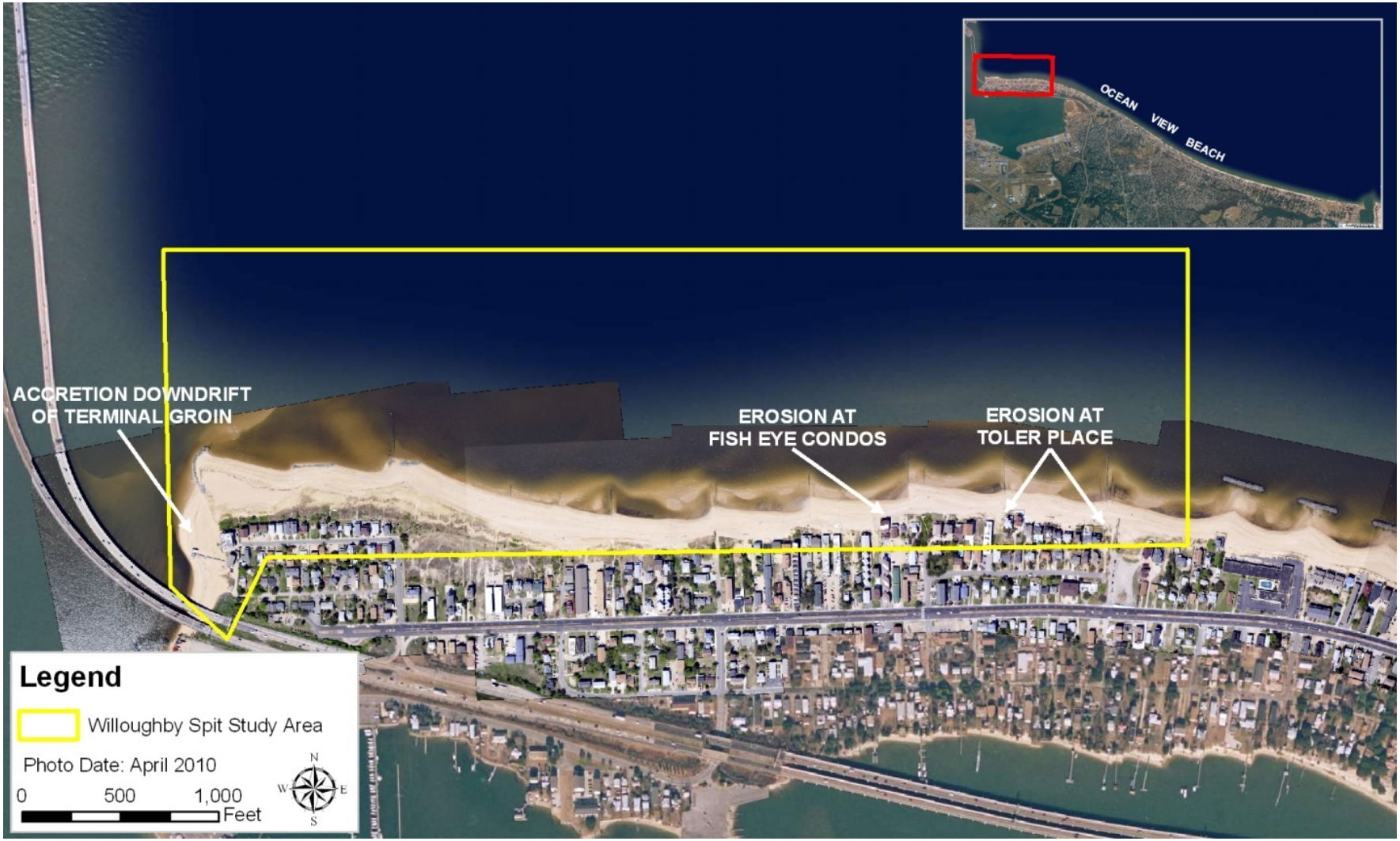
Presentation on the Willoughby Spit Shoreline Improvement Project of Ocean View Beach

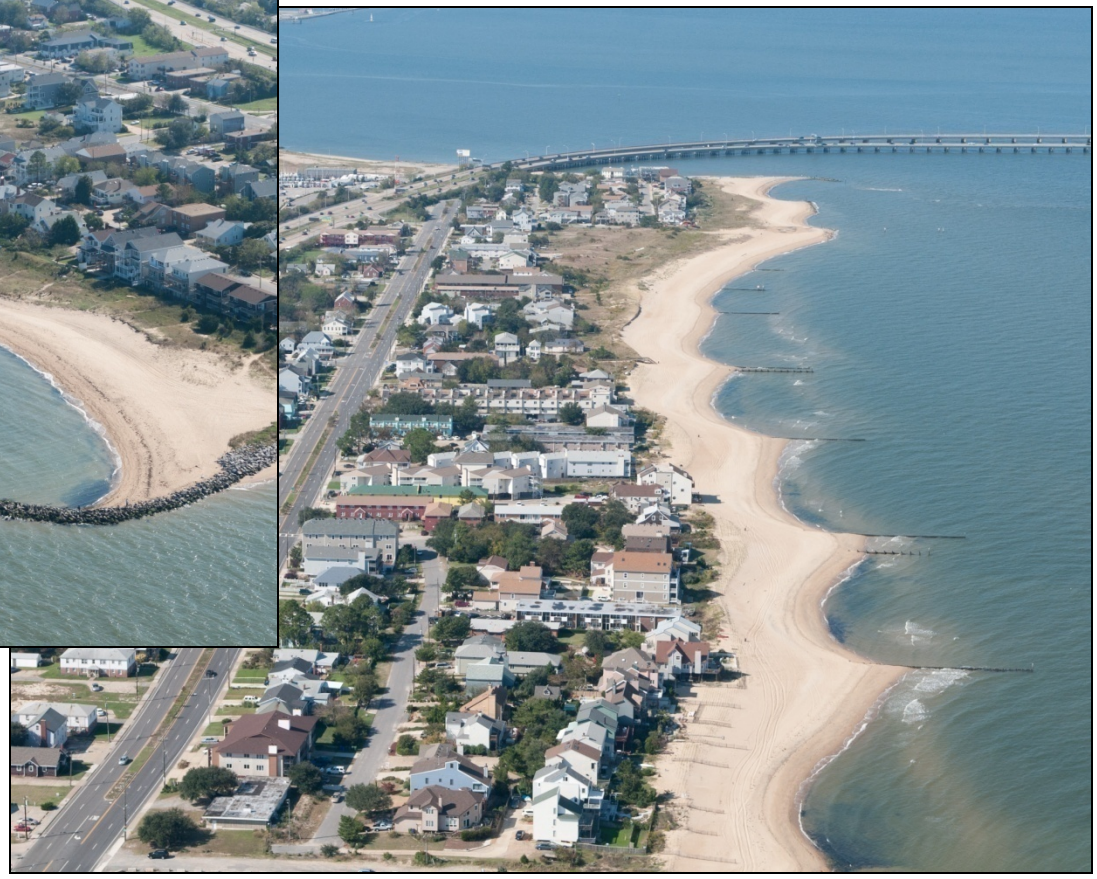
Moffatt & Nichol
March 2013

Problem Statement



Problem Statement

Willoughby Spit
(October 2011)



Scope

- Review Historical Data
- Develop List of Proposed Alternatives
- Perform Numerical Modeling of Shoreline Change and Local Hydrodynamics
- Present Study Findings and Recommended Alternative
- Construct Selected Alternative

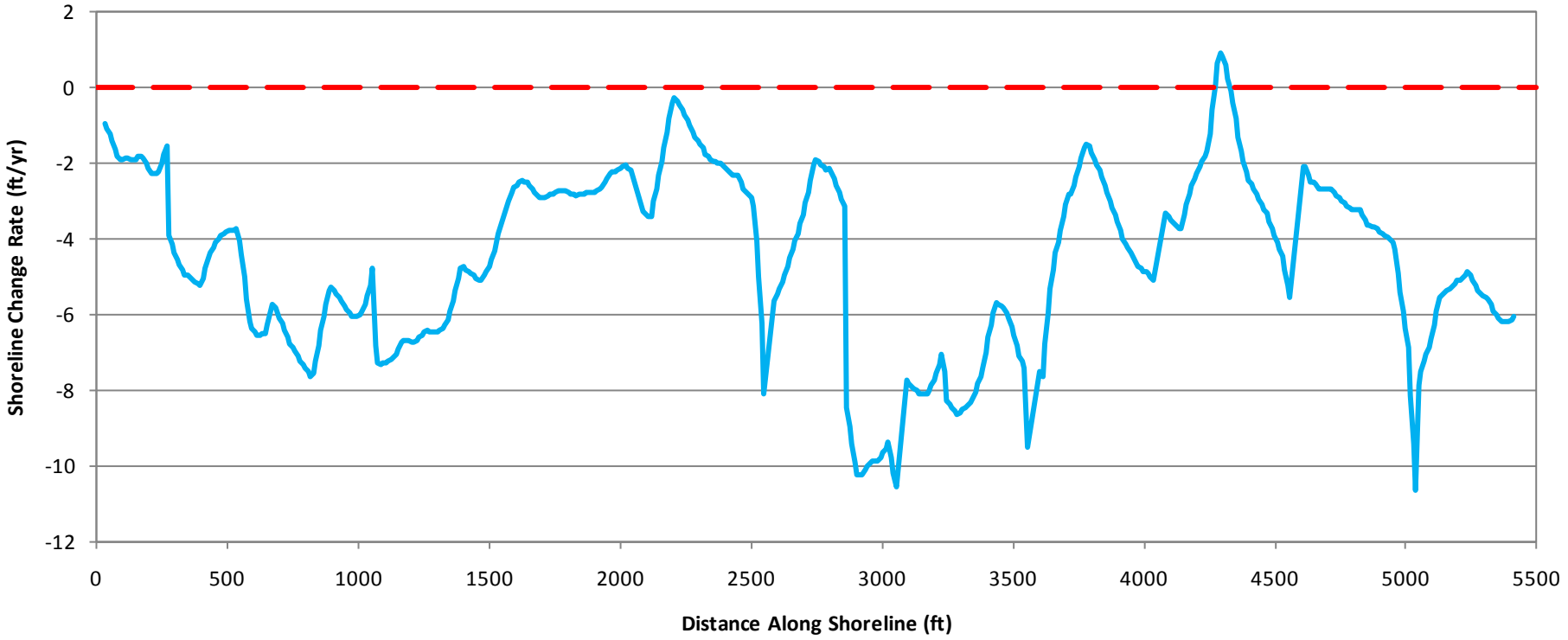
Data Collection

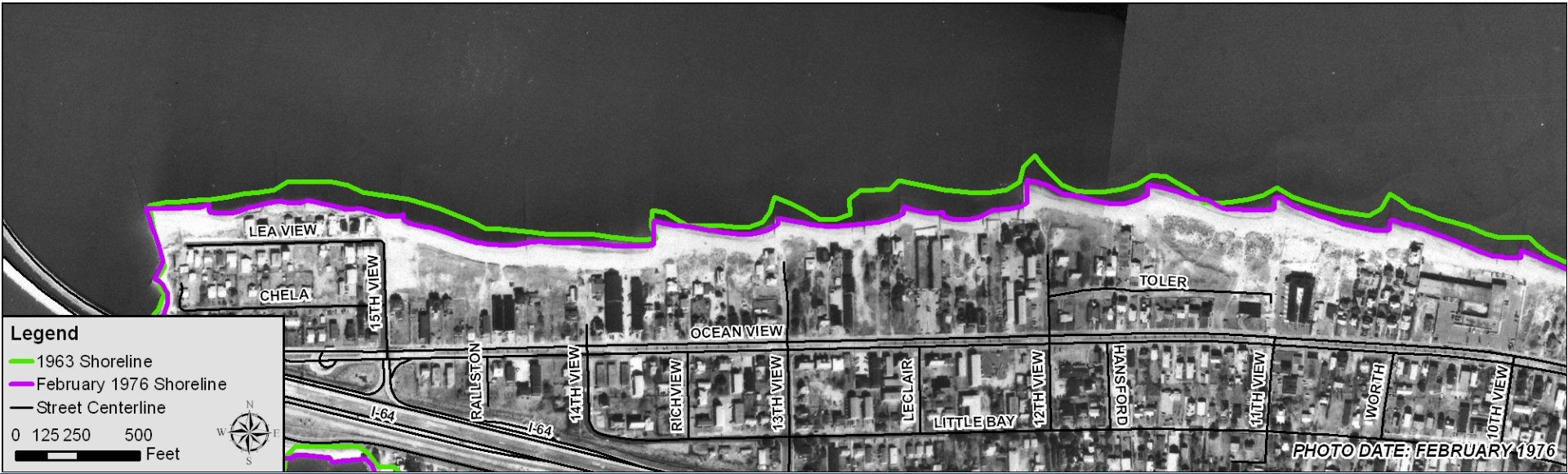
- Historical Aerial Photos – Shoreline Positions
- Beach and Bathymetric Survey Data
- Engineering Activities Log (Timeline of Erosion Control Projects)
- Wave and Water Level Data
- Beach Sediment Characteristics

Review of Historical Data at Willoughby Spit

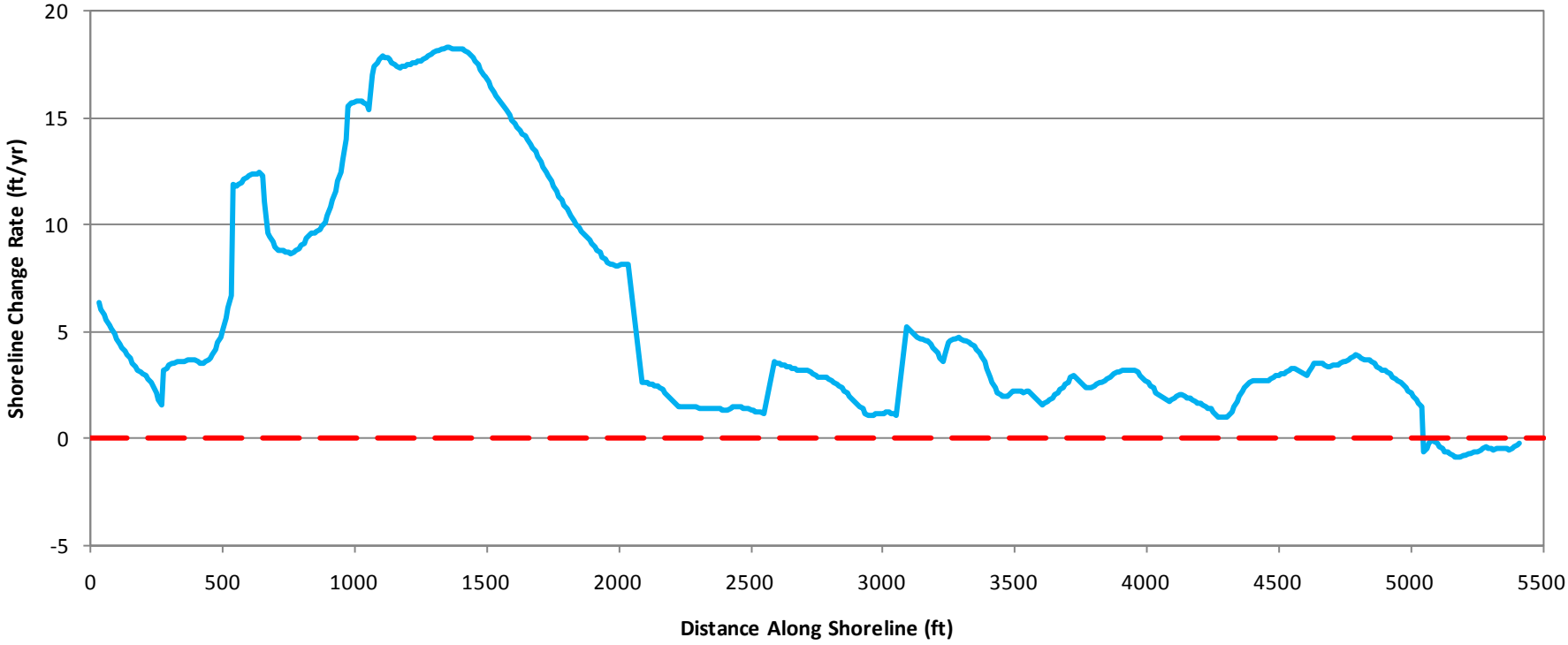
- **Digitized Shoreline Positions From Historical Aerial Photos (1916-2010)**
  - **Compared Photos and Relative Shoreline Positions**
  - **Calculated Net Shoreline Change (Erosion/Accretion)**
  - **Evaluated Impact of Engineering Interventions on Relative Shoreline Positions and Net Shoreline Change**

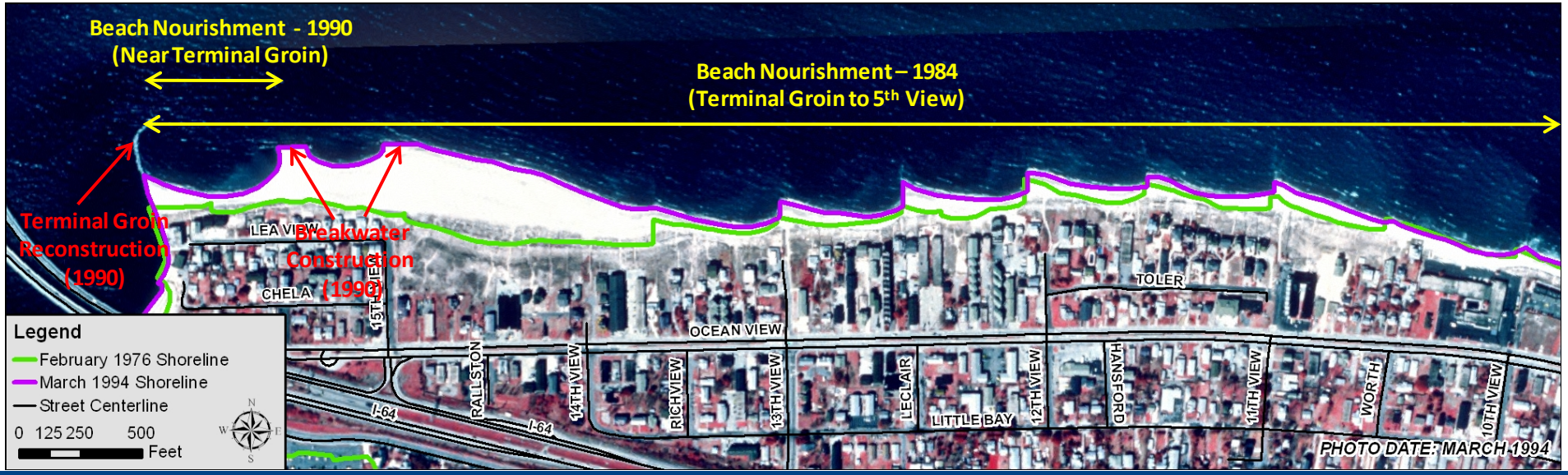
Shoreline Change Rate 1963-February 1976



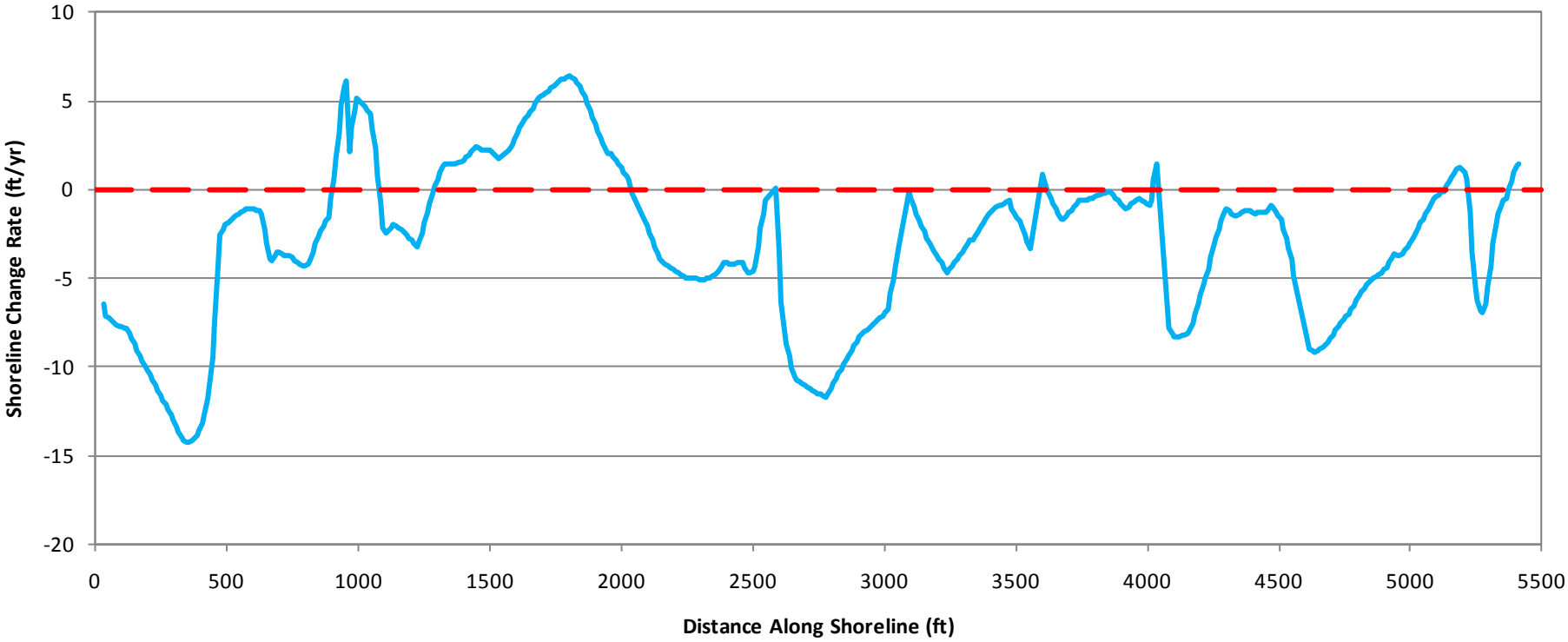


Shoreline Change Rate February 1976-March 1994





Shoreline Change Rate March 2006-April 2010



Review of Historical Data at Bay Oaks

- **Western End of the Willoughby Spit Area has Accreted**
- **Eastern End of the Willoughby Spit Area Shows a Trend of Slight Erosion**
- **Filling of the Groin Pocket Between 2002 and 2006 Likely Triggered a Change in Littoral Transport**

Development of Proposed Alternatives

- **Goals Of Proposed Erosion Control Alternatives**
  - **Provide Equivalent Protection to All Structures Along the Willoughby Spit Shoreline**
  - **Address the Issue of Accretion on the Downdrift Side of the Terminal Groin**

Development of Proposed Alternatives

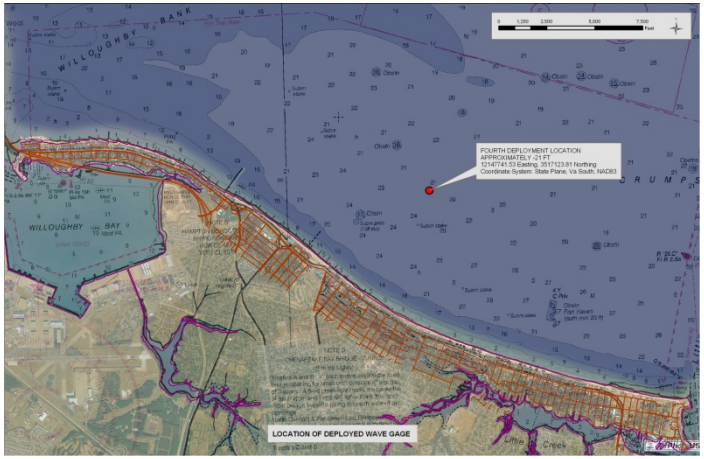
Unequal Distances From Shoreline to Structures

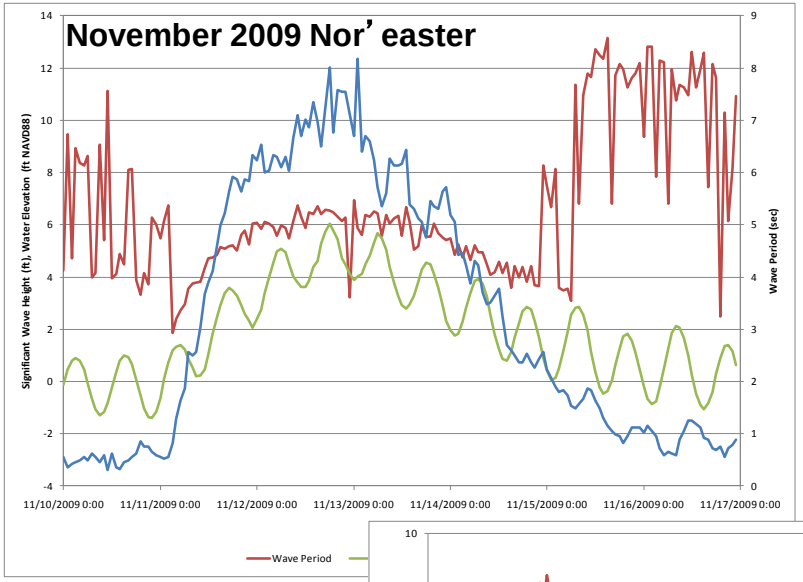
Accretion On Downdrift Side Of Terminal Groin

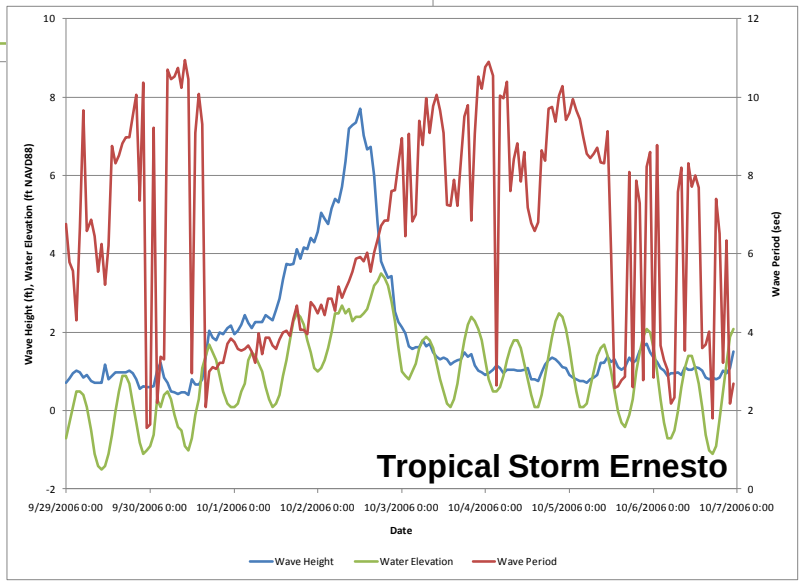
Development of Proposed Alternatives

- **Alternatives**
  - **Removal of Existing Groin Field**
  - **Beach Nourishment**
  - **Offshore Breakwaters**
  - **Various Configurations**

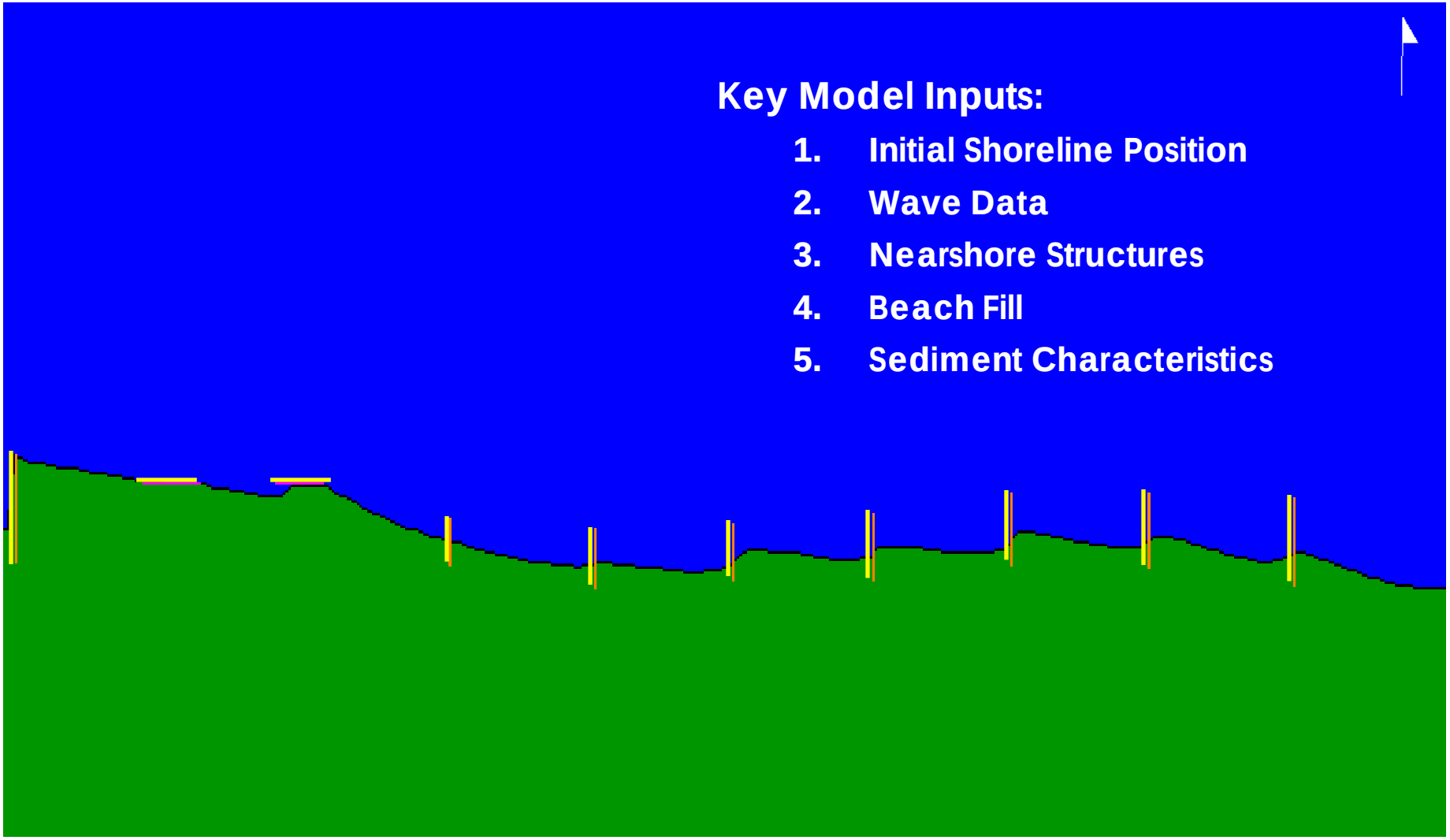
Measured Waves







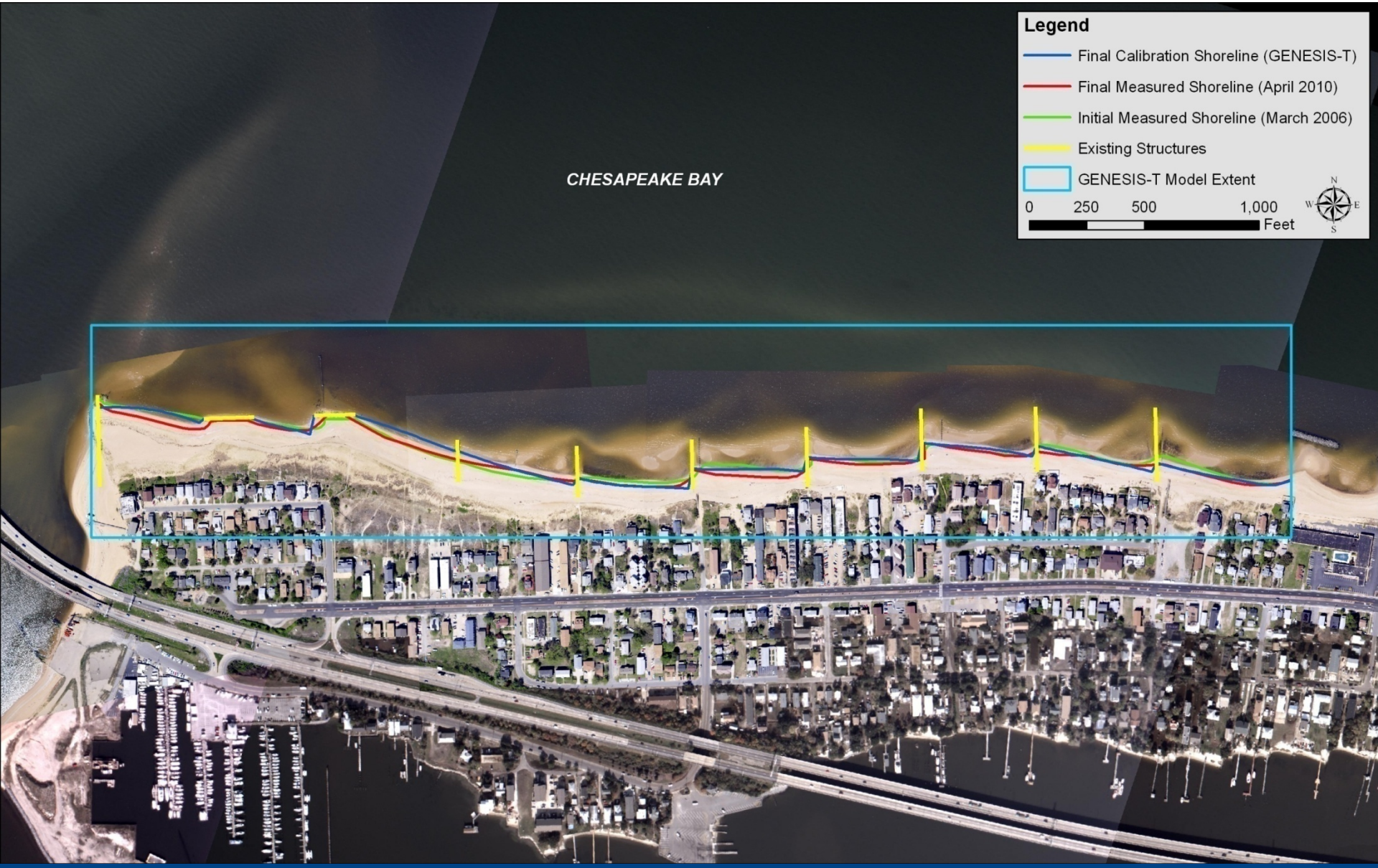
Modeling of Shoreline Change with GENESIS-T



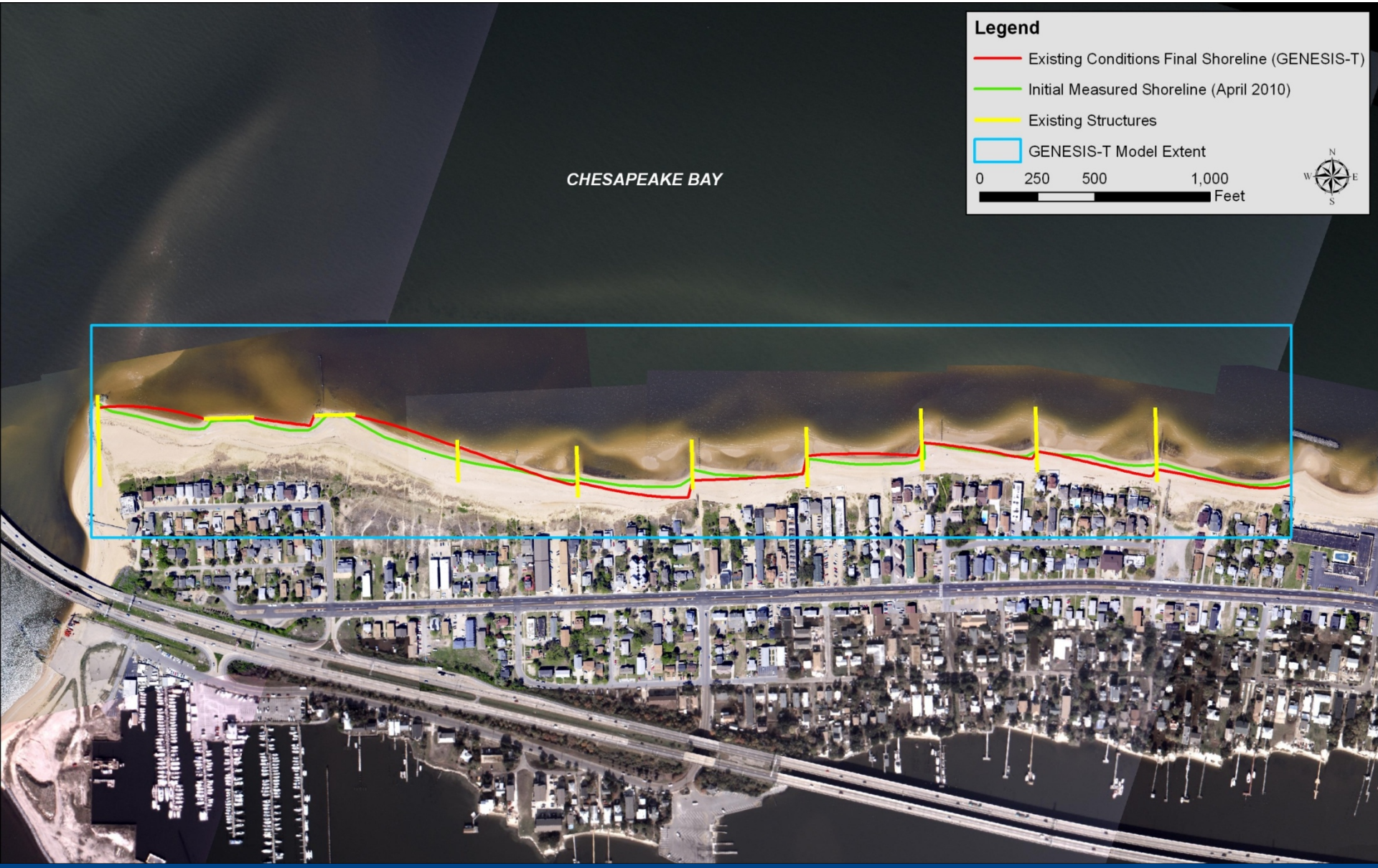
Modeling of Shoreline Change with GENESIS-T

- **GENESIS Modeling Scenarios**
  1. **Calibration Model**
     - **March 2006 – April 2010**
     - **Structural Conditions Remained Constant**
  2. **Existing Conditions Model**
     - **Existing Structural Conditions**
     - **8-yr Future Simulation**
  3. **With Project Models**
     - **Numerous Structural Configurations**
     - **8-yr Future Simulation**

Calibration Model

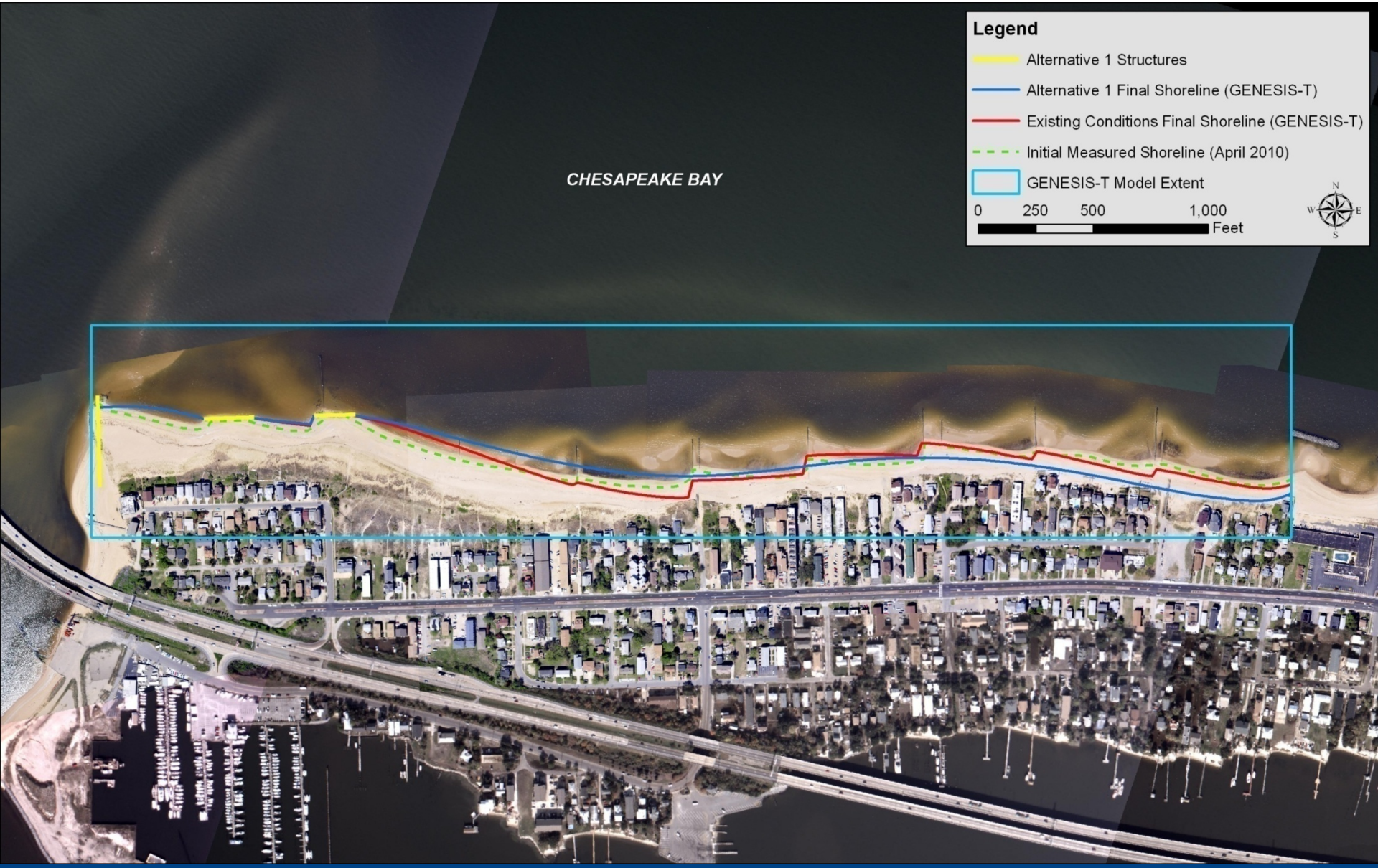


Existing Conditions Model



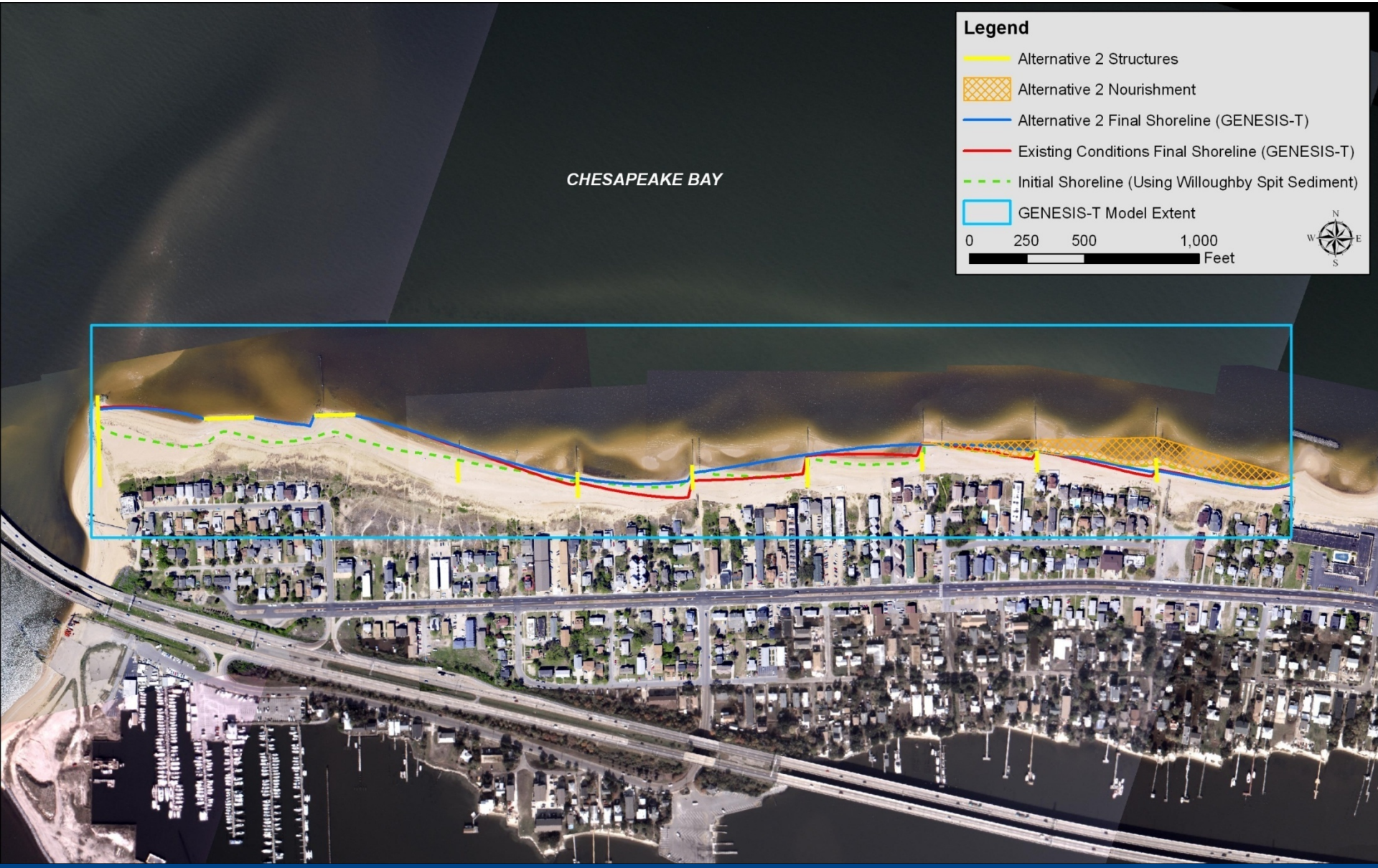
Alternative 1

Remove Existing Groin Field



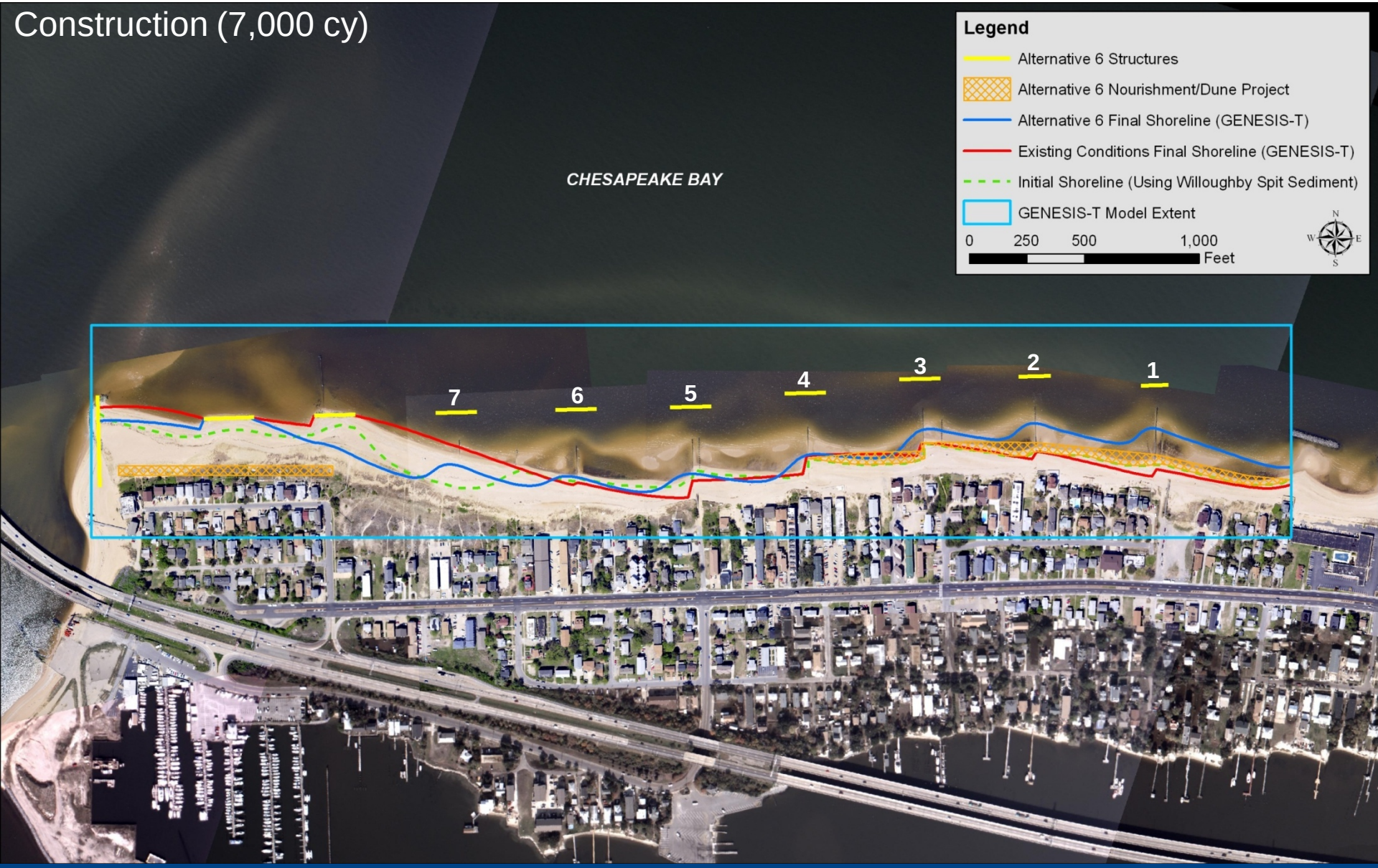
Alternative 2

Removal of Offshore Portion of Existing Groin Field and Beach Nourishment (45,000 cy)



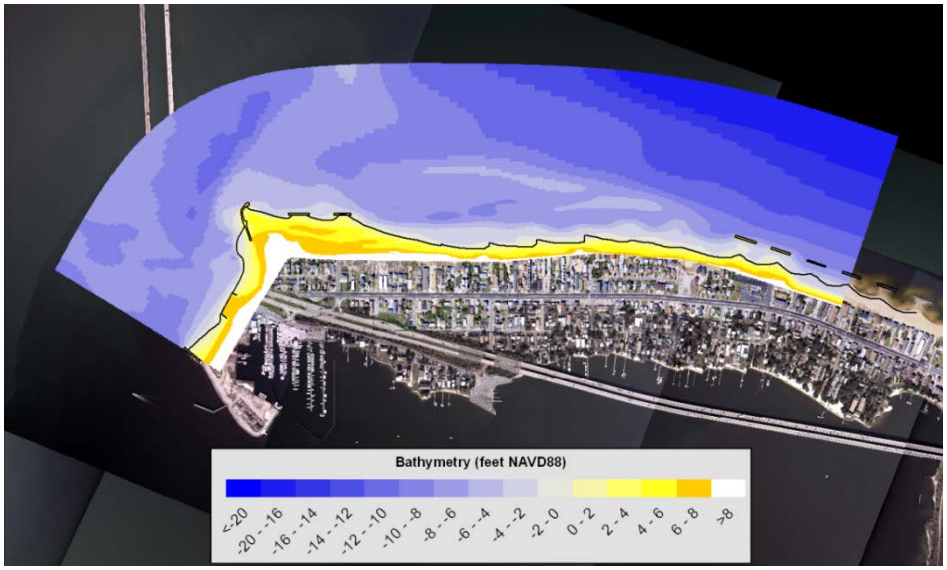
Recommended Alternative

Construction of 7 Offshore Breakwaters (Ls_1 =120 ft, Ls_2=140 ft, $Ls_{3,4,5,6,7}$=180 ft) and Removal of Existing Groin Field with Beach Nourishment (28,000 cy) and Dune Construction (7,000 cy)



Modeling of Coastal Processes with Delft3D

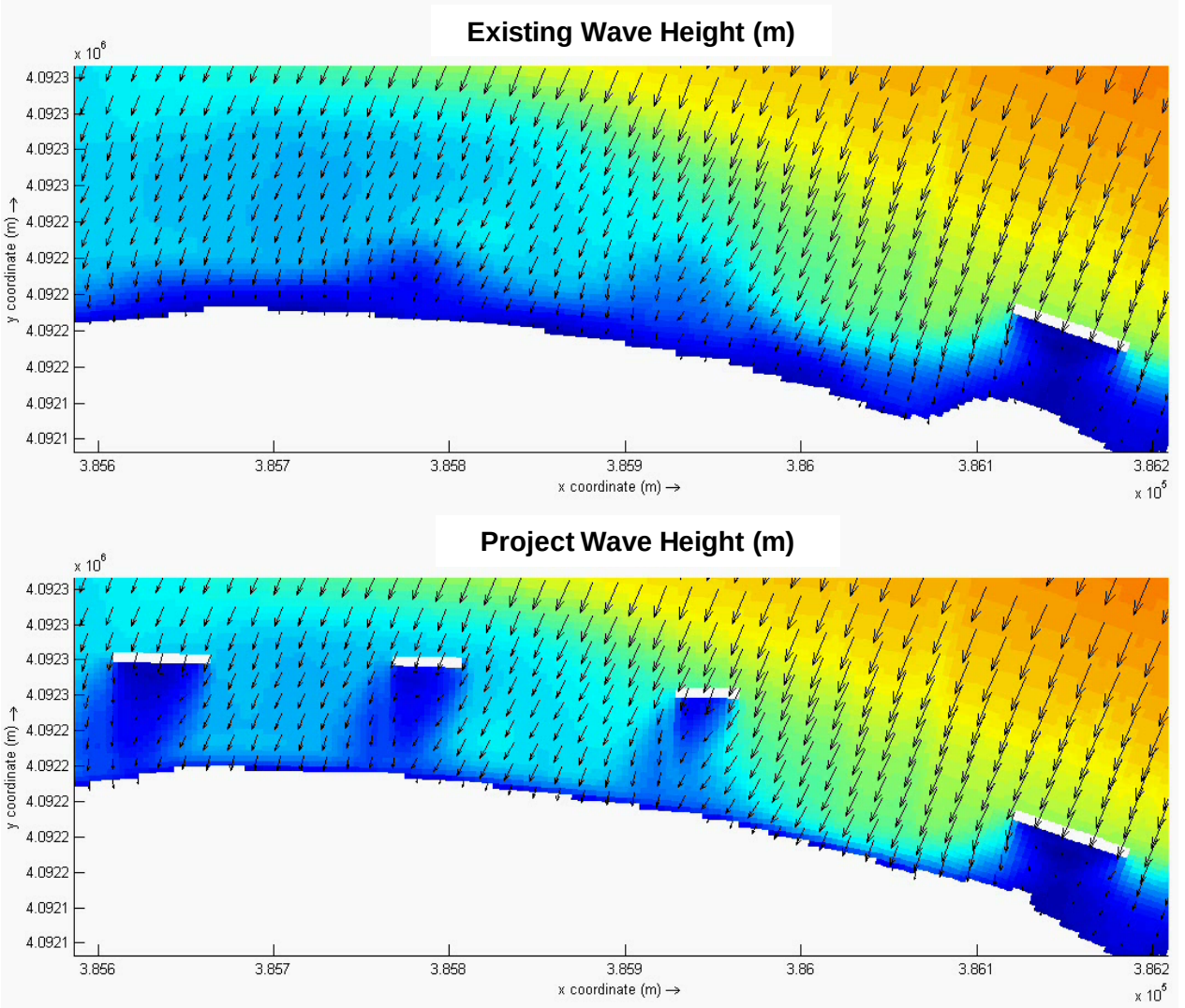
- **Delft3D Modules**
  1. Hydrodynamics
  2. Waves
  3. Sediment Transport
- **Delft3D Modeling Scenarios**
  1. Pre-construction
  2. Existing Conditions
  3. Selected Option(s)



- **Model Run for <u>Representative</u> Wave and Surge Conditions Roughly Equivalent to 5 Years Of Storm Impacts**
  1. Hs=5.6 ft, Tp = 5 sec, 22 deg from North, 1.9’ Surge – Conditions Run for 30 Days Straight

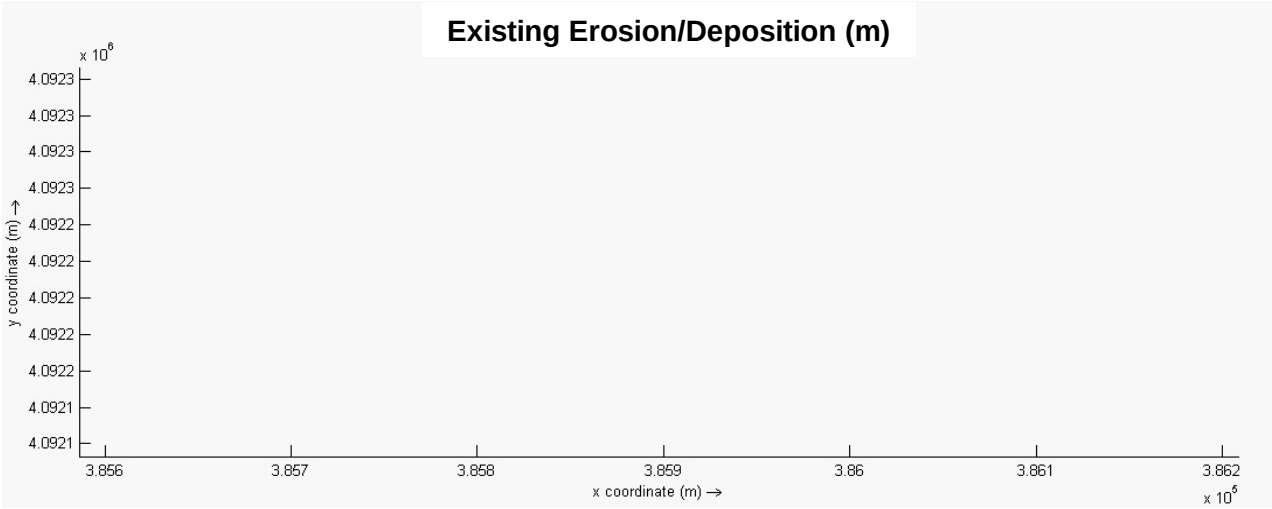
Modeling of Coastal Processes with Delft3D

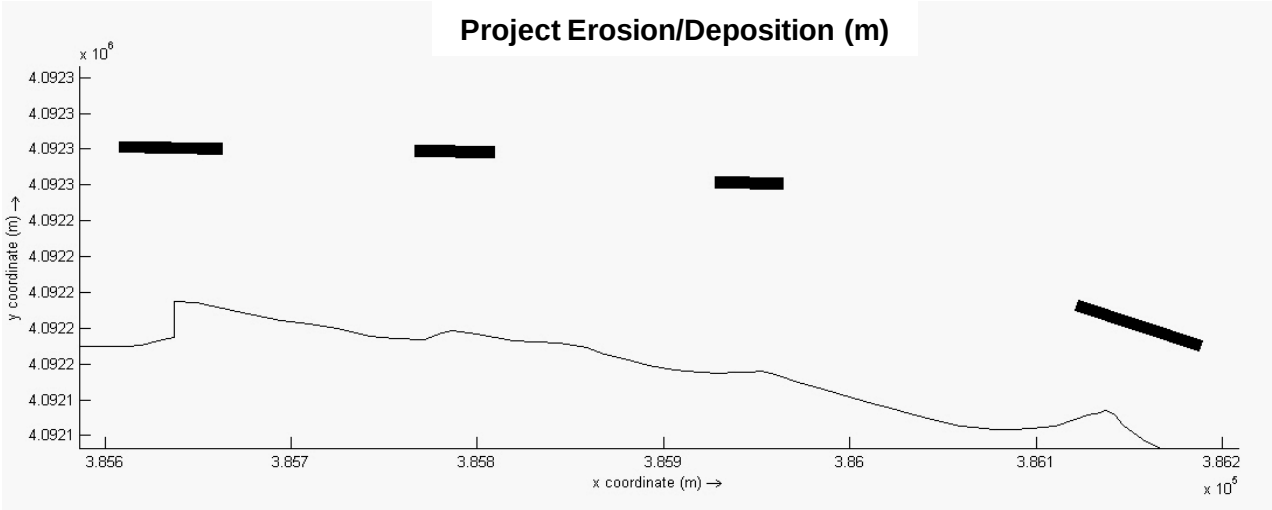
- **Model Animations**
  - **Existing vs. Project Wave Heights**
  - **Note Shadowing Effect of Breakwaters**

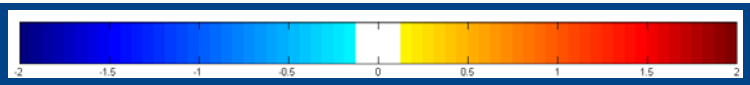


Modeling of Coastal Processes with Delft3D

- **Model Animations**
  - **Existing vs. Project Morphological Changes**
  - **Note Changes in Bathymetry and Erosional/ Depositional Patterns**

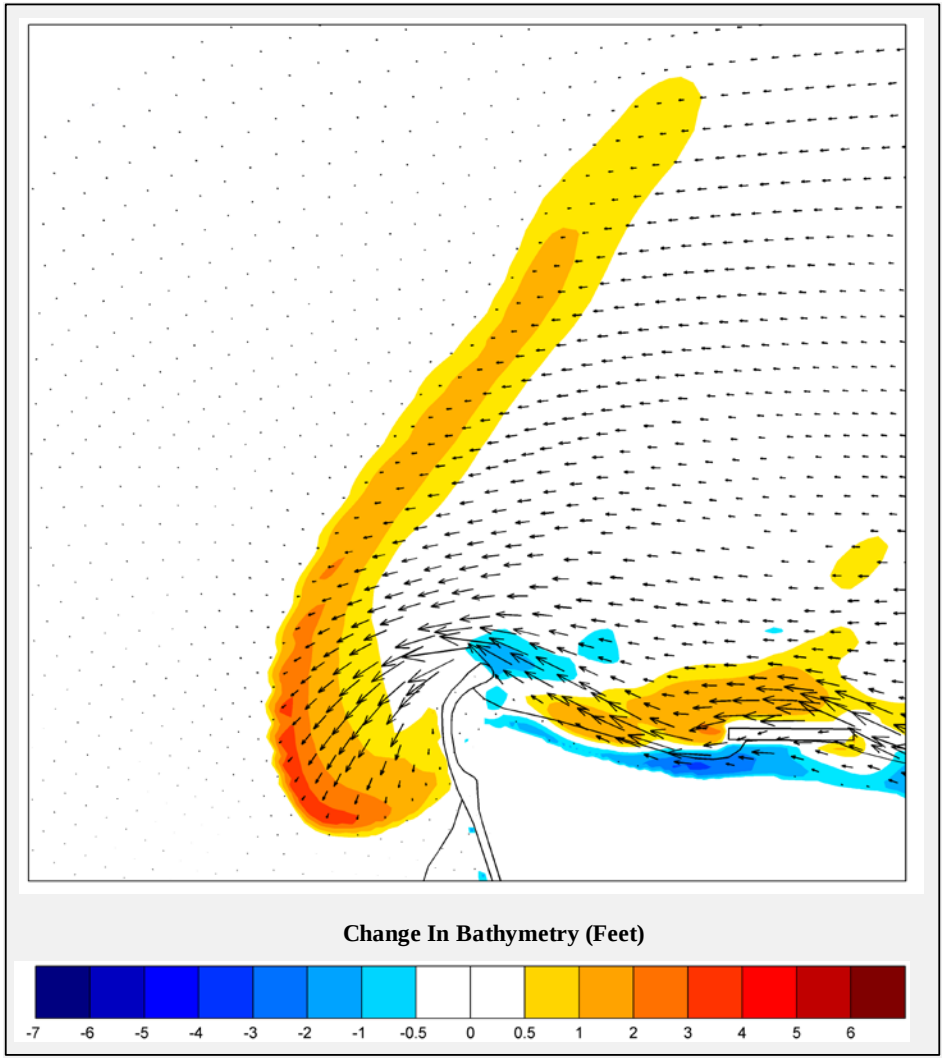






Modeling of Coastal Processes with Delft3D

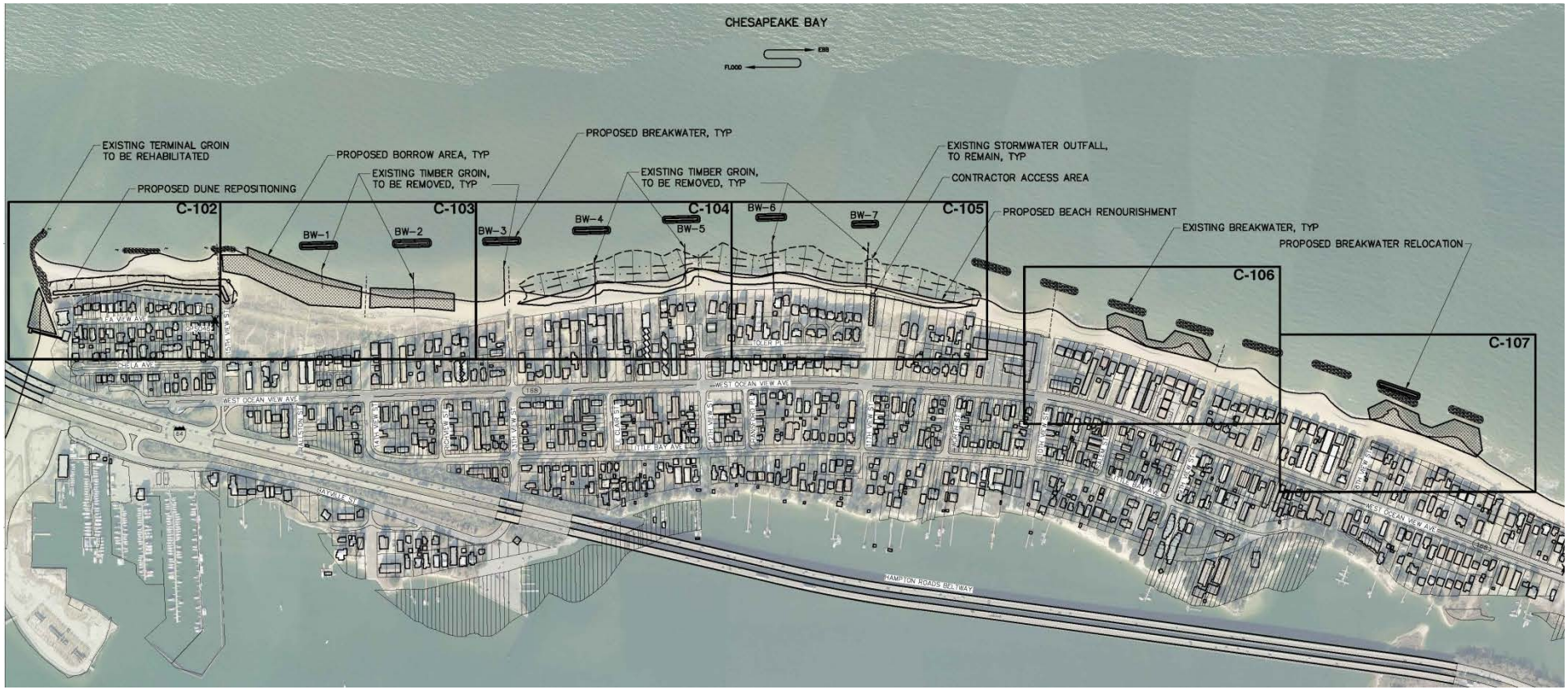
- **Sediment Transport Pattern**
  - **Majority of Material Being Transported Around the Groin**
  - **Small Amount of Material Transported Over Groin During Storm Events**
  - **Raising the Groin Shows Some Effect on Trapping More Sand**



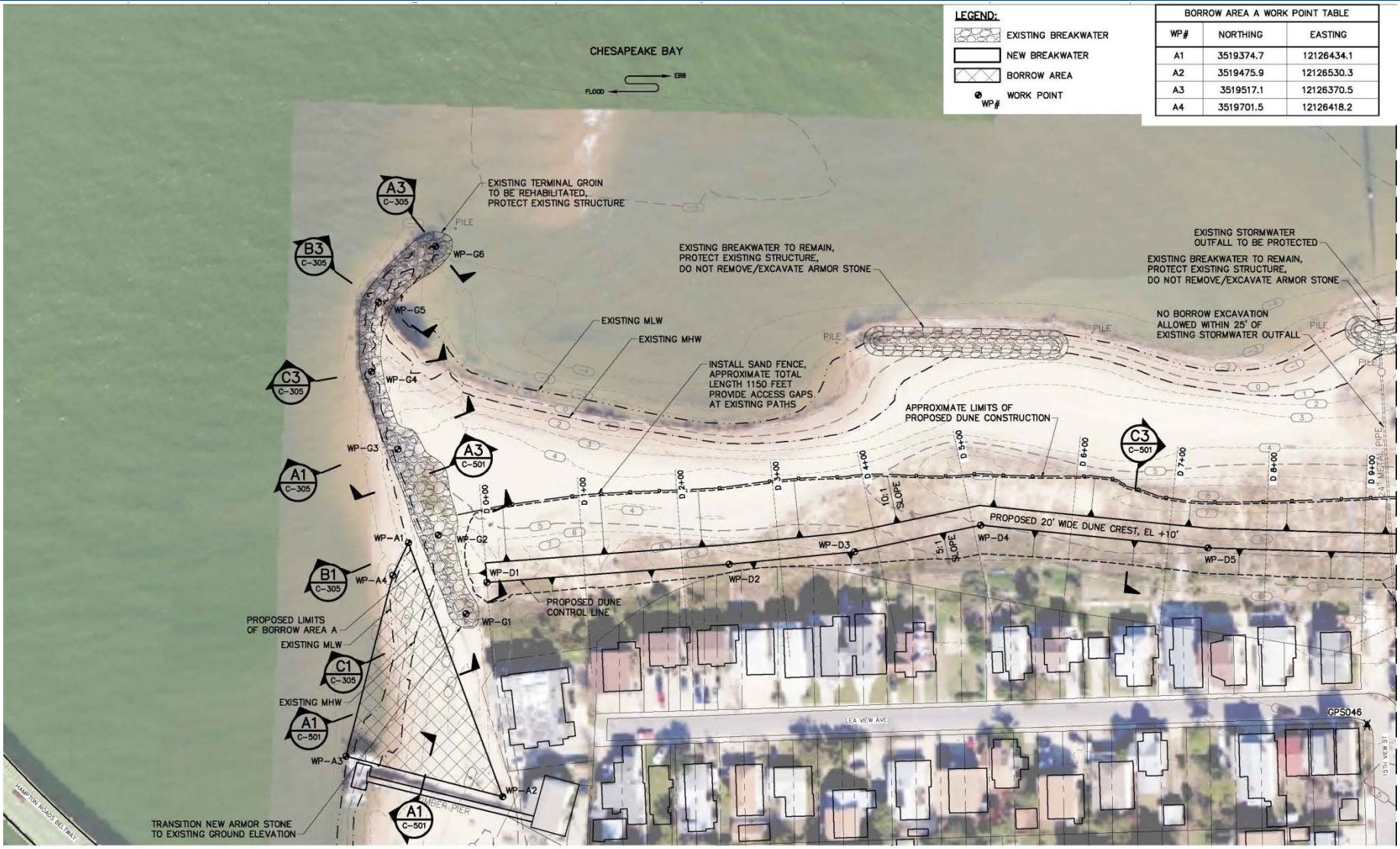
Study Findings and Discussion

- Terminal Groin and Existing Offshore Breakwaters Successful at Trapping Sand at the Western End of Willoughby Spit
- Historically, the Groin Field Stabilized the Remainder of the Shoreline
- More Recently, the Dilapidated Condition of the Groin Field has Caused the Eastern End of Willoughby Spit to Erode, Creating Unequal Protection Along the Shoreline
- Filling of the Groin Pocket has Allowed Sand to Travel Around the Terminal Groin
- An Ideal Shoreline Which Provides Equal Protection Can Be Achieved Through Removal of the Existing Groin Field, the Construction of 7 Offshore Breakwaters, and Beach Nourishment

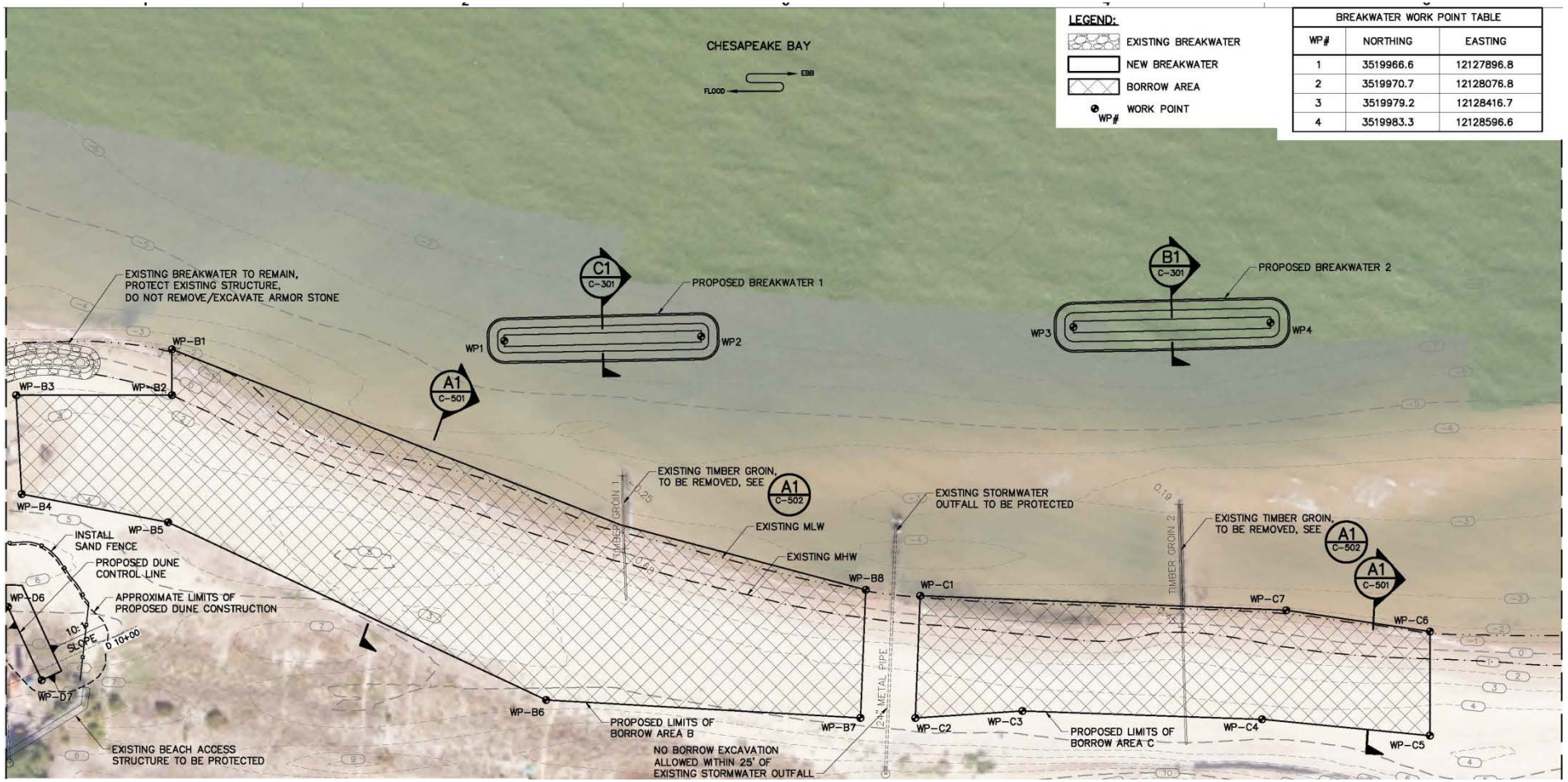
Plans


CHESAPEAKE BAY
EBB
FLOOD
EXISTING TERMINAL GROIN TO BE REHABILITATED
PROPOSED DUNE REPOSITIONING
PROPOSED BORROW AREA, TYP
EXISTING TIMBER GROIN, TO BE REMOVED, TYP
PROPOSED BREAKWATER, TYP
EXISTING TIMBER GROIN, TO BE REMOVED, TYP
EXISTING STORMWATER OUTFALL, TO REMAIN, TYP
CONTRACTOR ACCESS AREA
PROPOSED BEACH RENOURISHMENT
EXISTING BREAKWATER, TYP
PROPOSED BREAKWATER RELOCATION
C-102
C-103
C-104
C-105
C-106
C-107
BW-1
BW-2
BW-3
BW-4
BW-5
BW-6
BW-7
WEST OCEAN VIEW AVE
HAMPTON ROADS BELTWAY

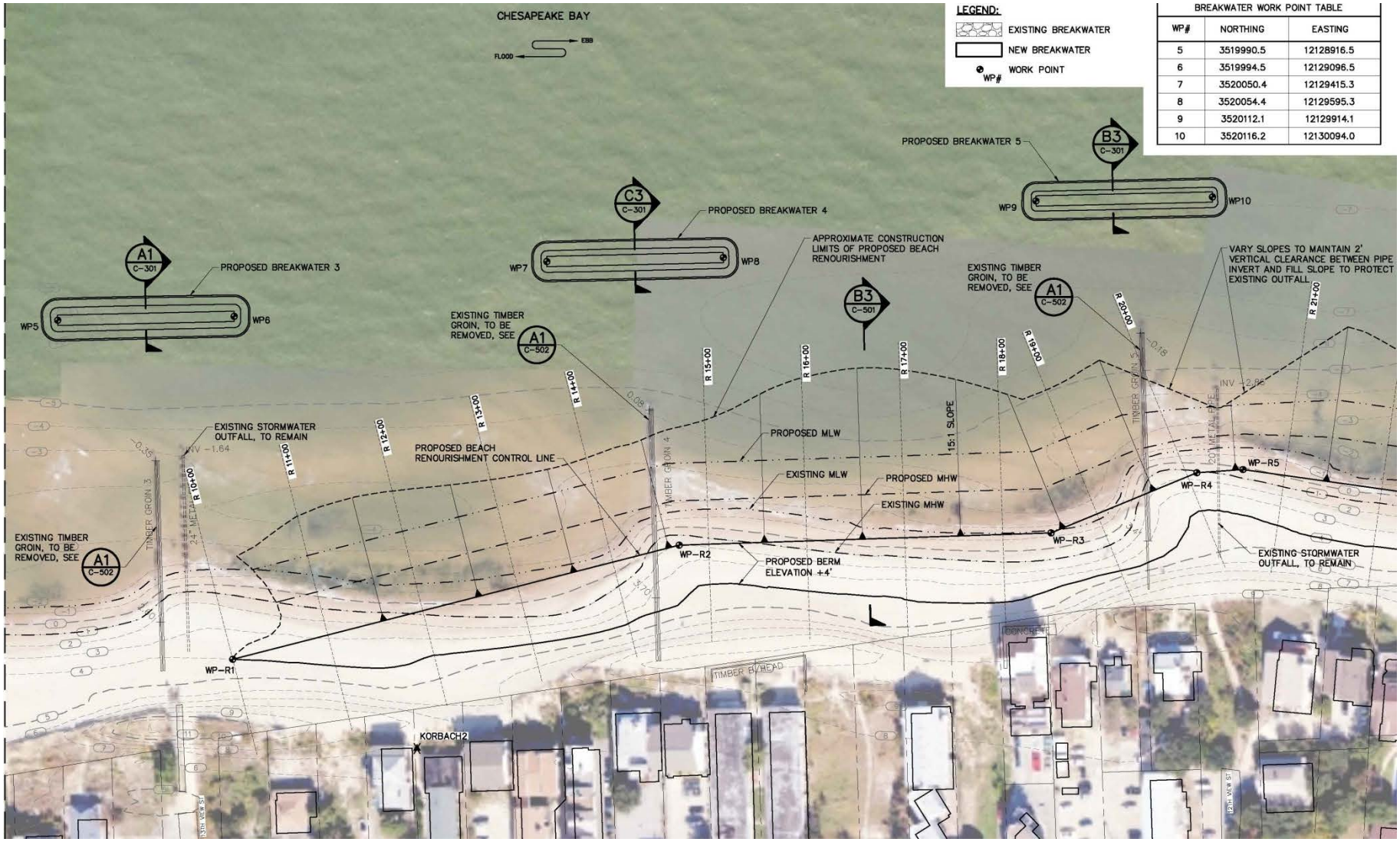
Plans


LEGEND:
EXISTING BREAKWATER
NEW BREAKWATER
BORROW AREA
WORK POINT
WP#
BORROW AREA A WORK POINT TABLE
WP# | NORTHING | EASTING
A1 | 3519374.7 | 12126434.1
A2 | 3519475.9 | 12126530.3
A3 | 3519517.1 | 12126370.5
A4 | 3519701.5 | 12126418.2
CHESAPEAKE BAY
EBB
FLOOD
EXISTING TERMINAL GROIN TO BE REHABILITATED, PROTECT EXISTING STRUCTURE
PILE
EXISTING BREAKWATER TO REMAIN, PROTECT EXISTING STRUCTURE, DO NOT REMOVE/EXCAVATE ARMOR STONE
EXISTING STORMWATER OUTFALL TO BE PROTECTED
NO BORROW EXCAVATION ALLOWED WITHIN 25' OF EXISTING STORMWATER OUTFALL
EXISTING MLW
EXISTING MHW
INSTALL SAND FENCE, APPROXIMATE TOTAL LENGTH 1150 FEET PROVIDE ACCESS GAPS AT EXISTING PATHS
APPROXIMATE LIMITS OF PROPOSED DUNE CONSTRUCTION
PROPOSED 20' WIDE DUNE CREST, EL +10'
10:1 SLOPE
5:1 SLOPE
PROPOSED DUNE CONTROL LINE
PROPOSED LIMITS OF BORROW AREA A
TRANSITION NEW ARMOR STONE TO EXISTING GROUND ELEVATION
WP-G1
WP-G2
WP-G3
WP-G4
WP-G5
WP-G6
WP-A1
WP-A2
WP-A3
WP-A4
WP-D1
WP-D2
WP-D3
WP-D4
WP-D5
D 0+00
D 1+00
D 2+00
D 3+00
D 4+00
D 5+00
D 6+00
D 7+00
D 8+00
D 9+00
A3 C-305
B3 C-305
C3 C-305
A1 C-305
B1 C-305
C1 C-305
A1 C-501
A3 C-501
C3 C-501
A1 C-501
LEA VIEW AVE
GPS046
HAMPTON ROADS BELTWAY

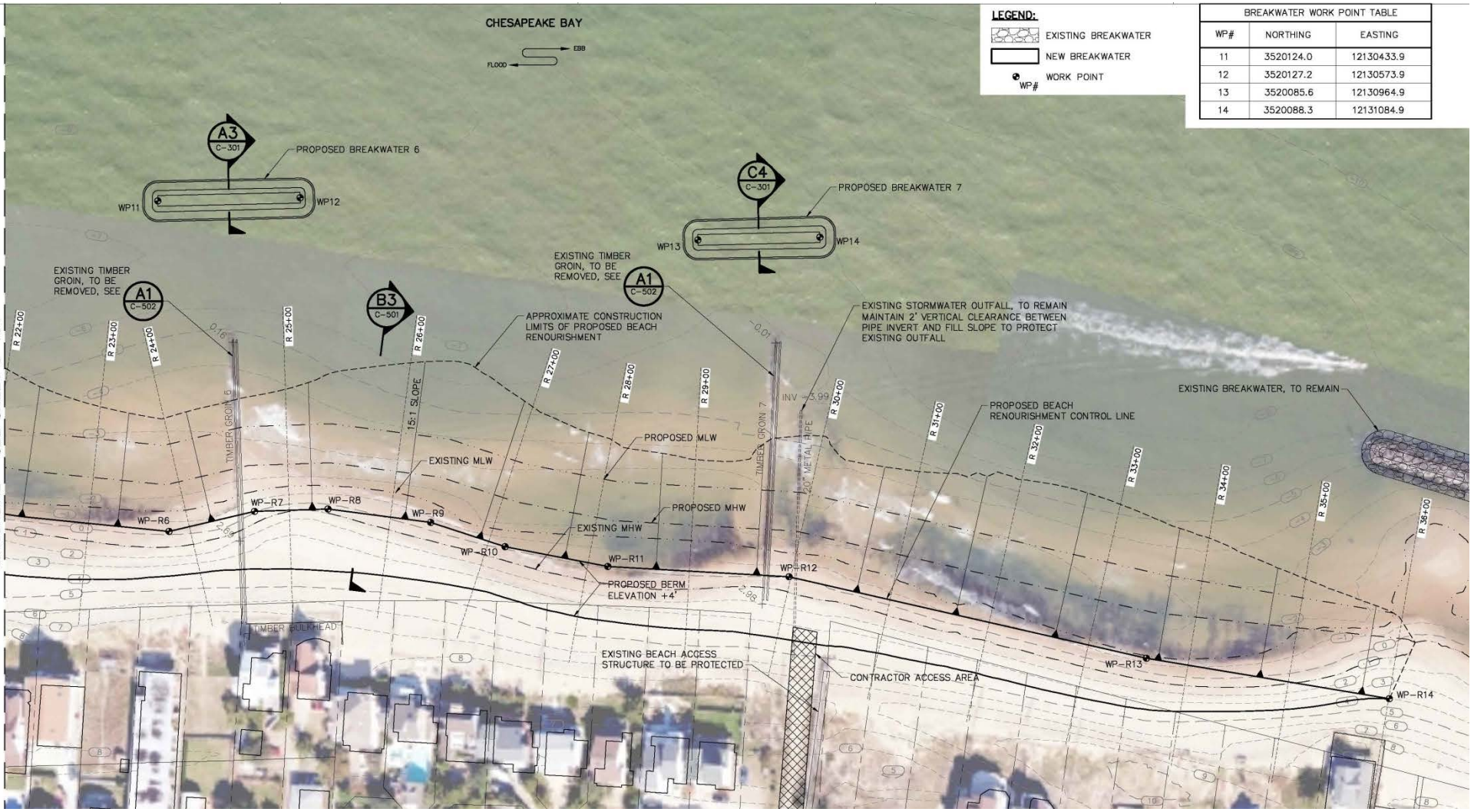
Plans


LEGEND:
EXISTING BREAKWATER
NEW BREAKWATER
BORROW AREA
WORK POINT
WP#
BREAKWATER WORK POINT TABLE
WP# | NORTHING | EASTING
1 | 3519966.6 | 12127896.8
2 | 3519970.7 | 12128076.8
3 | 3519979.2 | 12128416.7
4 | 3519983.3 | 12128596.6
CHESAPEAKE BAY
EBB
FLOOD
EXISTING BREAKWATER TO REMAIN, PROTECT EXISTING STRUCTURE, DO NOT REMOVE/EXCAVATE ARMOR STONE
C1 C-301
PROPOSED BREAKWATER 1
WP1
WP2
A1 C-501
B1 C-301
PROPOSED BREAKWATER 2
WP3
WP4
WP-B1
WP-B2
WP-B3
WP-B4
WP-B5
WP-B6
WP-B7
WP-B8
INSTALL SAND FENCE
PROPOSED DUNE CONTROL LINE
APPROXIMATE LIMITS OF PROPOSED DUNE CONSTRUCTION
10:1 SLOPE
0+00
1+00
WP-D6
WP-D7
EXISTING BEACH ACCESS STRUCTURE TO BE PROTECTED
EXISTING TIMBER GROIN, TO BE REMOVED, SEE A1 C-502
TIMBER GROIN 1
EXISTING MLW
EXISTING MHW
PROPOSED LIMITS OF BORROW AREA B
NO BORROW EXCAVATION ALLOWED WITHIN 25' OF EXISTING STORMWATER OUTFALL
EXISTING STORMWATER OUTFALL TO BE PROTECTED
24" METAL PIPE
TIMBER GROIN 2
EXISTING TIMBER GROIN, TO BE REMOVED, SEE A1 C-502
A1 C-501
WP-C1
WP-C2
WP-C3
WP-C4
WP-C5
WP-C6
WP-C7
PROPOSED LIMITS OF BORROW AREA C

Plans


CHESAPEAKE BAY
EBB
FLOOD
LEGEND:
EXISTING BREAKWATER
NEW BREAKWATER
WORK POINT
WP#
BREAKWATER WORK POINT TABLE
WP# | NORTHING | EASTING
5 | 3519990.5 | 12128916.5
6 | 3519994.5 | 12129096.5
7 | 3520050.4 | 12129415.3
8 | 3520054.4 | 12129595.3
9 | 3520112.1 | 12129914.1
10 | 3520116.2 | 12130094.0
PROPOSED BREAKWATER 5
B3 C-301
WP9
WP10
C3 C-301
PROPOSED BREAKWATER 4
WP7
WP8
APPROXIMATE CONSTRUCTION LIMITS OF PROPOSED BEACH RENOURISHMENT
A1 C-301
PROPOSED BREAKWATER 3
WP5
WP6
EXISTING TIMBER GROIN, TO BE REMOVED, SEE A1 C-502
B3 C-501
VARY SLOPES TO MAINTAIN 2' VERTICAL CLEARANCE BETWEEN PIPE INVERT AND FILL SLOPE TO PROTECT EXISTING OUTFALL
EXISTING STORMWATER OUTFALL, TO REMAIN
INV -1.64
PROPOSED BEACH RENOURISHMENT CONTROL LINE
PROPOSED MLW
EXISTING MLW
PROPOSED MHW
EXISTING MHW
15:1 SLOPE
TIMBER GROIN 3
TIMBER GROIN 4
TIMBER GROIN 5
24" METAL PIPE
20" METAL PIPE
WP-R1
WP-R2
WP-R3
WP-R4
WP-R5
PROPOSED BERM ELEVATION +4'
EXISTING STORMWATER OUTFALL, TO REMAIN
TIMBER BULKHEAD
CONCRETE
KORBACH2
13TH VIEW ST
12TH VIEW ST

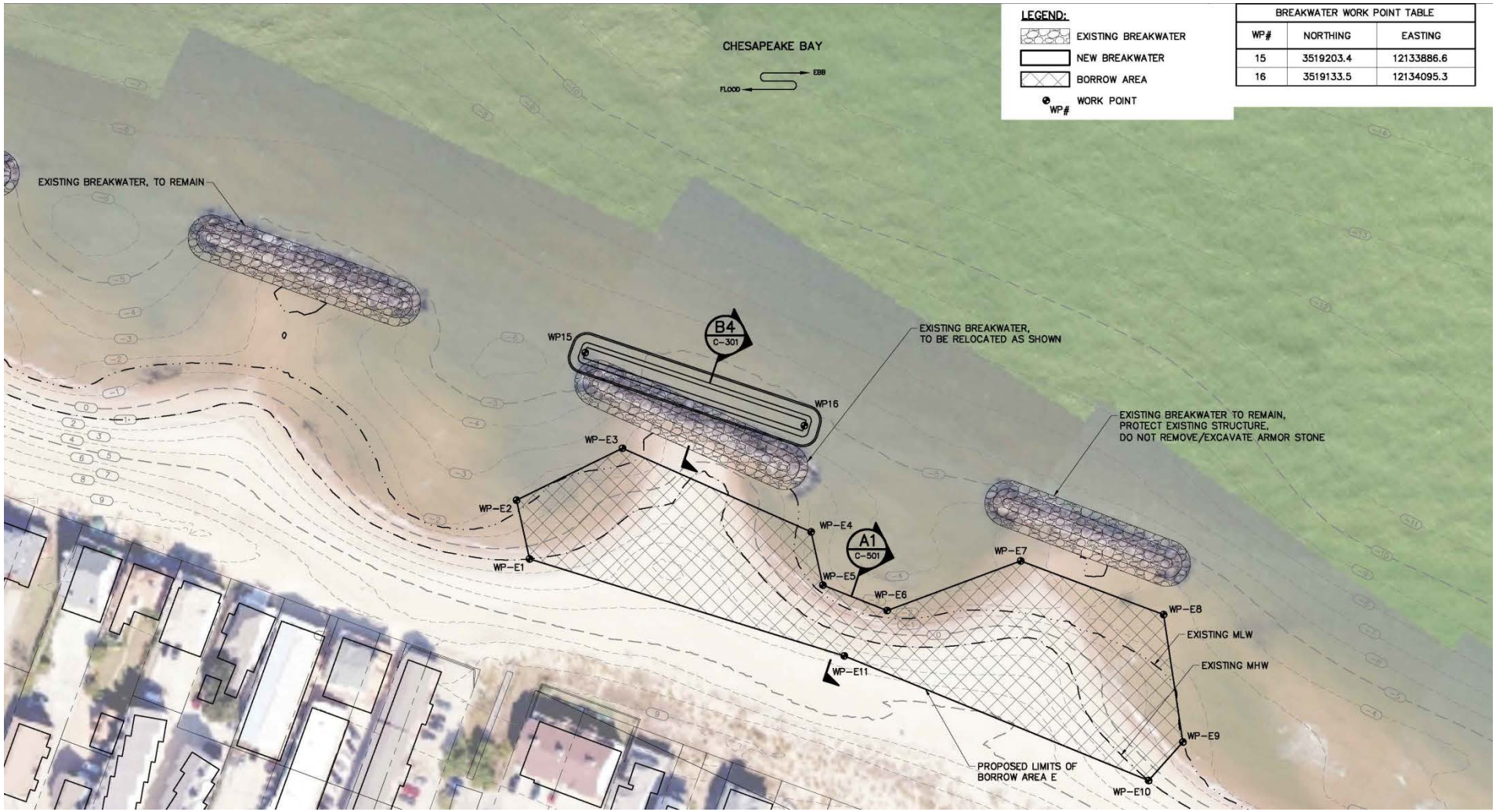
Plans


CHESAPEAKE BAY
EBB
FLOOD
LEGEND:
EXISTING BREAKWATER
NEW BREAKWATER
WORK POINT
WP#
BREAKWATER WORK POINT TABLE
WP# | NORTHING | EASTING
11 | 3520124.0 | 12130433.9
12 | 3520127.2 | 12130573.9
13 | 3520085.6 | 12130964.9
14 | 3520088.3 | 12131084.9
A3 C-301
PROPOSED BREAKWATER 6
WP11
WP12
C4 C-301
PROPOSED BREAKWATER 7
WP13
WP14
EXISTING TIMBER GROIN, TO BE REMOVED, SEE A1 C-502
B3 C-501
APPROXIMATE CONSTRUCTION LIMITS OF PROPOSED BEACH RENOURISHMENT
EXISTING STORMWATER OUTFALL, TO REMAIN MAINTAIN 2' VERTICAL CLEARANCE BETWEEN PIPE INVERT AND FILL SLOPE TO PROTECT EXISTING OUTFALL
EXISTING BREAKWATER, TO REMAIN
PROPOSED BEACH RENOURISHMENT CONTROL LINE
PROPOSED MLW
EXISTING MLW
PROPOSED MHW
EXISTING MHW
PROPOSED BERM ELEVATION +4'
15:1 SLOPE
TIMBER GROIN 6
TIMBER GROIN 7
24" METAL PIPE
INV -3.99
TIMBER BULKHEAD
EXISTING BEACH ACCESS STRUCTURE TO BE PROTECTED
CONTRACTOR ACCESS AREA
WP-R6
WP-R7
WP-R8
WP-R9
WP-R10
WP-R11
WP-R12
WP-R13
WP-R14
R 22+00
R 23+00
R 24+00
R 25+00
R 26+00
R 27+00
R 28+00
R 29+00
R 30+00
R 31+00
R 32+00
R 33+00
R 34+00
R 35+00
R 36+00

Plans

LEGEND:
EXISTING BREAKWATER
NEW BREAKWATER
BORROW AREA
WP#
WORK POINT
BORROW AREA D WORK POINT TABLE
WP# | NORTHING | EASTING
D1 | 3519502.8 | 12132373.9
D2 | 3519578.1 | 12132372.0
D3 | 3519594.9 | 12132416.5
D4 | 3519549.5 | 12132567.8
D5 | 3519451.5 | 12132592.4
D6 | 3519431.8 | 12132682.4
D7 | 3519496.7 | 12132748.8
D8 | 3519451.9 | 12132899.5
D9 | 3519365.5 | 12132948.4
D10 | 3519327.6 | 12132928.3
D11 | 3519410.2 | 12132584.5
EXISTING BREAKWATER, TO REMAIN
CHESAPEAKE BAY
EBB
FLOOD
EXISTING BREAKWATER TO REMAIN, PROTECT EXISTING STRUCTURE, DO NOT REMOVE/EXCAVATE ARMOR STONE
24" METAL PIPE
EXISTING MLW
EXISTING MHW
WP-D1
WP-D2
WP-D3
WP-D4
WP-D5
WP-D6
WP-D7
WP-D8
WP-D9
WP-D10
WP-D11
A1
C-501
PROPOSED LIMITS OF BORROW AREA D
EXISTING BREAKWATER TO REMAIN, PROTECT EXISTING STRUCTURE, DO NOT REMOVE/EXCAVATE ARMOR STONE
EXISTING BREAKWATER, TO REMAIN
TIMBER BULKHEAD
CONCRETE WALL
CONCRETE WALL
CONCRETE WALL
24" METAL PIPE
10TH VIEW ST
WEST OCEAN VIEW AVE

Plans


LEGEND:
EXISTING BREAKWATER
NEW BREAKWATER
BORROW AREA
WP#
WORK POINT
BREAKWATER WORK POINT TABLE
WP# | NORTHING | EASTING
15 | 3519203.4 | 12133886.6
16 | 3519133.5 | 12134095.3
CHESAPEAKE BAY
EBB
FLOOD
EXISTING BREAKWATER, TO REMAIN
B4
C-301
WP15
WP16
EXISTING BREAKWATER, TO BE RELOCATED AS SHOWN
EXISTING BREAKWATER TO REMAIN, PROTECT EXISTING STRUCTURE, DO NOT REMOVE/EXCAVATE ARMOR STONE
WP-E1
WP-E2
WP-E3
WP-E4
A1
C-501
WP-E5
WP-E6
WP-E7
WP-E8
EXISTING MLW
EXISTING MHW
WP-E9
WP-E10
WP-E11
PROPOSED LIMITS OF BORROW AREA E

QUESTIONS ?