Engineer Research and Development Center

GenCade Applications

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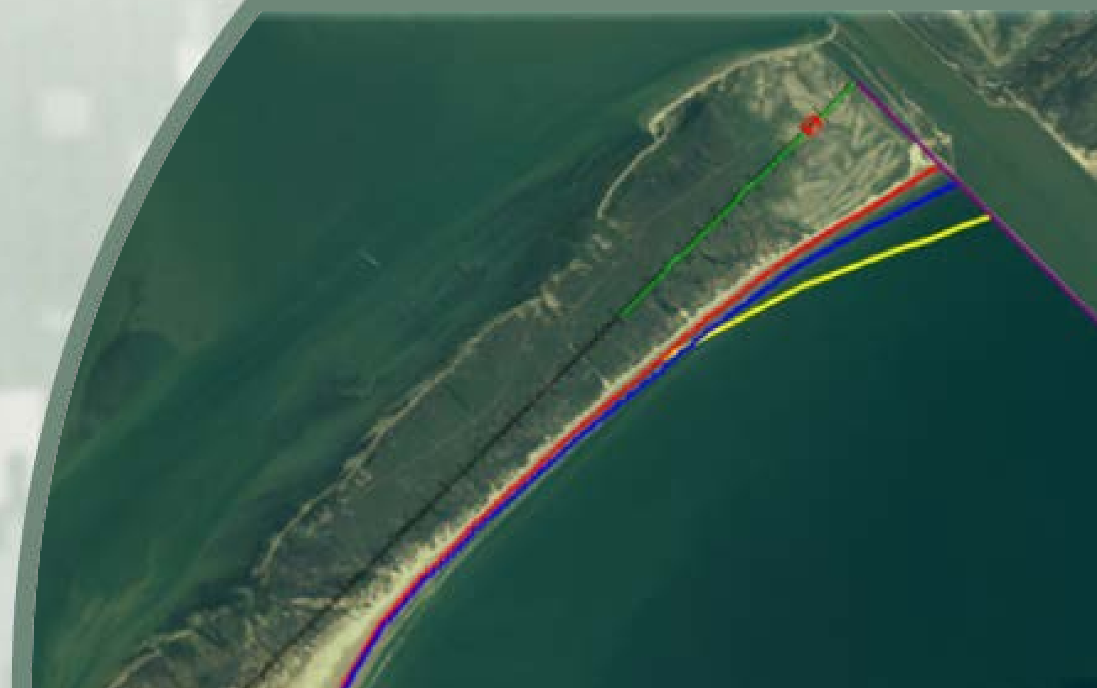


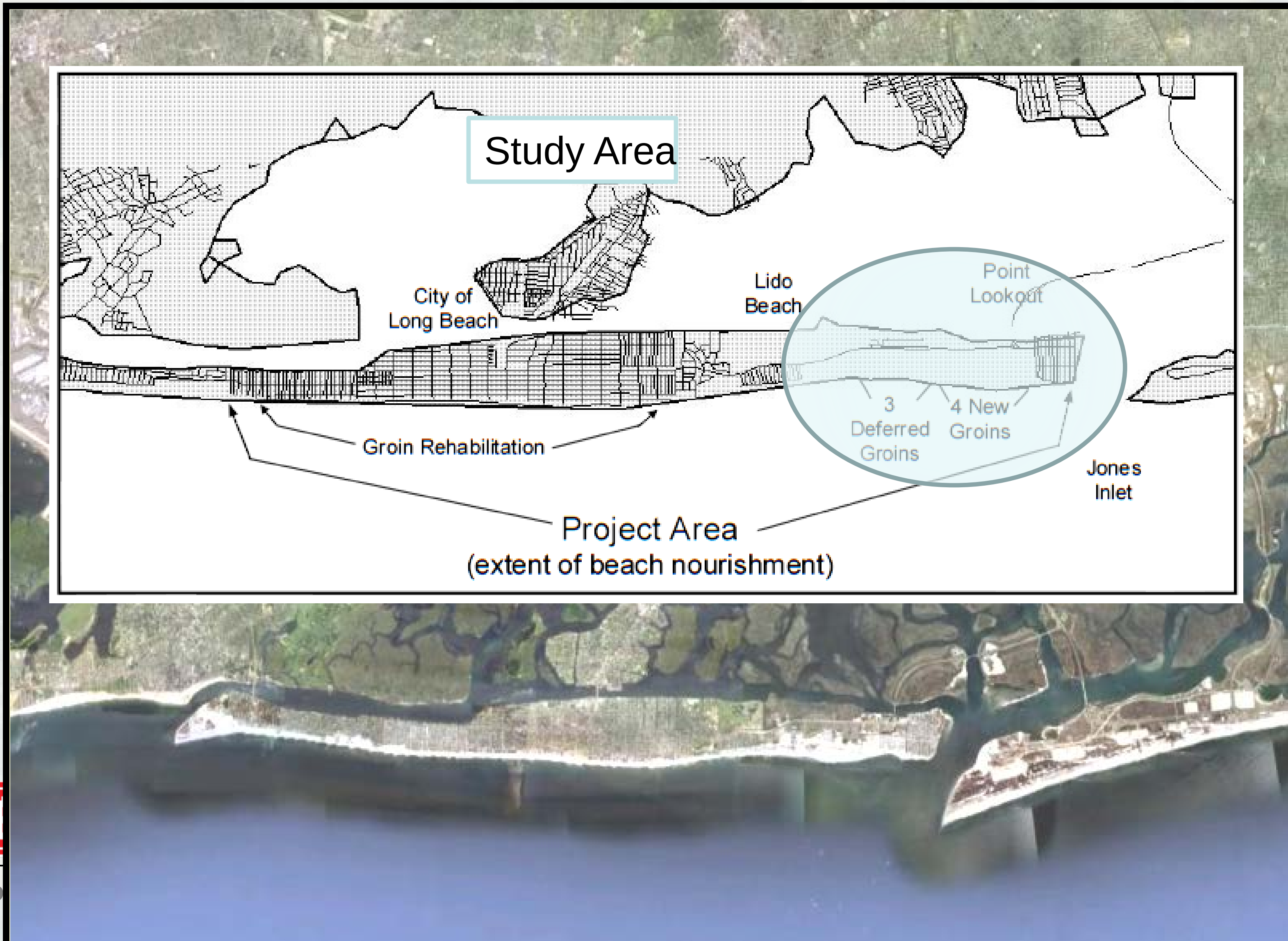
US Army Corps of Engineers®

Documentation

- Long Island, NY
- Onslow Bay, NC
- St. Johns County, FL
- Sargent Beach, TX
- Matagorda Peninsula, TX

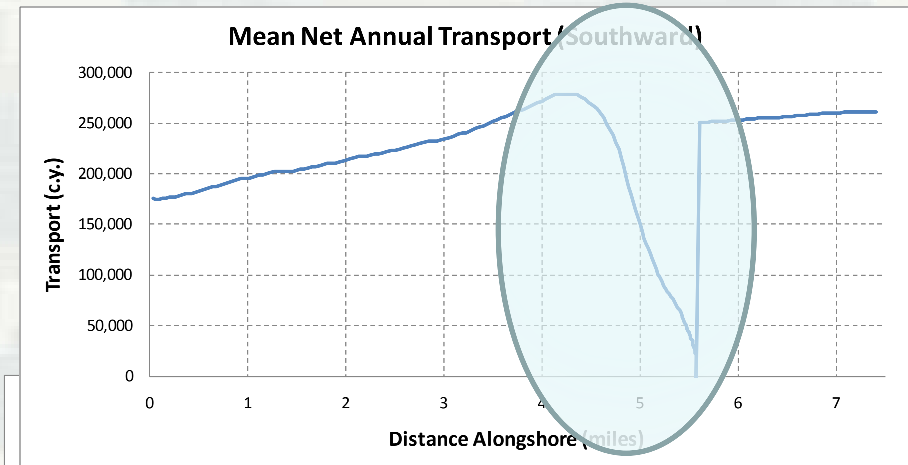
Beaufort Inlet, NC

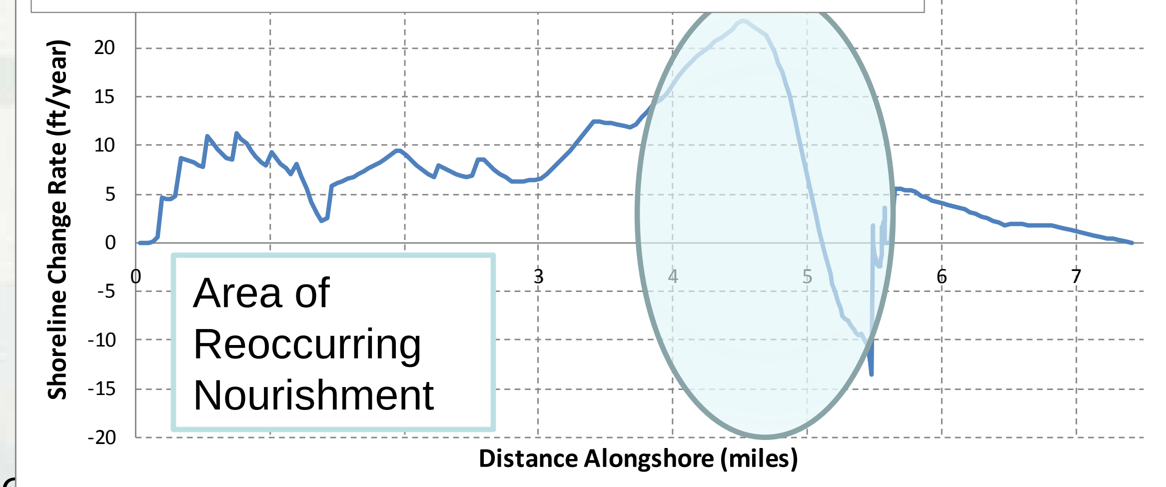
Point Lookout, NY – Study Area

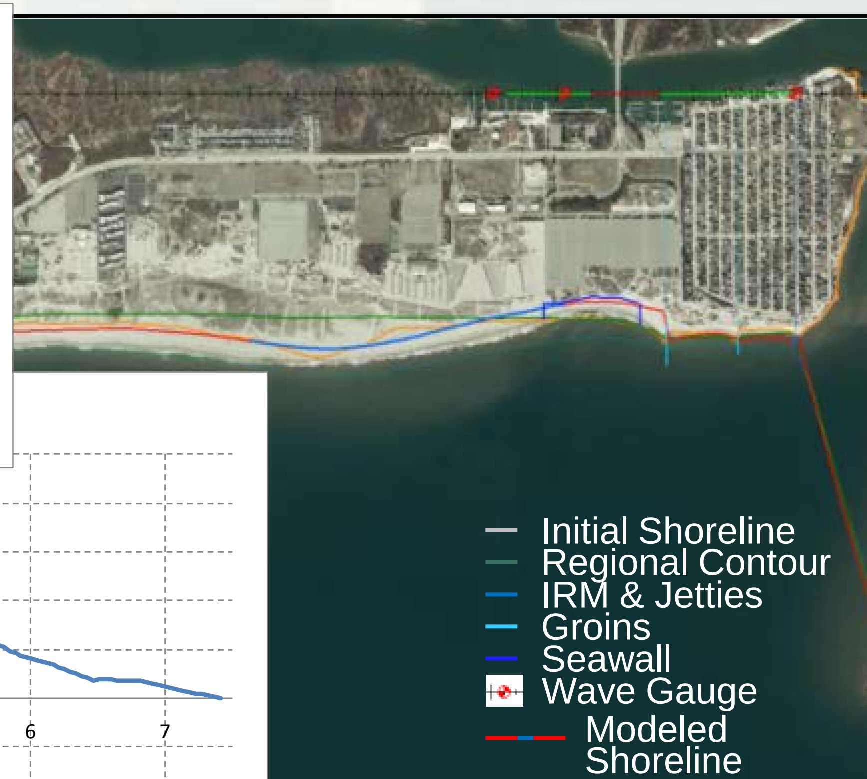


Point Lookout, NY – Model Setup

Modified Wave input to account for shoaling and sheltering







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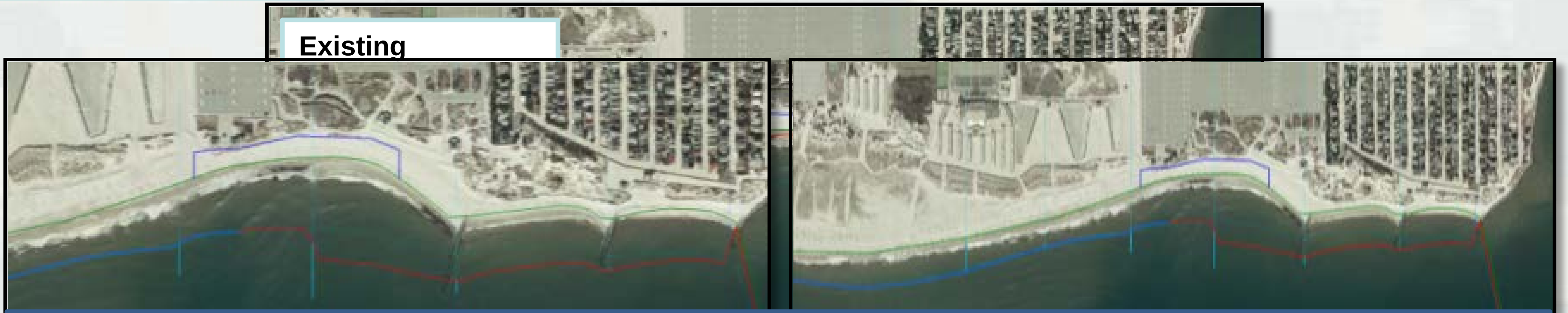
Point Lookout, NY - Results

Point Lookout, NY - Results

Modeling Results



Results of Alternatives

a) No action is not feasible for the SDR Project requirements

   I. Two additional groins had greatest effect on shoreline position, with little difference between the full length and shortened groins

   II. Four groins show greater shoreline accretion across Hempstead Beach, providing long-term stability for the erosion hotspot

   III. Terminal groin extension provides additional sand retention

   IV. Reoccurring nourishments are critical to project success

b) Long-term stability of shoreline at erosional hotspot can be mitigated with frequent nourishments. Structures spanning the erosional area were modeled and found to increase accretion at the shoreline, suggesting structures will best mitigate shoreline control.

c) GenCade was successful in evaluating long-term effects to the shoreline for the 50-year planning period

Ge

Onslow Bay, NC – Problem Statement

Use GenCade to

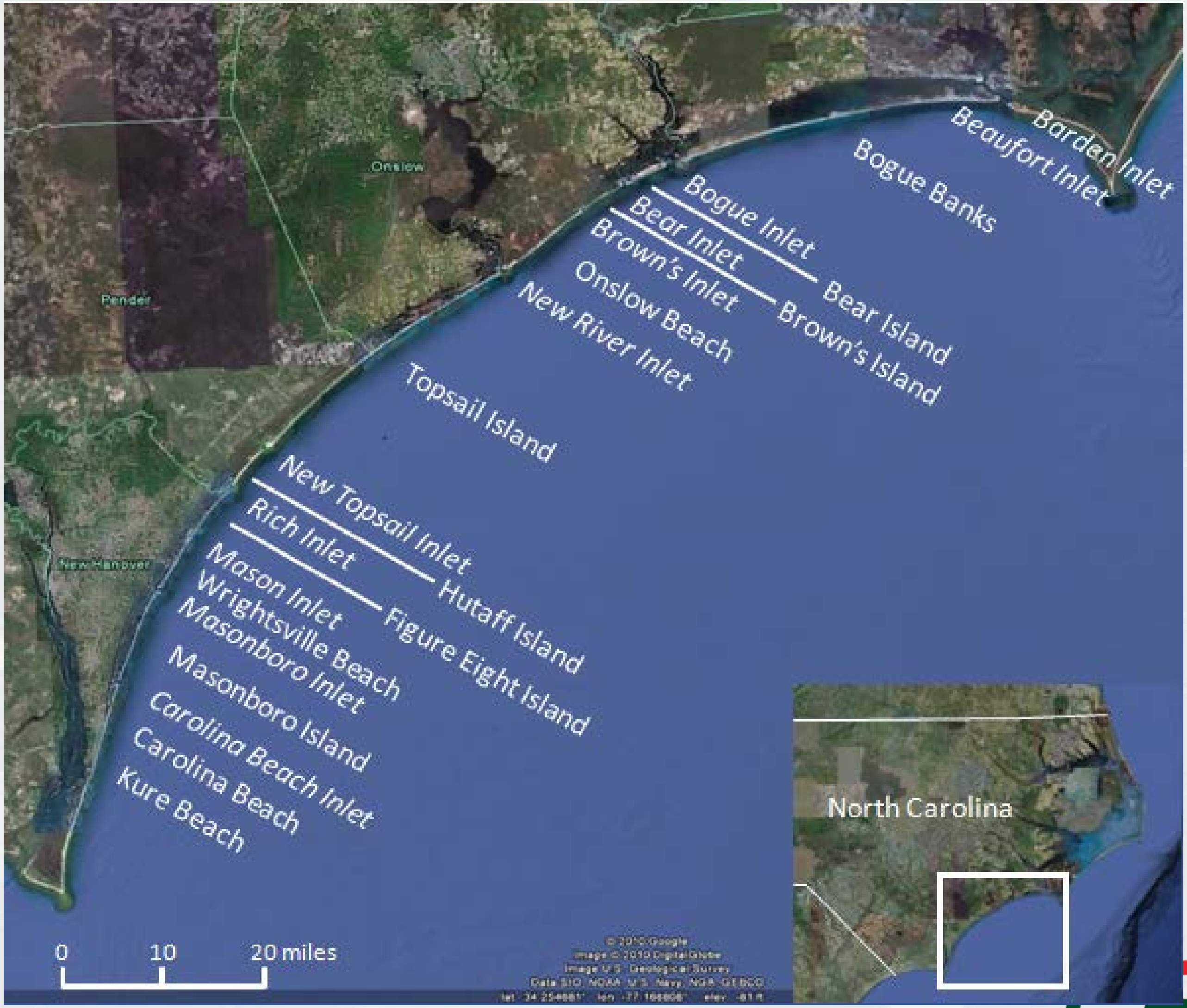
- Improve understanding of the regional sediment system
- Provide information for a sediment budget

Bogue Banks near Bogue Inlet

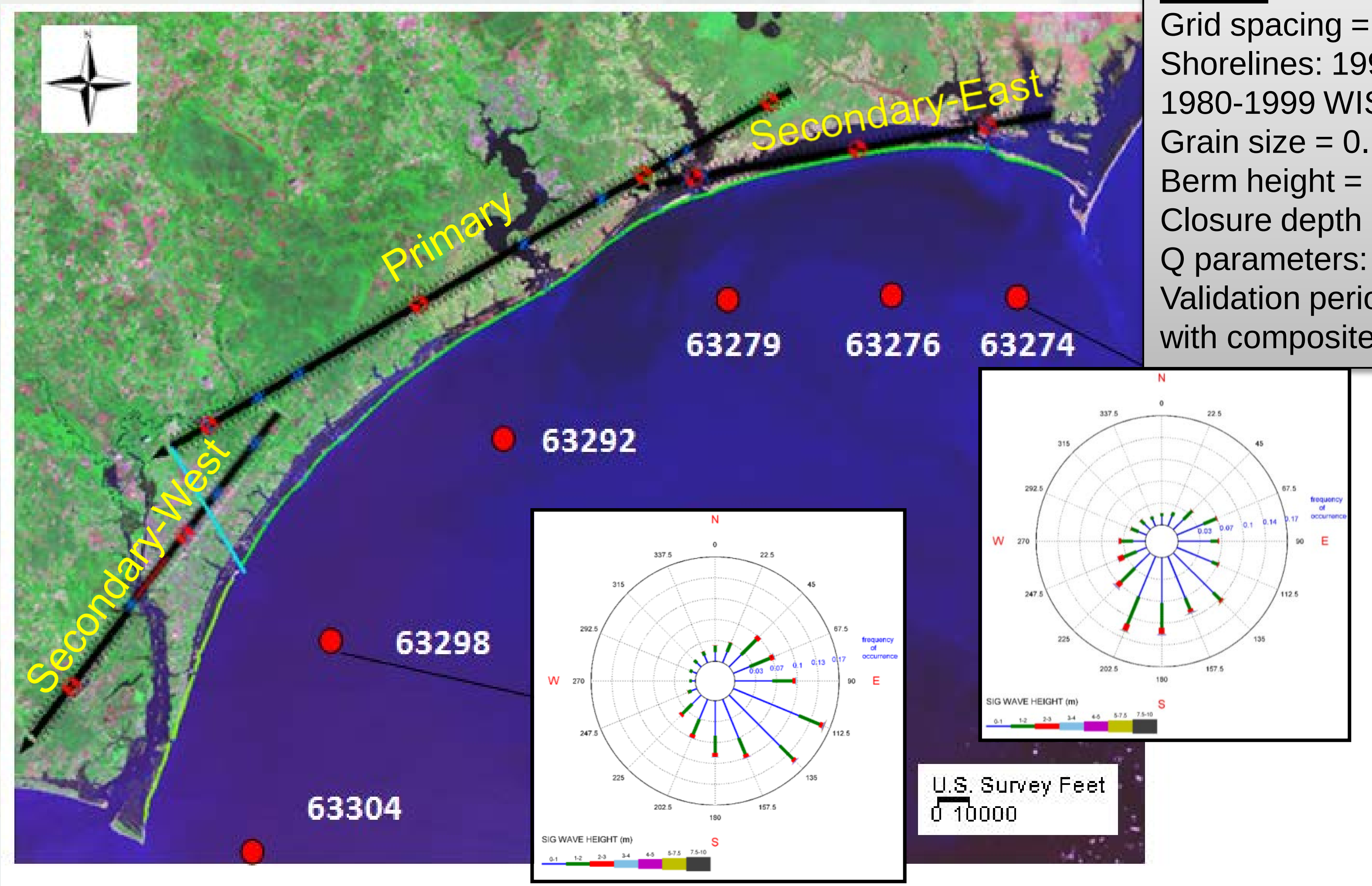
Fort Fisher Revetment

North weir jetty at Masonboro Inlet

Onslow Bay, NC - Overview

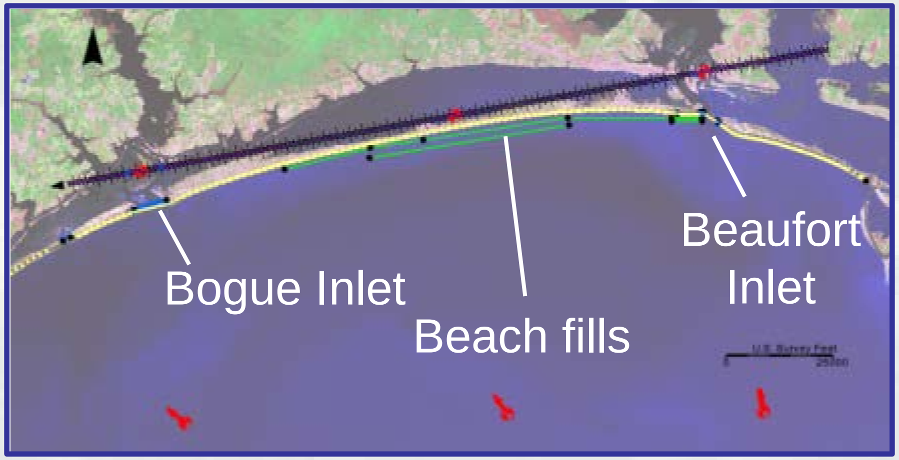


Onslow Bay - Procedure



Inputs:
Grid spacing = 300 ft
Shorelines: 1997 and 2004
1980-1999 WIS wave data
Grain size = 0.17mm
Berm height = 4.5 ft (MHW)
Closure depth = 26.5 ft (MHW)
Q parameters: K1=0.6; K2=0.4
Validation period: 1997-2004 with composite wave data.

Secondary - East Grid Setup



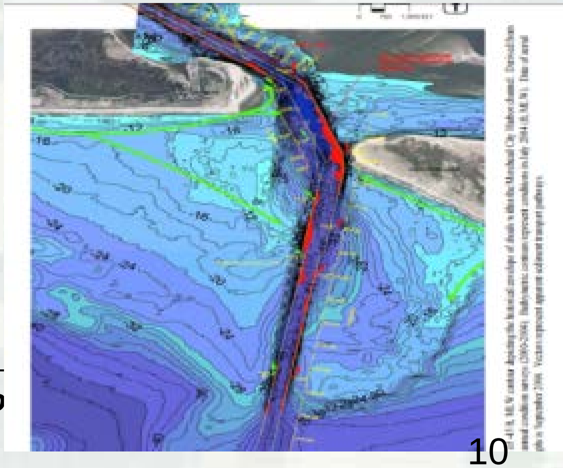
Beach Location	Date	Added Berm width (ft)
Fort Macon	2002	37.0
Pine Knoll Shores	2002	40.0
Indian Beach	2002	57.0
Emerald Isle (phase 2)	2003	51.0

Beaufort Inlet 1997 initial shoal volume estimated by subtracting yearly shoal volume change calculated by Olsen (2006) from the volume of the 2004 survey

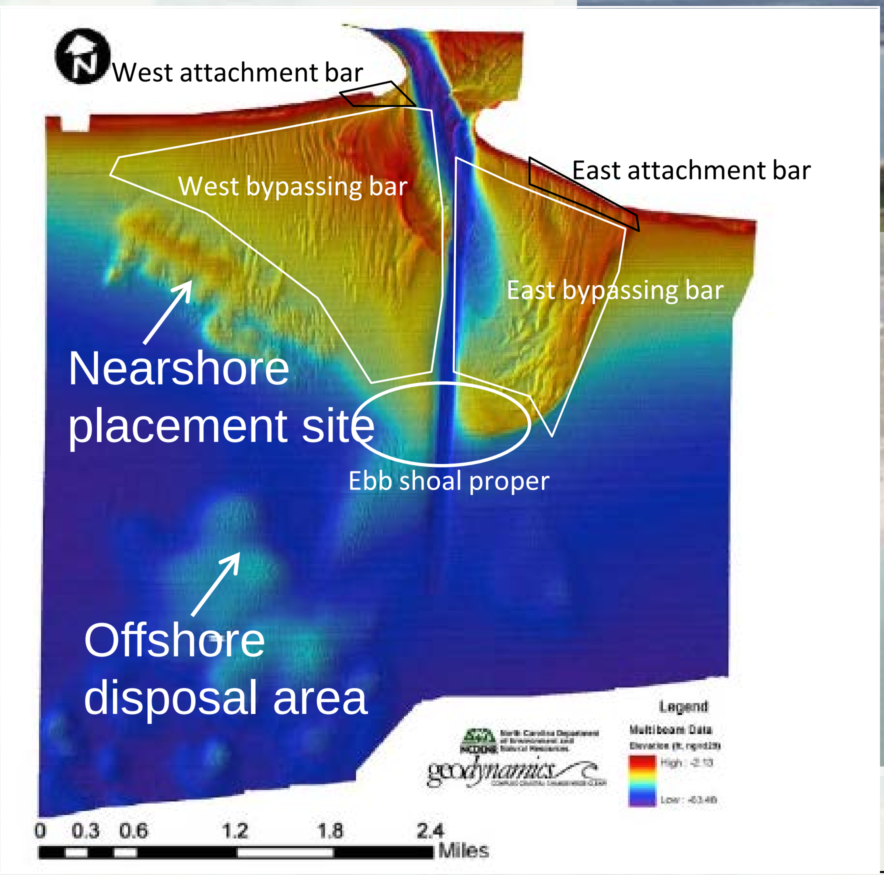
Used USACE published beach fill volumes

Used yearly maintenance dredging records and split volumes into East and West bypassing bars

	Outer channel dredging (cy)	From west byp. bar (70%, cy)	From east byp. bar (30%, cy)
1997	267,655	187,359	80,297
1998	2,240,267	1,568,187	672,080
1999	1,040,919	728,643	312,276
2000	1,701,659	1,191,161	510,498
2001	834,645	584,252	250,394
2002	861,074	602,752	258,322
2003	1,144,987	801,491	343,496
2004	813,119	569,183	243,936
Yearly average:	1,113,041	779,128	333,912



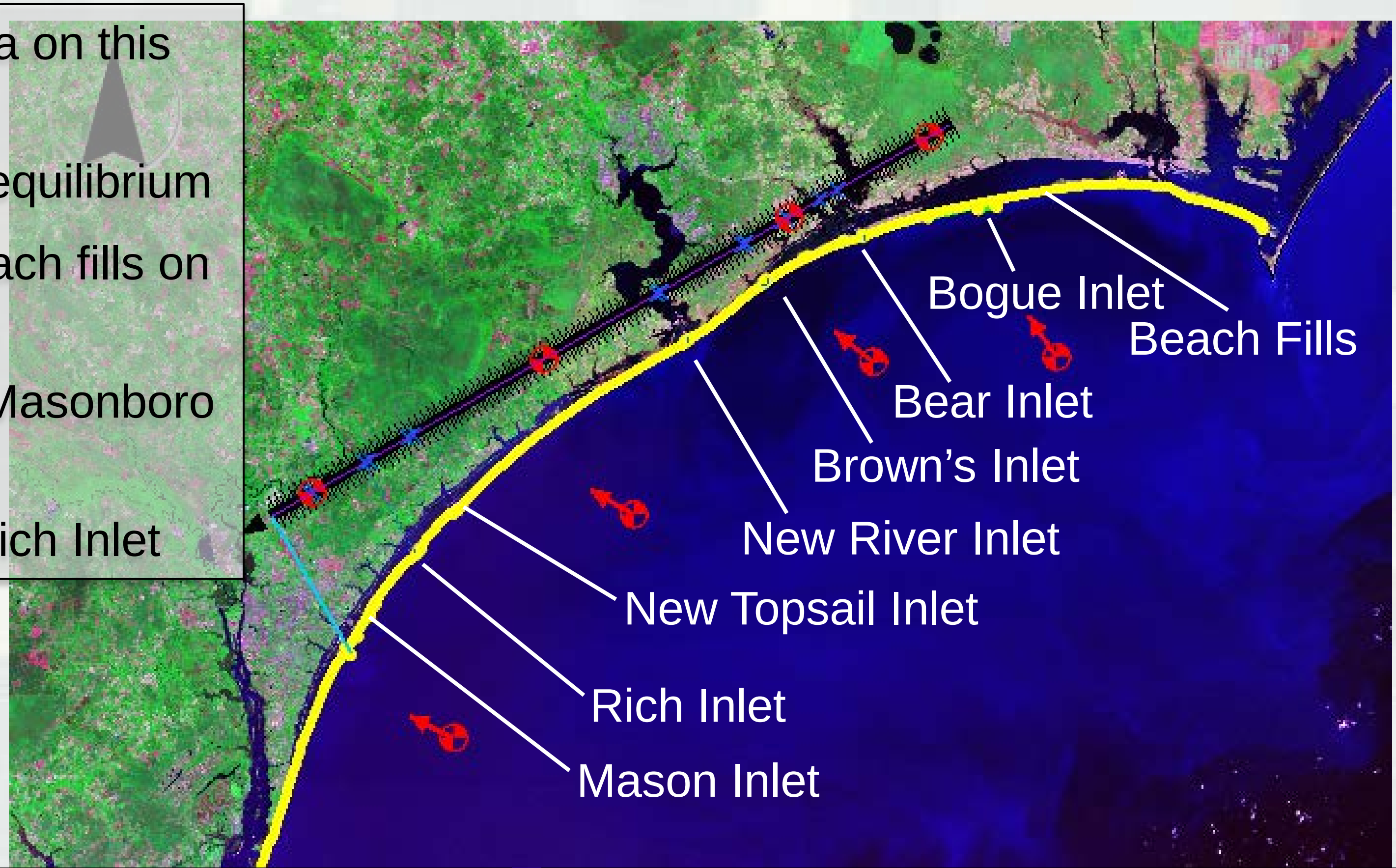
Representation of Beaufort Inlet in GenCade



- Estimated ebb shoal volume in 1900: 58.4 Mcy
- Estimated ebb shoal volume in 2004: 37.4 Mcy
- Channel depth in 1900 was 15 ft (MLW); dredged to 47 ft since 1994.
- Yearly average maintenance dredging 1 Mcy; all disposed offshore until 1997.

Primary Grid Setup

- Almost no data on this stretch of coast
- 7 Inlets all at equilibrium
- Includes 3 beach fills on Bogue Banks
- Gated BC at Masonboro north jetty
- Dredging of Rich Inlet



Beach Location	Date	Added Berm width (ft)
Pine Knoll Shores	2002	40.0
Indian Beach	2002	57.0
Emerald Isle (Phase 2)	2003	51.0

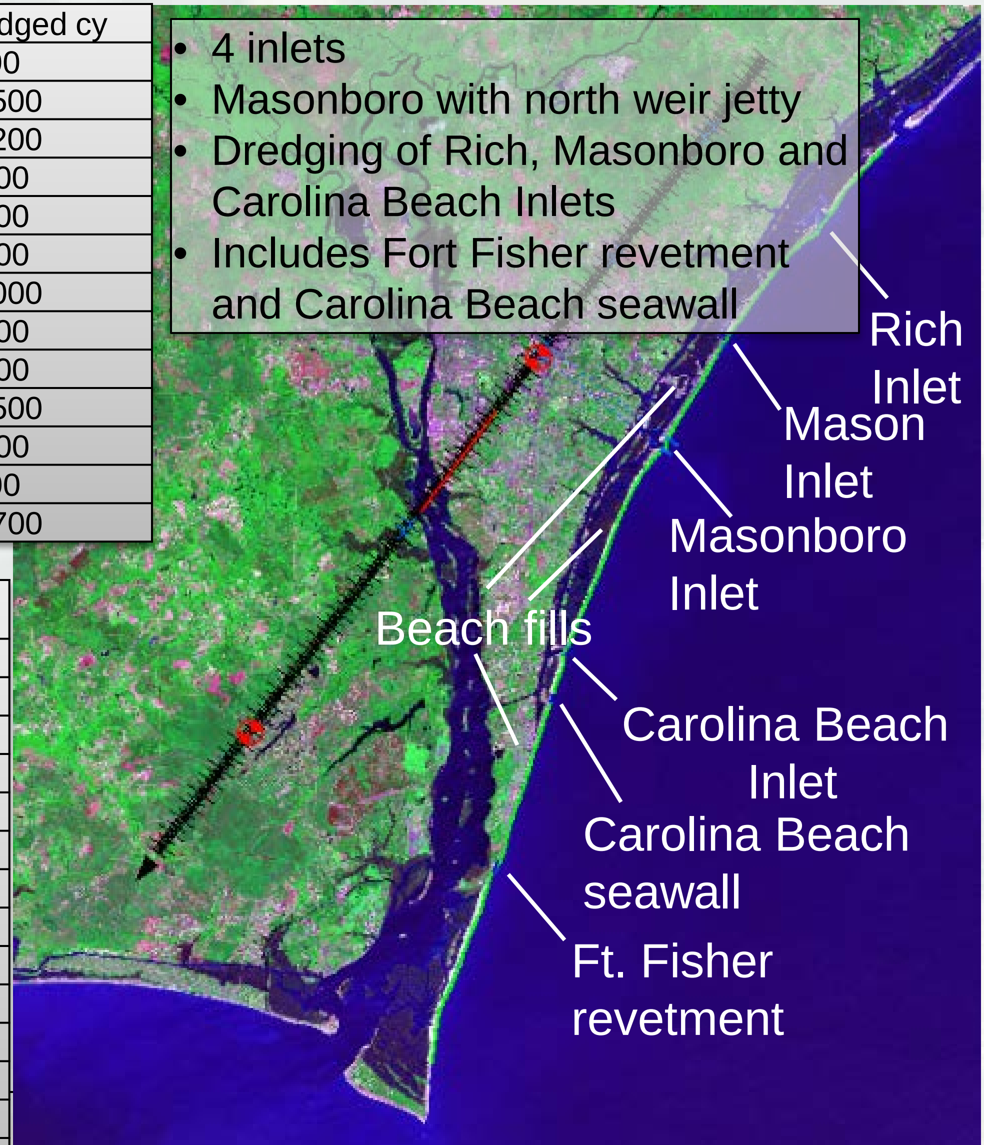
Inlet	Date	Volume Dredged, cy
Rich Inlet	1999	200,000
	2002	250,000
	2003	90,000

Secondary - West Grid Setup

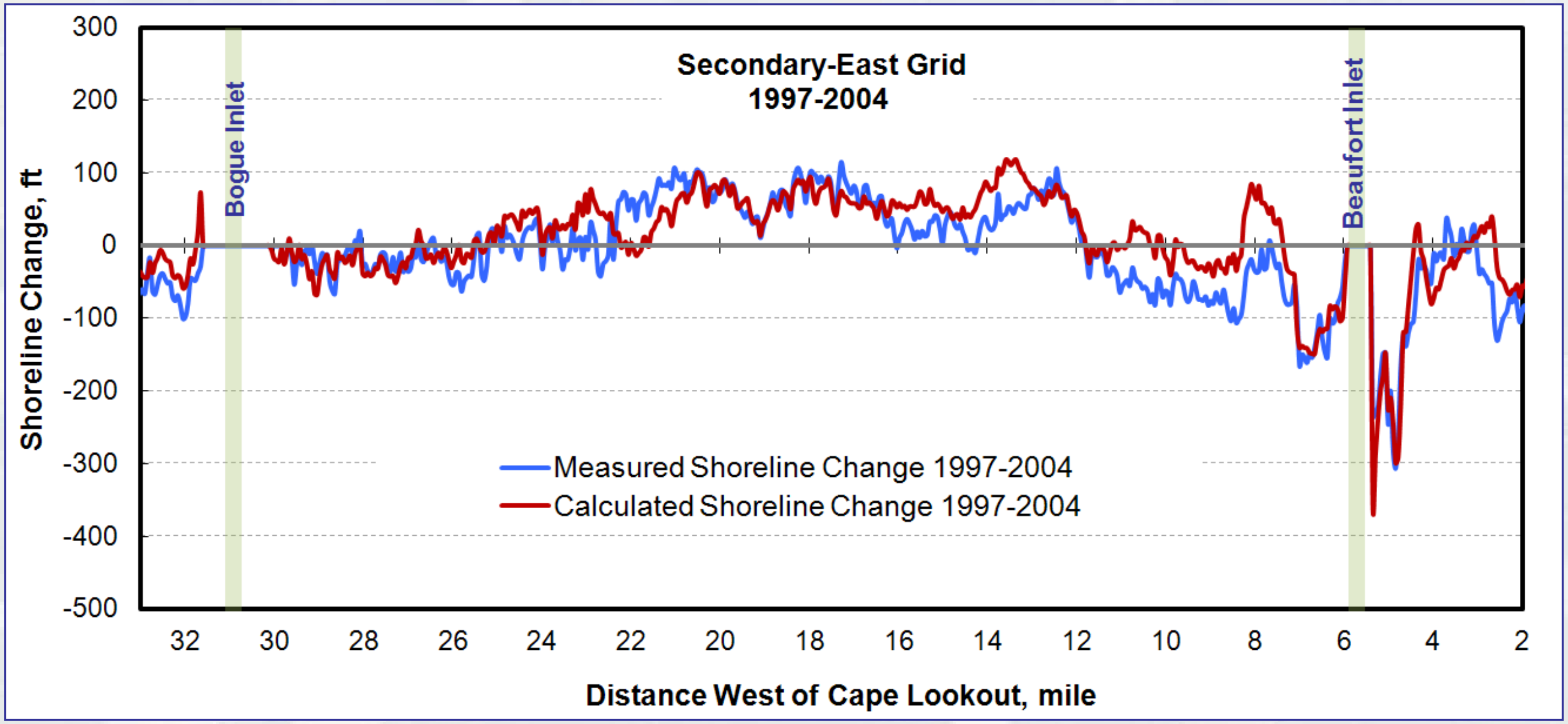
Inlet	Date	Volume dredged cy
Carolina Beach Inlet	1997	50,500
Carolina Beach Inlet	1998	1,525,500
Masonboro Inlet	1998	1,672,200
Carolina Beach Inlet	1999	188,000
Rich Inlet	1999	200,000
Carolina Beach Inlet	2000	188,000
Carolina Beach Inlet	2001	1,188,000
Carolina Beach Inlet	2002	188,000
Rich Inlet	2002	250,000
Masonboro Inlet	2002	1,302,500
Carolina Beach Inlet	2003	188,000
Rich Inlet	2003	90,000
Carolina Beach Inlet	2004	1,392,700

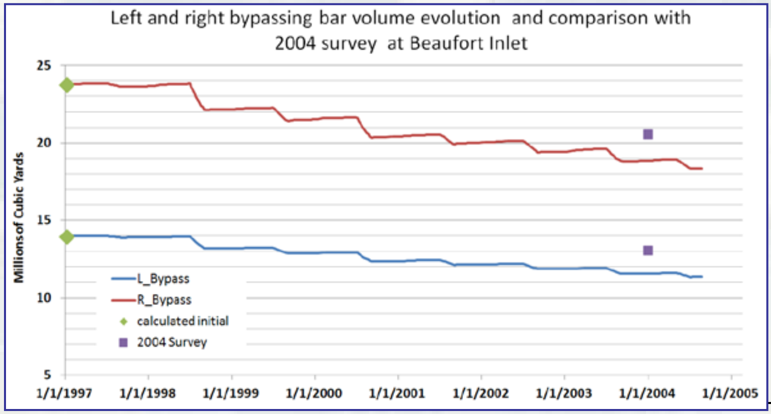
Location	Date	Added Berm Width (ft)
Kure Beach	1997	159.68
Kure Beach	1998	58.06
Wrightsville Beach	1998	95.34
Masonboro Island	1998	40.33
Carolina Beach	1998	94.52
Figure Eight Island	1999	38.71
Figure Eight Island	1999	38.71
Carolina Beach	2001	78.47
Figure Eight Island	2002	48.44
Figure Eight Island	2002	48.44
Wrightsville Beach	2002	67.97
Figure Eight Island	2003	17.42
Kure Beach	2004	9.19
Carolina Beach	2004	53.36

- 4 inlets
- Masonboro with north weir jetty
- Dredging of Rich, Masonboro and Carolina Beach Inlets
- Includes Fort Fisher revetment and Carolina Beach seawall



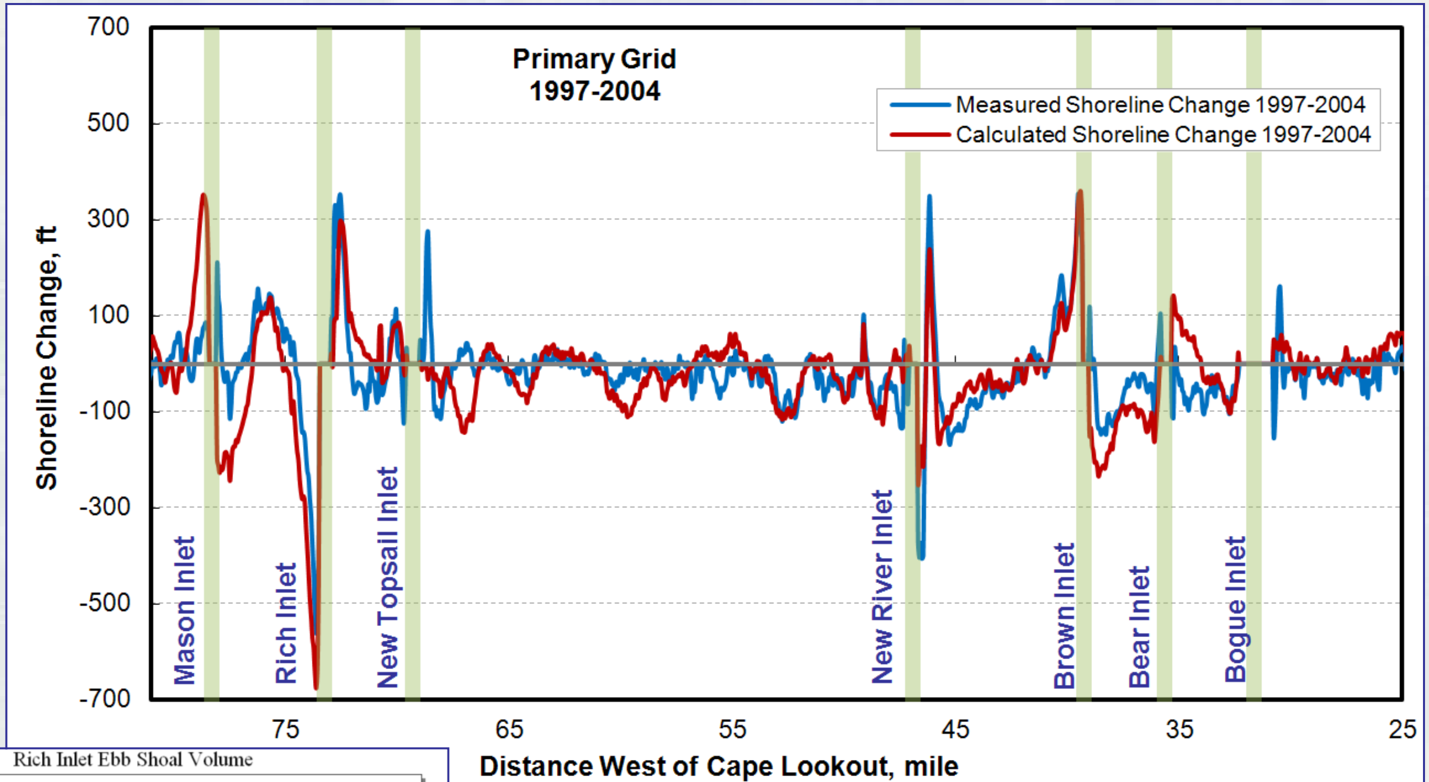
Results: Secondary-East Grid

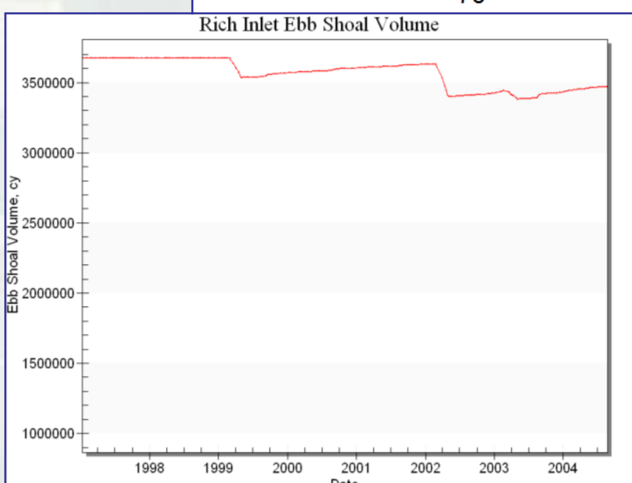




	Skill Score	Secondary-East Grid
Final Shoreline		
	BSS	0.63
	RMSE (ft)	16.5
	Bias (ft)	40.5
Shoreline Change	R^2	0.83

Results: Primary Grid





	Skill Score	Primary grid
Final Shoreline		
	BSS	0.37
	RMSE (ft)	-6.64
	Bias (ft)	55.6
Shoreline Change	R^2	0.70

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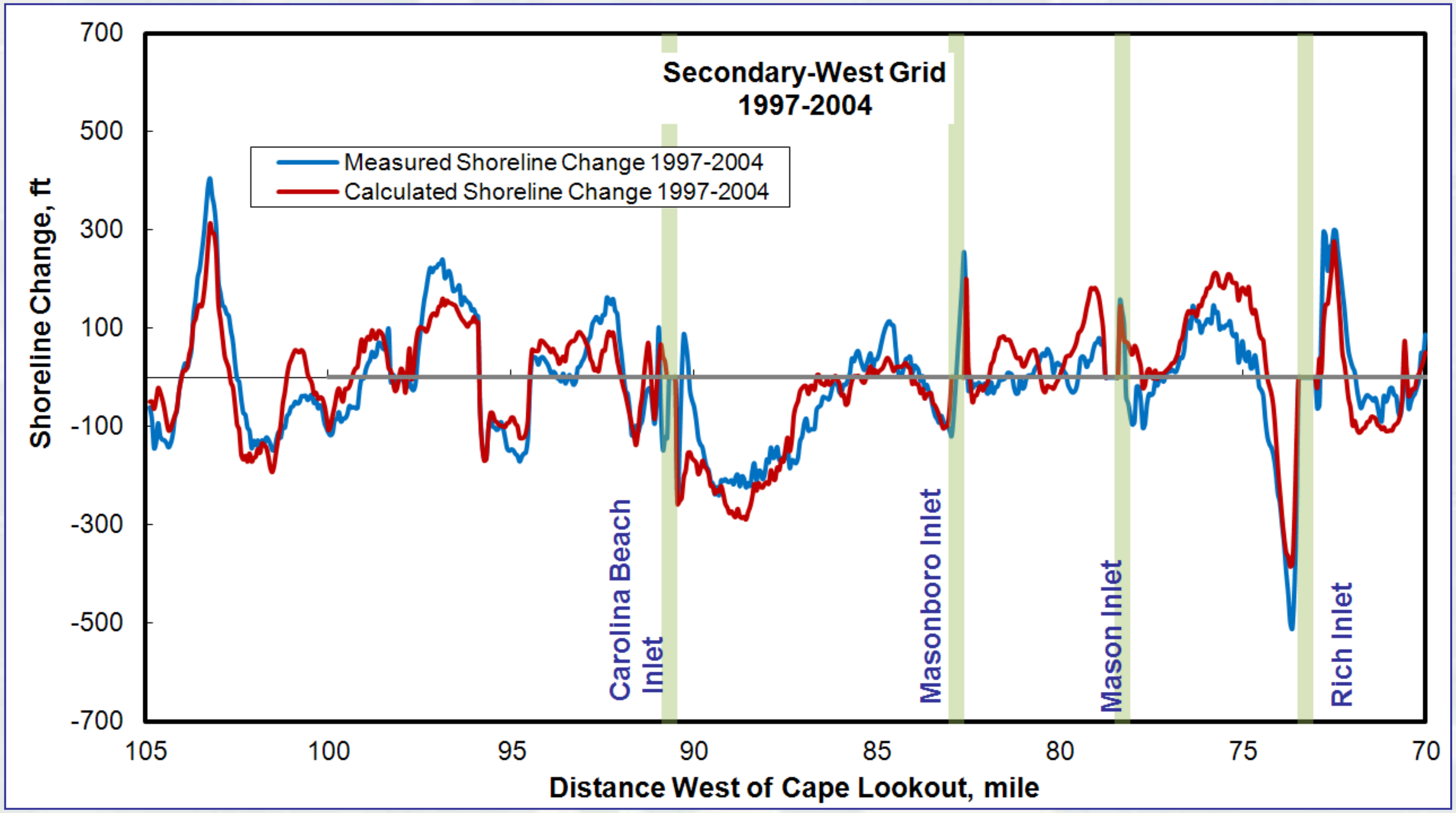
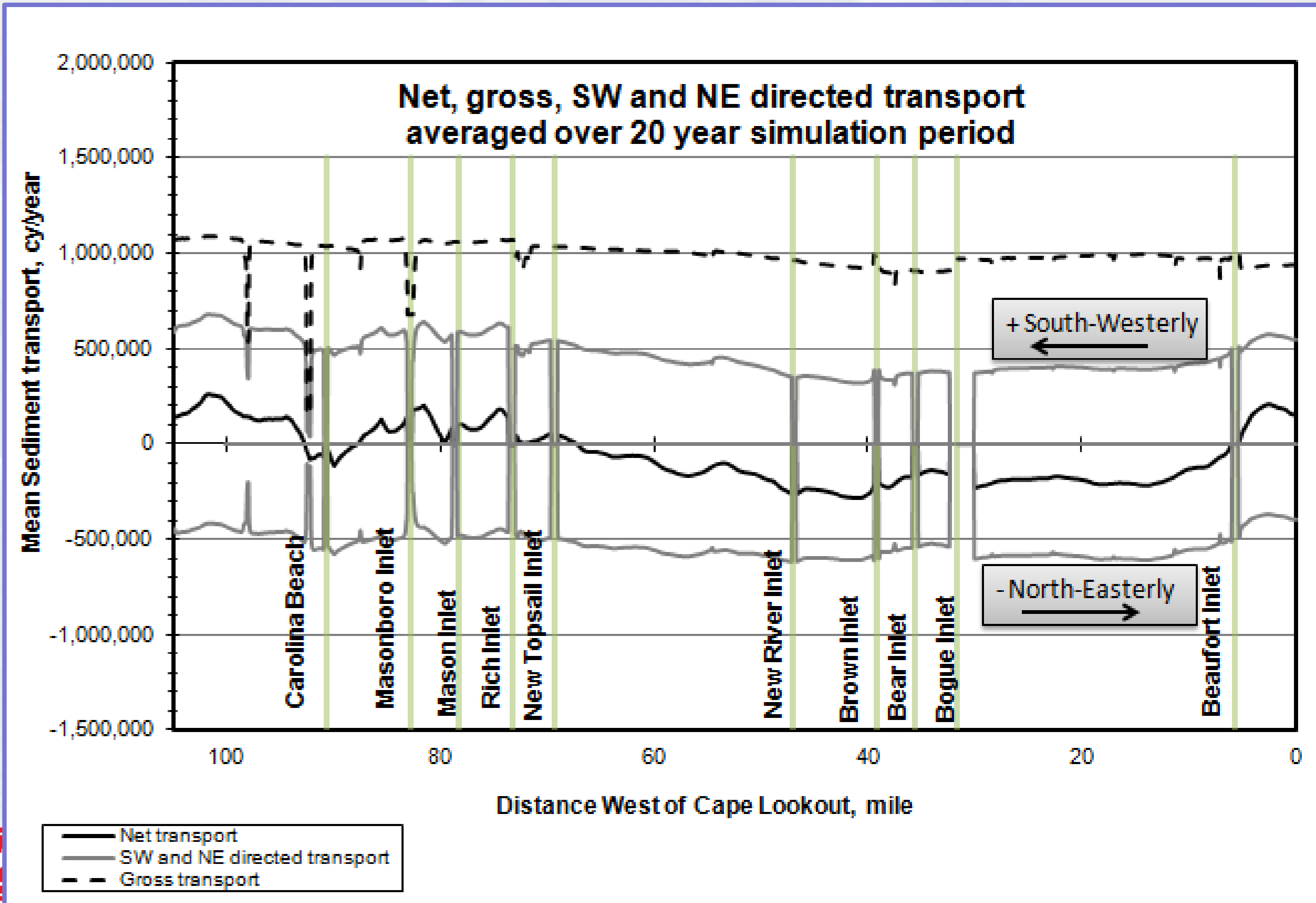
Results: Secondary-West Grid



	Skill Score	Secondary-West Grid
Final Shoreline		
	BSS	0.71
	RMSE (ft)	6.6
	Bias (ft)	67.0
Shoreline Change	R^2	0.84

Mean Transport, 1980-1999



Onslow Bay, NC - Summary

- Goodness of fit of the calculated shoreline (1997-2004) ranges from 0.37 to 0.71 (Brier Skills Score) with correlation coefficients (R^2) ranging from 0.70 to 0.84.
- Results from the 20 year simulation indicate a gross mean sand transport on the order of 1,000,000 cy/yr consistently across all of Onslow Bay. The net transport is generally small, less than 200,000 cy/yr, and directed to the northeast from New River Inlet to Beaufort Inlet and to the southwest for the southern half of the bay.
- Results indicate Beaufort Inlet is a convergent nodal point, meaning the <u>net</u> sand transport is into the inlet shoals (or into the bay) on both sides of the inlet. Hence, dredging of the shoal should have minimal <u>net</u> impact to adjacent beach.

St. Johns County, FL – Problem Statement

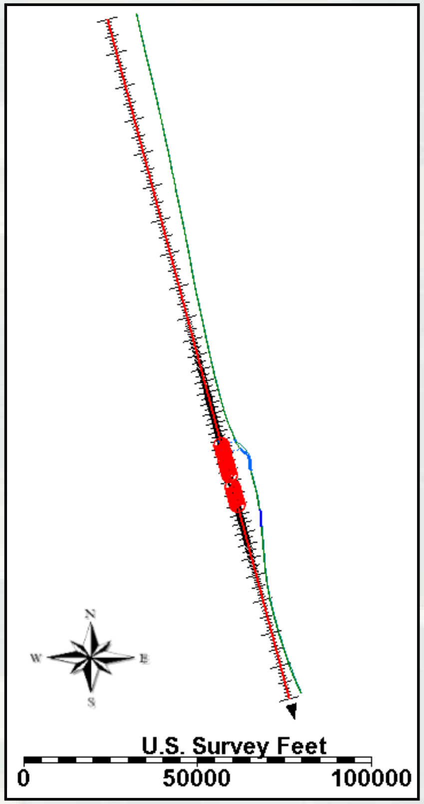
What is the optimal dredging volume and interval, and beach placement volume and interval that will supply adequate sand to maintain two Shore Protection Projects in St. Johns County?

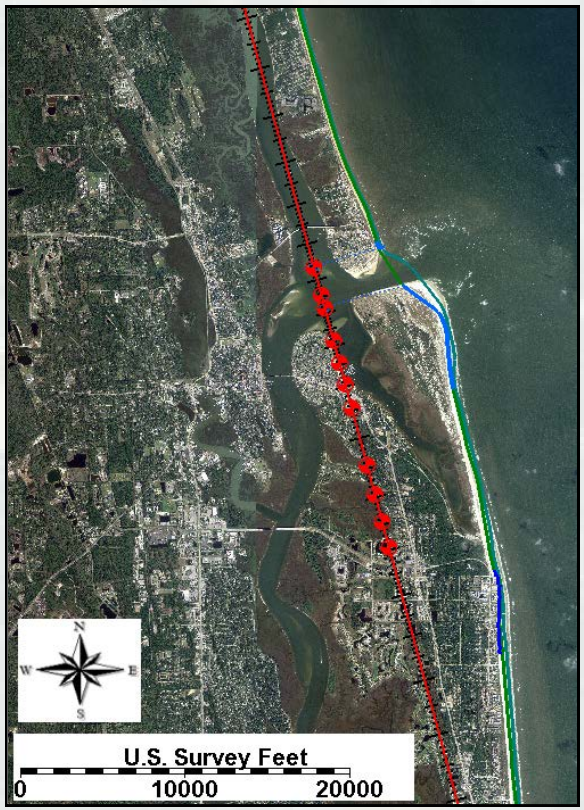
GenCade used to help answer:

What is the volumetric limit (cubic yards of sediment) that can be mined regularly from the ebb shoal in its present condition which does not cause a significant long-term effect on the morphology and volumetric recovery of the shoal?

How much sediment and what nourishment interval is required to maintain present volume of the active and planned Shore Protection Projects?

St. Johns County, FL – GenCade Grid Setup





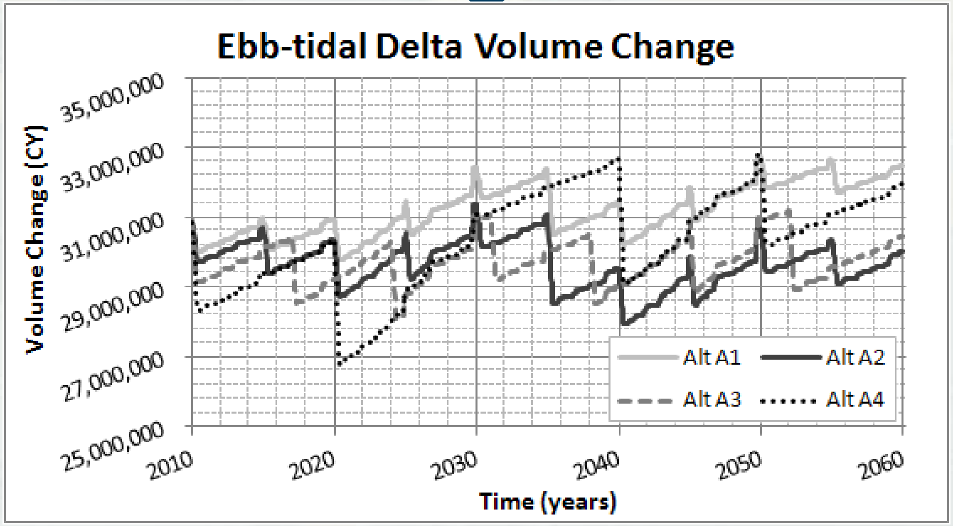
Input:

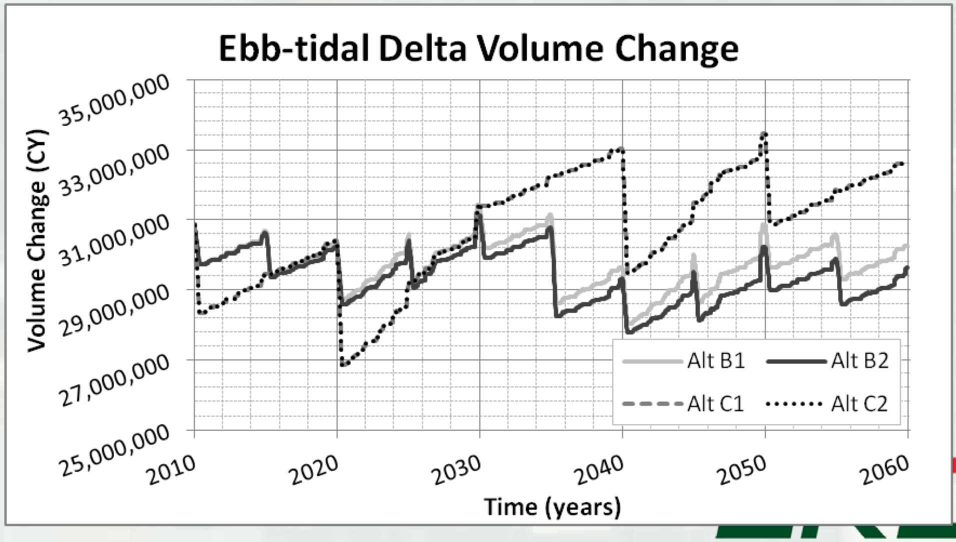
- 1986, 1999 Shorelines
- Waves
- Dredging/Placement Information
- Structures

Model Calibration Also Dependent On:

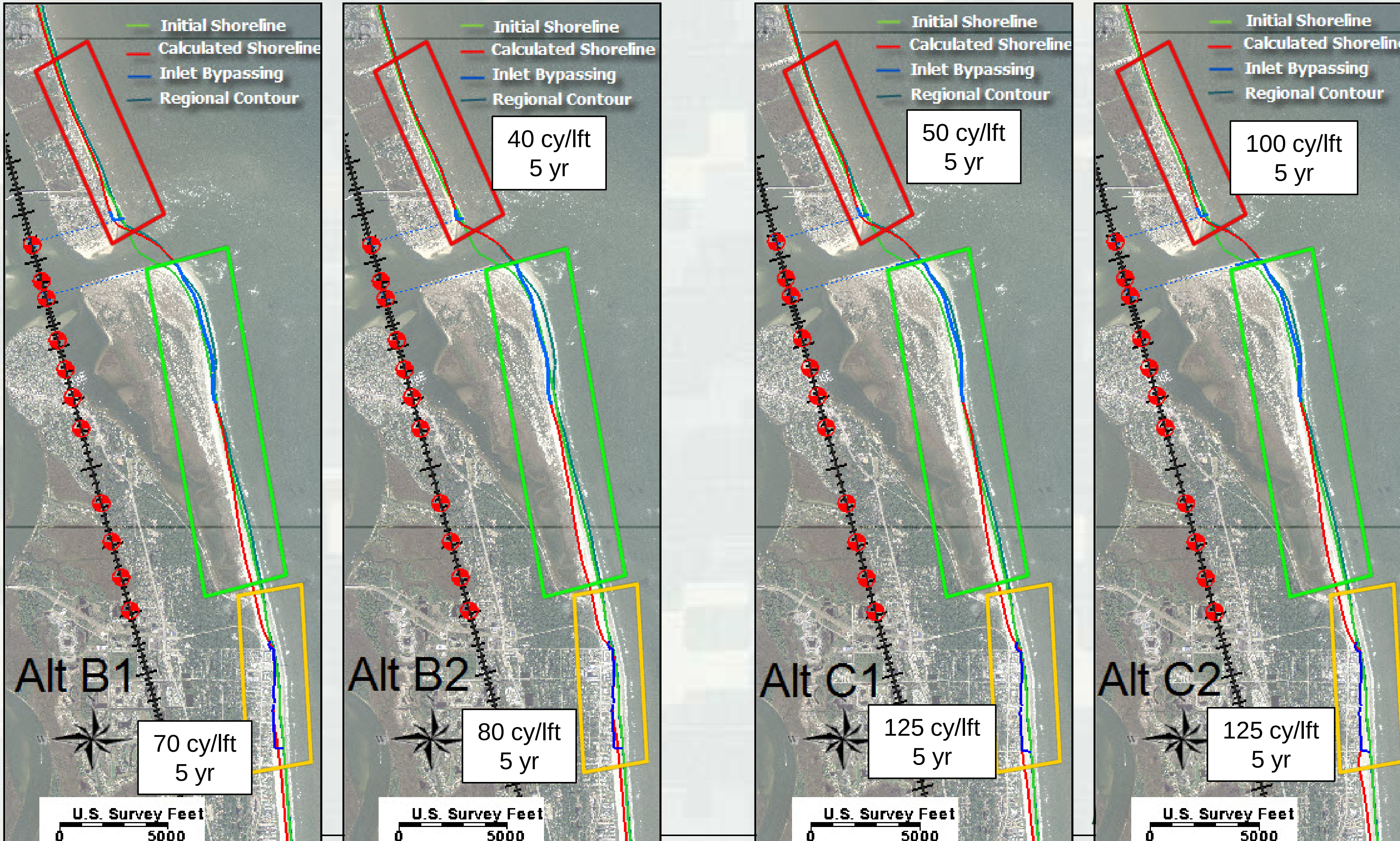
- Equilibrium Shoal Volumes
- Inlet Bypassing Rates & Locations
- Regional Contour
- Interpolation of Waves Between Gage Stationing

St. Johns County, FL – Ebb-Tidal Delta Volume Change

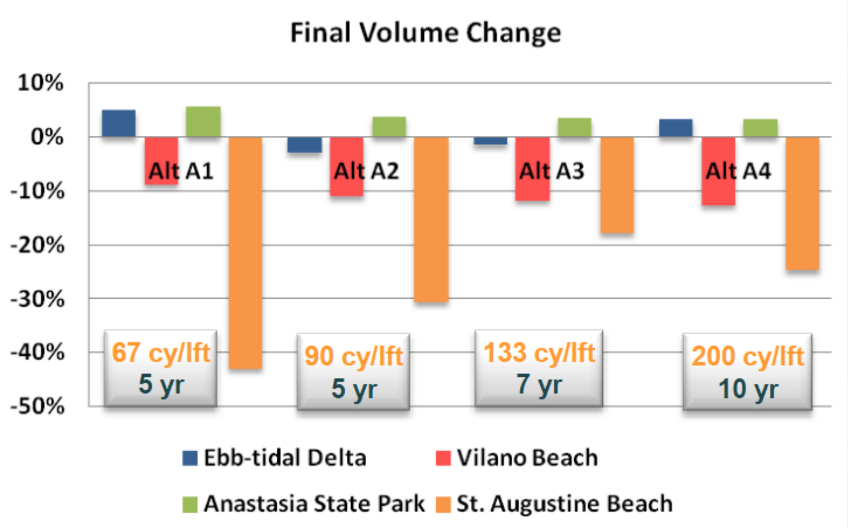


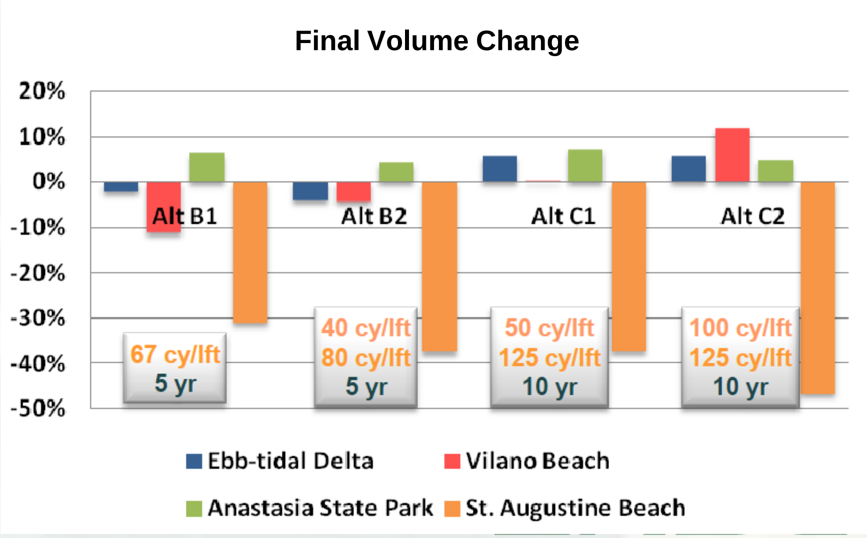


St. Johns County, FL - Results Plotted on SMS Grid

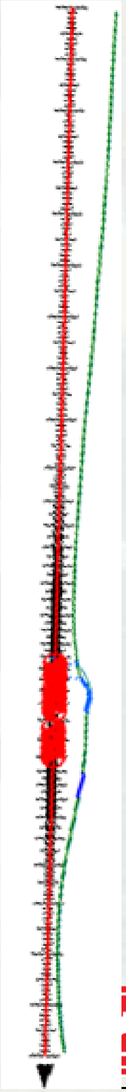


St. Johns County, FL – Volumetric Results



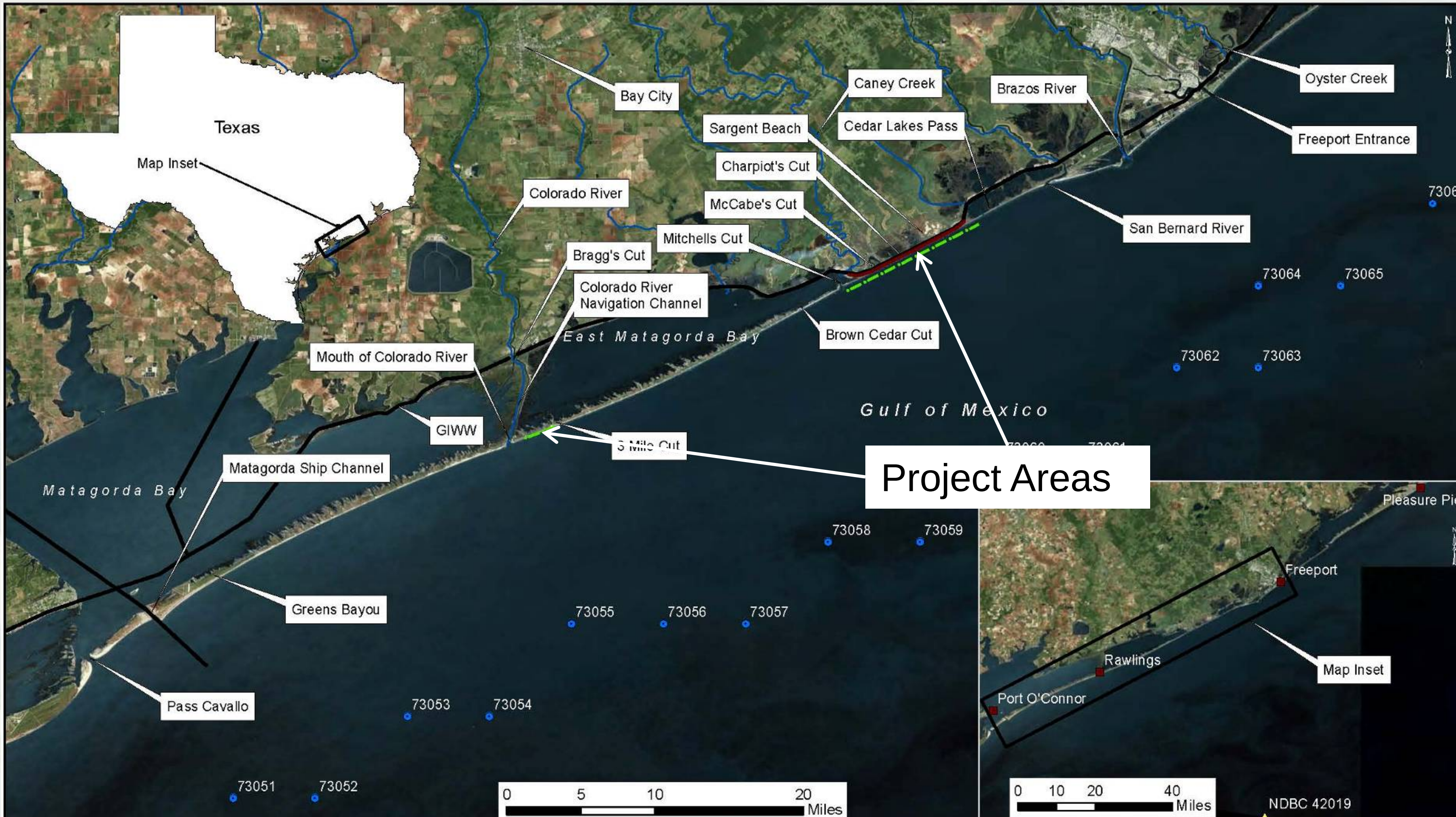


St. Johns County, FL - Summary

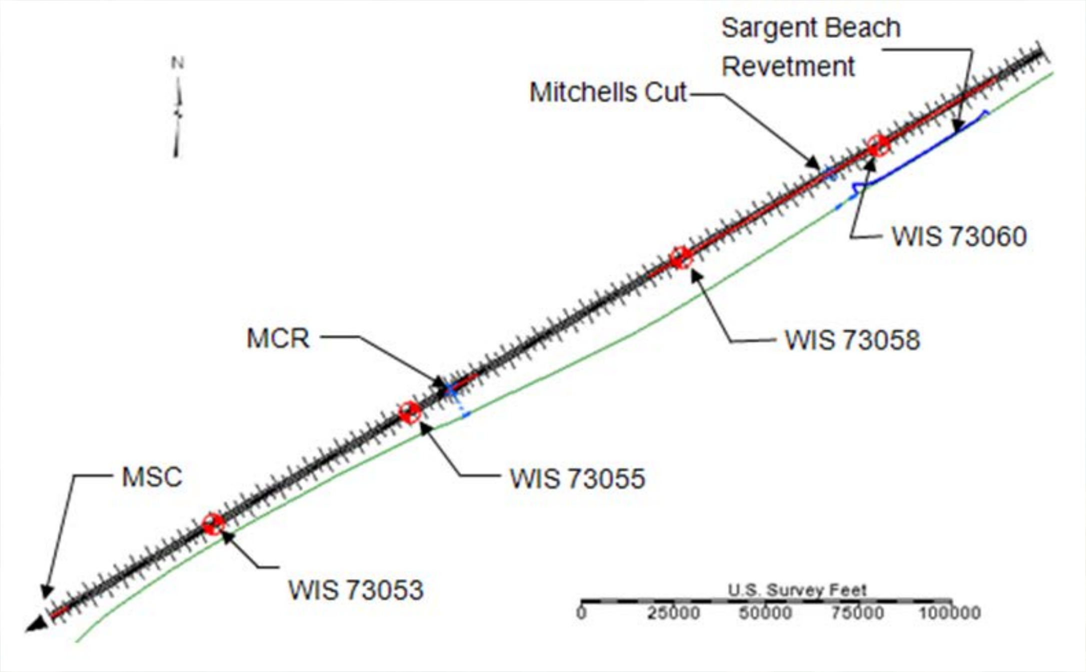


- The performance and estimate of certainty in GenCade as a sediment management planning tool is relative to the accuracy of the calibration. Furthermore, extensive analysis of measured data must be performed to properly inform the model on realistic bounds in a 3-dimensional morphologic environment.
- Though not all 3-dimensional morphologic processes are represented in the model, most general inferences about sediment transport and bypassing within the coastal zone can be applied to calculating future sediment budgets with GenCade.
- The benefits of coordinating and modifying dredging intervals can be explored simultaneously with varying beach fill volumes and intervals.
- The greatest benefit lies in determining optimal mobilization periods and coordinating regional efforts to save in mobilization and demobilization costs for dredging and beach fill placement.

Overview – Sargent Beach and Matagorda Peninsula, TX



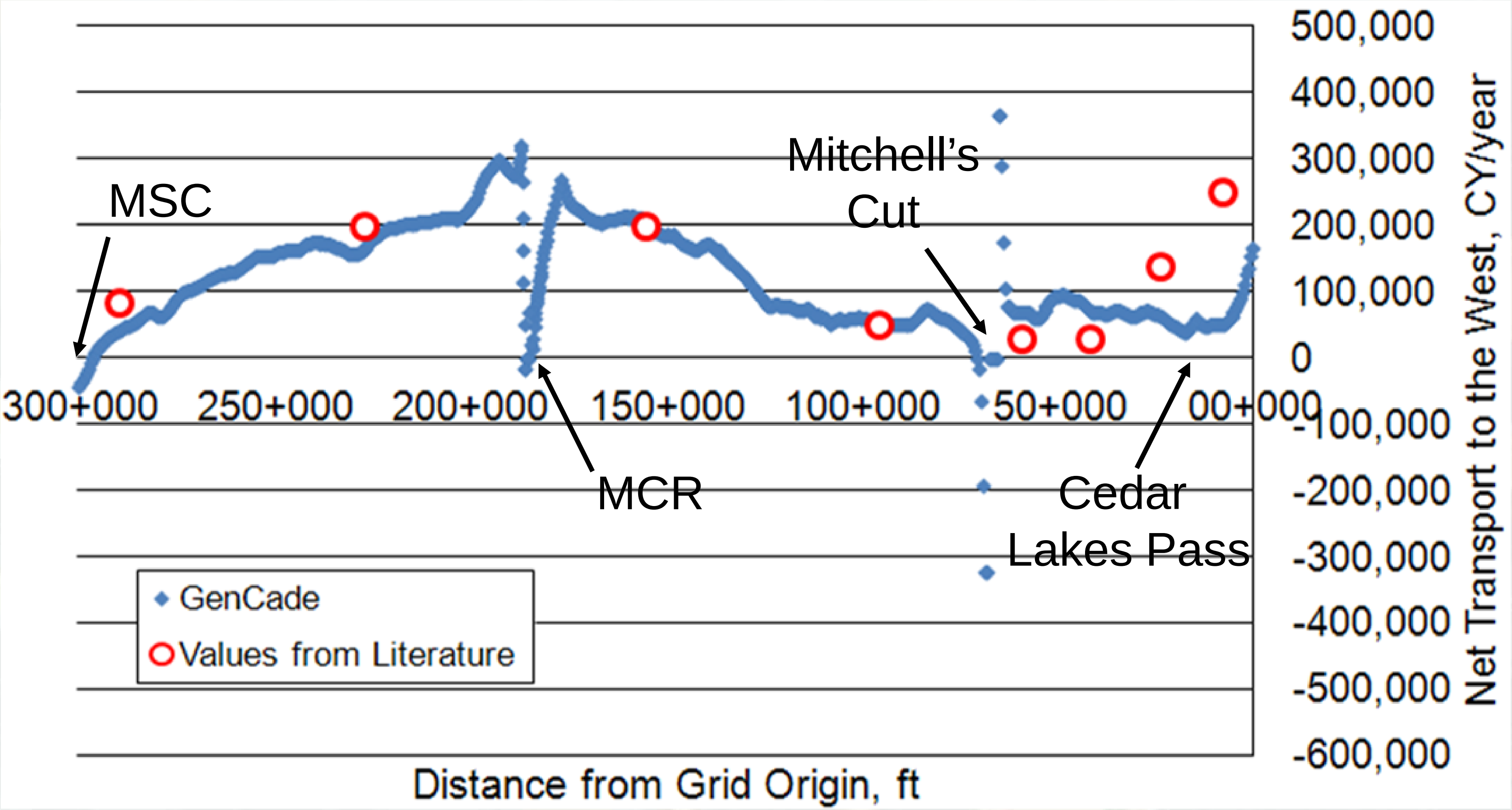
Calibration – Sargent Beach and Matagorda Peninsula



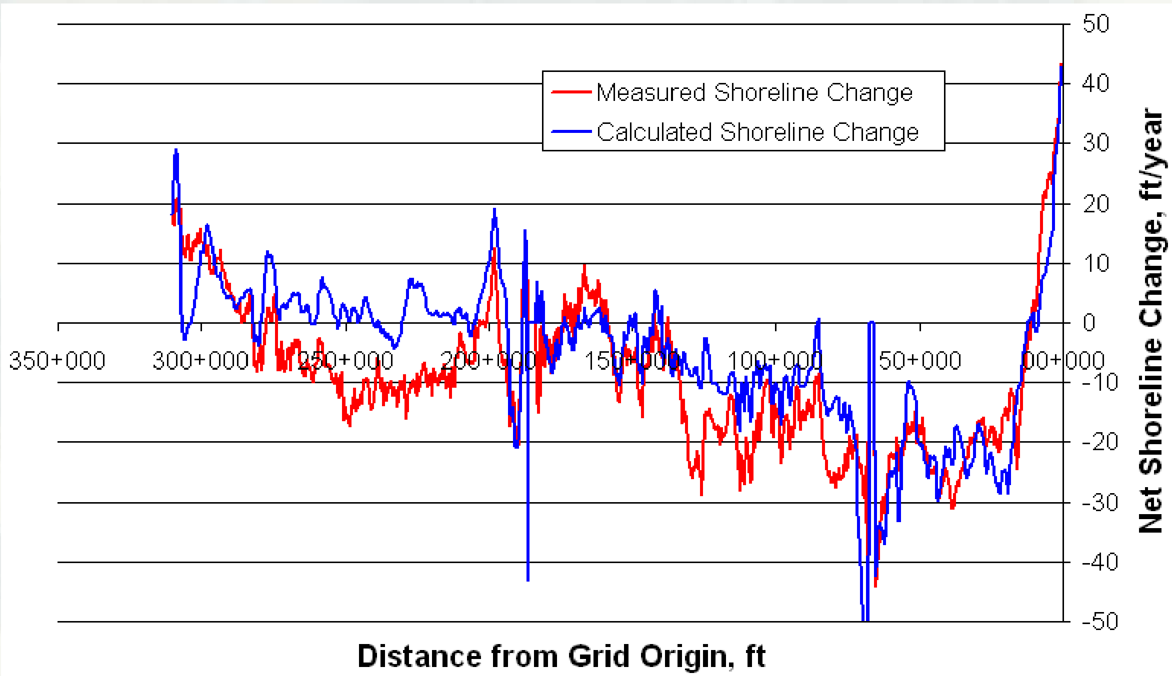
GenCade Input

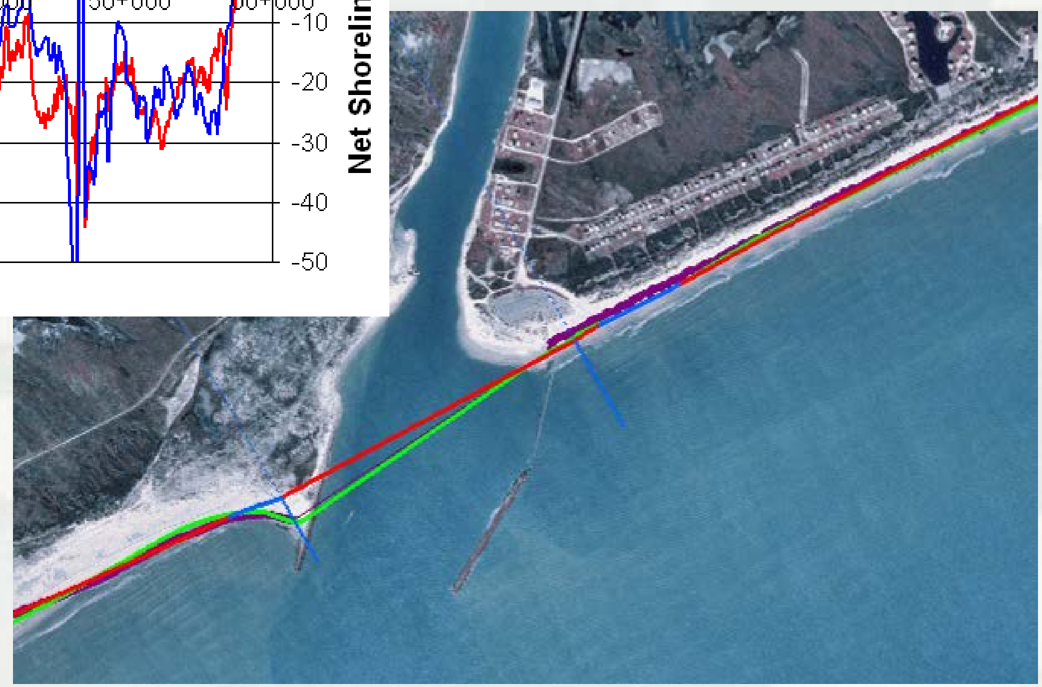
- 1995 and 2000 shorelines
- Waves (WIS 73060, 73058,73055, 73053)
- Sargent Beach revetment
- Mitchell’s Cut and Mouth of the Colorado River

Sargent Beach and Matagorda Peninsula: Net Transport



Sargent Beach and Matagorda Peninsula: 1995-2000 Measured Shoreline Change





Sargent Beach - Problem Statement

- Sargent Beach – fastest eroding beach in Texas

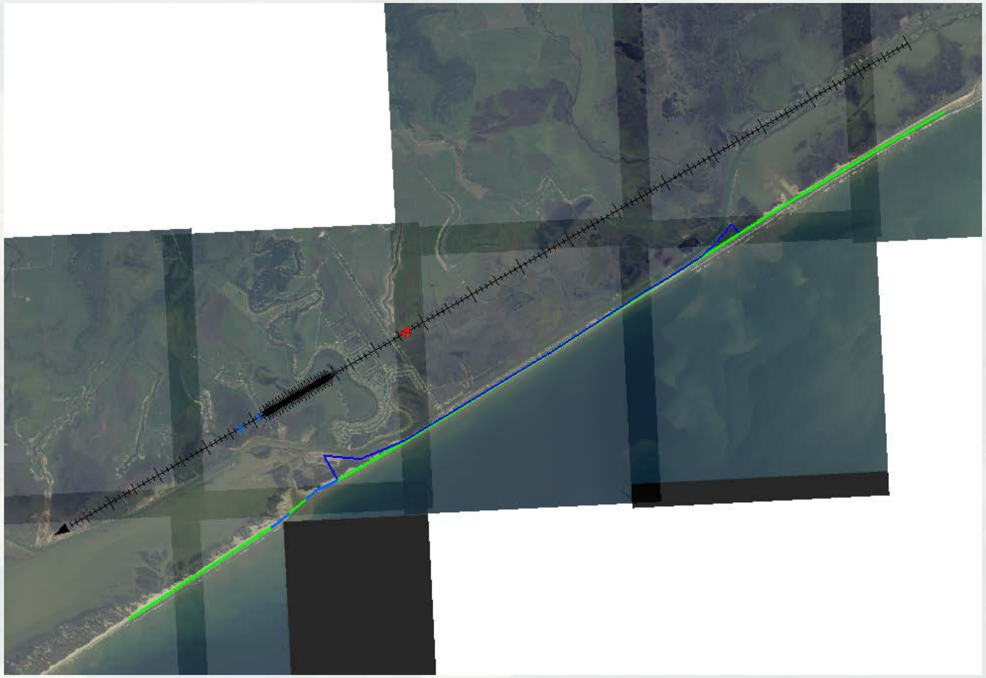
Determine feasibility of structural solutions to reduce erosion

- protect the beach habitat
- protect Gulf Intracoastal Waterway

Refined problem statement in Phase 2

- segmented breakwaters
- adaptive and scalable plan
- minimal downdrift impacts
- multiple layouts to accommodate incremental funding

Sargent Beach Alternatives



Sargent Beach alternatives use shorter grid than calibration

Breakwater alternatives required shorter grid due to computational time

Alt 0: No Action

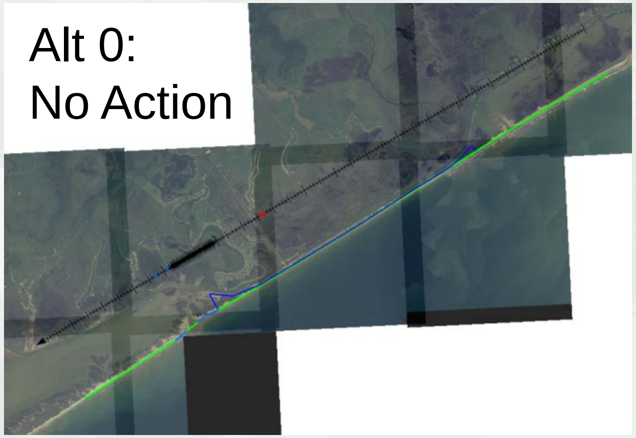
Alt 1: 3,000,000 cubic yard beach fill

Alt 2: Single Groin

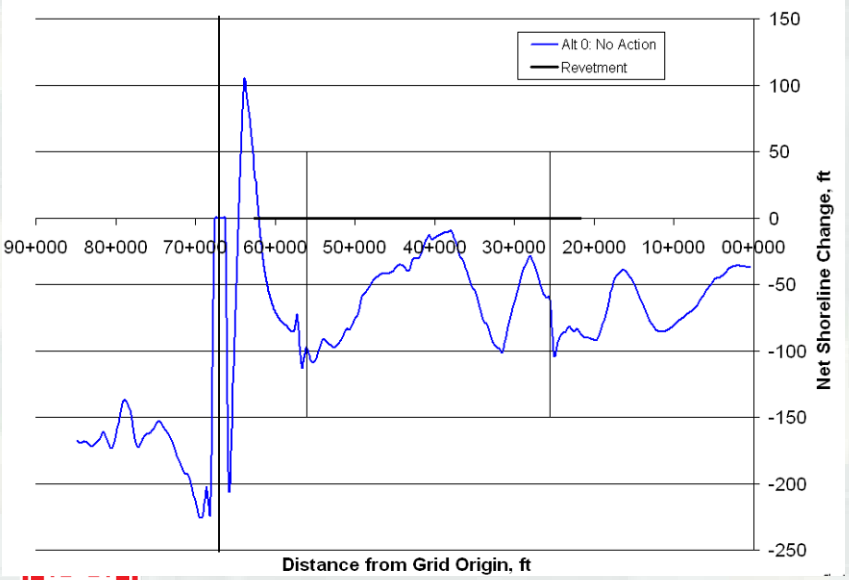
Alt 3: Groin Field

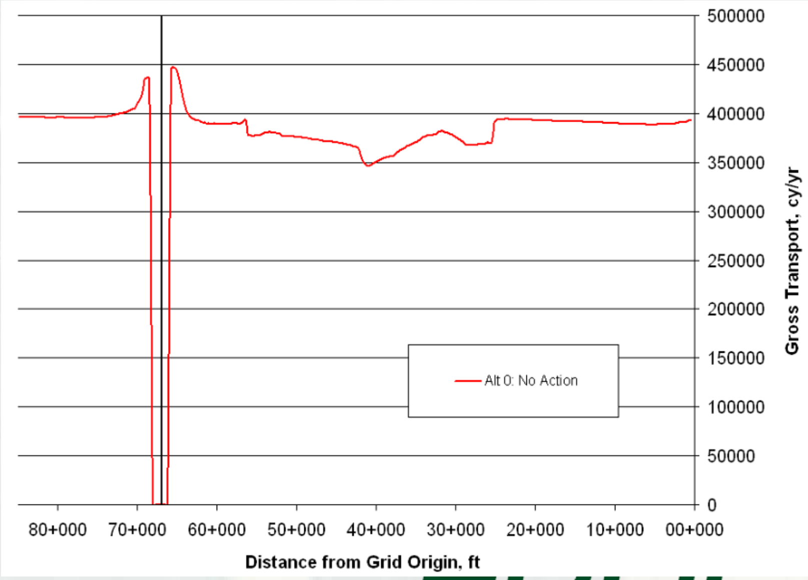
Alt 4: Breakwaters
- Phase 1: 10 Breakwaters; 220 ft Breakwaters; 330 ft Gaps
- Phase 2: 15 Breakwaters
- Final Phase: 81 Breakwaters

Sargent Beach Alternatives

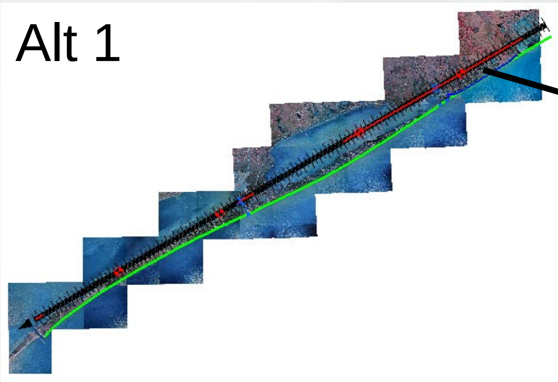


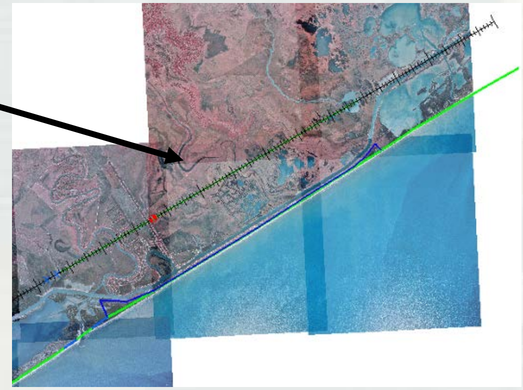
- About 6 miles of shoreline recedes to revetment after 5 years
- Gross transport about 400,000 cy/yr over entire domain





Sargent Beach Alternatives

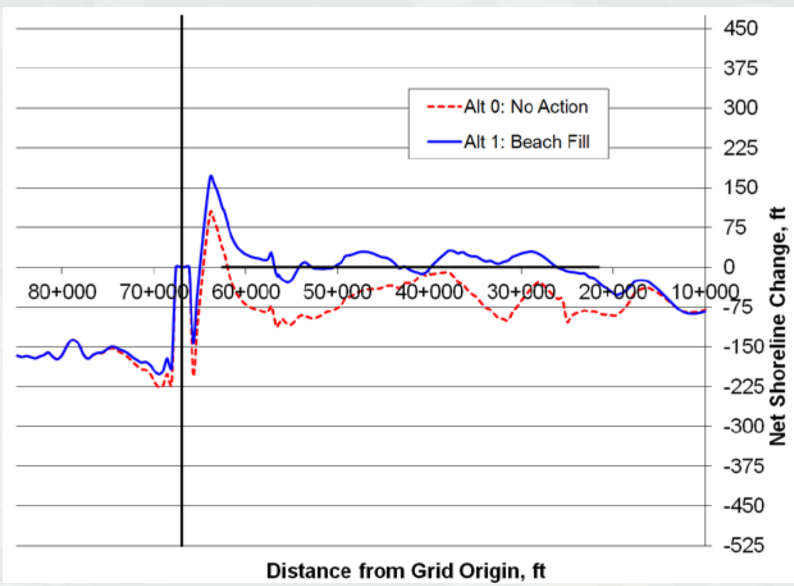




Alt 1: 3 million cubic yard beach fill over 10 miles

Placement density of 57 cy/linear foot

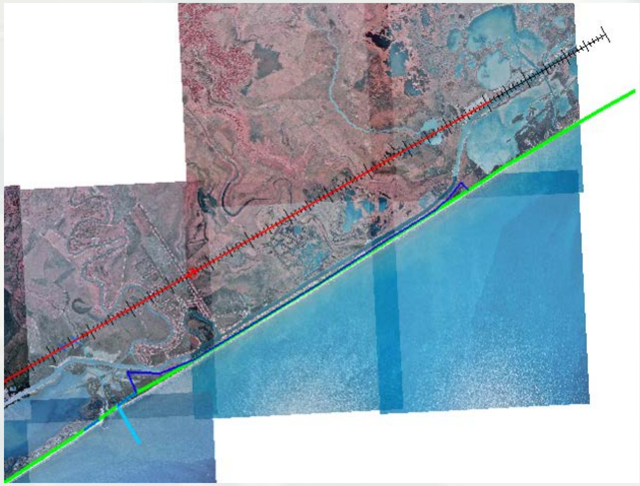
Added berm width of 100 ft



Beach fill does not increase beach width

Additional nourishments required to protect the beach (not cost effective)

Sargent Beach Alternatives

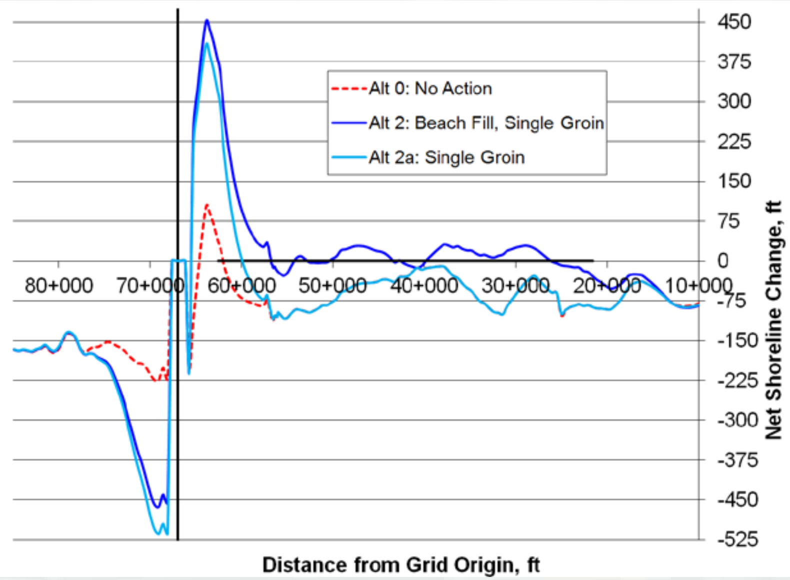


Alt 2: Single Groin East of Mitchell's Cut plus Beach Fill

Beach Fill identical to Alt 1

Unrealistically long groin to demonstrate maximum trapping capacity

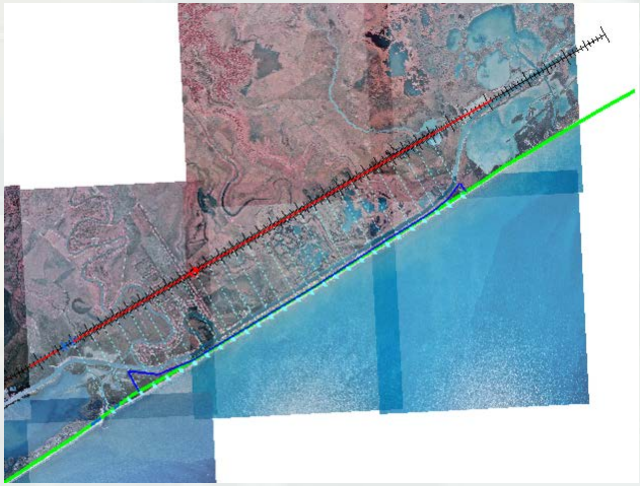
Alt 2a: Single Groin Only



Groin does not have impact on shoreline change northeast of 57+000 ft

Northeast of 57+000 ft, Alt 2 is identical to Alt 1 and Alt 2a is identical to Alt 0

Sargent Beach Alternatives



Alt 3: Groin Field plus Beach Fill

Beach fill identical to Alt 1

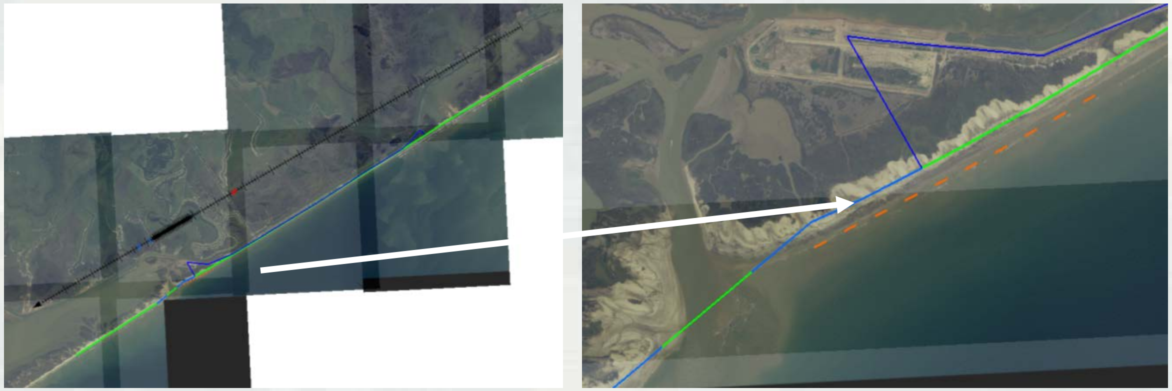
Includes 28 groins of 600 ft spaced 1800 ft apart

Alt 3a: Groin Field Only

Groin field has little effect on shoreline in front of revetment

Groin protects shoreline at northern end of revetment, but recedes to almost same location as Alt 0 along most of the revetment

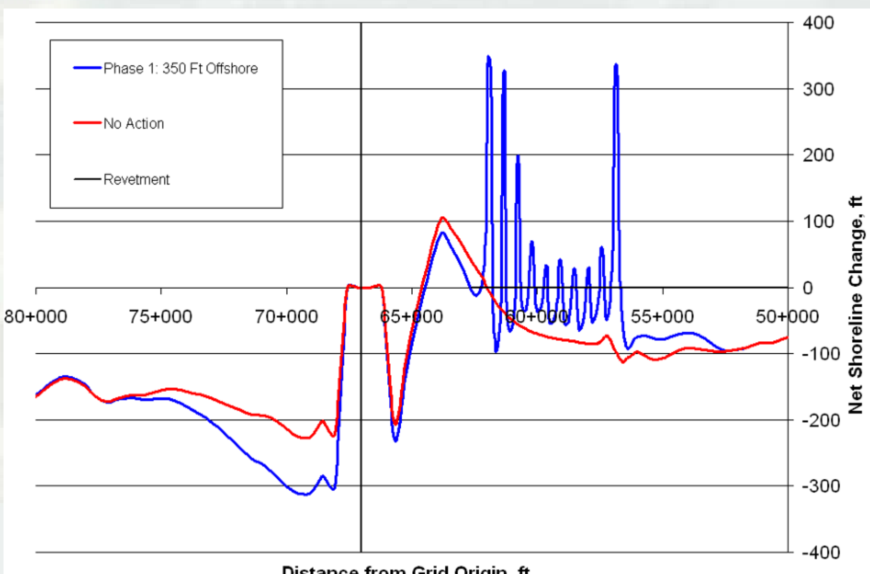
Sargent Beach Alternatives

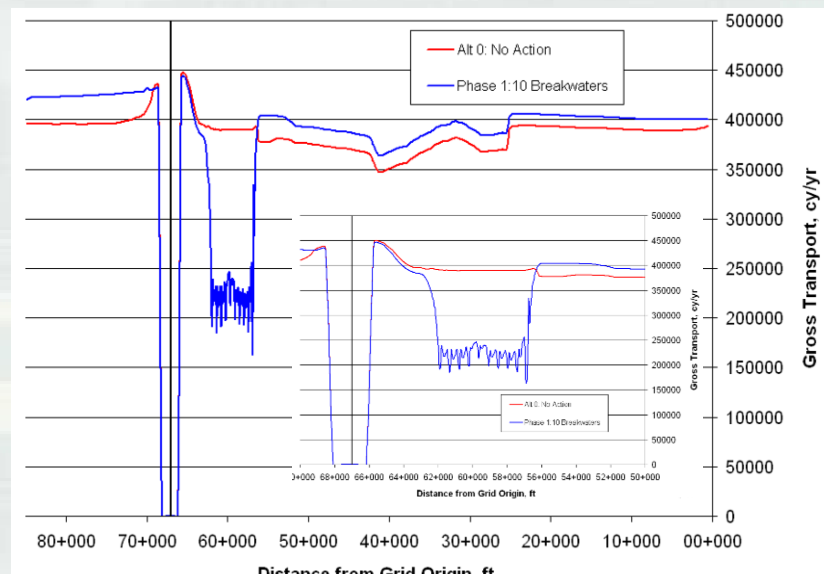


Alt 4: 10 breakwaters placed at 350 ft offshore

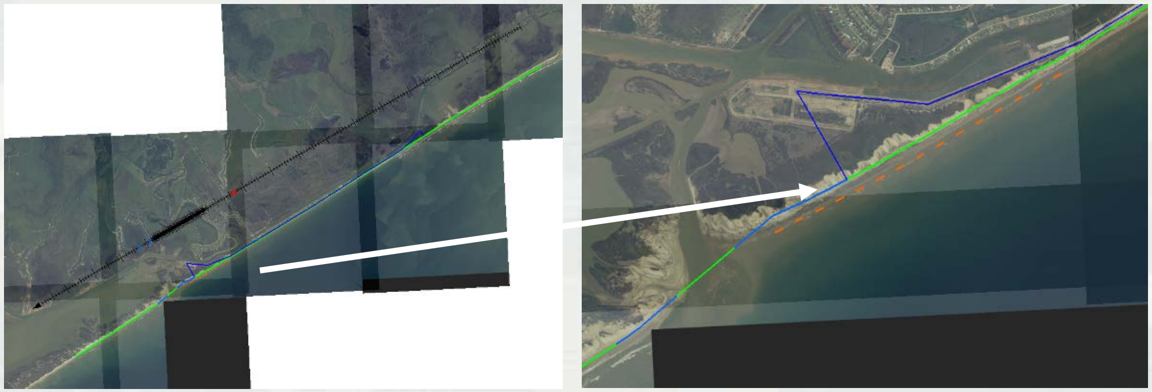
Breakwater length = 220 ft

Gap size = 330 ft





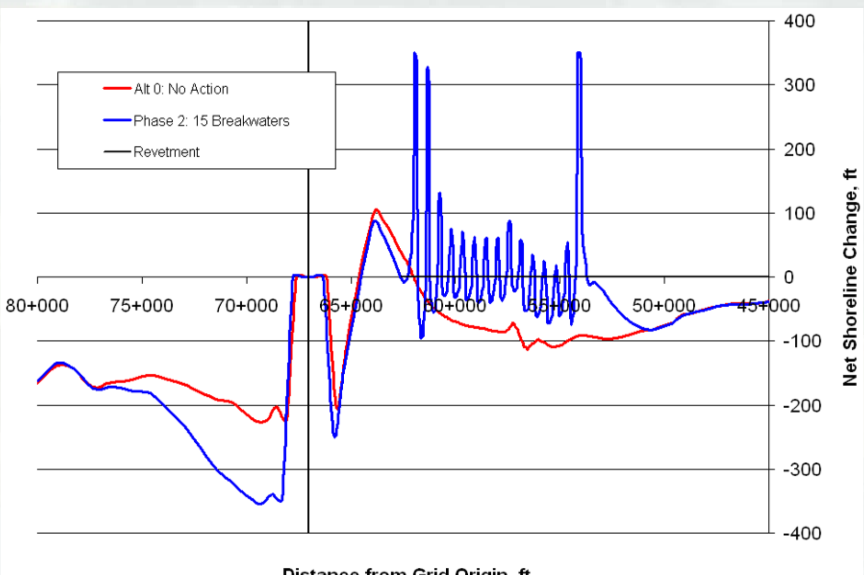
Sargent Beach Alternatives

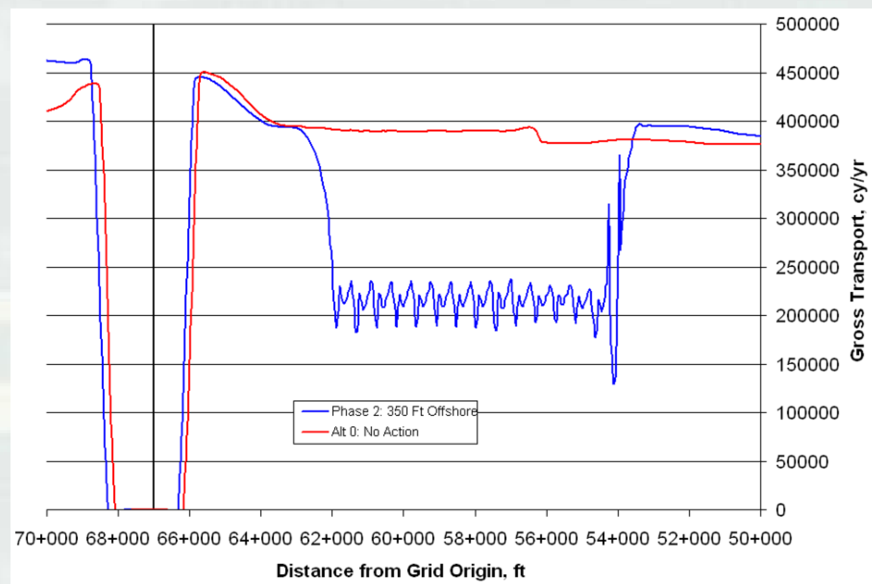


Alt 4, Phase 2: 15 breakwaters placed at 350 ft offshore

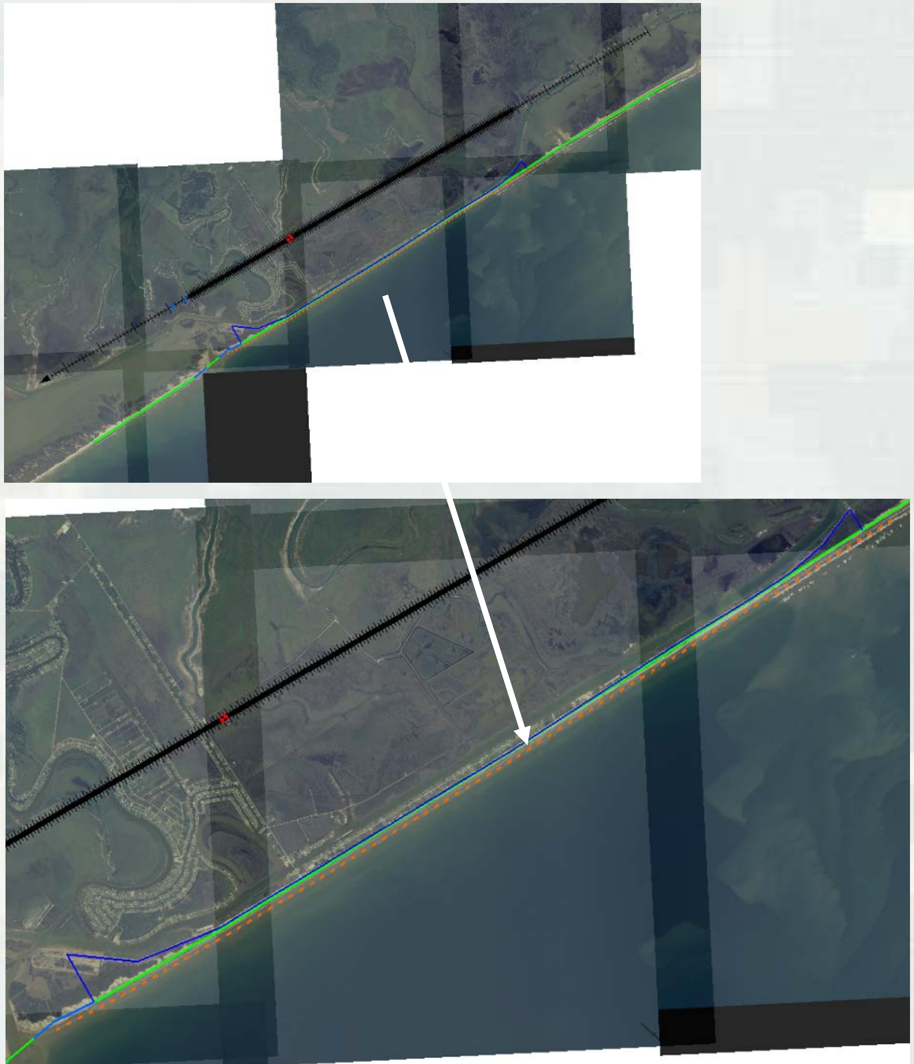
Breakwater length = 220 ft

Gap size = 330 ft





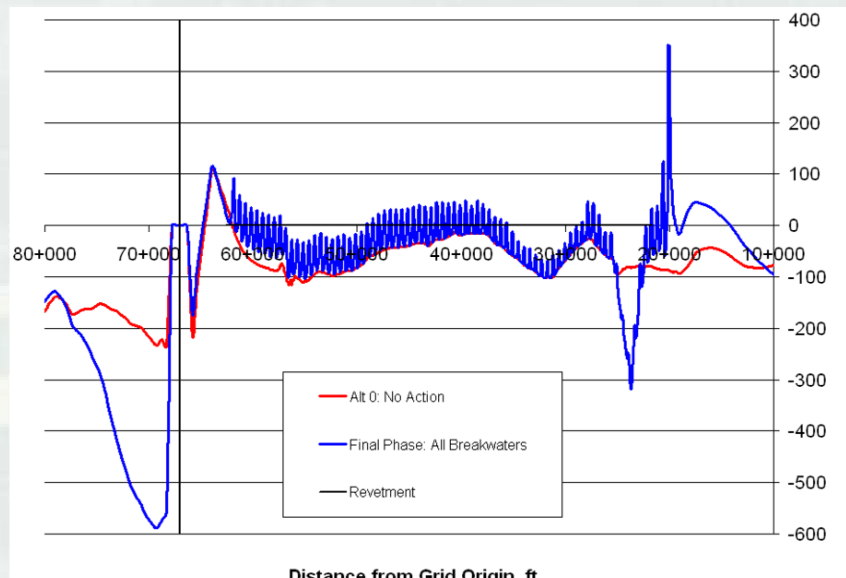
Sargent Beach Alternatives



Alt 4, Phase 3: 81 breakwaters placed at 350 ft offshore

Breakwater length = 220 ft

Gap size = 330 ft



Sargent Beach, TX - Summary

The best structural alternative at Sargent Beach is breakwaters

Multiple offshore distances and depths were tested with the breakwaters at Sargent Beach

Several phases were simulated for selected Sargent Beach breakwater setup

Mitigation beach fill necessary southwest of Mitchell’s Cut for Sargent Beach breakwaters

Matagorda Peninsula - Problem Statement

- Matagorda Peninsula – breached by ephemeral inlets in past

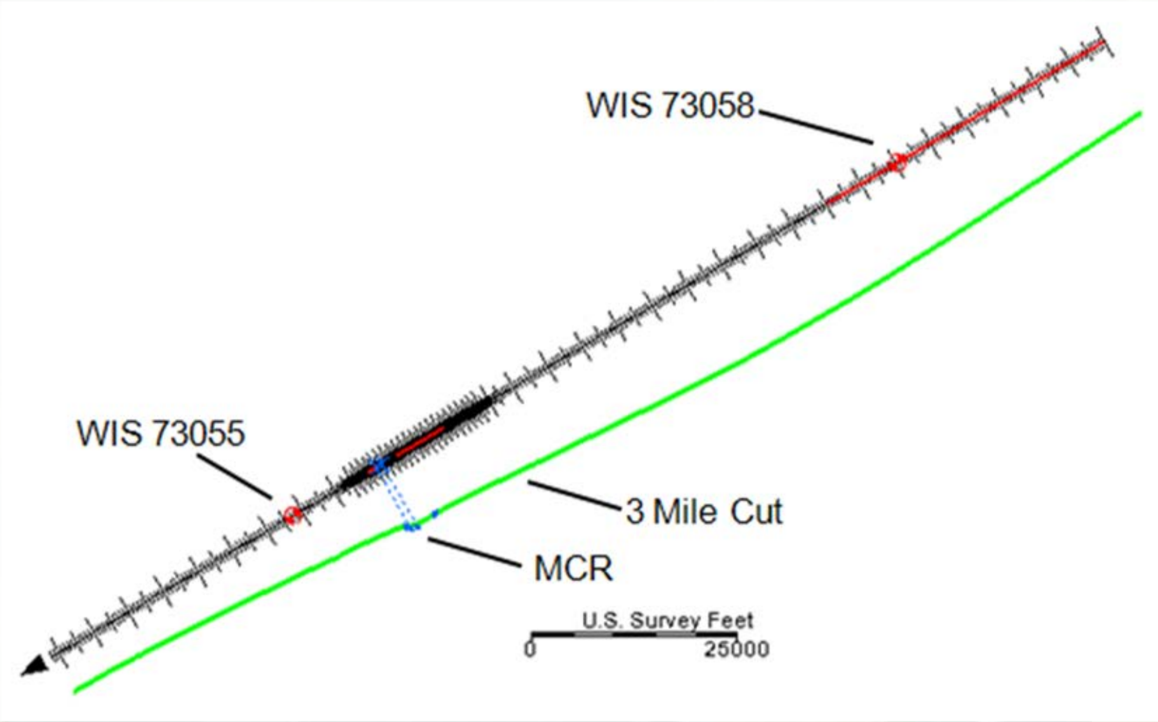
Determine feasibility of structural solutions to reduce erosion

- protect beach habitat
- reduce storm damage
- reduce sediment impoundment along the MCR east jetty

Refined problem statement in Phase 2

- groin field between 3 Mile Cut and MCR
- project goal to widen beach by 200 ft
- design so project does not impact 3 Mile Cut

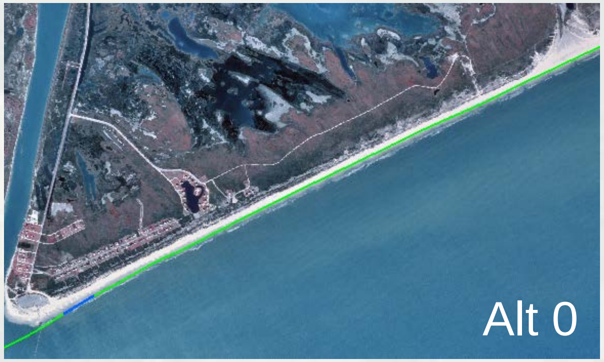
Matagorda Peninsula Alternatives

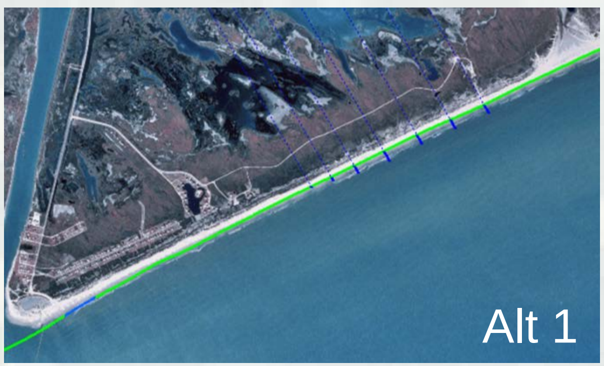


- Grid extends from 3.3 miles southwest of Mitchell's Cut to south west of MCR
- 28 miles long
- Smaller cell size between 3 Mile Cut and MCR
- 5 and 16 year long simulations

Matagorda Peninsula Alternatives

Matagorda Peninsula Alternatives

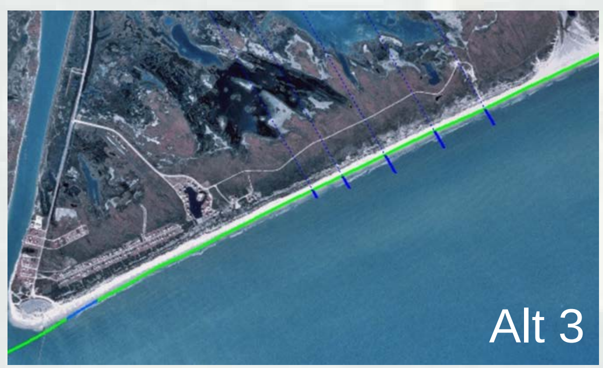




No beach fills

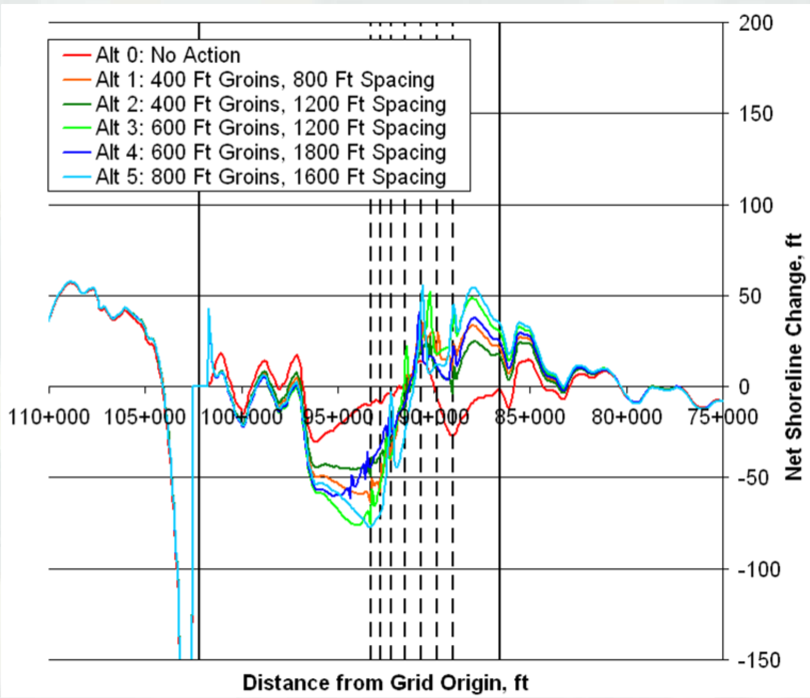
115,000 cy/yr of bypassing around MCR

P = 0.3

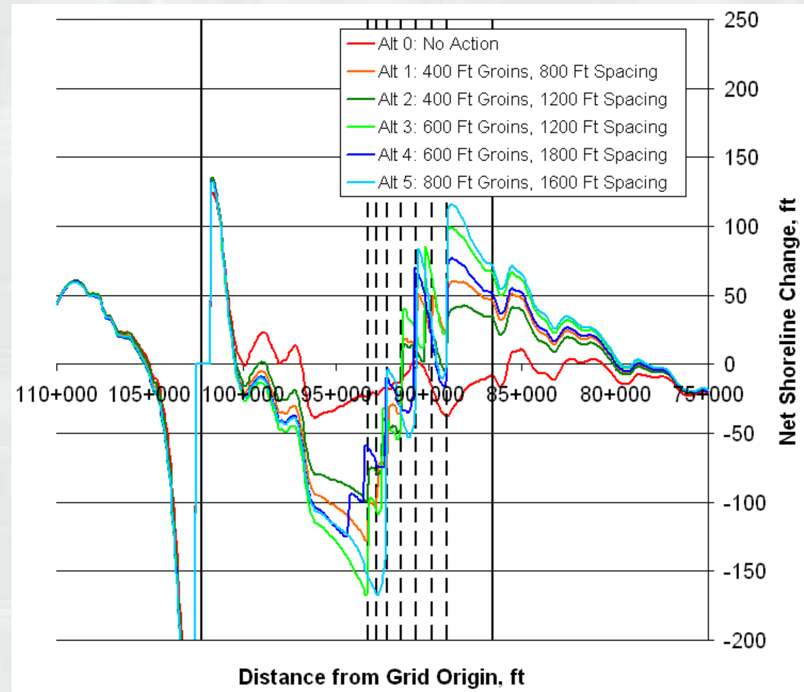


Matagorda Peninsula Alternatives

After 5 Years



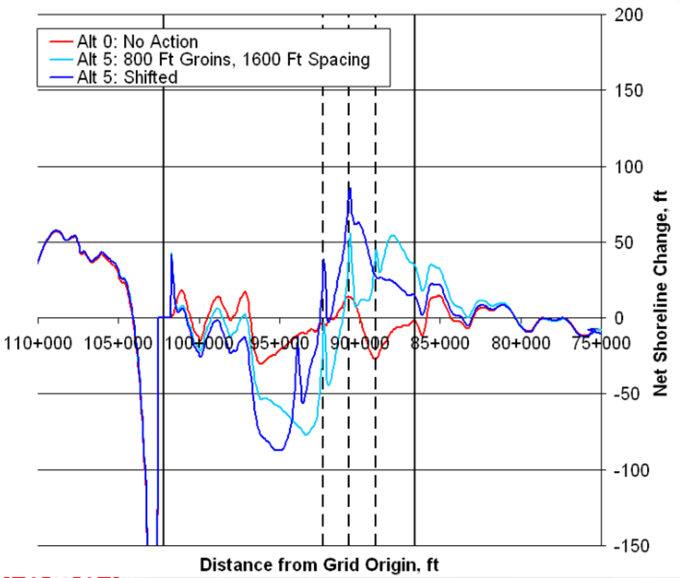
After 16 Years

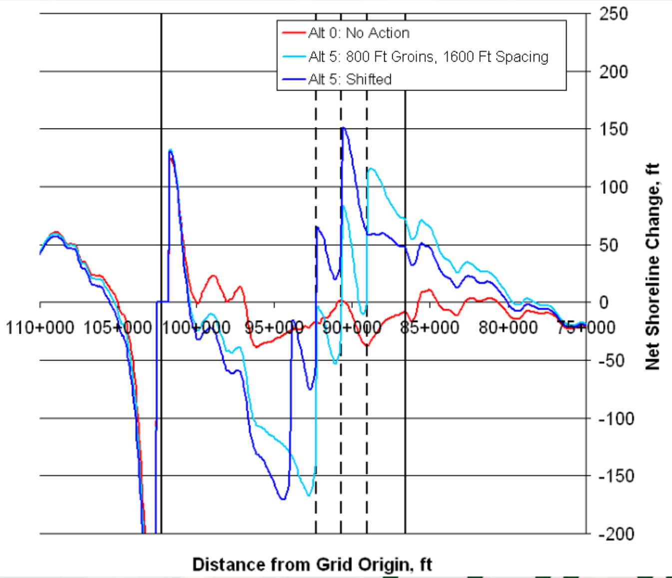


Based on preliminary simulations, Alt 5 was selected as the design alternative

Additional variations of Alt 5 were simulated

Matagorda Peninsula – Alt 5





Matagorda Peninsula – Alt 5 Comparison

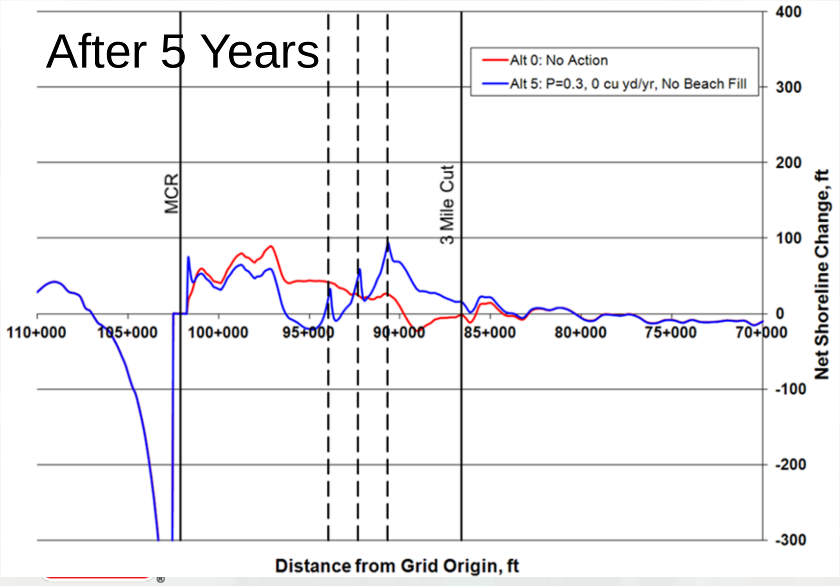
P = 0.3 for final design

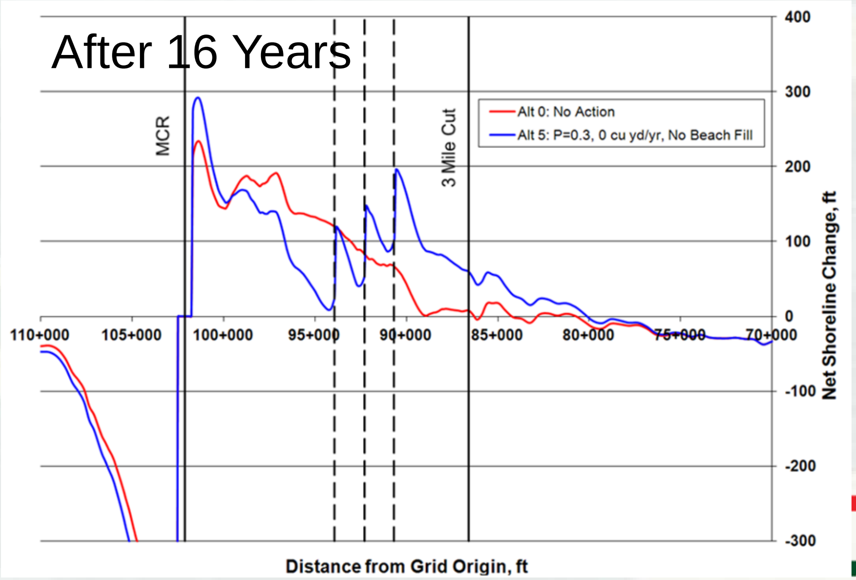
Compare No Action to
Alt 5 (no beach fill or bypassing)

After 5 years, greatest accretion to northeast of first groin (less than 100 ft)

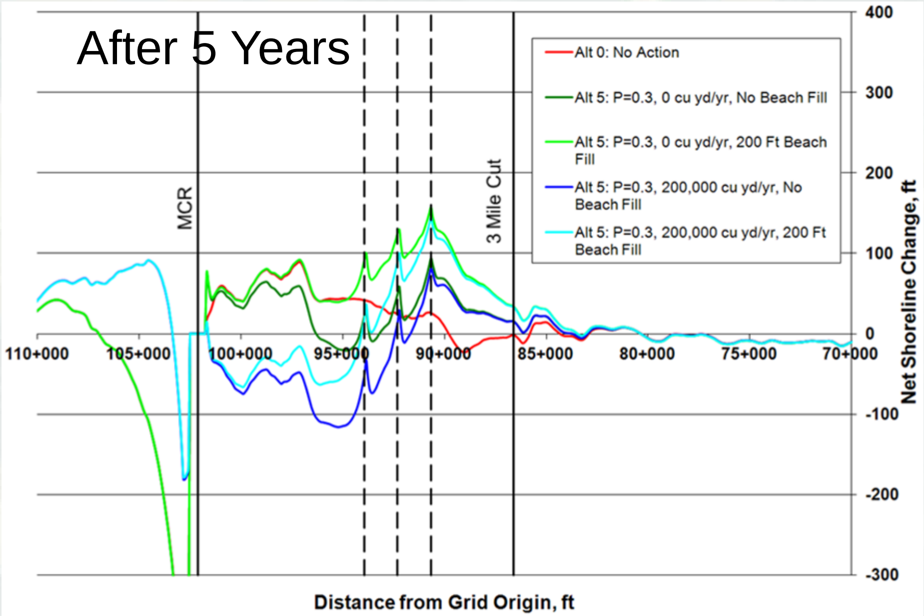
After 16 years, about 200 ft of accretion northeast of first groin

After 16 years, almost 300 ft of shoreline advance northeast of MCR



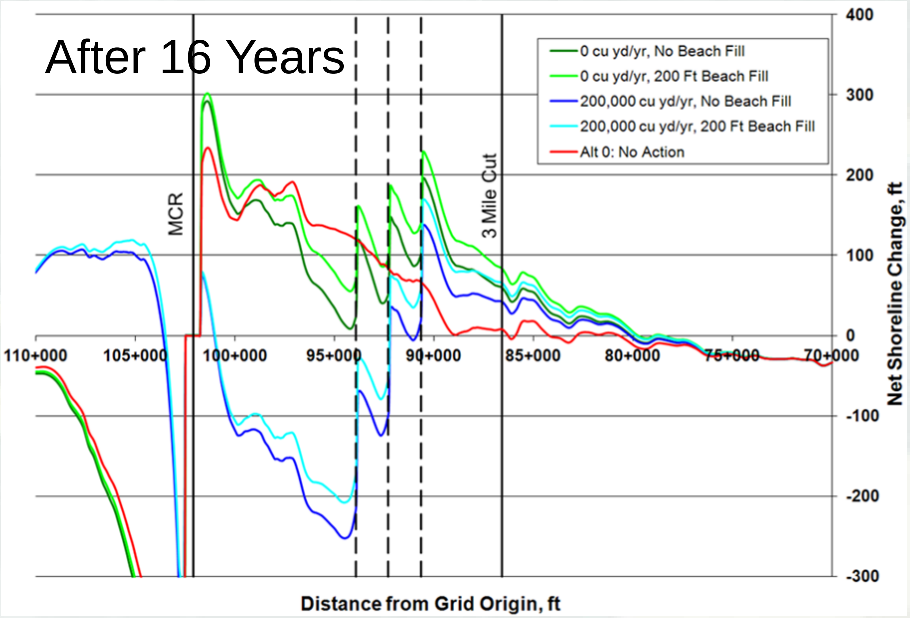


Matagorda Peninsula – Alt 5



- With 200,000 cy/yr of bypassing, erosion occurs with and without beach fills
- All cases result in accretion northeast of first groin

- Bypassing between 0 and 200,000 cy/yr may provide best result



Matagorda Peninsula - Summary

Shifting the groin field to the southwest significantly improved the results

Of the groin configurations modeled at Matagorda Peninsula, three groins of 800 ft spaced 1600 ft apart produced the best results

The rate of bypassing and the construction of a beach fill affects the shoreline change in the area