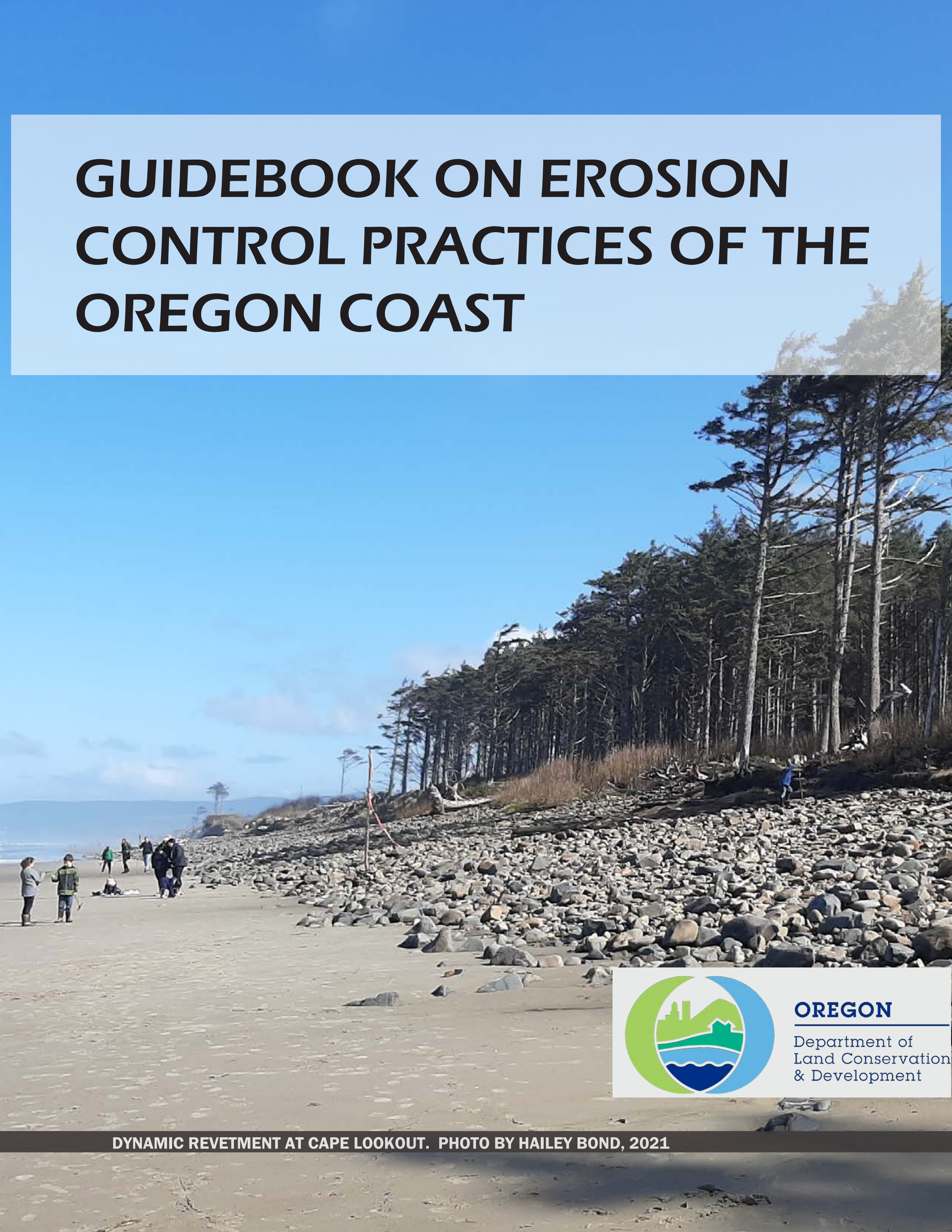
GUIDEBOOK ON EROSION CONTROL PRACTICES OF THE OREGON COAST



DYNAMIC REVETMENT AT CAPE LOOKOUT. PHOTO BY HAILEY BOND, 2021

OREGON
Department of Land Conservation & Development

Guidebook on Erosion Control Practices of the Oregon coast

Prepared by Hailey Bond

This project was undertaken as part of a Natural Resource Policy Fellowship funded by Oregon Sea Grant at the Department of Land Conservation and Development (DLCD).

Thank you to the many people that provided feedback, including Jay Sennewald (Oregon Parks and Recreation Department), Kirk Jarvie (Department of State Lands), Jon Allan (Oregon Department of Geologic and Mineral Industries), Megan Hoff (Lincoln County), Lisa Phipps (DLCD), Steven Shipsey (Oregon Department of Justice), Patty Snow (DLCD), and Tyler Krug (US Army Corps). Special thanks to Meg Reed at DLCD for her guidance and thorough review in every stage of this project.

CANNON BEACH. PHOTO BY HAILEY BOND, 2021

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1. EXECUTIVE SUMMARY

DUNES AT NEDONNA BEACH. PHOTO BY HAILEY BOND, 2021

Executive Summary

Statewide Planning Goal 18 focuses on conserving and protecting Oregon's beach and dune resources, and on recognizing and reducing exposure to hazards in this dynamic environment. Goal 18, Implementation Requirement 5, limits the placement of beachfront protective structures to those areas where development existed prior to 1977. This policy effectively places a cap on the amount of ocean shore that may be hardened, and thus limits the cumulative impacts of such hardening. Shoreline armoring fixes the shoreline in place, traps sediment, and causes scouring and lowering of the beach profile. These actions can result over time in the loss of Oregon's public beaches.

Goal 18 restricts shoreline armoring with the statement "Permits for beachfront protective structures shall be issued only where development existed on January 1, 1977." However, the goal does not specifically define the phrase "beachfront protective structure" (BPS). Currently, the determination of whether a structure is or is not a beachfront protective structure is made on a case-by-case basis by permitting agencies and local governments. During meetings of the Goal 18 focus group facilitated by DLCD in 2019, members explored options for creating a definition that could be consistently applied. Focus group members settled on the following definition for a beachfront protective structure:

> "A static structure that is intended to remain in a fixed position with the purpose of redirecting wave energy and to minimize or eliminate coastal erosion risk to development. BPS are purposefully constructed and intended to maintain that form over time. This includes, but is not limited to, rip-rap revetments, seawalls, groins, breakwaters, jetties, bulkheads, geotextile sandbags, sand burritos, gabions, and concrete or mortar reinforcement such as shotcrete. Beachfront protective structures do not include dynamic treatments such as sand nourishment, cobble revetments, and similar non-structural or nonfixed erosion mitigation measures."

To assist coastal practitioners in consistently applying the beachfront protective structure definition, the focus group recommended that DLCD put together this guidance document on common erosion control measures in Oregon and how they are regulated. In addition to clarifying what is and is not a BPS, the erosion control guidebook is designed to be a resource for coastal practitioners and community members looking for more information on Goal 18 and erosion control. The guidebook covers the main policies and land use goals relevant to the Oregon coast, typical and atypical permitting processes for erosion control, and details about erosion control measures viable for the Oregon coast. Specific topics include:

Beach Bill and Coastal Land Use Goals:

- Includes a brief history of the Beach Bill of 1967;
- Summarizes the coastal land use goals (Goals 16, 17, and 18) and describes how they influence regulations and permitting for different types of erosion control on the outer Oregon coast;
- Explains the way eligibility for beachfront protective structures is determined, including the definition of development and the jurisdictions responsible for making the determination; and
- Provides statistics broken down by littoral cell on the amount of structural erosion control and eligible properties along the coast.

Permitting:

- Includes details about the most typical permitting processes for erosion control through OPRD, including timeline, requirements, and emergency permits; and
- Provides basic information and resources for further information about more complex permitting situations at jurisdictional boundaries, such as erosion control structures located at stream outlets.

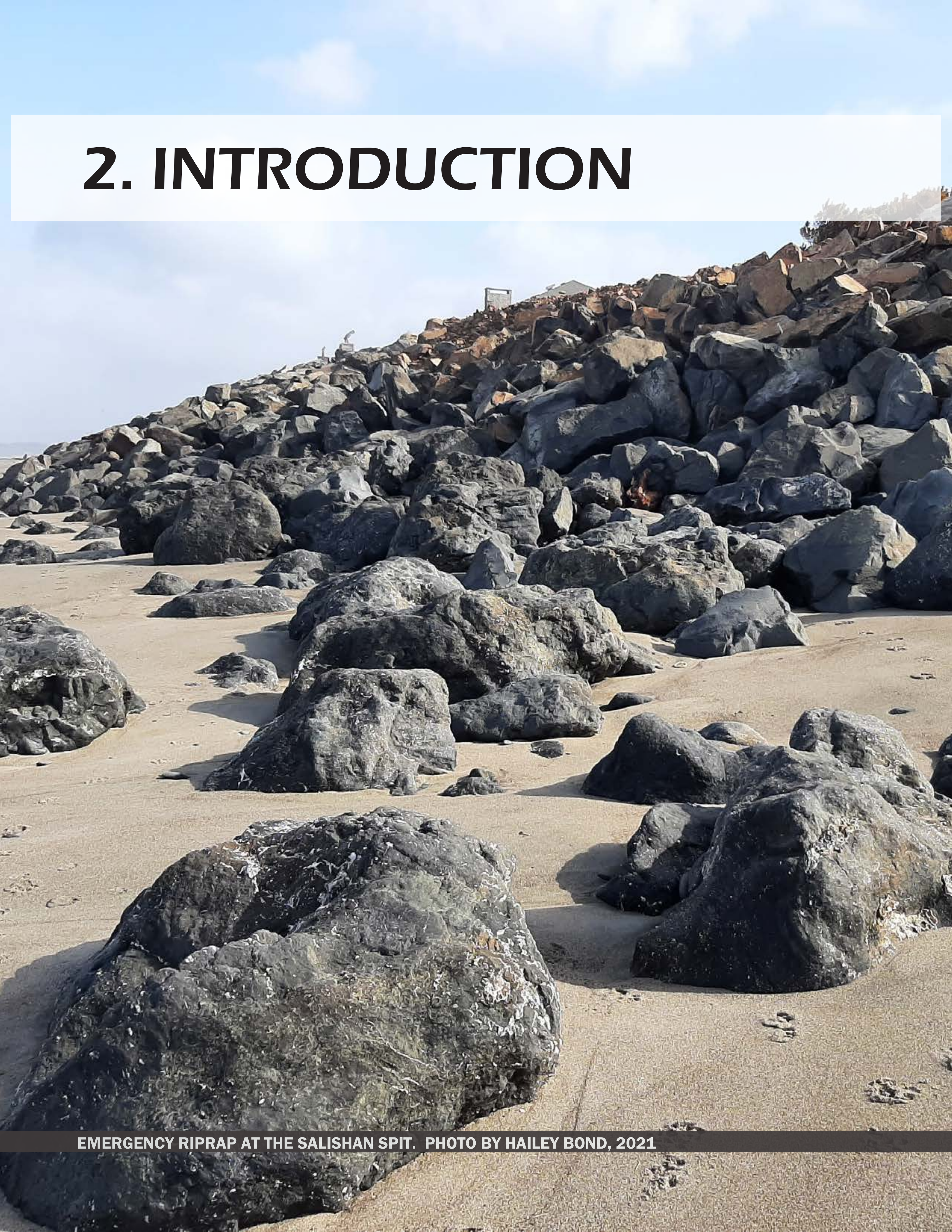
Erosion Control:

The guidebook discusses erosion control measures that are viable on the Oregon coast. The guidebook covers the benefits and drawbacks, regulatory information (including whether erosion control measures are considered structural), prevalence in Oregon, and suitability in responding to sea level rise impacts for each erosion control measure. Erosion control measures discussed include:

- Nonstructural: vegetative stabilization, dynamic revetment, beach nourishment, and beach scraping; and
- Structural: seawall, riprap revetment, sandbags, and gabion walls.

RIPRAP IN FRONT OF LINCOLN BEACH HOMES. PHOTO BY OREGON SHOREZONE, 2011

2. INTRODUCTION



EMERGENCY RIPRAP AT THE SALISHAN SPIT. PHOTO BY HAILEY BOND, 2021

Project Need

In 2019, the Department of Land Conservation & Development (DLCD) convened a focus group of relevant interest groups, local government staff, and state agencies to review the equity and consistency of the application of Statewide Planning Goal 18: Beaches and Dunes, Implementation Requirement #5. This provision of the Goal relates specifically to shoreline armoring requirements. Shoreline armoring is the placement of structural material on the oceanfront with the intention of minimizing the risk of coastal erosion to development (e.g., riprap, seawalls). The focus group considered information related to the practical, political, technical, and scientific aspects of Goal 18 shoreline armoring requirements.

One of the concepts under review by the focus group was the definition of a Beachfront Protective Structure as described in Goal 18. The focus group identified that while Goal 18 has requirements for where beachfront protective structures (BPS) can be placed along the Oregon coast, it does not define the term "beachfront protective structure." Whether a structure is or is not a BPS is currently determined on a case-by-case basis by local jurisdictions and the Oregon Parks and Recreation Department (OPRD) (Goal 18: Pre-1977 Development Focus Group, 2019).

The focus group identified three pathways that would allow for the implementation of a BPS definition. Two options could be pursued through legal means: 1) goal amendment to add a definition of BPS to Goal 18; or 2) rulemaking through OPRD's rules to add a definition. However, focus group members felt that as the status quo currently works in most cases, the benefits of a formal legal definition did not outweigh the effort of pursuing a legal process. The third option discussed by the focus group was for DLCD to put together a guidance document on common erosion control measures in Oregon and how they are regulated. This document could include the unofficial definition of BPSs discussed in focus group meetings (discussed in more detail later) and help OPRD and local jurisdictions more evenly apply standards on what is and is not a BPS.

The focus group recommended the guidebook option, and this document is the result.

Guidebook Audience

This guidebook is intended primarily for local planners to assist in the permitting of different kinds of erosion control. Planners might use this guidebook to understand the difference between a structural and non-structural erosion control mechanism, or might use it to find more information and resources when complicated questions involving multiple agencies come up. New planners might use this as a resource to acclimate to the permitting environment of the Oregon coast. Consulting engineers, environmental groups, homeowners, scientists, and others might also find this guidebook useful for its comprehensive overview of the permitting process of erosion control mechanisms and their viability on the Oregon coast, as well as a comprehensive list of references.

3. PHYSICAL SETTING OF THE OREGON COAST

DRIFTWOOD AND ROCK AT SEAL ROCK STATE RECREATION SITE. PHOTO BY HAILEY BOND, 2021

Wave Climate

Oregon is known for its extremely high-energy wave climate. These waves pose challenges to the safety of beachgoers and coastal property owners and contribute to erosion across the coast. Oregon waves are very seasonal in both height and direction. The smallest waves typically occur around July and August and typically average about 5 ft. The largest waves typically occur in December and January. The average winter significant wave height is 11.3 ft, but winter waves can often exceed 33 ft in deep water. Summer waves typically approach from the northwest, while winter waves approach from the southwest (Allan, Gabel, & O'Brien, 2018). Wave heights in Oregon are increasing over time: average significant wave heights are increasing by 0.05 ft/year (Ruggiero, Komar, & Allan, 2010). It is uncertain whether the increasing wave heights are caused by human-induced global warming or by natural climate cycles, but regardless of the cause, a continued increase in wave heights will undoubtedly affect coastal erosion and flooding potential in the future.

"Significant wave height" is a term describing the average of the highest third of waves measured. Significant wave heights are typically used to describe wave conditions because they best represent the wave conditions that most affect people and their safety.

Wave heights are not the only drivers of erosion on the Oregon coast; water levels also play a significant role. Oregon has an average tidal range of 5 - 6 ft, but during extreme spring tides, the tidal range can be 10 - 12 ft. In addition to tides, coastal water levels can also be affected by factors such as storm surge, wind, and river discharge (Allan, et al., 2015).

LARGE WAVES AT CAPE DISAPPOINTMENT, WASHINGTON. PHOTO BY JEFF RISHER PHOTOGRAPHY, 2020

El Niño and La Niña conditions also impact coastal erosion on the Oregon coast. In El Niño years, water levels along the coast are elevated and waves approach from a more southwesterly direction. Elevated water levels lead to increased erosion, and the wave direction pushes sediment northward. La Niña winters in Oregon tend to be colder, wetter, and produce larger waves than typical winters, causing widespread erosion across the Oregon coast (Allan, Gabel, & O'Brien, 2018; OSU Researcher analyzing erosion from La Niña, El Niño). Significant erosion on the Oregon coast has been associated with El Niño and La Niña events including the 1982-83 El Niño, 1997-98 El Niño, 1998-99 La Niña, 2015-16 El Niño, and 2020-21 La Niña events (Allan, Gabel, & O'Brien, 2018; Severe Erosion on U.S. West Coast during 2015-16 El Niño, 2017).

Sea Level Rise

Sea level rise in Oregon is influenced by both its tectonic setting and global-scale changes in the volume of water (US Army Corps of Engineers, 2021). The Oregon coast generally experiences uplift, which means that the land is rising and dampening the effects of sea level rise. Uplift in the central and northern Oregon coasts is currently being outpaced by sea level rise (i.e. sea level appears to be rising), while the south coast and the Columbia River are experiencing higher rates of tectonic uplift relative to sea level rise (i.e. sea level appears to be falling). However, global climate models continue to project increasing rates of sea level rise for the future that will soon outpace the tectonic uplift across the entire Oregon coast (Allan, Gabel, & O'Brien, 2018; Erosion Continues Damage on Oregon Coast - Homes Threatened, More Finds, 2021).

KING TIDES AT COQUILLE POINT, BANDON. PHOTO BY RICK POECKER, 2020

On the Oregon coast, sea level is projected to rise between -0.2 - 2.9 ft in the next 50 years, depending on location and climate scenario used. The central coast will experience more sea level rise than the north and south coasts because it experiences less tectonic uplift (US Army Corps of Engineers, 2021). Sea level rise will exacerbate flooding and coastal erosion, particularly during El Niño and La Niña events and the yearly King Tides.

Effects of Shoreline Armoring on the Beach

Statewide Planning Goal 18 limits the placement of beachfront protective structures and the cumulative impacts of shoreline hardening on beaches and dunes. BPS's do not protect the beach; rather, they protect the land and development behind the structure while negatively impacting the public beach.

When BPS's like riprap (the most common in Oregon) are placed on the beach, some of the beach is immediately lost due to the physical constraints of riprap construction. For optimal stability, riprap needs 1.5 - 2 ft of horizontal space for every foot of vertical coverage. Therefore, a riprap structure 25 ft tall (a reasonable estimate for Oregon) will lose 37.5 - 50 ft of beach in placement loss.

By preventing sand from eroding from the slope behind the BPS, the structure reduces the natural sand supply to the beach. Losing a sand source can affect the sediment budget, which is the balance between sediment sources (gain of sand) and sediment sinks (loss of sand). If too many sediment sources are limited in a littoral cell, the sediment budget can become unbalanced and lead to erosion. In littoral cells where the majority of the sand comes from erosion of the upland, a high percentage of shoreline armoring in the littoral cell can impact the sediment budget.

A littoral cell is a coastal compartment that contains a complete cycle of sedimentation including sources, transport paths, and sinks. In Oregon, sediment sources typically include rivers and coastal erosion, while sediment sinks typically include estuaries and offshore areas. Hardly any sand travels between littoral cells. Using littoral cells to describe the coast is useful because they reflect the physical processes that impact the coast better than jurisdictional boundaries like county or city limits.

BEACH NARROWING AT ROCKAWAY BEACH. PHOTO BY OREGON SHOREZONE, 2011

Over time, BPS's cause erosion and narrowing of the beach fronting them. Narrowing of the beach reduces north-south beach access, making it difficult or dangerous for people to walk on the beach during high tides. This can occur due to two processes. The first process contributing to beach narrowing is known as passive erosion, and it describes the effect of fixing the shoreline in place in an eroding area. Although the shoreline may be protected, erosion will continue to remove sand in front of the structure, causing the beach to narrow. Sea level rise will also contribute to this problem, leading to further erosion and beach narrowing in front of a BPS. Passive erosion is an unavoidable consequence of building structures on shorelines undergoing net long-term erosion, and can only be mitigated in the short-term through beach nourishment (Griggs, 2005). The second erosional process that can contribute to beach narrowing is known as active erosion and is less certain to occur than passive erosion. Active erosion refers to a seawall or revetment causing or accelerating erosion, and is situational and dependent on the location of the structure with respect to the mean water level and runup height (Ruggiero & McDougal, 2001). Active erosion becomes more likely when water levels regularly reach the toe of the BPS. In Oregon, active erosion is difficult to identify because rip embayments regularly cause significant longshore variations in erosion rate, making it impossible to distinguish increased erosion due to a structure from increased erosion due to rip embayments (Komar & McDougal, 1988). A literature review of relevant studies is provided in Griggs (2005) for further information on active erosion.

Rip embayments occur when rip currents focus wave energy onto a short stretch of coast, causing acute erosion during storms. On the Oregon coast, rip embayments are typically 5-10 lots wide. Rip embayments often form prior to the storm that causes erosion (Komar & McDougal 1988).

RIPRAP AT ROCKAWAY BEACH. PHOTO BY HAILEY BOND, 2021

4. RELEVANT POLICIES AND LAND USE PLANNING GOALS

BLOCK WALL AND GABIONS AT WECOMA BEACH. PHOTO BY HAILEY BOND, 2021

Background on policies and regulations implemented throughout Oregon's history can help contextualize the way erosion control structures are regulated on the Oregon coast. The Beach Bill of 1967 helped set aside the beach for public use in perpetuity, and the Coastal Land Use Planning Goals (adopted in 1977) helped prioritize the protection of coastal resources and public enjoyment of the beach within land use planning programs. These policies are useful to understanding the origin of existing permitting rules around beachfront protective structures.

Oregon's Beach Bill

The 1967 Beach Bill was a landmark piece of legislation that captured the attitude of Oregonians towards the idea of a public right to the beach. The bill has its roots in the designation of the public beach as a highway by Governor Oswald West in 1913. The public assumed that this designation gave them rights to the entire beach. However, challenges by private property owners in 1966 clarified that the beaches were only public below the ordinary high tide line and that 112 of the 262 miles of sandy beach were privately owned. This led to a high-profile fight in the Oregon Legislature to pass the Beach Bill in 1967, which "codified into law already existing public rights to dry sand beaches" and "gave the State Highway Commission the authority to police, protect, and maintain the property." (Straton, 1977)

GOVERNOR TOM MCCALL AT THE BEACH, 1967.
PHOTO CREDIT DLCD

The bill recognized easements of the dry sand for public use based on implied dedication and long recreational use without changing the underlying ownership of the beach. An exemption to taxation for the easements on dry sand was added after the passage of the bill (Straton, 1977).

For more information on the Beach Bill, see the DLCD website here or the Oregon encylopedia here.

After the bill was passed, the coast was surveyed to establish a permanent landward beach zone line. This survey approximated the vegetation line and is known as the "Statutory Vegetation Line" today. Until 1989, the Parks Department, a division of the Oregon Department of Transportation (ODOT), was the permitting authority for construction west of the statutory vegetation line. In 1989, the Parks Department separated from ODOT and became the Oregon Parks and Recreation Department (OPRD). OPRD was given jurisdiction over the beach west of the statutory vegetation line. During this time, the Department of State Lands (DSL) had jurisdiction between the statutory vegetation line and the highest measured tide. In 1999, ORS 196.800 and ORS 390.605 were amended with Senate Bill 11 to simplify the permitting process by changing OPRD's jurisdiction to "the land lying between extreme low tide of the Pacific Ocean and the statutory vegetation line as described by ORS 390.770 or the line of established upland shore vegetation, whichever is farther inland."

The Beach Bill solidified the mindset of Oregonians that the beach is a public resource that should be preserved for the public in perpetuity, and this notion continues to drive the state's approach to ocean shore alterations in Oregon today.

Coastal Goals

Goal 16: Estuarine Resources

Statewide Planning Goal 16 provides the principal guidance for the planning and management of Oregon's estuaries, which are the tidal mouths of rivers, where freshwater streams are met by the tide. The overall objective of Goal 16 is to "to recognize and protect the unique environmental, economic and social values of each estuary and associated wetlands; and to protect, maintain, where appropriate develop, and where appropriate restore the long term environmental, economic and social values, diversity and benefits of Oregon's estuaries." To accomplish this, the goal establishes detailed requirements for the preparation of estuary management plans, the review of individual development projects, and coordinated management by local, state, and federal agencies that regulate or have an interest in activities in Oregon's estuaries.

More information on coastal goals can be found on DLCD's website. An overview of the Statewide Land Use Planning Goals is avaliable here.

The goal requires individual estuary plans to designate appropriate uses for different areas within each estuary (estuary management units) based on biological and physical characteristics and features, and to provide for review of proposed estuarine alterations to assure that they are consistent with overall management objectives and that adverse impacts are minimized. Estuary designations include:

> Natural: Managed to assure the protection of significant fish and wildlife habitats, of continued biological productivity within the estuary, and of scientific, research, and educational needs. (Example: Sand Lake Estuary)

Conservation: Managed for long-term uses of renewable resources that do not require major alteration of the estuary, except for the purpose of restoration. (Example: Siletz Bay Estuary)

Development: Managed for more intense development or alteration, to provide for navigation and other identified needs for public, commercial, and industrial water-dependent uses. (Example: Yaquina Bay Estuary)

> A water-dependent use is a use or activity which can be carried out only on, in, or adjacent to water areas because the use requires access to the water body for water-borne transportation, recreation, energy production, or source of water.

Most Goal 16 requirements are implemented through locally adopted estuary plans, but some are applied by state agencies through their review of various permit applications

Goal 16 impacts the permitting and construction of shoreline protective structures in situations when erosion occurs at the junction between estuaries and the outer coast. Although the design of these protective structures at the seaward boundaries of estuaries may be similar to those of the outer coast, they are regulated differently than beachfront protective structures on the outer coast (Oregon Coastal Management Program, n.d.). In natural and conservation estuaries, riprap is very restricted, but riprap is less restricted in development estuaries.

This document provides some information about the permitting of beachfront protective structures on the boundaries between estuaries and the ocean shore, which may be affected by Goal 16. However, this document is not a guide for Goal 16.

JETTY LAGOON, COLUMBIA RIVER JETTY. PHOTO BY BRIANA GOODWIN, 2018

Goal 17: Coastal Shorelands

Statewide Planning Goal 17 outlines planning and management requirements for the lands bordering estuaries, as well as lands bordering the ocean shore and coastal lakes. In general, the requirements of Goal 17 apply in combination with other planning goals to direct the appropriate use of shoreland areas. Provisions in Goal 17 specifically focus on the protection and management of resources unique to shoreland areas. Examples of such resources include areas of significant shoreland habitat, lands especially suited for water dependent uses, lands providing public access to coastal waters, and potential restoration or mitigation sites.

Goal 17 requirements are implemented primarily through local comprehensive plans and zoning. Goal 17's Implementation Requirement 5 is particularly relevant to the permitting of erosion control mechanisms. It states that "land-use management practices and non-structural solutions to problems of erosion and flooding shall be preferred to structural solutions." This implementation requirement has led local governments and permitting agencies to create requirements for alternatives analyses, ensuring that structural erosion control is only used if necessary for the success of the project (Oregon Coastal Management Program, n.d.).

TAFT DISTRICT, LINCOLN CITY. PHOTO BY JOHN COLLINS, 2020

Goal 18: Beaches and Dunes

Statewide Planning Goal 18 focuses on conserving and protecting Oregon's beach and dune resources, and on recognizing and reducing exposure to hazards in this dynamic environment. Goal 18 is central to the work of coastal communities in addressing the impacts of coastal hazards and climate change in areas along the ocean shore.

Local governments are required to inventory beaches and dunes and describe the stability, movement, groundwater resources, hazards and values of the beach, dune, and interdune areas. Local governments must then apply appropriate beach and dune policies for use in these areas.

Goal 18's requirements of particular importance:

More information and resources about Goal 18 are available here.

Prohibition Areas (Implementation Requirement 2): The goal prohibits development on the most sensitive and hazardous landforms in the beach and dune environment, including beaches, active foredunes and other dune areas subject to severe erosion or flooding. This requirement has been instrumental in preventing inappropriate development on these critical landforms.

Shoreline Armoring (Implementation Requirement 5): The goal limits the placement of beachfront protective structures to those areas where development existed prior to January 1, 1977. The definition of development for purposes of Goal 18, Implementation Requirement #5 is "houses, commercial and industrial buildings, and vacant subdivision lots which are physically improved through construction of streets and provision of utilities to the lot." This policy effectively places a cap on the amount of ocean shore that may be hardened, and thus limits the cumulative impacts of such hardening.

Shoreline armoring can cause scouring and lowering of the beach profile, which can result over time in the loss of access to and use of Oregon's public beaches. New development is not eligible for structural shoreline protection and must account for shoreline erosion through non-structural approaches (e.g. increased setbacks). In the face of increased ocean erosion occurring in conjunction with climate change and sea level rise, limiting hard structures and allowing natural shoreline migration is a critical policy tool for conserving and maintaining Oregon's ocean beaches (Oregon Coastal Management Program, n.d.).

DUNES AT THE NEWPORT SOUTH JETTY. PHOTO BY HAILEY BOND, 2020

Working definition of ‘beachfront protective structure’

Goal 18 restricts beachfront protective structures as follows, “Permits for beachfront protective structures shall be issued only where development existed on January 1, 1977.” However, the goal does not specifically define a beachfront protective structure. Currently, this determination is made on a case-by-case basis by permitting agencies and local governments.

During meetings of the Goal 18 focus group, members explored options for creating a definition that can be consistently applied. Focus group members settled on the following definition for a beachfront protective structure:

> “A static structure that is intended to remain in a fixed position with the purpose of redirecting wave energy and to minimize or eliminate coastal erosion risk to development. BPS are purposefully constructed and intended to maintain that form over time. This includes, but is not limited to, rip-rap revetments, seawalls, groins, breakwaters, jetties, bulkheads, geotextile sandbags, sand burritos, gabions, and concrete or mortar reinforcement such as shotcrete. Beachfront protective structures do not include dynamic treatments such as sand nourishment, cobble revetments, and similar non-structural or non-fixed erosion mitigation measures.”

This document will use the above definition of a beachfront protective structure to provide guidance on which erosion control methods typically used in Oregon are considered to be beachfront protective structures and why.

EMERGENCY RIPRAP AT THE SALISHAN SPIT, PHOTO BY HAILEY BOND, 2021

Eligibility for Beachfront Protective Structures

Goal 18, Implementation Requirement 5 provides that permits for beachfront protective structures shall be issued only where development existed on January 1, 1977. Development is defined as:

- Houses, commercial and industrial buildings;
- Vacant subdivision lots which are physically improved through construction of streets and provision of utilities to the lot; or
- Areas where an exception to Goal 18 Implementation Requirement 2 has been approved.

Statewide Planning Goal 18 requires that local comprehensive plans identify areas where qualifying development existed as of January 1, 1977 for the purpose of determining eligibility for BPS. However, because this requirement was added after most jurisdictions had already approved their Comprehensive Plans, most coastal jurisdictions do not have an official inventory of the eligibility of coastal parcels for shoreline armoring. In 2014, the Oregon Coastal Management Program created a coast-wide inventory of coastal parcels that are designated as eligible and ineligible for shoreline armoring (available in the Ocean Shores Data Viewer). The inventory is maintained by the Oregon Coastal Management Program, and is a resource for all coastal jurisdictions. For more information on the inventory, see the Shoreline Armoring Policy Analysis Report (Gardner, 2015) and its appendices, which contain a detailed decision tree explaining how eligibility was determined for every lot on the Oregon coast. Although coastal jurisdictions may use this inventory as an aid in making an eligibility determination, they are not bound by it. Ultimately, local jurisdictions are responsible for determining the eligibility of a property for shoreline armoring.

Oregon's coastal atlas is available online here

EXAMPLE OF ELIGIBILITY MAP FROM THE COASTAL ATLAS, 2021

Eligibility and armoring statistics

The effects of Goal 18's restriction on beachfront protective structures can vary along the coast. Goal 18's policies interact with environmental conditions along the coast to create different challenges for different communities. As an example, Gleneden Beach is a hotspot of erosion on the Oregon coast and has a mix of oceanfront properties that are eligible and ineligible for beachfront protective structures. Thus, the shoreline armoring provision of Goal 18 and the eligibility status of particular lots are often an important topic in that community. However, in places like Seaside and Gearhart, which are experiencing a general trend of sand accretion, or places like Yachats, which has a rocky coastline, the eligibility status of properties is less important because they are not generally threatened by erosion.

To provide context for the different challenges faced by different places on the coast, data on eligibility for beachfront protection and current amounts of shoreline armoring are provided below for littoral cells from north to south. The shoreline length was calculated using NOAA's Continuously Updated Shoreline Product (CUSP), excluding jetty lengths. Shoreline armoring data is from the beachfront protective structure database, which is provided and continuously maintained by OPRD. The length of shoreline eligible for armoring was calculated using the intersection between eligible parcels and the line of vegetation (ORS 390.770).

Table 1: Eligibility and armoring statistics for each littoral cell on the Oregon coast.

Littoral Cell	Length of Littoral Cell (miles)	Length of Eligible coastline (miles)	Percent Eligible	Length of Structures (miles)	Percent Armored
Clatsop	22.56	3.53	16%	0.22	1%
Cannon	16.77	5.43	32%	2.36	14%
Rockaway	23.5	5.41	23%	1.70	7%
Netarts	13.43	0.59	4%	0.58	4%
Sandlake	9.83	0.76	8%	0.77	8%
Neskowin	13.72	4.20	31%	2.67	19%
Lincoln	25.97	14.14	54%	8.51	33%
Beverly	8.76	1.10	13%	0.12	1%
Newport	31.58	11.54	37%	4.00	13%
Heceta	13.39	0.81	6%	0	0%
Coos	71.32	1.89	3%	1.02	1%
Bandon	39.86	1.30	3%	0.04	0%
Elk	8.98	0.64	7%	0	0%
Humbug	17.11	0.82	5%	0.17	1%
Nesika	9.92	1.31	13%	0.06	1%
Rogue	12.54	0.56	4%	0.09	1%
Pistol	6.96	0	0%	0	0%
Ferrello	31.51	5.00	16%	0.47	2%

5. EROSION CONTROL PERMITTING

SEASIDE PROMENADE. PHOTO BY HAILEY BOND, 2021

Agencies and Jurisdictions

Oregon Parks and Recreation Department (OPRD)

OPRD has jurisdiction over the "Ocean Shore State Recreation Area," which is the area between extreme low tide and either the statutory vegetation line (ORS 390.770) or current vegetation line, whichever is further inland. OPRD may issue ocean shore alteration permits for shoreline armoring projects, access ways, sand alterations, pipelines, cables, conduits, and natural product removal. They do pre-project consultation and pre-project site visits to educate applicants on permitting processes and requirements. OPRD has authority to issue emergency permits. OPRD evaluates permits using general standards, scenic standards, recreation use standards, safety standards, and natural and cultural resource standards (OAR 736-020). While OPRD cannot regulate structures or other shoreline alterations that are landward of the most inland vegetation line, if the alterations are eventually exposed on the beach, they are considered by OPRD to be unpermitted structures and require a new permit. If structures are not in compliance with OPRD regulations, the agency can levy fines of up to $10,000 per day until offending structures are removed or brought into compliance, and/or the shoreline is restored.

OPRD AT CAPE LOOKOUT, 2011. PHOTO CREDIT DLCD

Local Governments and Planning Offices

Local governments are responsible for identifying beach and dune areas in comprehensive plans and establishing policies and uses for these areas. They are also responsible for identifying areas where development existed on January 1, 1977, and, therefore, which areas are eligible for beachfront protective structures. Local governments are involved in the permitting process through the 'Land Use Compatibility Statement' (LUCS) form. Through the LUCS form, local governments determine whether the proposed development conforms to the provisions in their local comprehensive plan and land use code. Those plans and codes must have been acknowledged by the Land Conservation and Development Commission (LCDC). On the coast, local governments have jurisdiction east of the statutory vegetation line or the actual line of vegetation, whichever is further east. In some cases, local governments may also have additional jurisdiction on the ocean shore related to National Floodplain Insurance Program requirements.

In some cases, local governments may also require a separate local permit (i.e. a building permit or floodplain development permit) for a beachfront protective structure outside of the permit required by OPRD. In cases where a structure is located landward of the vegetation line, a building permit or floodplain development permit (or, at minimum, a review of the proposed development) is likely required. Find more information about local permitting requirements, which may differ between jurisdictions, by contacting the local planning office directly.

Department of Land Conservation and Development (DLCD)

DLCD advises and provides guidance to local governments and state agencies on the implementation of Goal 18 (as well as all 19 of the statewide planning goals). DLCD maintains an unofficial Goal 18 eligibility inventory that serves as a resource for local governments to determine Goal 18 eligibility for any oceanfront parcel or lot. Local governments make the final eligibility determination but are able to use the Goal 18 inventory as a tool to aid in their determination. DLCD led the Goal 18 focus group that identified the need for this guidebook.

Most state permits for beachfront protective structures are handled only by OPRD. However, in situations where a beachfront protective structure is needed in estuarine areas, both the Department of State Lands and the United States Army Corps of Engineers are involved. Local governments may also require permits for the installation of shoreline protective structures in these areas. Find more information about local permitting requirements, which may differ between jurisdictions, by contacting the local planning office directly.

Department of State Lands (DSL)

DSL has jurisdiction over waters of the state, including estuary lands. Their jurisdiction extends to the highest measured tide or the upper edge of a wetland. When proposed in an estuary, shoreline protective structures are regulated under a removal-fill permit. DSL's Aquatic Resource Management Program (ARM) provides assistance during the permitting process, including information on which wetlands and waterways have removal-fill permit requirements, which requirements apply, and how the process works. They can also host pre-application meetings. DSL determines whether the project is consistent with the protection, conservation, and best uses of the water of the state and whether the project unreasonably interferes with preservation of waters for navigation, fishing, or public recreation. DSL can also issue emergency permits in circumstances that pose immediate and direct threats to public health, safety, or substantial property. DSL cannot issue permits that are contrary to Statewide Planning Goal 16 or the local comprehensive plans.

United States Army Corps of Engineers (USACE)

When shoreline protective structures are proposed in wetlands, waterways or estuaries, the USACE possesses regulatory jurisdiction pursuant to Section 404 Clean Water Act (CWA) and Section 10 of the Rivers and Harbors Act of 1899 (RHA). Examples of project activities which may trigger a Section 404 CWA permit nexus from the USACE include wetland or waterway dredge or fill activities required for the construction of utility lines, outfall structures, road crossings, streambank stabilization, or beach nourishment. Examples of project activities which may trigger a Section 10 RHA permit nexus from the USACE include dredging, construction or modifications of marinas, piers, wharves, floats, pilings, bulk heads, or submerged or aerial transmissions lines. In general, proposed work or structures occurring in, over, under or affecting navigable waters requires a Department of the Army permit issued by USACE. USACE Section 404 CWA regulatory jurisdiction extends to the high tide line in tidal waters, including wetlands. USACE Section 10 RHA regulatory jurisdiction extends to the mean high water mark in tidal waters.

Permitting Process

For most beachfront protective structures on the open coast, OPRD is the state permitting agency. Their jurisdiction extends from the extreme low tide line to either the existing vegetation line or the statutory vegetation line (ORS 390.770), whichever is further inland. The changing jurisdictional boundary to the east essentially serves as a rolling recreational easement that can move as the beach erodes. This rolling easement is illustratedfor cases of both erosion and accretion below.

EXAMPLE OF OCEAN SHORE JURISDICTION IN ERODING AREA. PHOTO BY OREGON SHOREZONE, 2011

EXAMPLE OF OCEAN SHORE JURISDICTION IN ACCRETING AREA. PHOTO BY OREGON SHOREZONE, 2011

Ocean shore alteration permits have the following requirements:

- Project justification and impacts: A detailed description of the hazard and the threat it poses to the property, and a description of all potential impacts
- Project details: Dimensions, materials, and construction methods for project)
- Analysis of hazard avoidance: An analysis of hazard avoidance alternatives, including the relocation of existing buildings or other infrastructure
- Geologic Report: For projects greater than 50 ft in length, a geologic report from a registered professional geologist experienced in coastal processes is required

Ocean shore alteration permit forms are available online here

A geologic report must address the following:

- The potential impacts from the proposed project on sand source, supply and movement on the affected beach as well as within the same littoral cell;
- The bank or bluff stability and erosion rates on the subject property and adjacent properties and the potential impacts of the proposed project on bluff stability and erosion rates on the subject and adjacent properties;
- A review of potential non-structural solutions, including, but not limited to, vegetative stabilization, non-structural dynamic revetments and foredune enhancement. The review shall describe reasons why non-structural solutions were unsuccessful, if tried, or why they were considered unfeasible.
- The known or suspected geologic and seismic hazards in the project area and how the proposed project may affect or be impacted by those geologic and seismic hazards.

Land Use Compatibility

Two jurisdictions need to sign off on an Ocean Shore Alteration Permit for it to be approved. First, the local government must fill out the planning department affidavit, which is called the Land Use Compatibility Statement (LUCS). The applicant is then responsible for submitting their permit application to the Oregon Parks and Recreation Department for their review and approval.

The planning department LUCS form review has two parts. In the first, the planning department makes the determination of the proposed beachfront protective structure's consistency with their local comprehensive plan and land use code by confirming that the subject property is eligible for structural beachfront protection under Goal 18 implementation provisions. While the Goal 18 eligibility inventory developed by DLCD can be used as a tool in this process, the local planning department alone is responsible for making the eligibility determination on the LUCS form, utilizing any and all information available to them, including building permit records, septic permit records, land use records, and assessor's records.

The second part of the LUCS form involves a determination by the local government on whether the beachfront protective structure is consistent with the local comprehensive plan and zoning ordinance.

After these determinations are made by the local government, OPRD evaluates the permit with a set of criteria given in OAR 736-020-0010 through 736-020-0030, discussed further below.

Permit Decisions

After a permit application is submitted, the proposed project is posted with public notice for 30 days and adjacent landowners with common property boundaries are notified. The public has the opportunity to request a public hearing, which OPRD will schedule if ten or more written requests for a hearing are received. The applicant may request a public hearing or OPRD can also schedule hearings on its own initiative for complex or controversial projects.

If less than ten requests are received for a public hearing, and no hearing will occur based on applicant's request or OPRD initiative, OPRD has 60 days from the date of application to issue a decision.

If more than ten requests are received for a public hearing, the hearing will typically be held near the proposed project site. Notice for the time, date, and location of the hearing is posted in the same manner as the first public notice. The applicants can give a short presentation at the hearing and anyone can testify. Speaking time may be limited based on the number of people giving testimony. The hearing is not intended to be a discussion. People can ask questions of the applicant, but the applicant can choose whether to answer them. No decision is made at the hearing, but public opinion is considered during the permit review process, pursuant to OAR 736-020-0005 (Factors Evaluated).

After a public hearing, OPRD issues a written decision within 45 days. To appeal this decision, a person or agency must have standing, meaning that they have been involved in the public hearing process prior to their appeal by requesting public hearing or submitting testimony.

Permit Criteria

OPRD evaluates permits using the following criteria. Only applications that meet the criteria will be approved.

General Standards (OAR 736-020-0010)

- Project Need – There shall be adequate justification for a project to occur on and alter the ocean shore area;
- Protection of Public Rights – Public ownership of or use of easement rights on the ocean shore is adequately protected;
- Public Laws – The applicant shall comply with federal, state, and local laws and regulations affecting the project;
- Alterations and Project Modifications – There are no reasonable alternatives to the proposed activity or project modifications that would better protect the public rights, reduce or eliminate the detrimental effects on the ocean shore, or avoid long term cost to the public;

- Public Costs – There are no reasonable special measures which might reduce or eliminate significant public costs. Prior to submission of the application, the applicant shall consider alternatives such as nonstructural solutions, provision for ultimate removal responsibility for structures when no longer needed, reclamation of excavation pits, mitigation of project damages to public interests, or a time limit on project life to allow for changes in public interest;
- Compliance with LCDC Goals – The proposed project shall be evaluated against the applicable criteria included within Statewide Planning Goals administered by the Department of Land Conservations and Development.

Scenic Standards (OAR 736-020-0015)

- Natural Features – The project shall retain the scenic attraction of key natural features, for example, beaches, headlands, cliffs, sea stacks, streams, tide pools, bedrock formations, fossil beds, and ancient forest remains;
- Shoreline Vegetation – The project shall retain or restore existing vegetation on the ocean shore when vital to scenic values;
- View Obstruction – The project shall avoid or minimize obstruction of existing view of the ocean and beaches from adjacent properties;
- Compatibility with Surroundings – The project shall blend in with the existing shoreline scenery (type of construction, color, etc.).

Recreation Use Standards (OAR 736-020-0020)

- Recreation Use – The project shall not be a detriment to public recreation use opportunities within the ocean shore area except in those cases where it is determined necessary to protect sensitive biological resources such as state or federally listed species;
- Recreation Access – The project shall avoid blocking off or obstructing public access routes within the ocean shore area except in those cases where it is determined necessary to protect sensitive biological resources such as a state or federally listed species.

Safety Standards (OAR 736-020-0030)

- Structural Safety – The project shall not be a safety hazard to the public due to inadequate structural foundations, lack of bank stability, or the use of weak materials subject to rapid ocean damage
- Obstructional Hazards – The project shall minimize obstructions to pedestrians or vehicles going onto or along the ocean shore area;
- Neighboring Properties – The project shall be designed to avoid or minimize ocean erosion or safety problems for neighboring properties;
- Property Protection - Beachfront property projects shall be designed to accomplish a reasonable degree of increased safety for the on-shore property to be protected.

Natural and Cultural Resource Standards (OAR 736-020-0030)

- Projects on the ocean shore shall avoid or minimize damage to the following natural resources, habitat, or ocean shore conditions, and where applicable shall not violate state standards
  - Fish and wildlife resources including rare, threatened, or endangered species and fish and wildlife habitats
  - Estuarine values and navigational interests
  - Historic, cultural, and archeological sites
  - Natural areas (vegetation or aquatic features)
  - Air and water quality of the ocean shore area
  - Areas of geologic interest, fossil beds, ancient forest remnants
- When necessary to protect native plant communities or fish and wildlife habitat on the subject or adjacent properties, only native, non-invasive plant species shall be used for revegetation

When OPRD issues permit approval, it includes conditions. These conditions can include, among others:

- To record on the property's deed a reference to the OPRD permit with conditions;
- A cash bond to ensure the permit conditions are met;
- A requirement that the project is constructed according to the approved plans;
- Requirements for beach access maintenance and inspections during construction;
- Requirements for sand coverage and vegetation plantings after construction;
- Deadline for project construction.

Approved shoreline alteration permits are available on OPRD's website here. Their rationale for approval of permits are available in these files.

Emergency Permits

Emergency permits can be issued for the ocean shore by OPRD for properties in "imminent peril", defined as "a situation in which property is likely to be severely damaged or destroyed by action of the Pacific Ocean or waters of a bay or a river, or by landslide or other natural forces, and where such damage would be likely to occur prior to the time required for approval of an Ocean Shore Permit."

For OPRD to issue an emergency permit for structural erosion control, the property must meet the Goal 18 eligibility requirement necessary for the issuance of a typical shore alteration permit. Eligibility is not waived in emergency circumstances.

Generally, OPRD first confirms with the local government that the proposed alteration is compliant with the local comprehensive plan and Goal 18. However, if the local government is unavailable to make a determination of eligibility, OPRD can still issue a provisional emergency permit with the understanding that if the property is later found to not meet eligibility requirements, the permit will be rescinded and any shore alteration will need to be reversed. Emergency Permits can be issued in written or verbal form.

Within a year of issuance of the emergency permit, the permittee must apply for and receive a permit to convert their temporary project approved under an emergency permit into a permanent ocean shore alteration.

Permitting in Estuaries

Estuary mouths and tidal stream outlets mark a shift in regulatory jurisdiction between Oregon Parks and Recreation Department (OPRD) and the Department of State Lands (DSL). The 'Ocean Shore' is regulated by OPRD, while the beds and banks of estuaries are regulated by DSL. When the migration of stream outlets threatens development and infrastructure and shoreline protective structures become necessary, the distinction between the two areas of regulatory jurisdiction becomes important.

At the mouth of an estuary or tidal stream, the boundary between OPRD jurisdiction (the ocean shore) and DSL jurisdiction (the estuary) is determined by extending a line across the mouth of the estuary that connects either: 1) the "statutory vegetation line" on either side of the estuary; or 2) the actual vegetation line on either side of the estuary, whichever line is further inland. The statutory vegetation line for many locations on the Oregon shore can be found on the Oregon Coastal Atlas. The actual vegetation line is determined by using the most recent aerial/ satellite photography available or through field surveys of the sites.

DSL Permits

DSL authorizes shoreline protective structures in the estuary using the removal-fill permit process. To begin that process, the "Joint Permit Application Form" is used ("joint" because the US Army Corps of Engineers uses the same application form for the parallel federal permit process; see USACE permitting section below).

Like OPRD's ocean shore permit, DSL's permit application includes a Land Use Compatibility Statement that must be filled out by the local planning department, indicating the status of the proposed protective structure's consistency with the local comprehensive plan and ordinances. For shoreline protective structures under DSL jurisdiction in estuaries and stream outlets, Goal 16 applies, which means that restrictions on shoreline protective structures are different than those on the ocean shore governed by Goal 18.

More information on DSL's removal-fill program is available here.

In many cases, estuarine protective structures will also require authorization from DSL as the landowner of the submersible lands of the estuary. This is called proprietary authorization and is a separate process from removal-fill permitting. DSL staff can be contacted directly about proprietary authorization.

Restrictions on shoreline protective structures

Under Goal 16, the only structure permissible for coastal erosion mitigation in natural and conservation management units is riprap. For the administration of Goal 16, riprap is defined by DLCD as "a layer, facing, or protective mound of stones randomly placed to prevent erosion, scour or sloughing of a structure or embankment; also, the stone so used. In local usage, the similar use of other hard material, such as concrete rubble, is also frequently included as riprap." Riprap is only allowed in these management units for uses that were developed as of October 7, 1977, which is different than Goal 18's eligibility cutoff date of January 1, 1977. Goal 16 also allows for the protection of unique natural resources, historical and archeological values, and public facilities regardless of their development date.

DSL Emergency Permits

Like OPRD, DSL also has an emergency permit process. These permits may be issued in circumstances that pose an immediate and direct threat to public health, safety, or substantial property. Permits can be issued as quickly as one day. However, under the emergency process, DSL can only approve the minimum amount of work necessary to alleviate the immediate risk and DSL may require additional work to be completed after the emergency has abated to reduce or mitigate the project's impact to the estuarine environment.

DSL Permit Evaluation

DSL is required by statute to make two determinations in issuing a removal-fill permit.

- The project is consistent with the protection, conservation, and best uses of the waters of this state; and
- The project does not unreasonably interfere with preservation of waters for navigation, fishing, or public recreation.

The terms "consistent," "protection," "conservation" and "best uses," and the "reasonableness" standard are subjective and allow DSL considerable discretion in decision-making.

Additionally, DSL is required to consider nine factors in making these determinations:

- **The public need for the proposed fill or removal and the social, economic or other public benefits likely to result from the proposed removal or fill**: DSL will consider whether the application has demonstrated a public need and what benefits the public may derive from the proposed removal-fill activity. When the applicant is a public body, DSL will generally accept the public body's finding as to local public need and benefit without further consideration.
- **The economic cost to the public if the proposed fill or removal is not accomplished**: DSL will consider the public economic costs if the removal-fill activity is not allowed. Examples of economic costs that DSL may consider include but are not limited to: impact to public infrastructure investments, increased travel time if road closure is required, and loss of access to public services.

- **The availability of alternatives to the project for which the fill or removal is proposed**: DSL will consider what alternative designs and construction methods were evaluated to avoid and minimize impacts to waters of this state. DSL must be able to conclude that the proposed project represents the practicable alternative with the least impact to waters of this state.
- **The availability of alternative sites for the proposed fill or removal**: DSL will consider whether there were alternative sites reasonably available to the applicant for the proposed project that would have lesser impacts to waters of this state.
- **Whether the proposed fill or removal conforms to sound policies of conservation and would not interfere with public health and safety**: DSL will consider how the proposed action incorporates appropriate protection of and conservation measures for waters of this state. Sound policies of conservation are considered at the project scale and within the landscape. DSL will also consider the potential positive and negative effects of the removal-fill on public health and safety. For example, positive effects might include removal-fill to protect a sewer line. Negative effects might include increased flood risk to nearby properties.
- **Whether the proposed fill or removal conforms with existing public uses of waters and with uses designated for adjacent land in an acknowledged comprehensive plan and land-use regulations**: DSL will consider the intended purpose of the removal-fill activity and its potential effect on existing uses of the waters proposed for impact, as well as effects of the removal-fill activity on designated uses of adjacent lands (e.g., whether the action significantly impairs, reduces or damages existing and designated land uses).
- **Whether the proposed fill or removal is compatible with the comprehensive plan and land use regulations for the area where the proposed removal of fill is to occur**. DSL will use the information provided by the local planning department in the Land Use Compatibility Statement for this consideration.
- **Whether the proposed fill or removal is for streambank protection**: ORS 196.805(2) identifies streambank protection as a beneficial use of waters.
- **Whether the applicant has provided all practical mitigation to reduce the adverse effects of the proposed fill or removal.** Proposals that involve permanent impacts to wetlands or waterways will typically require compensatory mitigation to offset those impacts.

Additional considerations for estuarine impacts: If the project involves fill or removal activity in an estuary for a "non-water dependent use," the following additional criteria must be satisfied:

- The removal-fill activity must be for a public use (e.g., a publicly owned project or privately owned project available for use by public)
- The removal-fill activity satisfies a public need that outweighs any harm to navigation, fisheries and recreation

Mitigation

The placement of protective structures in estuarine environments can have significant negative impacts such as destroying habitat for native species along the banks, creating new habitat for non-native species, increasing water temperature, and deflecting water energy onto other nearby lands, leading to increased erosion. Assessment of the proposed structure's impact on the local environment is required as part of the removal-fill application. For any identified permanent impacts to estuary functions, mitigation for those losses will be required. DSL generally prefers "mitigation in kind," where the impact at the project location is reversed elsewhere. If this is not possible, other methods like buying mitigation credits from an approved mitigation bank (if available) or contributing to the DSL payment-in-lieu program may be an option.

More information on DSL's removal-fill permitting program is available in their removal-fill guide. Mitigation information can be found in Chapter 8 of the guide.

US Army Corps Permitting

The Corps has two types of Department of the Army permits: General Permits and Individual Permits. General information is provided here, but an applicant needing one of these permits will need to seek further direction and information from USACE.

General Permits authorize activities that are similar in nature and cause only minimal adverse environmental impacts to aquatic resources, separately or on a cumulative basis. There are two types of general permits: Nationwide Permits and Regional General Permits.

Information about the Corps Nationwide Permits and Regional General Permits, including conditions is available here. More information about permits from the Portland District Office is available here.

Individual Permits are for activities that do not fit the requirements for a Nationwide Permit or Regional General Permit. There are two types of Individual Permits: Standard Individual Permits and Letters of Permission.

How the permit process works

Permit applications received by the Corps of Engineers are given identification numbers and reviewed for completeness. A request for additional information may be sent if necessary. For standard individual permit reviews, a public notice initiating a 15- or 30-day public comment period will be issued within 15 days of receiving all the required information. After the comment period, the Corps will review all of the comments. The Corps may ask for additional information at this time and a public hearing may be conducted if one has been specifically requested or determined to be necessary. For all projects, the Corps will consult with other state and federal agencies and Native American tribes as appropriate. When all considerations are satisfied, the District Engineer will make a decision to either issue or deny the permit application. If a permit is denied, the applicant will receive a written explanation.

The Corps' goal is to decide on all applications within 60 days after receipt of a complete application for general permits and 120 days for individual permits, unless: a decision is precluded as a matter of law or procedures required by law; the case must be referred to higher authority; the comment period of a public notice is extended; a timely submittal of information or comments is not received from the applicant; the processing is suspended at the request of the applicant; or information needed by the district engineer for a decision on the application cannot reasonably be obtained within the 60- or 120-day period.

USACE emergency and expedited permit processes

33 CFR § 325.2(e)(4) defines an emergency as a situation which would result in an unacceptable hazard to life, a significant loss of property, or an immediate, unforeseen, and significant economic hardship if a corrective action requiring a permit is not undertaken within a time period less than the normal time needed to process the application under standard procedures. In these situations, the USACE Division Engineer (a level above the Portland District) can authorize expedited reviews of permit applications.

Applicants are strongly encouraged to notify the Corps of the need to perform emergency work before taking any action so that there may be an opportunity to obtain authorization before conducting the action. Calls to discuss the situation should be made to the Corps Regulatory Project Manager for the relevant county, or the Portland or Eugene Section chief.

More information regarding the Corps expedited and emergency review process is available here.

Federal Consistency

Although the USACE does not independently evaluate permitted projects against Oregon's coastal land use goals, these federal permits are subject to state federal consistency review pursuant to the Coastal Zone Management Act (CZMA), as well as state water quality certifications under Section 401 of the Clean Water Act (401). Both the CZMA and 401 evaluations, conducted by the Oregon Coastal Management Program and Oregon Department of Environmental Quality respectively, incorporate requirements for consistency with the coastal goals and local land use planning, and have the authority to object/deny issuance of federal permits for inconsistent projects, or incorporate conditions to assure consistency with these standards into the federal permit.

Other Notes on Erosion Control Permitting

Each jurisdiction involved in ocean shore permitting has its own process and permit. However, to move forward with a project, all permits are needed. Permit approval from one agency does not guarantee permit approval from other agencies. Even when projects meet the requirements of the applicable land use planning goals, they are also not guaranteed a permit, as permitting agencies have additional requirements beyond those of the land use planning goals.

The Oregon coast has a high-energy wave climate with limited economic resources for major coastal projects. As discussed previously, Land Use Planning Goal 18 restricts beachfront protective structures to tax lots that were developed before January 1, 1977. Erosion control mechanisms can be divided into categories of structural and nonstructural. In this section, the limited number of erosion control mechanisms viable on the Oregon coast are covered in detail, with resources provided for further reading and research.

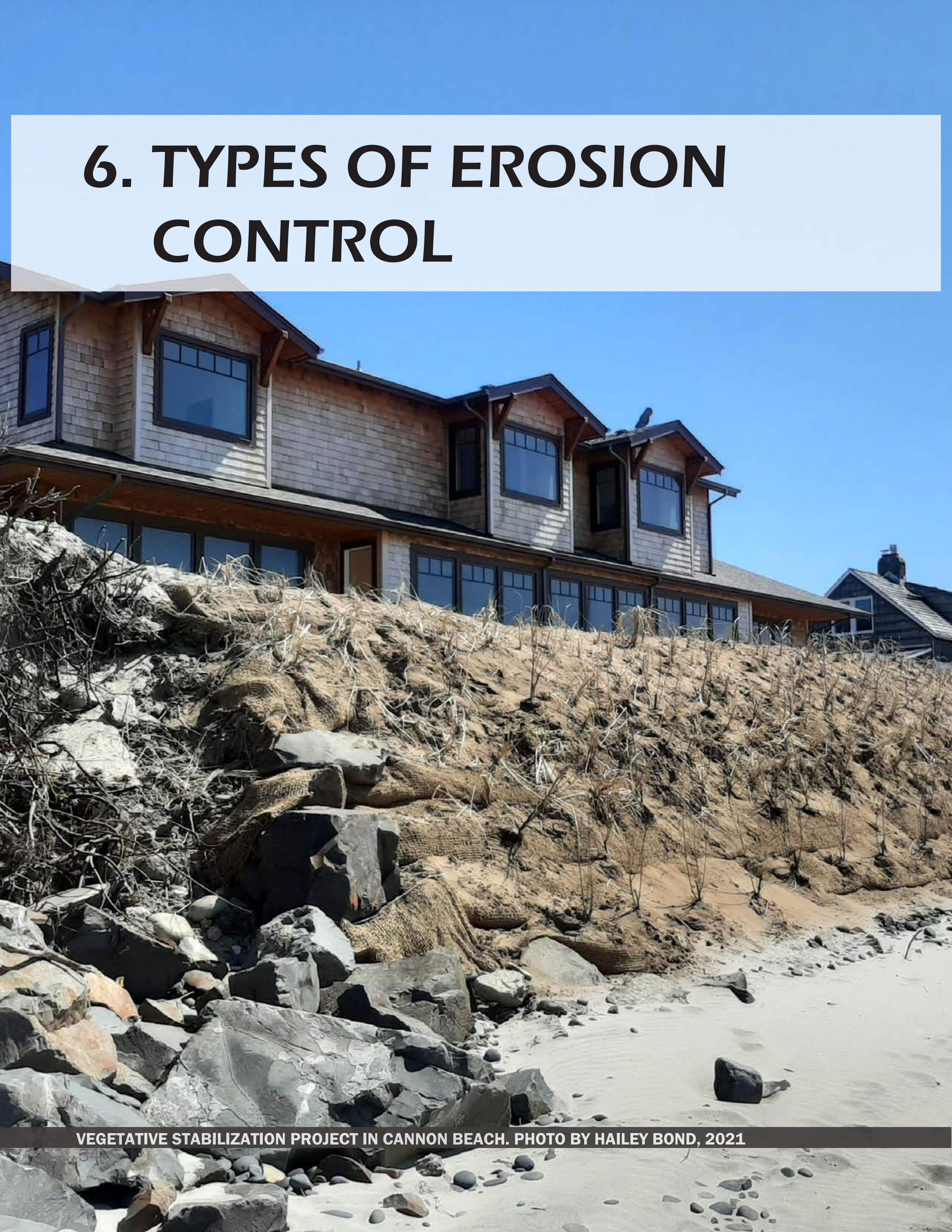
Living shorelines are commonly discussed as an option for nonstructural erosion control. The term “living shoreline” is a broad term that refers to the use of native vegetation to protect against shoreline erosion (Piercy, 2021). Living shorelines might include vegetation, oysters, rock sills, or wooden elements. While living shorelines provide protection against erosion while enhancing the environment in many parts of the world, they are better suited to areas with low-energy wave climates. This guidebook is focused on the high-energy outer coast of Oregon, so options suited to estuaries or other areas with low-energy wave climates are not covered in detail.

The term “hybrid living shoreline” refers to erosion control projects that include both natural and engineered features. They can vary drastically in their size, materials, and number of engineered features. Examples of hybrid structures in high energy wave environments are:

- A riprap revetment covered with an artificial dune (structural) (Winters, 2020);
- A dynamic revetment backed with an artificial dune (structural) (Allen, Komar, & Hart, 2003);
- A dynamic revetment, riprap revetment, piles, and planted terraces (structural) (Oregon Department of Transportation, 2017)l;
- A dynamic revetment and planted artificial dune (nonstructural) (Oregon Department of Transportation, 2017)

In Oregon, hybrid structures are subject to the same regulations as other kinds of erosion control measures. If a hybrid structure has any element that falls under the definition of a beachfront protective structure, it is considered a structure and thus will be regulated as such.

6. TYPES OF EROSION CONTROL



VEGETATIVE STABILIZATION PROJECT IN CANNON BEACH. PHOTO BY HAILEY BOND, 2021

Vegetative Stabilization

Vegetative Stabilization - Quick Facts

- **Vegetative stabilization uses biodegradeable jute or coir fiber to stabilize an eroding slope while plants are established.**
- **There are two examples of vegetative stabilization used on the Oregon coast, both in Cannon Beach and constructed in 2002 and 2020.**
- **In Oregon, the vegetation used is typically Hooker's Willow.**
- **After several years, these projects are nearly indistinguishable from a natural slope.**
- **Vegetative stabilization does not provide the same level of protection as riprap, and is only suited to areas with mild to moderate erosion.**
- **Because the jute fabric biodegrades after a few years, this erosion control is considered nonstructural and does not require eligibility for Goal 18 for construction.**

What is vegetative stabilization?

Vegetative stabilization in the high-energy wave environment of the Oregon coast refers to the use of biodegradable jute or coir fabric to stabilize an eroding slope while native vegetation can establish to provide longer-lasting protection against erosion. Typically, these projects are constructed by wrapping 8 – 24 in soil lifts in biodegradable fabric, which extends back into the slope approximately 6-8 ft (CalTrans, 2019; OPRD, 2002). The soil lifts are terraced to achieve the desired slope. Typically slopes for this method are 1.5-2 horizontal : 1 vertical (CalTrans, 2019). After construction of the stabilized bank, native vegetation is planted so it can establish a root system as the biodegradable fabric disintegrates. In Oregon, the native vegetation used for this kind of bank stabilization is typically Hooker's willow, which is resilient in the coastal environment and has roots capable of knitting the biodegradable fabric and soil together (OPRD, 2020). The types of plants and jute fabric need to be chosen thoughtfully so that the plants can become established by the time the soil fabric degrades. This type of project is also known as encapsulated soil lifts, fabric-encapsulated soil, or rolled erosion control products. It is common in riverine and highway bank stabilization.

Vegetative Stabilization in Oregon

There are two examples of this type of erosion control mechanism. Both projects were constructed in Cannon Beach: the first in 2002 and the second in 2020. The project constructed in 2002 has been successful; the willows have established and the bank looks completely natural. There has been no significant erosion at the project site since its construction. Monitoring will occur at the second site to examine its performance over time.

NONSTRUCTURAL EROSION CONTROL
Vegetative Stabilization

This erosion control mechanism is among the only designs of vegetative stabilization that can survive in Oregon's high-energy wave environment. After the willows stabilize and the jute fabric degrades, the project is nearly indistinguishable from a natural slope, a clear advantage over structural erosion control mechanisms like riprap. The willows also provide ecosystem services by providing a more favorable environment for other native plants and animals. The mature willows can protect the slope by dissipating wave energy through their branches rather than simply reflecting it, reducing the chance of scour or other negative impacts on the beach due to the stabilized bank. While costs of riprap revetments can vary, both the vegetative stabilization projects constructed on the Oregon coast have been significantly cheaper than most riprap projects.

While vegetative stabilization is a valuable alternative to the more common kinds of structural erosion control in Oregon, it is not suitable for every location. This design is not as sturdy as riprap, and therefore cannot protect against erosion in the same way. It is therefore only suited to areas with mild to moderate erosion. The project requires the successful establishment of willow plantings, so it can be affected by poor soil or unusual weather events. The terraced soil burritos are also vulnerable to erosion at the toe of the slope. Several collections of case studies of this type design have identified toe erosion as a common form of failure (Miller, 1998; Alaska Department of Transportation, 2003). Like riprap, the slope is only stable between 1.5 – 2 horizontal :1 vertical, and therefore takes up space on the beach.

VEGETATIVE STABILIZATION PROJECT IN CANNON BEACH JUST AFTER CONSTRUCTION. PHOTO BY HAILEY BOND, 2021

NONSTRUCTURAL EROSION CONTROL
Vegetative Stabilization

VEGETATIVE STABILIIZATION PROJECT IN CANNON BEACH 19 YEARS AFTER CONSTRUCTION. PHOTO BY HAILEY BOND, 2021

How will vegetative stabilization perform under sea level rise?

In many locations, vegetative stabilization and restoration has been proven to help mitigate sea level rise impacts by reducing flooding (Piercy, 2021). However in Oregon's high-energy wave environment, the increase of wave impact and erosion due to sea level rise will likely degrade the stabilized slope. Structural solutions or relocation of development may be needed under increased erosion due to sea level rise.

Vegetative stabilization policy

When constructed with biodegradable fabric, vegetative stabilization is considered a nonstructural erosion control mechanism and does not need Goal 18 eligibility for construction. It requires an OPRD permit for shore alteration. Check with the local jurisdiction for any local permits needed if the project will extend landward of OPRD's jurisdiction.

Vegetative stabilization references

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Dynamic Revetment

Dynamic Revetment - Quick Facts

- **Dynamic revetments are engineered beaches made of cobblestones (stones between 2.5 and 10 inches).**
- **The cobbles that compose dynamic revetments move with wave conditions, often gaining height during high-energy wave conditions and losing height during low-energy wave conditions.**
- **Construction of dynamic revetments is much cheaper than construction of traditional revetments because cobblestones can be dumped onto the beach rather than individually placed.**
- **Dynamic revetments do not provide the same level of reliable protection as traditional revetments, but have proven successful on high-energy coasts.**
- **Dynamic revetments require more maintenance than traditional revetments.**
- **Dynamic revetments are not suitable for use on single lots or in areas which don't already have cobbles on the beach.**
- **Because dynamic revetments move and reshape in response to wave conditions, they are not considered structures and do not require Goal 18 eligibility for construction**

What is a dynamic revetment?

Dynamic revetments (also called cobble beaches and cobble berms) are beaches made of cobble stones. Cobbles are defined as stones with a diameter between 2.5 – 10 in (Masselink, Hughes, & Knight, 2011). Cobble beaches exist naturally but can also be constructed in erosive areas to dissipate wave energy and mitigate further erosion. Unlike traditional rock revetments, the cobbles in a dynamic revetment are expected to move in response to waves. As they move and change their shape, they can dissipate wave energy.

Research on dynamic revetments has been somewhat limited, so no 'typical' designs or methods exist. However, field studies in Oregon and Washington provide valuable information about potential designs and construction methods for the high-energy waves here.

In Oregon, field studies of naturally occurring cobble berms observed that they typically had crest height elevations of 19 – 23 ft and were composed of small to large cobbles (1 – 5 in). Slopes of cobble beaches ranged from 7.7 degrees to 14.1 degrees (Allan, Geitgey, & Hart, 2005).

Dynamic revetments have many benefits over traditional static revetments. They are more flexible than traditional riprap because they move in response to waves, meaning that, unlike traditional revetments, movement does not mean failure. Movement in response to wave conditions is often desirable, as dynamic revetments can gain material and increase their crest elevations during high wave conditions (Bayle, Kaminsky, Blenkinsopp, Weiner, & Cottrell, 2021; Allan, Hart, & Tranquili, 2006; Allan & Hart, 2007). Dynamic revetments are also more cost-effective

Dynamic Revetment

DYNAMIC REVETMENT AT CAPE LOOKOUT. PHOTO BY HAILEY BOND, 2021

for several reasons. First, because the revetment moves and reshapes itself in response to wave conditions, the initial placement of the cobbles is less important than in the construction of a traditional revetment, making construction costs cheaper. Second, because the stone size is smaller, it is typically less expensive than typical armor stone. In Oregon, cobble beaches exist naturally, so constructed dynamic revetments are more compatible with the natural environment than other erosion control options (Allan, Geitgey, & Hart, 2005).

While dynamic revetments have advantages over traditional static revetments, there are drawbacks as well. As the cobbles can move, they don't provide the same level of protection as traditional riprap. Dynamic revetments also require more frequent maintenance, as cobbles can be moved off- or alongshore during extreme wave conditions. For the two dynamic revetments on the outer Oregon coast, maintenance approximately every 10 years is typical. Movement of cobbles can be especially concerning if the dynamic revetment is near a creek, as the cobbles could cut off the mouth of the creek (Oregon Department of Transportation, 2017). Cobbles also have the potential to become projectiles during storms, making them a hazard to people and property. Additionally, dynamic revetments work best over a stretch of coastline rather than on a lot-by-lot basis and thus may not be an appropriate option for an individual property owner.

Dynamic Revetment

Dynamic revetments in Oregon

Oregon has two engineered dynamic revetments on the open coast. The first was completed at Cape Lookout in 2000. Cobbles were removed from the south end of the beach and moved northwards in front of an eroding campground. An artificial dune was also constructed using sand-filled geotextile bags with a sand covering and vegetation planting. The crest of the artificial dune was 23-26 ft at the south end of the structure, and 26-33 ft at the north end of the structure. The dynamic revetment crest elevation was 17 ft in the north and 23 ft in the south. The dynamic revetment was not planned to stop all overtopping, but to limit it and protect the artificial dunes from erosion (Allan, Komar, & Hart, 2003). The dynamic revetment has experienced relatively minor damage over its 20-year life, with periodic replenishment of cobble needed by OPRD and repairs required in 2007 and 2021.

The second dynamic revetment on the open coast is at the south jetty of the Columbia River. It was put in place to prevent breaching of the spit, which could have severe consequences for the estuary and jetties. The project was completed in 2013 and had a crest elevation of 22 ft, a crest width of 65 ft, and a slope of 0.2 that was expected to equilibrate to a slope of 0.07. Maintenance for the revetment is expected every 10-15 years (Allan & Gabel, 2016) and will be completed by USACE. While Allan & Gabel (2016) identified erosion at the north end of the revetment and cobble movement southward, the revetment has withstood several significant wave events.

DYNAMIC REVETMENT AT THE COLUMBIA RIVER. PHOTO BY JONATHAN ALLAN, 2013

Dynamic Revetment

How will dynamic revetments perform under sea level rise?

Dynamic revetments function best when placed above high tide. As sea levels rise, dynamic revetments that are already in place are expected to self-adapt to sea level rise through rollover transport. In other words, as the water level gets higher, cobbles are expected to roll over the top of the revetment, causing the whole structure to retreat backwards and upwards (Bayle, Blenkinsopp, Masselink, Beuzen, & Almar, 2020).

Dynamic revetment policy

As dynamic revetments move and reshape in response to wave attack, they are considered non-structural and do not need to meet eligibility requirements under Goal 18 for permitting. If a dynamic revetment is constructed above the mean high tide line, it needs a permit from OPRD for construction. However, the permitting process at OPRD requires that shore alterations match their surroundings as much as possible. If a beach is sandy and does not naturally have some cobbles, a dynamic revetment may not be permitted for that beach. Check with the local jurisdiction for any local permits needed if the revetment will be landward of OPRD's jurisdiction.

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Beach Nourishment

Beach Nourishment - Quick Facts

- **Beach nourishment is the practice of adding sand to a beach to protect the backshore from erosion.**
- **Beach nourishment project designs are very specific to the location where they are constructed.**
- **Sand sources are often from offshore or from dredging of estuaries and rivers.**
- **Beach nourishment is not common in Oregon because of the high-energy wave climate and limited availability of sediment.**
- **Beach nourishment has occurred after dredging near the Columbia River and Port Orford.**
- **Beach nourishment is not considered a beachfront protective structure and does not require eligibility under Goal 18 for construction.**

What is beach nourishment?

Beach nourishment is the practice of adding sand to a beach to protect the backshore from erosion, enhance recreation, or improve habitat. Beach nourishment is especially common on the East and Gulf coasts (ASBPA, n.d.) Beach nourishment projects are very specific to the site conditions where the project will take place. The United States Army Corps of Engineers' Shore Protection Assessment recommends that engineers consider:

- Climatology
- The shape of the beach
- The type of native sand
- Volume and rates of sediment transport
- Erosion patterns and causes
- Waves and water levels
- Historical data and previous storms
- Probability of certain beach behaviors at the site
- Existing structures and infrastructure
- Past engineering activities in the area

Beach Nourishment

Sand for beach nourishment is typically dredged from offshore using a barge and pumped onshore, although sand can also be brought from land sources using trucks (USACE, n.d.). To ensure the longevity of the beach nourishment project, sand should be the same size or coarser than the local sediment (Masselink, Hughes, & Knight, 2011).

There are three typical ways of constructing a beach nourishment: 1) sand can be placed in dunes above the influence of most waves; 2) sand can be placed directly on the beach to widen it; or 3) sand can be placed just offshore to create a sandbar. If sand is placed in dunes, storm waves may remove the sand during periods of high water. If sand is placed directly on the beach, it is placed at a steep slope and expected to reshape by flattening and spreading out. When placed in an offshore sandbar, waves will push it onshore to widen the beach (USACE, n.d.). All these options will require periodic renourishment.

Due to the expected movement of sand as a beach nourishment project equilibrates to the wave conditions, beach nourishments must be applied over a stretch of coastline rather than on a lot-by-lot basis.

For many areas, beach nourishment is an ideal option to maintain beaches. Compared to other erosion control methods, beach nourishment is easier to construct and maintain, and is most similar to the natural ecosystem. With regular maintenance and a suitable sand source, beach nourishment programs can consistently keep beaches at the desired width and reduce threats from erosion and flooding. Beach nourishment is especially desirable as a non-structural options in areas where structural erosion control is not preferred or prohibited due to its impact on the beach. Beach nourishment can hold the beach in a more natural state by making up for any sediment deficits causing erosion.

However, the suitability of beach nourishment programs is heavily dependent on a reliable, sustainable, clean sediment source for the life of the project. A sediment source that is too far away can quickly drive project costs beyond what communities can pay. Construction of nourishments can also impact plants and animals on the beach when layers of sand and heavy machinery are used (UCSB Explore Beaches, n.d.).

How will beach nourishment perform under sea level rise?

Beach nourishment is used currently to mitigate sea level rise impacts in places where sediment sources are plentiful and beach nourishment is economically viable, like the East and Gulf coasts (Houston, 2020). As the rate of sea level rise increases, the volume of sand and the frequency of nourishment needed to maintain beach widths will likely increase, making beach nourishment more expensive and potentially no longer financially viable over time.

Beach Nourishment

Beach nourishment in Oregon

Beach nourishment is not common in Oregon for several reasons. First, suitable sand sources in Oregon are few and far between. Removing sand from offshore sources for use on the beach is difficult, costly, and has environmental and political ramifications. Dredging from estuaries is therefore the only viable sand source for beach nourishment (Tillamook County Department of Community Development, 2013). This sand may not be of the appropriate composition for beaches on the Oregon coast, and in many situations may be too far away to reasonably be used for cost-effective nourishment.

Due to Oregon's energetic wave climate, beach nourishment projects would require an immense amount of sand For example, to widen the beach by 100 ft in Neskowin, it was estimated that 250 cubic yards of sand would be required per linear foot of shoreline. For the approximately 7,000 ft of shoreline needing nourishment, ~1.8 million cubic yards of sand would be needed (Tillamook County Department of Community Development, 2013). Oregon's wave climate also means that maintenance may be needed more often in Oregon than in other places with less energetic wave climates.

Due to the high wave climate and lack of suitable sand sources, beach nourishment projects to protect the communities on the coast are estimated to come with high price tags. In 2017, USACE was involved in preparing a plan for beach nourishment project to protect Beverly Beach with an estimated cost of 15.5 million dollars (Oregon Department of Transportation, 2017). In 2013, 2,600 ft of beach nourishment in Neskowin was estimated at 18 million dollars (Tillamook County Department of Community Development, 2013).

The only two beach nourishment projects in Oregon listed on ASBPA's National Beach Nourishment Database are near the mouth of the Columbia River and near the Port of Port Orford breakwater (ASBPA, n.d.). These projects are both related to large federal navigation projects and are near estuaries with ongoing dredging. Material from dredging in the Port Orford harbor was also used to nourish beaches in the area to improve Snowy Plover habitat (NOAA, 2000).

Beach nourishment policy

Beach nourishment is considered a non-structural erosion control measure in Oregon, and therefore does not need eligibility under Goal 18 for construction. Beach nourishment projects require permits from OPRD for sand placed above the tide line and permits from USACE and DSL for sand placed below the high tide line (Tillamook County Department of Community Development, 2013). Check with the local jurisdiction for any local permits needed if the project will extend landward of OPRD's jurisdiction.

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Beach Scraping

Beach Scraping - Quick Facts

- **Beach scraping is the process of stimulating natural recovery from short-term erosion by moving sand from the intertidal zone to the beach.**
- **Beach scraping can be cost-effective and low-impact.**
- **Beach scraping is a temporary solution and not a long term management strategy.**
- **The amount of sand moved cannot exceed the natural rate of recovery. In other words, beach scraping can protect against damage due to consecutive storms but will not be effective in areas of chronic shoreline erosion.**
- **Beach scraping is not a beachfront protective structure and does not require eligibility under Goal 18 for construction.**

What is beach scraping?

Beach scraping is the process of stimulating natural recovery from short-term erosion by moving sand from the intertidal zone to the beach or upper beach through mechanical means (Carley, 2010). Beaches naturally experience cycles of erosion and accretion on timescales from single storms to seasons. During erosive periods, sand erodes from the beach or dunes and is transported to the swash zone or a sandbar. During accretive periods, smaller waves naturally push this sand back up on the beach, restoring the eroded beach and dunes. Beach scraping accomplishes this natural process through mechanical means by using heavy machinery to move sand from the swash zone to the beach. When the swash zone is flattened by removing sand, it encourages accretion by letting waves propagate further up the beach to deposit sand.

Under the right circumstances, beach scraping can be a cost-effective and low-impact way of protecting infrastructure. Beach scraping does not require any import of sand, and the sand is always compatible with the surroundings because it cycles naturally between the intertidal zone and the beach. A beach scraping project is relatively cheap, can be completed rapidly, and is compatible with the aesthetics of the beach.

While beach scraping is a useful tool in some situations, it has some significant limitations. Beach scraping is a temporary solution for erosion and is not a good strategy for long-term management. Depending on the conditions, scraping may need to be completed several times during a year. It is useful for preventing damage due to consecutive storms without recovery time between them but is not effective in areas where chronic shoreline erosion is occurring. The scraping rate cannot exceed the rate of recovery of the intertidal zone without causing additional erosion (Tye, 1983; McNinch, 1992).

Beach Scraping

The design and implementation of beach scraping programs is variable based on site conditions. However, some recommendations and observations can be found in literature. Bruun (1983) recommended scraping depths of 0.7 to 1.6 ft and placement of the sand in dunes. Tye (1983) studied a beach scraping project with scraping volumes of 300 ft^3/ft and concluded the scraping rate was excessive and the beach profiles did not recover. Gallien (2015) studied event, seasonal, and persistent berms in California and described event berms created by beach scraping as temporary structures with triangular cross-sections and relatively low volumes and crest elevations (43 ft^3/ft and 5ft, respectively).

Beach Scraping in Oregon

Beach scraping has been used infrequently on the Oregon coast. Private homes in Lincoln Beach and Cape Lookout State Park have both tried beach scraping but eventually pursued more permanent long-term solutions (riprap in Lincoln Beach and a dynamic revetment at Cape Lookout State Park). Beach scraping likely has limited utility in Oregon. In areas where chronic erosion is an issue, beach scraping at a rate less than that of the rate of recovery of the intertidal zone will not provide an acceptable level of protection. Beach scraping is useful when otherwise stable coastlines are in danger of infrastructure damage due to two consecutive storms.

How will beach scraping perform under sea level rise?

Beach scraping is best used as temporary measure to prevent episodic erosion, so it is not a good solution for mitigating the effects of sea level rise.

Beach Scraping Policy

Beach scraping is not a structural erosion control measure and does not require Goal 18 eligibility for construction. However, it does require an OPRD shore alteration permit and likely a joint removal-fill permit from DSL and USACE for removing sand in the intertidal zone. Check with the local jurisdiction for any local permits needed if the project will extend landward of OPRD's jurisdiction.

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Seawall

Seawall - Quick Facts

- **Seawalls are structures built parallel to the shoreline to protect the upland from wave action, erosion, and flooding.**
- **There are several types of seawall design; all are heavily engineered and must be designed based on site conditions.**
- **Seawalls are generally effective at reflecting wave energy and protecting the upland.**
- **Seawalls built on eroding coasts cause the beach to narrow.**
- **Seawalls are prone to failure, especially if improperly designed.**
- **Seawalls are common in populous places on the central Oregon coast.**

What is a seawall?

Seawalls are structures built parallel to the shoreline to protect the upland from wave action, erosion, and flooding. Seawalls are an extremely common method of controlling erosion on coastlines worldwide, and a quick image search will show a multitude of traditional and innovative seawall concepts on scales from single homes to entire cities. Most seawalls can be divided into three categories: vertical, curved, and stepped. As a note, many people include “rubble seawalls” in their seawall categories. However, in Oregon, rubble seawalls are typically known as riprap, and are discussed separately.

Vertical seawalls use a strong vertical face to reflect wave energy. They are typically made of concrete, but can also be made of sheet pile or other materials.

Curved seawalls are similar to vertical seawalls, but have a concave curved design to alter the way waves are reflected. Curved seawalls are intended to reduce the amount of scour that occurs due to wave reflection.

Stepped seawalls also protect the coast by reflecting wave energy, but the seawall, rather than having a smooth face, has a stair-step shape on the seaward side. Stepped seawalls are intended to break up and dissipate waves to better protect the upland and to prolong the life of the structure.

Seawalls are generally heavily engineered structures that must be designed based on wave heights, expected tides and storm surges, soil characteristics, and other factors.

Seawalls have a number of benefits over other coastal protection structures. Like riprap revetments, they are effective at reflecting wave energy and protecting the upland. They also have additional benefits over riprap structures. Seawalls take up less land than riprap, and can be incorporated into promenades (Seaside, OR is a good example). Seawalls also can provide flood protection in addition to erosion control, so they can be used as effective storm surge and sunny-day flood protection (CTCN, n.d.).

STRUCTURAL EROSION CONTROL

Seawall

While seawalls are effective at reflecting wave energy and preventing flooding, their effectiveness comes with a price. Seawalls have a significant effect on the beach. They fix the shoreline in place, causing passive erosion, a term for the lowering of the beach due to sea level rise. Without a place for the beach fronting the seawall to migrate upward and landward, it will narrow and eventually be lost to the rising seas. Seawalls also interrupt the natural replenishment of sand to the beach through erosion of cliff faces, called sediment impoundment, which can lead to further erosion on the beach. In addition to the passive erosion seawalls cause simply by their presence, seawalls also have the potential to cause active erosion by impacting hydrodynamics and sediment transport processes. Kraus and McDougal (1996) provide a literature review detailing the scientific debate over the nature of active erosion and the circumstances under which it will occur. Weggel (1988) developed a rating system to classify the active erosion a seawall might cause based on the location of the seawall and the depth of water at its base. This rating can change over time due to sea level rise. Komar and McDougal (1988) studied active erosion specifically on the Oregon coast and, while scour and flanking were evident in their lab experiment, the complex and high-energy processes on the Oregon coast typically mask effects of seawalls and other hard structures.

Seawalls are also prone to failure, especially if not properly designed. Changes in water level, wave height, or deterioration of the seawall materials can contribute to seawall failure (Stokes Marine, 2020). They also tend to be more expensive than other erosion control options.

Seawalls also have an impact on the appearance and recreational opportunities of the beach. Seawalls disrupt the connection between the upland and the beach and require beachgoers to use designated beach access points. They also are not visually appealing and not generally appreciated by beachgoers.

SEAWALL IN WECOMA BEACH, LINCOLN COUNTY. PHOTO BY HAILEY BOND, 2021

Seawall

How will seawalls perform under sea level rise?

Seawalls have an advantage compared to other erosion control mechanisms, because they are effective against flooding and may help communities delay the effects of sea level rise. However, by holding the coastline in place, seawalls will contribute to the narrowing and eventual loss of beaches due to sediment impoundment and passive erosion. Seawalls also have the potential for failure under changing water levels, making them vulnerable to sea level rise.

Seawalls in Oregon

Seawalls are a common sight along the central Oregon coast (e.g. Gleneden Beach), especially in populous areas. Riprap revetments are generally preferred over seawalls currently, but many seawalls in good repair are visible all over the coast.

PROMENADE AT SEASIDE. PHOTO BY HAILEY BOND, 2021

Seawall policy

Seawalls are intended to hold the coastline in place, reflect wave energy, and remain static, so they are considered structures. To move forward with construction of a seawall, a property must be considered eligible under Goal 18. Seawalls also require an Ocean Shore Alteration Permit from OPRD for construction. Check with the local jurisdiction for any local permits needed if the seawall will be landward of OPRD's jurisdiction.

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Riprap Revetment

Riprap Revetment - Quick Facts

- **A riprap revetment, or riprap, is an engineered structure made of large boulders that protects the upland.**
- **Riprap is extremely common in Oregon, and a well-known standard design has been developed by coastal practitioners.**
- **Because the face of riprap is sloped, it takes up space on the beach during its construction.**
- **When placed on an eroding coast, riprap causes narrowing of the beach.**
- **If any stones in the riprap structure move, the entire structure may be destabilized.**
- **Riprap is a beachfront protective structure, and requires Goal 18 eligibility for construction.**

What is riprap?

Riprap is an erosion control measure made of rocks placed on a slope for protection. Riprap is extremely common in Oregon; it accounted for 85% of hard stabilization structures constructed between 1976 -1999. The construction of riprap has a long history in Oregon, but riprap designs were not regulated in the early days of structural erosion protection. Komar and McDougal (1988) said about seawalls and riprap “Little consideration has been given to the design of these structures and their requirements specific to the Oregon coast, and the designs commonly are not based on sound engineering practice. As a result, some have not been successful.” Additionally, until the 1990s, homeowners regularly designed their own riprap protection, and this riprap commonly did not meet modern minimum standards for performance. For example, in the winter of 2020/21, riprap built in 1973 failed on the Salishan Spit, jeopardizing homes and requiring emergency protection. Before engineering geologic reports were required for structures over 50 ft in length, riprap was sometimes not properly engineered.

Over the years of riprap construction on the Oregon coast, a typical design has been developed by engineering geologists and contractors. The design of riprap typically involves a layer of permeable bedding material that separates the rock from the sand underneath, a layer of filter rock, a layer of quarry run bedding, and a layer of riprap armor. The riprap rocks are generally placed individually with three points of contact to provide stability rather than being randomly dumped (Hiller, Aberle, & Lia, 2018). Riprap armor is often covered with sand and planted with beach grass. Examples of riprap structures can be found in OPRD’s permit files.

Riprap is the most common erosion control measure in Oregon for a few reasons. Over time, it’s been proven extremely successful. Trial and error have helped to develop designs that are best suited for the highly energetic wave climate in Oregon. The material for riprap is also readily available on the coast. Construction is relatively simple, and many contractors on the Oregon coast are very experienced in the construction of riprap.

Riprap Revetment

RIPRAP ON THE SALISHAN SPIT. PHOTO BY HAILEY BOND, 2021

While riprap is generally successful as a short-term solution for erosion control, it has disadvantages. Riprap protects well against erosion, but in high wave conditions, wave overtopping and flooding can still impact structures behind the riprap. Riprap is susceptible to undermining due to scour, which can destabilize the whole structure and cause its failure. Riprap also has a negative effect on the beach. It takes up more space on the beach than other kinds of structural beachfront protective structures because it needs to be constructed at a 1.5 – 2 horizontal : 1 vertical slope. When placed on an eroding coast, riprap fixes the shoreline in place. However, sand continues eroding from in front of the structure causing beach lowering. This process is known as passive erosion. Under chronic erosive conditions, the beach may significantly narrow and create an artificial headland around the riprapped area. In some cases, riprap can increase the rate of erosion above the background rate. The impact of this process, called active erosion, is difficult to determine in Oregon, where variations in erosion rate can also be caused by powerful rip embayments. However, in general, active erosion is more likely to occur when the mean water level is above the base of the structure (Weggel, 1988; Ruggiero & McDougal, 2001).

How will riprap perform under sea level rise?

Existing riprap will become less effective as sea level rises. While riprap can protect against erosion, it can do little against flooding as sea level rises and wave heights increase. Rising sea levels and passive erosion will continue to narrow the beach and make it impassable for more of the year. Active erosion may also increase as structures are impacted more often by high water levels. Additionally, sea level rise can enable waves to travel further up the beach without their energy dissipating, increasing the chance for damage to the structure due to scour and movement of riprap stones.

Riprap Revetment

Riprap policy

Riprap revetments are intended to protect the upland, remain in place, and reflect wave energy, so they are considered a beachfront protective structure and require Goal 18 eligibility for construction. Riprap also requires an ocean shore alteration permit from OPRD, as well as any necessary local permits. Check with the local jurisdiction for any local permits needed if the revetment will extend landward of OPRD's jurisdiction.

RIPRAP CONSTRUCTION IN LINCOLN BEACH. PHOTO BY HAILEY BOND, 2021

Riprap revetment references

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Sandbags

Sandbags - Quick Facts

- **To prevent erosion, large geotextile tubes can be filled and stacked on the coast.**
- **Sandbags are generally considered a temporary solution to erosion; their lifespan is approximately 5 years due to UV exposure and damage.**
- **Sandbags can be placed without costly equipment or skilled labor, and are useful when materials such as rock or concrete are limited.**
- **When sandbags fail, they leave trash on the beach or in the water and can be an eyesore.**
- **Oregon has very few sandbag structures, but there is an artificial dune created with sandbags at Cape Lookout.**
- **Because sandbags are intended to remain in place and reflect wave energy, they are considered beachfront protective structures and require Goal 18 eligibiltiy for construction.**

What are sandbags?

Sandbags and sand tubes are names for the erosion control technique of filling geotextile (polyester and polypropylene are common) bags with sand to create a protective barrier against the ocean. In some places, sandbags are used as the most efficient protection material due to material or construction constraints (USACE Alaska). In others, sandbags are used for policy reasons because all other methods of protection have been prohibited (Neal, Pilkey, & Longo, 2017).

Sandbags are typically thought of as a temporary solution to erosion. Sandbag revetments are estimated to have a lifespan of approximately 5 years, although this can depend on the site conditions. Sandbag revetments can deteriorate due to UV damage of the geotextile fabric, and individual sandbags can fail due to small punctures, making them best for temporary protection (RISC-KIT, n.d.).

Sandbags are typically 3-5 ft wide and 7-15 ft long when measured flat. For an order-of-magnitude estimate, a sandbag 10 ft long and 5 ft wide, when filled, will contain approximately 3 tons of sand. Sandbag revetments must be constructed deep enough to avoid undercutting from changes in the beach profile, and filter fabric is recommended underneath the base of the revetment. Sandbags are most stable at a slope of 1.5-2H:1V but can be constructed at steeper slopes based on site conditions. Configurations of sandbags can vary widely, but typically they are laid across the dune face with approximately 30-50 percent overlap between bags. It is recommended for the sandbags to be covered with sand and feathered back into the face of the dune if possible (RISC-KIT, n.d.). USACE also recommends using a tether system to retain failed bags to avoid litter on the beach (USACE Alaska).

STRUCTURAL EROSION CONTROL
Sandbags

SANDBAGS ERODING FROM ARTIFICIAL DUNE, CAPE LOOKOUT. PHOTO BY HAILEY BOND, 2021

Sandbag revetments have advantages over traditional revetments for a few reasons. Depending on the scale of the project, they can often be placed without costly equipment or skilled labor. The geotextile bags are lower cost than transporting revetment rock, especially in situations where there are no suitable rock sources nearby. Sandbag revetments are also good for temporary protection during episodic erosion events where permanent riprap is unnecessary (RISC-KIT, n.d.).

In some situations, sandbags are used as more permanent erosion solutions. This has disadvantages compared to traditional rock revetments. The design life of sandbag revetments is only about 5 years due to UV damage to the bags and failure of the bags after punctures from debris or vandalism. Upon failure, sandbags can create an eyesore as the geotextile fabric litters the beach. Sandbag revetments also have the same potential as rock revetments and seawalls to impact the beach, as they fix the shoreline in place artificially and can increase wave reflection and scour. However, sandbag revetments typically fail before they can cause lasting harm to the beach (RISC-KIT, n.d.).

How will sandbags perform under sea level rise?

Sandbags have such a short design life that their performance under sea level rise is not relevant, as they will likely fail structurally before being impacted by effects of sea level rise.

Sandbags

Sandbags in Oregon

Sandbags are not commonly used in Oregon, as they are not suitable for the high-energy wave climate. However, geotextile sandbags were used in the construction of an artificial dune project at Cape Lookout, fronted by a dynamic revetment. The artificial dune was constructed with sandbags and then covered with sand and planted with vegetation. However, as erosion has impacted the artificial dune 20 years after its construction, some sandbags have failed and needed to be replaced. Sandbags were also used near Heceta Head, but failed under riverine processes and large wave runup during extreme storms.

Sandbag policy

In Oregon, sandbags and sand tubes are considered structures, because they are intended to stay in one place and reflect wave energy. Therefore, they can only be used to protect areas that are eligible for beachfront protective structures under Goal 18. Sandbag structures will also need an ocean shore alteration permit from OPRD for construction. Check with the local jurisdiction for any local permits needed if sandbags will be landward of OPRD's jurisdiction

Sandbag references

Neal, W., Pilkey, O., & Longo, N. (2017, April 1). Sandbagging at the Shore: North Carolina's Coastal Sand Bags and Political Sandbaggers. Retrieved from Coastal Care: https://coastalcare.org/2017/04/sandbagging-at-the-shore-north-carolinas-coastal-sand-bags-and-political-sandbaggers-by-william-neal-orrin-pilkey-norma-longo/

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Gabions

Gabions - Quick Facts

- **Gabions are wire baskets filled with rocks that can be used as building blocks for erosion control projects**
- **Gabion structures are cheaper than riprap or seawalls, and can build when large rock and concrete are scarce**
- **The wire used to construct gabions can easily be damaged or corroded, causing the baskets to fail.**
- **When gabions fail, they can become a safety hazard due to their sharp wire.**
- **Gabion structures are extremely prone to failure, both due to damage of the individual gabions and due to scour and undermining of the structure as a whole**
- **Gabion structures are considered beachfront protective strcutres, and require eligibility under Goal 18 for construction**

What are gabions?

"Gabion" is the term for a wire basket filled with rocks that can act as a building block for bank stabilization or erosion control projects. Gabion baskets can be arranged on top of a backfilled slope with a filter layer similar to typical riprap designs or can be stacked to form a seawall (USACE CEM). On the Oregon coast, gabion baskets are typically used to build new seawalls or to add height to already existing seawalls. A single gabion basket can vary in size, but standard baskets are 3 ft wide, between 6-12 ft long, and 1-3 ft tall. The recommended size of the stones filling the gabion basket is between 4-8 inches in diameter. To avoid abrasion on the wires from the rocks within the basket, gabions must be filled tightly (USACE, 2011).

Gabion structures are a popular attempted solution for erosion and bank stabilization throughout the world. They are typically cheaper than riprap or seawalls and can be built without heavy equipment or access to concrete or typical riprap rock. However, they are not suitable for every environment. The wire on gabion baskets can be damaged by wave action, debris, cobble, and foot traffic. When the wire on the baskets is damaged, it can rust and further compromise the integrity of the basket. As the wire corrodes, it can spill rock out onto the beach and become a safety hazard. Structures made of gabion baskets are therefore not suitable for beaches that typically have driftwood or cobble and are not suitable in areas where wave impact would be frequent and high-energy. Like other types of structural erosion control, gabion baskets can also be undermined by scour or sediment washout, threatening the stability of the entire structure. While gabion structures are typically less costly than riprap or seawalls, their lifespan is often shorter than expected due to damage. A study based in Puerto Rico describes the "life cycle" of gabion erosion control on the island, with the last stage in the life cycle being "replacement –

Gabions

GABION BASKETS AT WECOMA BEACH, LINCOLN COUNTY. PHOTO BY HAILEY BOND, 2021

failed gabions are replaced by more substantial hard structures or covered in concrete." The study suggests due to the regular replacement of gabions with a more substantial structure sooner than expected, gabions may not be as cost-effective as they seem (Jackson, Bush, & Neal, 2006). Gabion structures are classified by the USACE as having high reflection potential, indicating that they are similar to riprap and seawalls in their impact on the beach (USACE, 2011).

In Oregon, the use of gabion baskets is limited. Riprap and seawalls, while higher in cost, provide more reliable and sturdy protection. Of the few examples of gabion baskets used for erosion control on the Oregon coast, many are damaged.

How will gabions perform under sea level rise?

Because of their susceptibility to damage from wave action, existing gabion structures will likely become less effective and more prone to damage as sea levels rise and the structures are impacted by waves and debris more often. Like other kinds of structural erosion control, gabion structures are susceptible to failure due to scour and sediment washout beneath the structure, which will become more likely as sea level rises.

Gabions

Gabion policy

Gabion walls are intended to protect the upland, remain in place, and reflect wave energy, so they are considered a beachfront protective structure and require Goal 18 eligibility for construction. Gabion walls also require an ocean shore alteration permit from OPRD, as well as any necessary local permits. Check with the local jurisdiction for any local permits needed if the gabion wall will extend landward of OPRD's jurisdiction.

Gabion references

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