An aerial photograph of a city skyline, likely Norfolk, Virginia, featuring several prominent skyscrapers and modern buildings. In the foreground, a large outdoor event is taking place, with numerous white tents and a dense crowd of people. The scene is captured from a high angle, showing the layout of the event and the surrounding urban environment. The sky is clear and blue, suggesting a bright day.

Resilience in Norfolk

Enhancing Code Requirements & Update on the Norfolk Coastal Risk Management Study

Virginia Joint Subcommittee on Coastal Flooding
September 25, 2017

Norfolk's Resilience Strategy

Norfolk's Resilience Goals

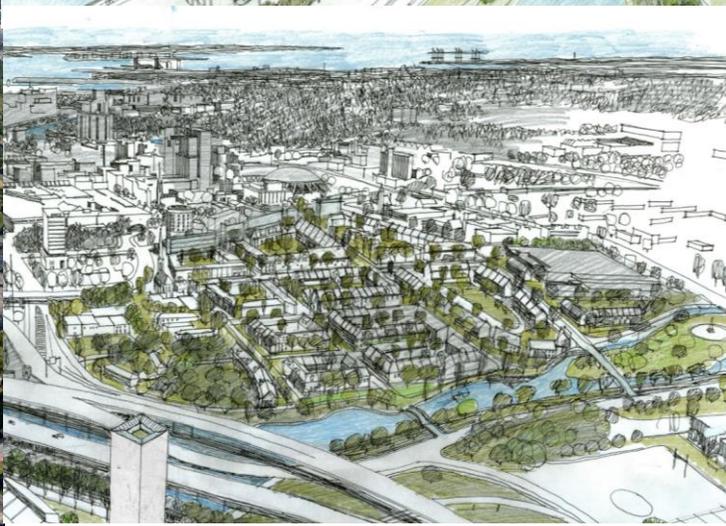
- Goal 1: Design the coastal community of the future
- Goal 2: Create economic opportunity by advancing efforts to grow existing and new industry sectors
- Goal 3: Advance initiatives to connect communities, deconcentrate poverty, and strengthen neighborhoods

100 RESILIENT CITIES

Milan * New York City * Quito
Melbourne * Boston * Bangalore
Rotterdam * Athens * Paris
Dakar * Juarez * Phnom Penh
Thessaloniki * Norfolk, Virginia
Medellín * Bangkok * Rio de
Janeiro * Barcelona * Los Angeles
Rome * Chicago * Da Nang * New
Orleans * Cali * Kigali * Huangshi
Singapore * Mexico City * Lisbon
Santiago de los Caballeros * San
Francisco * Belgrade * Ramallah
Glasgow * Montreal * Mandalay
Accra * Jacksonville * London
Toyama * Ashkelon * El Paso
Dallas * Jacksonville * Pittsburgh
San Juan * Durban * Semarang
Sydney * Amman * Vejle * Enugu
Porto Alegre * Surat * Santiago,
Metropolitan Region * Deyang
Wellington City * St. Louis * Byblos
Arusha * Christchurch * Tulsa
Chennai * Oakland * Bristol
Santa Fe * Berkeley * Boulder

Expanding Our Thinking

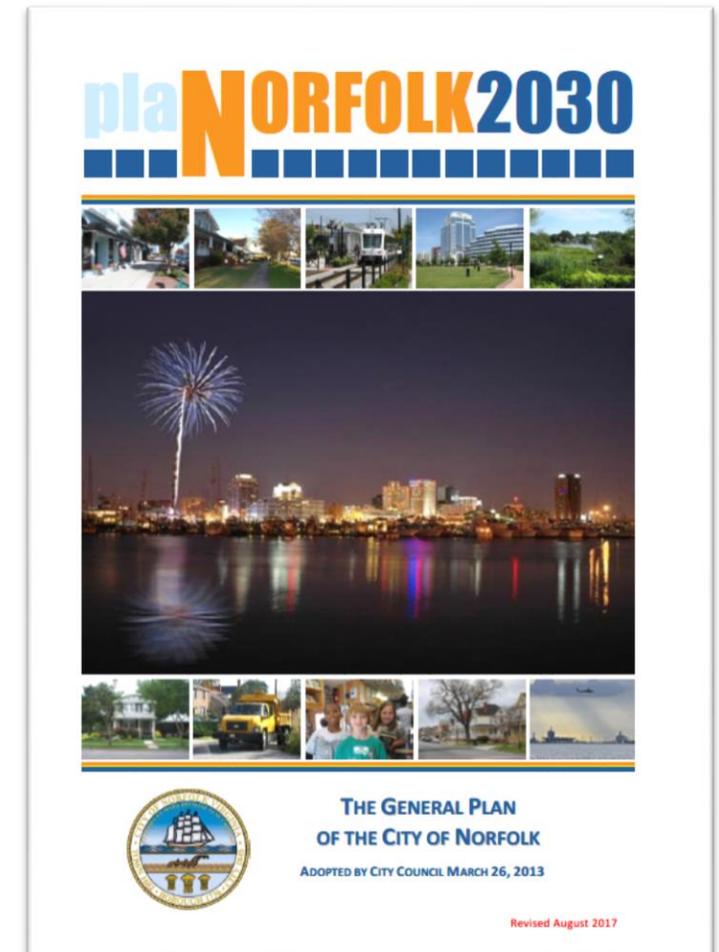
Expanding Our Thinking



Foundation for Creating the Future Coastal Community

plaNorfolk2030

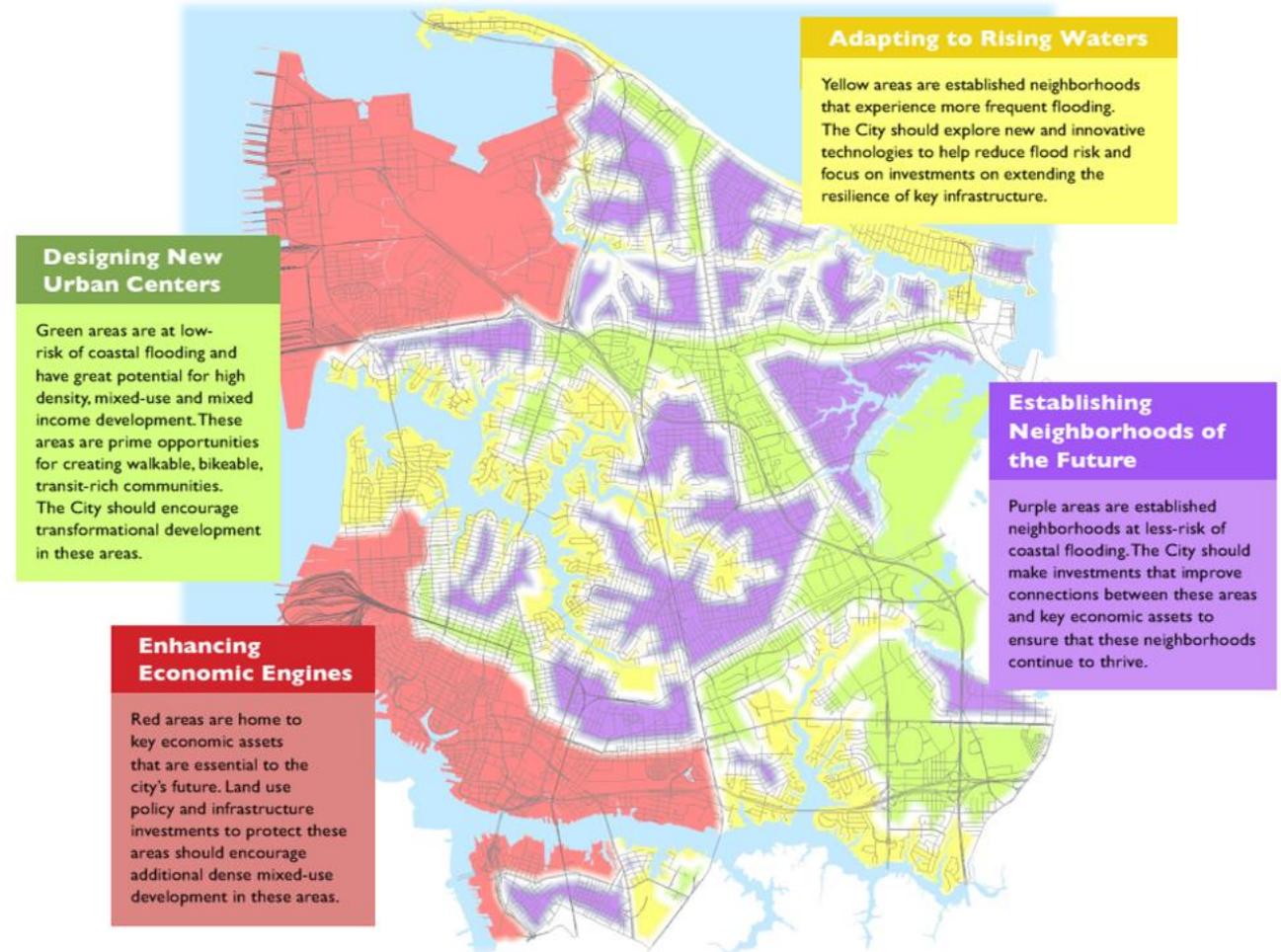
- Norfolk's comprehensive plan adopted in 2013
- Contains policies guiding land use decisions
- Facilitated community dialogue on need for increased resilience



Expanded Foundation

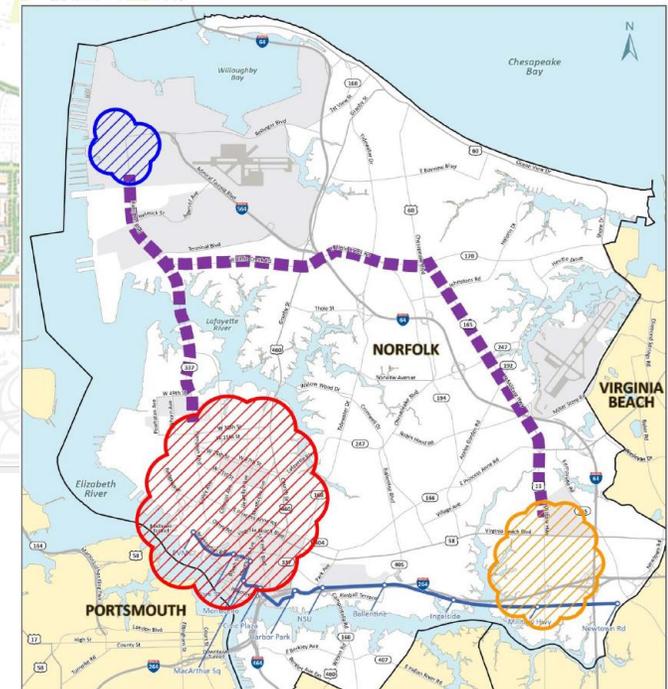
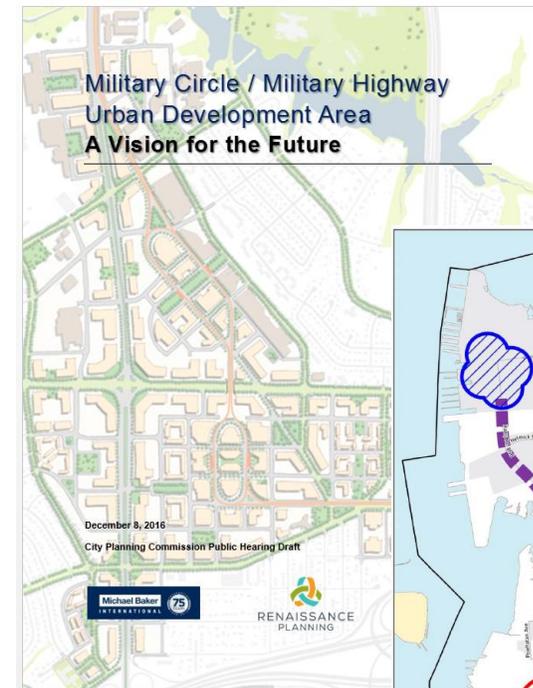
Vision 2100

- Strategy for addressing sea level rise in long-term future
- In the past, the focus was on the challenges
- In the future, those challenges will give rise to opportunities



Planning for Resilience

- Plans to bring increased intensity to “Green Areas”
 - Military Circle / Military Highway
 - Wards Corner
- Resilience as key factor in Light Rail Extension Studies



Code Changes for Resilience

Flood Zone Update

- Norfolk has stringent floodplain requirements
 - 3 feet of freeboard in 100-year floodplain
 - 18-inches above grade in 500-year floodplain
- CRS Rating is 8; will go to 7 in 2018



Code Changes for Resilience

Zoning Ordinance Rewrite

- Resilience Quotient
 - Risk Mitigation
 - Stormwater Management
 - Energy Options
- Required on-site back-up generation for community-critical uses



A background image showing a city skyline with several tall buildings under a blue sky with light clouds. The buildings are in various shades of blue and grey.

Resilient Building Considerations

Consider Total Cost of Ownership over 30-year mortgage

- In floodplain, 26% chance of a 100-year storm event
- In floodplain, 88% chance of significant nuisance flooding
- 10-12 named tropical cyclonic storms
- 2-3 nor'easters annually
- Tropical cyclones appear to be getting bigger & stronger

Initial acquisition cost is only a part of the picture

Resilient Building Codes

- Virginia USBC focuses on uniformity
- Conditions are not uniform
 - Seismic areas
 - Wildfire areas
 - Snow load areas
 - Coastal areas
 - Water, Wind, Energy



Resilient Building Codes

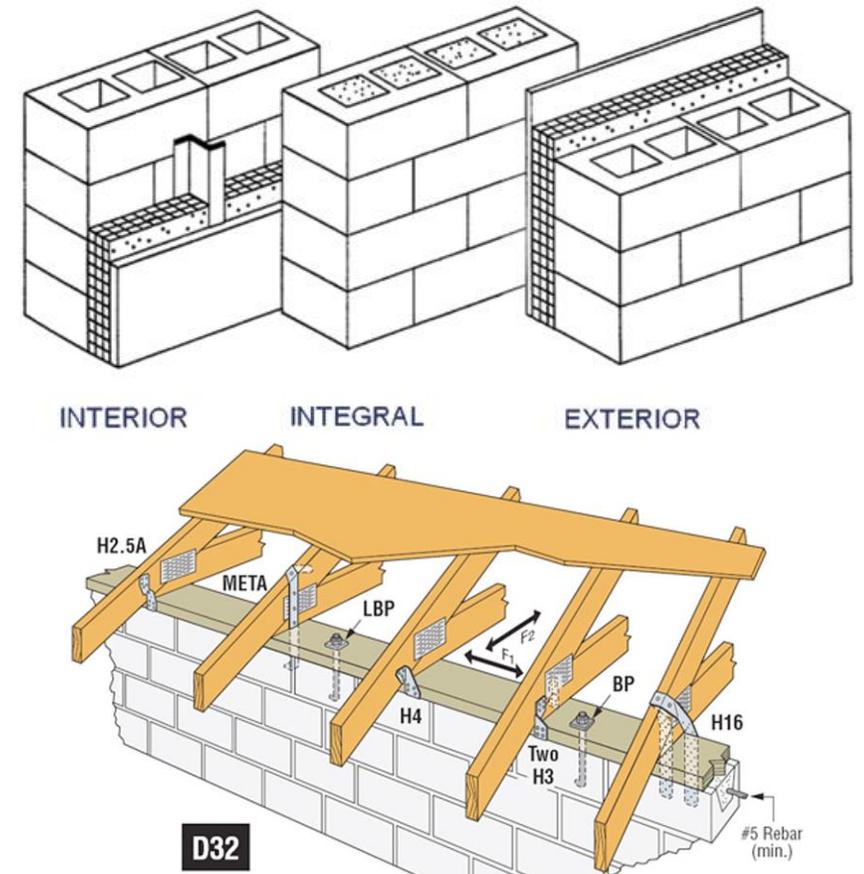
Florida Building Code

- Significant wind focus (ASCE-7)
 - 111mph+ everywhere
 - 130mph+ in Miami-Dade
- Limited local customizations allowed
- Higher standards for critical facilities
- Design, materials & techniques
- Elevation



Coastal Resiliency Code Considerations

- Use Mass Wall construction for exterior and foundation walls
 - Flood resistance, wind resistance, thermal values
- Increase wind loading requirements for walls and roofs from 110mph to 125mph close to coast; higher for critical facilities
 - Materials, anchoring & coverings
- Adopt National (IECC) Energy Code without amendments



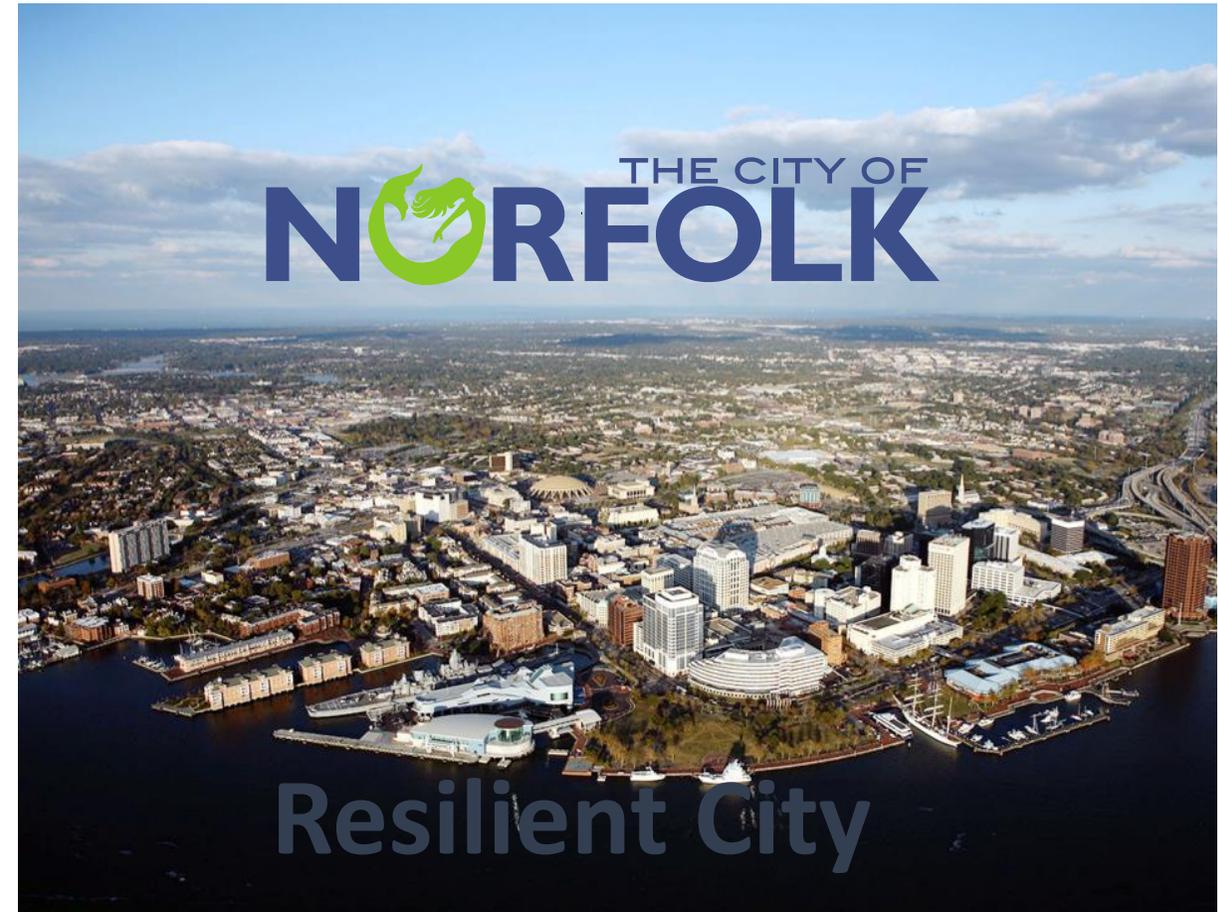
Next Steps

Norfolk's Resilience Code

- Final draft review
- Adoption by City Council
- Implementation

Enhancing the Building Code

- Opportunity to work with DHCD and other partners to create a process for developing Resilience Districts
 - Special requirements for building materials and standards



USACE Coastal Risk Management Study



3 x 3 x 3 Study

- Identified as a focus area in the North Atlantic Coast Comprehensive Study (NACCS)
- Authorized by resolution of the Senate Committee on Environmental and Public Works.
- Encompasses Entire City of Norfolk
- City non-federal sponsor \$1.5M of \$3M cost

USACE Coastal Risk Management Study

BOTTOM LINE UP FRONT TENTATIVELY SELECTED PLAN (TSP)

Alternative 4D (TSP/NED) Combination Plan with NIT SSB



Alternative 4d

Structural and Nonstructural
Combination

Cost Sharing

Initial construction:
65% Federal / 35% non-
Federal

Annual O&M Costs

\$4,971,000.

Total Project Cost

\$1,430,549,000

BCR

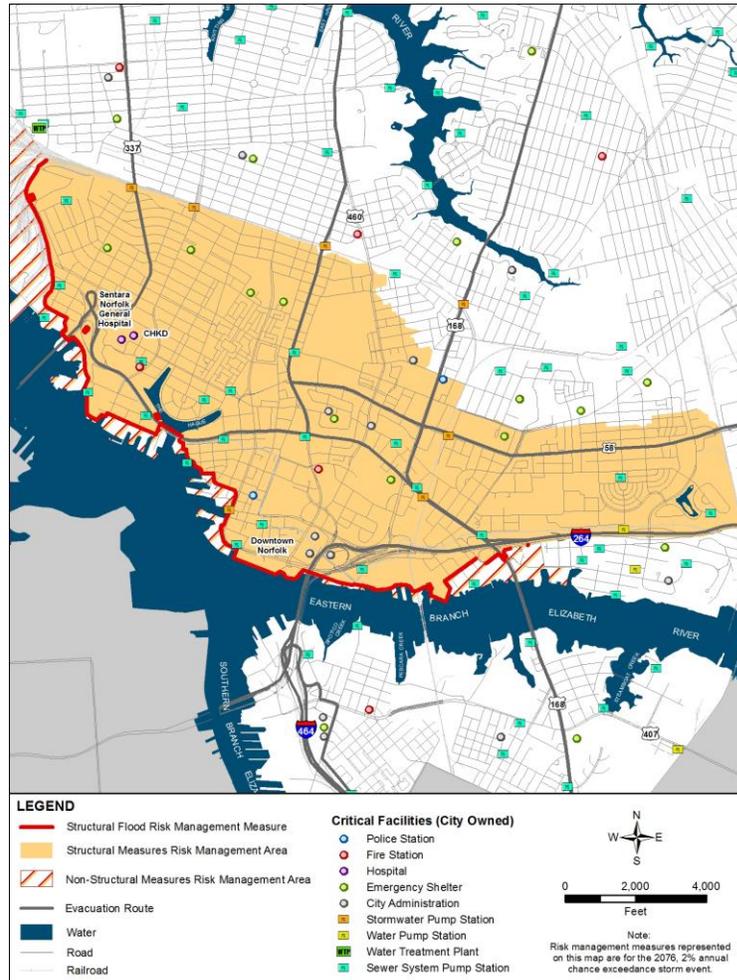
2.4

Average Annual Net Benefits

\$ 84,839,000

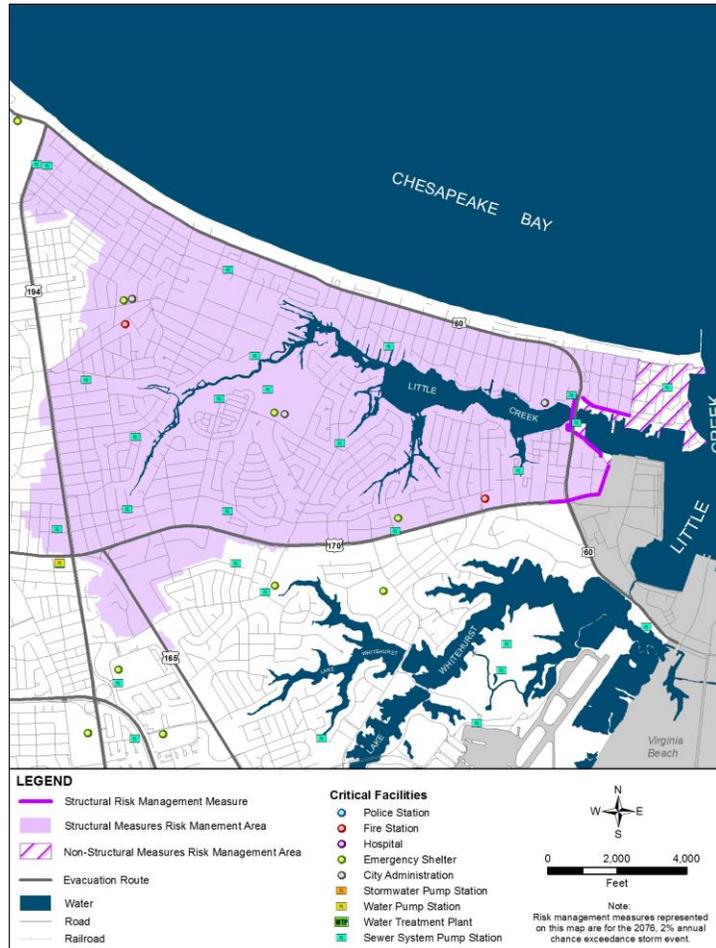


CRMS—Downtown Barrier System



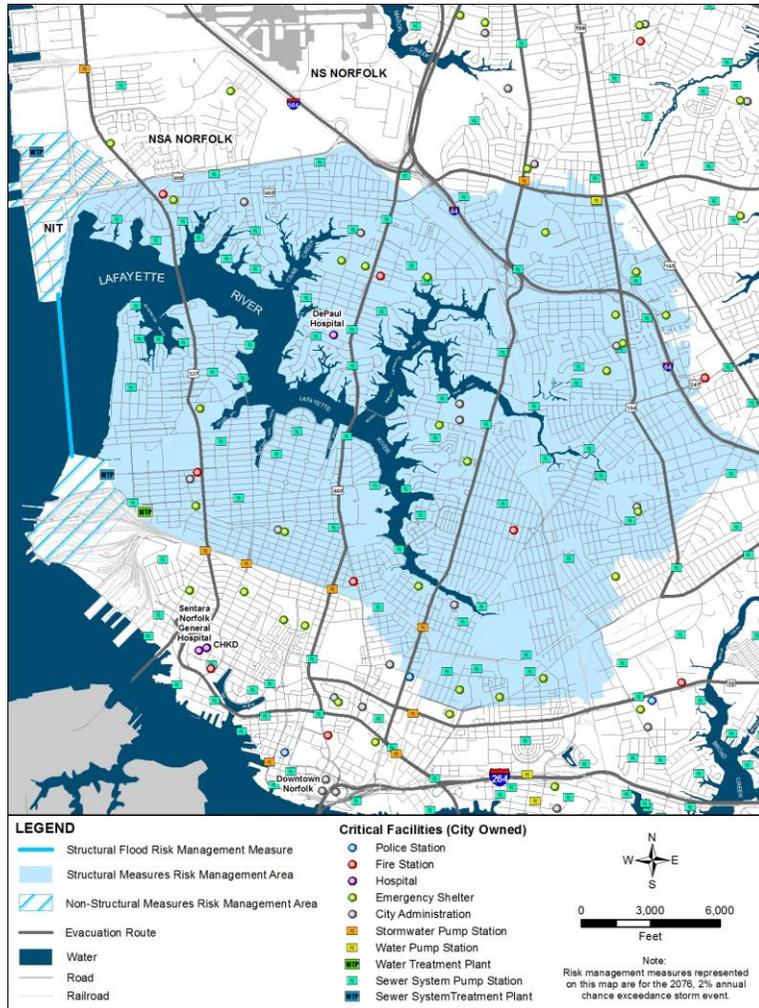
Description	Total Average Annual Costs	Annual Benefits	Annual Net Benefits	BCR	Total Project Cost
Downtown – Barrier System	\$9,212,000	\$50,379,000	\$41,167,000	5.5	\$242,747,000
Elizabeth River Eastern Branch (Nonstructural - EB-1)	\$1,900,000	\$6,351,000	\$4,451,000	3.3	\$50,072,000
Lyon Shipyard (Nonstructural – EB-1)	\$663,000	\$2,655,000	\$1,992,000	4.0	\$17,473,000

CRMS—Pretty Lake Barrier



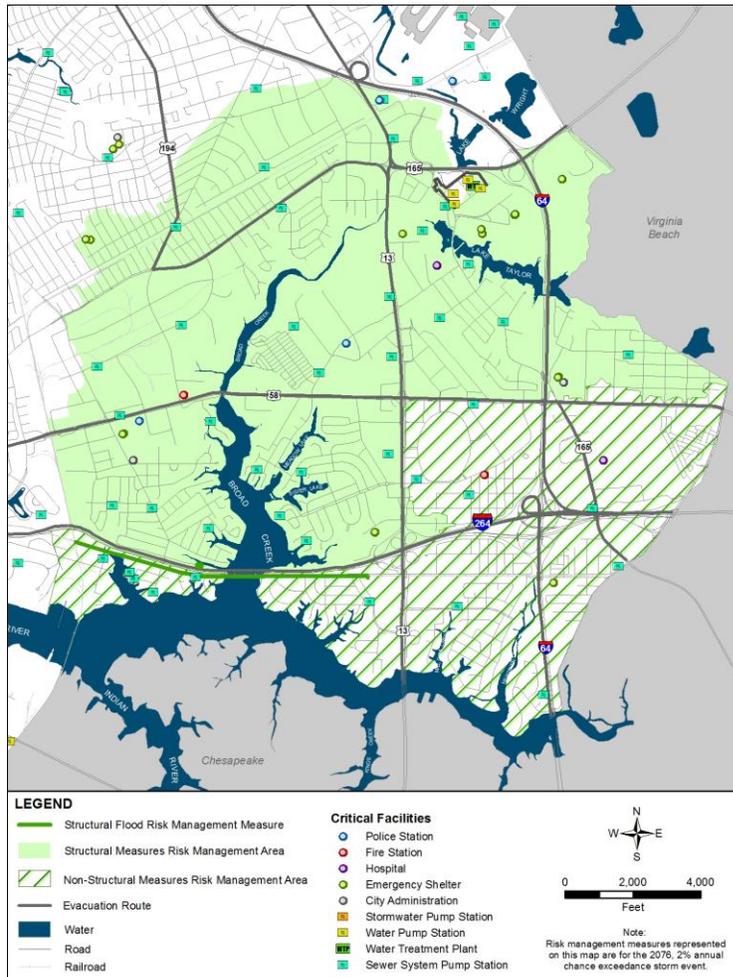
Description	Total Average Annual Costs	Annual Benefits	Annual Net Benefits	BCR	Total Project Cost
Pretty Lake Upper Surge Barrier	\$2,680,000	\$8,172,000	\$5,492,000	3.05	\$70,612,000
Pretty Lake Upper Nonstructural	\$7,107,000	\$8,133,000	\$1,026,000	1.14	\$187,279,000

CRMS—Lafayette River Barrier



Description	Total Average Annual Costs	Annual Benefits	Annual Net Benefits	BCR	Total Project Cost
Lafayette River Outer Surge Barrier	\$28,796,000	\$40,179,000	\$11,383,000	1.4	\$758,834,000
Lafayette River Outer Nonstructural (LR-1)	\$6,720,000	\$11,824,000	\$5,105,000	1.8	\$77,082,000

CRMS—Broad Creek Barrier



Description	Total Average Annual Costs	Annual Benefits	Annual Net Benefits	BCR	Total Project Cost
Broad Creek Barrier	\$4,869,000	\$8,319,000	\$3,450,000	1.7	\$128,317,000
Ingleside Rd. NS	\$622,000	\$877,000	\$255,000	1.4	\$16,391,000
Elizabeth Park NS	\$3,087,000	\$3,288,000	\$200,000	1.1	\$81,354,000

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