

Delaware's Vulnerability to Sea Level Rise and Adaptation Options

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Overview

- Sea level rise rates, future scenarios and importance of planning
- Highlights of statewide vulnerability assessment
- Adaptation options



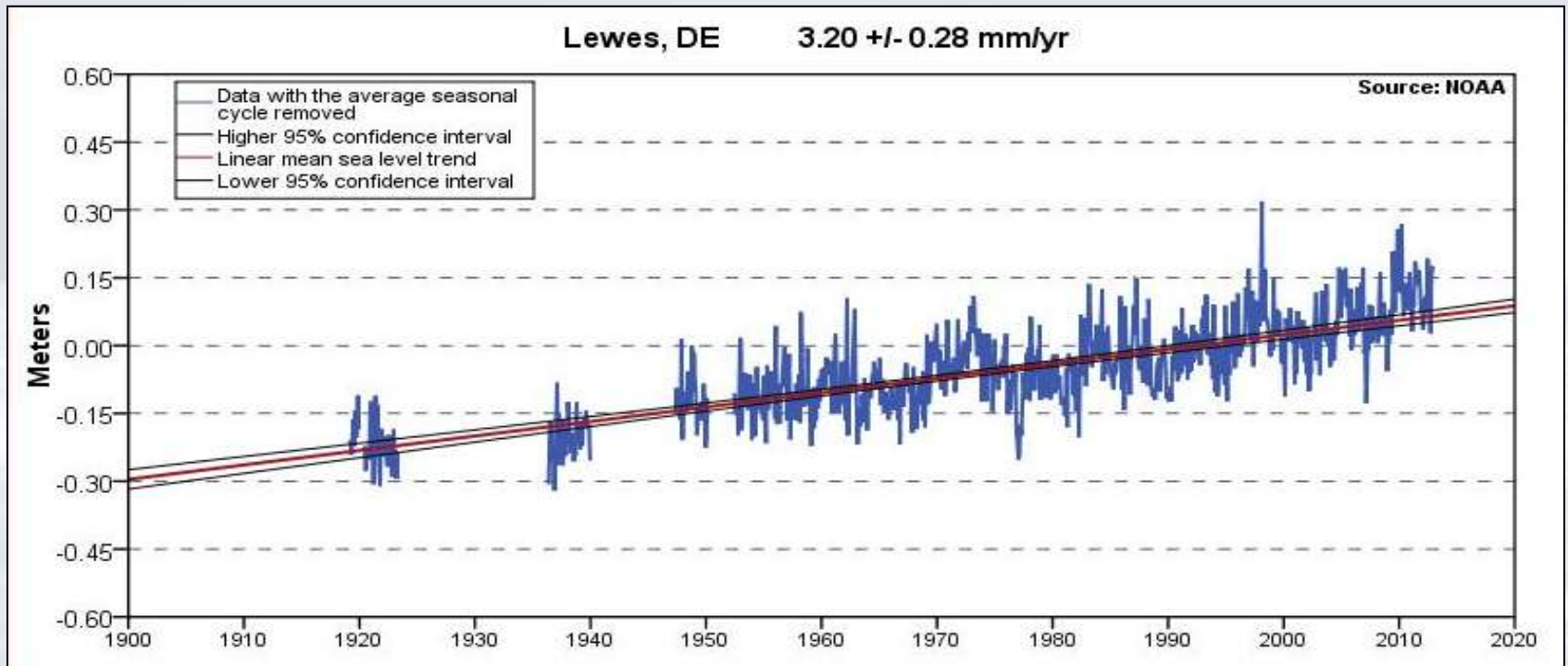
Sea Level Rise is...

- Increase in average tide height over time as a result of:
 - ✓ Thermal Expansion
 - ✓ Melting of glaciers & ice caps
- Influenced locally by *subsidence*



Annual Rate of Sea Level Rise

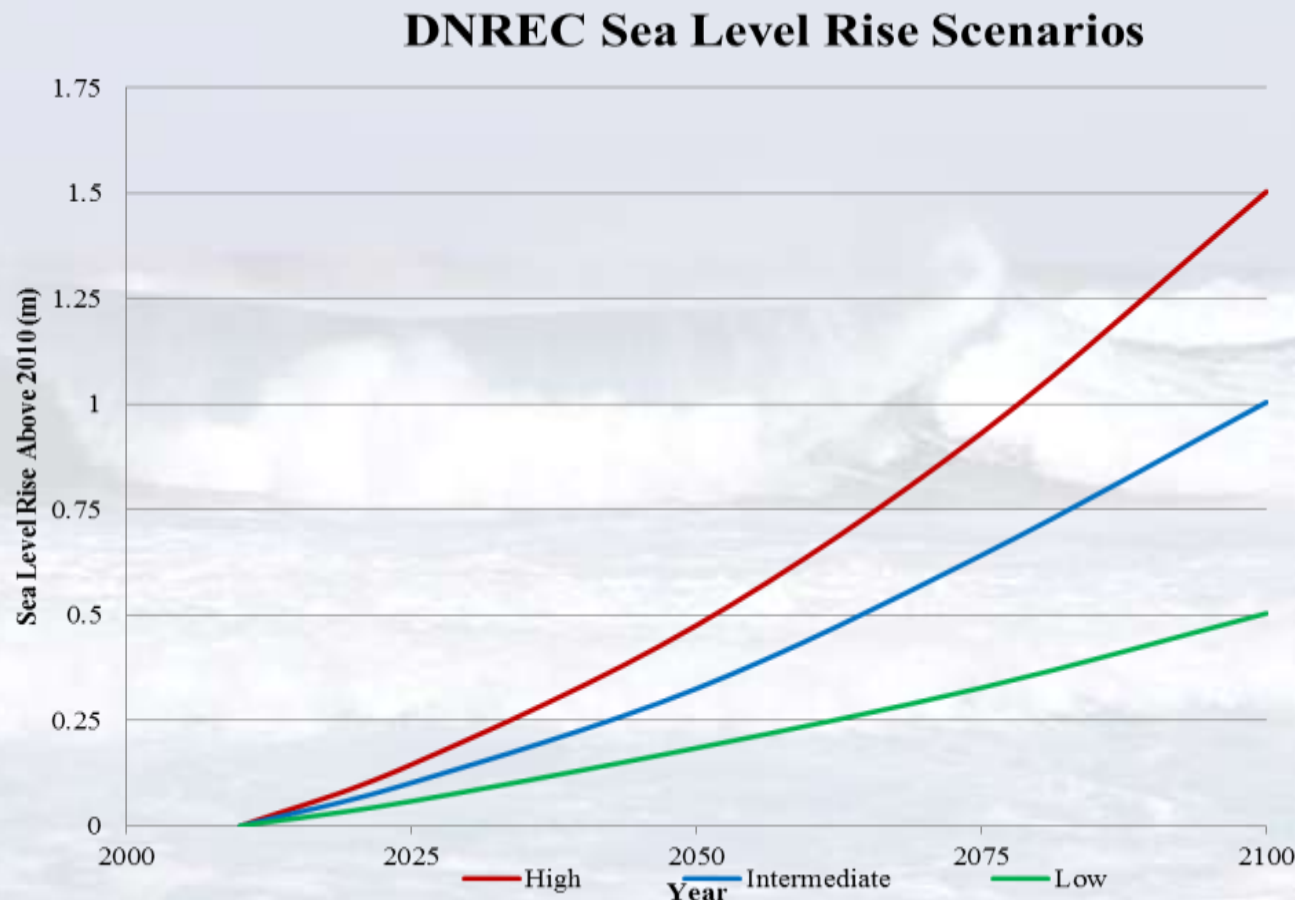
**Average annual rate in DE = 3.35 mm/yr
(13 Inches/100 years)**



Global rate = 1.7 mm/yr



Rates of SLR are very likely to accelerate in the future



Potential Impacts of Sea Level Rise

- Increased extent of periodic flooding
- Permanent inundation of coastal areas
- Saltwater Intrusion
- Economic & Social Impacts



Today's flood is tomorrow's high tide

- Ash Wednesday '62
 - ✓ Lewes, 4.6ft over MHHW
- Mothers Day '08
 - ✓ Lewes, 3.24ft over MHHW
- Veterans Day '09
 - ✓ Lewes 3.23ft over MHHW
- Sandy, 2012
 - ✓ Reedy Point—3.26ft over MHHW
 - ✓ Lewes—4.6ft over MHHW
- Dec 21, 2012
 - ✓ Reedy Point—3.36ft over MHHW



Planning for Sea Level Rise

- Land use & public works decisions have long life-span
 - ✓ Wise use of public funds and reduction of future risk
 - ✓ SLR rarely a consideration in project planning currently
- Minimize storm impacts
- Delawareans support it
 - ✓ 76 % think SLR will impact their area in 100 years. 14% say it already is
 - ✓ Of those, 80% say we should ***take action before impacts occur***



Goal of Sea Level Rise Advisory Committee

The goal of the Sea Level Rise Advisory Committee is to assess Delaware's vulnerability to current and future inundation problems that may be exacerbated by sea level rise and to develop a set of recommendations for state agencies, local governments, businesses and citizens to enable them to adapt programs, policies, business practices and make informed decisions.

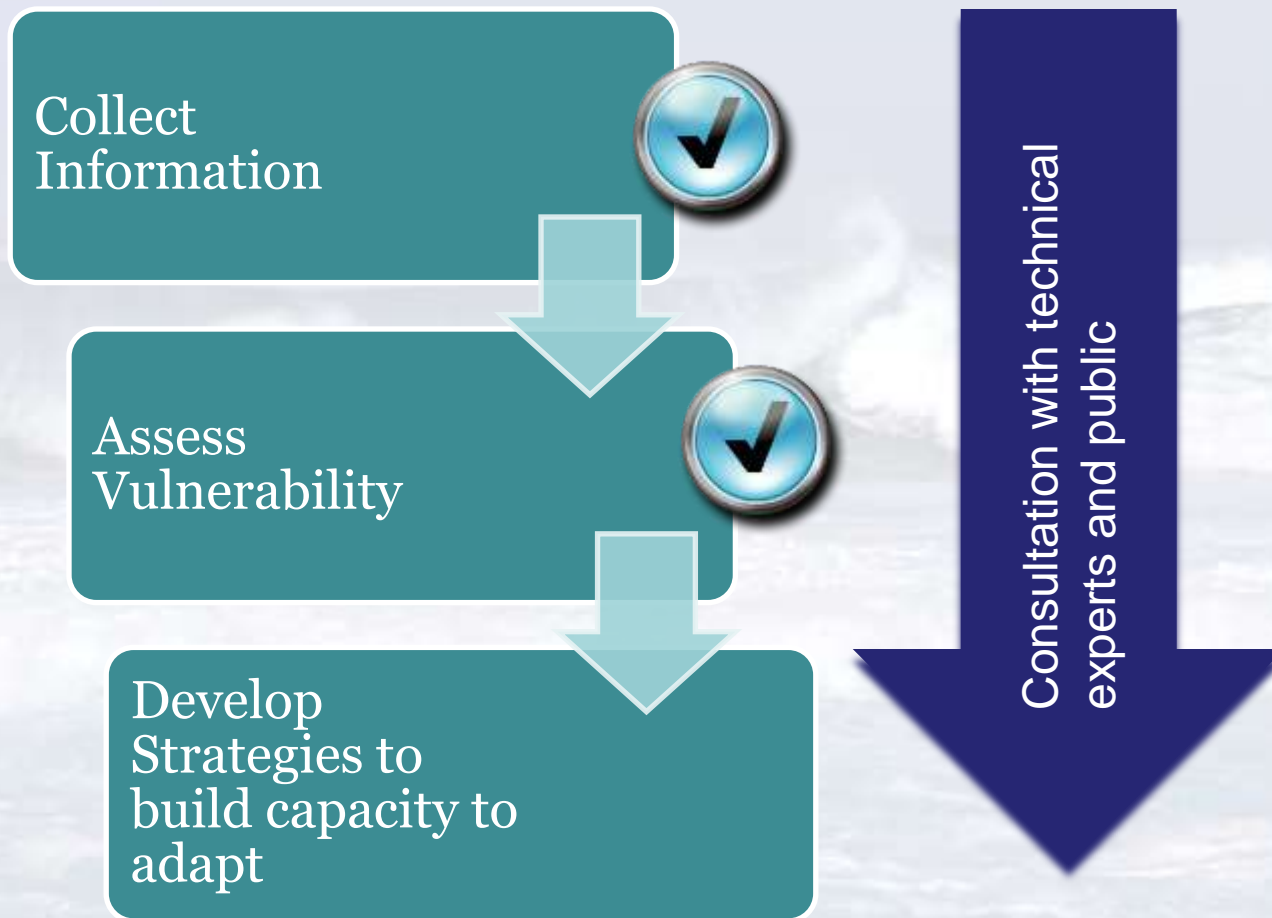


A SLR Adaptation Plan for Delaware

- A call to Action
- A document that explains, informs and guides adaptation responses
 - ✓ Guiding Principles
 - ✓ Case Studies
 - ✓ Build in Flexibility
- Outlines recommendations to to build capacity to adapt to sea level rise



Steps to an Adaptation Plan



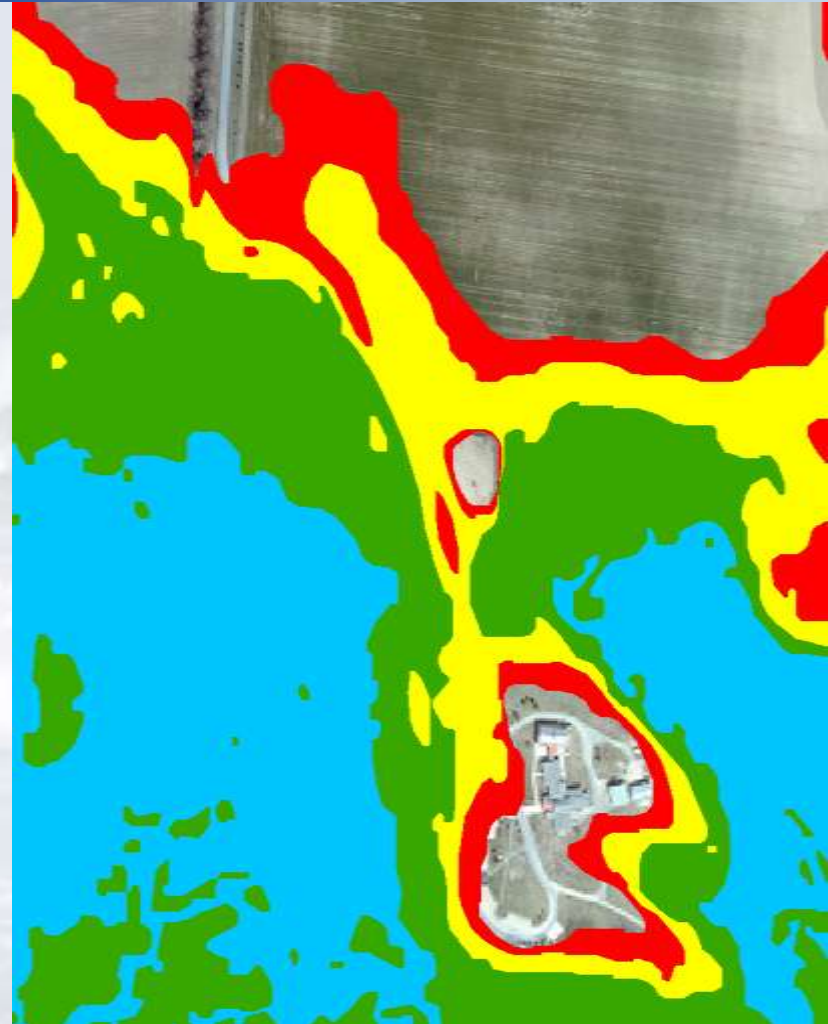
Adapted from NOAA (2010). Adapting to climate change: a planning guide for coastal managers



Sea Level Rise Scenario Maps

DNREC Planning Scenario Maps

- ✓ Bath-tub Model – does not account for future changes in shoreline or elevation
- ✓ High resolution aerial photography (LiDAR)
- ✓ For planning purposes only



Determining Vulnerability: Exposure, Impact and Risk

■ Exposure Analysis

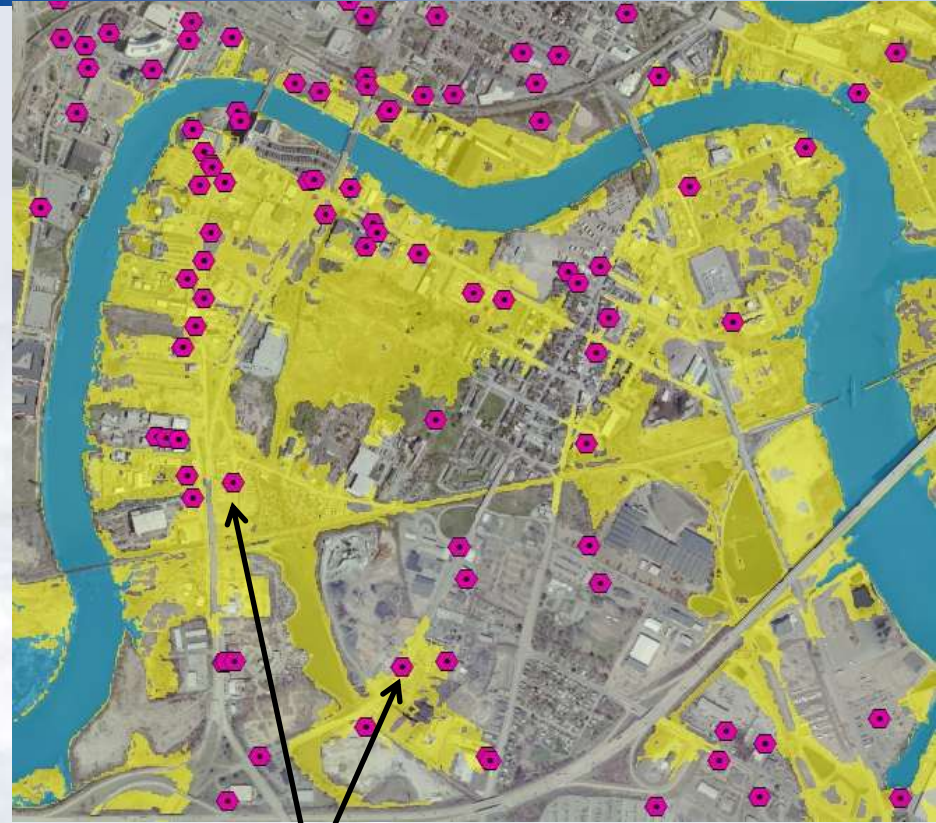
- ✓ Quantitative assessment
- ✓ Numbers and locations of resources potentially inundated were identified

■ Impact Assessment

- ✓ Qualitative
- ✓ Direct and secondary social, economic and environmental impacts

■ Risk Assessment

- ✓ Qualitative finding
- ✓ Based upon geographic extent of exposure and geographic extent of impacts



Potential Exposure of Underground Storage Tanks at 1.0 meter sea level rise



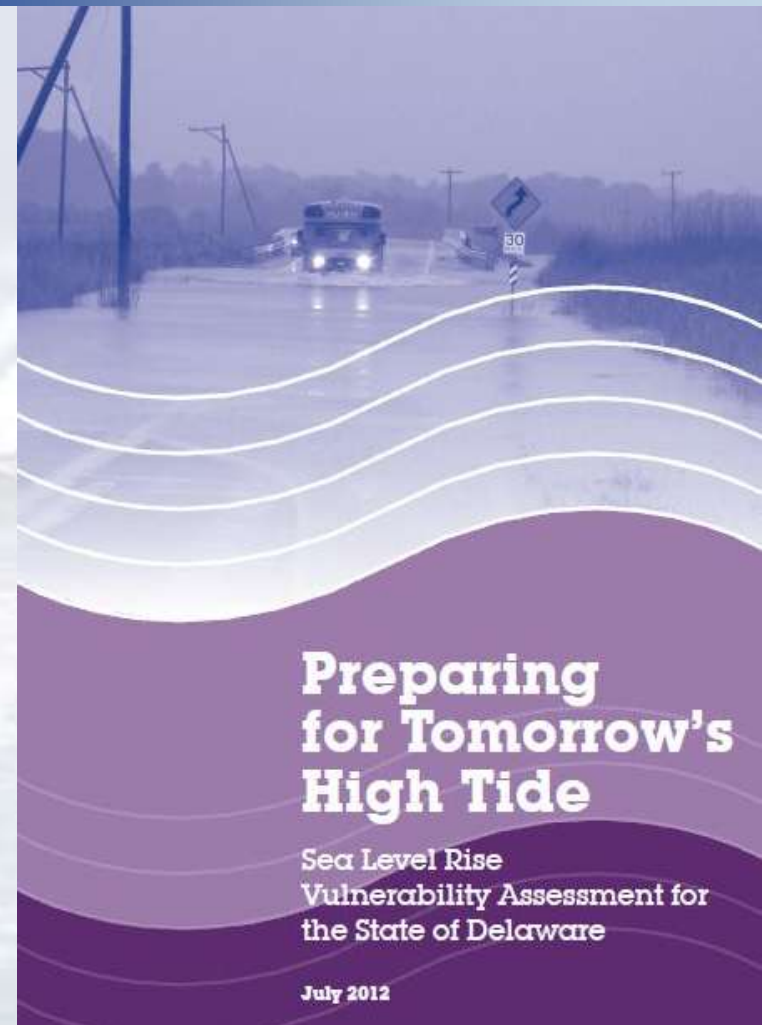
Vulnerability Assessment: Data Gaps

- Human responses
- Ability of land to keep pace naturally
- Extent of saltwater intrusion
 - ✓ Groundwater
 - ✓ Surface water
- Effects on depth to water table



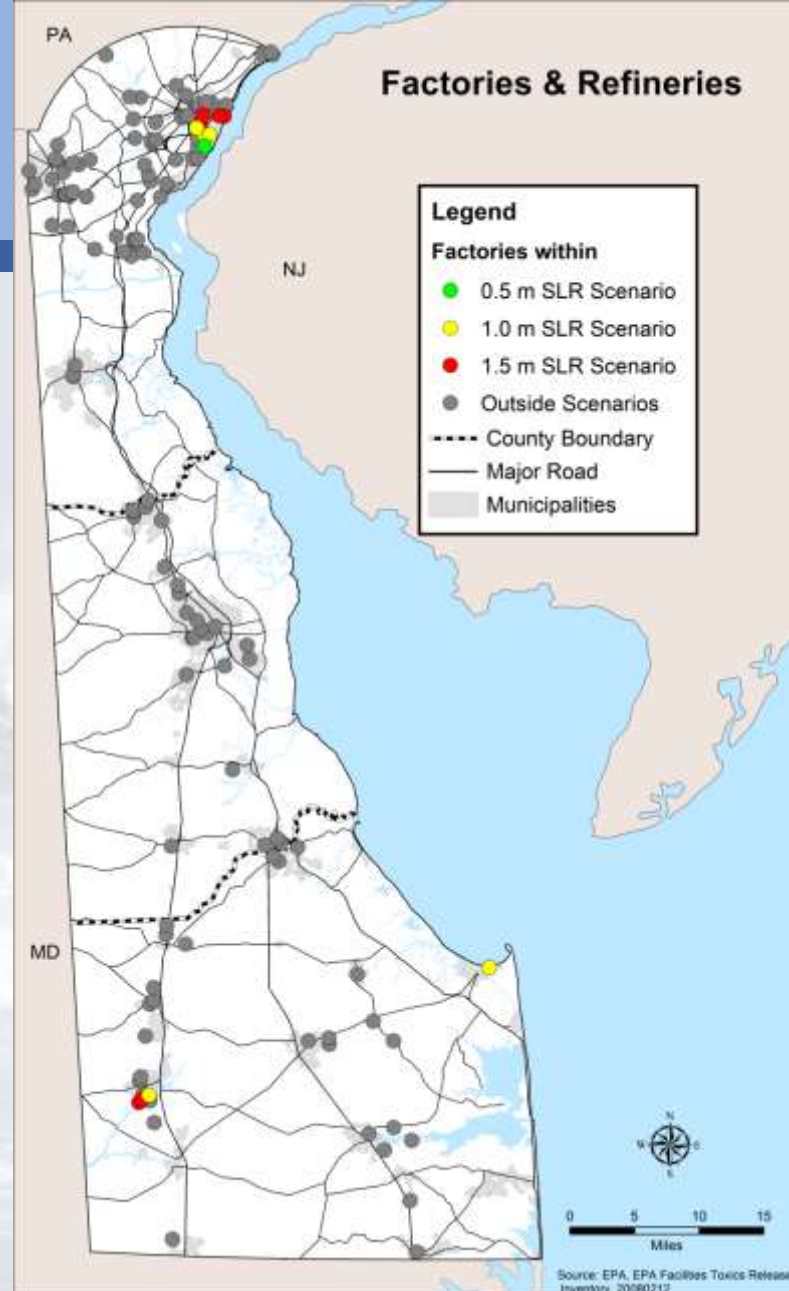
Vulnerability Assessment: Results

- Potentially Inundated
 - ✓ 8-11% Total Land Area
 - ***Tax assessed value \$1.5 B***
 - ✓ Direct effects in all counties and 31 towns
- Of highest concern statewide:
 - ✓ Industrial Areas and Port
 - ✓ Railroads, roads and evacuation
 - ✓ Dams and Dikes
 - ✓ Future development areas
 - ✓ Tourism/coastal recreation
 - ✓ Habitats and protected lands
 - ✓ Wells



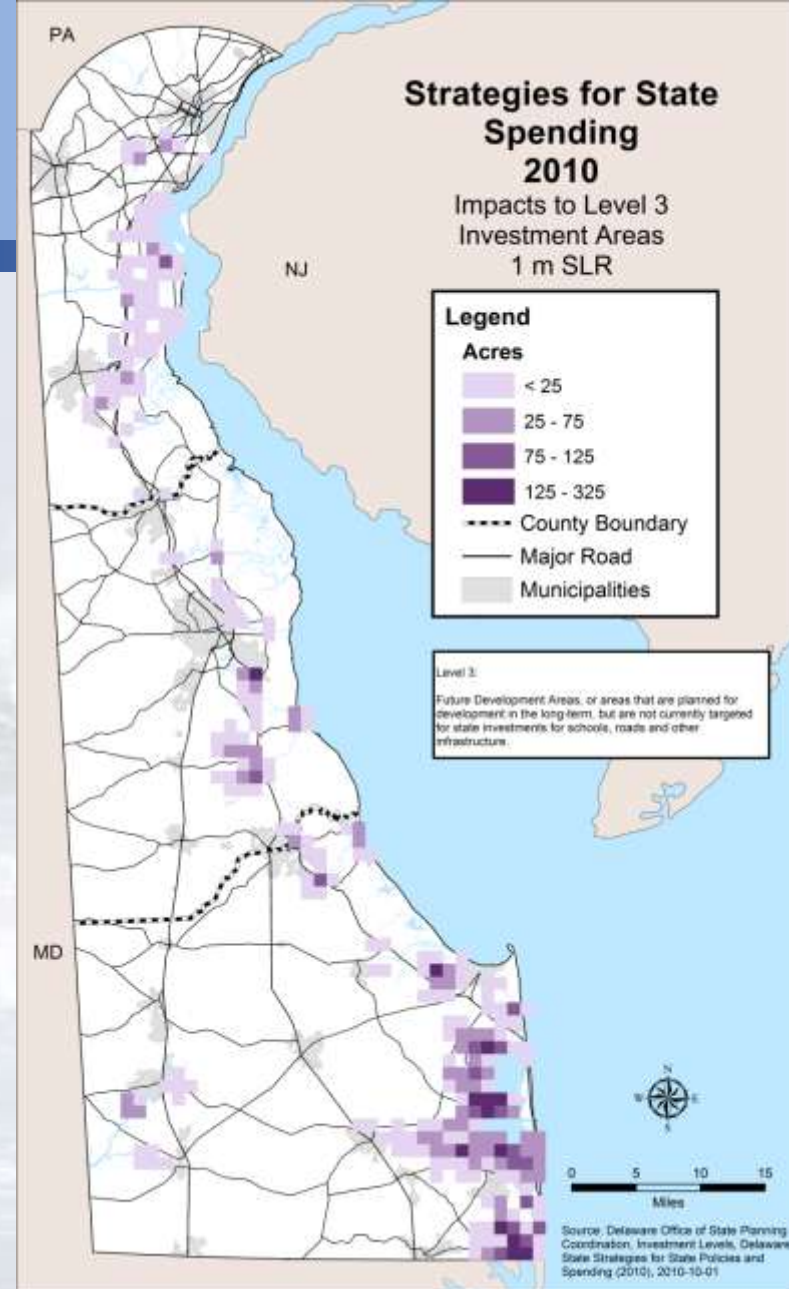
Industrial Areas

- 16%-25% of 4,000 acres permitted by CZA potentially inundated
 - ✓ Primary NCCo
- Impacts
 - ✓ Inundation of associated structures
 - ✓ Limited ability to relocate within state
- Statewide economic impact
- Potential for contaminant release
- Ranked as high



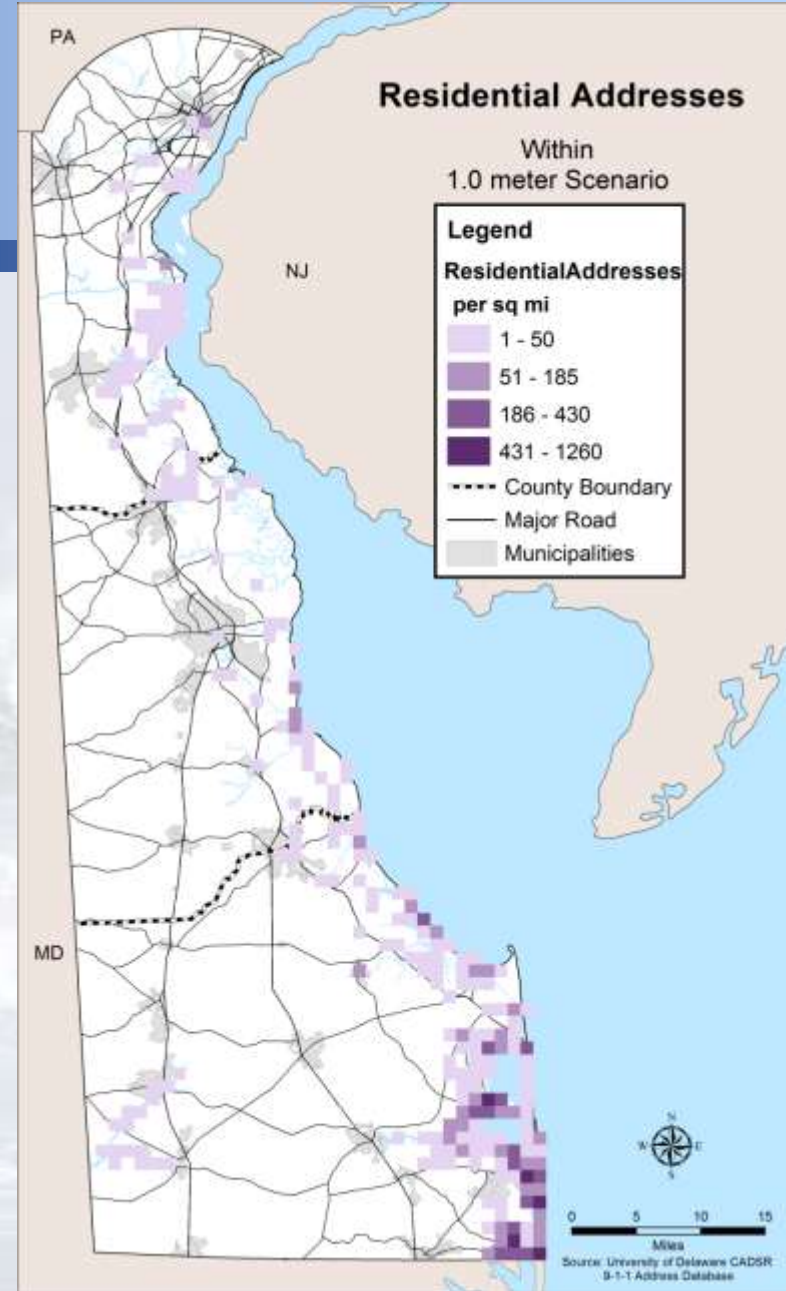
Future Development Areas

- 3%-7% of 152,000 acres of Level 3 areas potentially inundated
 - ✓ 4/5 in Sussex County
- Impact
 - ✓ Reduced growth zones
 - ✓ Challenge to redirect growth without limiting choice
- Statewide potential impacts for state funding, legal concerns.
- Ranked as high



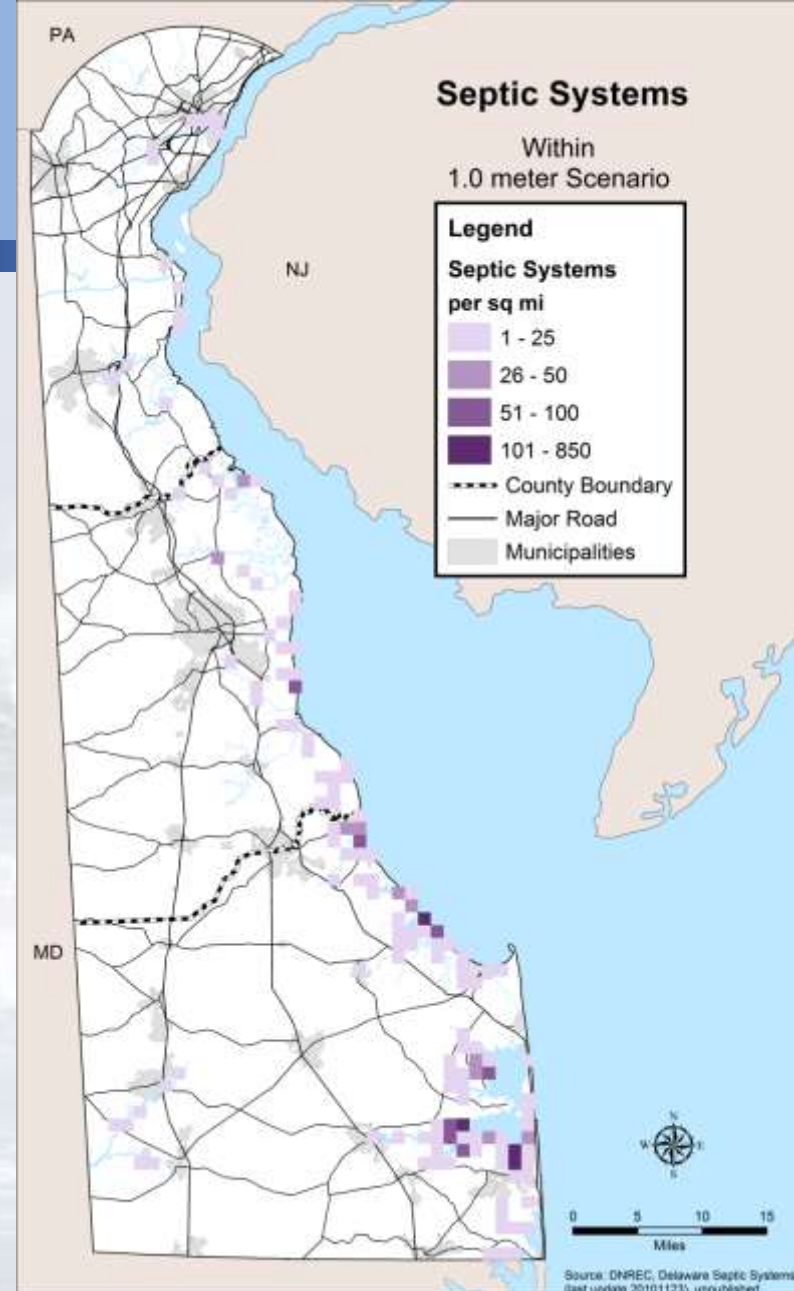
Residential

- 1%-5% of 346,000 addresses potentially inundated
 - ✓ Up to 32% of manufactured homes in Sussex
 - ✓ Up to 13% (15,000) homes in Sussex
- Impacts
 - ✓ Flood damage, insurance costs, access, community
- Varying ability to adapt
- Primarily County level impact
- Ranked as moderate



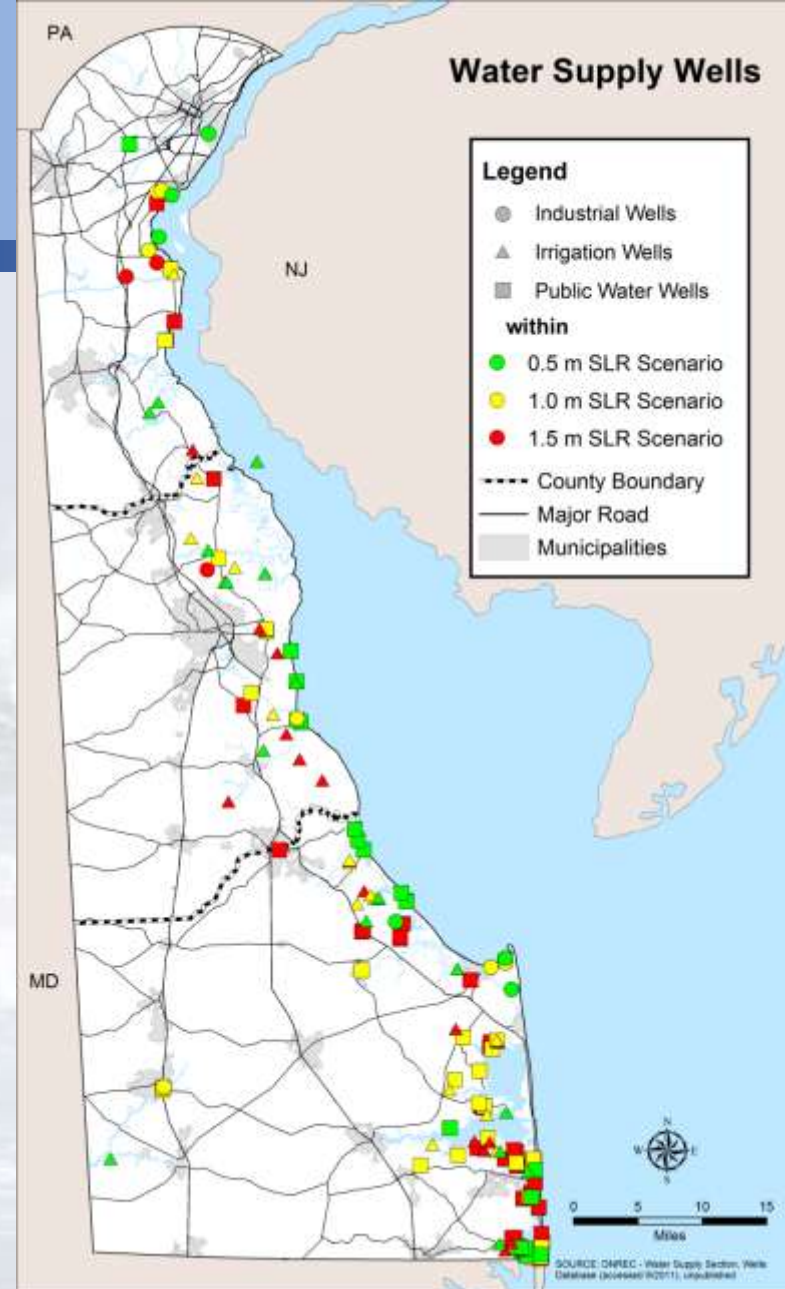
Septic Systems

- 1% - 4% of 78,000 potentially inundated
- Greatest exposure found in Sussex
 - ✓ High concentration along Inland Bays
- Functionality concerns before inundation
 - ✓ Rising water tables
- Ranked as moderate



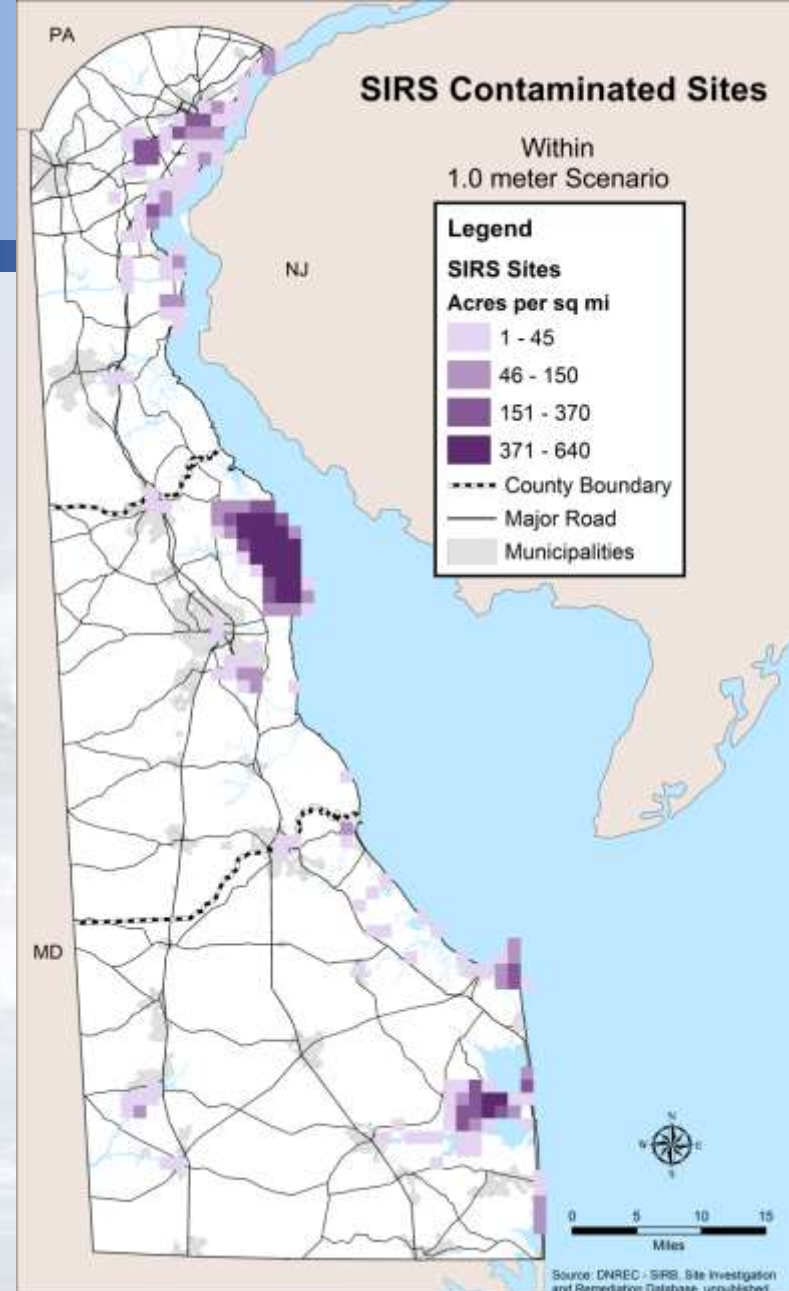
Wells

- Potentially inundated
 - ✓ Domestic wells: 3% - 7%
 - ✓ Industrial wells: 3% - 7%
 - ✓ Irrigation wells: 1% - 2%
 - ✓ Public wells: 2% - 10%
- Water supply concerns
- Saltwater intrusion may impact inland wells
 - ✓ Statewide concern
- Ranked as high



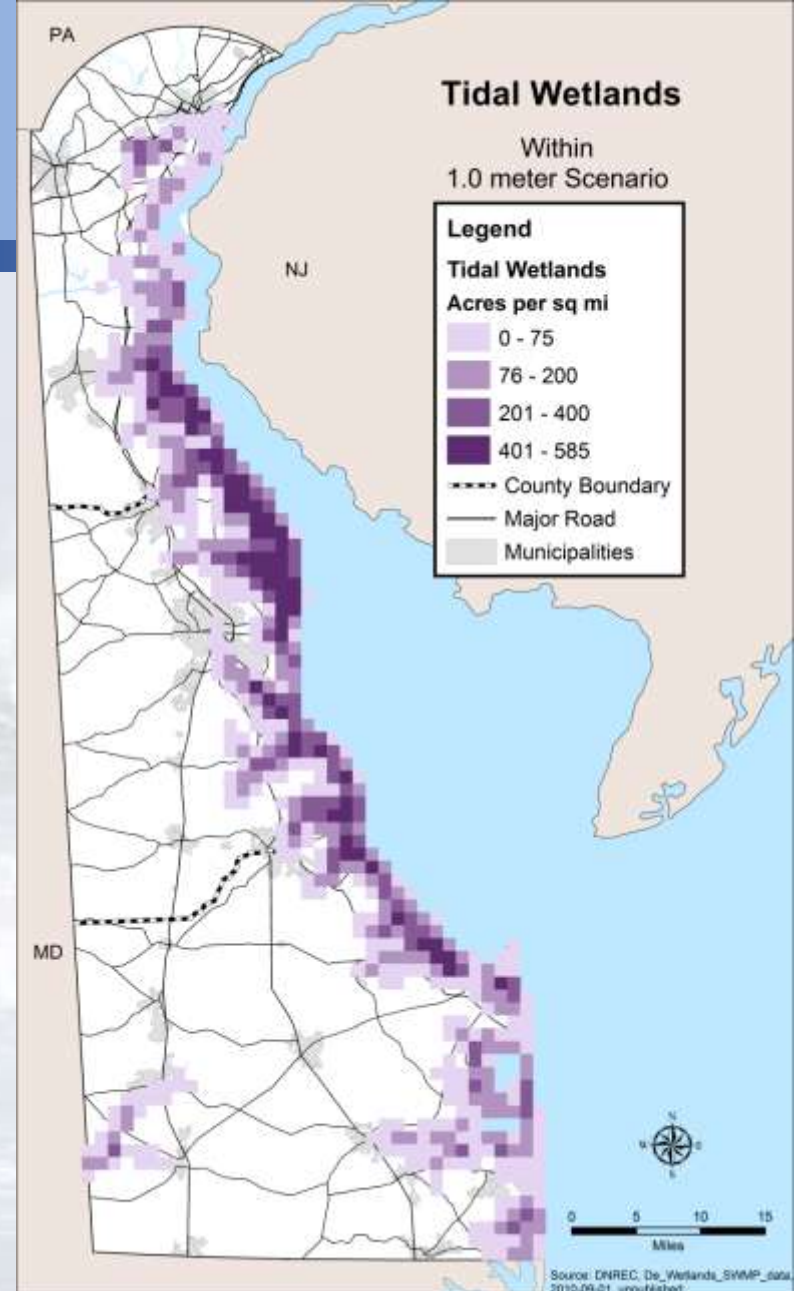
Contaminated Sites

- 41% - 54% of 60,000 acres potentially inundated
- 33% - 44% of 785 sites
- Exposure focused in:
 - ✓ Wilmington region
 - ✓ Bombay Hook
 - ✓ Inland Bays
- Potential for contaminant release
- Ranked as low



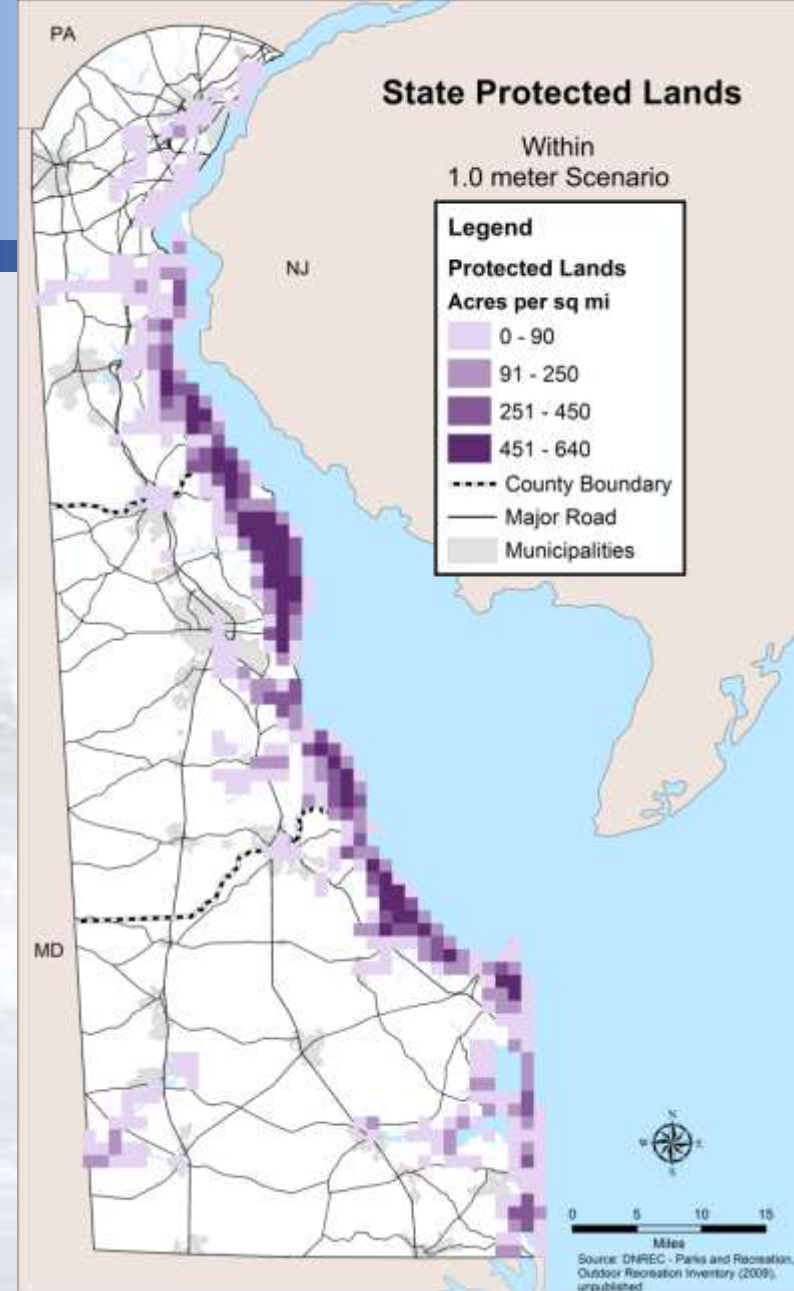
Tidal & Freshwater Tidal Wetlands

- Tidal
 - ✓ 97% to 99% of 73,000 acres potentially inundated
- Freshwater Tidal
 - ✓ 84% to 98% of 11,000 acres potentially inundated
- Conversion to open water
- Future salinity changes potential issue for tidal fresh
- Ranked as high



Protected Lands Statewide

- 37% to 44% statewide potentially inundated
- Includes
 - ✓ State owned lands
 - ✓ federal refuges
 - ✓ municipal holdings
 - ✓ public and private conservation easements
- Represent a variety of habitat types and outdoor recreation opportunities



The sky is not falling!



A Range of Adaptation Responses

- Protect
- Accommodate
- Retreat
- Avoid



These fashionable high-heeled flippers are an Accommodation strategy for sea level rise



Protect

Building structures designed to keep water away. This includes sea walls, bulkheads, dikes, living shorelines and beach replenishment.



Burtons Island



Accommodate

Reducing flood damage while living with its effects . This includes raising homes and roads, early evacuations and living by the tides.



Planned Retreat

Removing permanent structures from vulnerable areas in a planned and predictable way and allowing the shoreline to change naturally.



Glenville, 2003



Avoid

Identifying at-risk areas and directing new development to less vulnerable areas through voluntary measures and improved codes.



Lighthouse Cove, Fenwick Island DE



Choosing How and When to Adapt



Options for Preparing

- Coordination
- Regulatory Flexibility
- Consistent Policies for Future Growth
- Public Awareness
- Data
- Technical Assistance



Opportunities for research: Specific Options

- Development of a research and policy center...that would focus on applied research for sea level rise and adaptation
- Stormwater inundation coupled with SLR
- Storm Surges coupled with SLR
- Salinity Changes
- Ground Water Changes



Opportunities for research: Specific Options

- Human Responses to SLR and Adaptation
- Pilot projects and BMPs
- Secondary and cumulative impacts from adaptation
- Wetland migration and accretion
- Technical assistance to variety of decision-makers
- Social and Economic Costs of Adaptation



Thank you!

For more information:

Online SLR Map Viewer: <http://de.gov/slrmap>

Vulnerability Assessment: <http://de.gov/slrva>

Committee: <http://de.gov/slradvisorycommittee>

Options: <http://de.gov/adaptationengagement>

