National Program – Monitoring Completed Navigation Projects

Houston Ship Channel Shoaling Study

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US Army Corps of Engineers

BUILDING STRONG®

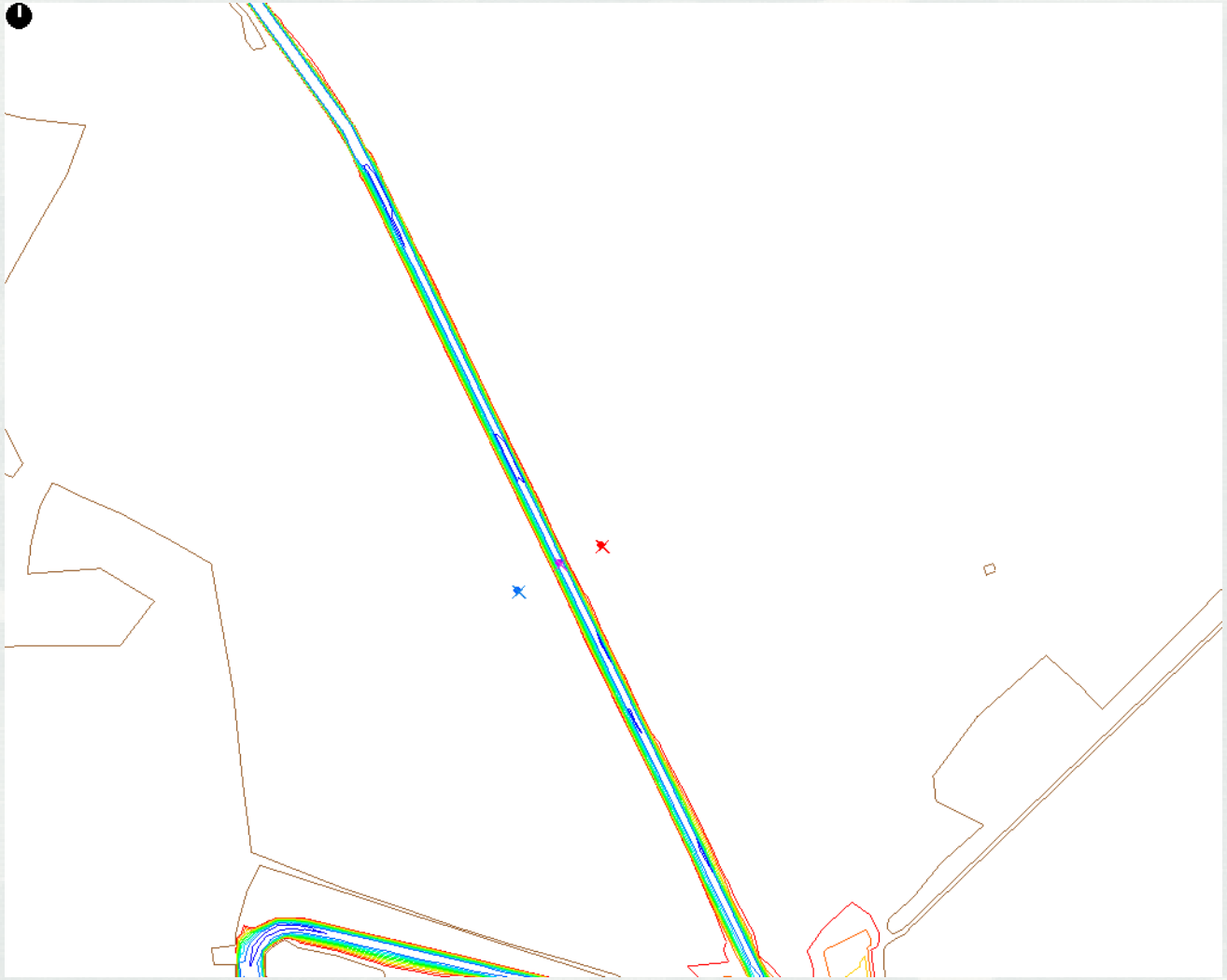
History of Galveston Bay Estuary Model

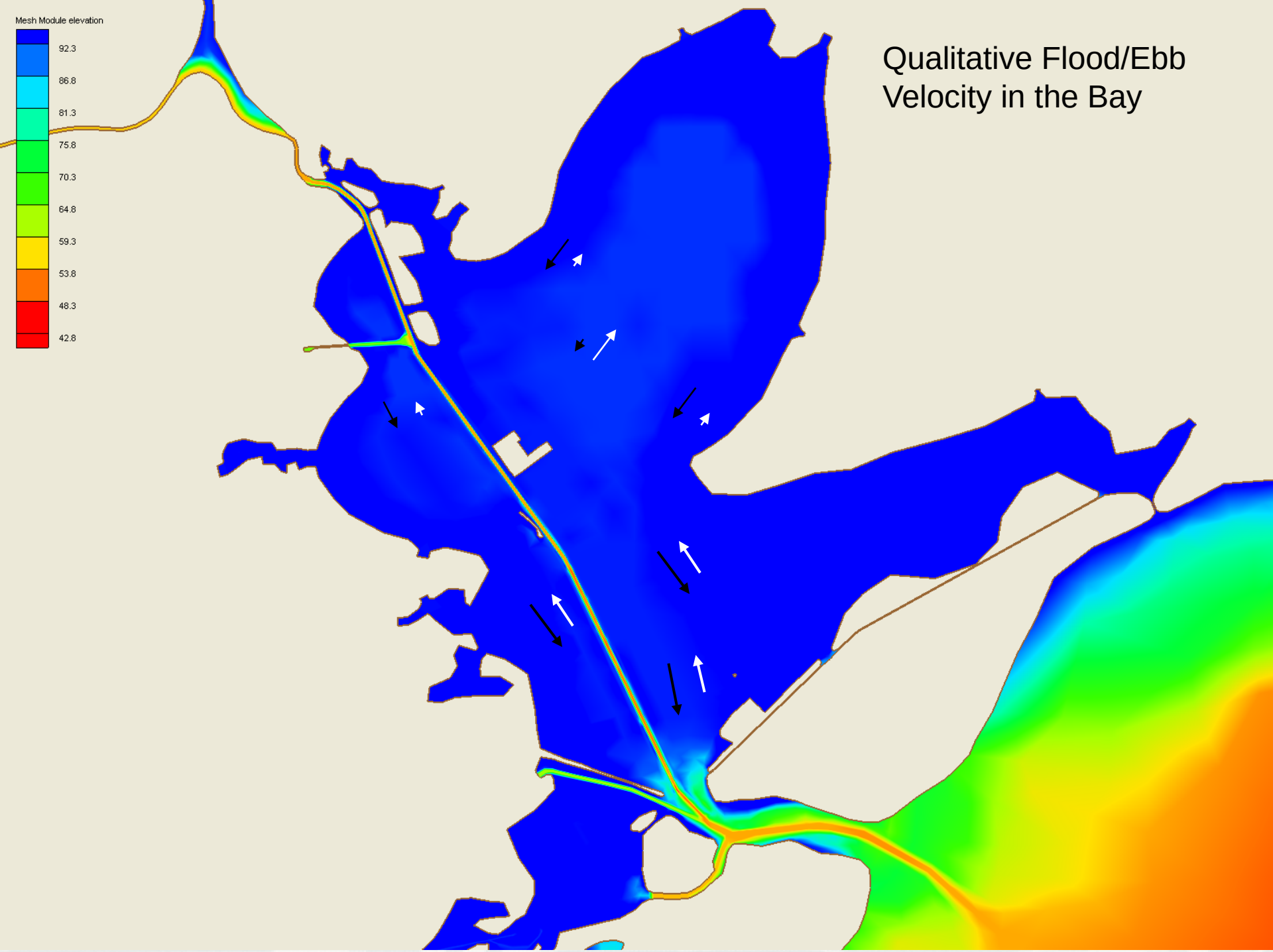
- Began in late 1980's – early 1990's
- First 1D/2D/3D model of its type
- Hydraulics Laboratory at Waterways Experiment Station
- Salinity variations with enlarged channel plans (HL-92-7)
- Barge Lane Analysis in early 2000's (TR-02-23)
- Sedimentation Study in mid – late 2000's:
  - Sediment tracer (TR-06-8)
  - Full sediment model with vessel effects (TR-08-8)
- Alternative Hydro and Sediment Plan Analysis (TR-09-6)
- Bayport Flare Hydro and Sediment with Ship Simulation (TR-11-??)
- MCNP

Galveston Bay Behavior

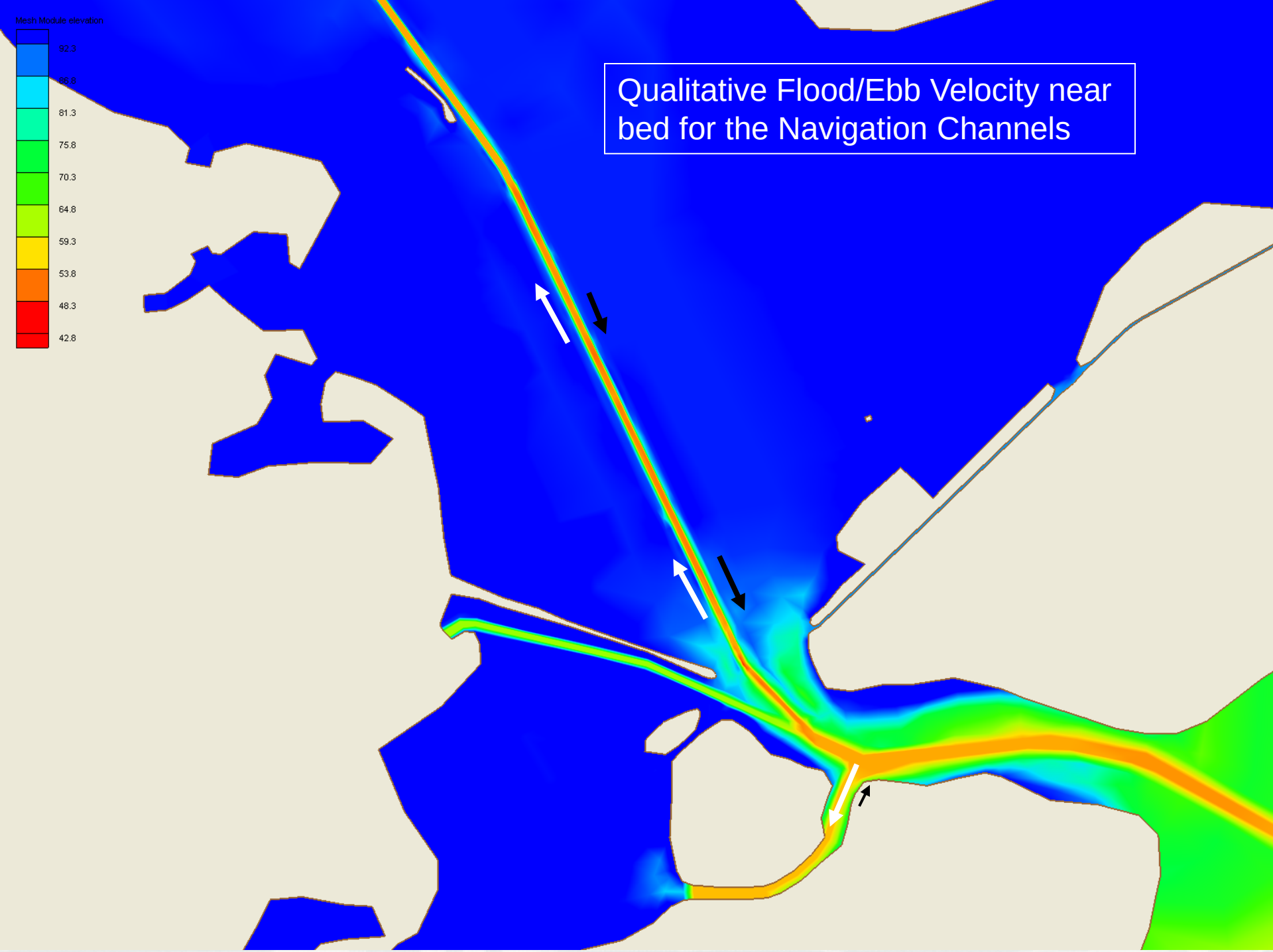
- Stronger currents in lower half of the bay therefore more mixing as a result so surface and bottom look more alike
- Small currents in upper half of the bay resulting in more stratification
- Channels' net drift tends to be flood directed
- Shallows' net drift tends to be ebb directed
- Supported by:
  - Current and Salinity Surveys in the 60's and 90's
  - Radioisotope study in the 60's
    - Net drift in channel at Atkinson Island is flood
    - Net drift in channel just above San Jacinto confluence is flood

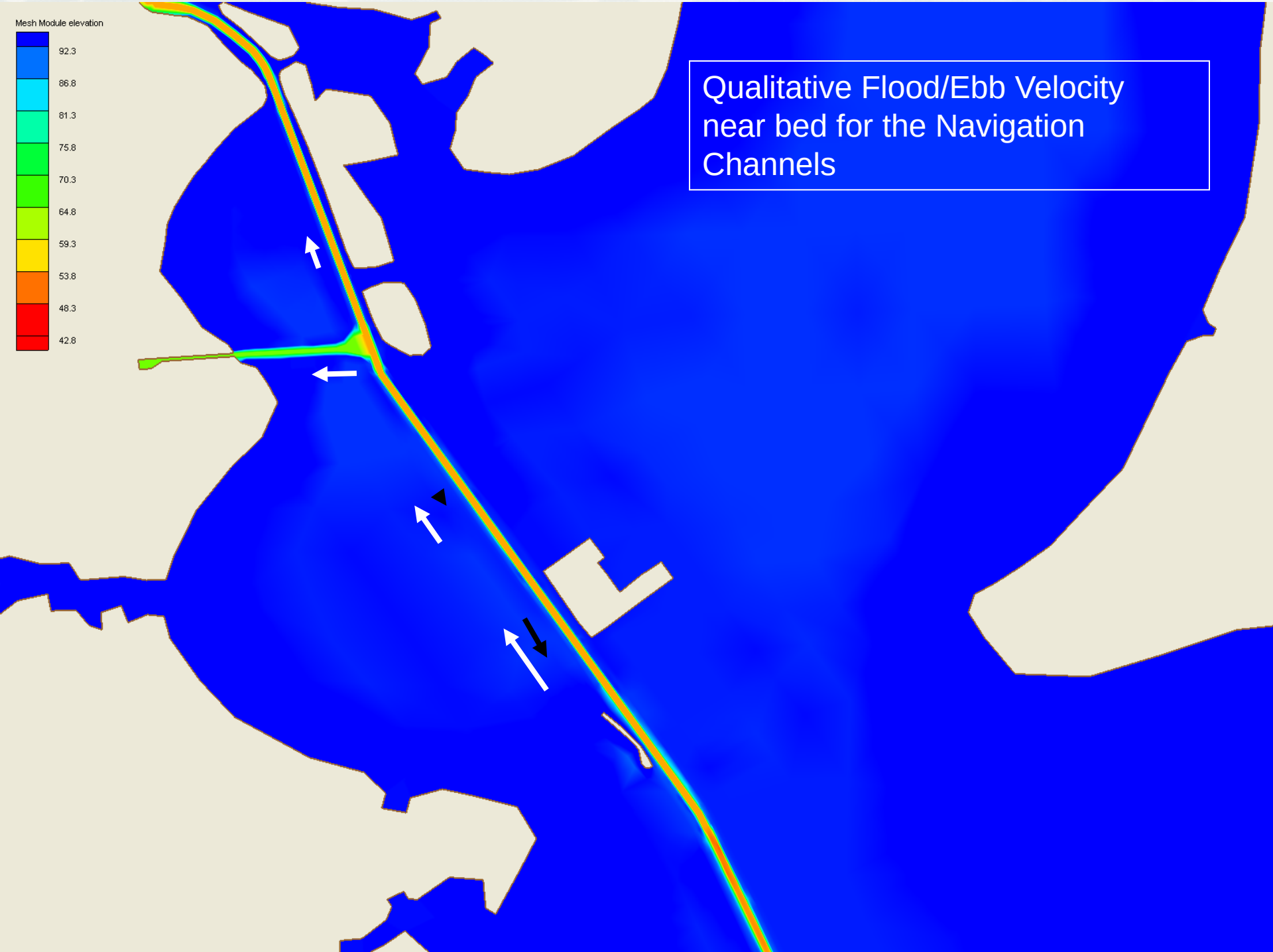
Bay Behavior (Near Bed)





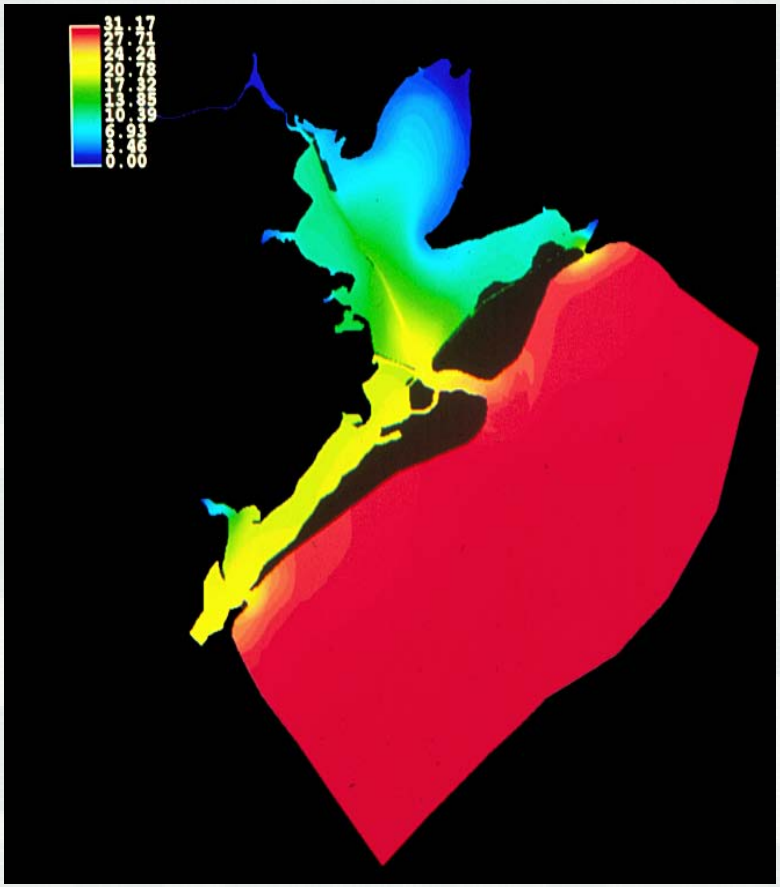
Qualitative Flood/Ebb Velocity in the Bay


Mesh Module elevation
92.3
86.8
81.3
75.8
70.3
64.8
59.3
53.8
48.3
42.8
Qualitative Flood/Ebb Velocity near bed for the Navigation Channels

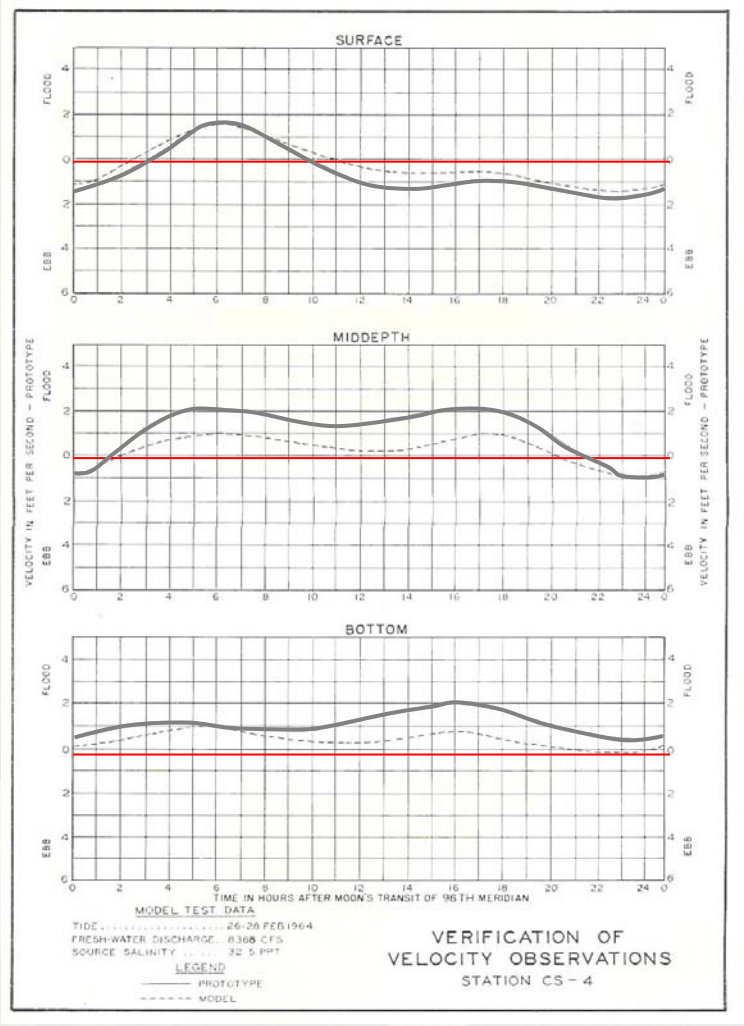


Qualitative Flood/Ebb Velocity near bed for the Navigation Channels

Salinity



near bed salinity



Field Data from the 1960's

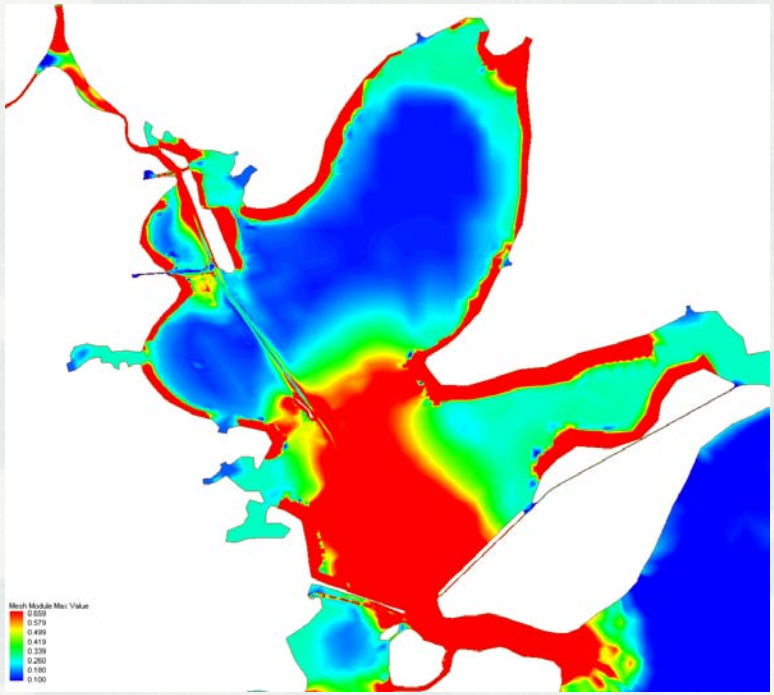
In channel near present site of mid-bay disposal

Findings From Sediment Model
(sediment model validated to Dec 2005 data and dredging records)

- Deeper regions of Trinity Bay don’t appear to be easily resuspended
- San Jacinto River appears to be more important than the Trinity River
- Vessel Effects are important
- Model suggests a 30% permanent increase overall

Depositional Environment

- Based on field data collection during a strong wind event and the inclusion of wind in the model, the impact of wind waves on resuspension of bed material is confined to the shallower areas of the bay



(contoured between 0.1 and 0.67 Pa)

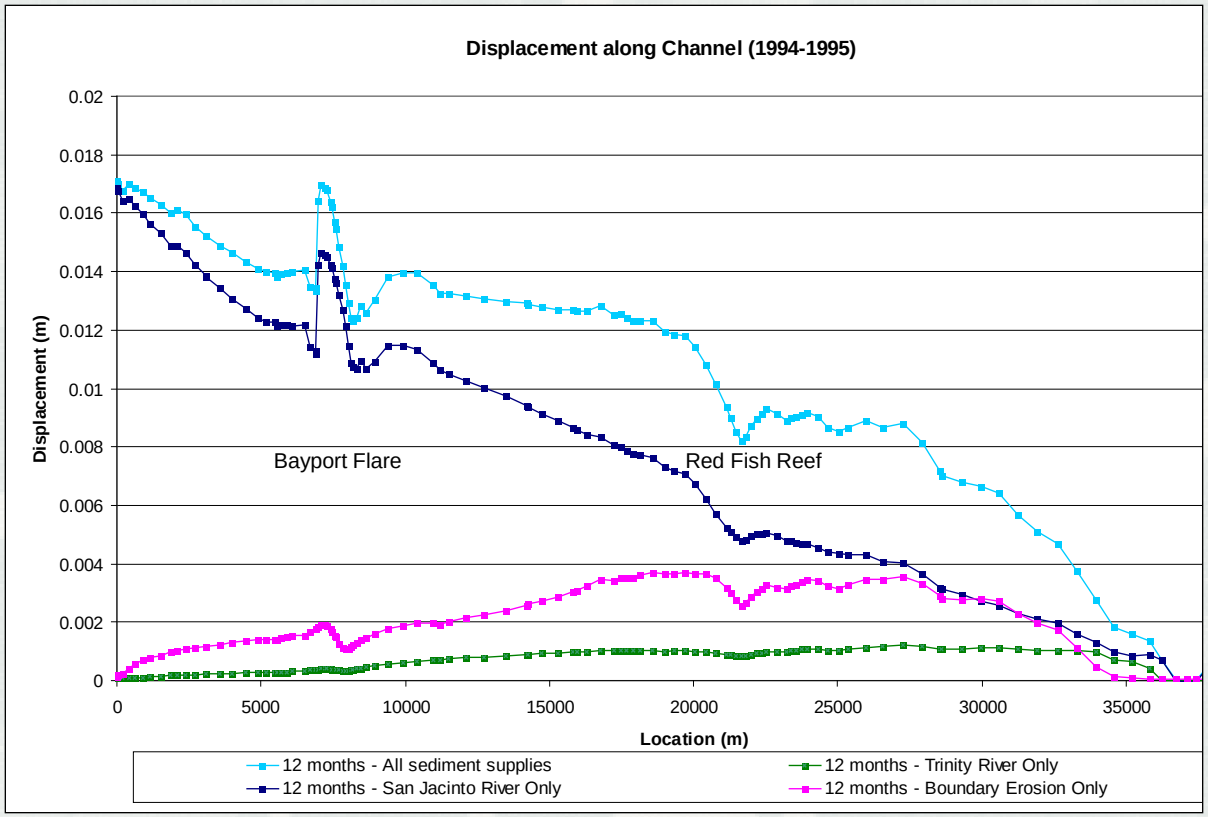
Maximum shear stress values during a one-year simulation to show areas of resuspension

Load vs. Displacement

Bulk deposition occurs during the large freshwater flow events. The San Jacinto River is of primary importance

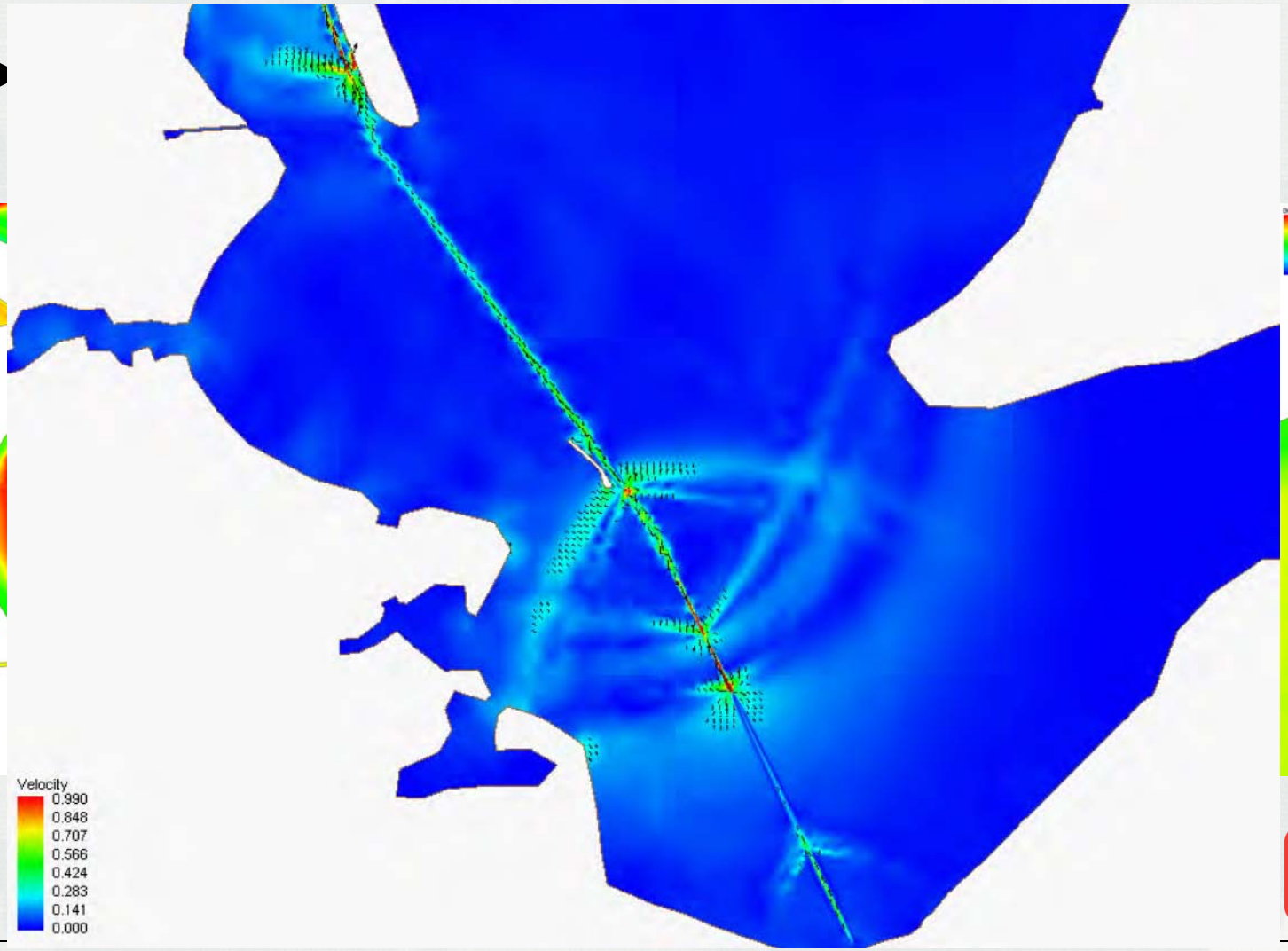
Bed deposition along the channel for various levels of sediment supply:

- All
- San Jacinto River
- Trinity River
- Shoreline Erosion



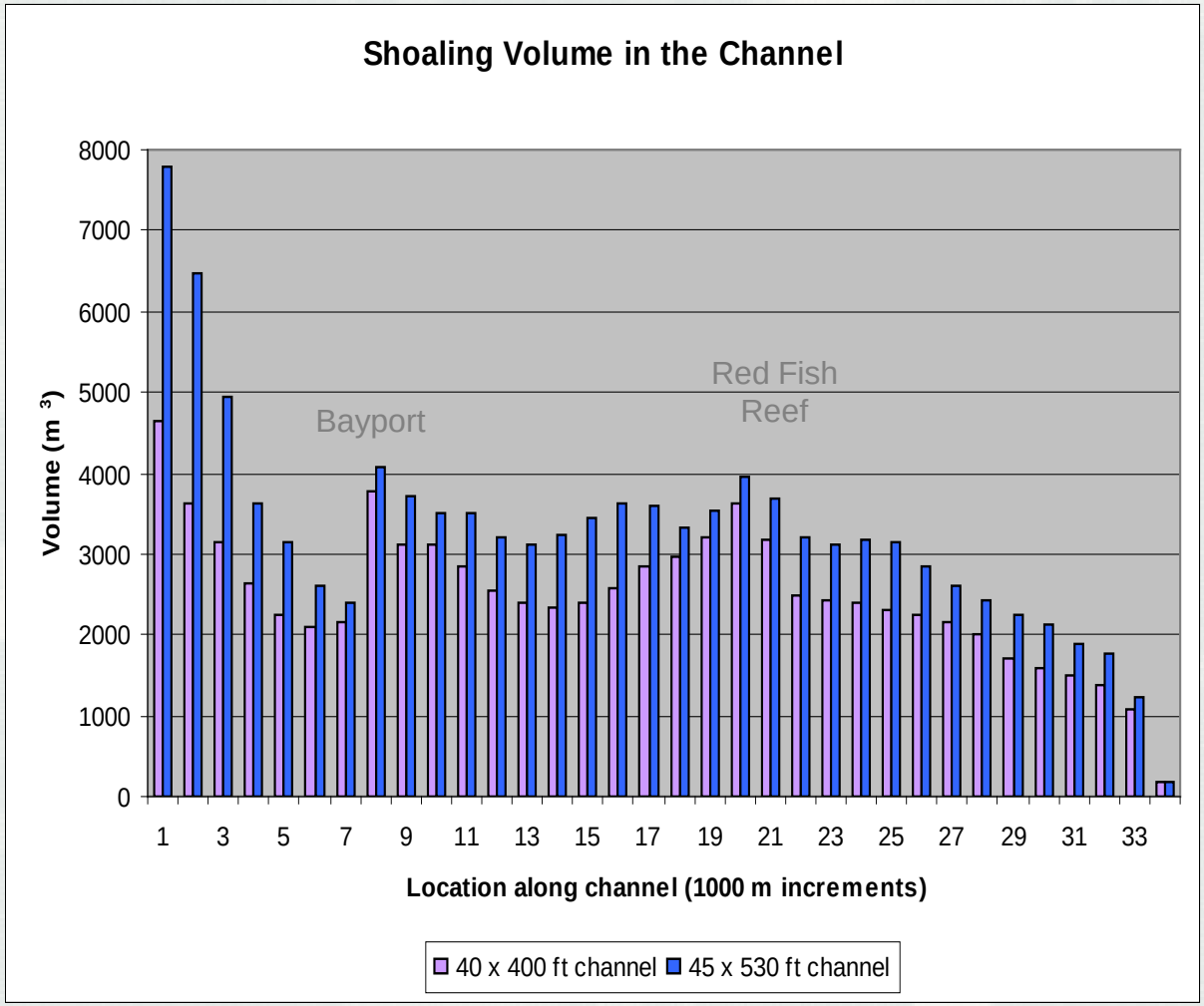
High flow water year (1995-1996)

Vessel Impacts on Sedimentation



Channel Shoaling Volume

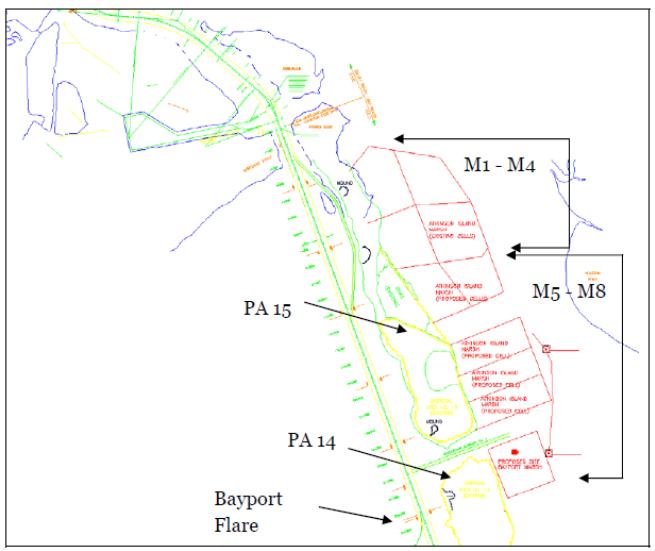
Average increase in shoaling, from the model, along the channel stations is 30%



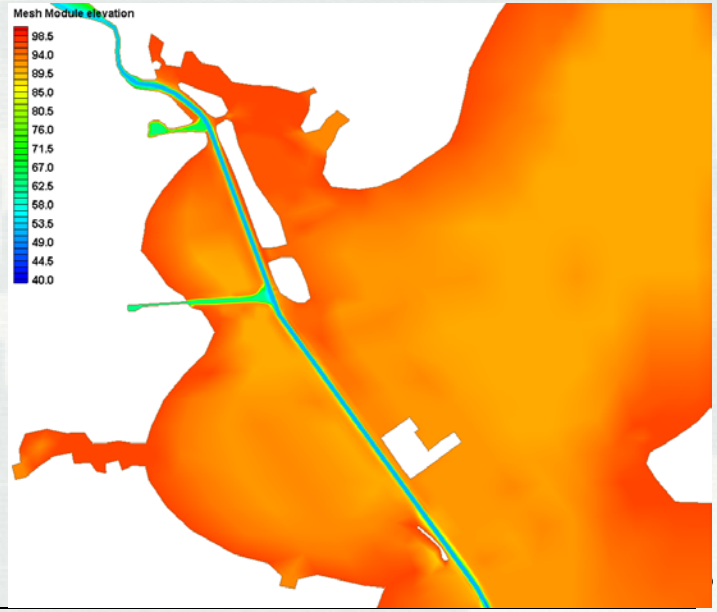
MCNP Improvements

- Determine the impact of the Atkinson Island expansion on dredging
- Collect sediment data during the Spring and during the Gulf salinity drop
- Determine vessel impacts and support with data collection
- Revalidate with a modern model

What is the effect of the Atkinson Island modifications?

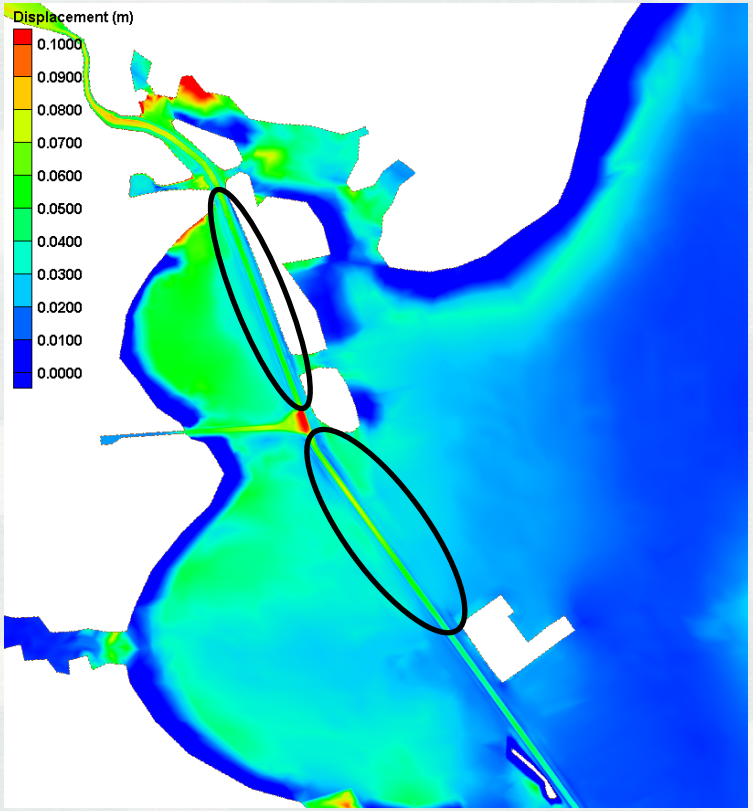


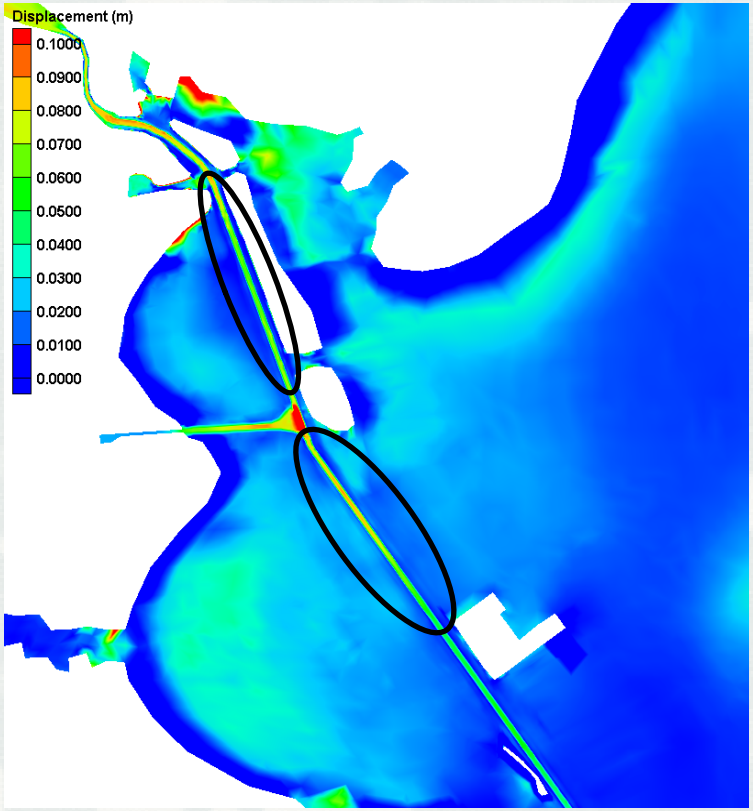
- Simulate the enlarged channel condition without the dredge disposal sites.



- More disposal sites are being added to Atkinson Island but how do these changes affect the hydrodynamics and therefore the sediment processes?

Channel Bed Change Comparison



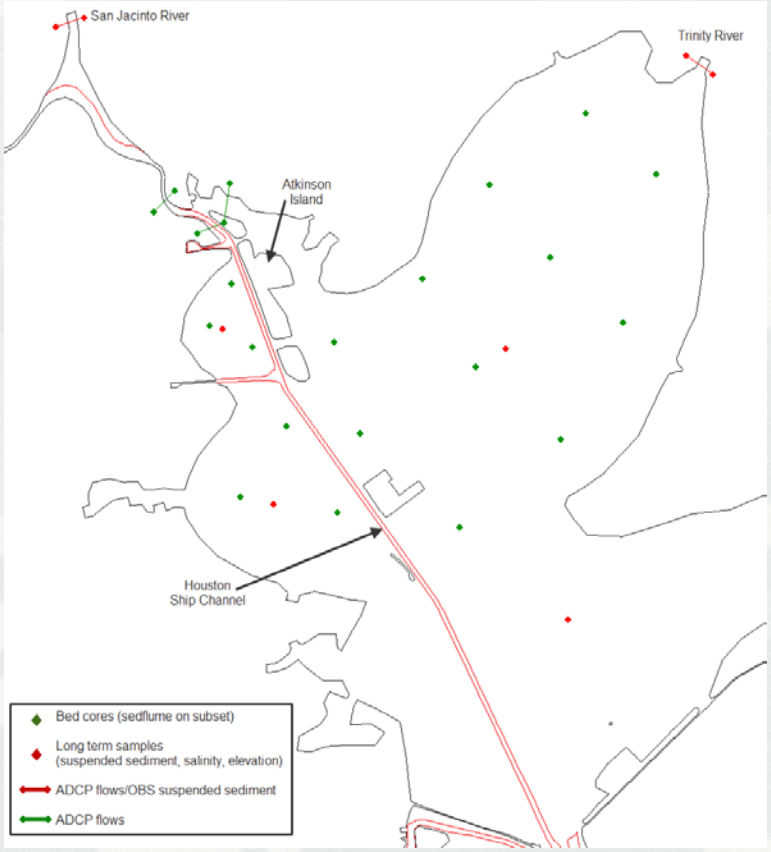


Even though the larger island removes some shoaling “hotspots”…

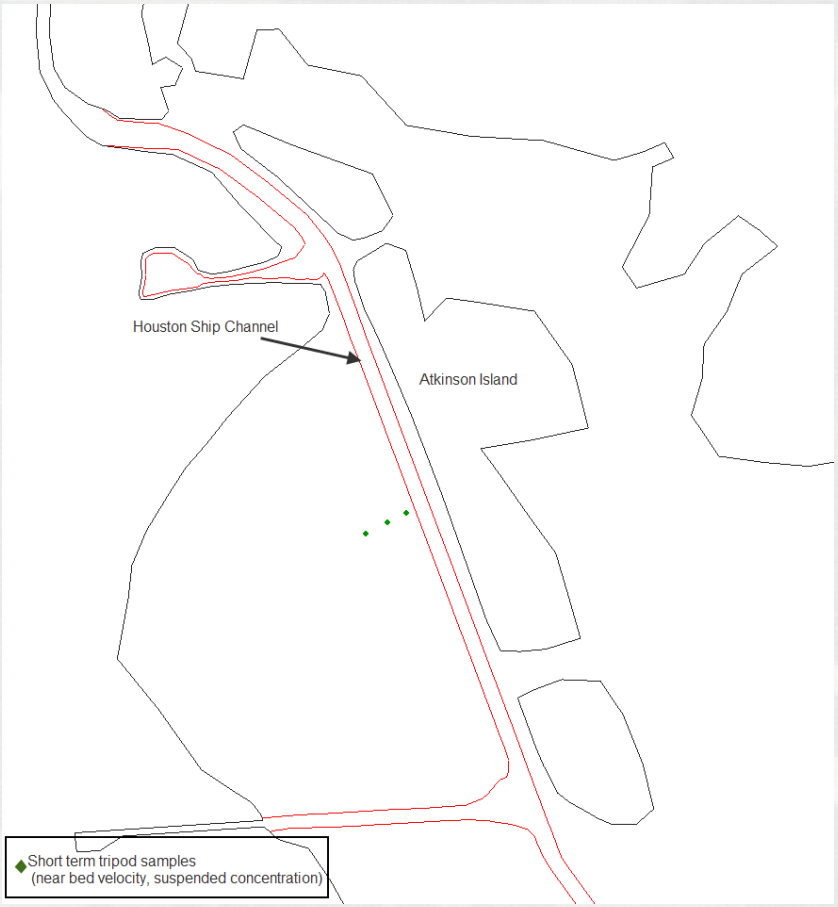
Along Atkinson Island – larger island increases deposition 4%
Bayport to Marsh Site – larger island increases deposition 10%

MCNP Sediment Data Collection

- Field data collection during April – June.
  - To determine properties of freshly deposited material, settling velocities, and floc characteristics
  - To determine changes in characteristics during the salinity drop in the Gulf of Mexico
  - To determine sediment loads entering the system from the Trinity River and San Jacinto River
- Long time period data at four locations to record suspended sediment concentration, salinity, and water surface elevation
- Flow and sediment load data on the Trinity and San Jacinto Rivers to determine load rating curve
- Bed cores distributed throughout the area to determine grain size, erosion characteristics, settling velocities, and floc properties



MCNP Vessel Data Collection



- Vessel induced resuspension data outside the ship channel
- Two-day collection with three tripods to determine spatial effect and timing.
- Will collect suspended sediment concentration at several depths as well as near bed velocity

MCNP Fluid Mud Data Collection

- Forms a dense layer
- Moves due to its own density and the shear due to the current
- Kept in motion by waves (vessels and wind waves)
- Generates large deposits in short periods

  - Fluid Mud
    - Where does it form
    - When does it form
    - Can we draw any conclusions about its effect on the total shoaling in the area

  - While performing the other collection efforts, passes will be made to determine if any fluid mud can be detected

Summary

- Behavior
  - Channels tend to carry sediment upstream and the shallows carry it downstream
  - Therefore sediment collects in the channels
  - Modeling suggests a 30% increase in sedimentation due to the channel enlargement
  - Vessel impacts are important
- MCNP Improvements
  - Sediment characteristics during Spring
    - Large freshwater flows indicate large amounts of freshly deposited material
    - Field data sampling has previously occurred in December and August-not during the time of high flow (Apr-Jun)
    - Fresh deposits likely have lower critical shear stresses and will therefore erode more easily
  - River Sediment Loads are poorly characterized
  - Impact of fluid mud could be substantial