DRONES FOR IMPROVING TRAFFIC SAFETY IN RITI COMMUNITIES IN WASHINGTON STATE

FINAL PROJECT REPORT

by

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for

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16. Abstract

Transportation and traffic safety is a primary concern in Rural, Isolated, Tribal, or Indigenous (RITI) communities in Washington (WA) State. Parallel to this, while emerging technologies (e.g., connected/autonomous vehicles, drones) have been developed and tested in addressing traffic safety issues, they are often not widely shared in RITI communities for various reasons. Compared with other technological advances, drone technologies have been rapidly improved and can be flexibly applied to multiple fields, including engineering, agriculture and disaster managements. The goal of this study is to explore and synthesize the opportunities, challenges and scenarios that drone technologies can assist to resolve traffic safety related issues and concerns in RITI communities. Through the outreach activities with the outer Pacific Coast in WA state, it is found that the principal concern within these communities are disaster management and mitigation since they are facing the threat of coastal erosion, earthquake and tsunami. Thus, the emergency management and hazard mitigation becomes the major way to further explore drone applications in the selected communities. To achieve this, we reviewed the current state of the drone technologies, conducted surveys from National Guard and coastal communities in WA, including City of Westport, South Beach Region, Grays Harbor County, Shoalwater Bay Tribe, and Quinault Indian Nation, to better understand their current needs, challenges and issues. Ultimately, recommendations of drone applications under specific scenarios are provided based upon the integration of drone technologies with community safety needs.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	**When You Know**	**Multiply By**	**To Find**	**Symbol**
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Transportation and traffic safety is one of the major concerns among the Rural, Isolated, Tribal or Indigenous (RITI) communities in Washington State. Based on the Fatality Analysis Reporting System of US Department of Transportation in 2017, approximately 41% of the vehicle-crash-caused-deaths happened along the rural roads in Washington, which ignites the significance and indispensability of targeting an effective, context-sensitive solution.

On the other hand, although emerging technologies such as drones, connected and autonomous vehicles are extensively researched and heatedly discussed to improve traffic safety, few of them have been widely shared with the RITI communities due to limited funding resources, tech/equipment hysteresis, etc. This research aimed to explore, acknowledge and synthesize the opportunities and challenges of applying drone technologies to alleviate or to resolve the traffic safety related issues within RITI communities. Although drones have been widely applied in both urban and rural area for several purpose (e.g., search and rescue, delivery, etc.), usage of drones towards the RITI communities has not been completely explored. Regarded as a promising advanced technology with multiple applications, drones are believed to provide an economic and effective way to solve the traffic safety challenges of RITI communities. However, limitations on drones, especially for RITI communities like flight restrictions, should be noticed and addressed.

Furthermore, since cultural characteristics vary in different communities, identifying the unique traffic safety needs for a given community is the key to further determine the correspondingly efficient drone applications for the community. Accordingly, a more comprehensive learning of drone technologies/ applications and a detailed, deeper awareness of the traffic safety needs based on the unique cultural characteristics for the targeted RITI communities become the two main tasks of this study as well as the foundation for future research regarding drone applications in RITI communities.

To achieve this, literature with respect to the current state of drone technologies (e.g., power, sensing), applications (e.g., incident management, infrastructure monitoring), related pros and cons has been substantially reviewed and summarized. Part of the RITI communities on the outer Pacific coast of Washington State, especially the City of Westport, but also Grays Harbor County, Ocosta School District, Shoalwater Bay Tribe, etc., are selected as our study area because they currently face social and economic challenges (such as unemployment, poverty, low education and residential instability) in addition to traffic safety challenges. Outreach activities from different agencies have been conducted and a survey was designed to enhance the understanding of the major concerns regarding traffic safety needs of our targeted communities. Through the integration of drone technologies with identified transportation and traffic safety needs and challenges of selected communities, recommendations of specific drone applications under certain scenarios are provided as the viable and context-sensitive solutions. Results from this research will lay the foundation for specific drone applications in RITI communities in future investigations.

CHAPTER 1. INTRODUCTION

1.1. General Background

Rural, Isolated, Tribal, and Indigenous (RITI) communities in Washington State (and the US) face many challenges including health care and education, economic development, and public safety. Among them, transportation and traffic safety has been one of the major concerns. Based on the "2016 Traffic Safety Facts 'Rural and Urban Comparison'" report from the Federal Highway Administration (FHWA), 50% of the 37,461 traffic fatalities occurred in rural areas (*1*). Besides, as shown in Figure 1.1, the American Indian and Alaskan Natives (AIAN) traffic fatality rate, based on national Fatality Analysis Reporting System (FARS) database, is 27.6 deaths per 100,00 people using data from 2005-2014, which approximately triples the next highest death rate among reported ethnic/racial groups (Fig.1.1) (*2*). Moreover, 21% of Washington's rural roads are reported in poor condition in 2017, the eleventh highest share in the U.S, and 5% of rural bridges in Washington are rated as poor/structurally deficient (*3*).

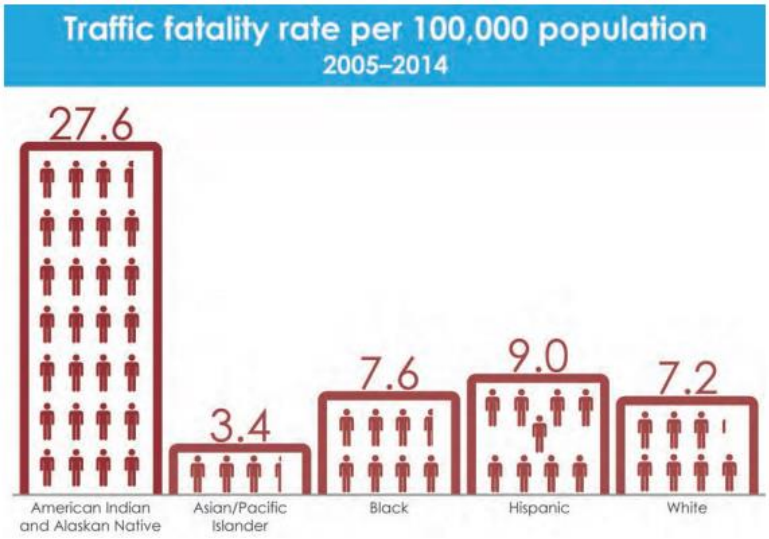

Figure 1.1 Traffic fatality rate in Washington State

Meanwhile, the planning tools and processes that typically govern transportation investments and traffic management in rural areas do not often align closely with planning for hazard mitigation. Nevertheless, good emergency management and hazard mitigation not only enhances effective preparation, reliable prevention and instant response for disaster, incident and emergencies, but also promises a safe, resilient and sustainable environment for daily mobility system. Local governments' Comprehensive Plans, which provide agencies a legally recognizable framework for making decisions regarding land use, transportation, public facilities, parks and open space (*4*), are often not fully required for non-urbanizing communities under the Washington State Growth Management Act (GMA). Displayed in Figure 1.2, eleven counties marked with gray color are identified as non-growth areas under the Washington GMA and are only subject to critical areas and natural resource lands planning requirement. Emergency planning for natural hazards such as flooding, major storms, earthquakes and tsunamis, however, is typically carried out by FEMA-regulated agencies and rarely integrates with Comprehensive Plans. While such hazards have become a major focus for a growing number of local

agencies, this lack of coordination results in a lack of funding and investment in strategies for normal development, including improvements to traffic safety and transportation infrastructure, that are also resilient to hazards. To better align planning for both emergency and everyday conditions, as well as to discover and develop a context-sensitive solution for traffic safety issues and transportation-related challenges in RITI communities, in this study, we plan first to understand current challenges and issues with respect to emergency management and hazard mitigations within these communities, and then to explore opportunities that can be linked with everyday developmental goals and objectives.

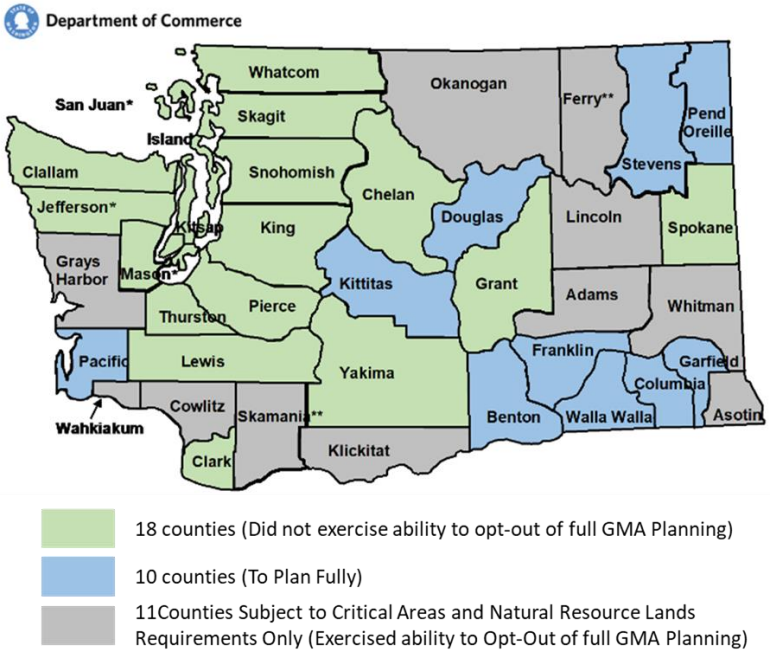

Figure 1.2 GMA Status of Washington counties and cities (*5*)

Another challenge is that the emerging technologies (e.g., connected/autonomous vehicles, drones, among others) that have been developed and tested to address traffic safety issues are often not shared widely in RITI communities due to limited funding and resources, and the dominance of major metropolitan centers and lack of attention to rural conditions in regional transportation developments. Compared with other advanced technology such as connected/autonomous vehicles which are still under research and testing for both operation and regulation, drone technologies are both mature and flexible in application. Therefore, in this study, we focus on exploring possible drone applications in RITI communities to resolve the traffic safety issues through identifying and synthesizing the current opportunities, challenges, and scenarios facing local agencies.

1.2. Problem Statement

As a cutting-edge technology that can be applied for various purposes including engineering, agriculture, and logistics, drones are able to provide both economic and effective solutions to traffic safety-related problems such as traffic monitoring and disaster management. However, drones also have limitations

that users should be aware of, especially when applied in RITI communities considering regulations from the Federal Aviation Administration (FAA) and local agencies. More importantly, unique traffic safety needs and challenges of RITI communities in Washington State should be identified and learned before proposing possible drone applications. In particular, for communities that pay attention to planning in critical areas and natural hazards, it is necessary to find their emergency needs and challenges and explore the connection with their daily requirements and issues so as to identify drone uses that can be leveraged under both daily and emergency scenarios.

To achieve this, we first review the current state of the practice of drones, their applications, technologies, regulations, advantages and limitations. With a better understanding of drones, we conduct outreach activities to communicate with community residents and representatives respecting their unique cultural characteristics, as well as the specific social/economic/education resource limitations of the community. To further identify specific drone applications, an online survey is designed based on the outreach activities and sent out to community representatives, including those from tribes, cities, counties and state. Finally, we summarize identified traffic and transportation needs and challenges and provide recommendations of drone application to improve safety in RITI communities.

The rest of this report is organized as follows: Section 2 discusses the literature on the state-of-the-art drone-related technology and applications, including current drone applications in Washington State. Section 3 provides brief summaries of the outreach activities conducted by the project team. Section 4 describes an online survey designed on the basis of community outreach meetings, followed by findings from the outreach activities and survey as well as recommendations for possible drone applications under various scenarios in Section 5. Finally, the conclusion and future research directions are provided in Section 6.

CHAPTER 2. LITERATURE ON DRONE TECHNOLOGY AND APPLICATION

2.1. State of the Art Drone Technologies

A drone is termed as an "unmanned aerial vehicle" (UAV) and has the ability to collect data, transport loads and conduct search and rescue, among other functions. Drones have been around for more than two decades, mainly applied in military applications. Over the last few years, drone adoption and usage have expanded across industries and obtained global awareness with a tremendous development of drone related technologies (*6*). Considering the current regulations from FAA and the flight authority, this study focuses on commercial drones, i.e., drones discussed in this report are limited to commercial drones only. It is now widely acknowledged that, for specific purposes, drones may provide a faster, safer, and cheaper alternative compared with traditional systems (such as helicopters). Nevertheless, drone applications also face multiple challenges and constraints. Thus, to better identify possible drone usage in RITI communities and understand their advantages and limitations, we provide a brief review of current drone related technologies, regulations, and applications; more detailed review on drone technologies can be found in Appendix A: UAV (Drones) technologies.

Generally, power, sensing and positioning are the crucial components in terms of drone technology. The power technology determines how long and how far a drone can operate. The majority of commercial drones are powered by batteries (approximately 96%). Other power resources, including hydrogen fuel-cells, petrol, and solar, are currently being discussed and under development (*7*, *8*). The sensing technologies are a key component of any drones which ensure a smooth and safe flight, accurate data collection and monitoring. Related sensors applied in drones include light detection and ranging (LIDAR), time of flight (ToF), and thermal vision cameras (*9*, *10*). Besides, positioning technology (often GPS) is a critical requirement of drones for navigation, accurate loading and returning (*11*).

Accompanying the increasing use of drones are FAA regulations to secure the flight, and public privacy and safety considering operation, loading and performance, and airspace requirements. Regulations mainly follow Title 14 CFR 107: the FAA drone laws require drones weighting over 0.55 pounds to be registered and properly marked with a label before flight. The drones must weigh less than 55 pounds and drone pilots must be at least 16 years old and hold a remote pilot airman certificate. Regarding operating a drone, it must fly during daylight hours, and be kept within the visual line of sight. In addition, a drone must fly under 400 feet above the ground level with speed less than 100 mph. Moreover, it must yield the right of way to manned aircraft and is required not to fly over people/operate from a moving vehicle (*12*).

Drones can be applied in a wide range of applications, including aerial photography, 3D mapping, search and rescue, avalanche and storm monitoring, building/infrastructure safety inspection, aerial photography, delivery and telecommunication (*6*, *13*–*15*). There are multiple benefits of using drones: they are budget friendly, easy to manipulate; with versatile flying capability; and are available to be applied to situations that require high location accuracy (e.g., to spray fertilizer and insecticides). By contrast, drones also encounter a certain number of limitations: drone operations are constrained by the FAA Part 107 regulations and the state laws such as controlled air space and limited weight; most of drone applications are affected by weather changes, especially when flying drones in rain or snow which

raise the risk for electronic components damage and communication interference between drones and the controllers; there are also concerns about privacy invasion, public injury due to falling accidents (*16*–*18*). Such benefits and limitations make drones suitable for specific scenarios only, which highlights the necessity of a context-sensitive solution when considering drone applications in RITI communities.

2.2. Practice of drones in Washington State

An increasing number of state departments of transportation (DOTs) have started leveraging drones to improve traffic safety and alleviate traffic congestion. According to a survey by the American Association of State Highway and Transportation Officials (AASHTO), 33 state DOTs have been or are exploring, researching or testing drones to inspect transportation infrastructures (such as bridges) and help clear/monitor vehicle crashes (*19*). The Washington State DOT has conducted a drone related project to test and evaluate their capabilities for traffic surveillance and data collection and avalanche control in 2008 (*20*). Besides, Washington State Patrol are reported to have one of the largest drone fleets in the country with 130 drones statewide. The drone pilot program in Washington State Patrol was started in 2016 and is mainly applied for photographing and documenting vehicle collision.

Apart from transportation and traffic safety, drones have also been applied by a growing number of local government agencies across many fields in Snohomish County of Washington: The Getchell department used drones with an infrared camera and a powerful zoom lens to capture a better view of fires. Drones were also applied to assist agencies in finding missing persons, and monitoring the fallen mud and trees so as to help evacuation. The city of Monroe was reported in November 2019 to start some drone projects in 2020. The city council aims to learn and identify possible drone applications in the city's police, public works, marketing and other departments (*21*). It can be noticed that drones begin to play an important role in assisting public agencies under certain scenarios. However, such technology is not widely applied into/shared with RITI communities in Washington due to various reasons. To introduce the drone technology as well as identify possible drone applications, we conduct several outreach activities to further learn the values, challenges and issues within the RITI communities.

CHAPTER 3. OUTREACH ACTIVITIES

To propose a context-sensitive solution with drone application in RITI communities, it is critical to communicate with the communities and be aware of their cultures, current traffic conditions, and traffic safety concerns and major challenges. The study region of this report focuses on the outer Pacific coast of Washington State, specifically the City of Westport. Participants also include the Ocosta School District, South Beach Regional Fire Authority, Grays Harbor County Emergency Management, Washington State Emergency Management Division, Shoalwater Bay Tribe, and Quinault Indian Nation. The South Beach Region refers to the area located on the Pacific Ocean and in Grays Harbor and Pacific Counties. Figure 3.1 displays the South Beach area vicinity map provided by Washington State Parks Commission (*22*), including towns of Westport, Tokeland, Grayland, North Cove, Ocosta, Bay City, Laidlow, Cohassett, and Dexter by the Sea (*23*).

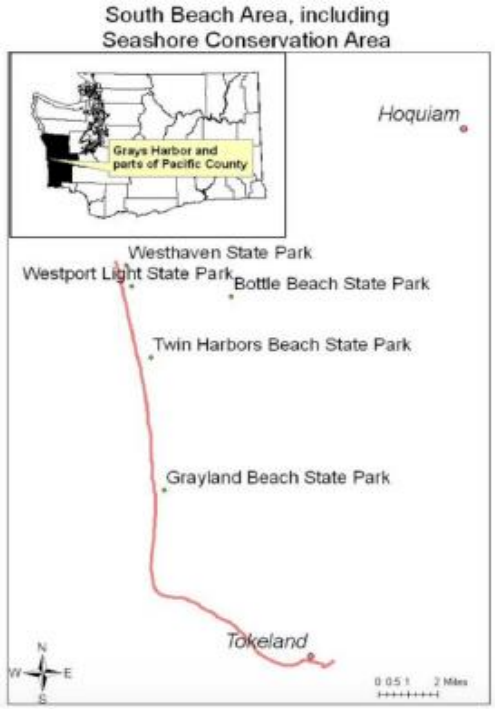

Figure 3.1 South Beach Area (*22*)

Through discussions with the community representatives, one of the major challenges that most coastal communities have encountered is the natural hazards, such as coastal erosion, sea-level rise (SLR), and tsunami, etc. Hence, it is imperative to come up with corresponding hazard mitigation and community resilience planning accordingly. To further explore traffic and transportation related challenges and possible drone applications within these communities, we organized and/or participated in a number of outreach activities, including the “Community Engagement for Costal Resilience” Studio and the “Washington National Guard Tsunami Workshop”. In this chapter, we briefly summarize the major outreach activities; more details can be found in Appendix B.

3.1. Community Engagement for Coastal Resilience Studio

The studio was organized and led by Co-PI of the project, Professor Dan Abramson from Urban Planning at the University of Washington (UW). The studio focused on community engagement, with the City of Westport and Shoalwater Bay Tribes as the main partners. To identify prior social, natural, built assets and values of the community under hazard scenarios, the studio prepared, implemented and documented several workshops with community leaders and residents (mainly from Westport) using asset-based community mapping techniques. The studio aimed to engage the broad local community members and agency stakeholders, covering representatives and the public from City of Westport, Shoalwater Bay Tribe, Grays Harbor County, Washington State emergency management agencies and researchers representing coastal ecology, transportation, public health, education, local business and historic resources to identify opportunities and challenges for integrating equitable and suitable hazard planning strategies into the Westport Comprehensive Plan. We participated in the studio as transportation researchers to help identify current transportation and traffic safety challenges as well as opportunities for possible applications of drones in various emergency scenarios. Detailed workshop documentation of this studio is provided in Appendix B: Workshop report for Westport Coastal Resilience.

As the focused study region, Westport is a small, rural town located at the mouth of Grays Harbor County near the Pacific Ocean on the southernmost peninsula (Figure 3.2). With a population of 2110, local residents in Westport still rely on fishing, shellfish harvesting, seafood processing, boat building and tourism for their livelihood (*24*). There are several reasons that we chose Westport as the study area. First, Westport is facing similar threats as other coastal communities, including “gradual” SLR, coastal erosion and events respecting to storm surges, tsunamis generated by distant earthquakes (e.g., from Alaska, Japan) or nearer-ones (such as Cascadia Subduction zone). Exploring the costal resilience-related issues at Westport enables us to further understand the challenges that all coastal communities are facing.

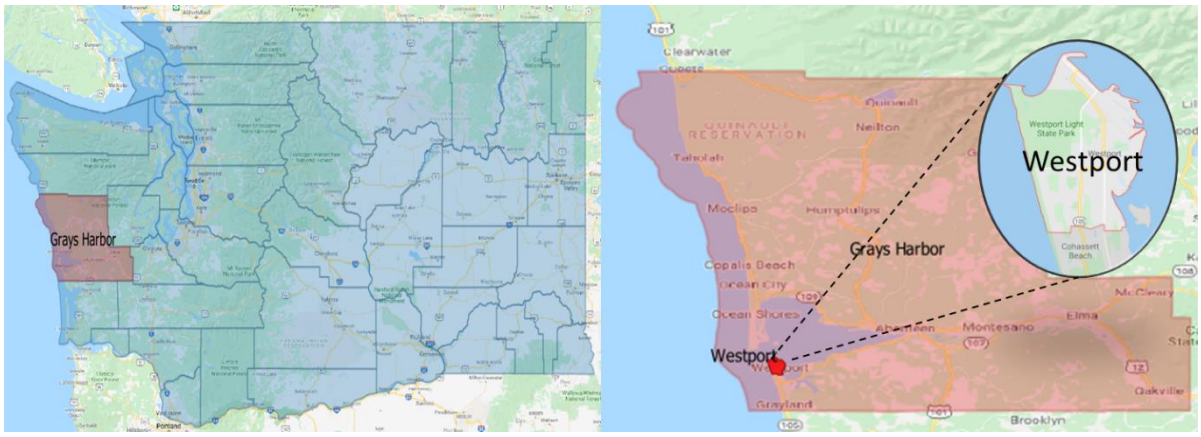

Figure 3.2 Geo-location of Grays Harbor County (left) and City of Westport (right)

On the other hand, to deal with the threat of tsunami, city of Westport worked with its southern Ocosta School District to build a vertical evacuation facility (Figure 3.3) that is on the roof of the new Ocosta Elementary School Gym and is known as the first structure serving as a haven for tsunami event in the US (*25*). Such tsunami evacuation facility not only shows that the Westport community is open to new

and innovative ideas, but also provides opportunities for researchers considering traffic safety and innovative technology (such as drone) applications, with respect to evacuation planning and post-disaster management.

Figure 3.3 Vertical evacuation facility of Westport – Ocosta School gymnasium (*25*)

Through the review of a previous Comprehensive Plan (CP) and discussion with Westport community members, the team found that transportation and traffic safety has been included in the Transportation and Circulation Element Chapter of the 2012 Comprehensive Plan Update (*26*). The 2012 CP regarding transportation field emphasizes the critical role of transportation improvements with respect to land use intensity, traffic flow increase and economic development. The chapter also addresses the importance of various transportation modes (such as pedestrian, public transit, and bicycle, etc.), and public safety measures before during and after an emergency. The goals, objectives, and policies are separated into two sections of the plan, including the general transportation and policies as well as the airport circulation. However, transportation and traffic planning with respect to hazard mitigation, which is critical not only to Westport but to all coastal communities, are not fully included in the current CP.

The studio consists of three phases: Phase I developed a general background understanding of Westport and the costal resilience and hazard mitigation project through the Westport steering committee meeting. Literature reviews of the 2012 Comprehensive Plan and tour trips of Ocosta School, Shoalwater Bay tribes, Tokeland, and South Beach Region were also conducted during this phase. In Phase II, we prepared and conducted community workshops for community representatives and the public based on findings from Phase I. Phase III integrated workshop documentation and findings, and drafted a recommendation report for updating the Comprehensive Plan.

In Phase I, we started by communicating with the Westport Steering Committee to identify engaged members, and discussing workshop protocols and possible Comprehensive Plan updates. Through communication and brainstorming with community representatives, including Kevin Goodrich (Director of Public Works), Rob Beardon (City mayor), Molly Bold (Marina Business Manager, Port of Grays Harbor) and Tracy Rosenow (Westport Police Chief), the region of engaged public in the workshop not only focuses on the entire city of Westport, but also the nearby area in the South Beach region including

Tokeland, Ocosta and Grayland considering cooperation (such as coordinate traffic control) during the evacuation period. Besides, the hazard scenarios taken into account in the workshop focus on the SLR and tsunami generated from various Cascadia Subduction Zone (CSZ) earthquake: Large and shallow magnitude 9.0 SCZ earthquake (L1), Medium and shallow magnitude 8.9 CSZ earthquake (M1). Finally, hazard mitigation planning based on the workshop findings were planned to be integrated into the comprehensive plan update. The following subsection introduces the outreach activities of Phase II; the summary of the major findings in Phase III will be presented in Chapter 5.

3.1.1. Westport/South Beach Workshop – 11/2018 (27)

There were two workshops consisting of 1) an invitation-only 'Partners Workshop' for community representatives in planning and emergency management on Nov 16, 2018 and 2) a 'Community Workshop' that was open to the general public on Nov 17, 2018. Both workshops attempted to identity the social, natural and built assets as well as the daily values of Westport under different hazard scenarios. In the meantime, the two workshops focused on making hazard mitigation more meaningful and concrete to the community as well as actionable and feasible to Westport and the larger South Beach region. The two workshops aimed to 1) Build on the current community's accomplishments in preparing for the earthquake and tsunami, such as the first vertical tsunami evacuation facility in Ocosta School; 2) Assist the city in drafting Comprehensive Plan updates that cover hazard mitigation that adapts and reflects Westport/South Beach values and needs; 3) Raise public awareness of emergency preparation considering their critical needs and encourage community self-reliance and mutual help when facing disasters; and 4) Explore daily values when preparing for rare and uncertain future events under various hazard conditions. The overview and structure of the two workshops can be generalized in Figure 3.4.

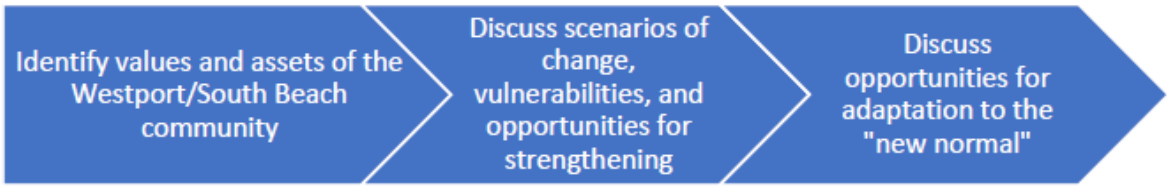

Figure 3.4. Workshop Approach and Structure (*27*)

During both workshops, participants were first asked to pinpoint Westport/South Beach assets that can support the community values. The reason of this approach is to think about changes when encountering with hazard condition as opportunities for mitigation strategies rather than threats. The community values refer to factors that makes Westport/South Beach a great place to live, work and play (*28*), such as nice neighborhoods, fishing, surfing and hunting. Assets also include specific places, groups or activities that support the values and are able to be mapped or associated with specific amenities, facilities, institutions, business, people or events. Next, the UW team from the studio shared information using maps with different potential hazard scenarios that Westport/South Beach are likely to face in the future, including flooding and coastal line change due to SLR, and the L1 and M1 tsunami scenarios. Two table groups of each workshop discussed the same set of SLR information while the other two tables each discussed a different earthquake scenario. Facilitators from each table group then asked participants to identify assets that would be lost in an event and think about the left assets that

could support community values. Finally, participants were asked to conduct brainstorming so as to figure out how the community could adapt to, prepare for, or take advantage of the "new normal" after the events. Figure 3.5 and Figure 3.6 below show the two workshop activities respectively. Results and findings from the workshop related to transportation are illustrated in Chapter 5.

Figure 3.5 "Partner workshop" on Nov 16, 2018

Figure 3.6 "Community Workshop" on Nov 17, 2018

3.2. WA National Guard Workshop – 6/2019

To learn the current needs and challenges of more coastal communities with respect to coastal emergency management, we participated in the 2019 National Guard/Emergency Management Division Tsunami Workshop at Seabrook, Washington. At the workshop, we presented our CSET projects as well as drone technologies to the workshop participants. The workshop participants mostly came from

coastal county emergency management and inner coastal emergency management representatives, including City of Aberdeen, City of Westport, Suquamish Tribe, Shoalwater Bay Tribe, Grays Harbor County, South Beach Region, Washington State Parks, Kitsap County, Pacific County, and Washington State Emergency Management. The workshop aimed to refine the Washington National Guard plan to assist coastal communities in a coordinated response under tsunami conditions.

During the workshop, attendees were firstly divided into five groups and were asked to discuss the current plans and challenges within their communities through a list of questions under a certain hazard scenario, a tsunami generated from Alaskan earthquake with a 3-hour evacuation time assuming no serious damage to the main roads/bridges. The workshop facilitator questions were based on the seventeen critical considerations (shown in Table 3.1) included in the Planning Considerations on Evacuations and Shelter-In-Place (*29*) of Federal Emergency Management Agency (FEMA). Based on the Comprehensive Preparedness Guide (CPG), such unique characteristics are required to be considered for state, local, tribal and territorial partners in planning for evacuation and/or shelter-in-place operations. Thus, the seventeen critical considerations are also selected as our key criteria when considering drone technologies under emergency situations.

Table 3.1 Critical consideration items

Critical consideration item	**Description**
1.Accessibility	Accessible resources, or accommodations and modifications for accessibility, ensure that evacuation and re-entry operations are inclusive of children and adults with access and functional needs.
2.Contraflow Lane Reversal	Contraflow lane reversal alters the normal flow of traffic (typically one or more lanes in the opposing direction on a controlled-access highway) to increase the flow of outbound vehicle traffic in an evacuation.
3.Correction Facilities	The Correctional System in the U.S. is comprised of incarceration within correctional facilities (e.g., jails, prisons) that detain individuals (inmates) involved in perpetrating crimes; community supervision of individuals conditionally released from prison (parole); or individuals who are under conditional liberty or provisional freedom (probation).
4.Domestic/Sexual Violence Shelters	Shelters that protects people who survived domestic and sexual violence.
5.Evacuation Clearance Time	The amount of time needed to move a threatened population to safety, given various factors such as the type of hazard or threat, level of notice of the incident, population characteristics of the area at the time, and public behavior. Clearance time is generally the time from the issuing of an evacuation order until the last evacuee exits a jurisdiction.
6.Fuel Management	Management of fuel in planning evacuation routes.
7.Homeless Populations	People who are homeless have limited resources to evacuate, stockpile food, store medications, and shelter in place.
8.Household Pets and Service Animals	During evacuation and re-entry operations, animals require tracking, embarkation, transportation, debarkation, care, feeding, husbandry/waste removal, veterinary support, and sheltering support.
9.Individuals with Access and Functional Needs	Individuals with disabilities, older adults, and individuals with limited English proficiency, limited access to transportation, and/or limited

Critical consideration item	Description
	access to financial resources to prepare for, respond to, and recover from an emergency.
10.Legal Requirements and Authorities	Evacuation planners should review all legal requirements and authorities during the planning sessions.
11.Mass Care Services	Mass care of instant and long-term evacuee support.
12.Population Assessment	Immediate assessment of evacuee population.
13.Terminology Used in Public Messaging	Concise, accurate, accessible, and understandable message for critical aspects of evacuation action.
14.Tourist Populations	Tourist population evacuation.
15.Tracking	Tracking of the movement of evacuees, animals, luggage and durable medical equipment.
16.Traffic Management	Effective traffic management for community evacuation.
17.Zonal Approach/Methodology	Zone assessment and identification and zone-based evacuation for the most vulnerable areas.

CHAPTER 4. ONLINE SURVEY

To further explore the current challenges, issues and needs in Washington RITI communities and identifying possible drone applications, we designed an online survey. The survey was conducted using the snowball sampling process. We first sent out questions to community representatives including National Guards, City of Westport, Grays Harbor County, Westport, South Beach Region, Washington Emergency Management Division, Shoalwater Bay Tribe, Quinault Indian Nation and Washington State Parks. Then we asked each participant to help share the questions with their colleagues and representatives from other RITI communities.

The survey begins with a general background introduction of the CSET project and an overview of the survey. To help participants better understand our questions and the drone technology, we provide a 10-min slide for a brief overview of drones, including their technology, applications, pros and cons as well as a proposed pilot study using drones for medical deliveries. Survey questions are divided into three parts: community challenges and needs as well as drone applications under emergency situations, current challenges and opportunities for drone application under daily usage, and the participants' information. The first part of the survey is based on the previous outreach activities, which found that one of the critical challenges for most coastal RITI communities is the lack of complete hazard mitigation planning and related strategies. Hence, questions on the first part are related to emergency plans for major hazards (tsunamis, earthquakes, severe storms or landslides), including the current challenges during evacuation, participants' views on application of emerging technologies such as drones for emergency conditions. The second part of the questions focuses on the current challenges and opportunities for daily usage of drones. The aim of this part is to identify possibilities of using drones during daily life. For instance, helping the fire department to check the fire situation, deliver and drop lifebuoy to save people, etc. Such daily usage not only increases the flexibility of drone application, but also provides more practice opportunities for drone operation to ensure a reliable and sustainable preparedness under emergency situations. The detailed survey questionnaire is provided in Appendix C. Major findings from the online survey are provided in Chapter 5 below.

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CHAPTER 5. RESULTS AND RECOMMENDATIONS

5.1. Outreach Activity Findings

This section summarizes the findings from the two workshops. We learned specific transportation and traffic safety needs and challenges through the Westport/South Beach workshop considering natural hazards in Westport, which also reflects similar requirement and issues in other coastal communities. To help better the transportation condition when facing SLR, tsunami, etc., we came up with multiple recommendations to resolve/eliminate the current issues. Apart from the transportation realm, we also embraced a better understanding of the current state, challenges and issues of the coastal emergency management from the WA National Guard Workshop which focused on the distant-sourced tsunami. These two workshops both helped us to stretch our thinking of the possible realm for drone applications.

5.1.1. Transportation and Traffic Safety in Westport

As mentioned in Chapter 3, the key challenge ahead of Westport is the lack of hazard mitigation plans to ensure the sustainability and resilience of the city. The executive summary of Westport Coastal Resilience Report based on the two workshops is displayed in Appendix D. Transportation and traffic safety in this sub-section mainly focuses on the emergency condition. Through discussion with citizens and community representatives in the workshops, the basic needs regarding transportation can be generalized as: more reliable and safer transportation facilities along evacuation route, a sustainable emergency plan of traffic management during evacuation and public education of disaster evacuations. Besides, telecommunication is highly linked with the transportation and is also the essential element for community connectivity. Based upon the community inputs, review of previous case studies and county hazard mitigation plan (*30*), detailed recommendations with respect to transportation and telecommunication improvements are shown in Table 5.1; more detailed findings related to transportation and telecommunication from the workshop can be found in Appendix E.

Table 5.1 Recommendations of transportation and telecommunication for Westport

	Strategies	**Hazard Mitigation Benefits**	**Co-Benefits for Community Values**
County Hazard Mitigation Plan	Provide education and training of evacuation information (e.g., evacuation route, ham radio operations) for local residents, students and employees in Westport	Increase Public knowledge of evacuation	• Promote neighborhood social ties
	Include support/backup from Fire, Police, Coast Guard and EMS in transportation management	Complete and clarify the responsibility of each department	• Clarify the duty and correlation of each department during emergency event
	Explore increasing capacity, reliability and geotechnical strength of existing key	Increase the reliability of the current evacuation route	• Increase the resilience and sustainability of the transportation infrastructure

	Strategies	Hazard Mitigation Benefits	Co-Benefits for Community Values
	evacuation and access routes (e.g. Elk River bridge)		
	Make telecommunication access more robust in the event of cellular disruption during disaster (Low-power FM radio, ham radio, Wi-Fi direct/WMN)	Ensure basic telecommunication functions during disaster	• Better wireless connection in Westport • Promote neighborhood social ties • Enhance telecom technology literacy among community members
	Explore ferry routes to Ocean Shores, Hoquiam and/or Aberdeen	Additional evacuation options for climate change, erosion, tsunami, earthquake, flood	• Greater connectivity to other Grays Harbor communities • Tourist and recreational attraction • Increased diversity of port function
	Arrange emergency/auxiliary service by neighboring upland air field in Grayland	Additional evacuation and supply option for tsunami, earthquake, flood	• Increased accessibility for possible new upland development
Community Input	Relocation of airport to upland site in Grayland	Improve the sustainability and resilience of the airport when facing climate change, erosion, tsunami, earthquake, flood	• Improve the traffic connection (e.g., new route/trail will be built towards the airport)
	Use 'hovercraft' for ferry evacuation to prevent stranding in shallow area	Safe, smooth and efficient ferry evacuation during tsunami, earthquake and flooding	• Possible increase in tourism • Diversity in transportation modes
	Establish 600 MHz LTE to increase LTE coverage and capacity; lay the foundation for 5G to increase the network quality	Improve the reliance and quality of telecommunication during disaster (tsunami, earthquake, flood)	• Increase the quality of services and enhance the signal of the cell phones for daily usage
	Apply HughesNet.com as satellite (Gen 5 satellite system) internet for telecommunication	Ensure basic telecommunication with satellite during disaster	• Increase the quality and resilience of satellite-connection
	Establish evacuation plans for elder/ADA people, in coordination with enhanced public transit	Ensure the safety of the elder/ADA people during disaster	• Diversify transportation service in Westport (e.g., shuttle, bus)
	Road re-engineering for current key evacuation and access route. (e.g., Montesano St)	Improve the sustainability and resilience of the road when facing climate change, erosion, tsunami, earthquake, flood	• Mitigate traffic congestion
Other Cases/Practices	Provide education and training of evacuation information (e.g., evacuation route, use of ham radio, LPFM radio) for local residents, students, employees and vulnerable population (the	Increased awareness from people in Westport of the evacuation information to ensure their cooperation during tsunami, earthquake, flood evacuation as well as their safety	• Promote neighborhood social ties • Improve community inclusivity

	Strategies	Hazard Mitigation Benefits	Co-Benefits for Community Values
	elder, ADA, tourists, non-English speaking natives)		
	Mobilize Ham Radio network for communication between Westport and state/county/neighbor cities in the event of cellular disruption	Ensure communication with places outside Westport during earthquake, tsunami (sending SOS message, asking support request from state/county/neighbor cities)	• Enhance regional and global connectivity • Provide outlet for or training in technical expertise
	Explore establishing LPFM Station	Provide disaster warning information and maintain broadcast function within Westport during earthquake, tsunami and other events of cellular disruption	• Enhances community identity and strengthens community relations • Provide outlet for or training in technical expertise
	Explore applicability of mobile mesh networks, direct or ad-hoc Wi-Fi and other off-grid networks for smartphones and personal computers, such as Sonnet, WiFi-Opp, etc.	Provide person-to-person communication within Westport during earthquake, tsunami and other events of cellular disruption	• Improve the network quality and service • Promote the development of e-commerce
	Use telecommunication systems to participate in regional telehealth programs	Ensure a reliable telemedicine system during tsunami, earthquake, flood	• Improve regular access to healthcare

5.1.2. Learning from WA National Guard Workshop

When considering community emergency management for evacuation and shelter-in-place protective actions in the emergency plans, the critical considerations (Table 3.1) became one of the crucial references that local agencies can provide. We learned the general community concerns through communications with coastal emergency management representatives from cities, counties, the region and the state and by reviewing the meeting notes to answer the critical item-based questions. Although emergency preparedness varies in different communities regarding evacuation facility, warning sirens and backup communication devices (such as ham radios), we noticed that there are many common challenges that all participating communities encountered: 1) Limited coverage when broadcasting the warning message: It is difficult for communities to reach out to all the people, especially for tourists along the beach and the homeless population. 2) Trigger to call for an evacuation: Communities are struggling with the time for evacuation since there is no certainty that a strong tsunami is coming which is necessary for evacuation when the tsunami siren is first triggered. 3) Search and rescue for the vulnerable population (non-English speaker, the elder, the disabled, hospital population, homeless population): Instant search and rescue for vulnerable populations are often impossible during/after the tsunami. 4) Transportation infrastructure concerns: For some counties, the critical egress route is unique, based on single highway/bridge and is under risk when a natural disaster happens. 5) Traffic management: Although there is a plan for contraflow lane reversal during the evacuation, there would be a concern of traffic mess considering people driving back for their families. 6) Medical supply: Compared with food supply that can be supported by neighborhood, medical storage is often inadequate after the disaster. How to instantly send out medical supplies, especially for vulnerable

populations is still under discussion. Faced with such challenges, drones are able to assist under certain scenarios. To further explore the possible drone applications based upon the identified challenges, we conducted an online survey to learn community perspectives toward drone applications

5.2. Online Survey Results

As a result of the snowball sampling process applied to the online survey, the number of survey responses are still rising. Here, we present some preliminary results based on our current participants. Answers may vary in communities based on their cultural, geographic, natural and economic conditions. To protect their privacy, we anonymously summarized the findings. One tribal community with warning sirens mentioned they have a drone from their Environmental Protection Department, and they are considering using drones for visual assessment of their current transportation infrastructures to ensure their reliability. However, evacuation problems are still critical with respect to spread warning message to the elders and the disabled. Half of the town is located on an old marsh where liquefaction becomes the big issue and there is only one egress road along the base of a hill by the sand dunes. Damaging the road would cut off the connection with the outside. The community is also considering using drones for disaster response in the future, while one of the barriers to utilizing drones is the necessity of developing related policies and procedures as well as being familiar with their usage. Although representatives from a region that covers two counties have considered using drones for disaster management, they identified the cost of drone technology as the major barrier. For spreading the warning message, one of the critical challenges is to ensure the same message is delivered as other local jurisdiction.

However, from the perspective of the state, they are not considering using drones into disaster response due to its cost, and the possibility of pushback from senior management or anti-tech types, storage issues, needs for training as well as privacy concerns from the public. For sending out warning messages, the largest barriers for the state are the communication networks (“specifically state/local conference calls and other human-department means of passing word which cause errors”) and public preparedness/education since many citizens are not clear if they are living in the tsunami zone or not.

Among all the responses, the drone application for daily use has been confirmed for transportation, photography and infrastructure monitoring. All participating communities mentioned the difficulty to reach out/search and rescue the vulnerable population and emphasized self-reliance. It is believed that under certain scenarios, drones can help to mitigate such issues since it is more flexible to operate for monitoring as well as delivering goods. Next, we provide recommendations of drone applications based on the above findings.

5.3. Recommendations of drone applications

Based upon the results from the two workshops and the online survey results, we proposed drone applications (Table 5.2) for three scenarios with possible limitations, determined by the 17 critical consideration items for emergency management. The three scenarios are: 1) tsunami generated from distant resource with a 3-hour evacuation time window and no main route damage (referred by WA National Guard Workshop tsunami scenario); 2) Tsunami generated suddenly, with limited evacuation time (less than 20 minutes) and under the risk of route damage; and 3) Normal situations, i.e., considering drones for daily usage.

Table 5.2 Proposed Drone Application under Different Scenarios

Order number	**Critical considerations**	**Scenario 1. Possible drone application for specific condition (Tsunami generated from distant resources; with 3-hour evacuation time and No main route damage)**	**Scenario 2. Possible drone application given uncertainty (Tsunami generated suddenly; with less than 20-min evacuation time and under risk of route damage)**	**Limitations**	**Scenario 3. Possible drone application for everyday use (not consistent with the critical item)**	**Agreed ratio of proposed drone application for daily usage based on survey results**
1	Accessibility	When Siren is triggered, spreading warning message/evacuation plan (in multi-language) using drones to non-English speaking area.	Spreading warning messages for 'inaccessible' area where people are more likely to miss the warning message, for instance, the beaches.	Flight regulations*, bad weather*, limited flight time*.	Transportation (traffic flow/accident monitoring)	100% (agreed)
2	Contraflow Lane Reversal	During the evacuation, using drones for monitoring the traffic to handle any emergency situation (e.g., car crash, transportation construction damage).	Drones can be operated to guide evacuees to the nearest vertical evacuation facility/higher and safer ground.	Flight regulations, bad weather, limited flight time.	Search and Rescue (e.g., help Police find missing people)	66.7%
3	Correctional Facilities	Assist with city/county evacuation plan for facility inspection, search and rescue.	-	Flight regulations, bad weather,	Photography (photographing for surfers, swimmers	100%

				limited flight time.	and touring advertisement).	
4	Domestic/Sexual Violence Shelters	When Siren is triggered, drones can spread warning message/evacuation plan (in multi-language). Drones can also be applied for searching and rescuing, deliver food and medical supplies for people in the Shelter after the events.	Drones can be applied for searching and rescuing, deliver food and medical supplies for people in the Shelter after the events.	Flight regulations, carry limitation, bad weather, limited flight time.	Infrastructure monitoring (e.g., construction inspection, victim monitoring. fire monitoring).	100%
5	Evacuation Clearance Time	Drones can be dispatched during the 3-hr warning time to save prioritized place (near ocean area). It can be used for spreading warning message, guiding evacuation, and evacuation monitoring (for instance, help to check the road chock point with the police to ensure it is not clogged).	Drones can be applied for search and rescue after the tsunami.	Flight regulations, bad weather, limited flight time, carry limitation*, conflict concern*	Telecommunication (e.g., Device inspection)	66.7%
6	Fuel Management	-			Good delivery	66.7%
7	Homeless Populations	Search and rescue during/after tsunami and supply delivery, cooperate with the organization who help to evacuate homeless people.	Similarly as the left.	Flight regulations, bad weather, limited flight time		

8	Household Pets and Service Animals	If county has confirmed service animals and has evacuation plan for them, cooperate with the county. Otherwise, animals can be rescued during the search and rescue process by drones.		Flight regulations, carry limitation, bad weather, limited flight time.
9	Individuals with Access and Functional Needs	Cooperate with city/county breakouts and plans, drones can be dispatched for supply delivery, including medical care and food. For health care place, drones may also be needed for searching and rescuing after the tsunami, besides, for communication between neighborhood zones, drones can be useful as a link hub when current telecommunication systems is damaged.	Similarly as the left	Flight regulations, carry limitation, bad weather, limited flight time, conflict concern.
10	Legal Requirements and Authorities	-		Drones-related legal regulation for emergency situation needs to be checked with Washington State Emergency

				Management Agency (WSEMA).
11	Mass Care Services	Drones can be used for post-disaster. First, checking the telecommunication system, if the communication system is robust, connect with counties/tribes/cities about the supply. Cooperate with goods delivery, especially for some inaccessible areas after tsunami. If the telecommunication system is damaged, using drones for building up the telecommunication system and check if goods supply is needed.	Similarly as the left.	Flight regulations, carry limitation, Conflict concern, bad weather, limited flight time.
12	Population Assessment	Drones can be applied for population assessment after the events when tracking the evacuation and searching and rescuing, especially for some inaccessible areas.	Same as the left	Flight regulations, Conflict concern, bad weather, limited flight time.
13	Terminology Used in Public Messaging	-		
14	Tourist Populations	Identifying the area with tourists, dispatch drones to spread warning message before tsunami. Using	Similar as the left.	Flight regulations, carry limitation, bad weather,

		drones for search and rescue after tsunami.		limited flight time.
15	Tracking	Using drones for evacuation monitoring, assist checking the road situation (accident, road/bridge damage) for rerouting and evacuation guidance with police.	Similar as the left.	Flight regulations, carry limitation
16	Traffic Management	For evacuation, drones can be dispatched for guiding the evacuation area or the place for ferries and in the meantime, drones are available for traffic situation monitoring.		Flight regulations, carry limitation, limited flight time
17	Zonal Approach/Management	-		

* Flight Regulation: authorized airspace must be checked before the flight.
* Carry limitation: for commercial drones, the weight should be less than 55 pounds, and weight limitation must also be checked for special drones to confirm a stable flight.
* Limited flight time: for most commercial drones, the flight time is limited between 20 minutes to 1 hour due to battery life.
* Bad weather: performance of drones will be reduced during atrocious weather (such as strong wind, heavy rain, extreme temperature).
* Conflict Concern: for search and rescue and goods delivery during/after disasters, there exists airspace conflict concerns with helicopters.

CHAPTER 6. CONCLUSION AND FUTURE STUDY

RITI communities in Washington face multiple challenges considering transportation and traffic safety. Through our outreach activities and online survey with coastal communities, this project identified that one of the critical challenges of such communities is the insufficient planning for hazard mitigation. The drone technology, regarded as one of the advanced technologies in recent years, has the ability to help improve the safety, resilience and sustainability of the communities. The goal of this study is to understand the safety needs of the targeted RITI communities, share drone technologies with the communities and assist in improving, but not constrained to, transportation. One of the major outcomes of this study is the draft Comprehensive Plan Update with the recommended transportation and telecommunication events, which is currently pending approval by City Council of Westport (*23*). In particular, suggestions for drone applications have been introduced in the chapter on "Transportation, Circulation, and Telecommunications Element," Policy #15, p.28, emphasizing that "The City should review applicable regulations to allow use of drones for emergency preparedness and management, including as enhancements to situational awareness (e.g. detecting and reporting traffic conditions, condition of roads and bridges, people in need of assistance, and aids in finding and following optimal evacuation routes), delivery of emergency supplies, telecommunication, etc." This represents a significant advance in local rural governance for traffic safety, hazards-resilient transportation, and emergency management related policies.

With the snowball process of sampling for our online survey, it is believed that we can receive increasing feedbacks from more and more communities and our research will continue. Moreover, interviews are planned for further contact with communities who are interested in using drones to discuss the possibility of pilot studies. The next goal of this research is to conduct a pilot study of using drones to improve traffic safety in RITI communities, and to further explore the specific drone applications and actual obstacles within the RITI communities.

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APPENDIX A: UAV (DRONES) TECHNOLOGIES

Power: batteries/gas/diesel [1]

- **Batteries**
  The most common power of drones (~ 96%[2]), mostly they are powered by lithium-polymer batteries (LiPos)/ Lilons, mostly lasts about 20 minter-flying depends on the load. However, new battery technology are in progress such as Li-S(Surfur) for higher energy density as well as Li-SOCL2 (2 times higher than LiPo) and Li-air(7 times higher than Lipo).

- **Hydro fuel cell**[2]
  Known as a cleaner power, with no direct pollution, no sound and extremely powerful source. Many companies are joining researches, productions for business and military usage.

- **Petrol. Kerosene, Methanol, Ethanol, LPG Propane**[2]
  Petrol-powered solution is also available for the drones with a remarkable flight performance, UAV factories 'Penguin C' fixed-wing is able to fly over 20 hours with one full tank of gasoline. This energy promise a reliability of flight combining high mass-specific energy [Wh/kg] and high volumetric-specific energy [Wh/l].

- **Other technology**
  - Solar Power: requiring large wings while a sound power for range-extenders for multirotor drones. Also there is power research in Solar Hybrids.
  - Tethered: allowed 'unlimited' flight time in a small radius – perfect for surveillance and reconnaissance(see Figure 1)
  - Laser transmitter: developed the UAV power-link tech (power beams drones equipped with a laser receiver – laser-based charging system) promising continuous flight.

Figure 7. Tethered drones

Sensing technologies

Drone technology includes Lidar, Photogrammetry, 3D mapping and Thermal sensors for terrific use.

- **Time of Flight Camera**[3]
  'ToF camera sensors can be used for object scanning, measure distance, indoor navigation, obstacle avoidance, gesture recognition, tracking objects, measuring volumes, reactive altimeters, 3D photography, augmented reality games and much more.'

- **Lidar**[4]
  (definition: Light detection and ranging, is a remote sensing where the environment is scanned with a pulsed laser beam and the reflection time of the signal from the object back to the detector is measured).

  UAV Lidar Sensor is used for: drones collision avoidance, ground and above ground imagery, structural inspection, night/low contrast/shadow situation scanning.

  Lidar UAV application example: Corridor mapping: power line, railway track, and pipeline inspection.

- **Thermal Vision Camera**[5]
  Application for detecting heat coming from almost all objects and materials turning them into images. Important factor to read thermal image: emissivity. Highly used for mining industry. It is easy to use but the user should be trained for the image interpretation, temperature depends, able to detect object with dust/smoke situation and fog/rain however is affected by atmospheric conditions.

- **Related equipment**
  - **Gimbals**[6]

    The essential part for capturing great aerial film, photography, 3D mapping, lidar and other driven imagery.

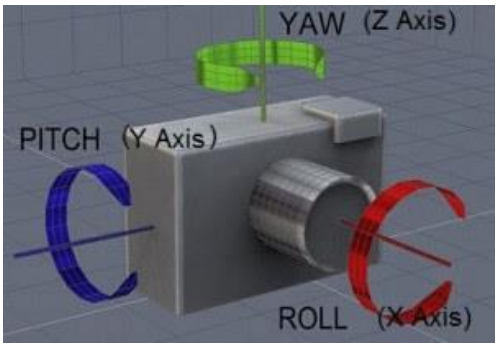

Figure 8. Drone Gimbal Axis Movement

Advantages

- **General Benefits**
  Cheap, Efficient and easy to use:
  UAV saves money by the expense for manpower and fuel. Besides, the accurate view can be promised by drones, it is easily deployable for acquiring view of a hard-to-reach area as well as a great tool for surveilling, searching and rescuing with less cost. Apart from that, it is user-friendly with minimal experience requirement. [7]

  Precision[8]
  With GPS device, UAV is available to be programed and maneuvered accurately to precise locations. Which is highly valued for precision of agriculture to spray fertilizer and insecticide, identifying weed infestation and crop health. Saving both time and cost.

- **Drones Delivery (comparing with trucks)**

  Flexibility

  Unlike trucks facing issues in traffic jam with limited route to choose and conflict from other vehicles, bikers and pedestrians. Space-friendly, no parking issues. Higher safety proved for pilot comparing with drivers..[9] Improve time management as well as energy conservation.

  Environmentally friendly

  Driven by battery power, delivery of drone seems more green with no tail gas generated from trucks which have a negative impact for the environment and human health like COx and NOx.[10]

Limitations:

Carry limitation

When it comes to heavy freight, there is no strengthen for drones, apart from that the more weights a drone carry results in higher cost:" commercially available drones can carry a range of weights from 20 to 220 kg. However, this distributed payload capacity also comes with a distributed price range – from the $17.99 Cheerson CX 10, to the $17,495 Freefly Alta 8."[11]

Invasion of Privacy

The operator of drones can use their drone trespassing others' property which is frightening and distressing. It is concerned that some people might use drones to spy and get private information without permission.

Accidents

The concern of injuries of persons or damage of hitting from drones falling due to user's inexperience and bad weather condition.

Limitation for flight condition

Both very hot and cold environment will have negative impact for drones which require harder working for motor in hotter environment and Lipo battery decrease for colder environment. Unstable flight of drones during rain, sleet or snow day, hard for positioning of drones with higher wind speed. [12]

Legal issues

FAA has set rules for the usage of drones in private and professional while grey area still exists and laws varies from different states.[7]

Regulations

- **Registration[13]**

FAA(Federal Aviation Administration) requires all drone owners to register each drone that is purchased weighing between 0.55lbs to 55lbs. If not registered as required, drone owner will be subject to civil and criminal penalties defined in the U.S. Government drone regulation terms. Two registration for recreational use and commercial for drone which all required the user name, address, phone number, drone information (covering manufacturer, model, serial number, retail name). Appendix A shows the acknowledge of safety guidance from FAA

- **Rules for commercial use of drones[14]**

  Commercial use of UAS(Unmanned aircraft system)

  - Selling photos or videos taken from a UAS
  - Using UAS to provide contract services, such as industrial equipment or factory inspection
  - Using UAS to provide professional services, such as security or telecommunications
  - Using UAS to monitor the progress of work your company is performing Applications:

Remote Pilot requirements:

- Must be at least 16 years of age
- Must hold a remote pilot airman certificate with a small UAS rating or be under the direct supervision of someone holding a remote pilot airman certificate
- Must pass the applicable Transportation Security Administration (TSA) vetting
- UAS requirements:
- Must weigh less than 55 lbs.*
- Must undergo pre-flight check by remote pilot in command (a.k.a. you or the person supervising the operation)
- Location requirements (click here for more details on these airspace classes):
- Operations in Class B, C, D and E airspace are allowed with the required Air Traffic Controller (ATC) permission
- Operations in Class G airspace are allowed without ATC permission

Operating Rules:

- Must fly under **400 feet above** ground level (AGL) or, if flying at an altitude higher than 400 feet AGL, stay within 400 feet of a structure
- Must keep the UAS in sight (i.e. visual line of sight), either by the remote pilot in command or a visual observer*
- Must fly during **daylight hours*** or civil twilight hours (30 minutes before official sunrise to 30 minutes after official sunset, local time) with appropriate anti-collision lighting
- Must fly at or **below 100 mph***
- Must yield right of way to manned aircraft*
- Must not fly over people*
- Must not fly from a moving vehicle unless you are in a sparsely populated area*
  (* f you want to operate UAS for commercial purposes outside of these rules, you may apply for a certificate of waiver. Link for application: f you want to operate UAS for commercial purposes outside of these rules, you may apply for a certificate of waiver.)

Available flying area
http://knowbeforeyoufly.org/air-space-map/

Application:

- **Search and rescue**

Drones is within consideration for assisting disaster management, application of UAV includes: acting as early warning systems, gathering information from disaster phase, re-establish the damaged or destroyed communication infrastructure, search and rescuing people, help assess damage as well as deliver supplies, speed up the inspections, etc.[15] Other research has discussed the drones usage for drowning[16], mountain search and rescues, locating victims and rescuing providers in a mountain environment, recent study has compared drone-snowmobile Techniques and Classical Line Search Technique (CTL) as two rescue techs.[17]

- **Transportation infrastructure monitoring / repair**

Several researches have discussed about the drone usage for transportation related project from civil construction monitoring to traffic volume data collection[18], one of the application for drones is to take photos, one joint project producing 3D BIM addressed that “Large areas can be surveyed

with the use of drones and fine details can be added from hand-held digital cameras or smartphones"[19]

- **Delivery of medical and other supplies (freight)**

One research discussed the possibility for package delivery with drones, with current battery technology, constructing a new network of urban warehouse or way station as support, it turns out that drones consume less energy per package-km than trucks however with additional warehouse energy required and the longer distance traveled will increase the life-cycle impacts greatly.[20]

- **Community Links(HUB)**

One research discussing a drone-based wireless power transfer anc communication platform has confirmed the ability to construct a low weight, easy to implement, commercially available drone basestation for data collection from remote sensor networks. However, as the flying duration is within 20 minutes, the signal coverage area is limited which requiring more advanced technology for drones in the future.[21]

Other*:

Before Public usage, drone are applied for military. The most popular drone for current market is DJL Phantom 3[3] ($125 - $999). Drones are also widely used for agriculture. Dronebase, the 'Uber' in drone service(link: https://www.dronebase.com/). "The number of hobbyist-owned drones will reach 3.6 million by 2021, more than triple the 1.1 million last year, the Federal Aviation Administration said in a report last week." [22]

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Appendix A.1 FAA Acknowledgments of Safety Guidance (Check All) *

I will fly for hobby or recreation ONLY
I will register my model aircraft
I will fly within visual line-of-sight
I will follow community-based safety guidelines and fly within the programming of a nationwide community-based organization
I will fly a drone under 55 lbs. unless certified by a community-based organization
I will never fly near other aircraft
I will notify the airport and air traffic control tower prior to flying within 5 miles of an airport*
I will never fly near emergency response efforts

New company with drone technology
http://about.att.com/innovationblog/cows_fly
https://code.facebook.com/posts/200887800439084/aquila-s-successful-second-flight-another-step-forward-in-bringing-the-world-closer-together/

https://www.dslrpros.com/sar-drones.html
https://www.dedrone.com/c/anti-drone-solution?gclid=EAIaIQobChMIquqBm4-a2wIVi8hkCh0LrAiOEAAYASAAEgI6-PD_BwE

https://kespry.com/solutions/insurance-roofing

https://www.amazon.com/Amazon-Prime-Air/b?ie=UTF8&node=8037720011
http://www.dhl.com/en/about_us/logistics_insights/dhl_trend_research/uav.html#.WwRzqkgvxPY
http://www.dhl.com/en/about_us/logistics_insights/dhl_trend_research/uav.html#.WwRzqkgvxPY

APPENDIX B: WORKSHOP REPORT FOR WESTPORT COASTAL RESILIENCE

Appendix A: Workshop Documentation

Recommendations for Westport's Comprehensive Plan Update

Prepared for the City of Westport, WA, by the University of Washington Urban Design & Planning Studio "Community Engagement for Coastal Resilience," URBDP 508B, Autumn 2018

UNIVERSITY of WASHINGTON

A Report based on Community Responses to Tsunami and Sea Level Rise Scenarios for purposes of Integrating the Grays Harbor County Multi-Jurisdiction Hazard Mitigation Plan with the City of Westport Comprehensive Plan

November 21, 2019

Table of Contents

List of Tables

List of Figures

1. Coastal Resilience Workshop Summary

1.1. Document Overview

This document includes a summary and documentation of two workshops held in Westport on Friday and Saturday, November 16 -17, 2018. It constitutes an appendix to the University of Washington (UW) Urban Design & Planning 508B Studio report of Recommendations for the City of Westport's Comprehensive Plan Update (Recommendations Report). UW faculty and students and members of the Westport Steering Committee or the project (Steering Committee) co-designed the workshops to engage partners and community members in hazard resiliency planning and gather input to inform the recommendations made in the Recommendations Report. This Appendix includes a summary of the workshop outcomes, as well as documentation from the discussions that took place both days. The workshops served as the primary opportunity for the UW team to gather input from a diverse representation of partners and community members, building on information gathered during previous meetings, site visits, and interviews.

1.2. Summary of Workshop Approach and Outcomes

This section provides a brief summary of the approach used during the two workshops and overarching themes that emerged from discussions. The two workshops consisted of (1) an invitation-only "Partners Workshop" for local leaders in planning and emergency management on Friday, Nov. 16, and (2) a "Community Workshop" widely advertised and open to the general public on Saturday, Nov. 17. More detail on the approach and outcomes for each day is provided below. Both workshops focused on the theme of making hazard mitigation more meaningful to the community and actionable in Westport and the larger South Beach area. Workshop goals included:

- Build on the community's already-significant accomplishments in preparing for a large earthquake and tsunami, including its construction of North America's first tsunami vertical evacuation structure;
- Help the City update its Comprehensive Plan Update, to include hazard mitigation in a way that reflects Westport/South Beach values and needs;
- Raise public awareness of households' needs and means to be prepared for emergencies, and encourage a culture of community self-reliance and mutual help;
- Discover everyday value in preparing for rare and uncertain future events, based on the use of complex and evolving scientific knowledge about multiple locally relevant hazards.

Though there were some minor differences between the two days, the workshops drew from the same general approach and organization of activities and discussion sessions, outlined in Figure 9 below.

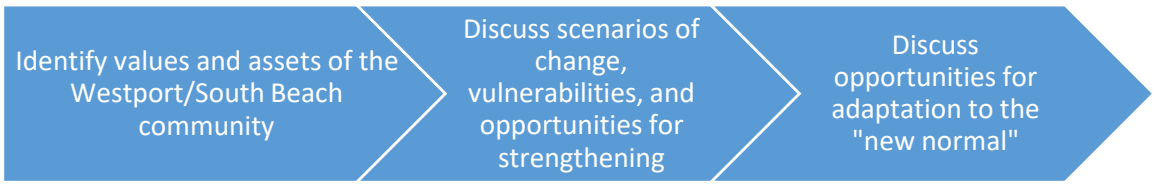

Figure 9. Overview of Workshop Approach and Structure

1.2.1. Values and Assets

In both workshops, participants first considered Westport/South Beach community values and then identified and located assets that support those values. This "appreciative inquiry" approach, rather than beginning with a focus on hazards and vulnerabilities, encourages participants to think about changes as opportunities rather than threats and helps them develop a holistic set of criteria to use in identifying hazard mitigation strategies.[1] Values were defined as: "what makes Westport/South Beach a great place to live, work and play?" Participants were encouraged to think of values as more general qualities, such as "I like how everyone knows each other" or "the fishing and hunting are really good around here; I can earn a living doing these things and feed my family!" They might be even more basic such as "good healthcare". Assets, on the other hand, were intended to consist of specific places, groups or activities that support these values and can be identified on a map or associated with particular amenities, facilities, institutions, businesses, people or events.

While the identified assets and values varied among days and discussion groups, many participants identified common themes. Table 3 below includes a summary of values and assets highlighted by workshop participants.

Table 3. Westport/South Beach Community Values and Supporting Assets

Values	Description and Supporting Assets
People are resilient	The people are hardworking, self-sufficient, innovative, resourceful and outdoor survivalists. The know how to fix boats, car, house, equipment, hunt, fish, and live outdoors.
Social bonds	People meet each other on the docks, at school events, at church gatherings or in the neighborhood. They help each other out and people have strong sense of belonging, community, and cultural identity here.
Education	The Westport Timberland Library and Ocosta School District are valued for providing education and communal space for children and families.
Naturally available foods	The ocean and forests surrounding Westport provide an abundant amount of fresh seafood, elk, deer, berries, and mushrooms for the community to fish, hunt, and collect freely with the right permits and equipment.
Natural resources for economic vitality	The scenic ocean views, local fisheries and aquaculture, and cranberry bogs are the heart of the economy in this area. Scenic ocean views drives tourism along the beaches and in the marina district. The local fisheries provide jobs for fishermen, and the seafood is processed in plants in the marina district. The fisheries also provide charter companies with tourists who want to do deep-ocean fishing. The cool climate and farmlands provide a place for cranberry bogs and a robust cranberry industry to thrive. Surrounded by the ocean, the city is an ideal place for a boating development industry.
Natural features for recreation	State and local parks and beaches provide excellent recreational space for hiking, running, walking, and site seeing. The ocean provides a place for swimming and surfing. These natural features enhance community health and well-being.

[1] An earlier version of the approach is discussed in Freitag, R. C., Abramson, D. B., Chalana, M., & Dixon, M. (2014). Whole Community Resilience: An Asset-Based Approach to Enhancing Adaptive Capacity before a Disruption. *Journal of the American Planning Association, 80*(4), 324-335.

Values	Description and Supporting Assets
Rural, seaside, and small-town local character	The area's rural character provides clean water and air which allow the natural features to thrive and enable people to enjoy the outdoors. The city feels quiet and relatively safe, there is minimal traffic, and the area is not densely populated. The downtown area has mostly local, non-franchised businesses and maintains a seaside character. People appreciate the quality of life here.
Public services	Local and regional public agencies support and enhance community safety and security.
Affordability and employment opportunities	Affordable housing and high-quality food in the area make it an attract place to live while enhancing quality of life. The natural resources (e.g., fishing, oyster, seafood processing, cranberry farming) and downtown businesses provide employment opportunities for residents of the region.
Historical features	The people of Westport are proud of their heritage and history. The Grays Harbor lighthouse and Westport Maritime Museum encapsulate these values.

Figure 10 shows community members and UW facilitators building a list of values and assets during the Saturday, November 17, workshop.

Figure 10. Values and Assets Brainstorming and Mapping Discussion

1.2.2. Hazards Scenarios

Following discussions of values and assets, the UW team shared information about different potential hazard scenarios that Westport/South Beach could face. The workshops focused on flooding and coastline change associated with sea level rise (SLR), as well as tsunamis and land subsidence associated with two possible scenarios of Cascadia Subduction Zone (CSZ) earthquake. In each workshop, one or

two table groups discussed the same set of SLR information, while two other table groups each discussed a different earthquake and tsunami scenario.[2]

The SLR information included projections for 2060, 2080, and 2100. Table 4 shows the SLR projections with different probabilities of coastal flooding for each time horizon.

Table 4. SLR Predictions and Associated Probabilities

Amount of SLR	2060	2080	2100
1 foot	11% probability	51% probability	77% probability
2 feet	0% probability	5% probability	27% probability
3 feet	0% probability	1% probability	5% probability

Source: table generated on 07/18/18 for the Washington Coastal Resilience Project, www.coastalnetwork.com/wcrp-documents.html

Both workshops also explored two near-source tsunami scenarios: one generated by a "medium" and "most shallow" Magnitude 8.9, or "M1", Cascadia subduction zone (CSZ) earthquake, which most resembles the last time a CSZ earthquake and tsunami occurred in 1700; and another generated by a "large" and "most shallow" Magnitude 9.0, or "L1", CSZ earthquake. Figure 11 shows how the M1 and L1 earthquake scenarios compare to other possible CSZ earthquake sources of tsunamis, in terms of: their magnitude (Mw); their depth below the ocean floor (most shallow, shallow, or deep); their likelihood of occurrence (i.e. if a CSZ earthquake occurs at all, what is the chance it will take one or another of these forms); and their associated amount (in meters) of uplift (red) or subsidence (blue) of the ocean bottom and land. Note that uplift and subsidence varies considerably at different distances from the fault offshore towards the land. (Contour intervals for uplift/subsidence are 3 meters, with reference to the tide level at Mean High Water.) These details of earthquake behavior are all very difficult to predict, not to mention the position along the 620-mile-long CSZ at which the next rupture might occur, and because they determine tsunami behavior at any one point on the coast, it is also difficult to predict *that* behavior, including the tsunami's time of arrival on the coast after the earthquake happens, the number and duration of waves, the depth and extent of flooding, the direction and speed of currents, etc.

Definitions and Acronyms

SLR = Sea level rise

MHW = Mean high water

CSZ = Cascadia Subduction Zone

L1 = Large and shallow magnitude 9.0 CSZ earthquake

M1 = Medium and shallow magnitude 8.9 CSZ earthquake

[2] Initially it was intended to have table groups rotate, "World Café"-style, at the end of the workshop so that most participants would have a chance to discuss more than one scenario, but there was not enough time in the schedule to allow that. However, each table reported out to the room, and this appendix and the Comprehensive Plan Update recommendations themselves represent a synthesis of the workshop discussions.

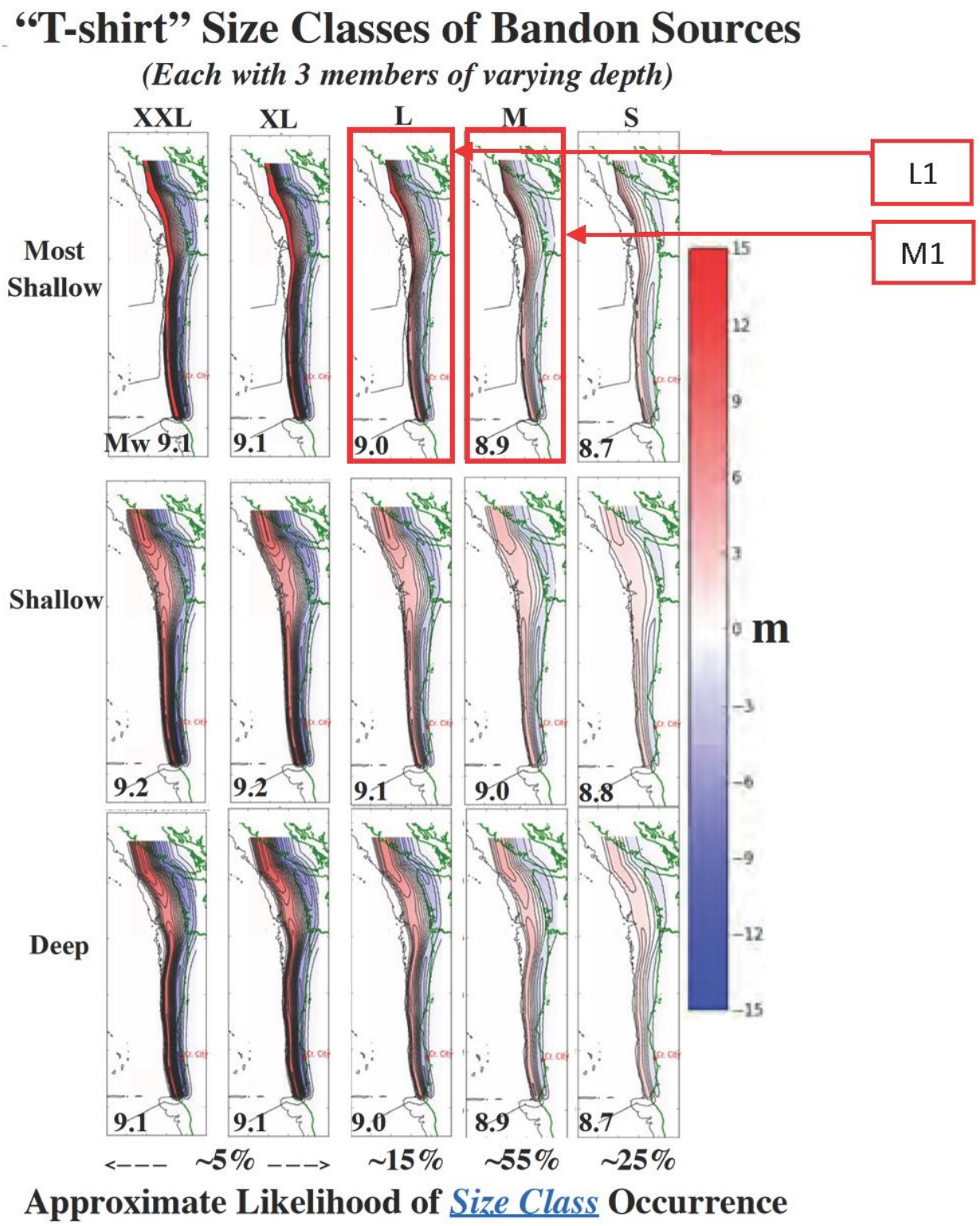

Figure 11. Suite of 15 Possible Cascadia Subduction Zone Fault Earthquakes. Source: Frank Gonzalez, based on a hazard assessment study for Bandon, Oregon. See Witter, Robert C, Yinglong Zhang, Kelin Wang, George R Priest, Chris Goldfinger, Laura L Stimely, John T English, and Paul A Ferro (2011):

Simulating Tsunami Inundation at Bandon, Coos County, Oregon, Using Hypothetical Cascadia and Alaska Earthquake Scenarios. DOGAMI Special Paper 43 (July 11): 1–63.

Presentation of these scenarios in the workshops emphasized that both earthquake and climate impacts modeling is probabilistic and uncertain, but it is based on an increasing amount of available historic data and sophistication of methods to analyze it. Not all possible CSZ earthquake scenarios were considered, nor were any distant-source earthquake-tsunami scenarios (such as the very large Alaska 1964 event). Still, working simultaneously with SLR and two near-source earthquake-tsunami scenarios enabled the participants to address both on-going, cumulative, and relatively more predictable if less severe changes (SLR) as well rarer, sudden, and less predictable but possibly more severe changes (earthquakes and tsunamis). Considering multiple scenarios has several benefits for the planning process, including:

- Helping to account for the uncertainty of future outcomes
- Encouraging forward-looking thinking beyond disaster response and survival, to mitigation, recovery and betterment
- Creating robust long-term strategies for land use and development, infrastructure and service investments, and environmental protection – i.e. strategies that work under multiple possible future scenarios of change
- Informing future decisions about prioritizing and implementing strategies

To inform discussion, the UW team developed several maps depicting flooding hazards and coastline change associated with the scenarios for both the Partners Workshop and the Community Workshop. For each map, the UW team developed a version showing the full peninsula, and a version showing Westport. There was one SLR map depicting the 1-, 2- and 3-foot rise in sea level shown in Table 4 (Figures 4 and 5; same map showing Westport and the peninsula).[3] Maps showing earthquake and tsunami hazards referred to both the "T-shirt sizes" of M1 and L1 earthquake scenarios depicted in Figure 11, but also referred to them in less specialized language, respectively: M1 = "Like the last time", i.e. what occurred in 1700; and L1 = "Maximum Considered" for official State emergency planning purposes. For each of these scenarios, the UW team prepared two types of maps: one type showing the inundation areas and maximum flooding depths over land during the first four hours following an M1 earthquake (Figures 6 and 7) and an L1 earthquake (Figures 8 and 9); and one type showing loss of coastal land due to earthquake subsidence following M1 (Figures 10 and 11) and L1 events (Figures 12 and 13). The flooding depth maps were used only in the Partners Workshop, which addressed both immediate tsunami response as well as long-term mitigation, recovery, and adaptation to possible "new normals"; the Community Workshop used only the subsidence maps as it focused primarily on anticipating these "new normals".

[3] Note that the maps shown in the workshop contained an error, by depicting what is actually a 5-foot rise in sea level as a 3-foot rise. See the Erratum at the end of this Appendix that shows the correct areas flooded at 1-, 2-, 3- and 5-foot rise in sea level (Figure 44). Given that the two time-horizons for which workshop participants chose to discuss SLR effects – 2060 and 2080 – involved only 0% and 1% probabilities of 3-foot sea level rise respectively, the impact of this error on discussion was probably negligible.

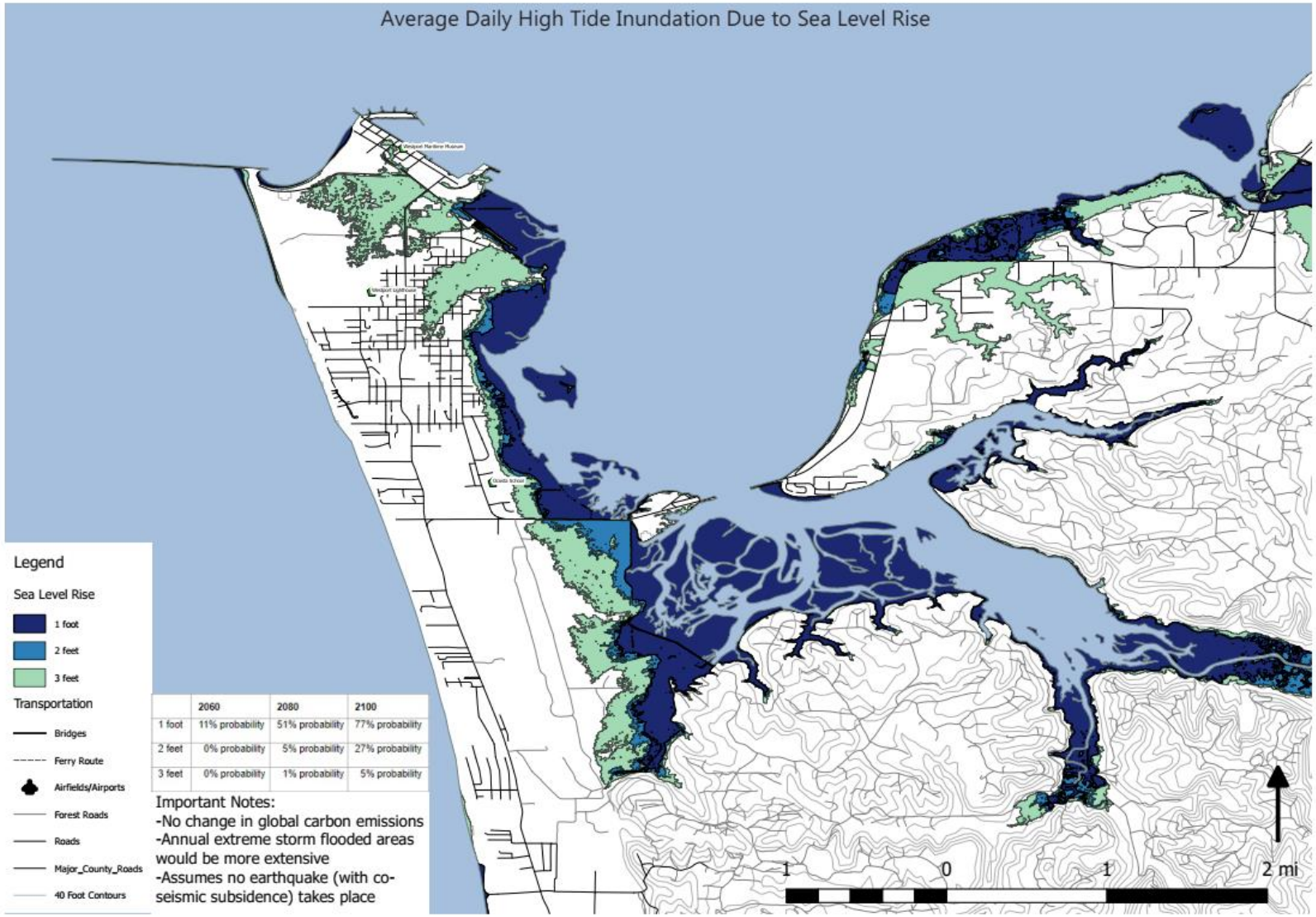
Average Daily High Tide Inundation Due to Sea Level Rise
Legend
Sea Level Rise
1 foot
2 feet
3 feet
Transportation
Bridges
Ferry Route
Airfields/Airports
Forest Roads
Roads
Major_County_Roads
40 Foot Contours
2060
2080
2100
1 foot
11% probability
51% probability
77% probability
2 feet
0% probability
5% probability
27% probability
3 feet
0% probability
1% probability
5% probability
Important Notes:
-No change in global carbon emissions
-Annual extreme storm flooded areas would be more extensive
-Assumes no earthquake (with co-seismic subsidence) takes place
1
0
1
2 mi

Figure 12. Regional Map of Average Daily High Tide Inundation under Different SLR Scenarios (1-3 feet)

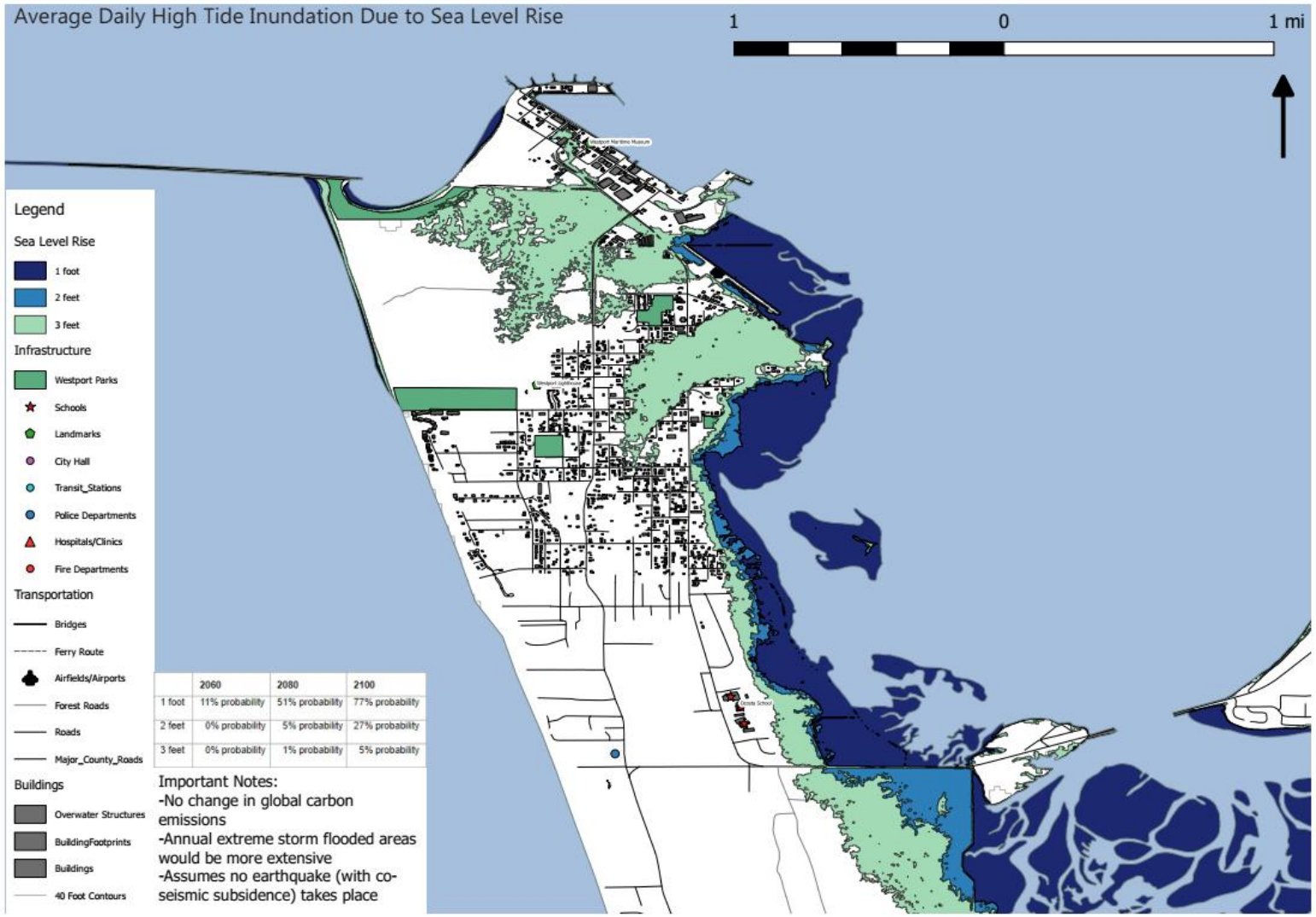

Figure 13. Westport Map of Average Daily High Tide Inundation under Different SLR Scenarios (1-3 feet)

)

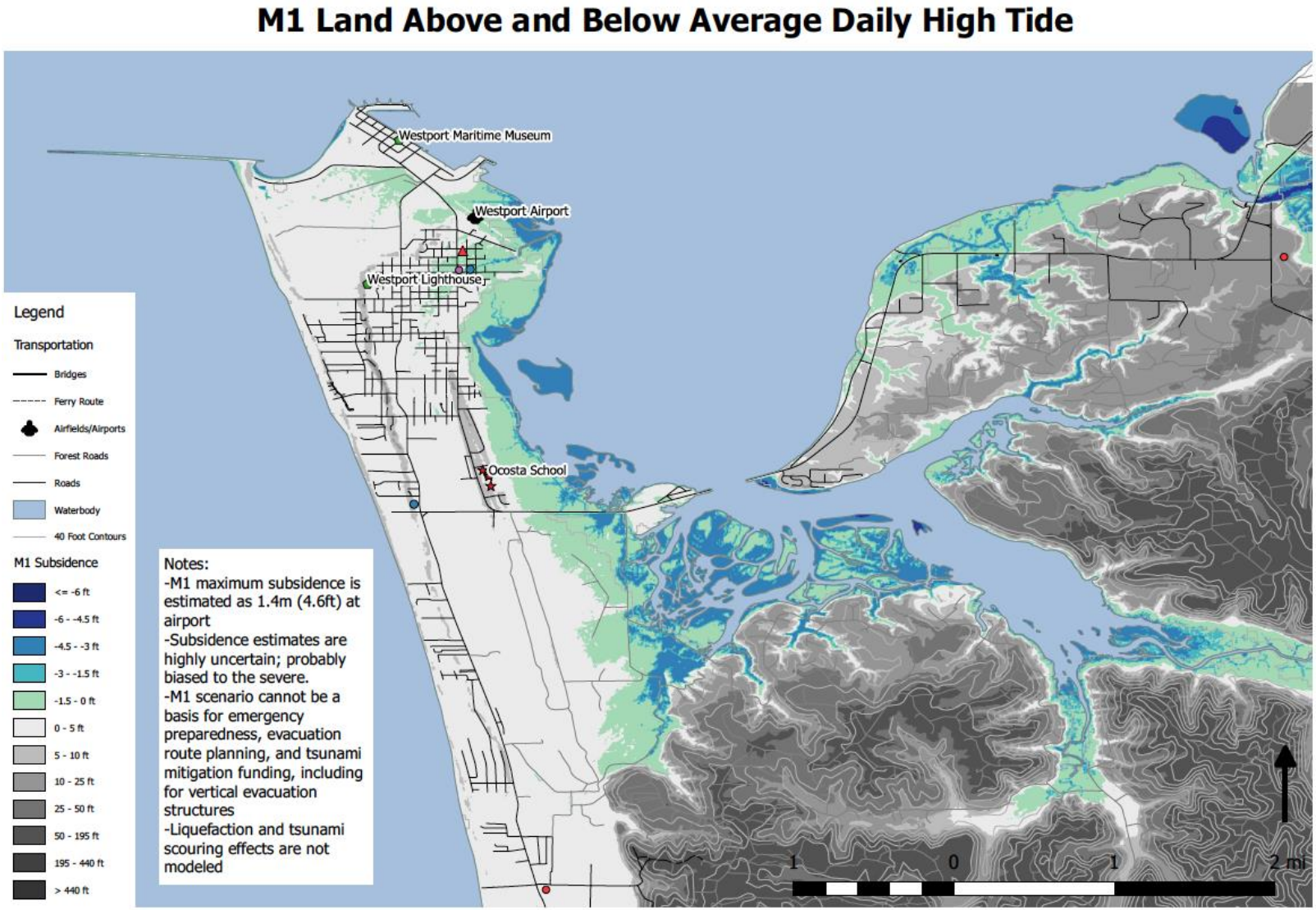

Figure 14. Regional Map Depicting Land Subsidence after an M1 Event

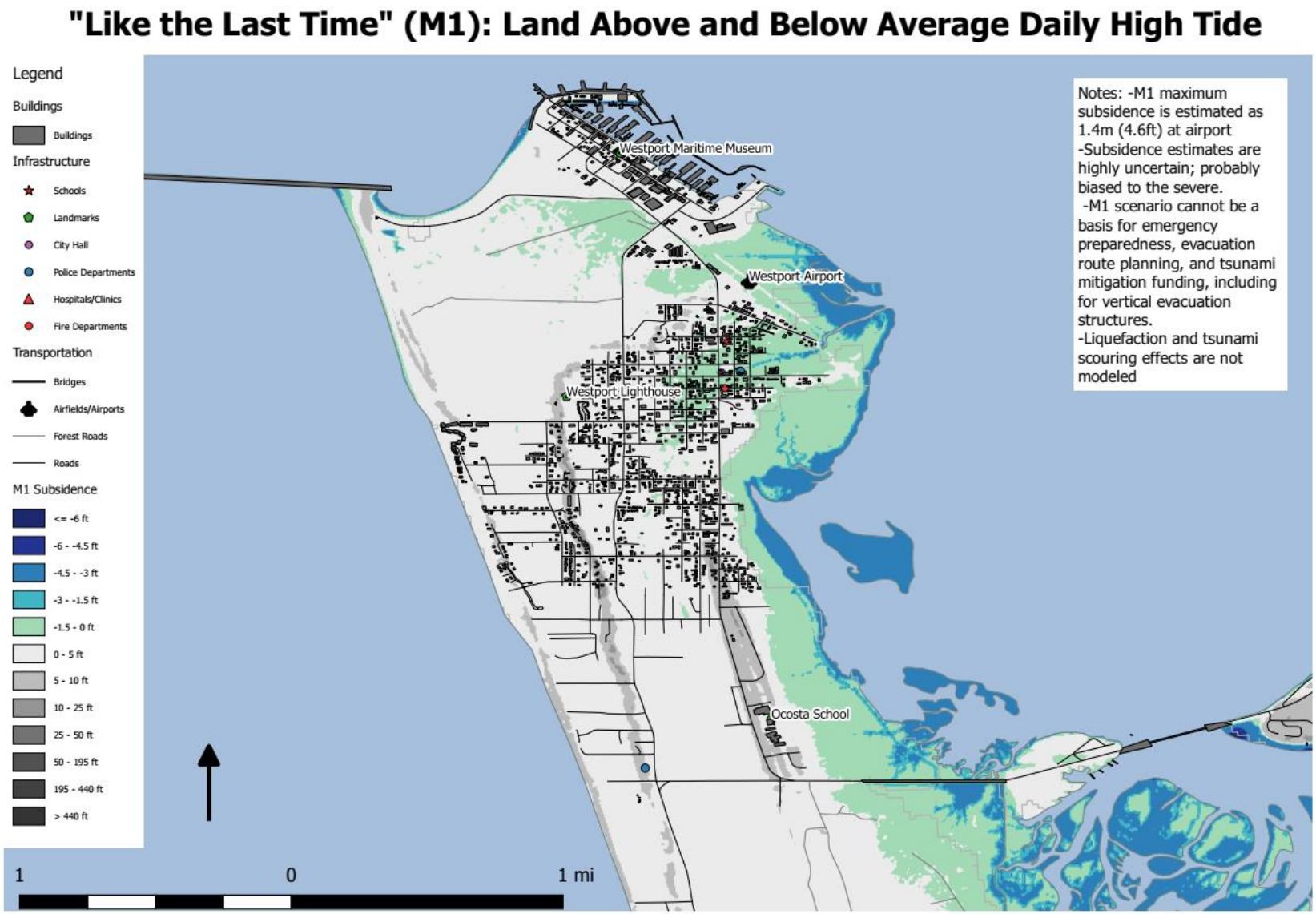

Figure 15. Westport Map Depicting Land Subsidence After an M1 Event

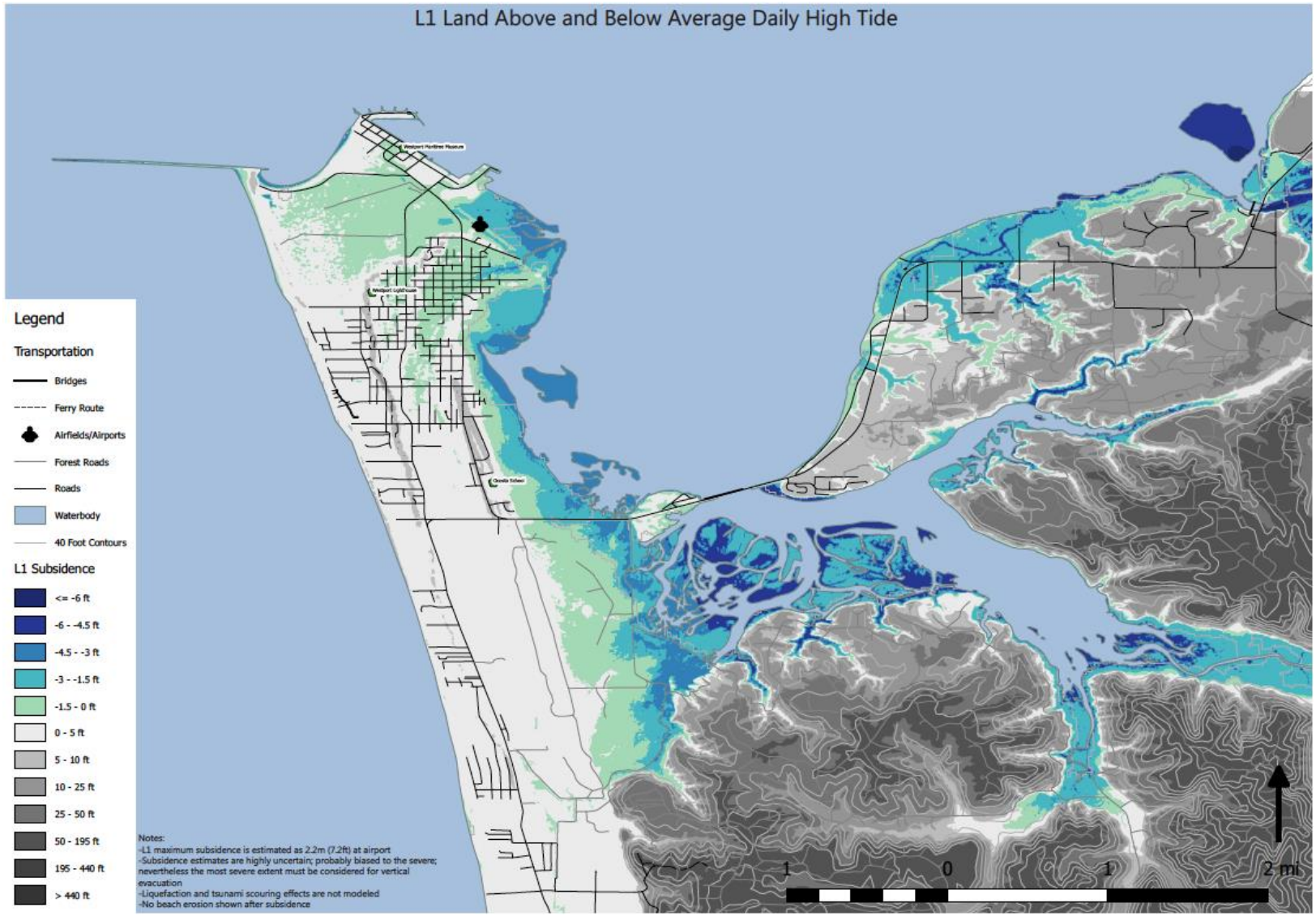

Figure 16. Regional Map Depicting Land Subsidence After an L1 Event

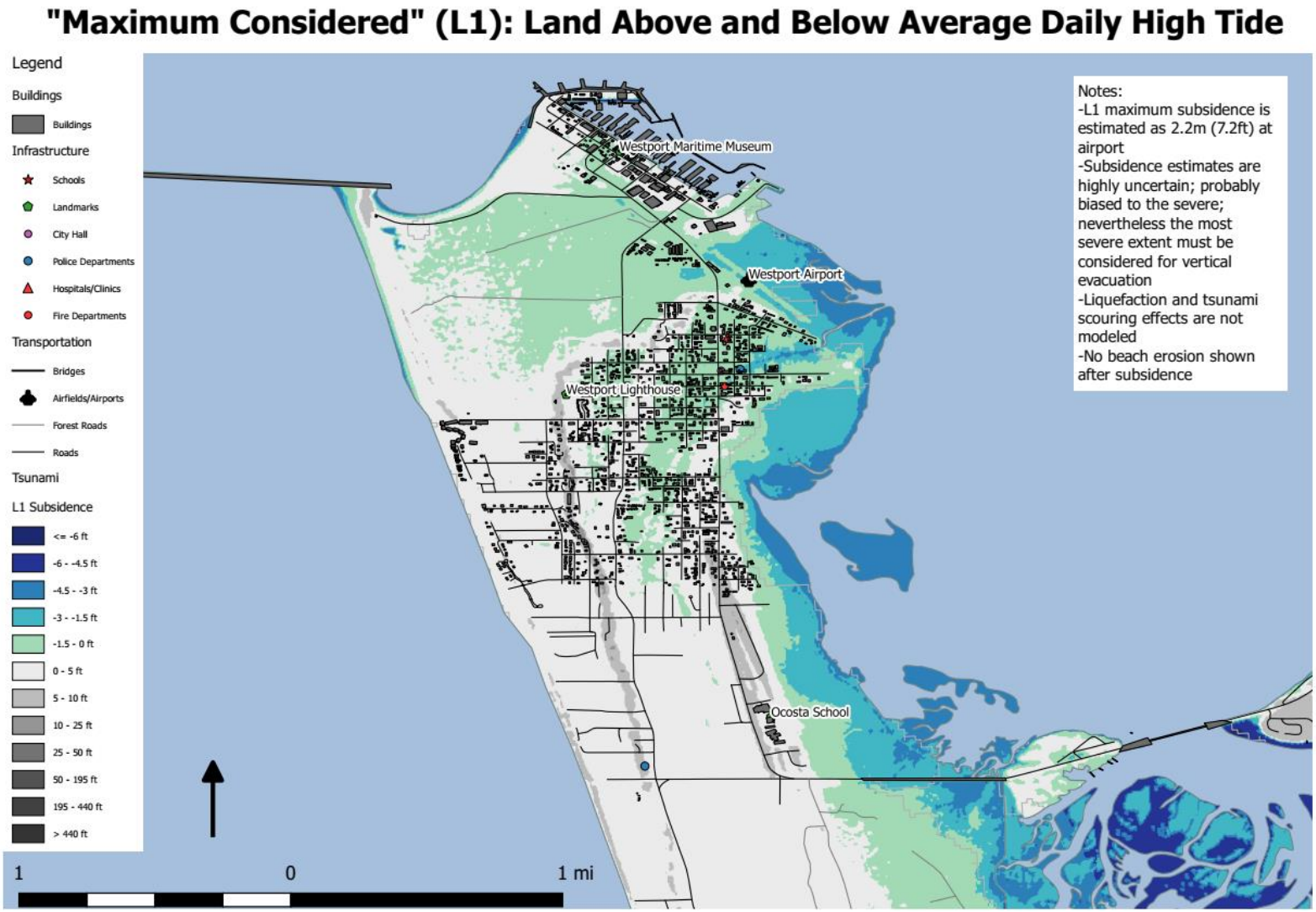

Figure 17. Westport Map Depicting Land Subsidence After an L1 Event

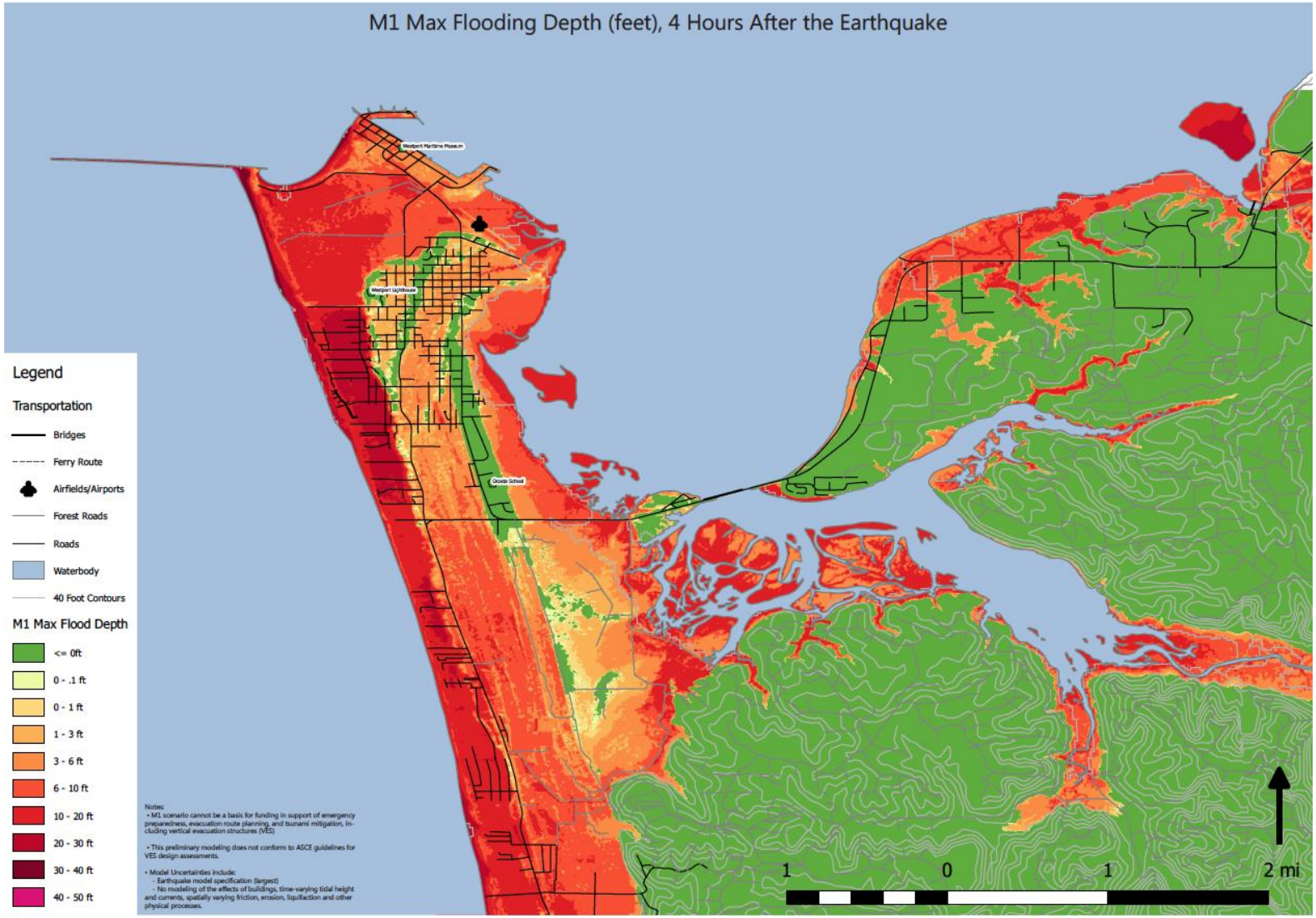

Figure 18. Regional Map Depicting Max Flooding Depth of M1 Event

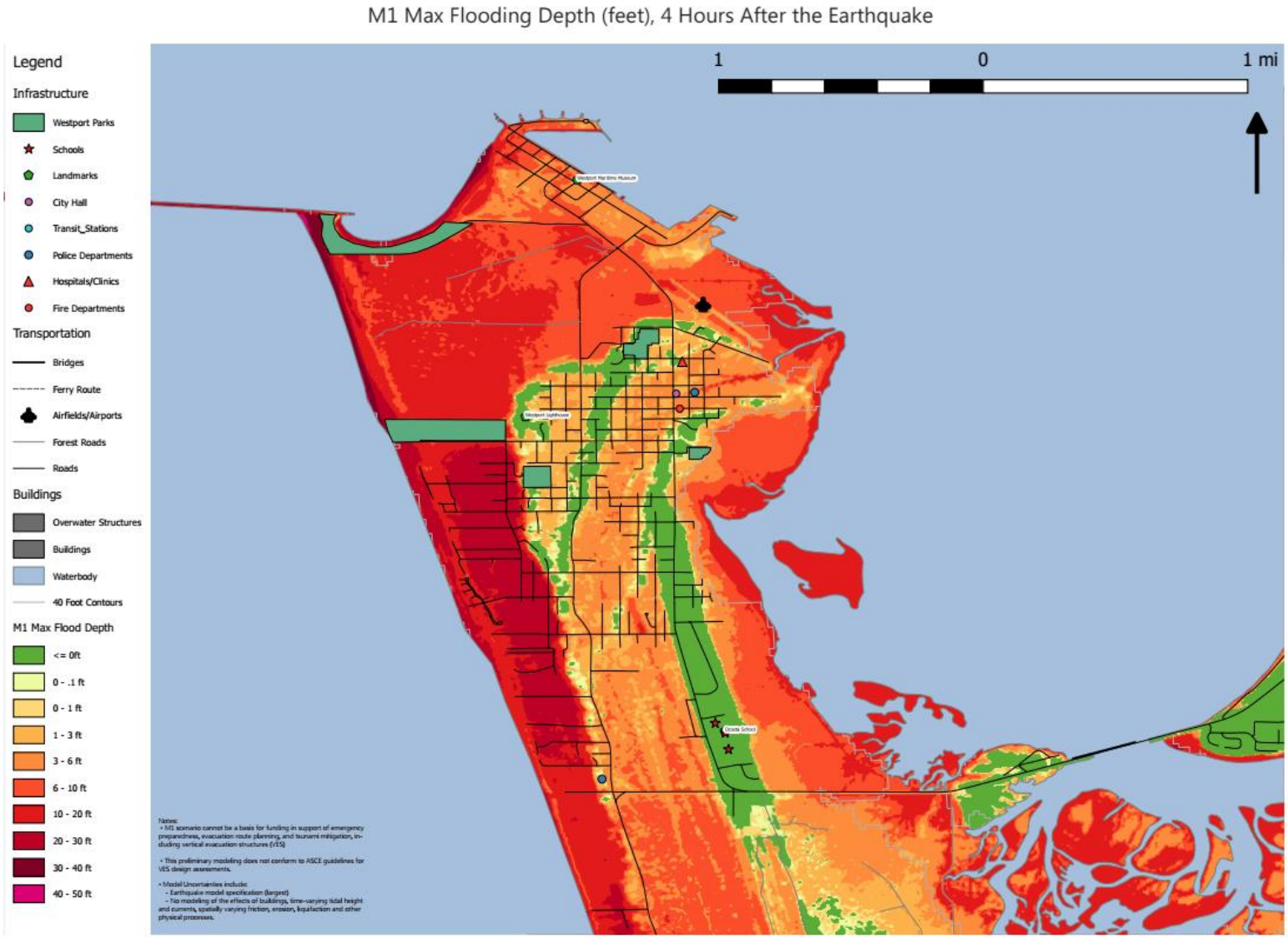

Figure 19. Westport Map Depicting Max Flooding Depth of an M1 Event

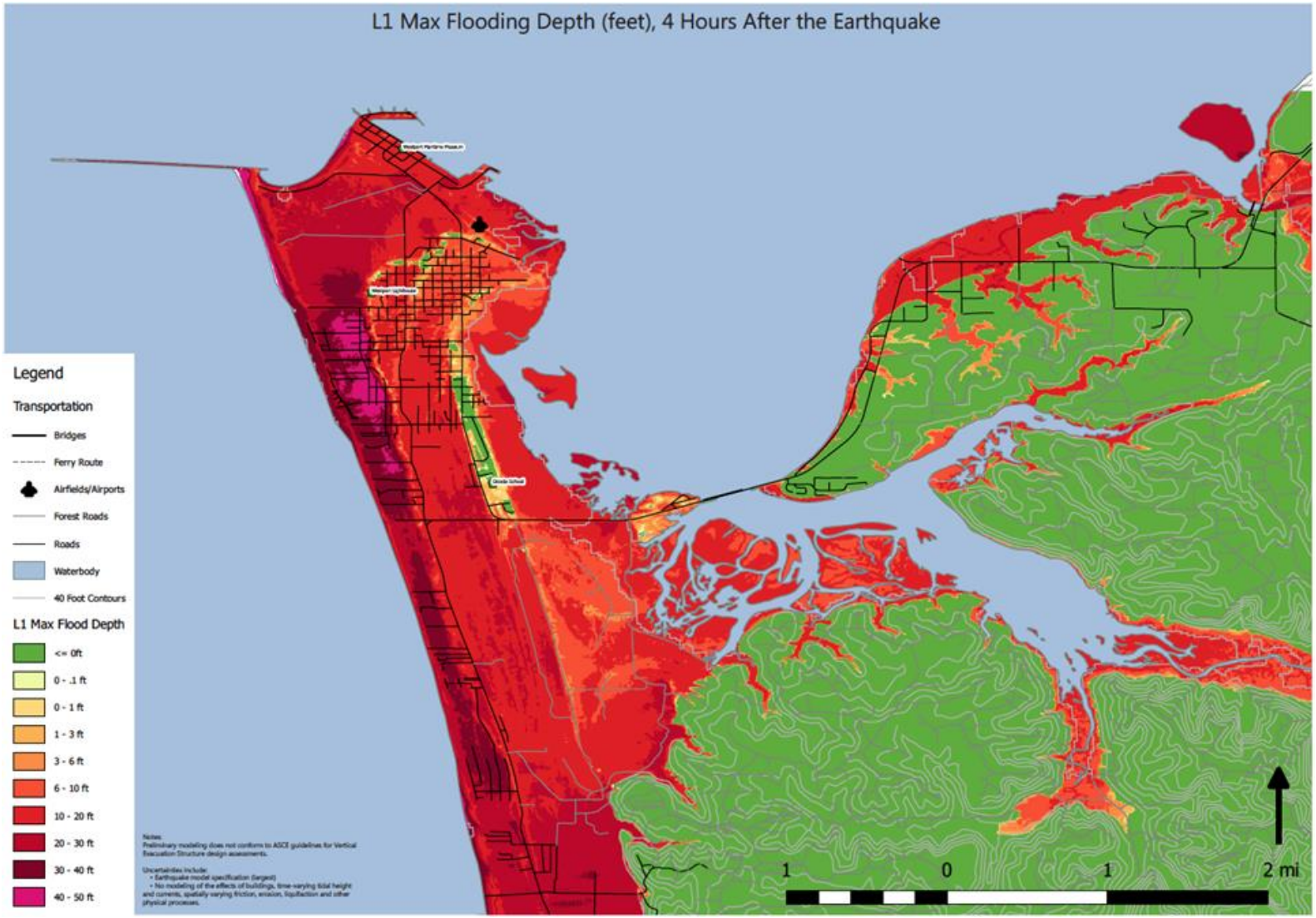

Figure 20. Regional Map Depicting Max Flooding Depth of an L1 Event

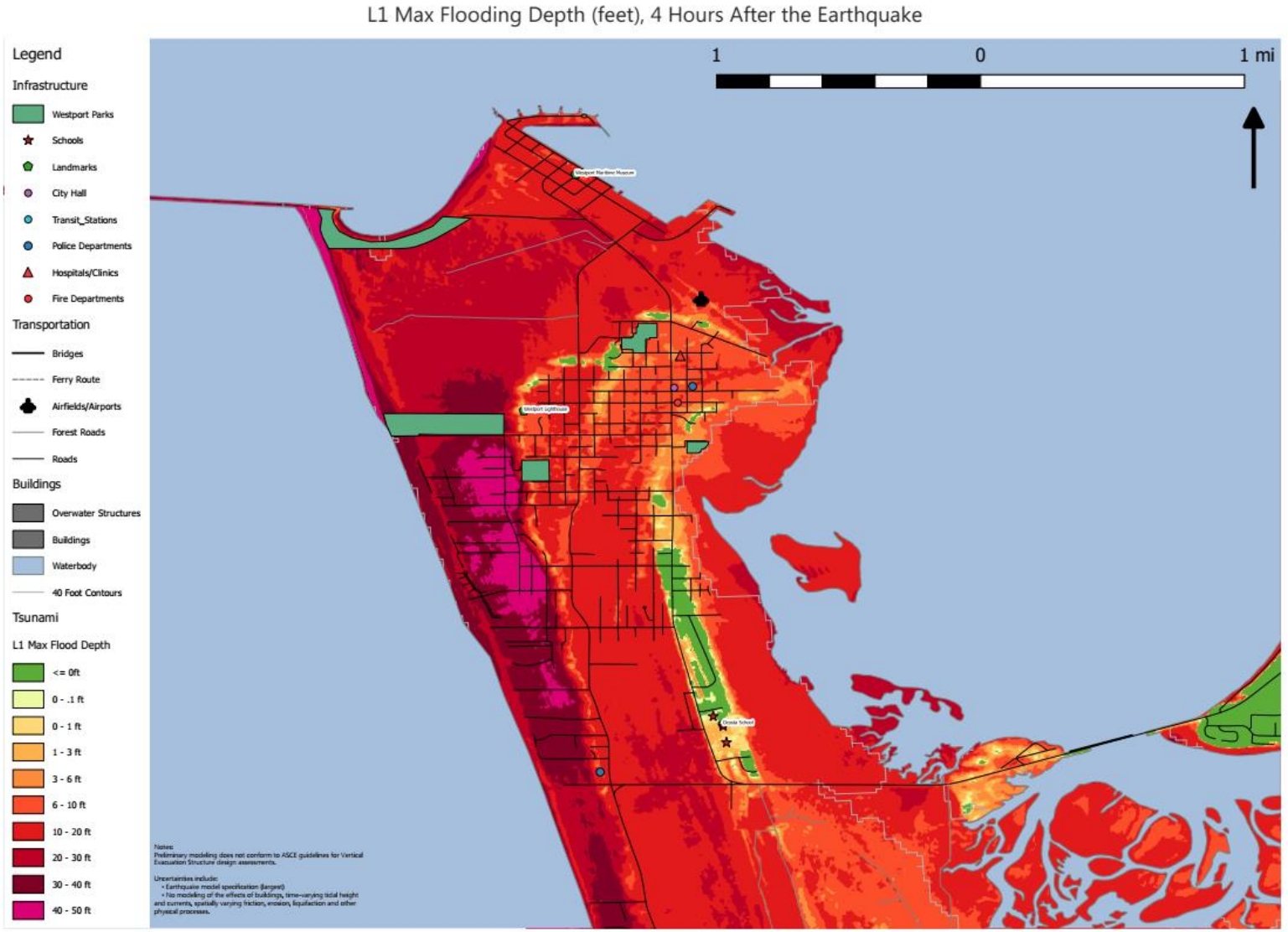

Figure 21. Westport Map Depicting Max Flooding Depth of an L1 Event

To further prompt participants to think positively and creatively for the long term, the UW team also first presented some imagery of historic coastline change on the Westport peninsula, due to sediment deposit and erosion, dredging and filling, and construction of the Westhaven jetty (Figures 14-16), and asked participants to recall any memories they had of previous earthquakes and tsunamis. Participants were encouraged to consider how much change the community had already experienced over 150 years, how it had responded to that change as well as created much of it itself, and therefore how future changes could pro-actively achieve co-benefits of mitigation, as opposed to being just reactive to conditions outside of the community's control.

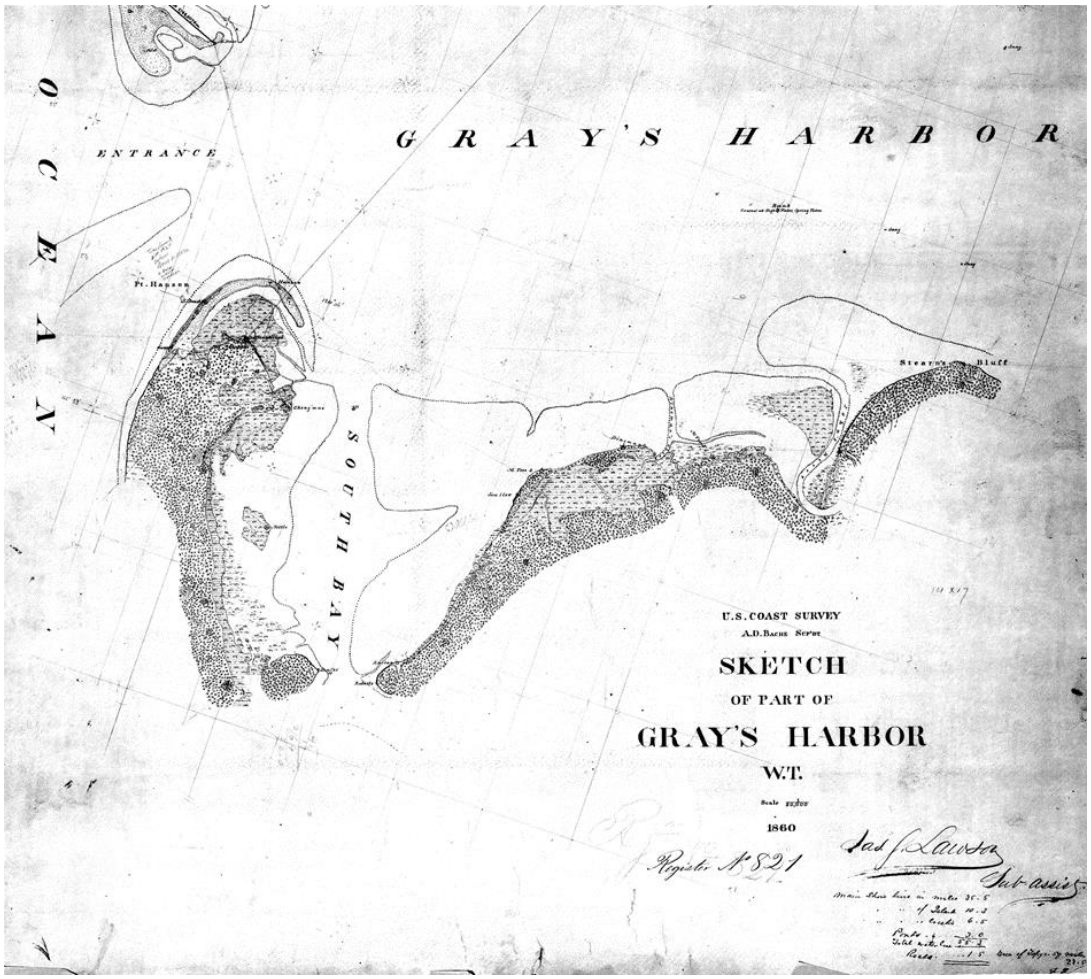

Figure 22. Imagery of Historic Coastline: 1860 Map of the Westport Peninsula and Grays Harbor. Map Source: NOAA Non-georeferenced NOAA Shoreline Survey Scans, https://nosimagery.noaa.gov/images/shoreline_surveys/survey_scans/T-821.jpg

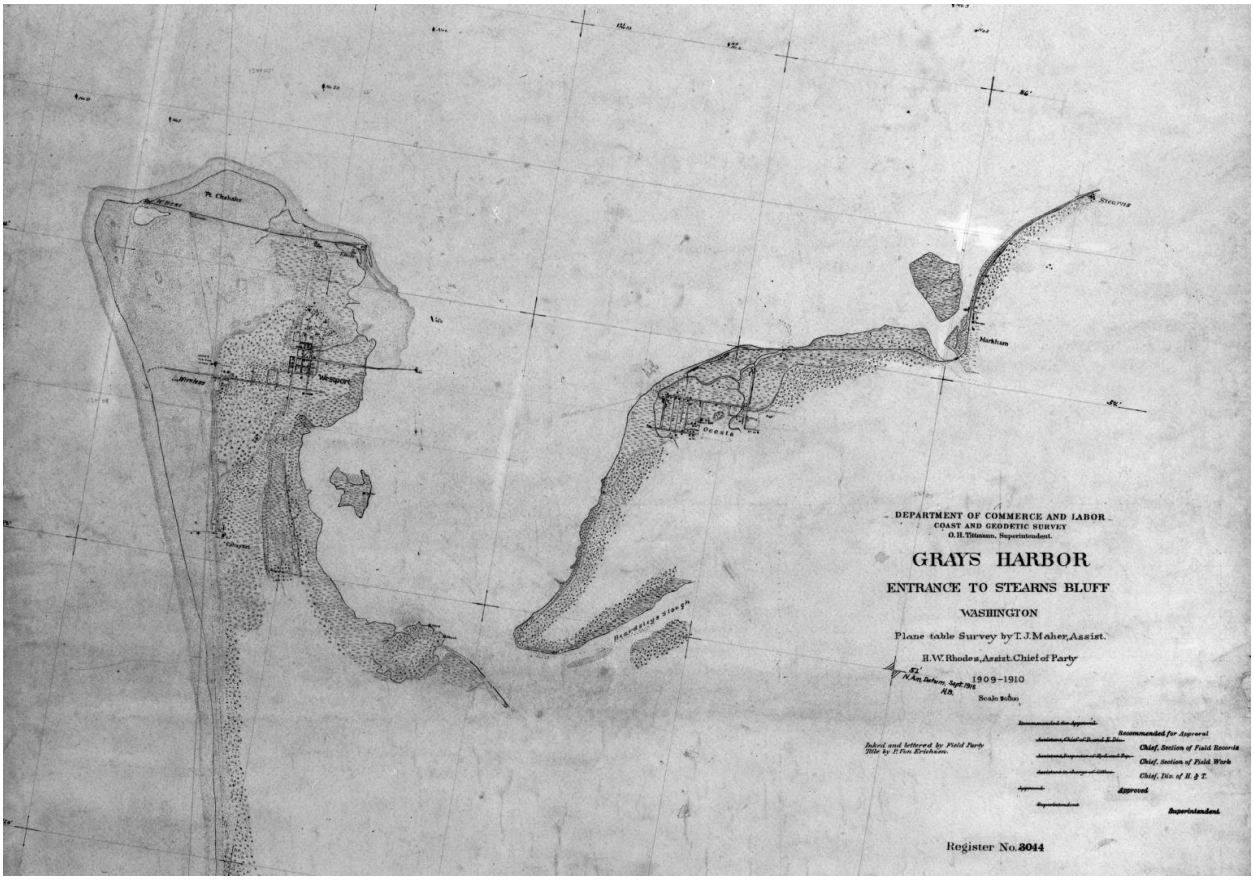

Figure 23. Imagery of Historic Coastline: 1910 Map of the Westport Peninsula and Grays Harbor. Map Source: NOAA Non-georeferenced NOAA Shoreline Survey Scans, https://nosimagery.noaa.gov/images/shoreline_surveys/survey_scans/T-3044.jpg

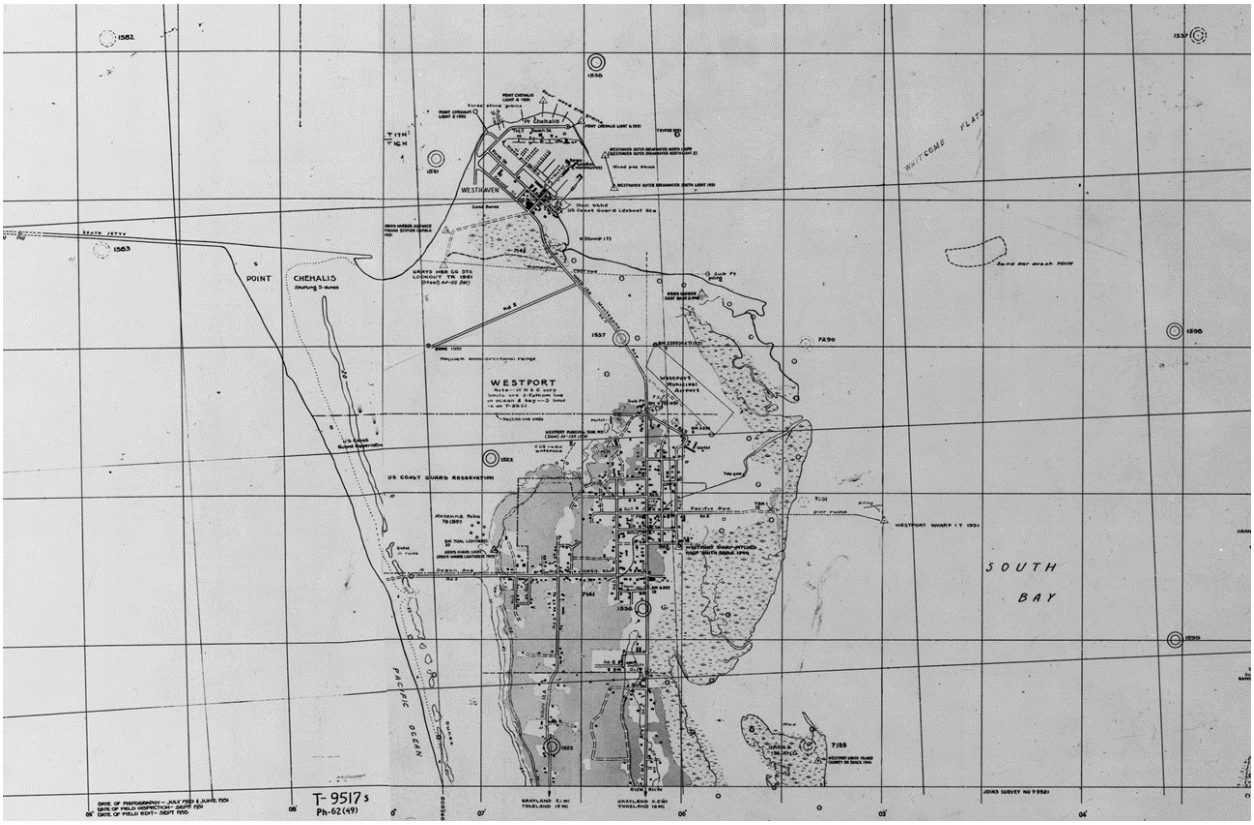

Figure 24. Imagery of Historic Coastline: 1950 Map of the Westport Peninsula and Grays Harbor. Map source: : NOAA Non-georeferenced NOAA Shoreline Survey Scans

Some examples of common themes that emerged from discussions are described below; see *Sections 2 and 3* for more detail on discussions.

- **Transportation Infrastructure Improvements:** Participants frequently discussed their perception that Westport's key transportation infrastructure (e.g., highways, roads, bridges) may be vulnerable to hazards, there is a risk of "being cut off" in an event, and resilience needs to include infrastructure improvements, both for mobility and communication. Such improvements could bring the co-benefits of participation in rural broadband development and attraction of employment opportunities.
- **Increasing Preparedness:** Participants discussed the need to make sure other residents are aware of hazards and that all residents have a plan in place to respond to an event. They discussed increasing preparedness through outreach, as well as practical approaches like gathering supplies and establishing more evacuation/meeting sites where residents can go during/after an event. Co-benefits to such preparedness would be increased sociability among residents and greater "situational awareness" at an individual level.
- **Uncertain Response to Large/Rare Events:** Participants had difficulty envisioning adaptation to the "new normal" following a large (M1 or L1) type event, and what the city could do now to be resilience to the possibility of such an event. Some of the ideas in response to SLR, such as improvements to key bridges and highways leading to the peninsula, or restrictions on building in flood-prone areas, were noted as being useful also for mitigating impacts of an earthquake,

tsunami, and land loss due to subsidence. A significant area of possible action included exploring the relocation of critical facilities and services facilities out of harm's way, to higher ground within the peninsula, and even outside Westport's city limits, which might bring opportunities for new investment and improved facilities. However, participants worried whether "Westport would still be Westport" if large parts of the community had to abandon the peninsula, either in anticipation of a major disaster, or in recovery from one.

2. Westport/South Beach Partners Coastal Resilience Workshop Documentation

This section documents the Friday, November 16, 2018 Partners Workshop, including an overview of the workshop and documentation of discussion sessions.

2.1. Partners Workshop Goal and Agenda

The Partners Workshop focused on the theme of making hazard mitigation more meaningful to the community and actionable in Westport. Overall workshop goals are described in the summary section above. The Partners workshop, however, as a gathering of local leaders and other experts in hazards mitigation and emergency planning, including members of the Westport/South Beach Tsunami Safety Committee who are currently leading the community's efforts to build more tsunami vertical evacuation structures, addressed information about tsunami inundation and flood depths that was not used in the Community Workshop.

The Partners Workshop included a combination of presentations, facilitated discussion/brainstorming exercises, and participatory mapping. Mapping exercises during the Partners Workshop were conducted using WeTable, a participatory geographic information system (GIS) platform that uses open-source QGIS software and a projector, allowing participants to digitize geographic information in real time using a calibrated pen and a tabletop map projection (Figure 25 17).

Figure 25. Participants in the Partners Workshop use WeTable to Map Values and Assets

Participants sat at tables set up to discuss one of the three hazard scenarios (SLR, M1, L1, see Figure 26 18). The room was set up to allow some experts and observers to "float" but in fact nearly all participants joined one or another of the tables.

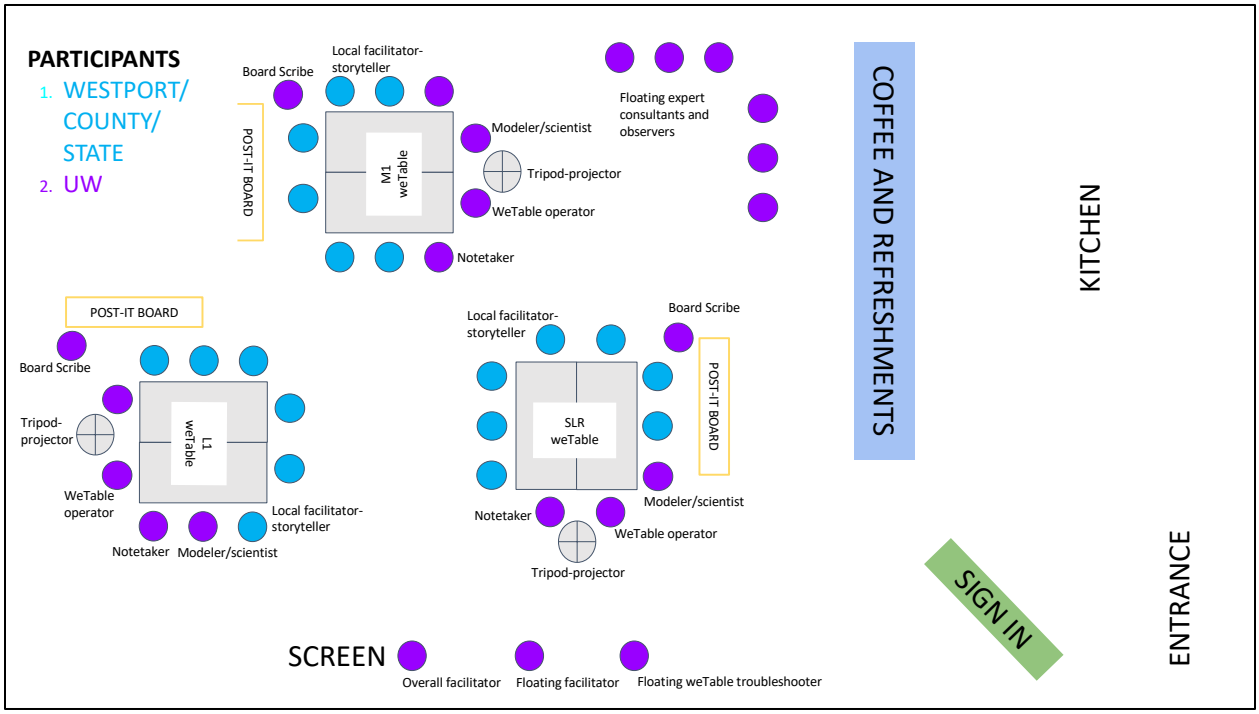

Figure 26. Partners Workshop Room Setup

Table 5 below includes the workshop agenda and approximate timing of the meeting. Sub-sections in this appendix are organized by scenario and roughly follow the agenda below.

Table 5. Partners Workshop Agenda

Approximate Timing	Agenda Item
2:30-3:00pm	Coffee and refreshments
3:00-3:10pm	Welcome and introductions
3:10-3:15pm	Overview of workshop goals and activities
3:15-3:45pm	Discussion Round 1: Values and asset mapping
3:45-4:25pm	Discussion Round 2: Scenarios of change and survival
4:25-4:45pm	Discussion Round 3: Strategies of adaptation to possible “new normals”
4:45-4:55pm	Report out: Storytelling
4:55-5:00pm	Next steps

2.2. Partners Workshop Participants

The Partners Workshop convened 24 individuals representing the city, county, and state agencies with expert knowledge regarding Westport and/or hazard mitigation planning in the region, as well as UW team members. Participants included representatives of the following organizations listed in Table 4 below.

Table 6. Participating Organizations

Organization Type	Represented Organizations
City of Westport/South Beach area	Department of Public Works, Police, Chamber of Commerce, South Beach Regional Fire Authority, Ocosta School, Tsunami Safety Committee, Westport Property Development, Timberland Library, Westport-by-the-Sea condominiums
County Agencies	Grays Harbor County Department of Emergency Management,
State Agencies	Washington State Parks, Washington State Emergency Management Division
Other local stakeholders	Shoalwater Bay Tribe
UW Faculty and Students	Department of Urban Design & Planning, Dept. of Applied Mathematics, Dept. of Civil & Environmental Engineering, Dept. of Earth & Space Sciences, School of Forestry and Environmental Sciences, Pacific Northwest Seismic Network, US Geological Survey

2.3. Partners Workshop Discussion Documentation

As described in the *Summary of Workshop Approaches and Outcomes* section above, meeting participants first discussed values of Westport/South Beach. UW Facilitators prompted this discussion with the question: "What makes Westport/South Beach a great place to live, work and play?" In addition, facilitators provided lists universal quality-of-life values excerpted from the United Nations Millenium Ecosystem Assessment (e.g., shelter, food, etc.). Following the value-brainstorming exercise, facilitators asked participants to list community- and place-specific assets that support each value. Note-takers recorded the list of values and assets on poster paper. Figure 19 shows an example of the values-assets brainstorm. In addition to listing assets, participants marked the location of each asset on a projected map of the Westport peninsula; the geographic location of each asset was recorded using WeTable and saved to a map for each scenario group. The SLR, M1, and L1 subsections below include information from the values discussion and asset mapping exercise for each scenario.

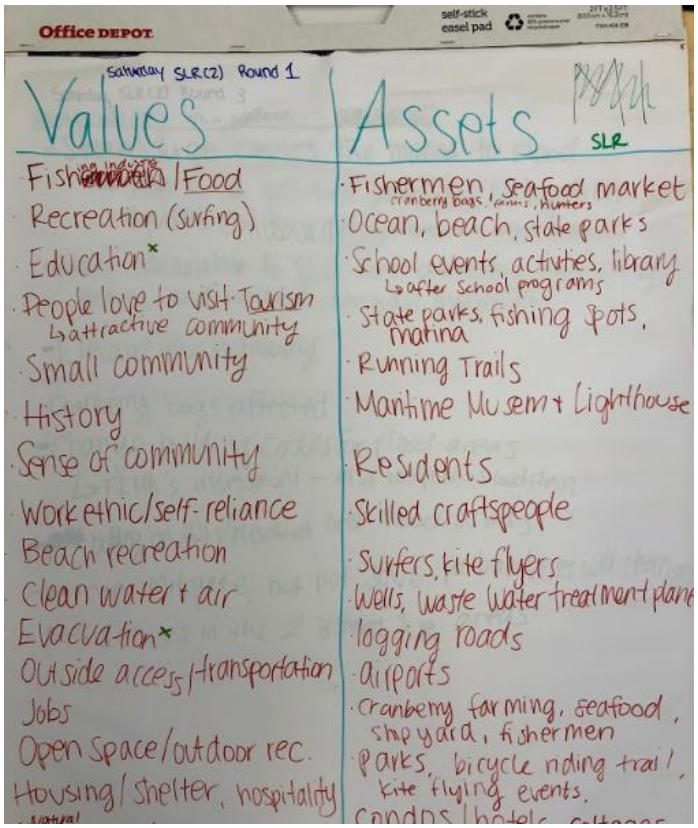

Figure 29. Example Values and Assets Brainstorm

After discussing values and assets, the UW team presented stories of coastal change, illustrating potential changes that Westport could face by presenting historical shoreline

maps (Figures 14-16), maps of flooding depth and subsidence in an M1 earthquake and tsunami scenario, and maps of flooding depth and subsidence in an L1 earthquake and tsunami scenario. The UW team also presented information about earthquake modeling uncertainty, liquefaction, and tsunami inundation areas and evacuation.

In addition to information on each scenario, the UW team asked respondents for memories of the 1964 Alaska Earthquake and tsunami. Participants recalled hearing news reports of the event, being afraid of a tsunami, and the evacuation process. They described how the whole Westport peninsula was evacuated to high ground where the school is now.

Following the presentation of the hazard scenarios, facilitators asked participants to identify assets that would be lost in an event and think about existing assets that could support community values in the place of lost assets. Finally, facilitators asked participants to imagine how the community could adapt to, prepare for, or take advantage of the "new normal" suggested by their scenarios, including brainstorming strategies that would help Westport/South Beach continue to support its values. The SLR, M1, and L1 subsections below also include information from these discussions.

2.3.1. Sea Level Rise (SLR) Scenario

The SLR discussion group identified and discussed the following values and assets included in Table 5. Figures 20 and 21 below show the assets that the SLR group mapped.

Table 7. Partners Workshop SLR Group Discussion of Values and Assets

Values	Assets
Outdoor recreational opportunities	Parks and beaches; ocean; Westport lighthouse; state parks, including the Grayland beach state park
Independence	None indicated
Education	School
Close-knit community	School
Strong family and friends ties	School
Vision and innovation	School
Access to fresh seafood	Ocean; Brady's Oysters, Westport Marina
Quality of life	Downtown, marina area, cranberry bogs
Natural beauty and history	lighthouse
Low crime rate	None indicated
Scientific opportunities	local clues to regional earthquakes/tsunamis (on the harbor/ shores/ intertidal zones); John's River
Tourism	None indicated
Health	None indicated
Good social relations	None indicated
Security	None indicated
Freedom of choice	None indicated
Other	Airport, highways, marina, police, fire department, homes

Figure 28. Community Assets Identified by Friday SLR Group - Westport

Figure 29. Community Assets Identified by Friday SLR Group - Regional

In addition to the values and assets listed above, the group discussed the following:

- Westport is an attractive destination for tourists; a lot of tourists visit the area and the outdoor recreation opportunities are a draw
- The area is rich in natural beauty and people statewide benefit from scientific evidence of past hazard events found in the Westport area
- Westport is a safe place without gangs or violence
- Downtown Westport is a business hub, most businesses are located there
- The cranberry bogs and related industry support values and family ties

After discussing values and assets and hearing the presentation about potential hazards, the group discussed vulnerabilities. Discussion focused on the themes listed below.

- **Transportation and public service infrastructure:** Participants identified the airport, highways (including to Aberdeen), police, and fire department as vulnerable to SLR. Participants discussed that access to the town will be compromised, including the highway to the south east, noting that even a bad El Nino year could cut off road access. They also noted that the airport and associated assets will be lost to SLR. The clinic is not vulnerable to SLR.

- **Marina/commercial district and businesses:** Participants observed that with 1 foot of SLR, the marina is not affected, but parts of the commercial district are. They noted that Brady's has high ground next to it.
- **Residential areas:** Homes may be lost to SLR, but possibly not at only one foot of rise.
- **Other topics:** Participants expressed concern over replacing lost assets.

For the discussion of "new normal" and strategies to help support Westport's values, participants focused on the 2060 SLR scenario (1 foot; 11% probability). Discussion included the themes listed below.

- **Relocation:** Possible to buy out properties and move homes, though Taholah has been working on that for 20 years without much progress; need to move the airport
- **Infrastructure investments:** Need to address risk to the marina through a possible retrofit; can make periodic infrastructure investments with federal support; concern about safety of the bridge and need to plan a new bridge; bridge is outdated so there may be the possibility to gain political support for replacement; road could be rerouted through Ocosta; need for climate resilient building codes; need to reroute and elevate roads, including a possible levy system.
- **Political context:** Potential lack of political will to build something for 40 years from now; SLR in Westport may not be a top priority. City government is a strong asset for advocating for a new bridge or better road, because some decision-makers still deny SLR.
- **Other topics:** Assets overlap between sea level rise and subsidence, so strategies are relevant to both scenarios; Brady's oysters may be affected by SLR, but oyster beds could move further in. School will remain.

2.3.2. M1 "Like the Last Time (1700)" Earthquake and Tsunami Scenario

The M1 discussion group identified and discussed the following values and assets included in Table 8. Figures 22 and 23 below include the assets mapped by the M1 group.

Table 8. Partners Workshop M1 Group Discussion of Values and Assets

Values	Assets
Fishing industry; including a strong sense of belonging to the fishing industry	Ocean companies, including WA crab, ocean cold, Ocean Gold, Harn's, the docks and marina, the Tokeland marina, oyster processing facilities, the Westport shipyard, and the fishing fleet
Tourism industry, in the context of the tourism value being rooted in Westport being a unique place that people want to visit	Chamber of Commerce, small businesses
Education and school system are valued in this area, including successful athletic programs	Ocosta School, library, high school
Culture of community support and strong sense of community; one participant noted: *"Being not from the area, it's clear how much coastal communities have a strong sense of community. People stick together, fall and rise together, have strong bonds between neighbors."*	The community group called We Fish (a group of families that have helped to build community); Maritime museum, Marina, and port office; churches though they are sometimes not well attended; Stores and restaurants including the grocery store, the Hungry Whale and the Midtown Deli; community centers including the Westport Y, VFW and the Senior

Values	Assets
	Center, the Grange Hall, the Rec Hall, and the Grayland Community Center; attractions like the observation tower
Access to parks, beaches, and nature	State Parks including Westhaven, Twin Harbor, Bottle Beach, Westport Light, and Grayland Beach; the Long Beach peninsula
Cranberry industry	None indicated
Self-reliance of residents	Access to hunting and fishing
Necessary material	Water infrastructure, including the north water tower and wastewater treatment plant, the south water tower; gas stations and stores; airports and rural runways
Health	One in-town doctor's office called the Beach Clinic that houses one doctor, one PA, one nurse practitioner; the main hospital is 30 minutes away in Aberdeen
Social relations	City Hall
Security	Fire department, some stations down south in Grayland; coast guard station; police department

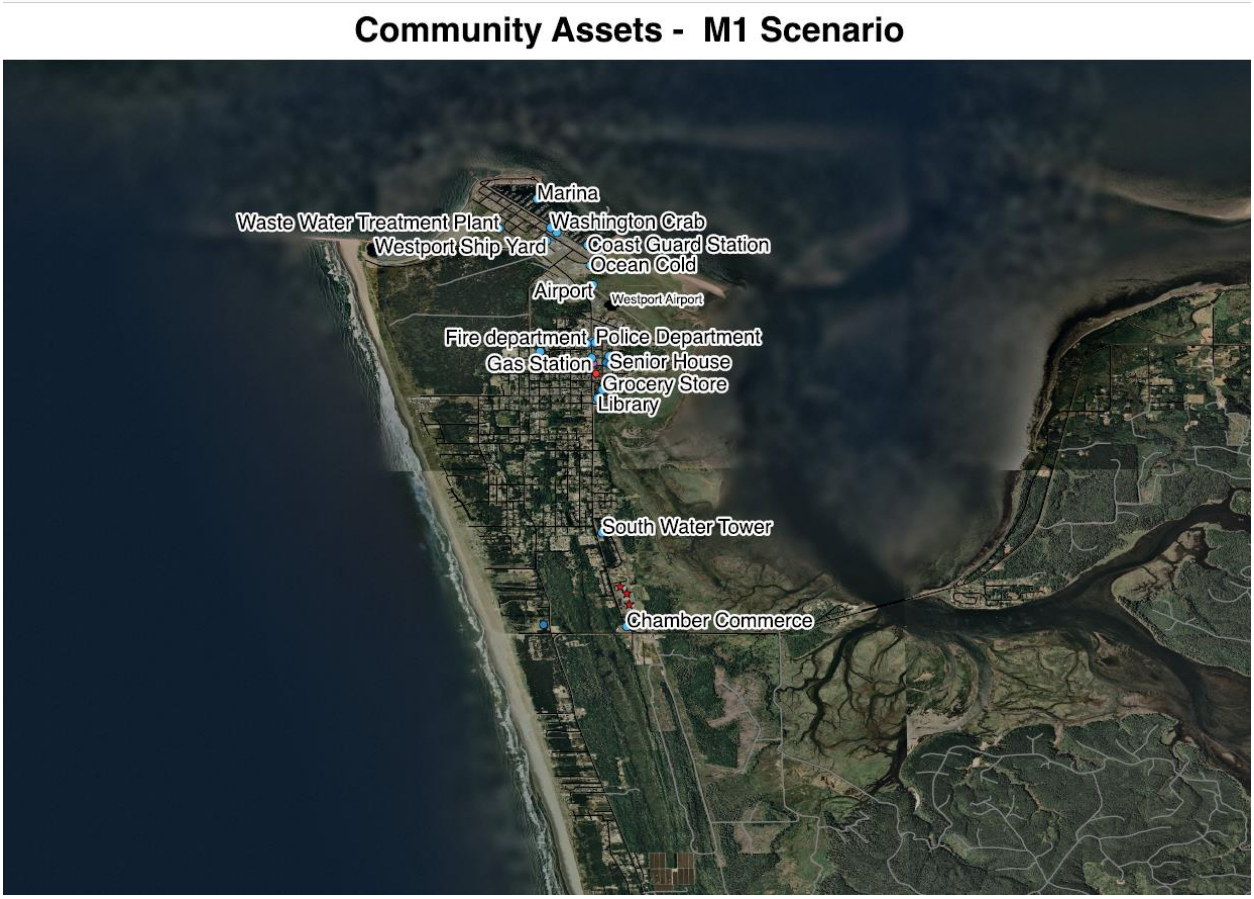

Figure 30. Community Assets Identified by Friday M1 Group - Westport

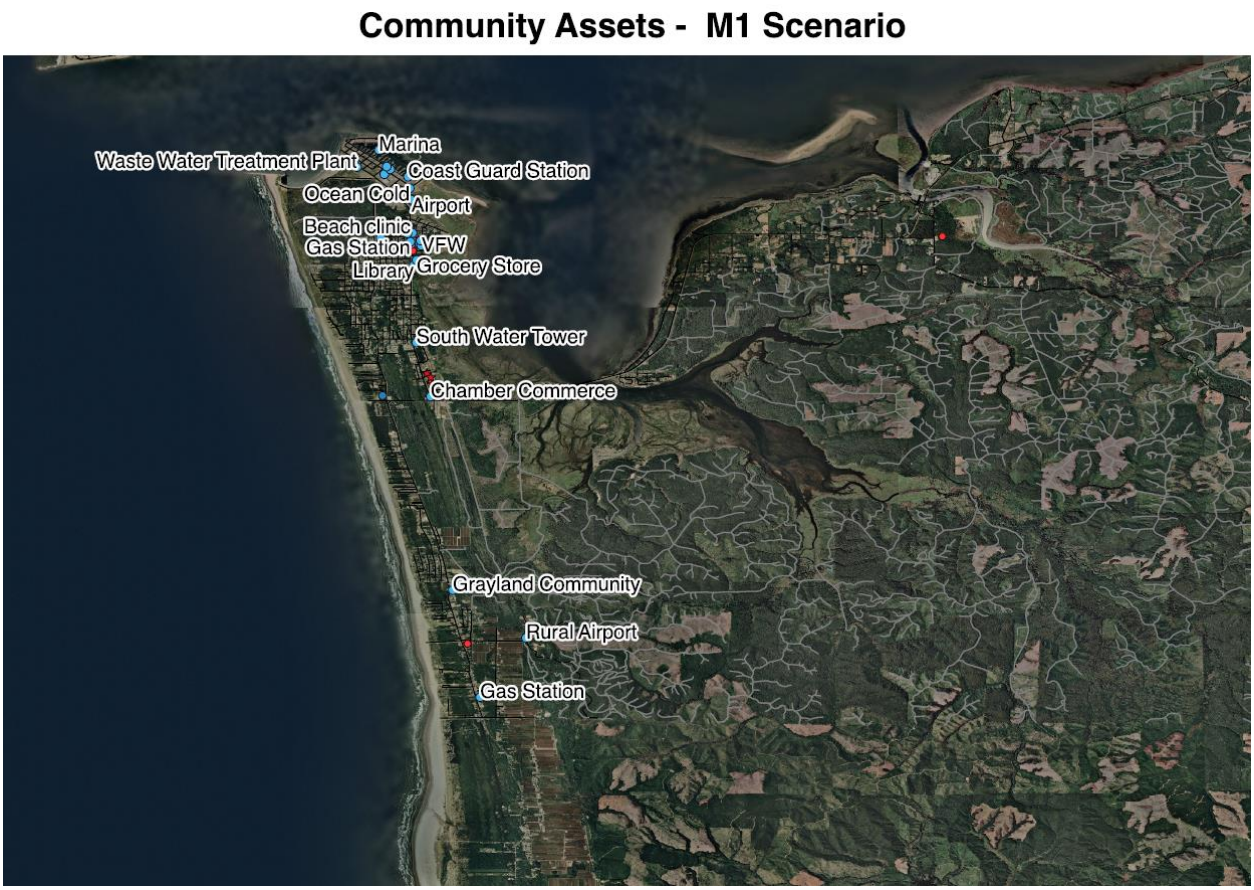

Figure 31. Community Assets Identified by Friday M1 Group - Regional

The M1 group discussed assets that are **vulnerable** to an M1 tsunami scenario, including:

- Assets that support the fishing industry, including seafood processing plants, docks and the marina, and the shipyard, boats
- The library could be affected, and the high school would be unlikely to survive; the old part of the elementary school would also be affected
- Assets that support Westport's sense of community would be affected, including the maritime museum and marina area, as well as grocery stores, restaurants, and community centers
- Assets that provide necessary resources, including gas, transportation infrastructure (e.g., roads and bridges), and water infrastructure (e.g., wastewater treatment)
- Routes to the vertical evacuation structure

The M1 group also discussed **adapting existing assets**, including:

- Chamber of commerce can be used to store and provide supplies
- Tsunami vertical evacuation structure at Ocosta School is a key asset for hazard response and is stocked with food, water, and some emergency supplies, but may need more.
- Preparing residents to have their own evacuation kits
- Using the water tower as another location for supplies
- Identify areas on high ground where the city can store supplies

- Areas that can provide opportunities to evacuate by air

Discussion of adaptation to a "new normal" focused on the following:

- **Preparing and recovering from hazards:** need to develop evacuation routes, provide more vertical evacuation in accessible places, and gather more supplies (e.g., food, water, radios, and generators) to store in evacuation areas; need to work with state and county to ensure there is a plan for Westport in the event of a disaster
- **Improving transportation and infrastructure:** bridges may be destroyed by earthquakes; will need to re-establish the jetty after the event; need to identify logging roads that could be used for accessing Westport after an event; need to mitigate risks of tree fall and landslides on access roads; need more signage demarcating tsunami zones and evacuation routes
- **Education:** need to educate residents about risks; need to educate tourists who visit Marina district in the summer, other areas have brochures and outreach to hotels; need to make presentations to hotel and motel owners and do outreach to campers in the state park (county is working on these projects currently); need to provide information about how to respond to an earthquake and tsunami
- **Funding:** Need to identify sources of funding (e.g., FEMA) to help with preparedness
- **Multi-use evacuation structures:** could create vertical evacuation structures to be a tourist attraction, providing vertical evacuation and education; could also incorporate event center and multi-purpose area

2.3.3. L1 "Maximum Considered" Earthquake and Tsunami Scenario

The L1 discussion group identified and discussed the following values and assets included in Table 9. Figure 24 below show the assets mapped by the L1 group.

Table 9. Partners Workshop L1 Discussion Group of Values and Assets

Values	Assets
Going fishing (as a chance to meet people) and crabbing	beaches, ships, docks, jetty
Having a sense of community and strong social bonds	Residential areas and neighbors, State Parks and beaches, fishery, boats, marina; one participant noted: *"A lot of people know each other and when people do need help, everybody helps."*
Obtaining benefits from the local resources (natural and economic)	Fishery, oyster farms, beach, tourism industry, ship/boats industries, marina, businesses, restaurants, ship yards, fish processing; one participant noted: "*We do have everything here in Westport"*
Having unique waterfront businesses and rural character	Beaches, ships, fishery, marina and dock area, tourism (infrastructure), safe neighborhoods,
Having unique culture and strong cultural identity	Library is cultural, social, and educational asset; the school, along with its evacuation center is an important part of the community; include Tokeland and Shoalwater Bay Tribe as parts of the community; the 105 bridge; neighbors and community; marina and jetty; beaches and nature

Values	Assets
Obtaining support from public service providers	Fire department; Chamber of Commerce because it provides us with natural, cultural, business/economic resources and policy; Police station for public safety; drugs store/pharmacy and clinic

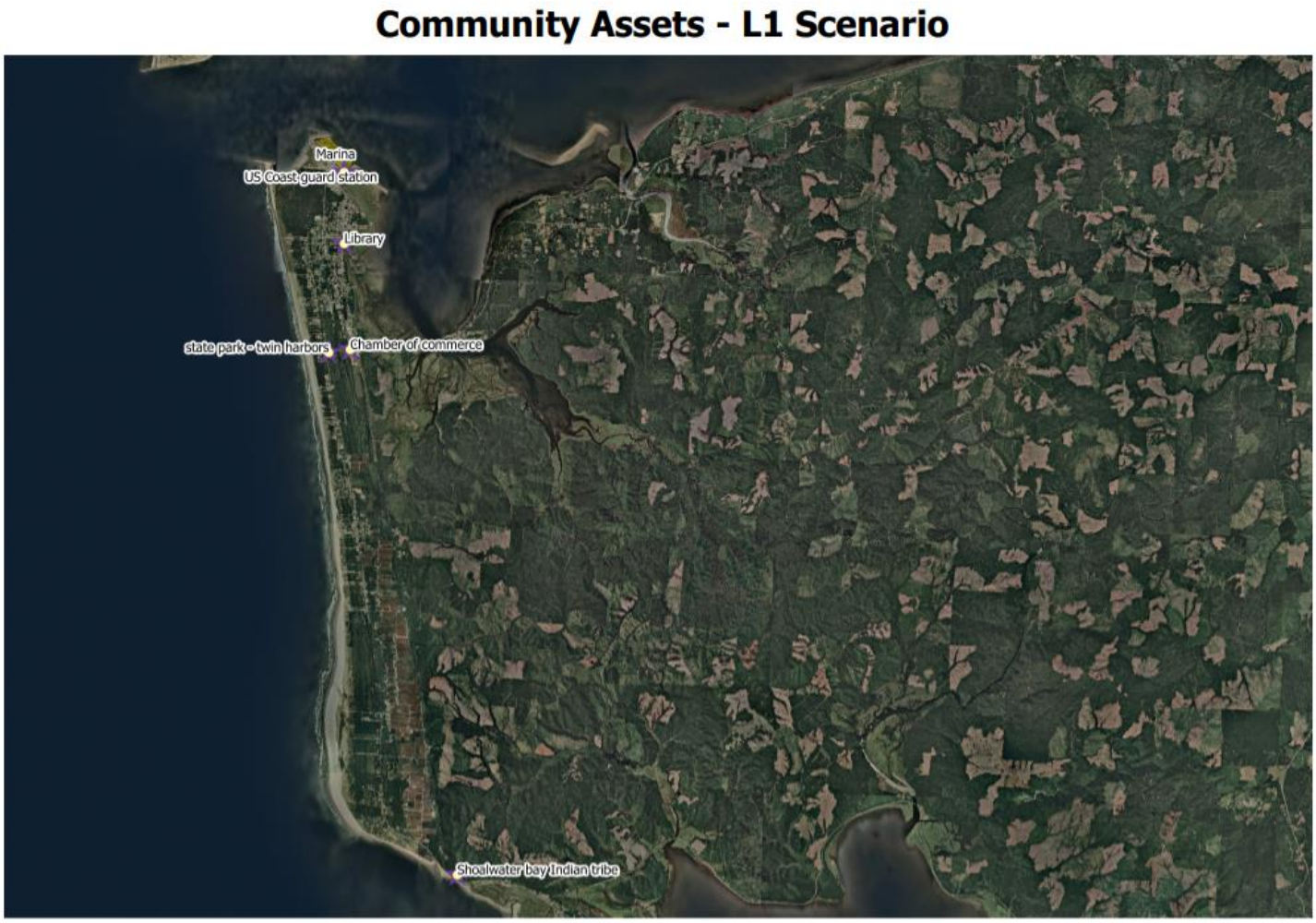

Figure 34. Community Assets Identified by L1 Group - Regional

Following presentation of the hazard scenarios, L1 group members discussed values and assets that are **vulnerable** to the L1 tsunami, including the themes described below.

- **Sense of community and social bonds:** residential areas will be affected, need to think about the structures that will exist after event
- **Cultural identity:** need to add life safety information to important cultural centers
- **Other values and assets:** key public services like the police department will be gone, school will be inundated; economy is strong but L1 will destroy many assets

The L1 group also discussed **adapting existing assets**, including:

- Planning for the worst, including that dunes and boats may not offer protection

- Strengthening access, including the need for access to relocate/move from the city and considering how and where to relocate if infrastructure is destroyed – could require "starting over"
- Need to ensure that people have insurance to help with rebuilding

Finally, the L1 group discussed proactive strategies for adapting to a potential "new normal" post tsunami event, including the following themes.

- **Buying new land:** Participants noted that there might be a need to buy new land. Concerns included funding to purchase land after a devastating disaster, zoning considerations, potential lack of support from relying on the government, adjacent areas also being vulnerable, and possible FEMA funding
- **Moving infrastructure:** Participants brought up the possibility of moving the city's infrastructure to Tokeland, nothing that the Marina will be destroyed.
- **Relocating/moving to safer areas:** Participants noted needs for access to the south, need for a new bridge if destroyed, and need to somehow create cohesion if people need to be relocated; concern that without economy and resources, people will leave and not return; need for access to Aberdeen through timber lands.
- **Regaining the collective memory of recovery experiences**: need to draw from memory of rebuilding and survival after tsunami in 1964 for long-term planning and education

2.3.4. Workshop Summary: Telling the Story of Westport/South Beach

After the final group discussions of strategies for adapting to a "new normal," representatives from each group shared from their group discussions, using a storytelling format. This section includes the "stories" from each discussion group.

L1: *"When we first started this project, I was very negative about L1, because what is left? But we've had good discussion about what can you do. Regarding long-term planning over the next 40-50 years, do you buy land and redevelop inland? This could be a good strategy. We will have a bit of land where we sit here, but the infrastructure will be gone. When we looked at values – sense of community, economy, shipbuilding, fishing, tourism, how community comes together and helps, rural character of Westport – why people chose to live here, because it's awesome to live here. In L1, everything goes away. How do we plan to keep these things in place? We talked about many things, but focused on how to make it over the bridge. The wastewater treatment and water tower are gone… do I go to city and ask for them to build a new one that won't be affected by L1? Can the city look for property outside the area and encourage people to move? But if we move out there then we lose these values that are tied to where Westport is and what it is. Long-term planning for L1 Cascadia scenario is very difficult. For example, if you don't have a school, people will not stay here… are we going to start building another school as a long-term strategy? Will be hard to convince community to do this, but would be a good idea because it will sustain our values. Do we move all the good stuff out of Westport? I don't know. Do we annex land for 15 miles? This is only the L1, there are bigger things that can happen. We encourage everyone to get flood insurance."*

Comment: *"There's another insurance product – parametric insurance, where the event itself triggers payout, not claims and damage assessment. If you are trying to get funding to rebuild quickly, parametric insurance is an option that could work. Flood insurance will cover individuals; but it is claims based. Parametric insurance can move more quickly. But it could be an insurance rabbit hole and you*

would need to consider if it's a good source of funds, but it can be mobilized more quickly. Say we have money to rebuild, are people going to choose to rebuild here? Is there going to be anywhere to rebuild here?"

***M1:** "We have a sliver of land, the elementary school, chamber, water tower, street of flags left after this event. We discussed how much storage and supplies we can cram into this area. How can we get more storage and supplies at the chamber and water tower? How can we prepare the rest of Westport that will be underwater? Vertical evacuation, evacuation routes… there are tourists who may just be here for the day and not know anything about tsunamis. Incorporating signage into tourist hot spots, campsites, hotels, observation tower, and preparing these locations. We talked about how to get out of here without a bridge, talked about logging roads, how we can get supplies and get people out of here."*

***SLR**: "Ours was pretty easy, ours assumes SLR of 1 ft. by 2060. As of now only 98% of world's scientists say this… we would lose virtually no homes, but would lose bridge, highway into Aberdeen, roads, marshlands. We would still have the school and housing. If we do have political will – our bridge is outdated, not built to current standards, no bike lane or pedestrian access. With political will, we could get the bridge redone. We have already had an instance where we had to reroute a road down south. Wouldn't be a hard sell to reroute through the Ocosta subdivision, which is high ground. We aren't worried [about our scenario]."*

3. Westport/South Beach Community Coastal Resilience Workshop Documentation

This section provides documentation of the Saturday, November 17, 2018 Community Workshop, including an overview of the workshop and documentation of discussion sessions.

3.1. Community Workshop Goal and Agenda

Building on the Partners Workshop held the previous day, the Community Workshop sought to more broadly engage community members from Westport and the wider South Beach area in Westport's hazard mitigation and long-term planning process. The workshop was designed to learn about community values, priorities, and gather creative suggestions at the intersection of hazard mitigation and long-term planning. The overarching Community Workshop goal was the same as the Partners Workshop: to make hazard mitigation more meaningful to the community and actionable in Westport.

Like the Partners Workshop, the Community Workshop included a combination of presentations, facilitated discussion/brainstorming exercises, and participatory mapping. Mapping exercises were conducted by asking attendees to mark values and assets on large paper maps of the Westport area depicting land subsidence and inundation for each scenario, rather than using WeTable. Participants sat at tables corresponding with each hazard scenario (SLR, M1, L1, Figure 25). To accommodate the larger and more diverse group of participants, four tables were set up, with two of them discussing SLR, and one of these staffed with local interpreters for Spanish speakers.

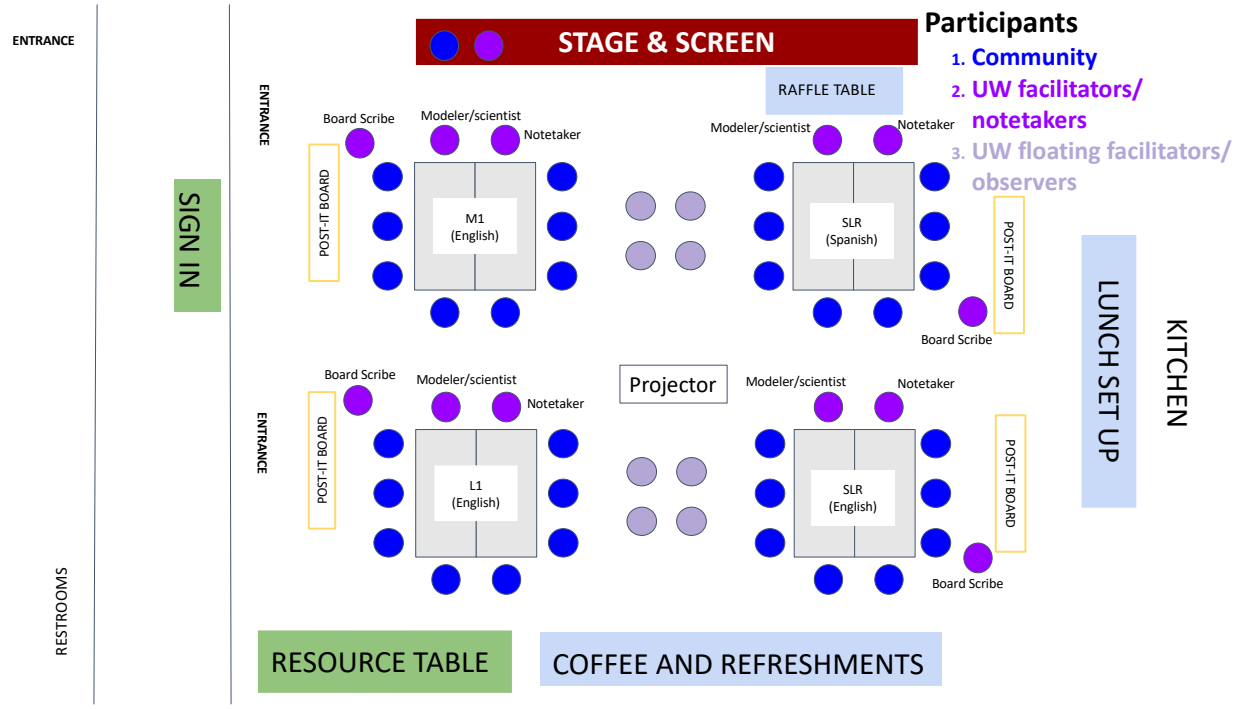

Figure 33. Community Workshop Room Setup

Error! Not a valid bookmark self-reference. includes the workshop agenda and approximate timing of the meeting; sub-sections in this appendix are organized by scenario and following the agenda below.

Table 10. Community Workshop Agenda

Approximate Timing	Agenda Item
9:30-10:00am	Coffee and refreshments
10:00-10:05am	Welcome and introductions
10:05-10:10am	Emergency safety protocols and raffles
10:10-10:20am	Purpose of the workshop and agenda
10:20-11:45am	Round 1: Values and asset mapping
11:45am-12:15pm	Social capital video, lunch break, and raffle
12:15-12:45pm	Round 2: Supporting values and strengthening assets
12:45-1:05pm	Stories of coastal change and survival
1:05-1:30pm	Round 3: Planning for a "New Normal"
1:30-1:50pm	Storytelling
1:50-2:00pm	Next steps
2:00-2:30pm	Vertical evacuation site tour

3.2. Community Workshop Participants

The community workshop was open to all residents and community members of Westport/South Beach. 30 Participants attended the workshop representing Westport, South Beach, Ocean Shores, and the surrounding area. Some participants attended both the Friday and Saturday workshops, including staff

from City of Westport Public Works, Chamber of Commerce, Tsunami Safety Committee, Westport Property Development, Ocosta School District, Grays Harbor County Commission and Emergency Management, WA State Emergency Management Division, and residents of more distant communities in the County, such as Montesano and Ocean Shores. Four UW tsunami scientists attended both workshops, as did all the UW urban design and planning faculty and student facilitators and notetakers.

3.3. Community Workshop Discussion Documentation

The Community Workshop was structured similarly to the Partners Workshop, with some differences in the discussion themes and approaches. In general, there was a greater focus on identifying values and assets, and on adapting to "new normals," rather than on vulnerability to the impacts of tsunami inundation immediately following an earthquake. With the more diverse, and less technically expert group of participants, the Community Workshop replaced discussion of those vulnerabilities with a Round Two discussion on everyday quality of life needs ("Supporting Values and Strengthening Assets"). There was also more of an emphasis on education about preparedness and reminders of the work the community had already done to plan for tsunami vertical evacuation.

As in the Partners Workshop, participants started with a Round One discussion to brainstorm values and assets with someone else at their table and recording ideas on a post-it note, responding to the prompt regarding what they appreciate about Westport. After the post-it notes brainstorm activity, each table collectively built a list of values and assets on poster paper. Participants then used pens and large paper base maps of Westport and the surrounding area to locate assets (Figures 26 and 27), though in some cases, the . Finally, the Round ended with a "storytelling" report-out to the whole room, defining Westport in terms of its values and assets, related in Section 3.3.4 below.

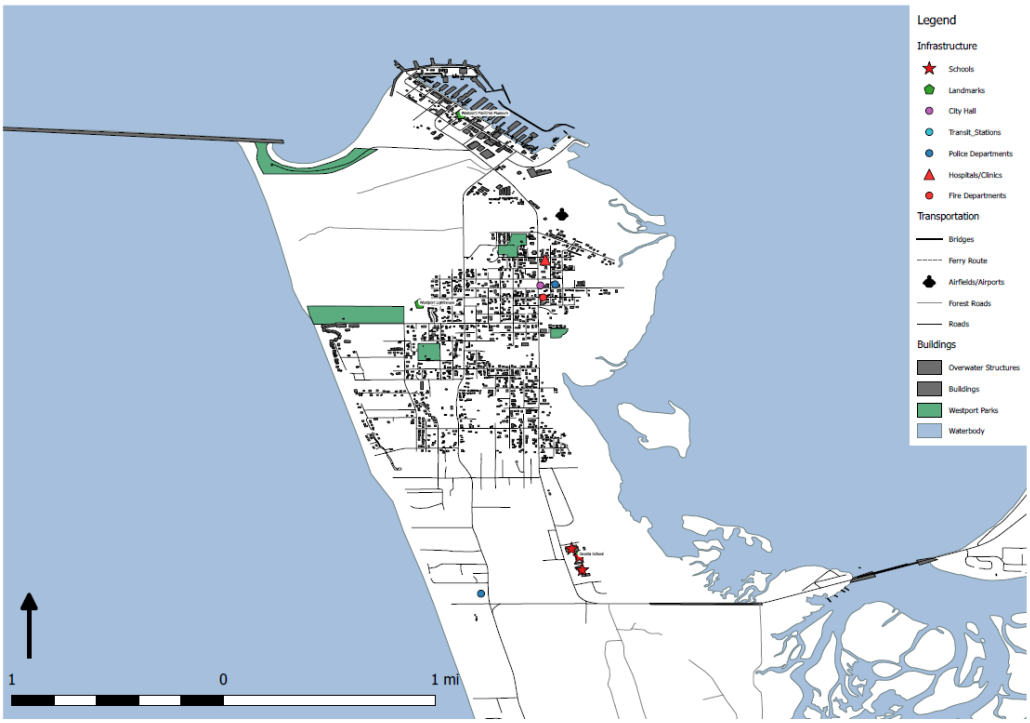

Figure 34. Base Map of Westport Prepared for the Workshop

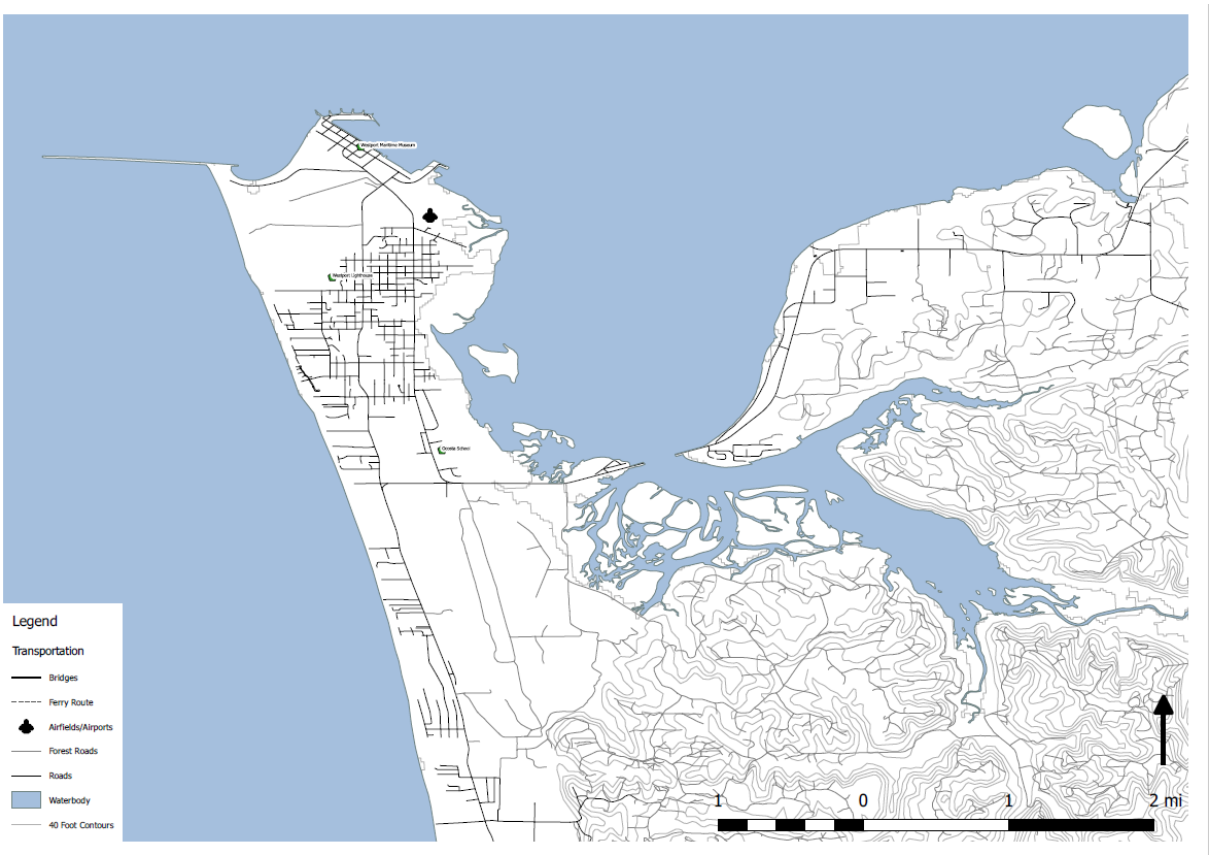

Figure 35. Base Map of the Peninsula Prepared for the Workshop

After the values and assets brainstorm, facilitators shared a video about social capital[4] and a brief presentation on emergency preparedness.[5] The Round Two discussion asked participants to review their list of values and assets, identify any values that are not adequately supported by existing assets, and brainstorm ways to strengthen assets to better support values.

The UW team then presented information about hazards, as "Stories of Coastal Change and Survival." This session included some very basic science on SLR, M1, and L1 hazards. Rather than show the simulations of M1 and L1 tsunami flooding depth used in the Partners Workshop, this session of the Community Workshop reviewed the State Department of Natural Resources' latest tsunami inundation maps (based on an L1 scenario) and reviewed Westport's prior work beginning with Project Safe Haven up through the construction of the new Ocosta Elementary School evacuation structure, and the role of this facility in hazard mitigation and life safety.[6]

[4] Social capital video can be found here: https://www.fema.gov/preptalks/aldrich.
[5] Emergency preparedness presentation included the following FEMA videos on first aid response: Why You Need to Stop Bleeding Right Away, https://www.youtube.com/watch?v=z331Zcmropc; How you stop bleeding, https://www.youtube.com/watch?v=e1nR5stSZn0; You are part of the team, https://www.youtube.com/watch?v=i8Wc5VwksPU
[6] *Project Safe Haven: Tsunami Vertical Evacuation on the Washington Coast; Grays Harbor County*, 2011, report available at https://mil.wa.gov/uploads/pdf/emergency-management/haz_safehavenreport_graysharbor.pdf.

As in the Partners Workshop, this session of the Community Workshop also presented images of historic coastal change, shown in Figures 14-16, and the UW team asked respondents for memories of the 1964 Alaska Earthquake and tsunami. Participants recalled their memories of the ground shaking and being afraid, including being woken up from sleep by the shaking. One participant reflected on how that experience made her more aware of the forces beyond our control, and that she is grateful for the opportunity to discuss preparedness.

For the final Round Three discussion, facilitators asked participants to imagine how the community could adapt to, prepare for, or take advantage of the "new normal" suggested by each scenario, including brainstorming strategies that would help Westport/South Beach continue to support its values, and even address some of the everyday needs identified in Round Two. The SLR, M1, and L1 subsections below include details from these discussions.

3.3.1. Sea Level Rise Scenario

The two SLR discussion groups identified and discussed the following values and assets included in Table 11. Figures 28 to 31 below show the assets that the SLR group mapped.

Table 11. Community Workshop SLR Discussion of Values and Assets

Values	Assets
Access to fresh food	Fishermen, seafood market, hunters, clam digging is a draw for visitors
Recreation opportunities and access to nature and open space	Surfing, ocean, beach access, roads/trails suitable for running, biking trail, city park
Quality educational opportunities	School, including events and activities, library, Ocosta School building
Desirable location that people enjoy visiting	Tourism opportunities, including state park and fishing opportunities
Small, quiet town	Small population
Rich maritime history	Museum, lighthouse
Sense of community and community values	Residents, strong work ethic, self-reliance, skilled craftspeople
Clean air and water	Wastewater treatment plan, wells
Access to the wider area	Airport, logging roads that could be used for evacuation
Employment opportunities	Cranberry bogs/industry, jobs provided by the shipyard, seafood industry
Availability of goods and services in Westport	Hospitality and accommodations, pharmacy (which sells some groceries), grocery store, good restaurants that draw visitors from the wider area (but may be closed during the week)

Paula Ackerlund, who as Superintendent of Schools at the time led the effort to rebuild the school, gave a brief presentation of the school's features.

Figure 36. Community Assets Identified by Saturday SLR Group 1 - Region

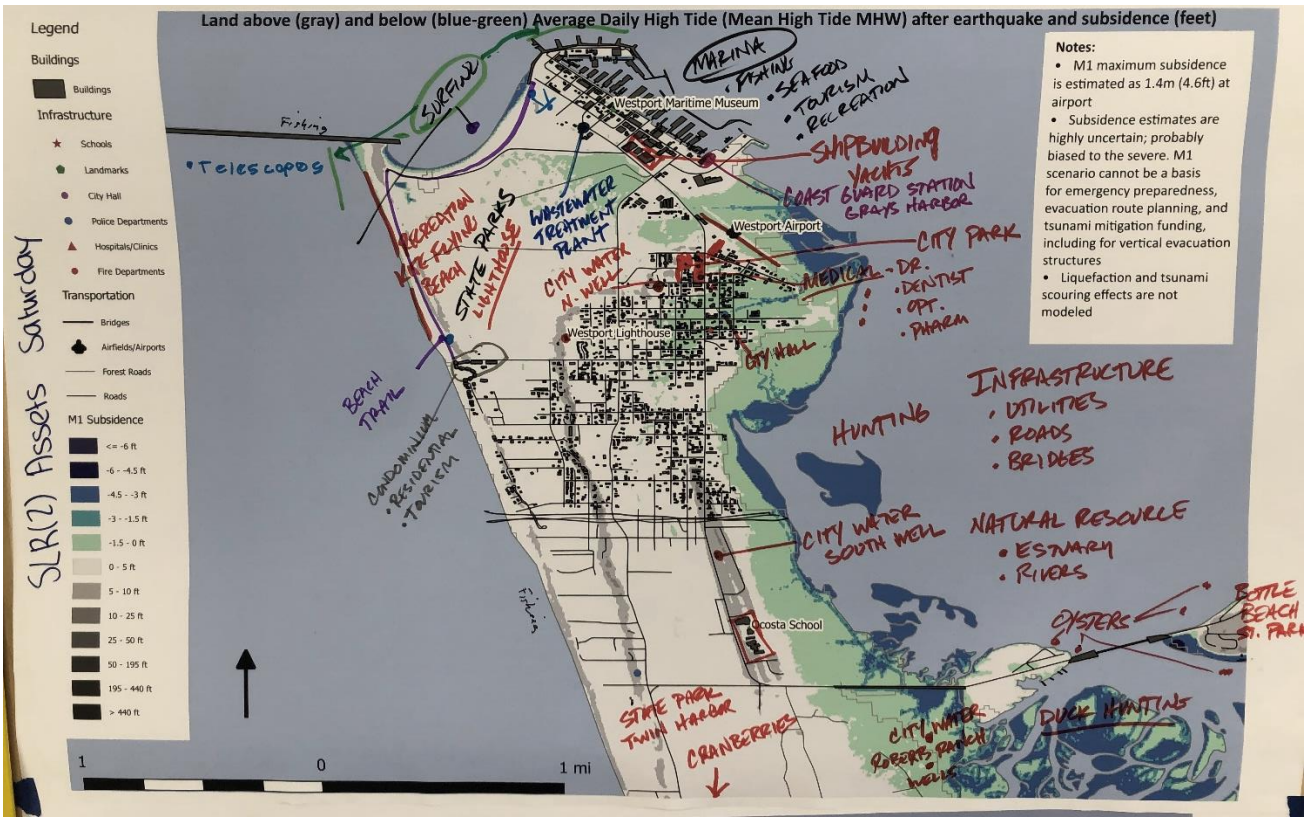

Figure 39. Community Assets Identified by Saturday SLR Group 1 - Westport

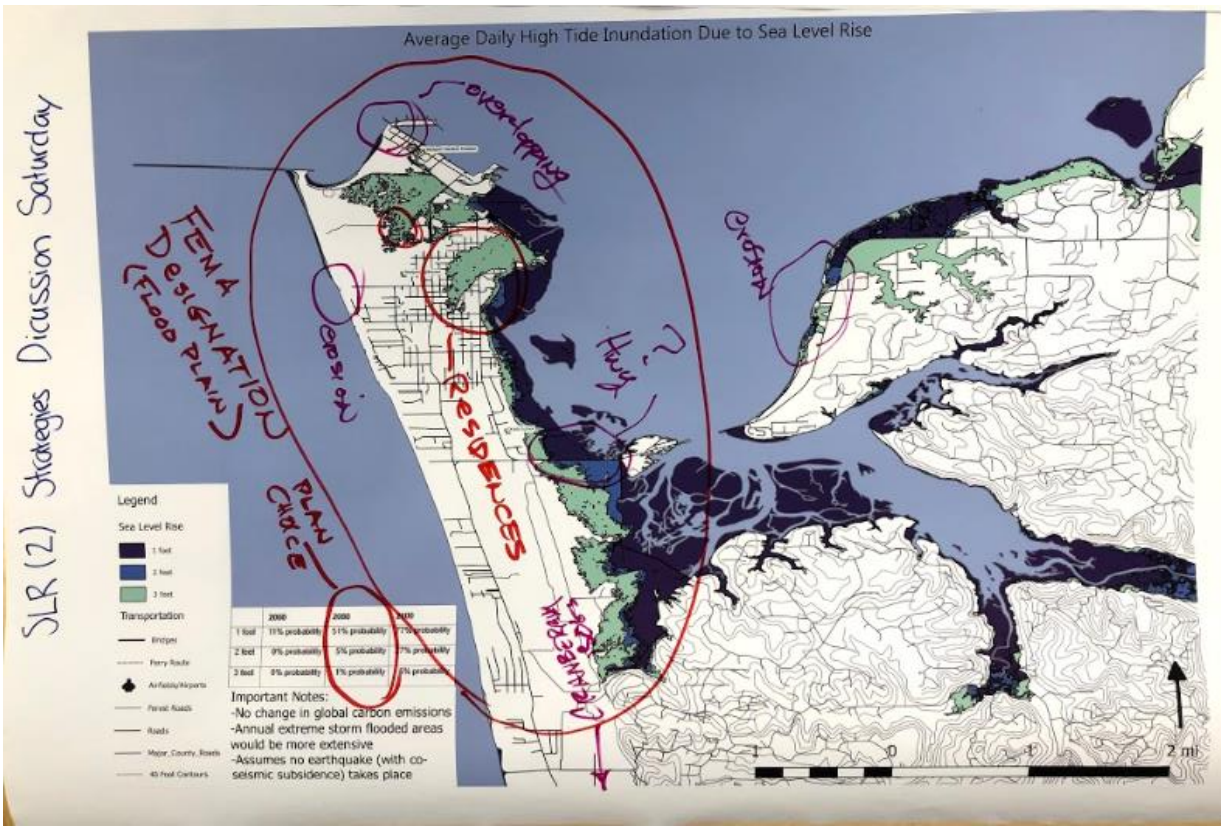

Figure 38. Community Assets Identified by Saturday SLR Group 2 – Region

Figure 39. Community Assets Identified by Saturday SLR Group 2 - Westport

In addition to the values and assets listed in Table 10, participants discussed the following during the values and assets brainstorming session:

- Westport is a place that has many assets – but it can be challenging year-round when restaurants and shops are closed in the winter
- The community has an "underdog spirit" that helps people band together; there is a sense of needing to face challenges and be able to be self-reliant (e.g., repair boats, cars, houses)
- While there are employment opportunities and industries that are valued, many people do not work
- There may be new recreation assets – such as potential campgrounds that the state park is developing

After discussing values and assets and hearing the presentation about social resilience, the group reviewed their list of values and assets, identified those that are not adequately supported, and brainstormed ways to better support these elements. Table 10 includes values and assets that participants identified as vulnerable, and opportunities for supporting these values and assets.

Table 12. Community Workshop SLR Discussion of Vulnerable Values and Opportunities for Strengthening

Vulnerable Values and Assets	Vulnerabilities and Opportunities for Strengthening
Education and preparedness	• Many tourists will not know what to do in an earthquake or tsunami, need signage and meetings related to hazard preparedness, potentially through hotels and restaurants. • There may be a mentality that if people can make it to a facility that has supplies after an event, they will be taken care of. Need to promote individual preparedness so that people have supplies and are more self-sufficient.
Community involvement	Neighbor groups can enhance/provide community support; breaking down the community into smaller groups can help
Housing and lodging	Shortage of affordable housing needs to be addressed
Infrastructure	• Retrofitting bridges is needed now as a preparedness step, other improvements needed though infrastructure is generally pretty good. • Currently building a new water facility on higher ground that could hopefully withstand an M1 event
Access to wider region	Have logging roads that can be used for access if bridges are compromised, but there may be gates; need to work on gaining access, such as through conversations with forestry logging industry
Health/medical facilities	Have medical facilities in town, but could consider moving facilities and/or supplies to high ground
Services and amenities	Grocery stores close very early, could need to be addressed

Other topics discussed included:

- Response and planning are limited to within the City of Westport; people who live to the south will need to rely on the county; could consider someday annexing southern area where school is located
- It will be important to work with the county on expanding vertical evacuation; city needs more than one vertical evacuation location
- Need to coordinate with the county on mitigation

After the presentations of potential hazard scenarios and information about Westport's vertical evacuation structure, participants discussed how the community could adapt to, prepare for, or take advantage of the "new normal." The Saturday SLR group focused on the 2080 SLR scenario that has a 55% probability of occurring. Discussion included the following:

- Beach erosion needs to be incorporated into planning; SLR and erosion become more critical with storms, and storm surge will flood areas in the marina. Dealing with erosion can be a political issue – there may be a need to add more sand, but this is not permitted by the Department of Ecology.
- 100 years can go by pretty fast, meaning that SLR scenarios may be reality sooner that it seems. However, there is difficulty addressing SLR because of bureaucracy issues with the Army Corps of Engineers and general political environment where some politicians don't believe in global

warming. There is a need to start planning today to address future SLR risk, but projections may change in the future.

- Given that flooding will be significant, there may be a need to pass laws restricting new development in wetland areas, but there could be pushback and blaming of the city if restrictive new laws are passed. However, there is a need for new codes for flood-prone areas; some cities adopt international building codes, because usually FEMA decides the codes. Most of Westport is not in floodplain based on FEMA assessments, which could lead to political problems addressing flood risk. Flood-related regulations may mean that it will cost more to build homes and/or obtain insurance, which will have opposition.
- High priority risks include potential flooding of the highway, which would need to be moved, and the fact that saltwater will kill valuable cranberry bogs.

3.3.2. M1 "Like the Last Time (1700)" Earthquake and Tsunami Scenario

The M1 discussion group identified and discussed the following values and assets included in Table 13. Figures 32 and 33 below shows the assets that the group mapped.

Table 13. Community Workshop M1 Discussion of Values and Assets

Values	Assets
Local industries and employment opportunities (e.g., maritime industry, cranberry industry, etc.)	• Marina and seafood processing plants drive local revenue. The Westport shipyard, Washington Crab Producers, and Ocean Gold provide a ton of jobs and support the seafood industry • Ocean spray provides jobs and is located further south. The Markham factory is where they make craisins. The berries for juice and fresh are shipped to Henderson Nevada.
Supportive community and strong networks	Community organizations and support networks, including: • Christian outreach group, which provides free food, monetary resources to support those in need; is a cooperative of all the churches in the area. Located at the corner of Veterans Forest in the Living Hope Church building. • The Giving Freely Westport Facebook Group gives surplus stuff to neighbors, is a group of about 25 people, is also a way for neighbors to meet • Catholic Church • Food banks, where people donate and cook Thanksgiving for people in need
Supportive community and neighbors	Elementary school and high schoolers help each other, neighbors know each other
Access to fresh food and seafood	Community garden, clamming along the beach south of the jetty
Good services and security, government institutions	• Westport has the Coast guard, City Hall, fire department and ambulance and an engaged police department who actually checks in on people and businesses; people like the Police Chief are an asset • Citizen academy, crime watch • Emergency services/EMS

Values	Assets
Historical character and livability of a small town	• Small town is comfortable and livable • Lighthouse, museum, etc.
Good access to nature and ocean	Beaches, lighthouse trail, walkable for the community, big state park
Mom n' pop character of local businesses	Local restaurants and stores
Clean water	Water treatment plant
Access to wildlife and shellfish	Clamming along the beach south of the justice
Access to the outdoors, nature, ocean and healthy lifestyles	• Campgrounds, twin harbors state park, national forest, lighthouse hiking trail that used to be a boardwalk • Open spaces, nature, some of the best air in the entire state • Temperate weather • Beaches
Sense of opportunity and affordability	• Affordable real estate and the sense that people can open businesses if they want to
Places that are attractive to tourists	Beaches, State Parks, etc.
Access to good education	Small schools

Figure 40. Community Assets Identified by Saturday M1 Group – Westport

Figure 41. Community Assets Identified by Saturday M1 Group – Region

Table 12 includes values and assets that participants in the M1 discussion identified as vulnerable, and opportunities for strengthening values/assets.

Table 14. Community Workshop M1 Discussion of Vulnerable Values and Opportunities for Strengthening

Vulnerable Values/Assets	Vulnerabilities and Opportunities for Strengthening
Access to the outdoors; clean beaches	Need beach cleanups; beach is often a mess after the tourists come here
Fishing industry	• Marina is vulnerable to SLR and tsunami, would need to be reinforced • Vulnerable to regulatory impacts; people say that the town used to be twice as big as it is now, but have been hit hard by fishing regulations
Benefits from tourism economy	Need education for tourists and visitors about hazards
Supportive community organizations	• Need emergency supplies at the senior center and schools (ex: bottled water, blankets, cots) • Need food delivery for seniors because food is costly here • Need senior and accessibility transit
Infrastructure provisioning	• Water infrastructure needs strengthening

Vulnerable Values/Assets	Vulnerabilities and Opportunities for Strengthening
	• Need to improve drainage on the peninsula (e.g., state park has ponds that fill) • Need to improve accessibility throughout the community. Currently, it's hard for seniors and disabled people to get around. Need bike lanes and crosswalks with lights.
Employment opportunities	• Need more connectivity to the wider region (e.g., Ocean Shores); Ferry to Ocean Shores is in progress; would need a supporting bus that runs on the weekends to make this effective • Need more housing and employment synergy to wider region, need more access to Ocean Shores for activities, particularly for young people
Historic buildings	Need earthquake triggered access doors to the lighthouse
Character of having local mom n' pop businesses	There are many for-sale signs, which gives the impression that there the town is dying; need to work on keeping businesses here.
Strong community	Need a place for young people to gather, like a skating rink to keep the kids busy
Emergency services and preparedness	• Need a response plan and triage approach • AEDs & medical supplies needed across locations • Need first aid and medical training, especially for seniors

Participants next discussed options for adapting to and preparing for the new normal, focusing on new strategies to support community values and assets and mitigation needs. Discussion included the following:

- **Transportation:** There is a need to address vulnerability of the bridge and options for getting in and out of the peninsula; this would be a first priority in recovering from an M1 event. There is discussion of adding a ferry system. The airport is critical for getting supplies in and out and could be moved to the other side of the peninsula to mitigate flood risk; if not possible, Westport could access the private airport.
- **Relocation:** If the M1 event were to occur, Westport could rebuild in a new location on high ground. Participants suggested rebuilding up on the hill in Grayland, and then where they would safe in the event of an M1 event happening again – the town could be "Grayport" or "Westland." Hills and high ground could provide a long-term option after a tsunami. However, participants expressed concern about abandoning Westport following an M1, because based on the subsidence map, they think the city could recover to some extent in its current location.
- **Hazard recovery assets:** The safe haven structure would probably still be standing, and the Coast Guard and military would help respond to an M1. There is a need to determine how these entities would access Westport (e.g., via a logging road because there would be no bridge).
- **Risk of isolation:** Westport is vulnerable to isolation; creative solutions like logging roads, a ferry system where the coast guard could land ships and access people at a dock, seaplanes/a water airport could all mitigate this risk.
- **Engineering solutions:** Participants discussed the possibility of raising sections of Westport using dredged material to elevate lowlands before an event creates a need to rebuild or requiring that new construction is built higher than the present level. Lessons could be learned from Alaska towns with regards to this solution. Other ideas included building levees to protect the marina and bringing in fill to pre-empt flooding hazards. Participants liked the idea of reinforcing the

bridge and other areas as appropriate now to pre-empt an event. Some cited examples that the Army Corps is working on protecting other areas of the coast. However, some participants noted that these solutions can cause adverse impacts (e.g., dredging can cause loss of the dunes as is happening in Washaway Beach) and could be damaged by a tsunami wave. Furthermore, land gets built back up naturally after a tsunami event.

- **Rebuilding:** Participants noted that rebuilding could be difficult for the elderly and the rebuilding process might require that Westport change its appearance. Participants suggested that the city might need more high-rise buildings because there will be less land available for housing; older prefab homes will be gone, and the city will need housing to be rebuilt.
- **Local economy:** Some aspects will remain unchanged after an event. For example, Westport will still be primarily a fishing town, and will still need business and industries to support the fishing industry, which will recover. Participants discussed recovering Westport's economy after a tsunami, including that the city is unique now because of local businesses and a lack of franchising. Some participants emphasized that they would want to preserve local character; however, some noted that they may need to court franchises and investment to generate rebuilding efforts. They noted that Washington is growing and there could be pressure for expansion here. They agreed that the oyster growing business wouldn't be affected long-term, though the oyster beds would have to be re-established and/or re-zoned. The cranberry industry would be vulnerable because cranberries grow in peat bogs and don't like salt. Commercial fishing would still be available, but there may be a need to replace the Marina.

3.3.3. L1 "Maximum Considered" Earthquake and Tsunami Scenario

The L1 discussion group identified and discussed the following values and assets included in Table 15 below. Figures 34 and 35 below shows the assets that the group mapped. The discussions of values and assets in the L1 group were influenced by the magnitude of the event. Some participants had difficulty identifying values and assets in a pre-disaster context, and others focused on the magnitude of the potential wave and emergency response (e.g., fire department, coast guard, etc.).

Table 15. Community Workshop L1 Discussion of Values and Assets

Values	Assets
Strong community bond	Schools
Having skilled, hardworking, and open-minded residents	Human resources/people in the city: mechanics, seafood processing workers, fishermen; independent and resourceful individuals with skills
Having access to fresh foods	Forests, oyster farms, elks hunters, Marina docks
Having natural resources for recreations: hiking, walking on the beach and surfing	Camping grounds, blue sky, long beach walks, playgrounds, two surfing spots in the city, surf shops and surfing community, beach trails
Economy opportunity	Vacant lots in the business center, possibility of farming, possible new employment opportunities at the State Park, logging, fishing industry, cranberry industry
Safety and security provided by the city	Airport, Coast Guard, water towers (public and private owned), no traffic
Resiliency provided by the city	fire department, communication system, broadband technology

Figure 42. Community Assets Identified by Saturday L1 Group – Westport

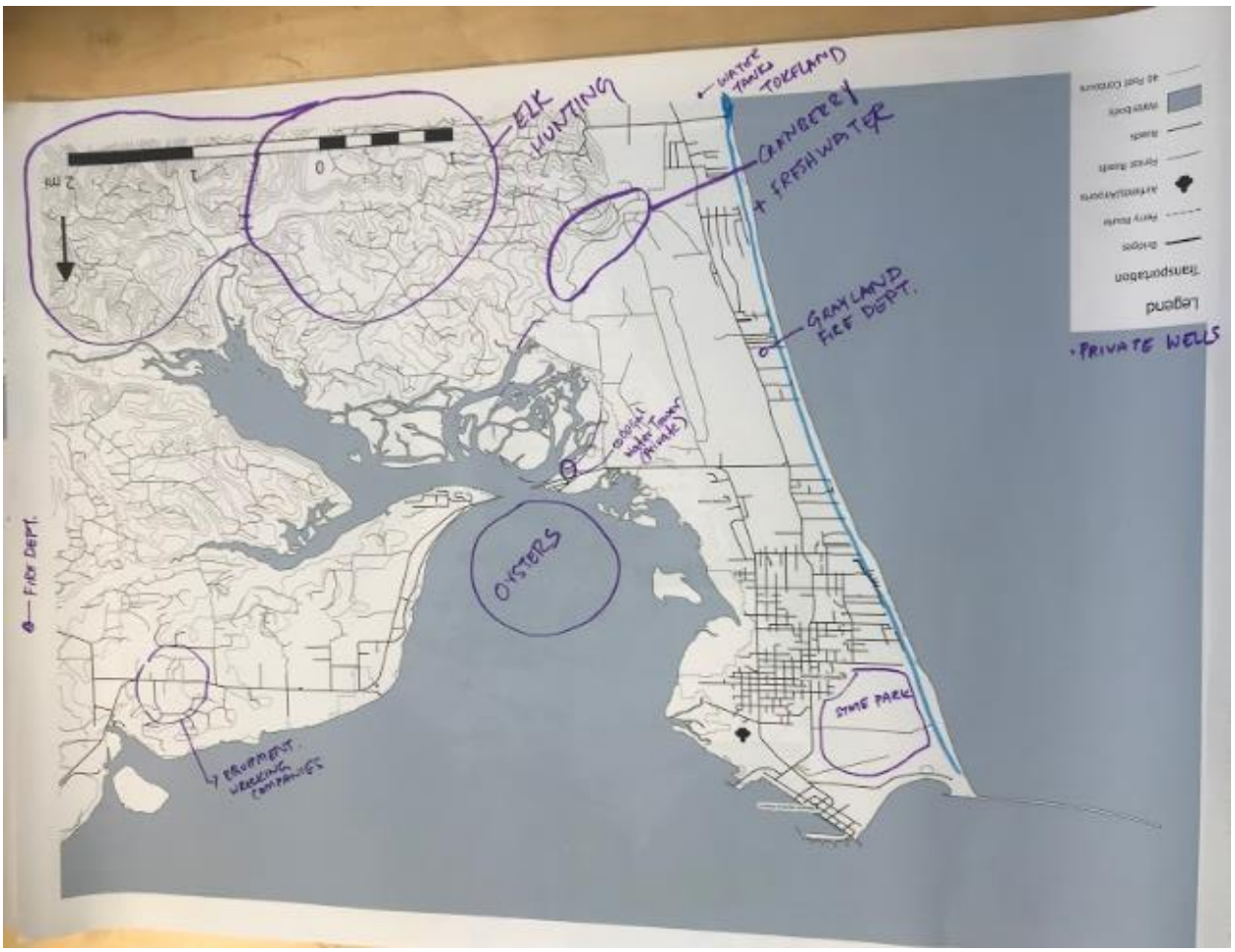

Figure 43. Community Assets Identified by Saturday L1 Group - Region

The L1 group then discussed values and assets that are vulnerable to hazards, identifying the following vulnerabilities:

- Communications systems, including internet access
- Economic diversity
- Vital facilities/services, including fire department and EMS, radios, powerlines, generators, port systems, signage, water resources, transportation system
- Tourism industry and visitors

With regards to adaptation to a "new normal," the L1 group focused on ideas including relocating the community to a safe areas and/or increasing the height/level of the road systems and bridge.

3.3.4. Values and Assets Storytelling

The Community Workshop had two opportunities for report-back and storytelling to the whole room. The first story-telling opportunity followed the values and assets discussions held at the individual tables in Round One. Values and assets stories shared by representatives from each group are included below.

Group 1: *"Once upon a time, along the coastal shores of Washington, there was an idyllic community called Westport. This place had blue skies, fresh water, razor clamming, and long beach walks. It became*

not just a place for us to live, work, and play, but also became a playground for people from Portland and Seattle to come; these people appreciated that they could drive here on uncrowded roads and experience a quality of life that was not hectic. Here, we value our resiliency, independence, and helping and supporting one another. This community was worried because they found that they were subject to natural disasters, and due to the remoteness of the community and the distance from urban areas, the community would have to rely on itself. But the community had lots of assets and resourceful people who like to meet together and work on issues these. So, they met and discussed what they could do and prioritized strategies. This community had so much resilience and such a can-do attitude, and so much awareness, they built the first vertical evacuation structure in North America."

Group 2: *"Once upon a time in Westport, we valued our small community, the feeling of closeness that you can only have in a small down. We valued our fishing industry and the jobs that it provides, diverse cultures and people coming together, the cranberry industry, our schools, and our community gardens. We liked that we have lots of beaches where you can even see bald eagles; you wouldn't find that back home in Indiana. The weather here is so nice that the tourists come visit us – there's only 30 degrees variation during the year, and no snow. We liked that it's not heavily industrialized or commercialized, not tore up or denuded; it's still beautiful and untouched. There's green everywhere. You can see deer, see elk; you can go crabbing for dinner. Anyone here can go get a fresh seafood meal and it doesn't cost a fortune. You just have to take the time and go sit on dock with the other who are out there trying to catch their dinner. Everyone here is coming together to make things better, for us all to grow and prosper. And we value our traditions."*

Group 3: *"Once upon a time there was a sleepy fishing village with more salmon than they knew what to do with. As the resources dwindled, people didn't stop coming, so the town diversified. It added services, recreation opportunities, so that full time residency could be more convenient here in Westport. We value that we are a small town that has a can-do attitude and a working-class mentality. Westport has banded together not only for recreation services, but also health services, food services, and an operational marina which is pretty unique – not many communities have a big marina like that."*

Group 4: *"Once upon…. The traffic and stress of [the city] drove him out here, dragging his wife with him. They moved to a small community on the coast of Washington. He fell in love with the place that had one stoplight that was shut off after Labor Day and not turned back on until Memorial Day. They liked the beach, clean air, and schools – this was a surprise because they were coming from [a place with big schools and they weren't sure how it would compare]. They liked that everyone knew everyone; and people were independent – the fishermen were independent business people. They liked that there was a community value of hard work. Westport kids got up early worked harder than any other kids they had seen. There were seven and eight-year-old kids cleaning fish on the docks in the mornings, and the children of business people worked for the family business. This led to independence. They liked the general quality of life, it's probably the most giving community they had ever witnessed. When people need something, people rally around and get it to them. They didn't like that the community was resistant to change. Over the past 40 years, this has changed; this community now wants to move forward in every way possible. When you come down I-5 and turn the corner, your stress just drops… and by the time you get to the beach, it's gone."*

3.3.5. Adaptation Storytelling

Later during the meeting, participants had another opportunity to use storytelling to share the discussions from their table groups. The second storytelling session focused on adaptation and resilience to hazards.

Group 1: ***"****A long time ago in a galaxy far away… there were lots of diverse opinions. In our group, we were looking at pre-planning and post-reality. Pre-planning, we were thinking about how we can prevent destruction. Maybe geotubes, levees, dykes, and vertical evacuation structures that have double and triple uses and roles. How do we minimize loss of life and community viability? We need to protect the economy, commerce, viable transportation, and utility corridors for power and transportation. Thinking about the post – scenario, how much destruction do you have to deal with and what are the realities?"*

Group 2: ***"****Once upon a time in Westport, with strength and determination, the town was able to regrow from a tsunami. They devised a water airport for supplies while the bridges were being rebuilt. Some people moved up on the bluffs to escape the congestion. They built high rises to house people. Our biggest asset is fishing industry and it was not affected. The oyster beds moved inland as the land receded, the docks are still there, much of our tourism is based on deep sea fishing and we would still have that. We would just need to move and shift a bit and I believe we would be fine. This town is strong, we are survivors, it's a close-knit community, and we would be strong in the face of adversity."*

Group 3: ***"****We are dealing with sea level rise in the year 2080. The challenges are both physical and political. The physical changes that would need to take place would need to be taken care of in a political manner. Flood plain inundation would be residential and commercial – the docks and marina would be affected. We would have to go through the political wrangle of why you would require stricter and more costly regulations, that would be more prohibitive of what you can and can't do with your property. Inundation would affect municipal and commercial infrastructure and would have effects on the residential areas and transportation corridor. We are in for another political wrangle."*

Group 4: ***"****We chose to focus on 11% chance of 1 foot of sea level rise by 2060. Recognizing the assumptions that these predictions are made based on current information of climate change, and projections could be different. Under this scenario, we would lose access to Aberdeen. The road would be under water in the Ocosta curve. Up by O'Leary Creek would also be under water and the bridge would be inadequate. We would lose the airstrip. The bridge would be a difficult situation. This is an opportunity because there are other reasons to replace the bridge and straighten the curve other than safety under SLR. In South Beach we have a history of successfully moving roadways because of encroachment."*

4. Workshop Feedback Survey Results

Coastal Resilience Project – Westport Workshop Survey Results 11.16.2018

Instructions: Please answer the questions below using a 1 to 7 scale (1 = not at all to 7 = extremely).	
Questions	**Response average**
1. In general, would you say that people try to be helpful?	5.8
2. In general, would you say that people are looking out for themselves?	5.2
3. How concerned are you about sea level rise?	5.4
4. How concerned are you about a Cascadia Subduction Zone (CSZ) earthquake and tsunami?	5.9
5. After participating in this workshop, do you feel you have a greater understanding than before of the possible impacts of sea level rise or a CSZ earthquake and tsunami on your community?	6.3
6. How confident do you feel that your community will thrive even as sea level rises?	4.9
7. How confident do you feel that your community will recover from a CSZ earthquake and tsunami?	4.1
Two weeks after a Cascadia Subduction Zone earthquake and tsunami, who are you expecting to rely on for help? (Circle one for each)	
a. People in my home	6.0
b. People in my neighborhood	5.2
c. People from my church or faith-based group	3.6
d. Non-profit organizations	4.2
e. Fire, police, emergency services personnel	5.2
9. Describe what you expect the City government of Westport to do after a disaster.	
Take care of its people first!	
Emphasis on rebuilding and re-instate means to sustain life for the collective good. Be open to improvements! Thanks so much for this workshop!	
Volunteer guidance and assistance. Begin finding/assisting survivors and assisting evacuation accessibility for all who need it.	
Not much.	
Not much if anyone survives than (illegible)	
As much as their resources allow.	
Abandon (illegible)	
Provide shelter, other services. Locate survivors. Arrange for rescue.	
Help as best as they can with all that they have available.	
Communicate, request state/federal resources. Organize relief/recovery efforts.	
Provide fuel, tools, and equipment for locals to clear their areas.	
Implement a working disaster plan.	
Panic and be overwhelmed. Rescue operations (evac, medical). Infrastructure removal and repair.	
Set up emergency medical stations. Help with accessibility of finding people.	
Door to door/enlist Coast Guard.	
The best they can.	
Keep people calm and looting down. Implement measures agreed upon. Coast Guard and National Guard.	
Do their best to help EVERYONE in need.	
Keep up the plan on recovering already set by preparedness.	
Whatever possible for less able/disadvantaged.	

Below are the results of a survey that the UW team circulated to workshop participants following the workshops to solicit their feedback and input.

5. Erratum: Corrected Map of Sea Level Rise Projections

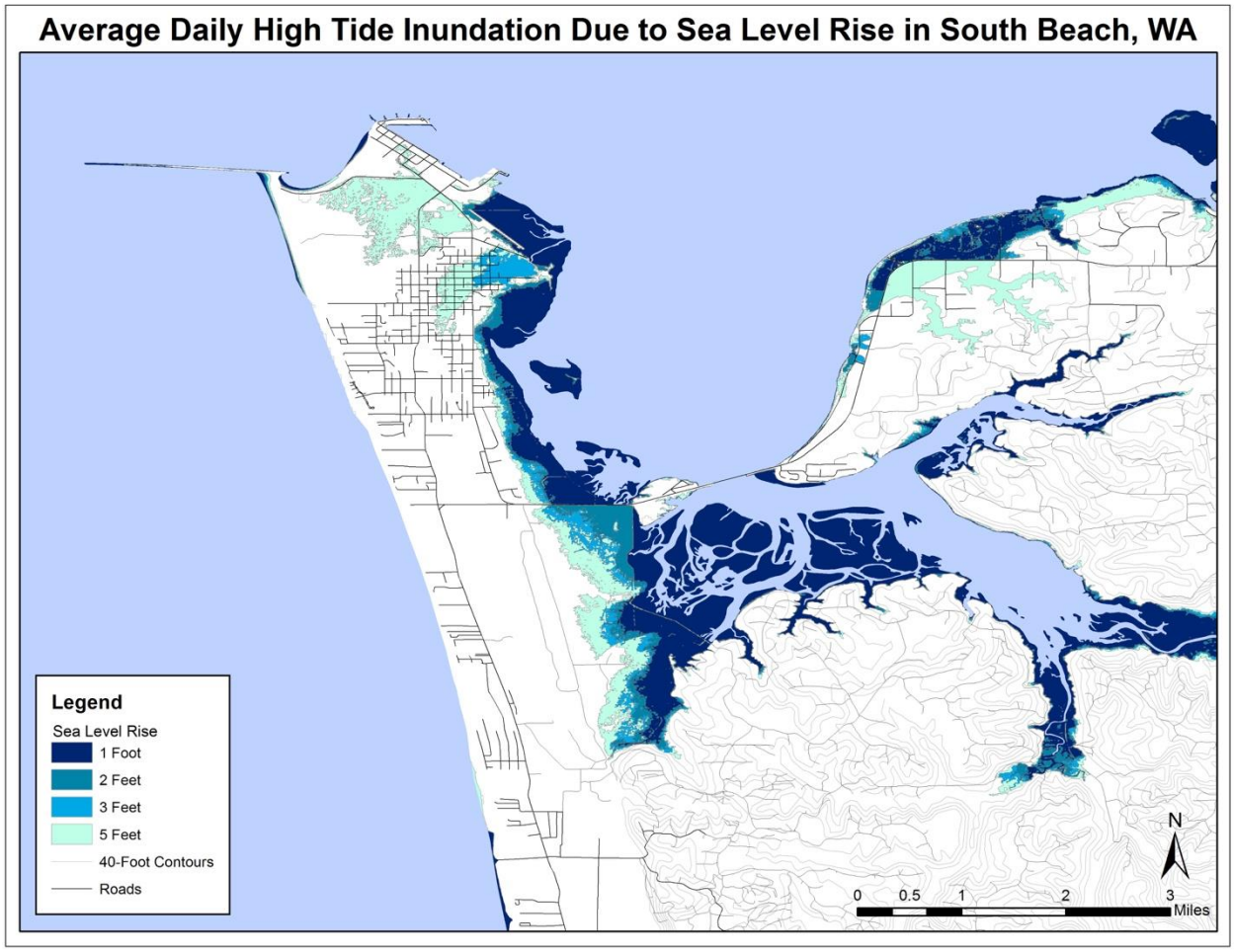

Figure 44. Sea Level Rise for Westport and South Beach, WA, corrected March 2019, post-workshop.

APPENDIX C: ONLINE SURVEY

Print view of 'UW CSET Survey on Potential for Drone Applications in Rural Emergency Evacuation and Management'

I. Background

This online survey is part of a project funded by CSET (Center for Safety Equity in Transportation). CSET works directly with RITI communities (Rural, Isolated, Tribal and Indigenous) as a catalyst for assessing their needs and identifying possible resources. The initiative focuses on transportation safety, education, training and workforce development programs.

The aim of this online survey is to understand the current challenges, issues and needs surrounding hazard scenarios in Washington State RITI communities. With this information, we will explore a context-sensitive solution using drones as a new technology. Based on our previous outreach work with RITI communities and agency stakeholders, including the City of Westport, the South Beach Regional Fire District, Grays Harbor County Emergency Management, Quinault Indian Nation, Shoalwater Bay Tribe, and the Washington State National Guard among many others, we divided the study into two scenarios: emergency and normal situations. We hope to identify possible drone applications for each type of situation, as well as a local partner willing to undertake a pilot project with us.

The survey is of course completely voluntary on your part; you are not obligated to answer any question, though we hope you will answer as many as you can. We'd like to ask you a total of 35 questions that cover three general areas.

First, we'd like to know about your emergency plans for major hazards including tsunamis, earthquakes, severe storms, or landslides. What are the challenges, especially related to transportation, that you see in these hazards? What are the current challenges during emergency situations (e.g., tsunami, earthquake)? What are your views on how emerging technological applications such as UAV (Unmanned Aerial Vehicle), or drones, could play a role in the emergency?

Second, we'd like to learn about the current challenges and opportunities for daily use of the proposed new technology.

Last, we would like to ask three questions about which community you work in, in what capacity, and for how long. Finally, we ask if you would be willing to have us call you for a follow-up interview, and/or to discuss the possibility of partnering on a pilot project, and if so, to provide us with your contact information.

And if at any point you have questions for us, please feel free to email Yiran Zhang at yiranz94@uw.edu, Prof. Jeff Ban at banx@uw.edu, or Prof. Dan Abramson at abramson@uw.edu.

Before we start, to help you better understand drone technology, we'd like to share with you a 12-slide brief introduction to drone tech and our project. The slides includes a two-minute video and link to a brief news item, and may take in total about ten minutes to read.

I. Emergency

The following questions are mainly related to tsunami evacuation. We would like to learn about the current challenges and barriers you face to managing such an emergency.

Question 1.

34 questions left ahead.

Imagine that you are facing a distant earthquake (originating in Alaska) that may generate a tsunami in your location. You have three hours to evacuate. What challenges, if any, do you anticipate to sending out the warning message?

Question 2.

33 questions left ahead.

Can you elaborate on the challenges of spreading the warning message?

Question 3.

32 questions left ahead.

During the evacuation, some transportation infrastructures, such as highways or bridges, may be vulnerable to damage from ground shaking, landslides, liquefaction, or flooding. Have you considered any plans to inspect bridges and other infrastructure during the evacuation?

- ○ Yes
- ○ No
- ○ Other:

Question 4.

31 questions left ahead.

Briefly, how would you conduct this evaluation?

Question 5.

30 questions left ahead.

What are the challenges to conducting this assessment? What new technologies (e.g., drones, Lidar) have you considered, if any, to overcome these challenges?

Question 6.

29 questions left ahead.

If you encountered an unexpected situation (for instance, liquefaction blocked roads or damaged bridges), do you have a plan to inform the residents and evacuees in your region?

- ○ Yes
- ○ No

Question 7.

28 questions left ahead.

How you plan to spread the warning and guide them to alternative evacuation routes?

Question 8.

27 questions left ahead.

Do you plan to employ any emerging technologies to send the warning message?

(If you find questions tough to answer/confusing, you can check the slide for more information)

- ☐ Smartphone apps / notifications
- ☐ Drones
- ☐ Social media
- ☐ Radio / television broadcasting
- ☐ Other:

Question 9.

26 questions left ahead.

Do you have a plan for guiding tourists—most of whom will be unfamiliar with the evacuation route—to refuge sites?

- ○ Yes
- ○ No

Question 10.

25 questions left ahead.

Please describe your plan for tourist evacuation.

(If you find questions tough to answer/confusing, you can check the slide for more information)

Question 11.

24 questions left ahead.

If your current telecommunication infrastructure fails, what back-up technologies do you have available to guide evacuees?

(If you find questions tough to answer/confusing, you can check the slide for more information)

Question 12.

23 questions left ahead.

Do you have evacuation plans for vulnerable populations? These could include, for example, people with disabilities, the elderly, or people who are homeless.

(If you find questions tough to answer/confusing, you can check the slide for more information)

- ○ Yes
- ○ No

Question 13.

22 questions left ahead.

What are the barriers to reaching vulnerable evacuees?

Question 14.

21 questions left ahead.

What technology do you plan to use for searching and rescuing? Can you explain your *plans?*

(If you find questions tough to answer/confusing, you can check the slide for more information)

Question 15.

20 questions left ahead.

Do you have a search and rescue plan for people with disabilities?

- ○ Yes
- ○ No

Question 16.

19 questions left ahead.

Can you explain the plans, if any, to use emerging technologies for searching and rescuing people with disabilities?

(If you find questions tough to answer/confusing, you can check the slide for more information)

Question 17.

18 questions left ahead.

During a tsunami, earthquake, or other disaster, what places do you expect will pose a danger to rescuers? What about after the disaster?

Question 18.

17 questions left ahead.

What is the plan for ensuring the safety of rescuers in these areas? What technologies (e.g., telecommunications, drones, helicopters) do you plan to use?

(If you find questions tough to answer/confusing, you can check the slide for more information)

Question 19.

16 questions left ahead.

Are there any plans to supply essential goods (medicine or food, for example) after the disaster?

- Yes
- No
- Other:

Question 20.

15 questions left ahead.

How do you plan to transport these goods to evacuees?

(If you find questions tough to answer/confusing, you can check the slide for more information)

Question 21.

14 questions left ahead.

Are there any places where you anticipate that normal delivery (by truck) will not be available during the disaster?

- Yes
- No

Question 22.

13 questions left ahead.

What are your plans for getting to these hard-to-reach places?

(If you find questions tough to answer/confusing, you can check the slide for more information)

Question 23.

12 questions left ahead.

What are the other obstacles to delivering goods?

Question 24.

11 questions left ahead.

If the disaster destroys the current communication system, do you have backups?

- ○ Yes
- ○ No

Question 25.

10 questions left ahead.

Have you considered using experimental technology (such as ham radio, wireless mesh network, drones) to help recover telecommunications? If yes, could you share with us the possible technologies you plan to use?

(If you find questions tough to answer/confusing, you can check the slide for more information)

- ○ Yes
- ○ No
- ○ Possible technologies:

Question 26.

9 questions left ahead.

II. Regulation and the Possibility for Daily Application of Drones

The following questions are mainly related to the opportunities and challenges for drone applications.

Have you considered using drones in disaster response situations before?

- ○ Yes
- ○ No

Question 27.

8 questions left ahead.

In which aspect do you think drones can see daily usage?

(If you find questions tough to answer/confusing, you can check the slide for more information)

- ☐ Transportation (Traffic Monitoring)
- ☐ Search and Rescue
- ☐ Photography
- ☐ Infrastructure Monitoring
- ☐
- ☐
- ☐

Telecommunication
Supply/Goods Delivery
Other:

Question 28.

7 questions left ahead.

Does your city currently place any regulations/restrictions on using drones in emergency situations?

(If you find questions tough to answer/confusing, you can check the slide for more information)

- Yes
- No

Question 29.

6 questions left ahead.

How about for normal situations?

- Yes
- No
- Other:

Question 30.

5 questions left ahead.

Can you briefly explain these regulations or restrictions?

Question 31.

4 questions left ahead.

What do you see as the barriers to applying new techniques such as drones?

(If you find questions tough to answer/confusing, you can check the slide for more information)

Question 32.

You have reached our last-question page, congratulations and thanks!

III. Personal Background

Last but not least, we'd like to know your background and a bit about the context of your experience.

With which community are you working?

- Westport/South Beach
- Ocean Shores/North Beach
- County

- ○ State
- ○ Quinault Indian Nation
- ○ Shoalwater Bay Tribe
- ○ Other:

Question 33.

In which sector do you work? (Select as many as apply.)

- ☐ Emergency Services (EMS)
- ☐ Planning
- ☐ Public Works
- ☐ Elected Official
- ☐ Law Enforcement
- ☐ Other:

Question 34.

How long have you worked in this sector?

Question 35.

Please provide your contact information (email address/phone) if you would be willing to have us contact you for a follow-up interview on your answers, and/or to discuss participation in a pilot drone project.

APPENDIX D: EXECUTIVE SUMMARY OF WESTPORT COSTAL RESILIENCE REPORT

Localizing Hazard Mitigation

Recommendations for Westport's Comprehensive Plan Update

EXECUTIVE SUMMARY

Prepared for the City of Westport, WA, by the University of Washington Urban Design & Planning Studio "Community Engagement for Coastal Resilience," URBDP 508B, Autumn 2018

A Report based on Community Responses to Tsunami and Sea Level Rise Scenarios for purposes of Integrating the Grays Harbor County Multi-Jurisdiction Hazard Mitigation Plan with the City of Westport Comprehensive Plan

November 21, 2019

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Project Summary

As the first community in North America to build a tsunami vertical evacuation structure (at the Ocosta Elementary School), the Ocosta School District and larger Westport-South Beach community has demonstrated extraordinary political will, community spirit, and long-term thinking. The City of Westport is considering additional vertical evacuation structures within the city limits, as necessary for the safety of its residents, visitors and employees. To ensure that these structures are cost-effective, function in a variety of possible emergencies, and also enhance daily life in the community, the City has partnered with the University of Washington's Department of Urban Design and Planning (UW Team) in a Coastal Resilience Project. Project goals were established in a Memorandum of Understanding signed in September 2018 by Westport Mayor Robin Bearden and Prof. Abramson on behalf of the UW Team:

- Engage a broad range of local community members as well as municipal and agency stakeholders, including residents, the City of Westport, Shoalwater Bay Tribe, Grays Harbor County, Pacific County, State and local emergency management agencies, Federal representatives, and other stakeholders representing coastal ecology, transportation, public health, education, local businesses and historic resources.
- Support ongoing efforts to improve community resilience in the City of Westport and surrounding areas, including collaborative efforts among multiple coastal communities.
- Identify opportunities for integrating equitable and just localized hazards planning with general community development planning, urban design and public health via the City's Comprehensive Plan update and other infrastructural improvements, including transportation and telecommunications.
- Learn from the successes won and challenges faced by the City of Westport and its residents to inform ongoing policy decisions around hazard planning and to share lessons learned with other communities both within our region and beyond.

In accordance with these goals, the attached full report provides detailed recommendations for integrating hazard mitigation strategies (from the Grays Harbor County Multi-Jurisdiction Hazard Mitigation Plan) into the City of Westport's Comprehensive Plan (Comprehensive Plan). Although the scope of the Comprehensive Plan is broader than hazard mitigation, the recommendations focus on opportunities to incorporate hazard mitigation into the plan and highlight potential co-benefits of these strategies. The recommendations should be viewed as possible answers to the question: How can mitigating coastal hazards in Westport also help the community achieve its everyday goals for development? Westport will need to complement these recommendations with other considerations related to community development and resilience when updating the Comprehensive Plan.

Process

An interdisciplinary group of students and faculty from the University of Washington's Department of Urban Design and Planning (UW team) developed the recommendations through a Coastal Resilience Project conducted with the Westport Tsunami Safety Committee and other community members. The Project involved reviewing the Comprehensive Plan and the Grays Harbor County Multi-Jurisdiction Hazard Mitigation Plan (County HMP), conducting additional research, including an extensive, quarter-long community engagement process in Autumn 2018. Engagement activities included two workshops held in Westport in November and a public open house in December.

The County HMP identifies earthquake, tsunami, erosion, and flooding as the top hazards of concern for Westport, though Steering Committee members asked the UW team to consider severe weather and climate change as possibly also deserving high priority attention. For discussion in the workshops, the UW Team prepared maps of multiple tsunami scenarios and sea level rise (SLR) scenarios, reflecting a range of severity and likelihood of different kinds of hazards facing Westport. Input from the workshops, open house and other follow-up meetings, and pre-workshop site visits are discussed throughout the full report. Appendix A to the full report includes detailed documentation of the workshops themselves.

Recommendations

The County HMP Westport annex listed six initiatives which can conceivably align with different elements of the Comprehensive Plan: (1) Vertical Tsunami Evacuation Structure; (2) Public Outreach Program; (3) Emergency Management Plan; (4) Emergency Communications Plan; (5) Critical Facilities Evaluation; (6) Transportation and Right of Way Improvements. The Comprehensive Plan currently includes six elements: Land Use, Transportation and Circulation, Economic Development, Community Appearance and Natural Resources, Area-Wide Development, and Shorelines Goals and Policies, as well as other chapters focused on overarching goals and objectives and implementation. The UW Team has drafted recommendations for updating each of the six existing elements, as well as adding a new element, Health and Well-Being:

- **Land Use Element:** Highlights opportunities to utilize land use-related tools and approaches to increase resiliency to flooding and other hazards. The section emphasizes approaches including land acquisition and strategic location of critical facilities, hazard-resilient buildings and infrastructure, and water management as key opportunities to mitigate hazards.
- **Transportation, Circulation, and Telecommunications Element:** Identifies opportunities to strengthen existing transportation plans and infrastructure to support evacuation and disaster response. This section also recommends including Telecommunication and proposes innovative technologies for improving internet access and other forms of communication.
- **Economic Development Element:** Describes areas of alignment between hazard mitigation and Westport's economic development goals. Recommendations include renovating existing structures to provide multi-purpose benefits, e.g. both vertical evacuation and event space.
- **Community Identity and Natural Resources Element:** Recommends dividing the current Community Appearance and Natural Resources Element into two new elements, with "community appearance" broadened to "community identity ". Recommendations describe creative opportunities for introducing new development and infrastructure that improves hazard resilience while maintaining and enhancing Westport's character and image.
- **Area-Wide Development Element:** Incorporates regional considerations into hazard mitigation planning and opportunities for accessing regional assets to increase hazard resiliency.
- **Shoreline Master Program:** Outlines opportunities to incorporate sea level rise (SLR) projections while promoting best practices for conservation and use of Westport's shoreline.
- **Health and Well-Being Element:** Proposes a new element focused on health and well-being of Westport residents, for both emergency response, hazard mitigation and long-term resilience.

Table 1 below includes a summary of key crosscutting recommendations; check marks indicate elements that include a recommendation relevant to the crosscutting themes identified. The full report includes more detail and specificity regarding strategies.

Table 16. Summary of Recommendations and Alignment among Elements

Crosscutting Recommendations	Land Use	Transp. & Telecom.	Econ. Devel.	Identity	Area Wide	Shore.	Health
Implement climate-smart and hazard resilient development and zoning based on best-available sea level rise/flood data, including in the Marina District	✓		✓	✓	✓	✓	✓
Build multi-use vertical evacuation structures that are integrated with community and economic development goals	✓		✓	✓	✓		✓
Develop innovative transportation and accessibility solutions		✓	✓	✓	✓	✓	✓
Consider securing access to higher ground, including assessing feasibility and identifying possible near-term uses	✓		✓	✓	✓		✓
Identify and implement creative adaptation solutions and land uses for low lying areas	✓		✓	✓	✓		
Improve evacuation/emergency response planning, training, preparedness, and communication		✓		✓	✓		✓
Support transportation infrastructure improvements (e.g., critical roads, bridges, airport) and transportation management		✓	✓		✓		✓
Strategically site/relocate critical facilities to low-risk areas within Westport	✓			✓	✓		
Improve drainage and stormwater infrastructure	✓			✓		✓	
Improve communications capacity and technology		✓	✓		✓		✓
Implement economic, community, and cultural development initiatives			✓	✓			✓
Promote sustainable land and natural resources management			✓	✓	✓		
Establish community health center	✓	✓					✓
Improve availability of community demographic and health needs data							✓
Support resilient, local food systems	✓		✓	✓			✓

Table 2 below includes a summary of crosscutting recommendations and provides a snapshot of the specific focus of each element relating to the crosscutting recommendations.

Table 17.Summary of Recommendations and Alignment among Elements (continued on following page)

Crosscutting Recommendations	Land Use	Transportation, Circulation & Telecommunication	Economic Development
Implement climate-smart and hazard resilient development and zoning using best-available sea level rise/flood data	Climate/hazard resilient building codes and infrastructure investment		Resilient infrastructure in the Marina; new cultural district
Build multi-use vertical evacuation structures that are integrated with community and economic development goals	Additional multi-use vertical evacuation capacity		New or retrofitted vertical evacuation infrastructure (e.g., Chateau Westport)
Develop innovative transportation and accessibility solutions		New ferry routes and vessel technology	New ferry and high ground trail network
Consider securing access to higher ground, including assessing feasibility and identifying possible near-term uses	Purchase, acquisition, or annexation of higher land		Acquisition of higher ground land
Identify and implement creative adaptation solutions and land uses for low lying areas	Funding to change use patterns in flood prone areas		Relocation of homes and restoration of flood-prone areas
Improve evacuation/emergency response planning, training, preparedness, and communication		Evacuation drills and route planning, emergency radio infrastructure, and emergency planning	
Support transportation infrastructure improvements (e.g., critical roads, bridges, airport) and transportation management		Improvements to key routes	Reconstruction of key roads/bridges
Strategically site/relocate critical facilities to low-risk areas within Westport	Research and evaluation of critical facilities siting		
Improve drainage and stormwater infrastructure	Improvements to storm and wastewater drainage		
Improve communications capacity and technology		Telecommunication improvements (e.g., LTE, low power radio)	Improved internet and cellular connectivity
Implement economic, community, and cultural development initiatives			Improved web presence and local art shops
Promote sustainable land and natural resources management			Conservation of open space for public use and ecosystem services
Establish community health center	Co-locate with vertical evacuation structure	Co-locate with broadband internet access	
Improve availability of community demographic and health needs data		Enhanced disaster medical response	

Support resilient, local food systems	Zoning for community food gardens		Community garden produce market

Community Identity and Natural Resources	Area-Wide Development	Shoreline Master Program	Health and Well-Being
Flood-smart building design	Zoning and policies that promote resilient development; evaluate critical facilities exposure	Inclusion of sea level rise projections and focus on adaptation opportunities	Land use planning updates and protection of important habitat (e.g., oyster beds)
Retrofitting existing and/or building new vertical evacuation structures	Network of vertical evacuation structures		Community health center with vertical evacuation capacity
New ridge trail	New ferry, ridge trail system, logging/forest road access	Earthquake resistant beach access and trail connections	Opportunities for physically active living
Development of resorts on hilly land outside the city	Assessment of feasibility and possible uses for higher ground outside city		
Wetland resort development and open space	Identification of new economic development opportunities	Preservation of coastal vegetation	
Emergency evacuation route signage	Regional collaboration with county and private sector on evacuation planning		Coordinating volunteer organizations to support emergency aid
	Transportation infrastructure improvements	Incorporation of sea level rise into infrastructure planning	
Relocation of critical facilities	Feasibility of relocating critical facilities		
Blue-green stormwater infrastructure		Vulnerability assessment of wastewater treatment and mitigation needs	
	Improved cellular and internet connectivity		Regional telehealth programs
Potential aerial tourism opportunities			Walking-friendly environment; affordable housing
Coastal resources mapping	Protection of open spaces and ecosystem services		
			New telehealth system and improved health outreach
			Health service providers and knowledge of community needs
Gardens and markets for neighborhood identity			Increase healthy food options and local self-sufficiency

Mutually Supporting Area-wide Development Strategies

The overlap among strategies and elements illustrates the importance of taking a comprehensive, integrative approach to increasing community resilience and mitigating hazards in Westport. The overlap also illustrates the principle that a robust and effective strategy should not only mitigate a hazard (and ideally more than one hazard scenario) but also provide multiple benefits to the community on an everyday basis, regardless when or whether the hazard manifests itself or not. In this way, robust strategies account for the uncertainties and unpredictability of the timing and severity of future possible hazardous events and ensure the protection of the highest community values (e.g. human life), while allowing the community to realize other values (e.g. economic development) under normal "blue sky" conditions. Finally, the integration of mitigation strategies with everyday life helps to ensure that such strategies are well-understood and internalized by community members, making them more effective.

One key hazard mitigation consideration for the city may be the acquisition of land (or at least access to land) at higher elevations both within and outside the city limits, such as the dune ridges on the Westport peninsula, uplands in Bay City across the Elk River or atop the bluffs in the direction of Grayland. Relocation of important public and emergency facilities, and possibly some housing, to the dune ridges on the peninsula would help protect them from the more likely but less severe hazards such as sea level rise, even if it does not protect them from the most severe (but much less likely) tsunami events. Building these facilities as vertical evacuation structures would allow them to serve at least as life-saving protection in a severe tsunami. Combining vertical evacuation with frequently used facilities such as the school, City Hall, the fire and police stations, clinics, hotels, etc., would also help community members and visitors become familiar with where to go in such an emergency, and potentially support the HMP's Public Outreach Program initiative. Including vertical evacuation in new hotel and event space construction could lever Economic Development to support mitigation, and vice versa. Designing such a facility to function as a highly visible landmark (e.g. on high ground) could both enhance Westport's city image (Community Identity and Appearance) and also serve as a form of Public Outreach, raising awareness of where to evacuate.

Acquiring even higher ground outside the current city limits would function as a form of "insurance" against a future with higher water caused by sea level rise, or by the rare but possible inundation and subsidence associated with an earthquake and tsunami. This is a nascent idea that would require considerable research into the feasibility and community desire to pursue it. Several sections below reference this idea, and it is important to note that at this stage, land acquisition is not recommended for relocating Westport now; rather, the city could pursue options including annexation, land swaps, easements, or other mechanisms to gain access to higher ground for a variety of uses.

Low-lying, flood-vulnerable critical facilities and even residential properties could be bought-out for relocation to higher ground, and redeveloped for near-term profitable commercial development.

Higher ground outside the city limits could be developed to provide economic opportunities in the near-term and used more directly by the city over the long-term. What might be useful (and even profitable) in normal times as an ecologically low-impact camping area, hunting lodge, educational and research facility, or resort development, may serve as an emergency refuge and resettlement area after a major disaster.

In sum, the UW Team developed these recommendations after considering the following questions, based on the above overarching considerations and principles, and after reviewing the County HMP, the Comprehensive Plan, and all community input:

1) How many different hazard scenarios does each strategy mitigate, given the nature, severity, timing and likelihood of the hazard? (The more hazards it mitigates, the more robust the strategy.)
2) Which Comprehensive Plan Element goals can each mitigation strategy help to achieve? (The more, the better.)
3) What additions or revisions to the Comprehensive Plan goals does each mitigation strategy suggest? (The more alignment, the more resilient the community's development will be.)
4) What additions or revisions to the Comprehensive Plan goals would better reflect community values? (An important reality check to inform the validity of the answers above as well as priorities for implementation.)

As the City's Planning Commission considers these recommendations, the UW Team invites further dialogue on these questions, and looks forward to further revising the recommendations as necessary.

APPENDIX E: TRANSPORTATION CHAPTER OF WESTPORT COSTAL RESILIENCE REPORT

Chapter 3. Transportation, Circulation, and Telecommunication Element

3.1. Introduction

Transportation and circulation is a vital and major determinant of land use development within an area and should be addressed when updating the Comprehensive Plan. The smooth operation of the transportation system provides an opportunity to improve the effectiveness of emergency response and hazard mitigation. This section covers two major parts of the Comprehensive Plan: Transportation and Circulation (including both general traffic and airport circulation) and proposes a new sub-element: Telecommunications. Telecommunication is highly linked with transportation, as both are essentially forms of connectivity within the community and between it and other places. This new sub-element guides future development of wireless communication, and helps maintain connectivity during a disaster. New technologies of transportation and telecommunication increasingly affect each other's demand for services and both function for many similar goals.

The design, plan and construction of transportation and telecommunication requires coordinating with land use planning, economic development, and urban design. This section also provides suggestions for relocation and/or reinforcement of current transportation facilities. One obvious benefit of this is to ensure safety and efficiency in the event of an evacuation (e.g., tsunami, earthquake). However, the cost of reconstruction might be a barrier to achieving some suggested goals.

The current goals of Transportation and Circulation Element are:

To maintain and improve the City of Westport's circulation and traffic to address the following:

1. Provision of safe, adequate, and improved access;
2. Improvement of traffic flow;
3. Needs of those using differing modes of transportation are served;
4. Compatibility of transportation types is enhanced;
5. Provision of efficient access for Police, Fire and EMS response;
6. Transportation and circulation is coordinated with the goals and objectives of the other elements of this plan, especially land use; and
7. To develop a transportation and circulation system which serves all types of users in the most economical, efficient, and compatible manner possible, and which minimizes the costs of transportation facilities to the taxpayer.

Current goals of airport circulation:

1. An all-weather airport facility with adequate length to accommodate the needs of area businesses and aviation-based tourism traffic that is located in an area compatible with an airport and its associated activities;
2. Ensure that individuals who live, work, or own property near the airport enjoy a reasonable amount of freedom from noise and other undesirable impacts;

Proposed goals of telecommunication:

1. Develop city-wide communication tools to improve efficiency of local public services and private sector activity
2. Increase regional data connectivity to reduce dependence on out-of-town trips for some services;
3. Increase diversity and redundancy in wireless communication options, both to enhance daily life and to ensure functional telecommunication during emergencies when normal connections are compromised.

3.2. Opportunities for Integration

Table 5 below displays the six hazard mitigation initiatives from the Grays Harbor County HMP and describes opportunities and obstacles for aligning hazard mitigation strategies with the transportation, circulation, and telecommunication goals.

Opportunities and obstacles described below focus on aspects of hazard mitigation that are relevant to transportation, circulation, and telecommunication, including the goals which exist in the current Comprehensive Plan (e.g., evacuation route, pedestrian safety, conflict between pedestrian and vehicle, the transportation design associated with EMS, etc.). The Grays Harbor County HMP has addressed the importance of reliable evacuation during a disaster. Hence, we recommend addressing emergency response planning during evacuation in the Comprehensive Plan.

In addition, Westport should also consider the reliability of the current transportation infrastructure. For instance, the Elk River SR 105 bridge would be damaged based on current tsunami models; hence, reinforcing the existing infrastructure in the transportation system is necessary.

Table 18. Aligning Hazard Mitigation Initiatives and the Transportation, Circulation, and Telecommunication Element

Hazard Mitigation Initiative	Opportunities for Alignment with Transportation, Circulation, and Telecommunication Goals	Conflicts with or Obstacles to Alignment with Transportation, Circulation, and Telecommunication Goals
Vertical Tsunami Evacuation Structure	• Identify evacuation routes both internal and external for vehicles and pedestrians. • Install resilient telecommunications hubs at vertical evacuation sites	• The evacuation route to vertical evacuation may not be reliable due to ground shaking, liquefaction, flood and wave force during tsunami.
Public Outreach Program	• Educate the public regarding evacuation (evacuation route, method), including vulnerable populations (the elder, ADA, , non-English speakers) (revised) • Improve tsunami evacuation street and trail signage • Use official website/Facebook/Twitter in Westport to spread information about evacuation, tsunami/storm warning (revised)	• The outreach program may fail to reach all of Westport and the wider community.
Emergency Management Plans	• Transportation facilities should apply appropriate design principles to protect adjacent residential areas. Design of transportation facilities should include input from representatives of the Public Safety and Emergency Management staff to improve access for these services.	• High cost for reinforcement/re-engineering.

Hazard Mitigation Initiative	Opportunities for Alignment with Transportation, Circulation, and Telecommunication Goals	Conflicts with or Obstacles to Alignment with Transportation, Circulation, and Telecommunication Goals
	• Design new evacuation route for new vertical evacuation building. • Consider Police, Fire, Coast Guard and EMS roles in transportation management after disaster • Plan transportation improvements for emergency events, e.g. upgrading of Elk River Bridge	
Emergency Communications Plan	• Consider applying telecommunication technology for emergency communication inside/outside of City of Westport during disaster.	• The quality and service of wired and cellular connections may be limited under emergency situations such as disaster (tsunami, earthquake).
Critical Facilities Evaluation	• Ensure the location of new transportation infrastructure not within the hazardous area (e.g., erosion, inundation).	• The cost of new transportation infrastructure will increase.
Transportation and Right of Way Improvements	• The City of Westport should develop and maintain a pedestrian system providing safe, adequate, and efficient access to all areas of the community, particularly to major nodes and centers of activity. • Pedestrian and vehicular flow should, be improved in the business district, with particular attention to minimizing vehicular and pedestrian conflict.	• Expanding development and public facilities/infrastructure into new areas would require additional coordination with Grays Harbor County, WSDOT (e.g., signal control, crosswalk).

3.3. Community Input

Citizens of Westport are resilient, hard-working, self-sufficient, and many have outdoor survival experience. They have practical skills to repair boats, cars, houses, and other equipment. During a disaster, residents will likely be able to fix equipment (e.g., ham radio, boats). Many residents know how to hunt, fish, and live outdoors. In addition, the social bonds are tight, people are willing to help each other, and they have a strong sense of belonging, which is an asset in a disaster response and evacuation situation. Westport is abundant in seafood, berries, mushrooms, and other natural food resources for the community. These resources will help provide supplies for residents during disaster, which also requires a sound logistics transportation system. All these elements make it possible for the community to survive during disasters in Westport. The following quote from a Westport resident highlights these values:

> *"We value our small community, the feeling of closeness that you can only have in a small town. We value our fishing industry and the jobs that it provides, diverse cultures and people coming together, the cranberry industry, our schools, and our community gardens."*

We obtained many helpful suggestions from Westport residents regarding transportation, circulation, and telecommunication during the community engagement activity. Participants in Westport suggested ideas, including: strengthening the bridge over the Elk River; using a ferry to travel to Ocean Shores/Hoquiam/Aberdeen; elevating the current land area; building higher buildings; and relocating the current airport because it is at risk of flood impacts under many hazard scenarios.

Community members also suggested using a hovercraft for ferry transport since it can prevent issues with stranding in shallow areas that ferries may experience. The route of the ferry to Ocean Shores is suggested to be modified from the north of Ocean Shores to Downtown Ocean Shores due to the low elevation of northern Ocean Shores and the high possibility it may be inundated during the tsunami. In addition, community members provided suggestions regarding telecommunication including apply broadband internet in the rural areas, use 600 MHz to bring extended range LTE[7]; improve the LTE coverage and capacity in Westport; use HughesNet.com as Satellite internet for communication during disaster. Table 6 below summarizes the community input we gathered.

Table 19. Community input related to the Transportation, Circulation, and Telecommunication Element

Strategy Theme	Strategy example
Strengthen weak points in existing regional transportation connections	• Relocate the Westport airport to higher ground • Supplement airport with emergency use of other potential airfields, as in Grayland • Rebuild the SR 105 bridge over Elk River to withstand earthquake and tsunami impacts
Diversify regional transportation connections	• Use 'hovercraft' (capacity with 40-46 persons) to deal with the shallow draft needs • Widen SR 105 bridge over Elk River to increase foot and bicycle capacity • Develop upland bike and foot trail to Grays Harbor College and Aberdeen
Supplement and integrate transportation systems with telecommunication	• Expand broadband internet in rural area • Establish 600 MHz LTE to increase LTE coverage and capacity, lay the foundation for 5G to increase the network quality • Use HughesNet.com satellite (Gen 5 satellite system) for internet communication when regular broadband or cellular systems are disrupted • Support and train ham radio operators for emergency communications

3.4. Recommendations

3.4.1. Transportation and Circulation

One of the key tsunami evacuation routes is along Montesano Street (the red solid line shown in Figure 45) from the Marina District to the north residential area in Westport. However, the route may be vulnerable to liquefaction and/or ground subsidence from a CSZ earthquake. Furthermore, the route as it passes the airport is vulnerable to the more extreme CSZ earthquake subsidence and SLR scenarios due to its low elevation.

[7] Long-Term Evolution; a 4G mobile communications standard.

Figure 45. Key evacuation route along Montesano St in L1 CSZ earthquake subsidence (right) and SLR (left)

We recommend testing the soil composition and liquefaction hazard under this section of Montesano St., for possible need to reinforce, rebuild and/or elevate the road with deep-pile structural support to ensure its function under impacts of strong ground motion, tsunami wave force and scouring/erosion, liquefaction, and flooding due to storms, sea level rise, and co-seismic subsidence. Additionally, we recommend arranging supplemental support for emergency situations from the nearest neighboring airfield site on high ground (above 200 feet elevation) in Grayland, shown in Figure 46.

The ferry route could be redesigned to support rescue efforts after an earthquake and tsunami. However, some concerns remain including impact to shellfish beds and other natural resources along the ferry route, as well as stranding in shallow areas.

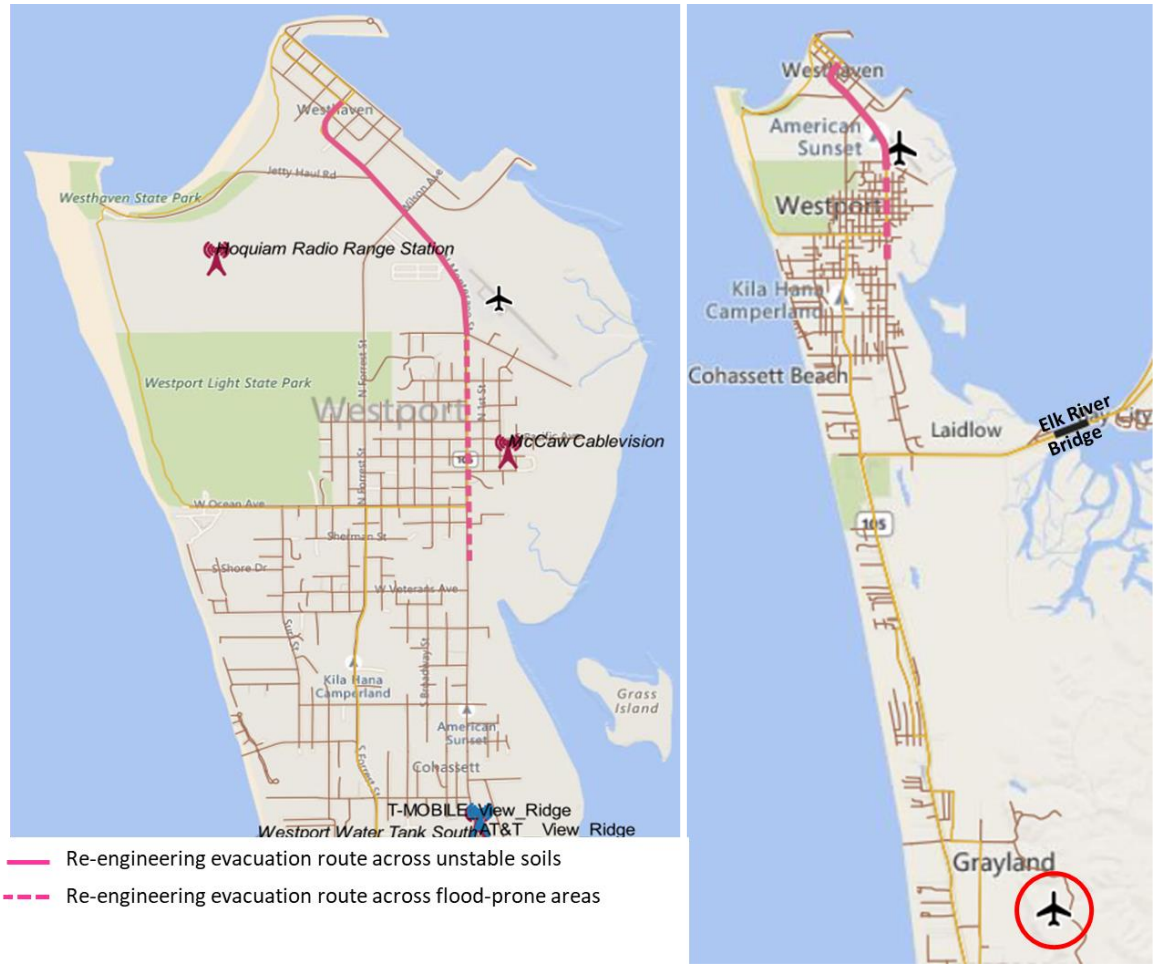

Figure 46. Suggested reengineering area (left) and suggested auxiliary airport in Grayland (right)

3.4.2. Telecommunication

Figure 46 also displays the current locations of cell and communication towers in the City of Westport. Given that these networks may be vulnerable in a major earthquake, we recommend augmenting them with a range of alternative technologies. Residents may use ham radio to transmit SOS messages and call for search and rescue from the state, county, and neighboring cities, as well as to receive information about the regional situation. In addition, the Federal Emergency Management Agency (FEMA) recommends one method to support state and local emergency communication functions: the ARRL (American Radio Relay League) for amateur radio operators to offer electronic communications for state and local government (Coile, 1997).

For additional diversity of communication inside the City of Westport, Low Power FM radio (LPFM) can serve as emergency communication during/post disaster. LPFM stations can be heard about 3.5 miles if there is no blocking from topography, a bigger station or other obstacles. Washington state has the second-highest concentration of low-power FM radio stations in the country with 68 stations for 7.4 million people. LPFM is low cost and low-tech, and easily managed by small groups of enthusiasts, students and other amateurs. The establishment of a LPFM station at a vertical evacuation site would enhance communication in the community. It is important to consider the daily function of such a station,

in order to build familiarity with the technology. The Ocosta School, for example, might incorporate the station in its vertical evacuation building, and also use it to train students in the technology and practice of broadcast media, announcing events and providing the community with sportscasting, news and other educational information including occasional emergency tips.

Higher-tech wireless or mobile ad hoc networks can also add options to strengthen a community's self-sufficient and adaptable communication when regional systems with fixed hubs or routers break down. "Sonnet" is one technology being developed as the most advanced off-grid mobile mesh network; it brings the long-range wireless communication of the walkie-talkie to the smart phone, allowing the user to send text message, voice recording, and GPS coordinates between smartphones up to 9 miles apart, even without cellular coverage or satellite internet access. This section recommends exploring a range of such options, that in combination with lower-tech ham radio and LPFM, may increase the community's resilience to telecommunication disruption, even as the region overall experiences improved normal connectivity through rural broadband.

The introduction of rural broadband, including the possibility of a trans-Pacific fiber-optic cable landing station in Grays Harbor County, will greatly increase normal connectivity in the region. Westport/South Beach should consider how this connectivity may change every day social and economic activity in the community, including changes in travel behavior, and how connectivity (and the activities it supports) may be disrupted in a disaster. For example, healthcare access (recommended as a new Element in the Comprehensive Plan), may benefit from rural broadband by participating in regional telehealth systems, reducing residents' need to visit health clinics and hospitals. Telehealth may also facilitate long-distance triage and other emergency medicine provision in a disaster. To do so, however, it is dependent on a robust telecommunications system. The integration of locally self-reliant and robust systems as described above with new regional connectivity technologies can reduce such vulnerabilities.

Based upon the opportunities from the Grays Harbor County HMP integration and community input described above, as well as case study and advanced practice research, Table 20 below summarizes recommendations related to transportation, circulation, and telecommunications.

Table 20. Recommendations for Updating the Transportation, Circulation, and Telecommunication Element

	Strategies	Hazard Mitigation Benefits	Co-Benefits for Community Values
County Hazard Mitigation Plan	Provide education and training of evacuation information (e.g., evacuation route, ham radio operations) for local residents, students and employees in Westport	Increase Public knowledge of evacuation	• Promote neighborhood social ties
	Include support/backup from Fire, Police, Coast Guard and EMS in transportation management	Complete and clarify the responsibility of each department	• Clarify the duty and correlation of each department during emergency event
	Explore increasing capacity, reliability and geotechnical strength of existing key evacuation and access routes (e.g. Elk River bridge)	Increase the reliability of the current evacuation route	• Increase the resilience and sustainability of the transportation infrastructure
	Make telecommunication access more robust in the event of cellular disruption during disaster (Low-power FM radio, ham radio, Wi-Fi direct/WMN)	Ensure basic telecommunication functions during disaster	• Better wireless connection in Westport • Promote neighborhood social ties • Enhance telecom technology literacy among community members
	Explore ferry routes to Ocean Shores, Hoquiam and/or Aberdeen	Additional evacuation options for climate change, erosion, tsunami, earthquake, flood	• Greater connectivity to other Grays Harbor communities • Tourist and recreational attraction • Increased diversity of port function
	Arrange emergency/auxiliary service by neighboring upland air field in Grayland	Additional evacuation and supply option for tsunami, earthquake, flood	• Increased accessibility for possible new upland development
Community Input	Relocation of airport to upland site in Grayland	Improve the sustainability and resilience of the airport when facing climate change, erosion, tsunami, earthquake, flood	• Improve the traffic connection (e.g., new route/trail will be built towards the airport)
	Use 'hovercraft' for ferry evacuation to prevent stranding in shallow area	Safe, smooth and efficient ferry evacuation during tsunami, earthquake and flooding	• Possible increase in tourism • Diversity in transportation modes
	Establish 600 MHz LTE to increase LTE coverage and capacity; lay the foundation for 5G to increase the network quality	Improve the reliance and quality of telecommunication during disaster (tsunami, earthquake, flood)	• Increase the quality of services and enhance the signal of the cell phones for daily usage
	Apply HughesNet.com as satellite (Gen 5 satellite system) internet for telecommunication	Ensure basic telecommunication with satellite during disaster	• Increase the quality and resilience of satellite-connection
	Establish evacuation plans for elder/ADA people, in coordination with enhanced public transit	Ensure the safety of the elder/ADA people during disaster	• Diversify transportation service in Westport (e.g., shuttle, bus)

	Strategies	Hazard Mitigation Benefits	Co-Benefits for Community Values
	Road re-engineering for current key evacuation and access route. (e.g., Montesano St)	Improve the sustainability and resilience of the road when facing climate change, erosion, tsunami, earthquake, flood	• Mitigate traffic congestion
Other Cases/Practices	Provide education and training of evacuation information (e.g., evacuation route, use of ham radio, LPFM radio) for local residents, students, employees and vulnerable population (the elder, ADA, tourists, non-English speaking natives)	Increased awareness from people in Westport of the evacuation information to ensure their cooperation during tsunami, earthquake, flood evacuation as well as their safety	• Promote neighborhood social ties • Improve community inclusivity
	Mobilize Ham Radio network for communication between Westport and state/county/neighbor cities in the event of cellular disruption	Ensure communication with places outside Westport during earthquake, tsunami (sending SOS message, asking support request from state/county/neighbor cities)	• Enhance regional and global connectivity • Provide outlet for or training in technical expertise
	Explore establishing LPFM Station	Provide disaster warning information and maintain broadcast function within Westport during earthquake, tsunami and other events of cellular disruption	• Enhances community identity and strengthens community relations • Provide outlet for or training in technical expertise
	Explore applicability of mobile mesh networks, direct or ad-hoc Wi-Fi and other off-grid networks for smartphones and personal computers, such as Sonnet, WiFi-Opp, etc.	Provide person-to-person communication within Westport during earthquake, tsunami and other events of cellular disruption	• Improve the network quality and service • Promote the development of e-commerce
	Use telecommunication systems to participate in regional telehealth programs	Ensure a reliable telemedicine system during tsunami, earthquake, flood	• Improve regular access to healthcare