

An aerial photograph showing a long, narrow inlet of water between two landmasses. The water is dark green and blue. On the left side, there is a sandy beach with many people and umbrellas. A long, dark structure, possibly a breakwater or pier, extends from the beach into the water. On the right side, there is a parking lot with many cars and a building. The background shows a residential area with houses and trees. The sky is overcast.

**Delaware Inland Bays
and Indian River Inlet
USACE Involvement Since 1935**

**Jeff Gebert
USACE Philadelphia District
19 September 2013**

What we will cover . . .

- **USACE authorities**
 - Navigation & shore protection
- **What we know about IRI and bays**
- **Ongoing USACE work**
 - Projects
 - Studies
- **CAC questions**

USACE Study Region . . . Your backyards

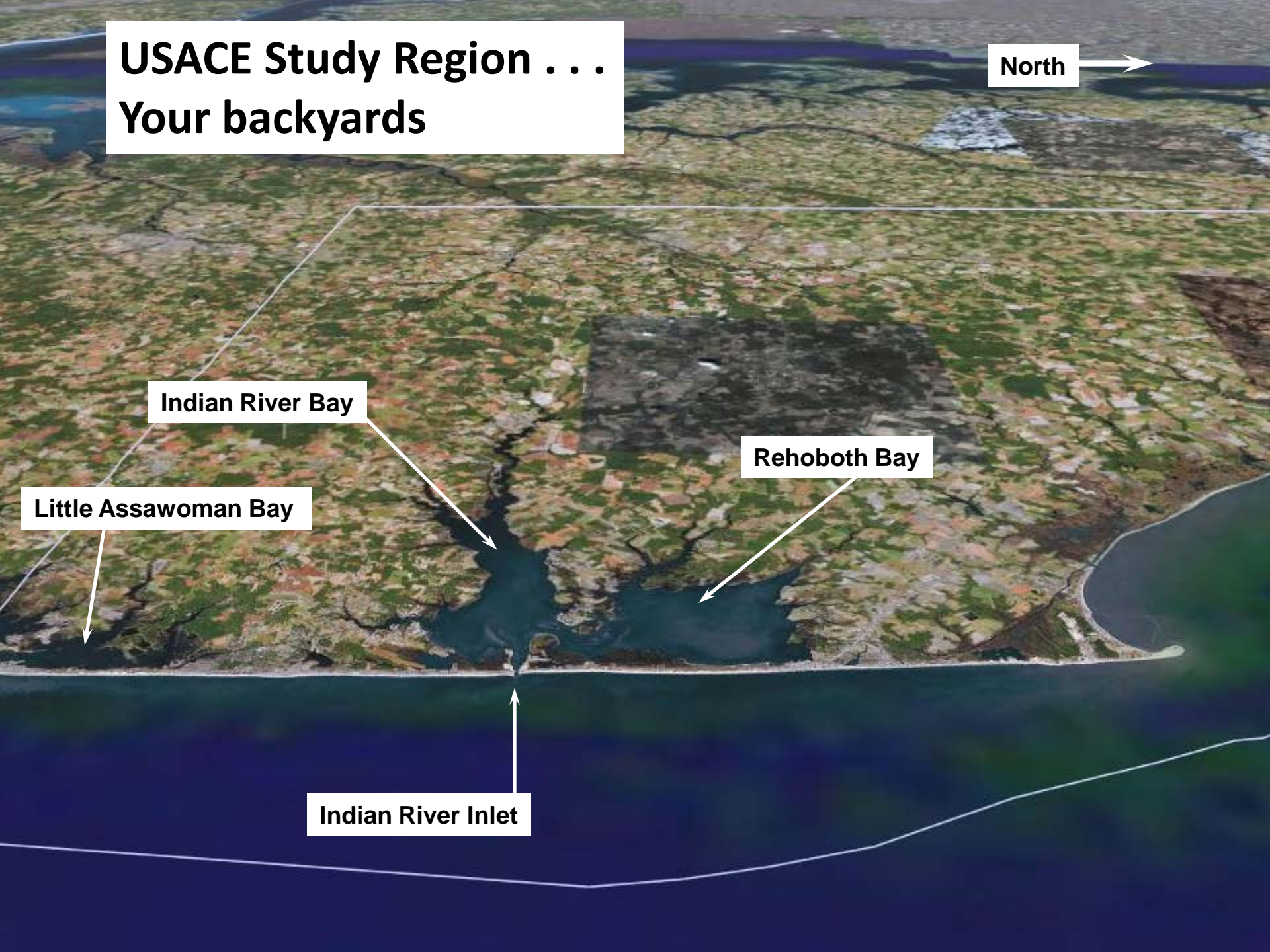
North →

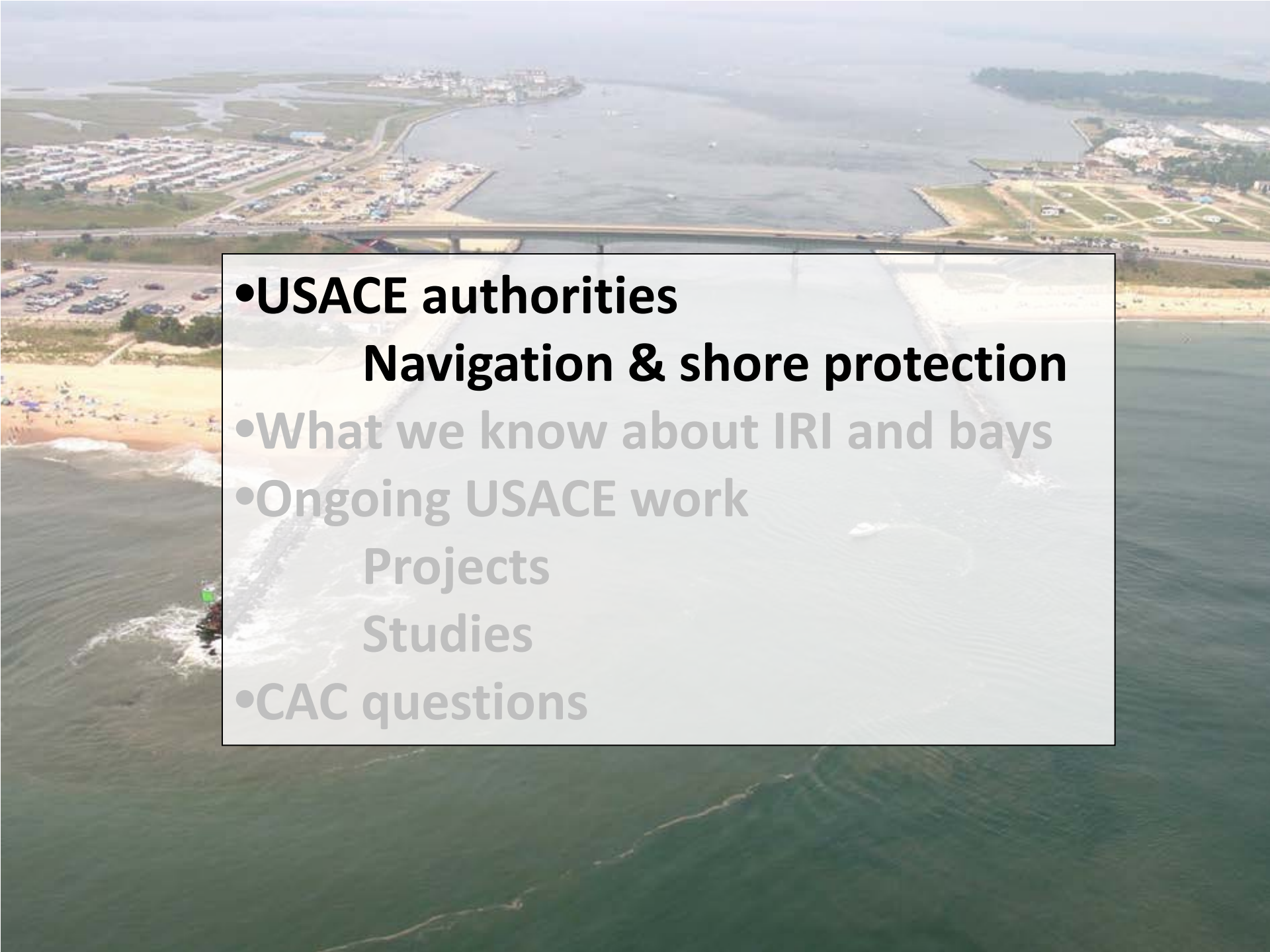
Indian River Bay

Rehoboth Bay

Little Assawoman Bay


Indian River Inlet



- 
- An aerial photograph of a coastal area. In the foreground, there's a sandy beach with some people and a small boat in the water. A long bridge spans across a wide body of water. In the background, there are residential areas, parking lots, and some industrial or construction sites. The water is a mix of light and dark green, suggesting different depths or vegetation. The sky is overcast.
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USACE Navigation Projects

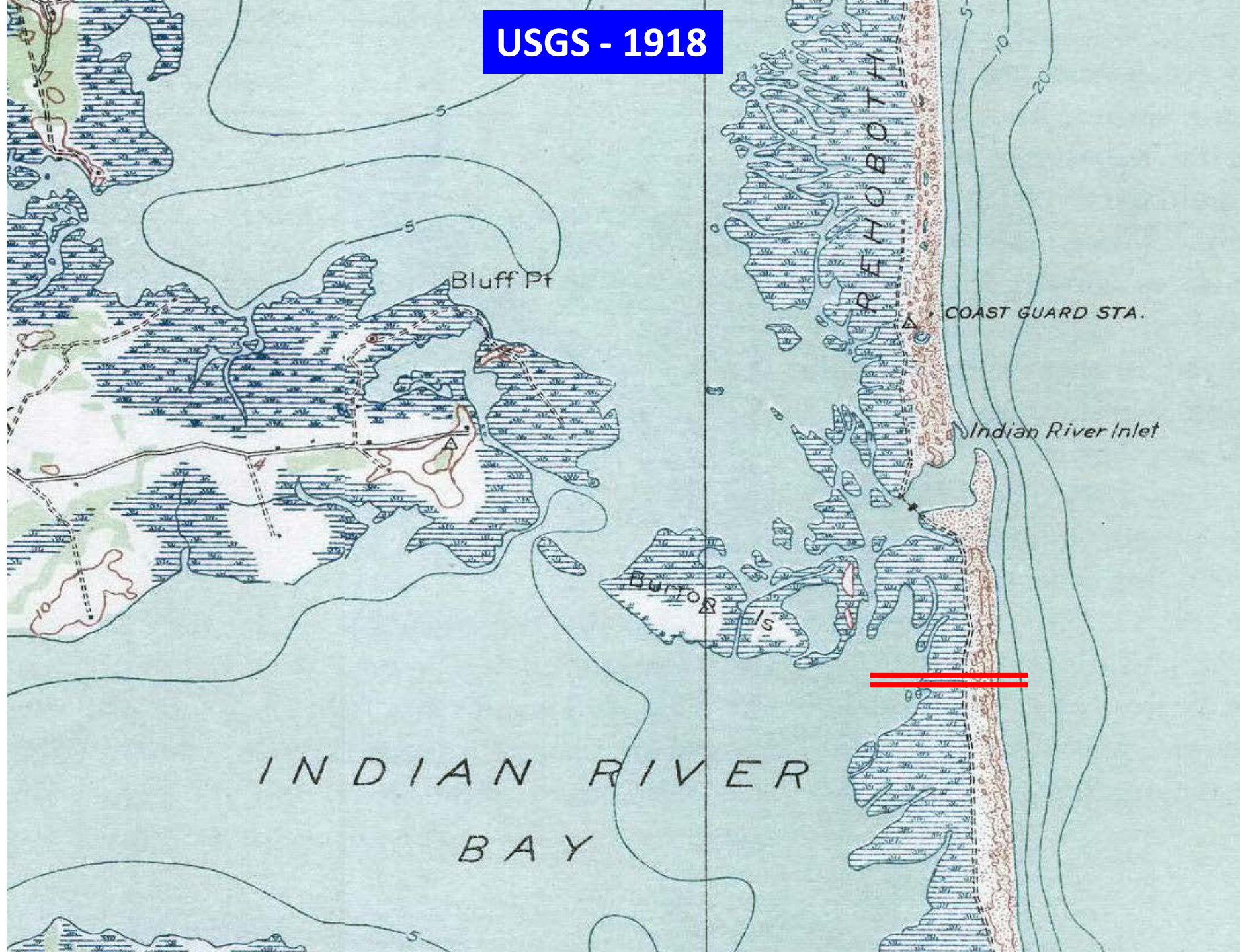
Roosevelt Inlet to Savannah Rd

 Delaware Intercoastal Waterway

 Indian River Inlet



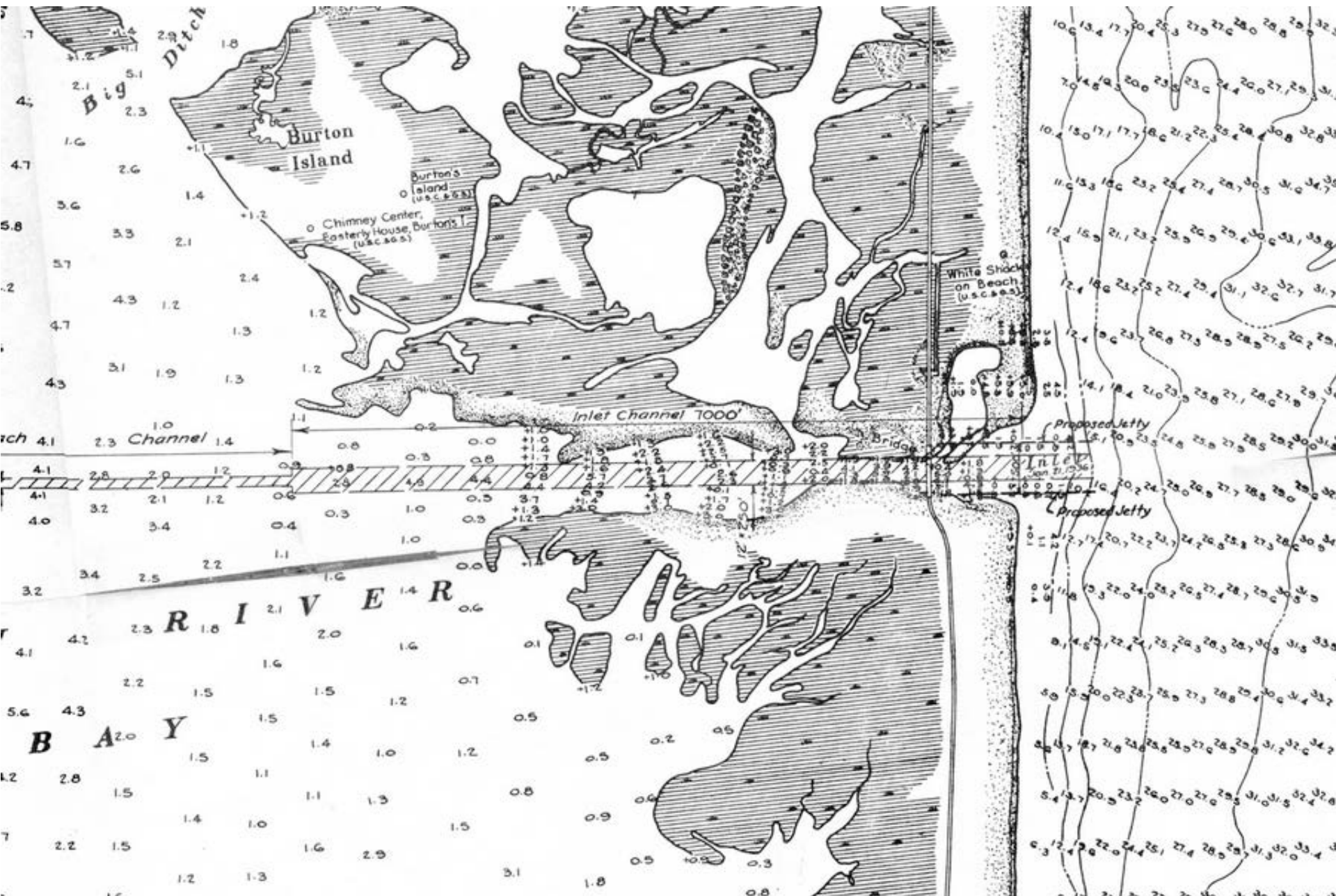
USGS - 1918



Indian River Inlet, 1931



1935 USACE Survey



REPORT OF THE DISTRICT ENGINEER

SYLLABUS

1937

HD 41

District engineer recommends improvement of Indian River Inlet, Del., by levees and dredging to afford 12-foot navigation and to restore sea-food industry in Indian River and Rehoboth Bays through increased salinity, at an estimated cost of \$415,500 for new work (\$408,000 through Engineer Department plus \$7,500 through Lighthouse Service) and \$10,500 annually for maintenance (\$10,000 through Engineer Department plus \$500 through Lighthouse Service), provided local interests furnish a cash contribution of \$160,000, all lands required for right-of-way and disposal areas, and agree through proper local authority to construct an adequate movable-span highway bridge across the inlet.

WAR DEPARTMENT

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., February 26, 1937.

Subject: Survey report on Indian River and Indian River Inlet.
To: The Division Engineer, North Atlantic Division, New York, N. Y.

AUTHORITY

1. This review report is submitted in compliance with instructions from the Chief of Engineers dated March 2, 1935, and endorsed by the division engineer under date of March 6, 1935; also with instructions from the division engineer of August 21, 1935, and with further instructions from the division engineer of October 27, 1936, transmitting recommendations made in letter of the Board of Engineers for Rivers and Harbors to the Chief of Engineers dated October 23, 1936, pursuant to the following resolution of the Committee on Rivers and

Indian River Inlet, 1938



Indian River Inlet, 1968



1968

DELAWARE COAST, BEACH EROSION CONTROL
AND HURRICANE PROTECTION

LETTER
FROM
THE SECRETARY OF THE ARMY
TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, DEPARTMENT OF THE ARMY, DATED MAY 13, 1968, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND AN ILLUSTRATION, ON A REVIEW OF THE REPORT ON DELAWARE COAST, BEACH EROSION CONTROL AND HURRICANE PROTECTION, REQUESTED BY A RESOLUTION OF THE COMMITTEE ON PUBLIC WORKS, UNITED STATES SENATE, ADOPTED JANUARY 7, 1963



PRESENTED BY MR. RANDOLPH

JULY 2, 1968.—Referred to the Committee on Public Works and ordered to be printed with an illustration

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1968

USACE - DE Shore
Protection Projects



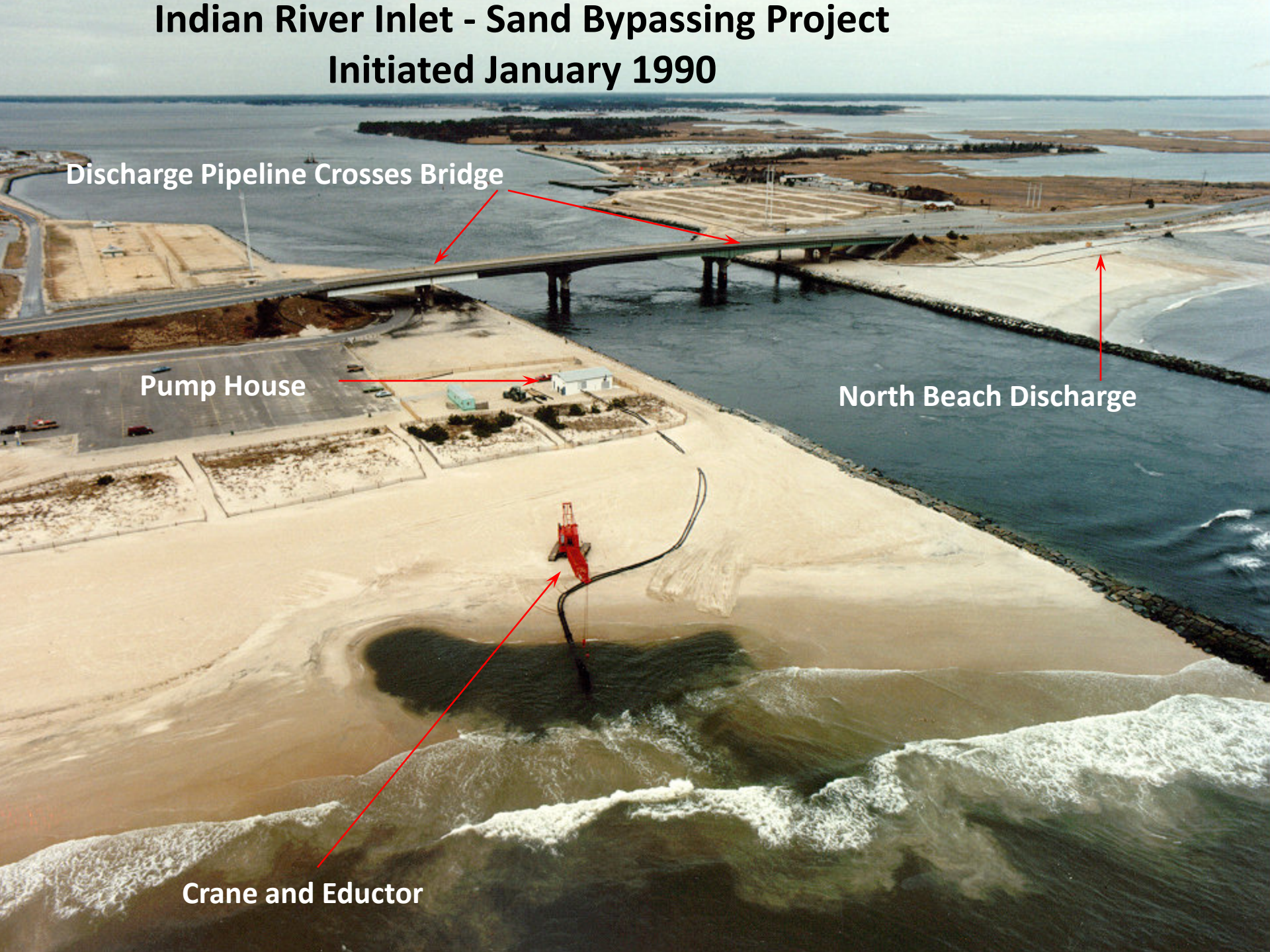
Indian River Inlet - Sand Bypassing Project Initiated January 1990

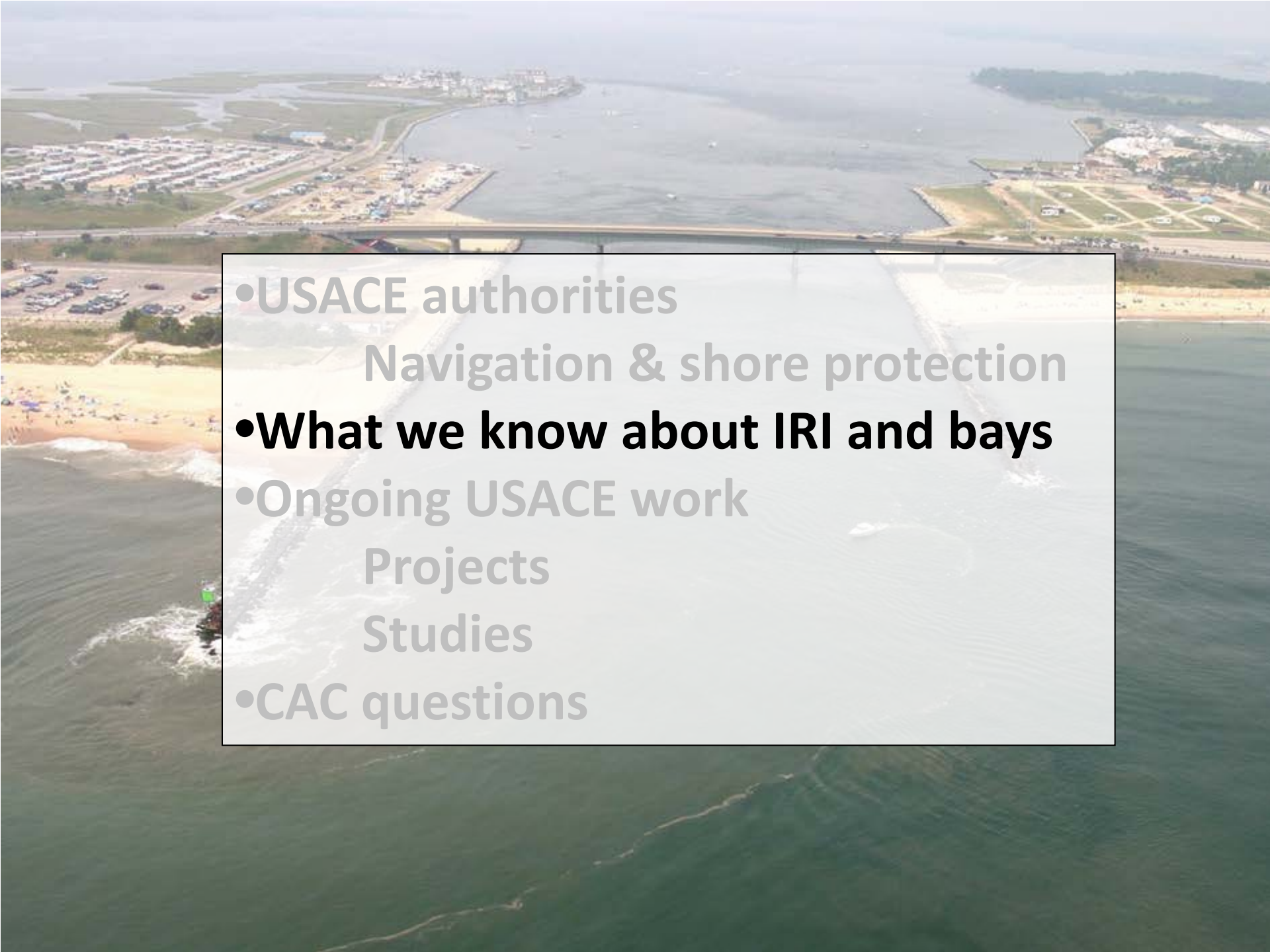
Discharge Pipeline Crosses Bridge

Pump House

North Beach Discharge

Crane and Eductor



- 
- An aerial photograph of a coastal area. In the foreground, there's a sandy beach with some people and a small boat in the water. A long bridge spans across a wide body of water. In the background, there are various land developments, including what looks like a residential area and some industrial or commercial sites. The water is a mix of light and dark green, suggesting different depths or vegetation. The sky is overcast.
- USACE authorities
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Bays

Surface area:
29 sq mi.

Upland DA:
250 sq mi.

Inlet Tidal Prism
 $\times 10^8$ cu ft

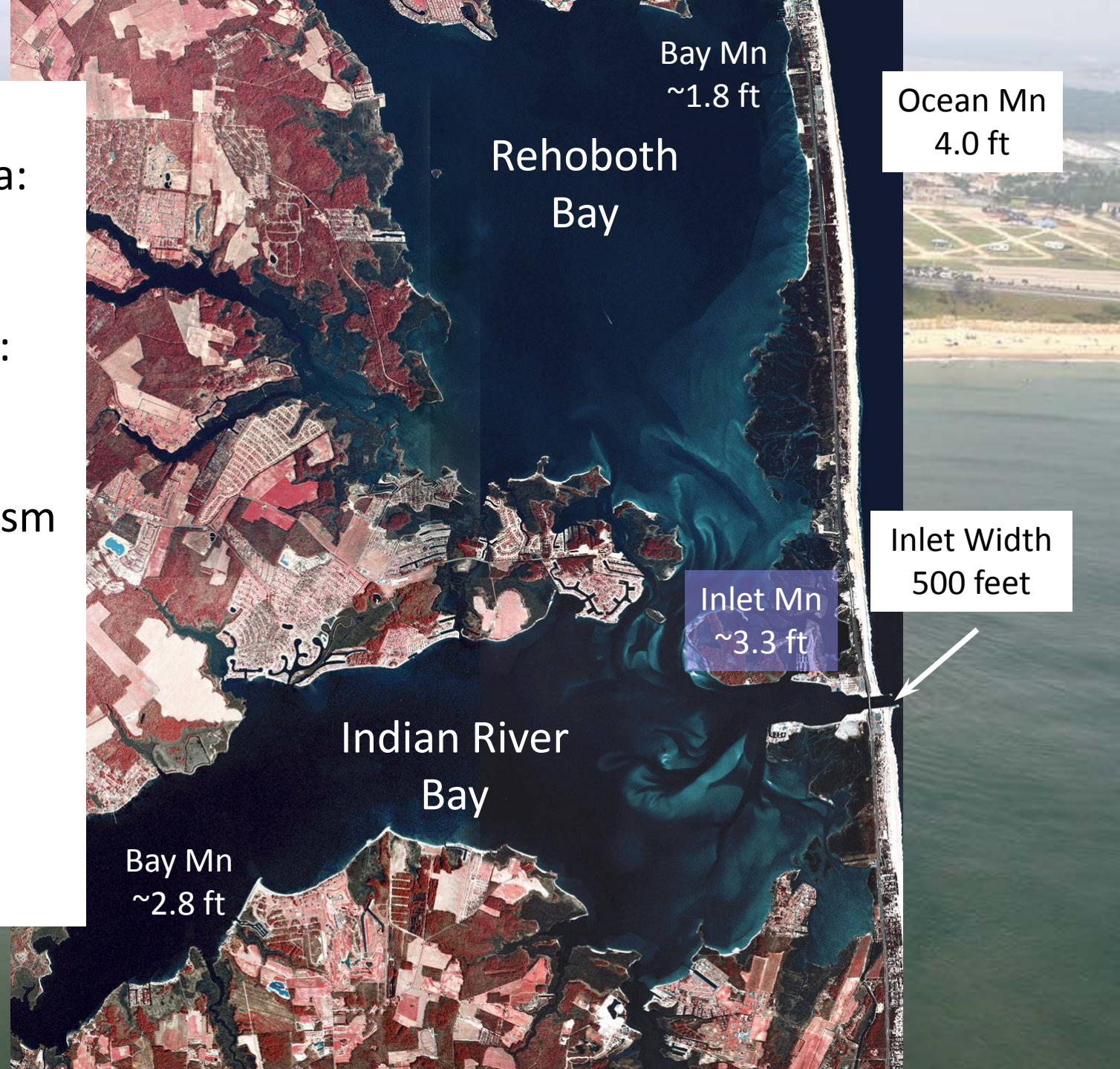
1948: 4

1975: 10

1983: 20 - 33

1986: 13 - 15

2004: 10 - 22



Bay Mn
~1.8 ft

Ocean Mn
4.0 ft

Rehoboth
Bay

Inlet Mn
~3.3 ft

Inlet Width
500 feet

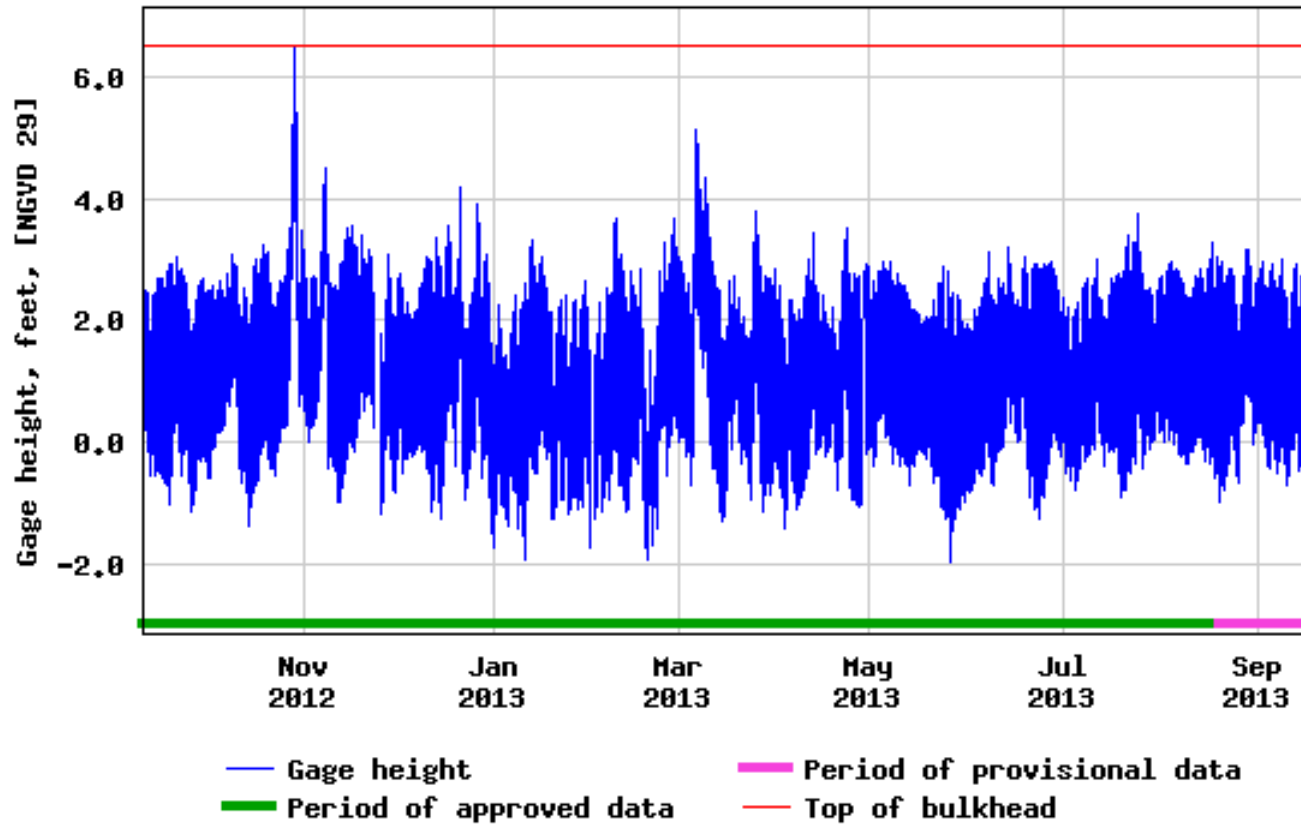
Indian River
Bay

Bay Mn
~2.8 ft



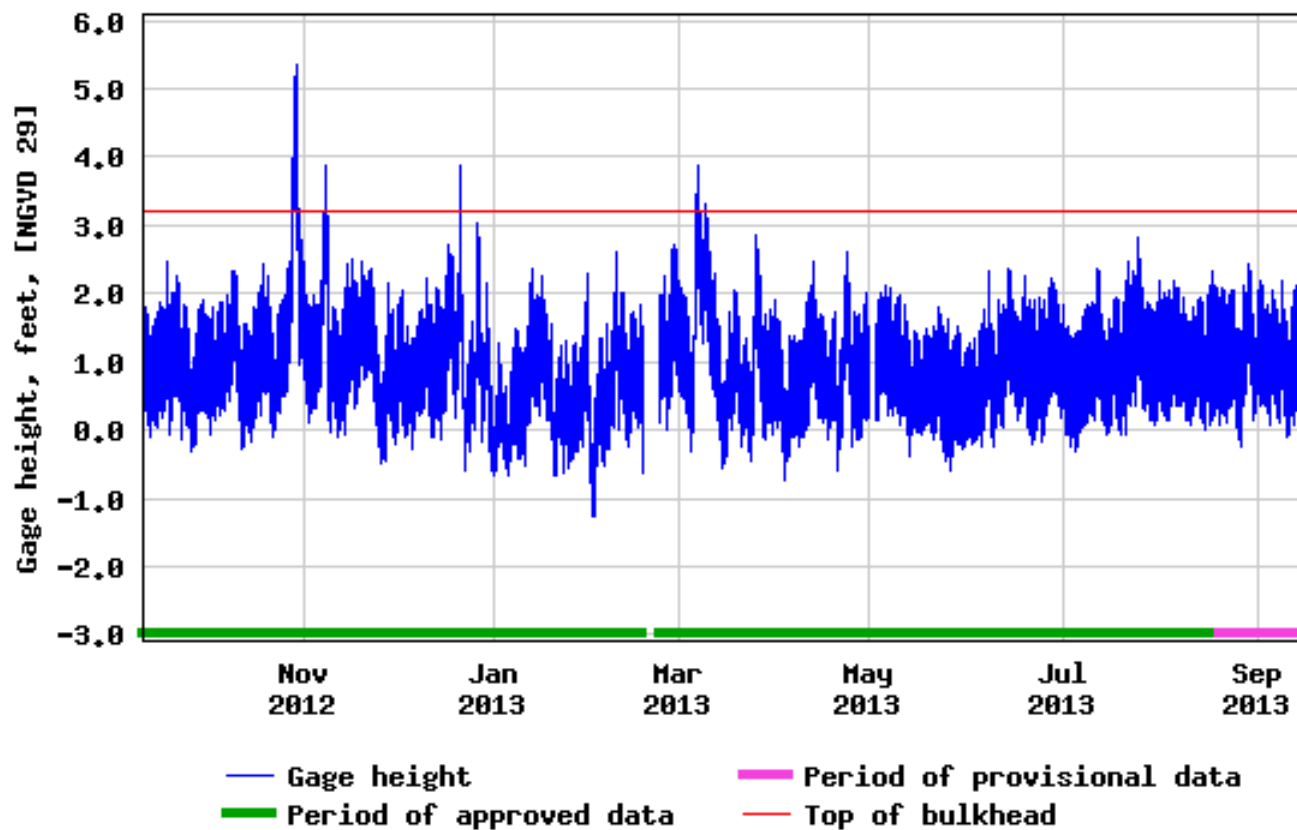
Tide gage locations (2013)

USGS 01484683 INDIAN RIVER BAY INLET NEAR BETHANY BEACH, DE



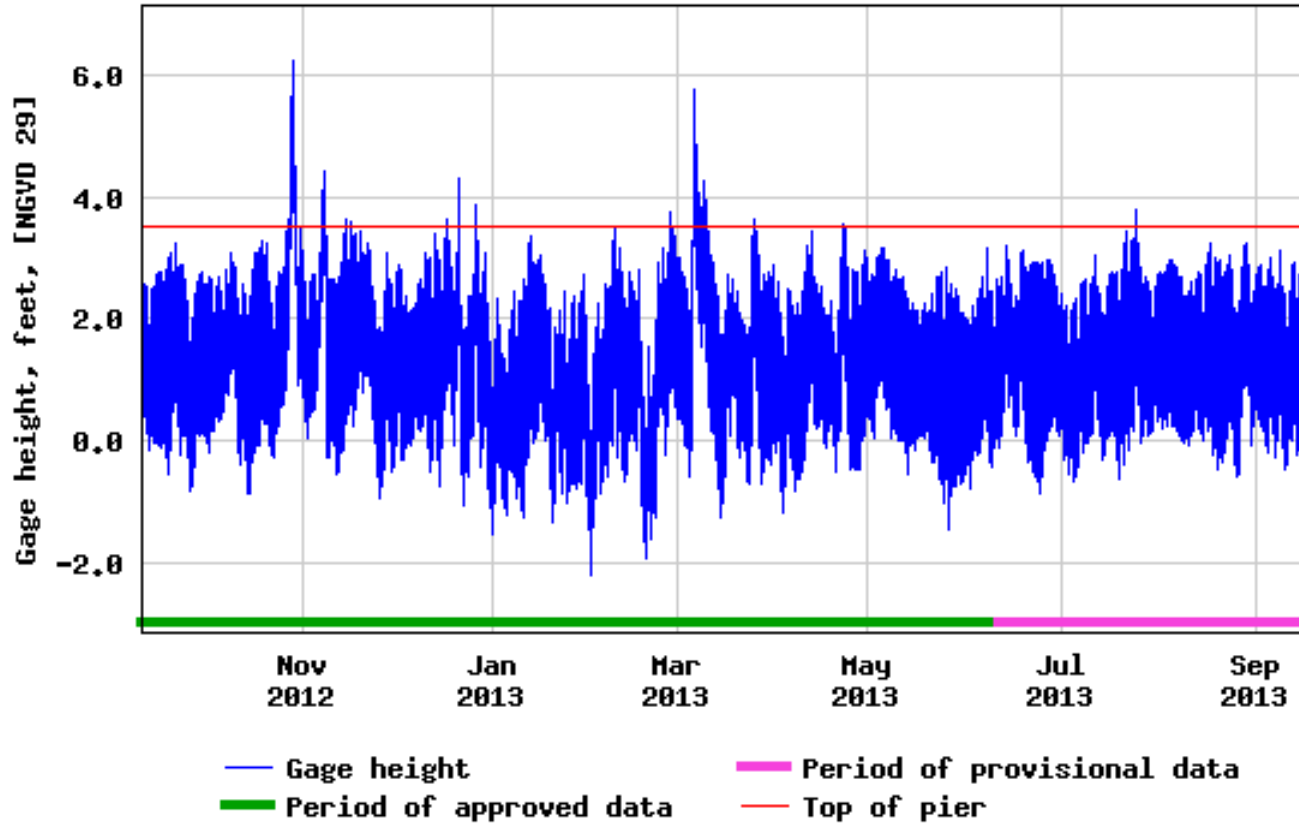
Mean Range ~ 3.3 feet

USGS 01484670 REHOBOTH BAY AT DEWEY BEACH, DE



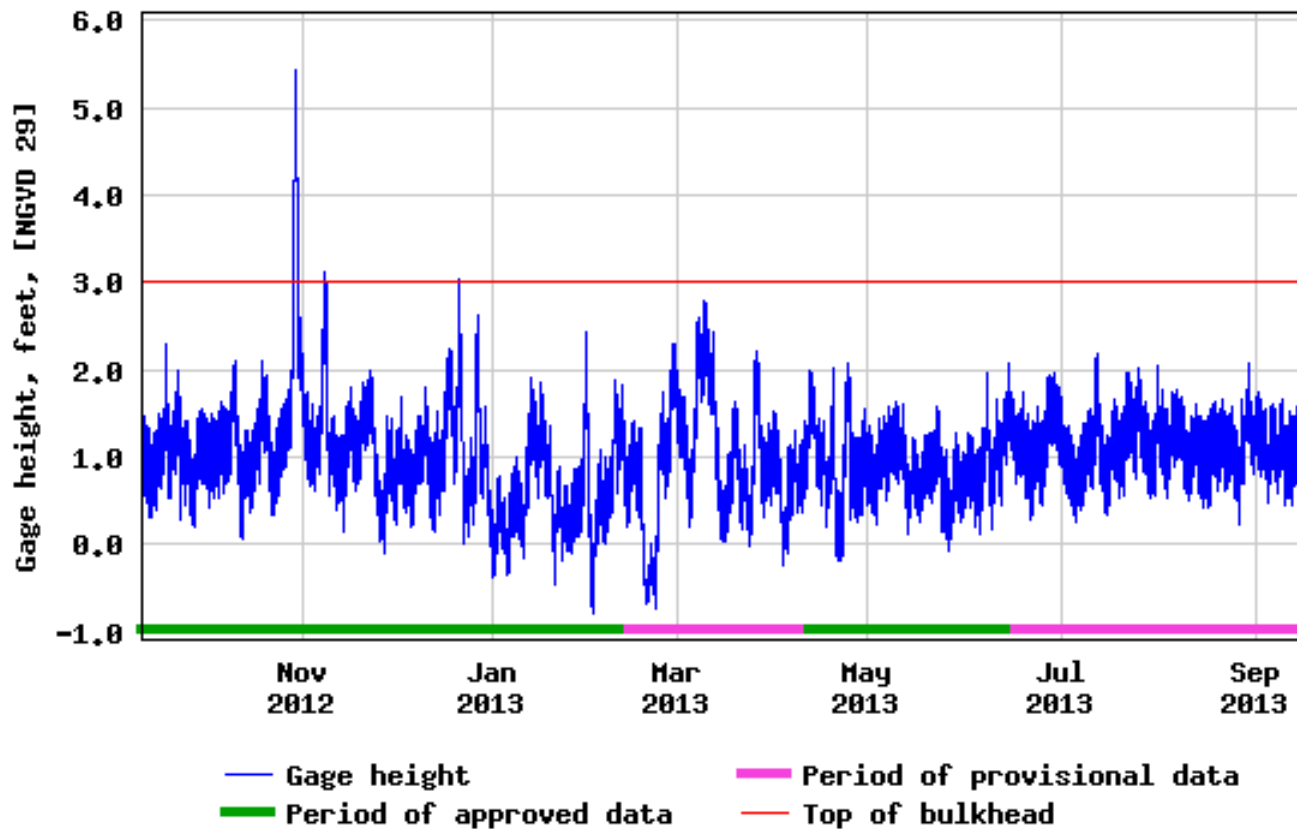
Mean Range ~ 1.8 feet

USGS 01484540 INDIAN RIVER AT ROSEDALE BEACH, DE



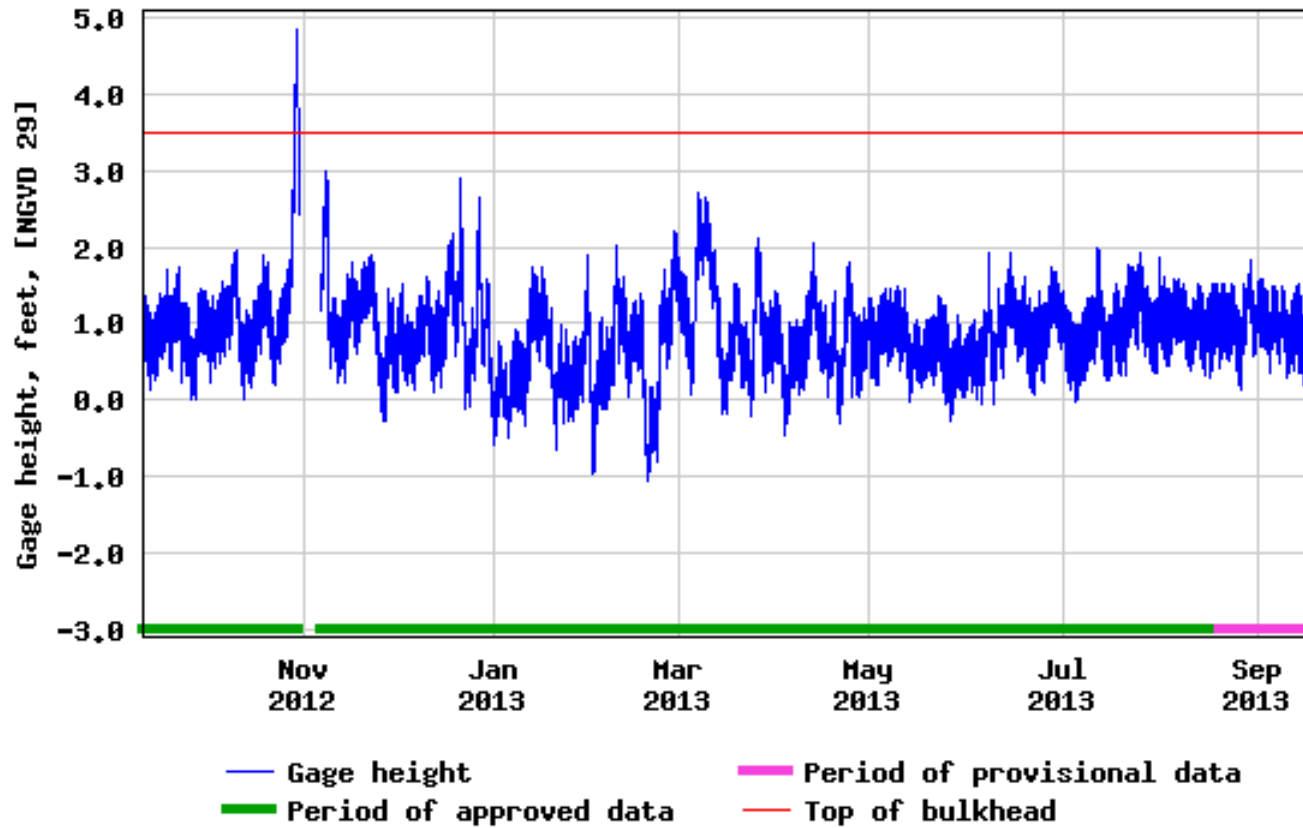
Mean Range ~ 2.8 feet

USGS 01484696 JEFFERSON CREEK AT SOUTH BETHANY, DE



Mean Range ~ 1.0 feet

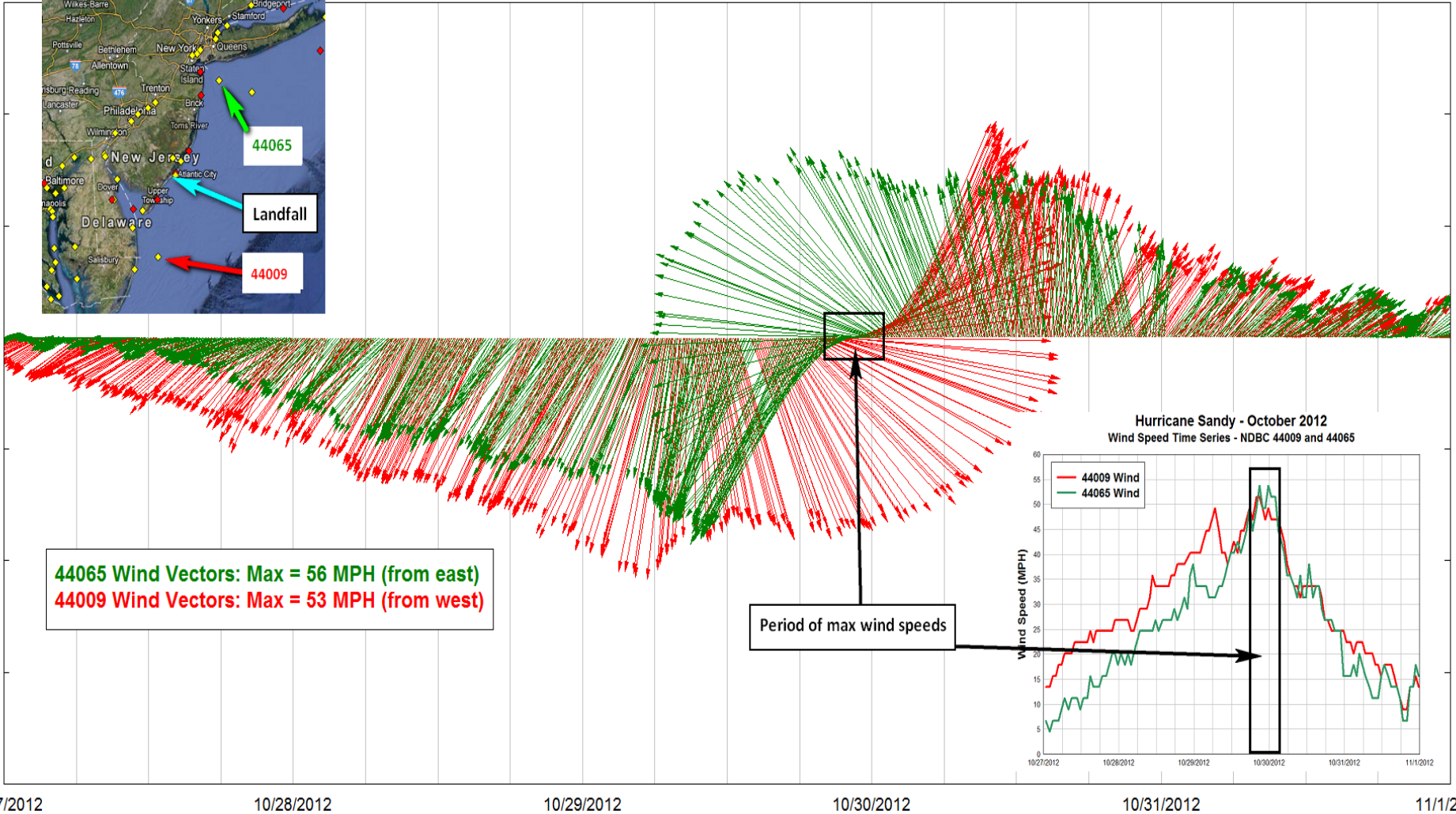
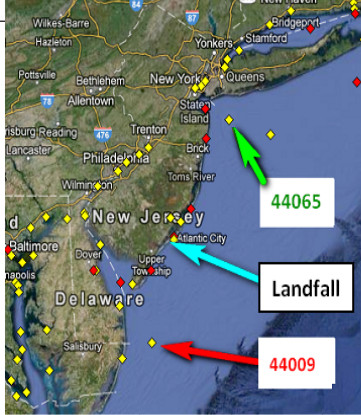
USGS 01484701 LITTLE ASSAWOMAN BAY AT FENWICK ISLAND, DE



Mean Range ~ 1.1 feet

Hurricane Sandy

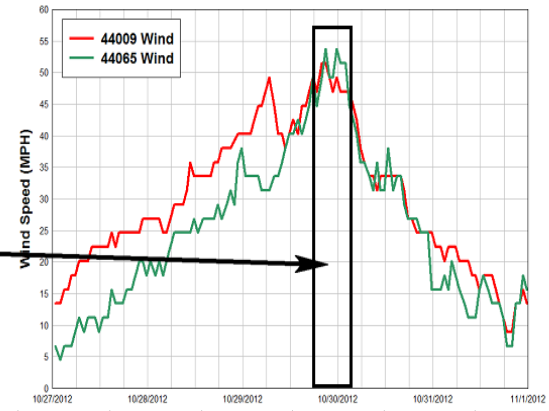
Hurricane Sandy - October 2012
Wind Vector Time Series at NDBC 44009 and 44065



44065 Wind Vectors: Max = 56 MPH (from east)
44009 Wind Vectors: Max = 53 MPH (from west)

Period of max wind speeds

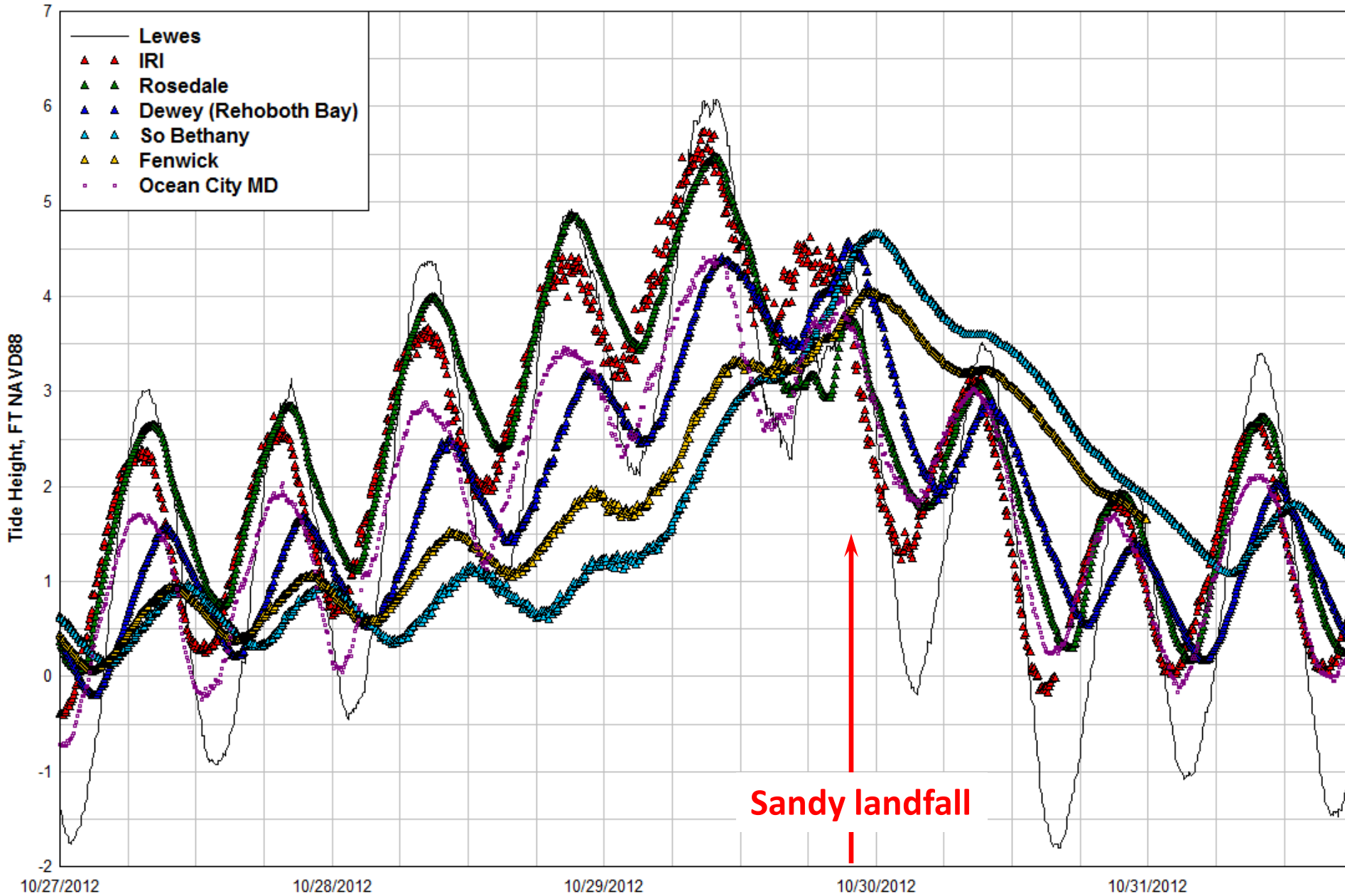
Hurricane Sandy - October 2012
Wind Speed Time Series - NDBC 44009 and 44065



10/27/2012 10/28/2012 10/29/2012 10/30/2012 10/31/2012 11/1/2012

Sandy Tides in Delaware Inland Bays

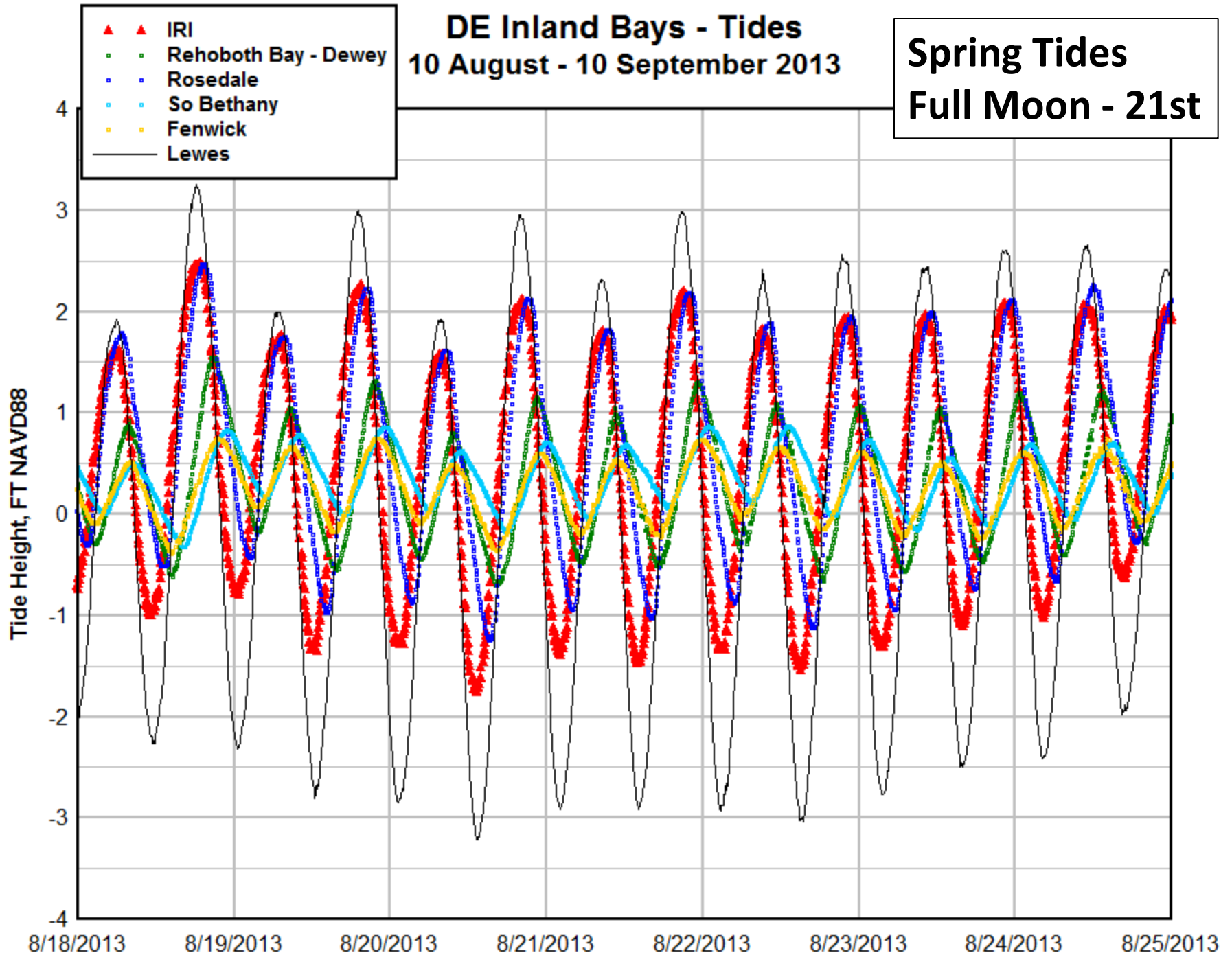
27 - 31 October 2012



DE Inland Bays - Tides

10 August - 10 September 2013

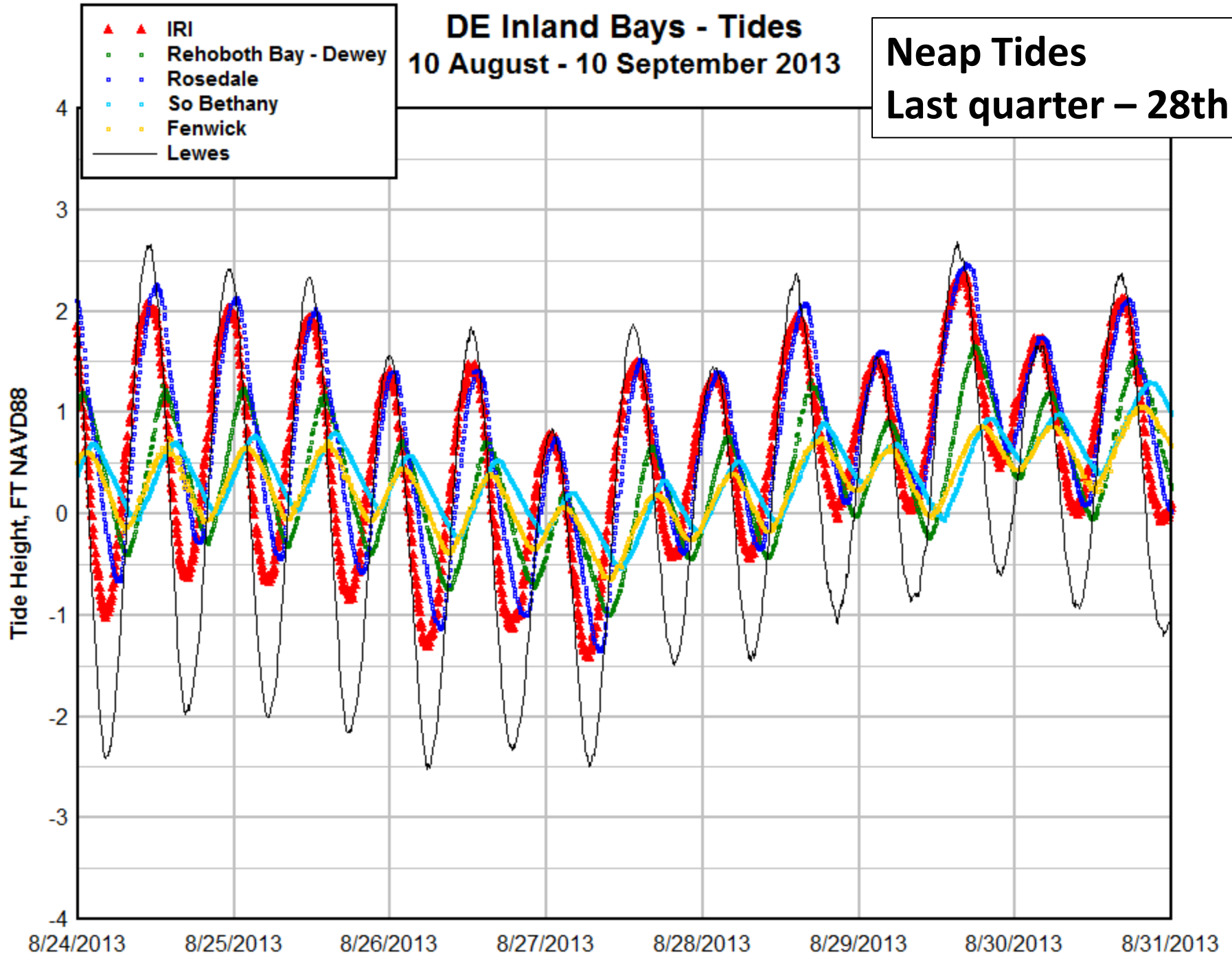
Spring Tides
Full Moon - 21st



DE Inland Bays - Tides

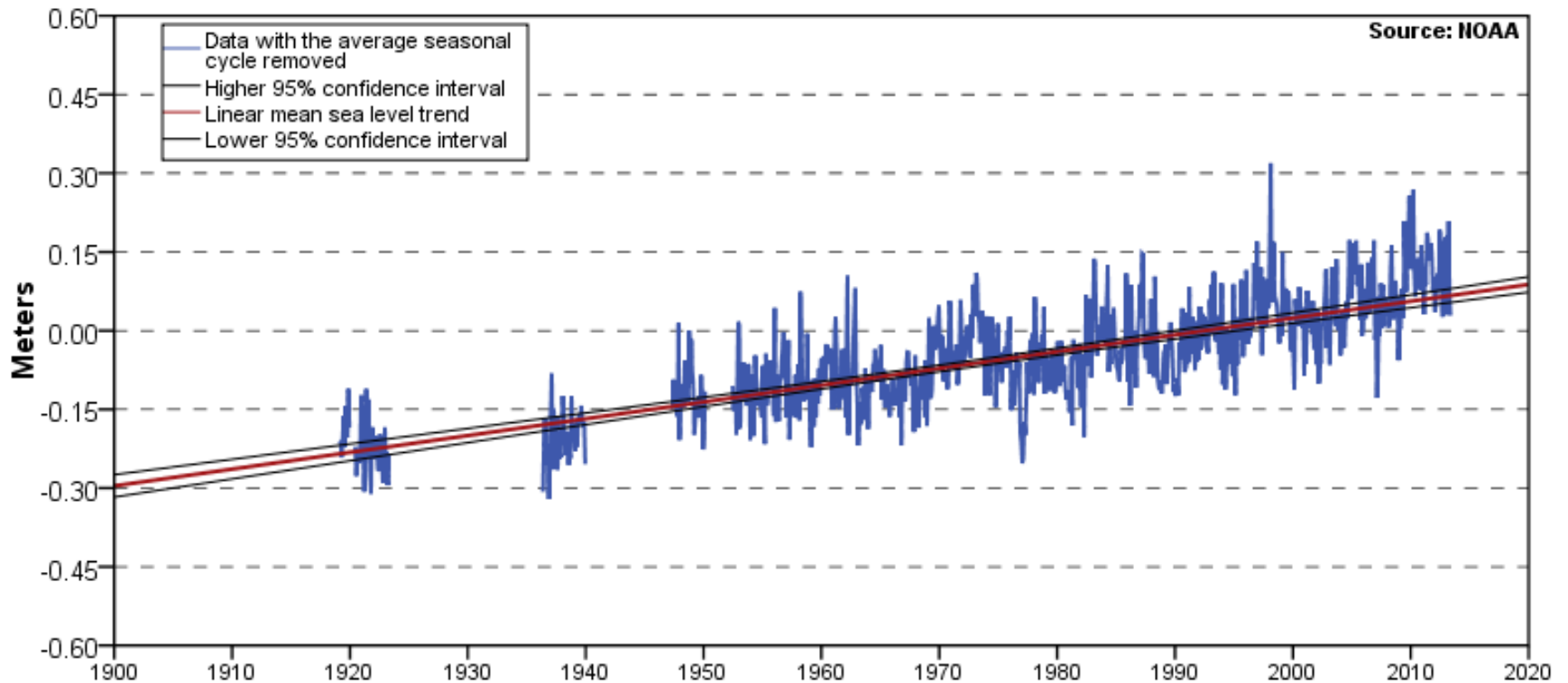
10 August - 10 September 2013

Neap Tides
Last quarter – 28th



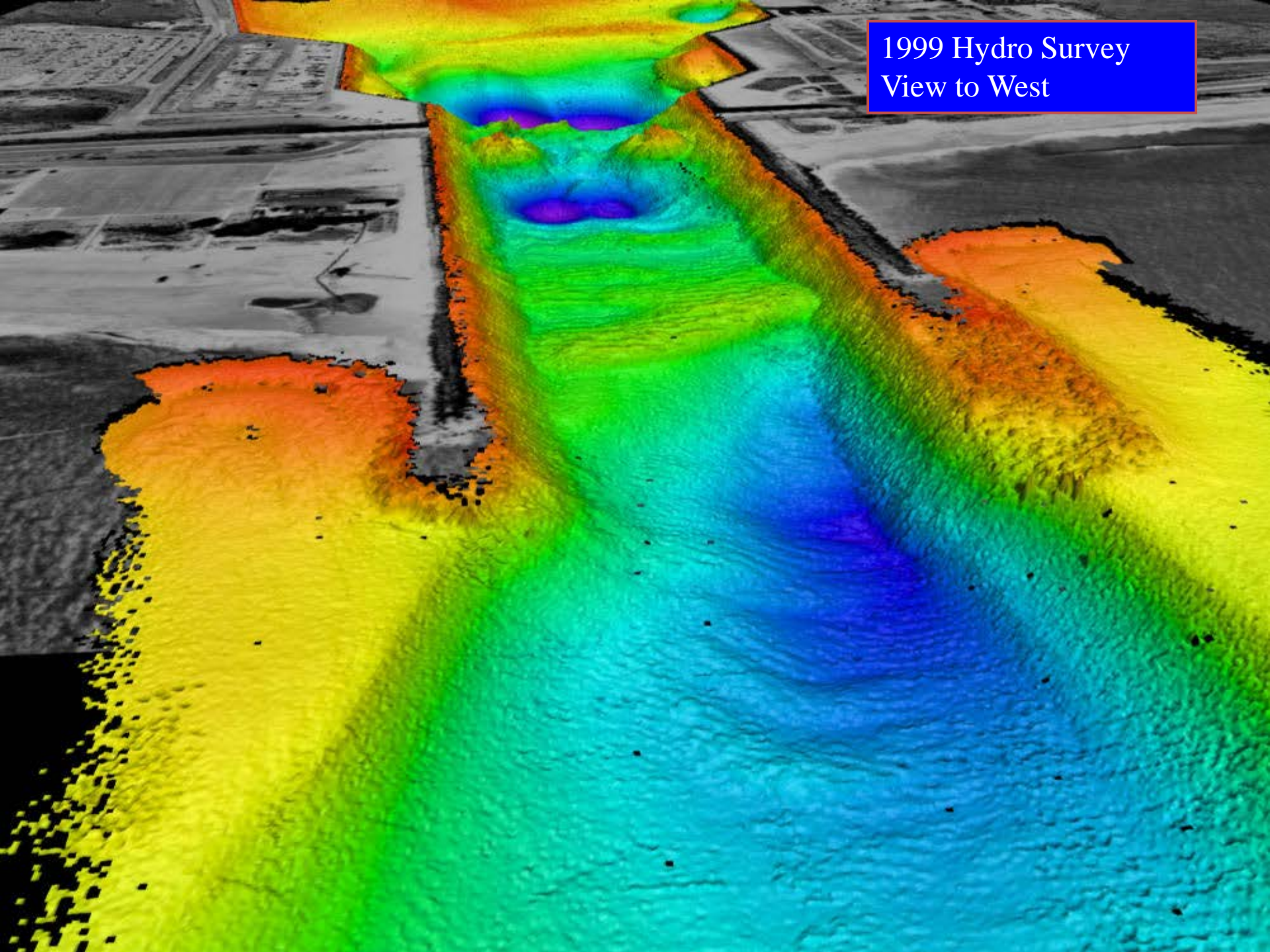
Mean Sea Level Trend 8557380 Lewes, Delaware

Lewes, DE 3.20 +/- 0.28 mm/yr

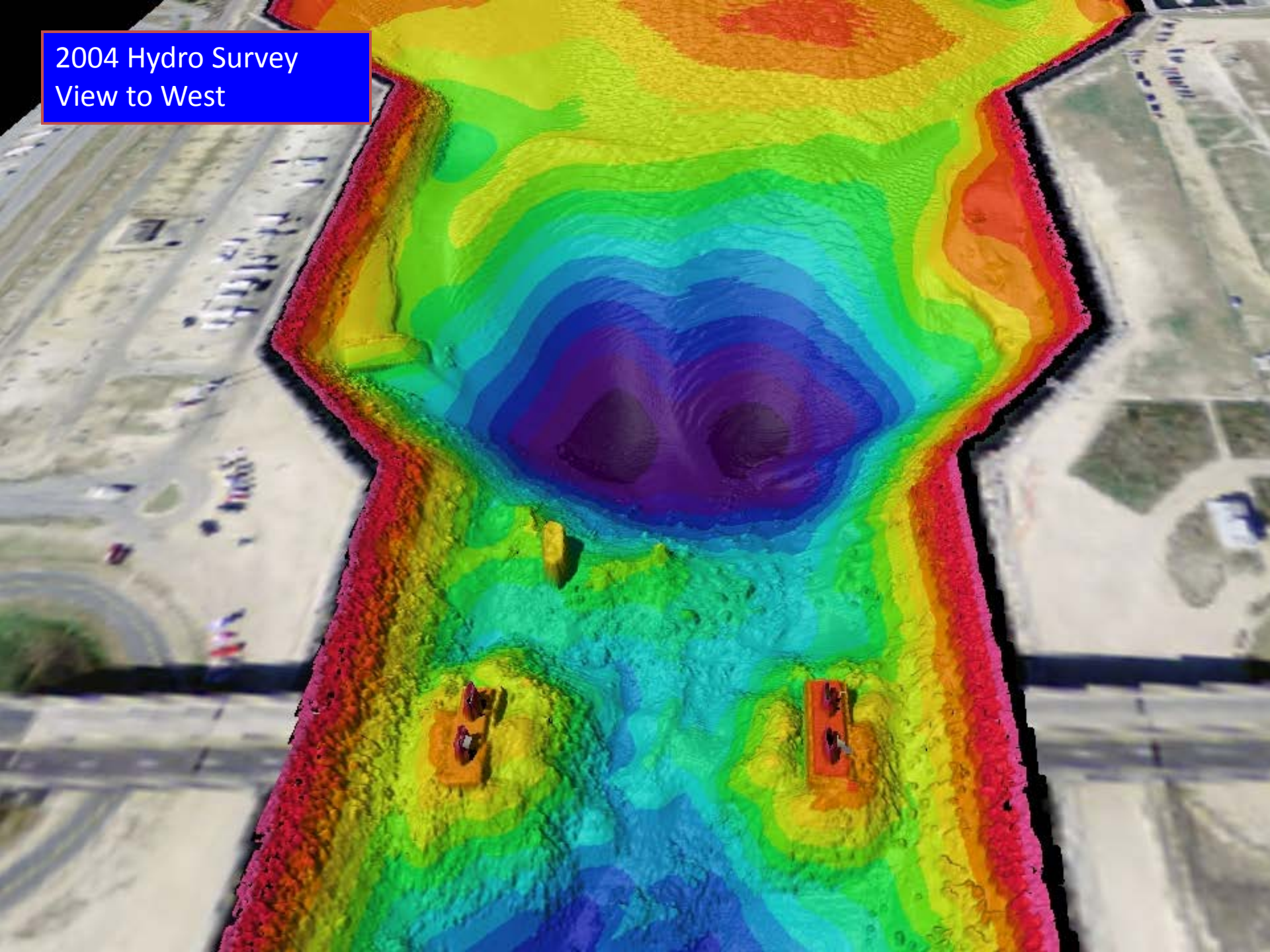


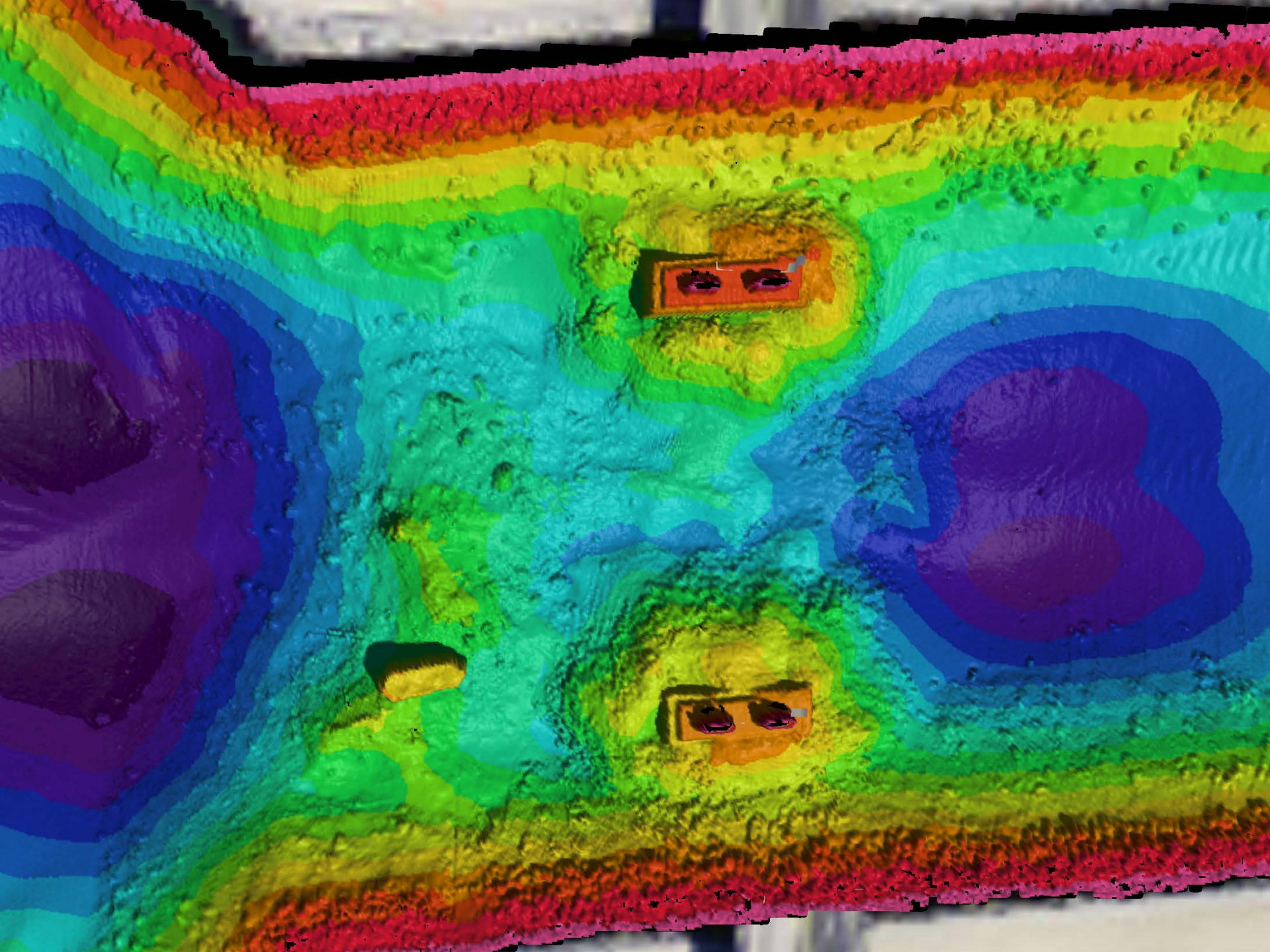
The mean sea level trend is 3.20 millimeters/year with a 95% confidence interval of +/- 0.28 mm/yr based on monthly mean sea level data from 1919 to 2006 which is equivalent to a change of 1.05 feet in 100 years.

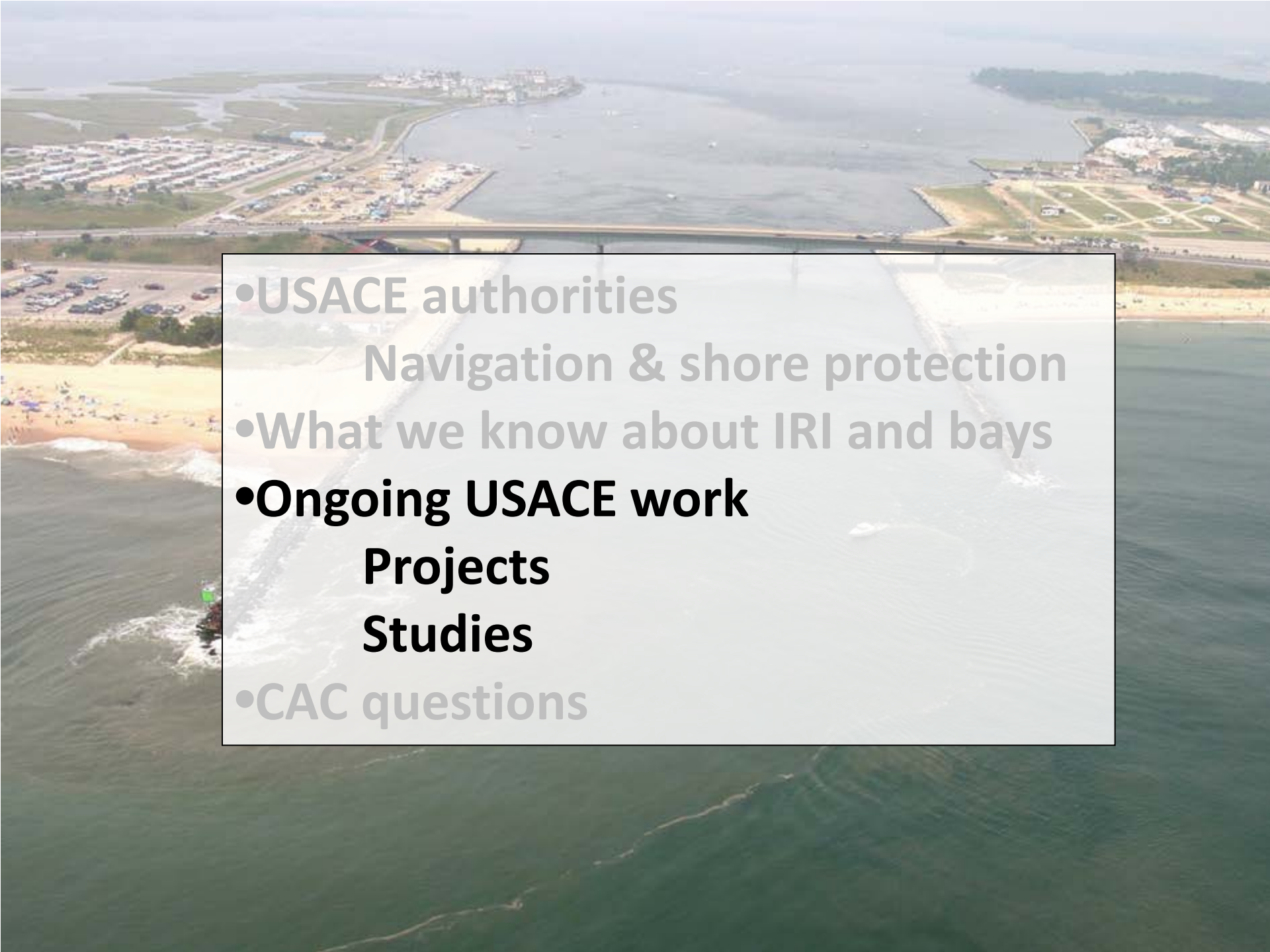
1999 Hydro Survey
View to West



2004 Hydro Survey
View to West



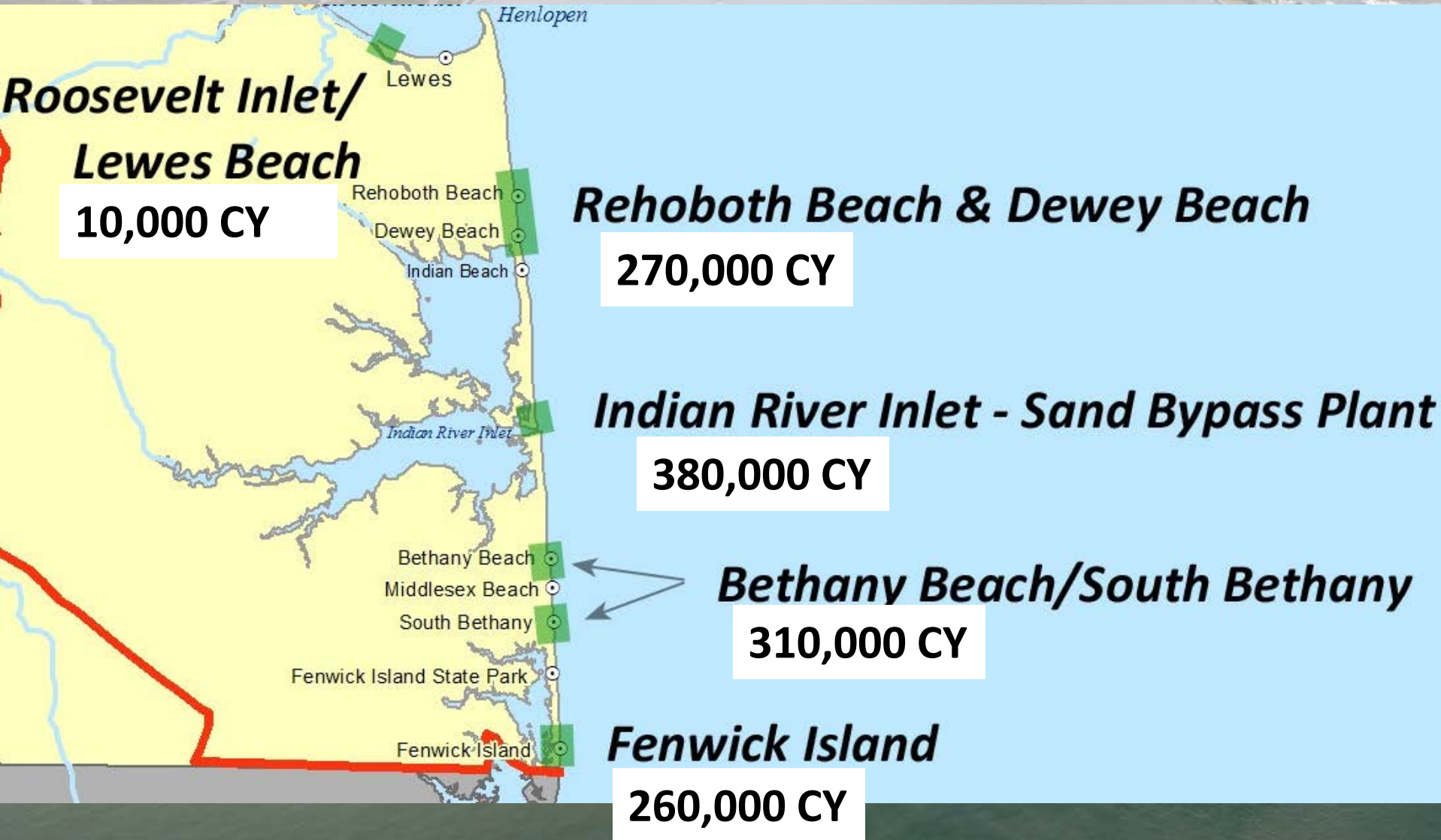


- 
- An aerial photograph of a coastal area. In the foreground, there's a sandy beach with some people and a small boat in the water. A long bridge spans across a wide body of water. In the background, there are residential areas, parking lots, and some industrial or construction sites. The water is a mix of light and dark green, suggesting different depths or vegetation. The sky is overcast.
- USACE authorities
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 - Projects**
 - Studies**
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**Hurricane Sandy
Indian River Inlet**

Hurricane Sandy Restoration



Pennsylvania Avenue, Bethany Beach, DE Flood Reduction Study

- 2009-Study initiated
 - Resident survey, economic analysis, and review of previous studies
- 2012-FSCA signed, \$60K Fed and \$60K non-Fed funds received
 - storm water runoff model was completed, potential structure locations identified outside of Town
- 2012- Hurricane Sandy
 - Town was flooded for days and for longer than adjacent communities
- 2013-Received \$80K of Sandy funds
- 2013-Back bay tidal flooding model is being completed, PDT site visit on 7 August




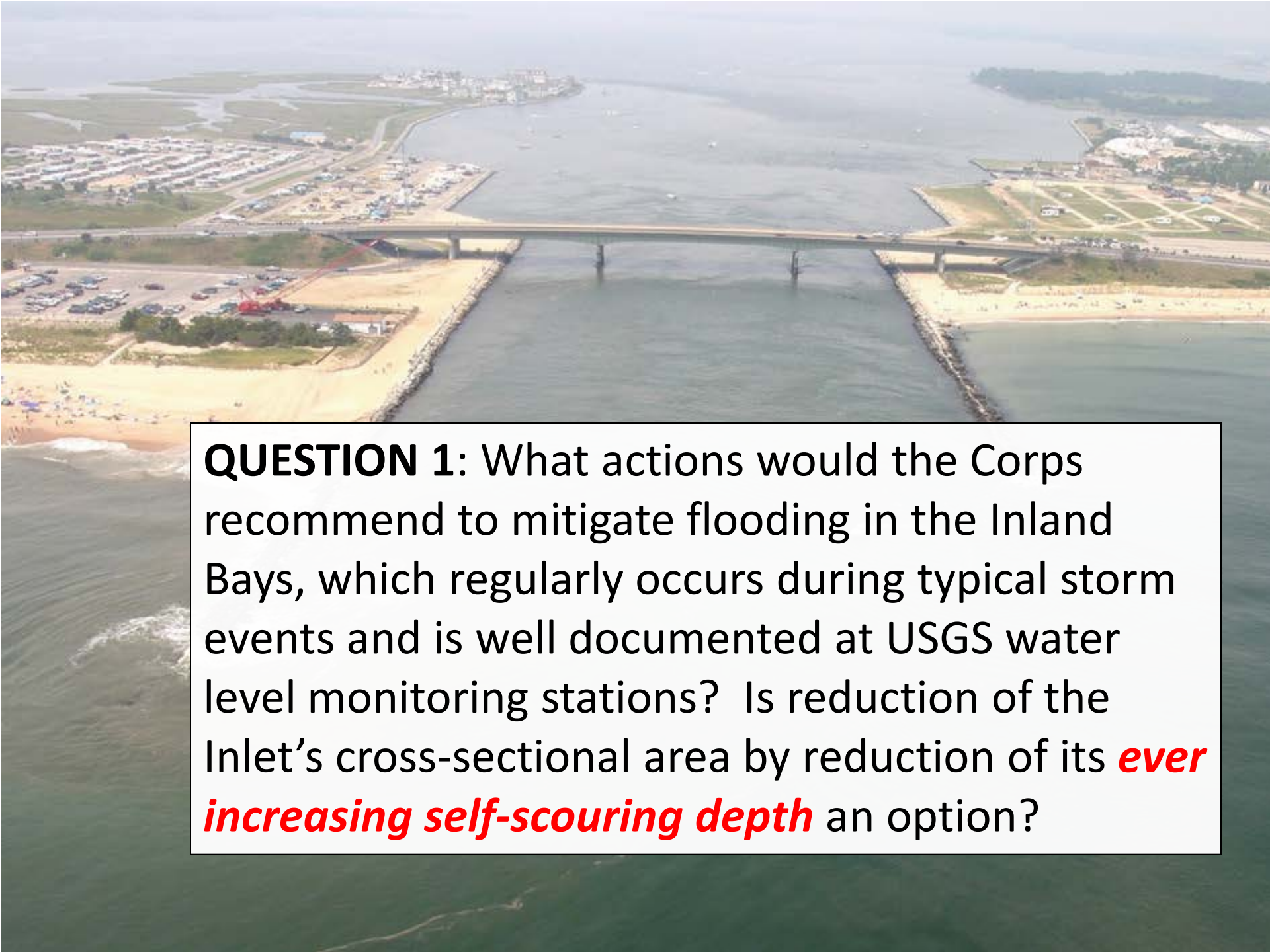


Pennsylvania Avenue, Bethany Beach, DE

Next Steps

- Complete first phase
 - Preliminary alternatives, model alternatives, meet with Town and DNREC
- Resume plan formulation
 - Define existing conditions
 - Determine future without project conditions
 - Formulate Alternative Plans
 - Evaluate Alternative Plans
 - ATR
- Draft Feasibility Report Submittal- March 2014

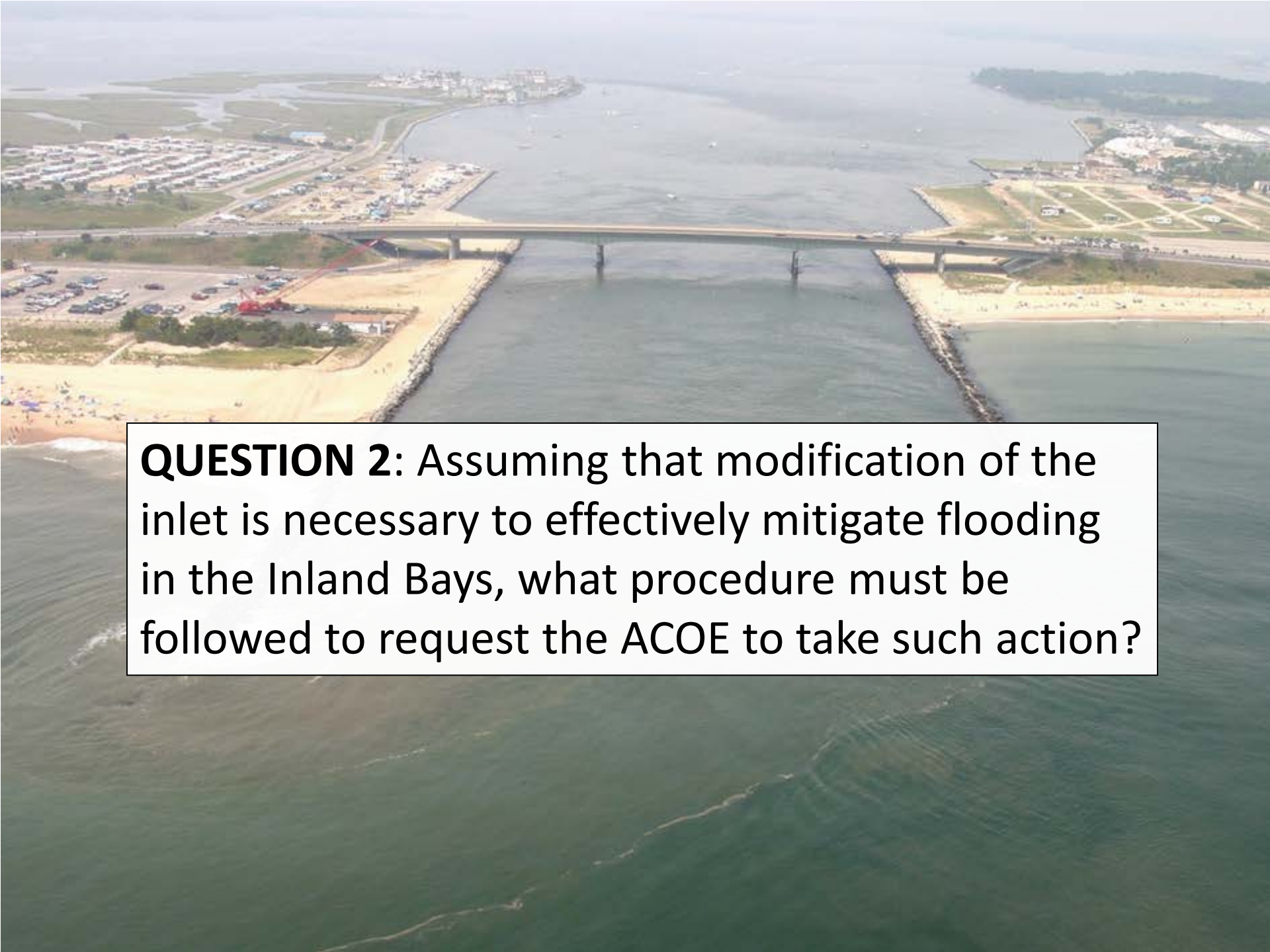
- 
- An aerial photograph of a coastal area. In the foreground, there's a sandy beach with some people and a small boat in the water. A long bridge spans across a wide body of water. In the background, there are residential areas, parking lots, and some industrial or construction sites. The water is a mix of light and dark green, suggesting different depths or vegetation. The sky is overcast.
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An aerial photograph of a coastal inlet. A long bridge spans across the inlet, connecting two landmasses. The land on both sides is developed with residential areas, parking lots, and some commercial buildings. The water in the inlet is calm, and the surrounding ocean is visible in the foreground. The sky is overcast.

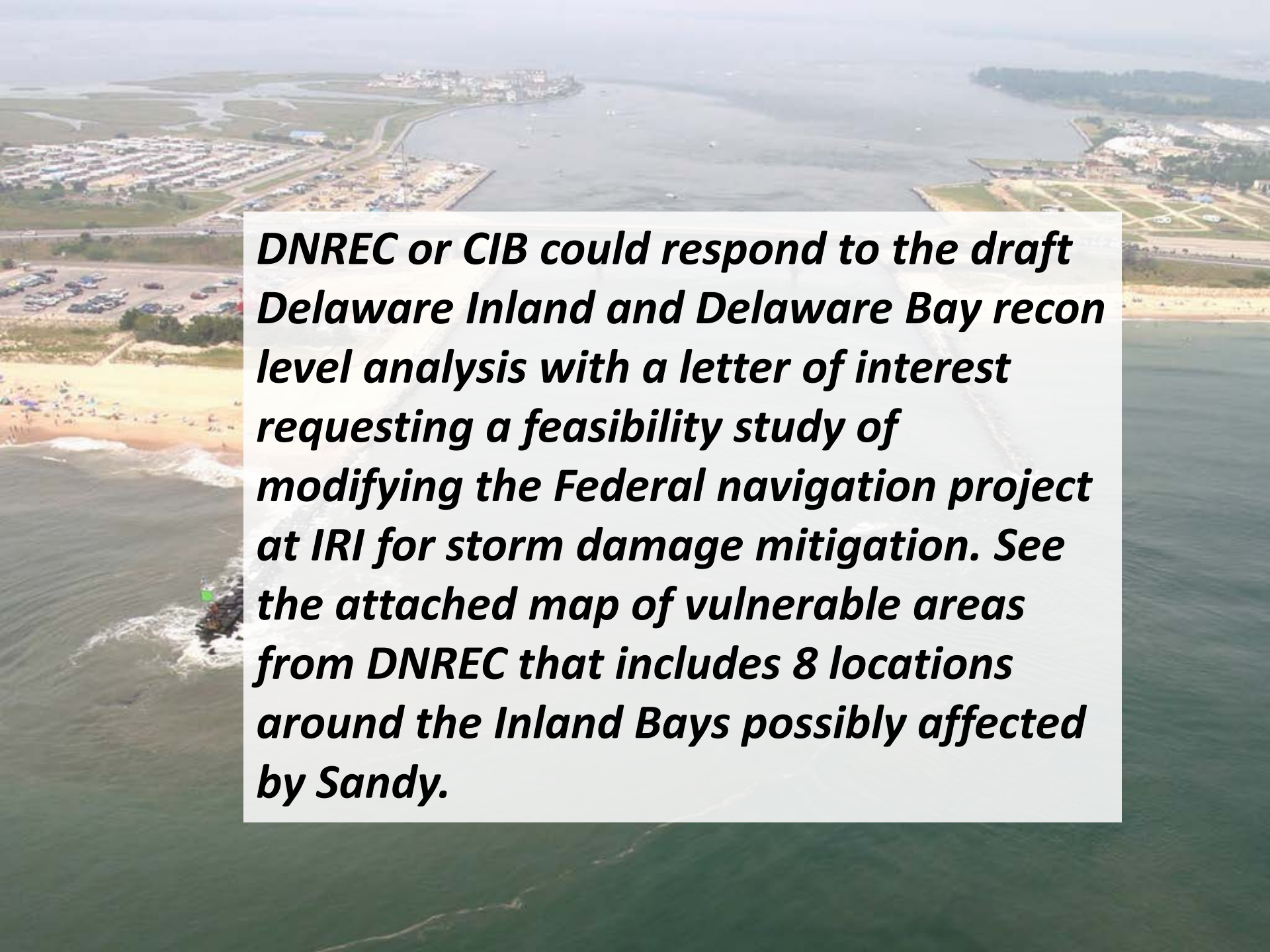
QUESTION 1: What actions would the Corps recommend to mitigate flooding in the Inland Bays, which regularly occurs during typical storm events and is well documented at USGS water level monitoring stations? Is reduction of the Inlet's cross-sectional area by reduction of its *ever increasing self-scouring depth* an option?



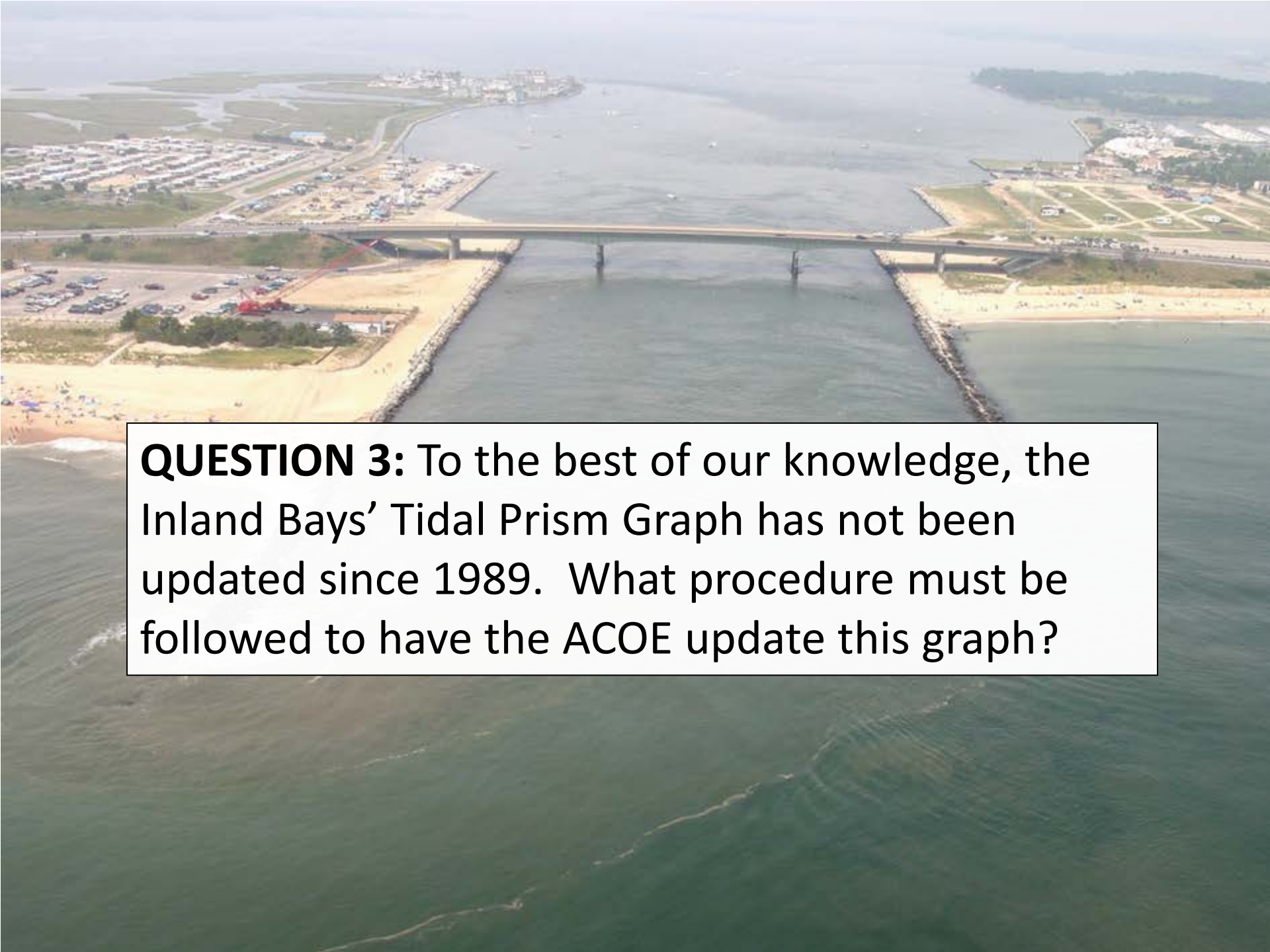
One potential solution . . .



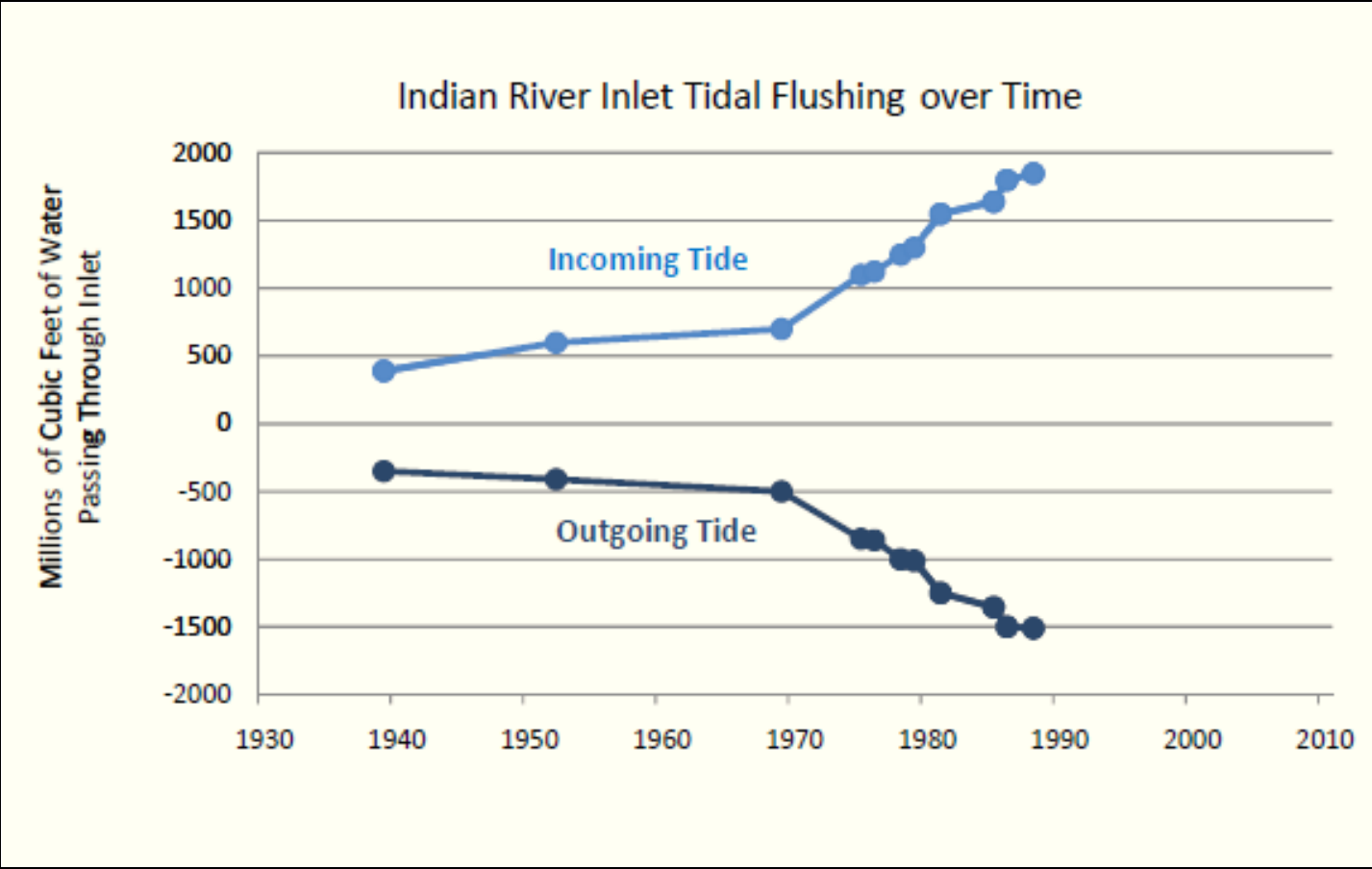
QUESTION 2: Assuming that modification of the inlet is necessary to effectively mitigate flooding in the Inland Bays, what procedure must be followed to request the ACOE to take such action?

An aerial photograph of a coastal region. In the foreground, there is a sandy beach with some people and a small structure. The ocean waves are breaking onto the shore. In the middle ground, there is a large residential area with many houses and a parking lot. A road runs through the area. In the background, there is a large body of water, likely a bay or inlet, with a small town or village on a peninsula. The sky is overcast.

DNREC or CIB could respond to the draft Delaware Inland and Delaware Bay recon level analysis with a letter of interest requesting a feasibility study of modifying the Federal navigation project at IRI for storm damage mitigation. See the attached map of vulnerable areas from DNREC that includes 8 locations around the Inland Bays possibly affected by Sandy.

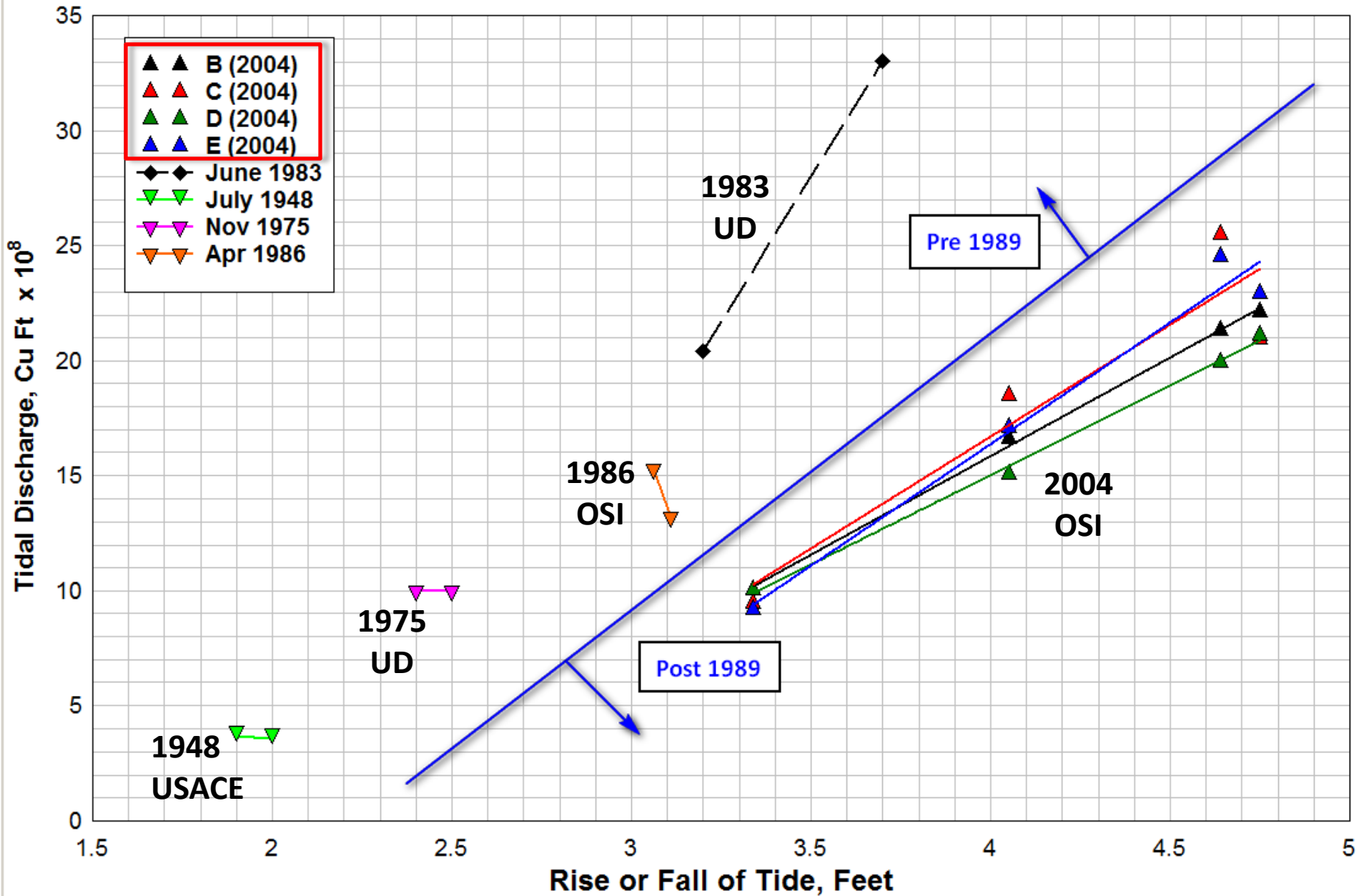


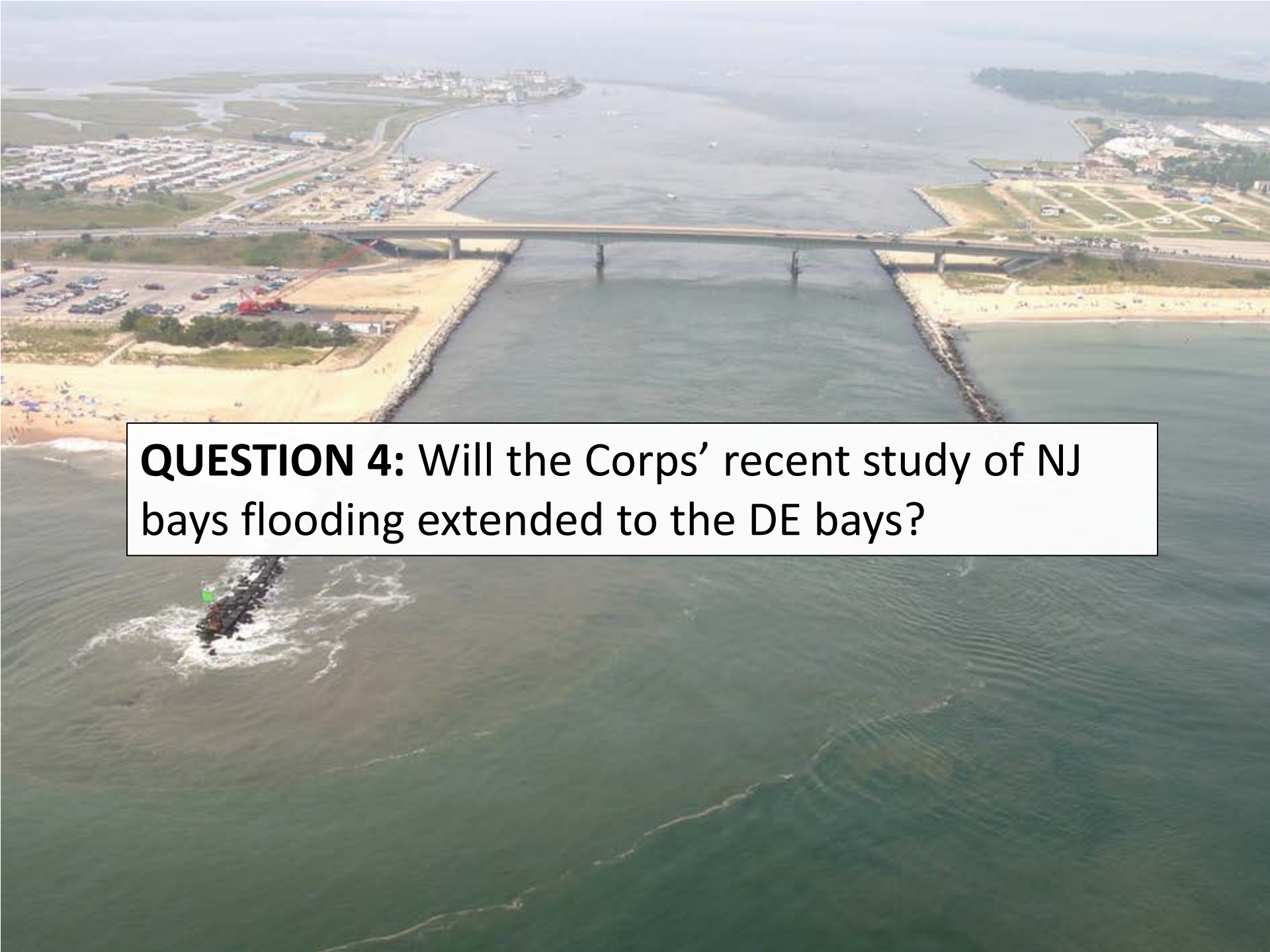
QUESTION 3: To the best of our knowledge, the Inland Bays' Tidal Prism Graph has not been updated since 1989. What procedure must be followed to have the ACOE update this graph?



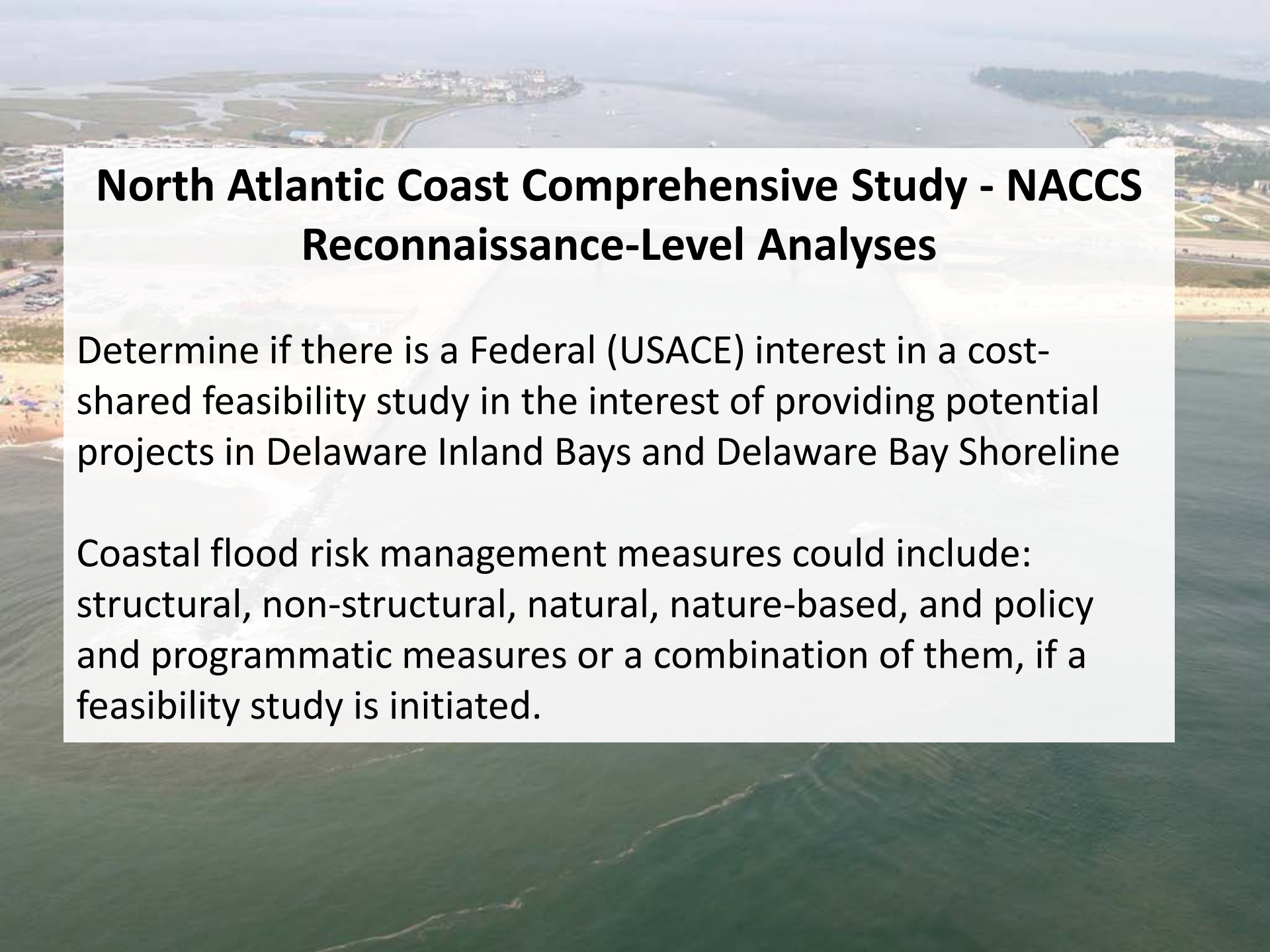
Source: 2011 State of the Bays Report

December 2004 Indian River Inlet Tides and Tidal Prisms





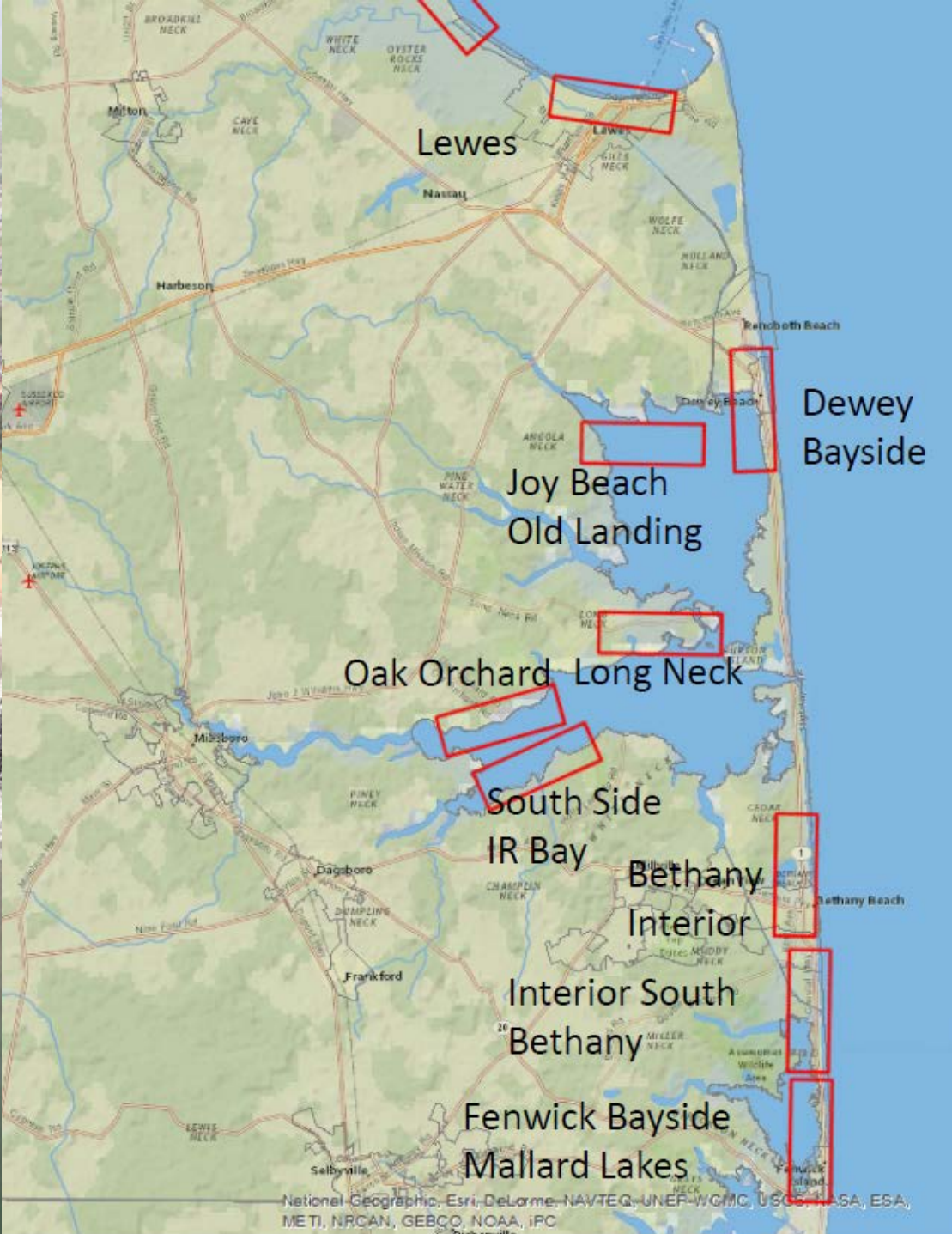
QUESTION 4: Will the Corps' recent study of NJ bays flooding extended to the DE bays?

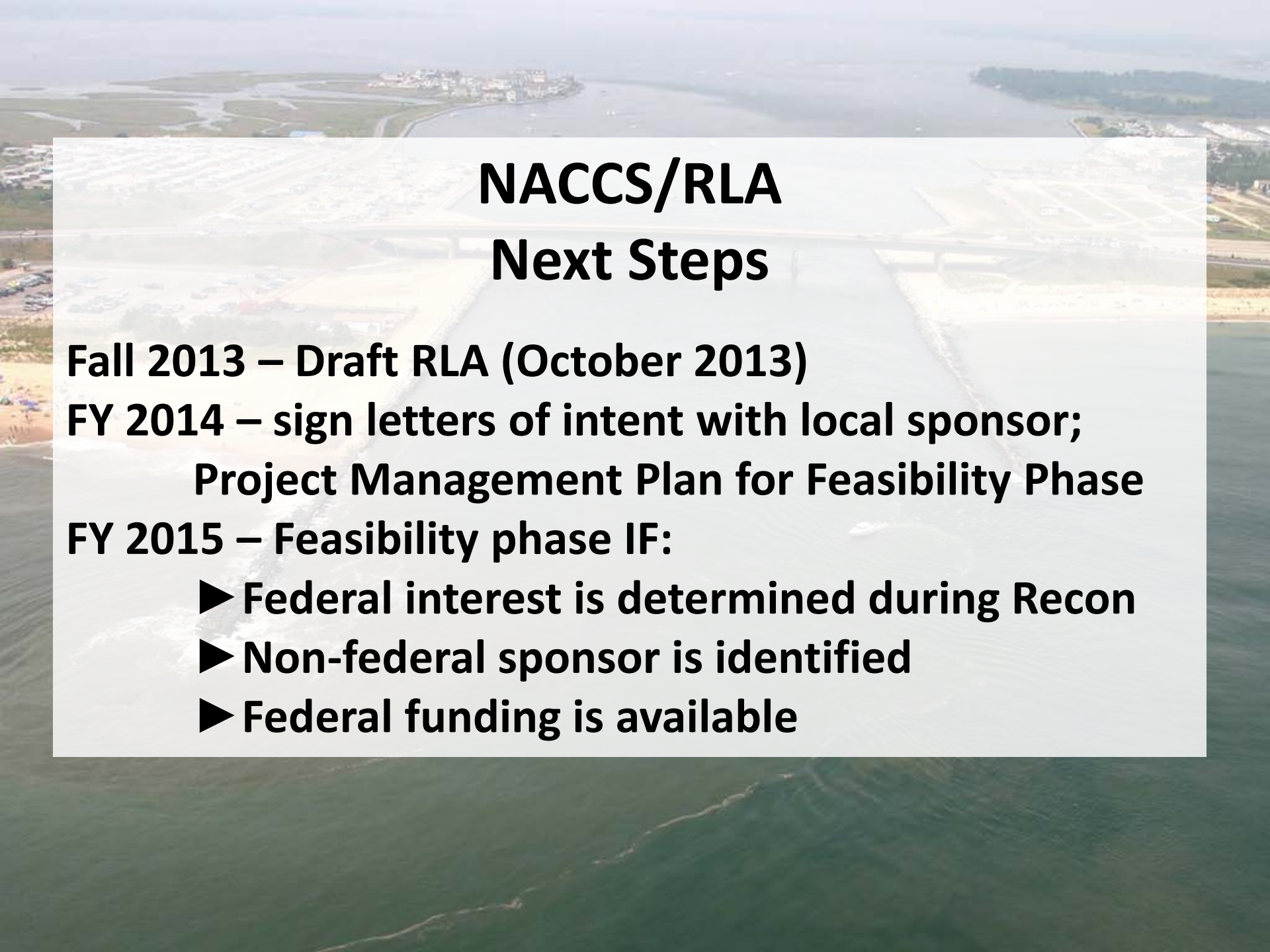
An aerial photograph of a coastal region, likely Delaware Bay, showing a large body of water, marshlands, and a small town on a peninsula. The image is used as a background for the text overlay.

North Atlantic Coast Comprehensive Study - NACCS Reconnaissance-Level Analyses

Determine if there is a Federal (USACE) interest in a cost-shared feasibility study in the interest of providing potential projects in Delaware Inland Bays and Delaware Bay Shoreline

Coastal flood risk management measures could include: structural, non-structural, natural, nature-based, and policy and programmatic measures or a combination of them, if a feasibility study is initiated.





NACCS/RLA

Next Steps

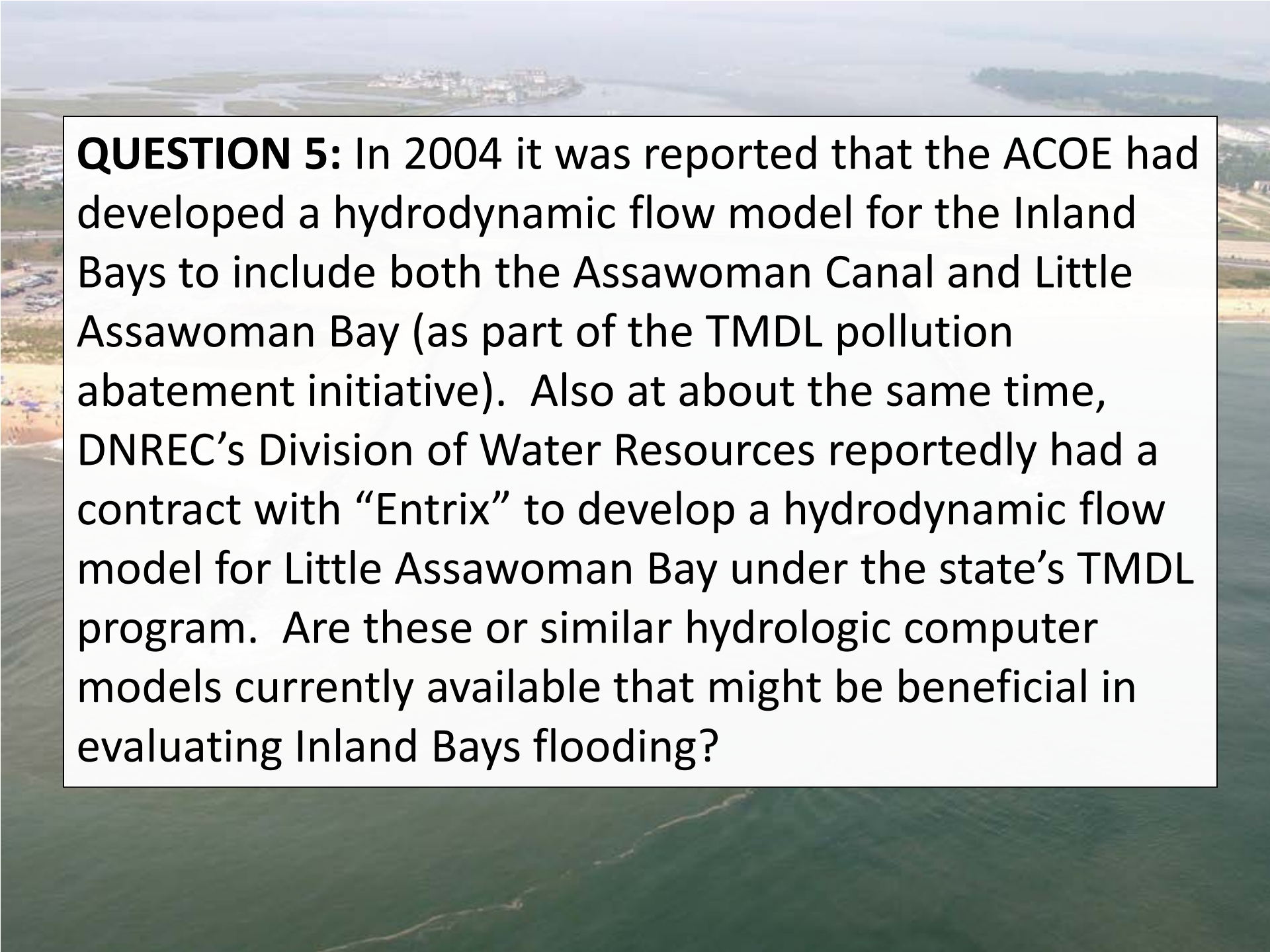
Fall 2013 – Draft RLA (October 2013)

FY 2014 – sign letters of intent with local sponsor;

Project Management Plan for Feasibility Phase

FY 2015 – Feasibility phase IF:

- ▶ Federal interest is determined during Recon**
- ▶ Non-federal sponsor is identified**
- ▶ Federal funding is available**

An aerial photograph of a coastal region, likely the Inland Bays area mentioned in the text. The image shows a mix of green land, blue water, and some buildings or structures. The water appears to be a bay or inlet, with some landmasses and a canal visible. The overall scene is a natural coastal landscape with some human development.

QUESTION 5: In 2004 it was reported that the ACOE had developed a hydrodynamic flow model for the Inland Bays to include both the Assawoman Canal and Little Assawoman Bay (as part of the TMDL pollution abatement initiative). Also at about the same time, DNREC's Division of Water Resources reportedly had a contract with "Entrix" to develop a hydrodynamic flow model for Little Assawoman Bay under the state's TMDL program. Are these or similar hydrologic computer models currently available that might be beneficial in evaluating Inland Bays flooding?

INLET PROCESSES MODELING STUDY – INDIAN RIVER INLET, DELAWARE

Draft Report

30 June 2006

INTRODUCTION

This report presents results of the first phase of a numerical modeling study of Indian River Inlet, Delaware. The scope of the study is to analyze inlet processes that control scour, structure stability, ebb and flood shoal change, and tidal exchange between the Atlantic Ocean and Rehoboth and Indian River Bays. The objectives of the study are to: (1) identify causative factors that have produced persistent scour in several areas of the inlet and led to structural instability, (2) understand the function of the inlet in controlling sediment transport patterns, and its influence on the regional sediment budget, and (3) apply the information gained from the first two objectives to develop and evaluate design alternatives to minimize scour and stabilize inlet structures, maintain navigation, improve sediment management at the inlet, and enhance water quality in the bays. The first phase of the work presented herein focuses on inlet circulation modeling including: data collection, model grid development, evaluation of ocean and bay water level modeling stations, model calibration, and preliminary assessment of alternatives. The second phase of proposed work will include: detailed assessment of alternatives (impacts on inlet circulation, sediment transport patterns and backbay water levels), environmental studies, selection of a recommended plan, and development of plans and specifications for the recommended plan. The third proposed phase is construction of the recommended plan.

December 2004 Measurements



Figure 1: Indian River Inlet survey area



Discussion, Q&A





Pre-bypassing - 1988



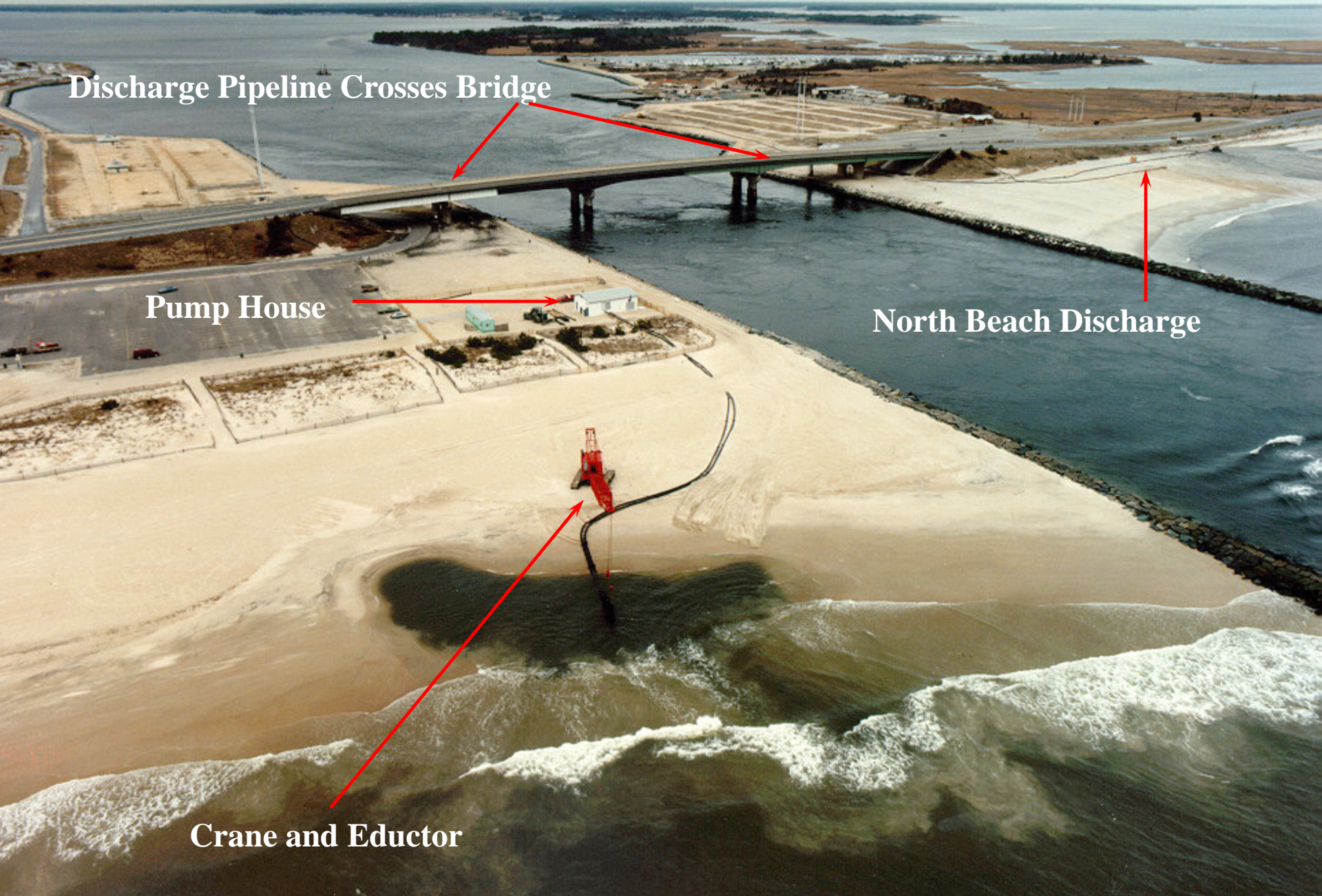
Indian River Inlet - Sand Bypassing Components

Discharge Pipeline Crosses Bridge

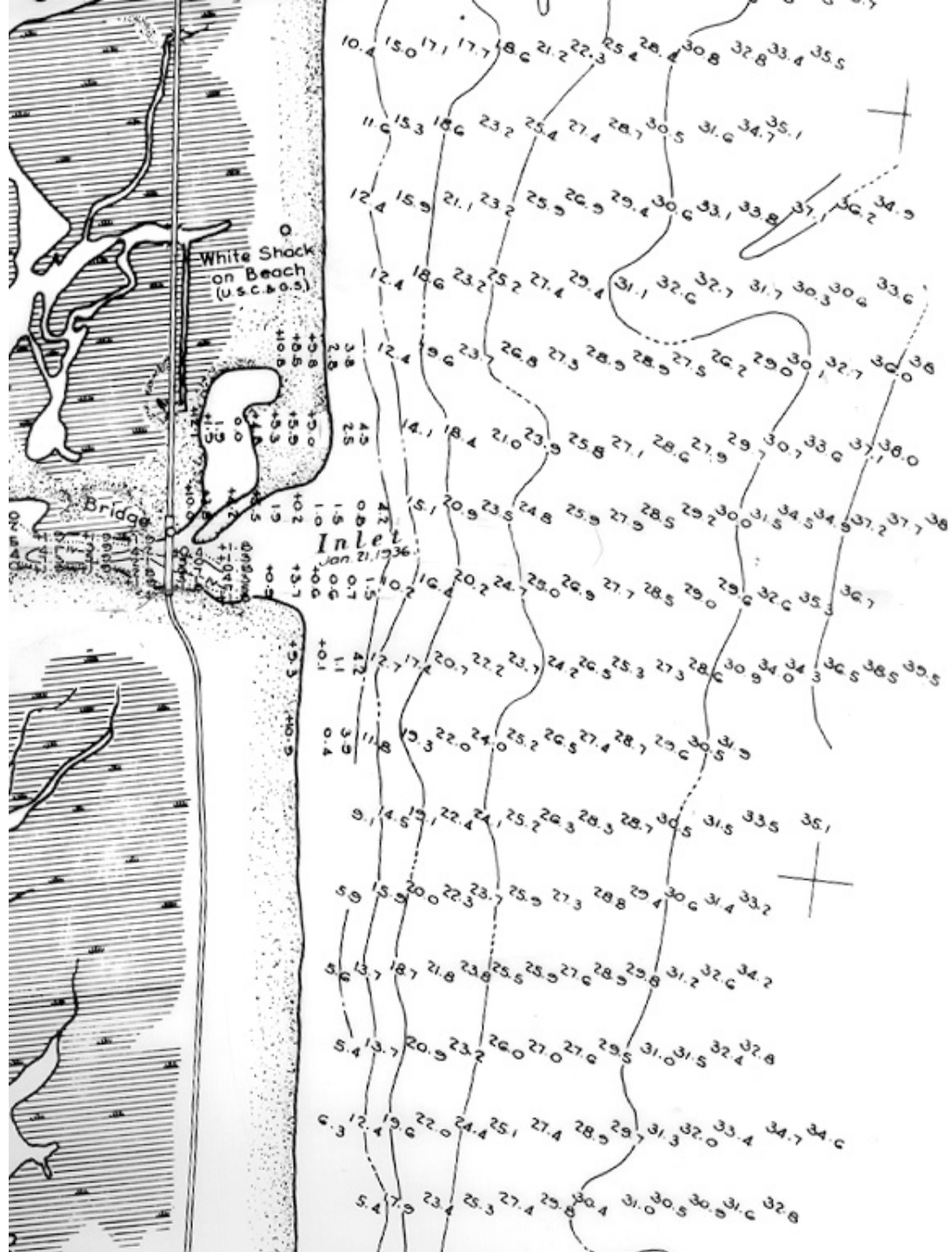
Pump House

North Beach Discharge

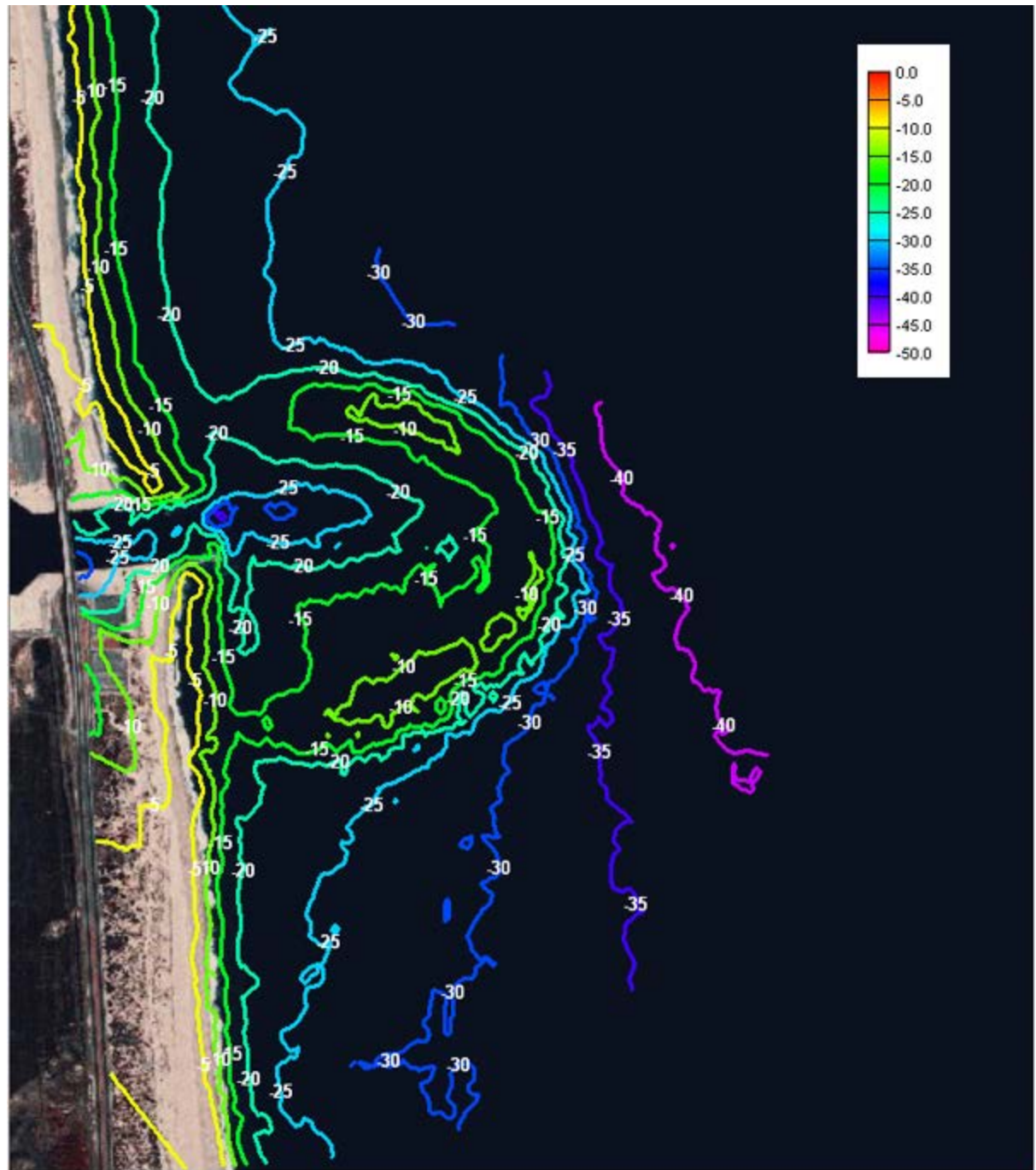
Crane and Eductor



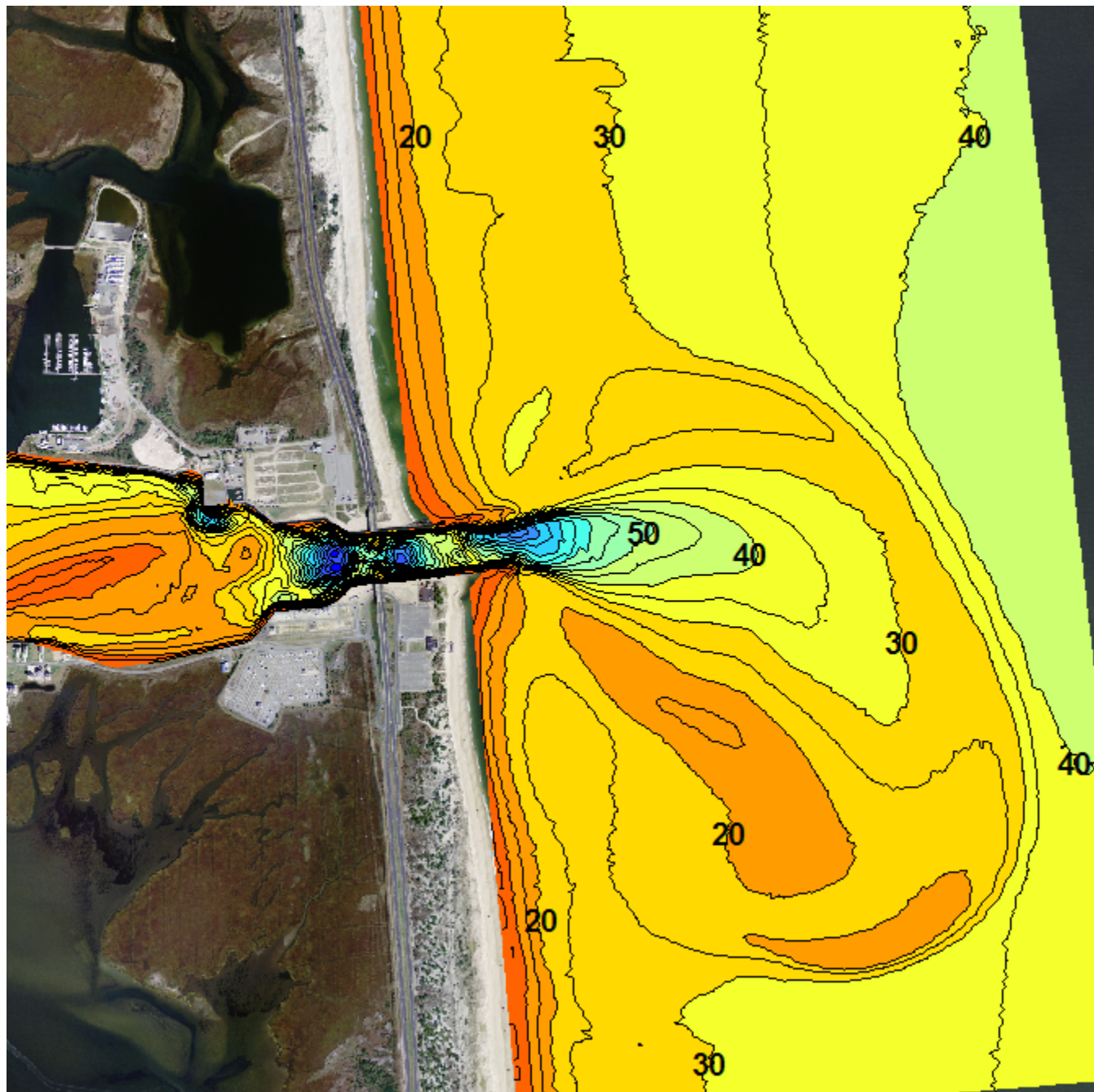
Bathymetry 1935



Bathymetry 1962



Bathymetry 2004











October 2003

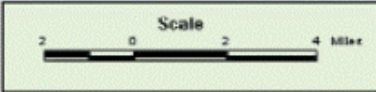
Ebb jet deflection to south





 Assawoman	 Iron Branch
 Buntings Branch	 Lewes-Rehoboth Canal
 Indian River	 Little Assawoman Bay
 Indian River Bay	 Rehoboth Bay

Scale

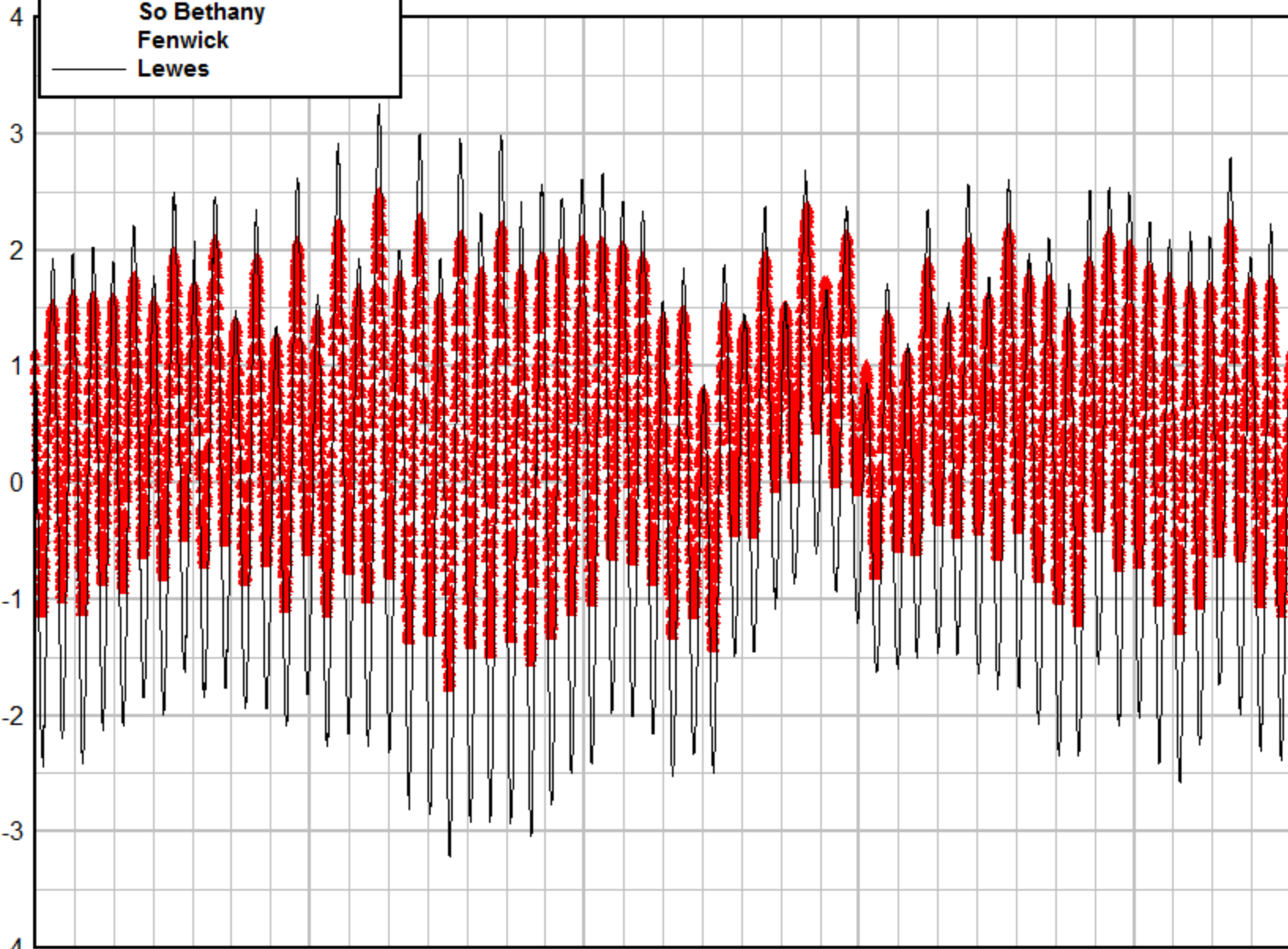


DE Inland Bays - Tides

10 August - 10 September 2013

- ▲ ▲ IRI
- Rehoboth Bay - Dewey
- Rosedale
- So Bethany
- Fenwick
- Lewes

Tide Height, FT NAVD88



8/10/2013

8/17/2013

8/24/2013

8/31/2013

9/7/2013

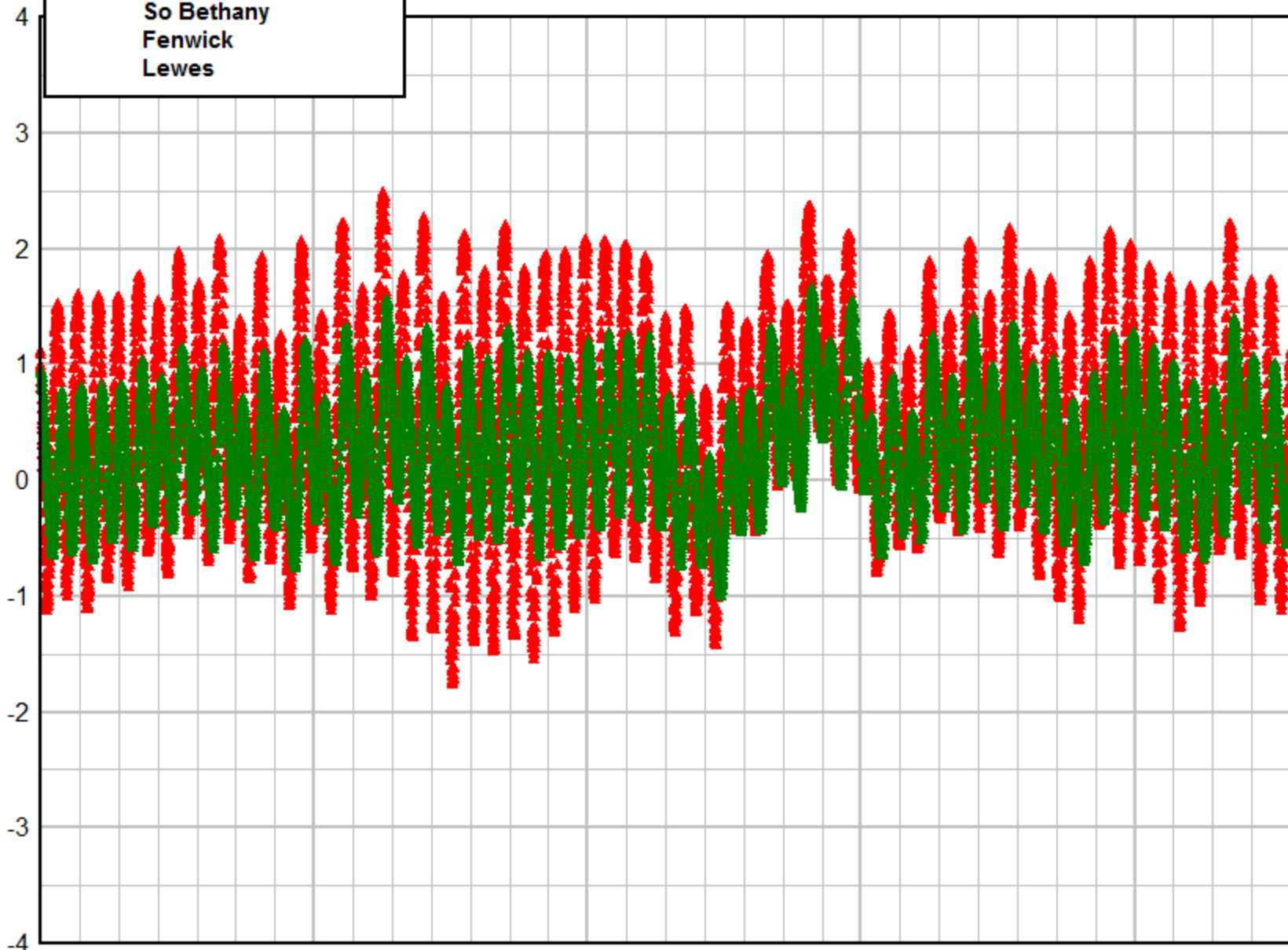
9/11/2013

DE Inland Bays - Tides

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Tide Height, FT NAVD88



8/10/2013

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9/7/2013

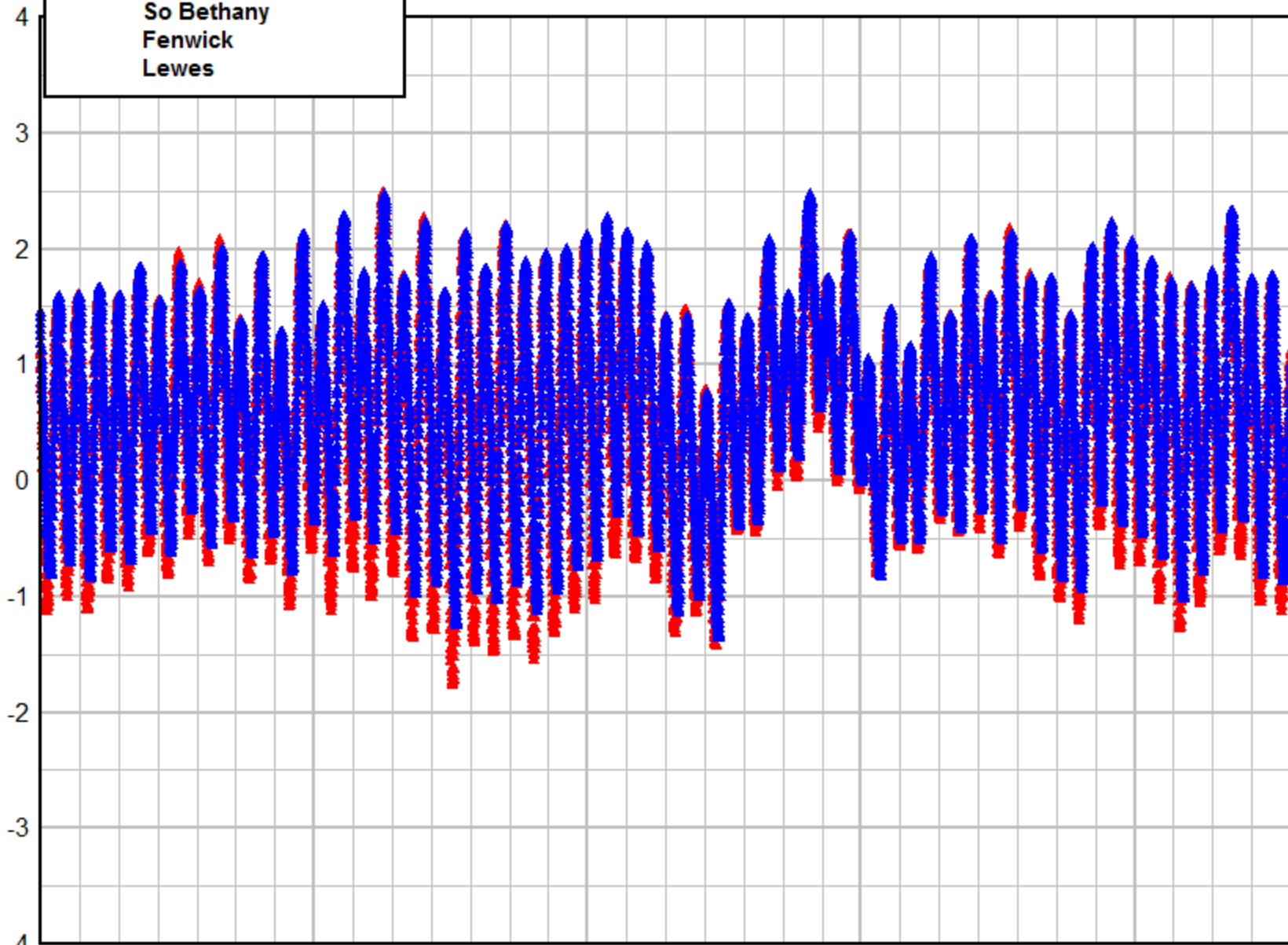
9/11/2013

DE Inland Bays - Tides

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Tide Height, FT NAVD88



8/10/2013

8/17/2013

8/24/2013

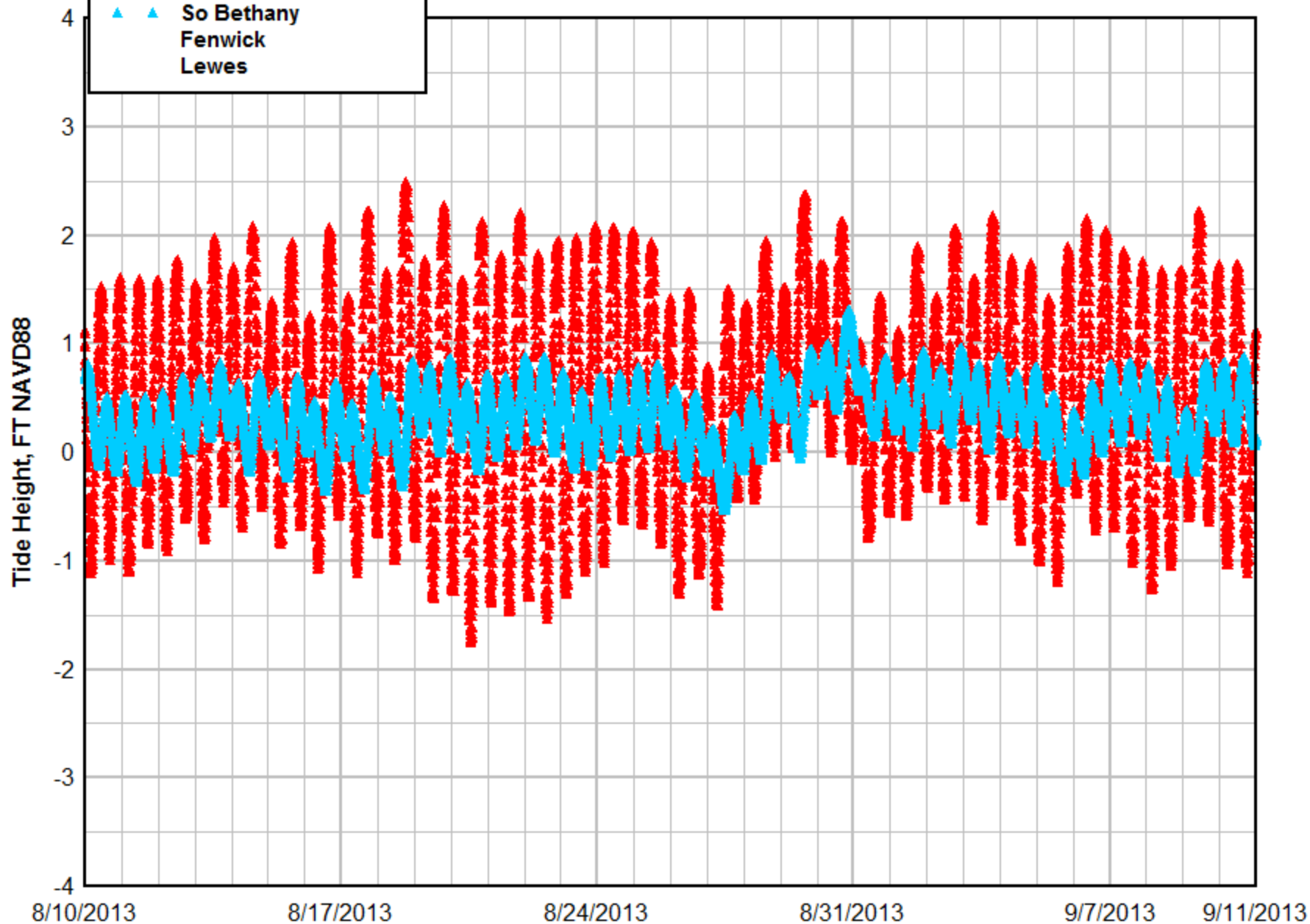
8/31/2013

9/7/2013

9/11/2013

DE Inland Bays - Tides

10 August - 10 September 2013

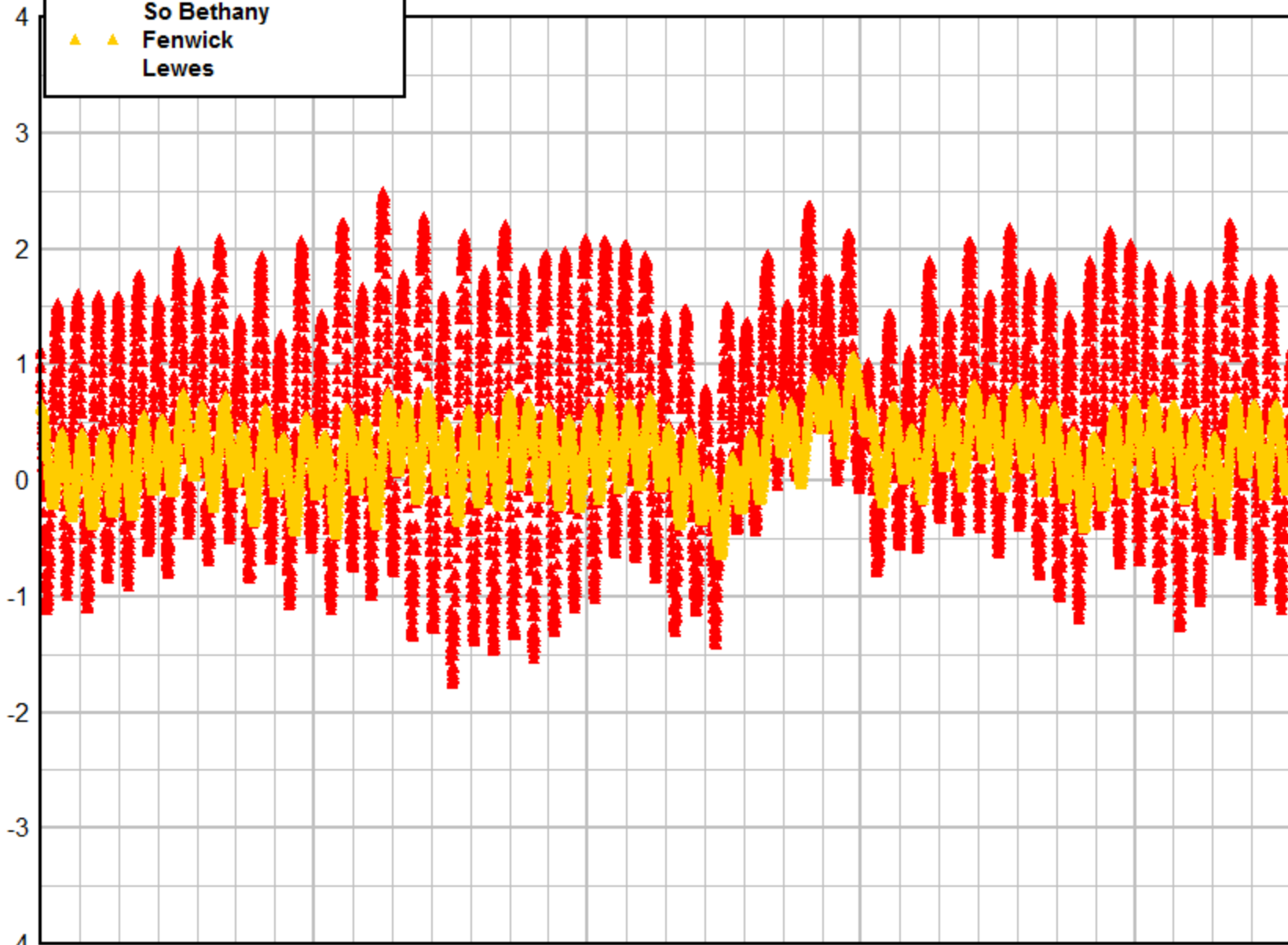


DE Inland Bays - Tides

10 August - 10 September 2013

- ▲ ▲ IRI
- Rehoboth Bay - Dewey
- Rosedale
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- ▲ ▲ Fenwick
- Lewes

Tide Height, FT NAVD88



8/10/2013

8/17/2013

8/24/2013

8/31/2013

9/7/2013

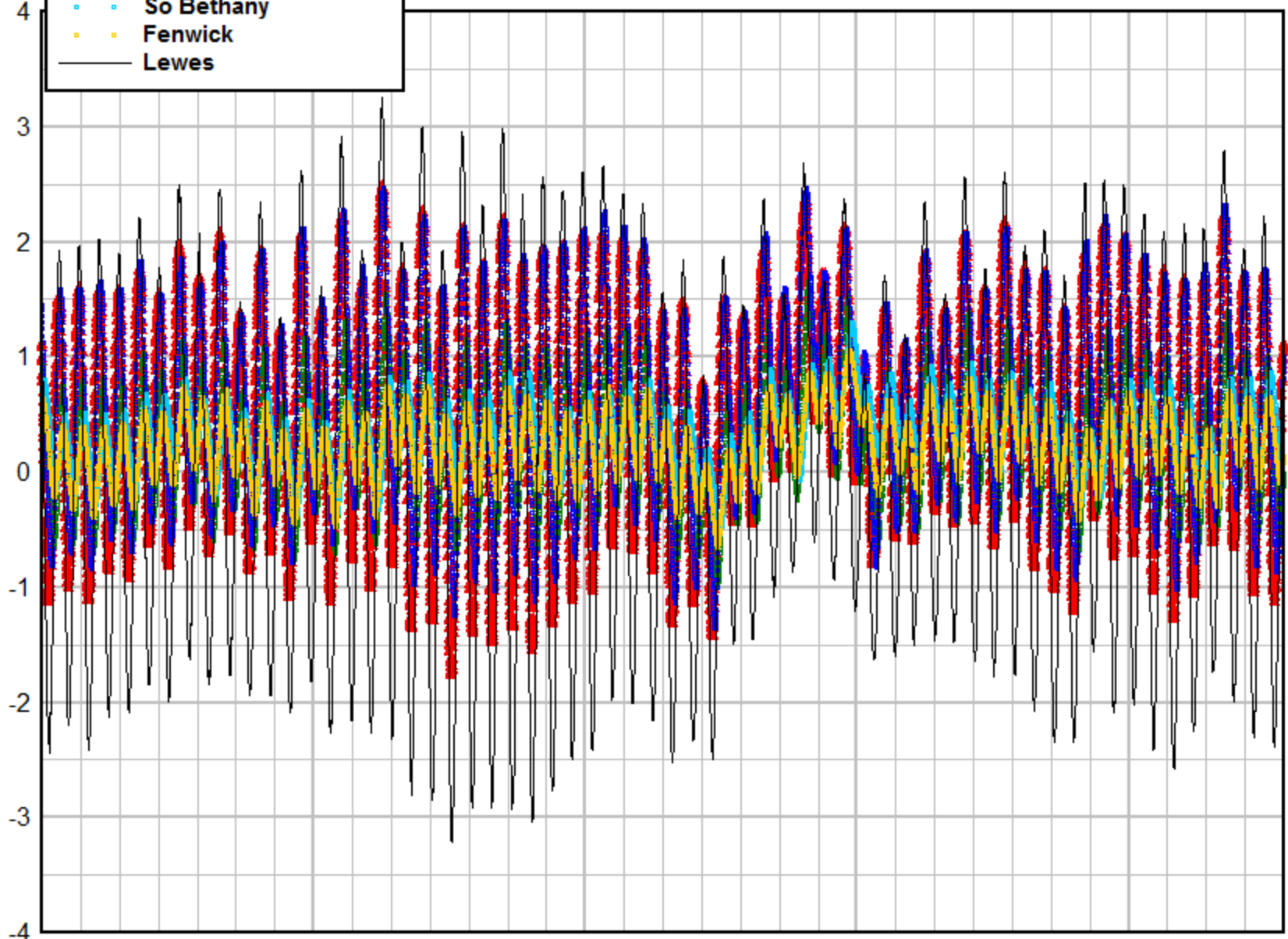
9/11/2013

DE Inland Bays - Tides

10 August - 10 September 2013

- ▲ IRI
- Rehoboth Bay - Dewey
- Rosedale
- So Bethany
- Fenwick
- Lewes

Tide Height, FT NAVD88



8/10/2013 8/17/2013 8/24/2013 8/31/2013 9/7/2013 9/11/2013