining soil. High water tables can close to beaches and there are existing issues at Brinnon-Quilcene and Golden Sands. Climate change induced sea level rise is likely to exacerbate this issue in coastal environments. The Beckett Point neighborhood came together to grind and pump waste up to a community drain field. Adaptation options include: re-engineering individual septic systems and re-engineering or developing neighborhood septic systems (easy with enough money). Politically it can be difficult to balance individual and community rights when it comes to individual systems. Regulators can use dye tests to show homeowners when a system is failing and there is a program for homeowners to conduct their own inspections.

Highway 112: Climate change could impact the highway through sea level rise, coastal flooding, landslides, river flooding, and culvert damage. With sea level rise, portions of the highway may flood during storms. There may be increased river flooding, increased landslides due to heavy precipitation that could overflow or damage roads; and trees falling over the road could restrict access to the correction center. Highway 112 is ranked as moderate to high impact in a recent Washington Department of Transportation study. Non-climate related issues include the limited funding available for maintenance and current land use planning policies. Currently, there is a process to manage short-term closures and repairs; a work policy for replacing culverts; and the highway has been identified as moderate/high vulnerability, which may provide additional funding for adaptation. Other strategies to reduce vulnerability are to move the highway; replace the culverts; riprap shoreline edge; and prevent future landslides by diverting water.

Hoko/Ozette road: The road is already affected by scour and there have been road failure issues in the past. Climate change may exacerbate these issues by increasing river flooding. Non-climate issues include logging and land use policies (this is the only one road for 50 homes and provides access to the park). Continued or enhanced maintenance could decrease vulnerability. Ultimately there are limited options for moving the road and this would require a lot of advanced and funding.

Forest Roads for Fighting Fires: These forest roads impacts include higher temperatures, longer dry periods, and changes to wind patters (impacts helicopters usage for fighting fires). There is fuel already on the ground and will wildfire risk likely get worse. Some roads are being decommissioned and culverts are not being replaced. It is important to insure fire fighters have access to key areas and some roads need to be maintained. Policy changes by Olympic National Park to fight fires may be considered.

Sewer Outfall Infrastructure: Sewer treatment is concentrated at one source. In Port Angeles, that source is Hill Street/Marine Drive serving west Port Angeles and this area is currently inundated at high water. The stormwater system has more diversified inputs and outputs. Currently, the pump stations in Port Townsend are one to two feet above sea level and thus at risk from sea level rise. If all the stations three feet above current water levels were compromised, that would impact a large portion of Port Townsend. There are a lot of adaptation choices including: increasing outfall pipe diameters, segmenting the system, use upland storage (Port Angeles is already building additional upland storage), or pump the outflow. Pumping treated effluent would be less expensive than building a plant. Wastewater pumping would be much more difficult because of the diverse inputs/outputs of the system. Large-scale precipitation events are currently not treated as the water is assumed to be clean enough. Rain gardens are not necessarily a permanent fix as they require maintenance to continue to be effective.

Medium-Low Vulnerability

Vacuum Sewer System at Elwha Lowlands: Climate change impacts to this system could center around questions of if the groundwater table may rise (owing to dam removal and sea level rise) or if flood plains may change inundating low lying vacuum chambers and pump stations. The system is currently engineered for 100-year events (1% annual probability of occurrence). In the longer term, it may be possible to moving system uphill and away from flooding as the tribe has upland options available.

Highway 116: Sea level rise and the associated coastal flooding could affect a one-mile section of this highway. Existing culverts have been identified as moderately vulnerable in a recent Washington Department of Transportation assessment noting that State Route “116 currently has only a few feet of freeboard.” Reducing flood risk may mean replacing or elevating the bridge and causeway. This route provides access to Marrowstone Island.

Highway 20 and the Port Townsend Ferry: These highways were identified as a moderately vulnerable in a recent Washington Department of Transportation study. The ferry dock itself is less vulnerable but highway 20 provides access to the ferry as well as access to the Port Townsend Water Street retail area and may be inundated by sea level rise and coastal flooding. The ferry provides backup transportation options for the Hood Canal Bridge and alternative access to and from the peninsula. The culverts are part of a concurrent maintenance and operations and the connection with the ferry gives these areas a higher priority for funding. In the medium-term, a feasibility study to evaluate specific adaptation options, such as relocating the ferry terminal, may be useful, as implementation could be difficult.

Port Angeles Landfill: The landfill is currently subject to erosion and waste is being relocated waste 100-200 yards past the erosion zone to decrease impacts of the erosion. The site was originally engineered to last for 50-100 years. The bank directly west of the landfill was armored and may be creating embayment at erosion site, which historically eroded approximately one foot a year and is now eroding at two-three feet per year. The ongoing remediation efforts may help lower the impacts of the erosion. Tradeoff between protection of bluffs and sediment supply and deflection of wave energy will need to be evaluated.

Highway 104 and the Hood Canal Bridge: Currently, highway 104 experiences some short-term closures. This route provides critical access to all portions of the North Olympic Peninsula. From the recent Washington Department of Transportation study, six feet of Sea Level Rise would result in a high impact scenario. Existing process have been designed to accommodate short-term closures and the bridge designed to accommodate a certain level of flooding. It may be necessary to redesign aspects of this transportation corridor for sea level rise and coastal flooding which takes advanced planning. The life of bridge is 75 years and it will eventually need to be replaced which will be the most cost effective time to make changes to elevation, routing, or design that takes into account the impacts of climate change.

Morse Creek and Hot Springs Road: Changing river flows will be the central impact of climate change in this area that already experiences scouring from high river flows. The old technology used when the bridge was built has the potential to fail during high flow events. Although there are only a limited number of houses in this area, Morse Creek provides critical access from Port Angeles to the west and Hot Springs Road is also critical access to a small population. The bridge is inspected annually for signs of destabilization due to scouring and existing processes include deflectors and other management options to decrease the impacts of the scouring. This area is identified as moderate vulnerability in recent Washington Department of Transportation assessment and will need planning and investment and studies.

City of Port Angeles Industrial waterfront, Ediz Hook and the Lower Elwha: Increases in coastal flooding from sea level rise as well as heavy precipitation events will likely affect this area, potentially accelerating bluff erosion, damaging and flooding trails east of Port Angeles, increasing Tumwater Creek flooding, exacerbating levee erosion on the Elwha, and potentially affect the heavily armored Ediz Hook. Increased frequency and duration of coastal flooding driven by coastal storms and potential changes in wind direction may impact utilities (i.e. exposed power poles

on Ediz Hook), the wastewater treatment at the Nippon mill, and possibly the City of Port Angeles. Impacts to fuel storage near the Nippon mill is a potential concern. Existing infrastructure tends to be old and in poor condition, earthquake/tsunami hazard is recognized but generally not well prepared for. Local government policies and practices can potentially be used to address some of these issues. Ediz Hook is managed in part at the federal level, so there are some local, state, and federal financial resources. There is space for relocation of some infrastructure. Comprehensive response to these issues will require money, updates to policies and practices, modifications to plans and regulations, along with education and outreach to local population to build political will.

Low Vulnerability

Clallam / Wheel / Ward / Burlingame Bridges: Changing river flow condition will be the central impact of climate change on these bridges as their bases are already affected by scouring during high flow events. The bridges are based on old bridge technology and if the foundations are undermined, the bridges could fail. Only a limited number of homes would be affected. There is a program to inspect bridges annually for scour related concerns and existing processes include installing deflectors and other infrastructure to reduce the risk of failure. These bridges were identified as moderately vulnerable in the recent Washington State Department of Transportation assessment.

Forest Roads to Communication Towers: Wildfire and extreme precipitation events could cause washout of these roads or limit ability to access the towers. The roads are there but not well maintained and often blocked by downed trees and erosion. Illegal dumping can also block roads. There are existing pressures to decommission forest roads and limited or no culvert replacement which both affect road quality. One existing need is to complete and inventory of all towers and roads used to access them, along with commitment to road maintenance and funding.

South Jefferson County: There may be increase flood risk due to heavy precipitation events in this area. Storm surge and winds have historically shut down the Hood Canal Bridge. Currently, flooding leads to contamination of wastewater systems and seawater intrusion can be an issue in some residential and community wells. Portions of this area need better land planning and management.

Electrical Transmission Infrastructure: Some vaults are currently inundated and some transformers in neighborhoods are in standing water during storm events (downtown Port Townsend deals with these issues). Shifting wildfire may increase risk to transmission lines. Brush control (fuel management) near power lines can be used to reduce risk. The impact of water in vaults should be evaluated.

Public Warning Systems (All Hazards): Sea level rise and coastal flooding may increase impacts to the hazard warning system. Currently, there is some saltwater intrusion into electronics (AHAB tsunami system) and this may be more frequent in the future with rising sea levels. Adaptation options include protecting system components and/or a moving them to higher ground.

Supplementary Information E: Workshop 2 Results

On April 15th, 16th, 17th, 2015 a diverse group of stakeholders representing state, county, city, federal, and tribal governments, Non-profit organizations, private sector companies, academic institutions, and interested individuals from across the North Olympic Peninsula (NOP) met in Sequim, Blyn, and Port Angeles to discuss opportunities for building Climate Resilience. These three workshops focused on the Region's **Critical Infrastructure, Ecosystems, and Water Supplies**, and were an extension to outcomes of the first series of workshops held November 2014 also on the North Olympic Peninsula. In those November workshops ("Workshop 1") a range of regionally-specific climate change vulnerabilities were identified and prioritized, in these April workshops ("Workshop 2"), adaptation strategies were identified and evaluated to address the prioritized Workshop 1 vulnerabilities.

The structure of Workshop 2 followed a general outline of: review of findings of Workshop 1 climate change science and vulnerabilities, a large group brainstorming on appropriate adaptation strategies (drawing inspiration from other national examples), targeted small group selection and evaluation of adaptation strategies, and large group review of prioritized adaptation strategies.

The collaborative results of Workshop 2 are presented below.

NORTH OLYMPIC PENINSULA RESOURCE CONSERVATION & DEVELOPMENT NOP RC&D

"Building Climate Resilience for our Region's Critical Infrastructure"
-April 15th, Sequim, WA-

Thirty-eight (38) stakeholders from across the North Olympic Peninsula convened to identify climate change adaptation strategies relevant to Critical Infrastructure on the North Olympic Peninsula. Attendees included:

First Name	Last Name	Organization
Lance	Bailey	City of Port Townsend
Katherine	Baril	Baril networks
Connie	Beauvais	Crescent Water Association
Jacob	Bell	Adaptation International
Jonathan	Boehme	City of Port Angeles
Barney	Burke	Jefferson PUD
Brad	Collins	City of Port Angeles
Carol	Creasey	Clallam County
Joshua	Crowley	STARR
Kate	Dean	NOPRC&D
Bud	Denney	Makah Tribe
Laura	Dubois	City of Sequim
Nan	Evans	Port Townsend
Jon	Fager	Port Angeles Business Association
Haley	Harguth	Hood Canal Coordinating Council
Donald	Hatler	Clallam Conservation District
Geoff	Hughes	Zoi Environment Network
Cindy	Jayne	NOPRC&D
George	Kovich	WSDOT Olympic Region

First Name	Last Name	Organization
Cheryl	Lowe	Jefferson MRC
Josh	Peters	WDNR
Sascha	Petersen	Adaptation International
Darlene	Schanfald	Olympic Environmental Council
Jill	Silver	10,000 Years Institute
Nam	Siu	Marine Surveys & Assessments
Eric	Toews	Port of Port Townsend
Ashley	Watkins	Jefferson County
Jesse	Waknitz	Port of Port Angeles
Dave	Wilkinson	Local 20/20 Climate adaptation group
Melissa	Williams	Feiro Marine Life Center
Sissi	Bruch	LEKT
Dave	Garlington	City of Sequim
Jonathan	Reanndeau	WSU Ext
Anna	Bausher	Jefferson County
Emily	Whitehead	Starr/FMEA Contractor
Mike	Doherty	Core Team
Randall	McCoy	Lower Elwha SKIallam
Cheryl	Lowe	Jefferson MRC

Below is a summary of the workshop discussion as it proceeded among three Critical Infrastructure breakout groups: **1) Downtowns, Ports, Coastlines; 2) Floodplains and Stormwater;** and **3) Sewer and Septic Systems.** The breakout groups focused on the following Climate change vulnerabilities identified in Workshop 1.

Breakout Groups	Climate Change Vulnerabilities from Workshop 1
Downtown, Ports, Coastlines	Downtown Port Angeles & Port Townsend, PT Boat Haven, PT Point Hudson, PT, Kah Tai Lagoon area, PA Industrial waterfront, Ediz Hook and Lower Elwha, Port of Neah Bay, vulnerable populations
Floodplains and Stormwater	Storm water Outfall Infrastructure, Floodplains, Storm water Management, vulnerable populations
Sewer and Septic Systems	Clallam Bay/Sekiu Sewage Treatment (short-term, long-term, overall), Septic Systems, Sewer Outfall Infrastructure, Vacuum Sewer System at Elwha Lowlands, Coastal Septic Systems Water Quality, vulnerable populations

The results include matrix display of the evaluation of prioritized adaptation strategies. The evaluation metrics and their coding used in these rankings were as follows.

Climate Preparedness Strategy Evaluation Criteria							
Timeframe for Implementation: The ideal timeframe for initiating implementation of the proposed action in order to be most effective. *(4 = Immediate, 3 = near-term (0-3 years), 2 = short term (3-10 years), 1 = long-term (10+ years)*	**Adaptive/ Flexible:** The proposed strategy allows for responding to uncertain outcomes or timing of climate change impacts *(4 = Very flexible, 2 = somewhat flexible, 0 =not flexible)*	**Cost of the Action:** Direct financial cost or economic costs of the project. *(4 = >$1M, 3= 1M -- $250,000, 2= 100,000 – 250,000, 1 = <$50,000, NA, Unknown)*	**Avoided Cost:** Perceived cost of inaction (financial or economic) ranked on same scaling as "Cost of Action". *(4 = >$1M, 3= 1M -- $250,000, 2= 100,000 – 250,000, 1 = <$50,000, NA, Unknown)*	**Technical Feasibility:** Current technology can be used and physically implemented to solve the problem it is meant to address (4 = High, 2 = Medium, 0 = Low).	**Political & Social Feasibility:** Action has political and social community support or, at a minimum, does not have political or community opposition. This also considers the "fundability" of an action. (4 = High, 2 = Medium, 0 = Low).	**Alignment with Other Community Goals:** The action has benefits for other community goals, plans, or actions, leads to increase in social resilience, if relevant; action is socially equitable. (4 = High, 2 = Medium, 0 = High)	**Environmentally Sound:** Actior increases resilience of natural environment in the face of a range of climate change impact action decreases the emission GHGs (has Mitigation Co-benefits); action complies with environmental regulations; the will be no immediate or cumulative negative environmental consequences from the action. (4 = Yes, 2 = Somewhat, 0 = No

Breakout session: Downtown, Ports, Coastlines

The morning brainstorming discussion included the following points. A compilation of promising practices from around the country was used to stimulate discussion and brainstorming of strategies that would be the most relevant and effective on the Olympic Peninsula:

- Include climate adaptation strategies in comprehensive plans, Shoreline Master Plans, and building codes
    - Create a sea level risk district for inclusion in Comprehensive Plan and promulgate new codes and code changes associated with managing for sea level risk.
- Rockwall, riprap, and additional fill
    - Reinforced rock walls, rip-rap, and other shoreline protection in critical areas
- Relocation, retreat zoning
    - Creation of incentives for retreat zoning and/or zoning and redevelopment restrictions and building code changes and/or enforcement to prevent building in the most vulnerable locations.
    - Abandon, relocate, raise, or seal any infrastructure that will sustain damage by inundation.
- Energy redundancy, smart grids, and move out of flood zone, or harden existing infrastructure, including solar panels and consider fueling stations
    - Build redundancy into energy supplies, especially for critical facilities such as hospitals, water treatment plants, etc.
    - Work with utilities and regulators to implement smart grid technology to assess system conditions in real time and speed up service restoration for critical customers via system configuration.
    - Identify, harden, and water seal critical infrastructure relative to electrical, heating, and ventilation hardware within the floodplain.
    - Utilize new technologies such as fiber optics, external hook-ups, and mobile generators to improve resilience.
- Remove hard protection and adopt soft defenses
    - Protect and restore natural systems along the shoreline to enhance buffer between coastal storms and development.
    - Develop protective green infrastructure in front of the facilities to create a natural buffer to storm surge and flooding.
    - Remove hard protection or other barriers to shoreline retreat and replace shoreline armoring with living shoreline protections
    - Adopt soft defense strategies, such as establishing aquatic vegetation beds, using natural or artificial breakwaters and beach nourishment, where appropriate (for example, shorelines that are more undeveloped and where a seawall would inhibit wetland migration and damage natural defense systems).
- Plan future development to minimize new issues:
    - Create a sea level risk district for inclusion in Comprehensive Plan and promulgate new codes and code changes associated with managing for sea level risk.

    - Incorporate climate change and coastal hazard considerations into building codes by increasing freeboard requirements to two feet above the current 100-yr flood plain as buildings are redeveloped, developed, or renovated
- Emergency management and flood insurance, including building relationships for community resiliency.
    - Prior to a hazard event, identify lead contacts serving vulnerable populations and coordinate actions to maximize safety and information sharing. Leads can assist and provide support during hazard events.
    - Establish a network of "block captains" that can be activated to go door to door to check on the health of high-risk neighbors.
    - Identify programs and grants that assist citizens in purchasing flood insurance and making flood proofing changes.
    - Work with residents to create a home emergency kit that ensures that all residents have the resources they need to survive in the event. A particular focus should be paid to elders and other more vulnerable segments of the population. This kit should include back-up medications, rations of food, and secondary communication technologies
    - Help individual households to take their own steps to reduce flooding, such as installing rain barrels and back-up power for sump pumps.
    - Expand training and education of health and social services systems/providers to identify and treat mental health problems and integrate mental health into systems and services deployed after extreme climate events.
    - Update flood maps to reflect changing risk associated with climate change - work with FEMA to revise existing flood maps to reconfigure existing and future risks from flooding.
    - Establish a public outreach campaign to ensure all homeowners in floodplains are aware of the various types of coverage options under the National Flood Insurance Program.
- Bioswales, green-roofs, permeable pavement, Low Impact Development techniques for future development including upland areas
    - Create bioswales to store water and help with natural drainage alongside roads.
    - Use permeable pavement to manage water and decrease urban run-off and flooding
- Green stormwater management
    - Incorporate green stormwater management into the floodplain management ordinance and flood protection overlay district.
- Ports: develop new lines of businesses, consider other options for shoreline access and use
- Community design centers to assist property owners in design and retrofitting
    - Establish community design centers to assist property owners in developing design solutions for reconstruction and retrofitting, and connect them to available City programs.
    - Do outreach and education on issues and solutions
    - Consider real estate disclosures
- Retrofit stormwater outfall to raise up to higher level
- Develop and utilize analytical decision making tools to help drive long term decisions

- Utilize latest FEMA floodplain information
    - Incorporate climate change and coastal hazard considerations into building codes by increasing freeboard requirements to two feet above the current 100-yr flood plain as buildings are redeveloped, developed, or renovated
    - Update flood maps to reflect changing risk associated with climate change - work with FEMA to revise existing flood maps to reconfigure existing and future risks from flooding.
    - Establish a public outreach campaign to ensure all homeowners in floodplains are aware of the various types of coverage options under the National Flood Insurance Program.
- Conservation easements and acquisition
    - Outreach and promote the establishment of conservation easements on private properties in high priority sites to provide resource protection as well as tax incentives for private property owners.
- Move critical archives outside of flood zone

- Explore and develop a creative financing program for residential and commercial properties to assist with retrofitting existing buildings; including assessing short term and long term options and considering insurance constraints
- Preserve agricultural land for floodwater management

In the afternoon, the initial brainstormed strategies listed below were evaluated based on the criteria described above. These raw scores were processed into the full list of adaptation strategies found in Appendix A: Comprehensive List of Adaptation Strategies.

Climate Preparedness Actions: Downtown, Ports, Coastlines	**Timeframe for Implementation**	**Adaptive Flexible**	**Cost of the action**	**Avoided Cost**	**Technical Feasibility**	**Political & Social Feasibility**	**Alignment with Community Goals**	**Environ-mentally Sound**
SHORELINE PROTECTION: Reinforced rock walls, rip-rap, and other shoreline protection, including seawalls, in critical areas	2.5	2	4	4	4	2.5	3	1
SOFT DEFENSES: • Protecting and restoring natural systems along the shoreline to enhance buffer between coastal storms and development. • Develop protective green infrastructure in front of the facilities to create a natural buffer to storm surge and flooding. • Remove hard protection or other barriers to shoreline	2.5	4	4	4	4	2.5	3	4

retreat and replace shoreline armoring with living shoreline protections. • Adopt soft defense strategies, such as establishing aquatic vegetation beds, using natural or artificial breakwaters and beach nourishment, where appropriate (for example, shorelines that are more undeveloped and where a seawall would inhibit wetland migration and damage natural defense systems.								
RELOCATION: • Creation of incentives for retreat zoning and/or zoning and redevelopment restrictions and building code changes or enforcement to prevent building in the most vulnerable locations. • Abandon, relocate, raise, or seal any infrastructure that will sustain damage by inundation.	1	2	4+	4	4	1	1	4
RETROFIT: retrofit existing infrastructure to deal with Sea Level Rise (raise buildings, etc.)	2.5	2	3	4	3	4	4	3
Comp plan, SMP, zoning, building codes, LID techniques, for future development, including; • Create a sea level risk district for inclusion in Comprehensive Plan and promulgate new codes and code changes associated with managing for sea level risk • Incorporate climate change and coastal hazard considerations into building codes by increasing freeboard requirements to two feet above the current 100-yr flood plain as buildings are redeveloped, developed, or renovated • Update flood maps to reflect changing risk associated with climate change - work with FEMA to revise existing flood maps to reconfigure existing and future risks from flooding	4	4	2	4	4	3	4	4

Emergency management and response planning • Prior to a hazard event, identify lead contacts serving vulnerable populations and coordinate actions to maximize safety and information sharing. Leads can assist and provide support during hazard events. • Establish a network of "block captains" that can be activated to go door to door to check on the health of high-risk neighbors. • Work with residents to create a home emergency kit that ensures that all residents have the resources they need to survive in the event. This kit should include back-up medications, rations of food, and secondary communication technologies • Help individual households to take their own steps to reduce flooding, such as installing rain barrels and back-up power for sump pumps. • Expand training and education of health and social services systems/providers to identify and treat mental health problems and integrate mental health into systems and services deployed after extreme climate events.	4	4	2	4	4	4	4	4
Residential outreach and education to property owners • Establish Community Design Centers to assist property owners in design and retrofitting infrastructure • Conduct outreach and education on climate issues and adaptation solutions • Consider real estate disclosures of climate change risk	4	4	2	3	4	4	4	4
Outreach and education on climate adaptation for community support; beyond individual outreach, outreach to community to build political will to drive adaptation	4	4	2	4	3	2	3	4

Decision making tools	4	4	1	4	4	2	4	4

Breakout Session: Floodplains & Stormwater

The morning brainstorming discussion included the following points. A compilation of promising practices from around the country was used to stimulate discussion and brainstorming of strategies that would be the most relevant and effective on the Olympic Peninsula:

- Encourage development of Green Streets in flood prone areas through the city.
- Delay of peak discharges and reduction of peak volumes by enhancing stormwater detention at upstream locations within drainage basins and incorporating other measures that enhance on-site detention and retention and infiltration of runoff, such as use of porous pavements, roof-top detention, grassed waterways, etc.
- Tide gates, "duckbill" valves, which seal a pipe end but still allow water to drain, and other backflow-prevention devices are used to ensure that water does not flow backwards through drainage infrastructure.
- To increase flood protection beyond the existing 100-year floodplain the city can: establish a flood protection overlay district from the Expanded Flood Risk Area and create voluntary and/or regulatory standards that would apply to the district, or adopt a suite of voluntary standards for development and redevelopment that would apply equally to the expanded flood risk area.
- Update flood maps to reflect changing risk associated with climate change - work with FEMA to revise existing flood maps to reconfigure existing and future risks from flooding.
- Establish a public outreach campaign to ensure all homeowners in floodplains are aware of the various types of coverage options under the National Flood Insurance Program.
- Explore and develop a creative financing program for residential and commercial properties to assist with retrofitting existing buildings.
- Utilize water conservation elements such as green roofs, rain gardens, cisterns, and bioswales on residential, commercial, industrial, and city-owned properties to capture stormwater.
- Create incentives to reward Low Impact Development projects that capture and reuse stormwater onsite.

The last three of these strategies were recognized for their particular attention to reducing impervious surfaces and establishing new stormwater retention abilities. The last two strategies were recognized as potentially effective "decentralized" strategies.

The following strategy – "Update flood maps to reflect changing risk associated with climate change - work with FEMA to revise existing flood maps to reconfigure existing and future risks from flooding" was identified as "in process". However, there are issues with levees in Clallam County so those areas will not be updated. The implication is that cheaper insurance may be offered behind levee. FEMA maps may only be able to use historical data because it drives decisions on regulations and insurance. FEMA is establishing a non-regulatory toolkit, which will allow entities to look into the future and map changing flood levels.

The group discussed the fact that emergency managers often take on public education regarding flooding response, so it may be redundant to put effort into these actions. The group discussed the need for "Critical Area Mapping" by entities as a way to preemptively identify at risk areas under climate change, although it was not clear who would conduct this mapping. Perhaps FEMA? It was recognized that they might have the most recent LiDAR data as they had flown up the Elwha and Dungeness. Participants discussed a system for better disclosure of flood risk for homes, perhaps information that went out yearly with Tax information? Currently this information only comes to light through a permitting process, despite the fact that governments could disclose hazards and insurance companies could respond. It was put forward that insurance companies and banks could support flood insurance because of FEMA's backing. FEMA, of course, does not issue permits, but they do incentivize more stringent requirements enforced by local governments, with lower insurance rates. It was suggested that local governments could take into account wider range of climate impacts to future flooding (above and beyond what FEMA can do) such as using new probabilities of 100-year flood events.

It was discussed that existing conservation easements and riparian buffers were essential to successful future management of stormwater. Individual efforts to capture stormwater were discussed, including the use of cisterns, and the fact that a pilot program for "green streets" was occurring in eastern (Jefferson?) county. The group wondered if the existing stormwater discharge guidebooks were still relevant under climate change?

A number of national strategies were identified as INEFFECTIVE for use on the NOP:

- Tide gates, "duckbill" valves, which seal a pipe end but still allow water to drain, and other backflow-prevention devices are used to ensure that water does not flow backwards through drainage infrastructure. (Ineffective because tide gates can fail within a short timeframe of installation, over the long term stormwater treatment should consider pumping stormwater through outfall infrastructure)
- Establish a public outreach campaign to ensure all homeowners in floodplains are aware of the various types of coverage options under the National Flood Insurance Program. (Ineffective because the group suggested homeowners should not rebuild in floodplain)
- Identify programs and grants that assist citizens in purchasing flood insurance and making flood proofing changes. (Ineffective because the group suggested homeowners should not rebuild in floodplain)

With regard to contamination during flooding, the application of biosolids on agriculture and forestry was brought up as an ongoing source of contamination.

In the afternoon, the initial brainstormed strategies listed below were evaluated based on the criteria described above. These raw scores were processed into the full list of adaptation strategies found in Appendix A: Comprehensive List of Adaptation Strategies.

Climate Preparedness Actions: Floodplains and Stormwater	Timeframe for Implementation	Adaptive Flexible	Cost of the action	Avoided Cost	Technical Feasibility	Political & Social Feasibility	Alignment with Community Goals	Environ-mentally Sound
Develop "Green streets" Municipal Pilot programs in flood prone areas	3.5	4	4	4	4	1	4	4
Delay of peak discharges and reduction of peak volumes by enhancing stormwater detention at upstream locations within drainage basins, generally policies involving Conservation & Riparian Buffers	2	2	4	4	4	1.5	2	4
Stormwater management on-site by Residential, Industry, Agriculture and Forestry sectors. Could utilize water conservation elements such as green roofs, rain gardens, cisterns, and bioswales	3	4	3.5	3.5	4	2.5	2.5	4
Tide gates, "duckbill" valves for Stormwater Outfall Infrastructure. Valves seal a pipe end but still allow water to drain.	2	1.5	2.5	3	4	4	4	1.5
Pumping efforts for Stormwater Outfall Infrastructure, which would address limitations of Tide Gates over the long term	-	-	-	-	-	-	-	-
Critical area flood mapping beyond FEMA's historical data. An entity could establish a climate change flood overlay specific to their future flood concerns.	3	4	2	4	4	2	4	4
Engagement in FEMA's Community Rating System (CRS), which involves potentially developing more stringent regulations and receiving a reduction in insurance rates.	4	2	1.5	3	4	2	4	4
Homeowner outreach for Relocation options outside floodplains, perhaps through a creative	3.5	0.5	3	3	4	0.5	2	2

financing program or cheaper insurance structure.								
Create Monetary & Non-monetary incentives for Stormwater Management or re-use, including within Low Impact Development (LID) projects.	3	3	4	3	4	0.5	2	4
Public outreach for opportunities in existing relevant stormwater programs (e.g. rain gardens, cisterns)	4	4	1	3	4	2.5	4	4
Public Outreach for Emergency Flooding prevention and response Strategies, including review of existing protocols and individual steps to reduce flooding, such as installing rain barrels and back-up power for sump pumps.	3	4	1	4	4	4	4	4

Breakout Session: Sewer and Septic Systems

The morning brainstorming discussion included the following points. A compilation of promising practices from around the country was used to stimulate discussion and brainstorming of strategies that would be the most relevant and effective on the Olympic Peninsula:

- Relocate Port Townsend municipal wastewater treatment plant (it is in the Sea Level Rise inundation zone)
- Identify properties at risk of coastal flooding, sea level rise, etc. where septic is likely to fail, incentivize moving
- Move septic systems that are close to ground or surface water sources
- Allow gray water usages and incentivize the use
- Allow composting toilets
- Produce energy from bio-digestion/ bio-solids
- Require education/ training for septic homeowners
- Encourage community septic systems in areas of flooding, Sea Level Rise, failing systems (LOSS)
- Pretreat sewage with tertiary wetlands
- Shorten response time when septic systems fail
- Increase monitoring of failing septic systems, and provide enforcement on non-compliance
- Separate storm water from sewage (municipal) or septic (homeowners)
- Enforce groundwater/ wellhead protection zones
- Allow LOSS outside of UGAs

- Allow use of reclaimed water
- Enhancement of gravity drainage for stormwater through installation of large diameter pipes and widened drainage ditches to counteract the reduced head that results from higher tail water elevations.
- Tide gates, "duckbill" valves for Stormwater Outfall Infrastructure. Valves seal a pipe end but still allow water to drain.
- Incorporate future infrastructure needs into utility rate design.
- Assess feasibility of shared septic/ sewer systems at neighborhood level.

In the afternoon, the initial brainstormed strategies listed below were evaluated based on the criteria described above. These raw scores were processed into the full list of adaptation strategies found in Appendix A: Comprehensive List of Adaptation Strategies.

Climate Preparedness Actions: Sewer and Septic Systems	**Timeframe for Implementation**	**Adaptive Flexible**	**Cost of the action**	**Avoided Cost**	**Technical Feasibility**	**Political & Social Feasibility**	**Alignment with Community Goals**	**Environmentally Sound**
Reduce inflow and infiltration	3.5	4	4	4	4	4	4	4
Adjust rates	3	2	2	4	4	0	4	4
Relocate Port Townsend municipal wastewater treatment plant (it is in the SLR inundation zone)	1	4	4	4	4	2	2	4
Allow grey water/ reclaimed usages	2	1.5	4	NA	4	2.5	2	2
Produce energy from bio-digestion/ bio-solids, removing waste from sewer/ septic stream	1	0	2	1	2	2	2	2
Allow LOSS outside of UGAs	4	2	2	3	4	2	2	4
Require education/ training for septic homeowners	4	3.5	2	2	4	1.5	2	4

NORTH OLYMPIC PENINSULA RESOURCE CONSERVATION & DEVELOPMENT NOP RC&D

"Building Climate Resilience for our Region's Ecosystems"
-April 16th, Blyn, WA-

Thirty-one (31) stakeholders from across the North Olympic Peninsula convened to identify climate change adaptation strategies relevant to Critical Infrastructure on the North Olympic Peninsula. Attendees included:

First Name	Last Name	Organization		First Name	Last Name	Organization
Helle	Andersen	Feiro Marine Life Center		Tami	Pokorny	Jefferson County Public Health
Kia	Armstrong	Nash's organic produce		Seraphina	Peters	Makah Fisheries Management
Connie	Beauvais	Crescent Water Association		Sascha	Petersen	Adaptation International
Jacob	Bell	Adaptation International		Bob	Phreaner	Olympic Peninsula Audubon and Streamkeeper
Carol	Creasey	Clallam County		Nam	Siu	Marine Surveys & Assessments
Kate	Dean	NOP RC&D		Dick	Stockment	Local 2020 Climate Adaptation Group
Nan	Evans	Port Townsend		Jeff	Taylor	Citizen Action Training
Owen	Fairbank	Jefferson Land Trust		Robert	Vreeland	Olympic Climate Action Group
Gretchen	Glaub	Puget Sound Partnership		Ken	Wiersema	Olympic Peninsula Audubon Society
Maureen	Goff	Sound Science		Jean	Walat	PT Marine Science Center
Ross	Goodwin	WA State Dept. of Natural Resources		Kevin	Clark	Local 2020 Climate Adaptation Group
Steve	Gray	Clallam County		Darlene	Schanfield	Olympic Environmental Council and Sierra Club
Cindy	Jayne	NOP RC&D		Ian	Miller	WA Sea Grant/ Adaptation International
Carol	Johnson	North Olympic Timber Action Committee		Jack	Gillubert	Port Angeles property owner
Patty	McManus	Nash's Organic Produce		Mike	Doherty	Core Team
				Randall	McCoy	Lower Elwha SKIallam

Below is a summary of the workshop discussion as it proceeded among three breakout groups: **1) Downtowns, Ports, Coastlines; 2) Floodplains and Stormwater;** and **3) Sewer and Septic Systems.** The breakout groups focused on the following Climate change vulnerabilities identified in Workshop 1.

Breakout Groups	Climate Change Vulnerabilities from Workshop 1
Nearshore Environment and Watersheds	Nearshore environment (natural, estuary, urban), Development in low-bank shorelines, Urban Run-off, Development on high-bank shorelines, Floodplains, Vulnerable populations
Forestry and Agriculture	Forest water quality, Soil erosion, Chimacum agriculture, Dungeness agriculture, Floodplains, Open space/Ag. Land, Vulnerable populations
Emerging Risks	Emerging vegetation/bacteria/wildlife/algae and water quality, Wild/commercial shellfish stocks, Shellfish hatchery, Salmon hatchery

The results include matrix display of the evaluation of prioritized adaptation strategies. The evaluation metrics and their coding used in these rankings were as follows.

Climate Preparedness Strategy Evaluation Criteria							
Timeframe for Implementation: The ideal timeframe for initiating implementation of the proposed action in order to be most effective. *(4 = Immediate, 3 = near-term (0-3 years), 2 = medium term (3-10 years), 1 = long-term (10+ years)*	**Adaptive/ Flexible:** The proposed strategy allows for responding to uncertain outcomes or timing of climate change impacts *(4 = Very flexible, 2 = somewhat flexible, 0 =not flexible)*	**Cost of the Action:** Direct financial cost or economic costs of the project. *(4 = >$1M, 3= 1M -- $250,000, 2= 100,000 – 250,000, 1 = <$50,000, NA, Unknown)*	**Avoided Cost:** Perceived cost of inaction (financial or economic) ranked on same scaling as "Cost of Action". *(4 = >$1M, 3= 1M -- $250,000, 2= 100,000 – 250,000, 1 = <$50,000, NA, Unknown)*	**Technical Feasibility:** Current technology can be used and physically implemented to solve the problem it is meant to address (4 = High, 2 = Medium, 0 = Low).	**Political & Social Feasibility:** Action has political and social community support or, at a minimum, does not have political or community opposition. This also considers the "fundability" of an action. (4 = High, 2 = Medium, 0 = Low).	**Alignment with Other Community Goals:** The action has benefits for other community goals, plans, or actions, leads to increase in social resilience, if relevant; action is socially equitable. (4 = High, 2 = Medium, 0 = High)	**Environmentally Sound:** Actior increases resilience of natural environment in the face of a range of climate change impact action decreases the emission GHGs (has Mitigation Co-benefits); action complies with environmental regulations; the will be no immediate or cumulative negative environmental consequences from the action. (4 = Yes, 2 = Somewhat, 0 = No

Breakout session: Nearshore environment and watersheds

The morning brainstorming discussion included the following points. A compilation of promising practices from around the country was used to stimulate discussion and brainstorming of strategies that would be the most relevant and effective on the Olympic Peninsula:

- Incorporate climate change more explicitly into comprehensive plans, Shoreline Master Plans
- Use adaptive approach for updating buffers or building codes (the intent here is to perhaps develop thresholds for sea level, or storm events, that would trigger changes to buffers or building codes)
- Create guidelines for changing zoning in response to climate change
- Add climate change related benefits to open space values (whose conservation are often incentivized)
- Expand or assess buffers related to anticipated climate change impacts
- Add additional climate related land types to open space zones- "critical areas"
- Restrict development with incorporation of climate change projections
    - For development adjacent to bluffs, require setbacks for buildings equal to 50 years of anticipated bluff retreat.
    - Restrict/prohibit development in erosion/flood/damage prone areas.
    - Update flood maps to reflect changing risk associated with climate change - work with FEMA to revise existing flood maps to reconfigure existing and future risks from flooding.
    - Use zoning, subdivision and site plan regulations, and/or a special overlay districts to designate high-risk areas for coastal flooding and/or erosion and specify the conditions for the use and development.
- Protect submerged, sensitive habitats- survey inventory, then monitor and identify potential future habitats and identify, protect species using or reliant on the habitat
- Identify potential salt water intrusion areas and limit or address development in those areas
- Conserve land in coastal areas by removing or limiting development potential through acquisition, conservation easements, and the purchase and transfer of development rights.
- Require stream/tributary buffers or conservation easements.
- Protect existing coastal wetlands.
- Enhance enforcement and address financial incentives associated with illegal shoreline uses
- Work with insurance industry to realistically value risk into the future and remove subsidies and/ or loans for development in high-risk areas. Don't insure or mortgage non-permitted properties (include clause that homeowner is responsible for climate related damage).
- Policies that encourage large lots and discourage "short-platting" to discourage sprawl.
- Identify and manage non-climate stressors, such as nutrient inputs, and temperatures in streams
- Contemplate what is the right "timeframe" for setting erosion buffers into the future: 75 years? 150 years?

- Use a carbon tax to mitigate for financial impacts to homeowners on shorelines, floodplains.
- Enforce disclosure to real estate purchasers. Focus on real estate professionals as responsive party.
- Train emergency response volunteers regarding potential climate related emergencies.
- Push FEMA to incorporate climate change in maps and guidance.
- Build or support a program for restoration or acquisition of sensitive or high-risk structures or properties, and remove armoring. Prioritize and inventory areas appropriate for protection vs. restoration.
- Develop graphic tools to illustrate climate impacts.

In the afternoon, the initial brainstormed strategies listed below were evaluated based on the criteria described above. These raw scores were processed into the full list of adaptation strategies found in Appendix A: Comprehensive List of Adaptation Strategies.

Climate Preparedness Actions: Nearshore Environment and Watersheds	**Timeframe for Implementation**	**Adaptive Flexible**	**Cost of the action**	**Avoided Cost**	**Technical Feasibility**	**Political & Social Feasibility**	**Alignment with Community Goals**	**Environmentally Sound**
Enforcement -Develop enforcement to remove financial incentives associated with illegal shoreline uses -Enforce required real estate disclosures -Enforce professional license consequences for contractors/ developers	-	-	-	-	-	-	-	-
Develop community climate action plans	3.5	4	2.5	4	3.5	2	2.5	4
Develop graphic tool to illustrate climate impact	4	2.5	2.5	4	4	3.5	3.5	4
Develop enforcement to remove financial incentives associated with illegal shoreline uses	3	3	3	4	4	3	3?	4
Inventory and survey submerged sensitive habitats and species that utilize them. Protect areas that those habitats may migrate to.	4	4	3.5	3	3	2.5	3	4
Push FEMA to incorporate climate change in rate maps and guidance	4	2	4	4	4	4	4	4
Work with banks to remove mortgage subsidies (e.g. loans) to high risk or unpermitted	4	4	3	4	4	2	3	4

development								
Prioritize and inventory shoreline and watershed areas appropriate for defense vs. retreat	2	2	2.5	4	3	2	2	4
Provide guidance on right "timeline" for erosion buffers (50, 75, 150 years) inclusive of climate change	3	2	-	4	4	2	2	4
Support and enhance watershed and nearshore habitat restoration	3.5	4	4	4	4	2	2	4
Manage non-climate stressors (nutrient inputs, temperatures in streams)	4	4	4	4	3	2	2	4
Assess and expand buffers related to projected impacts	2	4	3	4	4	1	3	4
Add climate related land types to current wetlands (e.g. areas upland of coastal), use some type of climate impact overlay.	3	4	2	4	3	1.5	4	4
Build and support a funding program appropriate for acquisition or restoration of high risk structures, armoring, etc.	2.5	4	4	4	4	1.5	2	4

Breakout session: Forestry and Agriculture

The morning brainstorming discussion included the following points. A compilation of promising practices from around the country was used to stimulate discussion and brainstorming of strategies that would be the most relevant and effective on the Olympic Peninsula:

- Research and breeding for drought-resistant, climate-adapted, resilient varieties
- Incentivize water conservation
- Explore options for groundwater recharge/ storage/ mitigation e.g.: using wetlands, rainwater collection
- Explore innovative technologies for water storage e.g.: bladders
- Use zoning/ building codes to reduce risk of fire at residential/ forest interface
- Create Best Management Practices for soil moisture retention/ conservation
- Provide education and outreach for landowners on drought resistant varieties, perennial cropping systems
- Incentivize/ promote local agricultural product purchasing
- Facilitate land swaps to get farmers out of floodplains

- Research options for "working buffers"- appropriate plants for use in riparian areas
- Create a Conservation Futures program in Clallam County to finance conservation deals
- Proactively manage for emerging pests
- Advocate for local allocation of water resources (departure from Ecology and current water law dictating local use)
- Use the "Community Forestry" model
- Incentivize Best Management Practices
- Identify agro-forestry techniques that would be appropriate to this region
- Identify and remove regulatory barriers to agricultural enterprises
- Designate additional soils of local/ historical significance to increase conservation values
- Remove barriers to getting Open Space taxation status
- Bring non-conforming parcels into accurate zoning (parcels taken out of agriculture or forestry use)
- Employ Forest Transition Overlay Zoning
- Create a market for consolidation of local ecosystem services, e.g. carbon sequestration
- Create and incentivize Best Management Practices for: drought-and-pest- resistant varieties, appropriate planting times, pesticide reduction, diversified systems, erosion control, maintaining forest cover
- Conduct outreach and education programs for fire prevention in residential areas
- Replace under-sized culverts, anticipate run-off issues and impacts to infrastructure
- Prioritize areas for conservation efforts based on ecosystem values: forest maturity, soil type, etc.
- Redirect beautification efforts (green lawns, hanging baskets of flowers) to drought-resistant varieties
- Enforce set-backs on building permits in forested areas

In the afternoon, the initial brainstormed strategies listed below were evaluated based on the criteria described above. These raw scores were processed into the full list of adaptation strategies found in Appendix A: Comprehensive List of Adaptation Strategies.

Climate Preparedness Actions: Forest and Agriculture	Timeframe for Implementation	Adaptive Flexible	Cost of the action	Avoided Cost	Technical Feasibility	Political & Social Feasibility	Alignment with Community Goals	Environmentally Sound
Encourage breeding and planting of drought tolerant, climate adapted, resilient varieties	4	4	3.5	4+	4	4	4	4
Create water storage and usage options at all scales for recharge, mitigation, irrigation	3	4	4	4	4	1	3	3
Create funding mechanism for conservation projects in Clallam County	4	3	NA- 3?	NA	4	1	2	4
Designate and prioritize for funding additional Agricultural soils	4	2	1	NA	4	2	2-Clallam, 3-Jefferson	4
Identify and monetize environmental services	2	2	NA	NA	4	2	2	4
Use education incentives & building codes to minimize fire risk in forest/ residential interface. Enforce set-backs	4	3	3	4	4	4	4	4
Create and incentivize Best Management Practices for climate change: impacts to soil moisture and health, erosion control, conservation irrigation, diversity of species.	3	4	3	4	4	4	4	4

Breakout session: Emerging Risks

The morning brainstorming discussion included the following points. A compilation of promising practices from around the country was used to stimulate discussion and brainstorming of strategies that would be the most relevant and effective on the Olympic Peninsula:

- Support research and monitoring plans that are specific to emerging climate change impacts on the NOP, for example the presence of invasive/migrating fish species, monitored through trace DNA molecular analysis and citizen science collecting seawater
- ID existing strategies to address emerging risks and assess functionality
- Provide more education and outreach (since some efforts are ongoing) to empower early detection of water quality impacts, including sources such as:
    - Pets
    - Livestock; enforce animal waste cleanup, modify livestock management practices to reduce animal contact with water bodies.
- Decentralized sewage treatment in neighborhood clusters to move away from individual septic systems

- Establish wildlife corridors along rivers (acquire, restore, manage) to ensure "conductivity" along rivers, floodplains and riparian buffers
    - Create an interconnected network of green spaces to support biodiversity and watershed-based water quality management.
    - Acquire and preserve existing vegetated, unprotected areas adjacent to river systems.
- Store/withhold water uplands to help mitigate impacts of lengthened dry season:
    - Disconnect drainage ditches (mostly those closest to agriculture) and redirect them to constructed wetlands or drainage basins.
    - Install conservation practices and restore runoff-prone rural lands to grassland or wetland.
    - Provide incentives to homeowners to take individual action
- Greater use of native plants at home and industrially:
    - Integrate native plant use into building codes
    - Provide incentives for removing lawns
    - Invasive plant removal
    - Stock more native plants at local nurseries
- Support improved stormwater management, such as rain gardens
- Support monitoring for Harmful Algal Blooms (HABs)
- Remediate recreational lakes lost to algae.
- Support more natural processing of nutrients such as through propagation of eel grass beds
- Re-energize efforts to reduce other stressors to salmon stream habitats, including: urbanization, sedimentation and pollution of streams, changes in streamside vegetation, erosion due to land-use practices such as road building and clear cutting, and the draining of wetlands.
- Create new or more supportive regulations for composting toilets
- Support and better utilize low-cost citizen science low-impact monitoring + analysis technologies (e.g. trace DNA)
- Explore emerging salmon hatchery technologies (climate impacts→ temperature, flows), like limits on production treatment of water
- Conduct shellfish bed habitat assessment under Ocean Acidification/ Sea Level Rise scenarios for improved decisions on seeding, potentially using Olympic oysters for adaptation
- Monitor and analyze salmon stream restoration sites for suitability/ altered quality
- Identify new areas for non-finfish aquaculture through climate change projections, such as seaweed

The following strategies were recognized as already "in-process" on the peninsula:

- Manage hatchery programs to minimize harm done to wild stocks (recognized the use of isolated ponds, "Nature's Ponds", to rear fish but not sure how effective that is; some hatcheries are trying to rehab wild fish (Elwha), use this to enhance other wild stocks, but still seeing competition from other invasive species like Atlantic salmon)

- Hatchery propagation and restocking of populations in areas where natural reproduction of native bivalves is limited. If this is pursued, ensure replaced stocks are indigenous to the area. (It was mentioned this may be detrimental to wild stocks)
- Transplant adult shellfish (assisted migration) from remnant populations into areas that are more suitable for reproductive success. (It was challenged as to whether this should continue as seeding strategies are often more dense than natural)
- Reduce application of biosolids to Agriculture and Forestry to lessen contaminant risk

Other thoughts shared included:

- It was discussed that Jefferson County attempted to not allow fish farming in their Shoreline Master Plan (SMP), which the Department of Ecology denied, but the county was able to prohibit use in some areas with rationale.
- Port Angeles has salmon aquaculture in its harbor, new SMP allows it with conditions, and currently it is under "conditional use" such as requiring large circulation and flushing like in the Strait. The latest interested companies have begun targeting open water.
- It was wondered what ecosystem impacts renewable energy may hold, such as wind and wave power.
- It was recognized that invasive species might find a special foothold in areas that are now snow-free
- The nutrient loading and overall nutrient balance in the environment is impacted by the commercial fertilizer industry
    - NEED: incentives for limiting fertilizer types available to consumers to less harmful types
- Implications of the lower Dungeness levee removal

In the afternoon, the initial brainstormed strategies listed below were evaluated based on the criteria described above. These raw scores were processed into the full list of adaptation strategies found in Appendix A: Comprehensive List of Adaptation Strategies.

Climate Preparedness Actions: Emerging Risks	**Timeframe for Implementation**	**Adaptive Flexible**	**Cost of the action**	**Avoided Cost**	**Technical Feasibility**	**Political & Social Feasibility**	**Alignment with Community Goals**	**Environmentally Sound**
Incentivize on-shore finfish aquaculture (aquaponics)	2	3.5	1.5	2	3	1.5	?	3.5
Localized water/sewer treatment or bringing rural areas on-line to centralized systems (2)	4	1-4	3.5	4	3	1.5	3.5	4
Create wildlife corridors in conjunction with floodplains/ riparian buffers (3)	3.5	3	?	4	4	?	4	4
Utilize low cost citizen science monitoring + analysis technologies	4	4	?	3.5	3	3	3	4

Integrate climate change projections into salmon hatchery planning	3.5	2	?	?	1	3	3	3
Evaluate and improve public outreach on water quality risks	4	3	3	3.5	3	3.5	3	4
Better incentivize native plant use (1)	4	4	1.5	2	3.5	2	3.5	4
Increased funding for Harmful Algae Bloom monitoring	4	4	2.5	?	4	2	2.5	4
Submerged native aquatic vegetation preservation and restoration for management of nutrient loading (3)	3	3	2	1.5	3	3	3	4
Monitor and analyze climate change impacts at salmon stream restoration sites (2)	3.5	3	3	3?	3	2.5	3	4
Feasibility analysis for new non-finfish aquaculture	3-4?	3	2?	2-4?	3.5	3	2-4?	3
Regional information sharing on incentive programs for rain gardens and other strategies	4?	3	2	?	4	3	2-4	4
Transition away from use of biosolids / industrial fertilizer on agriculture/ forestry lands	4	3	1?	1-4?	2-3	1.5	3	4

NORTH OLYMPIC PENINSULA RESOURCE CONSERVATION & DEVELOPMENT NOP RC&D

"Building Climate Resilience for our Region's Water Supplies"
-April 17th, Port Angeles, WA-

Twenty-six stakeholders (26) from across the North Olympic Peninsula convened to identify climate change adaptation strategies relevant to Critical Infrastructure on the North Olympic Peninsula. Attendees included:

First Name	Last Name	Organization
Connie	Beauvais	Crescent Water Association
Jacob	Bell	Adaptation International
Kevin	Clark	Local 2020 Climate Adaptation Group
Carol	Creasey	Clallam County
Kate	Dean	NOP RC&D
Bill	Graham	Jefferson PUD
Jennifer	Holderman	Department of Ecology
Ian	Jablonski	City of Port Townsend
Richard	Jahnke	Audubon Society, L2020
Cindy	Jayne	NOP RC&D
Carol	Johnson	North Olympic Timber Action Committee
Mike	Kitz	PUD #1 of Clallam County
Phil	Lusk	PW&U, City of Port Angeles

First Name	Last Name	Organization
Sascha	Petersen	Adaptation International
Susan	Porto	Jefferson County Public Health
Ann	Soule	City of Sequim Public Works
Judy	Surber	City of Port Townsend
Mary Ellen	Winborn	Clallam County
Dave	Wilkinson	L2020
Jonathan	Reanndeau	WSU Ext
Anna	Bausher	Jefferson County
Tyler	Ahlgren	
Craig	Fulton	Port Angeles Public Works
Aaron	Parker	Makah tribe
Mike	Doherty	Core Team
Bill	Peach	Clallam County Commissioner

Below is a summary of the workshop discussion as it proceeded among three breakout groups: **1**) **Surface Water Supplies; 2) Groundwater Supplies; 3) Water Quantity and Availability.** The breakout groups focused on the following Climate change vulnerabilities identified in Workshop 1.

Breakout Groups	Climate Change Vulnerabilities from Workshop 1
Surface Water Supplies	Surface Water Supplies of Port Townsend, Jefferson, Clallam PUD, Port Angeles, Dry Creek, City of Sequim, vulnerable populations
Groundwater Supplies	Jefferson, Clallam PUD, Sequim, and other Municipal Groundwater Systems, Private wells, Clallam Bay/Sekiu Water Supply, vulnerable populations
Water Quantity and Availability	Chimacum Agriculture, Dungeness Agriculture, Equitable use of water resources - in-stream flows and ecosystem needs, Paper Mills, Forestry, Agriculture

The results include matrix display of the evaluation of prioritized adaptation strategies. The evaluation metrics and their coding used in these rankings were as follows.

Climate Preparedness Strategy Evaluation Criteria							
Timeframe for Implementation: The ideal timeframe for initiating implementation of the proposed action in order to be most effective. *(4 = Immediate, 3 = near-term (0-3 years), 2 = medium term (3-10 years), 1 = long-term (10+ years)*	**Adaptive/ Flexible:** The proposed strategy allows for responding to uncertain outcomes or timing of climate change impacts (4 = *Very flexible, 2 = somewhat flexible, 0 =not flexible)*	**Cost of the Action:** Direct financial cost or economic costs of the project. *(4 = >$1M, 3= 1M -- $250,000, 2= 100,000 – 250,000, 1 = <$50,000, NA, Unknown)*	**Avoided Cost:** Perceived cost of inaction (financial or economic) ranked on same scaling as "Cost of Action". *(4 = >$1M, 3= 1M -- $250,000, 2= 100,000 – 250,000, 1 = <$50,000, NA, Unknown)*	**Technical Feasibility:** Current technology can be used and physically implemented to solve the problem it is meant to address (4 = High, 2 = Medium, 0 = Low).	**Political & Social Feasibility:** Action has political and social community support or, at a minimum, does not have political or community opposition. This also considers the "fundability" of an action. (4 = High, 2 = Medium, 0 = Low).	**Alignment with Other Community Goals:** The action has benefits for other community goals, plans, or actions, leads to increase in social resilience, if relevant; action is socially equitable. (4 = High, 2 = Medium, 0 = High)	**Environmentally Sound:** Actior increases resilience of natural environment in the face of a range of climate change impact action decreases the emission GHGs (has Mitigation Co-benefits); action complies with environmental regulations; the will be no immediate or cumulative negative environmental consequences from the action. (4 = Yes, 2 = Somewhat, 0 = No

Breakout session: Surface water supplies

The morning brainstorming discussion included the following points. A compilation of promising practices from around the country was used to stimulate discussion and brainstorming of strategies that would be the most relevant and effective on the Olympic Peninsula:

- Enhance Monitoring by:
  - Identifying areas/locations where additional monitoring is needed
  - Creating a data clearinghouse for water information from all the different organizations on the Peninsula. This would include universities, cities, non-profits, others, and would include both information resources and information needs (potential home is the NOPRCD).

  - When and where it is needed, install additional flow and snowpack sensors (there was agreement that the monitoring data is limited – Elwha and Dungeness each have only one flow sensor and one snowpack sensor – they especially need more monitoring "out west" and inventory of smaller streams.)
  - The data from all of these could be used to identify water storage sites, establish baseline of use and availability, and to enhance system management.
- Complete storage/recharge study considering:
  - Enlarging existing storage
  - Locations for new structures – off stream storage including conveyance
  - Groundwater infiltration rates
  - Potential for active recharge of groundwater resources – infiltration wells – potential for "banking" water during high flow events for use in low flow times.
- Enhance education through:
  - Research partnerships
  - Tour of existing facilities/locations
  - Targeted messaging around conservation
  - Workshops and peer exchange
- Manage/enhance upstream watersheds for the following: (Many of these lands are managed by the National Park or the National Forest so partnerships with them would be needed. Also some private lands.)
  - Surface water flow
  - Higher retention rates
  - Headwater sustainability
  - Water quality – concern about landscape ability to capture larger precipitation events. There are current issues with high turbidity during large rain events meaning that some reservoirs can't capture the rainfall because the turbidity is too high in Port Angeles (?). Also slower runoff means extra filtration, less pollution entering ponds and the water systems. Not sure exactly where the turbidity issue is happening. Also consider increasing buffers, using bio swales, slowing water flow so that it goes into the soil and doesn't run off as quickly.
- Direct engagement between municipal & industrial water users – evaluation of water reuse
  - Would start by studying economics, needs, and capacity
    - One idea was connecting water treatment plant in Port Angeles with the paper mill and using existing pipes to send water from the plant to the mill for processing; this idea kicked off the conversation and had some strong proponents

and some skeptics. It was thought that the plant produces 2.2 million gallons a day that could be sent to the mill using existing infrastructure (the pipe that goes to the mill is in the harbor and has been re-lined already three times).
    - Questions about whether Port Townsend could also pump to the Mill
    - Or Sequim could pump to commercial agriculture
- Enhance conservation through:
    - Outreach to new homeowners – maybe real estate agents could have a "welcome to the NOP packet"
    - Inverted block rate structure for water use (currently Port Angeles rate structure is flat in the summer). Or Time of use pricing (long way off due to lack of monitoring capability through the meters at this point).
    - Mandated low flow fixtures (comes with increase enforcement costs)
    - Outdoor planting incentives for native, drought tolerant plants, and rainwater capturing landscapes – maybe local grant programs. Use of drip irrigation.
    - Low Impact Development (LID).
- Encouraging the state to permit grey water reuse or lift restrictions.
- New incentives for emerging technologies
- Desalination Plant – research and/or implementation.

In the afternoon, the initial brainstormed strategies listed below were evaluated based on the criteria described above. These raw scores were processed into the full list of adaptation strategies found in Appendix A: Comprehensive List of Adaptation Strategies.

Climate Preparedness Actions: Surface Water Supplies	**Timeframe for Implementation**	**Adaptive Flexible**	**Cost of the action**	**Avoided Cost**	**Technical Feasibility**	**Political & Social Feasibility**	**Alignment with Community Goals**	**Environmentally Sound**
Enhance Monitoring by: -Identifying Areas/locations where additional monitoring is needed -Creating a data clearinghouse for water information from all the different organizations on the Peninsula. This would include universities, cities, non-profits, others, and would include both information resources and information needs (potential home is the NOPRCD).	3.5	4	2.5	3	4	3.5	4	4

-When and where it is needed, install additional flow and snowpack sensors (there was agreement that the monitoring data is limited – Elwha and Dungeness each have only one flow sensor and one snowpack sensor – they especially need more monitoring "out west" and inventory of smaller streams.) -The data from all of these could be used to identify water storage sites, establish baseline of use and availability, and to enhance system management.								
Complete storage/recharge study considering: -Enlarging existing storage -Locations for new structures – off stream storage including conveyance -Groundwater infiltration rates -Potential for active recharge of groundwater resources – infiltration wells – potential for "banking" water during high flow events for use in low flow times.	3.5	4	2	4	4	3	3.5	4
Enhance Education Through: -Research partnerships -Tour of existing facilities/locations -Targeted messaging around conservation -Workshops and peer exchange	4	4	1.5	2	4	4	4	4
Manage/Enhance upstream watersheds for the following: -Surface water flow -Higher retention rates -Headwater sustainability -Water quality – concern about landscape ability to capture larger precipitation events. There are current issues with high turbidity during large rain events, slower runoff means	-	-	-	-	-	-	-	-

extra filtration. – Also consider increasing buffers, using bio swales, slowing water flow so that it recharges into the soil								
Reuse wastewater: -Direct engagement between municipal & industrial water users – evaluation of water reuse	2	0	4	4	3	3	3	4
Inverted block rate structure for water use (currently Port Angeles rate structure is flat in the summer). Or Time of use pricing (long way off due to lack of monitoring capability through the meters at this point.	3	2	2	3	4	2	2.5	4
Encouraging the state to permit grey water reuse or lift restrictions.	2	2	1.5	1.5	4	2	2.5	2
New incentives for emerging technologies	-	-	-	-	-	-	-	-
Desalination Plant – research and/or implementation.	1.5	0	4	1	4	2.5	1	1.5
Enhance conservation through: outdoor planting incentives for native, drought tolerant plants, and rainwater capturing landscapes. –maybe local grant programs, use of drip irrigation.	3	4	1.5	2	4	2.5	3.5	4

Breakout session: Groundwater Supplies

The morning brainstorming discussion included the following points. A compilation of promising practices from around the country was used to stimulate discussion and brainstorming of strategies that would be the most relevant and effective on the Olympic Peninsula:

- Add new natural filtration areas for recharge
  - Reestablish natural surface water off-stream retention ponds and storage areas. Could be used for storing water for agriculture while also restoring important waterfowl habitat and increasing groundwater recharge.
  - Create new wetlands or wetland banks for water storage and filtration purposes.

- Recycle grey water for in-house and outside use, within a property; look at codes related to that and impacts on wastewater
- Consider a reclaimed water system
- Capture peak precipitation events for recharge
- Restore former wetlands and floodplains to capture seasonal peaks
- Protect aquifer and groundwater recharge areas
- Recharge aquifer with injection (could be from stormwater runoff, etc.)
- Do education, outreach, and incentives on conservation and impacts (residential), include climate action plans
    - Develop an educational guide for the general public about proper use of grey water systems.
    - Educate citizens about water conservation.
- Modify residential and commercial water rate structure to encourage conservation (it was noted that Port Angeles' rate structure is flat in the summer)
    - Charge more for certain uses; re-price water on a sliding scale.
- Stormwater capture for groundwater recharge, using historical ditches (Dungeness tight-lined these and wells went dry, since stormwater was not infiltrating groundwater table), or housing developments, parking lots, etc.
- Conjunctively manage surface and groundwater supplies, particularly during drought
- Research recharge models and surface water/ground water relationship (Port Angeles and Peninsula College has some data)
- Do outreach and education related to cisterns and rain barrels
- Onsite stormwater with injection wells
- Characterize potential recharge areas
- Evaluate group A and B water systems to see if they are at risk, including saltwater intrusion
- Conduct modeling of impacts of sea level rise on groundwater regarding saltwater intrusion
- Consider new reservoir storage options (Aquifer Storage and Recovery)
- For new development, encourage/require mitigation on water supply impacts
- Incentivize cluster development and low impact development methods, local storage, grey water, community wells.
- Do outreach and education on low impact development techniques that impact recharge
- Redirect stormwater outfall that currently goes to the ocean to storage areas
- Add more monitoring systems (on rivers such as Elwha, on snowpack, on wells, etc.), and collect data and analyze it to research impacts of changing precipitation patterns

- Add metering to existing wells so owners know how much they are using
- Research aquifer boundaries
- Develop/update drought response plans considering climate change impacts, and monitor the response when they are implemented

In the afternoon, the initial brainstormed strategies listed below were evaluated based on the criteria described above. These raw scores were processed into the full list of adaptation strategies found in Appendix A: Comprehensive List of Adaptation Strategies.

Climate Preparedness Actions: Ground Water Supplies	**Timeframe for Implementation**	**Adaptive Flexible**	**Cost of the action**	**Avoided Cost**	**Technical Feasibility**	**Political & Social Feasibility**	**Alignment with Community Goals**	**Environmentally Sound**
Create an outreach and incentive program encouraging grey water systems within a property, including first reviewing and revising building codes as needed (3)	4	4	1	2	2	2	2.5	4
Develop code and infrastructure for a municipal reclaimed water system (2)	4	3	4	4	3	2	3	2
Create an outreach, education and incentive program for private well users and small water systems that includes voluntary metering, addresses both indoor and outdoor water usage, and educates on the broader issue of the need for water conservation (what aquifer to you live in, etc.) (3)	3	4	2	2	4	3	3	4
Create an outreach, education and incentive program around using rain barrels and cisterns and other residential conservation methods (1)	3	4	2	4	4	2	2	4
Consider residential and commercial water rate structure to encourage conservation (3)	4	2	1	3	4	3	3	4
Identify, protect and restore natural recharge areas	3.5	4	3	3	3	3	3	4

including floodplains and wetlands (4)								
Look for opportunities for artificial recharge including infiltration basins, injection wells, and artificial lakes/ponds, and assess sources (reclaimed water, stormwater, peak river flows) (3)	2	2	4-1M+	2	2	2	3	3
Minimize runoff through: Low Impact Development (LID), forest and vegetation management, floodplain management (4)	4	4	2	4	4	3	3	4
Have systems and resources for seasonal groundwater level monitoring, including measurement of sea level rise indicators (2)	4	4	2	4	4	3	3	4
Streamline the administrative process for water rights, for example, the ability to move the point of withdrawal within a service area to minimize impacts (3)	2	2	2	3	3	2	2	3

Breakout session: Water quantity and availability

The morning brainstorming discussion included the following points. A compilation of promising practices from around the country was used to stimulate discussion and brainstorming of strategies that would be the most relevant and effective on the Olympic Peninsula:

- Utilize Smart Grid technologies, have real time data today, but need to display to users to encourage them to decide to take conservation measures and identify leaks. Currently required to meter but not real time data. At water plant have SCADA (Supervisor Control and Data Acquisition) (state suggests use) which is a hardware/software combination, gives turbidity, pH at the intake/ treatment source. Can currently track use happening in real time through reduction in water storage levels. However, some concern was expressed that too much feedback to user and through social media runs the risk of becoming a "nanny state"
- Water conservation efforts usually have to be conducted across entire system to be effective, current water use plans prioritize: 1. Residential 2. Livestock 3. Industry
- Need to undertake actions that address the intersection of septics and wells:

  - Modify on-site septic requirements to anticipate impaired performance as water table levels rise, such as determining the feasibility of replacing traditional septic systems with mound systems or holding tanks.
  - In problematic areas known for septic system failures, evaluate alternative wastewater treatment solutions, particularly for properties in areas vulnerable to sea level rise.
- Explore and develop a creative financing program for residential and commercial properties to assist with retrofitting existing buildings for more efficient water use. Potentially use taxes.
- Trade water rights, permanent vs. temporary, Department of Ecology has avenue to conduct, examples in eastern Washington, however trading water rights, where they go could have secondary impacts, can put in trust.
- New legislative orders for efficiency / conservation (e.g. similar to previous efforts for appliances, lightbulbs)
- Establish and restore natural retention ponds and storage that benefit wildlife and agriculture - restore and greatly expand riparian areas along waterways
- Create water reuse protocols
- Revisit land use policies for lawns vs. native plants, or gravel yards
- Promote reclaimed water as new source, including stormwater capture/ retention
- Could promote new water laws, such as groundwater rights, can move points of withdraw to lessen environmental impact (further upstream, out of coastal areas) NOT adopted in last year's session
- Promote reuse of wastewater by industries, Port Angeles mill could currently use all of the municipalities treated wastewater, Sequim is treated at tertiary but not additional, could use on golf course. Reuse of wastewater vs. building a new reservoir would be very cheap.
- Promote new technologies, such as agriculture water demand devices, irrigation only for what direct needs are.
- Take conservation measures to industry boards to argue financial incentives
- Re-visit pricing of very cheap water (e.g. Port Angeles currently has very cheap water)
- Create Incentives for forest managers to increase water retention, surface considerations are currently covered, not groundwater

Some additional relevant thoughts:

- It was recognized that within one water system users have potentially different "rights"
- Agriculture water rights that are switched over to other uses could jeopardize desired agriculture futures
- Current water rights law is from 1920s, 1930s? needs overhaul
- If you see salinization of wells where do you go with water rights? However, wells are sometimes exempt to water rights
- Overarching to senior water rights are any mandatory restrictions
- Pilot programs with sub-basins managing water (sub-basin understandings of inputs/ outputs, conservation/ re-use), approved by DOE in Dungeness, works because water rights are available.

- Currently there is not strong recognition of where water will come from; demands for increases without foresight of availability
- Could hauling water be in the region's future? Chimacum bringing it in now, no regulations in existence, comes from Ludlow out to Chimacum
- Port Townsend mill has had to shut down at times due to lack of water
- There are water retention problems with harvested forests, they have increased evapotranspiration, could work to identify these areas; forested have lower flow, slower release of groundwater, clear cut has increased surface flows and flashy run off. Could retention help? Use forest road plan to assist? Woody debris? Different species? Side channels + oxbows preserved… Currently not part of forestry practices permit
- Crisis point in water availability is end of summer

In the afternoon, the initial brainstormed strategies listed below were evaluated based on the criteria described above. These raw scores were processed into the full list of adaptation strategies found in Appendix A: Comprehensive List of Adaptation Strategies.

Climate Preparedness Actions: Water Quantity and Availability	**Timeframe for Implementation**	**Adaptive Flexible**	**Cost of the action**	**Avoided Cost**	**Technical Feasibility**	**Political & Social Feasibility**	**Alignment with Community Goals**	**Environmentally Sound**
Pilot programs for sub-basin management within water rights law (2)	2	2	4	4	4	2	2	4
New regulations on water efficiency	4	4	3	3	4	4	4	4
Forecasts for future water supply/ demand (5)	4	4	2.5	4	2	4	4	4
Legislation: wells can move their point of withdraw to lessen environmental impact	2+	4	3v	4	4	2	2	2
Industries re-use wastewater (low-cost, high volume) (2)	3	4	4	4	4	4	4	4
Smart irrigation technologies, demand use of devices	4	4	3.5	4	4	4	4	4
Consider modifying water rates to encourage conservation (eg. Port Angeles)	4	4	1	Ecosystem services-4	4	2	2^	4

Smart grid water use data shared with consumers to increase conservation	2	3	4	4 bottom line?	4	1	2	4
Mapping water retention for ecosystem values of landscapes, leading to $$ calculations (2)	4	4	3	Ecosystem services	4	3	3	4
Research regulatory framework on water hauling/ delivery	-	-	-	-	-	-	-	-
Outreach on stormwater use methods (native plants, rain gardens, permeable surfaces) "incentives + cost savings"	4	4	4-funding?	4	4	Pol-4, soc-2	2	4
Outreach on stormwater use (native plants, rain gardens, permeable surfaces) "conservation + ecosystems"	4-ongoing	4	2.5-funding?	4	4	4	4	4
Preserve, conserve, restore water retention efforts up-stream/ wetlands (4)	4-ongoing	4	3.5	Ecosystem services-4	4	3	3	4
Education on conservation values of water retention	4-ongoing	4	2.5-funding?	Ecosystem services-4	4	4	2	4

Supplementary Information F: GIS Map Development

This section summarizes the data sources, processes, and methods used to develop GIS mapping and analysis for the NOPRCD Climate Change Vulnerability Assessment and Adaptation Plan. All GIS data and maps developed as part of this project will be provided to NOPRCD and its governmental and tribal partners for future reference and use.

Data Sources

The GIS data used in this project were acquired from a number of federal, state, and local sources. Only published and verified data sources were selected. An abbreviated list of the most essential GIS data layers, as well as their sources, are provided in Table A.

Table A. GIS Layers and Sources

GIS Layers	*Source*
Aerial Orthoimagery	United States Department of Agriculture (USDA) National Agriculture Imagery Program (NAIP) 2013 (1 meter resolution), http://www.fsa.usda.gov/FSA/apfoapp?area=home&subject=prog&topic=nai
Hydrography, Clallam County	USGS National Hydrography Dataset (NHD), http://nhd.usgs.gov/; Clallam County GIS, http://www.clallam.net/maps/mapdata.html
Hydrography, Jefferson County	USGS NHD; Washington State Geospatial Portal (WSGP), http://geography.wa.gov/
Transportation, Clallam County	Clallam County GIS, http://www.clallam.net/maps/mapdata.html
Transportation, Jefferson County	Jefferson County GIS, http://www.co.jefferson.wa.us/idms/shapefiles.shtml
Critical Infrastructure, Clallam County	Clallam County GIS; WSGP
Critical Infrastructure, Jefferson County	Jefferson County GIS; WSGP
Lidar DEM, Clallam Bay and Sekiu	Puget Sound LIDAR Consortium (PSLC) 2005, http://pugetsoundlidar.ess.washington.edu/
Lidar DEM, Port Townsend	PSLC 2012 and PSLC 2001-02
Lidar DEM, Port Angeles	PSLC 2012
Lidar DEM, Dungeness River Delta	PSLC 2012
Lidar DEM, Neah Bay	United States Army Corp of Engineers (USACE) 2010, http://coast.noaa.gov/

Data Processing and Mapping

Once obtained, procedures to assure quality and comparability were applied to all GIS data. This included an assessment of overall alignment of spatial data and existence and accuracy of metadata by Adaptation International staff, as well as the use of a standard horizontal (NAD 1983 HARN, US Feet) and vertical datum (NAVD 88, US Feet). For this project, all data were projected using NAD 1983 HARN State Plane Washington North FIPS 4601 in US feet. For all data not in this projection upon receipt, a transformation was applied.

Map layout and design are the product of Adaptation International staff, and were created using ArcGIS 10.2 software.

Sea Level Rise Scenarios

Adaptation International staff developed locally specific relative sea level rise projections, adjusted for vertical land movement, for each of the five focus areas (Clallam Bay and Sekiu, Dungeness River Delta, Neah Bay, Port Angeles, and Port Townsend) using probabilistic methods derived from Kopp et al. (2014) for RCP 8.5 (for a more detailed explanation of the methods refer to **Appendix D- Sea Level Rise Analysis Details** of this report). Based on these projections, scenarios for *Sea Level Rise Inundation Area* (SLR), as well as *Annual Extreme Storm Flooded Areas with Sea Level Rise* (AES) were defined for each focus area for the years 2030, 2050, and 2100, respectively. Additionally, projections of *Storm Surge Today* were generated for each focus area in order to establish a baseline for comparison. Finally, for each scenario, elevation values representing the 50%, 25%, 5%, and 1% probable annual percent chance of occurrence were specified and then mapped using lidar derived digital elevation models (DEMs).

The lidar data used to map the sea level rise scenarios were gathered from a range of dates and sources. Lidar (**LI**ght **D**istance **A**nd **R**anging, also known as Airborne Laser Swath Mapping or ALSM) is a technology that employs an airborne scanning laser rangefinder to produce high-resolution topographic surveys of unparalleled detail. Lidar data for Neah Bay were collected by the United States Army Corp of Engineers (USACE) in 2010 and made available through the National Oceanic and Atmospheric Administration's (NOAA) *Digital Coast* web portal http://coast.noaa.gov/digitalcoast/. Lidar data for Clallam Bay and Sekiu were collected in 2005 by three separate agencies: Clallam County, WA Department of Natural Resources (DNR), and WA Department of Transportation (DOT). The three data sets were then merged and made available through the Puget Sound Lidar Consortium (PSLC; Note that registration is required to access PSLC data http://pugetsoundlidar.ess.washington.edu/). Lidar data for Port Angeles and the Dungeness River Delta were collected by the Federal Emergency Management Agency (FEMA)—specifically, data from the 2012 Jefferson-Clallam lidar Project--and made available through PSLC. Elevation data for Port Townsend were derived from two datasets: 1) FEMA 2012, which encompassed a narrow band along the coastal perimeter, and 2) lidar data collected by Clallam County in 2001-02 covering all inland areas. In the final Port Townsend scenarios, precedence was given to the newer FEMA 2012 data, while the 2001-02 data were used for all areas not contained within the 2012 boundary. Both lidar datasets used for Port Townsend were made available through PSLC.

In addition to the lidar derived elevation data, aerial ortho-imagery--used as the base images for the sea level rise scenarios--were obtained through the United States Department of Agriculture's (USDA) National Agriculture Imagery Program (NAIP) via the USDA's Geospatial Data Gateway (https://gdg.sc.egov.usda.gov/). The analysis used the most recently available imagery with 1-meter resolution, which was recorded in 2013. The metadata for the aerial imagery is available.

Finally, key resources, landmarks, and infrastructure within the three focus areas were mapped using a combination of obtained GIS data, information provided by the consultant team, and

through review of the ortho-imagery. Project staff and stakeholders confirmed the approximate locations of community resources during the engagement workshops.

Complete List of Maps

A total of 40 maps were developed for this project and are provided as part of this report. A complete list of maps is provided in Table B below.

Along with a map showing the overall *Project Area*, four overview maps were created from GIS data classified into one or more of the following categories: *Water Resources*, *Critical Infrastructure*, *Natural and Managed Ecosystems*, and *Community Vitality*. Each category is consistent with the distinct classifications used during the engagement workshops, and also found within this report.

Furthermore, a total of seven seal level rise projection maps were created for each of the five focus areas (Clallam Bay and Sekiu, Dungeness River Delta, Neah Bay, Port Angeles, and Port Townsend) using probabilistic methods derived from Kopp et al. (2014) and based on RCP 8.5. This includes maps of *Sea Level Rise Inundation Area* (SLR) and *Annual Extreme Storm Flooded Areas with Sea Level Rise* (AES) for the years 2030, 2050, and 2100, respectively, as well as a map of *Storm Surge Today* used to establish a baseline for comparison. The result is twenty-eight total probabilistic maps.

Regarding these twenty-eighty probabilistic sea level rise projection maps, it is important to note a number of caveats:

- The mapped "Current Shoreline" is the Mean Higher High Water datum, 1983-2001 epoch, as provided by the National Oceanic and Atmospheric Administration (NOAA).
- Maps use only elevation data, do not model hydrology, and do not reflect the influence of engineered shoreline structures, i.e. tide gates.
- Maps do not reflect shoreline change or erosion.
- Annual extreme flooding probabilities derived from historical data collected at nearby NOAA tide stations and do not take into account possible climate-related changes to storminess patterns.
- Maps do not reflect the additional flood risk associated with waves in elevating water level during storms.

Table B. Complete List of Maps

Overview Maps
Project Area
Water Resources
Critical Infrastructure
Natural and Managed Ecosystems
Community Vitality

Sea Level Rise Projections				
Clallam Bay/Sekiu	**Dungeness River Delta**	**Neah Bay**	**Port Angeles**	**Port Townsend**
Storm Surge Today	Storm Surge Today	Storm Surge Today	Storm Surge Today	Storm Surge Today
SLR 2030	SLR 2030	SLR 2030	SLR 2030	SLR 2030
AES and SLR 2030	AES and SLR 2030	AES and SLR 2030	AES and SLR 2030	AES and SLR 2030
SLR 2050	SLR 2050	SLR 2050	SLR 2050	SLR 2050
AES and SLR 2050	AES and SLR 2050	AES and SLR 2050	AES and SLR 2050	AES and SLR 2050
SLR 2100	SLR 2100	SLR 2100	SLR 2100	SLR 2100
AES and SLR 2100	AES and SLR 2100	AES and SLR 2100	AES and SLR 2100	AES and SLR 2100

Detailed list of GIS Data layers used

Projection: NAD 1983 HARN StatePlane Washington North FIPS 4601 (US Feet)

Critical Infrastructure Geospatial Data			
Data Layer	***Available Clallam County***	***Available Jefferson County***	***Source***
Transportation			
Roads	Yes	Yes	Clallam and Jefferson County GIS
Railways	Yes	Yes	Washington State Geospatial Portal (WSGP)
Bridges	Yes	Yes	WSGP
Culverts	Yes	Yes	WSGP
Health Care			
Hospitals	Yes	Yes	WSGP
Clinics	Yes	Yes	WSGP
Nursing Homes	Yes	Yes	WSGP
Assisted Living	Yes	Yes	WSGP
Adult Family Homes	Yes	Yes	WSGP
Emergency Response			
EMS	Yes	Yes	WSGP
Police/Guard	Yes	Unknown	Clallam County GIS
Fire Station	Yes	Yes	WSGP

Education			
Schools	Yes	Unknown	Clallam County GIS
Historic			
Historic Registry	Yes	Yes	WSGP
Utilities			
Radio	Yes	Unknown	Clallam County GIS
Electric	Yes	Unknown	Clallam County GIS
Electric/Water	Yes	Unknown	Clallam County GIS
Water	Yes	Unknown	Clallam County GIS
Waste Water	Yes	Unknown	Clallam County GIS
Waste Water Treatment Plant	Yes	Unknown	Clallam County GIS
Hazard Areas			
Slope Stability	Yes	Yes	WSGP
Shoreline Slope Stability	Yes	Yes	WSGP
Seismogenic Features	Yes	Yes	WSGP
Erosion Hazard	Yes	Yes	WSGP
Levee Inventory	Yes	Yes	WSGP
Floodplains	Yes	Yes	WSGP
Wildland Urban Interface (Fire Risk)	Yes	Yes	WSGP

Projection: NAD 1983 HARN StatePlane Washington North FIPS 4601 (US Feet)

Water Resources Geospatial Data

Data Layer	***Available Clallam County***	***Available Jefferson County***	***Source***
Hydrography			
Watersheds (HUC 8, 10, and 12)	Yes	Yes	National Hydrography Database (NHD)
Water Bodies	Yes	Yes	NHD
Flow Lines (Rivers and Streams)	Yes	Yes	NHD
Wetlands Inventory 2011	Yes	Yes	Washington State Geospatial Portal (WSGP)
Floodplains	Yes	Yes	Federal Emergency Management Agency (FEMA)
Water Quality			
Non-attainment Areas (TMDLs)	Yes	Yes	WSGP
Point-source Pollution	Yes	Yes	WSGP

(Dairies)			
Monitoring Stations	Yes	Yes	WSGP
Water Supply			
Lakes and Reservoirs	Yes	Yes	WSGP
Fish Passage Barrier Inventory			
Culverts	Yes	Yes	WSGP
Misc Barriers	Yes	Yes	WSGP
Dams	Yes	Yes	WSGP
Shoreline			
Shoreline Stability	Yes	Yes	WSGP
Levee Inventory	Yes	Yes	WSGP

Projection: NAD 1983 HARN StatePlane Washington North FIPS 4601 (US Feet)

Natural and Managed Ecosystems Geospatial Data			
Data Layer	***Available Clallam County***	***Available Jefferson County***	***Source***
Agriculture			
Land Use and Land Cover	Yes	Yes	Washington State Geospatial Portal (WSGP)
Primary Crop Group	Yes	Yes	WSGP
Soils / Prime Farmland	Yes	Yes	WSGP
Dairies	Yes	Yes	WSGP
Fisheries			
Aquatic Parcels	Yes	Yes	WSGP
Shellfish Harvest Locations	Yes	Yes	WSGP
Fish Passage Barriers Inventory	Yes	Yes	WSGP
Forestry			
Active Applications	Yes	Yes	WSGP
Applications (All)	Yes	Yes	WSGP
Biodiversity			
Endangered Species	Yes	Yes	US Fish and Wildlife Service (USFWS)
Habitat Conservation Plan Parcels	Yes	Yes	WSGP
Sensitive Aquatic Areas	Yes	Yes	WSGP
Rare Plants and High Quality Ecosystems	Yes	Yes	WSGP

Invasive Species	Yes	Yes	WSGP
Hazard Areas			
Slope Stability	Yes	Yes	WSGP
Shoreline Slope Stability	Yes	Yes	WSGP
Seismogenic Features	Yes	Yes	WSGP
Erosion Hazard	Yes	Yes	WSGP
Levee Inventory	Yes	Yes	WSGP
Floodplains	Yes	Yes	WSGP
Wildland Urban Interface (Fire Risk)	Yes	Yes	WSGP

Projection: NAD 1983 HARN StatePlane Washington North FIPS 4601 (US Feet)

Community Vitality Geospatial Data			
Data Layer	***Available Clallam County***	***Available Jefferson County***	***Source***
Boundaries			
Counties	Yes	Yes	Washington State Geospatial Portal (WSGP)
City Limits (polygon)	Yes	Yes	WSGP
Populated Places (Points)	Yes	Yes	WSGP
Urban Growth Areas	Yes	Yes	WSGP
Public Lands (Federal, State, Municipal, and Tribal)	Yes	Yes	WSGP
Cadastral	Yes	Yes	Clallam and Jefferson County GIS
Zoning			
Zoning (by County)	Yes	Yes	Clallam and Jefferson County GIS
Population			
2010 Census	Yes	Yes	US Natural Resources Conservation Service (NRCS)
Projected Population	Yes	Yes	US Environmental Protection Agency (EPA)
Health Care			
Hospitals	Yes	Yes	WSGP
Clinics	Yes	Yes	WSGP
Nursing Homes	Yes	Yes	WSGP
Assisted Living	Yes	Yes	WSGP
Adult Family Homes	Yes	Yes	WSGP

Emergency Response			
EMS	Yes	Yes	WSGP
Police/Guard	Yes	Unknown	Clallam County GIS
Fire Station	Yes	Yes	WSGP
Education			
Schools	Yes	Unknown	Clallam County GIS
Historic			
Historic Registry	Yes	Yes	WSGP
Air and Water Quality			
Total Maximum Daily Loads (TMDL)	Yes	Yes	WSGP
Water Quality Assessment	Yes	Yes	WSGP
Ozone	Yes	Yes	WSGP
Particulate Matter	Yes	Yes	WSGP