Modeling Potential Circulation Improvements in Old Tampa Bay

Tampa, FL

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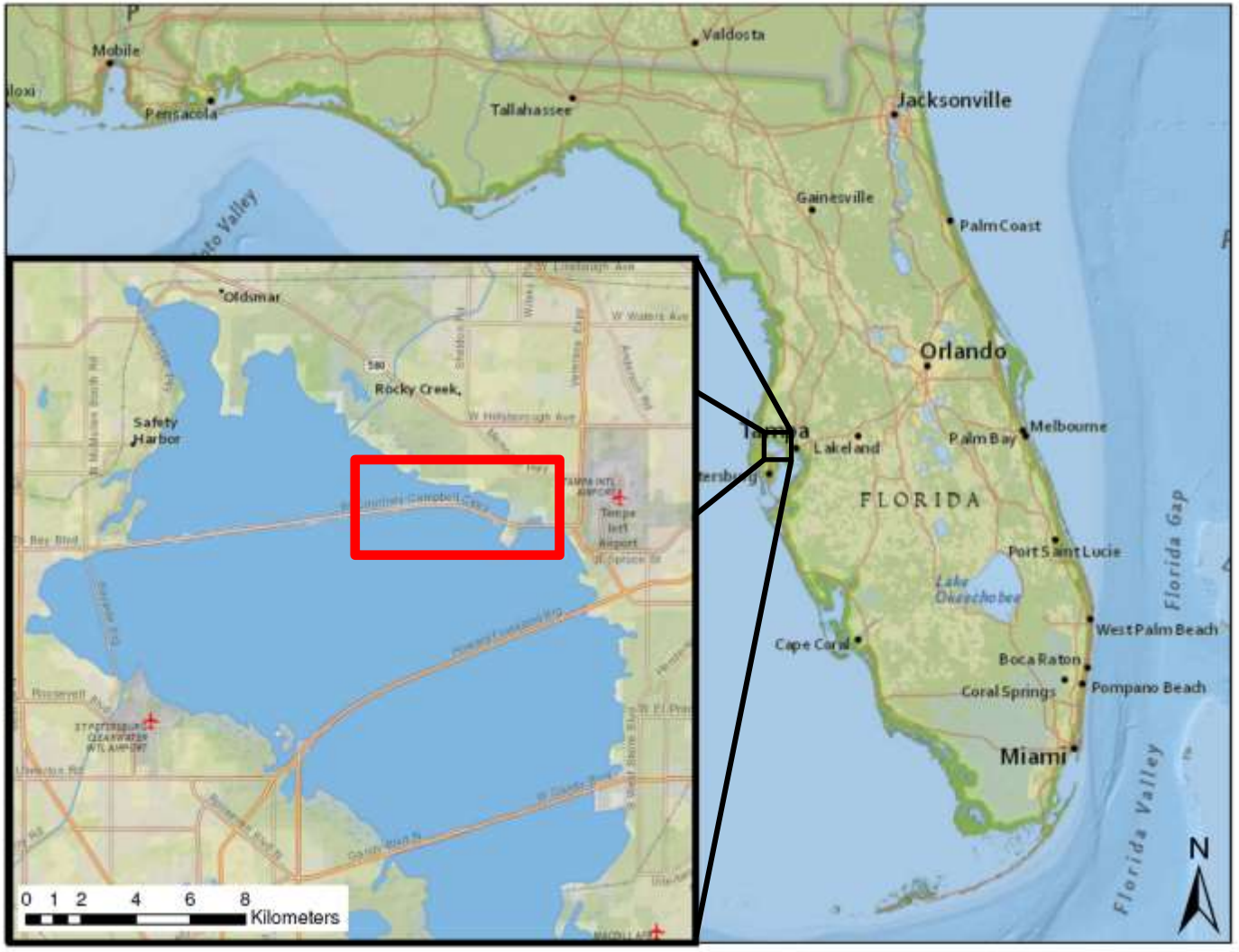
Project Location

Old Tampa Bay

Tampa, FL



Project Location

Old Tampa Bay

Tampa, FL

area of interest

Background

- Florida Department of Transportation (FDOT) anticipating significant costs with upcoming local construction and associated runoff treatment
- Department of Environmental Protection encouraging alternatives to wet detention ponds for treatment
- Area of concern in Old Tampa Bay north of the Courtney Campbell Causeway (SR60)
- Location of healthy seagrass beds in the 1930s prior to causeway construction

Background

- Phase I of this study determined that a modification of the Causeway (adding a bridge section to increase flow exchange) would likely bring about an ecological response greater than that achieved by additional runoff treatment
- Phase II involved the development and application of a hydrodynamic model to quantify the changes in circulation and residence time achieved by adding bridge segment

Methodology

- Field data collection (water levels, currents) during August-September 2015
- Bathymetric survey in area of interest
- Delft3D hydrodynamic model
  - Tidal and wind forcing
  - Coarse and nested regional and local model grids
  - Conservative constituent dispersion
  - Quantify changes in residence time with modification to the Causeway

Model Development

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Delft3D-FLOW hydrodynamic model

- Regional domain encompassing Tampa Bay to the Gulf of Mexico
  - Based on NOAA's Tampa Bay Operational Forecast System model
- Nested domain in area of interest driven by regional model
  - Uniform 10 m spatial resolution

Model Development

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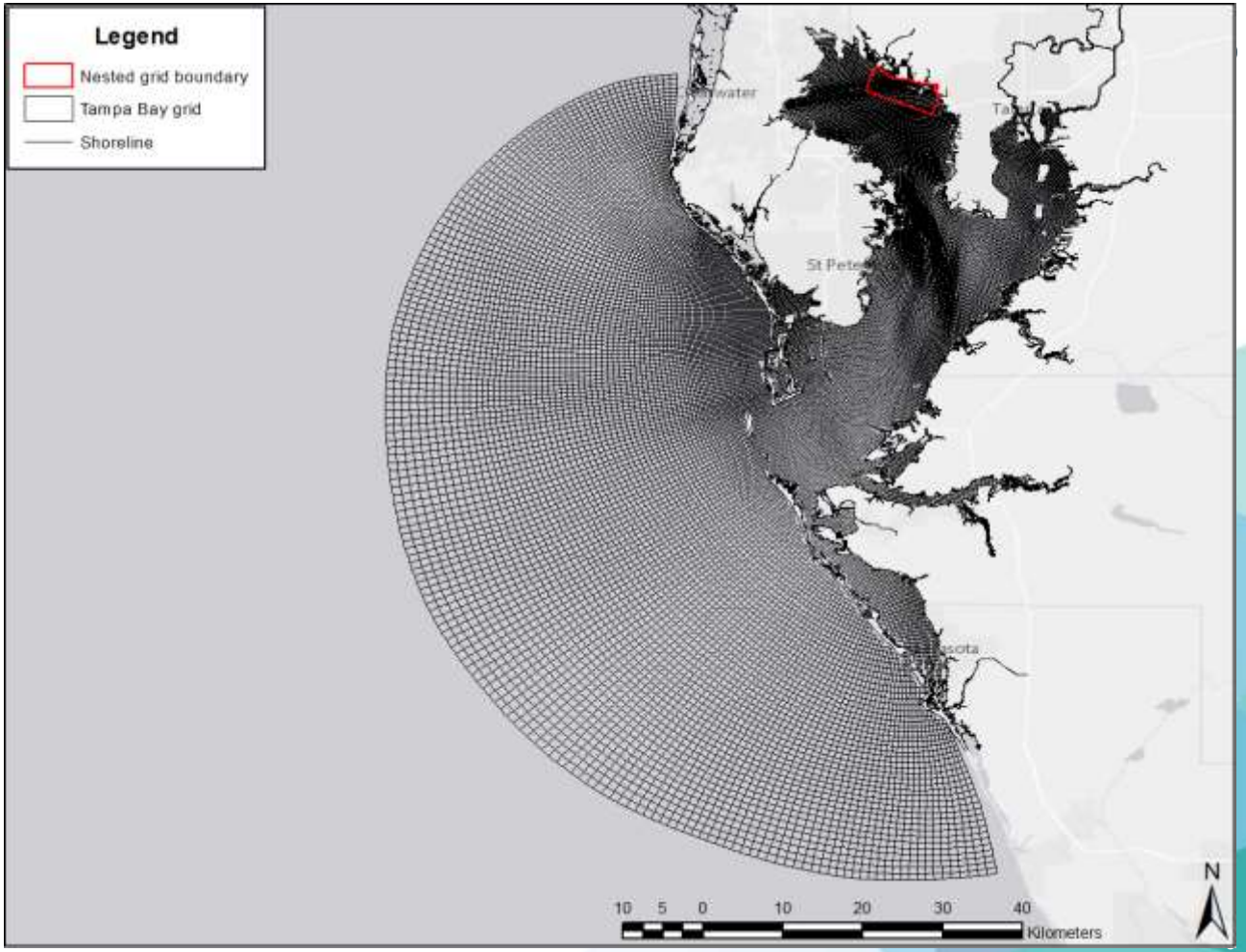
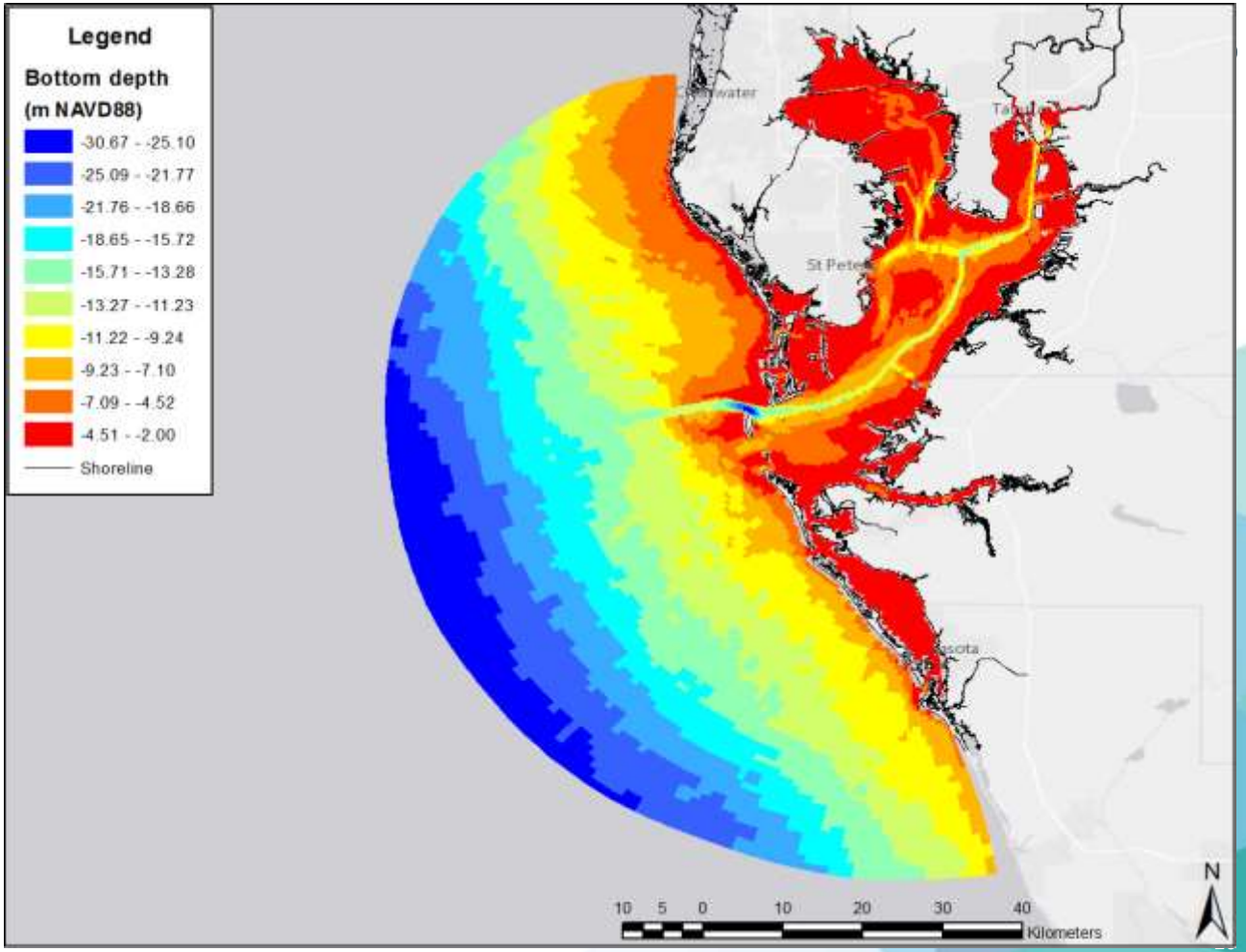
Delft3D-FLOW hydrodynamic model

- Spatially-varying tidal forcing at Gulf of Mexico
  - Constituents from Oregon State University Tidal Model Driver (TMD)
- Uniform wind forcing from measured data at NOAA Station 8726607
- Daily precipitation from Tampa International Airport (KTPA)
  - (over model domain only; no stormwater runoff into domain)
- Model run concurrent with field data collection period

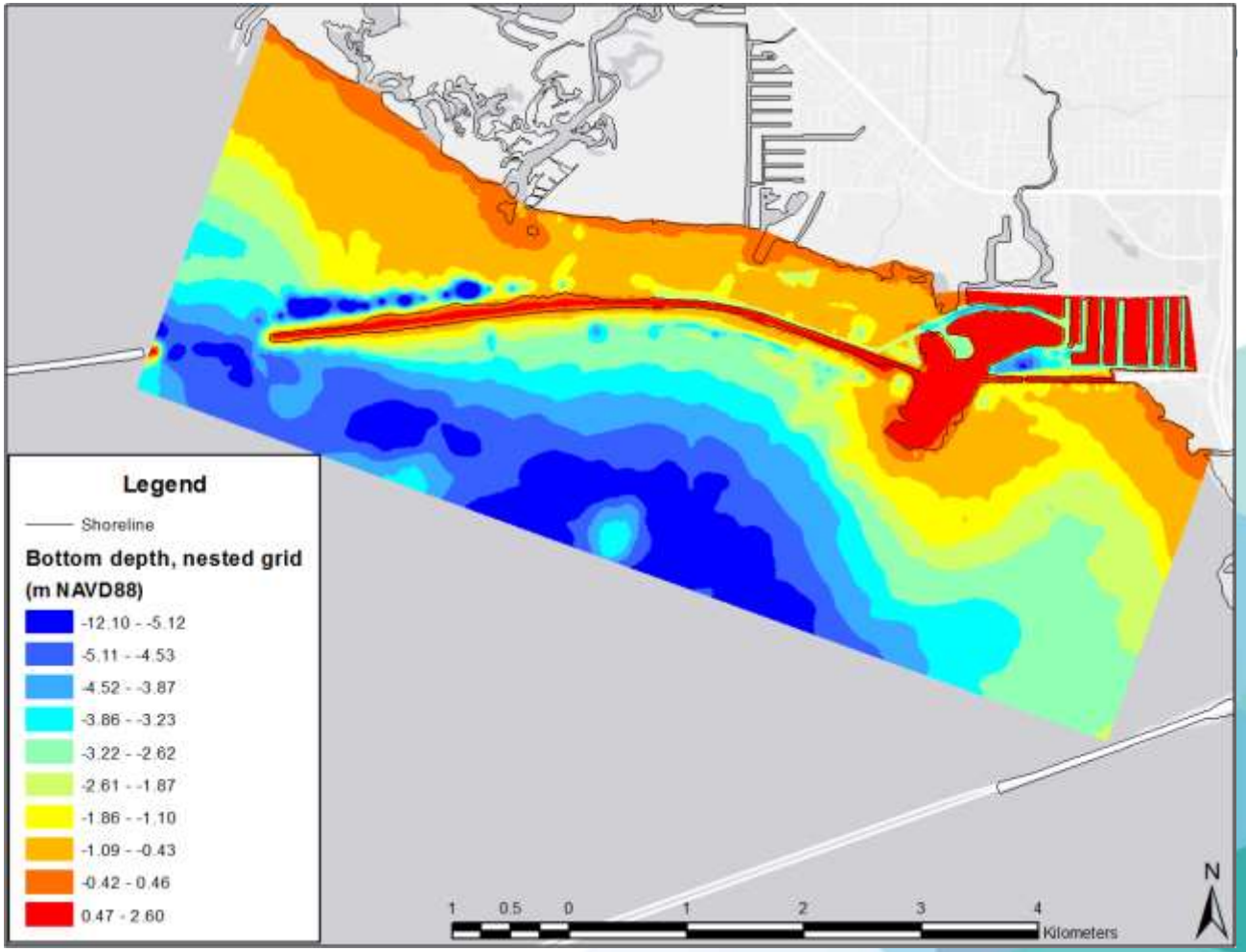
Regional Grid



Regional Grid



Nested Grid


Legend
Shoreline
Bottom depth, nested grid (m NAVD88)
-12.10 - -5.12
-5.11 - -4.53
-4.52 - -3.87
-3.86 - -3.23
-3.22 - -2.62
-2.61 - -1.87
-1.86 - -1.10
-1.09 - -0.43
-0.42 - 0.46
0.47 - 2.60
1 0.5 0 1 2 3 4
Kilometers
N

Proposed Bridge Location

60 m (200 ft) opening

flap-gate culverts

Modeled Scenarios

Name	Proposed Opening
Existing conditions	None (no change)
Alternative 1 200 ft opening	60 m (200 ft) width -2.3 m (-7.6 ft) NAVD88 bottom

Simulating Residence Time

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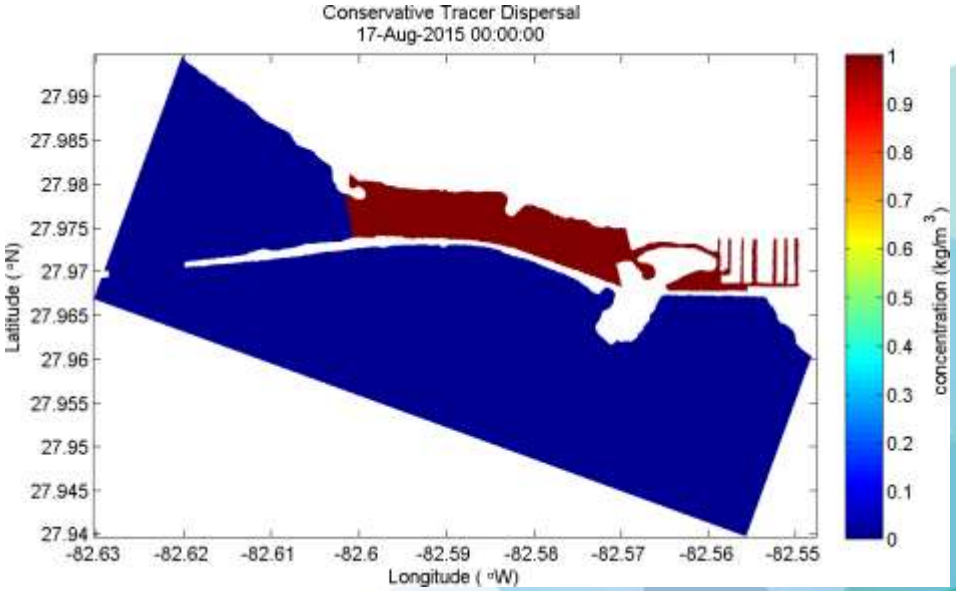
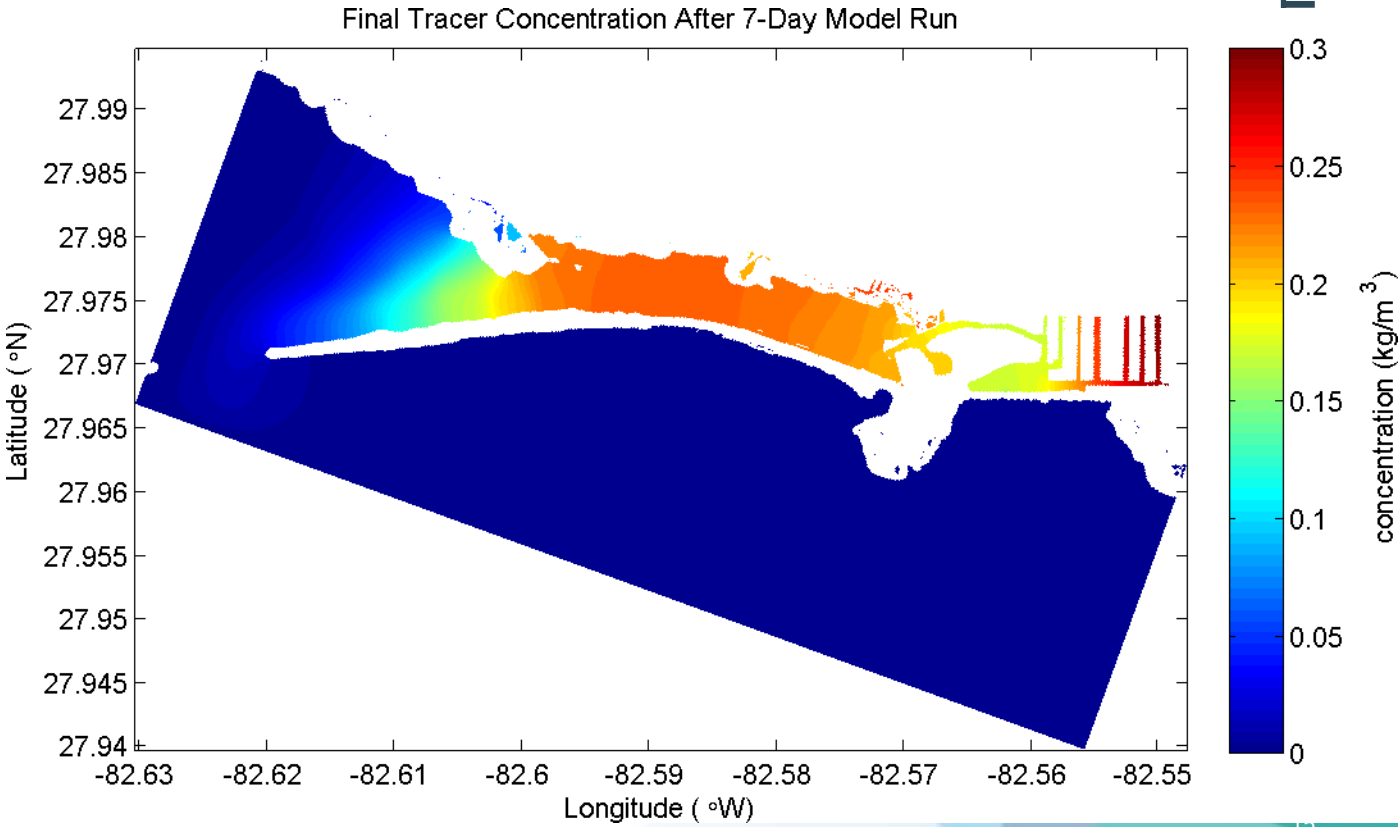
- Conservative, neutrally-buoyant, generic tracer in model
- Start with uniform 1 kg/m^3 in area of interest
- Run model for 1 week, compare initial & final concentrations in area of interest between the 2 alternatives



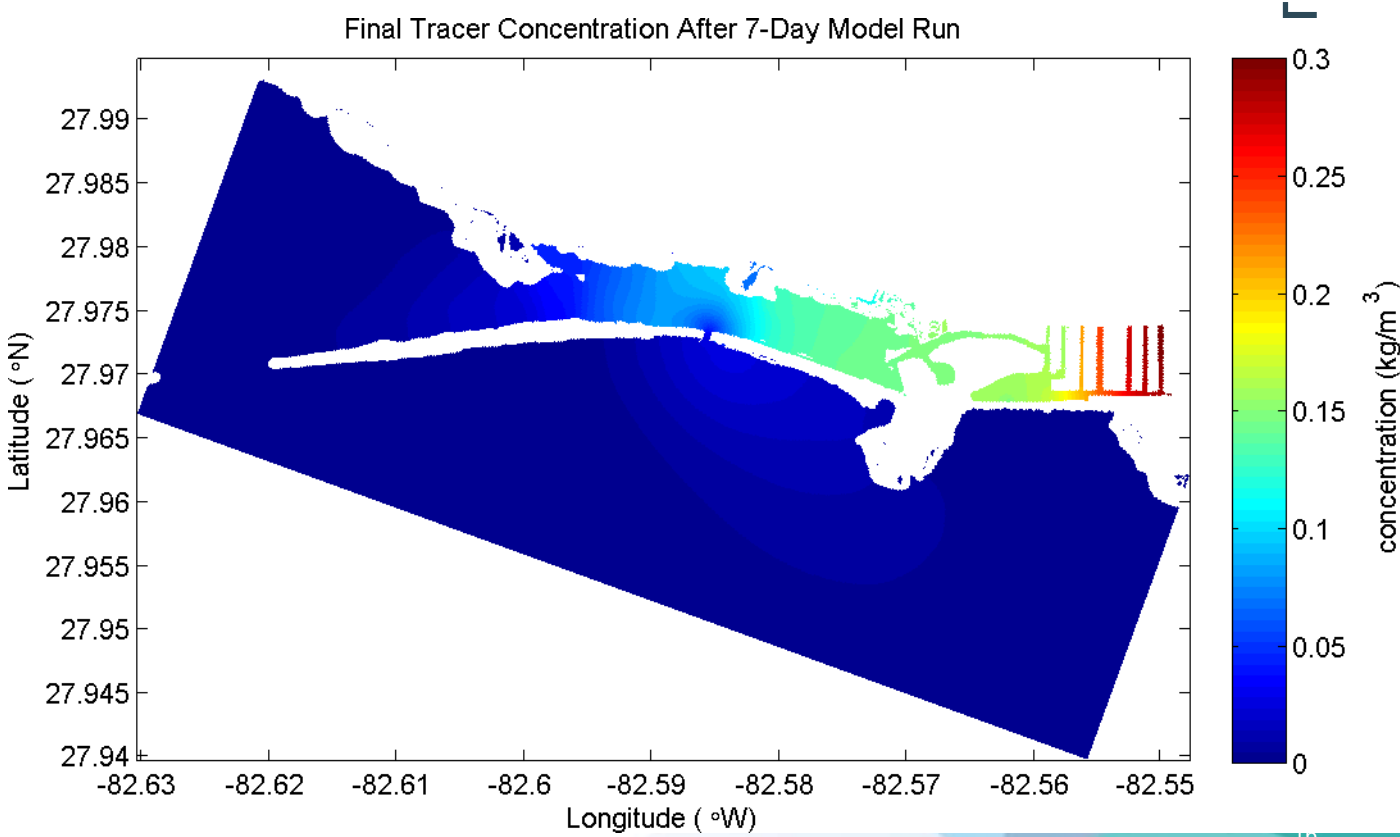
Results – Existing Conditions



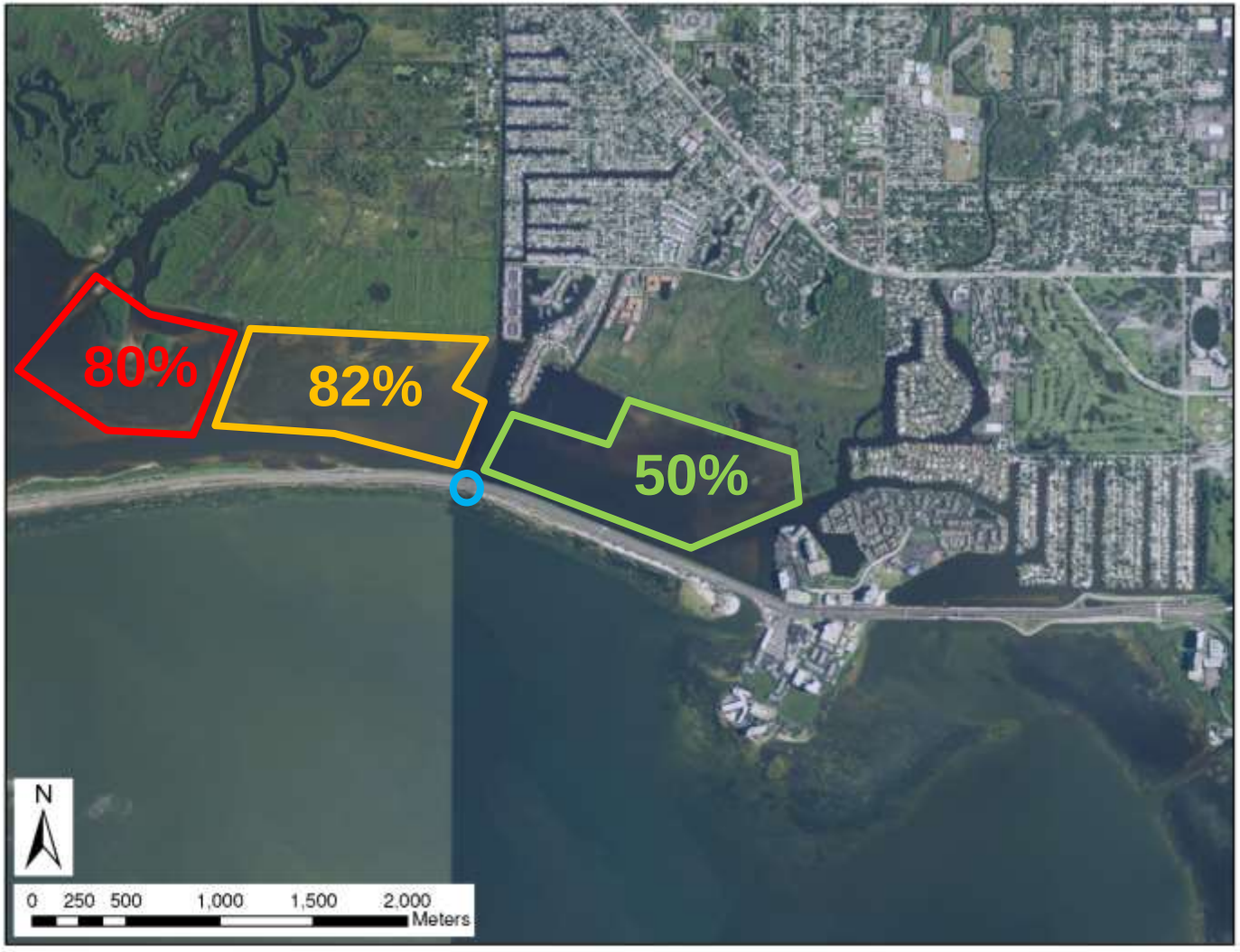
Results – 60 m Opening

Western area of interest: concentrations drop below 50% of initial level 2 days faster

Eastern area of interest: concentrations drop below 50% of initial level 1.5 days faster



Reduction in Residence Time



- Stratum A
- Stratum B
- Stratum C
- Bridge location

Conclusions

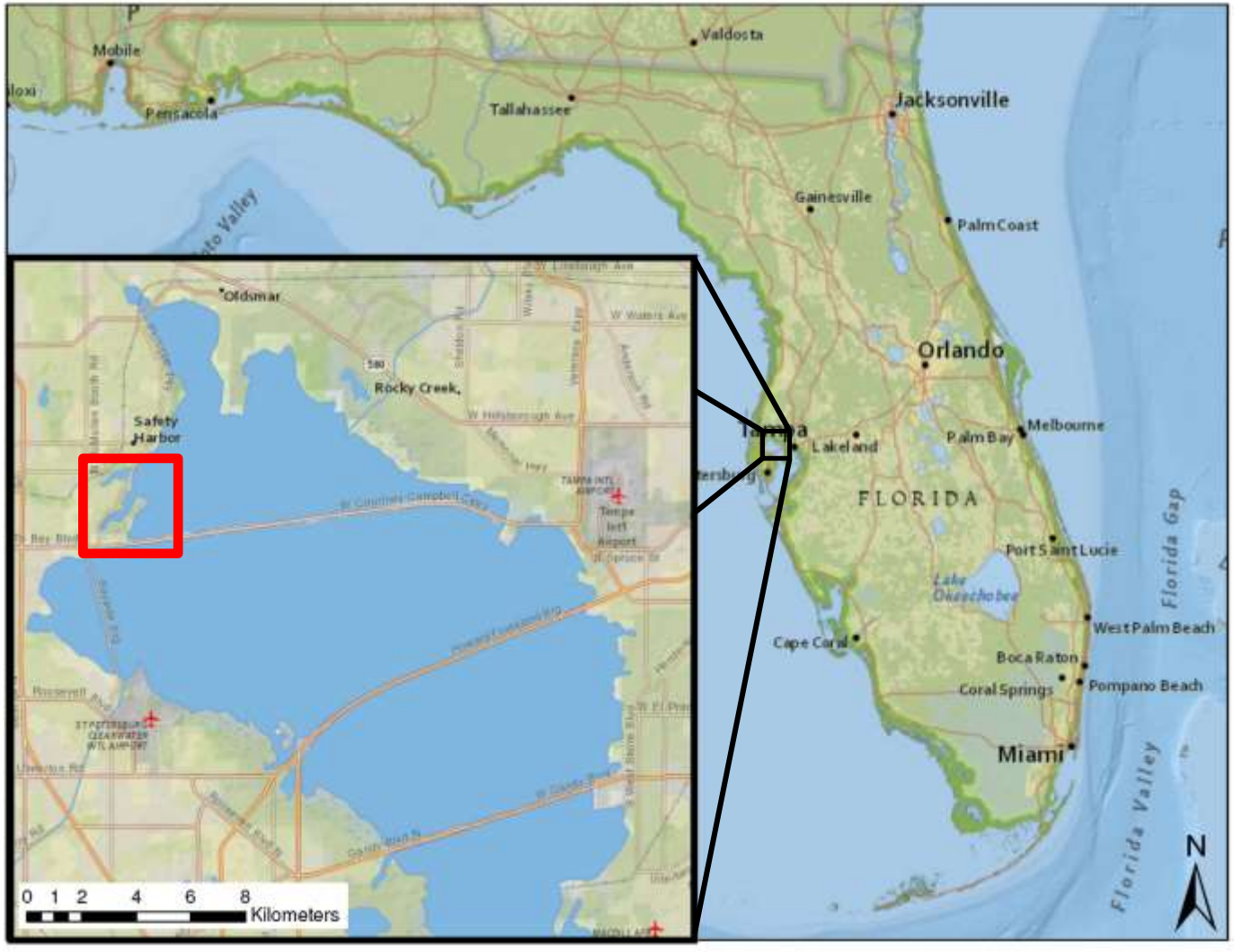
- Relief bridge effective in increasing exchange between area of interest and greater Tampa Bay
- Allows for freshwater runoff to be more readily dispersed, increasing salinity in the area
- Help return hydrodynamic conditions to pre-causeway historical conditions
- Gradually restore seagrass population to historical healthy condition

Conclusions

- Construction currently underway, completion Summer 2019

Further Work in Tampa Bay:

Cooper's Bayou

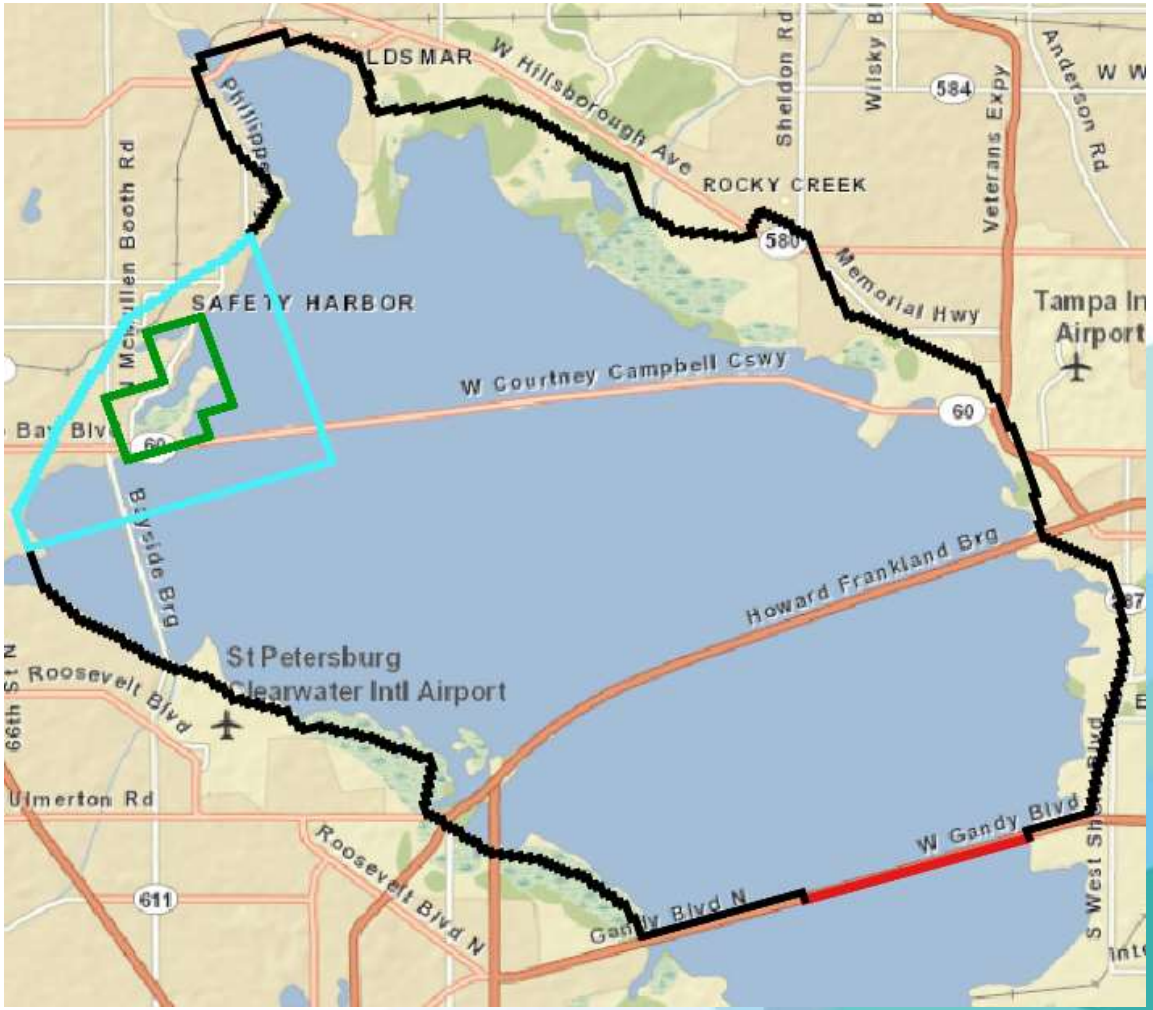


Overview

- Previous work inspired new investigations elsewhere
- Build upon 2017 study focused on stormwater runoff
- Increase circulation in historic seagrass areas in western OTB
- Use same methodology as before (generic tracers) to track water originating in Cooper’s Bayou and surrounding waters

Model Domain

- Based on work from a 2017 study
- Three grids (coarse, medium, fine) using Delft3D's domain decomposition



Model setup

- Grid encompassing Old Tampa Bay, with increasing spatial detail within Cooper’s Bayou
- Bathymetry from previous model
- Tidal boundary at Gandy Bridge
- Five model scenarios
- Residence time defined as the time to reach 10% of initial concentration of tracer (i.e. a 90% reduction)

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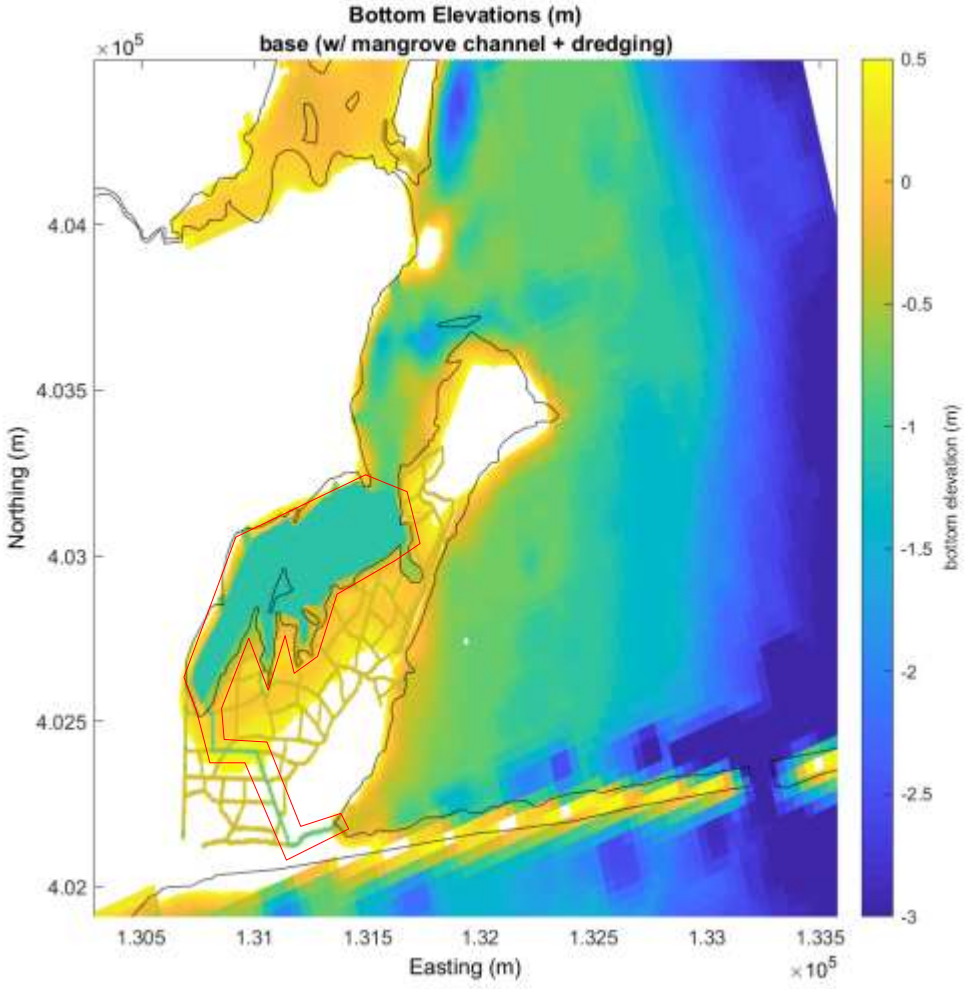
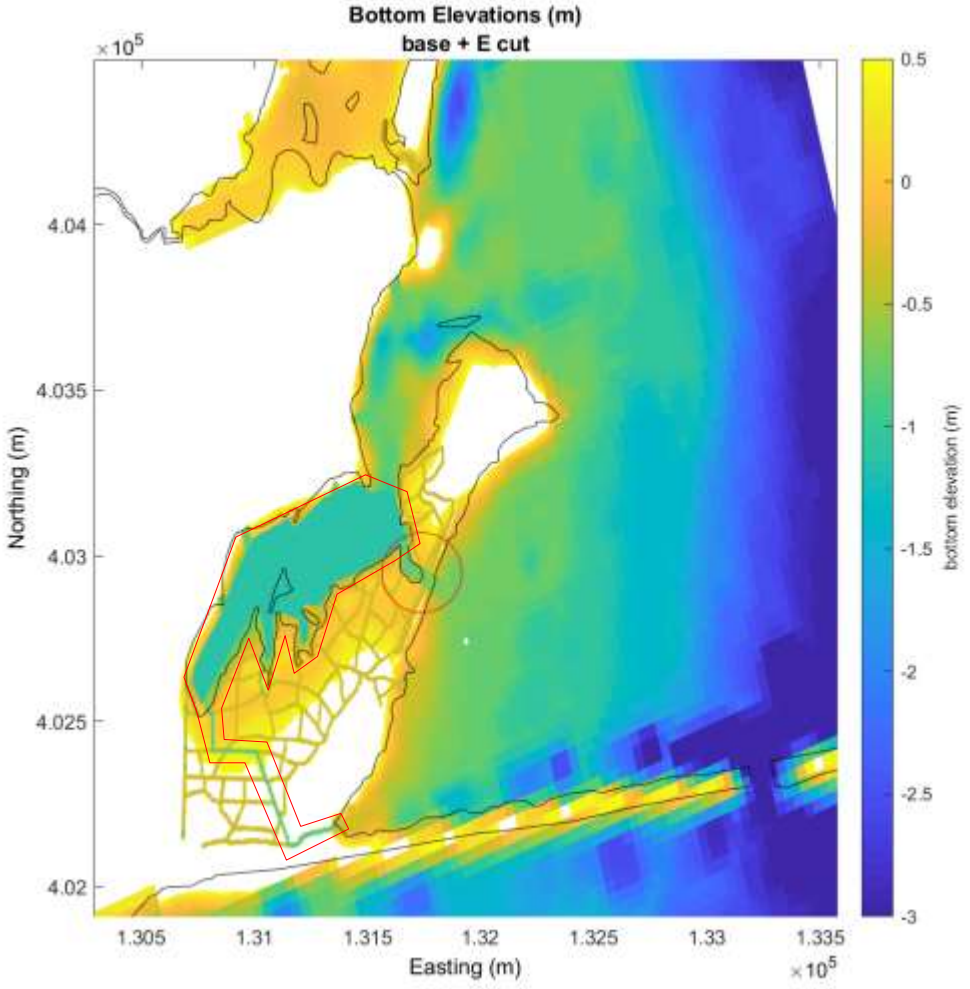
Model scenario 1: Base conditions

- Existing conditions, plus:
  - bayou dredging to 4 ft below MSL
  - Improved mangrove channel (option 2 in previous study)
  - channel enlargement at Damascus Rd. (current project)



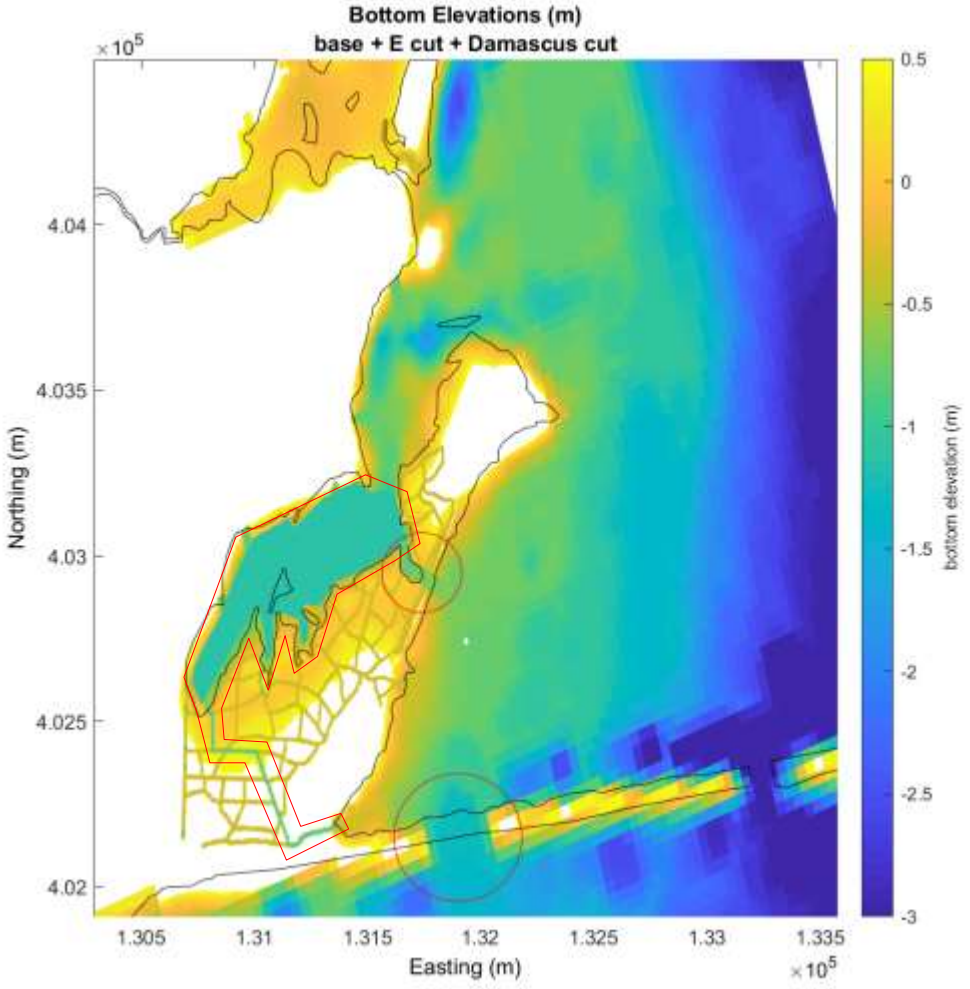
Model scenario 2: Eastern cut

- Base conditions, plus:
  - ~180 ft channel through the narrowest section of mangroves on the eastern side of the Bayou (circled in red)

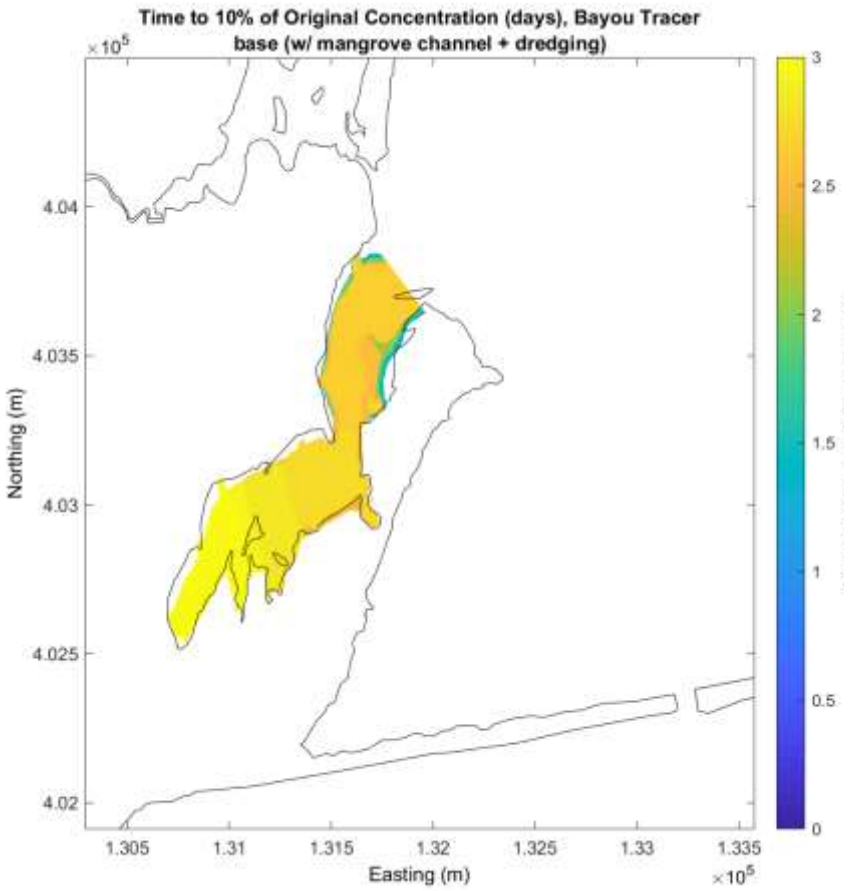


Model scenarios 3-5: Eastern cut + SR60 opening

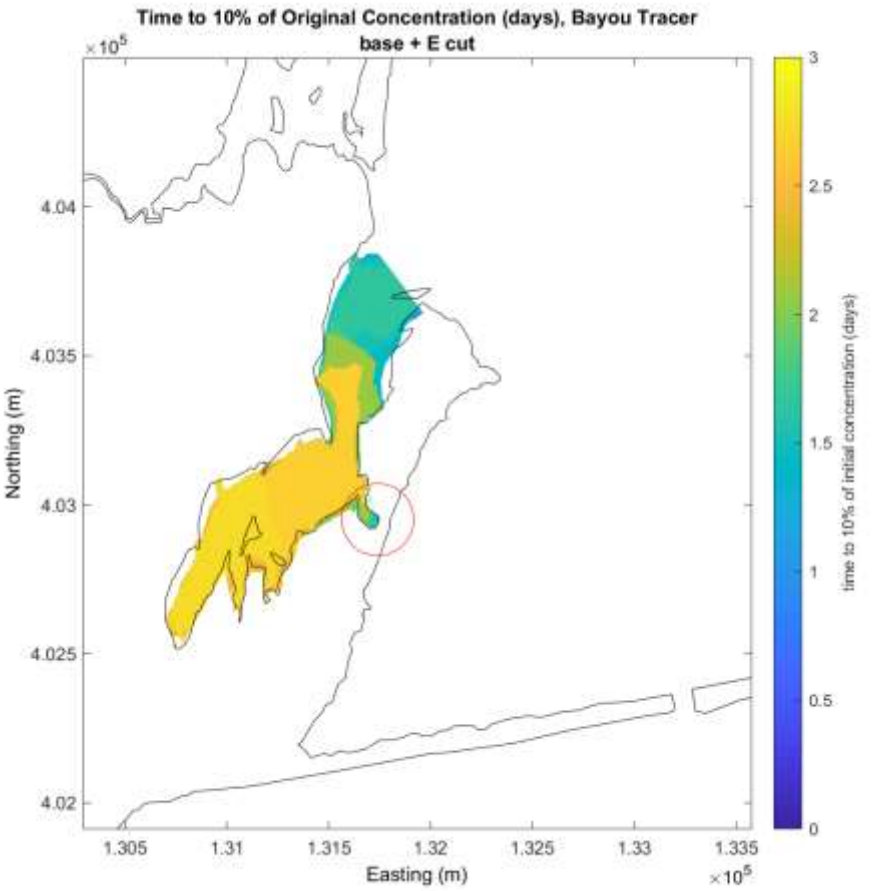
- Base conditions, plus:
  - ~180 ft channel through the narrowest section of mangroves on the eastern side of the Bayou (circled in red)
  - channel through SR60 east of Damascus Rd (circled in red) (800, 400, 200 ft widths tested



Residence time, Bayou tracer, Base vs. Scenario 2

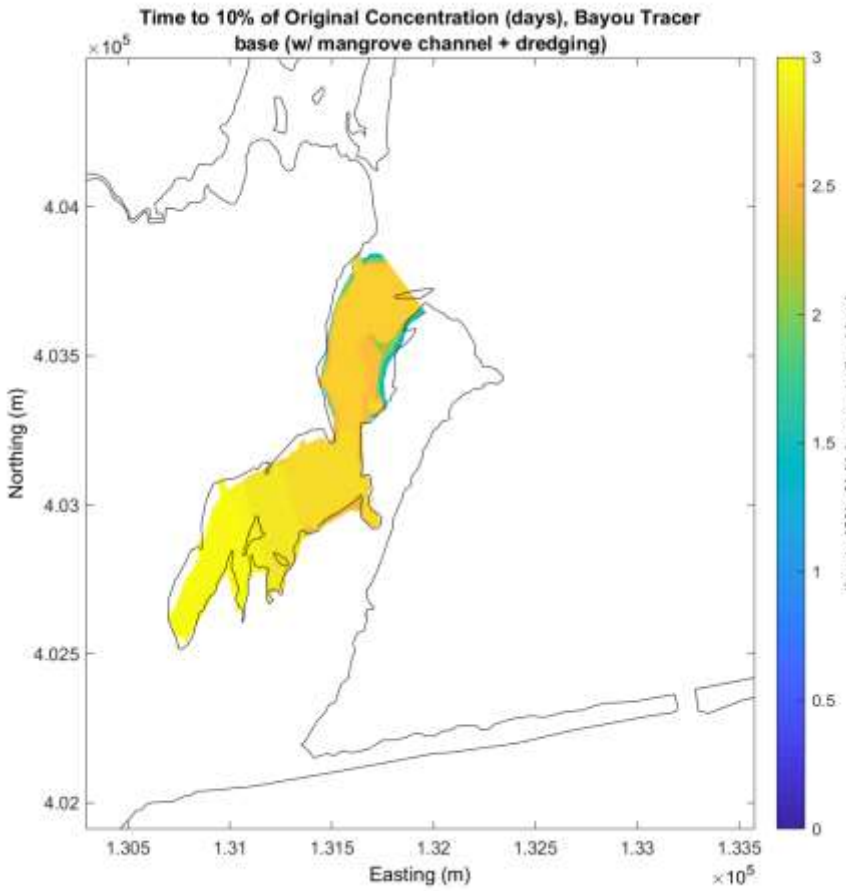


Scenario 1

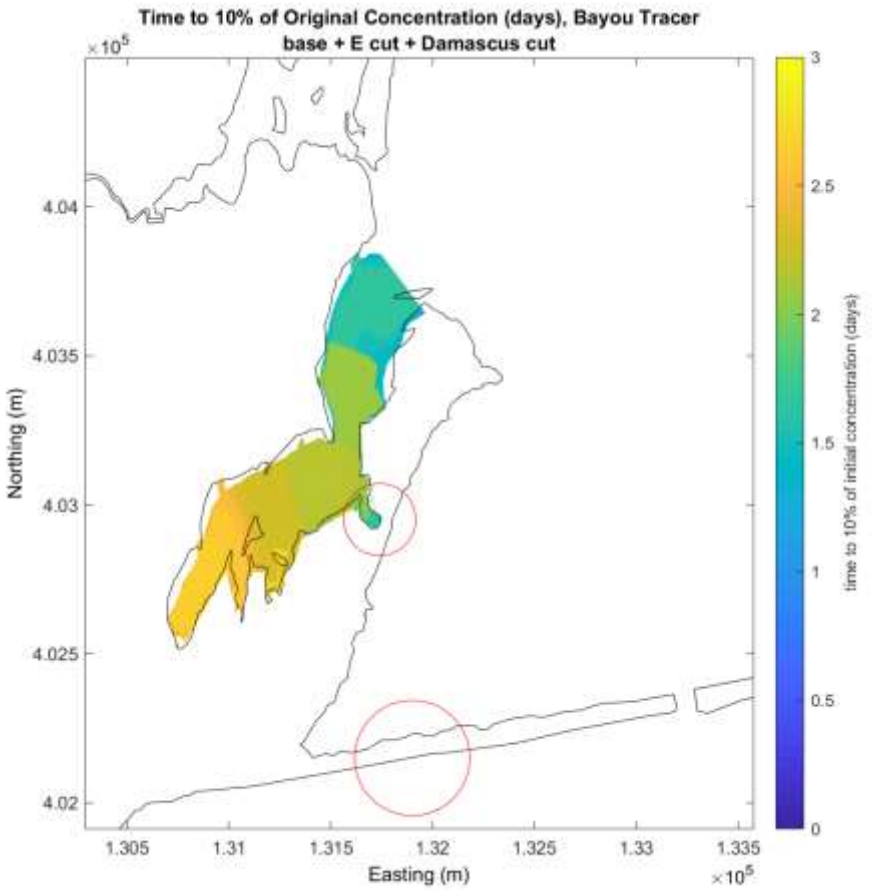


Scenario 2

Residence time, Bayou tracer, Base vs. Scenario 3

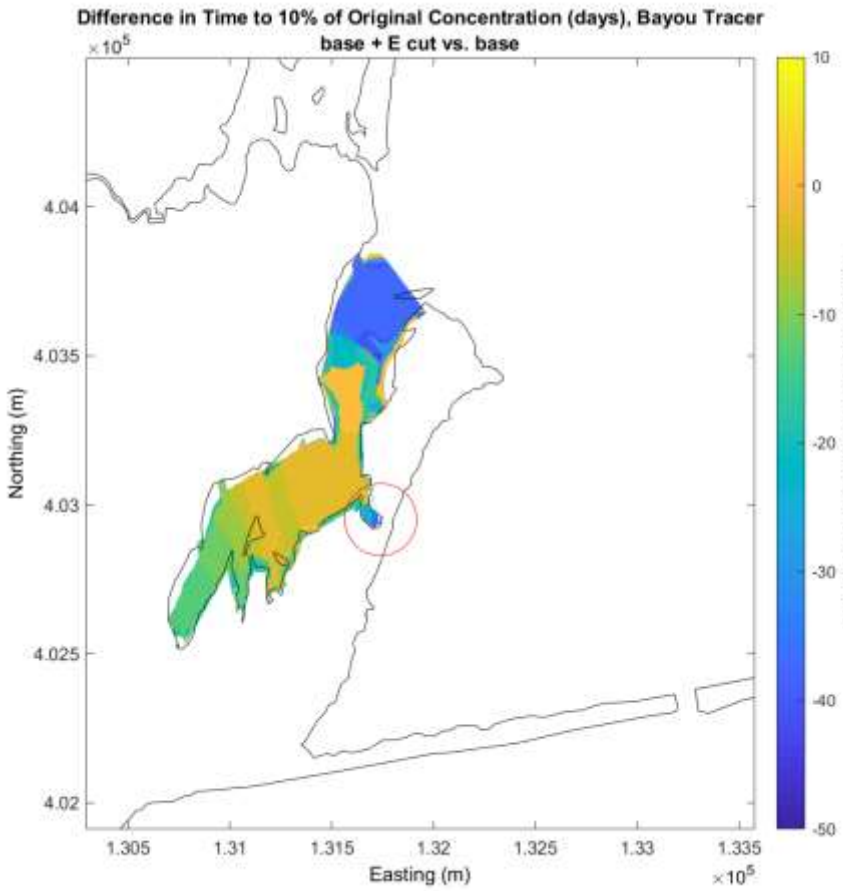


Scenario 1

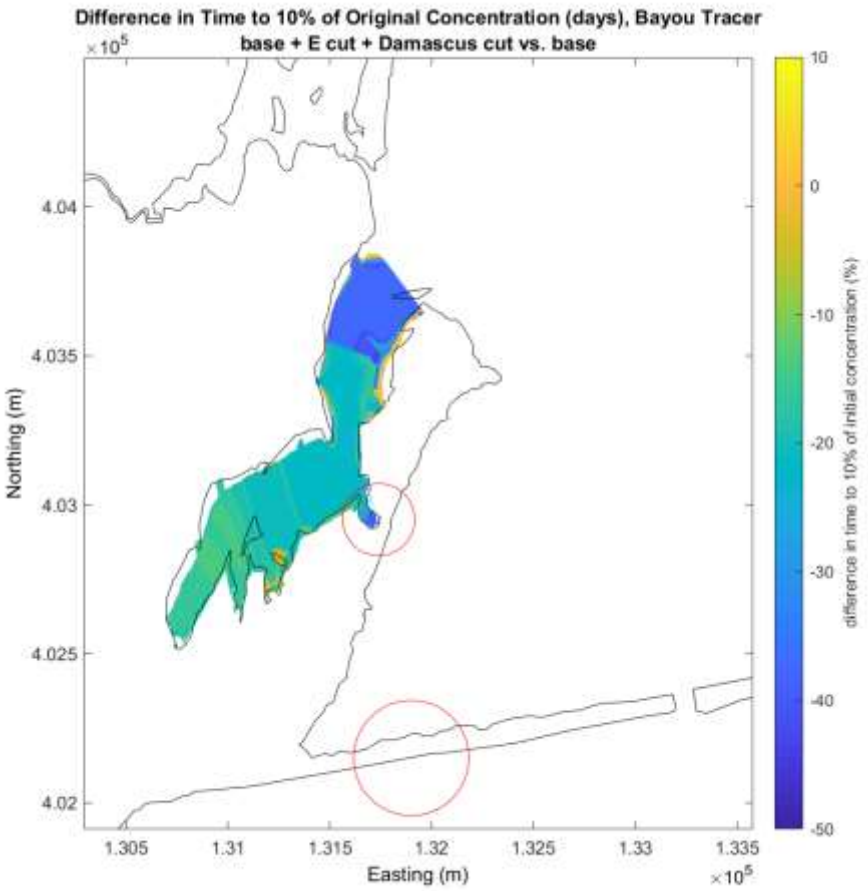


Scenario 3

Change in Residence time (%), Bayou tracer, vs. Base



Scenario 2



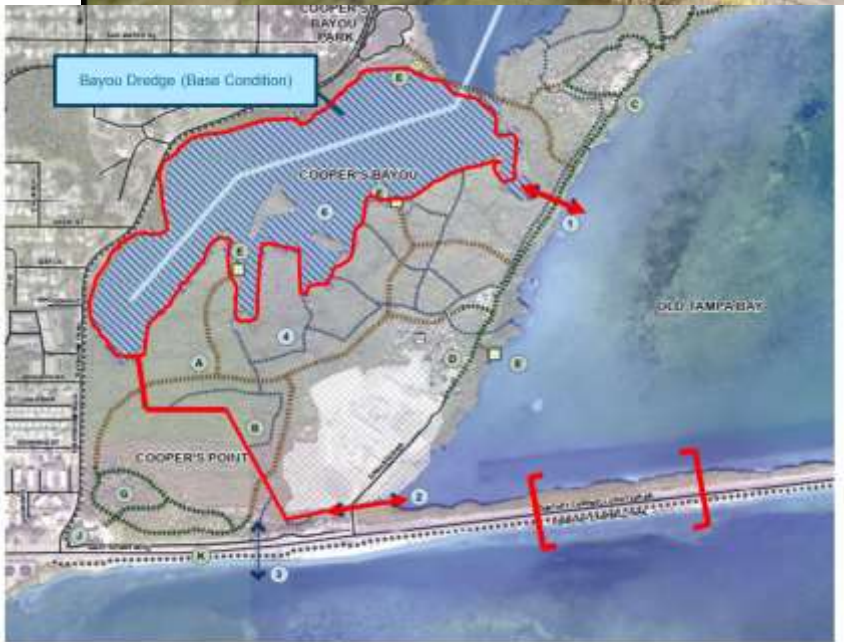
Scenario 3

Results

Location	Scenario	Residence time (days)	Change vs. Base (%)
south bayou	Base	3.17	-
	Eastern cut	2.75	-13
	Eastern cut + SR60 opening 800 ft	2.67	-16
	Eastern cut + SR60 opening 400 ft	2.75	-13
	Eastern cut + SR60 opening 200 ft	2.75	-13
middle bayou	Base	2.75	-
	Eastern cut	2.67	-3
	Eastern cut + SR60 opening 800 ft	2.17	-21
	Eastern cut + SR60 opening 400 ft	2.08	-24
	Eastern cut + SR60 opening 200 ft	2.67	-3
north bayou	Base	2.67	-
	Eastern cut	1.67	-37
	Eastern cut + SR60 opening 800 ft	1.67	-37
	Eastern cut + SR60 opening 400 ft	1.67	-37
	Eastern cut + SR60 opening 200 ft	1.67	-37

Summary

- Two of a number of projects in Tampa Bay seeking to enhance / restore historical flow pathways



Thank you!

Questions?