



# San Rafael ELEVATE

RESILIENT BY DESIGN | BAY AREA CHALLENGE

DESIGN REPORT

5 / 31 / 2018



RESILIENT  
BY  
DESIGN

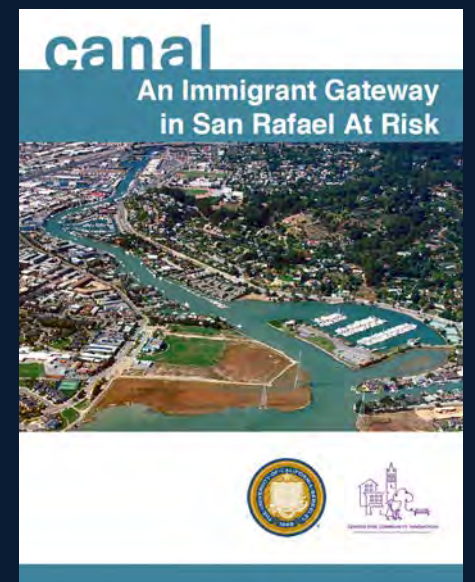
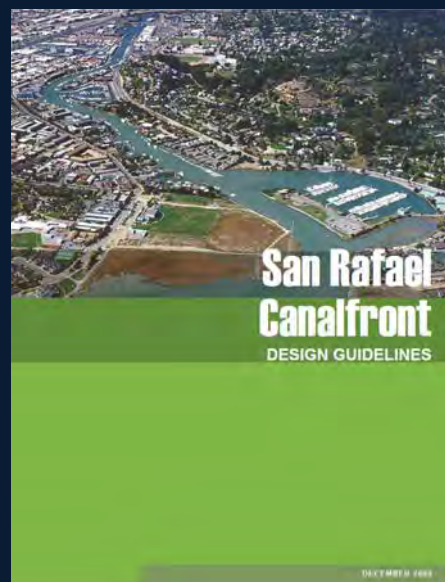
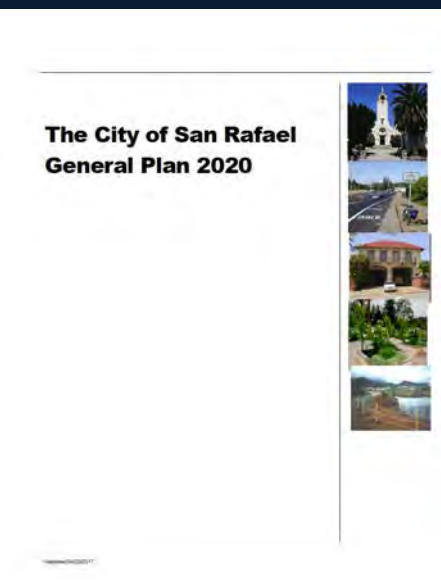
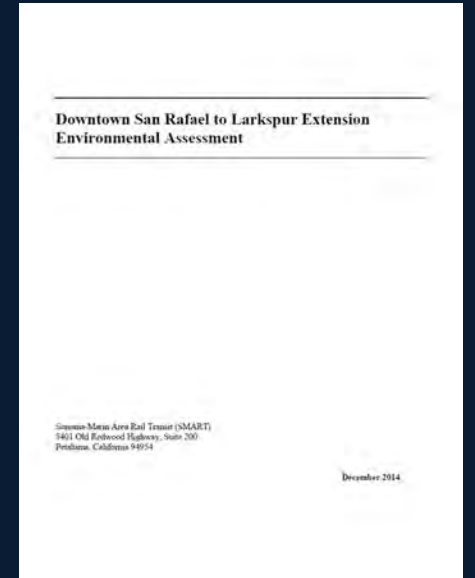
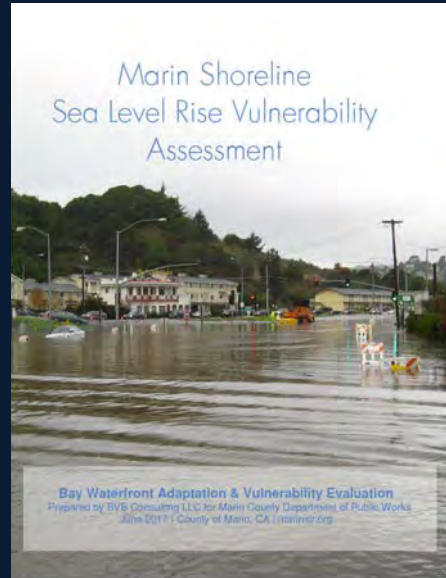
# Appendix

An aerial, monochromatic photograph of a coastal region. A long, multi-lane bridge spans across a wide body of water, extending from the foreground towards the background. In the distance, another bridge with multiple spans is visible. The foreground shows a city with a grid-like street pattern and a large, rectangular structure, possibly a stadium or arena. The sky is overcast with dark clouds. The word "Appendix" is overlaid in white text on the left side of the image.



# EXISTING STUDIES

The Bionic Team could not have gotten as far as the Team did in terms of understanding the social and ecological conditions on the ground without the immense amount of work already completed by the city, county, and various agencies. The Team built on this body of research with San Rafael specific economic and topographic analyses to inform design strategies.



## Marin Shoreline Sea Level Rise Vulnerability Assessment



Bay Waterfront Adaptation & Vulnerability Evaluation  
Prepared by BVB Consulting LLC for Marin County Department of Public Works  
June 2017 | County of Marin, CA | marinslr.org

### **VULNERABILITY ASSESSMENT:**

Prioritize preparation of an assessment.

### **FUNDING SOURCES:**

Investigate and pursue funding sources for staffing, studies and adaptation.

### **ENGAGE:**

Engage in countywide and regional efforts.

### **STAKEHOLDERS:**

Identify key stakeholders and initiate outreach.

### **IMPLEMENTATION:**

Commit to long-term implementation and programming.



San Rafael Shoreline - 1953

### **"CLIMATE ADAPTATION - SEA LEVEL RISE" SAN RAFAEL, CA WHITE PAPER**

January 2014

Prepared by the  
City of San Rafael  
Department of Community Development  
Paul A. Jensen, AICP, Community Development Director  
with the Assistance of Anais Hall, Sustainability Volunteer and  
The Department of Public Works  
File No. P13-002

### **OVERLAY ZONE:**

Study sea level rise impacts to areas prone to sea level rise.  
Based on study, impose adaptive measures.

### **HOLD THE LINE:**

Some areas with existing levees may be suitable for a raised levee solution.

### **RETREAT & CONVERT:**

Some undeveloped or diked baylands may be suitable for retreat and conversion to tidal marsh.

### **DREDGE THE CANAL:**

Continued dredging will increase navigable channel and help runoff flow from upstream.

### **HORIZONTAL LEVEE:**

Convert mudflats to marsh plain where suitable.

### **BARRIER:**

Could install a tide gate at the mouth of the creek.

# PRECEDENTS

## ARMOR



### New Orleans

West Closure Complex: \$14.5 billion Corps project including fortifications to protect 900,000 people (designed to withstand a 100-yr storm and reduce flooding from a 500-yr)

The Corps has changed their language from “flood protection” to “risk reduction” since people have a false sense of security; if any levee or pumps fail, a repeat of Katrina will happen

## RETROFIT



### Miami Beach

\$500 million plan to elevate streets and install pumps

Buys time but limestone foundation means levees will not protect; pumps fail under power outages caused by storms



## RETREAT



Biloxi-Chitimacha-Choctaw Tribe of Louisiana awarded \$48 million to relocate



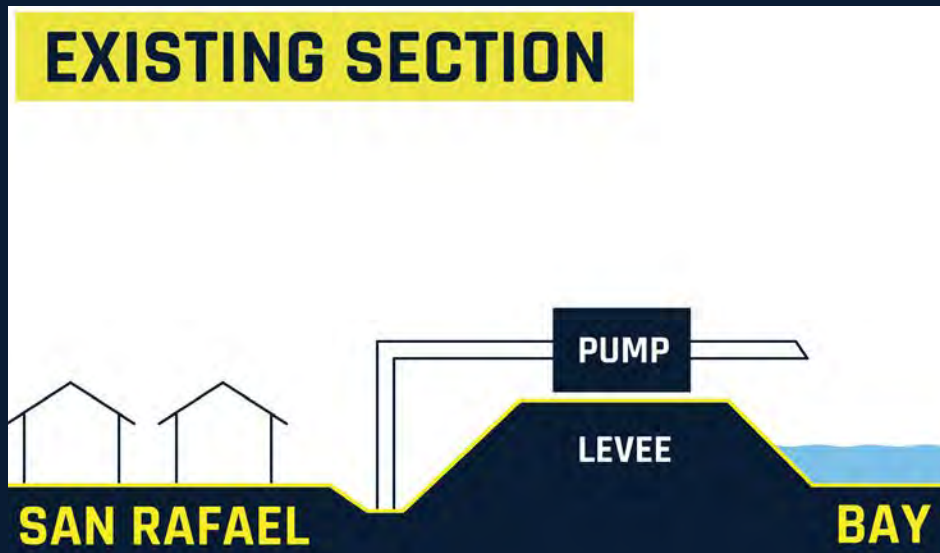
Residents of Shishmaref, Alaska voted to relocate



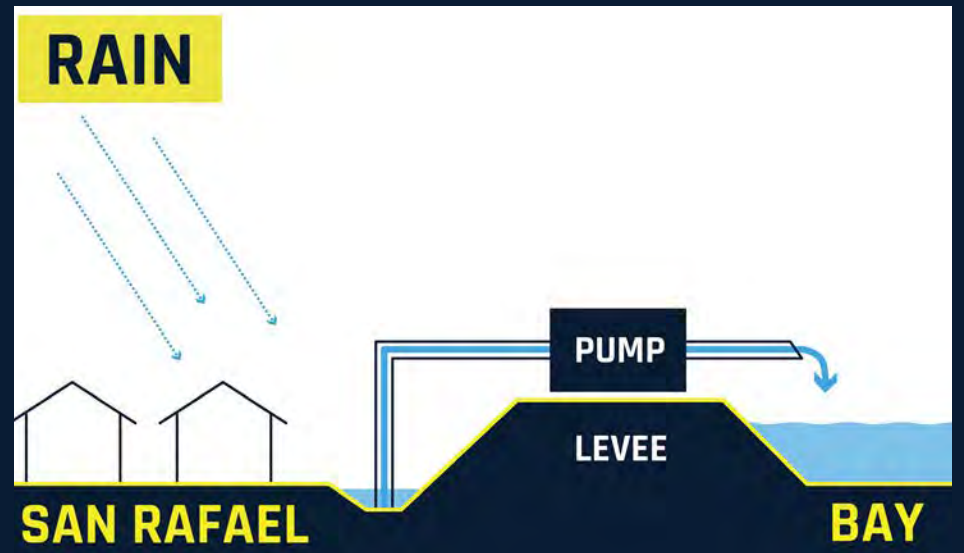
Kinston, NC decided to remove all residential structures from floodplain through voluntary acquisitions.

97% relocated within the city as neighborhoods, preserving the tax base.

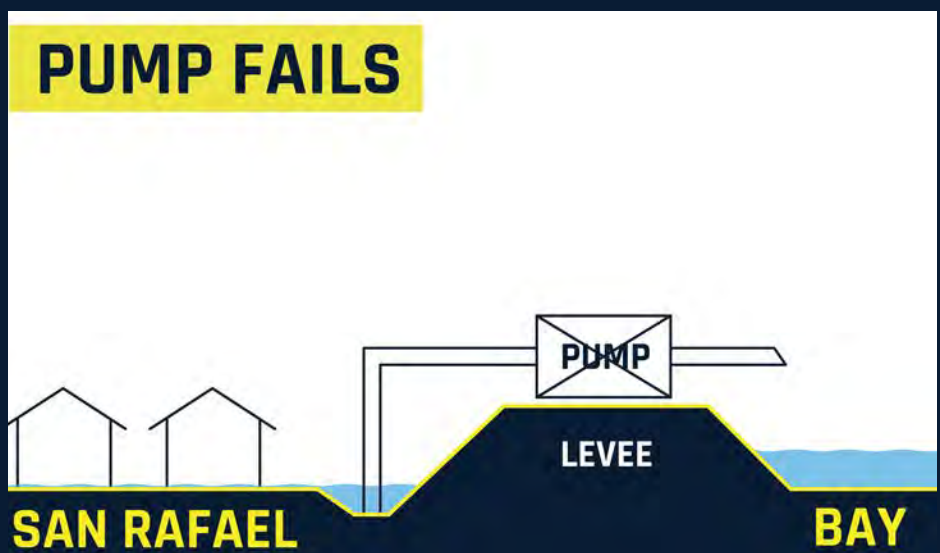
# HOW FLOODING WORKS



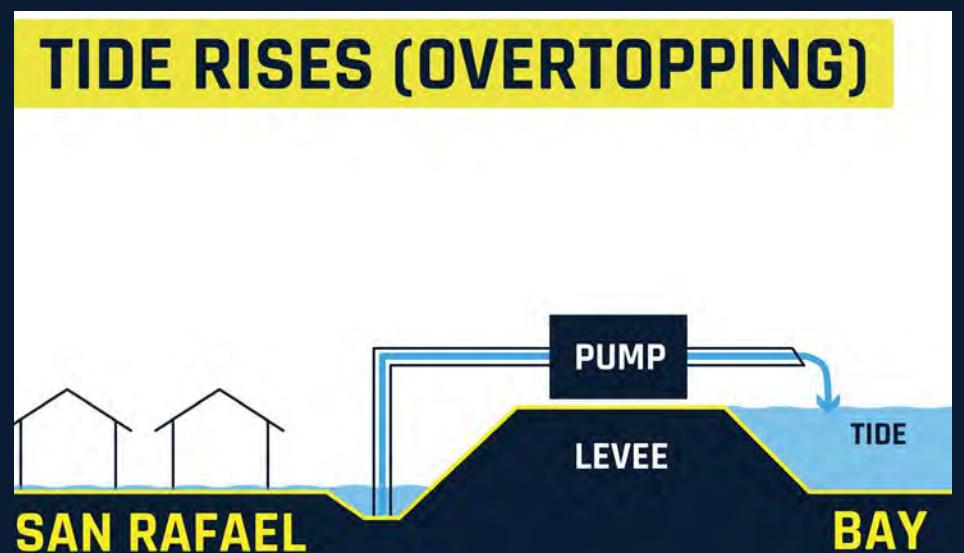
San Rafael has levees and pumps to manage its storm water.



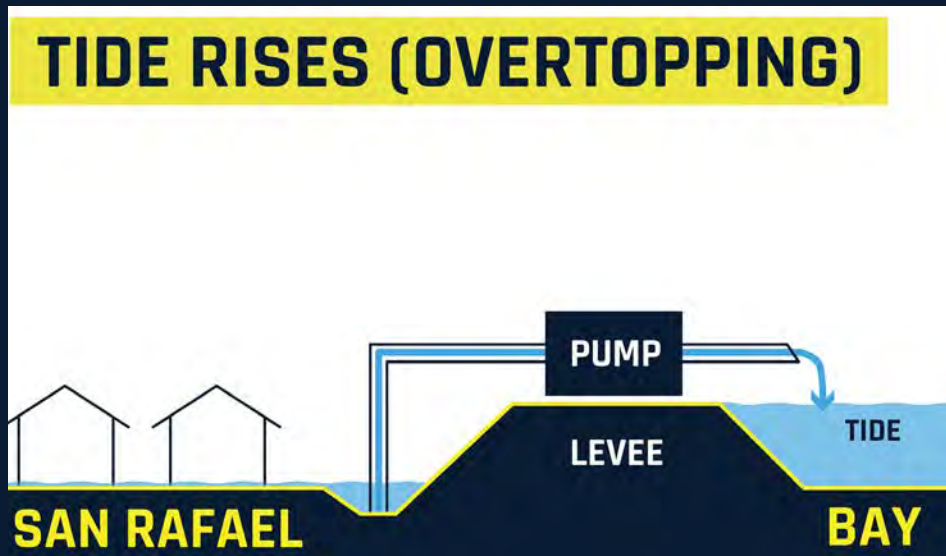
When it rains, the pumps pump water over the levee and into the bay.



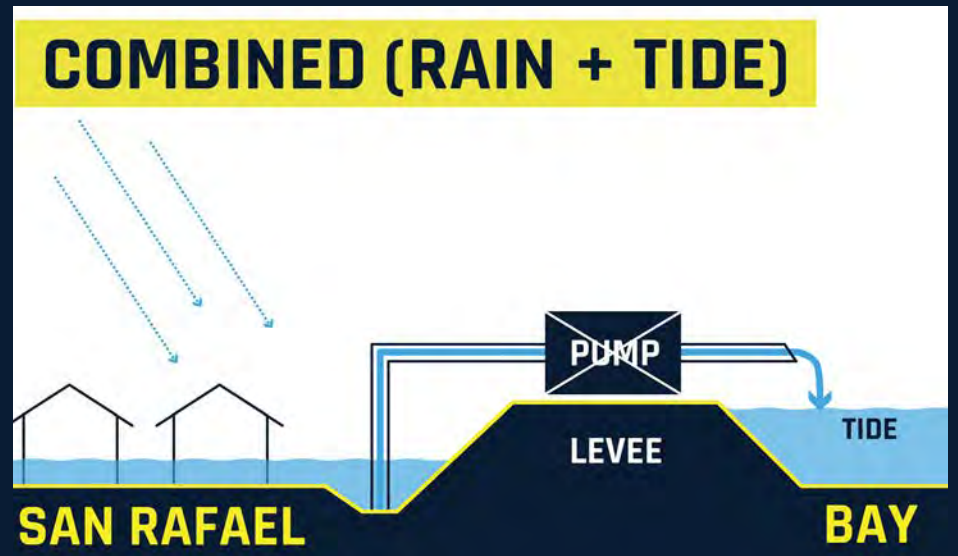
If the pumps stop working, the city will flood.



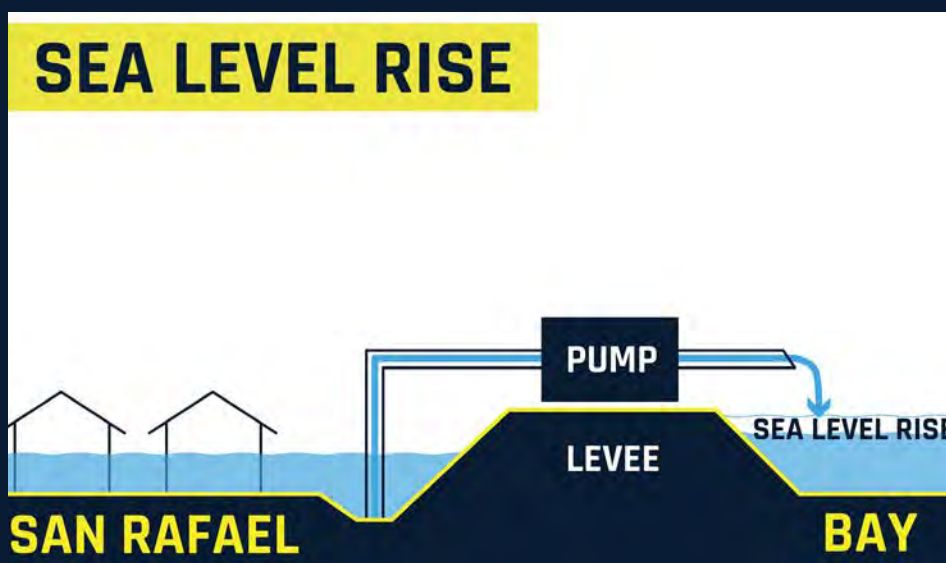
The Bay gets really big tides called king tides. A king tide can overtop the levees and flood the city.



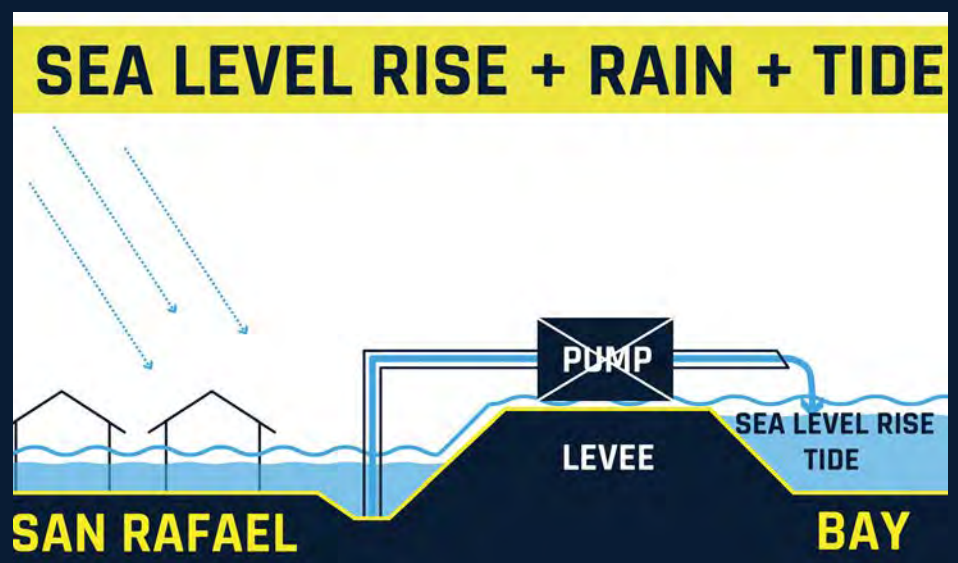
The Bay gets really big tides called king tides. A king tide can overtop the levees and flood the city.



If there is a king tide plus a big rain storm, the city will flood.



Sea level rise means there will be higher tides and more salt water all of the time. The salt water will go over the levees and flood the city.



If there is a king tide plus a big rain storm plus sea level rise, the city will flood.

# RAISING LEVEES + ROADS STUDY

A3



\*NOTE:  
 1-yr storm (7.87 ft) is equivalent to MHHW in 2040  
 100-yr storm (10.06 ft) is equivalent to a 25-yr storm or 10-yr storm w/ 9 in of sea level rise in 2040  
 500-yr storm (11.25 ft) is equivalent to a 100-yr storm in 2040 or MHHW w/ 60 in of sea level rise in 2100

\*\*Water elevations & datums from "San Francisco Bay Tidal Datum & Extreme Tides Study, February 2016

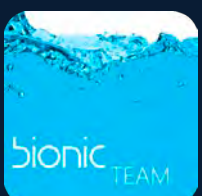


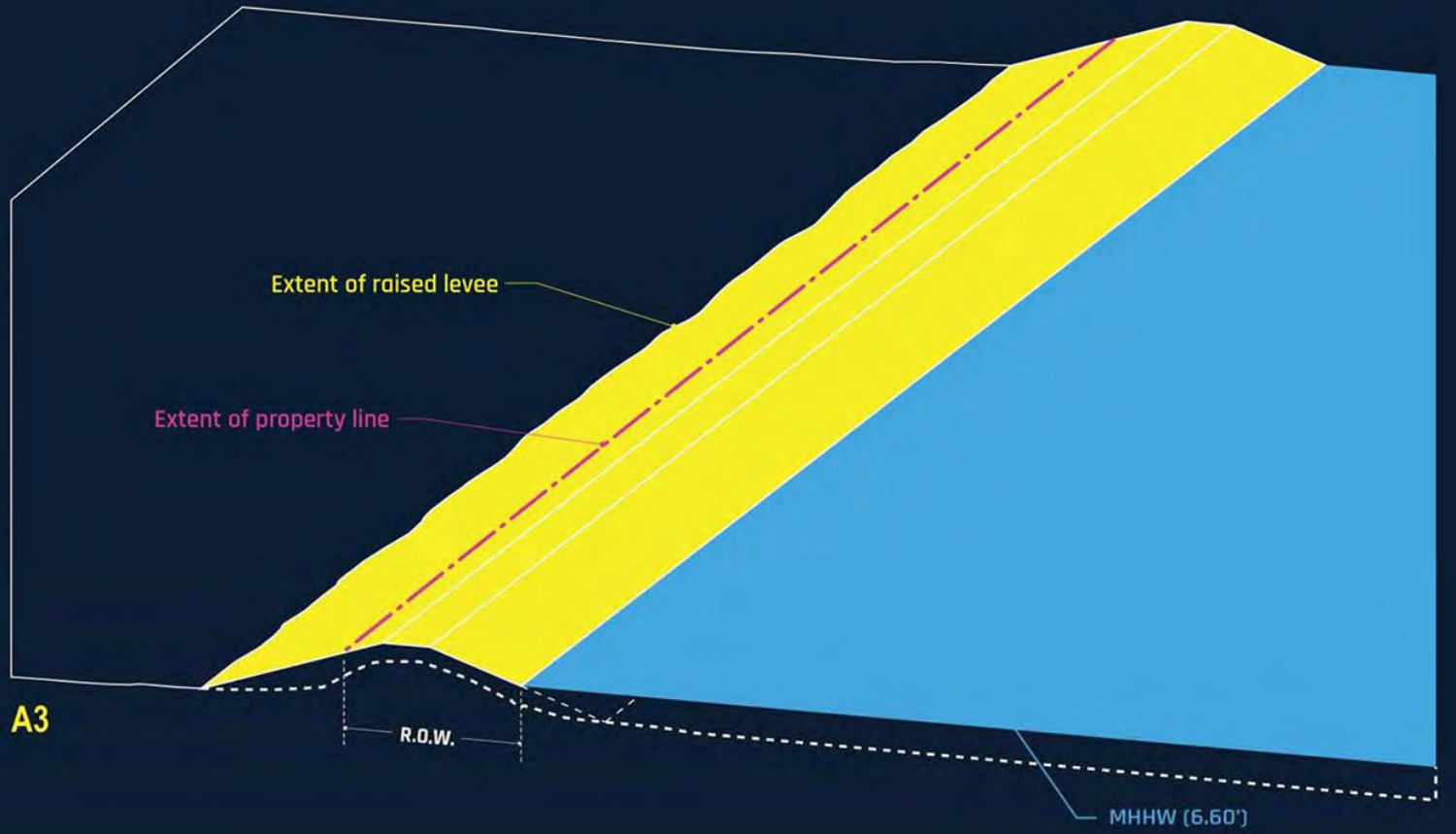
A9



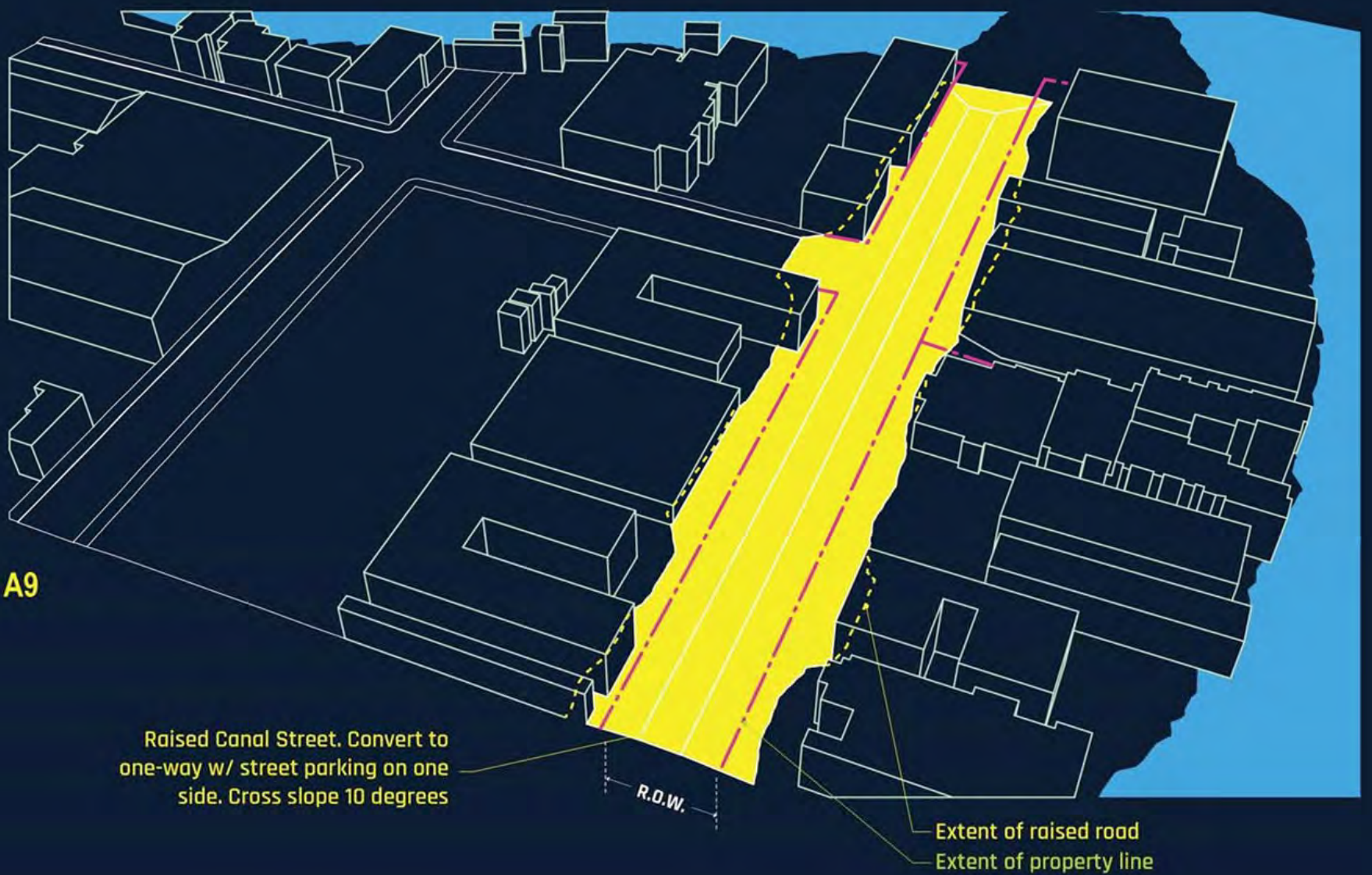
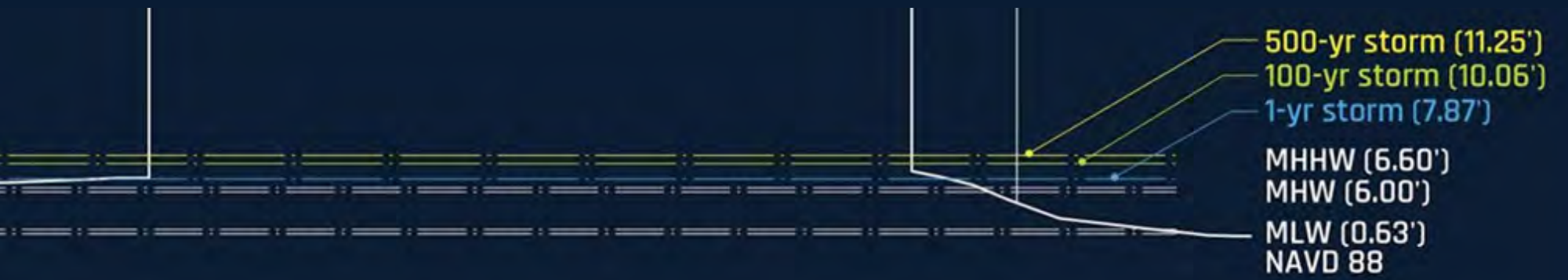
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\*\*Water elevations & datums from "San Francisco Bay Tidal Datum & Extreme Tides Study, February 2016





**Raised Levee (100-yr bfe + 3' freeboard)**



**Raised Canal Street (100-yr bfe + 1' freeboard)**

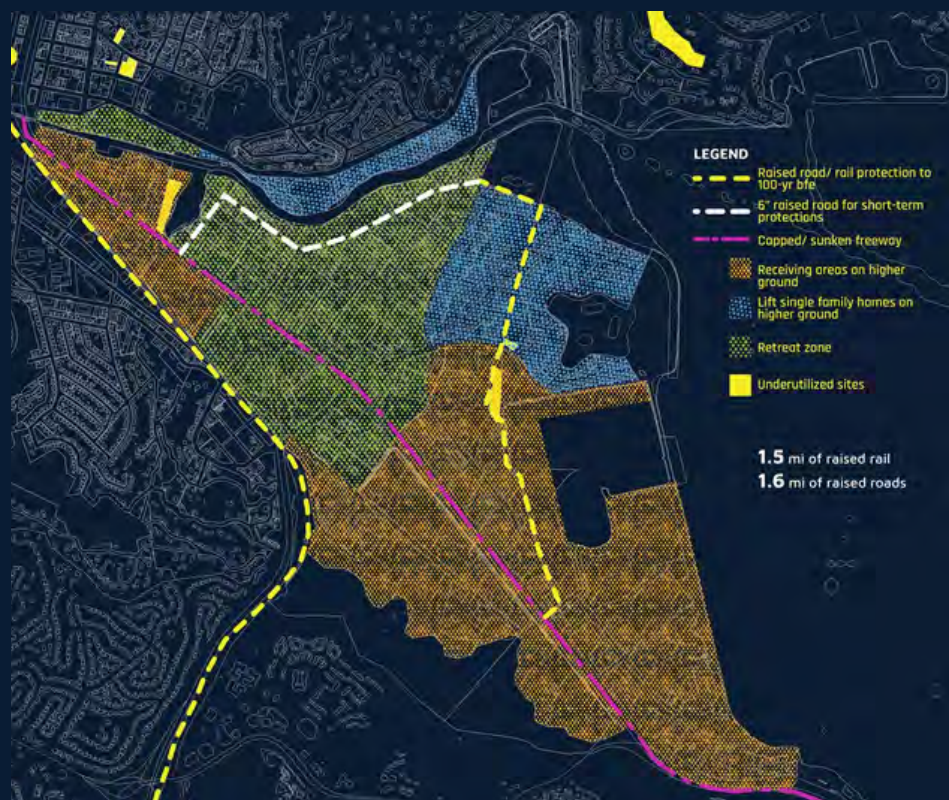
# ADAPTATION DESIGN STUDIES



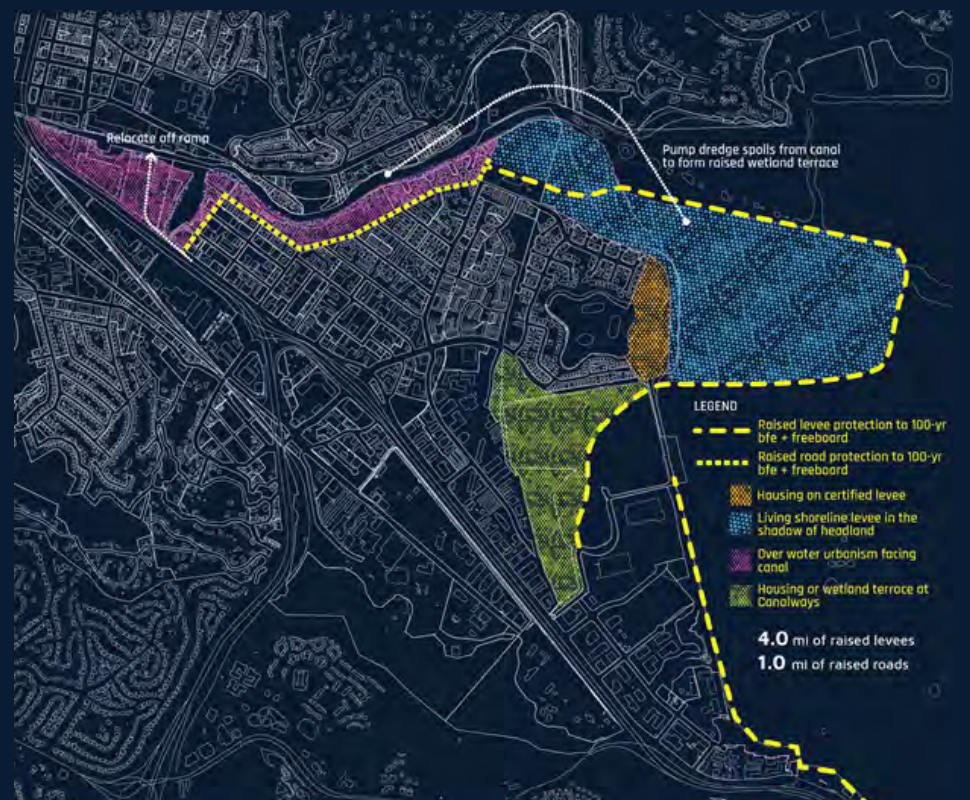
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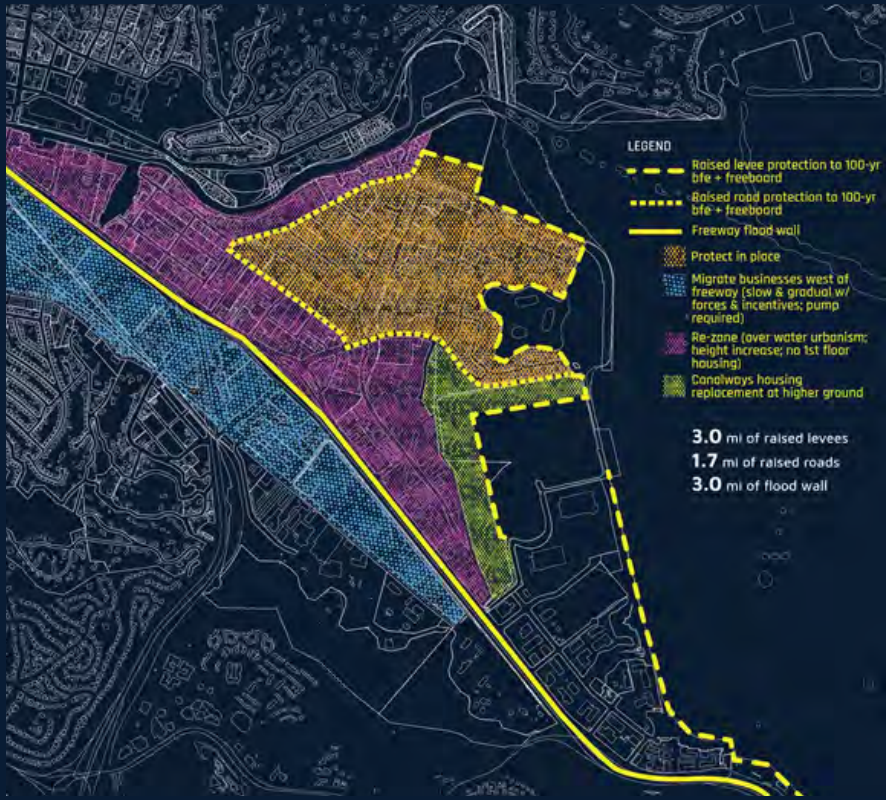
**PROTECT / LEVEE**



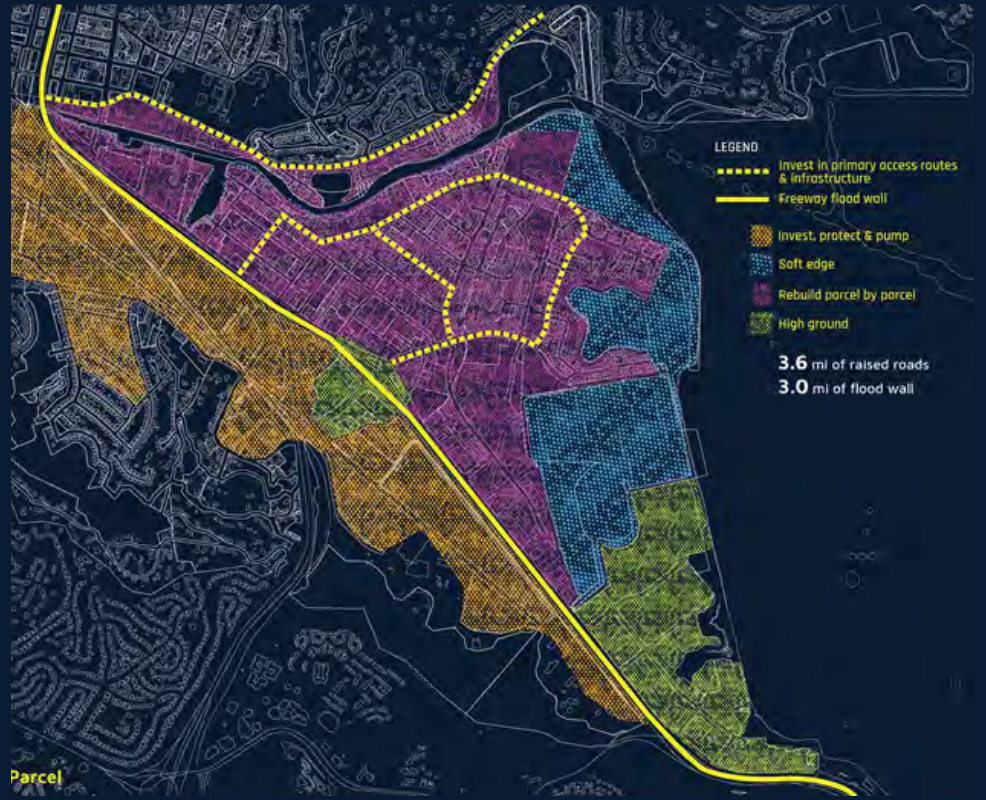
**MIGRATE / UPLAND**



**EXPAND / LIVING SHORELINE**



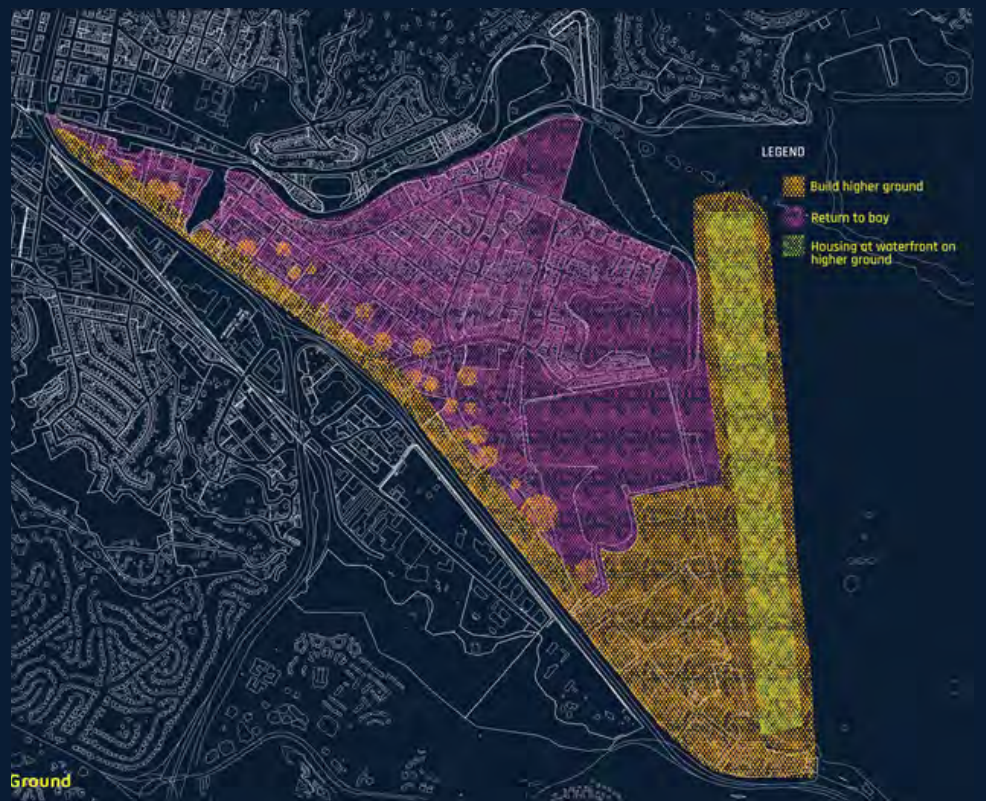
**MIGRATE BUSINESSES**



**REBUILD / PARCEL BY PARCEL**



**RETREAT / UPLAND**



**RETREAT / UPLAND**



**Bionic  
PennDesign  
WXY architecture + urban design  
Studio for Urban Projects**

Enterprise Partners  
SF State University  
Michael Yarne  
Keyser Marston Associates  
WRA Environmental  
RAD Urban  
Moffatt & Nichol