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COASTAL RESILIENCE IN INDUSTRIAL ENVIROMENTS

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

FLOOD DEFENSES

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.

TEMPORARY FLOOD BARRIER

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

DEMOUNTABLE FLOOD BARRIER

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)

MAPPING AND PRIORITIZING

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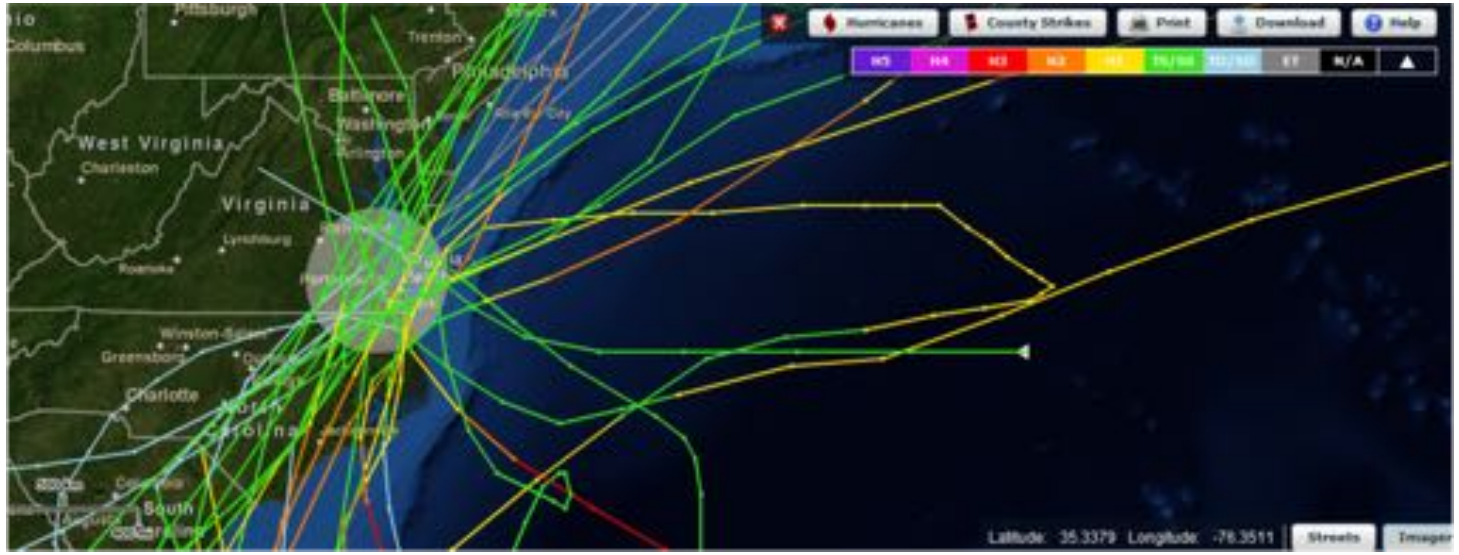
Hurricane Irene prompted Newport News Shipbuilding to investigate it's vulnerability and resilience option to coastal flooding in a two step process

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



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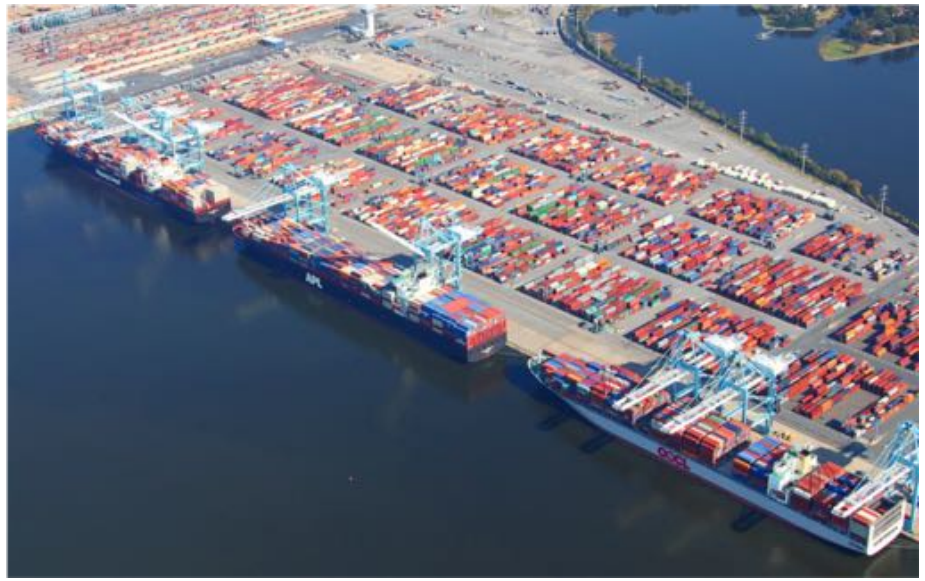
PORTS

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

Critical Infrastructure Mapping

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



Application of GIS for Risk Assessment and Planning

Impacting Events

- Hurricanes
- Coastal Flooding
- Sea Level Rise
- Snow Events
- Rainfall
- Flooding

A barge is moored along the Missouri River as floodwaters begin to creep into a dry bulk terminal in St. Joseph, MO, on Monday, March 19, 2019 (ORLIN WAGNER/AP Photo)

Leveraging Geospatial Technology and Tools: WHERE ?

Risk = Probability x Value

A warehouse valued at $1,000,000 dollars has a 20% probability of flooding in the next 10 years

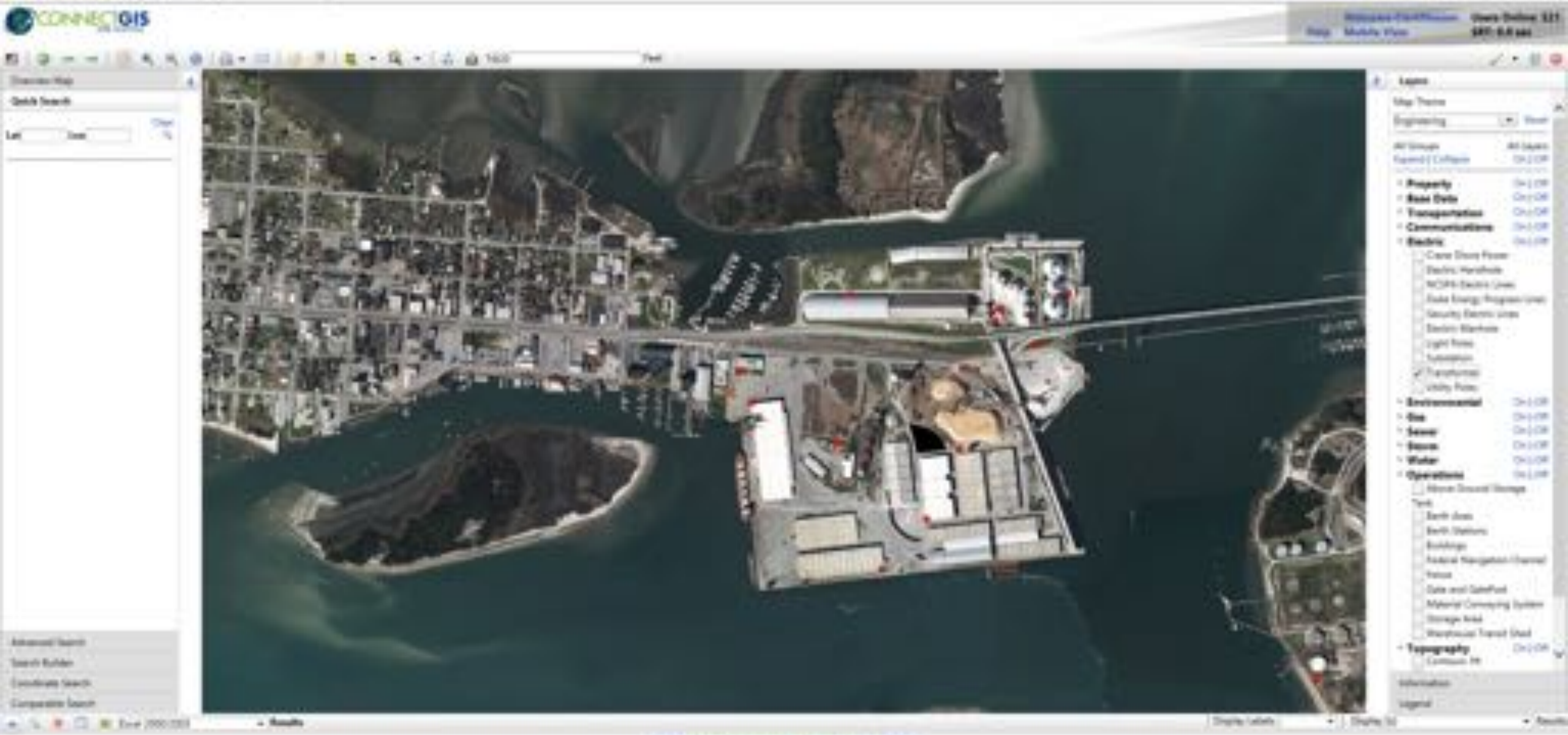
Risk = $1.0m x 20% = $200,000

An emergency generator operates pumps that protect 4 warehouses valued at $1,000,000 dollars each has a 10% probability of flooding in the next 10 years

Risk = $4.0m x 10% = $400,000

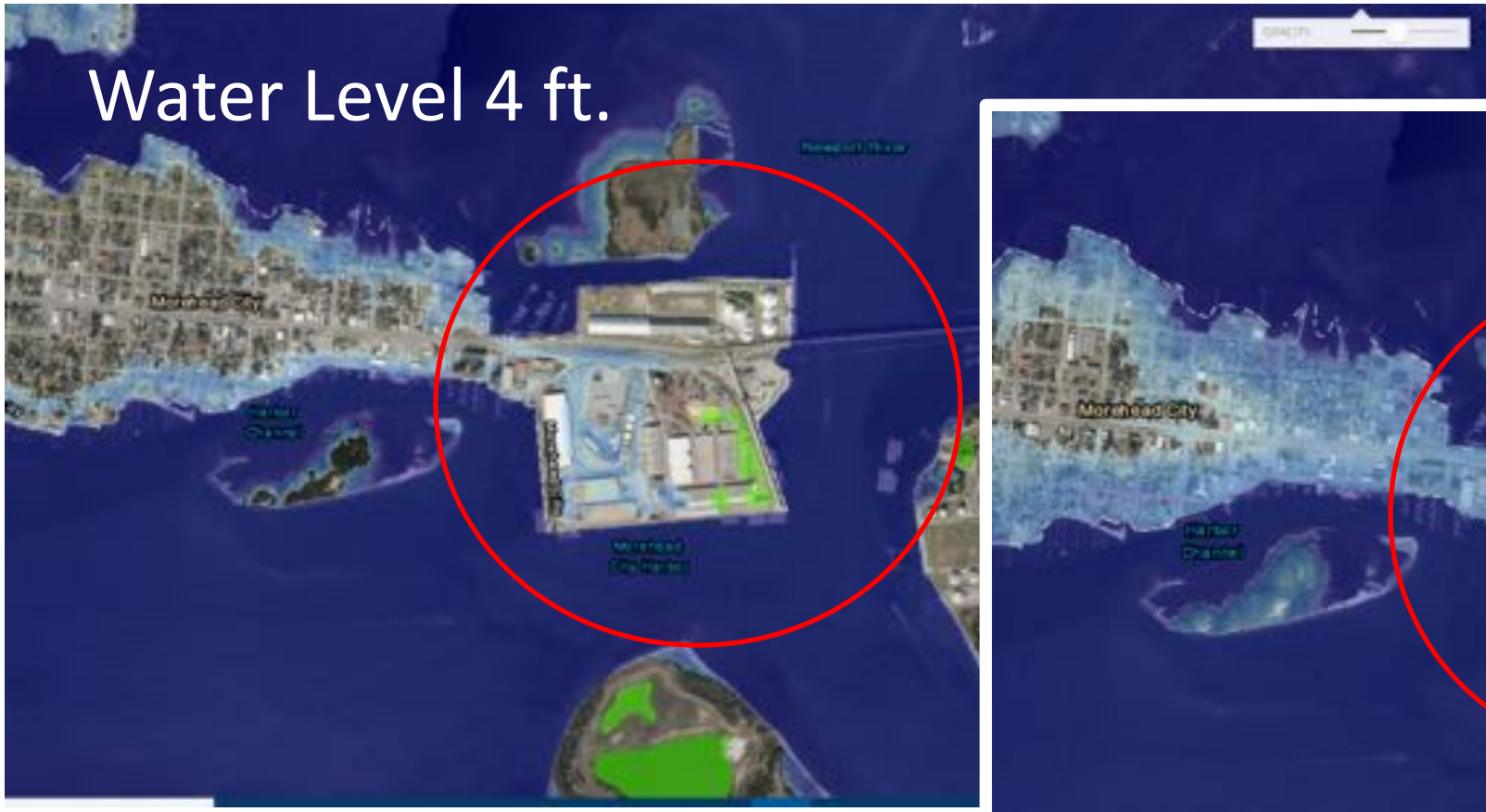
- ✓ **Identify Assets at Risk**
- ✓ **Criticality**
  - **Operations**
  - **Revenue**
  - **Owner Defined**

Leveraging Geospatial Technology and Tools



Leveraging Geospatial Technology and Tools:

Map areas at risk and prioritize assets



Model Least Impact & Worst case Scenarios

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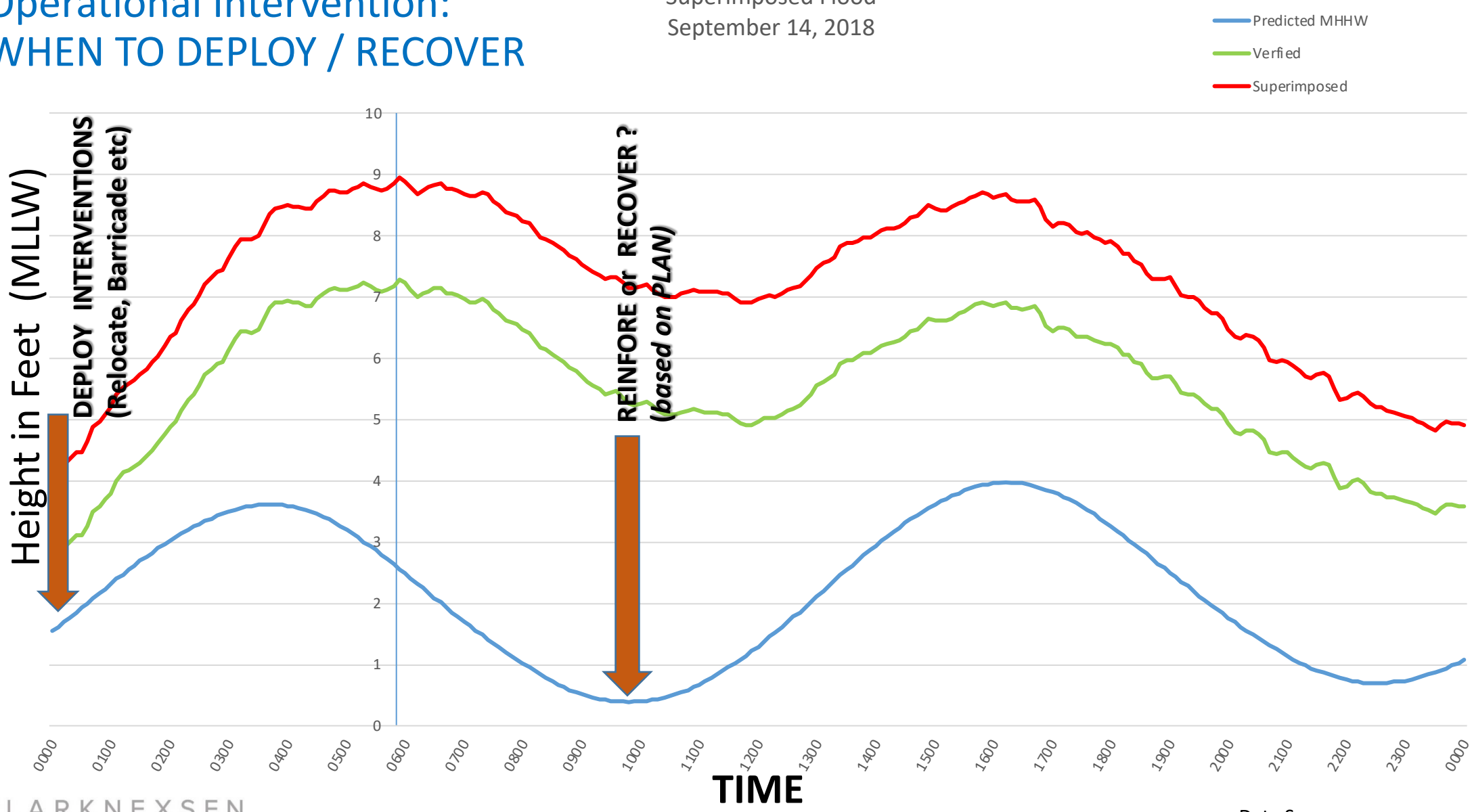
Assets at Risk (As an Example – by Facility Function)

Phased Emergency Operational Intervention: WHEN TO DEPLOY / RECOVER



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Data Source:

Flood Barriers

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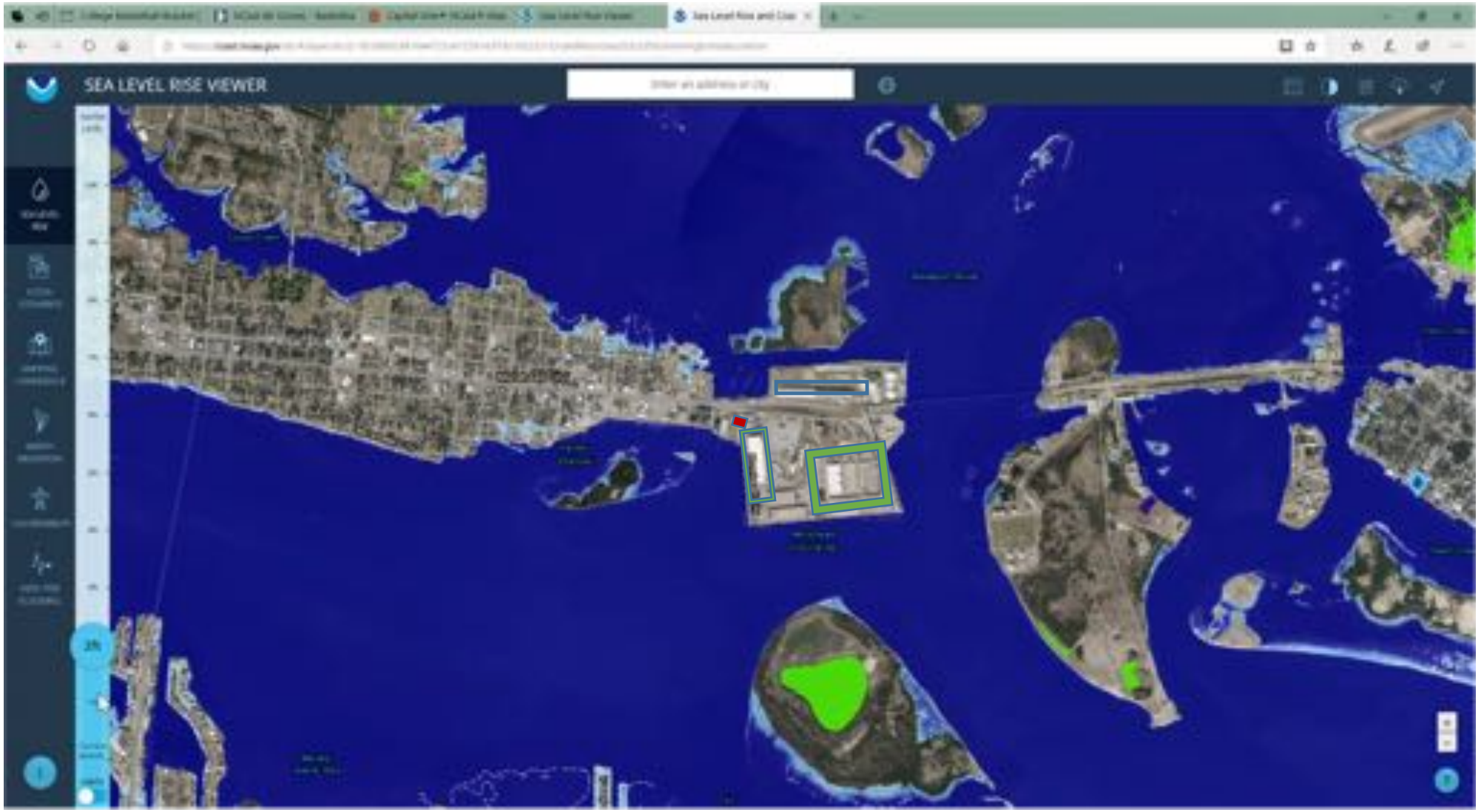
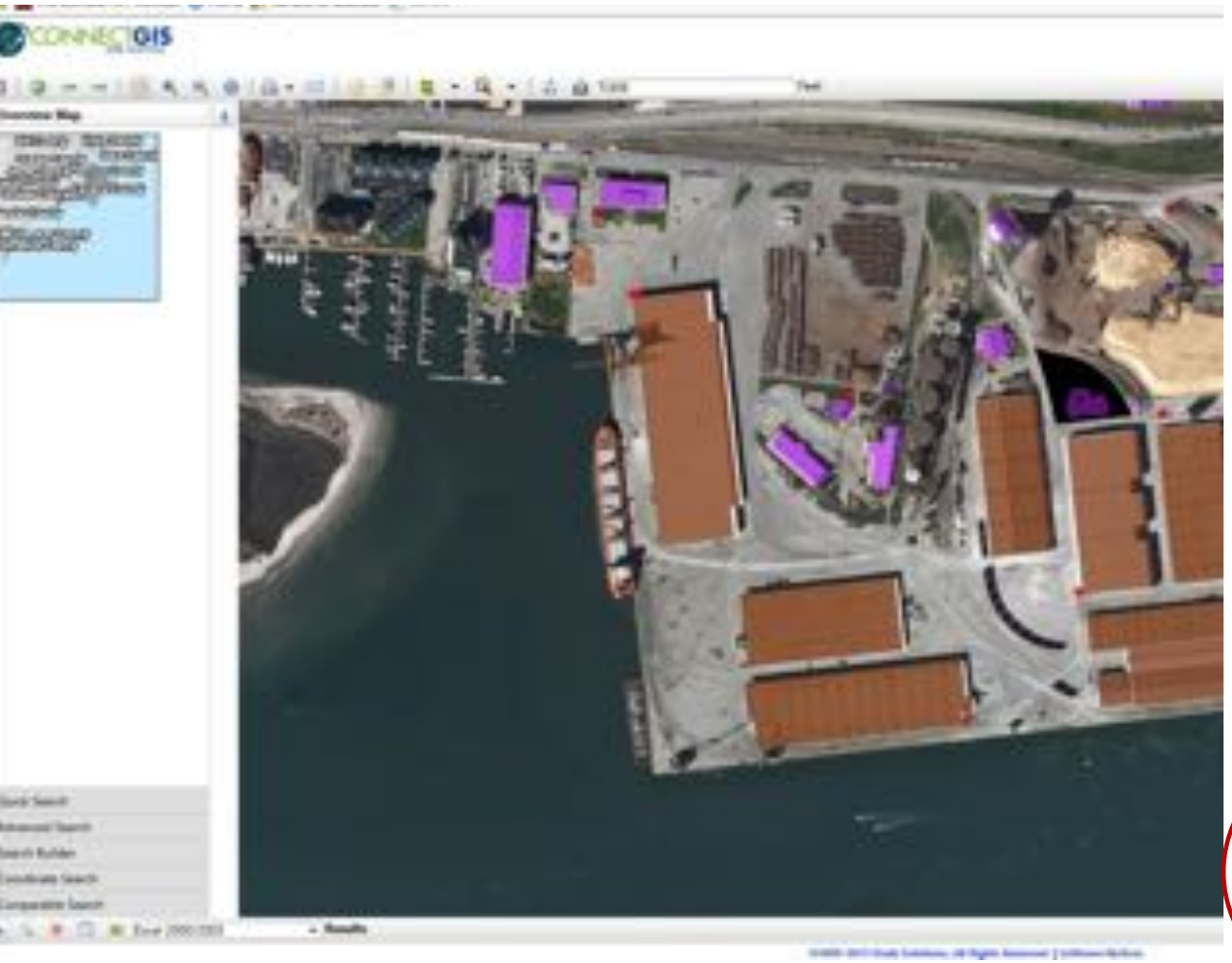
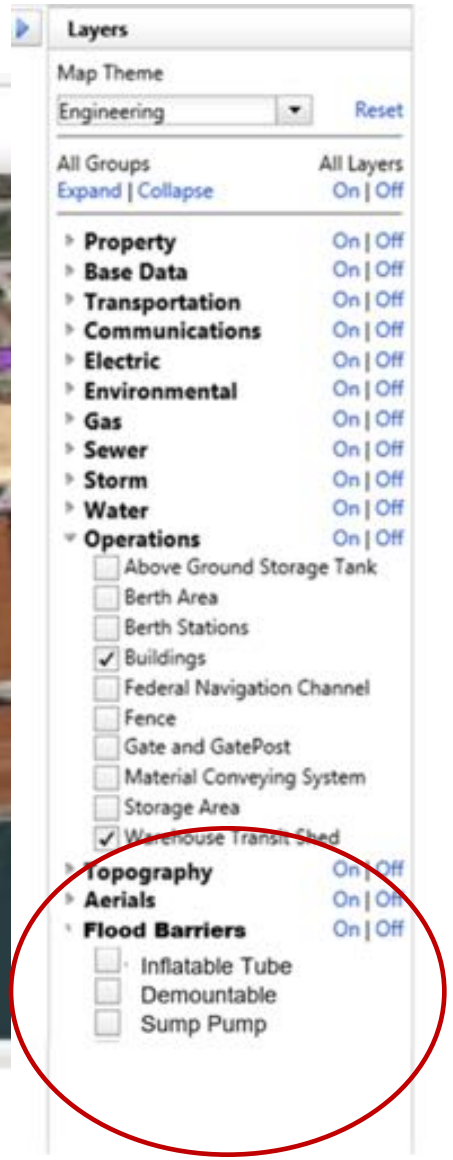
Simulated Flood Condition



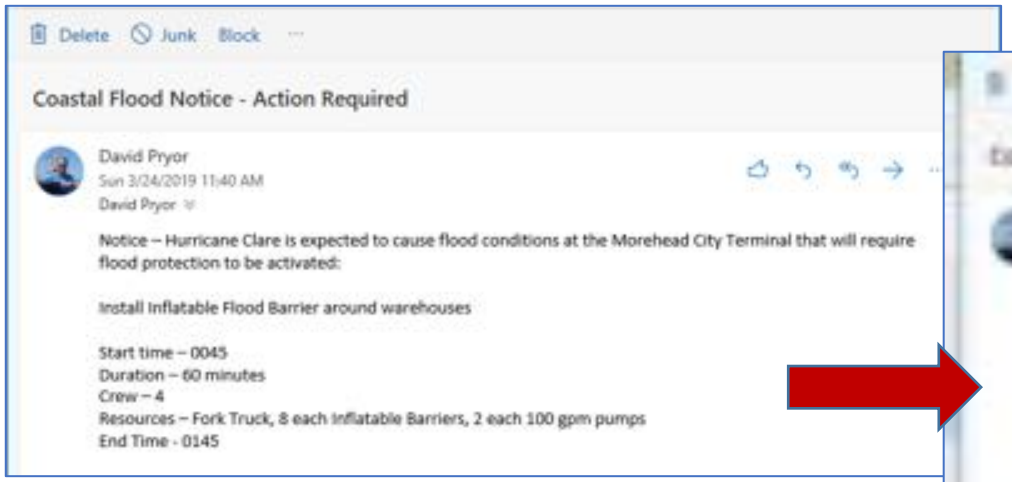
Enhanced GIS Database





Simulated Work Orders

- Deploy



- Recover

Benefits of a Phased Approach

Steps to Achieve Time Driven Resilience

- Prioritization of Assets
- Resilience Plan – What and Where
- Knowledge of Time required to deploy
- Link to Storm Water Level Prediction
- Link to appropriate Personnel

Benefits of a Phased Approach

- Minimal Disruption to normal Operation
- Manage impact / damage to a facility
- Limit the cost of labor
- Reduced Risk/Lower Insurance Rates

Leverage your investment in GIS to protect your most valuable assets while minimizing disruption

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.

Example of Hazard Inundation to Industrial Area with Assets

- **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, II or 100yr Flood Plain, Storm Surge)
- **Degrees of Impact**
- What is the **sphere of influence to neighboring areas** to industrial site?