

GIS and Critical Infrastructure Resiliency Hampton Roads, VA

Changing the Paradigm

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Versar, Inc.**

March 11, 2008

GIS and Critical Infrastructure Resiliency in Hampton Roads Region

➤ **The Team, Sponsors and Project**

- Hampton Roads Region
- Potential Hazards
- Critical Services and Facilities
- Critical Infrastructure
- Data and Issues
- Collaborative GIS and Resiliency

Virginia University Partnership



*Disaster Risk Reduction
Program*

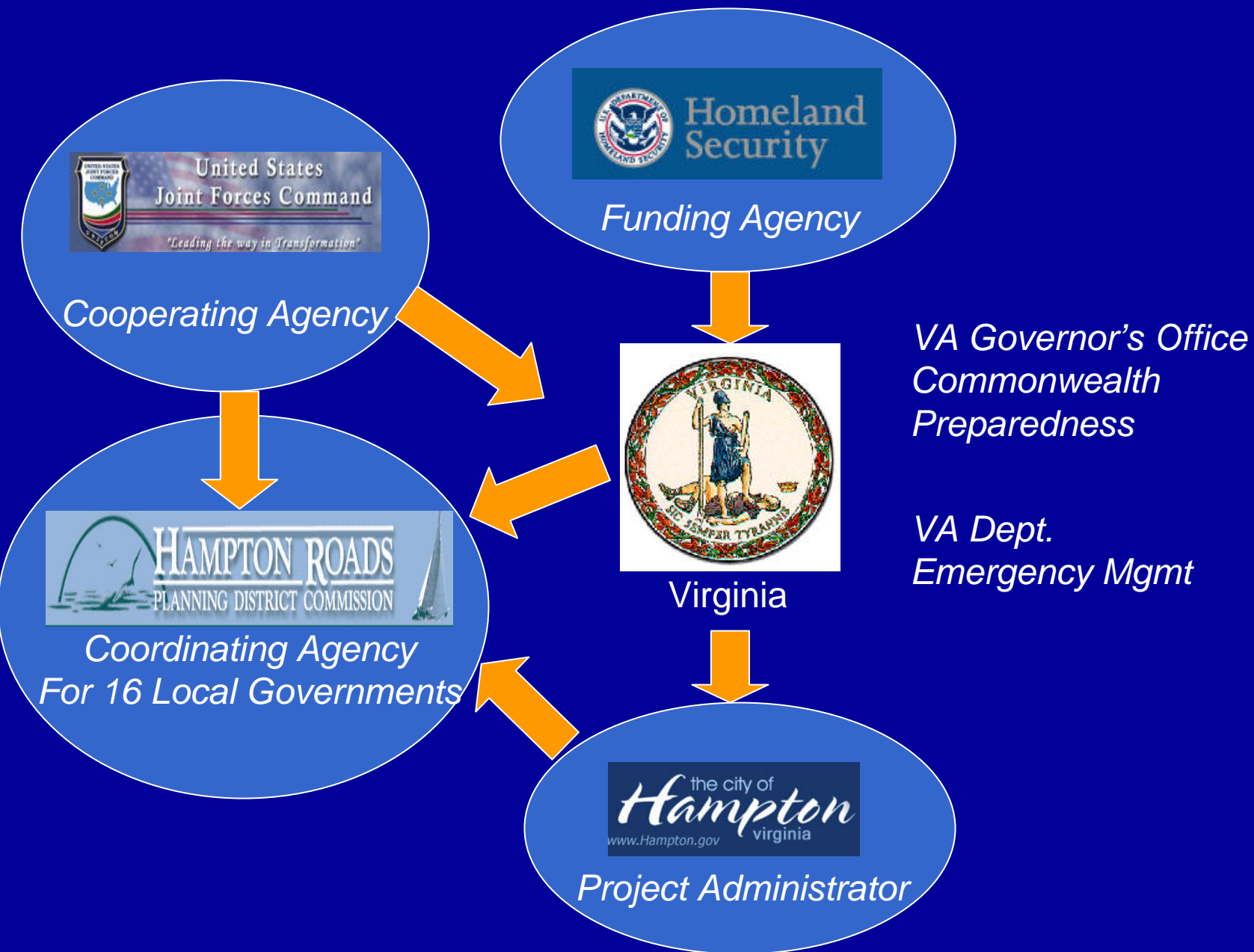


*Center of Risk Management for
Engineering Systems*



*VA Modeling Simulation and
Analysis Center*

Participating Agencies



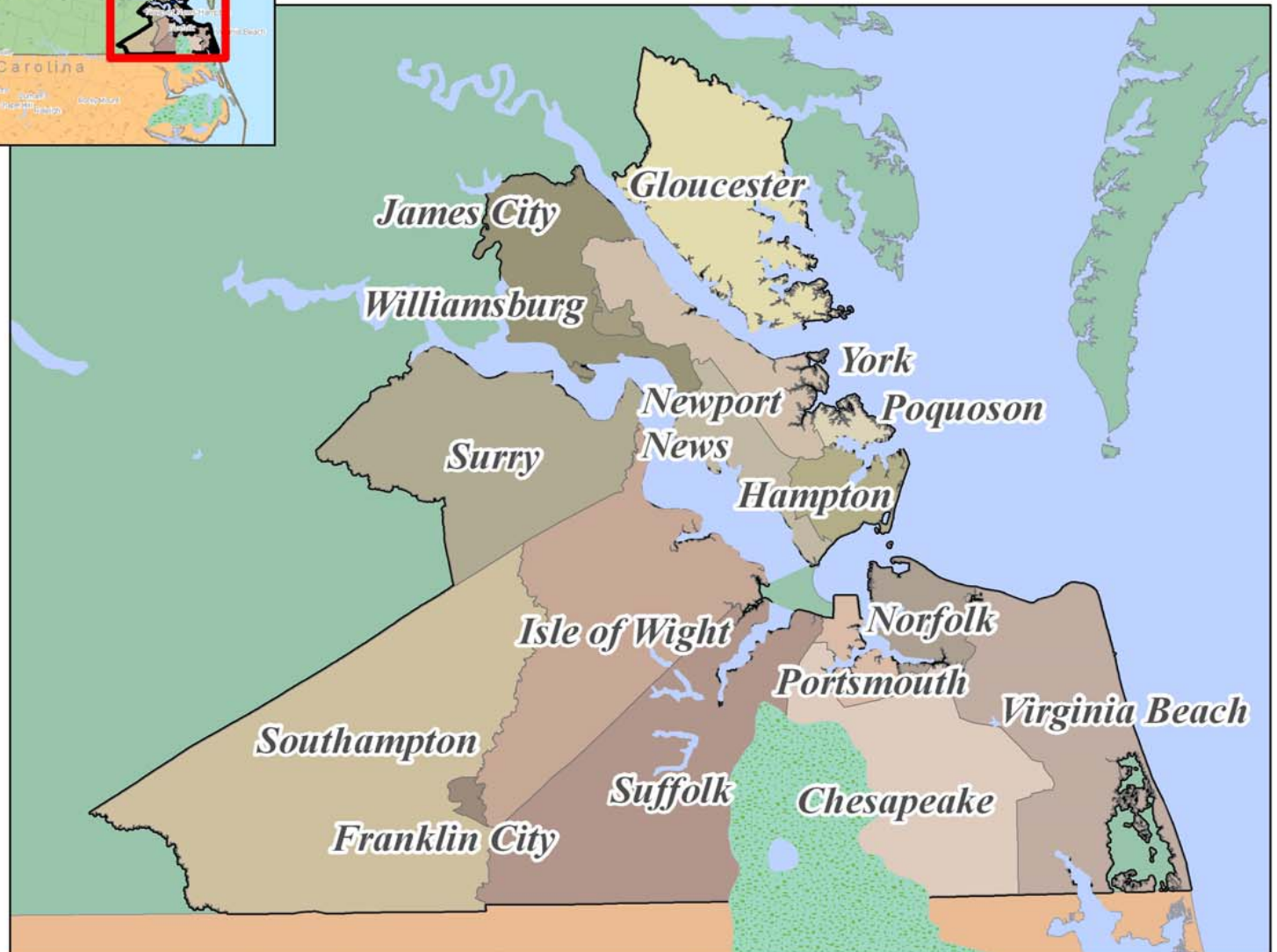
Project Objectives

1. Infrastructure *vulnerabilities and interdependencies*
2. Natural, technological and terrorist *risk scenario resilience*
3. *Resilience, preparedness and response capabilities gaps*
4. Military and civilian infrastructure interdependencies
5. Economic and social impacts of selected scenario events
6. *Regional resilience investment priorities* based risk, cost and benefit trade-offs
7. *A Hampton Roads region methodology as a national model*

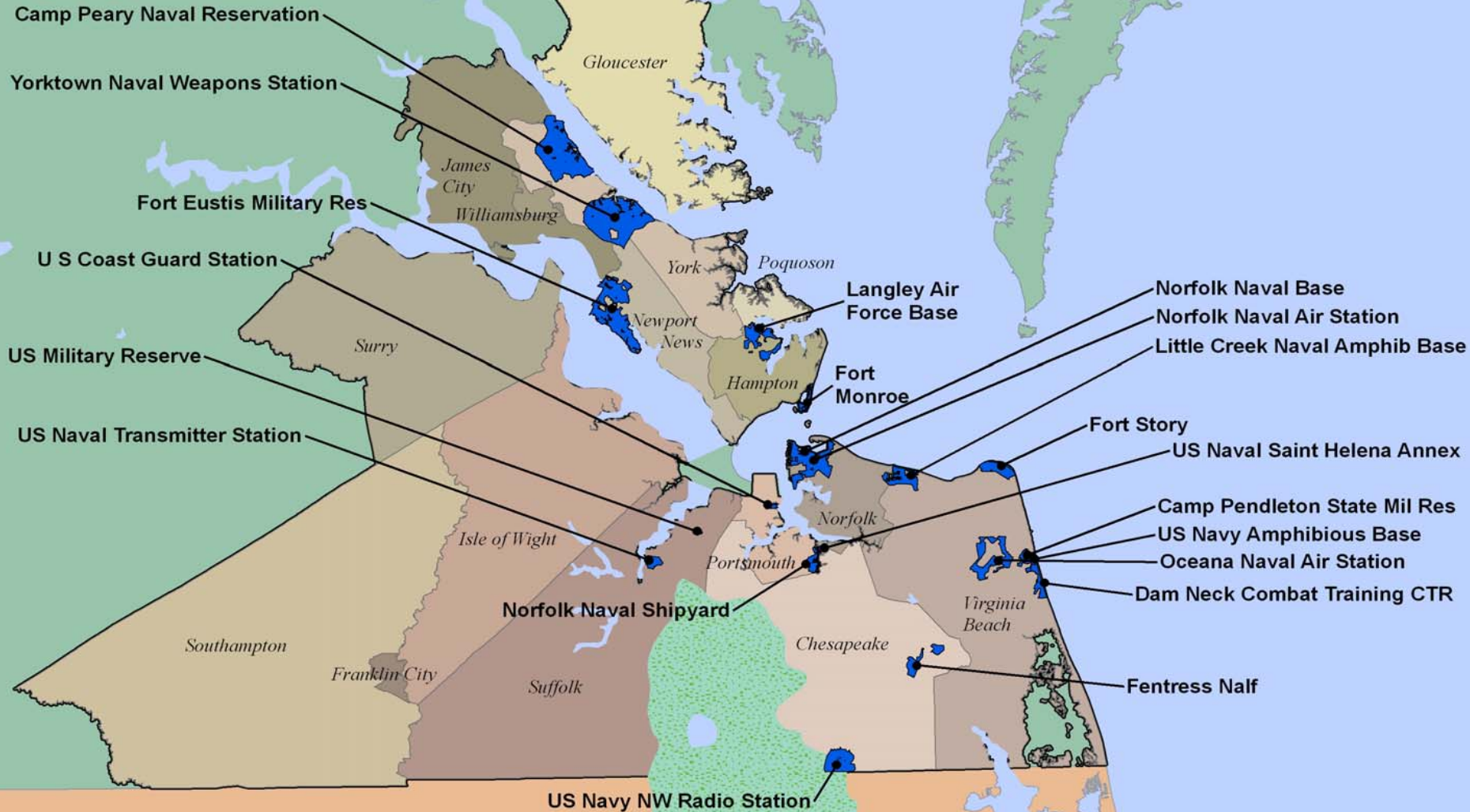
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Hampton Roads Region Virginia



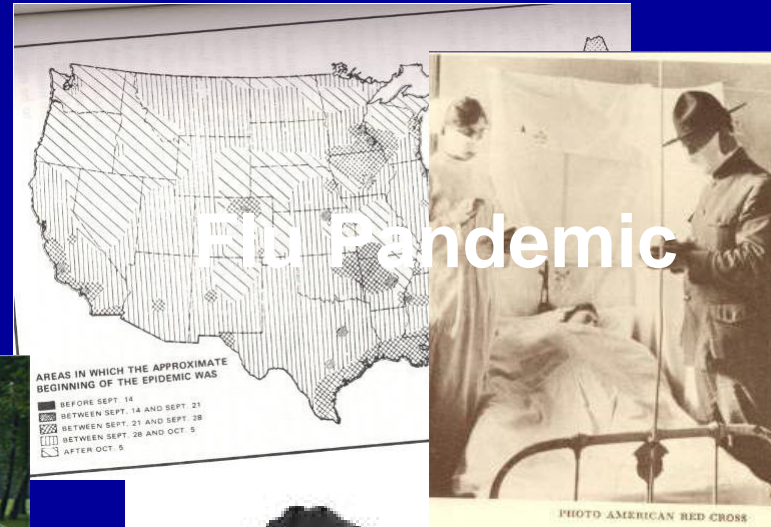
Hampton Roads Military Facilities



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Potential Hazards



GIS and Critical Infrastructure Resiliency in Hampton Roads Region

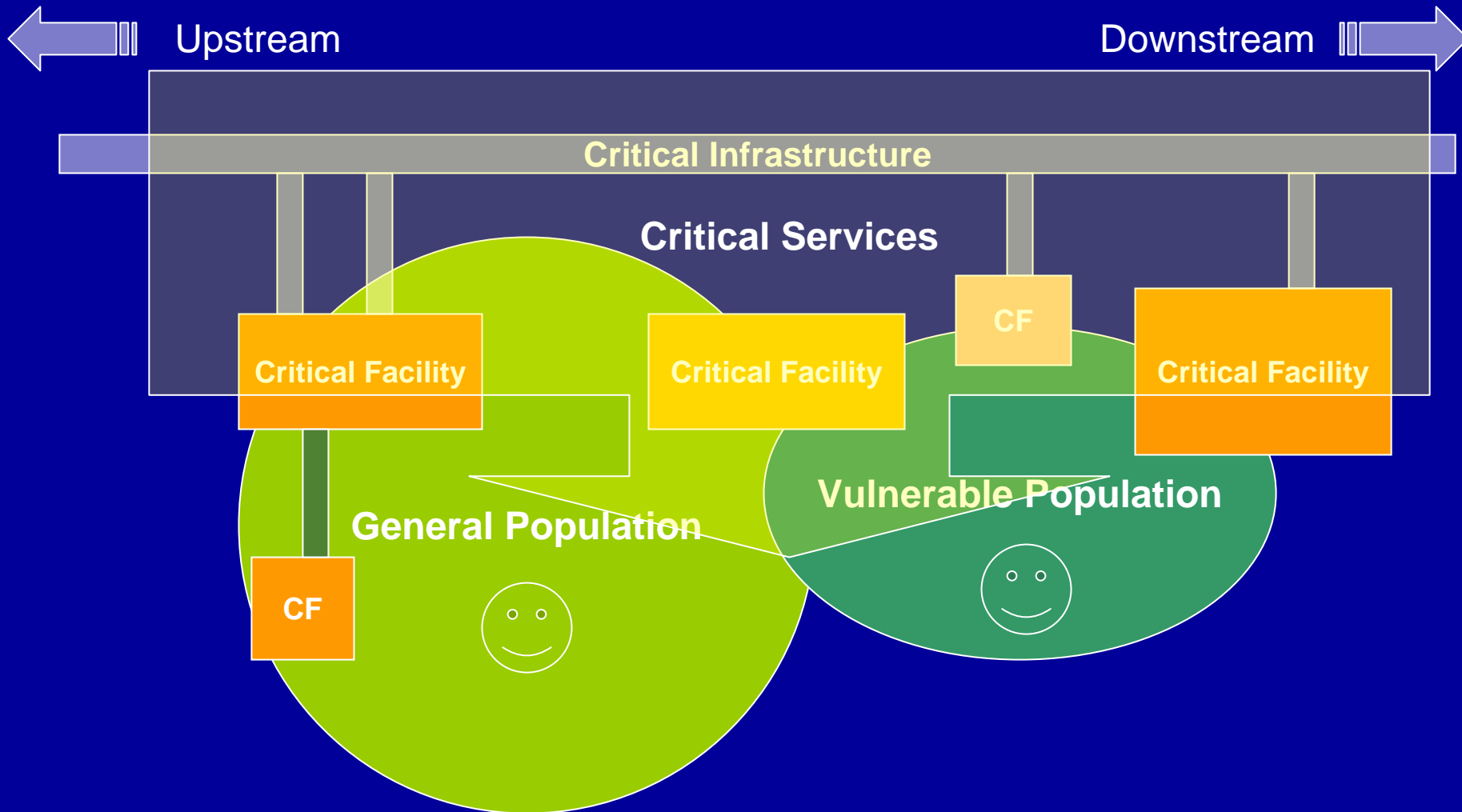
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Critical Services and Facilities

- Airports
- Police Stations
- Fire Stations
- Chemical Facilities
- Fuel Storage/Refueling Facilities
- Radio Facilities
- Transmission Towers
- Communication Central Offices
- Electric / Gas Utility Dispatch Ctrs
- EOCs
- 911 Call Centers
- Large Population Venues
- Large Rail / Port Facilities
- Major Bridges / Tunnels
- Military / National Guard Facs.
- Transportation Hubs
- Public Shelters
- Water Treatment Facilities.
- Water Storage Facilities
- Wastewater Treatment Plants
- Hospitals
- Medical & Treatment Centers
- Schools / Colleges
- Public Shelters
- Camp Grounds
- Trailer Parks

Relationships

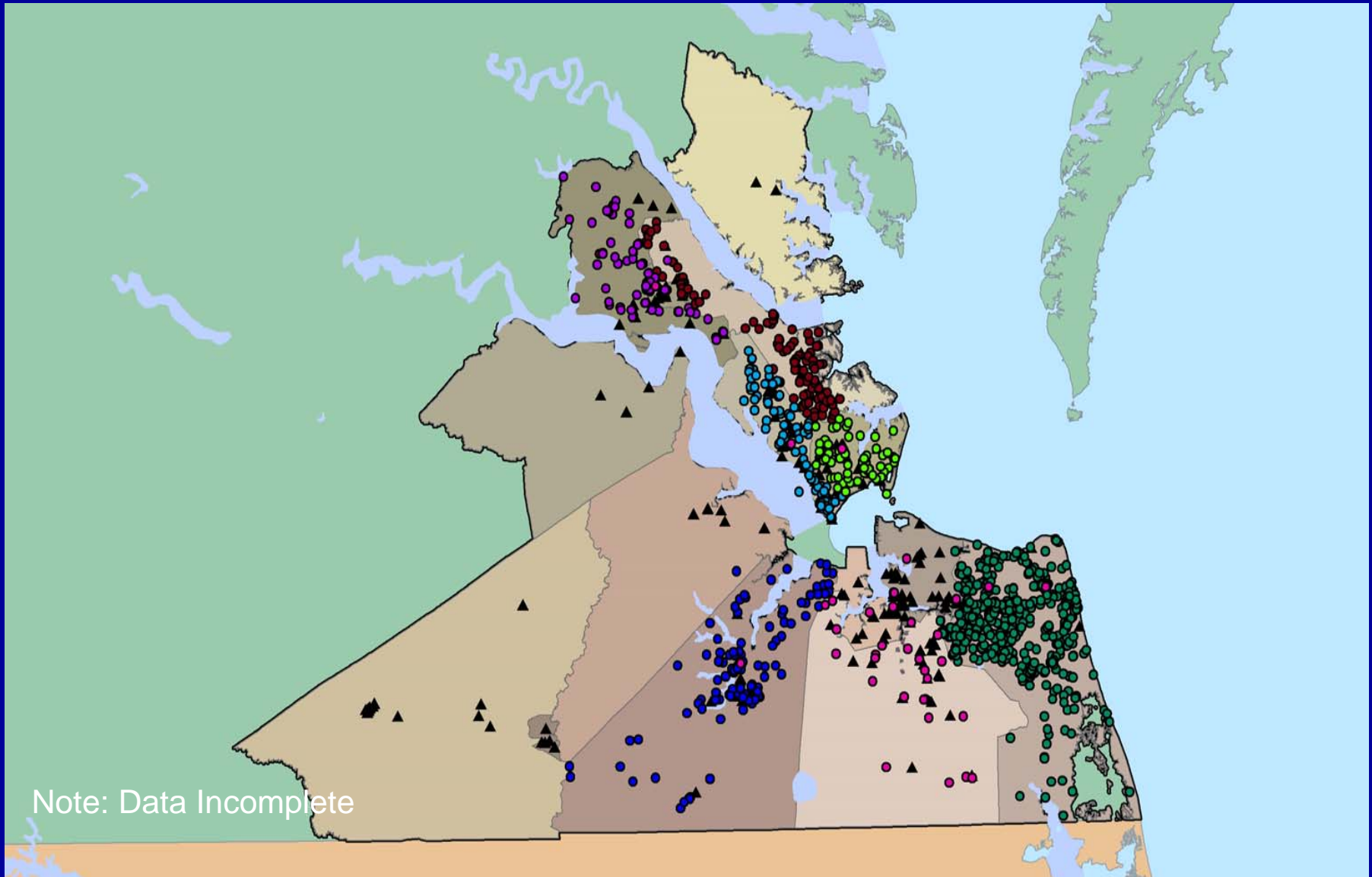
Critical Services – Facilities - Infrastructure



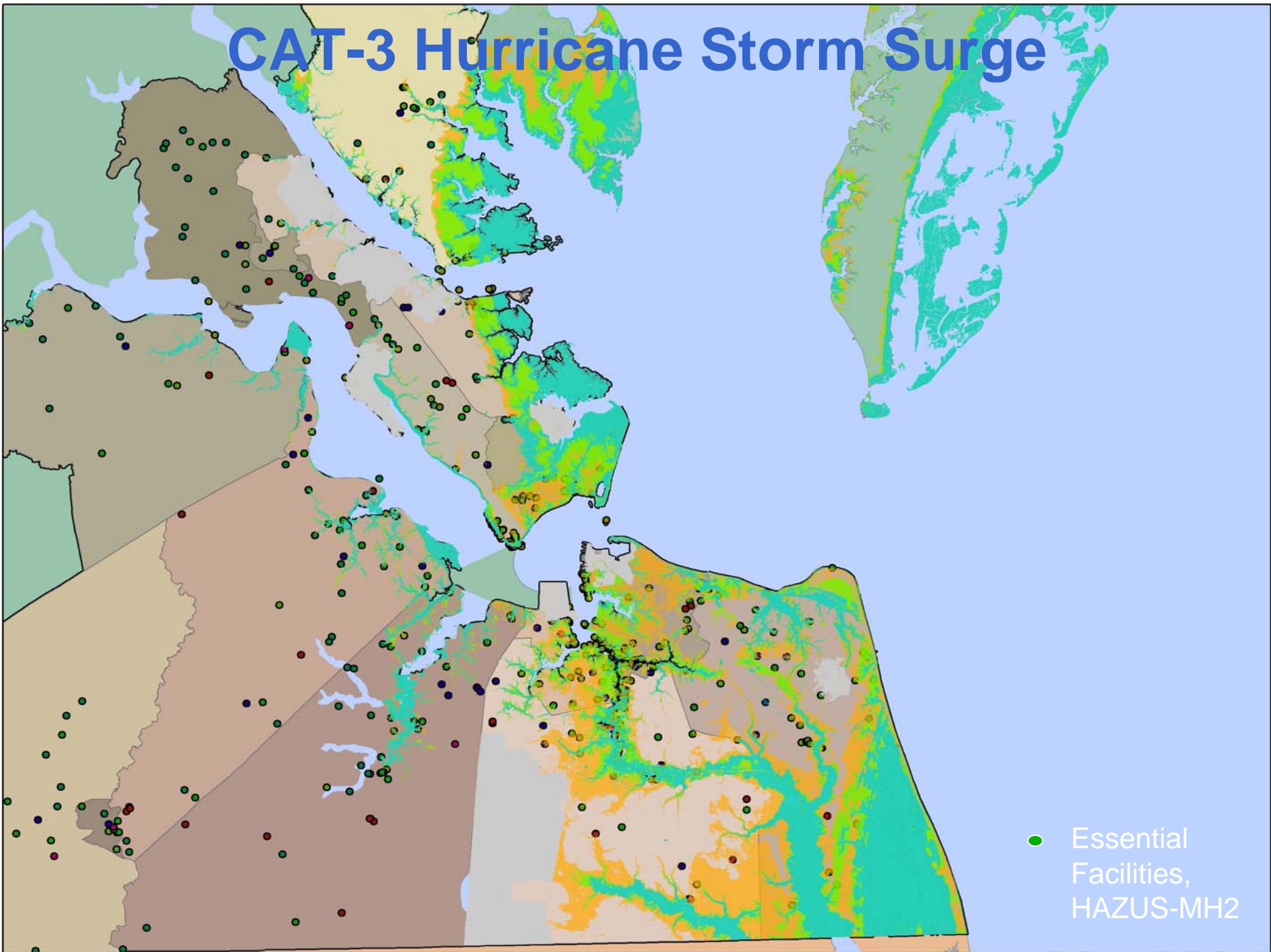
Critical Facility Service Analysis



HR State and Local Critical Facilities



CAT-3 Hurricane Storm Surge



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Critical Infrastructure

- Agriculture and Food
- Banking and Finance
- Chemical and Hazardous Materials
- Defense Industrial Base
- **Energy**
- Emergency Services
- Information Technology
- **Telecommunications**
- Postal and Shipping
- Healthcare and Public Health
- **Transportation**
- **Water**
- National Monuments and Icons
- Commercial Assets
- Government Facilities
- Dams
- Nuclear Facilities

Source: DHS National Plan - Critical Infrastructure and Key Resource Areas

Project Focus – 4 Critical Infrastructures

Energy

- *Electric Power*
- *Gas (Natural & LNG)*
- *Nuclear*
- *Oil*

Communications

- *Telephone Landlines*
- *Wireless - Cell*
- *Wireless - Microwave*
- *Cable*

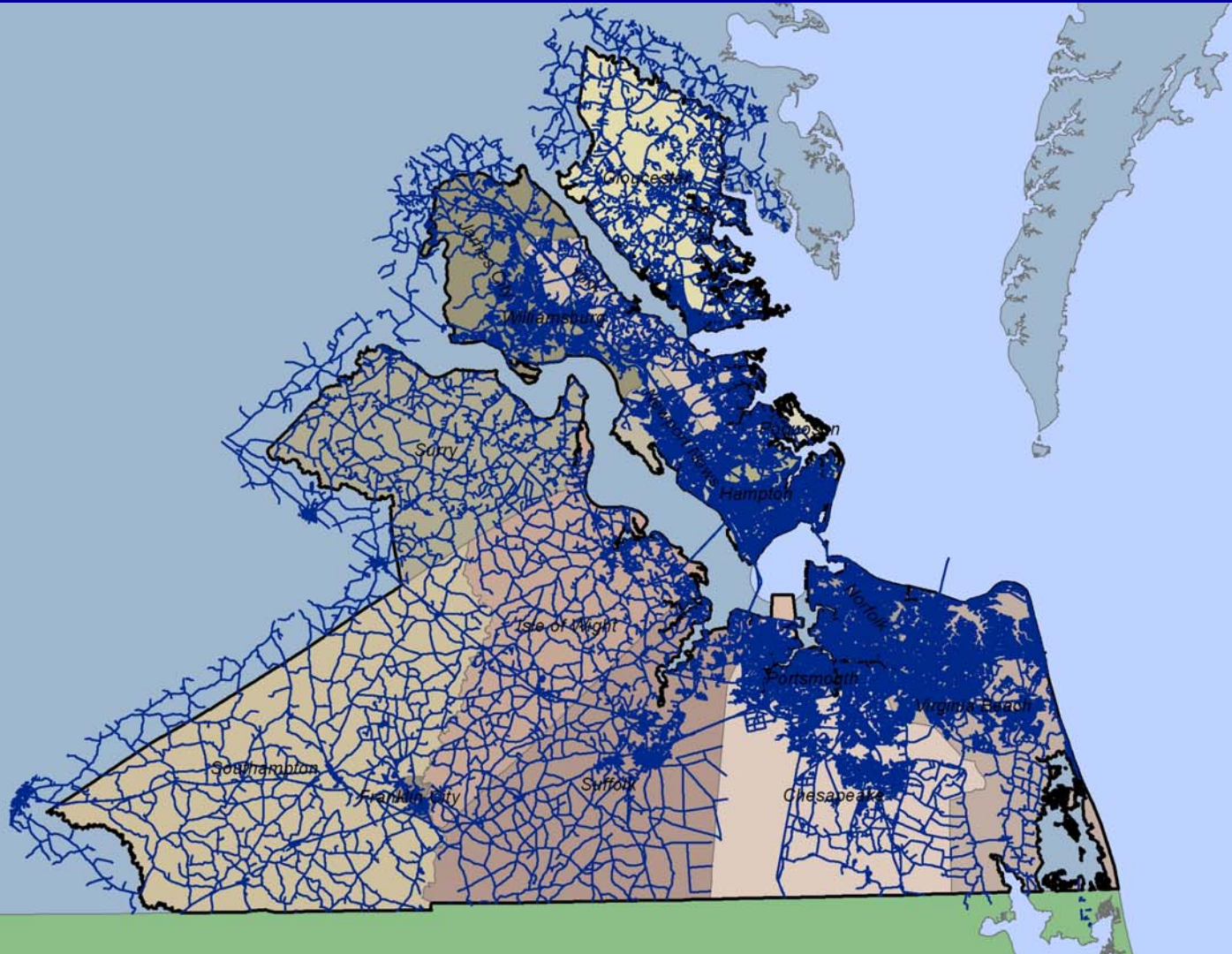
Water

- *Potable Water Supply*
- *Wastewater*

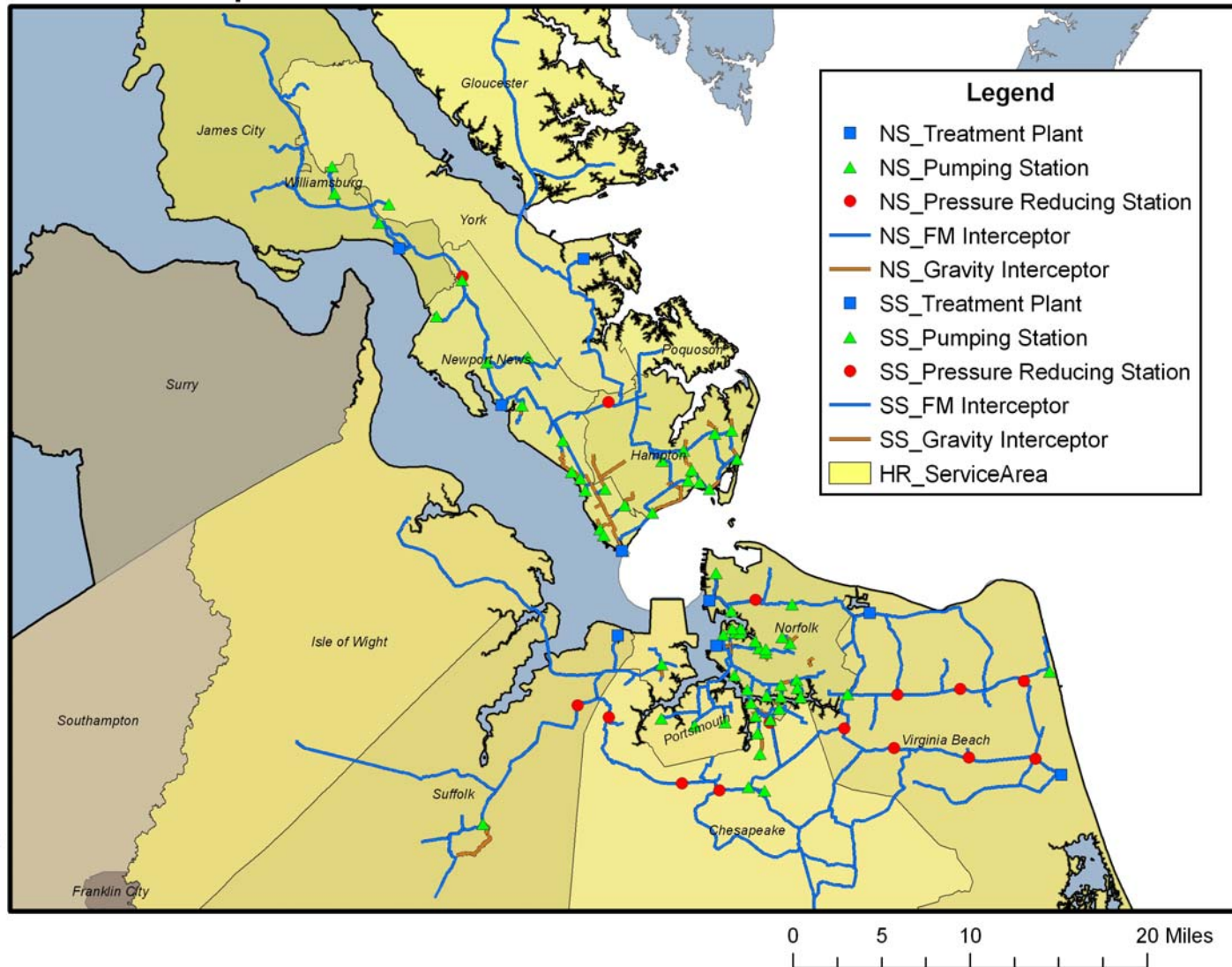
Transportation

- *Roads*
- *Bridges & Tunnels*
- *Rail*
- *Airports*
- *Ports*

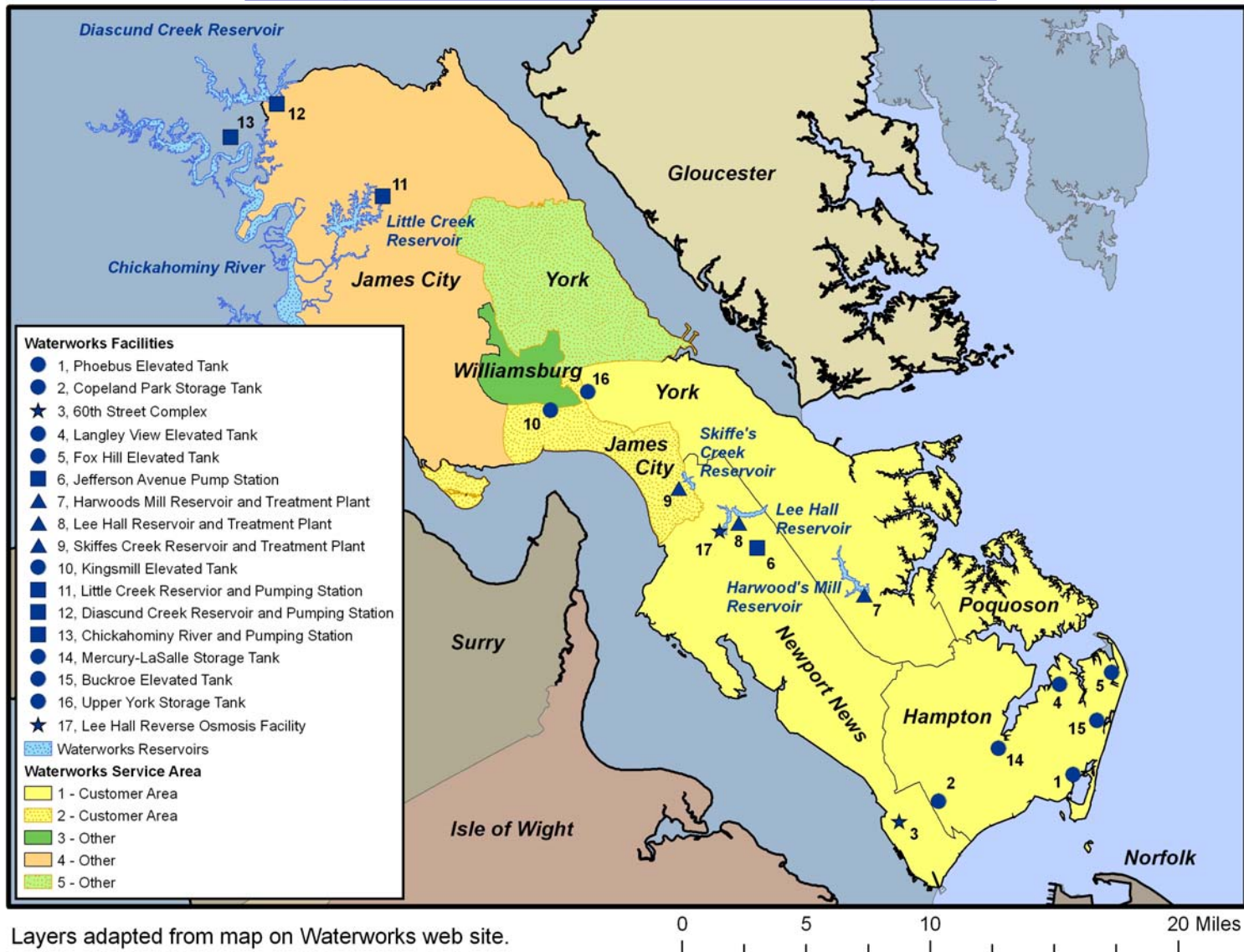
HR Roads Transportation System



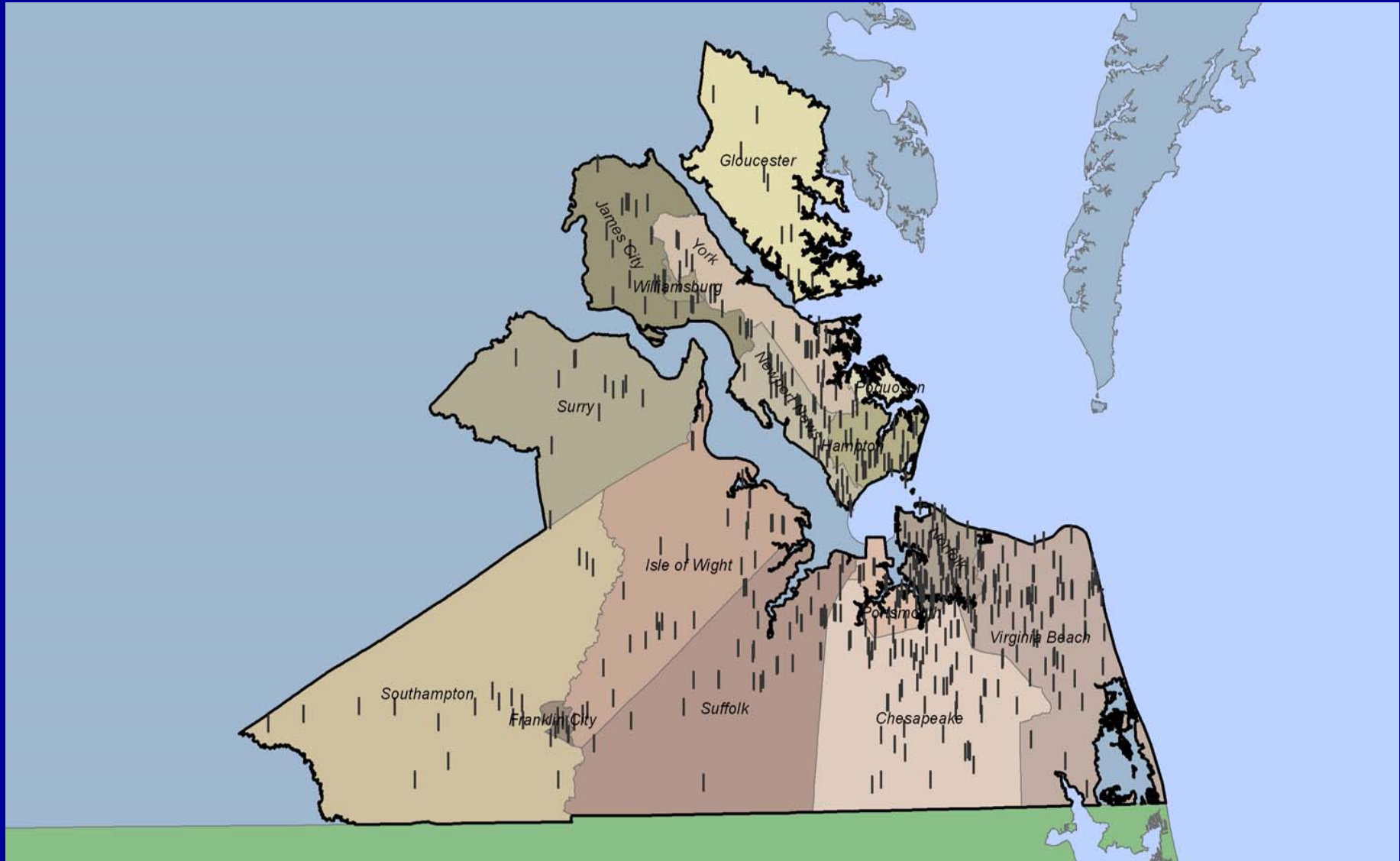
HR Sanitary District Wastewater System



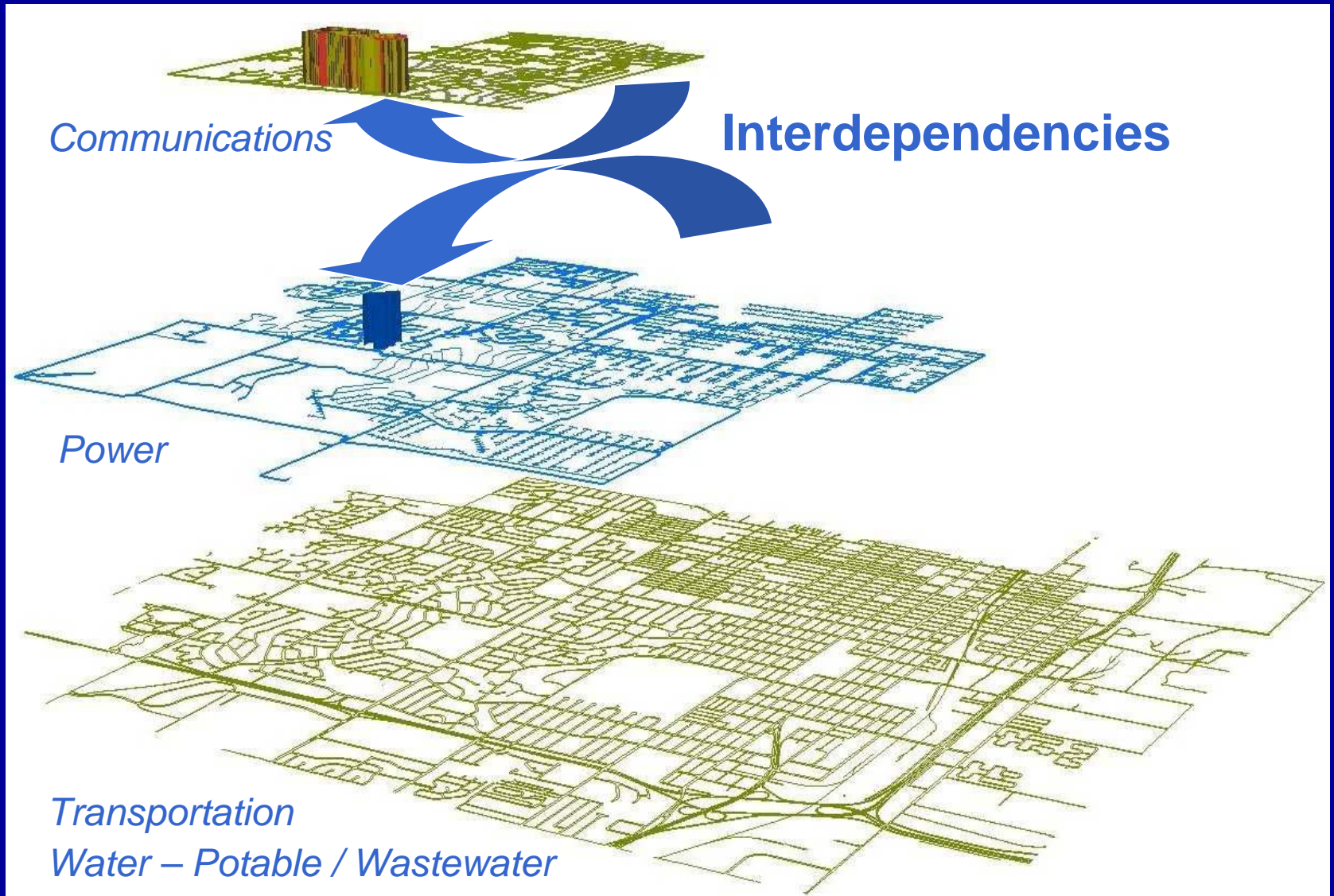
Newport News Waterworks System



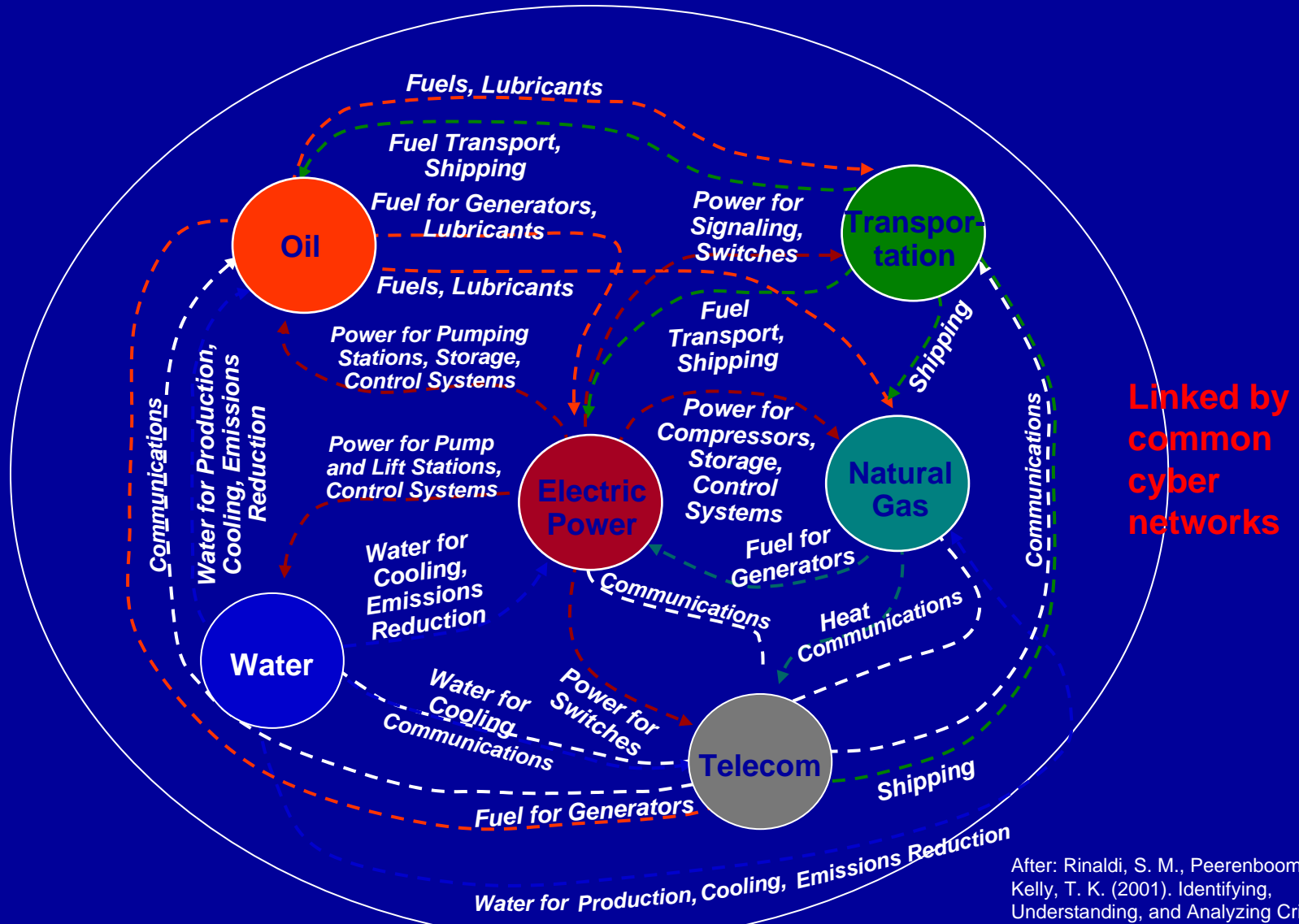
FCC Registered Communications Antennas



Critical Infrastructure Interdependencies



Interdependencies



After: Rinaldi, S. M., Peerenboom, J. P., & Kelly, T. K. (2001). Identifying, Understanding, and Analyzing Critical Infrastructure Interdependencies. *IEEE Control Systems Magazine*, 21(6), 11-25.

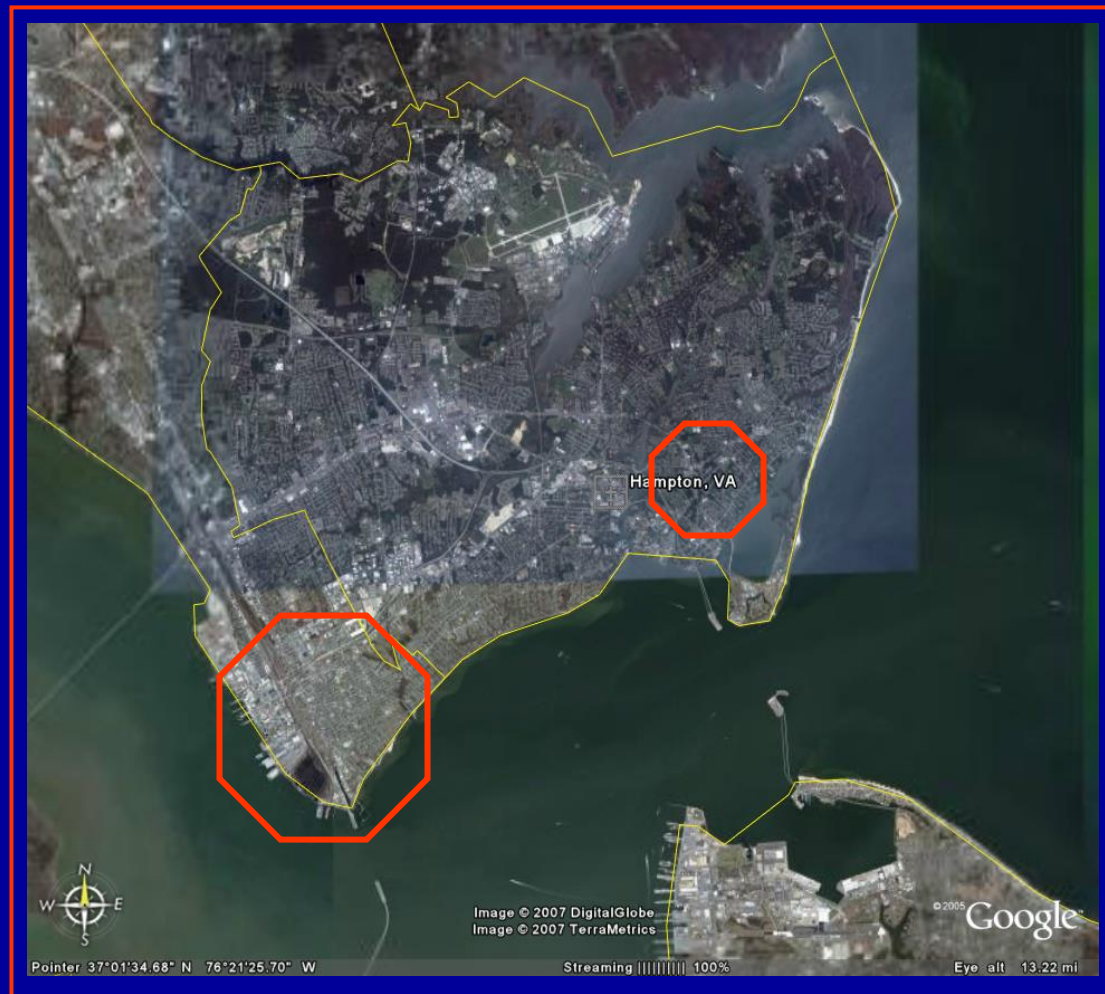
HR Project Area – Macro View

- Overall capabilities and limitations of four infrastructures
- Federal, Commonwealth, county, city, military, and infrastructure critical facilities identified
- Areas of disaster impacts



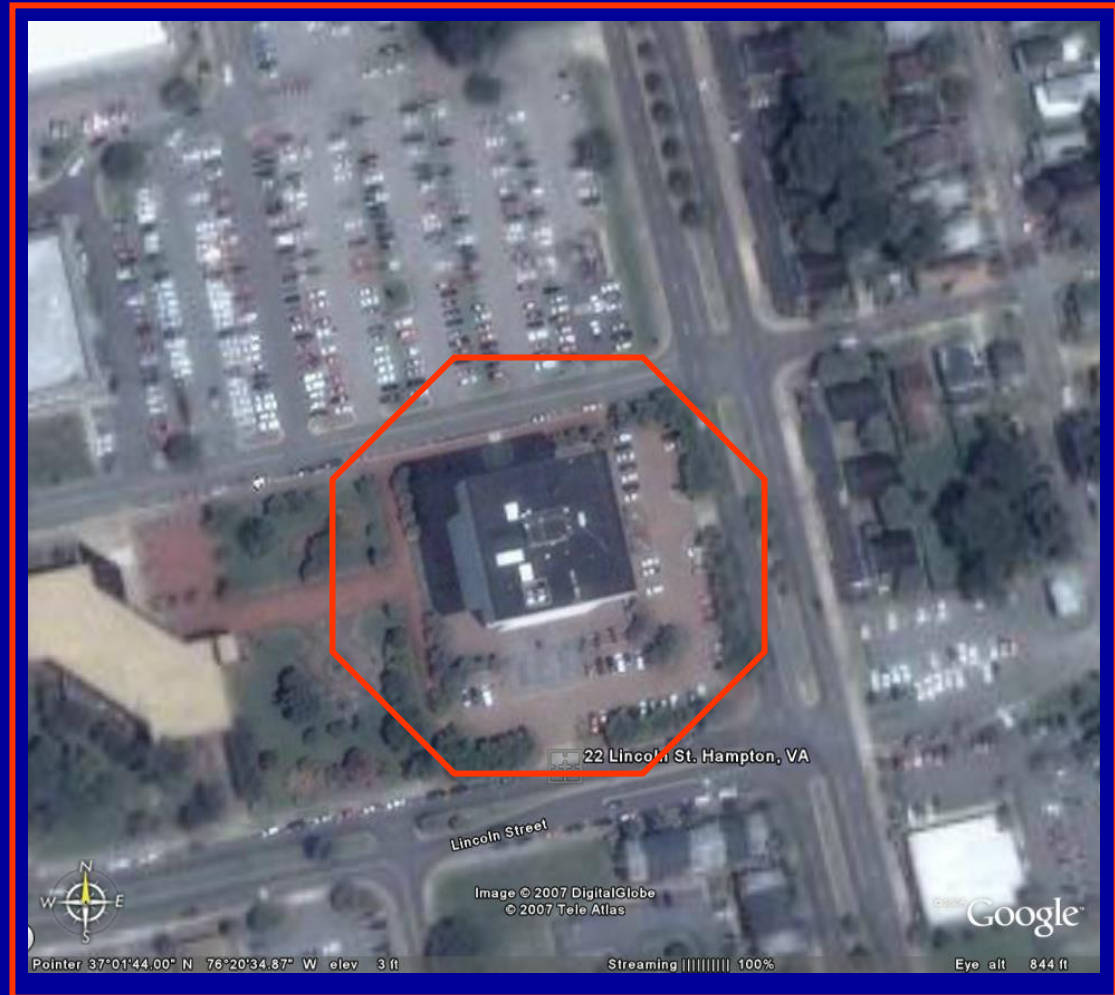
HR Project Area – Meso View

- HR Critical Facilities Matrix development
- Select areas for further evaluation



HR Project Area – Micro View

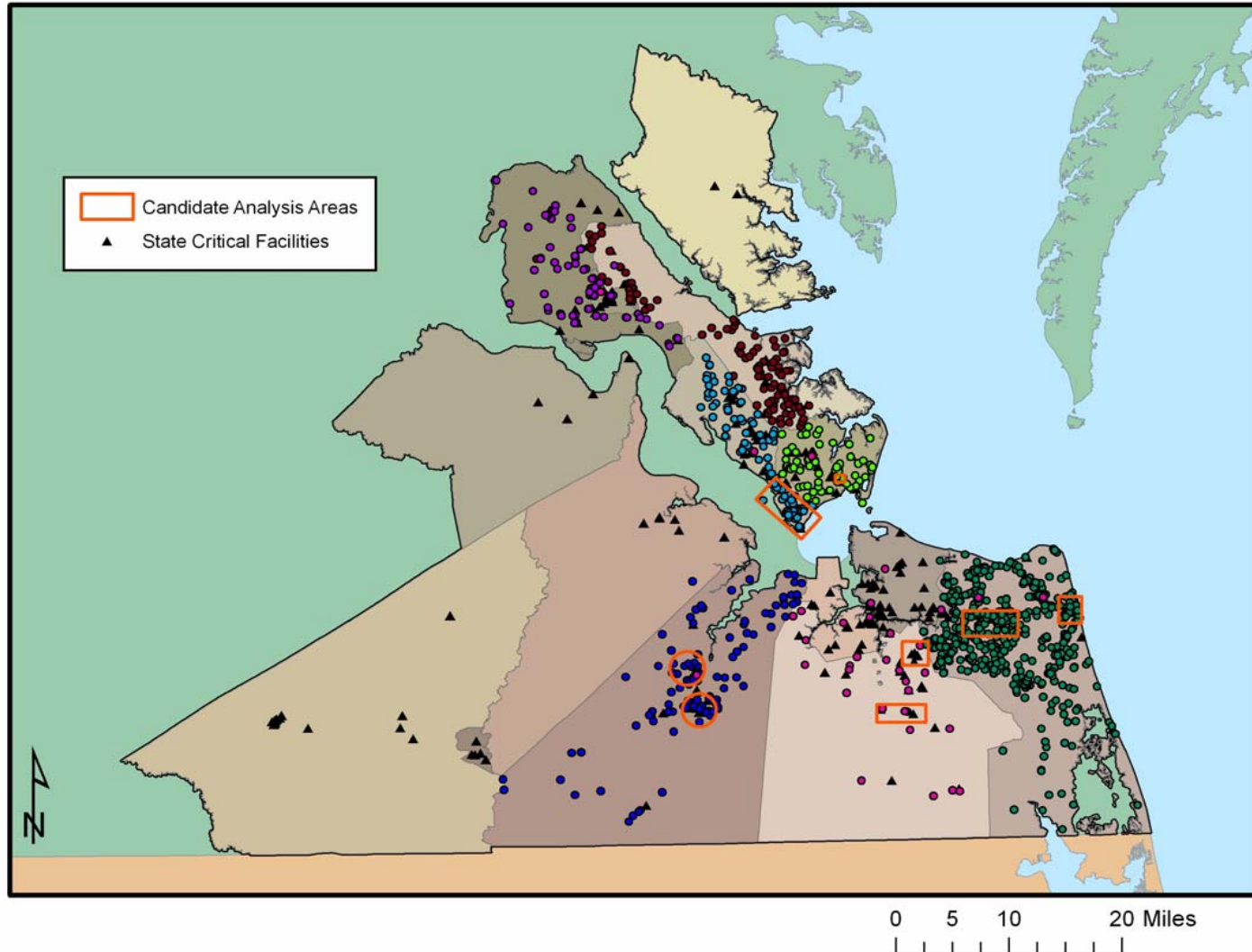
- Critical facility evaluation
- Infrastructure services to facility
- Resilience of facility & service infrastructures



Critical Facility – Values & Filters

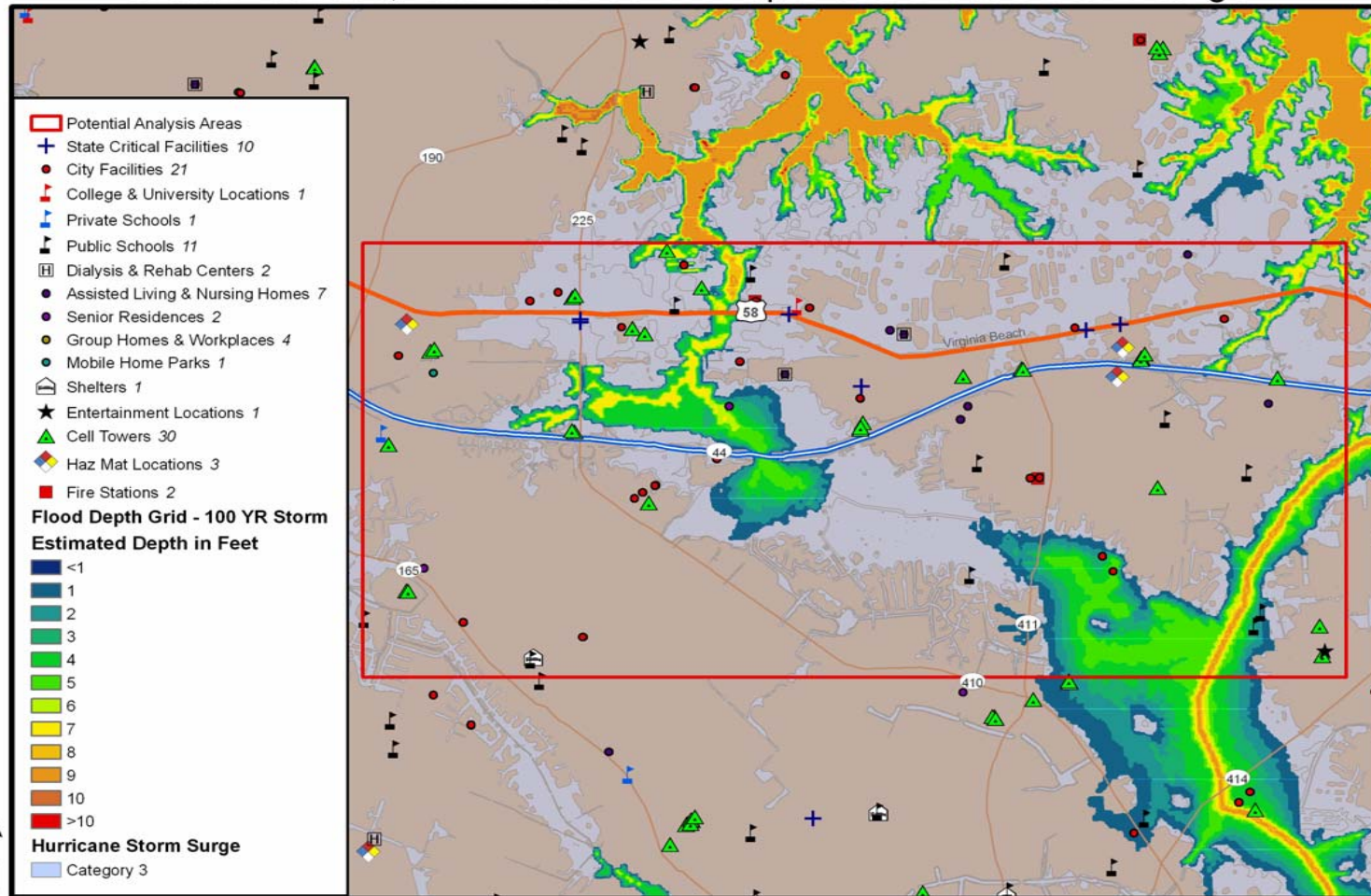
- Estimated Critical Facilities in HR Region: 2,000 - 3,000
- Potential Decision Filters
 - Availability of Infrastructure & GIS Data
 - Demography
 - Economic & Time Replacement
 - Critical Functions & Services
 - Topographic & Geographic Characteristics
 - History of Disaster Impacts
 - Infrastructure Service Characteristics
 - Organization Preferences or Priorities
 - Ownership
 - Political
- Select ~20 Representative Critical Facilities for Evaluation

Critical Facilities: Candidate Analysis Areas



Example Potential Analysis Area

Virginia Beach Potential Analysis Area Showing:
Critical Facilities, Estimated 100 YR Depth Grid & Cat 3 Storm Surge



Analysis Area is just over 11 Square Miles
and has approx. 100 Critical Facilities.

0 0.5 1 2 Miles

Modeling and Simulation

- Model Review and Selection
- Model Modification and Adaptation
- Model Validation
- Simulation of Infrastructure Interdependencies
- Simulation of Event Scenarios

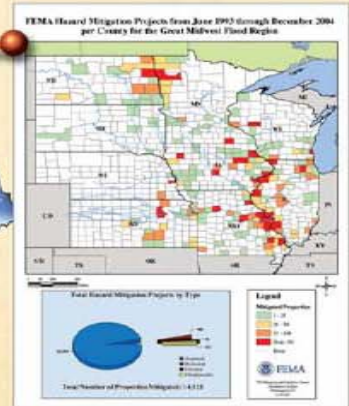
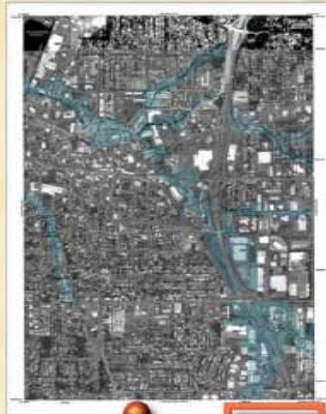


FEMA

Mapping for Decision Makers

Risk Identification

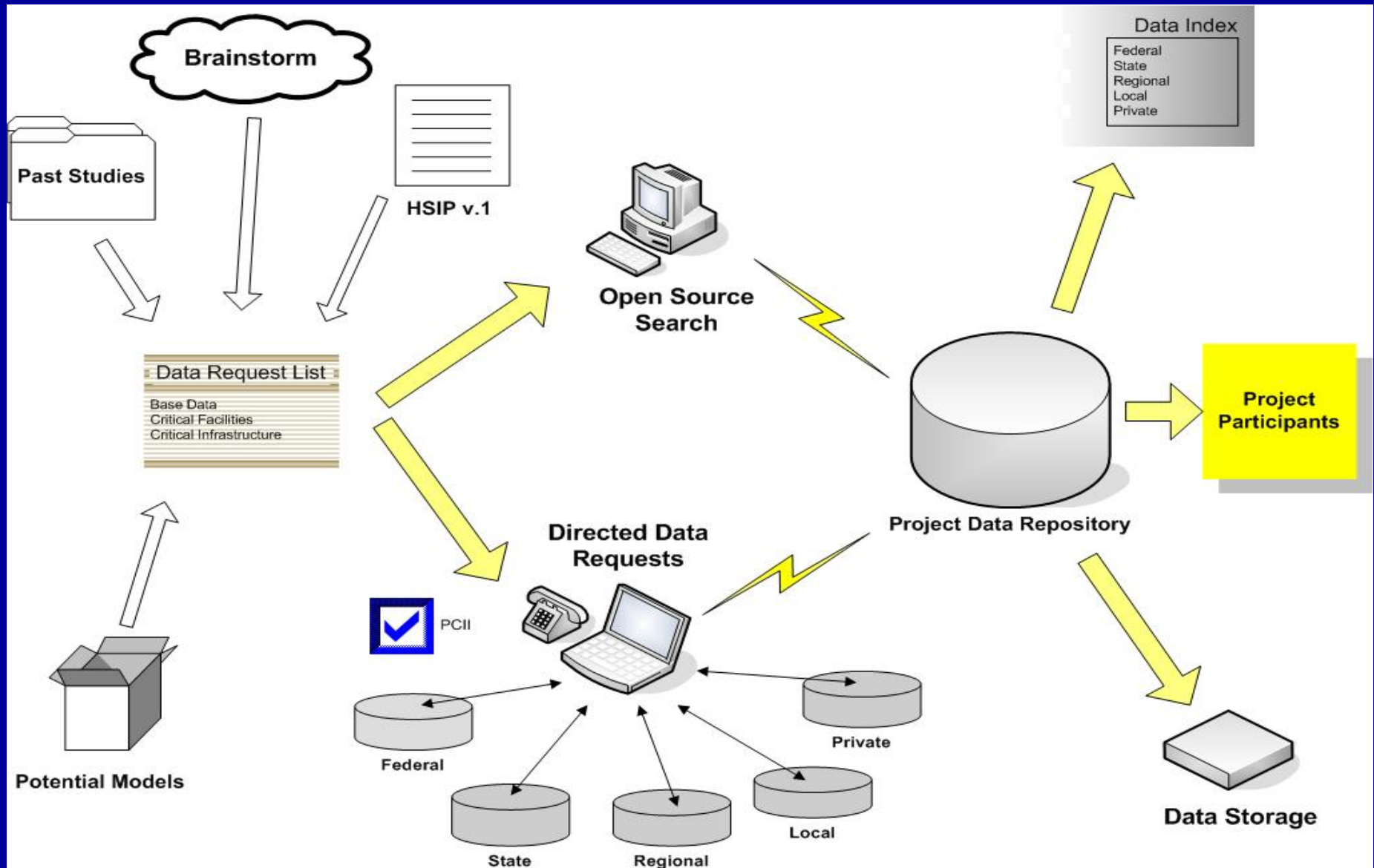
Digital Flood Insurance Rate Map (DFIRM)
Beaverton, Oregon, 2005



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Project Data Management Process



Data Collection Summary

- 16 Local Jurisdictions have GIS
- >1,000 Geospatial Data Layers (>50 GB)
- ESRI Shapefiles with Attribute Tables
- Some Geodatabases

Data Sources

- **Federal**
 - DOT
 - FCC
 - NGA (HSIP-Gold)
 - NOAA
 - USDA
 - USGS
- **State**
 - VGIN
 - VEDP
 - VDEM
 - VDEQ
 - VIMS
- **Regional**
 - HRSD
 - HRPDC
- **Local**
 - 16 Local Jurisdictions
- **Private**
 - Telecommunications
 - Natural Gas Utility
 - Electrical Utility
 - ESRI
- **Other**

Data Management Issues

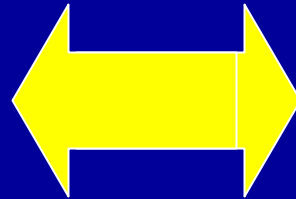
- **Lack of Metadata (*Data about Data*)**
- **No Common Data Format**
- **Critical Facilities**
 - Format
 - Symbology
- **Difficulty in Obtaining Certain Data**
 - Private Utility Sources
 - Federal - HSIP Gold (NGA/USGS) and iCAV (DHS)

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The Dilemma

We must *protect*
our data to help
keep us safe



We must be able to
see/use the data to
help *protect* us

Relevant Issues

- Hazards don't recognize political boundaries
- Infrastructure is often multi-jurisdictional
- Resiliency Planning requires spatial knowledge
- Planning requires intra- and inter-agency coordination
- Is the right spatial data available?
- Data security? How much?

Collaborative GIS Framework

- Adopt **common data format**
- Ensure **adequate metadata**
- Create a **distributed data sharing structure** -
 - Establish Cooperators Council
 - System to allow “looking but not touching”
 - Data owners retain and update data
 - Share with appropriate security
 - Joint modeling training and application

Do You Know Your Critical Infrastructure?



End Slideshow

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VA Emergency Management Association (VEMA) Annual Conference

- March 11-14, 2008
- Hampton Roads Convention Center
- GIS and Emergency Management Day
 - Preparedness
 - Response
 - Recovery
 - Mitigation
 - Resiliency
 - HAZUS

Data Opportunities

- **Regional Multi-Organization Data Collaborative**
 - Data Consistency (structure, format, metadata)
- **Training and Model Applications –**
 - Regionally-coordinated HAZUS-MH3 Modeling
 - Future Critical Infrastructure Resiliency Interdependency Modeling
 - Future Critical Infrastructure Resiliency Decision Modeling
- **Emergency Management Activities**

Base Map



Industrial Parks



Flood Plain



Danville, VA

Major Roads & Traffic Signals



Transit, Rail & Airport



Water Supply Utility



Wastewater Utility



Gas Utility Network



Analysis Objectives

- Characterize Current Infrastructures: Communications, Energy, Transportation, & Water
- Identify Vulnerabilities of Critical Jurisdiction & Infrastructure Facilities
- Identify Major Infrastructure Interdependencies
- Examine Impacts of Potential Cascading Failures
- Identify Opportunities to Isolate or Limit Cascading Failures

Vulnerable Population Facility Examples

Medical & Mental Health Facilities

- Hospitals
- Medical centers
- Clinics
- Kidney Dialysis centers
- Hospice

Schools

- Primary, Secondary, High
- Colleges, Universities
- Trade
- Public, private & religious
- Day-care centers

Correction Facilities

- Juvenile, adult, other
- City, County, State, Federal

Nursing & Recovery Facilities

Assisted Living Facilities

- Medical
- Mental Health
- Half-way houses

Retirement Facilities

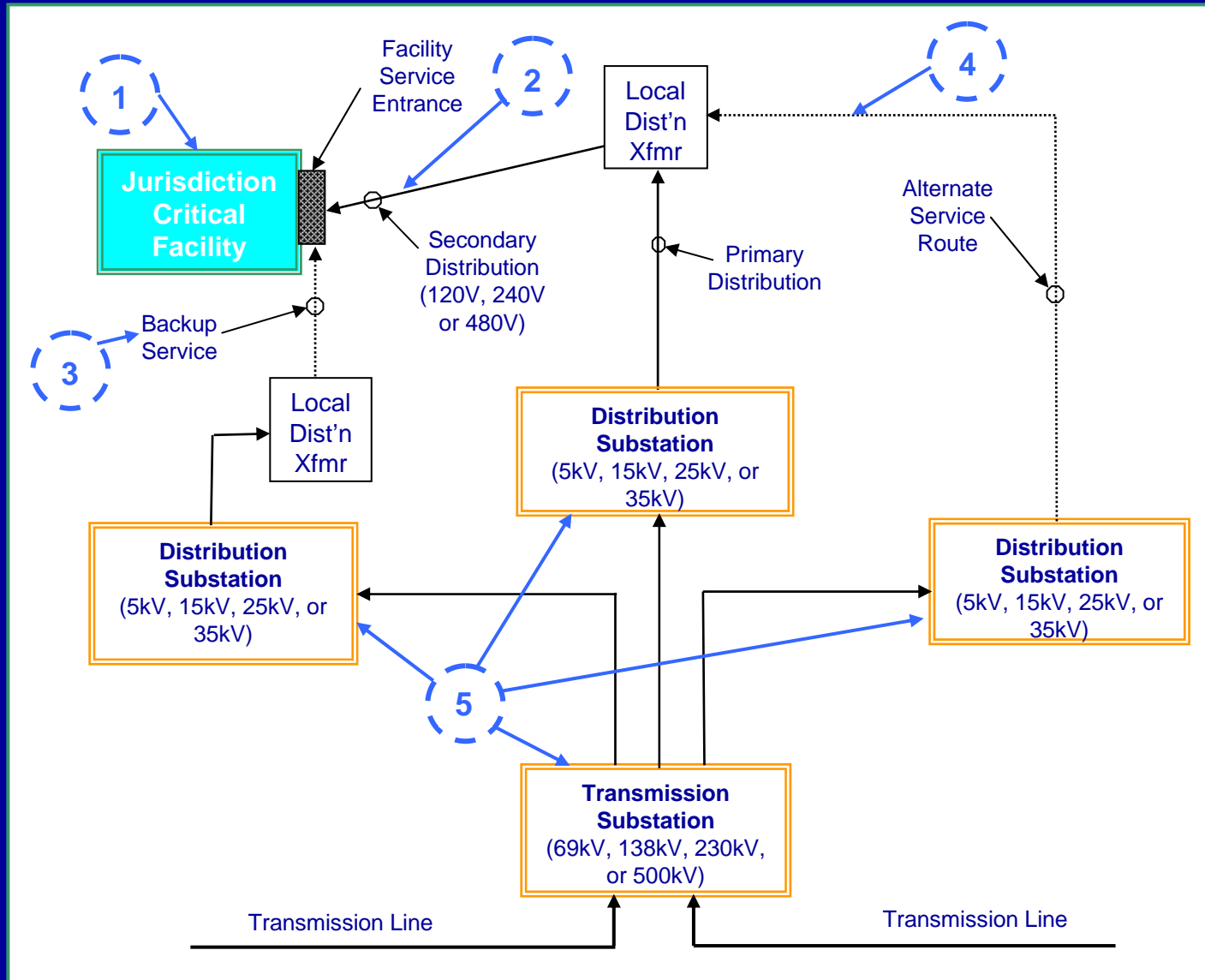
- Group homes
- Apartments/Condos
- Retirement communities

Social Service Facilities

- Salvation Army, Goodwill Industries
- United Way
- Religious
- City, County, State, Federal

Recreational/Social Facilities

Example: Electric Service Analysis

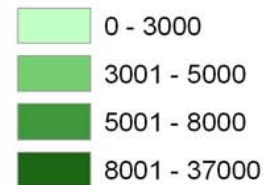


Infrastructure Interdependency Matrix

	Communications	Energy	Transportation	Water
Communications				
Energy				
Transportation				
Water & Wastewater				

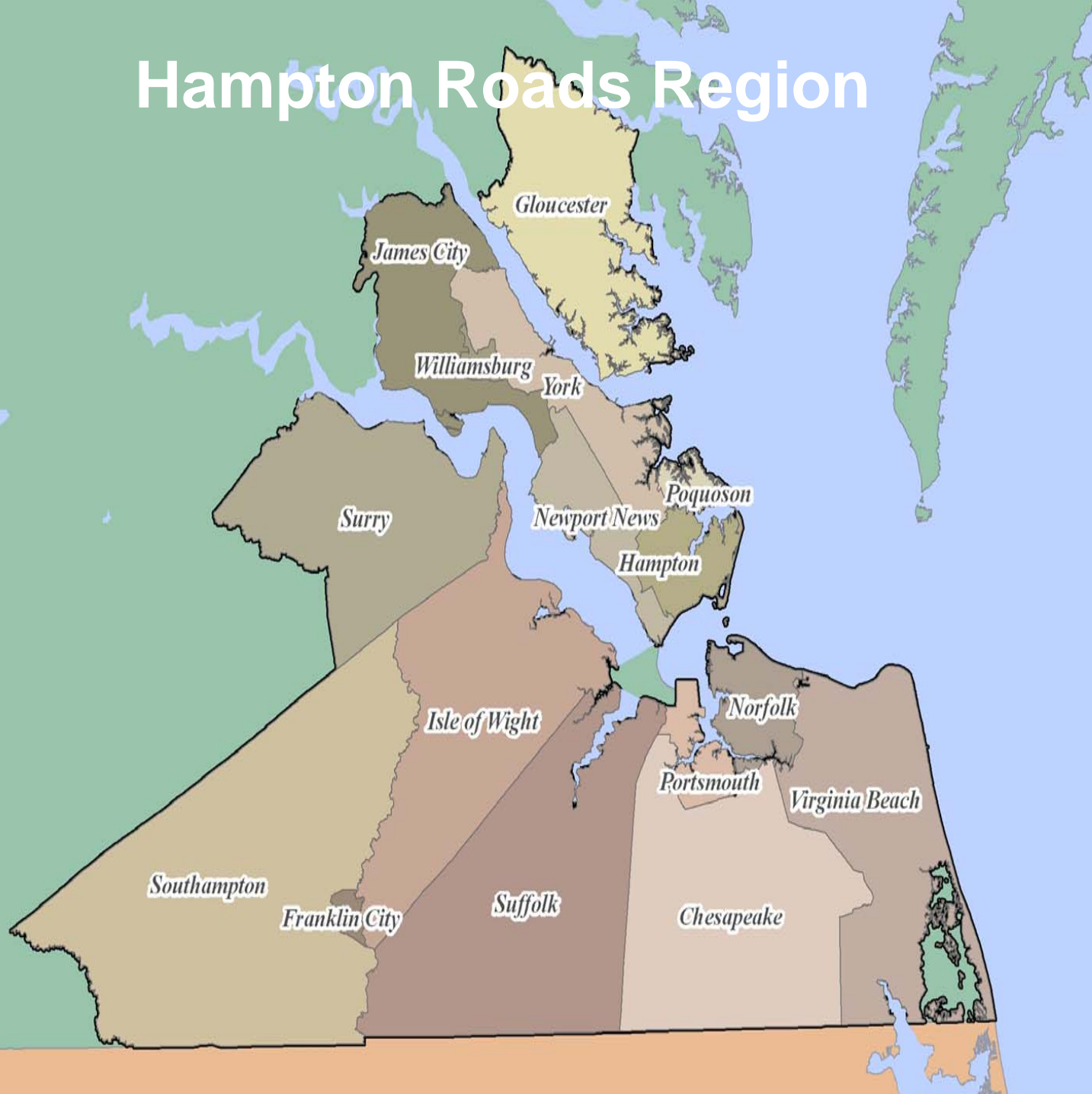
Population Concentrations

Population Yr 2000



Total population by
census tract

Hampton Roads Region



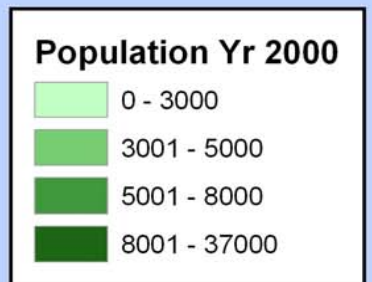
CAT-4 Hurricane Storm Surge



This map illustrates the projected storm surge for a Category 4 hurricane striking the Chesapeake Bay region. The surge is represented by a color-coded overlay on a topographic map, with red indicating the highest surge levels (likely above 10 feet) and transitioning through orange and yellow to green and blue for lower surge heights. The map includes the Delmarva Peninsula, the Maryland and Virginia portions of the Chesapeake Bay, and the surrounding coastal areas. Numerous small colored dots are scattered across the landmasses, representing the locations of essential facilities as identified by the HAZUS-MH2 model. The legend in the bottom right corner identifies these dots as 'Essential Facilities, HAZUS-MH2'.

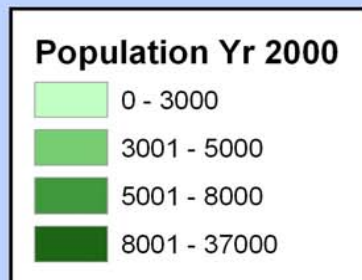
● Essential
Facilities,
HAZUS-MH2

CAT-3 Hurricane Storm Surge



Total population by
census track

CAT- 4 Hurricane Storm Surge



Total population by
census track

Recent Wastewater Spill

