Waterfront Stormwater Solutions Prototypes

Town of Coupeville

GREEN FUTURES RESEARCH & DESIGN LAB
University of Washington
College of Built Environments

COUPEVILLE PROTOTYPE

CONTEXT

The Town of Coupeville is located on Whidbey Island along the shoreline of Penn Cove, a shallow embayment of Puget Sound that is known for its shellfish and views of the North Cascades. It is about 57 miles with a ferry crossing north of Seattle and lies just west of the Skagit delta. Coupeville is a national registered historic district that comprises the 17,572-acre Ebey's Landing National Historic Reserve. Penn Cove is a state listed 303-d water body of concern because it is subject to eutrophication due to poor circulation and high stratification (Puget Sound Partnership 2009). The Town is interested in capturing and treating reclaimed wastewater and stormwater runoff to prevent further impacts to the low oxygen conditions, and if feasible, the Town intends to reclaim cleaned stormwater for farmland irrigation. This is of special interest since the town resides in the rain shadow of the Olympic Mountains and farming is a primary occupation. The pressing water quality concerns as well as the rich cultural heritage invite ample opportunity to apply ecological infrastructure to express the cultural and natural heritage values.

STORMWATER INFRASTRUCTURE

Coupeville's stormwater infrastructure is a separated system that consists of 13 outfalls within 14 basins. (Figure 49). The Town has been very proactive about reducing stormwater runoff into Penn Cove. The Island County Marine Resources Committee and the Town have implemented several projects to reduce runoff, including bioswales at the Library and a phytoremediation pilot project that collects and filters runoff from a parking lot located just north of Highway 20. This collaborative partnership is currently considering additional innovative treatment systems for their farmers market area, and adjacent to the parking lot at the wastewater treatment plant.

In 2008, the Town hired Island County to gather data about the pollutants conveyed by the Town's outfalls. Their data indicate levels of pollutants that exceed state criteria including: total nitrates, metals (copper and zinc), and fecal coliform. Petroleum hydrocarbons and total suspended solids are probably also pollutants of concern, but were not tested. Pollutant loads are

especially a liability in Penn Cove where increased nutrient loading can exacerbate hypoxic conditions, and fecal coliform bacteria can poison Penn Cove Shellfish's mussel farm, a significant local and state economic driver.

SITE

The location of the multi-functional infrastructure design project is located on a one-acre parcel just north of Captain Coupe Park and the wastewater treatment plant.

CONCEPT

Coupeville's heritage both natural and cultural is the inspiration for the site design. Natural heritage is reflected by replicating the pre-development soil and vegetation conditions through a modified low impact development treatment system. A design framework of a basket weave was inspired from the area's Native American cultural history and weaves the complex social, ecological and technical aspects of the site to generate two design alternatives.

STORMWATER TREATMENT

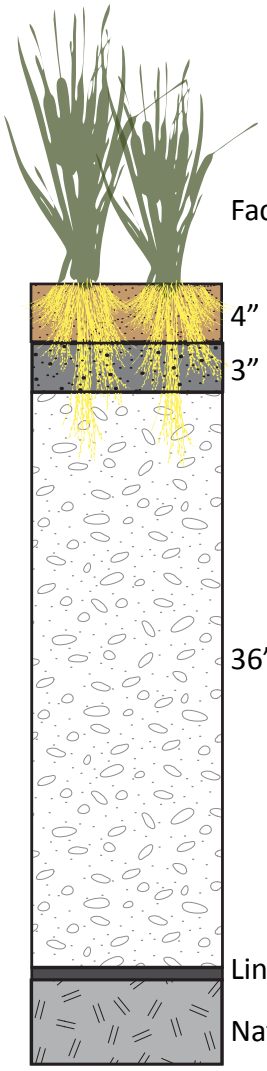
The design project uses subsurface wetlands to test their feasibility for stormwater treatment in the Pacific Northwest and for end-of-the pipe treatment capacity. Subsurface wetlands were developed as tertiary treatment for wastewater management and have subsequently proven effective as low-impact stormwater treatment approach in studies done by the University of New Hampshire (University of New Hampshire 2009). Stormwater performance of subsurface wetlands has only been evaluated in controlled laboratory settings or on the east coast where different weather conditions than the Pacific Northwest affect stormwater patterns, soil types, and plant selection. The Green Futures Lab proposed this method due to the high performance results found internationally and in New England, lack of knowledge for treatment capacity in the Pacific Northwest and to minimize risks of open exposed water to public health and safety of a predominantly residential neighborhood.

Engineers from SvR Design evaluated the stormwater volume from the entire Basin to derive the water quality storm event volume that would need to be treated, in addition to the overflow volume. At current build-out of the basin, an area of 44,932 square feet is needed to treat the first flush storm event. Since the site is 50,192 sq feet, most of the site will have to be utilized for treatment.

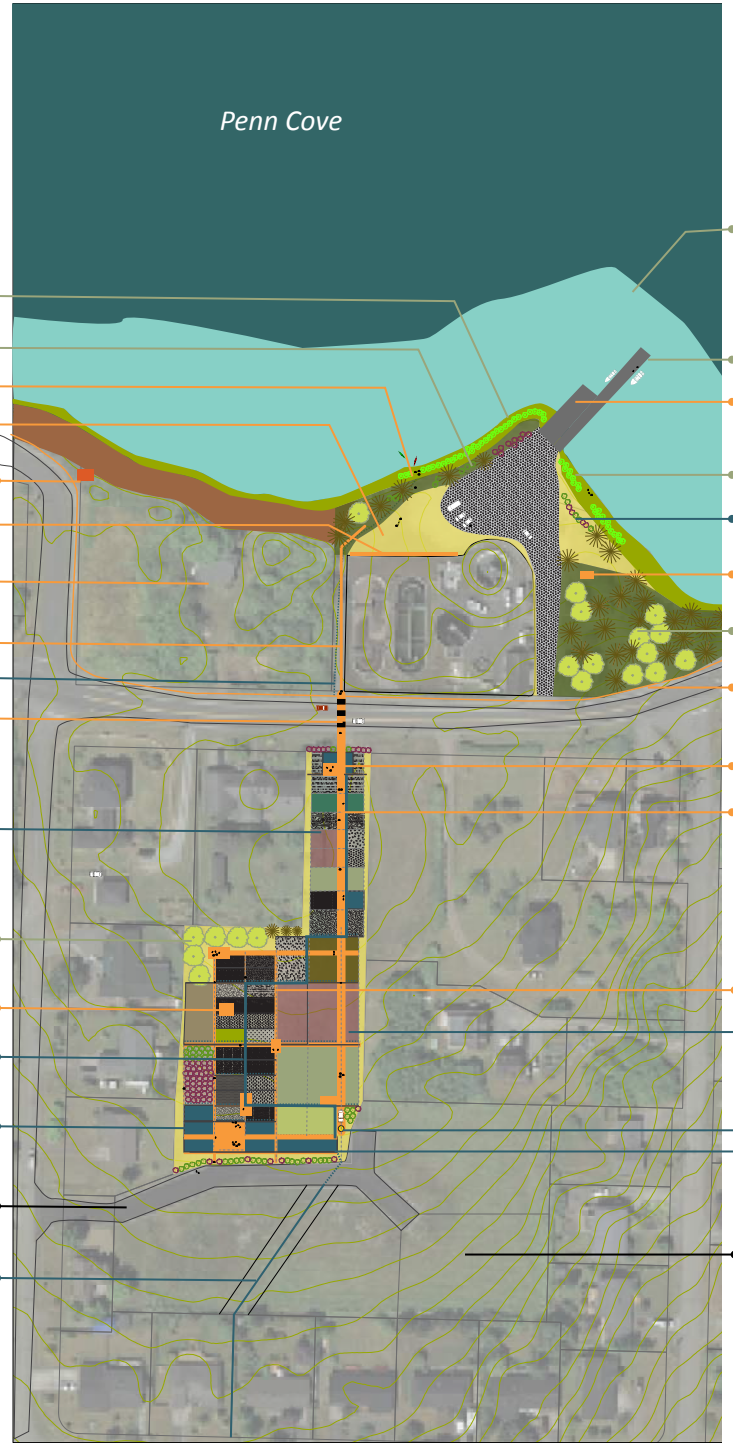
Biological treatment occurs in wetland soils that support vegetation and microorganisms that grow on plant root mat.

Pea gravel filters out particles to reduce clogging, and chemical and physical treatment processes.

Subsurface gravel layer supports physical & chemical treatment: traps pollutants in pore spaces, sorbtion, chemical reactions. Where roots penetrate into gravel, biologic treatment occurs.



COUPEVILLE PROTOTYPE - ALTERNATIVE 1
HERITAGE PARK



Stormwater treatment
Public access
Habitat
Other

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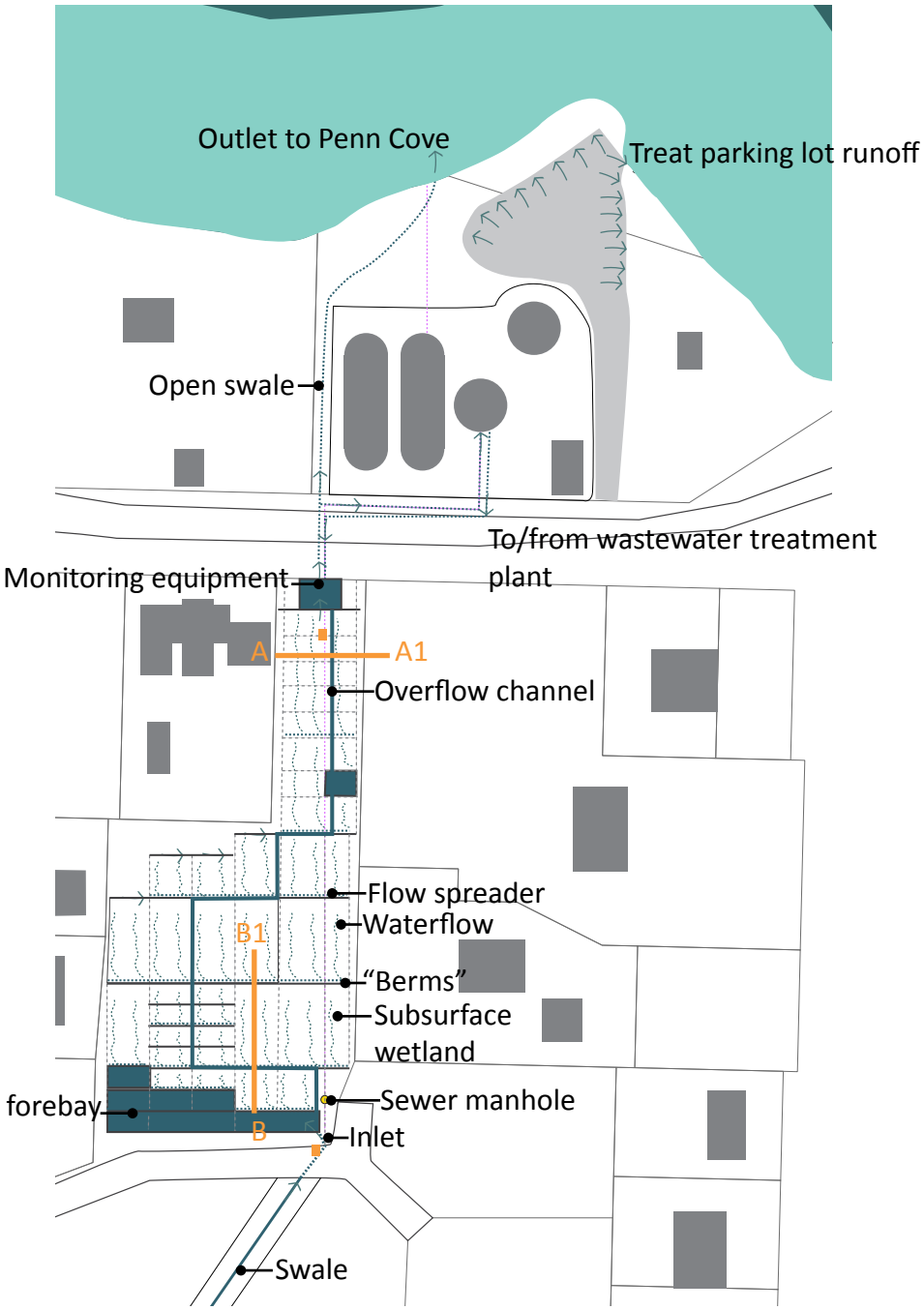
COUPEVILLE PROTOTYPE - ALTERNATIVE 1
HERITAGE PARK

The basket weave unit expressed through this design encourages greater flexibility in experimental research design. Subsurface wetlands can be modified in shape, size, depth, plant species, soil media make-up, and inundation length in order to test these individual features for treatment efficacy. Cells can be made larger or smaller depending on the research question or the results of initial monitoring.

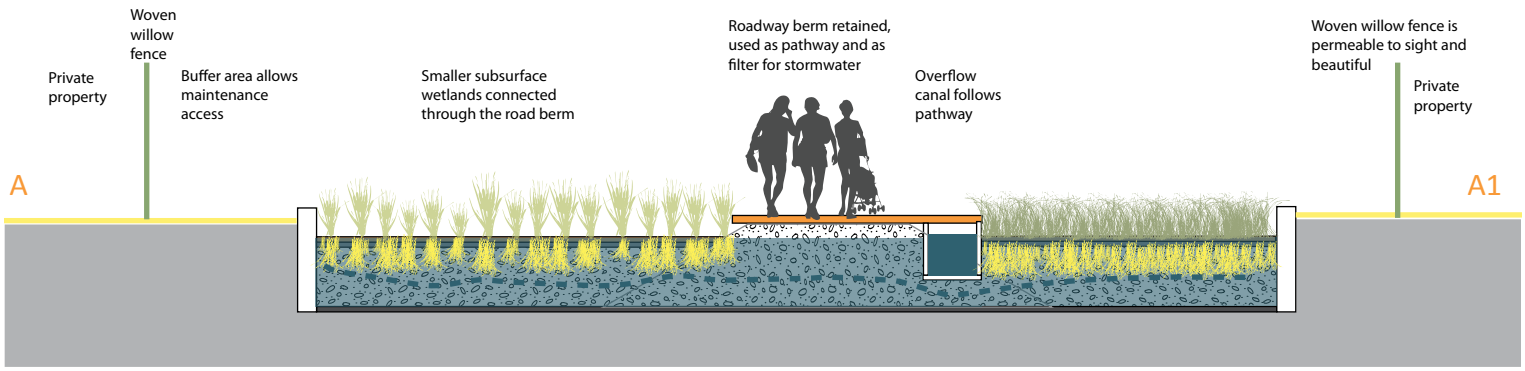
- Each cell consists of three layers of soil media that include either 24" or 36" of ¾" crushed stone, 3" of pea gravel, and 4" of wetland soil. Chemical and physical treatment occurs with these substrates.
- Facultative plants are planted into the media to support biological treatment through plant uptake and microbial activity in the root zone.
- I initially proposed testing the efficacy of larger plant species such as facultative trees – cedars and spruce to study how they might contribute to the process. While it is anticipated that utilizing larger plants like trees would incorporate a larger root mass that would in turn require deeper subsurface wetlands (allowing opportunity to test the efficacy of deeper subsurface wetlands) the deed restricts plants from being larger than 4 feet.
- An overflow pipe channel follows the basket grid and reveals the fluctuating seasonality of storm events. During the summer this channel may be dry- allowing it to serve as a pathway or alternatively, the outlet could be blocked to allow for water storage though the summer.
- A forebay is a required component of the subsurface wetland treatment process. In this example, the forebay is open and reveals the process of stormwater collecting and allowing sediments to initially settle out before water then moves through the subsurface wetland units. Pathways over the forebay allow it to become a design feature.
- Flow spreaders move water horizontally through each subsurface wetland cell to ensure adequate distribution.
- At NE 9th St, water enters a culvert to pass under the roadway. On the other side the water is daylighted again as a dry stream bed with weirs. This freshwater "stream" seeps into Penn Cove.
- Bioswales line the edge of the boat launch parking lot to prevent contamination by cars.
- Stormwater monitoring can be conducted at the inlet and the outlet to determine overall contribution of the treatment system for water quality before conveyance into Penn Cove. Similarly, grab samples can be collected from the inlets and outlets of the individual subsurface wetlands to evaluate specific design features. These data can then inform adjustments to the design in order to ensure water quality goals are met. These data will also help refine overall stormwater treatment design in Puget Sound.

COUPEVILLE PROTOTYPE - ALTERNATIVE 1
HERITAGE PARK

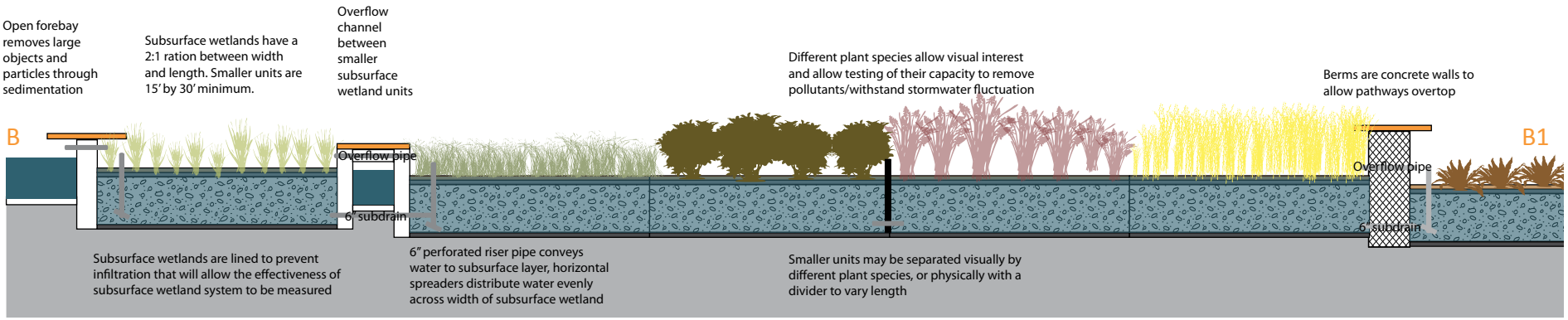


COUPEVILLE PROTOTYPE - ALTERNATIVE 1
HERITAGE PARK

Section A-A1



Section B-B1



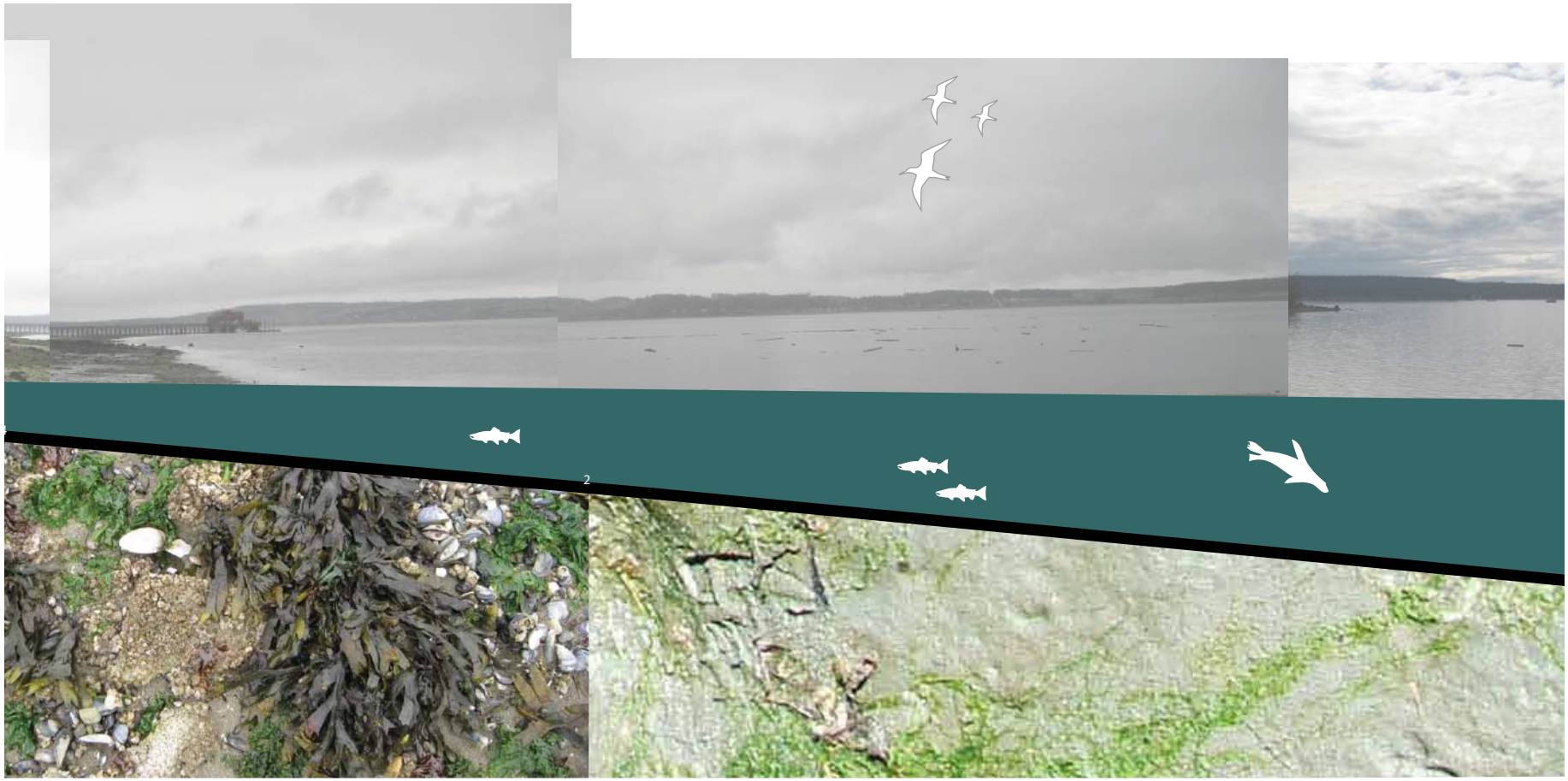
COUPEVILLE PROTOTYPE - ALTERNATIVE 1
HERITAGE PARK

Habitat areas

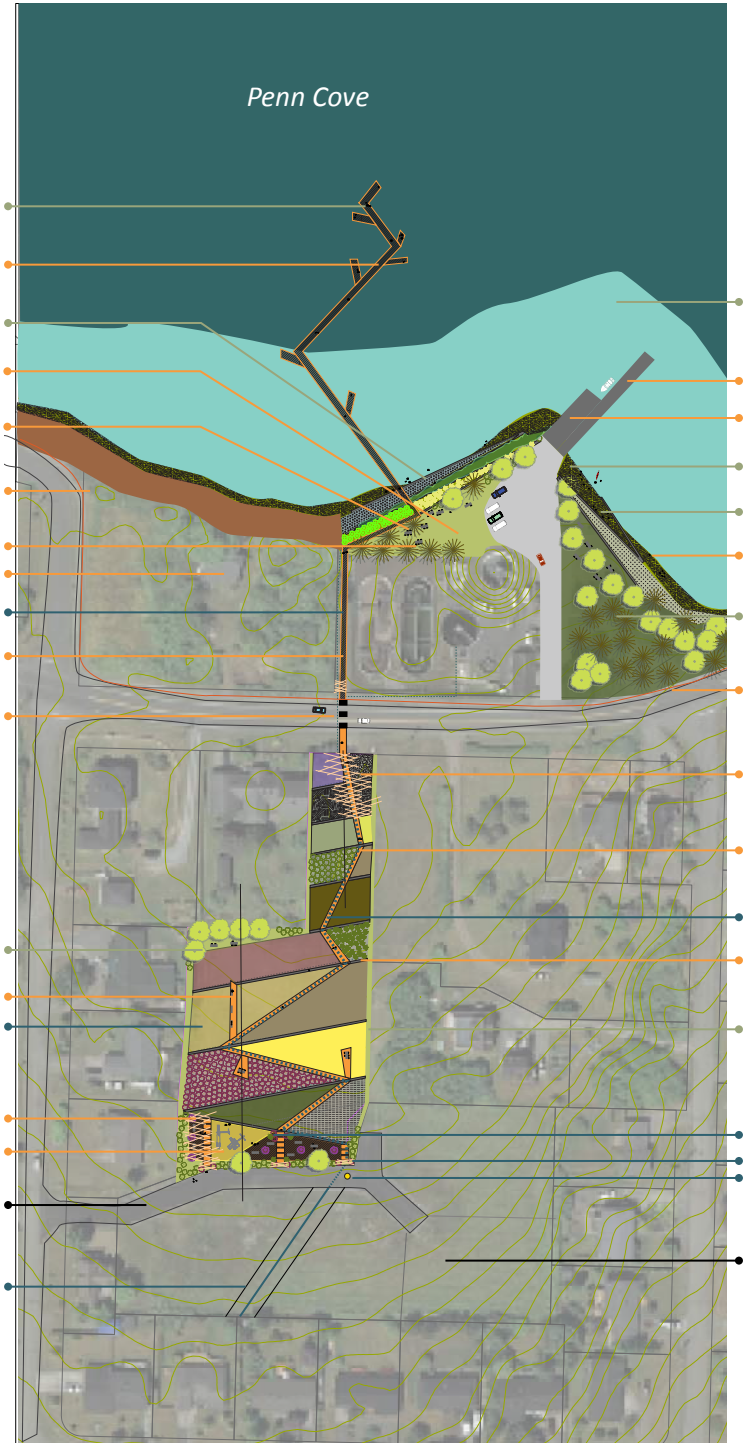
Public space areas

COUPEVILLE PROTOTYPE - ALTERNATIVE 1
HERITAGE PARK

COUPEVILLE PROTOTYPE - ALTERNATIVE 1
HERITAGE PARK



COUPEVILLE PROTOTYPE - ALTERNATIVE 2
WETLAND EXPLORATION PARK



- Stormwater treatment
- Public access
- Habitat
- Other

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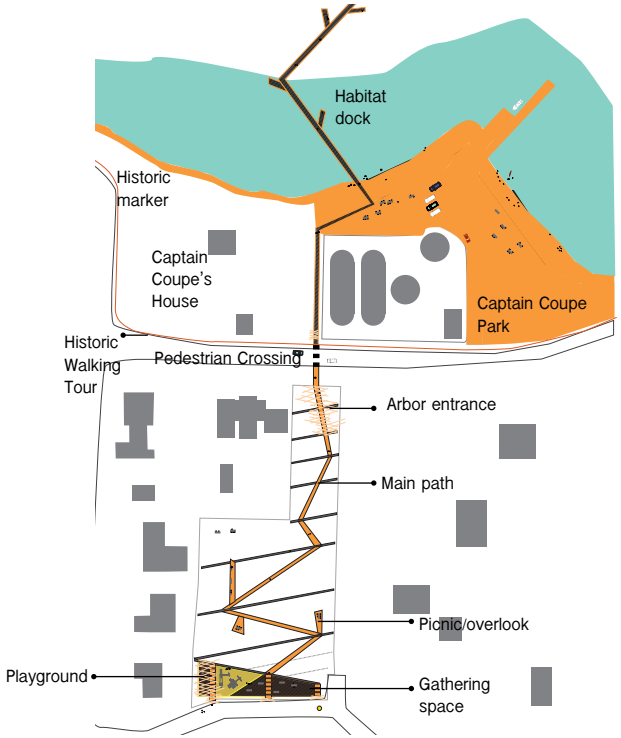
COUPEVILLE PROTOTYPE - ALTERNATIVE 2
WETLAND EXPLORATION PARK

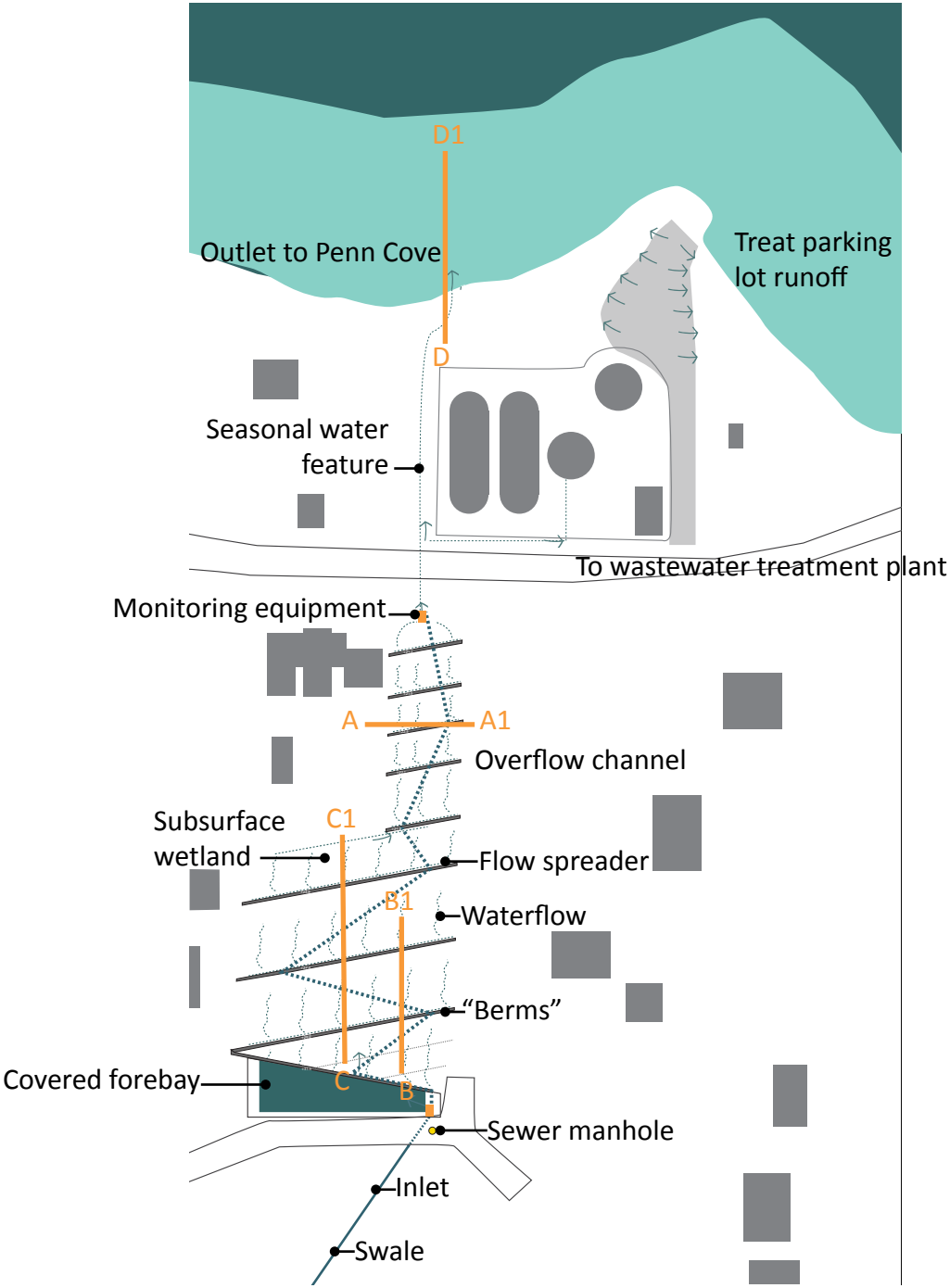
The subsurface wetlands are much larger in this design alternative. They mimic a horizontal basket weave that contrasts with the path and reflects a salmon scale basketry pattern.

- A covered forebay protects the public from open water that may pose health and safety risks and can be easily accessed through a clean-out station perhaps at the same time the sewer manhole is accessed for maintenance. This covered surface helps to introduce active public space since the majority of the site must be in a wetland type state. It is also not known how a covered forebay might function, so this site approach can test the idea. The covered forebay also allows permanent water quality monitoring equipment at the inlet as it will be secure underneath the forebay deck, and will be easily accessible.
- Flow spreaders evenly distribute water from the forebay across the subsurface wetlands to ensure horizontal spread.
- At NE 9th St the water goes under the road but is daylighted again once across. A dry stream with weirs allows the water to flow down into Penn Cove and to better connect people to the overall process.
- Subsurface wetlands are much larger, requiring less infrastructure. These units maintain a longer width to length ratio (2:1) to allow horizontal spread and consist of either 24” or 36” of ¾” crushed stone, in addition to 3” of pea gravel, and 4” of wetland soil. Chemical and physical treatment occurs with these substrates.
- Facultative plants are planted into the media to support biological treatment through plant uptake and microbial activity in the root zone.
- To maintain plantings during the summer without requiring irrigation, cleaned water could be pumped from the wastewater treatment plant back up into the forebay and allowed to run through the subsurface wetlands.
- The overflow channel flows underneath the main pathway to the culvert at NE 9th ST. Alternatively, the overflow water and the treated stormwater could be directed to the wastewater treatment plant where it can be stored and reused for farmland irrigation through their potential aquifer recharge project.
- Stormwater from the boat launch parking lot is directed into bioswales that line the edges of the parking lot to prevent contamination by the cars.
- Stormwater monitoring can be conducted at the inlet and the outlet to determine overall contribution of the treatment system for water quality before conveyance into Penn Cove. Similarly, grab samples can be collected from the inlets and outlets of the individual subsurface wetlands to evaluate specific design variables. These data can then inform adjustments to the design in order to ensure water quality goals are met. These data will also help refine overall stormwater treatment design in Puget Sound.

COUPEVILLE PROTOTYPE - ALTERNATIVE 2
WETLAND EXPLORATION PARK

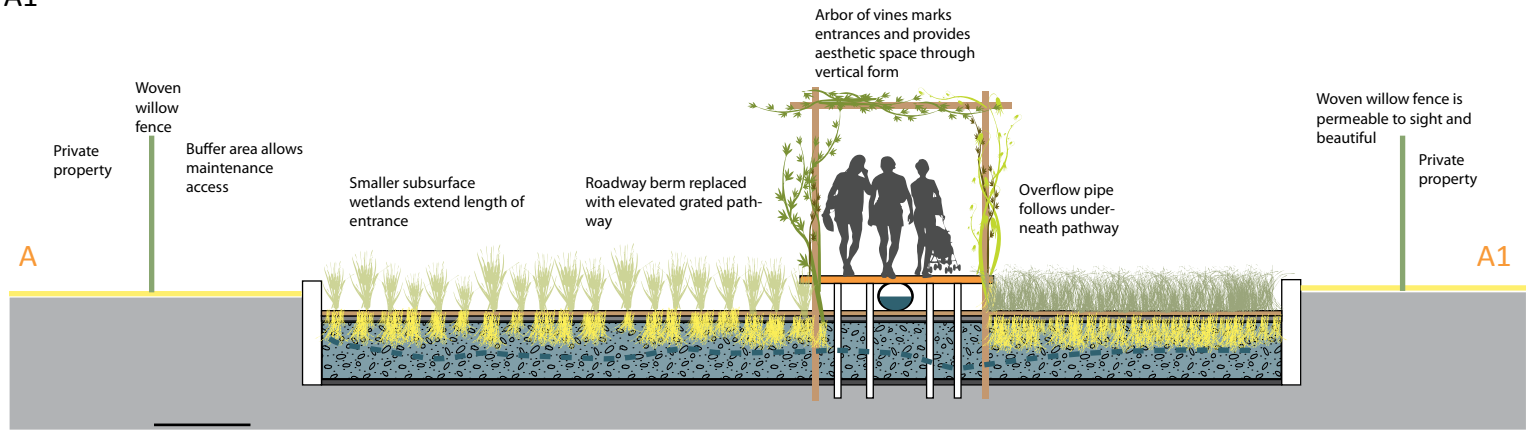


Public access areas

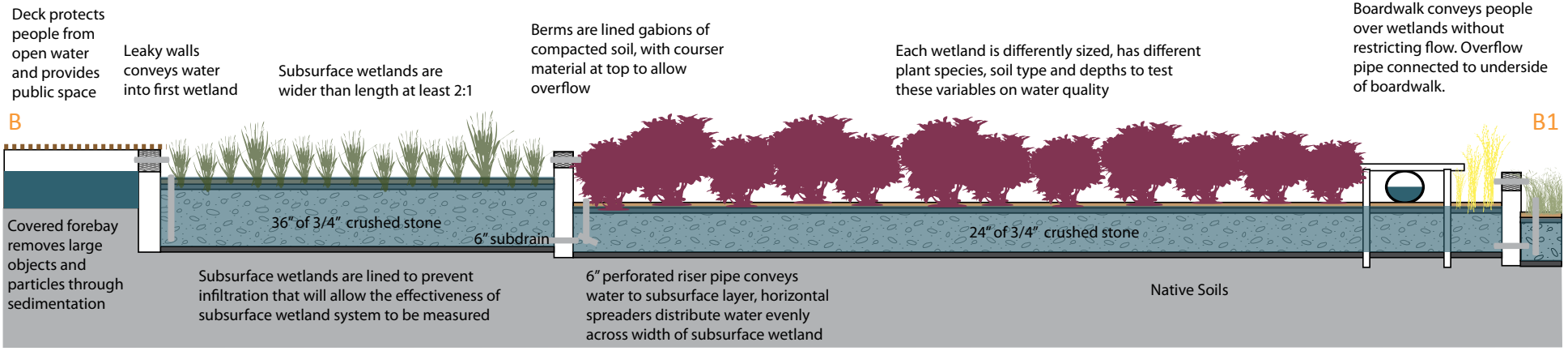


COUPEVILLE PROTOTYPE - ALTERNATIVE 2
WETLAND EXPLORATION PARK

Section A-A1



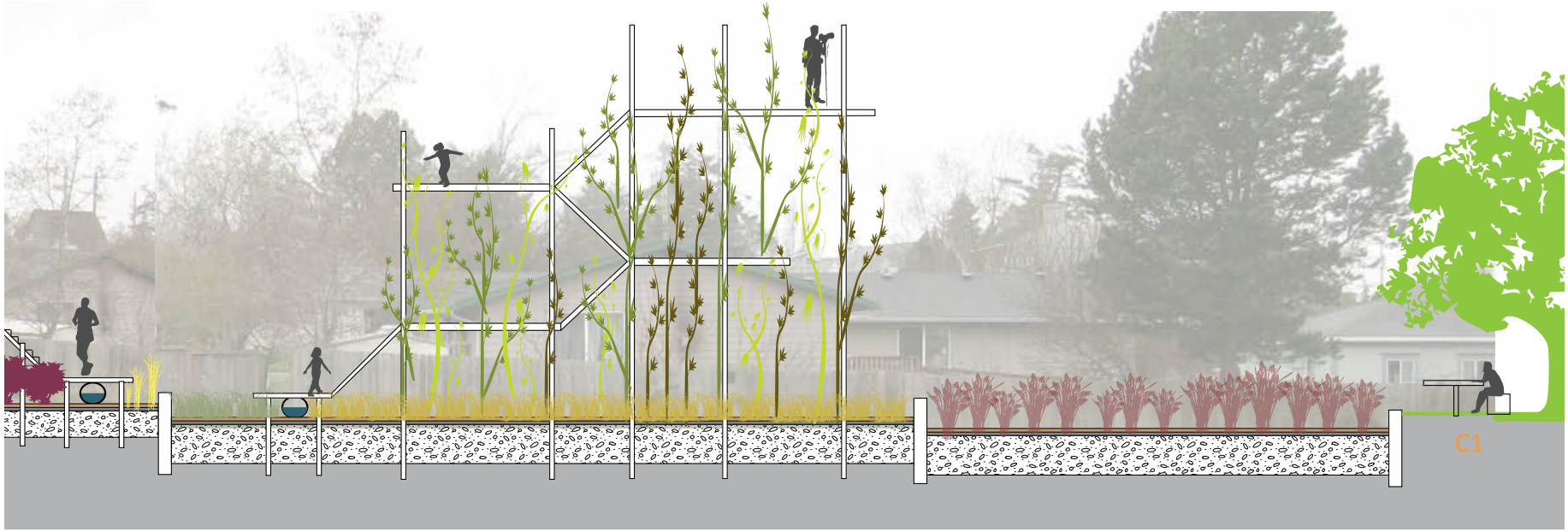
Section B-B1



COUPEVILLE PROTOTYPE - ALTERNATIVE 2
WETLAND EXPLORATION PARK

Section C-C1

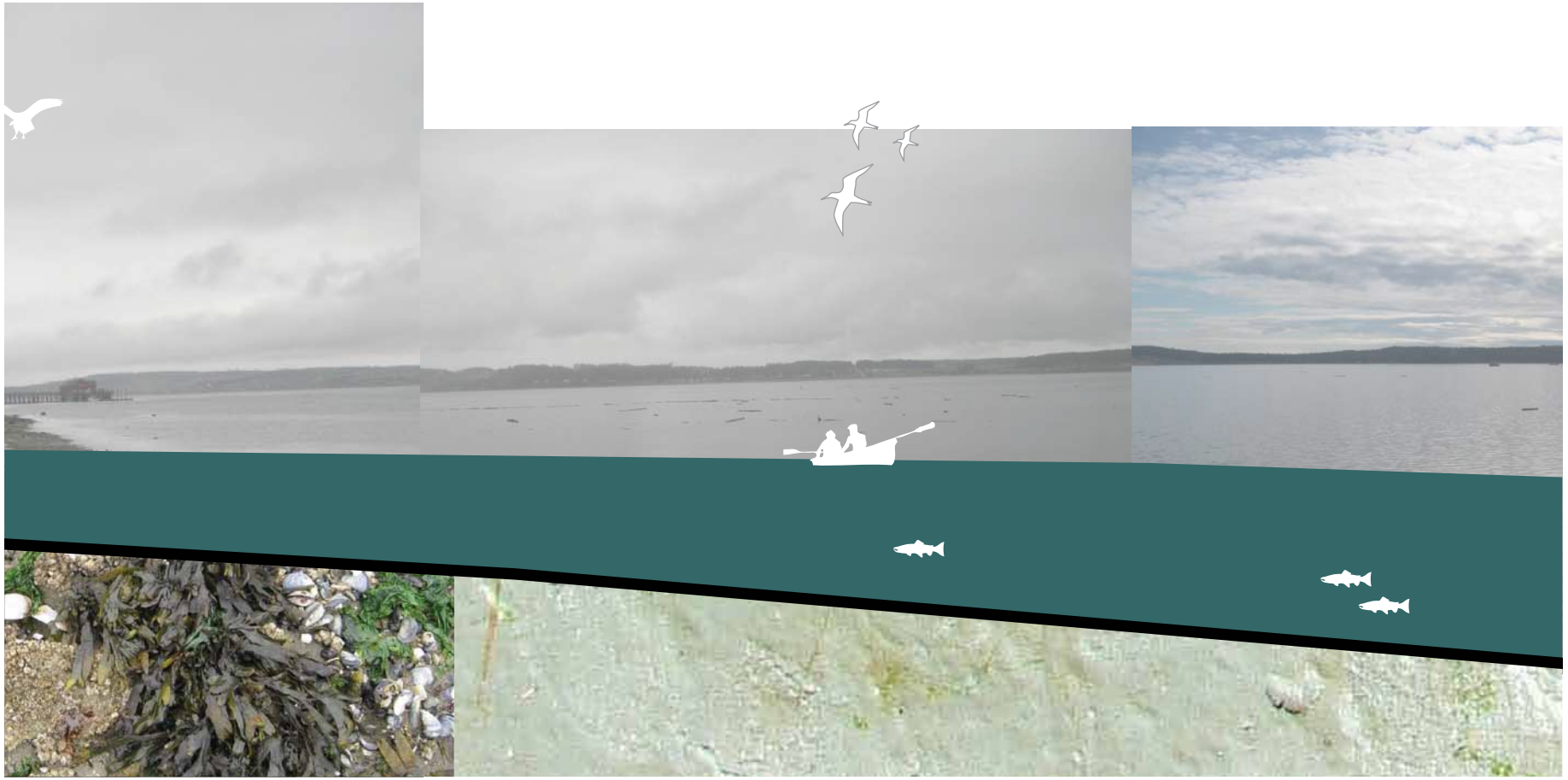
COUPEVILLE PROTOTYPE - ALTERNATIVE 2
WETLAND EXPLORATION PARK



COUPEVILLE PROTOTYPE - ALTERNATIVE 2
WETLAND EXPLORATION PARK

Section D-D1

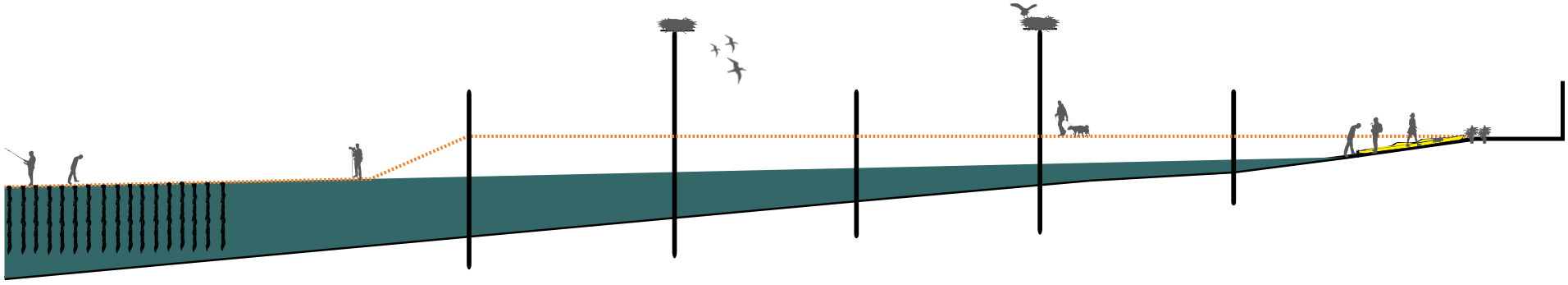
COUPEVILLE PROTOTYPE - ALTERNATIVE 2
WETLAND EXPLORATION PARK



D1

COUPEVILLE PROTOTYPE - ALTERNATIVE 2
WETLAND EXPLORATION PARK



Habitat dock patterned to create habitat; blue mussels for water filtration; nesting platforms for birds; structures for seaweeds and shellfish attachment and public access

COUPEVILLE PROTOTYPE - ALTERNATIVE 2
WETLAND EXPLORATION PARK