Halcrow

NY-NJ OUTER HARBOR GATEWAY

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- **Where do we go from here**
- **Questions**

Background

Top ten cities (in terms of assets) with highest exposure and vulnerability to climate extremes:

- **Miami**
- **Greater New York**
- **New Orleans**
- **Osaka-Kobe**
- **Tokyo**
- **Amsterdam**
- **Rotterdam**
- **Nagoya**
- **Tampa-St Petersburg**
- **Virginia Beach**

New York Observer

The Organization for Economic Co-operation and Development (OECD) , Nov 08

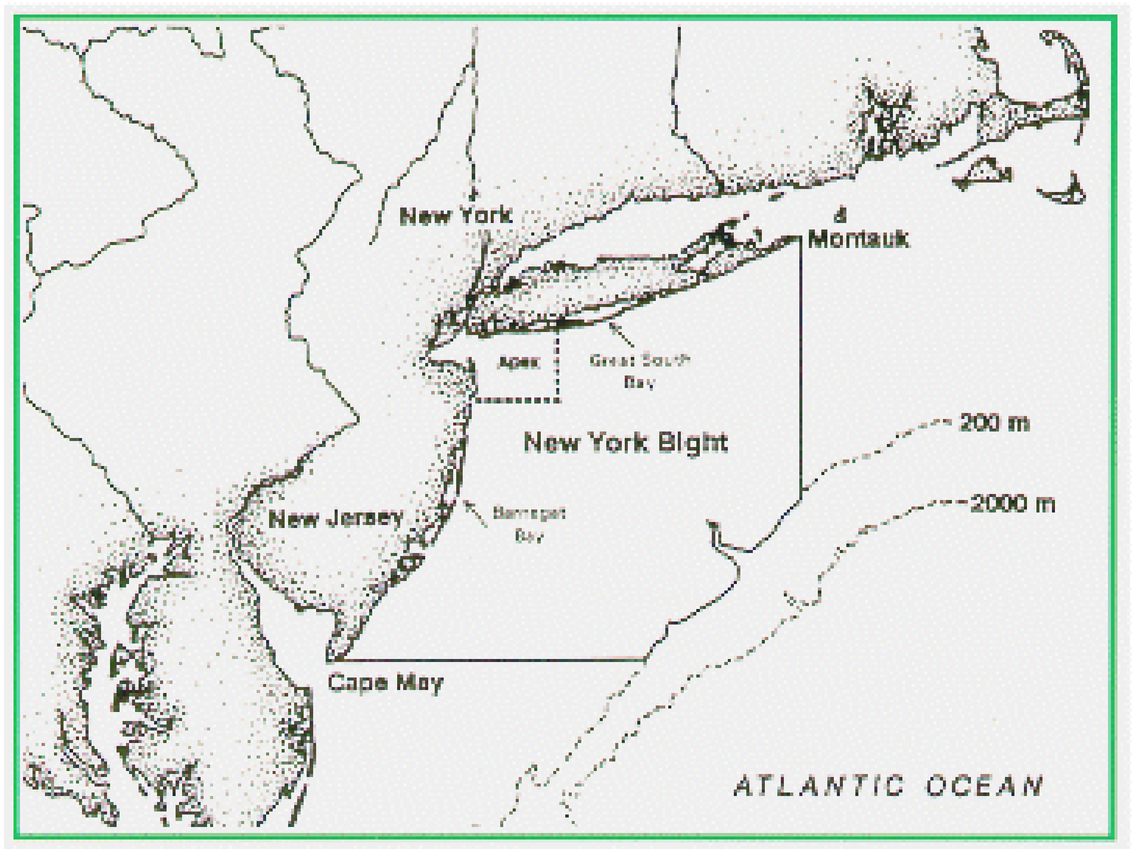
Background

- **Previous presentations include storm-surge barriers at:**
  - **the upper East River**
  - **the Narrows**
  - **the mouth of the Arthur Kill**

- **This presentation discusses an alternative to the latter two:**
  - **the Outer Harbor Gateway barrier across the mouth of the New York Bight**

Background

- **New York Harbor at apex of New York Bight**
- **Hydrodynamics dominated by oceanic boundary and inland flows, primarily the Hudson River**



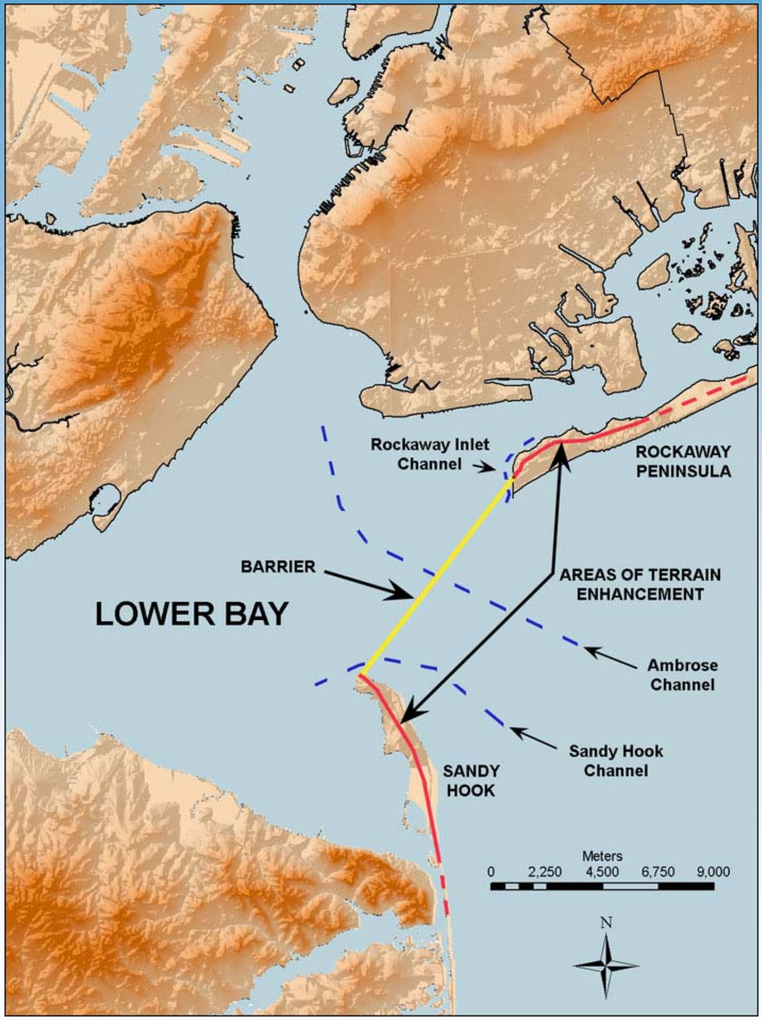
Location and Concept

Outer Harbor Gateway Barrier System

- **Spans mouth of the New York Bight between Sandy Hook and Breezy Point**
- **Protects most of the greater New York area from flooding**
- **Includes terrain enhancements along Sandy Hook and Rockaway peninsulas**

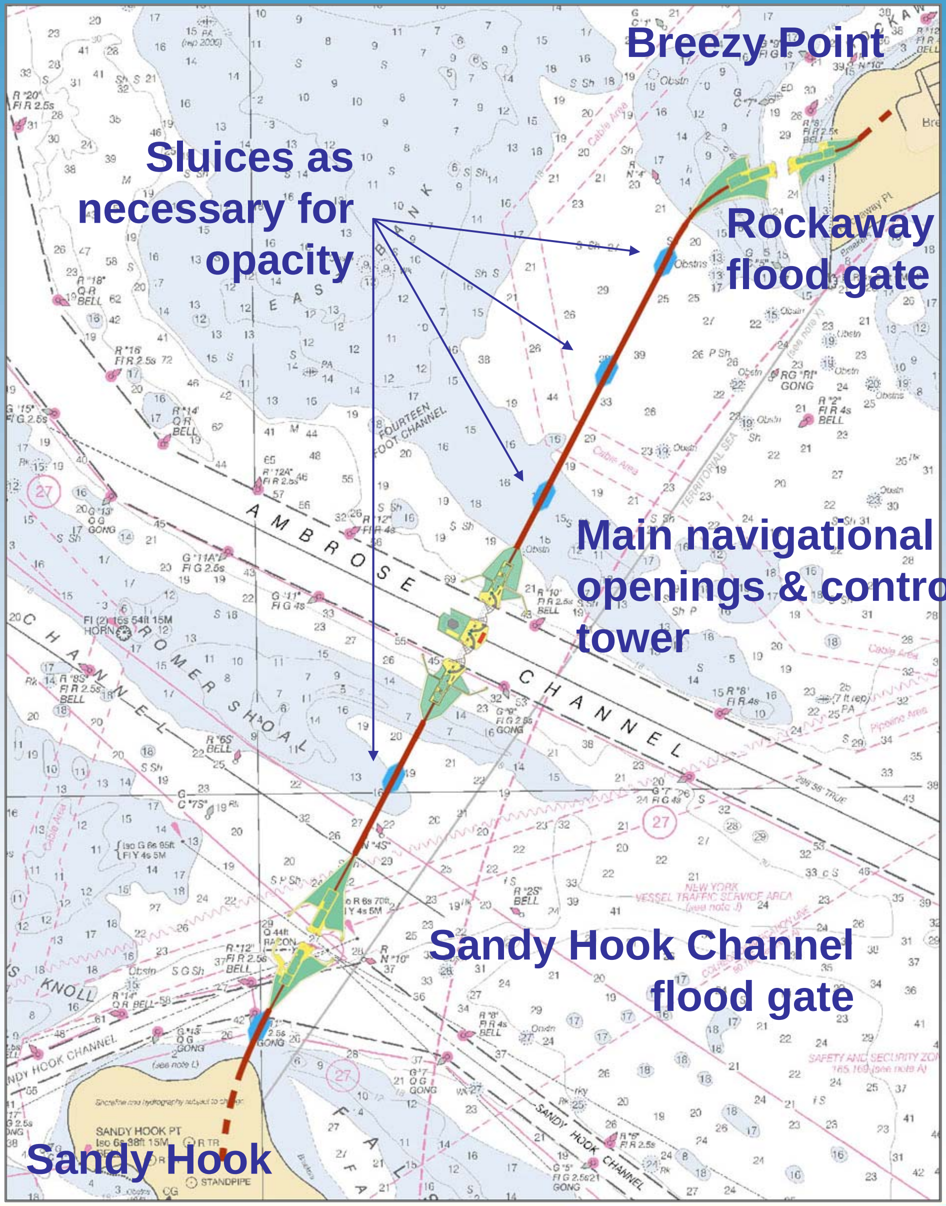
Considerations

- **Barrier opacity, number of openings, sluices and circulation, flow velocities**
- **Timing of closure, fluvial flow build-up, outflanking, operational procedures**
- **Environmental**
- **Socio-political**

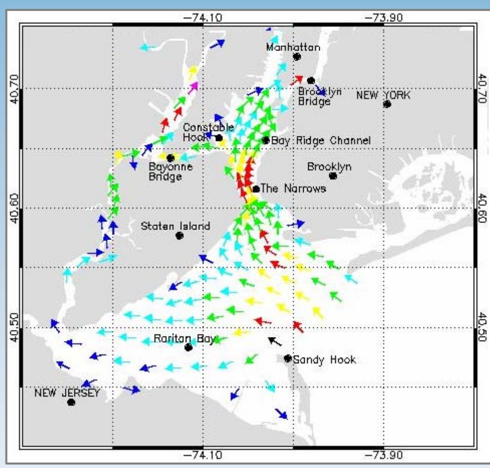


NY-NJ Outer Harbor Gateway

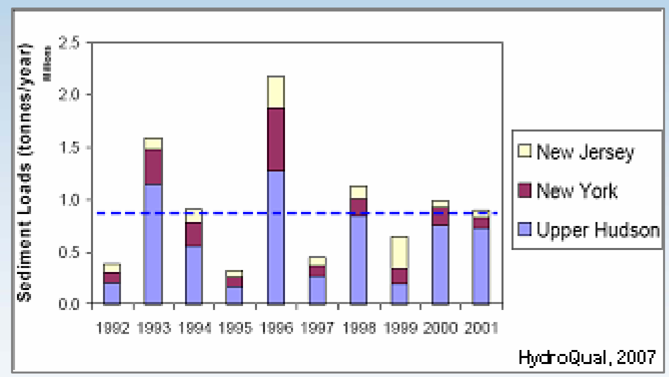
Location and Concept



Potential Barrier Issues



- **Ship Navigation**
- **Hydrodynamics**
- **Geomorphology**
- **Water Quality**
- **Design Life**
- **Environmental Impact**



Risk, Reliability and Consequence

Gate Requirements

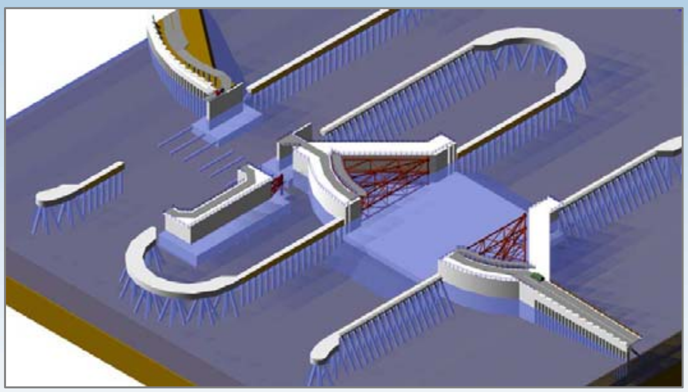
Withstand the Flood Event

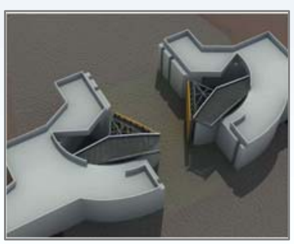
- **Exposed location open to Atlantic**
- **Overall height around 80 ft (normal water depth 50 ft)**
- **Potential for future channel deepening**

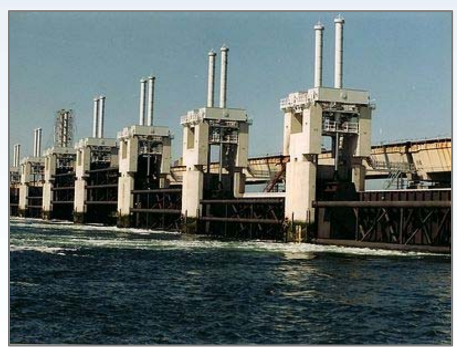
Available on Demand

- **Navigable by ocean going ships (width and depth of channel)**
- **Structural, mechanical and electrical maintenance**
- **Able to be deployed in bad weather (high winds + large waves)**

Gate Types







Gate Types

Possible Gate Types

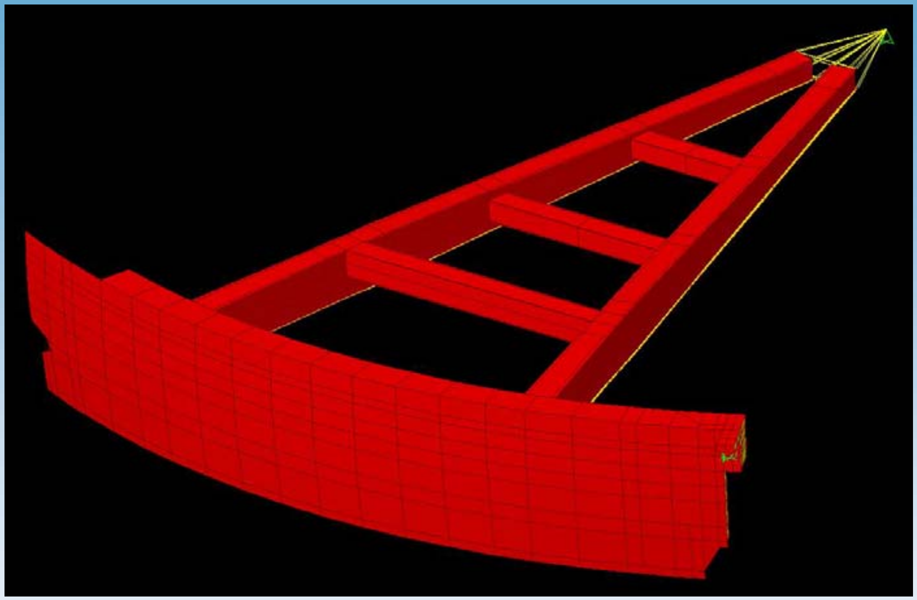
- Vertical Lift Gates
- Vertical Fall Gates
- Rolling Gates (Caissons)
- Miter Gates
- Base-hinged Flap Gates
- Rising Sector Gates
- Radial Fall Gates
- Vertical Axis Sector Gates

Large Radius Vertical Axis Sector Gates

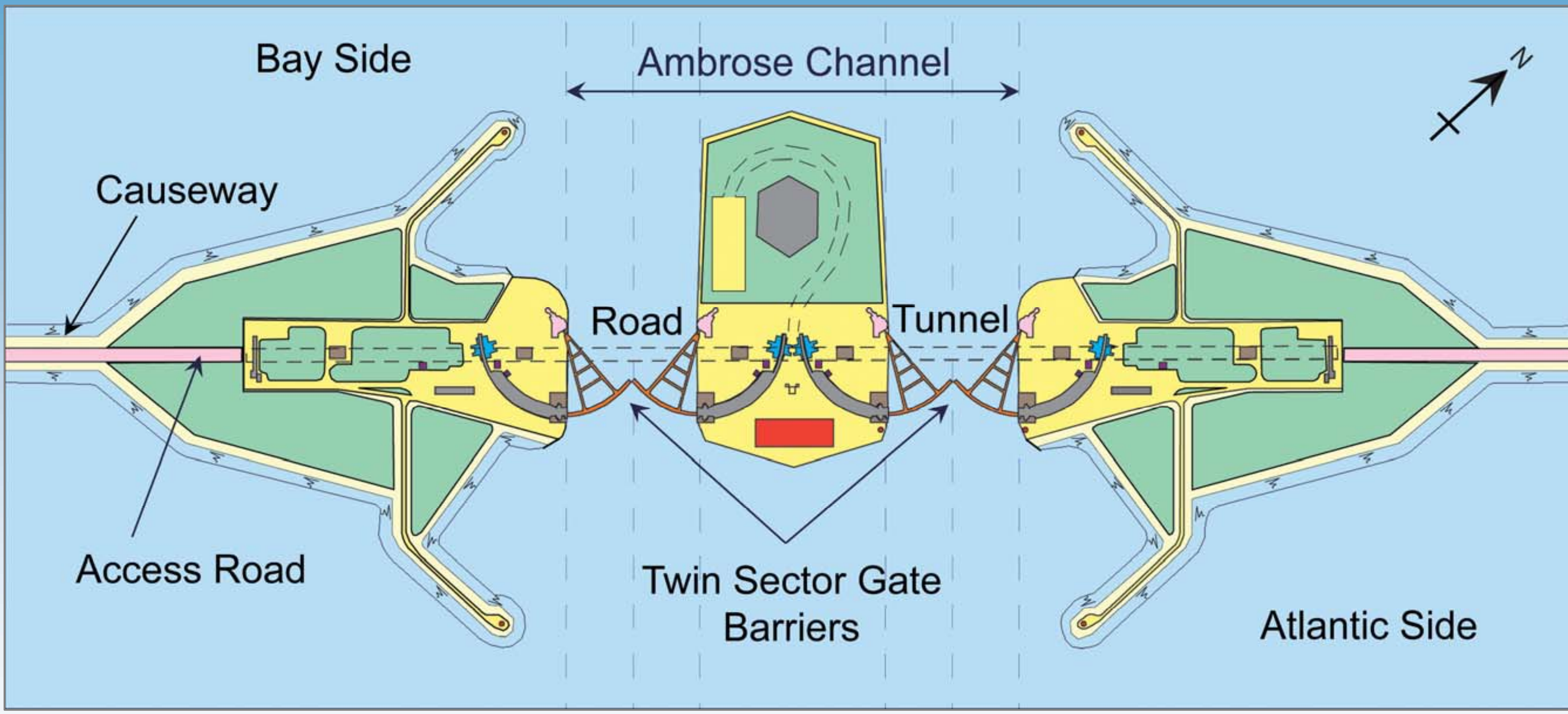
- Suitable for wide channel
- Stored and maintained in dry

Maeslant and St. Petersburg

Large Radius Vertical Axis Sector Gates



Ambrose Channel Gates

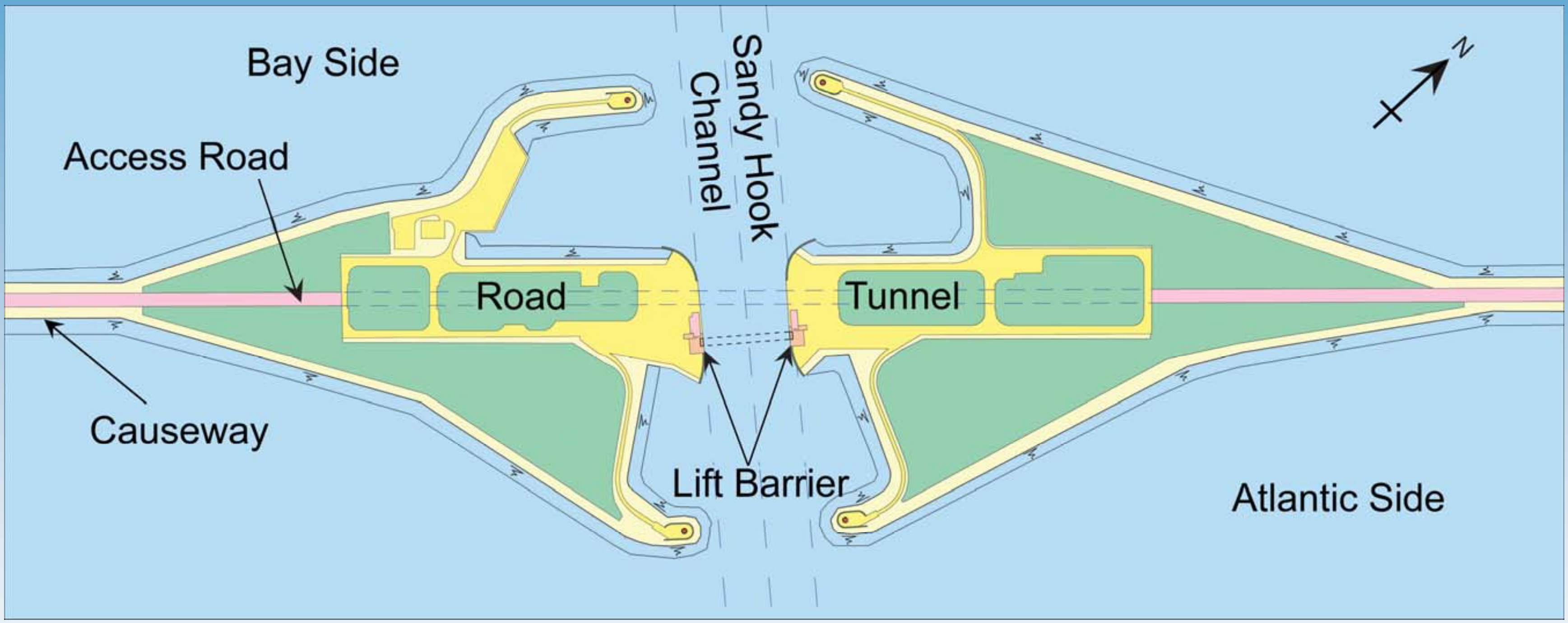


Ambrose Channel 2,000 ft wide

Each gate channel 600 ft wide

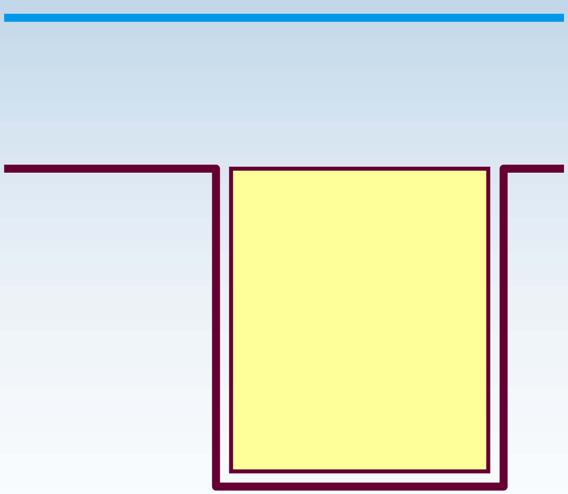
Control island 800 ft wide

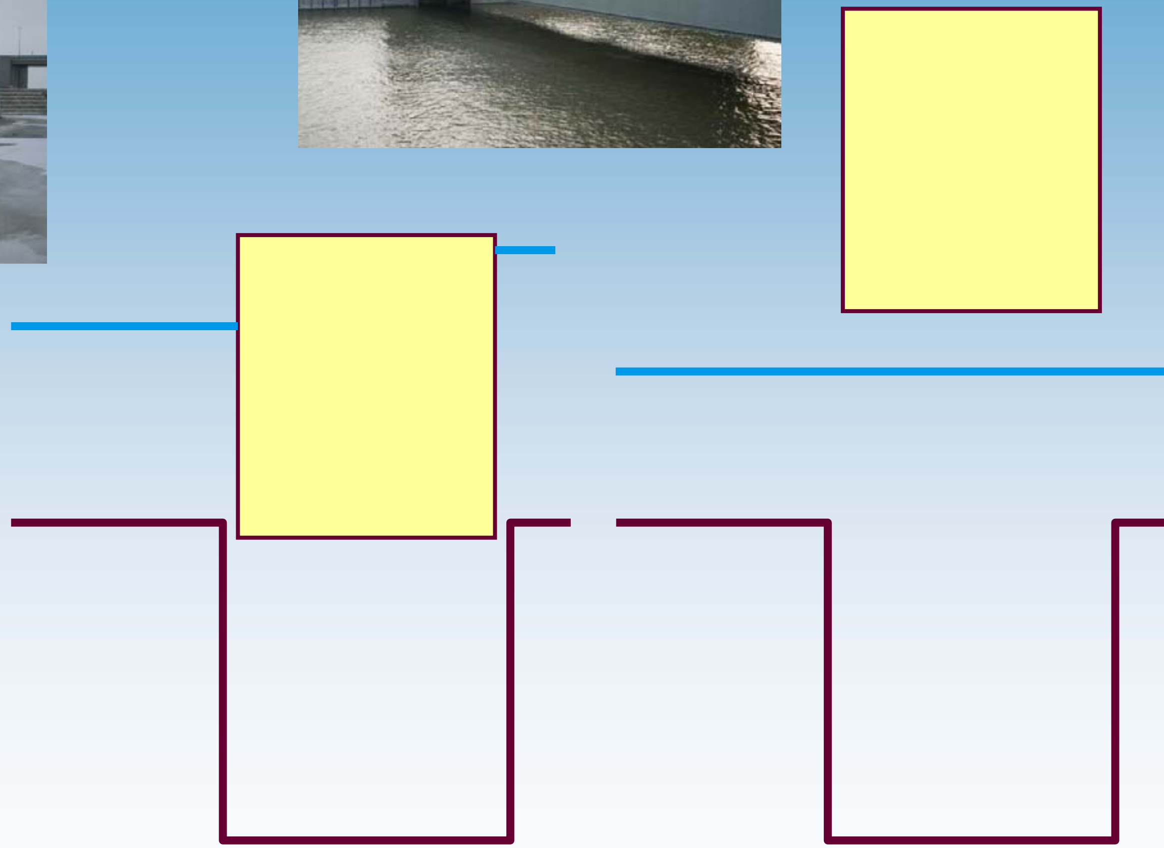
Sandy Hook Channel Gate



Lifting gate 300 ft wide

Sandy Hook Channel Gate





Gate open

Gate closed for defense

Gate raised for maintenance

Sluice Requirements

Water Quality

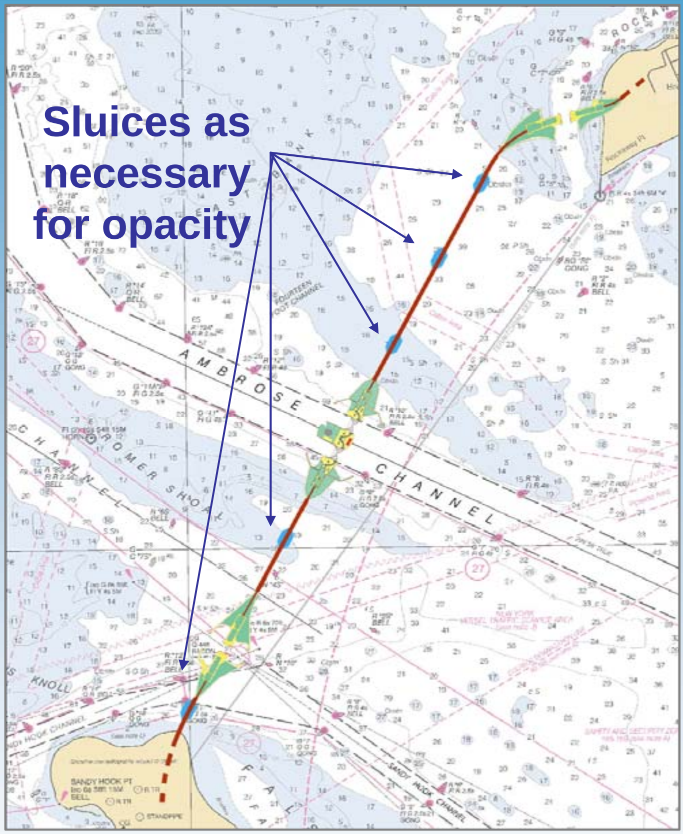
- **Provides water circulation vents**
- **Provides potential control of flushing actions**
- **Allow passage of marine life**
- **Influences environmental impact**

Operational issues

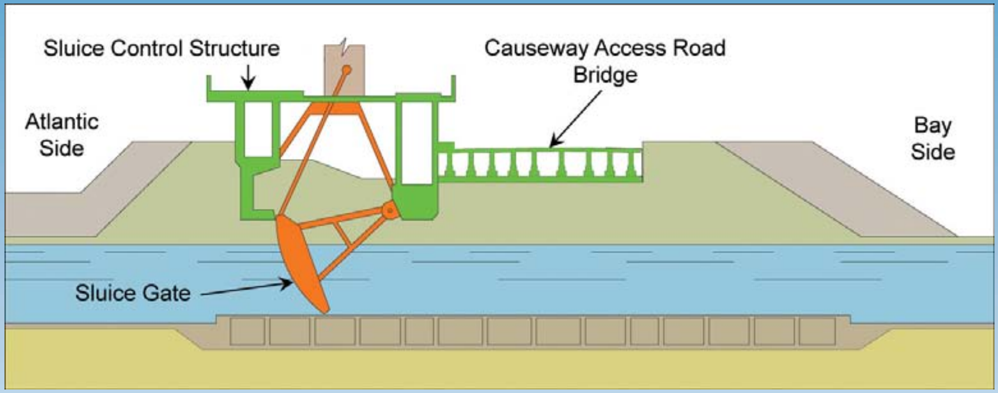
- **Provides control of water velocities**
- **Influences sedimentation**

Defense issues

- **Improves defense reliability**
- **Improves control over closure timing**

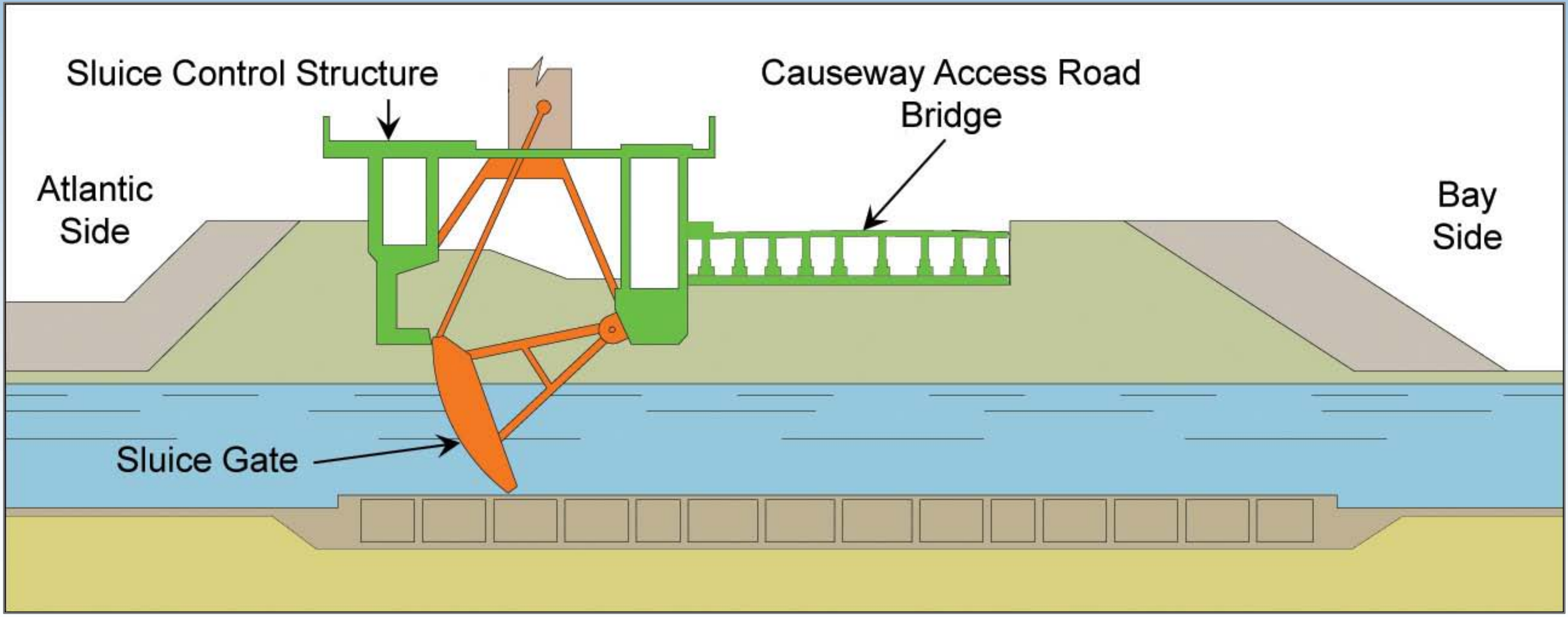


Sluice Types



Horizontal Axis Sector Sluice

- **80± ft wide**
- **Groups of 10±**
- **Sufficient number to provide required opacity**



Causeway Requirements

Connect the Gates

- **Span over 5 miles across apex of New York Bight**
- **Lowest feasible environmental impact**
- **Minimize socio-economic issues such as recreation value and aesthetics**
- **Possible multi-use options (highway/utilities)**

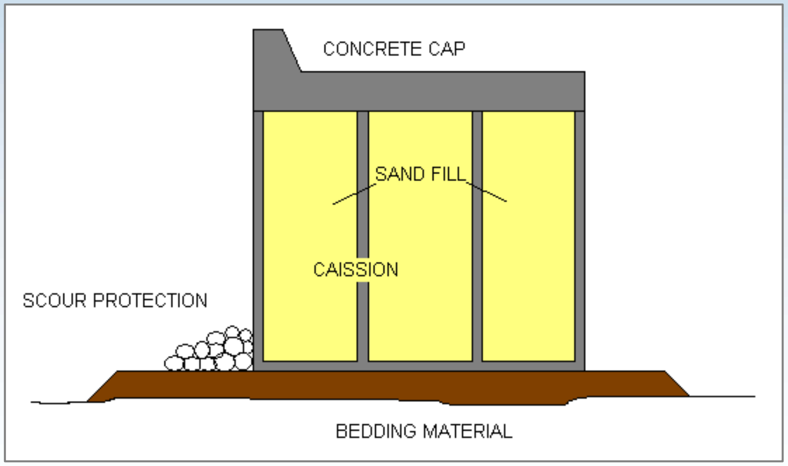
Withstand Normal and Storm Conditions

- **Structural stability against aggressive wave climate (both operational and storm conditions)**
- **Low/minimal maintenance and risk**
- **Available material for construction**

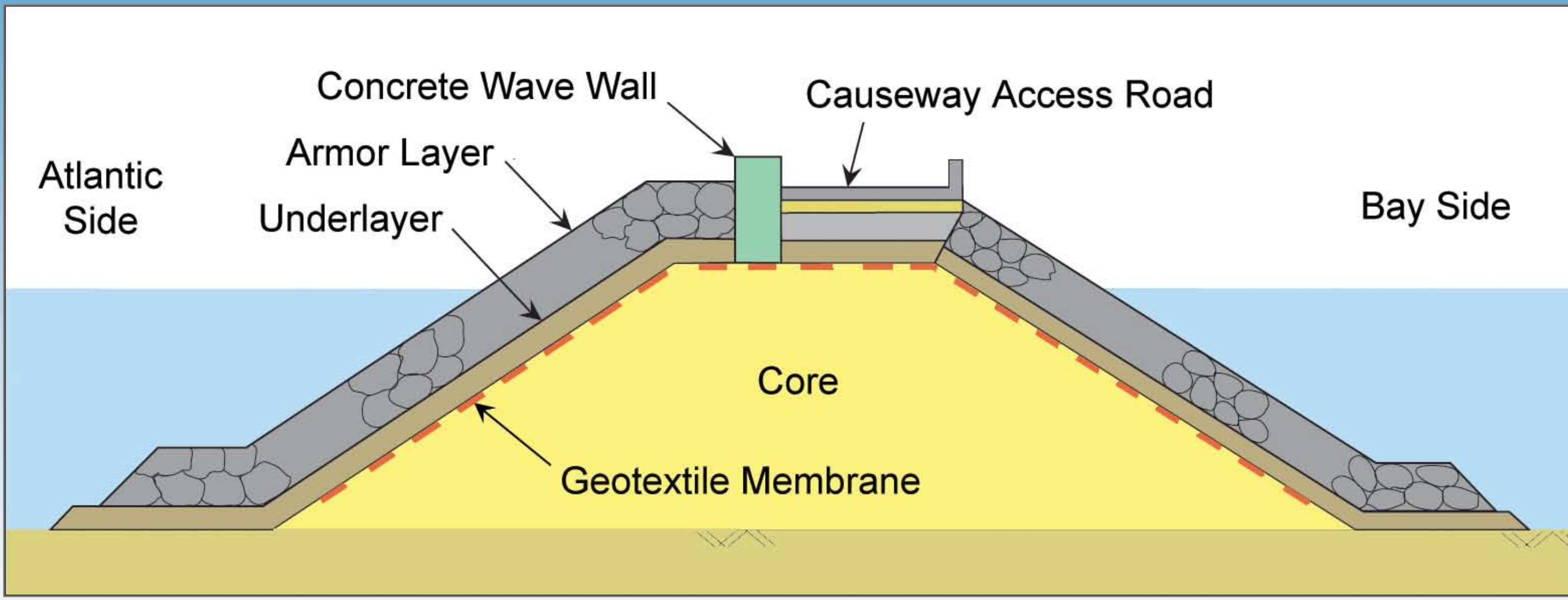
Causeway Types

OPTION	*PRINCIPAL MATERIAL*
Armor rock (rubble mound)	**Rock**
Concrete armor units	**Rock and Concrete**
Caissons	**Concrete and fill**
Connected piers (such as Oosterscheld)	**Concrete and steel**

Causeway Types



Armor Rock Causeway



Berm Requirements

Deflect and Mitigate Surge Waters

- **Extent relative to topography and consideration of factors (10± miles)**
- **Construct without critical impacts on housing/businesses, access routes and environmental/landscape**

Withstand Flood Event

- **Increase land elevation sufficiently to withstand predicted design life surge**
- **Structural stability against low-frequency occurrence**
- **Inoperable during normal/operational conditions**
- **Issues of seepage**

Berm Types

OPTION	*PRINCIPAL MATERIAL*
Articulated concrete blocks / mattresses (usually connected by steel wires / rods)	**Concrete**
Gabion structures (metal wire baskets)	**Rock and steel**
Grouted or cemented slopes	**Grout/cement**
Reinforced and vegetative soils	**Earth and geotextile**
Impervious layers such as asphalt and bituminous pavement	**Asphalt or bitumen**
Flexible structures such as geotubes	**Geotextile and sand**

Berm Types

Construction Issues

Access Navigation
- Maintain shipping routes during construction

Schedule Phasing
- Phased construction of Ambrose channel openings

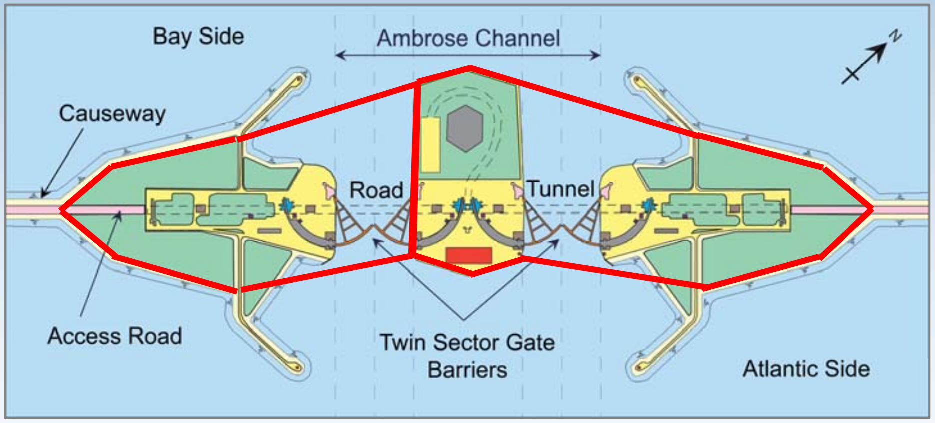
Material Availability
- Prefab. elements & dry working
- Huge quantities of rock & fill

Cost
- Land-based & marine working
- Down-time due to exposed location

Environmental Impacts

Gate Construction

- **Ambrose Channel Gates – Phased Construction**
  - **Navigation restricted to half channel width during construction phase**
  - **First gate and control island constructed within cofferdam**
  - **After first gate completed, second gate constructed within cofferdam**



- **Sandy Hook and Rockaway Inlet Gates**
  - **Channel closed throughout construction**
  - **Constructed within cofferdam**

Causeway Construction

Construction Cost

Ambrose Channel Gate Complex and Road Tunnel

Berms (terrain enhancement)

Sandy Hook Gate and Tunnel

Sluice Gate Complexes (10)

Causeway

Rockaway Inlet Gate and Bridge

Relative Cost

Total = $5.9 billion

$1 billion/mile of causeway

Existing Barriers

Oosterschelde barrier, Netherlands

- 5 mi (2 mi barrier + islands)
- Concrete piers with closable steel sides
- Estimated $3.4B ($1.7B/mi)
- Opened 1986

Maeslant, Netherlands

- 1,200 ft opening
- Moveable steel radius arms
- Estimated $0.86B ($4.3B/mi)
- Opened 1997

Lake Borgne IHNC barrier, New Orleans

- Design in progress
- Proposed 2 mile width with 150 ft navigation gates
- Estimated $0.7B ($0.35B/mi)
- Expected completion 2011

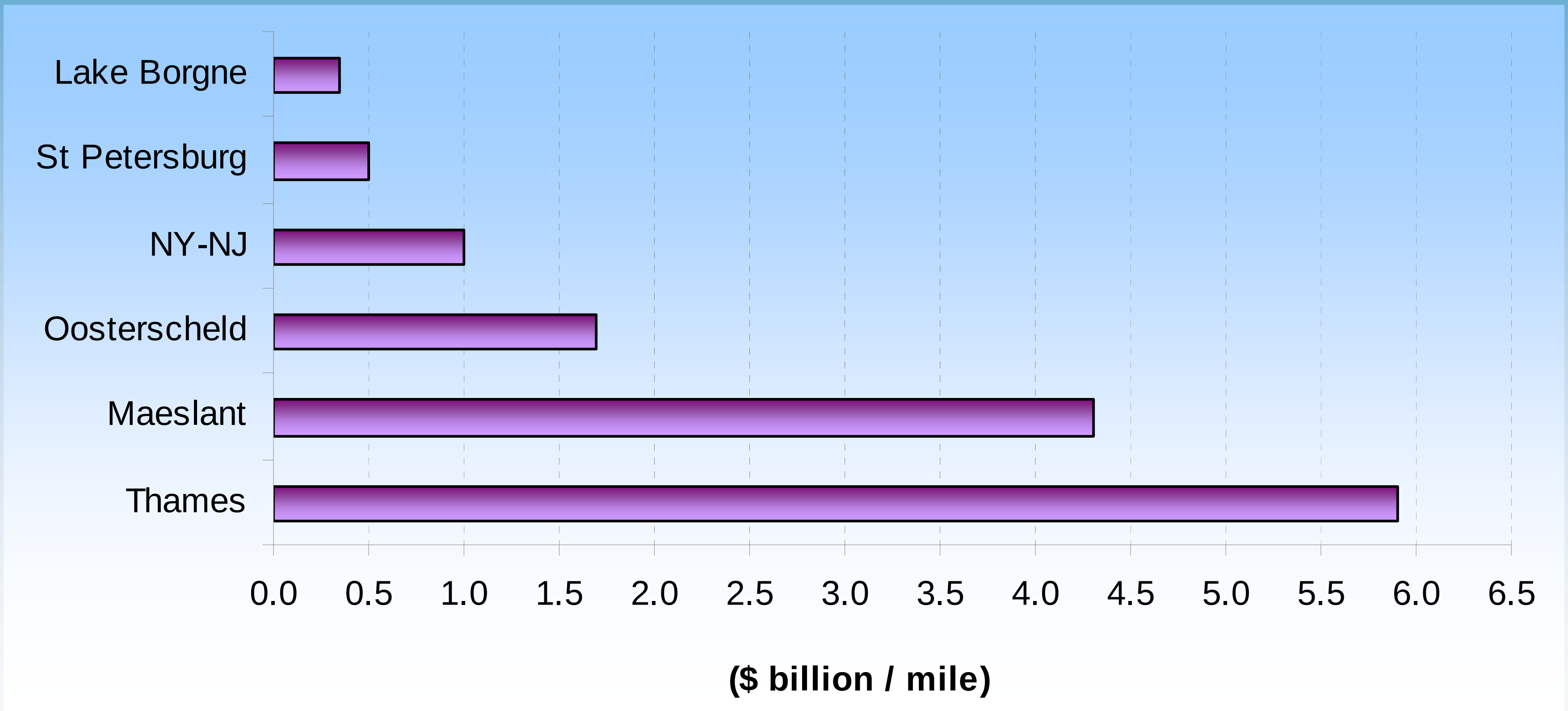
Thames barrier, United Kingdom

- 1,700 ft channel
- Circular hollow steel segments rotated between concrete piers
- Estimated $1.9B ($5.9B/mi)
- Opened 1982

St. Petersburg, Russian Federation

- 15 mi, across Gulf of Finland / Neva Bay
- 11 rock and earth embankments, 2 navigation passes (large radius gates), 6 water exchange complexes
- Estimated $6.4B ($0.5B/mi)
- Expected completion 2010

NY-NJ Outer Harbor Gateway



Where do we go from here?

•Innovation not Invention

Further Development

- **Gaining political and socio-economic will**
- **Studies to realize benefits, risks and consequences (human and financial)**
- **Investigation into options**
- **Preferred solution**

Questions