FACET

TECHNICAL MEMORANDUM

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PACIFIC
CONSERVATION DISTRICT

Integrated Stormwater Management and Outreach Project

CITY OF ILWACO

JUNE 2025

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SECTION 1

Introduction + Background

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Introduction

In partnership with the Pacific Conservation District (PCD), this technical memorandum is intended to document the results of case study research conducted to determine which salmon recovery practices, including green stormwater infrastructure (GSI) and low-impact development (LID) techniques would be appropriate to employ in the City limits. The appropriateness will be determined through an assessment of existing infiltration rates and soil conditions within the city. The results from the existing conditions analysis and case study research are intended to serve as a guide for the second phase of this project, which includes updating various goals, policies, and development regulations with the overarching goals of advancing salmon recovery, improving climate resiliency, and promoting regenerative stormwater management.

Background

This initial project concept was developed through a public workshop series (2023-24) focused on creating community-driven approaches to sea level rise resilience for human infrastructure and habitats across Baker Bay. Led by the Lower Columbia Estuary Partnership, Washington Sea Grant, and PCD and funded by the National Fish and Wildlife Foundation's National Coastal Resilience Fund, these workshops and associated outreach convened community members, local and state agencies, environmental non-governmental organization (NGOs), and elected officials to identify community and ecological assets, risks, and nature-based project opportunities.

Storms currently cause nuisance flooding across Ilwaco, which are compounded by king tide events. Projections for future precipitation and sea levels highlight the need to address stormwater in a distributed manner to relieve the compounding effect of sea level rise on local flooding and water quality. While the Port of Ilwaco has already initiated GSI systems to improve water quality, this proposal will expand the potential of GSI/LID infrastructure across the City of Ilwaco, protecting water quality for salmonids and other aquatic species while lessening the impact of current and future flooding events. This project also builds on the adaptation strategies identified in the current City of Ilwaco's Spatial Analysis of Sea Level Rise and Flooding Report that was recently conducted by Facet in June 2025. The assessment includes a groundwater analysis in focus areas within City limits to determine the extent that the City might be impacted by sea level rise and extreme flood events. Study results are documented in this memorandum.

Definitions

Several terms are utilized throughout this document that may reflect similar stormwater management approaches. For clarity, the following definitions are utilized:

Best management practices (BMPs) refer to the schedules of activities, prohibitions of practices, maintenance procedures, and structural and/or managerial practices, that when used singly or in combination, prevent or reduce the release of pollutants and other adverse impacts to waters of Washington State (Stormwater Management Manual for Western Washington, 2024).

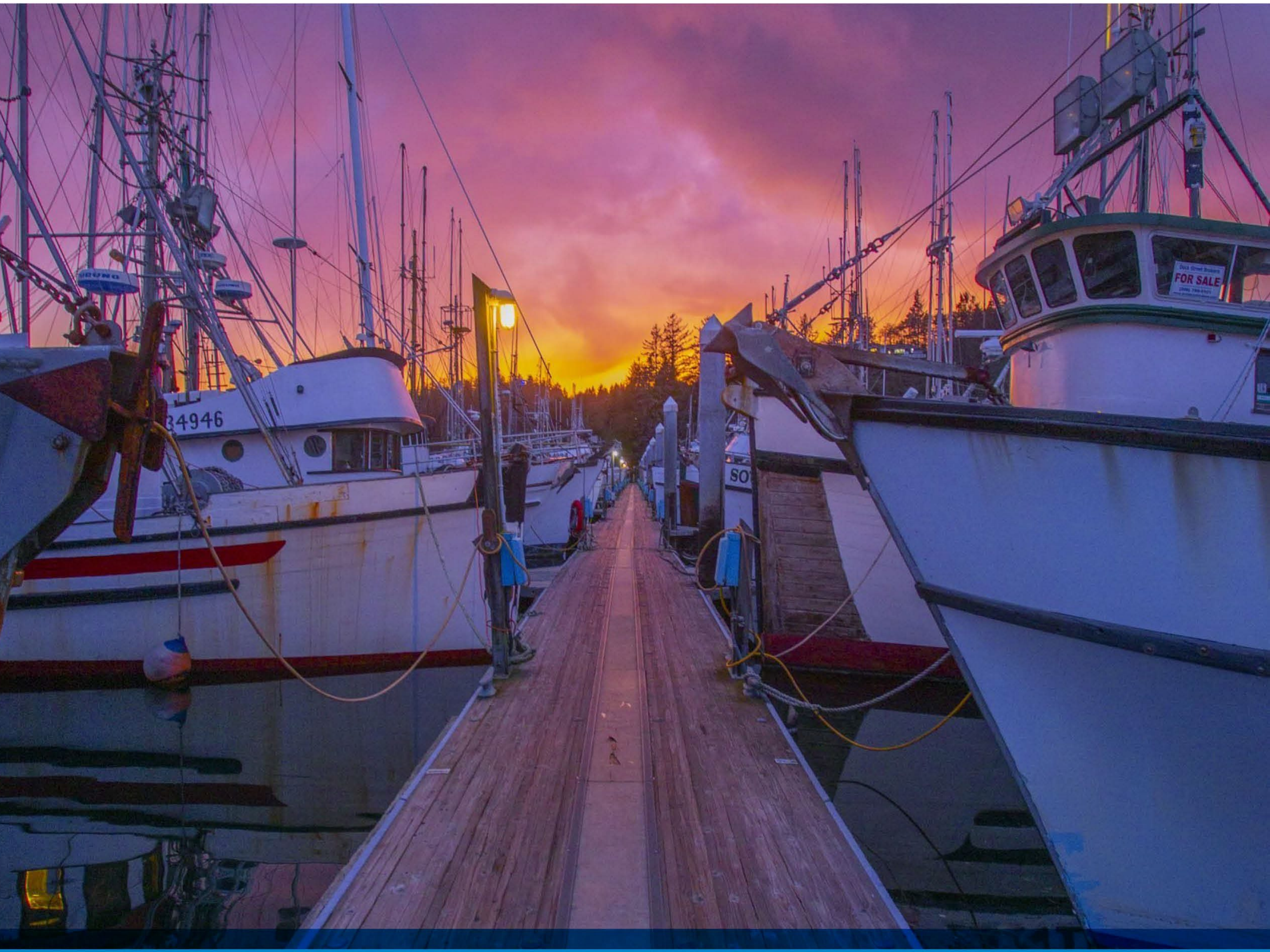
Low impact development (LID) refers to a stormwater and land use management strategy that strives to mimic pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation, and transpiration by emphasizing conservation, use of on-site natural features, site planning, and distributed stormwater management practices that are integrated into a project design (Stormwater Management Manual for Western Washington, 2024).

Green Stormwater Infrastructure (GSI) refers to a stormwater management strategy that emphasizes approaches that rely on natural or engineered-as-natural ecosystems to specifically control and manage stormwater runoff. Green stormwater infrastructure in this context includes utilizing rain gardens/bioretention, rain barrels/cisterns, green roofs, permeable pavements, bioswales, land conservation, urban trees and similar methods to treat and manage stormwater (EPA, 2012).
Key Functions and Benefits of GSI:

- Captures and slows stormwater runoff at its source
- Filters pollutants through vegetation and soil
- Enhances infiltration and groundwater recharge
- Reduces pressure on sewer and drainage systems
- Mitigates urban flooding and combined sewer overflows
- Supports urban tree canopy and biodiversity
- Reduces urban heat island effect
- Improves air quality and public space aesthetics
- Provides cost-effective, scalable stormwater solutions
- Aligns with regulatory frameworks (e.g., MS4 permits)

SECTION 2

Existing Conditions



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2.0 Existing Conditions Analysis

This subsection presents a comprehensive evaluation of environmental and infrastructure conditions within the City of Ilwaco. The assessment includes analysis of infiltration rates, existing impervious surface areas, drainage patterns, urban tree cover, and flood-prone locations. It also identifies potential sites for green stormwater infrastructure (GSI), low-impact development (LID), and areas appropriate for habitat protection or restoration. Due to the timing of this analysis, ground-truthing during periods of heavy precipitation will not be possible; therefore, it is recommended that on-the-ground verification during wet weather conditions be included in the Phase 2 Assessment to ensure a more accurate and complete understanding of seasonal drainage and flooding dynamics.

INFILTRATION RATES

Most soil types within the city limits are considered to have high infiltration rates based on the Natural Resources Conservation Services (NRCS) data.

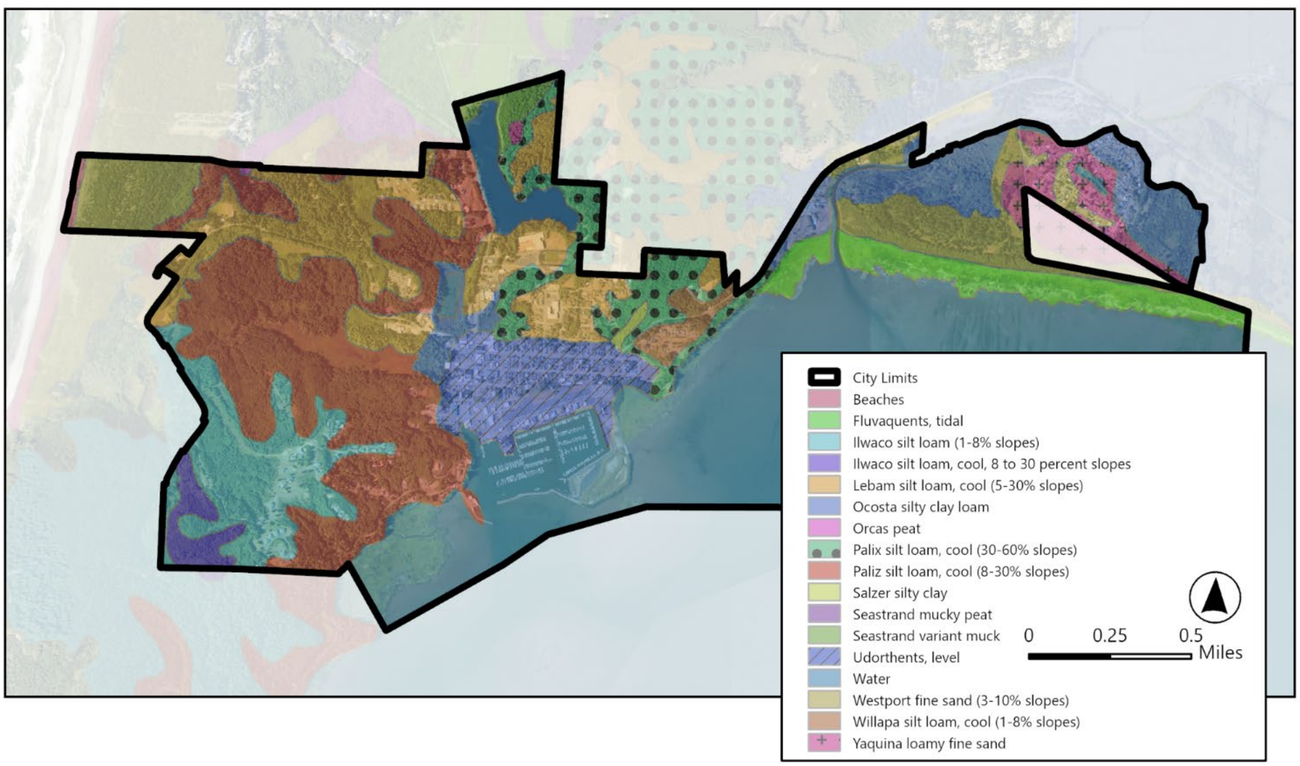

Figure 1. Soil types within the vicinity of the City of Ilwaco

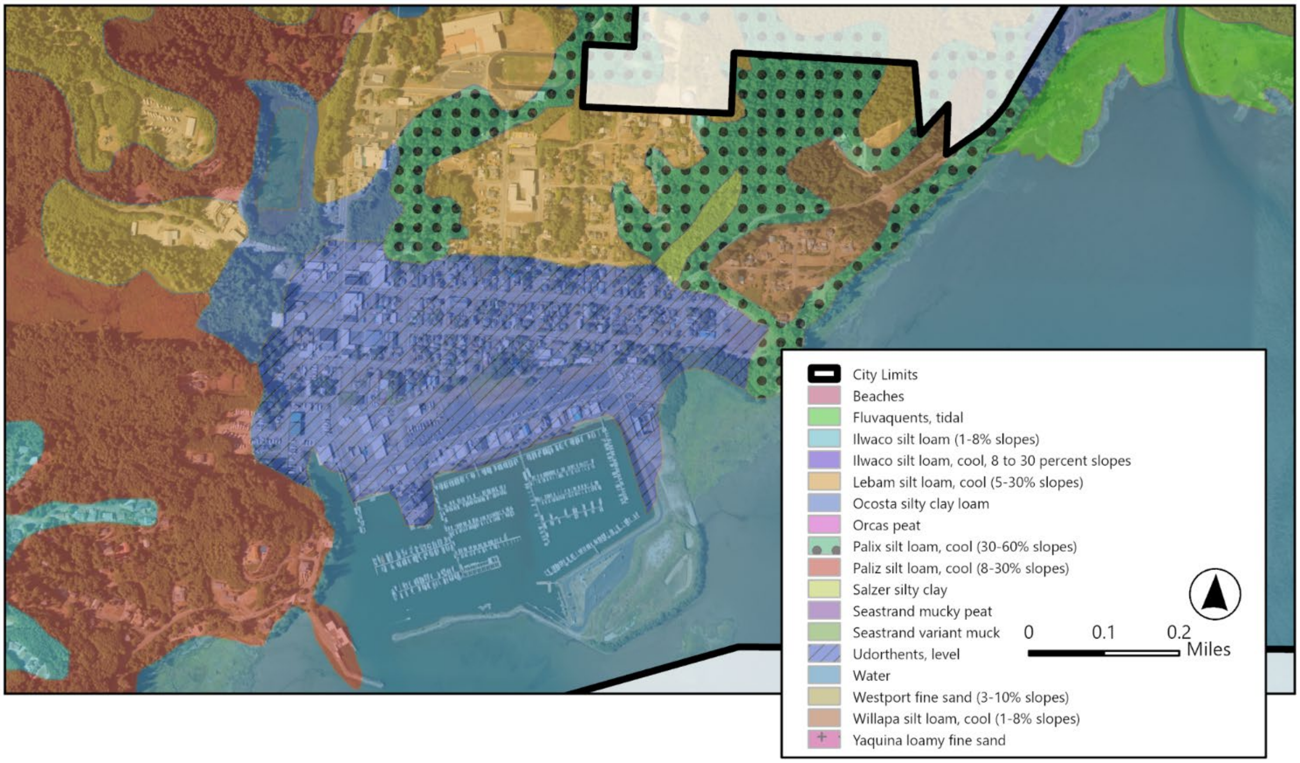

Figure 2. Soil types within the City of Ilwaco City Center.

Figure 3. highlights soils with low permeability, which may limit opportunities for GSI or LID techniques. These systems are most effective when constructed in permeable soils, allowing stormwater to infiltrate. In low permeability soils, water infiltrates slowly which can cause surface water ponding, localized flooding, and stress on vegetation within green infrastructure features. Additionally, poor infiltration reduces the effectiveness of pollutant removal, as water may bypass intended soil filtration areas. GSI or LID systems within these soil types are also more prone to becoming waterlogged, which can result in higher maintenance needs and potential performance issues. To compensate, designs may require modifications such as underdrains, engineered soils, or impermeable liners, which can increase complexity and cost. In some cases, alternative strategies such as green roofs or permeable pavements with subsurface storage may be more appropriate for areas with low infiltration capacity.

Even in soils with low permeability where more complex systems may not feasible, "low tech" solutions like rain gardens, vegetated buffer strips, disconnected down spouts, and stormwater level spreaders can help delay peak flows. These lower-cost options can also help scrub suspended solids, floatable trash, sediment, and help reduce water temperatures prior to it entering local waterways.

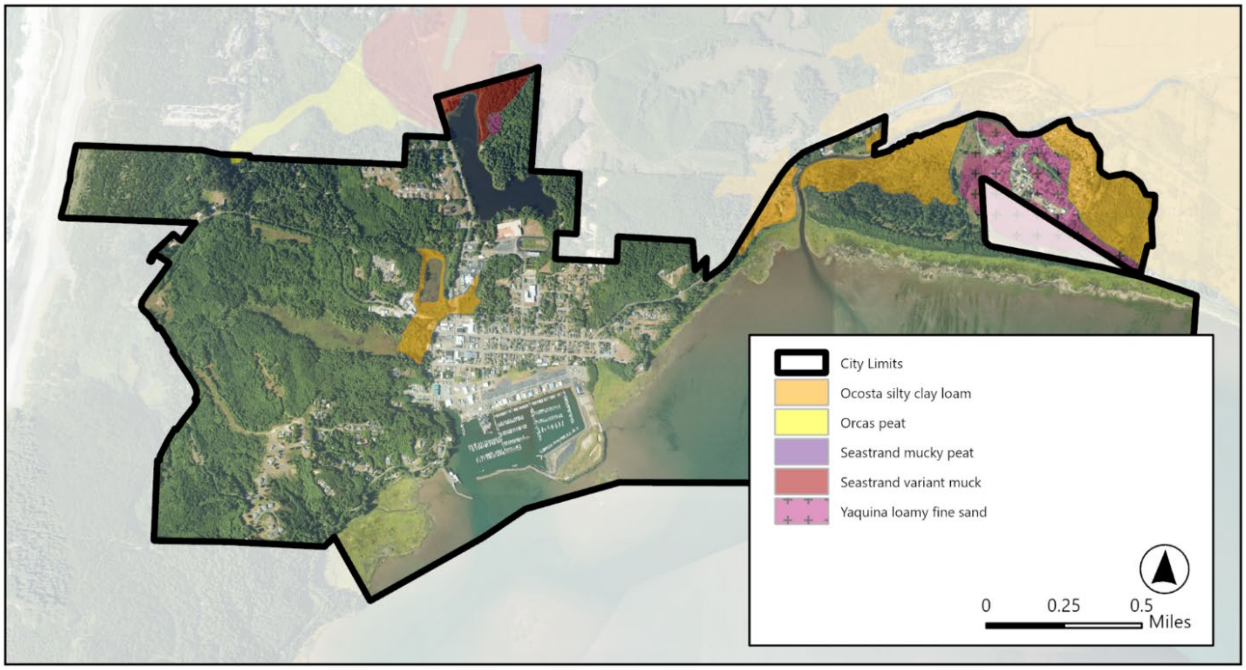

Figure 3. Low permeability soils within the City limits.

EXISTING IMPERVIOUS SURFACE AREAS

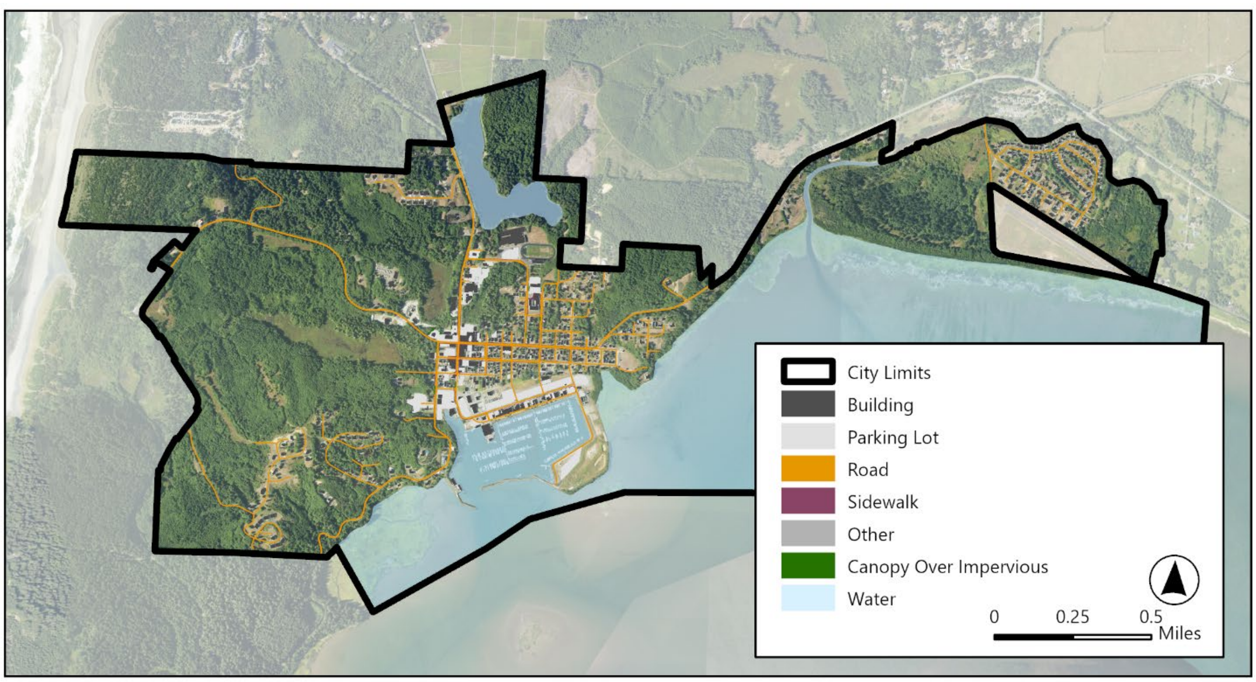

Figure 4. Impervious Surface Areas within City Limits

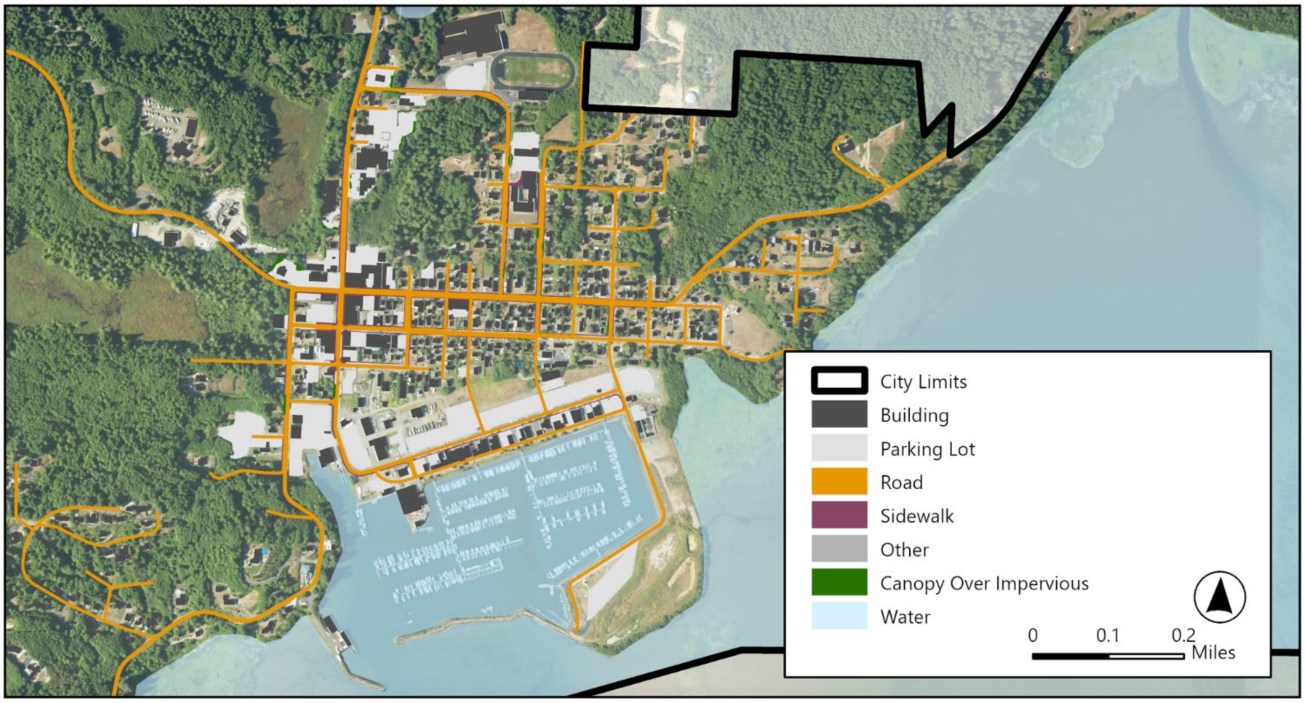

Figure 5 Close up of Impervious Surface Areas within City Limits

Table 1. Calculations of Impervious Surfaces within City Limits

Category	Area (acres)	Percent Area	Area (ft)[1]
Total Impervious Surface Area	**115.9**	**8.9%**	**5,050,383**
Buildings	44.6	3.4%	1,940,849
Other	0.1	<0.1%	2,930
Parking Lots	23.8	1.8%	1,037,314
Roads	44.2	3.4%	1,924,339
Sidewalks	3.3	0.3%	144,950
Waterbodies	870.1	Excluded	37,900,650
Tree Canopy Over Impervious Surfaces	0.7	0.1%	29,426
Pervious Surfaces	1,192.3	91.1%	51,934,452
Total Area of the City	**2,178.9**	**100%**	**94,914,910**
Total Area of the City minus waterbodies	**1,308.9**		

[1]Acres have been rounded to the nearest whole number.

GSI or LID approaches may not be suitable in geologically hazardous areas due to the potential increased risks of erosion or landslides.

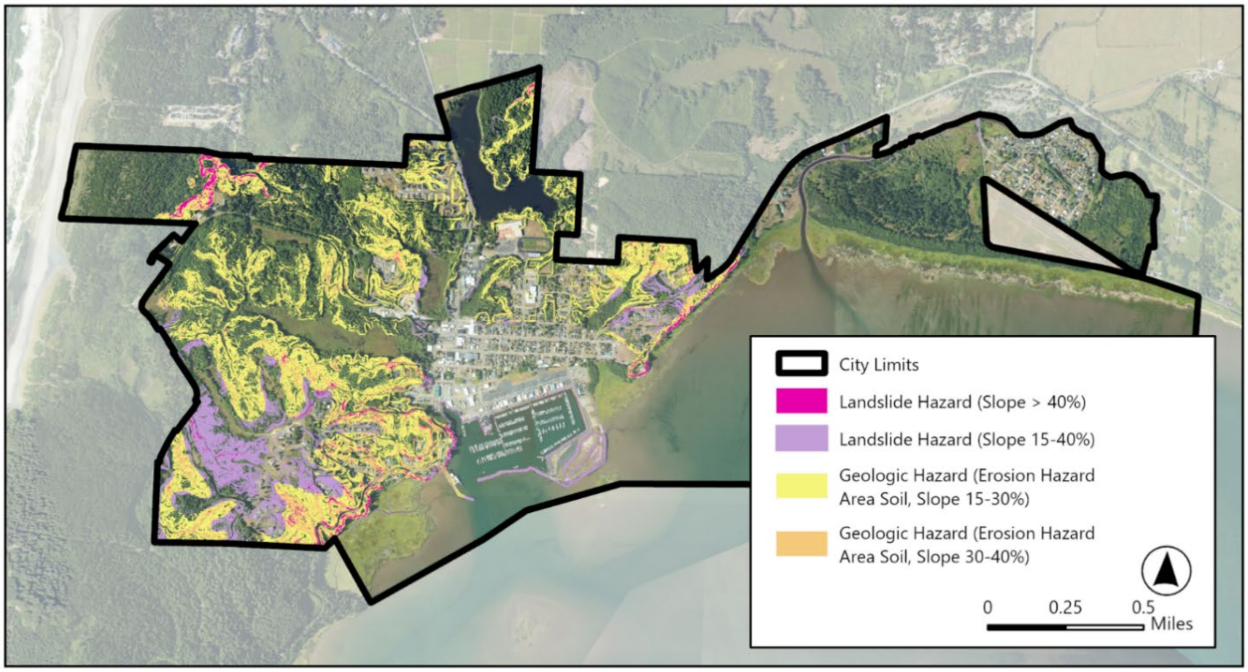

Figure 6. Geologically Hazardous Areas within City Limits

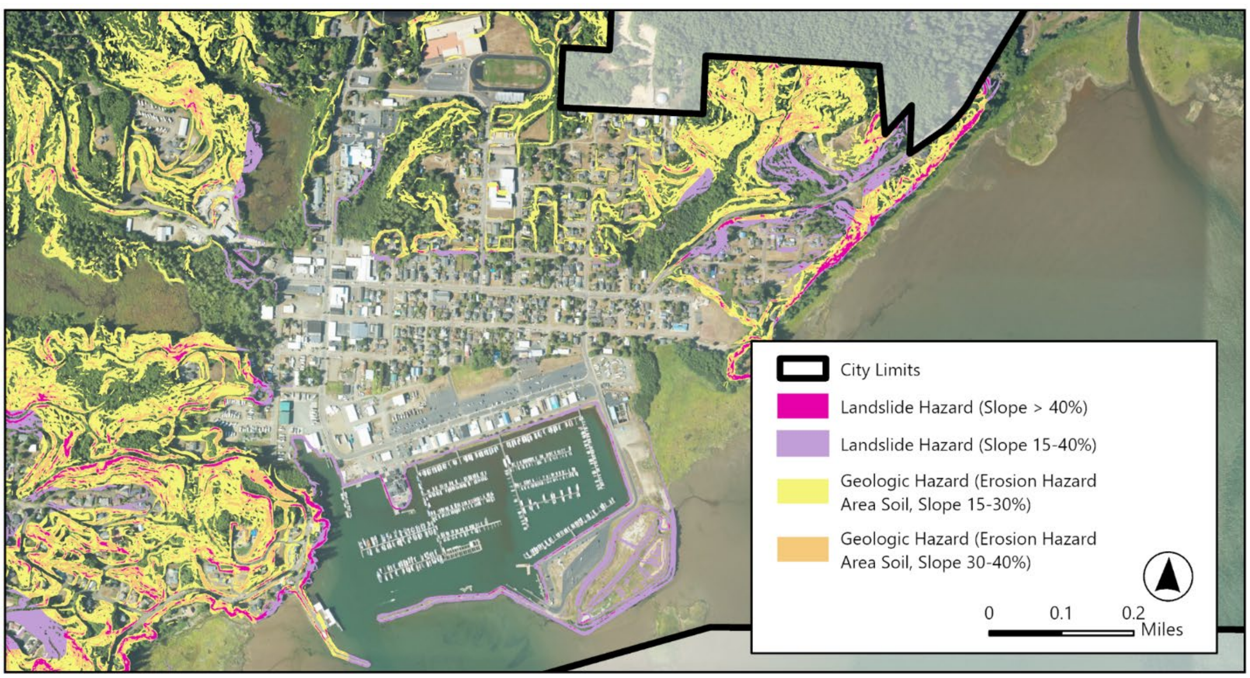

Figure 7. Close up of Geologically Hazardous Areas within City Limits

ILWACO CITY CENTER STORMWATER INFRASTRUCTURE

The City of Ilwaco has a municipal stormwater system that is shown in Figure X. The City's stormlines are aging terracotta infrastructure. Ongoing efforts are under way to determine the condition of these stormwater pipes, including dye testing. Other cities in similarly low-lying estuarine settings have documented infiltration and inflow issues due to aging infrastructure and high groundwater levels. Further assessment is needed within Ilwaco to determine where critical improvements need to be made. Further stormwater mitigation is discussed below in the Recommendations Section.

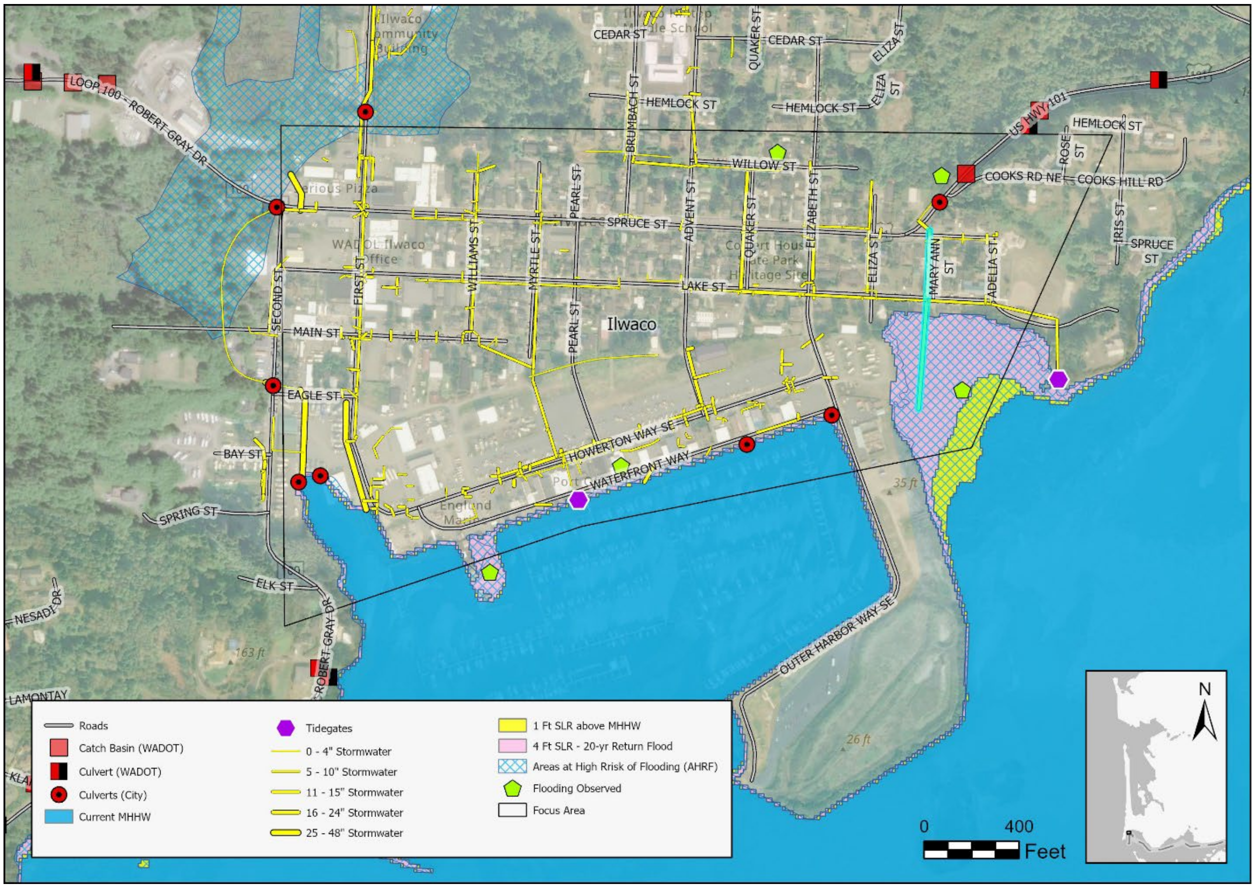

Figure 8. Stormwater Infrastructure with areas of existing flooding (Source: Facet, 2025)

Flooding has periodically been observed along Willow Street. during heavy rain events (S. Corsi, personal communication, February 24, 2025). The grass-lined swale adjacent to the road collects water (Photo 1). The GIS data states there is a stormwater line but with a diameter of zero (0) inches along Willow St. that lead to eight (8) inch and 12-inch stormwater lines on either end and midpoint. The GIS data does not show low permeability soils or any culverts in this area, despite one shown in the photo. Updated drainage infrastructure data will be helpful in diagnosing drainage issues and is a recommendation included later in this report.

Photo 1. Ditch drainage along Willow St.

Stormwater ponding has also been observed north of U.S. 101 at Cooks Rd (S. Corsi, personal communication, February 24, 2025). The GIS data shows a ten (10) inch WSDOT culvert and an 18-inch City stormwater line under U.S. 101 in this area. The stormwater line outfalls into the wetland that is mapped as being inundated with a one (1) feet of sea level rise (SLR) or four (4) feet under a 20-year storm return.

Photo 2. Flooding near Black Lake along U.S. 101

The structures' drainage capacity may be impeded as sea level rise (or SLR) increases the low tide elevation and reduces the time upland water must drain offshore. High precipitation volume and increased river output exacerbate outfall drainage in Baker Bay. Based on discussions with City staff, this issue is particularly relevant to the outlet onto Baker Bay Road. (S. Corsi, personal communication, February 24, 2025).

Photo 3. Stormwater Infrastructure near Black Lake along U.S. 101

VANDALIA STORMWATER INFRASTRUCTURE

Drainage infrastructure in this area consists of tide gates, culverts, stormwater tracts (catch basins) and roadside ditches. The roadside ditches are likely undersized and would benefit from more detailed analysis, regular maintenance, and connections to GSI/LID features.

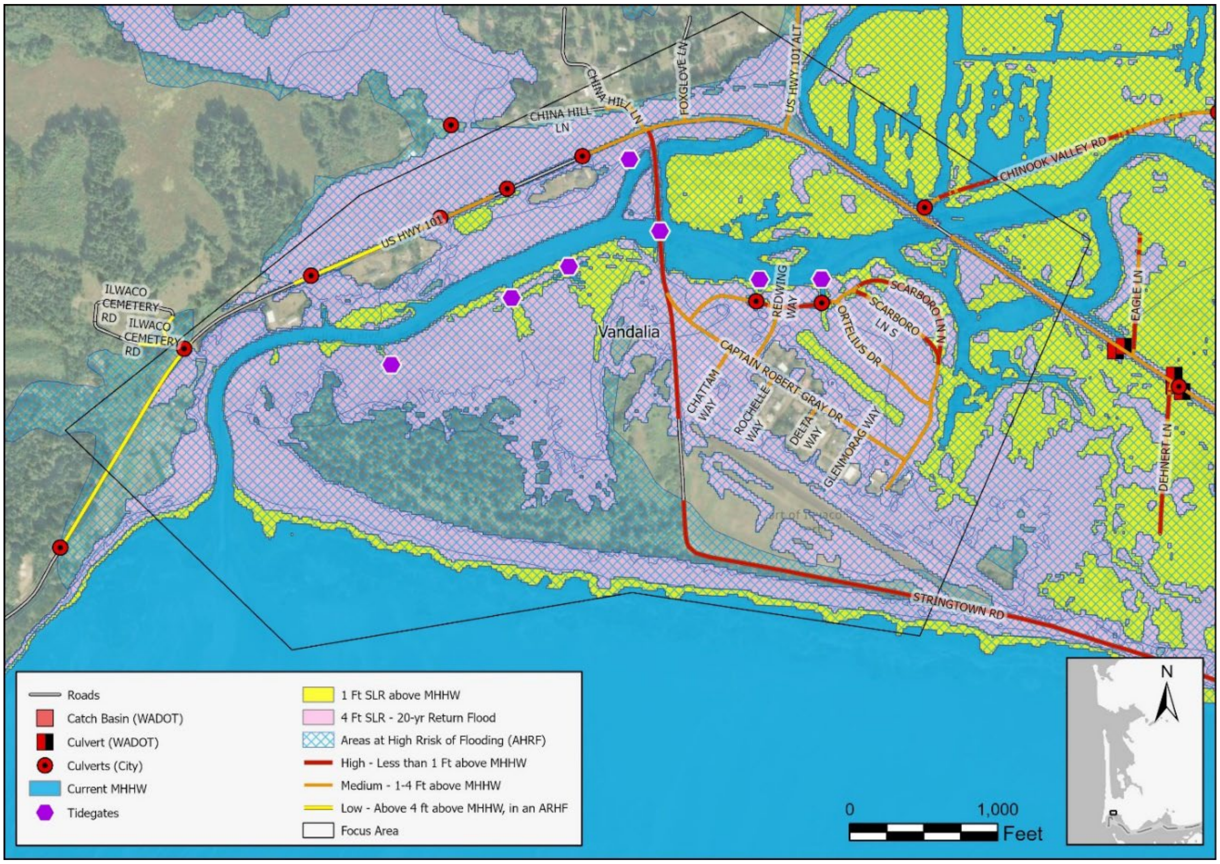

Figure 9 Stormwater Infrastructure within the Vandalia Neighborhood (Source: Facet, 2025)

Most of the area near the Wallacut River and the Vandalia Neighborhood is located within the designated FEMA floodplain and experiences longstanding challenges related to inadequate drainage (e.g. periodic flooding) and undersized stormwater infrastructure capacity.

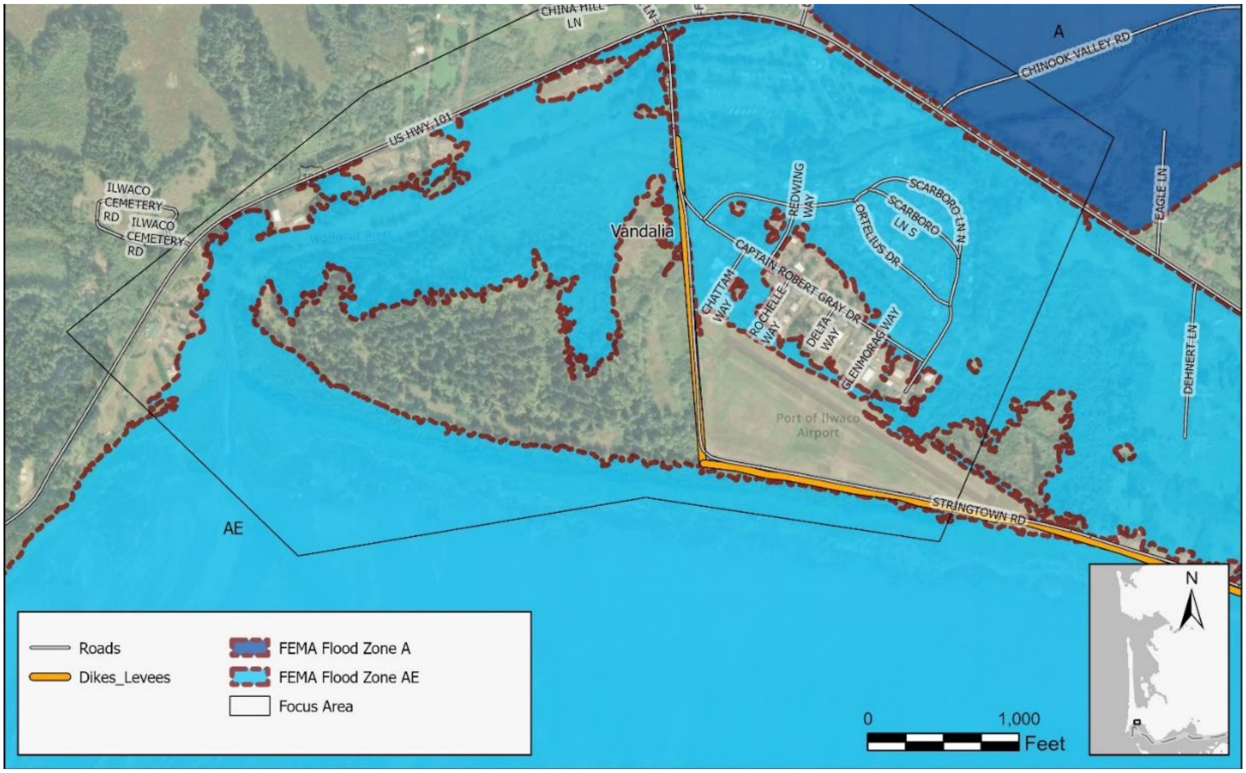

Figure 10. FEMA Flood Zone within the Vandalia Neighborhood (Source: Facet, 2025)

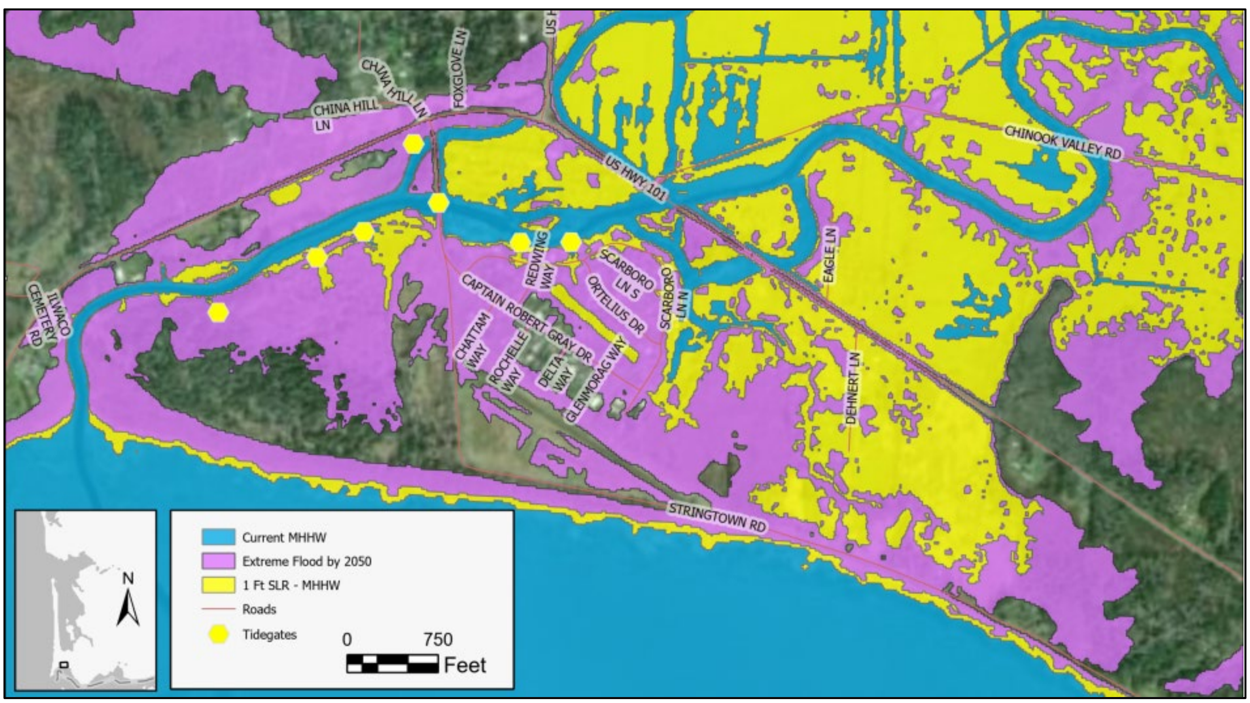

Figure 11. SLR and Extreme Flood Extent by 2025 with 50% certainty (Source: Facet, 2025)

This area is likely to be further impacted by extreme storm events and sea level rise as documented in the City of Ilwaco Spatial Analysis of Sea Level Rise and Flooding Report (2025).

EXISTING LOCAL PROJECTS

This section is intended to describe existing local efforts that may have a nexus with green stormwater infrastructure or low impact development techniques to improve water quality within the city. The local projects described in this report include the following:

- Baker Bay and Grays Bay: Community-Based Coastal Resilience Action
- Port of Ilwaco Green Stormwater Infrastructure (GSI) Project
- Port of Ilwaco Flood Protection

Baker Bay and Grays Bay: Community-Based Coastal Resilience Action

The Baker Bay and Grays Bay: Community-Based Coastal Resilience Action (referred to as the Bay to Bay project) was a three-year (2021-2024) initiative to assist locally-led efforts to reduce the changing seawater level's impact on people and habitats of Baker and Grays Bay. Located in the Lower Columbia River Estuary., this project focused on current flooding and potential future sea level rise impacts, how they relate to existing issues, and how to best respond to present and future issues simultaneously in accordance with community visions and scientific information. The Bay to Bay team consisted of Pacific Conservation District (PCD), Washington Sea Grant, the Lower Columbia Estuary Partnership, and Wolf Water Resources.

Through outreach, a public workshop series, existing plans review, and related technical assistance, the team assisted local, state, federal, and tribal participants to identify 6 priority resilience projects each, for Baker Bay and Grays Bay. The top-ranked project concept for Baker Bay was for Ilwaco stormwater management, which is actively being advanced through this project. It is described in further detail in the Existing Local Projects section of this report, along with other projects in the City of Ilwaco that resulted from the Bay to Bay project.

During the Bay-to-Bay workshops, participants identified existing issues related to hazards, habitat, and social or economic vitality in Ilwaco. Figures 12-15 describe these issues along with existing or potential future seawater levels. These maps along with other project context can be found in the final report for Bay to Bay (Blalock et. al. 2024) and the report's Appendix C - Maps for Baker Bay.

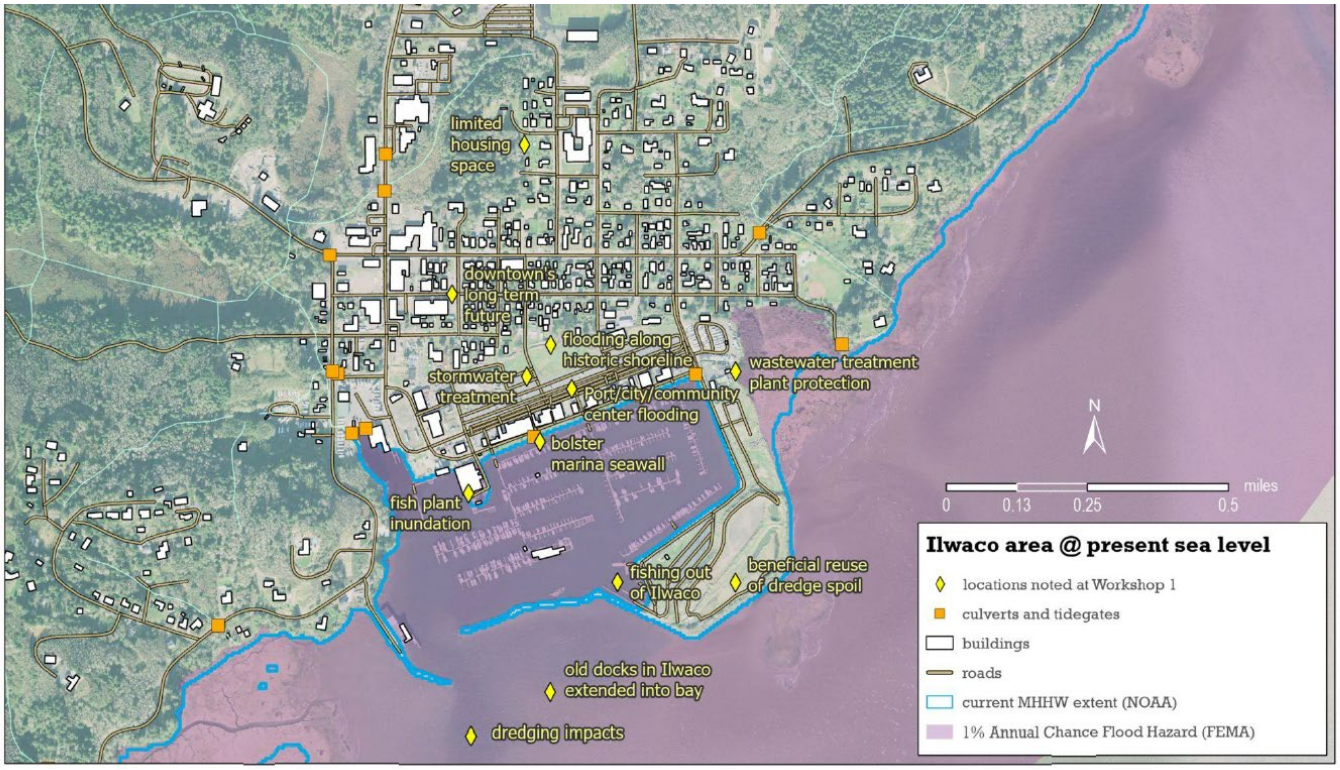

Figure 12. Issues identified by Bay to Bay participants for the City of Ilwaco's urban core, at present sea level with a large storm event (FEMA's 1% Annual Chance Flood Hazard). (Source: Blalock et. al. 2024)

Figure 13. Issues in the City of Ilwaco's urban core identified by Bay to Bay participants, with a potential future water level six (6) feet above mean higher high water (MHHW) resulting from a large storm event on top of sea level rise at varying magnitudes, or a six (6) feet of sea level rise, which is less probable. (Source: Blalock et. al. 2024)

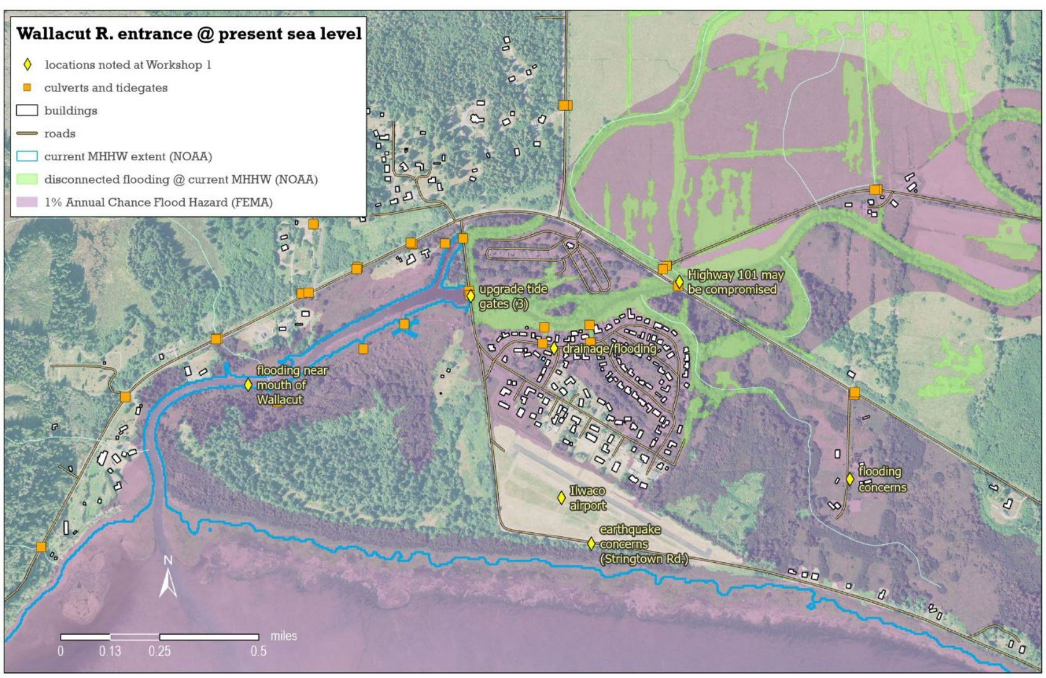

Figure 14. Issues in the City of Ilwaco's Vandalia neighborhood identified by Bay to Bay participants, at present sea level with a large storm event (FEMA's 1% Annual Chance Flood Hazard). (Source: Blalock et. al. 2024)

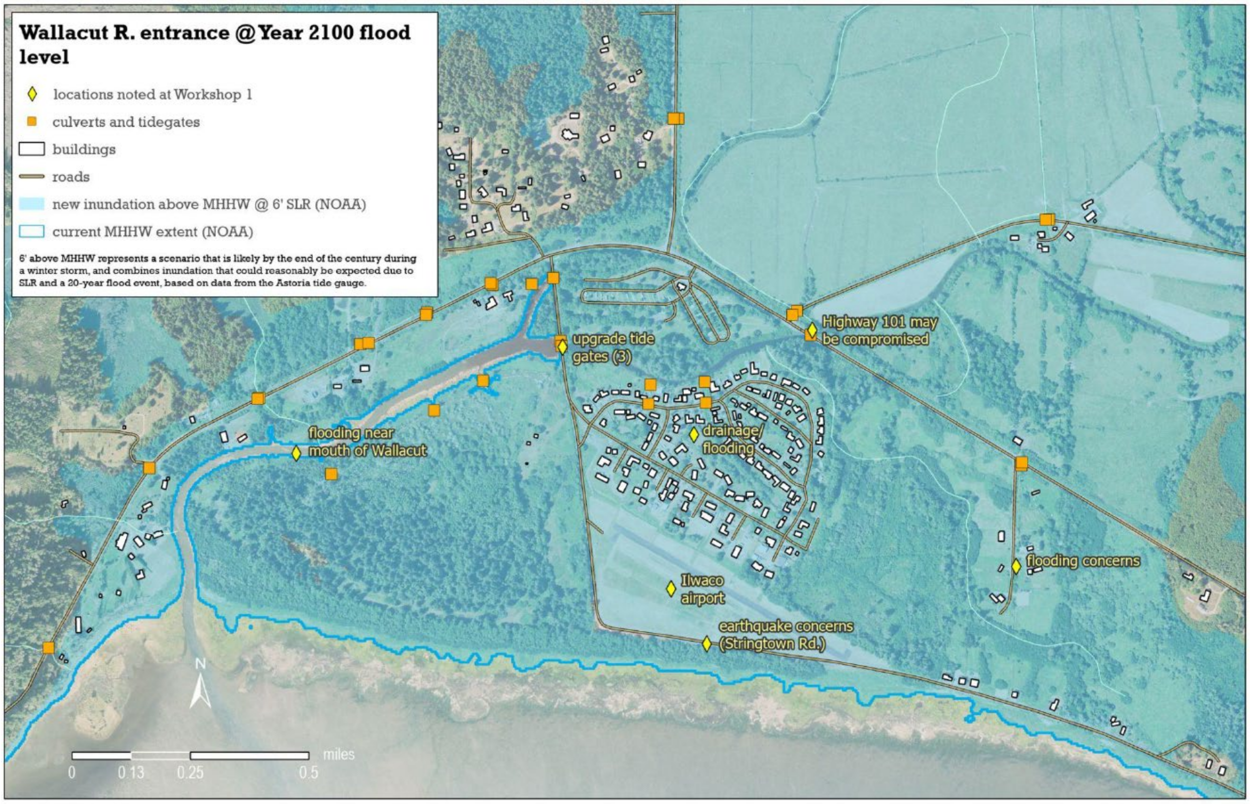

Figure 15. Issues identified in the City of Ilwaco's Vandalia neighborhood by Bay-to-Bay participants, with a potential future water level six (6) feet above MHHW (via a large storm event on top of sea level rise at varying magnitudes, or - less likely - via six (6) feet of sea level rise). (Source: Blalock et. al. 2024)

Based on participant perspectives, existing conditions takeaways from Bay to Bay included:

- Current nuisance flooding at the Port of Ilwaco marine occurs during extreme high tides, wind-driven waves, and combination events. This is expected to increase in the future as sea levels rise, and overall storminess increases in the region.
- City of Ilwaco's downtown experiences nuisance flooding during combined high tide and precipitation events, leading to stormwater backup and reduced infiltration of runoff into soils. This is expected to increase in the future as sea levels rise, and overall precipitation increases in the region.
- The Vandalia neighborhood regularly floods during combined high tide and precipitation events. This is expected to increase in the future as sea levels rise, and overall precipitation increases in the region.
- The Wallacut River tide gates are failing, and repair will likely require upgrades to fish passage. Upgrades could also assist to mitigate flood impacts for the area. Pacific County and Washington Department of Fish and Wildlife have been unsuccessful in implementing a solution, which may benefit from a broader, integrated vision aligned with other flood impact reduction efforts.

- After the finalization of the Bay-to-Bay report, PCD was notified by a City of Ilwaco Councilmember and residents about flooding and undersized culverts further upstream along the Wallacut River. Prior to this, all flooding issues identified had been downstream of the Wallacut River tidegates. This awareness highlights the opportunity for watershed-wide coordination to mitigate flooding impacts and habitat improvement.
- The Columbia Land Trust is a major landowner across Baker Bay and is involved in many potential habitat and hazards resilience projects. Their involvement in future resilience work is desirable, as they own land immediately adjacent to the Vandalia neighborhood.
- Regular communication regarding hazards, habitat changes, and land use across Baker Bay could build relationships between residents and landowners (including private upland and lowland landowners, Columbia Land Trust, WA State Parks, WA Department of Fish and Wildlife), and support multi-benefit resilience project development. Relationships across these organizations are likely to lead to increased motivation for action, access to resources, and authority to implement resilience actions.
- Local jurisdictions and special districts (City of Ilwaco, Pacific County, and Port of Ilwaco) should make sure to engage with Columbia Land Trust during long-range planning or other large-scale activities. Columbia Land Trust should also ensure their activities accommodate local needs and priorities.
- Collaborative approaches and large funding resources are necessary for all these projects. Lessons learned from emerging projects should be shared across project partners, perhaps through a continued resilience forum (e.g. Washington Coastal Hazards Resilience Network, Pacific County's Marine Resources Committee). Washington State agencies can provide assistance and should be involved at an early stage.
- Local efforts can better serve the community by aligning with these priorities:
  - Economic and physical infrastructure
  - Water access
  - Habitat
  - Housing
  - Community social spaces
  - Agricultural viability
  - Projects with multiple co-benefits
- There is limited local capacity to lead projects, advocacy, and other coastal resilience activities. This is coupled with a few opportunities for resilience related education and job training to support related long-term efforts. Resilience work can support larger community priorities by building capacity across multiple local public entities (e.g. City of Ilwaco, PCD), supporting local businesses, and engaging younger generations through educational activities and job training.

Port of Ilwaco Green Stormwater Infrastructure (GSI) Project

A GSI project was recently implemented at the Port of Ilwaco by the Lower Columbia Estuary Partnership and KPFF to help reduce contaminants entering Baker Bay from the adjacent parking lot. The Estuary Partnership is working alongside the City of Ilwaco and the Port of Ilwaco to enhance the water quality of Baker Bay. The project added stormwater treatment facilities along Howerton Avenue and its adjacent parking lots.

Currently, more than 40 storm drains convey untreated stormwater from these areas directly into Baker Bay. Stormwater runoff can be toxic to fish and wildlife, particularly from roads and parking areas. As rainwater flows across the pavement it picks up contaminants like vehicle oils and grease, metals in brake pad dust, trash, sediment, and a host of other pollutants, into storm drains, and directly into Baker Bay.

This $2.18 million project is completely funded by a grant from the Washington Department of Ecology and the Lower Columbia Estuary Partnership. The project will not cost anything to the City, the Port, the businesses, or the residents of Ilwaco.

Photo 4. GSI Project in the Port of Ilwaco Parking Lot

Photo 5. GSI Project at Port of Ilwaco facing Howerton Way

Port of Ilwaco Flood Protection

In 2020, the Port of Ilwaco submitted a proposal to FEMA's Building Resilient Infrastructure and Communities program, supported by Washington Sea Grant, Washington State Department of Ecology, and Moffat & Nichol. While the grant proposal was unsuccessful, this project would have completed the following activities:

1. Conducted a sea level rise study of all Port properties.
2. Repaired and/or raised the bulkhead at Jessie's Ilwaco Fish Company, now Safe Coast Seafoods; and

3. Designed a berm along the Ilwaco Marina waterfront to protect the Port's boardwalk and commercial spaces from flooding during storm events, king tides, future sea level rise, and combined events (Figure 16).

Figure 16. Conceptual drawing showing potential location of berm at Ilwaco Marina (Source: Moffat & Nichol)

Activity 1 was later advanced by the Bay to Bay project and the City of Ilwaco's current Sea Level Rise Vulnerability and Risk Assessment, both described above.

Activity 2 was later funded by the U.S. Department of Transportation (USDOT) Maritime Administration (MARAD)[1] and is in progress as of early 2025.

1 https://www.portofilwaco.com/poi-east-bulkhead-resilience-project/


Photo 6. Active construction of Safe Coast Seafoods Bulkhead

Activity 3 was scoped further during the Bay to Bay workshops and is shown below (Figure 17). Specific next steps involve identifying a competitive funding strategy to assess alternatives, incorporate public input, develop design documents, and implement this project (Figure 18). Additional details can be found in the Bay to Bay project's final report (ibid.), with specific reference to the report's Appendix E - Baker Bay Resilience Concepts.

1. Ilwaco shoreline flood protection

Figure 17. Ilwaco shoreline flood protection concept, developed by participants in the Bay to Bay project (Source: Blalock et. al. 2024).

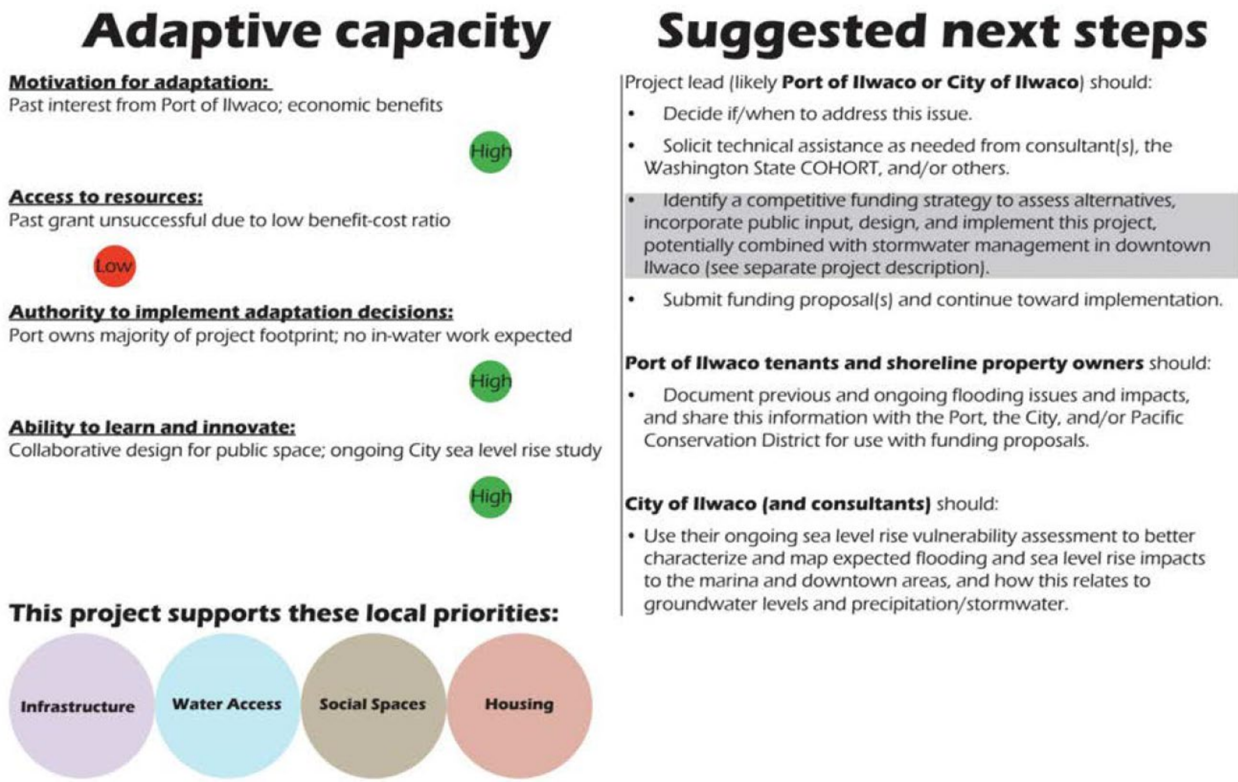

Figure 18. Adaptive capacity analysis and suggested next steps for Ilwaco shoreline protection. (Source: Blalock et. al. 2024)

This latest version of the shoreline flood protection concept expands the earlier Port of Ilwaco Building Resilient Infrastructure and Communities (BRIC) proposal in three (3) key ways, reflecting the incorporation of future sea levels and its focus on mutually-reinforcing activities. It now proposes

- Extending flood protection eastward/upstream to protect residences and City infrastructure outside of Port parcels,
- Applying beneficial dredge material to raise the marsh in lockstep with sea level rise, reduce wave impacts upon the marsh, protect downtown Ilwaco from flooding, and address the Port of Ilwaco's maintenance dredging and disposal needs[2], and
- Involving multiple partners, which may increase the competitiveness of this project for public funding.

[2] Similar beneficial use of dredged material is currently being explored by Pacific Conservation District and the Port of Chinook to address flooding and erosion in Chinook. Insights from this work may prove valuable for advancing this concept in Ilwaco.

ILWACO GREEN STORMWATER INFRASTRUCTURE (GSI) PRIORITIES

Bay to Bay participants prioritized distributed stormwater infrastructure across Ilwaco and the Vandalia neighborhood (such as swales, rain gardens, and other green stormwater infrastructure spread across strategic areas of city, Figure 19). While Vandalia could benefit from this work, participants focused on the urban core of Ilwaco based on the perception that there are more opportunities to successfully intervene.

Storm events regularly cause nuisance flooding across low-lying areas in the City of Ilwaco, affecting residences, roadways, and more. This is compounded by high tides. Distributed GSI Features would help manage stormwater where it falls. This can slow and store stormwater, reduce reliance on centralized infrastructure (e.g. drainage ditches which are at max capacity), and reduce the compounding impact of high tides and sea level rise on local flooding.

This project is likely to happen if funds and community support are confirmed, based on adaptive capacity criteria (Figure 20). Additional details can be found in the Bay to Bay project's final report (ibid.), with specific reference to the report's Appendix E - Baker Bay Resilience Concepts.

Figure 19. Concept for green stormwater infrastructure across downtown Ilwaco. (Source: Blalock et. al. 2024)

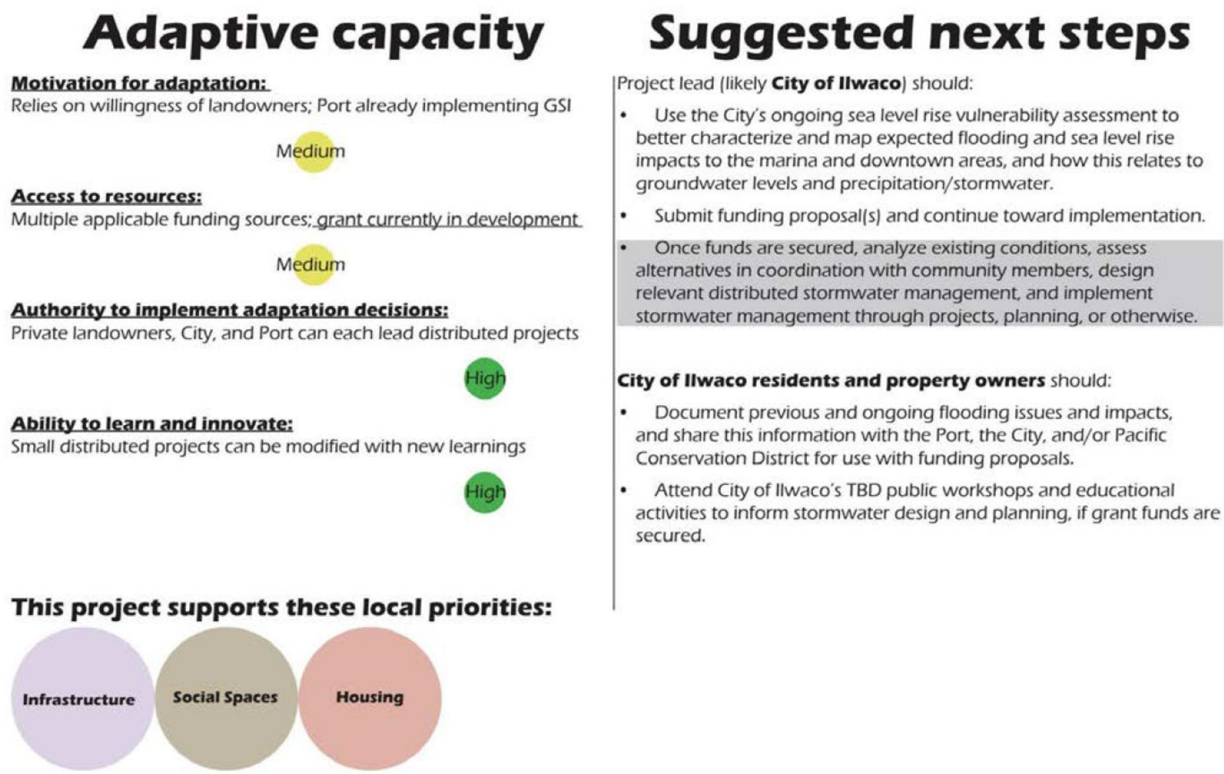

Figure 20. Adaptive capacity analysis and suggested next steps for green stormwater infrastructure across downtown Ilwaco. (Source: Blalock et. al. 2024)

LOWER WALLACUT RIVER WATER MANAGEMENT AND INFRASTRUCTURE IMPROVEMENTS

Combined storm events and high tides regularly cause disruptive nuisance flooding across Ilwaco's Vandalia neighborhood, affecting residences, roadways, Port of Ilwaco Airport, and more. Culvert replacement has been a priority for the County. Distributed stormwater management and nature-based flood water storage can slow and store stormwater, reduce reliance on centralized infrastructure (e.g. culverts), and reduce the compounding impact of high tides and sea level rise on local flooding. Since this historic wetland is naturally flood-prone, floodproofing of homes will likely be necessary alongside development regulations to reduce future risks.

Bay to Bay participants prioritized assessment and implementation of improved water management to reduce flood impacts along the lower Wallacut River around the Vandalia neighborhood, likely including culvert replacement, floodproofing homes, distributed stormwater management, and nature-based storage of flood waters (Figure 21). This is a near-term priority with future necessity: This project would help manage flooding that already occurs occasionally, affecting roads, homes, and other infrastructure. Flooding is expected to increase in frequency and magnitude with sea level rise and future weather conditions.

This project is likely to happen if funds and community support are secured, and if there is a local jurisdiction or other organization to lead this work, based on adaptive capacity criteria (Figure 22).

Additional details can be found in the Bay to Bay project's final report (ibid.), with specific reference to the report's Appendix E - Baker Bay Resilience Concepts.

After the finalization of the Bay to Bay report, PCD was notified by a City of Ilwaco Councilmember and local residents about flooding and undersized culverts further upstream along the Wallacut River. Prior to this, all flooding issues identified had been downstream of the Wallacut River tidegates. This awareness highlights the opportunity for watershed-wide coordination to mitigate flooding impacts and habitat improvement. Similarly, PCD has worked with agricultural landowners in unincorporated parts of the Wallacut River watershed to plant riparian vegetation, which can be a component of green stormwater infrastructure and habitat restoration. These aspects are not included in Figures 21 and 22 from Bay to Bay but could be addressed in a synergistic fashion involving coordination across multiple landowners and state agencies.

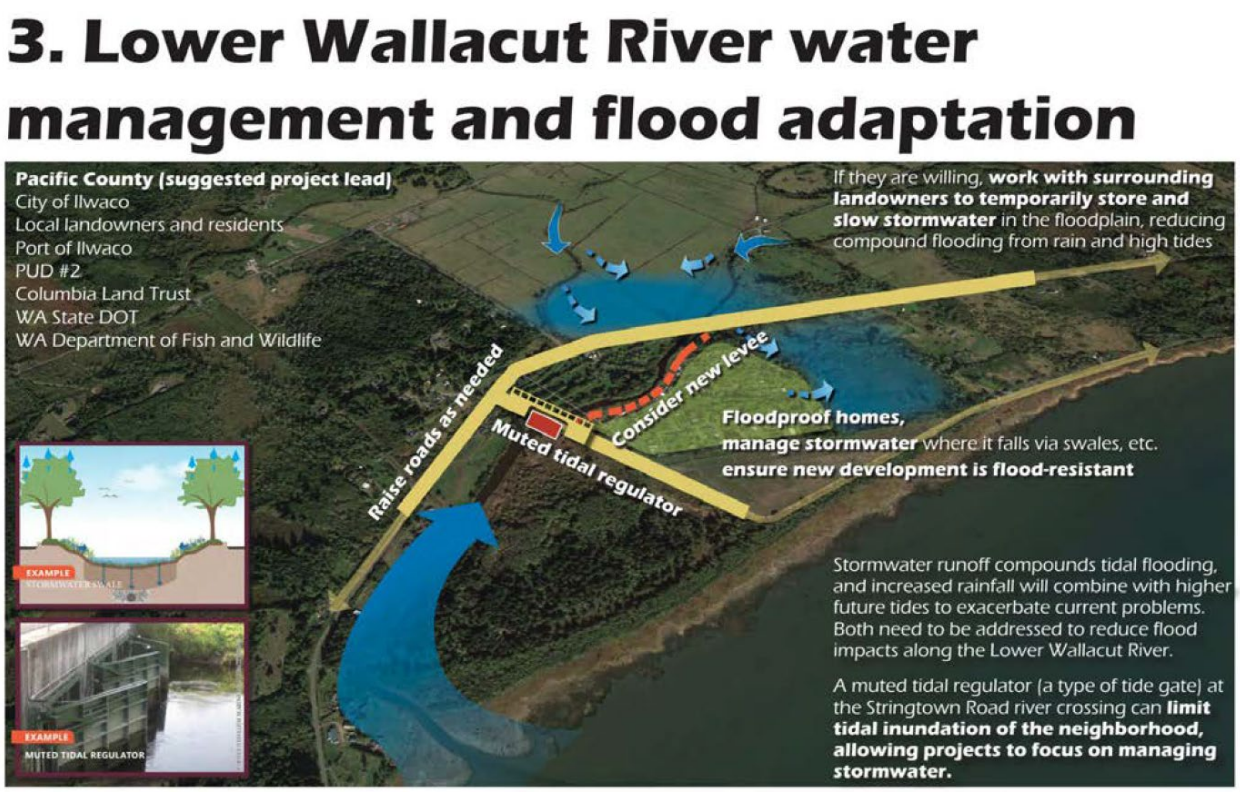

Figure 21. Concept for water management and flood adaptation across the Lower Wallacut River. (Source Blalock et. al. 2024)

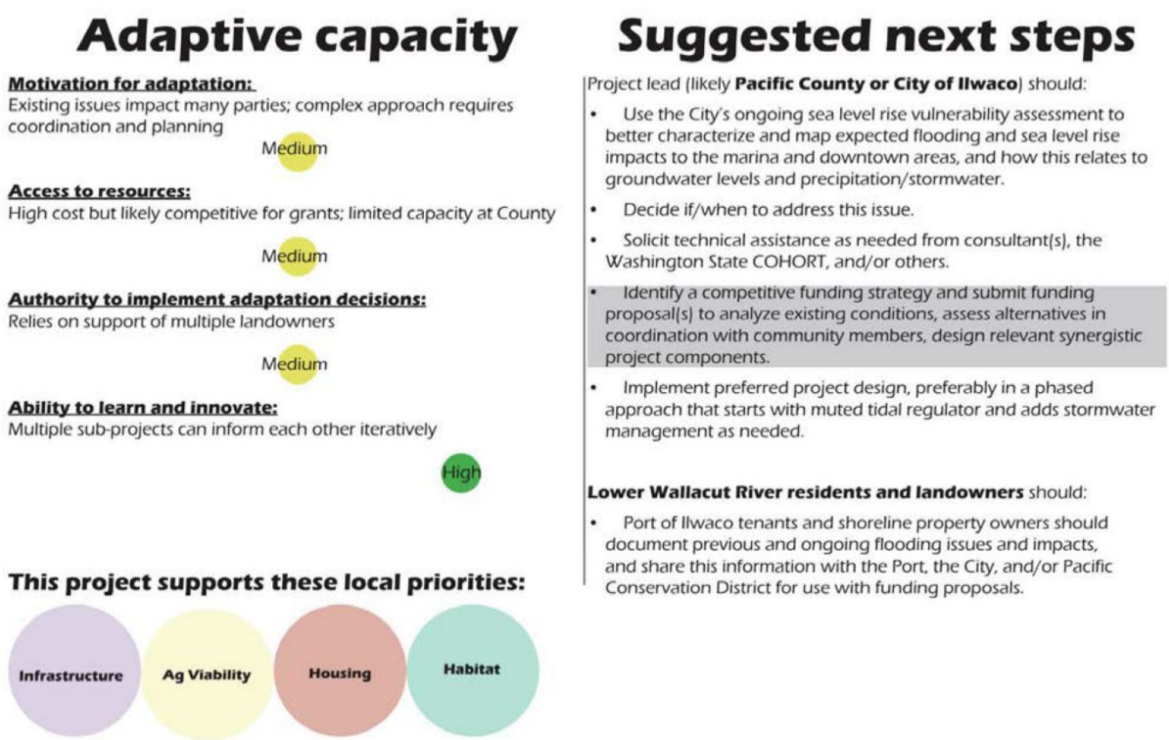

Figure 22. Adaptive capacity analysis for water management and flood adaptation across the Lower Wallacut River. (Source: Blalock et. al. 2024)

HABITAT AND RESTORATION OPPORTUNITIES

Coastal Margin Observation and Prediction Program

The Columbia River Inter-Tribal Fish Commission operates the Coastal Margin Observation and Prediction (CMOP) program[3]. Building from initial work by the Lower Columbia Estuary Partnership's (LCEP) Ecosystem Monitoring Program[4], CMOP is currently conducting monitoring activities at Ilwaco Slough (the marsh south of Robert Gray Drive in the vicinity of Klahanee Drive, (Figure 23). Ilwaco Slough is located southwest of the entrance to the Ilwaco Marina, in Baker Bay. The property is currently owned by Washington Department of Natural Resources. This site has developed in the past century as the bay filled in, likely due to changes in circulation from the construction of jetties at the mouth of the Columbia River, the placement of dredge material islands at the mouth of the bay, and changes in Columbia River flows.

Ilwaco Slough marsh is dominated by lush fields of Lyngby's sedge (*Carex lyngbei*) with higher portions occupied by tufted hairgrass (*Deschampsia cespitosa*) and cattail (*Typha angustifolia*). Being so close to the mouth of the Columbia River, the tidal channel is regularly inundated with brackish water (average salinity <10 Practical Salinity Units, however salinity up to 20 PsU occurs in the late summer). Selected as

[3] https://cmop.critfc.org/

[4] https://www.estuarypartnership.org/our-work/monitoring/ecosystem-monitoring-program

a long-term monitoring site in 2011, Ilwaco Slough was sampled for all Estuary Monitoring Program metrics every year except 2014 when only habitat and hydrology were monitored.

Here, CMOP is measuring salinity, temperature, water levels, turbidity, chlorophyll and dissolved oxygen, and expanding that LCEP program to add winter monitoring to the previous 3-season effort. CMOP is currently only funded to maintain monitoring for one winter, but their permit is for 5 years. Researchers from Pacific Northwest National Labs have been monitoring sediment accretion and erosion at the site, which will continue under CMOP's current permit. Pending monitoring results, potential restoration opportunities exist at Ilwaco Slough, which may be integrated with stormwater management for Klahanee Drive area of Ilwaco.

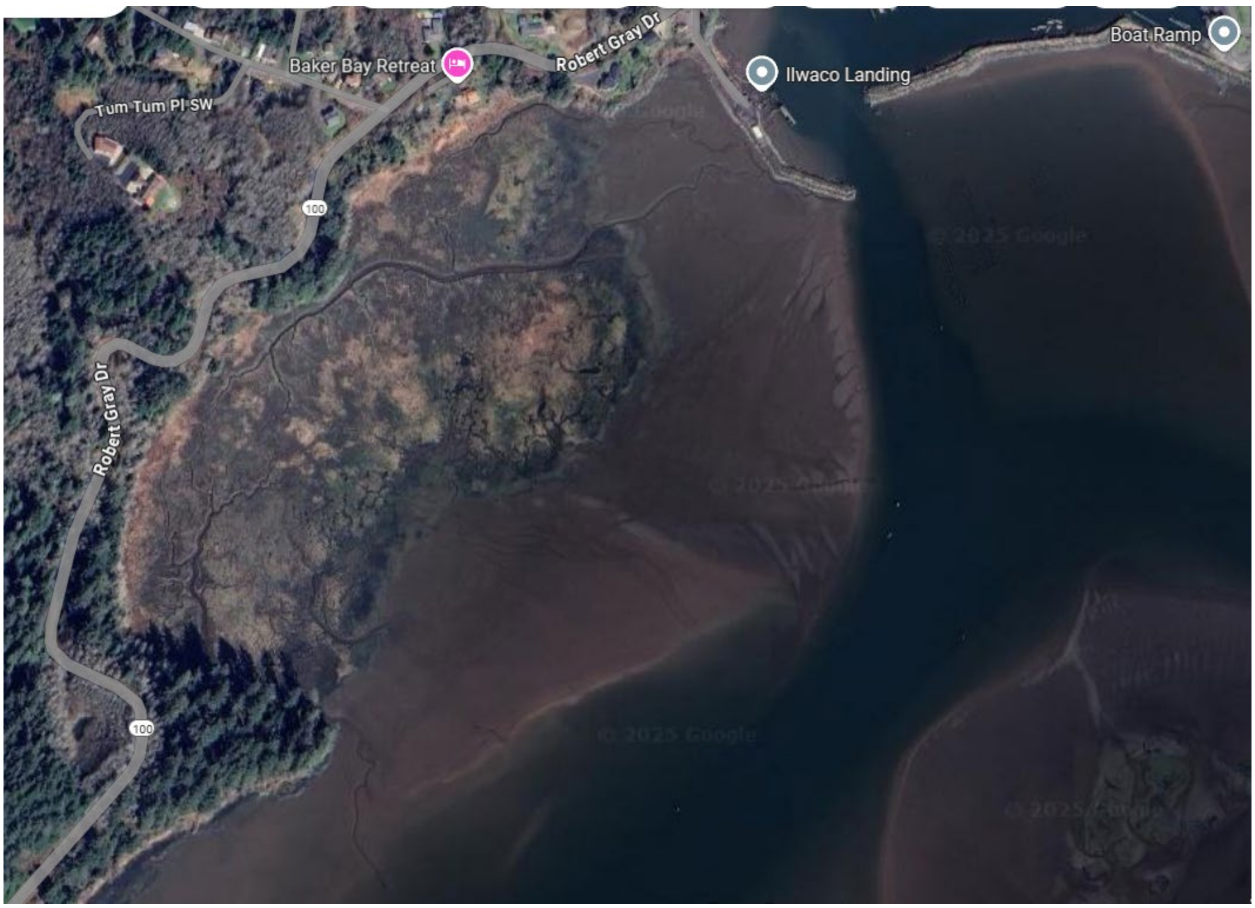

Figure 23. Ilwaco Slough (image via Google Maps)

Baker Bay and Grays Bay Project

During the Bay to Bay project, several specific community-prioritized habitats were mentioned, providing opportunities for conservation, restoration, and/or multi-benefit activities, including, but not limited to, improved stormwater management capacity through nature-based strategies:

A. Estuarine marsh between Ilwaco City Park and Wastewater Treatment Plant,

B. Freshwater wetlands (Fords Dry Lake and associated drainage) west of Ilwaco along the Discovery Trail,

C. The drainage ditch and associated wetlands between Port of Ilwaco's parking lot and downtown Ilwaco,

D. Columbia Land Trust-owned wetlands at the mouth of the Wallacut River,

E. Privately-owned wetlands adjacent to the Vandalia neighborhood (eastward), and

F. Additional wetlands and upland habitats across Baker Bay outside of Ilwaco city limits, which may be of consideration for holistic habitat restoration and associated planning.

Figure 24. Map of Bay to Bay Community Prioritized Habitats. (Source: Google Earth)

Lower Columbia Fish Recovery Board's Salmon Recovery Plan

The Appendix C – Program Directory of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan outlines several strategies highly relevant to salmon recovery efforts in and around Ilwaco, Washington (Lower Columbia Fish Recovery Board [LCFRB], 2010). One key focus is estuary and tidal wetland restoration, a critical strategy given Ilwaco's location near the Columbia River estuary and Baker Bay. This includes reconnecting floodplains by modifying levees and tide gates, restoring tidal flow, and re-establishing native wetland vegetation to support juvenile salmon rearing and migration (LCFRB, 2010).

Another important strategy is riparian buffer enhancement, which helps regulate stream temperatures, reduce erosion, and filter runoff. Actions under this approach include planting native trees and shrubs along streambanks, removing invasive species, and using fencing to exclude livestock from sensitive areas. These efforts improve instream conditions for salmon spawning and rearing (LCFRB, 2010).

Fish passage barrier removal is also emphasized. Many culverts and tide gates in coastal areas are outdated or undersized, blocking salmon from reaching upstream habitats. Recommended actions include surveying and prioritizing fish barriers and retrofitting or replacing structures to meet current passage standards, especially in collaboration with road maintenance and land management agencies (LCFRB, 2010).

Maintaining water quality and streamflow is equally essential, particularly during the dry summer months. Strategies include promoting water conservation, restoring wetlands and floodplain connectivity to increase natural storage and base flows, and implementing land use practices that reduce stormwater pollution. These steps help ensure year-round access to cold, clean water, an essential factor for salmon survival (LCFRB, 2010).

Finally, land protection and stewardship support long-term habitat security. Conservation easements, acquisitions of key floodplain parcels, and voluntary stewardship agreements with landowners can safeguard high-quality habitat and prevent future degradation. Engaging local communities in stewardship activities is also encouraged to build long-term commitment to salmon recovery (LCFRB, 2010).

6PPD-Q RISKS

6PPD (N-(1,3-dimethylbutyl)-N-phenyl-p-phenylenediamine) is a synthetic antioxidant used to prevent degradation in nearly all vehicle tires. When exposed to ozone, 6PPD reacts and forms a transformation product known as 6PPD-quinone (6PPD-q), which washes off road surfaces via stormwater runoff and enters streams, rivers, and estuaries (Washington State Department of Ecology, 2023). In 2020, researchers identified 6PPD-q as the chemical responsible for widespread pre-spawn mortality in coho salmon—a phenomenon now known as Urban Runoff Mortality Syndrome (URMS). Even trace concentrations of 6PPD-q are acutely lethal to coho within hours of exposure. Other salmonids, such as steelhead and Chinook, may also be at risk, particularly during early life stages or in estuarine habitats (Washington State Department of Ecology, 2022). Because tire wear particles are widespread and mobile, 6PPD-q represents a critical and newly recognized threat to Pacific Northwest salmon recovery efforts.

In Ilwaco, stormwater runoff from roads and parking lots poses a potential risk of transporting 6PPD-q into sensitive aquatic habitats. Key risk areas include the U.S. 101 corridor, particularly where it skirts Black Lake, and the downtown/port district, especially Howerton Avenue, where dozens of storm drains convey runoff from impervious surfaces into Baker Bay—a salmonid estuary connected to the Columbia River. These zones combine heavy traffic, aging drainage infrastructure, and direct flow paths into coho- and Chinook-utilized habitats. Studies indicate that tire-related contaminants are especially prevalent where road runoff is not filtered or detained prior to reaching surface waters (Washington State Department of Ecology, 2022). Mapping tools and local stormwater inventories can help identify these outfalls and prioritize mitigation where vehicle traffic, impervious cover, and aquatic habitat overlap.

OCEAN BEACH SCHOOL DISTRICT ENGAGEMENT

Through the Bay-to-Bay project, PCD documented community-supported resilience and restoration project concepts that are complex, costly, and in some cases contentious. This work will require a long-term approach, engaging multiple generations and embedding relevant environmental educational material in programming that can reach multiple audiences. As such, PCD seeks to support future local leaders for this work by providing youth educational programming about watershed processes, ecology, and changing environments. This will in turn assist education for adults via communication between youth and caregivers, and through ensuing adult-to-adult communications which can inform local landowners about the benefits of GSI. By creating educational materials for youth, PCD will also be creating materials accessible to a non-technical audience of any age, adaptable and reusable by educators elsewhere. Material produced through the City of Ilwaco's Integrated Stormwater Management and Outreach Project has the immediate opportunity to be embedded in Ocean Beach School District curricula as well as in PCD's ongoing education programming (e.g. Salmon in the Schools).

With funding secured through the Office of the Superintendent of Public Instruction, PCD initiated the "Salmon in the Schools" program for fourth and fifth grade students. This program focuses on the salmon life cycle while highlighting environmental changes, namely anthropogenic impacts, that negatively affect salmon and thereby the overall ecosystem. A focal point of this curriculum is riparian habitat and relates to GSI through discussion of native plant installations to improve water quality and habitat for salmon. To date PCD has engaged eight (8) classrooms in Ocean Beach School District with this program and has begun conversations with the Dylan Jude Harrell Community Center in Ilwaco to implement lessons from this curriculum into their afterschool programs.

SECTION 3

Case Studies

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3.0 Case Study Research

This subsection is intended to document the review of relevant case studies and planning resources to identify effective strategies and best practices in salmon recovery, green stormwater infrastructure (GSI), low-impact development (LID), and habitat protection and restoration. The goal is to develop a tailored suite of approaches that are practical, effective, and appropriate for implementation within the City of Ilwaco's unique environmental and community context.

As a small jurisdiction with an active waterfront and port, surrounded by parks, working forestlands and farmlands, Ilwaco is uniquely positioned albeit limited in its resources to address water quality in stormwater solutions. Fortunately, several pilot programs, public/private partnerships, and basin planning techniques are available to establish regional solutions to water quality, bringing co-managers to the table with common goals to work towards water quality improvements within Ilwaco Bay. This in-turn promotes the active fisheries out of the Port of Ilwaco.

Beginning with pilot projects, a way to gain momentum and public interest in the topic for larger regional efforts is through innovative options. One such opportunity to address harmful pathogens such as e-coli entering the bay is through use of mycofiltration (fungi) as a biofiltration technique to remove bacteria from stormwater. Previous EPA-funded studies show this technique to be an effective test case for mitigating nutrient loads before they enter the waterbody, either through inoculating the biofilter with alder (or similar) wood chips or the bioretention soils as green stormwater infrastructure (GSI).

The Stormwater Action Monitoring (SAM) collaborative between Washington jurisdictions, WSDOT, Ecology, and other consultant advisors conduct research and effectiveness studies in bioretention (filtration through an engineered soil mix) by looking at the long-term effectiveness of utilizing this media. Initial findings show that while the minimum 18-inch soil depth in standard plans can better filter contaminants than the minimum 6-inch depth, 6 inches can still adequately filter contaminants, so long as upkeep and maintenance needs are met. Regardless, bioretention facilities are overwhelmingly successful in improving water quality. SAM also studies alternative bioretention media like clean sand, coconut, and aluminum, per technical guidance by consultants and ecology within the SAM collaborative. The results suggest engineered soil could address poor infiltration issues persistent throughout the city. Alternatively, planter boxes may be an option to filtrate drains above ground to address infiltration issues and mimic bioretention water quality improvement processes.

STORMWATER PARKS

A stormwater park is a multifunctional stormwater mitigation system designed to manage and treat urban stormwater runoff while providing traditional park amenities, recreational opportunities, and/or ecological benefits. Stormwater parks integrate GSI—bioswales, rain gardens, retention ponds, and constructed wetlands—to capture, filter, and slowly release stormwater, improving downstream conditions for salmon. These features help reduce flooding, scrub pollutants, and can support biodiversity goals if habitats for native plants and wildlife are included. These parks can even have large detention basins that double as sport fields during dry months of the year. Stormwater parks offer a wide range of community and environmental benefits:

- Promote equity by bringing green space and recreation to underserved communities.
- Enhance climate resilience through increased green infrastructure and stormwater control.
- Cost-effective regional solution for treating stormwater runoff.
- Park renovations can incorporate stormwater features without losing recreational value.
- Add amenities like trails, benches, public art, and wildlife viewing areas.
- Offer educational opportunities about water quality, habitat, and environmental stewardship.
- Support Tribal treaty rights by improving water quality and fish habitat.
- Enable diverse funding through grants and multi-agency support.
- Scalable concept that can extend to floodplain parks, stormwater trails, and resilience parks.

Because stormwater parks are typically large park-sized spaces, they are most often designed as regional facilities. "With a moderate sized facility, a stormwater park can cost effectively treat stormwater from an entire basin, which could be hundreds of acres, and fix legacy stormwater problems from roads and land developed before current regulations were in place. A facility that can provide multiple services is especially useful in places where land is at a premium. (Puget Sound Regional Council 2025)"

There are now hundreds of stormwater parks throughout the county. Like traditional park spaces, visitors can enjoy walking trails, boardwalks, picnic areas, interpretive signage, and scenic viewpoints that highlight the park's environmental functions. Stormwater parks can also serve as educational hubs, showcasing GSI processes and sustainable stormwater management practices, while promoting environmental stewardship. By blending infrastructure with traditional park programming, stormwater parks offer a more functional, community-focused solution to stormwater management.

Lakemont Community Park

Lakemont Community Park, one of the region's earliest stormwater parks, was developed in the 1990s as part of an agreement tied to the construction of the Lakemont neighborhood. The City of Bellevue prioritized protecting nearby Lewis Creek and Lake Sammamish from erosion, phosphorus, and other pollutants. Spanning 16 acres, the park offers a variety of amenities, including a playground, two picnic shelters, tennis and basketball courts, a skate bowl, trails, restrooms, and a softball field. It is also connected to over three miles of multi-use trails that link Lakemont Park with Lewis Creek Park.

A defining feature of Lakemont Park is its extensive stormwater management system, which plays a key role in reducing flood risks and improving water quality. The system includes a large underground detention vault beneath the parking lot that captures sediment and pollutants, two sand filter basins for further treatment, and a high-flow storage basin for managing excess water during major storms. Typically, stormwater flows through the vault and sand filters before being released into Lewis Creek. In rare cases of extreme rainfall, overflow is directed to the storage basin and, if necessary, over a spillway into the creek. Soft-surface trails from the park also lead into the Lewis Creek open space, enhancing both ecological function and public access.

Manchester Stormwater Park

Manchester Stormwater Park in Kitsap County is another example of GSI that combines environmental restoration with community benefits. Built on the site of a former gas station, the park was designed to replace an outdated stormwater outfall and now treats runoff from surrounding roads, homes, and businesses using engineered soils, native plants, and a spiral rain garden. These systems filter pollutants and manage stormwater before it reaches Puget Sound, improving water quality and reducing flooding risks.

In addition to its ecological role, the park has evolved into a lively community hub, hosting farmers markets, educational events, and recreational activities. By transforming a previously underutilized space into a multifunctional public asset, Manchester Stormwater Park illustrates how stormwater infrastructure can simultaneously support environmental sustainability and enhance neighborhood livability.

Photo 7. NW Cascade Inc.

Spinney Homestead Park

The City of Kirkland installed an underground rainwater storage vault at Spinney Homestead Park. The primary objectives are to reduce stormwater runoff, improve water quality, and mitigate localized flooding within the Forbes Creek watershed. The surrounding 53-acre area was developed prior to modern stormwater regulations, resulting in untreated runoff discharging directly into Forbes Creek.

Yauger Park

Yauger Park serves as a key regional stormwater facility for the City of Olympia, managing runoff from surrounding impervious surfaces such as streets and parking lots. Stormwater is conveyed to the park through a network of drains and pipes, where it is treated using a series of engineered GSI features, including bioswales, weirs, and rain gardens. These systems are designed to replicate the natural hydrologic functions of pre-development wetlands by slowing runoff, allowing sediment to settle, and filtering pollutants such as oils, nutrients, bacteria, and tire particles, the leading cause of Coho salmon mortality in urban systems.

In addition to water quality treatment, these features provide flood mitigation benefits by promoting infiltration and reducing peak flows. The integration of native vegetation supports habitat creation and enhances the park's ecological value, while also offering recreational and educational opportunities for the community. During the rainy season, the park's design allows its central pond to intentionally overflow, temporarily flooding adjacent parking lots and ball fields to accommodate excess stormwater.

Following treatment within the park, stormwater continues its journey through a connected system of pipes, ditches, storm ponds, and constructed wetlands. It ultimately discharges into Black Lake Ditch, flows through Percival Creek, and enters Capitol Lake before reaching Budd Inlet and the Salish Sea. By managing stormwater at its source, Yauger Park contributes to the protection of downstream water bodies and supports regional watershed health.

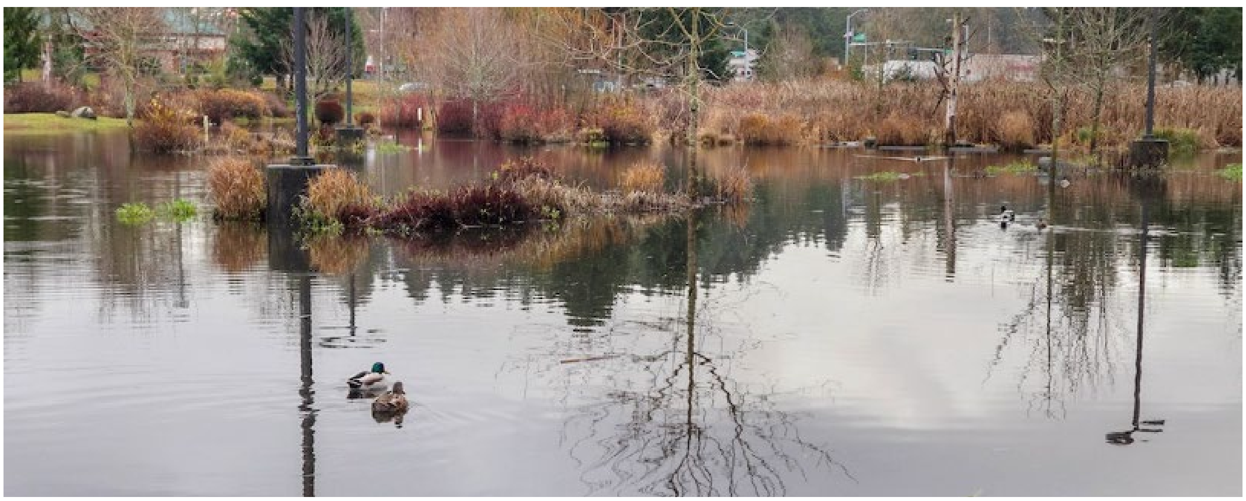


Photo 8. Salish Magazine Courtesy of City of Olympia

TREE PLANTING CAMPAIGN FOR FLOOD MITIGATION/STORMWATER REDUCTION

Trees, especially in urban environments, have immense social and economic value. They create shade, help scrub airborne pollution particulates, reduce the urban heat island effect, and provide habitat and resources for a myriad or urban wildlife species. However, trees are increasingly recognized for their ability to mitigate stormwater runoff. Their leaves and branch structures reduce erosion by intercepting rainfall prior to reaching the soil. Furrowed bark and complex root structures help channel and slow rainfall, allowing it to more slowly infiltrate, reducing the volume and intensity of stormwater runoff. Furthermore, in a process called transpiration, trees absorb large volumes of water from the soil through their root system and release it back into the atmosphere through their leaves, allowing for more water storage capacity in the soil below. Now, online tools like iTree (www.itreetools.org) can be used to calculate the benefits of trees.

According to the USDA Forest Service's 2020 report, urban forests contribute to the "triple bottom line" of sustainability—supporting environmental health, economic efficiency, and social well-being. The report highlights how trees not only mitigate stormwater impacts but also enhance community resilience to climate-related challenges. Through case studies and scientific analysis, it demonstrates how integrating trees can provide measurable benefits and serve as a cost-effective strategy for sustainable stormwater management.

Spokane Stormwater Project

In 2017, the City of Spokane implemented a $3.5 million stormwater management project in the West Central neighborhood as part of its Integrated Clean Water Plan. The initiative aimed to reduce the volume of stormwater entering the city's combined sewer system and improve water quality in the Spokane River. After evaluating various options, the city selected Silva Cells (www.deeproot.com) for their ability to manage stormwater underground while preserving surface-level infrastructure. A total of 3,306 Silva Cells were installed across 20 intersections, accompanied by the planting of 63 new trees. This approach provided both stormwater treatment and increased soil volume for healthy tree growth, all while maintaining existing curb lines and minimizing the loss of parking. The project demonstrated how Silva Cells can serve as a compact, low-maintenance solution that supports both environmental and infrastructure goals in dense urban settings.

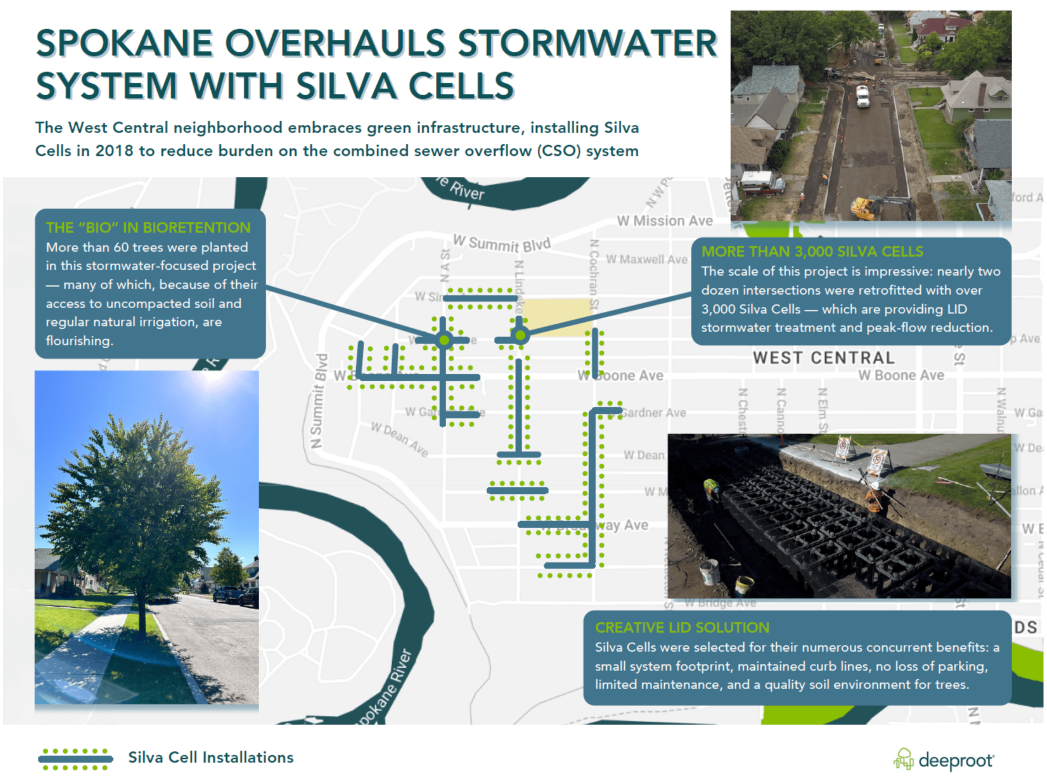


Figure 25: Deeproot- Spokane Stormwater Project.

Aurora Avenue's Secret Rain Garden

The Aurora Avenue Shoreline project was a major infrastructure upgrade aimed at modernizing a heavily used corridor while incorporating sustainable stormwater management. To address space constraints and environmental goals, Silva Cells were installed beneath the pavement to support both tree growth and stormwater treatment. These underground systems provided over 8,000 cubic feet of uncompacted soil for 40 trees and 1,600 cubic feet of stormwater storage. Stormwater enters the system through curb cuts and permeable surfaces, where it is filtered and absorbed by the soil and tree roots. This process helps reduce runoff volume, slow water flow, and remove pollutants before the water reaches nearby Lake Washington. The project demonstrates how Silva Cells can effectively integrate green infrastructure into dense urban settings without compromising surface functionality.

LID/BMP Options

By implementing LID/BMP facilities stormwater can be managed in a way that reduces the volume of runoff generated and maximizes the treatment capabilities of the landscape. The proposed stormwater improvements approaches are intended to be compliant with the latest Stormwater Management Manual for Western Washington (SWMMWW) and/or jurisdictional manual.

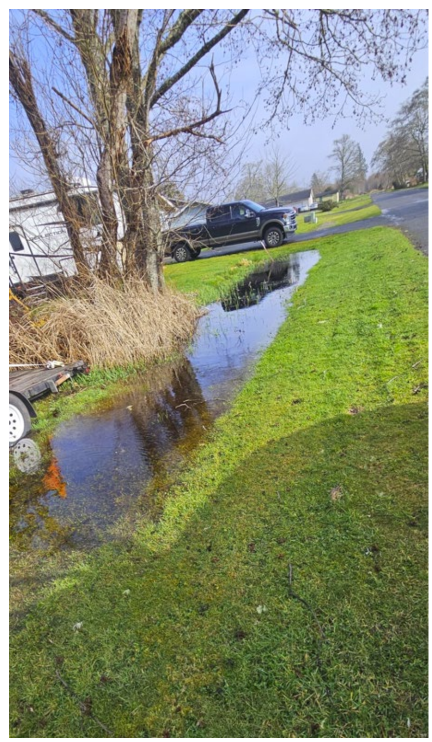
BIORETENTION

Depending on the site-specific design, Bioretention may act as both a flow control BMP, a treatment BMP and a LID BMP. Bioretention facilities have the potential to meet requirements in the SWMMWW manual for On-Site Stormwater Management (MR#5), Runoff Treatment (MR#6), Flow Control (MR#7), and Wetlands Protection (MR#8). Bioretention basins are shallow vegetated depressions that contain engineered soil that allow for stormwater infiltration and associated pollutant scrubbing. Depending on the need, they can be designed to provide retention (permanently holds stormwater) or detention (temporarily holds stormwater) services. However, some bioretention facilities have been shown to release phosphorous into the stormwater and should not be used within a quarter mile of phosphorous-sensitive waters. Bioretention is only available if there is a safe overflow pathway to municipal or private storm sewer systems. Vertical separation from the seasonal high water table requirements varies in relation to the area the bioretention facility serves (see SWMMWW for more information). Sizing bioretention facilities is commonly done in accordance with the Western Washington Hydrology Model (WWHM) and SWMMWW.

Bioretention cells are shallow depressions filled with designated plant types and built with a specific planting soil mix called bioretention soil mix (BSM) implemented for treatment. These cells are mostly used to treat and detain stormwater runoff. Infiltration can be an option when the native soil below have high infiltration rates, when proven via a geotechnical analysis. Inversely, cells can also be lined with an impermeable layer of geotextile fabric to prevent infiltration in low permeable soils and locations with high groundwater. In project areas where infiltration is infeasible, the bioretention cell is built with an underdrain to convey runoff after treatment to the treated stormwater discharge location. Bioretention cells can vary in size depending on the amount of runoff the facility is designed to treat.

The photo below (Photo 9) shows a bioretention cell near the end of construction, prior to planting and vegetation.

Photo 9. Bioretention Cell Before Vegetation



Bioretention Swales (Bioswale) are vegetated, shallow, landscaped depressions designed to capture, treat and infiltrate stormwater runoff before conveying cleaner runoff downstream. These features are most effective at capturing sediment, suspended solids (TSS), floating trash, and reducing water temperatures prior to reaching the discharge location. They can be extremely low cost and used in place of an existing ditch (see Photo 10 for an example of existing area that could potentially utilize a bioswale for treatment & conveyance) or depression, especially along roadways and parking lots.

Bioretention planters are landscaped depressions or planter boxes that use bioretention soil media and a variety of plant materials to treat stormwater runoff. These facilities usually have a smaller footprint which helps provide effective treatment and reduces stormwater runoff flow rates. Planter boxes are usually impervious and contain an underdrain while rain gardens are typically build into native soils to allow for direct infiltration. The photo below (Figure 26) shows the typical detail of a bioretention planter taken from SWMMWW.

Photo 10. Captain Robert Gray Drive and Chattam Way

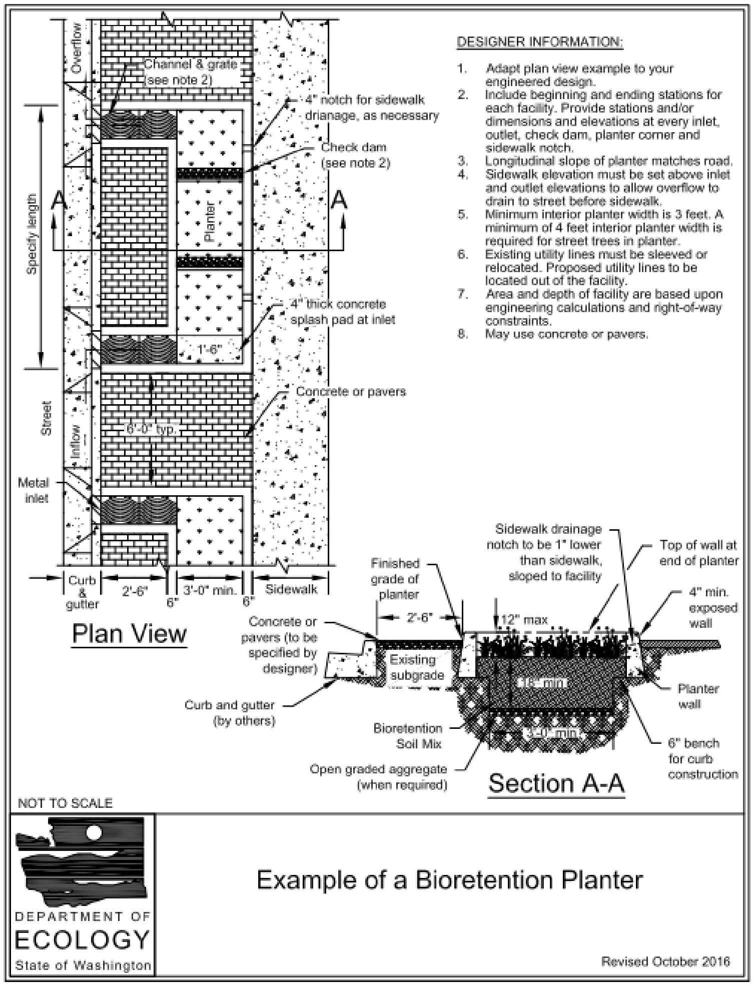


Figure 26. Figure V-5.19 Example of Bioretention Planter

All bioretention facilities are made with a layer of bioretention soil mix (BSM) used to treat the stormwater runoff of pollutants through infiltration.

RAIN GARDENS

A rain garden is a landscaped depression or swale that collects, absorbs, and filters stormwater runoff from roof tops, driveways, patios, and other impervious surfaces. Rain garden features offer multiple benefits beyond water management. When installed on both private and public lands, they can provide many co-benefits beyond stormwater capture, such as improved aesthetics, enhanced biodiversity and pollinator support, and increased property values.

Research and community engagement through the Bay-to-Bay project shows that GSI techniques are more widely supported when framed as beautification or placemaking features. Incorporating rain gardens into streetscapes, private residential yards, and public green spaces strengthens public buy-in while providing local stormwater management and improved water quality.

Collecting, absorbing and treating stormwater further up in the drainage system reduces the degree of reliance on water management further down in the system. For example, Ilwaco's hilltop residential lots or future development of vacant lots could help minimize the amount of water flowing into the City's existing stormwater infrastructure system. Localized efforts could potentially reduce ponding in areas such as Willow Street, which is a well-known area of existing flooding.

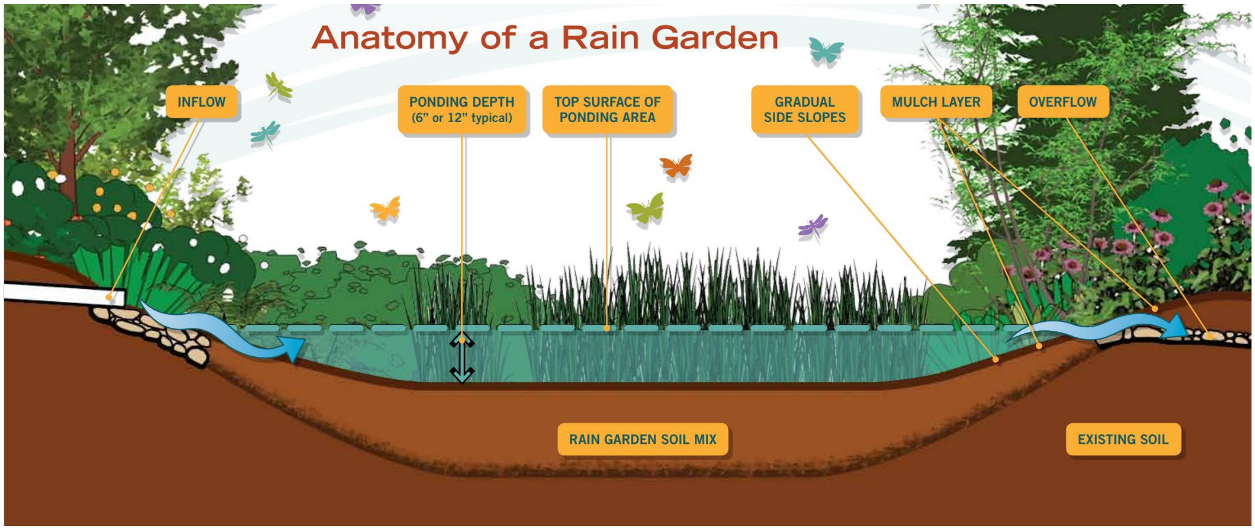


Figure 27. Anatomy of a Rain Garden (Source: Rain Garden Handbook for Western Washington, 2013)

PROPRIETARY SYSTEMS

Proprietary stormwater treatment systems are engineered devices designed to meet specific pollutant removal goals in compact or constrained urban environments, and they are widely used in Western Washington under the Department of Ecology's Technology Assessment Protocol – Ecology (TAPE) program. These systems include hydrodynamic separators, media filtration units, and high-rate biofiltration systems, such as the StormFilter by Contech, Aqua-Swirl by AquaShield, and Modular Wetlands System by Bio Clean. They are particularly useful in retrofit scenarios, high-density developments, or sites with limited space for traditional BMPs. To be approved for use, these systems must undergo rigorous field testing and receive a Use Level Designation (ULD) from Ecology, confirming their effectiveness in removing target pollutants like total suspended solids (TSS), phosphorus, and metals. Engineers must ensure that selected systems are installed per manufacturer specifications and maintained regularly to preserve treatment performance and regulatory compliance.

A modular wetland is a prefabricated bioretention chamber that is configured linearly for treating horizontal flow. This facility allows for a smaller footprint with options for integration within the existing or proposed storm drain infrastructure. Stormwater runoff is directed through the modular wetland where pollutants are treated before being discharged. During peak flows the modular wetland is configured to allow for bypassing the system.

Adaptable filtration can be used in conjunction with an established storm sewer system to provide collection and treatment where a typical catch basin would be used. These adaptable catch basins can be used to effectively manage surface water to prevent pooling. Filters can be placed within the adaptable catch basin to provide treatment. There are many different types and manufacturers for this type of facility.

Underground Detention and infiltration systems can store stormwater without taking up space and release it downstream at an allowable discharge rate or allow it to infiltrate in a controlled manner. These proprietary systems can come with pretreatment options.

PERMEABLE PAVEMENT

Permeable pavement is a key low impact development (LID) strategy endorsed by the Washington State Department of Ecology (SWMMWW) to manage stormwater runoff and improve water quality. It is designed to allow infiltration, storage, and partial treatment of surface runoff, thereby reducing pollutant loads and peak flow rates. Common types include porous asphalt, pervious concrete, permeable interlocking concrete pavers (PICP), and aggregate- or grid-based systems—each selected based on site-specific conditions such as traffic load, soil infiltration capacity, and slope. These systems are particularly effective in treating runoff by filtering out sediments, hydrocarbons, and heavy metals as water percolates through the pavement and underlying aggregate layers. Ecology's BMP T5.15 outlines design criteria to ensure structural integrity and hydrologic performance, requiring engineers to integrate these pavements into broader stormwater management plans. Proper maintenance and periodic inspection are essential to sustain their treatment capacity and regulatory compliance.

DISPERSION & INFILTRATION FACILITIES

Dispersion BMPs are non-structural stormwater management practices that reduce runoff volume and velocity by spreading flow over vegetated areas, mimicking natural hydrology. Common BMPs include BMP T5.10A: Downspout Full Dispersion, BMP T5.10B: Concentrated Flow Dispersion, and BMP T5.10C: Sheet Flow Dispersion. These are typically used in low-density residential developments or areas with sufficient vegetated buffer and gentle slopes. The SWMMWW requires minimum vegetated flow path lengths and stable receiving areas to ensure effective infiltration and prevent erosion. Engineers must evaluate site constraints such as slope, soil type, and vegetation cover to determine the appropriate dispersion method and ensure compliance with Minimum Requirement #5 (On-site Stormwater Management).

Infiltration BMPs are typically structural practices that capture and infiltrate stormwater into the ground, reducing runoff and improving water quality through natural soil filtration. Key BMPs include BMP T5.10D: Infiltration Trenches, BMP T5.10E: Infiltration Basins, BMP T7.30: Bioretention (Rain Gardens), and BMP T5.10F: Dry Wells. These are suitable areas with well-draining soils, low groundwater tables, and adequate separation from drinking water sources. The SWMMWW mandates site-specific infiltration testing, setbacks from structures and wells, and pretreatment to prevent clogging. Engineers must also design for overflow and maintenance access to ensure long-term performance and regulatory compliance under Minimum Requirement #7 (Flow Control) and #6 (Runoff Treatment).

6PPD-Q TREATMENT

Effective mitigation of 6PPD-q relies on intercepting and filtering stormwater before it reaches waterways. Research conducted by Washington State agencies and universities has found that bioretention systems—such as rain gardens, infiltration trenches, and compost-amended bioswales—can effectively remove 6PPD-q and eliminate associated salmon mortality (Navickis-Brasch et al., 2022). These systems rely on filtration and sorption processes in engineered soils or compost-rich media to trap tire-derived pollutants. In locations where infiltration is not feasible, sand filters, stormwater planters, or retrofit detention ponds with media amendments can provide treatment. Complementary source control measures—such as regular street sweeping, catch basin maintenance, and long-term advocacy for alternative tire formulations—also play a role (Washington State Department of Ecology, 2022). Local implementation should be evaluated in coordination with on-the-ground expertise to assess feasibility, soil constraints, and maintenance capacity.

Several small ports and municipalities have successfully implemented green infrastructure and best management practices (BMPs) to address stormwater pollution—including contaminants like 6PPD-quinone—in sensitive coastal and estuarine environments.

Port of Anacortes, WA: The Port of Anacortes has adopted a comprehensive Stormwater Management Program that includes GSI features such as vegetated swales and bioretention facilities to treat runoff from port operations. These measures reduce the discharge of pollutants, including those derived from tire wear, into Fidalgo Bay (Port of Anacortes, 2021).

City of Bellingham, WA: Bellingham has invested in widespread green stormwater infrastructure throughout urban neighborhoods. The city promotes the use of rain gardens and supports a volunteer Rain Garden Stewards program. These facilities reduce the stormwater volume and pollutant load, protecting downstream waters like Whatcom Creek and Bellingham Bay (City of Bellingham, n.d.).

Port of San Diego, CA: The Port of San Diego's stormwater management strategy GSI features such as bioretention basins, vegetated swales, and permeable pavement. These systems treat urban runoff before it enters San Diego Bay, helping reduce the impact of tire-derived and other urban pollutants on estuarine habitats (Port of San Diego, n.d.).

NETWORKED GSI

The effectiveness of GSI techniques increases significantly when individual components, such as rain gardens, bioswales, tree plantings, and pervious surfaces, are implemented in a coordinated, landscape-scale approach. Rather than relying solely on isolated infrastructure, a synergistic system would provide redundancy and resilience by improving system performance during high-intensity events. It is important to note the efficacy of networked green stormwater infrastructure. While there is value in implementing large GSI efforts, such as stormwater parks, or specific BMPs, when these and other approaches are distributed across the landscape, these techniques are mutually reinforcing and provide multiple co-benefits, such as shade, habitat, and air quality improvements.

This approach has been successfully demonstrated in places like New Orleans through Waggonner & Ball's Urban Water Plan, which subdivides the city into drainage basins and tailors GSI solutions to each area. Their model shows how spatially distributed systems can reinforce each other and respond to localized conditions, while still contributing to broader watershed resilience. A sub-basin analysis could be completed to determine where coordinated GSI techniques would have the greatest cumulative impact. This integrated strategy would improve stormwater management, reduce strain on the City’s existing infrastructure, and align with community values for greener, more livable spaces.

SECTION 4

GSI/LID OPPORTUNITIES

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4.0 GSI/LID Opportunities

Facet has been tasked with developing a list of stormwater management facilities that can be utilized for treatment and flow control for the City of Ilwaco. To effectively manage stormwater and enhance environmental resilience, the City of Ilwaco should prioritize the integration of Low Impact Development (LID) Best Management Practices (BMPs) into its neighborhood infrastructure. Recommended BMPs include bioretention systems, permeable pavements, and vegetated swales, which help reduce runoff volume and improve water quality by mimicking natural hydrology. The design and siting of these stormwater facilities must be guided by key site-specific factors such as runoff flow rates, pollutant loading, treatment benchmarks, and the infiltration capacity of existing soil types. For example, areas with sandy soil may support infiltration-based BMPs, while locations with poor draining clay soils may require filtration or detention-based solutions. A comprehensive assessment of these variables will ensure that LID strategies are both technically sound and aligned with regulatory requirements. The list of sites below provides preliminary examples of where GSI/LID approaches could be integrated to enhance water quality and overall stormwater management. These recommendations are expected to be refined and expanded upon in the second phase of this project, pending funding, through community outreach and engagement.

OUTER HARBOR WAY SE

Outer Harbor Way SE, on the outskirts of the Port of Ilwaco, has been identified as a potential location for water quality enhancement measures. Due to limited designated parking capacity, the roadway shoulders are frequently utilized for overflow parking during peak demand periods. As a result, pollutants from vehicles and runoff may flow directly into the marina without any treatment. The SWMMWW outlines a few different solutions that can be implemented to help treat surface runoff from roadway surfaces. Many are specifically built in a linear fashion to compliment the linearity of the roadway surfaces and fit within the existing right-of-way.

Compost-Amended Vegetated Filter Strips (CAVFS) are a valuable stormwater Best Management Practice (BMP) for treating runoff from pollution-generating impervious surfaces such as roadways, particularly those adjacent to sensitive environments like estuaries or wetlands. As described in the SWMMWW, CAVFS enhance traditional vegetated filter strips by incorporating compost into the soil profile, which improves infiltration, pollutant removal, and vegetation health. When installed along roadways lining a marina, these systems help intercept and treat runoff before it reaches the water, reducing the transport of oils, heavy metals, and sediments into the marine environment. Proper design is essential to maintain sheet flow and ensure the compost meets specific standards for organic content and permeability, especially in areas with high rainfall and limited space.

In addition to CAVFS, other Low Impact Development (LID) techniques can be employed to manage roadway runoff near marinas. Bioretention cells can be integrated into roadside landscaping or medians to capture and treat stormwater, while media filter drains and permeable shoulders offer compact, linear solutions suitable for constrained waterfront corridors. These BMPs are particularly important in marina settings, where protecting water quality is critical for aquatic life, recreational use, and regulatory compliance. The selection of appropriate BMPs should be based on site-specific factors such as runoff volume, pollutant loading, soil infiltration capacity, and maintenance access. Together, these strategies support a resilient, environmentally responsible approach to stormwater management in coastal urban infrastructure.

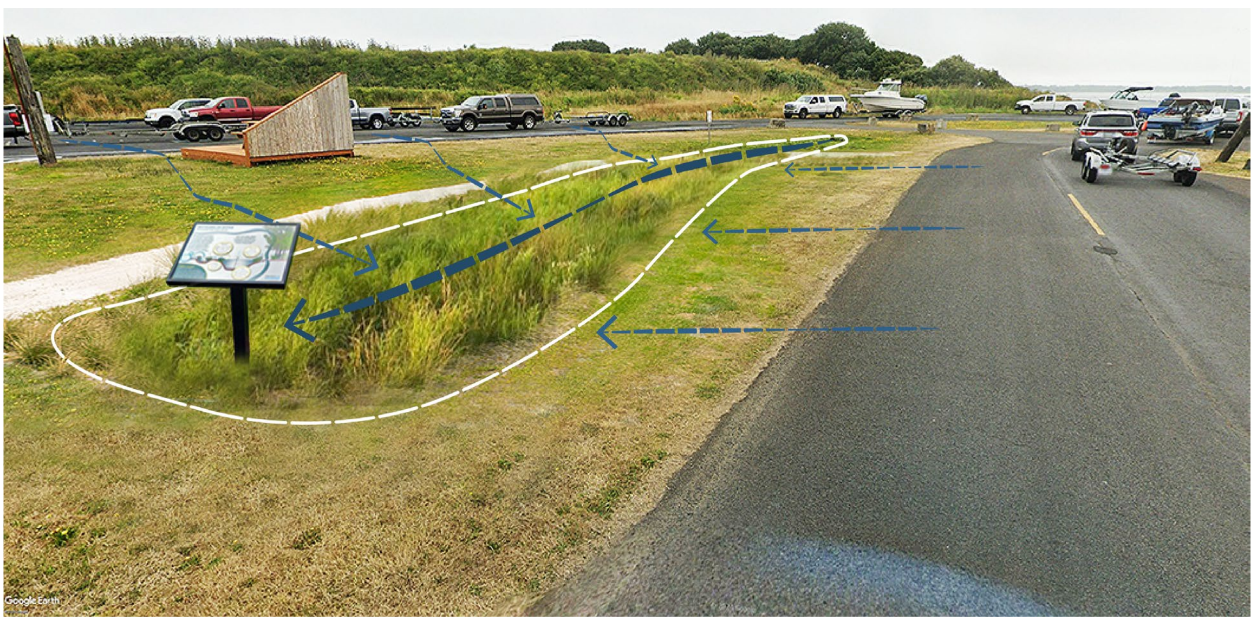

Photo 11. The parking lot median along Outer Harbor Way SE is a potential opportunity for GSI, like a bioswale, to capture and treat a large volume of sheet flow from the parking lot surface. This appears to be a viable option, while the other potential opportunity sites photographed below require further site analysis.

Photo 12. Outer Harbor Way SE (facing East)

Photo 13. Outer Harbor Way SE (facing West)

Photo 14. Parking Lot/Industrial Storage Area adjacent to Outer Harbor Way SE abutting estuarine wetland

VANDALIA NEIGHBORHOOD STORMWATER DETENTION AND WATER QUALITY IMPROVEMENT FACILITY

As described in the City of Ilwaco City of Ilwaco Spatial Analysis of Sea Level Rise and Flooding Report (2025), the Vandalia neighborhood could benefit from converting the currently undeveloped community tract to include detention and water quality improvement facility.

This could include adding a bioretention facility to provide removal of many stormwater pollutants and provide reductions in surface runoff flow rates. The bioretention facility includes a layer of bioretention soil mix (BSM) to treat stormwater runoff as well as can be designed to address flow control requirements. The existing tracts could be improved to provide better outlets, facilities, and water quality, particularly Tract “C” near between Ortelius Drive and Captain Robert Gray Drive (Figure X).

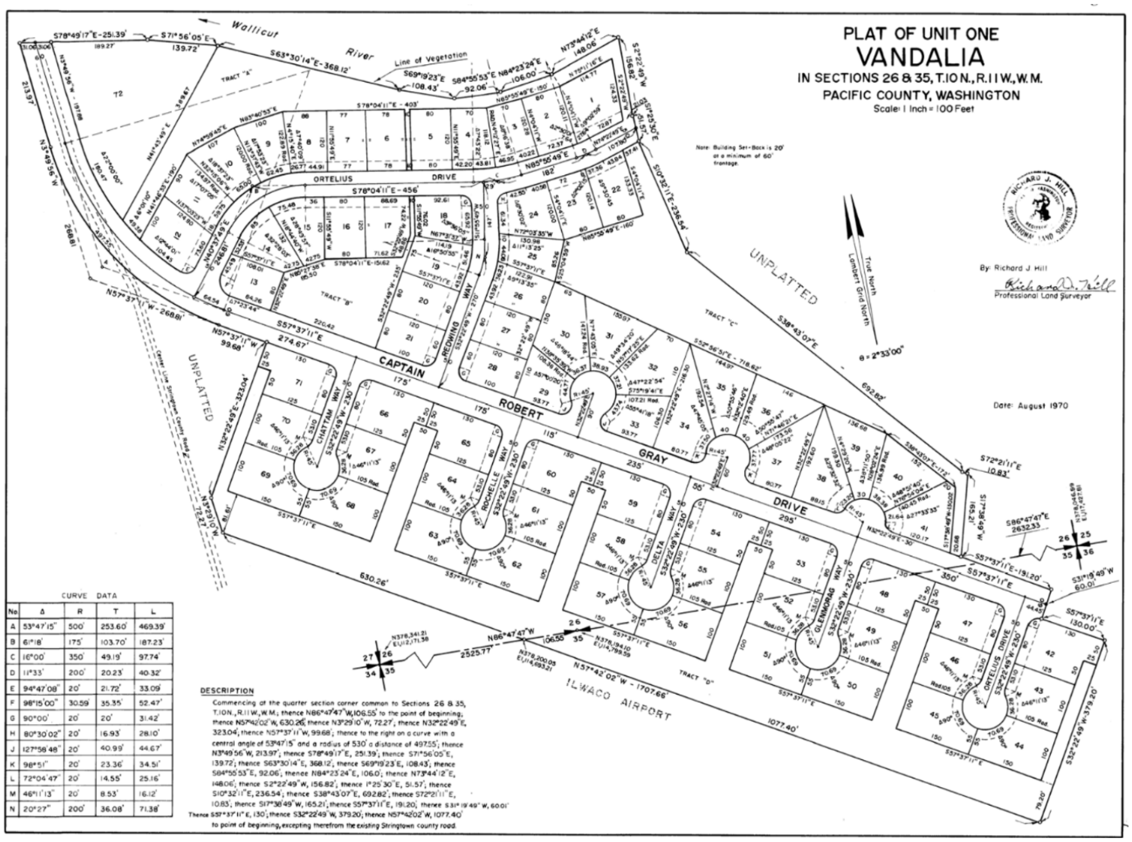

Figure 27. Plat of Vandalia

The outlets of Tract C could be improved for both water quality and quantity before entering the Wallacut River.

Photo 15. Outlet of Tract C before entering culvert under Orterlius Dr

Photo 16. Outlet of Tract C after culvert before entering Wallacut River

Photo 17. Crushed culvert under Ortelius Dr before entering Wallacut River

The City could also consider partnering with the Columbia Land Trust to treat stormwater from Vandalia and route it under Stringtown Rd to the property owned by the Columbia Land Trust to improve habitat functions.

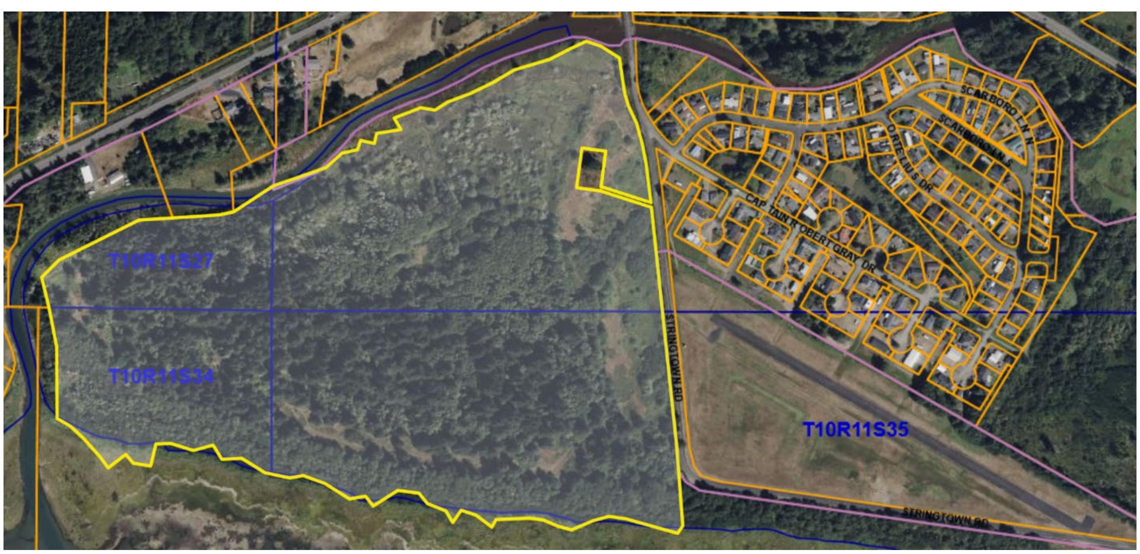

Figure 28. Columbia Land Trust Property adjacent to Vandalia Neighborhood (Source: Pacific County Mapsifter)

Photo 18. Columbia Land Trust Property abutting Wallacut River

Plants with saltwater tolerances could be planted along the banks of the Wallacut River. A community plan could be developed to detain and pump water. Compost Amended Vegetated Filter Strips (CAVFS) could be constructed along roadways to improve water quality.

Additionally, LID (low impact development) features such as rain gardens, bioretention facilities, enhanced swales, etc. could be placed to aid in stormwater management.

Photo 19. Ditch near Redwing Way and Ortelius Drive

SECTION 5
References

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5.0 References

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