NY-NJ OUTER HARBOR GATEWAY

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31st March 2009
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

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
Location and Concept

- Breezy Point
- Rockaway Inlet flood gate
- Main navigational openings & control tower
- Sandy Hook Channel flood gate
- Sandy Hook
- Sluices as necessary for opacity

- Sandy Hook Channel
- AMBROSE CHANNEL
- Breezy Point
- Sandy Hook
- Rockaway Inlet flood gate
- Main navigational openings & control tower
- Sandy Hook Channel flood gate
- Sandy Hook
- Sluices as necessary for opacity
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

Maeslant and St. Petersburg

- Suitable for wide channel
- Stored and maintained in dry
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

<table>
<thead>
<tr>
<th>OPTION</th>
<th>PRINCIPAL MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armor rock (rubble mound)</td>
<td>Rock</td>
</tr>
<tr>
<td>Concrete armor units</td>
<td>Rock and Concrete</td>
</tr>
<tr>
<td>Caissons</td>
<td>Concrete and fill</td>
</tr>
<tr>
<td>Connected piers (such as Oosterscheld)</td>
<td>Concrete and steel</td>
</tr>
</tbody>
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Causeway Types
Armor Rock Causeway

- Concrete Wave Wall
- Causeway Access Road
- Armor Layer
- Underlayer
- Core
- Geotextile Membrane

Atlantic Side

Bay Side
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
<table>
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<th>OPTION</th>
<th>PRINCIPAL MATERIAL</th>
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</thead>
<tbody>
<tr>
<td>Articulated concrete blocks / mattresses (usually connected by steel wires / rods)</td>
<td>Concrete</td>
</tr>
<tr>
<td>Gabion structures (metal wire baskets)</td>
<td>Rock and steel</td>
</tr>
<tr>
<td>Grouted or cemented slopes</td>
<td>Grout/cement</td>
</tr>
<tr>
<td>Reinforced and vegetative soils</td>
<td>Earth and geotextile</td>
</tr>
<tr>
<td>Impervious layers such as asphalt and bituminous pavement</td>
<td>Asphalt or bitumen</td>
</tr>
<tr>
<td>Flexible structures such as geotubes</td>
<td>Geotextile and sand</td>
</tr>
</tbody>
</table>
Berm Types
Construction Issues

- Maintain shipping routes during construction
- Access Navigation
- Phased construction of Ambrose channel openings
- Land-based & marine working
- Schedule Phasing
-Prefab. elements & dry working
- Down-time due to exposed location
- Cost
- Huge quantities of rock & fill
- Material Availability

Environmental Impacts

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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

Total = $5.9 billion
$1 billion/mile of causeway

Relative Cost
### Existing Barriers

<table>
<thead>
<tr>
<th>Existing Barrier</th>
<th>Details</th>
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| **Oosterschelde barrier, Netherlands** | - 5 mi (2 mi barrier + islands)  
- Concrete piers with closable steel sides  
- Estimated $3.4B ($1.7B/mi)  
- Opened 1986 |
| **Thames barrier, United Kingdom** | - 1,700 ft channel  
- Circular hollow steel segments rotated between concrete piers  
- Estimated $1.9B ($0.5B/mi)  
- Opened 1982 |
| **Maeslant, Netherlands** | - 1,200 ft opening  
- Moveable steel radius arms  
- Estimated $0.86B ($4.3B/mi)  
- Opened 1997 |
| **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 |
| **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 |
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