

**Incremental Housing as a Strategy to Address Coastal
Hazard-Related Housing Precarity and Vulnerability for Rural
Low-Income Households:
A Case Study in Westport, WA**

Courtney Ross

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Daniel B. Abramson

Gregg Colburn

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University of Washington

Abstract

Incremental Housing as a Strategy to Address Coastal Hazard-Related Housing

Precarity and Vulnerability for Rural Low-Income Households:

A Case Study in Westport, WA

Courtney Ross

Chair of the Supervisory Committee: Daniel B. Abramson

Department of Urban Design and Planning

As the population vulnerable to extreme weather events and climate change impacts, low-income communities are the most in need of affordable, climate change-resilient housing. However, traditional models for affordable housing development often overlook the specific needs of future residents, such as the ability to participate in the process and retain an element of control over their housing – an especially difficult challenge when future changes are unpredictable. This thesis explores an alternative model for affordable housing development, incremental building, and uses the city of Westport, WA as a case study for its application. I argue that an incremental building approach encourages participatory design in the development process, which can be particularly beneficial for low-income housing residents, and offers a more flexible form of development that can adapt more readily to changes in our environment.

Acknowledgments

I would like to thank Dan Abramson for his continued support throughout my time in the Urban Design program and in pursuing this thesis topic, and Gregg Colburn for lending his expertise in the real estate and housing field throughout the development of this thesis. This thesis is the culmination of two quarters of work on the subject, the first of which was conducted during Winter 2021 in the McKinley Futures Studio – Resilient Cities on the Pacific Rim – led by Dan and co-instructor Ken Oshima, who I would also like to thank for his contribution to the development of my thesis topic around incremental building. I'd like to thank Kevin Goodrich, Director of Public Works for the City of Westport, for his participation with our studio and support of my research, as well as multiple students from that studio who I would like to recognize for their contribution to the work in this thesis, including fellow MUP students Cara Donovan, Lauren Stevens, and Cristina Cano-Calhoun who supported and encouraged me throughout both quarters working on this thesis, and Amanda Hosmer, Variell Tertias Limas, and Eina Taguchi whose studio work this thesis references. Additionally, I'd like to acknowledge Ian Miller, who provided guidance on the analysis and interpretation of sea level rise estimates, Frank Gonzalez and Randy LeVeque, who conducted GeoClaw simulations and provided post-processed model products and guidance on their analysis and interpretation, and Cara Donovan, whose thesis is the vehicle for Ian, Frank, and Randy's guidance. Finally, a huge thank you to Jamie Clark and Katie Ross for their unending support, encouragement, and patience throughout my time in the MUP program and in developing this work.

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Preface

This thesis is part of a much larger body of work around resiliency to coastal hazards on the Pacific Rim, especially by the University of Washington and partners in Grays Harbor and Pacific Counties.^(1,2,3) The University of Washington has been engaged with the city of Westport since 2011, including multiple studio courses that supported the city's efforts toward building resiliency for its community – especially in the face of tsunami hazards from a Cascadia Subduction Zone (CSZ) earthquake, for which all communities in Pacific coastal Washington participated in the State's Project Safe Haven tsunami vertical evacuation planning program.⁴ In 2018, the University of Washington partnered with the City of Westport to review its long-term planning goals and provide recommendations for the city's Comprehensive Plan update that would lever its accomplishments in tsunami preparedness to address a wider range of coastal hazards and integrate hazard mitigation planning with everyday land use planning. In 2021, the University of Washington conducted an interdisciplinary studio looking at planning for and designing vertical evacuation structures (VES) and other resources to aid in disaster preparedness, recovery, and aid efforts. As a member of the 2021 studio, I focused on the idea of incremental housing, working with undergraduate architecture and

¹ Daniel Abramson et al., "Coastal Hazard Planning in Time" (NSF Coastlines and People EAGER Award #1940024, 2019).

² Robert Hutchinson and Daniel Abramson, "Dynamic Landscapes: South Beach, Washington" (Architectural League of New York's American Roundtable, December 2020).

³ Daniel Abramson et al., "Localizing Hazard Mitigation: Recommendations for Westport's Comprehensive Plan Update." (Seattle: University of Washington Institute for Hazards Mitigation Planning and Research, 2018).

⁴ "Safe Haven Vertical Evacuation Washington Coast Plans" (Washington Emergency Management, 2012 2009), <http://www.facebook.com/ProjectSafeHaven>".

landscape architecture students and graduate urban planning students to envision how the community of Westport might begin to draw new ties to hazard-safe land through incremental, community-led development in an area just outside what is considered the city of Westport today. This thesis and those of four other Master of Urban Planning students – Cara Donovan, Cristina Cano-Calhoun, Lauren Stevens, and Trajan Coke Smith – represent a continuation of the work started in that 2021 studio.

Chapter 1. Introduction

1.1. Problem Statement and Research Questions

Housing has been shown to be a major driver of social, economic, and health outcomes. Compton et al (2014) note that housing not only fulfills our basic human need for shelter and safety, but it also “provides a place for family and community gathering, it evokes a sense of stability and security, and it provides a sense of identity.”⁵ For low-income communities in the United States, housing affordability, security, and quality has been a perpetual issue – home ownership is unattainable for many low-income households which can have cascading consequences because real estate investment is one of the primary ways of building intergenerational wealth in the U.S. Within the U.S.’s traditional housing market structure, too-high down payment and mortgage costs prevent many low-income individuals and households from purchasing their first home. Home values and sale prices are too high and thus the down payment requirement (typically around 20%) and subsequent mortgage payments are out of reach.

Unfortunately, climate change will likely exacerbate these concerns in the not-too-distant future. It is widely understood that climate change and natural disasters disproportionately impact marginalized populations around the world, a phenomenon often referred to as the “climate gap.”⁶ Similar to housing, the impacts of climate change

⁵ Michael T. Compton and Ruth S. Shim, “Poor Housing Quality and Housing Instability,” in *The Social Determinants of Mental Health* (Washington, D.C., UNITED STATES: American Psychiatric Publishing, 2014), 171.

⁶ Seth B. Shonkoff et al., “The Climate Gap: Environmental Health and Equity Implications of Climate Change and Mitigation Policies in California—a Review of the Literature,” *Climatic Change* 109, no. 1 (December 1, 2011): 485–503.

and environmental hazards on poor communities are complex and interlinked, and include physical, economic, and social threats. The World Bank (2010) estimates that poor communities will bear 75% - 80% of the costs of climate change hazards, and Casillas and Kammen (2012) note that rural agricultural workers and other natural resource extraction workers, whose livelihoods are dependent on environmental conditions, will likely feel the greatest impacts.^(7, 8) For rural coastal low-income communities like Westport-South Beach, which is the focus of this thesis, physical threats may include flooding due to sea level rise (SLR), storms, tsunamis, and changing precipitation patterns. Within this category, it is particularly important to consider how natural disasters and changing environmental conditions will physically alter land availability and accessibility in the long-term, and the implications those changes have for how we as a society think about the built environment and development. Economic threats are linked to agricultural and natural resource extraction industries like industrial fishing and shellfish farming commonly located in coastal communities, and social threats relate to a community's access to disaster preparedness and recovery resources and aid.⁹ According to a Bureau of Labor Statistics' May 2019 survey, workers in the farming, fishing, and forestry industries earn just over \$28,000 annually, almost 10% below the national median income.¹⁰ Climate change will likely destabilize these industries which will have downstream impacts on the financial security of their workers. Further, these

⁷ "World Development Report 2010: Development and Climate Change" (Washington, DC: World Bank, 2010).

⁸ Christian E Casillas and Daniel M. Kammen, "Quantifying the Social Equity of Carbon Mitigation Strategies," *Climate Policy* 12, no. 6 (2012): 609–703, <https://doi.org/10.1080/14693062.2012.669097>.

⁹ Hutchinson and Abramson, "Dynamic Landscapes: South Beach, Washington."

¹⁰ "Support Activities for Crop Production - May 2019 OES Industry-Specific Occupational Employment and Wage Estimates" (Bureau of Labor Statistics, May 2019).

populations face physical threats to their housing independent of economic factors due to the undesirable and vulnerable location, quality, and condition of many low-income housing options.

It follows, then, that sustainable and hazard-resilient affordable housing stands to offer substantial benefits to low-income groups, particularly those likely to experience natural disasters. For coastal communities, projected environmental hazards may create a desire or need to develop new housing options for low-income households as a disaster preparedness and climate change adaptation strategy. Given what we know about the climate gap, new low-income housing strategies should prioritize sustainability and resiliency in design and construction and support intergenerational wealth-building opportunities. Pullen et al. (2009) define sustainable affordable housing as “housing that meets the needs and demands of the present generation without compromising the ability of future generation to meet their housing needs and demands.”¹¹ This definition can be thought of in terms of both the physical structure and financial growth and equity.

Design and construction of the housing unit have implications on both the structure itself and its inhabitants. As of 2018, the building and construction sector was estimated to have contributed 36% and 39% of final energy use and energy-related CO² emissions, respectively, globally. Of those total energy use and emissions shares, residential buildings alone accounted for 22% and 17% respectively.¹² By reducing the building

¹¹ S.F. Pullen et al., “Conceptualising Affordable and Sustainable Housing: Towards a Working Model to Guide Planning and Construction,” 2009.

¹² “2019 Global Status Report for Buildings and Construction” (Global Alliance for Buildings and Construction, 2019).

and construction sector's contribution to global carbon emissions through sustainable design and construction, climate change impacts to housing could also decline. Additionally, sustainable design and construction can influence inhabitants' physical and mental health. For instance, Garland et al. (2013) found that residents reported decreased asthma symptoms and asthma-related emergency room visits after living in a building certified by the United States Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) program as compared to their prior (non-LEED) residences.¹³ As temperatures rise, air quality worsens, and sea levels rise, poor communities will not only experience worsened health outcomes, but will also have to bear the costs of mitigating and treating related illnesses, a cost they may struggle to bear. Further, costs related to medical services and energy costs for things like ventilation and building cooling, a figure that has been steadily increasing since 2010, will comprise an increasing proportion of a household's monthly budget.¹⁴

Given traditional housing development models' high financial barrier to entry, it is necessary to consider alternative, less traditional models of housing to meet Pullen et al.'s (2009) definition of sustainable affordable housing and ensure that new affordable housing developments serve the specific needs of each community. Using Westport, Washington as a case study, this thesis will analyze how a new model of housing development—conceptualized around an incremental building approach—can address this housing vulnerability and precarity for low-income populations in rural

¹³ Elizabeth Garland et al., "Impact of LEED-Certified Affordable Housing on Asthma in the South Bronx," *Progress in Community Health Partnerships: Research, Education, and Action* 7, no. 1 (2013): 29–37, <https://doi.org/10.1353/cpr.2013.0010>.

¹⁴ "2019 Global Status Report for Buildings and Construction."

coastal communities. Incremental building requires a shift in thinking around standard architectural and construction processes in the U.S. – it is conceptualized around the idea that structures are meant to continually change and evolve as their users' needs change and evolve. If done well, design and construction of the initial structure and each subsequent expansion or reduction should support further changes in the future. Within the realm of housing, incremental building might also require involvement from residents and the surrounding community, rather than solely professional developers, architects, and/or contractors.

Broadly, this thesis seeks to understand how an incremental building approach to housing development addresses housing vulnerability and precarity for low-income communities, and how planners might apply this approach to the coastal community of Westport-South Beach to address the specific housing conditions at play there. More specifically, it will aim to address the following research questions:

- What are the housing conditions for low-income residents in Westport-South Beach and how are they threatened by sea level rise and other relevant coastal hazards like tsunamis, earthquakes, and seismic land subsidence?
- What non-traditional, alternative housing development models might address housing precarity and vulnerability for rural coastal low-income populations like those in Westport-South Beach?

1.2. Thesis Outline

In this introductory chapter, I have outlined the problem and research questions that I hope to address in subsequent chapters. I also discuss my methodology for conducting this study and limitations I encountered in the process.

In Chapter 2 I introduce the city of Westport, including basic demographic information about the current city's population as well as projected population changes, an analysis of the existing housing market, and an analysis of how three different hazard scenarios could potentially impact housing in the city.

In Chapter 3 I provide a review of the literature in three areas – rural affordable housing, housing and resilience to environmental hazards, and the concept of incremental building. Within the incremental building section, I also introduce a variety of case studies representing modern applications of the concept to affordable housing development. Case studies are divided into three categories – Core Houses, Modular/Pre-Fabricated Building, and Cohousing – though there is overlap in some areas.

In Chapter 4 I discuss an approach to planning for housing development that incorporates hazard projections as well as economic considerations for affordable and resilient housing. Additionally, I offer an argument supporting the application of incremental building to housing development in Westport and demonstrate how it could be applied at the site- and building-level.

In Chapter 5 I provide future opportunities for research into incremental building approaches to affordable housing development such as financing models, project delivery systems, and conceptualizations of housing as a build form. I also offer conclusions I

have drawn from this research.

1.3. Methodology

First, using geospatial data for L1 and M1 earthquake projections and their resulting tsunami projections, sea level rise projections, and property/parcel-level building assessment data, I will analyze the value, condition, quality, typology, and location of residential buildings in the city of Westport that are vulnerable in each hazard scenario. I will also use this data to understand where hazard-safe land might exist and identify potential locations for the development of new housing under different hazard scenarios. For tsunami scenarios, I will use a water level increase of 1 foot as a factor for hazard risk. I have chosen this metric because of the potential damage even 1 foot of tsunami inundation could create – because the typical height above floor level for electrical outlets is between 12 and 18 inches, a 1-foot increase in water levels would impact the electrical systems in most homes, causing major damage and potentially requiring significant repair work to, if not total replacement of, a home’s electrical system. (In fact, the force from a tsunami wave can be very destructive at even 1 foot, so this factor level is quite liberal.) For sea level rise, because wave force is less of a consideration, I will use a 3-foot increase in the water level.

1.4. Limitations

Due to the COVID-19 pandemic, I was unable to spend any significant amount of time with the community in Westport. Given that this study looks at low-income housing, it

would have been beneficial to engage with that community to understand their needs better. Additionally, while this study seeks to understand the range of housing conditions present in Westport-South Beach, it does not represent the condition for seasonal workers or those residents who may be more transient due to their employment. I was unable to find data regarding seasonal employment patterns and locations or seasonal worker-specific housing.

Hazard modeling methodology for the hazards anticipated for Westport and the surrounding area is constantly evolving. In 2018, students at the University of Washington participated in a studio which also looked at tsunami and sea level rise hazards for which they used earlier projections than those used in this thesis. For the purposes of this thesis, I used models from Winter Quarter 2021, but researchers were generating new, more nuanced models throughout Winter and Spring Quarters 2021. New scenarios modeled will incorporate local tide levels and sea level rise into the projected water level for future scenarios of CSZ earthquake events of different magnitudes and probabilities of occurrence.

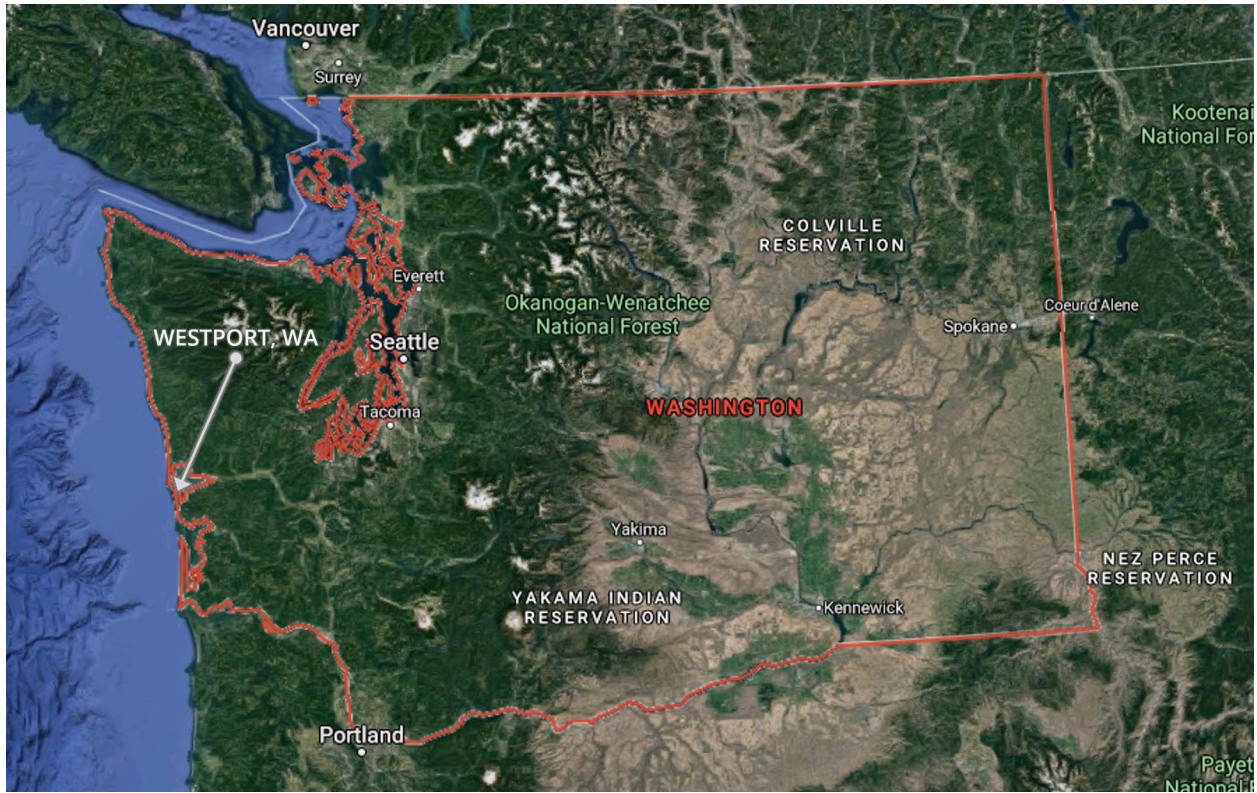


Figure 1: State-Wide Context Map | Source: Google Maps

Chapter 2. Westport, WA as a Case in Planning for Environmental and Economic Risks

2.1. Introduction to Westport

The city of Westport is a low-lying peninsula located in Grays Harbor County on the Pacific coast of Washington. Its history and current day identity are inextricably linked to the dynamic landscape with which it interacts. The Pacific Ocean and inland estuarial bays are critical drivers of Westport's economy which is largely supported by seasonal agricultural work such as industrial fishing, oyster farming, and cranberry farming, and water-related tourism attractions such as surfing and other beach-going activities. Westport's population, which makes up just 2.5% of the larger Grays Harbor County,

can be characterized as lower income, with the median annual household income just over \$42,400 as compared to almost \$63,000 nationally, aging, with 43% of the population over the age of 55, and stagnant.^(15,16,17,18) Within Grays Harbor County, the population is only expected to grow by about 6% by 2030, though it is unknown what proportion of that growth is expected to occur within the city of Westport specifically.¹⁹

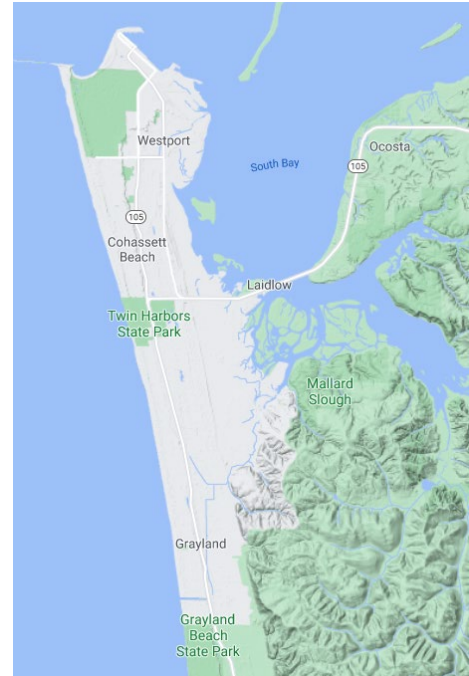


Figure 2: Regional Context Map | Source: Google Maps

Westport’s housing market appears to be static and fairly affordable but in poor condition and of low value, offering limited adequate options for its low-income residents. 46% of residential properties in Westport are valued below \$100,000, as compared to almost \$400,000 in Washington State, and about 66% are valued at \$15 / sqft or less (see Figure 3).^(20,21) Additionally, vacancy rates do not indicate a shortage of housing, with over 45% of units sitting vacant.²² The larger concern

¹⁵ “City of Westport: Age and Sex,” ACS 5-Year Estimates Subject Tables (United States Census Bureau, 2019).

¹⁶ “Grays Harbor County: Age and Sex,” ACS 5-Year Estimates Subject Table (United States Census Bureau, 2019).

¹⁷ “City of Westport: Income in the Past 12 Months (In 2019 Inflation-Adjusted Dollars),” ACS 5-Year Estimates Subject Tables (United States Census Bureau, 2019).

¹⁸ “City of Westport: Age and Sex.”

¹⁹ “Growth Management Act Population Projections for Counties: 2000 to 2030” (Washington State: Office of Financial Management, 2007).

²⁰ Dan Lindgren, “2020 Assessment for 2021 Tax Residential Improvement Characteristics,” Tax Assessment, 2020.

²¹ “Housing Market Snapshot” (Runstad Department of Real Estate: University of Washington, 2019).

²² “City of Westport: Occupancy Status,” ACS 5-Year Estimates Subject Tables (United States Census Bureau, 2019).

for housing in Westport is around the condition, quality, and location of low-income housing and the associated vulnerabilities to environmental hazards such as sea level rise and tsunamis. The average age of single-family homes and manufactured homes is 53 years and 35 years, respectively. Almost 20% of homes in the city are manufactured homes, and there are 10 RV/mobile home parks which, according to Rumbach et al., are more susceptible to the impacts of flooding, and the average condition rating for single-family homes and manufactured homes is 2.6 and 2.67, respectively, on a scale of 1 (low) to 6 (high).^(23,24) Slightly below typical homeownership rates in rural areas, Westport’s homeownership rate is around 62% and, despite the high vacancy rate in the

Table 1: Comparative Area Population and Housing Statistics

	City of Westport, WA	Grays Harbor County, WA
Population	1,817	72,779
Median Age	49.7	44.0
Median Household Income	\$42,439	\$51,240
Housing Units	~1,000	~31,000
Average Age	48 years	81 years
Vacancy Rate	46%	24%
Average Value	\$129,160	-
Average Condition	3.10	3.07
Average Quality	2.61	2.71

Source: US Census Bureau & Grays Harbor County Tax Assessor’s Office

²³ Andrew Rumbach, Esther Sullivan, and Carrie Makarewicz, “Mobile Home Parks and Disasters: Understanding Risk to the Third Housing Type in the United States,” *Natural Hazards Review* 21, no. 2 (May 1, 2020): 05020001, [https://doi.org/10.1061/\(ASCE\)NH.1527-6996.0000357](https://doi.org/10.1061/(ASCE)NH.1527-6996.0000357).

²⁴ Lindgren, “2020 Assessment for 2021 Tax Residential Improvement Characteristics.”

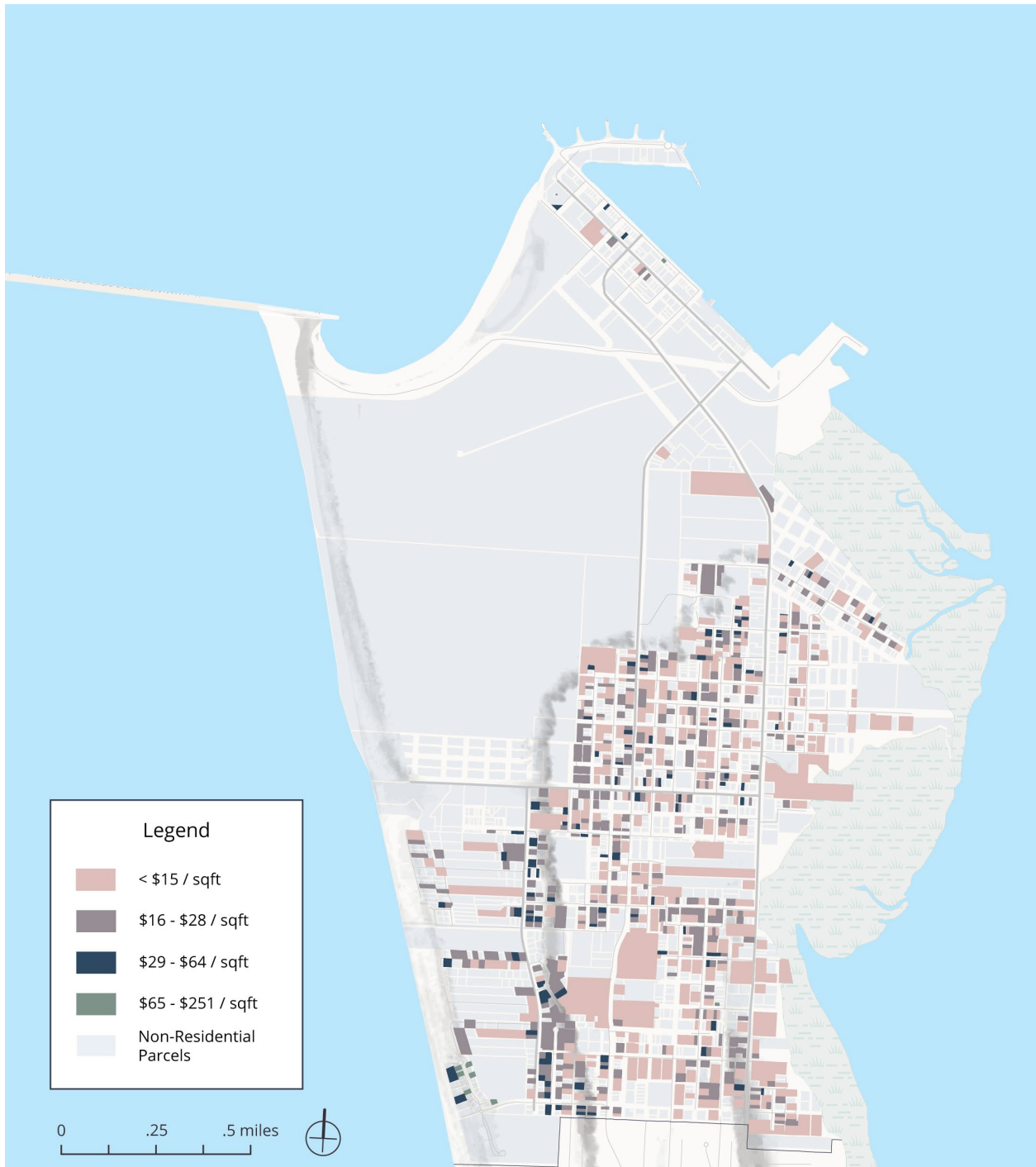


Figure 3: Residential Property Values | Source: Grays Harbor County Assessor's Office

area, some people still experience homelessness and housing instability challenges.²⁵ According to the Washington State Department of Social and Health Services, as of 2018, there were 2,055 homeless individuals in Grays Harbor County at large, 873 were literally homeless and 1,177 were unstably housed/couch surfing. Grays Harbor County is investing in systems and structures to address homelessness in the county through four primary modes – system support, emergency shelter, homelessness prevention, and rapid rehousing. The county has a goal to provide 129 households with rapid rehousing services, which they project to require mostly 2-bedroom structures.²⁶

2.2. Hazard Projections and Implications for Housing

The case of Westport is representative of the classic American settler mentality in which land is thought of as stable, free, and abundant – available for habitation as we see fit. We can see this in the predominance of single-family housing typologies, large

The Cascadia Subduction Zone rupture will produce Washington State's large tsunami. Portions of South Beach can expect waves to reach them within approximately 25-30 minutes of a CSZ earthquake. This rapid succession could result in high loss of life due to residents' inability to evacuate quickly to high ground. A CSZ earthquake followed by a CSZ tsunami could also result in severe economic and environmental impacts throughout Washington's coastal communities, including South Beach.

Grays Harbor County 2018 Hazard Mitigation Plan Update

²⁵ "City of Westport: Selected Housing Characteristics," ACS 5-Year Estimates Subject Table (United States Census Bureau, 2019).

²⁶ Cassie Lentz and Karolyn Holden, "2019-2024 Grays Harbor County Five Year Plan to Address Unmet Housing Needs" (Grays Harbor County Public Health & Social Services, July 2019).

parcels, and relative lack of density, as well as in residents' use of incremental building to customize their homes to their needs. This mentality, however, directly conflicts with the realities of future natural hazards and how they will impact the land. There are numerous natural hazards for which Westport must plan, each with its own implications on housing strategy. Due to its location along the Pacific "Rim of Fire" and within the Cascadia Subduction Zone (CSZ), the city of Westport is likely to experience a significant earthquake and subsequent tsunami in the coming years or decades. Historical data indicates that ruptures of the CSZ have produced very large earthquakes with tsunamis at recurring intervals in the past.²⁷ The exact timeframe and magnitude of the next event is unknown, but possible scenarios can be categorized by their projected size – S, M, and L – and their recurrence intervals, which translates roughly to the probability that they will occur within a certain future timeframe.²⁸ It is generally expected that there is a one-in-eight chance of a Magnitude 9 earthquake occurring along the entire CSZ within the next 50 years.²⁹ Westport's low elevation makes it extremely vulnerable both to tsunamis and sea level rise flooding, with little high ground for either evacuation or resettlement. For the purposes of this thesis, I have focused on two vetted earthquake scenarios – a moderately severe magnitude 8.9 (M1) earthquake which most closely resembles the last time a CSZ earthquake occurred in 1700, and a more severe "maximum considered"

²⁷ Tullan Spitz, "How Scientists Know When the Last Big Cascadia Earthquake Happened," OPB, 2015, <https://www.opb.org/news/series/unprepared/jan-26-1700-how-scientists-know-when-the-last-big-earthquake-happened-here/>.

²⁸ Robert C. Witter et al., "Simulated Tsunami Inundation for a Range of Cascadia Megathrust Earthquake Scenarios at Bandon, Oregon, USA," *Geosphere* 9 no. 6 (December 1, 2013): 1783–1803, <https://doi.org/10.1130/GES00899.1>.

²⁹ "Getting Ready for the next Great Cascadia Subduction Zone Earthquake," Pacific Northwest Seismic Network, accessed May 31, 2021, <https://pnsn.org/blog/2020/01/27/getting-ready-for-the-next-great-cascadia-subduction-zone-earthquake>.

magnitude 9.0 (L1) earthquake – and 1-3 ft of sea level rise.³⁰ Though an M1 earthquake is more likely to occur (~500-year occurrence) and its effects expected to be less severe, the state of Washington uses the L1 scenario (~2,500-year occurrence) as the basis for its inundation maps, evaluation planning, and critical facilities structural design. If an L1 earthquake does occur, it is extremely unlikely that much, if any, property can be saved – in this case, the city should focus its efforts on life-saving measures like vertical evacuation structures or accessibility to natural high ground.

Though tsunamis and sea level rise hazards both bring an element of uncertainty about the future to the community of Westport, the severity and lasting impacts from each look very different. The type of tsunamis anticipated for Westport are severe enough to cause major destruction, but the timeframe for their occurrence is difficult to predict. Sea level rise, however, is more certain, though it will be a gradual process with more manageable effects on the built environment. Figures 4 – 6 illustrate the spatial implications of each of these three hazard scenarios for Westport’s housing stock – an L1 earthquake and resulting tsunami, an M1 earthquake and resulting tsunami, and 1-3 ft of sea level rise. For the earthquake scenarios (Figures 4 and 5), the light orange shading represents 1 ft of wave inundation and the dark orange shading is 2+ ft of wave inundation. As you can see, particularly in the case of an L1 earthquake, there is extremely little high ground that will be untouched by tsunami waves. Planning for an L1 should, and already does, focus on life-saving measures as opposed to long-range development planning. With an

³⁰ Abramson et al., “Localizing Hazard Mitigation: Recommendations for Westport’s Comprehensive Plan Update,” 3.

M1 earthquake, there are two ridges in the south central and southeastern areas in the city that will likely be out of reach of the waves. Though hazard modeling is constantly evolving, these models (from Winter Quarter 2021) indicate that, in the event of an M1 or L1 earthquake, 40% – 95% (respectively) of housing in the city of Westport is estimated to be under at least 1 foot of water from the resulting tsunami. With 1-3 ft of sea level rise (Figure 6), a much smaller area will be inundated with flooding, and luckily those areas are relatively free of built structures. In the long-term, these and other hazard projections suggest that the amount of habitable land in Westport is likely to shrink, which has implications for density and how the city needs to grow to support existing community members.

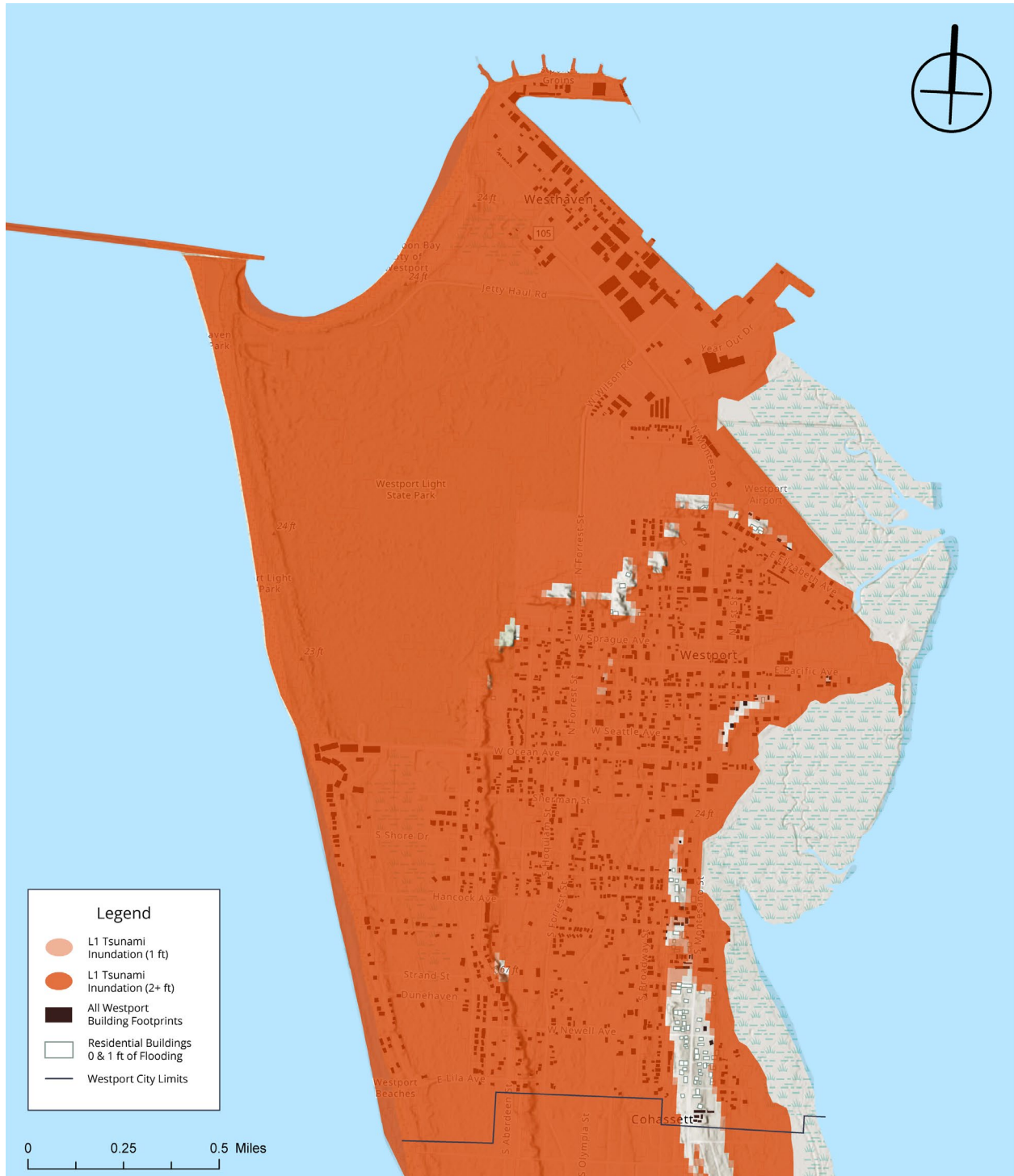


Figure 4: Westport, WA L1 Tsunami Inundation and Impacts to Housing

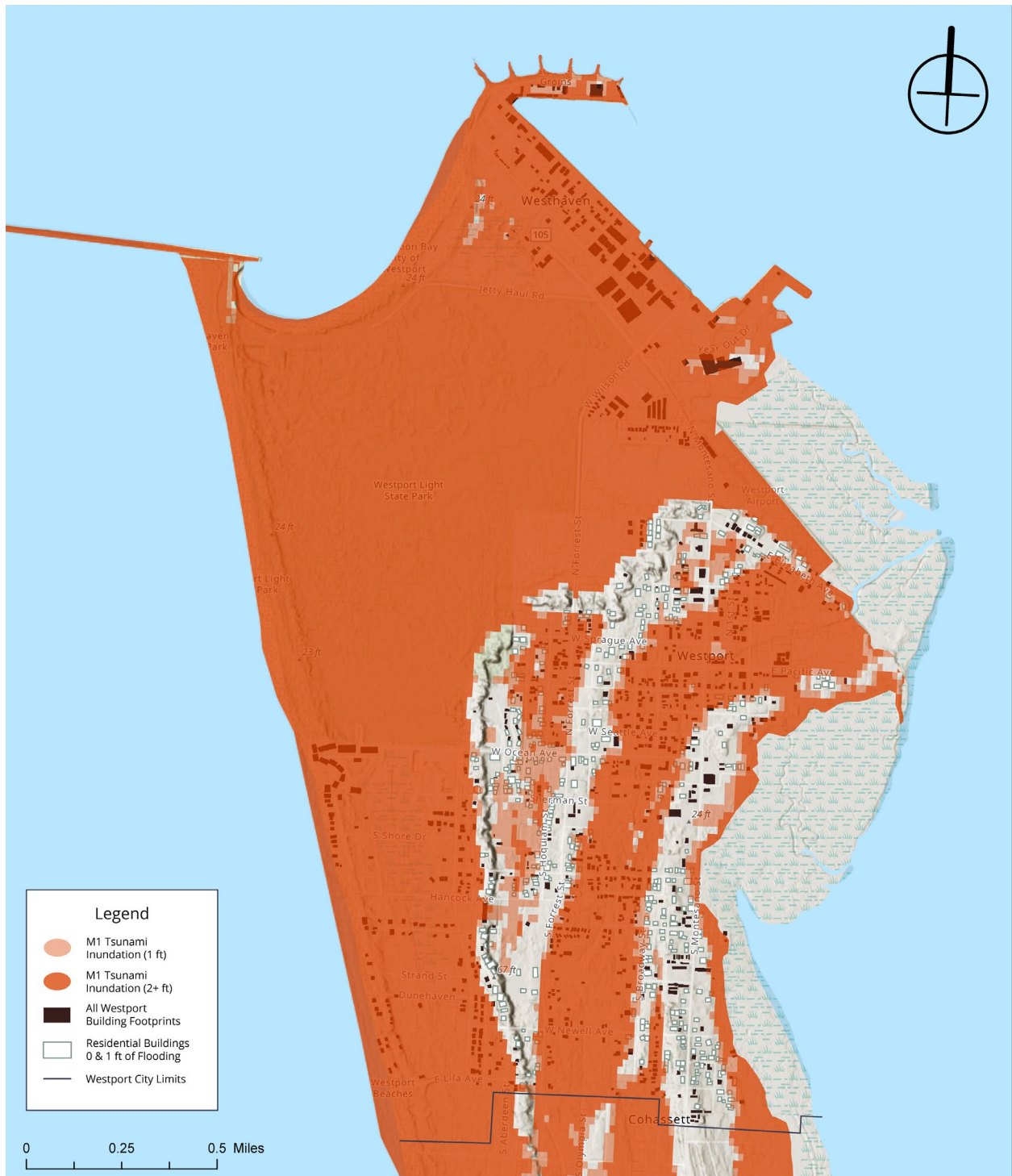


Figure 5: Westport, WA M1 Tsunami Inundation and Impacts to Housing

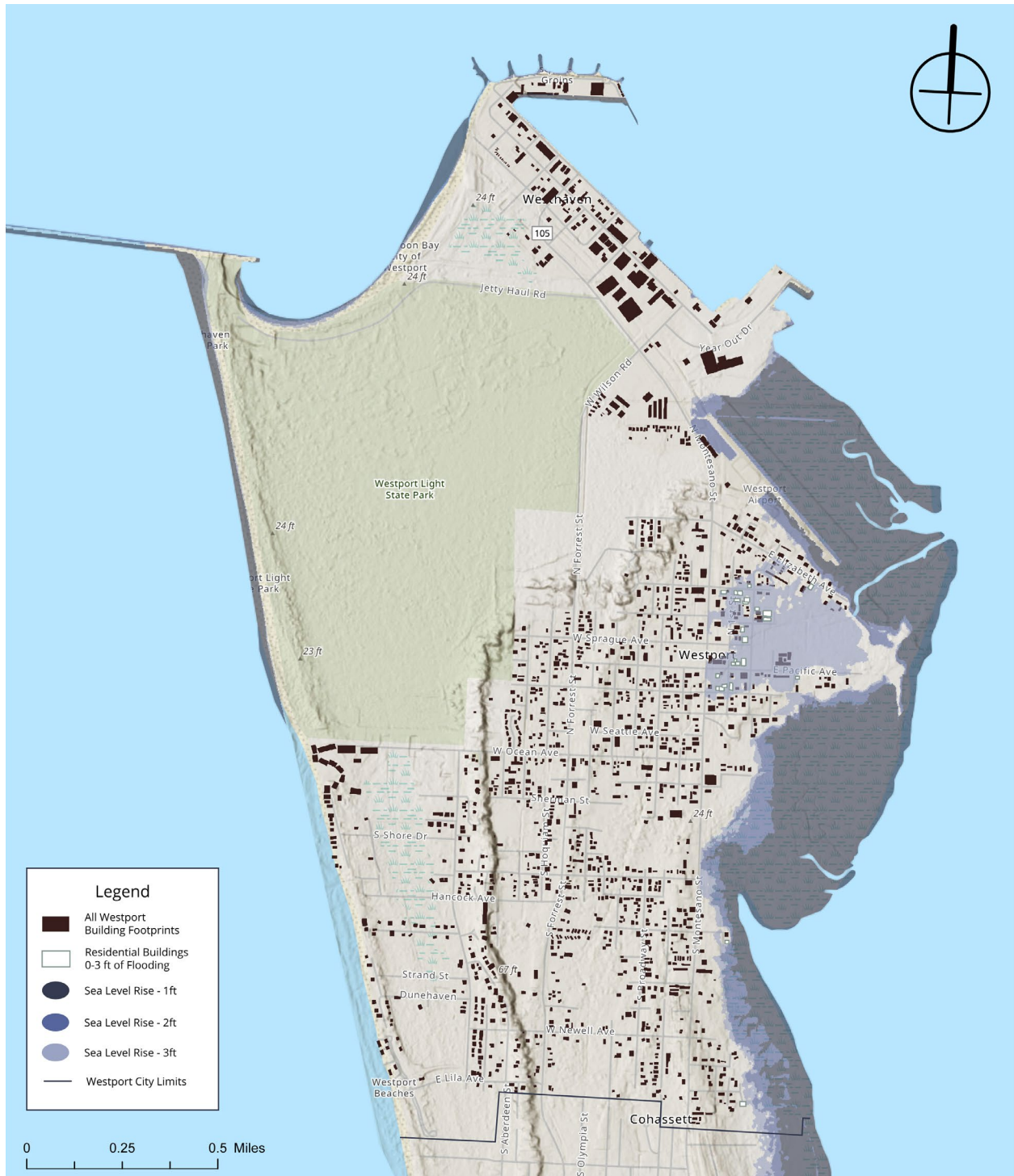


Figure 6: Westport WA 1-3 ft Sea Level Rise Projected Inundation and Impacts to Housing

Chapter 3. Literature Review: Incremental Strategies for Affordable, Hazard-Resilient Housing

3.1. Rural Affordable Housing

There are numerous ways to define housing affordability. Kropczynski & Dyk (2012) discuss the U.S. Department of Housing and Urban Development's (HUD) affordability index standard which is based on a "30% ratio of gross income spent on housing."³¹ Belden & Wiener (1999) provide a few perspectives on what affordable housing means to different people, industries, and regions. For instance, from the building industry's perspective, affordable housing is that which is "modest, no-frills" and "can be constructed for a specified cost" while "when the term 'affordable housing' is applied to a household unit, it is neither expensive nor inexpensive; it simply matches the household's ability to pay."³² While HUD's standard is the most widely used measure of housing affordability, the U.S. Department of Agriculture's (USDA) Rural Housing Service (RHS), which provides a range of financial support for the acquisition, construction, or rehabilitation of rural housing and is the primary mechanism for government-funded rural affordable housing aid, uses median income statistics to determine eligibility for its programs. RHS defines household incomes between 50% and 80% of the area median income (AMI) as "low-income", and household incomes below 50% of the AMI as "very low-income."

³¹ Jessica N. Kropczynski and Patricia H. Dyk, "Insights into Housing Affordability for Rural Low-Income Families," *Housing & Society* 39, no. 2 (July 2012): 125–48, <https://doi.org/10.1080/08882746.2012.11430603>.

³² Joseph N. Belden and Robert J. Wiener, *Housing in Rural America : Building Affordable and Inclusive Communities* (Thousand Oaks : Sage Publications, 1999).

Table 2: FEMA RAPT Resilience Indicators

Population-Focused Indicators	Community-Focused Indicators	Infrastructure Data	Hazard Data
CRIA Commonly Used Indicators	CRIA Commonly Used Indicators		Historic / Risk
% Population without Health Insurance ^{a,b}	Connection to Civic/Social Organizations	Nursing Homes	Flood Hazard Zones
% Population Unemployed ^{a,b}	Hospital Capacity	Hospitals	Tornado Paths
% Population without a High School Education ^{a,b}	Medical Professional Capacity	Urgent Care Facilities	Tropical Storms
% Population with a Disability ^{a,b}	Affiliation with a Religion	Public Health Depts.	Seismic Hazards
% Population without Access to a Vehicle ^{a,b}	Presence of Mobile Homes ^{a,b}	Fire Stations	Wildfire
% Population with Home Ownership ^{a,b}	Public School Capacity	Emergency Medical Services (EMS) stations	
% Population over 65 ^{a,b}	Population Change	Local Law Enforcement locations	NOAA Layers
% Population Single-Parent Households ^{a,b}	Hotel/Motel Capacity	911 Service Area Boundaries	Current Watches/Warnings
% Population with Limited English Proficiency ^{a,b}	Rental Property Capacity ^{a,b}	Mobile Home Parks	Hurricane Outlook: Atlantic
Median Household Income ^{a,b}		Places of Worship	Severe Weather Outlook
Gini Index: Income Inequality		Public Schools	Excessive Rainfall Outlook
		Private Schools	River Flood Outlook
Other Population Indicators		Colleges and Universities	
At-risk electricity-dependent Medicare beneficiaries		Prison Boundaries	
Tribal Populations		Transmission Lines	
		Electric Power Plants	
		Solid Waste Landfills	
		Wastewater Treatment Plants	
		Pharmacies (RX Open)	
		Dialysis Centers	
		High Hazard Dams	

Source: FEMA

A few distinct characteristics stand out within rural housing markets. While incomes are generally lower in rural areas, lower housing costs mean that rural areas do not necessarily carry a heavier cost burden than residents of urban areas. However, Belden & Wiener (1999) argue that the standard calculation for housing affordability using a ratio of income to housing cost “fails to recognize that low-quality housing is less costly because it fails to meet prescribed standards of decency and/or safety” and that such a

market inefficiency typically results in the overconsumption of low-quality units in rural markets.³³ Lastly, rural housing markets tend to experience higher home ownership rates than urban markets. As of 2017, rural home ownership rates were over 81% as compared to 60% for urban areas.³⁴

Since 2011, all financing from the USDA's RHS program has been dedicated to repairs and rehabilitation of existing housing rather than new construction. The program offers 30-year mortgages and rental assistance to property owners to support affordable housing efforts in rural America. In Washington State, this program provides mortgages and rental assistance to 292 rural property owners.³⁵ In recent years, there has been growing concern that the maturity of these mortgages is creating an affordable housing crisis in rural communities. As these mortgages mature and property owners exit the program, tenants in RHS properties face rent increases or the loss of their home because, legally, owners of these properties are "generally no longer required to provide housing for low-income tenants and properties are no longer eligible to receive rental assistance that is used to keep rents affordable for tenants."³⁶ In Washington State, there are 8,868 units as of May 2018 that could exit RHS's rural rental housing program, about 71% of which also receive rental assistance.³⁷

³³ Belden and Wiener, 46.

³⁴ Christopher Mazur, "Rural Residents More Likely to Own Homes Than Urban Residents," The United States Census Bureau (blog), accessed March 31, 2021.

³⁵ "Rural Housing Service: Better Data Controls, Planning, and Additional Options Could Help Preserve Affordable Rental Units" (United States Government Accountability Office, May 2018), 34, <https://www.gao.gov/products/gao-18-285>.

³⁶ "Rural Housing Service: Better Data Controls, Planning, and Additional Options Could Help Preserve Affordable Rental Units," 4–5.

³⁷ "Rural Housing Service: Better Data Controls, Planning, and Additional Options Could Help Preserve Affordable Rental Units," 34.

3.2. Housing and Environmental Hazards

Vulnerability to environmental hazards can be broken into two types – physical and social – and any number of factors can influence a population’s vulnerability to environmental hazards like those anticipated for the city of Westport. The U.S. Federal Emergency Management Agency (FEMA) considers both types of vulnerability in its Resilience Analysis and Planning Tool (RAPT), which uses a variety of indicators to analyze a community’s resilience to disasters. For instance, high home ownership rates are positive indicators of community resilience while the presence of mobile homes is a negative indicator. A study by Mehta et. al (2020), which looks at how the Low-Income Housing Tax Credit program (LIHTC) influences resiliency for affordable housing, notes that “low- and moderate-income renters are often most affected by disasters yet, homeowners receive the most federal disaster assistance” and, as previously mentioned, Rumbach et al. (2020) notes that mobile home parks and their residents have been shown to be especially susceptible to flooding, one of the primary hazards anticipated for Westport. ^(38,39) Hamideh & Rongerude (2018) support the RAPT methodology, stating that damage from a natural disaster is not limited to physical destruction from the event itself – race/ ethnicity, income, housing type and tenure, and neighborhood characteristics also play a role in a population’s vulnerability to a disaster. The authors argue that, due to the linkage between “older, lower-valued, and poorer quality” housing and lower-income and minority populations, “the physical and social concentration of damage leads to very different

³⁸ Aditi Mehta, Mark Brennan, and Justin Steil, “Affordable Housing, Disasters, and Social Equity: LIHTC as a Tool for Preparedness and Recovery,” *Journal of the American Planning Association* 86, no. 1 (January 2, 2020): 75, <https://doi.org/10.1080/01944363.2019.1667261>.

³⁹ Rumbach, Sullivan, and Makarewicz, “Mobile Home Parks and Disasters.”

recovery trajectories for housing in lower-income neighborhoods and communities of color.”⁴⁰ Rumbach et al. (2020) also acknowledge that affordable housing in general is at greater risk to natural hazards than the overall housing stock. Affordable housing can be more vulnerable due to its condition, quality, and/or location (exposure to hazards), and its residents’ social, economic, and mental/emotional vulnerability to the impacts of a disaster. Lee & Van Zandt (2018) note that housing tenure is a particularly important consideration for housing relief and recovery in the event of a disaster.⁴¹ Housing tenure has implications on residents’ access to government funding post-disaster, residents’ existing access to funds for housing maintenance and repair, and residents’ legal rights to prevent or prepare for disaster.

In recent years, the disaster management and recovery industry has identified resident participation in the post-disaster housing recovery process as critical to success. Maly & Shiozaki (2012) advocate for people-centered housing recovery processes and an owner-driven approach to housing recovery as a means of providing control to the resident over their housing recovery process. Maly & Shiozaki specifically examine housing recovery policy changes made between the 1995 Hanshin-Awaji Earthquake in Kobe, Japan and the 2004 Chuetsu Earthquake in Niigata Prefecture and analyze the ways in which the changes reflect a more people-centered housing recovery process. Notable improvements included increased government financial support for owner-

⁴⁰ Sara Hamideh and Jane Rongerude, “Social Vulnerability and Participation in Disaster Recovery Decisions: Public Housing in Galveston after Hurricane Ike,” *Natural Hazards* 93, no. 3 (September 1, 2018): 1629–48, <https://doi.org/10.1007/s11069-018-3371-3>.

⁴¹ Jee Young Lee and Shannon Van Zandt, “Housing Tenure and Social Vulnerability to Disasters: A Review of the Evidence,” *Journal of Planning Literature* 34, no. 2 (May 1, 2019): 156–70, <https://doi.org/10.1177/0885412218812080>.

led housing reconstruction and a more diverse menu of housing recovery options including community-based resettlement and relocation programs. The authors argue that “having options and incorporating flexibility in resettlement is a good start, and the options for individual residents must also be considered carefully.”⁴² Similarly, Hamideh & Rongerude (2018) note that “participatory structures such as deliberation and co-production build local capacity, facilitate consensus, and enable participants to reach a shared sense of a common future.”⁴³

3.3. Incremental Housing

Incremental housing is traditionally understood within the context of urban informality and poverty, particularly in developing countries and the Global South. The model grew out of inefficiencies in housing markets that resulted in a severe lack of affordable housing, prompting those individuals and families left behind to take matters into their own hands – slums, shantytowns, and favelas are often characterized by incremental building. Historically, informal settlements have started through the purchase of illegally subdivided land or simply squatting, and residents take on all construction tasks themselves or as a community. The informal nature of these settlements has traditionally meant that houses lack any or adequate access to public utilities, creating poor sanitation conditions, and substandard construction materials and practices create unhealthy and potentially dangerous living situations. Early government responses to the

⁴² Elizabeth Maly and Yoshimitsu Shiozaki, “Towards a Policy That Supports People-Centered Housing Recovery—Learning from Housing Reconstruction after the Hanshin-Awaji Earthquake in Kobe, Japan,” *International Journal of Disaster Risk Science* 3, no. 1 (March 2012): 65, <https://doi.org/10.1007/s13753-012-0007-1>.

⁴³ Hamideh and Rongerude, “Social Vulnerability and Participation in Disaster Recovery Decisions,” 1631.

rapid growth of informal communities came in the form of sites and services programs, which provided small, serviced plots of land and sometimes a core housing unit to the poor. Though undoubtedly employed informally before the 1970s, the concept of the core house originated more formally from sites and services programs implemented in developing countries. Often associated with the core house concept is the idea of self-help, where residents participate and/or lead the construction process in expanding their homes. One foundational assumption underlying core house concept is that traditional models of housing development can be prohibitively expensive for many households at the outset. By simplifying the initial build out of the home to only a small core unit, the upfront cost of the home can be lowered, making homeownership more attainable for a wider range of households. Key characteristics of core houses may include:

- Adaptability and customization
- Minimal or scalable upfront financial risk
- Provision of basic utilities/structure in initial build out
- Requirement for strong community support
- Potential for poor quality construction due to lack of technical expertise

Though sites and services programs were heavily endorsed by the World Bank throughout the 1970s – 1990s, they have since received strong criticism. As Owens et al. note, “critics argued that these projects took too long, were too complicated, ‘leaked’ to the non-poor, and suffered low occupancy because the sites were too remote and

far from jobs and income opportunities.”⁴⁴ However, Owen et al. argue that sites and services projects were in fact highly successful in creating “well-planned and well-serviced neighborhoods that are both livable and inclusive.”⁴⁵ The authors highlight innovative design elements such as a mix of plot sizes, increased density, the development of a road/open space hierarchy, mixed-use development, and strategic site selection for connectivity to transport and economic activity as key outcomes of sites and services programs.⁴⁶ More recently, governments are shifting their thinking around how to support incremental housing. In their study of incremental housing as an “enabling” approach to supporting affordable housing development in Latin American and Caribbean countries, Greene and Rojas (2008) note that “government programmes geared to build and finance finished homes directly for low-income households cannot solve the housing problem as a whole, as they offer a limited number of high-quality homes to few families, leaving most poor households without assistance.”⁴⁷ While governments still use formal housing construction approaches to address housing shortages, they are also beginning to think about ways to improve access to and support for incremental building solutions. Greene and Rojas (2008) note that governments are looking to the private sector to support affordable housing efforts and, though they have begun to shift their thinking around affordable housing provision and the use of an incremental housing approach,

⁴⁴ Kathryn E. Owens, Sumila Gulyani, and Andrea Rizvi, “Success When We Deemed It Failure? Revisiting Sites and Services Projects in Mumbai and Chennai 20 Years Later,” *World Development* 106 (June 1, 2018): 260, <https://doi.org/10.1016/j.worlddev.2018.01.021>.

⁴⁵ Owens, Gulyani, and Rizvi, 260.

⁴⁶ Owens, Gulyani, and Rizvi, “Success When We Deemed It Failure?”

⁴⁷ Margarita Greene and Eduardo Rojas, “Incremental Construction: A Strategy to Facilitate Access to Housing,” *Environment and Urbanization* 20, no. 1 (April 1, 2008): 90, <https://doi.org/10.1177/0956247808089150>.

there is still work to do. As of Greene and Rojas's 2008 study, incremental housing had not yet been supported via structured housing policies. More recently, researchers in the emergency management sector in the United States and abroad are testing the core house concept and incremental building approaches as a way to improve housing recovery effectiveness and speed.

At a more architectural scale, in the 1960s John Habraken advanced the concept of the "open building" which aims to address three key issues of 21st century mass produced housing – lack of diversity in housing choices, inflexibility of housing to adapt to user needs, and exclusion of the end user in the decision-making process. Habraken saw shifts occurring in the role that housing played in society in four areas – household makeup, the use of the home, sustainability, and ethics. The idea of a "household" was no longer defined by the traditional "nuclear family" – parents and their children – but was being broadened to include unrelated co-living scenarios, multigenerational living, etc. The use of the home was also changing – from a place of solely domesticity to one of work and productivity.⁴⁸ Habraken's open building concept argues for the separation of "immovable structures and common areas, [...] i.e. the 'base building', from that which can be transformable and can be adapted to the user, like the interior divisions."⁴⁹ He talks about how the division of these two "control levels" opens up a new market, which Setien (2012) calls "an open industrialization where the user has a choice."⁵⁰ Habraken defines a house as a process – "a dwelling is not something that can be designed or

⁴⁸ Israel Nagore Setien, "Open Building in the Collective Housing of the 21st Century: Possibilities and Limitations" (Kingston University, 2012), 7–10.

⁴⁹ Setien, 14.

⁵⁰ Setien, 15.

made. A dwelling is an outcome. The outcome of the housing process.”⁵¹

3.3.1. Case Studies

Core Houses

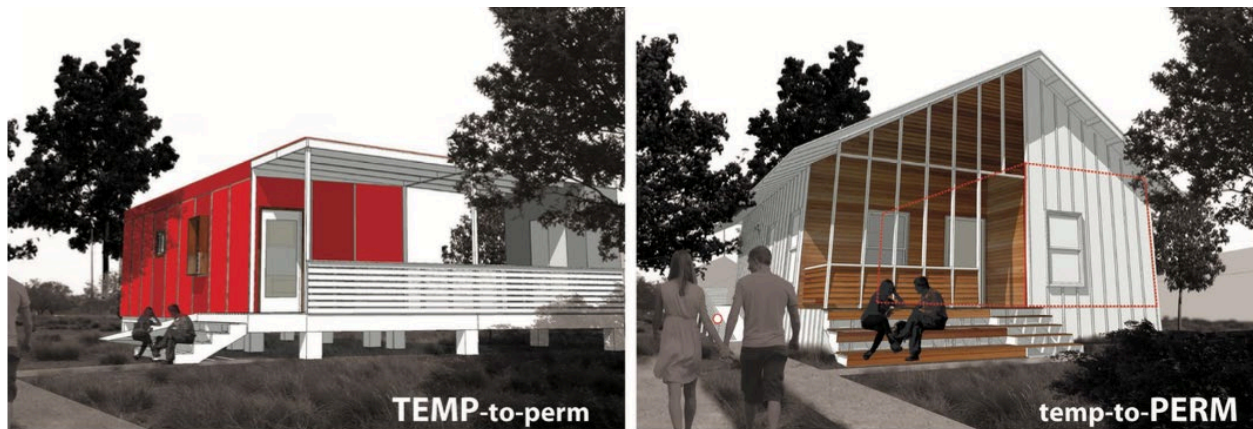


Figure 7: RAPIDO Renderings | Source: bcWorkshop

RAPIDO | Texas

RAPIDO homes, which include an initial core build out using pre-fabricated interlocking panels modeled after a FEMA trailer and subsequent expansion as funding becomes available, offer a promising modern application of the core house concept. The RAPIDO approach to housing recovery efforts was first developed in response to repeated government failures to provide adequate and equitable housing in the aftermath of four major hurricanes in Texas. One critical assumption underlying the RAPIDO approach is that, without effective pre-disaster planning, governments are largely unable to quickly, equitably, and effectively delivery housing to their citizens. The RAPIDO approach is built on the idea that governments must prepare for housing recovery prior to a disaster in

⁵¹ Setien, 16.

order to improve the speed and effectiveness of recovery efforts. The RAPIDO approach also strategically and effectively leverages both primary sources of government funding for housing recovery, FEMA funds and HUD Community Development Block Grants (CDBG), to increase the speed with which housing can be built in the immediate aftermath of a disaster while also ensuring long-term durability and resiliency of the housing provided.

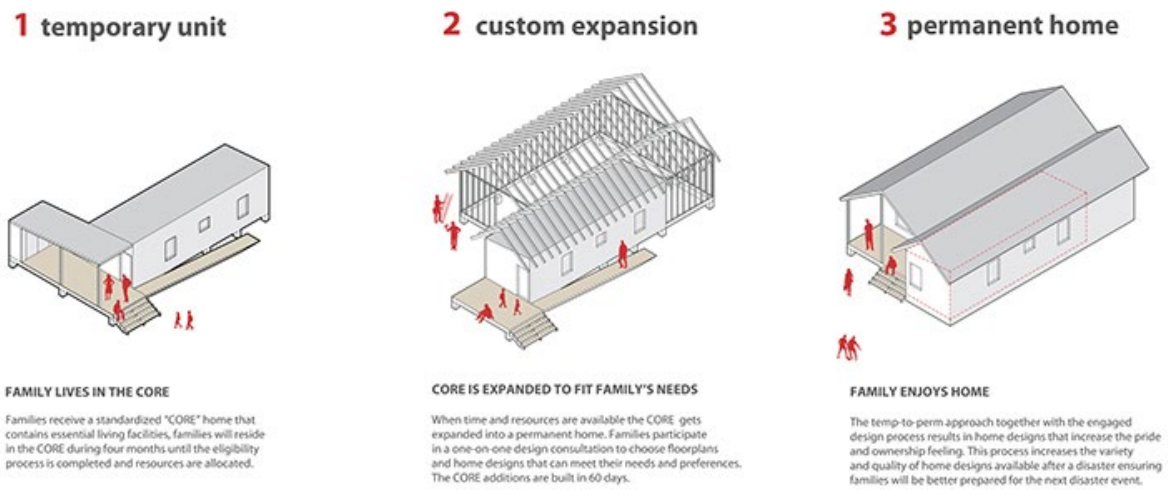


Figure 8: RAPIDO Model Conceptual Diagram | Source: bcWorkshop

Immediately following a disaster, FEMA funds are available for the construction of the initial core house which closely resembles a FEMA trailer. The core house can be built out in 3 days using pre-fabricated interlocking wall, roof, and floor panels, which are constructed and stored off-site prior to a disaster. As HUD CDBGs becomes available, residents can expand their homes from the initial core house which remains a part of the final structure. The production of RAPIDO homes is estimated to cost between \$125,000 and \$160,000 depending on local supply and labor costs, though this can be reduced significantly with the availability of local volunteer labor to assist with pre-

production and assembly.⁵²

John Henneberger highlights that RAPIDO's "genius is that it complies with the complexities of government regulatory requirements while being designed to meet the individual needs of a family to have a say in creating their home."⁵³ As previously discussed, disaster survivors need to retain some decision-making power in their recovery process – the RAPIDO model offers this possibility.

Villa Verde | Constitución, Chile

Villa Verde is a 484-dwelling unit, master planned community in Constitución, Chile established in the aftermath of an 8.8 magnitude earthquake in 2010. This project was part of a larger post-disaster reconstruction effort to address existing urban challenges. Through community consultation, the team learned about broader community concerns around seasonal flooding and public space, and were able to integrate those elements into the scope of the project with "a forest band between the city and the sea that would dissipate the force of future tsunami waves, but would also address the more immediate



Figure 9: Villa Verde Half Houses | Source: Elemental

⁵² John Henneberger, "RAPIDO Is Now a Proven Solution for Disaster Home Rebuilding That Is Rapid, Efficient, and Just – Let's Use It!," Texas Housers, June 7, 2019.

⁵³ Henneberger.

concerns of the community.”⁵⁴

All of the homes constructed in Villa Verde are modeled on the concept of the “half house,” an idea originally conceptualized by George Gattoni and later expanded upon by Chilean architect Alejandro Aravena, a 2016 Pritzker Prize recipient, in his concept for Villa Verde. The half house concept asserts that, rather than compromising building quality to supply low-income residents with an affordable home, we should scale back the size of the home to make it more affordable initially but provide the foundational elements to allow residents to expand it as they are able. The initial buildout of each unit in Villa Verde includes ^(55,56):

- 2 floors, 57 square meters
- 1st floor – unfinished concrete floors, 2nd floor – unfinished plywood floors
- 1 sink
- Concrete foundation
- Plumbing and electric
- Basic structure/framing for full house

Because the initial buildout includes the foundation, basic structure/framing, plumbing and electric, the incremental expansion process becomes less burdensome for residents

⁵⁴ “Sustainable Post-Tsunami Reconstruction Master Plan,” LafargeHolcim Foundation, January 7, 2017.

⁵⁵ “Half A House Builds A Whole Community: Elemental’s Controversial Social Housing,” ArchDaily, October 24, 2016.

⁵⁶ “Villa Verde Housing, Constitución - Alejandro Aravena ELEMENTAL,” Arquitectura Viva, accessed April 4, 2021.

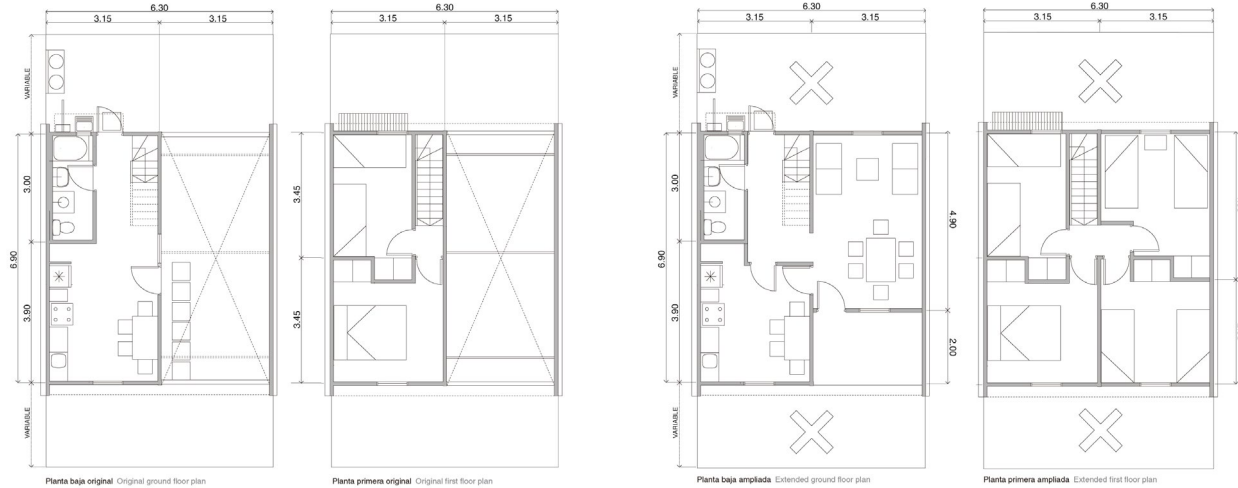


Figure 10: Left: Villa Verde Original Floorplans; Right: Villa Verde Expanded Floorplans | Source: Elemental

who may not have the technical knowledge or financial capacity needed to take on those components of construction. Residents of Villa Verde were also provided with a manual outlining options for expanding their home using standard building materials, and the architecture firm behind the development offered building workshops.

Pre-Fabricated/Modular Housing

Blokable

Blokable, a Vertically Integrated Modular (VIM) housing development company, offers a new model for developing sustainable affordable housing that is both high-quality



Figure 11: Blokable Renderings | Source: Blokable

and low-cost. VIM means that Blokable act as both the developer and the builder, giving it control the entire development process. The Blokable Building System (BBS) offers standardized studio, 1-, 2-, and 3-bedroom units pre-fabricated offsite as well as range of add-on elements such as decks, railings, stairs, cladding, and other architectural features to provide customization while retaining time- and cost efficiencies in the design and construction process. BBS units can be stacked (1-3 stories), combined, and connected in a variety of ways, including into multi-unit buildings with ground floor retail or open space. BBS units are energy efficient, using all electric systems that mean 60% lower heating and cooling costs and 30% lower overall utility costs, and use high quality

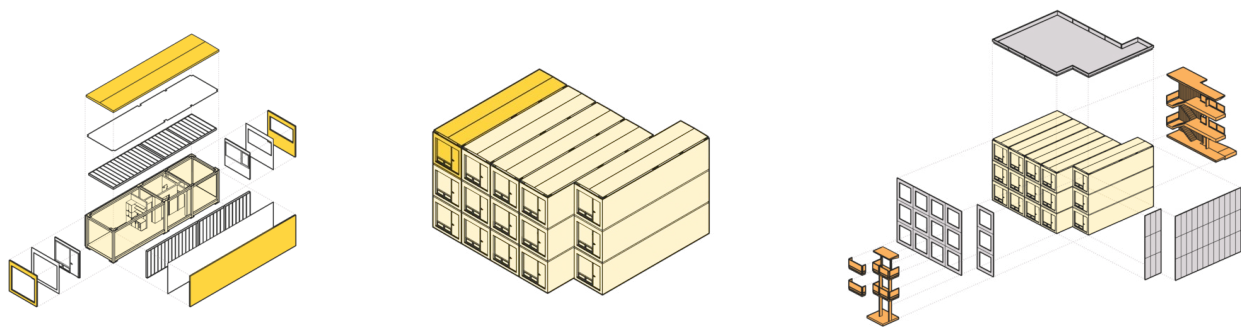


Figure 12: Blokable Building System (BBS) Axon | Source: Blokable

materials and systems to ensure resident comfort, accessibility, and safety and increase the useful life of each unit. Blokable’s first project, Blokable at Phoenix Rising, was completed in November of 2020 in Auburn, Washington. Each unit cost approximately \$125,000 to build, which is less than half the cost of a unit in a new apartment building, and serves residents who make 30% - 50% of the Area Median income.^(57,58)

Module | Pennsylvania

⁵⁷ “Blokable Unveils Phoenix Rising, the World’s First Vertically Integrated Modular Housing Development | Blokable,” accessed April 9, 2021.

⁵⁸ “Vertically Integrated Modular: Finally, an Incentive for Innovation in Housing Development | Blokable,” accessed April 9, 2021.

Established in 2016 in Pittsburgh, PA, Module focuses on urban infill projects by building small homes on vacant land and uses a standardized set pre-fabricated panels

to increase cost and time efficiency during the design and construction process. Module currently offers

13 different models, including 1-, 2-, or 3- bedroom homes to start (median size of 1,000 sqft), but also

has integrated into its model the ability for homes to be expanded in the future as users' needs change. A 1-bedroom home costs

around \$150,000, not including the land, site and foundation, or utilities.⁵⁹ Module homes are built to Zero Energy Ready Home standards set by the U.S. Department of Energy, and the modular model reduces

the typical construction timeline by three months (7.5 mos vs 11.5 mos).⁶⁰ Similar to Blokable, Module acts as both the developer and the builder, helping residents with permitting/zoning, land acquisition, design, and construction. As of 2021, the company

has completed two projects, with two more in pre-construction and three available for sale.



Figure 13: Module Home Models | Source: Module

⁵⁹ Pamela Babcock, "Tech Start-Ups Look to Disrupt the Affordable Housing Industry," Washington Post, July 2019.

⁶⁰ "Module | Energy Efficient Homes | Pittsburgh," Module, accessed April 13, 2021.

Co-Housing

Coop Housing at River Spreefeld | Berlin, Germany

Coop Housing at River Spreefeld's represents an example of Baugruppe ("building group"), an alternative model for housing based in collective, participatory, and self-initiated building and living. This project's mission is to "harness its location's unique potential to create a socially just, economically stable, and environmentally responsible



Figure 14: Coop Housing at River Spreefeld | Source: Eric Tschernow

urban building block."⁶¹ Rooted in the idea of communal living and self-help housing, this project includes multiple types of living and working space arrangements, flexible public spaces, and communal open spaces to facilitate multigenerational and multicultural living and a culture of openness and integration into the urban environment. The project is comprised of three buildings with 54 traditional individual dwelling units, six cluster units for communal living, and three communal terraces for resident use. The ground floors are mostly open to the public, including workspaces and community services such as a daycare, a carpentry workshop, and co-working spaces, as well as designated flexible spaces called "Option Rooms" which are "unassigned, unfinished spaces for

⁶¹ "Coop Housing at River Spreefeld / Carpaneto Architekten + Fatkoehl Architekten + BARarchitekten," ArchDaily, January 17, 2015.

community, social, or cultural projects.”⁶²

Residents collaborated closely with the architects on everything from the mix of living, work, communal, and public spaces that would meet both resident and community needs to the selection of building materials. Additionally, residents were able to participate in the process by taking on construction projects within their own units,

which not only enabled them to secure the needed equity capital for the project but allowed for low-income people to participate as well. Resident participation throughout the process allowed them to influence financial and design decisions that traditional models would have prohibited. One unique feature of this Baugruppen project is the ownership model – in this project, “a land grant or leasehold contract guarantees the long-term use of land in return for rent.”⁶³

Residents collaborated closely with the architects on everything from the mix of living, work, communal, and public spaces that would meet both resident and community needs to the selection of building materials. Additionally, residents were able to participate in the process by taking on construction projects within their own units,

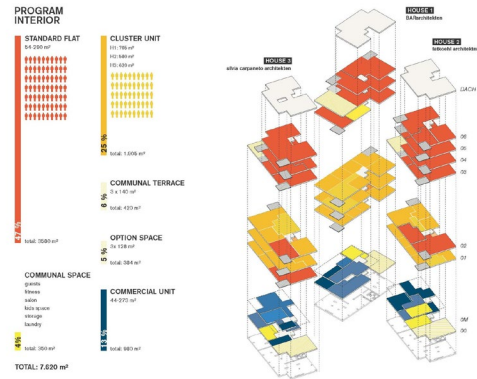


Figure 15: River Spreefeld Program Interior Diagram | Source: Architekten + Fatkoehl + BARarchitekten

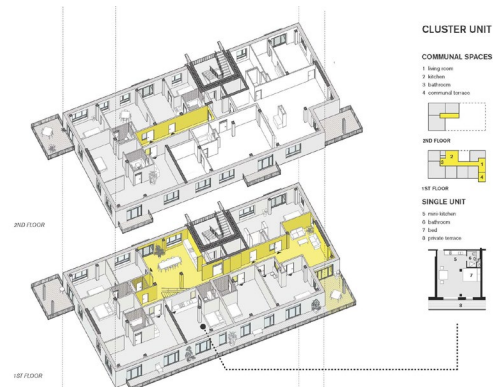


Figure 16: River Spreefeld Cluster Unit Diagram | Source: Architekten + Fatkoehl + BARarchitekten



Figure 17: River Spreefeld Working Area Diagram | Source: Architekten + Fatkoehl + BARarchitekten

⁶² “Coop Housing at River Spreefeld / Carpaneto Architekten + Fatkoehl Architekten + BARarchitekten.”

⁶³ Kristien Ring, “Reinventing Density: How Baugruppen Are Pioneering the Self-Made City,” The Conversation, accessed May 4, 2021.



Figure 18: Left: River Spreefeld Option Room; Right: River Spreefeld Carpentry Workshop | Sources: Johannes Dumpe, Michael Matuschka

R50 | Berlin, Germany

Another example of a Baugruppen project in Germany, R50 was developed through close collaboration between the owners, in this case a group of 19 households, and the architects. The group collectively pooled funds for the land purchase and construction, and intensive participation from owners enabled units to be customized to meet individual needs while also adhering to collectively agreed upon standards for interior finishes and fixtures.⁶⁴ The creative financing structure for this project enabled the owners to offer moderate home prices in a city facing a major affordable housing crisis, but in exchange, units were finished but not entirely “done”, according to resident Jesko Fezer. Units were intentionally left incomplete so that they remained “flexible for adaptation.”⁶⁵ The 20-unit building stands seven stories



Figure 19: R50 Exterior | Source: Andrew Alberts

⁶⁴ “R50 – Cohousing / Ifau Und Jesko Fezer + Heide & von Beckerath,” ArchDaily, February 8, 2015.

⁶⁵ Jessica Bridger, “Don’t Call It A Commune: Inside Berlin’s Radical Cohousing Project,” Metropolis, 2016.



Figure 20: R50 Interiors | Source: Andrew Alberts

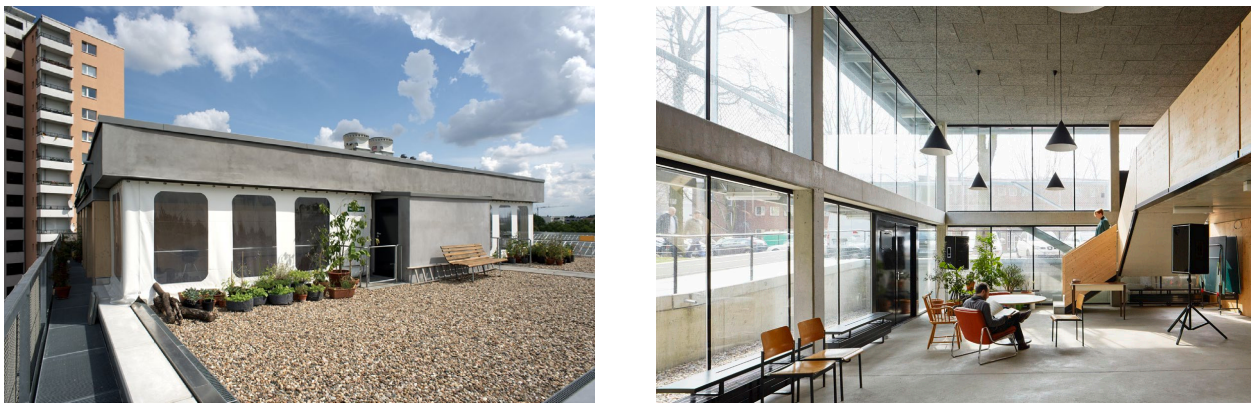


Figure 21: Left: R50 Rooftop; Right: R50 Ground Floor Community Space | Source: Andrew Alberts

tall, with a sunken double-height community space on the ground floor, a large urban garden, six floors of apartments above, and full rooftop space including a kitchen. The structure is composed of a concrete shell with modular wooden elements and a wire mesh façade, and wraparound balconies that function both as individual outdoor space and a secondary circulation route between units.^(66,67)

3.3.2. Summary

Each of these case studies illustrate new, innovative models for housing development

⁶⁶ Bridger.

⁶⁷ "R50 – Cohousing / Ifau Und Jesko Fezer + Heide & von Beckerath."

that challenge the status quo of developer-led, profit-centric development. Project goals and objectives are determined through a process of user participation and engagement with the intention of creating housing that more closely meets the needs of its users than traditional, one-size-fits-all mindsets. User participation means that housing development can be driven by community values and a shared vision for the future, which today often translates into more sustainable and healthier building approaches than we typically see from developer-led projects. However, it is critical to consider the financial models used to get these projects off the ground.

Chapter 4. Addressing Housing Vulnerability in Westport using Incremental Housing

4.1. Incremental Housing in Westport

The process of incremental housing might be well suited to the case of Westport for a number of reasons, including the financial and social benefits conferred on an individual/household level, the integration of participatory design and planning into low-income housing development, and support for shifts in community identity. The financial implications on homeownership for low-income populations is one of the most apparent benefits of an incremental housing approach. Within the United States' formal housing market structure, too-high home values and sale prices create unattainable down payment requirements and mortgage costs, which pose a major barrier to home ownership for many low-income individuals and households. As we saw in the RAPIDO and Villa Verde core house cases, an incremental housing approach could potentially reduce the cost of the initial home substantially, lowering the initial barrier to homeownership. Incrementality allows low-income households to make more frequent but smaller investments in their home over a longer period of time, rather than being shut out of the market for homeownership entirely because they cannot clear the initial barrier or being financially overburdened from the start in purchasing a home that may even exceed their initial needs.

Additionally, the process-oriented nature of incremental housing can provide social and emotional benefits by offering homeowners more control over their housing than

traditional housing development, which we have seen can be especially beneficial for low-income groups. By nature, incremental housing requires a person or community to understand their current and future housing needs, and the process of determining those needs in turn requires participation from the resident or community. As we learned from Maly & Shiozaki (2012), a people-centered approach to post-disaster housing recovery based in participatory design and planning led to more successful outcomes for affected communities. Taking learnings from post-disaster scenario housing recovery solutions and other research on approaches to affordable housing development, it is evident that integrating resident participation through an incremental housing process could yield better outcomes for low-income groups. As we saw in the case of the Villa Verde project, community participation through the incremental building process allowed the Elementale team to not only learn about the populations preferences around housing, but to get a much broader picture of community needs beyond just housing. Additionally, as Hamideh & Rongerude (2018) noted, participatory development structures allow residents to create a shared community vision for the future, which may be particularly important for the community of Westport given how natural hazards are projected to change the land and may influence community identity. We saw this play out particularly in the examples of co-housing discussed earlier, in which the collective group made decisions about how the project would grow based on values established by the group as a whole. As we saw in the Villa Verde case, the process of incremental building can also open up a new avenue for the city to engage with low-income residents who are often overlooked or unheard in formal community engagement processes. While

individual residents' perspectives and visions can be more directly integrated into the built environment through the design and construction of individual homes, the process also has the potential to facilitate collaboration between neighbors, leading to a more commonly held vision. For example, in the R50 and Coop Housing at River Spreefeld projects, residents were involved in everything from programming to building material selection, ultimately infusing the project with elements of the community's values at each level. For the community of Westport more specifically, incremental building and participatory design encourages collective action in planning for the future while still respecting Westport's culture of individuality and self-reliance.

Finally, given Westport's precarious location and environmental conditions, over time, managed retreat may become an increasingly attractive option or an imperative for some residents. However, in order for managed retreat to be a viable option, it will be important for the community to begin building a connection with new places outside the bounds of those with which it currently identifies. Rather than framing managed retreat as a wholesale relocation of a community, incremental housing solutions have the potential to foster these new connections more organically, gradually expanding the places and lands the community calls home.

4.2. Planning for New Housing

The complexity of housing precarity and vulnerability warrants a nuanced approach to housing development for the city of Westport. Hazards projections and mapping provide the opportunity to consider where to plan for densification and dedensification

in response to spatial data around land availability. In the unlikely event that an L1 earthquake occurs, the resulting tsunami would be so economically devastating – wiping out the entire port and the majority of built structures – that it makes little sense to plan development around those projections. However, the M1 projections indicate fairly large swaths of the city that would be untouched by a tsunami – this is the scenario around which the city should plan for future development. By thinking about long-range planning in terms of densification and dedensification and using incrementality to execute it, the city may be able to start navigating this conflict between necessary densification and the tried-and-true settler mentality.

One might think of a new approach to housing development that responds to “geographical threats” with “geographical answers”, as was the case in the Villa Verde project.⁶⁸ As a long-term asset, new housing should be constructed to either withstand the impacts of a disaster without causing major social or economic hardship or should be located in an area that is less vulnerable to flooding or other natural hazards. One approach to housing development that addresses this precarity and vulnerability might identify “sending” and “receiving” locations for housing based on the likelihood and time horizon for each hazard, and the population’s need within each area. Several county-wide and county specific hazard mitigation initiatives outlined in Grays Harbor County’s 2018 Hazard Mitigation Plan could support this approach to housing development. For instance, CW-5 seeks to update “parcel-level data to include more building-specific information which may be utilized [...] for enhanced risk assessment to provide a detailed

⁶⁸ “Sustainable Post-Tsunami Reconstruction Master Plan.”

loss estimation” and CW-23 will “continue to integrate mitigation planning data into ongoing land-use planning to assist in providing information necessary to enforce existing building codes, floodplain and critical areas ordinances, and shoreline protection.”^(69,70) These initiatives will enable residents and policy makers to make more informed decisions about future housing development that includes hazard risk projections.

From an urban design perspective, given the high rate of single-family homes in the city of Westport today as well as population projections for the next few years, single-family homes would likely be the most easily accepted housing typology for new affordable homes in this case. Westport is not expecting a large influx of new residents, so most homes being built today would primarily serve current residents who are accustomed to having single-family homes. Single-family homes may also offer more flexibility in terms of the construction process and more customization and control for residents in the development process. However, as previously noted, it is important to consider how hazard projections, including not only coastal flooding but also riverine flooding and wildfires, will influence the amount of safe land in the city. Many of the incremental housing case studies discussed in Chapter 4 were geared toward denser development, including attached housing with shared party walls, multi-family apartment buildings, or single-family residences with shared common spaces. Over time, the amount of habitable land in the city is likely to shrink, potentially creating a need for denser development than is currently the standard in Westport. Incremental building may be an approach to

⁶⁹ “Grays Harbor County 2018 Multi-Jurisdiction Hazard Mitigation Plan Update” (Grays Harbor County Department of Emergency Management, July 2018), 432.

⁷⁰ “Grays Harbor County 2018 Multi-Jurisdiction Hazard Mitigation Plan Update,” 427.

increasing density in the city over time without causing major disruption to the existing urban form.

4.2.1. Priority 1 Sending and Receiving Zones

Given that 1-3 feet of sea level rise is the most likely and probably the most immediate hazard risk, a priority 1 (P1) sending zone should focus on rehousing residents within that floodplain (Figure 23). Residents likely to be affected by sea level rise may be the most willing to relocate to avoid flooding since sea level rise is a more tangible risk with more “known” factors – while the exact timeline and magnitude of sea level rise



Figure 22: Priority 1 "Sending" Zone

is difficult to project, we know that the probability of water levels rising within the next 30 years is high and the areas likely to be flooded are relatively certain. Approximately 23 homes will experience flooding if sea level rise causes a 1-3 ft rise in water levels. Homes in this floodplain are primarily 1 – 1.5 story single-family or manufactured homes ranging anywhere from ~530 sqft to ~2,600 sqft. In determining a receiving zone for these residents, planners and policy-makers should consider both short- and long-term factors, including how a relocation might affect residents' daily lives, quality of life, and the larger community's identity, as well as the likelihood and severity of other environmental hazard scenarios. Unlike a tsunami, sea level rise will displace affected residents permanently, so the receiving location for these residents needs to be safe from multiple hazards in the long-term. While a comprehensive relocation is unlikely for Westport today, knowing that it may be necessary at some point, it would be beneficial to begin expanding/shifting the places and lands with which the community identifies to include more hazard-safe land to the southeast. The unincorporated towns of Grayland and Cohasset Beach directly south of Westport (see Figure 2) are similarly low in elevation, but high bluffs just inland of Grayland may become a desirable location for community relocation in the long-term. For this reason, southern locations may be the best option for the P1 receiving zone as it would support that shift in community identity closer to the bluffs without requiring residents to move too far outside their current idea of Westport's physical boundaries. Additionally, because the P1 sending zone is located at the north end of S Montesano Street, a main entrance into the city, the receiving zone for these residents should also be located along or close to S Montesano Street

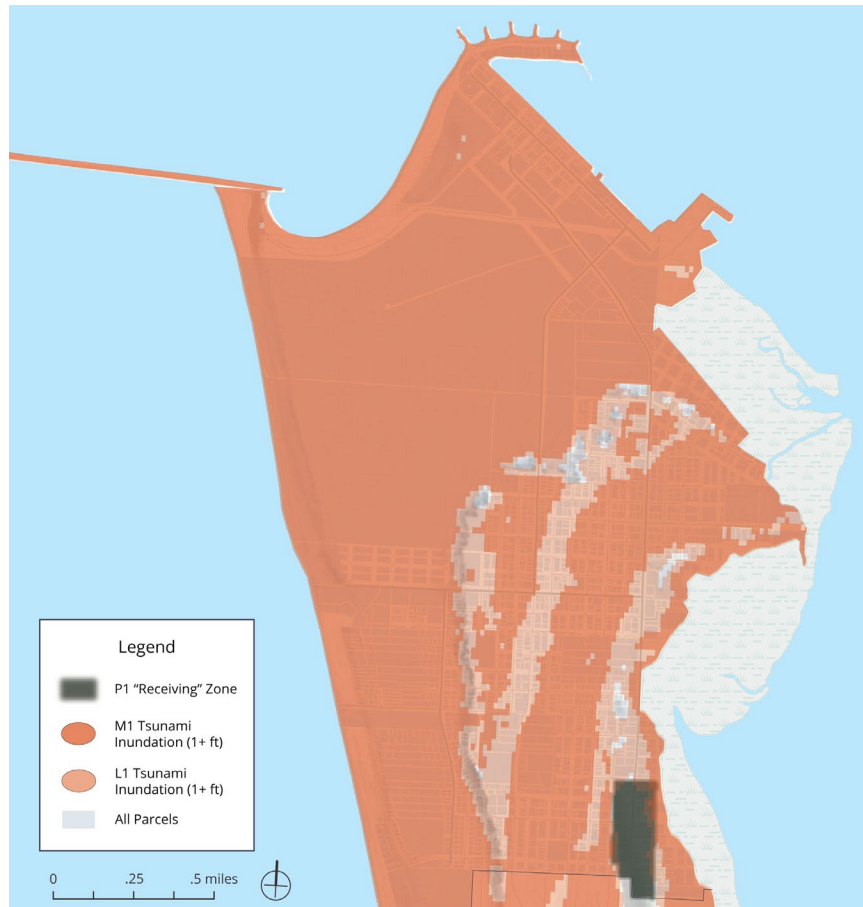


Figure 23: Priority 1 "Receiving" Zone

so residents' commute and travel patterns are not drastically disrupted. There is more than enough land zoned for residential uses within the recommended P1 receiving zone highlighted in Figure 24 to accommodate the residents being displaced from the P1 sending zone. However, almost all parcels are already developed/occupied which creates challenges for accommodating all residents from the P1 sending zone and might require consideration of additional sites on the bluffs further from town.

4.2.2. Priority 2 Sending and Receiving Zones

A priority 2 (P2) sending zone could consider the next most likely hazard – an M1

earthquake and resulting tsunami. Unlike sea level rise, an M1 event would affect a much larger proportion of residents but have more temporary impacts on the land and built environment. Residents living in areas vulnerable to an M1 event may be more resistant to relocating because earthquakes and tsunamis and their impacts are much more difficult to predict, both from a timing perspective and magnitude perspective. However, it would be beneficial for the city to include at least the most vulnerable residents living in these areas in a housing policy for rehousing at-risk residents. As we saw in Figure 4, higher value properties tend to be located closer to the ocean, particularly along the ridge where residents may have a better ocean view (and be safer from hazards), whereas lower value properties are more concentrated in the valleys between the ridges. As previously

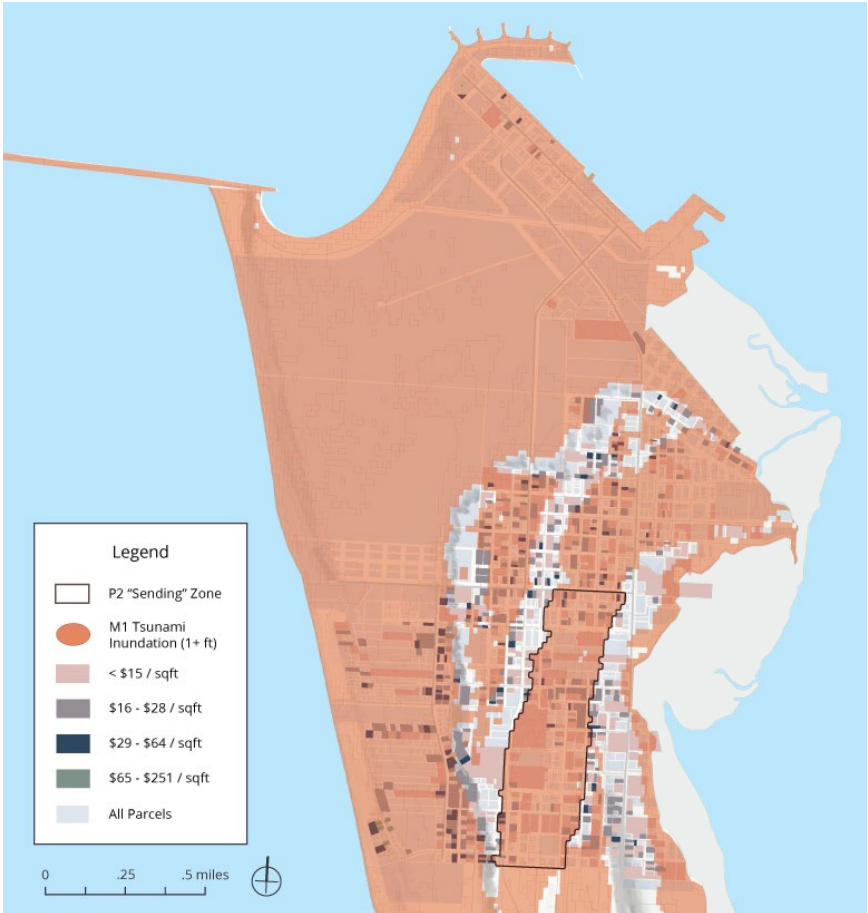


Figure 24: Priority 2 "Sending" Zone

discussed, low-income populations, especially those living in mobile home parks, are often the hardest hit by disasters for a range of reasons. In the absence of more granular income data, we can use property value data to identify likely-low-income households. High value properties should receive lower priority in housing policy given that their owners will likely be better equipped to respond to and recover from a disaster than owners of lower value properties. Figure 26 shows a potential P2 sending zone based on property value data and wave inundation projections for an M1 event. There are 148 homes located in this P2 sending zone ranging anywhere from ~300 sqft to ~3,200 sqft. Given the lower probability of an L1 event occurring and the impermanent impacts of a tsunami, residents living in the P2 sending zone could reasonably be rehoused in areas

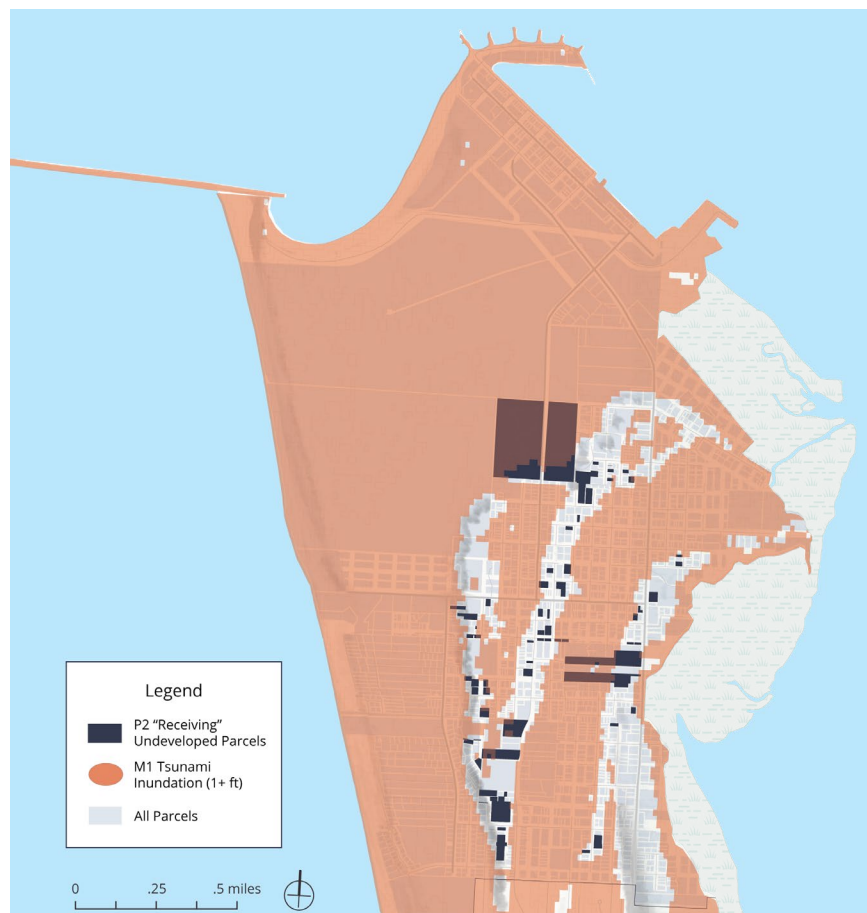


Figure 25: Priority 2 "Receiving" Areas

that would be safe in the event of an M1 but potentially at risk during an L1 event. There are 100 undeveloped parcels in Westport that would likely be safe during an M1 event, some of which are large enough to be subdivided to accommodate multiple homes.

4.2.3. Site Planning Example – P1 Receiving Zone

Parcels within this site located closest to S Montesano St, particularly between the city limits and W Maple Ave, should be relatively safe from flooding in even an L1 tsunami, though small areas peripheral to the site are likely to be inundated in an M1 event. These projections can be incorporated into site and building layout in a variety of ways. Generally, structures should be concentrated within the safe areas while parks,

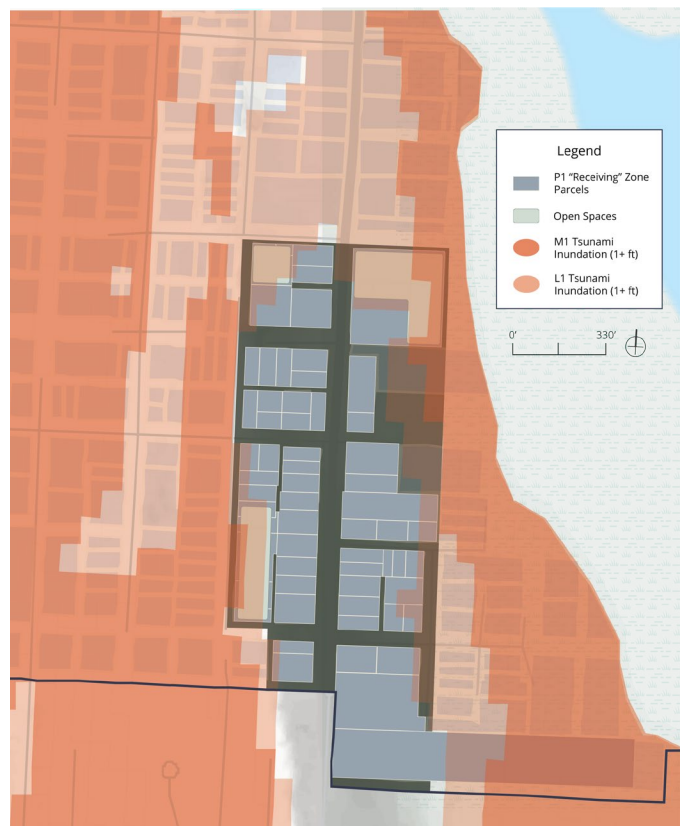


Figure 26: Figure-Ground Site Layout Illustration

green spaces, and other open spaces can be located in more flood prone areas. Figure 28 offers an illustration of how open spaces and built structures could be arranged to accommodate flooding while increasing resiliency for Westport’s housing stock.

Beyond the layout of built versus open spaces broadly, we can look at hazard projections at the individual site level and design each site to remediate flooding and

accommodate changes to the landscape over time. For open spaces, planting and vegetation design should incorporate information about the projected flow of water, rise in the water level, and the force of a tsunami wave so that those spaces can act as barriers between newly constructed housing and tsunami hazards. For instance, design of the open space closest to W Newell St could include a small, forested area with a staggered arrangement of trees to dissipate the force of a tsunami wave. Additionally, selection of trees included in this area should consider

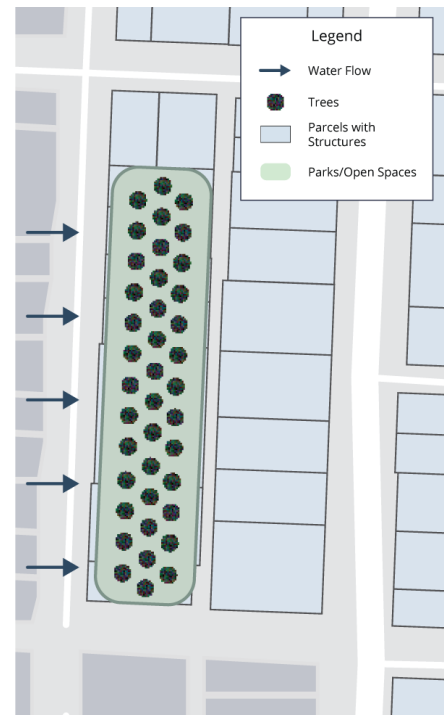


Figure 27: Illustrative Landscaping Plan

the following factors⁷¹:

- Height: Taller trees are more likely to break or be uprooted, creating dangerous debris during a tsunami
- Width: Wider trees are less likely to break from wave force (< 200 m, ideally)
- Density: Moderate density (40 – 70%) is most effective
- Vertical variation of density: Low branches and undergrowth
- Roots structure: stilt root structure and deep taproot with lateral roots provides protection

⁷¹ Keith Forbes and Jeremy Broadhead, *The Role of Coastal Forests in the Mitigation of Tsunami Impacts* (Food and Agriculture Organization of the United Nations, 2008), <http://hdl.handle.net/2027/umn.31951d02588778v>.

Additionally, structures can be designed and laid out such that, in the event of flooding, the most essential portions of the structure remain safe. We can apply the core house concept here – in theory, if the original core house could accommodate the household from the beginning, it could potentially temporarily function as the primary dwelling again in the event of the disaster. Incrementality will allow the home’s design and site layout to respond to the most recent projections for hazards, which, as I’ve noted, is constantly a moving target. Finally, Figure 29 illustrates how incremental building might develop on a few of the parcels located in the P1 receiving zone. Not only do the homes themselves grow, but new ones are added slowly, and common spaces and pathways are created as a result of the participatory nature of incremental building. Through a participatory process in the design and construction of the home itself, residents become more

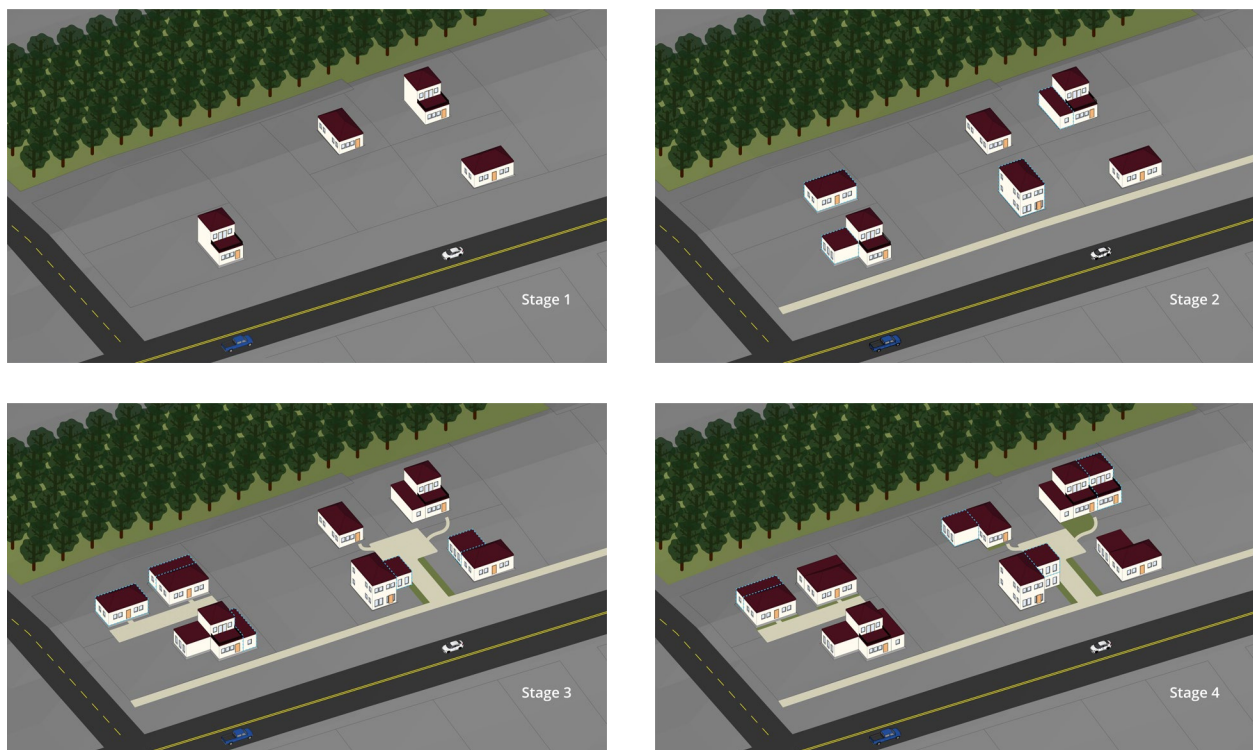


Figure 28: Illustration of Incremental Building Over Time

engaged in shaping the future of their community and may take collective action to drive change based on the larger groups' needs.

Chapter 5. Discussion and Conclusion

5.1. Opportunities for Future Research

5.1.1. Project Delivery Systems and Stakeholder Roles and Responsibilities

One of the biggest barriers to adoption and acceptance of an incremental building approach in the United States will likely be rooted in conceptualizations of success for affordable housing projects. Incremental building requires a shift in mindset for stakeholders in the affordable housing development process. For instance, in the building industry, success is often measured through an analysis of the project delivery system, primarily looking at cost and time factors within the design and building phases without considering post-occupancy metrics. This approach might also require changes to the roles that different actors play in the development process – it might require that architects shift from solely the designer to being more engaged in the full process of development, and owners become much more engaged in the design and construction process.⁷² Future research should look at how definitions of success among those groups delivering affordable housing might need to change before incremental housing can be successfully adopted in the United States.

5.1.2. Conceptualizations of Housing

The adoption of incremental building will also require a shift in how the building industry views housing as a built form. In part due to the project delivery systems in

⁷² Bridger, “What Cohousing Looks Like.”

place today, many architectural projects are thought of as “products” as opposed to “processes”. Project delivery systems emphasize the completion of the structure as the end goal, leaving little room for conceptualizations of housing as an ongoing, evolutionary process. Future research could look into how conceptualizations of housing within the building industry would contribute to how incremental building is received and implemented .

5.1.3. Financial Models

Financing is a crucial part of affordable housing development. I briefly provided overviews of financing models used in a few of the case studies, but the topic warrants much more in-depth study. Financing poses a major barrier to affordable housing development today and, while there may be some financial benefits of the incremental building approach to end users, it will be important to look at how the building industry and municipalities can support its adoption through creative, non-traditional financing models.

5.2. Conclusions

Through this study, it is apparent that incremental housing can be an empowering tool for low-income groups dealing with uncertainty for the future. Incrementality is a way of dealing with uncertainty because it offers flexibility in the development process, enabling individuals and municipalities to adapt more quickly and potentially more effectively to changes in the world. Traditional approaches to development – defined

“projects” with stated start and end dates, and with completion as the primary end goal – may be too immovable, inflexible, and permanent in a rapidly changing world, especially as we begin to experience the effects of climate change. While this approach could offer a solution to uncertainty in the development process on a broad scale, it could be especially useful for low-income, marginalized groups for whom control over housing choices is often limited. Incremental building provides a mechanism for bringing these groups to the table, leveraging a participatory design process to allow residents and owners to make values-driven decisions in a way that typical profit-centric models for housing development often do not. Similarly, it facilitates the development and adoption of a shared, community-value driven vision for the future. Low-income populations’ relative lack of control can be a major factor determining the success of housing. So, in order for sustainable, hazard-resilient affordable housing to be successful, low-income residents must be included in the process.

Based on the case studies examined here, there are two possible incremental building models suited to affordable housing development depending on the stakeholders involved and potentially the scale of the development – pre-fabricated, modular construction and self-help construction. Pre-fabricated, modular construction may be best suited for situations in which residents are limited in their ability or capacity to physically contribute to construction of the structure. Because off-site production can reduce on-site construction time and cost and modularity offers a variety of design options, pre-fabricated, modular housing can be built incrementally with resident input throughout the process. Pre-fabricated, modular building is already being tested as an

approach to affordable housing development, but the level of resident input into the design process seems to be minimal. This model might be best suited for government-led projects geared toward low-income residents who need more support throughout the development process, such as disabled or elderly individuals or victims of domestic violence. The second model, self-help housing, would work best for community-led projects where collective participation bolsters each individual's ability to contribute to the project. The self-help model requires that community members have the physical or mental capacity to contribute in some way to the construction of the home, and that may not be possible for all users of affordable housing.

Existing rural housing markets and development patterns combined with natural hazard projections for communities like Westport paint a deceptive picture – despite low land values and what looks like a wealth of undeveloped land, the city, in reality, may have less available habitable land to work with than it appears to. As coastal and other natural hazards threaten land availability in rural areas, it is likely that cities like Westport will need to consider increasing density in lower-risk areas to ensure the community's safety and longevity. While incremental building is already used in many rural settings and can be seen in housing typologies like RVs and manufactured homes, many of the incremental housing cases discussed in this thesis leverage much denser housing typologies than are common in rural settings today. In advocating for a denser form of incremental building in rural settings, it is critical to consider how the element of community-driven visioning can influence its reception and acceptance of the concept. The community participation that accompanies incremental housing approaches like

those outlined in this thesis would hopefully minimize resistance to new, denser housing typologies because they enables residents have a voice in how densification plays out in the community at large and for them on an individual basis. This is especially important in rural areas where the classic American settler mentality is still very prominent. An incremental approach to increasing density could be a strategy for navigating the conflict between the settler mentality that often promotes inefficiency land use and the realities of decreased future land availability from natural hazards.

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