Olympia Sea Level Rise Response Plan

MARCH 2019

LOTT Clean Water Alliance

Olympia

PORT of OLYMPIA

Olympia Sea Level Rise Response Plan

Project Partners: City of Olympia/LOTT Clean Water Alliance/Port of Olympia

Consultant: AECOM

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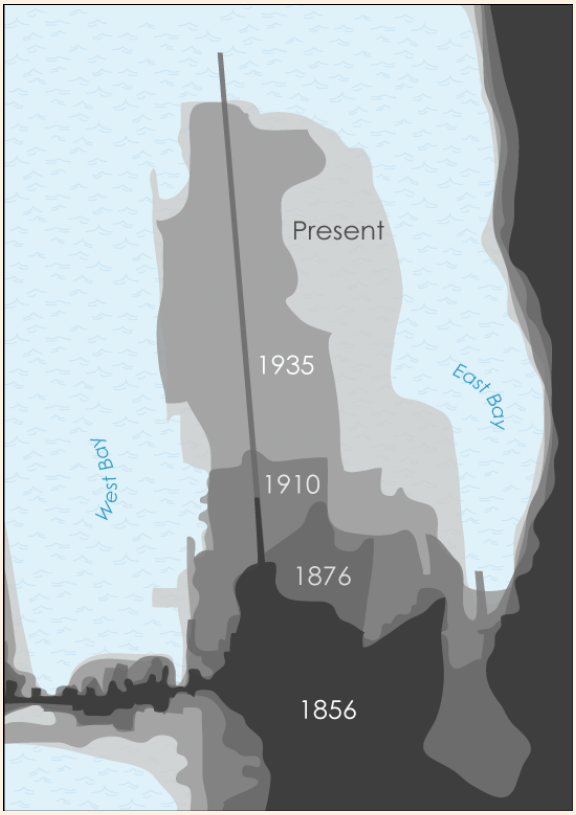
PLANNING CONTEXT

INTRODUCTION

Downtown Olympia has always been vulnerable to flooding. The confluence of high water levels in Capitol Lake and high tides in Budd Inlet can cause water to overtop the shoreline and spill into downtown streets and low-lying areas. Even with minimal amounts of sea level rise, the risk to our downtown's built environment and its many community services increases quickly and substantially. Downtown flooding is anticipated to become more frequent and severe in the future. This Sea Level Rise Response Plan (Plan) provides a comprehensive strategy for adapting to rising sea levels in both the near and long-term.

Downtown Olympia serves as the social, cultural, historic, and economic core of the City. Downtown's economic health is linked to the overall economic health of the region. The 450-acre downtown area contains vital infrastructure such as Olympia City Hall, the Budd Inlet Treatment Plant, the Port of Olympia marine terminal, and the emergency vehicle corridors between west and east Olympia. The Olympia Farmers Market, Heritage Park, and Percival Landing are important cultural and recreational places to many residents. Our waterfront and its link to Puget Sound are highly valued by our community and need to be protected.

Protecting and improving our downtown is central to the City's comprehensive plan, land use decisions, and development strategies. For many years, sea level rise has been an important topic during community planning discussions. Community plans for downtown assume and rely upon a comprehensive approach for responding to sea level rise.



A HISTORY OF CHANGE

Recognition of the changes that have occurred in our community helps frame our perspective of future change. Downtown Olympia and its peninsula have changed dramatically over the past 150 years. Over this time, approximately 15 dredge and fill projects added over 430 acres and nearly two miles of shoreline to downtown. We can anticipate more change in the downtown landscape in the decades ahead, such as raising of the shoreline and buildings, future development, and land use changes. Sea level rise will be one of the drivers of change, but not the only driver.

Source: Sea Level Rise: Re-imaging the Urban Edge, Brenda Lorene Snyder

PLANNING CONTEXT

Proactively adapting to sea level rise can help avoid damage and disruptions from more frequent flooding, thereby reducing costs in the long-term. Implementing a Sea Level Rise Response Plan ensures that agencies, stakeholders, and other key players are coordinated and working together to maximize the limited resources available to adapt to rising sea levels. As implementation occurs, compliance with local, state, and federal regulations will be required. More detailed information on the regulatory context that will inform implementation is included in the Plan's Planning Framework (Appendix B).

PROJECT PARTNERS – A UNIQUE COLLABORATION

The City of Olympia (City), Port of Olympia (Port), and the LOTT Clean Water Alliance (LOTT) (collectively referred to as the "Project Partners") worked together on this Plan. Each have essential public responsibilities and share similar, but unique, flooding threats – therefore, references to the individual entities in this Plan are intentional. The City is responsible for protecting critical public infrastructure and essential public health and safety services. The City owns portions of the shoreline and public street rights-of-way near the shoreline. The Port owns considerable shoreline property and maintains important commerce-related infrastructure funded by County-wide property tax levies. LOTT owns and operates the regional wastewater treatment facility that serves 118,000 people across the urban areas of Lacey, Olympia, and Tumwater in north Thurston County. Each Project Partner has contributed financially to this Plan's development and staff with broad expertise, responsibilities, and understanding of Olympia have helped shape the Plan.

Other entities have been involved in the planning process as well and will continue to be involved in the years to come. As manager of Heritage Park, Capitol Lake, and the Lower Deschutes Watershed, the Washington Department of Enterprise Services is a close partner. The Washington Department of Natural Resources will play a role as owner of portions of the Percival Landing and Isthmus shorelines. Other local, State, and federal governmental entities have been involved and offered support and expertise through the development of the Plan. These entities will play an increasing role in the future as the Plan is implemented.

THE PLANNING AREA

The sea level rise response planning process focuses on the downtown peninsula and upland areas that are susceptible to Budd Inlet and Deschutes River flooding (Figure 1). The project area encompasses the downtown peninsula from the eastern shoreline of the 4th Avenue Bridge in West Bay to the intersection of East Bay Drive and Olympia Avenue in East Bay. The planning area includes the Capitol Lake / Lower Deschutes Watershed shoreline along Heritage Park. The southern boundary of the planning area reaches to uplands on the southern side of downtown. The entire Port property and the LOTT Budd Inlet Treatment Plant are included. This area includes the key publically-owned infrastructure and services of the urban core.

A HISTORY OF FLOODING

Though damaging flooding in downtown last occurred in the 1970s, future winters could bring more frequent and severe flooding due to sea level rise. The right mix of tides, river flows, and weather could frequently flood downtown, causing appreciable property damage and loss of public services. With just 12 inches of sea level rise, the severity of flooding that currently occurs on average once every 100 years could occur as frequently as every other year. It is this acknowledgement of our current and future flooding risk that brought sea level rise to the forefront of long-term community planning.

Local and State operations and maintenance staff are coordinated and prepared to respond to downtown flooding. Fortunately, high tides are predicted long in advance. Strong weather patterns can typically be foreseen and monitored for several days in advance of an event. We can and will respond to most flooding threats competently and effectively. However, we know that the "perfect storm" could arrive any winter. Such a storm would be challenging to manage and could overwhelm our response capacity.

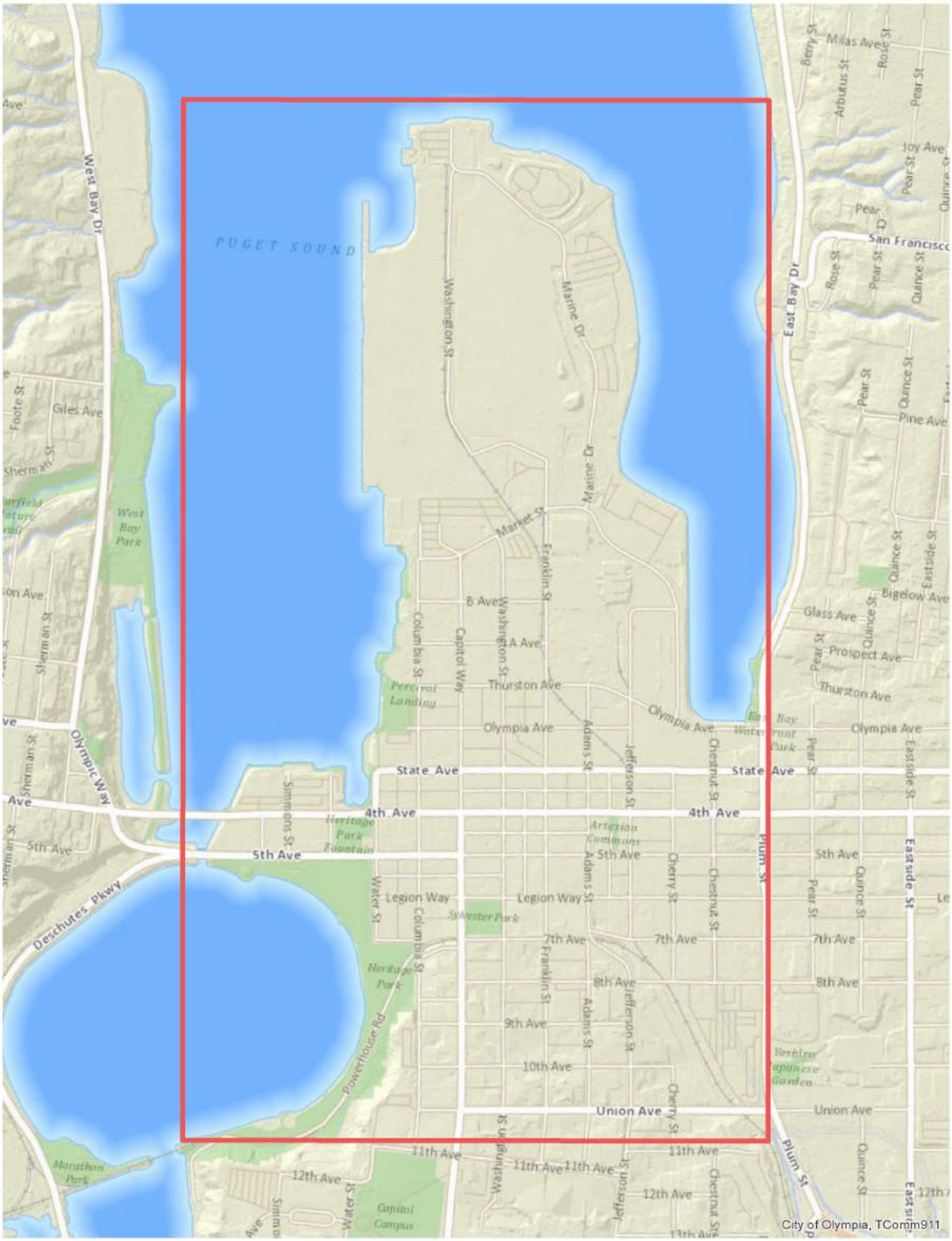
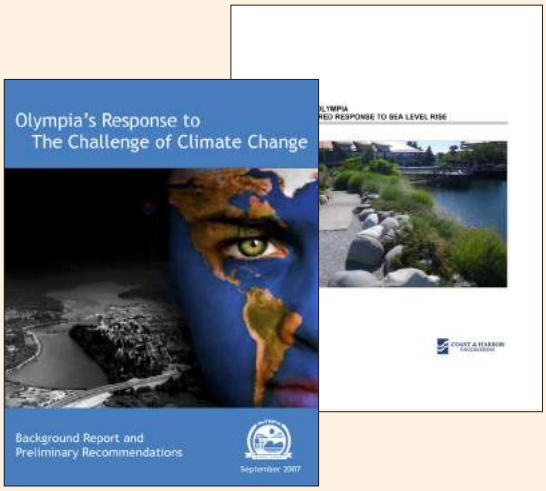


Figure 1. Olympia Sea Level Rise Response Plan Project Area

OLYMPIA LEADERSHIP ON CLIMATE CHANGE

Olympia was one of the first cities in the nation to begin planning for climate change. A number of studies have been completed since the early 1990s:

- City of Olympia's Response to the Challenge of Global Climate Change (1991)
- City of Olympia Preliminary Assessment of Sea Level Rise in Olympia, WA (1993)
- City of Olympia's Response to the Challenge of Climate Change (2007)
- City of Olympia's Engineered Response to Sea Level Rise (2011)
- LOTT's Budd Inlet Treatment Plant Sea Level Rise Vulnerability Assessment (2014)



UNDERSTANDING SEA LEVEL RISE IN OLYMPIA

Our community has long recognized our individual and governmental responsibilities for both minimizing climate change and adapting to its impacts. The City's awareness of and work related to climate change and sea level rise dates back to the early 1990s. The City updates its elected officials and the community annually on our progress. The Project Partners are well-poised to implement this sea level rise adaptation plan as a result of this early climate change and sea level rise engagement.

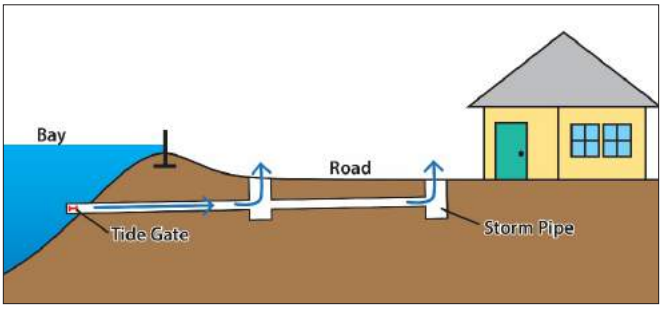
Since 2007, the City has been accumulating water elevation information on Budd Inlet and the Deschutes River. We have collected land elevation data and surveyed elevations for most buildings and infrastructure to understand how sea level rise could affect downtown and the ability to provide public services. This work forms the basis for the Project Partners' planning work.

The City and LOTT both previously conducted initial assessments of flood vulnerabilities to better understand how sea level rise would impact the downtown area and Budd Inlet Treatment Plant. The findings of those prior assessments helped steer the direction of the current adaptation planning effort.

Approximately every other year, high tides and Deschutes River flows cause minor, short-term flooding along the shoreline. Washington Department of Enterprise Services staff carefully manage Capitol Lake water levels. The City's Public Works Department staff manage stormwater valves and pumps in order to minimize the severity of flooding during high water events. Budd Inlet and Deschutes River waters occasionally flood downtown streets and parking lots, but subside quickly with minimal property or service impacts.

Project Partners staff track high water events in Capitol Lake and Budd Inlet. Flooding from these water bodies can enter City streets and catch basins connected to the combined storm/sewer system. This, in turn, can dramatically increase peak flows into LOTT's Budd Inlet Treatment Plant, and potentially overwhelm the plant's hydraulic capacity. Similarly, flooding along the Port's shoreline is monitored and managed.

Flooding in downtown Olympia can also occur when floodwater from Capitol Lake and/or Budd Inlet backflows into stormwater pipes and upwells in City streets through street drains. This occurs when water levels in Capitol Lake or Budd Inlet are higher than the elevation of the street drains. In some locations, floodwaters can then flow back into combined sewer catch basins that drain to the Budd Inlet Treatment Plant. City staff understand this dynamic and have been



evaluating its impacts and potential solutions for many years.

TAKING ACTION NOW

In addition to studying and understanding potential local impacts of sea level rise, the City, Port, and LOTT have long been taking actions to minimize flooding impacts in the downtown area. High water levels in Capitol Lake and Budd Inlet can backflow into stormwater pipes, reduce pipe capacity, and cause street flooding. The City maintains tide gates to prevent backflow into the stormwater collection system and prevent flooding in low-lying areas of downtown. Recently, the City and Port began installing additional tide gates and valves on several key stormwater pipes to lessen the frequency and severity of street flooding downtown.

In 2016, the City adopted a Sea Level Rise Flood Damage Reduction ordinance (OMC 16.80) that regulates development within areas potentially exposed to future flooding due to sea level rise. The ordinance requires that new construction and substantial improvements be elevated or flood-proofed to a height two feet above the current 100-year flood level in Budd Inlet.

LOTT accounts for sea level rise in design and construction of projects at the Budd Inlet Treatment Plant. Projects such as the LOTT Regional Services Center (2010), primary sedimentation basins (2014), and electrical switchgear equipment replacement (2016) were all constructed one to two feet higher in elevation. In addition, the new electrical switchgear equipment includes watertight enclosures and conduits to further protect sensitive equipment.

In early 2017, the Project Partners' planning and technical staff were tasked by their respective elected officials to develop a formal community plan that prioritizes strategies and investments for best responding to sea level rise, while protecting downtown's economic, social, and environmental values. AECOM, a consulting firm with national and international sea level rise adaptation experience, was selected to guide the Project Partners in developing this Plan.

PLANNING VISION, PURPOSE, AND PRINCIPLES

The Project Partners developed a planning framework to articulate and communicate the vision, purpose, guiding principles, and assumptions for the sea level rise adaptation planning process. The vision, purpose, principles, and assumptions are presented below.

VISION

The Sea Level Rise Response Plan will be a formal community plan that prioritizes strategies and investments for best responding to sea level rise, while protecting downtown's economic, social and environment values.

PURPOSE

- Develop an actionable plan to protect downtown from sea level rise within the planning horizon (see Assumptions below)
- Understand vulnerabilities and the implications of taking no action
- Identify priority sea level rise response actions and implementation timelines
- Estimate costs of actions and identify resources needed for implementation

FEASIBLE SOLUTIONS EXIST FOR OLYMPIA

The Project Partners are confident that with community support, the risks of sea level rise can be managed technically and financially in the decades ahead. There is strong community support for protecting, investing in, and ensuring that downtown is safe and welcoming. These values were expressed through multiple public processes and serve as the basis for the City's Comprehensive Plan. These values are also reflected in this Plan.

- Promote an understanding of the shared responsibilities between public, private, and community interests in adapting to sea level rise
- Identify responsibilities for Project Partners and other stakeholders

PRINCIPLES

- **Science:** Incorporate the best available science and lessons learned from other coastal communities to inform plan development
- **Adaptable Plan:** Develop the plan as a living document, expecting that assumptions, approaches and timelines will be adapted over time based on best available science
- **Public Involvement:** Engage community partners and stakeholders using an open and transparent process that incorporates community input
- **Protection:** Protect the social, historic, and economic heart of the City
- **Critical Infrastructure:** Provide for the continued operation of critical public infrastructure, including LOTT's Budd Inlet Treatment Plant and the Port's Marine Terminal, Swantown Marina, and Boatworks
- **Financial:** Ensure that adaptation strategies are evaluated for financial feasibility
- **Multiple Benefits/Innovation:** Prioritize innovative, inter-disciplinary solutions that increase resilience to sea level rise while providing multiple community and environmental benefits
- **Coordination:** Coordinate with and support other initiatives such as the City of Olympia Downtown Strategy and Thurston County Regional Council Climate Adaptation Plan

ASSUMPTIONS

Several key planning assumptions provide the basis for the Plan's approach, strategies, and implementation. The key assumptions are summarized below and documented in more detail in Appendix B, Sea Level Rise Planning Framework.

- **Project Area:** The project area includes the downtown peninsula (including Port of Olympia and Budd Inlet Treatment Plant) from the eastern shoreline of the 4th Avenue Bridge in West Bay to the intersection of East Bay Drive and Olympia Avenue in East Bay, also including the Capitol Lake shoreline along Heritage Park (Figure 1)
- **Risk Tolerance:** Given downtown's social, cultural, and economic importance and extensive public and private infrastructure, Olympia has a low risk tolerance for sea level rise. Nevertheless, the level of risk tolerance may be different for various assets depending on factors such as asset lifespan, criticality, and adaptive capacity.
- **Sea Level Rise Scenarios:** Given upward evolving sea level rise projections, the long planning horizon, and downtown's low risk tolerance, it is deemed appropriate to use high-range (lower-probability, higher impact) sea level rise scenarios for Puget Sound with local adjustments for Olympia
- **Planning Horizon:** The planning horizon for the Plan is the year 2100
- **Incremental Planning:** This planning process represents the necessary first incremental step to addressing sea level rise for the community. It is not the last step. As such, the Plan will not provide detailed costs or confirmed funding sources.
- **Capitol Lake:** The Plan will be adaptable to future decisions made by Washington State about the long-term management of Capitol Lake and Lower Deschutes River Watershed
- **Downtown Strategy:** The sea level rise response planning process and resulting plan will build upon and be consistent with the vision, goals, and recommended actions of the Downtown Strategy which was developed through an extensive public process.
- **Retreat Strategy:** A retreat strategy and associated costs are not within the scope of work of this project
- **Climate Change Mitigation:** Climate change (greenhouse gas) mitigation is outside the scope of this project. Nevertheless, some adaptation strategies may provide secondary benefits of mitigating greenhouse gas emissions.

SEA LEVEL RISE ADAPTATION PLANNING PROCESS

This sea level rise adaptation planning process leveraged experiences and lessons learned from other cities and governmental entities throughout the country. The Plan has been tailored to Olympia's unique characteristics and needs by incorporating the Project Partner's own climate change and sea level rise experience.

Sea level rise adaptation planning typically follows a seven-step process, summarized in Figure 2. To develop this Plan, the Project Partners completed the first five steps of the process. With steps 1-5 completed, the Project Partners are now well positioned to begin the

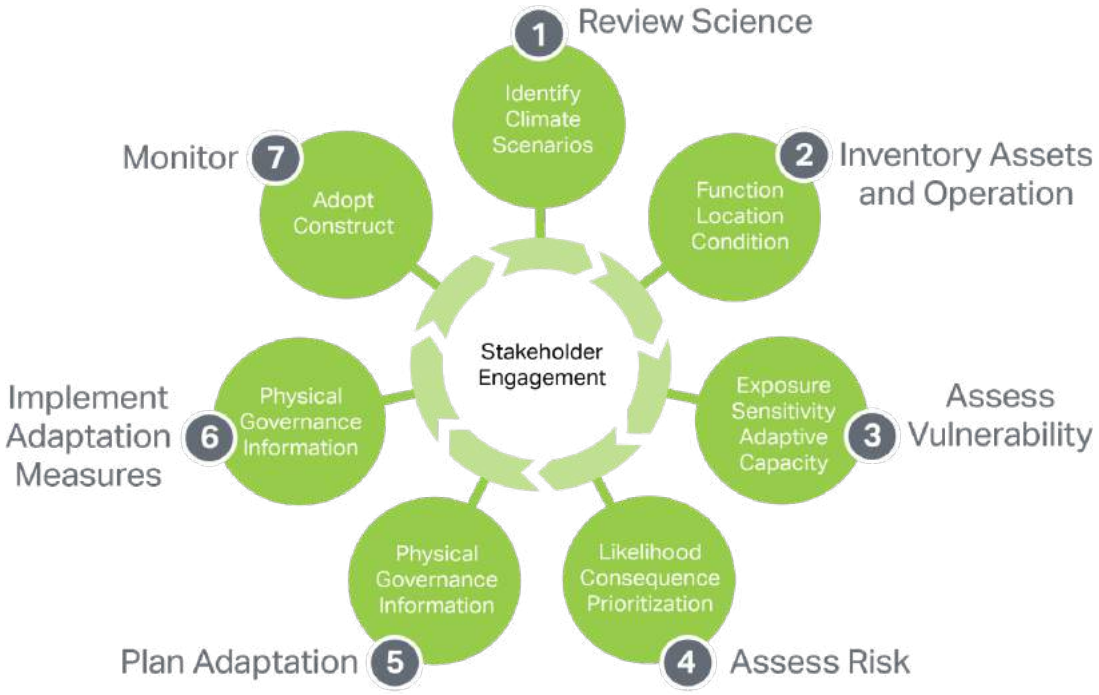


Figure 2. Sea Level Rise Adaptation Planning Process

implementation and monitoring phases. The purpose of each step in the planning process is summarized below.

STAKEHOLDER ENGAGEMENT

Stakeholder engagement is at the center of the sea level rise adaptation planning process, as community involvement is crucial to every step. The Olympia community has long been aware of and engaged in climate change and sea level rise issues and there was a high level of participation throughout this process. Community engagement since May 2017 included:

- E-newsletter project updates
- Four open house and community workshops
- Multiple coordination meetings with State agencies
- Numerous workshops with Project Partner staff
- Briefings for local community groups and appointed citizen advisory committees
- A month long Sea Level Rise Self-Guided Walking Tour and a walking tour event
- Climate change and sea level rise conference speaking engagements
- School children and teacher-training outreach events

More detail on our community outreach activities can be found in Chapter 2 and Appendix A.

STEP 1: REVIEW SCIENCE

Step 1 conducted a review of the best available science on sea level rise, coastal flooding, and precipitation in order to establish a scientific basis for evaluating climate change and sea level rise impacts to the project area.

The results of Step 1 are presented in the Climate Science Review, October 2017 (Appendix C) and summarized in Chapter 3.

STEP 2: INVENTORY ASSETS AND OPERATIONS

Step 2 developed a comprehensive inventory of assets located within the project area to better understand downtown's critical assets and functions. The inventory includes infrastructure owned and operated by the Project Partners as well as infrastructure supporting Project Partners' operations, but owned or operated by others. Additionally, downtown's historical, cultural, recreational, and public service amenities were evaluated.

The results of Step 2 are presented in the Vulnerability and Risk Assessment, March 2018 (Appendix D) and summarized in Chapter 4.

STEP 3: ASSESS VULNERABILITY

Step 3 evaluated asset and community services vulnerability to projected flooding by king tides and 100-year storm tides at each sea level rise scenario. Assets are considered vulnerable if they are exposed to existing or future flooding, are sensitive to flood waters, and have a low adaptive capacity to cope with impacts of flooding.

The results of Step 3 are presented in the Vulnerability and Risk Assessment, March 2018 (Appendix D) and summarized in Chapter 4.

STEP 4: ASSESS RISK

Step 4 evaluated the magnitude of the impact of flooding on those assets and services identified as vulnerable in Step 3. This was done by considering the social, environmental, and economic consequences of flooding for individual assets.

The results of Step 4 are presented in the Vulnerability and Risk Assessment, March 2018 (Appendix D) and summarized in Chapter 4.

STEP 5: PLAN ADAPTATION

Step 5 developed a comprehensive approach to responding to sea level rise for downtown Olympia. In addition to physical solutions, adaptation strategies included governance strategies, identification of informational gaps, and changes to operations and services.

The results of Step 5 are summarized in Chapters 6 through 8.

STEP 6: IMPLEMENT ADAPTATION MEASURES

Step 6 is a future step in the adaptation planning process to implement actions. Chapters 6 through 8 identify the actions that will be necessary to protect downtown from sea level rise and Chapter 9 includes a discussion of next steps for implementation.

STEP 7: MONITOR ADAPTATION

Step 7 is another future step to ensure that a process is in place to review current conditions against Plan assumptions and actions and inform future decision making. Monitoring is a critical and ongoing component of any successful adaptation planning effort. Given the long planning horizon for sea level rise and climate change, monitoring and subsequent adaptation is especially important.

Chapter 10 includes discussion of proposed monitoring actions that need to occur by the Project Partners to track changing environmental conditions, sea level rise science, and storm response.

WHAT IS THE CITY DOING TO ADDRESS THE CAUSES OF CLIMATE CHANGE?

Through this adaptation planning process, the Project Partners have focused on how to respond to the most critical climate change dynamic facing our community – sea level rise.

However, efforts are also underway on climate change mitigation. Mitigation refers to actions that communities take to limit greenhouse gas emissions and reduce the magnitude of long-term climate change. The Project Partners have implemented numerous common actions to reduce greenhouse gas emissions (e.g., purchase of Puget Sound Energy Green Power, LED lighting, electric vehicles, solar energy, etc.). The City is also building a multi-modal transporation system to reduce growth and automobile use and greenhouse gas emissions. This work is expected to continue over time.

Additionally, the City, in concert with neighboring cities and Thurston County, has set ambitious emission reduction goals for our community. Planning is underway to address the strategies that will be required to meet the emission reduction goals. Implementation of the mitigation strategies being developed will require community-wide engagement.

While it is important to continue to take actions to mitigate climate change, it is also necessary to take measures to adapt to the changing climate. Science shows that even with a dramatic reduction in carbon emissions beginning immediately, sea levels will continue to rise.

CHAPTER 2— ENGAGEMENT AND OUTREACH

ENGAGEMENT AND OUTREACH

Stakeholder and public engagement was at the center of each phase of the adaptation planning process as described in Figure 2. The Project Partner's public involvement and communication goals were to: 1) inform community members about flood risks associated with sea level rise and its various implications to our downtown area, and 2) involve and gather community input on potential adaptation actions and priorities through an iterative plan development process.

A Communication Plan was developed to guide outreach and involvement at each stage of the planning process. The Communication Plan identified key questions for each task and created outreach materials and strategies to help answer those questions. This chapter summarizes the public outreach and involvement activities conducted as part of this planning process. The complete Sea Level Rise Communication Plan is available as a separate document (Appendix A).

Existing information from previous public involvement and planning efforts was used as a foundation for sea level rise outreach, including the City of Olympia's Downtown Strategy and previous City planning efforts. Throughout the planning process, a variety of communication tools were used to raise awareness of the planning effort and share results.

The City redeveloped its long-standing sea level rise webpage which became the hub for information related to the planning effort. A sea level rise email listserv was created and subscribers were sent E-newsletters, at least quarterly, and more often as updates became available. Social media tools (Twitter, Facebook, NextDoor) were used to promote meetings, events, and opportunities for engagement, and to direct followers to the sea level rise webpage. Media coverage of the planning effort was promoted through news releases and contacts with local and regional reporters.

Olympia youth, specifically high school and college age community members, were a key audience. Outreach to youth included contact with area schools and individual teachers and professors that teach science, community planning, or other subjects related to sea level rise and climate change.

WHAT WE HEARD: WRITTEN COMMENTS FROM COMMUNITY MEMBERS

- *Should be phased consistent with observed sea level rise. Plan for the worst, but build in stages to accommodate new technology and building transitions.* (survey)
- *Establish a local improvement district (LID) to pay for any measure to defend downtown. Make the assessment to properties a function of the assessed value and the relative height to sea level rise. Do not charge the rest of the City to save downtown. At best, let property owners outside the affected area earmark a % of property tax assessment for sea level rise mitigation by the City.* (01/18/18)
- *Think now of increasing the setbacks to accommodate the need for berms and paths. Consider areas for selective flooding. At greater than 2 feet should we consider retreat?* (09/19/18)
- *Knowledge and awareness of the plan throughout Oly spurs people to double their climate mitigation efforts so as to reduce ultimate SLR* (06/27/2017)
- *Tax payers should be asked if they are willing to pay for expensive solutions such as dams and dikes* (06/27/2017)
- *Danger to unhoused population in downtown area* (survey, "other consequences")

Note: Selected written comments only. See Sea Level Rise community involvement webpage for complete meeting summary reports: http://olympiawa.gov/City-utilities/storm-and-surface-water/sea-level-rise/slr-community-involvement.aspx

SUMMARY OF PUBLIC AND STAKEHOLDER ENGAGEMENT

Table 1 presents a summary of public and stakeholder engagement activities conducted from 2017 to 2019 as part of the Plan.

Table 1: Summary of Public and Stakeholder Engagement Activities

Date	Format	Meeting content
2017		
Feb	– Public meeting	– Introduced the planning effort, refined project area and project goals
June	– Public meeting	– Reviewed sea level rise issues, sought input on flooding locations, refined project area and project goals
Sept	– Stakeholder meetings with City of Olympia departments, LOTT Clean Water Alliance, Port of Olympia, Intercity Transit, Thurston County, State of Washington, and Puget Sound Energy	– Reviewed vulnerability assessment, introduced adaptation strategy options, collected ideas on adaptation strategies
2018		
Jan	– Public meeting – On-line survey – Elected officials meeting	– Provided overview of flooding vulnerabilities, collected feedback on consequences of most concern and on evaluation criteria for selecting adaptation strategies – Survey participants answered same questions posed at public meeting – Provided project update and feedback
June – Sept	– Business community meetings with property owners, Chamber of Commerce, and Downtown Business Association. – Stakeholder meetings with Community Planning & Development, Parks, Arts, and Recreation, Fire & Police, Public Works, LOTT, Port of Olympia, and, State of Washington	– Discussed Percival Landing and the idea of managed retreat. Information was shared about intended adaptation strategies and which businesses may be outside of the lines of defense – Reviewed prioritization of adaptation strategies identified to date
Sept	– Public meeting – Elected officials meeting – Public self-guided walking tour – Briefings for state agencies including the Department of Enterprise Services, Department of Natural Resources, and Department of Ecology – The City sought input from its Utility Advisory Committee and Park and Recreation Advisory Committee	– Presented draft strategies and gathered feedback with a presentation and open house – Presented draft strategies and gathered feedback, and discussed governance issues and strategies – Downtown waterfront had kiosks, displays, and elevation markers to illustrate the impact of sea level rise – Discussed intended adaptation strategies
Dec	– Public meeting – City met with Utility Advisory Committee, Parks & Recreation Advisory Committee, and internal work groups. The Port and LOTT gathered staff input.	– Reviewed proposed plan and gathered feedback, through presentation, question and answer sessions, and Open House stations
2019		
Jan	– Elected officials meeting	– Shared the final plan and facilitated discussion about continued collaboration on sea level rise planning.

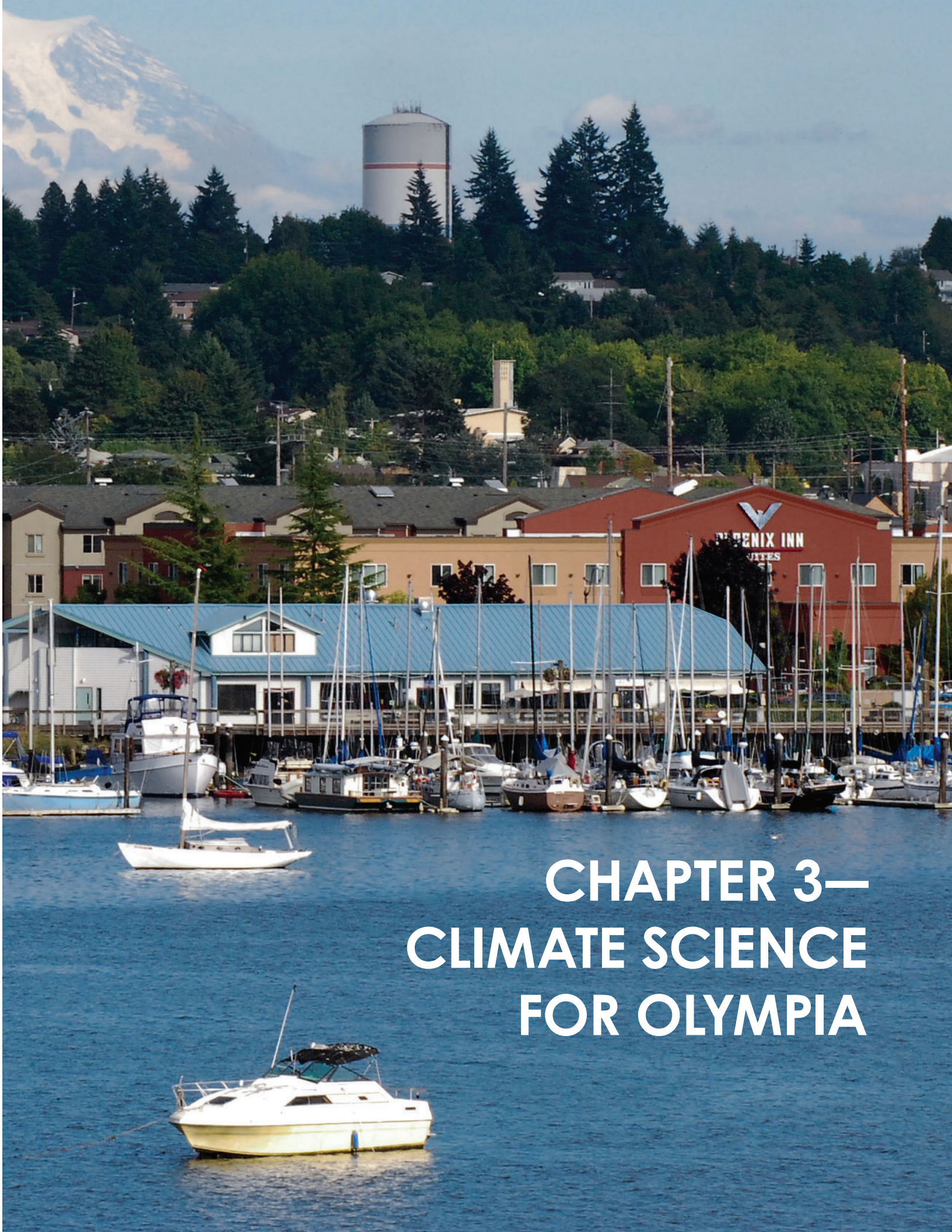
ADDITIONAL COMMUNITY ENGAGEMENT ACTIVITIES

In addition to the community engagement opportunities described above, presentations and discussions occurred throughout the planning process with numerous interested community groups and public organizations, advisory committees, commissions, associations, organizations, schools, and public events. Those groups and events are summarized in Table 2.

Going forward, it will be important to continue to engage the community and gather input on how to implement the Plan. The Plan recommends holding a public meeting at least annually to update the community on next steps and implementation efforts. An on-line involvement format may also be used to ask for feedback on preferred means of continued engagement on sea level rise planning.

Table 2: Additional Community Engagement Activities

Advisory Committees	Commissions	Associations	Organizations/Schools	Events
– Olympia Utility Advisory Committee – Olympia Parking and Business Improvement Area – Olympia Land Use and Environment Committee – Olympia Parks and Recreation Advisory Committee	– Olympia Planning Commission – Port of Olympia Commission – Heritage Commission	– Coalition of Neighborhood Associations – Olympia Downtown Association – League of Women Voters – International Longshore and Warehouse Union Local 47 – Chamber of Commerce	– Downtown Rotary – Gateway Rotary – Marshall Middle School – Teacher Training "Sea Level Rise in Urban Areas"	– Emergency Preparedness Expo – Arts Walk – Geohazards Symposium – Salish Seas Conference – Saint Martin's University Environmental Studies Forum – NW Climate Conference



CHAPTER 3—
CLIMATE SCIENCE FOR OLYMPIA

CLIMATE SCIENCE FOR OLYMPIA

The Project Partners have acknowledged our local vulnerability to potential sea level rise for several decades. The Project Partners have tracked the science of climate change and gathered Olympia-specific information. The following is a summary of sea level rise dynamics in Olympia. More detailed data and information is included in the Plan's Climate Science Review (Appendix C).

OLYMPIA'S LANDSCAPE

Olympia is located on Budd Inlet at the southern terminus of Puget Sound. The Deschutes River feeds Budd Inlet on the southwest side of the downtown peninsula and was dammed in 1951 to create Capitol Lake. Water levels within the lake are managed by a water control structure at 5th Avenue. This relationship between Puget Sound, the Deschutes River, and Capitol Lake affects Olympia's propensity to flood, both currently and into the future.

The Olympia shoreline has been greatly altered by development over the past century. Large portions of the downtown area and the Port of Olympia are built on artificial fill that was placed over several decades which shifted downtown's shoreline approximately 4,000 feet northward into Budd Inlet. These fill areas have been susceptible to subsidence and settling due to regional tectonic processes and natural soil compaction and are most susceptible to flooding from sea level rise. Currently available data indicates that the rate of subsidence in downtown Olympia is approximately 1 inch per decade. This will gradually increase the risk of flooding from sea level rise.

LAND SUBSIDENCE IN OLYMPIA

Olympia is sinking in elevation (a process referred to as "subsidence"). This subsidence is tied to the underlying geology and history of fill placement in Budd Inlet. Over the next five years, we will take steps to improve our long-term ability to monitor subsidence and understand its implications for flood risk.

Flooding along the downtown peninsula is due to complex coastal processes, which include high astronomical tides, storm surge, Pacific Ocean basin phenomena, and local wind and wave processes. Each of these processes can raise water levels independently and two or more may combine to form exceptionally high coastal water levels – particularly along exposed sections of shoreline where wave effects are important. The City has made significant investments in its downtown area over the past several decades, many of which are now vulnerable to flooding.

WATER LEVELS AND WAVES

Olympia's coastal water levels fluctuate naturally throughout the day due to astronomical tides produced by the gravitational pull of the moon and sun. Located at the southern end of Budd Inlet, Olympia experiences one of the largest tide ranges in Puget Sound. Typical daily tides reach heights of 14 to 15 feet above mean lower low water (MLLW) and the highest annual tides—called king tides—can exceed 16 feet.

Large storms associated with low pressure and high winds occur every winter in Puget Sound and can elevate water levels at the shoreline by 0.5 to 3 feet above normal tide conditions. Although the Olympia shoreline is protected from large ocean swells and waves, it is exposed to locally generated wind waves that can reach two to five feet.

In addition to coastal processes, large precipitation events also contribute to increases in local water levels. Heavy rainfall in the Deschutes River watershed can cause high river flows to overtop the river banks and overflow along the Capitol Lake shoreline.

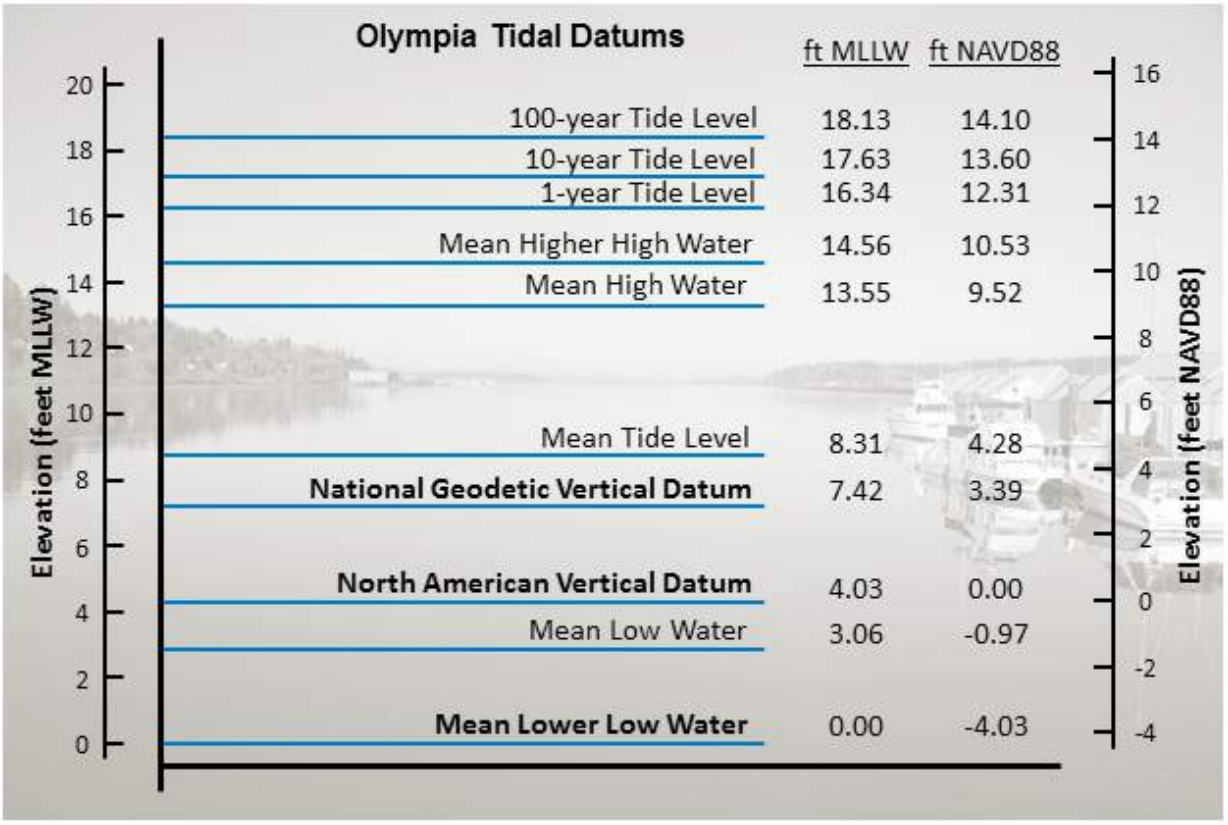


Figure 3. Tidal Datums and Extreme Tide Levels at Olympia

Figure 3 presents average tidal datums and extreme tide levels in Olympia. See call-out box for description of MLLW and NAVD88 vertical datums used to measure water levels and ground elevations in Olympia.

CAUSES OF CLIMATE CHANGE AND SEA LEVEL RISE

Recent State, federal, and international climate reports have reiterated that evidence of climate change is unequivocal and that the human influence on the climate system is clear (IPCC 2014, USGCRP 2018, Miller et al. 2018). Over the past few centuries, the composition of the atmosphere has changed as a result of human activity; there has been an increase in the concentration of various greenhouse gases, aerosols, and ozone. These changes are due to the combustion of fossil fuels, agriculture, deforestation, and land use changes. The cumulative impact of these atmospheric changes has been a net warming of the earth's atmosphere and oceans at a global scale. As the planet has warmed, global sea levels have increased as a result of two primary processes:

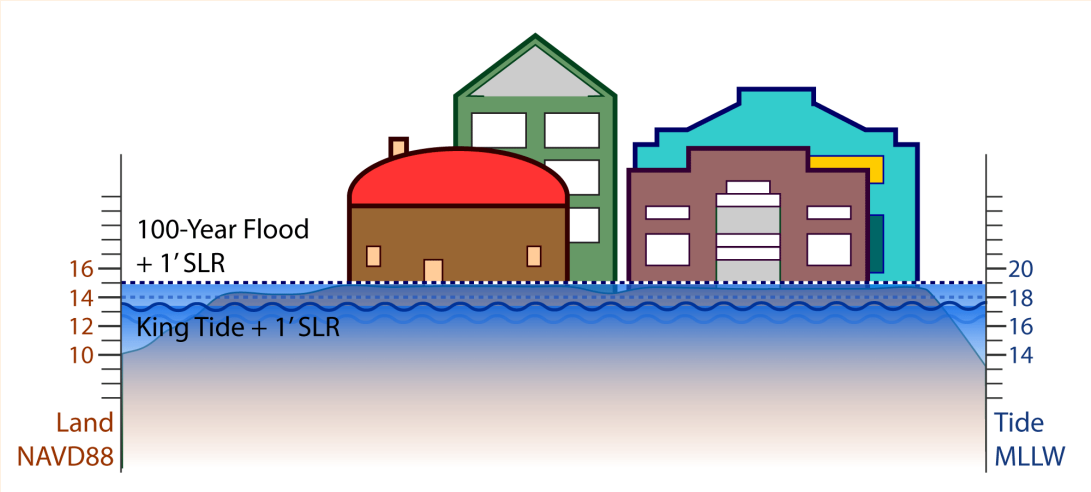
- The warming of the oceans causes water to expand, thereby increasing sea levels at the coastline; and
- The warming of the atmosphere has caused melting of polar ice sheets and mountain glaciers, which increases the volume of water in the world's oceans.

DIFFERENCE BETWEEN WATER AND LAND-BASED DATUMS (MLLW VS. NAVD88)

Tidal heights and ground elevations presented in this Plan are measured relative to standard reference levels called *vertical datums*. Vertical datums are established levels of zero elevation against which other water and land heights are measured. Two commonly used vertical datums for water and land elevations are summarized below:

- **Mean Lower Low Water (MLLW):** Boaters and sailors may be familiar with the MLLW tidal datum. MLLW is calculated by averaging the lower of each of the two low tides each day over a long-term observation period. Predicted and observed tide heights are then measured relative to the MLLW tidal datum. For example, typical daily high tides in Olympia reach heights of 13 to 15 feet above MLLW. Extreme tides reach heights of 16 to 18 feet MLLW.
- **North American Vertical Datum (NAVD88):** Surveyors and engineers often use a land-based datum called the North American Vertical Datum to measure ground and building elevations. Water levels in Capitol Lake and Budd Inlet can also be measured relative to NAVD88.

Vertical elevations of water levels and land features can be easily converted between MLLW and NAVD88. The graphic below shows how land and water elevations can be measured relative to either the MLLW or NAVD88 vertical datums, depending on project needs.



SEA LEVEL TRENDS

During the 20th century, global ocean levels increased at an average rate of 1.7 mm or 0.07 inches per year (IPCC 2013). Recent satellite altimetry observations show that this rate continues to accelerate every year due to increased melting of ice sheets in Greenland and Antarctica. Over the past 20 years, the rate has increased to 3.3 mm/year or 0.13 inches per year, roughly twice the average rate of the preceding 80 years (IPCC 2013; Chen et al. 2017).

Additionally, complex tectonic processes in the Pacific Northwest produce large spatial variations of land uplift and subsidence that lessen or amplify the relative rate of sea level rise with respect to the land. For example, large portions of the Olympic Peninsula are experiencing relatively high rates of uplift (3 to 4 mm/year), causing a relative drop in sea levels since the 1930s. In contrast, areas such as Olympia have experienced subsidence and more rapid relative rates of sea level rise. Analysis of long-term tide observations at Seattle indicates a 20th century sea level rise rate of 2.0 mm/year (equivalent to 8 inches/century), as indicated in Figure 4.

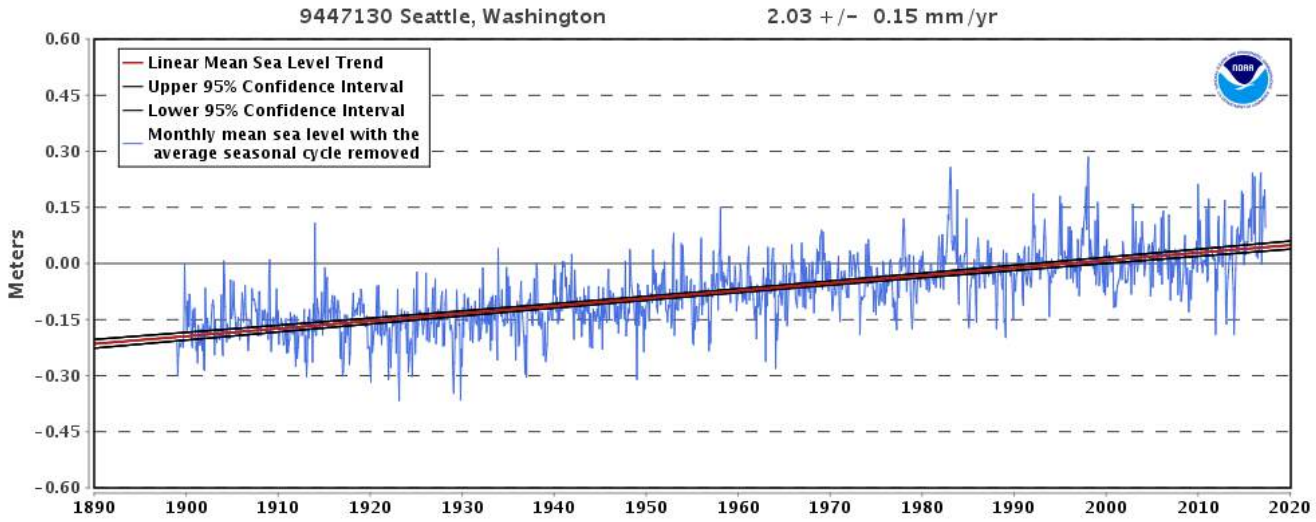


Figure 4. Observed Sea Level Rise Trends at Seattle Tide Station

Source: NOAA Tides and Currents sea level trends

HOW MUCH SEA LEVEL RISE HAS OCCURRED RECENTLY?

Scientists have been measuring sea level rise over the last couple decades using a sophisticated technology known as satellite altimetry. Since 1993, satellites have been measuring changes in sea level across the global oceans. These measurements have shown that global sea level rise is not uniform, with some areas experiencing higher rates of sea level rise than others (see Figure 5– red areas indicate regions of relatively high sea level rise). On average, global sea levels have risen 3.4 inches since 1993 and 2.5 inches since 2000.

Estimating local sea level rise in Puget Sound during the 21st Century is challenging due to short-term sea level rise variations and a lack of long-term monitoring stations. Additionally, large-scale Pacific Ocean basin phenomena such as the El Niño-Southern Oscillation and Pacific Decadal Oscillation influence West Coast sea levels and make it difficult to accurately estimate short-term sea level rise trends. Observations at the Seattle tide station indicate sea level rise of approximately 1.5 to 3.3 inches since 2000. Continued observation of sea level trends in Puget Sound will be required to better understand this changing dynamic.

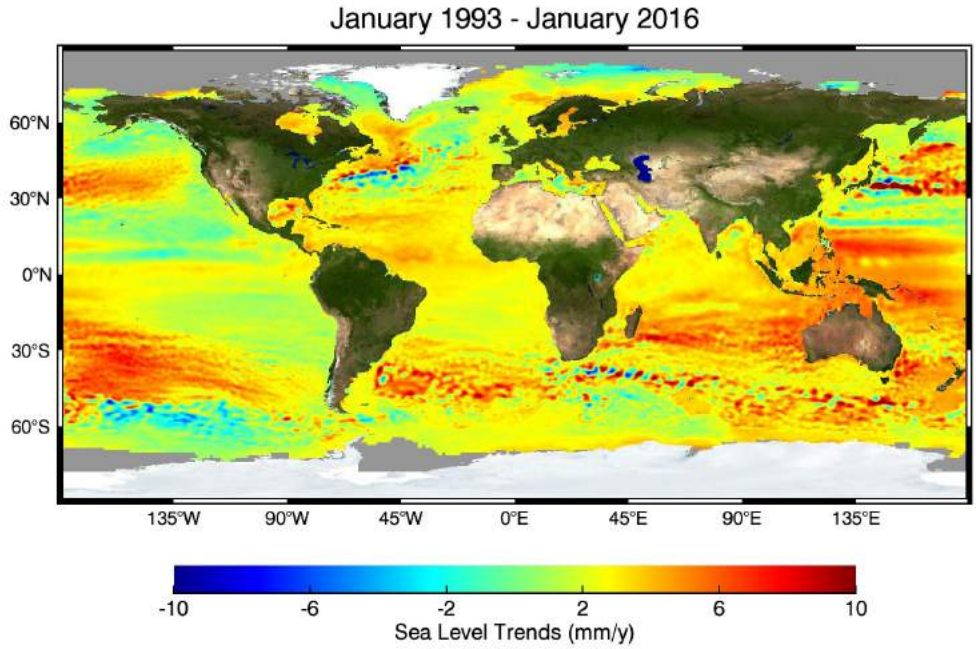


Figure 5. Sea Level Trends Globally January 1993-2016

Source: NASA Sea Level Change program

KEY SEA LEVEL RISE RESEARCH

The Plan relies on research regarded by experts in the field to be the best available. The Partners have long maintained close ties to the University of Washington Climate Impacts Group. The Group links science and decision making to help build regional climate resilience. Independently, staff keep abreast of emerging research and developments. Key research used in the Plan includes:

- Projected Sea Level Rise for Washington State – A 2018 Assessment, University of Washington
- Sea Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future, National Research Council
- Fifth Assessment Report, Intergovernmental Panel on Climate Change
- Various work efforts by the State of California
- Individual peer-reviewed research papers

SEA LEVEL PROJECTIONS

The science associated with sea level rise is regularly updated, revised, and strengthened. Although there is no doubt that sea levels have risen historically and will continue to rise at an accelerated rate over the coming century, it is difficult to predict with certainty what amount of sea level rise will occur over a given time frame.

A 2012 study by the National Research Council (NRC) provided projections of sea level rise at the Seattle tide station. The NRC study projected likely rates of sea level rise of 3 ± 2 inches by 2030, 7 ± 4 inches by 2050, and 24 ± 12 inches by 2100. The NRC study also provided unlikely but possible high-range estimates of 9 inches by 2030, 19 inches by 2050, and 56 inches by 2100. The NRC projections for Seattle incorporated a regional rate of tectonic uplift of 1 mm/year into the sea level rise projections. However, measurements at Olympia indicate the ground may be subsiding at a rate of approximately 1-2 mm/year (0.4-0.8 inches per decade). Therefore, the NRC sea level rise projections could underestimate the local rate of sea level rise for Olympia since the ground is sinking as the water levels are rising. In this Plan, we have modified the NRC projects to account for subsidence in Olympia.

Table 3 shows the NRC sea level rise projections modified for Olympia to incorporate local subsidence. Projections for Olympia are also shown graphically in Figure 6.

Table 3: Sea Level Rise Projections for Olympia

Year	Most Likely (inches)	High-Range (inches)
2020	3	7
2030	**5 to 7**	**11 to 13**
2040	8 to 10	16 to 18
2050	**11 to 13**	**23 to 25**
2060	15 to 17	30 to 32
2070	18 to 20	37 to 39
2080	22 to 25	46 to 49
2090	27 to 31	54 to 58
2100	**32 to 36**	**64 to 68**

Since initiation of the sea level rise response planning effort, new sea level rise projections were developed for the State of Washington by the Washington Coastal Resilience Project (Miller et al. 2018). The 2018 report provides an update to the 2012 NRC sea level rise projections by incorporating new science, accounting for local dynamics (such as subsidence and uplift), and providing information on the likelihood of different amounts of sea level rise under two future emissions scenarios. The new projections also extend to 2150.

As a component of this sea level rise planning effort, the 2018 report was reviewed to confirm that the projections adopted as part of this Plan were consistent with the latest available science for Puget Sound. This review found that the sea level rise projections presented in the Plan are generally consistent with the Olympia-specific projections provided in the new science document for 2050 and 2100, with the exception of the worst-case (0.1% probability of exceedance) estimate for 2100. The new projections indicate a very small probability of substantial sea level rise of up to nine feet by end of century; however, there is considerable uncertainty associated with the worst-case end-of-century projections. Under the high emissions scenario considered in the new report, there is approximately a one percent chance that sea level rise at Olympia would exceed the high-range projection (68 inches) assumed in this plan. Based on this review, the Project Partners concluded that the Plan projections are adequately conservative for response planning purposes at this time.

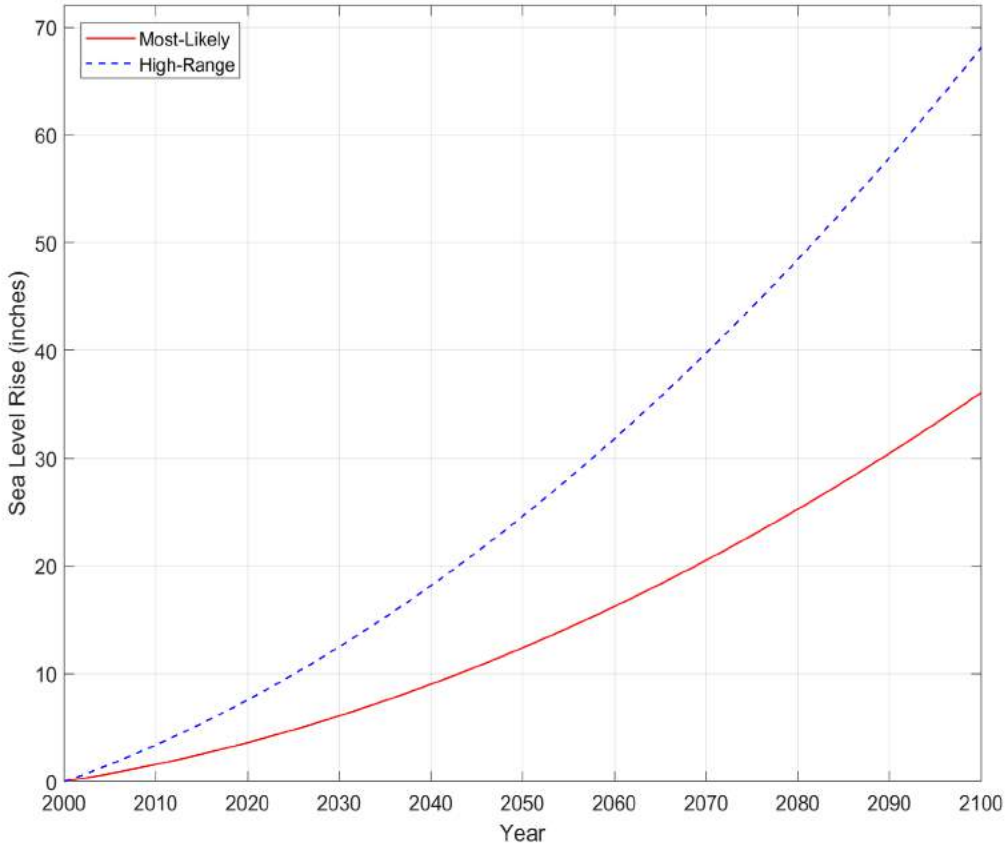


Figure 6. Sea Level Rise Projections at Olympia

PRECIPITATION PROJECTIONS

As with sea level rise, there is considerable uncertainty surrounding the effects of climate change on precipitation. Local precipitation projections are one of the least certain aspects of global climate models, as the models do not resolve many of the fine-scale and complex interactions that produce spatially variable rainfall.

Researchers evaluate future precipitation trends using General Circulation Models (GCM) that capture relevant ocean, terrestrial, and atmosphere processes and their response to increased atmospheric greenhouse gas concentrations. An increase in the frequency and intensity of downpours is one of the clearest historical precipitation trends related to climate change in the United States and one that is expected to continue in the future.

GCM results for the Puget Sound region indicate that Olympia and the Deschutes River watershed may experience a 10 to 30% increase in extreme 24-hour precipitation by mid-century and a 10 to 30% increase by end-of-century, depending on storm event and emissions scenario. Results also indicate that moderate intensity events (such as the present day 20-year rainfall event) could occur more frequently.

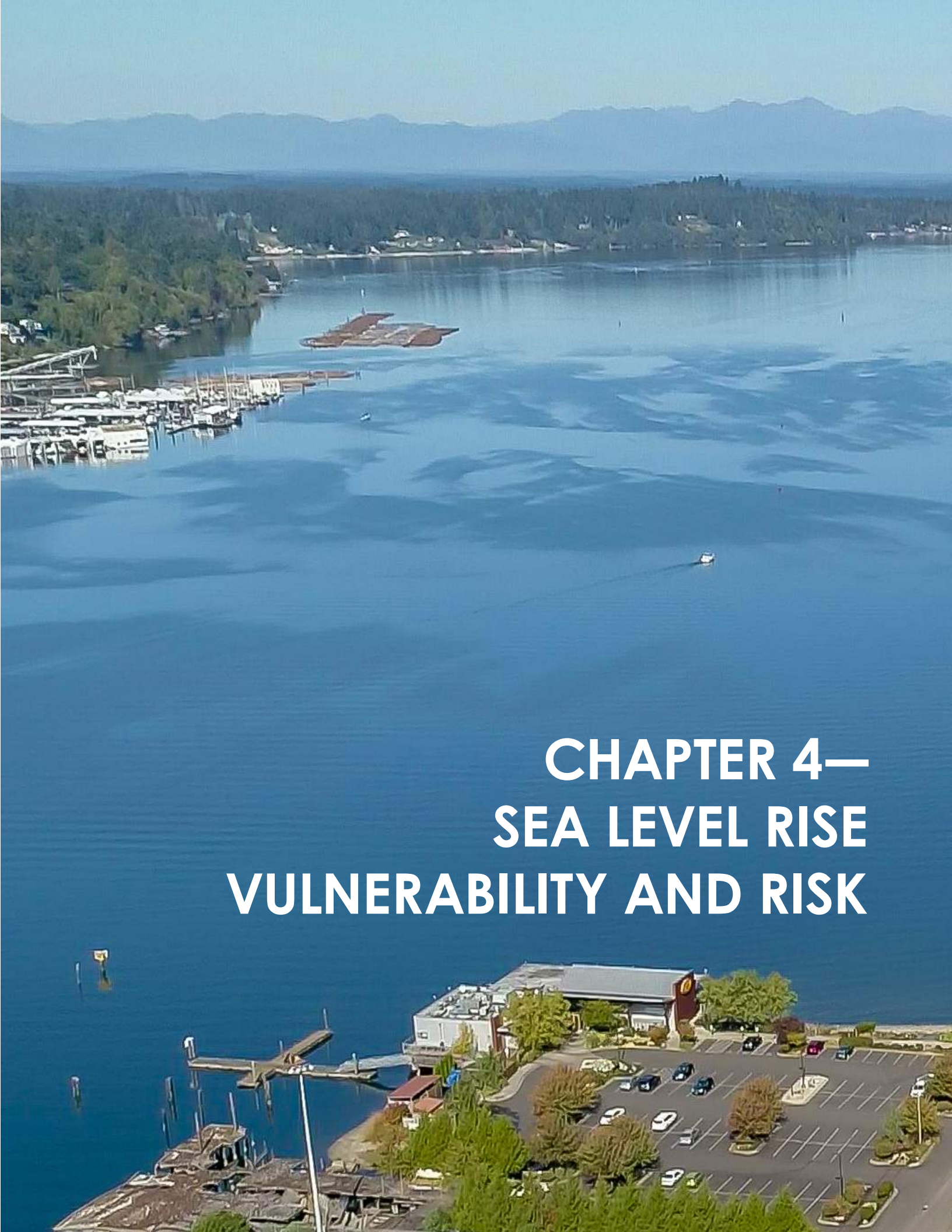
Atmospheric rivers, bands of moisture that transport large amounts of water vapor from the tropics, are also projected to increase in frequency and duration. Atmospheric rivers can deliver a substantial amount of precipitation over the course of several days, amplifying storm conditions and elevating local water levels.

Increases in precipitation intensity could cause more frequent urban flooding in Olympia and require increased capacity or more active management of increasing peak flows entering the Budd Inlet Treatment Plant.

Future discharge rates from the Deschutes River are uncertain; however, adjacent watersheds show projected increases in total winter runoff and peak discharge events such as the 10-year, 50-year, and 100-year discharges. Increases in peak discharge events may cause more frequent and higher magnitude flooding along the Capitol Lake shoreline and adjacent low-lying areas.

The Project Partners continue to monitor emerging research on the impacts of climate change to local precipitation. Changes in precipitation that affect stormwater management and Budd Inlet Treatment Plant operations are of particular interest to the Project Partners. The University of Washington Climate Impacts Group is currently conducting research on future local precipitation trends, with a focus on the needs of stormwater modeling and combined sewer outflow planning. More information on this work can be found on the Group's webpage.

CHAPTER 4—
SEA LEVEL RISE VULNERABILITY AND RISK



SEA LEVEL RISE VULNERABILITY AND RISK

The Project Partners conducted a vulnerability and risk assessment to evaluate flooding and sea level rise impacts to key assets, services, and operations within the Project Area. The Project Partners identified the sea level rise scenarios to be evaluated as part of the Plan, inventoried critical assets and operations, produced sea level rise inundation maps, and identified key vulnerabilities and risks.

WATER LEVEL AND SEA LEVEL RISE SCENARIOS

The vulnerability assessment evaluated the exposure of assets to coastal flooding as a result of king tides and the 100-year storm tide. *King tide* is a commonly used term to describe the highest astronomical tides that predictably occur a few times each year. The 100-year *storm tide* is a severe, rarely occurring flood event that is a combination of a high astronomical tide and storm surge. The 100-year storm tide has a 1-percent chance of occurring in any given year.

The vulnerability assessment evaluated sea level rise amounts of 0, 6, 12, 18, and 24 inches, combined with the king tide and storm tide water levels described above. The selected sea level rise scenarios correspond to the local Olympia sea level rise projections:

- **6 inches sea level rise:** most-likely projection at 2030
- **12 inches sea level rise:** most-likely projection at 2050; high-range projection at 2030
- **18 inches sea level rise:** most-likely projection at 2060; high-range projection at 2040
- **24 inches sea level rise:** most-likely projection at 2080; high-range projection at 2050

The vulnerability assessment did not evaluate sea level rise projections beyond 24 inches. The primary purpose of the assessment was to identify near-term impacts and tipping points to help prioritize the development and phasing of adaptation strategies. Beyond 24 inches of sea level rise, a large portion of Olympia would be exposed to extensive king tide and storm tide flooding. It is assumed that shoreline and stormwater improvements will have already been implemented before higher amounts of sea level rise occur. This does not mean that adaptation will stop at 24 inches of sea level rise. The physical adaptation strategies presented in Chapters 6 through 8 address sea level rise up to 68 inches.

KEY WATER LEVELS

The sea level rise vulnerability assessment evaluated exposure to coastal flooding as a result of king tides and the 100-year storm tide, as follows:

- **King Tide** (elevation 12.5 feet NAVD88 or 16.5 feet MLLW): a commonly used term to represent the highest astronomical tides that predictably occur a few times each year
- **100-year Storm Tide** (elevation 14.1 feet NAVD88 or 18.1 feet MLLW): a temporary increase in coastal water level due to a combination of high astronomical tide and storm surge due to low barometric pressure and local winds (not including wave effects at the shoreline, which may elevate flood levels higher)

Predicted amounts of sea level rise (e.g., 1 foot) are added “on top” of these baseline elevations to assess the vulnerability of downtown to sea level rise.

ASSET DATA INVENTORY

The Project Partners collected data on key assets and services located in the project area to better understand potential flooding vulnerabilities. They compiled geospatial data on asset locations, interviewed staff members during an asset data workshop with City, LOTT, Port, County, State, and Puget Sound Energy (PSE) representatives (PSE provides electricity to 1.1 million customers in western Washington, including all of Thurston County). The Project Partners also solicited input through a questionnaire completed by staff and during a Sea Level Rise Community Meeting through a workshop activity.

INDIVIDUAL ASSETS

The Project Partners compiled the information collected through the asset workshop and questionnaire into an asset database and grouped assets into categories for analysis in the vulnerability and risk assessment:

- **City Facilities:** buildings and facilities, parks, libraries, and museums
- **Fire and Police:** emergency response equipment, key access routes
- **Public Works:** pump stations, maintenance yards, sewer systems
- **Transportation and Parking:** City parking lots, roadways, and transit
- **Historic Structures:** such as those in the Olympia Downtown Historic District
- **LOTT Clean Water Alliance:** Budd Inlet Treatment Plant, pump stations, outfalls, force mains and interceptors
- **Port of Olympia:** buildings and facilities, terminals, marinas and boatworks, tenants
- **State/County/Federal Facilities:** buildings and facilities, parks
- **Private Utilities:** power substations, gas lines, and communications
- **Social Services:** community services
- **Community Assets:** private marinas, Farmer's Market, and theaters
- **Employment:** downtown employment

GROUP ASSETS

Some of the categories contained assets that were too numerous to evaluate on an asset-by-asset basis. These asset types were treated as "group" assets and evaluated at a higher level. This evaluation included City assets and others that are part of the stormwater and sewer system. Examples of group assets include street trees, catch basins, fire hydrants, parking lots, contaminated sites, and street lights.

The full asset inventory is included as an attachment to the Vulnerability and Risk Assessment (Appendix D).

FLOOD PROTECTION AND CRITICAL FACILITIES

Even a very small chance of flooding of Olympia's critical facilities may pose an unacceptable level of risk. Downtown Olympia contains a number of critical facilities that must be protected for the health and safety of our community.

The Federal Emergency Management Agency (FEMA) provides guidance on identifying critical facilities, which are those that provide services and functions essential to a community, especially during and after a disaster. Examples of critical facilities include: police and fire stations, vehicle and equipment storage, emergency response centers, medical facilities, schools and day care centers, power generating stations, and drinking water and wastewater infrastructure such as pumping stations and treatment plants.

FEMA recommends that, if possible, critical facilities should be located outside of high-risk flood areas. If a critical facility must be located within a flood area, it should be designed to higher protection standards and have flood evacuation plans in place. Protection of critical facilities could be achieved by designing these facilities to a higher standard, such as the 500-year flood level, or incorporating additional freeboard – for example, building to three feet above the base flood elevation (100-year flood level). This may also include elevating critical vehicular corridors that provide access to and from critical facilities so that fire and rescue equipment can travel safely during floods.

DOWNTOWN FLOODING AND SOCIAL EQUITY

The Plan acknowledges the potential impacts of sea level rise and flooding on vulnerable populations. Downtown residents could see their housing, services, and transportation networks disrupted by rising waters. In the next decade or two, we foresee unmanaged floods to be of short duration and without appreciable impacts to residents. However, in the longer term, unmitigated flooding could impact downtown residents, businesses, services, and transportation.

VULNERABILITY ASSESSMENT APPROACH

The vulnerability assessment followed a standardized process to evaluate exposure, sensitivity, and adaptive capacity of assets:

- **Exposure:** the nature and degree to which an asset, population, or system is exposed to sea level rise and flooding
- **Sensitivity:** the degree to which the physical condition and functionality of an asset, population, or system is affected by flood waters
- **Adaptive capacity:** the degree to which an asset, population, or system is susceptible to and able (or unable) to cope with adverse impacts of flooding

Assets are considered most vulnerable to sea level rise if they are exposed to flooding, are highly sensitive to (the damages from) floodwaters and are not easily adaptable.

EXPOSURE

The Project Partners created sea level rise inundation maps to evaluate asset exposure to king tide and 100-year storm tide events. The inundation maps were created by projecting each water level and sea level rise scenario overland and estimating the extent and depth of flooding. In addition, the inundation maps also delineate the shoreline and identify locations of shoreline overtopping for each mapped scenario. Exposure was evaluated by comparing the location of each asset to the flood extents for each water level and sea level rise scenario. Sea level rise exposure maps were developed for existing conditions and 6, 12, 18, and 24 inches of sea level rise (Figures 8–11). The maps also show inundation pathways for floodwaters to reach low-lying inland areas.

SENSITIVITY

Asset sensitivity was evaluated qualitatively based on considerations unique to different asset types. Each type has different sensitivities to flooding. Sensitivity to flooding was characterized for the following asset types: buildings and structures, transportation network, recreation and parks, and utilities. Example sensitivity considerations for two of the asset types, buildings and structures and utilities, are shown below:

- **Buildings and structures**
  - **Age and condition:** Older construction structures are more likely to be damaged by floodwaters
  - **Presence of electrical equipment:** Flooding of critical electrical equipment may lead to operation malfunction or failure of asset
  - **Life safety assets:** Certain facilities, such as fire/police stations, and emergency response centers, are more likely to have an appreciable impact on the community if damaged by floodwaters
  - **Elevation:** Some facilities are elevated above the adjacent ground elevation, making them less sensitive to damage by floodwaters
- **Utilities**
  - **Age and condition:** Older structures are more likely to be damaged by floodwaters
  - **Presence of electrical equipment:** Inundation of electrical equipment may lead to operation malfunction or failure of asset
  - **Presence of buildings and structures:** Buildings are likely to house mechanical and electrical equipment on lower floors that could be damaged if exposed to flooding
  - **Stormwater mains:** High tides and storm surge may reduce the capacity of the stormwater system to collect and convey runoff
  - **Sanitary sewer mains:** Flooding may increase rates of infiltration into sanitary sewer lines, thereby reducing the pipe's capacity to collect and convey wastewater

The sensitivity considerations for other asset types and sensitivity analysis are summarized in an attachment to the Vulnerability and Risk Assessment (Appendix D).

ADAPTIVE CAPACITY

Adaptive capacity evaluates the asset's ability to adjust to inundation or flooding in order to maintain its function or service. Adaptive capacity was assessed qualitatively based on a set of considerations that are applicable to each asset type, as follows:

- **Ability to elevate:** Existing asset can easily be raised to reduce vulnerability to flooding (for example, electrical panels may be exposed to floodwaters, but could be elevated without much effort or cost)
- **Ability to relocate:** Asset can easily be moved to higher elevation or outside of the floodplain to protect from flood damage (for example, City fleet vehicles are parked on a lot exposed to flooding, but could be

moved to another location during temporary flooding events)

- **Redundancy:** Presence of back-up generator, or an alternative building, or multiple access paths (alternative roadways and bus routes), or other means to provide asset substitution
- **Ability to adapt:** Assumes asset can adapt and be resilient to changes and recover from individual extreme events

The adaptive capacity analysis is summarized in an attachment to the Vulnerability and Risk Assessment (Appendix D).

KEY VULNERABILITIES, RISKS, AND FOCUS AREAS

The sections that follow present an overview of city-wide sea level rise impacts followed by more detailed discussion of specific vulnerabilities within four focus areas evaluated as part of the Plan.

SUMMARY OF CITY-WIDE SEA LEVEL RISE IMPACTS

A summary of sea level rise impacts to land, employment, residents, buildings, and roads is provided in Table 4 for sea level rise of up to four feet above the current 100-year flood level in Budd Inlet. As sea levels rise, high water events in Budd Inlet will inundate more area, impact people's homes and places of work, and disrupt travel on Olympia's streets.

FOCUS AREAS

Key vulnerabilities are identified using the concept of "focus areas". Each focus area has relatively common landscape traits, flood dynamics, and flooding vulnerabilities. Strategies for the different focus areas would work together to provide comprehensive flood protection for downtown. Four focus areas are identified for evaluation of vulnerabilities (Figure 7):

1. Capitol Lake / Lower Deschutes Watershed
2. Percival Landing and Isthmus
3. Budd Inlet Treatment Plant and Combined Sewer System
4. Port of Olympia Peninsula

The physical adaptation strategies presented in Chapter 6 follow this same framework. The key vulnerabilities identified within each focus area are summarized below.

CAPITOL LAKE / LOWER DESCHUTES WATERSHED FOCUS AREA

This focus area presents the foremost flooding risk under both current and future conditions. The eastern shoreline of Capitol Lake has flooded repeatedly over the years. Currently, the area is highly managed by the City of Olympia and Washington State Department of Enterprise Services staff during high tides and/or high flows in the Deschutes River.

Table 4: Olympia Exposure to Sea Level Rise

Elevation (feet)		Sea Level Rise	Land Inundated[1]	Employment[2]	Residential Population[3]	Buildings Impacted[4]	Roads Impacted
NAVD88	MLLW	(feet)	(acres)	(Number People)	(Number People)	(Number and [Value])	(Miles)
14	18	0	55	800	1484	18 [$15.0M]	1.7
14.5	18.5	0.5	108	1300	1694	140 [$91.4M]	5.7
15	19	1	163	2200	1780	197 [$172.4M]	11.5
16	20	2	252	2900	1860	175 [$237.6M]	20.3
17	21	3	322	3600	1932	321 [$341.0M]	30.4
18	22	4	368	7000	1988	337 [$370.3M]	41.8

Table 4 Notes:

1. Includes only acres above 13 feet NAVD88
2. Thurston Regional Planning Council: Population and Employment Forecast (2015 Update)
3. Thurston Regional Planning Council: Population and Dwelling Unit Estimates (2016)
4. A building was considered affected if it was in contact with flood water, values based on Thurston County Assessors parcel data (August 2016)

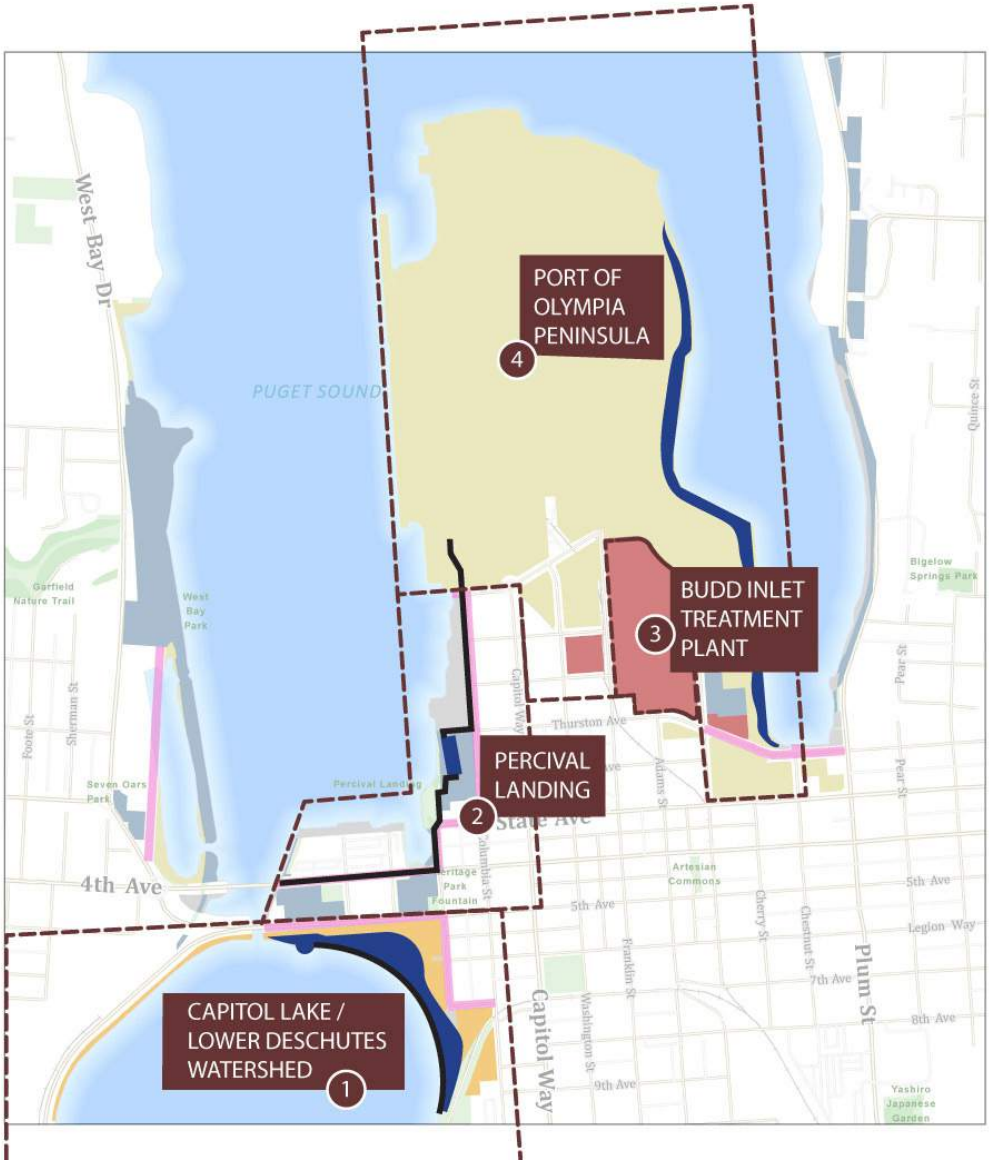


Figure 7. Olympia Sea Level Rise Response Plan Focus Areas

Shoreline elevations along Capitol Lake are approximately 13 to 14 feet NAVD88, compared to a 100-year flood level of approximately 15 feet. Under existing conditions, flood waters in Capitol Lake can overtop the Heritage Park shoreline and travel eastward and northward to inundate the following downtown areas:

- Heritage Park
- Railroad and tunnel
- Powerhouse Road
- Low-lying business district between 4th and 7th Avenues and Columbia and Simmons Streets

With low to moderate amounts of sea level rise (6 to 12 inches), Capitol Lake floodwaters could also inundate the Powerhouse, and a portion of the downtown Olympia historic district.

PERCIVAL LANDING AND ISTHMUS FOCUS AREA

A walk along Percival Landing during a king tide highlights the vulnerability of this focus area. During king tide events, water nearly reaches the top of the wooden boardwalk and overtops low-lying areas of the shoreline. The low elevation of the shoreline and the Landing combined with the limited available area for construction of new flood protection barriers are characteristic of this focus area.

The average elevation of the Percival Landing and Isthmus shoreline is 14 to 15 feet NAVD88, but portions are as low as 12.5 feet (the approximate elevation of an annual king tide). The 100-year coastal flood level is approximately 14 feet in this area. Under existing conditions, a large coastal storm event could flood

ECONOMIC CONSEQUENCES

The risk assessment identified various quantitative consequences of flooding. As a component of the monitoring program, the Project Partners will continue to calculate these costs. Example costs to our community include:

- Flood fighting expenses of approximately $38,000 per event to address a 100-year storm event of 9 hours in duration with 12 inches of sea level rise
- Single occupancy vehicle commuter delay costs of approximately $304,000 during a 100-year storm event with 24 inches of sea level rise
- Transit commuter delay costs of approximately $47,000 during a 100-year storm event with 24 inches of sea level rise
- Loss of 655 trees at an appraised value of $1,036,360 (by 36 inches of sea level rise)

the Percival Landing and Isthmus areas. With low to moderate amounts of sea level rise (6 to 12 inches), substantial flooding of the shoreline and inland areas could occur, potentially impacting the following assets:

- Olympia Center
- Water Street Lift Station (between Olympia Avenue and State Avenue)
- Percival Landing Park and Harbor House
- Key transportation corridors (4th Ave., Capitol Way)
- Waterfront restaurants and businesses

With moderate amounts of sea level rise (12 to 18 inches), marine floodwaters could travel eastward to impact larger areas of downtown and the Budd Inlet Treatment Plant, and northward to the marine terminal. Flooding along Percival Landing has implications to all three Project Partners.

BUDD INLET TREATMENT PLANT AND COMBINED SEWER SYSTEM FOCUS AREA

The LOTT Clean Water Alliance is a nonprofit governmental organization responsible for wastewater management services for the urban areas of Lacey, Olympia, and Tumwater in north Thurston County. LOTT currently serves a population of approximately 118,000 people. The Budd Inlet Treatment Plant (BITP) is LOTT's main treatment facility, processing approximately 14 million gallons of wastewater on an average day. Effective 24/7 operation of the plant is essential for our local public and environmental health. The potential future interaction of sea level rise with the BITP is complex and extends well beyond the confines of the plant site.

Sea level rise could impact the BITP in a number of ways. The primary near-term concern for the BITP is overland flooding from Budd Inlet and Capitol Lake and the impact to the combined sewer system in downtown Olympia. The combined sewer system conveys sewage from homes and businesses as well as stormwater from downtown streets to the BITP. During flood events, floodwaters can overtop the shoreline and travel overland and through the streets to flood catch basins that collect stormwater and carry it into the combined sewer system (Figure 13). This additional volume of water mixes with wastewater and is conveyed to the BITP.

The surcharge of combined floodwater and wastewater could overwhelm the treatment plant and result in additional treatment costs or increased likelihood of bypasses, in which untreated or partially treated wastewater is discharged directly to Budd Inlet through LOTT's marine outfalls. Additionally, if the treatment plant was overwhelmed by incoming flows, wastewater could back-up into the City's sewer collection system

OLYMPIA'S COMBINED WASTEWATER AND STORMWATER TREATMENT SYSTEM

In the mid-20th century, growing cities often combined wastewater with stormwater runoff flows from streets into one pipe system, the combined system. The pipes were then routed to wastewater treatment plants. This design occurred in large parts of downtown Olympia and in some of Olympia's older residential neighborhoods. Separating stormwater and wastewater flows into two piping systems now would be technically difficult and expensive. Fortunately, the Budd Inlet Treatment Plant currently has the capacity to treat typical wet season stormwater flows.

and potentially flood streets, homes, and businesses. During such a flood event, the primary activity of the treatment plant would be to convey incoming flows (comprising seawater, stormwater runoff, and sewage) through the plant and discharge it to Budd Inlet to alleviate upstream flooding.

The Project Partners used the sea level rise inundation maps to identify the location of stormwater catch basins in downtown Olympia that could convey floodwaters from the street to the BITP. Figure 13 shows the location of inundated catch basins for king tide and 100-year storm tide events for 0, 6, 12, 18, and 24 inches of sea level rise. Under existing conditions, approximately 25 catch basins primarily along 4th Avenue could be exposed to floodwaters during a large coastal storm event; however, with only 6 inches of sea level rise, that number increases to 150 dispersed around the downtown area.

Street flooding and higher groundwater levels due to sea level rise may contribute to increased rates of infiltration into underground pipes, further increasing peak flows. These peak flows could overwhelm the plant's hydraulic capacity. High concentrations of marine water (with high salinity content) in flood flows could also disrupt the biological treatment processes, which would require months to recover. Sea level rise will also increase water levels in Budd Inlet and require more frequent and longer duration pumping to discharge treated wastewater through LOTT's marine outfalls.

With moderate amounts of sea level rise (18 to 24 inches), overland flooding from Percival Landing and East Bay may also expose and damage BITP structures and interrupt operations during large coastal storm events. On-site facilities that may be vulnerable to flooding with moderate sea level rise include:

- Main utilidor (an underground corridor containing piping and pumps)
- Maintenance building
- Solids handling building
- Anaerobic Digesters
- Puget Sound Energy Thurston substation

PORT OF OLYMPIA PENINSULA FOCUS AREA

The Port of Olympia oversees extensive land area and shoreline. This focus area encompasses the restricted-access marine terminal as well as popular public access to the shoreline and associated recreation. The Port serves all citizens of Thurston County through property tax levies.

The shipping berth, marine terminal, and Port Plaza shorelines are 15 to 16 feet NAVD88 elevation on average; however, there are some low spots south of Port Plaza and at North Point with elevations as low as 13 feet. The 100-year coastal flood level is approximately 14 feet in this area. Under existing conditions, these low spots could lead to minor flooding of Port property during a large coastal storm event. With low to moderate sea level rise (6 to 12 inches), floodwaters could travel southward from North Point and northward from Percival Landing and impact the following assets:

- Marine Terminal (cargo yard, rail, and Warehouse A)
- Cascade Pole site and the groundwater treatment facility
- Stormwater pumping station
- Port Plaza and Farmers Market

The East Bay shoreline is generally higher in elevation (approximately 16 feet NAVD88) and assets along East Bay would not be exposed to flooding until moderate sea level rise (18 to 24 inches). With moderate sea level rise, a coastal storm event could impact the following Port assets:

- Olympia Area Rowing Center
- Swantown Marina and Boatworks
- Shipping berths
- Key transportation corridors (Marine Drive)

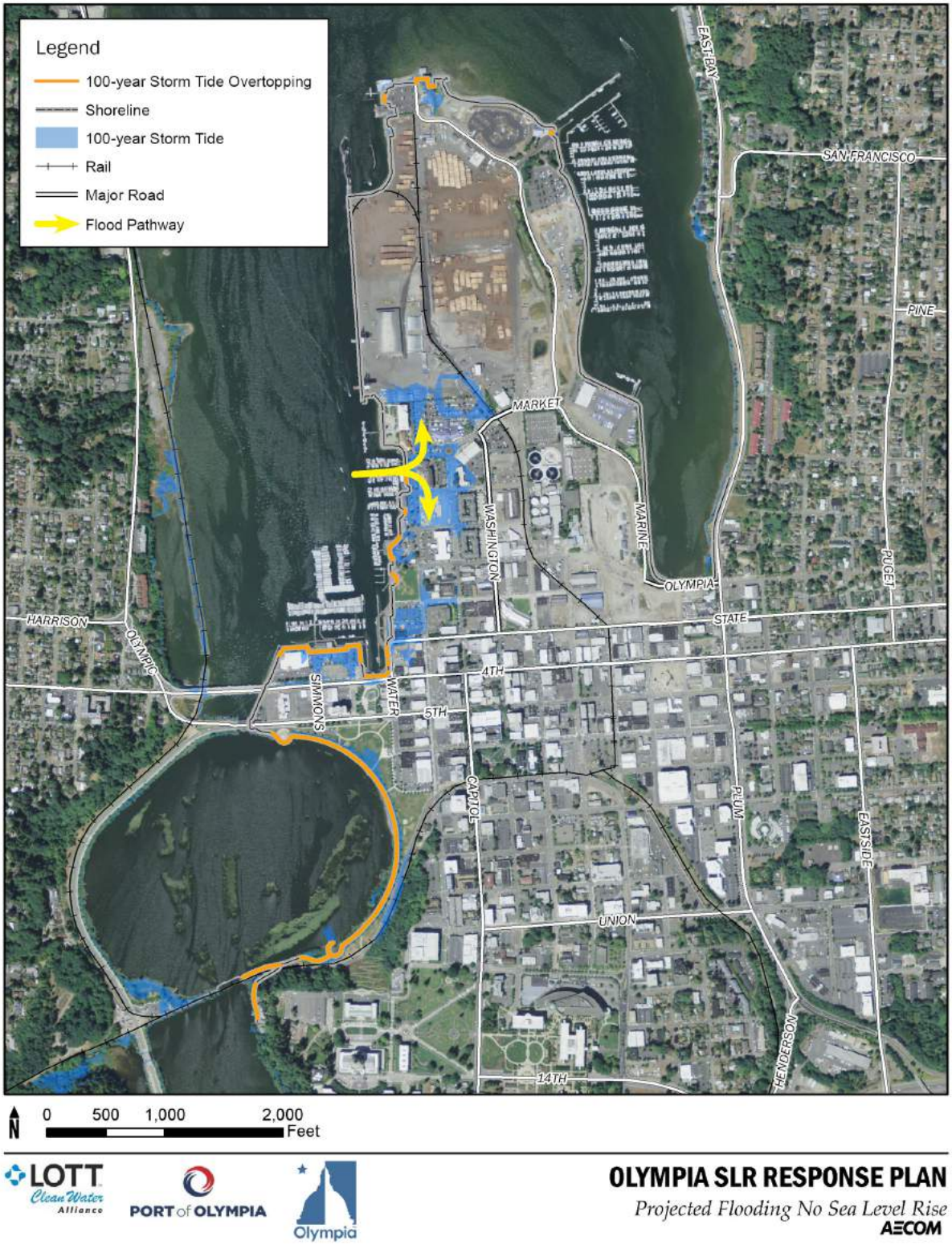


Figure 8. Inundated Assets at No Sea Level Rise

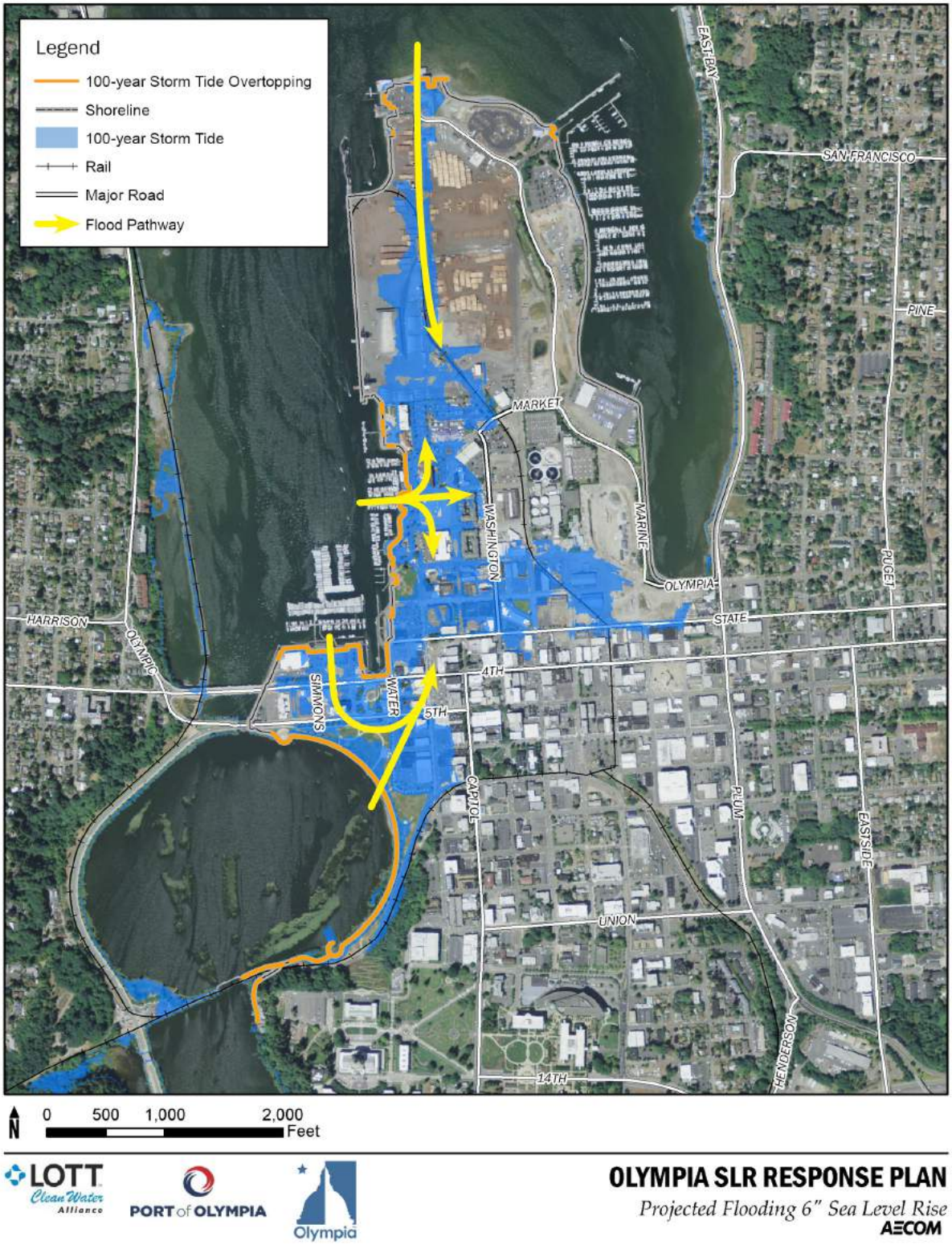


Figure 9. Inundated Assets at 6 Inches of Sea Level Rise

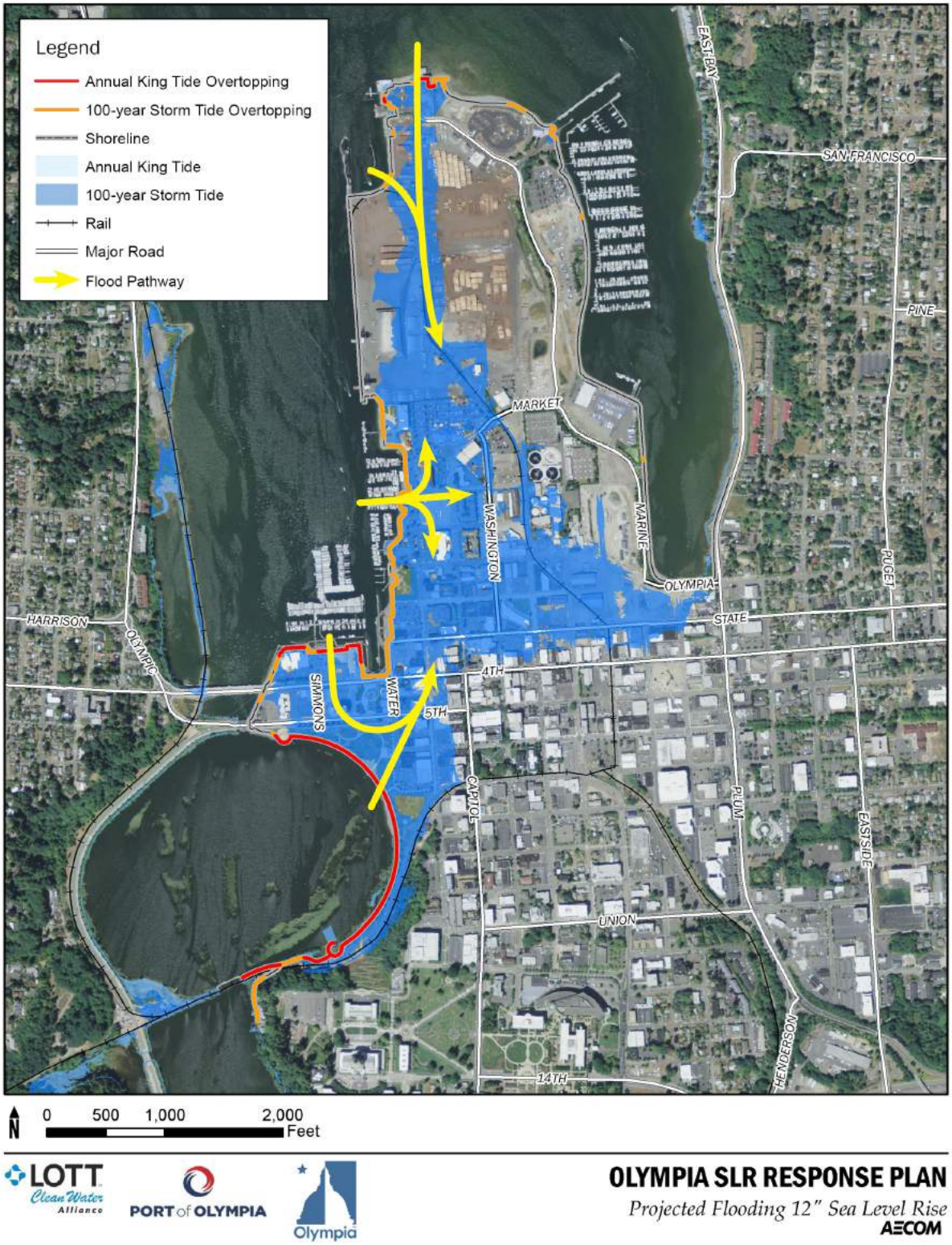


Figure 10. Inundated Assets at 12 Inches of Sea Level Rise

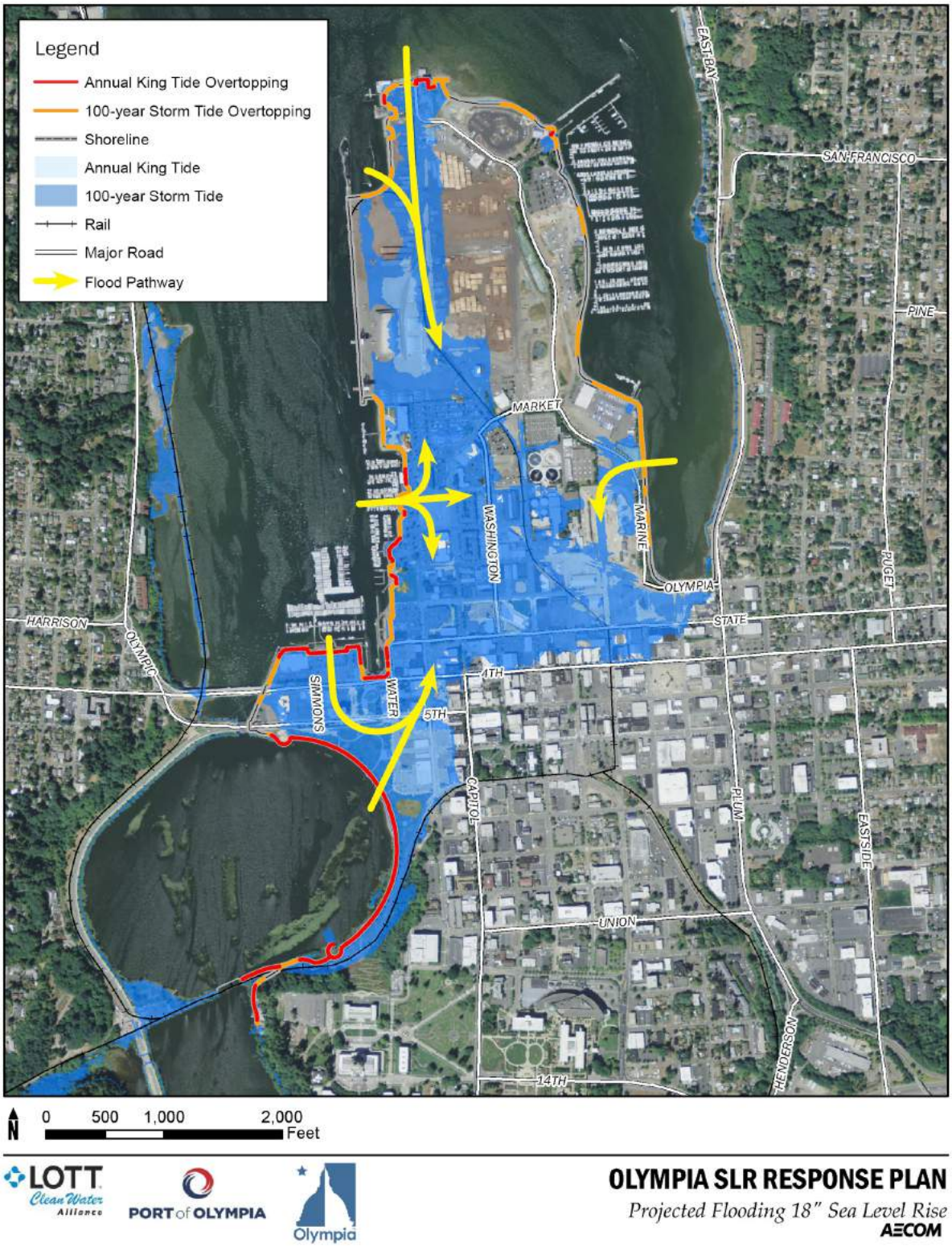


Figure 11. Inundated Assets at 18 Inches of Sea Level Rise

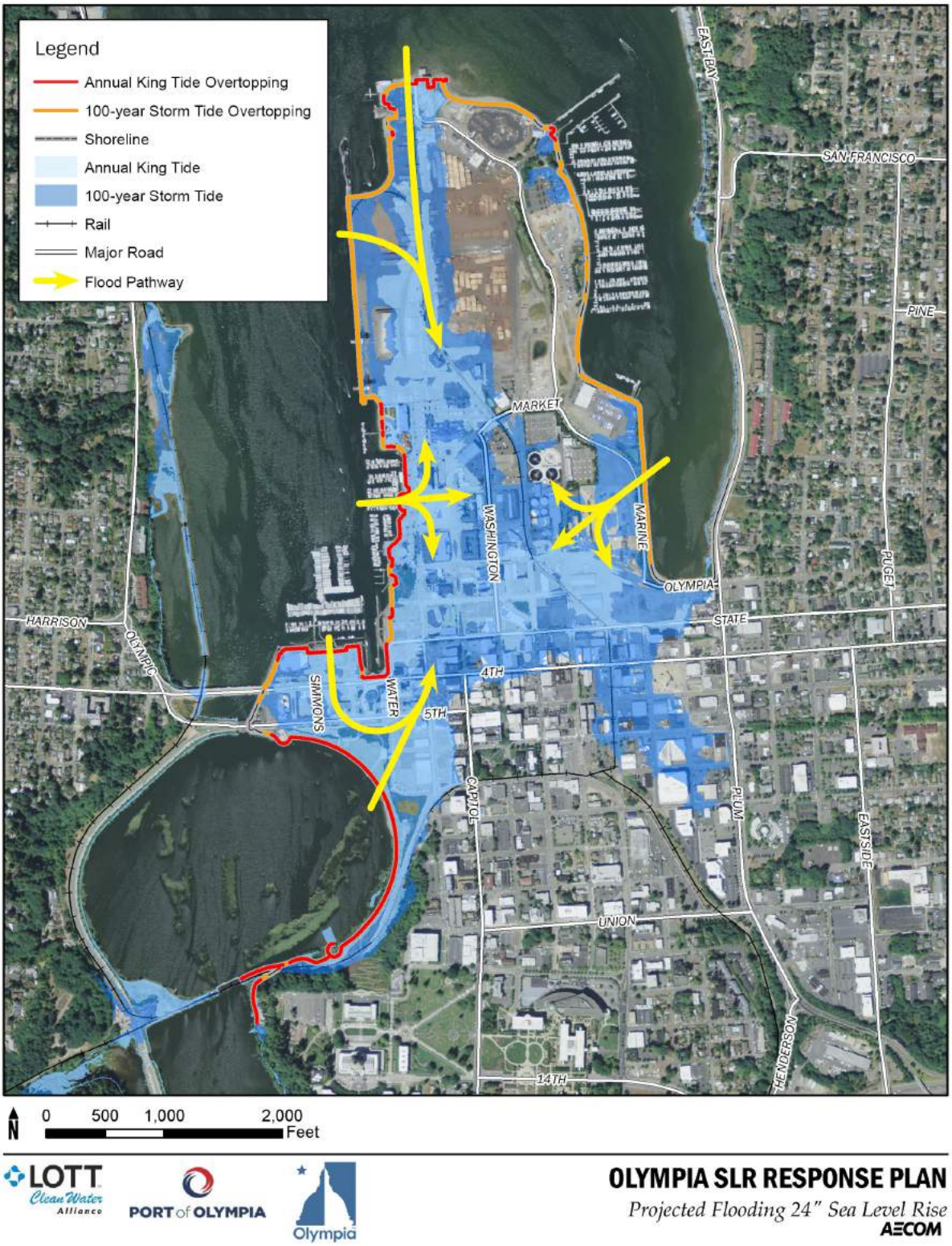


Figure 12. Inundated Assets at 24 Inches of Sea Level Rise

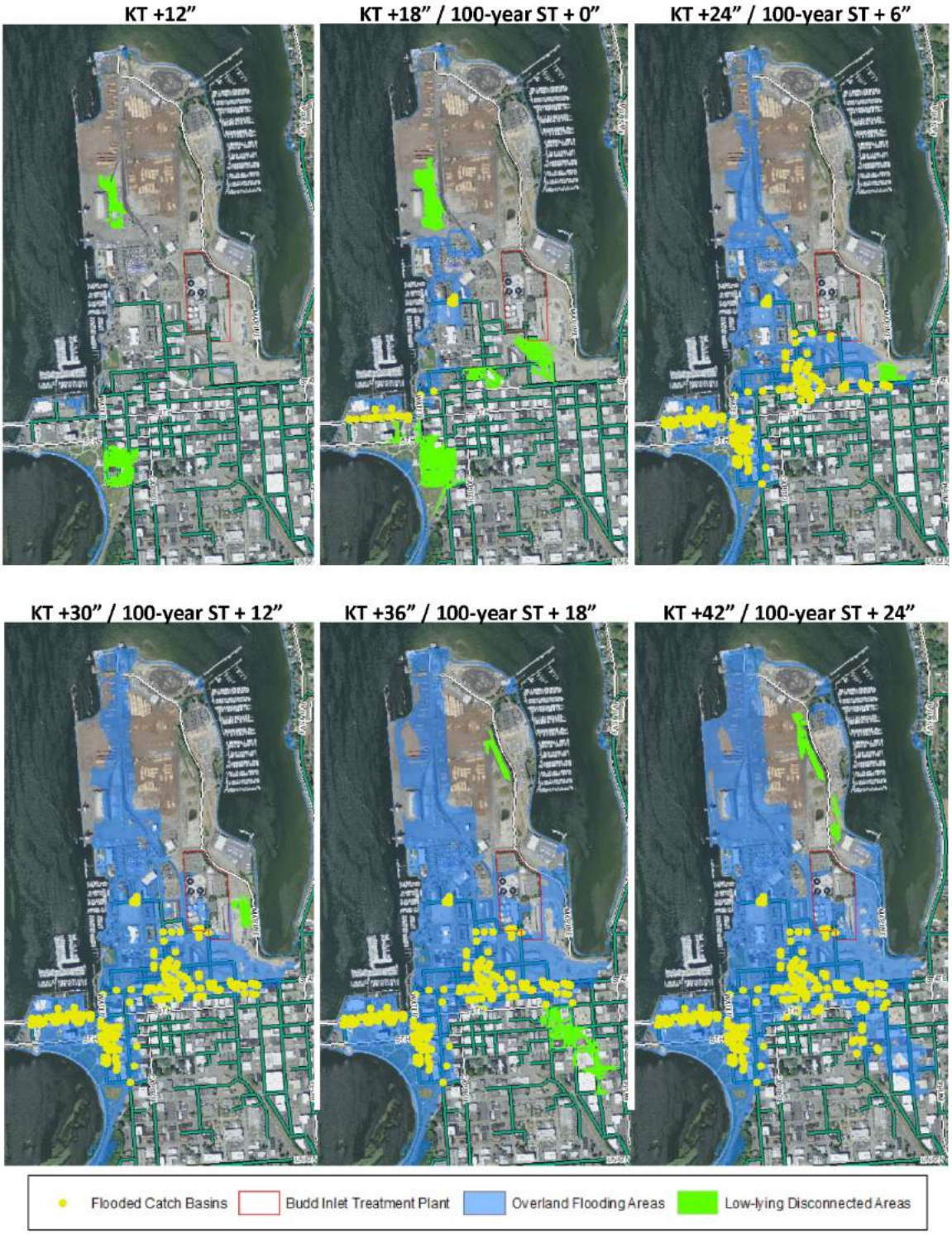


Figure 13. Locations of Stormwater Catch Basins that Drain to the Budd Inlet Treatment Plant
Note: KT = king tide and ST = 100-year storm tide in figure legend.

CHAPTER 5—
APPROACH TO ADAPTATION

APPROACH TO ADAPTATION

The Project Partners developed a suite of potential adaptation strategies to address the challenges of sea level rise in downtown Olympia. The adaptation strategies address the key vulnerabilities and risks identified for each of the four focus areas. This Plan provides a comprehensive, adaptable template for continued community and governmental action. Strategies will evolve and potentially change in the years and decades ahead.

PHASED APPROACH TO ADAPTATION

The Plan assumes that sea level rise will occur over the next several decades through the end of the century and beyond. While Olympia will have flood risks from high tides and storm surge in Budd Inlet and high flows in the Deschutes River, we do not have to adapt our entire shoreline for future sea level rise all at once. We have time to develop thoughtful, feasible, and cost effective solutions to address future flood risk; however, we need to maintain the momentum generated through this planning effort. At the same time, projects that are currently in the planning phase need to consider future flood hazards in their design so that investments in downtown anticipate changing environmental conditions.

The Project Partners have adopted an approach to adaptation that identifies near-term, mid-term, and long-term response actions that can be implemented over time:

- **Near-term** actions would be implemented in the next 5 years between 2019 and 2024 to address existing flood vulnerabilities and low sea level rise (less than 6 inches) and establish a governance structure and monitoring plan
- **Mid-term** actions would be implemented over the next 5 to 30 years between 2025 and 2050 to address flood vulnerabilities through mid-century and moderate sea level rise (up to 24 inches)
- **Long-term** actions would be implemented beyond 2050 to address flood vulnerabilities through end-of-century and high sea level rise (up to 68 inches)

PHASED IMPLEMENTATION

Olympia's sea level rise response will be phased over decades. However, early phases will need to be planned and implemented to support later phases, so that future strategies build upon near-term actions. This approach will be necessary both pragmatically and financially. With this in mind, early phases may be resource intensive as the foundations of subsequent phases are developed. Investments in adaptation will be made when sea level rise monitoring demonstrates the need.

While phased, the progression of adaptation actions must build upon one another. Early actions must support and be incorporated into subsequent actions. This need for forethought reinforces the need to sustain sea level rise response implementation.

This Plan also acknowledges that given the long-term planning horizon for sea level rise adaptation, there will be cycles of retrofit and rebuild for existing assets as they reach the end of their useful life. At that time, the asset owners will re-evaluate the siting and design of those facilities. For example, an asset could be replaced and rebuilt at a higher elevation or relocated to a less vulnerable area. Good planning, policies, and design standards can promote a more resilient Olympia by ensuring that there is appropriate guidance and regulations to adapt new construction to rising sea levels.

RETREATING FROM DOWNTOWN

Given the vulnerability of Olympia's entire downtown, including extensive infrastructure and investments, wholesale retreat is not a pragmatic strategy to pursue during the planning horizon considered in this Plan (2100). Above and below ground investments in our 450-acre downtown easily run in the billions of dollars. Relocating these assets would require billions more ($1.3 billion for the Budd Inlet Treatment Plant alone). The cultural amenities provided by the downtown core are valuable and irreplaceable. In addition to lost property and infrastructure value, retreat would require investments in demolition of infrastructure, disposal of debris, clean-up of contaminated sites, and tidal zone restoration.

Retreat or abandonment of select low-lying areas in response to sea level rise is a viable management strategy in certain situations. In fact, limited retreat from specific, targeted, areas of downtown may be likely or inevitable – for example, existing overwater buildings will be difficult to protect from rising seas in the long-term. As part of this planning effort, shoreline areas have been evaluated with respect to their vulnerability to rising waters, the human and environmental implications of flooding, and the potential measures needed to protect the area. This evaluation identified specific, limited areas that may need to be sacrificed (e.g., a road, a few buildings) as opposed to large-scale retreat of developed areas.

Community input received during the planning process raised the issue of widespread retreat from downtown. Widespread retreat is a strategy that has been evaluated as part of the planning process, and it has been determined to be unnecessary for the foreseeable future. This Plan focuses on adaptation strategies rather than large-scale retreat. Based on current information, the strategies identified in this plan are sufficient to protect downtown. However, evolving climate change and sea level rise projections will be closely monitored by the Project Partners and the adaptation strategy will be adapted to changing conditions over time.

FOCUSING ON PUBLIC PROPERTY

The physical adaptation strategies presented in this Plan are envisioned for construction on public rather than private property. At this stage in the planning and early implementation process, we need to provide a confident degree of feasibility and certainty. Fortunately, the majority of the downtown shoreline is owned by the Port, the City, and Washington State.

In shoreline areas where ownership is privately held or public ownership is highly constrained, the Plan proposes to align the physical adaptation strategies within City streets or public rights-of-way, rather than directly along the shoreline.

This shoreline protection approach could evolve in the years to come to include the construction of physical adaptation strategies on private property. However, some shoreline properties, such as those with buildings constructed over the water, offer limited opportunities for constructed flood protection. These issues and opportunities will continue to be evaluated and coordinated. Publicly funded work on private property would need to demonstrate benefit to the public.

STRENGTHENING PARTNERSHIPS

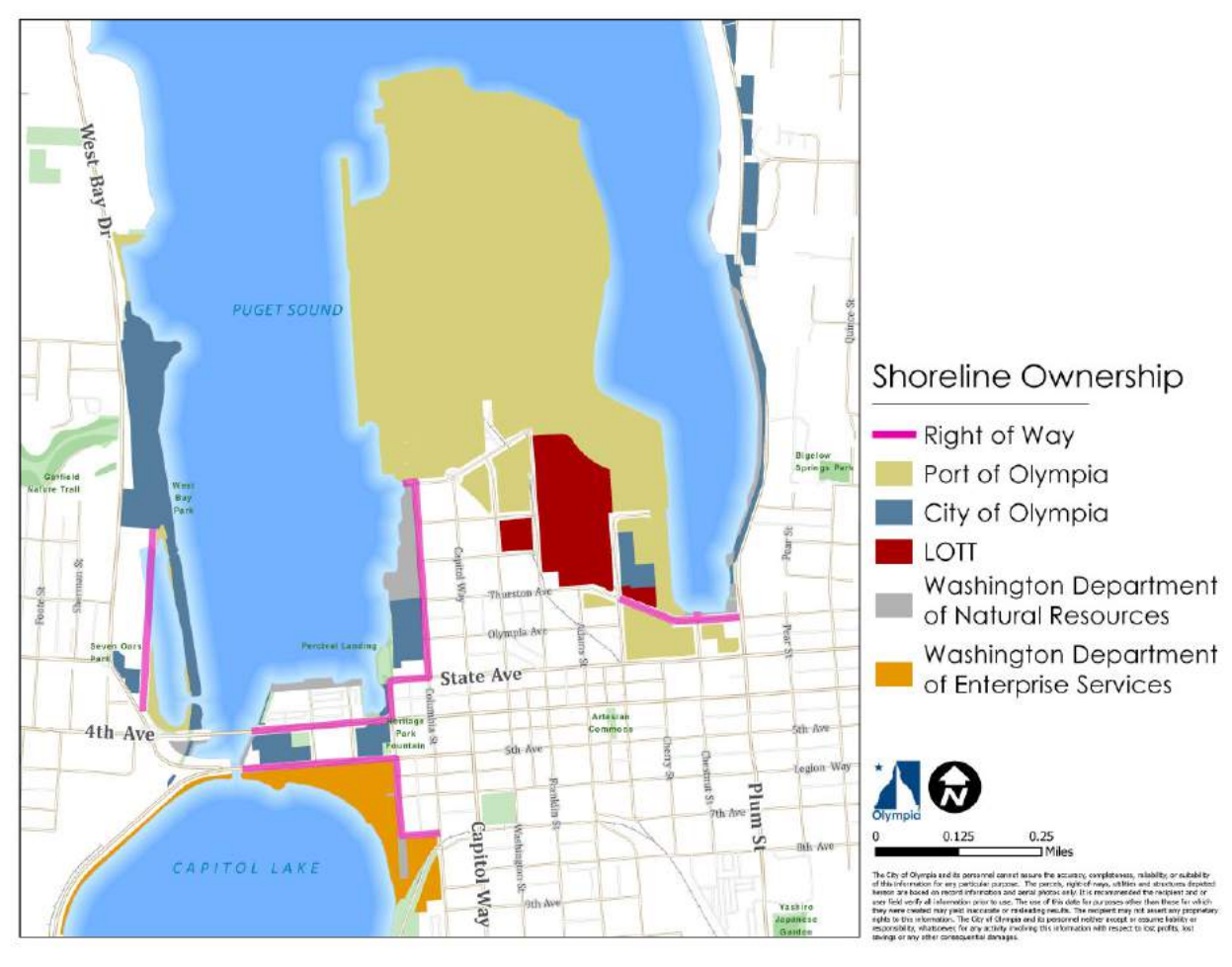
In addition to the Project Partners, many other entities have been involved in the planning process and will continue to be involved in the years to come. As manager of Capitol Lake, the Washington Department of Enterprise Services is a close partner. The Washington Department of Natural Resources plays a role as owner of portions of the downtown shoreline and tidelands. Other local, State, and federal governmental entities offered support and expertise and will continue to be involved. We anticipate an increasing role for these entities as the Plan is implemented.

Coordination and collaboration across governmental entities including tribes, non-profits, and private property owners will be needed in the near-term. These entities can join our continued planning efforts over the next few years as the Plan's strategies are refined and become increasingly specific.

Working together, we can envision a cohesive future shoreline with enhanced environmental and social amenities. Conversely, no action or the lack

WE ARE UNIQUE

There are many factors contributing to our local flooding dynamics. Olympia is in a unique position relative to most urban communities in that much of our shoreline is within public ownership. Public ownership of our downtown shoreline translates to community control and an ability to more easily plan for our flood protection future.



of a coordinated response would likely result in a fragmented, unfulfilled urban shoreline, and increase the risk of major flood damage.

STRATEGY TYPES

The Plan follows climate adaptation best practices by considering a range of potential adaptation strategy types, including physical, governance, informational, and operational strategies. Challenges rarely have only one solution and protecting downtown will take a variety of approaches. Sea level rise hazards cannot be mitigated effectively and efficiently through engineering solutions alone. The Project Partners are committed to developing a mix of strategies to address our projected future vulnerabilities:

- **Physical** strategies address flood vulnerabilities by making physical modifications to the shoreline or individual assets to make them less vulnerable to flooding. Examples include raising or strengthening seawalls, raising landscaping to protect inland areas from flooding, or increasing the capacity of the Budd Inlet Treatment Plant's pumping facilities. Some physical strategies would be developed jointly among the Project Partners and other stakeholders, while others may be developed individually.
- **Operational** strategies address flood vulnerabilities through operations and maintenance in response to changing conditions. Examples include traffic detours and coordinated emergency response during flood events or modifying protocols at Budd Inlet Treatment Plant to react to and manage high inflow events.

- **Governance strategies** address flood vulnerabilities through policies, plans, coordination, guidelines, and regulations. Governance strategies could be developed individually by each Project Partner or in collaboration. Examples include developing a financial strategy to raise funds for flood protection improvements, updating design standards to incorporate sea level rise considerations, developing agreements among the Project Partners and others to collaborate on future sea level rise planning efforts, or education and outreach activities with the community and key stakeholders.
- **Informational** strategies address data and knowledge gaps in our understanding of flood vulnerabilities. Examples include conducting a study to better understand the effect of elevated groundwater on the stormwater and sewer system or collaborating with regional research organizations on emerging climate change research.

Potential physical, operational, governance, and informational adaptation strategies for Olympia, their potential costs, and implementation steps are described in the following sections:

- Chapter 6: Physical and Operational Strategies
- Chapter 7: Governance and Informational Strategies
- Chapter 8: Cost of Adaptation
- Chapter 9: Implementation and Next Steps

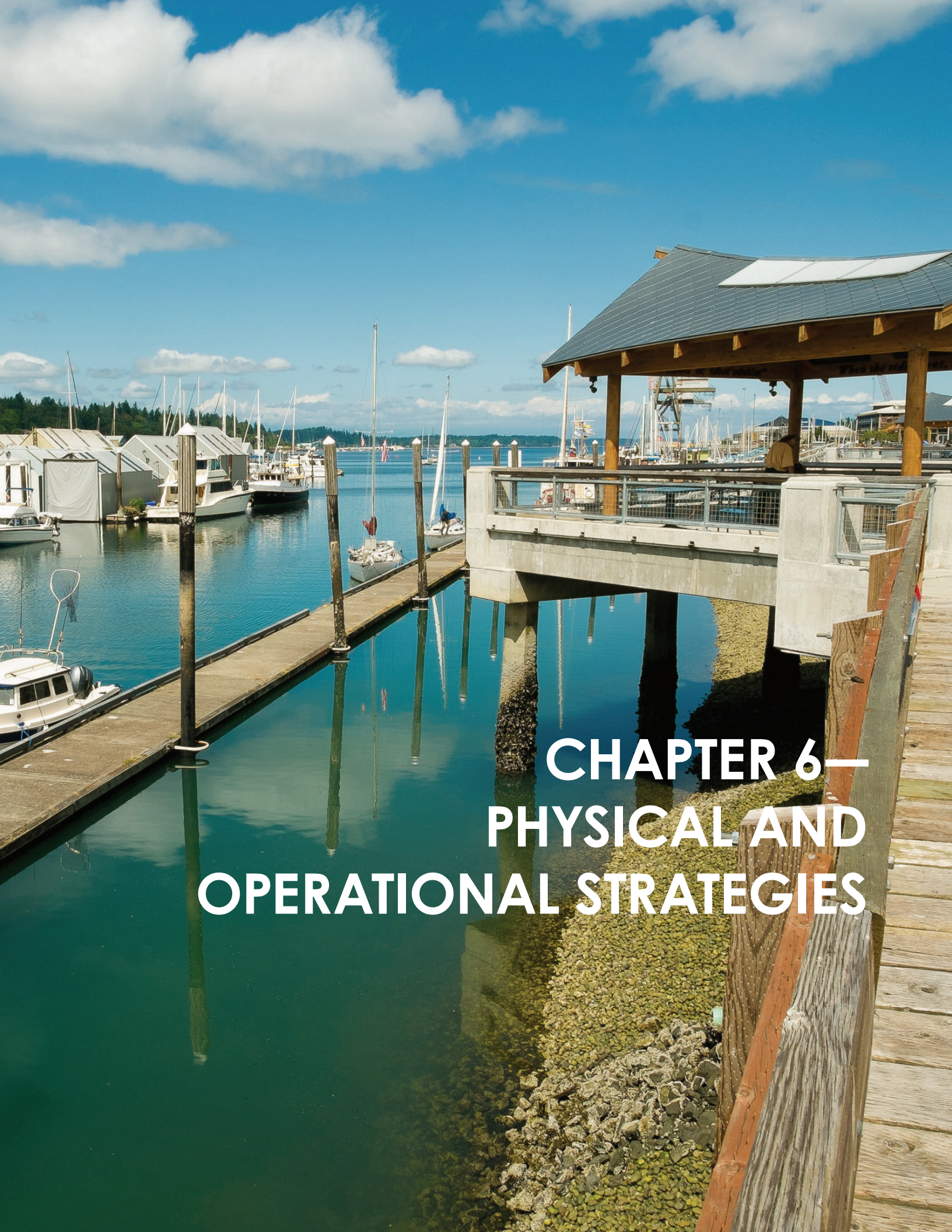
Chapter 9 presents a complete list of potential physical, operational, governance, and informational strategies for Olympia.

REGULATORY FRAMEWORK AND CONSIDERATIONS

Effective sea level rise adaptation will require coordination among agencies and tribes with jurisdiction along the shoreline. Over a dozen federal, tribal, State and local agencies play a role in managing Olympia's shoreline assets. This Plan's proposed governance strategies recognize that these entities are critical stakeholders who must be included as this Plan is implemented.

Protecting and improving downtown Olympia is central to the City's comprehensive plan, land use decisions, development strategies, and environmental management. This Plan was developed to both protect and improve downtown. While the City's current plans recognize the importance of planning for sea level rise, such existing plans and associated regulations may need to evolve as changes to the built environment become necessary to address sea level rise.

Public policy around climate change, flood risk, and sea level rise is expected to continue to evolve. Evolving policy could have an impact on how our adaptation strategies are implemented in the future. Continuing to be part of such conversations will be key to plan implementation.



CHAPTER 6— PHYSICAL AND OPERATIONAL STRATEGIES

PHYSICAL AND OPERATIONAL STRATEGIES

The Project Partners developed a suite of physical and operational strategies to address the key vulnerabilities and risks identified during the vulnerability and risk assessment for each of the four focus areas: Capitol Lake / Lower Deschutes Watershed, Percival Landing and Isthmus, Port of Olympia Peninsula, and Budd Inlet Treatment Plant / Combined Sewer System.

The Plan's end-of-century planning horizon is unusually long, but necessary. Climate change and sea level rise science remains uncertain. Downtown's built environment will also change over time. The concepts for constructing shoreline protection presented in this Chapter are valid from a present day engineering perspective. However, they will continue to be refined as we learn more, work with others, and evolve as a community.

MENU OF PHYSICAL STRATEGIES

The Project Partners researched physical sea level rise adaptation strategies identified by other cities around the country to identify which strategies were most relevant to Olympia. The strategies are categorized into three categories that can be combined to develop integrated plans for different portions of downtown, the Budd Inlet Treatment Plant, the combined storm/sewer system, and the Port:

- **Temporary flood protection** measures can be deployed at key locations to address infrequent, short-duration flooding events along the Budd Inlet and Capitol Lake shorelines. Some temporary measures automatically deploy, such as pop-up flood gates, while others such as sand bags or street grate seals require work crews to install or deploy.
- **Living with water** strategies accommodate floodwaters to lessen their impact by attenuating floodwaters or avoiding exposure. Living shorelines, floodable landscapes, and green infrastructure are examples of living with water strategies. In addition, some facilities may have the ability to be elevated above projected flood levels. Wet or dry floodproofing can lessen or eliminate damage by floodwaters to facilities that cannot be relocated or raised.
- **Permanent flood protection** provides a primary line of defense to prevent floodwaters from impacting low-lying inland areas of downtown. Some permanent flood protection measures will retrofit or raise existing shoreline features whereas others will require construction of new protective features. Examples of permanent flood protection include walls, berms, elevated paths, raised planters, and elevated streets.

Olympia's menu of physical adaptation strategies is shown in Figure 14. Real-world examples of flood and sea level rise strategies from around the country are shown in Figure 15. The strategies presented in the following sections for each focus area combine individual strategies from the menu into integrated plans to adapt downtown to rising sea levels.

LIVING OR GREEN SHORELINES

Naturally sloped, vegetated shorelines help moderate upland flooding by reducing wave energy as waves approach the shoreline. Green shorelines can reduce the risk of high waves overtopping the shoreline. Community members expressed a strong interest in pursuing living or green shorelines as part of the Plan.

Engineered living shorelines may combine traditional components of armored shorelines with more natural elements. Many communities around the globe are constructing green or natural shorelines in response to sea level rise.

Olympia has examples of living shorelines along Percival Landing, Port Plaza, and North Point. These gradually sloped areas, while modest in size, are biologically helpful components of an otherwise steep, impacted shoreline.

While environmentally worthwhile, the role of green shorelines for flood protection along Olympia's shoreline is limited. Waves are seldom over two-feet high in Budd Inlet. The Inlet is a relatively still body of water, so the influence of these small waves and their hydraulic energy on upland flooding is minor.

It is expected that physical adaptation strategies for the Olympia shoreline will incorporate green shorelines, primarily for habitat and aesthetic benefits. However, given the flood characteristics of Budd Inlet it will be necessary to also heighten the shorelines with steep or vertical barriers such as walls, berms, boardwalks, and elevated streets to prevent inundation of low-lying inland areas.

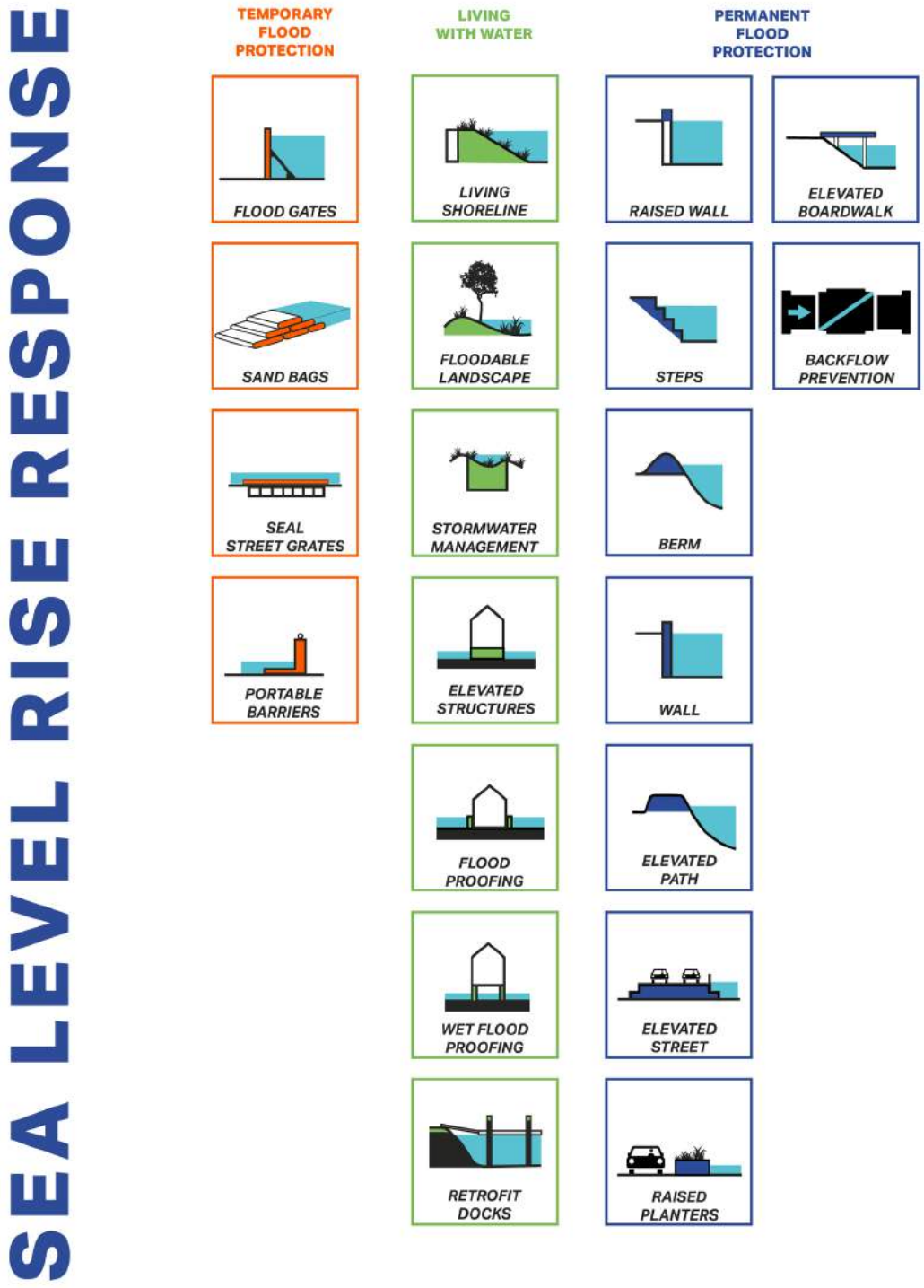


Figure 14. Olympia Menu of Physical Adaptation Strategies

Figure 15. Example Physical Sea Level Rise Adaptation Strategies Applicable to Olympia

FEMA AND THE NATIONAL FLOOD INSURANCE PROGRAM

The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program (NFIP). The NFIP was established in 1968 to reduce the impact of flooding on our nation's communities. It does so by providing insurance to property owners, renters, and businesses and encouraging communities to adopt and enforce floodplain management regulations. A community's participation in the NFIP is voluntary and the City of Olympia has participated in the NFIP since 1981. FEMA issues Flood Insurance Rate Maps (FIRM) to define areas that could be exposed to floods; these areas are known as Special Flood Hazard Areas (SFHA). While development is permitted within SFHAs, it must comply with minimum federal standards and local floodplain management ordinances. These standards typically apply to areas that are within the 1-percent annual chance (or 100-year) riverine and coastal floodplains. In addition, lenders require that homeowners located within SFHAs purchase flood insurance to insure against flood damage. It is important to understand that FIRMs only reflect current flood risk and do not consider sea level rise; however, future updates to FIRMs may result in changes to the mapped floodplain as a result of climate change, sea level rise, and other land use changes.

In Olympia, the coastal floodplain is a result of high tides, storm surges, and waves in Budd Inlet and the riverine floodplain is a result of high flows and water levels within Capitol Lake / Lower Deschutes Watershed. FEMA's most recent FIRM places only a small portion of Percival Landing and the Port shorelines within the coastal SFHA. A larger area of downtown in the vicinity of Capitol Lake, bounded by 4th Avenue on the north and Columbia Avenue on the east, is within the riverine SFHA. Much of the downtown area and western portion of the Port peninsula will be within the FEMA floodplain in the future with low to moderate sea level rise (6 to 12 inches).

Homes and businesses can be removed from the SFHA through a variety of actions, including relocating, elevating on fill, or constructing flood protection structures such as floodwalls or levees. In order to meet FEMA's standards, flood protection structures must be certified by a licensed engineer and accredited by FEMA. Accreditation is the process by which FEMA recognizes the protection afforded by a flood protection structure. Accreditation requires that flood protection structures have appropriate freeboard above the 100-year flood elevation and that rigorous technical analyses have been documented as part of the design. In addition, a community must commit to regular operations and maintenance to maintain accreditation. Only once a levee or floodwall is accredited by FEMA will the homes and businesses behind it be removed from SFHA. Flood protection structures constructed by the Project Partners will be designed to reduce flood risk to downtown whether or not they meet the standards for accreditation; however, only accredited flood protection structures will remove areas of downtown from FEMA's SFHA and relieve homes and businesses of the insurance and regulations associated with building in the floodplain.

As the Project Partners plan, design, finance, and construct physical adaptation strategies to address future flood risk due to sea level rise, careful consideration of the costs and benefits of meeting – or not meeting – FEMA accreditation standards will be required. While accredited flood protection may lessen the financial and regulatory burden on individual property owners and developers, building and maintaining accredited protection could be more costly for the community.

The U.S. Army Corps of Engineers (USACE) may have a role in the accreditation process for the flood protection structures. The Project Partners may request the USACE to conduct a Federal Interest Determination for the USACE's involvement in the refinement and implementation of the flood protection projects. If a Federal interest is identified, the USACE and local project sponsors would share the implementation costs and the USACE would assist in planning, design, and construction of the flood control projects. In this scenario, the USACE would provide emergency response / disaster assistance to rehabilitate flood control works threatened or destroyed by floods.

CAPITOL LAKE / LOWER DESCHUTES WATERSHED FOCUS AREA

The adaptation approach in the Capitol Lake / Lower Deschutes Watershed focus area will be initially to address existing flood vulnerabilities of downtown and the combined sewer system and then implement a neighborhood scale solution to address future flood vulnerabilities due to sea level rise. Shoreline elevations along Capitol Lake are approximately 13 to 14 feet NAVD88, compared to the current 100-year flood elevation of approximately 15 feet. The sections that follow present the near-term, mid-term, and long-term strategies for this focus area.

NEAR-TERM STRATEGIES

In the near-term, flooding within the Capitol Lake / Lower Deschutes Watershed focus area would be managed through flood event emergency response activities, installing backflow prevention on key stormwater outfalls and pipes, and minor landscaping of low spots to lessen flood impacts. However, even with these actions, low-lying areas within and adjacent to Heritage Park will remain vulnerable to flooding during infrequent, high-discharge flood events in the Deschutes Watershed. Additional flood protection measures will be needed to address existing and future flood hazards due to sea level rise.

MID-TERM STRATEGIES

Three potential physical strategies were developed to address mid-term flooding (up to 24 inches of sea level rise) along the Capitol Lake shoreline and downtown Olympia. All proposed strategies for the focus area maintain the essential functions of the park while providing flood protection for inland areas. The three potential physical strategies for this focus area include:

- Re-landscaping Heritage Park to create a raised berm; or
- Rebuilding and raising the current floodwall and walkway; and
- Installing a flood gate across the railroad and Powerhouse Road (required for both the berm and floodwall strategies)

An overview schematic showing the alignments and footprints of the strategies for the 24 inch sea level rise scenario is shown in Figure 16. Figures 17-19 show representative sections for existing conditions and the raised wall and berm strategies at 5th Avenue and Water Street. An opportunity to construct a living shoreline is possible with each of these options.

LONG-TERM STRATEGIES

A number of potential physical strategies were identified to address long-term flooding (up to 68 inches of sea level rise) along the Capitol Lake shoreline. The strategies for 68 inches of sea level rise are similar to the mid-term strategies; however, the mid-term strategies would be expanded and raised to address higher flood levels. The exact strategies that would be implemented for long-term sea level rise depend in part on the strategies previously implemented for mid-term sea level rise. The potential long-term strategies include:

- Raising landscaping in Heritage Park to create a higher berm and walkway; or
- Raising floodwall and walkway; or
- Raising both the park landscaping and floodwall; or
- Raising Water Street and 5th Avenue (optional strategy to harmonize adjacent street and park elevations and ensure emergency access)

An overview schematic showing the alignments and footprints of these potential long-term strategies is shown in Figure 20. Figure 21 shows representative sections for the raised berm and wall strategy at 5th Avenue and Water Street. While not shown, the raised berm or wall strategies could be implemented independently as well. The long-term strategy includes optional street raising along Water Street and 5th Avenue to provide better accessibility to Heritage Park and the Capitol Lake shoreline and to provide redundant protection for 5th Avenue, a key east-west connection across downtown.

In addition, there are a number of other actions that may be required in the long-term to address the impacts of sea level rise on the City's stormwater system. There are currently 30 stormwater outfalls that discharge to Capitol Lake. In the future, sea level rise may reduce the capacity of the stormwater system to discharge street runoff, especially during combined rainfall and flood events. To address this, the number of stormwater outfalls could be reduced by rerouting stormwater pipes to fewer, consolidated outfalls along the Capitol Lake shoreline and pumps could be installed to discharge stormwater against higher Capitol Lake water levels.

The Percival Drinking Water Pump Station, located across from Marathon Park along the Deschutes Parkway, would also require protection from floodwaters. The pump house could be protected by a perimeter berm or floodwall or by floodproofing the structure to seal doors, vents, and elevate critical electrical components.

Long-term decisions to retrofit, rebuild, or remove Capitol Lake dam would depend on future management decisions for Capitol Lake / Lower Deschutes Watershed. Climate change and sea level rise should be taken into consideration for any decisions about the future operations and maintenance of the dam.

SUMMARY OF PHYSICAL AND OPERATIONAL STRATEGIES

Table 5 presents a summary of the potential near-term, mid-term, and long-term strategies that could be implemented in the Capitol Lake / Lower Deschutes Watershed focus area to address sea level rise. Proposed governance and informational strategies are discussed in more detail in Chapter 7.

Table 5: Summary of Potential Physical and Operational Adaptation Strategies at Capitol Lake / Lower Deschutes Watershed Focus Area

Near-term Actions (0 to 5 years) Sea Level Rise: <6”	Mid-term Actions (5 to 30 years) Sea Level Rise: up to 24”	Long-term Actions (30+ years) Sea Level Rise: up to 68”
– Emergency response to flood events, including sandbags, portable pumps, sealing catch basins – Install backflow prevention on stormwater outfalls and other key pipes – Minor landscaping at key locations within Heritage Park to raise ground elevations	– Protect downtown by either constructing a new floodwall along the Capitol Lake shoreline or an elevated berm within Heritage Park – Relocate Capitol Lake path inland to a higher elevation – Install flood gate across railroad and Powerhouse Road	– Raise floodwall along shoreline and/or elevate berm within Heritage Park – Raise Capitol Lake shoreline path – Raise 5th Avenue and Columbia Street (optional) – Consolidate stormwater outfalls – Construct stormwater discharge pump station – Protect Percival Drinking Water Pump Station

COORDINATION WITH CAPITOL LAKE / LOWER DESCHUTES WATERSHED

The future of the Capitol Lake / Lower Deschutes Watershed is being evaluated by the Washington Department of Enterprise Services in collaboration with State, local, and tribal governmental and community stakeholders, including the Project Partners. An Environment Impact Statement (EIS) analysis is underway to consider the preferred long-term management strategy, which could involve retaining the lake, restoring the estuary, or some hybrid of the two options. The EIS will take approximately three years to complete. Sea level rise and flood protection will be necessary components of the EIS analysis.

This Plan acknowledges the potential for changes in Capitol Lake as a result of the EIS process and provides adaptation strategies that can be considered with the various management alternatives. Regardless of the future of Capitol Lake, the eastern shoreline along Heritage Park will need to be modified in order to prevent future downtown flooding. Different alternatives could present subtle changes in how the shoreline is modified to address sea level rise.

Additionally, the Department of Enterprise Services plans to move into the design, permitting, and construction of the preferred alternative upon completion of the final EIS. Depending on the outcome of the EIS, this project may incorporate flood hazard reduction elements.

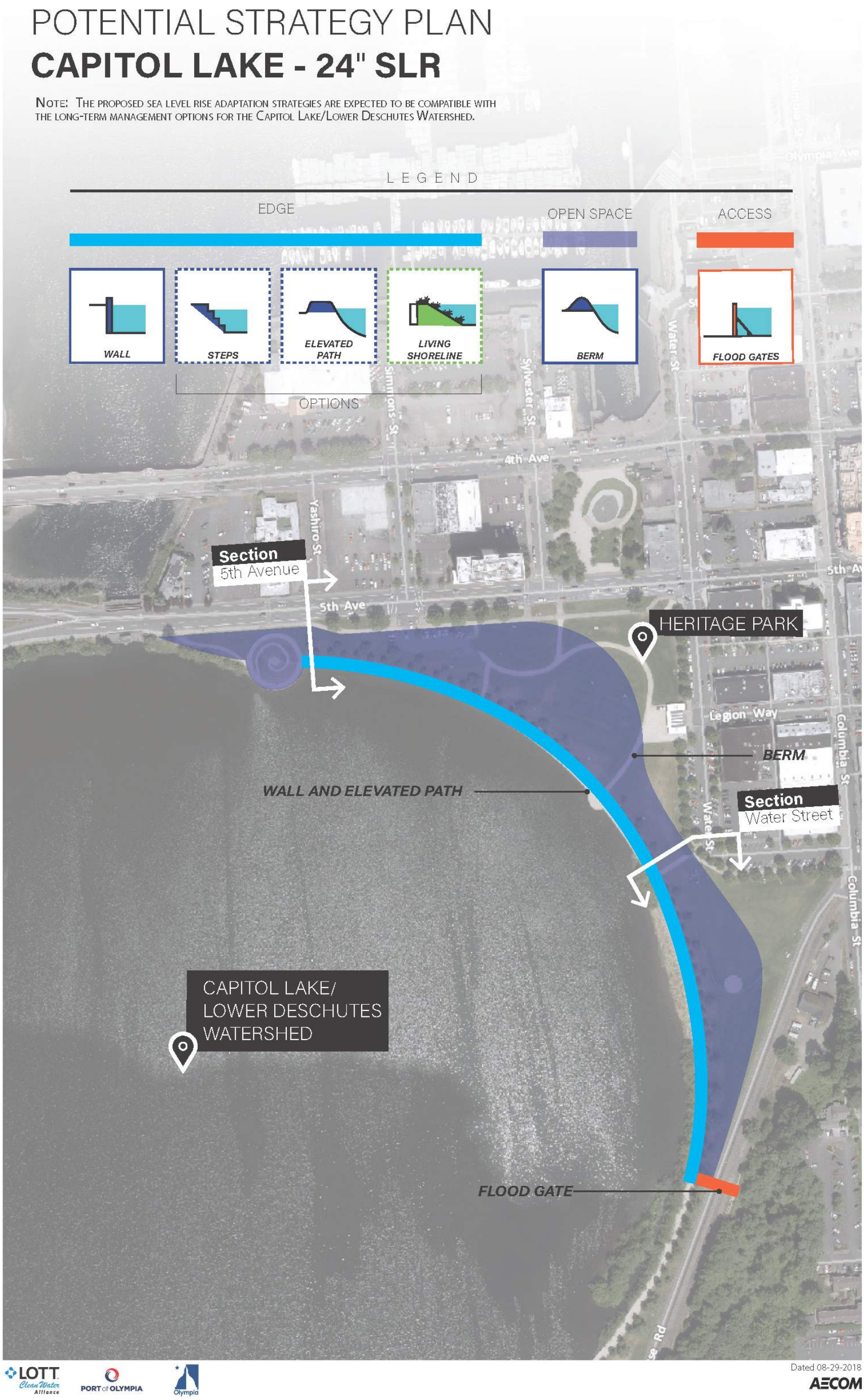
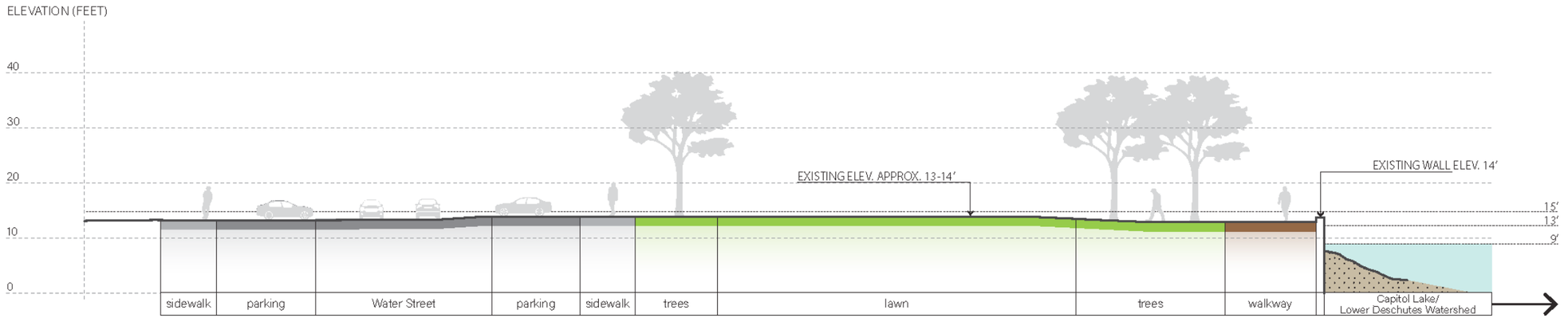


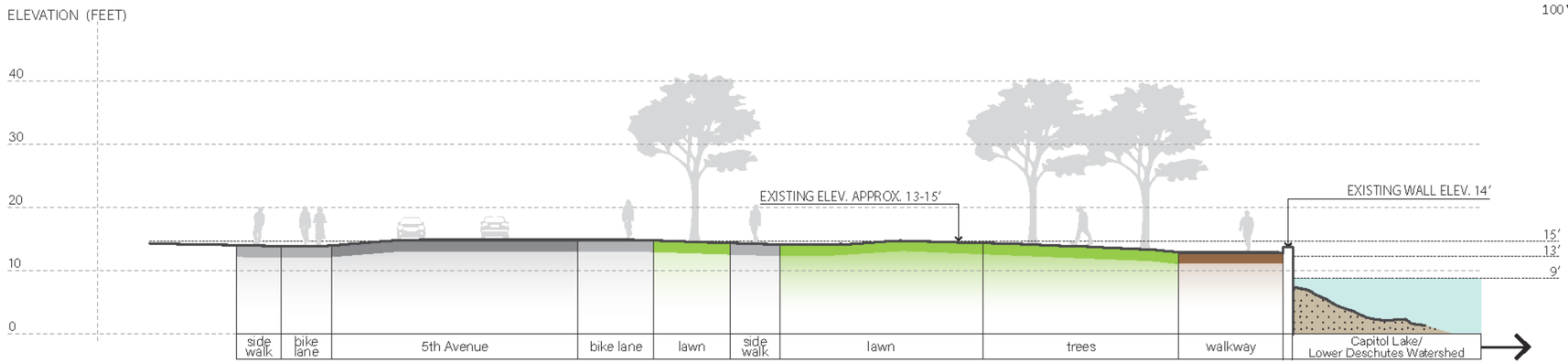
Figure 16. Potential Strategy Plan for Mid-Term Sea Level Rise (24 inches) at Capitol Lake

CAPITOL LAKE
EXISTING CONDITIONS

WATER STREET PERSPECTIVE



5TH AVENUE PERSPECTIVE



NOTES

ELEVATION DATUM:	NAVD88
TYPICAL WATER LEVEL:	9'
2 YEAR FLOOD:	13'
100 YEAR FLOOD:	15'

NOTES

ELEVATION DATUM:	NAVD88
TYPICAL WATER LEVEL:	9'
2 YEAR FLOOD:	13'
100 YEAR FLOOD:	15'

Figure 17. Existing Conditions at Capitol Lake / Lower Deschutes Watershed at Heritage Park

CAPITOL LAKE
MID-TERM SOLUTION FOR 24" OF SLR
CONSTRUCT NEW WALL

This strategy would construct a new wall and elevated path behind the existing Capitol Lake path at a higher elevation. Additional options for the new wall could include a stepped edge (Option B) or a seatwall (Option C). As flooding of the existing walkway becomes more frequent in the future, the existing wall and walkway could be removed and the lake edge converted to a living shoreline. The proposed sea level rise adaptation strategies are expected to be compatible with the long-term management options for the Capitol Lake/Lower Deschutes Watershed.

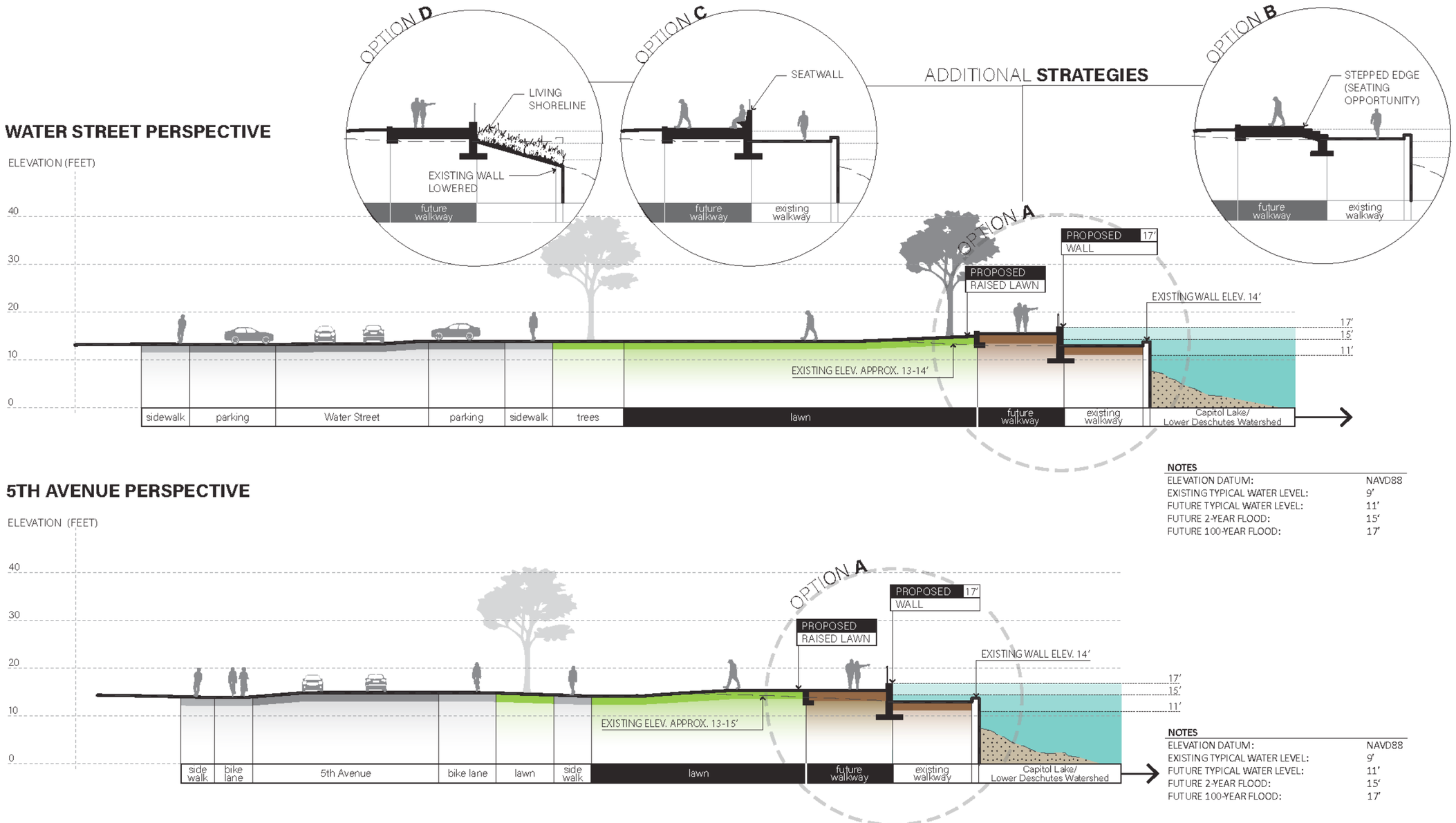


Figure 18. Potential Mid-Term Sea Level Rise (24 inches) Strategy for Capitol Lake / Lower Deschutes Watershed at Heritage Park: Construct New Wall

CAPITOL LAKE
MID-TERM SOLUTION FOR 24" OF SLR
CONSTRUCT NEW BERM

This strategy would construct a new berm and elevated path within Heritage Park at a higher elevation away from the water's edge. As flooding of the existing path becomes more frequent in the future, the existing wall and path could be removed and the lake edge converted to a living shoreline. The proposed sea level rise adaptation strategies are expected to be compatible with the long-term management options for the Capitol Lake/Lower Deschutes Watershed.

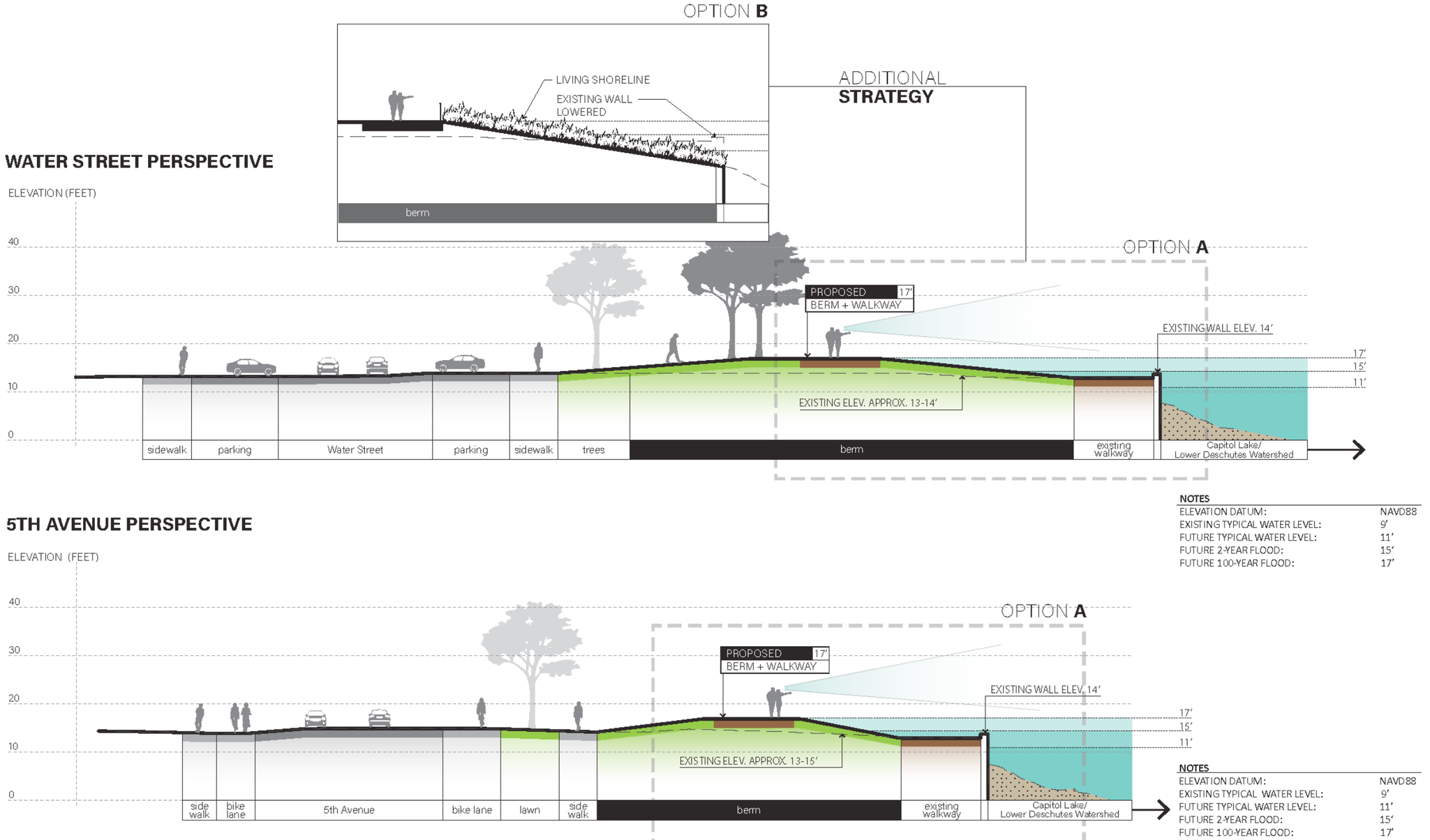


Figure 19. Potential Mid-Term Sea Level Rise (24 inches) Strategy for Capitol Lake / Lower Deschutes Watershed at Heritage Park: Construct New Berm

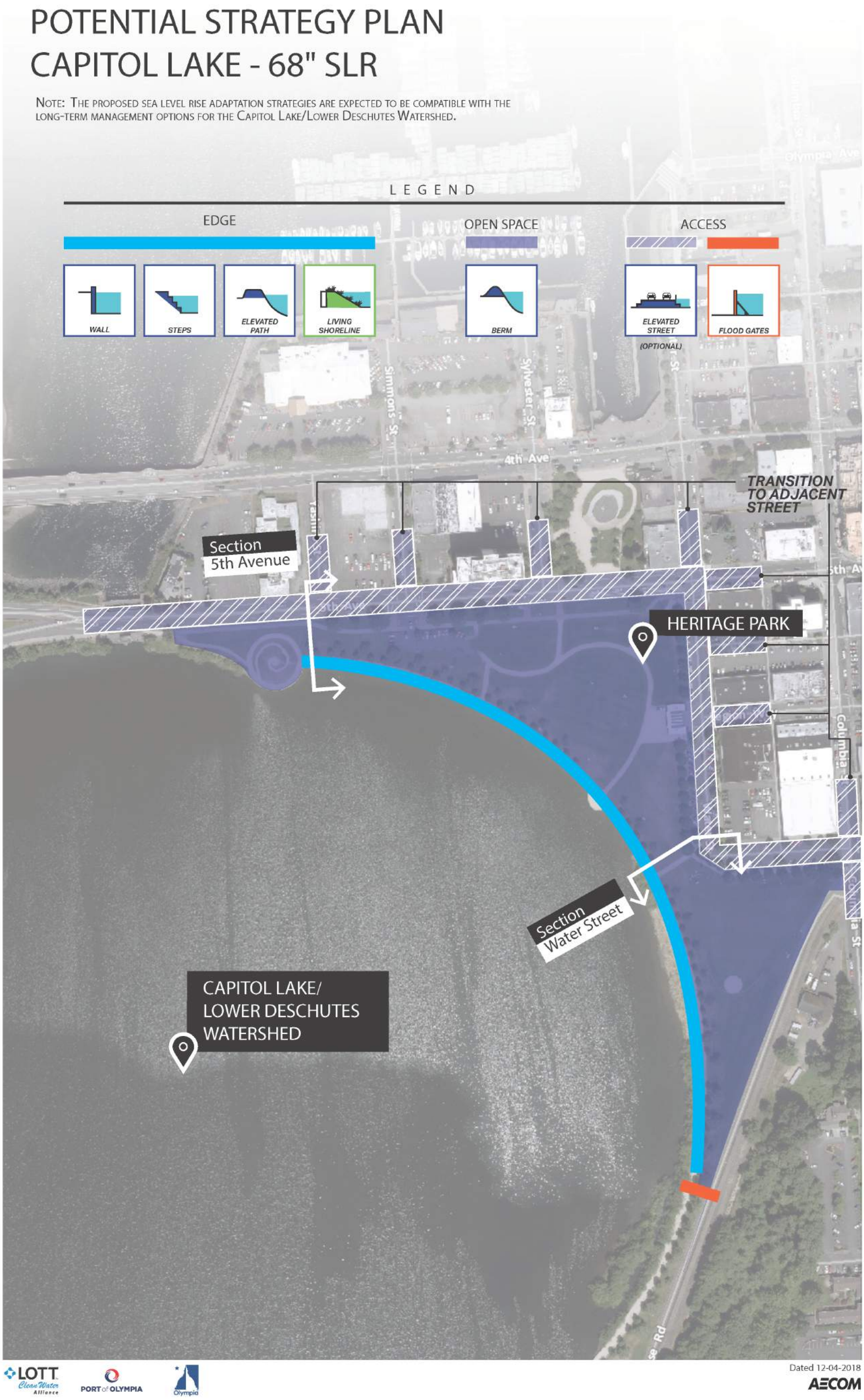


Figure 20. Potential Strategy Plan for Long-term Sea Level Rise (68 inches) at Capitol Lake

CAPITOL LAKE
LONG-TERM SOLUTION FOR 68" OF SLR
RAISE BERM AND HEIGHTEN WALL (OPTIONAL ELEVATED STREET)

This strategy would further raise the berm and surrounding landscape in Heritage Park and construct a stepped edge adjacent to the water. The existing path would be permanently inundated and could be removed and converted to a living shoreline. This strategy also includes optional raising of Water Street and 5th Avenue to harmonize adjacent street and park elevations. The proposed sea level rise adaptation strategies are expected to be compatible with the long-term management options for the Capitol Lake/Lower Deschutes Watershed.

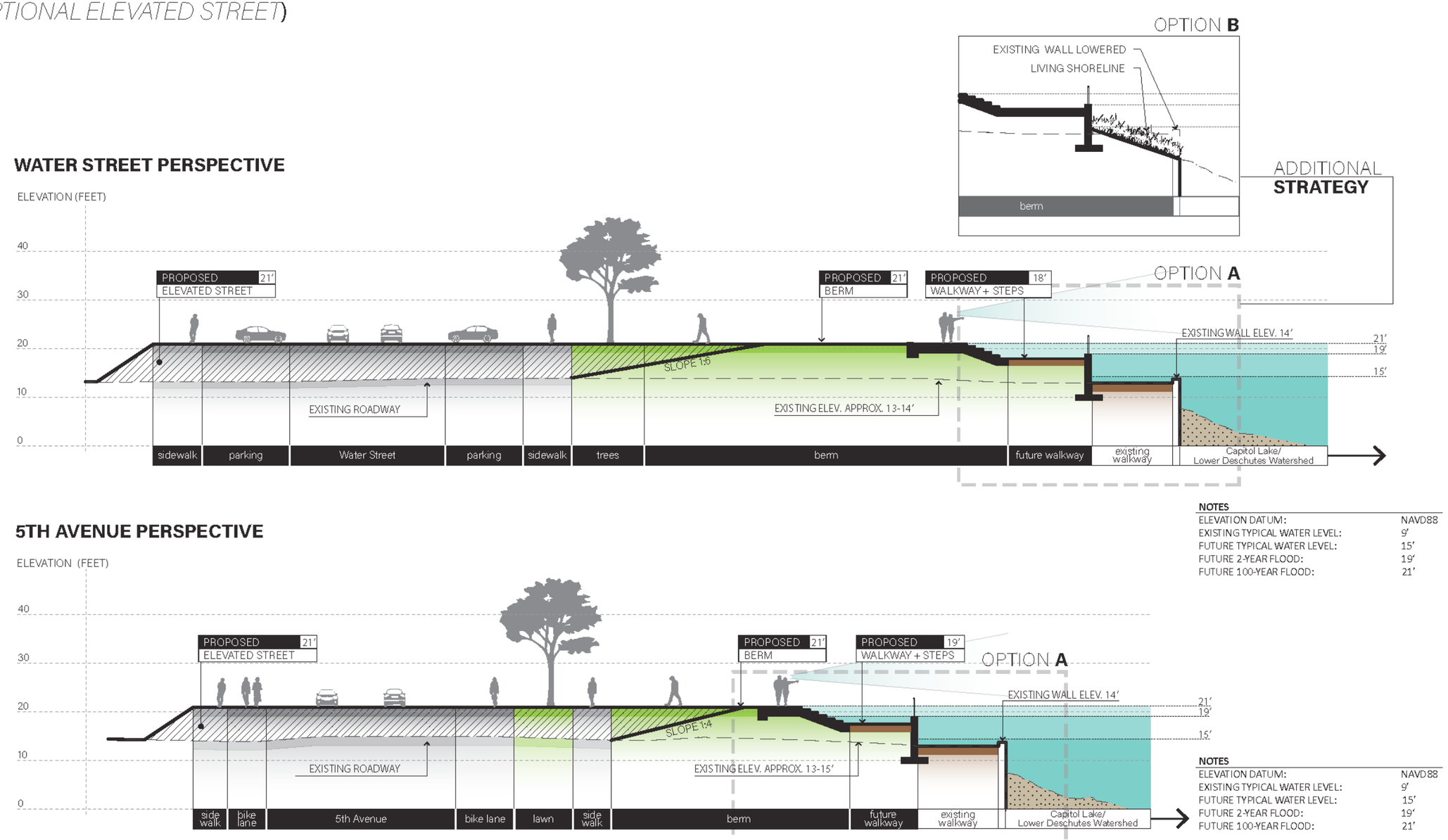


Figure 21. Potential Long-Term Sea Level Rise (68 inches) Strategy for Capitol Lake / Lower Deschutes Watershed at Heritage Park: Raise Berm and Heighten Wall

PERCIVAL LANDING AND ISTHMUS FOCUS AREA

The adaptation approach for the Percival Landing and Isthmus focus area relies on a suite of strategies initially to provide protection up to 24 inches of sea level rise, with the opportunity to build upon them to extend protection up to 68 inches of sea level rise. The sections that follow present the near-term, mid-term, and long-term strategies for this focus area.

NEAR-TERM STRATEGIES

In the near-term, flooding along the Percival Landing and Isthmus focus area would be managed through flood event emergency response activities, installing backflow prevention on key stormwater outfalls and pipes, and conducting outreach to business owners to increase awareness of flood vulnerabilities and encourage flood mitigation activities.

MID-TERM STRATEGIES

Mid-term sea level rise protection (up to 24 inches) could be provided by constructing a linked system of planter boxes, flood gates, flood walls, and berms. The linked system would create a new temporary shoreline during large coastal storm events to prevent flooding of low-lying inland areas of downtown. Raised paths, ramps, stairs, and landscaping would maintain current public access to the shoreline and businesses during non-storm conditions.

An overview schematic showing the alignments and footprints of the potential mid-term physical strategies is shown in Figure 22. As previously discussed, the alignment of the flood protection strategies is proposed to be located within the current public right-of-way. Opportunities may exist in the future for the City to acquire privately held waterfront leases of State lands, if and when they become available, to shift alignment of the flood protection strategies closer to the shoreline. Three sections (Olympia Avenue, Percival Landing Park, and Columbia Street) are highlighted on the schematic and additional details and representative sections are presented in the following sections.

Olympia Avenue
The existing conditions of Percival Landing at Olympia Avenue is shown in Figure 23. The existing shoreline is at an elevation of approximately 14 feet NAVD88. Two potential strategies were developed to address the 24 inch sea level rise scenario at this location: (1) construct a new wall and (2) elevate the boardwalk. A potential strategy to construct a new wall on the water side of the existing boardwalk is shown in Figure 24. The top of the wall would extend approximately two feet above the existing boardwalk. A potential strategy to elevate the existing boardwalk is shown in Figure 25. Steps or a ramp would provide access to the boardwalk from the adjacent street or parking areas. Both strategies would maintain current parking uses and pedestrian access to the waterfront.

Percival Landing Park
The existing conditions of Percival Landing at Percival Landing Park is shown in Figure 26. The existing shoreline is at an elevation of approximately 14 feet NAVD88. One potential strategy to address the 24 inch sea level rise scenario at this location is shown in Figure 27. This strategy would raise the landscaping within Percival Landing Park by one to two feet by constructing an elevated berm. During extreme coastal storm events, Budd Inlet floodwaters may overtop the existing shoreline and boardwalk; however, the raised berm would prevent flooding of low-lying inland areas.

Columbia Street
A potential strategy to address the 24 inch sea level rise scenario at this location is shown in Figure 28. This strategy would construct new raised landscaped areas and raise existing ones to install raised planter boxes to prevent floodwaters from impacting low-lying inland areas. The planter boxes would be planted with flood tolerant species and ramps or stairs would provide access to the shoreline. Pop-up flood gates would be installed across key access points, such as cross streets and pathways to allow access to the shoreline during non-storm conditions.

LONG-TERM STRATEGIES

Long-term sea level rise protection (up to 68 inches) could be provided by raising some existing features and replacing others with new elevated features, such as raised streets, farther inland. The linked system would create a new temporary shoreline during large coastal storm events in order to prevent flooding of low-lying inland areas of downtown. Raised paths, ramps, stairs, and landscaping would maintain current public access to the shoreline and businesses during non-storm conditions.

An overview schematic showing the alignments and footprints of the potential long-term physical strategies is shown in Figure 29. As previously discussed, the alignment of the flood protection strategies is proposed

PROVIDING ACCESS TO THE SHORELINE

Some of the physical strategies identified in the Plan may impede access to Olympia's shoreline because they will act as barriers to pedestrians and vehicles. Temporary flood barriers, such as sand bags and other deployables, can be installed before a flood event and removed shortly after. Permanent flood barriers, such as planter boxes and floodwalls, could make access to the shoreline more difficult if appropriate landscaping and details are not included to ensure ease of access. The representative cross sections included in the Plan depict some access options, including sloping landscaping to meet the tops of barriers and stairs to transition between features of different elevations. The Project Partners also anticipate that ADA compliant ramps would be installed in key locations to provide accessibility for all of Olympia's residents.

In addition to pedestrians, vehicular access to parking lots and waterfront businesses will be important to maintain during non-storm conditions. The strategy concepts included in the Plan have identified a number of locations for vehicular access based on existing roads and driveways (identified as orange symbols in Figure 22). At these locations, pop-up flood barriers (such as those manufactured by companies such as FloodBreak and others) could be installed. Pop-up barriers lay flat against the ground during non-storm conditions and automatically float up when submerged to form a continuous line of flood protection during flood events. As floodwaters recede, the flood gates lower to their pre-flood position. The details of pedestrian and vehicular access will be considered more thoroughly as part of the planning and design of specific flood protection projects in the decades ahead.

to be located within the public right-of-way. Three sections (Olympia Avenue, Percival Landing Park, and Columbia Street) are highlighted on the schematic and additional details on the mid-term and long-term strategies are presented in the following sections.

Olympia Avenue

One potential strategy to elevate and relocate the boardwalk farther inland to provide flood protection to inland areas is shown in Figure 30. Raised paths would provide access to the shoreline. Steps or a ramp could provide access to the boardwalk from adjacent streets or parking areas.

Percival Landing Park

Two options associated with a strategy to raise the boardwalk and heighten the wall along the shoreline are shown in Figure 31 and Figure 32. The existing landscaped area in Percival Landing Park could also be raised to harmonize elevations between the raised shoreline and adjacent inland areas.

Columbia Street

Protection of inland areas could also be achieved by raising City rights-of-way along Columbia Street, Water Street, and 4th Avenue. A representative street raising section at Columbia Street is shown in Figure 33. A the raised street would include two lanes of traffic and a multi-modal lane for bus and/or bike. The raised streets would require transitional slopes, ramps, and stairs to maintain access to adjacent cross streets, intersections, and sidewalks.

In addition, there are a number of other actions that may be required in the long-term to address the impacts of sea level rise on the stormwater system. There are currently 33 stormwater outfalls that discharge to Budd Inlet from Percival Landing and the Isthmus. In the future, sea level rise may reduce the capacity of the stormwater system to discharge street runoff, especially during combined rainfall and flood events. To address this, the number of stormwater outfalls could be reduced by rerouting stormwater pipes to fewer, consolidated, outfalls along the Percival Landing shoreline and pumps could be installed to discharge stormwater against higher Budd Inlet water levels.

SUMMARY OF PHYSICAL AND OPERATIONAL STRATEGIES

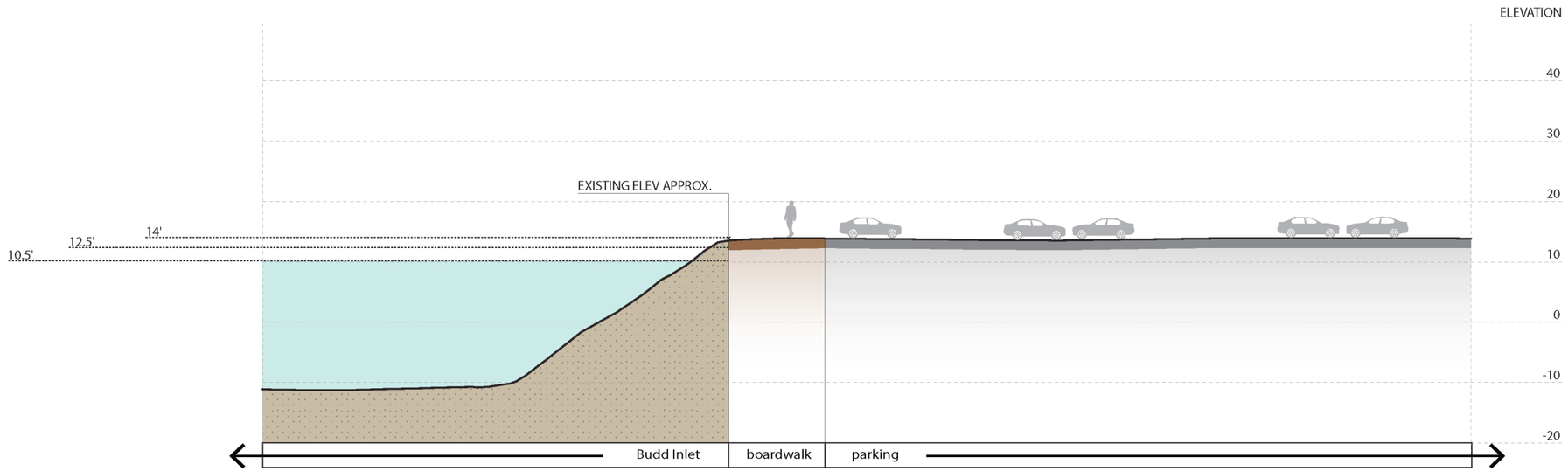
Table 6 presents a summary of the potential near-term, mid-term, and long-term strategies that could be implemented in the Percival Landing and Isthmus focus area to address sea level rise. Governance and informational strategies identified in the table are discussed in more detail in Chapter 7.

Table 6: Summary of Potential Physical and Operational Adaptation Strategies at Percival Landing and Isthmus Focus Area

Near-term Strategies (0 to 5 years) Sea Level Rise: <6”	**Mid-term Strategies (5 to 30 years) Sea Level Rise: up to 24”**	**Long-term Strategies (30+ years) Sea Level Rise: up to 68”**
– Emergency response to flood events, including sandbags, closing valves, and sealing combined sewer catch basins – Install backflow prevention (gates and valves) on stormwater outfalls and other key pipes	– Install raised planters within the City right-of-way along Columbia Street and 4th Avenue – Raise landscaping within Percival Landing Park – Elevate existing paths to provide access to the shoreline – Install flood gates across Simmons Street, Sylvester Street, A Avenue, B Avenue, and Corky Avenue – Acquire waterfront leases if and when they become available	– Raise Columbia Street, Water Street, and 4th Avenue – Elevate paths north and south of Percival Landing Park – Raise or retrofit wall along Percival Landing Park – Consolidate stormwater outfalls – Construct stormwater discharge pumping station(s)

Figure 22. Potential Strategy Plan for Mid-Term Sea Level Rise (24 inches) at Percival Landing

PERCIVAL LANDING
EXISTING CONDITIONS
OLYMPIA AVENUE PERSPECTIVE

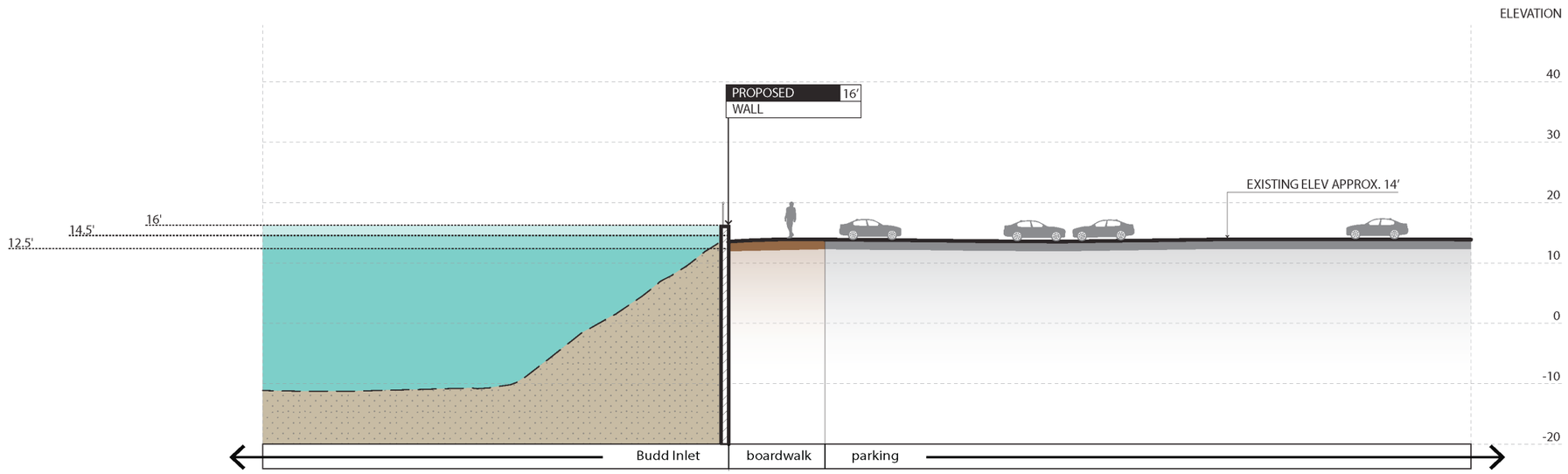


NOTES	
ELEVATION DATUM:	NAVD88
DAILY HIGH TIDE:	10.5’
KING TIDE:	12.5’
100 YEAR FLOOD:	14’

Figure 23. Existing Conditions Section for Percival Landing at Olympia Avenue

PERCIVAL LANDING
MID- TERM SOLUTION FOR 24" OF SLR
CONSTRUCT NEW WALL
OLYMPIA AVENUE PERSPECTIVE

This strategy would construct a new wall on the water side of the existing boardwalk to prevent flooding of inland areas. The top of the wall would extend approximately two feet above the boardwalk and would include a safety railing.



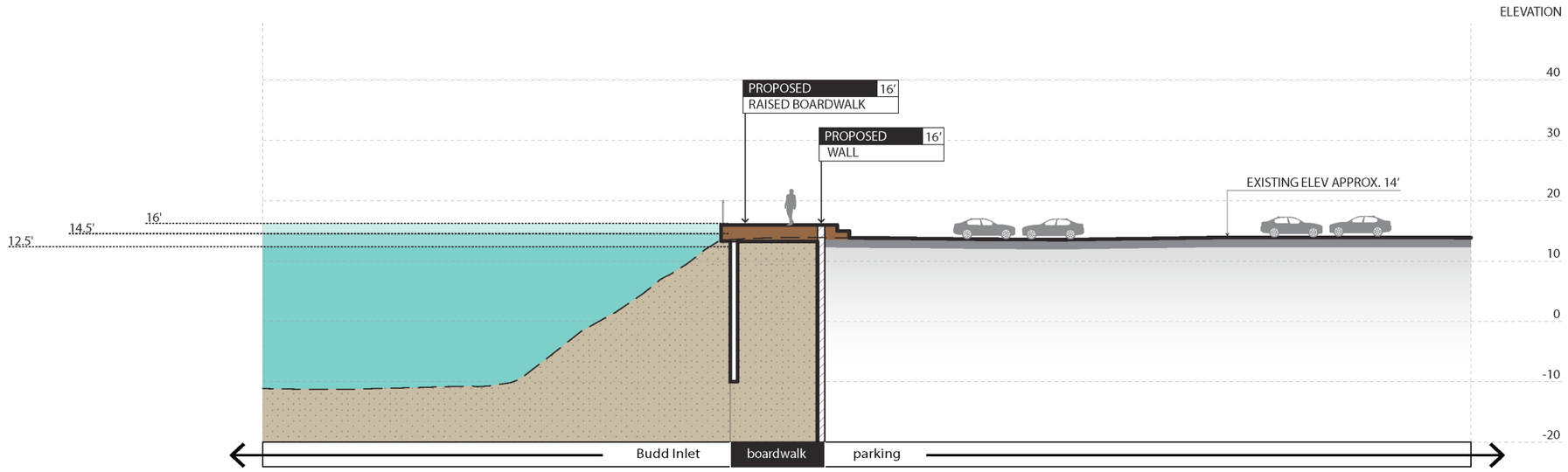
NOTES

ELEVATION DATUM:	NAVD88
FUTURE DAILY HIGH TIDE:	12.5'
FUTURE KING TIDE:	14.5'
FUTURE 100 YEAR FLOOD:	16'

Figure 24. Potential Mid-Term Sea Level Rise (24 inches) Strategy for Percival Landing at Olympia Avenue: Construct New Wall

PERCIVAL LANDING
MID- TERM SOLUTION FOR 24" OF SLR
ELEVATE BOARDWALK
OLYMPIA AVENUE PERSPECTIVE

This strategy would construct a new wall on the landward side of the existing boardwalk to prevent flooding of inland areas. The existing boardwalk would also be raised above future flood elevations. Steps or a ramp would provide access to the boardwalk from adjacent street or parking areas.

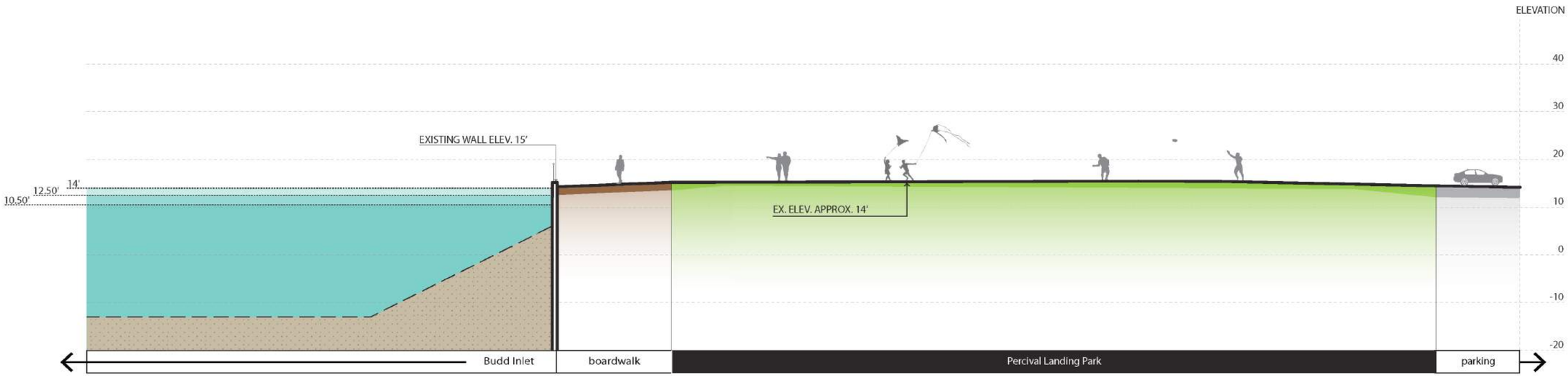


NOTES

ELEVATION DATUM:	NAVD88
FUTURE DAILY HIGH TIDE:	12.5'
FUTURE KING TIDE:	14.5'
FUTURE 100 YEAR FLOOD:	16'

Figure 25. Potential Mid-Term Sea Level Rise (24 inches) Strategy for Percival Landing at Olympia Avenue: Elevate Boardwalk

PERCIVAL LANDING
MID- TERM SOLUTION FOR 24" OF SLR
EXISTING CONDITIONS
PERCIVAL LANDING PARK PERSPECTIVE



NOTES

ELEVATION DATUM:	NAVD88
FUTURE DAILY HIGH TIDE:	12.5'
FUTURE KING TIDE:	14.5'
FUTURE 100 YEAR FLOOD:	16'

Figure 26. Existing Conditions Section for Percival Landing at Percival Landing Park

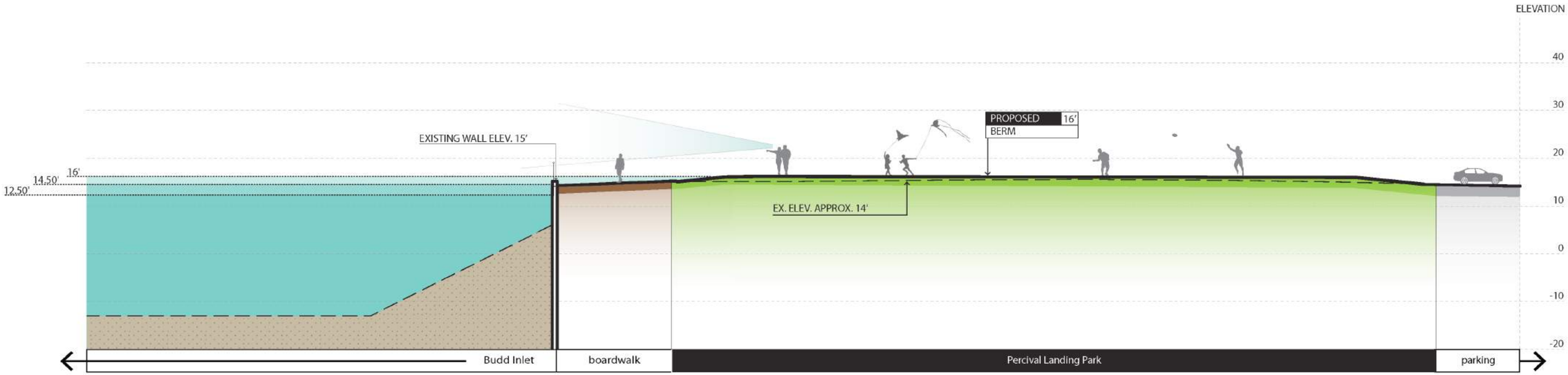
PERCIVAL LANDING

MID- TERM SOLUTION FOR 24" OF SLR

CONSTRUCT NEW BERM

PERCIVAL LANDING PARK PERSPECTIVE

This strategy would raise the existing ground elevation within Percival Landing Park by constructing an elevated berm. During extreme coastal storm events, flood waters in Budd Inlet may overtop the existing shoreline; however, the raised berm would prevent flooding of inland areas.

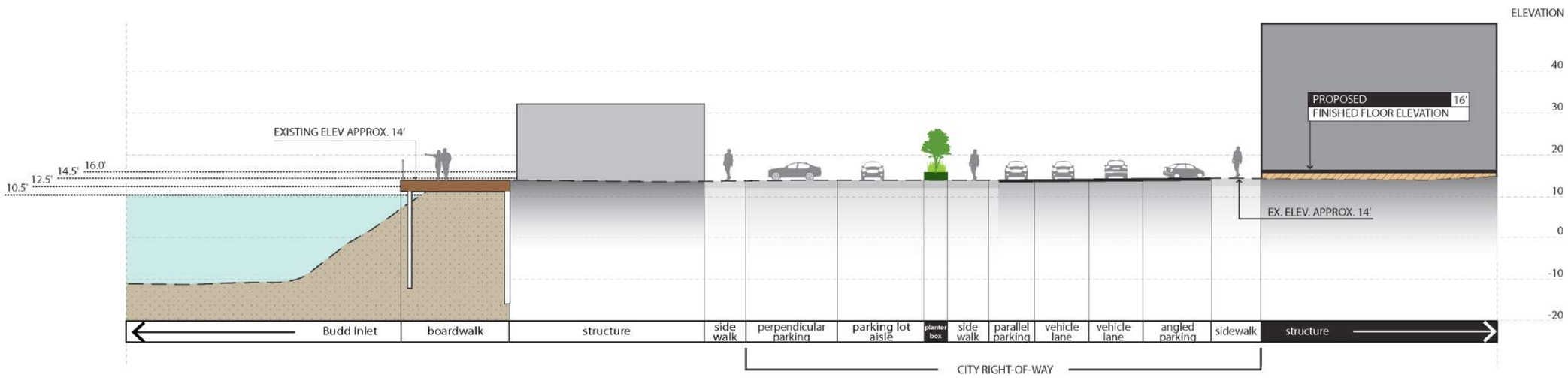


NOTES	
ELEVATION DATUM:	NAVD88
FUTURE DAILY HIGH TIDE:	12.5'
FUTURE KING TIDE:	14.5'
FUTURE 100 YEAR FLOOD:	16'

Figure 27. Potential Mid-Term Sea Level Rise (24 inches) Strategy for Percival Landing at Percival Landing Park: Construct New Berm

PERCIVAL LANDING
LONG- TERM STRATEGY FOR 24" OF SLR
PLANTER BOX
COLUMBIA STREET PERSPECTIVE

This low-impact strategy would construct a vertical barrier to mitigate flooding of inland areas. Additionally, the vertical barrier would function as a continuous planter box that would introduce flood-tolerant plant species to the corridor. The planter box may provide other benefits such as integrated seating amenities and ramps or stairs to provide access. The planter box would replace one row of parking and convert parking stalls along Columbia Street to parallel parking. Vehicular traffic lanes along Columbia Street would retain their existing condition alignment and width.



NOTES

ELEVATION DATUM:	NAVD88
DAILY HIGH TIDE:	10.5'
FUTURE DAILY HIGH TIDE:	12.5'
FUTURE KING TIDE:	14.5'
FUTURE 100 YEAR FLOOD:	16.0'

Figure 28. Potential Mid-Term Sea Level Rise (24 inches) Strategy for Percival Landing at Columbia Street: Raised Planter Box

Figure 29. Potential Strategy Plan for Long-Term Sea Level Rise (68 inches) at Percival Landing

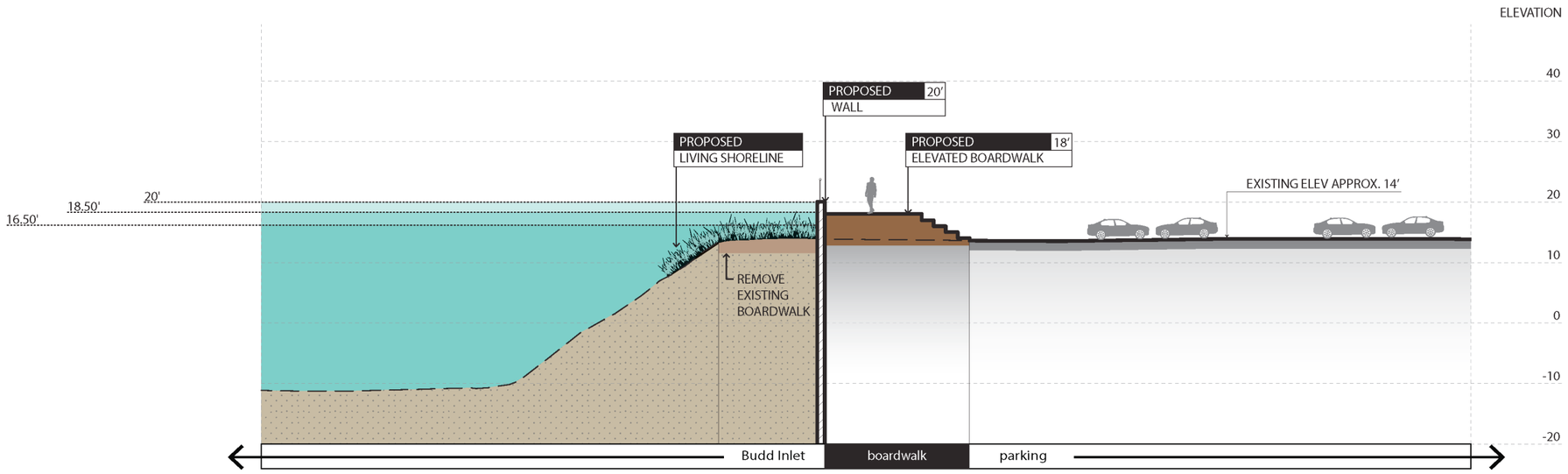
PERCIVAL LANDING

LONG- TERM STRATEGY FOR 68" OF SLR

ELEVATE AND RELOCATE BOARDWALK

OLYMPIA AVENUE PERSPECTIVE

This strategy would construct a new wall (or extend the existing wall) on the landward side of the boardwalk to prevent flooding of inland areas. A new boardwalk would be constructed on the landward side of the wall and the old boardwalk would be removed to restore a natural shoreline. Steps or a ramp would provide access to the boardwalk from adjacent street or parking areas.



NOTES

ELEVATION DATUM:	NAVD88
FUTURE DAILY HIGH TIDE:	16.5'
FUTURE KING TIDE:	18.5'
FUTURE 100 YEAR FLOOD:	20'

Figure 30. Potential Long-Term Sea Level Rise (68 inches) Strategy for Percival Landing at Olympia Avenue: Elevate and Relocate Boardwalk

PERCIVAL LANDING

LONG- TERM SOLUTION FOR 68" OF SLR

RAISE BOARDWALK AND HEIGHTEN WALL (OPTION A)

PERCIVAL LANDING PARK PERSPECTIVE

This strategy would raise the existing wall and boardwalk along the waterfront to prevent flooding of inland areas. Access to the boardwalk from Percival Landing Park would be provided by steps or a ramp.

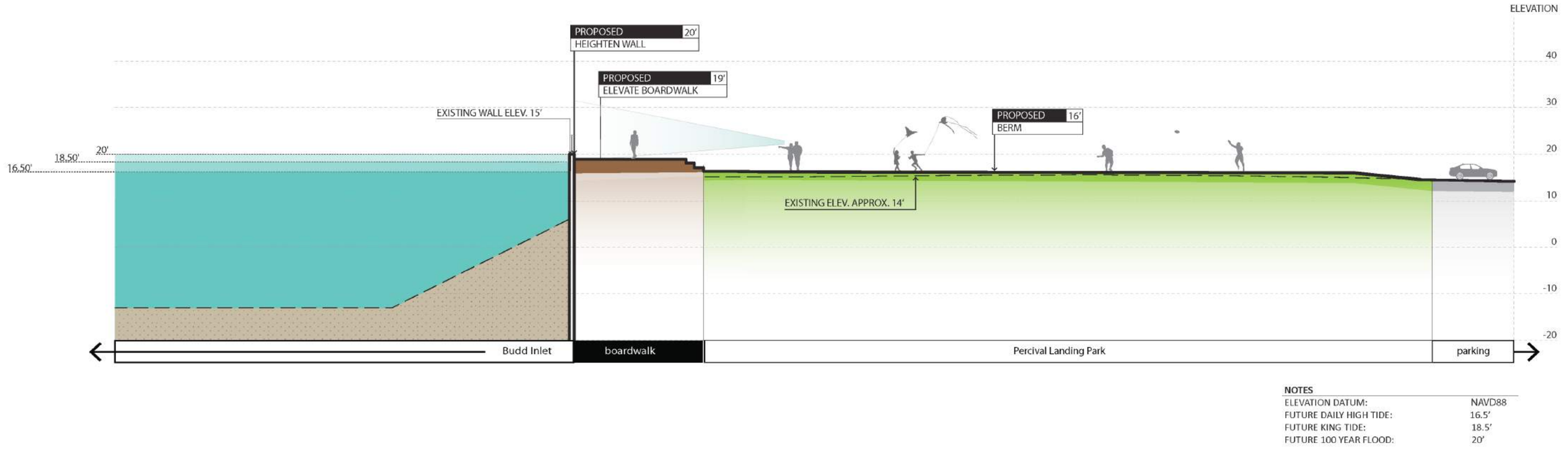


Figure 31. Potential Long-Term Sea Level Rise (68 inches) Strategy for Percival Landing at Percival Landing Park: Raise Boardwalk and Heighten Wall (Option A)

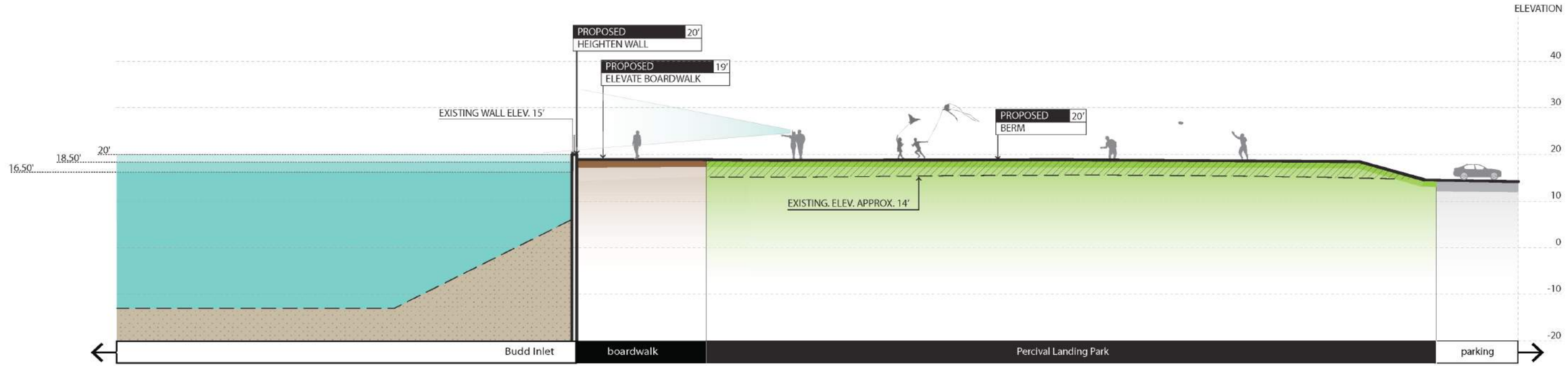
PERCIVAL LANDING

LONG- TERM SOLUTION FOR 68" OF SLR

RAISE BOARDWALK AND HEIGHTEN WALL (OPTION B)

PERCIVAL LANDING PARK PERSPECTIVE

This strategy would raise the existing wall and boardwalk along the waterfront to prevent flooding of inland areas. Percival Landing Park would also be raised to harmonize adjacent ground elevations between the boardwalk and the park.



NOTES

ELEVATION DATUM:	NAVD88
FUTURE DAILY HIGH TIDE:	16.5'
FUTURE KING TIDE:	18.5'
FUTURE 100 YEAR FLOOD:	20'

Figure 32. Potential Long-Term Sea Level Rise (68 inches) Strategy for Percival Landing at Percival Landing Park: Raise Boardwalk and Heighten Wall (Option B)

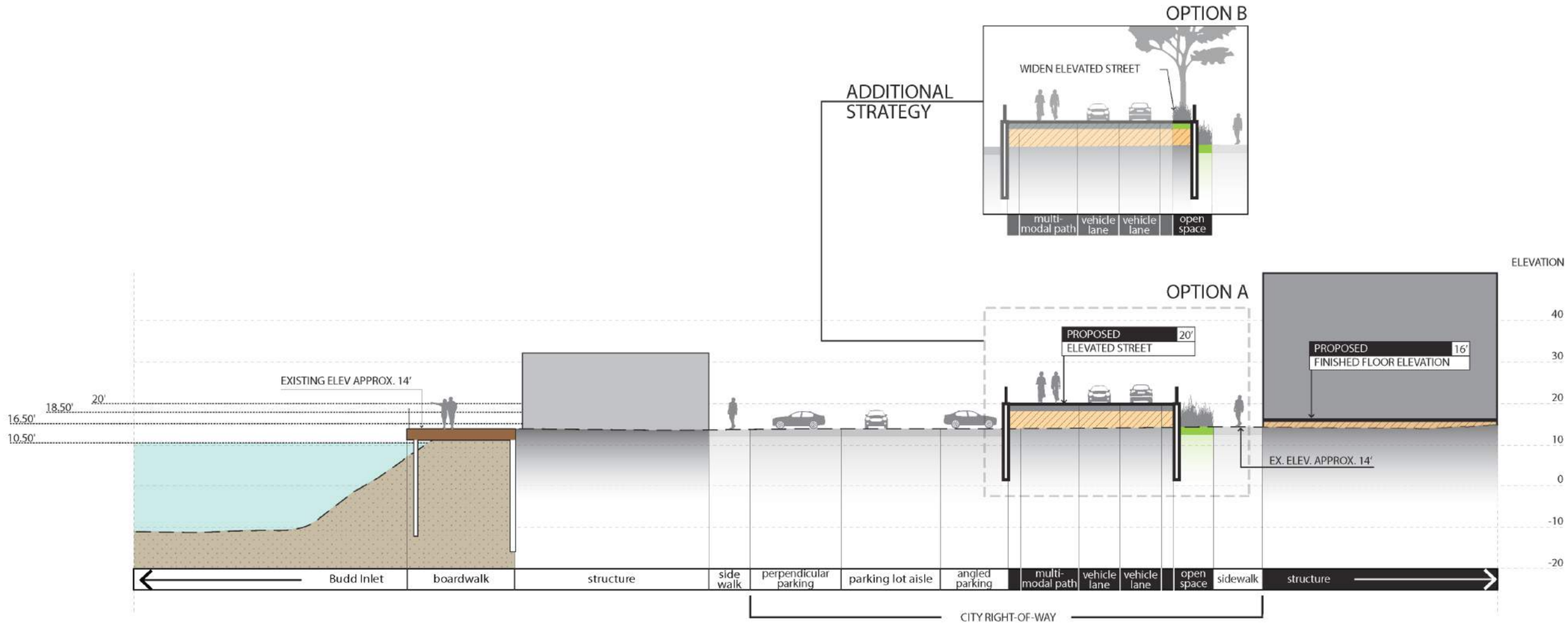
PERCIVAL LANDING

LONG- TERM STRATEGY FOR 68" OF SLR

RAISE STREET

COLUMBIA STREET PERSPECTIVE

This strategy would raise Columbia Street approximately five feet above its current elevation to prevent flooding of inland areas. The raised street would include two lanes of traffic and a multi-modal lane (for bus and/or bike). ADA accessible ramps and stairs would provide access for pedestrians at intersections. Open space areas along the elevated street and lower sidewalk would meet street tree requirements and integrate bioretention for water quality treatment. A similar elevated street strategy could be implemented along 4th Avenue to provide an integrated system of flood protection along the West Bay shoreline.



NOTES	
ELEVATION DATUM:	NAVD88
DAILY HIGH TIDE:	10.5'
FUTURE DAILY HIGH TIDE:	16.5'
FUTURE KING TIDE:	18.5'
FUTURE 100 YEAR FLOOD:	20'

Figure 33. Potential Long-Term Sea Level Rise (68 inches) Strategy for Percival Landing at Columbia Street: Raise Street

BUDD INLET TREATMENT PLANT AND COMBINED SEWER SYSTEM FOCUS AREA

As discussed in the key vulnerabilities section, the Budd Inlet Treatment Plant (BITP) is not expected to be exposed to flooding impacts during a large coastal flood event until approximately 18 inches of sea level rise – projected to occur sometime between 2040 and 2060. In the meantime, the majority of near-term impacts to the Budd Inlet Treatment Plant would be caused by excess floodwaters from Capitol Lake or Budd Inlet entering the combined sewer system through catch basins in the downtown area. The sections that follow present the near-term, mid-term, and long-term strategies for this focus area.

NEAR-TERM STRATEGIES

The most effective near-term adaptation approach for LOTT is to coordinate with the City and State to focus investments on protecting low-lying areas of downtown Olympia from flooding. This can be accomplished by developing protocols for emergency sealing of vulnerable catch basins and closing existing stormwater valves during flood events, and installing backflow prevention (e.g., gates and valves) in key stormwater pipes and outfalls.

In addition, LOTT may evaluate and refine its high flow standard operating procedures as needed to ensure plant operators are prepared for more frequent high flow events (due to sea level rise and coastal flooding, riverine flooding from Capitol Lake/Lower Deschutes Watershed, or high intensity local precipitation events – all of which are projected to increase as a result of climate change). LOTT can also continue to consider sea level rise as a design criteria for new capital projects, as it has done in the past to ensure that new facilities are resilient to future flooding. LOTT can study/monitor groundwater impacts around the Budd Inlet Treatment Plant and collaborate with Puget Sound Energy to develop a flood protection plan for the Thurston Substation, which provides power to the plant.

MID-TERM STRATEGIES

In the mid-term, LOTT would implement design standards to raise the elevation of upgraded and new treatment plant components and flood proof individual facilities or critical components at the BITP – particularly those that are lowest lying or underground. The Budd Inlet Treatment Plant will become increasingly dependent on shoreline flood protection as sea levels rise to minimize flooding into the combined stormwater/sewer system.

In addition, LOTT may investigate the feasibility and benefits of constructing additional equalization storage or other peak flow management measures and plan for a need to increase influent and effluent pumping capacity. LOTT may also consider redundant onsite flood protection at BITP to protect critical infrastructure at the plant. These measures would be evaluated and designed in the mid-term, with implementation in the long-term time period.

LONG-TERM STRATEGIES

In the long-term, LOTT will likely increase flood storage and pumping capacity at the BITP and upsize the north outfall pipe, in response to changing weather patterns and sea level rise. In addition to implementing perimeter flood protection, LOTT's previous vulnerability assessment of Budd Inlet Treatment Plant identified the following strategies to address long-term flood vulnerabilities at the plant:

CAN THE BUDD INLET TREATMENT PLANT BE RELOCATED?

LOTT conducted a study in 2016 to estimate the cost of relocating the Budd Inlet Treatment Plant to an upland site. Such a relocation would require acquiring land, constructing a new plant, modifying the regional wastewater collection system, and decommissioning the existing plant. While it is technically feasible to relocate the treatment plant, a number of significant challenges were identified. The total estimated cost to relocate the plant was estimated to be approximately $1.3 billion in today's dollars – significantly more than the cost to protect the plant in its current location.

- Install water-tight doors and bottom entry conduit throughout the plant
- Seal ducts, conduit entries, pipes, and HVAC equipment
- Raise critical equipment and/or provide watertight enclosures
- Conduct a detailed condition and vulnerability assessment of the electrical system

SUMMARY OF PHYSICAL AND OPERATIONAL STRATEGIES

Table 7 presents a summary of the potential near-term, mid-term, and long-term actions that could be implemented in the Budd Inlet Treatment Plant focus area to address sea level rise. Proposed governance and informational strategies are discussed in more detail in Chapter 7.

Table 7: Summary of Potential Physical and Operational Adaptation Strategies at Budd Inlet Treatment Plant

Near-term Strategies (0 to 5 years) Sea Level Rise: <6”	Mid-term Strategies (5 to 30 years) Sea Level Rise: up to 24”	Long-term Strategies (30+ years) Sea Level Rise: up to 68”
– Coordinate with City and State on winter flood preparedness activities to minimize flooding of the combined sewer system – Coordinate with City to prioritize installation of backflow prevention on key pipes and outfalls – Refine BITP’s high flow standard operating procedures – Collaborate with PSE to protect Thurston Substation	– Flood proof sensitive facilities at BITP and evaluate feasibility and benefits of construction of perimeter flood protection – Elevate upgraded/new BITP components above projected flood levels for redundancy	– Increase flood storage and pumping capacity – Upsize north outfall pipe – Implement onsite perimeter flood protection or additional facility flood proofing at BITP

FLOOD HAZARD MITIGATION AT TREATMENT PLANTS

The Project Partners researched efforts by other wastewater treatment plants around the country to protect their facilities from riverine flooding, coastal flooding, and sea level rise. Plants from Washington to California, Colorado, New Jersey, and Florida have projects in planning, design, or construction that are adopting flood protection criteria higher than standard engineering practices. Mitigation strategies include raising critical facilities, perimeter flood walls or levees, onsite stormwater collection and pumping, and floodproofing doors, penetrations, and vaults.

Multiple treatment plants are incorporating high-range sea level rise projections into design criteria for flood protection measures and adopting planning horizons ranging from 2040 to 2100. In addition, a number of plants are adopting a 500-year level of flood protection for their facilities, including the recently completed perimeter flood wall constructed at Tacoma’s Central Wastewater Treatment Plant.

At Budd Inlet Treatment Plant, the estimated 500-year flood level is approximately 0.2 to 0.3 feet higher than the 100-year flood level, so considering a higher level of flood protection would likely represent only a small incremental increase in cost.

PORT OF OLYMPIA PENINSULA FOCUS AREA

The Port of Olympia (Port) is a dynamic area that will likely see infrastructure changes through new construction and/or retrofits over the coming decades. As Port infrastructure is upgraded and replaced, it could be built progressively higher to accommodate sea level rise and future flood levels. The sections that follow present the near-term, mid-term, and long-term strategies for this focus area.

NEAR-TERM STRATEGIES

With the exception of a low shoreline segment at North Point that could allow floodwaters to inundate the parking lot area at KGY Radio, much of the Port peninsula is relatively high in elevation. As a result, the Port's near-term physical adaptation needs are minimal. Two outfalls may require installation of backflow prevention in the near-term to address marine flooding through the stormwater system:

- Outfall "A" – located in West Bay between the southern end of the shipping berths and north of Port Plaza
- Outfall "J" – located at North Point between Anthony's Hearthfire Grill and KGY Radio

With low amounts of sea level rise (6 inches), shoreline improvements at North Point, Port Plaza, and Percival Landing would be required to prevent flooding of portions of the marine terminal during a large coastal storm event. Potential redevelopment of North Point may address the low shoreline segment at that location; however, in the absence of such a project, the Port may explore alternatives to raise that portion of the shoreline to match adjacent segments. Without the physical barriers discussed in the previous section, future flooding at Percival Landing would direct water eastward and northward onto the southern end of Port property.

MID-TERM STRATEGIES

Mid-term physical and operational adaptation strategies for the Port focus on installing backflow prevention on remaining stormwater outfalls, raising low portions of North Point, Port Plaza, and the marine terminal, raising and protecting existing critical facilities (such as the Cascade Pole treatment facility), and evaluating the feasibility of raising the marine terminal and railroad tracks. Ongoing erosion of the shoreline along East Bay will continue to be monitored.

Three additional outfalls may require installation of backflow prevention to address marine flooding through the stormwater system due to mid-term sea level rise:

- Outfall "E" – located in East Bay at Swantown Boatworks
- Outfall "F" – located in East Bay at Marine Drive
- Outfall "K" – located in East Bay at Swantown Marina GHI docks parking lot

The locations of the mid-term physical adaptation strategies to address up to 24 inches of sea level rise are shown in Figure 34.

LONG-TERM STRATEGIES

Beyond 24 inches of sea level rise, additional actions along the Port's shoreline will be required to prevent flooding of inland areas, including the Budd Inlet Treatment Plant. The Billy Frank Jr. Trail along the East Bay and North Point shoreline could be raised to act as a flood barrier. The section of trail from Olympia Avenue to Swantown Marina could also be set back from the shoreline to provide protection from ongoing shoreline erosion in East Bay. The locations of the long-term physical adaptation strategies to address up to 68 inches of sea level rise are shown in Figure 35. A representative cross section of the Billy Frank Jr. trail raising is shown in Figure 36.

Long-term sea level rise adaptation for the Port will require a phased raising of the shipping berths and marine terminal. The shipping berths are at an elevation of approximately 16 feet NAVD88 and could accommodate approximately 24 inches of sea level rise before experiencing flooding during a large coastal storm event. At 42 inches of sea level rise, frequent flooding by king tides could begin to significantly impact marine terminal operations.

The Port's shipping berths were constructed between 1974 and 1999 and have anticipated lifespans of at least 50 years. This suggests that the Port may consider replacing the berths incrementally sometime between 2025 and 2050. The age and condition of the structures will dictate when they are rebuilt – not their exposure to sea level rise. It is anticipated that when the berths are reconstructed they will be raised to an elevation sufficient to avoid sea level rise impacts for the duration of their design life. Careful planning and design will be required to rebuild the shipping berths and raise adjacent portions of the marine terminal to maintain access (particularly rail access) and operations during and after construction. Similarly, marina docks and

gangways will need to be replaced in the future due to age and condition and could be elevated when rebuilt. A detailed evaluation of the feasibility, sequencing, and costs of reconstructing the shipping berths and marine terminal was not conducted as part of this Plan.

Coordination with the City will be an important aspect of the Port's sea level rise adaptation planning due to the Port and City's adjacent shorelines and shared flooding vulnerabilities from the Percival Landing shoreline.

SUMMARY OF PHYSICAL AND OPERATIONAL STRATEGIES

Table 8 presents a summary of the potential near-term, mid-term, and long-term physical and operational actions that could be implemented in the Port focus area to address sea level rise. Proposed governance and informational strategies are discussed in more detail in Chapter 7.

Table 8: Summary of Potential Physical and Operational Adaptation Strategies at Port of Olympia Focus Area

Near-term Strategies (0 to 5 years) Sea Level Rise: <6"	Mid-term Strategies (5 to 30 years) Sea Level Rise: up to 24"	Long-term Strategies (30+ years) Sea Level Rise: up to 68"
– Emergency response to flood events, including sandbags and coordination with the City – Install backflow prevention on stormwater outfalls "A" and "J"	– Elevate low-lying shoreline segments along North Point, the marine terminal, and Port Plaza – Monitor ongoing shoreline erosion along East Bay – Install backflow prevention on stormwater outfalls "E", "F", and "K" – Evaluate feasibility and phasing of incrementally raising shipping berths, cargo yard, and rail	– Raise Billy Frank Jr. Trail along East Bay and North Point – Monitor ongoing shoreline erosion along East Bay – Incrementally rebuild and raise shipping berths, marine terminal cargo yard, and rail to higher elevations as part of lifecycle replacement – Retrofit and rebuild marina docks and gangways to higher elevations over time as needed

Figure 34. Potential Strategy Plan for Mid-Term Sea Level Rise (24 inches) at Port of Olympia Peninsula

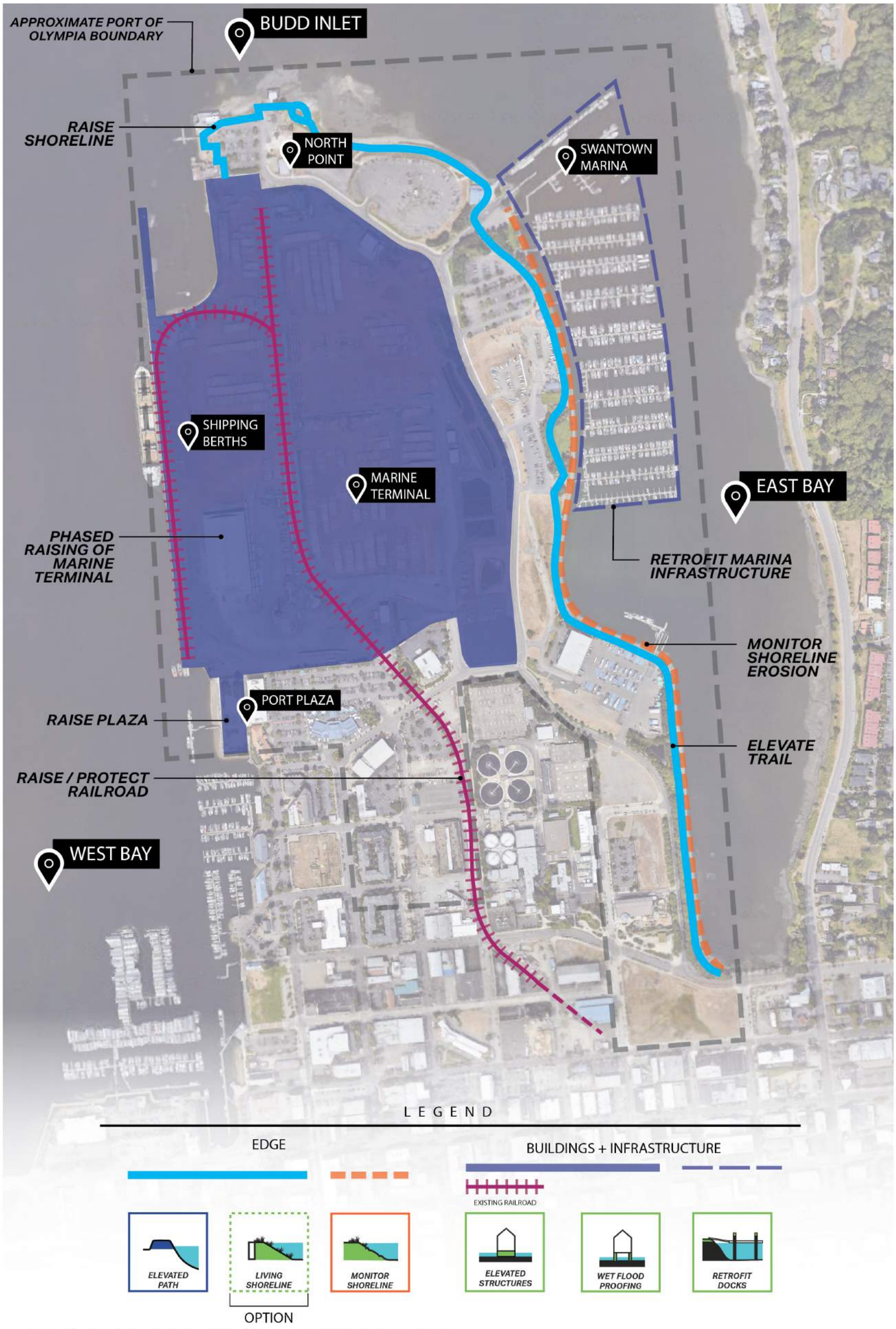
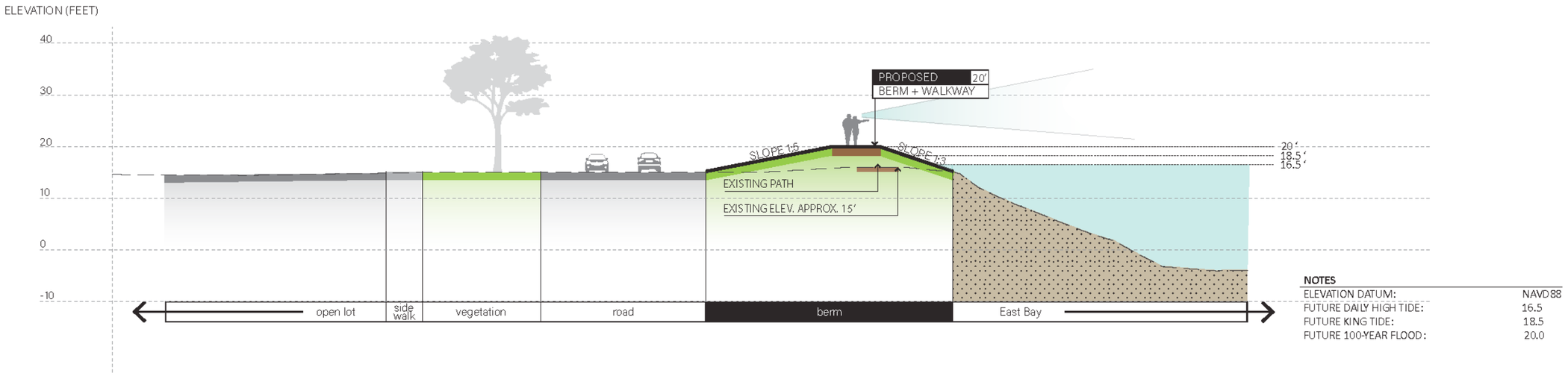


Figure 35. Potential Strategy Plan for Long-Term Sea Level Rise (68 inches) at Port of Olympia Peninsula

EAST BAY
LONG TERM SOLUTION FOR 68" OF SLR
ELEVATE PATH

This strategy would elevate the Billy Frank Jr. trail to raise it above future flood elevations and shift it inland to protect it from shoreline erosion. The elevated path would protect inland areas of Olympia, including the Budd Inlet Treatment Plant, from flooding.

MARINE DRIVE PERSPECTIVE



SWANTOWN MARINA PERSPECTIVE

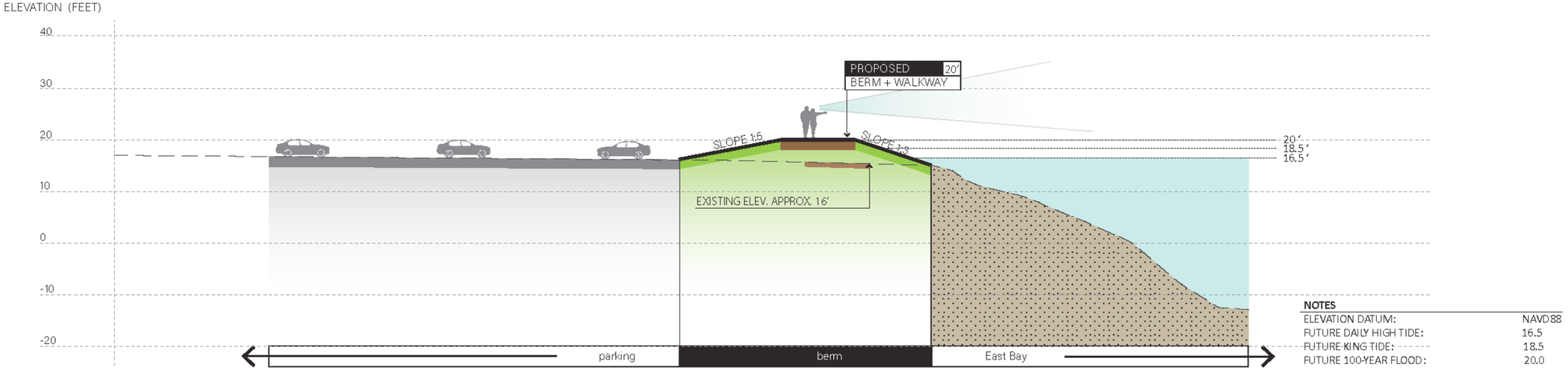
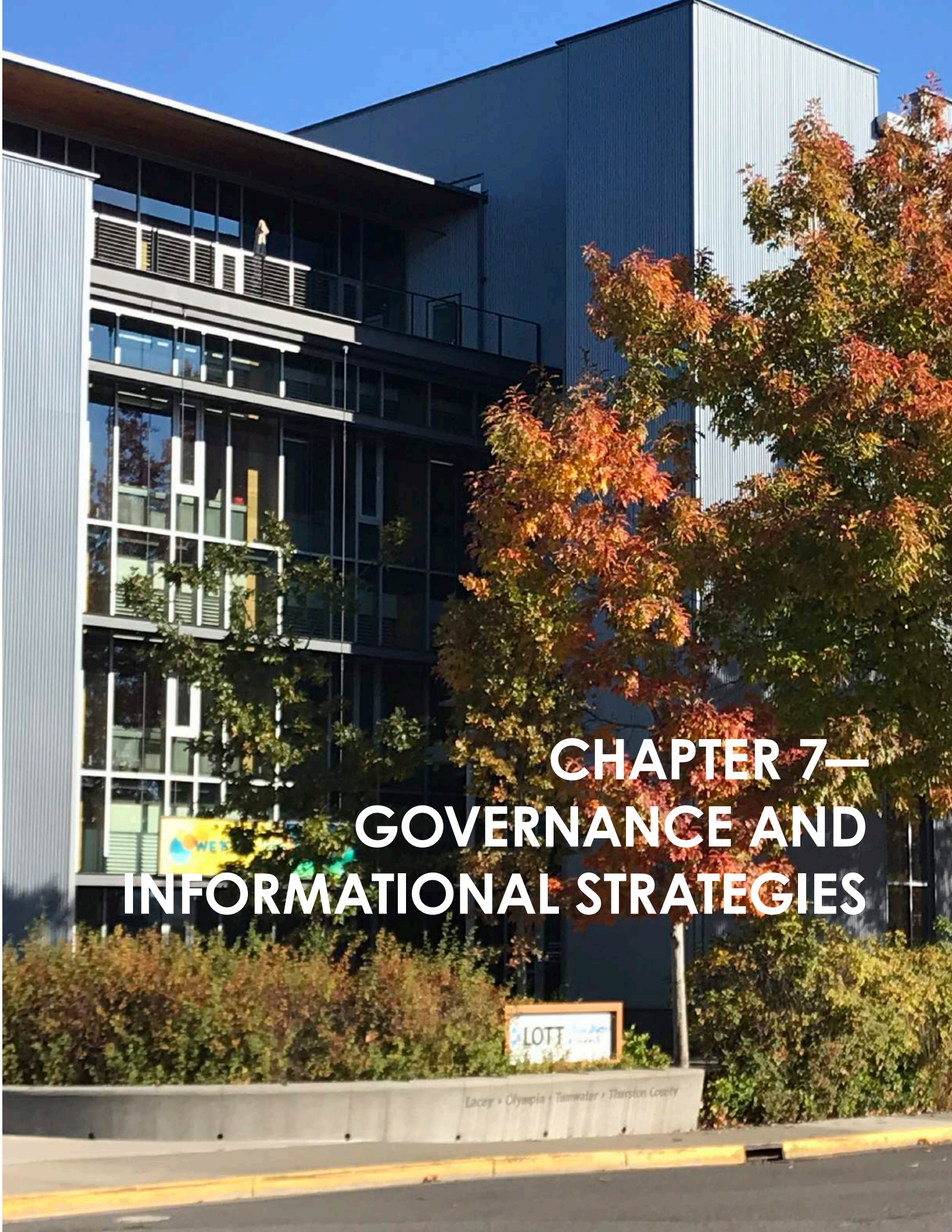


Figure 36. Potential Strategy Plan for Long-Term Sea Level Rise (68 inches) Along East Bay Shoreline (Billy Frank Jr. Trail): Elevate Path



CHAPTER 7— GOVERNANCE AND INFORMATIONAL STRATEGIES

GOVERNANCE AND INFORMATIONAL STRATEGIES

In order to adapt to sea level rise, the Project Partners will need to alter how they have traditionally planned, designed, regulated, made decisions, and budgeted for new developments or projects. While developing the Plan, the Project Partners reviewed the current governance structures, policies, and programs in place to identify specific governance strategies for the future. In addition, the Project Partners identified informational strategies to address key data and knowledge gaps. The Project Partners understand that developing appropriate governance and informational strategies is essential to responsibly implementing the Plan and its inevitable evolution in the decades ahead.

The sections that follow present key governance and informational strategies that were identified by the Project Partners for prioritization within the next five years.

FIVE-YEAR GOVERNANCE PRIORITIES

The Project Partners evaluated four types of governance strategies for consideration in the Plan:

- **Collaboration:** promote collaboration, coordination, and governance structure among the Project Partners and other key stakeholders and landowners
- **Policy:** update policies, codes, guidelines, and processes to consider sea level rise
- **Finance:** identify and establish funding sources for implementation of physical adaptation strategies
- **Education and Outreach:** continue education and outreach activities with the community and key stakeholders

Strategies within each type were prioritized for potential action within the next five years (2019-2024) by the Project Partners. They are grouped by strategy type, and include details of the mechanism and lead partners in charge of the strategy. Other governance strategies, which still may be investigated for implementation in the longer term are listed in Chapter 9.

COLLABORATION

FORMALIZE SEA LEVEL RISE COLLABORATION

Build on the partnerships developed during the Plan process to draft and execute a memorandum of understanding or interlocal agreement between the Port, LOTT, and the City. Establish an interjurisdictional governance framework for the purpose of monitoring, researching, and adapting to sea level rise.

Lead: City of Olympia, Port of Olympia, LOTT, and Department of Enterprise Services (DES)
Mechanism: Memorandum of Understanding / Interlocal Agreement

DEVELOP GOVERNANCE STRUCTURE AND ORGANIZATION

Develop a governance structure and organization to coordinate Olympia's sea level rise response, comprising the following groups:

THE IMPORTANCE OF GOVERNANCE STRATEGIES

Without effective governance, the Sea Level Rise Response Plan is of little value to our community. The Project Partners understand the critical importance of establishing the governmental and financial structure to support the timely implementation of this Plan. The Plan will be implemented over many decades and diligence needs to be sustained.

- **Oversight Committee:** Elected or appointed officials from various agencies to review and approve implementation of the sea level rise response actions
- **Technical Group:** Responsible for tracking science, monitoring sea level rise, and developing adaptation strategies. Existing Project Partner staff currently participating in the Plan development could transition into this group. The group would lay the foundation for future sea level rise response implementation.
- **Finance Group:** Responsible for developing, investigating, and pursuing funding opportunities
- **Citizen Advisory Group:** A private-public advisory group (possibly Olympia's existing Utility Advisory Committee) that would review technical work and make recommendations to the oversight committee

Lead: City of Olympia, Port of Olympia, LOTT
Mechanism: Memorandum of Understanding / Interlocal Agreement

CONTINUE REGIONAL EFFORTS TO DEVELOP AN OVERARCHING CLIMATE CHANGE POLICY

The City is working with other local cities and Thurston County on climate change mitigation efforts. The strategy proposes to continue and strengthen this partnership to develop a holistic climate change policy relating to climate adaptation efforts, in addition to setting ambitious emission reduction goals for the community.

Lead: Thurston Regional Planning Council
Mechanism: Memorandum of Understanding / Interlocal Agreement, Regional Climate Mitigation Plan

COORDINATE WINTER PREPAREDNESS AND EMERGENCY RESPONSE EFFORTS

Coordinate winter preparedness and emergency response efforts between the City of Olympia, Port of Olympia, and LOTT to ensure that emergency preparations and responses are coordinated across the organizations as sea levels increase. LOTT and the City will work together to minimize flooding impacts to the combined sewer system. The City will also conduct outreach to community stakeholders (e.g. the business community, social service providers, and vulnerable population advocates) to minimize the impact of flooding to the community.

Lead: City of Olympia, Port of Olympia, LOTT
Mechanism: Emergency Standard Operating Procedures; Community outreach

COORDINATE WITH ENERGY UTILITY VULNERABILITY ASSESSMENT

Coordinate with Puget Sound Energy (PSE) on their vulnerability assessment and sea level rise adaptation planning process, to address the vulnerability of natural gas lines, power lines, and substations.

Lead: LOTT
Partners: PSE
Mechanism: Coordination with PSE\

COORDINATE WITH USACE TO DETERMINE THEIR INVOLVEMENT IN FLOOD PROTECTION PROJECTS

There are a number of instances in which the U.S. Army Corps of Engineers (USACE) may become involved in the implementation of this Plan, beyond its role as a regulatory authority. This strategy proposes to coordinate with the USACE to understand the USACE's role in review, planning, design and/or construction of flood protection projects and with the USACE and the Coast Guard on shoreline projects near the navigation channel.

Lead: City of Olympia, Port of Olympia
Partners: Port of Olympia and LOTT
Mechanism: Coordination with USACE and Coast Guard

GOVERNANCE STRATEGY PRECEDENT: SOUTHEAST FLORIDA REGIONAL CLIMATE CHANGE COMPACT

In January 2010, Broward, Miami-Dade, Monroe, and Palm Beach Counties united to form the Southeast Florida Regional Climate Change Compact as a way to coordinate mitigation and adaptation activities across county lines. Since then, the four Compact counties have advanced local and regional responses to—and preparations for—the effects of climate change, including sea level rise, flooding, and economic and social disruptions. They have expanded to work with a growing number of federal, state, regional, municipal, nonprofit, academic, and private sector partners.

GOVERNANCE STRATEGY PRECEDENT: SEATTLE PUBLIC UTILITIES MAINSTREAMING CLIMATE INTO INTERNAL PLANNING AND DECISION-MAKING

Seattle Public Utilities integrated climate considerations into the four levels of their internal planning and operations: (1) organization-wide strategic planning, (2) planning at the water, drainage, and sewer division levels, (3) capital investment decision making, and (4) day-to-day operational decision making.

POLICY

UPDATE SHORELINE MASTER PROGRAM

Update the Shoreline Master Program to further address sea level rise and incorporate recommendations from the Plan. This update is likely to start in 2019.

Lead: City of Olympia
Partners: State of Washington Department of Ecology
Mechanism: Shoreline Master Program

UPDATE SEA LEVEL RISE FLOOD DAMAGE REDUCTION ORDINANCE

Update the City's existing sea level rise flood damage reduction ordinance (OMC 16.80) to incorporate additional provisions for sea level rise. Updates could potentially include:

- Account for higher flood elevation associated with Capitol Lake floodplain
- Require lowest floor to be elevated rather than flood-proofed
- Allow extra ceiling height in first floor to accommodate future floor raising
- Allow additional total building height to accommodate raised floors
- Define critical facilities and require constructing or floodproofing to 3 feet above the base flood elevation
- Require minimum finish floor elevation to be set considering project's projected lifespan

These options would be further researched and discussed with relevant stakeholders prior to adoption.

Lead: City of Olympia
Mechanism: Olympia Municipal Code

INCORPORATE SEA LEVEL RISE INTO OTHER PLANNING DOCUMENTS

Incorporate sea level rise considerations into relevant planning documents, such as the Comprehensive Plan, Downtown Strategy, Wastewater Management Plan, and others by the City, LOTT, and the Port.

Lead: City of Olympia
Partners: Port of Olympia and LOTT
Mechanism: Comprehensive Plans, LOTT Master Plan, Port Strategic Plan

INCORPORATE SEA LEVEL RISE CONSIDERATIONS INTO CAPITAL PLANNING

Develop and adopt guidelines for incorporating consideration of sea level rise in the capital planning process. This will ensure that capital projects located in the sea level rise vulnerability zone are designed to adapt to sea level rise.

Lead: City of Olympia, LOTT, Port of Olympia
Mechanism: Capital Facilities Plans

DESIGN STANDARDS / GUIDELINES UPDATES

Update design standards and/or guidelines for the City, LOTT, and the Port to consider sea level rise and increased precipitation intensity in project planning and design. Additionally, provide guidance on when outfall consolidation will be needed, when tide gates are sufficient, and when pump stations will be needed. Updated standards could incorporate the University of Washington Climate Impacts Group guidelines for Thurston County.

Lead: City of Olympia, Port of Olympia, LOTT
Mechanism: Drainage Design and Erosion Control Manual, Capital Facilities Plans, Engineering Design and Development Standards

REQUIRE BACKFLOW VALVES ON NEW CONSTRUCTION AND SUBSTANTIAL IMPROVEMENTS

Update Olympia's design standards to require backwater valves on sewer pipes for new construction and substantial improvements connected to the combined sewer system. Backwater valves are designed to allow

GOVERNANCE STRATEGY PRECEDENT: GUIDANCE FOR INCORPORATING SEA LEVEL RISE INTO CAPITAL PLANNING IN SAN FRANCISCO: ASSESSING VULNERABILITY AND RISK TO SUPPORT ADAPTATION

This Guidance provides direction from the Capital Planning Committee (CPC) to all departments on how to incorporate sea level rise into new construction, capital improvement, and maintenance projects. The CPC, in turn, uses the Guidance to determine whether department capital plans have adequately addressed sea level rise vulnerabilities, risk, and adaptation. If all departments follow this Guidance when developing their individual Capital Plans, the combined CCSF Capital Plan will ensure the resilience of San Francisco's public infrastructure projects to anticipated sea level rise. The Guidance includes a sea level rise checklist and direction on selecting an appropriate sea level rise scenario for the assessment.

water or sewage to flow only one way (out of a building). In the event that streets flood, water would not be able to back up into buildings.

Lead: City of Olympia
Mechanism: Engineering Design and Development Standards

REFINE HIGH FLOW STANDARD OPERATING PROCEDURES AT THE BUDD INLET TREATMENT PLANT

Update LOTT's standard operating procedures at the Budd Inlet Treatment Plant as needed to ensure plant operators are prepared for more frequent high flow events (due to sea level rise and coastal flooding, riverine flooding from Capitol Lake/Lower Deschutes Watershed, or high intensity local precipitation events – all of which are projected to increase as a result of climate change).

Lead: LOTT
Mechanism: Standard Operating Procedures

FINANCE

INVESTIGATE AND IMPLEMENT LONG-TERM PUBLIC FINANCING MECHANISM

Create a mechanism to generate local funding for sea level rise adaptation strategy implementation.

Lead: City of Olympia
Mechanism: Legislation, regional partners

CREATE SPECIAL DISTRICT TO FINANCE RESILIENCE IMPROVEMENTS

Create a financial mechanism to provide financing to property owners for resiliency improvements, such as a flood or local improvement district.

Lead: Thurston County (flood district); City of Olympia (local improvement district)
Mechanism: Legislation

PURSUE STATE AND FEDERAL FUNDING / LOBBY LEGISLATURE

Pursue federal and State grant funding, or lobby the State legislature for funding to support sea level rise planning and strategy implementation.

Lead: City of Olympia
Partners: Port of Olympia, LOTT
Mechanism: Grant applications, lobbying

EDUCATION AND OUTREACH

MAINTAIN AN UP-TO-DATE SEA LEVEL RISE PLANNING WEBSITE

Maintain the existing sea level rise planning website and corresponding story maps as new climate science, updated inundation modelling, and best practices in adaptation become available.

Lead: City of Olympia
Mechanism: City of Olympia website

DEVELOP AND IMPLEMENT A SEA LEVEL RISE COMMUNITY AND STAKEHOLDER EDUCATION AND ENGAGEMENT STRATEGY

Build on the long running engagement done to date and develop and implement an engagement strategy to ensure our community remains knowledgeable of the issues the community faces. This will be key to obtaining support for the activities that will be required to address increasing flooding events and to understand the community's tolerance for flooding.

Lead: City of Olympia
Partners: Port of Olympia, LOTT
Mechanism: To be determined

INCORPORATE SEA LEVEL RISE IN DISCUSSIONS FOR PLANNING PURPOSES

Outreach to developers regarding new sea level rise policies that would impact residential and commercial development projects in downtown. Outreach should occur as new policies are developed and adopted as well as during the approval process for individual projects.

Lead: City of Olympia
Mechanism: Stakeholder outreach

CONTINUE EDUCATION WORK WITH SCHOOLS

Continue to engage students at different levels in schools throughout Olympia to promote understanding and awareness of sea level rise issues. Engagement opportunities include field trips or in-classroom activities embedded into earth science curriculums.

Lead: City of Olympia, LOTT, Port of Olympia
Mechanism: Olympia School District

PLAY A ROLE AS REGIONAL SEA LEVEL RISE ADVISOR

Olympia is one of the first communities in Puget Sound to develop a sea level rise response plan. Olympia will continue its role as a leader in the region and act as a planning advisor to other regional jurisdictions as they seek to respond to sea level rise challenges in the future.

Lead: City of Olympia, LOTT, Port of Olympia
Mechanism: Regional collaboration, conferences and meetings

CONDUCT COMMUNITY WORKSHOPS TO BRAINSTORM FOCUS AREA STRATEGIES

This Plan developed initial concept level strategies to address existing and future flooding and sea level rise vulnerabilities within Olympia. Additional work will be required in the future to further develop these initial concepts and move them towards implementation. This strategy would build upon the momentum gathered through public and stakeholder engagement conducted through the development of this Plan by providing an opportunity for further community input into refinement of the conceptual strategies.

Lead: City of Olympia
Mechanism: Community workshops

OUTREACH TO DOWNTOWN BUSINESS OWNERS AND PORT TENANTS

Continue outreach to downtown business owners and Port tenants in flood-prone areas to inform them of evolving flooding and sea level rise vulnerabilities. Provide information and best practices for resilient building practices and flood preparedness. Coordinate with shoreline property owners to see how they can work with the City to protect private property and community resources.

Lead: City of Olympia and Port of Olympia
Mechanism: Community outreach

GOVERNANCE STRATEGY PRECEDENT: YESS (YOUTH EXPLORING SEA LEVEL RISE SCIENCE) PROGRAM IN MARIN COUNTY, CA

The YESS project empowers young people to engage directly in climate change solutions in their own communities. The project offers an experiential education program that incorporates cutting-edge classroom curricula with hands-on science, through which high school students explore why sea level rise is happening and how their lives will be impacted. They collect their own data, create communications products, and contribute to local science and policy decisions.

INFORMATIONAL STRATEGIES

Informational strategies help organizations further their understanding of sea level rise vulnerabilities and risks to be better able to plan for future sea level rise, for example, through research or monitoring programs.

The informational strategies below have been prioritized for potential action within the next 5 years by the Project Partners. They include details of the mechanism and lead partners that may be involved.

REFINE SEA LEVEL RISE AND FLOOD MONITORING STRATEGY

Refine and implement the initial sea level rise monitoring strategy included in Chapter 10 to provide a basis for adaptive management, implementation, and timing of capital projects and funding needs. Refinement of trigger points for actions will also be required. Data tracking [sea level changes] and incidents of storm-based flooding will be helpful in guiding adaptation planning and investments.

Lead: City of Olympia, Port of Olympia
Mechanism: Tacoma tide gauge, NASA, USGS, University of Washington Climate Impacts Group, and others

MONITOR LAND SUBSIDENCE

Install a geodetic array to monitor land subsidence throughout the downtown peninsula. The sea level rise figures used for this plan took into account subsidence, and having data for the peninsula itself would help the Project Partners understand if those figures need adjusting over time to better reflect actual subsidence locally.

Lead: City of Olympia
Mechanism: To be determined (could be incorporated into a new Sea Level Rise Monitoring Plan)

INITIATE GROUNDWATER STUDY

Conduct a hydrogeological investigation to evaluate tidal influence on groundwater. The study should evaluate the feasibility of surface barriers at different sea level rise elevations and at what elevations sheet piling or cut-off walls would become necessary. Groundwater elevation data collected throughout downtown will help establish a baseline for quantifying the impacts of Sea Level rise on future groundwater elevations and the effectiveness of surface flood barriers. Groundwater has the potential to impact building foundations, buried infrastructure and specifically the BITP. When tide elevations exceed land elevations behind flood barriers, hydraulic pressure may result in groundwater elevations above the land surface.

Lead: City of Olympia, LOTT
Mechanism: To be determined

UNDERSTAND FUTURE PRECIPITATION PROJECTIONS

The University of Washington Climate Impacts Group has studied the effect of climate change on precipitation in Thurston County. Currently, average annual precipitation totals are not projected to change significantly as a result of climate change. By mid-century, rainfall may occur less frequently, but intensities could increase by more than 20 percent, potentially resulting in larger urban floods.

Lead: City of Olympia
Mechanism: Drainage Design and Erosion Control Manual; Collaboration with researchers

UNDERSTAND LIQUEFACTION

Large areas of downtown are built on fill placed with limited engineering controls and are therefore susceptible to liquefaction during a seismic event. Groundwater plays a significant role in seismic vulnerability as soil saturation increases liquefaction risk. As seas rise, groundwater is expected to rise concurrently, increasing seismic vulnerability. Increased research on these interactions will guide engineering design so that sea level rise adaptation projects are resilient to seismic events.

Lead: City of Olympia
Mechanism: To be determined

UNDERSTAND THE IMPLICATIONS OF FEMA ACCREDITATION

In its flood hazard and risk mapping, FEMA only recognizes those flood protection systems that meet, and continue to meet, minimum design, operation, and maintenance standards that are consistent with federal requirements and local floodplain management ordinances. The implications of achieving FEMA accreditation, including cost, freeboard criteria, flood gate criteria, drainage, foundation requirements, and maintenance requirements, need to be understood and evaluated.

Lead: City of Olympia
Mechanism: To be determined

MODEL FLOW RATES FOR INDIVIDUAL STORMWATER OUTFALLS AND COMBINED SEWER SYSTEM

As sea levels rise, conveying and treating stormwater runoff through the Budd Inlet Treatment Plant and out of downtown will grow more challenging. Outfalls will need to be consolidated and pumping stations installed. Modeling will be needed to understand these dynamics and take future precipitation projections into account.

Lead: City of Olympia, LOTT
Mechanism: To be determined

SURVEY FINISHED FLOOR ELEVATIONS ON PORT PROPERTIES

Finished floor elevations need to be surveyed to better understand the vulnerabilities of structures on Port properties and inform tenants of their existing and future flood risk.

Lead: Port of Olympia
Mechanism: To be determined

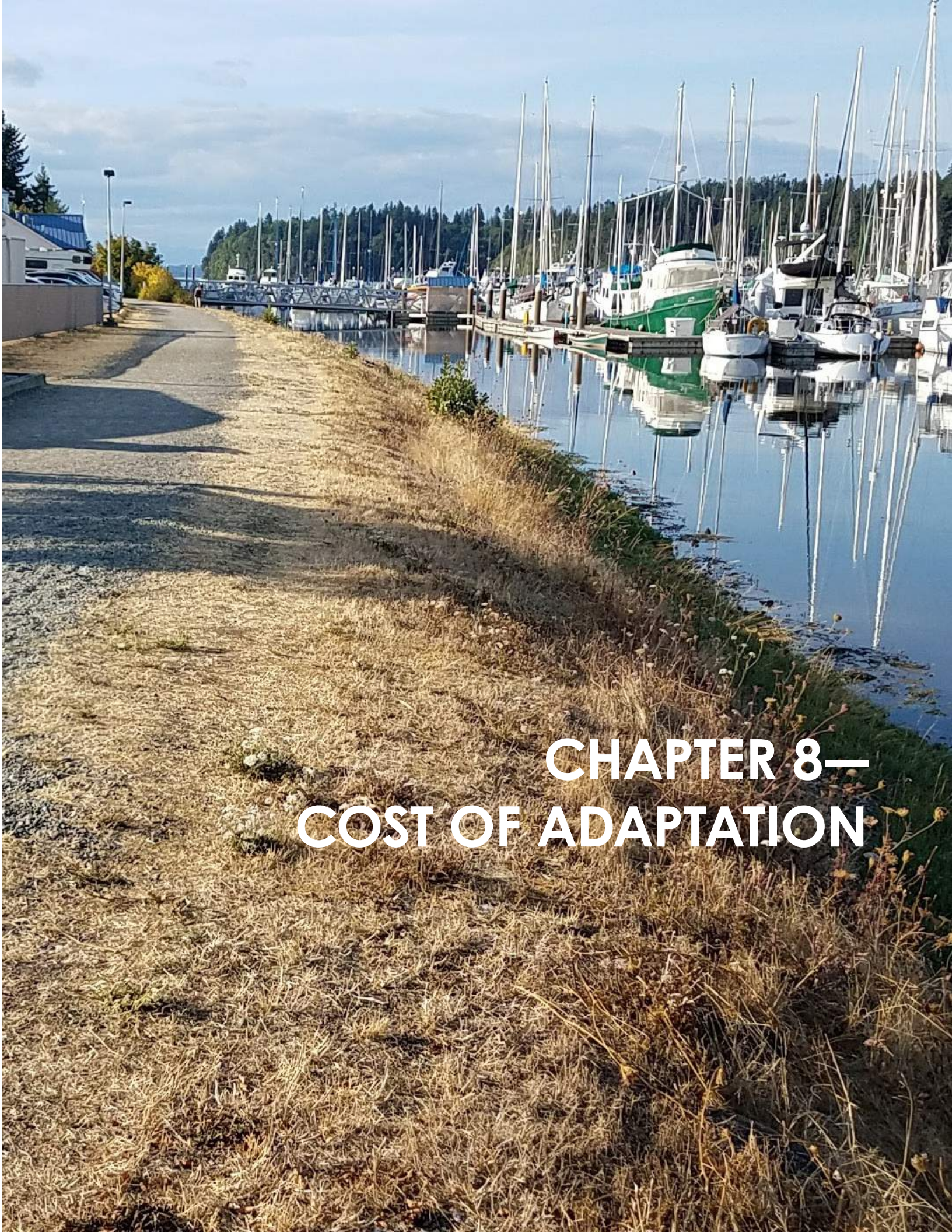
MONITOR ONGOING SHORELINE EROSION ALONG EAST BAY

Erosion along East Bay is currently undermining the Billy Frank Jr. Trail and the rate of erosion will likely increase with sea level rise. Further erosion could jeopardize the ability to modify the trail to create a flood barrier. The erosion needs to be monitored and mitigated.

Lead: Port of Olympia
Partner: City of Olympia
Mechanism: Monitoring program

INFORMATIONAL STRATEGY PRECEDENT: SANTA CLARA VALLEY WATER DISTRICT GROUNDWATER MONITORING PROGRAM, SAN JOSE, CA

The district actively monitors groundwater elevations to evaluate current groundwater conditions and land subsidence, optimize recharge efforts, assess groundwater storage, and support groundwater management efforts. The district also surveys hundreds of benchmarks each year to determine if there has been any change in the land surface elevation.



CHAPTER 8—
COST OF ADAPTATION

COST OF ADAPTATION

The sections that follow present estimated costs to implement the physical adaptation strategies described in this Plan and discuss potential funding and financing sources to fund implementation.

COST TO PROTECT OLYMPIA

The costs to protect downtown Olympia from flooding and sea level rise will be substantial; however, the cost of inaction will be far greater. Costs to implement the strategies identified in the Plan will be spread out over many decades and shared by the Project Partners and our community. High level costs for the physical strategies presented in Chapter 6 are provided in Table 9. The costs are presented by focus area. A detailed breakdown of costs for individual strategies within each focus area is provided in Chapter 9. Costs are provided in 2018 dollars and have not been escalated to future dollars.

IMPORTANCE OF PARTNERSHIPS

"Whenever feasible, adaptation planning efforts should be long term, comprehensive, and integrated across entities. Closely coordinating adaptation planning efforts and pooling resources can help to tap into efficiencies of scale and can support the design of multi-function projects that can qualify for a wider range of funding sources."

Source: Paying for Climate Adaptation in California: A Primer for Practitioners, October 2018, AECOM

Table 9: Estimated Costs of Sea Level Rise Adaptation in Olympia

Area / Strategy	Near-Term (0-5 years) Sea Level Rise: up to 6 inches	Mid-Term (5-30 years) Sea Level Rise: up to 24 inches	Long-term (30+ years) Sea Level Rise: up to 68 inches
Capitol Lake / Lower Deschutes Watershed	$0.2M	$3M to $6M	$3M to $118M
Percival Landing and Isthmus	-	$11M to $13.5M	$85M to $105M
Budd Inlet Treatment Plant	-	$1 to $6M	$12.5M to $15M
Port of Olympia Peninsula	$20K	$0.5M to $1M	$8M to $9.5M
Stormwater System	$1M	-	$82.5M to $100.5M
Total	$1.25M	$16M to $26M	$190M to $350M

Costs represent a preliminary opinion of probable costs to construct the identified physical sea level rise adaptations strategies. Costs include the following components:

- **Direct Costs:** This includes all labor, equipment usage, permanent and temporary materials, erosion / water pollution control, and spill prevention plans
- **Mobilization:** Part of the direct cost and includes cost allowances for mobilization / demobilization to the project site and setup temporary facilities and utilities. This is assumed to be 10% of the direct costs.
- **Contractor's Markup:** This includes costs for site general conditions, job supervision, contractor's office overhead, profit, and bonds. This is assumed to be at 25% of the direct cost.
- **Design Engineering and Permit Fees:** This includes a 15% allowance for the engineering design fee and environmental permitting and clearance requirements
- **Design Contingency:** This includes a 25% allowance for project design development during the design and construction phases of the project as more current and updated information for the project and site conditions are obtained
- **Construction Contingency:** This includes a 10% allowance for changes during the construction phase for possible unforeseen conditions, schedule delays, and project change orders
- **Contract Administration:** This includes a 30% allowance for contract administration and Project Partner staff time to oversee the design, permitting, and construction phases
- **Escalation:** Not included at this time

The estimated costs include many of the physical and operational strategies identified in Chapter 6 with the following exclusions within each focus area:

- **Capitol Lake / Lower Deschutes Watershed:**
  - No exclusions identified
- **Percival Landing and Isthmus:**
  - Acquire waterfront leases if and when they become available
  - Over water boardwalks and buildings
- **Budd Inlet Treatment Plant:**
  - Upsize north outfall pipe
  - Increase flood storage and pumping capacity
- **Port of Olympia Peninsula:**
  - Rebuild and raise marine terminal, shipping berths, and rail
  - Retrofit and rebuild marina docks and gangways
- **Stormwater System:**
  - Stormwater outfall consolidation along Capitol Lake shoreline

In addition, costs do not include environmental mitigation or land acquisition. Land acquisition costs are assumed to be small due to alignment of flood protection strategies within the public right-of-way.

POTENTIAL FUNDING AND FINANCING SOURCES

In Olympia, as in much of the country, existing public finance and governance models do not match the scale required to meet the anticipated needs of sea level rise adaptation. In order to maintain public safety, protection of investments, and business continuity of our downtown during existing and future climate conditions, the Project Partners will be challenged with identifying and accessing capital for project development, such as the adaptation strategies outlined in this Plan.

Various types of funding will need to be pursued. As discussed in the governance strategies section (Chapter 7), the Plan recommends creation of a sea level rise finance group. The finance group would be responsible for developing, investigating, and pursuing funding opportunities for sea level rise adaptation projects. The Project Partners will monitor potential grant opportunities, in addition to funding allocated in annual operating budgets or for capital improvement projects. Currently, there is a range of potential funding

REGIONAL EMERGENCY PLANNING AND FUNDING

The Hazards Mitigation Plan for the Thurston Region provides a general strategy to reduce the risks of the most destructive hazards that threaten the region. It addresses various types of risks including earthquakes, severe storms, flooding, volcanoes, and sea level rise. The Hazards Mitigation Plan serves as a tool to prioritize risks and potentially secure funding for solutions.

opportunities that are provided by federal, State, and local government. Table 10 below highlights several of these programs that support the implementation of climate resilience strategies. However, substantial additional funds will in all probability be needed. Future State and federal funding could be helpful, but those funding sources lack the high level of certainty necessary for our flood protection work.

Table 10: Potential Funding Sources for Sea Level Rise Adaptation Project Implementation

Federal	State	County	City
U.S. Army Corps of Engineers – Civil Works Program FEMA – Pre-Disaster Mitigation Program – Flood Mitigation Assistance Program NOAA – Coastal Resilience Grant Program	Department of Ecology – Flood Control Assistance Account Program – Floodplains by Design – Clean Water State Revolving Fund	Flood Control Zone District – Property taxes – Rates and fees – Local Improvement Districts – General Obligation Bonds	– Interlocal Agreements – Utility Funds – General Fund – Local Improvement Districts

Source: FCS Group, Funding Approaches to Address Sea Level, Issue Paper #1 for City of Olympia (June 2017)

CHAPTER 9— IMPLEMENTATION AND NEXT STEPS

IMPLEMENTATION AND NEXT STEPS

IMPLEMENTATION

While the Plan provides a comprehensive approach for adapting to sea level rise, effective implementation is critical. The Project Partners understand the importance of maintaining momentum on sea level rise response and acknowledge that adapting will be challenging. Our response is necessarily very long-term in nature and based on science that will evolve and change. We need to set up and implement a strong structure for implementing the Plan.

As discussed in previous chapters, the adaptation strategies are organized into several categories:

- Physical, identified by focus area:
  - Capitol Lake / Lower Deschutes Watershed
  - Percival Landing and Isthmus
  - Port of Olympia Peninsula
  - Budd Inlet Treatment Plant and Combined Sewer System
- Operational
- Governance, organized into four subcategories:
  - Collaboration
  - Policy
  - Finance
  - Education and outreach
- Informational

Table 11 presents a summary of these sea level rise adaptation strategies identified as part of the Plan. This summary also provides our understanding of implementation needs. The strategies will be further refined in the coming years as individual projects are planned, designed, permitted and implemented. The priority of implementation strategies is reflected by the timeframe provided in Table 11.

NEXT STEPS

The Project Partners are prepared to begin implementing the Plan in 2019. Many strategies can be started promptly at a staff level knowing that full implementation of each strategy could take several years or be ongoing. For the most part, existing staff and financial resources are adequate for 2019 work efforts.

Initially, special emphasis will be placed on operational and collaboration strategies. The Project Partners will build upon our current emergency response practices and interjurisdictional relationships to maximize our ability to respond to near-term flooding. The Project Partners will also establish internal and inter-jurisdictional work groups that will provide the necessary decision making structure for sustained implementation of the Plan. We understand that this is the most important task for 2019. Other strategies can be brought into play later in 2019 and beyond.

The Project Partners anticipate providing annual updates to our community and elected officials on both our progress in implementing the Plan and needed modifications to our strategies as we learn and respond to evolving sea level rise dynamics.

The Project Partners recognize that planning for and adapting to anticipated changes due to sea level rise presents many challenges for our community. However, it also presents an equal number of opportunities to reimagine how our downtown functions and how it can continue to prosper in the future. Our community needs a strategic, effective, long-term response plan to guide near-term planning and decision making. With diligent implementation, this Plan will prepare the community for future sea level rise, while improving and enhancing the many attributes of our downtown. When combined with renewed local government and community action to reduce greenhouse gas emissions, this Plan offers a path forward for locally responding to and adapting to climate change.

Table 11: Olympia Potential Sea Level Rise Adaptation Strategies

Strategy Type / ID	Strategy	Lead Agency	Resources	Time-frame
Physical Strategies				
Capitol Lake / Lower Deschutes Watershed				
Near-Term Strategies (up to 6 inches of sea level rise)				
CL-1	Install backflow prevention on stormwater outfalls and other key pipes	City of Olympia Public Works	Existing Staff $50K	2019-2024
CL-2	Minor landscaping at key locations to raise ground elevations	DES	$250K	2019-2024
Mid-Term Strategies (up to 24 inches of sea level rise)				
CL-3a	Construct new wall: Construct a new flood-wall at elevation 17 feet and elevate Capitol Lake path along the shoreline	DES	$4M - $6M	2025-2050
CL-3b	Construct new berm: Construct a berm at elevation 17 feet within Heritage Park and relocate Capitol Lake path inland to a higher elevation	DES	$3M - $5M	2025-2050
CL-4	Install flood gate across railroad and Pow-erhouse Road (required with wall and berm options)	City of Olympia Public Works	$200K - $300K	2025-2050
Long-Term Strategies (up to 68 inches of sea level rise)				
CL-5a	Raise floodwall: Raise floodwall and path along shoreline to 21 feet	DES	$2M - $2.5M	2050-2075
CL-5b	Raise berm: Raise berm and path in Heri-tage Park to 21 feet	DES	$8M - $10M	2050-2075
CL-5c	Raise floodwall and berm: Hybrid strategy that would raise floodwall and landscaping within Heritage Park	DES	$14M - $17M	2050-2075
CL-6	Replace flood gate across railroad and Powerhouse Road	City of Olympia Public Works	$300K - $400K	2050-2075
CL-7	Raise 5th Ave and Columbia Street (optional)	City of Olympia Public Works	$80M - $100M	2050-2075
CL-8	Consolidate stormwater outfalls	City of Olympia Public Works	TBD	2050-2075
CL-9	Construct stormwater discharge pump station	City of Olympia Public Works	$300K - $400K	2050-2075
CL-10	Protect Percival Drinking Water Pump Station	City of Olympia Public Works	$0.5M - $1M	2050-2075
Percival Landing and Isthmus				
Near-Term Strategies (up to 6 inches of sea level rise)				
PL-1	Install backflow prevention (gates and valves) on stormwater outfalls and other key pipes	City of Olympia Public Works	Existing Staff $50K	2019-2024
Mid-Term Strategies (up to 24 inches of sea level rise)				
PL-2	Install raised planters within the City right-of-way along Columbia Street and 4th Avenue	City of Olympia Public Works	$3M - $4M	2030-2035

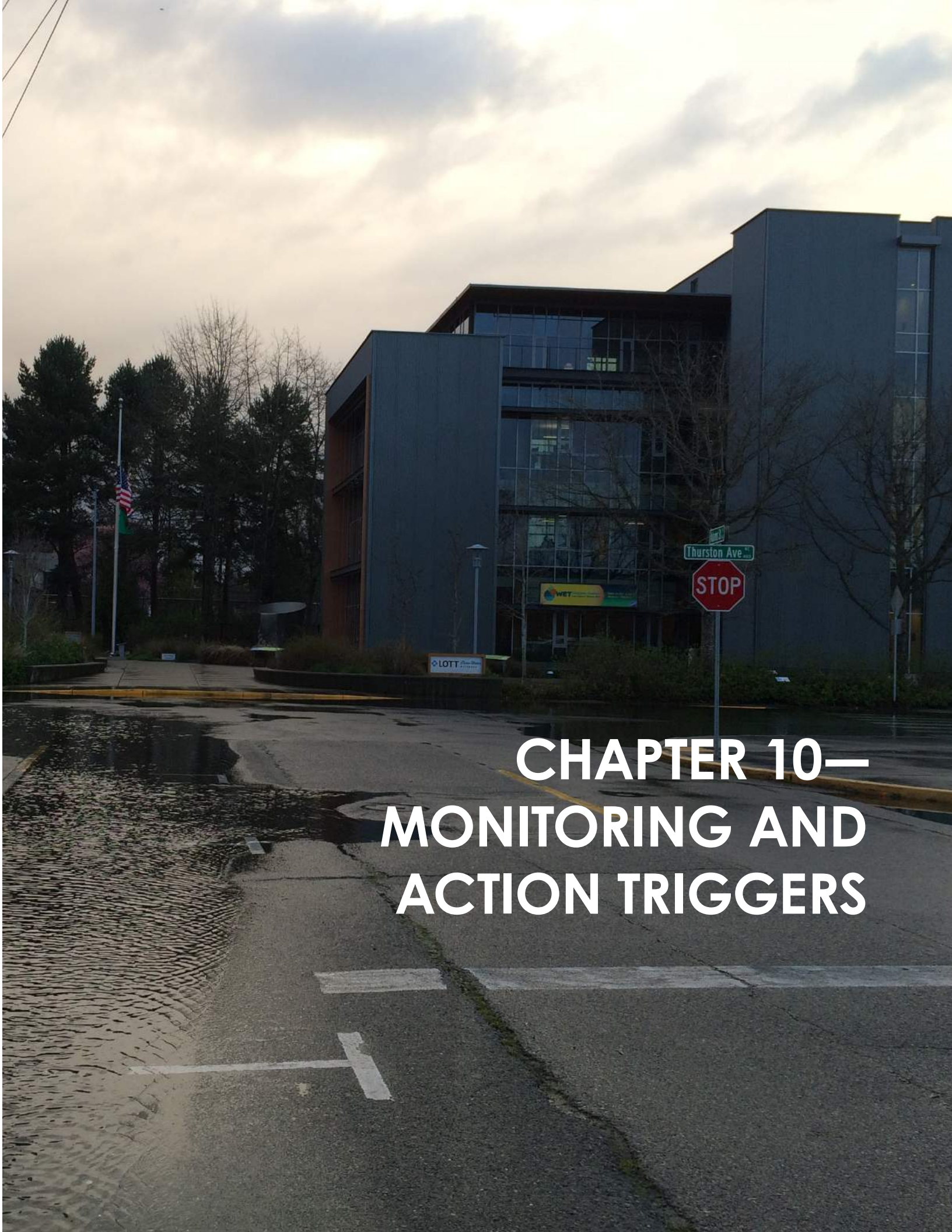
Strategy Type / ID	Strategy	Lead Agency	Resources	Time-frame
PL-3	Raise landscaping within Percival Landing Park	City of Olympia Parks	$0.1M - $0.2M	2030-2035
PL-4	Elevate existing paths to provide access to the shoreline	City of Olympia Parks	$0.6M - $0.8M	2030-2035
PL-5	Install flood gates across Simmons Street, Sylvester Street, A Avenue, B Avenue, and Corky Avenue	City of Olympia Public Works	$5M - $6M	2030-2035
PL-6	Acquire waterfront leases if and when they become available	City of Olympia Parks	TBD	2025-2050
Long-Term Strategies (up to 68 inches of sea level rise)				
PL-7	Elevate paths north and south of Percival Landing Park	City of Olympia Parks	$1.5M - $2M	2050-2075
PL-8	Raise or retrofit wall along Percival Landing Park	City of Olympia Parks	$0.5M - $0.6M	2050-2075
PL-9	Raise landscaping within Percival Landing Park	City of Olympia Parks	$1.2M - $1.4M	2050-2075
PL-10	Raise Columbia Street, Water Street, and 4th Avenue	City of Olympia Public Works	$80M - $100M	2050-2075
PL-11	Consolidate stormwater outfalls	City of Olympia Public Works	$8M - $10M	2050-2075
PL-12	Construct stormwater discharge pumping station(s)	City of Olympia Public Works	$14M - $17M	2050-2075
Budd Inlet Treatment Plant				
Near-Term				
BITP-1	Coordinate with the City and State on winter flood preparedness activities to minimize flooding of the combined sewer system.	LOTT	-	2019-2024
BITP-2	Coordinate with the City to prioritize installation of backflow prevention on key pipes and outfalls	LOTT	-	2019-2024
BITP-3	Refine BITP's high flow standard operating procedures	LOTT	-	2019-2024
BITP-4	Collaborate with PSE to protect Thurston Substation	LOTT	-	2019-2024
Mid-Term				
BITP-5	Flood proof sensitive facilities at BITP and evaluate feasibility and benefits of constructing perimeter flood protection	LOTT	$0.5M-$1M	2025-2050
BITP-6	Elevate upgraded/new BITP components above projected flood levels for redundancy	LOTT	$0.5M-$5M	2025-2050
Long-Term				
BITP-7	Increase flood storage and pumping capacity	LOTT	TBD	2040-2060
BITP-8	Upsize north outfall pipe	LOTT	TBD	2040-2060
BITP-9	Implement onsite perimeter flood protection or additional facility flood proofing at BITP	LOTT	$12.5-$15M	2050-2075

Strategy Type / ID	Strategy	Lead Agency	Resources	Time-frame
East Bay and Port Peninsula				
Near-Term Strategies (up to 6 inches of sea level rise)				
PORT-1	Install backflow prevention on stormwater outfalls "A" and "J"	Port of Olympia	$15k - $20k	2019-2024
Mid-Term Strategies (up to 24 inches of sea level rise)				
PORT-2	Elevate low-lying shoreline segments along North Point, the marine terminal, and Port Plaza	Port of Olympia	$0.5M - $0.7M	2025-2050
PORT-3	Install backflow prevention on stormwater outfalls "E", "F", and "K"	Port of Olympia	$30k - $50k	2025-2050
PORT-4	Evaluate feasibility and phased raising of shipping berths, cargo yard, and rail incrementally	Port of Olympia	TBD	2025-2050
Long-Term Strategies (up to 68 inches of sea level rise)				
PORT-5	Elevate low-lying shoreline segments along North Point and Port Plaza	Port of Olympia	$4.5M - $5.5M	2050-2075
PORT-6	Raise Billy Frank Jr. Trail along East Bay and North Point	Port of Olympia	$3M - $4M	2050-2075
PORT-7	Incrementally rebuild and raise shipping berths, marine terminal cargo yard, and rail to higher elevations as part of lifecycle replacement	Port of Olympia	TBD	2050-2075
PORT-8	Retrofit and rebuild marina docks and gangways to higher elevations over time as needed	Port of Olympia	TBD	2050-2075
EB-1	Construct pumping station for Moxlie Creek	City of Olympia Public Works	$60M - $75M	2050-2075
Operational Strategies				
OP-1	Emergency response to flood events, including sandbags, portable pumps, sealing catch basins	City of Olympia	Existing staff	2019-2024
OP-2	Collaborate on winter preparedness and emergency response efforts. Expand efforts to include protection of the combined sewer.	City of Olympia	Existing staff	2019-2024
OP-3	Annual funding for ongoing sea level rise adaptation planning efforts	City of Olympia	$150K/year	2019-2014
Governance Strategies				
Collaboration				
COL-1	Formalize sea level rise collaboration	Interjurisdictional	Existing staff	2019

Strategy Type / ID	Strategy	Lead Agency	Resources	Time-frame
COL-2	Develop governance structure and organization • Oversight Committee of elected/ appointed officials • Technical Group • Finance Group • Citizen Advisory Group	Interjurisdictional	Existing staff	2019
COL-3	Continue regional efforts to develop an overarching climate change policy	TRPC	Existing staff	2019-2024
COL-4	Coordinate winter preparedness and emergency response efforts	City of Olympia	Existing staff	2019-2024
COL-5	Coordinate with energy utility vulnerability assessment	LOTT	Existing staff	2019-2024
COL-6	Coordinate with USACE to determine their involvement in flood protection projects	Interjurisdictional	Existing staff	2019-2024
Policy				
POL-1	Update Shoreline Master Program	City of Olympia CP&D	Existing staff	2019
POL-2	Update Sea Level Rise Flood Damage Reduction Ordinance • Account for higher flood elevation associated with Capitol Lake floodplain • Require lowest floor to be elevated rather than floodproofed • Allow extra ceiling height to accommodate raised floors • Define critical facilities and require constructing or floodproofing to 3 feet above the base flood elevation • Require minimum finish floor elevation to be set considering project's projected lifespan	City of Olympia CP&D	Existing staff	2019-2024
POL-3	Incorporate sea level rise into other planning documents	City, LOTT, Port, DES	Existing staff	2019-2024
POL-4	Incorporate sea level rise considerations into capital planning	City, LOTT, Port, DES	Existing staff	2019-2024
POL-5	Design standards / guidelines updates	City, LOTT, Port, DES	Existing staff	2019-2024
POL-6	Require backflow valves on new construction and substantial improvements	City of Olympia CP&D	Existing staff	2019-2024

Strategy Type / ID	Strategy	Lead Agency	Resources	Time-frame
POL-7	Refine high flow standard operating procedures at the Budd Inlet Treatment Plant	LOTT	Existing staff with consultants	2019-2024
POL-8	Update Development Codes • Create a zones adjacent to and compatible with elevated street sections	City of Olympia CP&D	Existing staff	Beyond 2025
POL-9	Reduce or prohibit development in the most exposed areas while ensuring equity and beneficial use of these areas - applicable to properties water ward of proposed barriers	City of Olympia CP&D	Existing staff	Beyond 2025
POL-10	Establish a Transfer of Development Rights program to redirect development from highly exposed areas to less exposed areas	City of Olympia CP&D	Existing staff	Beyond 2025
Finance				
FIN-1	Investigate and implement long-term public financing mechanism	Project Partners	Proposed Financial Group with Consultant	2019-2024 and beyond
FIN-2	Create special district to finance resilience improvements	City of Olympia; Thurston County	Proposed Financial Group	2019-2024 and beyond
FIN-3	Pursue State and federal funding / lobby legislature	Project Partners	Proposed Financial Group with Consultant	2019-2024 and beyond
Education and Outreach				
ED-1	Maintain an up-to-date sea level rise planning website	City of Olympia	Existing Staff	2019-2024
ED-2	Develop and implement a sea level rise-specific Community Education and Engagement Strategy	Project Partners	Existing Staff	2019-2024
ED-3	Incorporate sea level rise in the discussions for planning purposes	City of Olympia	Existing Staff	2019-2024
ED-4	Continue education work with schools	Project Partners	Existing Staff	2019-2024
ED-5	Play a role as regional sea level rise advisor	City of Olympia	Existing Staff	2019-2024
ED-6	Conduct community workshops to brainstorm focus area strategies	City of Olympia	Existing Staff	2019-2024
ED-7	Outreach to downtown business owners and Port tenants	City of Olympia & Port of Olympia	Existing Staff	2019-2024

Strategy Type / ID	Strategy	Lead Agency	Resources	Time-frame
Informational Strategies				
IN-1	Refine sea level rise and flood monitoring strategy	City of Olympia Public Works	Existing staff with consultants	2019
IN-2	Monitor land subsidence	City of Olympia Public Works	Existing staff with consultants	2019-2024
IN-3	Initiate groundwater study	City of Olympia Public Works & LOTT	Existing staff with consultants	2019-2024
IN-4	Understand future precipitation projections	City of Olympia Public Works	Existing staff	2019
IN-5	Understand liquefaction	City of Olympia Public Works	Existing staff with consultants	2019-2024
IN-6	Understand the implications of FEMA accreditation	City of Olympia Public Works	Existing staff with consultants	2019-2024
IN-7	Model flow rates for individual stormwater outfalls and combined sewer system	City of Olympia Public Works	Existing staff with consultants	2019-2024
IN-8	Survey finished floor elevations on Port properties	Port of Olympia	Consultant	2019-2024
IN-9	Monitor ongoing shoreline erosion along East Bay	Port of Olympia	Existing staff	2019-2024



CHAPTER 10— MONITORING AND ACTION TRIGGERS

MONITORING AND ACTION TRIGGERS

The Project Partners developed an approach to monitoring local environmental conditions, new sea level rise research and science, and storm events and response in order to inform our adaptation implementation decisions. Monitoring climate change and sea level rise will be an essential element of effective response decision making. Given the long time horizon of the Plan and the level of scientific uncertainty regarding sea level rise, the Plan will need to be flexible and adaptable in the decades ahead. Implementing the Plan will require long lead times for financing and constructing flood protection structures. Governance responses, such as revisions to development standards and regulations, will also need to be incorporated into response timelines.

MONITORING PROGRAM

The Project Partners have a history of monitoring flood dynamics in Olympia as well as strong connections to scientific and academic researchers. The Project Partners will establish a monitoring program to track changing environmental conditions, new sea level rise research, and storm events and impacts to better prepare Olympia to respond to the challenges of sea level rise. This goal will be achieved by establishing key action triggers and implementing adaptation strategies to address key vulnerabilities before the frequency and severity of flooding due to sea level rise reaches an intolerable level for our community.

Building upon our current work, the Project Partners intend to implement the following approach to monitoring. Development and refinement of a monitoring program is identified as a key work task for the Project Partners in 2019.

LOCAL ENVIRONMENTAL CONDITIONS

The Project Partners identified a number of informational strategies (Chapter 7) to better understand local environmental conditions, including measuring land subsidence, conducting groundwater studies, and tracking local precipitation trends. In addition, the Project Partners identified the following strategies to monitor sea level trends within Puget Sound:

- Monitor changes in mean sea level and storm event data from the Seattle tide station. These data have been collected since 1899 and analyzed by State and federal researchers since the 1990s to identify sea level trends. This work will continue and provide the Puget Sound area observations on long-term sea level rise. The analysis will be critical to Olympia decision making.
- Monitor changes in mean sea level and storm event data from the Tacoma tide station. This tide station has been active since 1997 and provides real-time water levels. Tides at this station precede tides in Olympia by approximately 45 minutes. Monitoring the real-time water levels compared to predicted water levels helps inform emergency response efforts. As more data are collected, researchers will better understand regional sea level trends in central and southern Puget Sound.
- Monitor and document changing water levels in Budd Inlet associated with high tides and weather systems to create a trend analysis of Olympia-specific information. Pursue the installation of a NOAA-certified tide gauge in Budd Inlet.
- Consider partnering with area high schools, colleges, and citizen groups (e.g. Stream Team) to monitor local environmental conditions where feasible

NEW SEA LEVEL RISE RESEARCH AND SCIENCE

- Strengthen relationships with regional academic, State, and federal researchers. The Project Partners expect that sea level rise projections in the coming years will be more accurate and precise. Incorporate new science and data into planning and design of adaptation strategies as they are implemented.
- Track trends in global warming and its implications for local sea level rise. Sea level rise beyond 2050 is largely a function of future human activities (e.g., global population growth, land use, energy mix, new

technologies, etc.) and our efforts to mitigate harmful impacts of climate change.

STORM EVENTS AND RESPONSE

- Track changes in wet-weather flow patterns and any increases in peak flows to the Budd Inlet Treatment Plant attributable to sea level rise
- Monitor the condition and performance of flood barriers responsible for protecting downtown
- Track Project Partner participation in emergency response events, including cost to respond to such events

ACTION TRIGGERS

The monitoring program presented above will provide key information for local decision making in the decades ahead. Implementation plans will be based on projected sea level rise translated to a range of likely timeframes extending to 2100. However, actual implementation timelines for physical strategies will be based on monitoring of sea level rise trends and pre-determined action triggers for planning, design, permitting, financing, and construction. Action triggers for implementation of physical and governance strategies will be refined annually as needed.

Given current research and Olympia-specific flood dynamics, key sea level rise thresholds for actions identified in this Plan include the 6 inch, 24 inch, and 68 inch scenarios.

Key action responses to prepare Olympia for the key sea level rise thresholds include:

- Implement financing structures for funding flood protection projects
- Initiate project implementation (including planning, design, permitting, and construction), in many cases phased over time
- Modify development standards and regulations

The lead time for flood protection projects can be lengthy. Likely timeframes for small to large construction projects are as follows:

- Secure funding: 1 – 10 years
- Project design: 1 – 5 years
- Construction: 1 – 3 years

Depending on scale and complexity, flood protection projects could require 3 to 18 years from start to finish. The longest timelines are appropriate for the larger-scale projects identified for 24 to 68 inches of sea level rise. These timeframes need to be considered in decision making to ensure that projects are initiated with sufficient lead time to implement before flood risk reaches unacceptable levels for our community. Once a given set of flood barriers is constructed, the Project Partners will maintain the barriers and monitor changing environmental conditions to identify triggers to initiate planning of the next phase of projects. Given these timeframes and assuming sea level rise remains as currently projected, decision making needs to meet the following general timelines:

Level of Flood Protection	Phasing	Initiate Project Planning
Current conditions	Near-term	2019-2020
6 inches of sea level rise	Near-term	2019-2024
24 inches of sea level rise	Mid-term	2025-2050
68 inches of sea level rise	Long-term	2050 and beyond

If monitoring indicates changing sea level rise projections, in terms of either the magnitude or rate of sea level rise, the timeline for project initiation will necessarily change (either sooner or later). The projected amount of sea level rise is the key driver to decision making rather than the exact year. Additionally, nearer term projects will need to support and integrate into the longer projects.

APPENDICES

APPENDICES

A. Communication Plan and Record of Outreach

B. Sea Level Rise Planning Framework

C. Climate Science Review

D. Vulnerability and Risk Assessment

    1. City of Olympia Risk Assessment

    2. Port of Olympia Risk Assessment

    3. LOTT Budd Inlet Treatment Plant Vulnerability Assessment

E. Olympia Sea Level Rise Funding Approach Issue Paper

F. Public Comments and Responses

G. Washington State Environmental Policy Act (SEPA)

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