ICCE 2018
36TH INTERNATIONAL CONFERENCE ON COASTAL ENGINEERING 2018
Baltimore, Maryland | July 30 – August 3, 2018
*The State of the Art and Science of Coastal Engineering*

# Analysis of High Frequency Breaking Waves and Low Frequency Surges Generated in Harbors due to Passage of Deep-Draft Tankers

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PORT CORPUS CHRISTI™

# Passing Tanker Induced Waves in Narrow Channels

# PRESENTATION OUTLINE

## 1
**Project Background**
- Site Location
- Problem Understanding

## 2
**Ship Hydrodynamic Modeling**
- Model Background and Development

## 3
**Existing Conditions**
- Existing hydrodynamics

## 4
**Alternatives**
- Development
- Analysis

## 5
**Conclusions**

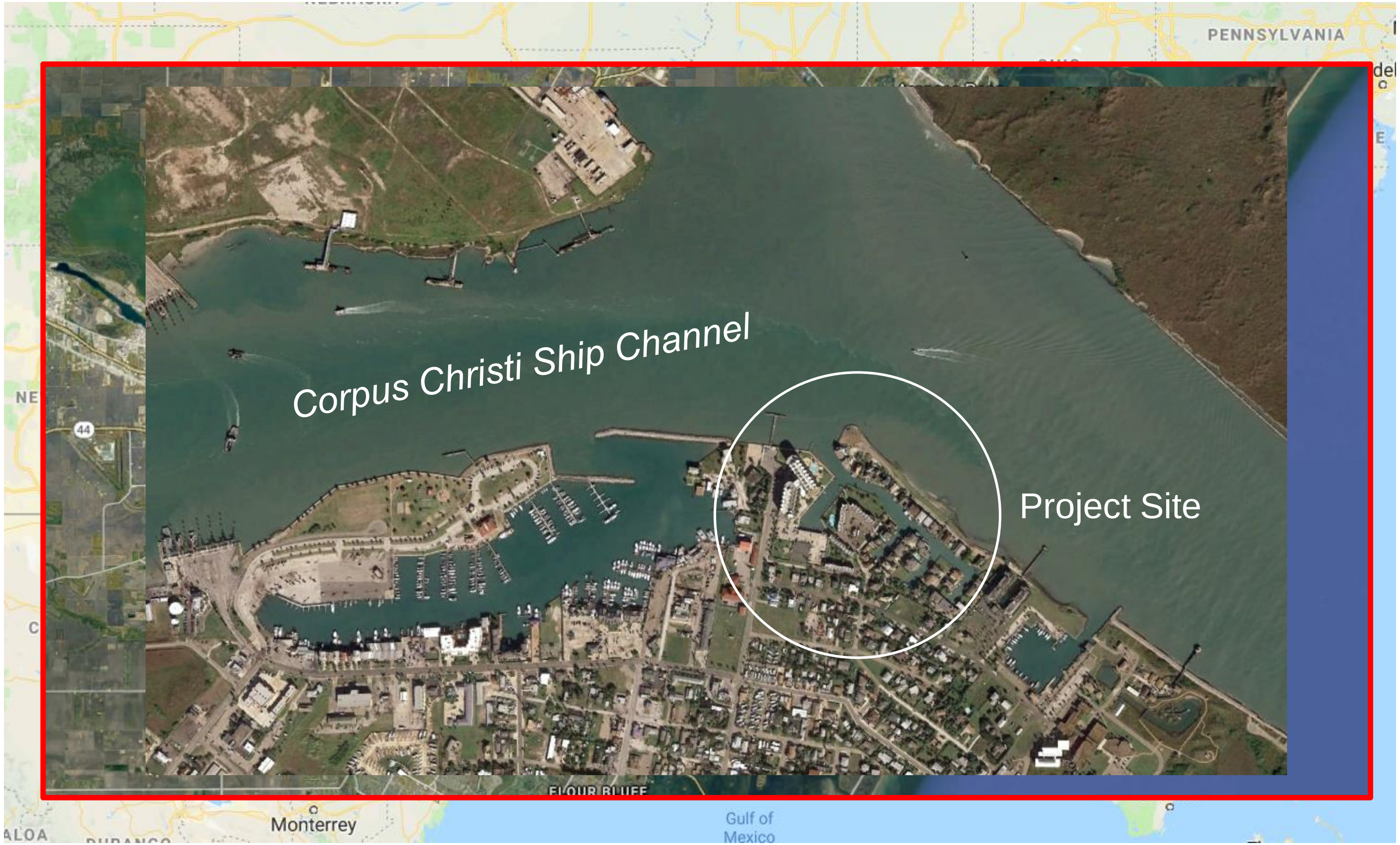
# PRESENTATION OUTLINE

1

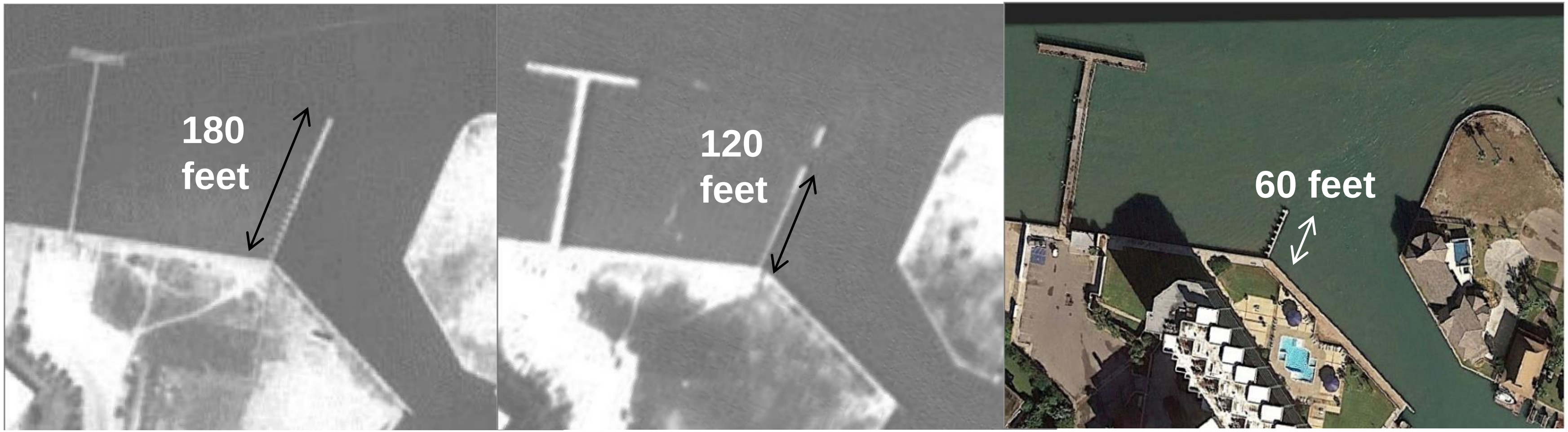
**Project Background**

- Site Location
- Problem Understanding

# Project Location



# Project Site History




1976
Originally constructed in 1976, rapid deterioration within a few years

1980
Gradual deterioration in the 80s -90s

2014
2003 to present relatively stable

# Problem understanding

1 Ship-induced wave energy enters the harbor, causes damage, disrupts operations.

2 Ship wave penetration is caused by heavily laden ships moving outbound.

3 Ship wave penetration supposedly more problematic in recent times than it was in the past.

4 Breakwater deterioration is a likely contributor to increased ship wave penetration.

# Problem


# Problem


# Project Objectives

1. Evaluate the mechanisms by which deep-draft ship waves enter the harbor.

2. Quantify the level of protection provided by the past and present entrance breakwater configurations.

3. Develop conceptual alternatives for improving conditions in the interior of the basin.

4. Develop conceptual-level cost estimates for engineering design, permitting and construction.

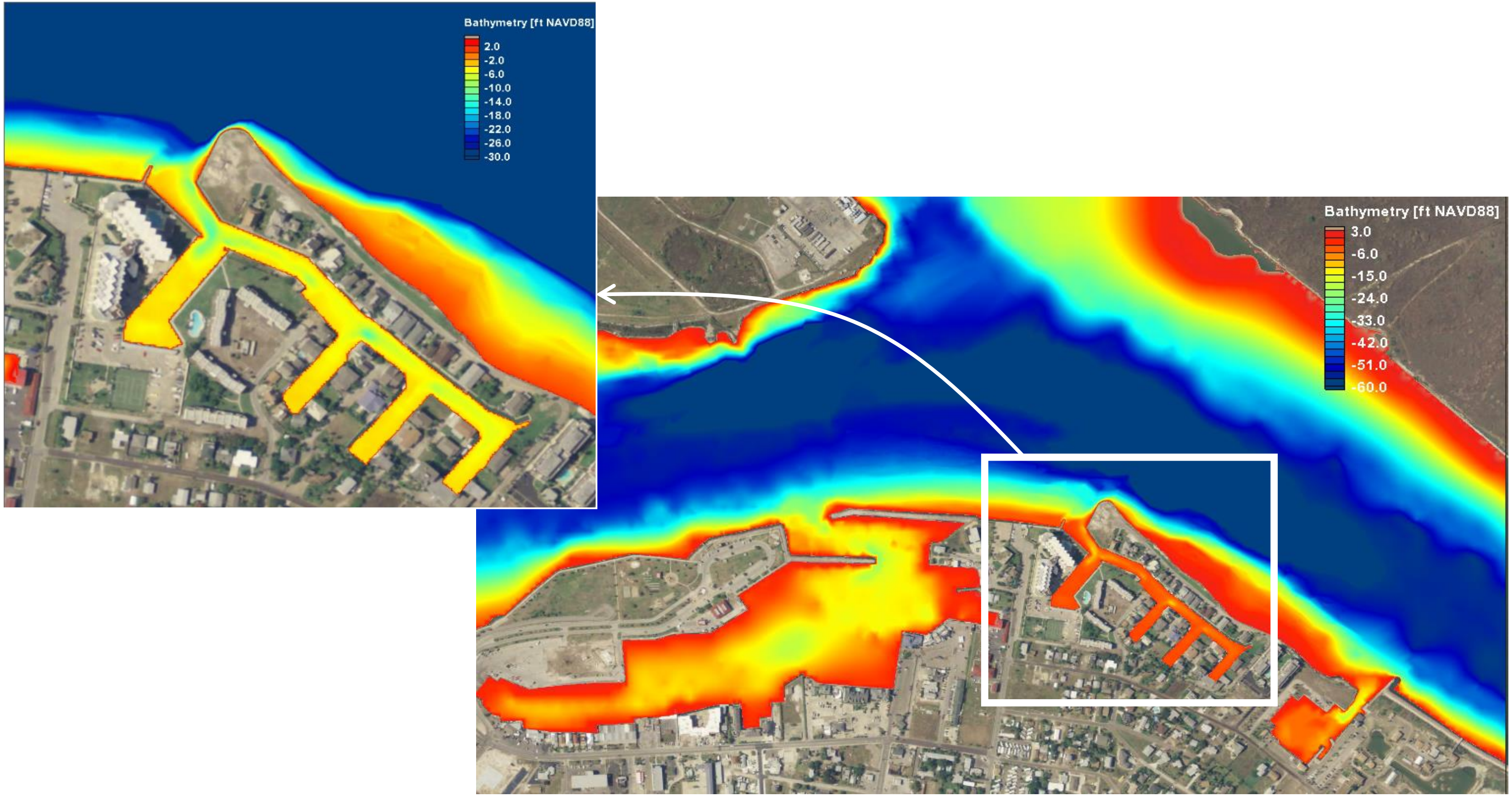
# PRESENTATION OUTLINE

2

**Ship Hydrodynamic Modeling**

- Model Background and Development

# Modeling Domain



# Design Vessel

**TYPE**
Tanker

**LENGTH**
900 ft.

**BEAM**
157 ft.

**DRAFT**
45 ft.

# PRESENTATION OUTLINE

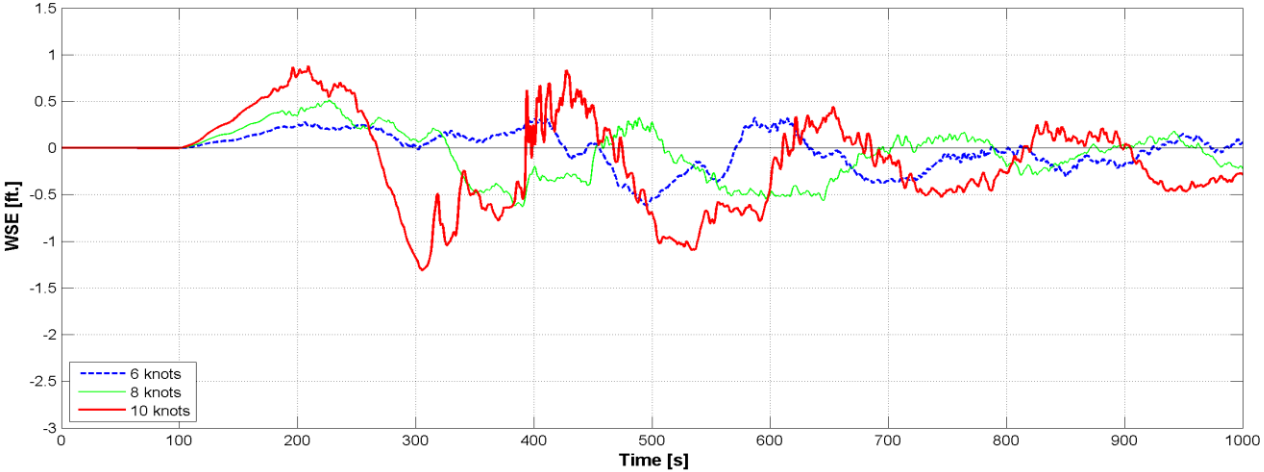
3

**Existing Conditions**

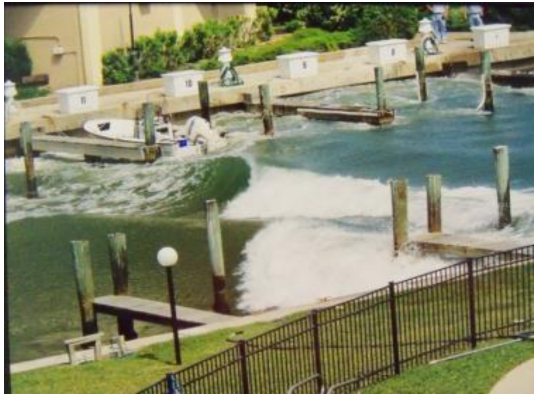
- Existing hydrodynamics

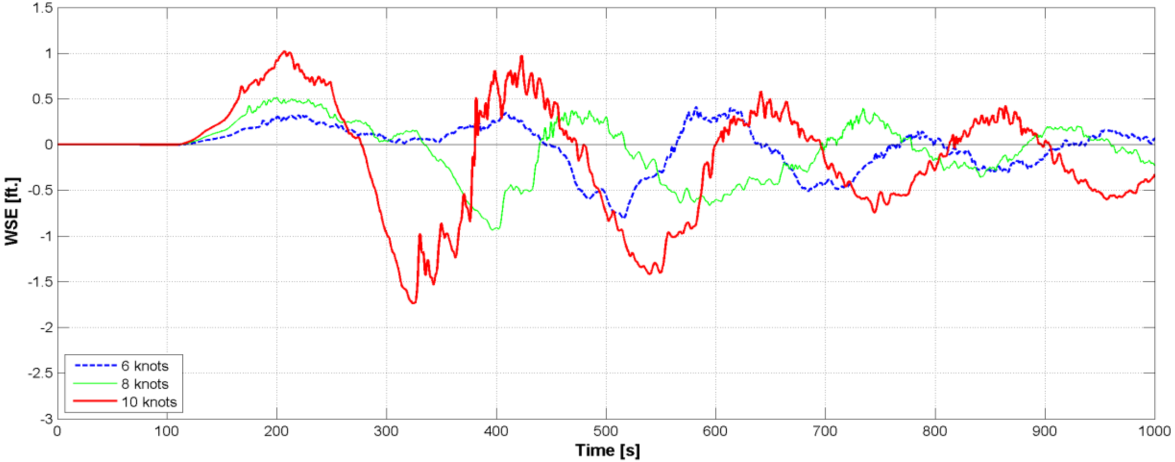
# Existing Conditions (WSE)

# Existing Conditions (WSE time series)

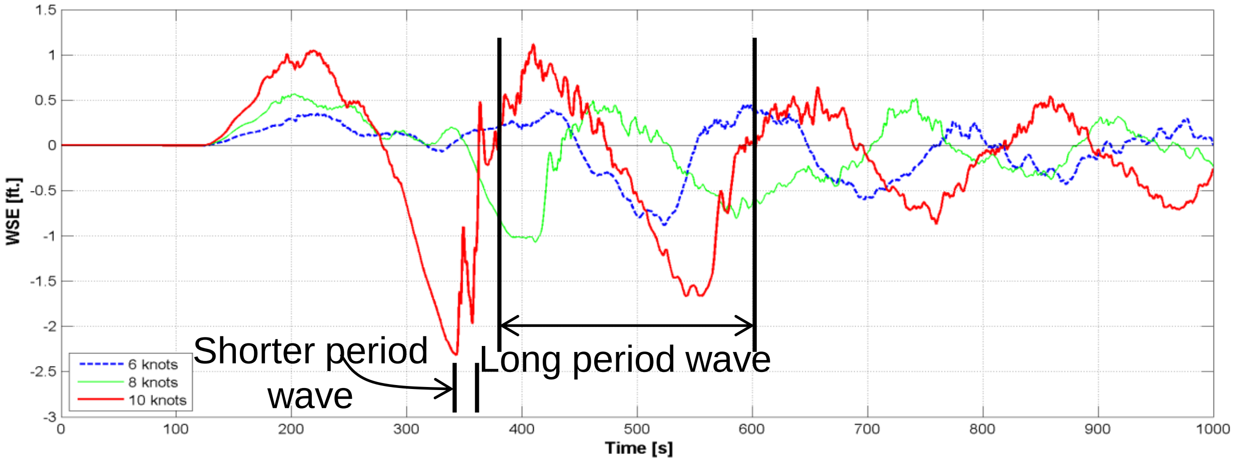



# Existing Conditions (WSE time series)

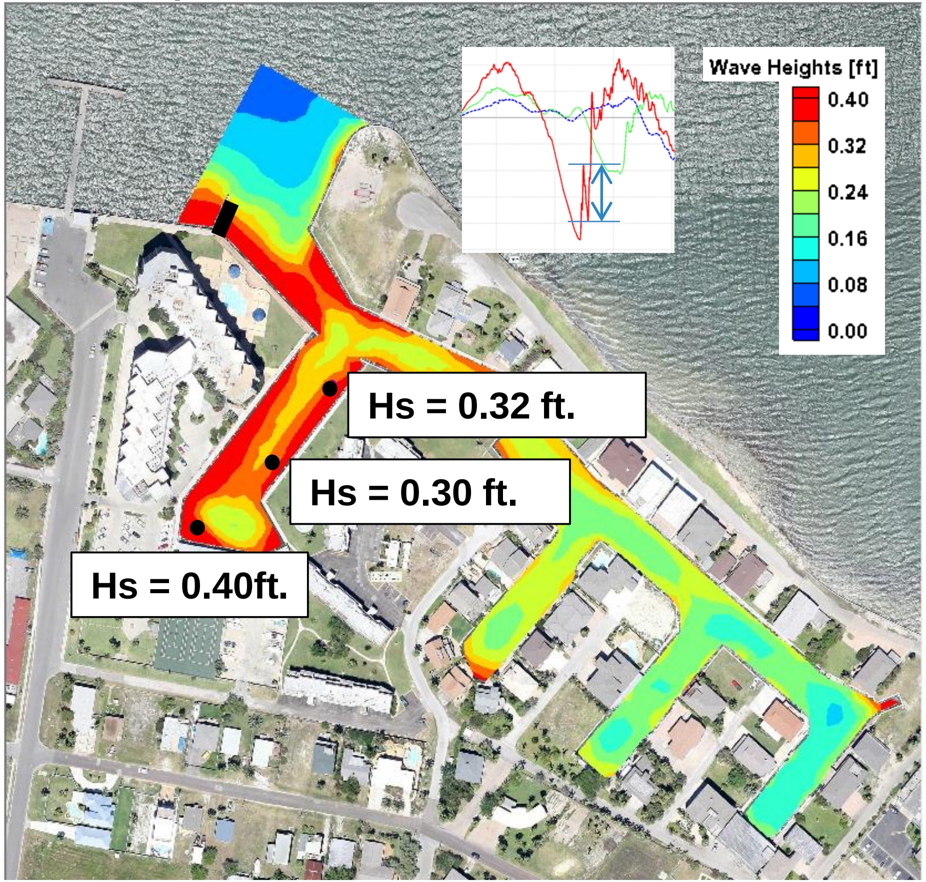





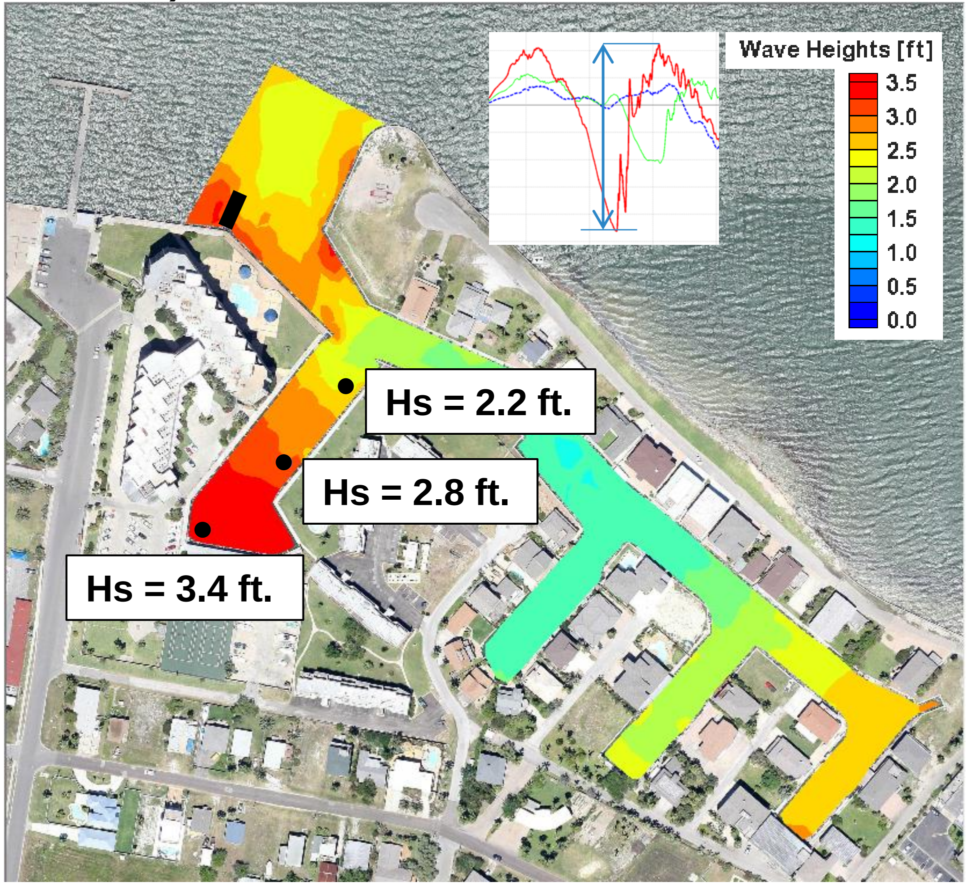
# Existing Conditions (WSE time series)

# Breaking (Short Period) Waves



# Surge (Long Period) Waves



# Existing Conditions Summary

### Qualitative Representation

Results qualitatively replicate observed conditions

### Vessel Speed

Pressure field effects significantly worse at higher speeds

### Pressure Field Components

Two components of the pressure field energy are present in the harbor

### Harbor Configuration

Harbor mouth configuration generates/allows in the higher-frequency component, i.e. visible surface breaking waves at higher speeds

### Alternatives

Breaking waves likely more damaging, however alternatives evaluated for their effect on both shorter and longer wave components

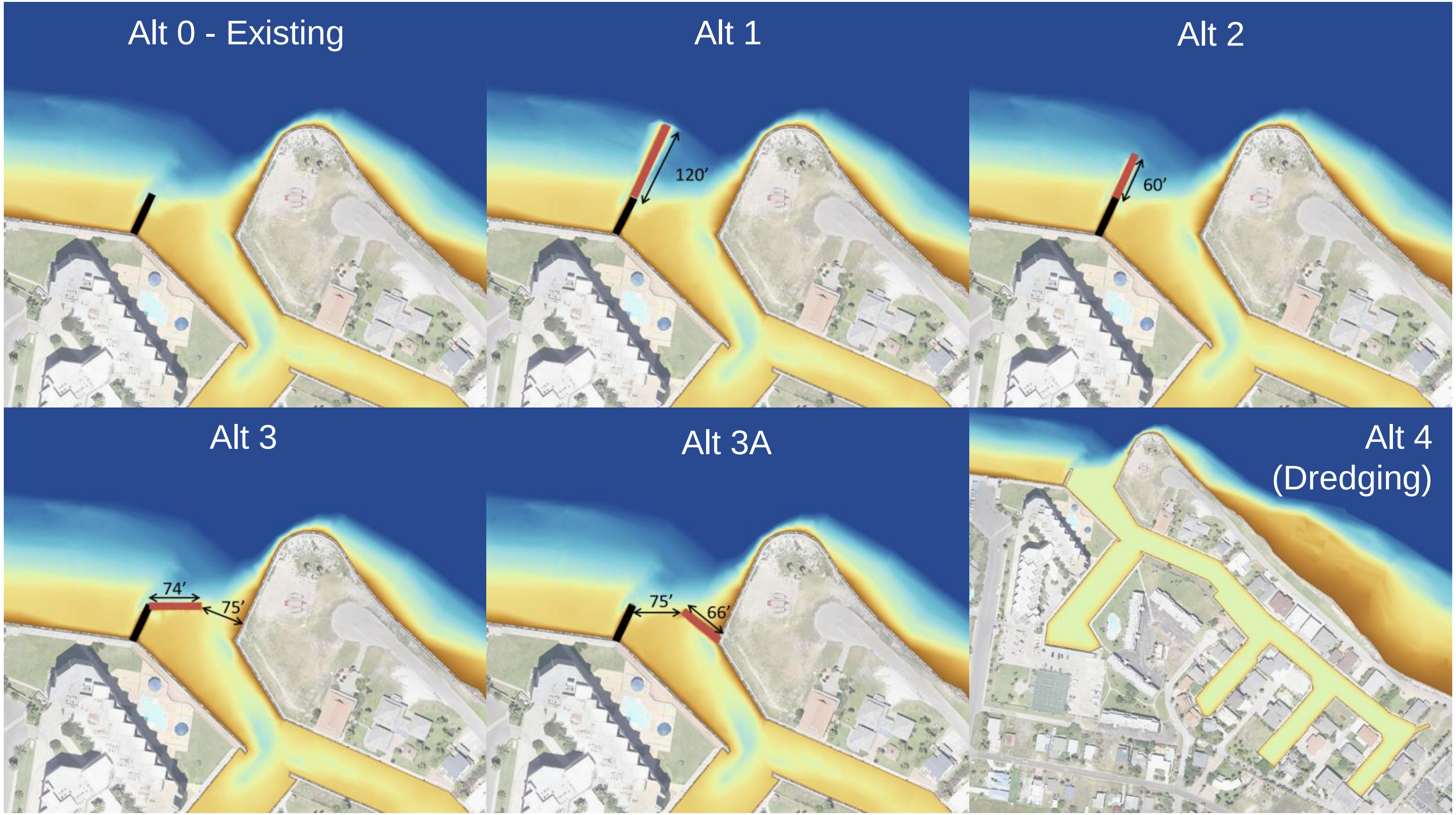
# PRESENTATION OUTLINE

4

**Alternatives**

- Development
- Analysis

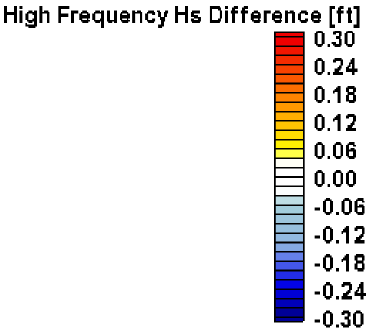
# Alternatives



# Breaking (Short Period) Wave Height Reductions

Straight and angled breakwaters most effective against breaking waves across entire marina.

Dredging alternatives reduce breaking wave heights first leg of marina, increases wave heights in inner regions of marina.

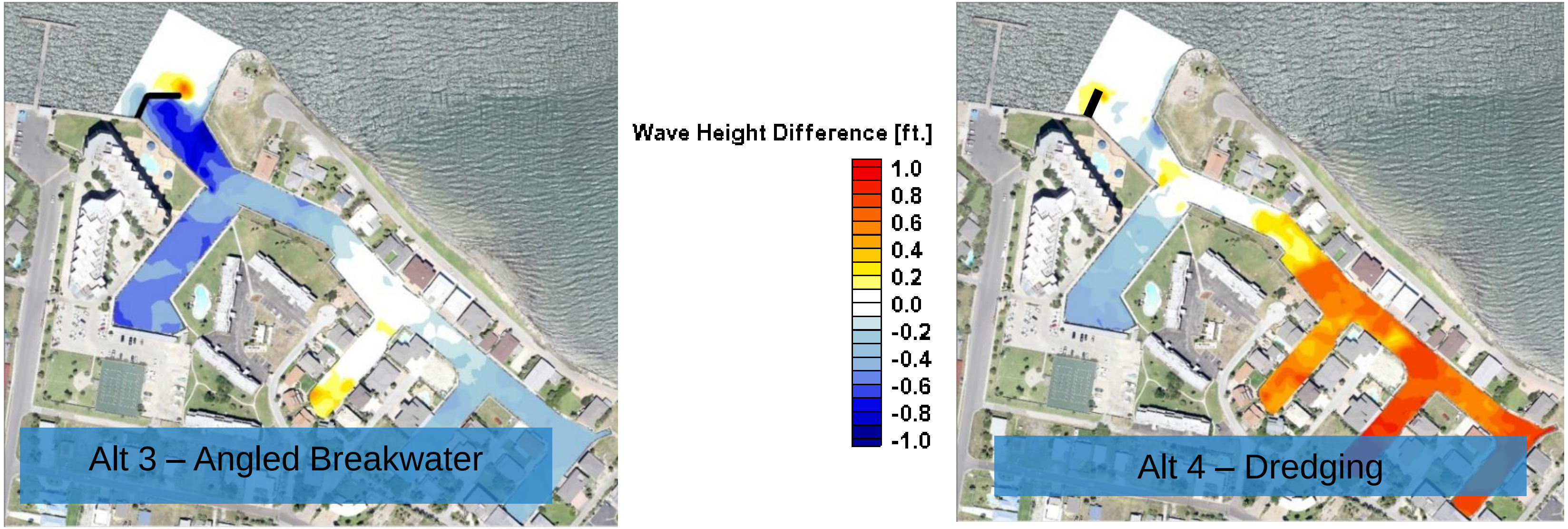




# Surge (Long Period) Wave Height Reductions

Angled breakwater alternatives (narrower entrances) most successful in reducing long-period surge wave heights.

Dredging alternatives resulted in higher surge height in inner areas of marina.

Straight breakwater alternatives resulted in little to no change in surge heights.



# Alternatives Performance Summary

### Breaking Waves

Long straight breakwater and angled west breakwater are most effective at reducing breaking waves in marina, as they are on the west side from which pressure fields approach.

### Surge Waves

Straight breakwater alternatives (i.e. same entrance width) do not reduce long-period water level fluctuations, since those fluctuations depend mostly on cross-sectional area at the entrance.

### Narrow Entrance

Narrower entrances improve conditions inside entire marina significantly, but create potential navigation safety concerns.

### Dredging

Dredging improves conditions in certain locations, worsens in other locations.

# PRESENTATION OUTLINE

5

**Conclusions**

# Conclusions

1 Ship hydrodynamic modeling qualitatively reproduces both complex wave systems in harbor.

2 Entrance breakwater changes are recommended as first priority.

3 Dredging purely for the sake of wave penetration reduction should be done selectively to avoid negative effects farther inside the marina.

4 Project currently under final design and construction process.

# THANK YOU! QUESTIONS?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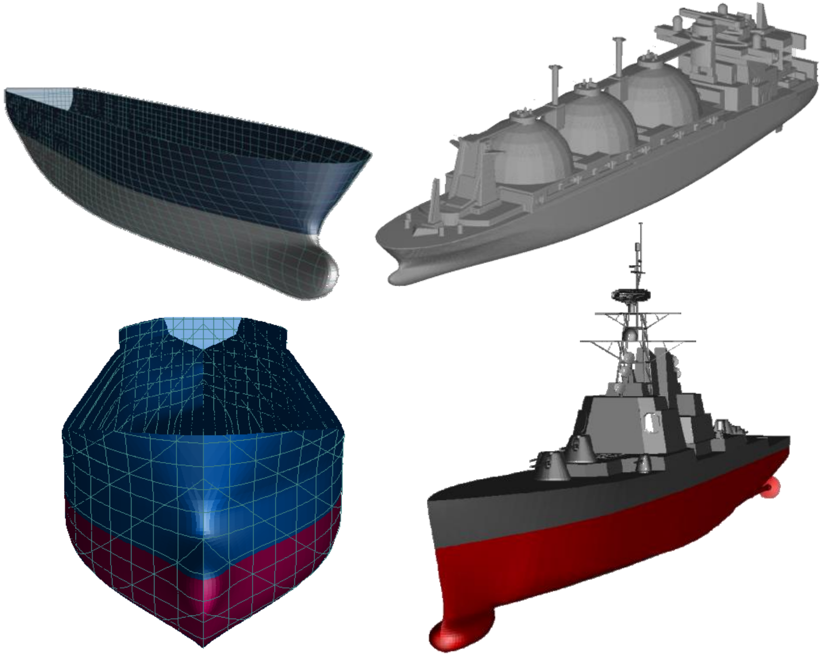
# Ship Hydrodynamic Modeling

Hydrodynamic model generated from coastal processes modeling system

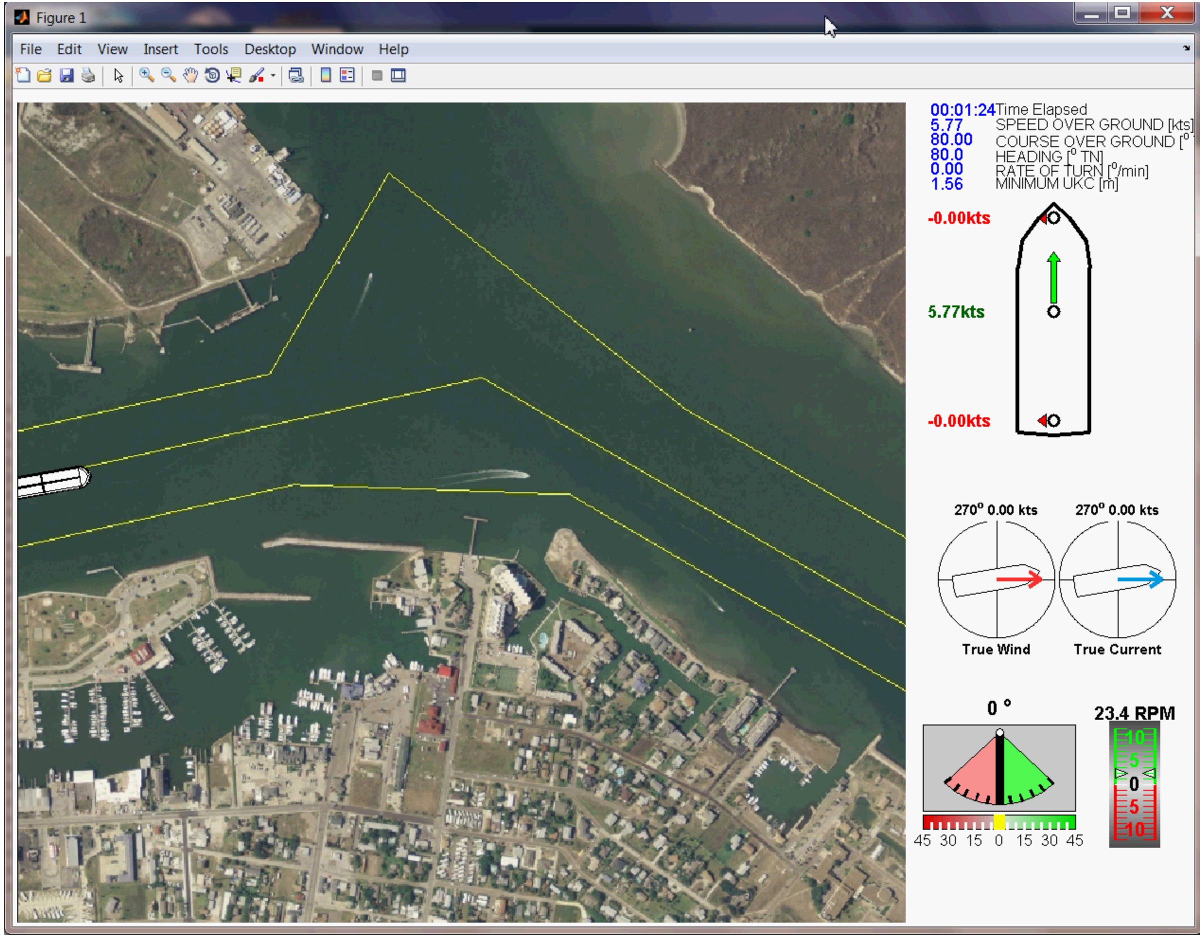
Incorporates ambient currents, waves, winds, tides.

Expanded to include multiple moving/berthed vessels (unlimited), complex maneuvering.

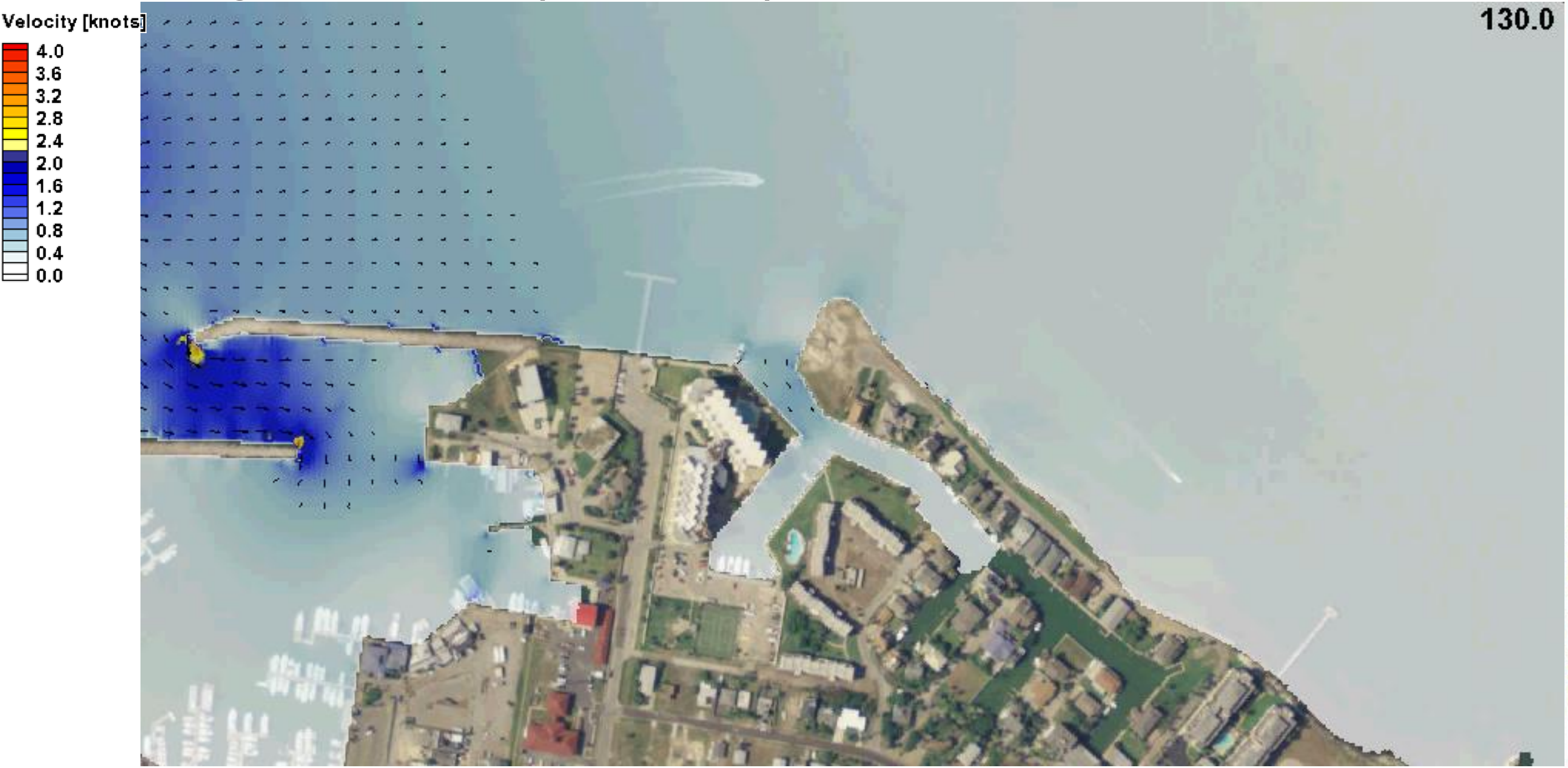
More Details
Frank Salcedo's presentation @ 11:20 – Dover Room



# MANEUVERING



# Existing Conditions (Velocities)



# Maximum Current Velocities