PLANNING FOR SEA LEVEL RISE IN HAMPTON ROADS

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Hampton Roads Planning District Commission

Image Source: City of Norfolk

Image Source: David Powell

Image Source: City of Norfolk

Image Source: Ben McFarlane

Understanding Sea Level Rise

Local governments need answers to three questions.

What is happening (or will happen)?

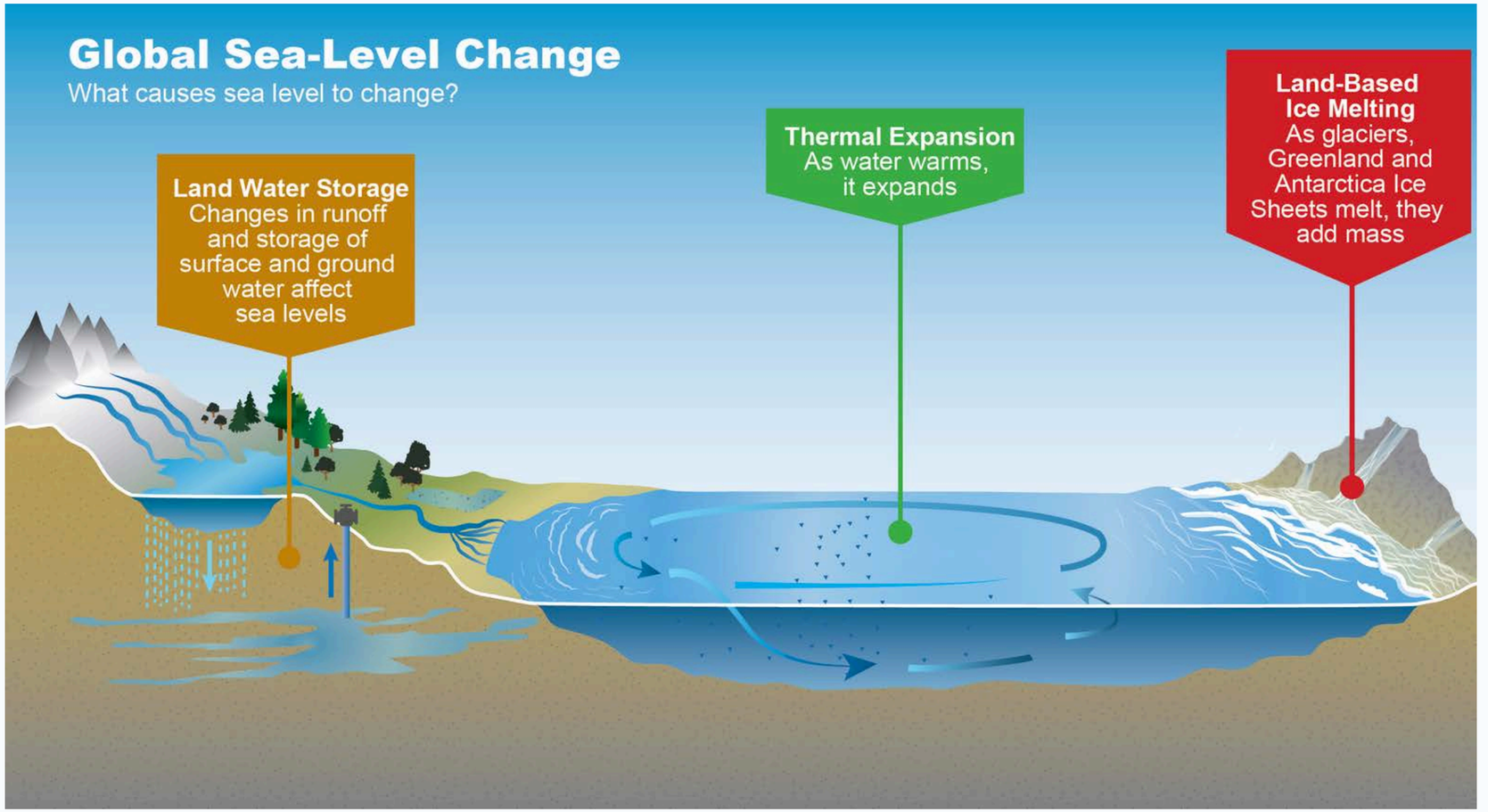
- What are the causes of sea level rise?
- How much will it rise?
- How fast will it rise?

What will the impacts be?

Is there anything we can do about it?

Global vs. Regional Sea Level Change

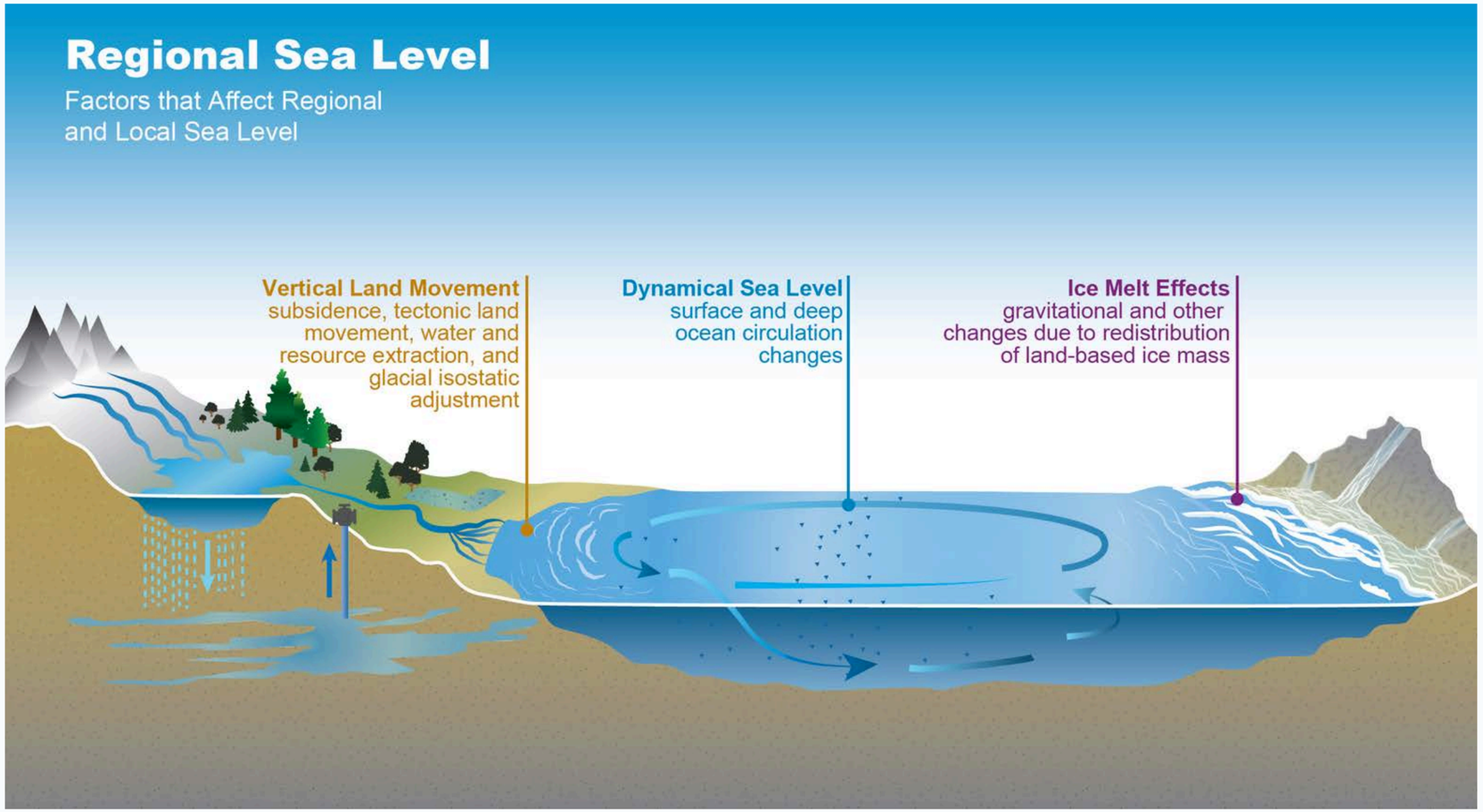
Global sea level rise is a result of changes in the volume and mass of the water in the world's oceans due to melting ice and thermal expansion.



Hall et. al (2016)

Global vs. Regional Sea Level Change

Regional or relative sea level change incorporates local trends, including vertical land movement (up or down), changes in ocean circulation, and ice melt effects.



Hall et. al (2016)

Why does it matter?

Understanding what is driving sea level change plays a critical role in decisions about what to do about it.

Some drivers of sea level change can be managed.

- Vertical land movement due to groundwater withdrawals

Some drivers have very small effects, so they can be ignored.

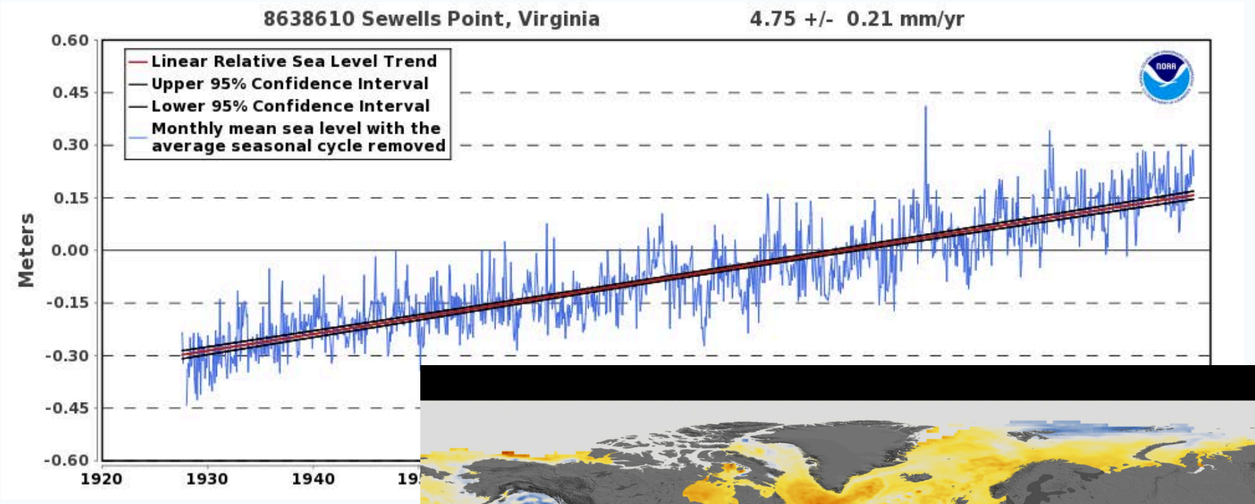
- Land compaction from heavy objects on the surface (in most places)

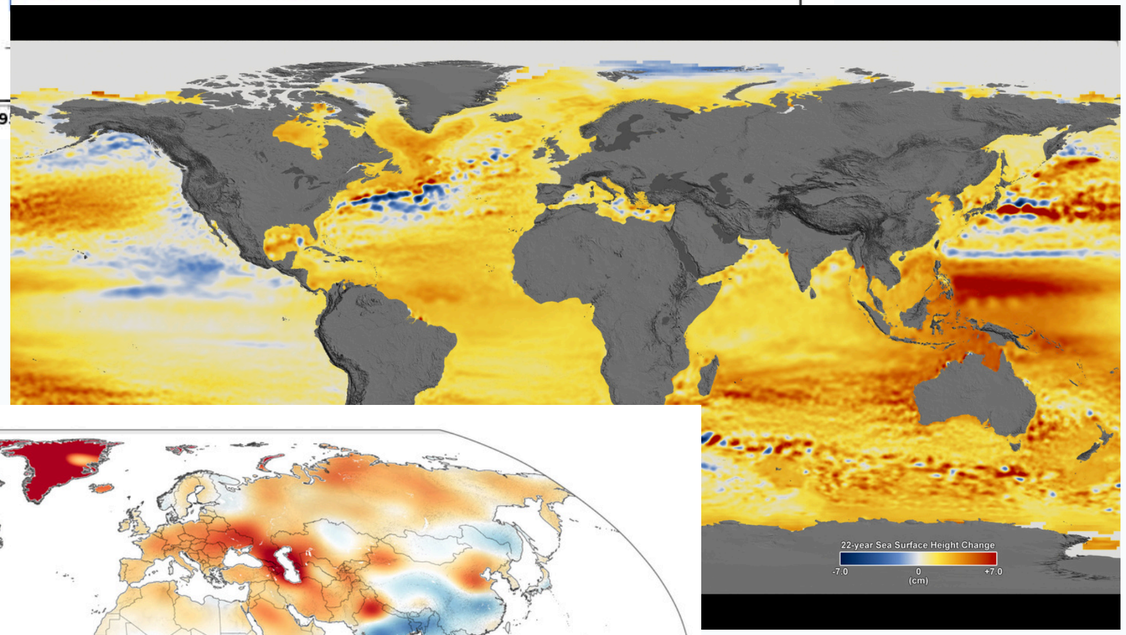
Some are relatively constant, while others are changing.

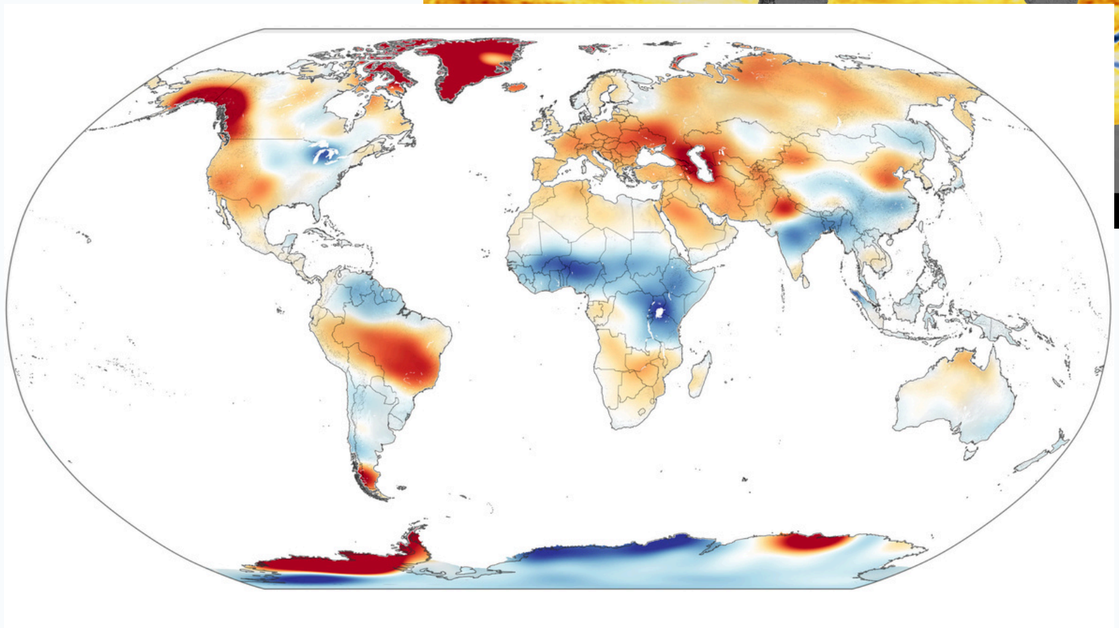
- Glacial isostatic adjustment (constant)
- Changing ocean currents (dynamic)

Measuring Sea Level Rise

Sea level trends are measured using tide gauges and satellite observations.







Vertical Land Movement

Vertical land movement can play a significant role in driving local sea level trends and potential responses.

Soil Compaction

Structures or activity on the surface can compact some types of soil.

Tectonic land movement

Motion of tectonic plates, including earthquakes, can lead to gradual or sudden changes in land elevation.

Resource Extraction

Groundwater withdrawals or oil/natural gas extraction can result in aquifer compaction or subsurface compression.

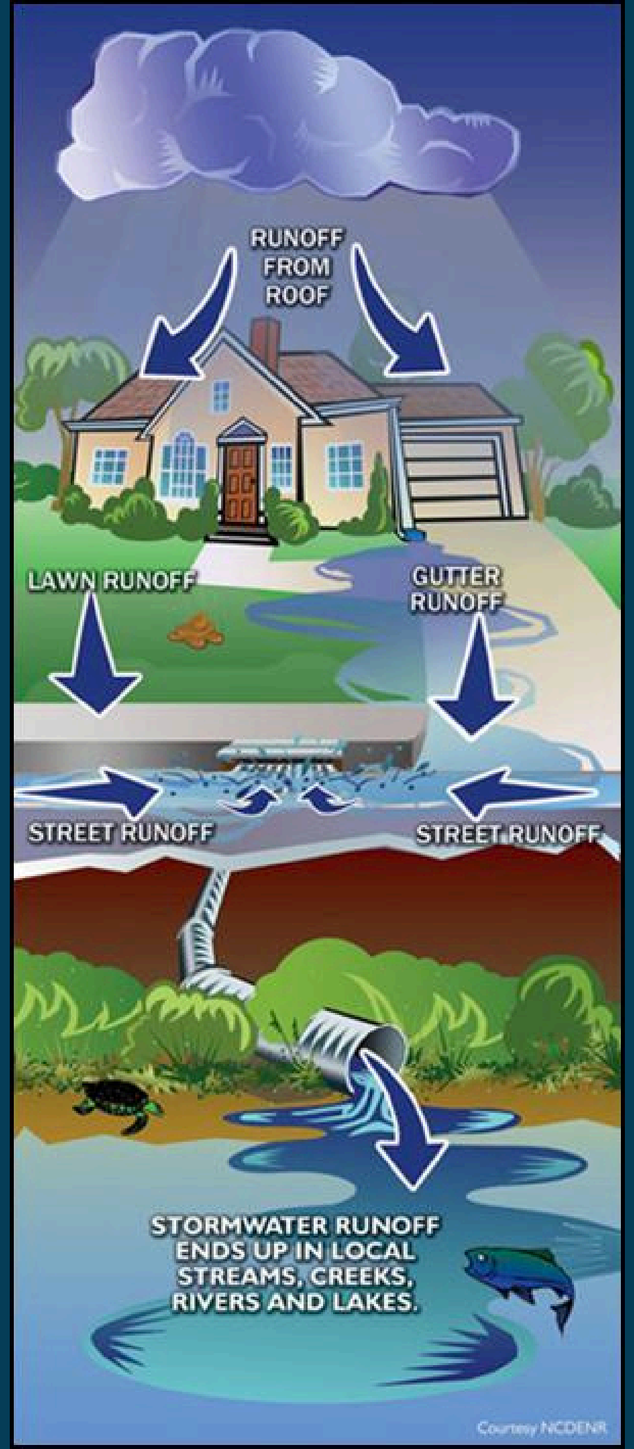
Glacial Isostatic Adjustment

Land can rebound or subside due to the recession of glaciers.

Stormwater Drainage Infrastructure

Drains in the streets and pipes connecting to streams are sized based on expected rainfall.

Pipes often drain to tidal waters and may be underwater during high tides.



Rainfall changes

Rain gauges have recently measured more frequent, larger rainfall events.

Precipitation models predict even more frequent, larger rainfall events in the future.

Stormwater infrastructure designs are based on historical rainfall data.

- State and local standards reference NOAA Atlas 14 which considered rainfall from 1948 to 2000.

If pipes and ditches are undersized for current and future rainfall, then more frequent and extensive flooding occurs.

- Old infrastructure can be rebuilt and new infrastructure can be sized for future rainfall.

PLANNING FOR SEA LEVEL RISE

Why do we need to adapt?

Hampton Roads is particularly vulnerable to sea level rise because of its history, location, and topography.

Hampton Roads is a low-lying coastal community with a long-settled, urbanized shoreline.

Several of the region's major industries are located on or near the shore (tourism, military, ship building, ports, etc.).

Historic sea level rise has resulted in more frequent and widespread flooding.

Climate change is projected to accelerate the rate of sea level rise, putting more people and assets at risk.

Planning for today vs. planning for tomorrow

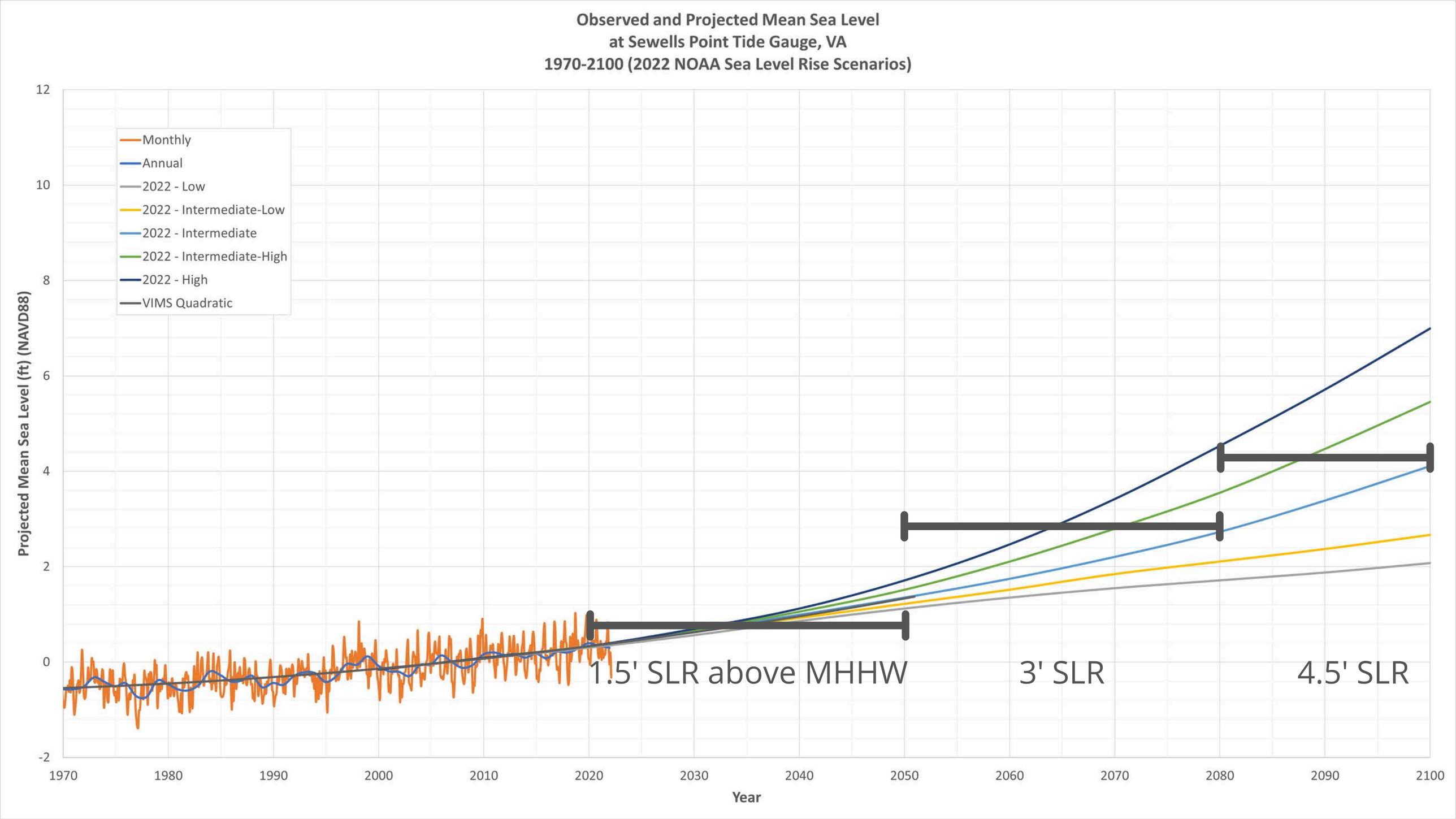
Effectively addressing sea level rise requires tackling challenges today while also planning and building for the future.

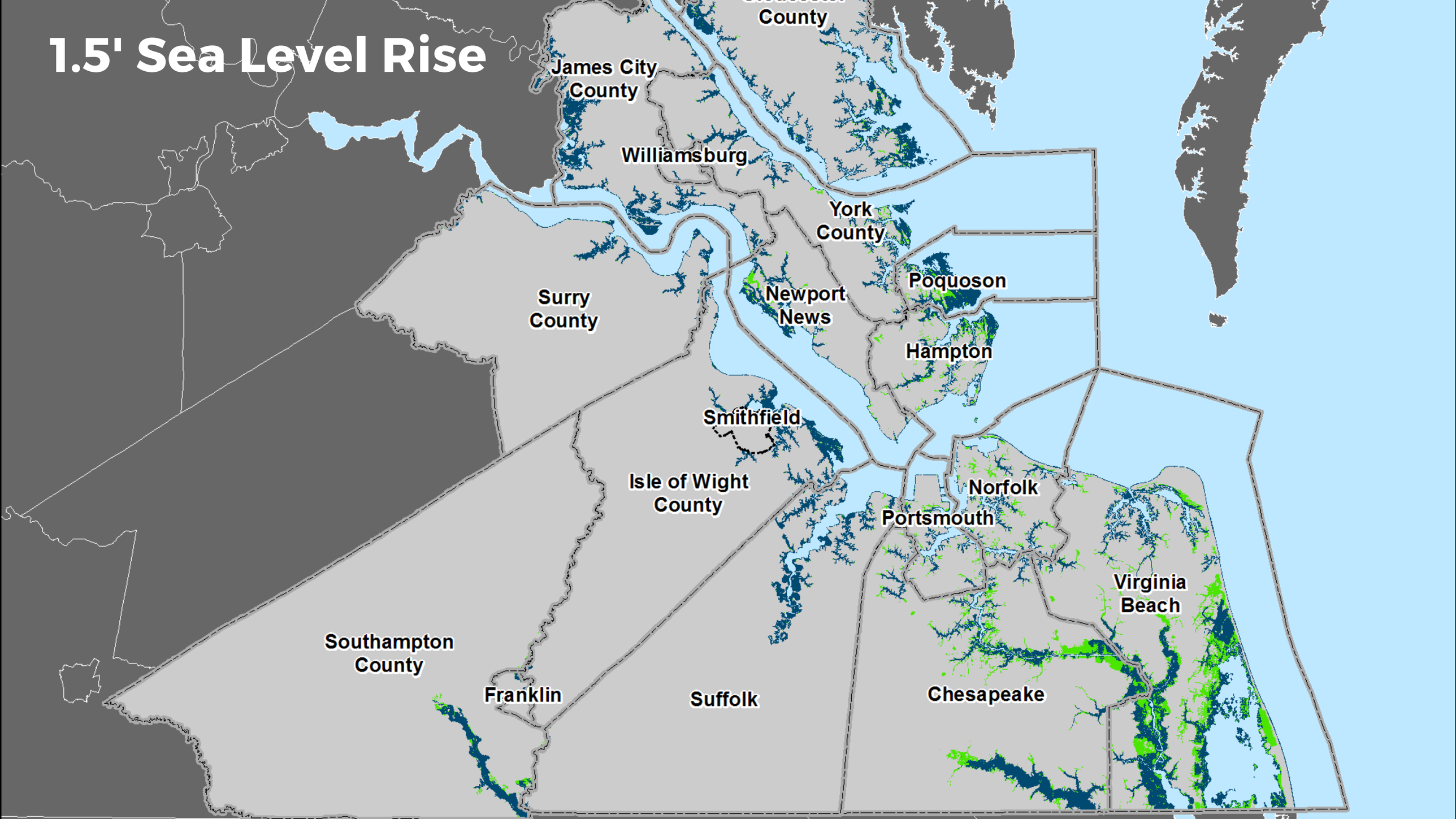
Recurrent Flooding

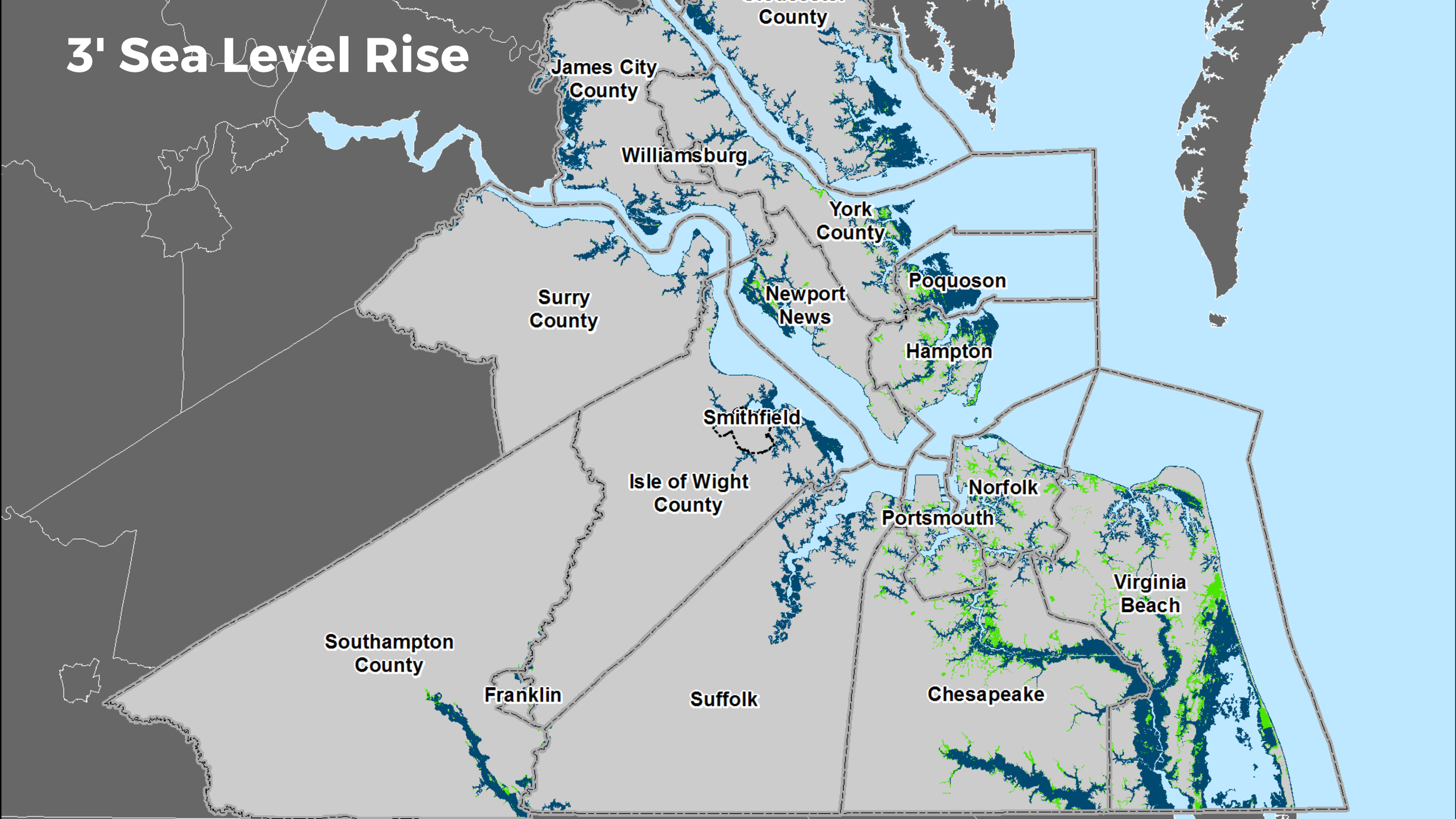
- Happening right now.
- Causes property damage, disruptions to life and commerce, and health impacts.
- **Operational challenge**

Sea Level Rise

- Projected to accelerate and cause significant impacts (inundation, flooding, saltwater intrusion, etc.) to public and private property.
- **Planning challenge**


Observed and Projected Mean Sea Level
at Sewells Point Tide Gauge, VA
1970-2100 (2022 NOAA Sea Level Rise Scenarios)
Monthly
Annual
2022 - Low
2022 - Intermediate-Low
2022 - Intermediate
2022 - Intermediate-High
2022 - High
VIMS Quadratic
Projected Mean Sea Level (ft) (NAVD88)
12
10
8
6
4
2
0
-2
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
2090
2100
Year
1.5' SLR above MHHW
3' SLR
4.5' SLR


1.5' Sea Level Rise
James City County
Williamsburg
York County
Poquoson
Newport News
Surry County
Hampton
Smithfield
Isle of Wight County
Norfolk
Portsmouth
Virginia Beach
Southampton County
Franklin
Suffolk
Chesapeake


3' Sea Level Rise
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Williamsburg
York County
Poquoson
Newport News
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Hampton
Smithfield
Isle of Wight County
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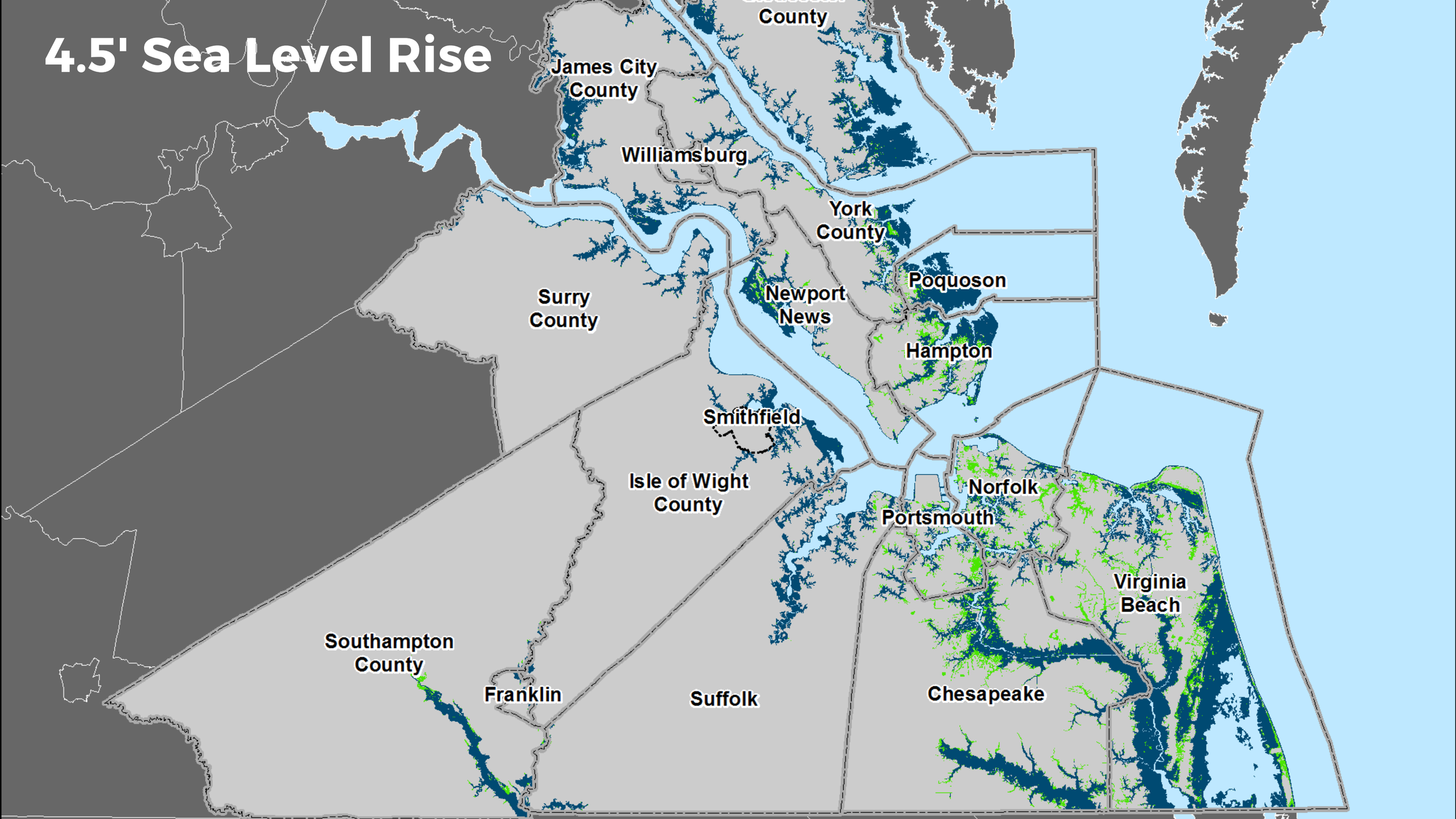
4.5' Sea Level Rise
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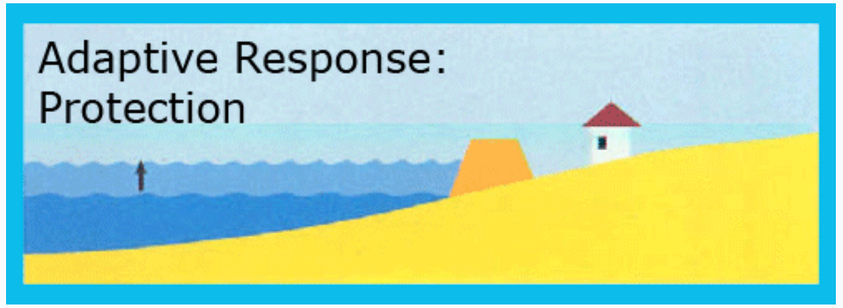
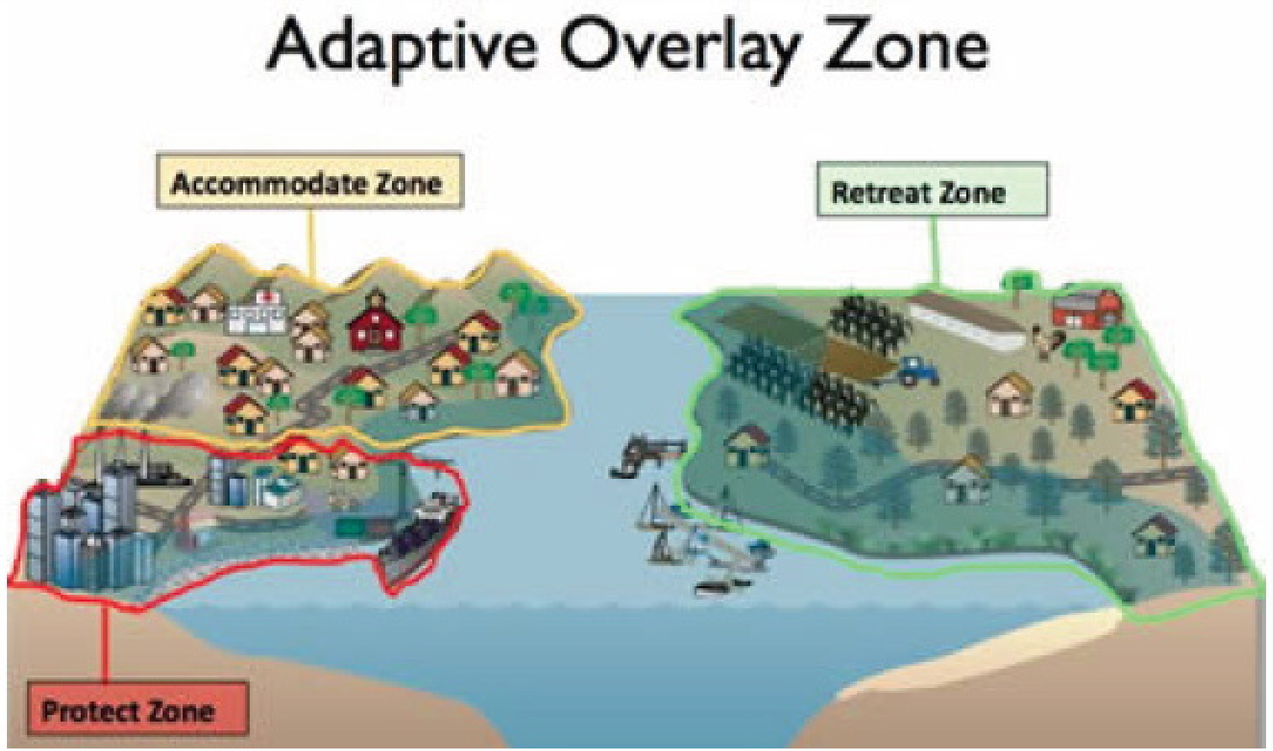
Franklin
Suffolk
Chesapeake

Adapting to Sea Level Rise



Adapting to Sea Level Rise - Retreat

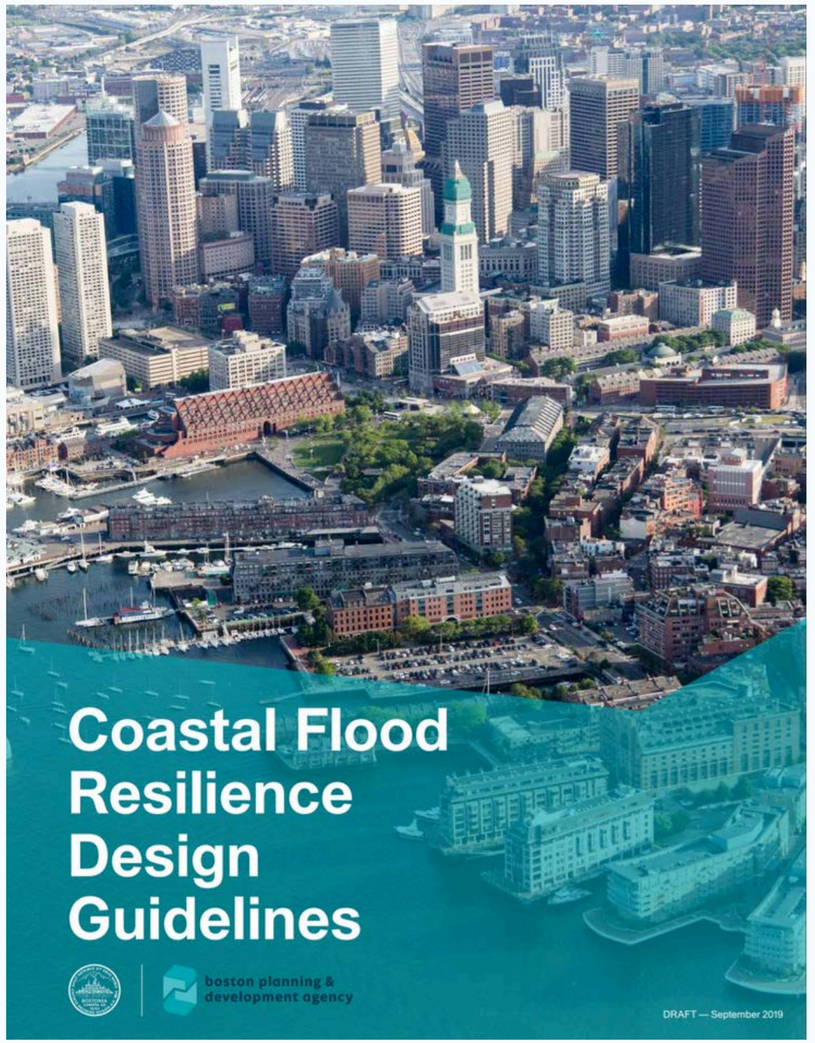
Moving out of or not building in vulnerable areas (property buy-outs, transfers of development rights, etc.).



Georgetown Climate Center, 2011

Adapting to Sea Level Rise - Accommodation

Structural improvements and behavioral changes that allow for “living with water” (raising houses, flood-proofing ground floors, moving cars to higher ground at high tides, etc.).



Adapting to Sea Level Rise - Protection

Large, structural improvements designed to keep water out and land dry (sea walls, flood gates, levees, etc.).

LOCAL CASE STUDY: HAMPTON, VA

PLANNING HOLISTICALLY FOR RESILIENCE

Resilient Hampton is a planning approach based on first identifying community values and then developing goals and strategies based on those values.

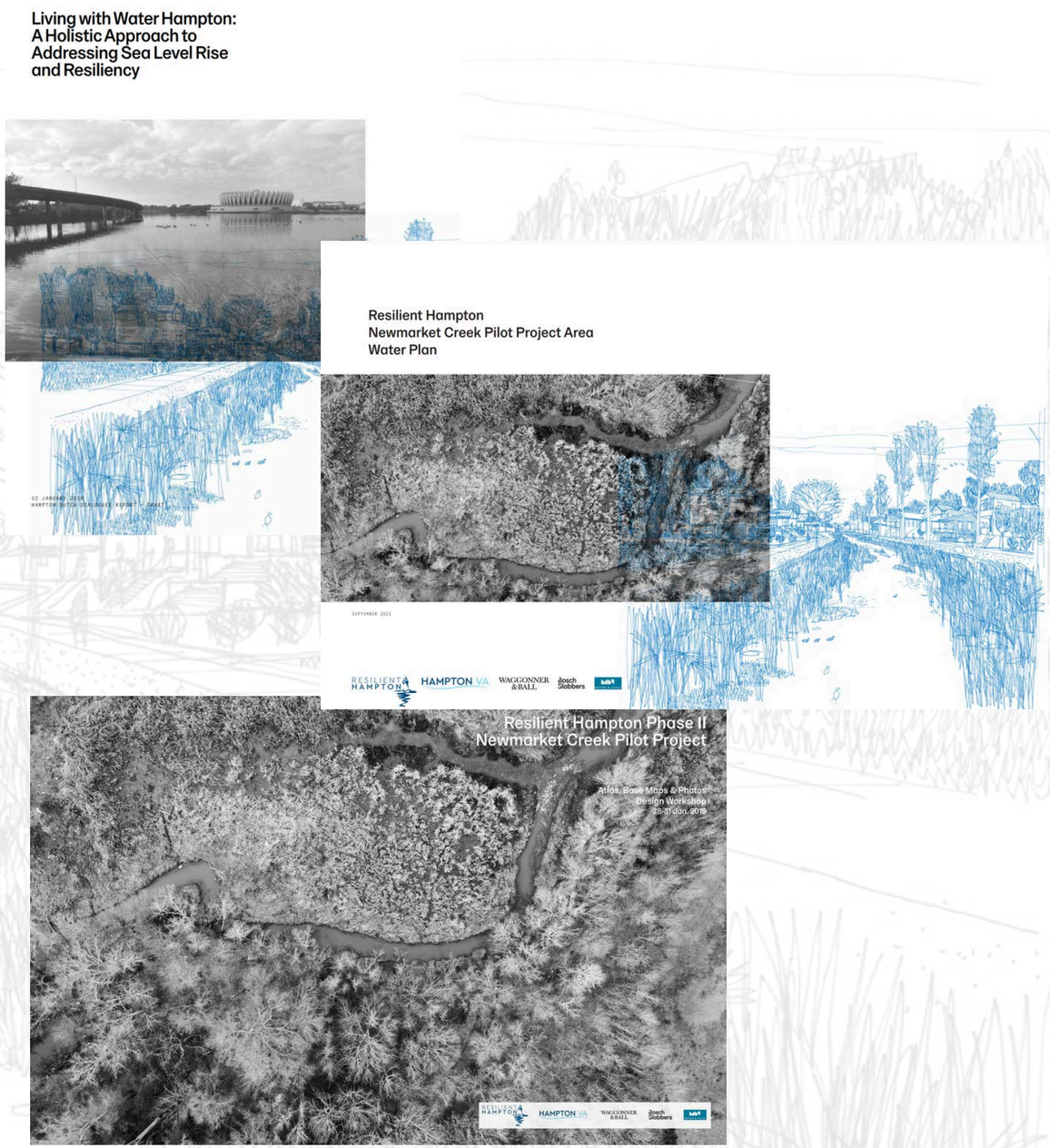
- **Safety**
- **Equity**
- **Nature**
- **Heritage**
- **Integration**
- **Sufficiency**
- **Nimbleness**
- **Innovation**

VALUES >> GOALS >> STRATEGIES

POLICY	EDUCATION & COMMUNICATION	PHYSICAL	OPERATIONS & MAINTENANCE
Zoning Stormwater Incentives	Public data Outreach	Protect assets Demonstration projects	Monitoring Cost savings

Values-Driven Planning

Resilient Hampton provides the foundation for the city's other planning and implementation efforts.

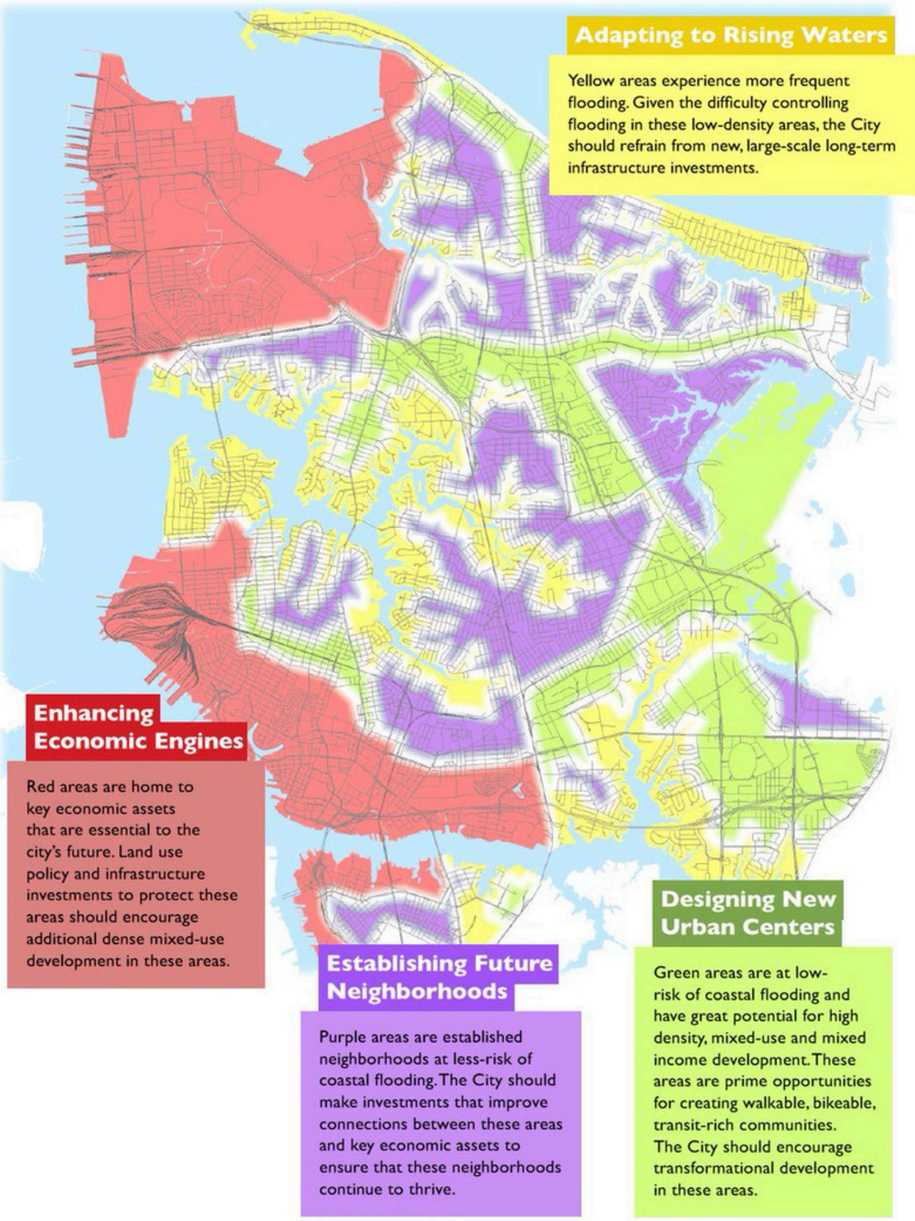


LOCAL CASE STUDY: NORFOLK, VA

(Very) Long Range Planning

Most comprehensive plans look out 20 to 30 years.

Norfolk's Vision 2100 looks out much further to inform the city's long-term priorities and policies for adapting to rising seas.



Norfolk Vision 2100 (City of Norfolk, 2016)

Building Resilience into Zoning

Norfolk incorporates resilience into its zoning ordinances through **higher minimum standards** for all development and a points-based **resilience quotient**.

Higher Minimum Standards

Stormwater Management

Store first 1.25" on site or have rain barrel installed (for SFH)

Risk Reduction

Freeboard requirements in 1% and 0.2% Annual Chance Flood Zones

Energy Resilience

Alternative energy sources on site or generator hookup

Building Resilience into Zoning

Norfolk incorporates resilience into its zoning ordinances through **higher minimum standards** for all development and a points-based **resilience quotient**.

Resilience Quotient

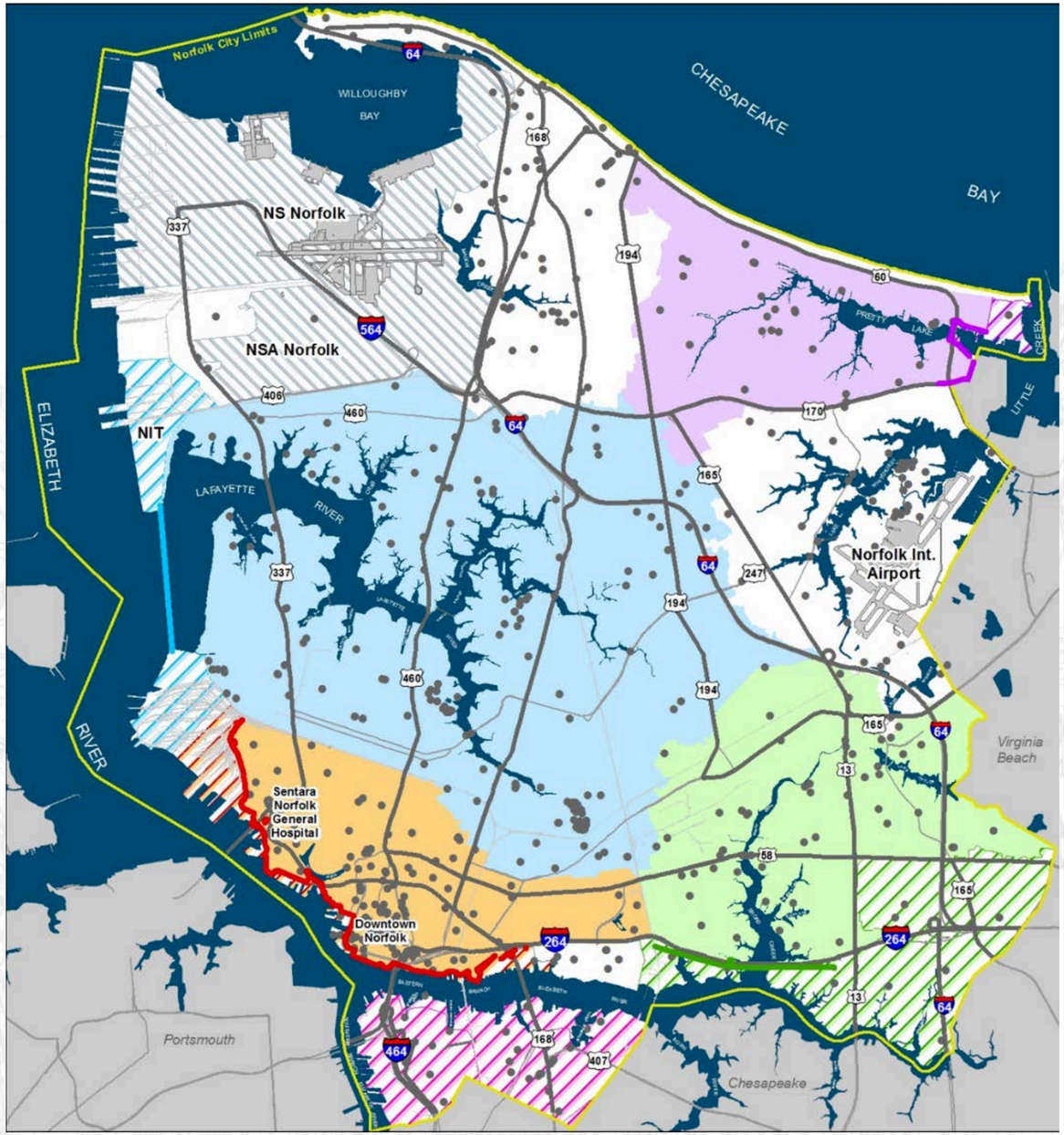
Points scored for certain activities related to stormwater management, risk reduction, and energy resilience.

Minimum points based on **location** (more points for areas with more risk), **size**, and **type** of development.

Alternative to satisfying quotient is site plan review.

Coastal Storm Risk Management

Norfolk's Coastal Storm Risk Management Plan with the U.S. Army Corps of Engineers was completed in February 2019. The city is now in the Preliminary Engineering and Design phase and was recently selected for construction funding.



Norfolk Coastal Storm Risk Management Plan (USACE 2019)

LOCAL CASE STUDY: VIRGINIA BEACH, VA

Engineering Solutions

Virginia Beach's Sea Level Wise Adaptation Strategy builds on a comprehensive assessment of the city's future climate, risk, and options for mitigation and adaptation.

Modeling

Future precipitation
Compound Flooding
Wind Tides
Stormwater

Socioeconomic Analysis

Insurance
Population Vulnerability

Strategy Development

Natural and Nature-Based Features
Neighborhood-Scale Structural
City-Wide Structural
Site-Level Risk Reduction
Policy Responses

Engineering Solutions

What impacts will there be?

What options do we have?

Which options are feasible?

How can we actually do it?

Image Source: City of Virginia Beach

Engineering Solutions

Not all strategies will work in all locations. Virginia Beach has identified appropriate solutions for each of the city's main watersheds.

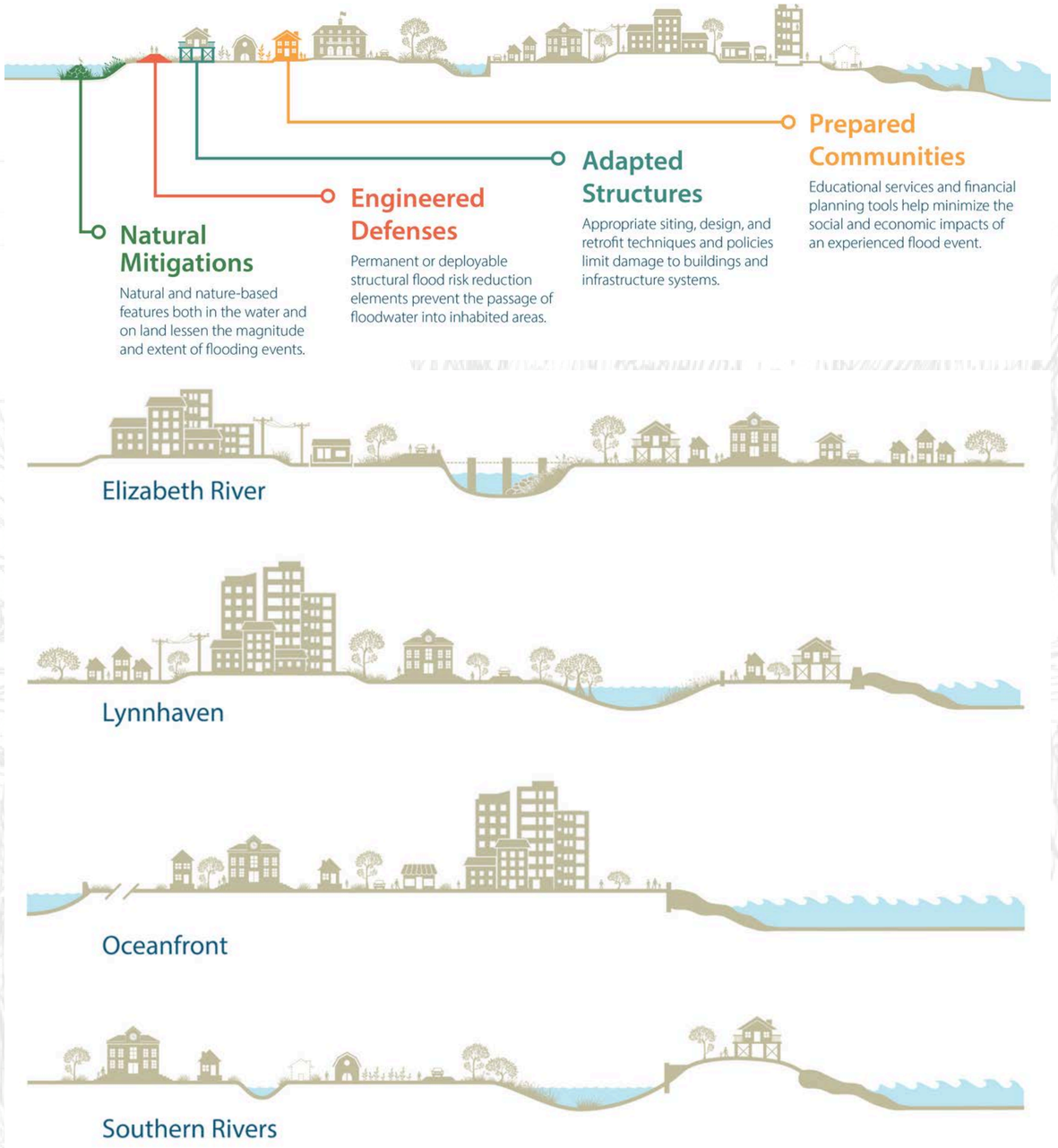


Image Source: City of Virginia Beach

Engineering Solutions

Virginia Beach has also adopted higher requirements that will force public and private development to address current and future flooding.

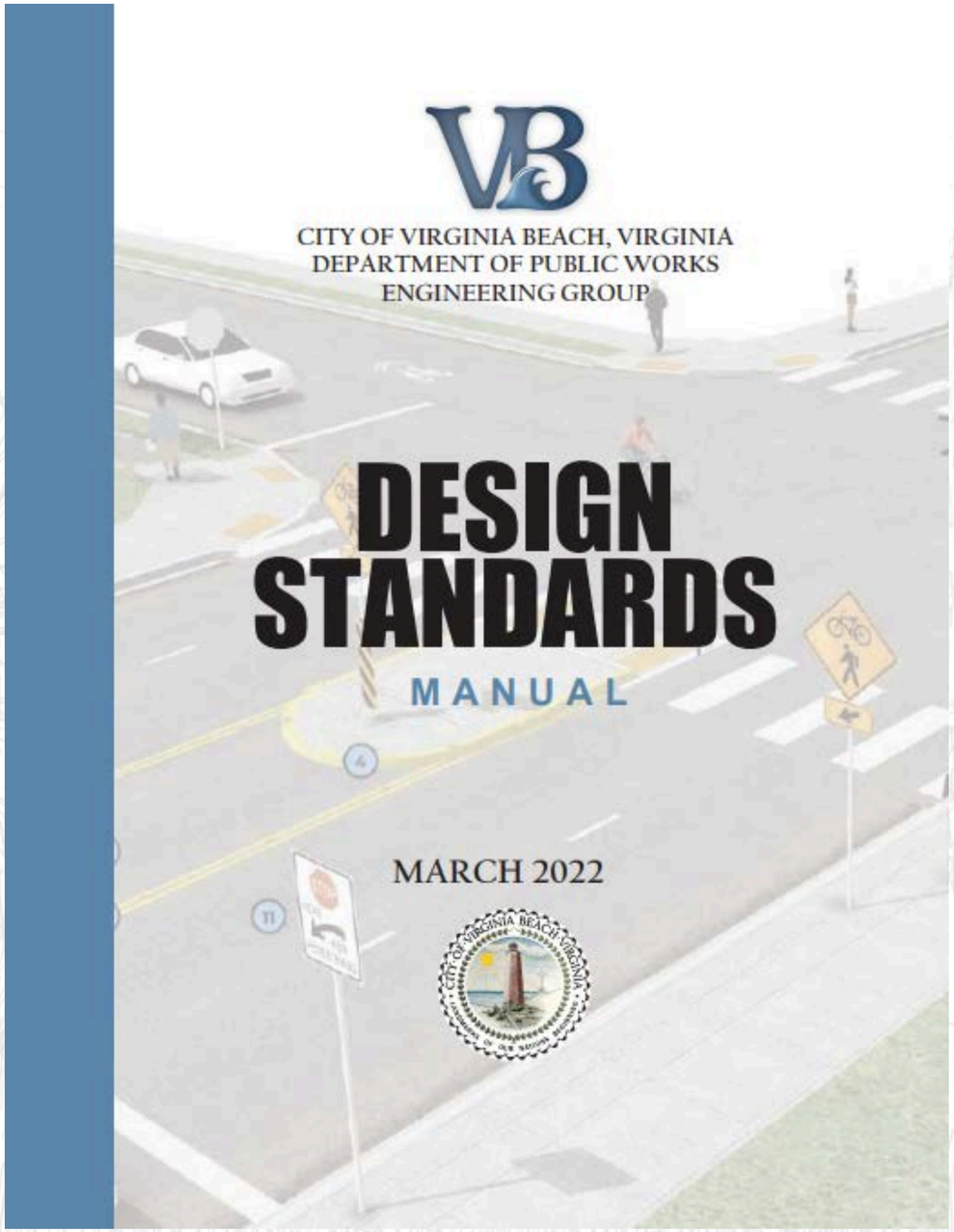


Image Source: City of Virginia Beach

Engineering Solutions

Virginia Beach is now funding a 10-year flood protection program with the proceeds from a $567M bond referendum passed in November 2021.

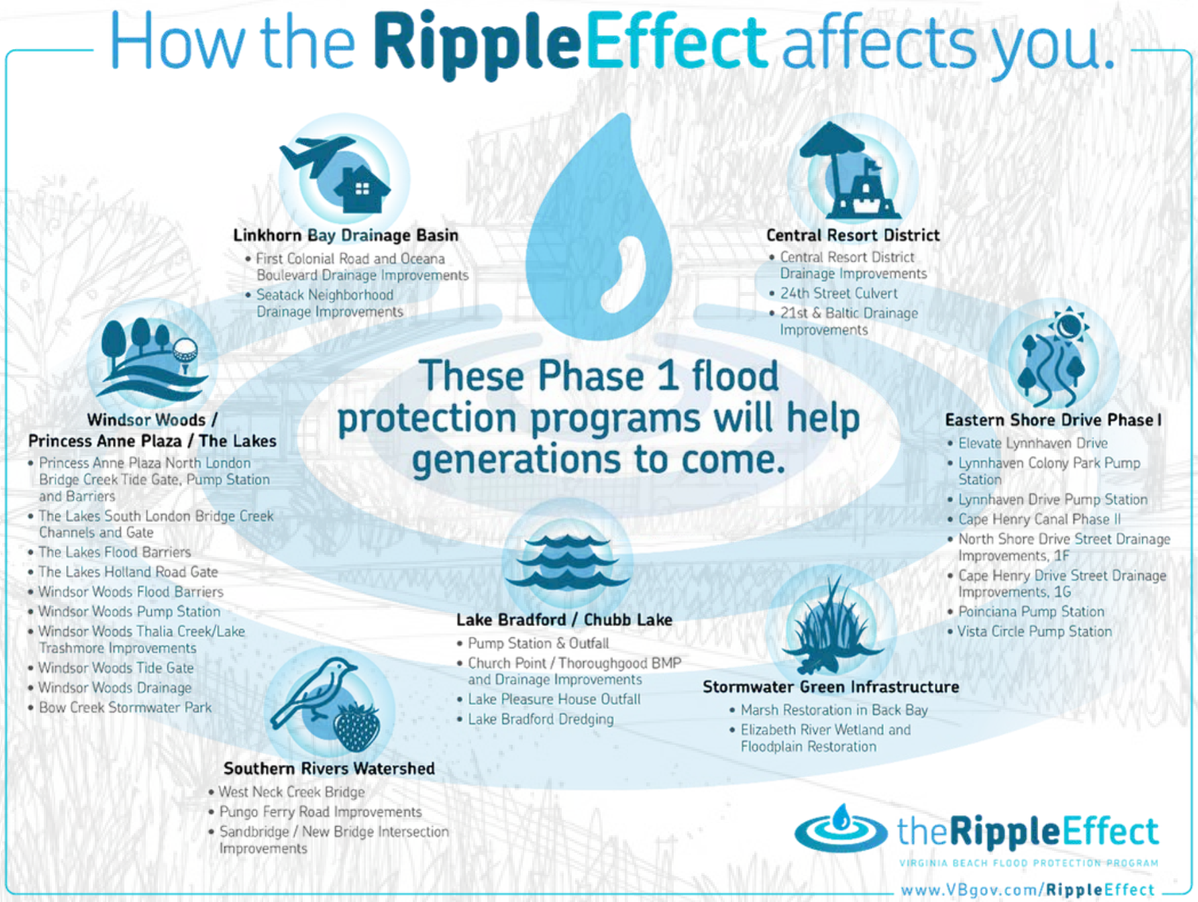
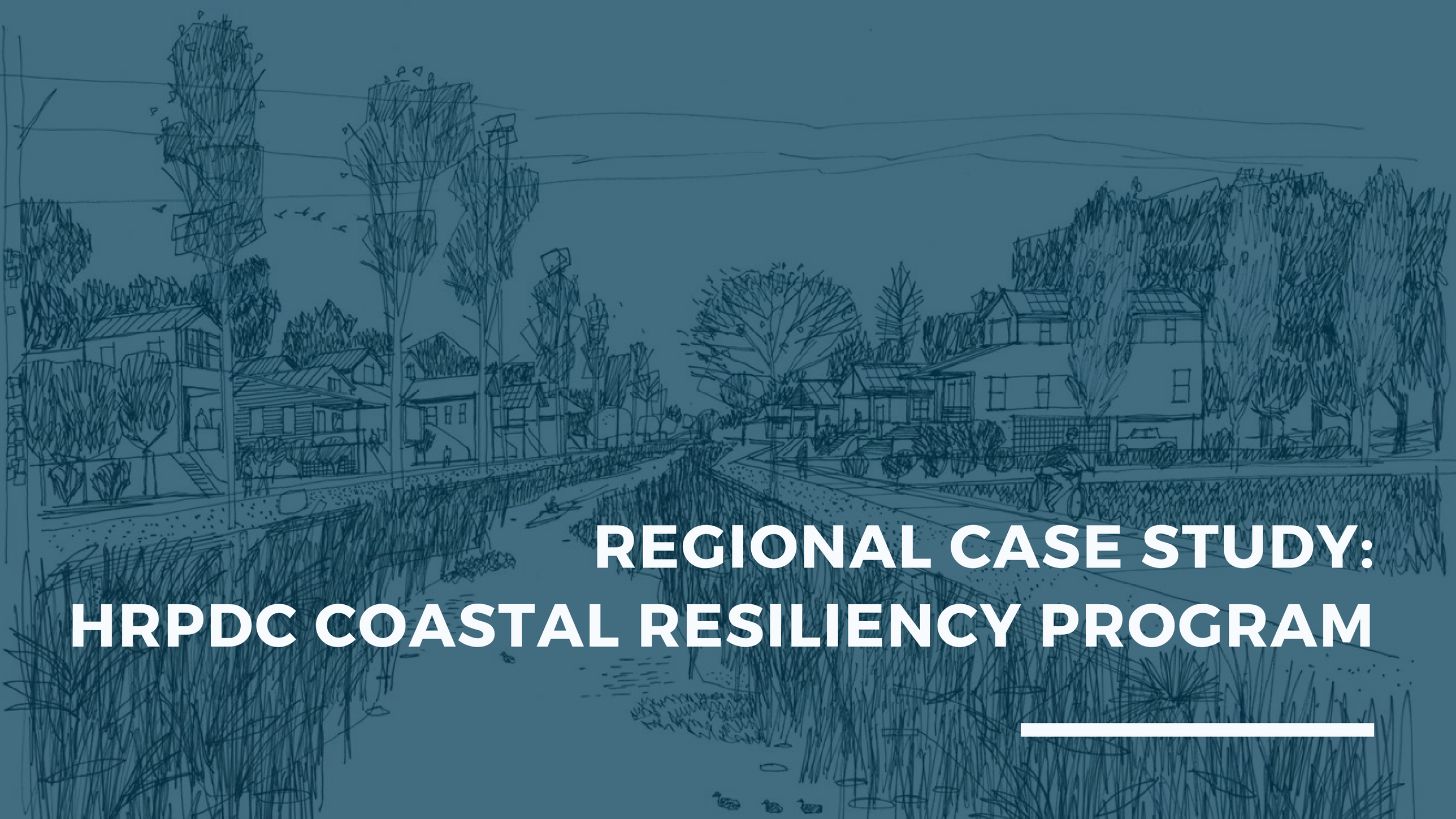


Image Source: City of Virginia Beach



REGIONAL CASE STUDY: HRPDC COASTAL RESILIENCY PROGRAM

HRPDC COASTAL RESILIENCY PROGRAM

Policy

Develop policy recommendations for local governments and technical products

Coordination

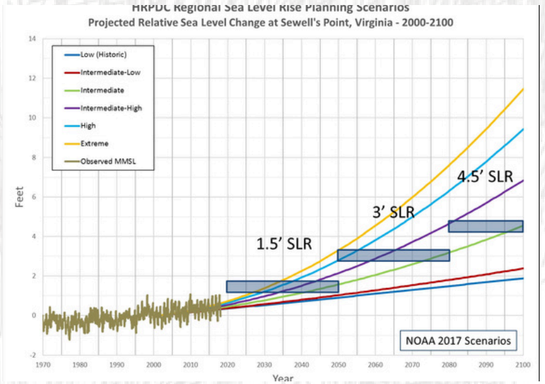
Coordinate regional planning efforts with localities and other partners

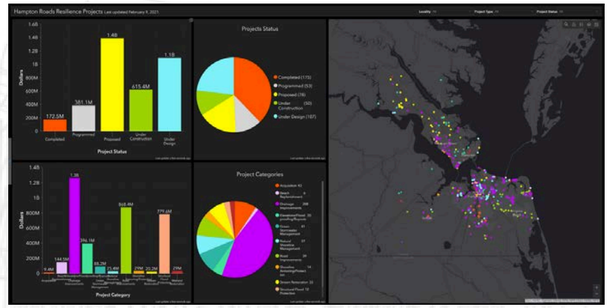
Outreach

Communicate actions that enhance resiliency and data to inform decisions across multiple scales

Projects

Conduct and implement research, analysis, and other projects





INFORMING DECISIONS

Community Actions

Document what localities are doing:

- Adaptation studies and plans
- Flood mitigation projects
- Programs that increase community resiliency

Identify possible opportunities for coordination and collaboration

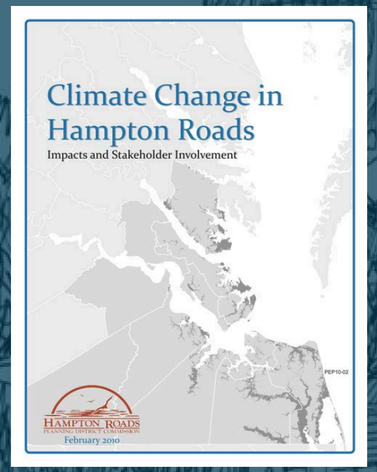
Individual Actions

Educate about flood issues and share facts specific to Hampton Roads

Encourage flood protection and mitigation actions:

- Purchasing flood insurance
- Protecting home and property from flood damage
- Staying safe before and during a flood event

HRPDC RESILIENCY PROJECTS



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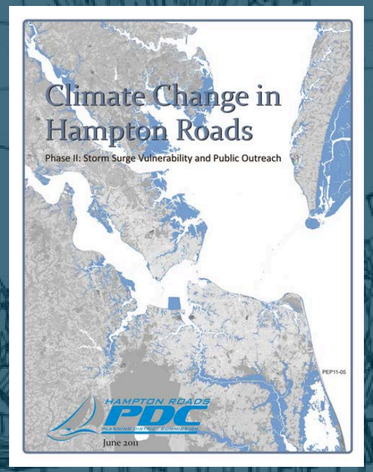

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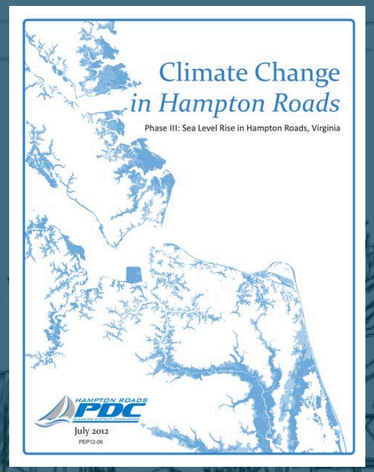

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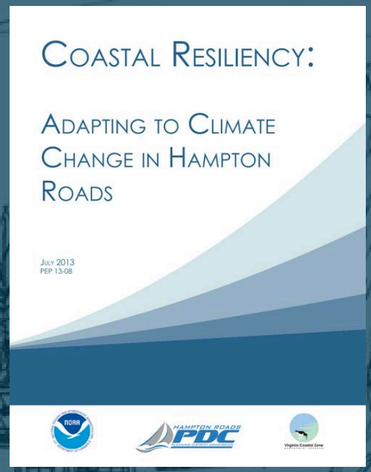

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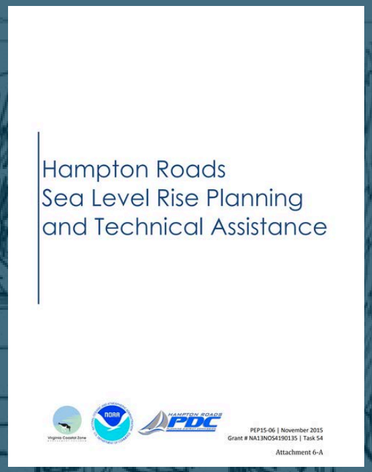

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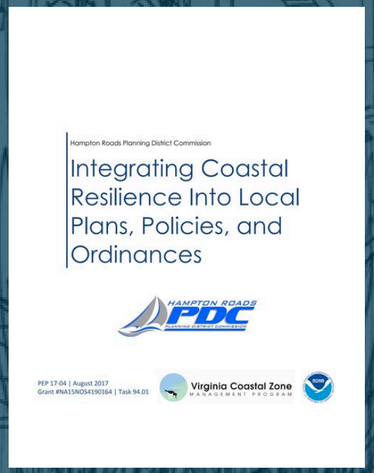

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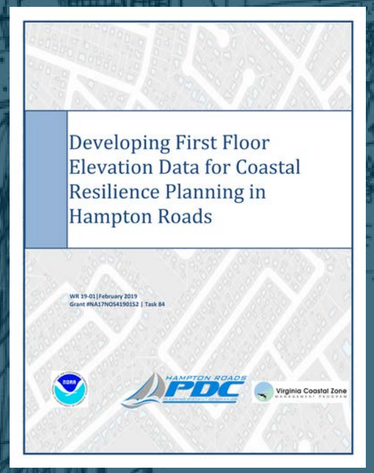

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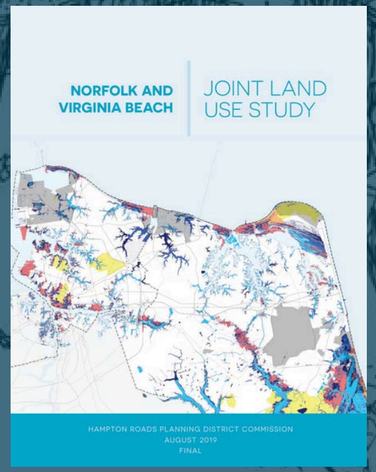

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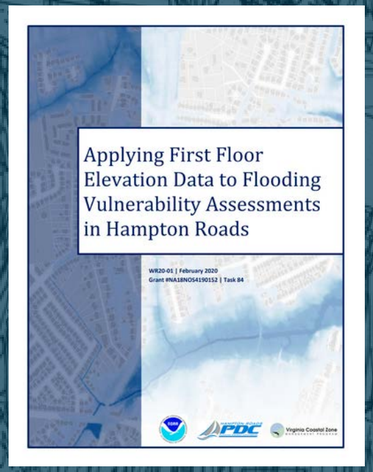

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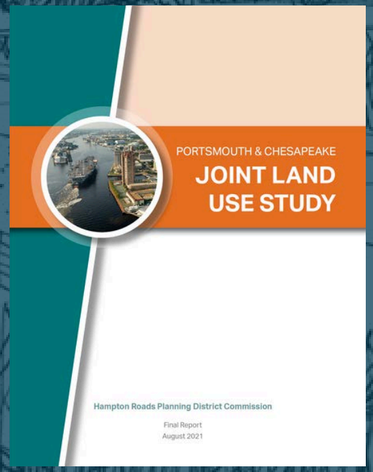

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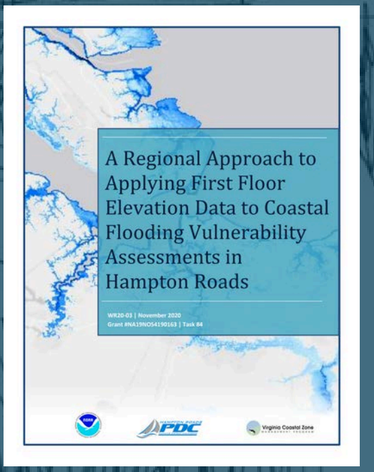


FY19

DESIGN STANDARDS

Our design standards and regulations are generally based on historic observations.

For public policies to work, it's important for expectations to align with reality.

If we expect the future to look different from the past or the present, we should design for those expected conditions.

A WAY FORWARD

Using available information, amend ordinances, policies, and regulations to account for future conditions under climate change.

These policies should reflect the best available science and be subject to regular review and updates.

Making these changes will help communities make better decisions about where, what, and how to build.

Resilient Design Guidelines: Projections

SEA LEVEL RISE

Regional sea level rise planning scenarios

PRECIPITATION

Future precipitation values based on climate models

Resilient Design Guidelines: Applications

FLOODPLAIN MAPPING	TAILWATER ELEVATIONS	DESIGN STORMS	JOINT PROBABILITY EVENTS
Projections of future floodplains incorporating sea level rise and riverine flooding	Boundary conditions based on watershed tidal elevations with sea level rise	Rainfall levels corresponding to various return periods	Design storms that pair tidal and rainfall events

ROADWAY FLOODING SENSORS

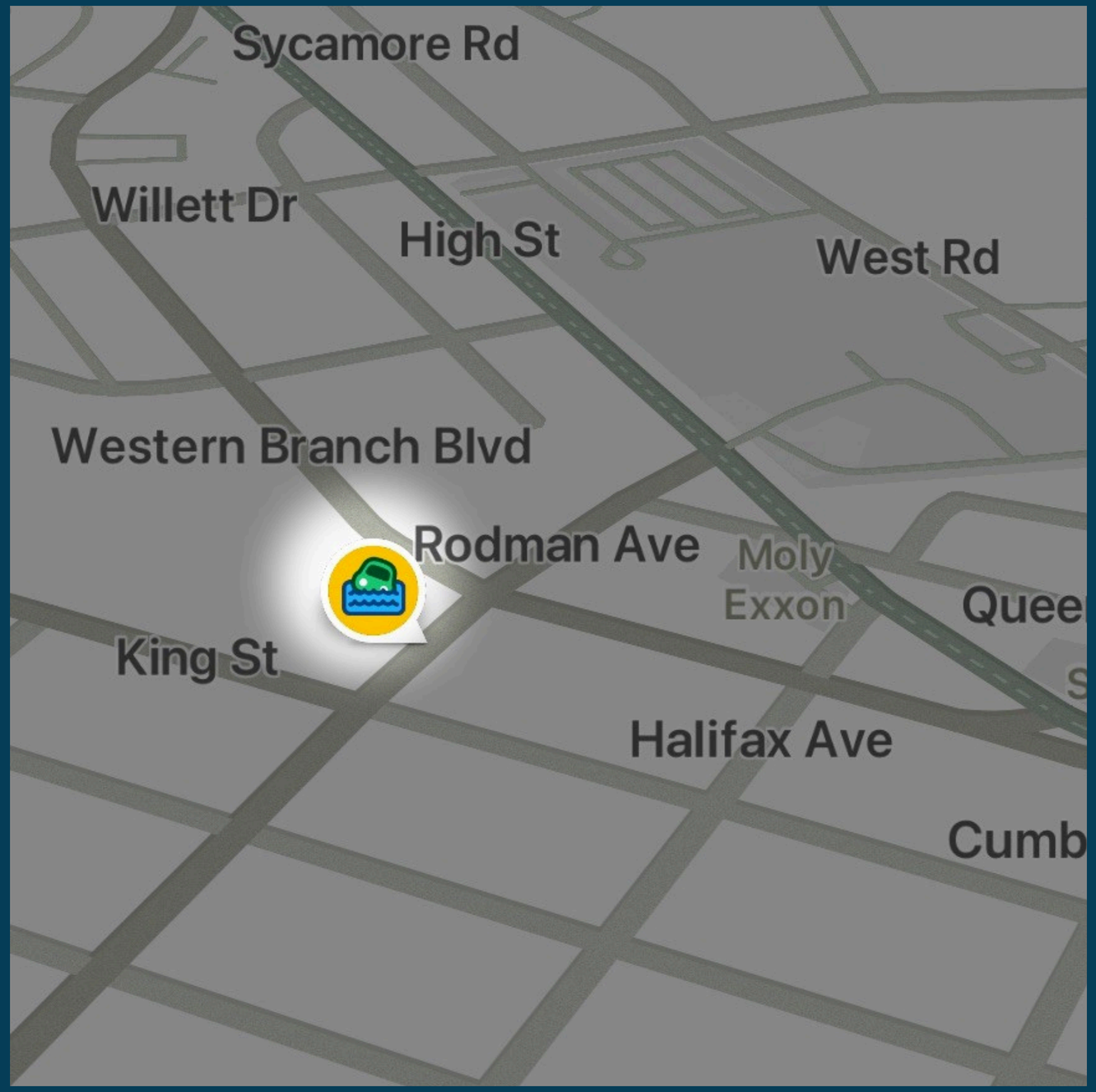
PROBLEM: Drivers don't know if a road is flooded. Alternate routes might be available and drivers could save time if they knew the area was flooded before they got there.

WAZE ALERTS

Sensors collect measurements every 5 minutes.

If water level is 2 inches above road elevation, a Flood Alert is sent to WAZE.

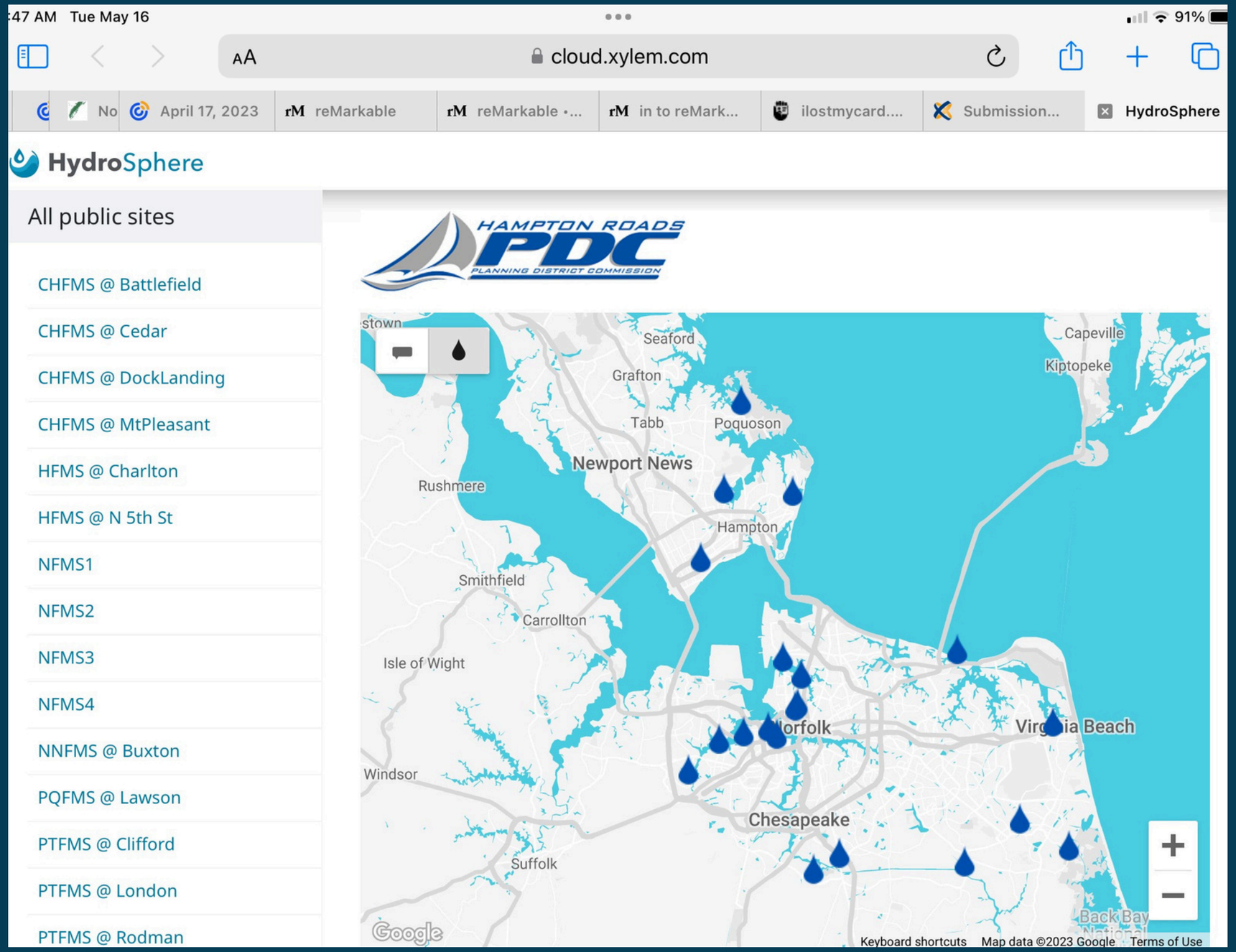
An icon appears on the map and drivers will be routed around the Flood Alert location.



PILOT PROJECT

Install 20 sensors to develop network backbone and vet concept.

All 20 sensors have been installed and are operating.



Questions

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HAMPTON ROADS PDC