



RESTORE
AMERICA'S
ESTUARIES

EFFECTIVENESS OF FLOATING WAVE ATTENUATORS FOR RESTORING AND PROTECTING COASTAL MARSH

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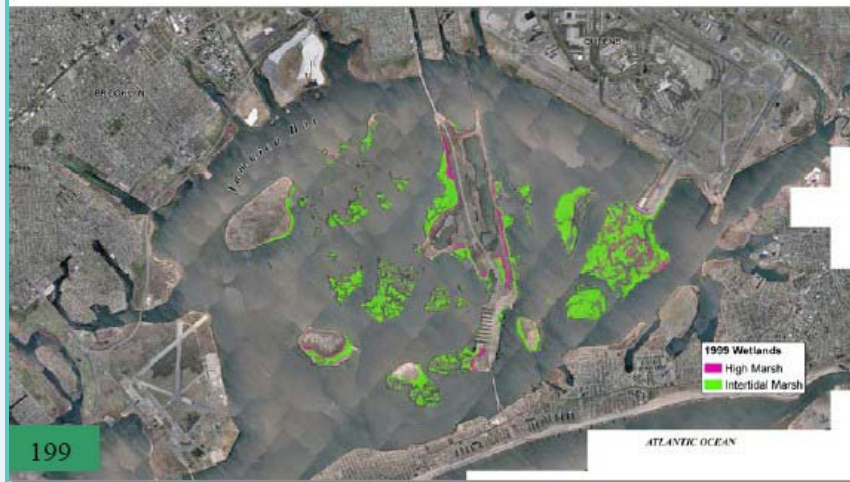
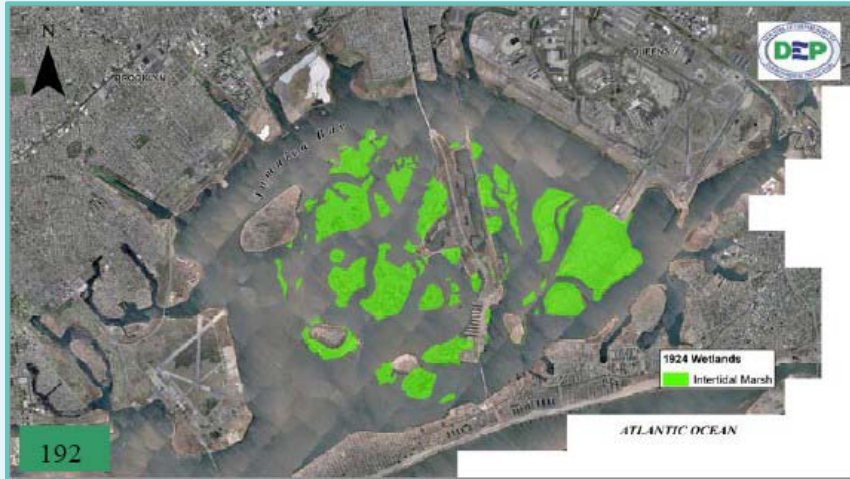
November 16, 2010



OUTLINE

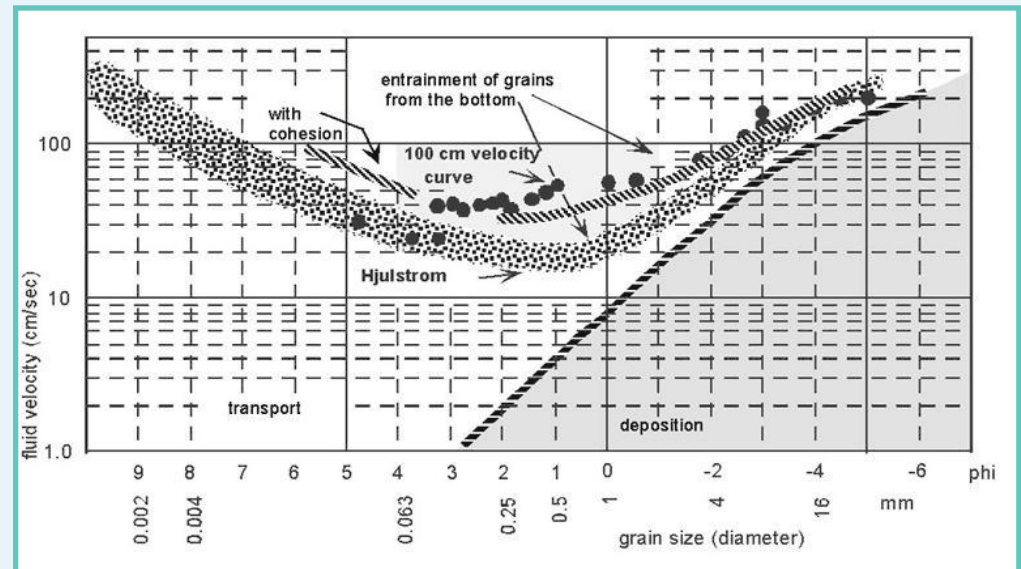
- Historic Marsh Losses
- Preliminary Design Considerations
 - Sediment Deposition
 - Fetch Limited Waves
 - Site Location
- Types Of Floating Wave Attenuators
- Cost Analysis
- Preferred Wave Attenuators
- Requirements for Final Design
- Questions

HISTORIC MARSH LOSS IN JAMAICA BAY (1924 – 1999)



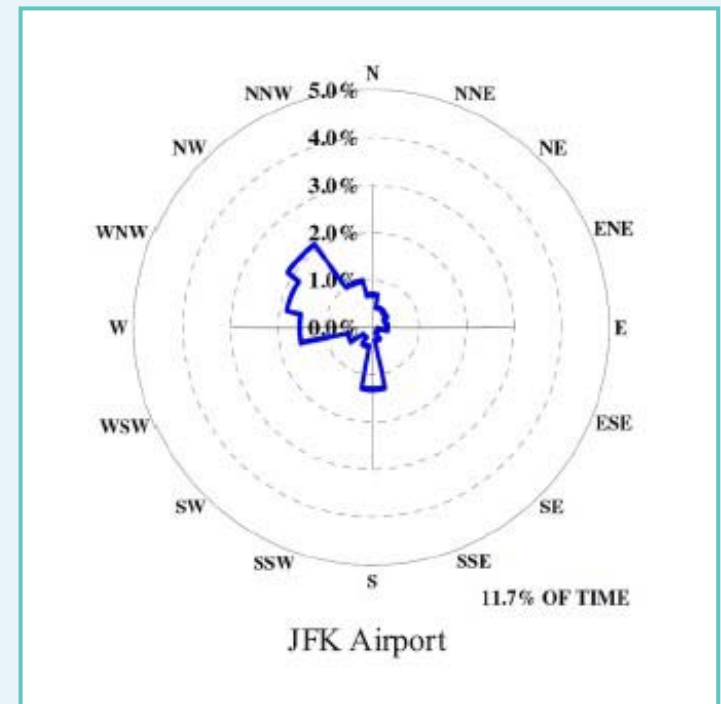
PRELIMINARY DESIGN CONSIDERATIONS – SEDIMENT DEPOSITION IS POSSIBLE

- Select a site where sediment deposition is possible
 - Wave Attenuator: Reduces wave energy transmission by **reflection** or **refraction** or both
 - Reduction in wave energy can decrease fluid velocity
 - Decreased fluid velocity allows for deposition of sediment
 - Attenuate waves not current



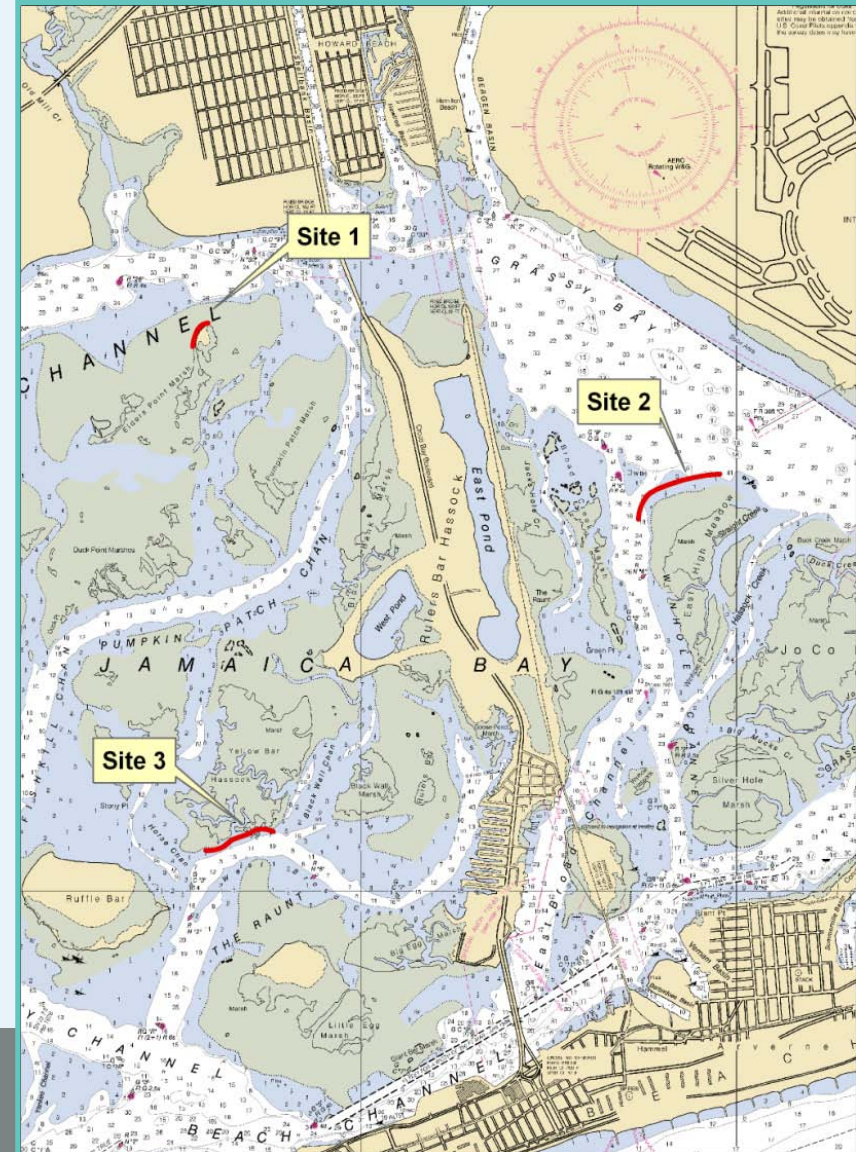
PRELIMINARY DESIGN CONSIDERATIONS – FETCH LIMITED WAVES

- Select a site with fetch limited waves
 - Shorter wavelengths than depth limited waves
 - Allow for smaller height of wave attenuator
 - For effective attenuation
 - 4' wave height of less
 - 4 sec period or less
 - Jamaica Bay wind data
 - JFK airport (1948 – 2005)
 - Wind speeds greater than 20 mph



PRELIMINARY DESIGN CONSIDERATIONS – SITE LOCATION

- Select a site with:
 - Sufficient water depth
 - Facing a dominant wind direction
 - Minimal to no wave reflective effect
 - Good bottom condition
 - Examples:
 - Site 1 and 2 are optimal
 - Site 3 is sub-optimal (strong tidal currents)



PRELIMINARY DESIGN CONSIDERATIONS – FLOATING WAVE ATTENUATOR SELECTION

- Requirements of Wave Attenuator
 - Provide wave attenuation
 - Wave Transmission Coefficient is key parameter
 - Verified with physical or numerical models
 - Varies with wave attenuator, mooring system, module connections, module width, wave climate, depth, etc.
 - Floating
 - Able to be placed in shallow or deep areas
 - Minimal disturbance to benthic environment
 - **Anchoring**
 - **Draft**
 - Ease of installation
 - Durability during year-round deployment
 - Cost

PRELIMINARY DESIGN CONSIDERATIONS – TYPES OF WAVE ATTENUATORS

- Box
- Pontoon
- Tethered Float
- Mat
- Floating Island

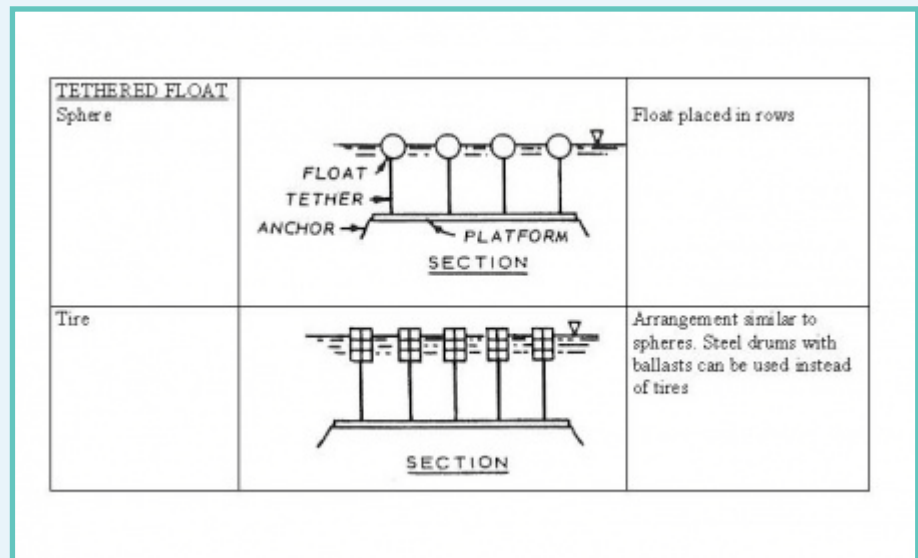
PRELIMINARY DESIGN CONSIDERATIONS – BOX FLOATING WAVE ATTENUATOR

- Box
 - Most common
 - Typically reinforced concrete modules
 - Either empty (HDPE ballast) or polystyrene filled
 - Flexible connections
 - High internal forces
 - Fixed pile anchoring systems



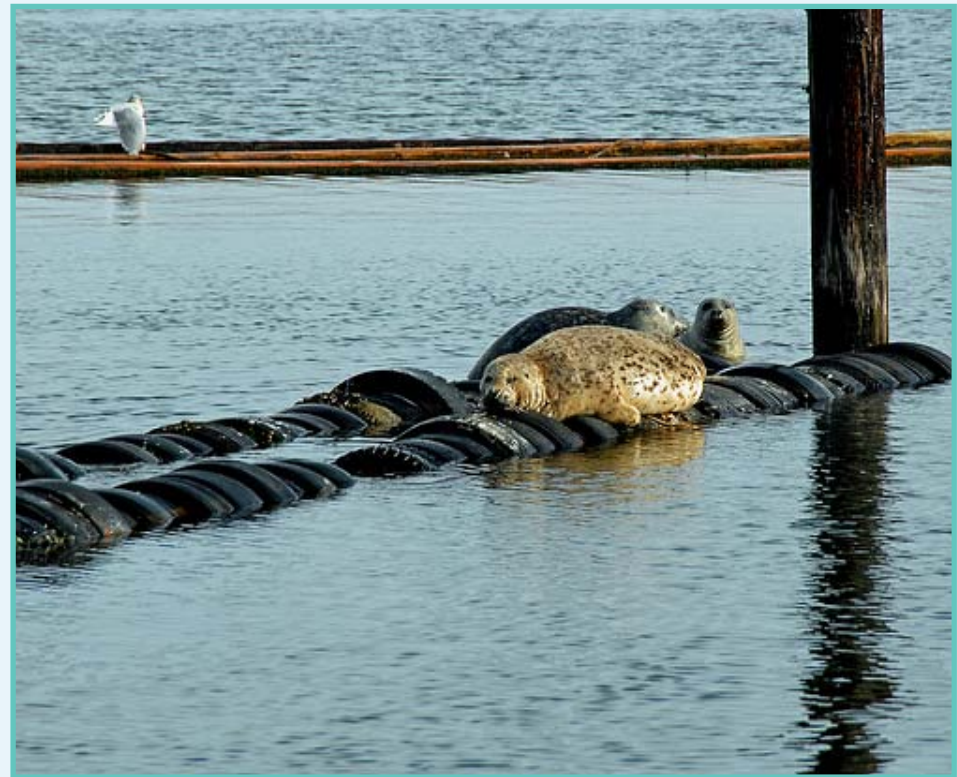
PRELIMINARY DESIGN CONSIDERATIONS – TETHERED FLOAT WAVE ATTENUATOR

- Tethered Float
 - Transportable wave protection system
 - Deep water applications for open ocean
 - Attenuates wave energy via drag produced during rapid and vigorous oscillations of a field of buoyant spheres tethered to remain just below surface
 - High cost
 - Minimal technical data



PRELIMINARY DESIGN CONSIDERATIONS – MAT FLOATING WAVE ATTENUATOR

- Mat
 - Easy installation and removal
 - Easy construction
 - Low anchoring loads
 - Less reflection and more refraction
 - Dissipitates more energy
 - Cost effective



PRELIMINARY DESIGN CONSIDERATIONS – MAT FLOATING WAVE ATTENUATOR



Source: <http://www.wavebraakker.com/floating-breakwater.htm>

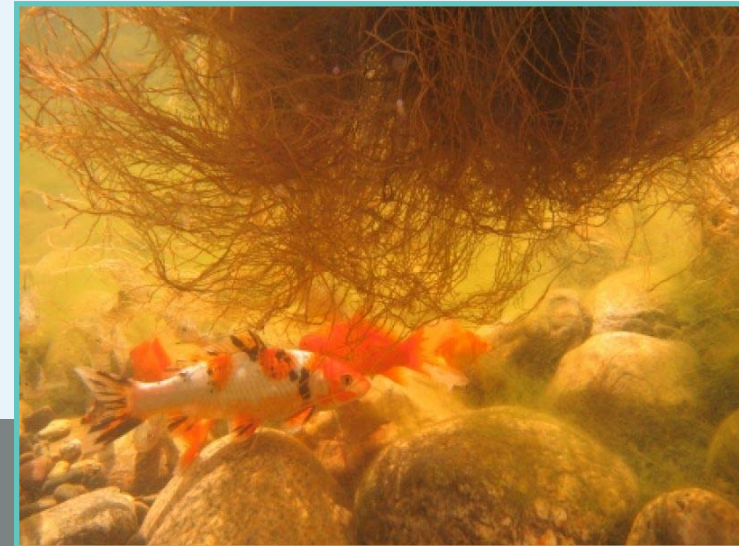


PRELIMINARY DESIGN CONSIDERATIONS – FLOATING ISLAND WAVE ATTENUATOR

- Floating Island
 - Buoyant mats with planted gardens
 - Made from recycled plastic and foam
 - Ecological benefits
 - Pollution removal
 - Habitat
 - Cost effective
 - Aesthetics
 - Low draft



Source: <http://www.floatingislandinternational.com/>



PREFERRED WAVE ATTENUATOR - COST ANALYSIS

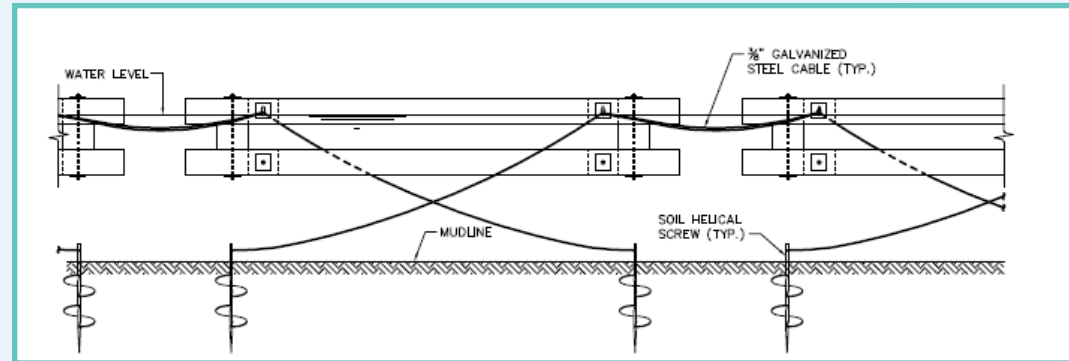
Type	Materials	Labor and Equipment	Total
WaveBraakker	\$640,000	\$150,000	\$1,198,000
Timber Log Bundle	\$100,000	\$175,000	\$415,000
WaveBreak	\$765,000	\$150,000	\$1,388,000
Floating Island	\$440,000	\$165,000	\$921,000

- Assumptions

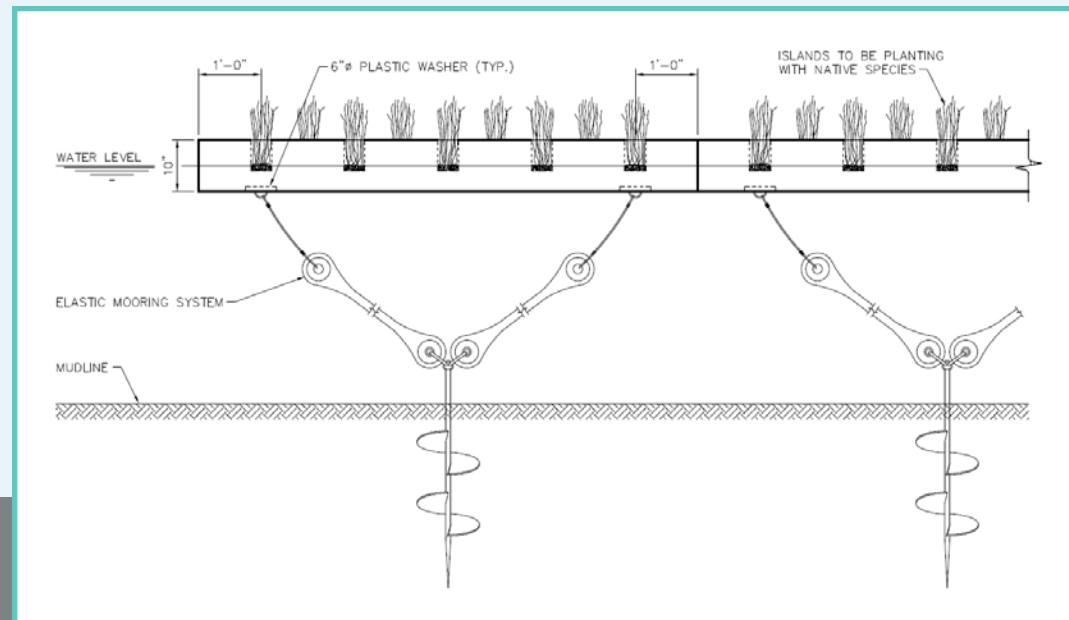
- Each floating wave attenuator is **2,500 linear feet**.
- Floating wave attenuator units will be fully assembled during permitting phase.
- Marine contractor can install 2,500 linear feet of floating wave attenuator in 3 weeks.
- Water depth is approximately 10 feet at installation sites.
- Staging area within 5 nautical miles.
- Navigation markers will be attached to each floating wave attenuator to address safety.
- Total price includes 50% markup (5% general conditions, 10% profit, 10% overhead, and 25% contingency).

PREFERRED WAVE ATTENUATOR - TYPE

- Timber bundle or Timber Matrix floating wave attenuator

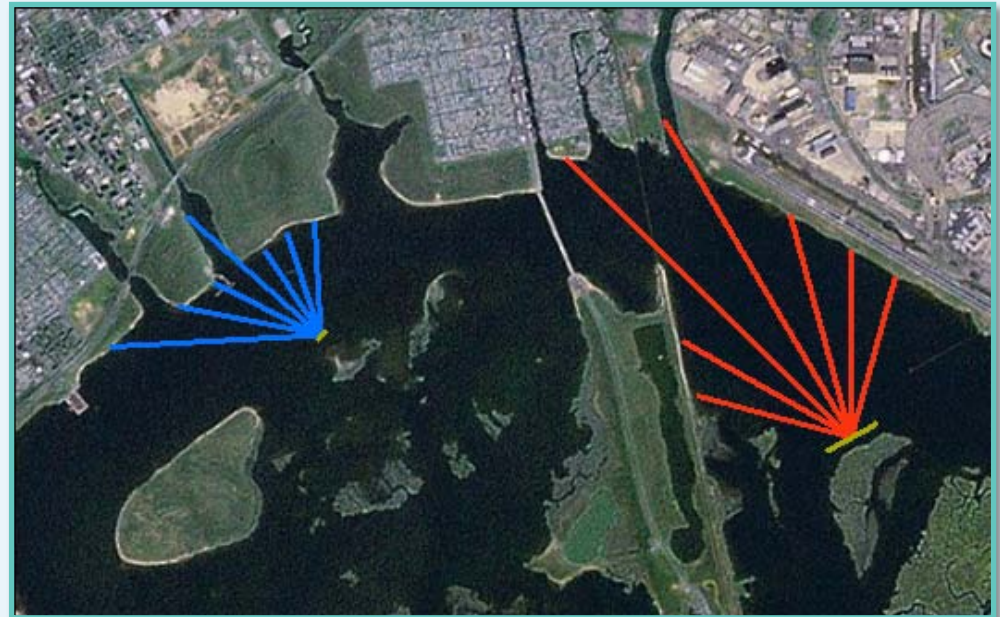
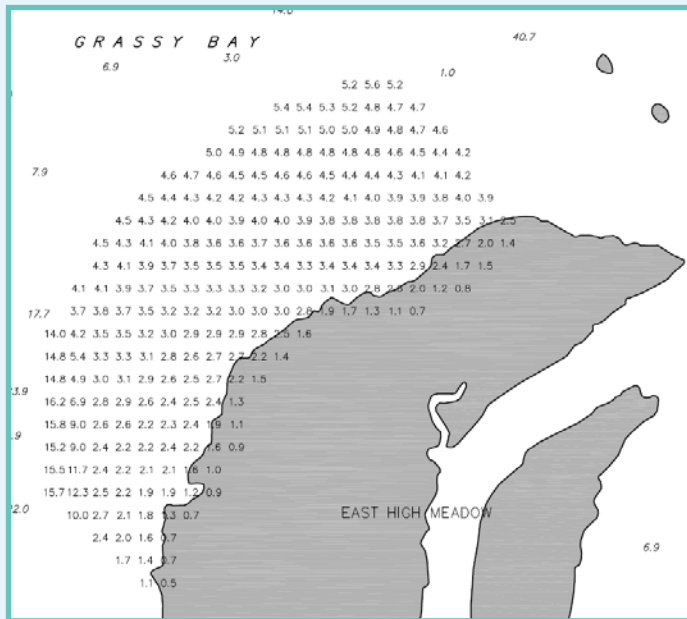


- Floating Island wave attenuator



FINAL DESIGN REQUIREMENTS

- Investigate sediment transport, wave and hydraulic processes, and foundations
- Obtain detailed bathymetry data for project site
- Detailed fetch analysis





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Supplemental (not part of presentation)

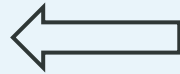
ANCHORING SYSTEMS

- Deadweight Anchor
 - Can be casted concrete or large rock
 - Must be sufficient static friction on bottom to resist movement
- Pile Anchor
 - Designed for soil's ultimate lateral resistance
- Embedment Anchor & Screw Anchor
 - Difficult to install in firm marine soil
 - Weak in soft soils
 - Fairly short lengths

ANCHORING SYSTEMS



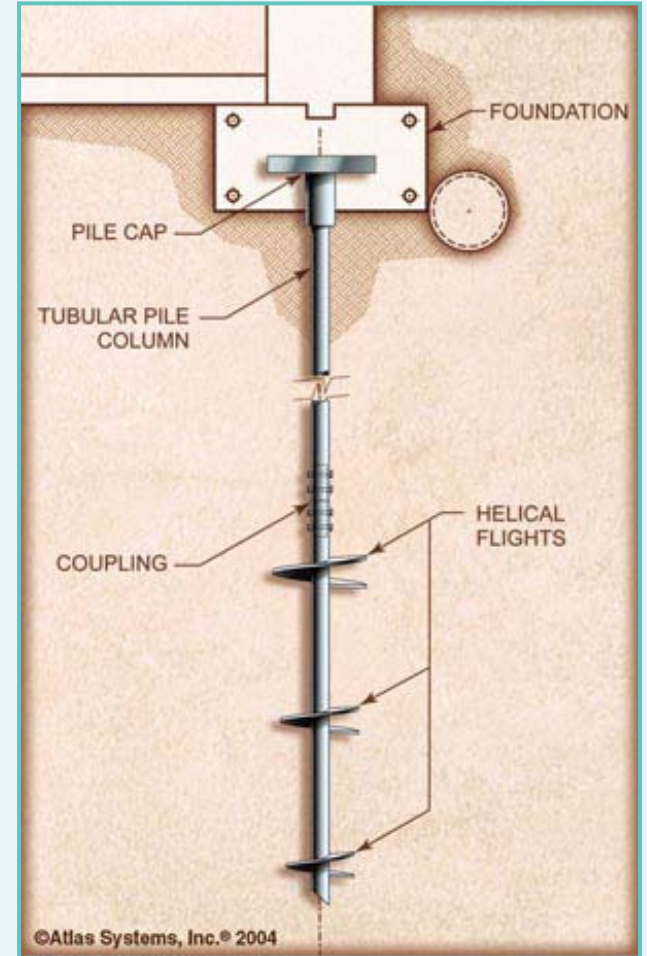
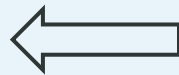
- Duckbill



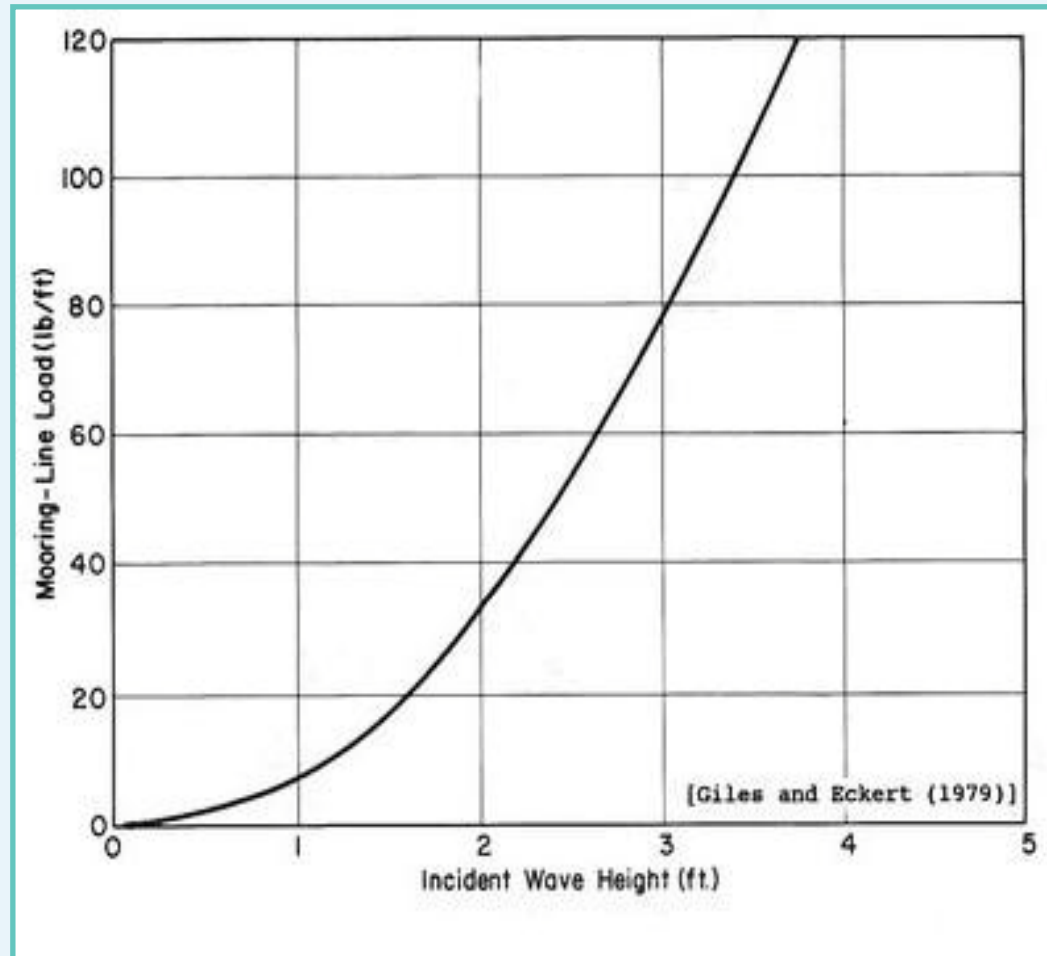
- Helical screws



- Piles



ANCHORING LOAD DETERMINATION



WAVE ATTENUATION

