

PROTECT Resilience Planning Grant

US-101 Beverly Beach Coastal Erosion Planning and Pre-Design Project



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Eligible Location:	US-101 Mile Point 133-136 'Beverly Beach'
Total Project Costs:	\$5,000,000
Program Grant Request Amount:	\$5,000,000
Federal (DOT) Funding Including Request:	\$5,000,000

Table of Contents

Table of Contents.....	2
Project Description.....	3
Project Location	6
Economic Growth and Tourism	6
Transportation Disadvantaged	7
Project Need for Resilience Planning and Predesign	8
Resilience Corridor.....	9
FEMA Floodplain	10
PROTECT Planning Grant.....	10
Response to Merit Criterion	11
Program Alignment.....	11
Schedule and Budget	14
Public Engagement, Partnerships and Collaboration	14
Innovation	15
Green Infrastructure Analysis	15

Project Description

The Oregon Coast Highway (US-101) is a 363-mile highway located along the Oregon Coast from California to Washington and connects dozens of coastal communities. Built in the 1920s and 1930s, US-101 is invaluable to national, state, and regional interests as it contains scenic, economic, emergency, and national defense attributes. US-101 is part of the National Highway System and Strategic Highway Network and is designated a Lifeline Route, Oregon Scenic Byway, National Scenic Byway, and Oregon Coast Bike Route:

National Highway System: Federally designated highways in rural and urban areas that provide access between an arterial and a major port, airport, public transportation facility, or other intermodal transportation facility.

Strategic Highway Network (STRAHNET): This is a network of highways which are important to the United States' strategic defense policy and which provide defense access, continuity, and emergency capabilities for defense purposes.

Oregon Highway Plan (OHP) Lifeline Route: The 1999 OHP Policy 1E designates lifeline routes as a secure network of streets, highways, and bridges to facilitate emergency service response and to support rapid economic recovery after a disaster. Keeping lifeline routes open is vital to the safety and economy of Oregon.

Oregon Scenic Byway: The OHP Policy 1D: Scenic Byways states "It is the policy of the State of Oregon to preserve and enhance designated Scenic Byways and to consider aesthetic and design elements along with safety and performance considerations on designated Byways."

National Scenic Byway: The National Scenic Byways Program is part of the U.S. Department of Transportation's Federal Highway Administration. The program is a grass-roots collaborative effort established to help recognize, preserve, and enhance selected roads throughout the United States. The U.S. Secretary of Transportation recognizes certain roads as All-American Roads or National Scenic Byways based on one or more archeological, cultural, historic, natural, recreational, and scenic qualities.

Oregon Coast Bike Route: The Oregon Coast Bike Route has been a popular bicycle route since 1982 when it was officially designated by the Oregon Transportation Commission. Thousands of bicyclists enjoy the Oregon Coast Bike Route annually.

The coastal location and age of US-101 presents various factors that are accelerating deterioration of the highway, including, but not limited to:

Construction Standards: Highways constructed during the 1930s to 1950s, such as US-101, used steeper fill slopes which now makes them more susceptible to failure.

Settlement: Fill settlement over the last 50-70 years has caused pipe constrictions and separation, adversely affecting highway sections.

Geology: Previous highway materials contained weathered sedimentary or volcanic rock that have since degraded to clay materials in the marine environment.

Subduction Zones: According to the National Research Council, the Oregon Coast is experiencing slight vertical uplift or sea level fall.

Climate: Climate change is increasing the intensity of major winter storms and generated wave heights creating further beach erosion.

The Oregon Coast Highway (US-101) Beverly Beach Coastal Erosion Planning and Pre-Design project will identify a long-term solution for the approximate two-mile segment of US-101 that is rapidly deteriorating due to consistent beachfront erosion. Combining factors include a narrow beach and a sand-starved littoral cell offering little protection against wave attack. In addition, the site is experiencing the weathering of non-durable rock, groundwater seepage from the roadway, and an undercut bluff due to wave erosion.

Every year, the Oregon Department of Transportation (ODOT) receives numerous complaints from the public, who observe the obvious erosion from the beach below (Figure 1). Years of constant wave friction, and more recent increase in king tides, have eroded the base of the highway, causing crumbling pavement and exposed guardrail posts. Maintenance crews do what they can to patch every year, but a long-term solution is necessary.



Figure 1. Exposed Guardrail Beach View

Further constraining the ability to construct permanent improvements to US-101 is related to 1980s statewide policy, which previously

prohibited ‘beachfront protective structures’ to the highway. This policy is called ‘Statewide Planning Goal 18 – Beachfront and Dunes’ which, until recently, restricted the types of erosion control improvements along US-101. Prohibited beachfront protective structures is the construction of any solution with retaining walls, rip-rap/large jetty rock, or other hard infrastructure. Over time, it was apparent that this policy was affecting the need for highway improvements and changes to policy were needed. In September 2022, a multi-year/multi-agency effort concluded and lifted this restriction, thereby allowing ODOT to apply for an exception to construct beachfront protective structures. The exception must illustrate different alternatives considered, provide a conceptual preferred design, and meet associated land use criteria.

As illustrated in Figure 2, this US-101 segment is in urgent need for an identified solution, developed designs, and construction of a permanent fix to the sloping area of highway.

The PROTECT Resiliency Planning Grant will allow ODOT to:

- Build upon existing planning studies, green infrastructure design, climate analysis, and existing conditions analysis at the site to identify a long-term beachfront solution.
- Develop conceptual designs to illustrate the preferred improvement that meets climate change goals while addressing multi-modes and equity needs.
- Address statewide regulations, such as Oregon Statewide



Figure 2. Highway Deterioration Street View

- Address statewide regulations, such as Oregon Statewide Planning Goal 18, and move forward in the regulatory process with Lincoln County, the Department of Land Conservations and Development (DLCD), and Oregon Parks and Recreation Department (OPRD).
- Prepare a final pre-design package that sets the project for future construction funding opportunities.
- Inform resilience designs for other at-risk Oregon coastal locations.

Project Location

US-101 Beverly Beach is centrally located in Lincoln County, connecting dozens of communities, businesses, recreational sites, and beachfront destinations (Figure 3). These communities rely on US-101 for tourism, freight, recreational, and multi-modal travel.

Economic Growth and Tourism

US-101 draws millions of recreational visits each year due to its scenic coastal route. The U.S. Department of Transportation has designated the 363-mile highway as an All-American Road and as the Pacific Coast Scenic Byway. While many travel the length of the coast, others are regionally focused. Popular tourist destinations to the north and south of the project area include Beverly Beach State Park, Yaquina Head lighthouse (designated as a Bureau of Land Management Outstanding Natural Area), and Newport's Oregon Coast Aquarium, which draws hundreds of thousands of visitors of all ages each year.

In addition, the State of Oregon has included this segment of the highway as part of the Oregon Coast Bike Route (OCBR), which is a portion of the Pacific Coast Bike Route designated by the Adventure Cycling Association. As an indication of the highway's biking popularity, an economic report determined that bicyclists took over 131,000 trips of 50 miles or more along the OCBR and spent upwards of \$56 million along the route in 2012.

Safely traveling this highway and reaching popular destinations is important for local residents as well as tourists. Due to limited housing and high prices, many local residents commonly travel between cities surrounding the project area, like Depoe

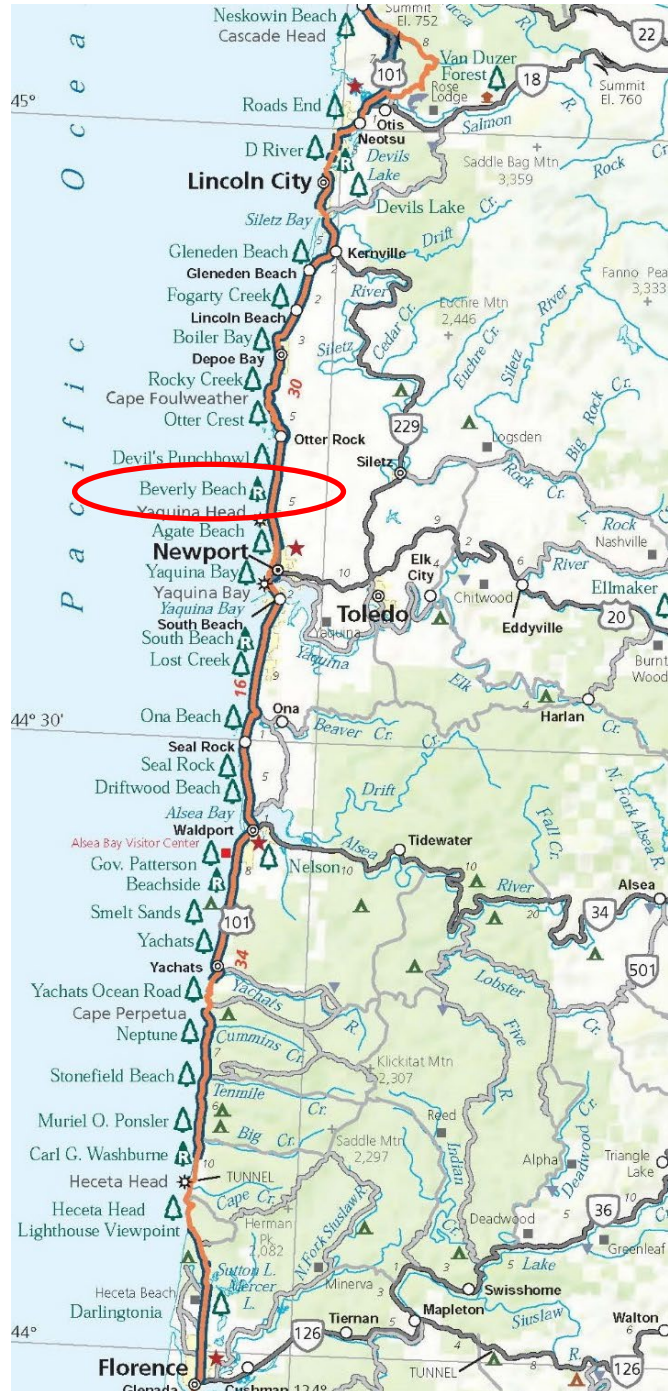


Figure 3. Oregon Coast Bike Route Map

Bay and Newport, to reach places of employment, schools, and day-to-day services.

The highway also serves the public with transit service run by Lincoln County. This service provides regular bus service to the north and south of Beverly Beach, from Lincoln City to Yachats, as well as trips to the Willamette Valley. Other transit providers coordinate with this service to destinations further up and down the coast and throughout Oregon.

Transportation Disadvantaged

ODOT's *Social Equity Index Map* uses 2019 American Community Survey block group data to identify Oregon's marginalized populations. This shows how many people are in a community, are ages 64 and older, live in poverty, have limited English proficiency, are disabled, or are non-white/Hispanic populations.



Figure 4. ODOT Social Equity Index Map

The Social Equity Index Map for Beverly Beach (Figure 4) indicates that this area has a Medium-High Disparity (third highest of four disparity values). This reflects that the area receives a relatively low amount of transportation investment and people in this area have generally less access to services and less input on transportation decisions.

The *US Department of Transportation Disadvantaged Census Tract* identifies disadvantaged communities through six transportation indicators, with communities having four or more indicators considered "highly disadvantaged." Beverly Beach has three of the six disadvantage indicators: 1) **Health** identifies communities based on variables associated with adverse health outcomes, disability, as well as environmental exposures; 2) **Economic** identifies areas and populations with high poverty, low wealth, lack of local jobs, low home ownership, low educational attainment, and high inequality; and 3) **Resilience** identifies communities vulnerable to hazards caused by climate change.¹

¹ USDOT Transportation Disadvantaged Census Tract (Historically Disadvantaged Communities).

<https://usdot.maps.arcgis.com/apps/dashboards/d6f90dfcc8b44525b04c7ce748a3674a>

Project Need for Resilience Planning and Predesign

With nearly two miles of active coastal bluff erosion, several sections of this highway are severely eroded and in critical need of repair. The eroding bluff edge has destroyed the shoulder pavement at this site and is currently threatening the highway guardrail. The section of coast in front of Beverly Beach State Park (BBSP) is arguably the longest and most critical coastal stretch of concern in the state, has been the subject of various studies, and jeopardizes the movement of people and goods along US-101.

This location is also a popular state park. The BBSP campground is one of the state's largest managed parks with over 280+ sites available for recreational travelers. BBSP includes access to a day-use area with miles of ocean beach, extending from Yaquina Head to Otter Rock, and is centrally located to whale watching viewpoints, tidepools, the Oregon Coast Aquarium, and shops and restaurants in Newport. Any disruption to US-101 at this location is likely to have significant impacts on beach recreation opportunities.

This area has an estimated daily traffic flow of 4,225 autos and 275 trucks in each direction (8,450 autos and 550 trucks total). Traffic model output suggests a single day closure at this site would generate a detour likely to add an additional 206,000 miles driven and 4,400 hours of driving time for autos and 38,300 miles and 440 hours for trucks.

The current condition of US-101 puts this area at risk from emergency repairs, which can have negative fiscal, environmental, and user impacts by not having enough time to thoroughly access variables and other repair options, often resulting in conservative design. Various costs include, but are not limited to:

Maintenance & Repair: Disruptions due to detours and major construction operations have been costly to the regional and local economies. Frequent maintenance for highway cracking and repair costs ODOT hundreds of thousands of dollars every year; however, when an emergency slide occurs this cost can escalate to millions of dollars, depending on the nature of the slide.

Environmental: Emergency repairs can also result in more extensive environmental damage than 'preventive' structures at the same location. Emergency repairs often result in a larger footprint for the repair, and work that is performed in an emergency situation is often conducted under adverse climatic weather conditions, which entails greater risk to workers, and reduces the effective use of environmental controls to contain adverse residual effects on surrounding areas. A well thought out approach for preventative slide repair, along with continuing coordination with permitting agencies, will help minimize the need for costly emergency repairs.

User Impacts: Emergency slide repair and ongoing maintenance activities can delay travel for users, including emergency services, tourists, and local residents. Using the traffic volumes above, the assumed values for lost time, vehicle operation costs, and the individual costs associated with a road closure were calculated to be approximately

\$241,000 per day. The added social costs from the additional emissions are approximately \$7,200 per day.

For the highway to be maintained in its current alignment, an engineered solution for coastal erosion is necessary.

Resilience Corridor

The project location is on a Tier-1 ODOT Climate Resilience Corridor. This means the project is along one of Oregon’s highest need corridors for climate resilience improvements. Beverly Beach is also at high risk to an estimated six overlapping climate hazards by mid-century (2055), meaning that the corridor is particularly vulnerable to multiple hazards at the same time and a higher frequency of safety and reliability interrupts from hazard impacts (Figure 5).

The climate hazards projected to impact the project location include coastal flooding, coastal erosion, landslides, inland flooding, very heavy precipitation, and an increase in very hot days. Except for extreme heat, these hazards are current and will continue to present future challenges. As sea levels rise over time, sea cliff erosion rates are expected to accelerate. The current pace of erosion is estimated to be up to 1.5 feet per year, combined with mass movement events that lead to larger episodic losses.² Primary drivers of erosion are increases in ocean wave heights and stronger wave intensity. This ongoing trend is exacerbated by more frequent storm surge events, extreme high tides, flooding and sea level rise.³

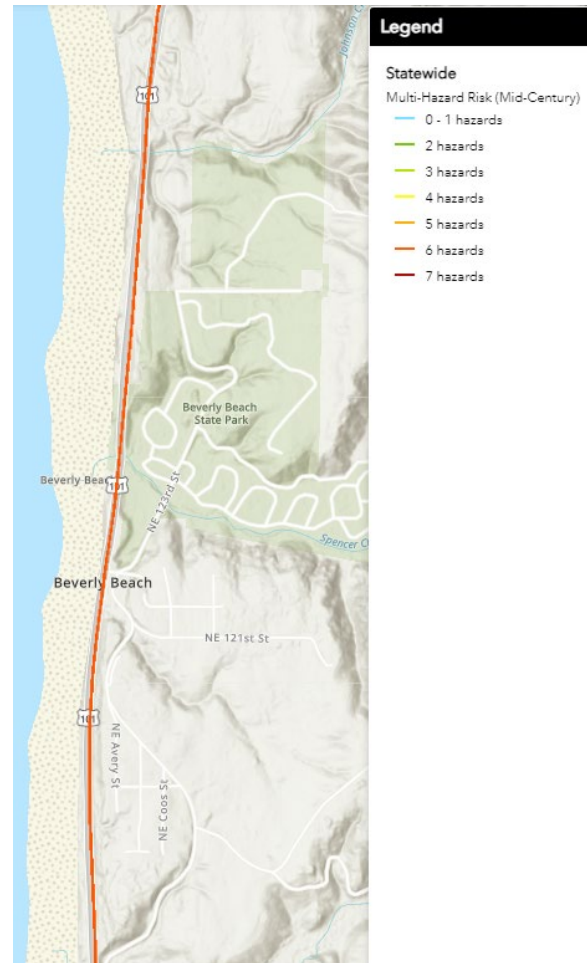


Figure 5. Multi-Hazard Risk Map

ODOT’s climate hazard projections use a representative concentration pathway 8.5 future emissions scenario and model ensemble mean of the 10 best performing global climate models

² Priest, G. R. (1999). Coastal shoreline change study northern and central Lincoln County, Oregon. *Journal of Coastal Research*, 140-157.

³ Ruggiero, P., Komar, P. D., & Allan, J. C. (2010). Increasing wave heights and extreme value projections: The wave climate of the US Pacific Northwest. *Coastal Engineering*, 57(5), 539-552.

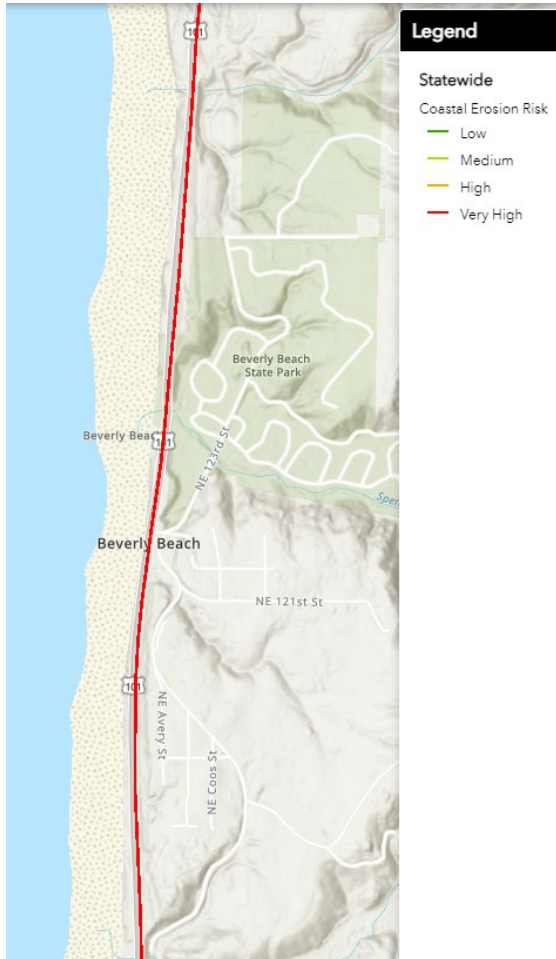


Figure 6. Coastal Erosion Risk Map

for the Pacific Northwest.⁴ ODOT’s climate modeling methods align with the Oregon Climate Change Research Institute, the state’s lead agency on climate change data and analysis.

Coastal erosion is a current and ongoing challenge at the project location. Future climate projections confirm very high risk to continued erosion challenges (Figure 6). Road infrastructure is heavily impacted by runoff from extreme precipitation events. Coastal flooding is increasingly common and exacerbated by more frequent and intense atmospheric river events, which include extreme precipitation over a short period of time. These events exacerbate flooding and landslide risk, especially when coupled with high tides and storm surge.⁵

Planning for future climate conditions will help ensure ODOT’s investments at this location are more resilient to future climate challenges.

FEMA Floodplain

The site is adjacent to FEMA floodway. ODOT will coordinate with Lincoln County related to any floodplain or floodway impacts throughout planning and design, though it is not anticipated

that the PROTECT Planning Grant will have any floodplain impacts.

PROTECT Planning Grant

As illustrated, this area is severely prone to high-risk events. It is expected this roadway will fail in upcoming years if further planning work, project identification, and eventual construction does not take place. It is estimated that construction could cost between \$100 million to \$200 million, so it is critical that funding be obtained to begin and complete planning work.

The PROTECT Resiliency Planning Grant will allow ODOT to:

- Build upon existing planning studies, green infrastructure design, climate analysis, and existing conditions analysis at the site to identify a long-term beachfront solution.

⁴ Rupp, D. E., Abatzoglou, J. T., Hegewisch, K. C., & Mote, P. W. (2013). Evaluation of CMIP5 20th century climate simulations for the Pacific Northwest USA. *Journal of Geophysical Research: Atmospheres*, 118(19), 10-884.

⁵ Corringham, T. W., Ralph, F. M., Gershunov, A., Cayan, D. R., & Talbot, C. A. (2019). Atmospheric rivers drive flood damages in the western United States. *Science advances*, 5(12), eaax4631.

- Develop conceptual designs to illustrate the preferred improvement that meets climate change goals while addressing multi-modes and equity needs.
- Address statewide regulations, such as Oregon Statewide Planning Goal 18, and move forward in the regulatory process with Lincoln County, DLCDC, and OPRD.
- Prepare a final pre-design package that sets the project for future construction funding opportunities.
- Inform resilience designs for other at-risk Oregon coastal locations.

Response to Merit Criterion

This section will speak to the four Merit Criterion for the PROTECT Resiliency Planning Grant.

Program Alignment

This project meets the Program Alignment Criterion of ‘Resilience Planning, Predesign, Design, or Data Tools,’ as the PROTECT Resiliency Planning grant will fund additional alternatives analysis, site conditions reporting such as geo-technical borings, and pre-design to identify a future construction project.

ODOT obtained a series of downscaled future climate datasets to develop a climate hazard risk assessment and map tool for Oregon’s state highways (see additional details below). The information was used to develop a corridor level, tiered resilience ranking system that locates highest need areas across the state, and a multi hazard analysis to isolate locations with overlapping high risks (by mid-century). These resources support planning and infrastructure resilience-building efforts broadly. As noted in the Resilience Corridor Section, to support resilience-building at Beverly Beach, ODOT’s climate hazard map has been used to identify the highest risk future climate hazards at the project location. This location-based resilience need information facilitates hazard-specific planning, including project design and construction elements that attenuate or mitigate each hazard risk.

Additional information resources and decision-support tools will be utilized to inform the multimodal planning process for the US-101 Beverly Beach Coastal Erosion Planning Grant. Several of these resources and tools are detailed below, including a specific site analysis for green infrastructure improvements along the Oregon Coast and Coastal Hazard Vulnerability and Risk Assessment tool. Each of the following models and assessments will be utilized to address critical needs for the Beverly Beach Coastal Erosion planning project:

In 2016, ODOT received funding to complete the *Green Infrastructure Techniques for Resilience of the Oregon Coast Highway Study* which analyzed how green infrastructure, or nature-based infrastructure for protective solutions, can help protect the Oregon Coast Highway from the impacts of extreme storms and coastal bluff erosion. This study produced a set of preferred alternatives, conceptual plans, and cost estimates for protection at three high-risk sites, including Beverly Beach. ODOT also collaborated with regulatory and resource agency partners to document design options that could be permitted and constructed under current rules and regulations.

In 2021, ODOT conducted a state-wide climate hazard risk assessment of Oregon’s state highway system. The analysis uses best-available downscaled climate data to provide corridor level risk rankings for nine different climate hazards impacting the transportation system. The results include mid- (2050) and late-century (2100) risk rankings. The data were combined with additional climate resilience variables like historical event frequency, asset condition, and social equity to develop a “hot spot” map and tiered ranking system of high resilience-building need. The data are integrated into three, popularly used planning tools available to agency staff and external partners. The climate hazard map tool can be found here:

<https://geo.maps.arcgis.com/apps/webappviewer/index.html?id=bf44dcc302574212b535e1ac22497e5a>

Also in 2021, ODOT developed a semi-automated landslide hot-spot identification tool for corridor level planning. The developed method integrates climate change predictions and seismic resiliency scenarios for prioritizing landslide mitigation sites at the landscape scale. As a proof-of-concept these methods to assess susceptibility, hazard, and risk management needs were successfully applied to four coastal mountain corridors (US30, OR06, US20, and OR42). The methods and tools delivered by this project can be applied to any landslide prone Oregon highway and the final report can be found at:

<https://www.oregon.gov/odot/Programs/ResearchDocuments/SPR808FinalReport.pdf>

In September 2022, ODOT completed a draft *US-101 Coastal Hazard Vulnerability and Risk Assessment for Mitigation Prioritization*. This report examined vital economic and emergency lifelines that connect coastal communities and provides access to numerous coastal destinations for Oregonians and tourists. Since structural mitigation is challenging due to the extensive Goal 18 regulatory exceptions processes, which were recently revised to allow for an exceptions-based process, the report proactively positions ODOT to effectively manage risks to support Goal 18. This report describes the development of a coastal highway hazard prioritization matrix that includes vulnerability, risk assessment, mitigation options, and management strategies for planning and project development. The final report is expected in early September 2023, and the interactive tool can be found at:

<https://experience.arcgis.com/experience/b9c625d22d5443b4b7e81c25cb53ed8a/page/Vulnerability-Analysis-Site-Summary/>

In addition to the above completed work, the US-101 Beverly Beach Coastal Erosion project will coordinate with other existing (state and local hazard mitigation plans) plans such as:

Coastal Landslide and Bluff Retreat Monitoring (SPR 807): ODOT is actively monitoring coastal landslides and will produce risk assessments for five landslide/eroding bluff sites over a seven year period (2016-2023). One of these monitoring sites is at Beverly Beach. The goal of this research is to develop a more comprehensive data-driven framework for prioritizing coastal asset management. The research will focus on the relationships between coastal bluff retreat, precipitation, groundwater and slide movement. The rate and magnitude of bluff retreat are essential measures to be used in prioritizing mitigation strategies in these areas. Results will be used to inform project-level risks, planning and policy decisions, and final decisions for shoreline protection.

Sea Level Rise Mapping Tool and Guidance: ODOT has developed a living web map layer projecting sea level rise vulnerability to guide project planning and design. Sea level rise data and assessment tools can enhance project decision-making and increase resilience to rising seas and extreme weather events. Sea level rise and storm surge mapping of ODOT assets from Oregon Department of Land Conservation and Development’s (DLCD) “Estuarine Sea Level Rise Exposure Inventory: State Highways (2017)” are used as primary sources of data. The estuary study uses mid-century (2050) and late-century (2100) projections of 1.5 feet and 4.6 feet of sea level rise, respectively. Data gaps are filled using the sea level rise mapping from the updateable NOAA Sea Level Rise Viewer 9. This information on potential future impacts will inform needed protection or alignment changes in vulnerable project locations or corridors. The results of this effort include a coastal flooding GIS map layer depicting inundation areas under mid- and late-century climate change and flooding scenarios (2050, 2100) and can be found as a layer within the above state-wide climate hazard risk assessment interactive map:

<https://geo.maps.arcgis.com/apps/webappviewer/index.html?id=bf44dcc302574212b535e1ac22497e5a>

Coastal Landslide Real-Time Monitoring Program Development: ODOT recently completed pilot testing for use of Real-Time-Kinetic Global Positioning Satellite Systems (RTK-GNSS) for continuous monitoring of active landslides. Based on this success ODOT is now developing standardized methods and protocols for site specific set-up and analysis and expanding the pool of units at needed coastal sites, preliminarily including Beverly Beach. The value of this technology and resulting data is that it will 1) inform closure actions and help estimate repair needs, 2) allow for monitoring where it is unsafe to drill, 3) allow for evaluation of mitigation measures, preliminarily including the proposed Beverly Beach site, and 4) provide continuous data for landslide behavior which may further inform how changing climate impacts infrastructure, which will further enable nimble planning strategies. This project will start in early fall 2023.

The final product of the US-101 Beverly Beach Coastal Erosion project will include the following pre-design and design elements:

- Resilience solutions based upon the above mentioned studies, including additional geotechnical exploration, on-site verification, and climate data.
- Nature based elements based upon the *Green Infrastructure Techniques for Resilience of the Oregon Coast Highway* noted above. While the study concluded that green infrastructure at Beverly Beach, such as cobble or sand tubes, was not cost effective as a stand-alone treatment, the analysis will be used to identify nature-based treatment options that coincide with long term improvements at Beverly Beach.
- Identify a permanent beachfront protective solution.
- Develop conceptual designs to illustrate the preferred improvement that meets climate change goals while addressing multi-modes and equity needs.

- Address statewide regulations, such as Oregon Statewide Planning Goal 18, and move forward in the regulatory process with Lincoln County, DLCDC, and OPRD.
- Prepare a final pre-design package that sets the project for future construction funding opportunities.

Schedule and Budget

The US-101 Beverly Beach Coastal Erosion detailed schedule and budget for each major project activity, milestone, and deliverable follows:

Task	Description	Budget	Schedule
1.0	Alternative Verification – Review previous studies, green infrastructure analysis, climate data, and summarize results related to long term improvements to Beverly Beach site.	\$ 150,000	2 months
2.0	Geotechnical/Archeological Exploration and Analysis – Subsurface exploration of 64 borings (6,389 feet of project/100 feet per boring) plus 6,400 hours of staff evaluation.	\$1,700,000	20 months
3.0	Conceptual Designs – Develop conceptual designs based upon information from Task 1 and 2.	\$700,000	5 months
4.0	Goal 18 Beachfront Protective Dunes Analysis – Compile documentation from Task 1-3 and present to Lincoln County, DLCDC, OPRD.	\$200,000	Concurrent with Task 3.0
5.0	Pre-design Package – Prepare pre-design package that includes Tasks 1-3 and approvals from Task 4.	\$500,000	5 months
6.0	30% Design – Begin 30% for future construction funding opportunities	\$1,750,000	12 months
	Total	\$5,000,000	

Any funding outside of Task 1-4 will go to extended design level work, allowing ODOT to refine design and prepare for future construction funding opportunities.

Public Engagement, Partnerships and Collaboration

This segment of US-101 is a vital connection to numerous coastal communities, federal lands, tribal communities, and recreational sites. Strategies to incorporate public engagement and collaborate with the wide array of applicable partners, include the following:

- Community Events – As ODOT continues additional site analysis, ODOT will conduct community events (online open houses, in person open houses) to present additional alternatives as needed. This will allow for input from an array of communities and individuals, including those areas with disadvantaged populations.
- Local Community Coordination – As noted, this section of Beverly Beach is a critical connection to various communities. ODOT will coordinate closely with the cities of Newport, Lincoln City, Depoe Bay, Yachats, and Waldport as this planning project

progresses. This coordination will include input on additional analysis, pre-design, and eventual design of the highway project.

- Cascades West Area Commission on Transportation (CWACT) – 30-member commission that provides a forum for local governments to collaborate on local, regional, and State transportation issues in the Benton, Lincoln, and Linn County Region. Improvements to US-101 are among the top priorities for CWACT.
- Oregon State Agencies – Department of Land Conservation and Development (DLCD) and Oregon Parks and Recreation Department (OPRD). Continue coordination with DLCD, OPRD, and other state agencies on specific solutions at Beverly Beach, including the process for a Goal 18 exception to construct long-term improvements to the site.
- Federal Agencies – Federal Highway Administration and other Federal Agency coordination will be critical to the success of the PROTECT Resiliency Planning Grant.
- Tribal Entities – The Confederated Tribes of Grand Ronde and Confederated Tribes of Siletz Indians are key partners with communities and land along US-101.
- Private Entities – ODOT will create an interested parties list to include private entities, businesses, and any other group with vested interest in the corridor.
- Emergency Services – Lincoln County Emergency Services is a critical partner for coastal evacuation planning.

Innovation

The US-101 Beverly Beach Coastal Erosion planning project will employ innovative or novel partnerships, technologies, and techniques that will be used to analyze risks and risk reduction strategies, starting with analysis previously conducted.

Green Infrastructure Analysis

In 2016, ODOT completed the *Green Infrastructure Techniques for Resilience of the Oregon Coast Highway* project which evaluated multiple nature-based solutions for three locations along the Oregon Coast (Figure 7). The analysis focused on the following improvements at Beverly Beach:

- Sand replenishment for wave energy dissipation
- Cobble beach for wave energy dissipation



Figure 7. Green Infrastructure Techniques for Resilience of the Oregon Coast

- Jetty rock for erosion protection at toe of the slope
- Dolos for erosion protection at toe of the slope
- Piles to aid retention of jetty rock
- Mechanically stabilized earth (MSE) slope for mid and upper slope protection
- Riprap as foundation for MSE slope and backing for jetty rock
- Sand tubes as foundation for MSE slope and backing for jetty rock
- Drainage blanket to control seepage and runoff

Analysis Assumptions and Preferred Concept

Since Beverly Beach is in an extreme environment that leads to harsh erosional conditions due to the high wave energy at this location, the analysis blended traditional hard improvements with nature-based components to attain an acceptable level of protection. Piles, jetty rock, riprap, drainage blanket, and MSE slope are all be considered traditional hard components. Nature based components include the cobble beach and the face of the MSE slope.

The cobble beach is composed of rounded cobbles that are meant to move and shift with wave impact and reduce the wave energy transferred to the rest of the system. The piles were needed to maintain the toe of the jetty rock and help hold it in place, especially since sources of very large jetty rock are not readily available. The jetty rock and riprap were needed to stabilize the toe of the slope from wave cut erosion. The MSE slope was needed to stabilize the upper portion of the bluff since the bluff is already perilously close to the traveled roadway. The drainage blanket controls seepage and runoff which aids in bluff stabilization and MSE slope integrity.

It is estimated that maintenance of this preferred alternative could be high. The cobble beach would likely need to be regraded each year, as well as replacing approximately 15 percent of the cobbles on a yearly basis. Every five years or so, during extreme winters, the entire cobble beach portion of the design would need to be replaced. Other portions of the design might also need maintenance during these extreme winters. Plantings in the MSE slope would likely need some ongoing maintenance and replanting.

The PROTECT Resiliency Planning Grant will build upon this preferred concept through refinement of planning and design to establish a preferred concept that incorporates long-term hard improvements with elements of green infrastructure.

Other Considerations

Features that were analyzed, but not included in the final concept plans, were dolos, sand tubes, and sand replenishment. Oregon Parks and Recreation Department would not allow dolos on the beach, primarily due to safety hazards to the public, but also for aesthetic reasons.

Many of the nature-based options explored took up a larger footprint than traditional hard engineering options. It was found that traditional hard engineering might sometimes be preferred over nature-based options for infrastructure protection for this reason. There were concerns that cobble beaches could potentially impact access to recreation and limit the amount of beach available for use by the public since cobbles are harder to walk on than sand. There were also concerns that cobble beaches could potentially impact natural habitats through the migration of material into the offshore environment.

The option of sand replenishment at Beverly Beach is one that was considered during ODOT's 2003 Spencer Creek Bridge project. Sand nourishment is a logical option to study since the beach is narrow and sand-starved, and there is a relatively close source of sand nearby. However, after further review, it was determined it would exceed \$1 million (2018 dollars) to dredge and haul sand into Beverly Beach. Additionally, the sand would not stay in place long enough to provide a buffer against the high wave energy experienced at Beverly Beach. There were also concerns that dredge spoils could make their way offshore and impact shellfish and other marine resources.

Overall, stand-alone green infrastructure improvements were found expensive or ineffective for long term use, hence the proposal for a combination of green infrastructure and hard engineering improvements.

Summary of Findings

This study was a valuable exploration of nature-based design solutions to protect infrastructure from coastal hazards that will likely worsen with extreme storms and the effects of climate change.

ODOT was able to engage the land use and permitting agencies on what specific protective design options or features were considered preferable, acceptable, or unacceptable. ODOT received clear information about what design options would be considered structural - or non-structural - in certain coastal environments and therefore subject to Goal 18 requirements, in addition to learning more about agency preferences for specific design features among the alternatives reviewed.

Coordination between state and local agencies was enhanced on issues related to coastal protection and options moving forward that may help implement future projects. The connections made through the study will be beneficial as ODOT seeks technical assistance, and further develop and implement solutions. There was a general consensus from resource agencies on the value of ODOT having nature-based infrastructure as a coastal protection option.

ODOT learned how to apply nature-based solutions on a conceptual level; however, to design to the level required for permitting and construction plans would require either outsourcing or bringing in more expertise in coastal design.

Partnerships and Next Steps

ODOT is pursuing collaboration with local tribes to develop place-based green infrastructure techniques, such as vegetative stormwater and erosion control that helps to protect or buffer other infrastructure assets. Implementing techniques using indigenous ecological knowledge of the project location may improve the likelihood of success, while also benefitting cultural practices and building relationships for ongoing engagement.

In addition, various permits are required through various agencies, such as:

- Goal 18 Exception (Lincoln County)
- Beachfront Protective Structures Permit (OPRD)

- US Army Corp for work on the beach
- Endangered Species Act clearance for Coho Salmon
- Essential Fish Habitat

Due to the complexities of the site and the various agency partnerships needed, ODOT would continue to demonstrate best practices in cost-sharing and technical expertise for the best outcome of the project using nature-based infrastructure as noted above. This includes continued coordination with Lincoln County, Tribes, Oregon Parks and Recreation Department, and the Department of Land Conservation and Development to ensure project success.