Metropolitan NY-NJ Storm Surge Working Group

PRESENTATION TO THE COPRI MET SECTION

THE SCIENCE OF STORM SURGE RISK REDUCTION

12 AUGUST 2020

The Metro Storm Surge Working Group

Citizen professionals and stakeholders dedicated to the premise that:

The protection of the greater Metropolitan Region against catastrophic flooding from ocean storm surges, climate change, and rising sea levels can best be secured by a regional approach that transcends geographic and political boundaries.

Agenda

Malcolm Bowman – Introduction to the Storm Surge Working Group (SSWG), climate change issues (sea level rise, storm surges, precipitation) that we need to worry about in the Metropolitan coastal region.

Jonathan Goldstick – Quick tour of existing storm surge gates in USA and Europe.

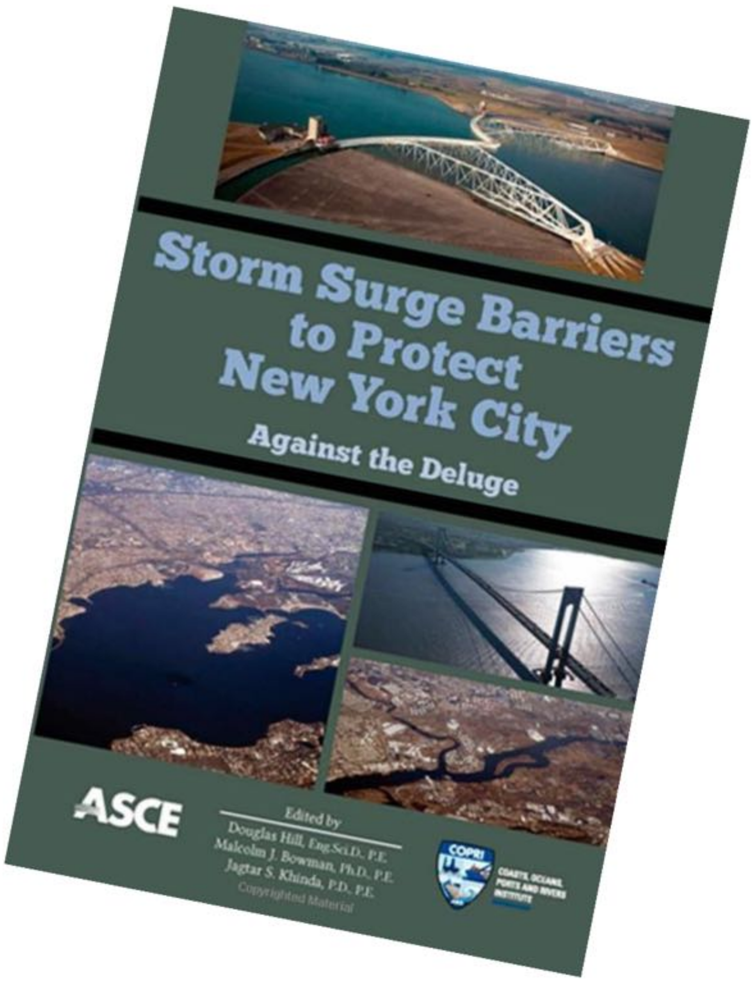
Hamish Bowman and Keith Roberts – High resolution hydrodynamic modeling and prediction of storm surges and extreme waves. Effectiveness and side effects of regional sea gates.

Daniel Gutman – Comparing alternatives.

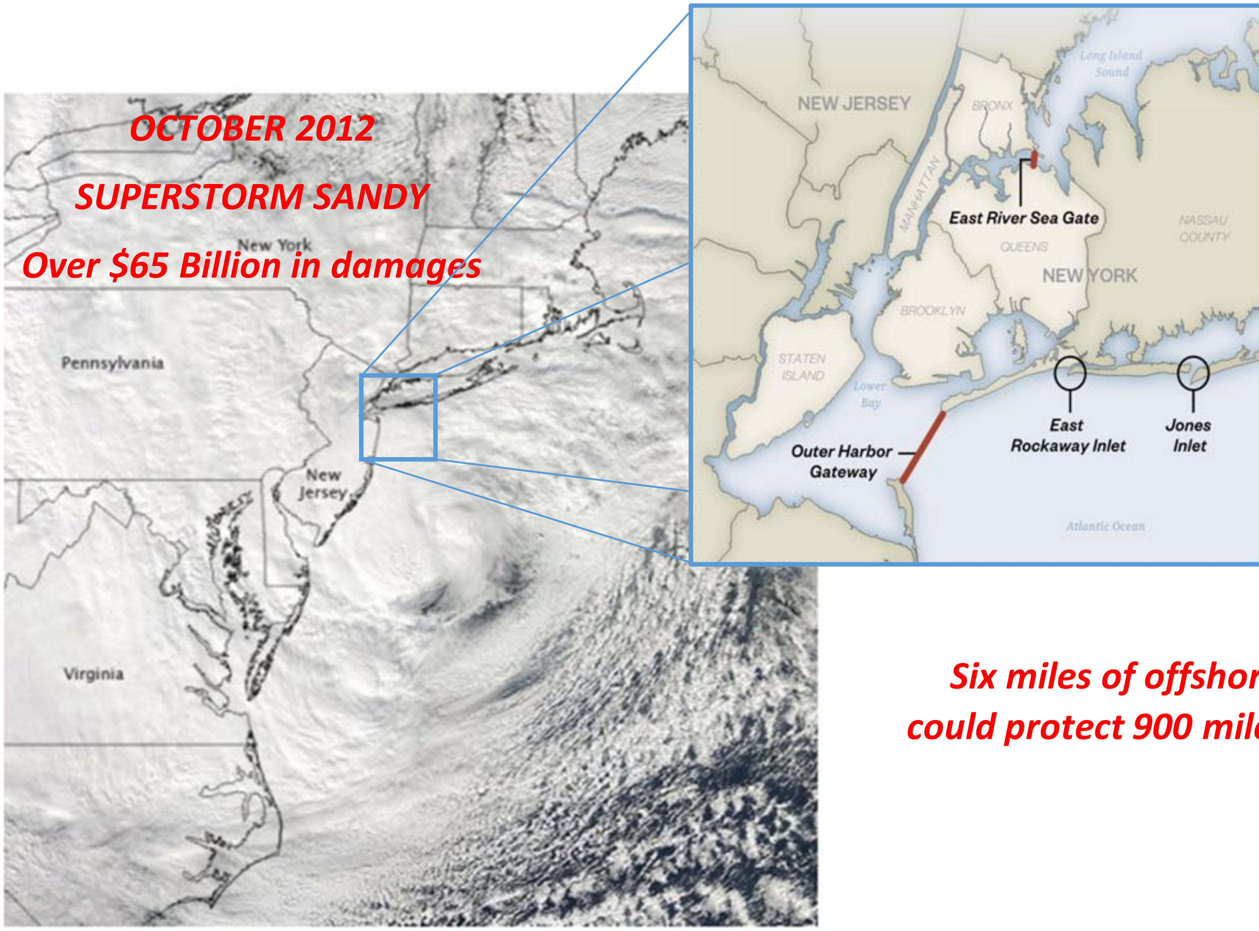
Jonathan Goldstick – Practical issues of local perimeter protection.

Suzanne Digeronimo – Discussion.

March 2009 ASCE Conference

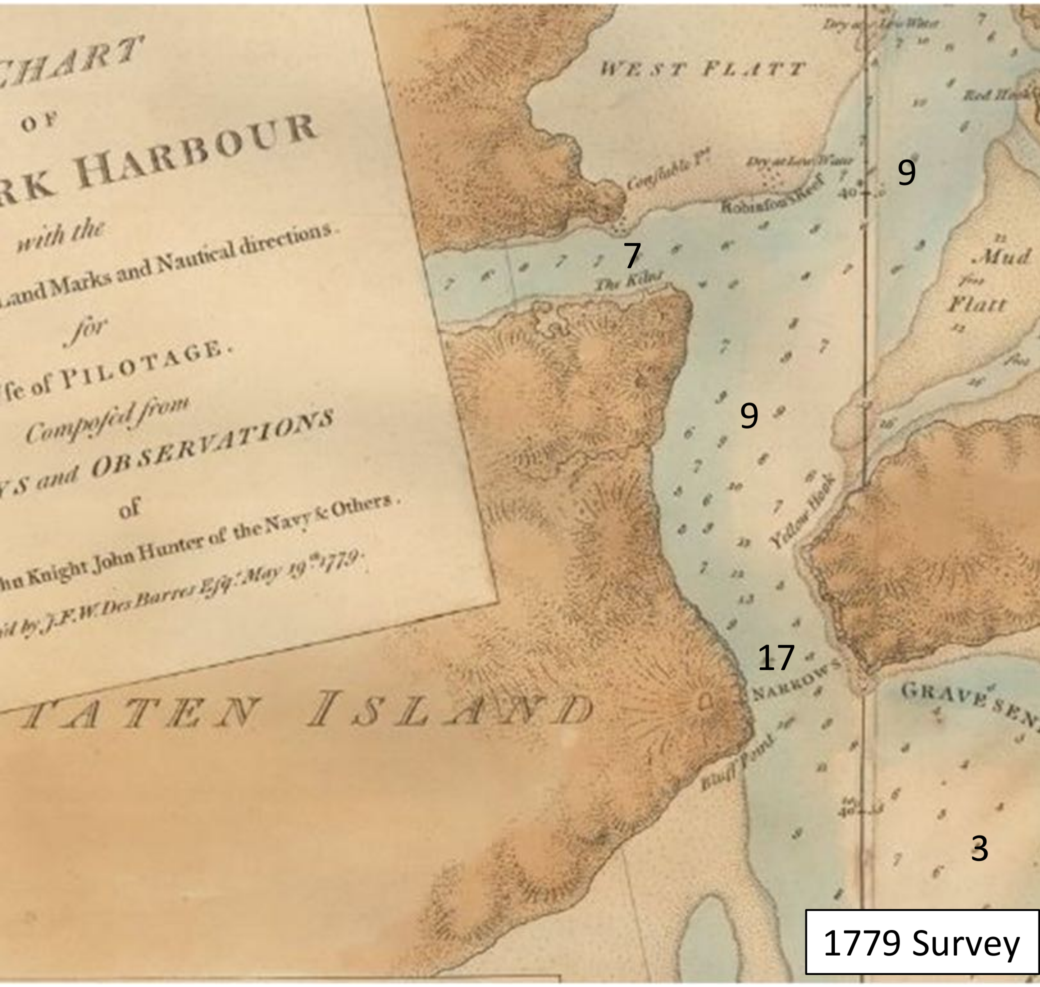


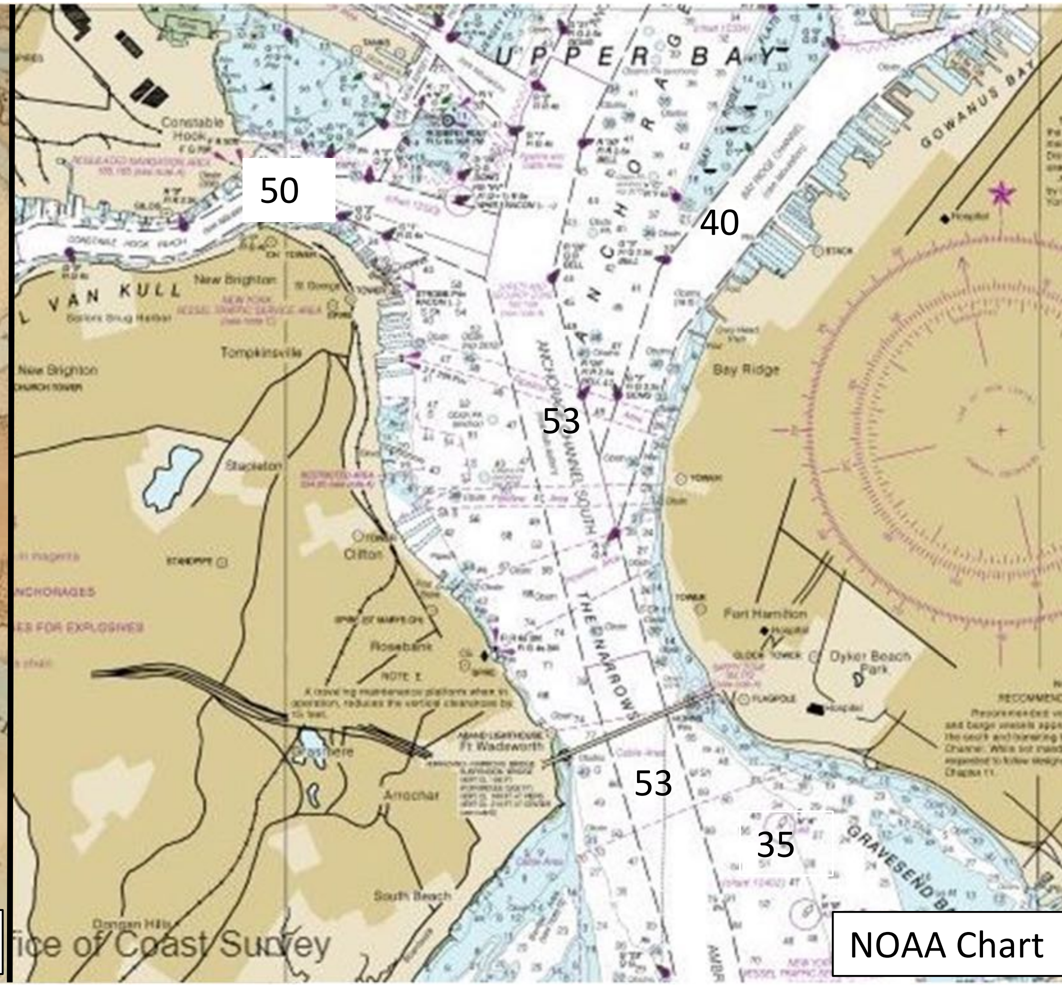
A Regional Approach to Match the Scale of the Threat



Six miles of offshore sea gates could protect 900 miles of shoreline

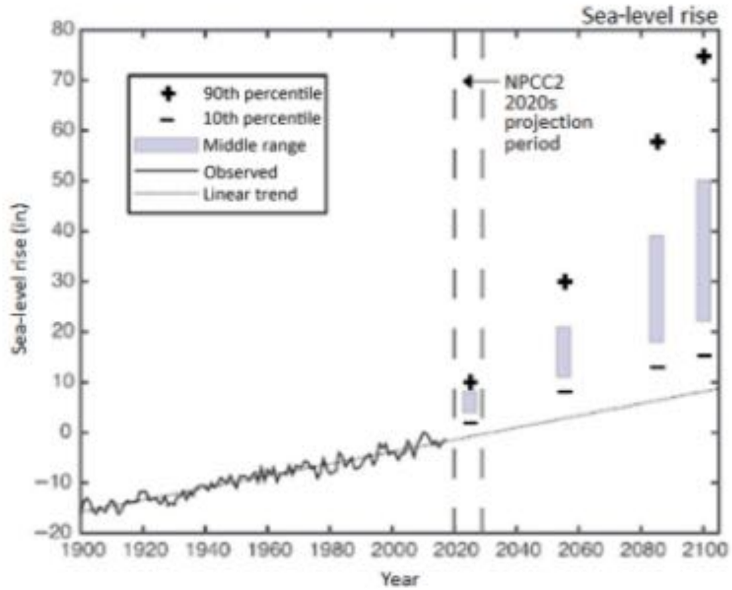
Environmental Baseline Bathymetry (depths in ft)





Sea Level Rise

- Historic data clearly shows a long-term trend in rising sea level rise and the rate of sea level rise is projected to increase
- The storm surge produced by Superstorm Sandy produced a 14 ft surge
    - Storm surge water levels exceed projected sea level elevations
- Surge elevations will be further increased by sea level ris



Observed sea level rise at The Battery in New York City compared with projected changes in sea level rise from the NPCC 2015 Report in the 2020s.

Source: **New York City Panel on Climate Change 2019 Report Chapter 3: Sea Level Rise**
Vivien Gornitz, Michael Oppenheimer , Robert Kopp , Philip Orton , Maya Buchanan , Ning Lin , Radley Horton , Daniel Bader
First published: 15 March 2019, NY Academy of Sciences
https://doi.org/10.1111/nyas.14006

Sea Level Rise Projections

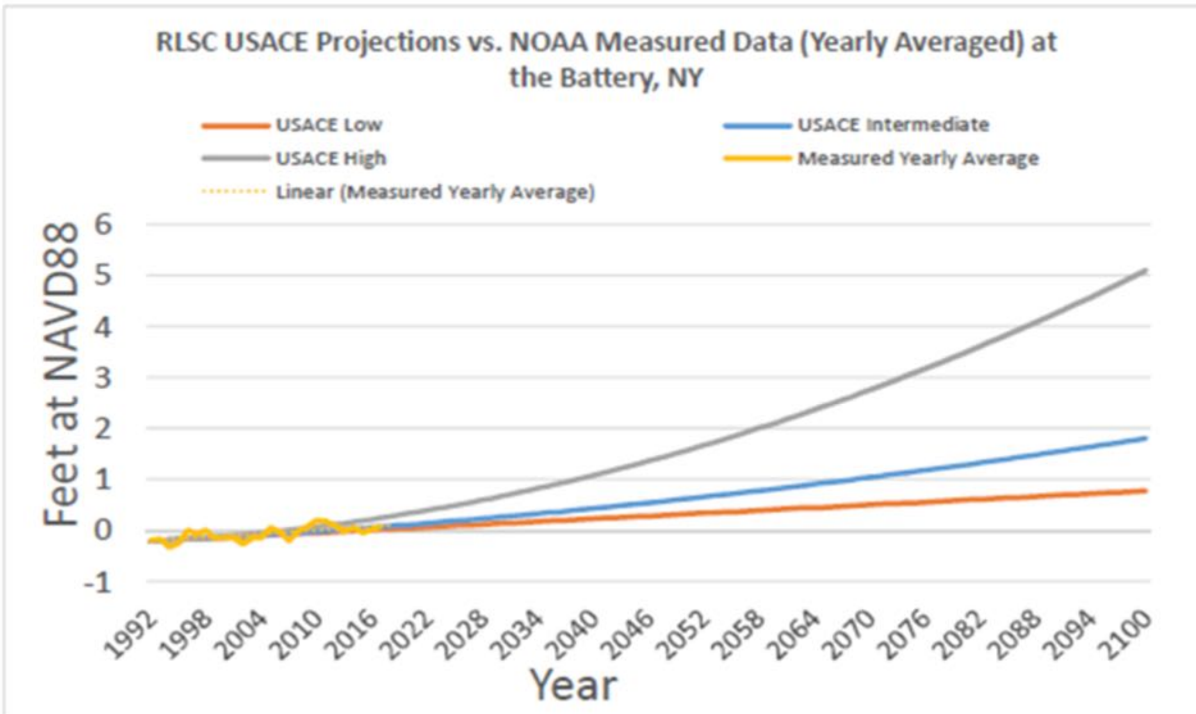
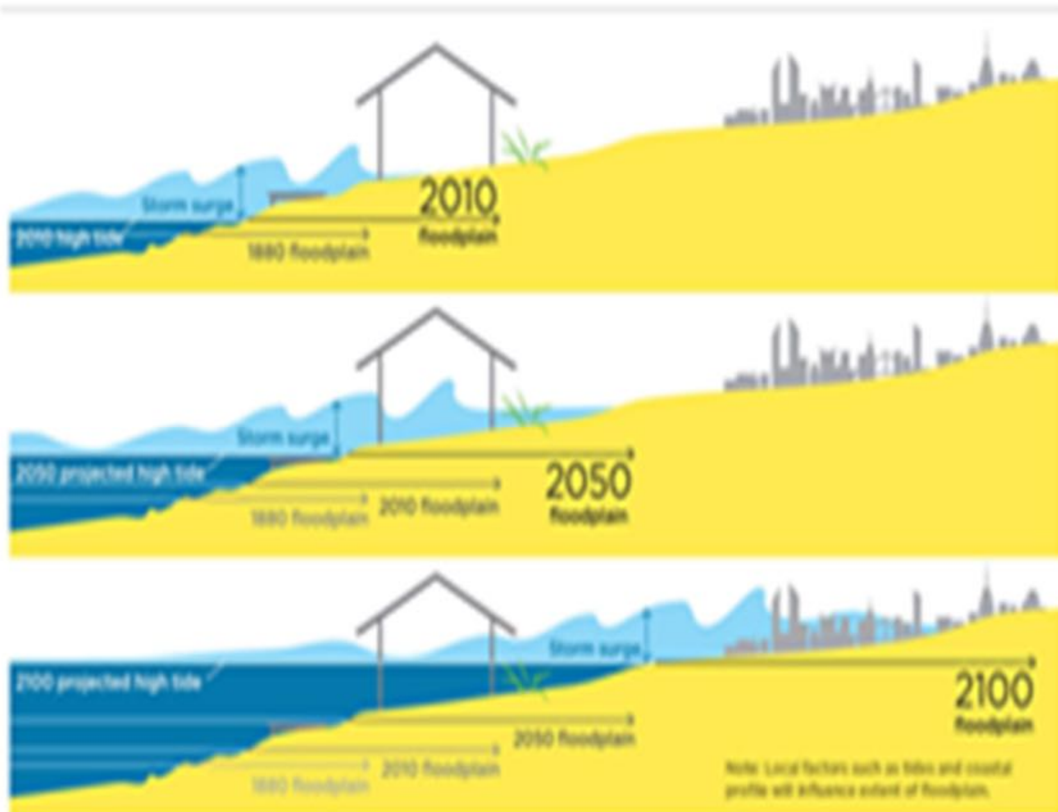
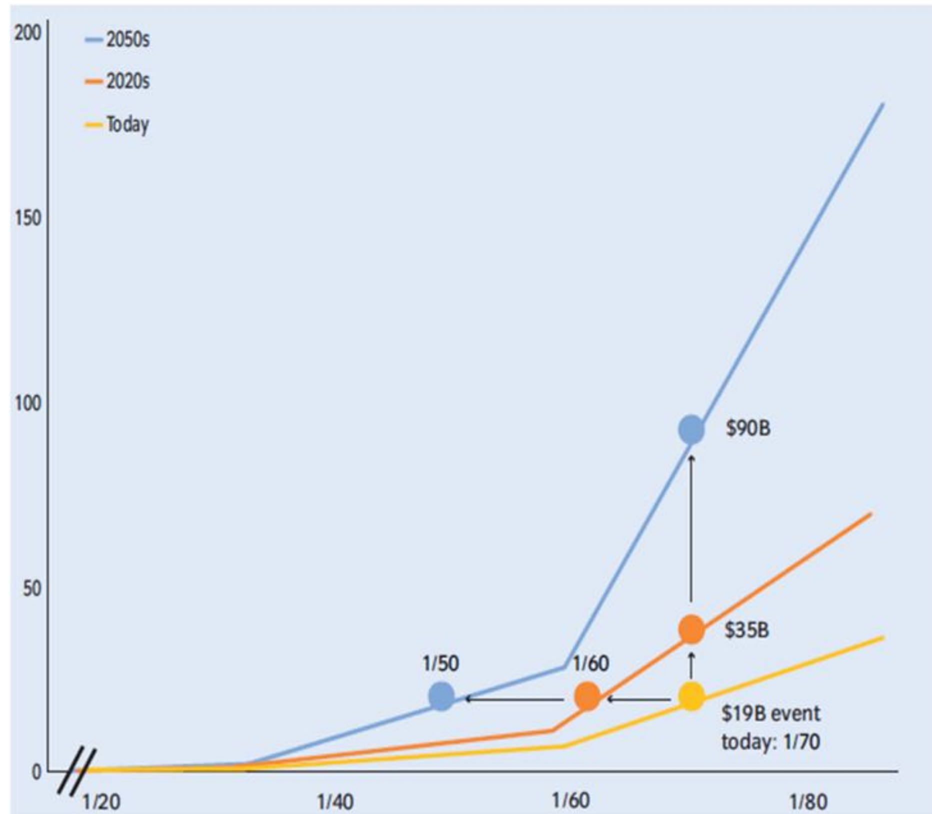


Figure 17. Sea Level Rise Projections

Storm Surge damage increases as sea level rises: 2010 to 2100



Ref: Union of Concerned Scientists

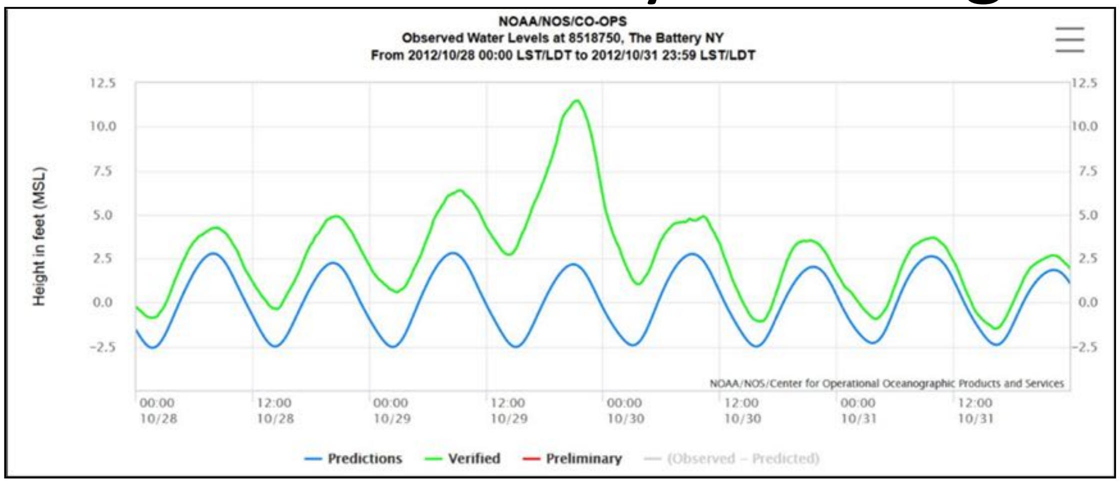


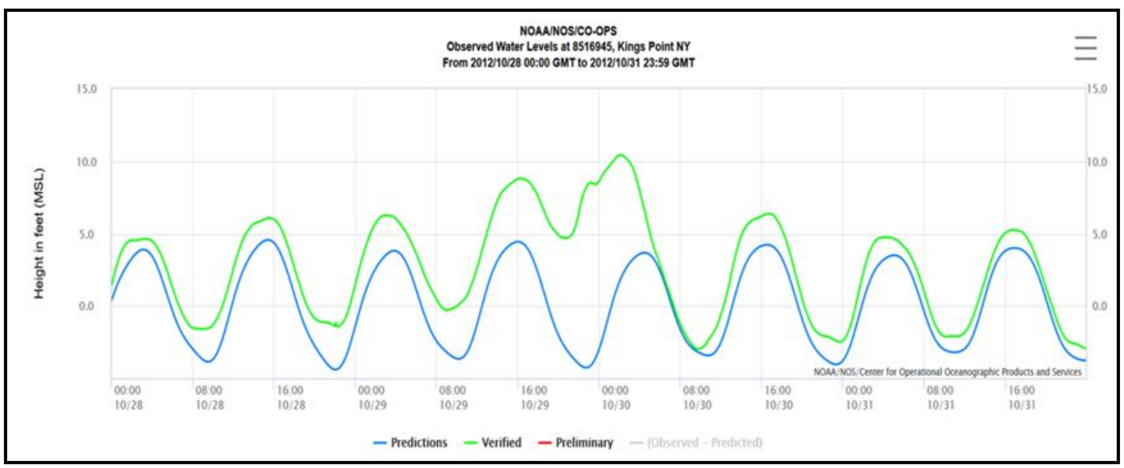
Ref: SIRR Report (2013)

Studies on Storm Risk Reduction Issues

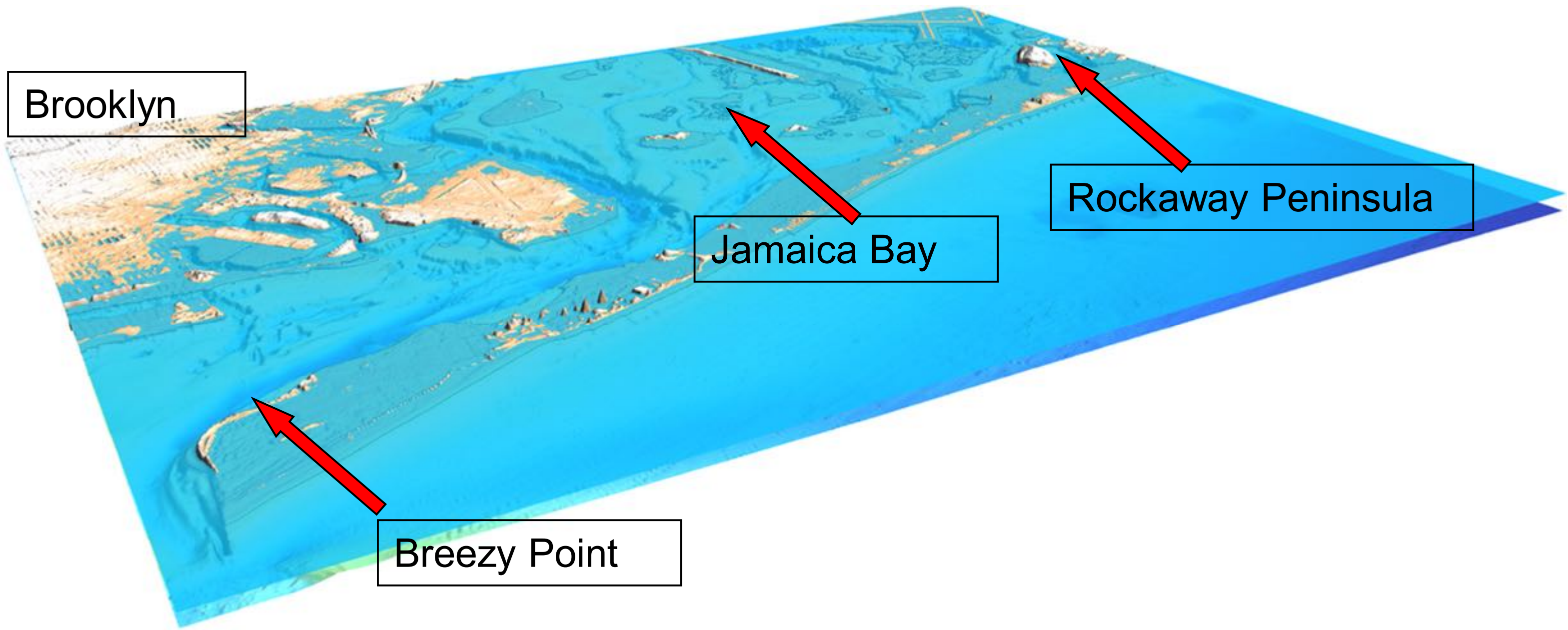
- **SIRR Report (commissioned by Mayor Michael Bloomberg soon after Sandy)**
- **USACE Harbor & Tributaries Study (2017-2020)**
- **North Atlantic Coast Comprehensive Study (NACCS)**

Sandy Surges
Observed at The Battery and Kings Point, LI





Hindcasting Sandy Inundation: South Shore of Long Island and Jamaica Bay

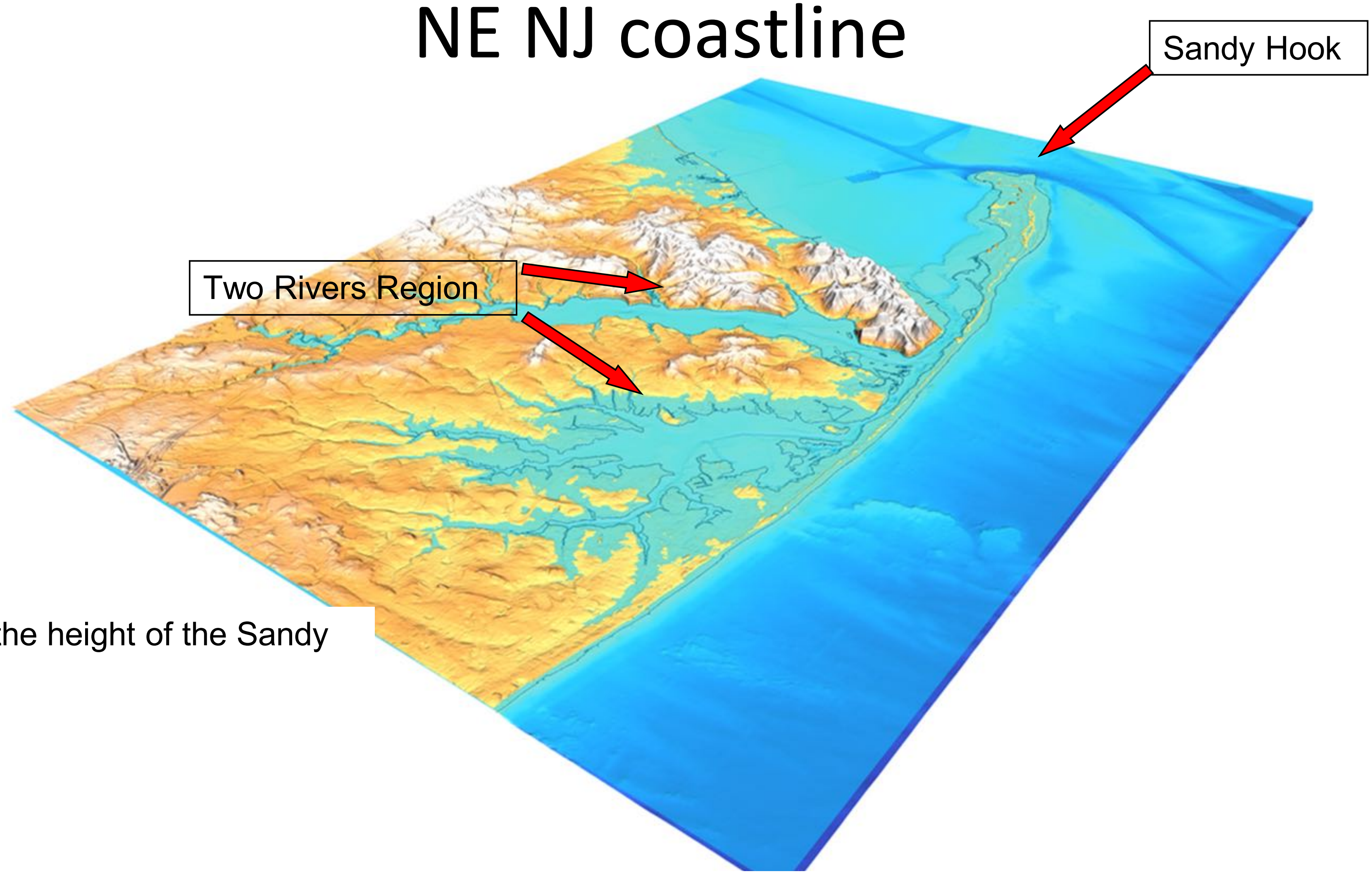


Flooding of Breezy Point and the Rockaways at the height of the Sandy storm tide.

Topography from LIDAR.

Surge from ADCIRC model driven by reformulated Sandy SBU WRF-ARW Forecasts.

Hindcasting Sandy Inundation: NE NJ coastline



Flooding at the height of the Sandy storm tide.

Circle of Protection

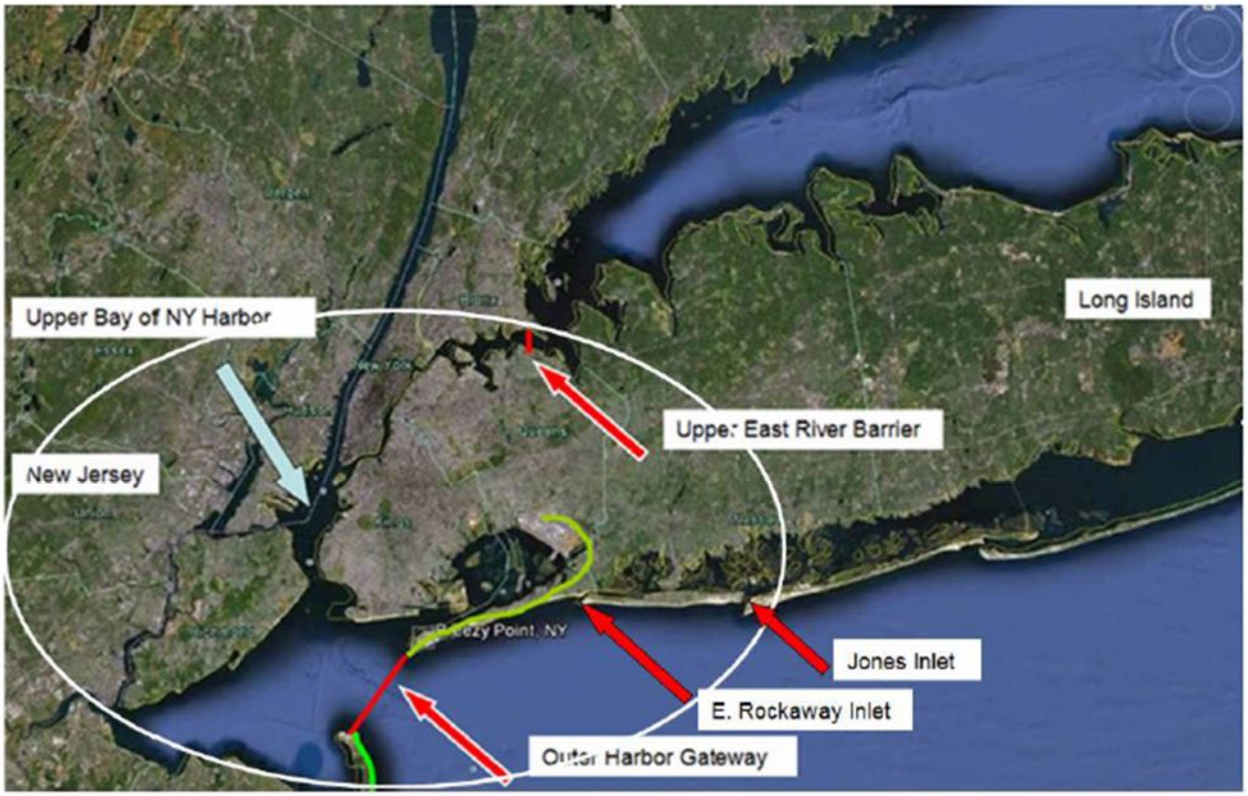
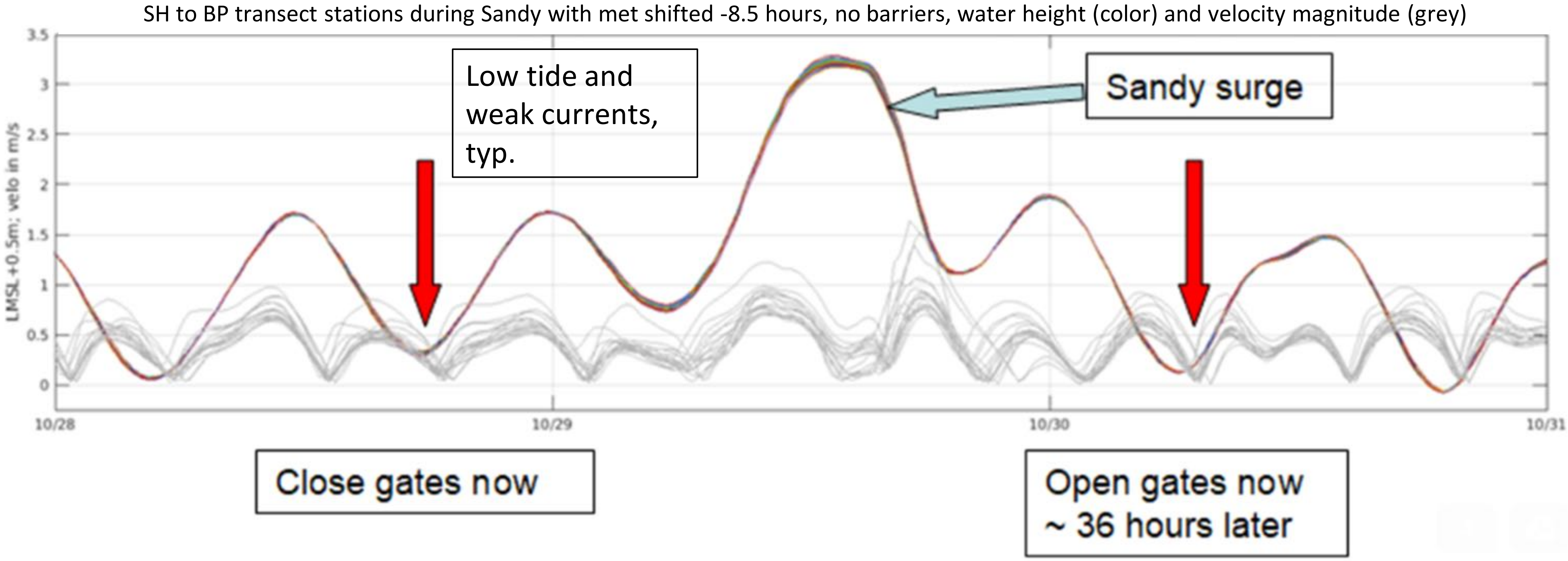


Fig 1: Location of Outer Harbor Gateway and the Upper East River Barrier. The Outer Harbor Gateway replaces an earlier alternative concept of barriers located at the Verrazono Narrows and Arthur Kill. The entire region within the circle of protection is kept dry from the worst storm surges.

Barrier Closure Timing



Metropolitan NY-NJ Storm Surge Working Group

Jonathan Goldstick

Quick tour of existing storm surge gates in USA, Europe and SE Asia

Global Flood Barriers

Netherlands

- Delta Works (Netherlands)
    - IJssel Barrier (1958)
    - Haringvliet (1971)
    - Eastern Scheldte (1986)
    - Hartel Barrier (1997)
    - Maeslant Barrier (1997)

United Kingdom

- Hull flood barrier (UK) (1980)
- Thames Barrier (UK) (1982)

Russia

- St Petersburg (2012)

Italy

- MOSE Barrier, Venice (2017)

Singapore

- Marina Barrage (2008)

USA

- Fox Point, Independence, Rhode Island (1966)
- New Bedford, Massachusetts (1966)
- Stamford, Connecticut (1969)
- IHNC Lake Borgne, New Orleans (2012)

Example Projects

Tees Barrage, England
230ft long with 4 no. gates,
$149 million

Thames Barrier, London
1,700ft long with 4 no. 200ft wide and 6 no. 100ft wide gates, $2.59 billion

Hull Impoundment, England
100ft wide with 1 no. gate,
$345 million

- Flood elevations
- Navigation
- Location and land ownership

Example Projects

St. Petersburg, Russia
16 miles long with 650ft wide sector gate and 340ft wide lift gate, $6.4 billion

New Bedford Harbor, MA
1.8 miles long with single 100ft wide gate, $200 million

Intracoastal Waterway, New Orleans 1.8 miles long, $1.24 billion

- Flood elevations
- Navigation
- Location and land ownership

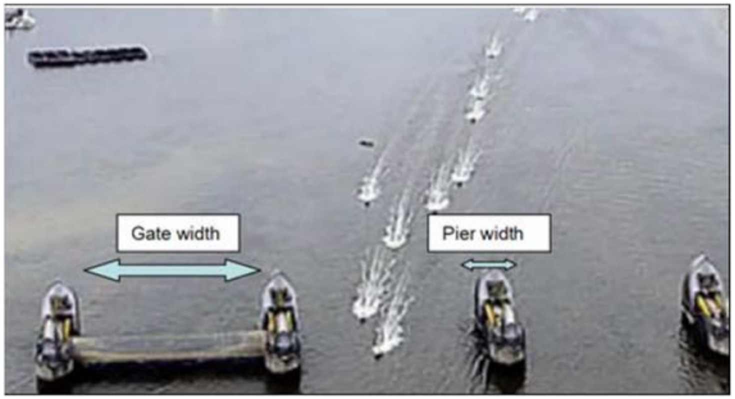
Types of Flood Gates

Lift gate lowered into defense position, significant air draft to allow navigation

Lifting gate lowered into defense position, significant air draft to allow navigation

Drop gate lowered into defense position, prevents navigation

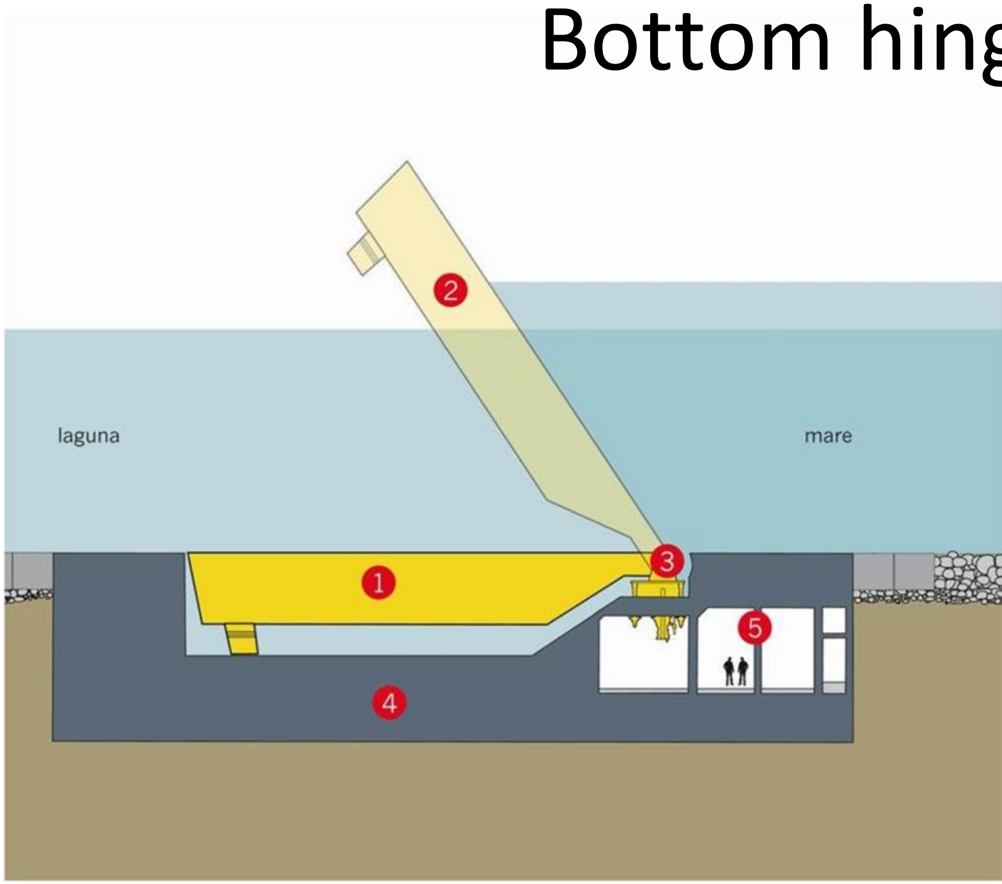
Lift gate raised into defense position from its seabed chamber



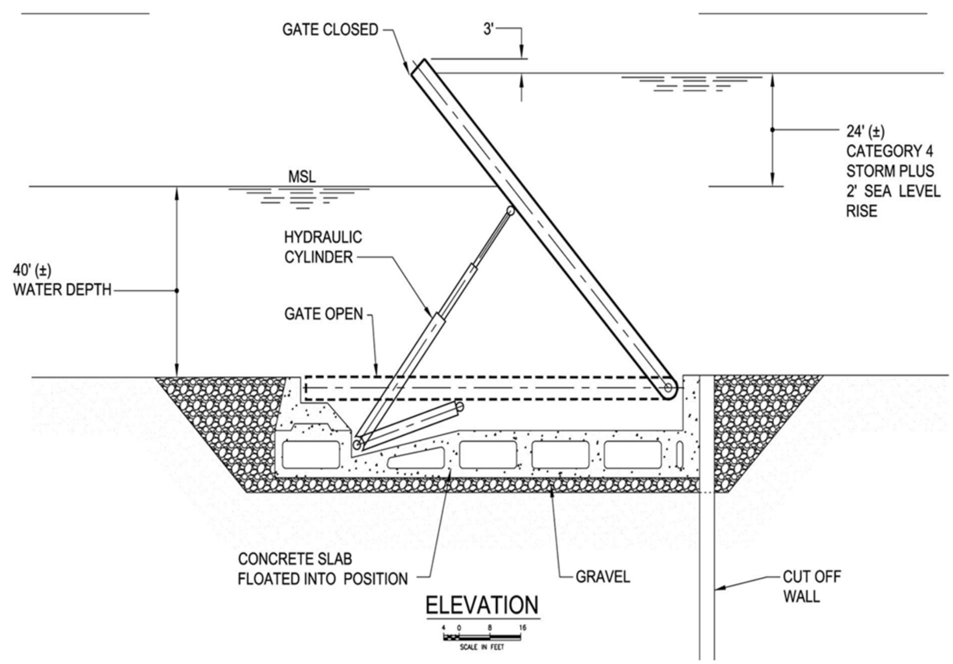
Thames River Barrier, opened in 1984.

Horizontal Axis Sector Gates

Bottom hinged barriers



Venice Lagoon flap gate operated by compressed air



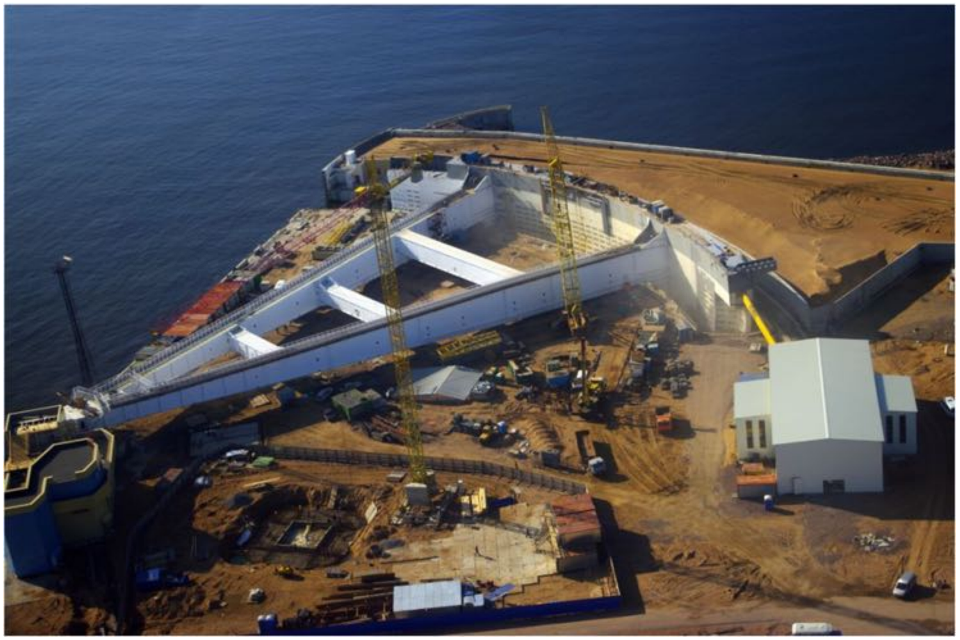
Flap gate operated by hydraulic cylinders

Types of Flood Gates

Mitre gates - span normally limited to about 100 ft with concrete pier between

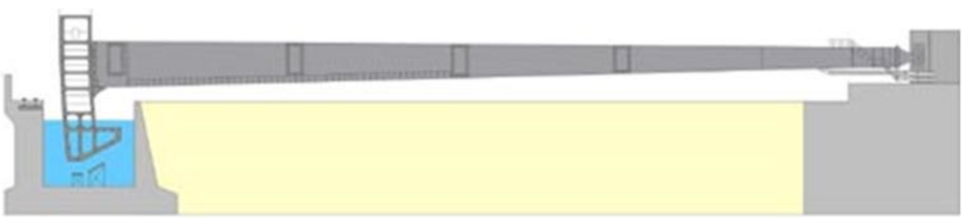
Sector gates – substantial land needed to accommodate gates in open position

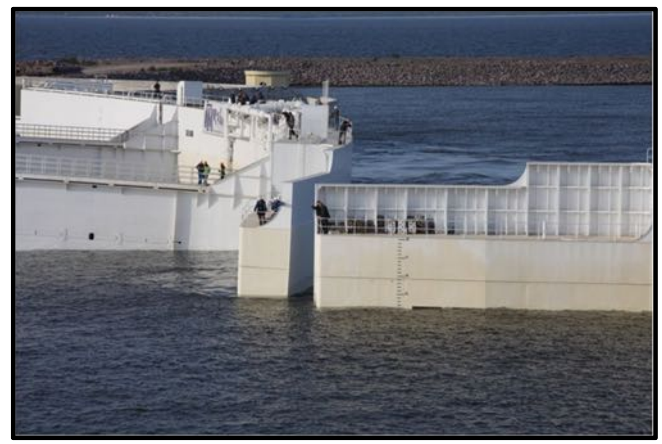
Types of Flood Gates



Main sector gates in permanent dry dock when gate is open. Floated into defense position and ballasted down to close.

Gap remains between and under gates





Maeslant Barrier Sector Gates

Metropolitan NY-NJ Storm Surge Working Group

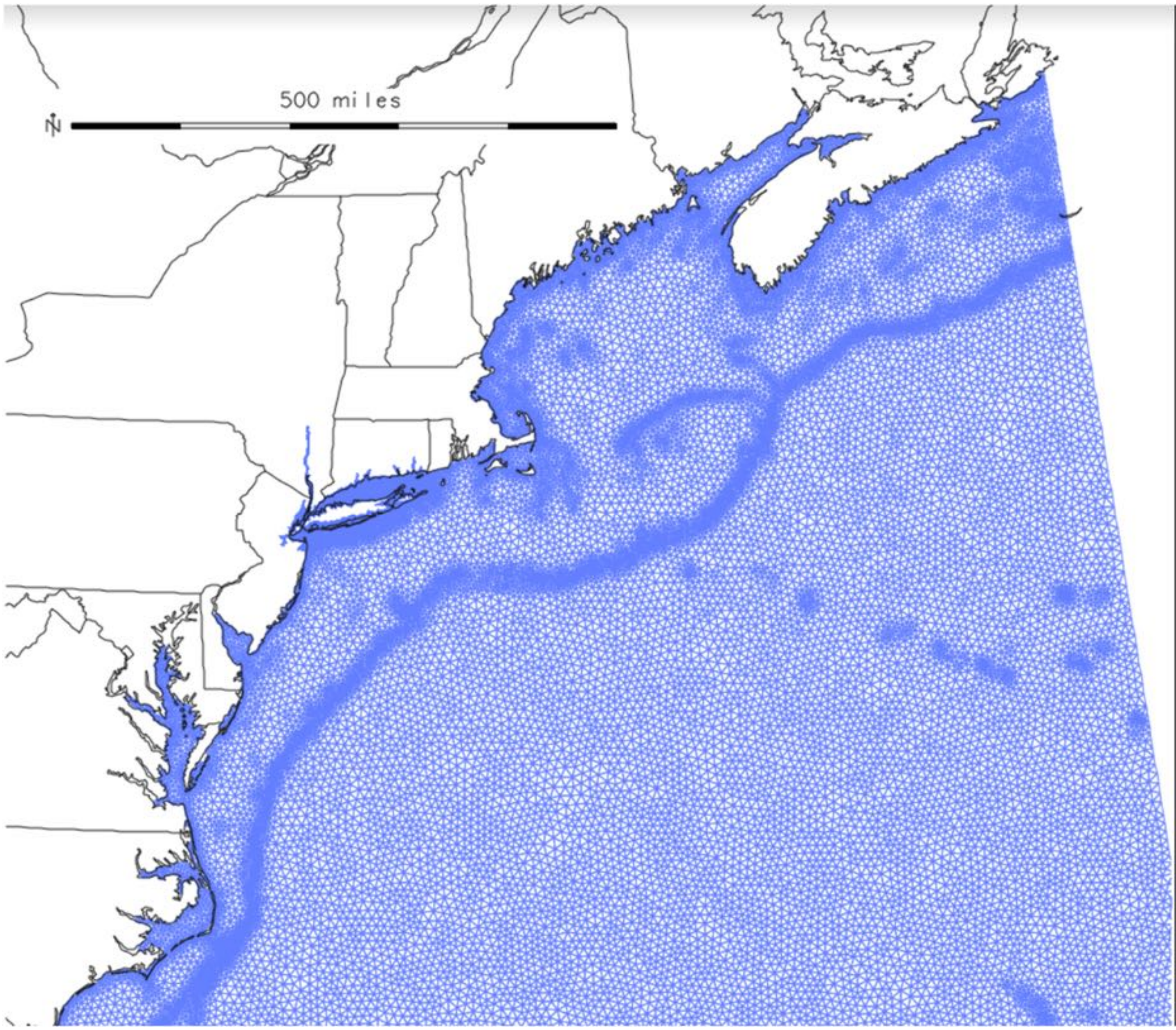
Hamish Bowman and Keith Roberts

- High resolution hydrodynamic modeling and prediction of storm surges and extreme waves.

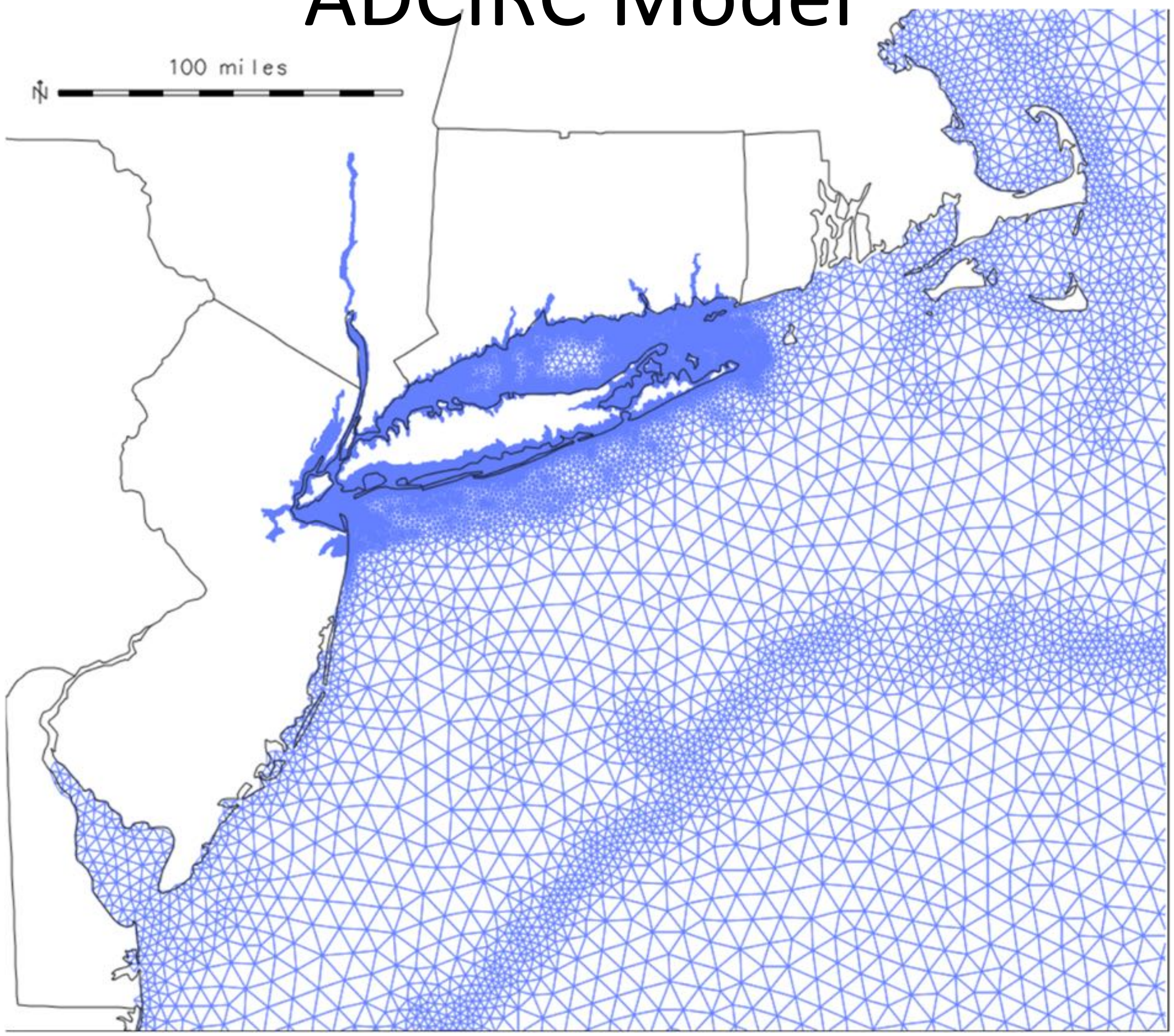
- Modeling effectiveness and side effects of regional sea gates.

ADCIRC Model Domain Used

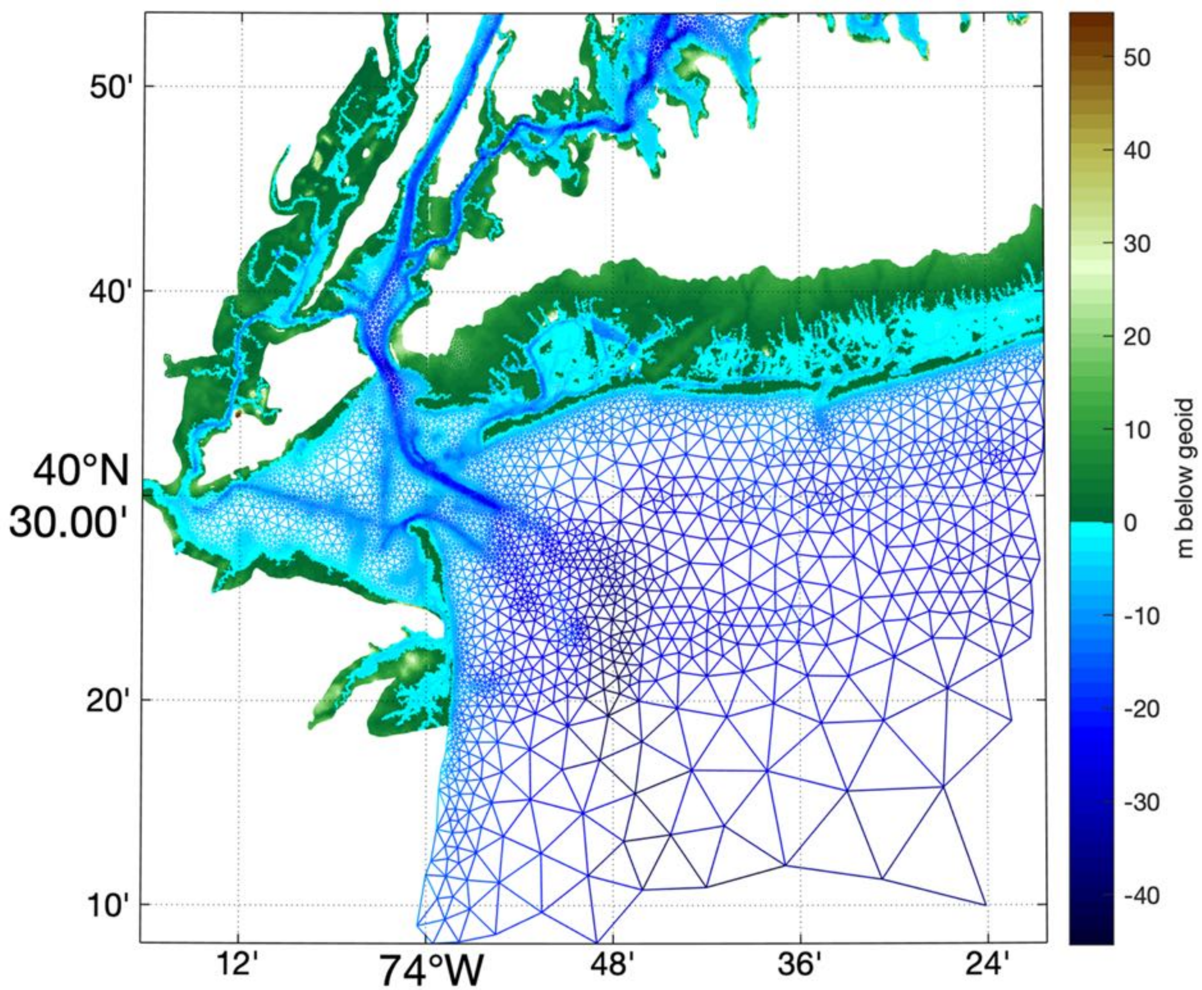
ADCIRC Model



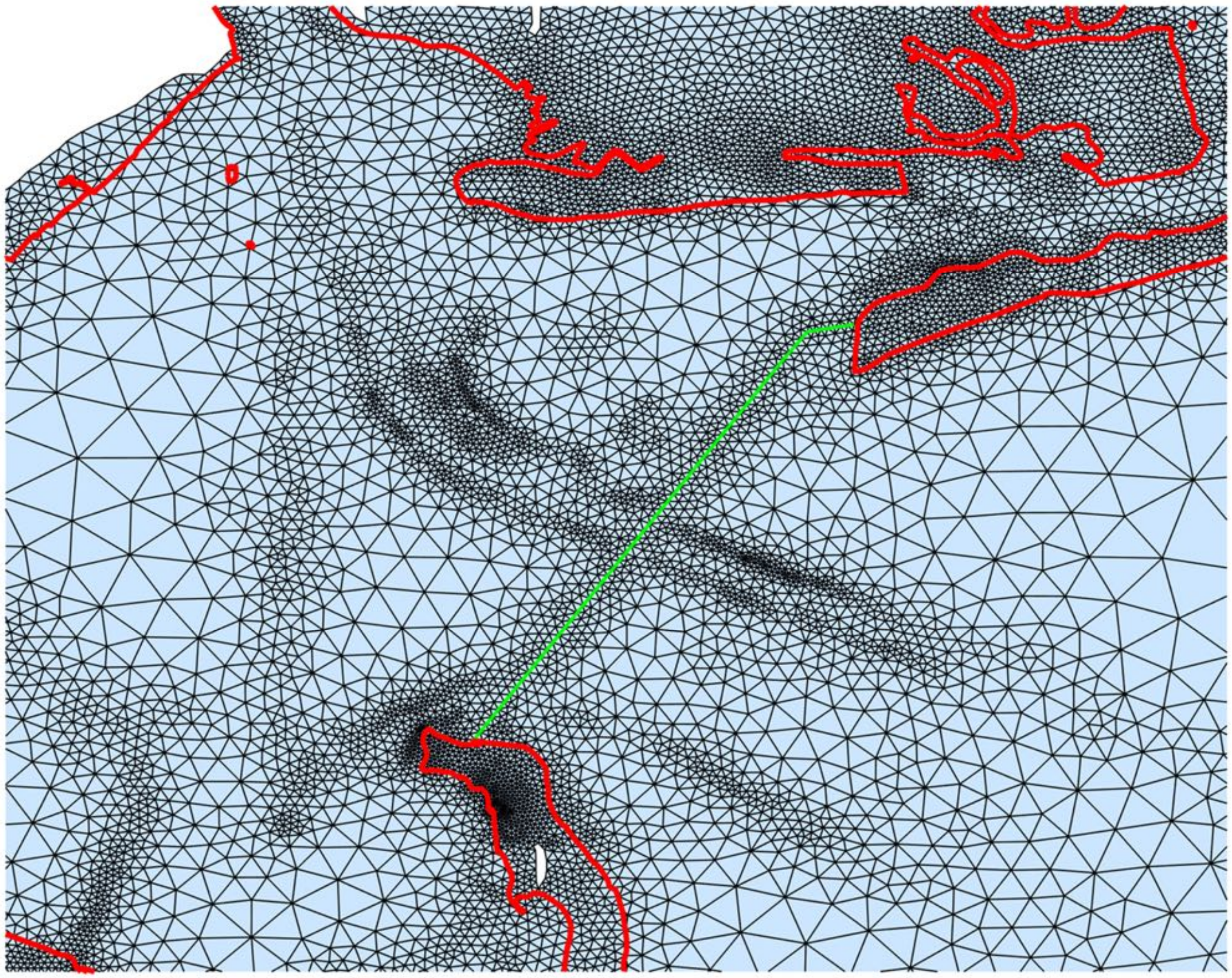
ADCIRC Model



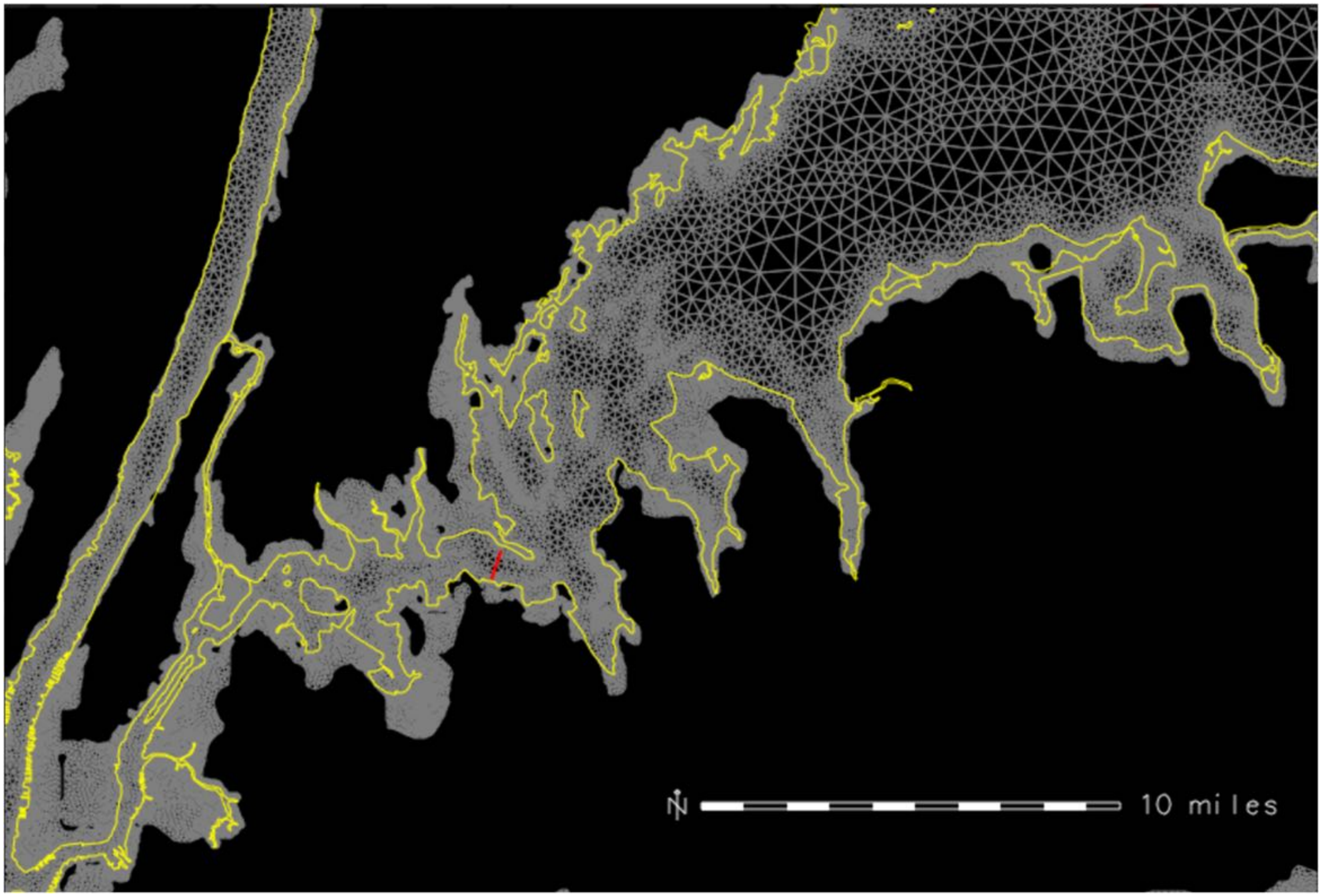
Topographic and Bathymetric Mesh



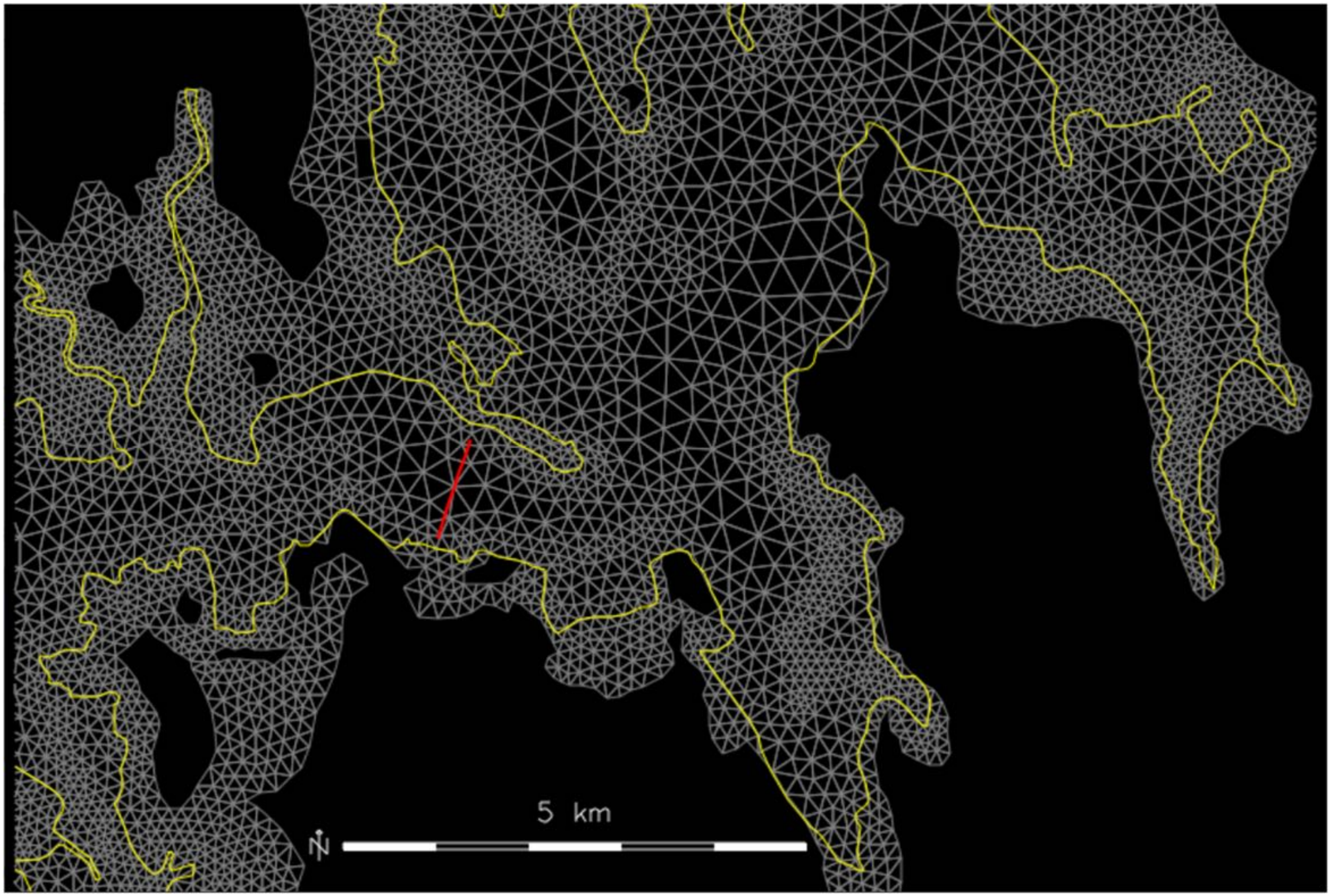
ADCIRC Model with Outer Harbor Barrier



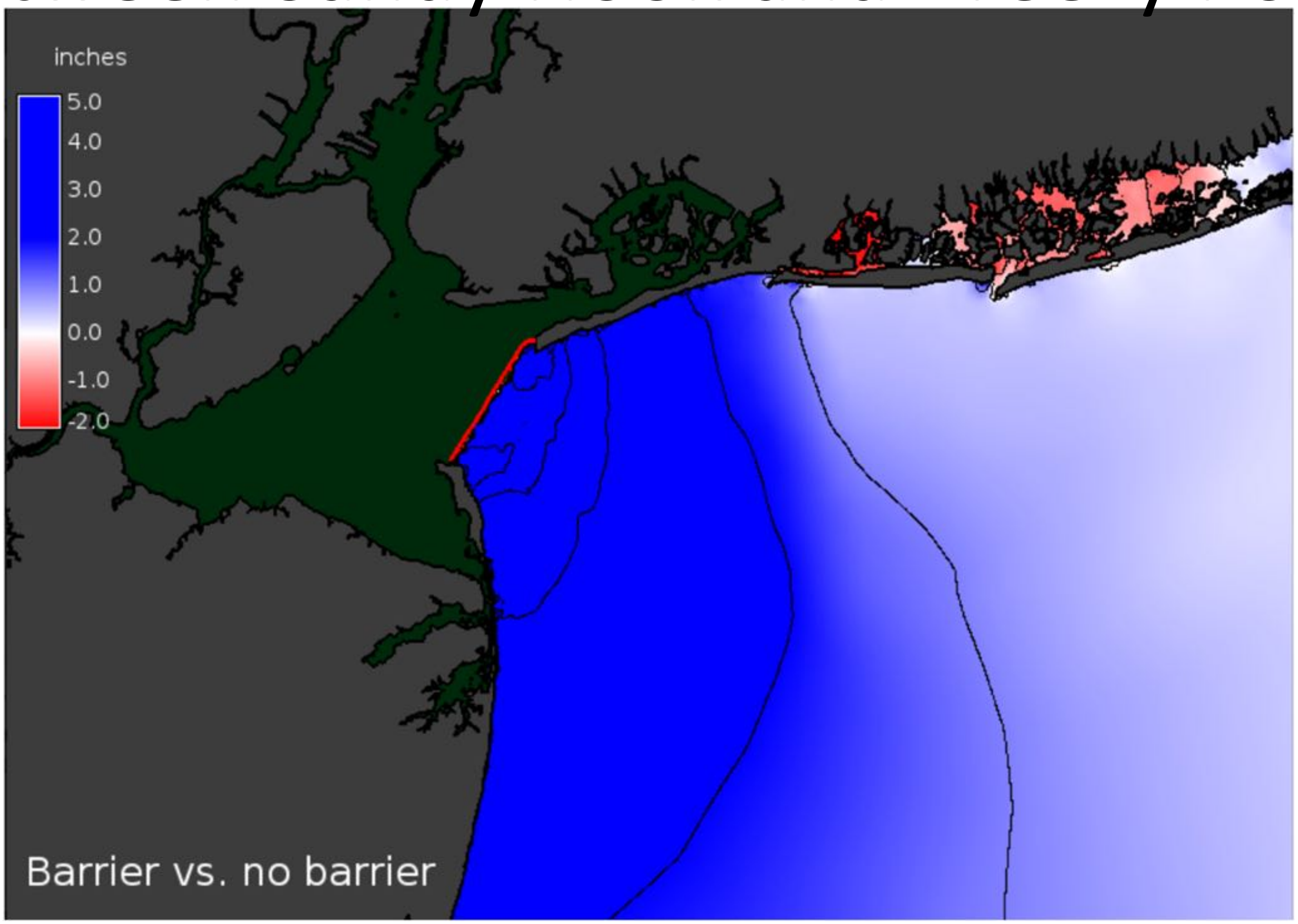
ADCIRC Model with Throgs Neck Barrier



ADCIRC Model with Throgs Neck Barrier (red)

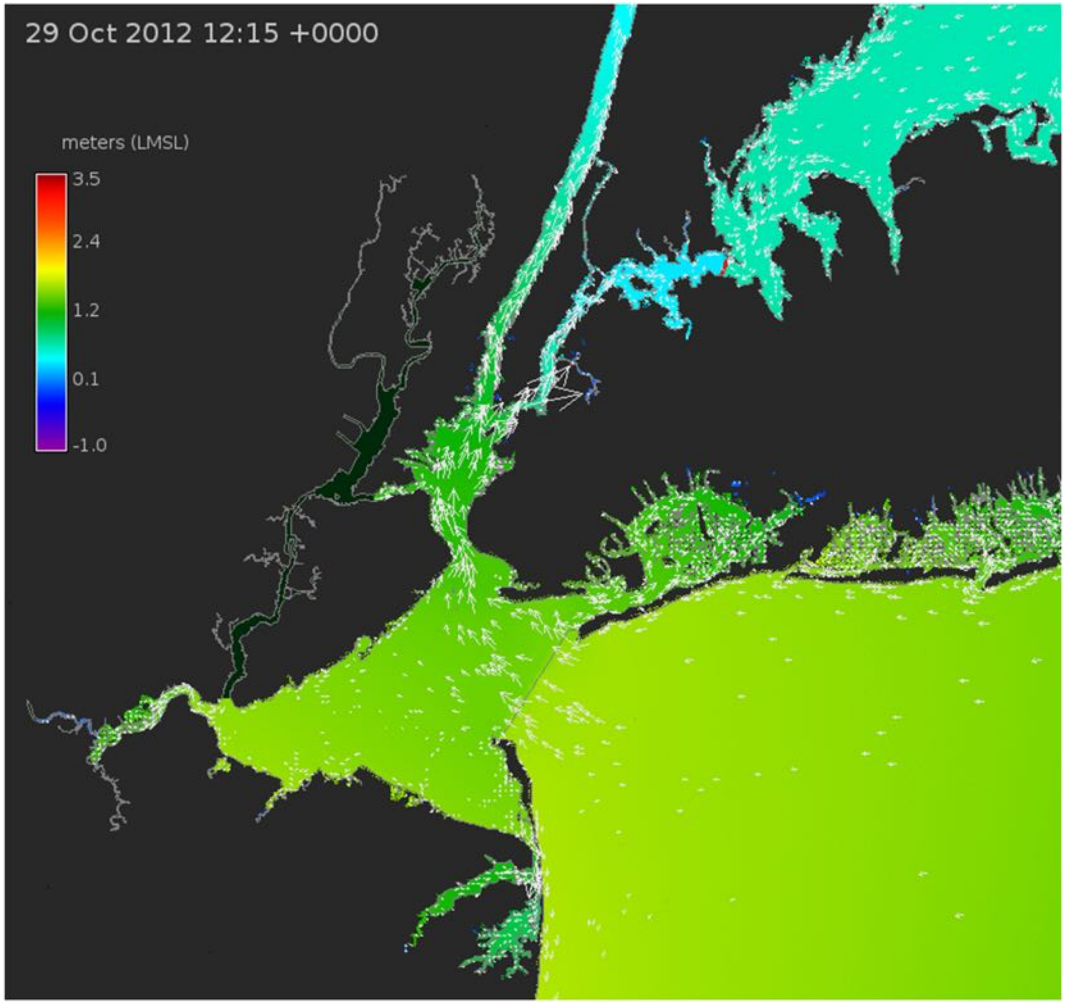


Additional Surge (in.) from Barrier Between Sandy Hook and Breezy Point



Contours in inches

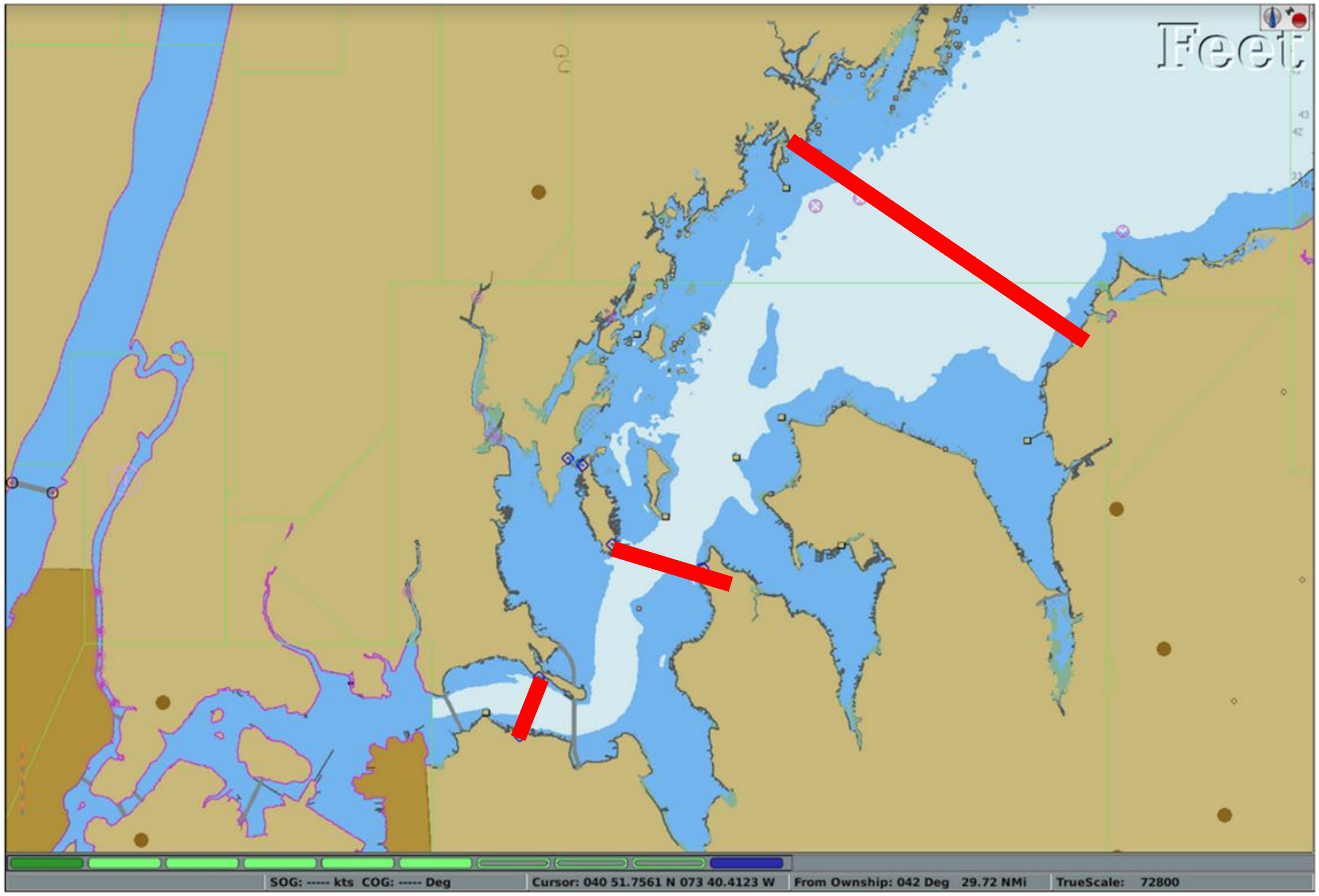
Animation of Surge Levels and Barotropic Currents



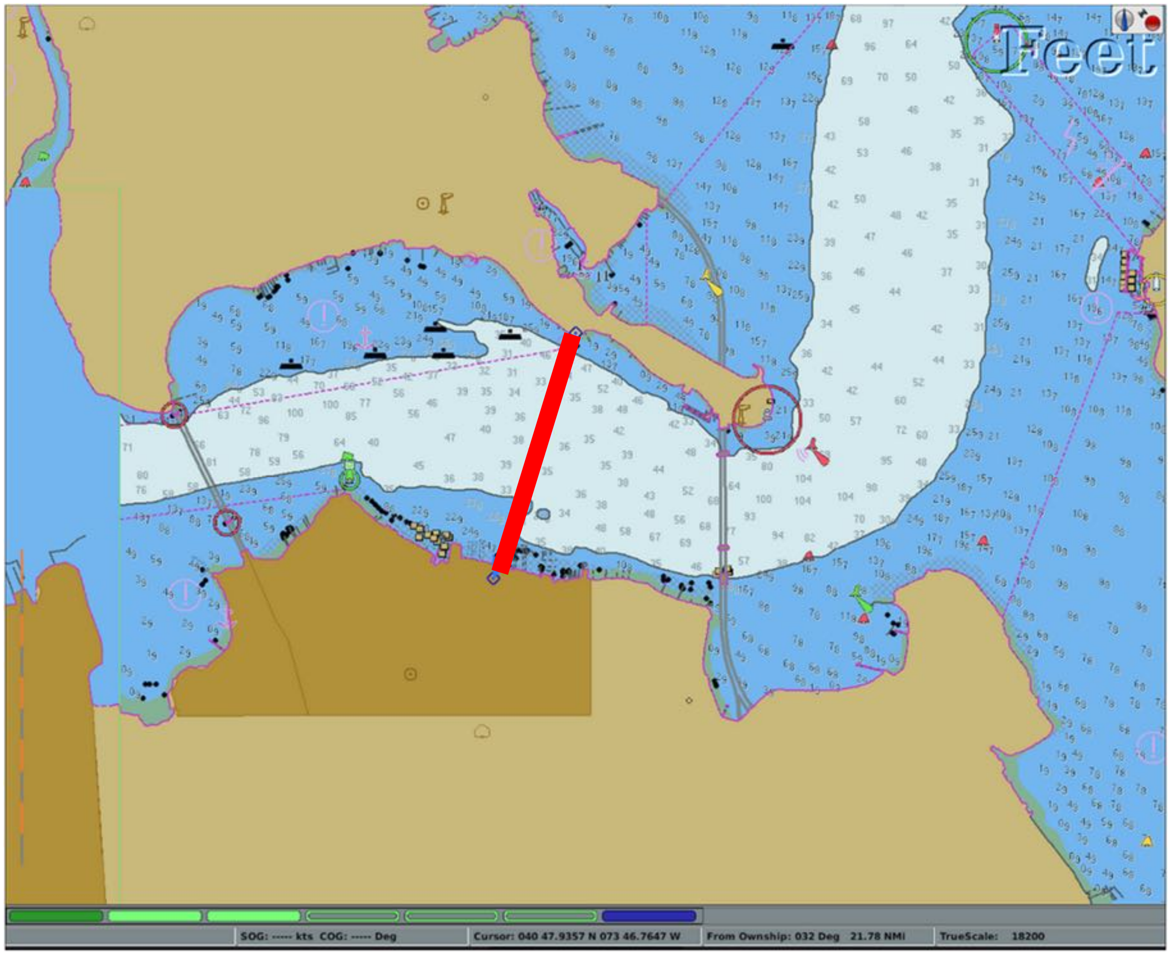
Animation of surge levels and barotropic currents in meters both inside and outside the barriers during Sandy.

Hudson River discharge measured at Troy included.

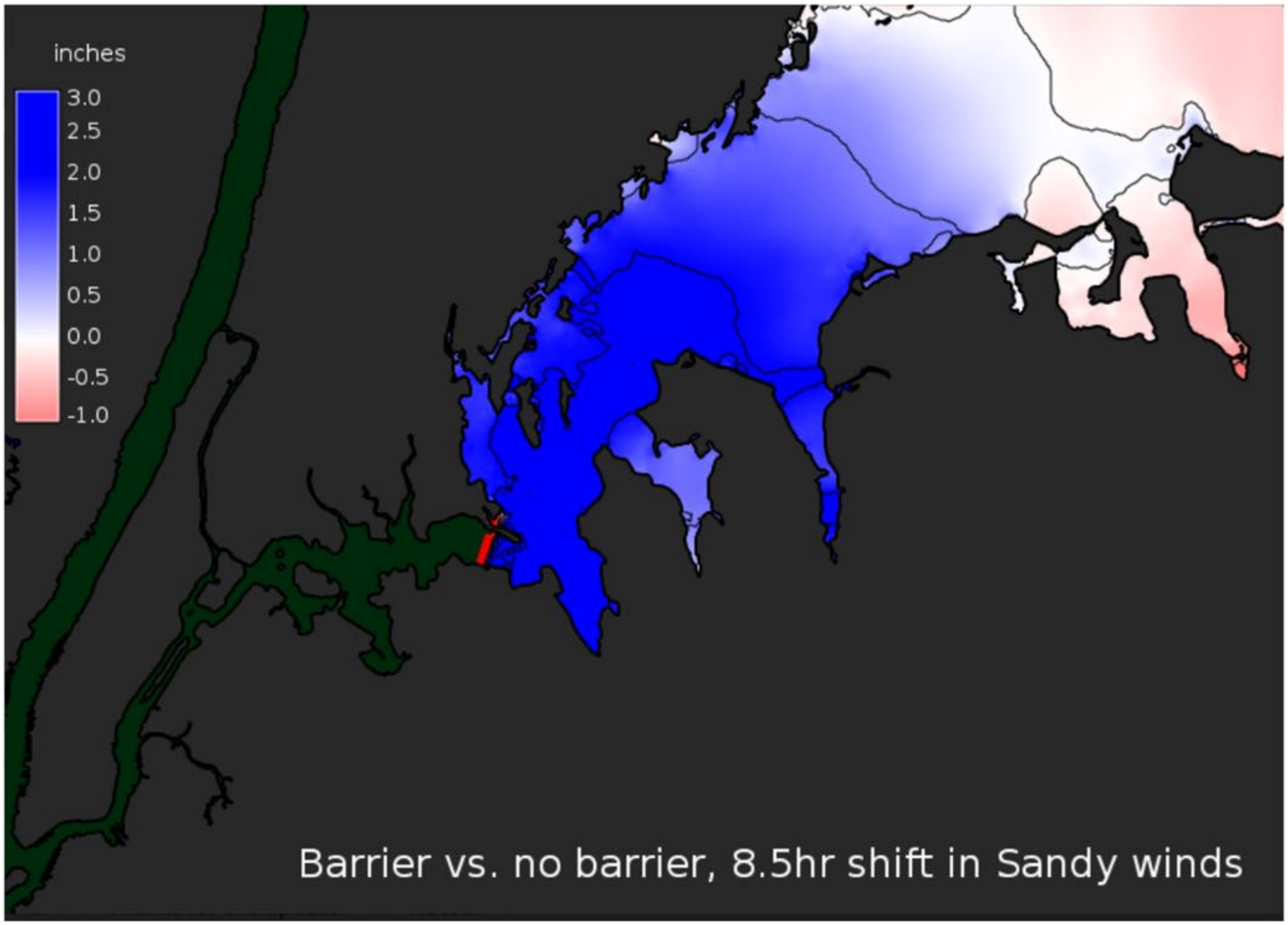
Potential Long Island Sound Barrier Locations



HATS Upper East River Barrier Location

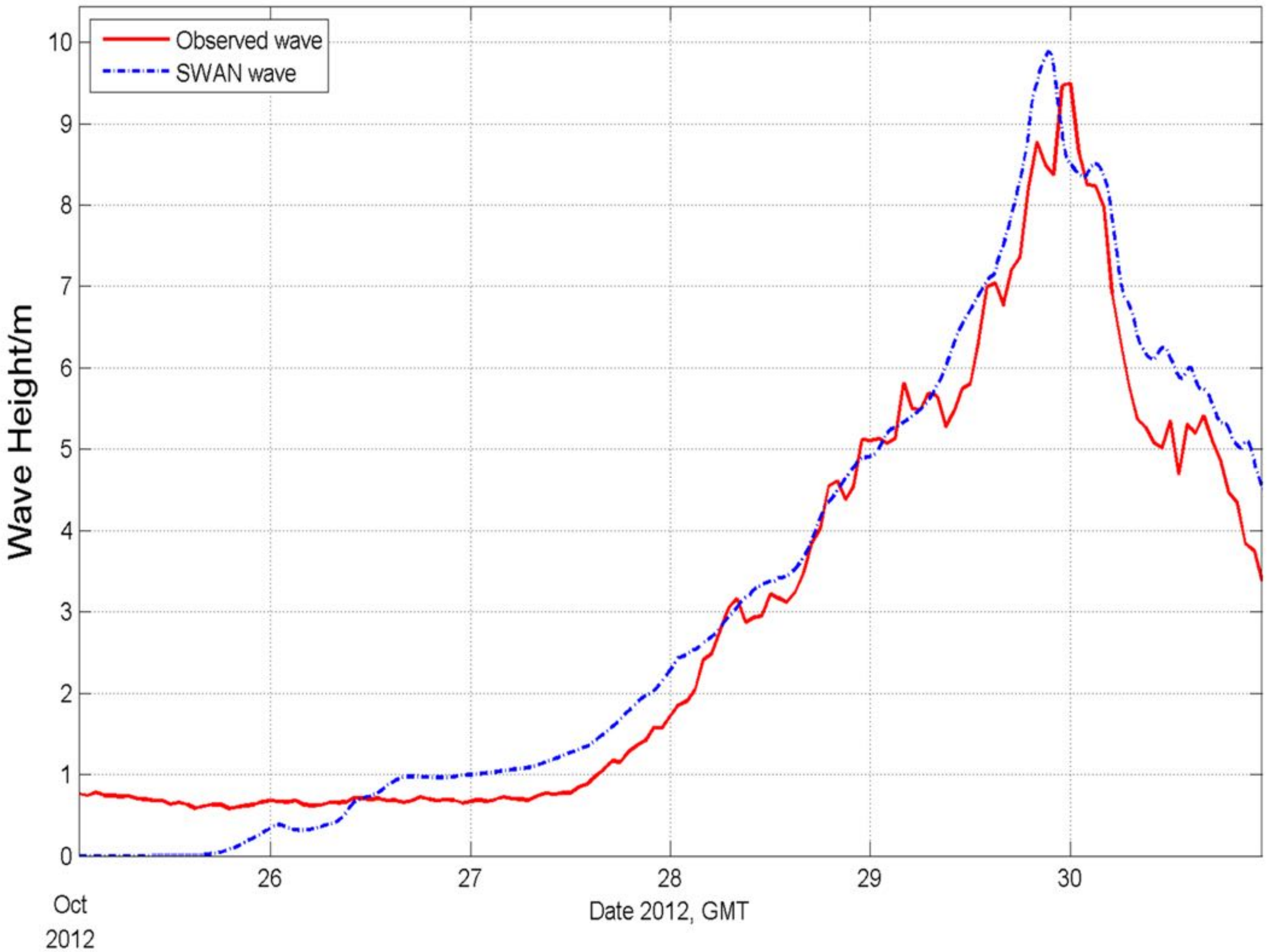


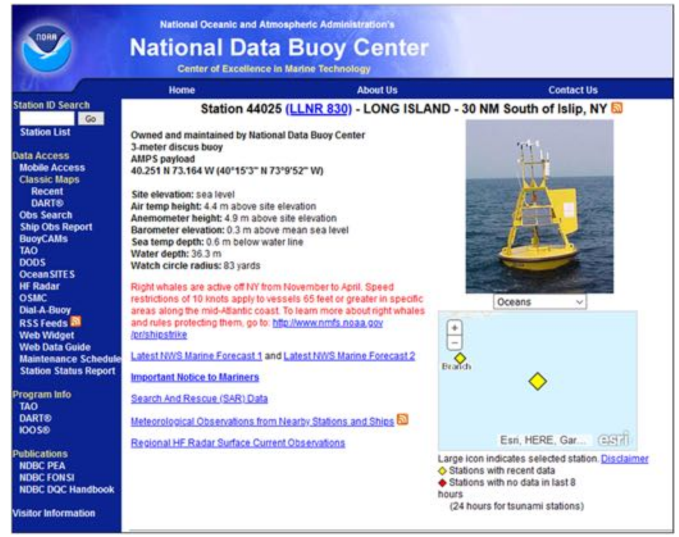
Additional Surge (in.) east of Throgs Neck Barrier



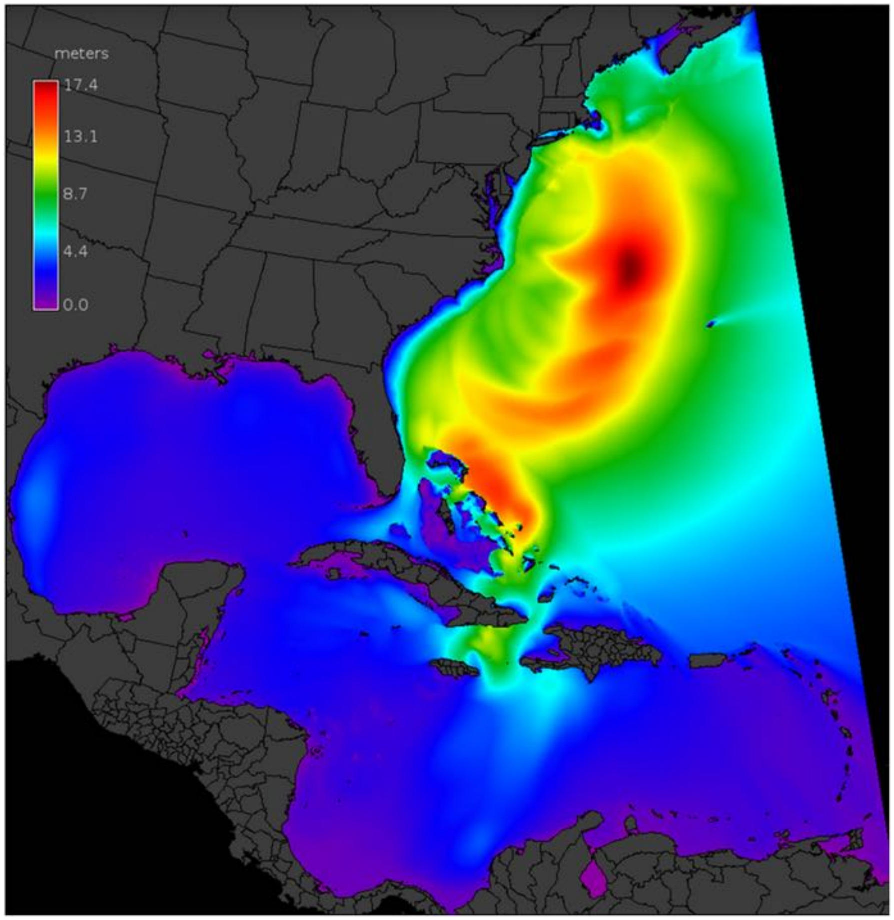
Wind time-shifted to create worst case scenario. Contours in inches.

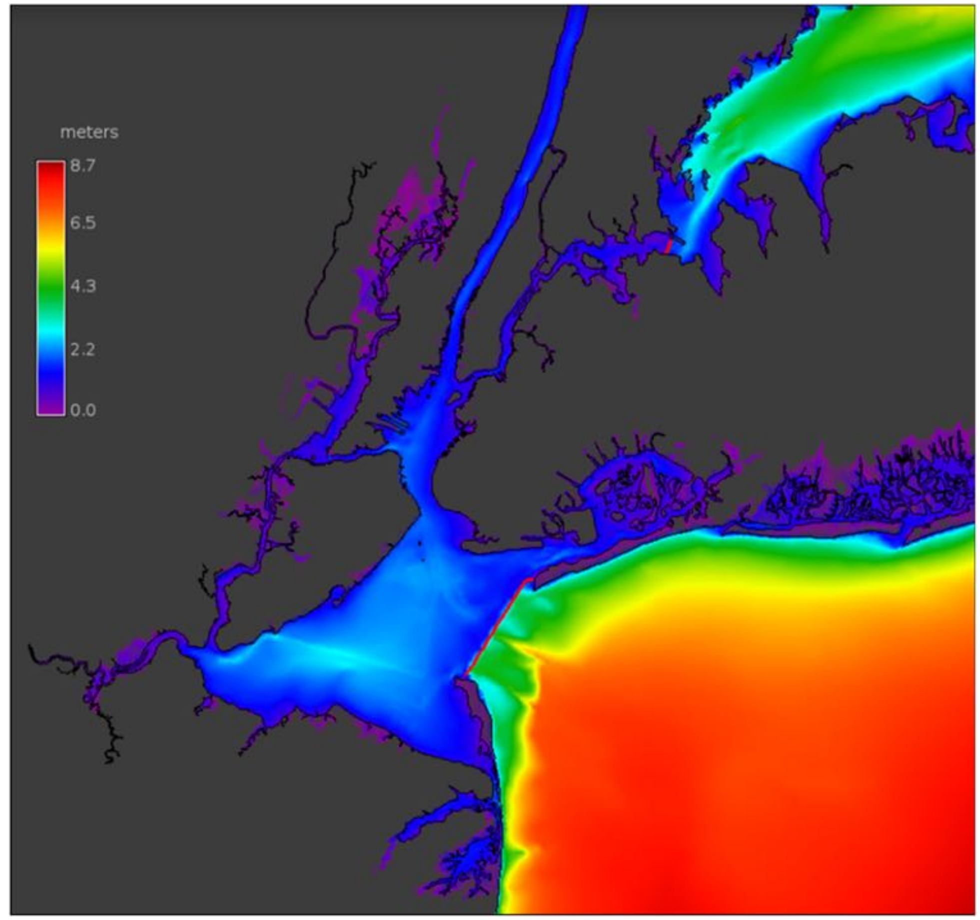
Significant Wave Height (m) at Buoy 44025





Maximum Significant Wave Heights
Generated by SWAN and ADCIRC – regardless of time





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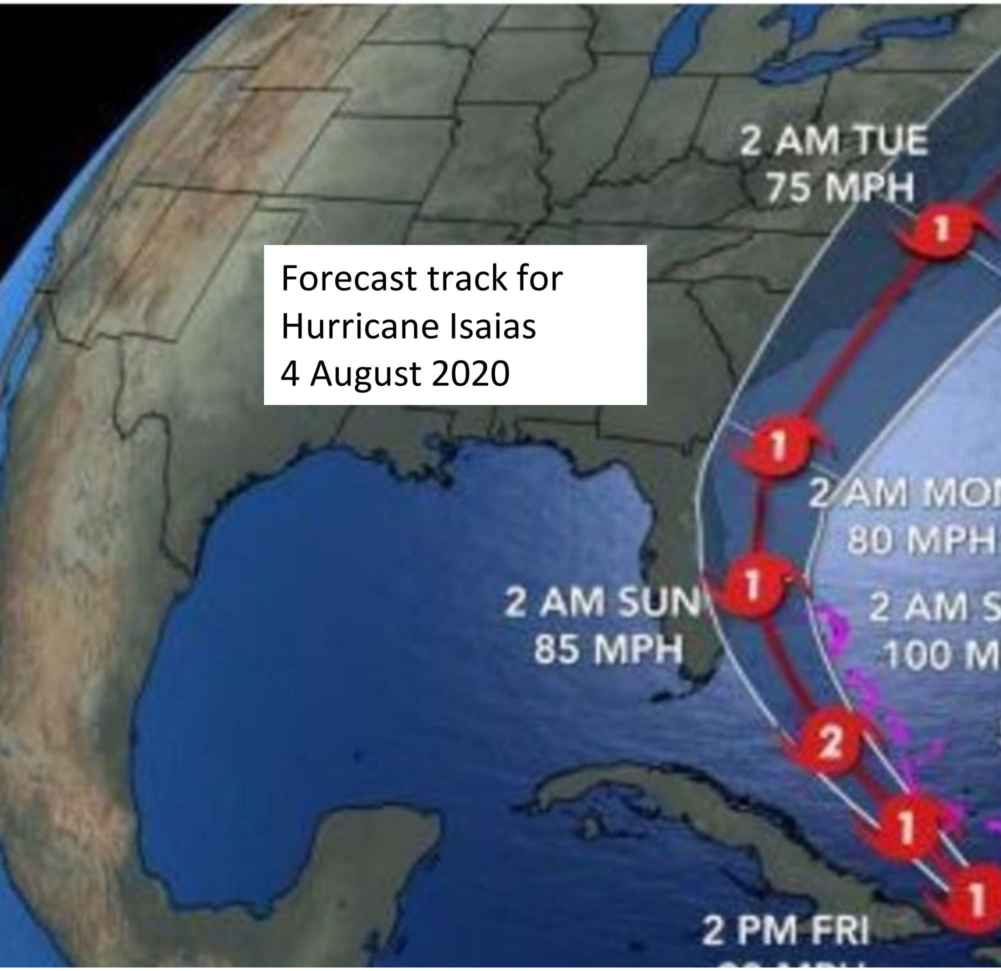
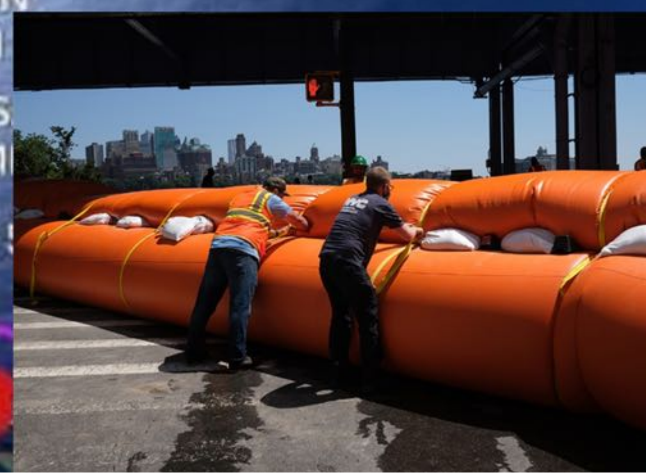
Jonathan Goldstick

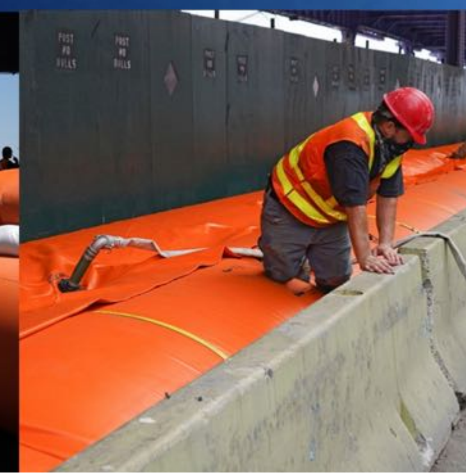
Practical issues of local perimeter protection.

Cost of Storm Preparation – before and after



Forecast track for
Hurricane Isaias
4 August 2020

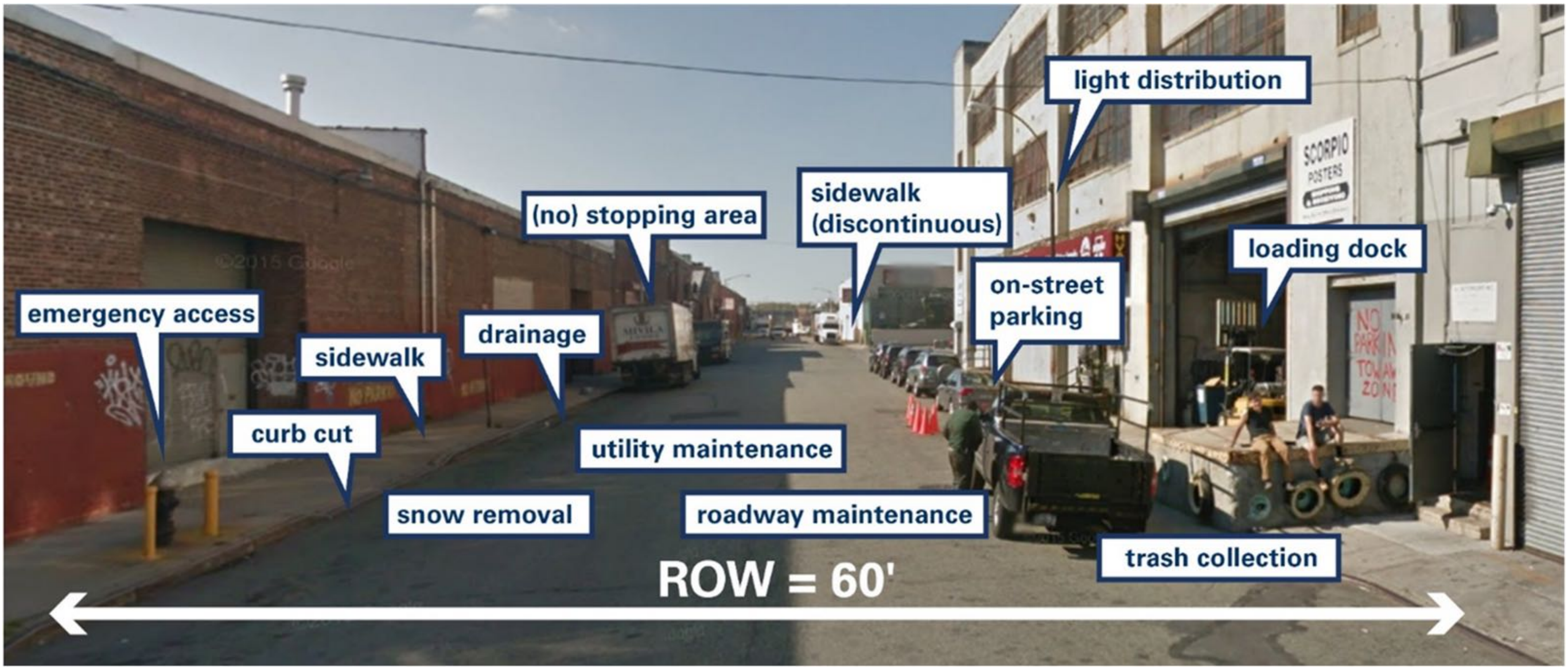




Gate Closing Logistics

Closing one barrier requires 10 workers, 2 trucks, and 4 police cars (from East Side Coastal Resilience)

Urban Infrastructure Challenges



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Daniel Gutman

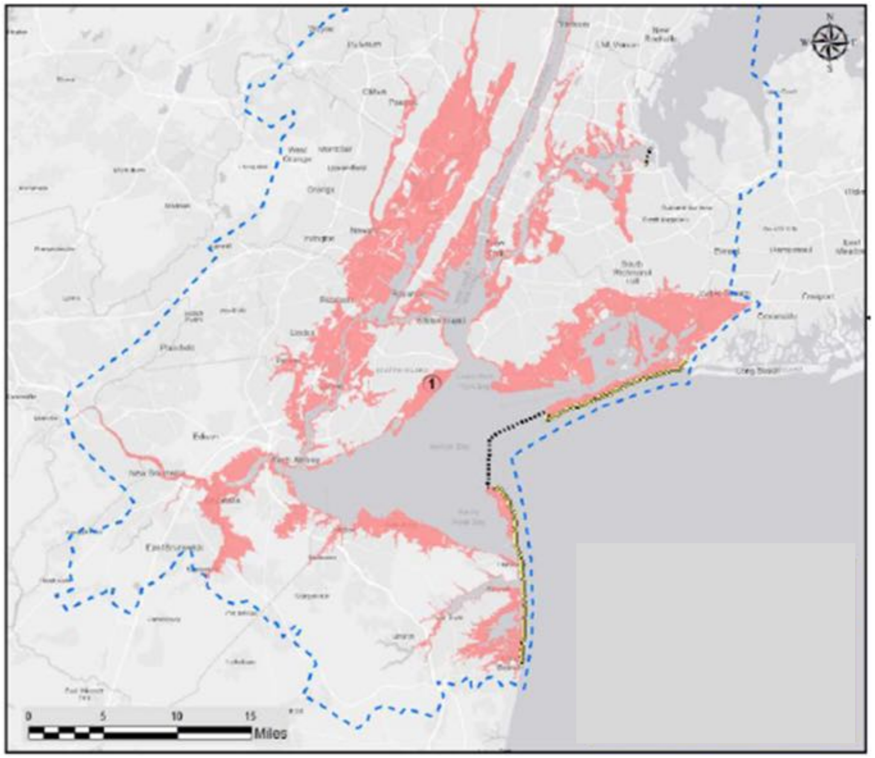
Comparing alternatives

USACE HATS Study

- Five alternatives, from regional offshore barriers to local shoreline barriers.
- Proposals are not alternative ways to achieve the same objective.
- Degree of risk reduction varies from > 75% to < 5%.

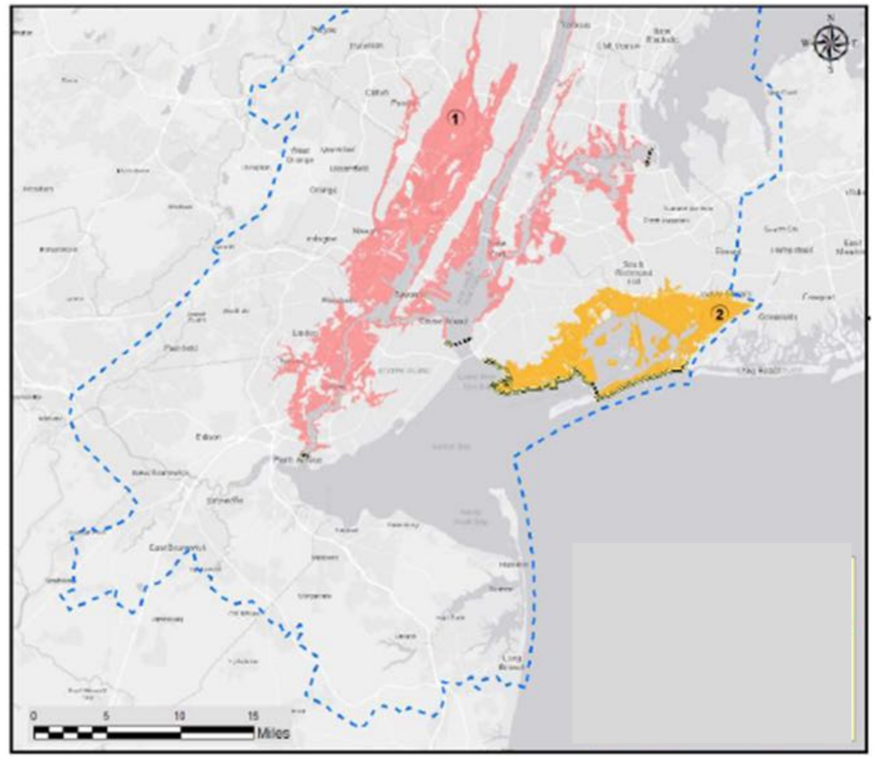
Risk Reduction for Alternatives

Alternative 2 95%



Throgs Neck
Outer Harbor

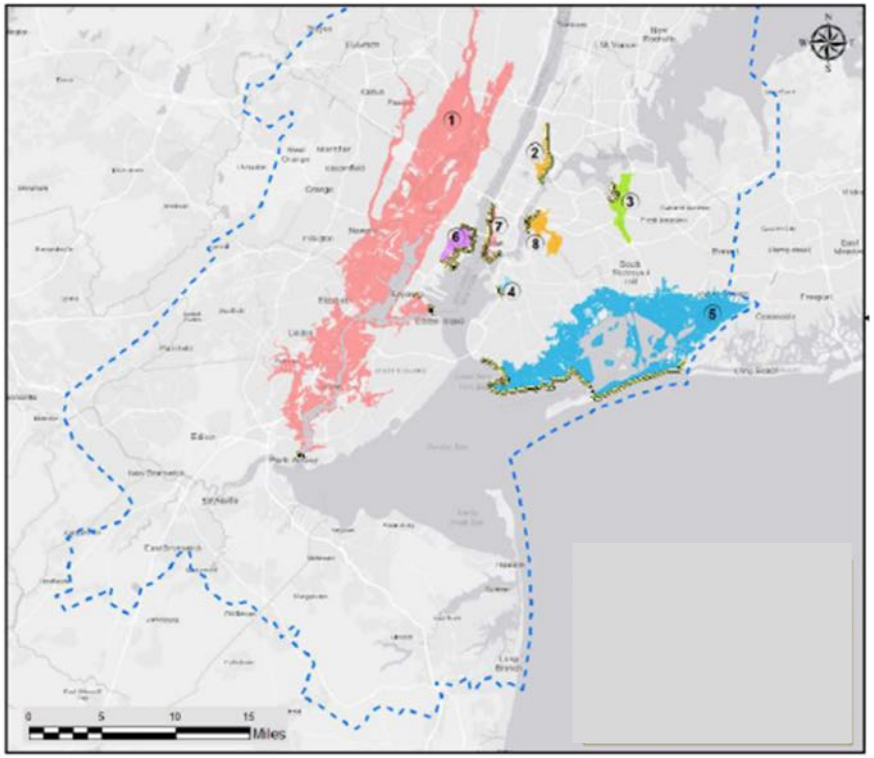
78% Alternative 3A



Throgs Neck
Arthur Kill Verrazzano Jamaica Bay

Risk Reduction for Alternatives

Alternative 3B 60%

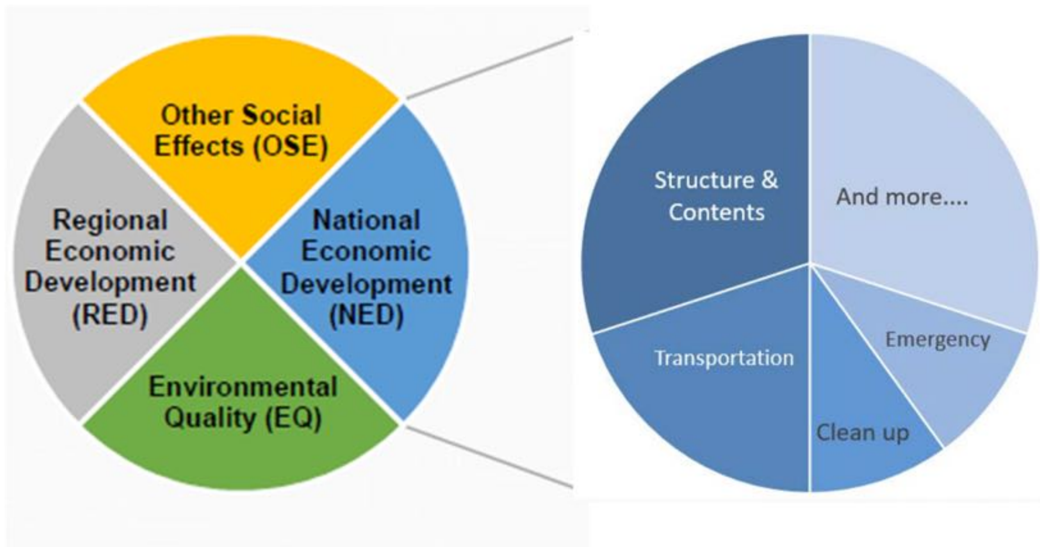


Kill van Kull
Arthur Kill
Newtown Creek
Gowanus Canal
Jamaica Bay

40% Alternative 4

Hackensack River
Newtown Creek
Gowanus Canal
Jamaica Bay

Analysis of Benefits



- Benefits based only on property values misses other values.
- Other (GIS) values are available, but not used to rank alternatives.
- To compare regional offshore barriers with local barriers, complete NYC and other non-federal plans should be incorporated.

Jonathan Goldstick
Summary

- **Flooding is a regional issue**
- **Little progress since Sandy has been made in protecting our region**
- **There is little consensus on how to proceed**
- **Informed public conversations are needed**
    - ***We are all responsible for ensuring that decisions are based on the best traditions of modern science.***

Metropolitan NY-NJ Storm Surge Working Group

Suzanne Digeronimo

Discussion – Q & A

The End

True or False

1. The height of a storm tide (surge plus tide) at landfall critically depends upon the height of the storm surge, the arrival time of the storm center and the phase of the tidal cycle.

True. *A storm tide at high tide will reach a higher elevation than a surge peaking at low tide.*

True or False

2. Storm surge is already capable of producing temporary increases in NY Harbor water levels that exceed projected sea level rise one hundred years in the future.

True

The 14 ft high water level produced by Sandy exceeds most long-term projections of sea level rise for the metropolitan area. Planning for and protection from both is not an either/or proposition.

True or False

3. A 100-year storm design standard offers more protection than the design standard of the Netherlands storm barrier system.

False
Much of the Netherlands system is designed for a 1-in-10,000 year storm.

True or False

5. A tsunami can typically be predicted days in advance whereas storm surges are highly unpredictable.

False. *Tsunami resulting from a sudden undersea earthquake will travel landward at 450 miles per hour. A storm surge is slower moving and can often be predicted several days in advance.*

True or False

6. Unstructured oceanographic model grids:

a. Efficiently represent complex coastal boundaries
b. May include finer mesh resolution in areas of highly variable bathymetry
c. Reduce or eliminate the need for nesting model domains
d. Provide high accuracy with fewer grid cells than other types of model grids
e. All of the above.

Correct answer: e.

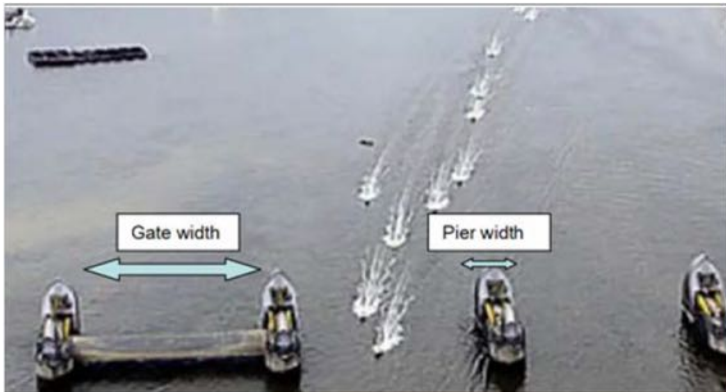
The 1 in 100-Year Probability

- The 1% Annual Exceedence Probability (AEP) flood has a 1% chance of occurring in any given year
  - However, during the span of a 30-year mortgage, a home in the 1% AEP (100-year) floodplain has a 26% chance of being flooded at least once

- Chance of 100-year flood not occurring this year is 99%
- Chance of 100-year flood not occurring in any two years is 99% x 99% = 98%

- Chance of 100-year flood not occurring in 30 years is 0.99^{30} = 74%
- Chance of 100-year flood occurring once in 30 years is 1 – 74% = 26%

- Chance of 100-year flood occurring within a 100-year interval is $1 - .99^{100}$ = 63%

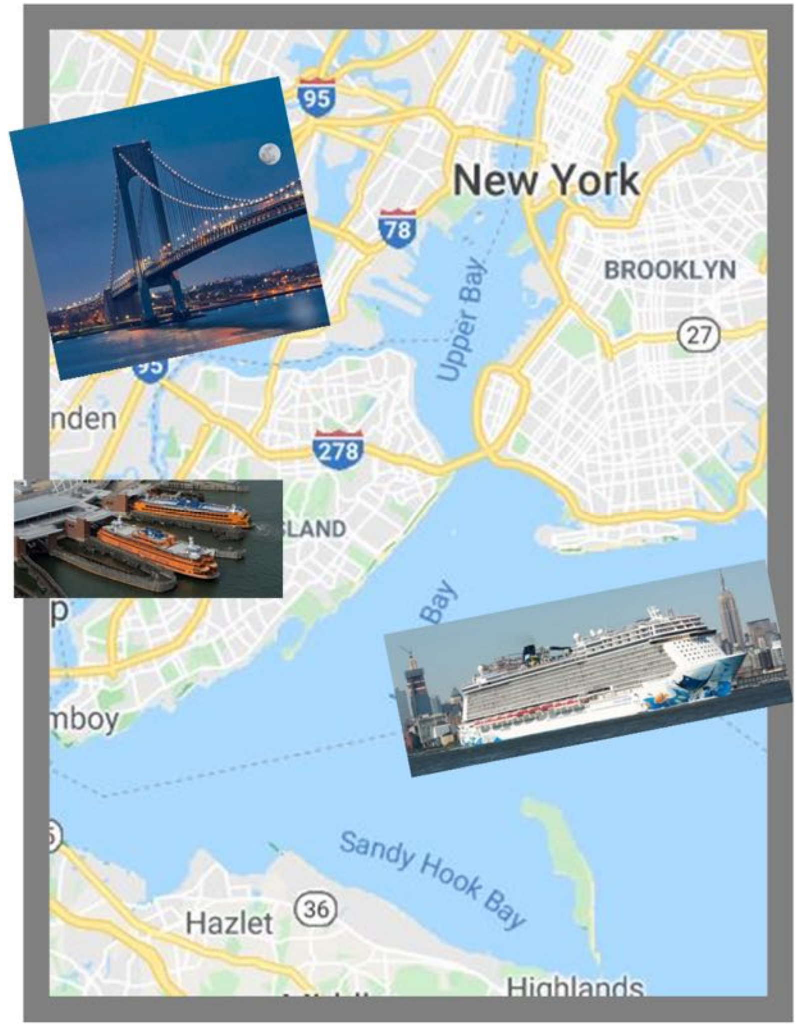


Thames River Barrier, opened in 1984.

Cruiseliner passing through Thames Barrier. The **barrier**, made up of 10 steel **gates**, reaches 520m (1,700ft) across the **river**. When open, the **gates** lie flat on the **river** floor and close by being rotated upwards until they block the **river**. The four main **gates** span 61.5m (200ft) and weigh more than 3,000 tonnes each

"Giant dams enclosing North Sea could protect millions from rising waters" **by Jon Henley and Alan Evans. The Guardian, 12 Feb 2020.**


A CHART
OF
NEW YORK HARBOUR
with the
for
the Use of PILOTAGE
Composed from
SURVEYS and OBSERVATIONS
WEST FLATT
LONG ISLAND
WEST BANK
EAST BANK
RARITON BAY
Engraved chart of New York Harbour. Atlantic Neptune. Published by J. F. W. Des Barres, 1779
NATIONAL MARITIME MUSEUM


New York
BROOKLYN
Upper Bay
95
78
27
278
Bay
Sandy Hook Bay
Hazlet
36
Highlands

- End of Part I – Hydrodynamic modeling with ADCIRC.

- Start of Part 2. SSWG benefit/cost analyses.

- End of Part 2. some benefit/cost analyses

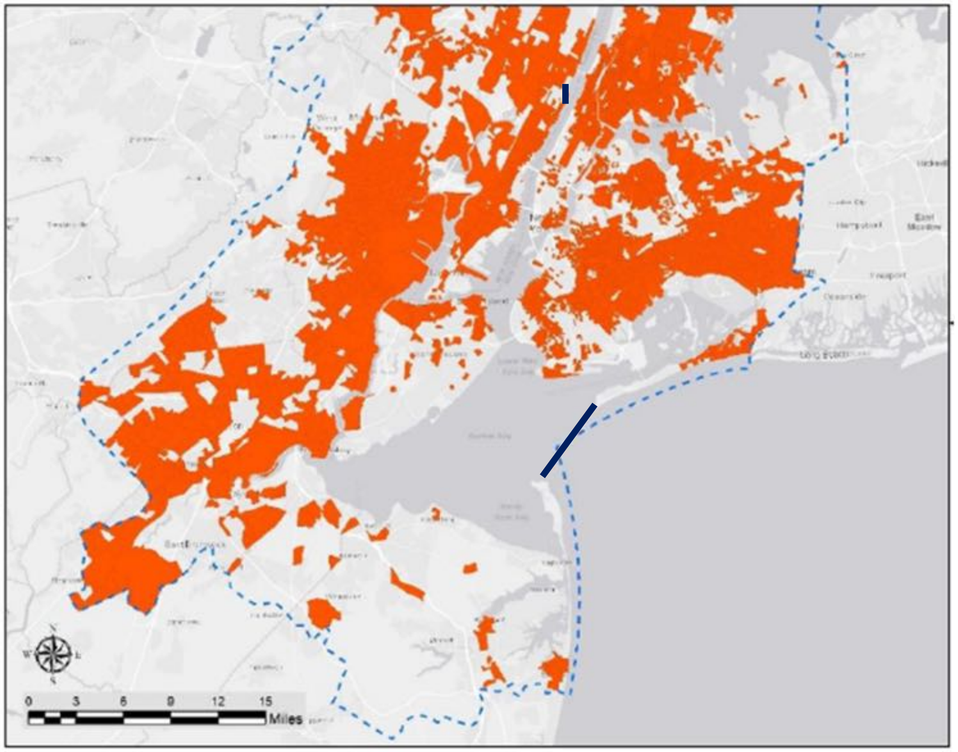
- Start of Part 3: Some thoughts on alternative designs…….

SSWG – USACE Discussions

- Construction cost sensitivity to construction timeline
  - $120 billion to $63 billion reduction for HATS Alternative 2
- Project life
  - 100 years vs 50
- Protecting more of region – even with reduced benefits
- Closure criterion
  - Determines anticipated number of closures
- Reliability of onshore vs offshore measures
- Timing and method of public engagement

Environmental Justice

Extent of 1% probability flood.



Environmental justice areas.