## PROJECT DESCRIPTION

This study will assess the feasibility of a nature-based green infrastructure project at Stinson Beach to develop a resilient beach and dune ecosystem that enhances existing habitats and public access, supports vibrant recreational opportunities for users of all socioeconomic circumstances, and provides flood and erosion protection against existing coastal hazards and future sea level rise.

### 1) Specific Need for the Project

Nestled between the Pacific Ocean, Bolinas Lagoon, and Federal and State Parkland (Exhibit 1), Stinson Beach is West Marin's most vulnerable community to rising sea levels and future coastal storms. In 2014, the Marin County Community Development Agency (CDA) commenced Collaboration: Sea-Level Marin Adaptation Response Team (C-SMART) to develop adaptation solutions for West Marin. To date C-SMART has produced two major deliverables: the *Sea Level Rise Vulnerability Assessment* and the *Adaptation Report,* and this proposed project would be part of CDA's continued efforts. This study would convene a unique cross disciplinary team of experts to assess the feasibility of a multi-objective natural infrastructure project as an alternative to coastal armoring. This study would additionally have statewide and possibly national and global applicability through evaluating the interplay between sediment, plants and geometry to inform other dune restoration projects.

Stinson Beach is part of the Golden Gate National Recreation Area (GGNRA) and an international tourism destination that attracted two-thirds of a million visitors in 2015.[1] It is anticipated that these numbers could near or exceed 1 million annual visitors over the next 50 years. The beach provides low to no cost recreation for people of all socioeconomic circumstances and is a critical link of the California Coastal Trail. The *Vulnerability Assessment* concluded the beach itself is highly vulnerable, subject to rising sea levels, storms, and coastal erosion. As much of the beach is currently backed by development, roadways, and/or hills, minimal room is available for transgression, and retreat areas are quite limited. If no action is taken, the beach at Stinson will likely be a victim of 'coastal squeeze', as water and waves erode and drown this resource of great natural, economic and cultural importance. Included in the *Vulnerability Assessment* are beach width estimates at the five C-SMART scenarios considering sea level rise (SLR), storm surge and geomorphic change from coastal erosion (Table 1), and a corresponding map (Exhibit 2).

**Table 1. Beach width under the C-SMART scenarios.**

| Scenario – SLR amount & Storm | | Beach Width (m) |
|---|---|---|
| 1 | 25 cm SLR + annual storm | 48 |
| 2 | 25 cm SLR + 20 year storm | 48 |
| 3 | 50 cm SLR + 20 year storm | 32 |
| 4 | 100 cm SLR + 100 year storm | 9 |
| 5 | 200 cm SLR + 100 year storm | 2 |

The *Vulnerability Assessment* concluded that 200 to 400 of Stinson Beach's homes may be exposed to flooding by 2030, which could increase to nearly 600 by the end of the century along with septic systems and water lines (Exhibit 3). Dozens of roads could also be flooded, including Calle del Arroyo, the only way in and out of the Seadrift and Calles and Patios neighborhoods.

[1] AECOM. *West Marin Visitor Needs Assessment,* August 2017

Some Stinson Beach residents have lived in the area since the 1970s and many are not wealthy. Property owners are threatened with growing costs associated with SLR, including compliance with FEMA National Flood Insurance Program requirements. Lower income earners in the hospitality and construction industries could be driven out by escalating expenses.

The following is an excerpt from the *Adaptation Report* that identifies several conceptual alternatives for Stinson Beach adaptation including dune restoration/nourishment[2]:

> *Dune restoration would include placement of sand, graded and planted to form back beach dunes. Beach nourishment is recognized as a natural way of mitigating backshore erosion as well as maintaining a wider beach through sacrificial erosion of the dunes. A variant includes placement of cobble (rounded rock) which is often naturally present as a lag deposit below beaches in California. This strategy includes the dune enhancement activities below:*
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> - *Dune augmentation (adding sand to dunes to provide protection during storm events), especially to raise low-lying beach access paths to prevent flood waters from flowing into the neighborhoods behind the dunes.*
> - *Ceasing any activity that adversely affects the sediment supply of the dunes.*
> - *Planting vegetation. Planting native dune vegetation, together with wind action, will help build up and stabilize dunes.*
> - *Fencing off sensitive areas and creating dune walkways.*
> - *Interpretive signs and other outreach activities to highlight the habitat and coastal protection values of stable sand dunes.*

Dune restoration could have multiple benefits in providing habitat, recreation and flood protection. Natural shoreline protection can increase points in FEMA's Community Rating System program, of which Marin is enrolled, leading to reduced flood insurance premium rates. Dune creation has less impact to beach ecology than coastal armoring such as seawalls, and thus would be easier to permit under California Coastal Commission (CCC) and Greater Farallones National Marine Sanctuary (GFNMS) policies.

GGNRA is initiating Stinson Beach resiliency planning including a Vulnerability Assessment for the beach's federal portion, which will be informed by Marin County's *Vulnerability Assessment*. As outlined in the letter of support for this grant application, GGNRA will benefit from this project, which identifies viable solutions for this resource that spans Federal and County boundaries.

Funding for adaptation on California's open coast is quite minimal. While Measure AA and Resilient by Design have brought adaptation resources to San Francisco Bay communities, Marin's oceanfront areas are not eligible for such programs and comparable efforts for the coastside are limited. This grant program is thus an important opportunity to support a much-needed ocean-oriented project, which could serve as a model for other coastal communities throughout the state and elsewhere.

[2] ESA, 2015a. SLR Adaptation Alternatives for Marin County, Prepared for Marin County. October 1, 2015.

**2) Project Goals and Objectives**

Project Goal: Assess the feasibility of a nature-based green infrastructure project at Stinson Beach to develop a resilient beach and dune ecosystem that enhances existing habitats and public access, supports vibrant recreational opportunities for users of all socioeconomic circumstances, and provides flood and erosion protection against existing coastal hazards and future sea level rise.

Marin County seeks support to investigate the use of vegetated sand dunes and potentially cobble berms as part of a multi-decade adaptation strategy. This project would build upon work done to date, including the *Vulnerability Assessment* and *Adaptation Report,* and serve as a necessary intermediary basis for planning, design and implementation of a dune restoration project. The proposed new work will investigate the feasibility of these nature-based adaptation measures within the context of a long-term adaptation plan expected to include additional adaptive actions. The feasibility study will look at a range of geometries formed with sand and dune plants, and cobble. Each alternative will include a detailed description with dimensions, materials, quantities and engineers' estimates of construction costs and reconstruction frequency. The plan will be sufficiently detailed to assess public support and regulatory feasibility to formulate next steps. Anticipated thresholds (time and SLR) will be identified to ascertain the duration of each alternative.

Project Objectives include:

1) Understand sediment transport along Stinson Beach's shore.
2) Characterize historical and modern shoreline change trends.
3) Identify sand sources and sand grain size at candidate sand source sites.
4) Assess the performance relative to flood and erosion hazards at Stinson Beach.
5) Quantify expected life for a range of SLR scenarios, and life-cycle costs (first cost and reconstruction after storms), in terms that inform feasibility as well as support a broader long-term adaptation plan.
6) Assess the performance relative to ecology, with a range of alternatives spanning the more engineered (gray) to more natural (green continuum).
7) Engage local residents and beach users in the decision-making process through presenting and soliciting input on project alternatives
8) Evaluate project alternatives with criteria including recreation, habitat, public support, flood protection, costs, and environmental impacts.
9) Identify existing regulatory barriers to implementation.

**3) Specific tasks that will be undertaken**

CDA, serving as project managers, will convene a multi-disciplinary team with technical expertise in land use planning, engineering, botany, and geology. The following is a list of tasks which would serve as the basis for a detailed work program:

1) Existing Conditions, Goals, and Objectives
    a. Reaffirm project description, goals and objectives
    b. Literature Review
        i. Summarize comparable projects (Ocean Beach, Santa Monica, Surfer's Point, etc.)

ii. Review the *Natural Infrastructure Guidelines/Blueprint* to be completed as part of *California's Fourth Climate Change Assessment.*

c. Develop basemap, and delineate subarea with cross sections using digital terrain models.
d. Use existing information to characterize beach ecology. Relate it to beach width and elevation so future shore geometry projections can be evaluated relative to existing ecology.
e. Through available data and interviews, identify and characterize reference sites to provide guidance on the sediment sizes, plants, and geometries to inform design. Reference sites will consist of (a) natural sites and (b) constructed sites.
f. Characterize shore dynamics
    i. Use available information to describe shore dynamics (location, long-term trends, seasonal and storm fluctuations, nearshore wave climate and longshore transport gradients, wave runup and overtopping).
    ii. Engage with the US Geological Survey (USGS) on their hydrodynamic and sediment transport models to analyze regional sediment transport and the fate of sand placement alternatives
    iii. With available information, map and describe historical and modern shoreline change.
    iv. Use available information to refine the littoral cell conceptual model and better understand beach response to climatic variability, including interaction with the Bolinas Lagoon tidal inlet and sand bars.
g. Characterize sediment (site and potential source(s)) and evaluate sources:
    i. Sample sand grain sizes at Stinson Beach and develop grain size distributions.
    ii. Inventory existing sediment characterization datasets.
    iii. Acquire sediment data from other sources which may include the USGS, US Army Corps of Engineers (USACE), GFNMS (Exhibit 4) and the Marin-Sonoma Coastal Regional Sediment Management Plan.
    iv. Compare grain size distributions to potential sand sources. Identify sediment source data gaps. Sample sites (considering seasonal variability) and analyze sediment for grain size, physical properties, and chemicals of concern.
    v. List potential sediment source sites with order of magnitude estimates of sediment availability.
    vi. Evaluate the feasibility of dredging and dredged material reuse from suitable locations.

*Deliverable: Existing conditions memo. This will include study area maps, shoreline dynamics, spatial gradients in longshore transport, wave focusing hot spots, historical and modern shoreline change, and possible sediment source sites. Methods and results of the littoral cell conceptual model will be documented, and sand source/receiver sites will be evaluated.*

2) Climate Scenarios and Adaptation Criteria
    a. Climate scenarios will be used to assess how long dune features will have sufficient volume to mitigate the erosion and flooding associated with storm events. The volume of sand needed to absorb a range of storm erosion events will be computed, and compared with the loss of volume associated with gradual shore migration in response to SLR. In this way, the effectiveness of a constructed dune can be assessed in terms of amount of SLR, and the length of time that adequate volumes of sand remain to mitigate storm hazards. A "high" SLR scenario would indicate a shorter probable life and more frequent reconstruction than the moderate or low scenario projections, for example. The consideration of more than one

SLR scenario is consistent with state guidance for adaptation planning[3] and coastal development permit applications.[4] It should be noted that frequent re-construction will diminish feasibility in terms of cost, ecology and human-impacts.

b. Thresholds for adaptation actions: Higher levels of SLR, such as the higher levels forecast for 2100 and beyond, may overwhelm the protection afforded by constructed natural infrastructure. Therefore, additional adaptation actions can be expected. The thresholds for additional adaptive actions will be computed.

*Deliverable: Climate scenario and adaptation criteria memo*

3) Alternative Development and Evaluation
   a. Building upon options identified in the *Adaptation Report*, a range of adaptation alternatives along a grey-green continuum will be developed. The alternatives will include near-term and long-term alternatives and could include: more traditional dune-embankment creation, dune creation with native plants and steep and hummock alternative geometries, and dune creation with cobble berm. The cobble mass geometry may include both high berm and low lag deposit geometries.
   b. Options for sand and cobble sources and placement will be evaluated.
   c. A summary matrix will evaluate alternatives with considerations including: design life analysis, geomorphic and coastal habitat benefits, environmental impacts, regulatory considerations, storm/SLR protection levels, public access, and constructability. Critical will be evaluation of how long each alternative would be effective for.
   d. The functional life of each alternative will be computed in terms of SLR amount and time associated with the selected SLR scenarios (see Climate Scenarios, Task 2). The amount of retreat (horizontal and vertical) to extend the functional life of each alternative will be computed. This information is critical for comparison with shore armoring alternatives and to inform a long-term adaptation plan.

*Deliverable: Evaluation memo of potential nature-based adaptation alternatives.*

4) Public Outreach / Community Engagement. Once alternatives are developed public workshops will be held, with widespread outreach, including focused invitations to beach managers, permitting agencies, beach users, and residents. Alternatives would be presented by engineering consultants with opportunities for questions. Stakeholders will be polled on community acceptability.

*Deliverable: Public workshop summary report that identifies preferred alternatives based on community input*

5) Regulatory and Policy input
   a. Collaborate with agencies including GFNMS, GGNRA, USACE, Environmental Protection Agency, National Marine Fisheries Service, Regional Water Board, California State Coastal Conservancy (SCC), CCC, State Lands Commission, Marin County Parks, NGOs, harbor and port operators, and others, to identify lessons learned and opportunities for policy initiatives to support restoration activities. This could include collaboration with the Greater Farallones Association and GFNMS to evaluate the regulatory landscape regarding dredging and placement of sand within the GFNMS boundaries.

[3] Ocean Protection Council. Update to the State of California Sea-Level Rise Guidance Document. April 2013.
[4] California Coastal Commission. Interpretive Guidelines for Addressing Sea Level Rise in Local Coastal Programs and Coastal Development Permits. August 2015.

b. Work with agency staff to evaluate regulations and policies relevant to dredging and sand placement within their jurisdiction.
c. Seek Agency staffs' input on feasibility assessment of sand placement alternatives.

*Deliverable: Technical memo identifying policy options to support dredging and sand placement activities on Stinson Beach, and summarizing collaboration with Agency staff and lessons learned.*

6) Project management including recurring calls with consultants and involved agency staff.
*Deliverable: Quarterly invoices with relevant aforementioned deliverables.*

***Final deliverable: Stinson Beach Dune Restoration Feasibility Study.***

**4) Work products or other deliverables**

This final project deliverable would be the *Stinson Beach Dune Restoration Feasibility Study* (*Study*). Summary memos would be completed for each of the tasks mentioned above, serving as 'seeds' to develop into draft *Study* chapters. While a technical document, the *Study* would be filled with images and diagrams and written in a way that is understandable by people with varying degrees of technical expertise and interests. An accompanying fact sheet would also be developed with main points for the general public. The *Study's* audience would likely include:

- Marin County Board of Supervisors
- Staff from local, state, and federal agencies including: Marin County CDA, Marin County Department of Public Works, Marin County Parks, Marin Community Foundation, Stinson Beach Village Association, Stinson Beach Water District, Seadrift association, CCC, SCC, GGNRA, and GFNMS; and non-governmental organizations
- Resource managers and adaptation professionals in other jurisdictions
- Local residents and visitors

**5) Approach to measuring and reporting your project's effectiveness**

Public involvement should be integrated into any community planning process. Since C-SMART commenced in 2014, Stinson Beach and other West Marin community members have expressed a great deal of appreciation for CDA's proactive approach to SLR adaptation. Like all other C-SMART phases to date, public input will be solicited on this project. Given the technical nature of this study, engineering consultants will be asked to present the adaptation alternatives in public workshops, to which agency staff, beach users and residents will be invited. Participants will be polled on their preferred alternative.

Peer to peer networking has been a high priority for CDA staff to transfer information and share lessons learned on C-SMART to contribute to the greater collective knowledge of adaptation planning. Forums such as the CA Coastal Resilience Network and state and national adaptation conferences have served as valuable means to network with counterparts in other coastal communities. CDA staff will showcase the *Study* through such forums to share results with other jurisdictions who may be interested in dune restoration. Included in the key audience would be planners, engineers, resource managers, scientists and other adaptation professionals.

6)