WETLAND RESTORATION:

EAST SAN RAFAEL LANDFILL TREATMENT

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UNIVERSITY OF CALIFORNIA DAVIS
LANDSCAPE ARCHITECTURE

WETLANDS RESTORATION:
EAST SAN RAFAEL LANDFILL TREATMENT

Presented to Department of the Landscape Architecture and Environmental Design at the University of California, Davis. In partial fulfillment of the requirements for the Degree of Bachelors of Science in Landscape Architecture.

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DEDICATION

Thanks to my family, for all the support in the past few years. Without their help, I could not have finished my education.

Thanks to all my LDA classmates for sharing the best memory in the past three years.

ACKNOWLEDGMENTS

First and foremost I would like to take this moment to thank my committee members: Emily Schlickman, Sheryl-Ann Simpson, and Eliska Rejmankova for supervision and motivation. I would also to thank my instructor Elizabeth Boults and TA Gayle Totton for advising on my project when I have hard time. Thanks to all the staff in Landscape Architecture program at UC Davis.

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Through my entire project, I have faced lots of troubles and stress. Thank you to everyone who gave me support and helped me pass through challenges.

ABSTRACT

This project discusses restoring salt marsh land in the Canalways Property in San Rafael, California. This study will focus on two aspects: restoration and recreation. The San Rafael Canalways Property has been filled with demolition debris for decades, and the natured habitat has disappeared. Restoring the marshland will provide Habitat for two endangered species located in this site: the California Clapper Rail and the Salt Marsh Harvest Mouse. The design will explore a suitable tidal marsh land for the two endangered species by setting back the levee and growing pickleweed on brackish marsh. Moreover, on the recreation perspective, the design of Canalways Property will focus on a walking trail on the levee on the east side of the property. The design will focus on different typologies and provide different views such as a deck, a skywalk, a viewing platform and provide different views when people walk. Also, the walking trail is a part of the San Francisco Bay Trail. The San Francisco Bay Trail project concentrates on providing a completed non-motor pathway for pedestrians and bikes which is also the recreational purpose of Canalways Property. This project tries to bring people close to wild nature.

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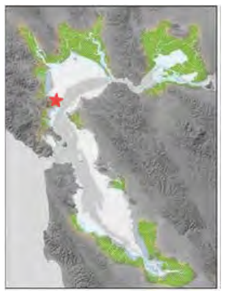


Fig. 1-11770-1850 wetland

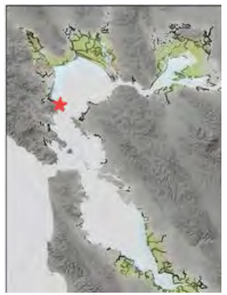


Fig. 1- 2 1850- 1960 wetland

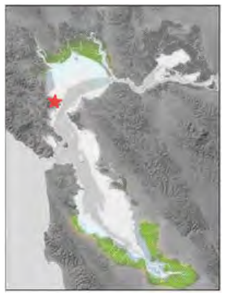


Fig.1- 3 1960-2014 wetland

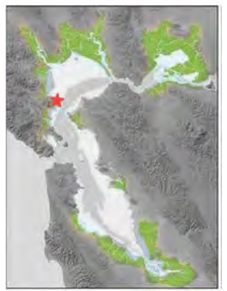


Fig.1- 4 2014-future wetland

BACKGROUND

Wetlands are an area of marshy land, the area between open water and dry land. Wetlands can support many species of fish, mammals, and birds. Wetlands can also improve water quality and control flooding.

Historically, the San Francisco Bay Area was the habitat of thousands of plants and animals. Before 1850, large numbers of species were killed by unrestricted hunting. Starting from the Gold Rush, people began to destroy the habitat of thousands of wetland species. People started to fill the bay for commercial use, and wetlands began to disappear. Some species declined, and some ceased exist. By the end of 1950, more than 80 percent of the salt marshes were filled-in for urban expansion.

In 1961, three women, Catherine Kerr, Sylvia McLaughlin, and Esther Gulick organized a campaign to Save the Bay. Meanwhile, the Army Corps of Engineers reported that if people continued to develop the Bay by 2020, the Bay would become a small shipping canal. Today, more than fifty thousand people participate in a Save the Bay program. Industrial pollution has been reduced. The Bay has been developed as a shoreline for parks and outdoor spaces connected with the Bay Trail;a public area for walking and biking. The fill the Bay project has been stopped, and wetland restoration projects are being developed.

SAN RAFAEL CANALWAYS PROPERTY

Fig. 1 - 5 Context Map: San Rafael Canalways Property

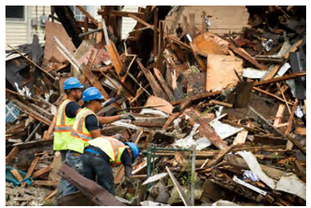


Fig. 1 - 6 Landfill: Demolition debris

Fig. 1 - 7 Landfill: Yard Trimming

THE SITE

Fig. 1 - 8 Salt Marsh Harvest Mouse

Fig. 1 - 9 California Clapper Rail

The study area of this research project is located in East San Rafael and is called the “Canalways Property”. In 1958, the theme of the San Rafael General plan was called “Fill the Bay”. Most of the coastal land in San Rafael was planned to be filled to create “waterfront” and “canal type” residential communities. Until 1987 the Canalways Property was filled in with demolition debris, asphalt, yard trimming, and brush clippings. This eighty-five acre area belongs to a private owner, and the owner’s original ideal was to fill the wetlands and built a multi-story office. The project was stalled in the 1980’s because two listed endangered species(Salt Marsh Harvest mouse and California Clapper Rail) were found in the area. Since then, Canalways Property has become a big open space, and marshes are randomly growing on this site. There is also a walking path across the middle of this site. Several commercial use proposals related to this site have been submitted to the city of San Rafael. The rejection states that this site has sensitive species. The city of San Rafael needs to re-classify the zoning of this area based on an approved development plan, and under the requirements of the California Environmental Quality Act, any design proposed will be sent to environment review to evaluate the impact to the environment.

SAN RAFAEL 2020 GENERAL PLAN:

There is a policy in the San Rafael 2020 General Plan: The city will regard the remaining wetlands in East San Rafael:

NH-55 Canalways:

> *Recognize the high resource value of the site's wetlands that provide habitat to many species, which may include rare and endangered species. In addition, recognize that this site is in an area affected by traffic congestion. With any development of this property, butter site wetlands from buildings and parking lots, and obtain trail easements and improvements for the jean and john Starkweather Shore-line Park. Development shall be located along the western edge of the site and greatest extent feasible in areas outside of delineated wetlands or areas determined as critical upland habitat for endangered species."*

This quote propose that by 2020, the city of San Rafael will focus on proposed habitat for endangered species. Therefore, this property cannot be zoned as residential, commercial or industrial, so the only one zoning is wetland.

CANALWAYS ZONING MAP

Fig. 1 - 10 Canalways zoning map

CURRENT CONDITION:

The Planned Development District document shows that the Canalways site does not have an approved development plan and list of permitted and conditional uses. Also, The Canalways property has been known to be a sensitive environmental area that could be negatively impacted by development. In addition, the project is located in a wetland overlay district and is potentially to be zoned as wetland.

GOALS

This project has three goals:

1. Create divers salt marsh habitats for different species.
2. Complete the San Francisco Bay Trail to further the recreational purpose.
3. Reconstruct the levee to reduce flood.

RESEARCH

ENDANGERED SPECIES HABITATS

RECREATIONAL AREAS

FLOOD CONTROL STRATEGY

PICKLEWEED:

Fig. 2 - 1 Pickleweed: before absorbing salt water

Fig. 2 - 2 Pickleweed: after absorbing salt water

HABITAT:

California Clapper Rail

&

Salt Marsh Harvest Mouse

Both the California Clapper Rail and Salt Marsh Harvest Mouse inhabit brackish and salt marshland. Usually, marshland has three levels; high, middle, and low. High marsh zones function as refuge for many species escaping from high tides. Pickleweed is one of the most abundant plants in the salt marshes of Marin County. The stems are generally green, but once the succulent stems take up salt water, they become red.

TIDAL MARSH

Fig. 2 - 3 Low tidal marsh **Fig. 2 - 4** Middle lower tidal marsh **Fig. 2 -5** Middle higher tidal marsh **Fig. 2 - 6** high tidal marsh

Sea levels rise and fall in what is called tidal movement caused by gravitational forces and the rotation of the earth. A tidal marsh is a type of coastal marsh. Tidal movement determines tidal marsh flooding characteristics. Based on sea level changes, the tidal marsh can be zoned as lower or higher. In turn tidal marshes can also be divided into salt marshes and fresh water marshes.

Regarding salt marshes, high marshes have less tidal flow, so the salinity levels are lower. In contrast, due to the frequent tidal flows in the lower marshes, the salinity levels are much higher. Plants in salt marshes are of course tolerance of salt. The most common salt marsh plants are Galssworts (*Salicornia spp*) and Cordgrass (*Spartina spp*.) Species have different tolerances, so each species has its own habitat along the marsh. For example, Pickleweeds are located in high marshes whereas Cordgrass are in lower marshes.

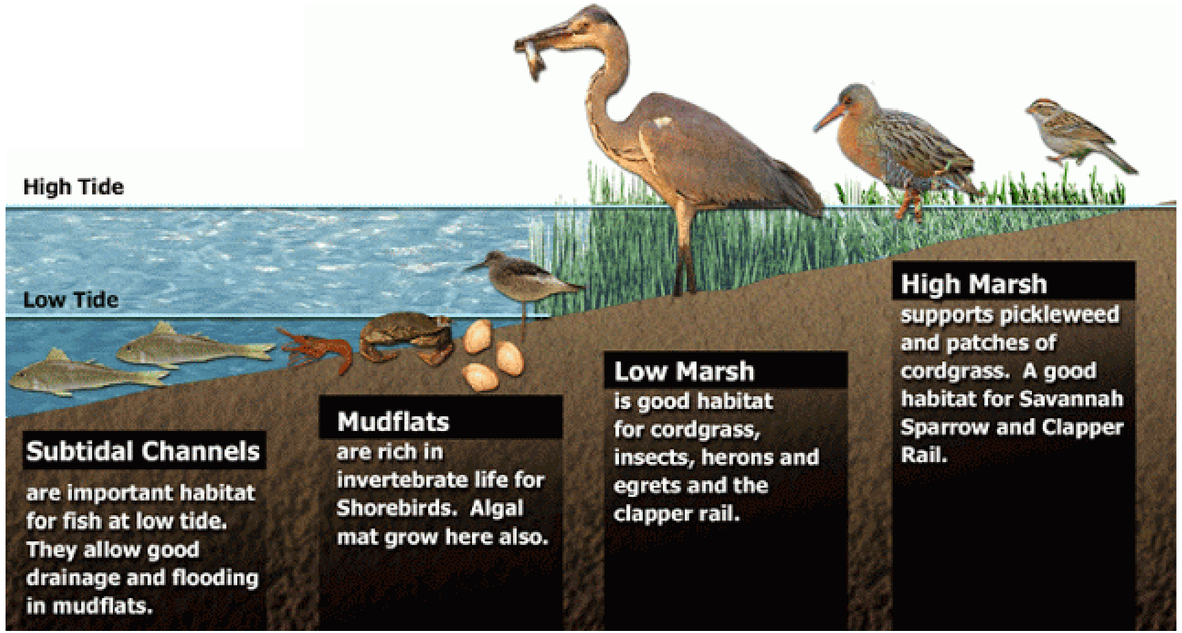


Fig. 2 - 7 Salt Marsh Zones

FEDERAL LISTED SPECIES (MARIN)

Animals

Fig. 2 - 8
California least tern
Sterna antillarum browni

Fig. 2 - 9
Chinook salmon
Oncorhynchus tshawytscha

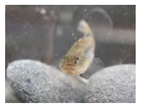


Fig. 2 - 10
Tidewater goby
Eucyclogobius newberryi

Fig. 2 - 11
Vernal pool tadpole shrimp
Lepidurus packardi

Fig. 2 - 12
California red-legged frog
Rana aurora draytonii

Fig. 2 - 13
California clapper rail
Rallus longirostris obsoletus

Fig. 2 - 14
California tiger salamander
Ambystoma californiense

Fig. 2 - 15
Western snowy plover
Charadrius alexandrinus nivosus

Fig. 2 - 16
Steelhead
Onchorhynchus mykiss

Fig. 2 - 17
San Francisco garter snake
Thamnophis sirtalis tetrataenia

Fig. 2 - 18
Salt marsh harvest mouse
Reithrodontomys raviventris

Fig. 2 - 19
Southern sea otter
Enhydra lutris nereis

Plants

Fig. 2 - 20
Contra Costa goldfields
Lasthenia conjugens

Fig. 2 - 21
California sea-blite
Suaeda californica

MARSHLAND

Between Golden Gate Bridge to Point San Pedro(Marin)

Most remnant and historic tidal marshes in Marin County lack sufficient size for restoration, and any restoration or expansion plan can only be achieved to a very limited degree. Now, most remaining marshlands are small and isolated, but support endangered or locally important species. For example, Pickledweed Park is the only habitat for California clapper rails in Marin County. A suitable restoration design not only provides a new habitat zone but also provides connectivity for endangered species to move through the region. Also, the final proposed marshland design will add missing associated habitats, such as brackish ecotones and mudflat ecotones.

SAN FRANCISCO BAY TRAIL

Fig. 2 - 22 Bay trail: San Francisco Bay

The San Francisco Bay walking trail is a 500 mile network for bicycling, pedestrian and wild life watching. When the Bay Trails are completed, they will connect nine counties and 47 cities in the shoreline of the bay area. Today, 60 percent of the Bay Trails (about 330 miles) have been completed. The reason that the trail has not been completed is that it needs widening and paving . The Canalways Property is the unfinished part of the San Francisco Bay trails because the levee is unpaved and narrow.

The San Francisco Bay Trails is a circulation pathways; it consists of paved paths, gravel trails, bike lanes and sidewalks. In addition, the purpose of the bay trails is not only providing circulation for bicycling and pedestrians but also providing wildlife watching area. Even though the project has not been completed, all the finished parts are focused on completing the non-motor paths: to widen and pave the path. The wildlife watching areas can be small branches extending to the paths, such as decks, platforms or skywalks. The wildlife watching areas will give people a space to be close to nature and will not hold up traffic on the circulation paths.

BAY TRAIL: MARIN PART

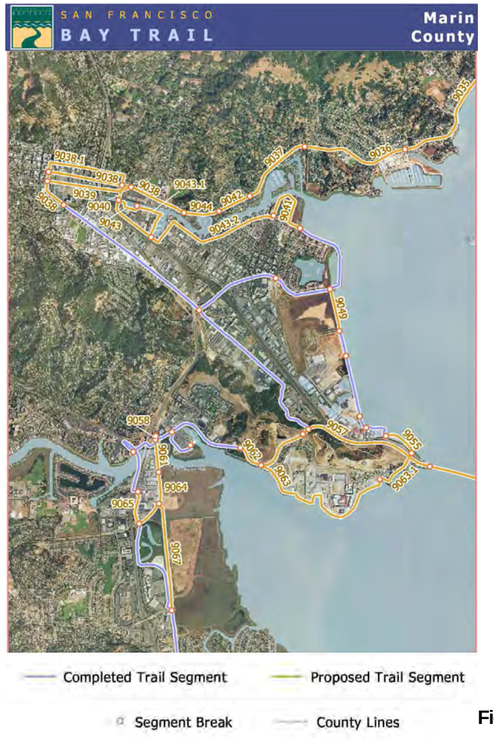


Fig. 2 - 24 Bay trail: signage

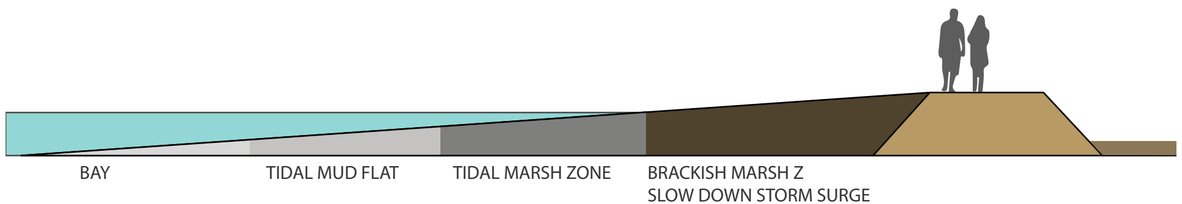
The levee located on the east side of the Canalways property in San Rafael is part of the San Francisco Bay Trail. Unfortunately, the uncompleted part of the trails is narrow and unpaved.

Fig. 2 - 23 Bay Trail: Marin county

LEVEES

TRANSITIONAL LEVEE

Fig. 2 - 25



“HORIZONTAL” LEVEE

Fig. 2 - 25

LEVEES COMPARISON

Compare to transitional levees, the “Horizontal levees” provide several zones that will reduce flooding. The brackish marsh zone was covered with alkali bulrush and, the brackish marsh would slow down a storm surge.

CASE STUDIES

DESIGN ELEMENTS

IMPLEMENTATION

MICRO HABITAT

QUNLI STORMWATER PARK

Qunli Stormwater Park is located in Harbin City, Heilongjiang Province, China. The park was built in 2009, and is situated in the middle of the new residential district called Qunli New Town. Since this 84.5-acre wetland is surrounded by developed infrastructure, the original task was to preserve the existing wetland. Landscape design firm Turenscape was in charge of this project, which includes connecting the urban water system and transforming the site into a stormwater park. The Qunli Stormwater Park not only redirects the stormwater to the wetland, but also provides multiple ecological services: such as collecting, cleaning, and storing water.

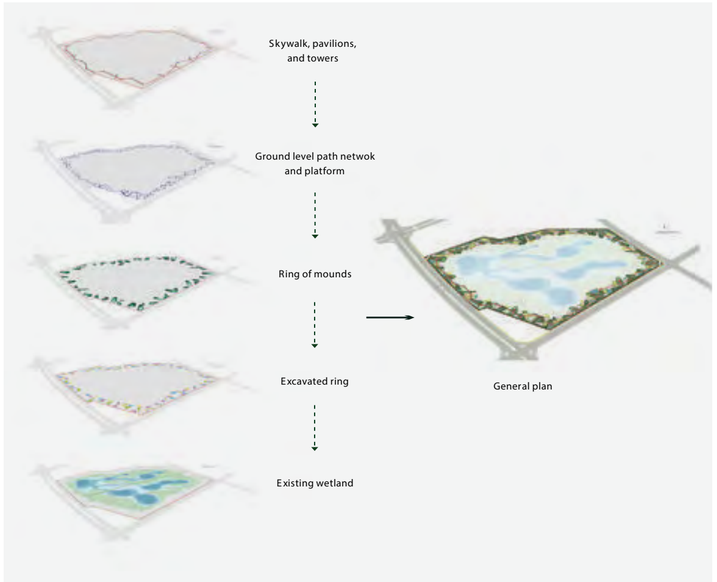


Fig. 3 - 1 Layer diagrams

DESIGN FEATURES & ELEMENTS

Platform

Skywalk

Necklace of ponds and mounds

Five pavilions:

Bamboo, wood, brick, stone and metal

Two viewing tower:

One made of steel, the other made of wood

Fig. 3 - 2 Pathway and ponds

Fig. 3 - 3 Pavilion

Fig. 3 - 4 Platform

Fig. 3 - 5 Pathway and ponds

Fig. 3 - 6 Skywalk

Fig. 3 - 7 Viewing Tower

PICKLEWEED PARK

Picklweed Park is located in East San Rafael, one mile north of the Canalways property. The 4-acre pickleweed marsh is the only habitat for the California Clapper Rail in Marin County. There are four habitat zones in and around Pickleweed Park: Bay water habitat, tidal salt marsh habitat, upland habitat and mudflats habitat. The San Francisco Bay Trail also provides access to Pickleweed Park. Plants on the ocean side of the trail flourish, but on the inland side it is drying out. This environmentally sensitive habitat zone is also a recreational use area. A football field and a library are also located on the east side of the Marshland.

Fig. 3 - 8 Pickleweed Park

DESIGN FEATURE & ELEMENTS

Habitat for Endangered: California clapper rail

Recreational area close to sensitive habitat zone

Close to Canalways property

PG&E Power line tower

Soccer field

County library

Fig. 3 - 9 Shrubs between levee and pickleweed

Fig. 3 - 10 Unpaved pathway

Fig. 3 - 11 Pickedweed

Fig. 3 - 12 Marsh dry out

SOUTH BAY SALT POND RESTORATION

South Bay Salt Pond Restoration is the largest wetland restoration project on the west Coast. The plan is to re-create a 15,000-acre wetland of South Bay Salt ponds. Currently there are 65 industrial ponds located south of the San Mateo Bridge, and these ponds need to be restored to be tidal wetland and managed habitat ponds. In addition, federally listed endangered species are also found in this region: These includes California Clapper Rails and Salt Marsh Mice. The goals of the project are to restore a mixed wetland habitat and provide public access to wildlife and recreation. These are goals shared with the San Rafael Canalways project.

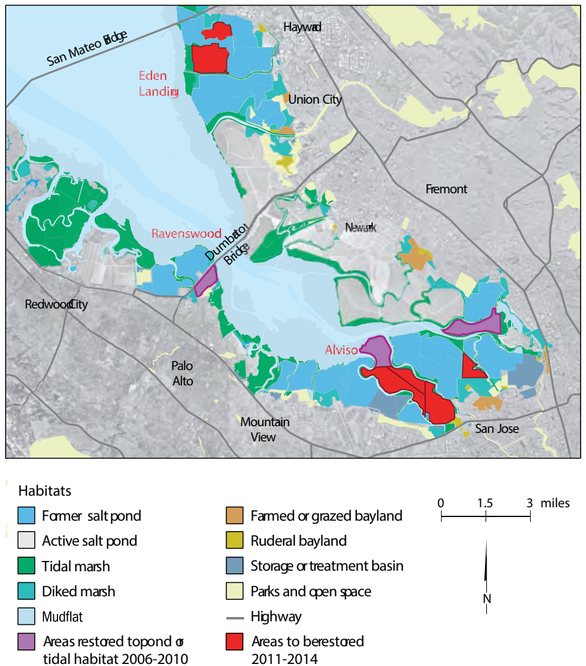


Fig. 3 - 13 South Bay Restoration Diagram

DESIGN FEATURES & ELEMENTS

One interesting restoration design is Bird Island. The Penisula's Ravenswood area is a 240- acre pond with 30 built habitat islands. Some of the ponds are covered by vegetation, and some are mini-mudflats. These islands are only a couple feet high create micro habitats for shorebirds.

Fig. 3 - 14 Mudflat, island for birds habitats

Fig. 3 - 15
Willet with crab in mouth.

Fig. 3 - 16
Shoreline bird: Avocet

SITE ANALYSIS

EXISTING CONDITION

ANALYZED DIAGRAMS

OPPORTUNITIES AND CONSTRAINTS

CONDITION

Fig. 4 - 1
Canalways property context map

Fig. 4 - 2
Stormwater flow pipe

Fig. 4 - 3
City owned detention pond

Fig. 4 - 4
Unpaved path

Fig. 4 - 5
Walking path: elevation change from target

Fig. 4 - 6
Proposed past in the canalways property

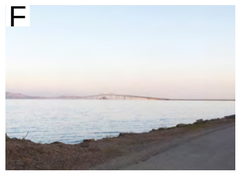


Fig. 4 - 7
Bridge ocean view

Fig. 4 - 8
Ocean-levee-wetland toward to south

Fig. 4 - 9
Wetland-levee ocean toward to north

Fig. 4 - 10
Paved path

Fig. 4 - 11
Inside the landfill

Fig. 4 - 12
West side of the property: proposed path

Fig. 4 - 13
Plants inside the wetland

CIRCULATION

Legend

- Trails
- Bikeway
- Road

Fig. 4 - 14 Circulation diagram

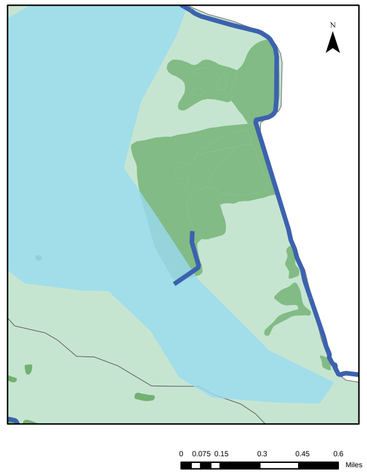
CONTEXT

Legend

- San Rafael Zoning
- Building Footprint

Fig. 4 - 15 Context diagram

HYDROLOGY



Legend

- National Hydrography Flow Line
- Groundwater
- Wetland
- Watershed Major

Fig. 4 - 16 Hydrology diagram

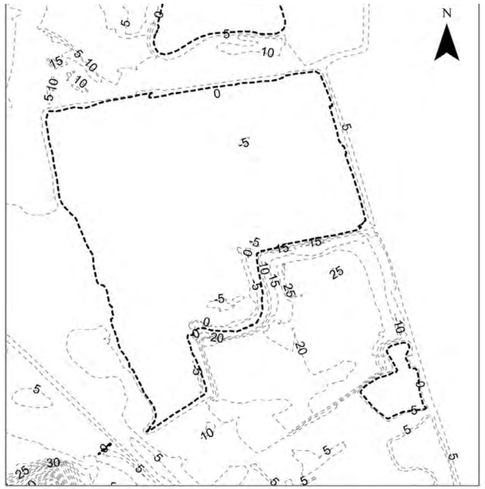
WETLAND

Legend

- Parcel
- County Boundary
- Watershed (Major)
- Watershed (Sub)
- Freshwater Emergent Wetland
- Freshwater Pond
- Other Freshwater Wetland
- Ocean Bay

Fig. 4 - 17 Wetland diagram

CONTOUR



Legend

- contour interior urban
- Ocean level countour

Fig. 4 - 18 Contour diagram

OPPORTUNITIES & CONSTRAINTS

Opportunities

1. Pickleweed marsh: Habitat for Salt Marsh Harvest Mouse.
2. Lagoon and island: Habitat for shoreline birds
3. Paved Pathway: Potential Bay Trail
4. Unpaved Existing pathway: Potential Bay Trail
5. Ocean View: Potential gathering area & wildlife watching area
6. City Owned Pond: Detention Pond- Vernal Pool
7. Fresh water marsh

Constraints

7. Private owned land: difficult to Propose any plan
8. Unpaved levee: Part of the Bay trails, not completed part.
9. Newly Built Target Store: Historical land fill (Mudflat)
10. Home Depot: historical landfill
11. Highway 580: Isolated accessibility for wildlife from upland

Fig. 4 - 19

DESIGN

MASTER PLAN

DIAGRAMS

SECTION

PERSPECTIVE

MASTER PLAN

Fig. 5 - 1

1.Platform-wildlife watching area

2.Platform-Sitting

3.Skywalk-Wildlife Watching area

4.Newly Built Target Store

5.Detention Pond

6.New Pedestrian Walk

7.Fresh Water Marsh

8.Brackish Marsh

9.New Levee

10.Tidal Marsh

11.Tidal Mud Flat

12.Birds Habitat Island

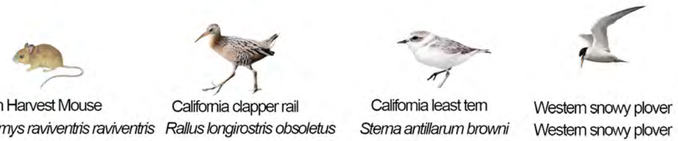
The design focused on two aspects; restoration and recreation. Even though the Canalways property is privately owned, much evidence suggests that this property must be designed as wetland. Based on the research, providing habitat zones for the two endangered species is the key point in design of this property. The contour diagram shows that the Canalways property is at sea level. If the levee is taken out, the brackish marsh will be restored, but also this site will face flooding issues. If we keep the levee, there is no land to create a habitat. The only neutral way to design this area is to setback the levee in order to prevent flooding and also create a habitat zone.

From the recreational perspective, providing a wide paved pathway would qualify as completing the San Francisco Bay Trail in this part. In addition, providing a place for gathering and wildlife watching is the goal for a recreational aspect.

Today, 33 percent of the San Francisco Bay Trail needs to be competed. Features like the skywalk and platform will attract people to visit. The Bay Trail is functional for circulation, but a gathering area would functions as a stop station for people to take a break and enjoy nature. Such features can be built on other place along of the entire Bay Trail.

ANIMAL HABITATS

Endangered Species



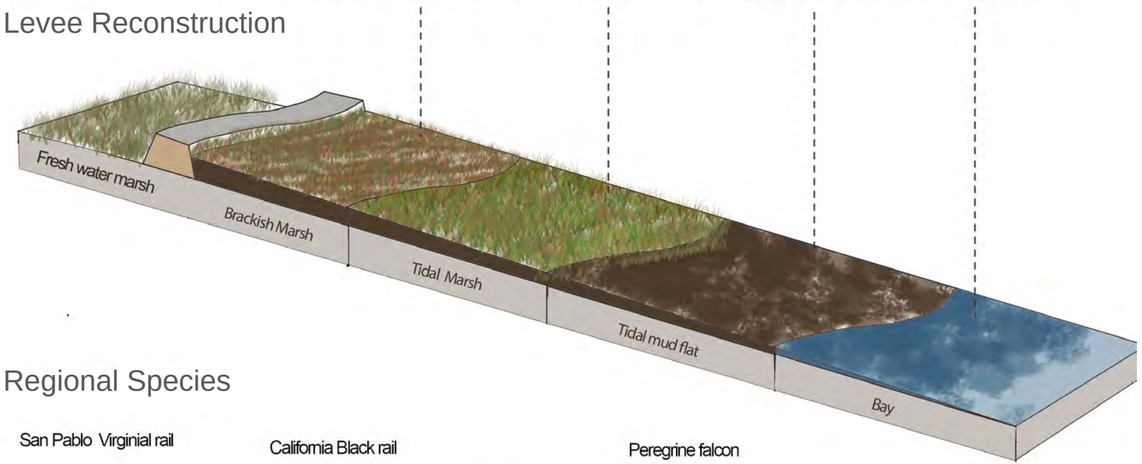
Salt Marsh Harvest Mouse
Reithrodontomys raviventris raviventris

California clapper rail
Rallus longirostris obsoletus

California least tern
Sterna antillarum browni

Western snowy plover
Western snowy plover

Levee Reconstruction



Regional Species

San Pablo Virginial rail

California Black rail

Salt Marsh Common Yellow throat

Salt marsh wandering shrew

Peregrine falcon

Shorebirds

wading brids

California sea-lion

Fig. 5 - 2

PLANT HABITATS

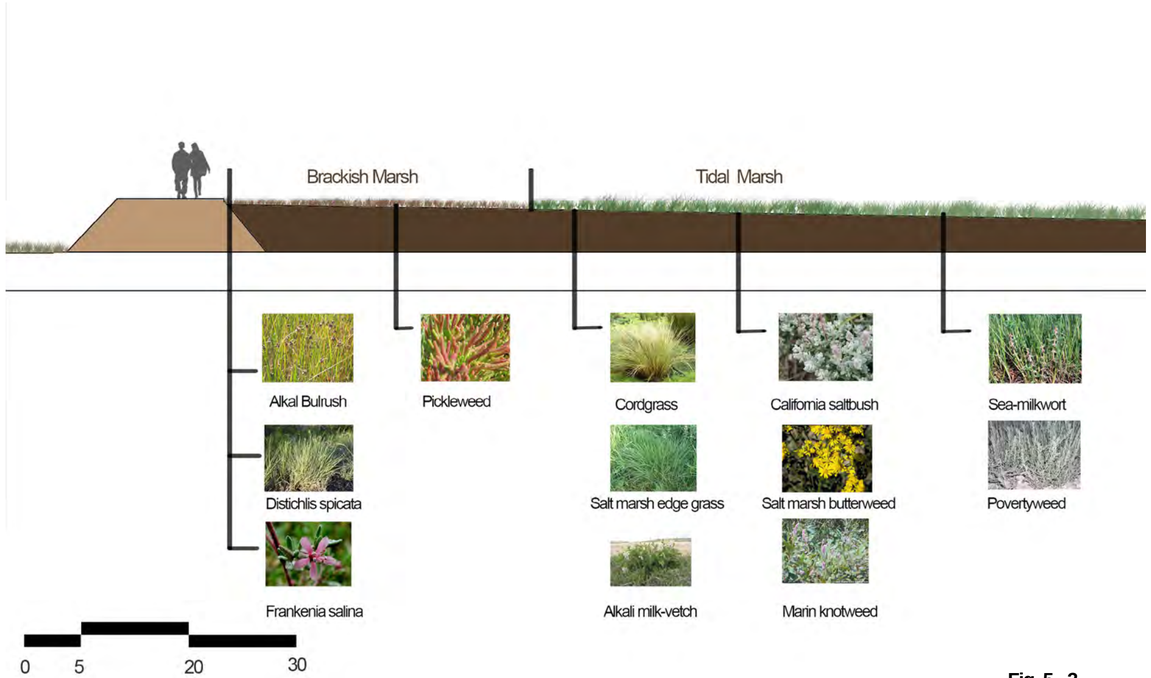


Fig. 5 - 3

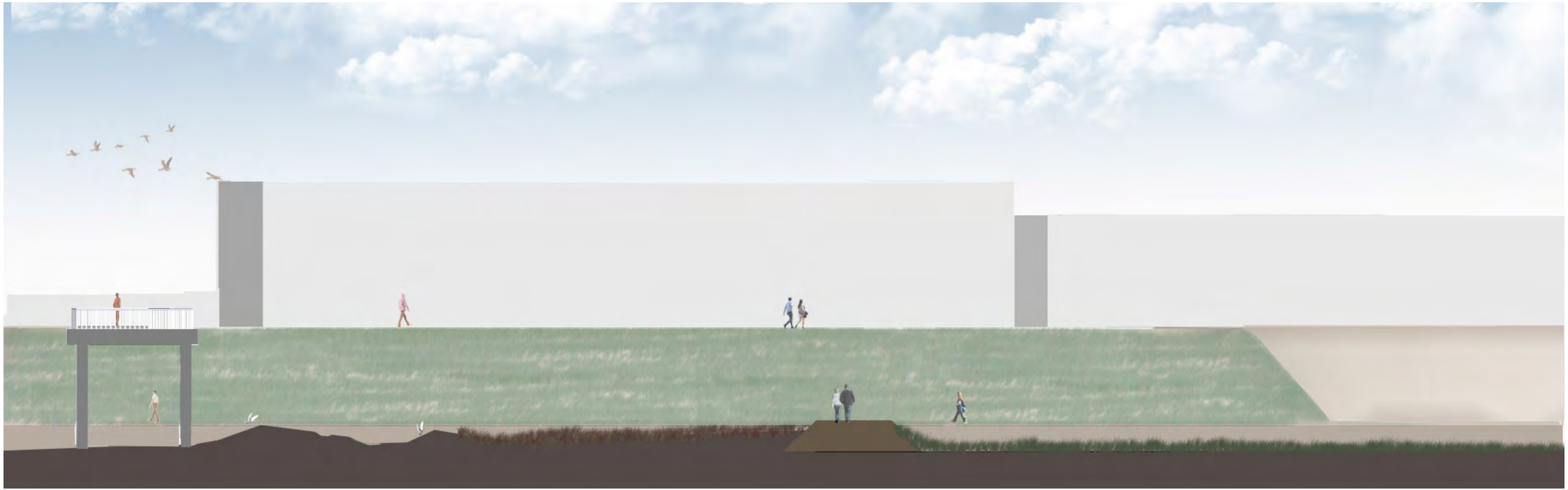


Fig. 5 - 4 **SECTION**

0 5 10 20 40ft

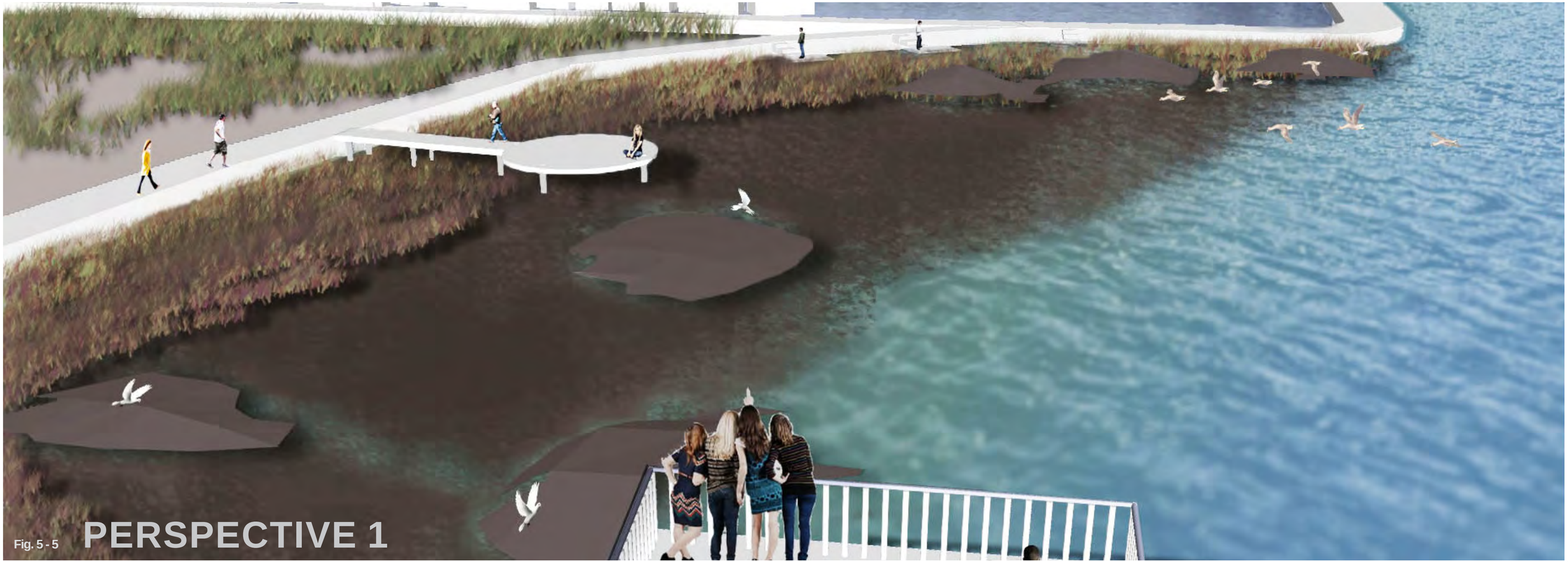


Fig. 5 - 5 **PERSPECTIVE 1**

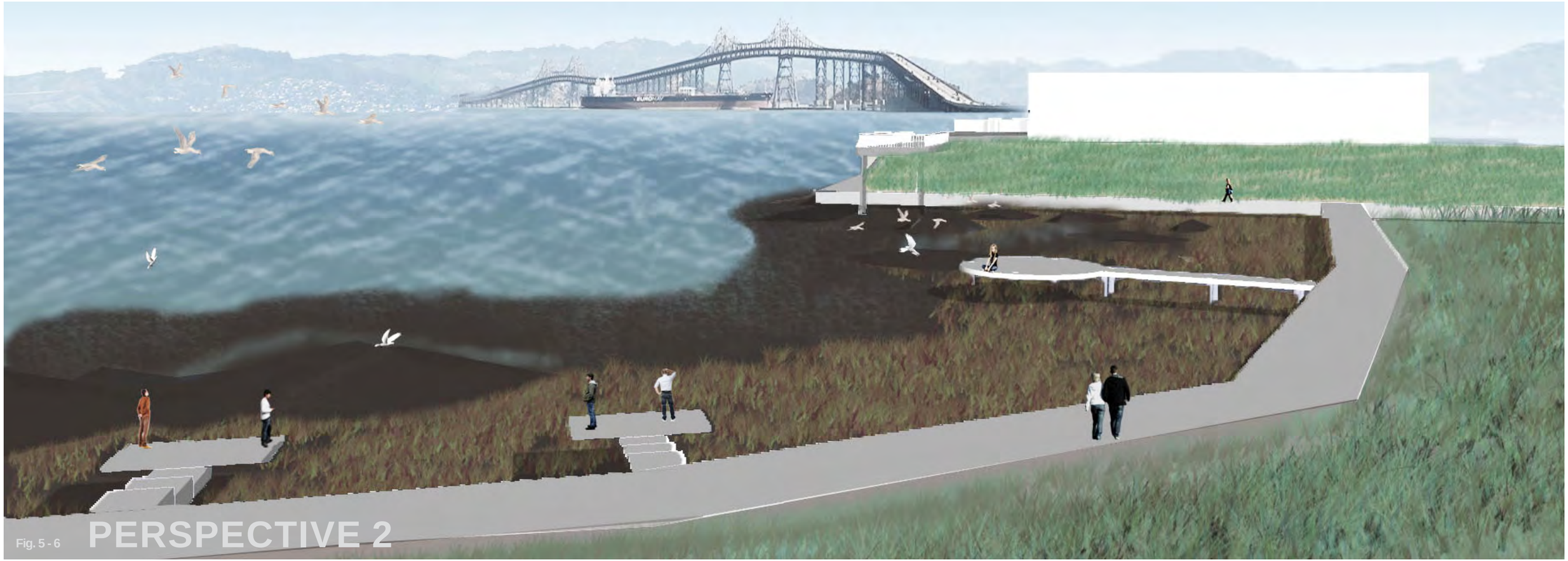


Fig. 5 - 6 **PERSPECTIVE 2**

POTENTIAL DEVELOPING AREAS

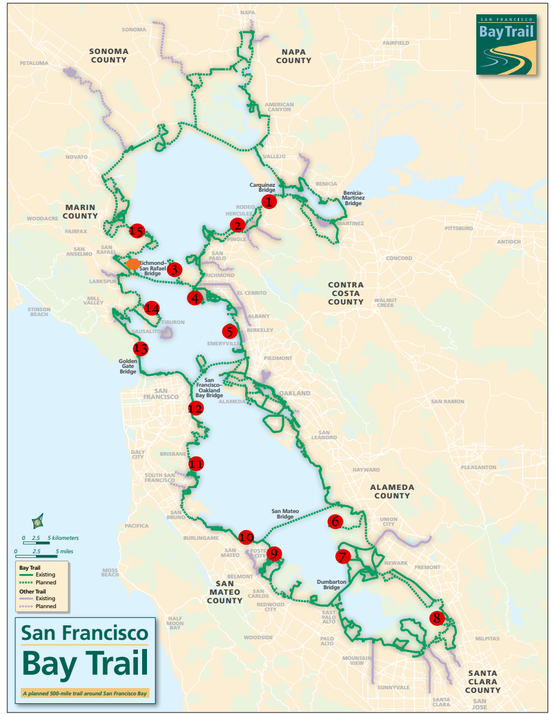


Fig. 5 - 7

1.San Pablo Bay Regional shoreline, Hercules, CA

2.Point pinole regional shoreline, Hercules, CA

3.Point Molate shoreline, Richmond ,CA

4.Miller knox regional shoreline, Alameda, CA

5.Golden Gate Fields shoreline, San Leandro, CA

6.Alameda Point shoreline , Union City, CA

7.West Dike Road, Fremont, CA

8.Coyote Creek trail, Milpitas, CA

9.Redwood Shores Ecological reserve , Foster City, CA

10.Airport Blvd. Burlingame, CA

11.Tunel Avenue shoreline Brisbane, CA

12.Candlestick Point State Recreation Area San Francisco, CA

13.Swedes Beach Sausalito, CA

14.Paradise Drive Tiburon, CA

15.Point San Pedro San Rafael, CA

Canalways Property San Rafael,CA

CONCLUSIONS

Historically, people have destroyed wetlands for economic proposes. Species have lost habitat and become endangered. Since the 1960's, people have realized the importance of wetlands. Land-fill projects have been stopped, and wetlands restoration projects have been started. Landscape designers have to be familiar with ecologies to provide sustainable designs and bring people outside to enjoy wildlife.

The wetland restoration project in Canalways property east San Rafael has focused on creating a robust salt marsh habitat, providing gathering and habitat watching areas, and reconfiguring the levee for flood protection. Endangered species will migrate to this new habitat, and people will come to this place to visit. The design features in Canalways property can also be implement to linked areas along the San Francisco Bay Trail.

THANK YOU

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