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CLIMATE

'Innovative' approach to sea level rise is first of its kind in San Francisco Bay

By **Tara Duggan**, Staff Writer

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Volunteers from the nonprofit organization Save the Bay plant native species at a horizontal levee pilot project under construction in Palo Alto.

Laure Andrillon/For the S.F. Chronicle



Under a fresh plot of dirt along the San Francisco Bay, a revolutionary new way to address climate change is taking shape in Palo Alto.

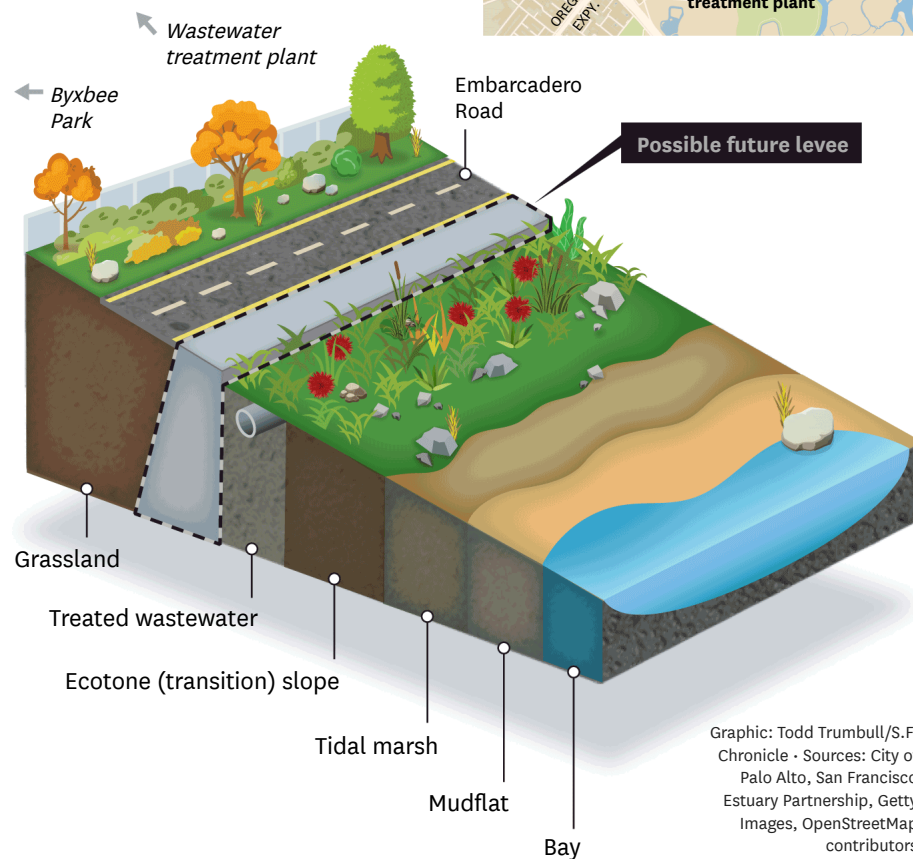
Young native plants are taking root in the soil, which sits atop a layer of wood chips, a layer of sand and a layer of gravel. Treated water from a nearby wastewater plant will soon trickle through it all, irrigating the plants while getting extra filtering before going into the bay.

This so-called living levee is designed to grow in elevation as plants die off and sediment settles, adjusting to rising seas and protecting the shoreline from big storms. It can be used in conjunction with conventional seawalls, which don't integrate into the habitat and may eventually be overtopped.

That is the plan behind Palo Alto's new project along its shore, which will be the first of its kind in the San Francisco Bay when it debuts this spring and one of only a few known similar projects worldwide. Also called a horizontal levee because it is wide and gently sloping, it will turn a 315-foot stretch of the shoreline back to a freshwater marsh, with a few modern twists. The project is meant to be a blueprint for other projects both in Palo Alto and elsewhere in the bay; Hayward plans to debut a mile-long version next summer.

Palo Alto's 'living levee'

To prepare for rising sea levels, Palo Alto is creating a so-called living levee — the first of its kind in the San Francisco Bay — and turning a 315-foot stretch of shoreline back into a freshwater marsh. Considered an innovative alternative to a seawall, the project is intended to control flooding and will utilize treated water from a nearby wastewater plant.



Graphic: Todd Trumbull/S.F. Chronicle · Sources: City of Palo Alto, San Francisco Estuary Partnership, Getty Images, OpenStreetMap contributors

"In some ways, this is a return to the way that water used to enter the bay before all the development took place," said David Sedlak, a professor of civil and environmental engineering at UC Berkeley who has been doing research on a horizontal levee prototype from another Hayward location for about a decade.



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California law requires all municipalities on the bay and in the coastal zone to have a plan by 2034 to protect shorelines from sea level rise. While Foster City opted to build a [massive seawall](#), the state encourages what are called nature-based

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algae bloom in the bay in 2022. The levees can be cost-effective and are more attractive than a wall or a pile of rocks.

“The Bay Area is looking at several large problems simultaneously: sea level rise, increased frequency of storms and nutrient pollution of the bay, and solving these separately in the traditional way — building higher concrete levees or upgrading sewage treatment plants — will be quite expensive,” said Sedlak. “And so there’s a lot of enthusiasm for finding multibenefit solutions.”

Caitlin Sweeney, director of the San Francisco Estuary Partnership, a regional government organization that collaborated on the project and operates under the U.S. Environmental Protection Agency, called the levee exciting and innovative.

“This project is very important locally, but it’s also very important regionally,” she said.



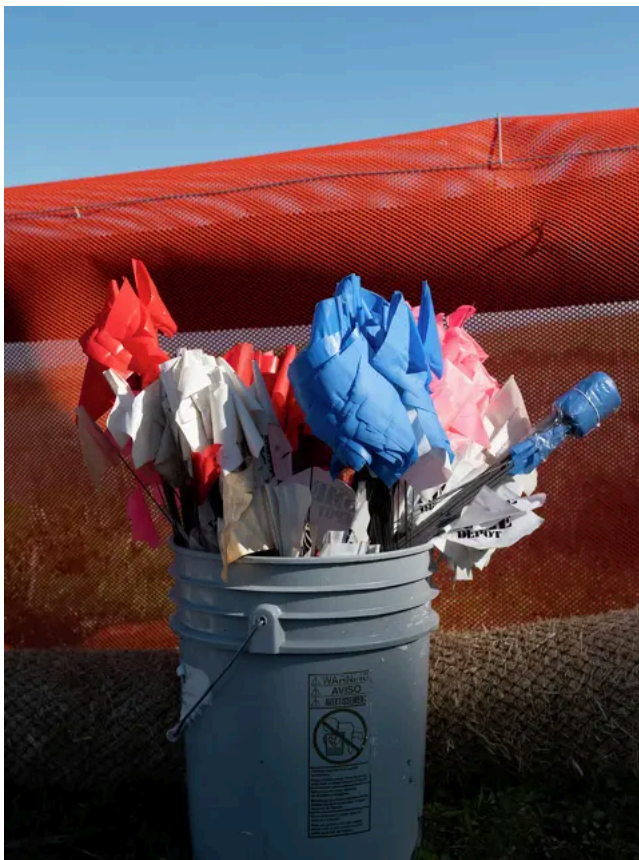
Save the Bay plants volunteers work on a horizontal levee pilot project in Palo Alto.
Laure Andrillon/For the S.F. Chronicle

Human-caused climate change is expected to cause sea levels to rise by [0.8 feet in the Bay Area by 2050](#) and by 3 feet at the end of the century compared to 2000 levels, based on intermediate projections from the California Ocean Protection Council. Addressing sea level rise in the bay [is expected to cost \\$110 billion](#), according to the Bay Conservation and Development Commission.

It's difficult to determine cost-effectiveness of the levees at this stage, as organizers believe the price tag will drop over time. The Palo Alto pilot project is expected to cost \$7 million, with funding from the EPA, the California Department of Water Resources and the State Coastal Conservancy. A similar, much larger project, [First Mile in Hayward](#), is estimated to cost at least \$13.9 million, according to a spokesperson for the San Francisco Estuary Partnership. Foster City's considerably longer, 6-mile seawall cost \$90 million and does not filter water or provide native habitat.

But there are ways to use both traditional and horizontal levees in conjunction, depending on the type of real estate available on the shore. [A study](#) this year from UC Santa Cruz and the U.S. Geological Survey found that when combined with existing levees around the San Francisco Bay, horizontal levees [could reduce](#) the risk of flooding by 30%.

Volunteers with the nonprofit organization Save the Bay have already planted native riparian shrubs like black elderberry and ninebark at the Palo Alto levee, said Jessie Olsen, habitat restoration director of Save the Bay. Such plants thrive in the type of freshwater marsh that originally existed here, fed by streams that have long been diverted.





Top: Flags used by Save the Bay to signal recently planted native species in Palo Alto. Above: Sheena Li, a volunteer, plants native species. Laure Andrillon/For the Chronicle

“we’re trying to mimic,” she said. The plant community will create a tidal marsh — a large area stretching between the levee site and the

es and sedges, creeping wild rye, and flowering coastal species like

harvest mouse and Ridgway’s rail, both endangered species that only at the shoreline from flooding and keep up with sea level rise for 40 to watershed protection with the city of Palo Alto.

“It’s a big effort,” Engelage said. “As the bay hits the project site and slows its flow, it will also drop sediment out onto the project site,” and increase in elevation, hopefully in sync with rising tides.

The horizontal levee also aims to solve a problem that most people would rather not think much about: what to do with wastewater. It’s being constructed right next to Palo Alto’s Regional Water Quality Control Plant, one of 37 wastewater treatment plants that were built along the bay shoreline because they rely on gravity to pipe sewage from communities and discharge treated water into the bay. That makes those plants particularly vulnerable to sea level rise as well as contributors to water quality problems.





A volunteer from Save the Bay plants helps prepare a horizontal levee pilot project under construction in Palo Alto.
Laure Andrillon/For the S.F. Chronicle

Under the Clean Water Act, the treatment plants are required to remove pathogens, but nutrients — such as nitrogen and phosphorus — and other pollutants typically remain in the water. In 2022, those nutrients fueled a massive algae bloom and fish die-off in the bay, a disaster experts say is likely to become more common with climate change. Two years later, the San Francisco Regional Water Quality Control Board, a state agency, required that the treatment plants reduce the levels of nutrients they release into the water by 40% over the next decade.

Palo Alto's horizontal levee was designed to remove nutrients from the treated water, but it will only handle 100,000 gallons of the 20 million gallons of wastewater the plant releases into the bay each day. Engelage said that's because it's a pilot program.

"We want to learn everything we can from this project, and then eventually we want to connect it to the larger levee improvement projects that need to happen here in the next 20-ish years," Engelage said, referring to ideas to build more horizontal levees and a larger traditional levee inland from the new one in Palo Alto.



One big hurdle for the city's new levee was permitting, and the resolution of that will pave the way for other projects, said Sedlak of UC Berkeley. Typically, sewage plants pipe their treated water far into the bay. Palo Alto had to work with regulators to release the water along the edge of the bay, he said.

At the experimental horizontal levee at the Oro Loma Sanitary District in Hayward, Sedlak and his team are researching how to best remove contaminants, including trace organic compounds from pharmaceuticals and pesticides, from the water. Unlike Palo Alto's, the levee does not discharge water into the bay.

The team found that horizontal levees would require a large amount of land to "polish" all of the wastewater discharged by Bay Area treatment plants. Over the long term, a better use could be treating the brine that is left over from recycling

wastewater, which is five times as concentrated, Sedlak said. He expects Bay Area cities to recycle more of their wastewater in the coming years.



View of a horizontal levee pilot project under construction in Palo Alto.
Laure Andrillon/For the S.F. Chronicle

Overall, Sedlak said the Palo Alto project provides many other benefits, including flood control.

Sedlak only knows of two other places in the world using similar nature-based tools to simultaneously address flooding and water quality, though they are not horizontal levees per se. In Belgium, one project involved planting willow trees on sand dunes along the North Sea to filter brine from recycled water. China has used a concept called "[sponge city](#)" to design urban landscapes that capture stormwater and reuse it rather than try to keep it at bay.

Olsen of Save the Bay hopes that having volunteers assist with planting at Palo Alto's new levee, and its location near an existing trail, will help the public better understand the concept.



"I don't think a lot of people even know that excess wastewater is getting discharged into the bay, although it's heavily regulated," she said. "But then the idea of percolating it through a slope adjacent to an area that you walk your dog or run — it's a strange idea, sure. But it's safe."

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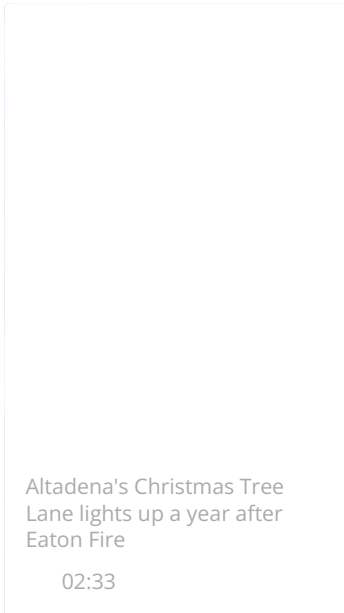
**Tara Duggan**

REPORTER



Tara Duggan is a staff writer in the Chronicle's climate and environment team who focuses on sea level rise, the marine environment, wildlife and animals in general. Tara has written investigations into nonprofit organizations and businesses and the narrative story "The Fisherman's Secret," a finalist for an Online Journalism Award.

Tara was previously in the Chronicle's Food and Wine department, where she earned a James Beard Foundation Award. She is the author of five cookbooks, and her work has appeared in the New York Times and Food & Wine. Reach her at tduggan@sfchronicle.com.

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