Oro Loma and Castro Valley Sanitary Districts to Test Experimental Levee

Can a wedge of gravel, mud and grasses, irrigated by treated wastewater, help San Francisco Bay shorelines and sewage plants adapt to future extremes?
Groundbreaking Spring 2015

The National Research Council projects a regional rise in sea level for San Francisco Bay in the range of 4.8-23.9 inches by 2050 and 16.7-65.5 inches by 2100. In addition, the National Oceanic and Atmospheric Administration lists the Bay Area as one of the top ten most vulnerable metropolitan regions in the country. To prepare for more flooding and wet weather, those in charge of the shoreline infrastructure now in harm's way are making plans, and one of them involves a 10-acre experiment on a field adjacent to the Oro Loma and Castro Valley wastewater treatment and purification plant in San Lorenzo. (For brevity's sake, subsequent references to the Oro Loma and Castro Valley project throughout this overview refer only to Oro Loma).

The idea of doing something at Oro Loma had its origins in a 2008 Hayward Area Planning Association (HASPA) initiative to evaluate the potential impacts of sea level rise on the shore between San Lorenzo Creek and the San Mateo Bridge. HASPA had seen pictures of Bay waves crashing over local levees after a big storm in 2005, and realized that sea level rise could worsen such events in the future, so they hired consultants Philip Williams and Associates (now ESA) to examine the threat in more depth. This evolved into one of the Bay Area's first serious multi-agency, multi-jurisdictional planning efforts around sea level rise.

One adaptation proposal by ESA and Peter Baye was to create a new type of levee to mimic the natural slope from historic wetlands into upland areas. If planted with sedges and grasses, and irrigated with treated wastewater, this wedge of habitat, built alongside the new levee, could slow down waves, resist floods, and protect infrastructure and homes in the Bay Area flats. When the Oro Loma Sanitary District offered a site for testing some of these adaptation ideas in 2012, support for the project grew. The district felt it would be a good investment in its future ability to provide services to its 46,000 customers, and to protect its facilities in any kind of weather or flood condition.

Slated to begin construction in spring 2015, the project will turn a degraded, diked bayland into an outdoor laboratory. Here, construction crews will create two things: first, a two-acre wetland basin that can both remove nutrients from wastewater and provide extra wet weather storage capacity; and second, on one side of the basin, the experimental levee. Wastewater that has already undergone secondary treatment will pass first across the surface of the basin and treatment wetland, and second through the levee and down into the sub-layers of 1.4 acres of the experimental habitat slope. The idea is that the combination of treatment wetlands and newly designed habitats, and surface and sub-surface filtering processes, will support native plants and purify the water enough so that one day this kind of system can be directly connected to the edge of the Bay. Meanwhile, the new treatment wetland and basin is also designed to store up to eight million gallons of enhanced primary treated wastewater during a storm or peak flow event.

Operation of what everyone is now calling the Oro Loma Horizontal Levee should begin in early 2016. Project partners include the two sanitary districts, which co-own the treatment plant, and the East Bay Dischargers Authority. Oro Loma also collaborated with the San Francisco Estuary Partnership to get funding through the Integrated Regional Water Management Program (IRWMP). Other project consultants and partners include Jeremy Lowe, ESA Associates; Peter Baye; Whitley Burchett and Associates; David Sedlak and Alex Horne, ReNUWIt, UC Berkeley; The Bay Institute and Save The Bay. The approximately $9 million budget is being covered largely by the two sanitary districts and an IRWMP grant of $2.1 million through the California Department of Water Resources.

The Experiment:
Soils, Plants, Wastewater and Nutrients

THE SANDWICH DESIGN

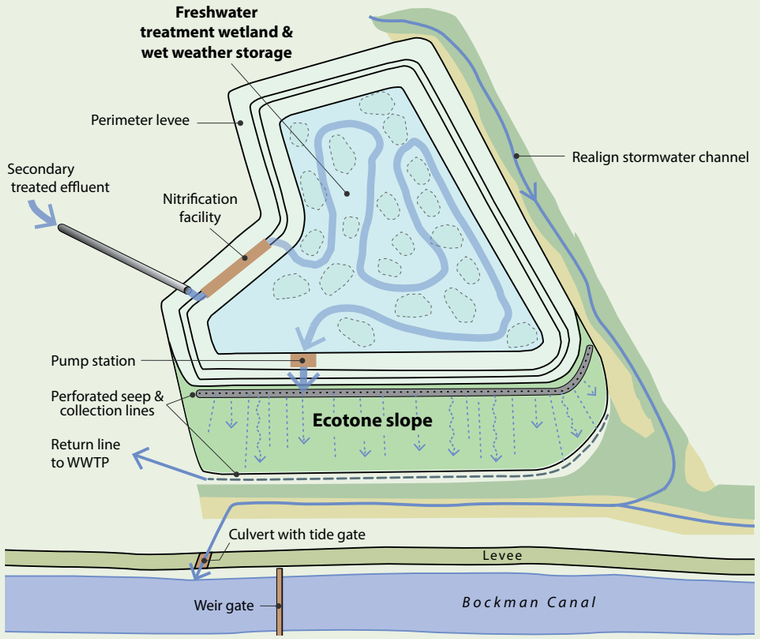
Each of the 12 experimental beds in the Oro Loma horizontal levee (or what scientists call an "ecotone slope") is set up like a sandwich. The bottom layer is impermeable clay, the middle layer is porous gravel, and the top layer is a mixture of bay mud and sandy soil where plants can grow roots. In most seasons, most of the water is expected to seep through the gravelly middle layer. The experiment seeks to create a terrestrial, not tidal, habitat with a subsurface watering system. As each bed is watered, scientists expect to see chemical and biological changes in both the treated effluent and the soils and plant roots it encounters.

NUTRIENTS A-Z

Some of the nutrients in sewage remain in the water after conventional treatment. Though adding nutrients to soil can help plants grow, when too many nutrients enter the Bay via wastewater discharges they can cause problems like algae blooms. When too much algae blooms and dies, it removes oxygen from the water and suffocates fish. Although San Francisco Bay has been historically resistant to such impacts from high nutrient loads, there is growing concern that changing conditions are pushing us toward a tipping point. As a result, the wastewater treatment community is partnering with regulators, environmental agencies and NGOs to evaluate alternatives for a long term response to increasing nutrient impacts on the Bay, which the Oro Loma experiment will explore.

REMOVING NUTRIENTS

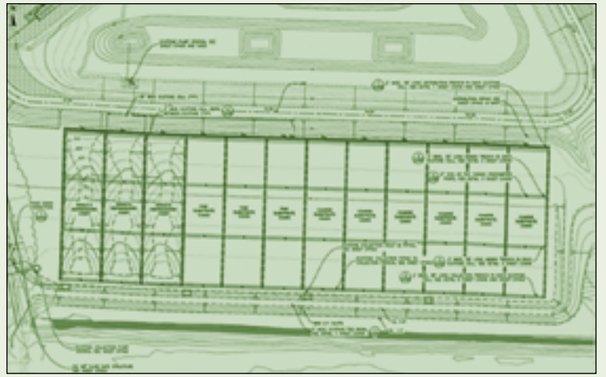
This experiment will use plants and soil microbes to remove nutrients from treated wastewater coming out of the Oro Loma Sanitary District facility. After passing through a conventional treatment wetland full of cattails and bulrushes, scientists estimate 10-30 percent of nutrients will be removed. The water will then be seeped into the buried gravel layer of the sandwich beds, which will include some wood chips. Two things should happen as it flows through this layer. First, microbes living in the wood chips will absorb nitrates and release inert nitrogen gas through a process referred to as denitrification. Second, plants growing in the soil above will sink roots down as far as the gravel layer and take up some of the water and nutrients. Scientists will test water going in, passing through, and coming out of the system to measure how effective the ecotone is at removing nutrients and other impurities. To guarantee no threats to Bay water quality from this experiment, the final product will be returned to the treatment plant. Project managers hope the effluent from the horizontal levee will turn out to be so highly purified that any future replicate slopes could be connected with, and seep into, outlying marshes and the Bay. Scientists also hope to see removal of the trace amounts of pharmaceuticals and synthetic hormones that are often present in the effluent — contaminants of emerging concern to the Bay ecosystem.



Source: ESA

SPECS

- Ecotone Area: 1.4 acres
- Ecotone Width: 480 feet
- Experimental Cells: 12 cells, each 40 feet wide & 150 feet long
- Ecotone Elevation: 5-foot drop basin side to canal, 30:1 slope
- Ecotone Vegetation Palettes: 4
- Ecotone Wet Zone: 2 feet
- Treatment Wetland Area: 2 acres
- System flow range: 100–300,000 gallons per day



The experiment is divided into 12 beds and will test four different combinations of soil types, plant species and watering regimes, as well as provide three replicates. Source: ESA

TREATMENT TOOLBOX

Removing problematic nutrients from wastewater with advanced technology requires significant energy and chemical inputs compared to a natural treatment system. The main reason wastewater treatment engineers select such systems is that they can control the entire process and reliably meet water quality objectives. A natural treatment system like the ecotone slope or wetland, on the other hand, is harder to control directly. Processes at work in them also vary with the seasons: microbes and plants are less active in the wintertime, for example. Scientists hope to better understand this seasonable variability through the Oro Loma experiment. In the case of San Francisco Bay, the fact that treatment performance may diminish in winter may not be an intractable problem, as that's when storms flush water quickly out the Golden Gate. Indeed in this region nutrient removal may be more important in spring, summer and fall — a period when the ecotone is expected to provide the greatest benefits.

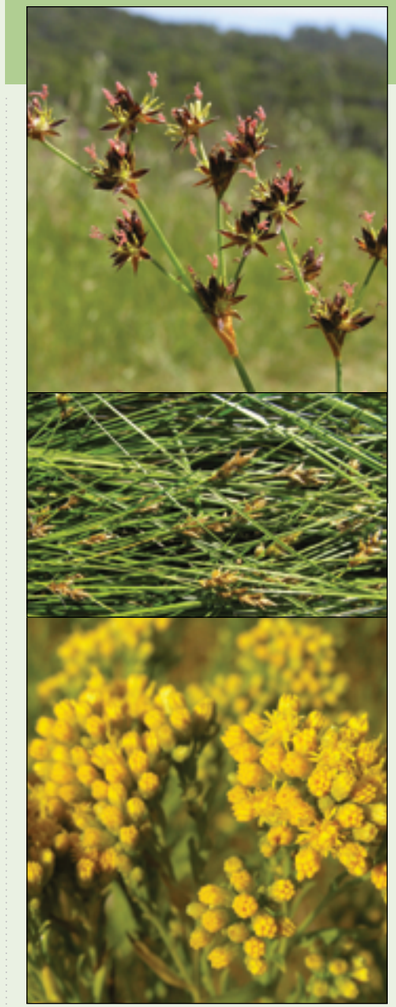
NATIVE PLANTS & NURSERY

The planting palette for the Oro Loma was carefully chosen to include a diverse range of species native to wet meadows, stream banks, and low spots where seasonal pools might occur. Species were also chosen for their efficiency in removing nitrates and phosphorus from wastewater. The growing and planting will be done by Save The Bay's community-based restoration program. First they will locate existing East Bay plant stocks growing in lowlands or grasslands, and then harvest or transplant material to a new nursery established on the Oro Loma property. There, they plan to grow more than 70,000 seedlings in 50 raised beds for use in the experiment. More than 20 species — including creeping wild rye, Baltic rush, spikerush, basket sedge and field sedge, western ragweed, California blackberry, and alkali bulrush – will be tested for growth and resilience in the experimental ecotone slope.

THREE-YEAR MONITORING PLAN

The Oro Loma project is an experiment. What happens on the project site will be meticulously monitored over the next three years by researchers from the University of California, Berkeley as part of the NSF ReNUWIt Engineering Research Center. These scientists and other team members will monitor both ecological and effluent treatment parameters. Every three months, they will assess general site conditions (stress, erosion, damage from grazing waterfowl), plant health and vigor, composition of the plant community, and any encroachment by weeds and invaders. They will also take samples of water coming in and going out of the ecotone slope for lab analysis at UC Berkeley. At the lab, they will also measure everything from concentrations of various kinds of nitrogen and phosphorous to the amount of total organic carbon, temperature, pH, dissolved oxygen, salinity and more.

> "Responding to sea level rise in an environmentally friendly way is a decent win; but it can be a grand slam if it succeeds in addressing the water quality, flooding and habitat loss problems we face on our shorelines all at once."
>
> **JASON WARNER**
> **GENERAL MANAGER**
> **ORO LOMA SANITARY DISTRICT**



Brown-headed rush, field sedge, and western golden rod, three species to be tested in the experiment. Photos: Peter Baye

The Challenge:
Funding, Collaboration and Regulation

The Oro Loma experiment is timely. Findings from its water quality, flood control and habitat restoration tests will inform much-needed improvements and adaptations to the shoreline's infrastructure in the decades ahead. Many levees and flood control facilities and sewage treatment plants are more than 50 years old, and were built in the Clean Water Act era when federal and state grants covered most costs. The time to plan is now; everything from railroad tracks to gas pipelines to freeways and airports will be in the same boat as flood risk increases. Much of what makes the Bay Area hum is built right on its shores. Though concerns about such challenges to our infrastructure have been growing for decades, funds to address them have not.

Beyond the price tag, the regulatory and institutional challenges of doing multi-benefit projects remain substantial. When clean water regulations, flood control specs, and bans on Bay fill were written 20-50 years ago, local conditions were quite different than they are today. In the same time span, scientific results from regional water quality monitoring programs and ecosystem restoration activities are suggesting the need for change in our priorities for the management of wastewater, sediment and flooding whilst continuing to protect the Bay's ecological riches. Those involved in the Oro Loma project are not alone in tackling these challenges. Groups all around the Bay Area are now trying to collaborate on shoreline protection projects with multiple objectives like the one described in these pages.

The Oro Loma experiment is located at a mid point on the 22-mile-long EBDA pipeline that collects treated wastewater from six plants and moves it to a centralized discharge outfall. Exploring ways to decentralize this discharge and tap this valuable source of fresh water to irrigate new sea level rise adaptation projects is one goal of the Oro Loma project. Map by Molly Mehaffy Design, MBA Consultants, SFEI & ESA.

"The challenges of modernizing our institutions to handle these multi-benefit projects are more complex than the science or engineering of designing and building them. If this small experimental project succeeds, it will help convince people that the extra effort required to make it compliant with the patchwork of regulations out there, or to use pots of money that normally are reserved for other purposes, may be worth it. Oro Loma has been a wonderful partner on the project."

DAVID SEDLAK
PROFESSOR
UNIVERSITY OF CALIFORNIA BERKELEY

"If we're going to ask ratepayers to ante up, it's time to look at all options. Maybe treatment is good enough now that instead of piping wastewater into outfalls in 30 feet of Bay water, we can run it through wetlands. Rather than spending $50 million to rehabilitate our outfall, I'd rather spring for something where we can see the benefits right on our shore."

MICHAEL CONNOR
GENERAL MANAGER
EAST BAY DISCHARGERS AUTHORITY

"Some partners have got land, some have sediment, some have water, some have other resources. Individually we're not going to fix the problem, but working together I think we can."

JEREMY LOWE
COASTAL GEOMORPHOLOGIST
ESA ASSOCIATES

PROJECT PARTNERS & FUNDERS
Oro Loma Sanitary District
Castro Valley Sanitary District
East Bay Dischargers Authority
California Dept. of Water Resources
San Francisco Estuary Partnership
The Bay Institute
Save The Bay

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