Urban Design for Resilience to Multiple Uncertain Hazard Scenarios
Robust Strategies for Coastal Resilience in Westport, Washington

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Abstract

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This thesis explores the development of robust urban design strategies for resilience in the face of multiple uncertain and complex hazard scenarios. Resilient urban design is illustrated through the case of Westport, a coastal city in the State of Washington, which faces inundation threats from multiple possible tsunami scenarios as well as from climate change-driven sea level rise. Community workshops with local and state experts in pre-disaster planning as well as members of the general public inform the strategies and their integration into an upcoming update of Westport's Comprehensive Plan (documented in Appendices). The urban design strategies consist of: (i) a suite of built environmental projects – including vertical evacuation structures and routes, complete streets, and flood-tolerant development – that, together, mitigate the impacts of a range of hazards varying in their likelihood, suddenness, and severity; (ii) an adaptive planning strategy that provides a long-term vision of how these projects may be implemented over time, in increments; and (iii) a Community Based Social Marketing strategy to ensure that the built environment projects are relevant to community members' daily life and contribute to the city's on-going development; connected to people (strengthening social capital) and therefore are successful in their purpose (or utilized to their full potential) to function in an emergency situation.

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Sreya Sreenivasan | MUP 2019
University of Washington

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Chapter 1 | Introduction

On October 10th, 2018, Hurricane Michael, a Category 4 storm, decimated almost the entire community of Mexico Beach, Florida in a matter of hours. By contrast, North Cove in Washington state earned the moniker 'Washaway Beach', as it has been subjected to the chronic hazard of coastal erosion, which has been worsening due to sea level rise and increasing storm surges. This has contributed to the gradual disappearance of a coastal community. To anyone working in the field of urban planning, the first question they would ask themselves after looking at these visuals would be, 'What can we do to ensure that the people we are planning for are not left homeless one fine day? How can we anticipate these events and insure the cities' future, when not only are these extreme events uncertain; so too, is the very measure of that uncertainty (e.g., the tails of the probability distributions)[1]'. In addition to the timing, the severity or magnitude of these events are frequently uncertain.

Figure 1 Image of Mexico Beach, FL after Hurricane Michael. Source: https://www.msn.com/en-us/news/world/in-florida-beach-hamlet-not-much-left-after-hurricane-michael/ar-BBOh0vo

Figure 2 Image showing coastal erosion at North Cove (Washaway Beach). Image source: http://www.washawaybeach.com/history/ by Erika Langley

[1] Marina Alberti, "*Cities That Think like Planets Incomplete Knowledge , Uncertainty , and Surprise,*" in Cities That Think like Planets: Complexity, Resilience, and Innovation in Hybrid Ecosystems (Seattle: University of Washington Press, 2016), 188, https://muse.jhu.edu/.

Now consider some other communities like Westport, a coastal city in the state of Washington, which faces both chronic and episodic threats. These include "gradual" sea-level rise (SLR) and events ranging in severity from storm surges to tsunamis generated by distant earthquakes, such as in Alaska or Japan) and nearer-ones, such as on the Cascadia Subduction Zone (CSZ) just off-shore of Washington state. On the suddenness spectrum for natural hazards, rising seas and other climate change impacts pose challenges to Westport from one end while impending seismic and tsunami events loom over the city at the other end. These hazards' severity, likelihood, and suddenness change over time, and interact in complex ways. SLR on its own is a relatively moderate threat in the short term, but increases in severity and probability of occurrence within a few decades, and increasingly exacerbates the sudden impact of storms, which themselves become more severe due to some of the same climate changes that affect sea level.[2] Earthquake and tsunami hazards, by contrast, vary in their severity but are sudden whenever they occur, with warning times for tsunamis ranging from a few hours to only 15 minutes. Compared to storms, earthquakes and tsunamis are extremely rare events, but scientists have begun to identify historical periods in which they are likely to recur.[3] Moreover, there is a complex interaction between SLR and subduction zone tectonics and seismicity: gradual tectonic uplift may negate SLR hazards on some sections of the coast, until a megaquake produces sudden subsidence, which then increases the area at risk of inundation from SLR. Conversely, SLR over time will increasingly exacerbate exposure to flooding from a megaquake-generated tsunami. These effects all vary greatly along different sections of the coast at the local scale.

Human settlements themselves are complex systems that have always adapted to the natural hazards around them. Complexities pose threats, but they also breed opportunities. Uncertain natural hazards can give rise to new long-term tourism opportunities for Westport through urban design strategies (as proposed in Chapter 4 of this thesis) that can be adapted to varying scenarios.

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[2] Ian Miller et al, *Projected Sea Level Rise for Washington State – A 2018 Assessment*, a collaboration of Washington Sea Grant, University of Washington Climate Impacts Group, Oregon State University, University of Washington, and US Geological Survey, prepared for the Washington Coastal Resilience Project (2018).

[3] Brian Atwater, *The Orphan Tsunami of 1700: Japanese Clues to a Parent Earthquake in North America* (Reston, VA; Seattle: U.S. Geological Survey; in Association with University of Washington Press, 2005); George R. Priest et al, "Confidence levels for tsunami-inundation limits in northern Oregon inferred from a 10,000-year history of great earthquakes at the Cascadia subduction zone," *Natural Hazards* (2010) 54(1): 27.

Complexity and uncertainty are, therefore, key considerations while planning and designing for resilience [4]. How can a community Plan and Design for resilience in the face of multiple uncertain scenarios?

Problem Statement

"How can a community Plan and Design for resilience in the face of multiple uncertain scenarios?"

While the answer to this question above may require years of research by more than one expert as circumstances faced by different communities would not be the same, I hoped and attempted to contribute to the conversation by expressing my ideas through a specific case. Here, I have considered the case of Westport, WA, a community I had the good fortune to engage with through an academic program in the University of Washington (refer Chapter 2). Within the case of Westport, my research revolves specifically around the use of urban design strategies in handling multiple uncertain hazard scenarios. This is indeed a restricted scope in planning for resilience. However, in my research, I find great value in using an urban design centered approach and I intended to express the same through this thesis.

Let us consider the compositions of cities. When broken down to a few basic elements, this constitutes the natural environment, the built environment and then the sociological elements. One field that addresses all three of these basic tangible components is Urban Design. It is, therefore, logical to consider Urban Design as a potentially useful tool in resilience thinking for city planning. Quigley, Blair and Davison through their recent paper in the Journal of Urban Design, establish a theoretical link between urban design and the concept of evolutionary resilience, by discovering shared cross-cutting themes between the two fields [5] (refer Chapter 3 for the themes).

[4] Robert Mugerauer and Kuei-hsien Liao, "*Ecological Design for Dynamic Systems : Landscape Architecture ' s Conjunction with Complexity Theory*," Journal of Biourbanism, no. 2013 (2012): 32-33.

[5] Mura Quigley, Neale Blair, and Karen Davison, "*Articulating a Social-Ecological Resilience Agenda for Urban Design,*" *Journal of Urban Design* 23, no. 4 (2018): 581–602, https://doi.org/10.1080/13574809.2018.1440176.

Research Questions

My thesis inquiry is framed by a series of questions. While I respond to many of these questions in order to attempt to answer the principal question, I do not attempt to answer all of them through this thesis since they are beyond the scope of this study and require further research and specific expertise. Nevertheless, I have included them in this paper as they are important considerations for the City while planning to achieve urban resilience.

The principal question that the thesis began with is,

"How can robust Urban Design strategies be created and used to achieve resilience in the face of multiple uncertain hazard scenarios for a coastal community like Westport?"

As is typical when addressing big questions or problems using an analytical approach, I ask several ancillary questions, by responding to which I try to answer the principal. The following 3 questions sum up the three parts of the Chapter 4 of this study.

a. How can built environment projects be leveraged to protect against risks from less predictable natural hazards while also retaining their relevance during non-emergency times?

b. How can the built-environmental projects be executed in a manageable and feasible way by a community like Westport, which faces multiple uncertain scenarios, as part of a broader adaptive planning strategy?

c. As the built environmental projects are executed, how can the City ensure that their local community, at any given time, uses these projects optimally during times of emergency?

Outline

I have structured this thesis document into 5 Chapters and each chapter is further composed of smaller sections as outlined below.

Chapter 1 Introduction: This chapter introduces the thesis. It gives the research questions that guide this thesis as well as the methodology used in this research.

Chapter 2 The curious case of City of Westport: This chapter elucidates the reasons for the choice of the case. It also gives an overview about the city in general along with an image of Westport as described by its community members. These inputs by the community themselves are crucial to the ideas expressed in this thesis, as they serve as both guidance and justifications to the urban design strategies prescribed through this research.

Chapter 3 Resilience to multiple uncertain hazard scenarios through Urban Design: This chapter explores scholarship regarding the role of urban design in resilience to uncertain scenarios. This exploration also leads to the derivation of principles for resilience through urban design, that help formulate the specific strategies explained in the next chapter.

Chapter 4 Robust Urban Design Strategies for Westport: The chapter is organized based on the three sub-research questions. The sum of the responses of these questions collectively act as my response to my principal research question.

Chapter 5 Conclusions and Discussions: In this chapter I discuss the limitations and the broader implications of this research. I have also included my thoughts and reflections on this thesis process and the future research gives way to.

Methodology

I consider my research to be inductive in nature. Although it was my personal interest in the topic of resilience of built environment that led me to focus on designing and planning for uncertainties, it was my serendipitous introduction to the case itself that gave rise to my specific research questions and subsequent urban design strategy formulation. Following my research path, I will first present the case, which is the City of Westport and the community engagement efforts that resulted in a set of

value and assets as identified by the community. Although I present my engagement with relevant scholarship next in this paper, in my research process, this was a parallel branch. These ultimately lead to the urban design strategies recommendations. The Figure 3 Flowchart describing Research Methodology sheds light on the two branches of the research.

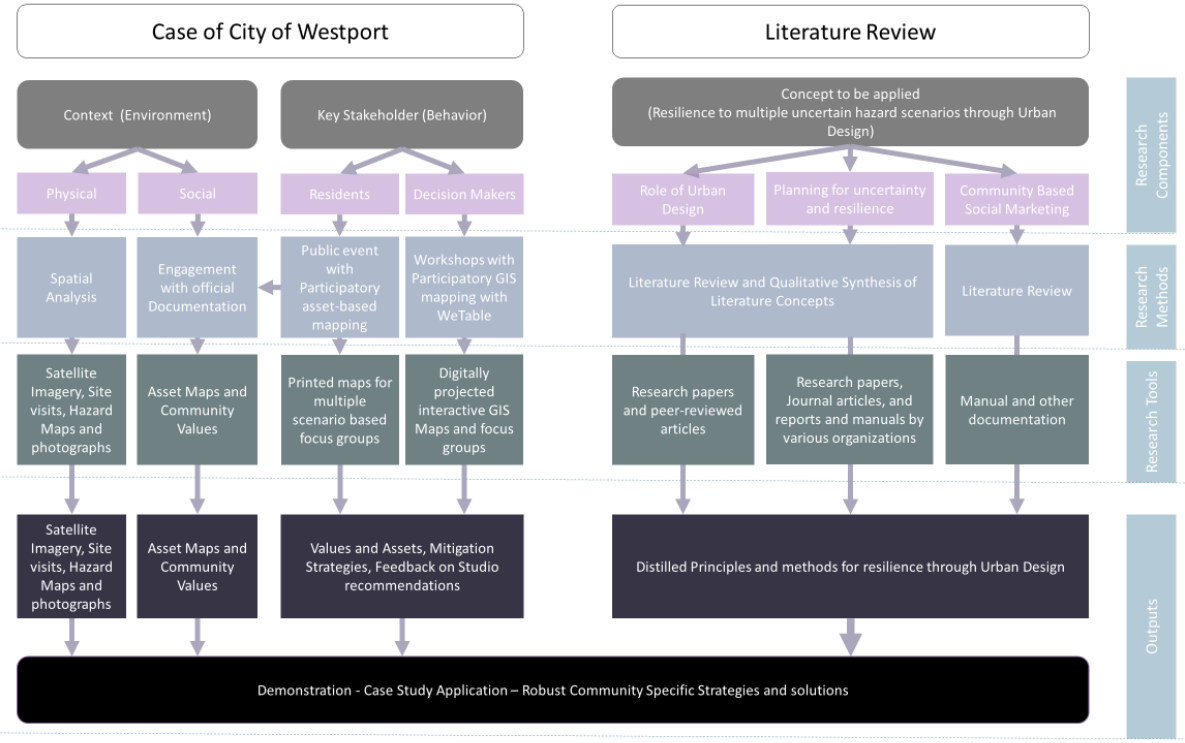

Figure 3 Flowchart describing Research Methodology by author

While Chapter 2 contains the work involved in the left-side branch of the research, Chapter 3 details my engagement with various related scholarship. The flowchart gives an overview of the components, tools and methods of research used to arrive at the robust set of community specific urban design strategies for resilience to multiple uncertain hazard scenarios. Through these strategies it would be possible to create a vision for Westport which could then guide the Comprehensive Plan for the city.

This thesis also builds on the urban design recommendations made for the City during the 'Community Engagement for Coastal Resilience' studio process in the Autumn 2019 quarter to use it as a platform to explore how robust urban design strategies can be developed to handle multiple uncertain hazard scenarios, particularly those involving inundation.

Chapter 2 | City of Westport, WA in the face of Uncertainties

I derive the contextual characteristics of the case of Westport from different sources; the **physical and regulatory context** from secondary sources like the Comprehensive Plan of City of Westport, County Emergency Management Plan, preliminary real estate market analysis, Grays Harbor County Assessor's Office, U.S. Census, and Natural Hazard maps used during the Studio (from sources like National Oceanic and Atmospheric Administration Agency [NOAA], University of Washington's Tsunami Modelling Team, etc.) and the **social context** from primary sources like workshops and the direct interactions with the local community by myself and other students and faculty of the Studio, during the course of the Studio.

Why Westport?

This thesis branches from on-going efforts by an interdisciplinary team from the University of Washington while partnering with the City of Westport, WA, which is the case for illustration I use in this thesis. I was introduced to this city and its challenges in planning for coastal resilience through the 'Community Engagement for Coastal Resilience' studio in the Autumn 2019 quarter. The studio involved engaging with the local community which resulted in recommendations by the students and faculty of the studio on updates to the Comprehensive Plan of the City of Westport.

In addition to the fact that Westport, like some other coastal communities, faces both chronic and episodic threats, it also is subjected to added complexity inflicted upon it by its specific geographic features. All the natural high grounds (high enough to be safe from the maximum considered case for tsunami in the region) are well outside the city limits. In short, not only does Westport face multiple uncertainties regarding the hazards, it also has complexities posed by various other factors.

The main challenge that the circumstances of Westport poses for its planners and decision makers is that it is not easy to entirely uproot the community and move to higher grounds as it would take the communities completely away from the ocean and the economic opportunities that it presents, at this point of time. This would only be a feasible option when the sea-level rises or a Cascadia event has destroyed much of the City's built environment and severely altered the shoreline. On the other hand, it is also not wise to wait for an event to happen in order to start working on this move to

comparatively safer grounds. How can the City reconcile these two conflicting yet key considerations for continued survival?

Figure 4 Ocosta School gymnasium - Nation's first structure to be designed to function as a vertical evacuation site. Source: Structure Magazine. https://www.structuremag.org/?p=14009

I have also taken Westport as a case for my thesis since it also worked with the Ocosta School District, which includes Westport, to incorporate a tsunami vertical evacuation facility into the roof of the new Ocosta Elementary School Gym – the first structure built in the nation to act as a safe haven in the event of a tsunami. This shows that the Westport and South Beach community is not only open to new ideas but ready to make innovative ideas a reality with its political will, community spirit and long-term thinking[6].

Geographic and Economic Aspects of Westport

To better understand the specific circumstance of Westport, we must look at the significance and contribution of the city to the state's as well as the nation's economic base along with its geographic features.

[6] *University of Washington Urban Design and Planning Studio "Community Engagement for Coastal Resilience"- URBDP 508B - Autumn 2018, "Localizing Hazard Mitigation - DRAFT Recommendations for Westport's Comprehensive Plan Update,"* 2019, https://doi.org/10.1002/ejoc.201200111.

Located on a peninsula on the south side of the entrance to Grays Harbor from the Pacific Ocean, the city of Westport is part of the Grays Harbor County in the state of Washington. Grayland, to the south, is its nearest neighboring coastal community accessible by land, in unincorporated Grays Harbor County. All these areas, including unincorporated communities further North-east, East and South

Figure 5 Location of Westport, WA. Source: ESRI.

such as North Cove, Tokeland, Ocosta and Markham, are collectively referred to by the local community as the South Beach[7], although North Cove and Tokeland are part of Pacific County, which bounds Grays Harbor County on the south. The average elevation within Westport's city limits is 23 feet(7m) with the highest around 45ft (14m) at the top of the sand dune ridges. There are two such sand dunes that run north-south in the peninsula. Most of the city's residences and amenities are nestled between these ridges. (Figure 6)

[7] Editors, "*About Us*," South Beach Bulletin (Westport, 2019), http://www.southbeachbulletin.com/about-us/. June 17,2019.

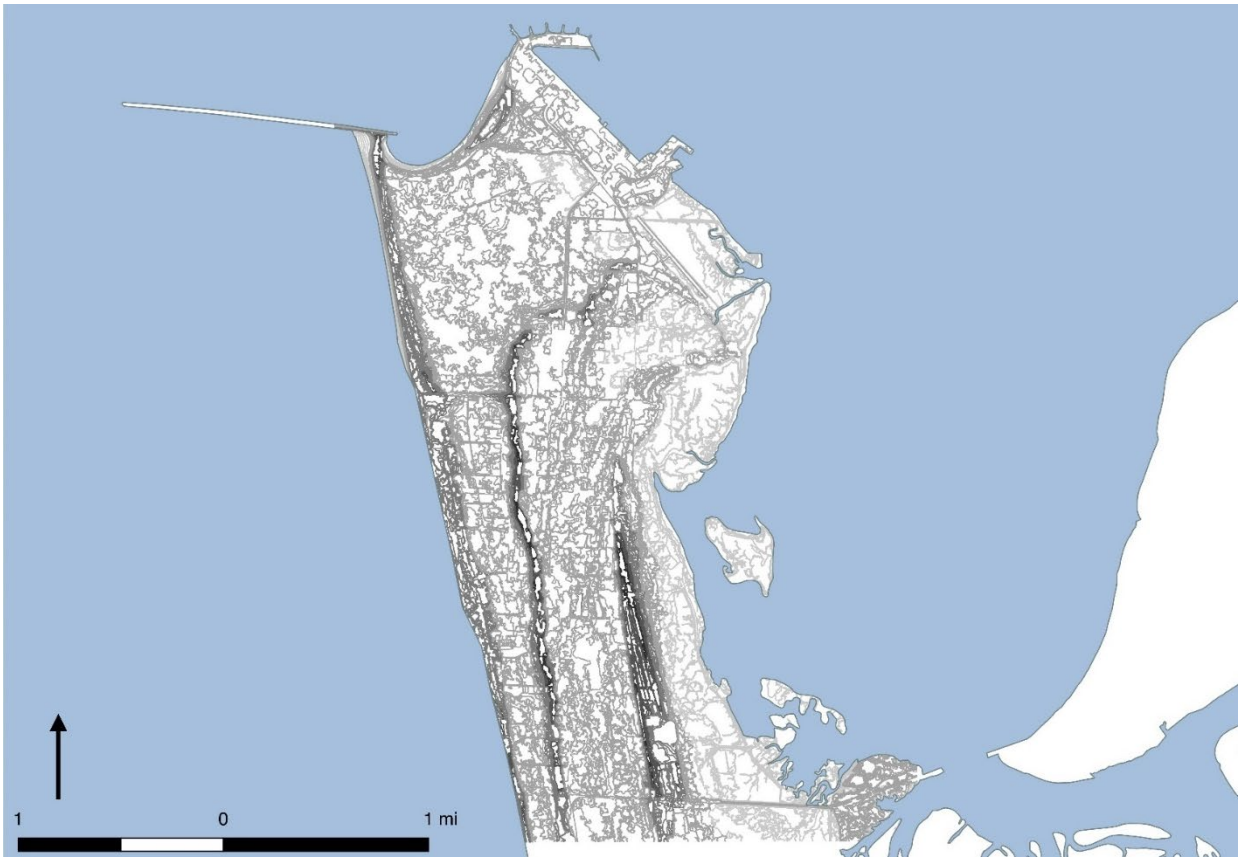

Figure 6 Map showing the two sand dune ridges in Westport, WA. Source: Studio maps and data.

Today, Westport with a population of 2,110, still relies on fishing, shellfish harvesting, seafood processing and tourism for much of its livelihood. More recently, boat building has also become an important part of Westport's economic base.

$32.1 million of state and local taxes were generated by activity at just the Port of Grays Harbor marine terminals, Westport Marina (which is the largest marina on the outer coast of the United States's Pacific Northwest), and real estate tenants. In addition, the Port collected $545,000 of leasehold taxes from its tenants according to the Economic Impacts Report by the Port of Grays Harbor in 2014. During summers, the area also attracts tourists twice the size of its resident population, which was 2,099 according to the 2010 census.

City of Westport – From the perspective of its Community

In order to develop the Comprehensive plan recommendations, we engaged with the community to understand what they valued in their community and what they considered as assets. The community and stakeholder inputs were gathered at different stages, primarily during the Community engagement studio (See Appendix D). A participatory asset-based mapping[8] method was utilized in both the workshops with the decision-makers and the community-wide workshop. While GIS based WeTable was used in the former, the community-wide workshop was a manual process over printed maps in order to make the community feel more inclusive[9]. These contributions by the community then guided the content of the suggestions for better preparedness of the community and improving the resilience of the city in the form of Comprehensive Plan update recommendations. The community engagement timeline is given below in Table 1.

Table 1Timeline of major community engagement efforts through the studio

Date	Community Engagement/Event Type
November 16, 2018	Partners Workshop w/ WeTable, McCausland Hall
November 17, 2018	Public Workshop, Ocosta Elementary School
December 07, 2018	Presentation to Steering Committee, McCausland Hall
December 08, 2018	Poster Open House, Tackle Box
February 25	City Council meeting

During the first two workshops, the participants went through a series of 3 rounds of discussion. The first was the identification of values and assets of the community. These values were written down and assets were usually mapped or just listed. The second round introduced a specific hazard

[8] Robert C. Freitag et al., "*Whole Community Resilience: An Asset-Based Approach to Enhancing Adaptive Capacity before a Disruption*," *Journal of the American Planning Association* 80, no. 4 (2014): 324–35, https://doi.org/10.1080/01944363.2014.990480.

[9] WeTable: The availability of limited number of digital drafting devices led to limitations on the number of people who could mark on the projected map at a given time. It also required the user to develop a certain level of comfort in handling the drafting device used and so many participants hesitated to volunteer to use the device.

scenario and the participants identified the values and assets that were threatened by the hazard. The third round was discussion of mitigation strategies for the specific hazard.

Community Values

The community values and assets were derived primarily from the Public Workshop that was conducted on November 17, 2018. The details of the workshop process and some of the raw responses received during the event are included in the Appendix D.

The community cherishes its idyllic coastal town setting with blue skies, visual and physical proximity to the ocean and all the recreational activities that are depended on, some specifically so to the Pacific North-West coast; long beach walks, razor clamming, surfing, deep-sea fishing, etc. The community members also appreciate that they can live, work and play in and around the same place but also enjoy a lifestyle with a rural pace. The community members also value their relationship and trust that they share with each other.

Community Assets

The assets identified by the community were derived from both discussions of the community as well as the participatory mapping exercises. The Table 2 offers a summary of the assets as expressed by the community. Refer Appendix D for the assets mapped during the workshops.

Table 2 Key community assets from the Workshops as summarized by Lan Nguyen

Asset Type	What it includes
People are resilient	The people are hardworking, self-sufficient, resourceful and outdoor survivalists. People 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, church gatherings or in the neighborhood. They help each other out and people have strong sense of belonging 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 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 cranberry bogs are the heart of the economy in this area. Scenic ocean views drives tourism along the beaches and marina district. The local fisheries provide jobs for fishermen and the seafood is processed 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 provide excellent recreational space for hiking, running, walking, and site seeing. The ocean provides a place for swimming and surfing. The natural features enhance community health and well-being.
Rural character	The rural character provides clean water and air which allows the natural features to thrive and people to enjoy the outdoors. The character also as well as minimizes traffic and population.
Public services	Local and regional public agencies support and enhance community safety and security.
Affordability	Affordable housing and high-quality food in the area make it an attract place to live while enhancing the quality of life.
Historical features	The people of Westport are proud of their heritage and history. The Grays Harbor lighthouse and Westport Maritime Museum encapsulate these values.

Overview of the uncertain natural hazard scenarios

Although Westport faces many natural hazard scenarios, in this thesis, I have chosen three hazard scenarios to illustrate my proposition. These hazards vary in their likelihood, suddenness, and severity. I have focused my scope to the impacts caused primarily by the inundation aspects of these hazards. The first is the maximum probable Sea level rise scenario. The map was created by the

research assistant of the Studio based on localized probabilistic data on sea level rise provided by Ian Miller of WA Sea Grant who also helped with its interpretation for the workshops conducted as part of the Studio efforts. Although the likelihood of this scenarios is higher than the other two, it is characterized by less suddenness and severity that scales up with the temporal scale. The second is the M1 tsunami which the experts have assigned with a maximum probability inundation scenario given other current environmental conditions. The third is the L1 tsunami scenario which is the 'maximum considered' tsunami inundation based on a severe anticipated near-source Cascadia earthquake types in order to communicate an unambiguous message for life safety and critical facilities planning scenario by the State of Washington. University of Washington's M9 project faculty Frank Gonzalez, Randy LeVecque and Loyce Adams ran GeoClaw models of tsunami scenarios, produced maps of flooding depth and land subsidence (which I have also used in this thesis), and helped interpret them for community use during the workshop[10]. The two tsunami scenarios are characterized by high factor of suddenness and medium and high severity respectively. Although I consider the uncertainty revolving around the seismic events that trigger tsunamis, but do not use a seismic event with a specific associated magnitude as an isolated scenario for my illustration. See Appendix D for the Hazard maps.

The participants of the workshop also were given these three above-mentioned scenarios to which they responded with some mitigation strategies which have been summarized below.

Tsunami and Sea-level Rise mitigation strategies by the Community decision-makers and members

Following are some of the main strategies that the workshop participants formulated based on the scenarios they were presented with.

M1 Tsunami Event:

- Educating the general public of the evacuation routes and vertical evacuation structures,
- Adaptation of Marina district to safely accommodate population seasonal flux,

[10] University of Washington Urban Design and Planning Studio "Community Engagement for Coastal Resilience"- URBDP 508B - Autumn 2018, "*Localizing Hazard Mitigation - DRAFT Recommendations for Westport's Comprehensive Plan Update.*",6.

- Hazard evacuation signages.

L1 Tsunami Event:

- Relocate wastewater treatment facility,
- Invest in property on higher grounds outside the city limits

Sea Level Rise:

- Retrofitting the Marina,
- Rerouting and elevating roads and bridges,
- Relocate airport,
- Buyout of at-risk properties with federal funds for the relocation of homes to safer areas.

Recommendations were presented to the community for feedback. Refer Appendix C for the recommendations.

Chapter 3 | Resilience through Urban Design – Literature Review

In this chapter, I have included the overviews of primary pieces of scholarship that guided my overall research. I have employed more scholarly works as resources when formulating my resilience strategies, which are not all mentioned in this section.

During my engagement with various literature on resilience, I encountered multiple definitions for the term resilience. For my thesis I select that definition or perception of the term 'resilience' as applied in the field of planning, which I consider to be the most evolved based on the work of Simin Davoudi. The paper is part of a collection of works presented at a conference and published in 2012, titled, *"Applying the Resilience Perspective to Planning: Critical Thoughts from Theory and Practice*". edited by Simin Davoudi and Libby Porter. Davoudi describes the origin of the contemporary meaning of the term resilience in the context of planning and emerging parallels between resilience thinking and interpretive approach to planning. She traces the evolution of this term to what is now known as Evolutionary or Socio-ecological resilience. It takes into account the complex socio-ecological interdependencies and the uncertainties that accompany it[11]. The concept of evolutionary resilience considers complexity and uncertainty as opportunities. The new normal would be the state beyond the threshold and the article considers this to be positive. It also provides the challenges associated to planning with evolutionary resilience which include:-

1. Reliance of Governments on self-organization capacity of individuals,

2. What constitutes the desirable outcome?

3. System boundaries: "Resilience from what to what?" and possible resulting exclusionary practices.

4. Power & politics: "Resilience for whom?". Who is rewarded and who is punished?[12]

These are challenges that need to be addressed when proposing urban design strategies.

The concept of socio-ecological resilience is also explored in the piece "Urban Transitions: On Urban Resilience and Human-Dominated Ecosystems." by Henrik Ernstson, Sander E.Van Der Leeuw, Charles

[11] Simin Davoudi, "*Applying the Resilience Perspective to Planning : Critical Resilience : A Bridging Concept or a Dead End?,*" Planning Theory & Practice 13, no. 2 (2012): 304-305.
[12] Davoudi.305-306.

L. Redman, Douglas J. Meffert, George Davis, Christine Alfsen, and Thomas Elmqvist[13]. The report talks about cities as 'systems of cities' rather than a city in its individual existence, analyzing thresholds and cross-scale interactions. It provides four crucial arguments that broaden the understanding of resilience: 1) "Cross-scale interactions" can act as key driving changes,

2) Cities are part of "systems of cities",

3) Cities are extreme innovation hubs,

4) How to harness urban innovation.

The report concludes that uncertainty should be handled through experimentation, learning and innovation[14]. Furthermore, urban innovation is at the heart of resilience as urban innovation, which is a driver of urbanization, influences ecosystems negatively. The report also makes a case for directing the urban innovation towards sustainability to achieve urban resilience. It illustrates these ideas through case studies of three cities for their urban innovations. The essay 'Urban Sustainability and Resilience—Why We Need to Focus on Scales' by Thomas Elmqvist (a professor in Natural Resource Management at Stockholm University and Theme Leader at the Stockholm Resilience Center.) further emphasizes the importance of scalar considerations while understanding the concept of urban resilience[15].

While the above literature dealt with the abstract aspects of urban resilience, implementation of the concept of urban resilience into the planning process would require the identification of tangible and intangible components that the urban resilience is associated with. The tangible components have been referred to as "capitals" in some academic works. These capitals would need to be protected, conserved and strengthened to ensure resilience of a city. In my research, these have been identified through studies for hazard mitigation and post-disaster resilience literature. The "Built Capital" is what has been widely discussed especially in Hazard Mitigation programs of organizations like FEMA. However, the need to focus on not just the built capital but also on the "Natural Capital" and the "Social Capital" is discussed in the paper by Robert C. Freitag, Daniel B. Abramson, Manish Chalana,

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[13] Henrik Ernstson et al., *"Urban Transitions: On Urban Resilience and Human-Dominated Ecosystems," Ambio* 39, no. 8 (2010): 531–545, https://doi.org/10.1007/s13280-010-0081-9.
[14] Ernstson et al. 541.
[15] Thomas Elmqvist, *"Urban Sustainability and Resilience—Why We Need to Focus on Scales,"* The Nature of Cities, 2013, https://www.thenatureofcities.com/2013/03/27/urban-sustainability-and-resilience-why-we-need-to-focus-on-scales/.

and Maximilian Dixon. The paper proposes the 'Asset based mapping workshop' as a tool to gather data about these different capitals from a community[16].

In my thesis I use these capitals and their relationship as the base for the urban design strategies that I propose. I have attempted to visualize the relationship of these three capitals for planning and designing for resilience through Figure 6 . The figure is also roughly reflective of the weightage of consideration I have given these capitals in my urban design strategies proposal. I also explore the relationship between the Built (Red circle in the Figure 6) and Social (Yellow circle) capitals, denoted by orange dashed line, in my thesis using the Community Based Social Marketing strategy.

Figure 7 Relationship between the three capitals - Conceptual Image by author

This provides a segue into the exploration of the relationship of urban resilience and urban design. A more recent study, by Mura Quigley, Neale Blair & Karen Davison (Built Environment Research

[16] Freitag et al., *"Whole Community Resilience: An Asset-Based Approach to Enhancing Adaptive Capacity before a Disruption."*.326.

Institute, Ulster University, Newtownabbey, UK), examines around 43 works within i) General resilience studies ii) Urban resilience studies and iii) Resilience studies that specifically discuss urban design, to establish theoretical links between urban design and resilience as well as adaptive design and planning, through a qualitative synthesis approach[17]. Their literature review results frequent cross-cutting themes across the works that reinforce the significance of **diversity, social capital, innovation and learning in resilience** within urban design[18]. The authors observe that there appears to be 'clear gap in understanding if urban design currently embeds resilience thinking'. They also make arguments towards the need to shift towards 'social process and away from a purely aesthetic conversation in urban design'.

Another paper published around the same time as Quigley, Blair and Davison and which also discusses the resilience of urban form (particularly to climate change), was authored by Tapan Dhar and Luna Khirfan from the University of Waterloo, Canada. Dhar and Khirfan analyze and summarize the evolution of the concepts of resilience in urban planning. But their research efforts led them to form a framework called Urban Design Resilience Index[19], which consists of urban morphological concepts with sample variables that are intended to function as the interface between human and natural systems in order to enhance the resilience of both newly developed urban areas or pre-established ones. They also attempt to graphically interpret these concepts in their framework, which is included in the Appendix E. Among the numerous works they cite, is the work of Stephane Hallegatte. This I find significant, as my pursuit, through a different avenue, to understand 'planning with uncertainties', had already familiarized me with the literature and this, to me, further strengthens the validity of the study.

Much of the intangible threads of urban resilience have been identified through studies on planning for and with uncertainty and complexity. The study I chose for review is "Strategies to adapt to an uncertain climate change" by Stephane Hallegatte, particularly as it pertains to the uncertainty due to climate change. In this study, Hallegatte examines five methods:

[17] *Quigley, Blair, and Davison, "Articulating a Social-Ecological Resilience Agenda for Urban Design."*.581-682.
[18] Quigley, Blair, and Davison.592.
[19] Tapan K. Dhar and Luna Khirfan, *"A Multi-Scale and Multi-Dimensional Framework for Enhancing the Resilience of Urban Form to Climate Change," Urban Climate* 19 (2017): 81, https://doi.org/10.1016/j.uclim.2016.12.004.

(i) **No-regret strategies** which are those that yield benefits even in absence of climate change[20];

(ii) **Reversible strategies** which favors reversible and flexible options such as urban growth restriction – a decision that can later be reversed;

(iii) **Safety margin strategies** which involves buying "safety margins" in new investments;

(iv) **Soft strategies** are those that promote soft adaptation strategies, including long-term prospective; institutional and financial tools fall within this category. These are also reversible strategies.

(v) **Strategies that reduce decision time horizons** include short term options such as buildings in hazard zones that are accompanied by uncertainty of any sort can be built to last for shorter lifetimes.

The Appendix 4 consists of a list of all the principles and concepts for resilience that I came across in the various literature. Many of these principles overlap in meaning and I have selected 6 based on their frequency in the works I engaged with and relevance to urban design strategies. Table 3 gives the principle of resilience that I have selected to be applied in urban design strategies for resilience to multiple uncertain hazard scenarios.

Table 3 List of Resilience Principles

Principles	Description
Diversity/Heterogeneity	Diversity of uses at the same time. Diverse means of mitigation can also build redundancy for safe-to-fail systems. Eg: Complete streets, use of breakwaters and tsunami barrier forests.

[20] Stéphane Hallegatte, *"Strategies to Adapt to an Uncertain Climate Change," Global Environmental Change* 19, no. 2 (May 1, 2009): 244, https://doi.org/10.1016/j.gloenvcha.2008.12.003.

Latency	It can be used to build adaptive capacity, redundancy and safety margins. Half-determined spaces inherently exhibit latency that can be adapted over time.
Flexibility	Gives rise to reversible strategies Eg: Polyvalent spaces exhibit flexibility in purposes and soft-strategies exhibit flexibility in their structures.
Modularity	Decentralization is the key of modularity. It helps build self-sufficiency and to an extent promotes self-organization.
Cross-scale and Multiscale interaction	Helps build redundancy and connectivity. At the same time it reduces redundancies in decision-making.
Learning	It is achieved through feedback loops and it leads to innovation within the system.

Using these principles, I also propose an adaptive planning strategy to provide the long-term vision to create the built environmental strategies incrementally in a phased and efficient manner.

The timeframes and the different scales that act over the building blocks help bind their different pieces together to enable the evolutionary resilience of the system and act as the intangible components.

Based on the various literature that I engaged with, I have identified **three important scales**. These are Spatial scale, Socio-organizational scale and Temporal scale. Figure 8 shows a graphic representation of the integration of the different scales. Spatial scale relevant to a city government can be classified into site level, street level, block/neighborhood level, city level and Sub-county regional level.

The **Socio-organizational scale** can begin with the individual and moving up through levels such as family, neighborhood, City Department levels all the way up to Federal Level.

Temporal scaling, in this thesis, has been used as the scale of a project as spread over the time continuum. This creates project classifications as short, mid and long duration. For example, fixing a broken street-lamp can be classed as a short-duration task while establishing a network of streets can

be classed as long-duration project. But, a long duration task like that can also be composed of many medium duration tasks such as laying of individual streets.

The temporal scaling of the Resilience plan has further been adapted from other coastal communities in the region. Raskin and Wang in their paper present a 50 year plan for coastal communities, through Seaside, Oregon as an example. (Raskin and Wang 2017)

The **timeframes** can be based on time scheduling of goals. Short-term goals are those that needs to be achieved soon while long-term goals are those that are planned to be achieved later. For this thesis, I also propose using an additional type of **scenario-based timeframe**. The scenarios are prioritized based on varying characteristics of likelihood, frequency, severity, suddenness, and cumulative impact. Although the magnitude of or risk potential from sea-level rise may be lower (more so because of their less sudden nature than actual impacts to assets, in that there is time to put disaster mitigative measures in place), its predictability is higher than a tsunami event in the Cascadia Subduction Zone as tsunami predictions depend on accuracy of seismic[21] event predictions, which so far have been difficult to obtain. The factor of uncertainty colors the integrated scale and necessitates the adoption of an adaptive planning model.

[21] (United States Geological Survey (USGS) n.d.) https://www.usgs.gov/faqs/can-you-predict-earthquakes?qt-news_science_products=3#qt-news_science_products . June 09,2019.

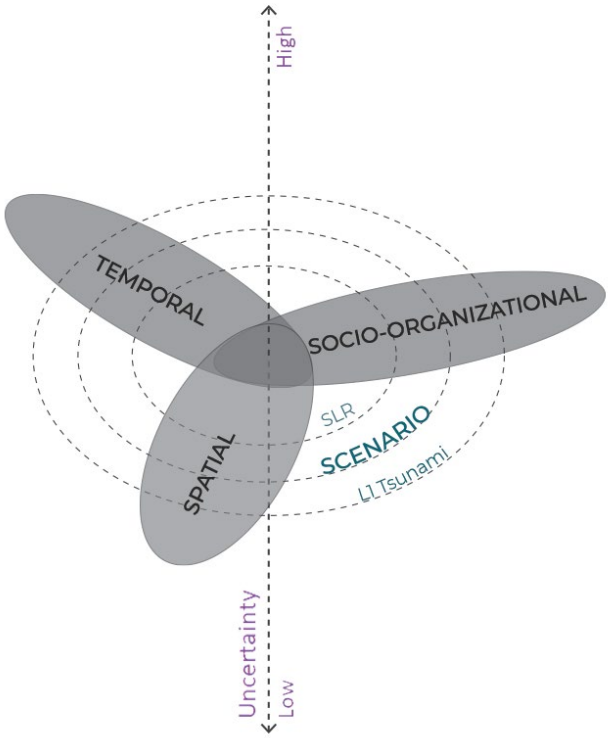

Figure 8 Conceptual graphic showing the integration of various scales for resilience planning by the author, inspired by a similar graphic by T.Dhar and L.Khirfan.

The social capital can be leveraged to strengthen the built capital by strengthening the bond between them. I propose the use of social resilience strategies which are derived from Community Based Social Marketing to fortify this symbiotic relationship.

While built environment and infrastructure resilience to these stresses is being explored and implemented, efforts should also be extended to ensure individual emergency preparedness and social resilience of the community involved. This would also ensure that the built environment be utilized more efficiently to enhance the overall resilience of the city to these threats. Although Westport seems to have a tighter-knit resident community than many other places, - the City actively supports local businesses and excludes national chain franchises - the increase in population during tourist season as well as future development that is aimed at population growth will increase the need to take action to improve the social capital of the city.[22] A way in which the City can ensure this is

[22] Daniel P. Aldrich and Michelle A. Meyer, *"Social Capital and Community Resilience," American Behavioral Scientist* 59, no. 2 (2015): 254–69, https://doi.org/10.1177/0002764214550299.

by taking preemptive steps to establish physical infrastructure and processes that facilitate the continued social resilience of the city.

Later in this paper, I explore the use of Community Based Social Marketing strategy for disaster mitigation. This is a relatively new territory and therefore I have not been able to identify sufficient literature to support my solutions. The documents or sources that I refer to for this sub-topic are works by Doug Mckenzie-Mohr, a report by NOAA on use of CBSM for coastal resilience and presentations by faculty members from universities in Japan who visited the University of Washington, Seattle and Westport to present on lessons learned from the March, 2011 tsunami in Japan.

In general, Community-based social marketing involves five key steps.

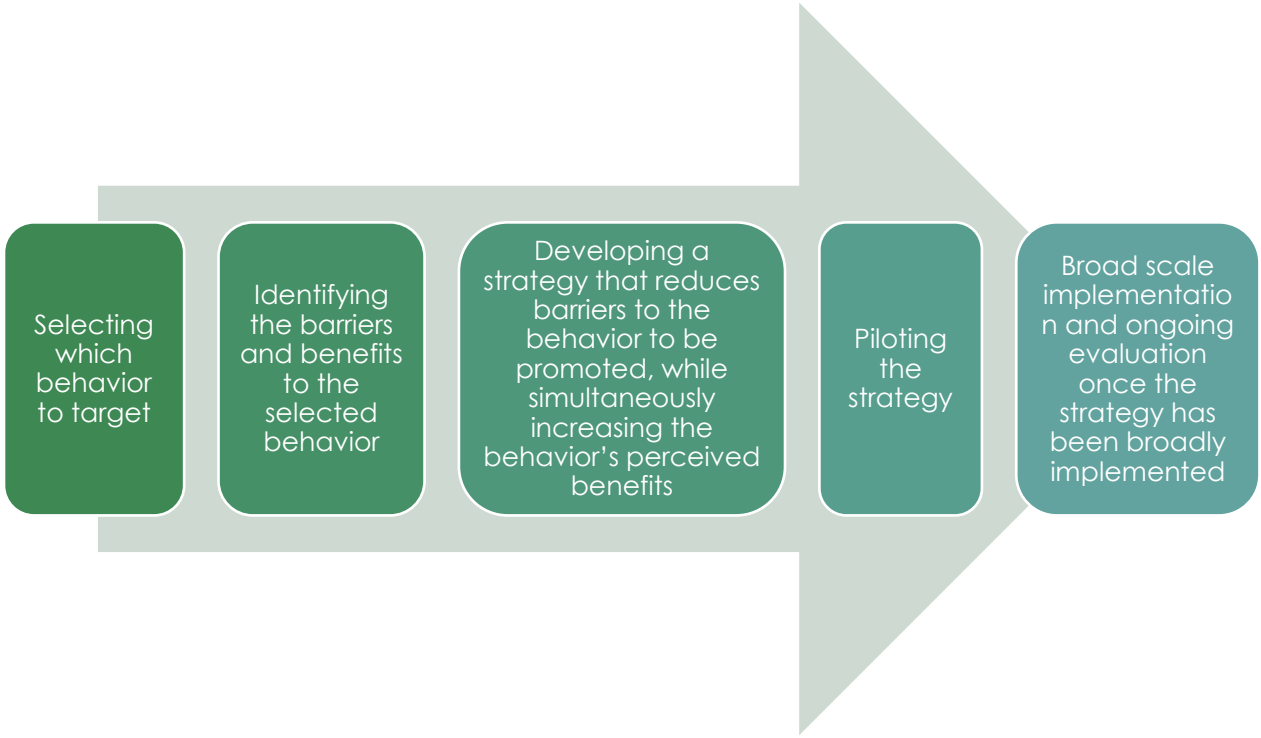

Figure 9 Process for implementation of CBSM prescribed by McKenzie-Mohr

Once the target audience is determined, the process begins with the determination of a behavior that should be exhibited by the audience (eg: turning off the light switches), in order to acquire desirable results for the strategy goal (eg: Reduction in energy consumption). The next step would be to identify the benefits of and barriers in engaging in such activity. (eg: Benefit: Extended life of light fixtures, Barrier: Switches are usually not located near the entrance). The next step would be develop strategies to reduce the barriers (eg: Building regulation demanding that there be a master switch at

the entrance hallway of every house or connected to remote switches accessible through personal devices such as phones.) and at the same time increases the perceived benefits of the behavior (eg: Less frequent changing of light bulbs means less garbage production and reduced environmental pollution). Once the strategy has been formulated, the next step would involve testing the strategy at a small controllable scale. The results from the piloting step would reveal areas for improvement for the strategy. Finally, the optimized strategy would then be rolled out at the full intended scale.

The benefit of this approach lies in that it is a **result-oriented approach**. Therefore, organizations with limited resources find this approach very beneficial. Like sustainability, urban resilience also depends on behavior of people as well as the physical and natural environment. CBSM is a method that has been designed to cultivate such desirable behavioral change which are mostly based on social norms and habits. For urban resilience, individual actions of every individual matters significantly. However, it is not apparent unless we are able to perceive the collective results. CBSM recognizes this and leverages human tendencies to 'fit in' within the larger society by communicating to individuals that 'they are not alone' in engaging in the specific desirable activity.

All the literature mentioned in this section so far are focused on the devising of the strategies themselves. However, in order to ensure that the strategies are adopted seamlessly into the comprehensive planning of a city, my proposed strategies are also overlaid with considerations adapted from those prescribed by FEMA for integrating hazard mitigation into local planning. The Federal Emergency Management Agency recommends 'making the business case' [23] integration of hazard mitigation into local planning. I suggest the same for the adoption of the hazard mitigation strategies themselves. This can eb achieved by identifying co-benefits or using the 'No-regrets' strategy method[24]. The document also provides some arguments for 'Promotion of ideas and values that align with community values and ideals'[25] , particularly in making the business case. There are numerous opportunities and benefits to integrating the hazard mitigation plan into local planning[26].

[23] Federal Emergency Management Agency, *"Integrating Hazard Mitigation Into Local Planning - Case Studies and Tools for Community Officials,"* 2013.2-1.
[24] Hallegatte, *"Strategies to Adapt to an Uncertain Climate Change."*,244.
[25] Federal Emergency Management Agency, *"Integrating Hazard Mitigation Into Local Planning - Case Studies and Tools for Community Officials."*2-2.
[26] Federal Emergency Management Agency.2-4&2-5.

Chapter 4 | The Resilient Urban Design Strategies

In this chapter I present my urban design strategies for resilience to multiple uncertain hazards scenarios in Westport. The strategies consist of a primary suite of built environmental strategies that are accompanied by strategies based on adaptive planning and Community Based Social marketing. Together these interlinked strategies present a holistic product that has greater robustness. This would also allow a unified vision to be created that would make the strategies easier to understand and work with. Consistency with the Comprehensive Plan of the city for these strategies has been attempted by aligning them with the Community Identity recommendations for the Comprehensive Plan update made during the Studio. Refer Appendix C. The consistency with Comprehensive Plan goals is therefore subject to the City's impending decision to adopt the Studio recommendations.

In formulating my strategies, I have also drawn from the 'Multiple Prevention Theory' by Syuto(Shuto) Nobuo which guides the tsunami disaster mitigation strategies of Japan[27], which include both built environmental strategies as well as community based strategies for decision-making and conduct during tsunami events.

[27] Taro Ichiko, "*Decision-Making and Conduct Patterns of People during the 2011 Tohoku Tsunami, Japan*" (Westport, WA., 2018).4.

The Suite of Built-Environment Strategies

This section responds to the first sub-research question,

a. *How can built environment projects be leveraged to protect against risks from less predictable natural hazards while also retaining their relevance during non-emergency times?*

The suite can be categorized into two broad categories:- (i) The Vertical Evacuation network (ii) The Long-term adaptive relocation projects.

Before I explored these strategies, I looked at how attention to overall urban form of Westport will booster the social resilience of the community as well as provide economic resilience opportunities. The skyline of the city also influences the visual identity of the city. With that in mind, I observed that there is only one feature distinctly visible at the skyline of Westport from the marina (See Figure 10) or from some parts of the city. This is one of the City's reservoirs. For the most part the city appears to be flat from the ground.

An important point to be considered is that much of the higher ground within the city is shrouded by trees and are not as easy to distinguish. It is therefore important to direct future development of the city in such a way that the skyline of the city informs the viewer of the presence and location of vertical evacuation structures. For this purpose, the city should mandate form-based codes that only allow those buildings designed to withstand earthquakes and tsunamis to be built above 40ft in height.

UDG Guideline recommendations

- Buildings on the shoreline need to have their ground levels open to reduce the debris with tsunami water flow. The second levels shall have walls that are designed to break-away in the event of massive flooding.
- For lesser impact on the structure, orient buildings diagonal or perpendicular to the wave.
- Space buildings, particularly larger ones, out to reduce damming effect.
- Pedestrian friendly street façade to maintain the "Little Idyllic town" image. Reduce the building mass as perceived from the street level but ensure visibility of the structure as a vertical evacuation from other parts of the city.

Figure 10 View from Marina. The Water tank in the distance is the only distinctly visible vertical landmark.

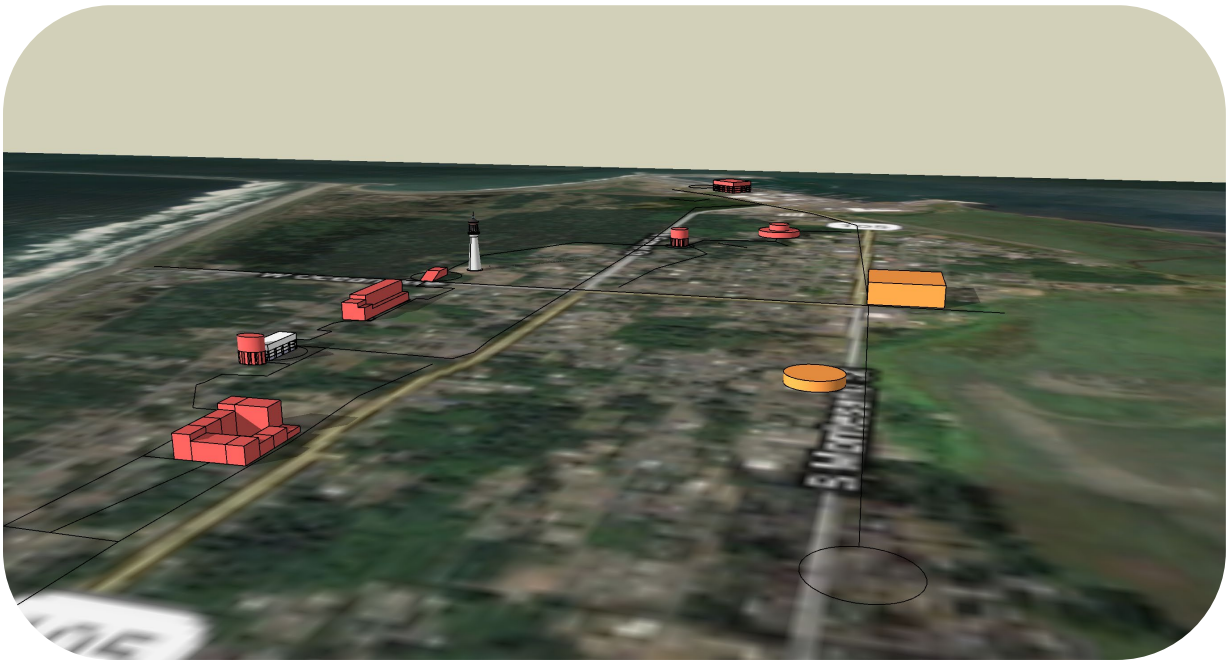

Figure 11 Conceptual view of proposed evacuation structures, looking towards the Marina.

Following are some of the other form-based codes to be adopted by the City:-

(i) The Vertical Evacuation Network

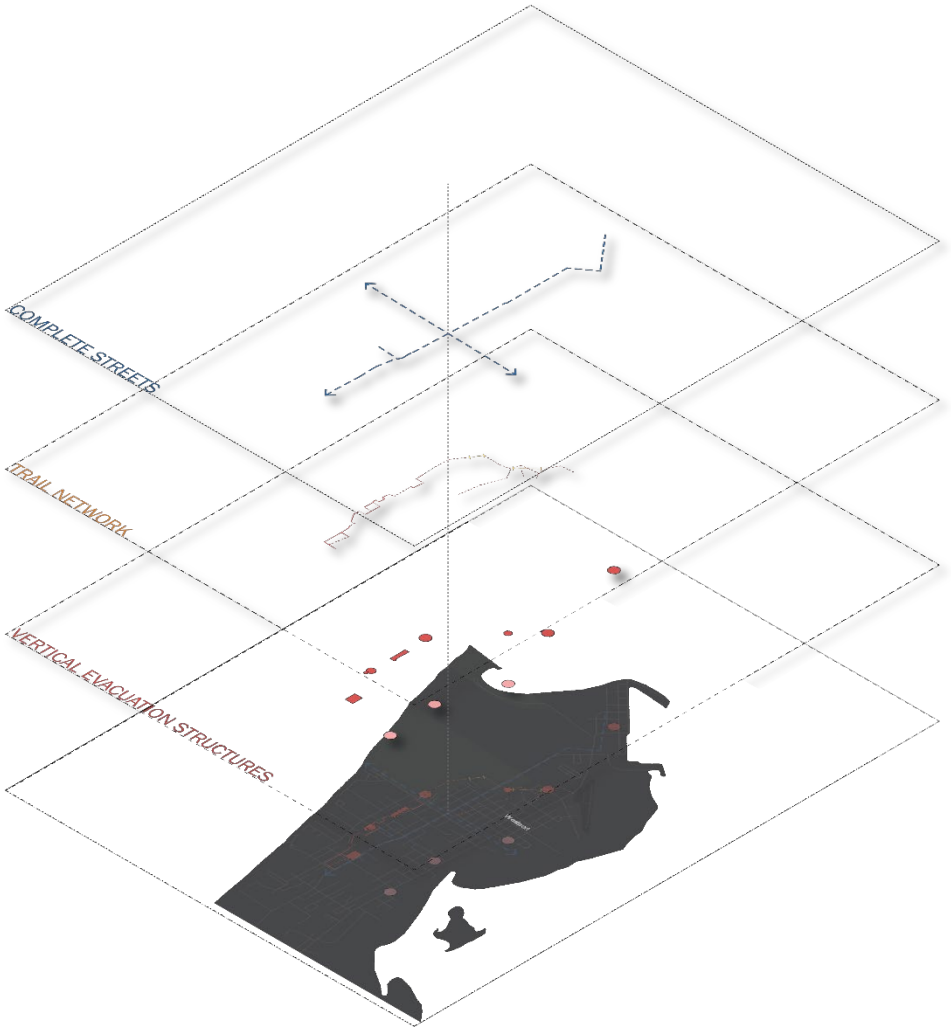

Figure 12 Layers of the Vertical evacuation network

The vertical evacuation network is designed based on the resilience principles so that the vertical evacuation structures can function autonomously for a given amount of time after a hazard event for post-disaster survival of the refugees. For instance, the sustainability design recommendations account for power, water, food, basic sanitation and some basic emergency supplies. Latency and polyvalence are incorporated in the structures design of the structures in order to make the spaces they create flexible as the design recommendations include large open plans that are sometimes half-determined spatially or polyvalent in functionality. The three layers of the network also exhibit diversity of purposes and uses and their functional designations follow a 'No regrets' strategy pattern as they all have purposes suited for everyday functioning of the city independent of their use as

evacuation structures. The network is also multi-scaled and exhibits cross-scale connectivity; the network can be extended to the broader South Beach community, the vertical evacuation structures can have emergency-beacons that can act as communication devices not only between each of the other structures within Westport, but also with neighboring communities, and the network layers themselves follow a hierarchy in terms of direction of evacuation (horizontal for the layers of access to the structures and access between the structures, and vertical within the evacuation structure). The proposed network design offers opportunities for innovation as it has room for feedback, as will be evident in the strategy of adaptive planning. The flexible nature of the spatial design of the network itself offers room for innovation by modifying the inherent latencies as the hazard science progresses.

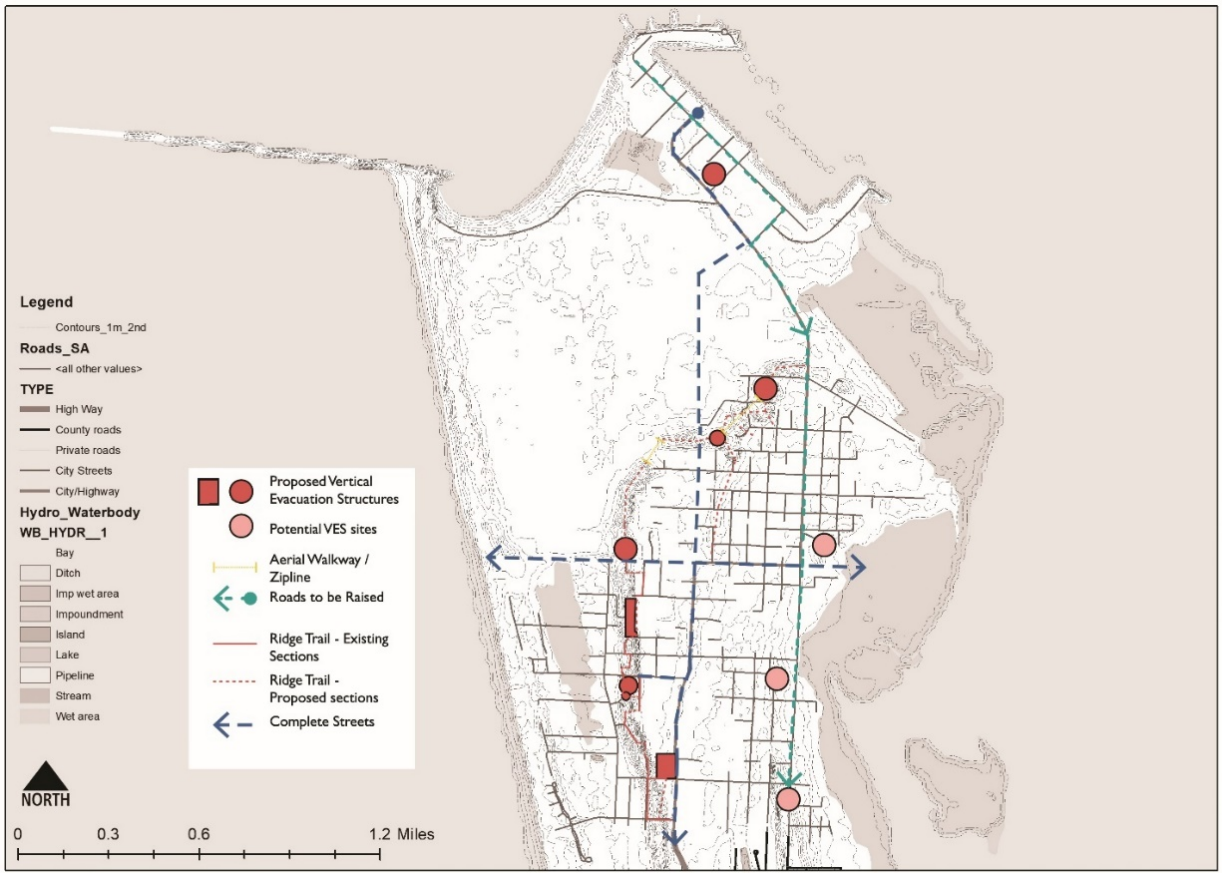

Figure 13 Map of the proposed Vertical Evacuation Network for Westport,WA by author.

The design for this network (See Figure 13) began by following the 'Working evacuation route plan' by the State Emergency Management department, Project Safe Haven Report[28] (Refer sections for

[28] Grays Harbor County Emergency Management, "*Project Safe Haven : Grays Harbor County,*" 2011, https://mil.wa.gov/uploads/pdf/emergency.../haz_safehavenreport_graysharbor.pdf%0A%0A.

Westport) and the Studio DRAFT report[29] (Appendix C). I have incorporated my personal observations and community input into the proposal. The network is composed of Vertical evacuations structures of various types, connected to the different neighborhoods and activity centers of the city through complete streets and to each other through the ridge trail, ziplines or aerial walkways.

The network can be connected to high grounds outside the city limits in the future. In order for such a network extension in the future, Westport and broader South Beach community should consider raising and building a sturdy roadway, with potential to convert to Complete Streets eventually, that leads to a potential high ground near Grayland. The path of the road would can follow an existing timber/logging route. This, however, requires further research into land availability. The eastward land connection of Highway 105 (between Westport and Bay City), will need to be elevated by bridges and rebuilt to withstand both an earthquake and tsunami.

Figure 14 Extension of the Network towards potential tsunami safe grounds outside the city limits.

[29] University of Washington Urban Design and Planning Studio "*Community Engagement for Coastal Resilience"- URBDP 508B - Autumn 2018,* "Localizing Hazard Mitigation - DRAFT Recommendations for Westport's Comprehensive Plan Update."

a. Vertical evacuation structures

These are the structures that would act as the refuge during the tsunami event. For Westport these can be in the form of Multi-level parking facility, Civic center, Observatory and Event center, Housing, and Hotel. The locations for these structures have been determined by the following factors, although not necessarily in that order:-

- Low or zero predicted inundation areas *(Note: In some cases where the sites in an L1 scenario doesn't show any difference in inundation depths, M1 scenario maps show some difference. In those cases I have chosen the site that shows lesser inundation depths in the M1 scenario.)*
- Population density
- Proximity to existing activity centers
- Accessibility by pedestrians through existing evacuation routes
- Existence of other structures
- Ownership of all the property on site
- Community Input
- Distance between the different vertical evacuation structures

The functional designation of these structures, apart from serving as vertical evacuation sites has been determined by evaluating the following criteria:-

- Community Input
- Ability to attract people so that the structure becomes a regular destination for many people
- Ability to generate revenue

The broad design guidelines (Appearance, Structure, Material) of these structures shall be determined by adherence to the following principles:-

Legibility

The structure should display at the minimum a marker that signals its purpose as an evacuation structure. This can further be achieved by making the appearance of the building distinct and easy to describe.

Sustainability

The structure should be equipped with smaller scaled wind turbines or solar panels for power. Depending on the scale of the structure, rainwater harvesting system must be considered. Roof gardens, vegetable patches, etc. should be provided.

Functional flexibility

- All vertical evacuation structures must have flexibility in its functions. To this effect, the levels above the flood elevation should preferably have an open floor plan.
- Cache of emergency supplies and other necessities:

Structural Qualities

Ideal building materials include concrete[30] , steel frames and engineered reinforced concrete frames[31] with robust shear walls [32] for resistance to hazards such as earthquakes, tsunamis and fires. Stucco[33], which is usually made from Portland cement, sand and lime, can be used to enhance the visual appearance and texture of the structure while also adding to the fire resistance of the structure.

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[30] a. "*Concrete for Exterior and Structural Walls.*" InterNACHI. Accessed June 10, 2019. https://www.nachi.org/concrete-exterior-walls.htm. For Fire resistant and durable qualities of concrete;
b. Nazzaro, Robin M; Rhodes, Keith A. *Technology Assessment: Protecting Structures and Improving Communications During Wild Land Fires*. DIANE Publishing. 2005. https://books.google.com/books?id=LfpOxuuonmoC&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q=concrete&f=false (Nazzaro and Rhodes 2005) Use of concrete for fire-resistant roofs;
c. McGrath, Jane."*Top 5 Fire-resistant Building Materials*". HowStuffWorks.com.30 May 2012. Accessed May 21 2019. https://home.howstuffworks.com/home-improvement/construction/materials/5-fire- resistant-building-materials.htm.

[31] (Saatcioglu, Ghobarah and Nistor 2005) Saatcioglu, Murat, Ahmed Ghobarah, and Ioan Nistor. "*Effects Of The December 26, 2004 Sumatra Earthquake And Tsunami On Physical Infrastructure*." ISET Journal of Earthquake Technology 42, no. 4 (December 2005): 79 . Accessed June 09, 2019. hhttps://www.researchgate.net/publication/246027624_Effects_of_the_December_26_2004_Sumatra_earthquake_and_tsunami_on_physical_infrastructure.
The authors investigate the seismic and tsunami resistance of different types of building structures.

[32] (ASCE 7 Subcommittee on Tsunami Loads & Effects 2011) This report by the American Society of Civil Engineers offers other recommendations for buildings to withstand earthquake and tsunami events. The organization published 2016 edition of ASCE 7 (ASCE 7-16) which includes a new chapter on tsunami loads, and new regulations on when buildings must be designed with consideration of tsunami loads.

[33] (Nazzaro and Rhodes 2005) Pg.38 Under the sub-topic Fires resistant building materials the authors explain, "*Exterior walls, siding, decks, and doors made of fire-resistant building materials, such as…… stucco, help structures resist such damage and destruction.*" *More information regarding this can be found in Appendix III of their book.*

The ground level should be open to let water pass through in the event of a tsunami. The floors above up to the VE zone or flood elevation zone should have walls that are designed to break-away in the event of a tsunami.

- Provisions should be made to store emergency supplies. The building should also house an emergency beacon.
- Marine emergency lights to be fitted at inundation levels. Multiple ascending paths to these buildings would be ideal. These could include elevators, stairs, ramps, ladders, scalable walls, variable leveling of structure, fitted heavy duty pulleys to haul the injured, etc.

Table 4 Types, sites and significance of the various vertical evacuation structures

Functional Designation	Site	Significance
Multi-Level Parking	Marina District	- High population density - Distant from Ocosta School.
Observatory	City Watershed land	- High Population density - Existing Popular Activity center
Recreational Center and Civic Center	2 potential sites	- Relocation of some of the critical amenities like Fire station, Town Hall, Museum
Mid-rise Housing	Grand Army Memorial Park	- Addresses growing housing shortage - Potential for holding emergency supplies
Hotel	Chateau Westport	- Utilizes existing structure - Will house unwary tourists - Easier to house some emergency supplies
Event Center Attachment to Observatory	Near Light House	- Provides additional amenities - Potential to be used as a tourist attraction post-subsidence
Senior Multi-level Housing	Newell and Forrest	- Strengthens the sand dune

Most of the sites for the proposed vertical evacuation structures are on the ridges of the sand-dunes.

Multi-level parking

Figure 15 Key Map of Vertical Evacuation Network highlighting Multilevel Parking site in red.

This type of built environment project is one example of integrating Vertical evacuation with multi-functional everyday use.

I propose this structure for the **Marina District.** The site I am using as an example is currently owned by **Stormwatchers LLC** according to the data Grays Harbor County Assessors Map. The site area is roughly 23,000 sq.ft. As was the case with most of the sites selected, I chose this site as an example as it would be located in area of lesser tsunami inundation based on the modelling that was available to us at the time of the Studio. The site is also adjacent to the Project Safe Haven Report site in the same area which was based on an earlier tsunami modelling. It is however smaller than that prescribed by the Project Safe Haven as my concept involves only a single multipurpose building and not a complex of multiple buildings. In general, the significance of locality of this site is that during a given day, the commercial and waterfront activities attract many people. The situation is further pronounced during peak tourist season and hence, a vertical evacuation structure in or around this site is key to saving lives particularly during near-source tsunami events.[34] The modular built environmental project I

[34] (UrbDP 508 Studio B Faculty and Students 2018) *"Working on vertical evacuation, possibly multi-level parking structure for marina district because school is too far under a localized EQ situation. Got approved for pre-plan, now working on advanced assistance plan for FEMA funding."*

propose can be built on a different site in the Marina district and more than one may be built over the course of time. The final site selection would also be subject to more localized tsunami modelling as well as other considerations like soil stability/geological conditions, more amenable ownership or potential redevelopment projects that can be leveraged for tsunami vertical evacuation available, etc.

The proposed structure is a simple multi-level parking structure with diverse amenities like roof top café with restrooms, vegetable garden, wind turbines and Rainwater harvesting. The roof-top space can be designed as a polyvalent space. Provisions can be made to hang advertisement banners on the side that can be rolled up to be used as a tarp cover during emergencies as a form of protection from the elements like sun and rain, post-disaster. Pile foundations and the many large, aligned openings would cause the structure to overturn less readily. Fire-proofing this structure is paramount due to its

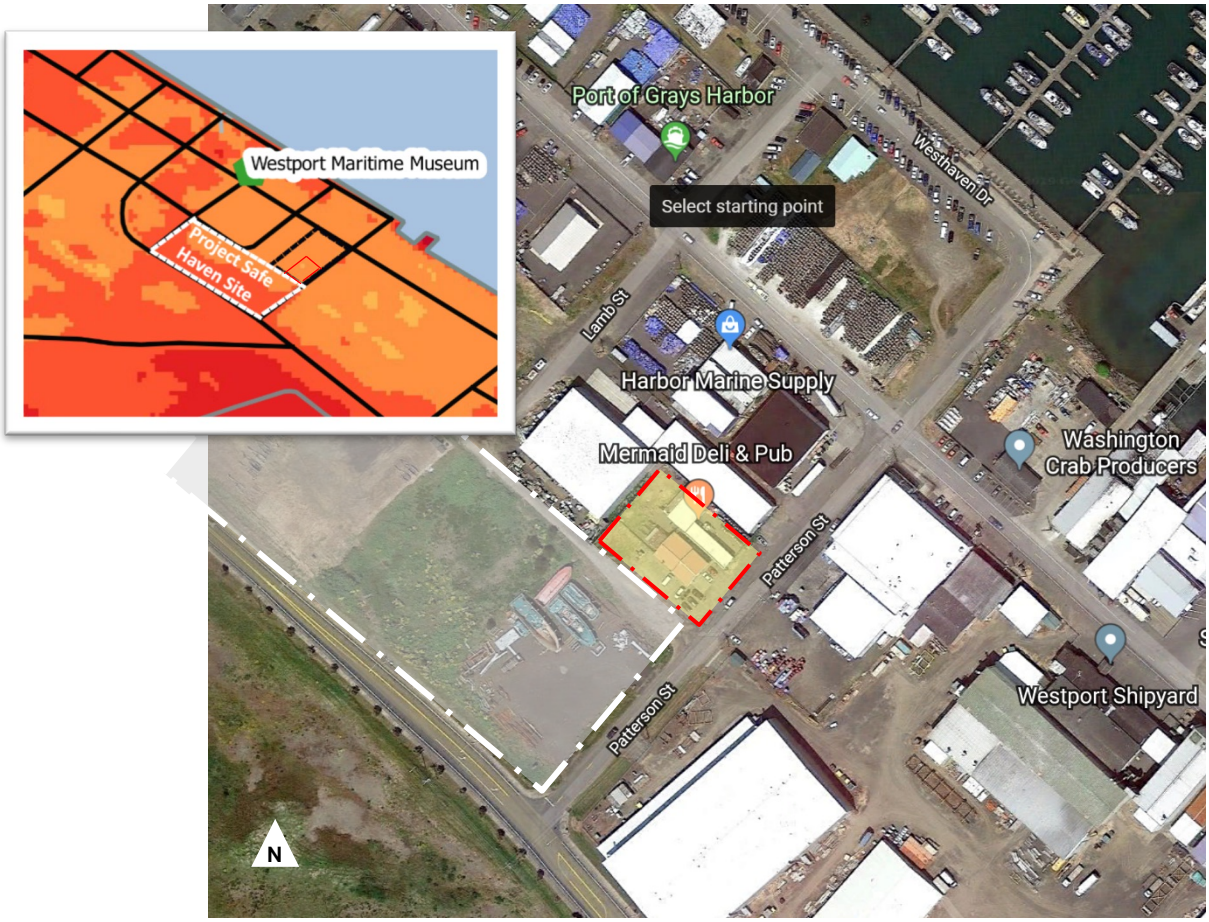


Figure 16 Marina Site. Source: Google Earth. (Inset) Source: M1inundation depth in the area.

proximity to fuel docks. The roof top can also be used as a site for kite flying or storm watching if the eventual site is close enough to the shoreline.

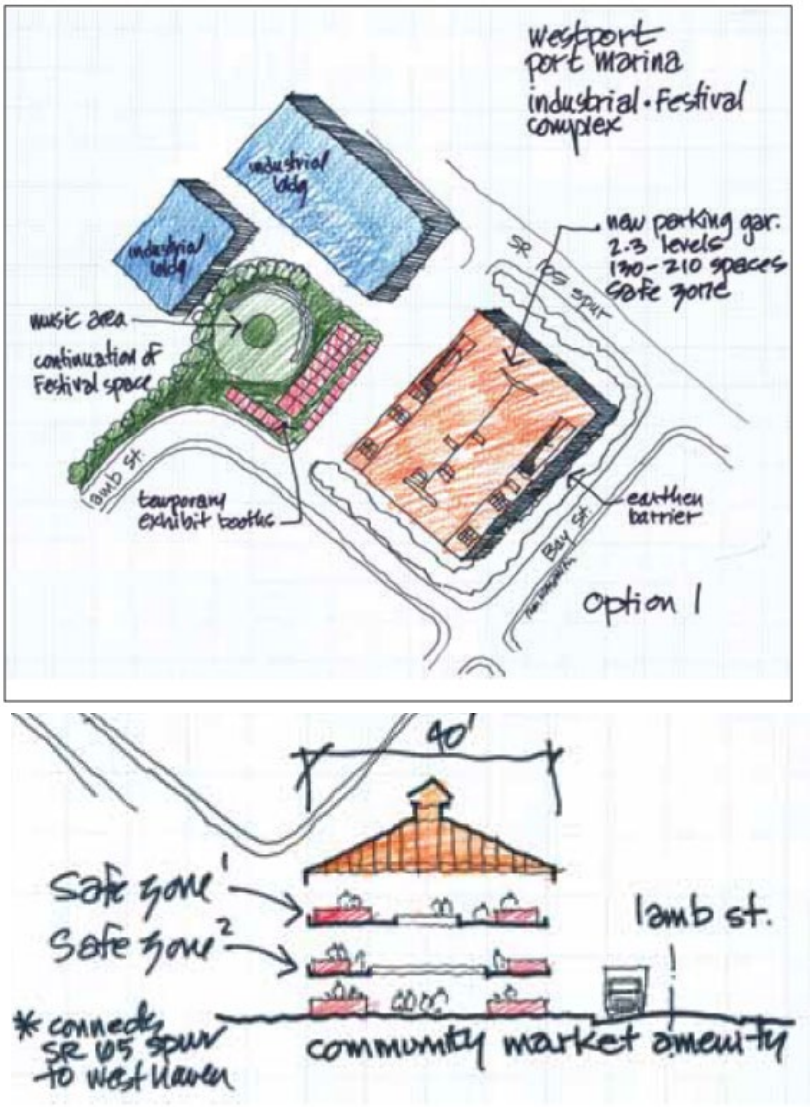


Figure 17 One of the Design Concept Proposal for Industrial Festival complex at the marina site from the Project Safe Haven.

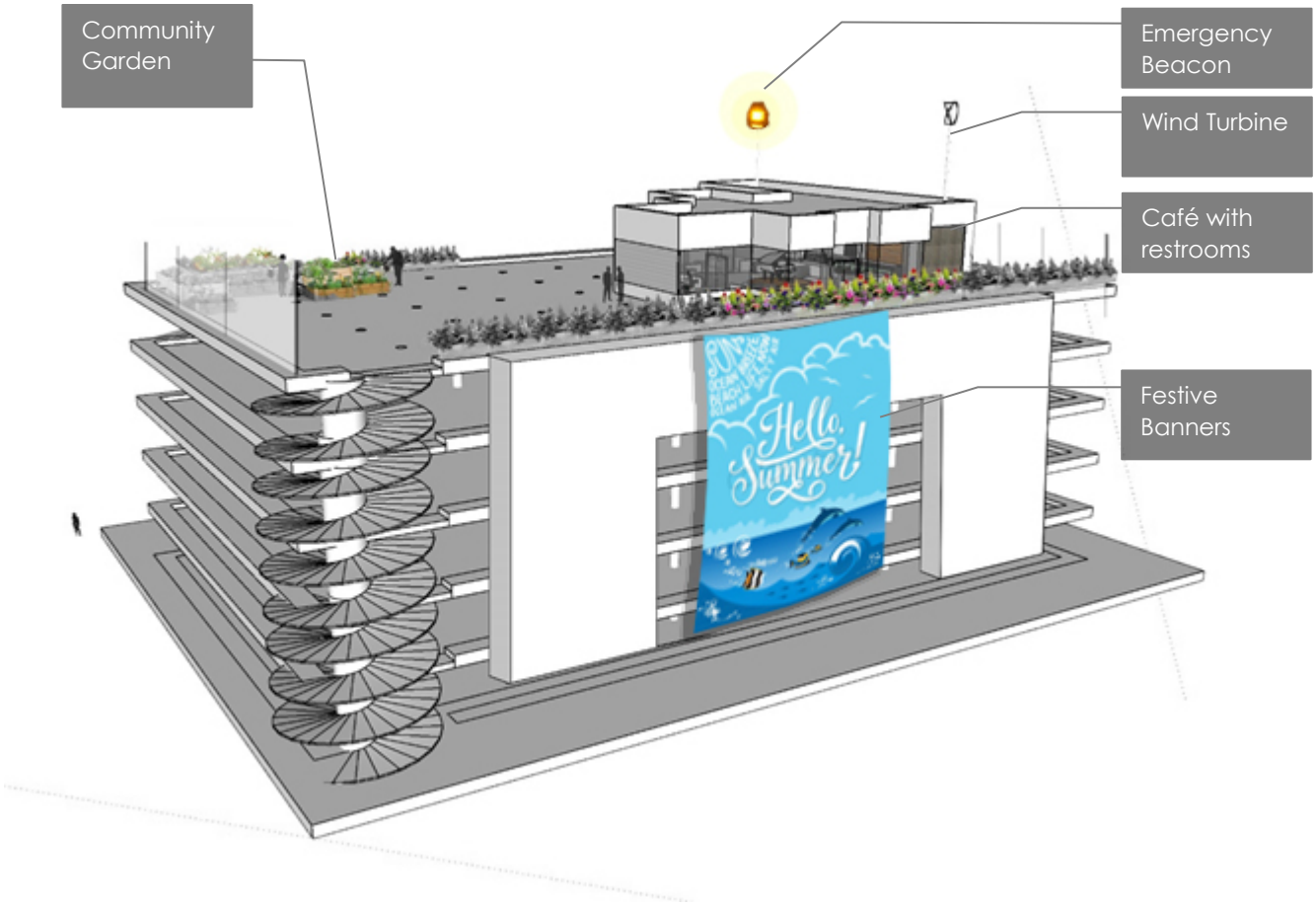


Figure 18 Conceptual model view of proposed multi-level parking structure

Recreational Center

The approximately 42,000 sq.ft potential site is already owned by the City of Westport. The site is within the Westport City Park on Elizabeth Ave and therefore a site that the community is already familiar with. The site is also one of the closest natural high-grounds to the more densely populated areas of the town.

The final stage of this multi-staged project would consist of a combination of recreational uses like rock-climbing wall, Ziplines, open-air community event space, bleachers for the ballpark, restaurants or small shops. The bleachers can be built into the berm as part of the access ramps and steps.

Figure 20 Key Map of Vertical Evacuation Network highlighting Recreational complex site in red.

Figure 19 Orientation of the recreational complex structure with reference to the ball field.

Figure 21 Westport city park site for civic center. Source: Google Earth.

Figure 22 Conceptual image of the final stage of the recreation center with the varied recreational activities.

This project can be executed as a phased development. The phases would be guided by the financial ability of the city. The phased approach allows the City to start working on this development even when they can only fund part of the final project at a given time. This also allows room and time for multiple funders to shoulder the cost and responsibility of this project. In this proposal I have assigned three phases for the project. The first phase is the construction of the berm with attached bleachers for the ballfield. It will also provide open-space for community gatherings and events. The design height of the berm would ensure safety from smaller flooding events. The berm can also be engineered in a way that will be conducive for future superstructure construction. The second phase of the project will involve the building that will host a restaurant, pub or any such purpose. It could also house other flooding and sea level rise threatened community resources for social groups,

community kitchens, food banks, etc. depending on the spatial extent and other conditions. The third phase will be to complete the construction of the tower structure to allow for other recreational purposes like rock climbing wall and ziplines connecting to other vertical evacuation structures. An alternative to the above second and third phase is constructing the tower as the second phase in order to allow income from the recreational purpose and then construct the building as the third phase to include other amenities. (See Figure 23)

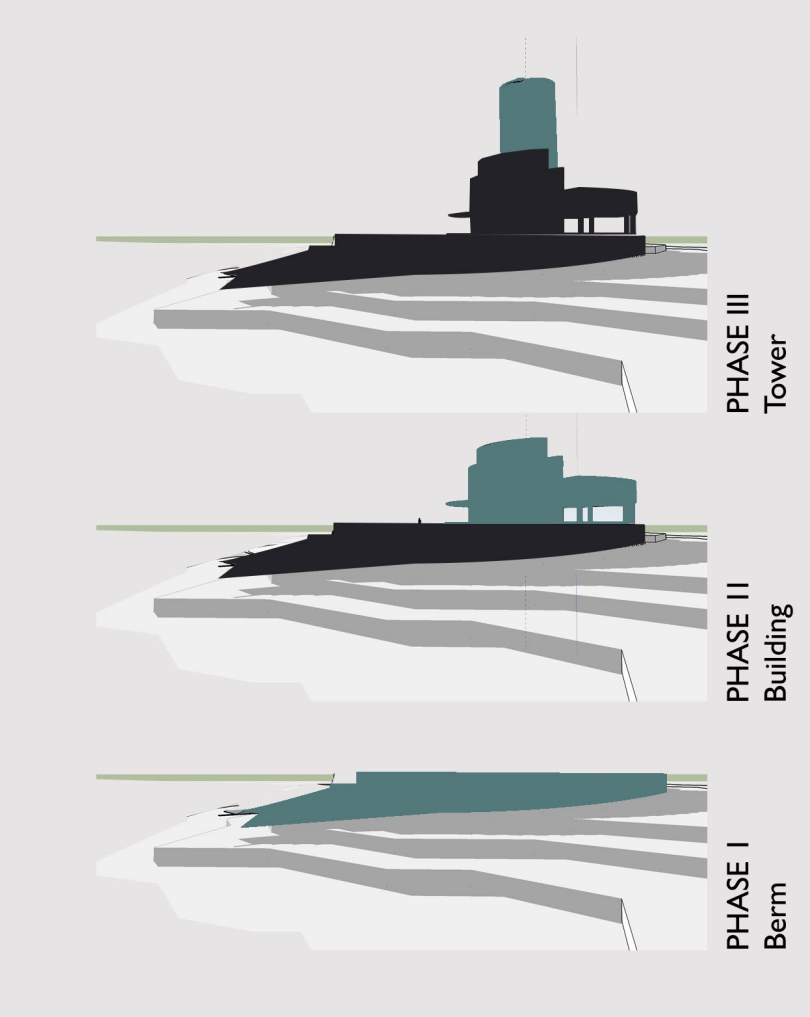


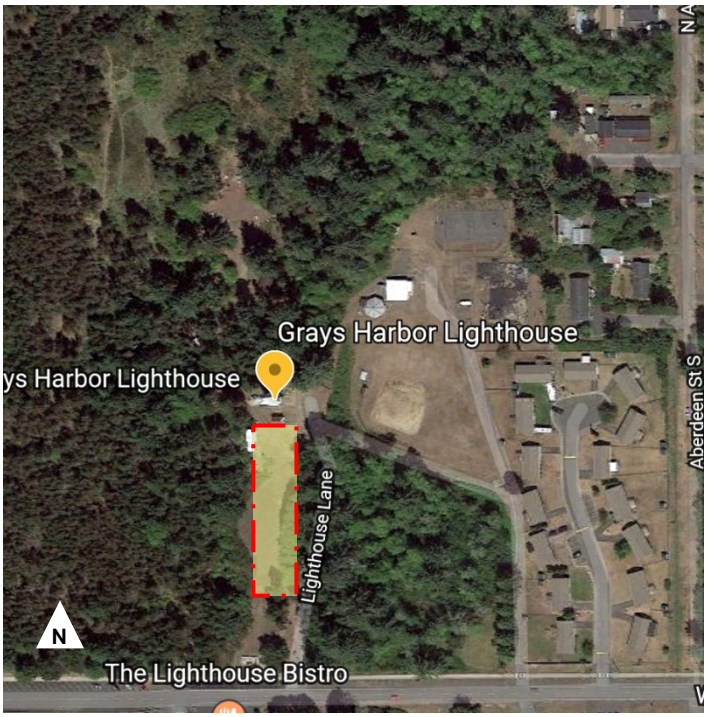
Figure 23 Phasing of the Project

Observation Pavilion

The potential site for this project is owned by the Westport and South Beach Historical Society and the site measures approximately 20,000 Sq.ft. Significance of this site lies in the fact that there are 200-300 residents living in Westport by the Sea condominium.[35] The Pavilion design can be based on one of the options provided in the Project Safe Haven report[36].

Figure 25 Site for Observation Pavilion. Source: Google Earth

Figure 24 Key Map of Vertical Evacuation Network highlighting Lighthouse Observation Pavilion site in red.



[35] (UrbDP 508 Studio B Faculty and Students 2018) "*Kevin – have we included condos and homeowners associations? Westport by the sea - has been subject to coastal erosion, storm damage has brought water close to their buildings. 200-300 residents. Homeowners association and Westport by the sea management. George is the contact. Those folks will need to go somewhere very quickly even in minor events. They will be underwater and stranded even in a minor event.*"

[36] Grays Harbor County Emergency Management, "*Project Safe Haven : Grays Harbor County.*"

Figure 22 shows the design options presented by the Project Safe Haven. I think these options are the

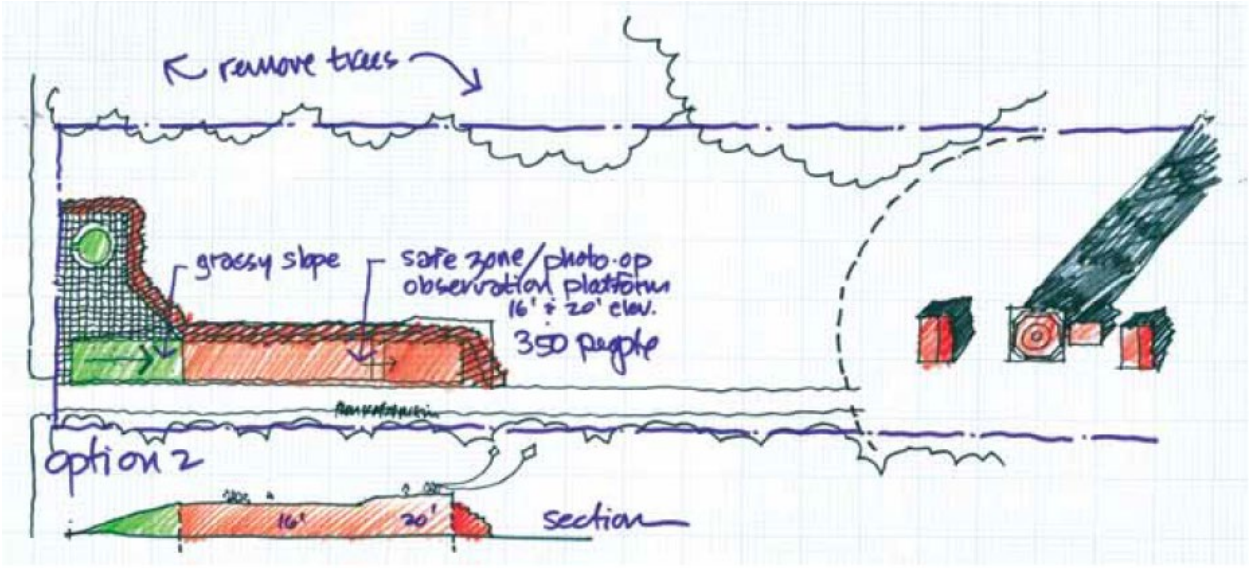


Figure 26 Option 1 and 2 for the lighthouse site. Source: Project Safe Haven report.

most appropriate for the site. The could include design elements that can serve as special photo-op features. An example is a simple frame at a marina in Cape Town, South Africa.

Figure 27 An example of framing photo-op found in Cape Town, South Africa

Housing – Senior and Affordable

Is there Support of the existing Comprehensive Plan of the city for proposed multi-use vertical evacuation structures?

According to the city's current **Comprehensive plan**, the city aims to plan for a projected population of 3,200 in the city of Westport, and a projected population of 4,100 for the Westport area by the year 2030. I also aims to provide efficient land in suitable locations for the various uses needed to meet the demands of expected population increases and an expanded and stable economy and to minimize land use conflicts and encourage compatibility between land uses through careful and attractive design and the use of appropriate open space. The city also wants to encourage the redevelopment of underutilized or dilapidated properties and areas and prevent overcrowding of land use in the city, thus providing for adequate air, light, and protection from fire and noise pollution.

Over the last decade, several new residential developments were permitted and/or completed within the city. These developments created the first **traditional condominium style developments** and proposed the development of small cottage style homes for lower income families. Change in state laws required that Westport allow Manufactured Homes in all zoning districts. Westport has always been a destination for the development of **private vacation homes**. The downturn in the economy created an **increase** in the number of residences that were turned into **commercial vacation rentals** and an increase in c**ommercial home occupations in the residential areas**. The city does not want to discourage these commercial uses but wants to ensure the impacts of them on traditional residences and neighborhoods are eliminated where possible.

Based on these trends, the types of multi-family residential developments has increased to include multiple units on a single parcel and combined units with between two and four units per building. These developments may include single family residences, condominium developments, and townhouse developments. The four land use classifications with varied standards to create a matrix of higher and lower densities, from the previous comprehensive plan has been retained. The comprehensive plan states the city's intention to continue the mix of residential development while providing for the growing interest in commercial uses that are consistent with residential areas.

Is there support of preliminary real-estate market analysis for proposed multi-use vertical evacuation structures?

Demographic characteristics supporting the proposed multi-family development:

The population data acquired from the 2017 ACS 5 year shows that the population is rising for the city of Westport. It also shows that the current population pyramid is not very balanced. Not only is there a significantly higher senior female population, given the current median age, the city is looking at a future with more senior residents (assuming the current population does not move away). This suggests to me a need to not only provide more safer housing and better access to health care facilities but also a need to attract new and keep the existing younger population. Also to be noted, is

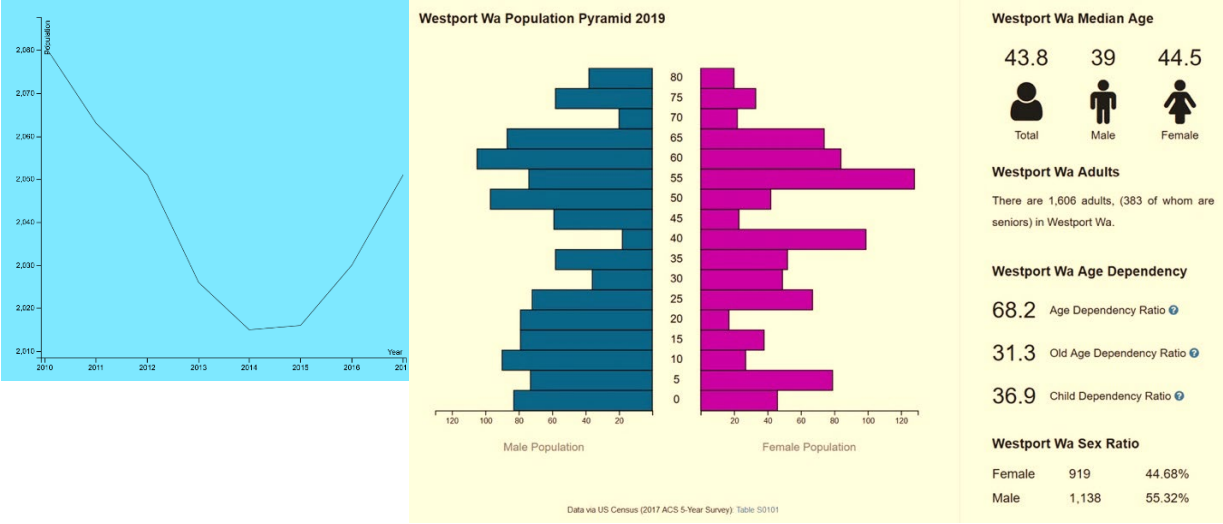


Figure 28 a. Increase in population (2010-2019) b. Population pyramid. Data Source: 2017 ACS 5 year Survey.

that 50% of the population is single.

Does the current housing market support the proposed multi-family development?

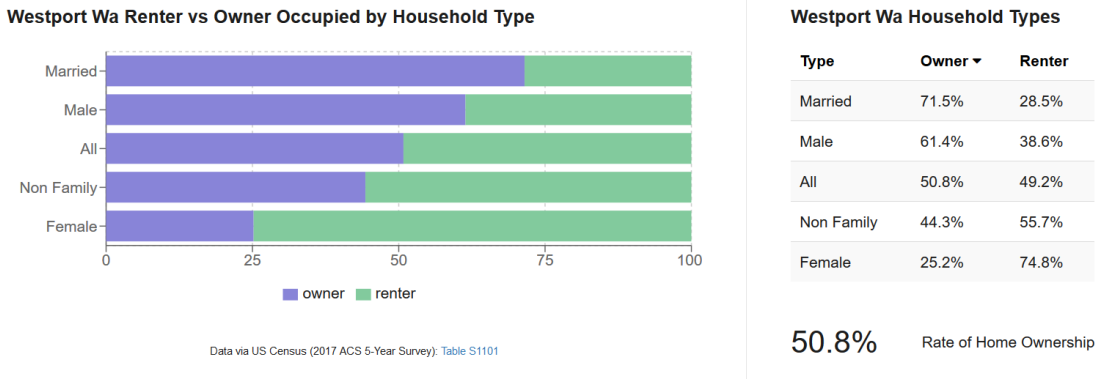


Figure 29 Renter vs Owner Occupied household proportions. Data Source: US Census (2017 ACS 5-year Survey).

The data on household type and home ownership also support the proposal. There is higher proportion of single female renter household currently while multi-person households own their homes. The 13.5% and 2.9% increases in per unit median sales values of the single and 2 bedroom units indicate that there is a demand for such smaller units within the city. Refer Appendix 2 for additional details.

I look at two sites for the two projects; one west of Grand Army Central Park and one south of the Kila Hana Camperland site.

The Grand Army Central Park site is a good example to be developed as mixed-use affordable housing option. This site is also already owned by the City of Westport. Along with housing, the project can house some recreational activities and also incorporate some retail shops. The idea again would be to take advantage of the existing ball field and provide additional functionalities for the area that would promote daily visits to the site by residents from the neighborhood. The other co-benefit to such a project is how the residents could provide informal security in the form of 'eyes-on-the-street' for the playground from the patios and observation decks.

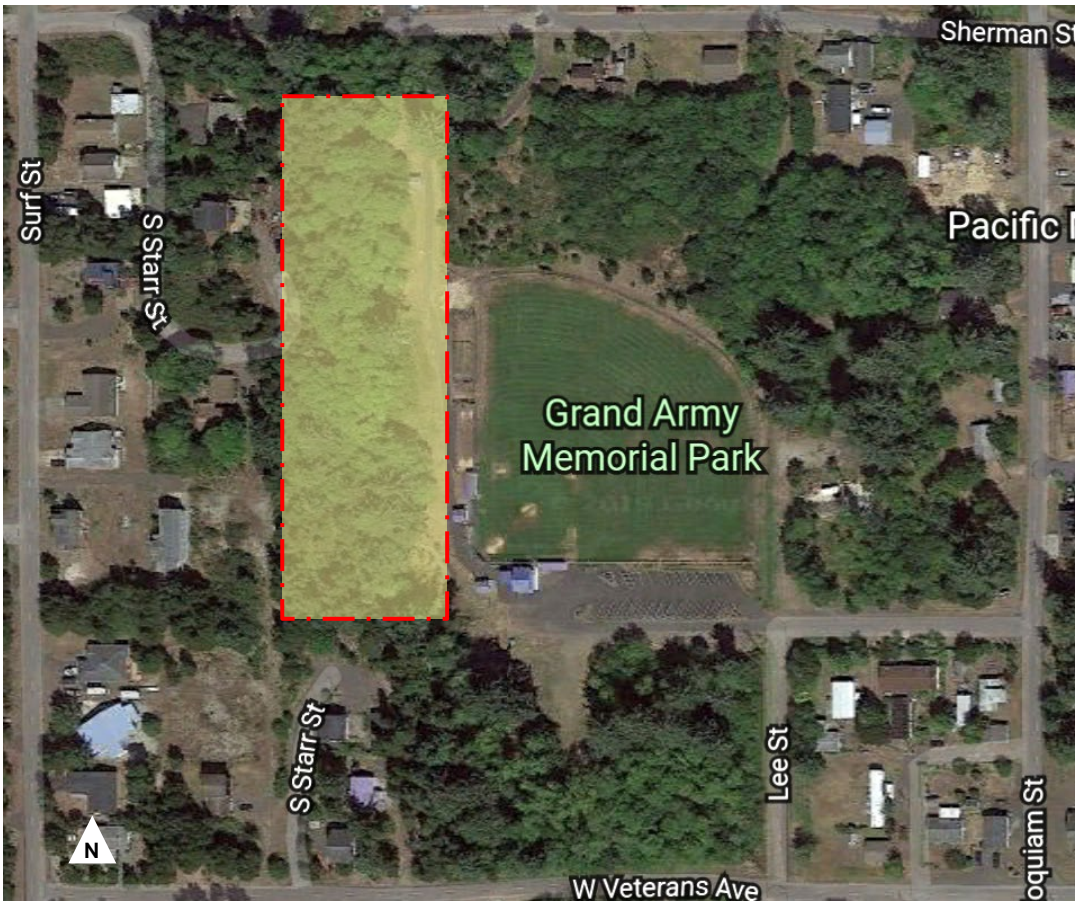


Figure 30 The site for Affordable Housing. Image Source: Google Earth.

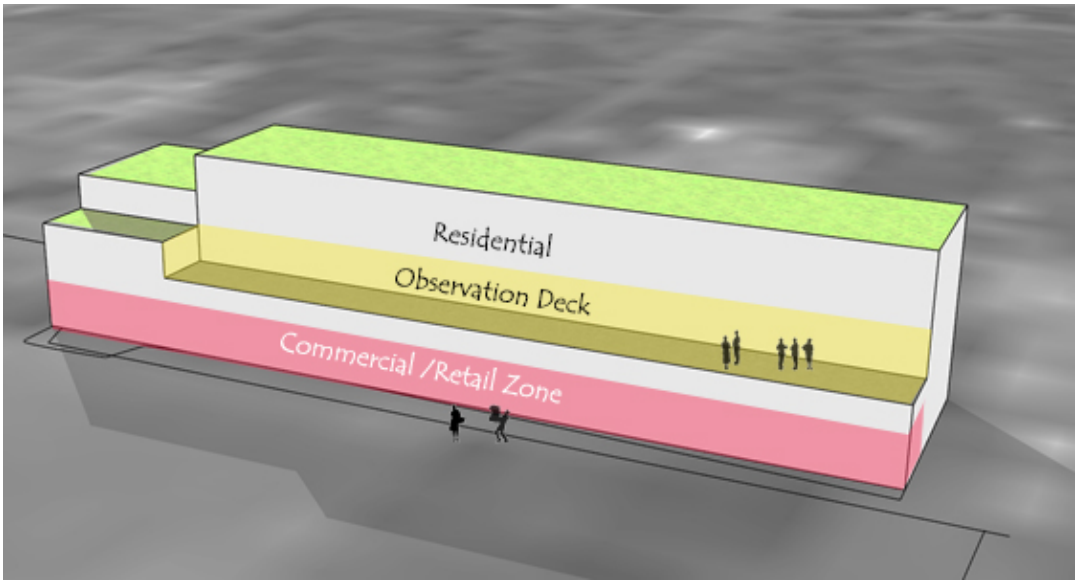


Figure 31 A conceptual Block model of the Affordable housing form based zoning.

Figure 32 Key Map of Vertical Evacuation Network highlighting Affordable Housing site in red.

The Figure 31 is a representation of the programmatic elements of the affordable housing evacuation structure with basic building mass design. The lowest level would house the public domain of the building which can be in the form of any commercial or recreational facilities like a gymnasium, indoor games area, grocery shop, etc. For a tsunami safe structure, the lower levels would need to be structurally as open as possible and provides the opportunity to spatially connect the nearby open ball park to the building itself through amenities open to the public. The upper level deck can be oriented to face the ball field and act as observation deck for activities of the Grand Army Memorial Park. The roof-tops of the residential units can act as connected private patios or community gardens. It could also house a

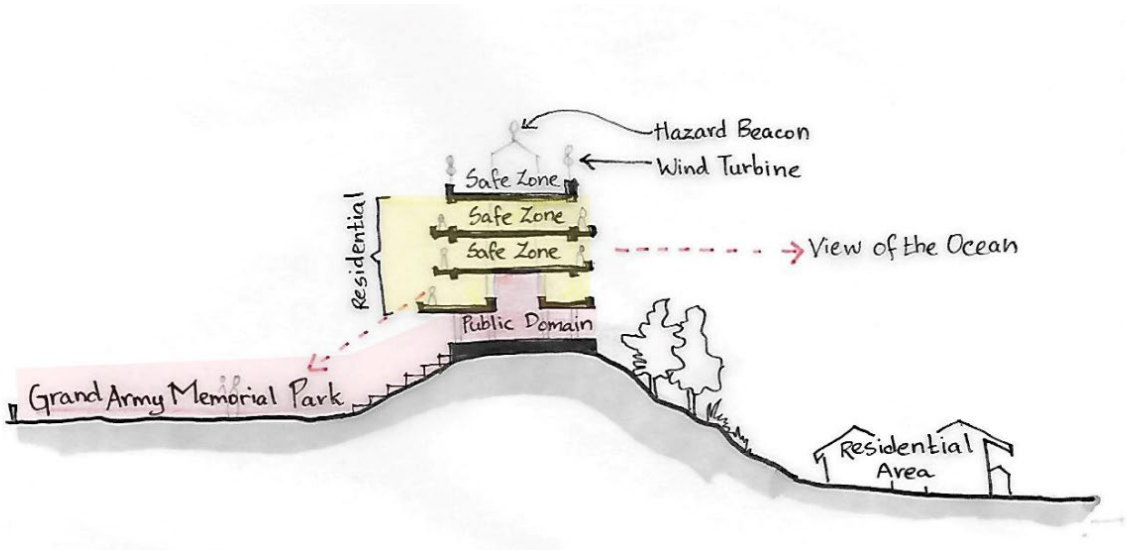


Figure 33 Sectional Sketch by author showing the relationship of the affordable housing vertical evacuation structure to the surrounding area.

community kitchen. The massing of the building is stepped and facilitate the scaling of the building with temporary ladders or such amenities from the exterior of the building. While the residential side would face the ocean side with views of the ocean, the patios or observation decks facing the playfield would also serve as the 'eyes-on-street' for the on-goings of the area and provide an informal security

surveillance to the area. Such an activation of the space would encourage more people to visit the site making it more familiar to them, thereby, increasing the chances of the structure to be used as a vertical evacuation structure.

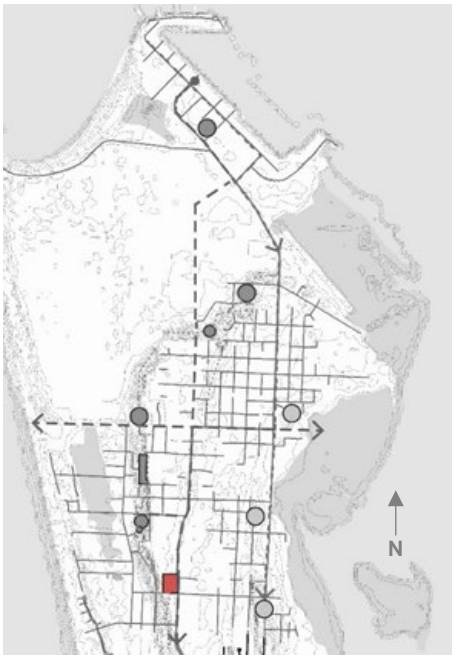


Figure 34 Key Map of Vertical Evacuation Network highlighting Senior Housing site in red.

The site I have chosen to demonstrate an example of Senior housing is owned by the State of Washington and is roughly 83,000sqft. It is also accessible by the Highway 105 which would be useful for emergency vehicles.

The proposal includes housing and healthcare facilities for senior citizens. The overall building massing can be designed to be accessible from the exterior. Figure 35 and Figure 36 are two such examples. OSU's Marine Studies Building (which is currently under construction) is a good example of the incorporation of ramps for vertical access in the overall design of the building. Like the Ocosta School gym, the Marine Studies Building is also designed as a vertical evacuation structure and is yet another example of a multi-functional design. In the 'Vitae' building design by the Italian architect Carlo Ratti, the building sports a ramp that extends all the way to the top of the building. The ramp has additional purpose as a space for an urban vineyard. The provision of such multi-purpose ramps would help evacuate people with mobility challenges in the event of elevator malfunctions, both during a disaster event or even when individual emergencies arise during everyday functioning of the senior center, when the elevators may be temporarily inaccessible while also having everyday utility throughout the year. Care should be taken to design or orient ramps away from the predicted direction of the initial and returning tsunami wave which may cause the wave to run up the ramps.

Figure 35 The 'Vitae' building in Milan, Italy, by Carlo Ratti. (Inset)Image of the urban vineyard on the sloped terrace.

Figure 36 Rendering of planned Marine Studies Building at Oregon State University's Hatfield Marine Science Center in Newport,OR. Source: https://fa.oregonstate.edu/project-delivery/marine-studies-building-project

Figure 37 Forrest and Newell Site for Senior Housing

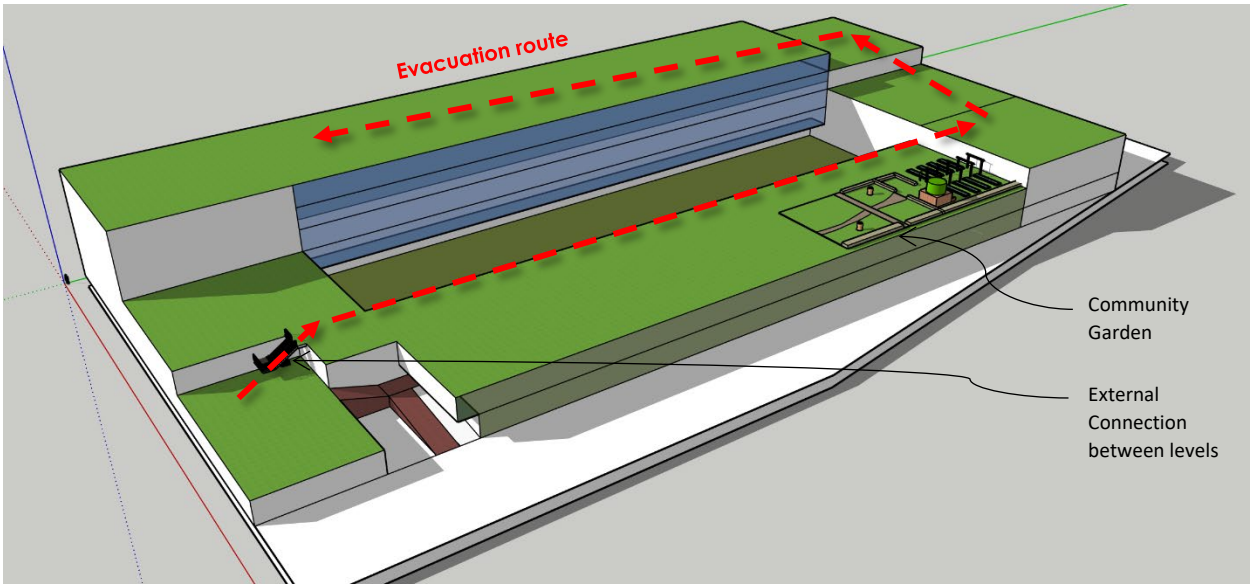


Figure 38 A conceptual block model for the proposed Senior Housing facility by the author.

Hotel – Retrofit

Figure 39 Key Map of Vertical Evacuation Network highlighting Hotel site in red.

The Chateau Westport owned by the Chateau Westport group, is a possible candidate for this type of vertical evacuation structure. The significance of this site lies in its proximity to residential zone and the number of tourists that it caters all through the year.

The Chateau Westport can be tested to be retrofitted to withstand earthquake and tsunami. At the least, this would include opening up the lower storeys and soft storey seismic retrofitting. If this is not a feasible option, the City and the hotel owners can look at the option of rebuilding the structure. If possible, consideration can be made to include a conference facility at the roof level. This was an amenity found to be in demand during the community engagement process of the Studio.

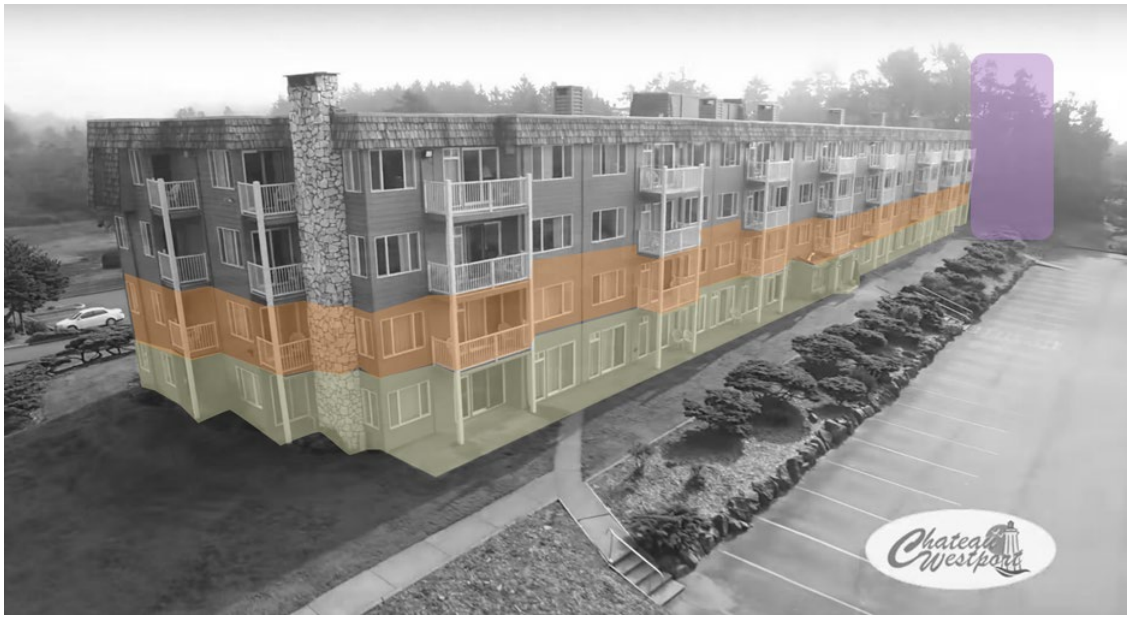


Figure 40 View of the Chateau Westport. The yellow zone indicates complete opening up of the level for flood resilience and orange zone indicates the levels that would need breakaway wall systems. Original Image Source: https://web.archive.org/web/20190628152127/https://www.chateauwestport.com/.June28,2019. Edits: Author.

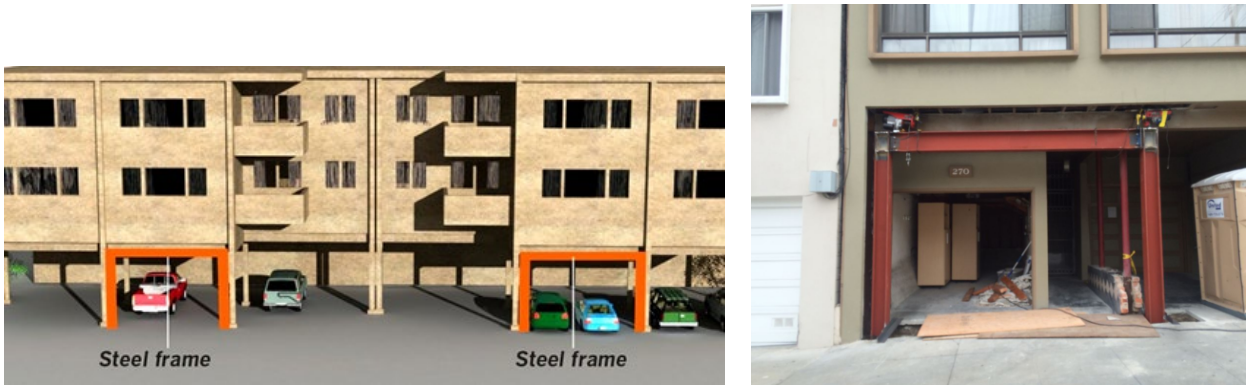


Figure 41 Examples of Soft-storey retrofits. Source: https://web.archive.org/web/20190628152803/http://www.wcpc-inc.com/soft-story-retrofit/. June 28,2019.

Another option to be considered if neither of the aforementioned is feasible immediately, is to construct a basic structure similar to that in Figure 42 standalone vertical evacuation tower or deck the design of which may or may not incorporate recreational purposes. The structure can also house a conference facility connected to the roof of the existing hotel structure. The purple patch in the Figure 40 indicates the potential site for this facility.

Figure 42 Example of a basic stand-alone tsunami vertical evacuation structure in Japan. Source: https://www.youtube.com/watch?v=wDh_kiVjmw4. June 29,2019.

Among the other vertical evacuation sites, there is potential to designate their functions for a civic center and other amenities. The sites are mostly on the easstern dune ridge and are predicted to be least inundated in an L1 scenario in Hazard maps available.

Figure 43 Key Map showing potential sites for Civic center highlighted in pink along the eastern dune ridge.

Does the market survey support a multi-use civic and commercial center?

Due to a dearth of relevant statistical data, I resorted to surveys on websites like Yelp to help me address this question. The bottom line is that all these amenities, recreational and utilitarian, are located in the peninsula and not really on natural high grounds. Therefore, there is a definite need to develop more of these amenities on the higher ground.

b. Access between the structures

Figure 44 This key map shows the path of the Ridge trail(red-orange) and path of the Zipline/Aerial walkways (Pale Yellow)

Ziplines and Aerial walkways

Aerial walkways and ziplines can be used to connect two vertical evacuation structures particularly when the path cross private property or unstable terrain. The advantage lies in the fact that the ground over which these serve (except where the tower are located) will not need to be reinforced substantially. They will also be more useful between when a tsunami warning is put out and when the event occurs. A limitation will be that they may not remain functional post-event. These also provide eco-tourism opportunities.

Ridge Trail:

This is elevated trail system which is comprised of existing roads, pathways and potential easements through private lands over the sand dune ridge. The trail will be reinforced or strengthened where

required. The purpose of this trail is to connect the various vertical evacuation structures by ground and act as a path for everyday exercise.

Figure 45 Image of a zipline.

Figure 46 Images of aerial walkways through forests in Washington state.

Figure 47 Example of potential trail features. https://www.suedtirolerland.it/images/cms/D-0414-aldein-jochgrimm-weg-steig-auf-das-weisshorn.jpg

c. Access to the network - Complete streets

These are streets typically designed to accommodate all types of traffic such as motorists, bicycles and pedestrians. Unlike the complete streets of big cities, size and population of Westport does not necessitate a separate lane for transit and motorists.

An added layer for more wholistic completeness is rendered by using the streets for improving the city's resilience against potential hazards. For Westport, these streets will also be integrated with blue-green stormwater infrastructure to reduce flooding during higher precipitation seasons. Adding swales and raising the pedestrian sidewalk will help the roads act as stormwater conduits and keep the sidewalks usable. It will also be marked with evacuation route signs. These include markers on the street-lamps, yellow arrows on the road and reflective yellow catseye markers on the roads. The paint markers are cheaper additions and can be used a temporary markers leading to current available safe grounds until better vertical evacuation structures are created.

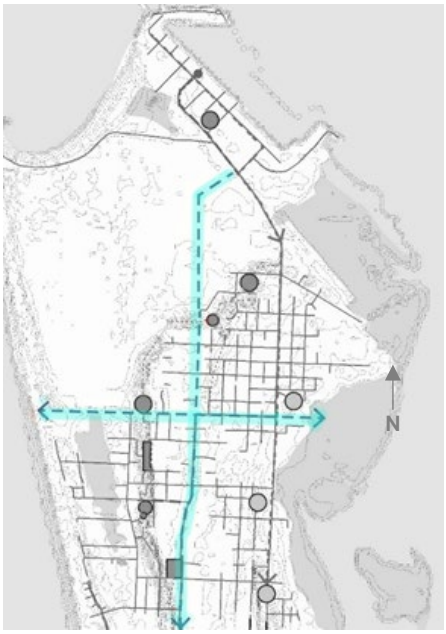


Figure 48 Key Map highlighting the path of the proposed Complete streets in Cyan.

Another feature to these streets that can be implemented in the form of urban design guideline regulations is the roof color code for buildings that line a hazard evacuation route. (See Figure 49). A requirement to aesthetically include some form of reflectors into the façade of these structures can also be codified into the Urban Design Guidelines of the City of Westport. This is to ensure that in the event of a major earthquake, the remains of at least some of these markers will help guide the survivors towards vertical evacuation structures or other safe haven.

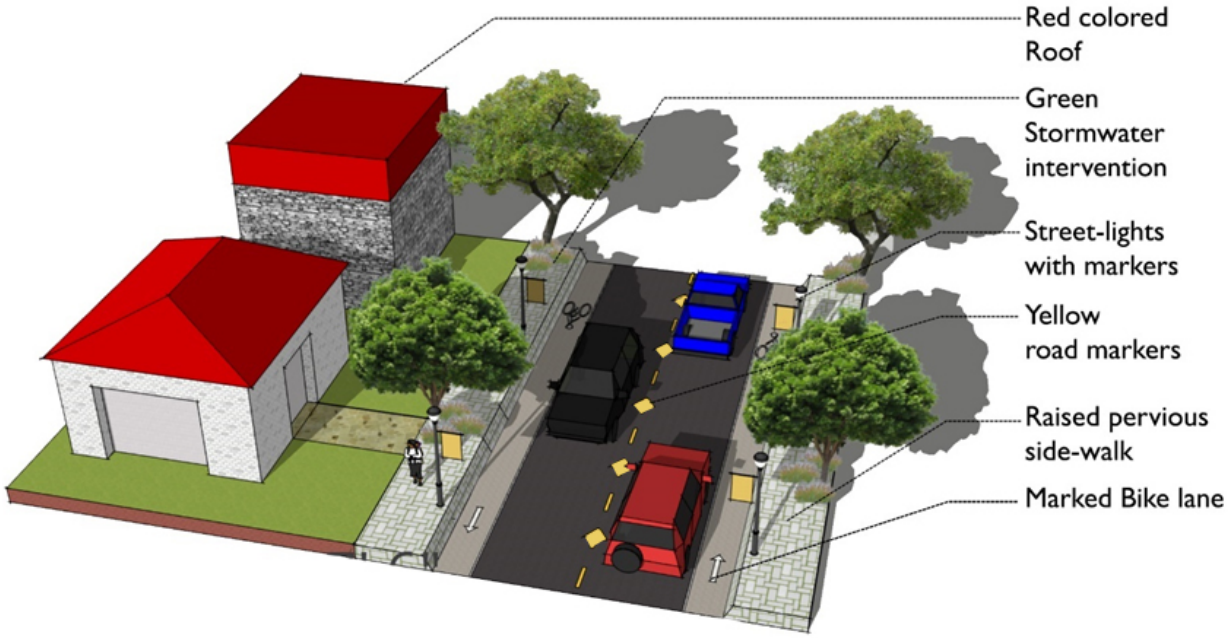


Figure 49 Model of Complete Streets by Author

Figure 50 Marina District envisioned with some of the features of complete streets presented to community for feedback.

Figure 51 Example of existing Blue-Light Phone system in university campuses in the country.

The streets can further be enhanced and employed for the education of hazard preparedness using stand-alone devices.

Stand-alone devices:

These are obelisk-like small structures that can be used instead either on their own as sculptures or can be integrated with street-lights and signages. These are devices that will hold information material or can be used to establish an emergency communication network. This can be done in multiple ways not limited to include detachable hazard lights, sirens, Public announcement systems, seasonal tourist information material holders, etc.

A version of this can be found in many university campuses in the nation, popularly called as 'blue light phone poles'. (See Figure 51) Blue light phones are devices that are placed around college campuses for students to use when they need assistance like jumping a dead battery in a parking lot, personally experience an emergency, or witness a crime.

For Westport, these can also be unique features to be designed by local artists and can later be incorporated into tourist education programs for tsunami preparedness. Tourist programs can include games like spotting all the obelisks or the ones that give hazard information vs. ones that give preparedness information.

(iii) The Long-term adaptive relocation projects

The Figure 52 demonstrates a possible relocation strategy. In the nearer term, the city could look at moving the critical facilities like the Fire station to a site further inland and at a higher elevation so as to be safe from tsunami inundation. The site would still be located on a site along the S Montessano Street, which is a wide street which would be a necessity for the fire engine to quickly travel to even the farthest tip of the peninsula. The site (best available) could be within the city limit or in the unincorporated area just outside the city limits. The City could engage with timber and logging companies and other private entities and facilitate a land swap directly between high grounds near Bay city or near Grayland and the low-lying land that are within the 100 year floodplain. The floodplain could be used to establish the wetland resort. Indirect land swaps could be established using Land banks and Transfer of Development Rights Bank strategies, similar to ones established in other parts of the state.

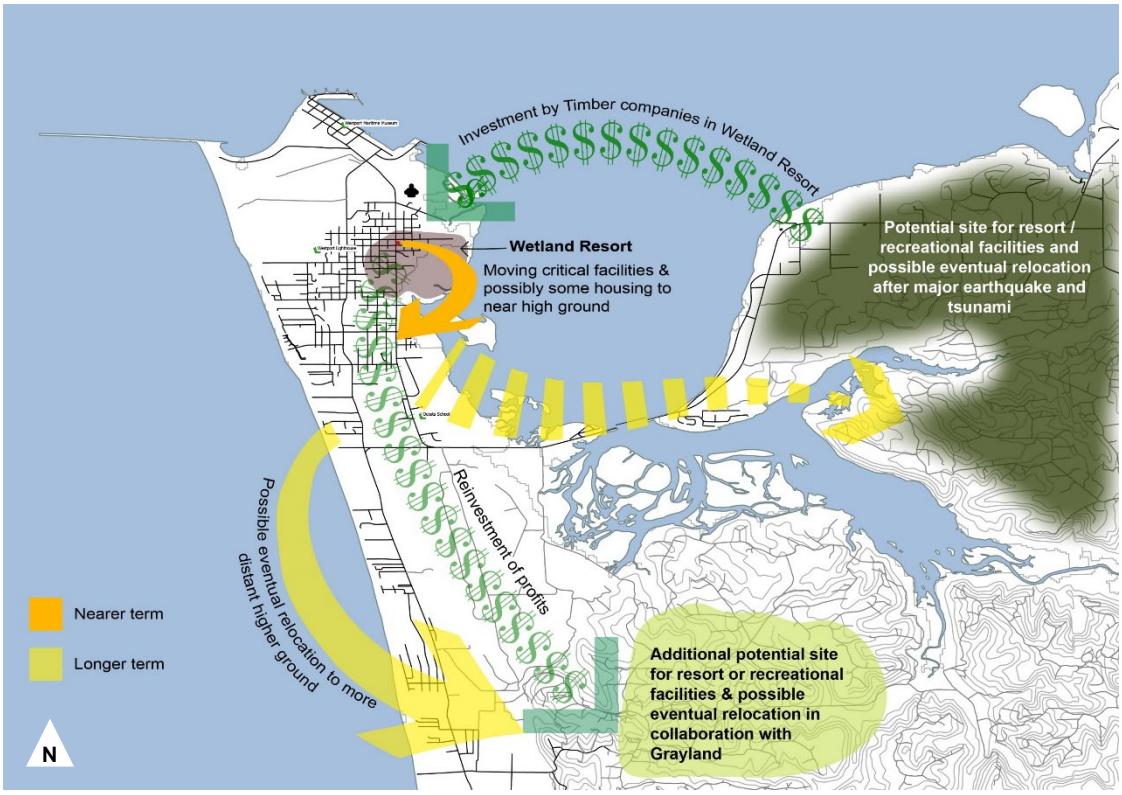


Figure 52 A potential Relocation strategy for Westport.

Hill Resorts

The plan to establish this eventual relocation option can begin with purchasing high ground land outside the city limits, which are mostly steeper slopes. After ensuring their seismic safety, they can be developed to be used as campgrounds as shown in Figure 53. As the City gains more financial ability or if it finds the right private partners, tree-house resorts (See Figure 54) with minimal ecological invasion can be developed. In the event of a disaster, the City can look into developing a full-fledged community similar to those in Figure 55.

Figure 53 Phase I - Camp site - A hill campground in WA state. Source: https://www.myolympicpark.com/.image/t_share/MTQ1NjkwMzExNzY4Mjg2MjYw/ol-sol-duc-campground_npspd_680.jpg

Figure 54 Phase II - Minimally Invasive Tree House resorts. Example from Skamania County, WA. Source: Designboom. https://www.designboom.com/architecture/the-cinder-cone-treehouse-skate-bowl-foster-huntington-skamania-washington-06-03-2015/

Figure 55 Phase III. Example: Steep Hillside development of Mantra Samui Resort in Thailand. Trip Advisor, SA.

Lowland Homes to wetland resorts

There are a number of homes that face the threat of sea level rise in the low-lying areas. The city can mandate that these houses in the 100-year floodplain be retrofitted to prevent flooding, particularly during the storm seasons. This may also help the city secure Hazard mitigation grants from county, state and federal government agencies. The city can also buy out property (or rope in a real estate company), retrofit and lease the houses back to the community. Once the houses are retrofitted and flooding becomes more frequent, including tidal flooding, the residents can be relocated to more permanent housing. The houses can now be employed as wetland resorts. This will also need storm-wave breaking mechanisms installed in front of the resort.

Figure 56 Phase I - A home being raised for flood prevention in Snohomish County, WA

Figure 57 A home raised for flood prevention, Snohomish County, WA. Source: Zillow.com

Figure 56 Phase II Example of a wetland resort. Source: Ker & Downey. https://kerdowney.com/destinations/malaysia/malaysia-borneo/kinabatangan-wetlands-resort/

Figure 59 Moe Yun Gyi Wildlife Sanctuary & Wetlands Resort when during low tides. Source: Agoda.

Figure 60 Moe Yun Gyi Wildlife Sanctuary & Wetlands Resort during high-tides. Source: Trip Advisor, NZ.

An Adaptive Planning Strategy

This strategy is in response to the second sub-research question.

b. How can the built-environmental projects be executed in a manageable and feasible way by a community like Westport, which faces multiple uncertain scenarios?

Further, in trying to create the framework for the adaptive planning strategy, I ask two questions of particular relevance to the case-study of Westport.

i. How do we achieve limited to high-resilience[37] for a unique community like Westport, where low resilience is characterized by maintaining status quo with low post-disaster recovery, limited refers to protecting most vulnerable population and high denotes complete relocation of the town center?

ii. How can the transition to a potential relocation site be smoothened and achieved for a community such as Westport where relocating to natural high ground under current circumstances would mean a total dissociation from the city's primary economic bases and complete transformation in the very identity of the community?

The strategies for the long-term visioning of the built environmental projects that I propose are inspired by scenario planning and adaptive planning theories. The sample adaptive planning model that I demonstrate for Westport is characterized by resilience principles like innovation as it has room to learning from feedback loops (learning from newer climate change models, or newer tsunami models due to rise in sea levels, etc.). The model is also multi-scaled and encourages cross-scale interactions. The model accounts for uncertainty by using Reversible strategies and soft-strategies.

A dominant theme of urban resilience is adaptive planning. The adaptive planning process is characterized by heterogeneity, flexibility, modularity, feedback, latency and half-determinacy of the city's master comprehensive plan spread along cross-scale spatial and temporal interactions.

An example of spatial scaling for planning with respect to Westport is presented in Figure 57. This can also be used to base the Governance scaling for this community. The intermediate level names 'South

[37] Jay Raskin and Yumei Wang, "*Fifty-Year Resilience Strategies for Coastal Communities at Risk for Tsunamis,*" *Natural Hazards Review* 18, no. 1 (2016): B4016003, https://doi.org/10.1061/(asce)nh.1527-6996.0000220.1.

Beach' is of particular importance to Westport. This is imperative for Westport as the city is a peninsula and the nearest high-grounds are either near Grayland or in Bay City and the path to these sites is through unincorporated land in the Grays Harbor County. The cities around Westport, particularly what has come to be known as the South Beach area, are at similar economic and population scales as Westport and so face similar crises as Westport. Partnering with these communities would help with future relocation efforts of the city. One comment by a participant of the public workshop from the studio, on creating 'Grayport' or 'Westland' (portmanteaux from 'Westport' and 'Grayland'), shows the willingness of at least some community members towards such a partnership.

Figure 61 shows the availability of high ground near Grayland. It also gives the ownership of those lands, which includes both private and government agencies. This further highlights the benefit of forming a South Beach Alliance/ Coalition and working with the county. The Bunker hill gravel pit within one of the logging company sites has already been designated as an assembly area in the current tsunami evacuation plan by the State Emergency Management Department.

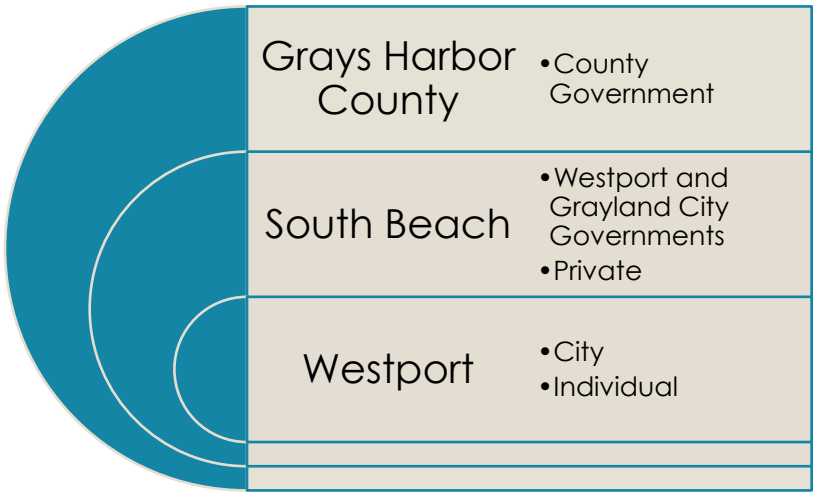


Figure 61Spatial and Socio-organizational Hierarchy for Westport. Source: Author.

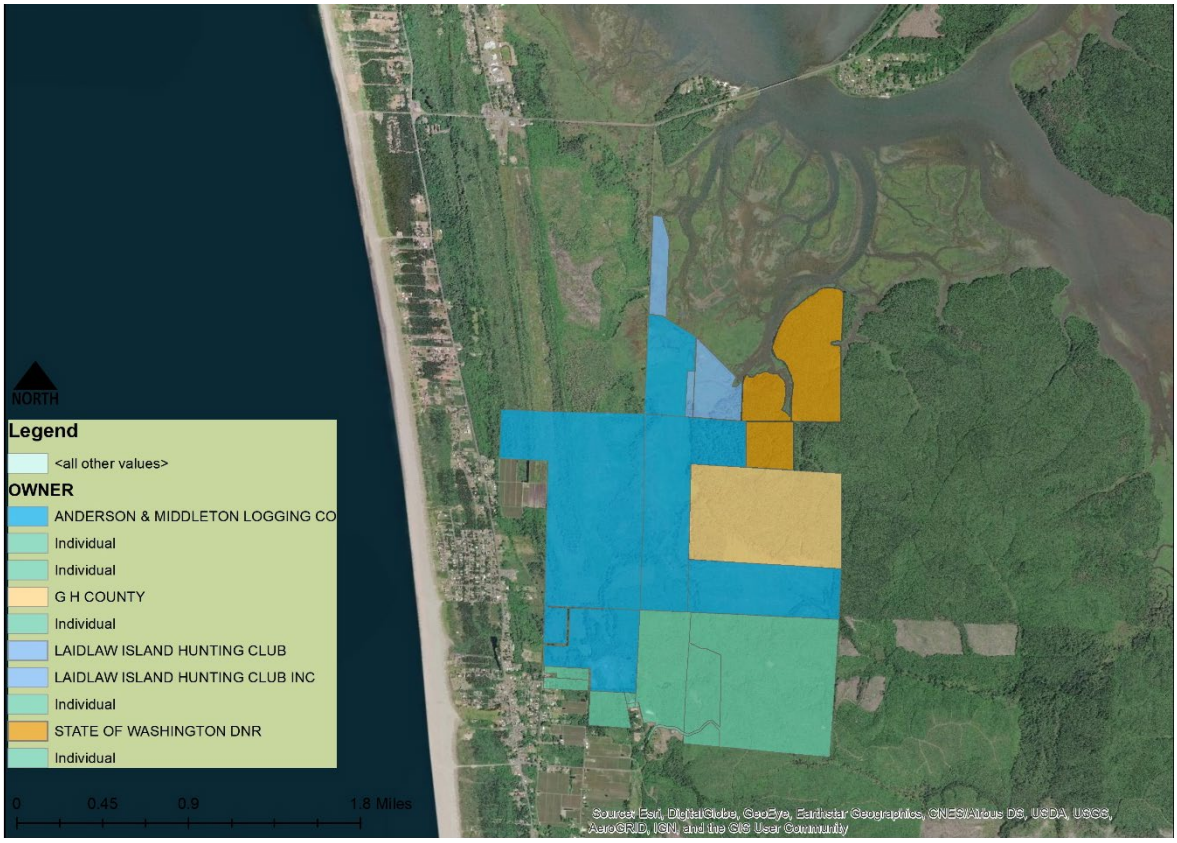


Figure 62 Ownership of the high ground for potential Uphill relocation facility development. Data Source: Grays Harbor County Assessors.

In order to be able to scale and sequence the plan goals for resilience (specifically for a tsunami threatened community), we must understand the broad goals. (Raskin and Wang 2017) list the following:-

- Moving critical and essential facilities to high ground
- Relocate vulnerable populations to high ground
- Improve and create evacuation options.
- Improve emergency operations plan.
- Create post disaster recovery plan.
- Develop redundant or alternative critical infrastructure.

The temporal scaling and sequencing dimension of the plan for a resilient Westport is created by intersecting two approaches. i) (Raskin and Wang 2017) provide an example for phased relocation of critical facilities within 50yrs. ii) Scenario based sequencing and planning. The first approach helps give a basic structure to the long-term relocation process while the second helps to make the plan more flexible and helps addresses sudden shocks to the community. Here, I have created basic

sample plans for the City of Westport viz., the Plans A, B and C. Each are individual 50 year plans based on different starting points. All the plans for demonstration purposes assume that the city maintains its present conditions of disaster preparedness.

Plan A assumes that an L1 tsunami is a certain event at any point in the future and sea level rise up to 3 feet is a certain event in the next 80-100 years. The spatial extent of sea-level rise is based on current conditions.

Plan B would kick into action when a smaller earthquake and tsunami event occurs. This would leave the city with some damage. However, most of the city is not inundated and the city has much left to begin recovery efforts with. When this plan comes into action, it would call for a reassessment of sea-level rise scenarios, etc., especially if the event was faced with land subsidence.

Plan C would be implemented if the city were to be affected by a massive subduction zone earthquake which may or may not be followed by an L1 or at least an M1 tsunami. In this case, since much of the city will be left inundated, the city will have to start from ground-up on a nearby high-ground or integrate with a different community.

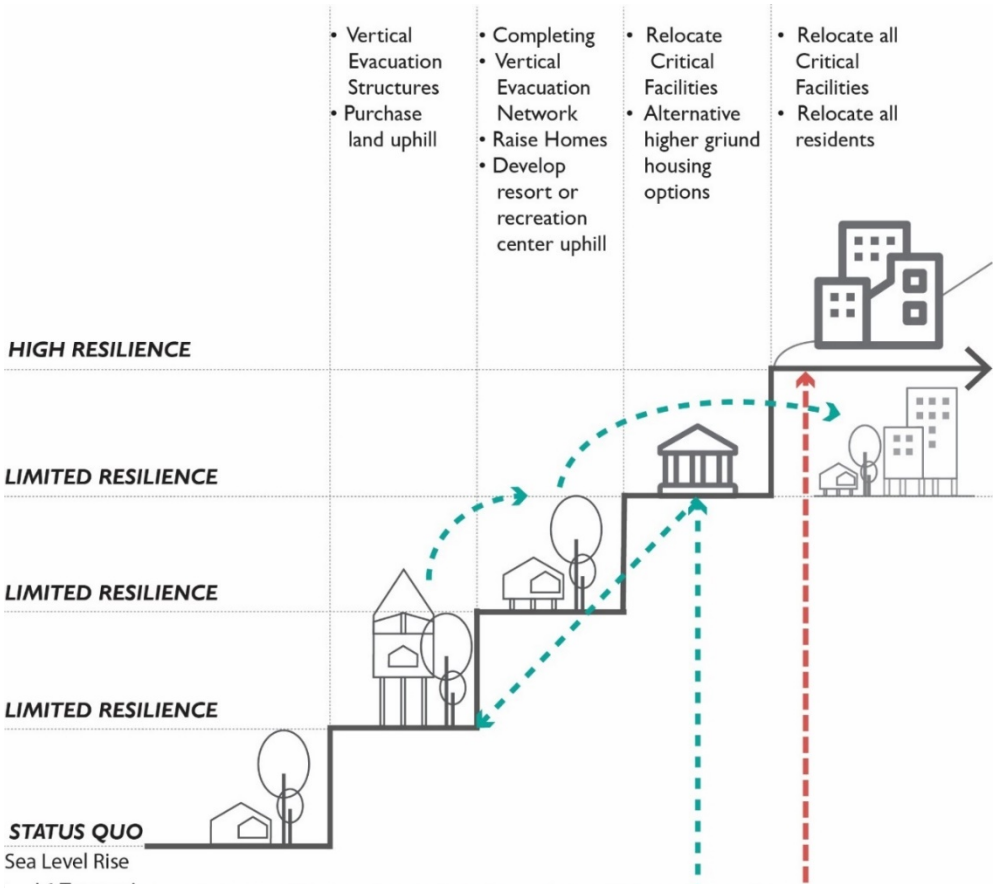


Figure 63 Phasing of projects and scenario-based plan revision

Figure 59 serves as a conceptual representation of the use of the second approach. The three Plans follow that.

Table 5 Plan A

Timeline	Protect	Adapt	Retreat
Near Term (<10yrs)	- Vertical evacuation - Adoption of Hazard Evacuation route specific urban design guidelines	- Raise homes, - Green stormwater infrastructure	- Relocation of Fire department, civic center. **(in 5yrs)** - Adopt a PDR (Purchase of Development Rights) program, - Restrict development in areas of maximum predicted tsunami inundation and within 100-year floodplains or reduce high-value and high occupancy use structures, - Carefully determine the extension of and budgeting for infrastructure such as sewer lines, water lines, etc. - Hill Resort – Phase 1 – Site acquisition **(in <2yrs**) and basic facilities **(in 5 yrs)**
Mid Term (10-30 yrs)	Trail network	Lease waterfront homes, Safe-to-flood campuses	Hill Resort – Phase 2 –critical infrastructure **(15 yrs)**
Long Term (31- 50 yrs)	Shoreline natural	Convert waterfront homes to resorts (seasonal)	Hill resort – Phase 3 – Use as community residences, Complete Relocation of Community, Relocating Marina facilities when the sea level rises by 3ft.

Table 6 Plan B - Minor to Medium Hazard Scenario

Timeline	Protect	Adapt	Retreat
Near Term (<10yrs)	- Rebuilding Marina facilities - Vertical evacuation - Adoption of Hazard Evacuation route specific urban design guidelines	- Green stormwater infrastructure	- Rebuilding Fire department, civic center (in 2 yrs) - Adopt a PDR (Purchase of Development Rights) program, - Restrict development in areas of maximum predicted tsunami inundation and within 100-year floodplains or reduce high-value and high occupancy use structures, - Carefully determine the extension of and budgeting for infrastructure such as sewer lines, water lines, etc.
Mid Term (10-30 yrs)	Trail network	Salvage waterfront homes for redevelopment into wetland resorts, Flooding safe cam puses	Hill Resort

Long Term (31- 50 yrs)	Shoreline natural	Convert waterfront homes to resorts (seasonal)	Complete Relocation of Community

Table 7 Plan C for the worse and worse case scenarios. Text in red denotes the strategies of the plan for current conditions. Text in blue denotes the possibilities if the resilience plan has been implemented even to some small degree.

Timeline	Protect	Adapt	Retreat
Near Term	- Salvage remaining property - Repair any damages	- Refuge for survivors - Reevaluate Comprehensive Plan and devise new strategies	- Regroup community and take stock of survivors and possessions - Shift Marina and fishing facilities to new location
Mid Term	Find long-term relocation site - Improve seismic stability of existing structures	Integrate into or with other neighboring communities - Adapt to shifting economic base	- Move or develop oyster beds to new inter-tidal lands.
Long Term		- Explore new opportunities offered by the changed shorelines	

A recommendation for the Plan A where the L1 or any such tsunami scenarios does not occur untilmajority of the community has been successfully relocated, is a provision that should be included when formulating the Comprehensive plan. Following is a sample of how this can be done.

'*Provision to review and revise the comprehensive plan post any significant hazard event or once every 6*[38] *years.'*

[38] (MSRC 2018) Each Washington city and county must periodically review and, if needed, revise its comprehensive plan and development regulations every eight years to ensure that they comply with the GMA, as per the schedule provided in RCW 36.70A.130.
An additional two years for meeting the review and revision requirements is granted to smaller and slow-growing counties and cities that meet certain criteria. County reviews of designated urban growth areas (UGAs) must also be completed according to this schedule, and evaluation requirements for the buildable lands program must be completed by counties and cities one year before those deadlines.
By these regulations of GMA, 6 years + 2 years of additional time if needed would help prepare the city for an adoption of GMA.

- If the event is of a major scale, the revision following the post-event revision shall be 5 years beyond that point.
- If the event is not considered major, yet is significant, the post-event revision would be minor and Comprehensive Plan Update shall occur as scheduled prior.
- The City has to ensure that all the subsidiary or back-up plans are also updated accordingly.

i. In the event of S1 tsunami or none at all in the next 70 yrs, the standard plan (Plan A: Phased development') would be executed. This would also include financial investment for a rainy day.

ii. To be able to revive the city in the event of an unexpected disaster, the appropriate subsequent plan, (Plan B or C) for Recovery and Rebuilding would be executed. This plan could be based on what has been predicted to be the expected 'new normal', say, land only on the hills. Cashing in on investments made elsewhere.

An additional dimension to this adaptive planning model that follows the concept of heterogeneity mentioned in the resilience concepts, will be the estimation of optimum life cycle costs for projects and employing a mix of projects built for varying life cycles/spans.

Social Resilience strategies

These set of strategies respond to my third sub-research question.

c. *As the built environmental projects are executed, how can the City ensure that their local community, at any given time, uses these projects optimally during times of emergency?*

The strategies I propose are designed to ensure that the community is connected to the built-environmental strategies and thereby make best use of the emergency structures during times of emergencies. I propose the use of the Community Based Social Marketing technique as a potential strategy.

Community Based Social Marketing (CBSM) strategies are useful to ensure that individuals are prepared for sudden emergencies and thereby strengthen the social resilience of the community involved. In this thesis, I explore the potential of CBSM to be implemented as urban design strategies to fortify the built environment interventions designed to safe-guard the community during emergencies and work on the principle that 'social construction of places' have reciprocal influences over social behavior. Strengthening social resilience therefore will have spatial resilience implications and vice-versa.

Target audience characteristics

As per the steps for CBSM prescribed in the literature (see Figure 1Process for implementation of CBSM prescribed by McKenzie-Mohr), the first step is to identify the target audience.

Westport's population is diverse and can include specific groups such as seasonal workers (some commuting and others residing temporarily), daily commuting employees (many people who work in Westport live elsewhere around Grays Harbor), etc. While the City may have to work on devising communication strategies specific to each of the population groups, here, I am limiting the target audience to two broad categories of the Westport community - the residents and the seasonal tourist populations, for the purpose of demonstration of the CBSM strategy. Although, both of these groups would require slightly different approaches to make them more resilient to natural hazards, they are both important as their characteristics are representative of the largest portion of the population at risk.

Figure 64 Westport during Tourist season. Source: South Sound Magazine.

Selecting which behavior to target

Figure 65 Tsunami Evacuation Route Signage in Westport,WA. Source: Columbian. https://www.columbian.com/news/2015/oct/29/tsunami-vulnerable-towns-grapple-with-safety/

Unlike cases where CBSM has typically been employed, there is no negative behavior in this regard that particularly hinder the achievement of the desired goal. However, there are new behaviors that need to be fostered. The behaviors I have identified here based on community input from workshops are:-

a) Being aware of the threats of the area beforehand

b) Identifying the threat at the time of occurrence, which can be any time within the city.

c) Prompt action to escape the threat (including knowledge of safe refuges, safety measures, relevant emergency resources, etc.)

d) Ability to take necessary action post disaster.

The residents would also have to be prepared to positively handle any additional chaos ensuing from panicking tourists, that they may have to encounter.

It is possible that the closest high ground or vertical evacuation may still not be easily reachable from the regular places of many people. This gives rise to a need to include regular training to get to safe havens. A way for the public, at least the resident group, to incorporate this behavior in daily life can be facilitated through use of CBSM.

If the City can persuade the public to adopt certain behaviors such as those mentioned above, social resilience can be improved. Frequently, it is the fear of the unknown - unknown threat, ignorance of safety procedures, etc., that induces panic and dangerous behavior.

Identifying the barriers and benefits to the selected behavior

The barriers to adopting the aforementioned positive behavior have also been identified based on community input from the community workshops, input form the city staff and emergency planners and discussions during the course of the studio are listed below.

The main barriers identified are insufficiencies in the following:

Knowledge	Accessible Emergency Resources
○ General knowledge on local hazards ○ Knowledge on emergency procedures	○ Supplies and skills (resources) for prolonged sustenance

○ Appropriate risk perception ○ Easily accessible information resources	○ Accessible refuges ○ Skills for emergency action ○ Ways to communicate with nearby communities

Developing a strategy that reduces barriers to the behavior to be promoted, while simultaneously increasing the behavior's perceived benefits:

CBSM prescribes a few techniques of overcoming the identified barriers.

Communication

On the Information sources front, efforts should be made to communicate in multiple ways ("heterogeneity") including using the built environment (refer: haz-mit totems and street design). Tours of natural hazard mitigation features, evacuation sites, routes and heritage features, as was already suggested by some of the participants in the decision-makers workshop, would be beneficial in making a both target groups practice more resilient and sustainable behavior. A PAS can also be used for seasonal use during peak tourist season.

Norms

'Knowledge on emergency procedures' and 'Skills of emergency action' can be promoted by establishing norms around evacuation procedures and sustainable practices is central to this method of public engagement. Taking an example from "the Miracle of Kamaishi" (Maly 2018) during the 2011 Tohoku Tsunami, where 3,000 students evacuated successfully (which also saved some nearby community members as they were alerted by the procession of students and followed them), the norm if made visible would be effective. More emergency drills need to be incorporated. Regular jogging and biking could follow some of these evacuation routes.

Reducing the use of vehicles with fossil fuel can reduce pollution of water and environment and reduces contribution to atmospheric temperature increase. Overall reduction in possession and use of vehicles such as cars and trucks can mitigate climate change effects. However, the bigger, more relevant benefit for a coastal city like Westport with potential tsunami hazard lies in the reduction in

potential debris that would have negative impact on the Vertical evacuation structures. It will also reduce the financial loss to the community as a whole under such circumstances.

Figure 66 Students and guests at the Ocosta School take part in a tsunami drill at Ocosta School in April,2018. Source: The Daily World.

Figure 67 Coneptual deisgn showing Vertical Evacuation structure near a biking route used everyday. Source: Degenkolg. https://degenkolb.com/projects/tokeland-tsunami-tower-conceptual-design/. June 28,2019.

The city can facilitate this automobile reduction in multiple ways such as:-

- Developing complete streets and therefore, facilitating better pedestrian and bicycle movement through the city
- Improving public transportation means like buses, shuttle services and ferries.
- Shuttle services can also be contracted to private companies.
- Different vehicle sharing systems such as those seen in the bigger cities (eg: Lime cars, Lyft,etc.) can also be experimented with. This also provides an opportunity for public-private partnership.
- Car pooling can also be introduced or mandated as the city grows in population numbers.

One way of developing Skills for longer term survival is group hunting or fishing tours and community kitchens or barbecues.

Social Diffusion

Figure 68 Example of obstacle course activities for families

Figure 69 Working with family, friends or neighbors who may have mobility difficulties

General knowledge on local hazards, Knowledge on emergency procedures, Skills for prolonged sustenance and Skills for emergency action can be fostered and improved using social diffusion strategies. The adoption of new behavior by an individual when they observe a friend or family engaging in that behavior is the basis of this tool. A possible event idea is an obstacle course

competition for varying age groups, or a competition event where families or neighbors work together to survive a simulated hazard scenario to foster better community spirit. Local youth and adult sports teams (also surfing groups) could be engaged to take on the role of identifying and helping the senior members of the community and/or those community members who are physically or mentally challenged.

These activities also provide opportunities for learning to improve evacuation procedures and facilities for people with special challenges.

Partnership with fitness and mobility companies (eg: Strava, Endomondo, etc.) can be fostered to establish special specific physical exercise challenges related to the evacuation route. Such challenges can be initiated and tracked using mobile device applications with incentives like badges and honors, which will also create fitness communities. Challenges can be miles on the evacuation route or number of laps between a popular spot in the city to the nearest vertical evacuation structure. The latter can particularly be useful for potential volunteer rescue workers.

Services and Products

One method for ensuring availability of some amount of food supply at the evacuation sites is the siting of community vegetable and fruit gardens on the roofs of vertical evacuation structures and/or locating cafes and small grocery stores within the safe zones in these structures.

Encouraging the development of community kitchens or barbecue grills on natural high grounds or in one of the vertical evacuation structures can help in community members become familiar with cooking together and so be able to provide for themselves and each other during emergencies. Some cities have employed methods such as ‘time banking’ and ‘community currency’ to maintain community gardens and other public spaces. For Westport, this can be an important tool to be used

during tourist season, where residents can be engaged to disseminate information to tourists by helping organize hazard preparedness activities.

Convenience

This strategy can particularly be useful in addressing accessibility concerns to the emergency facilities

Figure 70 Community vegetable Garden of Via Verde. Source: AIA New York. https://www.aiany.org/architecture/featured-projects/view/via-verde-the-green-way/

and resources. The City must ensure that the design for vertical evacuation towers and evacuation routes are accessible for all kinds of people by incorporating ADA standards for design of the structures. Drone systems and radio systems along with helicopter services could help address this barrier of accessibility to the particular behavior while also improving communication options with neighboring communities. (UrbDP 508 Studio B Faculty and Students 2018). It would be beneficial to establish a common understanding between neighboring cities and communities before-hand.

Piloting the strategy

Some of the Social diffusion strategies could be piloted among school students and the younger generation. An ethnically and economically diverse residential block of the city can be chosen to test some of the built environment interventions like street design. Alternatively, surfing community or other such community groups can be chosen to pilot the strategy.

Broad scale implementation and ongoing evaluation once the strategy has been broadly implemented

This step would be informed by the pilot strategies. Some strategies like those that educate the tourists and other inexpensive measures, probably need not be piloted.

Community Based Social Marketing is indeed a good approach for behavioral change at the community level and can be implemented through techniques of communication, norms, convenience, social diffusion, and services and products. Making the vertical evacuation sites at locations which also include everyday amenities, whereby the residents form a habit of travelling to the location by foot is a good strategy. Such use of the built environment to shape behavior as was also noted by Sir Winston Churchill when he said,

"We shape our buildings, and afterwards, our buildings shape us."

Chapter 5 | Conclusion

The case of Westport serves as a grounded/place-based demonstration of the ability of Urban Design to address resilience of the built environment to multiple uncertain and complex hazard scenarios by proposing a suite of Built environmental projects, that can not only be feasibly implemented in increments over time with appropriate integration into the Comprehensive Plan, but also be made relevant to the daily life of the community members to ensure the successful use of the projects as intended during a given emergency situation.

Limitations:

This paper is based on preliminary and basic research. Further research and advice from the experts such as those in the field of geology, infrastructure planning, ecology, etc. would help improve the strategies explored in this thesis. There are also not many precedents to some of the concepts presented in this work, which makes the evaluation of the presented concepts and solutions harder.

In my proposed adaptive planning model for resilience, the facets of planning that I have considered are limited to my fields of expertise. Although I consider some economic opportunities in the strategies proposed, financial planning is one more layer that when integrated into any resilience planning initiative will make the resilience strategies more robust and richer. Even the built environment development projects themselves would benefit from better integration with landscape and ecological solutions than presented in this thesis.

In this paper, I also only illustrate my thesis using certain impacts of the hazard scenarios, particularly ones that are apparent and have the potential to have great impact on the case study considered (particularly threats from sudden inundation due too tsunamis). However, in reality, a city would also need to be aware of the possibility of threats posed by national level economic crises, national and international politics, international relationships of the country (particularly for coastal cities), other climate change related impacts (such as ocean acidification and arrival of invasive species and their impact on aquaculture to name two more) or other potential threats that are not yet apparent as the field of science is still progressing.

Even most of the built environment strategies presented need to be reevaluated based on site specific studies of geology, tsunamis and engineering feasibilities of the proposed structures or if they are indeed structurally feasible, what of their financial feasibility? Further, the strategies also need to be evaluated with a race and social justice lens to guarantee equitable distribution of resilience resources for all the residents and visitors of the city.

More research into avoiding potential damages due to ships docked just beyond Westport is needed. Depending on wave direction and other factors, this may or may not be a big concern for Westport.

Figure 71View towards NW from the observatory in Westport revealing large vessels. April 28,2019. Image: Author

The thesis also does not consider potential partnership with the city of Oceanshores across the bay to the North of Westport. The City of Westport should also consider working with Oceanshores.

The feasibility of the high grounds suggested around Westport needs to be thoroughly researched before any plans involving these areas or investments are made.

Implications

I expect that the demonstration of the implementation of the concepts of urban resilience at a city scale invokes further projects of this nature throughout the planning community. Everybody has ideas that a city planned for all of its residents will benefit from. How do we actively engage with people to customize the resilience strategies for their community? This is not to say that outsider perspectives don't add values. However, while working with the Community of Westport I was humbled by the knowledge and thoughts that some of the community members have put into what can be done for their community. Experience is the greatest teacher and experience oftentimes takes years to gather. This is where collective community experiences and knowledges improve resilience strategies for planning and urban design.

The discussions on urban design as a tool for resilience, from my experience of this research, has revealed that the use of urban design in urban resilience has remained in the academic and theoretical realm. My thesis is an attempt to translate these theories into practical solutions.

Furthermore, the urban design strategies for resilience prescribed would open up more possibilities for urban planners with a more wholistic perspective of the field of planning and also offers an opportunity for sustainability measures to reconcile with hazard mitigation measures. Although sustainability and resilience are understood as different fields altogether usually, they are indeed very much related, in that they are both forward thinking in their approach and are geared towards protecting our future.

On a different tangent, my experience with community decision-makers of Westport and some that I met in other communities has revealed that frequently, urban design is dismissed as mere aesthetic feature and the urban design guidelines as mandatory element of the Comprehensive Plan. Through this thesis, I also wanted to express the functional benefits of urban design methods and strategies to counter in order to be able to fully exploit the potential of urban design and its multi-faceted approach to urban creation.

Directions for future research

To begin with specificities, there is potential in natural mitigation strategies such as tsunami control forests. Although this is still a growing research avenue, the tsunami mitigation studies in Japan have some evidence of the effectiveness of these forests for waves up to ~20feet (5-7m)[39]. For Westport specifically, determining the geological behavior and characteristics of the dune ridges will be of great use. Piloting of certain strategies mentioned in my thesis will have immense value in finer calibration of these strategies. On a general note, I came across many indices and frameworks to evaluate the resilience of a system. However, there are not many such frameworks available to create a resilient system.

[39] Anawat Suppasri et al., "*Lessons Learned from the 2011 Great East Japan Tsunami: Performance of Tsunami Countermeasures, Coastal Buildings, and Tsunami Evacuation in Japan,*" *Pure and Applied Geophysics* 170, no. 6–8 (2013): 1002–1004, https://doi.org/10.1007/s00024-012-0511-7.

Reflections

On a personal note, this thesis also reflects my personal development goal to strike that necessary balance between the different scales of perception from the minutiae to broader themes needed for performing any work effectually. Some of the urban design strategies are also derived based on my personal quest of built environment as a medium for communication.

The Growth Management Act of the State of Washington proposes that cities include a vision statement in their Comprehensive Plan. It is also recommended that these visions be developed with the community members as the vision would reflect their communal identity and also direct their future growth (RCW 36.70A.20). Since the strategies in this thesis were guided by what we heard through our community engagement, the vision it helps create more closely reflects the community's wishes.

As and when technology develops, the resilience plan for Westport would and should evolve. Afterall, humankind laughed at the thought of flying until the airplanes were invented, the advent of which opened up many new possibilities.

"A system disturbance has the potential to create opportunity for doing new things and for new tools that facilitate more resilient behavior."[40]

Further, the idea of a potential threat itself is a disturbance (albeit not physical) that offers opportunity for doing new things and for new tools that facilitate more resilient behavior. Uncertainties pose great difficulties while making concrete plans under a tight budget. Ensuring that each strategy serves more than one purpose justifies the expenses and ensures that they are more readily accepted by the community (the no regrets strategies). In order to ensure this diversity in benefits, it is highly important that the planners of a city be able to successfully balance the understanding of the various connected fields involved in creating a resilience roadmap for a city. While it would be almost impossible for any one individual to possess expertise in all the allied fields, the adaptive resilience model for planning allows a more structured way to help the experts from all the different fields to work together in a more productive way. It is after all not a new thought that "a planner wears many different hats". It is often not specified how many different hats a planner needs

[40] Quigley, Blair, and Davison, 2018, 594.

to wear. For a small city like Westport, with limited resources, an existence of multifaceted comprehensive adaptive plan would help lay out the specific skill set requirements well ahead of time thereby enabling the City to engage or hire appropriate experts or professionals at the appropriate times.

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Appendices

Appendix A

Community Based Social Marketing

Social Resilience through application of Community Based Social Marketing

Sreya Sreenivasan | UrbDP 600 Independent Study | Spring 2019

Introduction:

This paper explores the use of Community Based Social Marketing (CBSM) in making a coastal community resilient to uncertain hazard scenarios through the case of Westport. CBSM strategies are useful to ensure that individuals are prepared for sudden emergencies and thereby strengthen the social resilience of the community involved. While some of these strategies can be integrated into Emergency Management Programs, others can be combined with tourism programs and other policies of the City. Some can be implemented as urban design strategies to fortify the built environment interventions designed to safe-guard the community during emergencies and work on the principle that 'social construction of places' have reciprocal influences over social behavior. Strengthening social resilience therefore will have spatial resilience implications and vice-versa.

In general, Community-based social marketing involves five key steps.

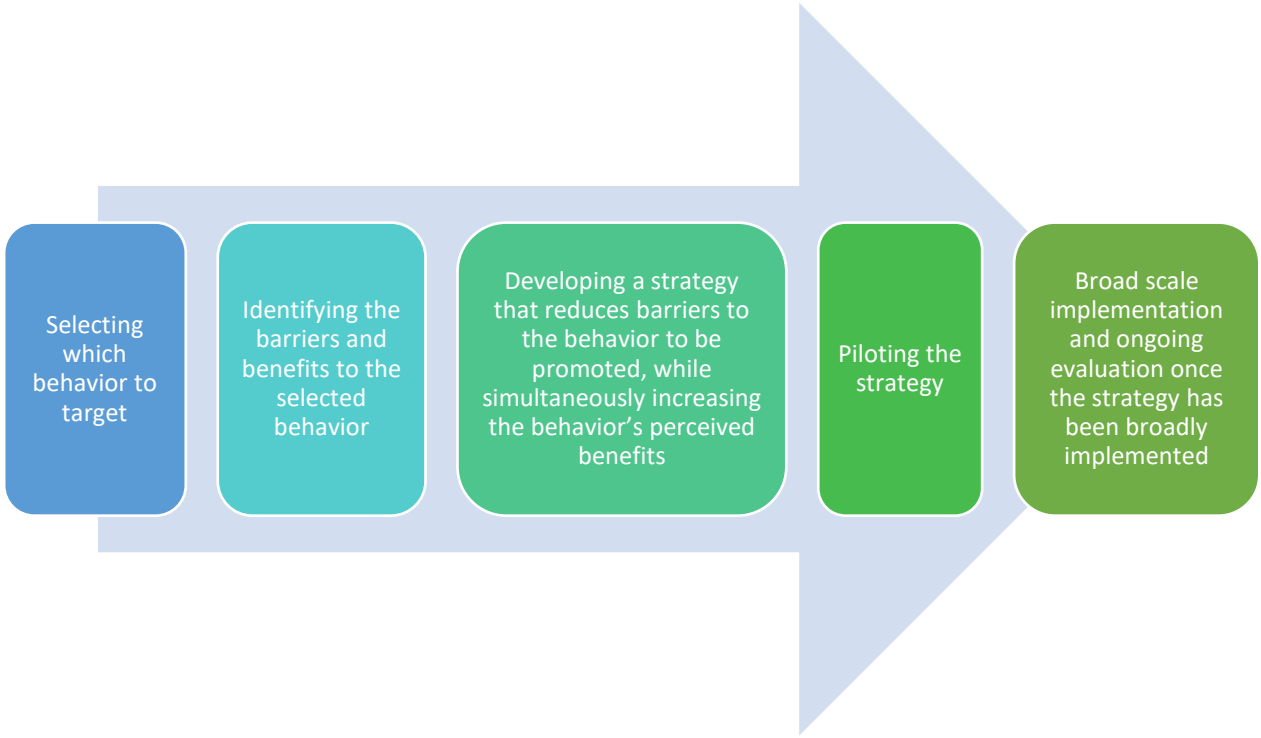

Figure 1Process for implementation of CBSM prescribed by McKenzie-Mohr

Once the target audience is determined, the process begins with the determination of a behavior that should be exhibited by the audience (eg: turning off the light switches), in order to acquire desirable results for the strategy goal (eg: Reduction in energy consumption). The next step would be to identify the benefits of and barriers in engaging in such activity. (eg: Benefit: Extended life of light fixtures, Barrier: Switches are usually not located near the entrance). The next step would be develop strategies to reduce the barriers (eg: Building regulation demanding that there be a master switch at the entrance hallway of every house or connected to remote switches accessible through personal devices such as phones.) and at the same time increases the perceived benefits of the behavior (eg: Less frequent changing of light bulbs means less garbage production and reduced environmental pollution). Once the strategy has been formulated, the next step would involve testing the strategy at a small controllable scale. The results from the piloting step would reveal areas for improvement for the strategy. Finally, the optimized strategy would then be rolled out at the full intended scale.

The benefit of this approach lies in that it is a result-oriented approach. Therefore, organizations with limited resources find this approach very beneficial. Like sustainability, urban resilience also depends on behavior of people as well as the physical and natural environment. CBSM is a method that has been designed to cultivate such desirable behavioral change which are mostly based on social norms and habits. For urban resilience, individual actions of every individual matters significantly. However, it is not apparent unless we are able to perceive the collective results. CBSM recognizes this and leverages human tendencies to 'fit in' within the larger society by communicating to individuals that 'they are not alone' in engaging in the specific desirable activity.

Target audience characteristics:

As per the steps for CBSM prescribed in the literature (see Figure 1Process for implementation of CBSM prescribed by McKenzie-Mohr), the first step is to identify the target audience.

Here, I am limiting the target audience to the two broad categories of the Westport community, the **residents** and the **seasonal tourist populations**. Although, both of these groups would require slightly different approaches to make them more resilient to natural hazards, they are both important as they constitute the largest portion of the population at risk.

Selecting which behavior to target:

Unlike cases where CBSM has typically been employed, there is no negative behavior in this regard that particularly hinder the achievement of the desired goal. However, there are new behaviors that need to be fostered. The behaviors I have identified here based on community input from workshops are:-

- **Being aware** of the threats of the area beforehand
- **Identifying** the threat at the time of occurrence, which can be any time within the city.
- **Prompt action** to escape the threat (including knowledge of safe refuges, safety measures, relevant emergency resources, etc.)
- Ability to take necessary **action post disaster**.

The residents would also have to be prepared to positively handle any additional chaos ensuing from panicking tourists, that they may have to encounter.

It is possible that the closest high ground or vertical evacuation may still not be easily reachable from the regular places of many people. This gives rise to a need to include regular training to get to safe havens. A way for the public, at least the resident group, to incorporate this behavior in daily life can be facilitated through use of CBSM.

If the City can persuade the public to adopt certain behaviors such as those mentioned above, social resilience can be improved. Frequently, it is the fear of the unknown - unknown threat, ignorance of safety procedures, etc., that induces panic and dangerous behavior.

Identifying the barriers and benefits to the selected behavior:

The barriers to adopting the aforementioned positive behavior have also been identified based on community input from the community workshops, input form the city staff and emergency planners and discussions during the course of the studio are listed below.

The main barriers identified are insufficiencies in **knowledge** and **accessible emergency resources**.

- General knowledge on local hazards
- Knowledge on emergency procedures
- Appropriate risk perception
- Easily accessible information resources
- Supplies and skills (resources) for prolonged sustenance
- Accessible refuges

- Skills for emergency action

- Ways to communicate with nearby communities

Developing a strategy that reduces barriers to the behavior to be promoted, while simultaneously increasing the behavior's perceived benefits:

CBSM prescribes a few methods of overcoming the identified barriers.

Communication:

To address knowledge gaps, particularly risk perception, the City can begin with devising short, easy-to-remember, persuasive messages about hazard awareness and resilience practices. On the Information sources front, efforts should be made to communicate in multiple ways ("*heterogeneity*") including using the built environment (refer: haz-mit totems and street design). Online social media groups and public city council meetings could also be leveraged along with summer community events to educate the public. Tours of natural hazard mitigation features, evacuation sites, routes and heritage features, as was already suggested by some of the participants in the decision-makers workshop, would be beneficial in making a both target groups practice more resilient and sustainable behavior. A PAS can also be used for seasonal use during peak tourist season.

Figure 2 Group tours and social media

Figure 1 Establishing norms - Biking trail, School that students attend everyday

Norms:

Figure 3 A ridge trail connecting the different vertical evacuation structures and Complete streets promote everday commuting by non-automotive means.

Figure 4 Establishing norms: Students attend school everyday

'Knowledge on emergency procedures' and 'Skills of emergency action' can be promoted by establishing norms around evacuation procedures and sustainable practices is central to this method of public engagement. Taking an example from "the Miracle of Kamaishi" (Maly 2018) during the 2011 Tohoku Tsunami, where 3,000 students evacuated successfully (which also saved some nearby community members as they were alerted by the procession of students and followed them), the norm if made visible would be effective. More emergency drills need to be incorporated. Regular jogging and biking could follow some of these evacuation routes.

Reducing the use of vehicles with fossil fuel can reduce pollution of water and environment and reduces contribution to atmospheric temperature increase. Overall reduction in possession and use of vehicles such as cars and trucks can mitigate climate change effects. However, the bigger, more relevant benefit for a coastal city like Westport with potential tsunami hazard lies in the reduction in potential debris that would have negative impact on the Vertical evacuation structures. It will also reduce the financial loss to the community as a whole under such circumstances. The city can facilitate this automobile reduction in multiple ways such as:-

- Developing complete streets and therefore, facilitating better pedestrian and bicycle movement through the city
- Improving public transportation means like buses, shuttle services and ferries.
- Shuttle services can also be contracted to private companies.
- Different vehicle sharing systems such as those seen in the bigger cities (eg: Lime cars, Lyft,etc.) can also be experimented with. This also provides an opportunity for public-private partnership.
- Car pooling can also be introduced or mandated as the city grows in population numbers.

One way of developing Skills for longer term survival is group hunting or fishing tours and community kitchens or barbecues.

Social Diffusion:

General knowledge on local hazards, Knowledge on emergency procedures, Skills for prolonged sustenance and Skills for emergency action can be fostered and improved using social diffusion strategies. The adoption of new behavior by an individual when they observe a friend or family engaging in that behavior is the basis of this tool. Nowadays there is also such opportunity in the form of social

media. A well-known example is the “Ice bucket challenge’ for awareness of the disease ALS which was viral on the internet for a while. Similar challenges can include a sustainable behavior or an emergency preparedness challenge. A possible event idea is an obstacle course competition for varying age groups, or a competition event where families or neighbors work together to survive a simulated hazard scenario to foster better community spirit. Local youth and adult sports teams (also surfing groups)

Figure 7 ALS Ice Bucket challenge

Figure 7 Example of obstacle course activities for families

Figure 7 Working with family, friends or neighbors who may have mobility difficulties

could be engaged to take on the role of identifying and helping the senior members of the community and/or those community members who are physically or mentally challenged.

These activities also provide opportunities for learning to improve evacuation procedures and facilities for people with special challenges.

Partnership with fitness and mobility companies (eg: Strava, Endomondo, etc.) can be fostered to establish special specific physical exercise challenges related to the evacuation route. Such challenges can be initiated and tracked using mobile device applications with incentives like badges and honors, which will also create fitness communities. Challenges can be miles on the evacuation route or number of laps between a popular spot in the city to the nearest vertical evacuation structure. The latter can particularly be useful for potential volunteer rescue workers.

Services and Products:

In the case of Westport, the City would need to find a way to subsidize the purchase of emergency supplies and devices. Alternative resources would also need to be made available along with making people aware of the availability of these resources. One alternative method for ensuring availability of some amount of food supply at the evacuation sites is the siting of community vegetable and fruit gardens on the roofs of vertical evacuation structures and/or locating cafes and small grocery stores within the safe zones in these structures. Encouraging the development of community kitchens or barbecue grills on natural high grounds or in one of the vertical evacuation structures can help in community members become familiar with cooking together and so be able to provide for themselves and each other during emergencies. Some cities have employed methods such as 'time banking' and 'community currency' to maintain community gardens and other public spaces.[1] For Westport, this can be an important tool to be used during tourist season, where residents can be engaged to disseminate information to tourists by helping organize hazard preparedness activities.

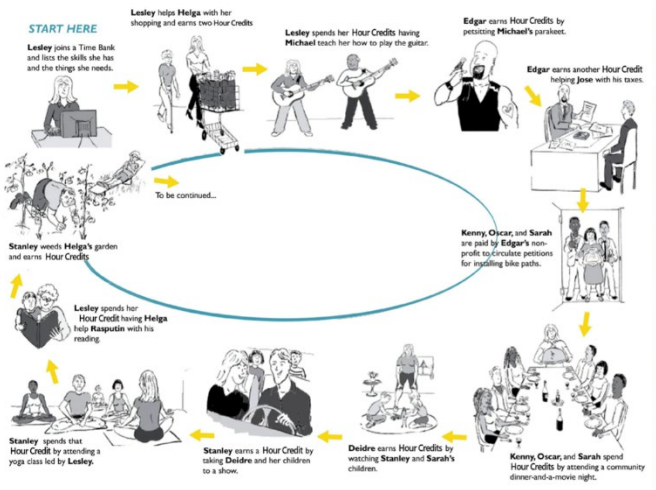

Figure 8 Example of Time-banking system

Figure 9 Community Garden Example

[1] Aldrich and Meyer, "Social Capital and Community Resilience."

Convenience:

This strategy can particularly be useful in addressing accessibility concerns to the emergency facilities and resources. The City must ensure that the design for vertical evacuation towers and evacuation routes are accessible for all kinds of people. **Updating the city's website to act as the one-stop-shop for all relevant information for the city residents and visitors should be given serious consideration.** Some of the built environment interventions mentioned earlier can also achieve this. Drone systems and radio systems along with helicopter services could help address this barrier of accessibility to the particular behavior while also improving communication options with neighboring communities. (UrbDP 508 Studio B Faculty and Students 2018). It would be beneficial to establish a common understanding between neighboring cities and communities before-hand.

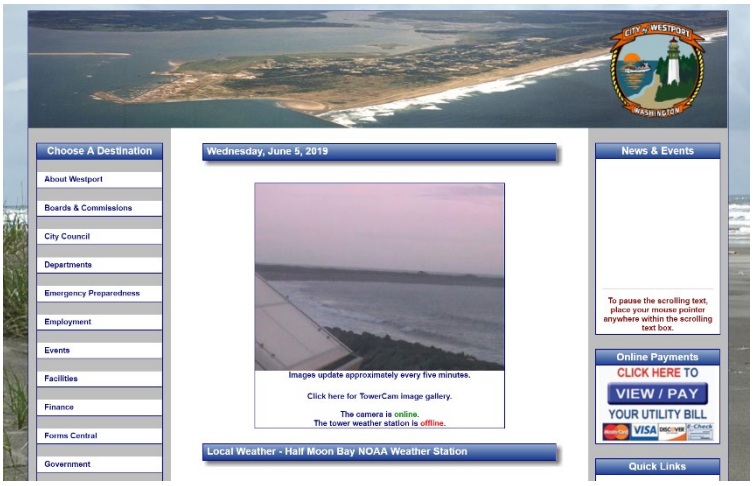

Figure 10 Current Website interface of the City of Westport. There is room to make the website more engaging and accessible.

Piloting the strategy:

Some of the Social diffusion strategies could be piloted among school students and the younger generation. An ethnically and economically diverse residential block of the city can be chosen to test

some of the built environment interventions like street design. Alternatively, surfing community or other such community groups can be chosen to pilot the strategy.

Broad scale implementation and ongoing evaluation once the strategy has been broadly implemented:

This step would be informed by the pilot strategies. Some strategies like those that educate the tourists and other inexpensive measures, probably need not be piloted.

Conclusion:

Community Based Social Marketing is indeed a good approach for behavioral change at the community level and can be implemented through techniques of communication, norms, convenience, social diffusion, and services and products. It would need to be paired with other forms of behavioral change strategies. Making the vertical evacuation sites at locations which also include everyday amenities, whereby the residents form a habit of travelling to the location by foot is a good strategy. Such use of the built environment to shape behavior as was also noted by Sir Winston Churchill when he said,

"We shape our buildings, and afterwards, our buildings shape us."

Appendix B

DRAFT Recommendations for Westport's Comprehensive Plan Update, (2019)

Westport Coastal Resiliency Report

Executive Summary

Localizing Hazard Mitigation

DRAFT 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

December 31, 2018

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 Management 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 1. 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 2.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, as shown in Figure 1.

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.

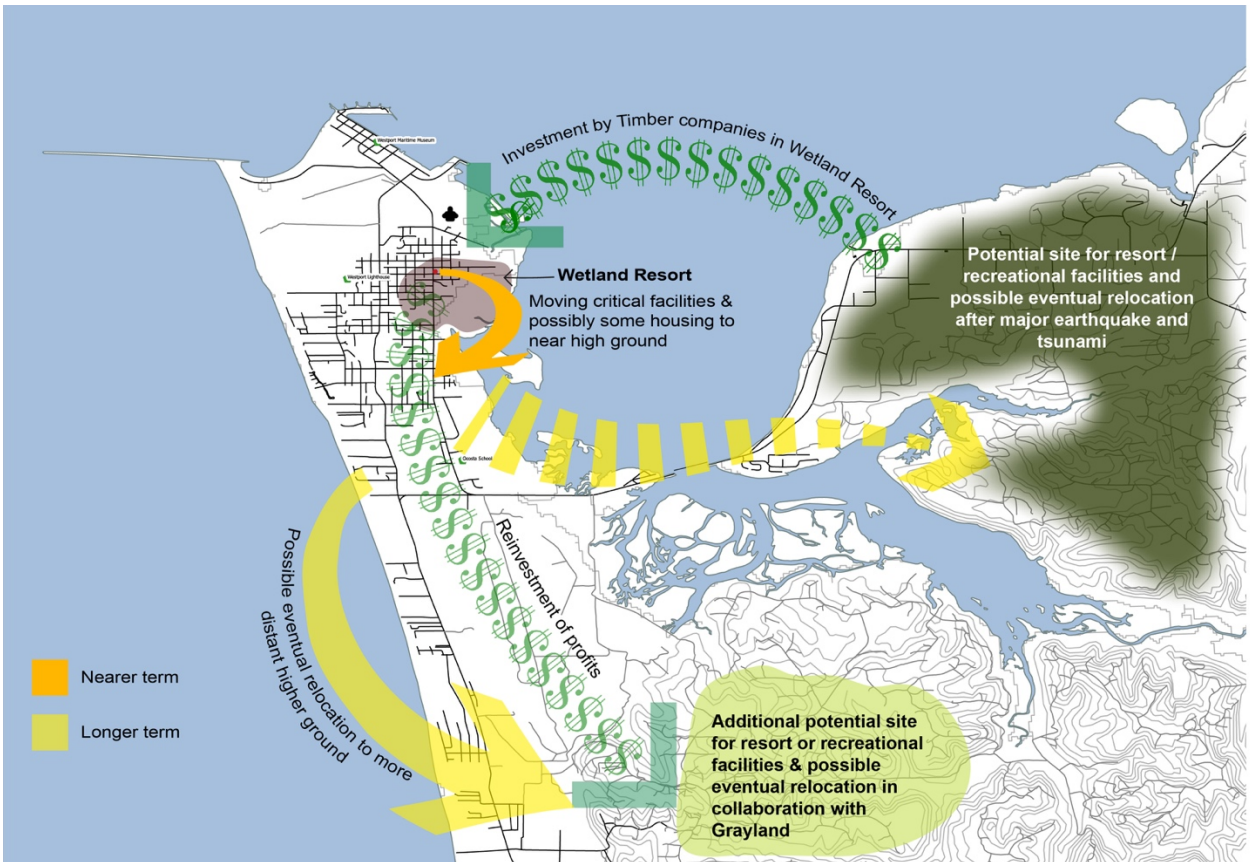

Figure 1. Land and development rights swaps for resilient long-term land use (map by Sreya Sreenivasan)

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 C

DRAFT Recommendations for Westport's Comprehensive Plan Update, (2019)

Westport Coastal Resiliency Report

Excerpts (Ch.1 and Ch.5)

Localizing Hazard Mitigation

DRAFT 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

January 7, 2019

Preface and Report Contributors

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. In one of the lowest-income areas of the state, taxpayers voted overwhelmingly to approve the bond that funded the extra cost of designing and building this unprecedented structure. Westport's achievement has since inspired federal authorities to enable new funding for additional such structures, and thus has led the way for many other coastal communities to build them. It has also inspired the University of Washington (UW) team that prepared this report to assist the community to broaden its efforts in planning for a safe and resilient future. The team thanks all the members of the public from Westport, South Beach, and Grays Harbor County who participated in the community workshops and otherwise shared their local knowledge with each other and the team. This report is dedicated to them and their community.

The UW Autumn Quarter 2018 Urban Design & Planning 508B studio team consists of the course instructor, Prof. Daniel Abramson; doctoral research assistants Katherine Idziorek and Lan Nguyen; and the students who each researched and drafted an element of the recommendations as follows:

- Helen Stanton (Masters of Urban Planning): *Land Use Element*
- Yiran Zhang (PhD in Civil & Environmental Engineering): *Transportation, Circulation and Telecommunications Element*
- Pegah Jalali (PhD in Environmental and Forest Sciences): *Economic Development Element*
- Sreya Sreenivasan (Masters of Urban Planning): *Community Identity and Natural Resources Management Element*
- Charlotte Dohrn (Masters of Marine & Environmental Affairs): *Area-Wide Development Element*
- Lauren Kerber (Masters of Marine & Environmental Affairs): *Shoreline Master Program Element*
- Catharina Depari (PhD in Urban Design & Planning), *Health and Well-being Element*

Community, Environment & Planning (CEP) major Sophia Nelson provided GIS and WeTable support. CEP alumna Kiana Ballo provided community outreach support. Charlotte Dohrn and Dan Abramson compiled and edited the report for consistency.

The team is grateful for the support, guidance and contributions of many people, and would like particularly to thank the following partners and participants: Mayor Robin Bearden and the City Council of Westport; Kevin Goodrich, Westport Director of Public Works, and other members of the Westport Tsunami Safety Committee, Paula Akerlund, Molly Bold, Harry Carthum, Leslie Eichner, Kurt Hilyard, Tracy Rosenow and John Shaw; Ocosta High School Principal Heather Sweet and science teacher Jon Harwood; South Beach Regional Fire District Chief Dennis Benn; Grays Harbor County Emergency Manager Hannah Cleverly; Shoalwater Bay Tribe Council Chair Charlene Nelson, and Emergency Manager Lee Shipman; WA State Parks Ranger Miles Wenzel; WA State Emergency Management Division Earthquake, Tsunami and Volcano Program Manager Maximilian Dixon and Mitigation Strategist Derrick Hiebert; and Glenn Coil. UW Institute of Hazard Mitigation Planning and Research Co-Director Bob Freitag coordinated his Floodplains Management course with the studio, and provided expertise based in the experience of Project Safe Haven tsunami vertical evacuation and other community

resilience planning in the region. UW Prof. Alison Duvall and other M9 project faculty supported the participation of doctoral student Lan Nguyen, and contributed time and expertise themselves, including especially the following: Frank Gonzalez, Randy LeVeque and Loyce Adams ran GeoClaw models of tsunami scenarios, produced maps of flooding depth and land subsidence, and helped interpret them for community use; Brian Atwater also helped interpret coastal geo-history and assisted with community outreach; Ian Miller of WA Sea Grant provided localized probabilistic data on sea level rise and helped with its interpretation; Ann Bostrom and David Schmidt provided insight on the communication of seismic scientific uncertainty and risk, and assisted with WeTable setup. Cynthia Chen and Xuegang Ban provided transportation systems expertise and supported the participation of doctoral students Katherine Idziorek and Yiran Zhang.

The studio was supported through an NSF grant for Interdisciplinary Research in Hazards and Disasters (Hazards SEES) to develop and use Magnitude 9 Earthquake Scenarios - Probabilistic Modeling, Warnings, Response and Resilience in the Pacific Northwest (project “M9”); a Bullitt Foundation grant for Building Community Adaptive Capacity as part of the Foundation’s initiative in Thought Leadership and Innovation in Applied Urban Sustainability Research, Scholarship and Action; and a grant from the Center for Safety Equity in Transportation (CSET) for coordination and context-sensitive transportation solutions that address the safety needs of rural, isolated, tribal and indigenous (RITI) communities.

Localizing Hazard Mitigation

DRAFT Recommendations for Westport's Comprehensive Plan Update

1. Introduction

This report provides recommendations for updating the City of Westport Comprehensive Plan (Comprehensive Plan) to increase community resiliency by identifying opportunities to integrate hazard mitigation strategies with planning goals. An interdisciplinary group of students and faculty from the University of Washington's Department of Urban Design and Planning (UW team) developed these recommendations as part of a collaborative Coastal Resilience Project conducted with the Westport Tsunami Safety Committee, which comprised the local Steering Committee for this project, and other community members. The UW team conducted this project as the focus of an Autumn 2018 urban planning studio class. The UW team developed these recommendations by reviewing the Comprehensive Plan and the Grays Harbor County Multi-Jurisdiction Hazard Mitigation Plan (County HMP), conducting additional research, and orchestrating an extensive, quarter-long community engagement process. The community engagement process included Coastal Resilience Workshops held in Westport in November 2018 that served as an opportunity for collective visioning of community resilience. Appendix A includes detailed documentation of the workshops; however, we integrated input from the workshops, follow-up meetings, and pre-workshop site visits throughout this report.

1.1. Project and Report Goals

This section provides a brief overview of overarching Coastal Resilience Project goals and the goals of this report. 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 Department of Urban Design and Planning and studio team. The goals include:

- 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

As a primary output of the project, this report is intended to guide the City of Westport when updating and/or implementing the current Comprehensive Plan. The report provides recommendations for localizing hazard mitigation strategies identified in the County HMP and aligning these strategies with the broader goals and values of the Westport community to increase resilience. It is important to note that the scope of the Comprehensive Plan is broader than hazard mitigation; however, this report focuses on opportunities to incorporate hazard mitigation into the plan and highlights 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.

1.2. Report Overview

This section outlines the content of this report, provides an overview of how recommendations were developed, and describes the information included in each report section. The current Comprehensive Plan 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 additional chapters focused on overarching goals and objectives and implementation. This report includes a section providing recommendations for updating each of the six existing elements, as well as a proposed new element; an overview of each section is provided below.

- **Land Use Element:** Highlights opportunities to utilize land use-related tools and approaches to increase the 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 integrate hazard mitigation into the Comprehensive Plan.
- **Transportation, Circulation, and Telecommunications Element:** Identifies opportunities to strengthen existing transportation plans and infrastructure to support evacuation and disaster response. In addition, this section recommends including telecommunication as a component of this element of the Comprehensive Plan 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, including proposing new opportunities for bolstering the local economy while enabling hazard mitigation. Recommendations include renovating existing structures to provide multi-purpose benefits including vertical evacuation and conference/event space.
- **Community Identity and Natural Resources Management Element:** Recommends dividing the current Community Appearance and Natural Resources Element into two new elements focused on community identity and natural resources management. Recommendations related to these topics describe creative opportunities for introducing new development and infrastructure that improves hazard resilience while maintaining Westport's character.
- **Area-Wide Development Element:** Highlights the importance of incorporating regional considerations into hazard mitigation planning and opportunities for accessing regional assets to increase hazard resiliency.

- **Shoreline Master Program:** Outlines opportunities to update the Shoreline Master Program 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, including identifying key health and well-being considerations of hazard mitigation and long-term community resilience.

The recommendations presented in this report draw from four primary sources: the Comprehensive Plan, the County HMP, community input, and other relevant cases and research. Westport adopted its Comprehensive Plan in 1998 and updated it in 2013; the plan provides a policy guide for the physical, economic, and social development of the city. Grays Harbor County updated its HMP in 2018; the plan describes county-wide hazards and mitigation initiatives and also includes a Westport-specific annex (and annexes for other jurisdictions). The County HMP identifies earthquake, tsunami, erosion, and flood as the top hazards of concern for Westport (Table 10-7 in the HMP Westport Annex), though Steering Committee members asked the UW team to consider severe weather and climate change as possibly also deserving high priority attention. To mitigate the risks associated with these and other hazards, the Westport annex listed six initiatives, which are referenced throughout this report: (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.

To further localize these initiatives, and consider what additional ones may be desirable, the UW team gathered input from the Steering Committee and community members during site visits, in-person and telephone interviews and meetings, and community stakeholder and public workshops. The UW team facilitated two Westport/South Beach Coastal Resilience Workshops on November 16th and 17th, 2018. The workshops used an "appreciative inquiry" and asset mapping approach to encourage participants to first identify community values and assets before discussing the impacts of different hazard scenarios and what mitigating strategies would be appropriate for them. While the studio did not focus on assessing community needs and priorities for development in general, beginning the workshop discussions with an appreciative inquiry provided a kind of "reality check" on the validity and priority of both Comprehensive Plan goals and HMP strategies, and also helped to prompt new and creative ideas for recovery and resilience.

In the workshops, each table of discussants focused on one of three specific hazard scenarios – sea level rise and two potential near-source Cascadia Subduction Zone (CSZ) earthquake and tsunami scenarios with ground subsidence (large and rare events). Although the workshop did not equally consider all relevant hazards (e.g. coastal erosion, distant-source tsunamis, and many seismic hazards including shaking, liquefaction and landslides), the outcomes are broadly relevant to hazard mitigation (see *Appendix A* for more information regarding the workshops). The UW team also gathered input through feedback on draft recommendations presented to the Westport Steering Committee and other key stakeholders on December 7th, 2018, and at a community open house on December 8th. A full timeline of community engagement activities prior to and during the studio is included in Section 1.3 below.

In addition, the UW team engaged hazard experts and conducted additional research throughout the quarter to inform the development of recommendations. Each section of this report follows the same general structure, described below.

- **Introduction:** provides an overview of the current Comprehensive Plan Element, including goals and objectives
- **Opportunities for Integration:** highlights opportunities for integrating the existing six hazard mitigation initiatives from the Westport Annex of County HMP with the Comprehensive Plan Element
- **Community Input:** summarizes community input relevant to the Comprehensive Plan Element gathered during workshops and other engagements
- **Recommendations:** presents synthesized recommendations based on integration opportunities and input for updating the Comprehensive Plan Element
- **References Cases and Further Relevant Information:** describes relevant examples and/or case studies and provides references for the sources cited within each section

1.3. Timeline of 2018 Engagement Activities

July 19 – Collaboration proposal to Westport City Council
August 3 – Collaboration proposal to Westport Tsunami Safety Committee, McCausland Hall
September 5 – Mayor Bearden and Prof. Abramson signed Memorandum of Understanding
September 26 – Public forum on Japanese experience of 2011 earthquake and tsunami
October 12-13 – Workshop mid-planning meeting and community site visit, McCausland Hall
November 5 – Scenario review and protocol design meeting, via Zoom
November 16 – Partners Workshop w/ WeTable, McCausland Hall
November 17 – Public Workshop, Ocosta Elementary School
December 7 – Presentation to Steering Committee, McCausland Hall
December 8 – Poster Open House, Tackle Box

1.4. Overarching Considerations

While each section of this report provides targeted recommendations for updating each element of the Comprehensive Plan, there is significant overlap in the strategies that emerged from the County HMP initiatives and integrating community input across elements. The overlap among sections 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, and even 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, and thus enhances their effectiveness.

For example, 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 [as summarized in Table 1], 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, as shown in Figure 1. As detailed in the recommendations for each Element below, 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, depending on the needs. What might be useful (and even profitable) in normal times as an ecologically low-impact camping area, hunting lodge or resort development, may serve as an emergency refuge and resettlement area after a major earthquake and tsunami. As an example of this model, a nonprofit recently acquired property just south of the Westport city limits from a timber company and will transfer the property to the Washington Department of Fish and Wildlife. Westport is working with the nonprofit and the state to ensure that the city can maintain easements on this piece of property for critical water infrastructure and aquifer access. These easements are essential to ensuring provisioning of water resources to residents and businesses now and in the future. This case provides one example of how the city can leverage land access to help ensure a sustainable, resilient future. [Possible map here of municipal, private, and public landholdings around Westport]

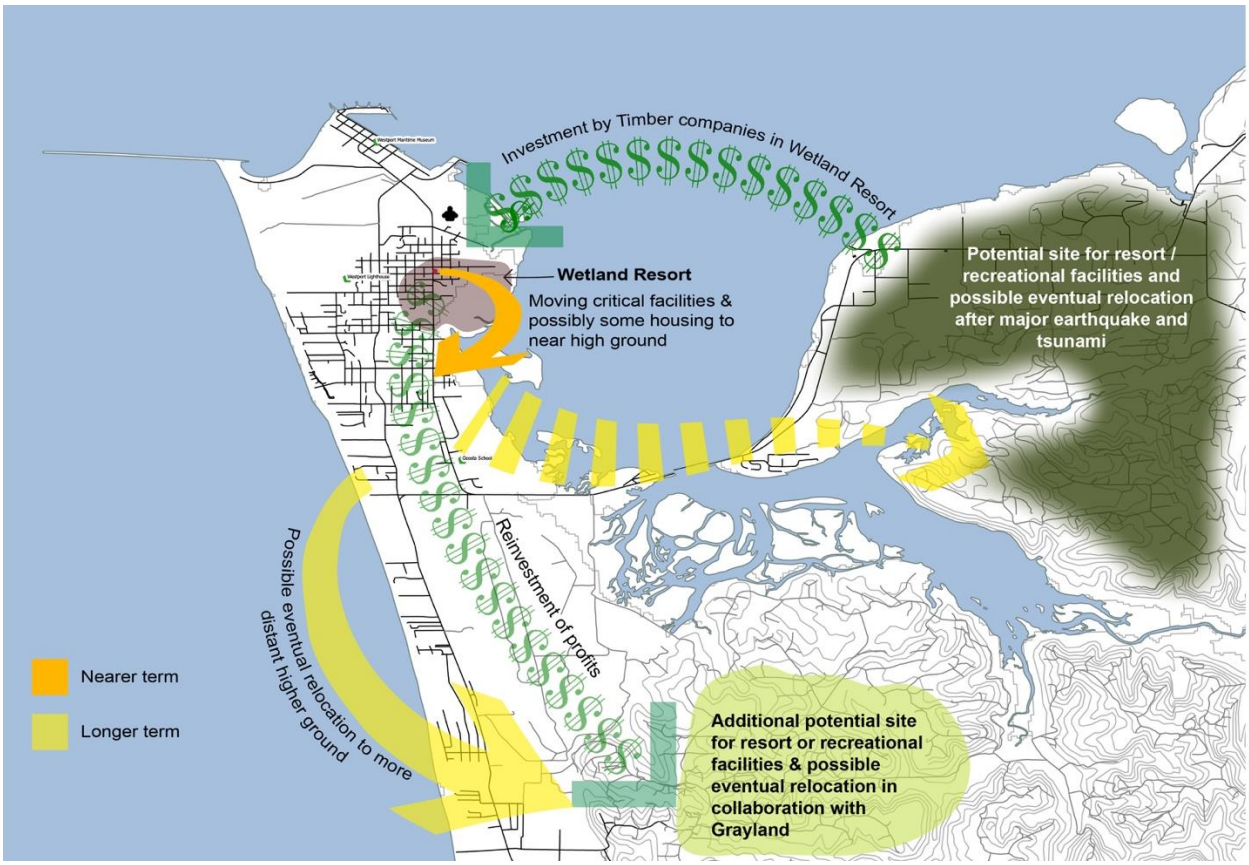

Figure 1. Conceptual diagram of possible land and development rights swaps for resilient long-term land use (map by Sreya Sreenivasan)

In sum, we asked based 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? (Not the main focus of the studio, but an important reality check to inform the validity of the answers above as well as priorities for implementation.)

Table 1. Summary of Alignment and Overlap between Comprehensive Plan Goals and HMP Strategies/Initiatives

[Include here a summary table – a simplified version of our Goals x Strategies matrix – to show the key overlaps among the Elements. But we will have to work on this over the next couple of weeks, after sending this draft to Kevin and other Steering Committee members.]

5. Community Identity and Natural Resources Management Elements

5.1. Introduction

Chapter 7 of the Comprehensive Plan is the Community Appearance and Natural Resources Element. It currently captures two topics that require more in-depth evaluation.

We propose that the element be expanded and split into two separate sections (Figure 8):

1. Community Identity
2. Environmental Protection or Management

This reorganization would allow the scopes of each of the two new elements to be broadened to achieve a holistic planning approach.

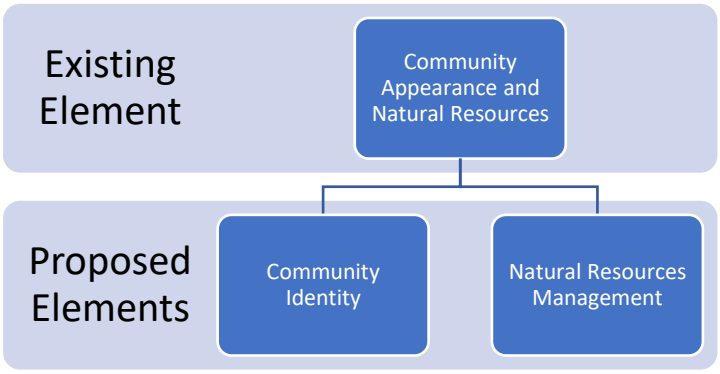

Figure 8. Schematic of proposed division of element into two sections

Chapter 7 of the present version of the Comprehensive Plan focuses on the aesthetics of the built environment of the city to enhance the character of the city, quality of life for community well-being, and community attachment to place, as well as promoting tourist-oriented economic development. It also aims to recognize the importance of the natural resources, conserve them, and to improve the public awareness of these natural heritage features. We propose that the separation of the Element into two individual elements would help to better achieve these stated goals of the city.

The purpose of the Element currently in the Comprehensive Plan includes enhancing the character of the city and quality of life for community well-being, fostering community attachment to place, making way for tourist-oriented economic development, and conserving the natural resources of the city by creating public awareness of the natural heritage.

The reorganization would expand the scope of the element to include the following aspects:

- Community identity
- Urban resilience
- Hazard mitigation
- Heritage conservation

Using “Community Identity” instead of “Community Appearance” improves the scope of the Element and would also help to seamlessly incorporate the Historic Preservation for conservation and promotion of local culture into the Comprehensive Plan. The community identity element can also benefit from using urban design methods in various ways. Some of the common urban design methods that can be useful for Community Identity creation and preservation are as follows:

1) Cognitive/memory maps and city-image analysis (Lynch 1960)
2) Transect analysis
3) Placecheck
4) Observation of social life in public places; desire line mapping (Whyte 1980)

The Natural Resources section of Chapter 7 can be expanded as "Natural Resources Management and Conservation". The element would then need to be developed with addition of more relevant information and data.

Although they would exist as two different elements in the Comprehensive Plan, natural resources are also considered to be part of the community's identity. Therefore, it would be prudent to develop the two elements concurrently with provisions in each element to encourage/ensure mutual interaction.

The Urban Design Guidelines would continue to exist as a separate document. The updates to the Urban Design Guidelines should be made based on the strategies established in the Community Identity and Natural Resources Management Elements.

5.2. Opportunities for Integration

The city should consider the use of urban design methods (like transect analysis, cognitive mapping and city image analysis) to identify and map optimum evacuation routes and places of refuge, to test public awareness of their existence; and to determine how that awareness is related to elements of Westport's urban form, including the layout of streets and other pathways, coastline and topography, land uses and ground cover, prominent buildings and other landmarks, and gathering places (Figure 9). Three key aspects of community identity derive from these elements which are also crucial to successful disaster preparedness:

1) Legibility: the extent to which these elements help residents and visitors understand how the community is spatially organized and orient themselves in it (Lynch 1960)
2) Vitality: the extent to which these elements support social activity and life in general (Whyte 1980)
3) Meaning: the significance that residents and visitors individually and collectively attach to elements of urban form (Hester 1985)

Figure 9. Urban Design Approach, City of Greensburg, Kansas (L); Desire lines to create evacuation route maps (R)

This section includes opportunities and obstacles for integrating hazard mitigation initiatives from the County HMP with community identity (Table 11), natural resource management (Table 12), and urban design guidelines (Table 13).

Table 11. Aligning Hazard Mitigation Initiatives and the Community Identity Element

Hazard Mitigation Initiative	Opportunities for Alignment with Community Identity	Conflicts with or Obstacles to Alignment with Community Identity Goals
Vertical Tsunami Evacuation Structure	● The design of the vertical evacuation structures should correspond with the community appearance goals. These structures could contribute to identity creation of the community as well as serve as prominent landmarks for the city.	● Conflicts with parts of the Objective #3 (To preserve, as feasible, Light, Views, Privacy, Open space, Shorelines, Other natural features) ● Technical requirements of vertical evacuation may present challenges to enhancing legibility, vitality and meaning
Public Outreach Program	● Public outreach and education programs could be conducted at some of the well-designed public spaces including vertical evacuation structures.	N/A
Emergency Management Plans	● Community appearance guidelines could be leveraged to highlight the location of some of the assets of the city, as identified by the EMP as well as evacuation routes.	● Moving businesses can be costly, also more detailed feasibility studies need to be done ● business owners might resist moving
Emergency Communication Plan	● Addressed in Telecommunications part of Transportation, Circulation and Telecommunications Element	N/A
Critical Facilities Evaluation	● Improvements to capital facilities should incorporate new design guidelines aimed at emergency management and disaster preparedness.	N/A
Transportation and Right of Way Improvements	● Signage in ROW Improvements must correspond to Design guidelines. However, there are no specific guidelines for signages in the UD Guidelines doc. Street edge surfaces must also be designed to aid emergency evacuation and highlight the routes.	N/A

Table 12. Aligning Hazard Mitigation Initiatives and the Natural Resources Management Element

Hazard Mitigation Initiative	Opportunities for Alignment with Natural Resources Management	Conflicts with or Obstacles to Alignment with Natural Resources Management Goals
Vertical Tsunami Evacuation Structure	● Designing the structure in a setting that showcases or takes advantage of the natural resources of Westport (native plant and animal species, views of the ocean, the wetlands, etc.) could provide as good educational tools as well as attraction for visitors.	N/A
Public Outreach Program	● Educational tours or information plaques are tools that can be used to inform about the natural capital of the city.	N/A
Emergency Management Plans	● Strengthen natural high-grounds like the ridges and hills to serve as evacuation routes as well as to site evacuation towers.	● Would require purchase of multiple parcels of private land which would also involve relocation of houses that already exist on the ridge.
Emergency Communication Plan	N/A	N/A
Critical Facilities Evaluation	● While retrofitting capital facilities, stormwater management systems incorporating native vegetation and the designation of open spaces for stormwater detention should be encouraged.	N/A
Transportation and Right of Way Improvements	● ROW improvements must include appropriate green stormwater management measures.	● This could possibly involve widening of streets.

Table 13. Aligning Hazard Mitigation Initiatives and Urban Design Guidelines

Hazard Mitigation Initiative	Opportunities for Alignment with Urban Design Guidelines	Conflicts with or Obstacles to Alignment with Urban Design Guidelines
Vertical Tsunami Evacuation Structure	● If the structure were designed to be iconic, it could promote the economic vitality of the place by bringing in more tourists. ● The design of the Vertical Evacuation structures should correspond with the visual aesthetic guidelines prescribed by the UDG. ● The appearance of the Vertical Evacuation structures should correspond with the visual aesthetic guidelines prescribed by the UDG.	● Involving an urban design firm specializing in design of iconic buildings could cause the cost of the vertical evacuation tower to rise. However, the conceptual design of the building could be decided through a design competition.
Public Outreach Program	● Outreach and education planners should refer to UDG or work with urban designers to plan the outreach and education strategies. ● Include small structures (like pillars/obelisks/totems) into the landscape of Westport that can be used to disseminate information about hazards. These can become unique features (like the warning tower) around Westport, adding more character to the image of the city. ● Activities like "placecheck" or Disaster Preparedness tours, scavenger hunts or treasure hunts (spot the info obelisk or warning tower, etc.) during tourist season can be good education tools as well as economic opportunities.	N/A
Emergency Management Plans	● Guidelines should include ones that consider the use of particular surface treatments of walls, pavements and streets that would aid ease of visual access to assets and emergency supplies. ● Urban Design analysis methods can be used to identify evacuation routes. ● Find trivial (or seasonal) alternate purposes for back-up equipment that would be needed in an emergency.	N/A
Emergency Communication Plan	● Provision to include distress signal devices (beacons, etc.) as part of the general urban design requirements of buildings could be made.	N/A
Critical Facilities Evaluation	● Capital facility design in commercial zones must be in accordance with the new UDG. ● Community identity features to be considered while retrofitting capital facilities.	N/A
Transportation and Right of Way Improvements	● Make provisions to accommodate for both the commercial needs as well as hazard mitigation while avoiding clutter. ● Signages in ROW Improvements must correspond to Design guidelines. However, there are no specific guidelines for signages in the UD Guidelines doc. ● ROW improvements must follow guidelines for streets that would set a hierarchy in aesthetic design for street types in different zones.	N/A

5.3. Community Input

The workshops held in Westport with the community stakeholders in November provided many valuable insights; Figure 10 includes the most relevant community input that we received for this section of the Comprehensive Plan.

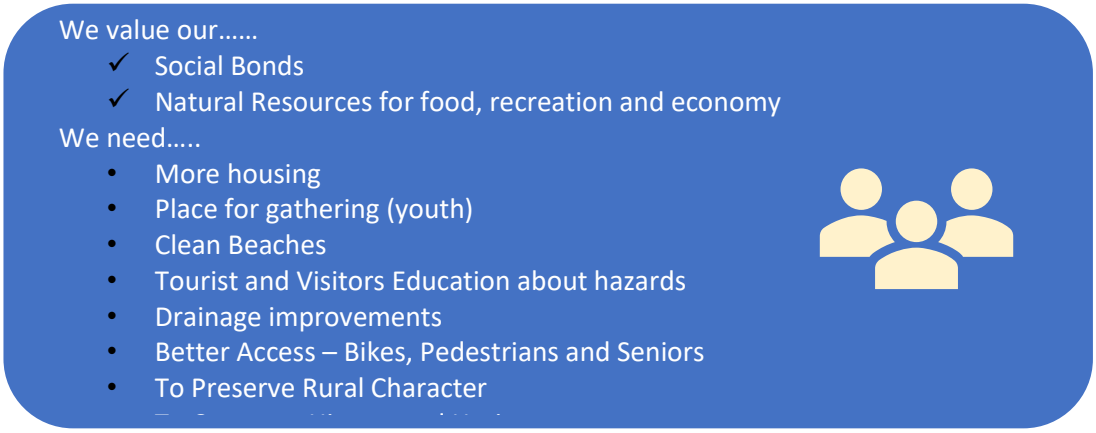

Figure 10. Summary of what we heard at the workshops in Westport

Table 14 below includes themes and examples of strategies relevant to community identity and natural resources emphasized by workshop participants. In addition, at the community report back event on 7th December 2018, community members expressed great interest in seeing a "Seabrook (near Ocean Shores) like development" in Westport. This suggestion can be incorporated but needs to be customized for Westport so as to ensure appropriate development.

Table 14. Community Input Related to Community Identity and Natural Resources Management

Strategy Theme	Strategy Examples
Connectivity throughout the region	• Establish interconnected trail system network for bikes and pedestrians • Explore the use of seaplanes as alternative air transportation mode. • Improve and demarcate major evacuation routes throughout the city. This would help in easier identification of the routes as well as ease of access for emergency vehicles.
Information-sharing and preparedness	• Using special devices to communicate hazard information and warning. • Using signages and information boards to educate the public. • Integrate vertical evacuation structures and other evacuation sites into everyday routine of the public if possible. This habituates the residents with the evacuation procedures, routes and sites.
Balancing growth and resilience	• Building a community that can accommodate for increasing storm surges to a greater extent and leveraging it for economic growth • Adapt by building more safer housing in the form of mid-rise apartments to keep younger generation within the city once broad band systems are improved
Education of the public particularly tourists	• Installing signages and special devices for information dissemination (e.g., Haz-Mit Totems). • Coding the built environment through color and texture themes for way-finding.
Conservation of resources and identity	• Create programs for beach clean ups after peak tourist season. • Move important historic artefacts to higher altitude facilities. • Protect the natural environment and the character of the built environment.
Economic Improvement	• Improve tourism opportunities (e.g., More themed resorts, activities, etc.) • More housing options to attract and/or to retain younger population.

5.4. Recommendations

Table 15 below summarizes recommendations for updating this Element of the Comprehensive Plan based on integrating County HMP initiatives, input from community members and additional information. Each strategy included in the table is explained in more detail below.

Table 15. Recommendations for the Proposed Community Identity and Natural Resources Management Elements

	Strategies	Hazard Mitigation Benefits	Co-benefits for Community Identity and Natural Resources Values
County Hazard Mitigation Plan	1. Explore the option of designing a vertical evacuation tower as iconic structures	• Easier to locate the evacuation site	• Attracts more tourists and thereby improves the economy
	2. Implement innovative emergency evacuation route signage system	• Easier to identify the evacuation routes even if structures collapse due to an earthquake • Aids in evacuating tourists and visitors faster	• Adds to the unique identity of the city. • The implementation of these interventions can be integrated with regular building and street maintenance measures.
	3. Explore the use of special emergency management devices like Haz-Mit totem poles	• Can be used for information dissemination, as warning devices and to house small emergency supplies.	• Adds to the character of the city. • Can be used as part of tourist activity like 'treasure hunt' etc.
Community Input	4. Wetland resort development in the lowlands	• Acts as a buffer for the inner city	• Allows maximum economic utilization of the land before sea level rise and/or a natural disaster makes it completely unusable
	5. Explore the option of building mid-rise apartments	• Can act as vertical evacuation structures	• Alleviates housing shortage issues
	6. Relocating critical facilities	• During emergencies the critical facilities can be protected and available for use.	• This may uplift the economy and development in and around the new location of the critical facilities.
Other strategies	7. Resorts in the hills outside the city limits	• Ensures that a habitable refuge is available during and after major hazards like tsunamis • Can be used as a site for emergency supplies and vehicles including helicopters	• Improves the tourism driven economy. • Can be developed into the new city post a major disaster. • Can be used as the new site for important cultural/historic artefact for social resilience.
	8. Encourage flood accommodative building design.	• Houses are protected from flooding due to storm surges, king tides and possibly from minor tsunami events.	• Elevated resort buildings in the lowlands could be designed in a way which takes advantage of the tidal flooding and storm surges. This could contribute to tourism during storm season.

	Strategies	Hazard Mitigation Benefits	Co-benefits for Community Identity and Natural Resources Values
	9. Chateau Westport retrofit/reconstruction	• Act as a vertical tsunami evacuation option • Strengthen it against seismic forces	• The retrofitting process could be used as an opportunity to include sustainability measures and improve the appearance of the hotel.
	10. Ridge Trail	• Serves as alternative emergency evacuation routes.	• Bike trails can act as green transportation modes. • Bicycle tours can be a tourist activity to get acquainted with the city.
	11. Implementing blue-green storm water infrastructure measures	• Reduces stormwater related flooding	• Contributes to improved appearance of the city. • Improves carbon sequestration • Creates more public spaces
	12. Mapping of natural resources	• Utilized to formulate natural hazard mitigation strategies	• Helps to identify, measure and locate the various natural resources which then helps conservation and prudent use of the resources.
	13. Using Coastal vegetation to mitigate storm surge impacts	• Reduces the impacts of waves	• Aids in the conservation of the local flora and fauna. • Would help in attracting wildlife enthusiasts.
	14. Explore the option of aerial tourism	• Opens options for aerial emergency evacuation	• Contributes to an additional tourist activity • Will be helpful in acquainting the public to the image of the city from the air thereby enhancing their attachment to the city

1. **Explore the option of designing a vertical evacuation tower as iconic structures:** Vertical evacuation structures can be designed with iconic or unique forms that serve as tourist attractions and also reinforce the identity of Westport. Designing structures in such a way will also help in 'way-finding'(i.e., help in identifying the evacuation structures during emergency situations). More measures of tsunami resistance through architecture must be explored (Craven 2018).

2. **Implement innovative emergency evacuation route signage system:**

Figure 11. Right of way interventions

Evacuation route signages should be better integrated into the built environment. Unlike a few sign boards, treating the entire stretch of an evacuation route would help better in communicating its purpose to the general public. For instance, if flooding occurs, it would be easier to tell people to follow the path with roofs painted red (Figure 11). Emergency lamps, powered by solar batteries, can light up the path during the night. Solar (or wind powered) street lamps would be beneficial for the city residents even in the winter months (as was heard during the open house conducted on December 8,2018 at the Tackle box).

3. Explore the use of special emergency management devices like Haz-Mit totem poles: These are devices that can be used to disseminate local hazard information. They can also be used to house small emergency supplies like a flare or a torch. If connected to a regional warning system, they may also be used as warning beacons. These poles could be designed by local artists and represent the culture of Westport. They can also be incorporated into tourist activities like "Spot the Haz-Mit Totem contest", which would ensure that the tourists are made aware of these structures. It would also draw their attention to the hazard information displayed by the device. Totems can be designed and crafted by neighboring Shoalwater Bay Tribe (see Economic Development Element).

Figure 12. Concept of Haz-Mit Totem Pole (Art installation from Wawa Information center, Canada has been used as an example to illustrate the concept.)

4. Wetland resort development in the lowlands:

The city could consider buying the low-lying lands, especially those that would be most susceptible to sea level rise, and lease back the land to private resort developers. However, the resort should be developed in a way such that it accommodates flooding. This can be achieved through building the resort cottages on stilts or piles. The king tide and storm surge waters would pass underneath the structures.

Figure 13. A wetland resort in Malaysia

The benefit of such a development is that during the initial years there would be only minor seasonal flooding. They could even be used as retirement community homes. However, as the years progress and the global sea level rises, the resort land will be inundated with high tide water but the cottages themselves will be dry. This would prove as a unique 'living-on-the-water' experience that could attract tourists seeking such unique experiences. They could also be infused with some tourist focused recreational aquaculture. At this point permanent dwelling in these structures must be prohibited and only tourists/vacationers should be allowed to use these structures. Farther into the future, the structures could probably serve as tourist facilities while the elevated pathways can serve as piers and docks. Eventually, the structures could be condemned for any type of housing

Figure 14. Ecologically low-impact stormwater- and draught-tolerant environmental educational retreat at Islandwood, Bainbridge Island (Berger Partnership)

purposes. For possible locations to site the wetland resort refer to Figure 18 showing potential ridge trail route and locations for wetland resorts.

Figure 15. Moe Yun Gyi Wildlife Sanctuary & Wetlands Resort when dry (L) and when water rises (R)

5. **Explore the option of building mid-rise apartments:** Apartments with 4-10 stories can be built to provide affordable housing on limited higher ground. These can also serve as vertical evacuation structures. When building such structures care should be ensured that the at least the top two levels of the building are wide enough and accessible to hold as many people as possible during an emergency situation. The city should ensure that such buildings be built only after appropriate geological and seismological studies are conducted. They should preferably be situated on locations on top of the ridges after sufficiently reinforcing the ridges. Care should also be taken in building only limited number of such structures as they can interfere with the small-town charm of the city, which is highly valued by its current residents. Potential sites are marked as purple dots on the map (Refer to Figure 16 Potential relocation of the fire station; Yellow arrow describes the relocation of the fire station to a site on the natural ridge.)
6. **Relocating critical facilities:** Critical facilities can be relocated to higher grounds. In order for relocation to be feasible and useful for the immediate future, critical facilities like the fire department should not be relocated outside the current city limits. Identifying the important roadways and widening them could ensure quicker access by the fire engines (routes highlighted in red on Figure 16).

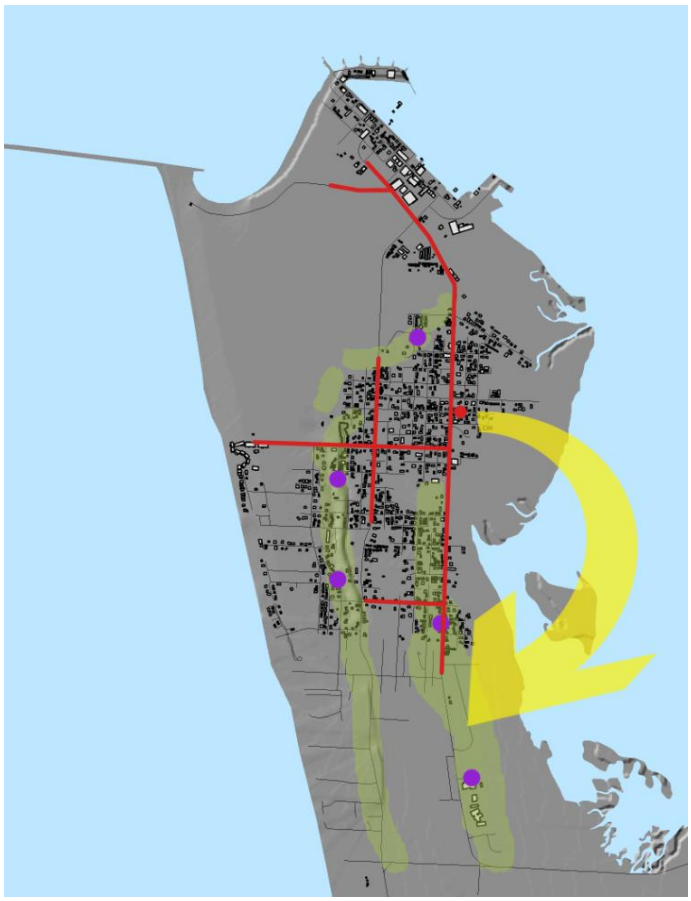

Figure 16. Potential relocation of the fire station; yellow arrow shows relocation of the fire station to a site on the natural ridge.

7. **Resorts in the hills outside the city limits:** The city should also explore the option of locating resorts outside the current city limits (see Figure 1). These can take the form of forest retreat facilities on what are currently private highlands (Figure 17). This again could be a public-private partnership endeavor. These could be made of a combination of eco-friendly structures and permanent structures. These permanent structures would be serviced by basic infrastructure. The design of the permanent structures could be such that it can be expanded in the future, should there be need for a more permanent residential establishment due to natural hazards. They can also act as temporary

refuges during peak storm events for the resident community of Westport. Tree houses can be a potential lower-cost elevated housing option.

Figure 17. A tree house in Skamania County, WA

8. **Encourage flood accommodative building design:** In the most basic sense, this means elevating structures above a minimally-obstructed ground surface. Floodwaters should be allowed to pass under the structure. Buildings within the 100-year FEMA floodplain should be encouraged to be elevated above the base flood elevation. Large sites could also include stormwater detention areas.

9. **Chateau Westport retrofit/rebuild:** Existing hotels such as Chateau Westport must be explored as alternative vertical evacuation sites. They may require retrofits to make them resistant to seismic forces. More importantly they may be easier to retrofit for the near-term evacuation needs (should such a need arise) as building new structures would take longer.

10. **Ridge Trail:** Establish bike and hiking trail system that also connect to the vertical evacuation structures. In the event that roads are inaccessible these could potentially serve as alternate routes. Also, they can be used as an economic resource (bike tours) as well as tourist education tools.

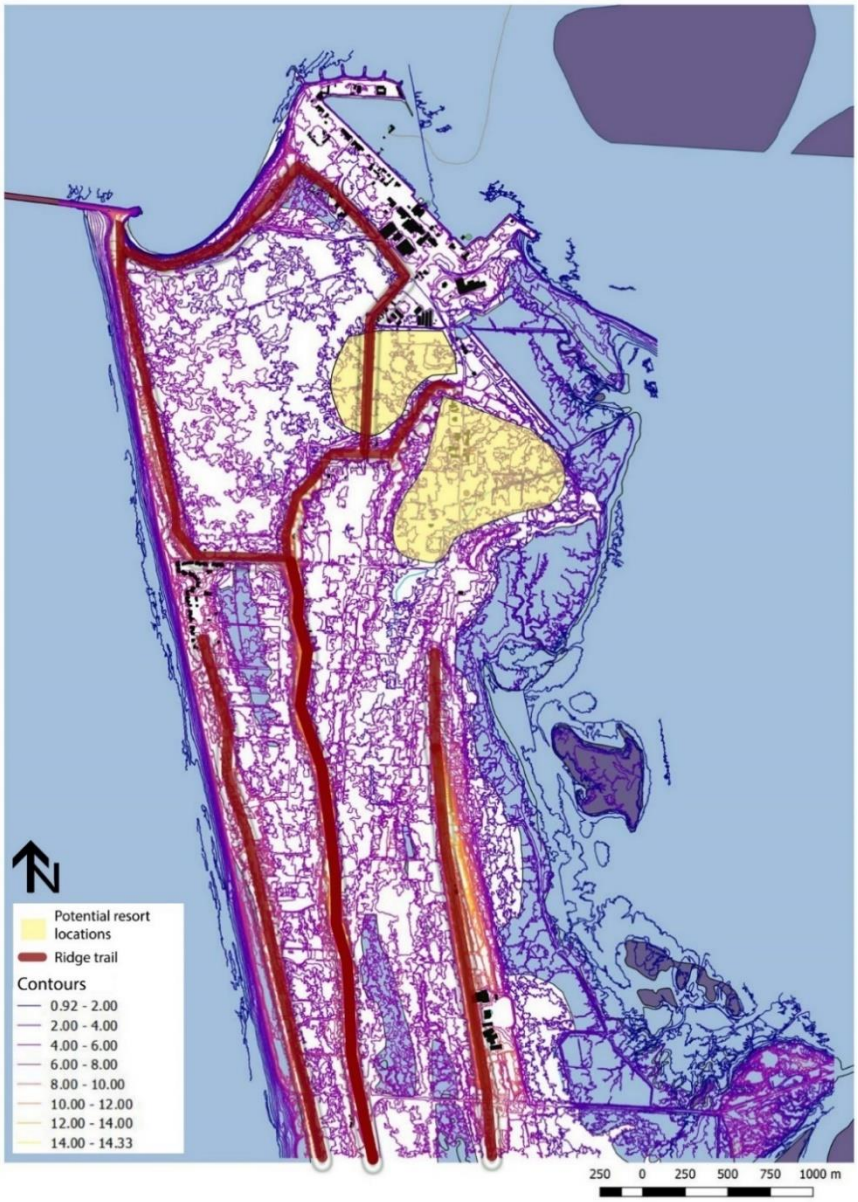

Figure 18. Potential locations for Wetland resort and potential ridge trail routes

11. **Implementing blue-green stormwater infrastructure measures:** Implementing blue and green stormwater infrastructure would prove beneficial to the city in multiple ways. This involves swales along transportation corridors, detention ponds, sunken public squares or play grounds that can flood during storms and prevent flooding of the neighborhood, rain garden in residences, etc.

Figure 19. City of Greensburg, Kansas, Green stormwater infrastructure

Figure 20. An example of floodable public recreational space (stormwater detention)

12. **Mapping of natural resources:** This strategy is aimed at taking advantage of the natural resources of the city. In order to be able to leverage the natural topography and vegetation for hazard mitigation purposes. This strategy involves documenting the bio-diversity and the land form of the city and nearby region. This would also help in conserving the natural resources better. Information from

these studies and documentation can be used to make advertisement and information material for the tourists and nature enthusiasts.

13. **Using Coastal vegetation to mitigate storm surge impacts:** Explore the option of using native vegetation for hazard mitigation purposes. Coastal wetland vegetation could attenuate waves. Native grass species could be planted on sand dunes to reduce erosion from winds, storm surges and tides. More vegetation also attracts avian fauna that have also been known to act as informal warning systems for natural episodic hazards. This, however, has yet to be proved effective through proper scientific studies.

14. **Explore the option of aerial tourism:** The city should consider the possibility of introducing aerial tourism. This can be achieved in different ways. If a sea-plane port is established, sea-plane tours could be offered. If helicopters were to be acquired and housed at the hill resorts, these could be used for public tours during tourist season and as emergency air-vehicles in times of need. The tour would prove valuable in establishing a strong image of the city for the public. This fosters a greater sense of attachment with the city itself. A great example is the iconic aerial view of the Central Park in New York city. The system could also be established with collaboration from neighboring jurisdictions like Grayland and Ocean shores. Following are some of the sites that can be incorporated in the tour:

The light house is part of Westport's identity. Even when sea levels have risen greatly in the future, the structure could still act as a tourist attraction.

Figure 21. Example of view of a light house

The layout of the built form of the city can be leveraged to act as a sight to be seen.

Figure 22. Building layout - Pattern of the city's-built form

The tall structures of the evacuation structures can be used as valuable aerial sights. They would provide great contrast to the other features of the city.

Figure 23. Mid-rise buildings through the city

The views of the Grays harbor can also be leveraged along with Oyster farms. This could give the Oyster farmers an incentive to invest in this endeavor. Sun-set and Sun-rise tours could be offered as special events.

Figure 24. Views of the harbor and oyster farms

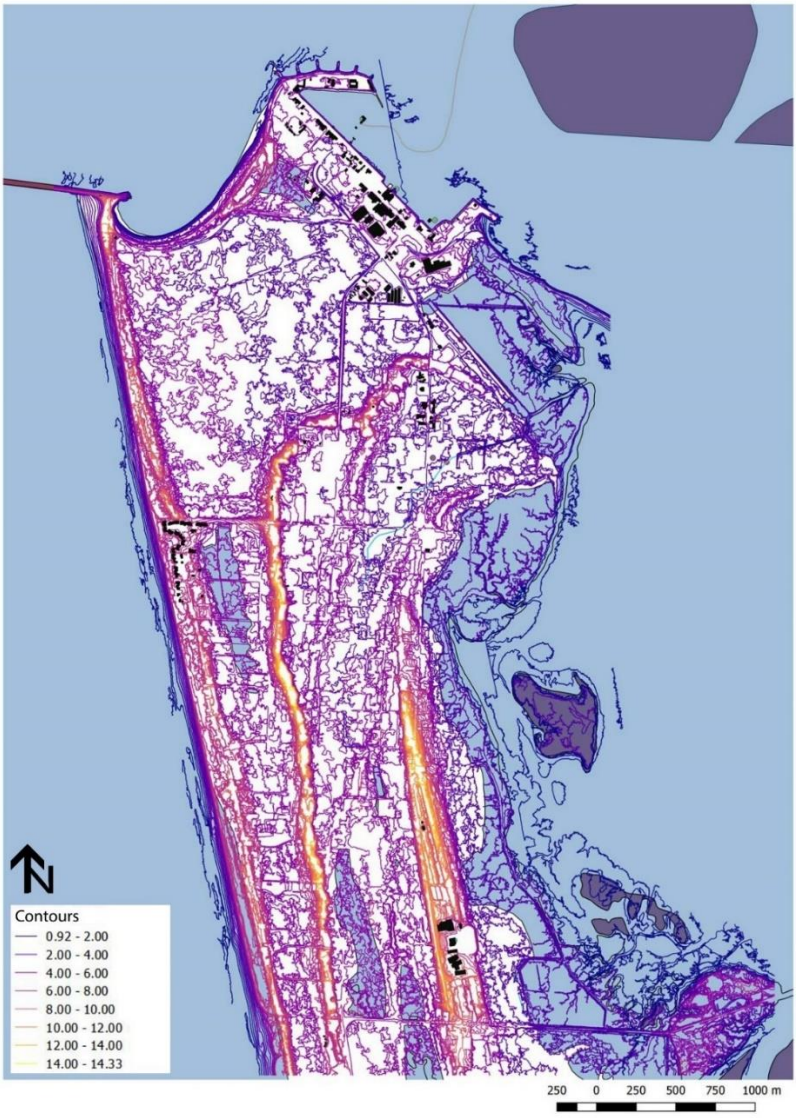

Figure 25. Map showing the location of the ridges within the city

5.5. References and Additional Resources

Craven, Jackie. 2018. Architecture of tsunami resistant buildings. September 26. Accessed December 10, 2018. https://www.thoughtco.com/architecture-of-tsunami-resistant-buildings-177703.

Hester, Randall. 1985. "Subconscious Landscapes of the Heart." *Places* 2(3), 10-22.

Lynch, Kevin. 1960. *The Image of the City*. The MIT Press.

More information on possible vertical evacuation sites can be found in the document “Project Safe Haven”.

“Project Safe Haven: Pacific County Final Report.” 2011.

Whyte, William H. 1980. *The Social Life of Small Urban Spaces*. Washington, D.C.: Conservation Foundation. See also the Project for Public Places, https://www.pps.org/.

Additional resources:

- The recovery plan of the City of Greensburg, Kansas, is a good document to observe the possibilities of use of urban design for hazard mitigation and sustainability. https://archive.epa.gov/region07/cleanup/greensburg/web/pdf/gb_ltcr_plan_final_hires070815.pdf
- Some information of Blue-green infrastructure can be found on the following website: https://ramboll.com/services-and-sectors/planning-and-urban-design/blue-green-infrastructure-design
- Some resources from FEMA for elevating structures in floodplains: https://www.fema.gov/media-library/assets/documents/725
- FEMA manual for coastal construction is available at the following link: https://www.fema.gov/media-library/assets/documents/3293
- An example article that explains the use of desire lines: https://99percentinvisible.org/article/least-resistance-desire-paths-can-lead-better-design/
- A resource for transect analysis: https://transect.org/
- A resource for placecheck: https://placecheck.info/en/

Appendix D

DRAFT Community Engagement for Coastal Resilliency in Westport

DRAFT 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

January 25, 2019

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 1 below.

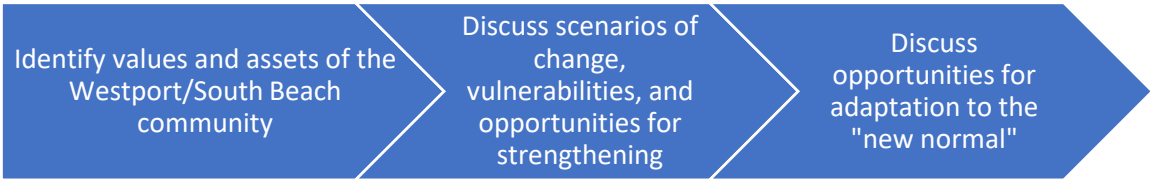

Figure 1. Overview of Workshop Approach and Structure

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 1 below includes a summary of values and assets highlighted by workshop participants.

Table 1. 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 2 shows community members and UW facilitators building a list of values and assets during the Saturday, November 17, workshop.

Figure 2. 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]

[Definitions and Acronyms?]

The SLR information included projections for 2060, 2080, and 2100. Table 2 shows the SLR projections with different probabilities of coastal flooding for each time horizon.

Table 2. 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 3 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.

[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.

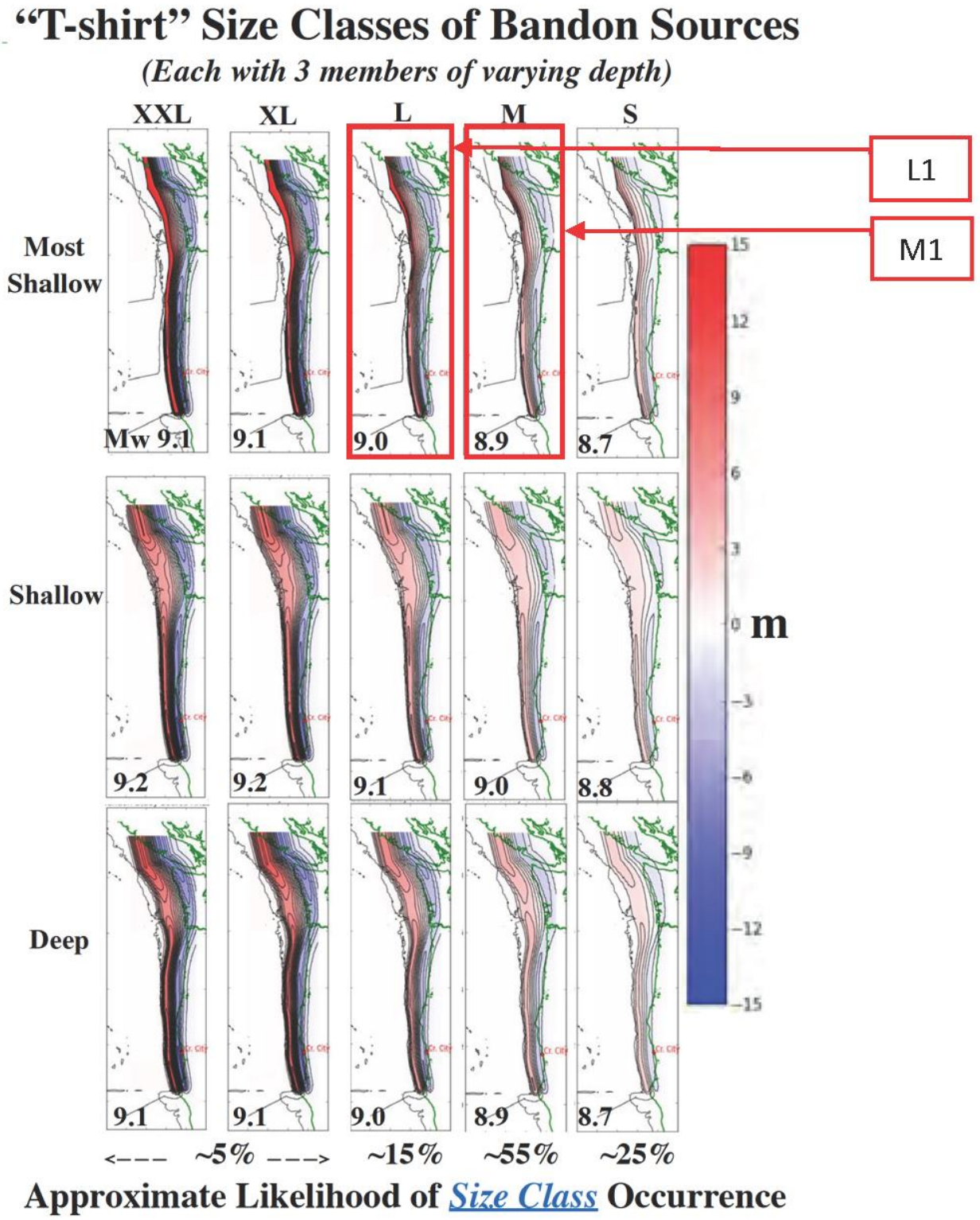

Figure 3. Suite of 15 Possible Cascadia Subduction Zone Fault Earthquakes. Source: Frank Gonzalez, based on a hazard assessment study for Bandon, Oregon. See Witter, Robert C, Yinglong Zhang, Kelin Wang, George R Priest, Chris Goldfinger, Laura L Stimely, John T English, and Paul A Ferro (2011): Simulating 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 2 (Figures 4 and 5; same map showing Westport and the peninsula). Maps showing earthquake and tsunami hazards referred to both the “T-shirt sizes” of M1 and L1 earthquake scenarios depicted in Figure 3, 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”.

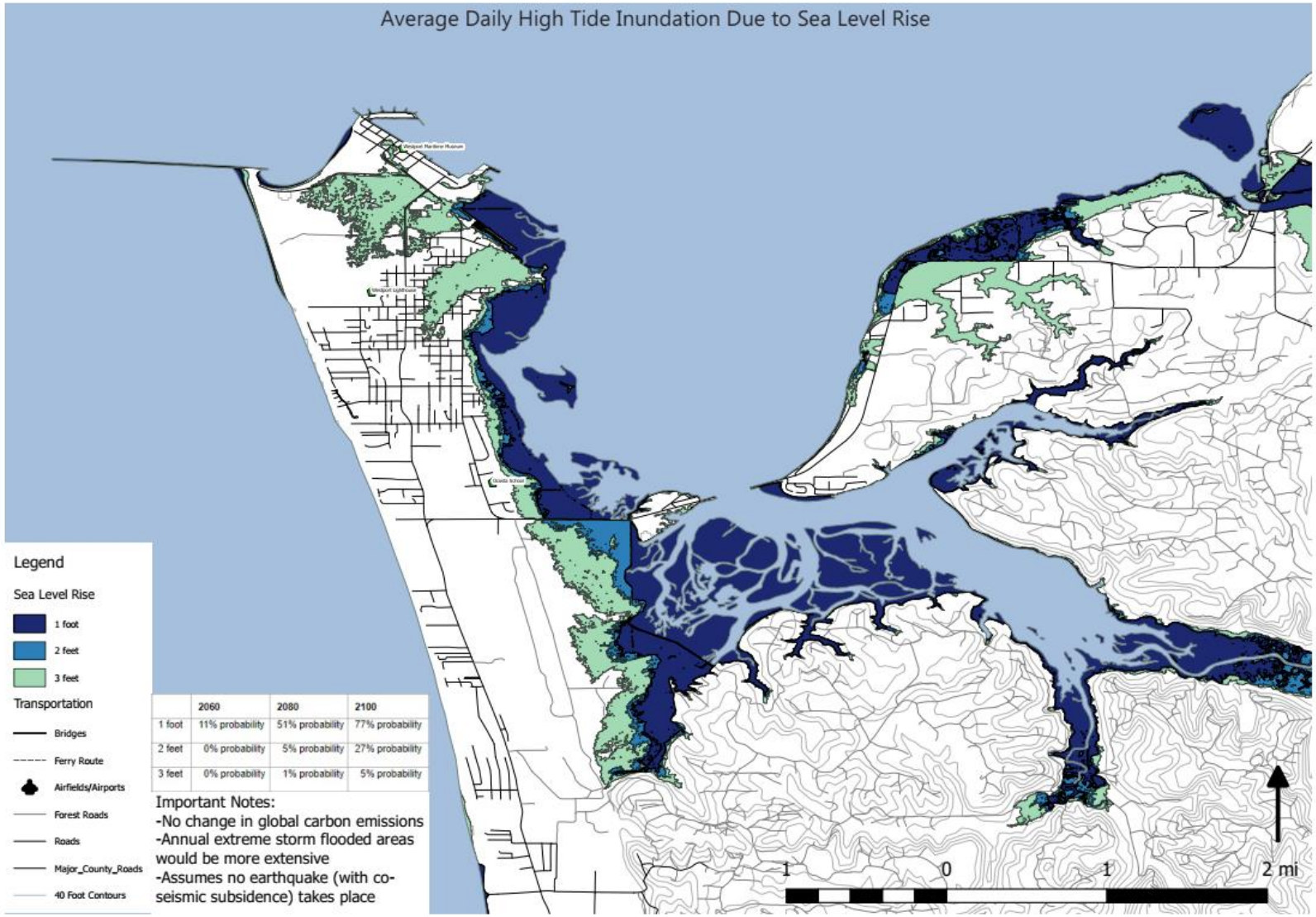

Figure 4. Regional Map of Average Daily High Tide Inundation under Different SLR Scenarios (1-3 feet)

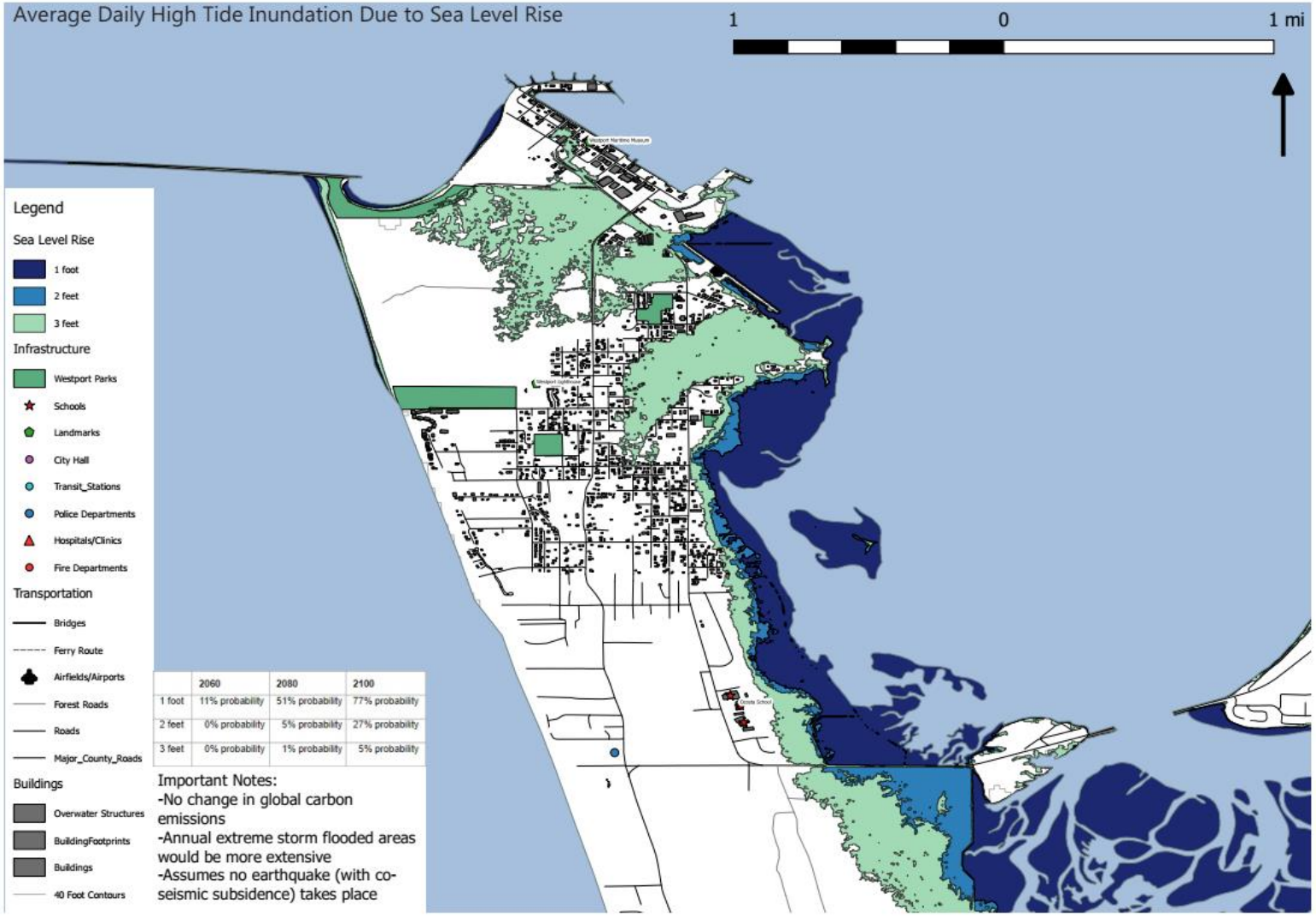

Figure 5. Westport Map of Average Daily High Tide Inundation under Different SLR Scenarios (1-3 feet)

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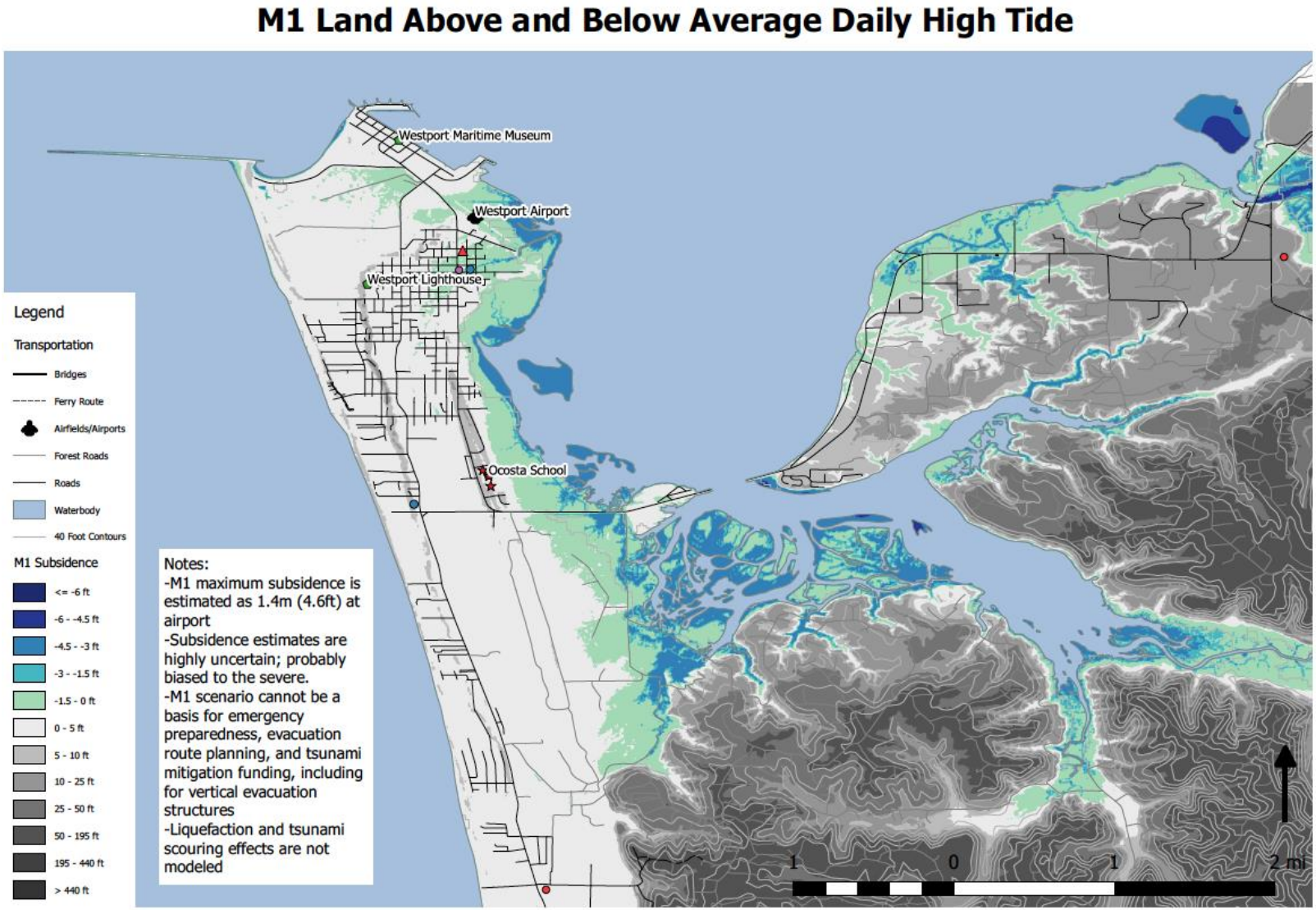

Figure 6. Regional Map Depicting Land Subsidence after an M1 Event

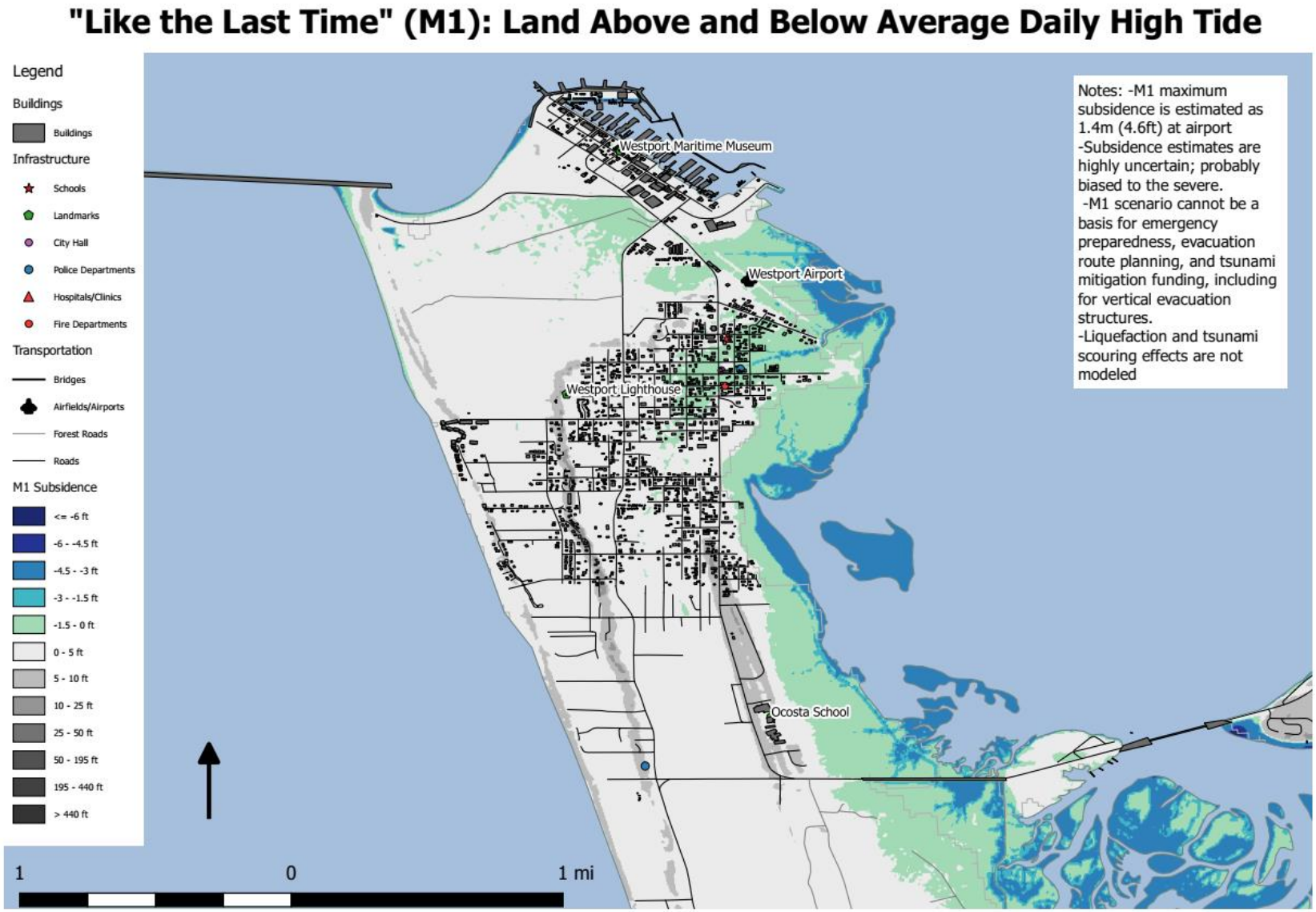

Figure 7. Westport Map Depicting Land Subsidence After an M1 Event

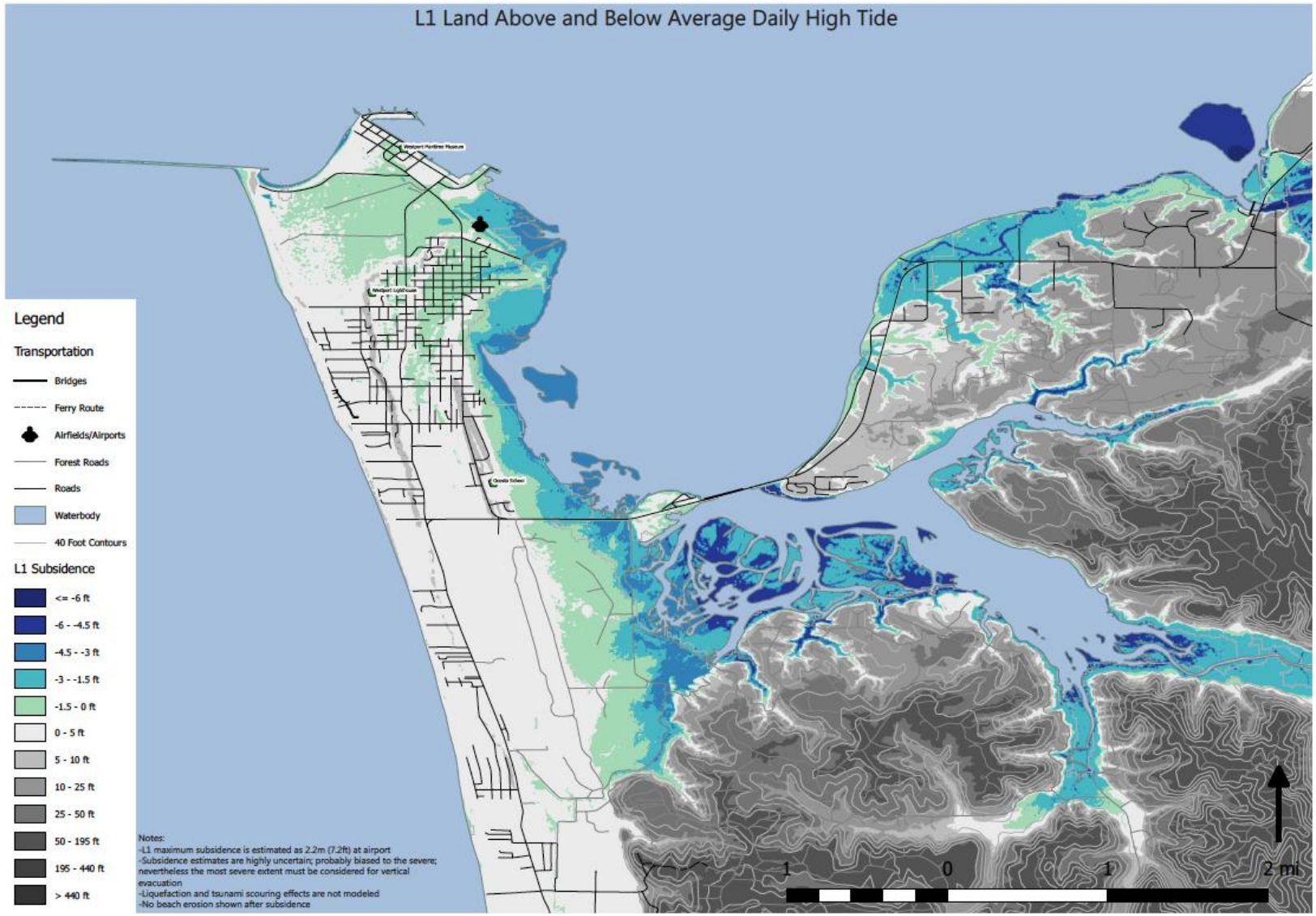

Figure 8. Regional Map Depicting Land Subsidence After an L1 Event

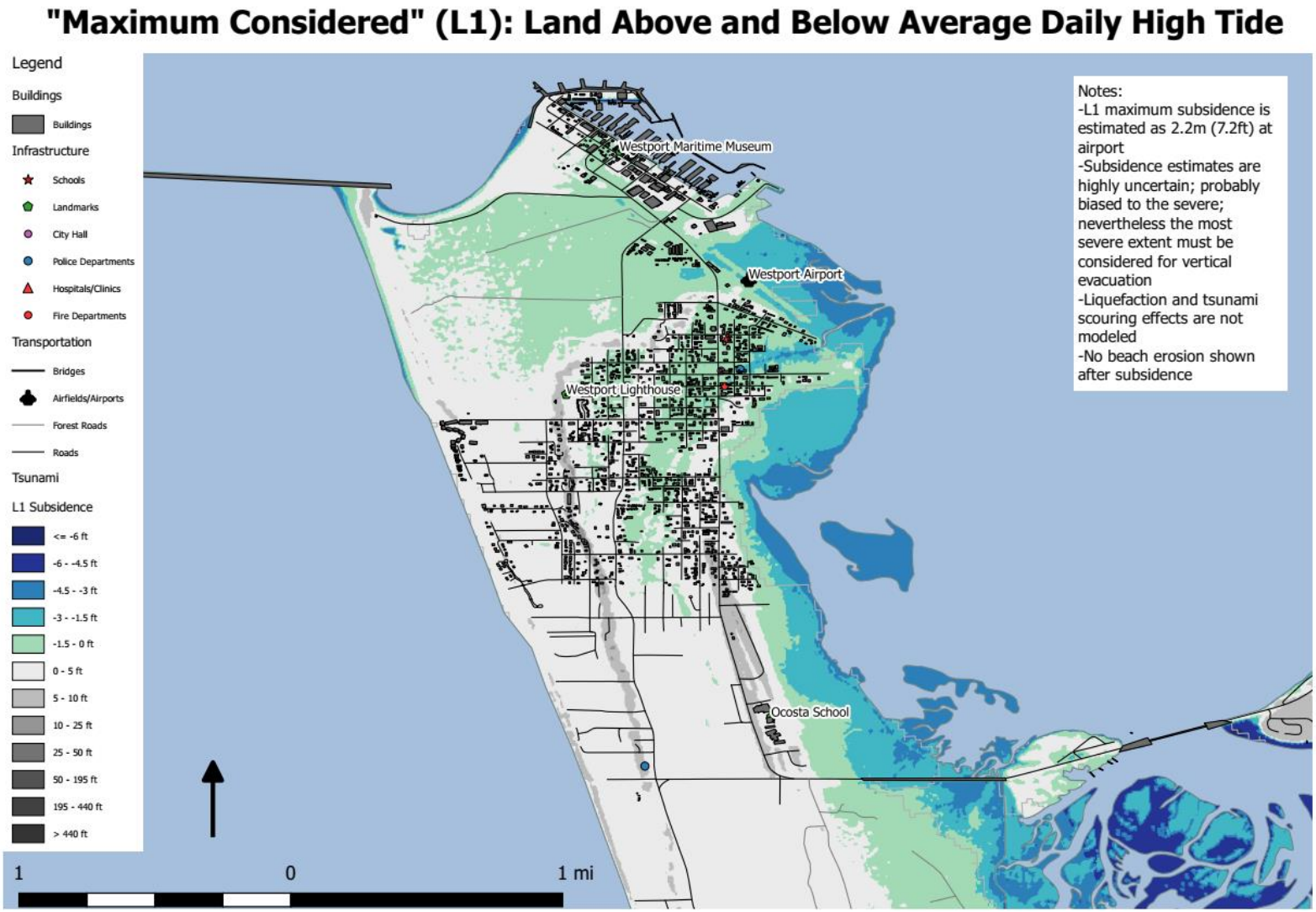

Figure 9. Westport Map Depicting Land Subsidence After an L1 Event

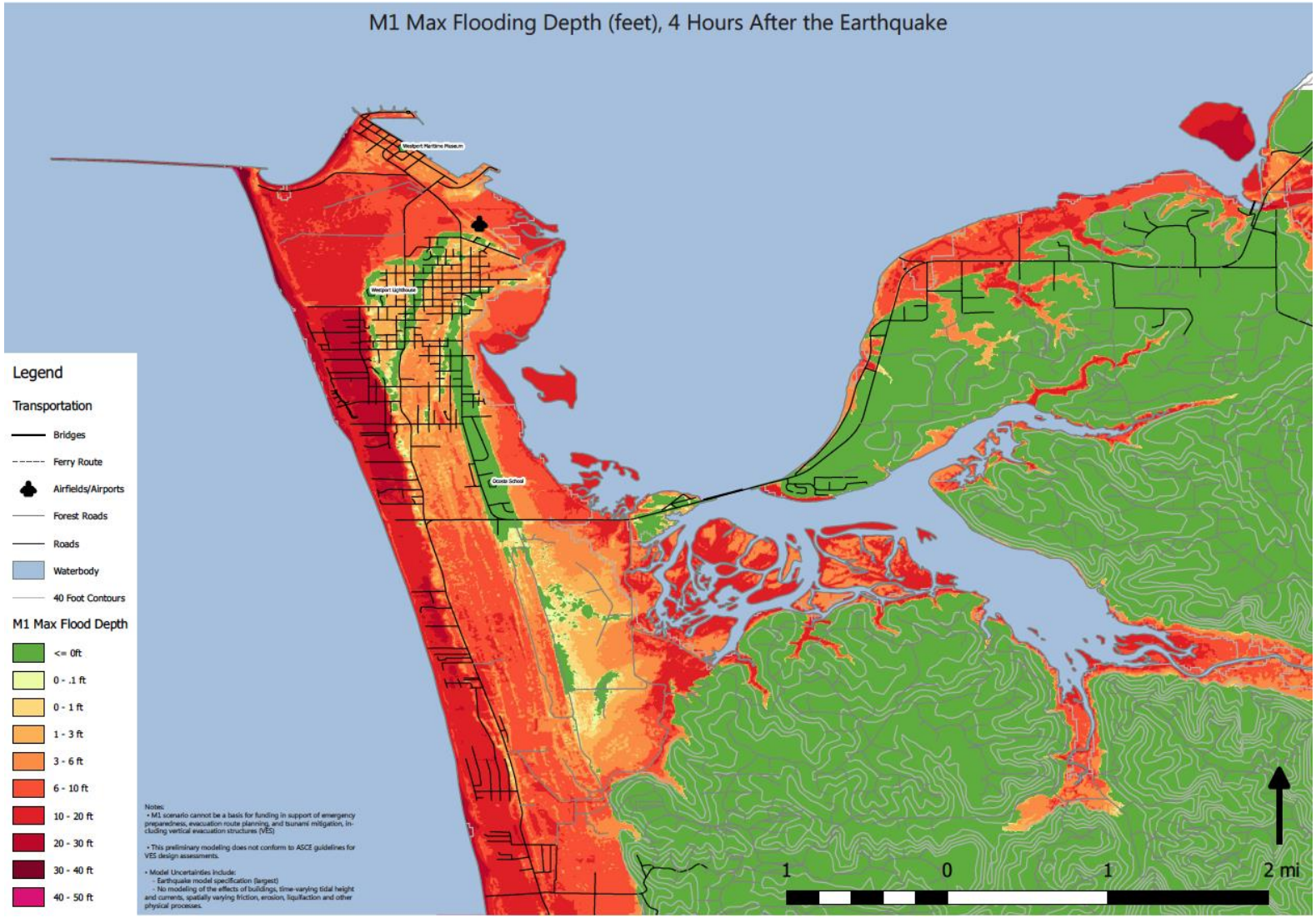

Figure 10. Regional Map Depicting Max Flooding Depth of M1 Event

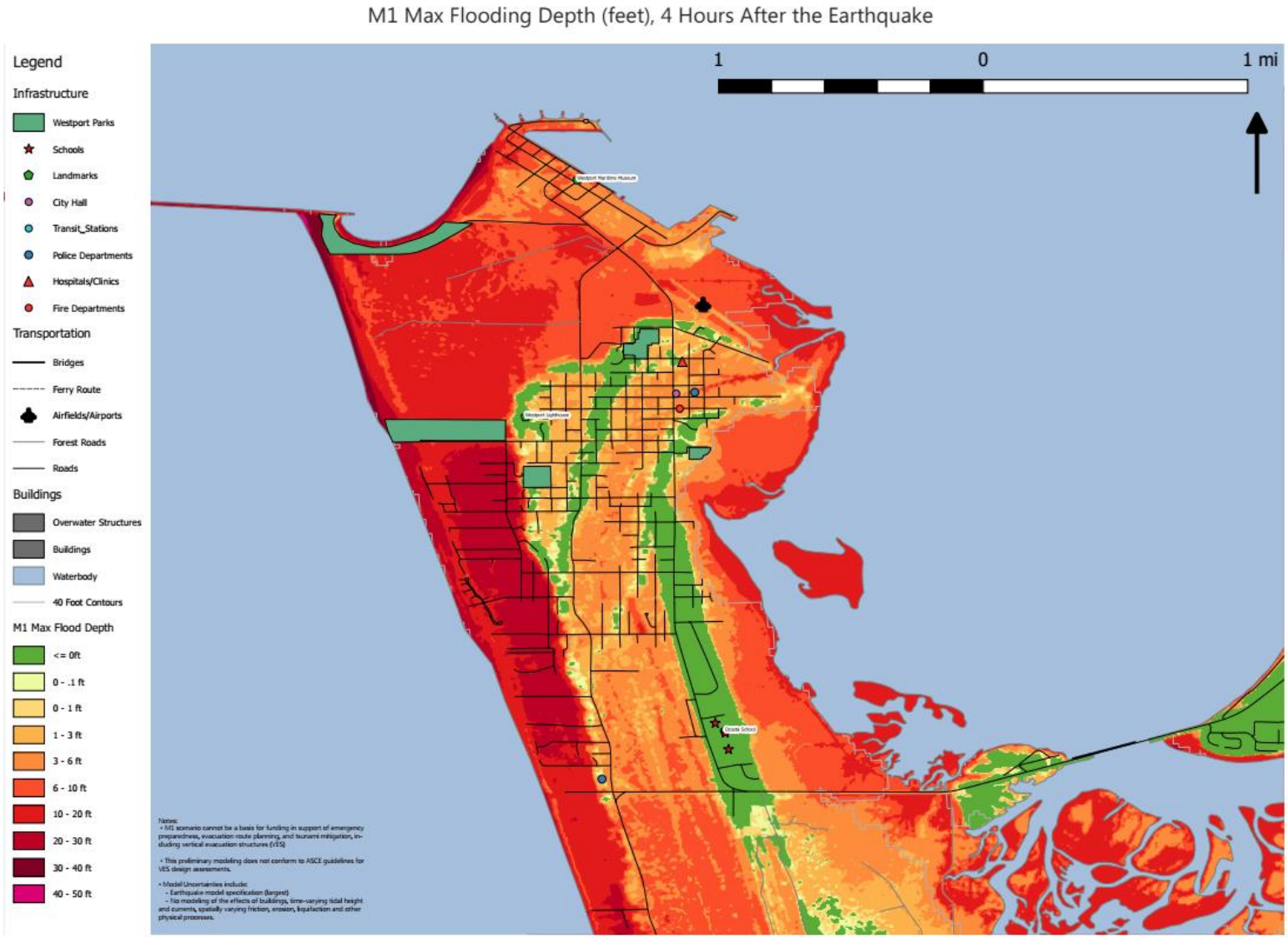

Figure 11. Westport Map Depicting Max Flooding Depth of an M1 Event

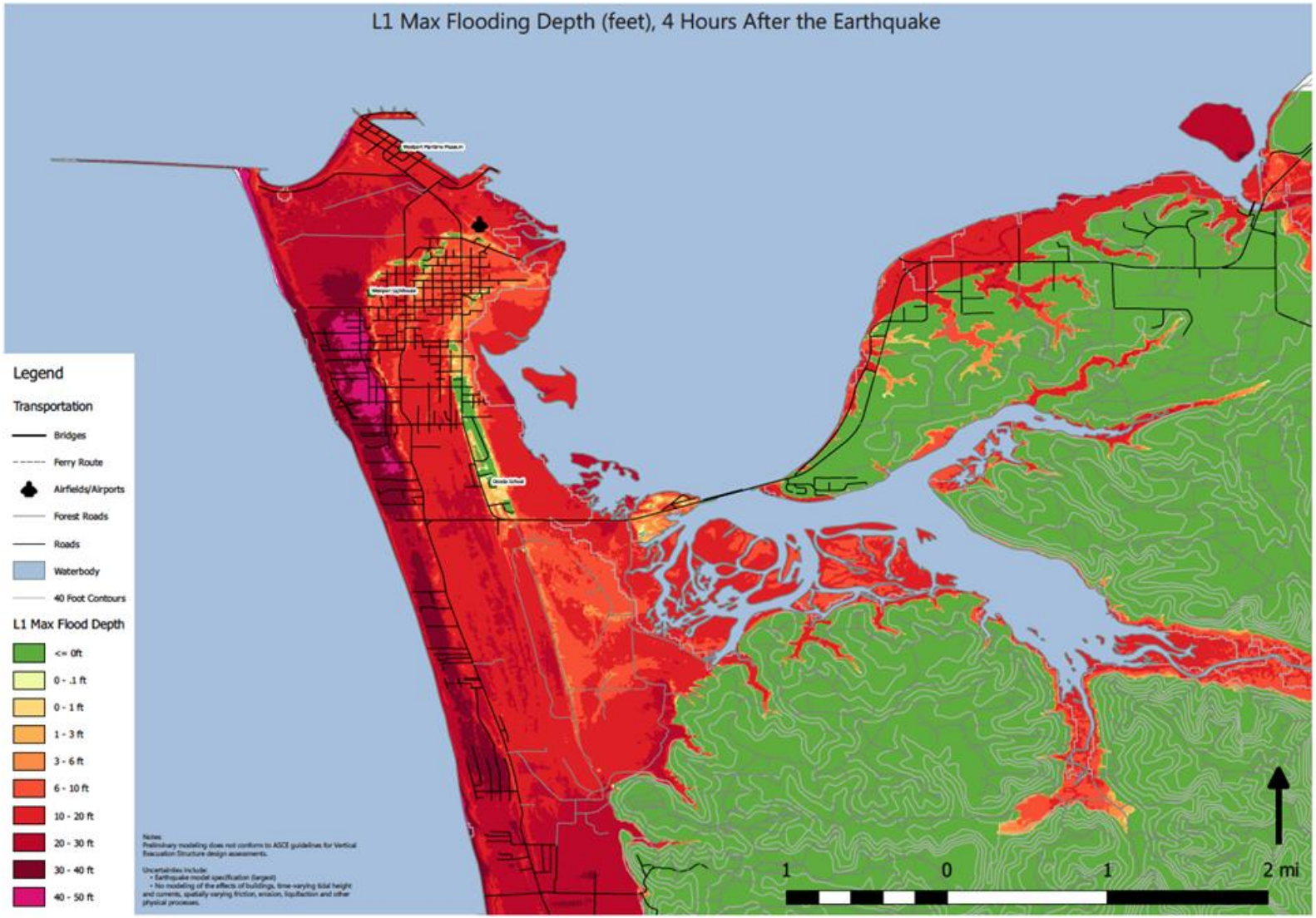

Figure 12. Regional Map Depicting Max Flooding Depth of an L1 Event

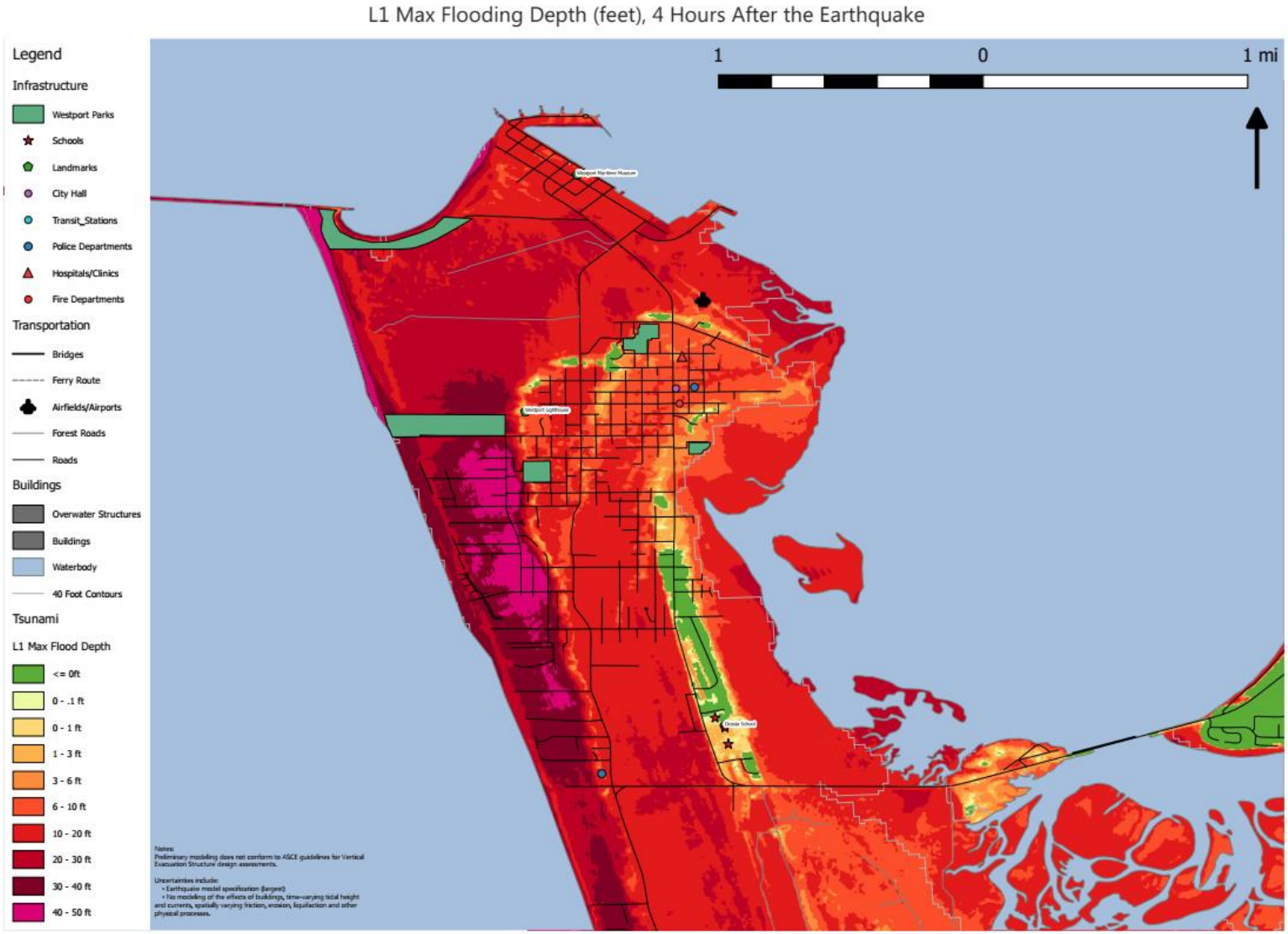

Figure 13. Westport Map Depicting Max Flooding Depth of an L1 Event

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.

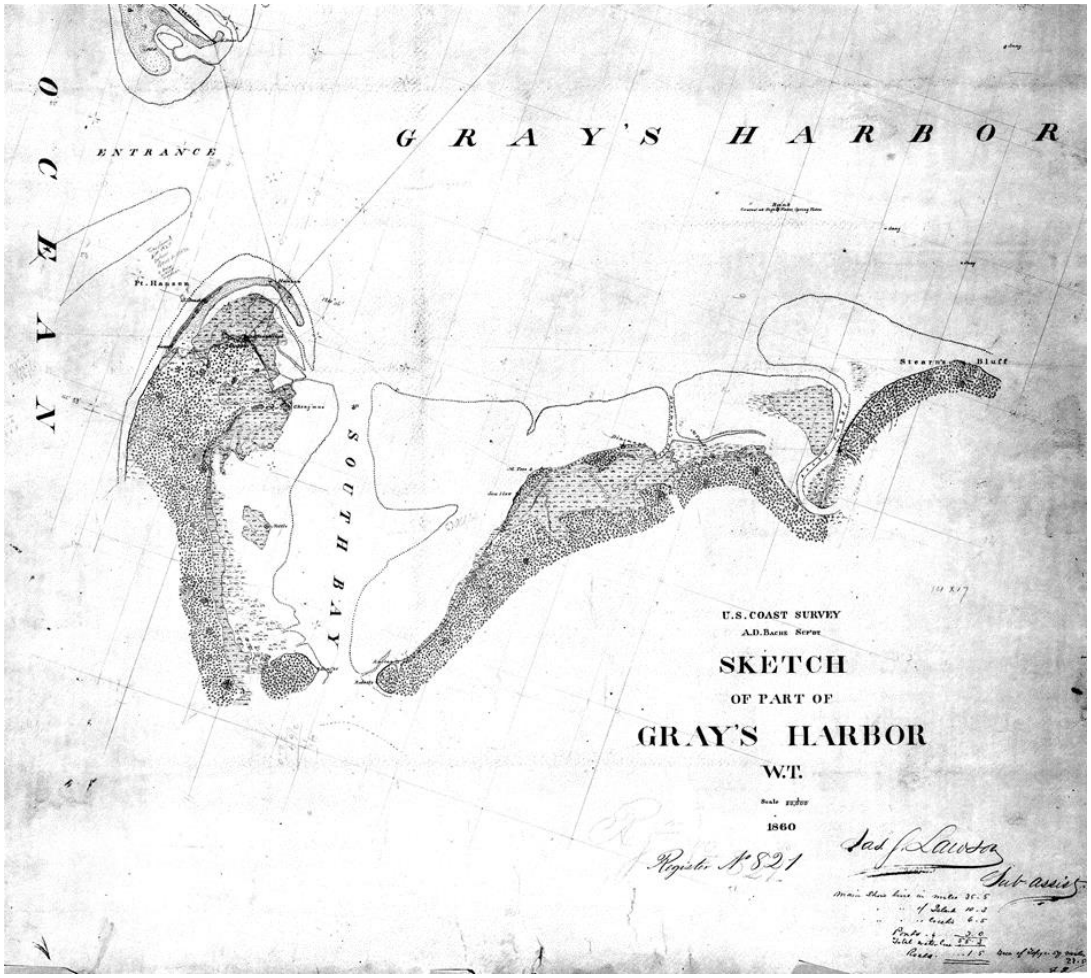

Figure 14. Imagery of Historic Coastline: 1860 Map of the Westport Peninsula and Grays Harbor. Map source:

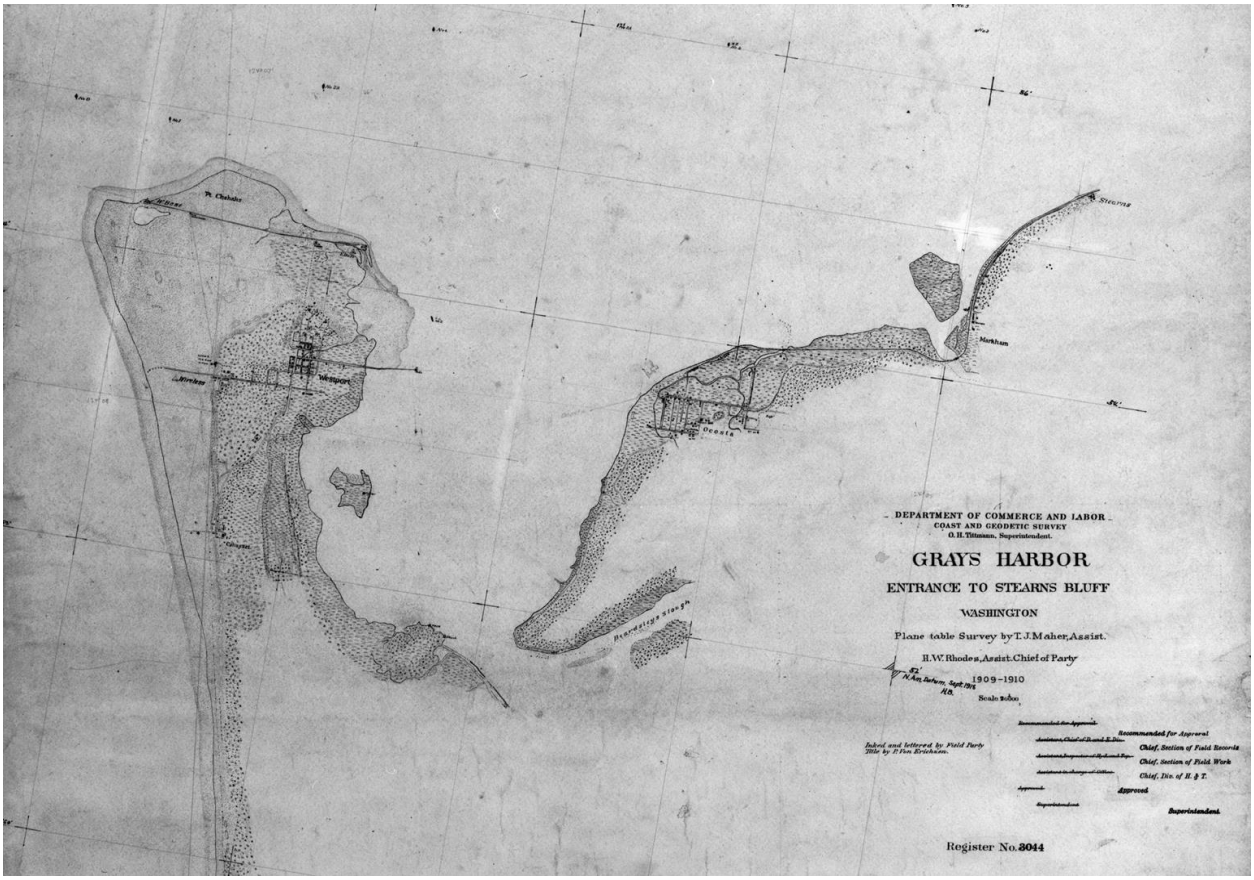

Figure 15. Imagery of Historic Coastline: 1910 Map of the Westport Peninsula and Grays Harbor. Map source:

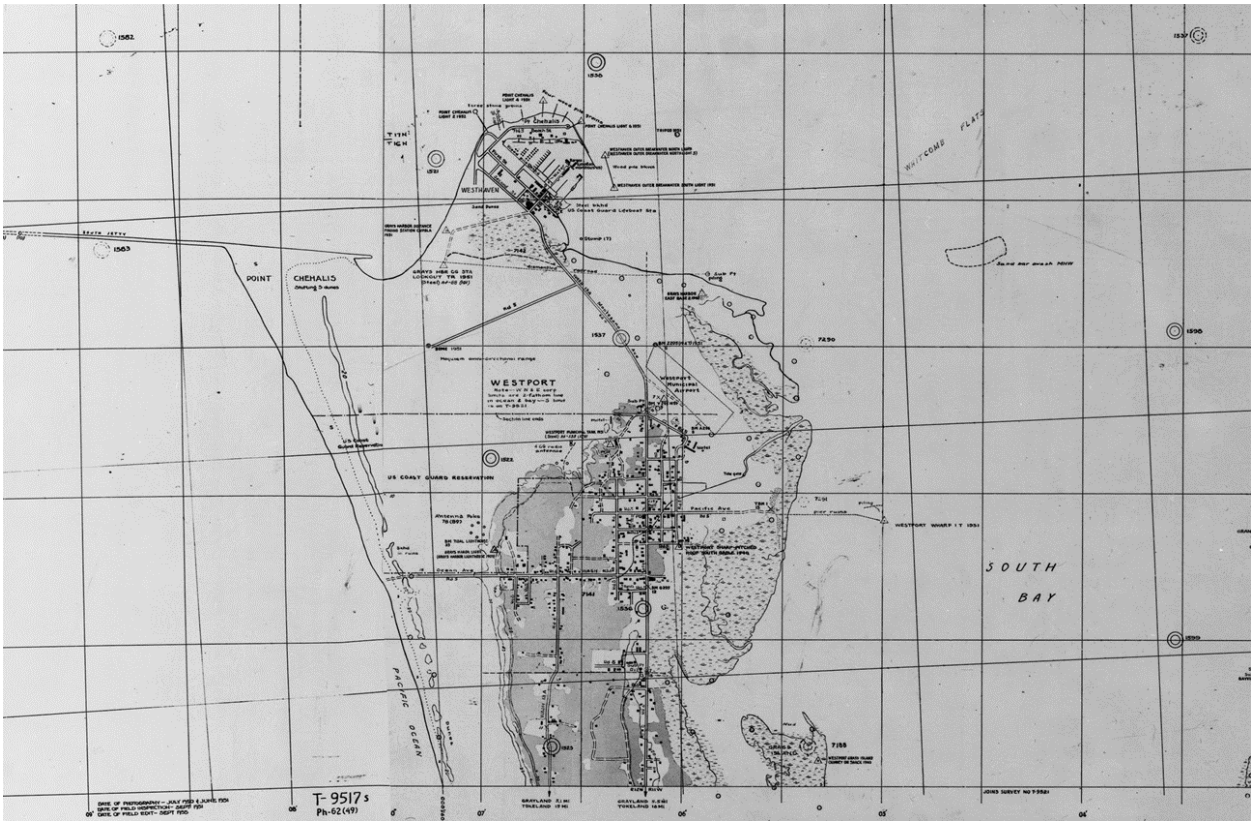

Figure 16. Imagery of Historic Coastline: 1950 Map of the Westport Peninsula and Grays Harbor. Map source:

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 17 17).

Figure 17. 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 18 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.

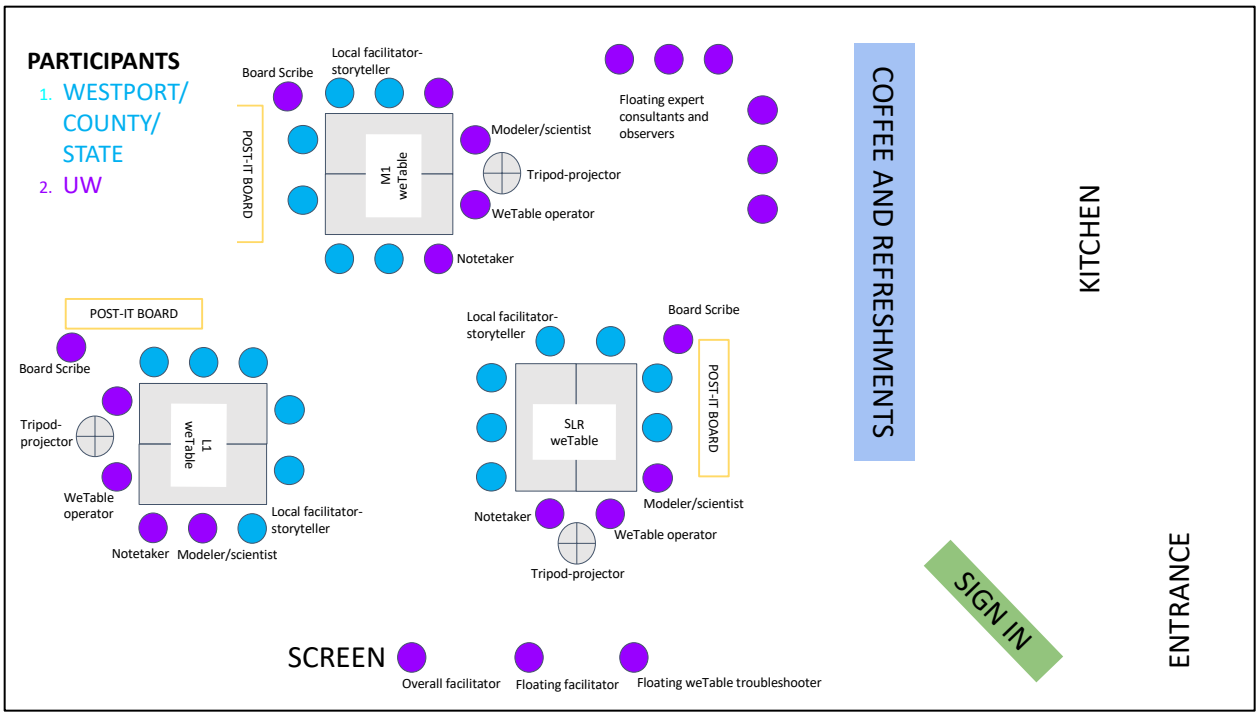

Figure 18. Partners Workshop Room Setup

Table 3 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 3. 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 4. 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

Organization Type	Represented Organizations
	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.

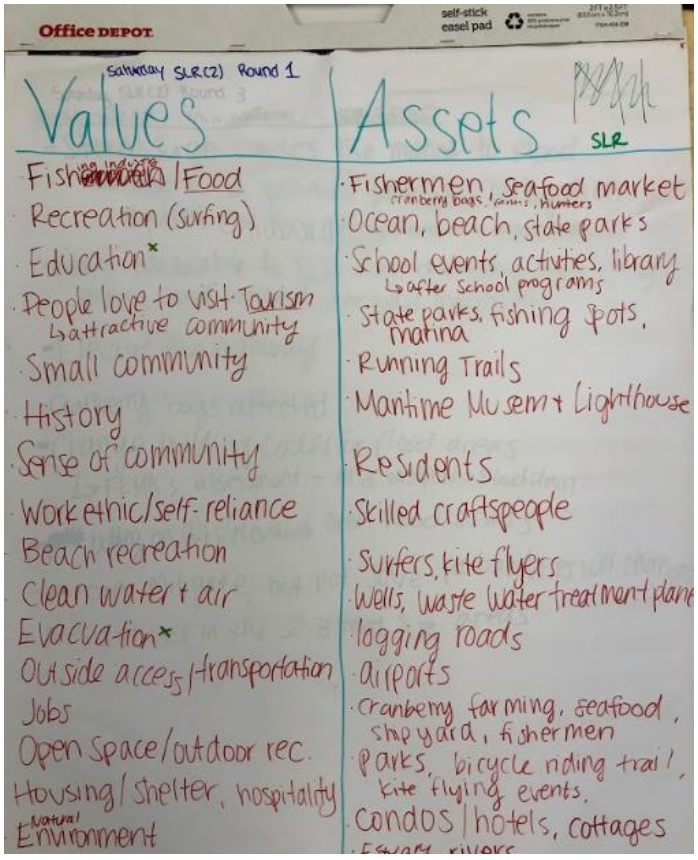

Figure 19. Example Values and Assets Brainstorm

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 5. 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 20. Community Assets Identified by Friday SLR Group - Westport

Figure 21. 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 6. Figures 22 and 23 below include the assets mapped by the M1 group.

Table 6. 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 Center, the Grange Hall, the Rec Hall, and the Grayland Community Center; attractions like the observation tower

Values	Assets
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

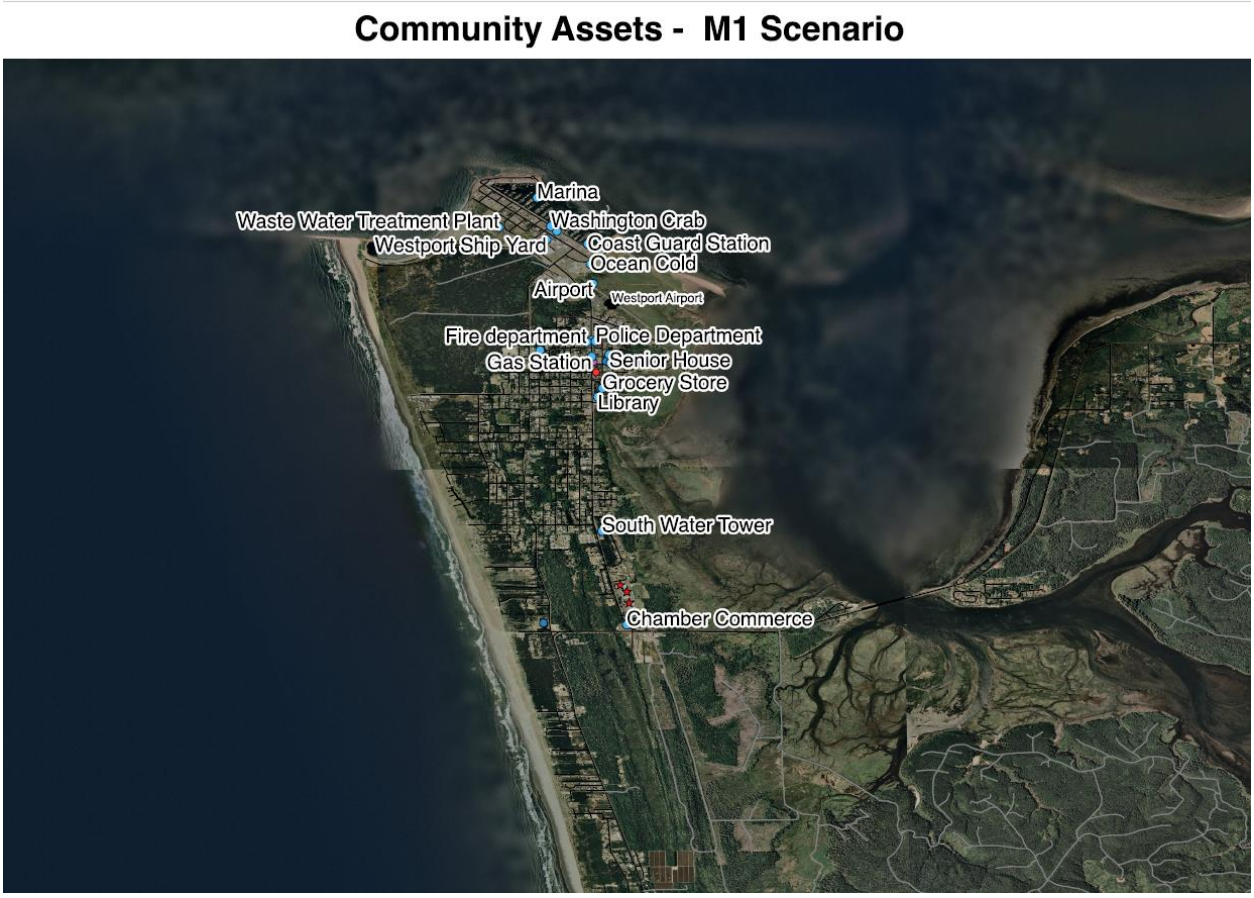

Figure 22. Community Assets Identified by Friday M1 Group - Westport

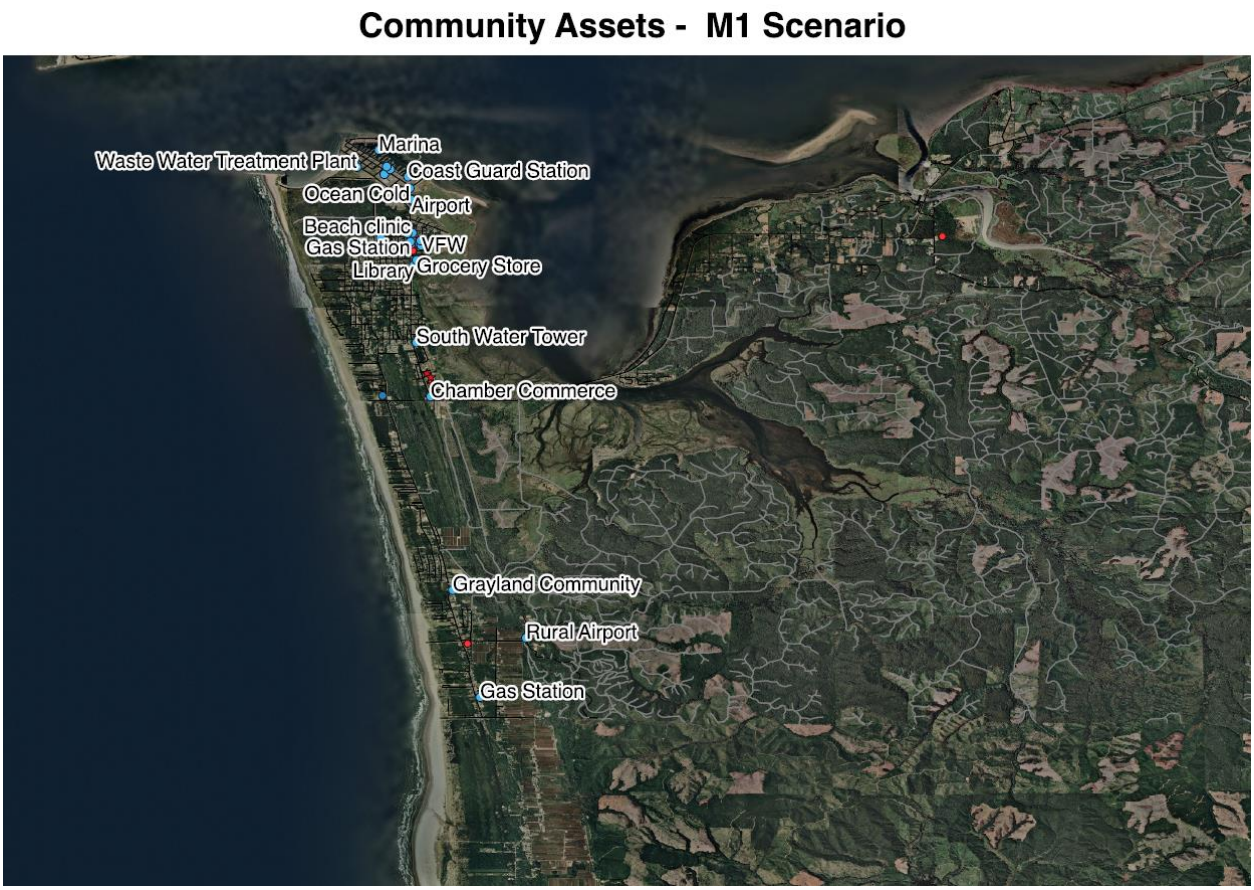

Figure 23. Community Assets Identified by Friday M1 Group - Regional

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 7. Figure 24 below show the assets mapped by the L1 group.

Table 7. 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
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

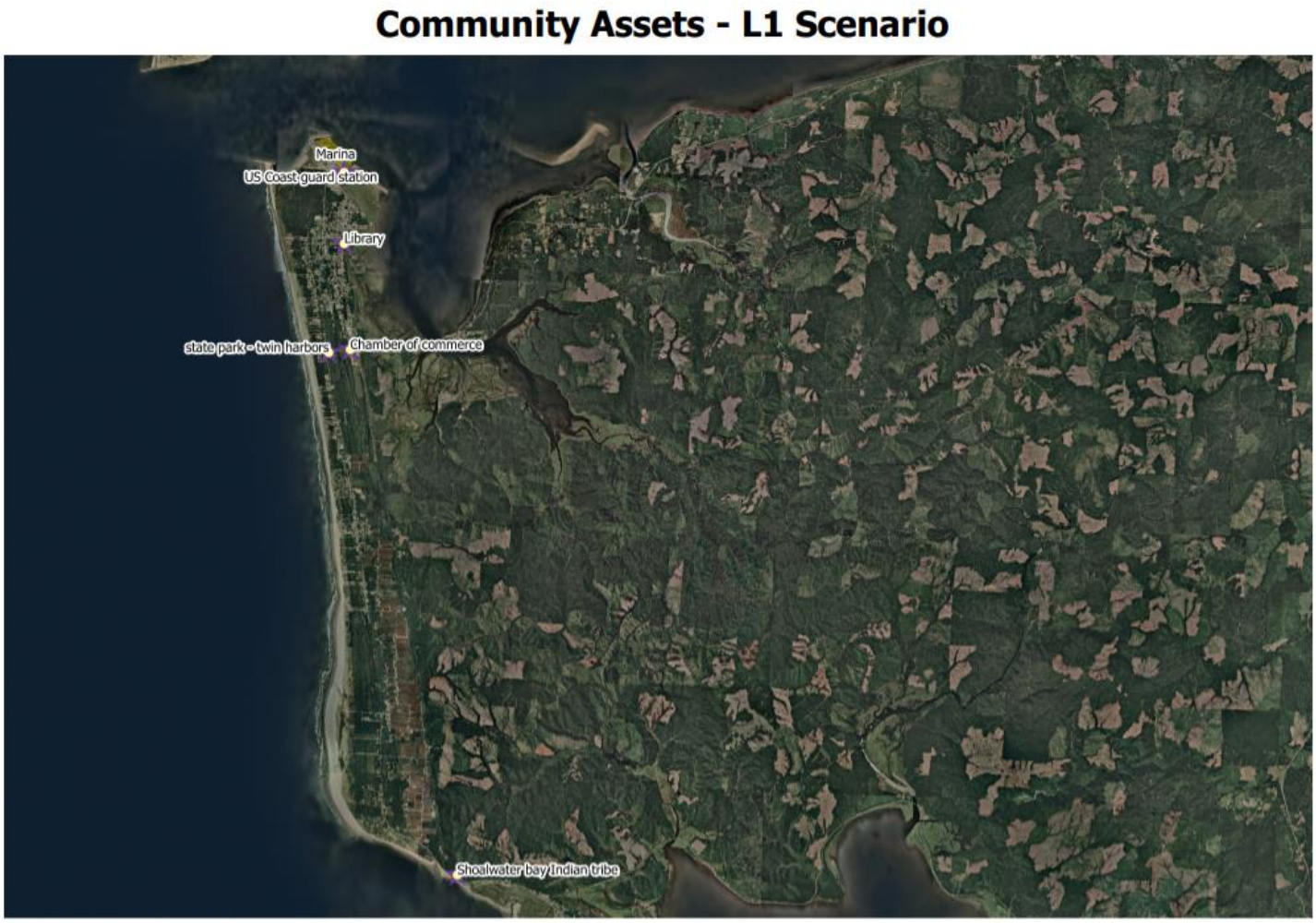

Figure 24. Community Assets Identified by L1 Group - Regional

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.

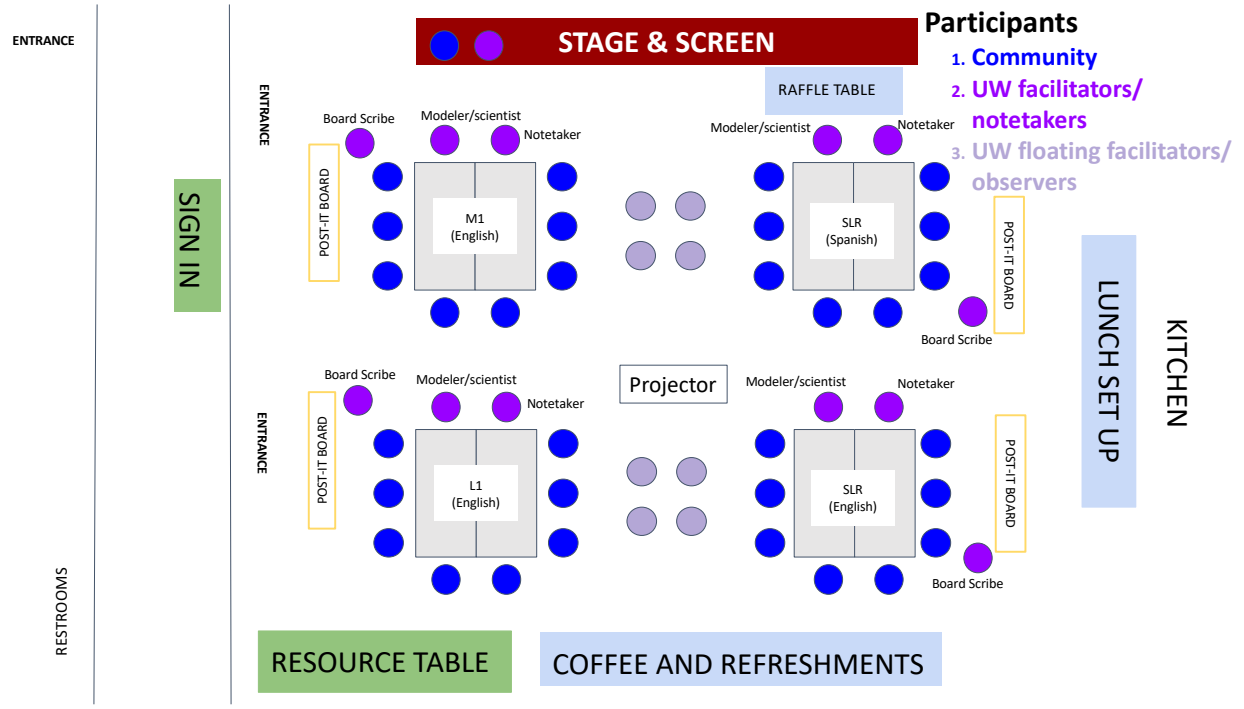

Figure 25. Community Workshop Room Setup

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 8. 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.

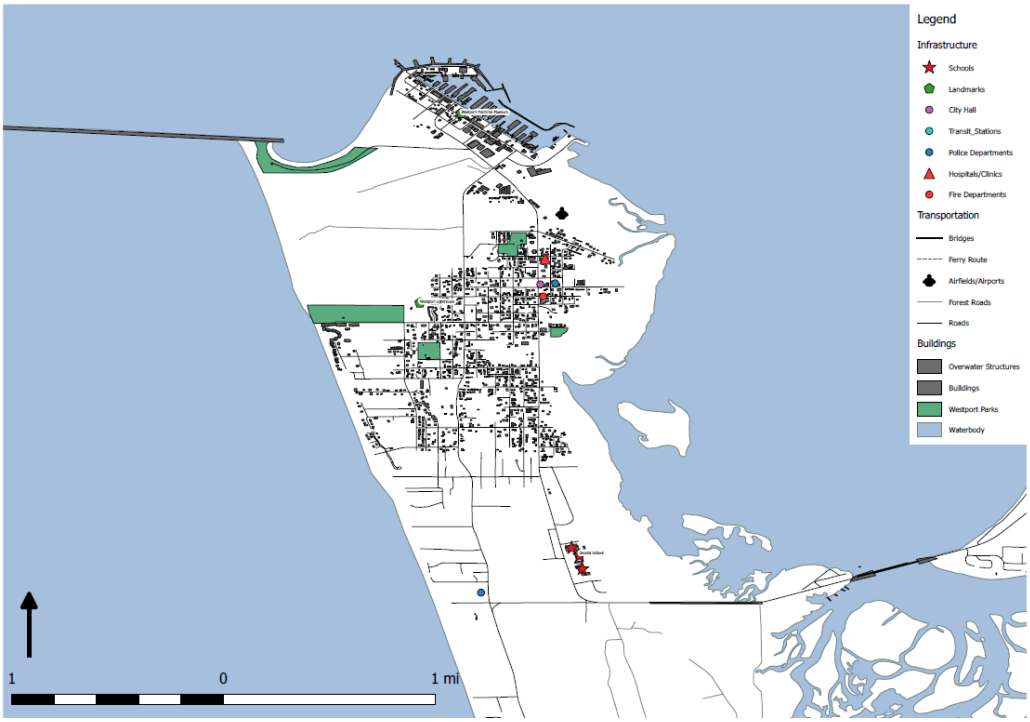

Figure 26. Base Map of Westport Prepared for the Workshop

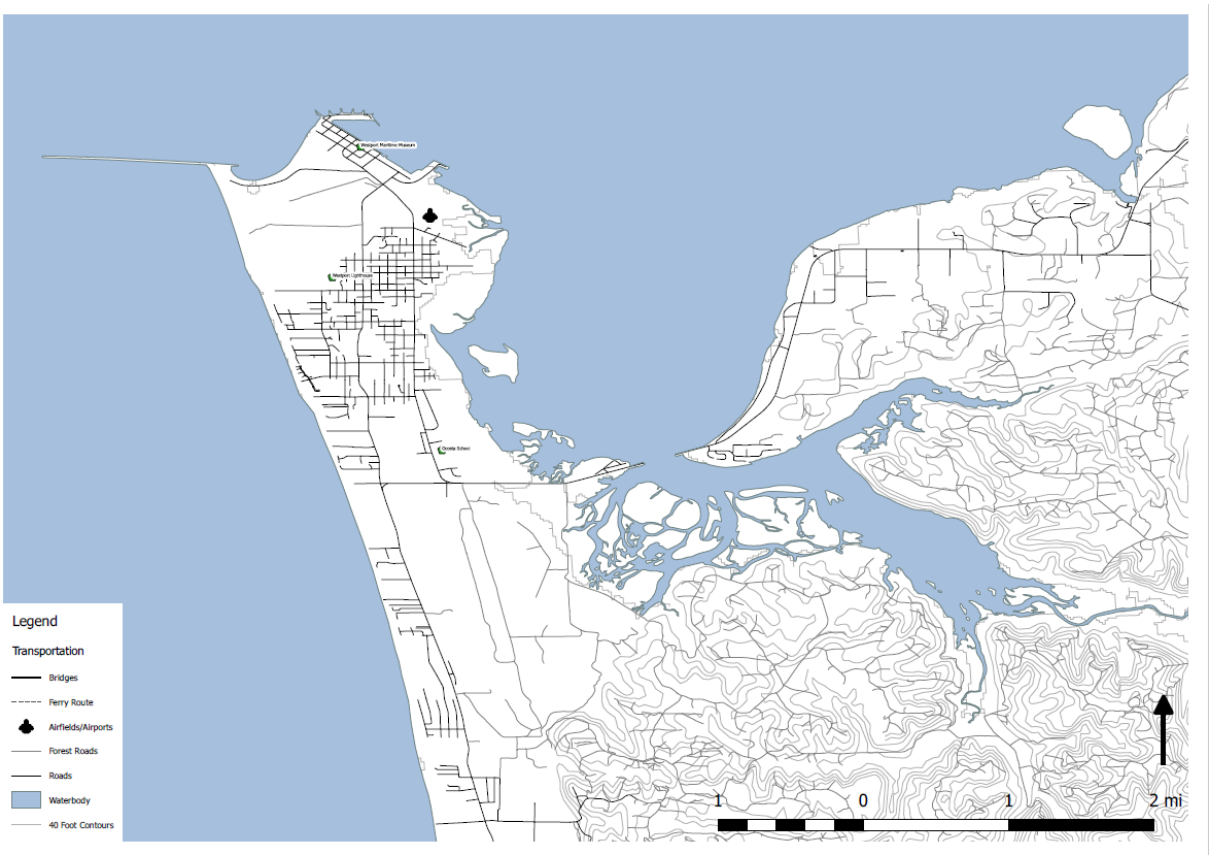

Figure 27. Base Map of the Peninsula Prepared for the Workshop

After the values and assets brainstorm, facilitators shared a video about social capital[3] and a brief presentation on emergency preparedness.[4] 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.[5]

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

[3] Social capital video can be found here:
[4] Emergency preparedness presentation included a video on first aid response, found here:
[5] *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. 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.

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 9. Figures 28 to 31 below show the assets that the SLR group mapped.

Table 9. 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)

Figure 28. Community Assets Identified by Saturday SLR Group 1 - Region

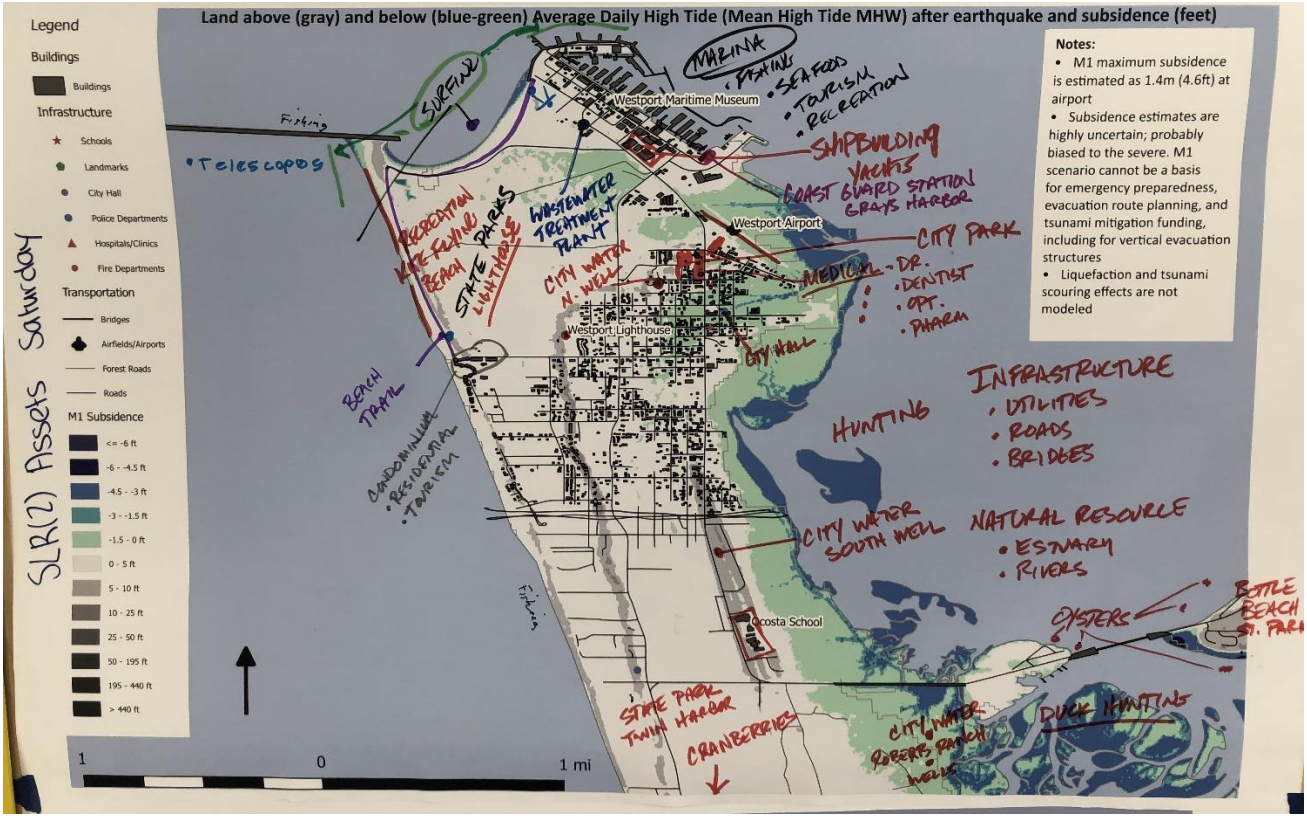

Figure 29. Community Assets Identified by Saturday SLR Group 1 - Westport

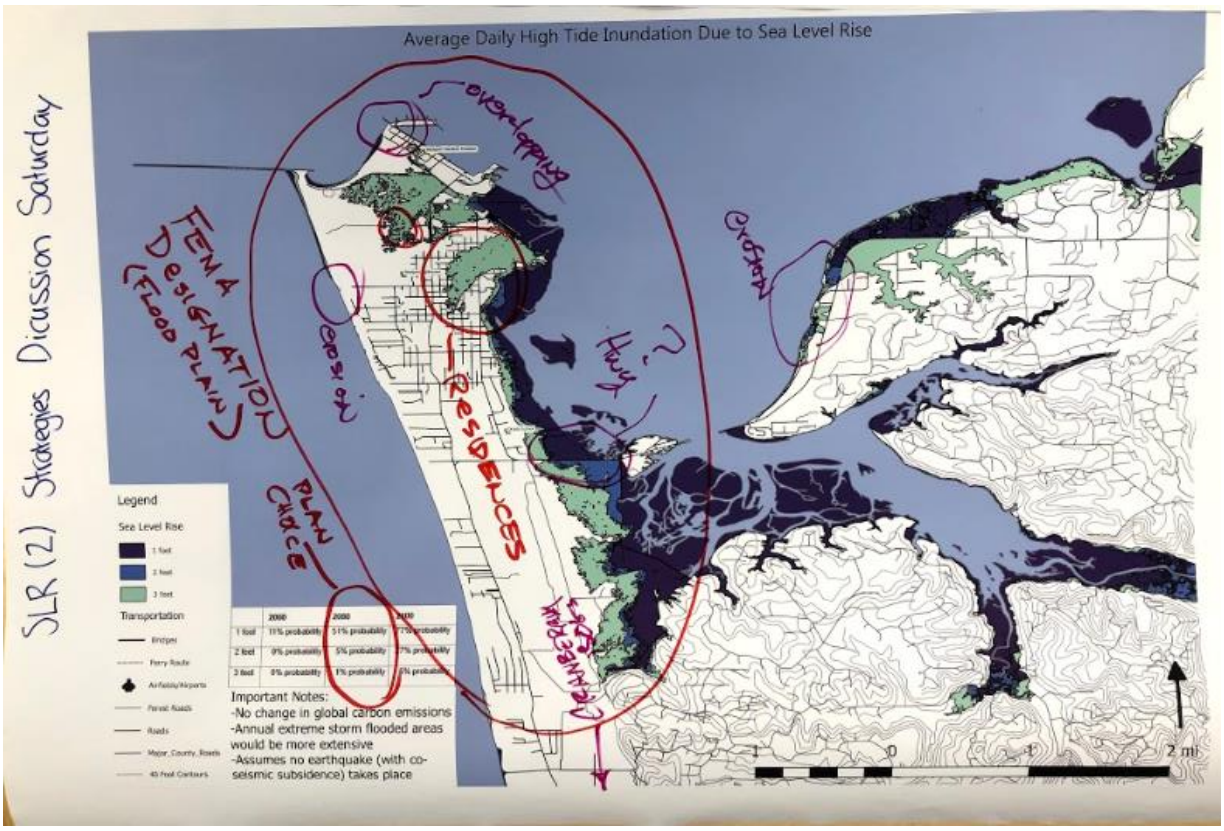

Figure 30. Community Assets Identified by Saturday SLR Group 2 – Region

Figure 31. 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 10. 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 11. Figures 32 and 33 below shows the assets that the group mapped.

Table 11. 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
Historical character and livability of a small town	• Small town is comfortable and livable • Lighthouse, museum, etc.

Values	Assets
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 32. Community Assets Identified by Saturday M1 Group – Westport

Figure 33. 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 12. 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 • 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 13 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 13. 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 34. Community Assets Identified by Saturday L1 Group – Westport

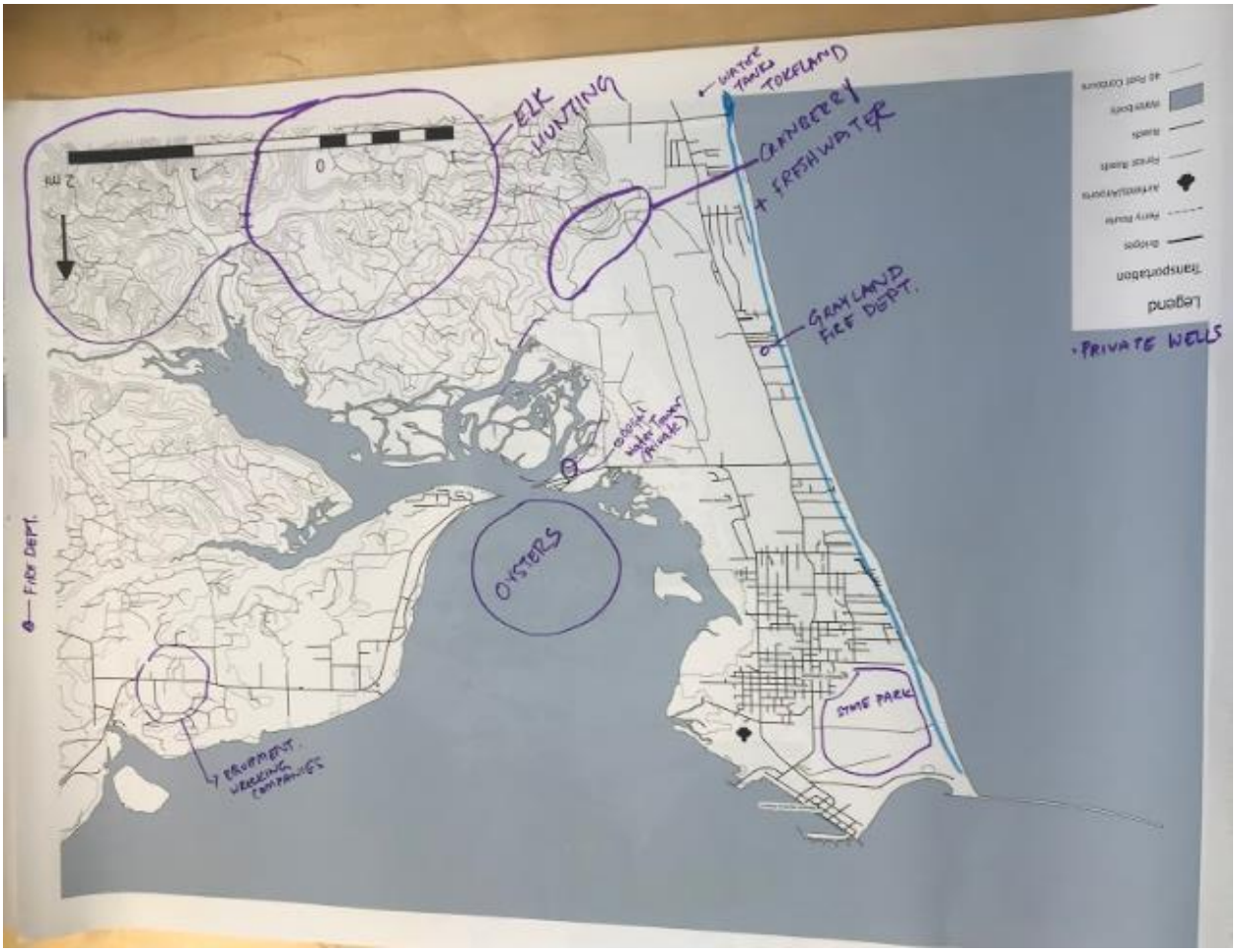

Figure 35. Community Assets Identified by Saturday L1 Group - Region

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

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

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.	

Appendix E

Literature Review

Principles and concepts of Resilience from Literature Review

Concepts	Descriptions	Sample Indicators	Sources	Application and Examples	**Relevance to Westport**
Harmony with Nature	Harmony and consistency between nature and urban forms promote ecological resilience (i.e. bounce-forward model). Ecological design advocates several techniques for maintaining the dynamic of a natural system to enhance resilience. For example, the porosity of urban surfaces could influence the management of water runoff. Similarly, incorporating green infrastructure reduces climatic impacts, particularly from flash floods and urban heat island.	Links between green, blue and gray infrastructure [a] (the degree of design potential to facilitate these links), and alternative and renewable sources of energy (the variety of these sources)	(McHarg, 1969; Smithson, 1974; Waldheim, 2006b)	For Rapid and slow onset events (e.g. coastal flood surges, inland flash flooding, or sea-level rise). The biodegradable mangrove carpets together with the naturalized bioswales maintain the contiguous relationship between the reef, the sea grass, the mangrove ecosystem and the wetlands so as to facilitate adaptations in Tobago (Khirfan and Zhang, 2016)	Coastal flora in the Wetlands continued inland as bioswales and detention ponds, public spaces.
Latency	Latent urban form holds innate design opportunities to cope with uncertainty while accommodating different future uses which are not essentially in use now. It includes pre-emptive urban design strategies that	Predefined room for future functions to be accommodated (clarity between explored and unexplored spaces)	(Anderson, 1978; Moudon, 1986)	For Rapid onset events (e.g. hurricanes) Also, Tsunamis. Adequate street-space for temporary shelters immediately after a disaster in Haiti (Norton, 2013, p. 216)	Flux spaces, alleys, etc.- Under-used spaces, public – open spaces for temporary shelters, Stadium seating to act as an elevated berm, Multi-

	differentiate urban form and its uses from explored to unexplored domains.				storey parking structures
Polyvalent spaces and diversity	Polyvalent spaces and their design highlight the capability of an urban system (e.g. a street or building) to serve diverse uses at the same time. Such design could enhance this potential to increase resilience during and after a disaster.	Capacity to serve diverse functions needed particularly during a disaster (the efficiency and number of these uses)	(Hertzberger, 1991; Roggema et al., 2012)	For Mostly rapid onset events (e.g. storm surges) Also, Tsunamis Diverse uses of Singapore Bay project's landscapes in reducing flood and windstorm impacts (Czerniak, 2007)	Flux spaces
Indeterminacy (or half determinacy)	Indeterminacy leaves a range of possibilities to cope with unknown changes-functional, spatial, and environmental-over time. Most importantly, it prescribes several design strategies to control the changes that might involve partial or full physical adjustments of urban form.	Distinction between determined and not-determined components of urban form (the degree of clarity in terms of design)	(Habraken, 1972; Kendall and Teicher, 2000; Lynch, 1981)	Slow onset events (e.g. sea-level rise) Rapid and slow onset events (e.g. coastal flood surges, inland flash flooding, or sea-level rise)	Coastal Residential areas to be converted to Wetland Resort in the future, Forest Resort to be converted to residential area in the future , elevated trails for walking and biking, new city hall with shopping, public square and proximity to emergency services?
Heterogeneity	Heterogeneity separates different components of urban form into different parts and spreads out risk across time and space. The degree of heterogeneity offers varieties within a given urban system that	Hierarchies of urban forms according to their life-time and spatial positions (the clarity of these Classifications through design)	(Auld, 2008; Cadenasso, 2013; Czerniak, 2007)	For Rapid and slow onset events (e.g. flood surges and sea-level rise). Constructing less-durable urban form in vulnerable prone areas in accordance with the area's risk (Hallegatte, 2009)	Collapsible, cheaper structures near/on the beach. Mixed Use spaces. Lowest floors of structures to be transparent with sudden flooding to

	potentially include multiple scopes to deal with uncertainty.				maintain structural integrity, Temporal heterogeneity in development plans for the city.
Modularity	Modularity of an urban system controls and groups different parts and facilitates their change/modification without affecting others. Thus, it enables professionals and communities to retrofit or change only the parts affected by a circumstance.	Clear/virtual clustering of urban form (number and size of each module/cluster and their degree of independence)	(Ahern, 2011; Lister, 2007)	For Mostly slow onset events (e.g. heat waves). Distributed energy sources in Negril (e.g. renewable energy sources in the Rockhouse Hotel) that are independent from the central system ensure uninterrupted energy during emergency (Dhar and Khirfan, 2016b)	New Development in self-sufficient clusters (solar panels/ wind turbines, community gardens/ kitchen garden, deep freezers, access to game.
Connectivity	Well-connected and hierarchical networks of urban infrastructure increase the scopes for future development and facilitate emergency recovery actions, including evacuation planning.	Interplay between streets and blocks (the size/number of blocks or superblocks and number of nodes)	(Allen, 2001; Mehaffy and Salingaros, 2015; Smithson, 1974)	Rapid onset events (e.g. hurricanes). Multiple and redundant street networks to generate many alternatives for recovery and reconstruction (Sharifi and Yamagata, 2014)	Desire lines, Zip-lines, creation of multiple trails, connectivity through buildings and stepped graduation.
Cross-scale interactions		Based on Non-equilibrium model	Lecture		Temporal and spatial scaling of community development plans through multiple visions.
Self – Organization		Based on Non-equilibrium model	Lecture		
Feedback		Based on Non-equilibrium model	Lecture		

Mitigation		Based on Equilibrium model	Lecture		
Diversity			Quigley, Blair, Davison, 2018	functional diversity in terms of general adaptability over time (adaptive capacity); response diversity in terms of adaptation after a disaster or event	*(Similar to principles of Latency)*
Social Capital			Quigley, Blair, Davison, 2018	How urban morphology affects capacity to respond to change; ability for collective action to occur	Use of CBSM in Westport
Innovation			Quigley, Blair, Davison, 2018	Design as innovation; iterative design processes to allow testing of ideas; temporary changes to urban form to test outcomes	Complete streets model testing
Learning			Quigley, Blair, Davison, 2018	adaptive design with experimentation; learning through experience of engagement and collaboration across professional silos and wider stakeholders; emphasis on design process	Can also be implemented through adaptive planning process.
Density, Diversity and Mix	Reduce carbon footprint			Round-the-clock, mixed uses for diversity of users, allowing for low inputs of energy for transportation and logistics	Recreational hub, Civic center

Pedestrians First	Increase sustainability, quality of life, location desirability	Increase sustainability, quality of life, location desirability	Complete streets
Transit Supportive	Reduce car dependency and oil dependency	Mobility hubs, intense corridors, transit-oriented development and design	Complete streets, Shuttle services
Place-Making	Improve neighborhood identity and neighborhood structure	Pedestrian scale, local destinations, population density	Strategic siting of the Vertical evacuation structures
Complete Communities	Reduce carbon footprint	Connectivity, everyday activities within 500m radius	Complete Streets
Integrated Natural Systems	Enhance health of natural systems	Transform development patterns, preserve wetlands, endangered species and natural systems	Green stormwater infrastructures, wetland conservation
Integrated Technical and Industrial Systems	Increase efficiency of city as a system and reduce carbon footprint.	Use waste products from one industry as an input to another	*Not considered for Westport at an industrial scale at this point.* Use of stored rainwater to irrigate public and private gardens.
Local Sources	Become more self-sufficient, decrease costs, improve local economy	"100-mile diet:" sources within 100 miles should be prioritized	Establish a vegetable garden in the city, residential backyard and roof-top kitchen gardens to be encouraged
Redundant and Durable Life Safety and Critical	Key infrastructural and safety systems to withstand event	Design in durability into whole system so one disruption does not result in disruption of another	*Similar to the principle of Modularity.* Self-sufficient vertical evacuation structures

Infrastructure Systems			
Resilient Operations	Reduce servicing costs and environmental footprints	Compact development that relieves stress on municipal services and infrastructure	Improvement of public and private mass transit and pedestrian access, rental and shared vehicle system, green stormwater infrastructure
Engaged Communities	Sum total of individual choices and actions will be sustainable	Raising awareness through community design processes and educational programs	Implementation of CBSM, informing through built environment.

[a] *Green, blue, and grey infrastructure: where both green and blue infrastructure refer to natural and semi-natural landscape elements while grey infrastructure refers to human-made and often engineered elements like roads, dams, and paved areas. Green infrastructure includes bioswales, woodlands, natural grasslands and ecological parks while blue infrastructure includes natural buffer basins or watercourses that link grey and green infrastructure.*

Urban Design Resilience Index – *Dhar and Khirfan, 2016*

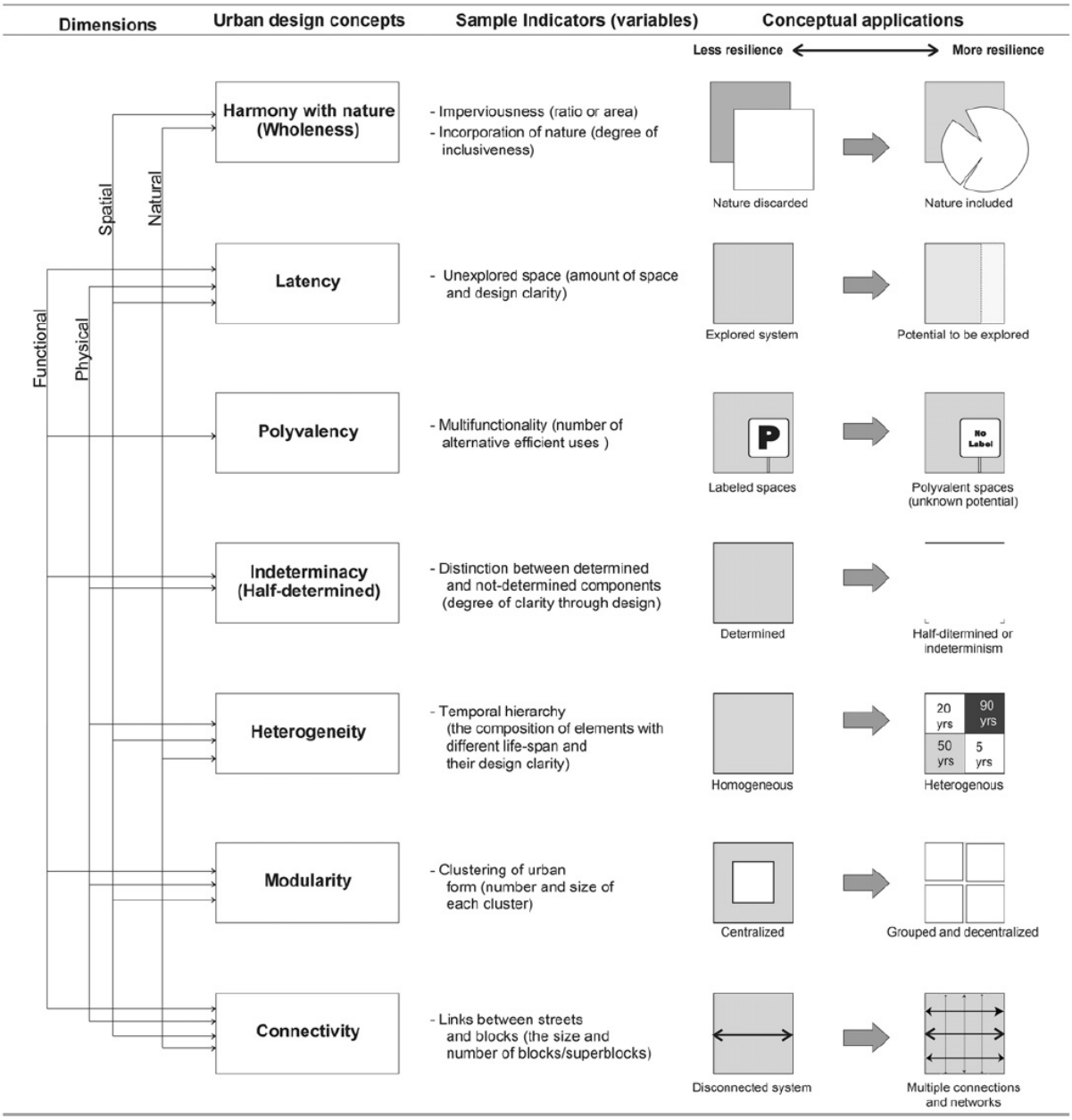

Fig. 6. UDRI's design concepts and sample variables.