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## Coastal Resilience in Industrial Environments

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# CLARK NEXSEN

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## COASTAL RESILIENCE IN INDUSTRIAL ENVIROMENTS

David Pryor, P.E. and Kate Chaney, GISP

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# INDUSTRIAL ENVIRONMENTS



SHIPYARDS



PORTS



MILITARY



INDUSTRIAL

# INDUSTRIAL ENVIRONMENTS



## Impact of Coastal Flooding, SLR and Waves

- Interruption of Normal Operations
- Threat to Assets
  - Personnel
  - Product
  - Machinery and Vehicles
  - Buildings
- Interruption of Utilities
- Interruption of Supply Chain



# INDUSTRIAL ENVIRONMENTS



## Industrial Environment Coastal Resilience Requirements

- Easily Deployed and Recovered
- Fits Business Plan
- Minimal Impact to Normal Operations

## Industrial Environment Assets

- Manpower
- Heavy Vehicles & Material Handling Equipment
- Storage Space
- Autonomy



# INDUSTRIAL ENVIRONMENTS



## Common Solutions

- Retreat – Moving assets away from the risk areas
- Elevation – Raising structures above expected water levels
- Hard Defense – Structures to hold back coastal flooding
- Policy Changes – Planning and procedures of infrastructure and assets placed in the risk area

## Industrial Application

**Limited Opportunities**

**Limited Opportunities**

**Potential**

**Potential**

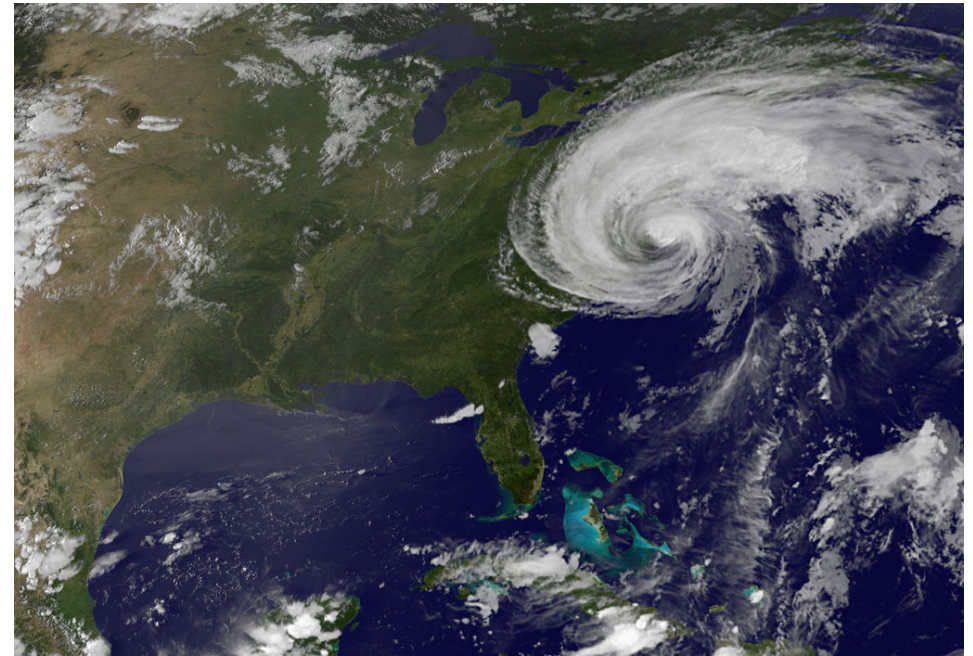
# SHIPYARDS



Hurricane Irene prompted Newport News Shipbuilding to investigate its vulnerability and resilience option to coastal flooding in a two step process

1. Hindcast study of coastal flooding which includes Sea Level Rise
2. Investigation of resilience options balancing risk with cost of implementation

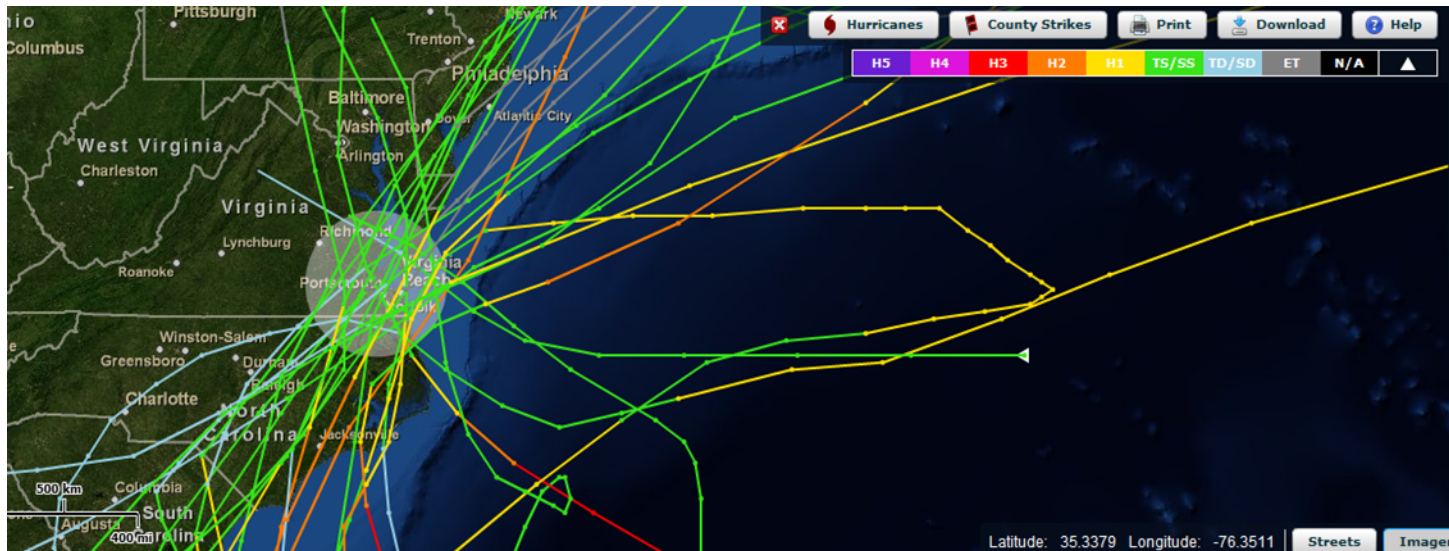
Credit Halcrow, a CH2M Company, 2011



# SHIPYARDS

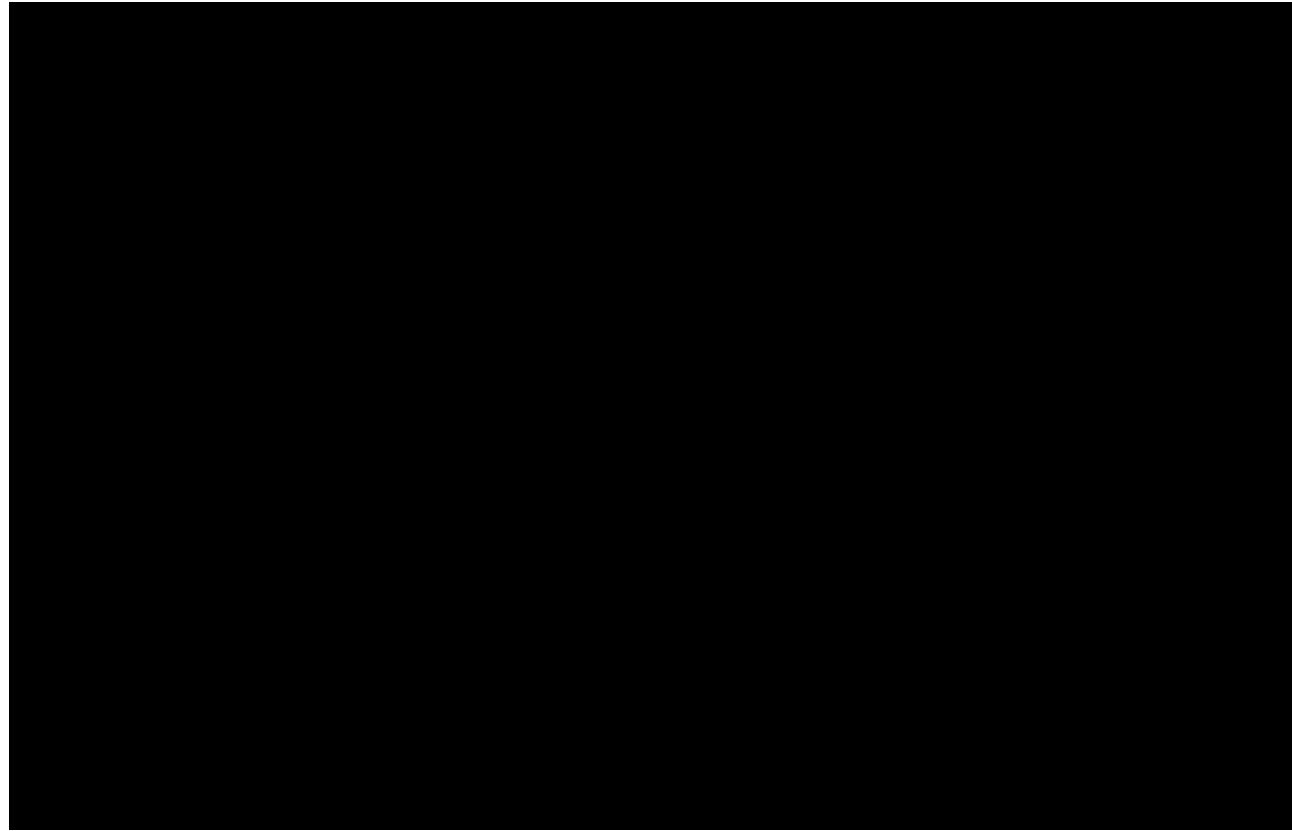


- 51 Hurricanes in 111 years produced 4 Coast-Normal hurricanes in Hampton Roads
- Methodology of Study using Mike 21 FM HD and Cyclone Wind Generator
  - Model Offshore Bathymetry from Atlantic Ocean to NNS
  - Model Boundary Conditions
  - Wind Field Generation
  - Surge Modelling and Calibration

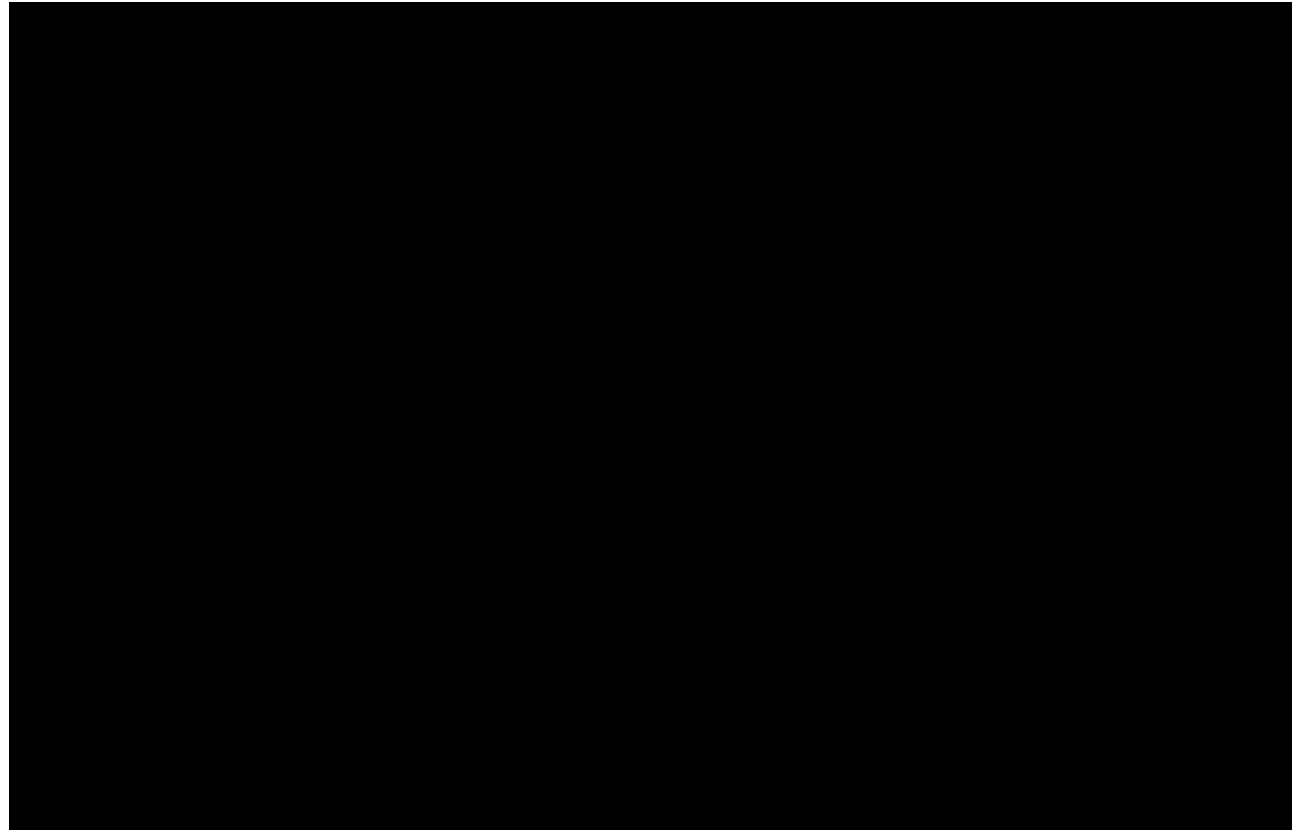




# SHIPYARDS



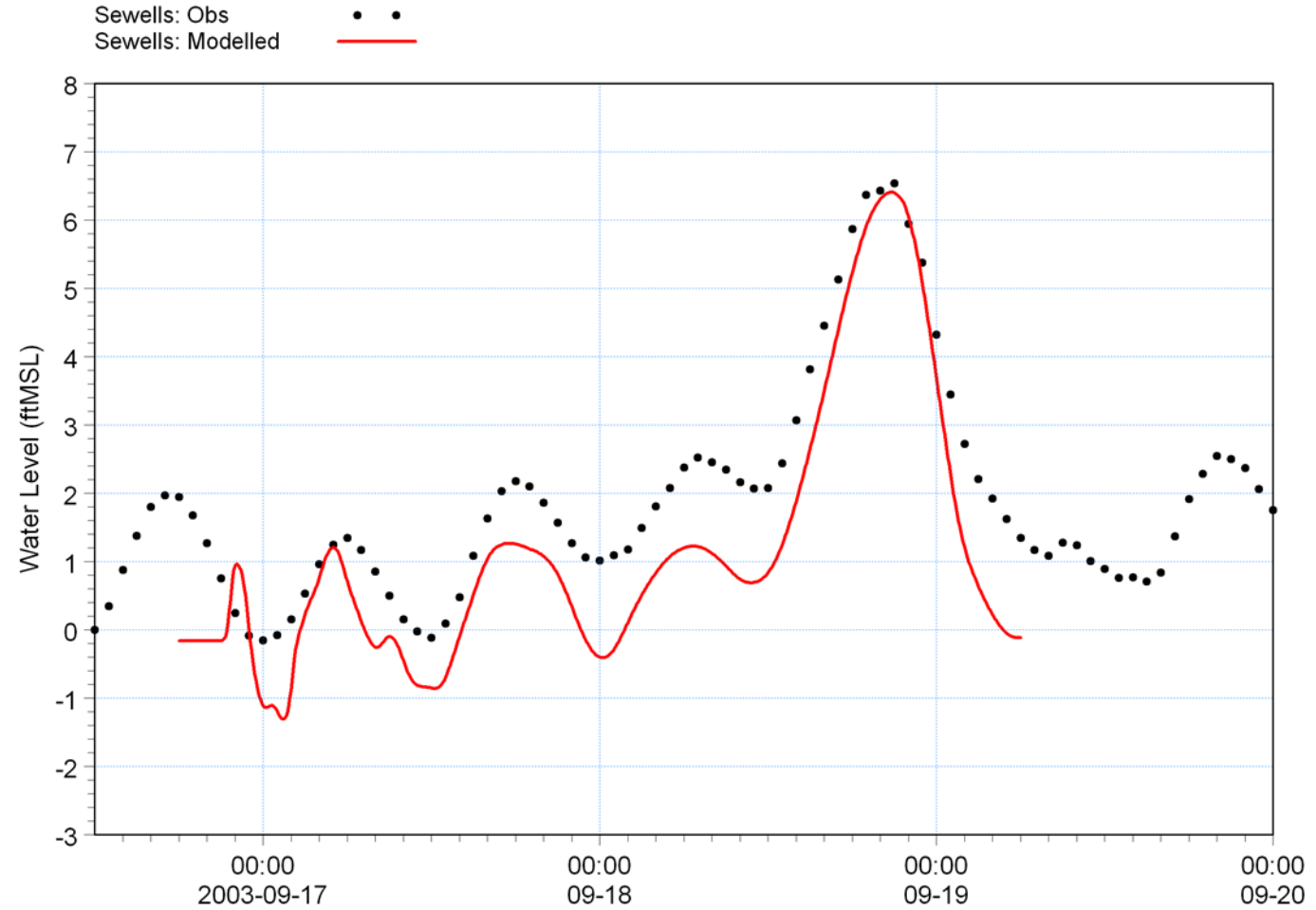
# SHIPYARDS





## Calibration of Hurricane Isabel

- Model versus observed water level at Sewells Point Station





## Resilience Options

- Hard Defenses
- Policy Changes

## Three Barrier Classifications

**Temporary** – Removable flood protection devices that are wholly installed immediately prior to a flood event and completely removed after flood levels have subsided

**Demountable** – A moveable flood protection device that is partially pre-installed and requires some operation or installation prior to and after a flood event

**Fixed** – A flood protection device that is fully installed prior to a flood event and does not require operation.

# SHIPYARDS



## Water Filled Tube

### Advantages:

- Quick and easy to install
- Relatively small storage space required
- Installation only requires a small team and mobile pumps
- Tears can usually be repaired in service
- Reusable

### Disadvantages:

- High width-to-height ratio is restrictive for larger tubes
- Highly susceptible to vandalism or damage by sharp objects
- Major tears or punctures can lead to failure of the whole system
- Require relatively flat surfaces
- Difficulty in expelling all water from tube following use can lead to deterioration
- water freezing in tubes can lead to failure
- UV radiation can result in deterioration over time



# SHIPYARDS



## Rigid and Flexible Barriers

### Advantages:

- Quick and easy to install
- No equipment or machinery required for installation
- Small storage space required
- Easily transportable in cars and small pick-up trucks
- Low bearing pressure on bedding surface
- Low mobilization, demobilization and clean-up requirements
- Easily cleaned and reusable

### Disadvantages:

- Susceptible to leakage at low water levels
- May twist or flap under heavy winds and current
- Susceptible to vandalism and accidental tear or puncture
- Membrane is susceptible to heavy winds (especially before flood peak)



# PORTS



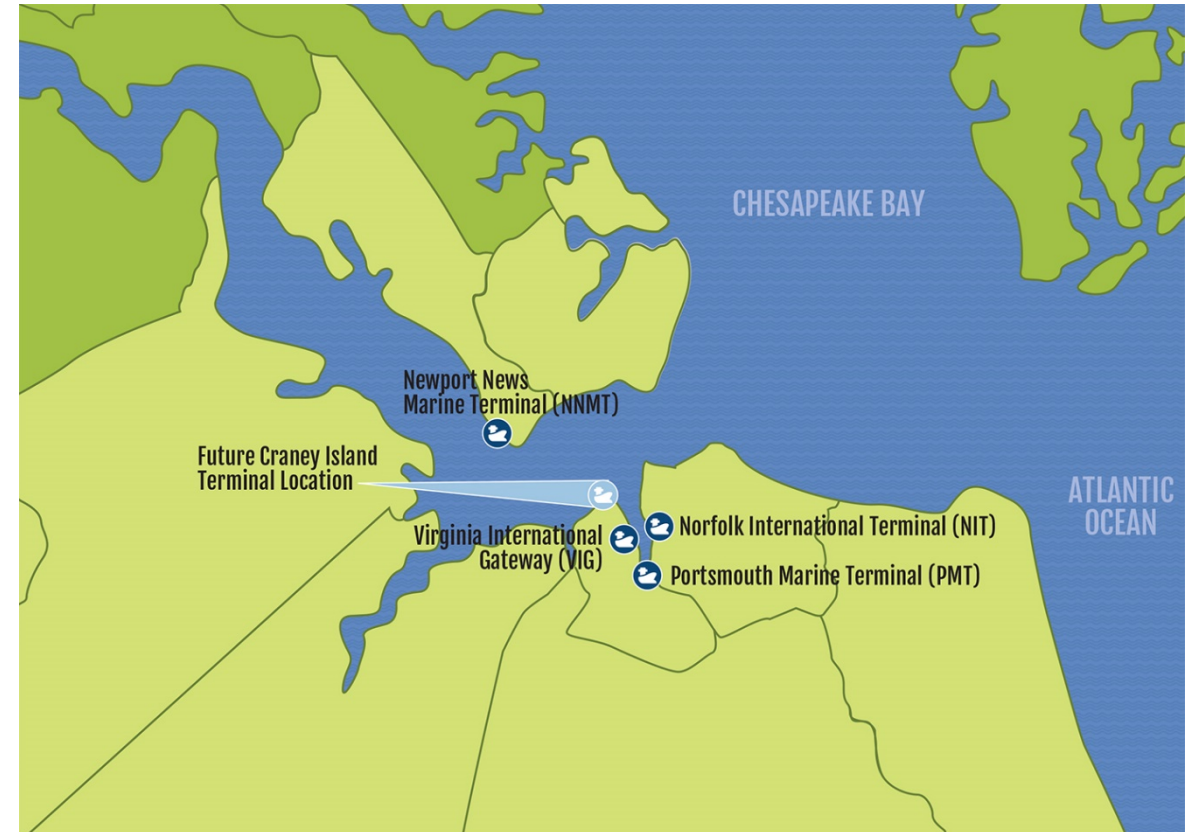
## Virginia Port Authority

### 4 Hampton Roads Terminals/2 Virginia Terminals:

- NIT 567 Acres, Container
- VIG, 291 Acres, Container
- PMT, 287 Acres, Container and leased use
- NNMT, 165 Acres, Mixed Use
- VIP, 161 Acres, Container
- RMT, 121 Acres, Mixed Use

### Issues:

- Millions to ensure resilience in all ports
- Revenue Generator for 1 in 10 in Virginia
- Multiple ports/multiple risks

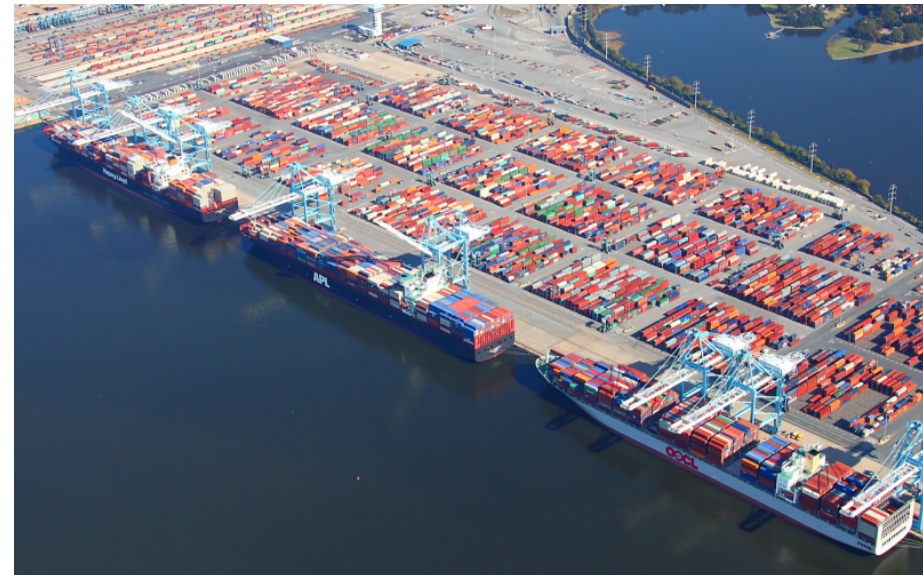


# PORTS



## Critical Infrastructure Mapping

- NIT and VIG
- Prioritize Maintenance and Engineering Actions
- Considers Sea Level Rise
- Risk Assessment Matrix
- 2017 Budgeted for Engineering and Maintenance actions
- PMT, RMT, NNMT & VIP are next





# PORTS



## Optimize NIT South

- Current Manual Straddle Carrier Operation
- Densification of containers
- VMASC Risk Assessment
- Climate Change and SLR considered



# PORTS



## North Carolina Port Authority

### Two Terminals:

- Wilmington and Moorehead City
- Mixed cargo ports
- 286 acres/276 acres

### Issues:

- Millions to ensure resilience in both ports
- Emergency Power available for critical assets
- Suffer through it/Damage Control



# NAVY FUEL TERMINAL

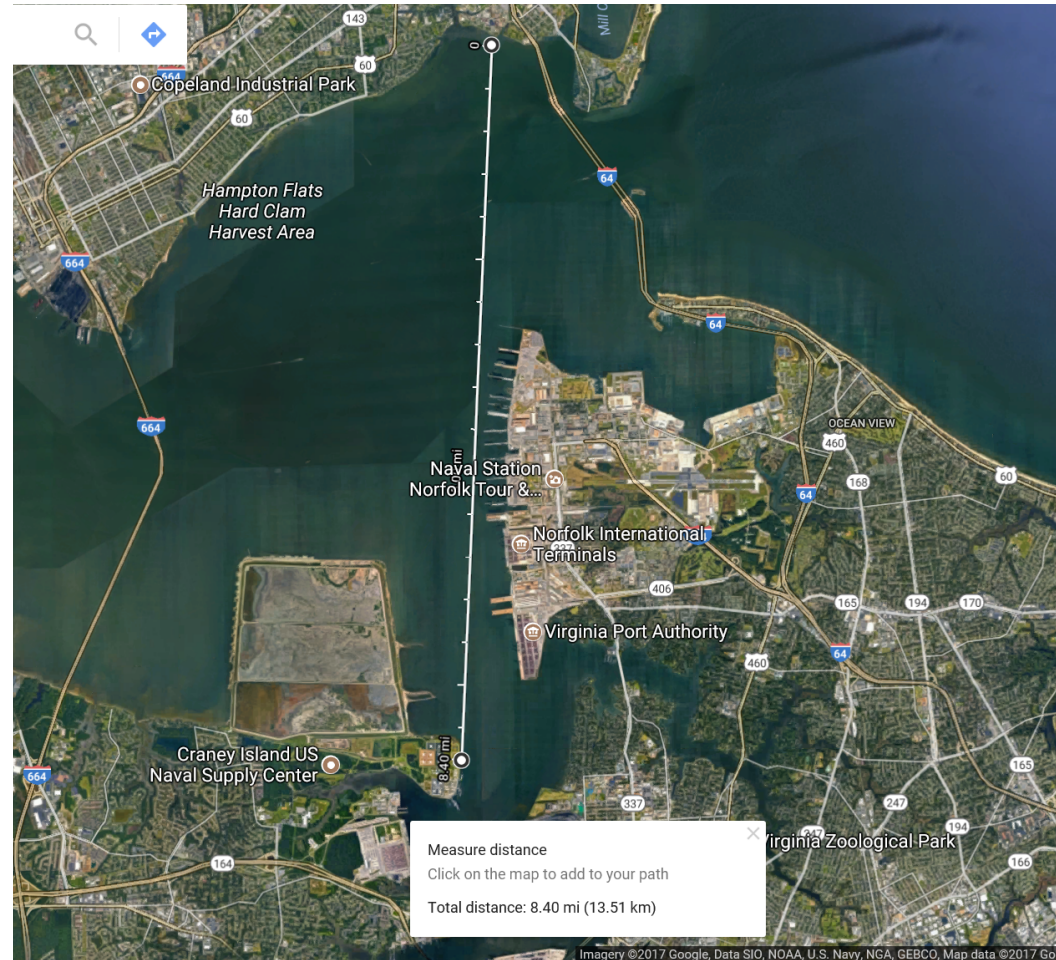


## Craney Island Fuel Terminal

- Key naval asset on the east coast
- Open to 8 mile fetch from Chesapeake Bay

### Actions:

- 2011 – Improved Shoreline Protection System
- Raised Pier D Elevation for Storm Surge and SLR
- Raised fuel farm tanks
- Raised SCADA equipment, transformers, switchgear



# Application of GIS for Risk Assessment and Planning

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- Kate Chaney, GISP

# Connecting the Industrial Environment with Spatial Technology



## Key Questions when using GIS

- **Ask** – What is the problem?

Responses during events, Preparedness, Continuity of Operations and Safety.

- **Acquire** – Find your data

Where are the assets; how critical are they to the facility and operations?

- **Examine** – Is your data appropriate?

Currency of the data; Accuracy and completeness / attribution to make decisions.

- **Analyze** – Tools and models. **Analysis is the core strength of GIS**

How to propose data driven thinking and decision making.

- **Act** – Share maps, reports, charts, and tables

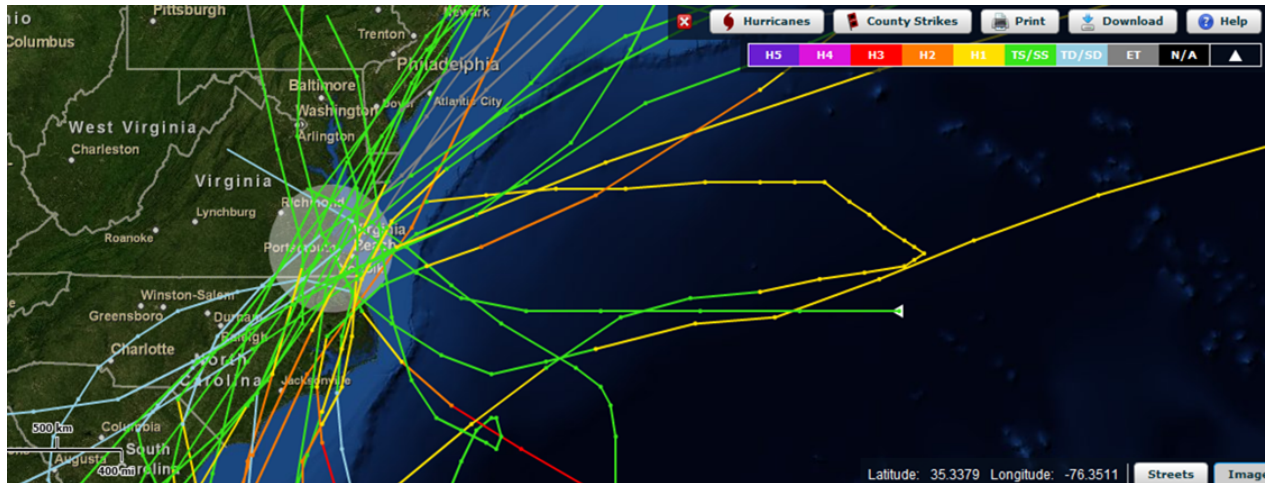
**Thinking spatially and big picture.**





# USING GIS FOR INDUSTRIAL ENVIRONMENT COASTAL RESILIENCE REQUIREMENTS

- Historical Events (Existing Data) & Other Lessons Learned (51 Hurricanes in 111 years produced 4 Coast-Normal hurricanes in Hampton Roads)



# INDUSTRIAL ENVIRONMENTS & HAZARD ZONES

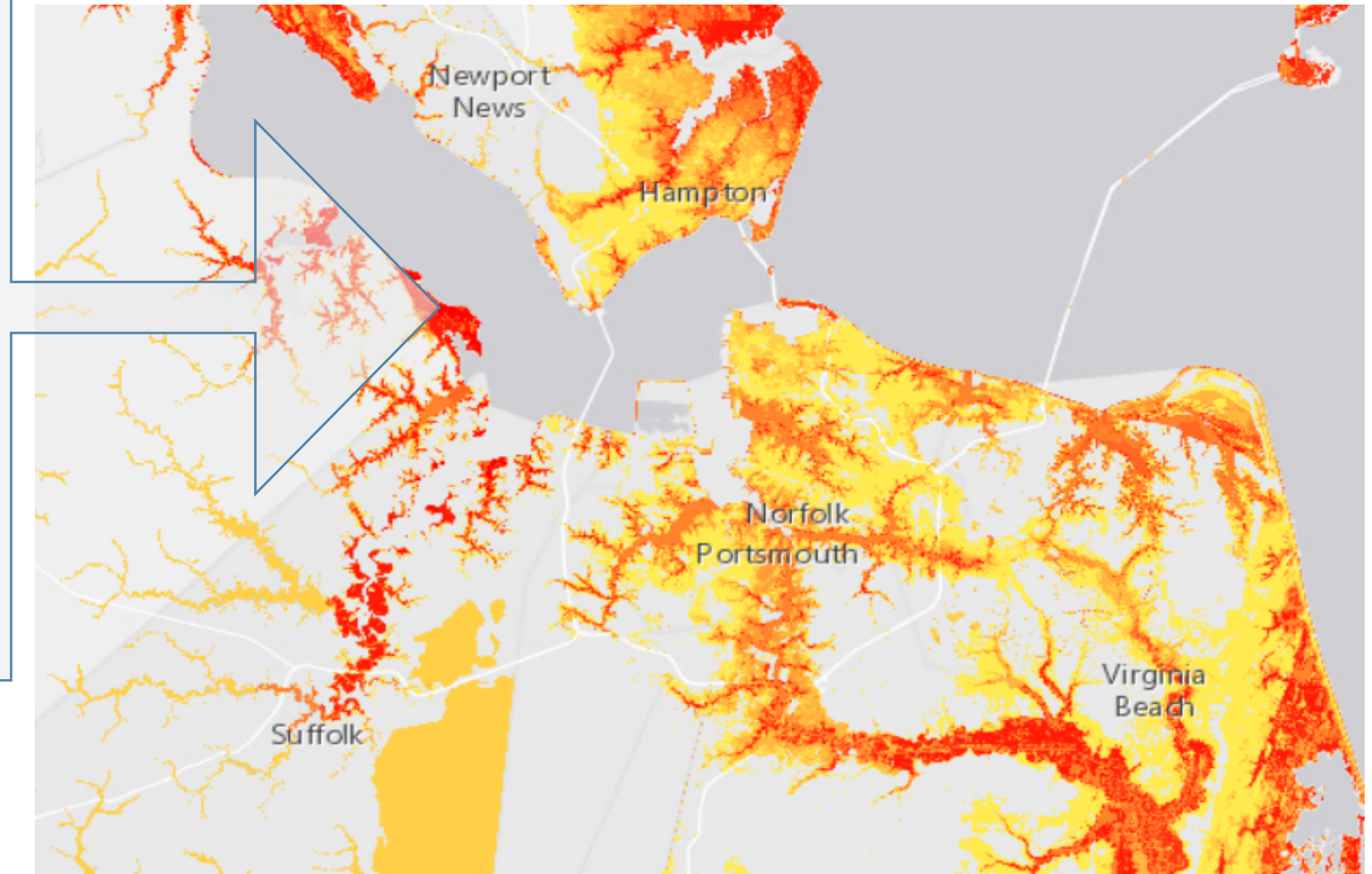


## Existing Data

### Hazard Zones:

- FEMA Zones (% annual chance): V zone (1%) & A zone (1%) & 0.2%
- Shallow Coastal Flooding (NWS flood thresholds)
- Sea Level Rise (Above MHHW): 1 ft & 2 ft & 3 ft

**Number of Hazards: 7**

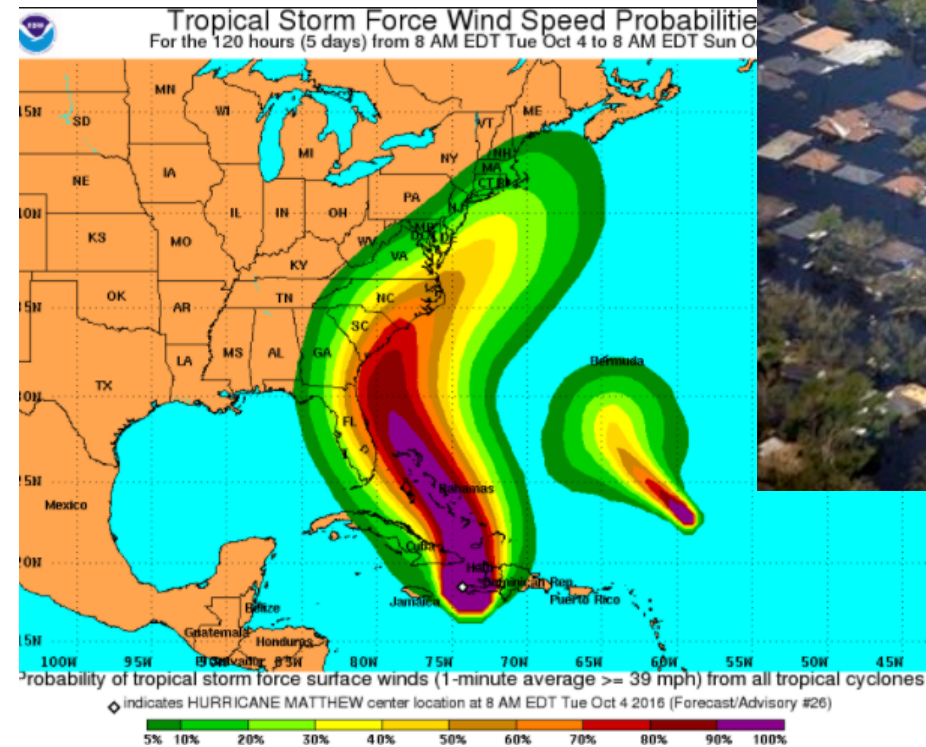


<https://www.coast.noaa.gov/floodexposure/#/map>



# USING GIS FOR INDUSTRIAL ENVIRONMENT COASTAL RESILIENCE REQUIREMENTS

- Degrees of impact (Known and Predictive) – Decision for type of protection needed for facility.
- What are the impacts? Human, Economic, Infrastructure, Land/Water, Industrial and natural Environments
- Risk Assessments, Displacement, Predictive, Continuous Operations & Reduced Recovery Time





# INDUSTRIAL ENVIRONMENTS & GIS

## Impact Zones to Critical Infrastructure and Assets

How do we maintain operations during a hazardous event?  
As the hazard increases, the potential also goes up for a decrease in operations.



- **Critical Asset** – What is it? Where is it? How can we minimize hazards toward it? Reducing Operational down time
- **Hazard Threat Levels** (CAT I, II, III or 100yr Flood Plain, Storm Surge)
- **Degrees of Impact**
- What is the **sphere of influence to neighboring areas** to industrial site?

Example of Hazard Inundation to Industrial Area with Assets



# GIS as a SOP / Business Benefits

- Not only event driven
- Functional and Procedural for Daily Operations
- SOP
- Decision Support
- Site specific information that is useful to surrounding areas, businesses, and municipalities.



# Primary Thread connecting site functions – SPATIAL DATA /GIS



GIS -- integrative platform for management and analysis of all spatial things



Different shareholders can share the costs of the GIS investment



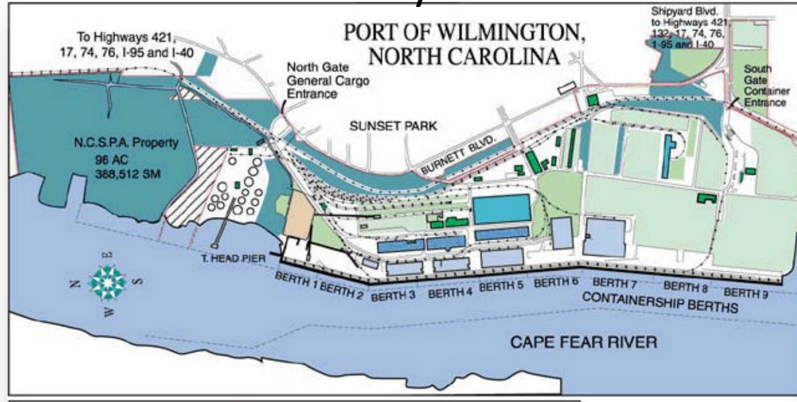
## Data is King – The Power of GIS

- Data outputs will need interpretation to create information for decision makers
- Data-Rich to Insight-Driven
- Increased Customer Service & Effectiveness
- Reduce Operational Recovery Time

# GIS -Visualization Across Scales



Facility



Structures / Units / Terminals



Asset



MICRO  
To  
BIG PICTURE



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# THANK YOU

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