Ocean Park Civic League

Michael Mundy, P.E.

Nov. 9, 2023

CITY OF VIRGINIA BEACH

Agenda

01 Stormwater Background Information

02 City GIS Maps

03 Recurrent Flooding Indicator Maps

04 Flood Protection Program

05 Future Flood Protection

Stormwater Background Information

Understanding Water

photo of bathroom sink overflowing with water - Bing images

High Tide Impacts

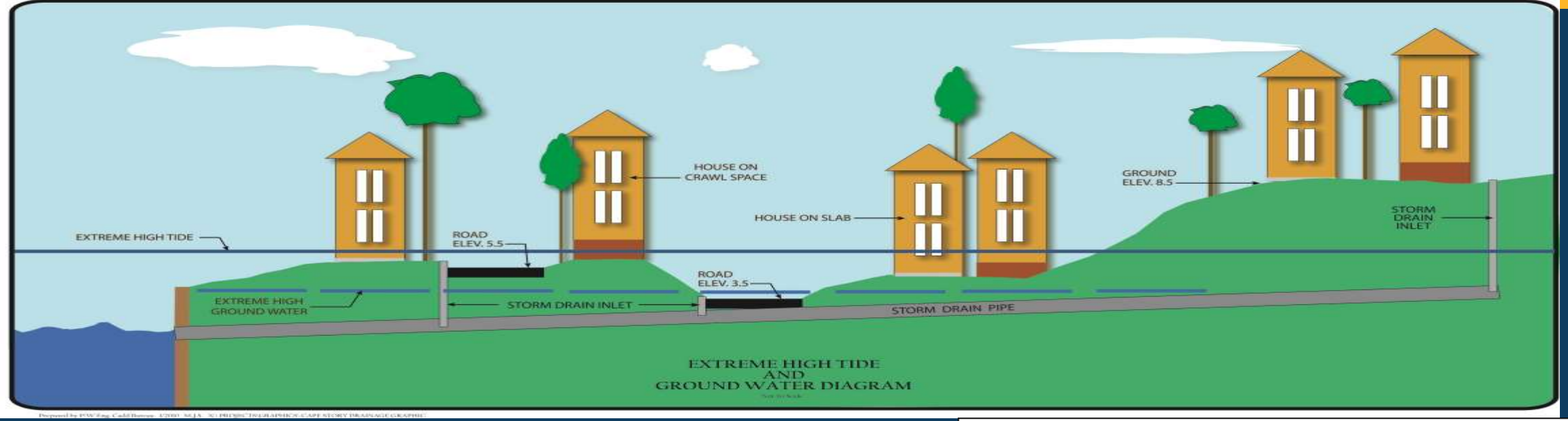
Coastal Flood Pathways and Extreme Tidal Elevations

Coastal Storms 1998 - 2018

STORM	DATE	WS ELEV (Ft.) (Lynnhaven Inlet)
Nor'Ida	11/09	6.90
Hurricane Isabel	9/03	6.20*
Thanksgiving N'easter	11/06	6.00*
Twin N'easter #2	1/98	5.85*
Hurricane Sandy	10/12	5.70
Hurricane Irene	8/11	5.50
Columbus Day N'easter	10/06	5.30*
Twin N'easter #1	2/98	5.20*
Tropical Storm Hermine	9/16	4.53
Hurricane Joaquin	10/15	4.40
Hurricane Floyd	9/99	4.25
Hurricane Matthew	10/16	4.24

Elevations are referenced to land survey datum NAVD88

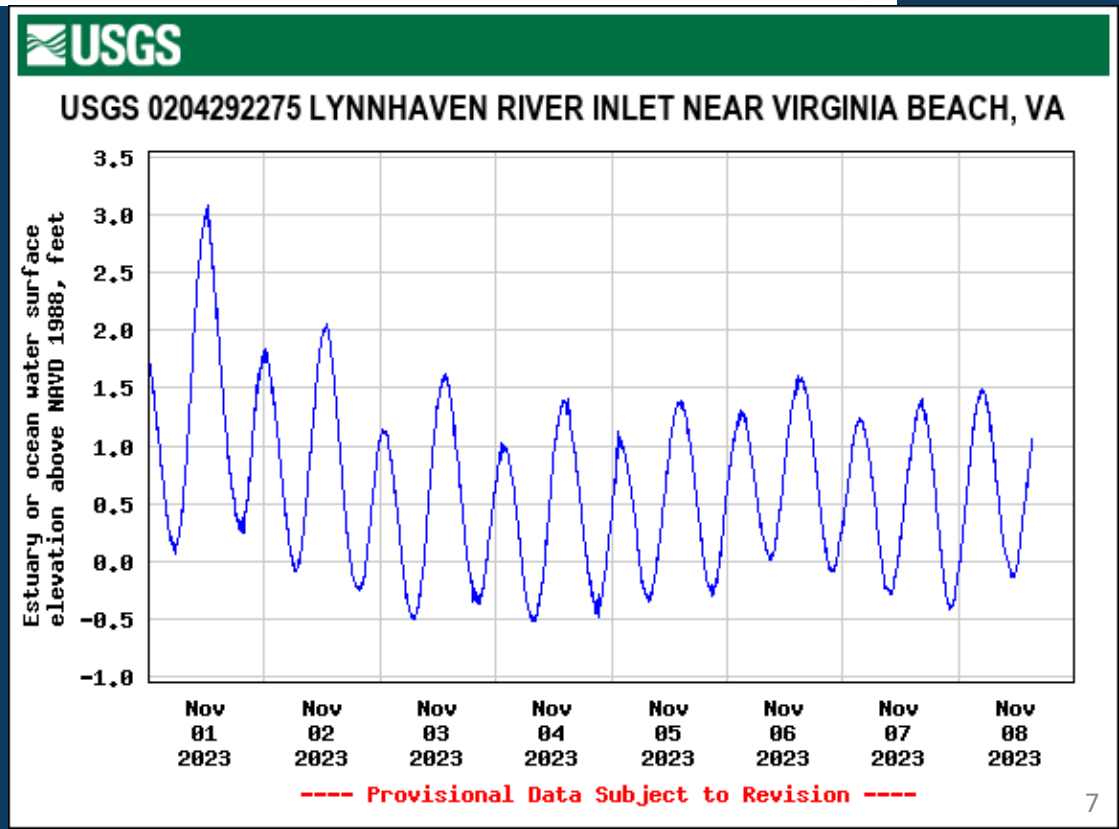
* indicates estimated elevation



United States Geological Survey (USGS)

https://waterdata.usgs.gov/va/nwis/current/?type=flow

USGS Tide Gauges Virginia



POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

NORFOLK WSO AIRPORT, VIRGINIA (44-6139) 36.9033 N 76.1922 W 0 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 2, Version 3
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2004
Extracted: Mon Feb 21 2011

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.41	0.65	0.82	1.12	1.40	1.66	1.78	2.17	2.57	2.93	3.39	3.77	4.39	4.97	6.71	8.30	10.27	12.24
2	0.48	0.77	0.97	1.34	1.68	1.99	2.15	2.60	3.08	3.57	4.10	4.57	5.30	5.97	8.00	9.86	12.15	14.44
5	0.55	0.88	1.12	1.59	2.03	2.47	2.66	3.24	3.85	4.62	5.28	5.82	6.66	7.40	9.71	11.84	14.48	17.00
10	0.63	1.00	1.27	1.84	2.39	2.95	3.21	3.90	4.66	5.51	6.29	6.87	7.79	8.58	11.12	13.42	16.37	19.03
25	0.71	1.13	1.43	2.12	2.82	3.55	3.90	4.76	5.74	6.82	7.81	8.39	9.43	10.28	13.10	15.60	19.01	21.77
50	0.78	1.24	1.56	2.36	3.19	4.09	4.54	5.57	6.76	7.96	9.14	9.68	10.80	11.69	14.72	17.33	21.14	23.92
100	0.84	1.33	1.69	2.58	3.56	4.63	5.20	6.40	7.83	9.21	10.61	11.08	12.27	13.19	16.42	19.11	23.32	26.07
200	0.90	1.43	1.80	2.81	3.94	5.21	5.91	7.32	9.02	10.59	12.25	12.60	13.87	14.80	18.21	20.93	25.59	28.25
500	0.98	1.55	1.95	3.10	4.45	6.01	6.91	8.61	10.73	12.66	14.73	14.86	16.16	17.10	20.72	23.41	28.72	31.16
1000	1.05	1.65	2.08	3.36	4.91	6.73	7.83	9.82	12.34	14.42	16.87	16.97	18.05	19.02	22.73	25.35	31.20	33.39

* These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting forces estimates near zero to appear as zero.

Inundation Areas

Elevation: *10* ft NAVD 88

Buildings: *1400*

Elevation	3	4	5	6	7	8	9	10
Buildings	9	73	307	582	872	1186	1343	1400

Kimley-Horn and Associates, Inc.

VB | theRippleEffect

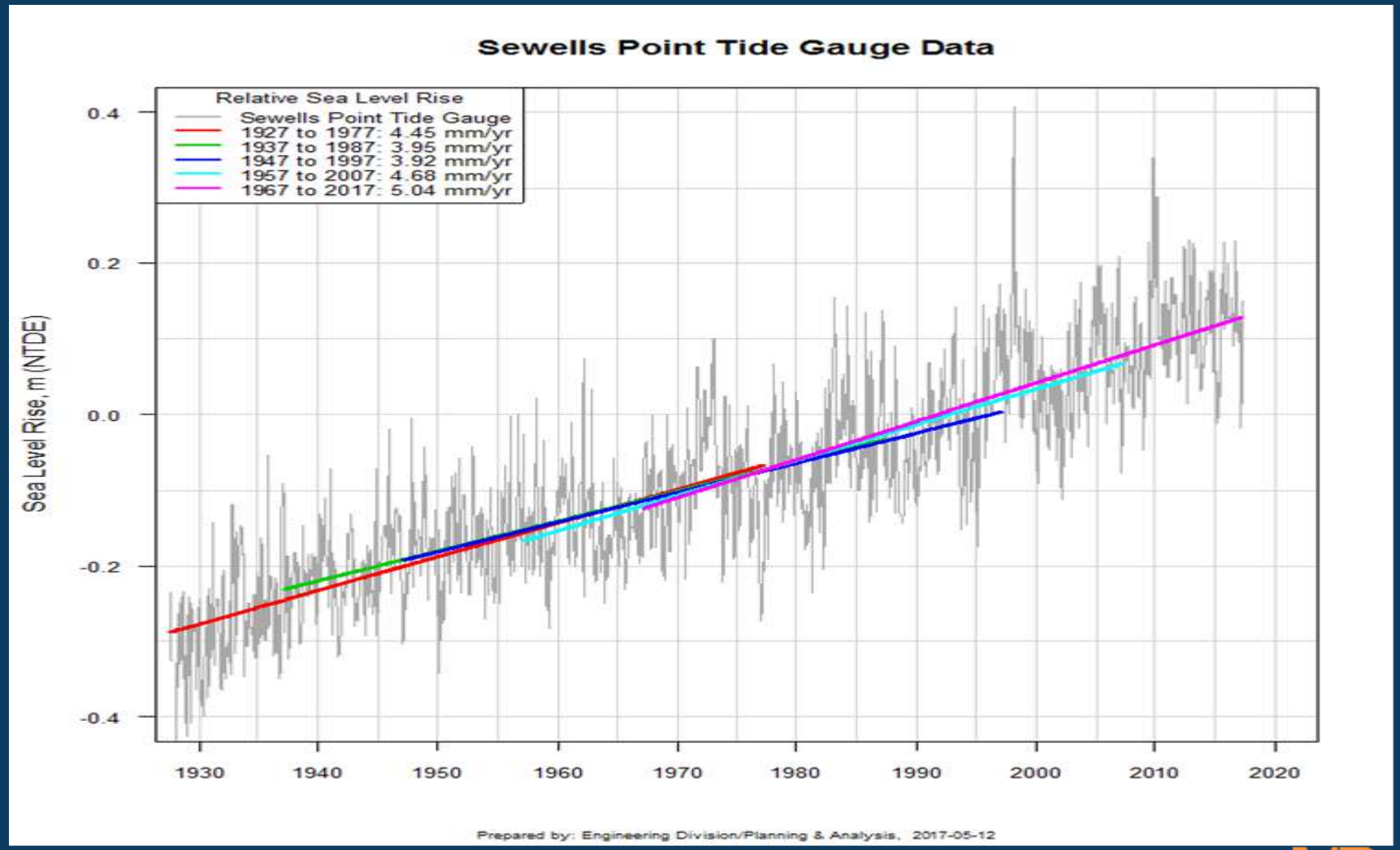
Pump Station Watershed Boundaries

Ocean Park Phase I Station
Powhatan Ave

Ocean Park Phase II Station

Sewells Point Tide Gauge Data

Sewells Point, VA 4.44 +/_ 0.27 mm/yr



Future Tidal Elevations

The Virginia Institute of Marine Science (VIMS) is predicting

- In 20 to 40 years anticipate 1.5-foot increase in tidal elevations
- In 40 to 80 years anticipate 3.0-foot increase in tidal elevations

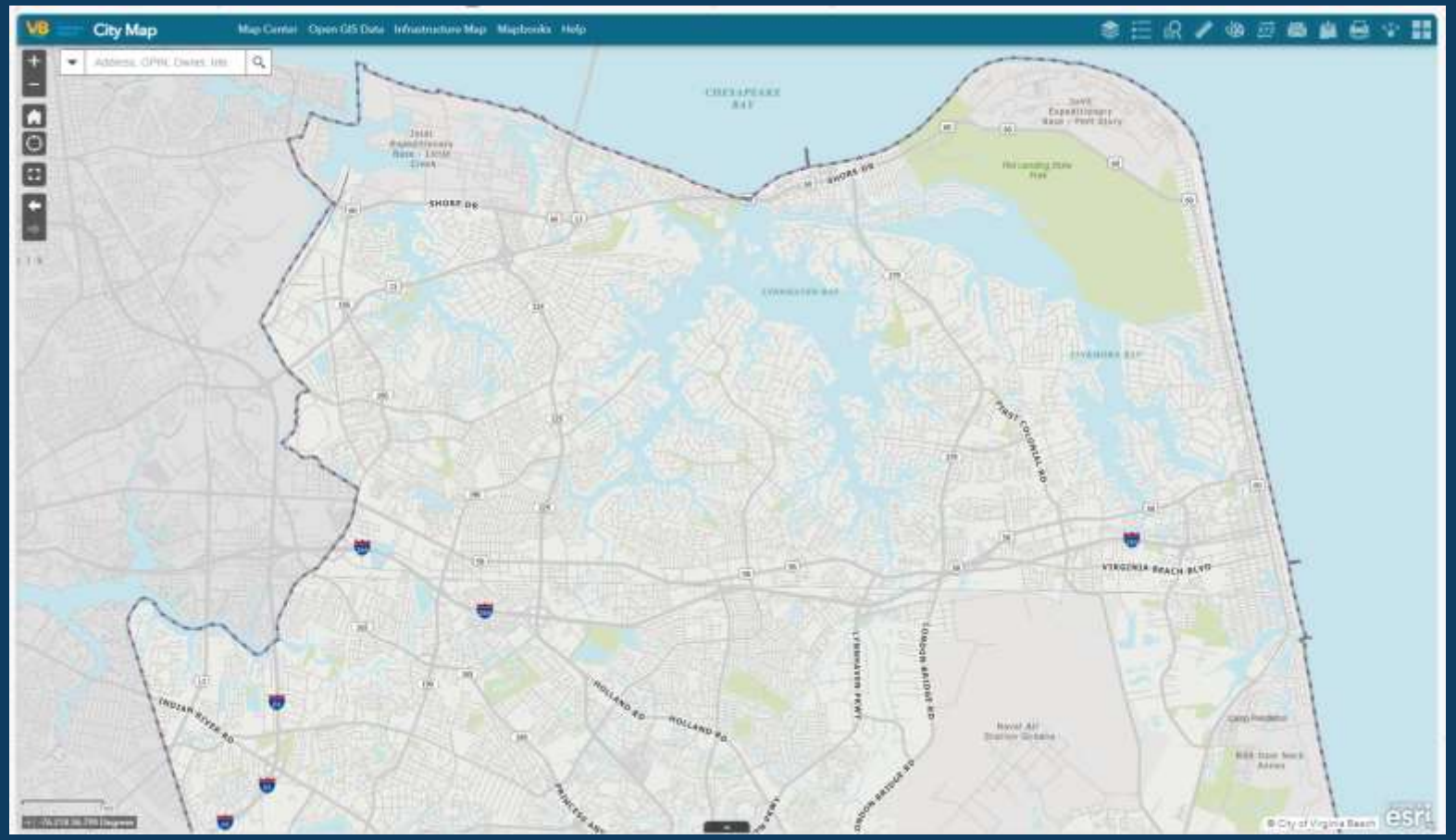
This means:

- Current tidal range is High Tide (1.5 to 1.8 feet) and Low Tide (-0.8 to -1.2 feet).
- In 20 to 40 years anticipate High Tide (3.0 to 3.3 feet) and Low Tide (0.7 to 0.3 feet)
- In 40 to 80 years the anticipate High Tide (4.5 to 4.8 feet) and Low Tide (2.2 to 1.8 feet).

City GIS Maps

City GIS Maps

- City GIS map allows the user to select different layers
  - Property Layers
  - Street Layers
  - Stormwater Layers
  - 2023 Aerial imagery
  - Topographic Elevations



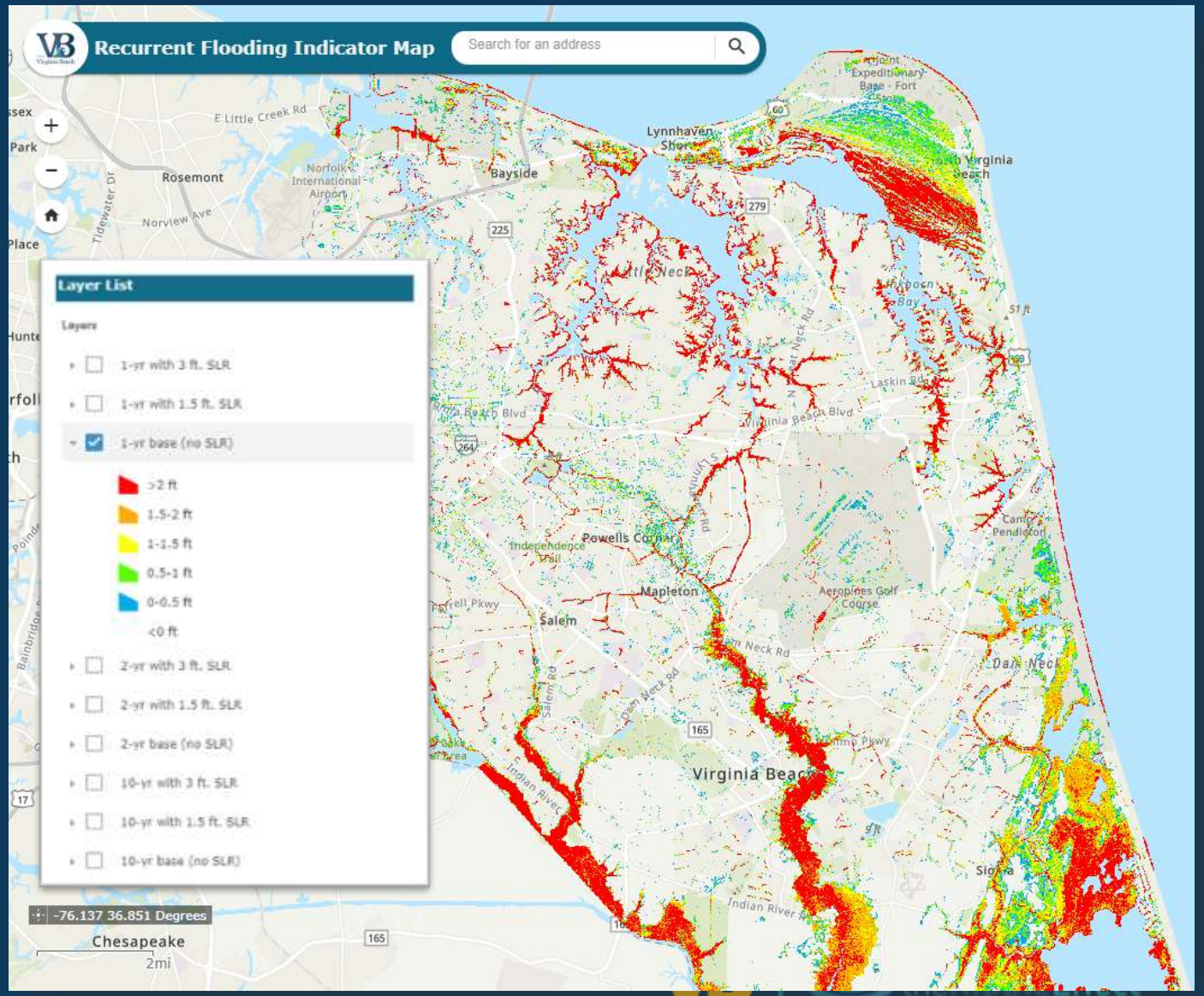
https://virginiabeach.gov/services/map-center

Recurrent Flooding Indicator Maps

Recurrent Flooding Indicator Map

- City GIS flood map allows the user to select the flooding layer
  - Different recurrence interval storms and sea level rise conditions
- Link to the GIS map is posted on the City FPP webpage

www.virginiabeach.gov/RippleEffect



Recurrent Flooding Indicator

The storm events listed are hypothetical storm events of a given frequency interval and duration.

A 1-year storm event has a 100% chance of occurring in a calendar year.
A 2-year storm event has a 50% chance. A 10-year storm event has a 10% chance.
A 25-year storm event has a 4% chance.
A 50-year storm event has a 2% chance.
A 100-year storm event has a 1% chance of occurring in a calendar year.

It is possible for multiple, larger storm events to occur in a single calendar year. For example, Virginia Beach, in 2016, experienced 100-year, 250-year (0.4% chance of occurrence), and 1000-year (0.1% chance of occurrence) storms within a 6-week period.

Recurrent Flooding Indicator

Boundary conditions listed indicate the elevation of the water (NAVD 88) for the duration of the storm event.

Base represents today's conditions,
1.5-feet sea level rise represents conditions between 2045-2065 and
3-feet sea level rise represents conditions between 2065-2085.

These elevations were generated based on historical analysis and modeling, prepared by Dewberry as part of the Sea Level Wise Adaptation Strategy Report.

Recurrent Flooding Factors and Probability

Rainfall Event	Starting Tidal Elevation
1 Yr	10 Yr
2 YR	5 YR
10 YR	1 YR
25 YR	2 YR
50 YR	2 YR
100YR	3 YR

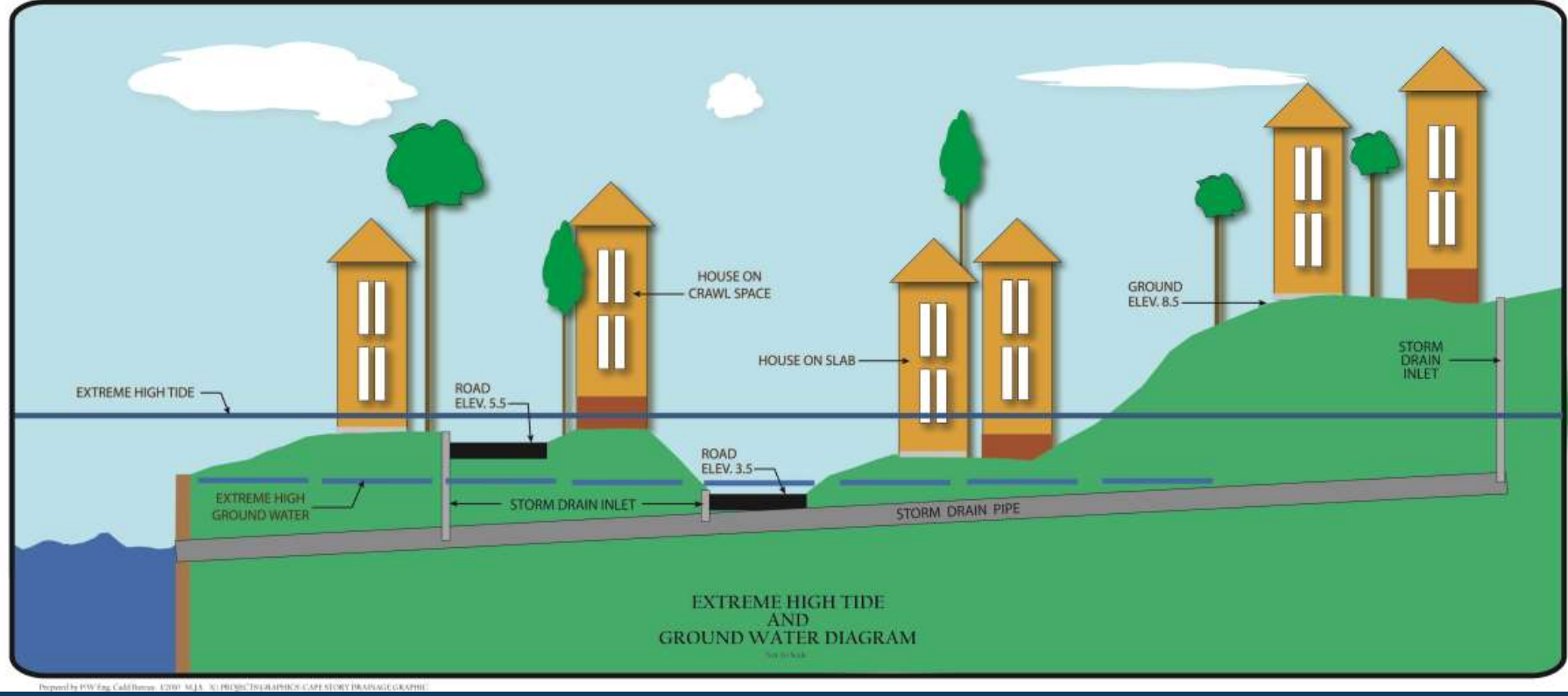


TABLE J-12
Design Tidal Elevations for Virginia Beach
All Elevations in feet relative to the North American Vertical Datum (NAVD) of 1988

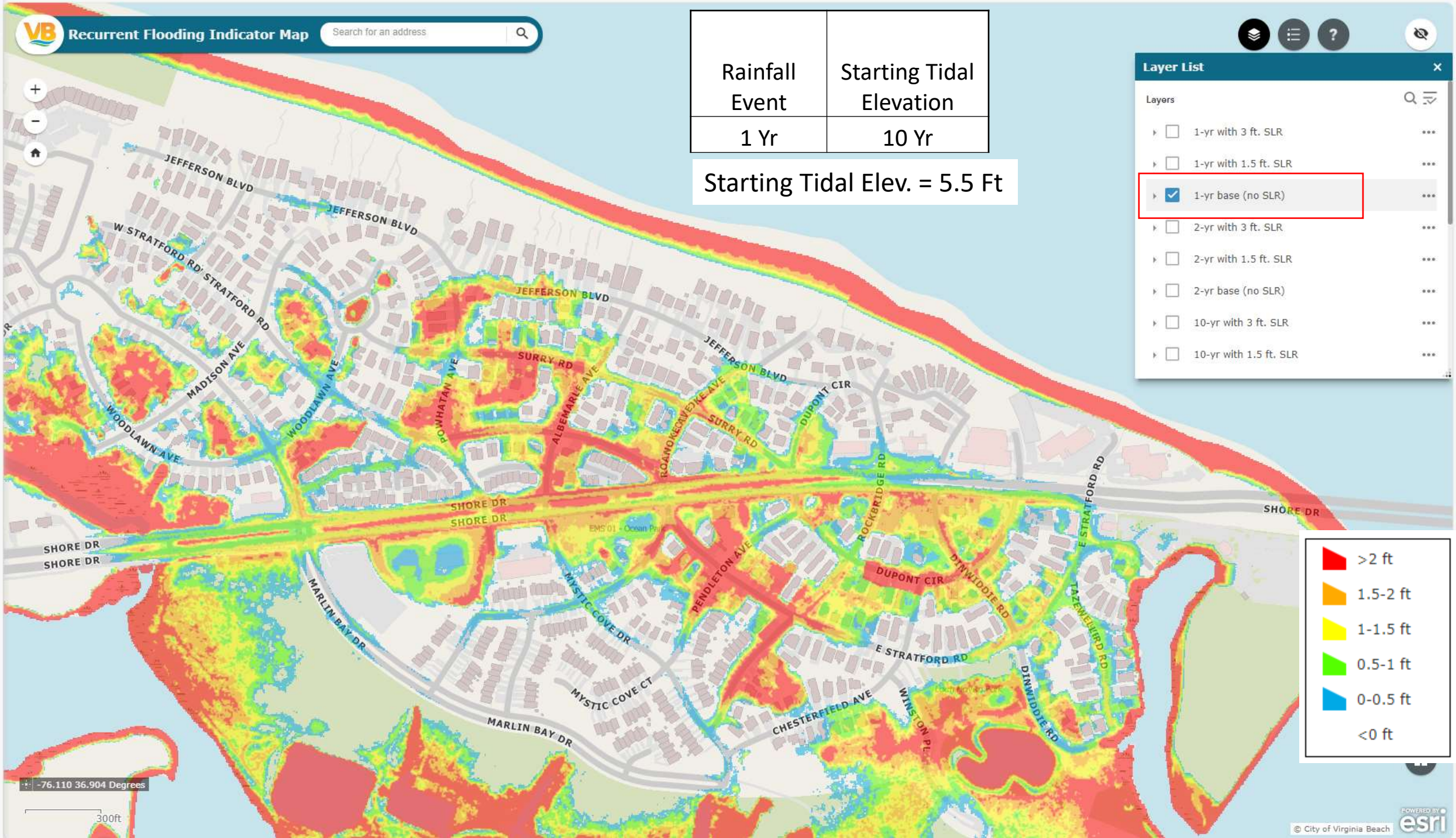
Location	Design Level	1-YR	2-YR	3-YR	5-YR	10-YR	25-YR	50-YR	100-YR	500-YR
Lynnhaven Bay & River, Eastern Branch	Existing Condition	3.1	3.6	4.0	4.4	5.2	5.8	6.2	6.7	8.5
	1.5 ft SLR	4.6	5.1	5.5	5.9	6.7	7.3	7.7	8.2	10.0
	3.0 ft SLR	6.3	6.9	7.3	7.7	8.5	9.2	9.6	10.1	12.0
Lynnhaven Bay & River, Incl. all areas other than Eastern Branch (Western Branch, Broad Bay, Linkhorn Bay, Little Neck Creek)	Existing Condition	3.2	3.9	4.3	4.8	5.5	6.3	6.9	7.4	9.3
	1.5 ft SLR	4.7	5.4	5.8	6.3	7.0	7.8	8.4	8.9	10.8
	3.0 ft SLR	6.4	7.2	7.6	8.1	8.8	9.7	10.3	10.8	12.8


Recurrent Flooding Indicator Map
Search for an address
Rainfall Event
Starting Tidal Elevation
10 Yr
1 Yr
Starting Tidal Elev. = 3.2 Ft
Layer List
1-yr base (no SLR)
2-yr with 3 ft. SLR
2-yr with 1.5 ft. SLR
2-yr base (no SLR)
10-yr with 3 ft. SLR
10-yr with 1.5 ft. SLR
10-yr base (no SLR)
25-yr with 3 ft. SLR
25-yr with 1.5 ft. SLR
>2 ft
1.5-2 ft
1-1.5 ft
0.5-1 ft
0-0.5 ft
<0 ft
JEFFERSON BLVD
W STRATFORD RD
STRATFORD RD
MADISON AVE
WOODLAWN AVE
POWHATAN AVE
SURRY RD
ALBEMARLE AVE
ROANOKE AVE
DUPONT CIR
ROCKBRIDGE RD
E STRATFORD RD
SHORE DR
EMS 01 - Ocean Park
PENDLETON AVE
MYSTIC COVE DR
MYSTIC COVE CT
MARLIN BAY DR
DINWIDDIE RD
TAZEWELL RD
CHESTERFIELD AVE
WINSTON PL
Loch Haven Park
-76.109 36.904 Degrees
300ft
© City of Virginia Beach
esri


Recurrent Flooding Indicator Map
Search for an address
Rainfall Event
Starting Tidal Elevation
10 Yr
1 Yr
Starting Tidal Elev. = 4.7 Ft
Layer List
Layers
1-yr with 3 ft. SLR
1-yr with 1.5 ft. SLR
1-yr base (no SLR)
2-yr with 3 ft. SLR
2-yr with 1.5 ft. SLR
2-yr base (no SLR)
10-yr with 3 ft. SLR
10-yr with 1.5 ft. SLR
>2 ft
1.5-2 ft
1-1.5 ft
0.5-1 ft
0-0.5 ft
<0 ft
JEFFERSON BLVD
W STRATFORD RW STRATFORD RD
MADISON AVE
WOODLAWN AVE
POWHATAN AVE
DUPONT CIR
SHORE DR
E STRATFORD RD
MARLIN BAY DR
MYSTIC COVE CT
CHESTERFIELD AVE
DINWIDDIE RD
TAZEWELL RD
EMS 01 - Ocean Park
-76.100 36.911 Degrees

Rainfall Event	Starting Tidal Elevation
1 Yr	10 Yr

Starting Tidal Elev. = 8.8 Ft



Rainfall Event	Starting Tidal Elevation
1 Yr	10 Yr

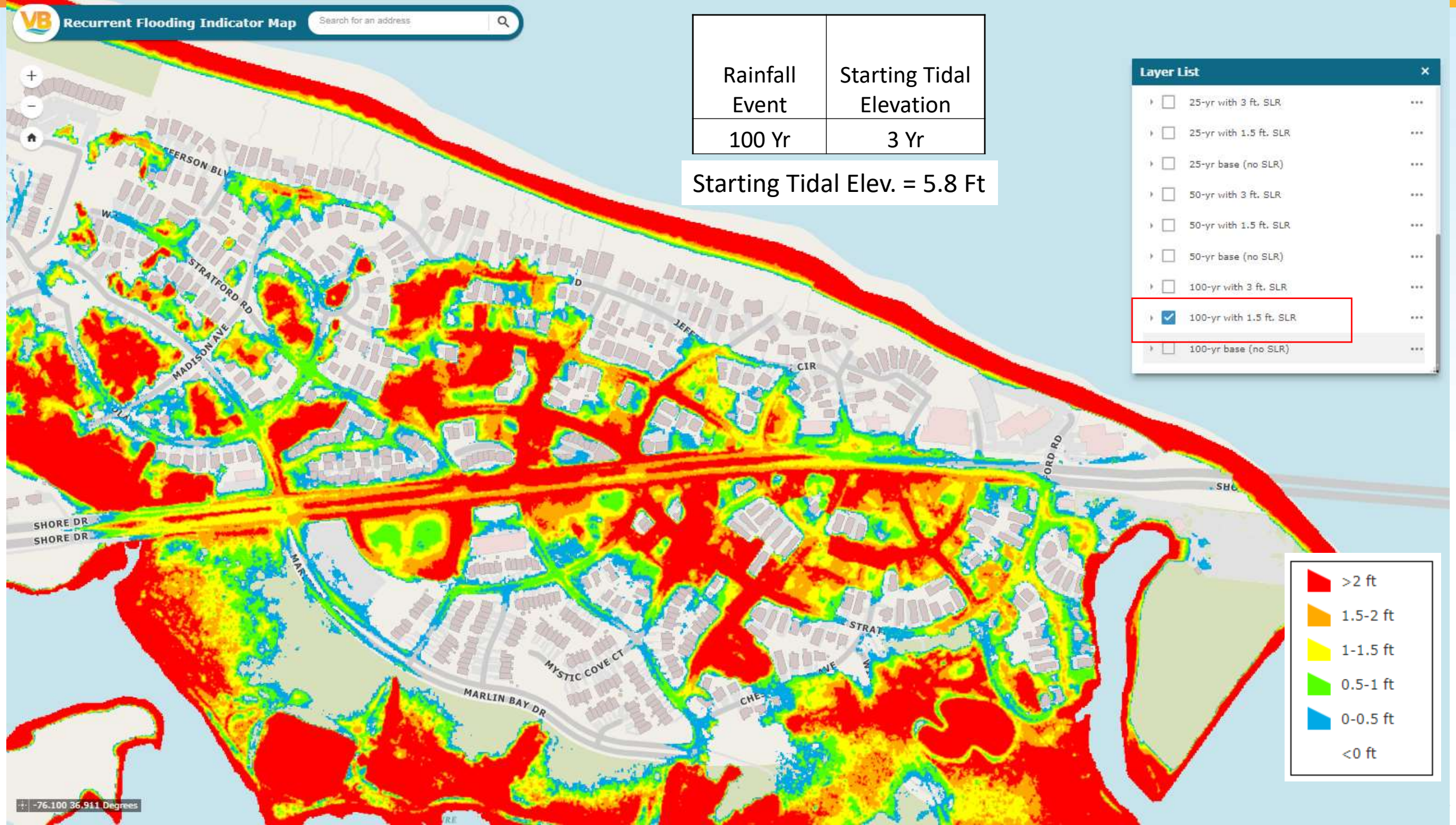
Starting Tidal Elev. = 5.5 Ft

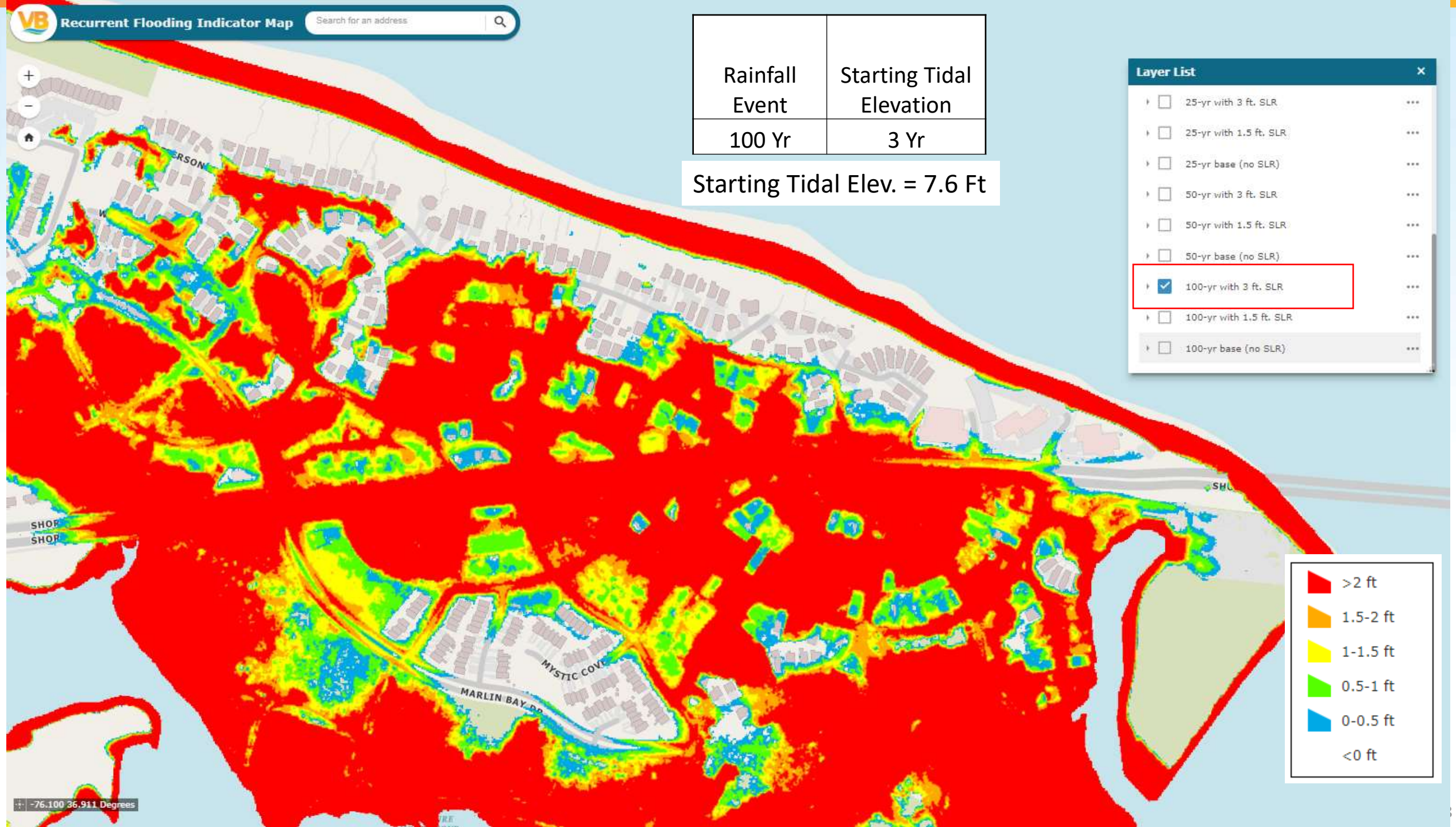
Rainfall Event	Starting Tidal Elevation
1 Yr	10 Yr

Starting Tidal Elev. = 7.0 Ft


Recurrent Flooding Indicator Map
Search for an address
Rainfall Event
Starting Tidal Elevation
10 Yr
1 Yr
Starting Tidal Elev. = 6.4 Ft
Layer List
2-yr base (no SLR)
10-yr with 3 ft. SLR
10-yr with 1.5 ft. SLR
10-yr base (no SLR)
25-yr with 3 ft. SLR
25-yr with 1.5 ft. SLR
25-yr base (no SLR)
50-yr with 3 ft. SLR
50-yr with 1.5 ft. SLR
>2 ft
1.5-2 ft
1-1.5 ft
0.5-1 ft
0-0.5 ft
<0 ft
JEFFERSON BLVD
W STRATFORD RW
STRATFORD RD
MADISON AVE
WOODLAWN AVE
POWHATAN AVE
SURRY RD
ALBEMARLE AVE
ROANOKE AVE
DUPONT CIR
ROCKBRIDGE RD
E STRATFORD RD
SHORE DR
PENDLETON AVE
MYSTIC COVE DR
MYSTIC COVE CT
MARLIN BAY DR
DINWIDDIE RD
TAZEWELL RD
CHESTERFIELD AVE
WINSTON PL
EMS 01 - Ocean Park
300ft
© City of Virginia Beach
esri

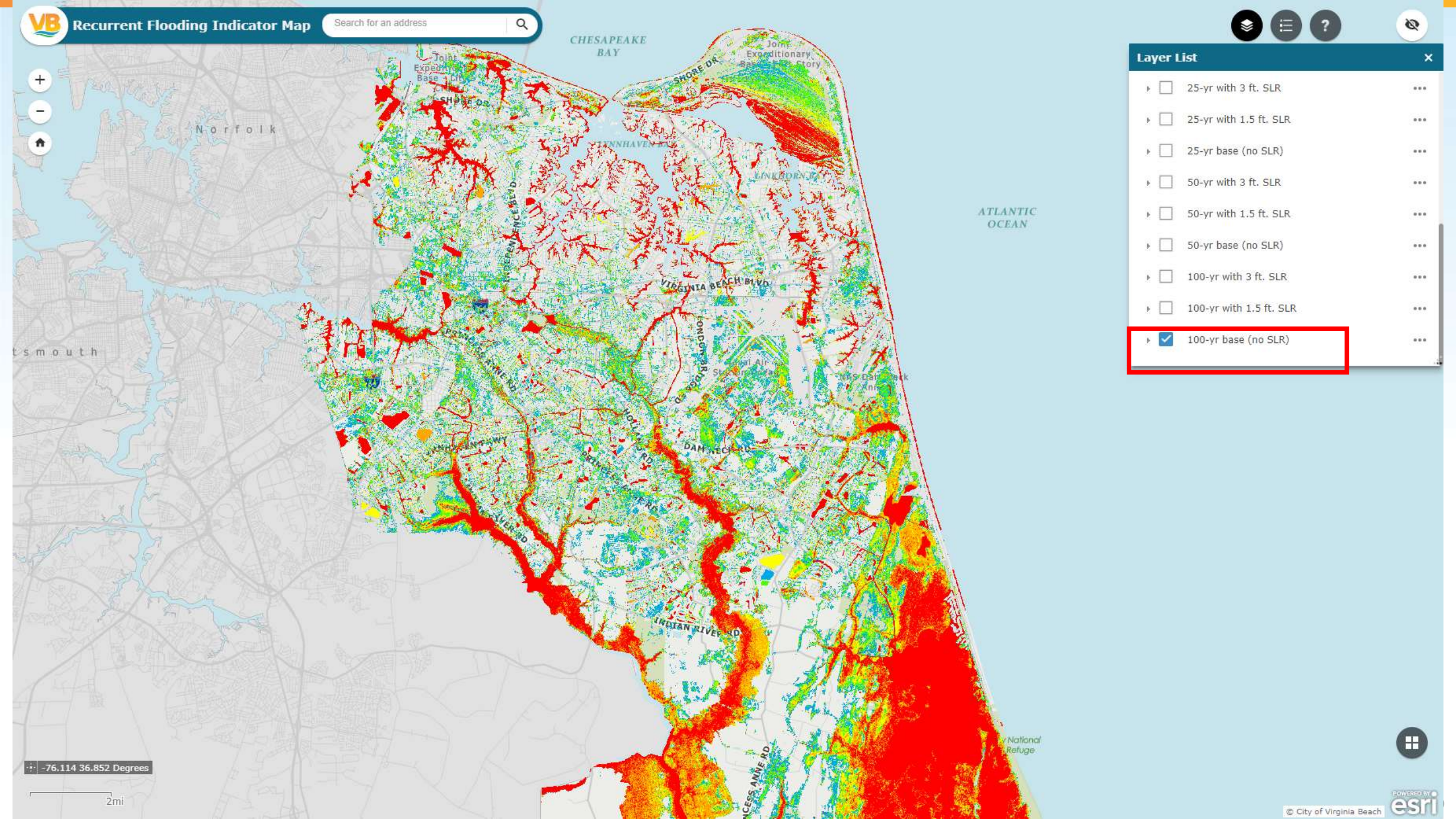

Recurrent Flooding Indicator Map
Search for an address
Rainfall Event
Starting Tidal Elevation
100 Yr
3 Yr
Starting Tidal Elev. = 4.3 Ft
Layer List
25-yr with 3 ft. SLR
25-yr with 1.5 ft. SLR
25-yr base (no SLR)
50-yr with 3 ft. SLR
50-yr with 1.5 ft. SLR
50-yr base (no SLR)
100-yr with 3 ft. SLR
100-yr with 1.5 ft. SLR
100-yr base (no SLR)
>2 ft
1.5-2 ft
1-1.5 ft
0.5-1 ft
0-0.5 ft
<0 ft
SHORE DR
JEFFERSON BLVD
W STRATFORD RD
E STRATFORD RD
MADISON AVE
WOODLAWN AVE
POWHATAN AVE
DUPONT CIR
MARLIN BAY DR
MYSTIC COVE CT
CHESTERFIELD AVE
DINWIDDIE RD
-76.100 36.911 Degrees

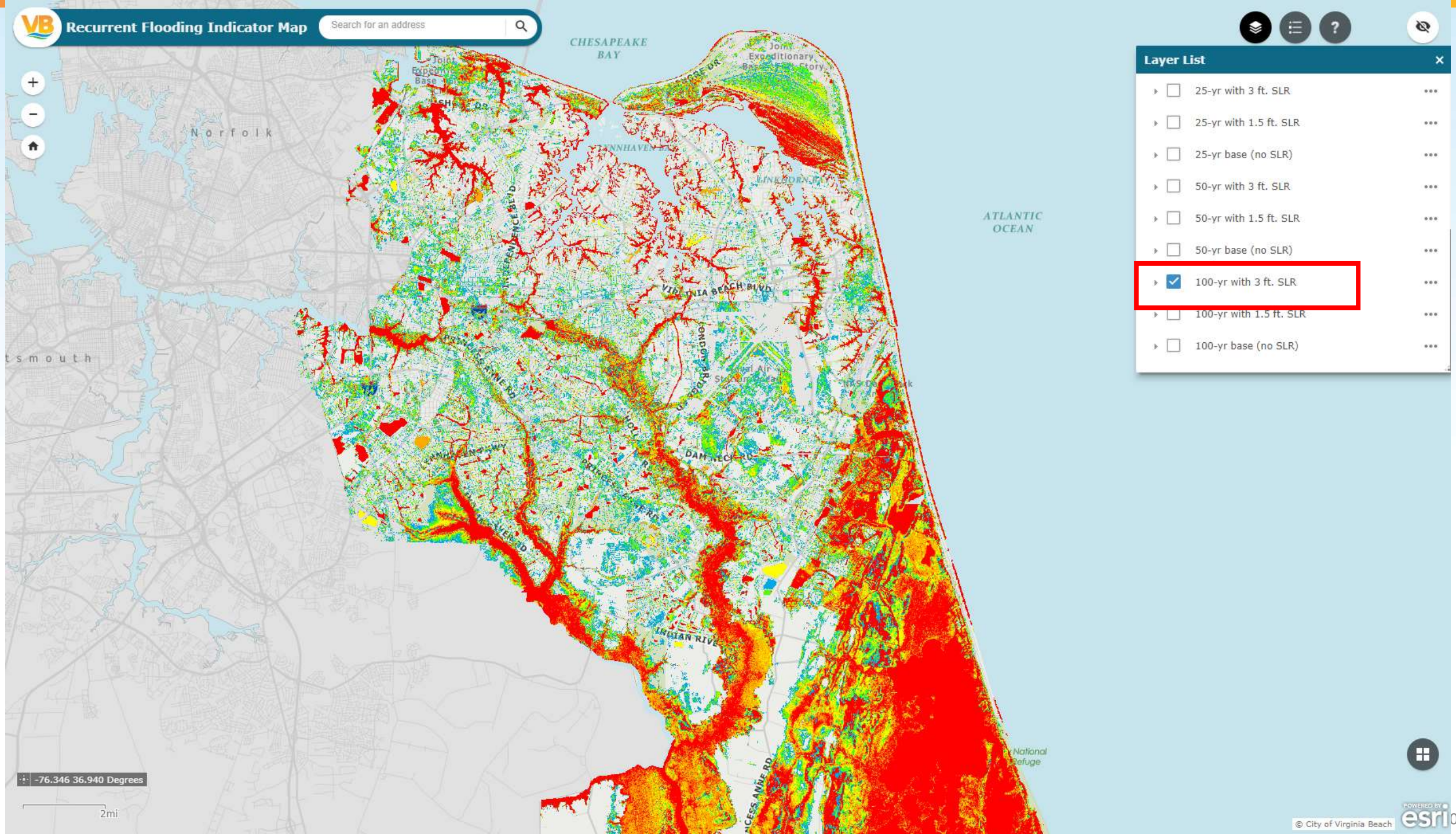

Recurrent Flooding Indicator Map
Search for an address
Rainfall Event
Starting Tidal Elevation
100 Yr
3 Yr
Starting Tidal Elev. = 5.8 Ft
Layer List
25-yr with 3 ft. SLR
25-yr with 1.5 ft. SLR
25-yr base (no SLR)
50-yr with 3 ft. SLR
50-yr with 1.5 ft. SLR
50-yr base (no SLR)
100-yr with 3 ft. SLR
100-yr with 1.5 ft. SLR
100-yr base (no SLR)
>2 ft
1.5-2 ft
1-1.5 ft
0.5-1 ft
0-0.5 ft
<0 ft
STRATFORD RD
MADISON AVE
SHORE DR
MARLIN BAY DR
MYSTIC COVE CT
-76.100 36.911 Degrees



Rainfall Event	Starting Tidal Elevation
100 Yr	3 Yr

Starting Tidal Elev. = 7.6 Ft


Recurrent Flooding Indicator Map
Search for an address
Layer List
25-yr with 3 ft. SLR
25-yr with 1.5 ft. SLR
25-yr base (no SLR)
50-yr with 3 ft. SLR
50-yr with 1.5 ft. SLR
50-yr base (no SLR)
100-yr with 3 ft. SLR
100-yr with 1.5 ft. SLR
100-yr base (no SLR)
CHESAPEAKE BAY
ATLANTIC OCEAN
Norfolk
VIRGINIA BEACH BLVD
SHORE DR
INDIAN RIVER RD
-76.114 36.852 Degrees
2mi
© City of Virginia Beach
esri


Recurrent Flooding Indicator Map
Search for an address
Layer List
25-yr with 3 ft. SLR
25-yr with 1.5 ft. SLR
25-yr base (no SLR)
50-yr with 3 ft. SLR
50-yr with 1.5 ft. SLR
50-yr base (no SLR)
100-yr with 3 ft. SLR
100-yr with 1.5 ft. SLR
100-yr base (no SLR)
CHESAPEAKE BAY
ATLANTIC OCEAN
Norfolk
VIRGINIA BEACH BLVD
-76.346 36.940 Degrees
2mi
© City of Virginia Beach
esri

Flood Protection Program

Master Projects

Flood Protection Capital Improvement Program

FY 2023–2024 Capital Improvement Program (CIP)

Adopted on July 1, 2023

$743.8 M **6-year total appropriated funding**

Includes $567.5M from Stormwater Bond Referendum

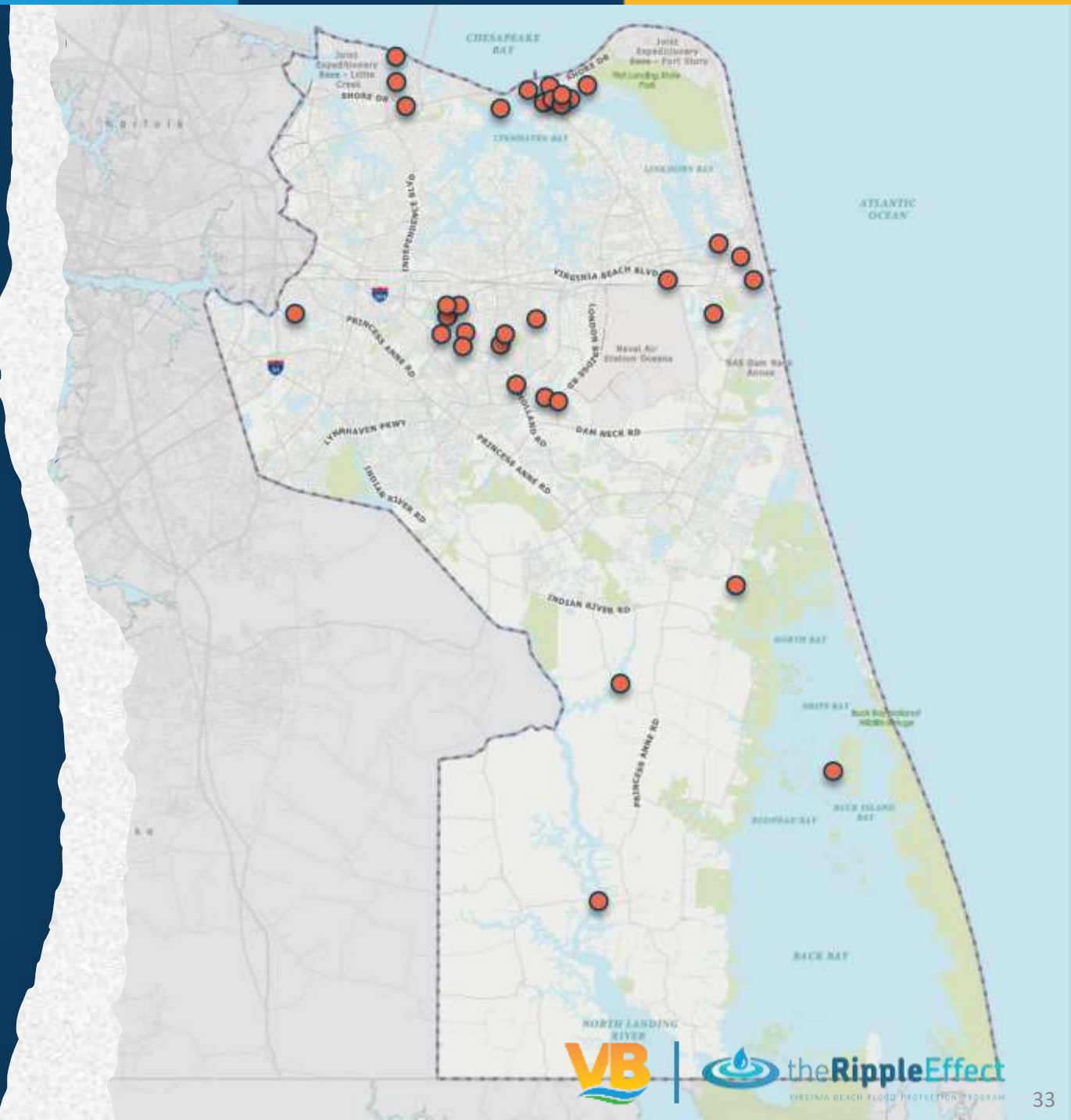
45 projects and programs

7 **master projects containing 35 of the 45 projects and programs:**

- Central Resort District
- Eastern Shore Drive Phase I
- Lake Bradford/Chubb Lake
- Linkhorn Bay Drainage Basin
- Southern Rivers Watershed
- Stormwater Green Infrastructure
- Windsor Woods, Princess Anne Plaza & The Lakes

10 **stand-alone projects and programs**

- Project Locations



Future Flood Protection

Watershed Approach

- Each watershed has distinct flooding challenges and opportunities
- 4 Watersheds – 15 Drainage Basins
- Master Plans are underway to identify projects to mitigate flooding in the 15 drainage basins

Multiple Layers of Adaptation

Natural Mitigations

- Land Conservation
- Beach and Dune Nourishment
- Marsh Restoration
- Living Shorelines
- Maritime Forests
- Aquatic Vegetation
- Shellfish Reefs
- Seagrass Restoration

Engineered Defenses

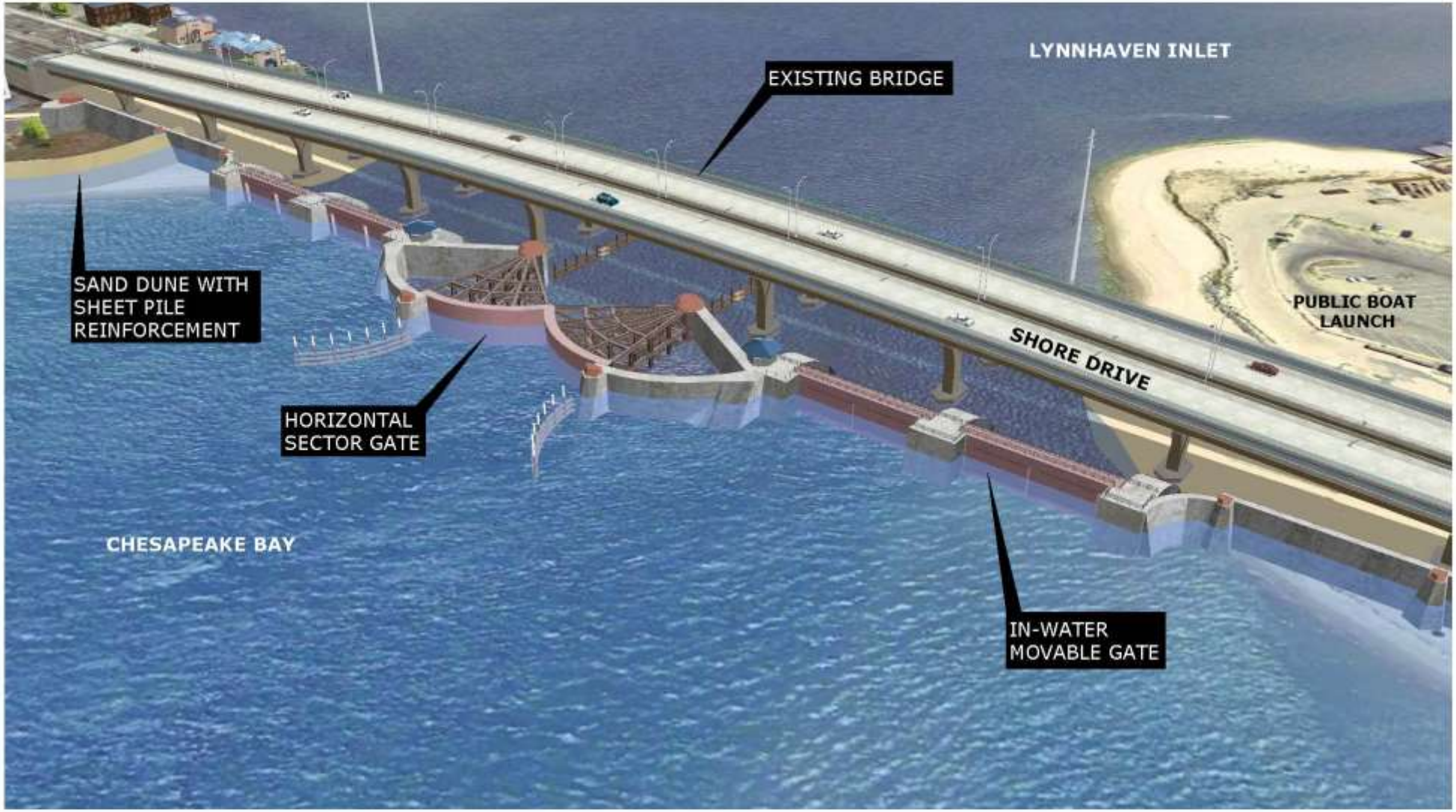
- Earthen Levee
- Floodwall
- Seawall
- Gates

Adapted Structures

- Wet/Dry Flood Proofing
- Structure Elevation
- Mitigation-Reconstruction
- Voluntary Acquisition
- Floodplain Regulation
- Responsible Development

Prepared Communities

- Educational Workshops
- Business Outreach
- Community Partnerships
- Military Coordination
- Flood Insurance Expansion



COMBINATION GATE SOLUTION (ENLARGED)

For More Information

Flood Protection Program –

https://pw.virginiabeach.gov/stormwater/flood-protection-program

Sea Level Wise –

https://pw.virginiabeach.gov/stormwater/stormwater-planning/sea-level-wise

Michael W. Mundy, PE –

MMundy@vbgov.com

Thank You!

Questions?