

# Estuary Rehabilitation

## Stream Flow Restoration to

# Kaelepulu Estuary



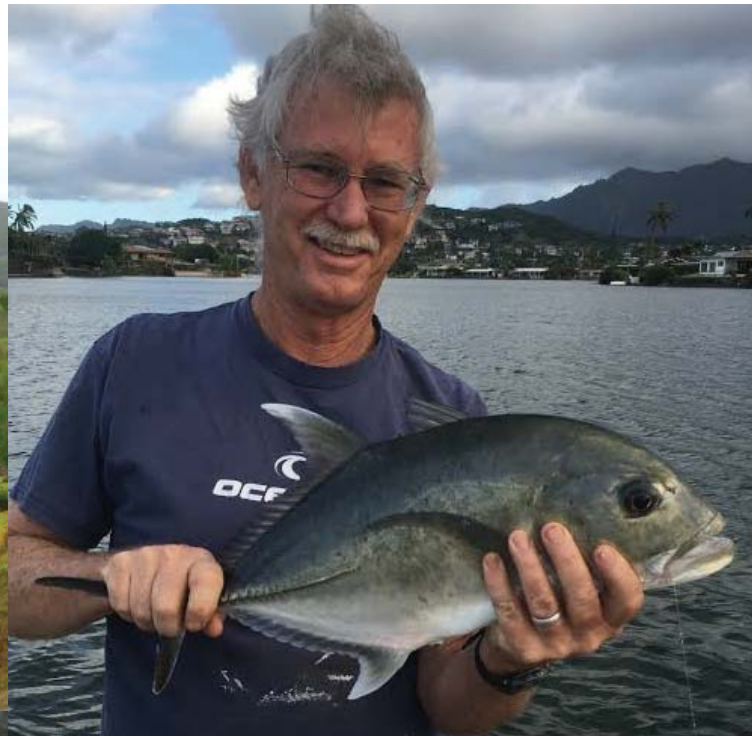
Pacific  
American  
Foundation







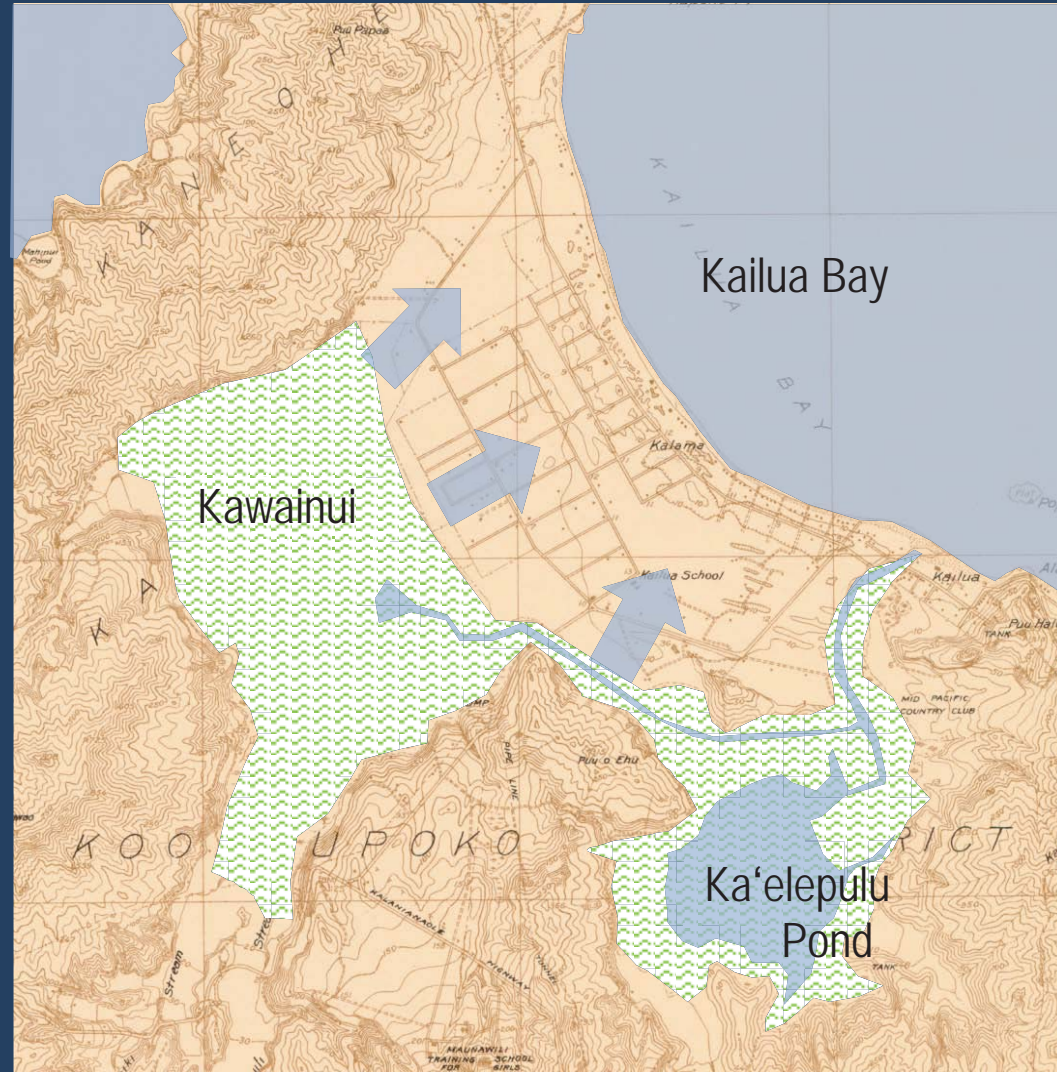
# Ka'elepulu Estuary provides abundant natural resources



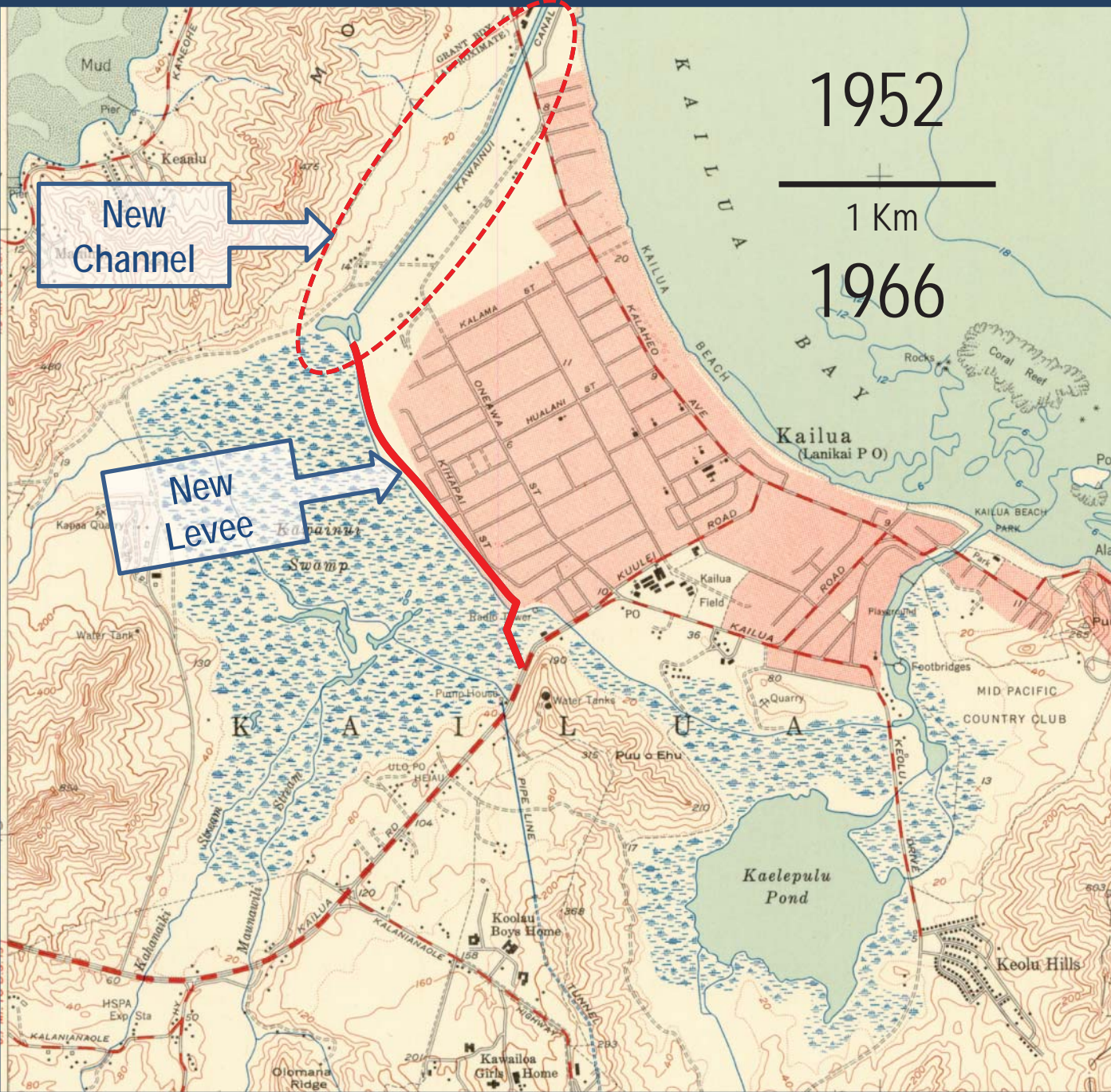


# Ahupua'a o Kailua 1928

- Maunawili, Kahanaiki, Kapa'a streams flowed into Kawainui, the 2<sup>nd</sup> largest freshwater fishpond in Hawai'i
- Water flowed from Kawainui to Ka'elepulu Estuary and stream then out to Kailua Bay
- Waioniki flowed into Ka'elepulu Pond
- Mostly open to the ocean







New Channel

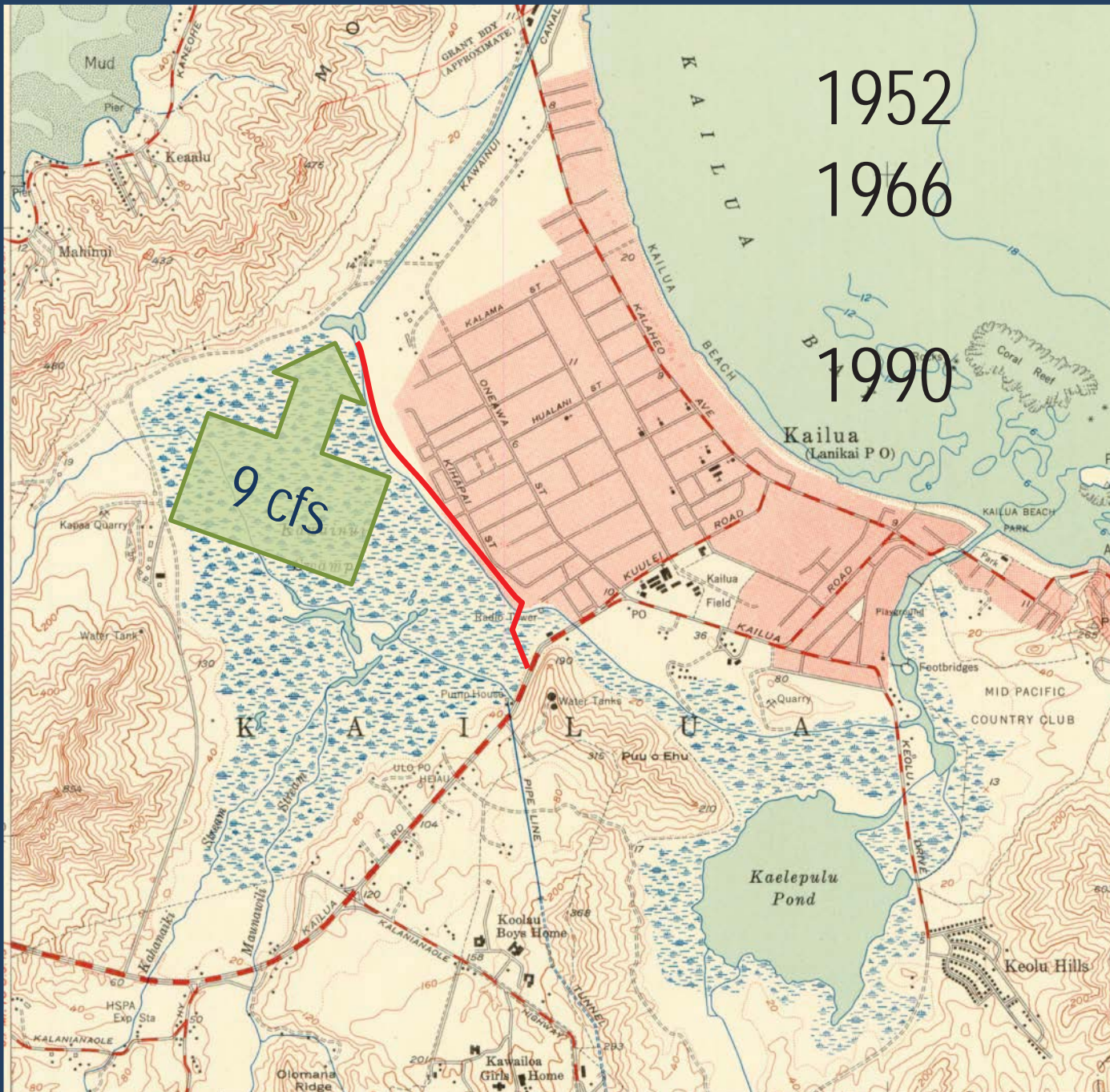
New Levee

1952

1 Km

1966





1952

1966

1990

9 cfs





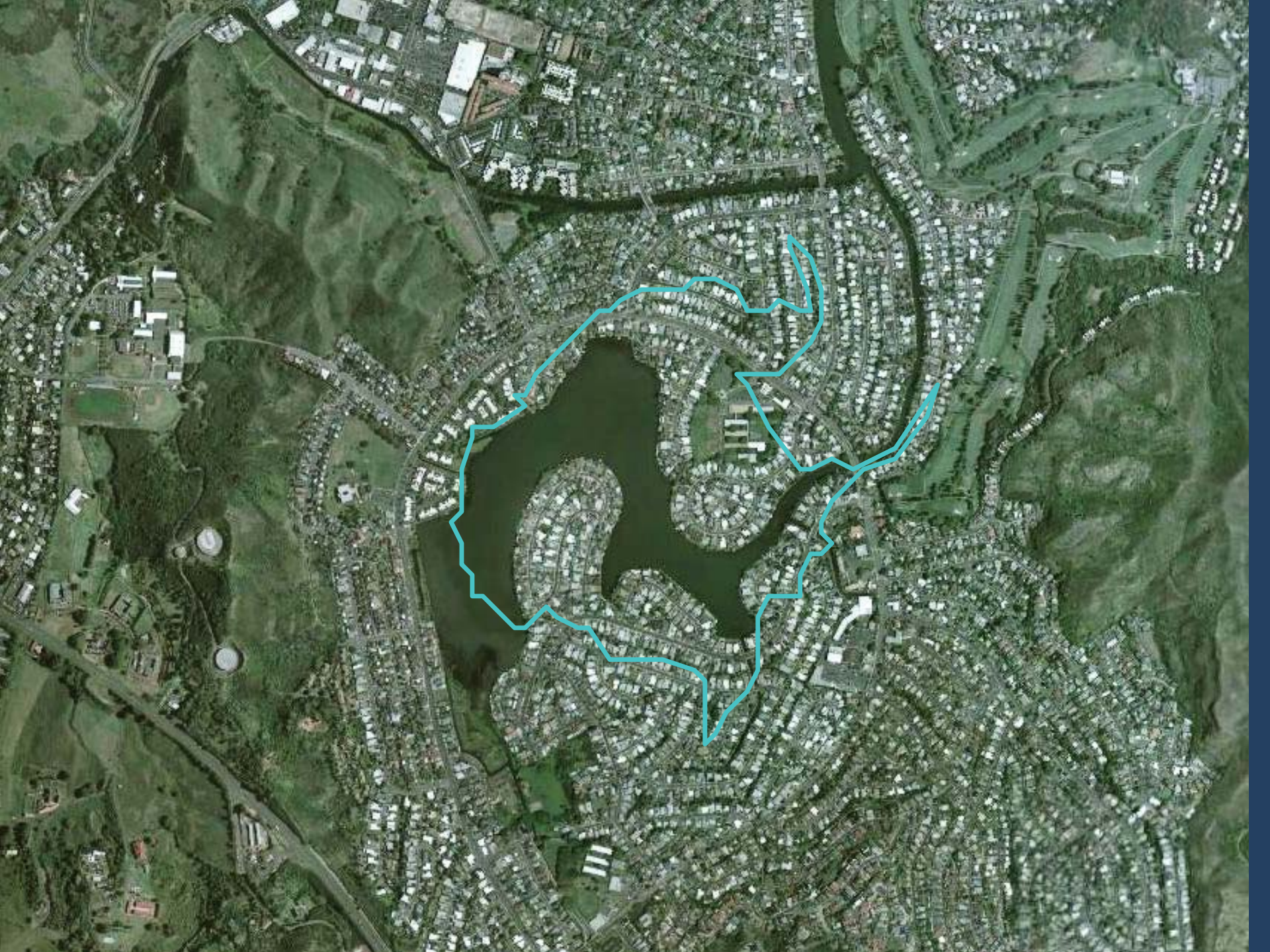
1958

1030

2682

268







# Present Day Kailua

Kaelepulu

Kailua

Kawainui

A satellite map of the Kailua area in Hawaii. The map shows a coastal town with a large bay. A red line outlines a specific area within the town, and a blue shaded area covers a larger portion of the bay and surrounding land. A white line follows the coastline. Labels 'Kaelepulu', 'Kailua', and 'Kawainui' are placed on the map. The background is a satellite image showing terrain, buildings, and the ocean. The Google Earth logo is in the bottom right corner.



What would happen if 2 CFS of stream flow was restored into the Ka'elepulu system from Kawainui?



# Pilot Project of Flow Restoration Predicted Outcomes

## POSITIVE potential impacts

- Increased average surface elevation from 1.5 ft to 2.0 ft MLLW
- Decreased stagnation in Kawainui Stream
- Elimination of summer low-water events associated with bad odors, fish die-off events, and avian botulism threats
- Lower salinity in Kawainui Stream
- Improved stream mouth opening efficiency due to higher hydraulic head
- Improved water level control in wetlands with ESA birds
- Improved fisheries by opening estuary nursery habitat.

## NEGATIVE potential impacts

- Increase pollution into Kailua Bay
- Increased flood threat from water transfer past flood levee
- Increased flood threat due to a weakened levee
- Lowered water surface elevation in Kawainui Marsh



KAWAINUI MARSH

FLOOD CONTROL LEVEE

ITT WETLAND

KAWAINUI STREAM

KAILUA ROAD

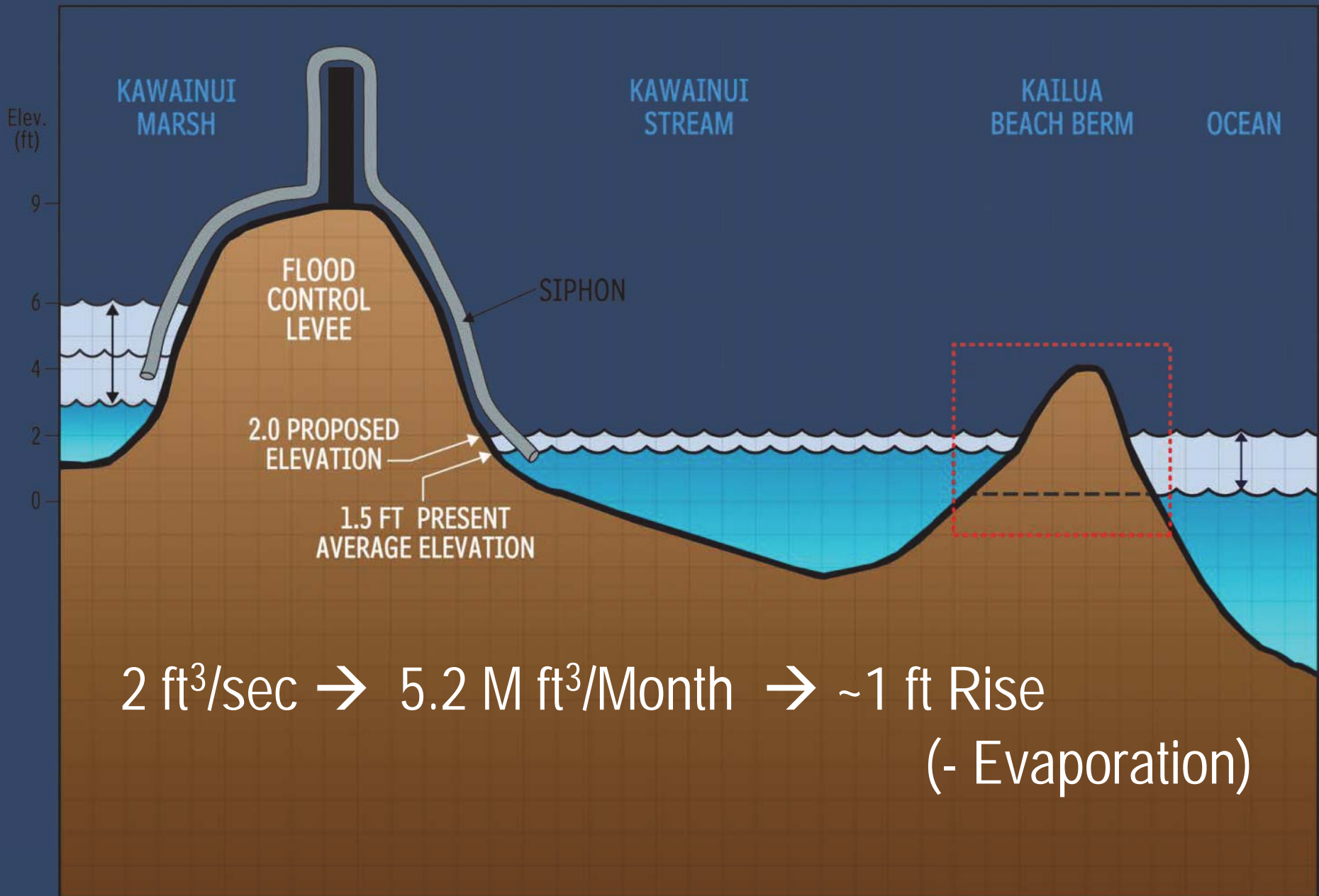


© 2016 Google

HAMAKUA MARSH

Google earth

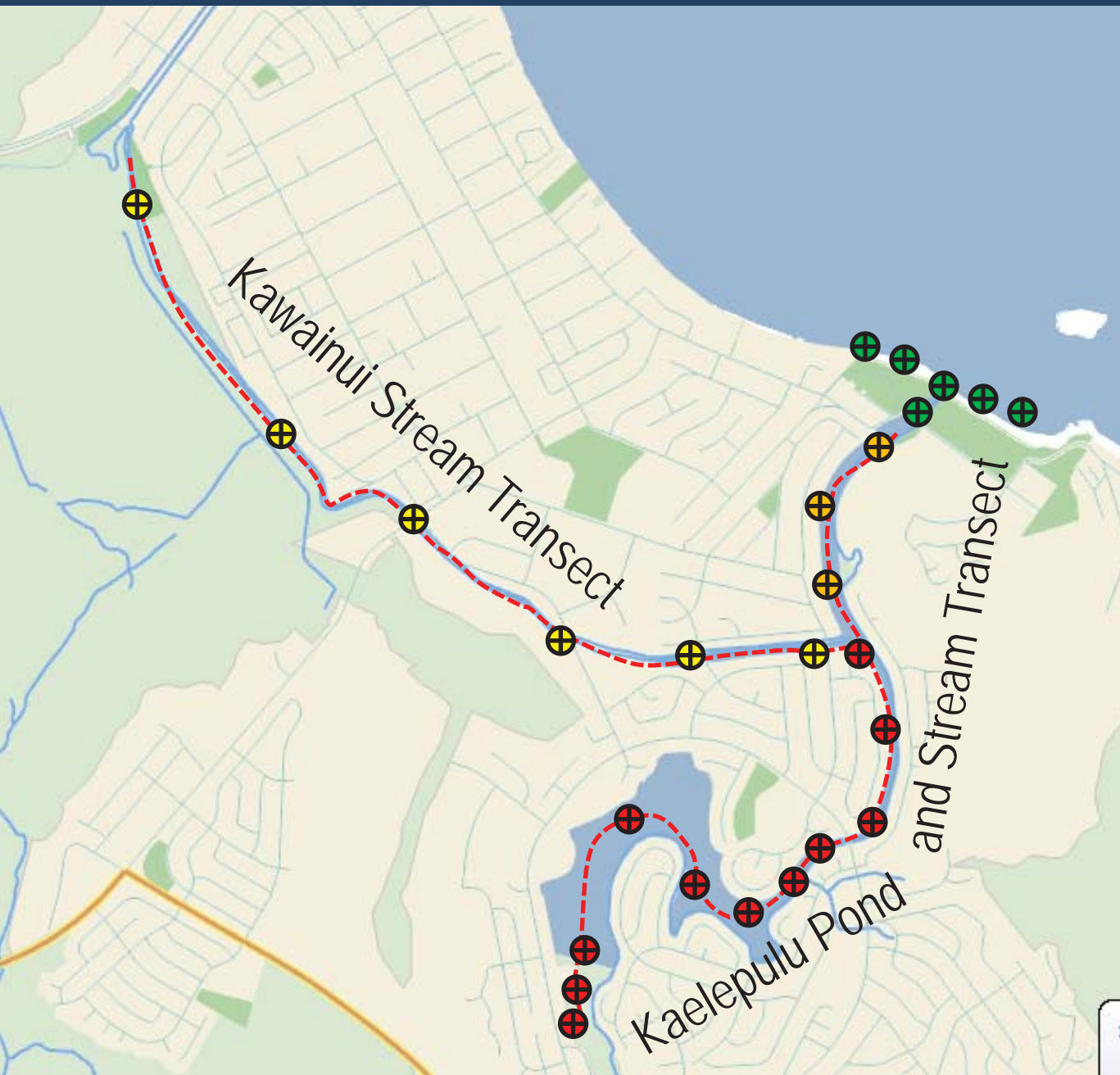












# PHYSICAL WATER QUALITY TRANSECTS OF ESTUARY

CONDUCTED  
BEFORE AND  
AFTER EACH  
STREAM MOUTH  
OPENING EVENT

T, Salinity, pH, NTU,  
Chl-a, PC, DO%

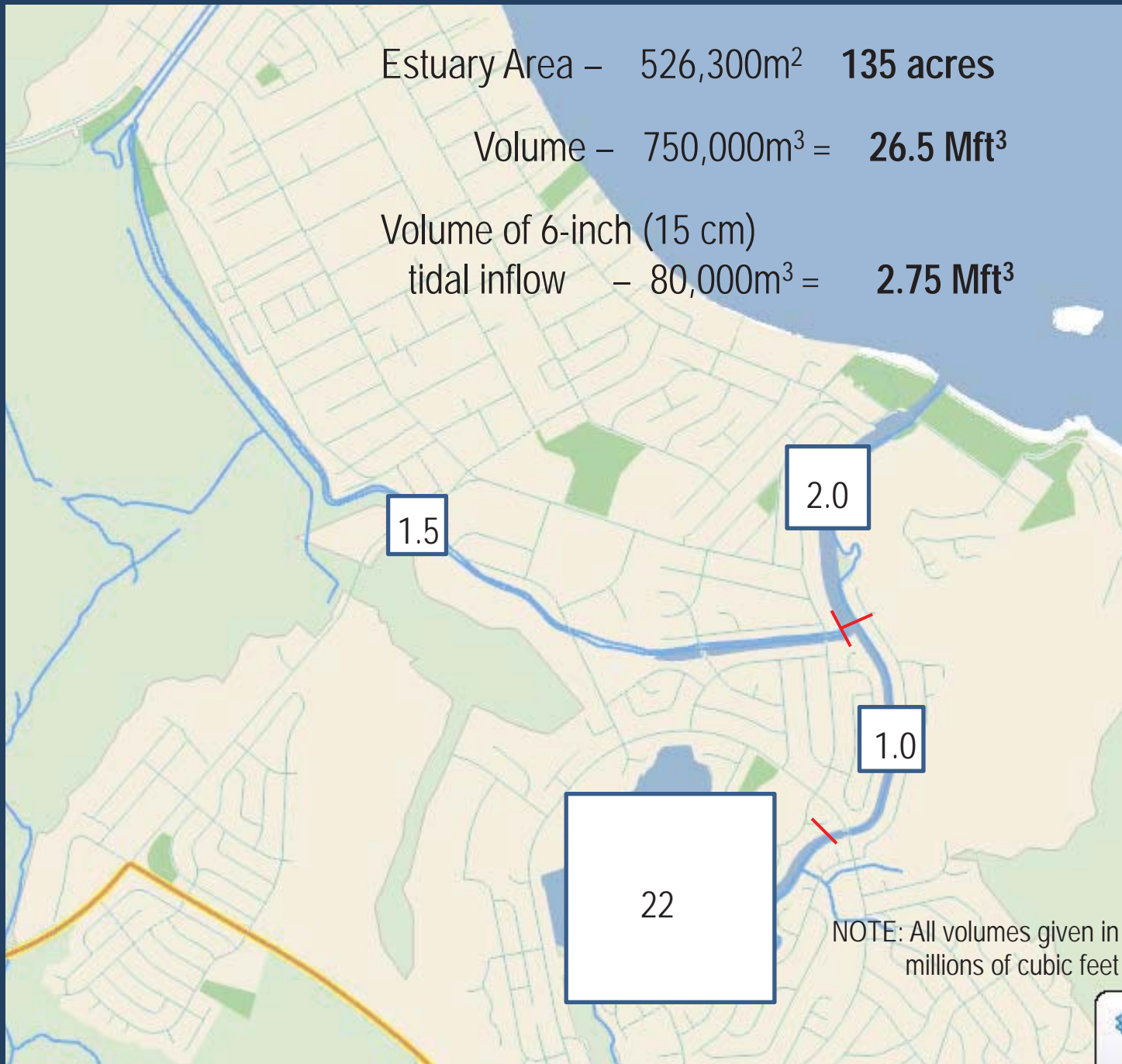
- @ 15 cm
- 30 cm
- 60 cm
- 120 cm
- 180 cm



Estuary Area – 526,300m<sup>2</sup> 135 acres

Volume – 750,000m<sup>3</sup> = 26.5 Mft<sup>3</sup>

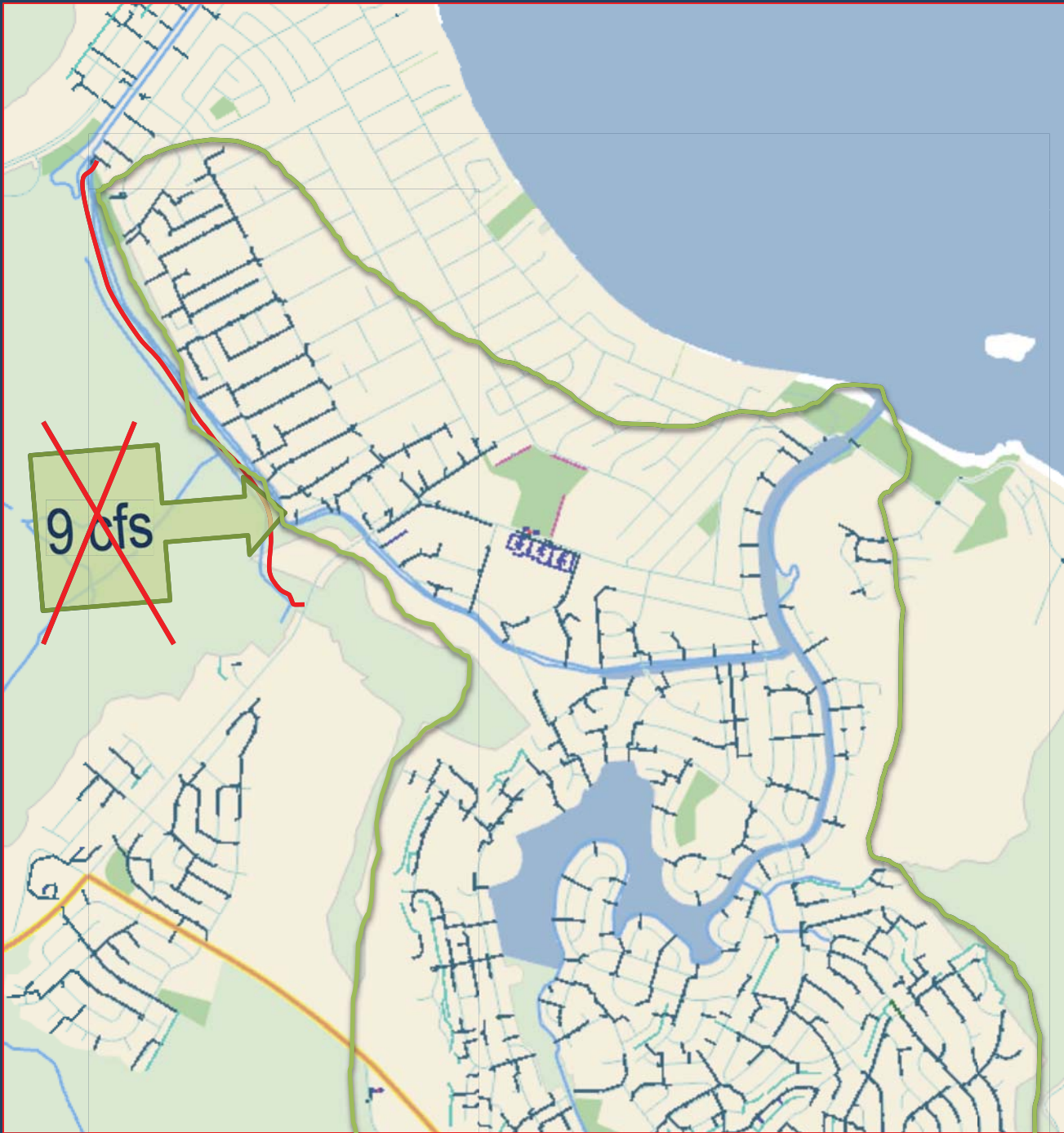
Volume of 6-inch (15 cm)  
tidal inflow – 80,000m<sup>3</sup> = 2.75 Mft<sup>3</sup>





# 6 ESTUARY CHALLENGES

- NO PERENNIAL STREAM FLOW
- URBAN STORM WATER FLOWS
- CONSTRUCTION RUNOFF
- BATHYMETRY CHANGES
- DECREASED STREAM MOUTH EXCHANGE
- MANGROVE



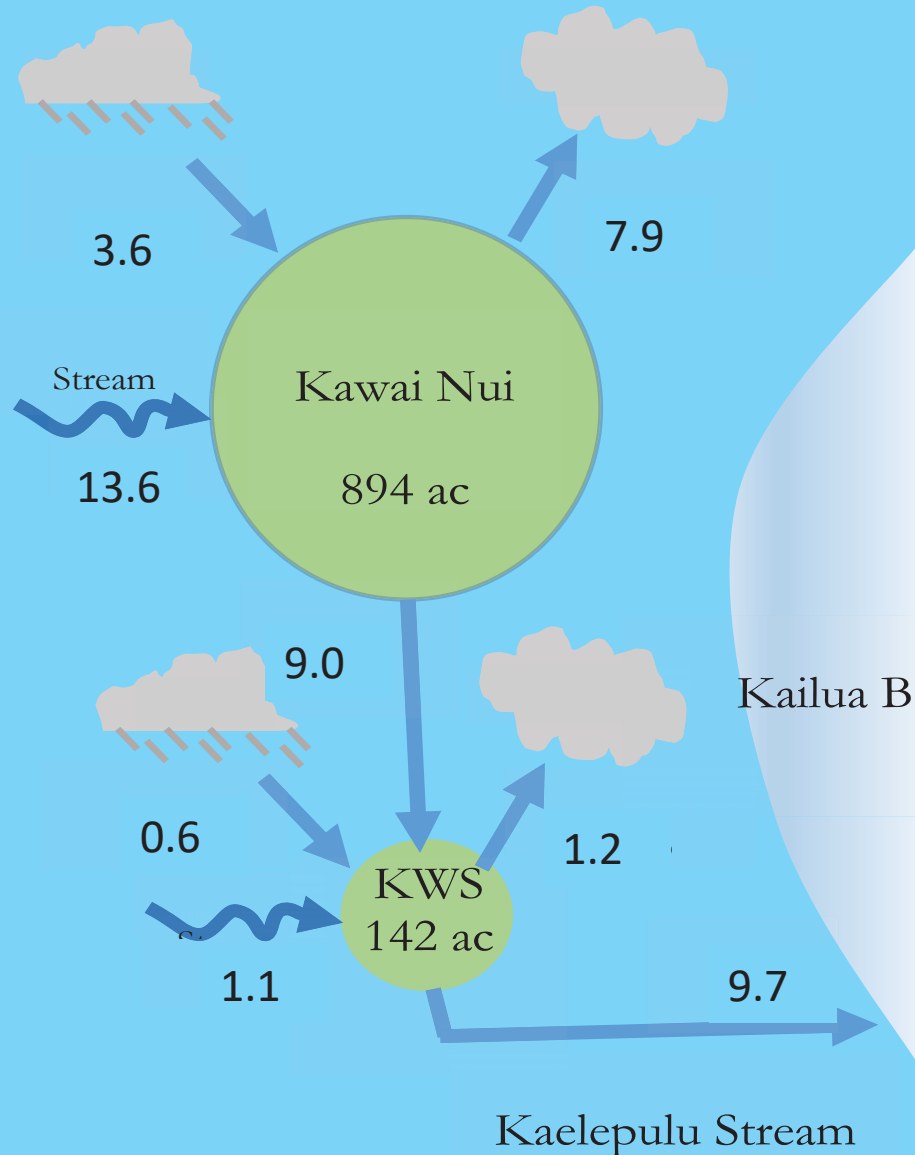
Of the 6 main problems confronting the estuary:

1. Lack of sufficient water flow
2. Pollutant flows from urban storm drains
3. Pollutant flows from construction sites
4. Poor salt wedge penetration into pond
5. Poor exchange at stream mouth
6. Invasive mangrove

Improving water flow has been deemed likely to provide the greatest benefit with the least effort.

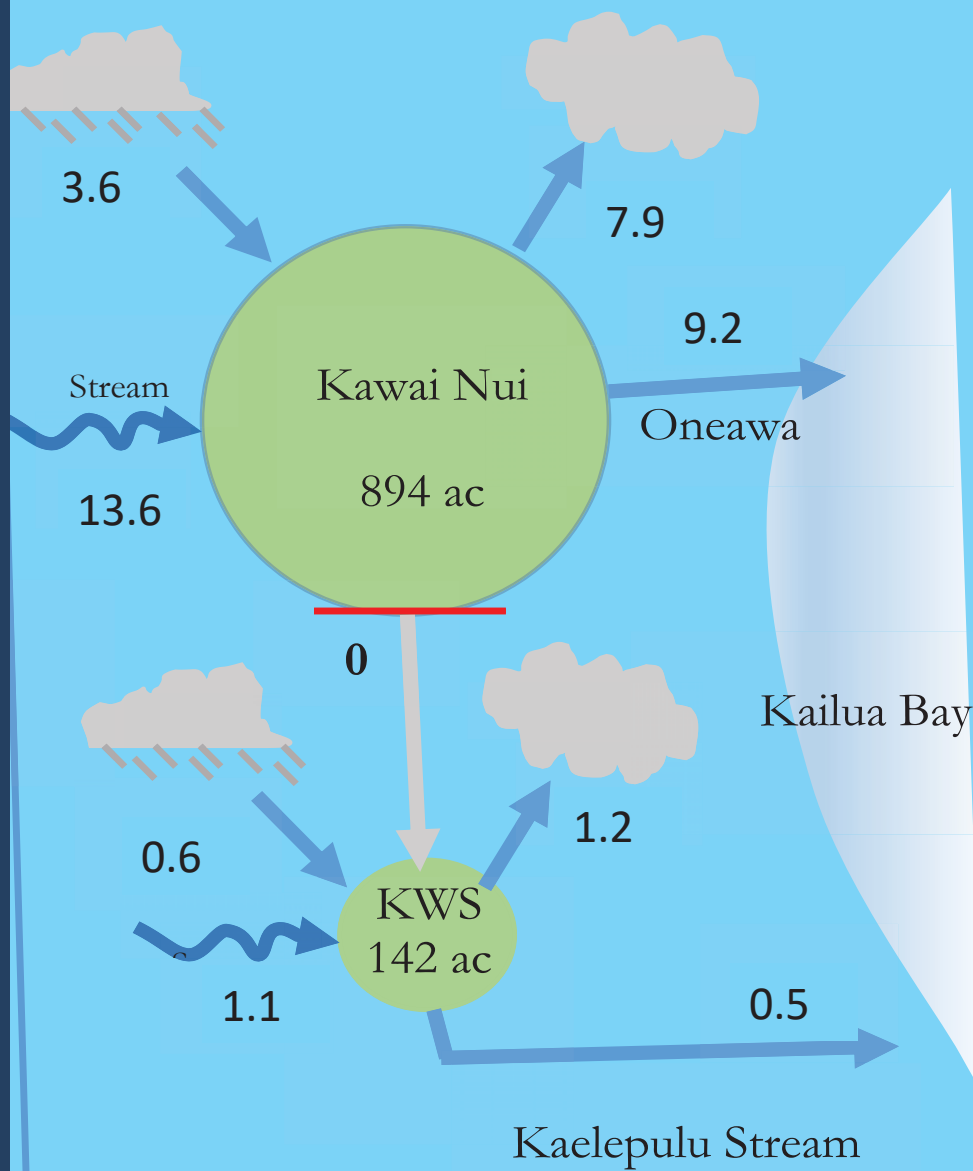


# PAST



ANNUALIZED  
AVERAGE  
FLOW  
IN  
CFS

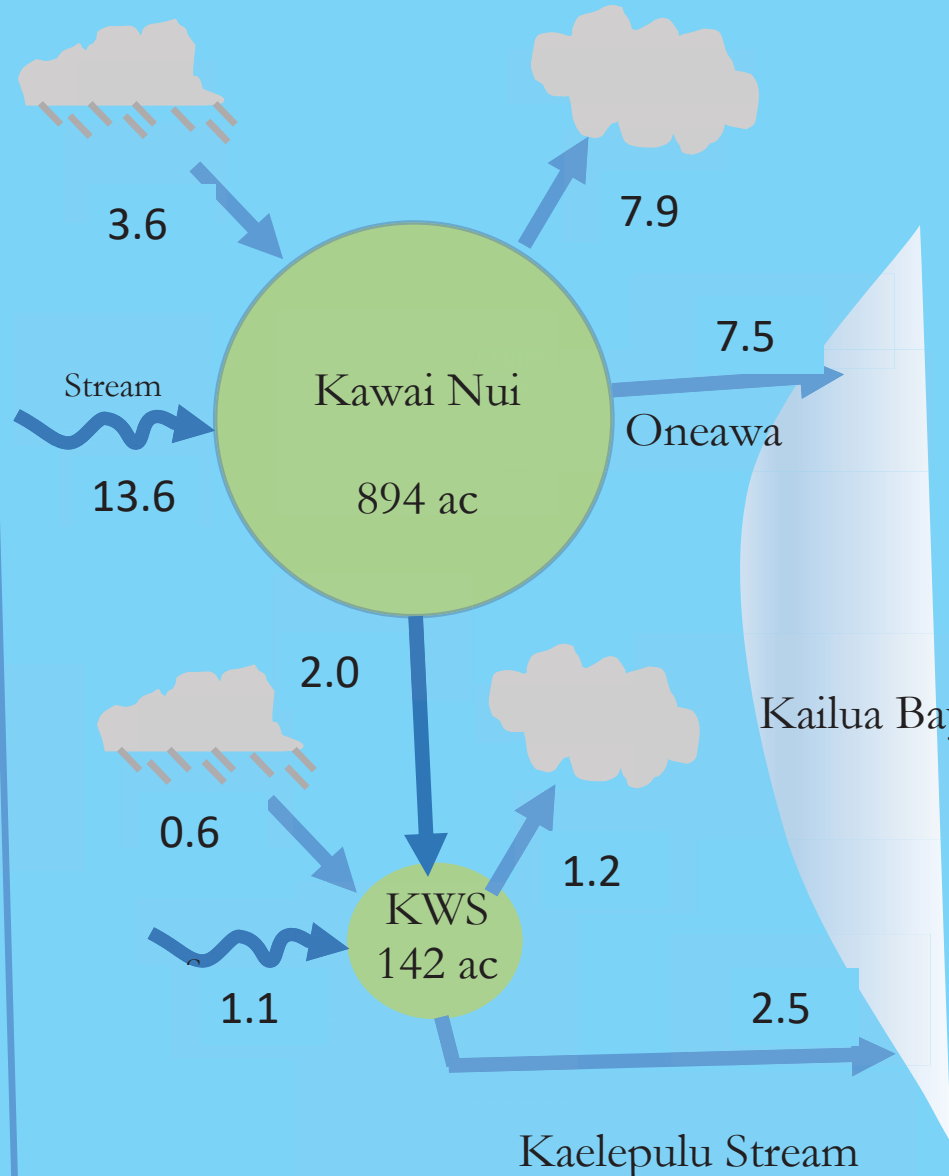
# PRESENT



ANNUALIZED  
AVERAGE  
FLOW  
IN  
CFS

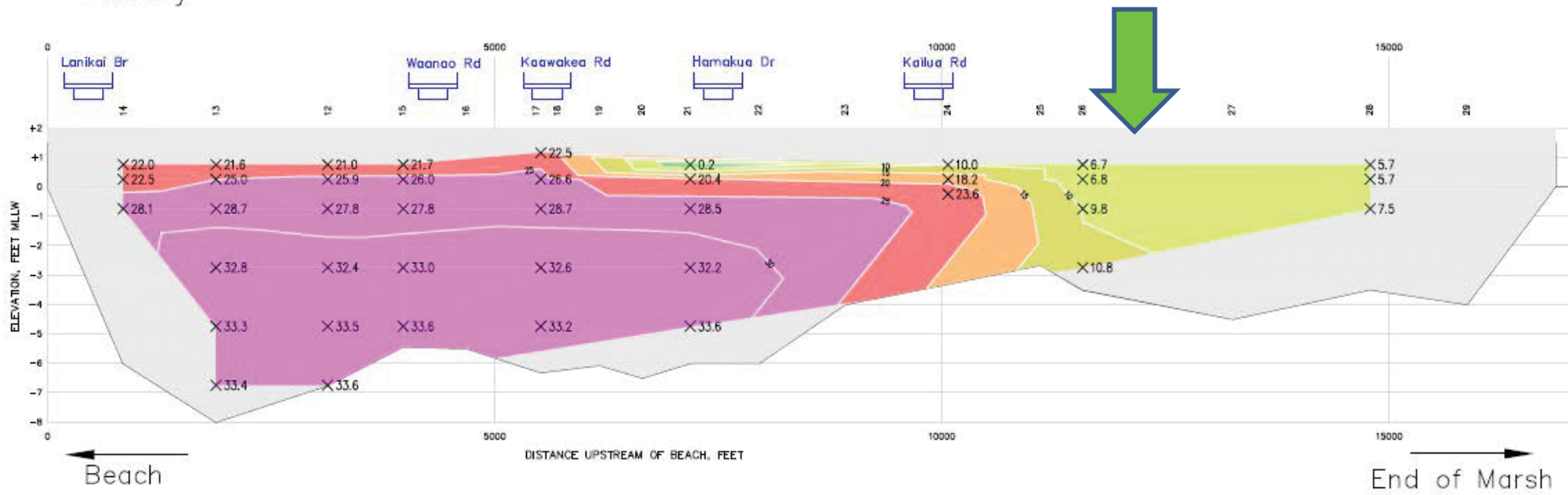


# FUTURE



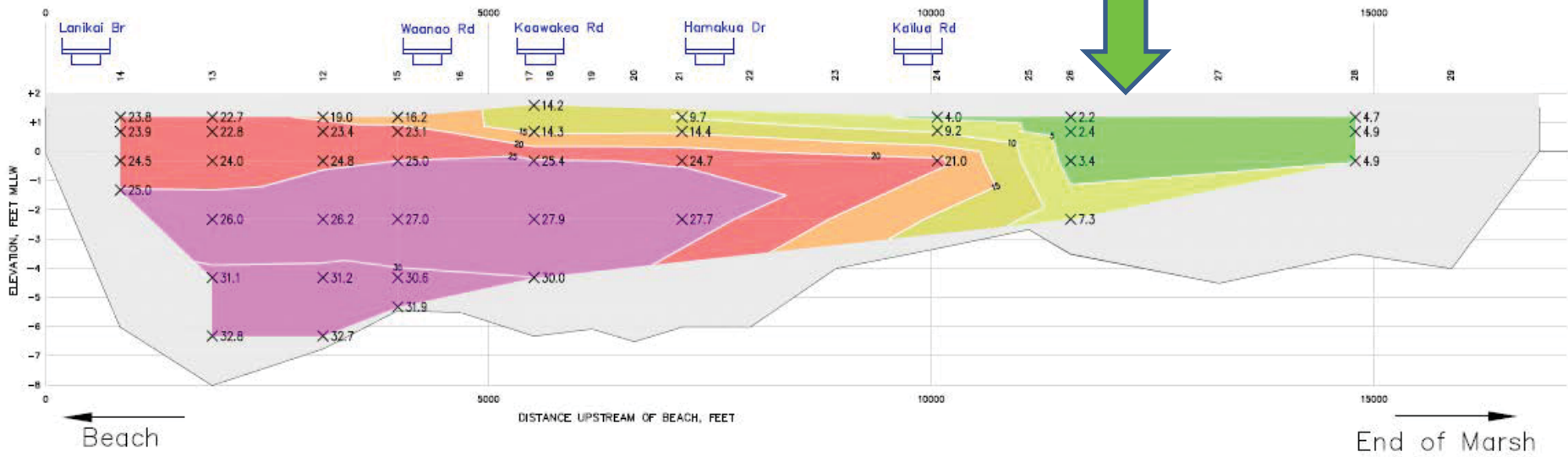
ANNUALIZED  
AVERAGE  
FLOW  
IN  
CFS

# Salinity

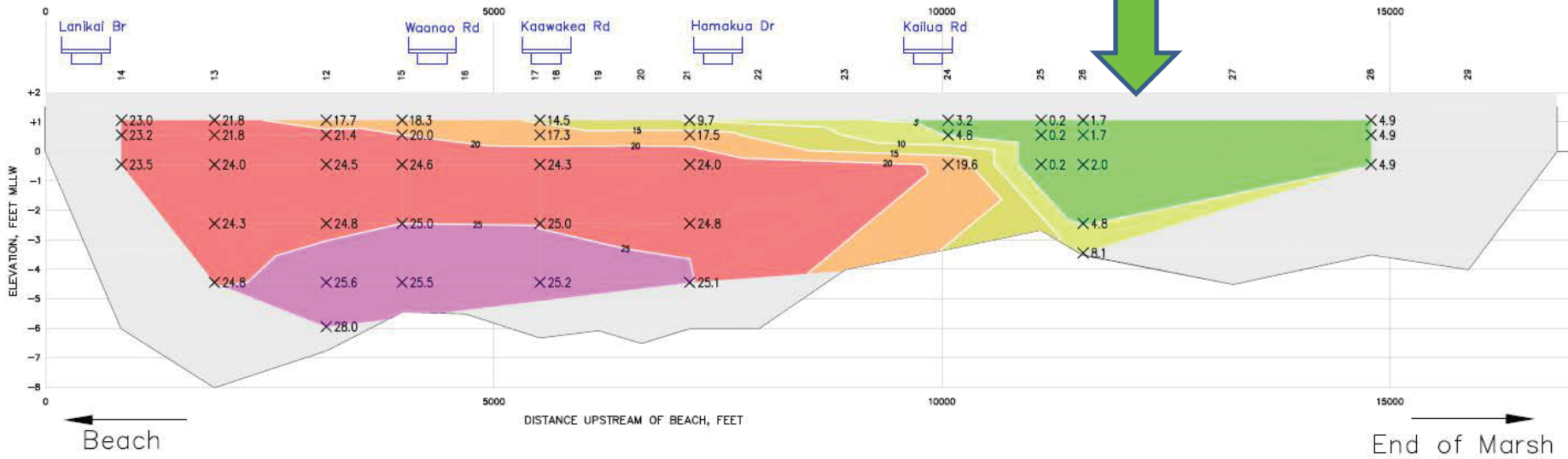




# Salinity

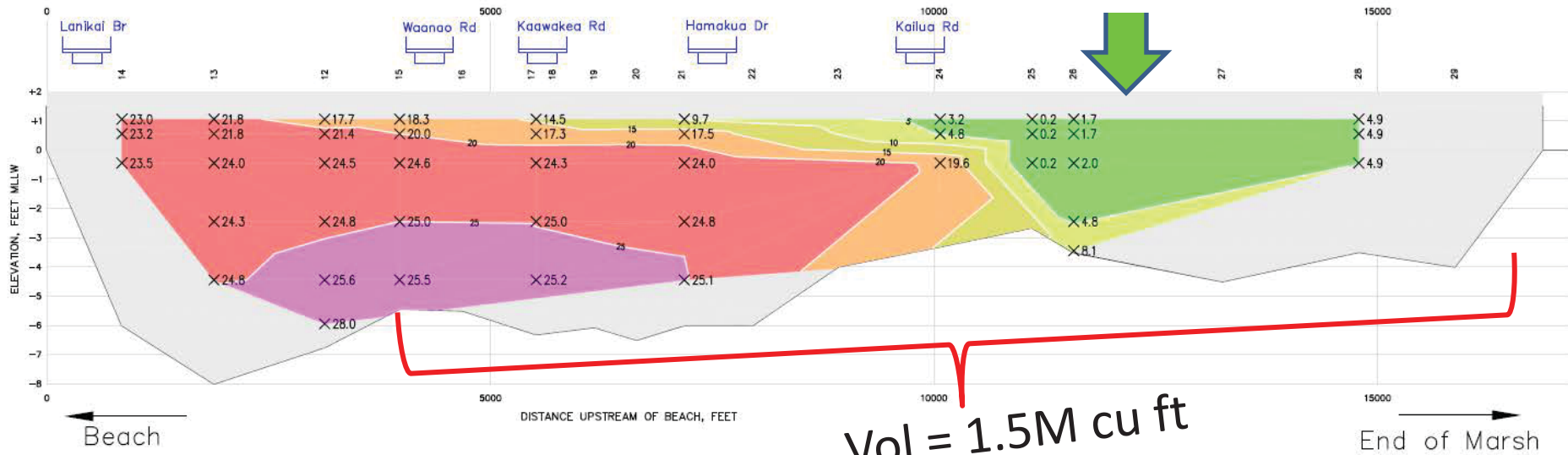


# Salinity





# Salinity



3M cu ft

Vol = 1.5M cu ft



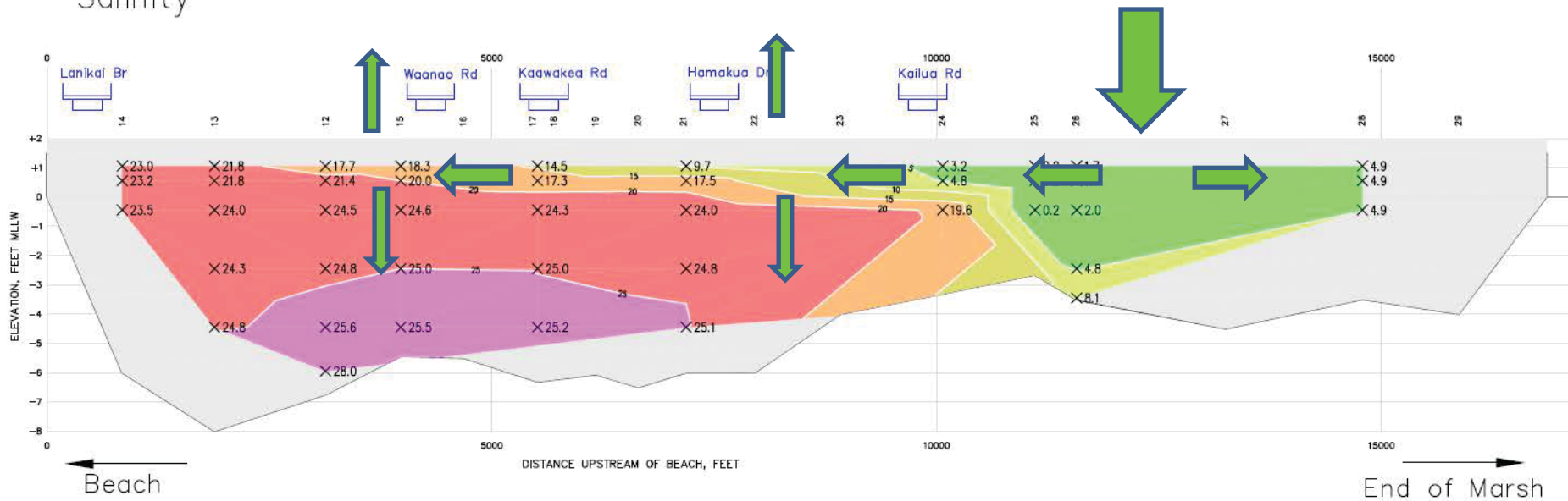
FRESH WATER  
INFLOW SPREADS  
RAPIDLY ALONG THE  
SURFACE OF  
KAWAINUI STREAM  
AND DOWNSTREAM  
TOWARDS THE  
BEACH.

VERTICAL MIXING  
OCCURS MORE  
SLOWLY  
MAINTAINING  
STRATIFICATION  
THROUGHOUT THE  
MONTH.

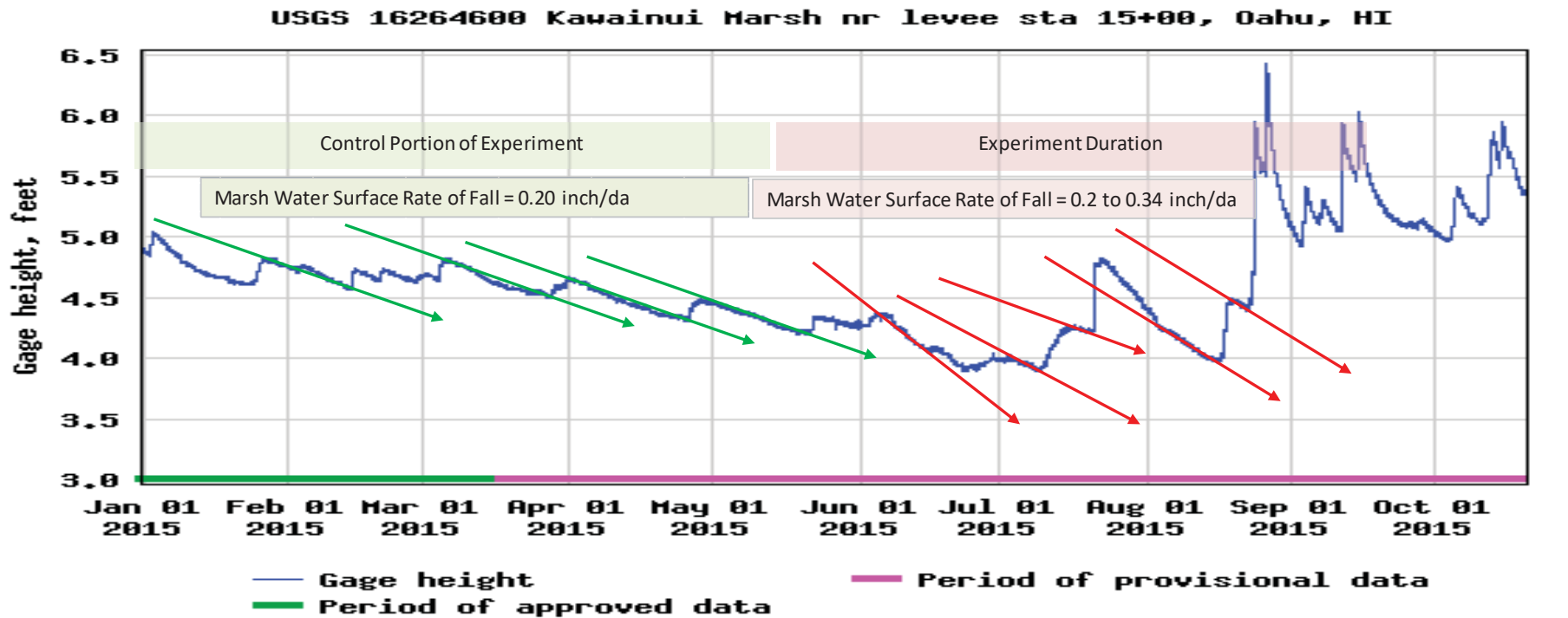


# FRESH WATER INFLOW APPEARS TO FLOW RAPIDLY ALONG THE SURFACE AND EITHER EVAPORATE OR SLOWLY MIX WITH LOWER WATER LAYERS AND MAINTAINING STRATIFICATION

## Salinity



# WATER SURFACE ELEVATION OF KAWAINUI MARSH SOURCE WATER

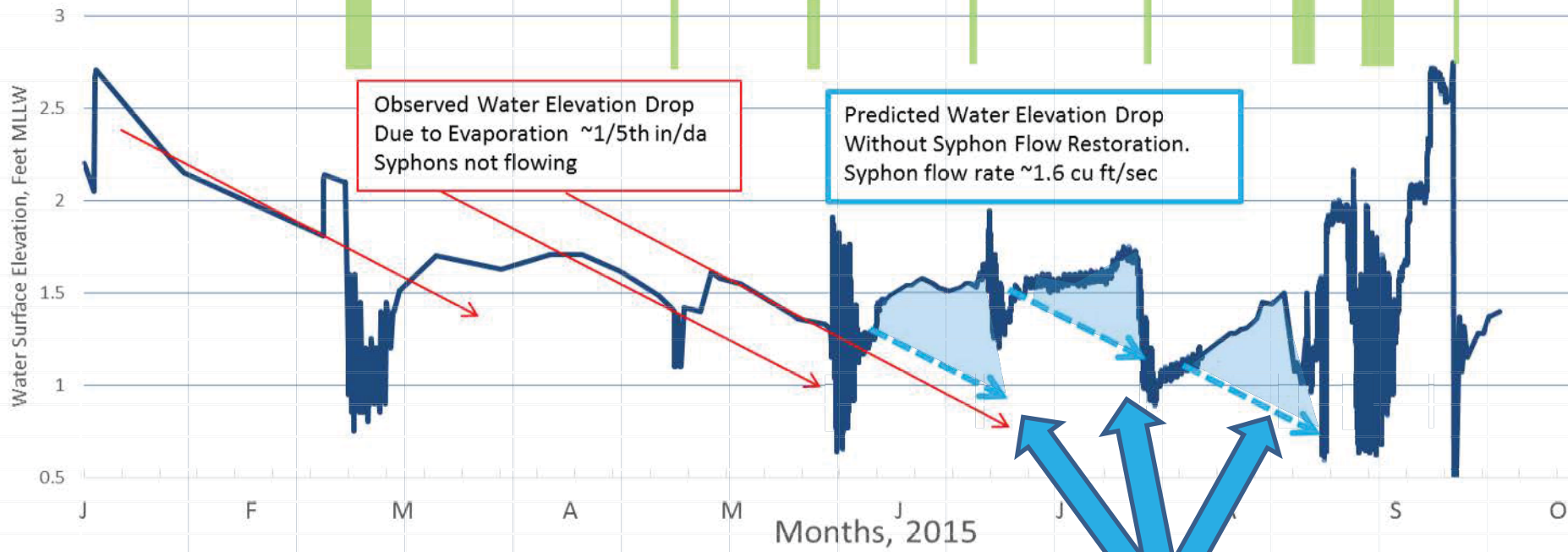


Graph courtesy of the U.S. Geological Survey



# WATER SURFACE ELEVATION OF KA'ELEPULU

Kaelepulu Water Surface Elevation, 2015 Feet MLLW



$\sim 3$ M cu ft Water

Transferred Each Month



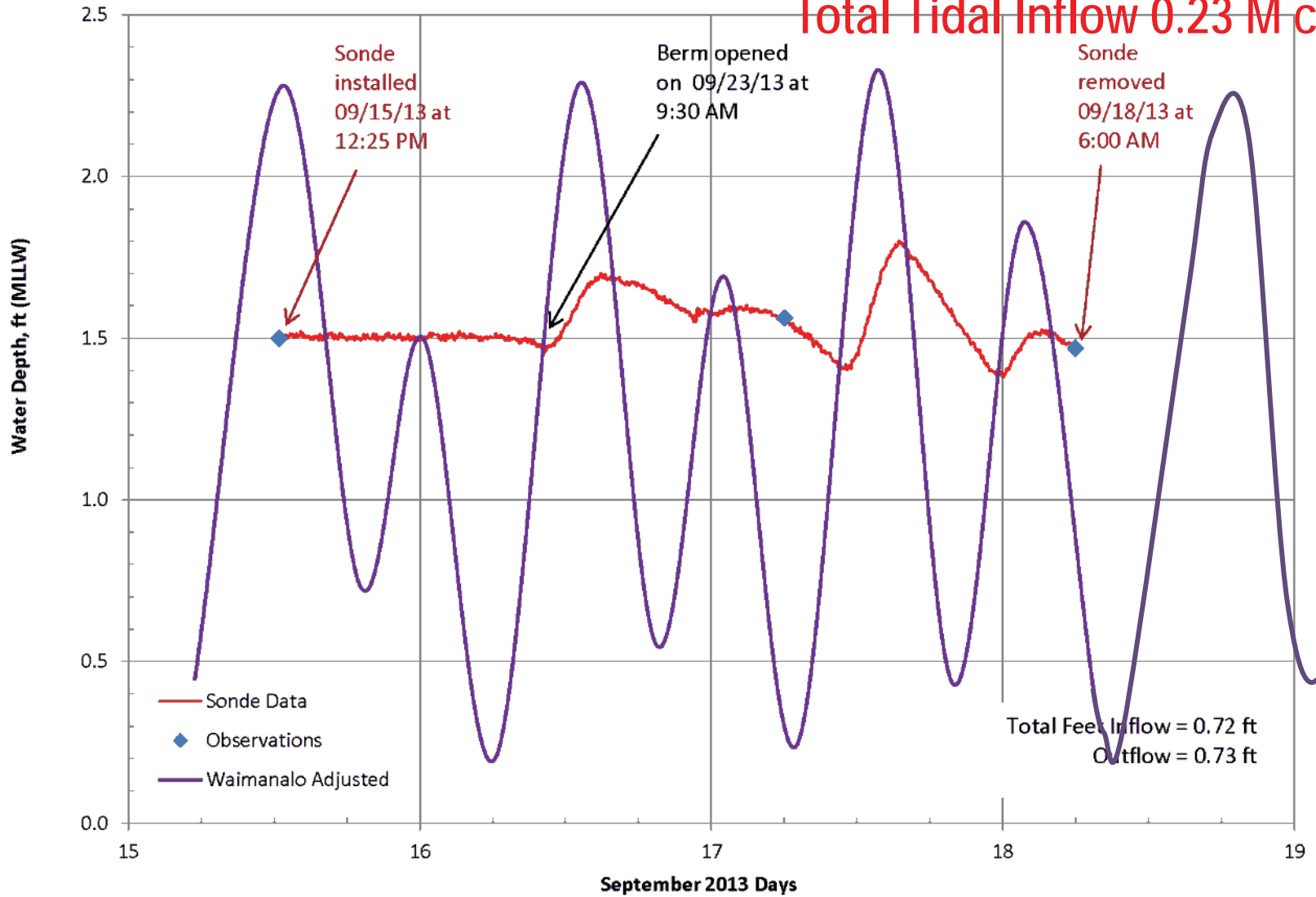




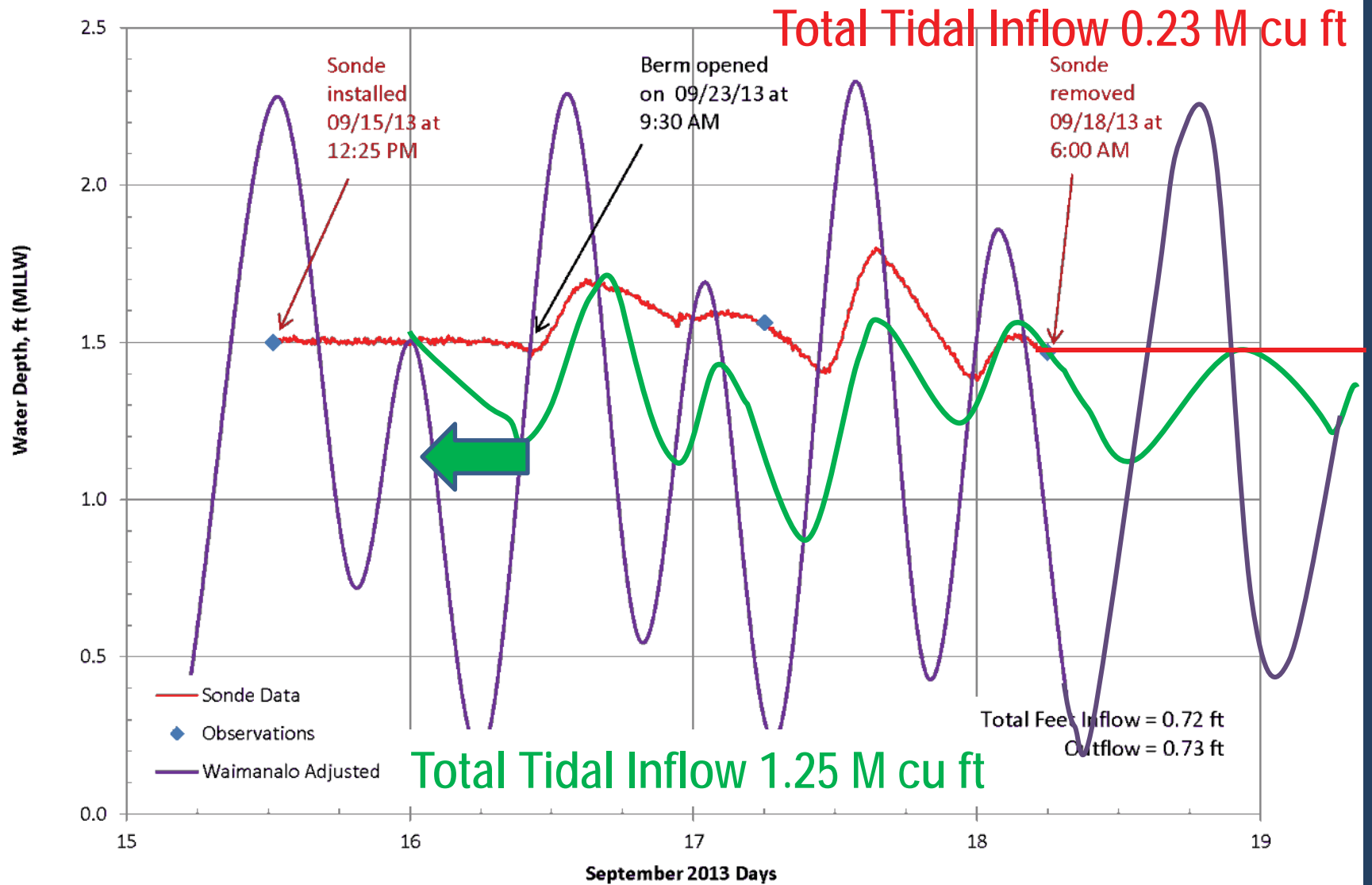


# Water Levels in Kaelepulu Stream

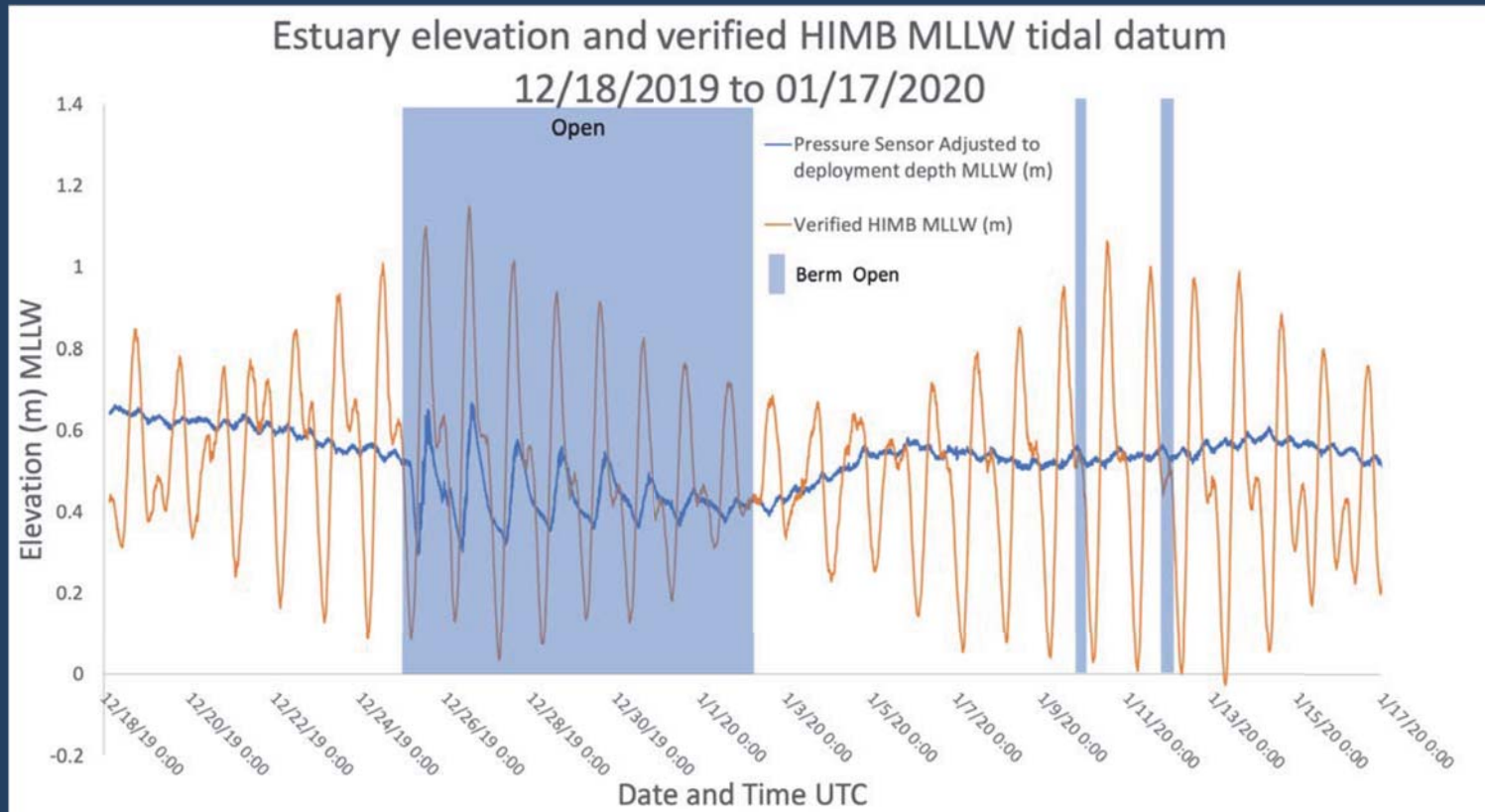
Total Tidal Inflow 0.23 M cuft



# Timing of Stream Mouth Opening to Maximize Initial Outflow Results in an Increase of Total Exchange



# Results: Berm opening duration



Total Ebb (m)	Total Flood (m)	Total Elevation Change (m)	Total Volume Exchange (m <sup>3</sup> )	Net Volume Exchange (m <sup>3</sup> )	Percent Exchange
-1.39	1.30	2.69	1,549,336.41	-51,131.14	149.75%

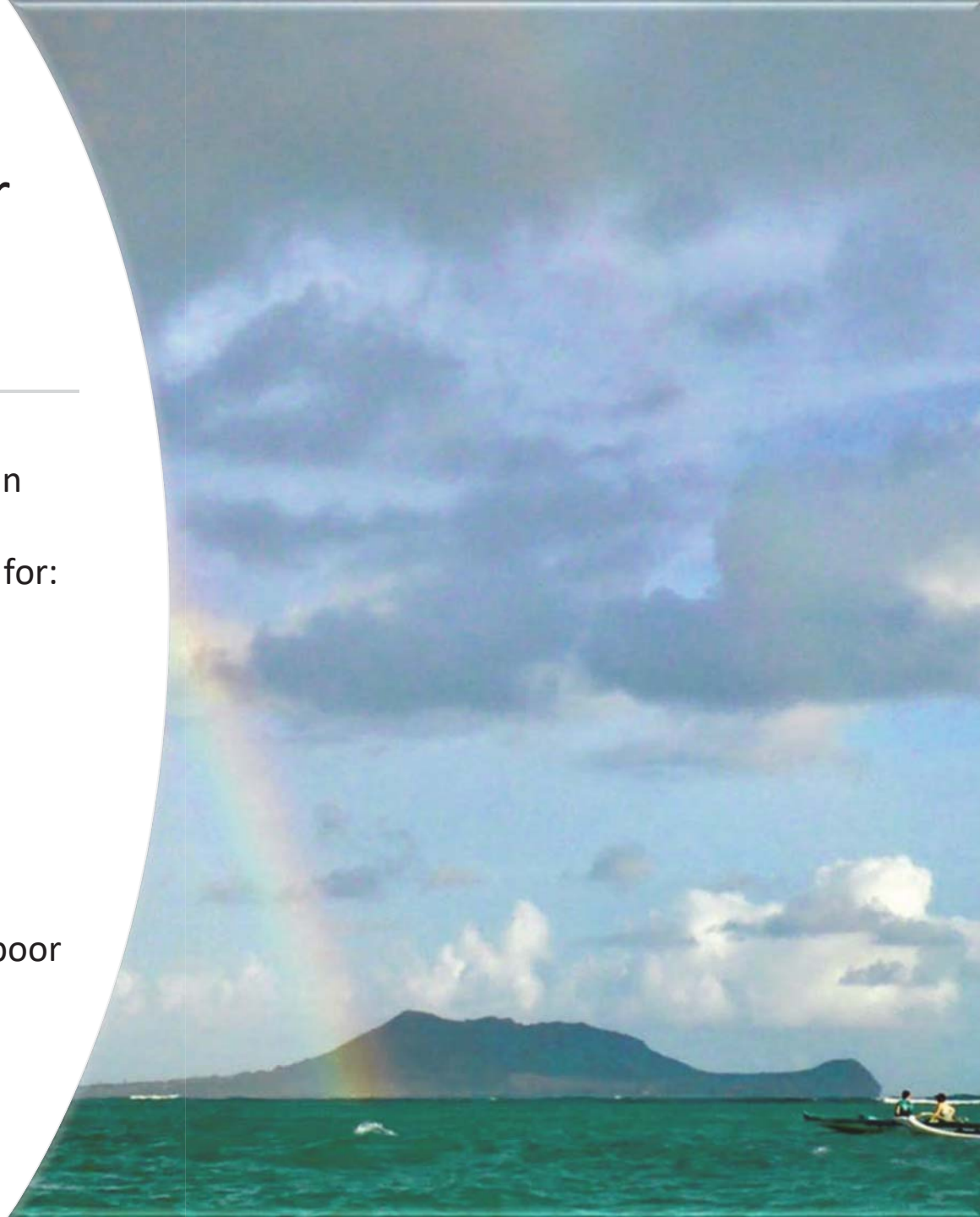


# Water Quality Parameters Along Kailua Beach standardizing "Wet" and "Dry" Department of Health conditions



# Results: Beach Water Quality Parameters

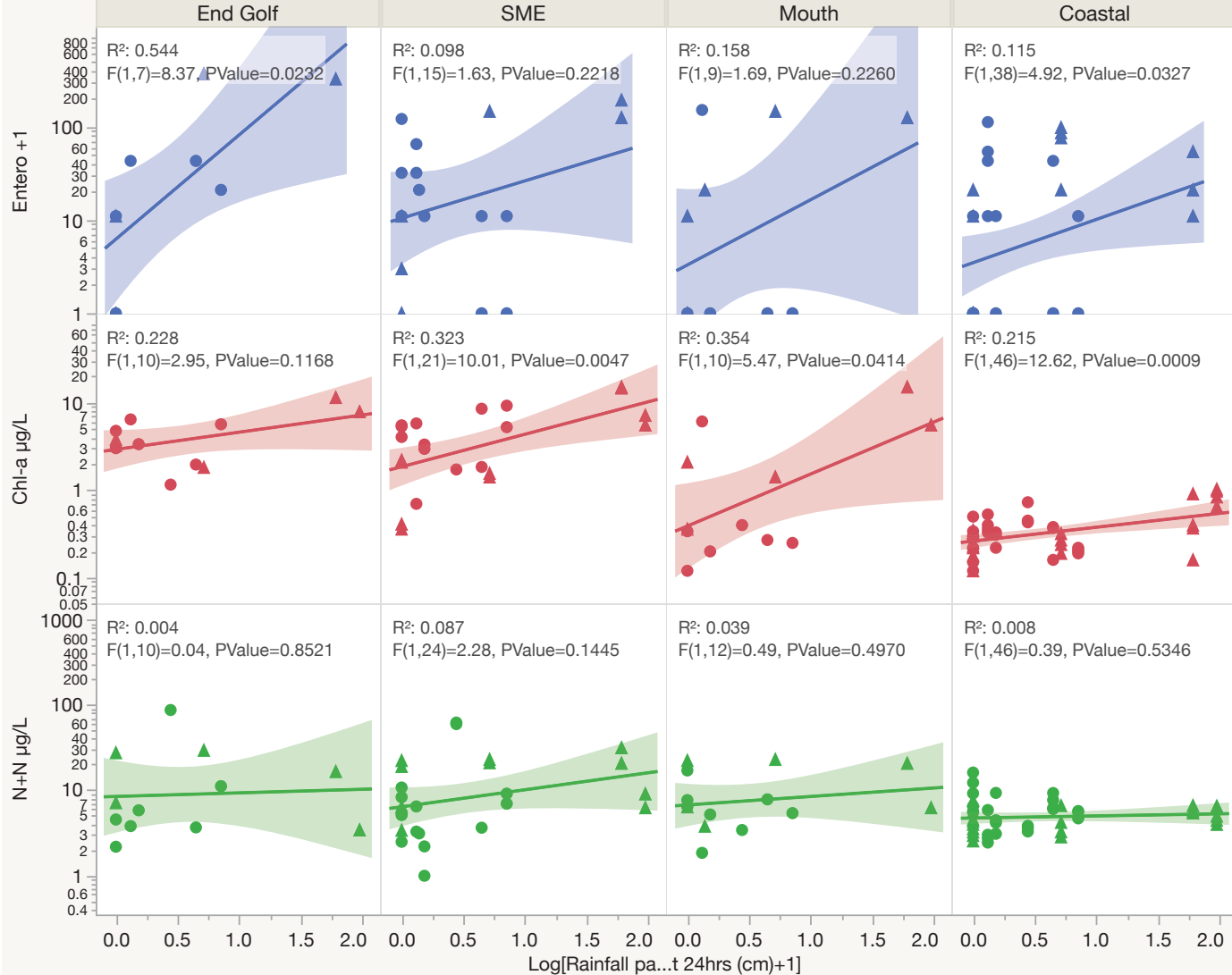
- There is **no statistical difference** in water quality along Kailua Beach when the berm is open or closed for:
  - Dissolved Oxygen
  - Enterococcus
  - Total Nitrogen
  - Chlorophyll-a
  - Total Phosphate
- Salinity does go down, this is not unexpected or a contribution to poor water quality



# Log Entero +1, Chl-a, N+N vs. Log[Rainfall pa...t 24hrs (cm)+1]

Regres Sect ordered by Distance from Mouth (m) (descending)

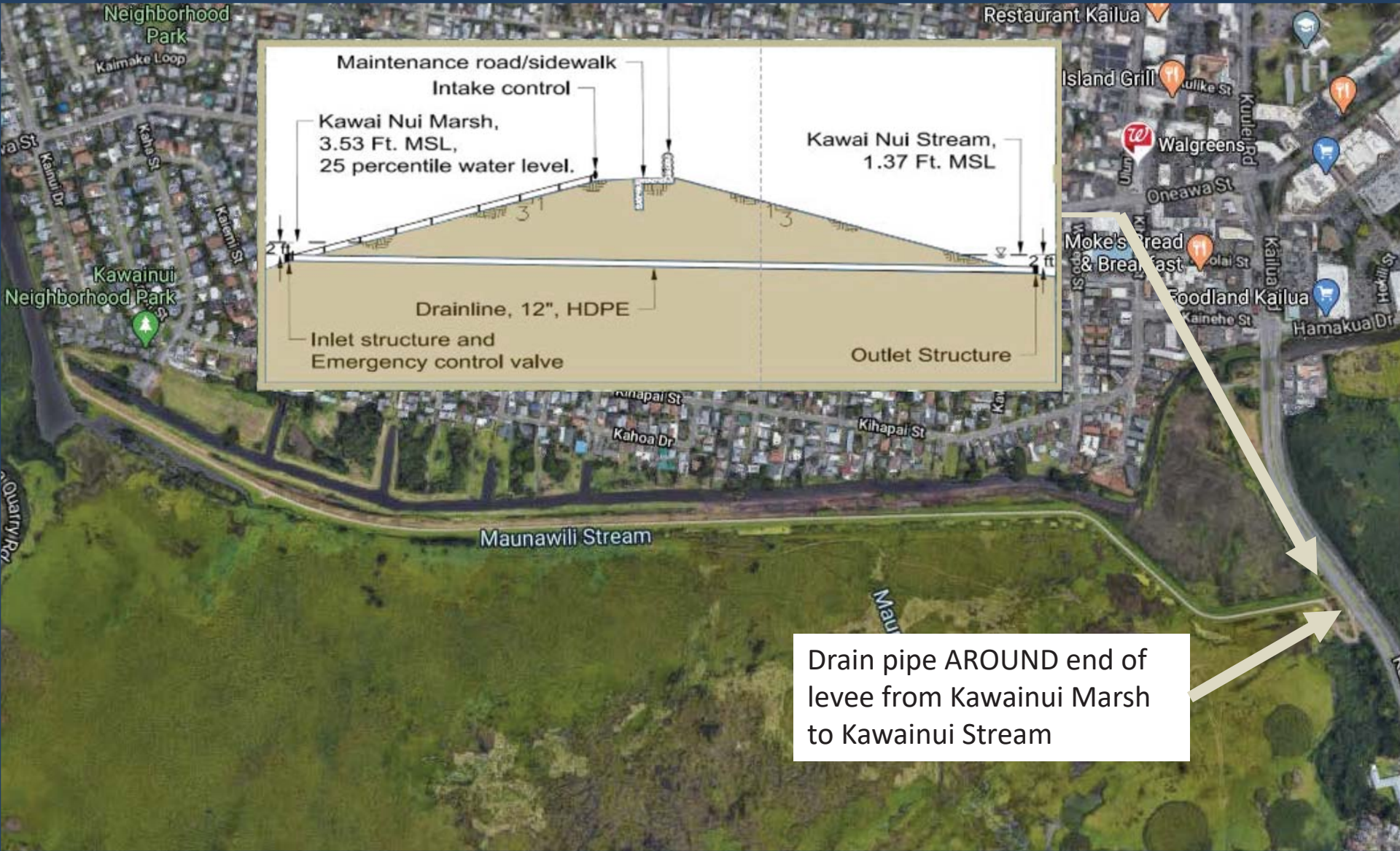
- Entero +1
- Chl-a µg/L
- N+N µg/L











Maintenance road/sidewalk

Intake control

Kawai Nui Marsh,  
3.53 Ft. MSL,  
25 percentile water level.

Kawai Nui Stream,  
1.37 Ft. MSL

Drainline, 12", HDPE

Inlet structure and  
Emergency control valve

Outlet Structure

Drain pipe AROUND end of levee from Kawai Nui Marsh to Kawai Nui Stream

# Outcomes of 1.5 CFS Flow Restoration

## POSITIVE

- ✓ Increased average surface elevation from 1.5 ft to 2.0 ft MLLW
- ✓ Decreased stagnation in Kawainui Stream
- ✓ Elimination of summer low-water events associated with bad odors, fish die-off events, and avian botulism threats
- ✓ Lower salinity in Kawainui Stream
- ✓ Improved stream mouth opening efficiency due to higher hydraulic head
- ✓ Improved water level control in wetlands with ESA birds
- ? Improved fisheries by opening estuary nursery habitat.

## NEGATIVE

- X Increase pollution into Kailua Bay
- X Increased flood threat from water transfer past flood levee
- X Increased flood threat due to a weakened levee
- N/S Lowered water surface elevation in Kawainui Marsh – insignificant



# QUESTIONS ?

