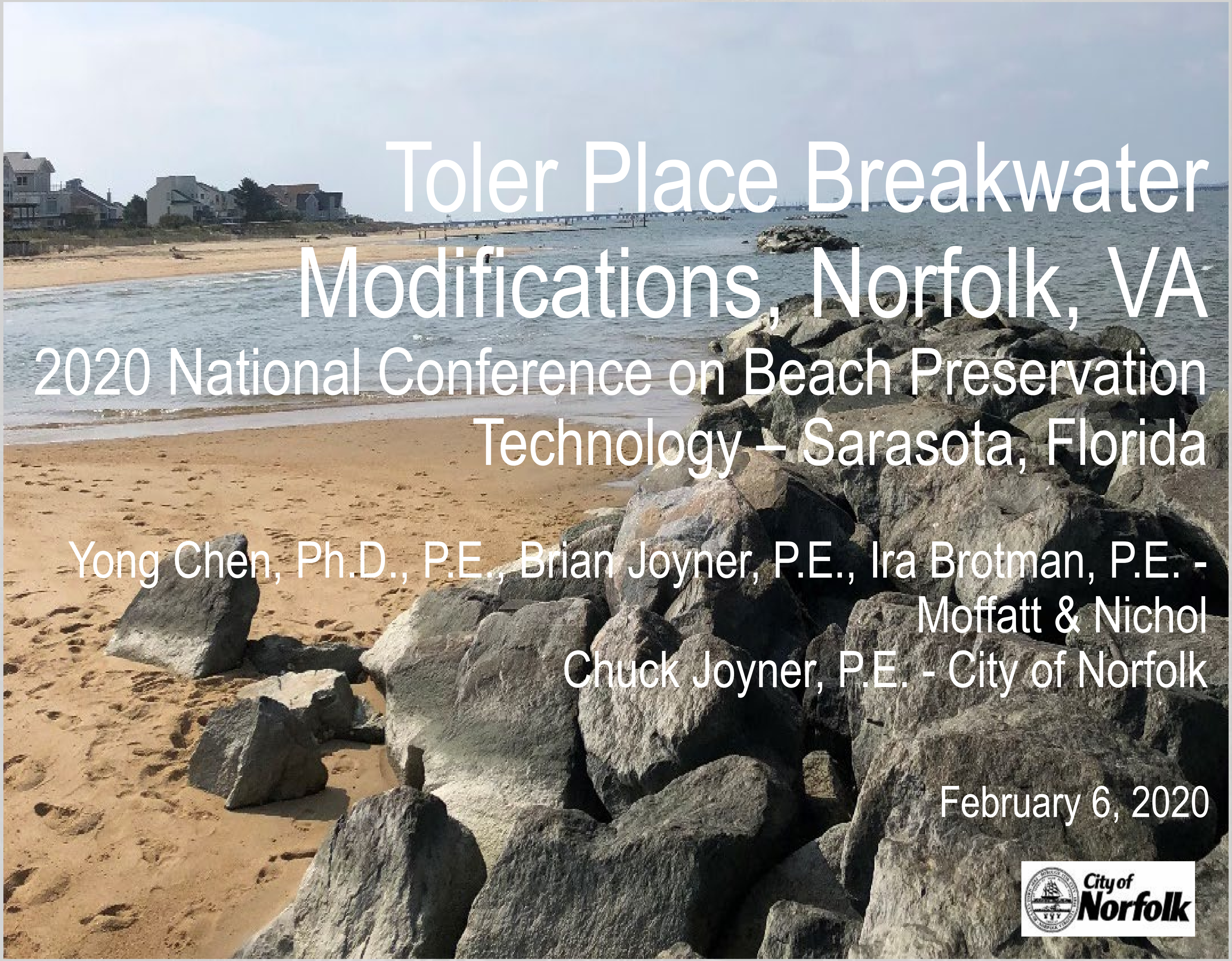


Toler Place Breakwater Modifications, Norfolk, VA

2020 National Conference on Beach Preservation Technology – Sarasota, Florida

Yong Chen, Ph.D., P.E., Brian Joyner, P.E., Ira Brotman, P.E. - Moffatt & Nichol
Chuck Joyner, P.E. - City of Norfolk

February 6, 2020

City of Norfolk

moffatt & nichol

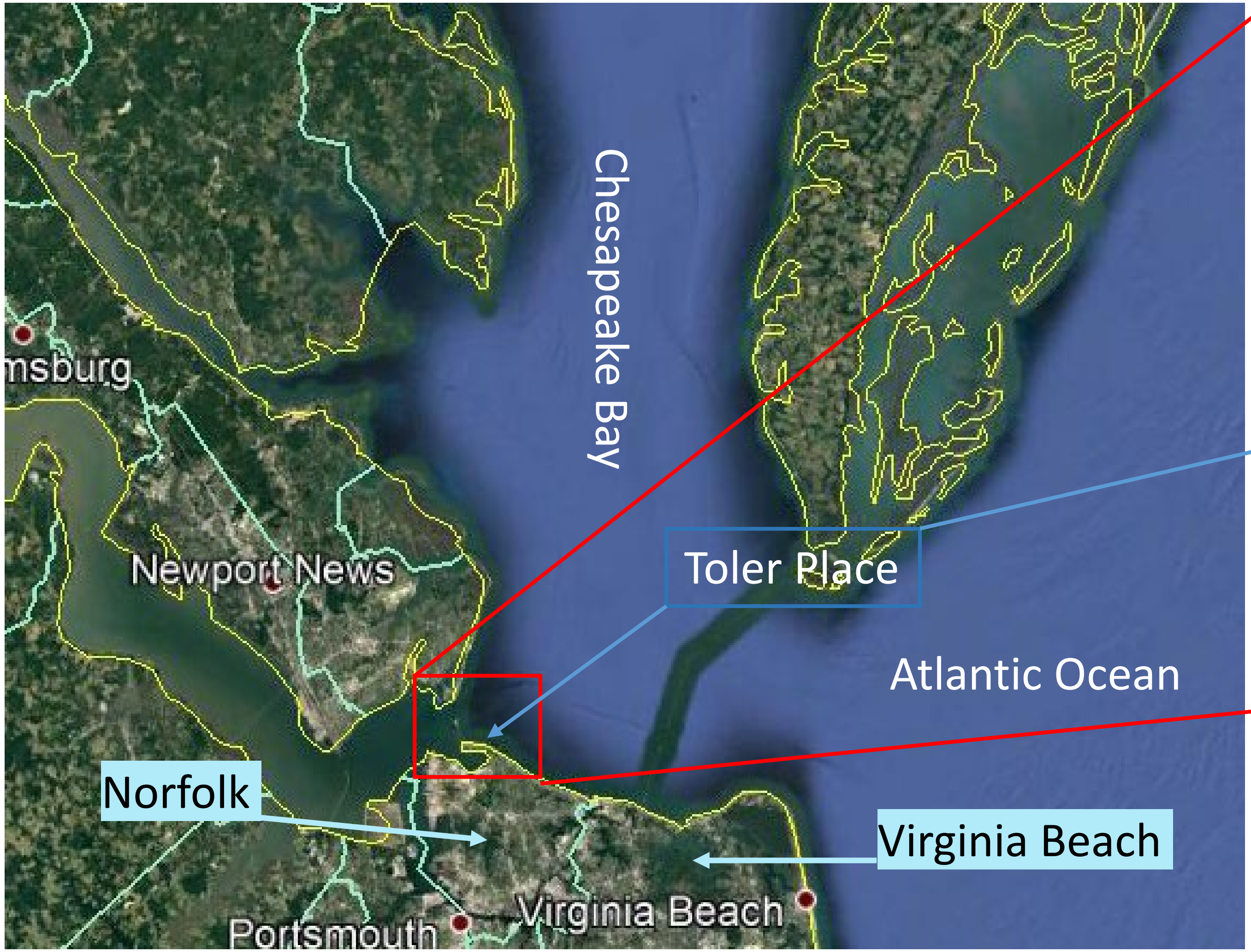
Creative People, Practical Solutions.®

moffattnichol.com

Presentation Outline

1. Project Background
2. Preliminary Breakwater Design
- Spectral Wave Modeling
- Shoreline/Morphological Modeling
- Alternatives
3. Detached Breakwater Design and Permitting

Toler Place Breakwater System – Location Map



- Largest estuary
- Sandy beaches in Norfolk and Virginia Beach

Toler Place Breakwater System - History

- Transition area: between Willoughby Spit Breakwaters and 800 Block Breakwaters

- 800 Block Breakwaters: constructed in 1997-1999, modified in 2013

- Willoughby Spit Breakwaters: constructed early 2013

- Federal beach nourishment project: 1.2 million cubic yards over approximate 6 miles completed in May 2017

Toler Place
Hot spot

Toler Place Breakwater System - History

- Toler Place transition area is a historical erosion hot spot area

- Residents' concerned that the 2013 breakwaters and Federal May 2017 Beach nourishment has not sufficiently stabilized local beach morphology at Toler Place

Google Earth: May 2018

City of Norfolk

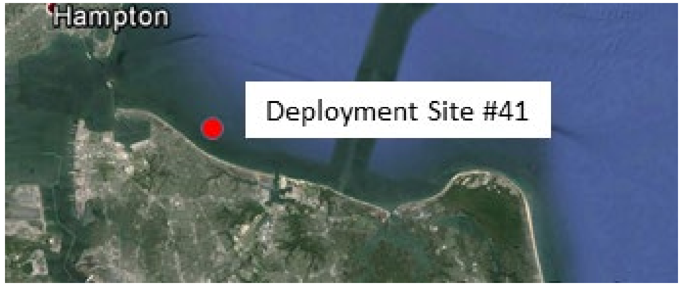
moffatt & nichol

Toler Place Breakwater System - Methodology

1. Field data: bathymetry, waves, winds and currents
- Norfolk wave gage (every 4 months)
- Profile surveys (every 6 months)
- NOAA wave and wind data

2. Coastal shoreline/morphology numerical modeling:
- MIKE 21 spectral wave model
- USACE GenCade model
- 3DCSTM model
- Delft3D model

3. Challenging for sediment transport modeling?
- Field survey, physical modeling, numerical modeling



Norfolk Wave Gage since March 2006

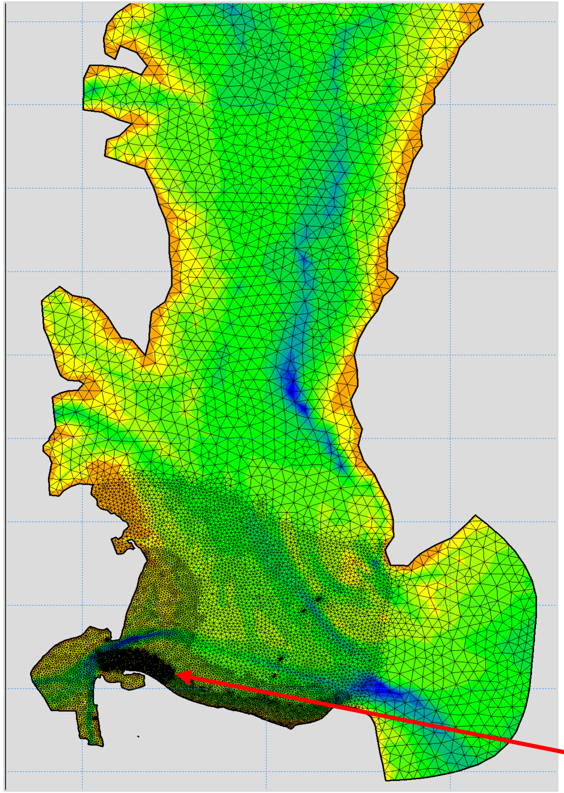
City of Norfolk

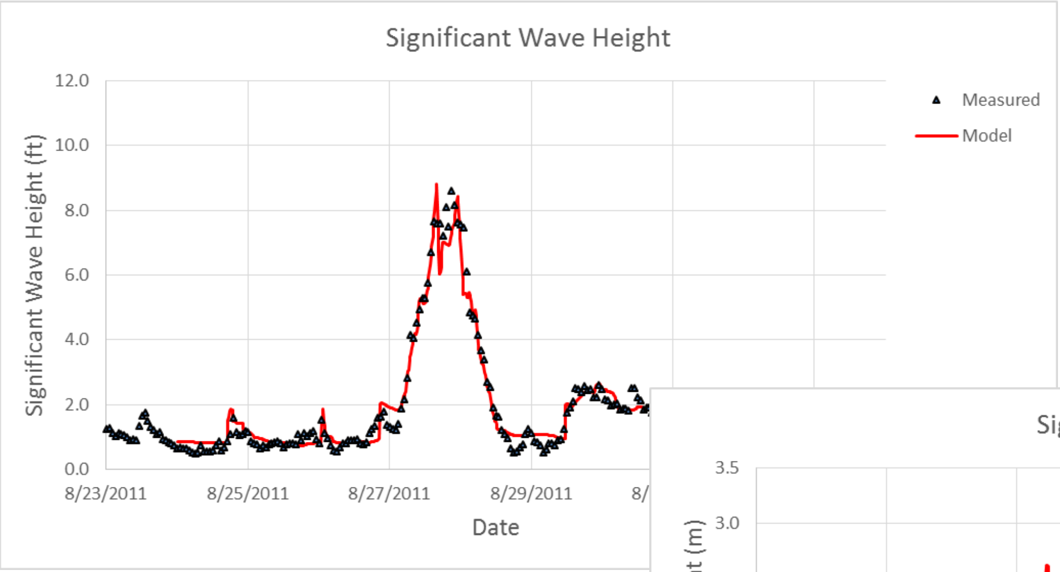
moffatt & nichol

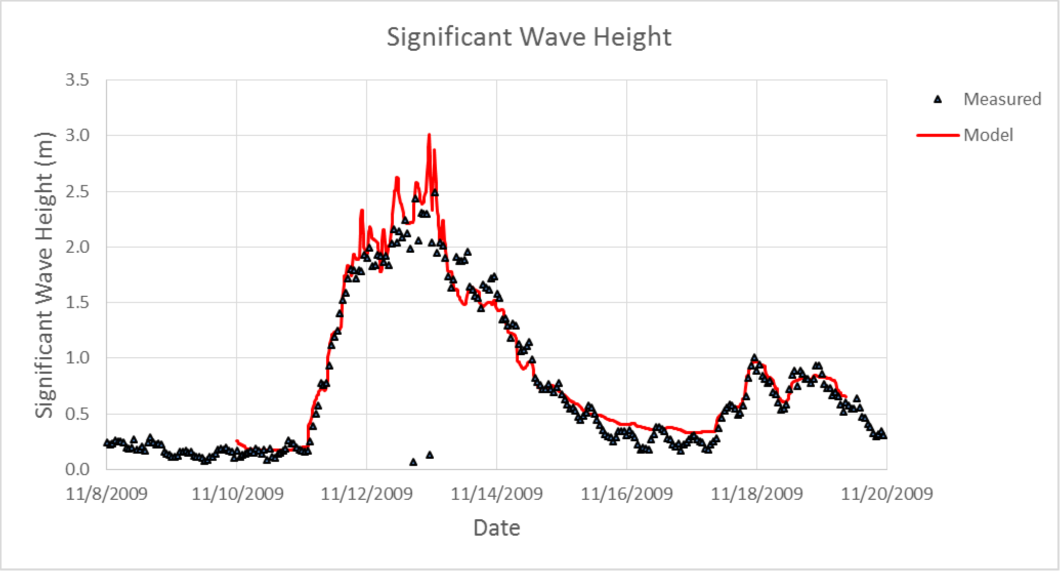
Spectral Wave Modeling

- MIKE 21 Spectral Wave Model

- Model resolution: 10 – 15 m
- Wave model calibration
- Long-term time series wave Transformation from offshore to nearshare area







City of Norfolk

moffatt & nichol

Shoreline/Morphological Modeling

1. The USACE GenCade one-line shoreline model
- Used to initially evaluate design alternatives
- 1D modeling limitation

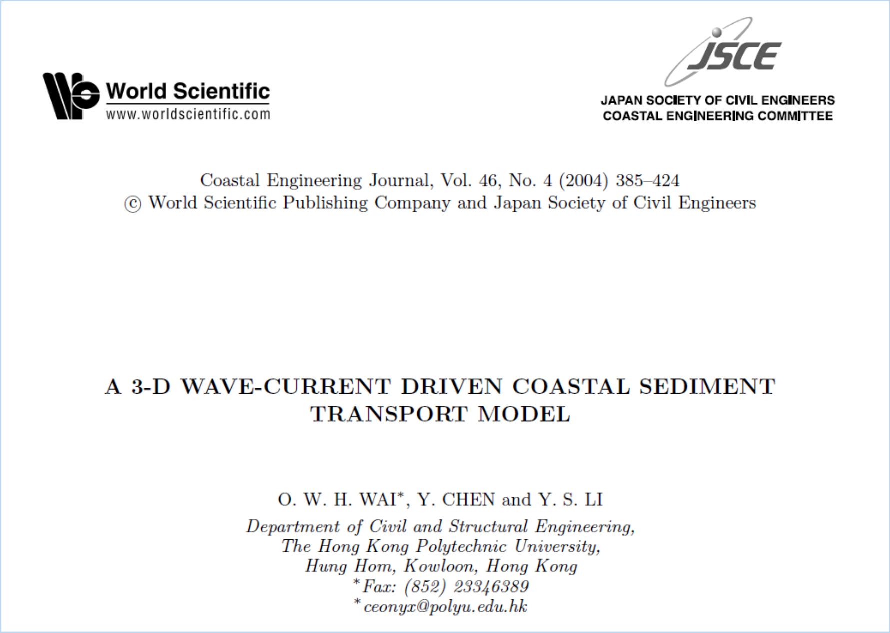
2. The 3DCSTM morphological model
(Q.W.H. Wai, Y. Chen and Y.S. Li, 2004, Coastal Engineering Journal)
- Used to study the alternatives in greater detail
- Support selection of the most preferred alternative
for construction

3. The Delft3D 3D morphological model
- Used as a check and confirmation of the performance
of the 3DCSTM model

Shoreline/Morphological Modeling

3D Coastal Sediment Transport Model (3DCSTM)

- Sponsored by the Hong Kong Research Grants Council (RGC), established in 1991 with the objective of building up research capability in Hong Kong, China
- Similar with Delft3D, USACE's CMS and DHI MIKE21
- The 3D model has been used for challenging coastal engineering projects in China and USA.
- Updated to flexible mesh system
- Detailed wetting and drying technique
- Efficient for monthly and/or yearly long-term time-series coastal morphological simulation using a PC.
- Challenging projects? Inlet sediment management, beach nourishment project, preliminary jetty design, preliminary breakwater deign, channel and basin siltation study



World Scientific
www.worldscientific.com

JSCE
JAPAN SOCIETY OF CIVIL ENGINEERS
COASTAL ENGINEERING COMMITTEE

Coastal Engineering Journal, Vol. 46, No. 4 (2004) 385–424
© World Scientific Publishing Company and Japan Society of Civil Engineers

A 3-D WAVE-CURRENT DRIVEN COASTAL SEDIMENT TRANSPORT MODEL

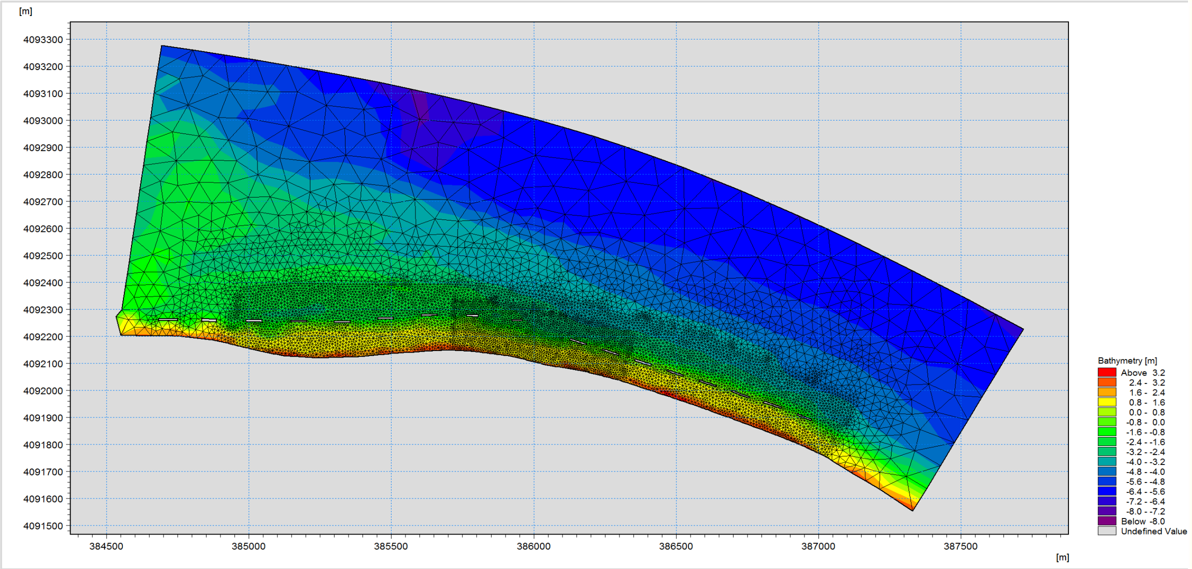
O. W. H. WAI*, Y. CHEN and Y. S. LI

Department of Civil and Structural Engineering,
The Hong Kong Polytechnic University,
Hung Hom, Kowloon, Hong Kong
**Fax: (852) 23346389*
**ceonyx@polyu.edu.hk*

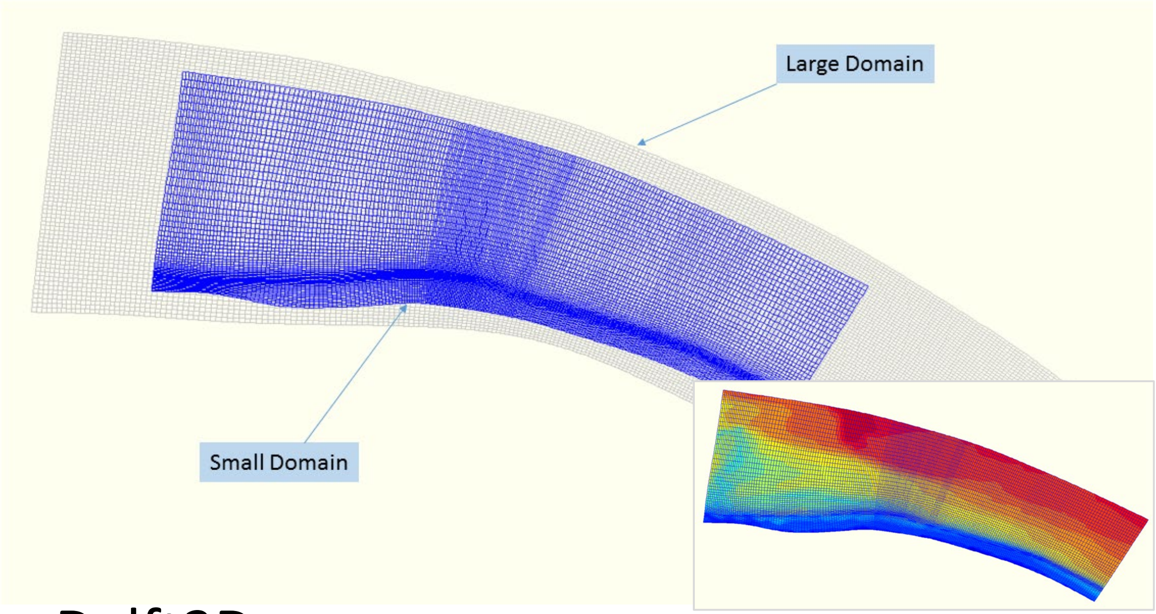
City of Norfolk

moffatt & nichol

Shoreline/Morphological Modeling - Calibration



3DCSTM



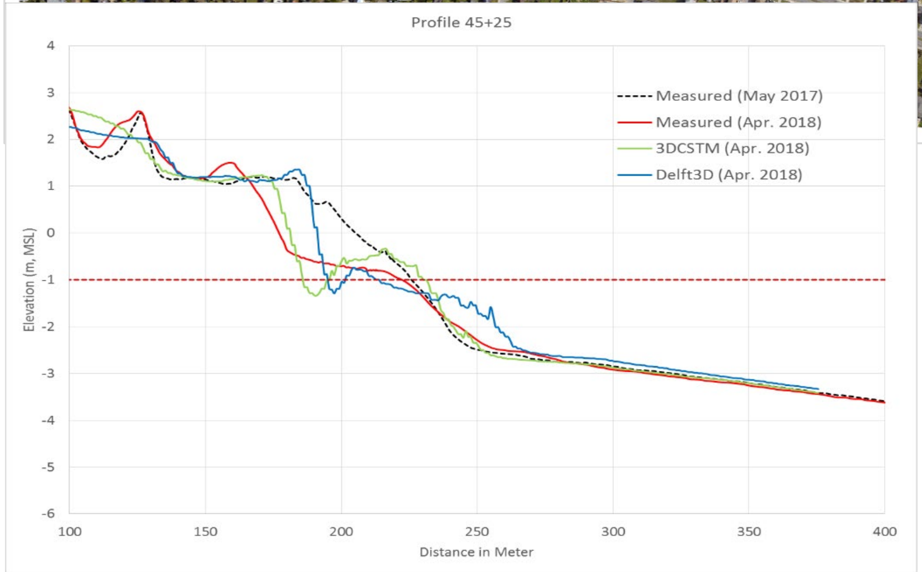
Delft3D

- 1D GenCade shoreline model, no production runs
- 3DCSTM and Delft3D Model resolution: 10 – 15 m
- Vertical layer: 5 layers
- Model computational time: 20 hr for 1-year simulation

City of Norfolk

moffatt & nichol

Shoreline/Morphological Modeling - Calibration



- Model calibration and validation

- Result difference between Delft3D model and 3DCSTM model

City of Norfolk

moffatt & nichol

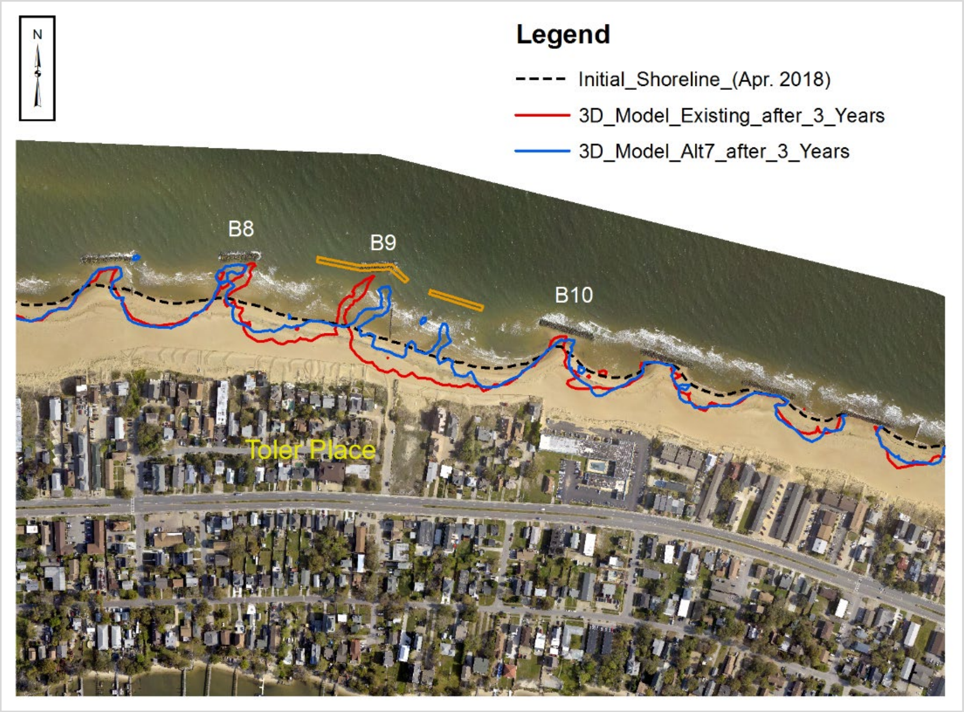
Shoreline/Morphological Modeling - Alternatives

7 alternatives for 1-year time-series simulation

- Breakwater length
- Gap width
- Shoreline/beach response to the breakwater modifications

Shoreline/Morphological Modeling - Alternatives

Alternative 7: after 1 year
with and without additional breakwaters



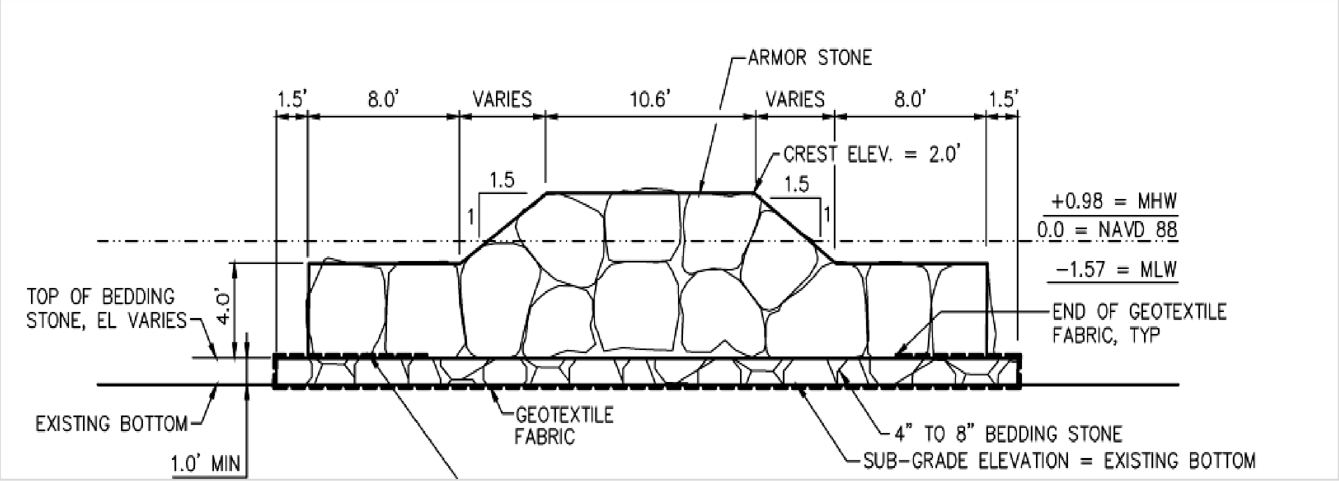
Alternative 7: after 3 years
with and without additional breakwaters

Offshore Breakwater Design and Permitting

The breakwater modification project was reviewed and permitted by

- Virginia Marine Resources Commission (VMRC)
- USACE Norfolk District

The construction is scheduled for Spring 2020



Typical offshore breakwater construction profile

City of Norfolk

moffatt & nichol

moffatt & nichol

Creative People, Practical Solutions.®

THANK YOU!

moffattnichol.com