

# Amendment Application and Delivery Strategies for Tidal Marsh and Waterway Thin-Layer Pilot Plot Construction



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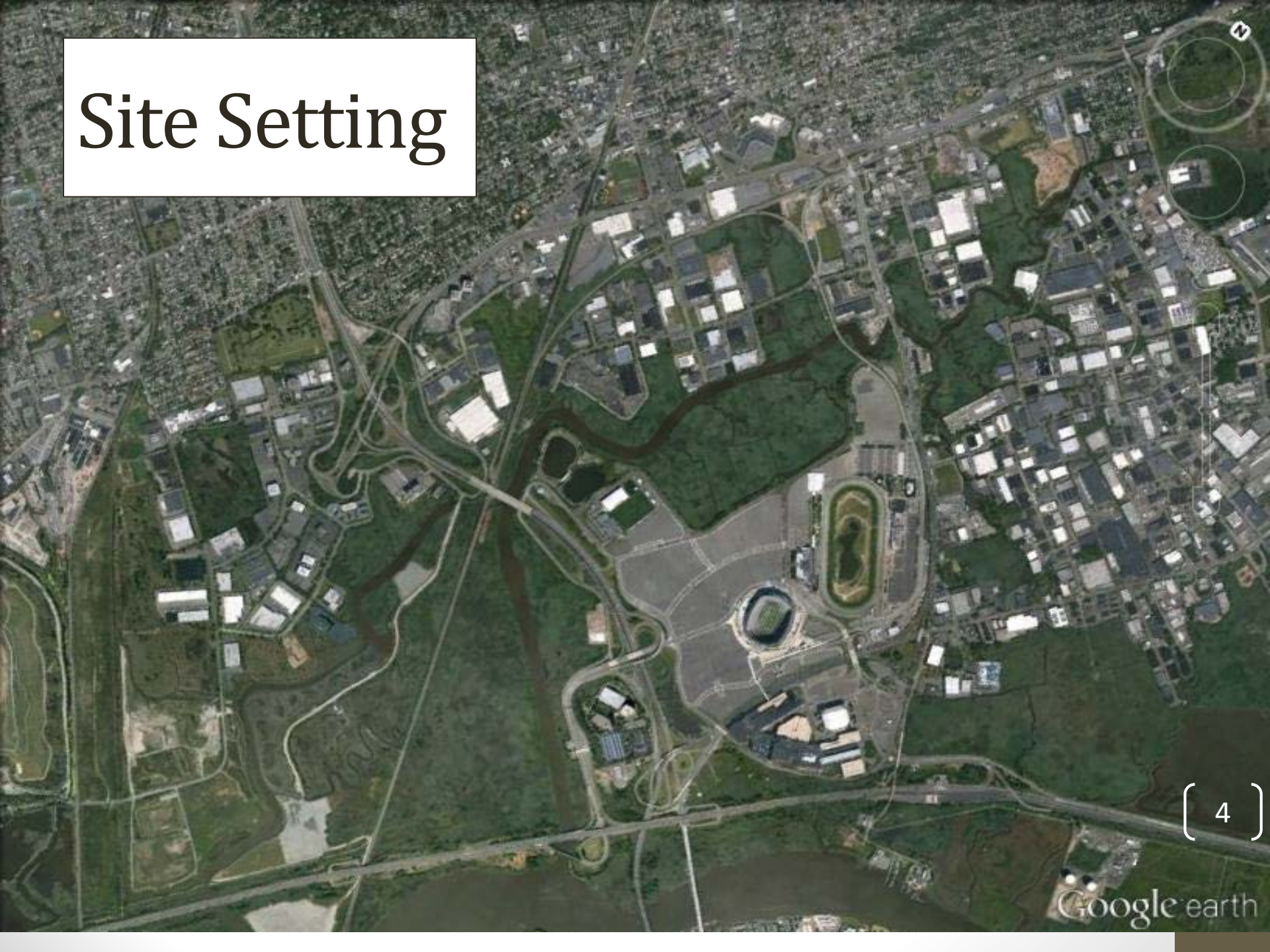
# Project Objectives/Overview

- Shallow water depths, narrow channels and large surrounding marsh areas create challenging physical and environmental conditions for thin-layer cover placement in an urban tidal estuary.
- Program required unique construction approaches to minimize disturbance and maintain stability of the system.
- This presentation summarizes the techniques evaluated in the field and identifies the approaches and procedures that worked most effectively

# Project Objectives/Overview

- Location: Urban fringing marsh tidal estuary in the northeast
- Objectives:
  - Construct pilot plots of thin layers (up to 6 inches) of sand and other materials
  - Multiple mudflat and marsh locations
  - Minimize disturbance and maintain stability of the system

# Site Setting



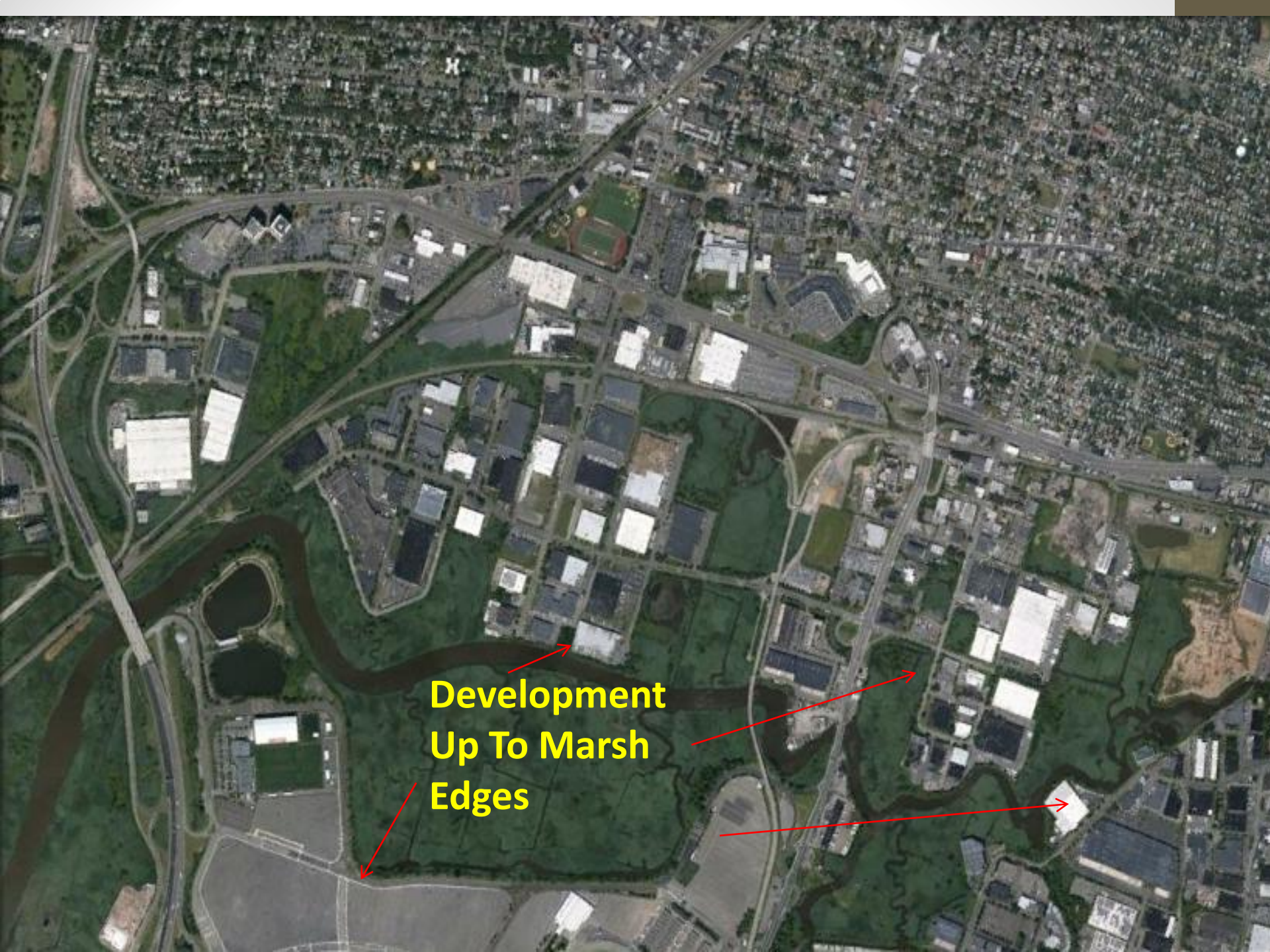
★ - Support Area

▬ - Work Area



# Physical and Logistical Challenges

- **Physical access limited by the nearly complete commercial/industrial development of the land adjacent to the tidal marshes.**
- **Marsh and sediment disturbance must be minimized**
- **Waterway Challenges**
  - **Shallow water depths (2 to 5')**
  - **Narrow/winding channels**
  - **Low/narrow bridges (less than 6' vertical clearance)**
- **Marsh Challenges**
  - **Large and densely vegetated marsh areas surrounding waterways**
  - **Many small tributaries/ditches traversing marshes**
  - **Mudflats and marshes inundated large portion of day**



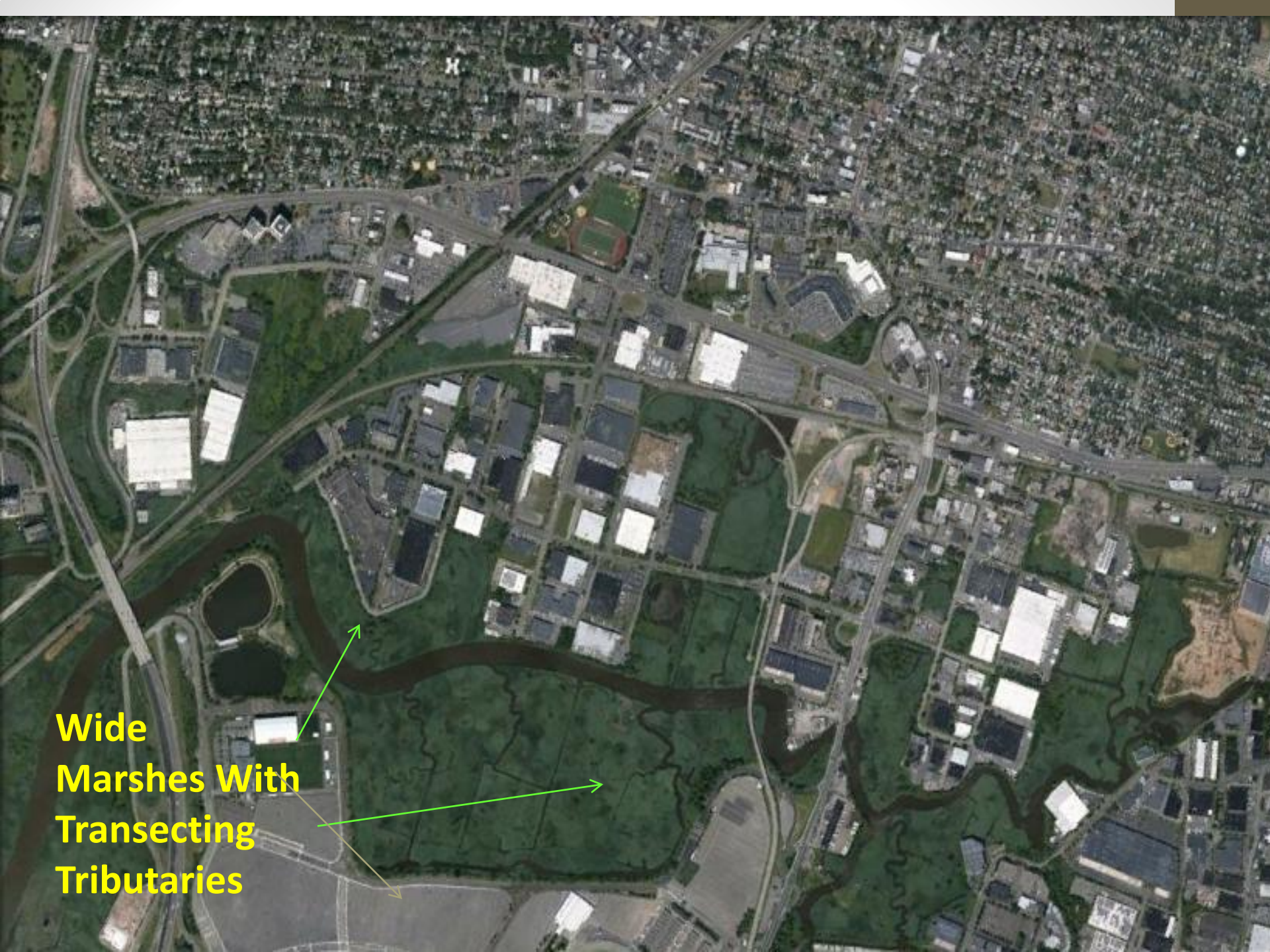
**Development  
Up To Marsh  
Edges**



**Shallow/Narrow  
Winding  
Waterways**







**Wide  
Marshes With  
Transecting  
Tributaries**

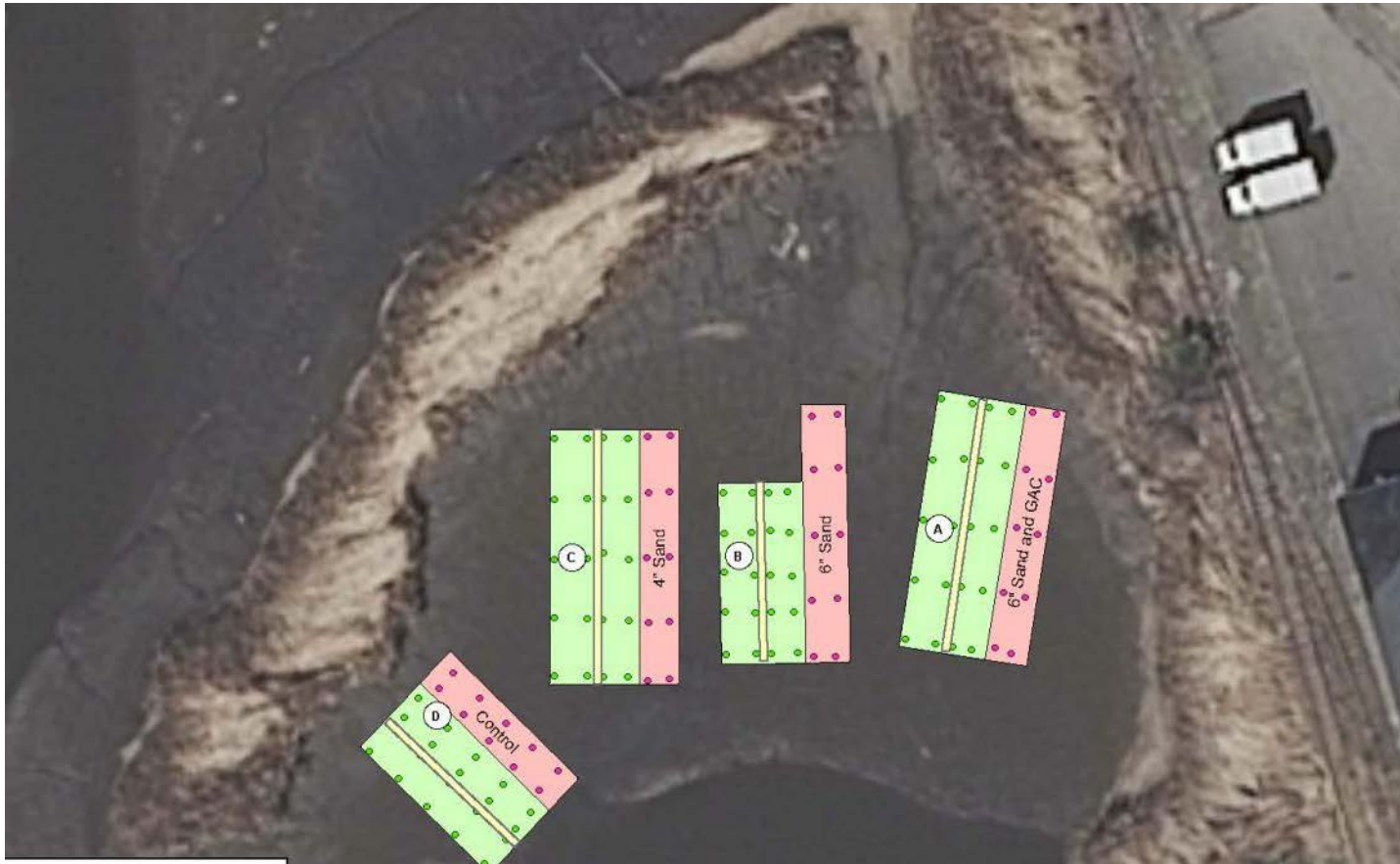




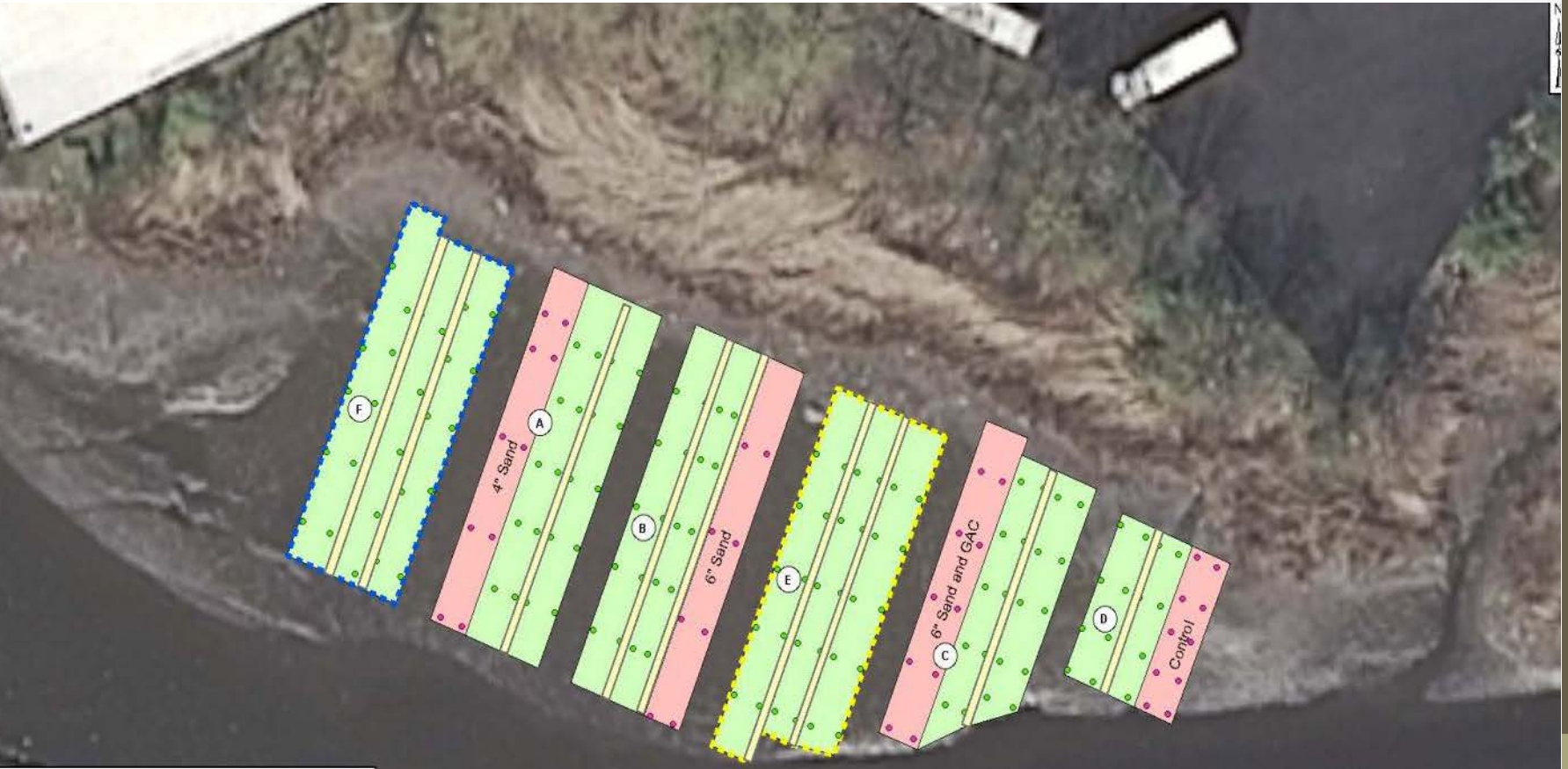
**Low/Narrow  
Bridges**



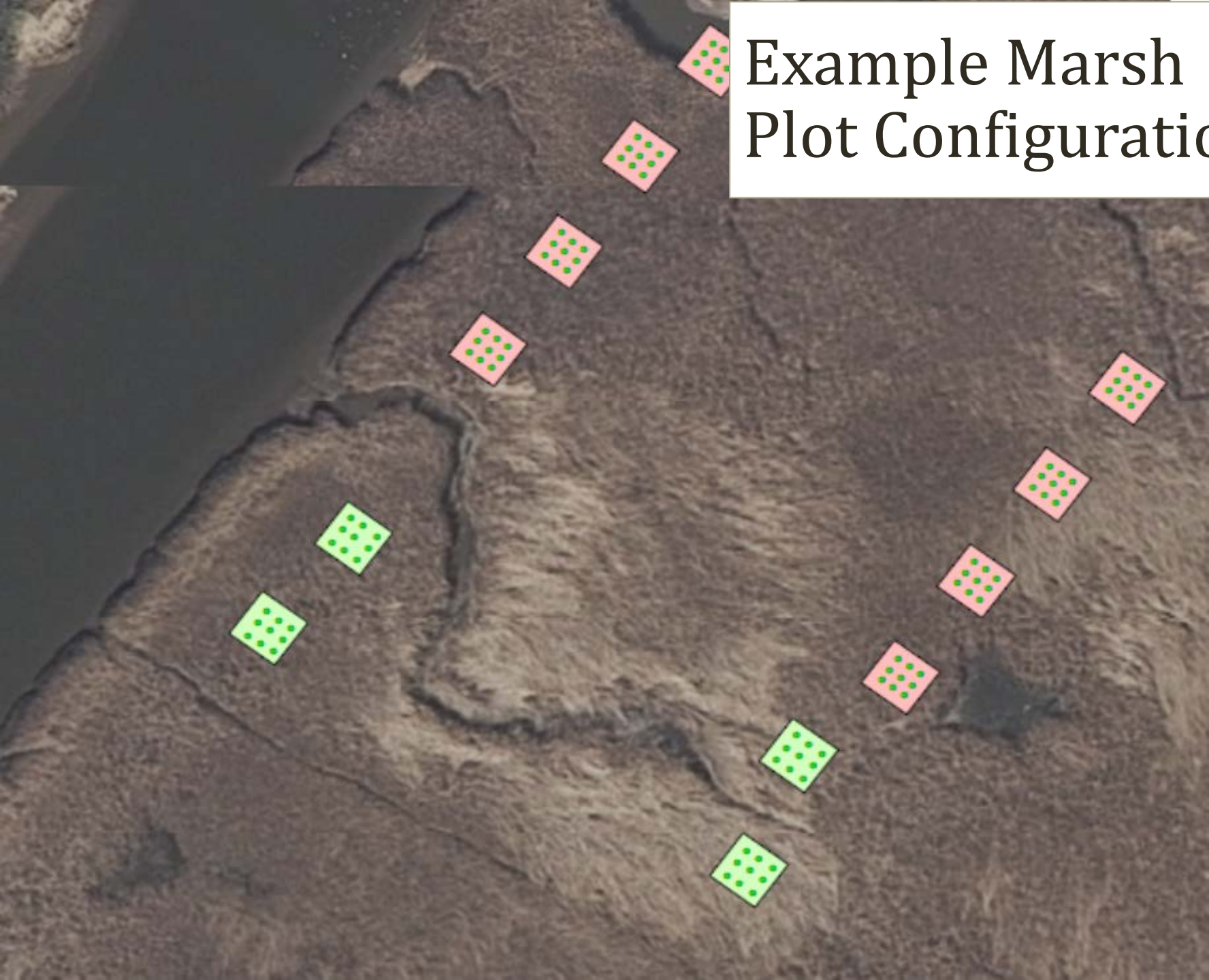
# Example Mudflat Plot Configuration



# Example Mudflat Plot Configuration



# Example Marsh Plot Configuration



# Combination of Technologies

- **Transport personnel, equipment and materials from staging/access points**
  - Safely
  - Limit disturbance
  - Effectively: Construct plots as designed
- **Areas were not accessible via water due to shallow water depths**
- **Alternative combinations of construction technologies and techniques were tested to limit:**
  - Disturbance of marsh areas and
  - Resuspension of sediments in the waterways

# Combination of Technologies

- **Technology selection based on length of marsh to traverse between staging area and work area**
  - **Moderate marsh traverse (up to approx. 150 feet):**
    - **Pneumatic Delivery**
    - **Telebelt® truck mounted telescoping conveyor belts**
    - **Vortex™ Granular Blower**
  - **Large marsh traverse (approx. 1000 to 2500 feet):**
    - **Slurry delivery systems**
    - **Telebelt® Combined with modular mats**

# Site Preparation

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**Installation of walkways**



**Marking Placement area**



**Support Area Telebelt**



# Moderate Marsh Traverse – Pneumatic Delivery



# Observations

- **Difficulties with clogging and feed system**
- **Slow delivery**
- **Difficult control of delivery**
- **Possible improvements with additional development/testing**

# Moderate Marsh Traverse – Vortex™ Granular Blower

## Test Plot Clearing



Test Plot Area after Clearing



Test Plot Area after Raking

# Loading and Placement of Amendment Material



# Completed Plots (Sedimite®)



# Observations

- **Effective and controlled placement of granular amendment requiring light application density**
- **Applicable to difficult to reach areas.**
- **Large placement areas with larger traverses will require additional logistics to deliver amendment supply to work area.**

# Moderate Marsh Traverse – Telebelt®







# PS Construction: Delivery Approaches



**Telebelt delivery with grading to elevation**



**Completed plot**



**Final elevation marker**

# Observations

- **Pros**
  - Reaches over marsh and waterways
  - Effective and manageable control of placement
  - Good placement rates
- **Cons**
  - Limited reach
  - Not designed for off-road use

# Long Marsh Traverse - Slurry



**Mixing of sand and site water  
for slurry**



**Slurry placement**



**Slurry lines extended through  
marsh**

# Slurry Delivery: Marsh



10 26 2012

***Phragmites* cleared**



11 19 2012

**Slurry placement and grading**



11 13 2012

**Fencing elevation stakes installed**

# PS Construction: Marsh



**Completed test plot in marsh**

# Marsh Buggy - Mudflat placement



# Observations

- **Pros**
  - **Ability to transfer material long distances across marshes/waterways**
  - **Limited haul roads**
  - **Effective control of placement**
- **Cons**
  - **Marsh buggy support/placement needed for mudflats**
  - **Management of slurry to prevent clogging**
  - **More equipment and personnel intensive than Telebelt<sup>®</sup>**

# Long Marsh Traverse - Telebelt® with Modular Mats





# Modular Mat Staging



# Modular Mat Access Path



# Observations

- **Pros**
  - **Mat system effective for traversing marsh with road going equipment**
  - **Limited marsh disturbance**
  - **Effective placement control**
  - **Good placement rates**
- **Cons**
  - **Need to physically transport materials across marsh**
  - **Telebelt® not designed for off-road**

# Construction Phase Observations

- **Pneumatic delivery was not effective under the conditions tested**
- **Some problems were encountered**
  - equipment/logistical problems
  - high tides,
  - Superstorm Sandy
- **The Telebelt<sup>®</sup>, Slurry system, Vortex<sup>™</sup> and temporary mat technologies successfully achieved the project objectives while limiting marsh and sediment disturbance.**
- **Additional economies of scale likely for larger scale projects**

# Monitoring Physical Stability

- **Monitor Pilot Plot Stability**
  - **Surface Elevation**
  - **Thickness of Placed Material**
  - **Thickness of Newly Deposited Sediment**
  - **Consolidation of underlying sediment**
  - **Evaluation of Potential Intermixing**
    - **Surface of placed material with new sediment**
    - **Bottom of placed material with underlying sediment**
- **Monitor for Lateral Distribution**

# Construction Quality Assurance Observations

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- Variable Mudflat and Marsh Surfaces
- Initial consolidation/displacement of soft mudflat sediments during placement



# Completed Pilot Plot



# Plots As they Look Now

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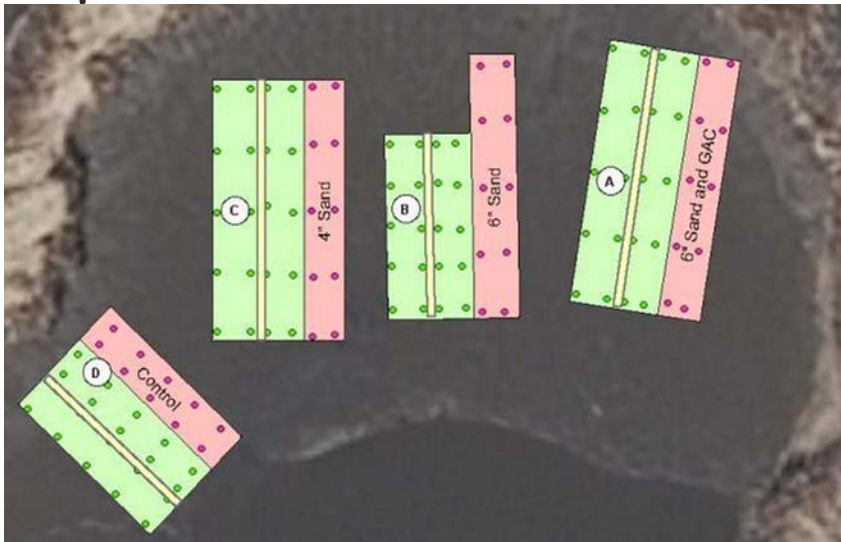


# Monitoring Approach

- **Fixed PVC Monitoring Points**
  - **Construction quality control (thickness)**
- **Licensed Surveyor**
  - **Replaced PVC Monitoring Points**
  - **Requires access and visits by surveyor**
- **Field Cores/Measurements**
  - **Measure thickness of new sediment, placed material, and intermixing**
  - **Observe geochemical conditions**
  - **Monitor for Lateral Distribution of Placed Sand**

# Consistent Monitoring Locations

- Large dataset 32 plots x 9 core locations per plot = 288 points with multiple measurements per point
- Control Plots have same monitoring as Pilot Plots
- 



# Fixed PVC Monitoring Points



- Driven 4 feet into mudflats
- Used to establish target thickness during Construction



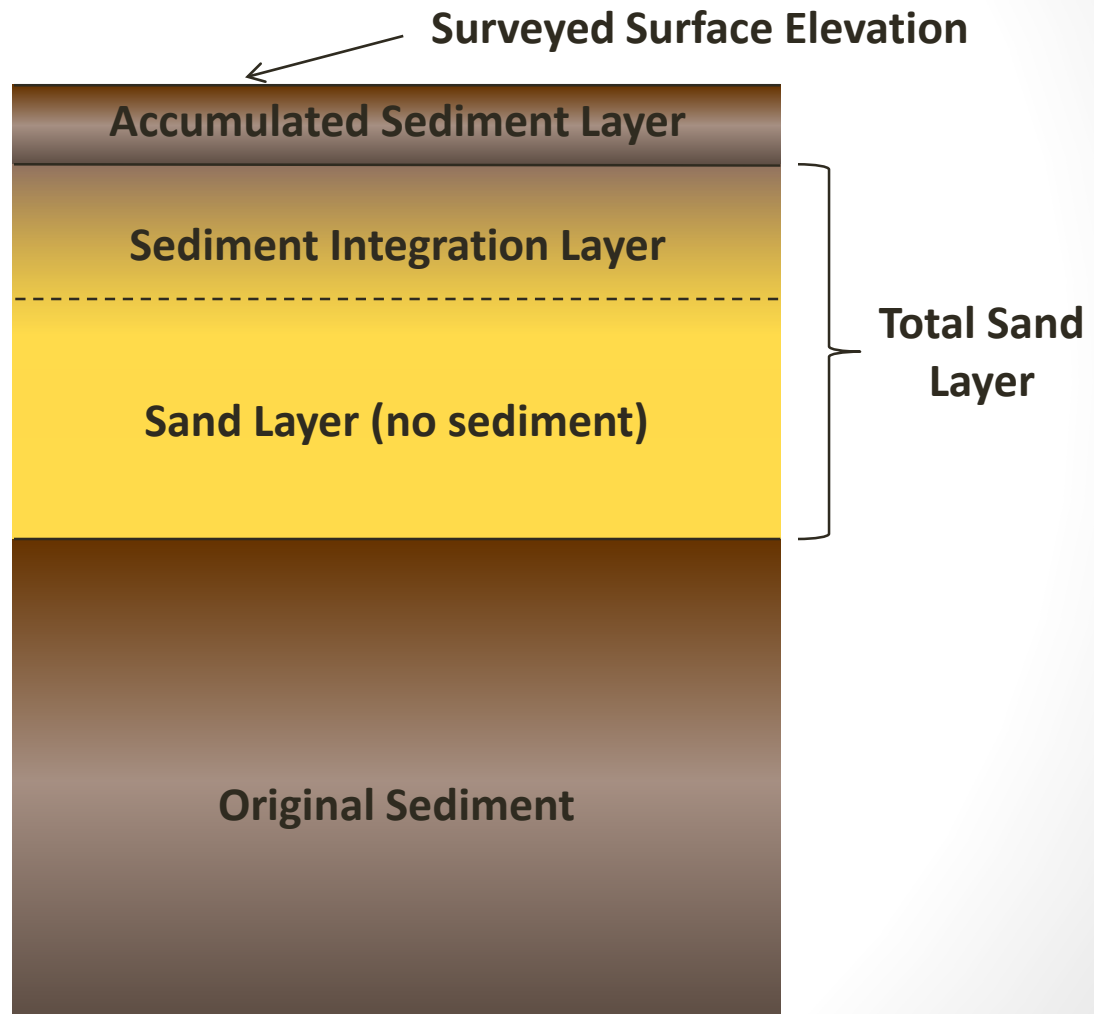
# Physical Measurement Considerations

- Surface Sediment Layer
- Placed Sand/Amendment Layer
  - Variations in As-built thicknesses
  - Consolidation after placement
  - Redistribution? – Cores between plots
- Surface Elevation
  - New Sediment deposition
  - Variations/Changes in Sand/Amendment Layer Thickness
  - Consolidation of Sand into mudflat

# Physical Monitoring Data: Layer Thicknesses



Phase 2 Core from May 2014



# Sediment Deposition on Plots

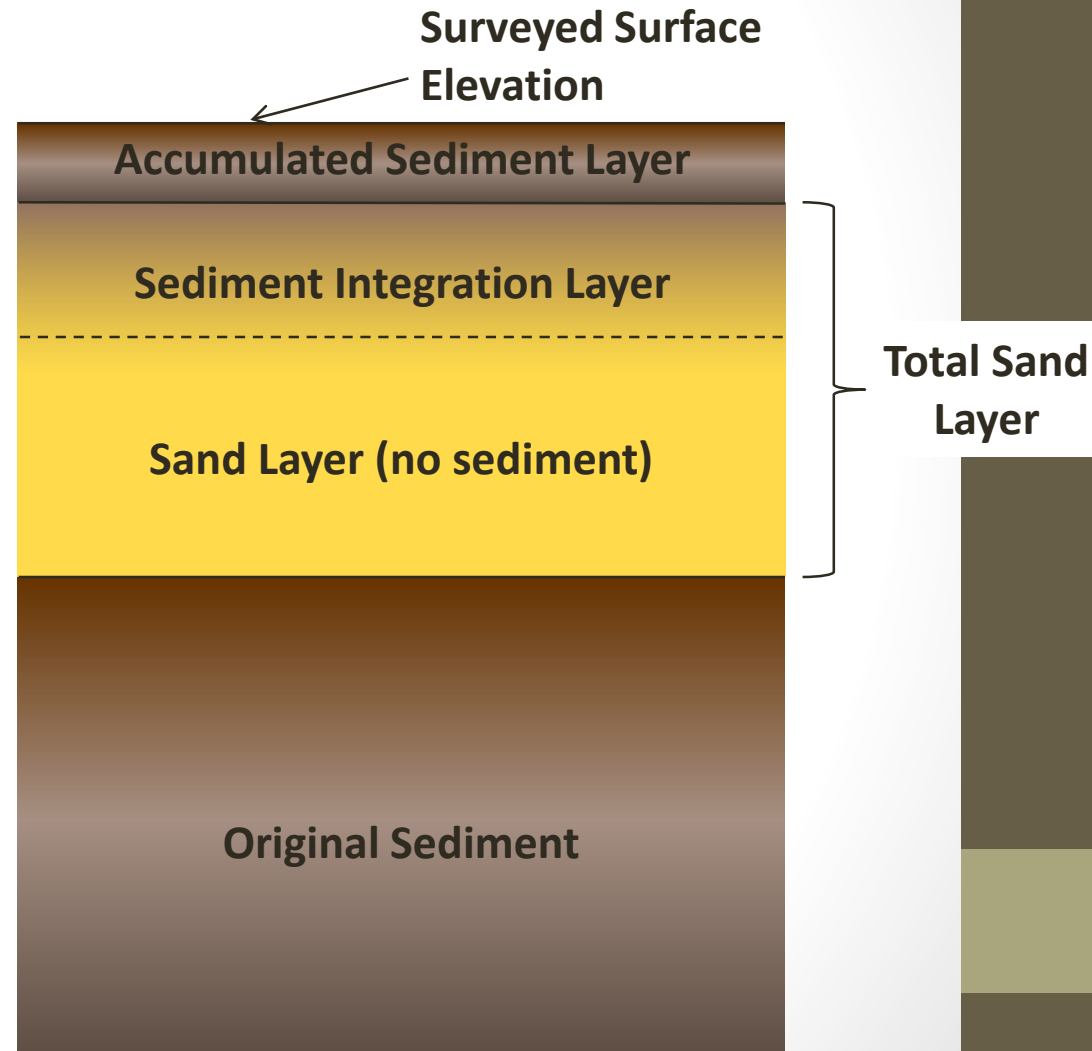


- Hurricane Sandy
  - Sand visibly stable
  - New sediment observed on top of sand
- Potential Considerations Related to other metrics (e.g. sand thickness, plot surface, etc.)



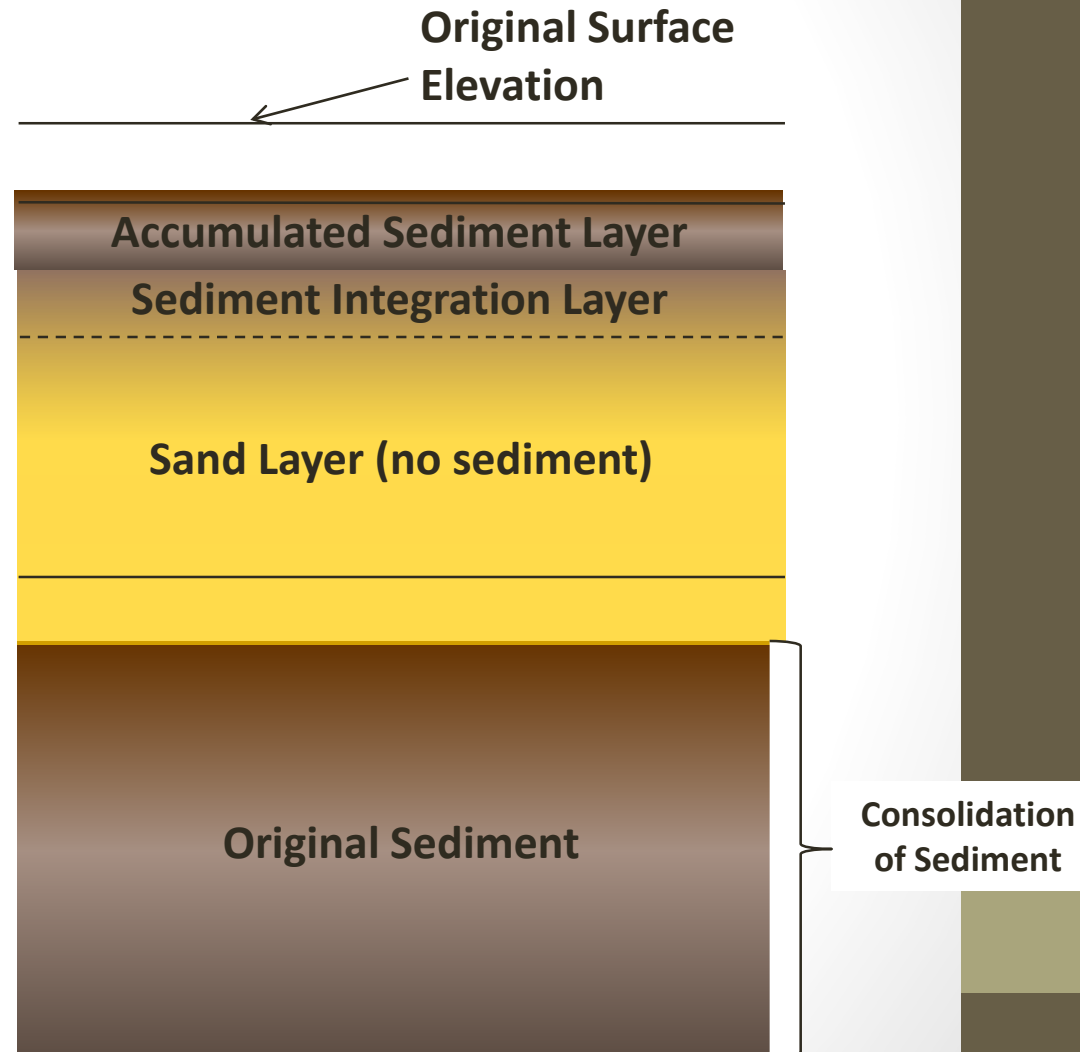
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# Physical Measurement Considerations

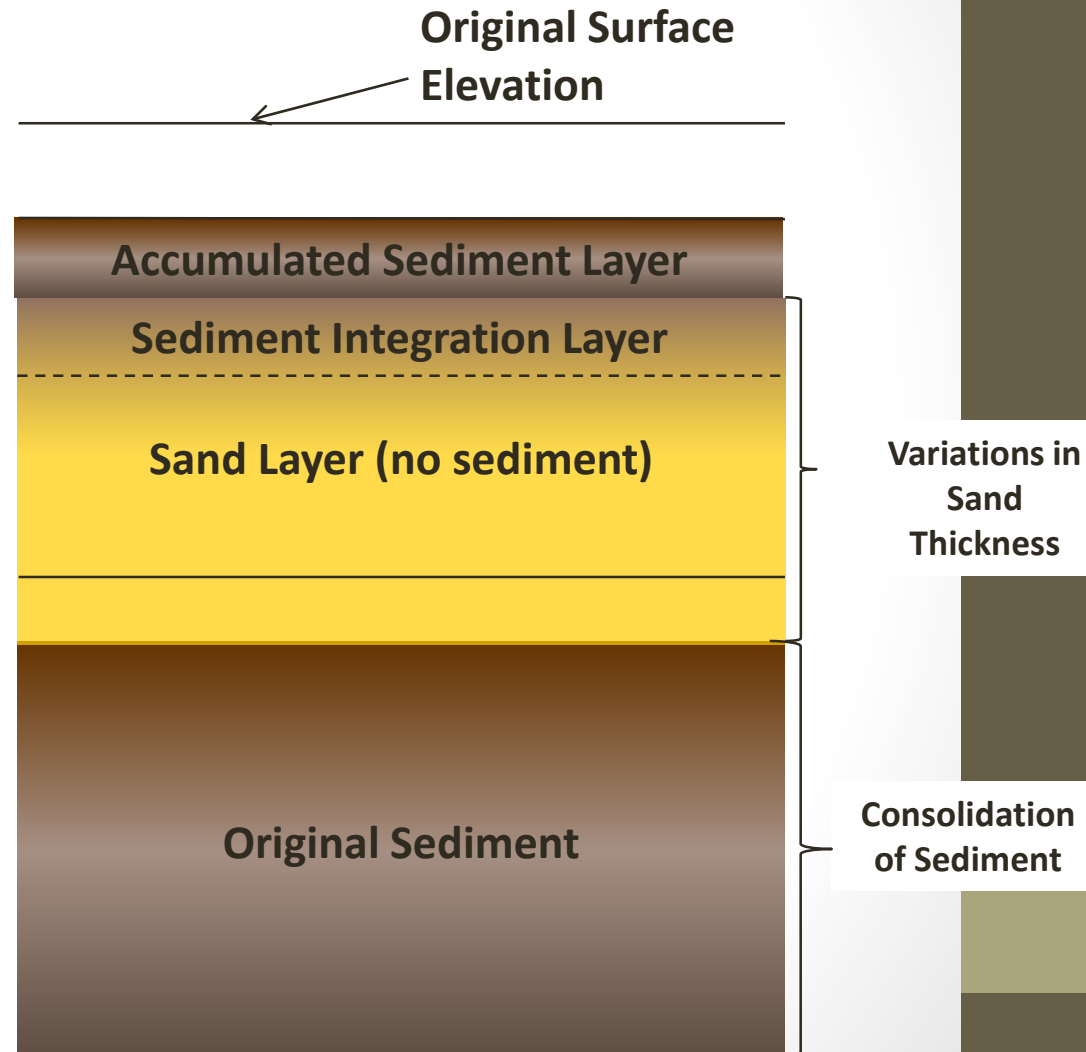
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- Surface Elevation
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# Data Analysis Considerations

- **6 Areas**
- **32 Total plots**
- **9 Measurement Locations per Plot**
- **Multiple measurements per location**
  - **Surface elevation**
  - **Surface sediment layer thickness**
  - **Sand Sediment Interface observations**
  - **Top of Sand/Amendment Elevation (Calculated)**
  - **Sand/Amendment layer thickness**
  - **Bottom Elevation (calculated)**

# Data Analysis Considerations

- **Measurement Variables and Variations**
- **Geotechnical Evaluation of data**

# Conclusions

- **Sediment remedial actions in fringing marsh systems pose substantial construction and logistical challenges**
- **Creative combinations of construction techniques can be used to successfully place thin-layers of sand/amendments**
- **Waterway and marsh conditions also pose challenges for physical monitoring of the stability of plots.**
  - **Monitoring tools require careful selection and management**
  - **Soft sediments and post-construction consolidation must be considered**

# Questions?