CHARLESTON CITY PLAN
LAND & WATER ANALYSIS

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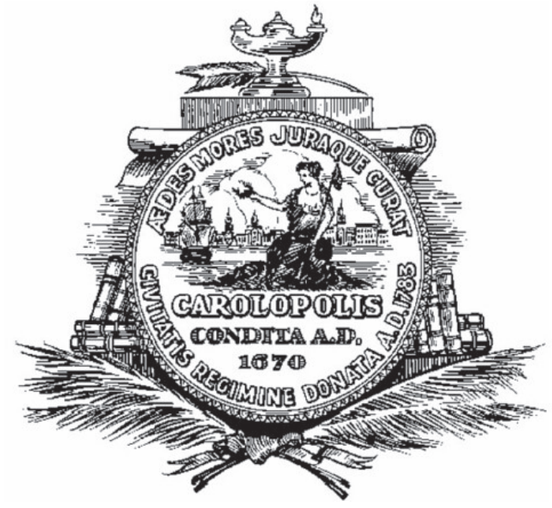
- OUTER WEST ASHLEY
- JAMES ISLAND
- JOHNS ISLAND
- DANIEL ISLAND
- CAINHOY

APPENDIX



WAGGONNER & BALL

THE WATER INSTITUTE OF THE GULF®

Robinson Design Engineers

SURCULUS

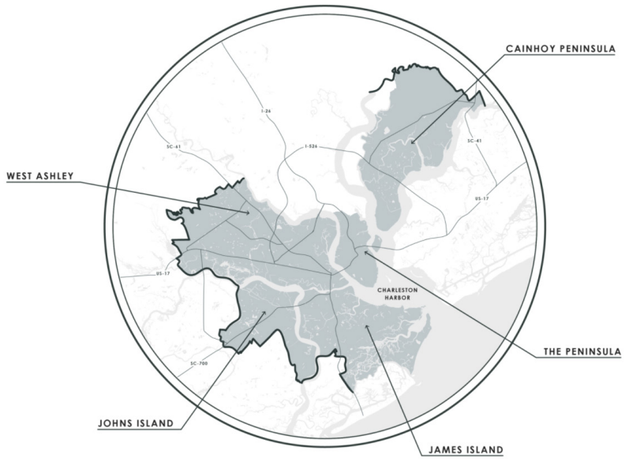
EXECUTIVE SUMMARY

Charleston has seen extraordinary change in the last half century. The city has doubled in population and increased in area nearly sevenfold since the 1970s, all while the effects of climate change begin to reverberate throughout the Lowcountry. The interaction between those two forces of growth and climate make flood risk a moving target, creating new areas of risk and exacerbating old ones. A long-term strategy is necessary to plan for those two forces of growth and climate. The Charleston City Plan aims to direct the development of Charleston over the next ten years with an awareness of these long-term trends. Embedded within the City Plan, this Land & Water Analysis serves as the preface to that strategy: not a set of policy or project recommendations, but the underlying data to inform future City decisions.

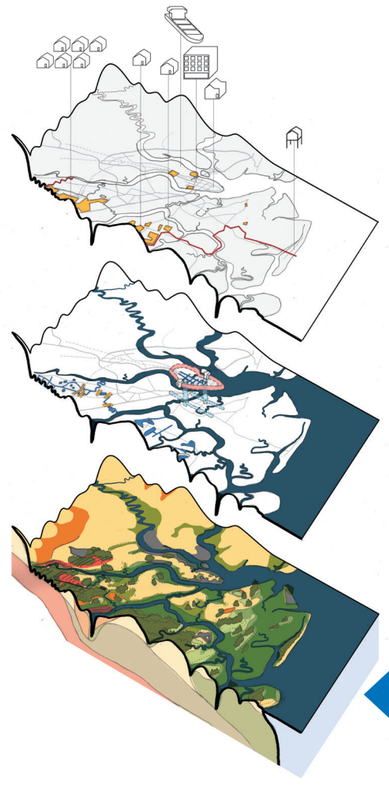
The Land & Water Analysis was led by David Waggonner of Waggonner & Ball Architecture / Environment and Dale Morris of The Water Institute of the Gulf, the leaders of Dutch Dialogues Charleston. Local partners Robinson Design Engineers and Surculus Design also contributed to Dutch Dialogues, and the team built off that shared experience and knowledge of place for the Land & Water Analysis.

The process began from the ground up with a study of fundamental aspects of land and water. The team mapped multiple types of water, from tide to rain to storm surge, and met with local communities and stakeholders to get an on-the-ground sense of flooding throughout the city (extensive community engagement was conducted through the larger City Plan development process). Watershed boundaries, not political boundaries, guided the analytical approach, sometimes requiring a view beyond City jurisdiction. The watershed approach resulted in analyses for the Region and seven watershed areas: Peninsula, inner West Ashley, outer West Ashley, James Island, Johns Island, Daniel Island and Cainhoy. Within each watershed, the analysis began with elevation (what is the land's relative risk?), mapped watershed sensitivity (how does land affect its surroundings?), and overlayed environmental sensitivity (where are critical habitats and ecological resources located and how are they changing?). The outcome of the analysis is four broad planning categories for the City, with its citizens, to weigh as it reimagines its future: grow, defend, adapt and reserve.

With multiple flood risk mitigation projects on the horizon and an imperative to adapt vast swaths of Charleston's built environment to ever changing flood risk, the need for an analytic framework to guide those tasks is crucial. The goal of the Land & Water Analysis is to create a way to see flood risk and opportunities to increase resiliency in Charleston that inform the next decade of change and beyond.



CHARLESTON
CITY PLAN
THE CITY OF CHARLESTON COMPREHENSIVE PLAN 2020



DUTCH DIALOGUES™ LAYERED PLANNING

INHABITATION
Development & land use

INFRASTRUCTURE
Drainage & transportation networks

GROUND
Soil, water & ecology

LAND & WATER ANALYSIS

TEAM & STAKEHOLDERS

TEAM

Waggonner & Ball
- David Waggonner
- Andy Sternad
- Lex Agnew

The Water Institute of the Gulf
- Dale Morris

Robinson Design Engineers
- Joshua Robinson
- Emma Collins
- Lucy Rummler

Surculus
- Erin Stevens
- Taylor Schenker

ELECTED OFFICIALS

Sandy Senn, State Senator District 41
Marie DelCioppo, District 1 Councilmember
Harry Griffin, District 10 Councilmember
Karl Brady, District 5 Councilmember
Carol Jackson, District 12 Councilmember
Dudley Gregorie, District 6 Councilmember
Ross Appel, District 11 Councilmember
Mike Seekings, District 8 Councilmember
Kevin Shealy, District 2 Councilmember
Perry Waring, District 7 Councilmember
Peter Shahid, District 9 Councilmember
Jason Sakran, District 3 Councilmember
Robert Mitchell, District 4 Councilmember

CITY STAFF

Jacob Lindsey, Planning Director
Amanda Herring, Planning Director Interim
Matt Fountain, Director of Stormwater Management
Christopher Morgan, Planning Manager
Philip Overcash, Senior Planner
Allen Davis, Civic Design Center Director
Chloe Stuber, Planner
Kinsey Holton, Stormwater Management
Steven Julka, Floodplain Manager
Jason Kronsberg, Director of Parks
Eric Pohlman, West Ashley Coordinator
Eric Schultz, TRC Administrator
Su Griffin, Neighborhood Services Manager
Morgan Gundlach, Urban Designer

BUSINESS & REGIONAL STAKEHOLDERS

Josh Dix (Metro Realtors)
Chuck Jarman (Clemson Extension)
Lauren Gellatly (LLF)
Alison Simmons (Berkeley County Planning)
Kathryn Basha (BCD COG)
Jane Baker (DI Company)
Scott Barhight (MetroChamber)
Jason Crowley (CCL)
Laura Cantrall (CCL)
Betsy LaForce (CCL)
David Ray (LCLT)
Chris Magaldi (Thomas & Hutton)
Chris Mack (FEMA consultant)
Tim Callahan, PhD (College of Charleston)
Jeff Lamberson (Citadel)
Elizabeth Fly (TNC)
Winslow Hastie (Historic Charleston Foundation)
Norm Levine (College of Charleston)
Bruce Binney (LLT)
Carl Taylor (LLT)
Michelle Sinker (OSI)

CITIZEN LEADERS

Diane Hamilton (West Ashley)
Katherine Anderson (West Ashley)
Carolee Williams (West Ashley)
Frances Waite (West Ashley)
Mason Holland (Cainhoy/Daniel Is)
Fred Lincoln (Cainhoy)
Eileen Dougherty (James Island)
Amy Luisi (James Island)
Greg Payton (James Island)
Harriet Reavis (James Island)
Troy Miller (James Island)
John Zoglar (Johns Island TF)
Wagener Terrace Neighborhood Assn.

ANALYTICAL APPROACH

LAND & WATER CONTEXT

Land	Water
Elevation	Rain
Land Cover	Tides
Development	Floodplain
Ecology	Storm Surge
Soils	Sea Level Rise

1

ELEVATION ZONES

↕

What is your risk?

+

2

WATERSHED SENSITIVITY

↔

How do you impact your surroundings?

+

3

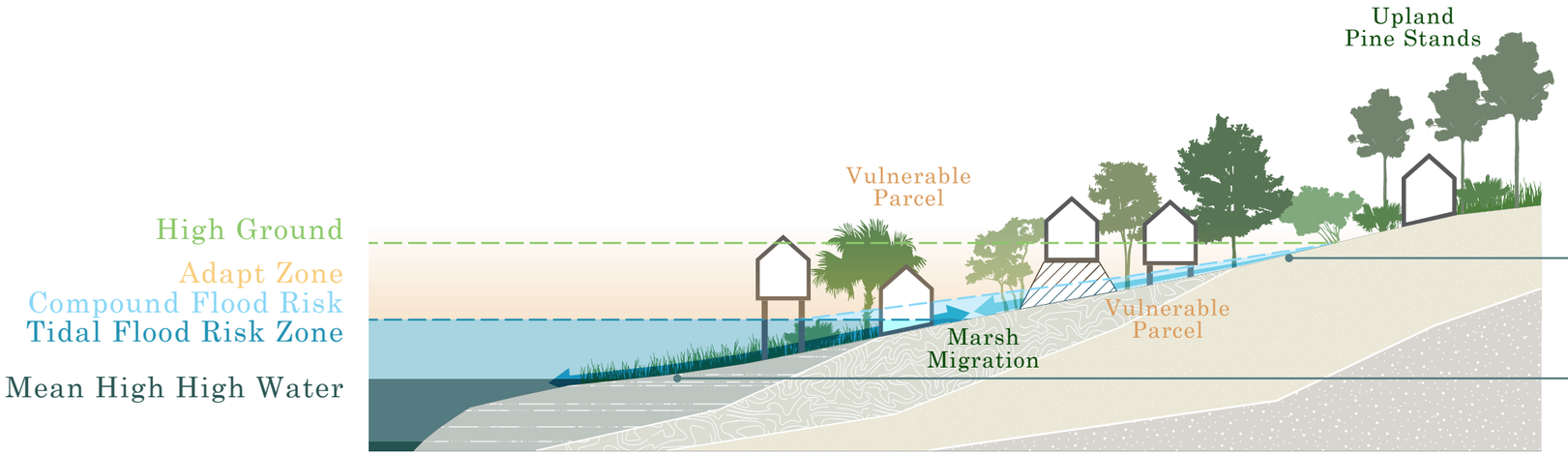
ENVIRONMENTAL SENSITIVITY

What other ecological considerations need to be taken into account?

ANALYTICAL APPROACH

LAND & WATER CONTEXT ⟶ 1 ELEVATION ZONES + 2 WATERSHED SENSITIVITY + 3 ENVIRONMENTAL SENSITIVITY

1 ELEVATION ZONES



2 WATERSHED SENSITIVITY

VULNERABILITY

Number of vulnerable parcels Locally and Downstream

WATERSHED SIZE

Potential for Runoff Accumulation

TIDAL EXTENT

Potential for Drainage Backup

3 ENVIRONMENTAL SENSITIVITY

ECOLOGY

Marsh Migration, Existing Canopy, Large Intact Ecosystems

SOILS

Ability to Infiltrate, Groundwater Levels

WATER BENCHMARKS

2/3 OF CHARLESTON

INSIDE THE URBAN GROWTH BOUNDARY IS IN THE FEMA 100 YEAR FLOODPLAIN

10.2 INCHES OF RAIN

OVER 24 HOURS EVERY 100 YEARS

17 FEET STORM SURGE

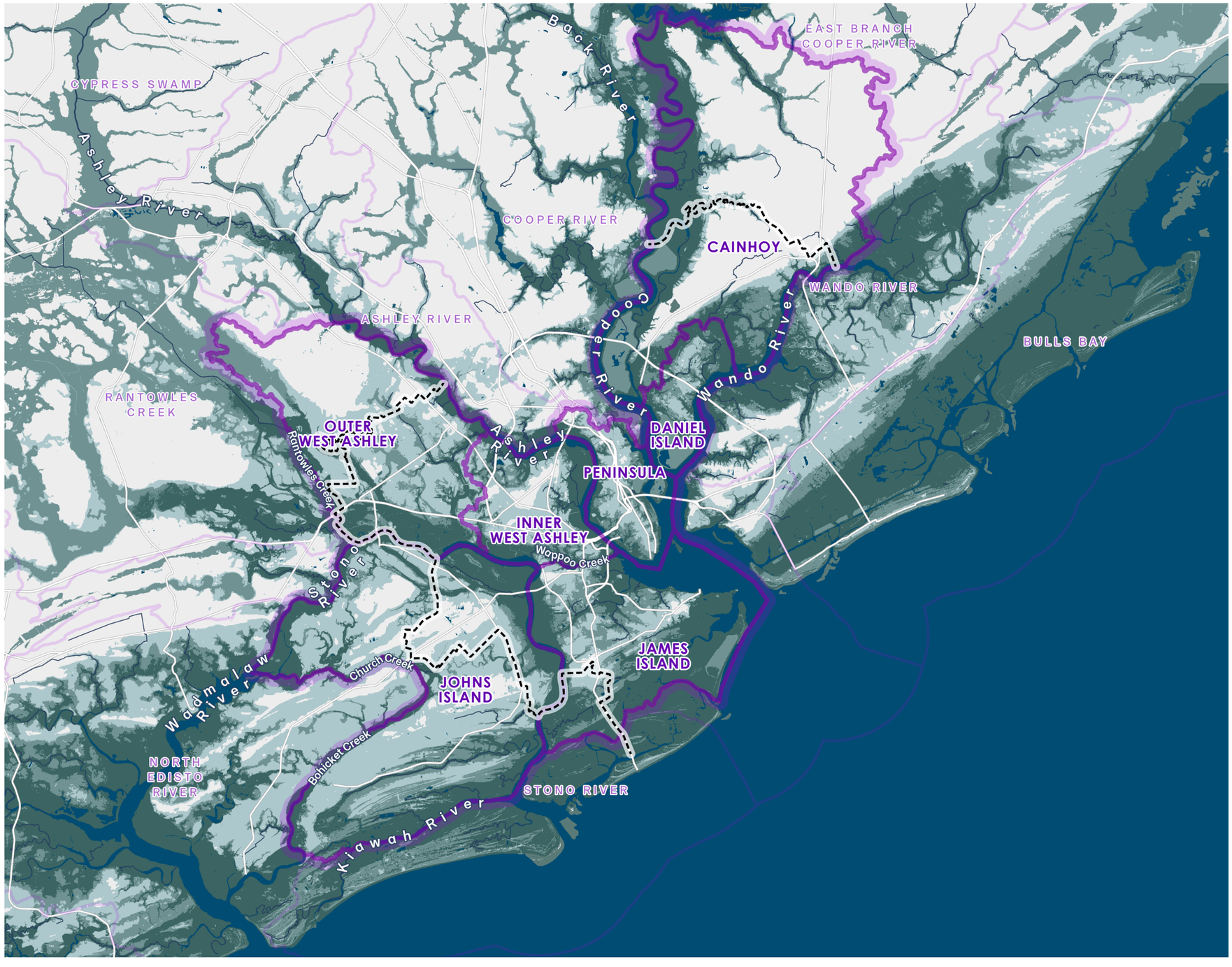
NOAA MAXIMUM POSSIBLE CATEGORY 3 STORM SURGE

3 FT OF SEA LEVEL RISE

BY 2080

7 WATERSHED AREAS

PENINSULA, INNER WEST ASHLEY, OUTER WEST ASHLEY, JAMES ISLAND, JOHNS



Watersheds Neighborhood

Urban Growth Boundary

Water

1 inch = 4 miles

Miles

10

ELEVATION ZONES

Zones based on elevation and flood risk.

HIGH GROUND

High ground is defined as land outside of the FEMA 100 year floodplain and above the NOAA max category 3 storm surge. High ground has the lowest flood risk and stormwater detention here has the greatest watershed benefit.

ADAPT ZONE

The adapt zone consists of land outside of the FEMA 100 year floodplain that is still within the NOAA maximum storm surge of a category 3 hurricane. Rain and storm surge flooding in this zone is infrequent but not impossible.

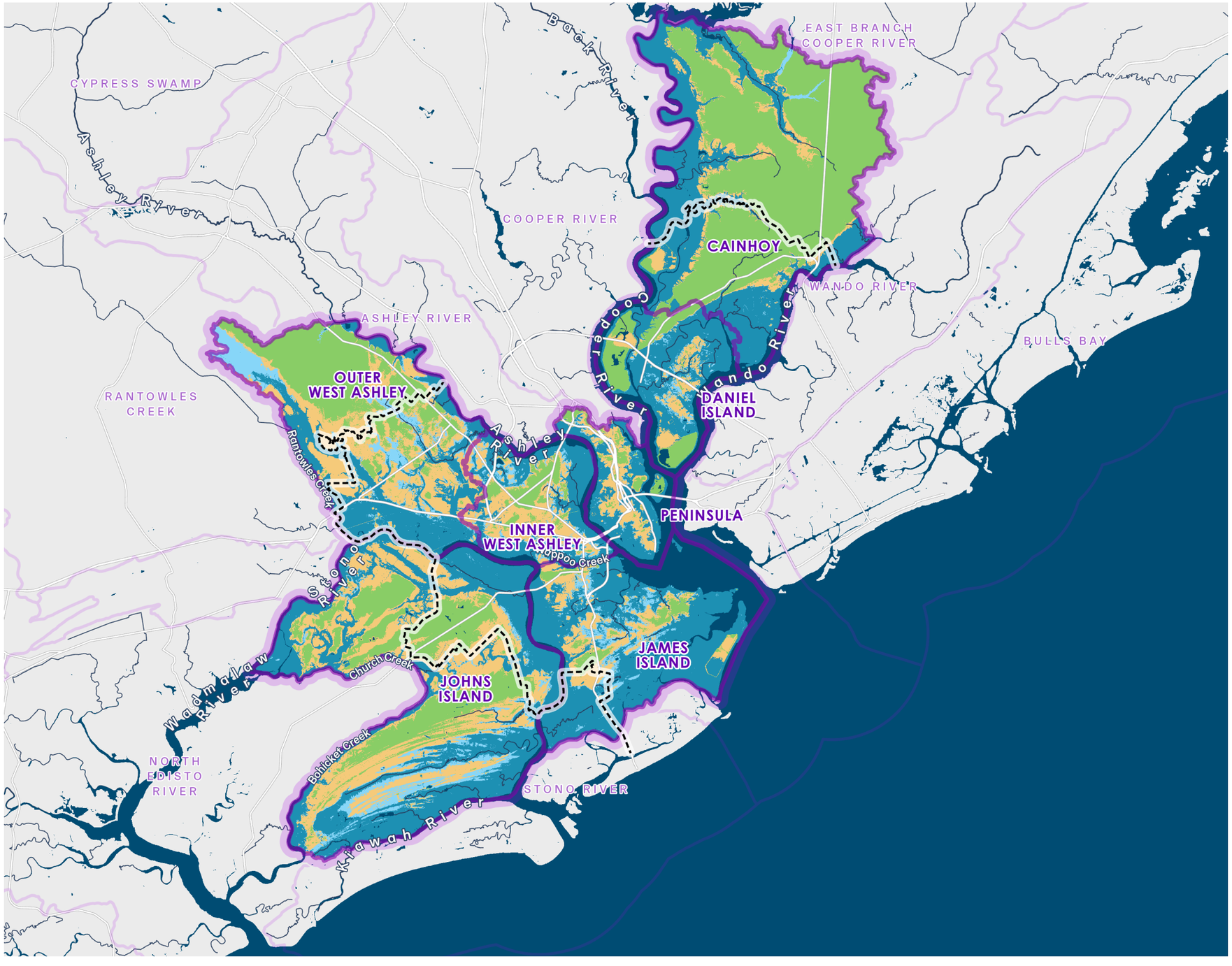
COMPOUND FLOOD RISK

This zone encompasses areas within the floodplain above the tidal flood risk zone where flood risk comes from a mixture of rainfall, runoff and tidal conditions.

TIDAL FLOOD RISK ZONE

This zone encompasses the lowest land in Charleston. Nearly 100% of this zone is in the 100 year floodplain. Flooding is frequent and can come solely from tidal events independent of precipitation. Sea level rise driven marsh migration occurs in this dynamic zone.

Marsh Migration Zone

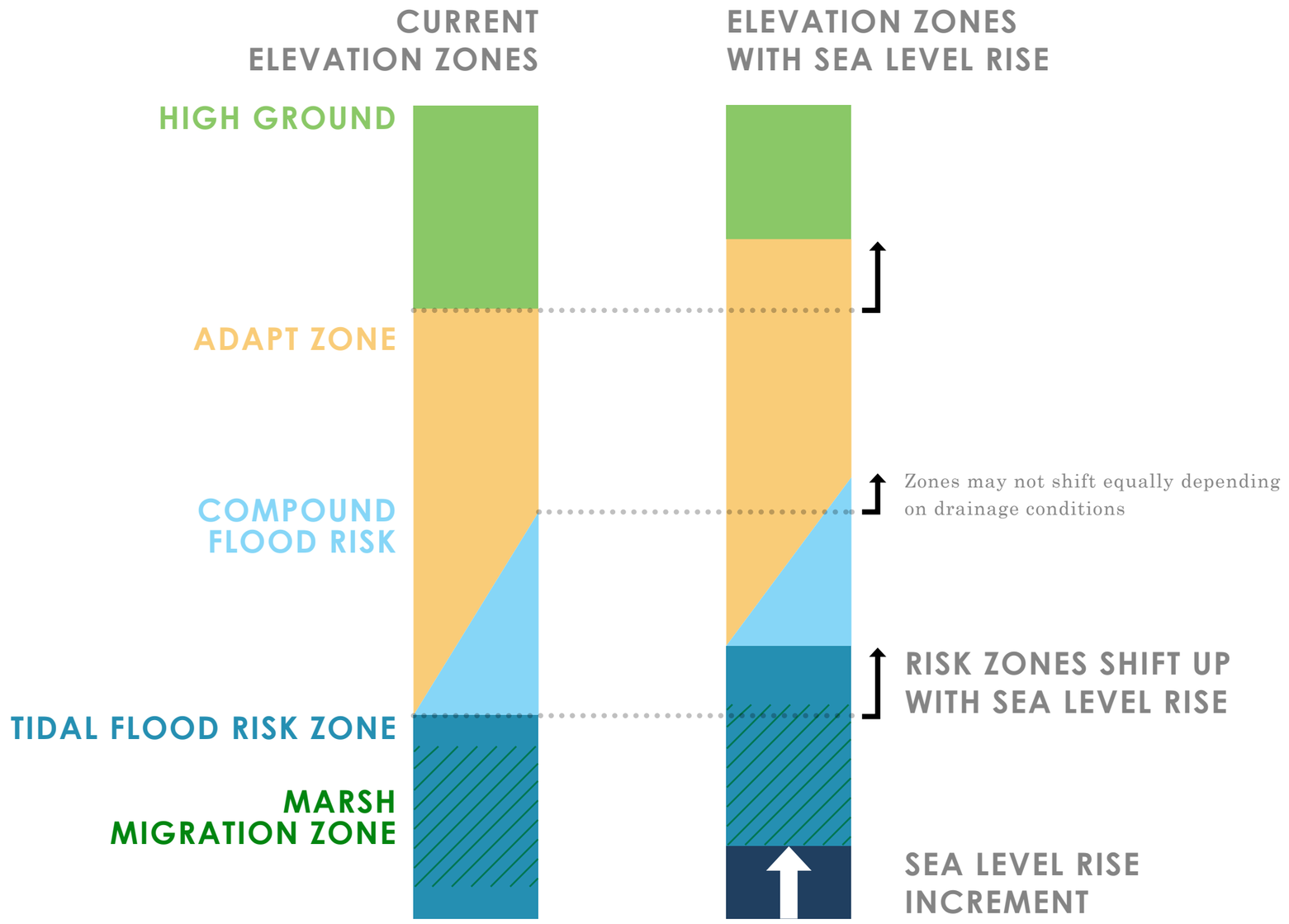


1 inch = 4 miles

Miles 10

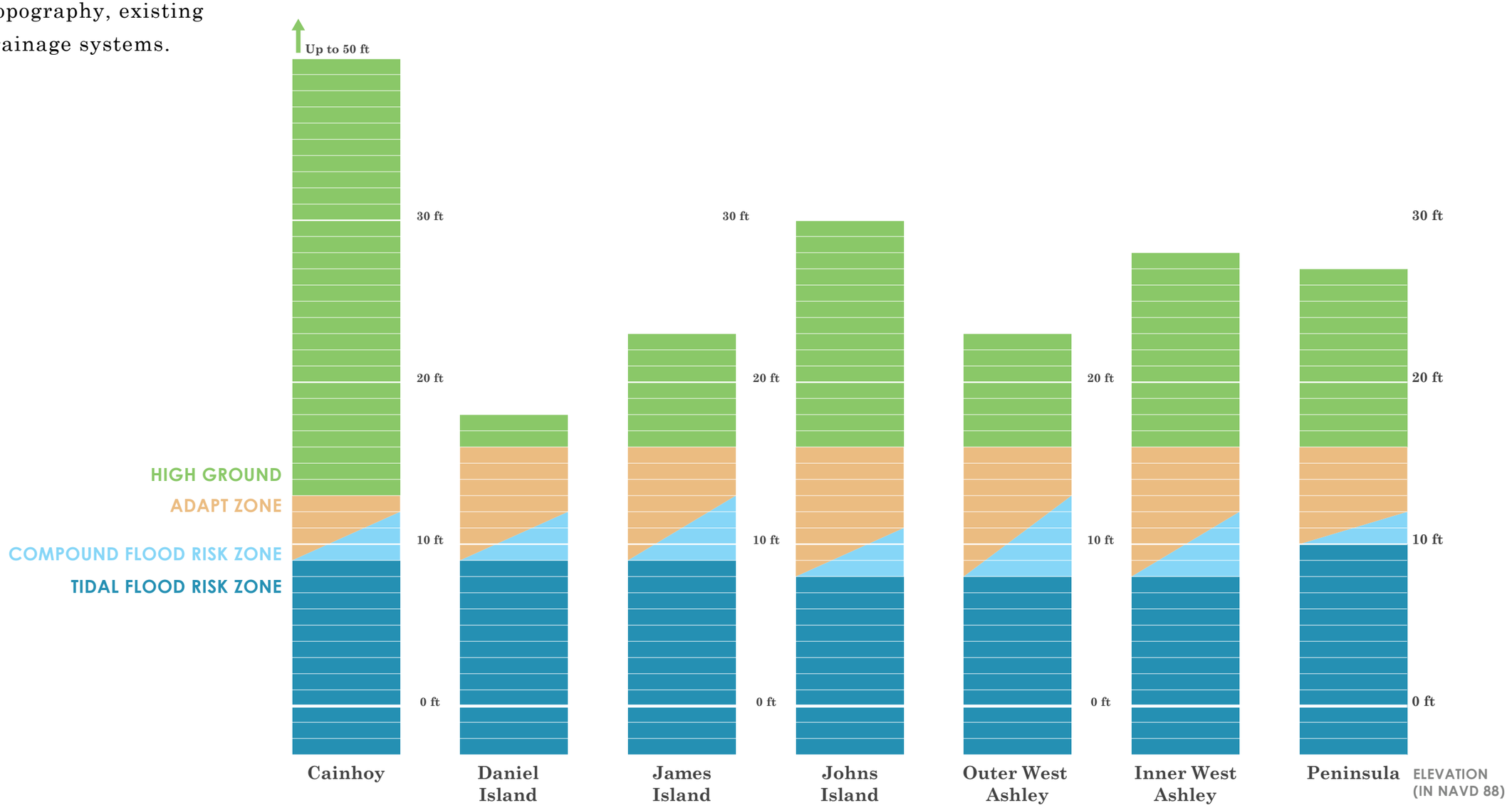
ELEVATION ZONES & SEA LEVEL RISE

The elevation zones shift upwards with sea level rise. By defining risk in terms of elevation, risk mitigation strategies can be adapted to future sea level rise scenarios.



ELEVATION ZONES PER WATERSHED AREA
WITHIN THE URBAN GROWTH BOUNDARY

Elevation zones vary across watershed areas in Charleston based on local conditions such as topography, existing development, and drainage systems.

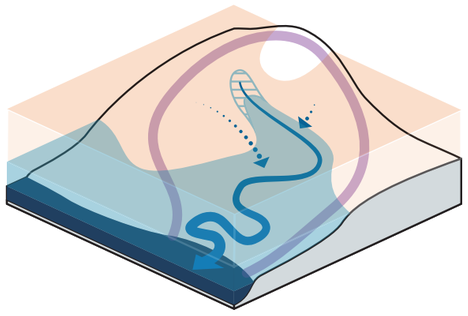


WATERSHED TYPE

WATERSHED TYPOLOGY INFLUENCES POTENTIAL FLOOD RISK

SMALL WATERSHEDS

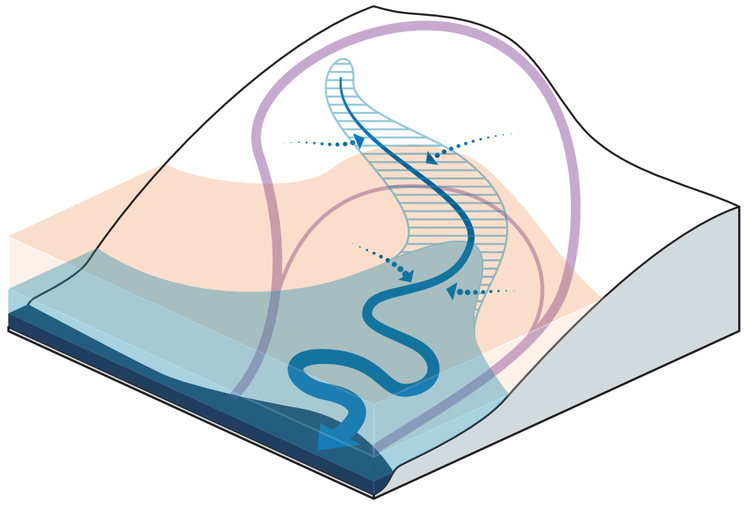
- SMALL WATERWAYS OR SHEET FLOW
- LOWER POTENTIAL RUNOFF ACCUMULATION
- LOWER POTENTIAL DRAINAGE BACKUP



Runoff
Drainage Path
Watersheds
Subwatersheds
Tidal Flooding
Compound Flooding
Maximum Storm surge

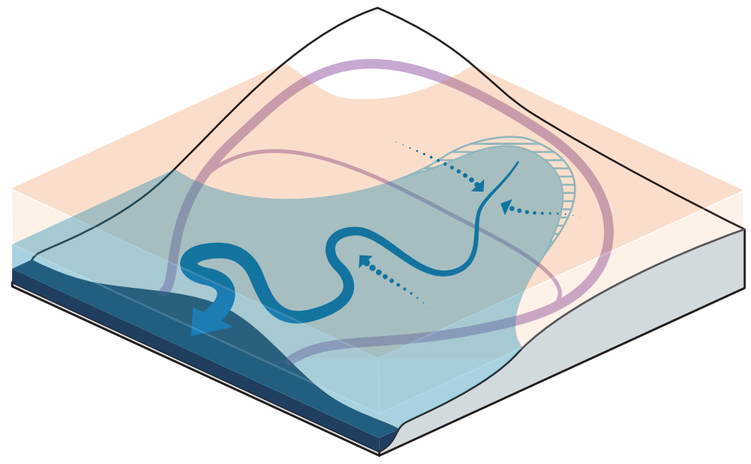
LARGE WATERSHEDS

- LARGE, WELL-DEFINED WATERWAYS
- WATERSHEDS ARE LARGE ENOUGH TO BE BROKEN DOWN INTO UPSTREAM & DOWNSTREAM SUBWATERSHEDS



LARGE INLAND

- UPSTREAM PORTIONS SIGNIFICANTLY ABOVE THE TIDAL RANGE
- HIGHER POTENTIAL RUNOFF ACCUMULATION
- MODERATE POTENTIAL DRAINAGE BACKUP



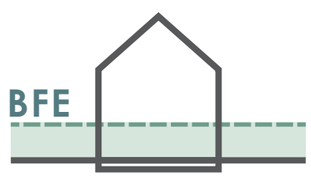
LARGE TIDAL

- MAJORITY IS TIDAL OR TIDALLY INFLUENCED
- HIGHER POTENTIAL RUNOFF ACCUMULATION
- HIGHER POTENTIAL DRAINAGE BACKUP

STRUCTURE TYPE & VULNERABILITY
NUMBER OF VULNERABLE PARCELS PER WATERSHED

Combined Vulnerability & Risk Definitions come from the NEMAC+Fernleaf Vulnerability and Risk Assessment (2020).

"VULNERABLE" DEFINITION USED FOR WATERSHED ANALYSIS

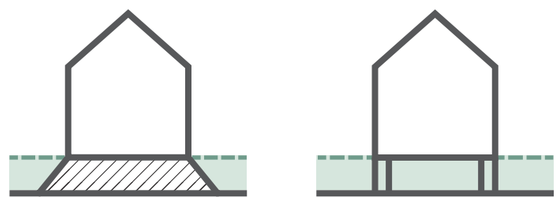


HIGH COMBINED VULNERABILITY & RISK

IN THE 100 YEAR FLOODPLAIN

BUILT BEFORE BFE REQUIREMENTS

(1971 for Charleston, 1983 for Berkeley)

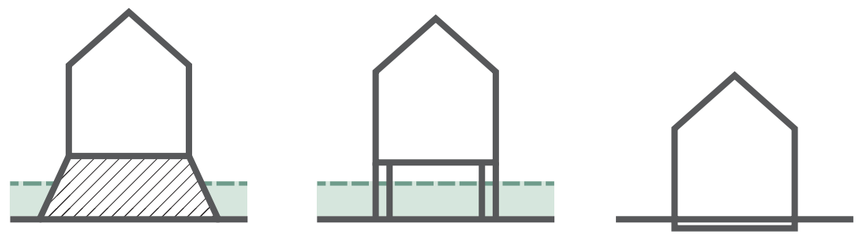


MEDIUM COMBINED VULNERABILITY & RISK

IN THE 100 YEAR FLOODPLAIN

BUILT AFTER BFE REQUIREMENTS

(1971 for Charleston, 1983 for Berkeley)



LOW COMBINED VULNERABILITY & RISK

OUTSIDE THE 100 YEAR FLOODPLAIN

BUILT AFTER BFE+1 REQUIREMENTS

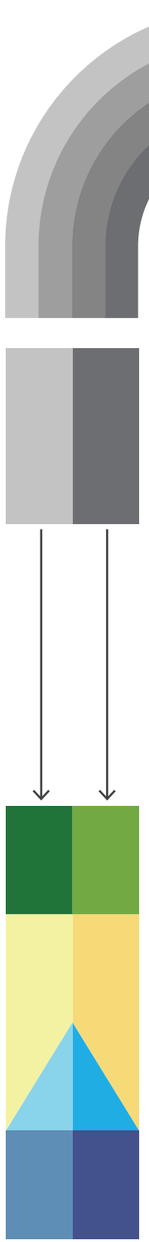
(2015 for Charleston, 2018 for Berkeley)

WATERSHED SENSITIVITY
VULNERABLE PARCELS AND WATERSHED TYPOLOGY

Watershed sensitivity refers to a parcel's effect on its surroundings and properties downstream. Watershed sensitivity combines the number of vulnerable parcels in a watershed with the flood risk of the watershed from a typological standpoint. Depending on the combination of those two factors, watershed and zone are classified as high or normal sensitivity. Number of vulnerable parcels are weighted higher than watershed typology to preference real potential impacts to structures.

NORMAL SENSITIVITY
Combination of less flood prone watersheds and a low number of vulnerable parcels. Typically smaller and/or less developed watersheds.

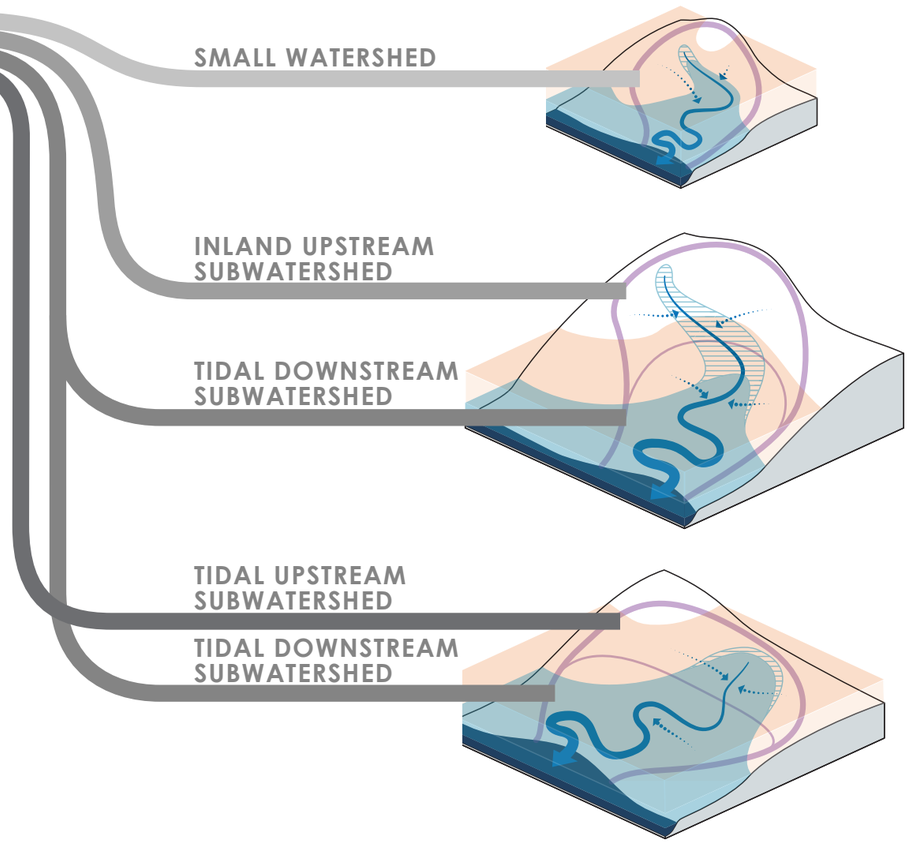
HIGH SENSITIVITY
Combination of more flood prone watersheds and a high number of vulnerable parcels. Typically larger tidal watersheds and/or watersheds where development happened before BFE regulations.



HOW MANY VULNERABLE PARCELS IN THE SUBWATERSHED?



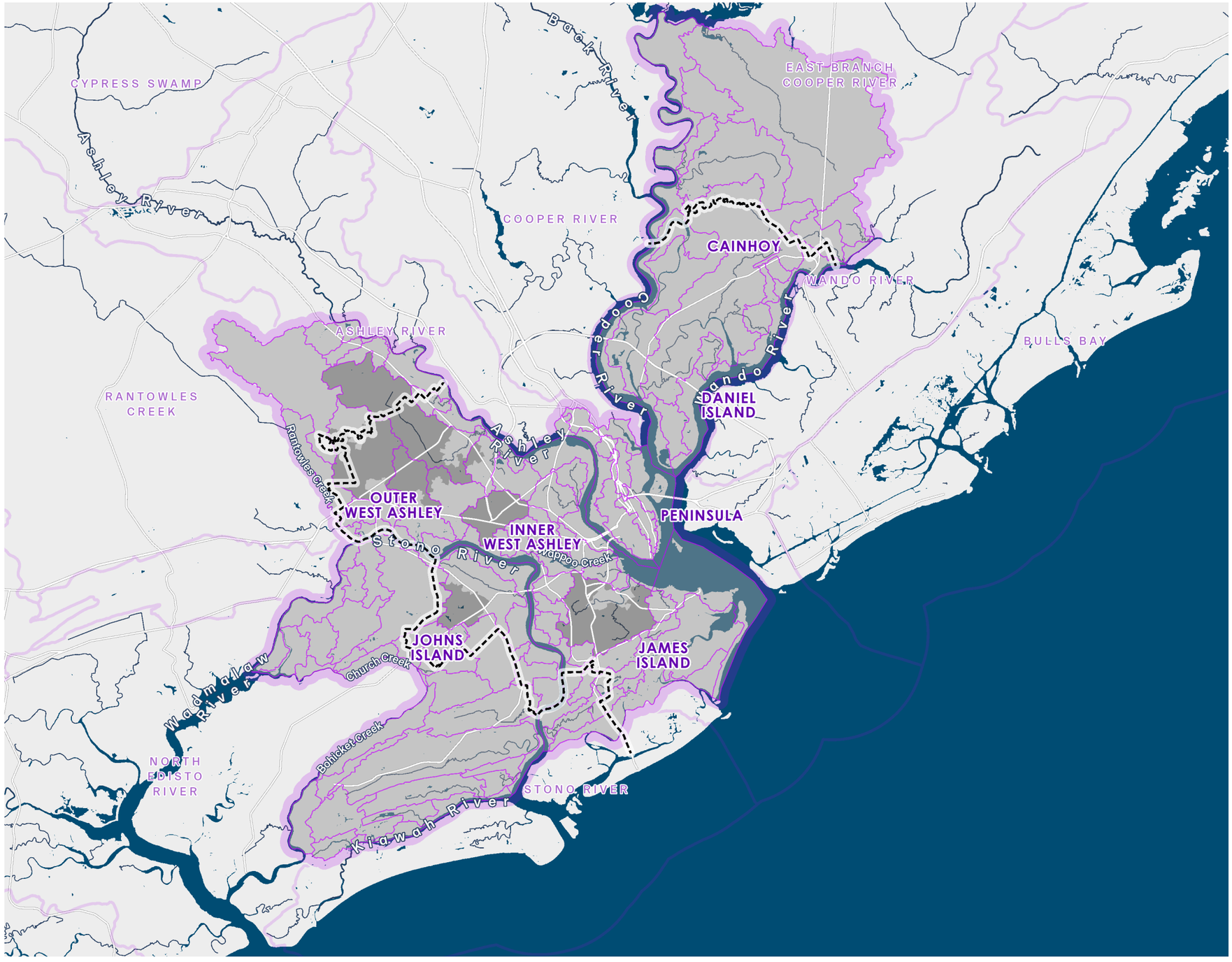
HOW FLOODPRONE IS THE WATERSHED TYPOLOGY?



WATERSHED SENSITIVITY

TYPE OF WATERSHED + NUMBER OF VULNERABLE PARCELS

Larger tidal watersheds with a substantial number of parcels built in the floodplain before BFE regulation have a higher sensitivity to flood risk. (e.g. James Island Creek and Church Creek in West Ashley). While not everywhere in these watersheds has high flood risk, any increase in runoff has a high potential to detrimentally affect local and downstream parcels.



Legend

Watershed Impact

- High Sensitivity
- Normal Sensitivity

Project Watersheds

Urban Growth Boundary

Water

1 inch = 4 miles

Miles

10

ELEVATION ZONES & WATERSHED SENSITIVITY

The combined elevation zone + watershed sensitivity maps show the relative risk of an area and how that area impacts the flood risk of its surrounding.

HIGH SENSITIVITY

Combination of more flood prone watersheds and a high number of vulnerable parcels. Typically larger tidal watersheds and/or watersheds where development happened before BFE regulations.

NORMAL SENSITIVITY

Combination of less flood prone watersheds and a low number of vulnerable parcels. Typically smaller and/or less developed watersheds.

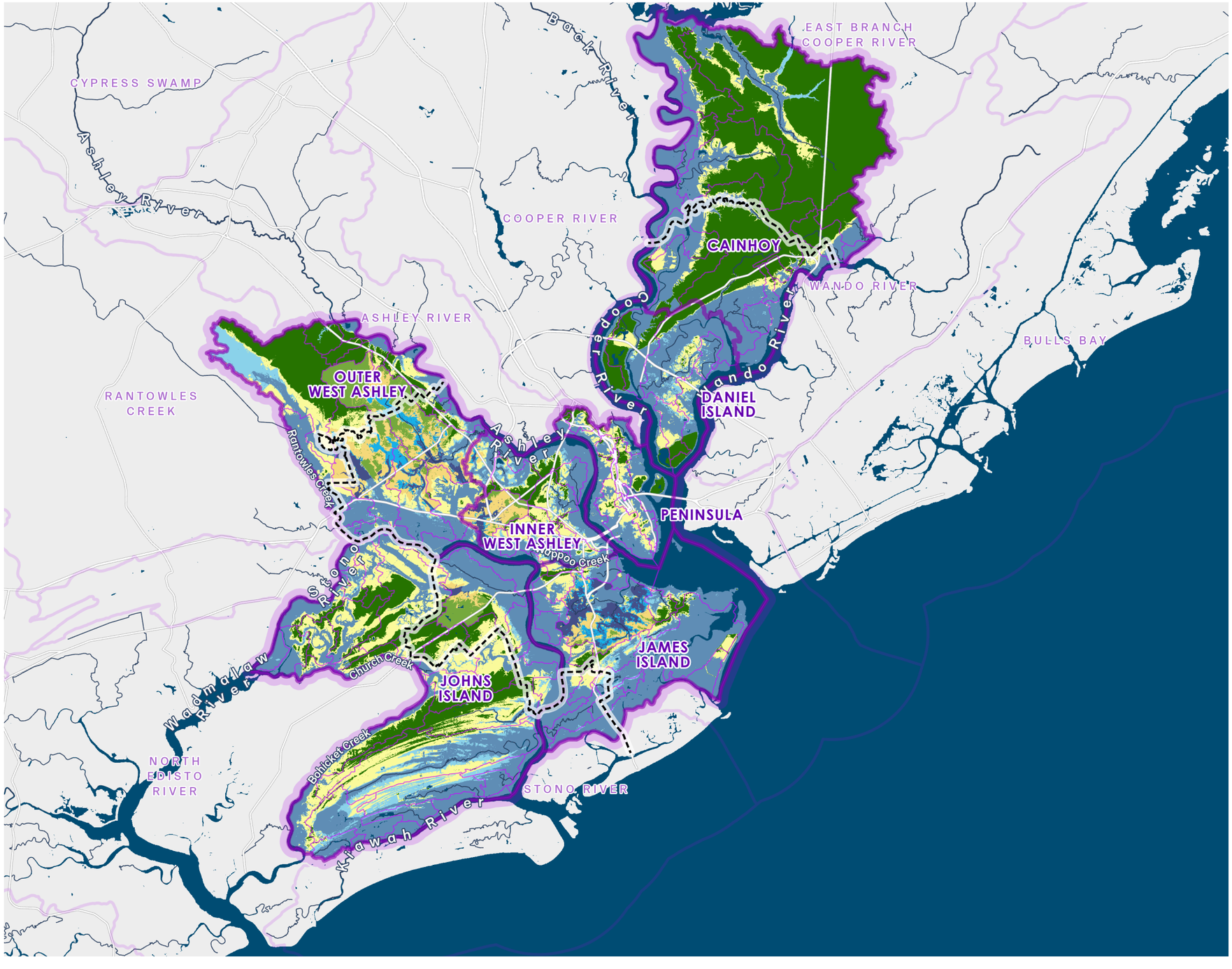
HIGH GROUND

ADAPT ZONE

COMPOUND FLOOD RISK

TIDAL FLOOD RISK ZONE

Marsh Migration Zone



1 inch = 4 miles

Miles 10

AREA OF ZONES PER WATERSHED AREA
WITHIN THE URBAN GROWTH BOUNDARY

Watershed Area	Total Area (SqMi)	TIDAL FLOOD RISK ZONE		COMPOUND FLOOD RISK		ADAPT ZONE		HIGH GROUND	
		NORMAL SENSITIVITY	HIGH SENSITIVITY	NORMAL SENSITIVITY	HIGH SENSITIVITY	NORMAL SENSITIVITY	HIGH SENSITIVITY	NORMAL SENSITIVITY	HIGH SENSITIVITY
Peninsula	14.4	9.2		0.4		3.2		1.5	
Inner West Ashley	20.7	9.3	0.6	1.6	0.2	4.2	1.9	2.3	0.6
Outer West Ashley	25.5	9.4	1.7	0.9	1.7	3.2	5.3	0.9	2.5
Johns Island	17.6	8.4	0.1	0.5	0.1	3.1	0.4	3.6	1.5
James Island	38.6	26.1	2.7	1.4	1.5	3.1	1.8	1.6	0.3
Daniel Island	11.7	7.8		0.8		1.9		1.2	
Cainhoy	34.4	17.5		0.4		2.4		14.1	

LANDSCAPE TYPOLOGIES

HIGH GROUND

ADAPT ZONE

COMPOUND FLOOD RISK

TIDAL FLOOD RISK ZONE



UPLAND RIDGES



LOWLAND FLOODPLAIN



COASTAL EDGE COMMUNITY



URBAN/SUBURBAN REFORESTATION

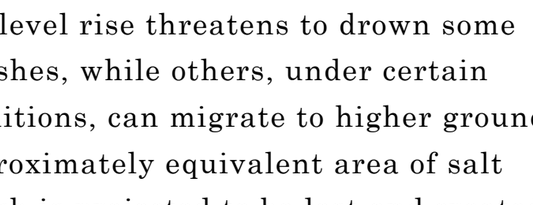
MARSH MIGRATION WITH 3 FT OF SEA LEVEL RISE

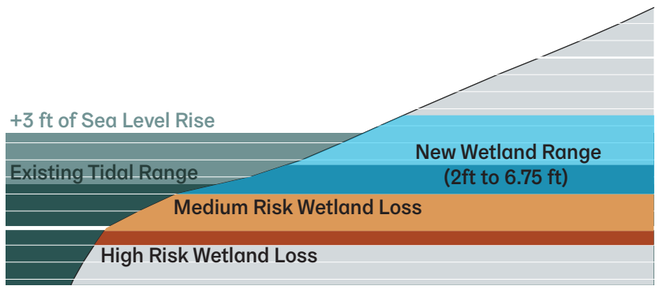
Sea level rise threatens to drown some marshes, while others, under certain conditions, can migrate to higher ground. Approximately equivalent area of salt marsh is projected to be lost and created if they are allowed to migrate without obstruction.

Data sources: USGS, MRLC

EXISTING WETLAND RANGE ≈ -1 TO 3.75 FT (NAVD)

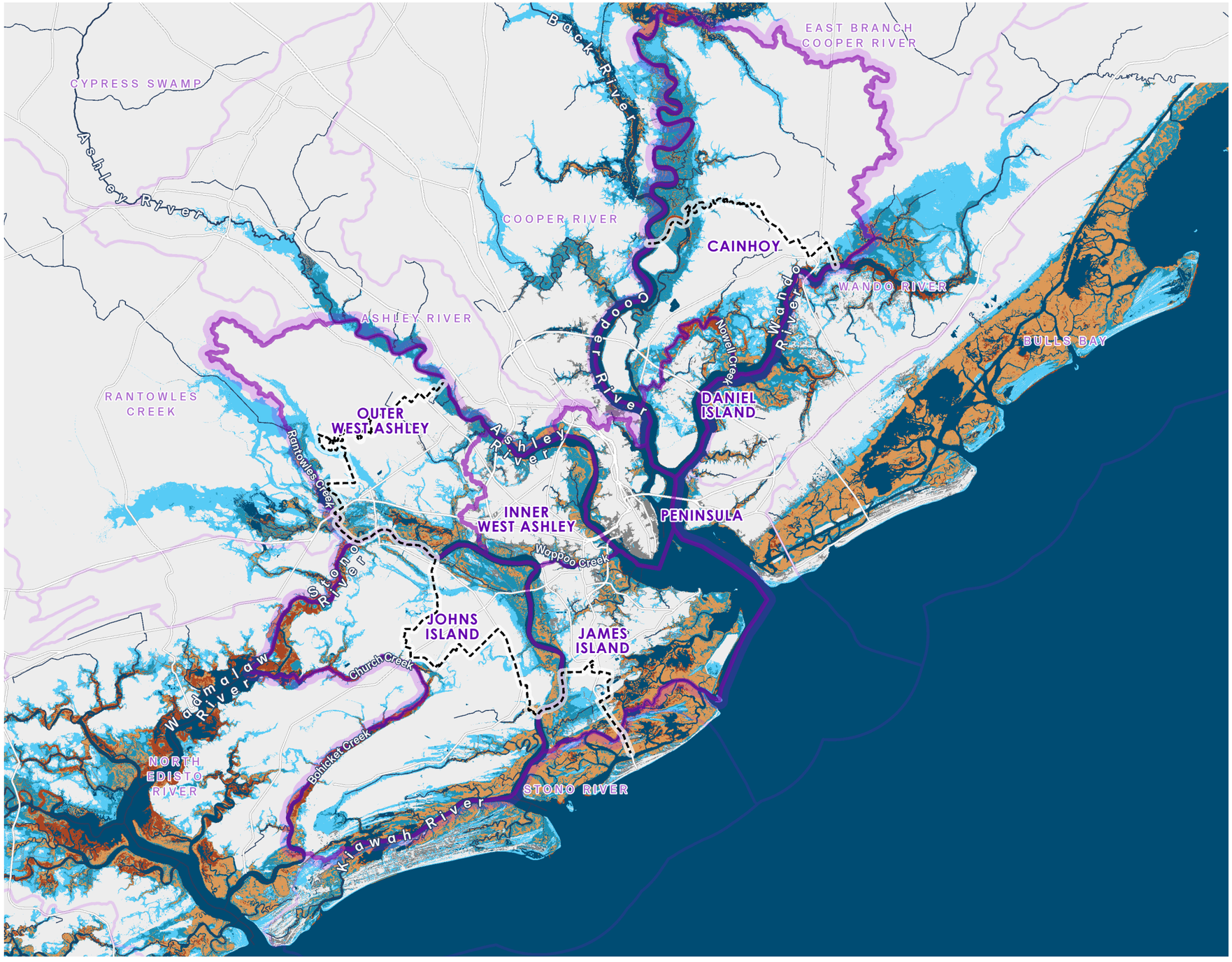
WETLAND MIGRATION ZONE ≈ 2 TO 6.75 FT (NAVD)





1 inch = 21,120 feet

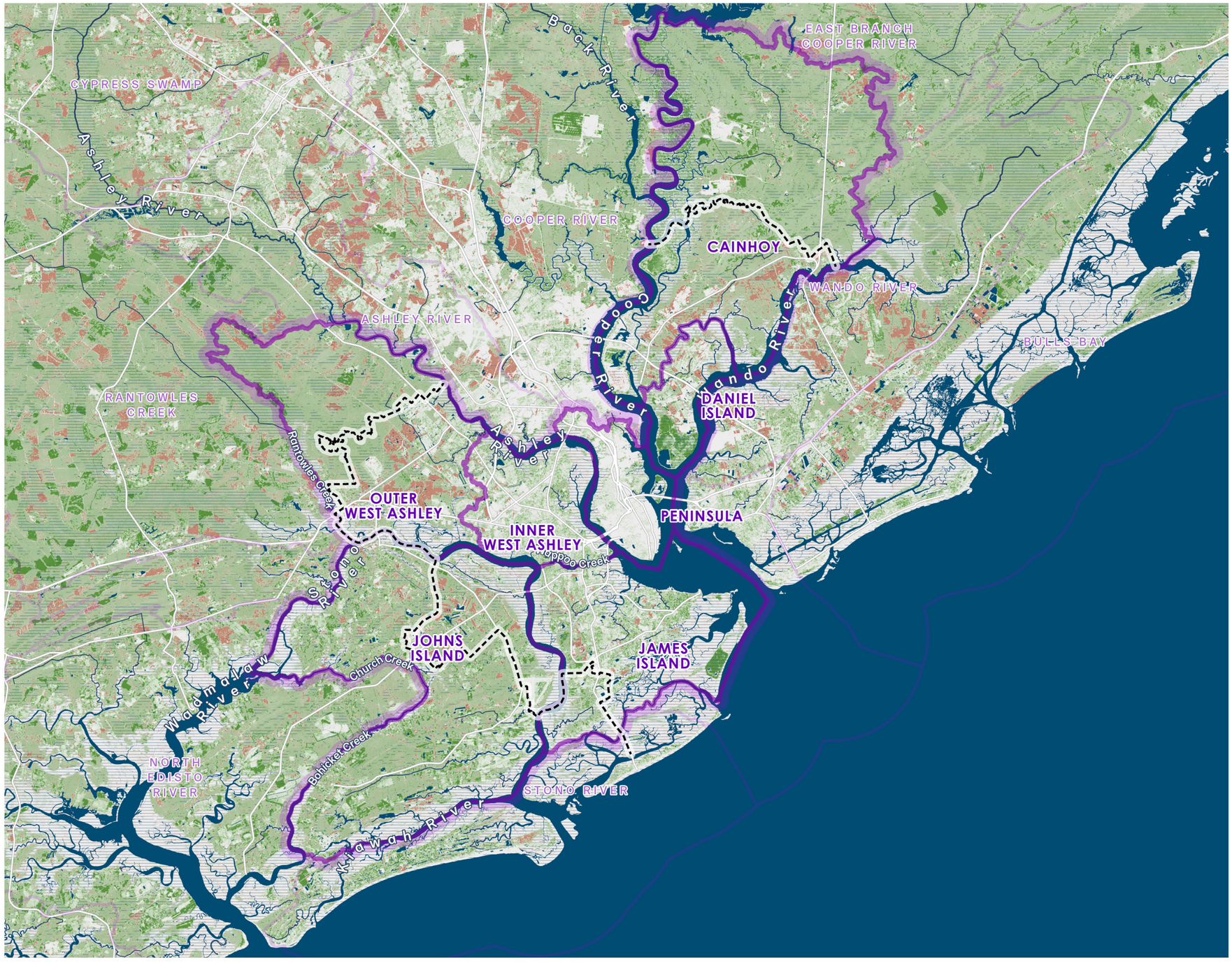
Miles 1



TREE CANOPY DENSITY & CHANGE

Tree canopy has been lost around Charleston's periphery as the city expanded outward.

Data sources: Global Land Cover Facilities



Legend

Tree Canopy (2015)

Dense

Sparse

Canopy Change (2000-2015)

High Gain

High Loss

Watersheds Neighborhood

Urban Growth Boundary

Water

Water

Wetland

1 inch = 4 miles

Miles

10

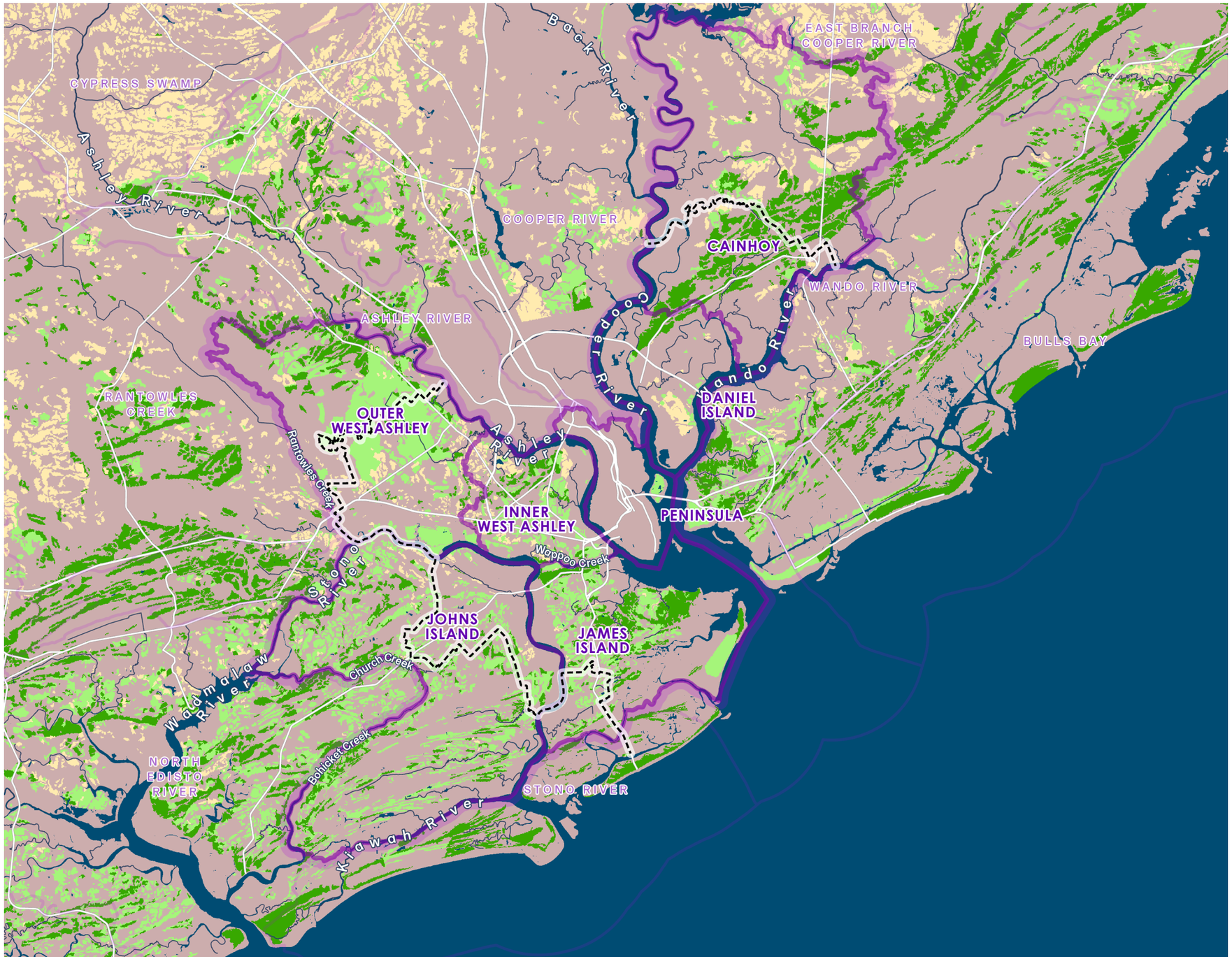
SOIL HYDROLOGIC GROUPS

Soil hydrologic groups define a soil's capacity to absorb water.

Data source: USDA

HYDROLOGIC GROUPS

- A: ABSORBS THE MOST WATER
- B: ABSORBS SOME WATER
- C: ABSORBS LITTLE WATER
- D: POORLY DRAINED AND/OR ABSORBS BASICALLY NO WATER



1 inch = 4 miles

Miles 10

PLANNING STRATEGIES

GROW

Responsibly increase development and population density. Growth makes the most sense in areas with low sensitivity and low risk. Growth must occur in tandem with water management.

DEFEND

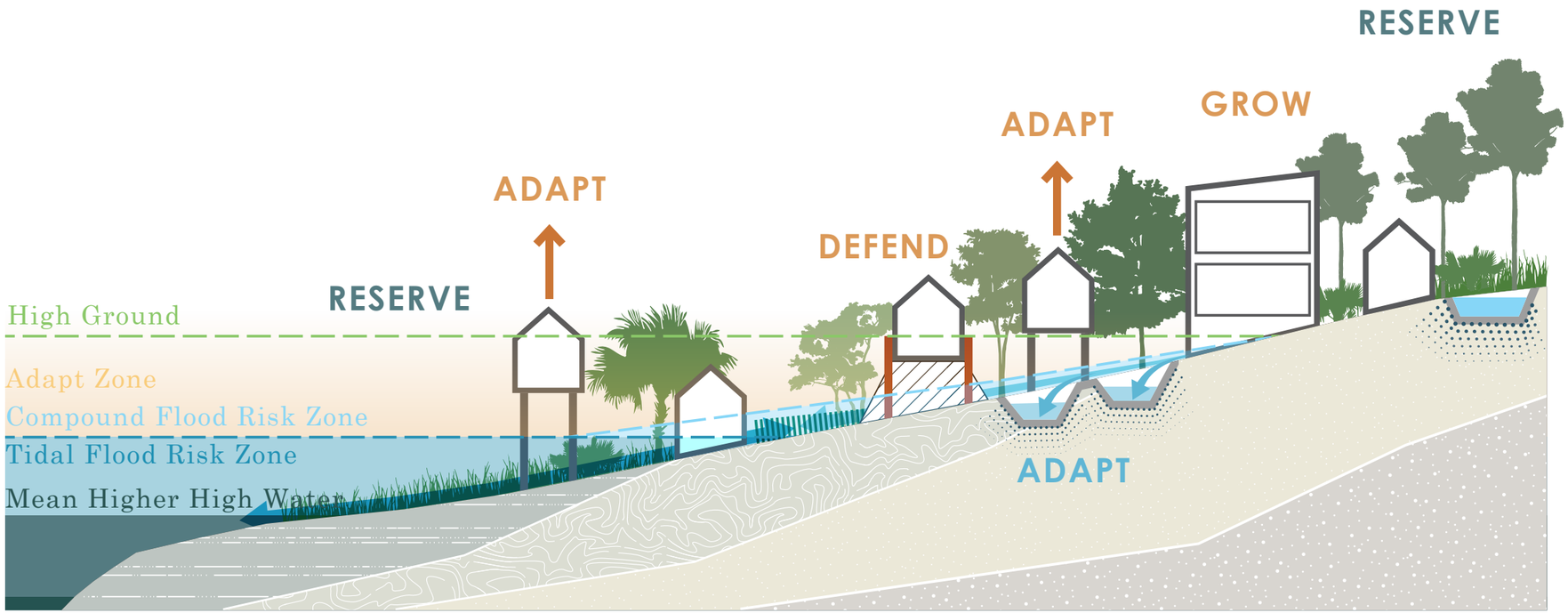
Protect buildings and infrastructure with engineered measures such as berms, flood walls and pumps. Defensive measures should be reserved for areas with the highest risk and lowest sensitivity (e.g. where the displacement of floodwater will not exacerbate risk elsewhere.)

ADAPT

Retrofit vulnerable existing infrastructure to be resilient to water risks. Raising structures reduces risk with limited to no increase in watershed sensitivity. However, adaptive capacity is limited by building typology.

RESERVE

Restore and preserve natural ecosystems. Reserve is applicable to all zones and should factor future change. Ecosystems providing stormwater benefits and essential wildlife habitats exist throughout Charleston and should be preserved.



REGION

FLOODING BENCHMARKS

WATER CONTEXT

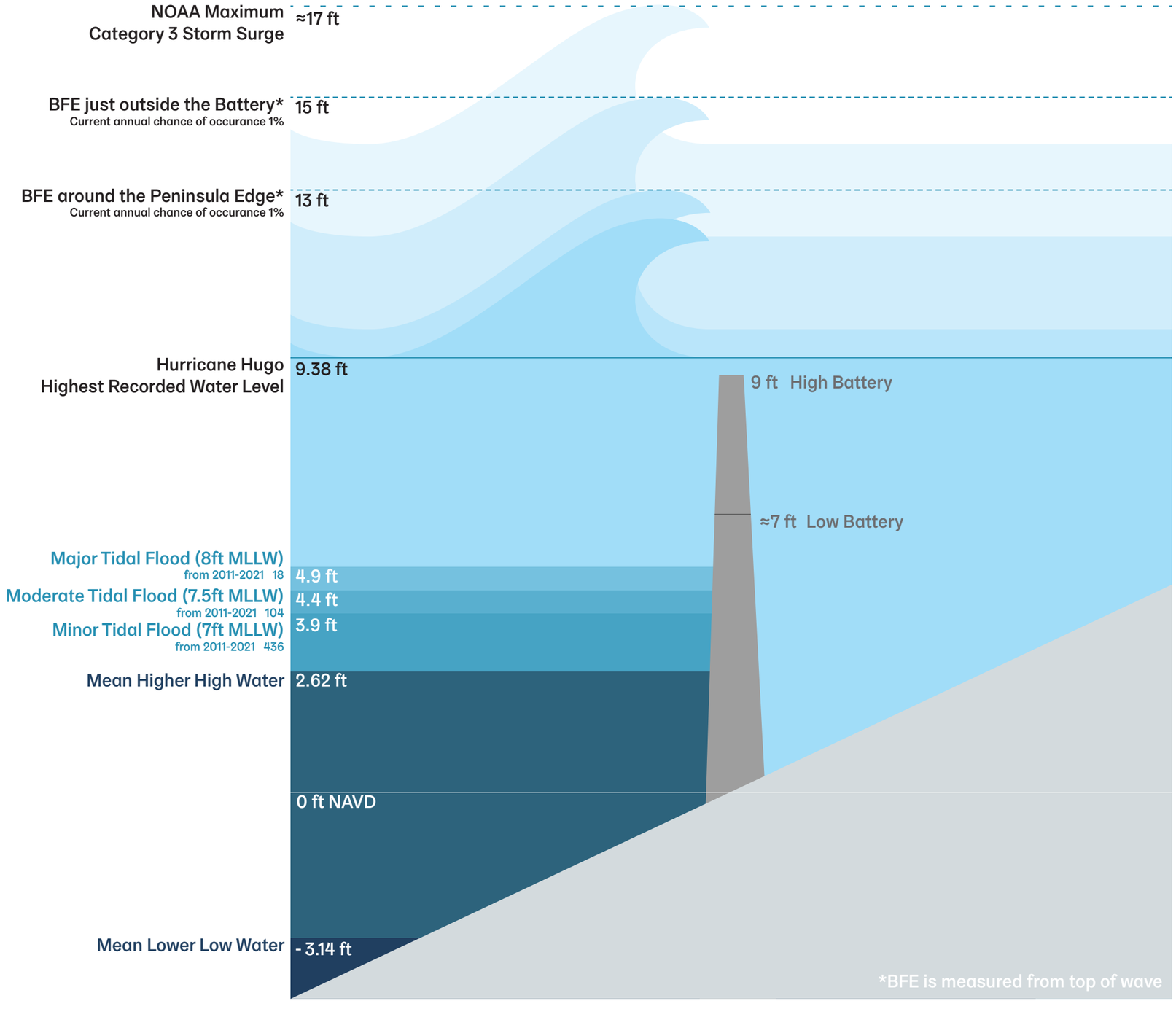
ELEVATION RISK ZONES

WATERSHEDS

ELEVATION ZONES & WATERSHED SENSITIVITY

ENVIRONMENTAL SENSITIVITY

CRITICAL FLOODING BENCHMARKS (NAVD)



WATER CONTEXT

Rain bomb frequency and intensity is increasy across the country and in Charleston.

RAINFALL (NOAA ATLAS 14)

CHARLESTON, SOUTH CAROLINA

DURATION	FREQUENCY					
	2 YR*	10 YR*	25 YR*	100 YR	500 YR	1,000 YR
1 HR	2.0”	3.0”	3.5”	4.4”	5.5”	6.0”
12 HR	3.5”	5.5”	6.6”	8.7”	11.5”	12.9”
24 HR	4.2”	6.5”	7.8”	10.2”	13.3”	14.7”
48 HR	4.9”	7.4”	8.9”	11.6”	15.0”	16.6”
1 WEEK	6.4”	9.3”	11.1”	13.9”	17.5”	19.1”

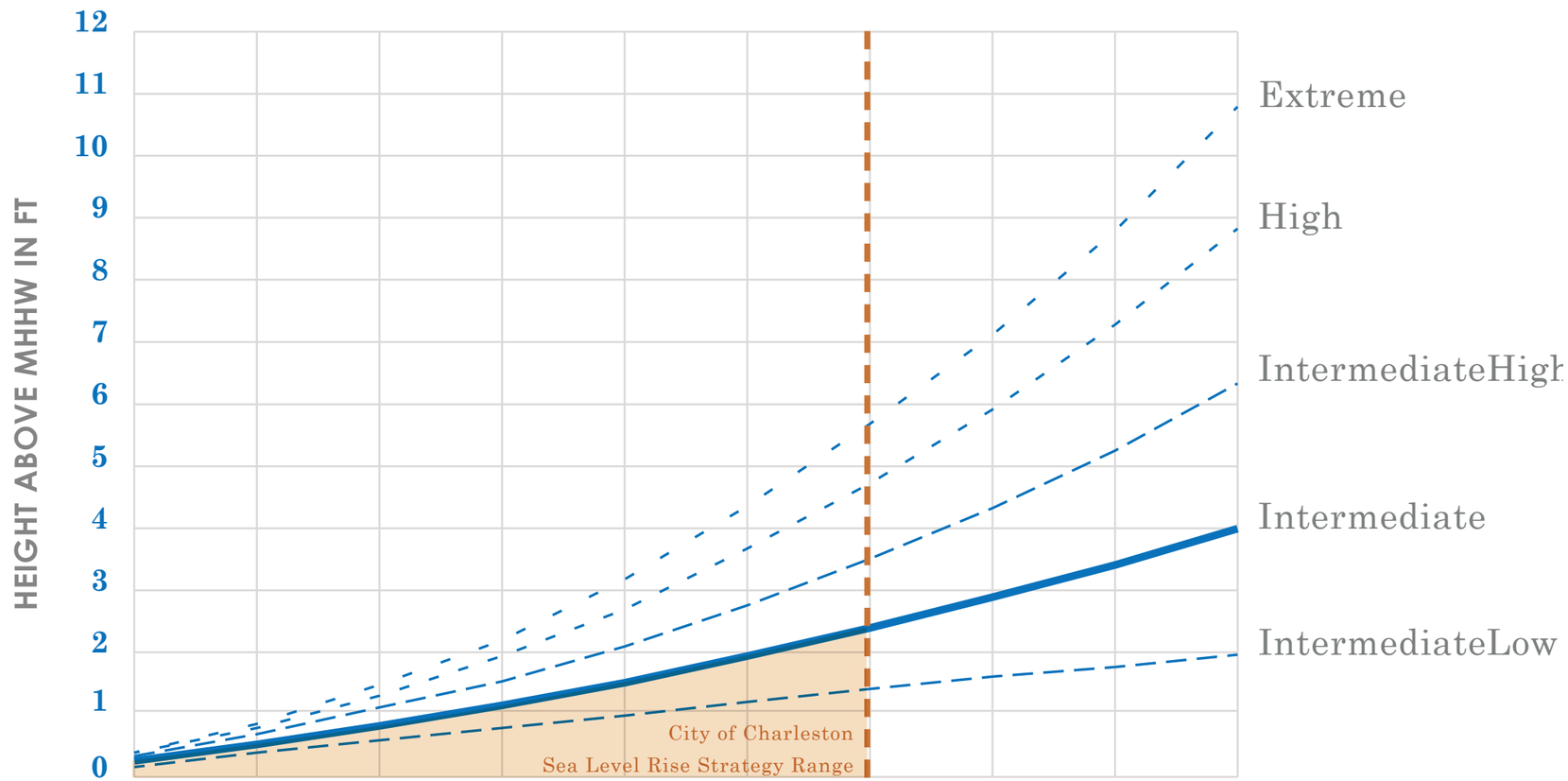
* Regulatory design storms

WATER CONTEXT

The City of Charleston Sea Level Rise Strategy (2019) anticipates 2-3' of rise by 2070.

SEA LEVEL RISE SCENARIOS (NOAA)

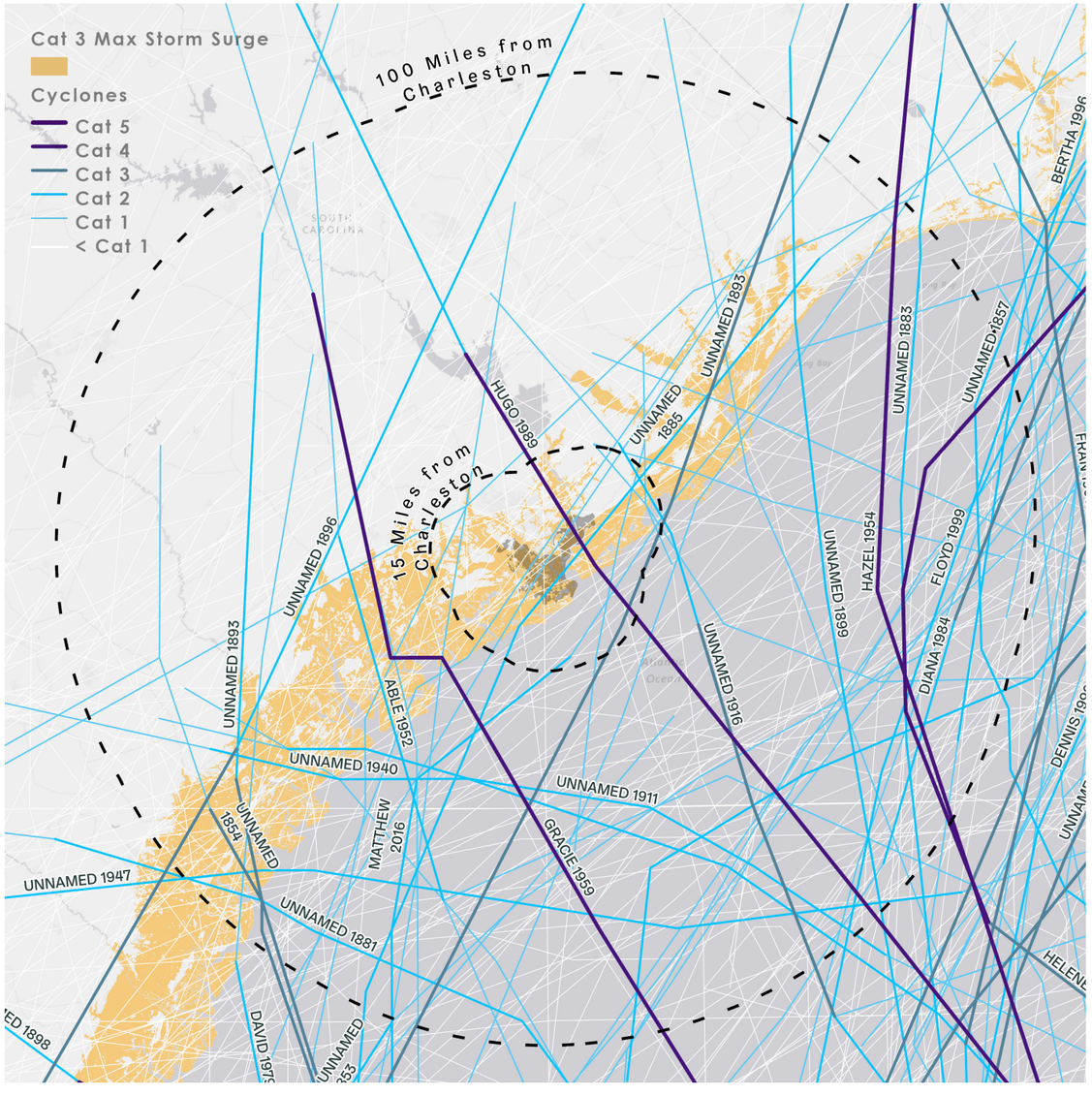
CHARLESTON, SOUTH CAROLINA



	2010	2020	2030	2040	2050	2060	2070	2080	2090	2100
Extreme	0.4	0.9	1.5	2.2	3.2	4.4	5.7	7.1	8.8	10.8
High	0.4	0.8	1.3	1.9	2.7	3.7	4.7	5.9	7.3	8.8
IntermediateHigh	0.3	0.7	1.1	1.5	2.1	2.8	3.5	4.3	5.3	6.3
Intermediate	**0.3**	**0.5**	**0.8**	**1.2**	**1.5**	**1.9**	**2.4**	**2.9**	**3.4**	**4.0**
IntermediateLow	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0

HURRICANES & STORM SURGE

CHARLESTON, SOUTH CAROLINA



HURRICANE PATHS 1850 - 2020

	within 100 miles	within 15 miles
Category 5	0	0
Category 4	4	1
Category 3	7	1
Category 2	13	3
Category 1	27	8
Total	51	13

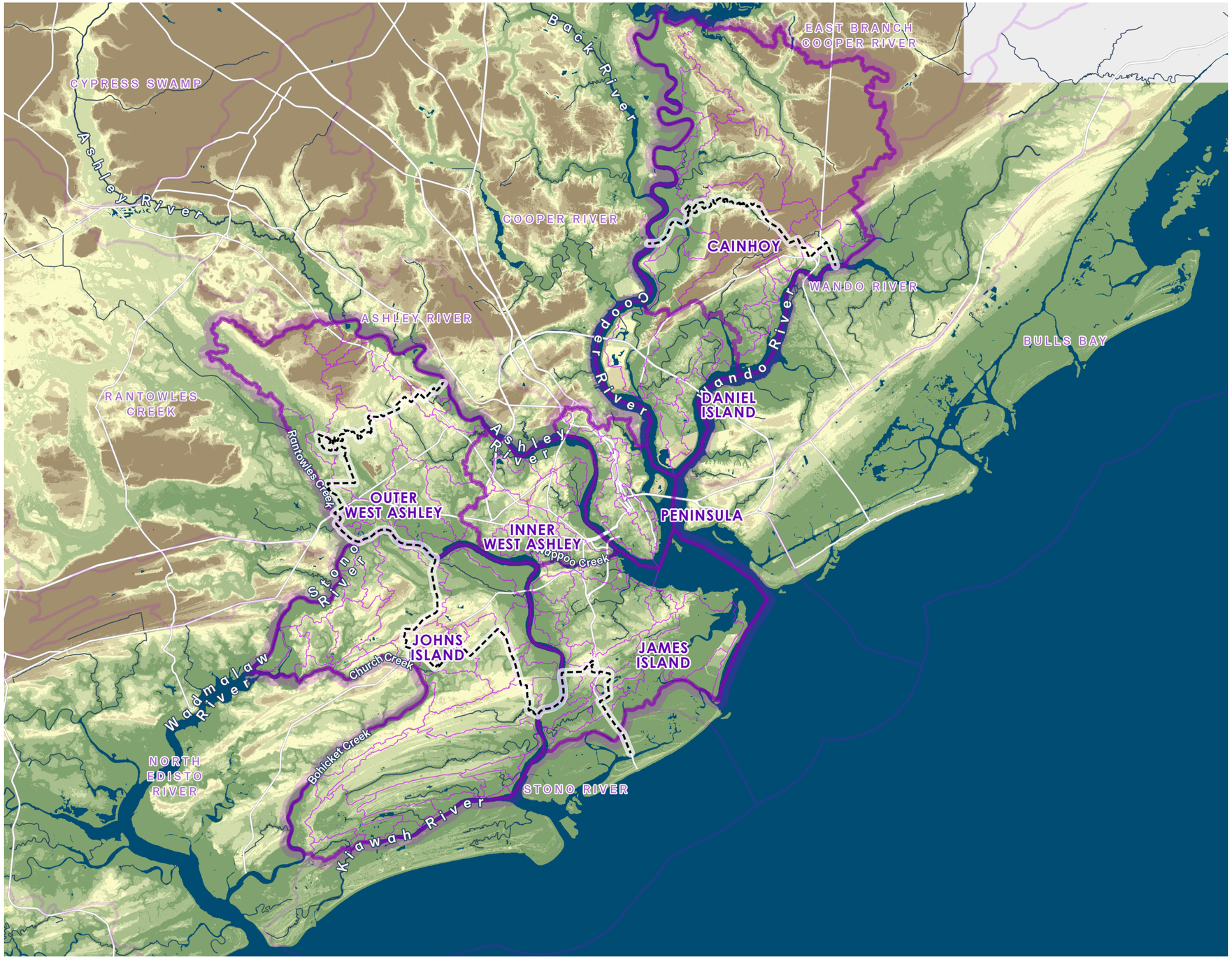
Used for "100 Year Storm Surge"

(NOAA SLOSH Model)

LOW COUNTRY ELEVATION

Most of Charleston is below 25 ft (NAVD) with the exception of Cainhoy and parts of Johns Island.

Data source: USGS



Legend

Elevation (NAVD88)

- >30 ft
- 25-30 ft
- 20-25 ft
- 15-20 ft
- 10-15 ft
- 5-10 ft
- <5 ft

Watershed Neighborhood

Project Watersheds

Other Watersheds

Urban Growth Boundary

Water

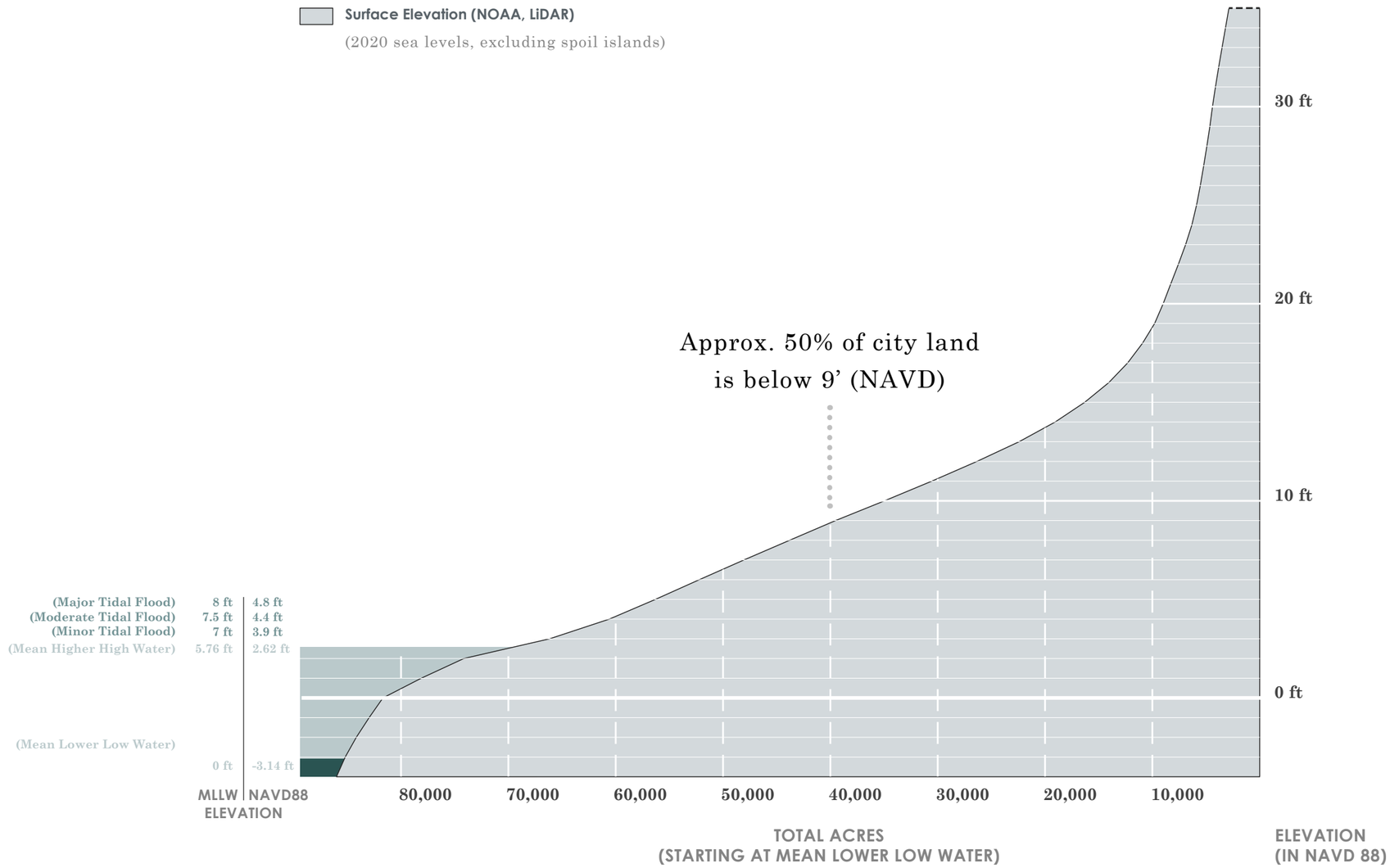
1 inch = 4 miles

Miles

10

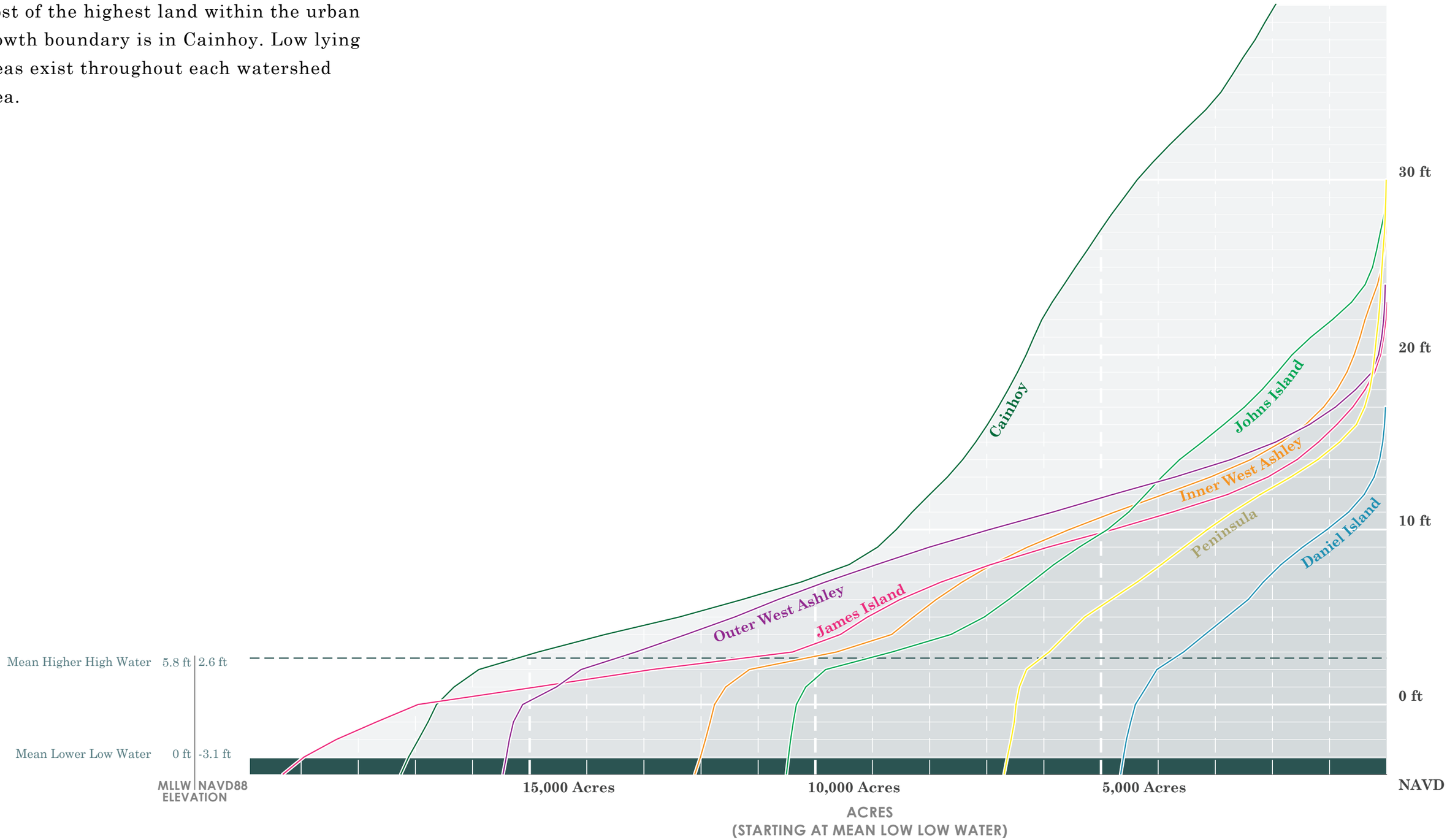
CITY LAND ELEVATION DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

Half of the 85,000 acres within the urban growth boundary, are below 9 feet NAVD. Less than 10% of the land within the urban growth boundary is over 30 feet NAVD.



ELEVATION DISTRIBUTION BY WATERSHED AREAS
WITHIN THE URBAN GROWTH BOUNDARY

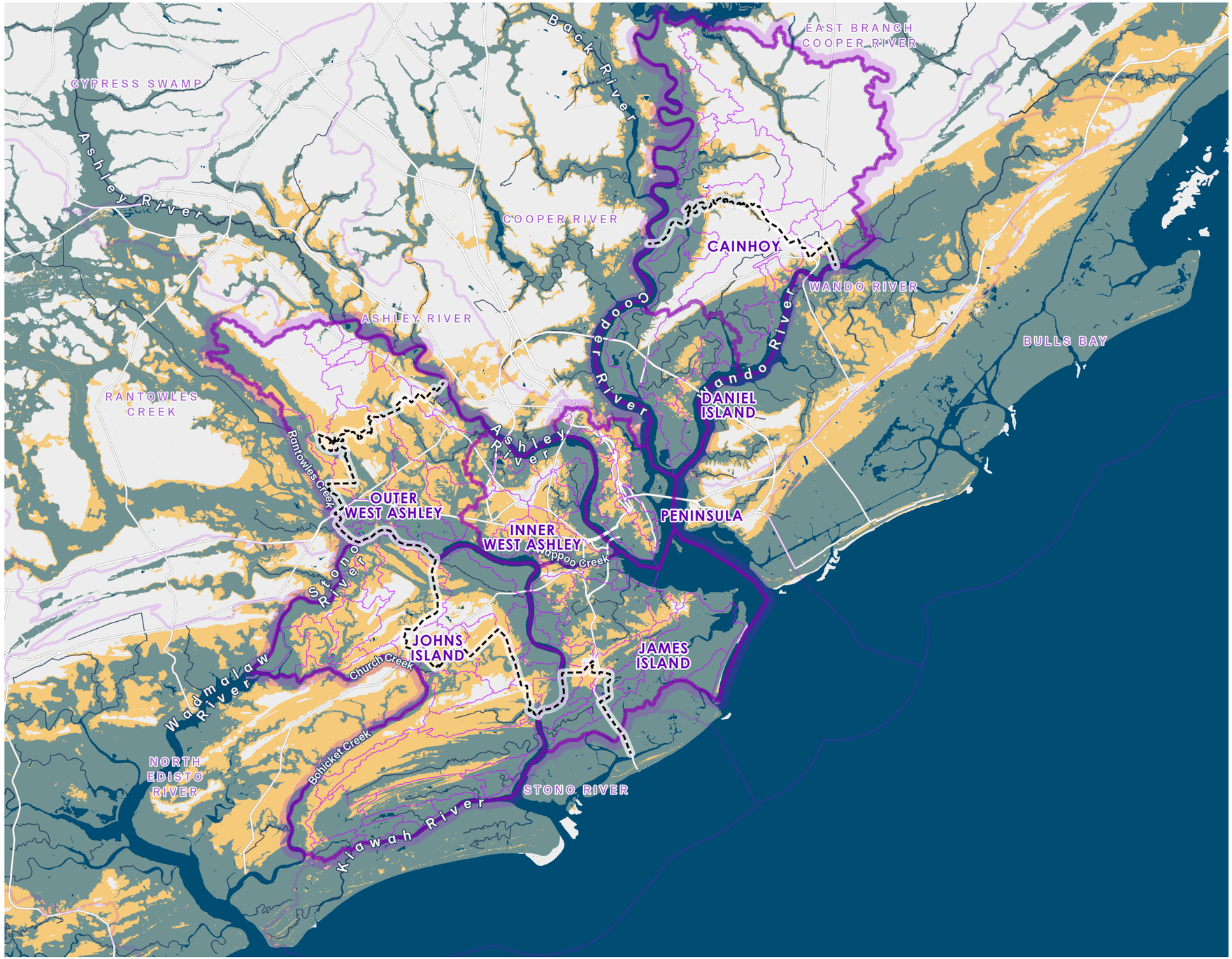
Most of the highest land within the urban growth boundary is in Cainhoy. Low lying areas exist throughout each watershed area.



STORM SURGE AND FLOODPLAIN

About two thirds of Charleston is in the FEMA 100 Year Floodplain, and even more of it is in the NOAA maximum category 3 storm surge zone. For planning purposes, all of the floodplain is also subject to storm surge risk.

Data sources: NOAA, FEMA



Legend

- 100 Year Floodplain
- Cat 3 Max Storm Surge
- Watershed Neighborhood
- Project Watersheds
- Other Watersheds
- Urban Growth Boundary
- Water

1 inch = 4 miles

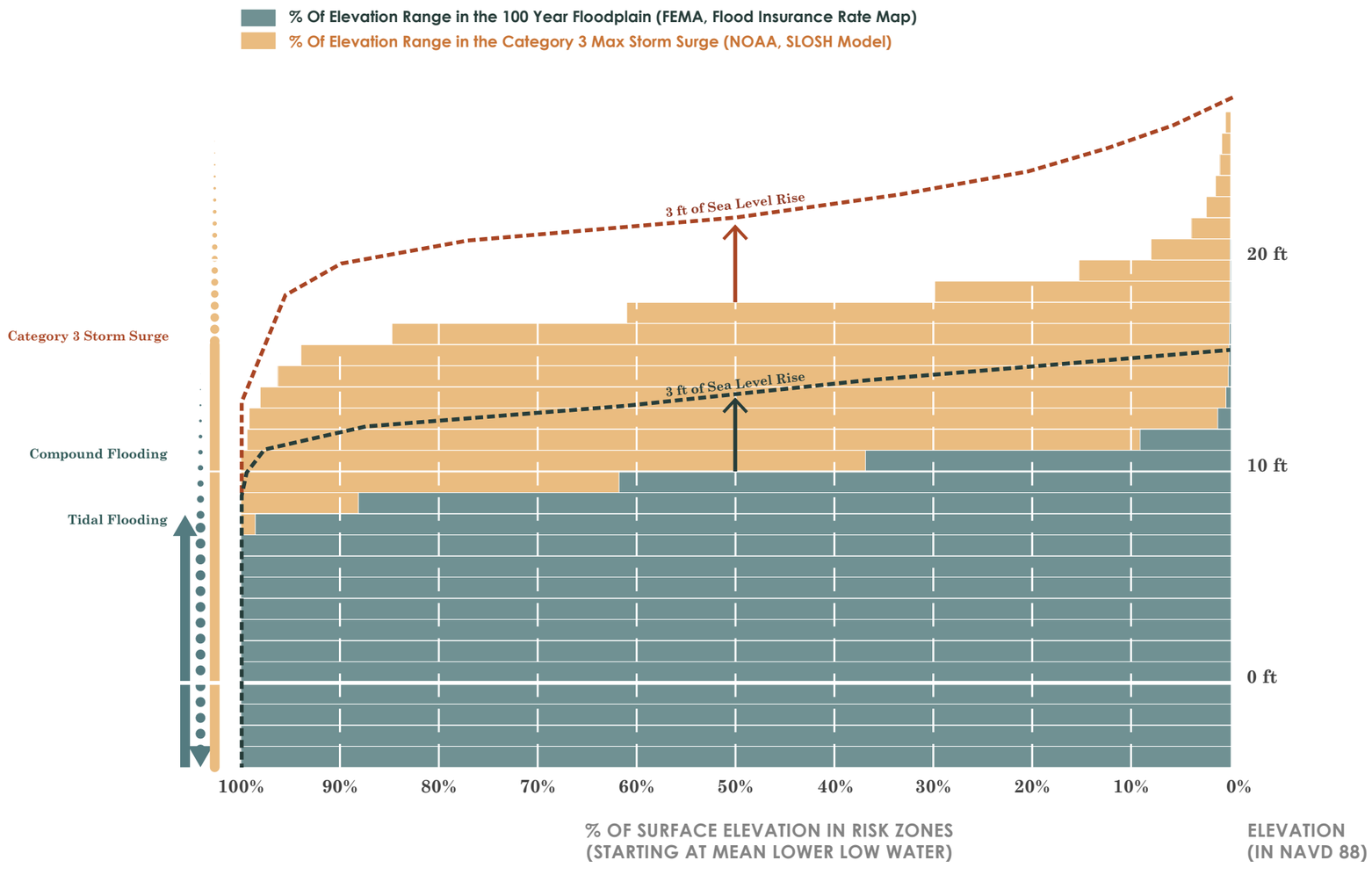
Miles 10

FLOODPLAIN AND STORM SURGE

Below 8 feet (NAVD) almost 100 percent of Charleston is within the FEMA 100 Year Floodplain. Below 16 feet (NAVD) almost 100 percent of Charleston is within the NOAA maximum category 3 storm surge. Both those benchmarks are likely to increase with sea level rise.

ELEVATION FLOOD RISK RELATIONSHIP

Within the UGB excluding spoil islands

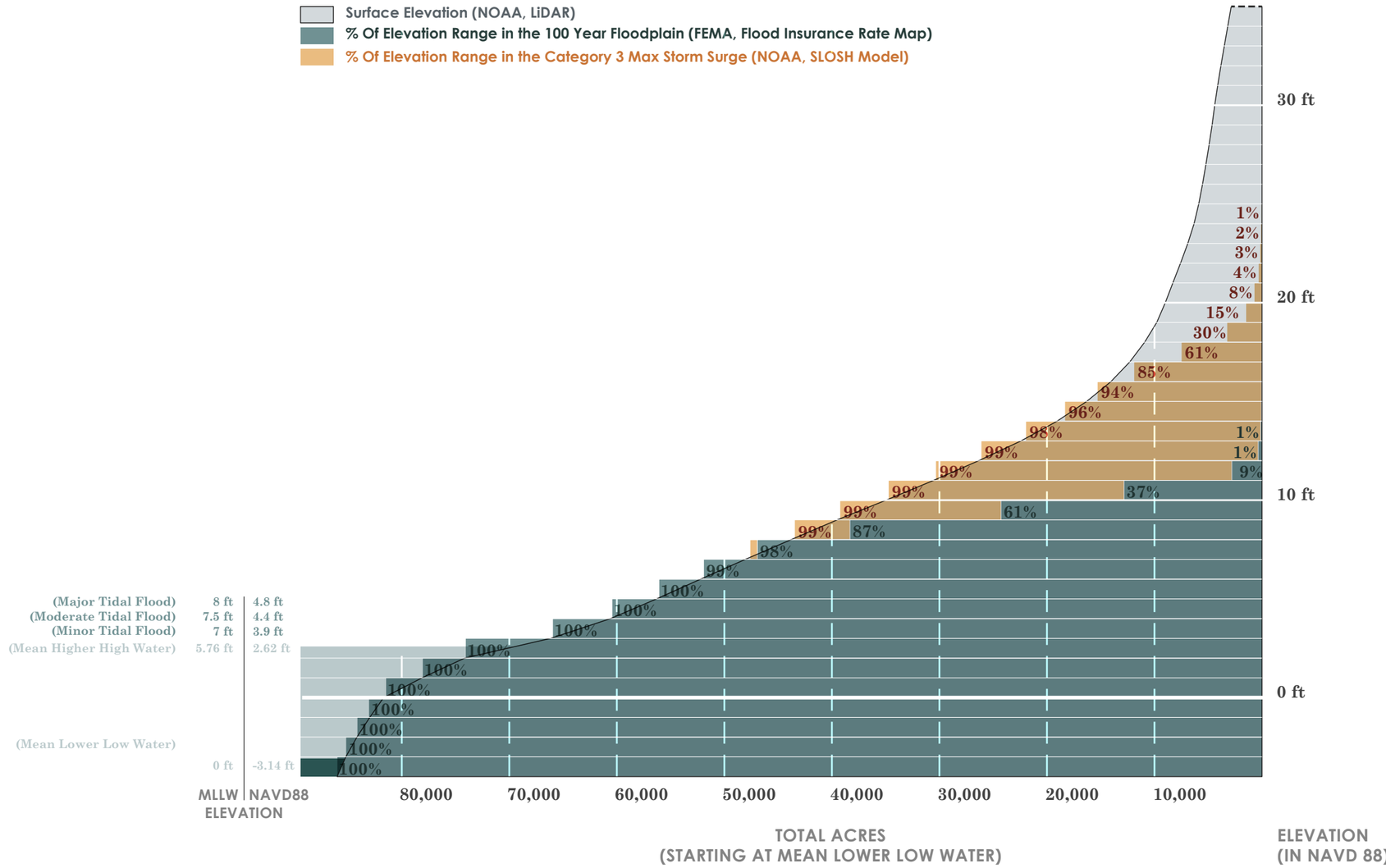


ELEVATION & FLOOD RISK DISTRIBUTION

Very little land within the urban growth boundary is above both the floodplain and the storm surge zone.

ELEVATION DISTRIBUTION

Within the UGB excluding spoil islands


Surface Elevation (NOAA, LiDAR)
% Of Elevation Range in the 100 Year Floodplain (FEMA, Flood Insurance Rate Map)
% Of Elevation Range in the Category 3 Max Storm Surge (NOAA, SLOSH Model)
30 ft
20 ft
10 ft
0 ft
1%
2%
3%
4%
8%
15%
30%
61%
85%
94%
96%
98%
99%
99%
99%
99%
98%
99%
100%
100%
100

ELEVATION RISK ZONES

HIGH GROUND

High ground is defined as land outside the FEMA 100 year floodplain and above the NOAA max category 3 storm surge. Typically encompassing old beach ridges and river bluffs, high ground has the lowest flood risk and the greatest capacity for stormwater detention and infiltration in Charleston. It holds both the greatest opportunity and responsibility to reduce downstream precipitation-related flood risks, for whatever actions occur in these areas, the consequences (good or bad) will mainly be felt downstream.

ADAPT ZONE

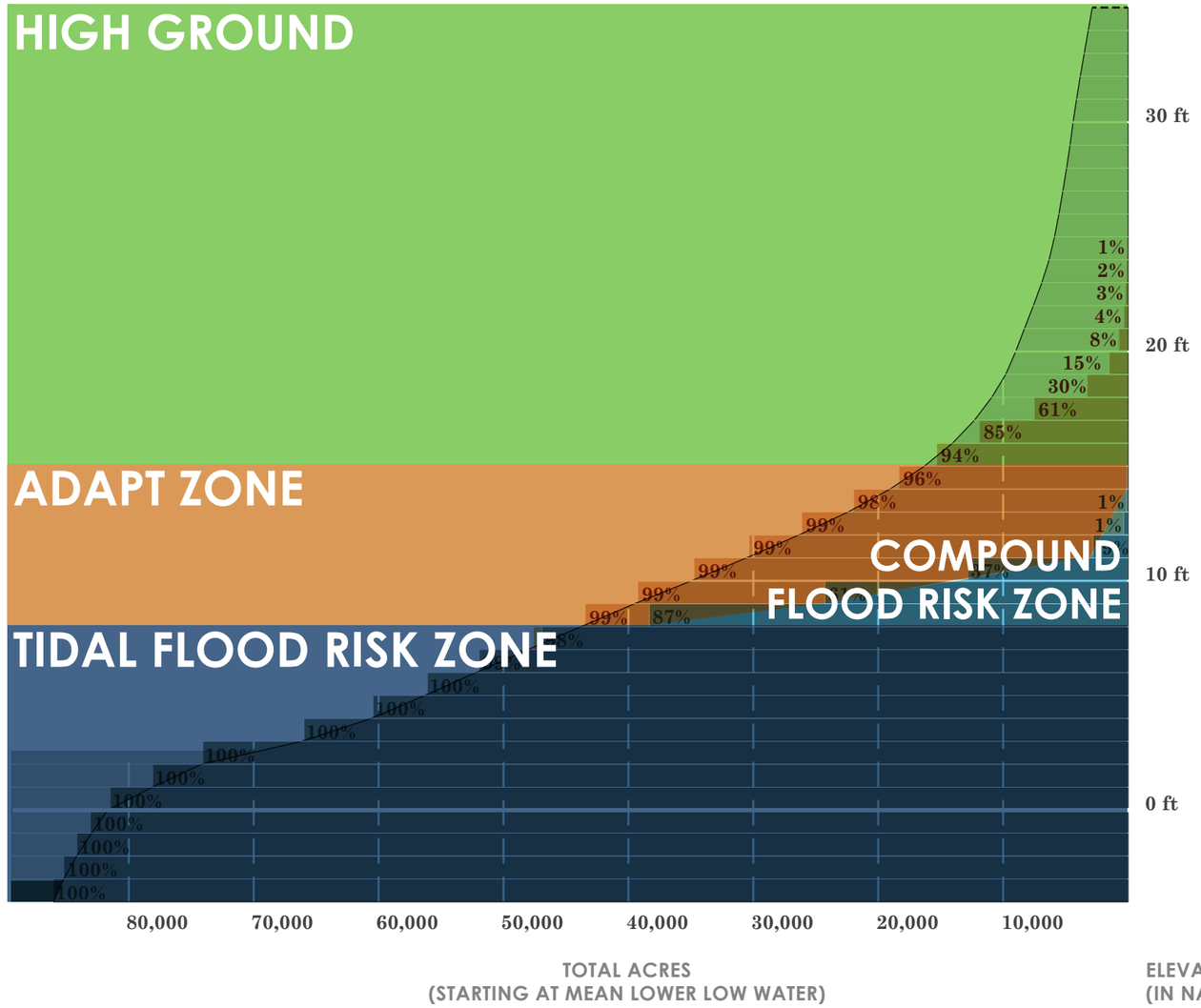
The adapt zone consists of land outside of the 100 year floodplain that is still within the maximum modeled storm surge zone of a category 3 hurricane. Flooding in this zone is infrequent but not impossible. Detention and infiltration is usually but not always feasible. Responsible development requires appropriate stormwater management techniques, and adverse downstream impacts are not inevitable. Structures in this zone should be elevated to address storm surge risk and runoff should be mitigated.

COMPOUND FLOOD RISK ZONE

This zone encompasses areas within the floodplain where flood risk comes from a mixture of rainfall, runoff and tidal conditions. Elevating structures to safe levels using fill can increase local and downstream flood risk in ways that are difficult to offset. Fill displaces floodwater and increases runoff, exacerbating local and downstream flood risk. The use of detention basins is not always feasible depending on groundwater conditions.

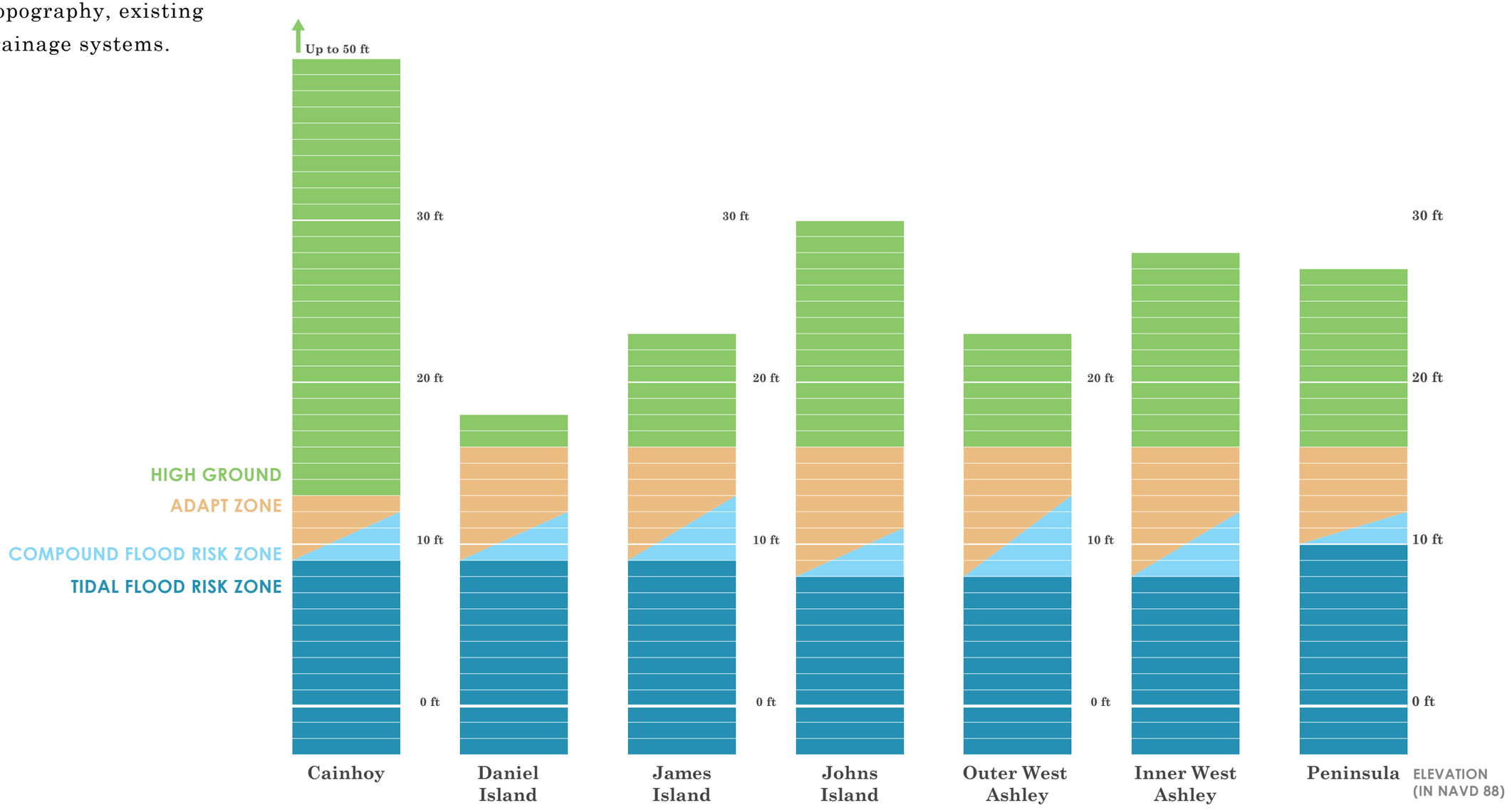
TIDAL FLOOD RISK ZONE

This zone encompasses the lowest land in Charleston. Nearly 100% of this zone is in the 100 year floodplain. Flooding is frequent and can come solely from tidal events independent of precipitation. Both stormwater detention and infiltration can be infeasible in this zone and elevating structures to safe levels typically requires piers.



ELEVATION RISK ZONES PER WATERSHED AREA
WITHIN THE URBAN GROWTH BOUNDARY

Elevation zones vary across watershed areas in Charleston based on local conditions such as topography, existing development, and drainage systems.



ELEVATION RISK ZONES

Zones based on elevation and flood risk.

HIGH GROUND

High ground is defined as land outside of the FEMA 100 year floodplain and above the NOAA max category 3 storm surge. High ground has the lowest flood risk and stormwater detention here has the greatest watershed benefit.

ADAPT ZONE

The adapt zone consists of land outside of the FEMA 100 year floodplain that is still within the NOAA maximum storm surge of a category 3 hurricane. Rain and storm surge flooding in this zone is infrequent but not impossible.

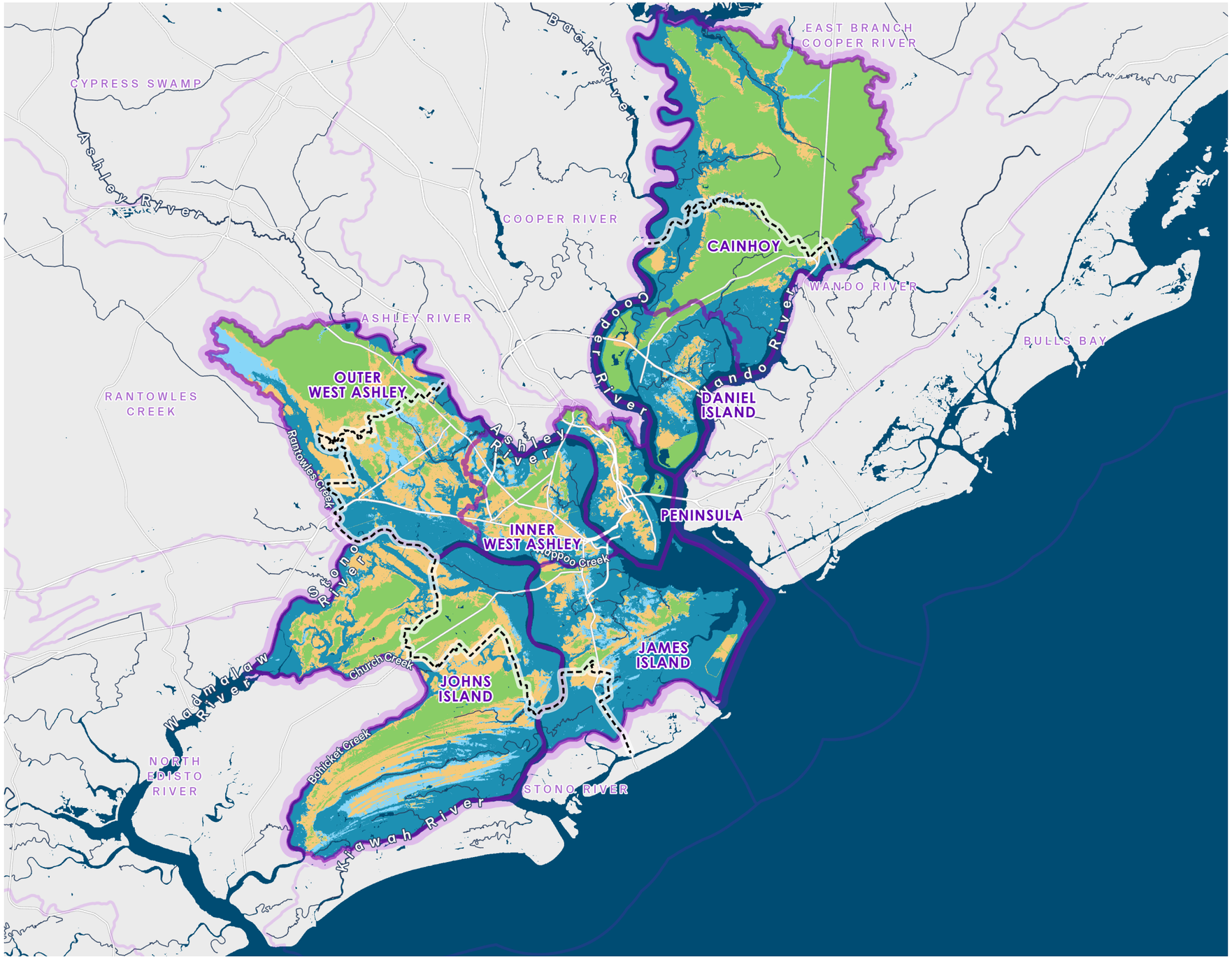
COMPOUND FLOOD RISK

This zone encompasses areas within the floodplain above the tidal flood risk zone where flood risk comes from a mixture of rainfall, runoff and tidal conditions.

TIDAL FLOOD RISK ZONE

This zone encompasses the lowest land in Charleston. Nearly 100% of this zone is in the 100 year floodplain. Flooding is frequent and can come solely from tidal events independent of precipitation. Sea level rise driven marsh migration occurs in this dynamic zone.

Marsh Migration Zone



1 inch = 4 miles

Miles

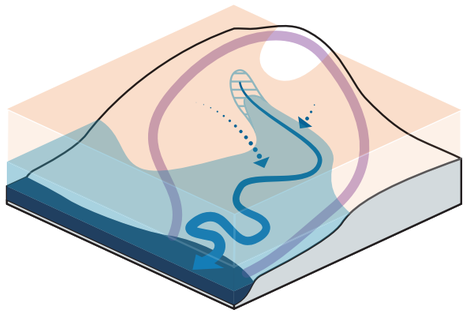
10

WATERSHED TYPE

WATERSHED TYPOLOGY INFLUENCES POTENTIAL FLOOD RISK

SMALL WATERSHEDS

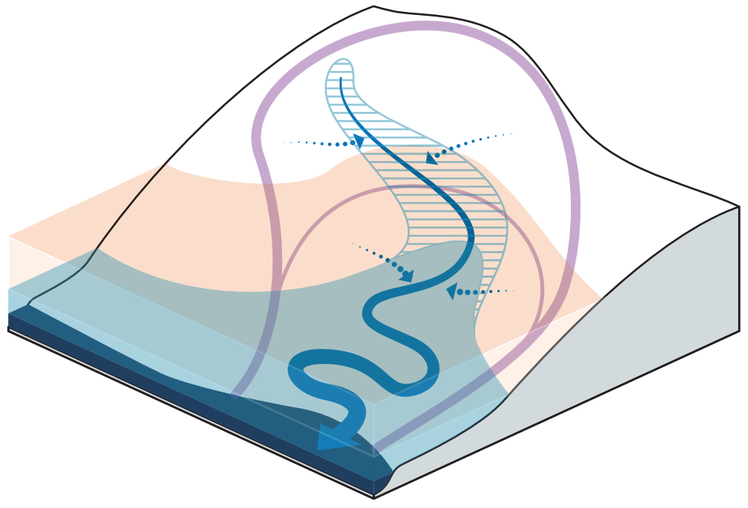
- SMALL WATERWAYS OR SHEET FLOW
- LOWER POTENTIAL RUNOFF ACCUMULATION
- LOWER POTENTIAL DRAINAGE BACKUP



Runoff
Drainage Path
Watersheds
Subwatersheds
Tidal Flooding
Compound Flooding
Maximum Storm surge

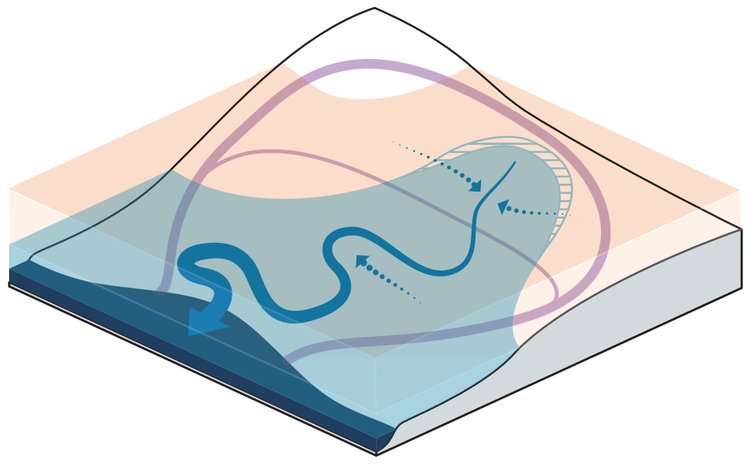
LARGE WATERSHEDS

- LARGE, WELL-DEFINED WATERWAYS
- WATERSHEDS ARE LARGE ENOUGH TO BE BROKEN DOWN INTO UPSTREAM & DOWNSTREAM SUBWATERSHEDS



LARGE INLAND

- UPSTREAM PORTIONS SIGNIFICANTLY ABOVE THE TIDAL RANGE
- HIGHER POTENTIAL RUNOFF ACCUMULATION
- MODERATE POTENTIAL DRAINAGE BACKUP

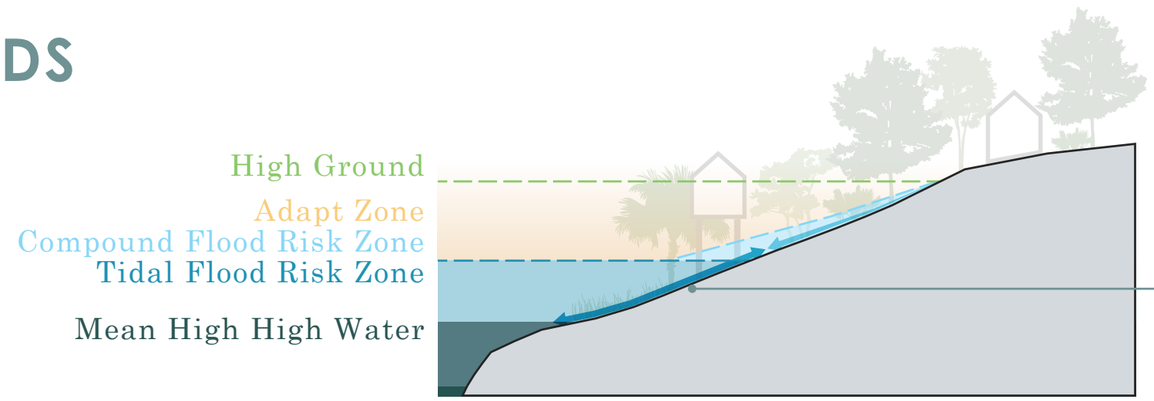


LARGE TIDAL

- MAJORITY IS TIDAL OR TIDALLY INFLUENCED
- HIGHER POTENTIAL RUNOFF ACCUMULATION
- HIGHER POTENTIAL DRAINAGE BACKUP

ELEVATION ZONES & WATERSHED TYPES

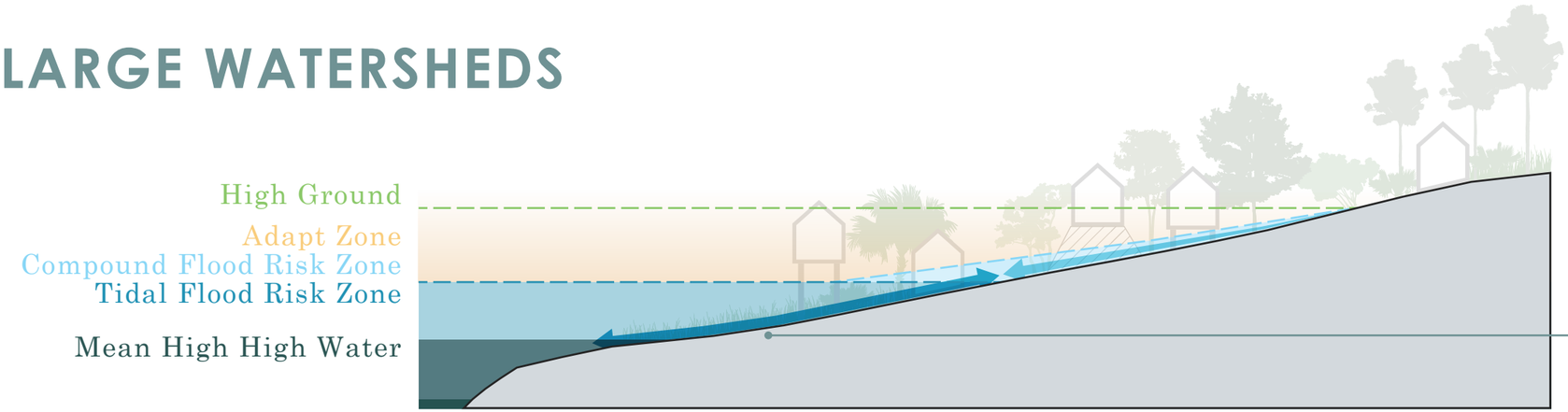
SMALL WATERSHEDS



SMALL WATERSHED
Lower Potential for Runoff Accumulation

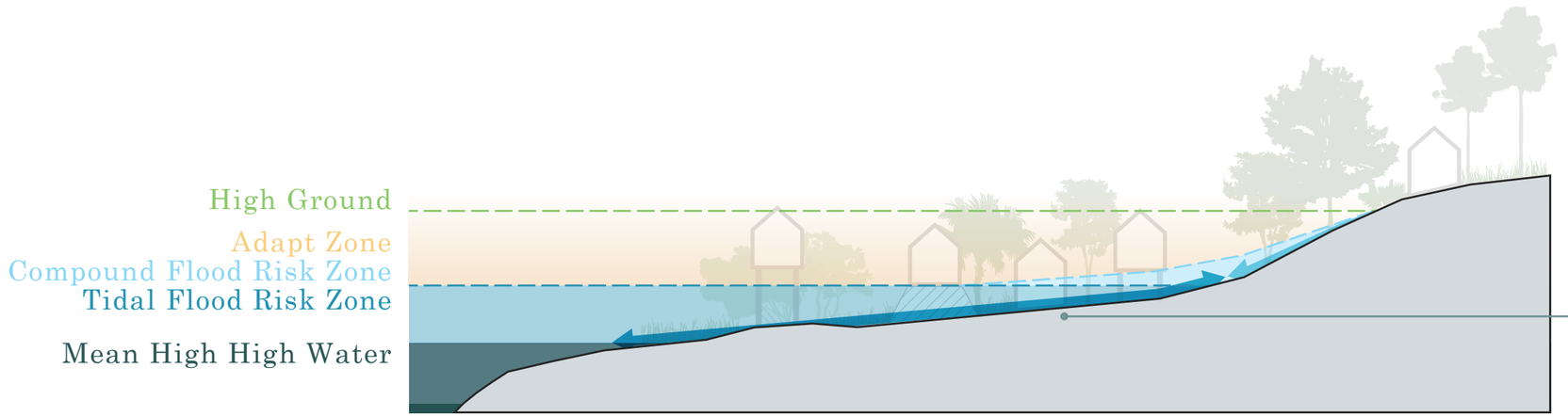
SMALL TIDAL EXTENT
Lower Potential for Drainage Backup

LARGE WATERSHEDS



LARGE WATERSHED
Higher Potential for Runoff Accumulation

SMALL TIDAL EXTENT
Moderate Potential for Drainage Backup

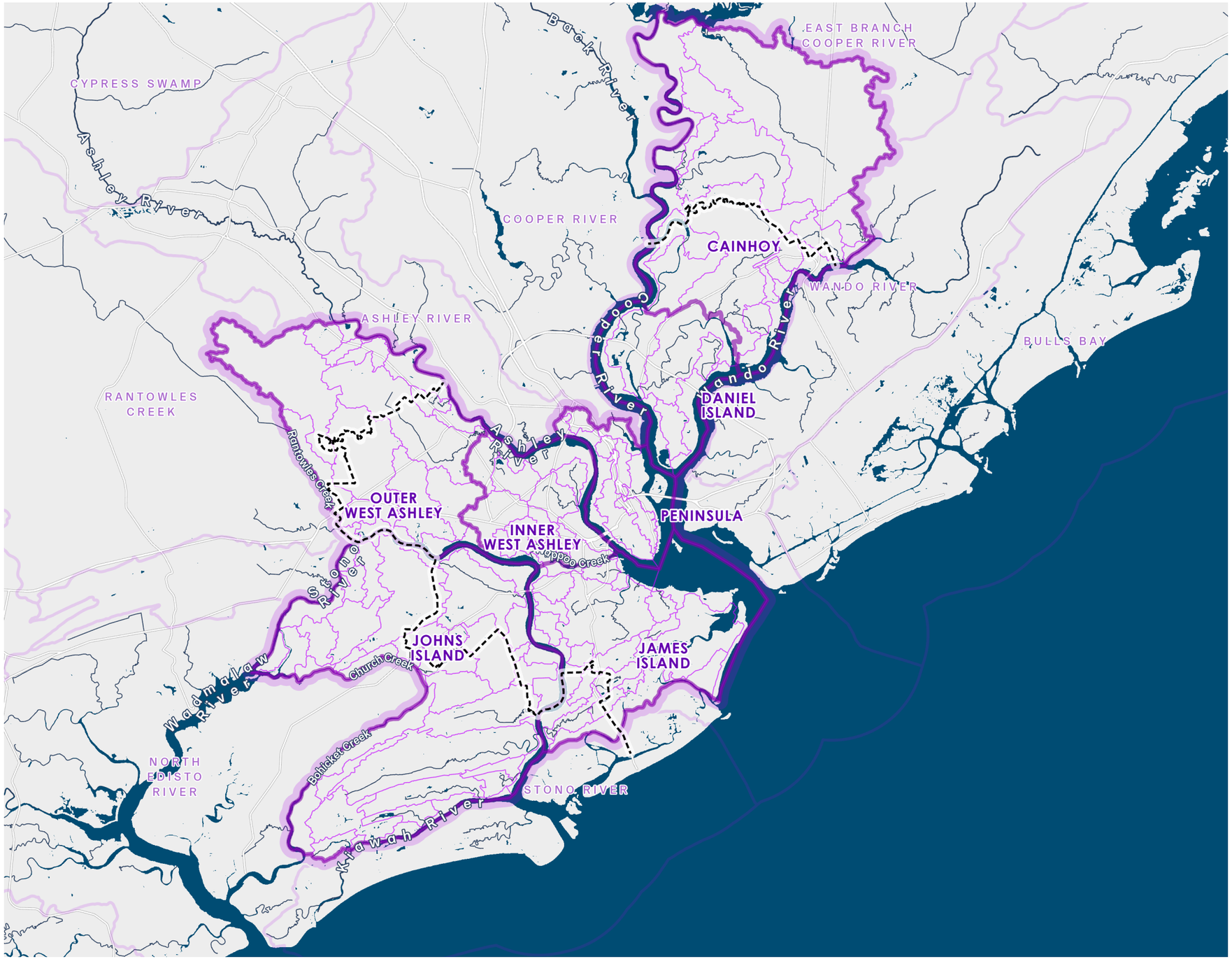


LARGE WATERSHED
Higher Potential for Runoff Accumulation

LARGE TIDAL EXTENT
Higher Potential for Drainage Backup

WATERSHEDS

Around 90 watersheds intersect the City of Charleston. Some of these originate outside City boundaries.



Legend

- Watershed Neighborhood
- Project Watersheds
- Other Watersheds
- Urban Growth Boundary
- Water

1 inch = 4 miles

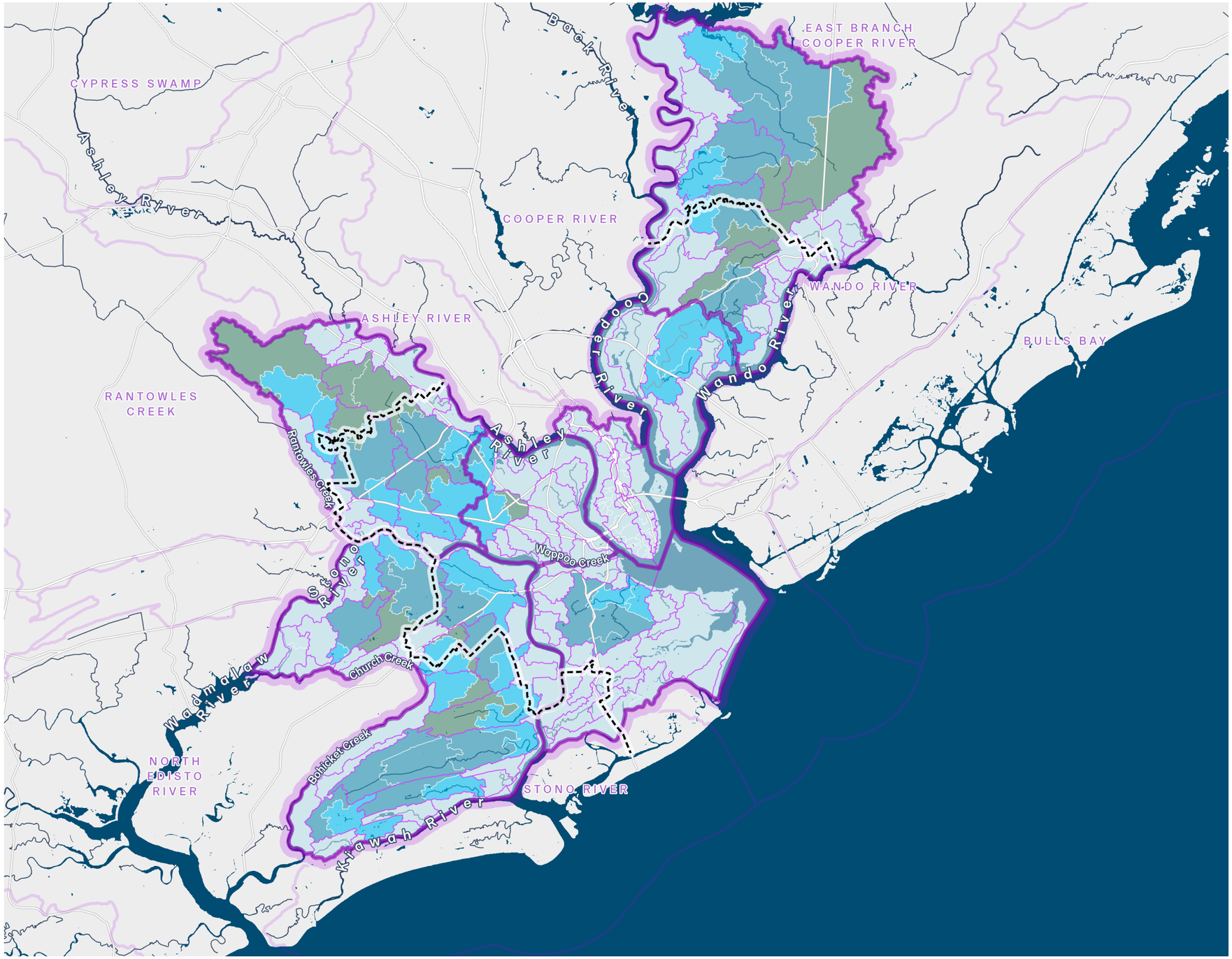
Miles

10

WATERSHED TYPE

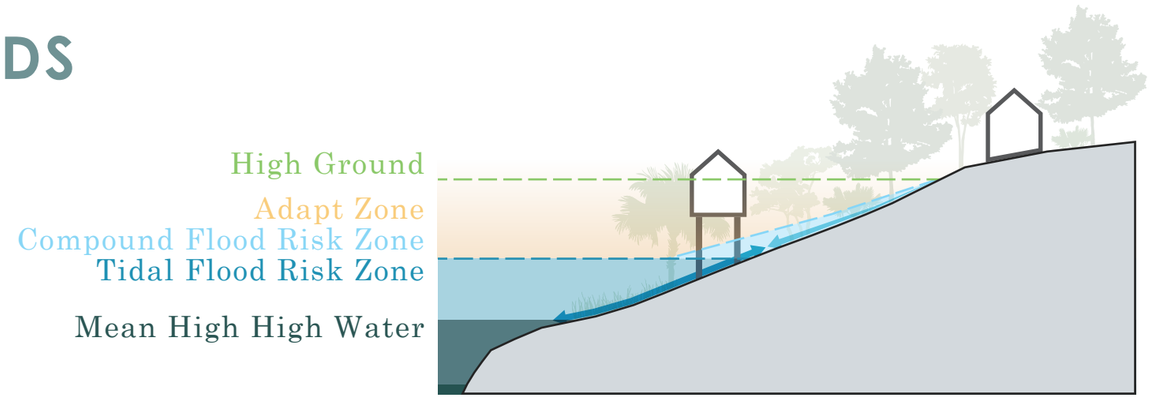
Watersheds and subwatersheds are classified by size, length (upstream/ downstream), and tidal influence to understand how the physical characteristics of waterways impact flood risk.

Large Watersheds have upstream and downstream subwatersheds. Subwatersheds boundaries were calculated through a flow accumulation analysis. Every aproximately 2 miles runoff has to flow from any given point to the watershed's outlet constitutes a subwatershed.



ELEVATION ZONES & WATERSHED SENSITIVITY

SMALL WATERSHEDS

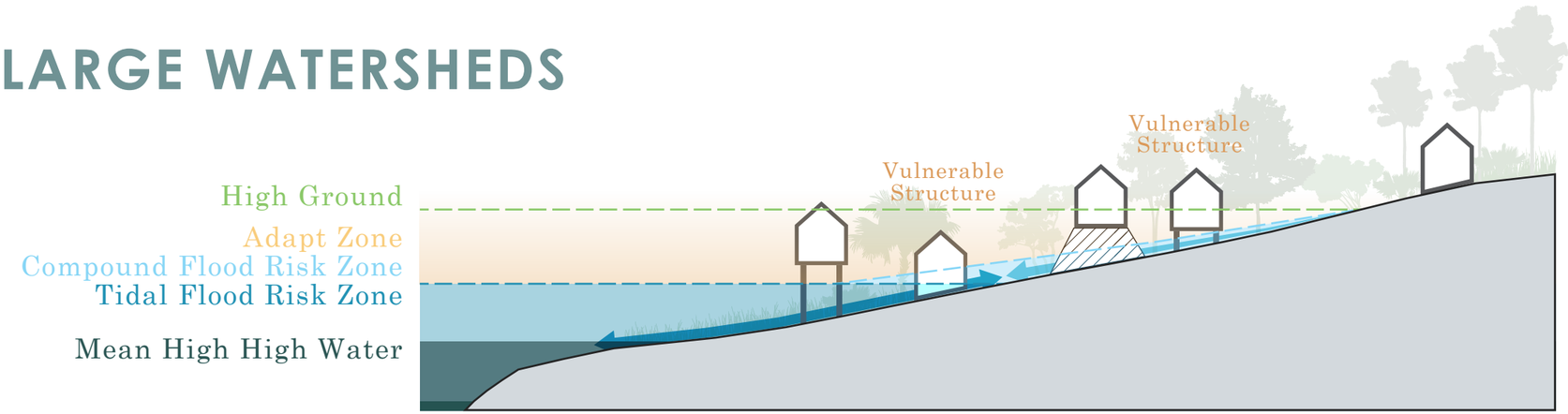


SMALL NUMBER OF VULNERABLE STRUCTURES

SMALL WATERSHED

Lower Potential for Runoff Accumulation

LARGE WATERSHEDS



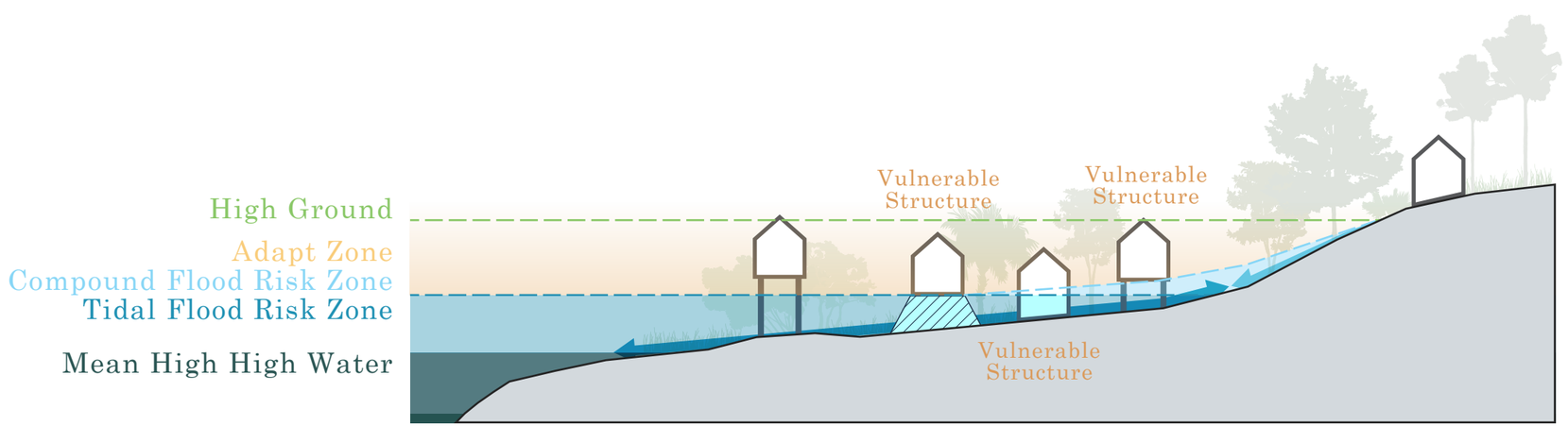
LARGE NUMBER OF VULNERABLE STRUCTURES

LARGE WATERSHED

Higher Potential for Runoff Accumulation

SMALL TIDAL EXTENT

Moderate Potential for Drainage Backup



LARGE NUMBER OF VULNERABLE STRUCTURES

LARGE WATERSHED

Higher Potential for Runoff Accumulation

LARGE TIDAL EXTENT

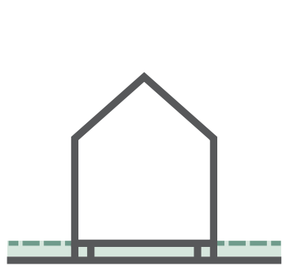
Higher Potential for Drainage Backup

BUILDING TYPOLOGIES

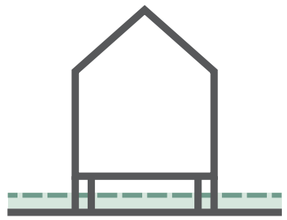
FLOOD ADAPTIVE

NON-ADAPTIVE

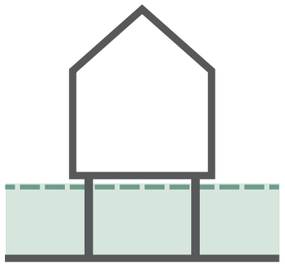
RESIDENTIAL



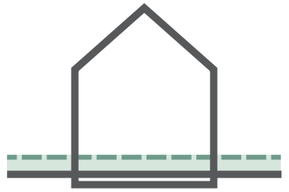
Pier & Beam



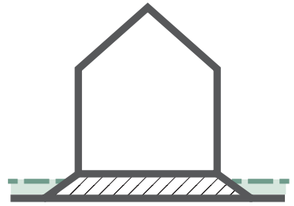
Pier & Beam (raised)



Pier & Beam
(coastal zone)

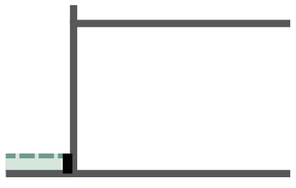


Slab on Grade

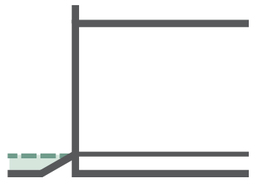


Slab on Fill

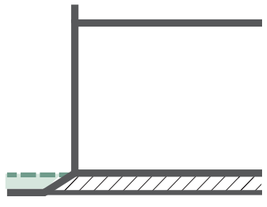
COMMERCIAL & INSTITUTIONAL



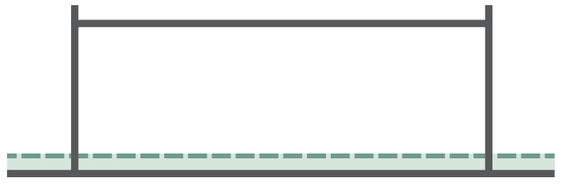
Dry Flood Proof*



Interior Elevated*



Elevated on Fill**



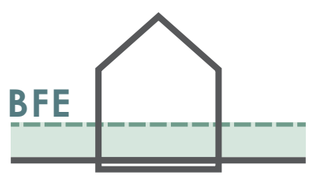
Unmodified Slab on Grade

*If renovated, only if existing construction type allows
**Only if sufficient additional runoff mitigation & water storage features are in place

STRUCTURE TYPE & VULNERABILITY
NUMBER OF VULNERABLE PARCELS PER WATERSHED

Combined Vulnerability & Risk Definitions come from the NEMAC+Fernleaf Vulnerability and Risk Assessment (2020).

"VULNERABLE" DEFINITION USED FOR WATERSHED ANALYSIS

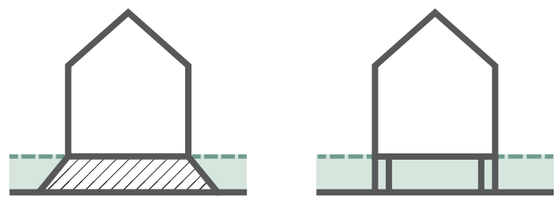


HIGH COMBINED VULNERABILITY & RISK

IN THE 100 YEAR FLOODPLAIN

BUILT BEFORE BFE REQUIREMENTS

(1971 for Charleston, 1983 for Berkeley)

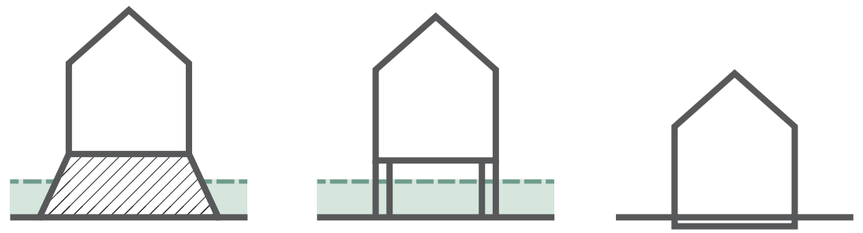


MEDIUM COMBINED VULNERABILITY & RISK

IN THE 100 YEAR FLOODPLAIN

BUILT AFTER BFE REQUIREMENTS

(1971 for Charleston, 1983 for Berkeley)



LOW COMBINED VULNERABILITY & RISK

OUTSIDE THE 100 YEAR FLOODPLAIN

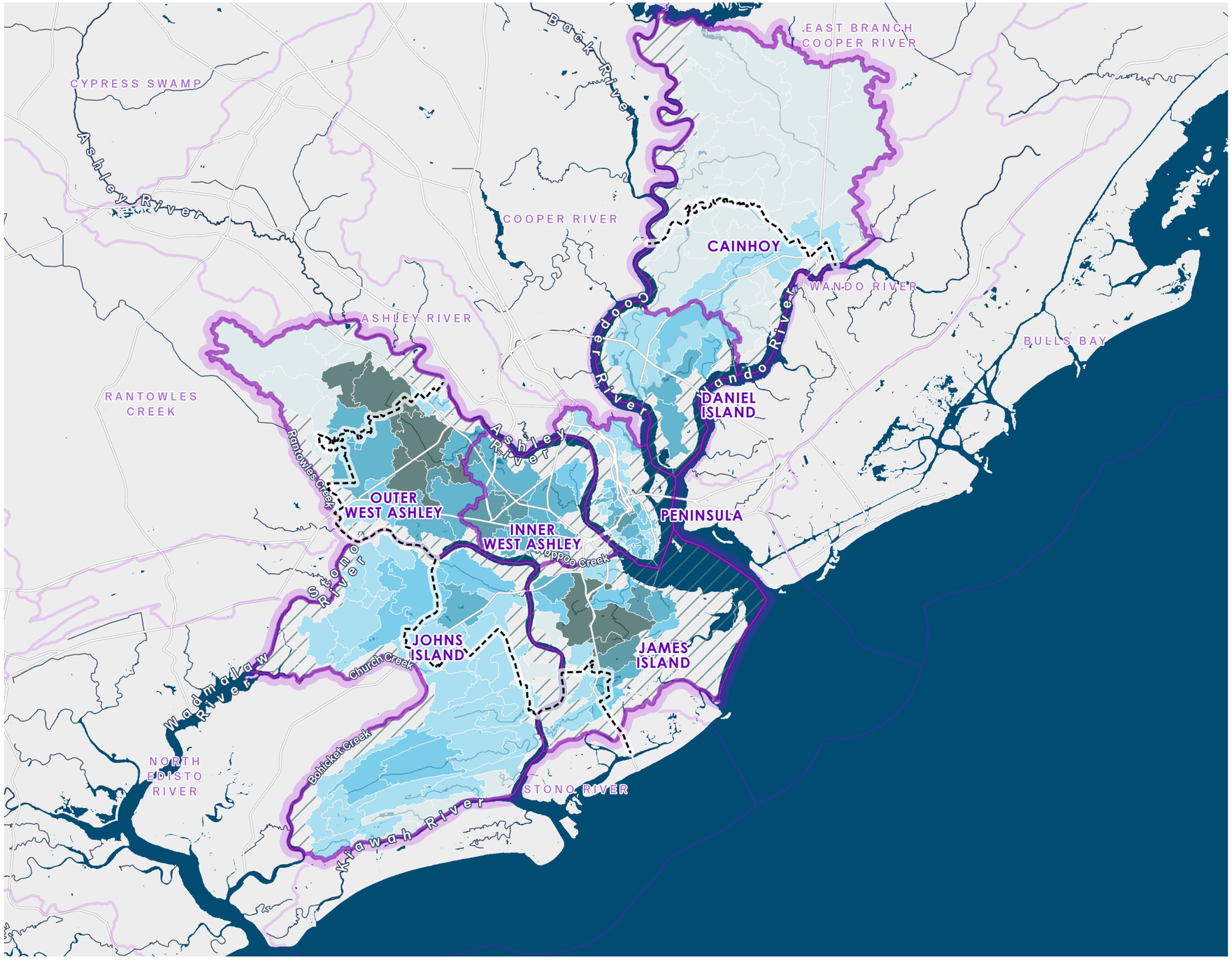
BUILT AFTER BFE+1 REQUIREMENTS

(2015 for Charleston, 2018 for Berkeley)

VULNERABLE PARCELS: LOCAL & DOWNSTREAM

This map shows the total number of vulnerable parcels in each subwatershed plus vulnerable parcels in downstream subwatersheds. Vulnerable parcels are defined as any parcel with a structure built in the 100 year floodplain before BFE+1 regulations went into effect. This definition aligns with the “Medium Combined Risk and Vulnerability for Residential Parcels” definition from the 2020 Vulnerability and Risk Assessment.

Sources: NEMAC+Fernleaf



Legend

Vulnerable Parcels Local & Downstream

- ≤10
- ≤250
- ≤500
- ≤1000
- ≤1500
- >1500
- <excluded>

Watershed Neighborhood

Other Watersheds

Urban Growth Boundary

Water

1 inch = 4 miles

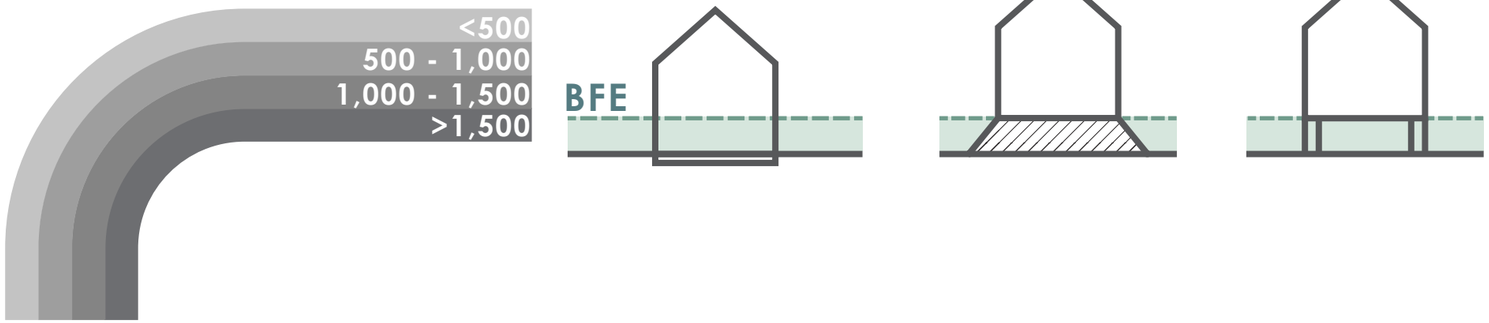
Miles

10

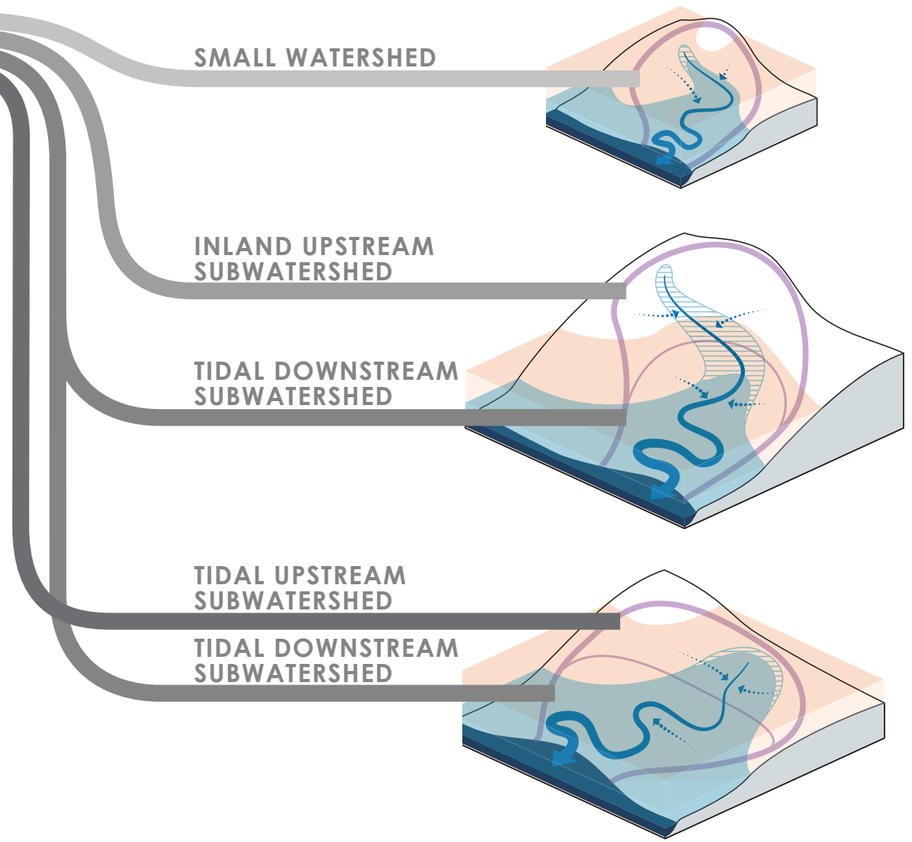
WATERSHED SENSITIVITY
VULNERABLE PARCELS AND WATERSHED TYPOLOGY

Watershed sensitivity refers to a parcel's effect on its surroundings and properties downstream. Watershed sensitivity combines the number of vulnerable parcels in a watershed with the flood risk of the watershed from a typological standpoint. Depending on the combination of those two factors, watershed and zone are classified as high or normal sensitivity. Number of vulnerable parcels are weighted higher than watershed typology to preference real potential impacts to structures.

HOW MANY VULNERABLE PARCELS IN THE SUBWATERSHED?



HOW FLOODPRONE IS THE WATERSHED TYPOLOGY?

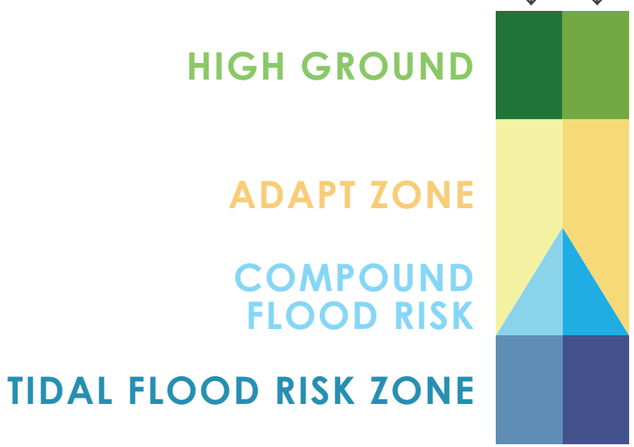


NORMAL SENSITIVITY

Combination of less flood prone watersheds and a low number of vulnerable parcels. Typically smaller and/or less developed watersheds.

HIGH SENSITIVITY

Combination of more flood prone watersheds and a high number of vulnerable parcels. Typically larger tidal watersheds and/or watersheds where development happened before BFE regulations.



ELEVATION ZONES & WATERSHED SENSITIVITY

The combined elevation zone + watershed sensitivity maps show the relative risk of an area and how that area impacts the flood risk of its surrounding.

HIGH SENSITIVITY

Combination of more flood prone watersheds and a high number of vulnerable parcels. Typically larger tidal watersheds and/or watersheds where development happened before BFE regulations.

NORMAL SENSITIVITY

Combination of less flood prone watersheds and a low number of vulnerable parcels. Typically smaller and/or less developed watersheds.

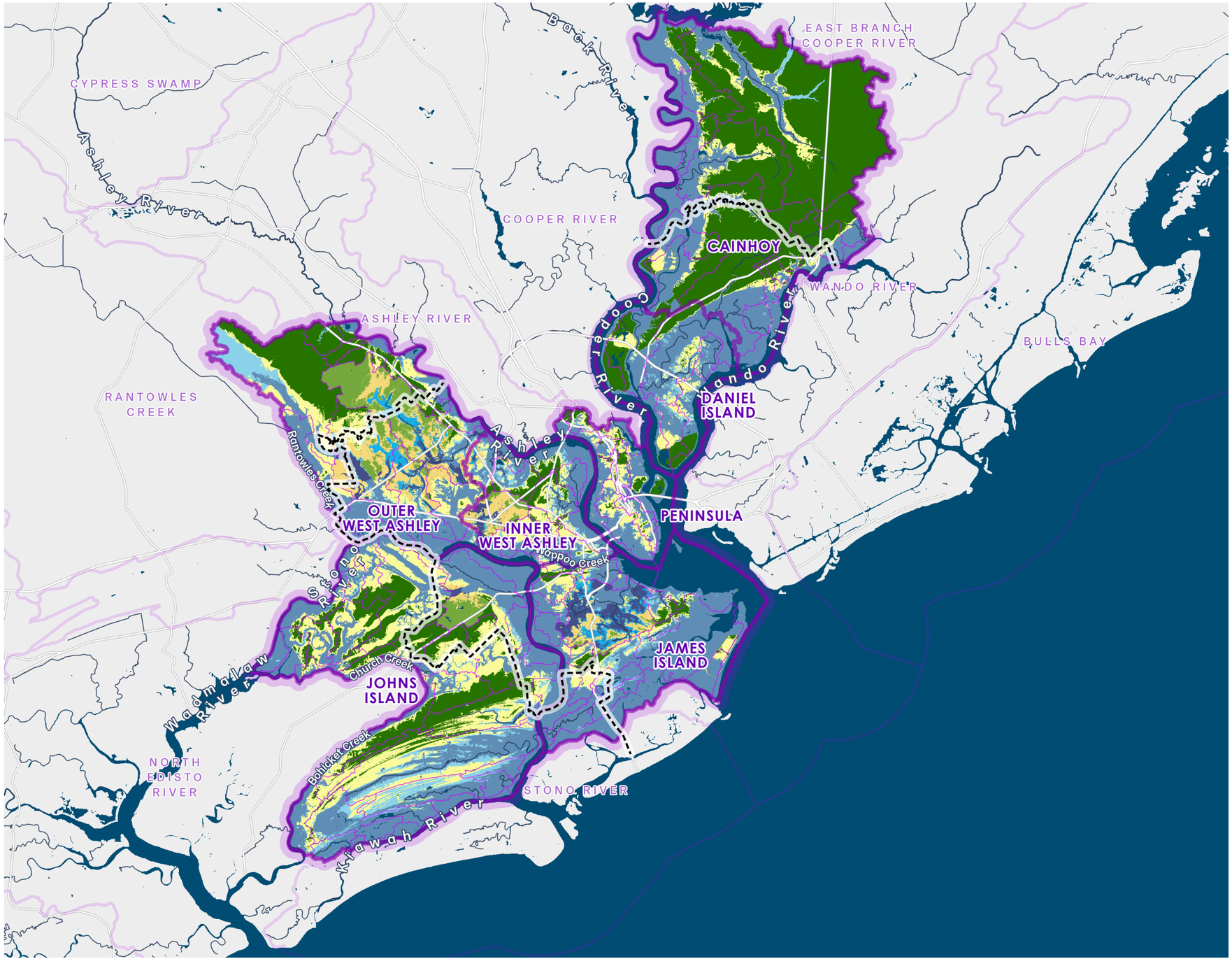
HIGH GROUND

ADAPT ZONE

COMPOUND FLOOD RISK

TIDAL FLOOD RISK ZONE

Marsh Migration Zone



1 inch = 4 miles

Miles

10

AREA OF ZONES PER WATERSHED AREA
WITHIN THE URBAN GROWTH BOUNDARY

Watershed Area	Total Area (SqMi)	TIDAL FLOOD RISK ZONE		COMPOUND FLOOD RISK		ADAPT ZONE		HIGH GROUND	
		NORMAL SENSITIVITY	HIGH SENSITIVITY	NORMAL SENSITIVITY	HIGH SENSITIVITY	NORMAL SENSITIVITY	HIGH SENSITIVITY	NORMAL SENSITIVITY	HIGH SENSITIVITY
Peninsula	14.4	9.2		0.4		3.2		1.5	
Inner West Ashley	20.7	9.3	0.6	1.6	0.2	4.2	1.9	2.3	0.6
Outer West Ashley	25.5	9.4	1.7	0.9	1.7	3.2	5.3	0.9	2.5
Johns Island	17.6	8.4	0.1	0.5	0.1	3.1	0.4	3.6	1.5
James Island	38.6	26.1	2.7	1.4	1.5	3.1	1.8	1.6	0.3
Daniel Island	11.7	7.8		0.8		1.9		1.2	
Cainhoy	34.4	17.5		0.4		2.4		14.1	

ECOLOGICAL SENSITIVITY

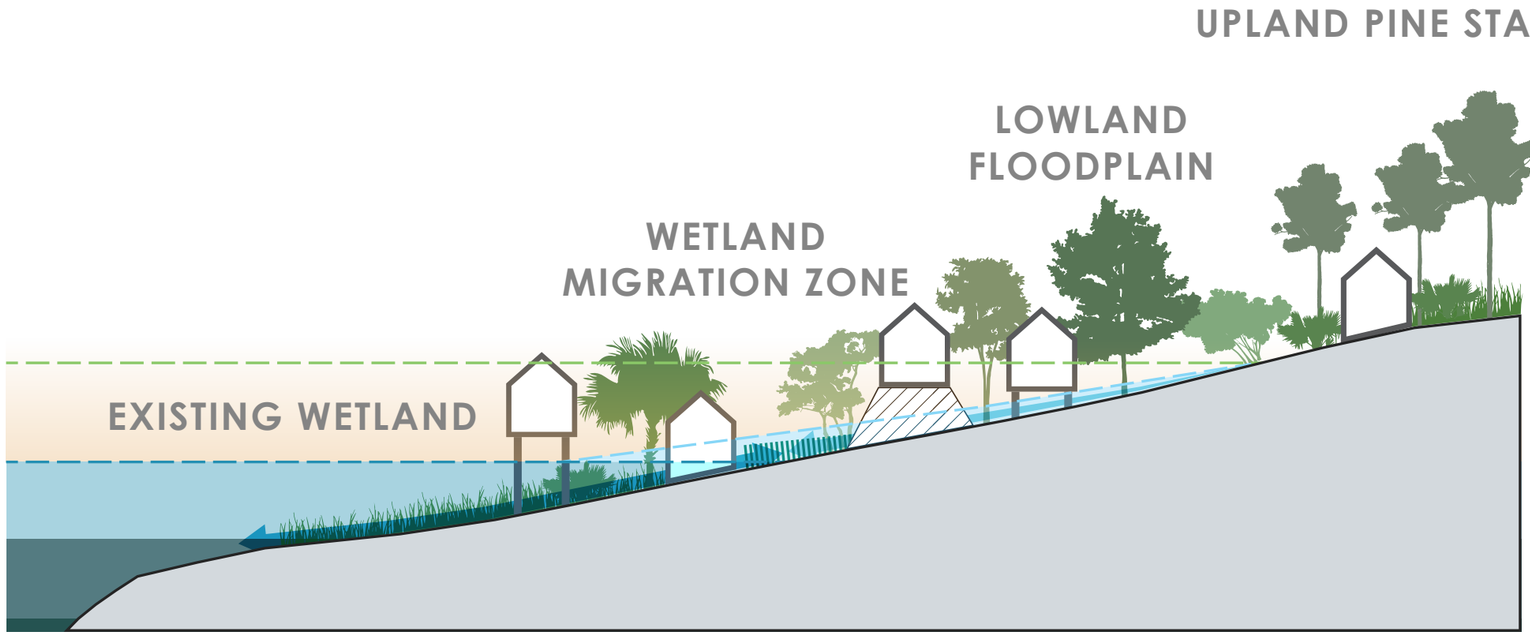
High Ground

Adapt Zone

Compound Flood Risk Zone

Tidal Flood Risk Zone

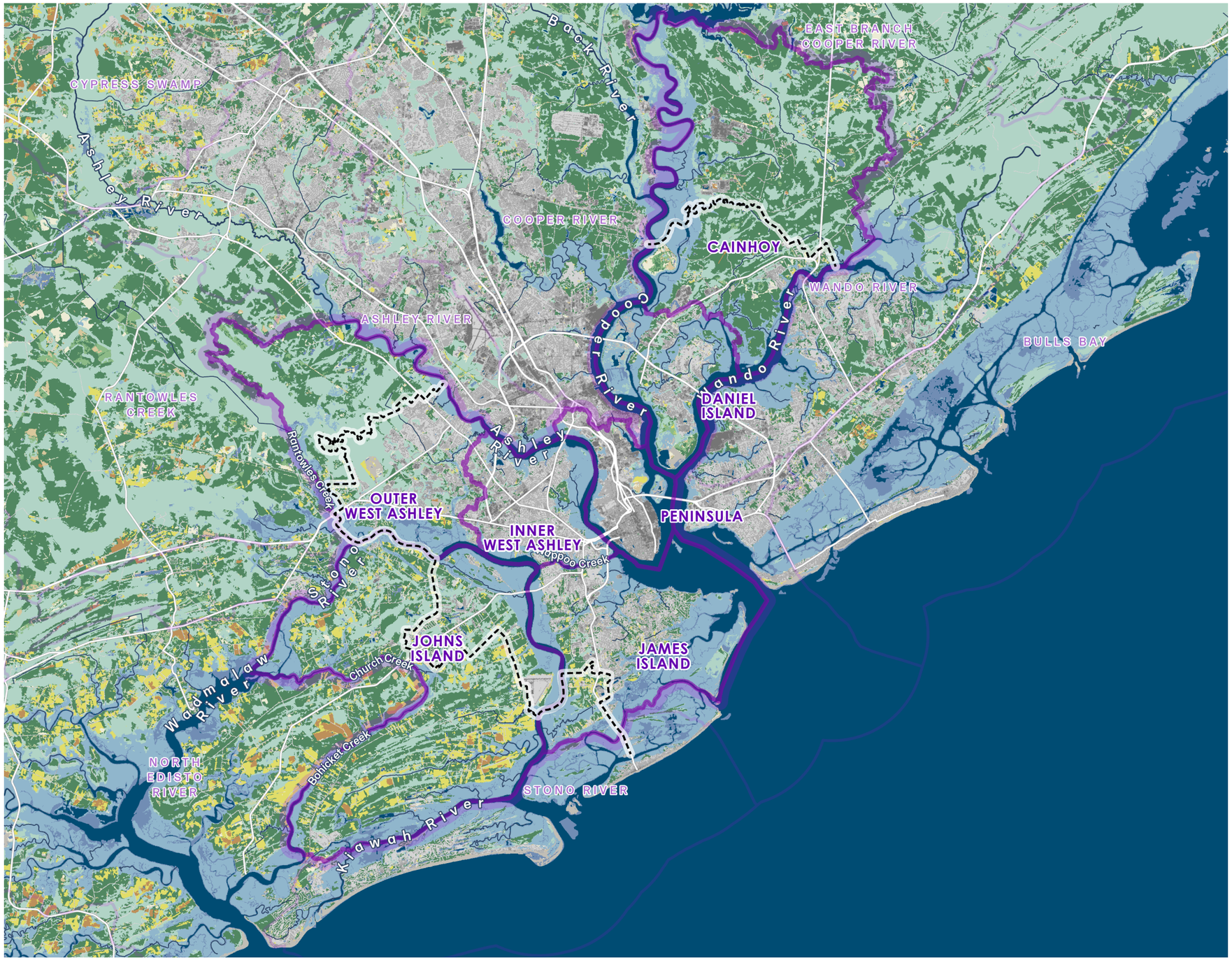
Mean High High Water



LAND COVER

Land cover in metro Charleston as of 2016.

Data sources: Multi-Resolution Land Characteristics Consortium



Legend

Land Cover 2016

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetland

Watershed Neighborhood

Other Watersheds

Urban Growth Boundary

Water

1 inch = 4 miles

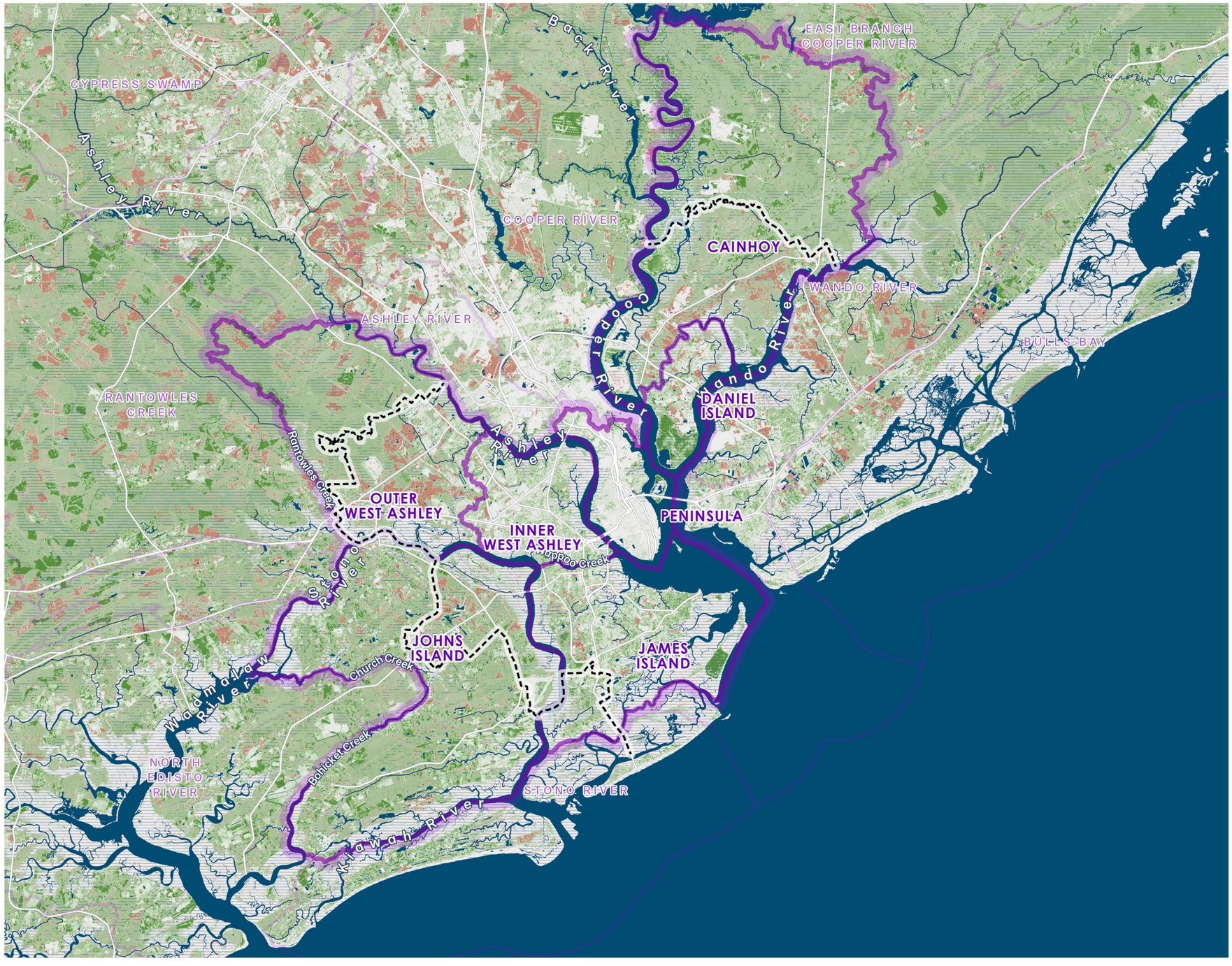
Miles

10

TREE CANOPY DENSITY & CHANGE

Tree canopy has been lost around Charleston's periphery as the city expanded outward.

Data sources: Global Land Cover Facilities



Legend

Tree Canopy (2015)

Dense

Sparse

Canopy Change (2000-2015)

High Gain

High Loss

Watersheds Neighborhood

Urban Growth Boundary

Water

Water

Wetland

1 inch = 4 miles

Miles

10

LANDSCAPE TYPOLOGIES



COASTAL EDGE COMMUNITY

Coastal Edge Community can tolerate salt air and occasional inundation from major storms; most durable for locations identified for likely marsh migration

- Live oak *Quercus virginiana*
- Eastern red cedar *Juniperus virginiana*
- Pine *Pinus species*
- Palmetto *Sabal palmetto*
- Southern Magnolia *Magnolia grandiflora*

- Dwarf palm *Sabal minor*
- Yaupon holly *Ilex vomitoria*
- Red bay *Persea borbonia*
- Wax myrtle *Myrica cerifera*
- Salt myrtle *Baccharis halimifolia*

- Sea Oxeye Daisy *Borrichia frutescens*
- Sea beans *Salicornia virginica*
- Smooth cordgrass *Spartina alterniflora* (aka *Sporobolus alterniflorus*)
- Saltmeadow cordgrass *Spartina patens*
- Sand cordgrass *Spartina bakeri*
- Sweetgrass *Muhlenbergia capillaris*
- Needlerush *Juncus roemerianus*



LOWLAND FLOODPLAIN

Lowland Floodplain can tolerate periodic freshwater and / or brackish inundation; plants selected for tolerance of poorly drained soils due to soil composition or high water table (Hydrologic Groups C-D).

- Bald Cypress *Taxodium distichum*
- Black Gum *Nyssa sylvatica*
- American Beech *Fagus grandifolia*
- Swamp chestnut oak *Quercus michauxi*
- Water Oak *Quercus nigra*
- Laurel oak *Quercus laurifolia*
- American Hornbeam *Carpinus caroliniana*

- Summersweet *Clethra alnifolia*
- Inkberry holly *Ilex glabra*
- Irises *Iris species*
- Swamp sunflower *Helianthus angustifolius*
- Wax myrtle *Myrica cerifera*
- Dwarf palm *Sabal minor*
- Swamp lily *Crinum americanum*
- Rosemallow hibiscus *Hibiscus moscheutos*
- White top sedge *Rhynchospora colorata*
- Fakahatchee grass *Tripsachum dactyloides*
- Common rush *Juncus effusus*



UPLAND RIDGES

Upland Ridges can tolerate periodic freshwater inundation if well-draining soils are present (Hydrologic Groups A-B)

PINE FOREST
- Longleaf pine Pinus palustris
- Carolina wiregrass Aristida stricta
- Little bluestem Schizachyrium scoparium
- Indian grass Sorghastrum nutans
- Switch grass Panicum virgatum
-Inland sea oats Chasmanthium latifolium
- Slender wood oats Chasmanthium latifolium
- Pitcher plants Sarracenia purpurea
- Partridge pea Chamaecrista fasciculata
- Black-eyed Susan Rudbeckia hirta

MIXED HARDWOOD FOREST
- Southern magnolia Magnolia grandiflora
- Live oak Quercus virginiana
- Water oak Quercus nigra
- Sweetgum Liquidambar styraciflua
- American beech Fagus grandifolia
-Red oak Quercus falcata
- Laurel oak Quercus laurifolia
- American hornbeam Carpinus caroliniana
- Sweetbay magnolia Magnolia virginiana
- Tulip poplar Liriodendron tulipifera
- American holly Ilex opaca
- Yaupon holly Ilex vomitoria
- Carolina Cherry Laurel Prunus caroliniana



URBAN/SUBURBAN REFORESTATION

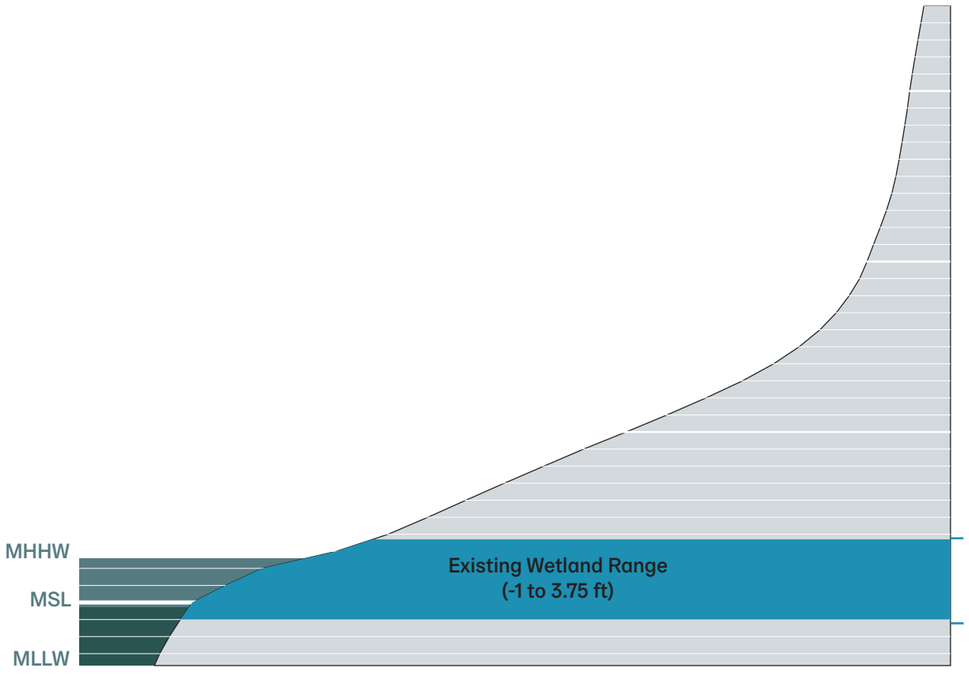
Urban / Suburban Reforestation requires native species tolerant of poor nutrient soil, root constriction, and other urban / suburban conditions

- Southern magnolia Magnolia grandiflora
- Live oak Quercus virginiana
- Willow oak Quercus phellos
- Bald cypress Taxodium distichum
-American hornbeam Carpinus caroliniana
- Sweetbay magnolia Magnolia virginiana
- Eastern red cedar Juniperus virginiana
- Palmetto Sabal palmetto

- Itea Itea virginica
- Yaupon holly Ilex vomitoria
- Inkberry holly Ilex glabra
- Beautyberry Callicarpa americana
- Oakleaf hydrangea Hydrangea quercifolia
- Wax myrtle Myrica cerifera
- Sweetgrass Muhlenbergia capillaris
- Switch grass Panicum virgatum
- Inland sea oats Chasmanthium latifolium

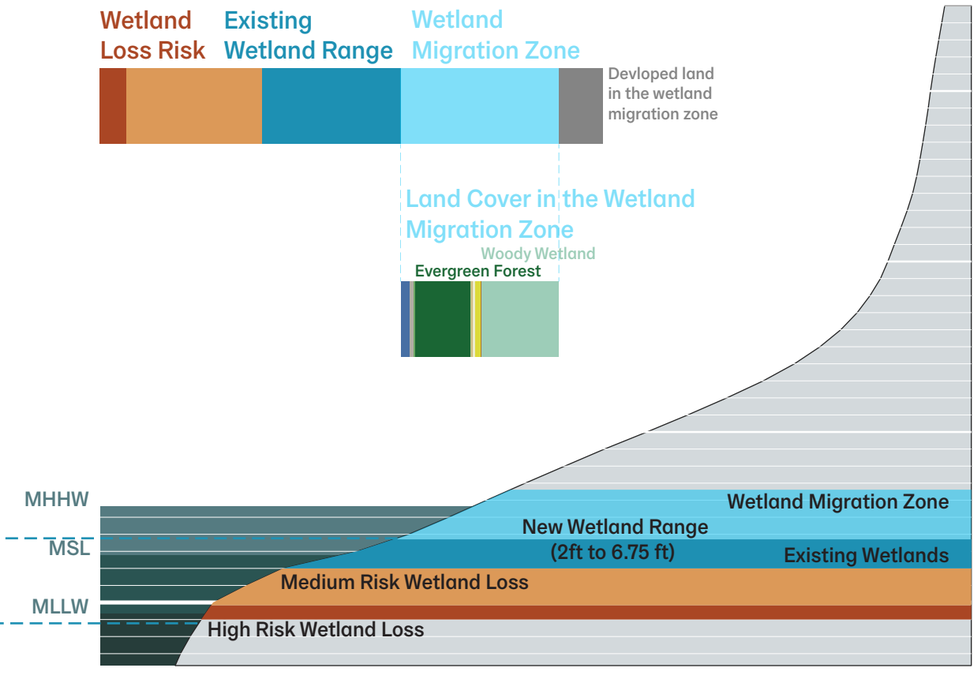
MARSH MIGRATION WITH 3 FT OF SEA LEVEL RISE

EXISTING WETLAND RANGE



Currently around 80% of herbaceous wetlands in Charleston exist between slightly below mean sea level and slightly above mean higher high water (-1 to 3.75 ft NAVD).

PROJECTED WETLAND RANGE WITH 3' OF SEA LEVEL RISE



With 3' of sea level rise around half of existing wetlands fall below the projected wetland range (2 to 6.75 ft NAVD). Wetlands below that range are considered medium risk for loss. Wetlands below mean lower low water are considered high risk for loss. Within the future wetland range, everywhere that is not already herbaceous wetland is considered the marsh migration zone. Most of that land is currently woody wetlands.

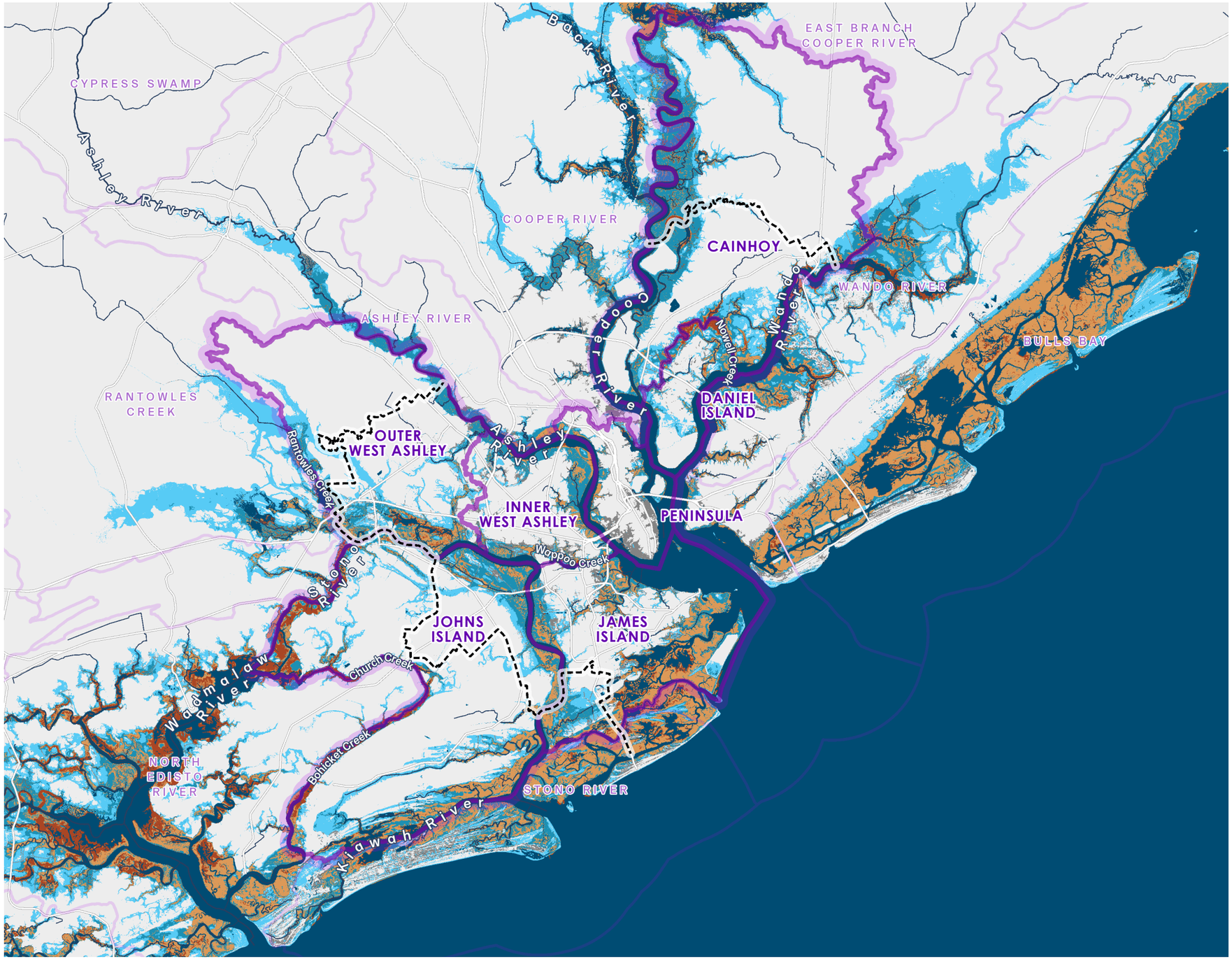
MARSH MIGRATION WITH 3 FT OF SEA LEVEL RISE

Risk of wetland loss is highest along the coast. Most of the space for marsh migration is in inland watershed areas like inner West Ashley and Cainhoy.

Data sources: USGS, MRLC

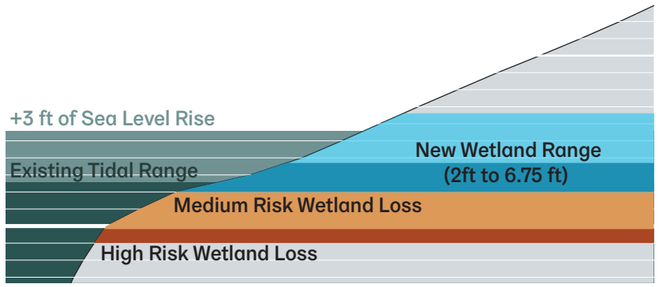
EXISTING WETLAND RANGE
≈ -1 TO 3.75 FT (NAVD)

WETLAND MIGRATION ZONE
≈ 2 TO 6.75 FT (NAVD)



Wetland Loss Risk | Existing Wetland Range | Wetland Migration Zone

Devloped land in the wetland migration zone



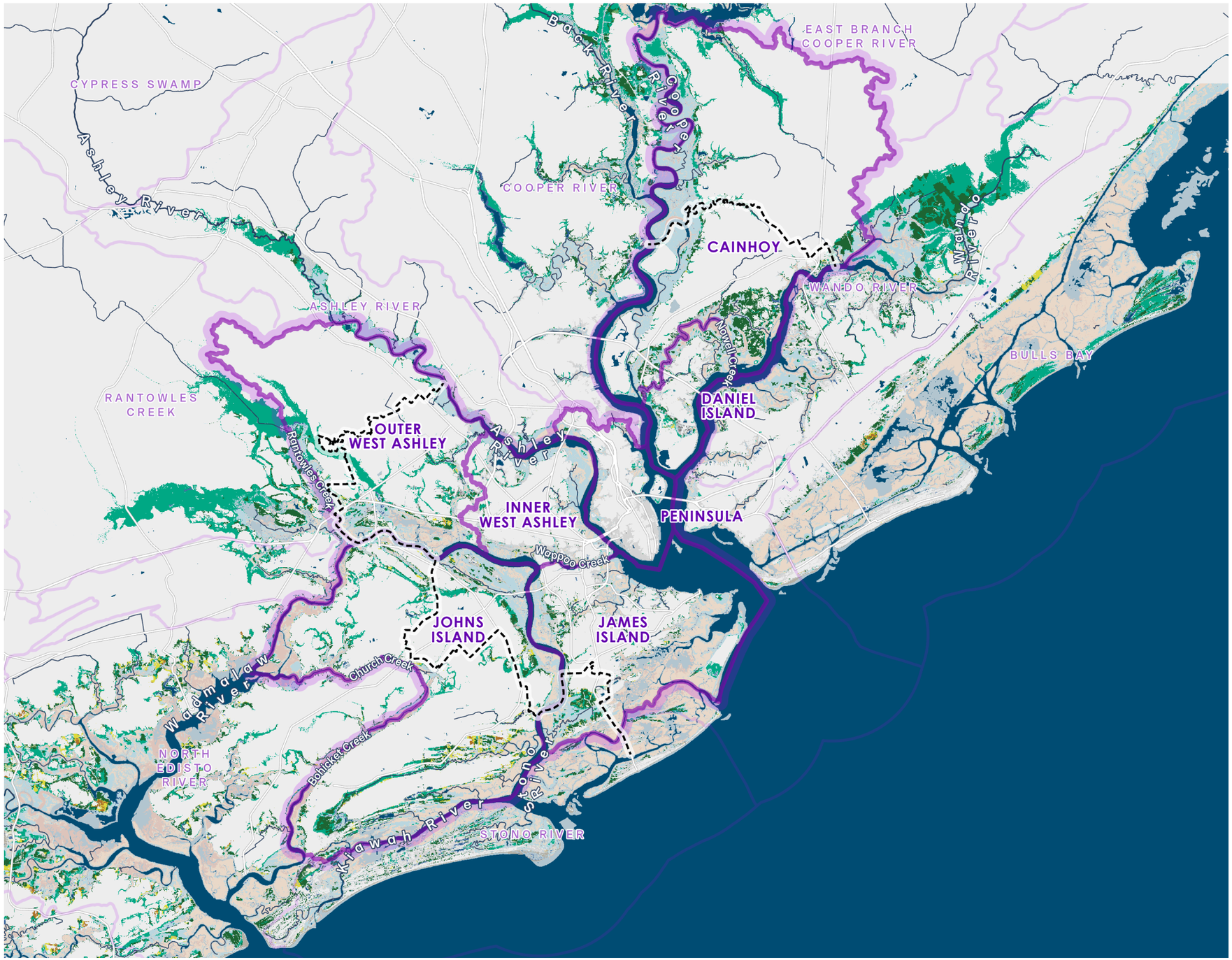
1 inch = 21,120 feet

Miles 1

LAND COVER IN THE MARSH MIGRATION ZONE

The low lying forested edges near existing herbaceous wetlands have the highest potential for marsh migration. Much of this land is already swampy.

map sources: USGS, MLRC Consortium



Legend

Land Cover in Wetland Migration Zone

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands

Wetland Migration

- High Risk Wetland Loss
- Medium Risk Wetland Loss
- Low Risk Wetland Loss
- Wetland Migration Zone
- Wetland Migration Zone - Developed

Watersheds Neighborhood

Urban Growth Boundary

Water Region

1 inch = 21,120 feet

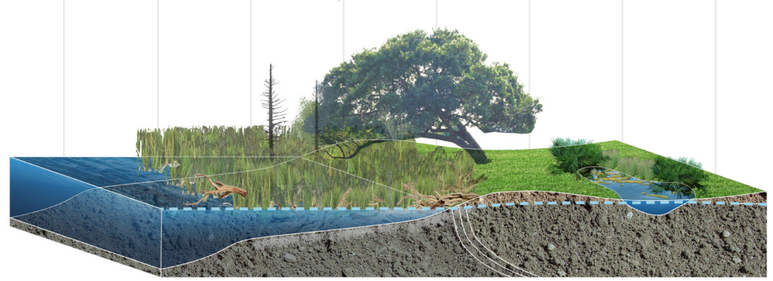
Miles 1

MARSH MIGRATION: WHAT TO EXPECT



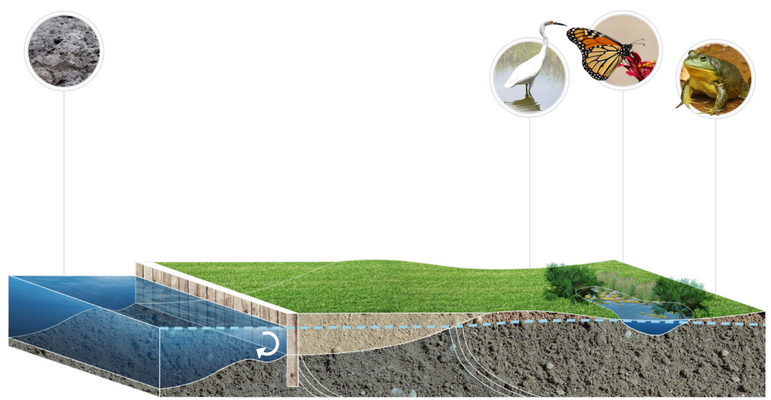
EXISTING MARSH

RESERVE STRATEGIES GIVE MARSHES ROOM TO MIGRATE



MARSH MIGRATION & GROUNDWATER SURFACING

DEFEND STRATEGIES CAN CUT MARSHES OFF FROM THE NEW WETLAND ZONE CREATED BY SEA LEVEL RISE



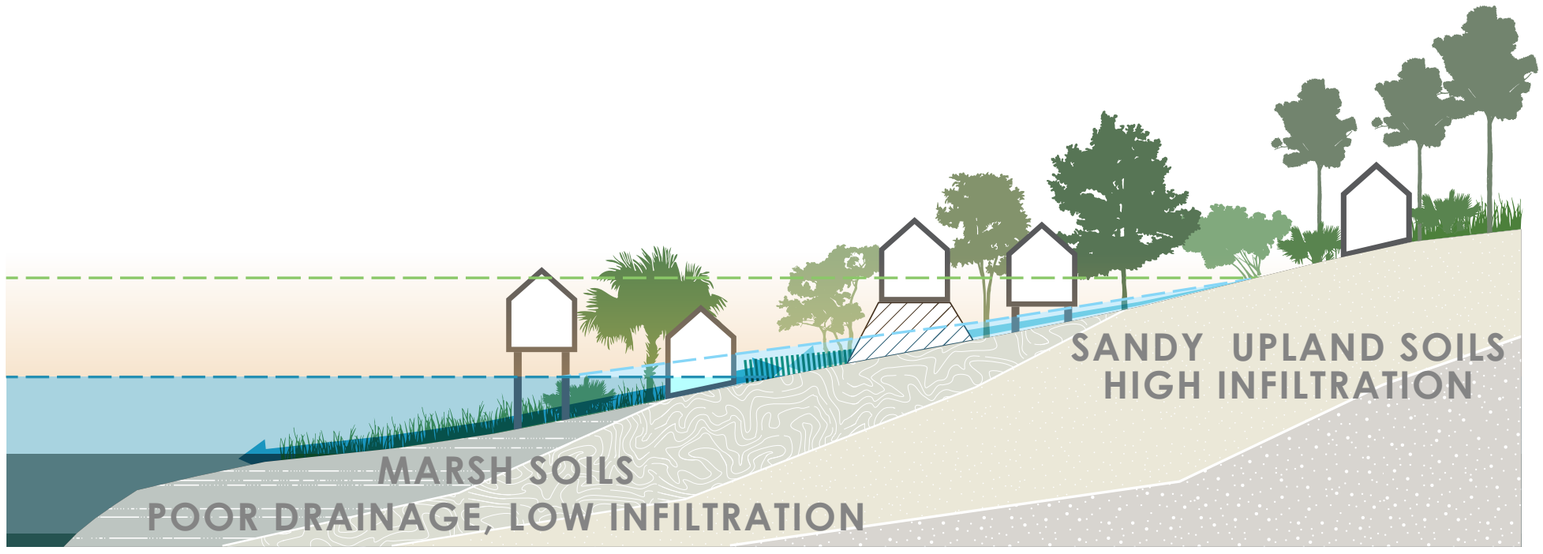
SEAWALL / MARSH EXTINCTION

ECOLOGY + SOIL

High Ground

Adapt Zone
Compound Flood Risk Zone
Tidal Flood Risk Zone

Mean High High Water



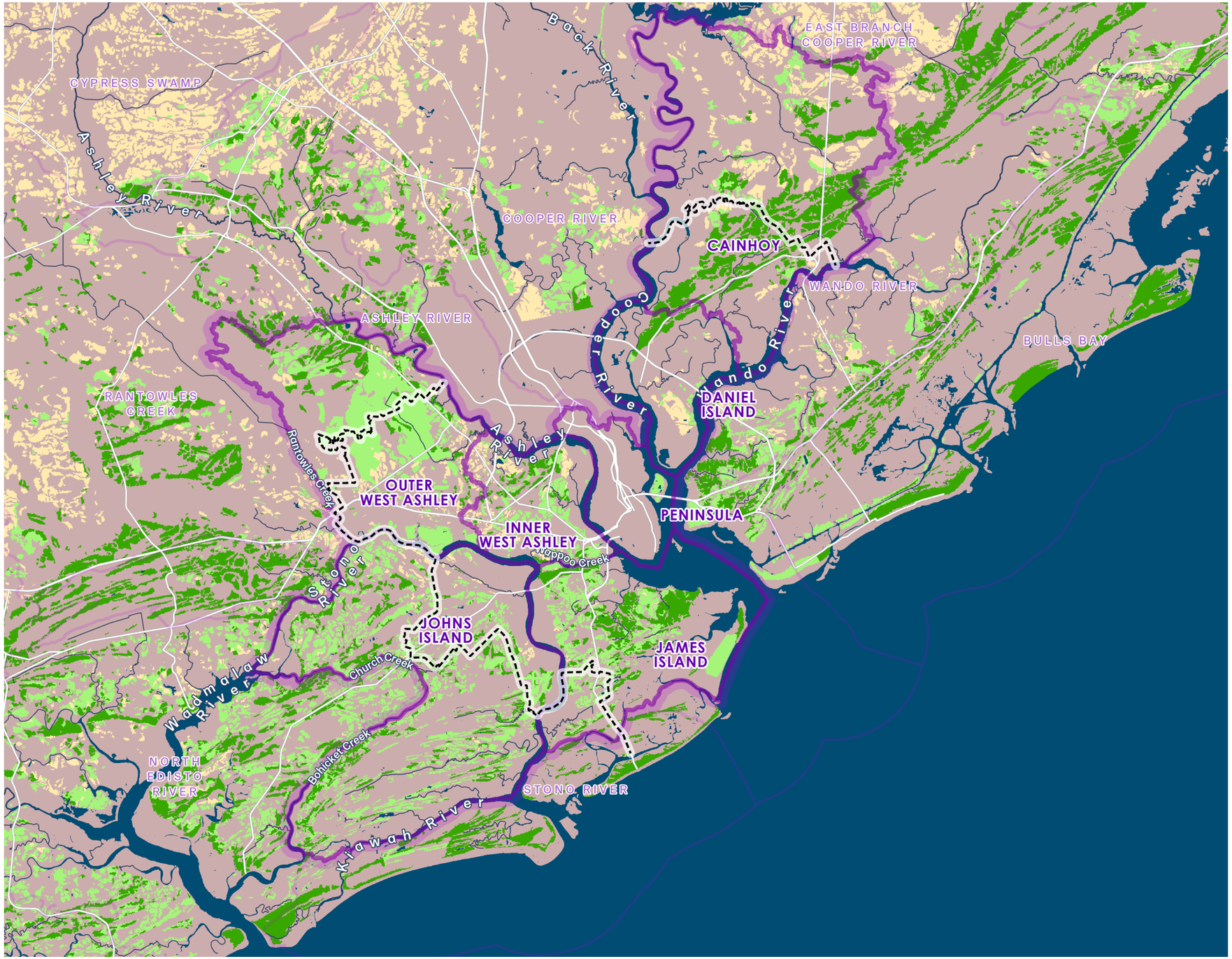
SOIL HYDROLOGIC GROUPS

Soil hydrologic groups define a soil's capacity to absorb water.

map sources: USDA

HYDROLOGIC GROUPS

- A: ABSORBS THE MOST WATER
- B: ABSORBS SOME WATER
- C: ABSORBS LITTLE WATER
- D: POORLY DRAINED AND/OR ABSORBS BASICALLY NO WATER



1 inch = 4 miles

Miles

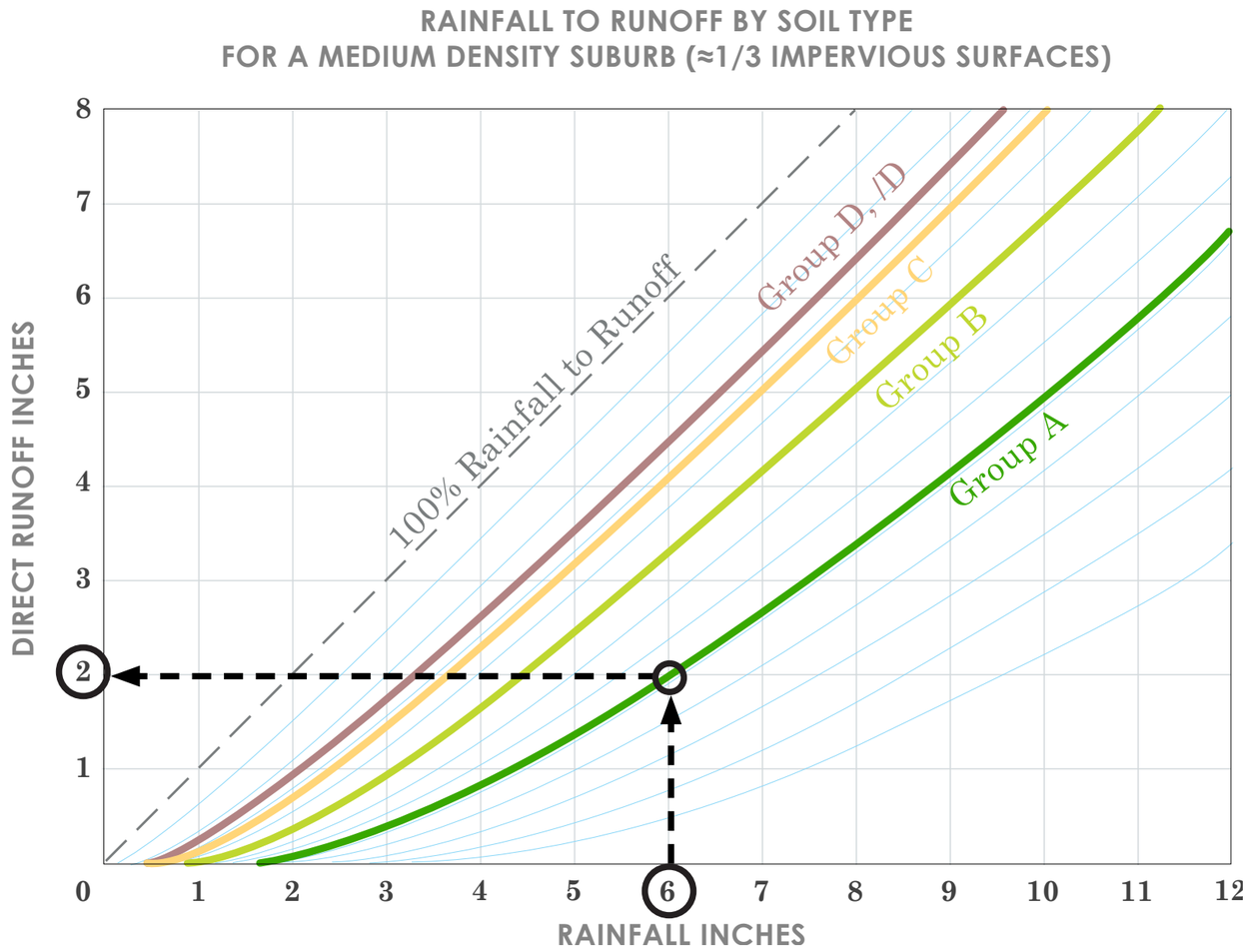
10

WATERSHEDS + SOIL TYPE

Effective soil infiltration can significantly reduce runoff volume.

map sources: USDA

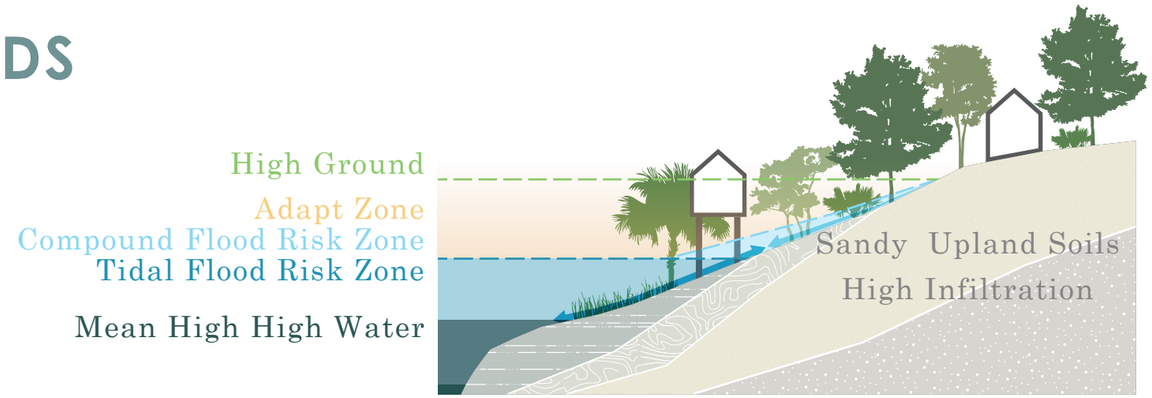
RUNOFF ESTIMATE BY SOIL AND LAND COVER TYPE



Hydrologic groups classify how well soils infiltrate and retain water. Hydrologic groups are matched with land cover characterizations to estimate runoff. For paved surfaces, around 98% of rain becomes runoff, while sandy or gravelly soils with little to no impervious surfaces have a much lower runoff ratios.

ELEVATION ZONES, WATERSHED & ENVIRONMENTAL SENSITIVITY

SMALL WATERSHEDS

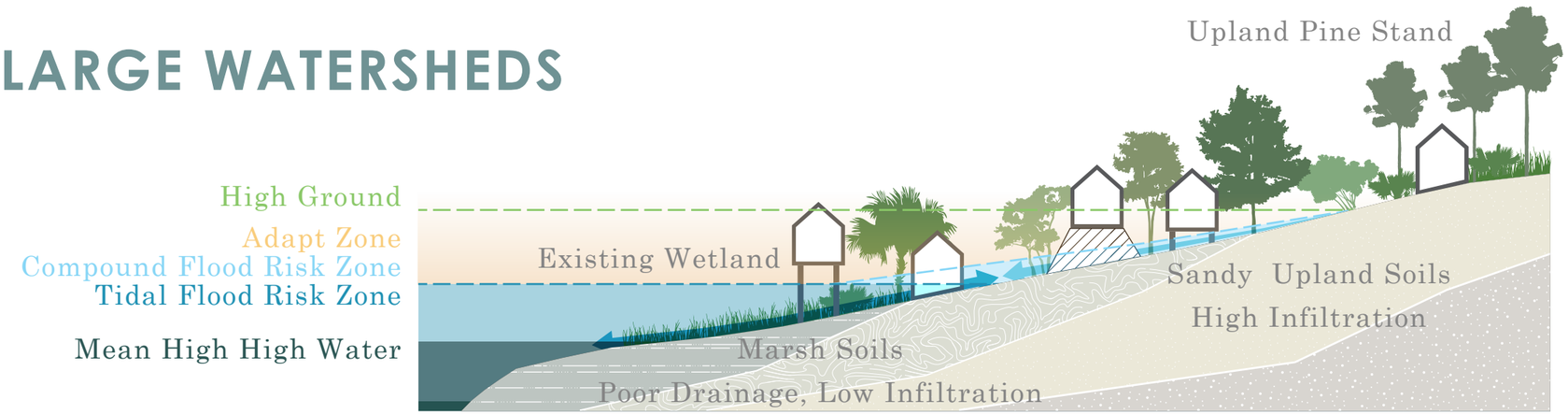


SMALL NUMBER OF VULNERABLE PARCELS

SMALL WATERSHED

Lower Potential for Runoff Accumulation

LARGE WATERSHEDS



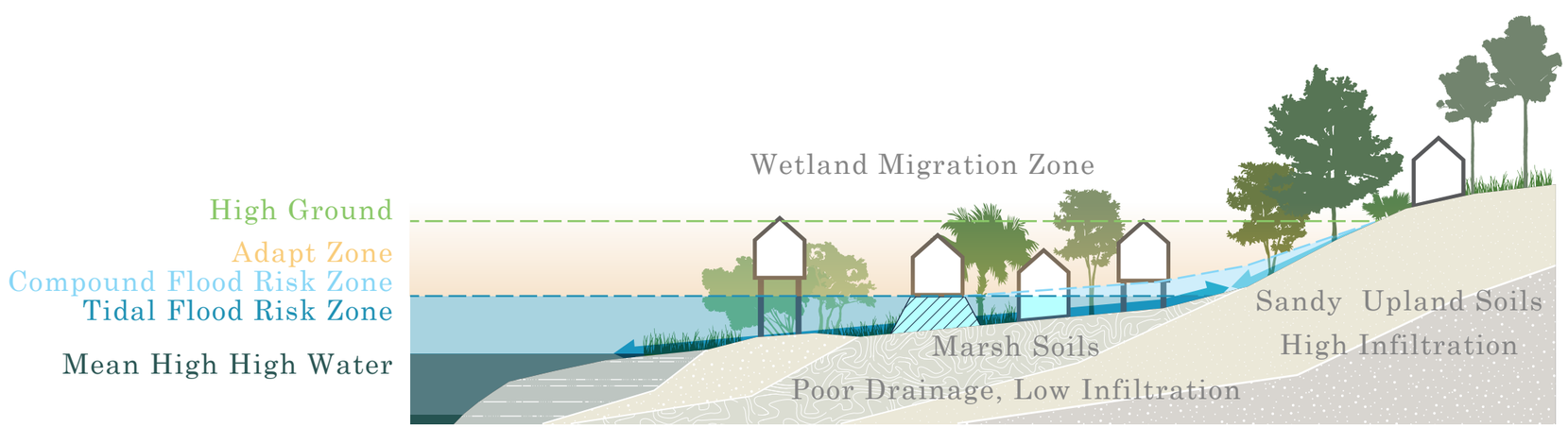
LARGE NUMBER OF VULNERABLE PARCELS

LARGE WATERSHED

Higher Potential for Runoff Accumulation

SMALL TIDAL EXTENT

Moderate Potential for Drainage Backup



LARGE NUMBER OF VULNERABLE PARCELS

LARGE WATERSHED

Higher Potential for Runoff Accumulation

LARGE TIDAL EXTENT

Higher Potential for Drainage Backup

LAND & WATER IMPLICATIONS

ELEVATION ZONES + WATERSHED SENSITIVITY

PLANNING STRATEGIES

WATER MANAGEMENT MEASURES

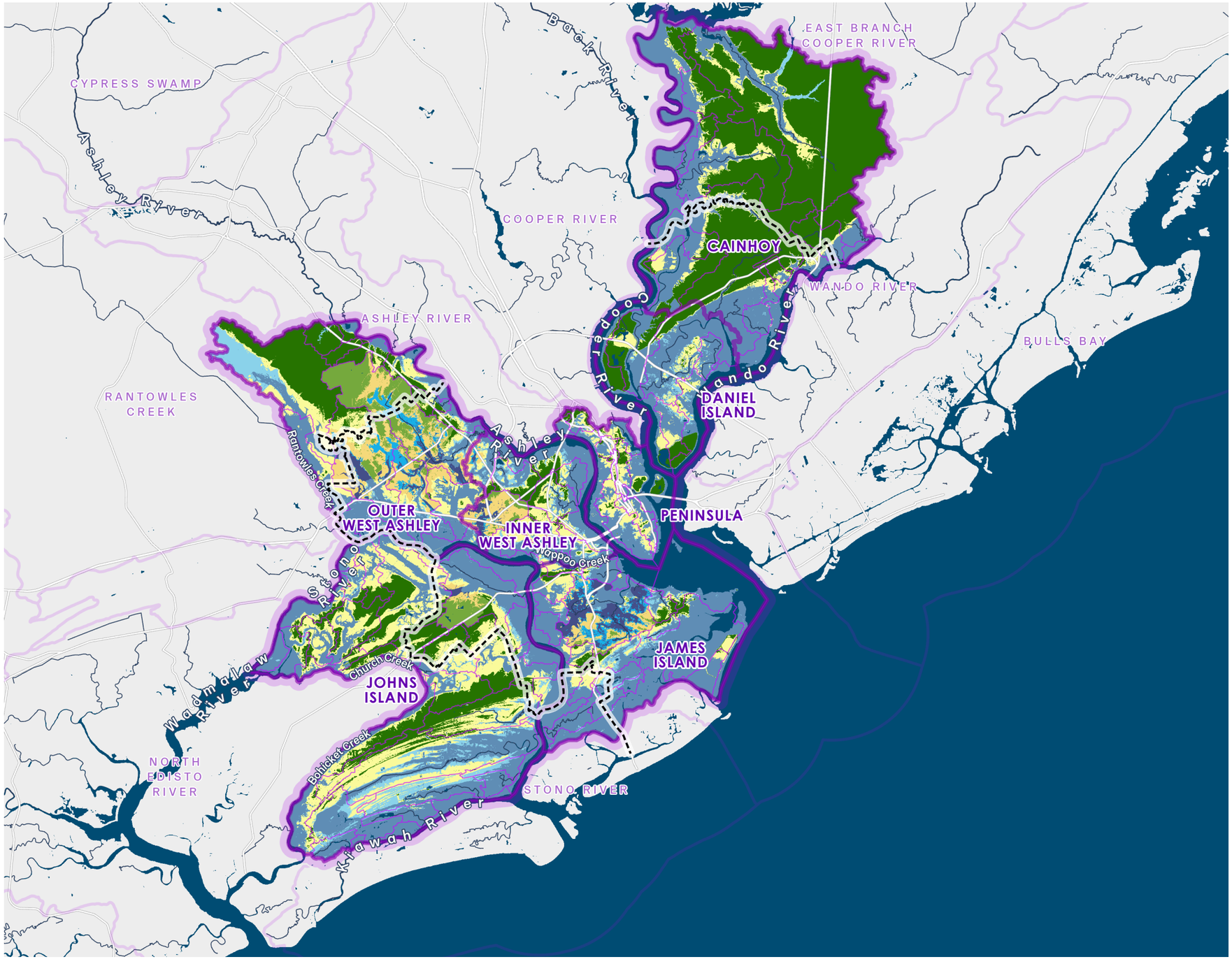
LAND & WATER IMPLICATIONS

HIGH GROUND, low sensitivity areas represent some of the safest ground in Charleston, however, high ground uses can have the most downstream impacts. Runoff on high ground has to travel through every lower zone before it exits a watershed, amplifying the consequences for water management.

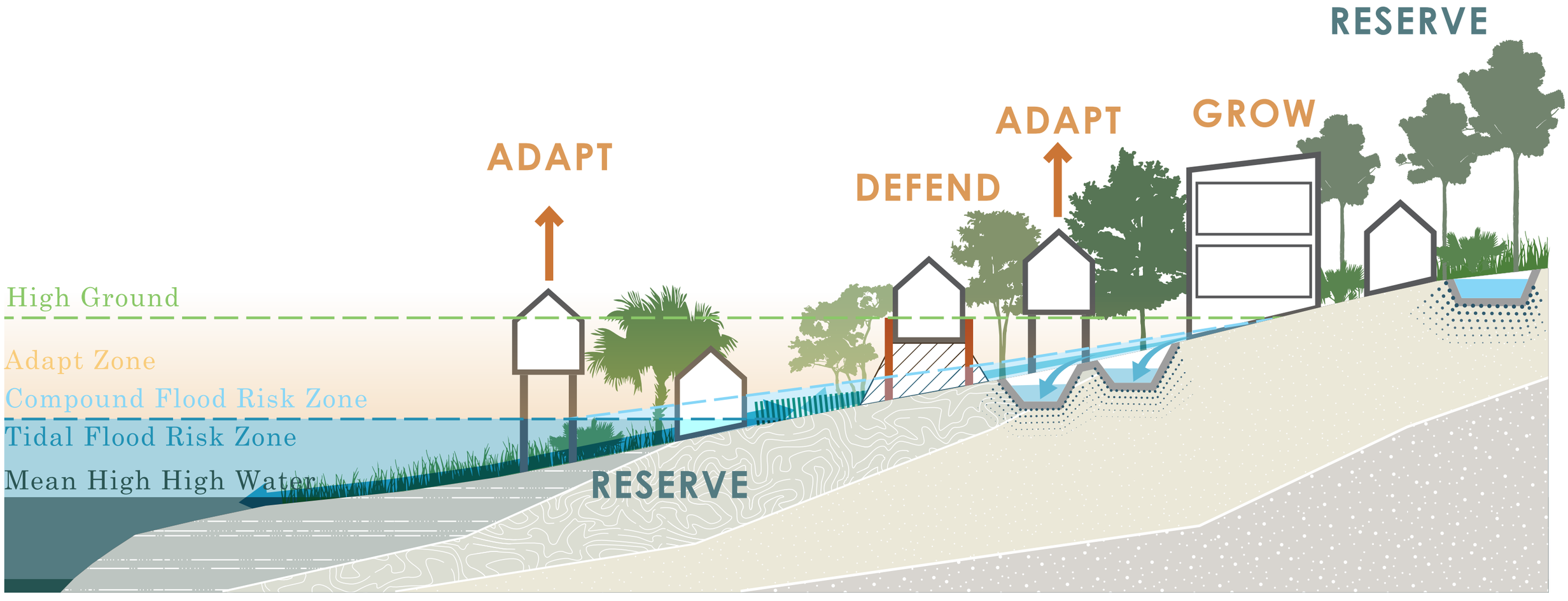
The **ADAPT ZONE** must anticipate change. Parts of the adapt zone already experience flooding and others could see flooding in the future. The adapt zone must manage both the runoff generated within the watershed as well as runoff inherited from high ground zones.

COMPOUND FLOOD RISK areas represent some of the most sensitive flooding conditions in Charleston. Displacing floodwater or increasing runoff in these areas has a substantial and immediate impact both locally and downstream.

Flood risk in the **TIDAL FLOOD RISK ZONE** is pervasive and the hardest to mitigate. In high sensitivity watersheds, this risk is amplified by number of vulnerable parcels, high runoff, and slow drainage. This zone is impacted by the cumulative watershed conditions upstream and therefore must also inform decisions made upstream.



PLANNING STRATEGIES



PLANNING STRATEGIES

GROW

Responsibly increase development and population density. Growth makes the most sense in areas with low sensitivity and low risk. Growth must occur in tandem with water management.

DEFEND

Protect buildings and infrastructure with engineered measures such as berms, flood walls and pumps. Defensive measures should be reserved for areas with the highest risk and lowest sensitivity (e.g. where the displacement of floodwater will not exacerbate risk elsewhere.)

ADAPT

Retrofit vulnerable existing infrastructure to be resilient to water risks. Raising structures reduces risk with limited to no increase in watershed sensitivity. However, adaptive capacity is limited by building typology.

RESERVE

Restore and preserve natural ecosystems. Reserve is applicable to all zones and should factor future change. Ecosystems providing stormwater benefits and essential wildlife habitats exist throughout Charleston and should be preserved.

	Tidal Flood Risk Zone		Compound Flood Risk		Adapt Zone		High Ground	
	High Sensitivity	Normal Sensitivity	High Sensitivity	Normal Sensitivity	High Sensitivity	Normal Sensitivity	High Sensitivity	Normal Sensitivity
GROW					◒	◒	◒	●
DEFEND	◒	●		◒				
ADAPT	◒	◒	◒	◒	◒	◒		
RESERVE	●	●	●	◒	●	◒	◒	◒

WATER MANAGEMENT MEASURE MATRIX

WATER MANAGEMENT MEASURE	DESCRIPTION	APPROPRIATENESS FOR IMPLEMENTATION IN ELEVATION RISK ZONES High Ground · Adapt Zone · Compound Flood Risk · Tidal Flood Risk	WMM ANCILLARY BENEFITS ● Yes ◒ Partially ○ No	
			AMENITY VALUE	HABITAT VALUE
Preservation	Practice of protecting a natural area from development		●	●
Reforestation	Practice of planting trees and associated plant communities		●	●
Salt Marsh Restoration	Altering a former/degraded salt marsh's physical, chemical, or biological characteristics to regain natural function		●	●
Living Shoreline	A structure composed of natural materials to stabilize shorelines and prevent erosion and enhance habitat		●	●
Wetland Restoration	Altering a former/degraded wetland's physical, chemical, or biological characteristics to regain natural function		◒	●
Stormwater Wetland	Constructed wetland; Shallow vegetated depressions that receive stormwater inputs for water quality treatment		◒	●
Channel Naturalization	Practice of redesigning a waterway's course and re-grading and stabilizing its banks to regain natural functions		◒	●
Bioretention	Shallow depressional areas filled with an engineered soil media and planted with woody and herbaceous plants		●	◒
Open Channel System	Channels and swales that capture and treat the water quality design storm and safely convey larger storm events		●	◒
Green roof	Rooftop practices that capture and store rainfall in an engineered growing media that supports plant growth		●	◒
Wet Detention Pond	Stormwater storage practices that consist of a permanent pool with a littoral shelf		●	◒
Rainwater Harvesting	Systems that store rainfall for future use		●	○
Infiltration Basin	Shallow excavations designed to intercept and infiltrate post-construction stormwater runoff		○	○
Permeable Paving	Alternative paving surfaces that allow stormwater infiltration or storage by filtering runoff through surface voids		○	○
Dry Detention Practices	Underground vaults and tanks that detain stormwater and provide an alternative for space-limited areas		○	○
Tide Gates	Mechanical gates that close to prevent high tides from reaching lowland areas		○	○
Storm Sewer	Gray infrastructure that drains stormwater from impervious surfaces to waterways or treatment facilities		○	○
Flood Barrier	Gray infrastructure that prevents high tides or storm surge from reaching certain areas, up to a certain level		○	○

HIGH GROUND ZONE

The goal in the High Ground Zone is to maintain or increase existing percent of permeable surface cover and maintain or reduce net volume of stormwater runoff.

LANDSCAPE TYPOLOGIES

This zone contains two landscape typologies, Upland Ridges and Urban/Suburban Reforestation. Upland Ridges can tolerate periodic freshwater inundation if well-draining soils are present (Hydrologic Groups A-B). The pine forests and mixed hardwood forests of this typology have a high infiltrative capacity, and uptake rainwater through root systems and transpire it back into the atmosphere. Existing areas of this typology are important to preserve. Urban/Suburban Reforestation areas also play an important role in infiltration, absorption, and transpiration of rainwater. These areas require native species tolerant of poor nutrient soil, root constriction, and other urban / suburban conditions.



Upland Ridge



Urban/ suburban Reforestation

WATER MANAGEMENT MEASURES RECOMMENDATIONS

All of the WMM's listed below can be implemented in the High Ground Zone. However, some are higher priority than others due to their effectiveness and ancillary benefits (see Water Management Measure fact sheets for details). The Defend planning strategy is not appropriate in this zone.

WATER MANAGEMENT MEASURE	PRIORITY FOR IMPLEMENTATION IN ZONE? ● Yes ◒ Partially ○ No	PLANNING STRATEGY CATEGORY			
		Reserve	Defend	Adapt	Grow
Preservation	●	•			
Reforestation	●	•		•	•
Stormwater Wetland	●			•	•
Bioretention	●			•	•
Open Channel System	●			•	•
Green Roof	●			•	•
Wet Detention Pond	◒			•	•
Rainwater Harvesting	◒			•	•
Infiltration Basin	◒			•	•
Permeable Paving	◒			•	•
Underground Detention	○				•
Storm Sewer	○				•

ADAPT ZONE

The goal in the Adapt Zone is to manage both the runoff generated within the watershed as well as the runoff shed from the High Ground Zone and protect against large storm surge events.

LANDSCAPE TYPOLOGIES

This zone contains two landscape typologies, Upland Ridges and Urban/Suburban Reforestation. Upland Ridges can tolerate periodic freshwater inundation if well-draining soils are present (Hydrologic Groups A-B). The pine forests and mixed hardwood forests of this typology have a high infiltrative capacity, and uptake rainwater through root systems and transpire it back into the atmosphere. Existing areas of this typology are important to preserve. Urban/Suburban Reforestation areas also play an important role in infiltration, absorption, and transpiration of rainwater. These areas require native species tolerant of poor nutrient soil, root constriction, and other urban / suburban conditions.



Upland Ridge



Urban/ suburban Reforestation

WATER MANAGEMENT MEASURES RECOMMENDATIONS

All of the WMM's listed below can be implemented in the Adapt Zone. However, some are higher priority than others due to their effectiveness and ancillary benefits (see Water Management Measure fact sheets for details). The Defend planning strategy is not appropriate in this zone.

WATER MANAGEMENT MEASURE	PRIORITY FOR IMPLEMENTATION IN ZONE? (● Yes ◒ Partially ○ No)	PLANNING STRATEGY CATEGORY			
		Reserve	Defend	Adapt	Grow
Preservation	●	•			
Reforestation	●	•		•	•
Wetland Restoration	●	•		•	•
Stormwater Wetland	●			•	•
Bioretention	●			•	•
Open Channel System	●			•	•
Green Roof	●			•	•
Wet Detention Pond	◒			•	•
Rainwater Harvesting	◒			•	•
Infiltration Basin	◒			•	•
Permeable Paving	◒			•	•
Underground Detention	○				•
Storm Sewer	○				•

COMPOUND FLOOD RISK ZONE

The goal in the Compound Flood Risk Zone is to limit growth, maintain or reduce net volume of stormwater runoff, and adapt vulnerable infrastructure wherever possible.

LANDSCAPE TYPOLOGIES

This zone contains two landscape typologies, Lowland Floodplain and Urban/Suburban Reforestation. Lowland Floodplains can tolerate periodic freshwater and/or brackish inundation. Plants in this typology play an important role in absorbing and transpiring water and have a high tolerance of poorly drained soils due to soils composition or high water table (Hydrologic Groups C-D). Existing areas of this typology are important to preserve. Urban/Suburban Reforestation areas are also an opportunity for infiltration, absorption, and transpiration of rainwater. This typology requires native species tolerant of poor nutrient soil, root constriction, and other urban / suburban conditions.



Lowland Floodplain



Urban/ suburban Reforestation

WATER MANAGEMENT MEASURES RECOMMENDATIONS

All of the WMM's listed below can be implemented in the Compound Flood Risk Zone. However, some are higher priority than others due to their effectiveness and ancillary benefits (see Water Management Measure fact sheets for details). The Grow planning strategy is not appropriate in this zone.

WATER MANAGEMENT MEASURE	PRIORITY FOR IMPLEMENTATION IN ZONE? ● Yes ◒ Partially ○ No	PLANNING STRATEGY CATEGORY			
		Reserve	Defend	Adapt	Grow
Preservation	●	•			
Reforestation	●	•		•	
Wetland Restoration	●	•		•	
Stormwater Wetland	●			•	
Open Channel System	●			•	
Green Roof	●			•	
Rainwater Harvesting	◒			•	
Permeable Paving	◒			•	
Tide Gates	◒		•		
Flood Barrier	◒		•		
Storm Sewer	○				

TIDAL ZONE

The goal in the Tidal Zone is to limit growth, restore marsh and wetland function, and allow for marsh migration where appropriate.

LANDSCAPE TYPOLOGIES

This zone contains one landscape typology, Coastal Edge Community. The Coastal Edge Community can tolerate salt air and occasional inundation from major storms. It is the most durable for likely marsh migration.



Coastal Edge Community

WATER MANAGEMENT MEASURES RECOMMENDATIONS

All of the WMM's listed below can be implemented in the Tidal Zone. However, some are higher priority than others due to their effectiveness and ancillary benefits (see Water Management Measure fact sheets for details). The Grow planning strategy is not appropriate in this zone.

WATER MANAGEMENT MEASURE	PRIORITY FOR IMPLEMENTATION IN ZONE? ● Yes ◒ Partially ○ No	PLANNING STRATEGY CATEGORY			
		Reserve	Defend	Adapt	Grow
Preservation	●	•			
Reforestation	●	•		•	
Salt Marsh Restoration	●	•		•	
Living Shoreline	●	•	•	•	
Wetland Restoration	●	•		•	
Stormwater Wetland	●			•	
Channel Naturalization	●			•	
Green Roof	●			•	
Rainwater Harvesting	◒			•	
Tide Gates	◒		•		
Flood Barrier	◒		•		

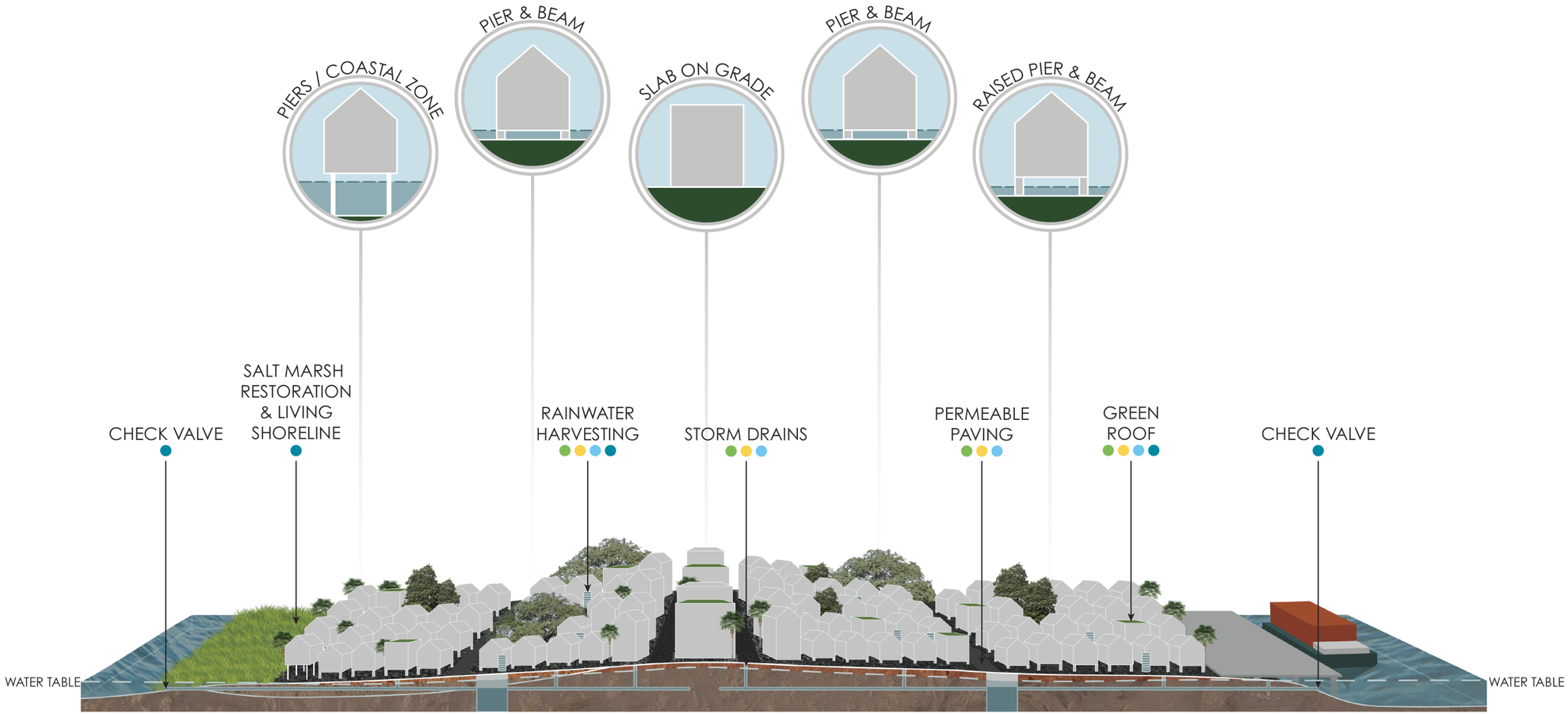
PENINSULA

WATER

LAND

RISK ZONES

RECOMMENDATIONS



PENINSULA TRANSECT

ASHLEY R.	MARSH	WETLAND INFILL	GROUP D SOIL	COOPER RIVER
TIDAL FLOOD RISK	COMPOUND FLOOD RISK	ADAPT ZONE	COMPOUND FLOOD RISK	TIDAL FLOOD RISK

SURCULUS

WATER

WATERSHEDS

WATERSHED TYPES

WATERSHED VULNERABILITY

100 YEAR FLOODPLAIN

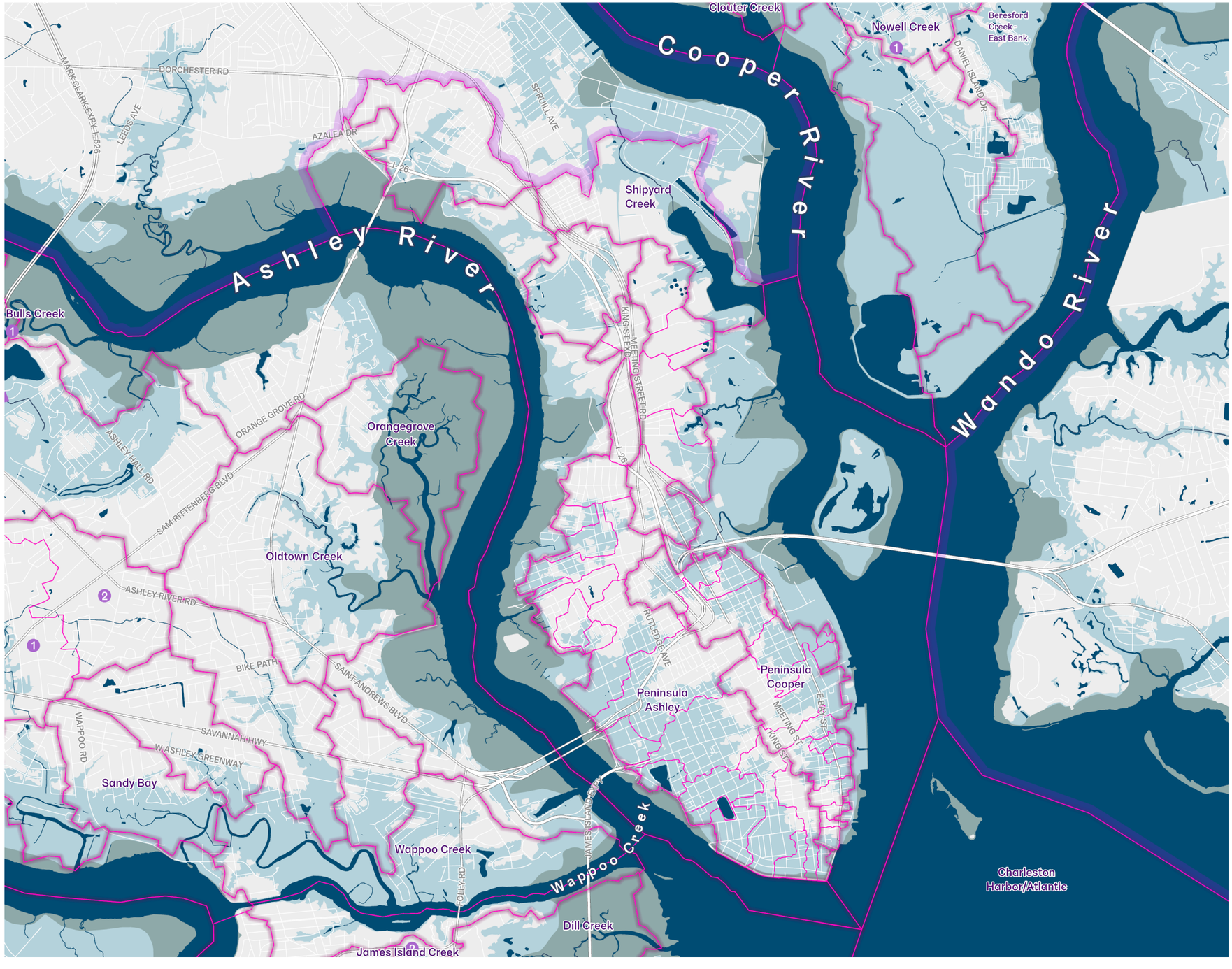
STORM SURGE

SEA LEVEL RISE

MARSH MIGRATION

WATERSHEDS

The Peninsula has around 50 small urban watersheds which flow either into the Ashley or the Cooper river. The watersheds flowing into the Cooper are typically smaller, while the Ashley watersheds are larger and lower.



Legend

DFIRM

- 100 Year Floodplain
- VE Zone

Project Watersheds

Project Subwatersheds

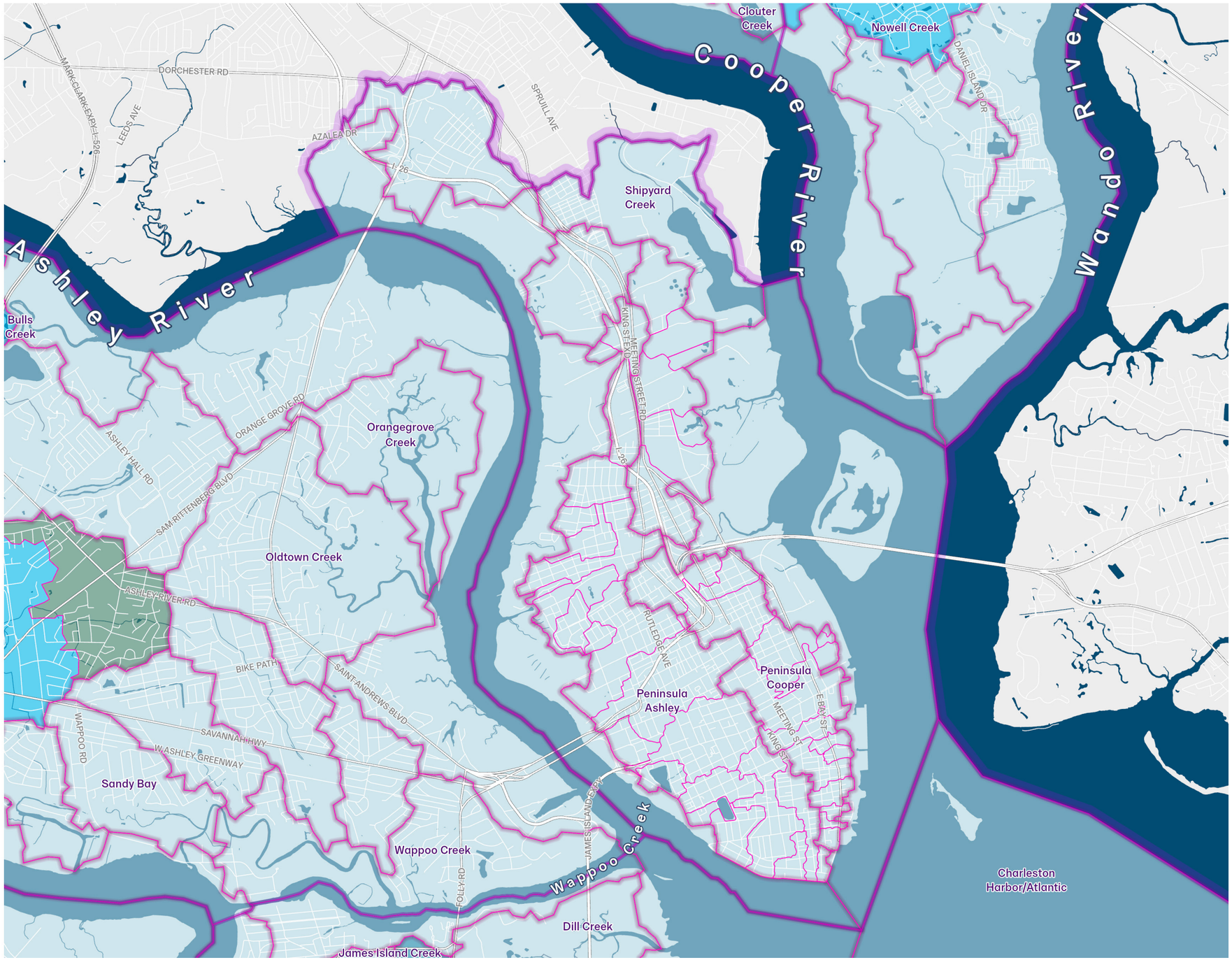
- Subwatershed Order (1 being closest to the outlet)
- Watershed Interconnectivity Point

1 inch = 4,000 feet

Miles 1

WATERSHED TYPES

All of the watersheds in the Peninsula experience some tidal influence.



Legend

Subwatershed Type

- Small, Tidal
- Large, Outlet Tidal
- Large, Upstream Tidal
- Large, Upstream Inland

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

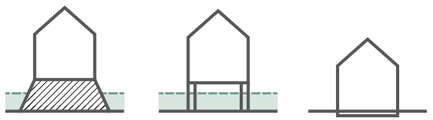
Water

- Water

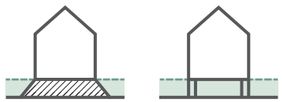
1 inch = 4,000 feet

Miles 1

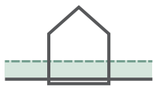
STRUCTURE VULNERABILITY
USING THE 2020 RISK AND VULNERABILITY ASSESSMENT DEFINITIONS



Low Combined Vulnerability & Risk
Outside the 100 year floodplain
Built after BFE+1 requirements



Medium Combined Vulnerability & Risk
In the 100 year floodplain
Built after BFE requirements or raised to BFE



High Combined Vulnerability & Risk
In the 100 year floodplain
Built before BFE requirements

*All heights relative to BFE need verification

100 Year Floodplain and BFE
- No BFE
- BFE

Watersheds Neighborhood

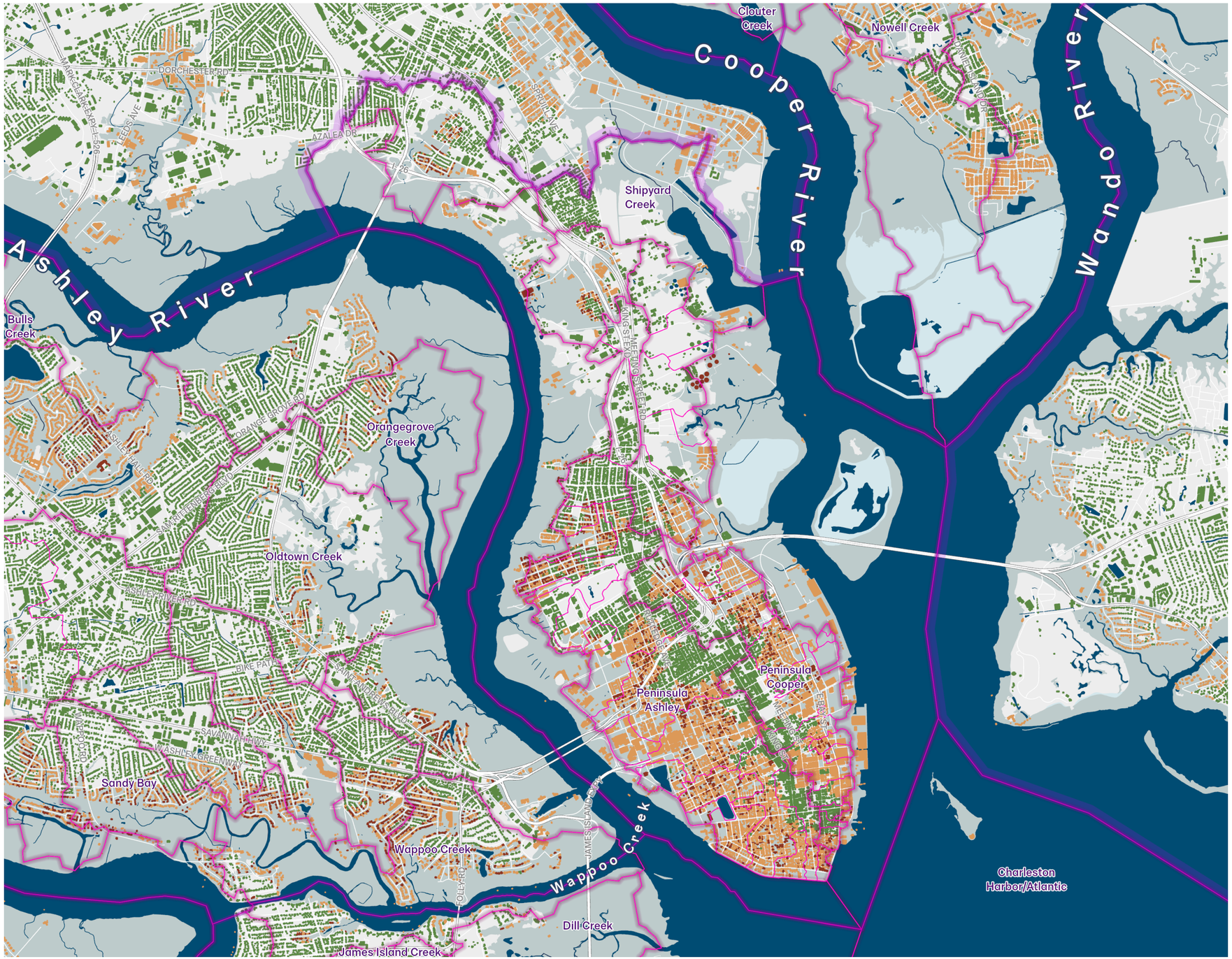
Project Watersheds

Project Subwatersheds

Urban Growth Boundary

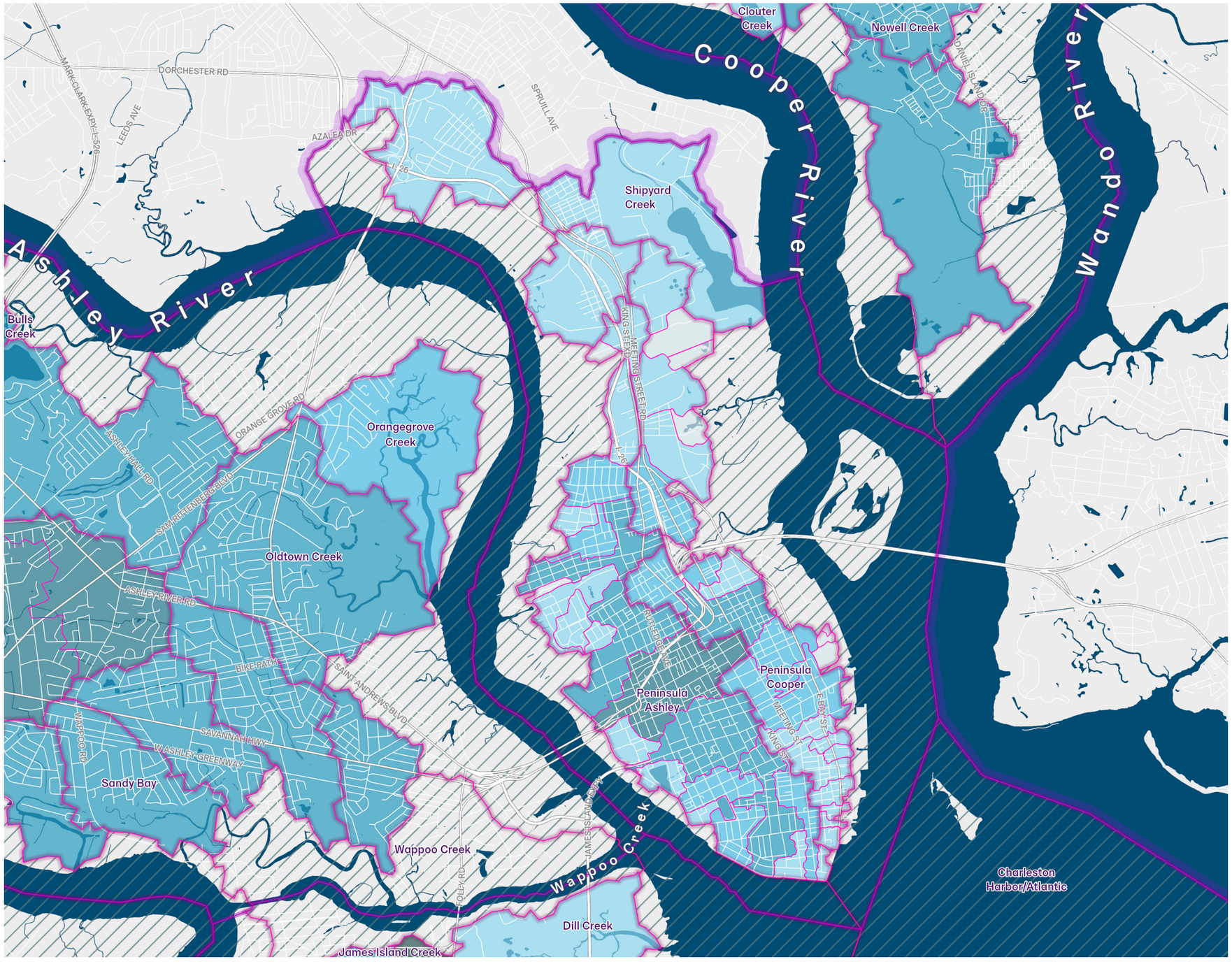
Water
- Water

1 inch = 4,000 feet
Miles
1



NUMBER OF VULNERABLE PARCELS

Vulnerable parcels are spread fairly evenly across the Peninsula. Larger watershed tend to have the most vulnerable parcels.



Legend

Vulnerable Parcels Local & Downstream

- ≤10
- ≤250
- ≤500
- ≤1000
- ≤1500
- >1500
- <excluded>

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

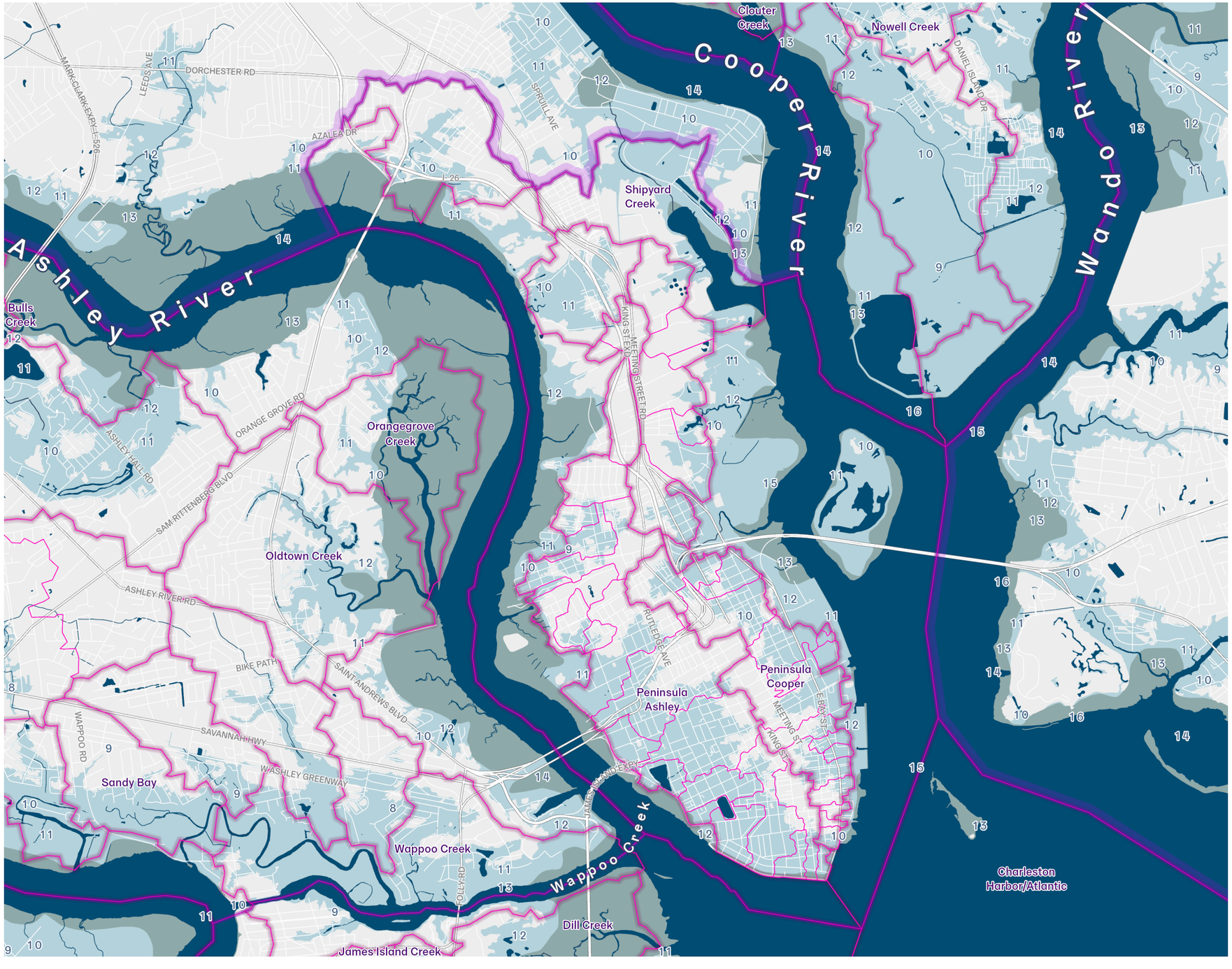
1 inch = 4,000 feet

Miles 1

100 YEAR FLOODPLAIN

Most of the Peninsula is in the 100 year floodplain with VE zones along the edges. Base flood elevation is slightly higher on the Cooper side.

map sources: FEMA



Legend

DFIRM (**Blue #'s** are BFE in NAVD)

- 100 Year Floodplain
- VE Zone

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

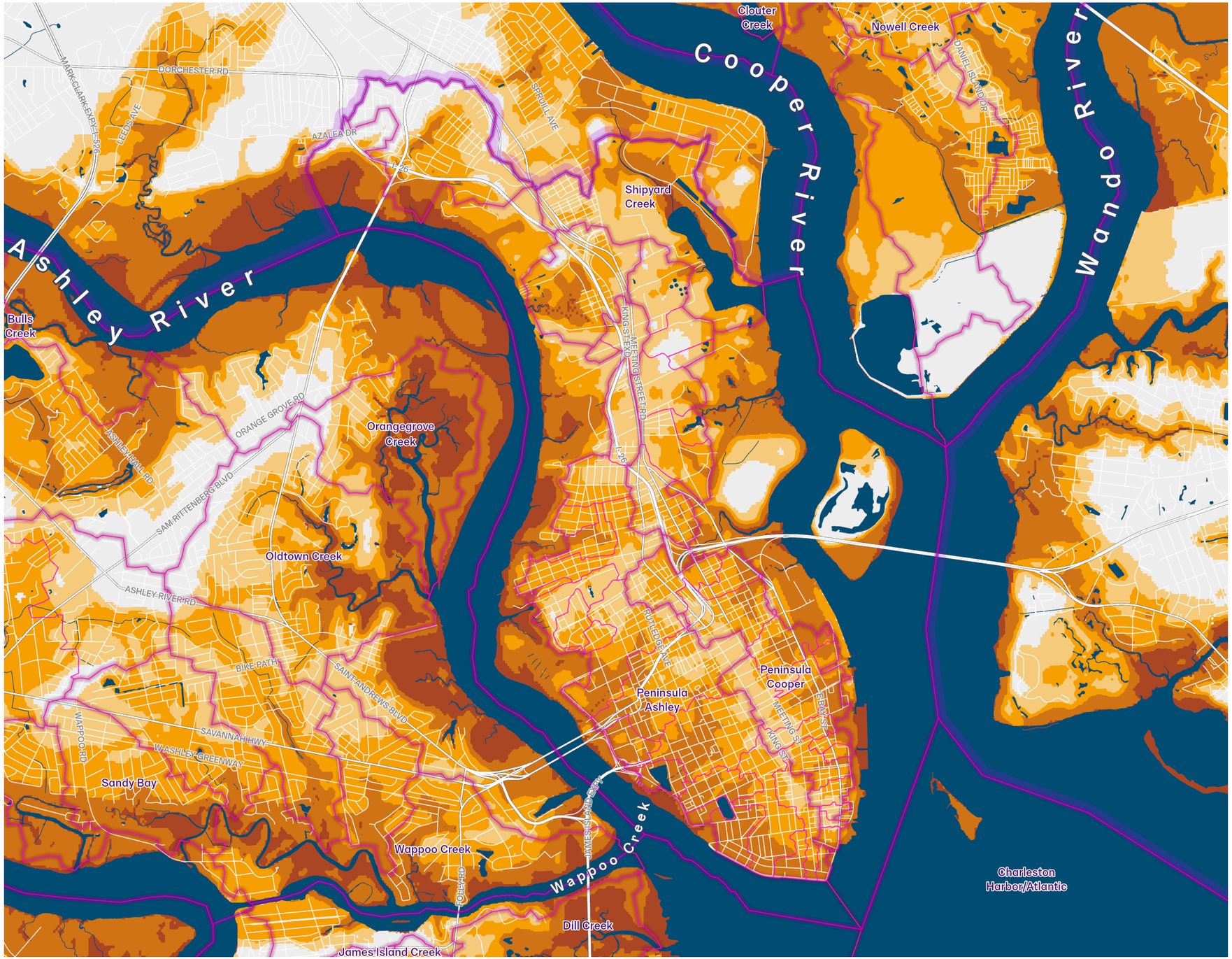
1 inch = 4,000 feet

Miles 1

MAXIMUM CATEGORY 3 STORM SURGE

Virtually all of the Peninsula is within the NOAA max category 3 storm surge, with the exception of Laurel Island.

map sources: NOAA



Legend

Cat 3 Max Storm Surge (Above Ground)

- <5 ft
- 5-10 ft
- 10-15 ft
- >15 ft

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

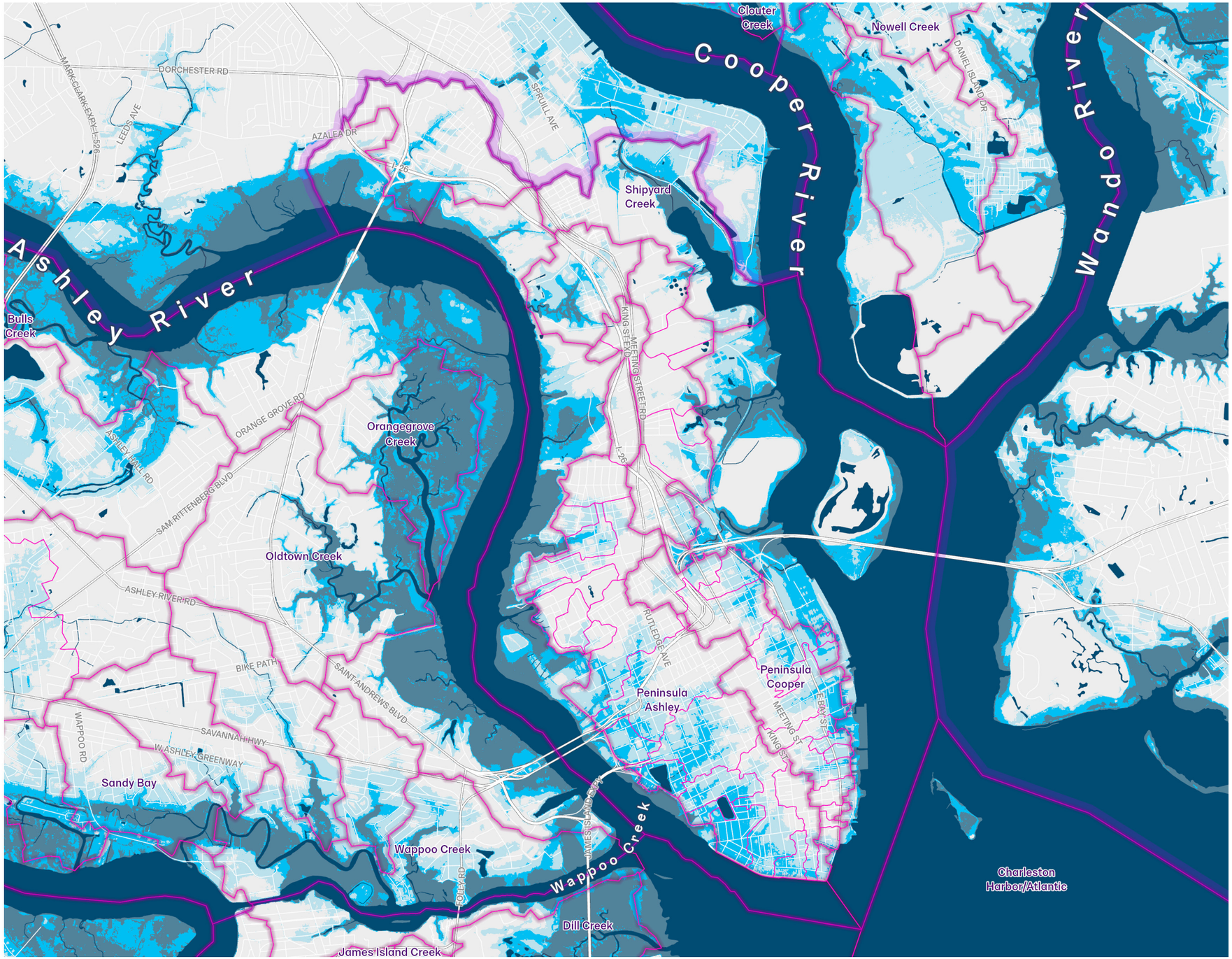
1 inch = 4,000 feet

Miles 1

TIDES AND SEA LEVEL RISE

Large portions of Peninsula are at risk of regular tidal inundation with 3 feet of sea level rise. Most of those areas are former tidal creeks.

map sources: USGS



Legend

Tides and Sea Level Rise

- Current MHHW
- MHHW +3ft of Sea Level Rise
- Highest Recorded Water Level (Hugo)

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

1 inch = 4,000 feet

Miles 1

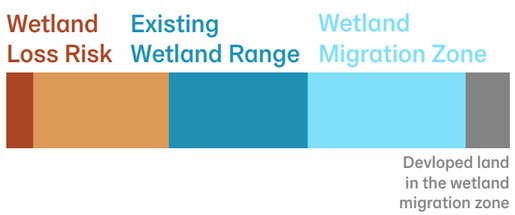
MARSH MIGRATION WITH 3 FT OF SEA LEVEL RISE

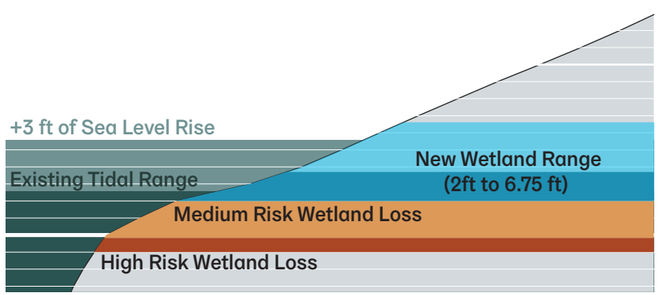
Most of the wetlands along the edge of the Peninsula are at risk of loss with 3 ft of sea level rise.

map sources: USGS, MLRC Consortium

EXISTING WETLAND RANGE
≈ -1 TO 3.75 FT (NAVD)

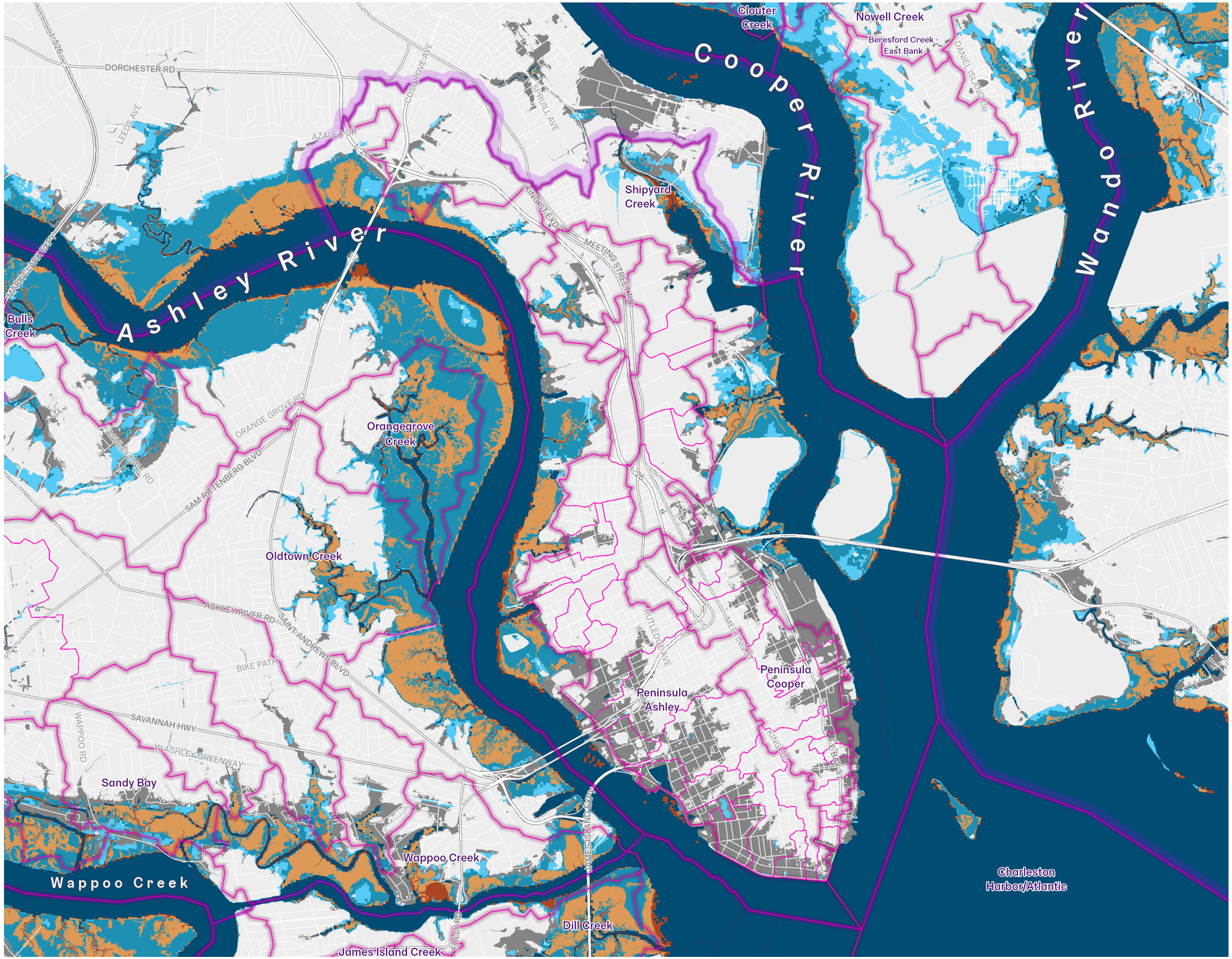
WETLAND MIGRATION ZONE
≈ 2 TO 6.75 FT (NAVD)





1 inch = 4,000 feet

Miles 1



LAND COVER IN THE MARSH MIGRATION ZONE

Considering the level of development on the Peninsula, there is little room for marsh migration.

map sources: USGS, MLRC Consortium

Legend

Land Cover in Wetland Migration Zone

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands

Wetland Migration

- High Risk Wetland Loss
- Medium Risk Wetland Loss
- Low Risk Wetland Loss
- Wetland Migration Zone
- Wetland Migration Zone - Developed

Watersheds Neighborhood

Project Watersheds

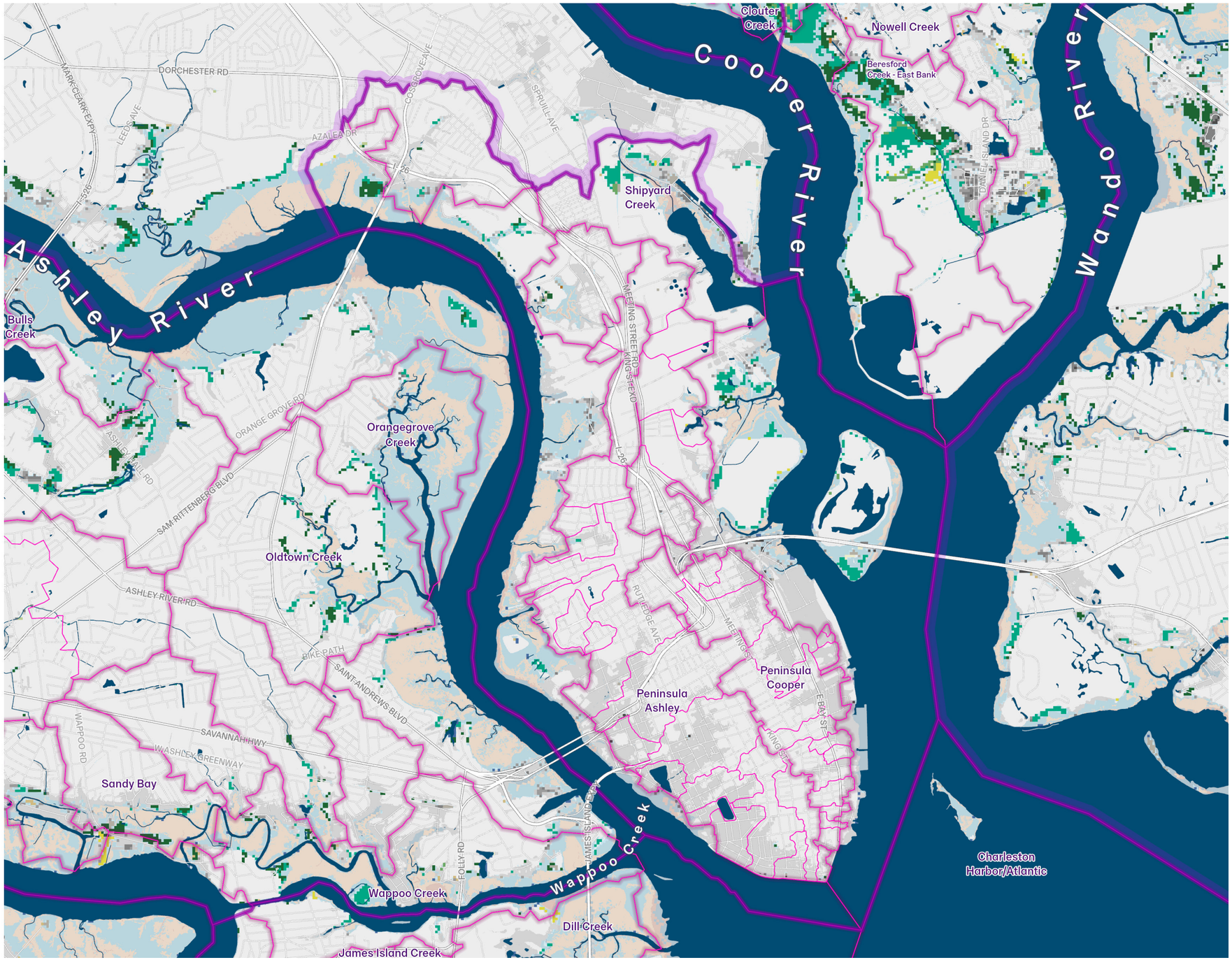
Project Subwatersheds

Urban Growth Boundary

Water

1 inch = 4,000 feet

Miles 1



LAND

ELEVATION

LAND COVER

ELEVATION & LAND COVER DISTRIBUTION

SOIL

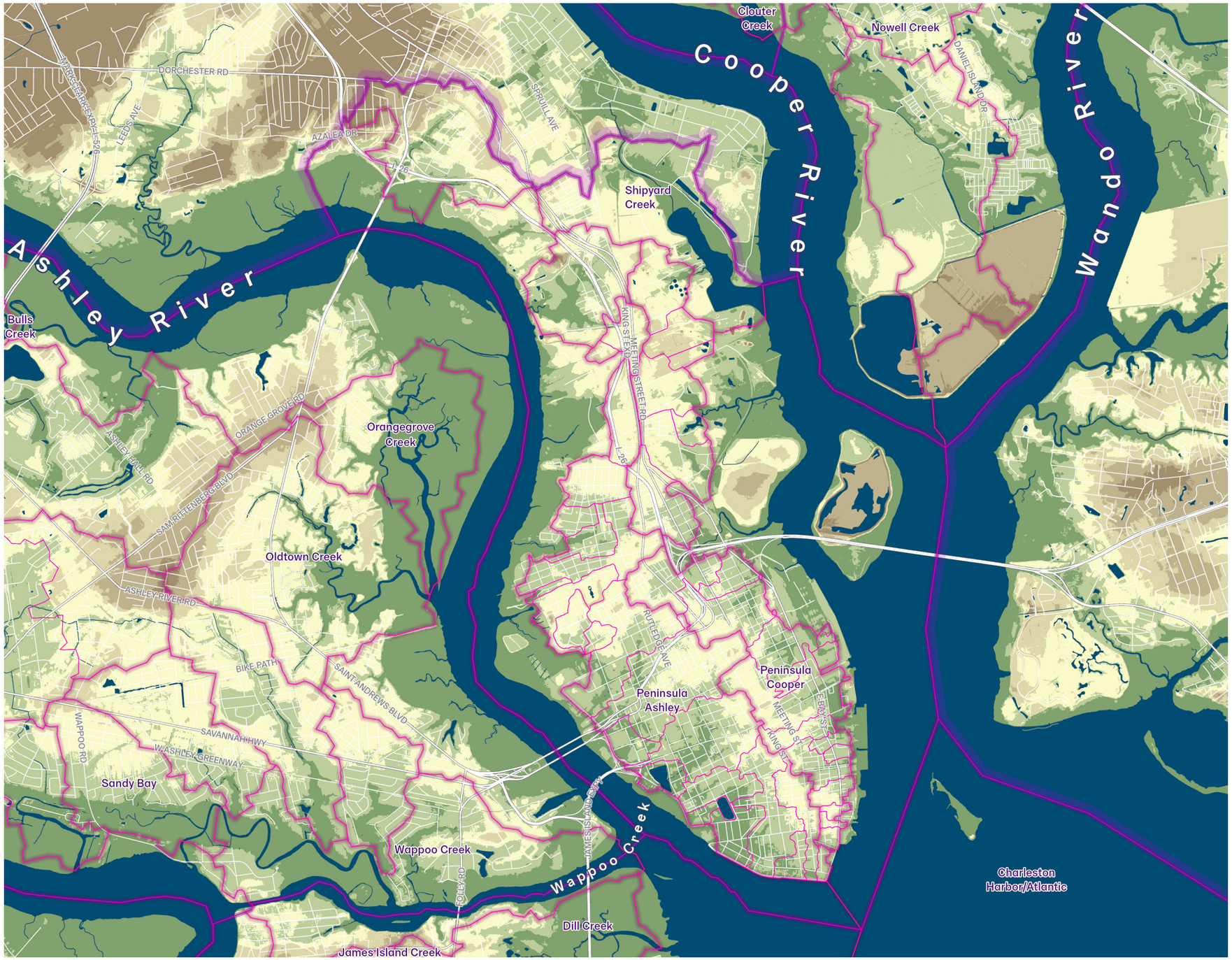
TREE CANOPY

JURISDICTIONS

ELEVATION

Most of the Peninsula is below 15 feet (NAVD) with the exception of Laurel Island, which was created with fill.

map sources: USGS



Legend

Elevation (NAVD88)

- >25 ft
- 20-25 ft
- 15-20 ft
- 10-15 ft
- 5-10 ft
- <5 ft

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

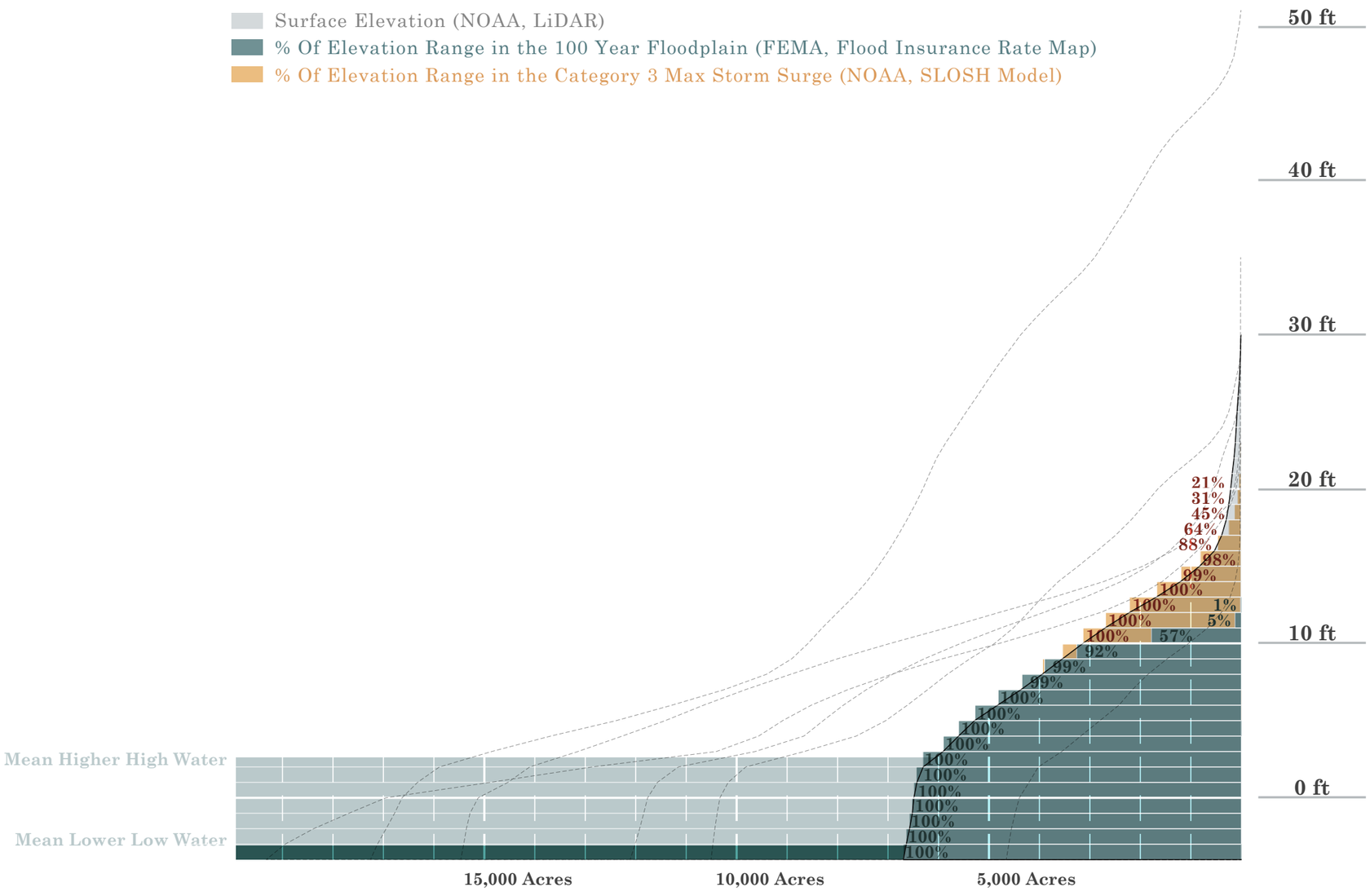
Water

1 inch = 4,000 feet

Miles 1

SURFACE ELEVATION DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

Most of the Peninsula land surface at or below 11' is in the floodplain. Almost all of the land surface is at risk for max category 3 storm surge.

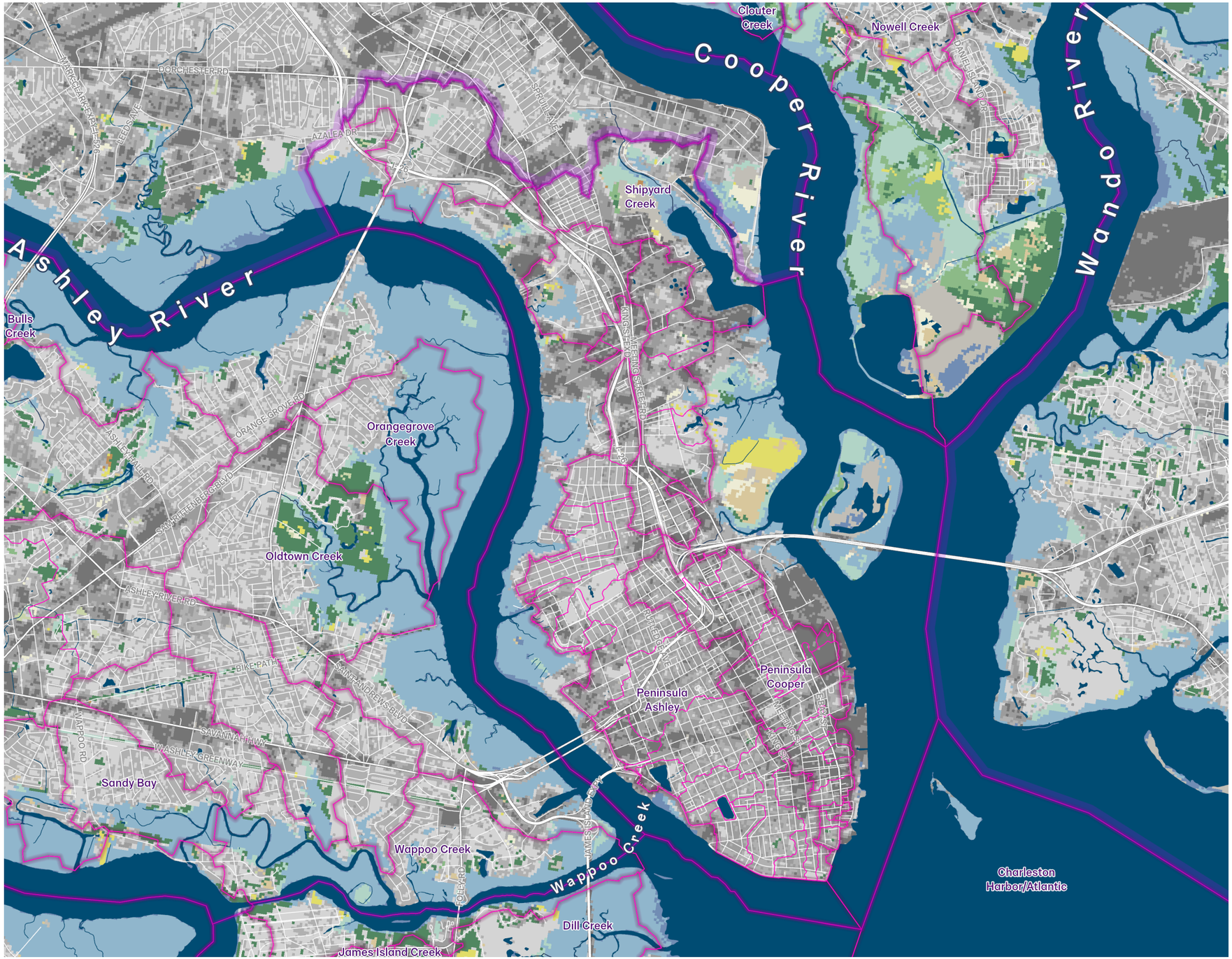


ACRES
(STARTING AT MEAN LOWER LOW WATER)

LAND COVER

The Peninsula is the most densely developed area in Charleston.

Map sources: NLCD



Legend

Land Cover 2016

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetland

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary

Water

- Water

1 inch = 4,000 feet

Miles 1

ELEVATION & LAND COVER DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

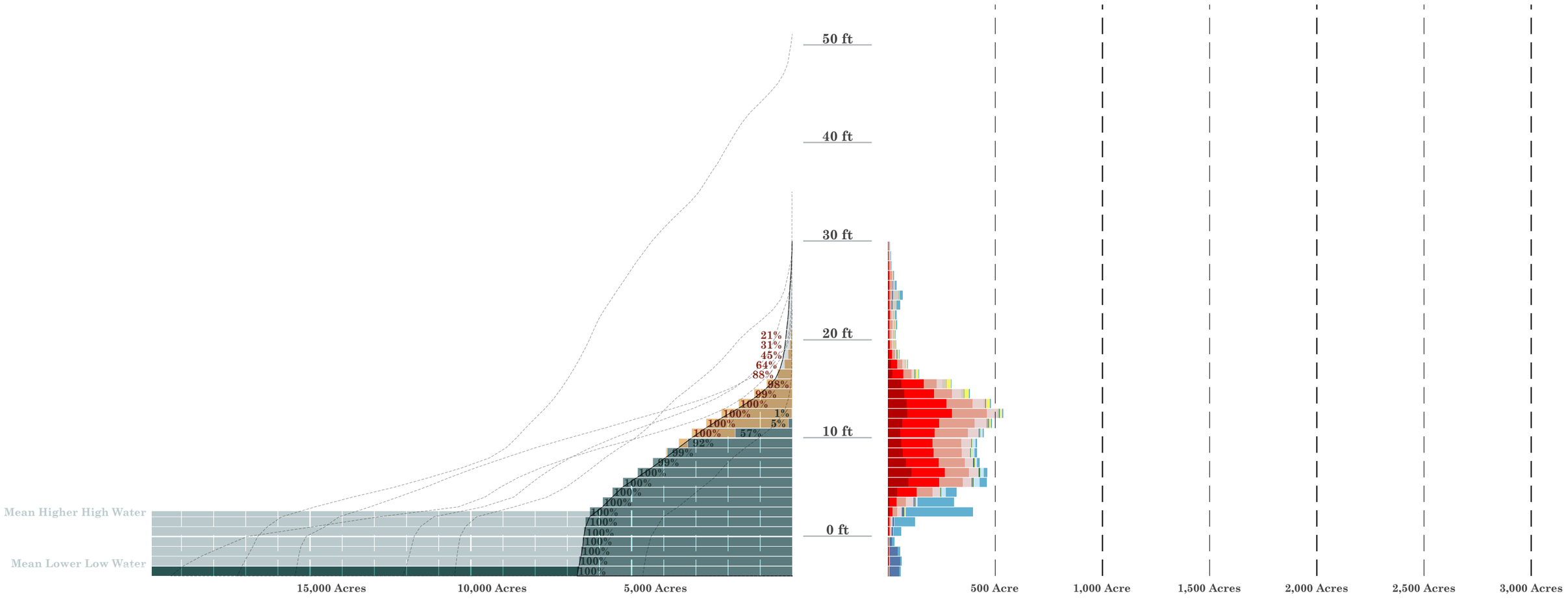
PENINSULA

SURFACE ELEVATION

- Surface Elevation (NOAA, LiDAR)
- % Of Elevation Range in the 100 Year Floodplain (FEMA, Flood Insurance Rate Map)
- % Of Elevation Range in the Category 3 Max Storm Surge (NOAA, SLOSH Model)

LAND COVER

- Developed High Intensity
- Developed Medium Intensity
- Developed Low Intensity
- Developed Open Space
- Open Water
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Shrub/Scrub
- Grassland
- Pasture
- Crops
- Woody Wetland
- Emergent Herbaceous Wetland
- Outside Urban Growth Boundary



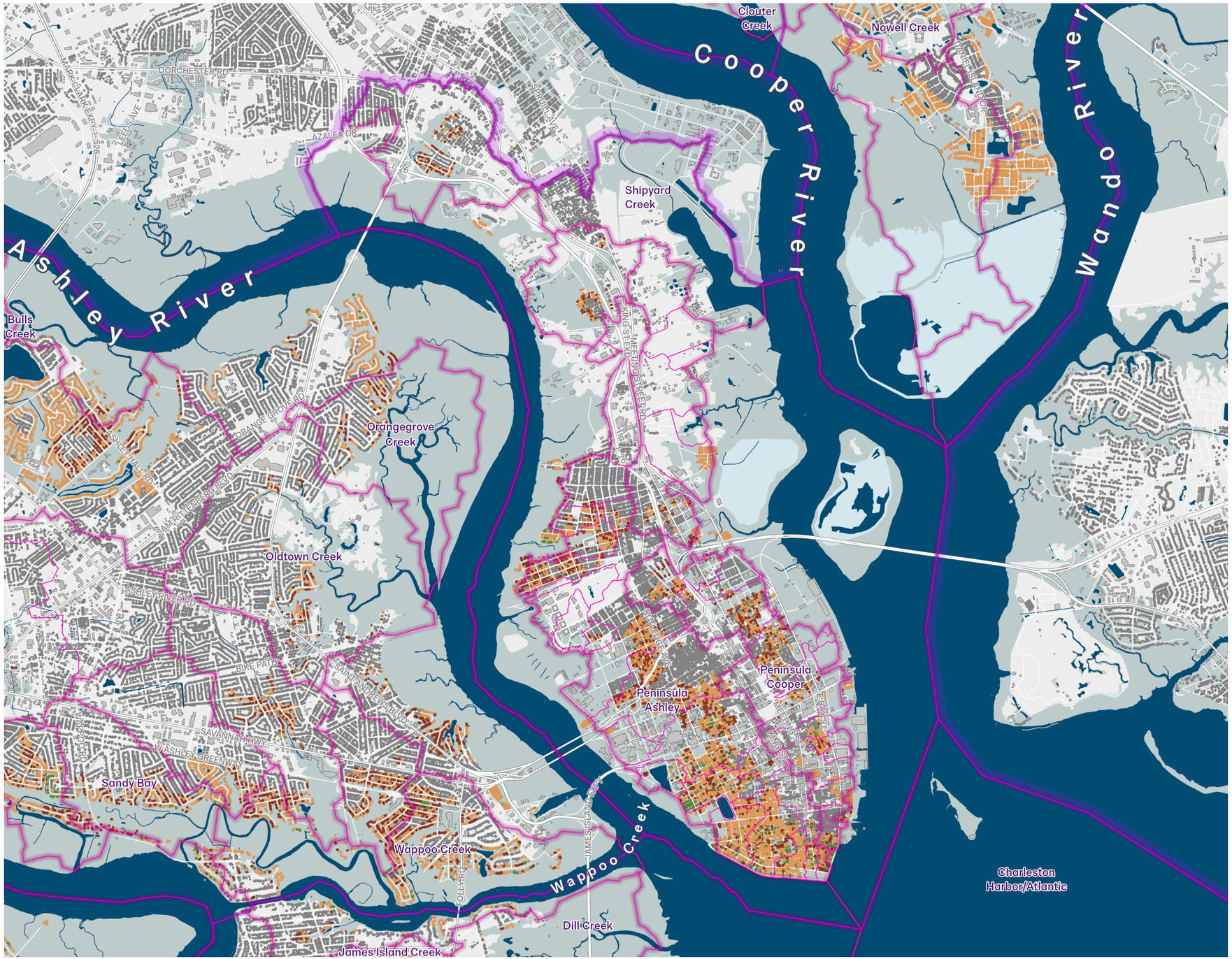
ACRES
(STARTING AT MEAN LOWER LOW WATER)

LANDCOVER DISTRIBUTION IN WATERSHED
(National Land Cover Database)

RESIDENTIAL BUILDING TYPE

High risk, historic, hard to adapt structures are spread throughout the Peninsula.

map sources: City of Charleston



Legend

Residential Structures
- Outside Floodplain, all footing types
- Built to BFE/BFE+2, Peirs
- Built to BFE/BFE+2, Slab-on-Grade or Unknown
- Built Pre-BFE Regulations
- Non Residential

100 Year Floodplain and BFE
- No BFE
- BFE

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water
- Water

1 inch = 4,000 feet

Miles 1

ELEVATION & RESIDENTIAL BUILDING TYPE DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

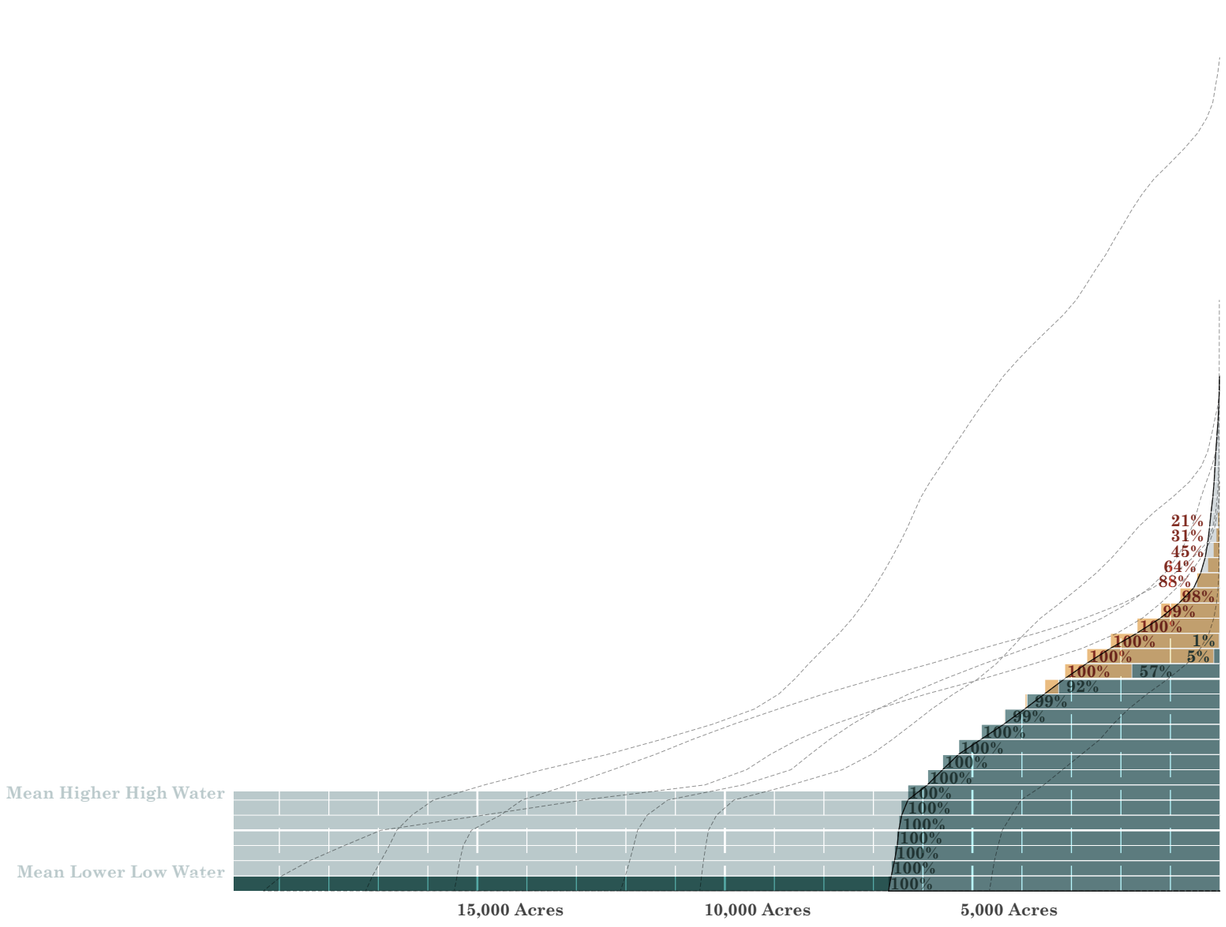
PENINSULA

SURFACE ELEVATION

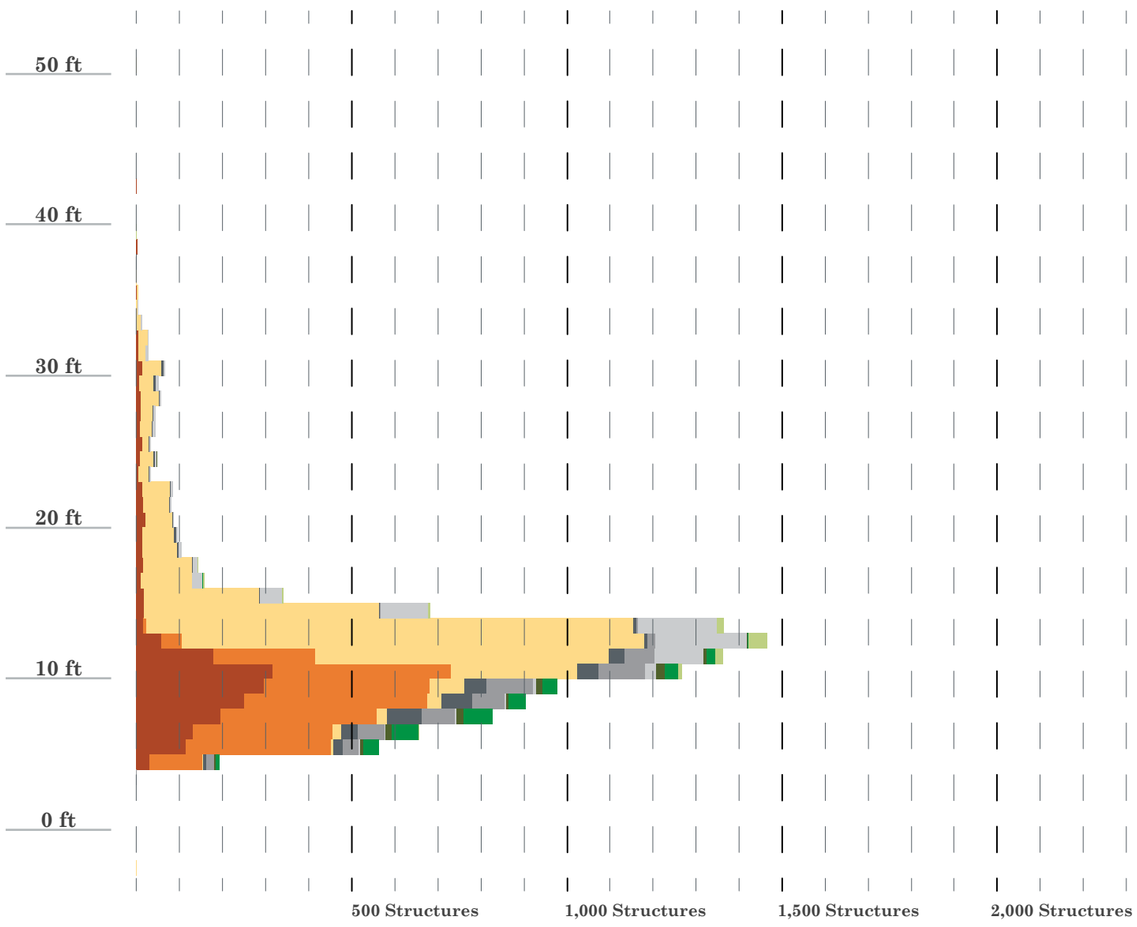
- Surface Elevation (NOAA, LiDAR)
- % Of Elevation Range in the 100 Year Floodplain (FEMA, Flood Insurance Rate Map)
- % Of Elevation Range in the Category 3 Max Storm Surge (NOAA, SLOSH Model)

RESIDENTIAL STRUCTURES

- Slab on Grade: inside 100 year floodplain before BFE requirement
- Slab on Grade: inside 100 year floodplain rasied to BFE/BFE+1
- Slab on Grade: outside 100 year floodplain
- Unknown: inside 100 year floodplain before BFE requirement
- Unknown: inside 100 year floodplain rasied to BFE/BFE+1
- Unknown: outside 100 year floodplain
- On Peirs: inside 100 year floodplain before BFE requirement
- On Peirs: inside 100 year floodplain rasied to BFE/BFE+1
- On Peirs: outside 100 year floodplain



ACRES
(STARTING AT MEAN LOWER LOW WATER)



STRUCTURE BASE ELEVATIONS
(STARTING AT MEAN LOWER LOW WATER)

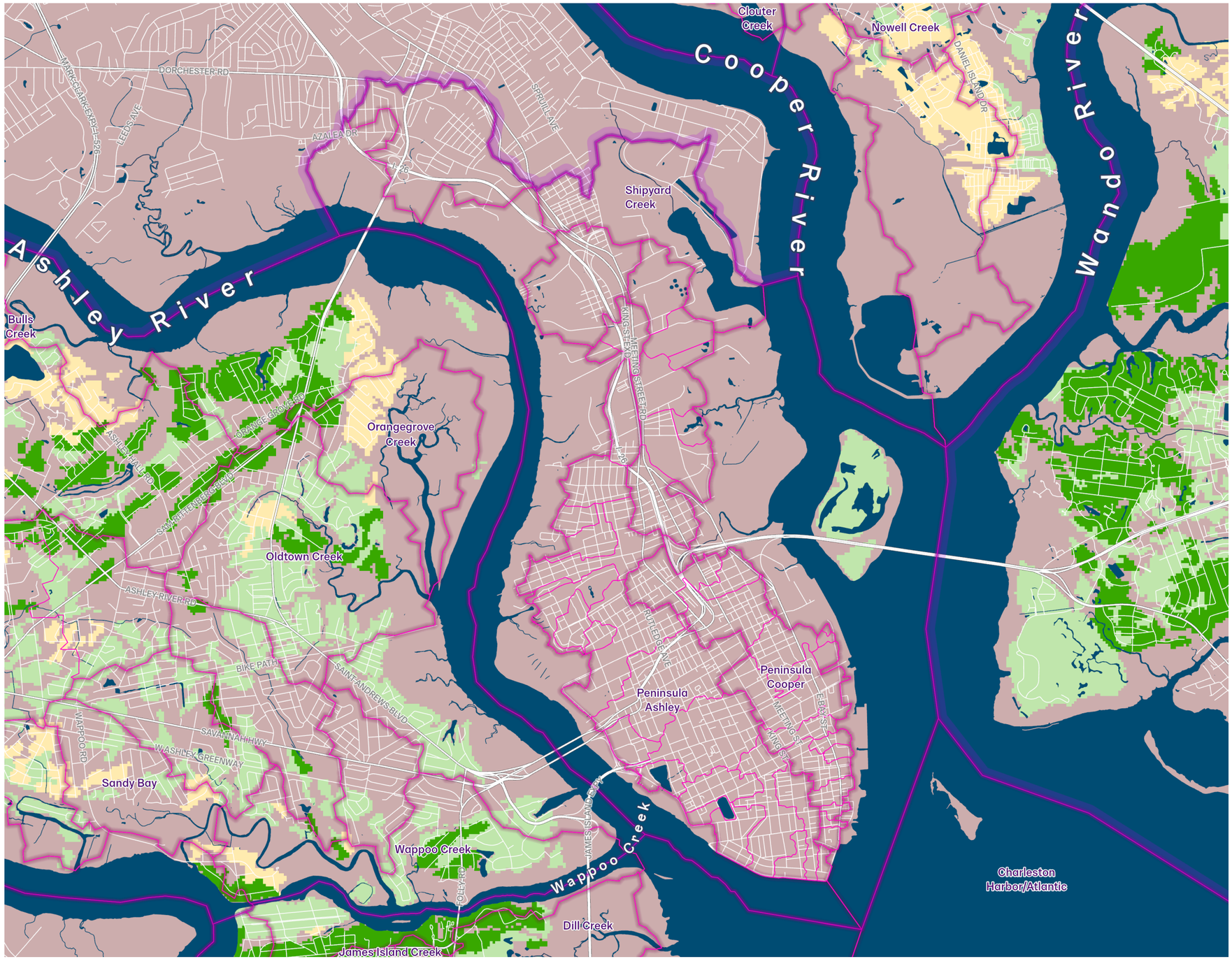
SOIL TYPES

All of the Peninsula soils are unmapped due to extensive disturbance (fill) and historic development. They are considered Group D with little to no ability to absorb water.

map sources: USDA

HYDROLOGIC GROUPS

- A: ABSORBS THE MOST WATER
- B: ABSORBS SOME WATER
- C: ABSORBS LITTLE WATER
- D: POORLY DRAINED AND/OR ABSORBS BASICALLY NO WATER



1 inch = 4,000 feet

Miles 1

TREE CANOPY DENSITY & CHANGE

The densest canopy on the Peninsula occurs in Hampton Park, on spoil islands, and old landfills.

map sources: GLCF



Legend

Tree Canopy (2015)

- Dense
- Sparse

Canopy Change (2000-2015)

- High Gain
- High Loss

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

1 inch = 4,000 feet

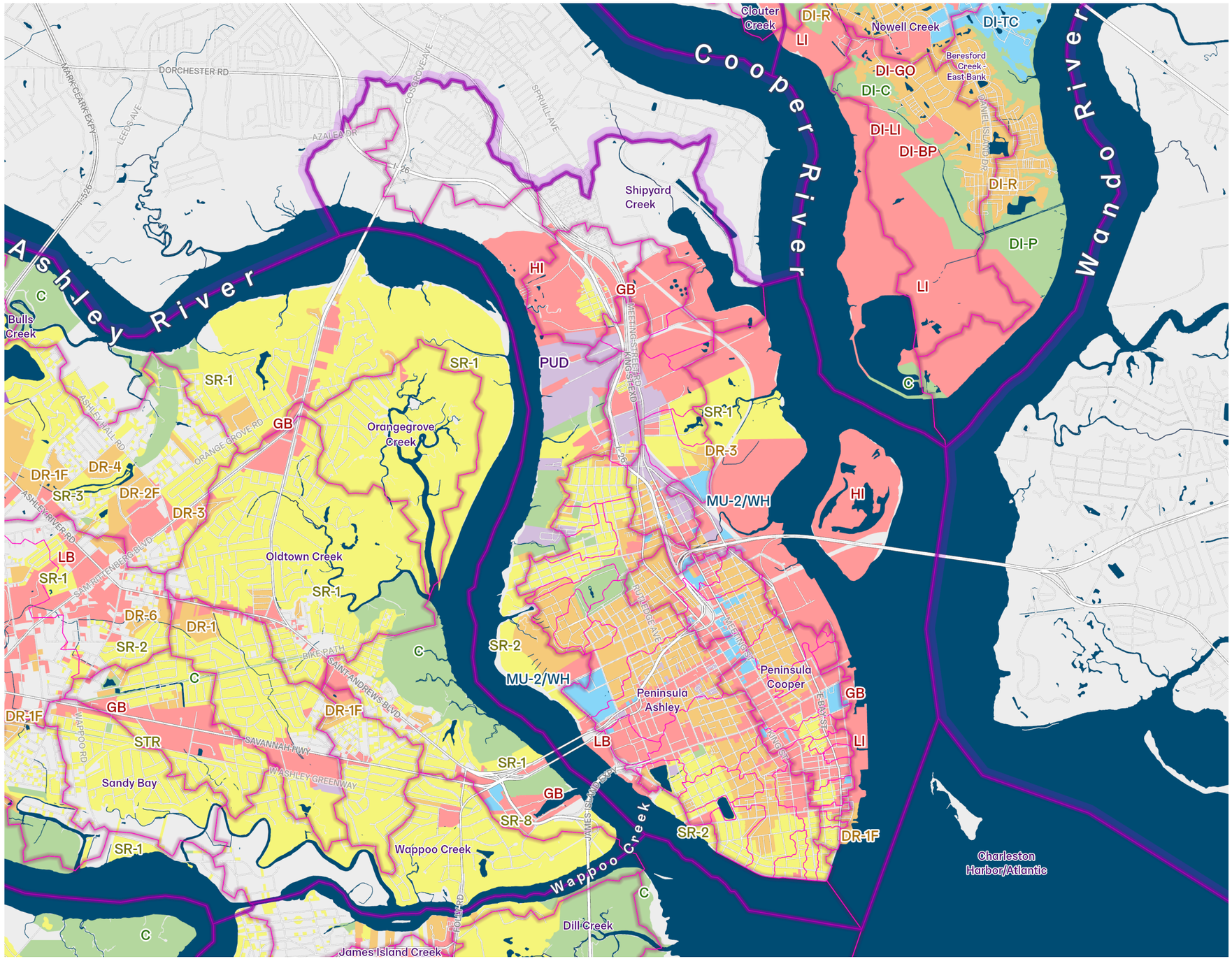
Miles

1

ZONING

The Peninsula has a diverse range of zoning over a small area and some of the densest development in Charleston.

map sources: City of Charleston



Legend

Zoning

- Parks & Conservation
- Single Family Residential
- Diverse Residential
- Planned Development
- Mixed Use
- Business & Industrial

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

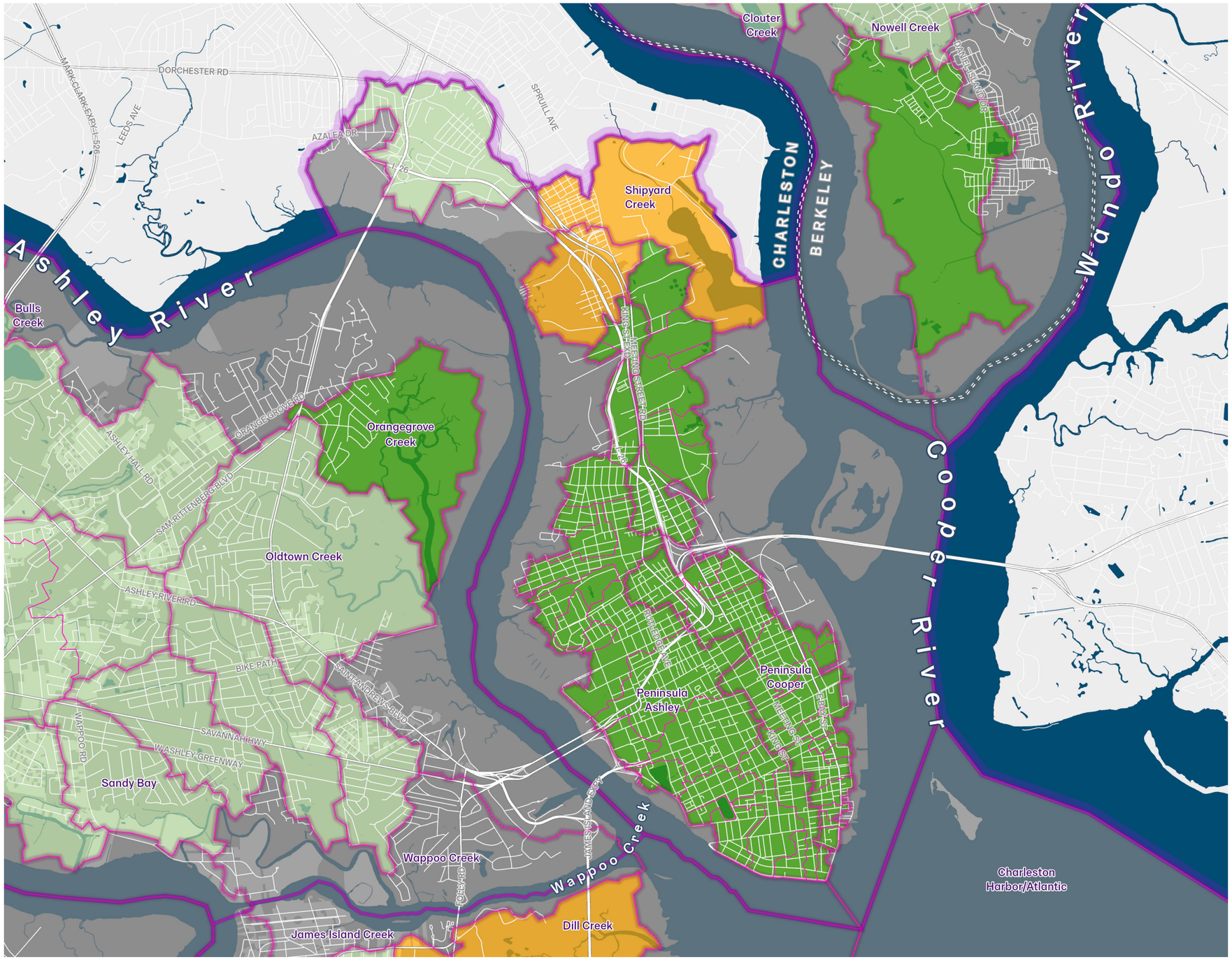
Water

1 inch = 4,000 feet

Miles 1

JURISDICTIONAL COMPLEXITY

Most of the watersheds intersecting the Peninsula fall entirely within the City of Charleston's jurisdiction.



Legend

Watershed Jurisdiction

- Entirely Within Charleston City
- Single-City, Single-County
- No City, Single-County
- Multi-City, Single-County
- Multi-City, Multi-County
- Excluded

Counties

- Charleston City Limits

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds

Urban Growth Boundary

Water

- Water

1 inch = 4,000 feet

Miles 1

LAND & WATER IMPLICATIONS

ELEVATION RISK ZONES

ELEVATION RISK ZONES & WATERSHED SENSITIVITY

ELEVATION ZONES

Most of the Peninsula falls into the tidal flood risk zone. There is very little high ground on the Peninsula outside of Laurel Island.

HIGH GROUND

High ground is defined as land outside of the FEMA 100 year floodplain and above the NOAA max category 3 storm surge. High ground has the lowest flood risk and stormwater detention here has the greatest watershed benefit.

ADAPT ZONE

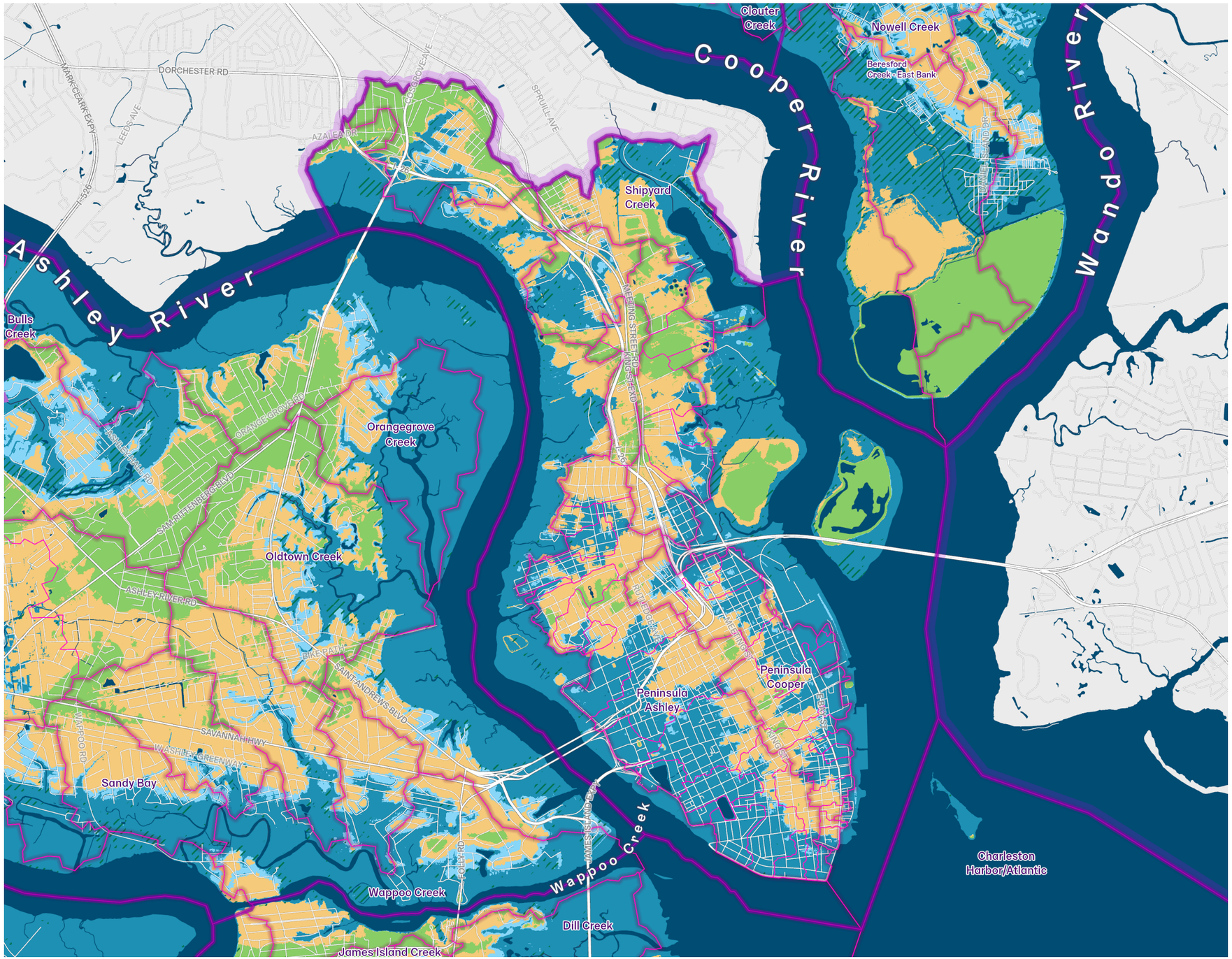
The adapt zone consists of land outside of the FEMA 100 year floodplain that is still within the NOAA maximum storm surge of a category 3 hurricane. Rain and storm surge flooding in this zone is infrequent but not impossible.

COMPOUND FLOOD RISK

This zone encompasses areas within the floodplain above the tidal flood risk zone where flood risk comes from a mixture of rainfall, runoff and tidal conditions.

TIDAL FLOOD RISK ZONE

This zone encompasses the lowest land in Charleston. Nearly 100% of this zone is in the 100 year floodplain. Flooding is frequent and can come solely from tidal events independent of precipitation. Sea level rise driven marsh migration occurs in this dynamic zone.



1 inch = 4,000 feet

Miles 1

ELEVATION ZONES

While most of the Peninsula falls into the tidal flood risk zone, the proposed U.S. Army Corps perimeter protection system mitigates major flood risk for this zone.

HIGH GROUND

High ground is defined as land outside of the FEMA 100 year floodplain and above the NOAA max category 3 storm surge. High ground has the lowest flood risk and stormwater detention here has the greatest watershed benefit.

ADAPT ZONE

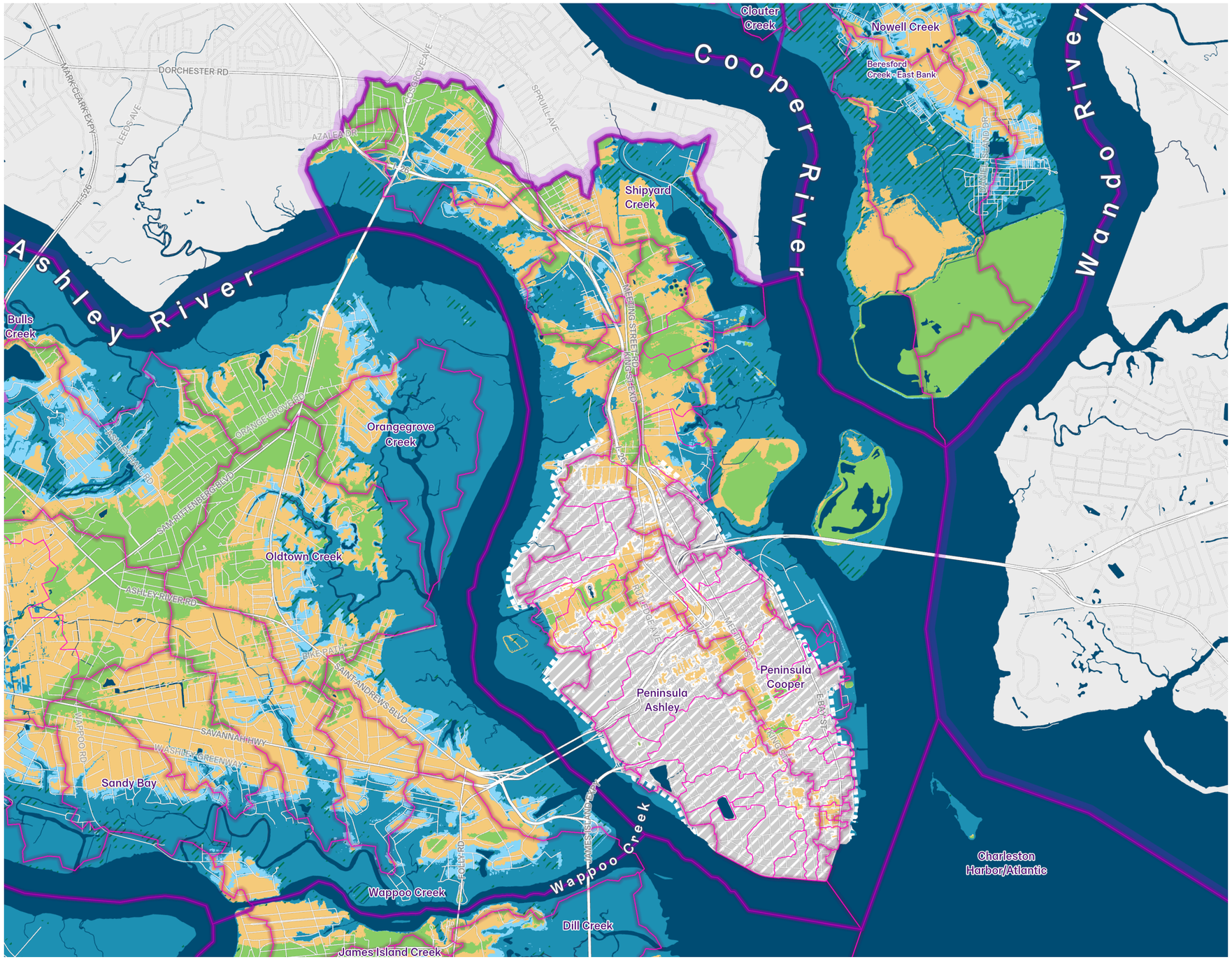
The adapt zone consists of land outside of the FEMA 100 year floodplain that is still within the NOAA maximum storm surge of a category 3 hurricane. Rain and storm surge flooding in this zone is infrequent but not impossible.

ALIGNMENT ZONE

The proposed perimeter protection would provide storm surge mitigation for areas below 12 ft NAVD and inside the alignment.

TIDAL FLOOD RISK ZONE

This zone encompasses the lowest land in Charleston. Nearly 100% of this zone is in the 100 year floodplain. Flooding is frequent and can come solely from tidal events independent of precipitation. Sea level rise driven marsh migration occurs in this dynamic zone.



1 inch = 4,000 feet

Miles 0 1

ELEVATION RISK + WATERSHED SENSITIVITY

Most of the Peninsula consists of smaller, low sensitivity watersheds, although the number of vulnerable parcels on the Peninsula is high.

HIGH SENSITIVITY

Combination of more flood prone watersheds and a high number of vulnerable parcels. Typically larger tidal watersheds and/or watersheds where development happened before BFE regulations.

NORMAL SENSITIVITY

Combination of less flood prone watersheds and a low number of vulnerable parcels. Typically smaller and/or less developed watersheds.

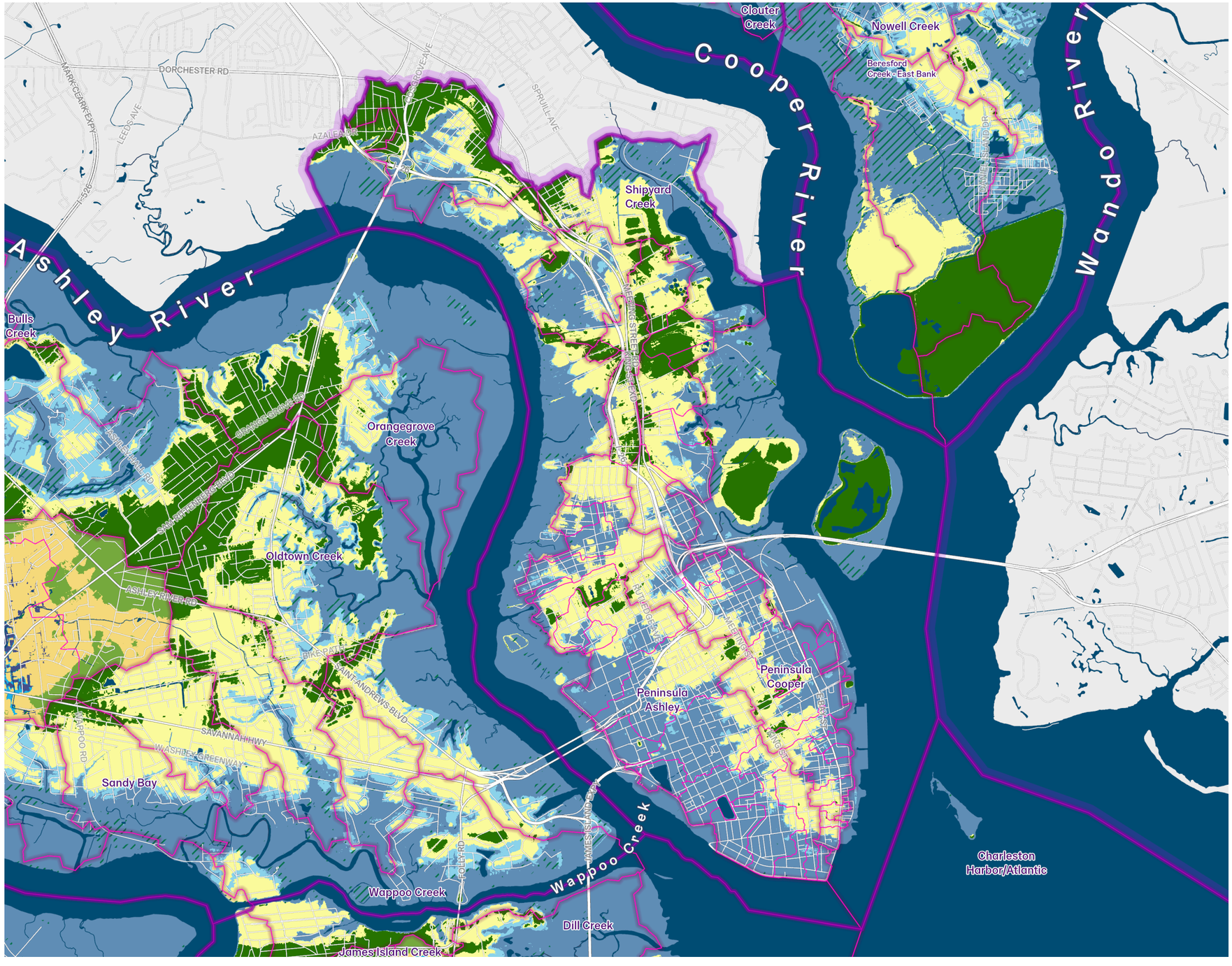
HIGH GROUND

ADAPT ZONE

ALIGNMENT ZONE

TIDAL FLOOD RISK ZONE

Marsh Migration Zone



1 inch = 4,000 feet

Miles 1

RISK + SENSITIVITY + ZONING

Higher ground on the Peninsula largely coincides with the business and commercial spine along King and Meeting Street. The lower ground has a broad variety of zoning types.

Legend

Zoning

- Parks & Conservation
- Single Family
- Diverse Residential
- Planned Development
- Mixed Use
- Business & Industrial

Risk & Watershed Impact

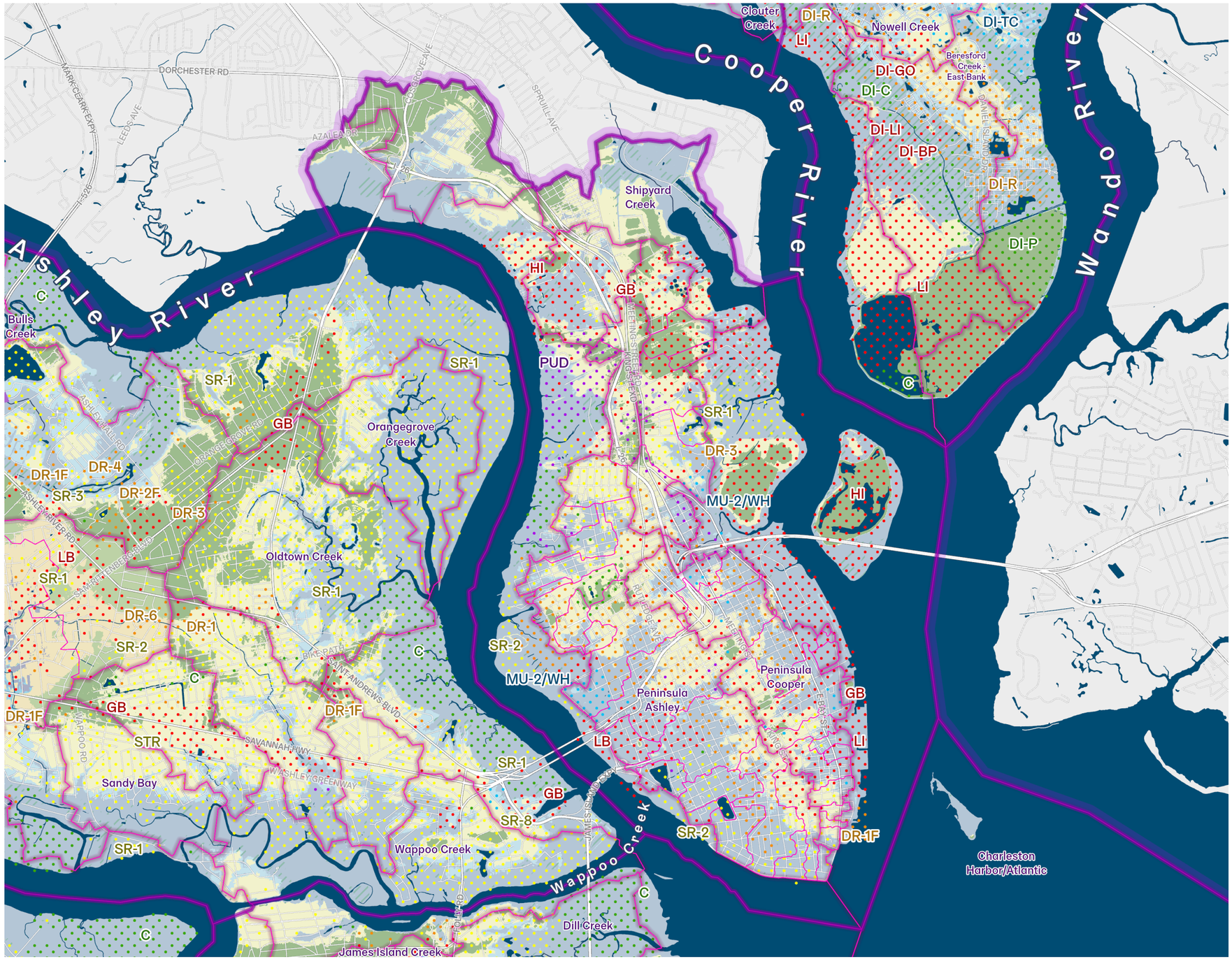
- High Ground, Normal Sensitivity
- High Ground, High Sensitivity
- Adapt Zone, Normal Sensitivity
- Adapt Zone, High Sensitivity
- Compound Flood Risk, Normal Sensitivity
- Compound Flood Risk, High Sensitivity
- Tidal Flood Risk, Normal Sensitivity
- Tidal Flood Risk, High Sensitivity
- Marsh Migration Zone

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary
- Water

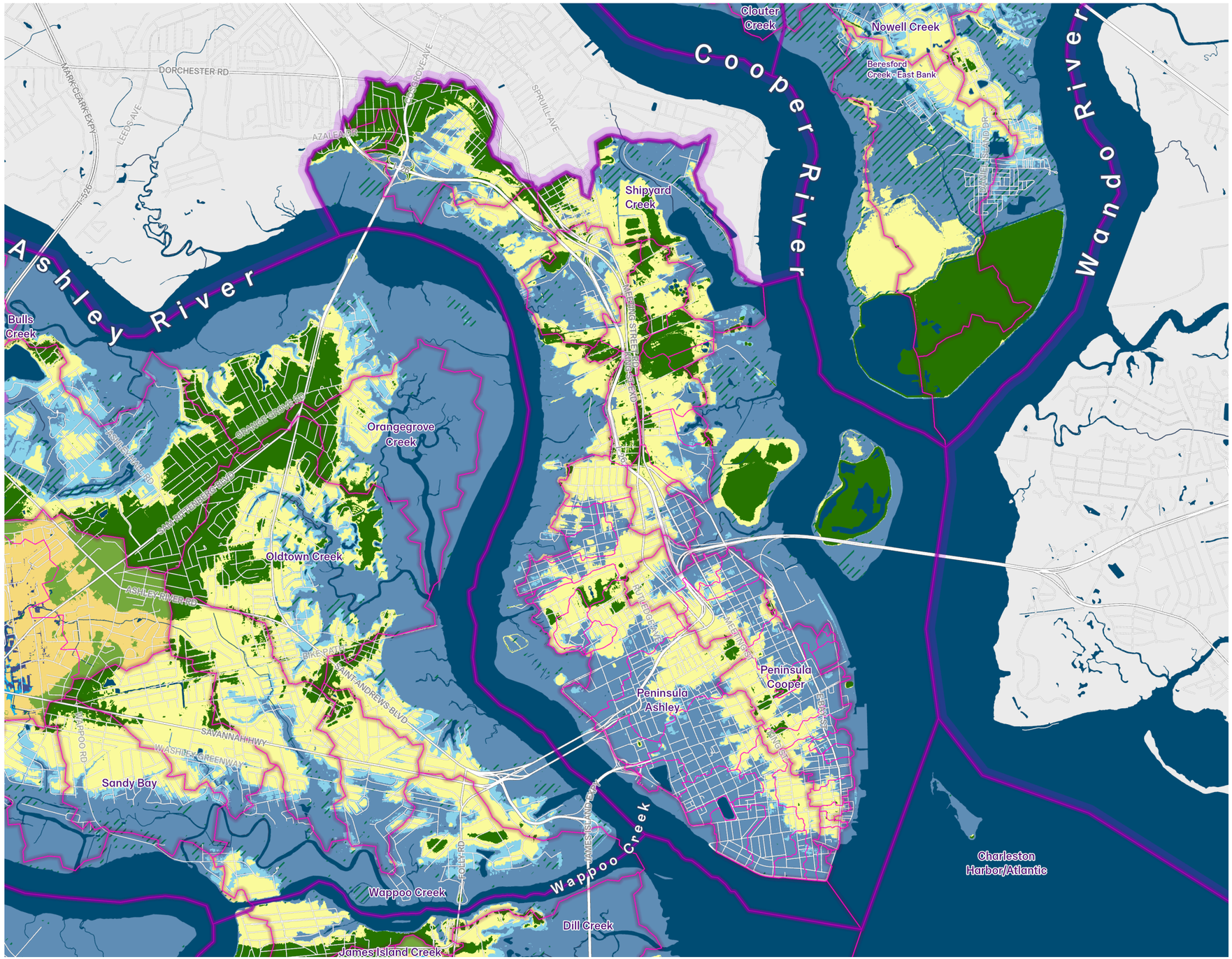
1 inch = 4,000 feet

Miles 1



LAND & WATER IMPLICATIONS

- High ground is limited to a few areas: Laurel Island, Hampton Park and some industrial parcels in the north of the city.
- The soil on the Peninsula is generally considered poor for infiltration.
- Most of the Peninsula's wetlands will be at risk with 3 feet of sea level rise. Most of the Marsh Migration zone on the Peninsula is already developed, leaving no place for marsh to go as waters rise.
- Small urban watersheds limit the potential watershed sensitivity, but the number of vulnerable parcels is high with significant portions in the tidal flood risk zone.
- The proposed U.S. Army Corps perimeter protection alignment mitigates coastal storm surge risk in the tidal flood risk zone, but increasingly common tidal events and rainfall related flooding will still need to be addressed.



1 inch = 4,000 feet

Miles

1

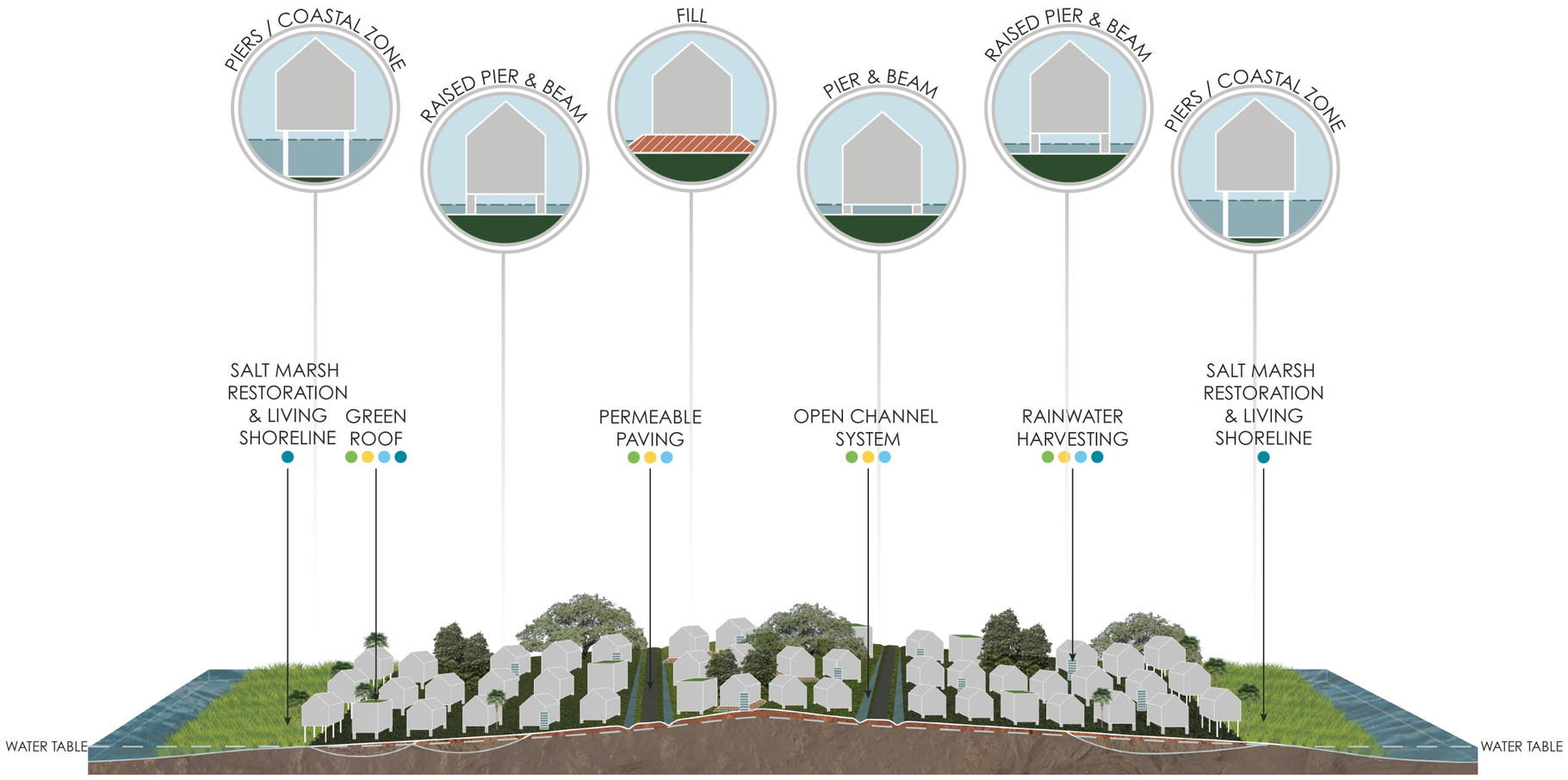
INNER WEST ASHLEY

WATER

LAND

RISK ZONES

RECOMMENDATIONS



INNER WEST ASHLEY TRANSECT



SURCULUS

WATER

WATERSHEDS

WATERSHED TYPES

WATERSHED VULNERABILITY

100 YEAR FLOODPLAIN

STORM SURGE

SEA LEVEL RISE

MARSH MIGRATION

WATERSHEDS

Inner West Ashley has 11 watersheds that flow into the Stono or Ashley Rivers or Wappoo Creek.



Legend

DFIRM

100 Year Floodplain

VE Zone

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Subwatershed Order (1 being closest to the outlet)

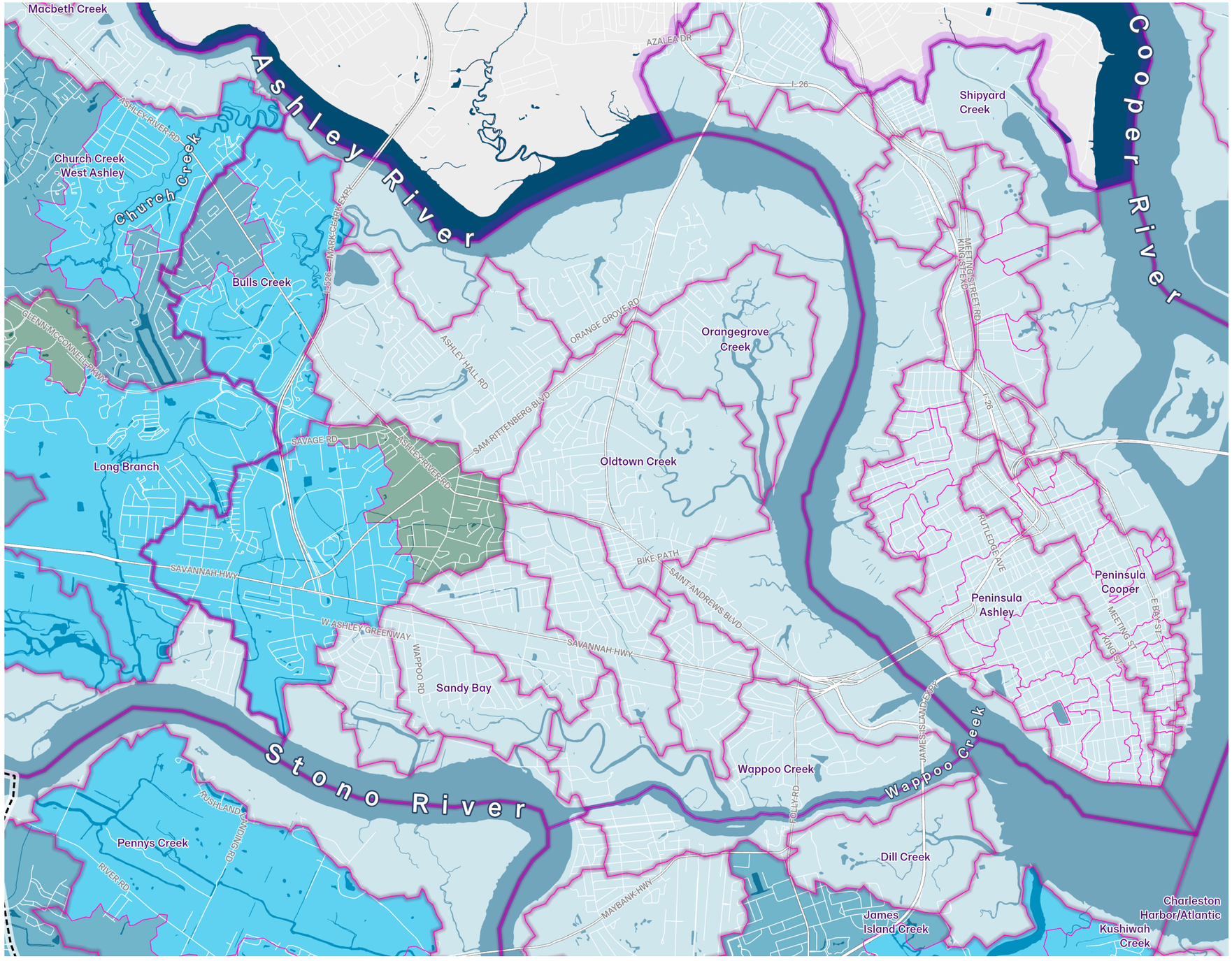
Watershed Interconnectivity Point

1 inch = 4,000 feet

Miles 1

WATERSHED TYPES

Most of inner West Ashley's watersheds are small and tidal, with the exception of Bulls Creek and an unnamed Stono River tributary west of Sandy Bay.



Legend

Subwatershed Type

- Small, Tidal
- Large, Outlet Tidal
- Large, Upstream Tidal
- Large, Upstream Inland

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

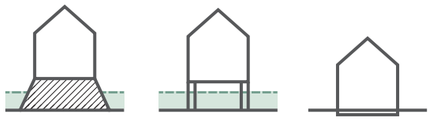
Water

- Water

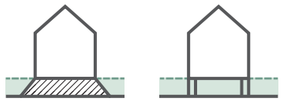
1 inch = 4,000 feet

Miles 1

STRUCTURE VULNERABILITY
USING THE 2020 RISK AND VULNERABILITY ASSESSMENT DEFINITIONS



Low Combined Vulnerability & Risk
Outside the 100 year floodplain
Built after BFE+1 requirements



Medium Combined Vulnerability & Risk
In the 100 year floodplain
Built after BFE requirements or raised to BFE



High Combined Vulnerability & Risk
In the 100 year floodplain
Built before BFE requirements

*All heights relative to BFE need verification

100 Year Floodplain and BFE
- No BFE
- BFE

Watersheds Neighborhood

Project Watersheds

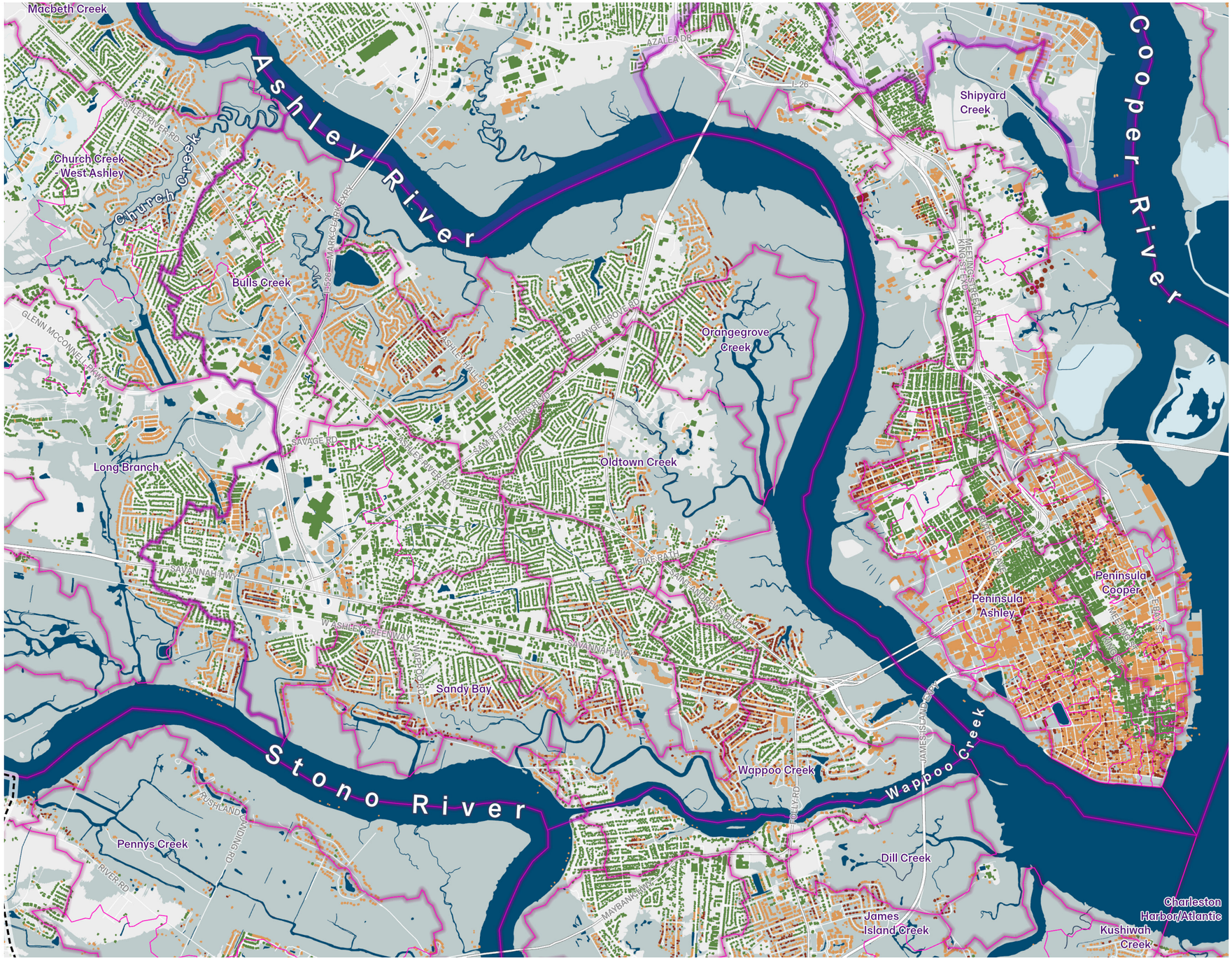
Project Subwatersheds

Urban Growth Boundary

Water
- Water

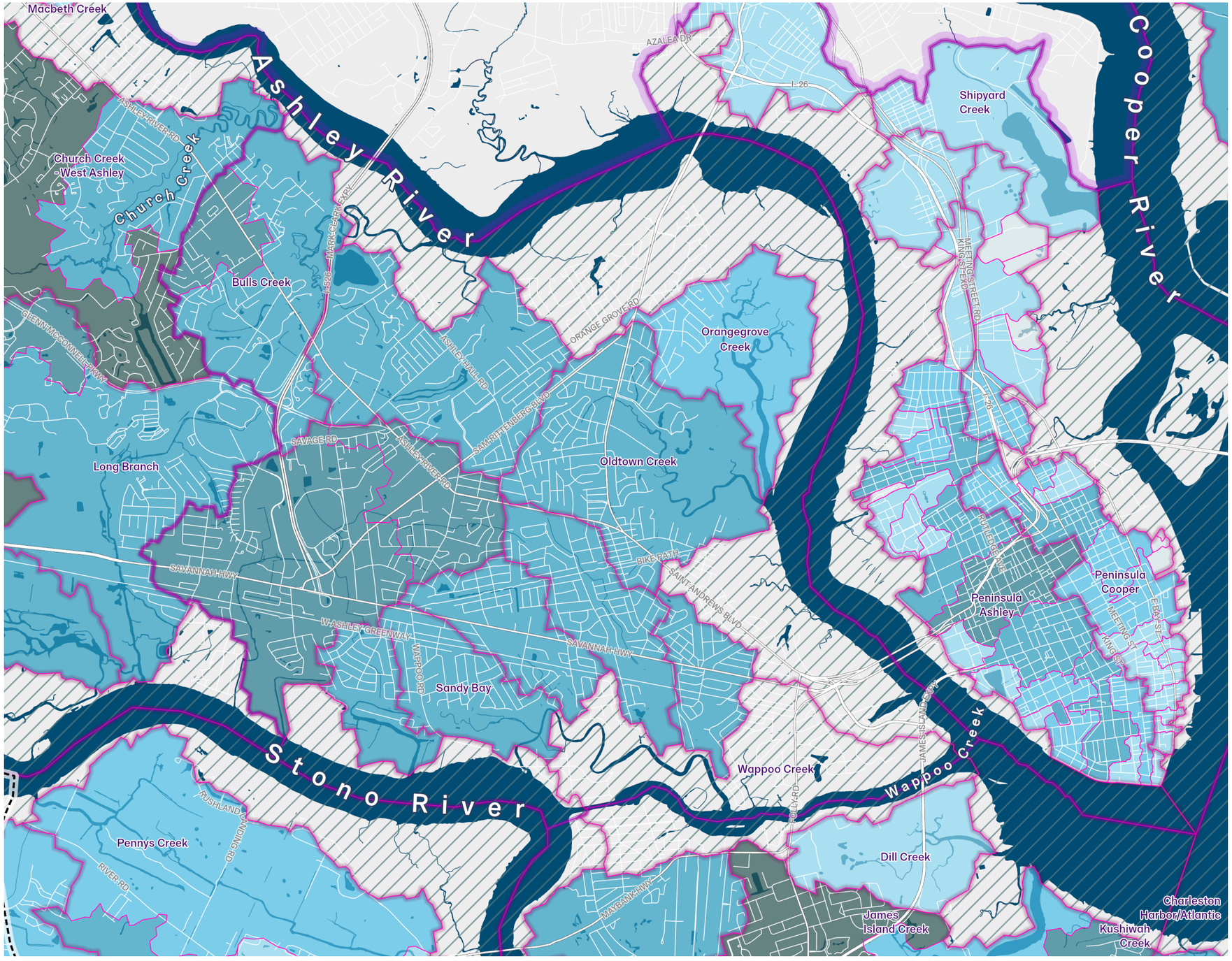
1 inch = 4,000 feet

Miles 1



NUMBER OF VULNERABLE PARCELS

Most of the watersheds in inner West Ashley have a moderately high number of vulnerable parcels due to age of development and structure types.



Legend

Vulnerable Parcels Local & Downstream

- ≤10
- ≤250
- ≤500
- ≤1000
- ≤1500
- >1500
- <excluded>

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

1 inch = 4,000 feet

Miles

1

100 YEAR FLOODPLAIN

Much of inner West Ashley is outside of the 100 year floodplain.

map sources: FEMA



Legend

DFIRM (**Blue #'s** are BFE in NAVD)

- 100 Year Floodplain
- VE Zone

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

1 inch = 4,000 feet

Miles 1

MAXIMUM CATEGORY 3 STORM SURGE

Other than the highest ground, most of inner West Ashley is in the maximum storm surge zone of a category 3 hurricane.

map sources: NOAA



Legend

Cat 3 Max Storm Surge (Above Ground)

- <5 ft
- 5-10 ft
- 10-15 ft
- >15 ft

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

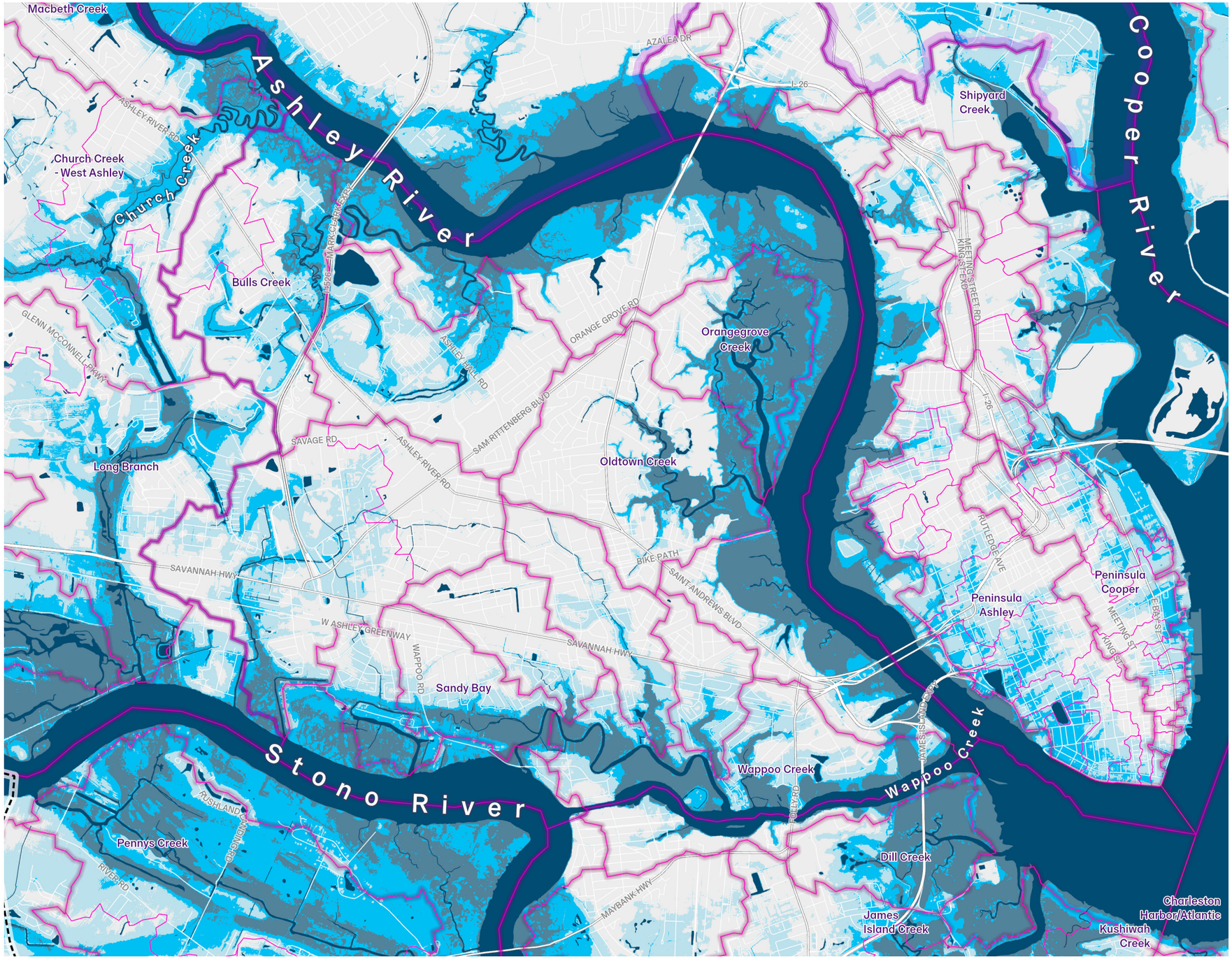
1 inch = 4,000 feet

Miles 1

TIDES AND SEA LEVEL RISE

Most of the developed land in inner West Ashley is not at direct risk from 3 feet sea level rise, however higher tides will affect drainage rates and flows.

map sources: USGS



Legend

Tides and Sea Level Rise

- Current MHHW
- MHHW +3ft of Sea Level Rise
- Highest Recorded Water Level (Hugo)

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

1 inch = 4,000 feet

Miles 1

MARSH MIGRATION WITH 3 FT OF SEA LEVEL RISE

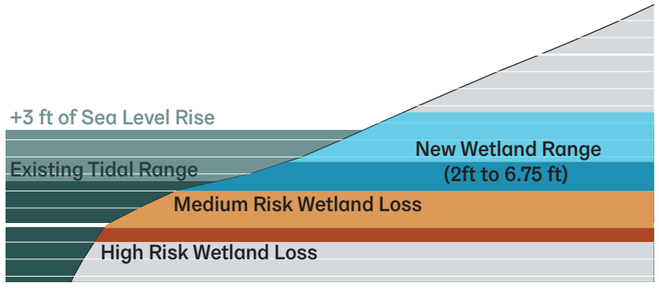
Wetlands closer to the Charleston Harbor are at a higher risk of loss from sea level rise with little room for migration within inner West Ashley.

map sources: USGS, MLRC Consortium

EXISTING WETLAND RANGE
≈ -1 TO 3.75 FT (NAVD)

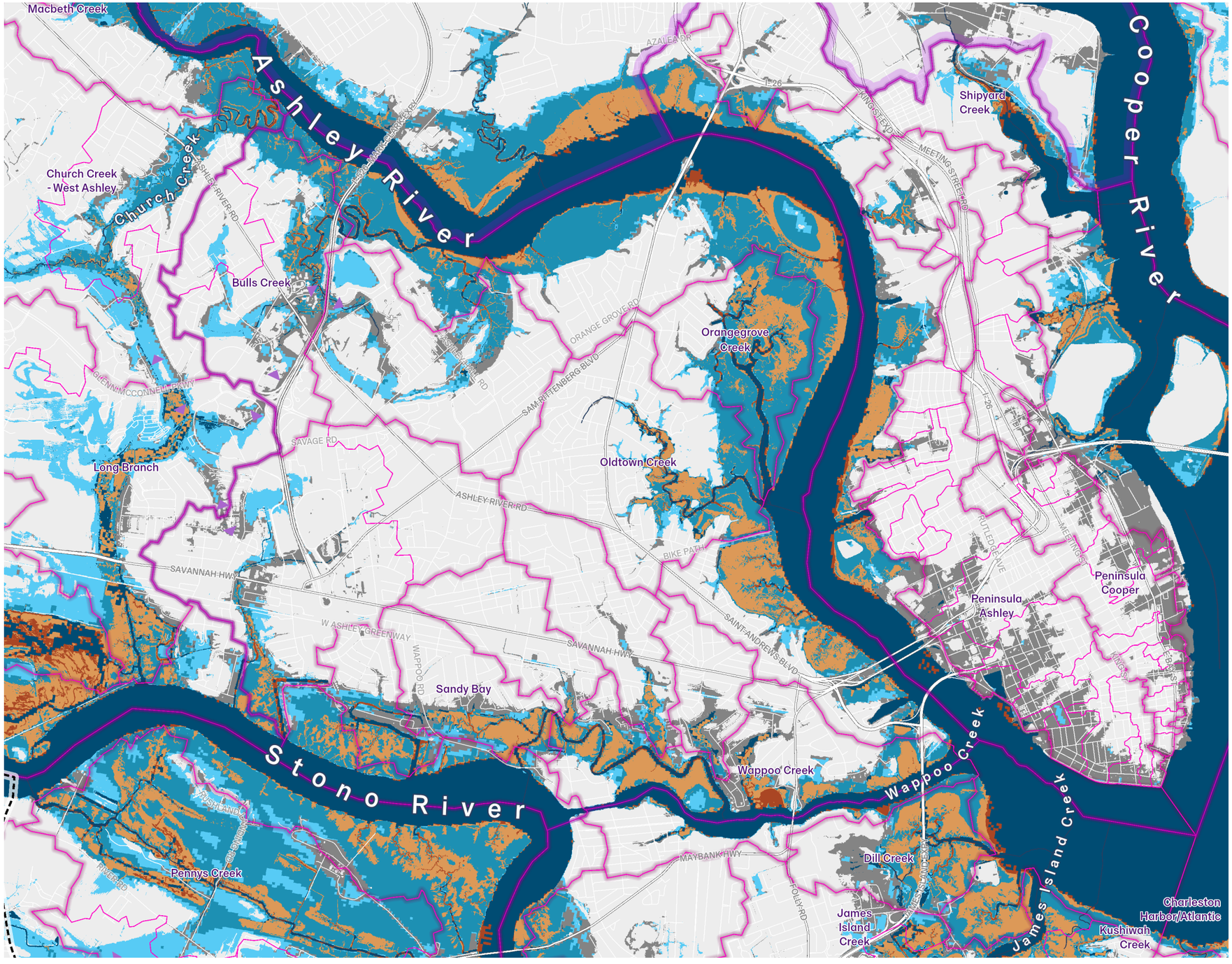
WETLAND MIGRATION ZONE
≈ 2 TO 6.75 FT (NAVD)





1 inch = 4,000 feet

Miles 1



LAND COVER IN THE MARSH MIGRATION ZONE

Most of the possible marsh migration in inner West Ashley would be woody wetlands transitioning to herbaceous wetlands.

map sources: USGS, MLRC Consortium

Legend

Land Cover in Wetland Migration Zone

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands

Wetland Migration

- High Risk Wetland Loss
- Medium Risk Wetland Loss
- Low Risk Wetland Loss
- Wetland Migration Zone
- Wetland Migration Zone - Developed

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

1 inch = 4,000 feet

Miles 1



LAND

ELEVATION

LAND COVER

ELEVATION & LAND COVER DISTRIBUTION

SOIL

TREE CANOPY

JURISDICTIONS

ELEVATION
NAVD

Much of inner West Ashley is high by Charleston standards with areas above 20 feet along Sam Rittenberg Blvd.



Legend

Elevation (NAVD88)

- >25 ft
- 20-25 ft
- 15-20 ft
- 10-15 ft
- 5-10 ft
- <5 ft

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

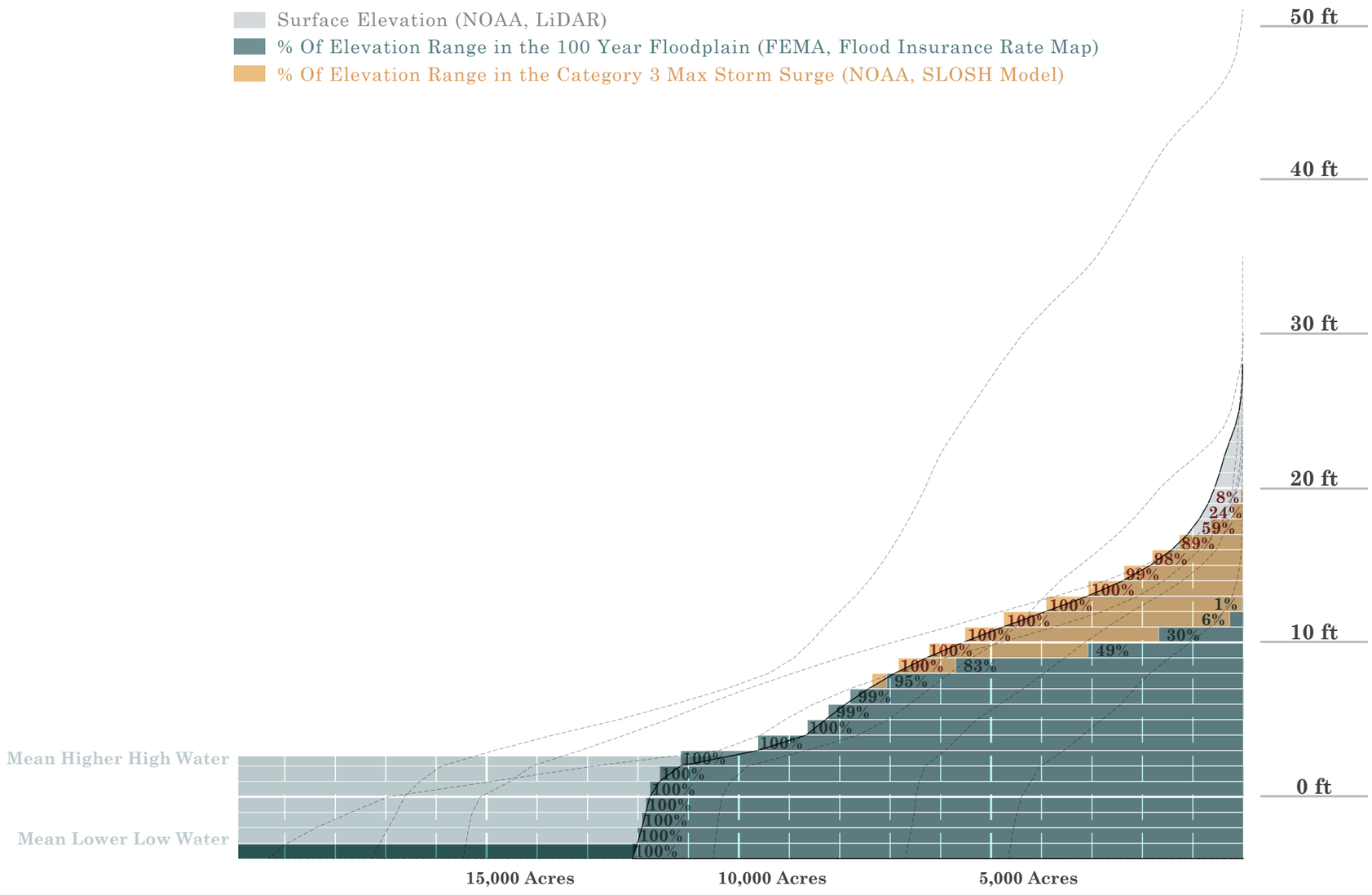
Water

1 inch = 4,000 feet

Miles 1

SURFACE ELEVATION DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

Most land surface at or below 9’ is in the floodplain. Almost all of inner West Ashley land is at risk from max category 3 storm surge.



ACRES
(STARTING AT MEAN LOWER LOW WATER)

LAND COVER

Almost all of inner West Ashley is moderately dense development.

map sources: MLRC Consortium

Legend

Land Cover 2016

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetland

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

Water

1 inch = 4,000 feet

Miles 1



ELEVATION & LAND COVER DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

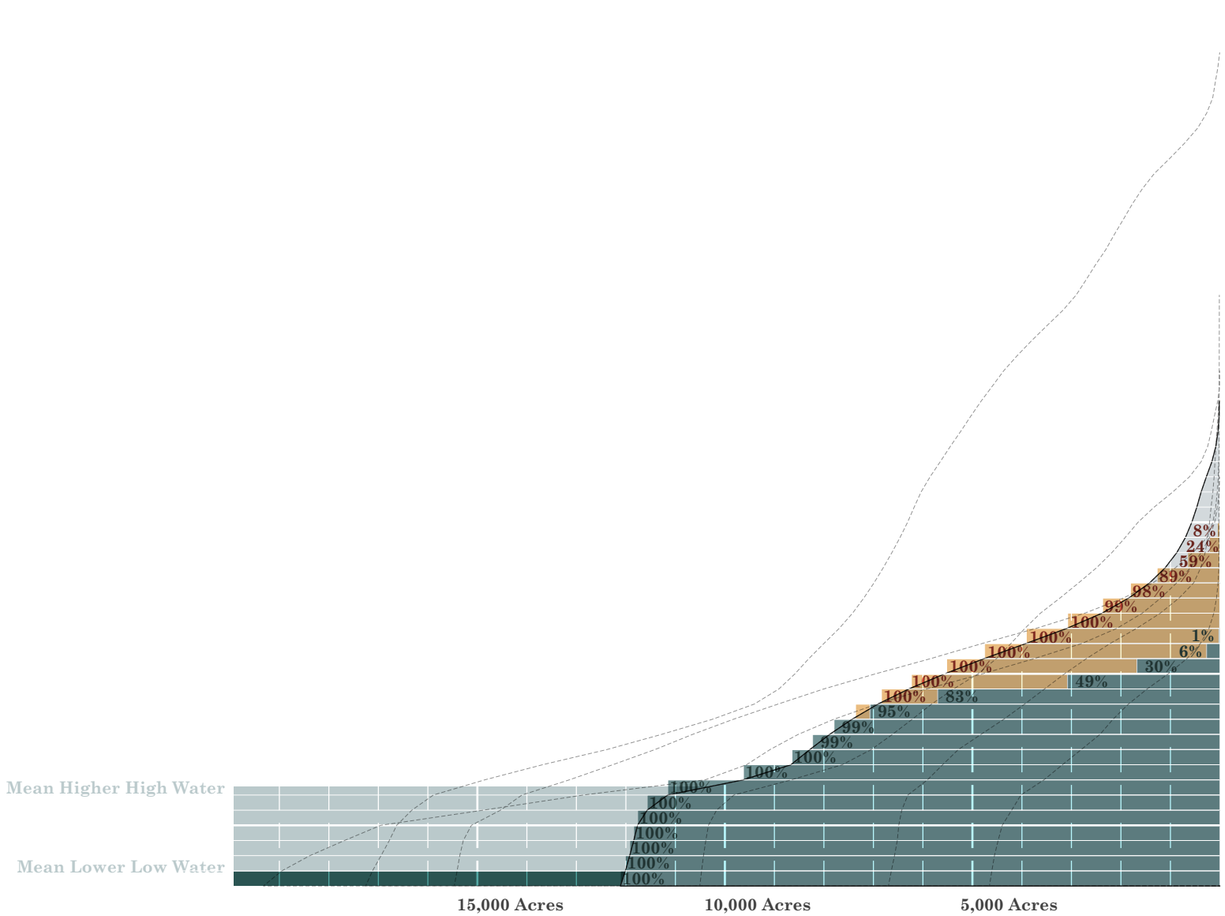
INNER WEST ASHLEY

SURFACE ELEVATION

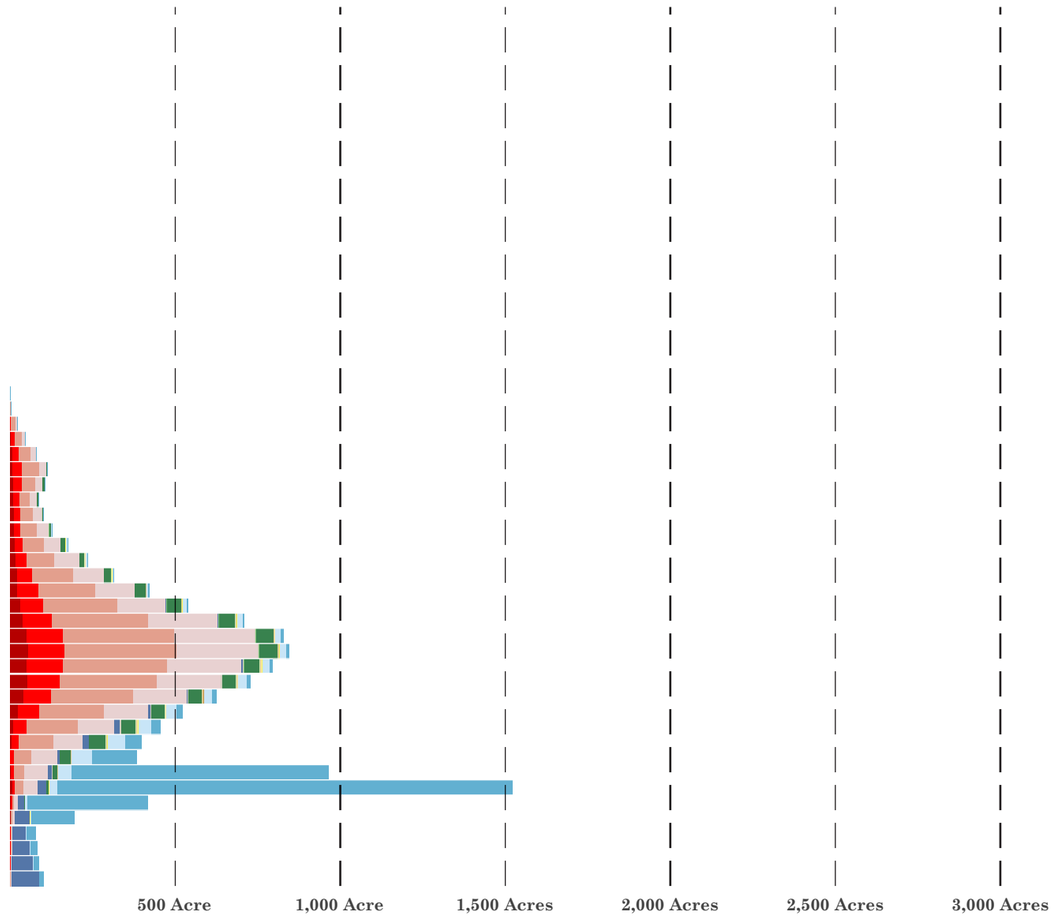
- Surface Elevation (NOAA, LiDAR)
- % Of Elevation Range in the 100 Year Floodplain (FEMA, Flood Insurance Rate Map)
- % Of Elevation Range in the Category 3 Max Storm Surge (NOAA, SLOSH Model)

LAND COVER

- Developed High Intensity
- Developed Medium Intensity
- Developed Low Intensity
- Developed Open Space
- Open Water
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Shrub/Scrub
- Grassland
- Pasture
- Crops
- Woody Wetland
- Emergent Herbaceous Wetland
- Outside Urban Growth Boundary



ACRES
(STARTING AT MEAN LOWER LOW WATER)

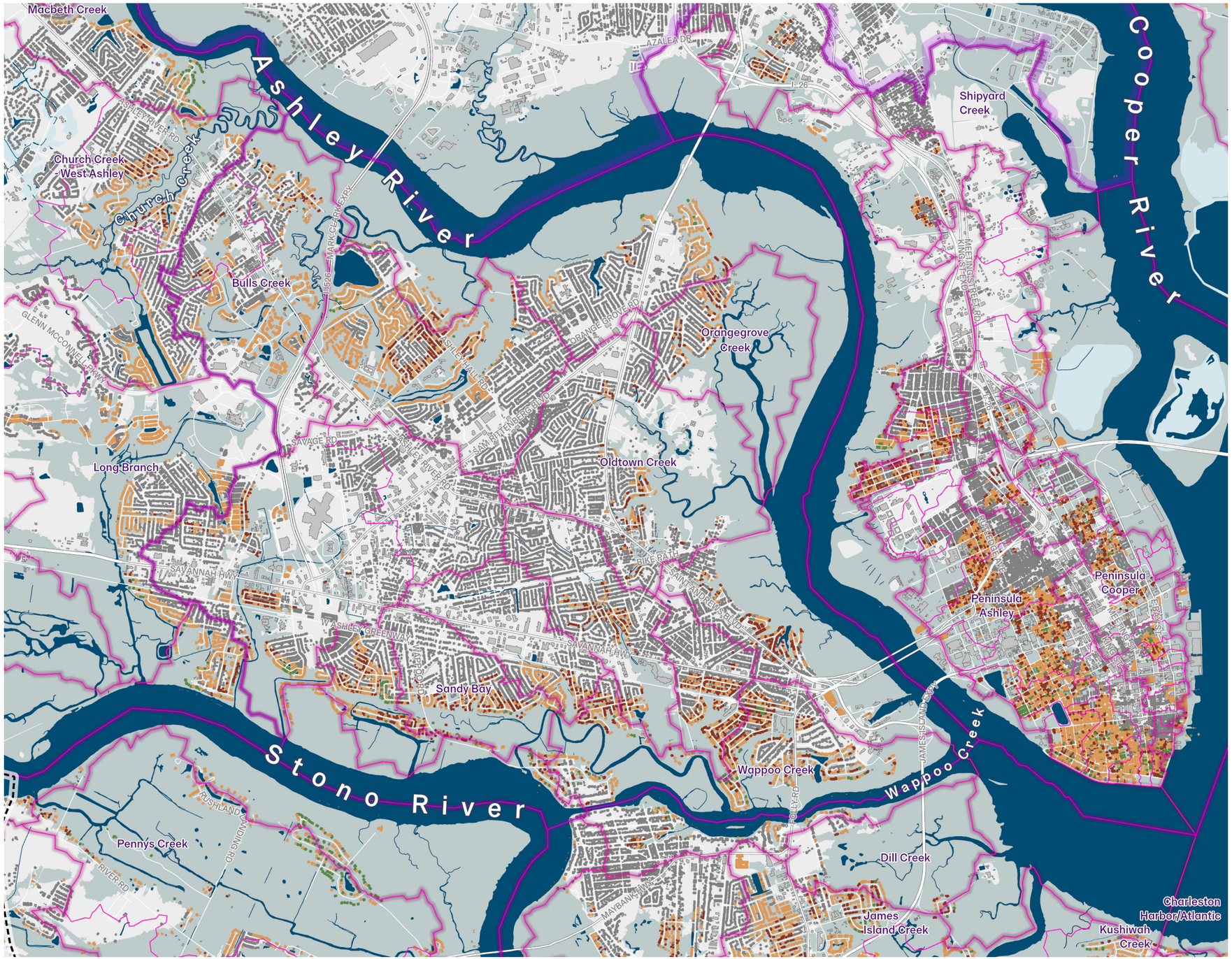


LANDCOVER DISTRIBUTION IN WATERSHED
(National Land Cover Database)

RESIDENTIAL BUILDING TYPE

While large areas of inner West Ashley are outside the floodplain, much of the development within the floodplain was constructed before BFE regulations were in place.

map sources: City of Charleston



Legend

Residential Structures
- Outside Floodplain, all footing types
- Built to BFE/BFE+2, Peirs
- Built to BFE/BFE+2, Slab-on-Grade or Unknown
- Built Pre-BFE Regulations
- Non Residential

100 Year Floodplain and BFE
- No BFE
- BFE

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water
- Water

1 inch = 4,000 feet

Miles 1

ELEVATION & RESIDENTIAL BUILDING TYPE DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

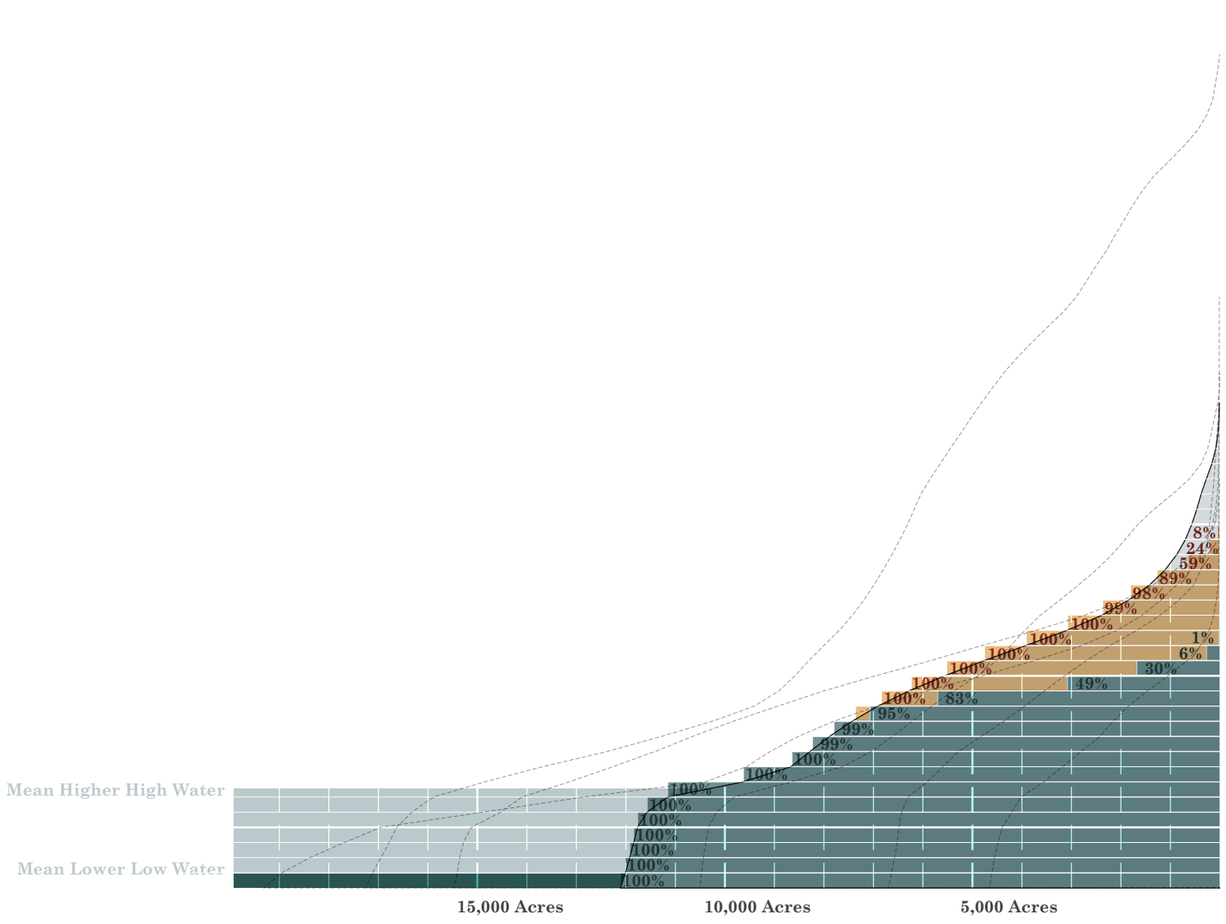
INNER WEST ASHLEY

SURFACE ELEVATION

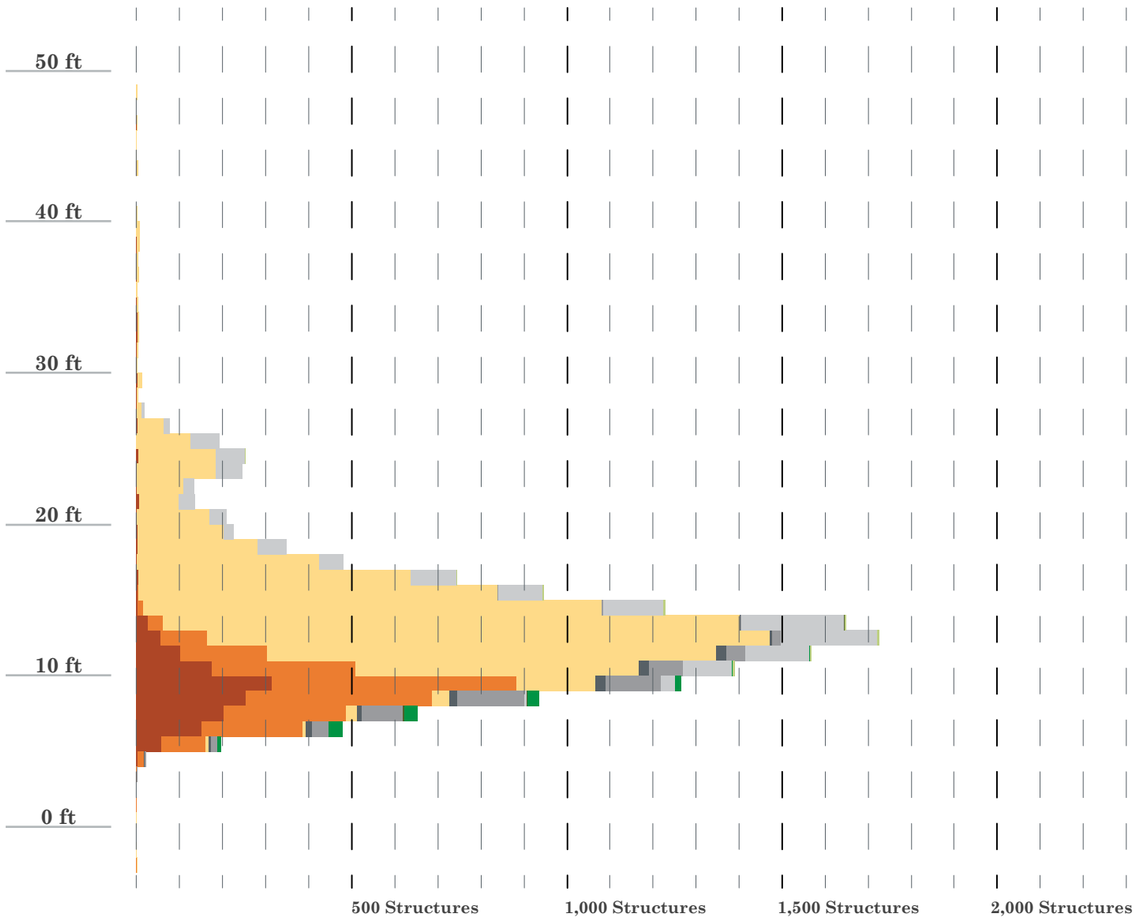
- Surface Elevation (NOAA, LiDAR)
- % Of Elevation Range in the 100 Year Floodplain (FEMA, Flood Insurance Rate Map)
- % Of Elevation Range in the Category 3 Max Storm Surge (NOAA, SLOSH Model)

RESIDENTIAL STRUCTURES

- Slab on Grade: inside 100 year floodplain before BFE requirement
- Slab on Grade: inside 100 year floodplain rasied to BFE/BFE+1
- Slab on Grade: outside 100 year floodplain
- Unknown: inside 100 year floodplain before BFE requirement
- Unknown: inside 100 year floodplain rasied to BFE/BFE+1
- Unknown: outside 100 year floodplain
- On Peirs: inside 100 year floodplain before BFE requirement
- On Peirs: inside 100 year floodplain rasied to BFE/BFE+1
- On Peirs: outside 100 year floodplain



ACRES
(STARTING AT MEAN LOWER LOW WATER)



STRUCTURE BASE ELEVATIONS
(STARTING AT MEAN LOWER LOW WATER)

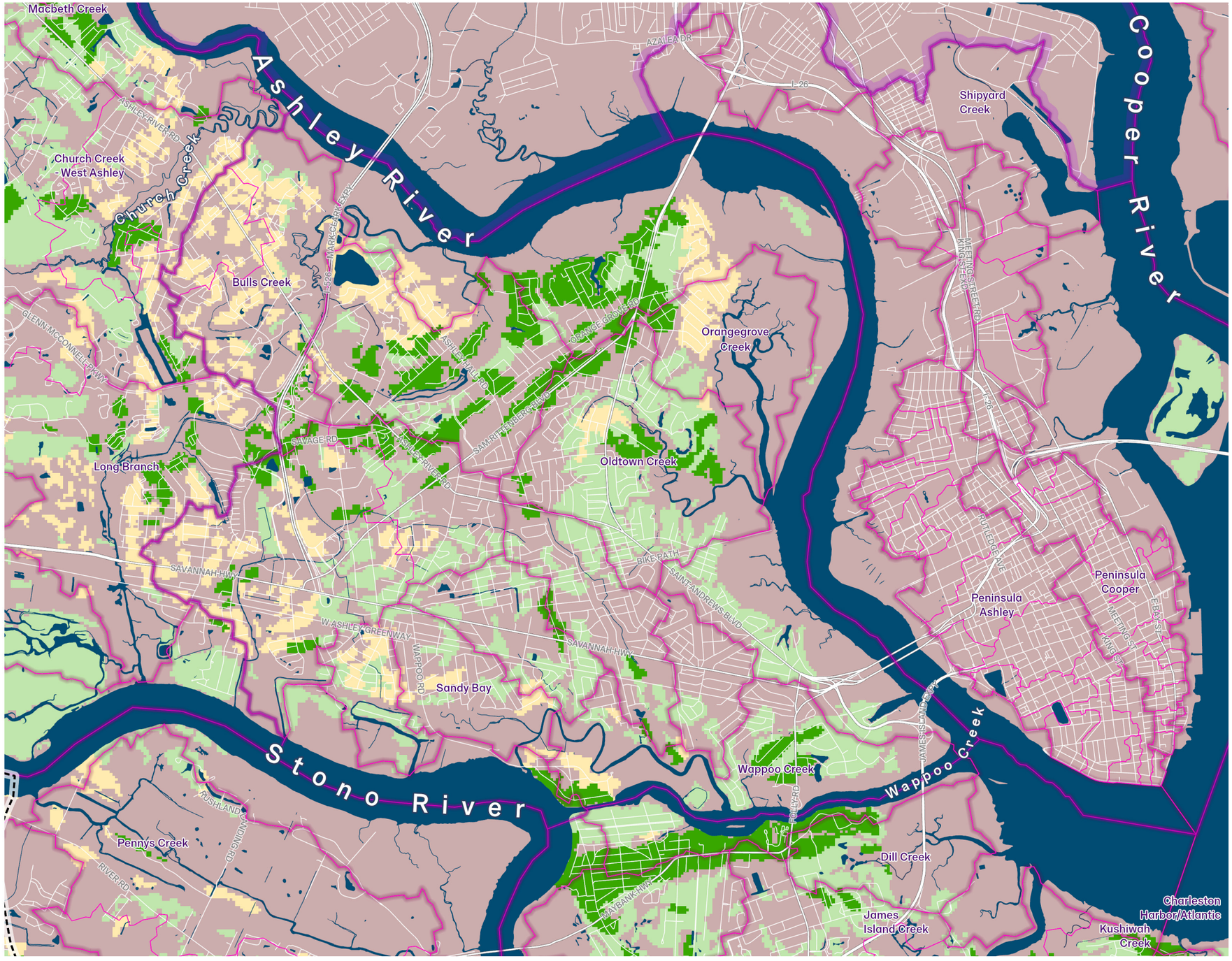
SOIL TYPES

Pockets of high ground in inner West Ashley have a high capacity for infiltration.

map sources: USDA

HYDROLOGIC GROUPS

- A: ABSORBS THE MOST WATER
- B: ABSORBS SOME WATER
- C: ABSORBS LITTLE WATER
- D: POORLY DRAINED AND/OR ABSORBS BASICALLY NO WATER



1 inch = 4,000 feet

Miles

1

TREE CANOPY DENSITY & CHANGE

Tree canopy is stable and somewhat dense.

map sources: GLCF



Legend

Tree Canopy (2015)

Dense

Sparse

Canopy Change (2000-2015)

High Gain

High Loss

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

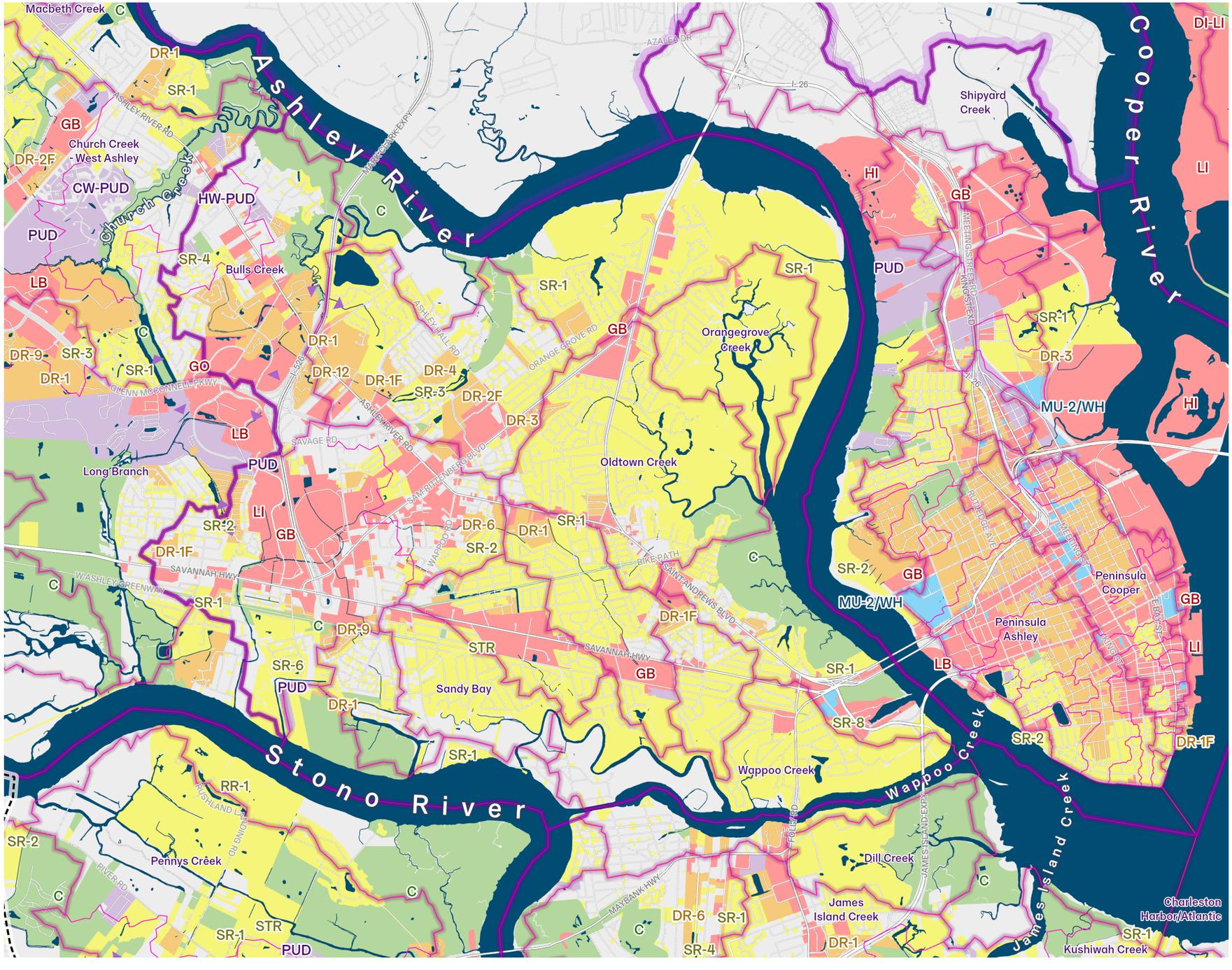
Water

1 inch = 4,000 feet

Miles 1

ZONING

Fragmented political jurisdictions result in zoning gaps.



Legend

Zoning

- Parks & Conservation
- Single Family Residential
- Diverse Residential
- Planned Development
- Mixed Use
- Business & Industrial

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

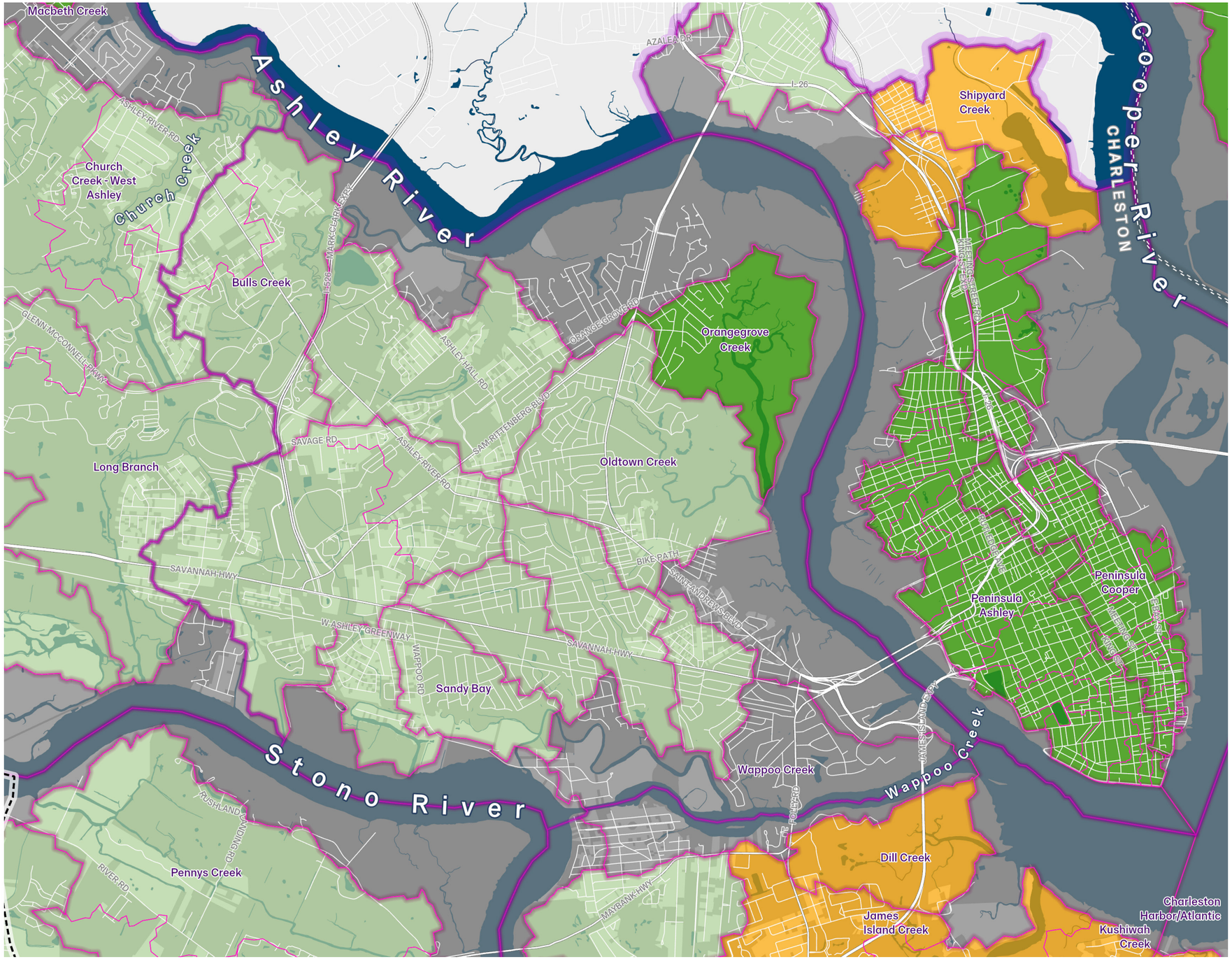
Water

1 inch = 4,000 feet

Miles 1

JURISDICTIONAL COMPLEXITY

Most of Inner West Ashley's watersheds criss-cross a patchwork of incorporated space.



Legend

Watershed Jurisdiction

- Entirely Within Charleston City
- Single-City, Single-County
- No City, Single-County
- Multi-City, Single-County
- Multi-City, Multi-County
- Excluded

Counties

- Charleston City Limits

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary

Water

- Water

1 inch = 4,000 feet

Miles 1

LAND & WATER IMPLICATIONS

ELEVATION RISK ZONES

ELEVATION RISK ZONES & WATERSHED SENSITIVITY

ELEVATION ZONES

A large swath of relatively high ground exists in Inner West Ashley along Sam Rittenberg Blvd near Old Charles Towne.

HIGH GROUND

High ground is defined as land outside of the FEMA 100 year floodplain and above the NOAA max category 3 storm surge. High ground has the lowest flood risk and stormwater detention here has the greatest watershed benefit.

ADAPT ZONE

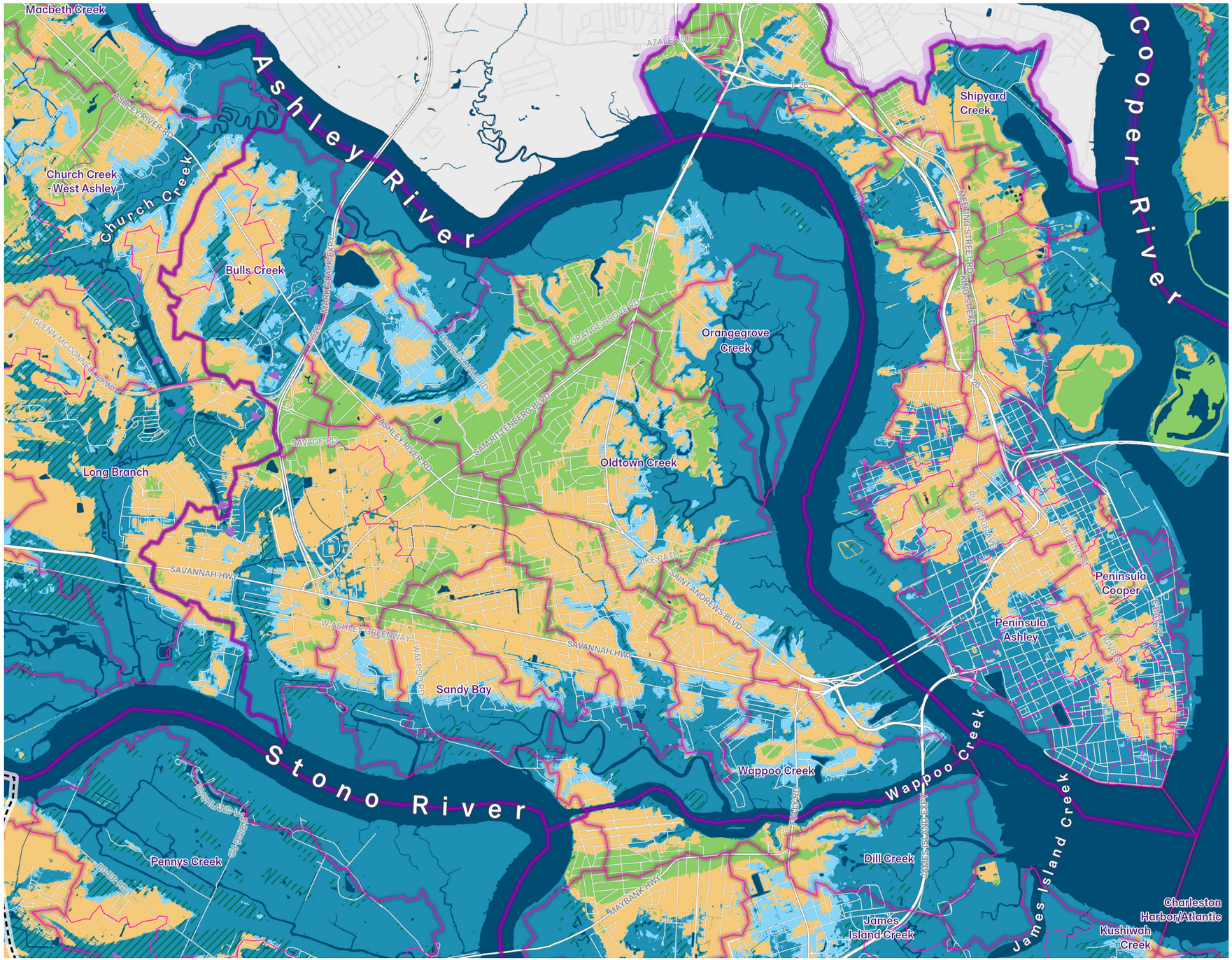
The adapt zone consists of land outside of the FEMA 100 year floodplain that is still within the NOAA maximum storm surge of a category 3 hurricane. Rain and storm surge flooding in this zone is infrequent but not impossible.

COMPOUND FLOOD RISK

This zone encompasses areas within the floodplain above the tidal flood risk zone where flood risk comes from a mixture of rainfall, runoff and tidal conditions.

TIDAL FLOOD RISK ZONE

This zone encompasses the lowest land in Charleston. Nearly 100% of this zone is in the 100 year floodplain. Flooding is frequent and can come solely from tidal events independent of precipitation. Sea level rise driven marsh migration occurs in this dynamic zone.



Marsh Migration Zone

1 inch = 4,000 feet

Miles 1

ELEVATION RISK + WATERSHED SENSITIVITY

Most of inner West Ashley's watersheds are small and low sensitivity with a moderately low number of vulnerable parcels.

HIGH SENSITIVITY

Combination of more flood prone watersheds and a high number of vulnerable parcels. Typically larger tidal watersheds and/or watersheds where development happened before BFE regulations.

NORMAL SENSITIVITY

Combination of less flood prone watersheds and a low number of vulnerable parcels. Typically smaller and/or less developed watersheds.

HIGH GROUND

ADAPT ZONE

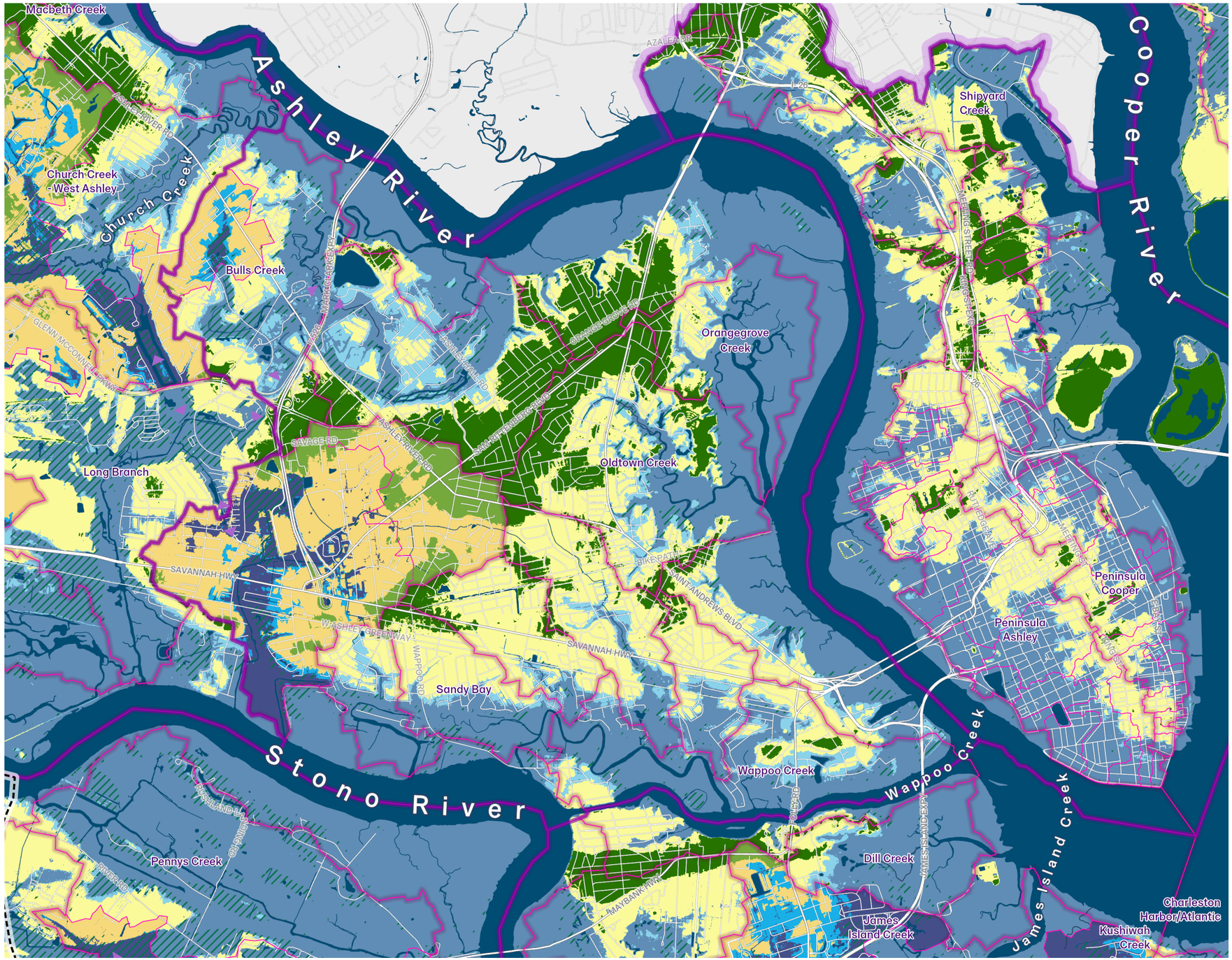
COMPOUND FLOOD RISK

TIDAL FLOOD RISK ZONE

Marsh Migration Zone

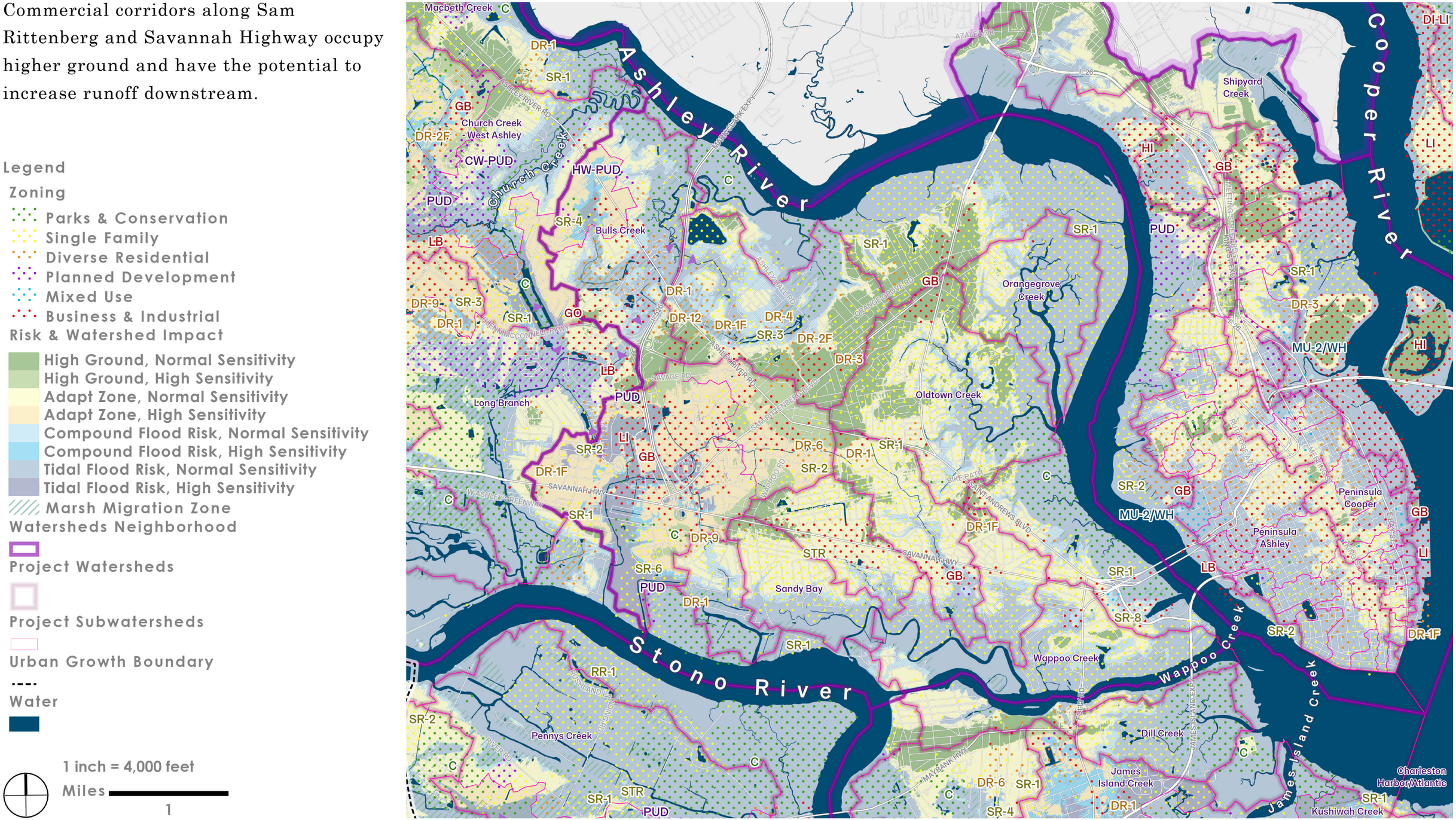
1 inch = 4,000 feet

Miles 1



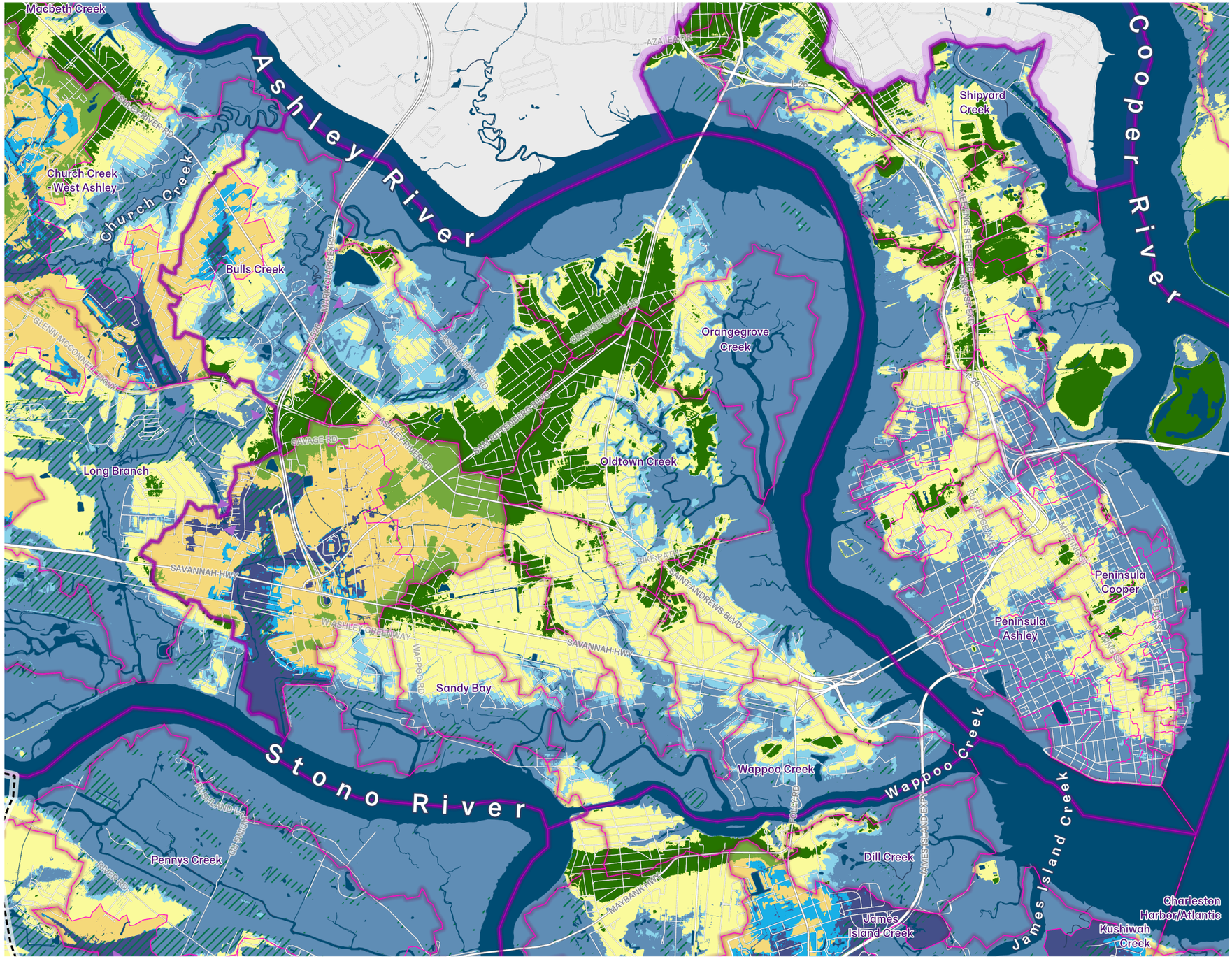
RISK + SENSITIVITY + ZONING

Commercial corridors along Sam Rittenberg and Savannah Highway occupy higher ground and have the potential to increase runoff downstream.



LAND & WATER IMPLICATIONS

- Significant areas are outside of the 100 year floodplain.
- Within the 100 year floodplain, many structures were built prior to BFE regulations and therefore likely fall below current elevation standards.
- High ground occurs primarily along Sam Rittenberg Blvd.
- Soils in the high ground and adapt zone are typically well suited for infiltration.
- While most of the watersheds are smaller, drainage constrictions created by dense development and transportation corridors can exacerbate flooding.



1 inch = 4,000 feet

Miles 1

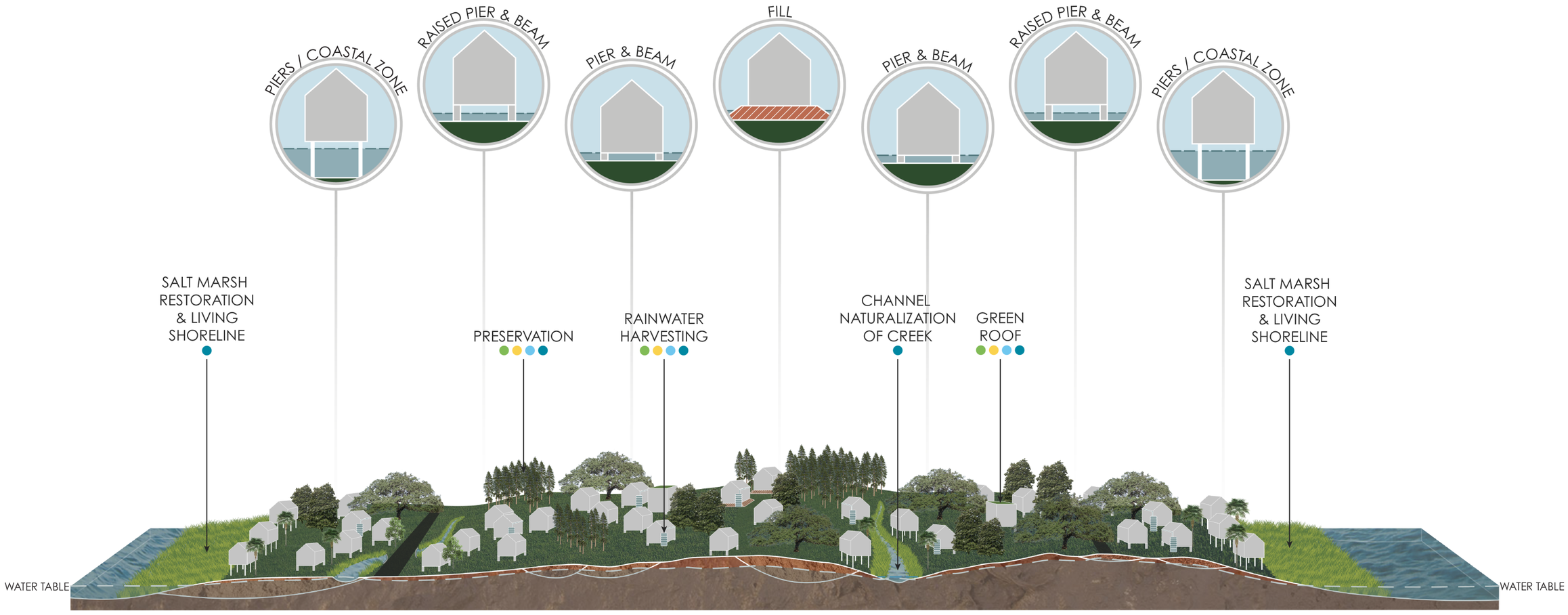
OUTER WEST ASHLEY

WATER

LAND

RISK ZONES

RECOMMENDATIONS



OUTER WEST ASHLEY TRANSECT

STONO	MARSH	GROUP B SOIL	GROUP D SOIL	C SOIL	B SOIL	D SOIL	GROUP B SOIL	GROUP D SOIL	C SOIL		C SOIL	D	MARSH	ASHLEY RIVER
TIDAL FLOOD RISK	ADAPT ZONE			HIGH GROUND	ADAPT	TIDAL		ADAPT	HIGH GROUND		ADAPT	TIDAL FLOOD RISK		

SURCULUS

WATER

WATERSHEDS

WATERSHED TYPES

WATERSHED VULNERABILITY

100 YEAR FLOODPLAIN

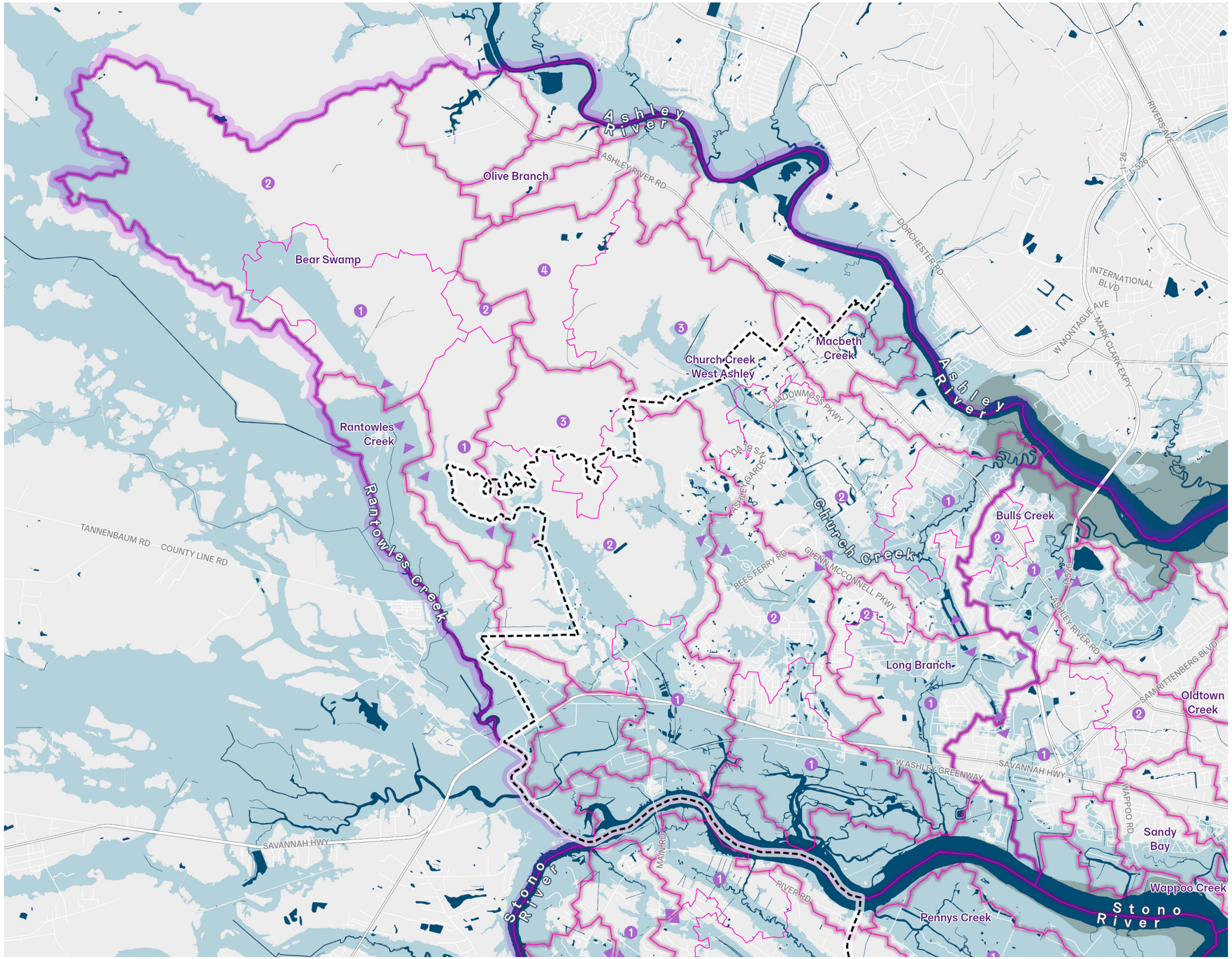
STORM SURGE

SEA LEVEL RISE

MARSH MIGRATION

WATERSHEDS

Outer West Ashley has 11 watersheds, many of which are large and extend well beyond the city limits of Charleston (e.g. Church Creek and Bear Swamp). These swampy watersheds have many points of interconnectivity where the boundary between watersheds is fluid and floodwater can easily spill from one watershed to another.



Legend

DFIRM

100 Year Floodplain

VE Zone

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Subwatershed Order (1 being closest to the outlet)

Watershed Interconnectivity Point

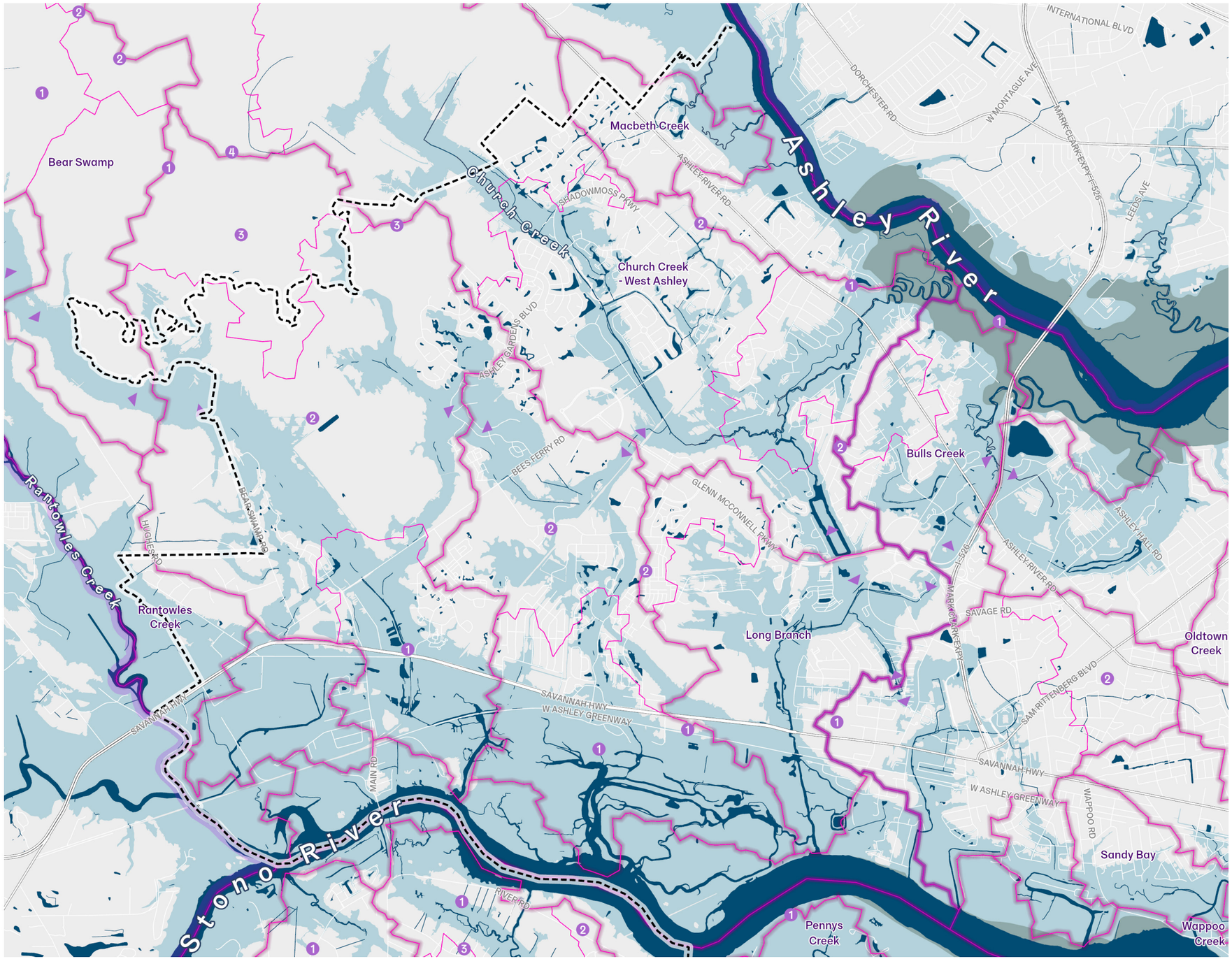
1 inch = 6,000 feet

Miles

1

WATERSHEDS

There are 8, mostly large watersheds, within the urban growth boundary in outer West Ashley.



Legend

DFIRM

- 100 Year Floodplain
- VE Zone

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

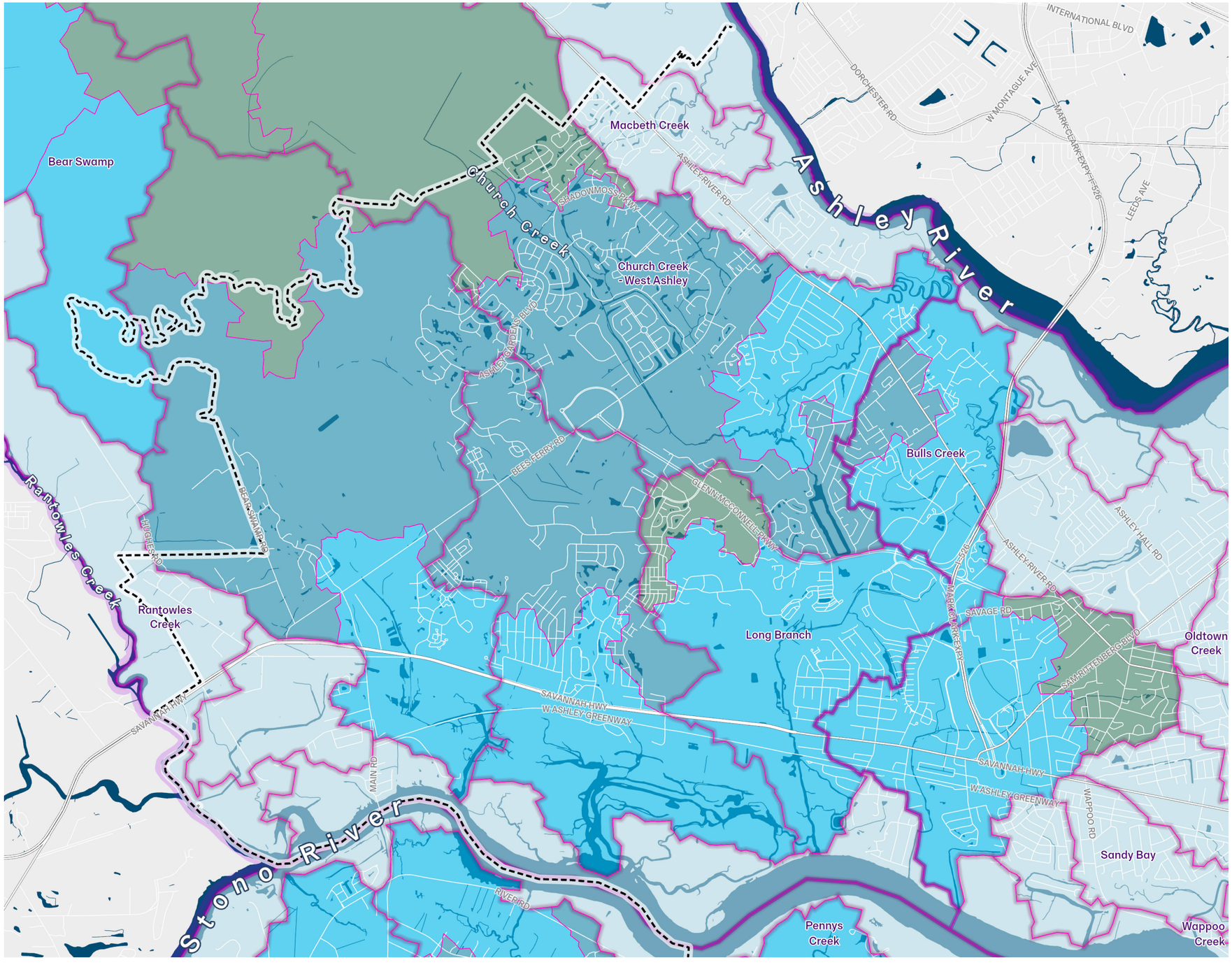
- # Subwatershed Order (1 being closest to the outlet)
- Watershed Interconnectivity Point

1 inch = 4,000 feet

Miles 1

WATERSHED TYPES

Most of the watersheds in outer West Ashley are large enough to contain upstream and downstream subwatersheds, so there is greater potential for consequences to compound as water moves downstream.



Legend

Subwatershed Type
- Small, Tidal
- Large, Outlet Tidal
- Large, Upstream Tidal
- Large, Upstream Inland

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

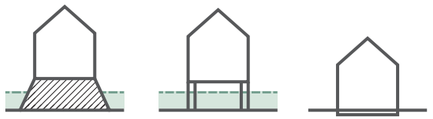
Urban Growth Boundary

Water
- Water

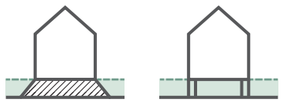
1 inch = 4,000 feet

Miles 1

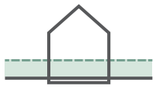
STRUCTURE VULNERABILITY
USING THE 2020 RISK AND VULNERABILITY ASSESSMENT DEFINITIONS



Low Combined Vulnerability & Risk
Outside the 100 year floodplain
Built after BFE+1 requirements



Medium Combined Vulnerability & Risk
In the 100 year floodplain
Built after BFE requirements or raised to BFE



High Combined Vulnerability & Risk
In the 100 year floodplain
Built before BFE requirements

*All heights relative to BFE need verification

100 Year Floodplain and BFE
- No BFE
- BFE

Watersheds Neighborhood

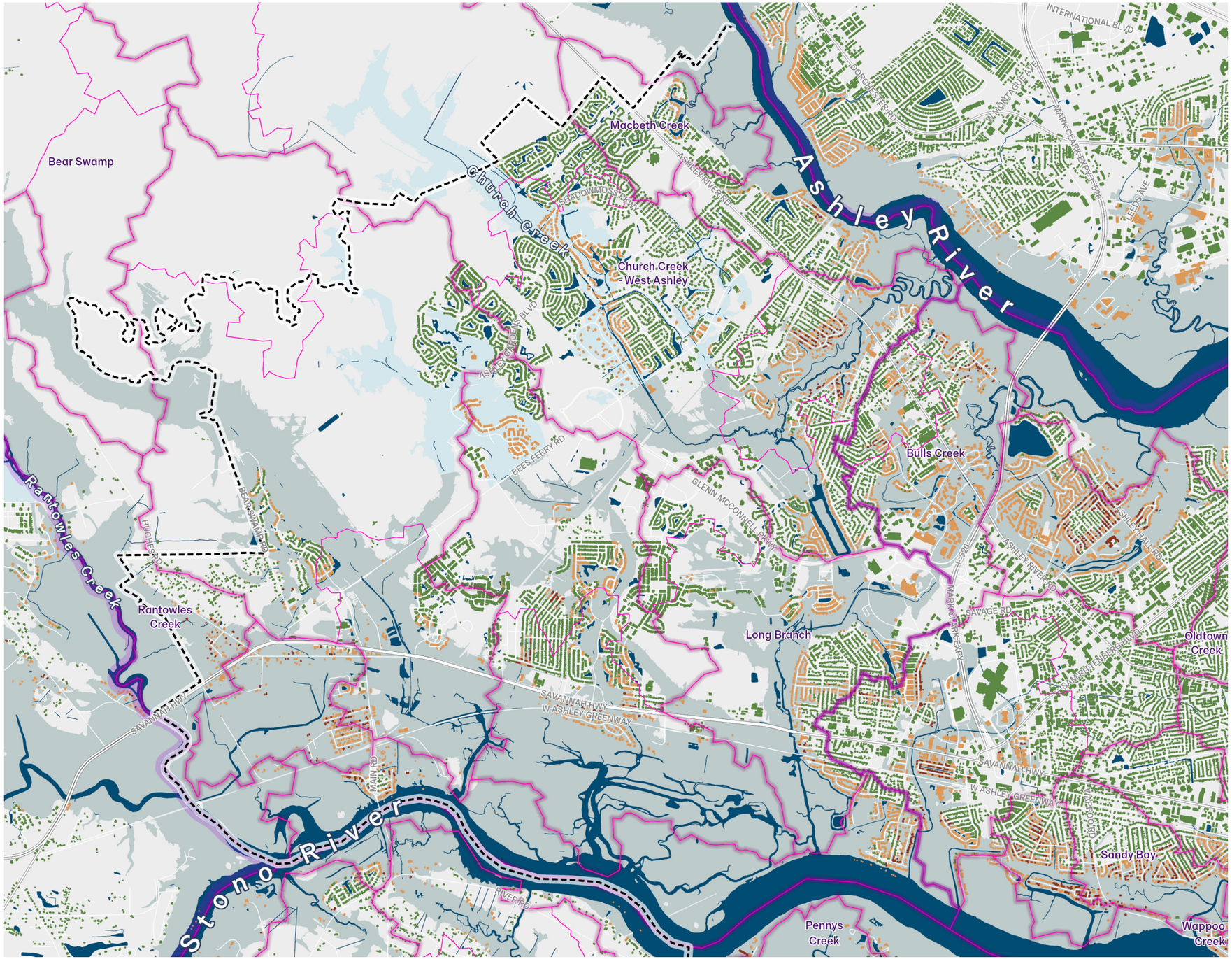
Project Watersheds

Project Subwatersheds

Urban Growth Boundary

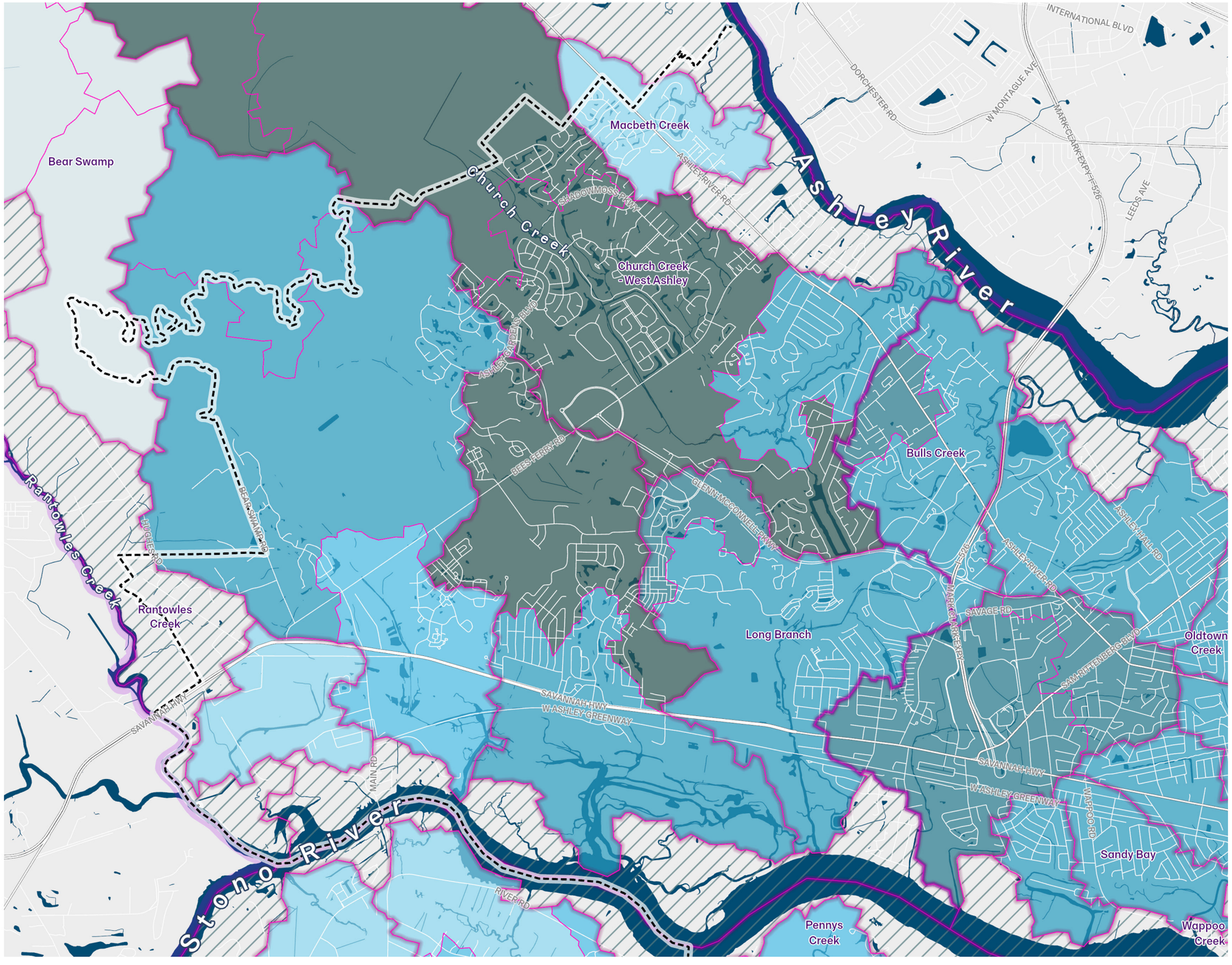
Water
- Water

1 inch = 4,000 feet
Miles 1



NUMBER OF VULNERABLE PARCELS

The Church Creek watershed has a greater number of vulnerable parcels than most watersheds in Charleston.



Legend

Vulnerable Parcels Local & Downstream

- ≤10
- ≤250
- ≤500
- ≤1000
- ≤1500
- >1500
- <excluded>

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

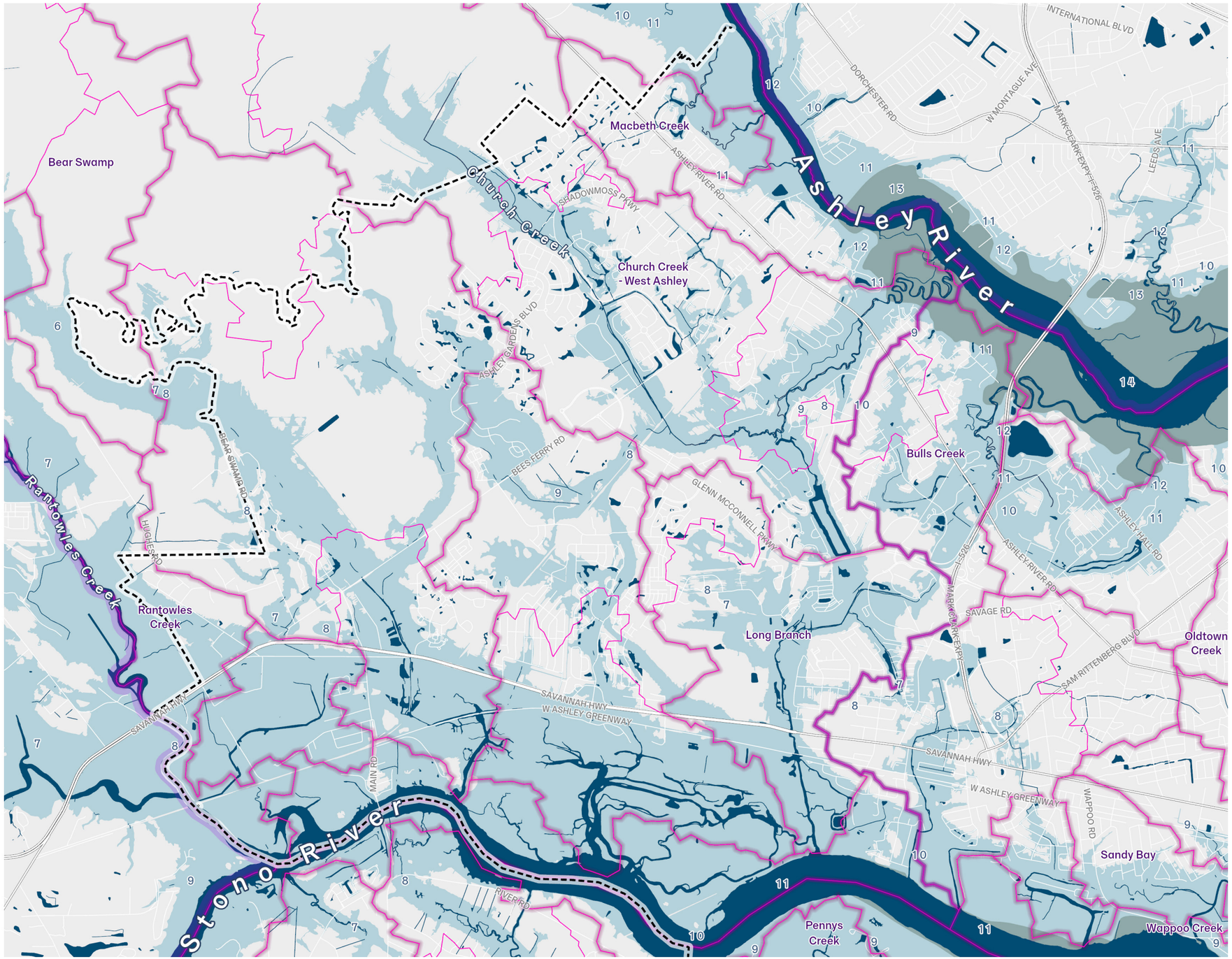
1 inch = 4,000 feet

Miles 1

100 YEAR FLOODPLAIN

The floodplain in outer West Ashley is flat, sprawling and interconnected. One watershed's impact can easily spill over into another.

map sources: FEMA



Legend

DFIRM (**Blue #'s** are BFE in NAVD)

- 100 Year Floodplain
- VE Zone

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

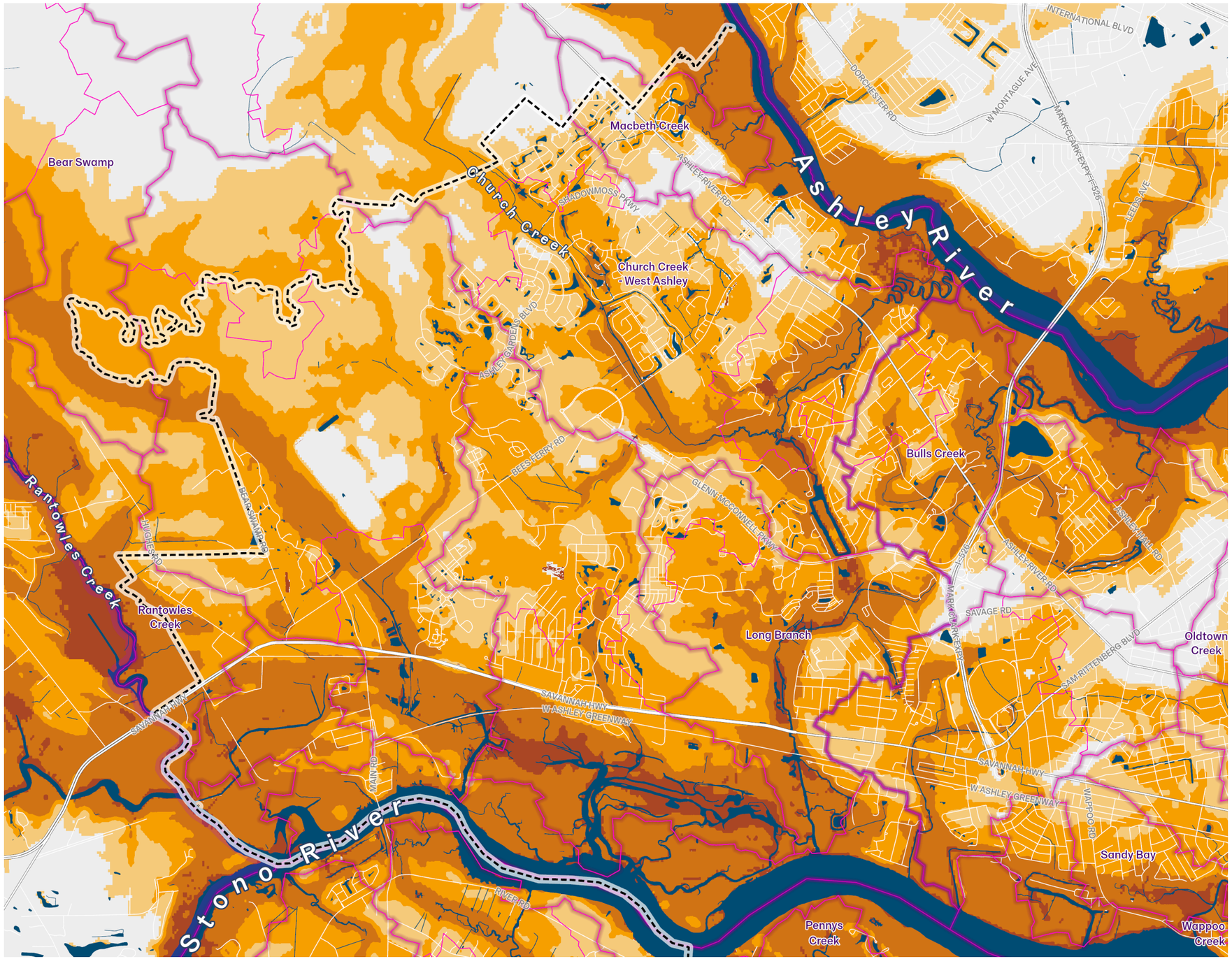
1 inch = 4,000 feet

Miles 1

MAXIMUM CATEGORY 3 STORM SURGE

Despite being somewhat inland, most of outer West Ashley is in the maximum category 3 storm surge zone.

map sources: NOAA



Legend

Cat 3 Max Storm Surge (Above Ground)

- <5 ft
- 5-10 ft
- 10-15 ft
- >15 ft

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

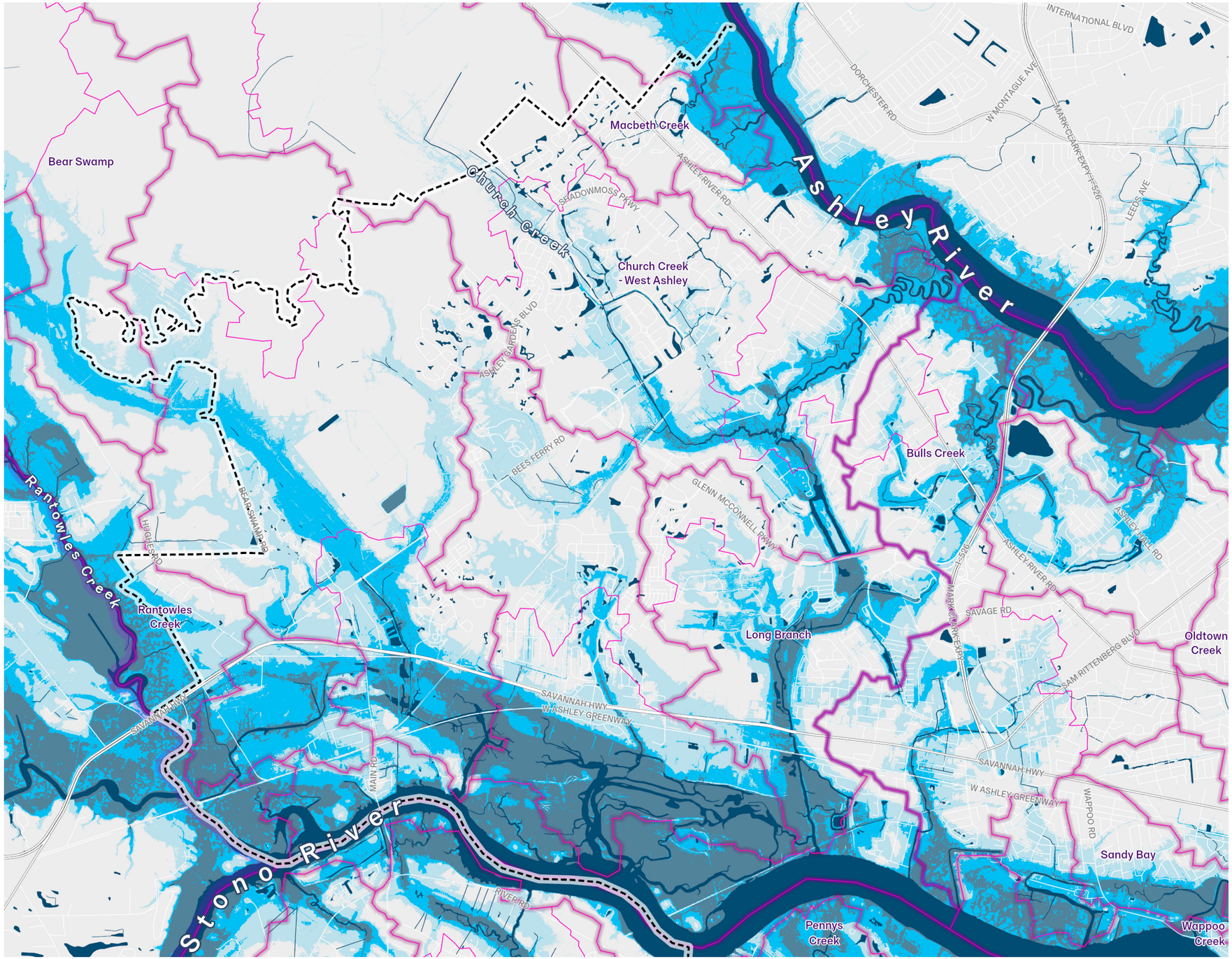
1 inch = 4,000 feet

Miles 1

TIDES AND SEA LEVEL RISE

3 feet of sea level rise significantly impacts outer West Ashley's waterways, extending tidal influence far upstream and potentially exacerbating the drainage issues that already exist in many of the watersheds (e.g. Church Creek).

map sources: NOAA, USGS



Legend

Tides and Sea Level Rise

- Current MHHW
- MHHW +3ft of Sea Level Rise
- Highest Recorded Water Level (Hugo)

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

1 inch = 4,000 feet

Miles 1

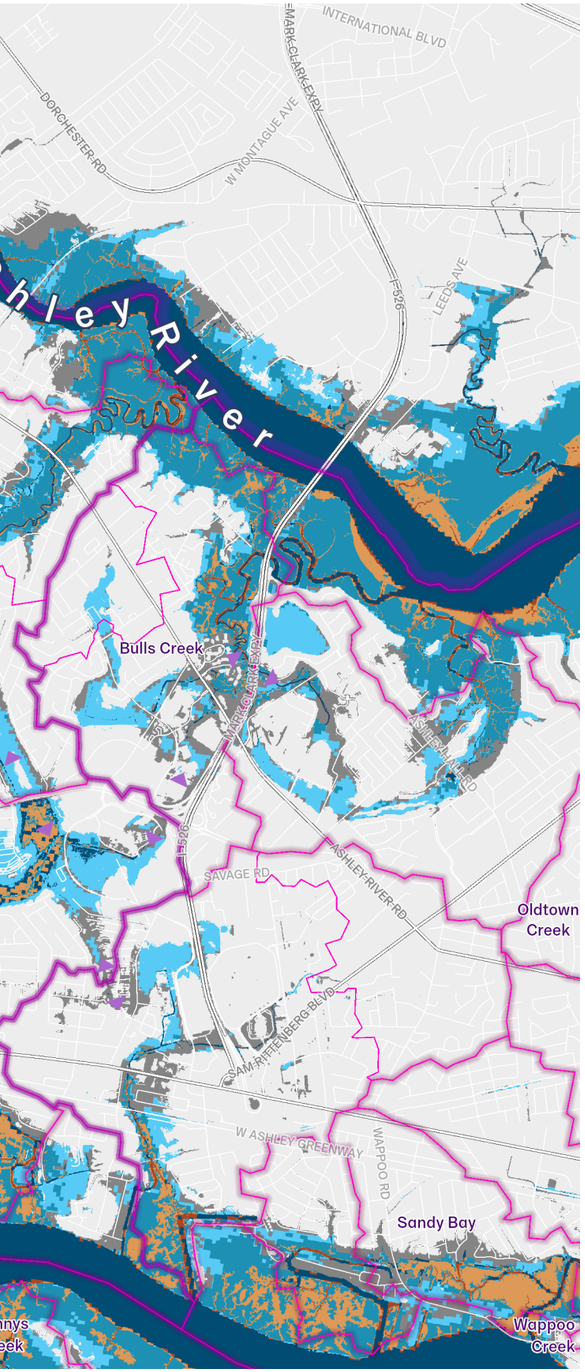
MARSH MIGRATION WITH 3 FT OF SEA LEVEL RISE

Much of the marsh migration zone in Charleston exists in the swampy watersheds of outer West Ashley, especially near Rantowles Creek and Bear Swamp.

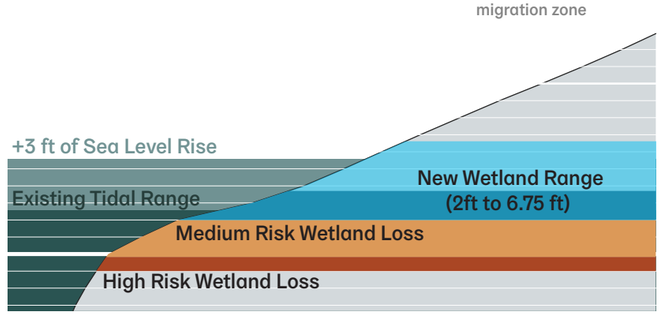
map sources: USGS MLRC Consortium

EXISTING WETLAND RANGE
≈ -1 TO 3.75 FT (NAVD)

WETLAND MIGRATION ZONE
≈ 2 TO 6.75 FT (NAVD)







1 inch = 4,000 feet

Miles 1

LAND COVER IN THE MARSH MIGRATION ZONE

Large swaths of inland woody wetlands and evergreen forests near the Stono River could transition to herbaceous wetlands in outer West Ashley.

map sources: USGS, MLRC Consortium

Legend

Land Cover in Wetland Migration Zone

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands

Wetland Migration

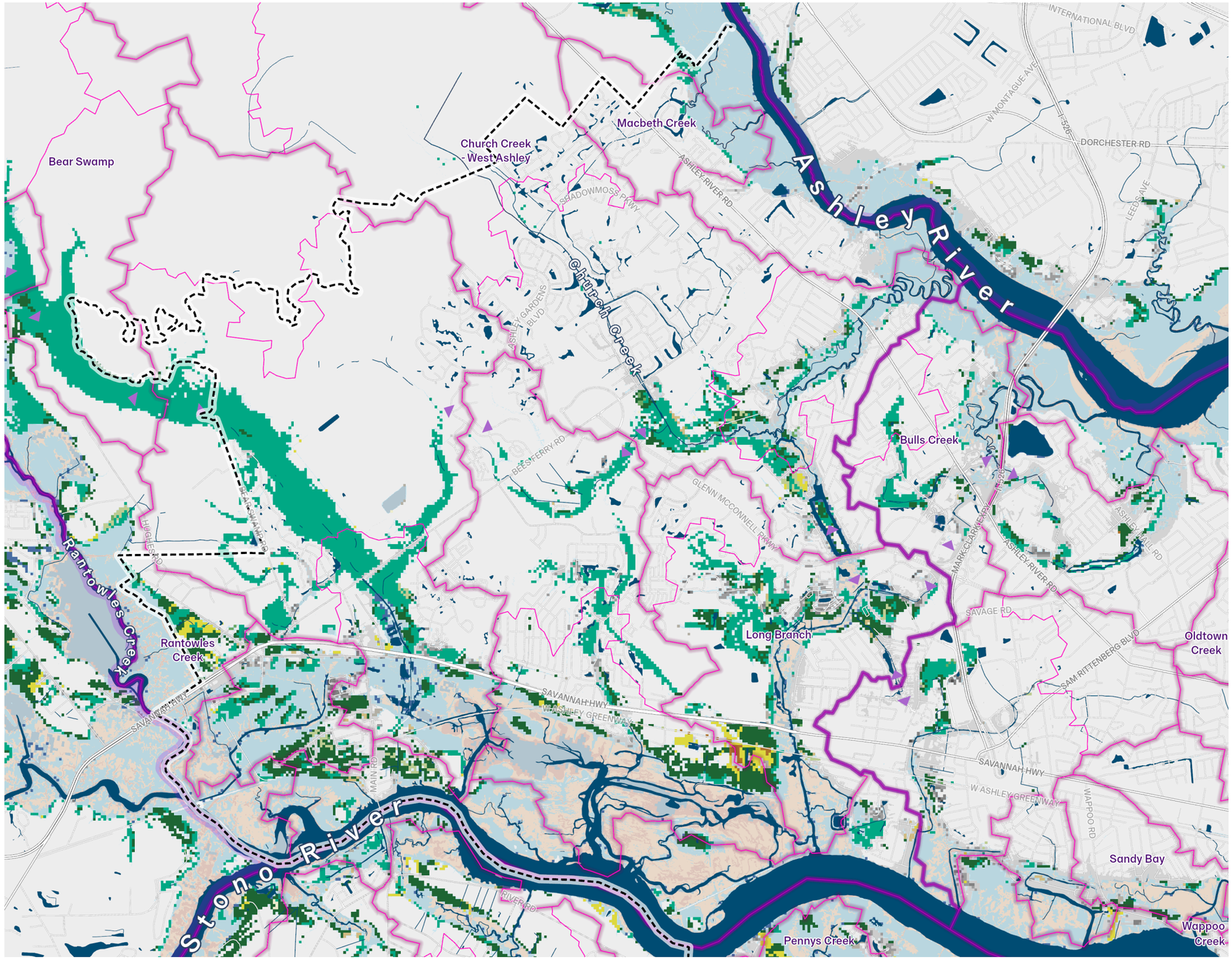
- High Risk Wetland Loss
- Medium Risk Wetland Loss
- Low Risk Wetland Loss
- Wetland Migration Zone
- Wetland Migration Zone - Developed

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary
- Water

1 inch = 4,000 feet

Miles 1



LAND

ELEVATION

LAND COVER

ELEVATION & LAND COVER DISTRIBUTION

SOIL

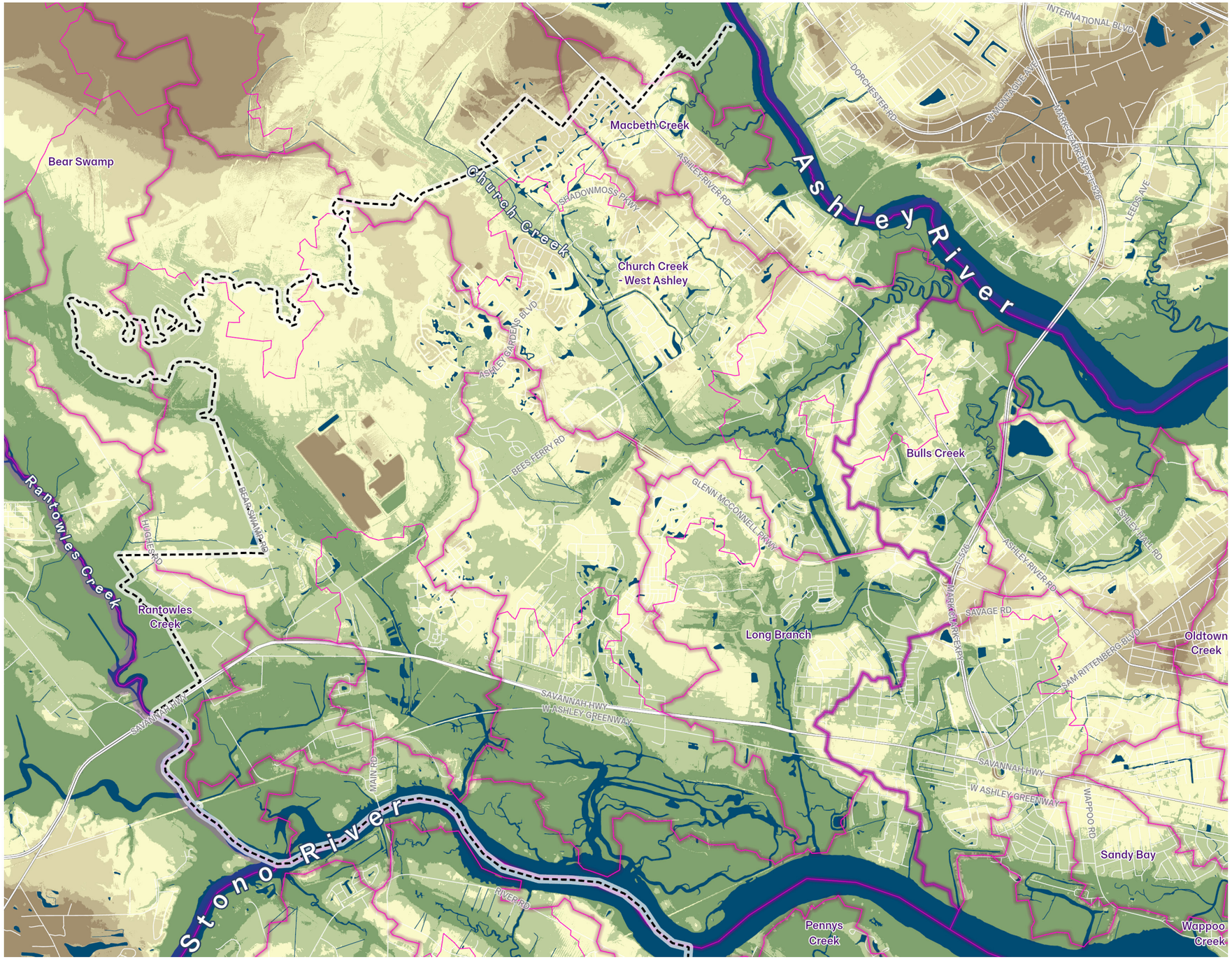
TREE CANOPY

JURISDICTIONS

ELEVATION

Most of outer West Ashley is low with small patches of moderately high ground spread throughout. Drainage is a challenge over long stretches of ground with little slope.

map sources: USGS



Legend

Elevation (NAVD88)

- >25 ft
- 20-25 ft
- 15-20 ft
- 10-15 ft
- 5-10 ft
- <5 ft

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

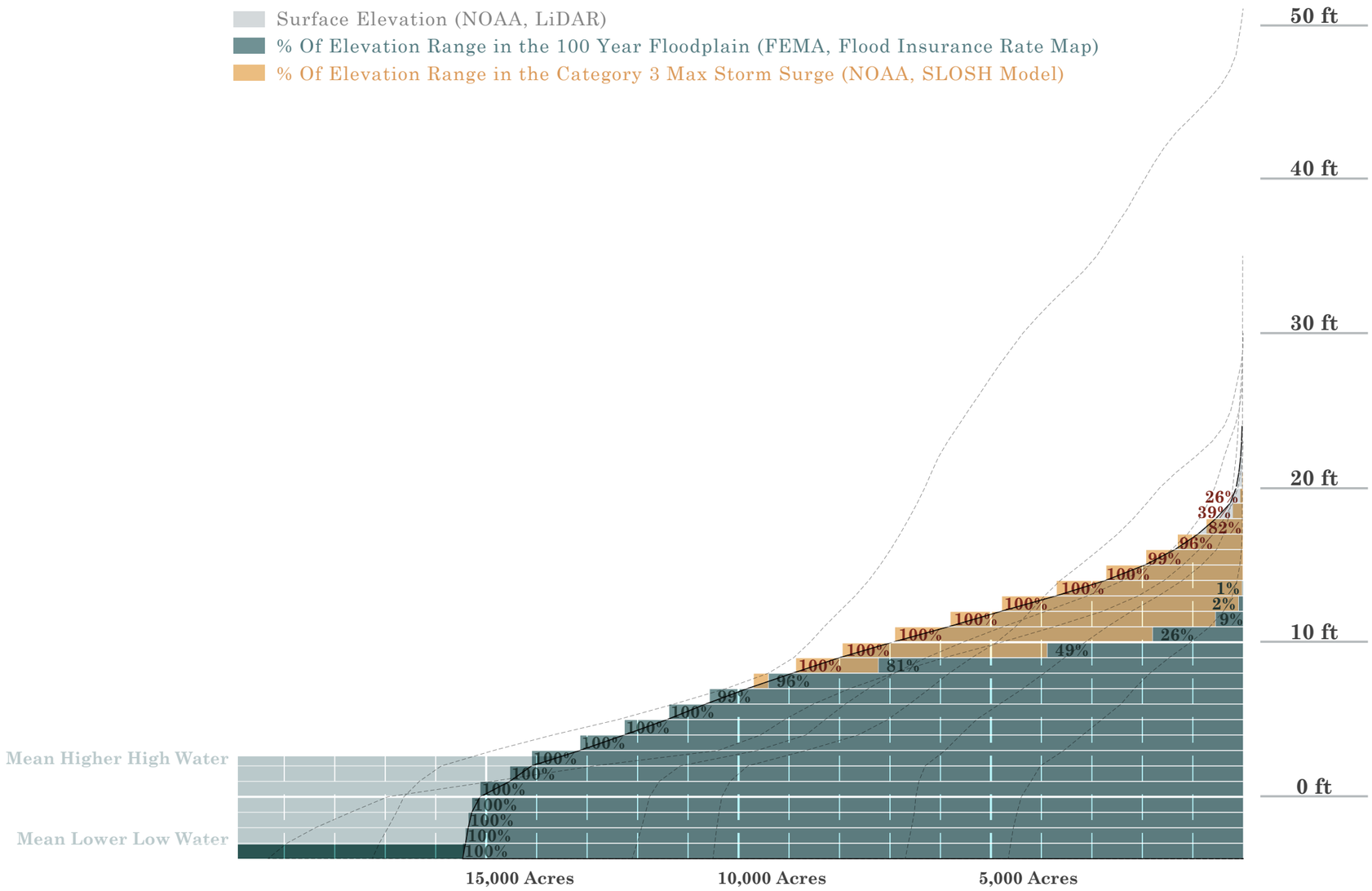
Water

1 inch = 4,000 feet

Miles 1

SURFACE ELEVATION DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

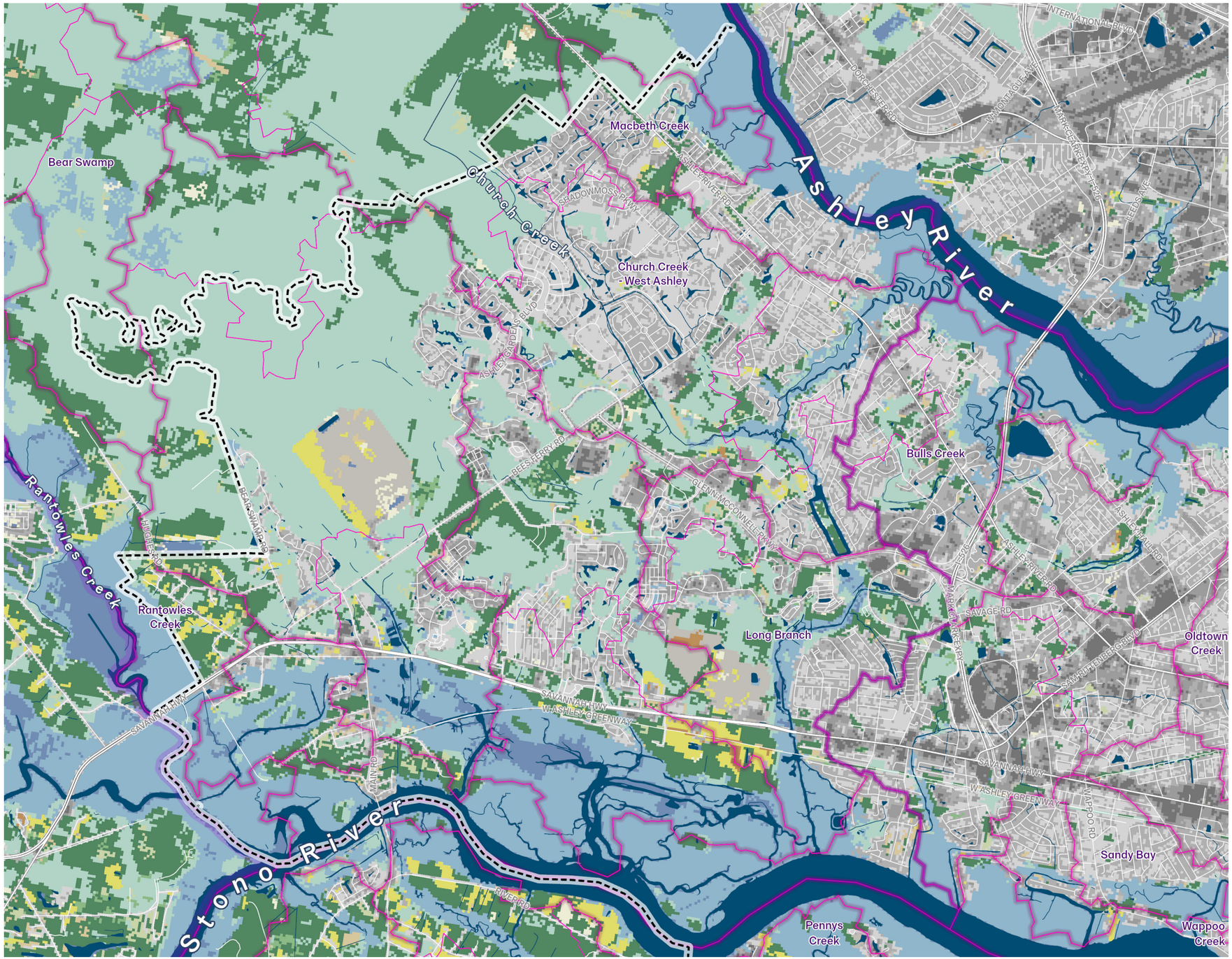
Most land surface at or below 9’ is in the floodplain. Almost all of inner West Ashley land is at risk from max category 3 storm surge.



LAND COVER

Outer West Ashley still has large portions of swampy undeveloped land, often located in upstream conditions.

map sources: NLCD



Legend

Land Cover 2016

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetland

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

Water

1 inch = 4,000 feet

Miles 1

ELEVATION & LAND COVER DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

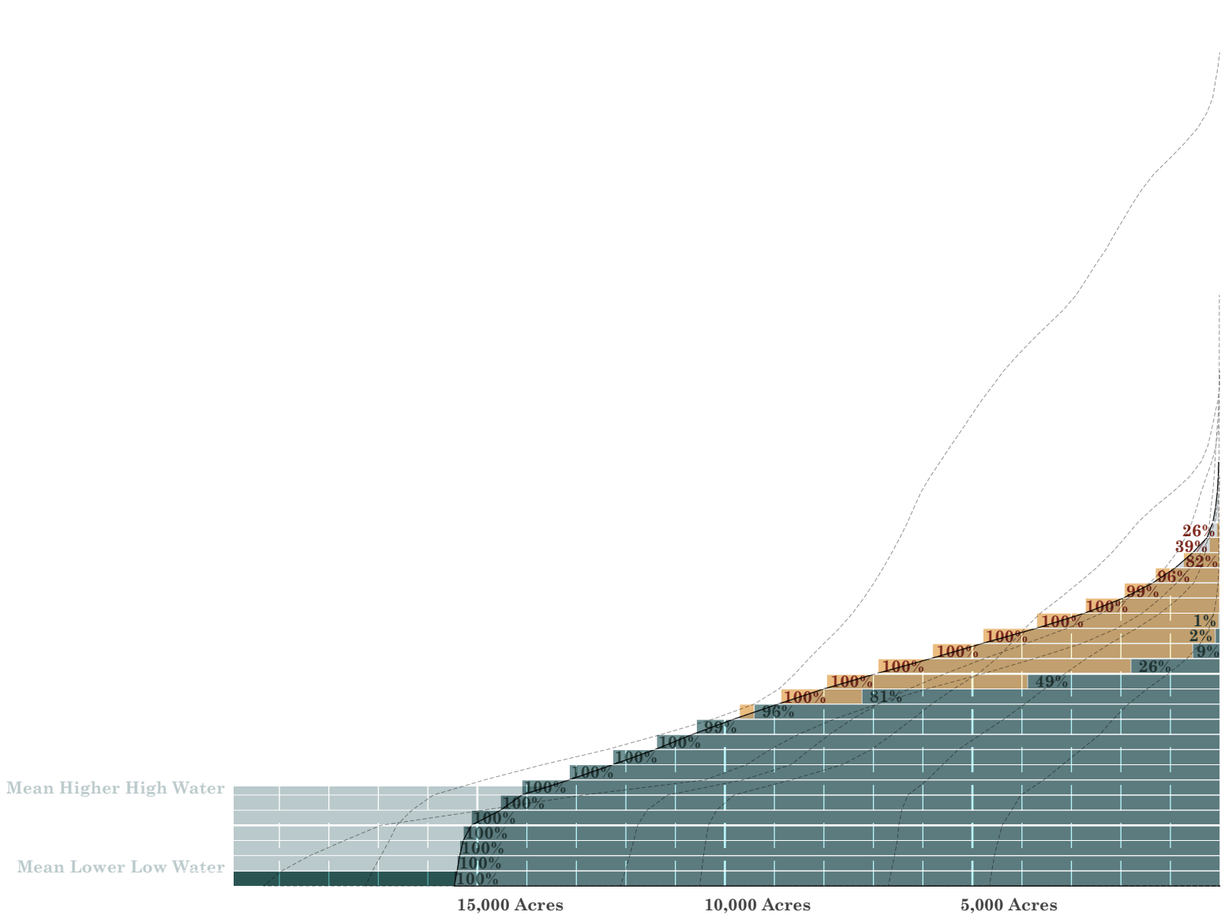
OUTER WEST ASHLEY

SURFACE ELEVATION

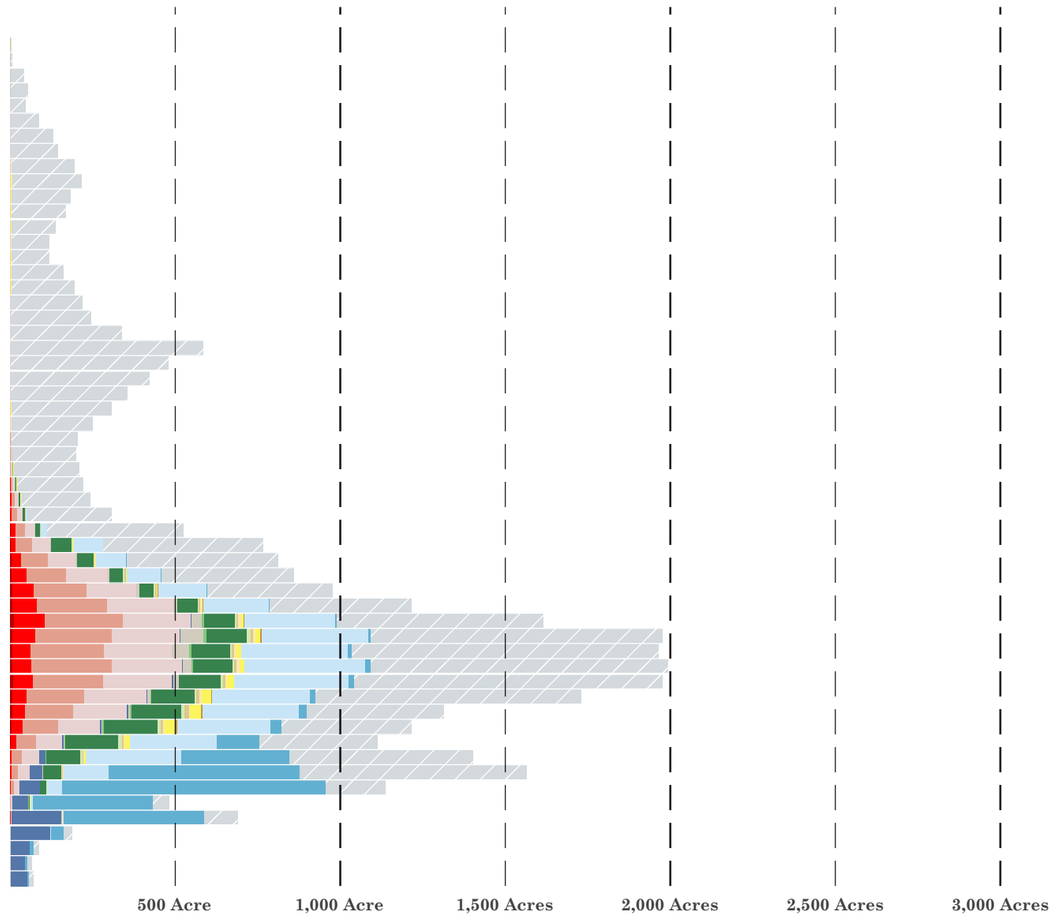
- Surface Elevation (NOAA, LiDAR)
- % Of Elevation Range in the 100 Year Floodplain (FEMA, Flood Insurance Rate Map)
- % Of Elevation Range in the Category 3 Max Storm Surge (NOAA, SLOSH Model)

LAND COVER

- Developed High Intensity
- Developed Medium Intensity
- Developed Low Intensity
- Developed Open Space
- Open Water
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Shrub/Scrub
- Grassland
- Pasture
- Crops
- Woody Wetland
- Emergent Herbaceous Wetland
- Outside Urban Growth Boundary



ACRES
(STARTING AT MEAN LOWER LOW WATER)

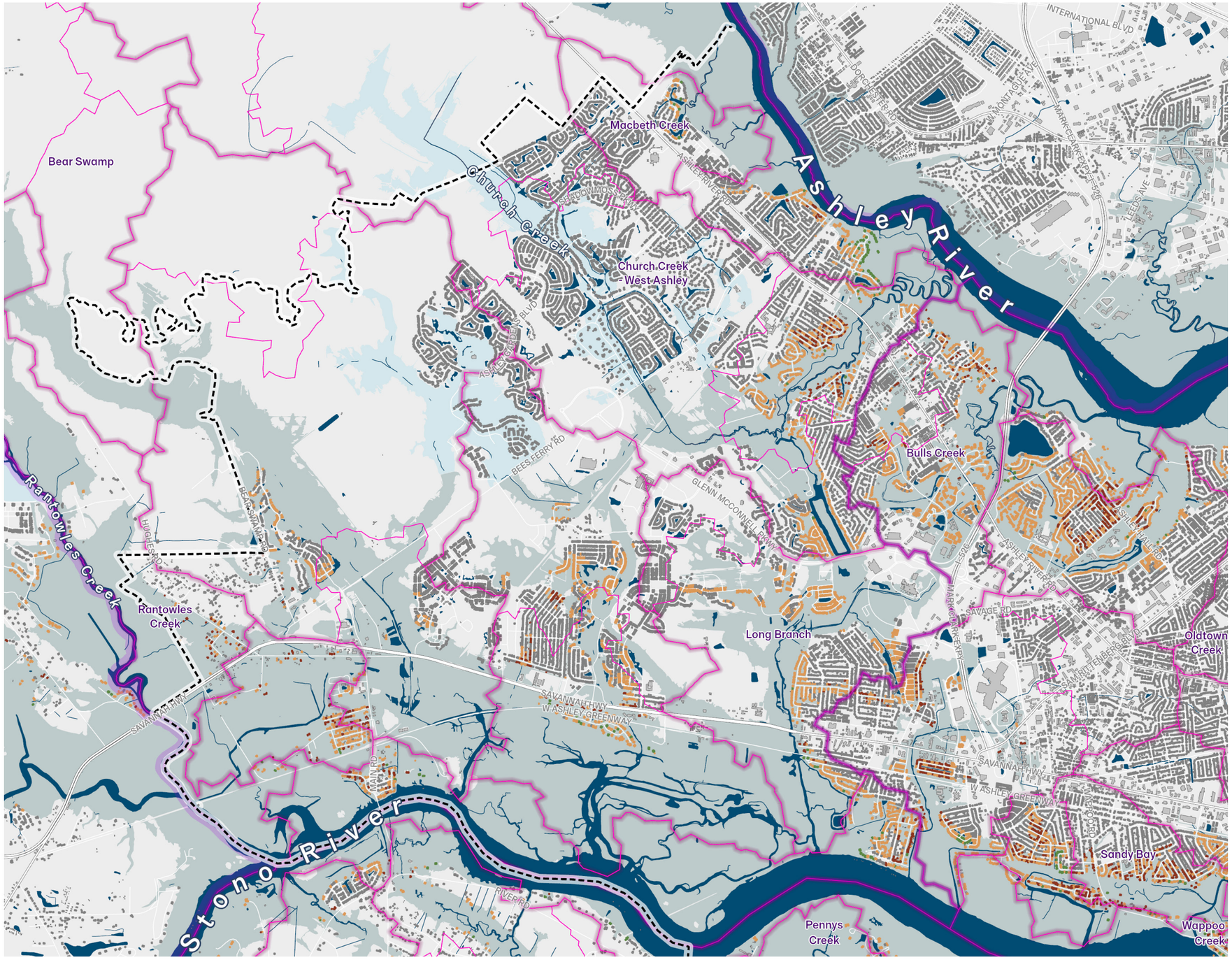


LANDCOVER DISTRIBUTION IN WATERSHED
(National Land Cover Database)

RESIDENTIAL BUILDING TYPE

Much of the development in outer West Ashley's floodplain happened either prior to BFE regulation or in areas where no BFE has currently been set.

map sources: FEMA



Legend

Residential Structures

- Outside Floodplain, all footing types
- Built to BFE/BFE+2, Peirs
- Built to BFE/BFE+2, Slab-on-Grade or Unknown
- Built Pre-BFE Regulations
- Non Residential

100 Year Floodplain and BFE

- No BFE
- BFE

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

1 inch = 4,000 feet

Miles 1

ELEVATION & RESIDENTIAL BUILDING TYPE DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

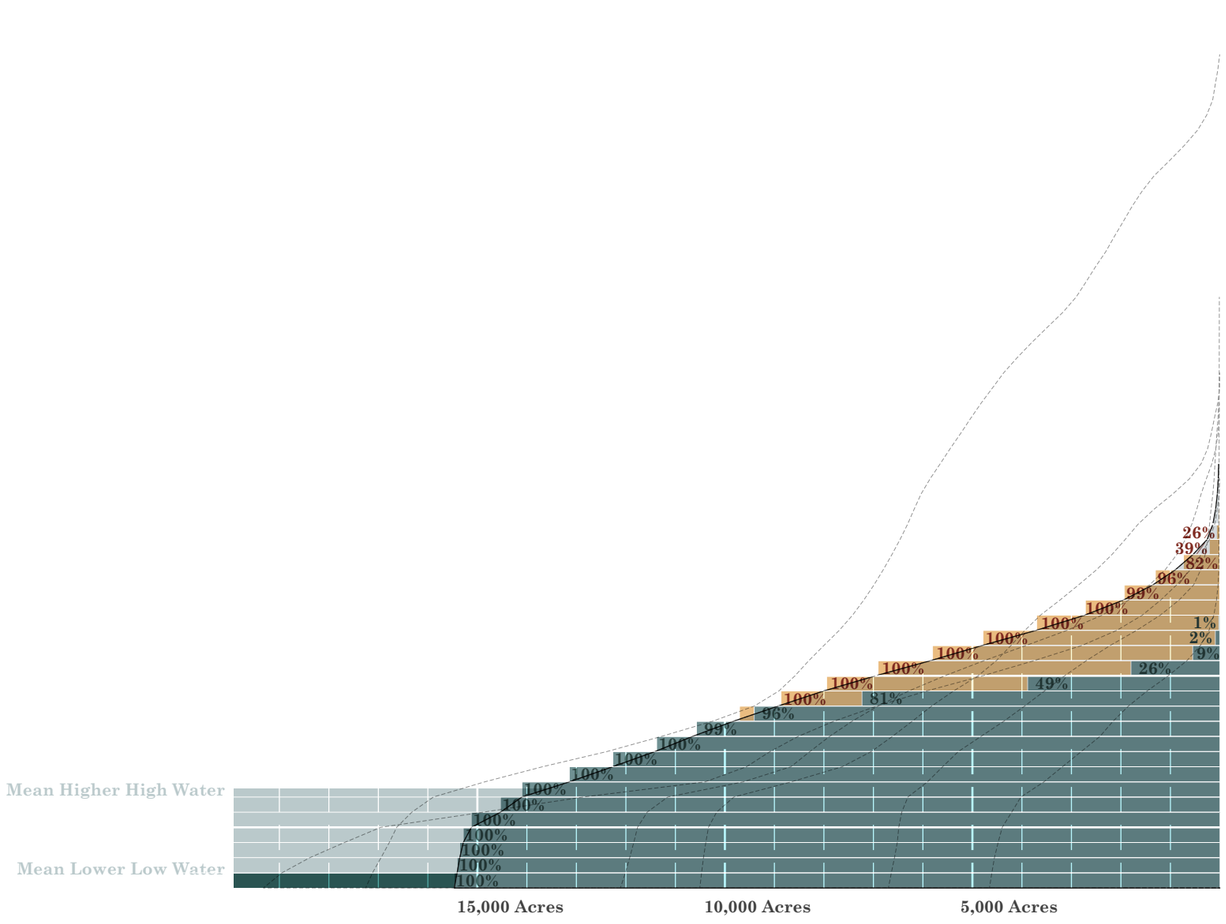
OUTER WEST ASHLEY

SURFACE ELEVATION

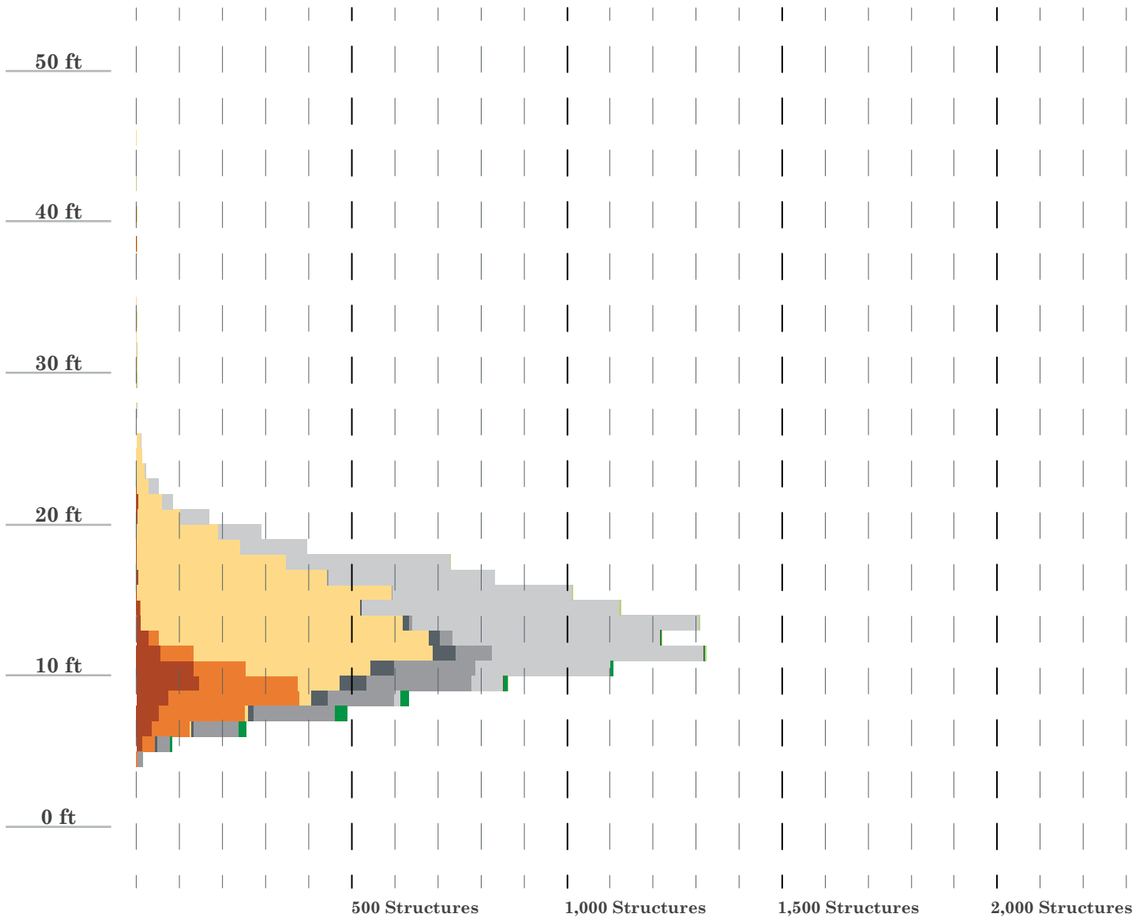
- Surface Elevation (NOAA, LiDAR)
- % Of Elevation Range in the 100 Year Floodplain (FEMA, Flood Insurance Rate Map)
- % Of Elevation Range in the Category 3 Max Storm Surge (NOAA, SLOSH Model)

RESIDENTIAL STRUCTURES

- Slab on Grade: inside 100 year floodplain before BFE requirement
- Slab on Grade: inside 100 year floodplain rasied to BFE/BFE+1
- Slab on Grade: outside 100 year floodplain
- Unknown: inside 100 year floodplain before BFE requirement
- Unknown: inside 100 year floodplain rasied to BFE/BFE+1
- Unknown: outside 100 year floodplain
- On Peirs: inside 100 year floodplain before BFE requirement
- On Peirs: inside 100 year floodplain rasied to BFE/BFE+1
- On Peirs: outside 100 year floodplain



ACRES
(STARTING AT MEAN LOWER LOW WATER)



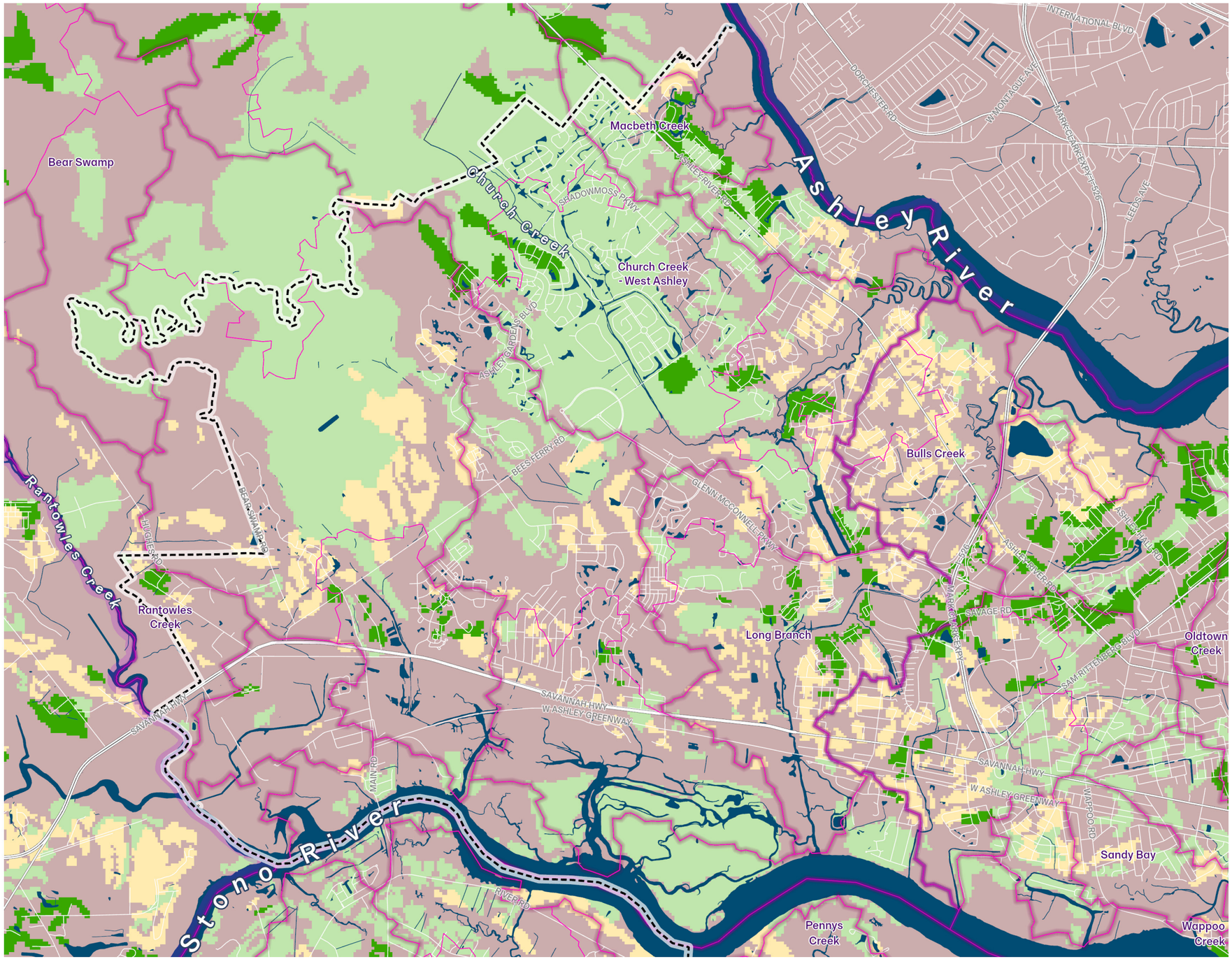
STRUCTURE BASE ELEVATIONS
(STARTING AT MEAN LOWER LOW WATER)

SOIL TYPES

Although much of the soil in outer west Ashley appears to have a moderate infiltration capacity, these areas have been substantially disturbed by phosphate mining in the 19th and early 20th centuries.

map sources: USGS

- A: ABSORBS THE MOST WATER
- B: ABSORBS SOME WATER
- C: ABSORBS LITTLE WATER
- D: POORLY DRAINED AND/OR ABSORBS BASICALLY NO WATER



Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

Water

1 inch = 4,000 feet

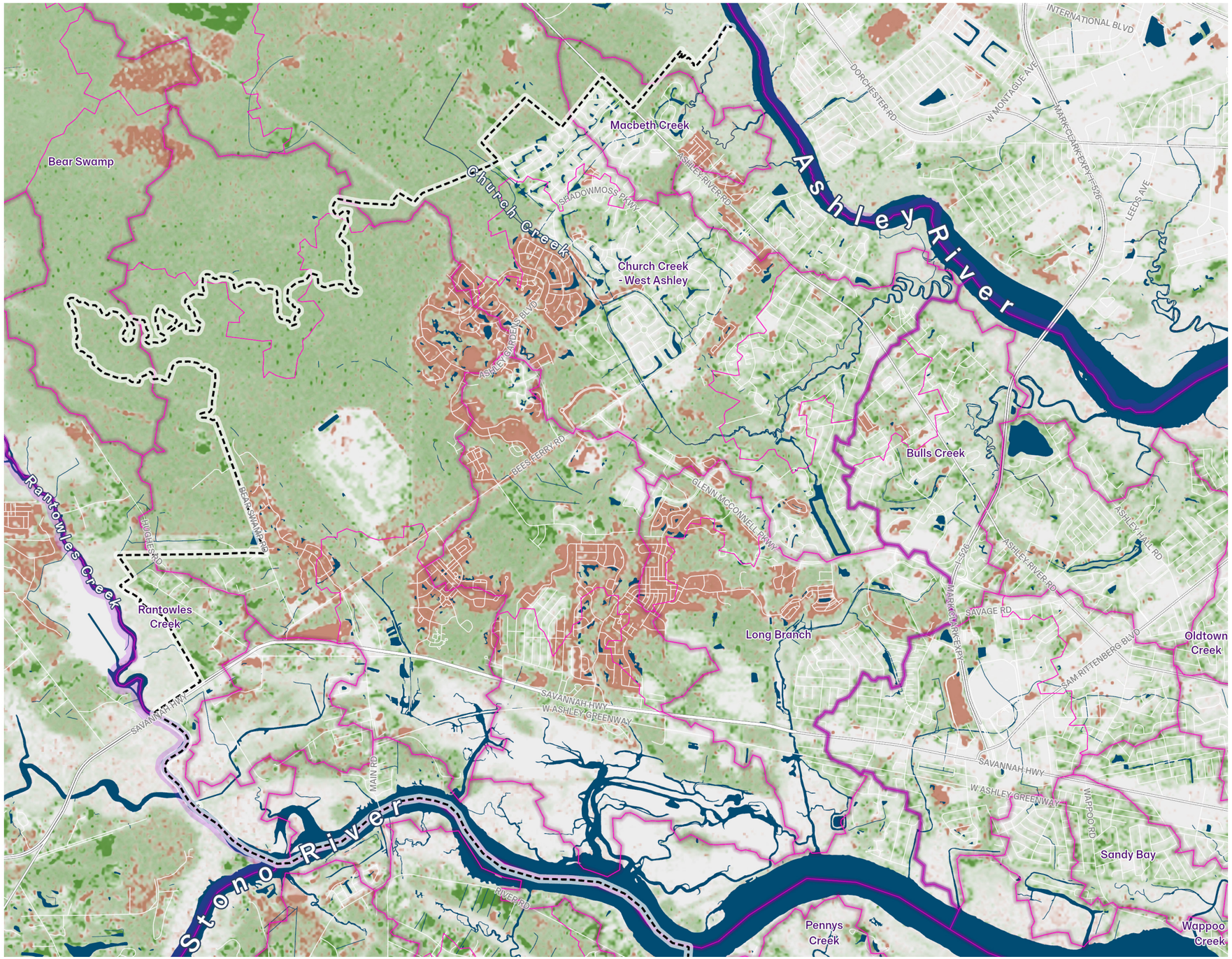
Miles

1

TREE CANOPY DENSITY & CHANGE

Tree canopy loss in outer West Ashley has been high in the last two decades due primarily to new suburban development.

map sources: GLCF



Legend

Tree Canopy (2015)

- Dense
- Sparse

Canopy Change (2000-2015)

- High Gain
- High Loss

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary

Water

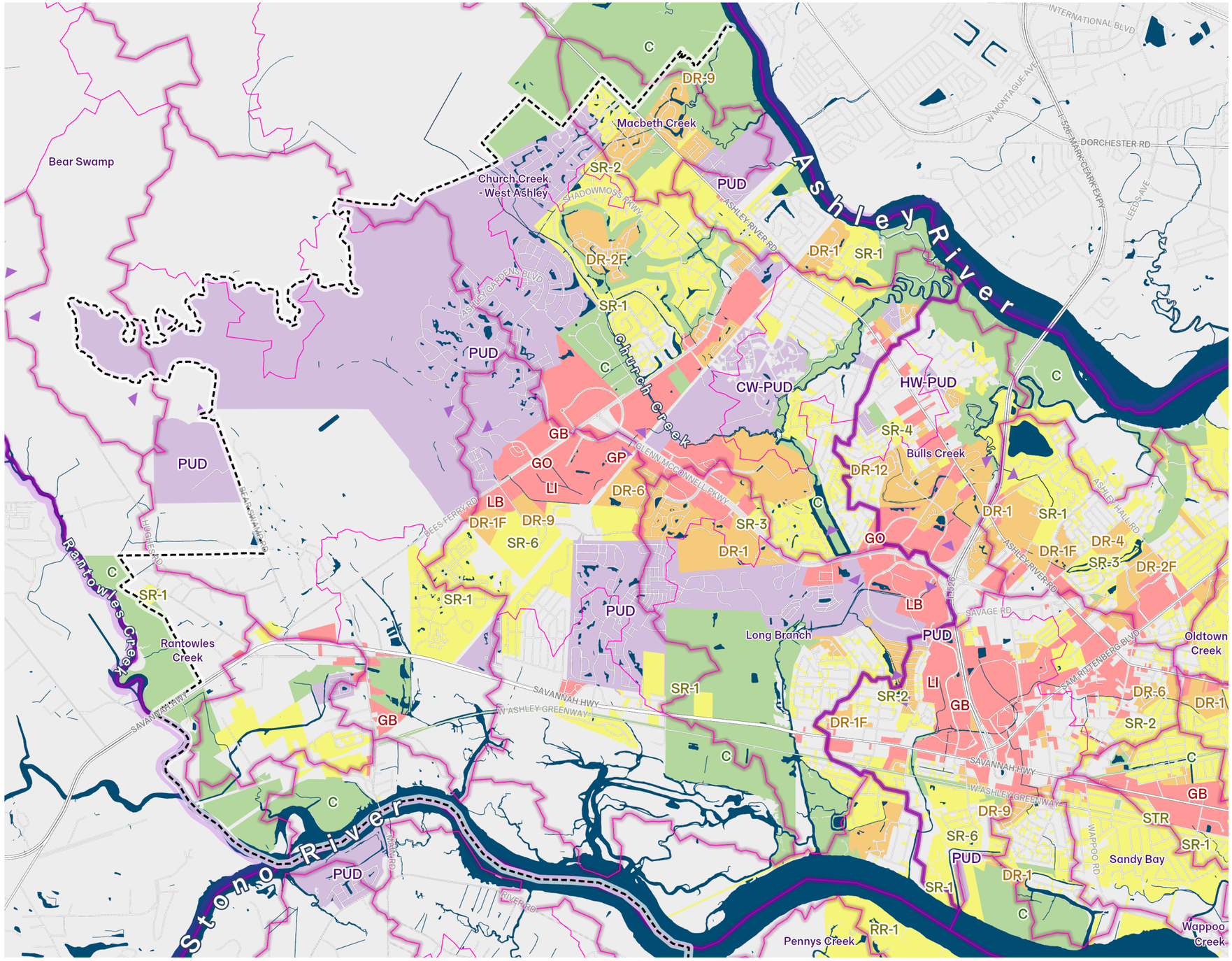
- Water

1 inch = 4,000 feet

Miles 1

ZONING

Fragmented political jurisdictions result in zoning gaps.



Legend

Zoning

- Parks & Conservation
- Single Family Residential
- Diverse Residential
- Planned Development
- Mixed Use
- Business & Industrial

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

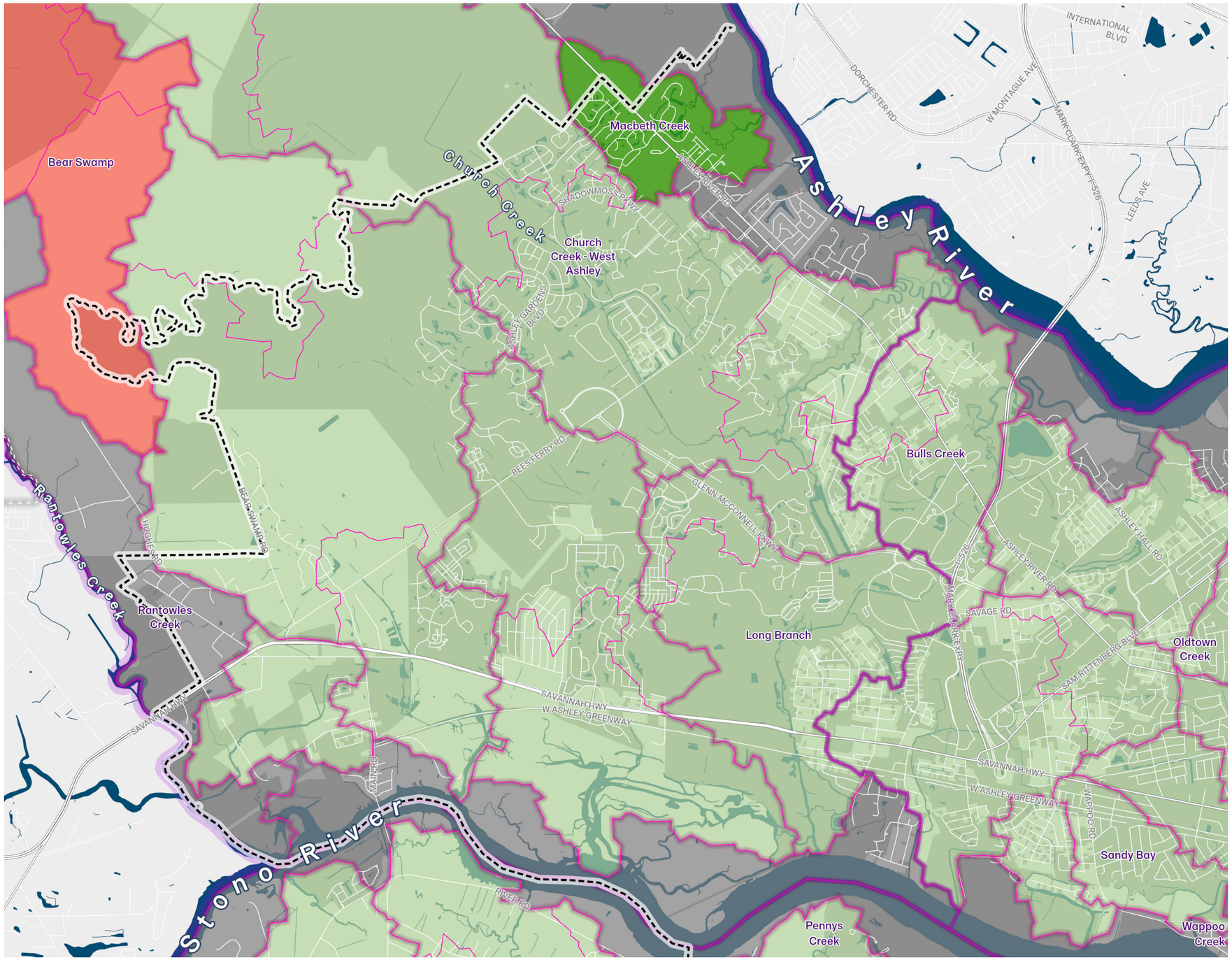
Water

1 inch = 4,000 feet

Miles 1

JURISDICTIONAL COMPLEXITY

Most of outer West Ashley's watersheds criss-cross a patchwork of incorporated space.



Legend

Watershed Jurisdiction
- Entirely Within Charleston City
- Single-City, Single-County
- No City, Single-County
- Multi-City, Single-County
- Multi-City, Multi-County
- Excluded

Counties
- Charleston City Limits

Watersheds Neighborhood
- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary

Water
- Water

1 inch = 4,000 feet

Miles 1

LAND & WATER IMPLICATIONS

ELEVATION RISK ZONES

ELEVATION RISK ZONES & WATERSHED SENSITIVITY

ENVIRONMENTAL SENSITIVITY

ELEVATION ZONES

Most of the high ground in outer West Ashley is outside of the urban growth boundary.

HIGH GROUND

High ground is defined as land outside of the FEMA 100 year floodplain and above the NOAA max category 3 storm surge. High ground has the lowest flood risk and stormwater detention here has the greatest watershed benefit.

ADAPT ZONE

The adapt zone consists of land outside of the FEMA 100 year floodplain that is still within the NOAA maximum storm surge of a category 3 hurricane. Rain and storm surge flooding in this zone is infrequent but not impossible.

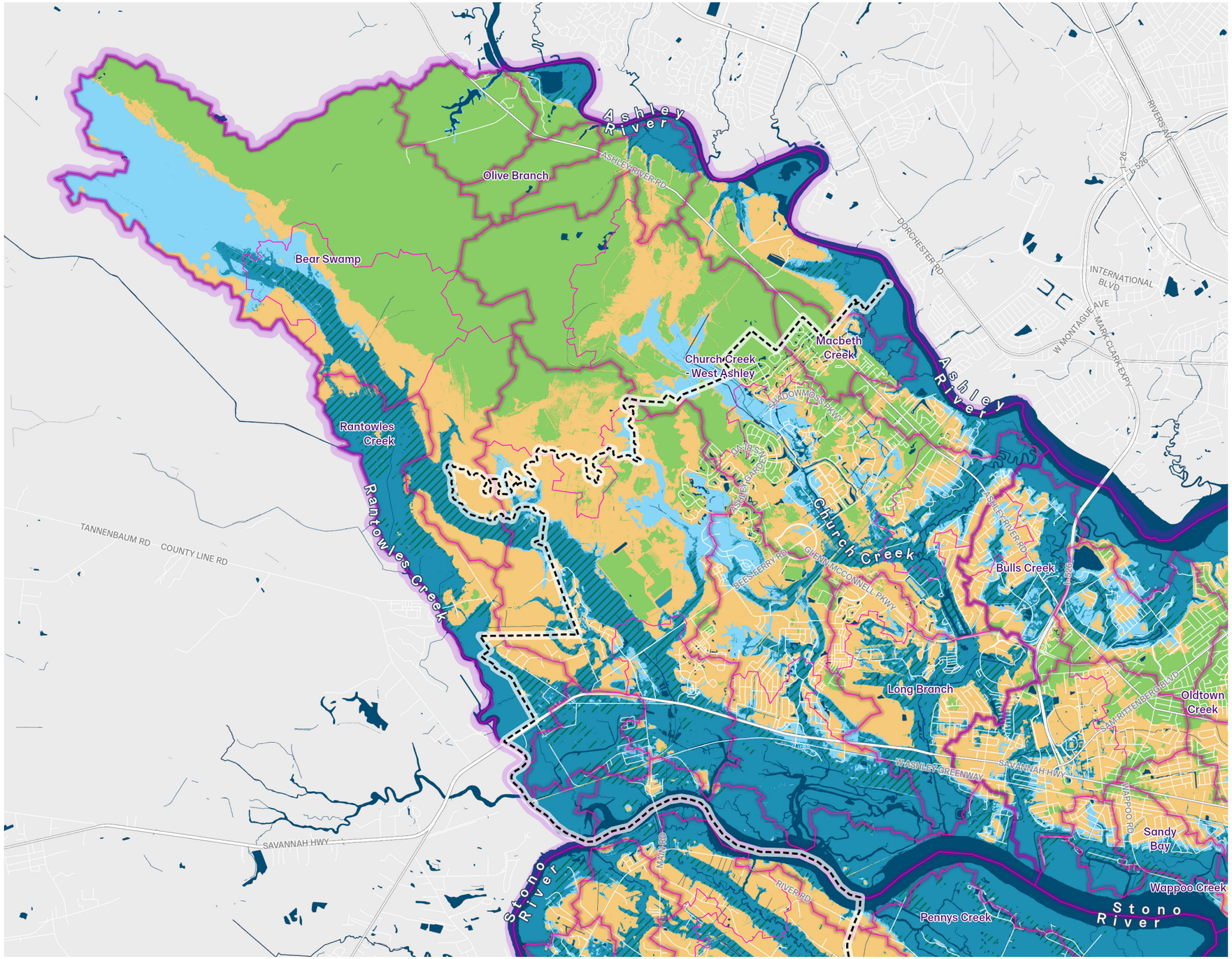
COMPOUND FLOOD RISK

This zone encompasses areas within the floodplain above the tidal flood risk zone where flood risk comes from a mixture of rainfall, runoff and tidal conditions.

TIDAL FLOOD RISK ZONE

This zone encompasses the lowest land in Charleston. Nearly 100% of this zone is in the 100 year floodplain. Flooding is frequent and can come solely from tidal events independent of precipitation. Sea level rise driven marsh migration occurs in this dynamic zone.

Marsh Migration Zone



1 inch = 6,000 feet

Miles 1

ELEVATION ZONES

Within the urban growth boundary high ground exists in patches. Most developed areas are in the adapt zone.

HIGH GROUND

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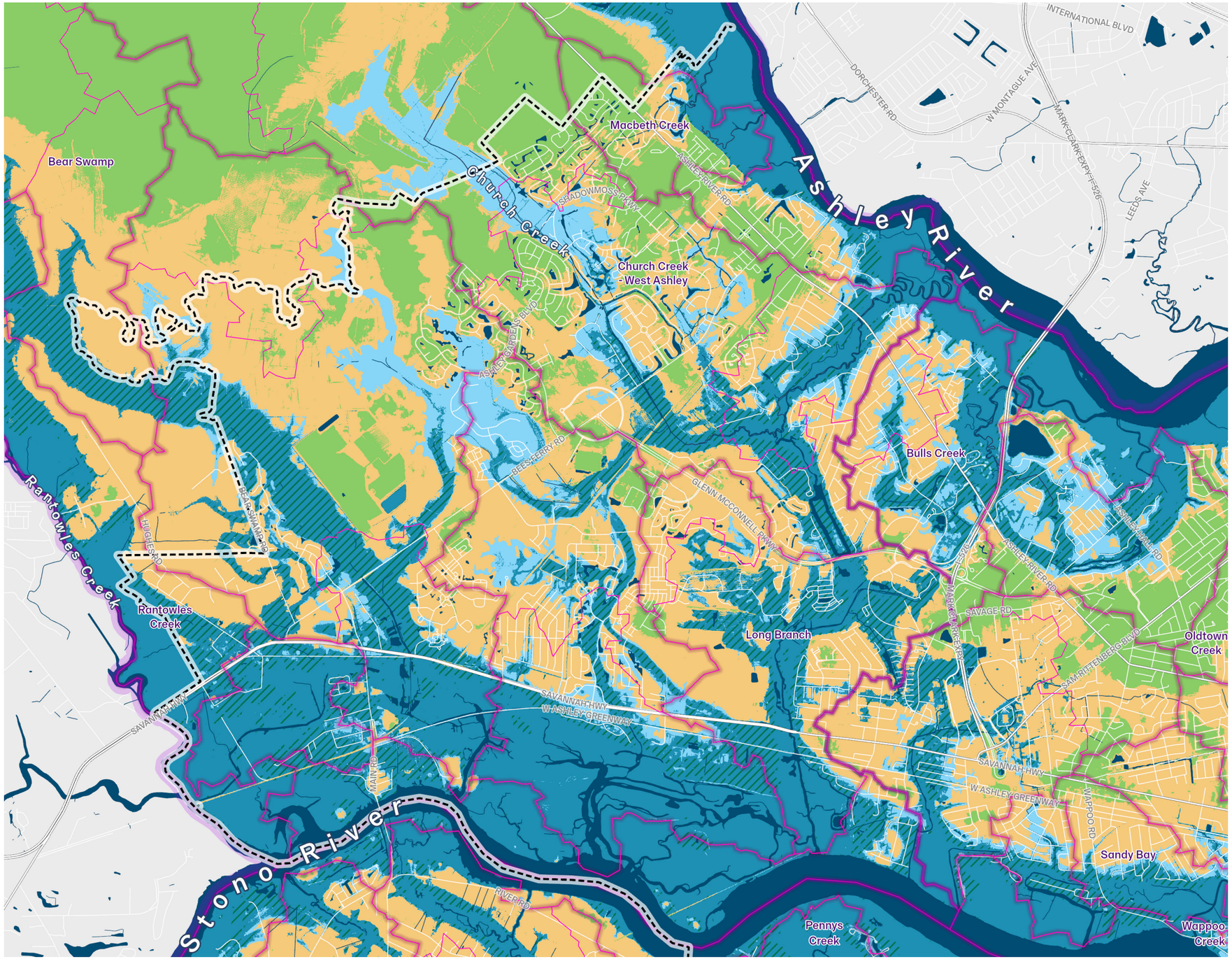
Marsh Migration Zone

1 inch = 4,000 feet

Miles 1



ELEVATION RISK + WATERSHED SENSITIVITY

Around a third of the Church Creek watershed—and the runoff it receives—is outside the urban growth boundary in undeveloped former phosphate mines.

HIGH SENSITIVITY

Combination of more flood prone watersheds and a high number of vulnerable parcels. Typically larger tidal watersheds and/or watersheds where development happened before BFE regulations.

NORMAL SENSITIVITY

Combination of less flood prone watersheds and a low number of vulnerable parcels. Typically smaller and/or less developed watersheds.

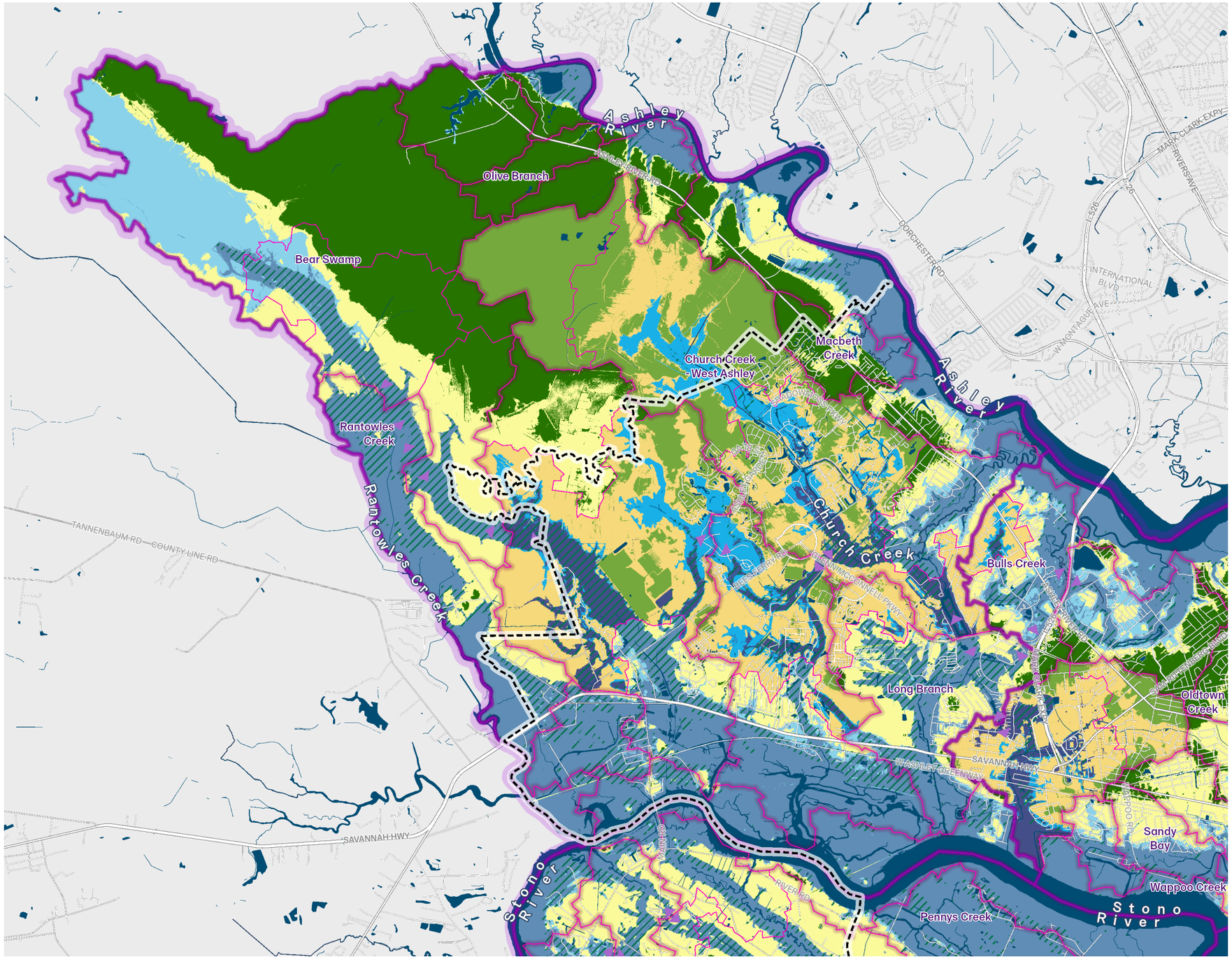
HIGH GROUND

ADAPT ZONE

COMPOUND FLOOD RISK

TIDAL FLOOD RISK ZONE

Marsh Migration Zone



1 inch = 6,000 feet

Miles 1

ELEVATION RISK + WATERSHED SENSITIVITY

Most watersheds in outer West Ashley are high sensitivity given their size, tidal influence, and number of vulnerable parcels.

HIGH SENSITIVITY

Combination of more flood prone watersheds and a high number of vulnerable parcels. Typically larger tidal watersheds and/or watersheds where development happened before BFE regulations.

NORMAL SENSITIVITY

Combination of less flood prone watersheds and a low number of vulnerable parcels. Typically smaller and/or less developed watersheds.

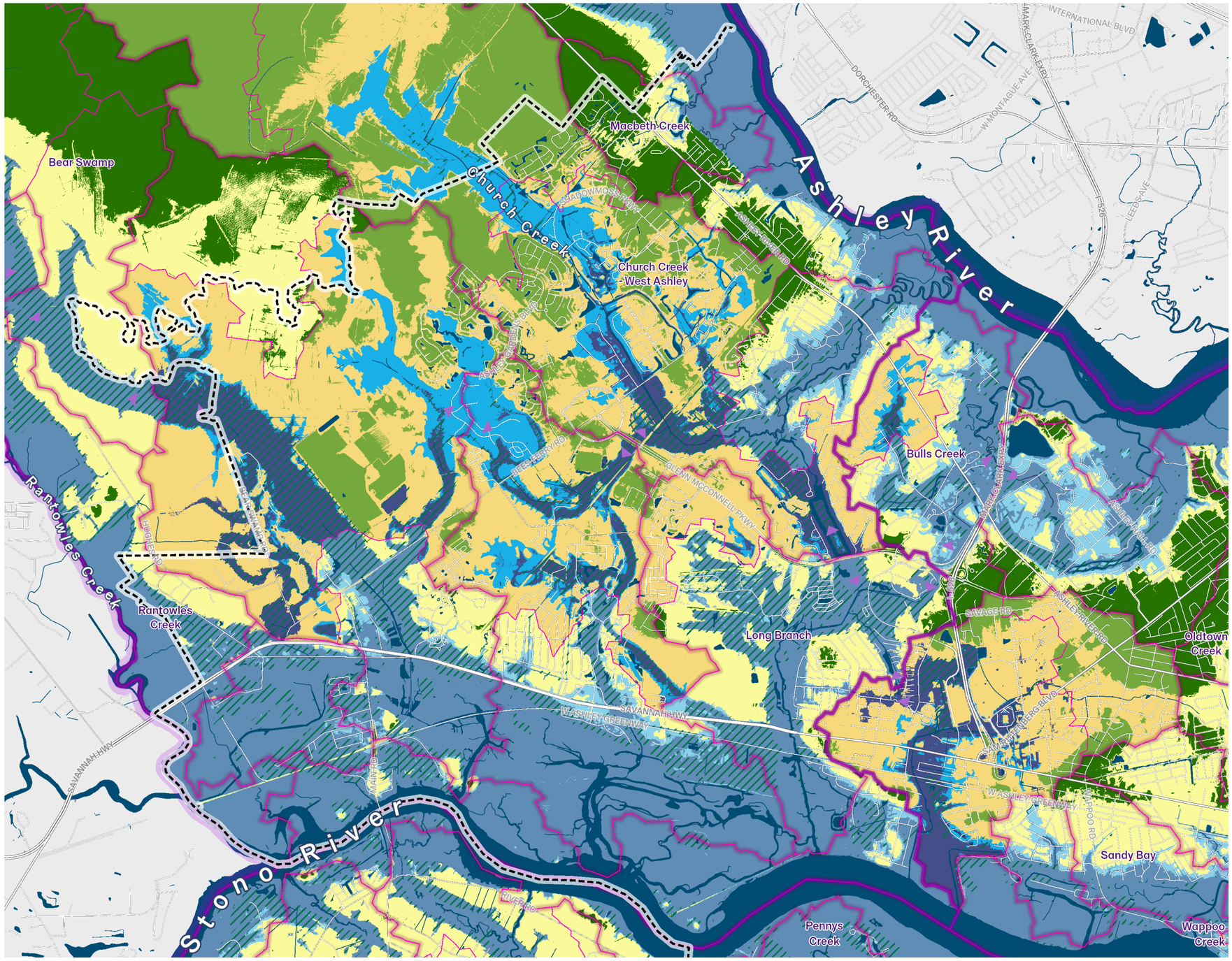
HIGH GROUND

ADAPT ZONE

COMPOUND FLOOD RISK

TIDAL FLOOD RISK ZONE

Marsh Migration Zone

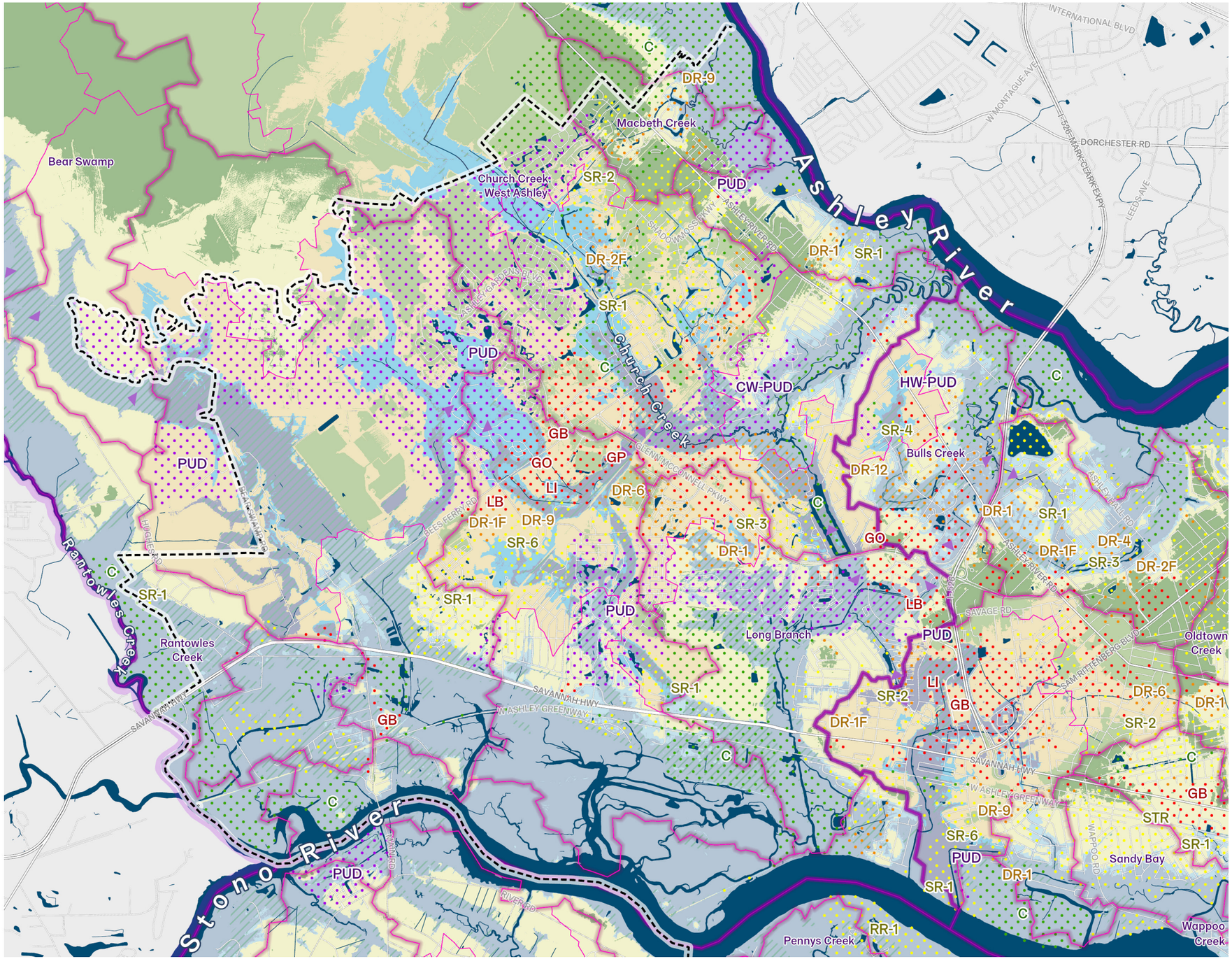


1 inch = 4,000 feet

Miles 1

RISK + SENSITIVITY + ZONING

Planned Developments occupy much of West Ashley, spanning across watersheds and elevation zones.



Legend

Zoning

- Parks & Conservation
- Single Family
- Diverse Residential
- Planned Development
- Mixed Use
- Business & Industrial

Risk & Watershed Impact

- High Ground, Normal Sensitivity
- High Ground, High Sensitivity
- Adapt Zone, Normal Sensitivity
- Adapt Zone, High Sensitivity
- Compound Flood Risk, Normal Sensitivity
- Compound Flood Risk, High Sensitivity
- Tidal Flood Risk, Normal Sensitivity
- Tidal Flood Risk, High Sensitivity
- Marsh Migration Zone

Watersheds Neighborhood

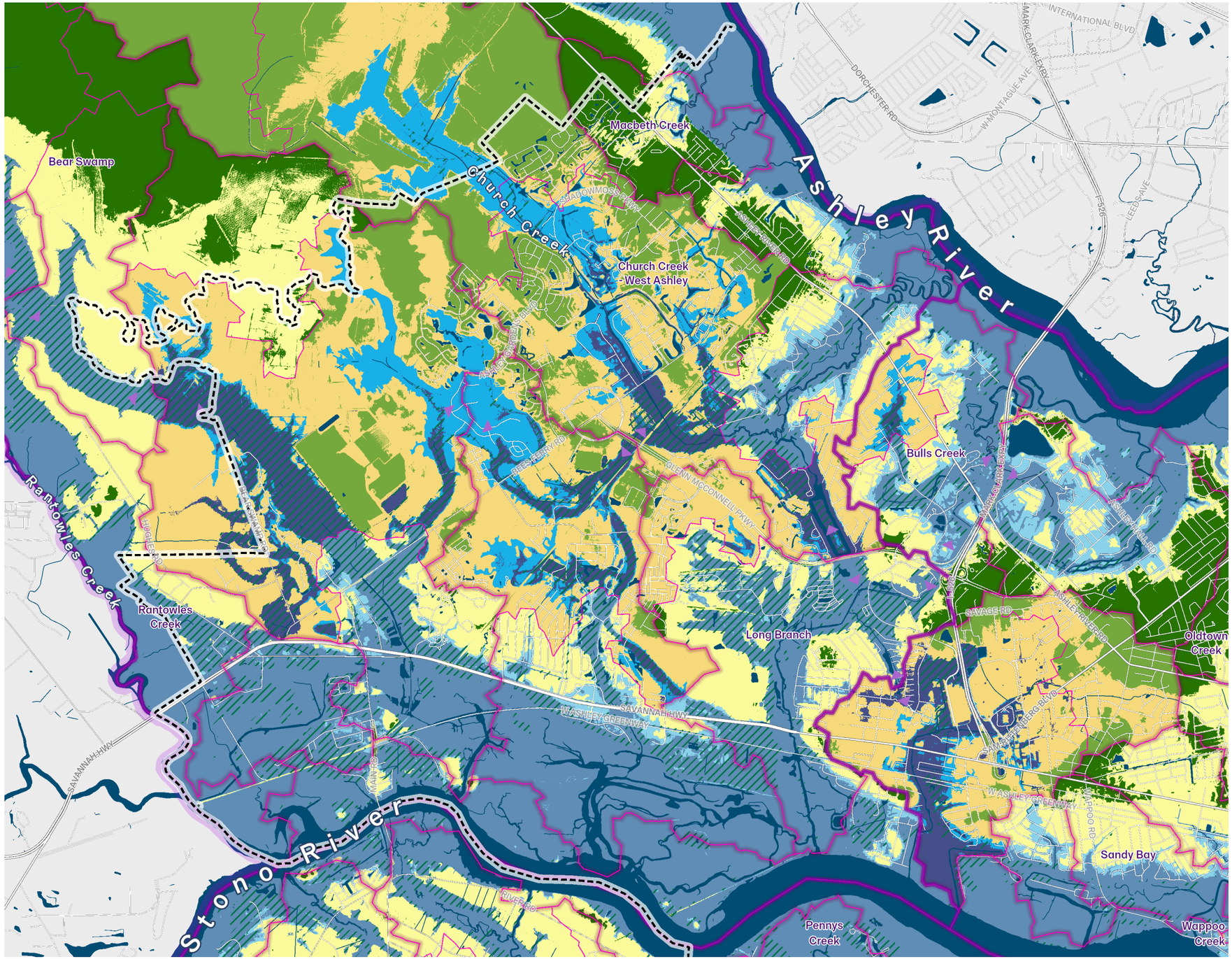
- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary
- Water

1 inch = 4,000 feet

Miles 1

LAND & WATER IMPLICATIONS

- Large watersheds and high numbers of vulnerable parcels create significant watershed sensitivity.
- Except for along Ashley River Road, much of the high ground is located in high sensitivity watersheds.
- Waterways and floodplains are complex and interconnected, and water management interventions—both obstacles and improvements—can ripple across watersheds.
- Soils have the potential for infiltration throughout, but alterations to the landscape from phosphate mining likely diminishes, or even eliminates, that potential.
- Recent tree canopy loss is high.
- Marsh migration potential is high, especially in the watersheds around Rantowles Creek.



1 inch = 4,000 feet
Miles
1

JAMES ISLAND

CHARACTER

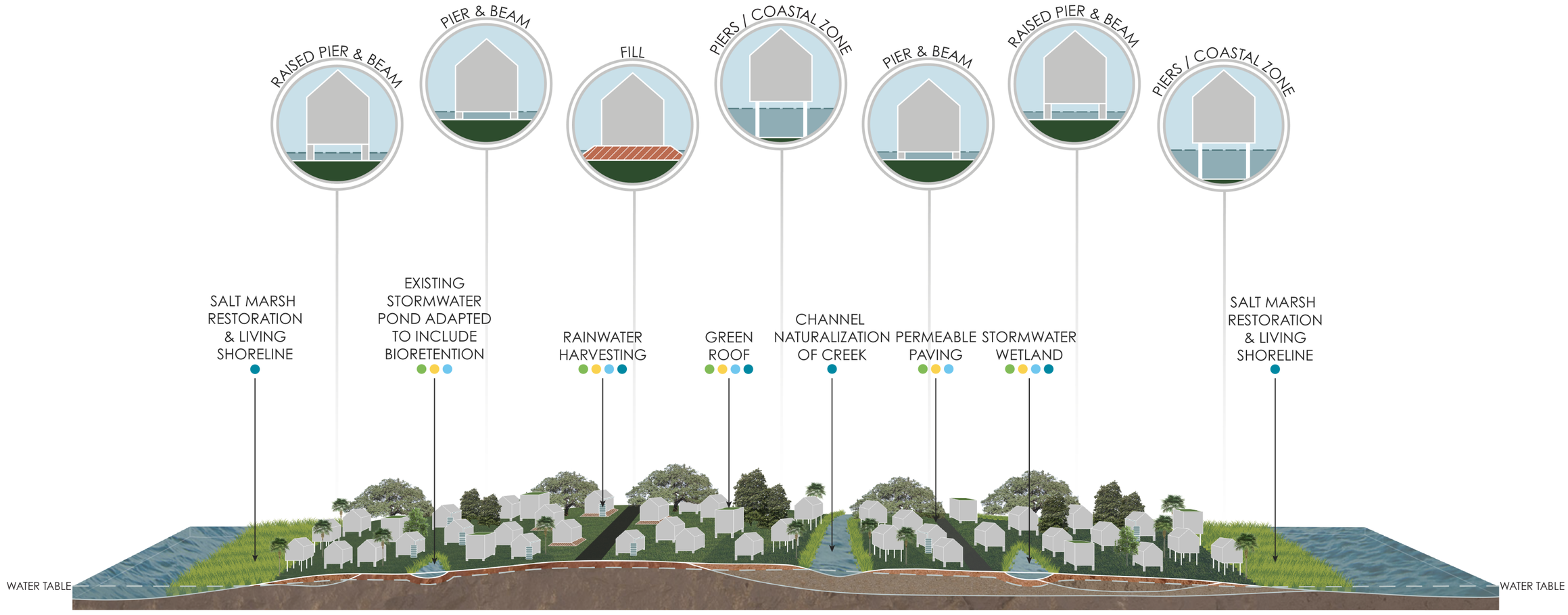
WATER

LAND

RISK ZONES

RECOMMENDATIONS

LANDSCAPE



JAMES ISLAND TRANSECT

STONO RIVER	MARSH	GROUP B	GROUP D SOIL	GROUP A SOIL	GROUP B SOIL	A	MARSH	CHARLESTON HARBOR
TIDAL FLOOD RISK	ADAPT ZONE	HIGH GROUND	ADAPT ZONE	TIDAL	COMPOUND	ADAPT ZONE	TIDAL FLOOD RISK	

SURCULUS

WATER

WATERSHEDS

WATERSHED TYPES

WATERSHED VULNERABILITY

100 YEAR FLOODPLAIN

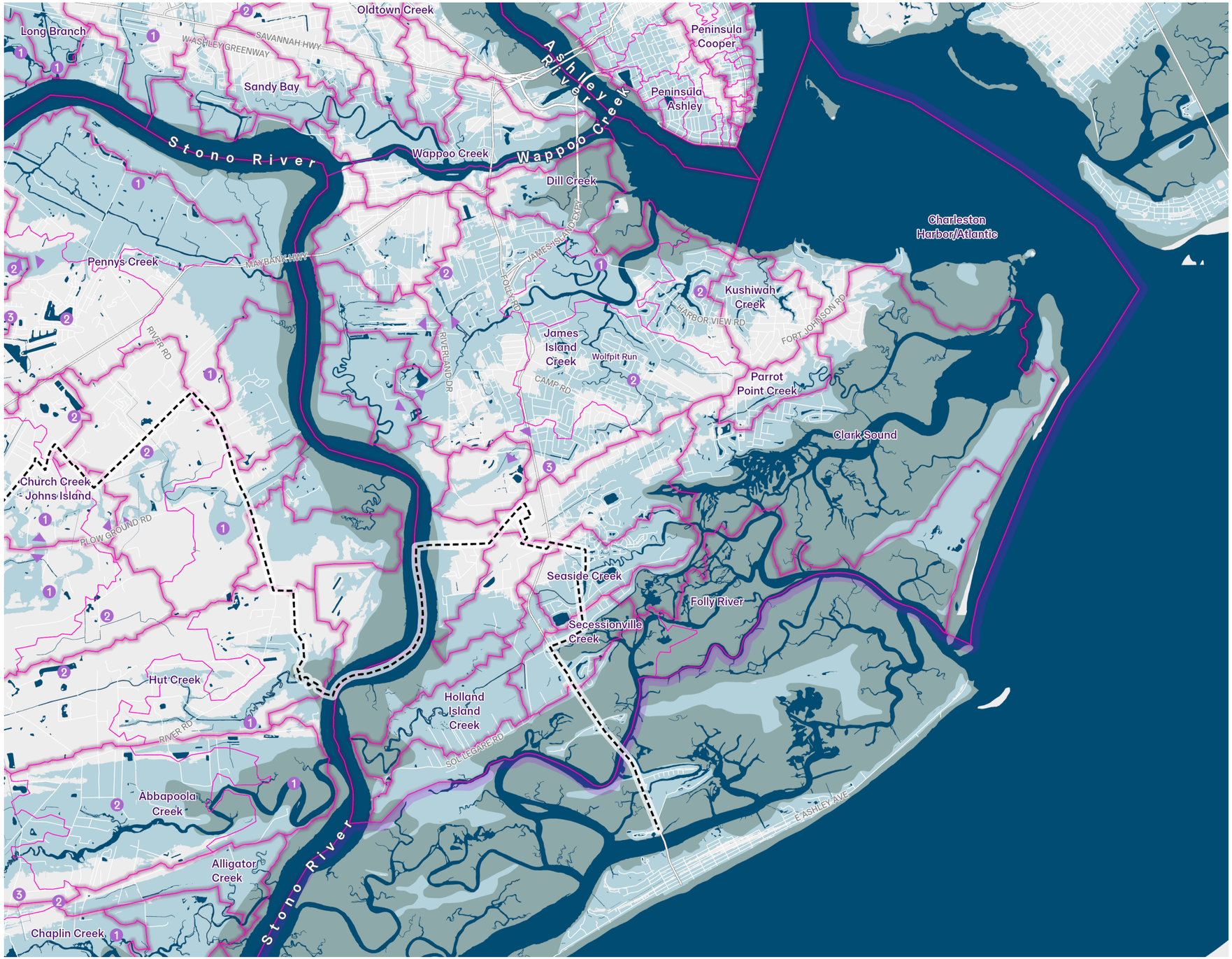
STORM SURGE

SEA LEVEL RISE

MARSH MIGRATION

WATERSHEDS

James Island has one large tidal watershed, the James Island Creek watershed, surrounded by several smaller watersheds.



Legend

DFIRM

100 Year Floodplain

VE Zone

Project Watersheds

Project Subwatersheds

Subwatershed Order (1 being closest to the outlet)

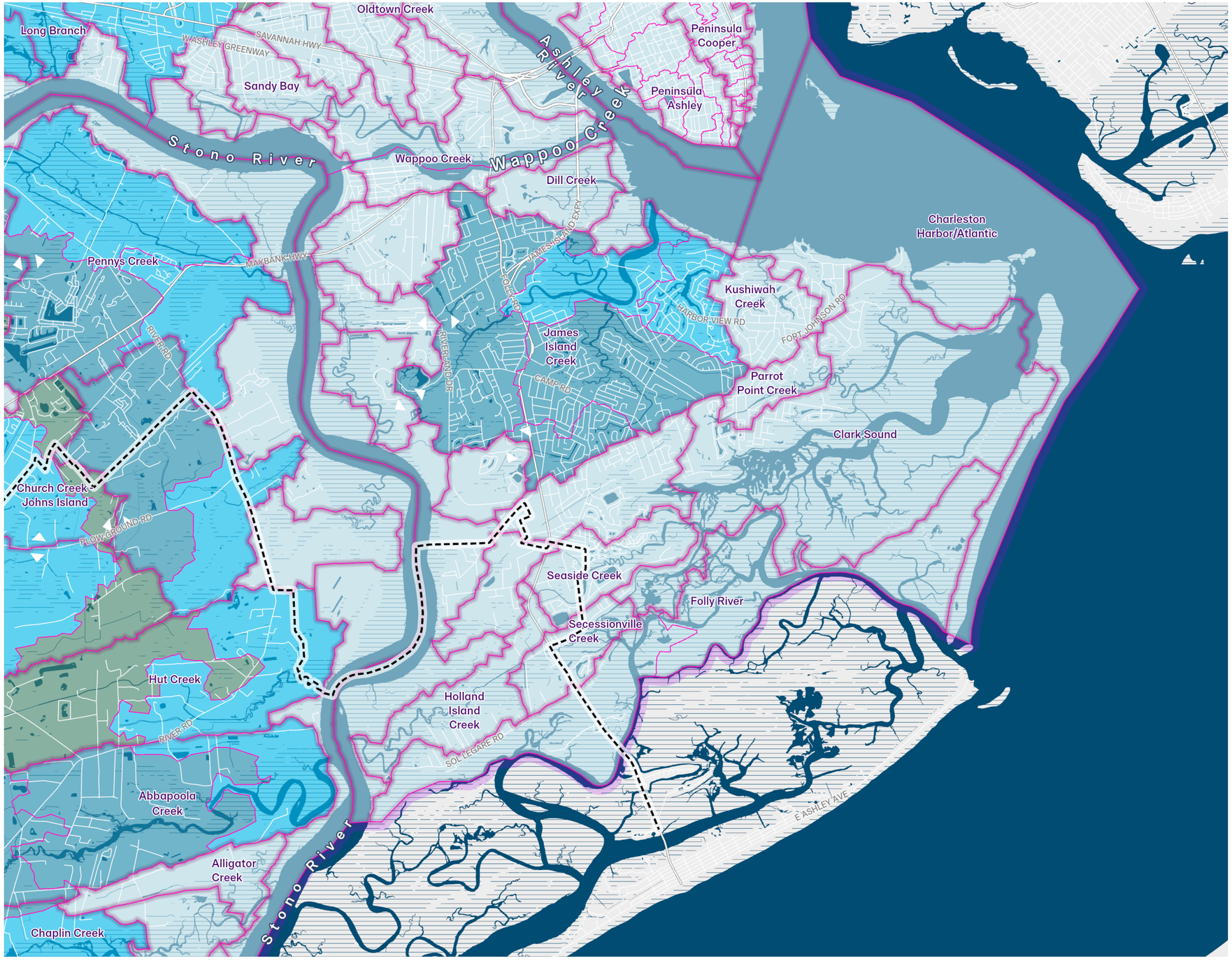
Watershed Interconnectivity Point

1 inch = 6,000 feet

Miles 1

WATERSHED TYPES

James Island Creek is a large tidal watershed with multiple subwatersheds and tributaries (e.g. Wolfpit Run).



Legend

Subwatershed Type
- Small, Tidal
- Large, Outlet Tidal
- Large, Upstream Tidal
- Large, Upstream Inland

Water
- Water
- Wetland

Project Watersheds

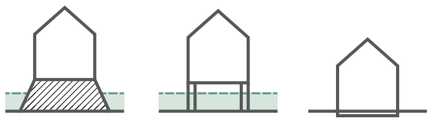
Project Subwatersheds

Urban Growth Boundary

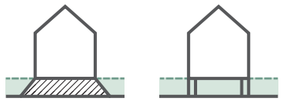
1 inch = 6,000 feet

Miles 1

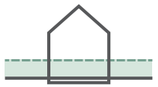
STRUCTURE VULNERABILITY



Low Combined Vulnerability & Risk
Outside the 100 year floodplain
Built after BFE+1 requirements



Medium Combined Vulnerability & Risk
In the 100 year floodplain
Built after BFE requirements or raised to BFE



High Combined Vulnerability & Risk
In the 100 year floodplain
Built before BFE requirements

*All heights relative to BFE need verification

100 Year Floodplain and BFE
- No BFE
- BFE

Watersheds Neighborhood

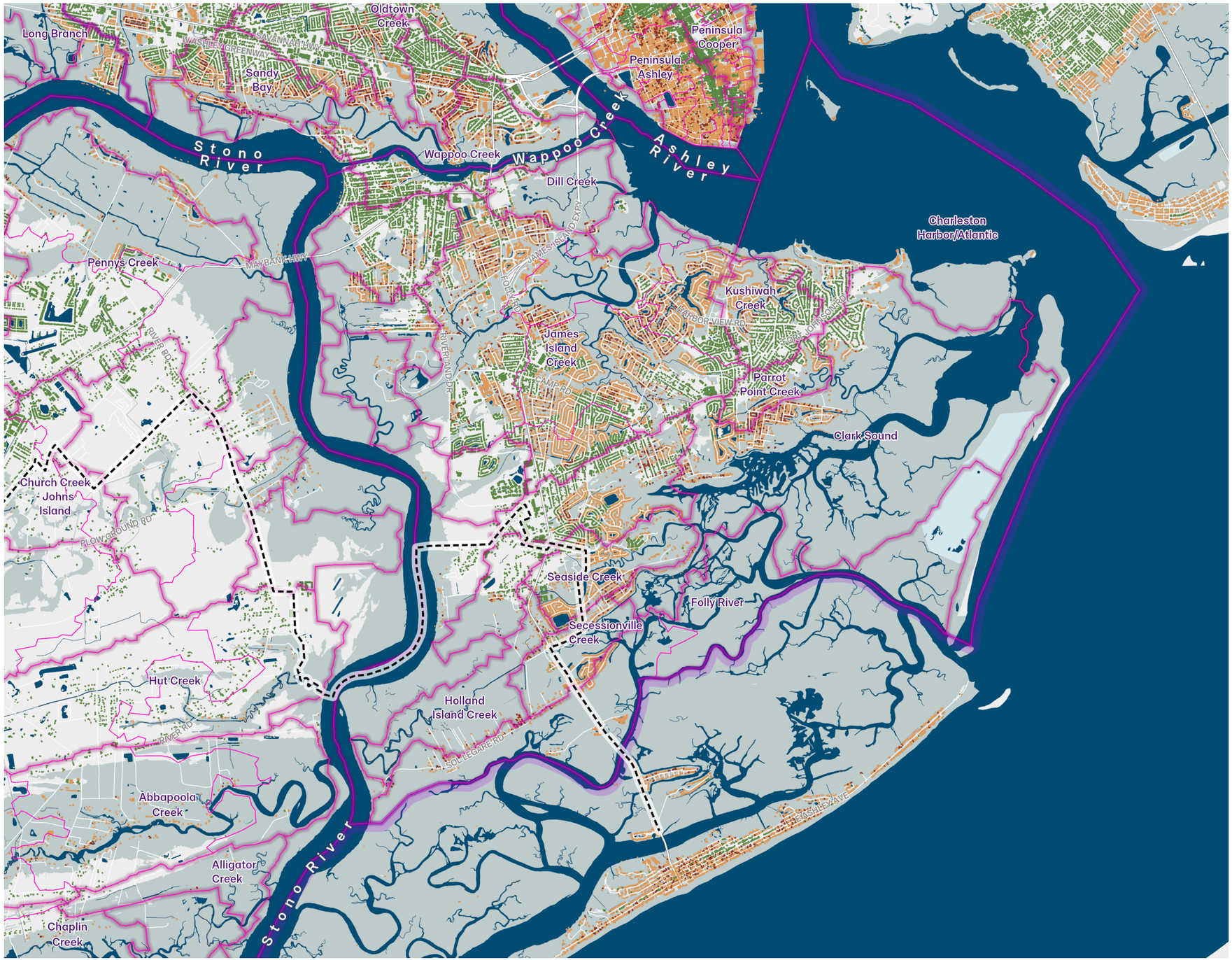
Project Watersheds

Project Subwatersheds

Urban Growth Boundary

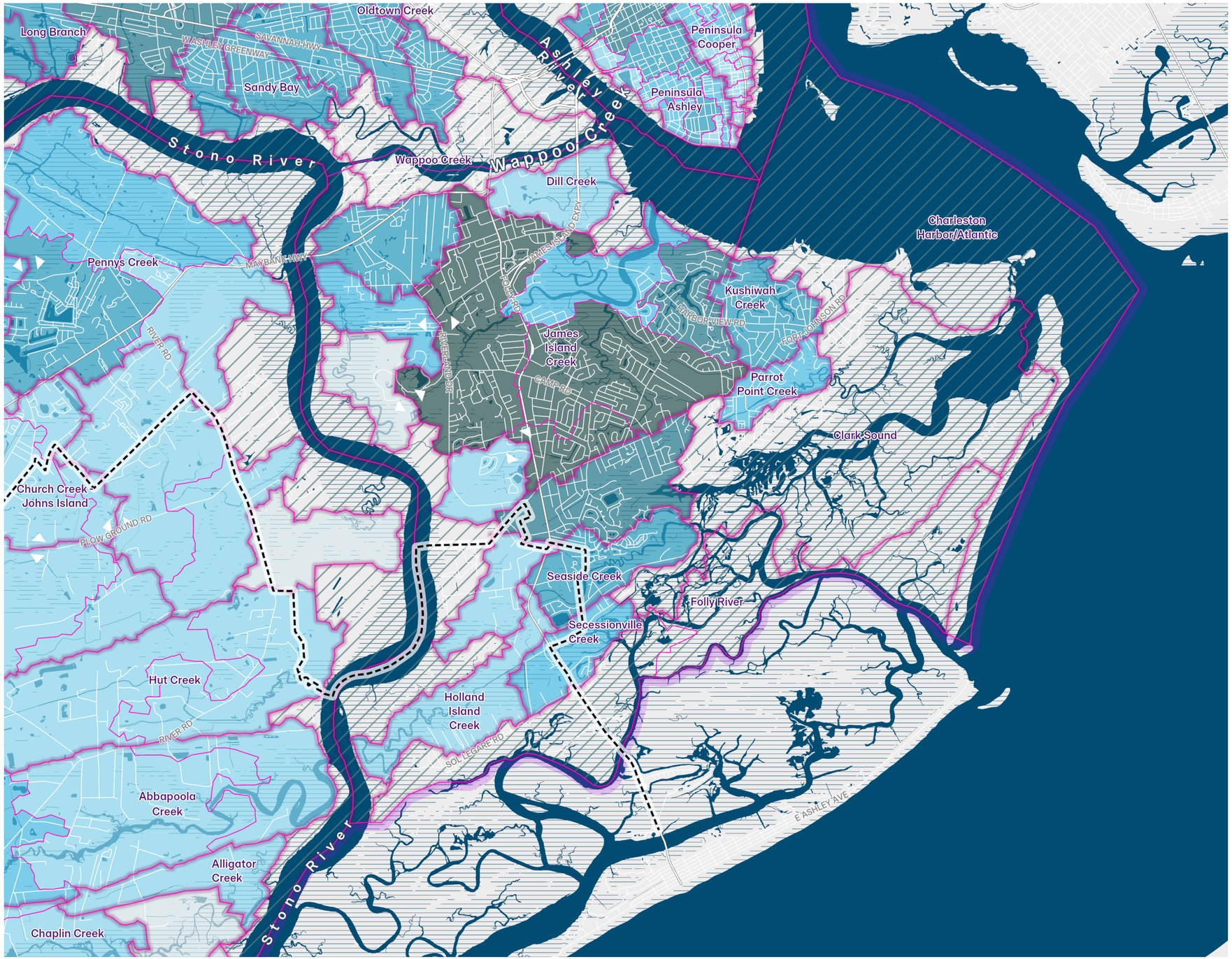
Water
- Water

1 inch = 6,000 feet
Miles
1



NUMBER OF VULNERABLE PARCELS

The James Island Creek watershed has the highest total number of vulnerable parcels in all of Charleston.



Legend

Vulnerable Parcels Local & Downstream

- ≤10
- ≤250
- ≤500
- ≤1000
- ≤1500
- >1500
- <excluded>

Water

- Water
- Wetland

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

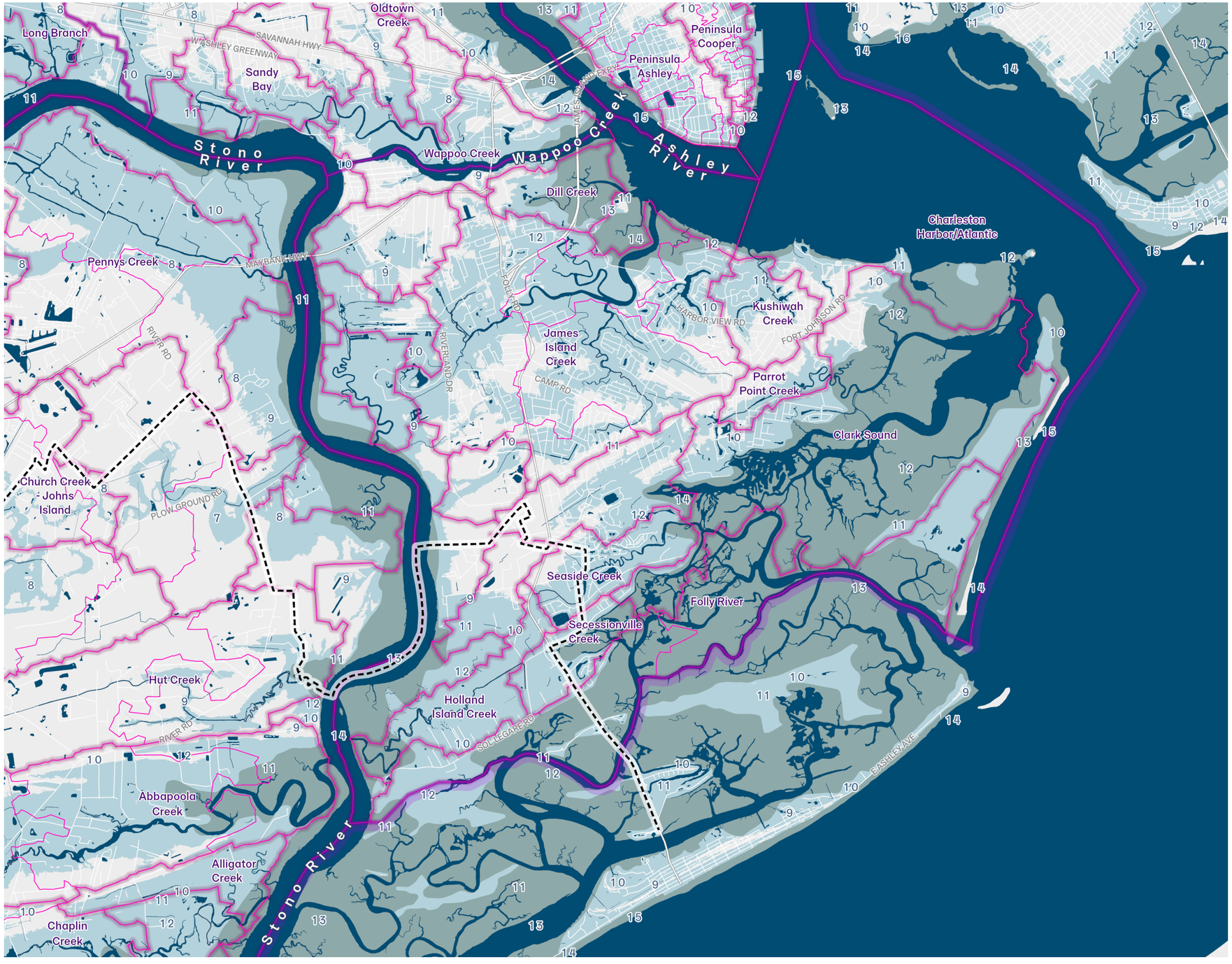
1 inch = 6,000 feet

Miles 1

100 YEAR FLOODPLAIN

Most of James Island is in the 100 year floodplain.

map sources: FEMA



Legend

DFIRM (**Blue #'s** are BFE in NAVD)

- 100 Year Floodplain
- VE Zone

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

1 inch = 6,000 feet

Miles 1

MAXIMUM CATEGORY 3 STORM SURGE

Most of James Island is in the maximum storm surge zone for a category 3 hurricane.

map sources: NOAA



Legend

Cat 3 Max Storm Surge (Above Ground)

- <5 ft
- 5-10 ft
- 10-15 ft
- >15 ft

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

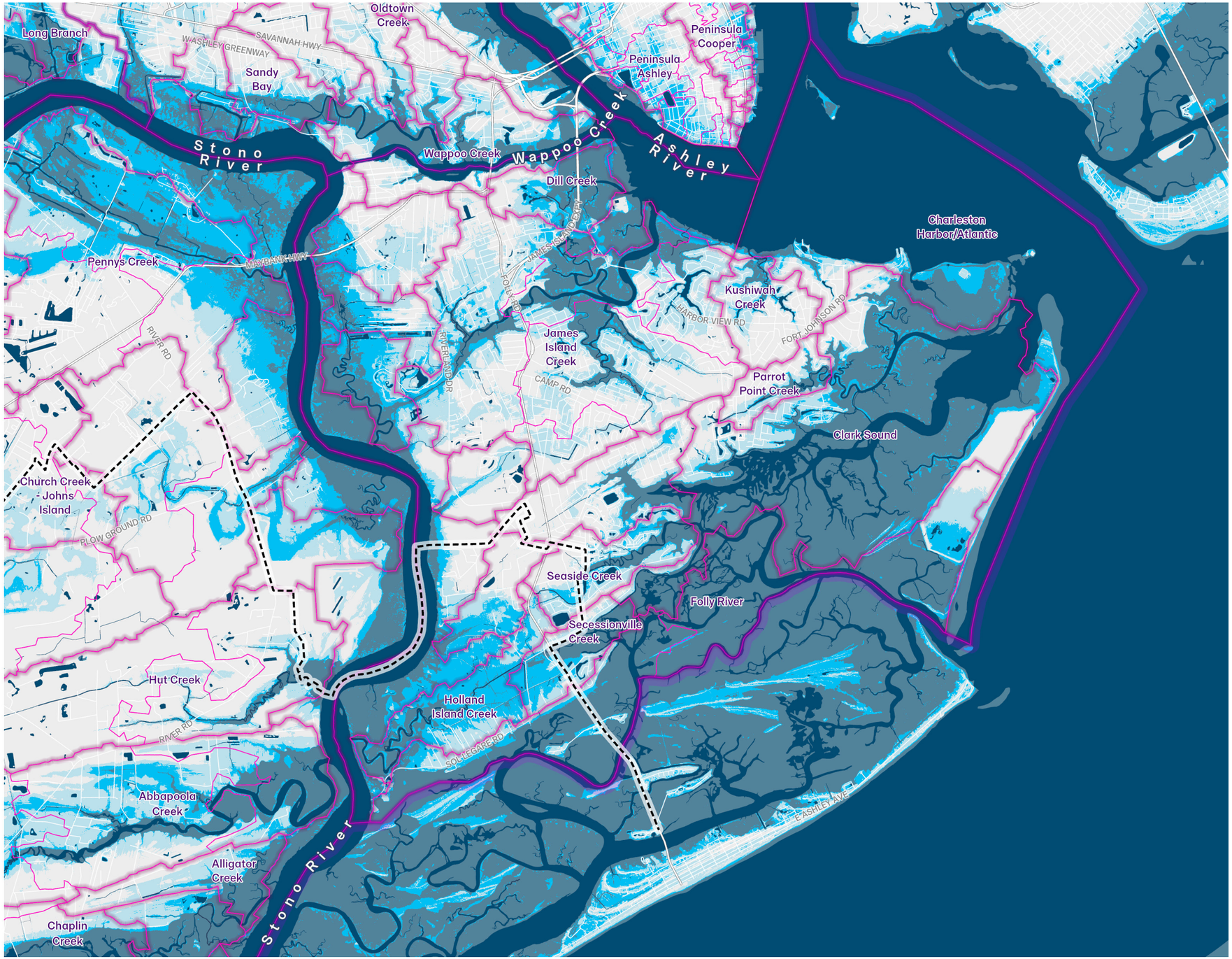
1 inch = 6,000 feet

Miles 1

TIDES AND SEA LEVEL RISE

Most of James island is not at direct risk from 3' of sea level rise, however higher tail water conditions will likely diminish drainage system functionality.

map sources: NOAA



Legend

Tides and Sea Level Rise

- Current MHHW
- MHHW +3ft of Sea Level Rise
- Highest Recorded Water Level (Hugo)

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

1 inch = 6,000 feet

Miles 1

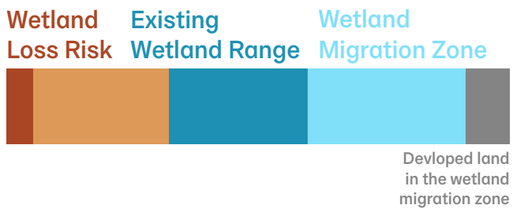
MARSH MIGRATION WITH 3FT OF SEA LEVEL RISE

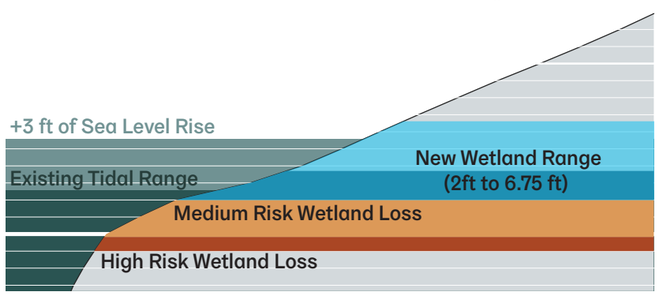
Risk of wetland loss is high throughout James Island, with little to no space on the island for wetlands to migrate in the future.

map sources: NOAA, MLRC Consortium

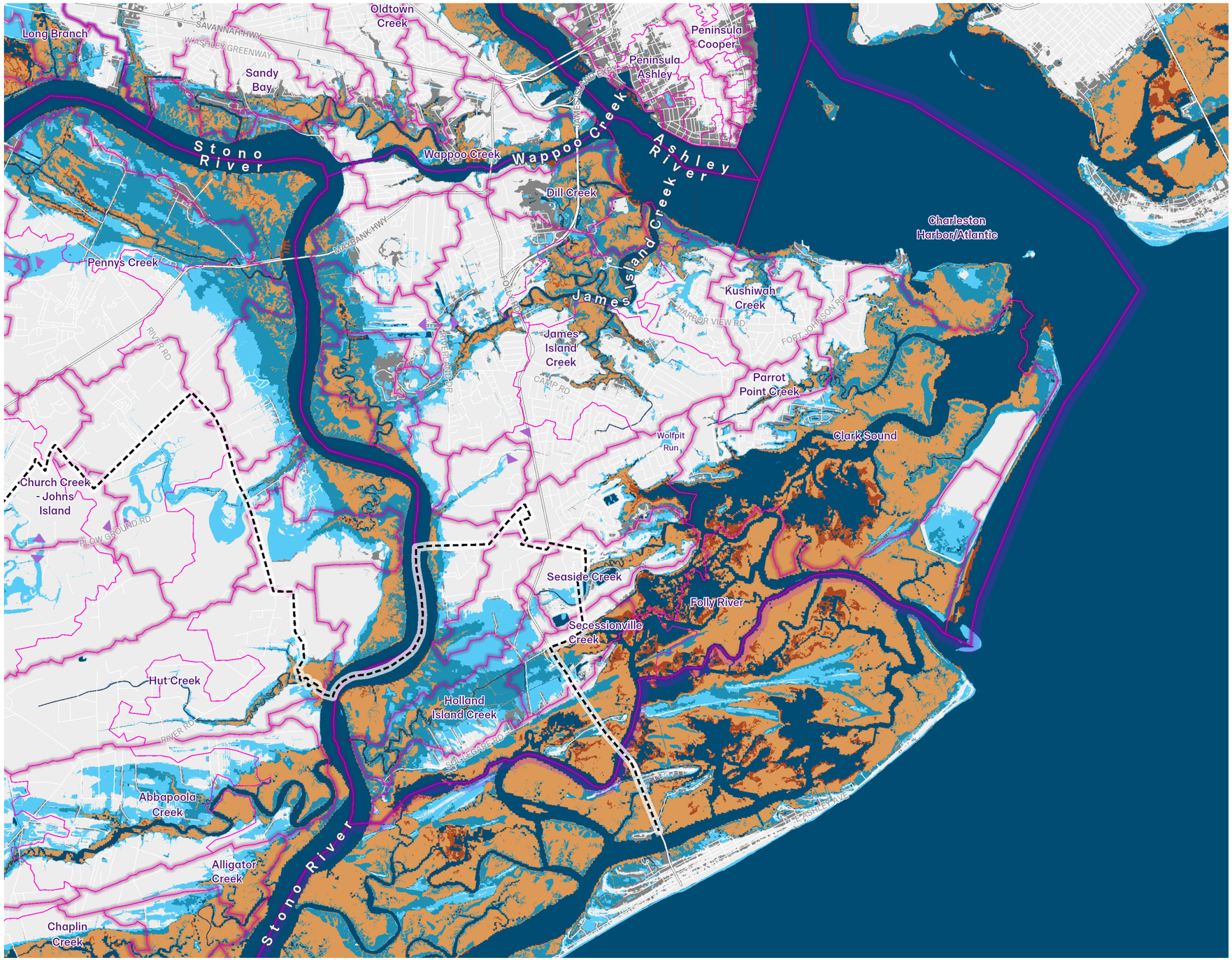
EXISTING WETLAND RANGE
≈ -1 TO 3.75 FT (NAVD)

WETLAND MIGRATION ZONE
≈ 2 TO 6.75 FT (NAVD)





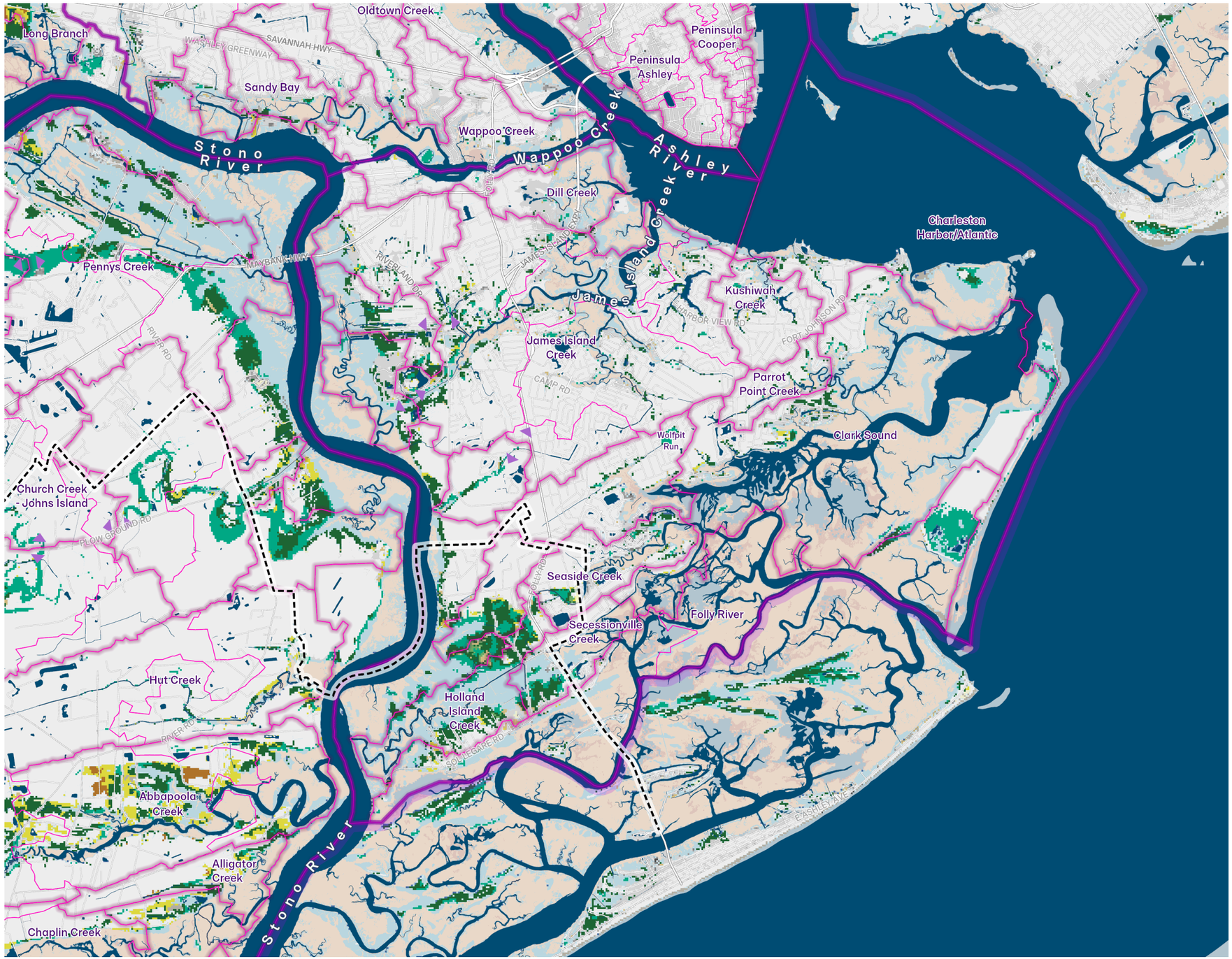
1 inch = 6,000 feet
Miles 1



LAND COVER IN THE MARSH MIGRATION ZONE

The forested fringes of James Island have the most potential for marsh migration.

map sources: USGS, MLRC Consortium



Legend

Land Cover in Wetland Migration Zone

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands

Wetland Migration

- High Risk Wetland Loss
- Medium Risk Wetland Loss
- Low Risk Wetland Loss
- Wetland Migration Zone
- Wetland Migration Zone - Developed

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary
- Water

1 inch = 6,000 feet

Miles 1

LAND

ELEVATION

LAND COVER

ELEVATION & LAND COVER DISTRIBUTION

SOIL

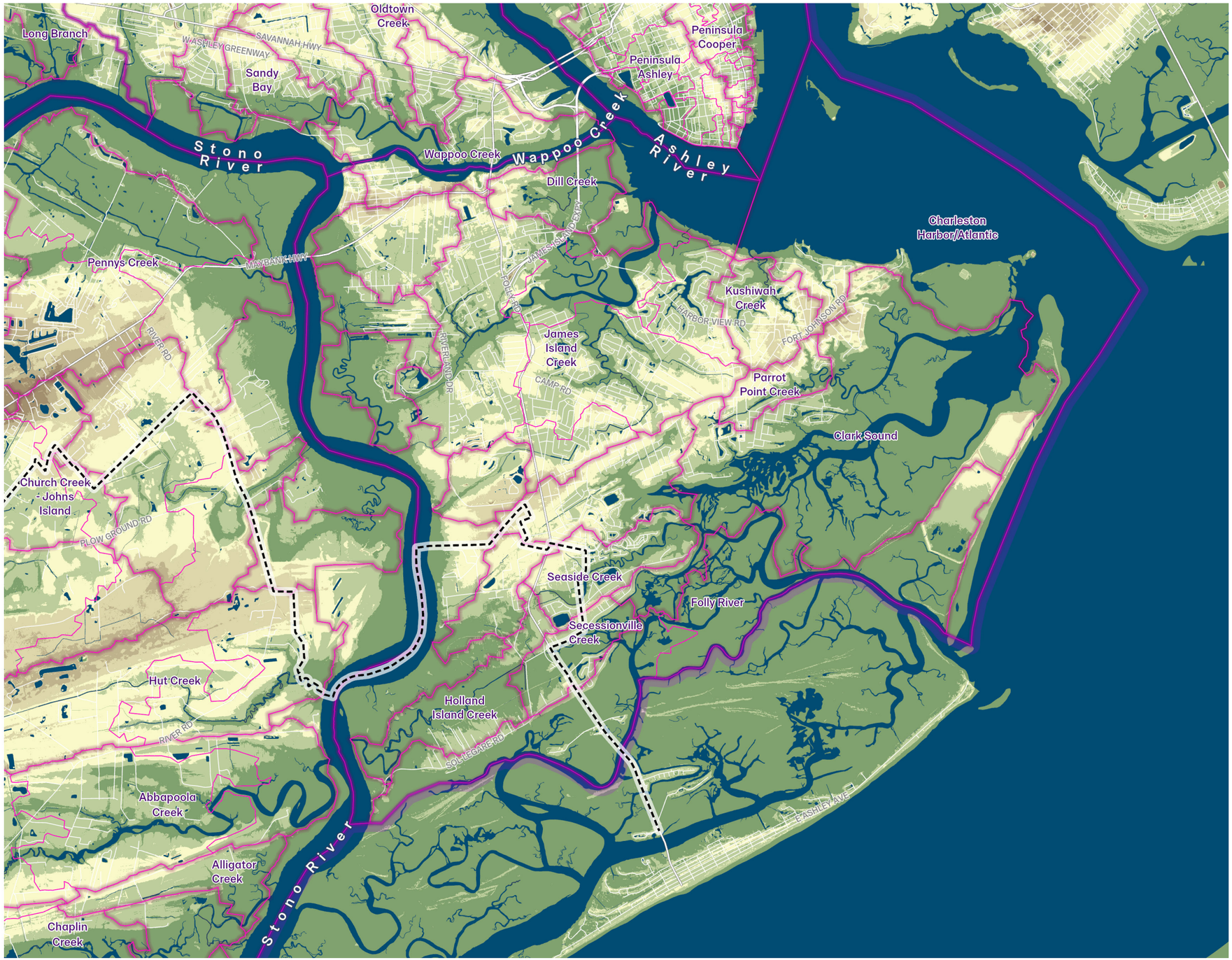
TREE CANOPY

JURISDICTIONS

ELEVATION

Patches of moderately high ground exist on James Island near the banks of the Wappoo and along Fort Johnson Rd.

map sources: USGS



Legend

Elevation (NAVD88)

- >25 ft
- 20-25 ft
- 15-20 ft
- 10-15 ft
- 5-10 ft
- <5 ft

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

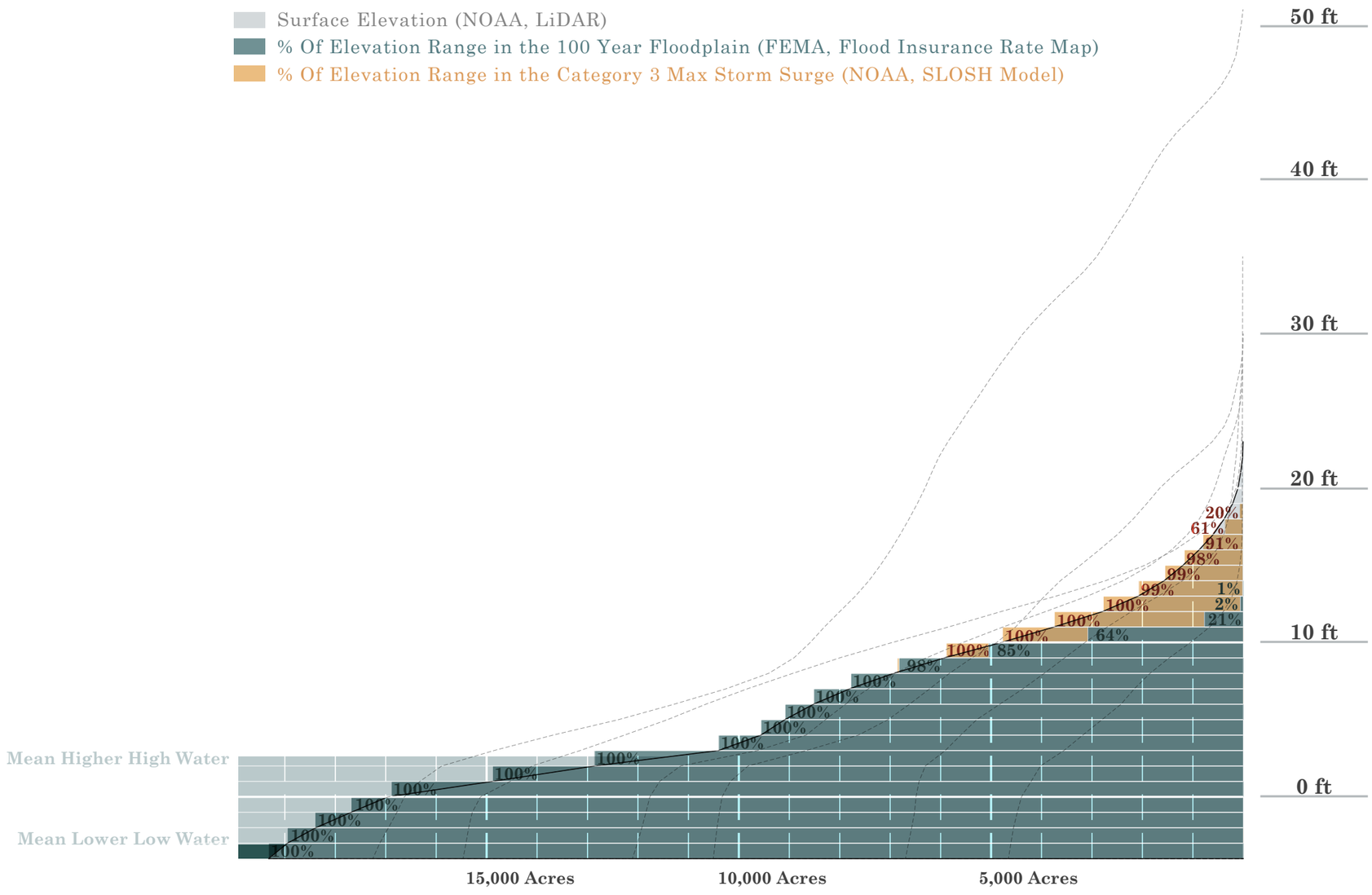
Water

1 inch = 6,000 feet

Miles 1

SURFACE ELEVATION DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

Most land surface at or below 11' is in the floodplain. Almost all of James Island is at risk from max category 3 storm surge.

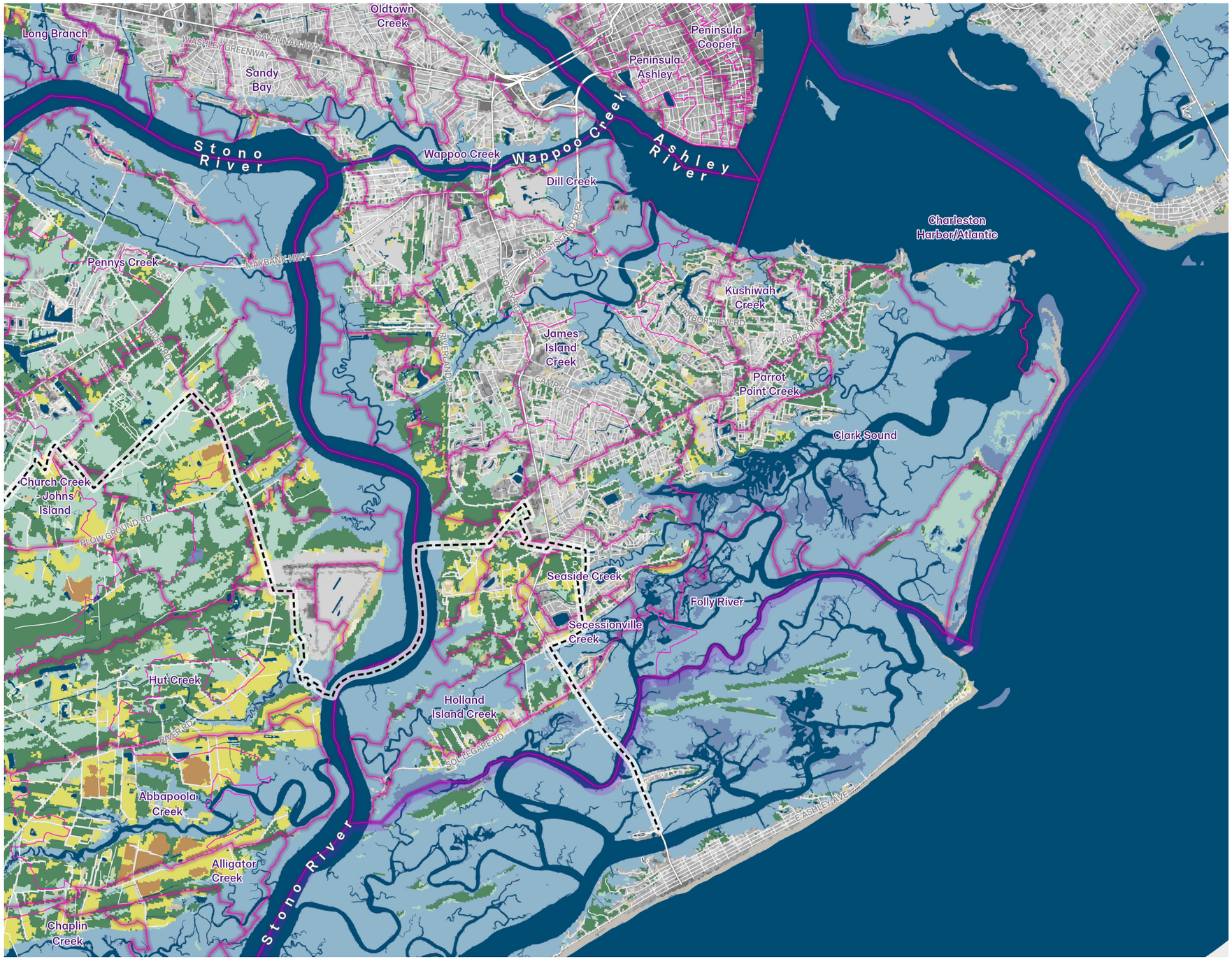


ACRES
(STARTING AT MEAN LOWER LOW WATER)

LAND COVER

Most of James Island is developed, with remnant patches of agriculture and woodlands along the Stono River.

map sources: MLRC Consortium



Legend

Land Cover 2016

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetland

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

Water

1 inch = 6,000 feet

Miles 1

ELEVATION & LAND COVER DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

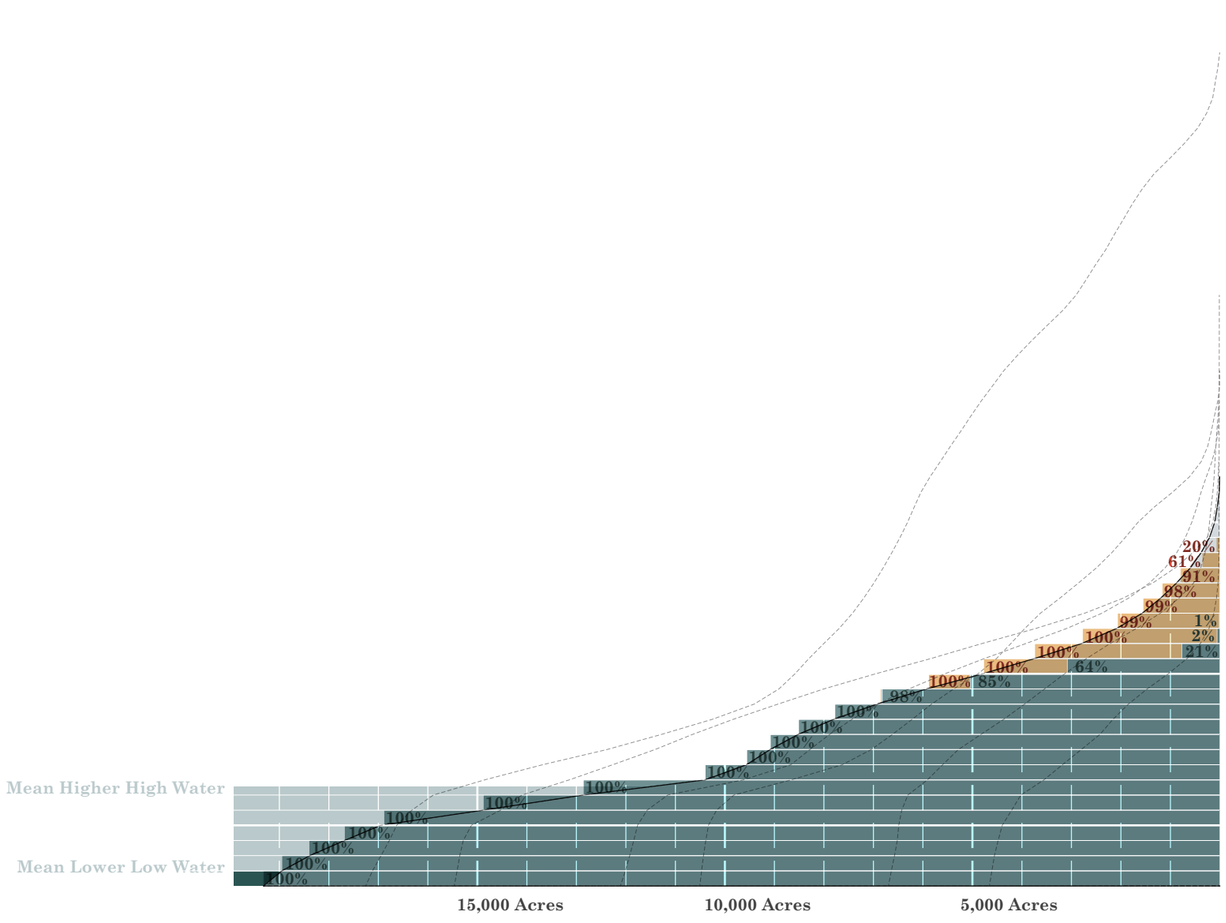
JAMES ISLAND

Surface Elevation (NOAA, LiDAR)
% Of Elevation Range in the 100 Year Floodplain (FEMA, Flood Insurance Rate Map)
% Of Elevation Range in the Category 3 Max Storm Surge (NOAA, SLOSH Model)

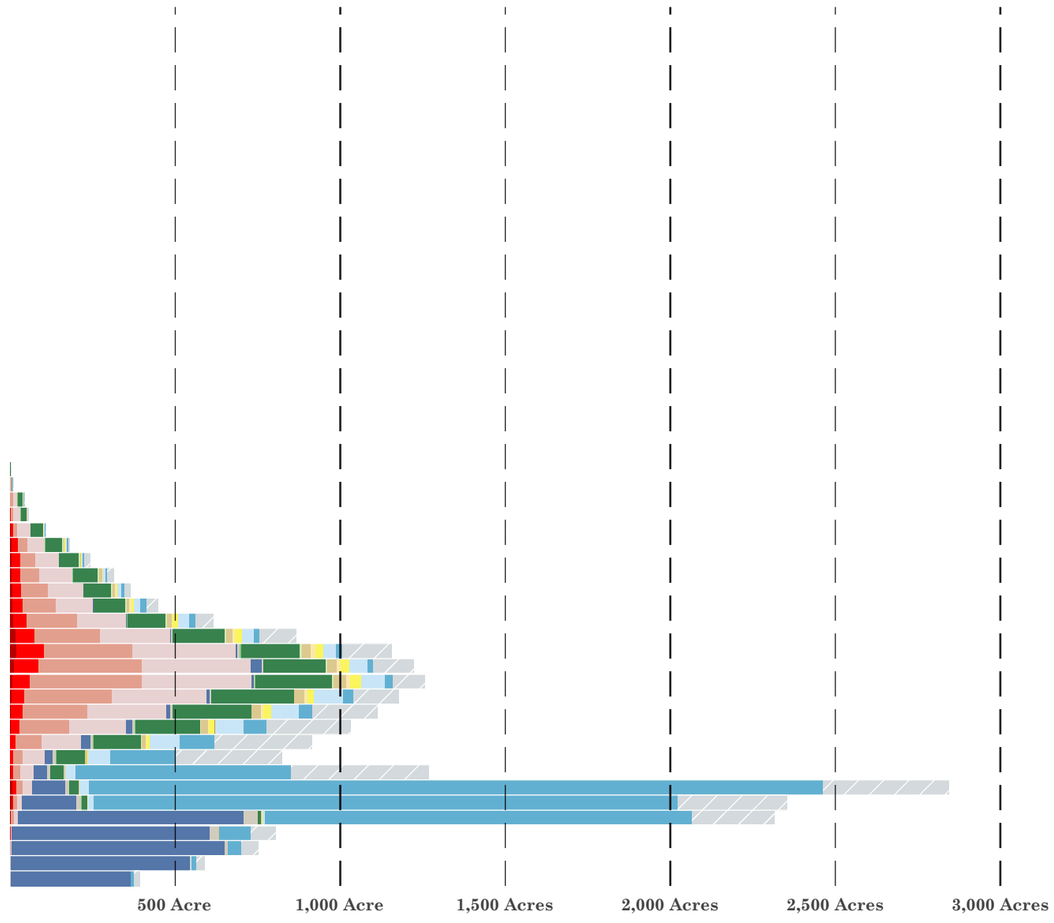
SURFACE ELEVATION

LAND COVER

Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Open Water
Barren Land
Deciduous Forest
Evergreen Forest
Shrub/Scrub
Grassland
Pasture
Crops
Woody Wetland
Emergent Herbaceous Wetland
Outside Urban Growth Boundary



ACRES
(STARTING AT MEAN LOWER LOW WATER)

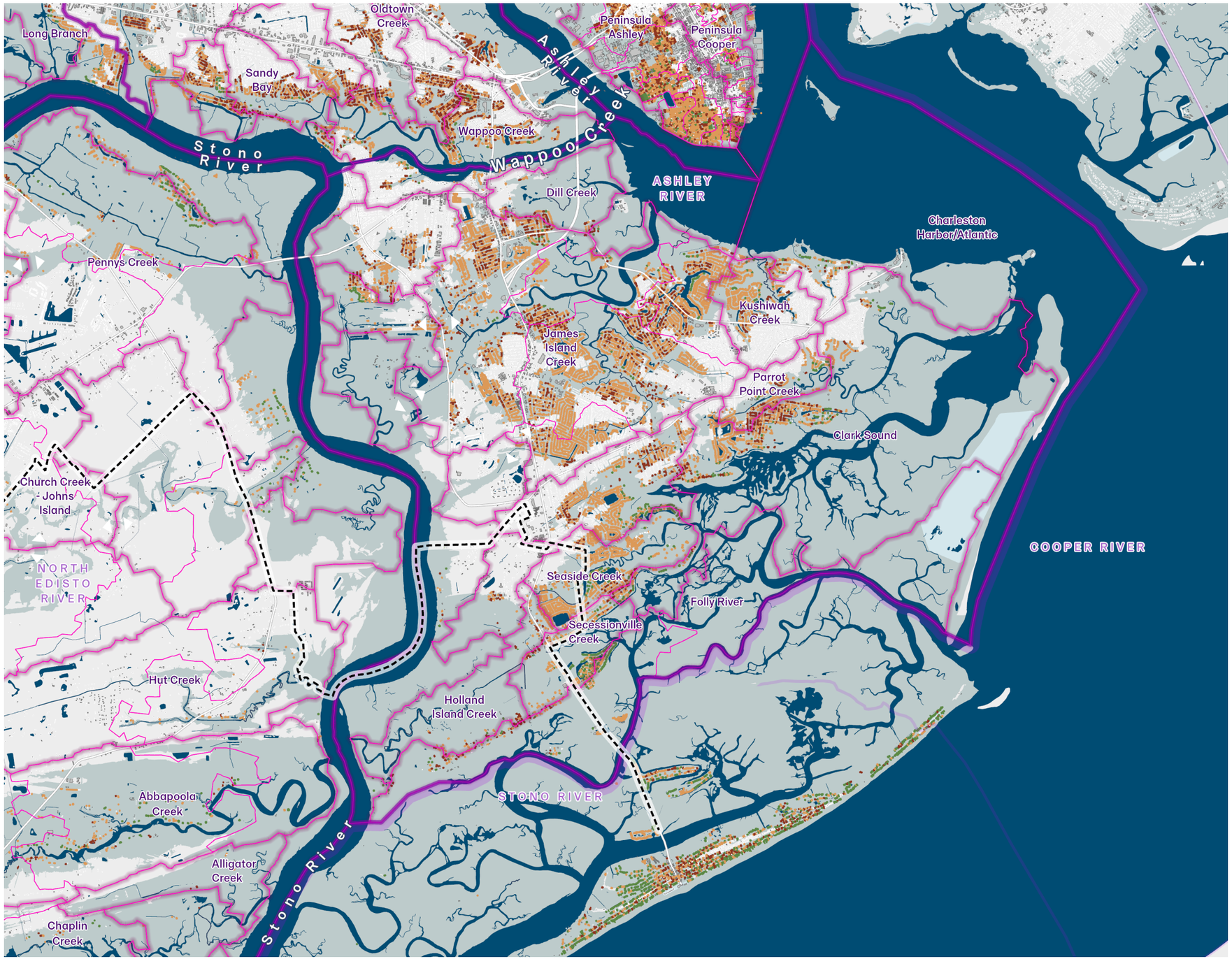


LANDCOVER DISTRIBUTION IN WATERSHED
(National Land Cover Database)

RESIDENTIAL BUILDING TYPE

Much of the development on James Island was built in the 100 year floodplain before BFE regulations went into place.

map sources: City of Charleston



Legend

Residential Structures

- Outside Floodplain, all footing types
- Built to BFE/BFE+2, Peirs
- Built to BFE/BFE+2, Slab-on-Grade or Unknown
- Built Pre-BFE Regulations
- Non Residential

100 Year Floodplain and BFE

- No BFE
- BFE

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water
- Wetland

1 inch = 6,000 feet

Miles 1

ELEVATION & RESIDENTIAL BUILDING TYPE DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

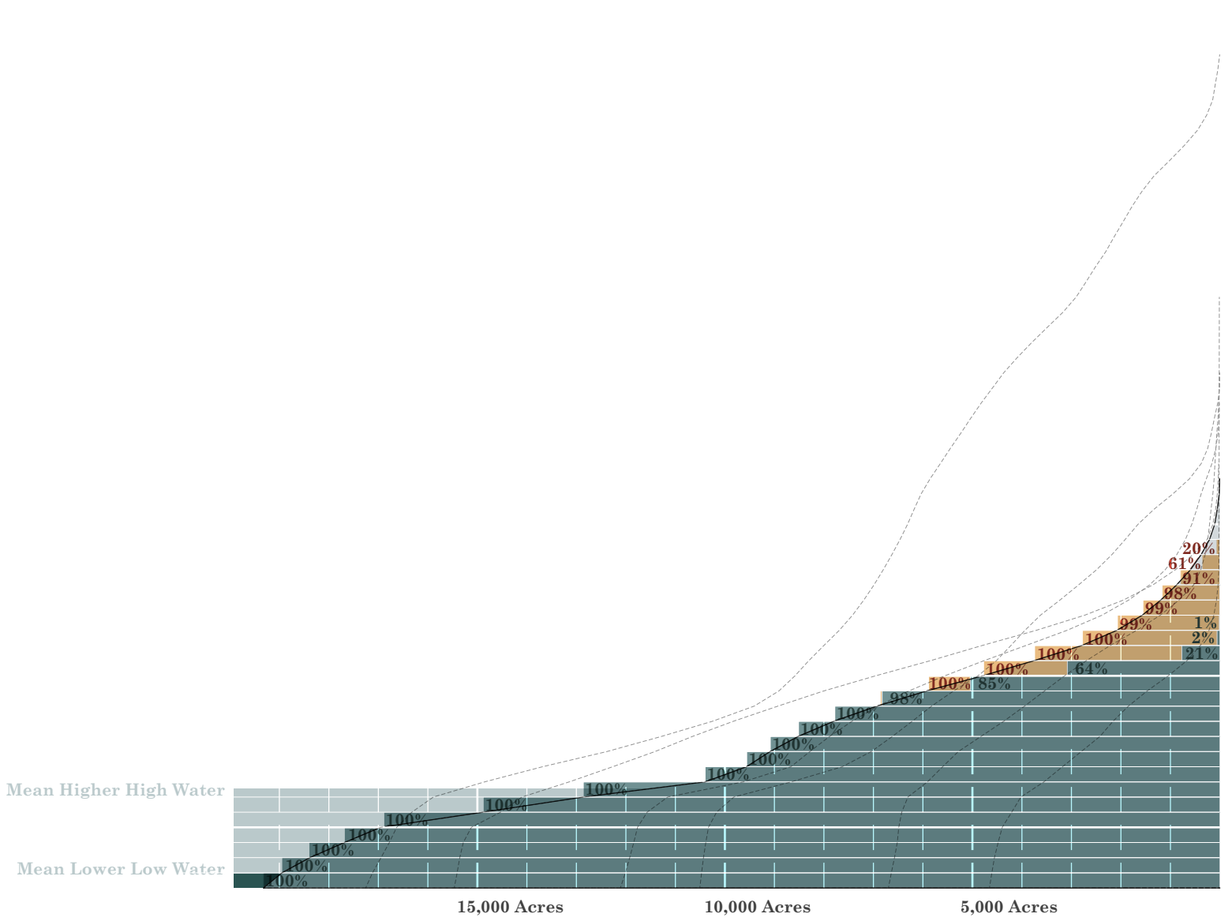
JAMES ISLAND

Surface Elevation (NOAA, LiDAR)
% Of Elevation Range in the 100 Year Floodplain (FEMA, Flood Insurance Rate Map)
% Of Elevation Range in the Category 3 Max Storm Surge (NOAA, SLOSH Model)

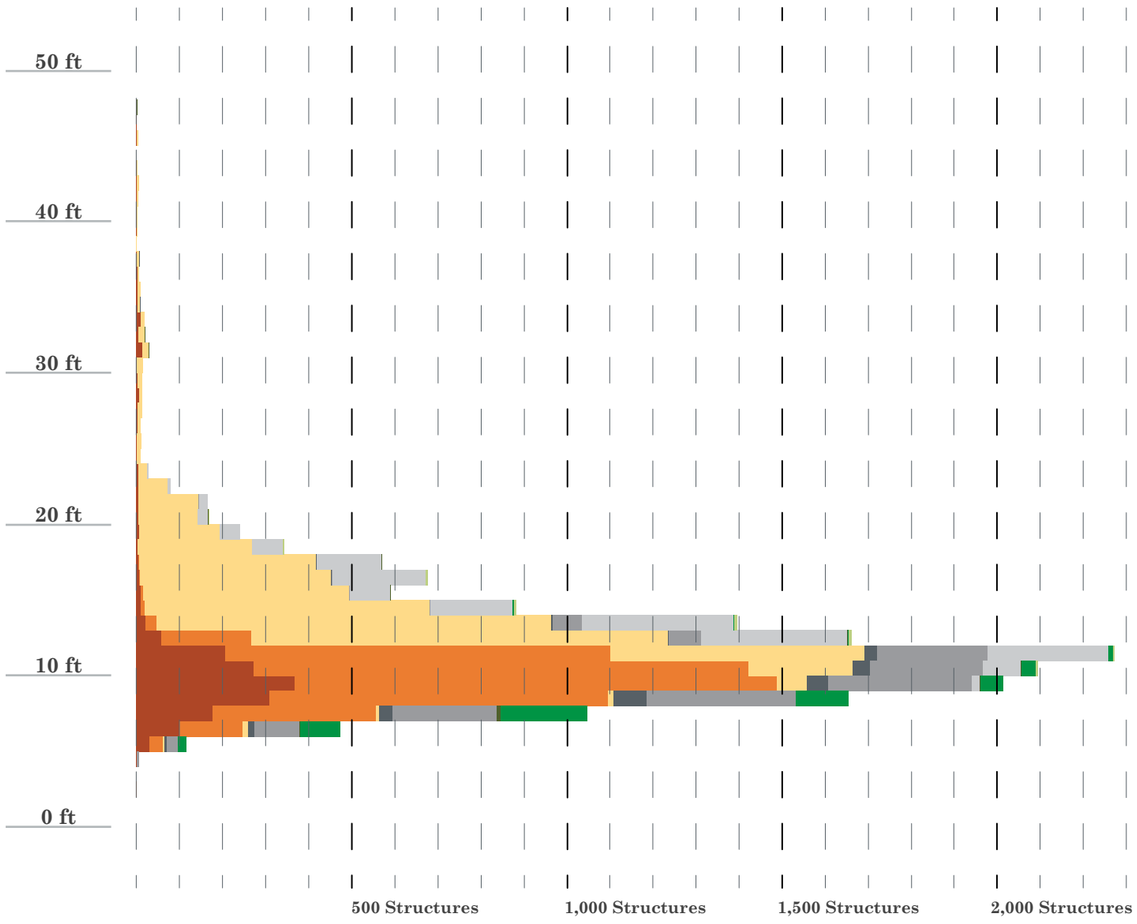
SURFACE ELEVATION

RESIDENTIAL STRUCTURES

Slab on Grade: inside 100 year floodplain before BFE requirement
Slab on Grade: inside 100 year floodplain rasied to BFE/BFE+1
Slab on Grade: outside 100 year floodplain
Unknown: inside 100 year floodplain before BFE requirement
Unknown: inside 100 year floodplain rasied to BFE/BFE+1
Unknown: outside 100 year floodplain
On Peirs: inside 100 year floodplain before BFE requirement
On Peirs: inside 100 year floodplain rasied to BFE/BFE+1
On Peirs: outside 100 year floodplain



ACRES
(STARTING AT MEAN LOWER LOW WATER)



STRUCTURE BASE ELEVATIONS
(STARTING AT MEAN LOWER LOW WATER)

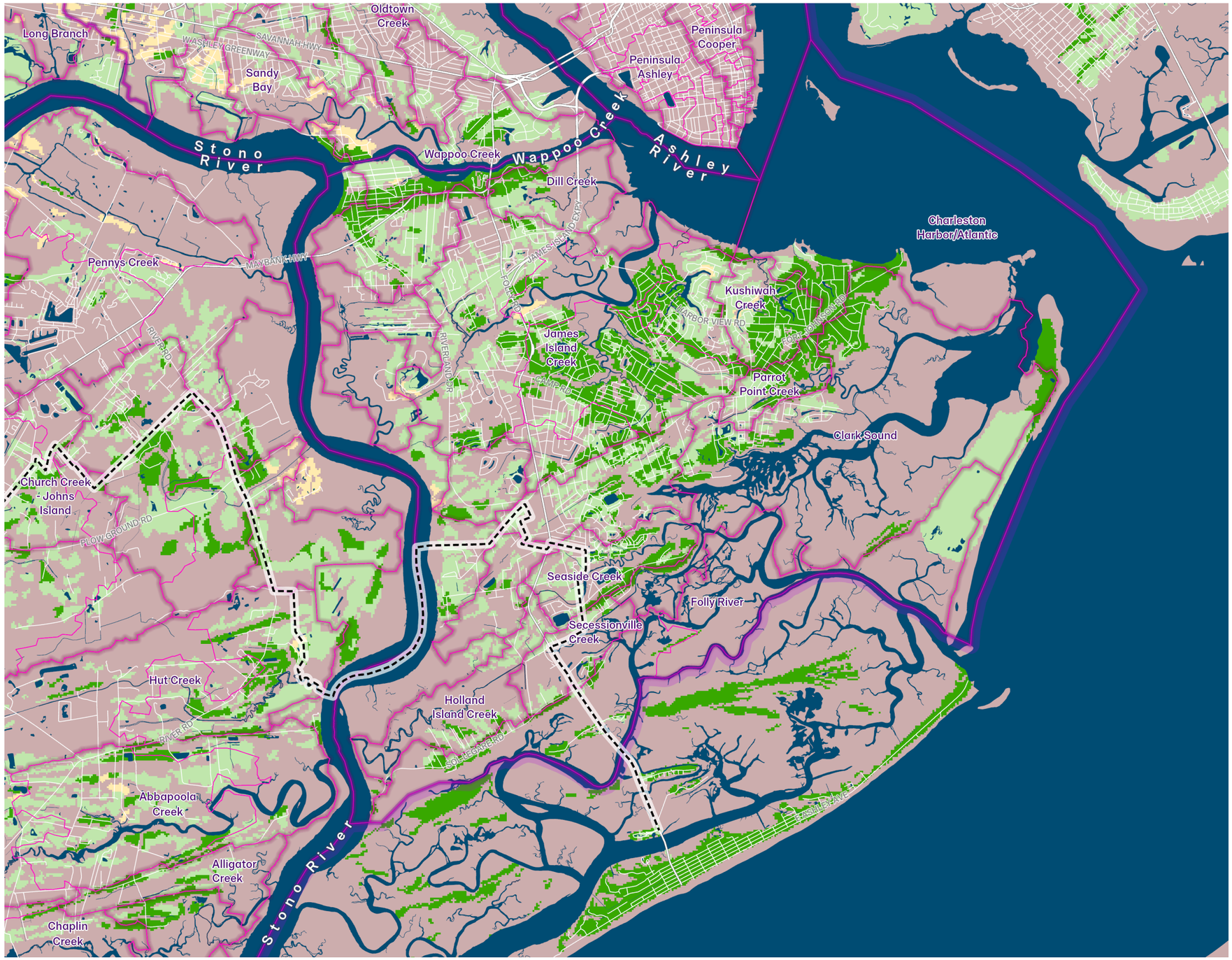
SOIL TYPES

Most of the higher ground on James Island has high to moderate infiltration capacity.

map sources: USDA

HYDROLOGIC GROUPS

- A: ABSORBS THE MOST WATER
- B: ABSORBS SOME WATER
- C: ABSORBS LITTLE WATER
- D: POORLY DRAINED AND/OR ABSORBS BASICALLY NO WATER



1 inch = 6,000 feet

Miles 1

TREE CANOPY DENSITY & CHANGE

Tree canopy is moderately stable and moderately dense.

map sources: GLCF



Legend

Tree Canopy (2015)

- Dense
- Sparse

Canopy Change (2000-2015)

- High Gain
- High Loss

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

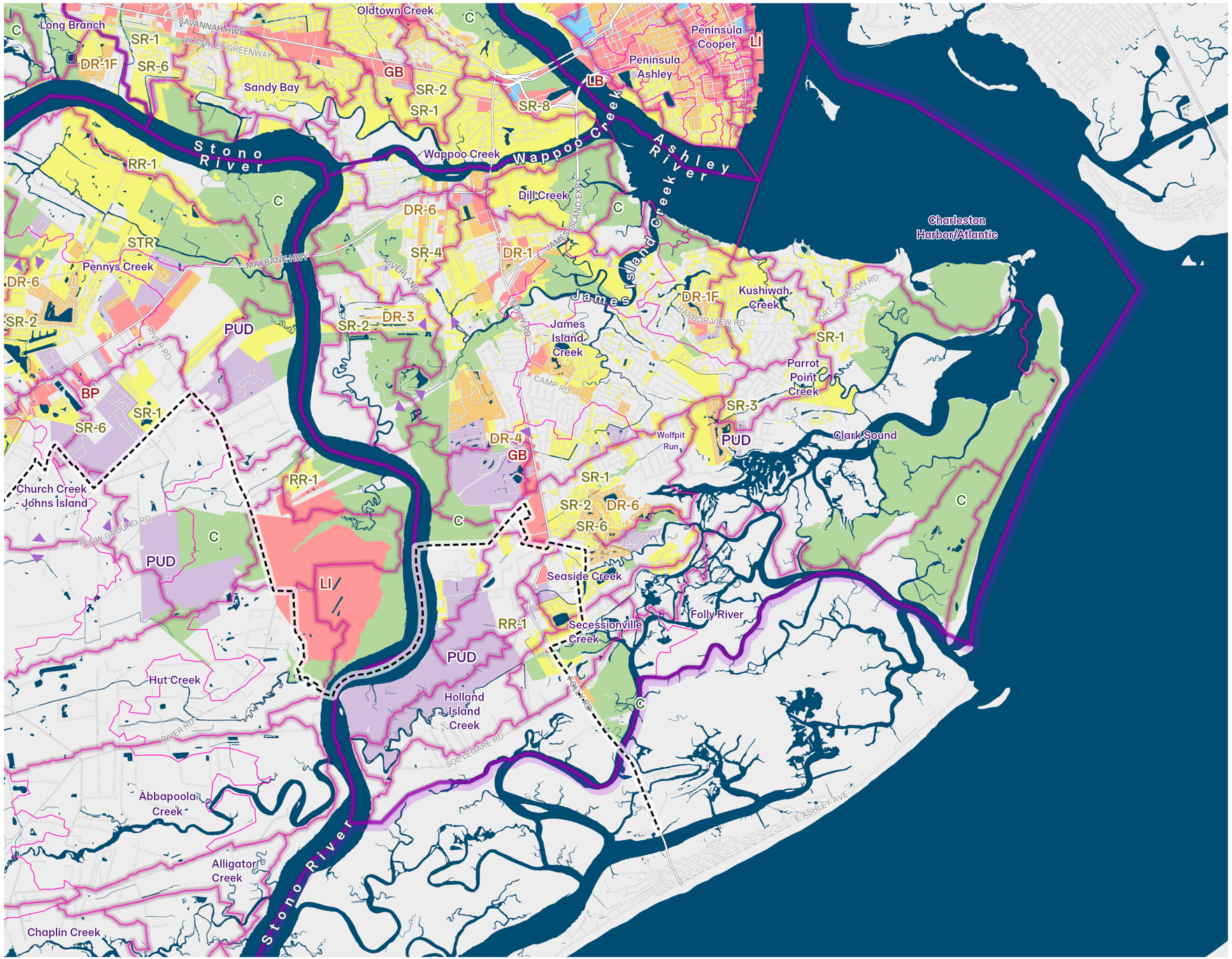
- Water

1 inch = 6,000 feet

Miles 1

ZONING

Fragmented political jurisdictions result in zoning gaps, especially within James Island Creek watershed.



Legend

Zoning

- Parks & Conservation
- Single Family Residential
- Diverse Residential
- Planned Development
- Mixed Use
- Business & Industrial

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

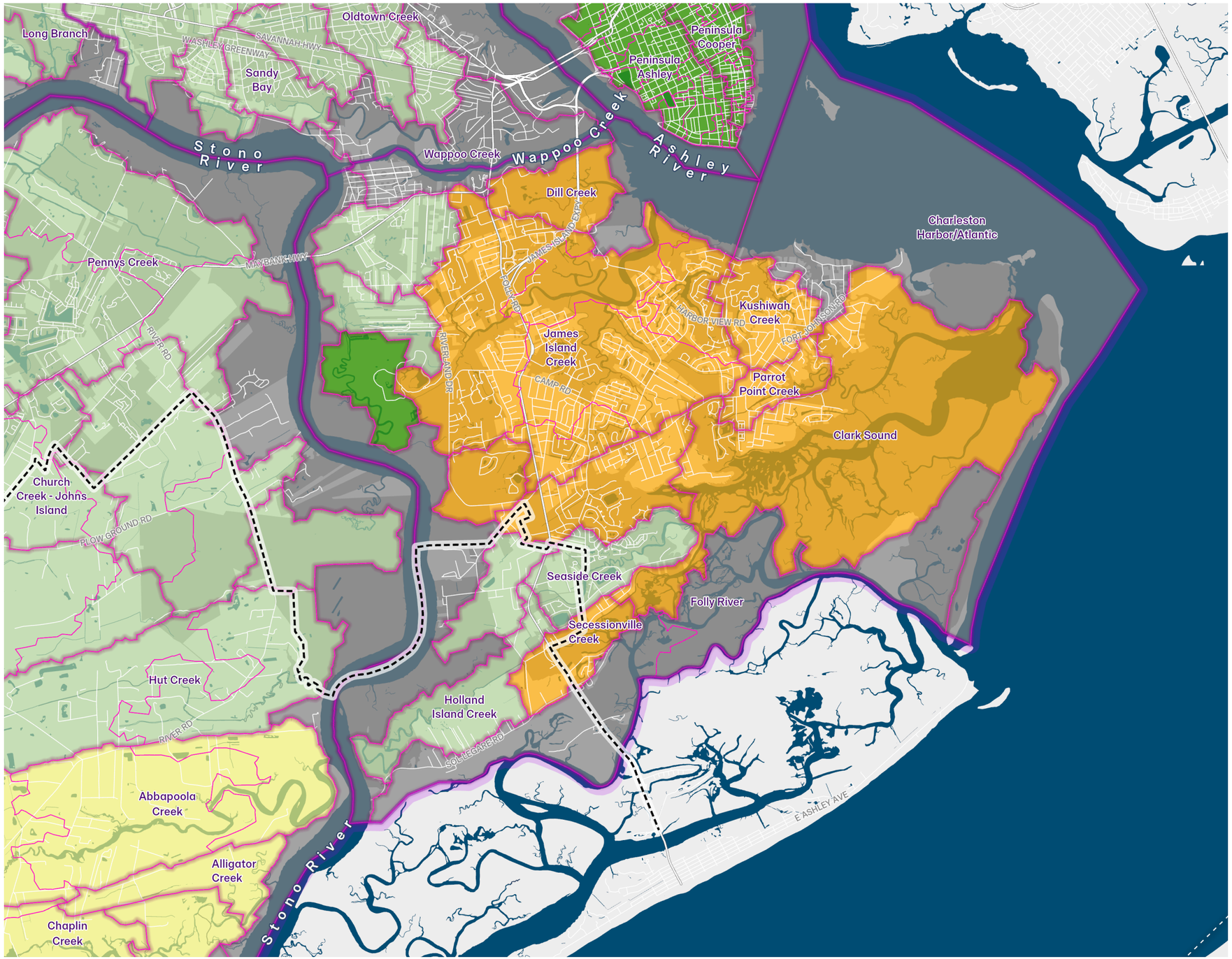
Water

1 inch = 6,000 feet

Miles 1

JURISDICTIONAL COMPLEXITY

The City of James Island and the City of Charleston form a complicated patchwork of jurisdictions on James Island. Most of the watersheds have some portion in both jurisdictions, creating coordination challenges for drainage networks.



Legend

Watershed Jurisdiction

- Entirely Within Charleston City
- Single-City, Single-County
- No City, Single-County
- Multi-City, Single-County
- Multi-City, Multi-County
- Excluded

Counties

- Charleston City Limits

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary

Water

- Water

1 inch = 6,000 feet

Miles 1

LAND & WATER IMPLICATIONS

ELEVATION RISK ZONES

ELEVATION RISK ZONES & WATERSHED SENSITIVITY

ELEVATION ZONES

Patches of high ground exist on James Island near the banks of the Wappoo and along Fort Johnson Road. Compound flood risk is a challenge in low-slope areas with significant exposure to tidal influence.

HIGH GROUND

High ground is defined as land outside of the FEMA 100 year floodplain and above the NOAA max category 3 storm surge. High ground has the lowest flood risk and stormwater detention here has the greatest watershed benefit.

ADAPT ZONE

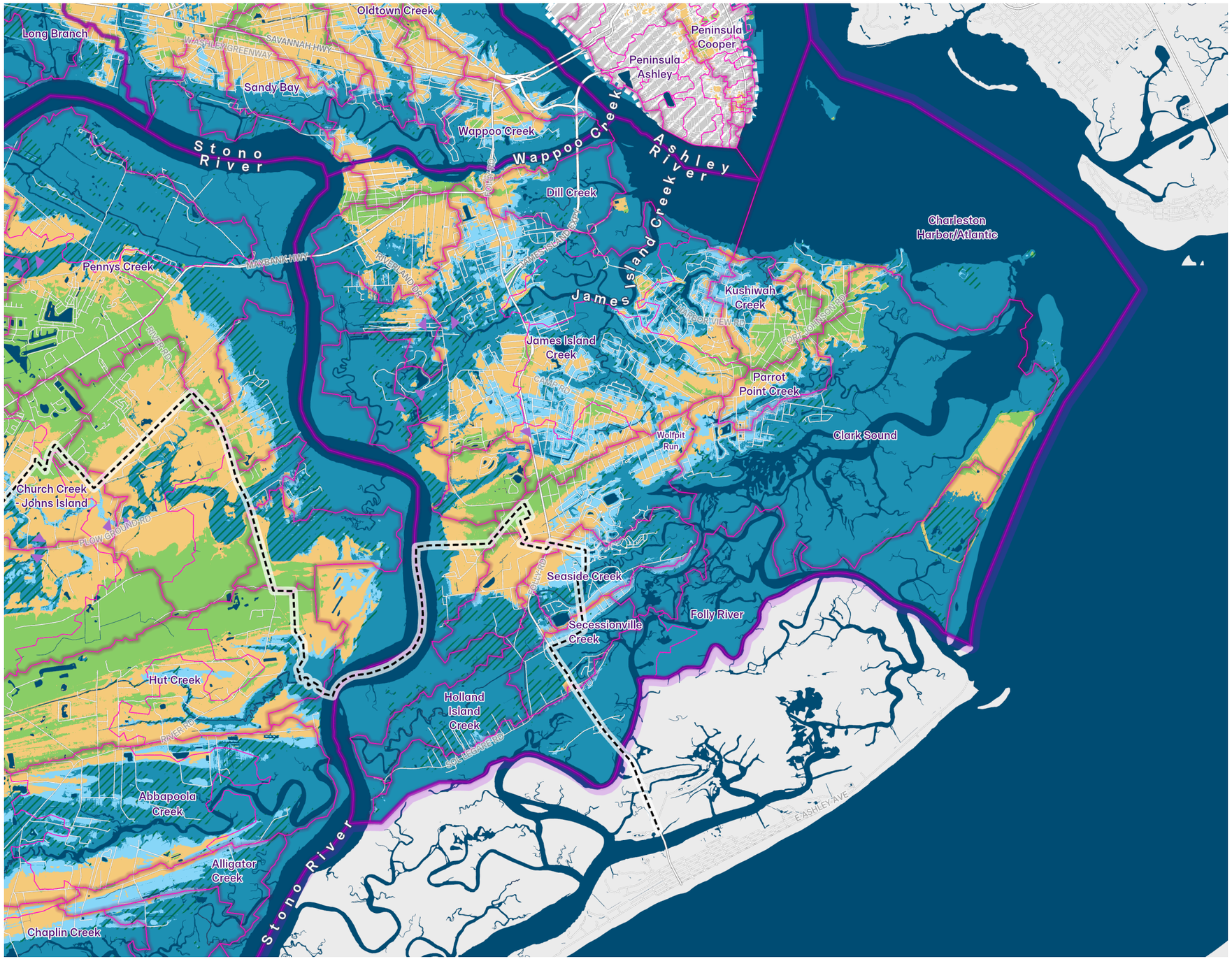
The adapt zone consists of land outside of the FEMA 100 year floodplain that is still within the NOAA maximum storm surge of a category 3 hurricane. Rain and storm surge flooding in this zone is infrequent but not impossible.

COMPOUND FLOOD RISK

This zone encompasses areas within the floodplain above the tidal flood risk zone where flood risk comes from a mixture of rainfall, runoff and tidal conditions.

TIDAL FLOOD RISK ZONE

This zone encompasses the lowest land in Charleston. Nearly 100% of this zone is in the 100 year floodplain. Flooding is frequent and can come solely from tidal events independent of precipitation. Sea level rise driven marsh migration occurs in this dynamic zone.



1 inch = 6,000 feet

Miles 1

ELEVATION RISK + WATERSHED SENSITIVITY

The James Island Creek watershed has significant areas of high risk and high sensitivity.

HIGH SENSITIVITY

Combination of more flood prone watersheds and a high number of vulnerable parcels. Typically larger tidal watersheds and/or watersheds where development happened before BFE regulations.

NORMAL SENSITIVITY

Combination of less flood prone watersheds and a low number of vulnerable parcels. Typically smaller and/or less developed watersheds.

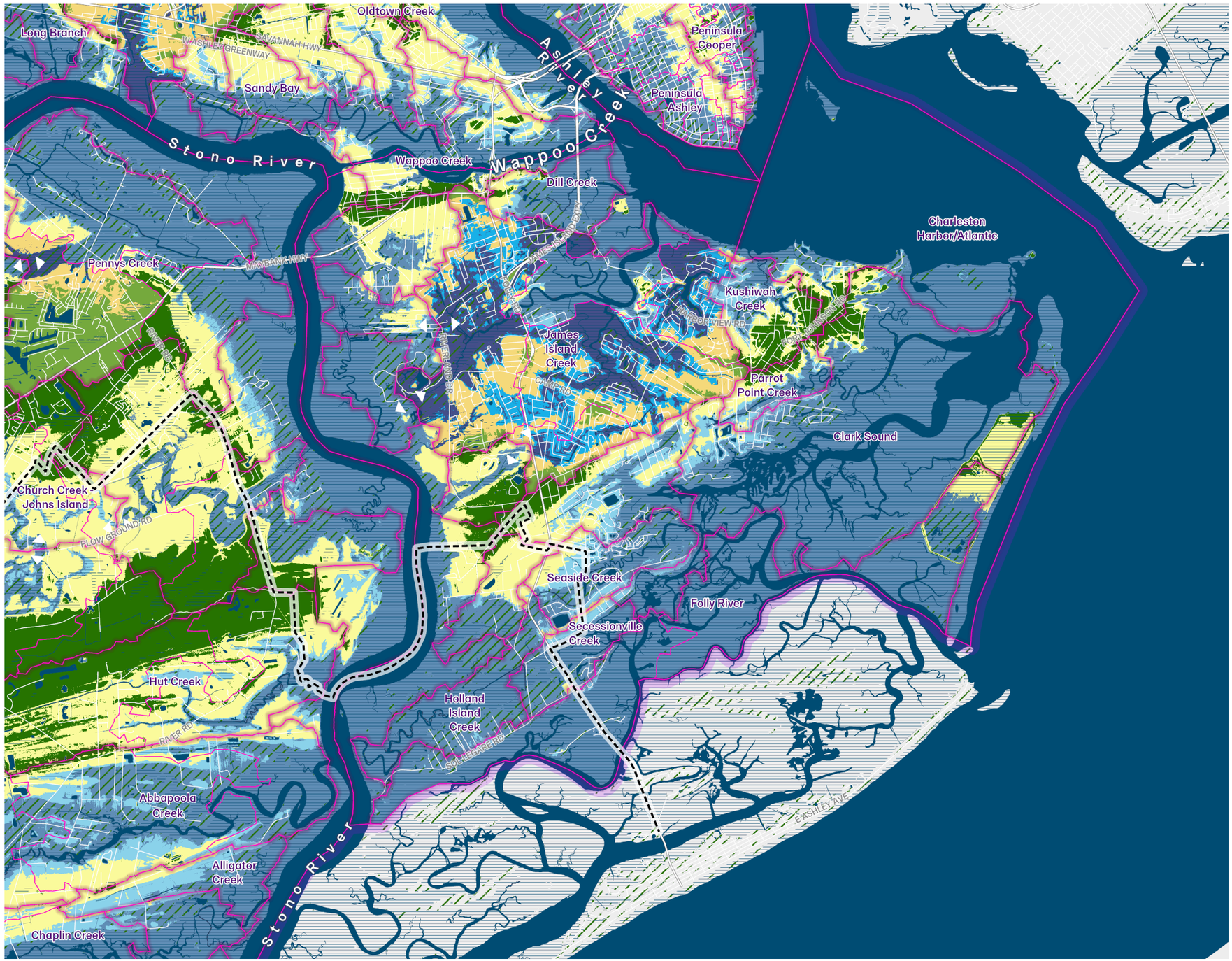
HIGH GROUND

ADAPT ZONE

COMPOUND FLOOD RISK

TIDAL FLOOD RISK ZONE

Marsh Migration Zone



1 inch = 6,000 feet

Miles 1

RISK + SENSITIVITY + ZONING

While swaths of the lowest elevations in James Island are zoned for conservation, much of it has already been developed.

Legend

Zoning

- Parks & Conservation
- Single Family
- Diverse Residential
- Planned Development
- Mixed Use
- Business & Industrial

Risk & Watershed Impact

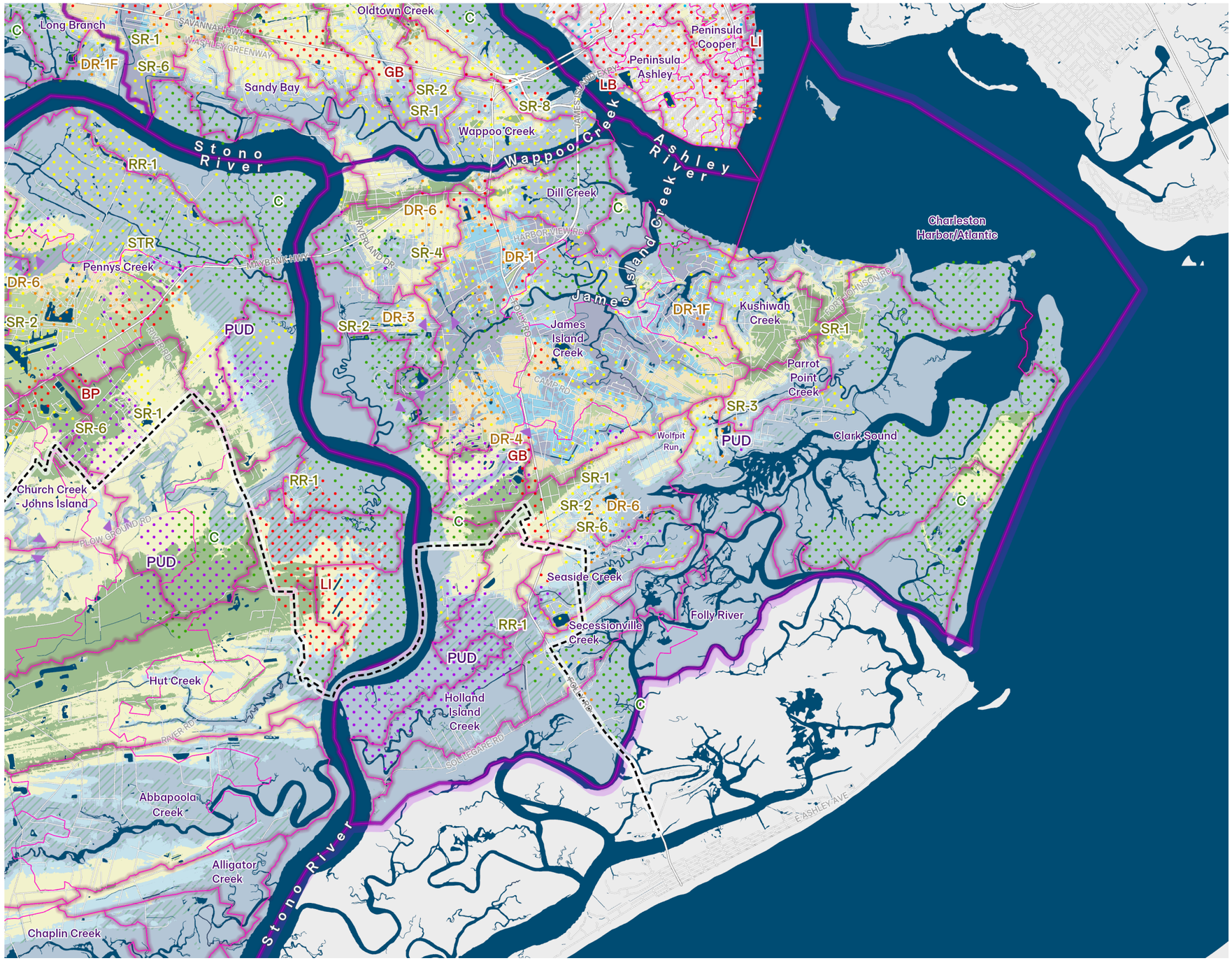
- High Ground, Normal Sensitivity
- High Ground, High Sensitivity
- Adapt Zone, Normal Sensitivity
- Adapt Zone, High Sensitivity
- Compound Flood Risk, Normal Sensitivity
- Compound Flood Risk, High Sensitivity
- Tidal Flood Risk, Normal Sensitivity
- Tidal Flood Risk, High Sensitivity
- Marsh Migration Zone

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary
- Water

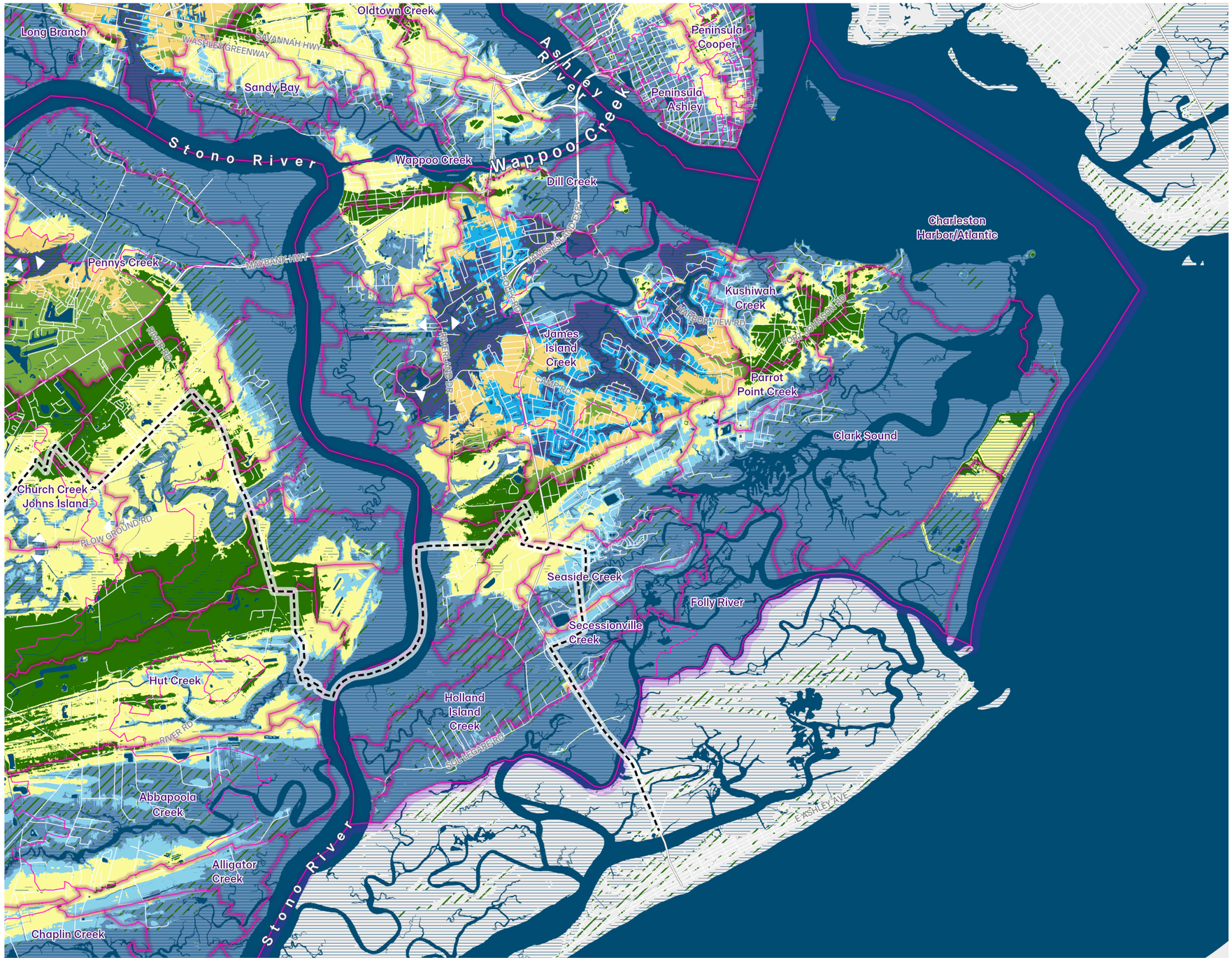
1 inch = 6,000 feet

Miles 1



LAND & WATER IMPLICATIONS

- Much of James Island drains into the James Island Creek Watershed, a large, highly sensitive tidal watershed home to thousands of vulnerable parcels.
- High ground is predominantly outside the City of Charleston's jurisdiction, occurring along the banks of the Wappoo and along Fort Johnson Rd.
- Jurisdictional complexity pervades almost all of the watersheds and elevation zones.
- Risk of wetland loss is high throughout the island in a 3' sea level rise scenario.



1 inch = 6,000 feet
Miles 1

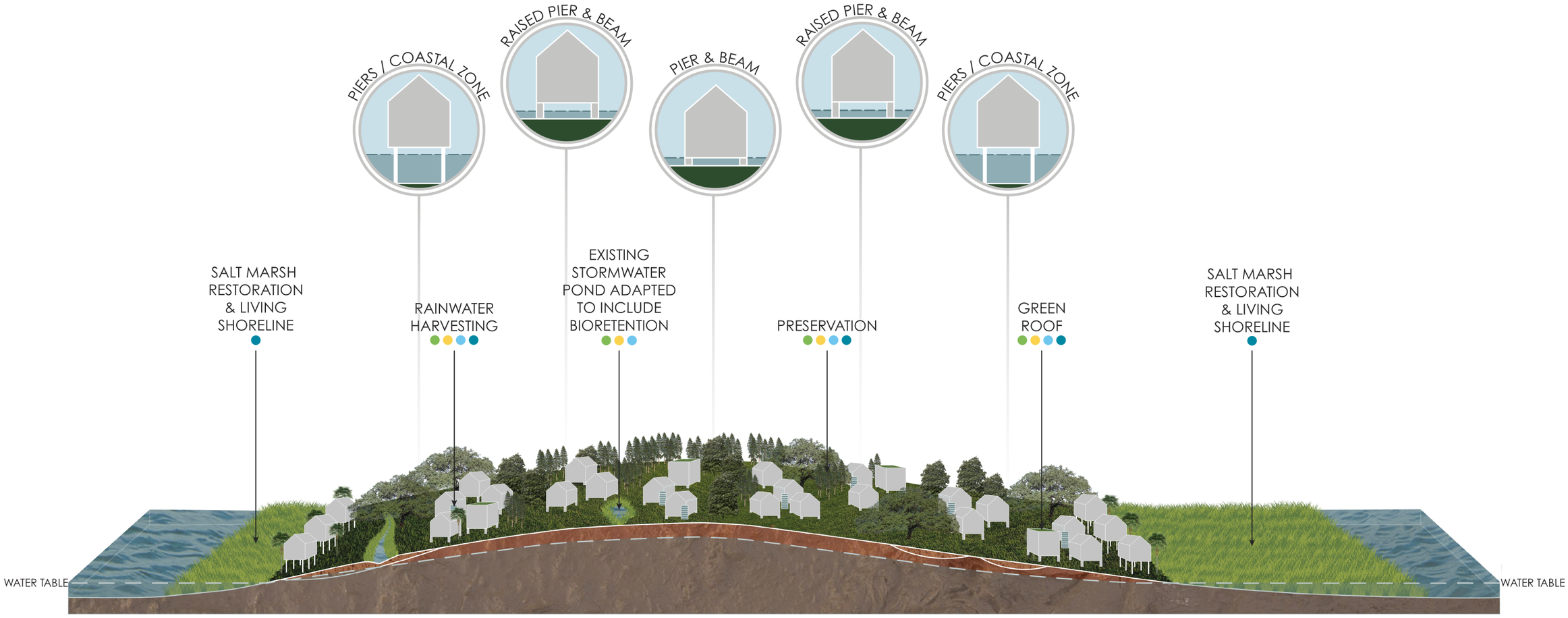
JOHNS ISLAND

WATER

LAND

RISK ZONES

RECOMMENDATIONS



JOHNS ISLAND TRANSECT

CHURCH CREEK, WADMALAW	MARSH	GROUP B SOIL	GROUP D SOIL	B SOIL	B SOIL	GROUP D SOIL	MARSH	STONO R.
TIDAL FLOOD RISK		ADAPT ZONE	HIGH GROUND			ADAPT ZONE	COMP.	TIDAL FLOOD RISK

SURCULUS

WATER

WATERSHEDS

WATERSHED TYPES

WATERSHED VULNERABILITY

100 YEAR FLOODPLAIN

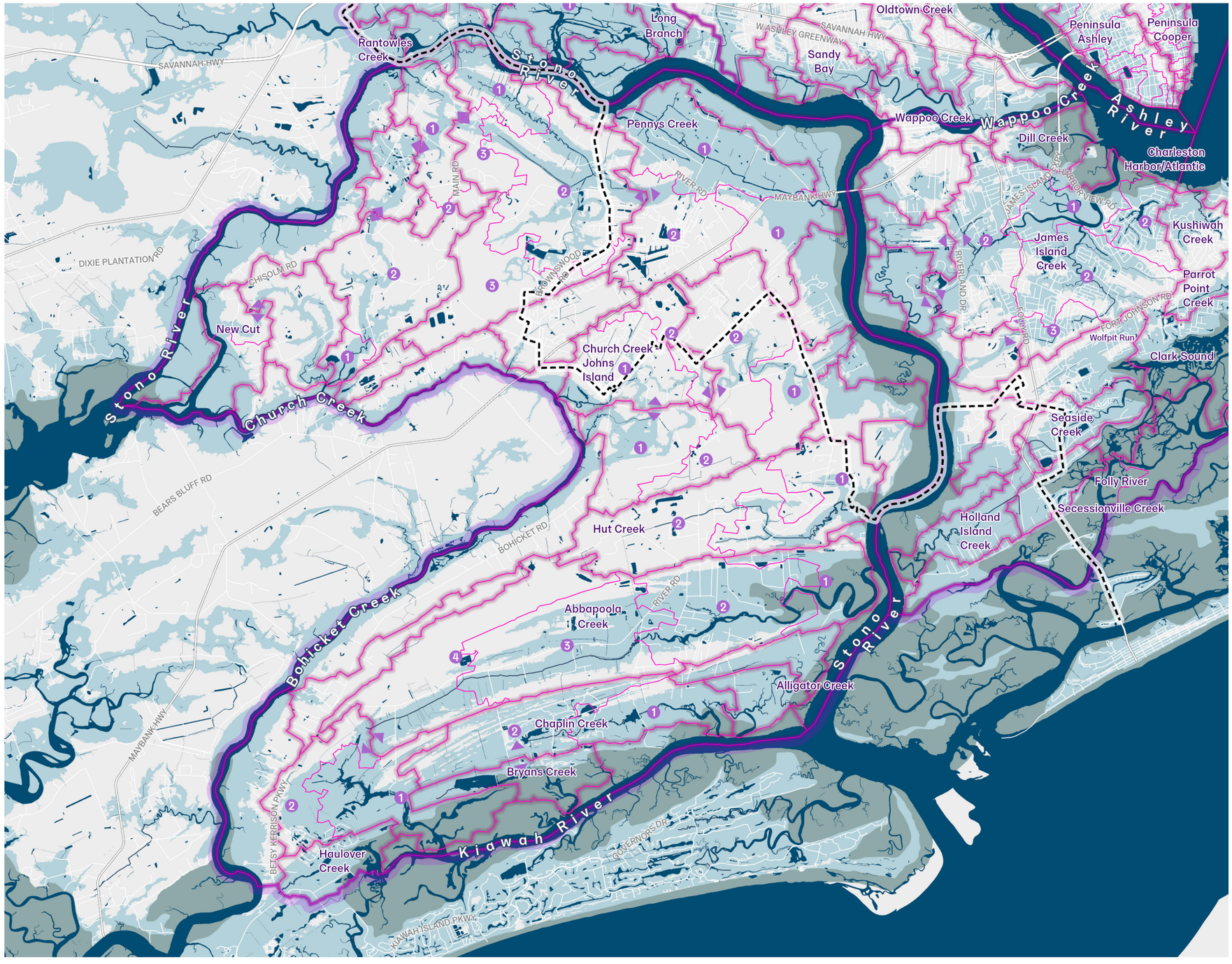
STORM SURGE

SEA LEVEL RISE

MARSH MIGRATION

WATERSHEDS

Johns Island has 22 watersheds which can empty into several different waterways: the Stono River, the Kiawah River, Bohicket Creek and Church Creek.



Legend

DFIRM

100 Year Floodplain

VE Zone

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Subwatershed Order (1 being closest to the outlet)

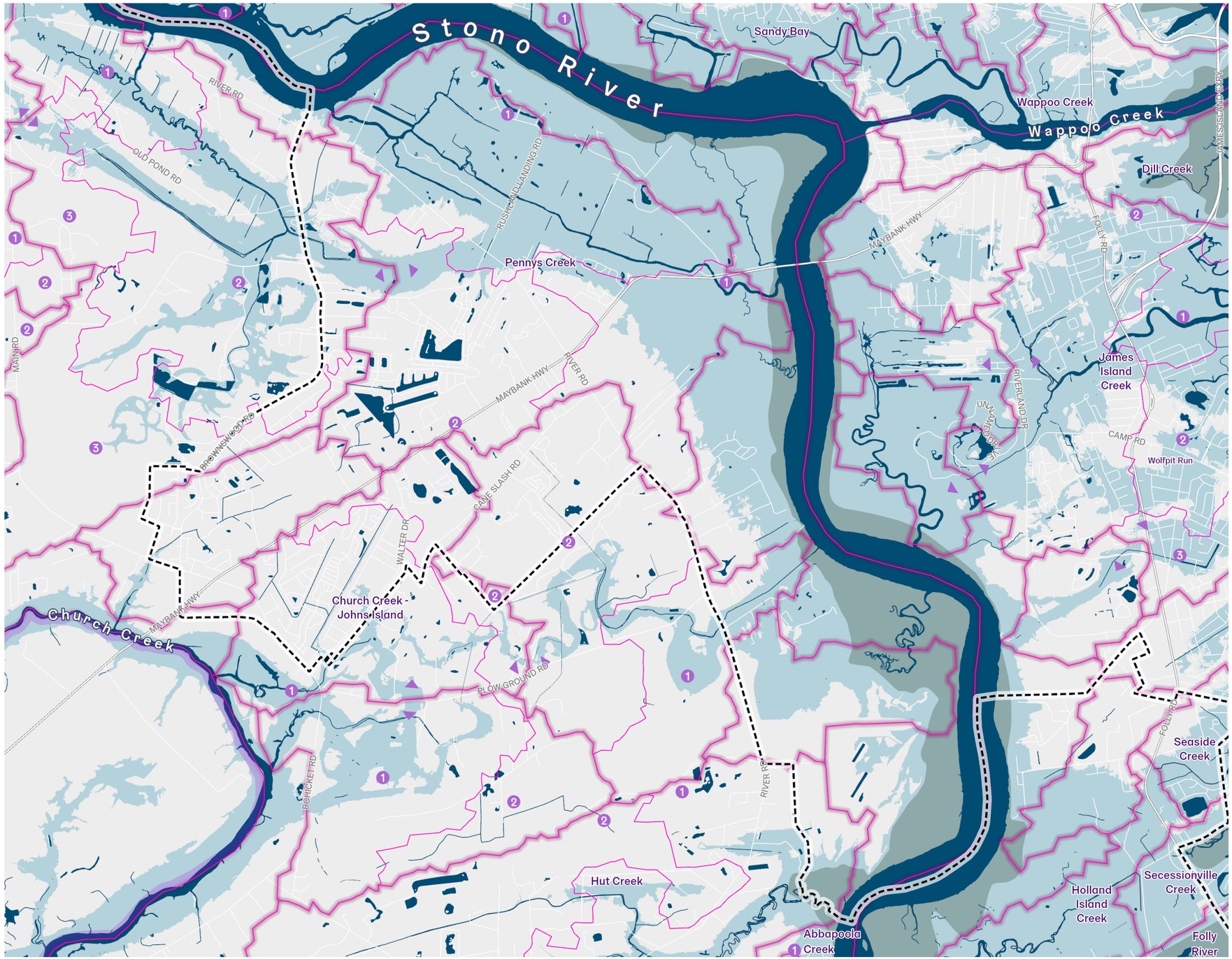
Watershed Interconnectivity Point

1 inch = 8,000 feet

Miles 1

WATERSHEDS

Five watersheds intersect the Urban Growth Boundary (not including sheet flow conditions into bounding waterways). Drainage from Maybank splits north into Pennys Creek and south into Church and Burden Creek.



Legend

DFIRM

100 Year Floodplain

VE Zone

Project Watersheds

Project Subwatersheds

Subwatershed Order (1 being closest to the outlet)

Watershed Interconnectivity Point

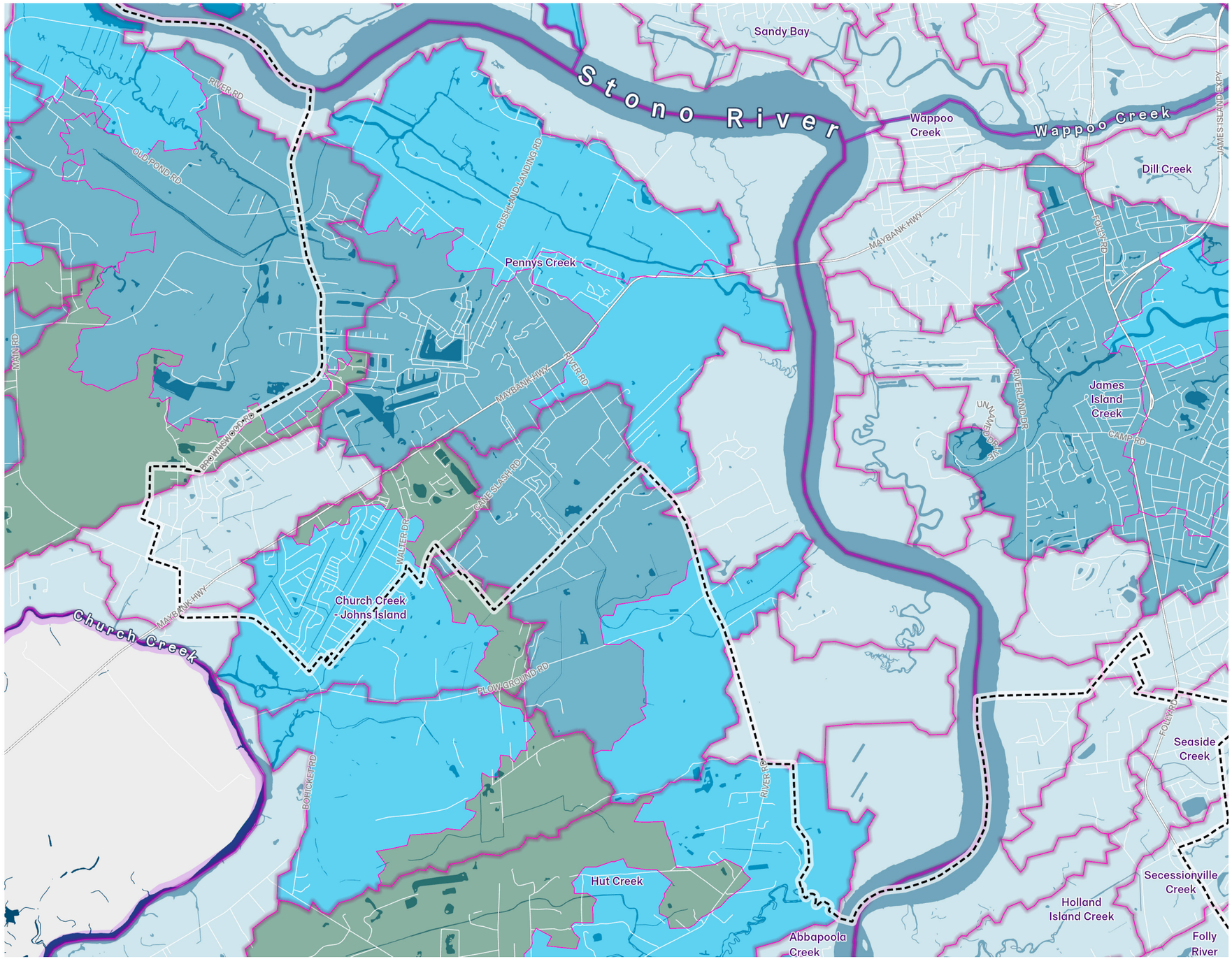
1 inch = 4,000 feet

Miles

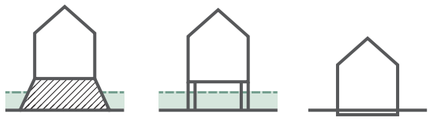
1

WATERSHED TYPES

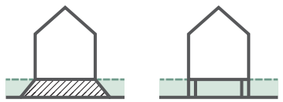
Most of the watersheds on Johns Island are large, with distinct upstream and downstream conditions.



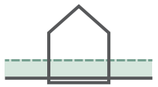
STRUCTURE VULNERABILITY
USING THE 2020 VULNERABILITY AND RISK ASSESSMENT DEFINITIONS



Low Combined Vulnerability & Risk
Outside the 100 year floodplain
Built after BFE+1 requirements



Medium Combined Vulnerability & Risk
In the 100 year floodplain
Built after BFE requirements or raised to BFE



High Combined Vulnerability & Risk
In the 100 year floodplain
Built before BFE requirements

*All heights relative to BFE need verification

100 Year Floodplain and BFE
No BFE
BFE

Watersheds Neighborhood

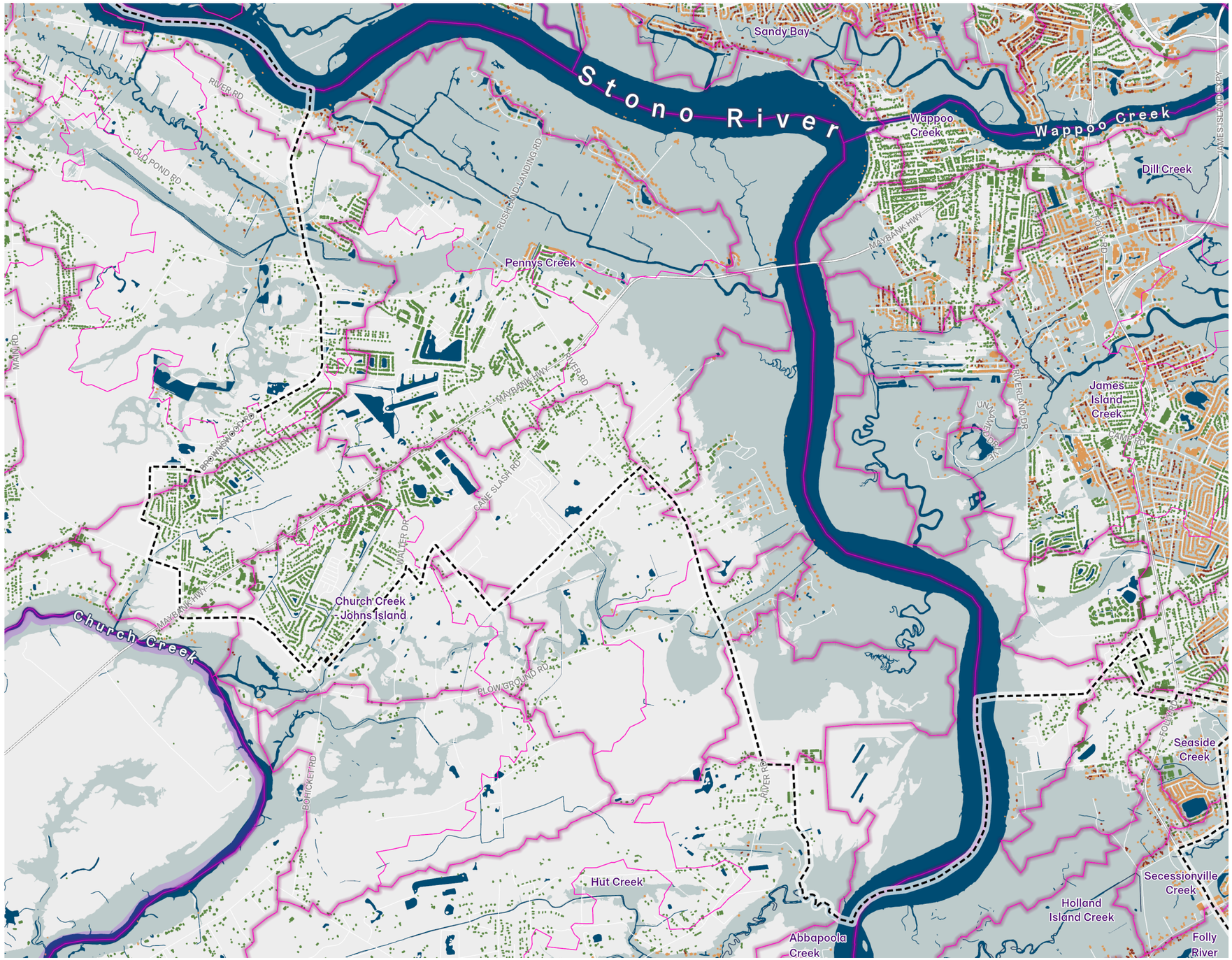
Project Watersheds

Project Subwatersheds

Urban Growth Boundary

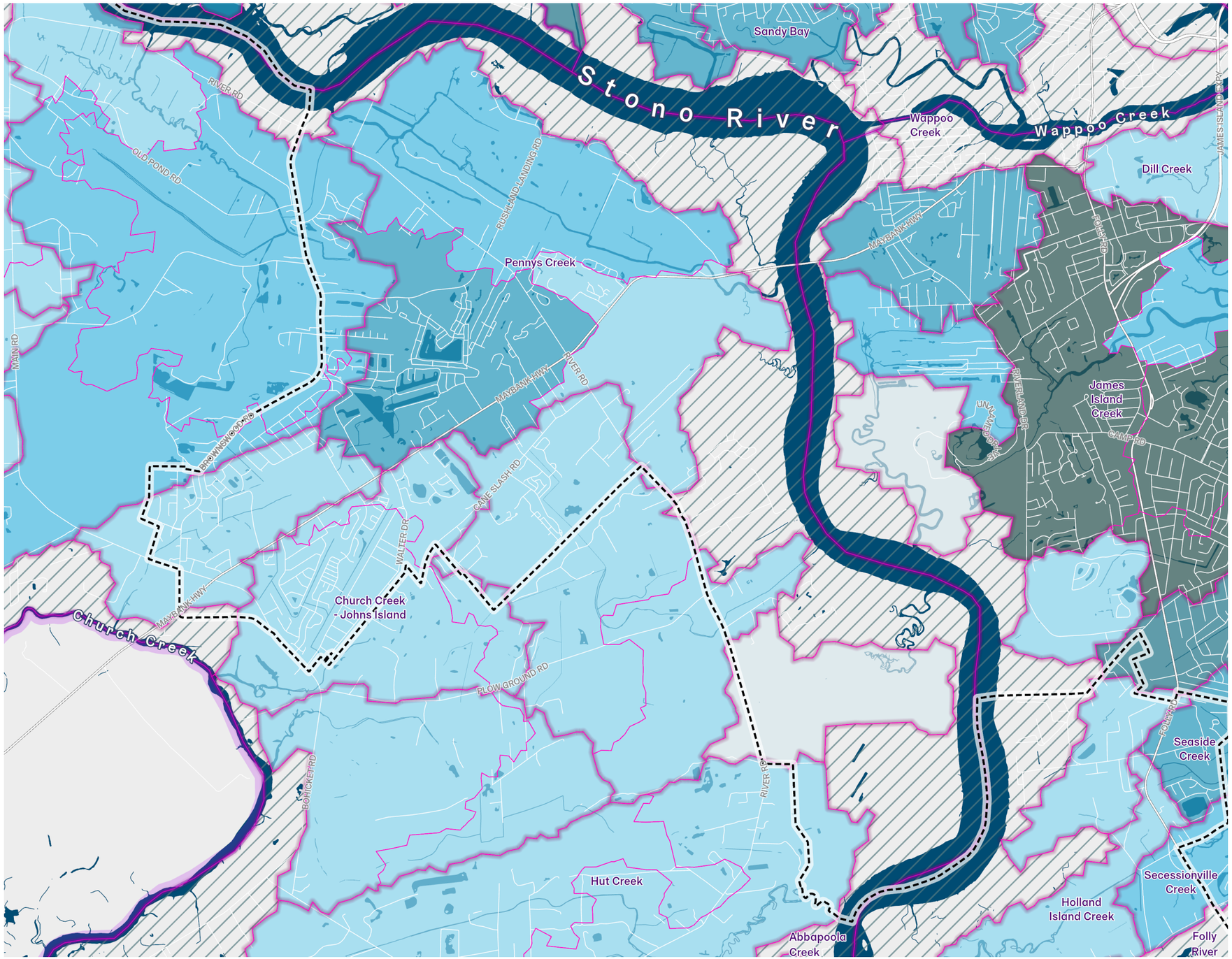
Water
Water

1 inch = 4,000 feet
Miles
1



NUMBER OF VULNERABLE PARCELS

Most of the watersheds on Johns Island have a moderately low number of vulnerable parcels. This is due in part to the moderately low current level of development and higher land surface elevations.



Legend

Vulnerable Parcels Local & Downstream

- ≤10
- ≤250
- ≤500
- ≤1000
- ≤1500
- >1500
- <excluded>

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

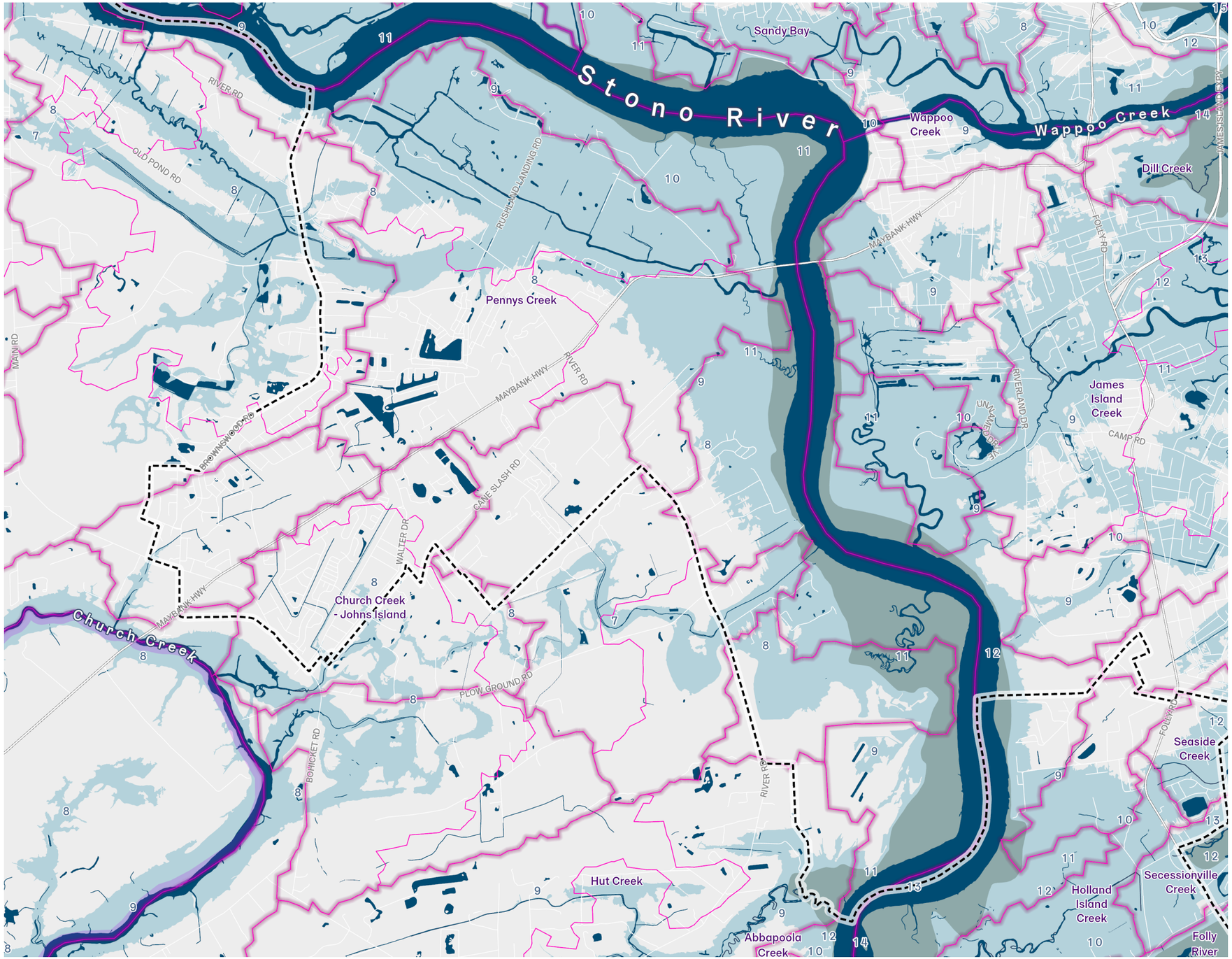
1 inch = 4,000 feet

Miles 1

100 YEAR FLOODPLAIN

Most of the developed areas on Johns Island are outside of the 100 year floodplain.

map sources: MLRC Consortium



Legend

DFIRM (**Blue #'s** are BFE in NAVD)

- 100 Year Floodplain
- VE Zone

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

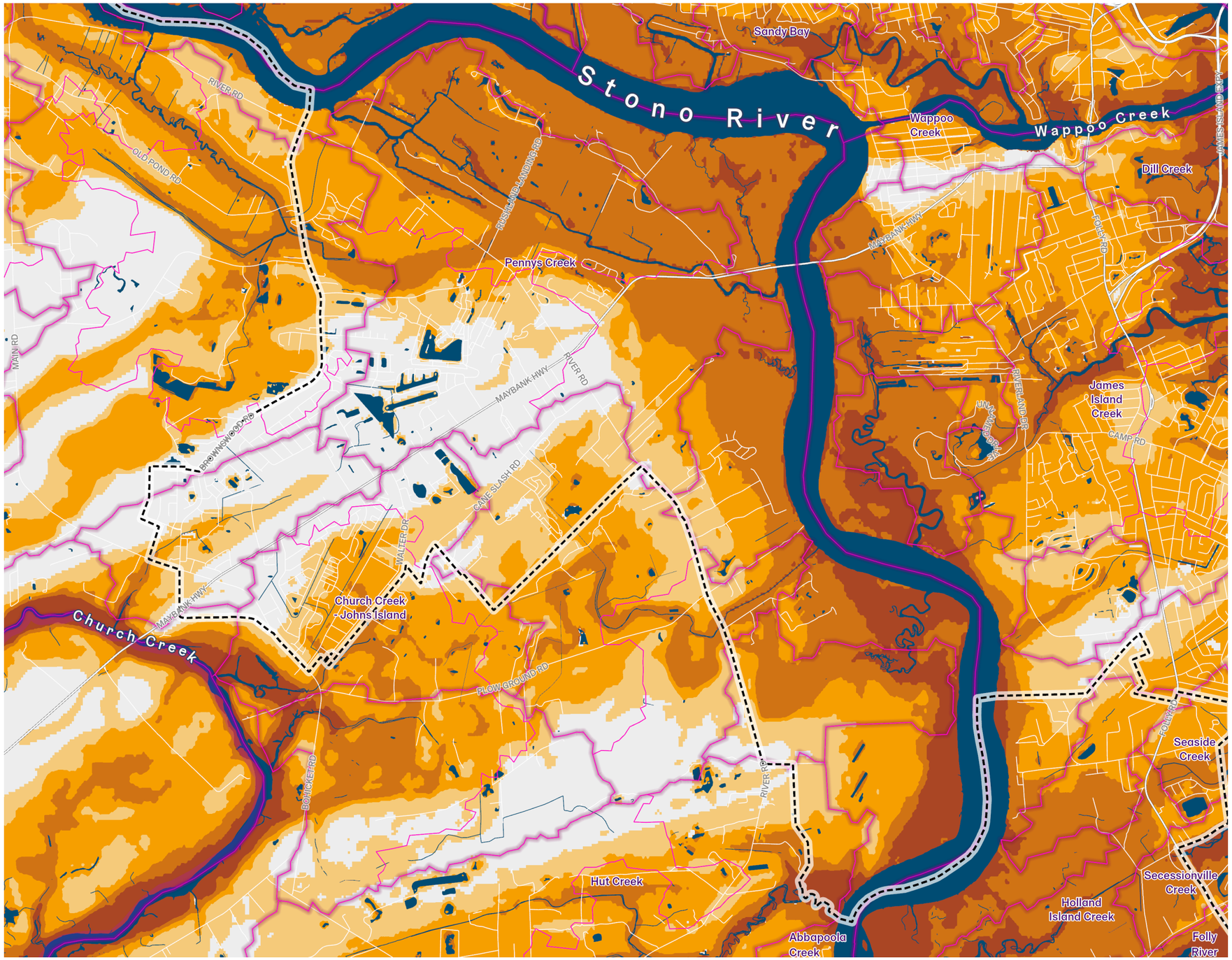
1 inch = 4,000 feet

Miles 1

MAXIMUM CATEGORY 3 STORM SURGE

Much of the developed area on Johns Island is above the maximum storm surge zone for a category 3 hurricane, but storm surge may impact the few critical access roads off the island.

map sources: NOAA



Legend

Cat 3 Max Storm Surge (Above Ground)

- <5 ft
- 5-10 ft
- 10-15 ft
- >15 ft

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

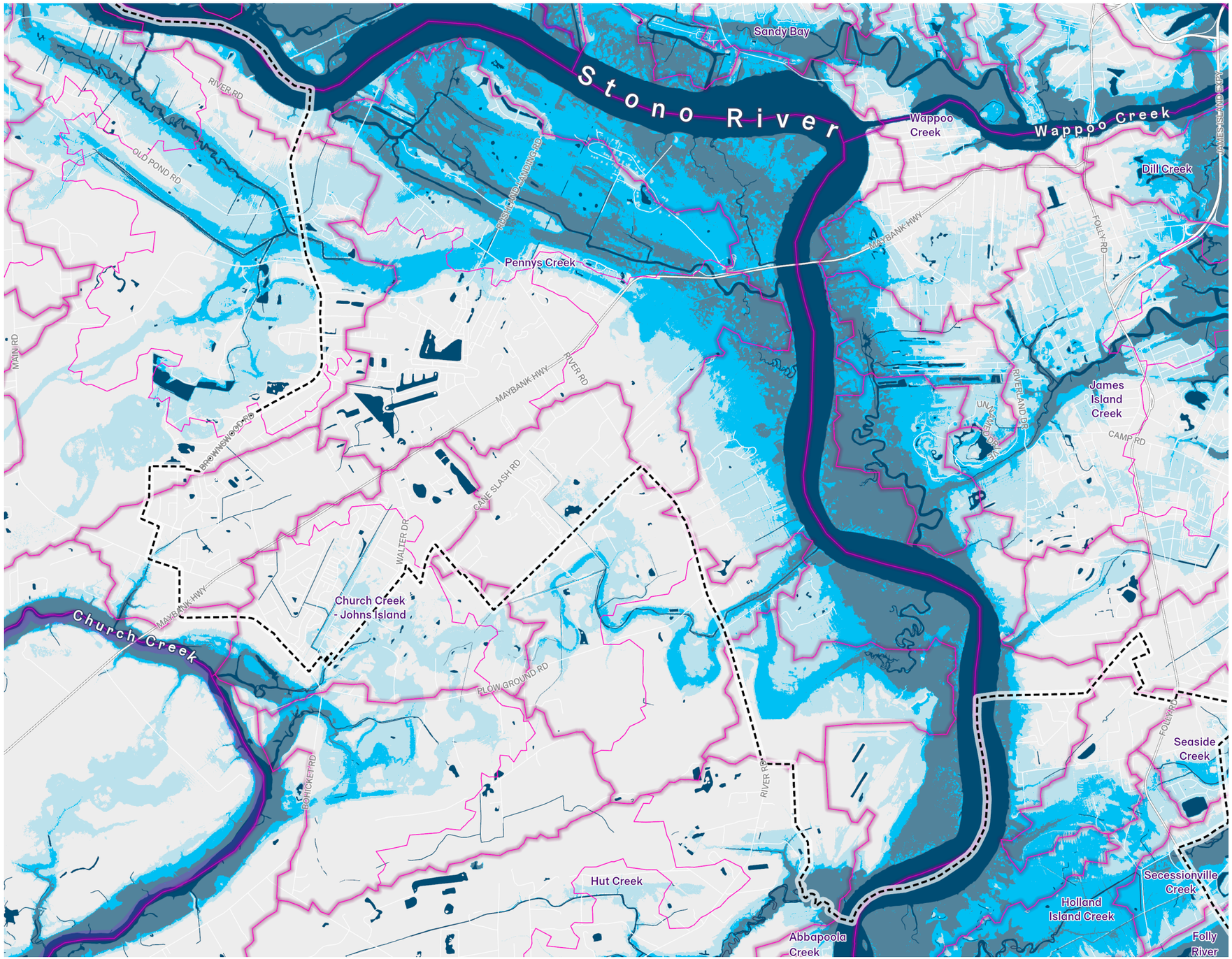
1 inch = 4,000 feet

Miles

1

TIDES AND SEA LEVEL RISE

The wetlands along the Stono River are most impacted by 3' of sea level rise.



Legend

Tides and Sea Level Rise

- Current MHHW
- MHHW +3ft of Sea Level Rise
- Highest Recorded Water Level (Hugo)

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

1 inch = 4,000 feet

Miles

1

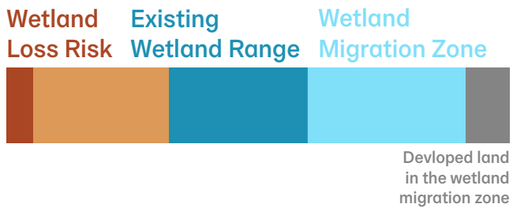
MARSH MIGRATION WITH 3FT OF SEA LEVEL RISE

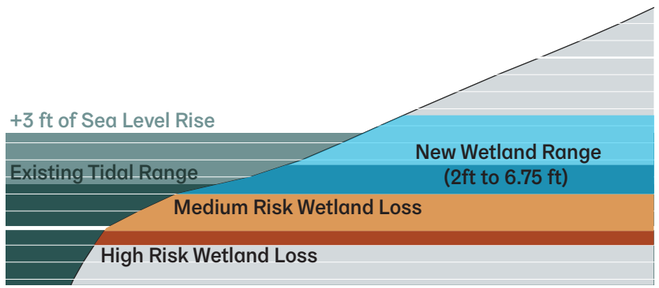
Risk of wetland loss is highest along the Stono River with some space to migrate inland. Landscape succession in this area will be highly visible.

map sources: USGS MLRC Consortium

EXISTING WETLAND RANGE
≈ -1 TO 3.75 FT (NAVD)

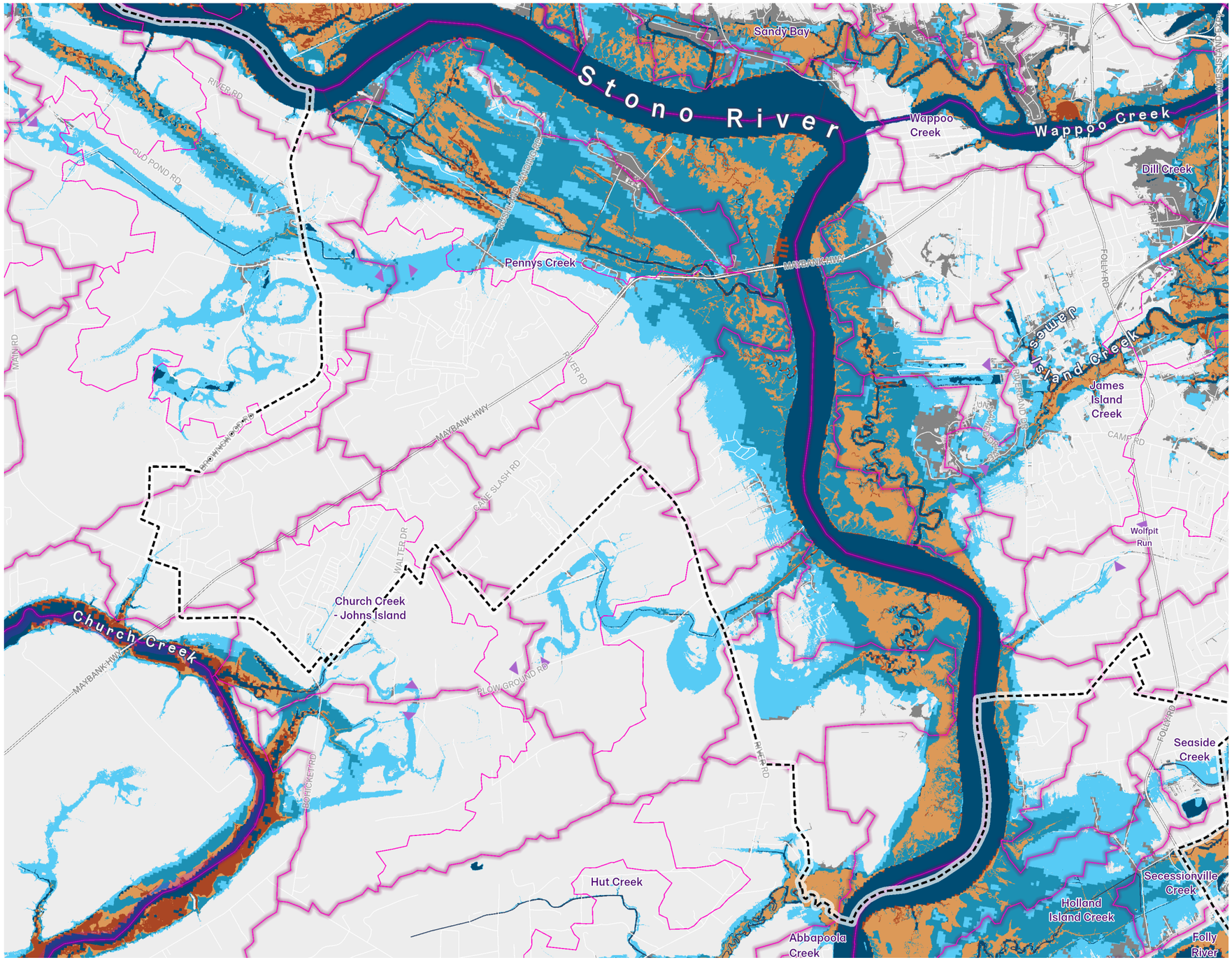
WETLAND MIGRATION ZONE
≈ 2 TO 6.75 FT (NAVD)





1 inch = 4,000 feet

Miles 1



LAND COVER IN THE MARSH MIGRATION ZONE

The marsh migration zone in Johns island has a mix of woody wetlands, evergreen forests and agricultural land.

map sources: USGS, MLRC Consortium

Legend

Land Cover in Wetland Migration Zone

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands

Wetland Migration

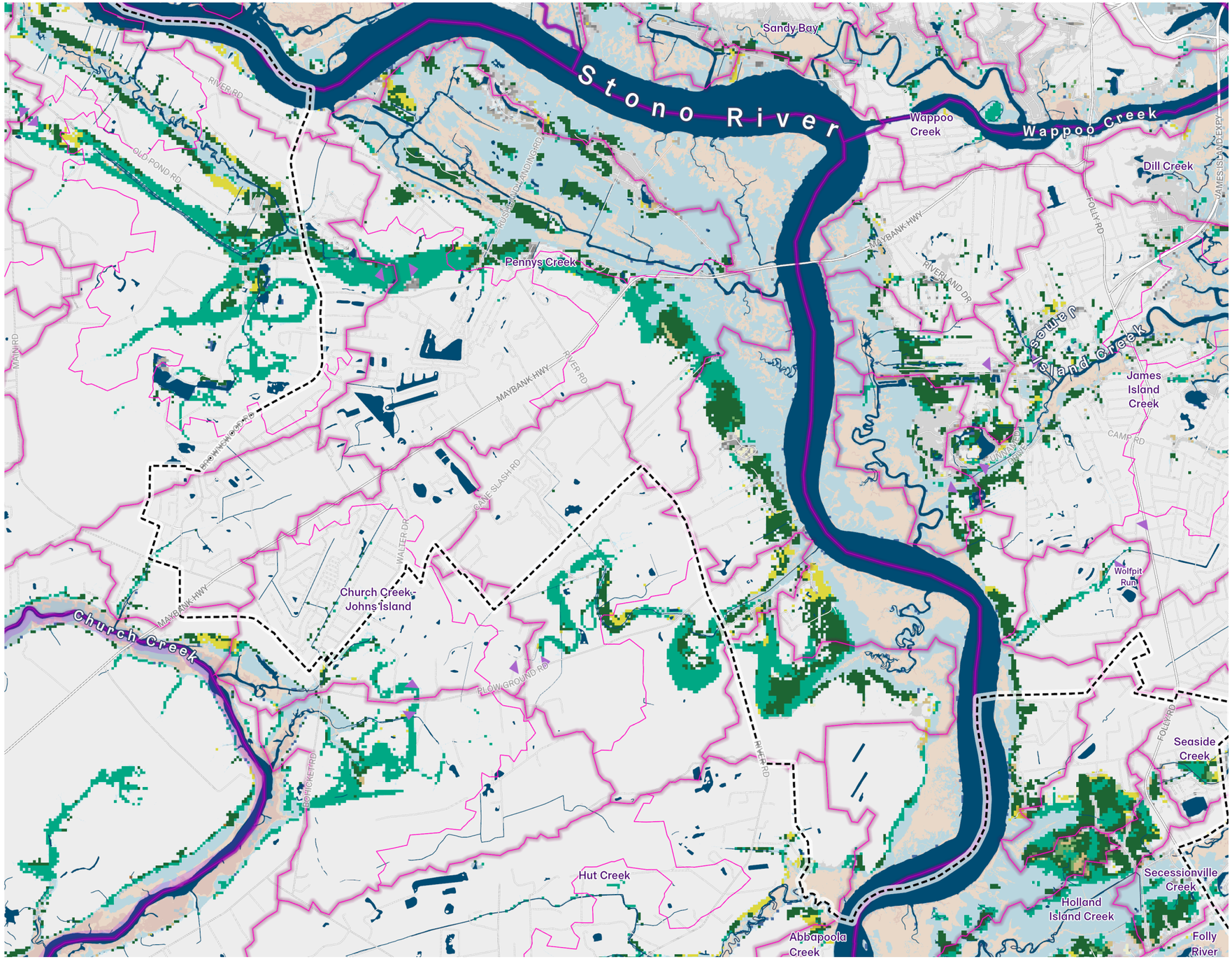
- High Risk Wetland Loss
- Medium Risk Wetland Loss
- Low Risk Wetland Loss
- Wetland Migration Zone
- Wetland Migration Zone - Developed

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary
- Water

1 inch = 4,000 feet

Miles 1



LAND

ELEVATION

LAND COVER

ELEVATION & LAND COVER DISTRIBUTION

SOIL

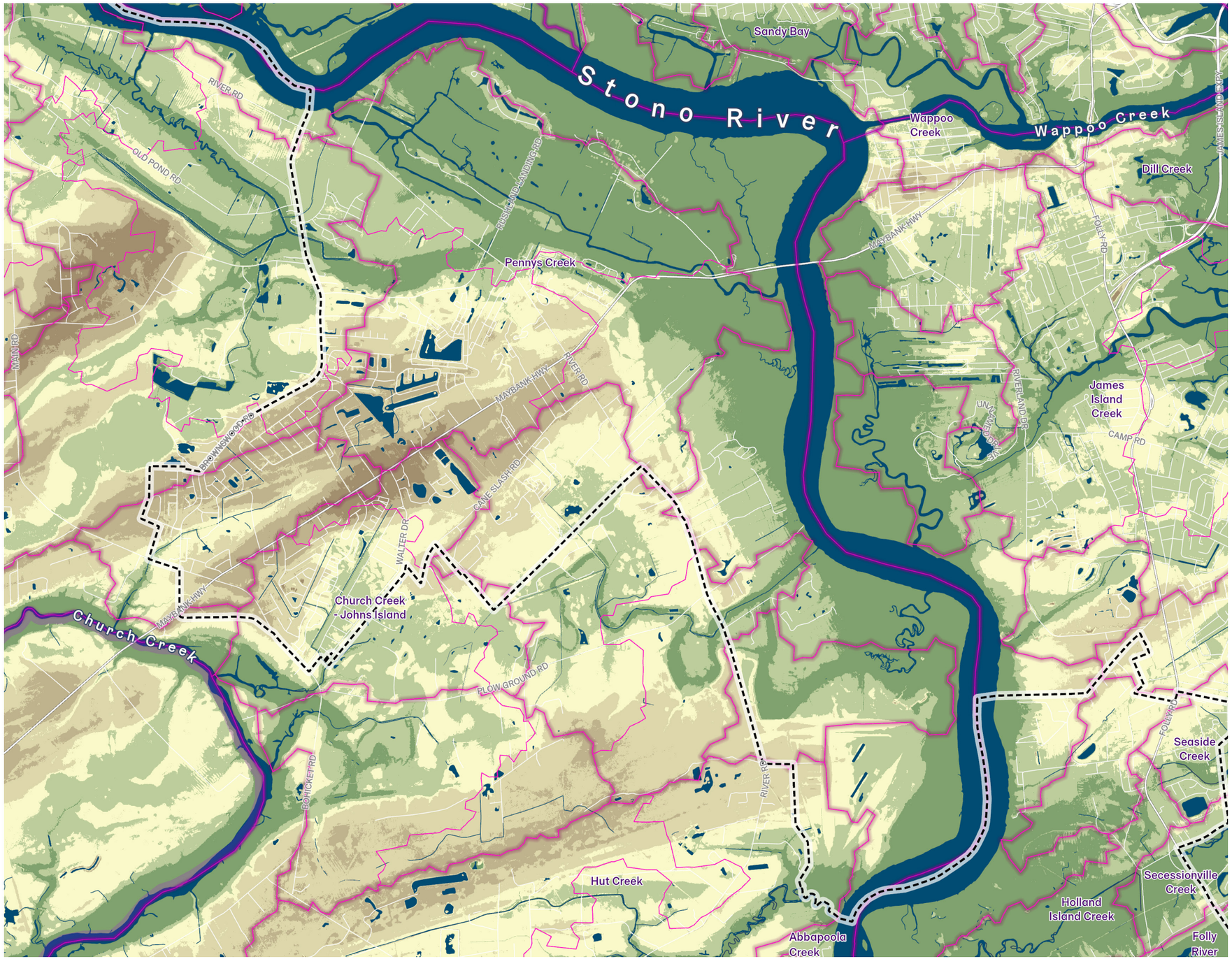
TREE CANOPY

JURISDICTIONS

ELEVATION

Historic beach ridges on Johns Island create relatively high elevations for Charleston with some areas above 25 feet.

map sources: USGS



Legend

Elevation (NAVD88)

- >25 ft
- 20-25 ft
- 15-20 ft
- 10-15 ft
- 5-10 ft
- <5 ft

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

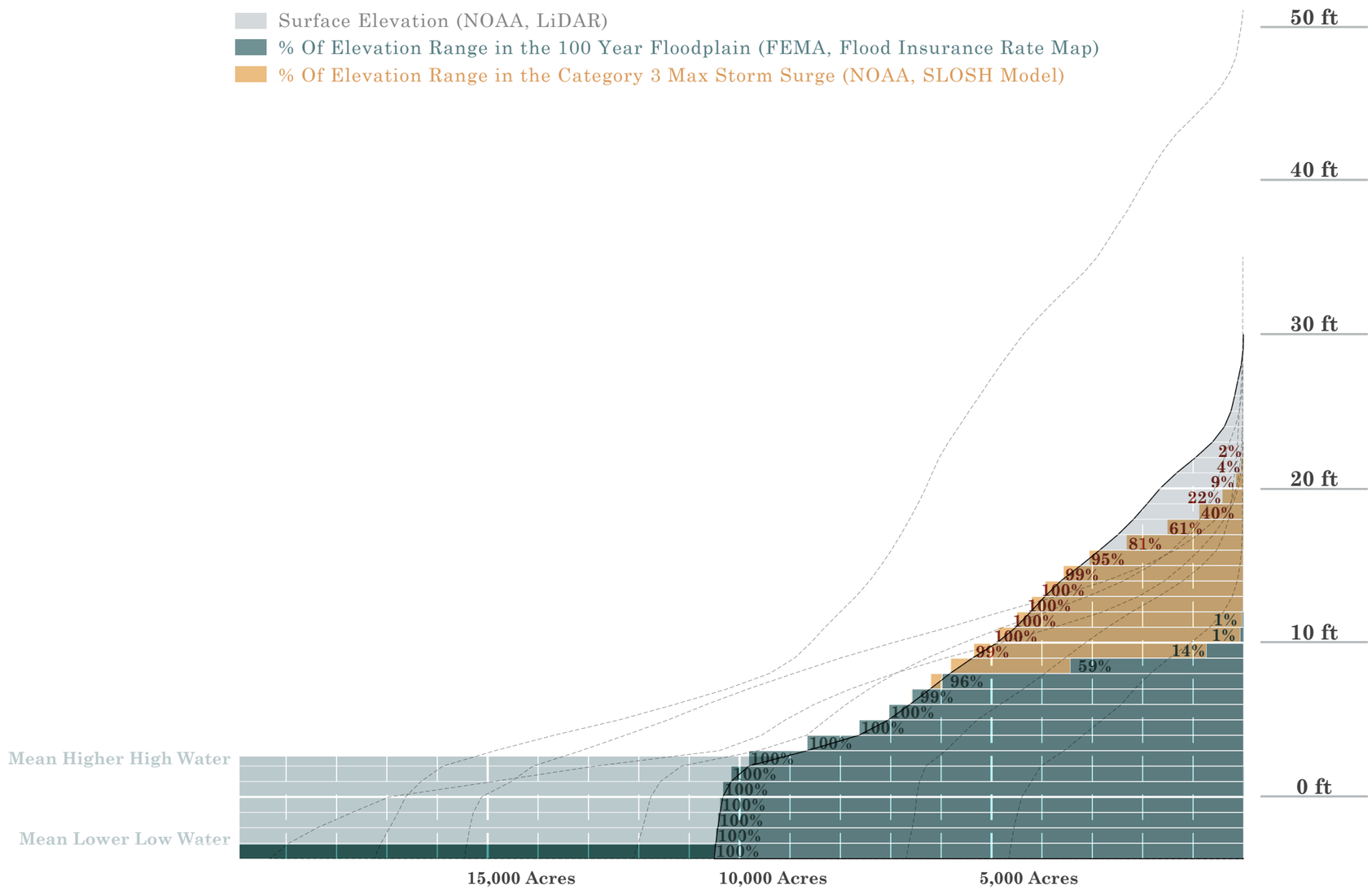
- Water

1 inch = 4,000 feet

Miles 1

SURFACE ELEVATION DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

Most land surface at or below 9’ is in the floodplain. Land surface above 17’ is outside the risk from max category 3 storm surge at current sea levels.



ACRES
(STARTING AT MEAN LOWER LOW WATER)

LAND COVER

Johns Island is still significantly undeveloped, though changing quickly.

map sources: MLRC Consortium

Legend

Land Cover 2016

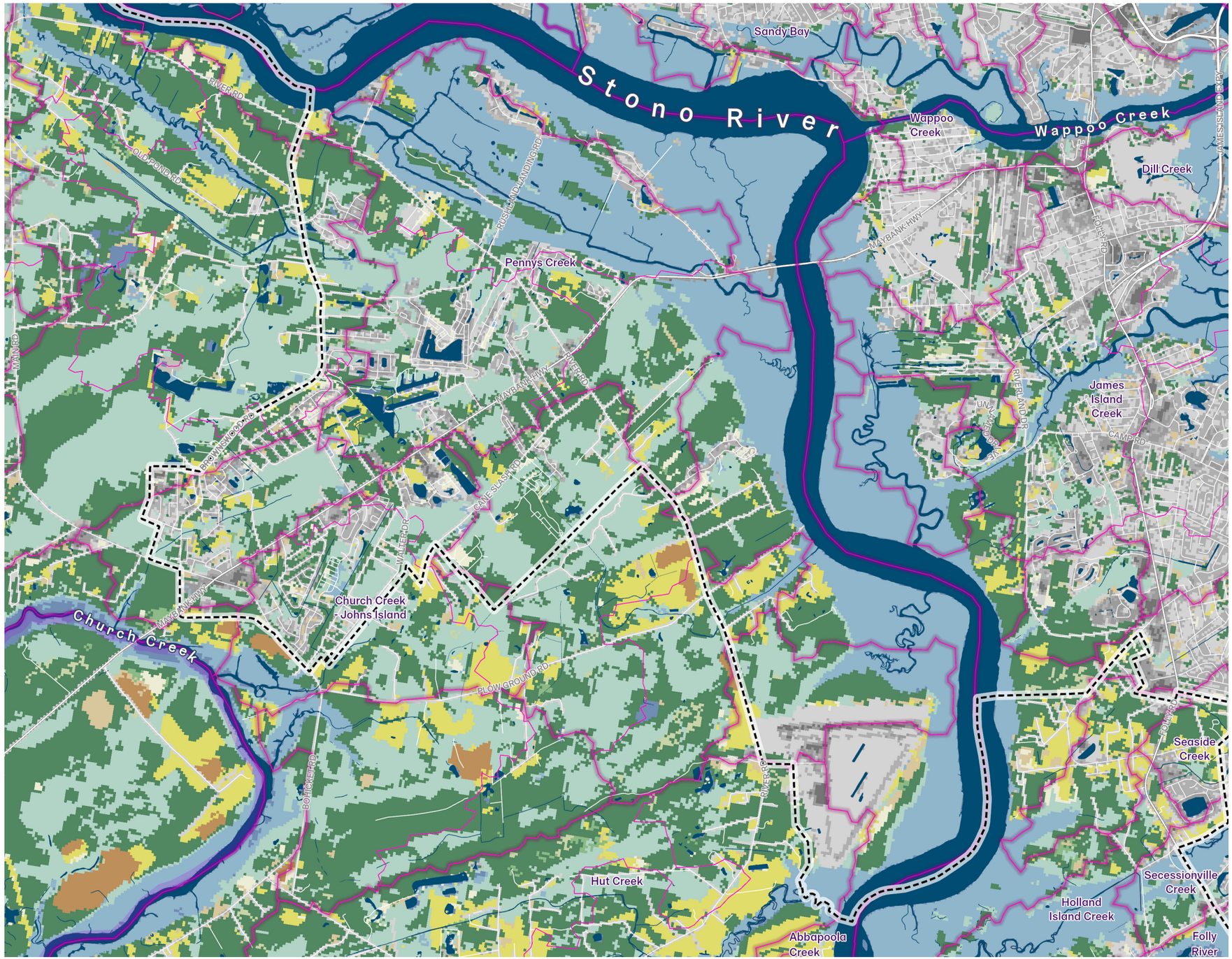
- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetland

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary
- Water
- Water

1 inch = 4,000 feet

Miles 1



ELEVATION & LAND COVER DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

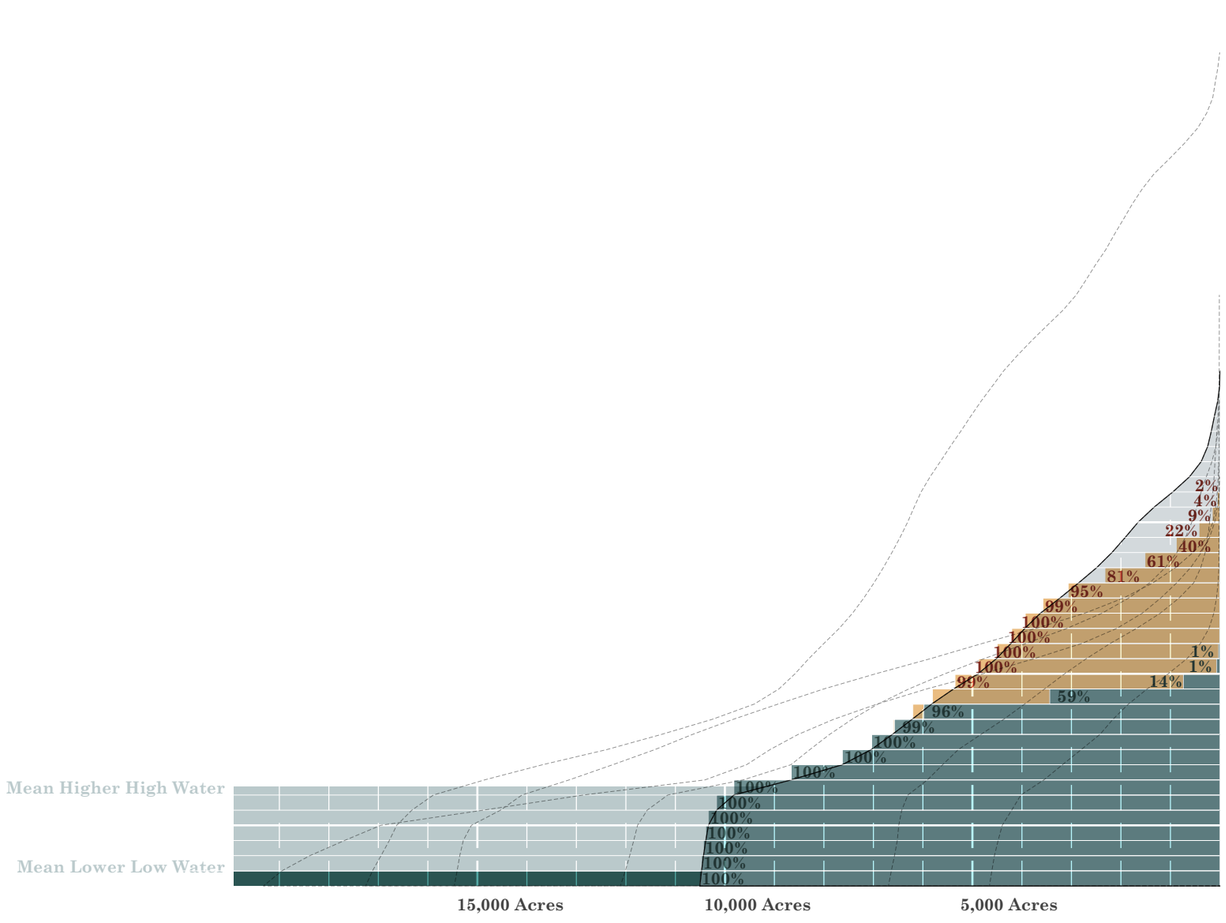
JOHNS ISLAND

SURFACE ELEVATION

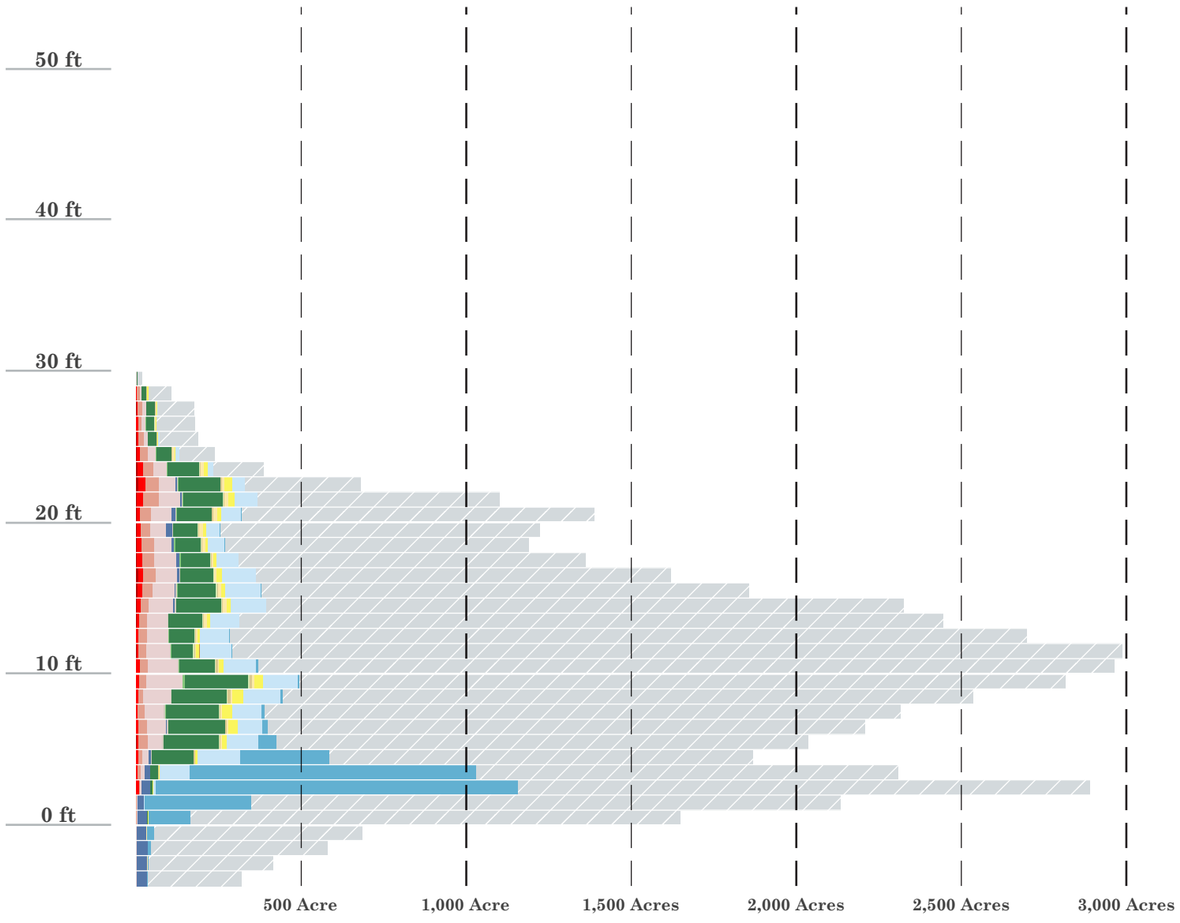
- Surface Elevation (NOAA, LiDAR)
- % Of Elevation Range in the 100 Year Floodplain (FEMA, Flood Insurance Rate Map)
- % Of Elevation Range in the Category 3 Max Storm Surge (NOAA, SLOSH Model)

LAND COVER

- Developed High Intensity
- Developed Medium Intensity
- Developed Low Intensity
- Developed Open Space
- Open Water
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Shrub/Scrub
- Grassland
- Pasture
- Crops
- Woody Wetland
- Emergent Herbaceous Wetland
- Outside Urban Growth Boundary



ACRES
(STARTING AT MEAN LOWER LOW WATER)

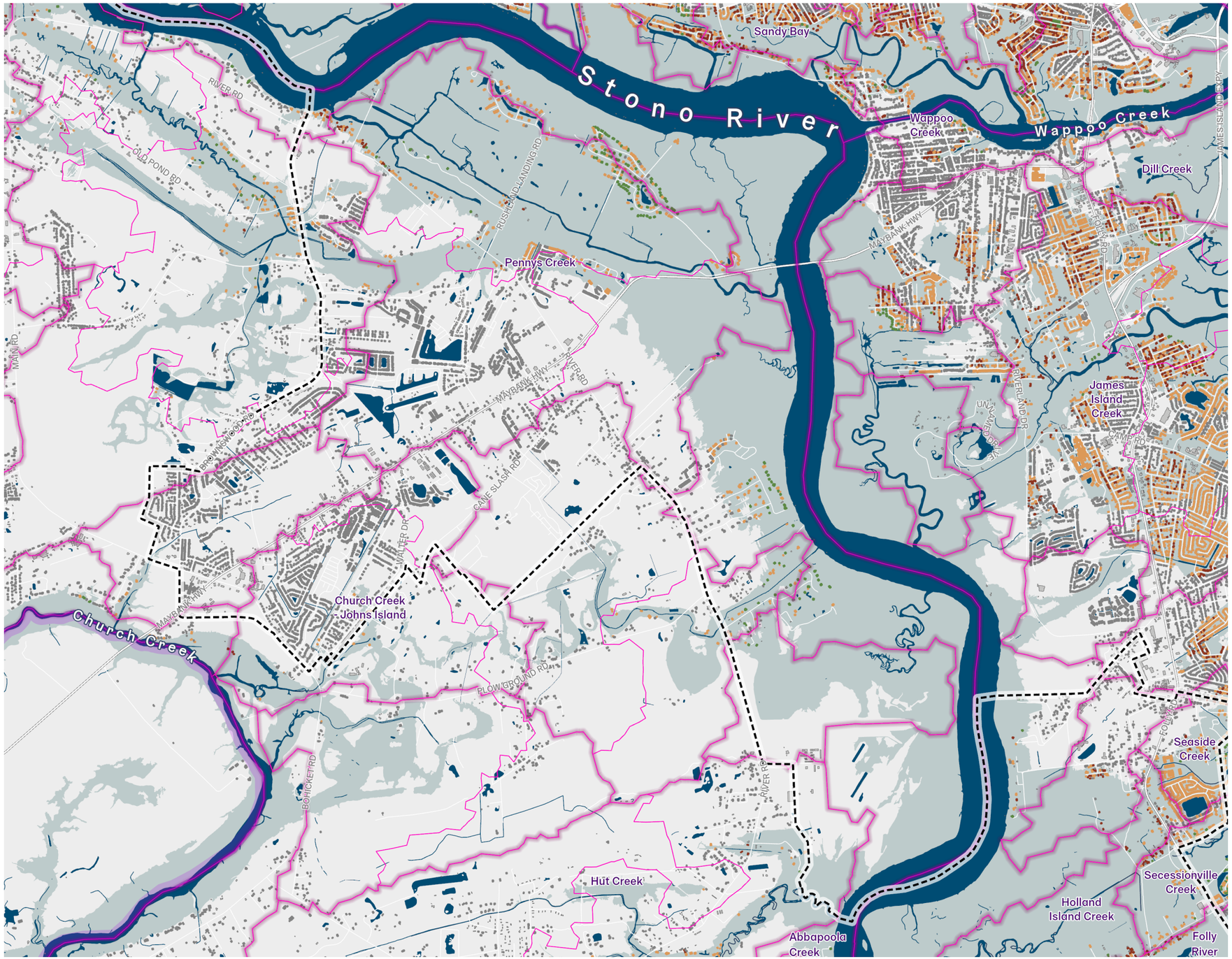


LANDCOVER DISTRIBUTION IN WATERSHED
(National Land Cover Database)

RESIDENTIAL BUILDING TYPE

High risk structures on Johns Island are mostly limited to developments on hammocks and along river banks.

map sources: MLRC Consortium



Legend

Residential Structures
- Outside Floodplain, all footing types
- Built to BFE/BFE+2, Peirs
- Built to BFE/BFE+2, Slab-on-Grade or Unknown
- Built Pre-BFE Regulations
- Non Residential

100 Year Floodplain and BFE
- No BFE
- BFE

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water
- Water

1 inch = 4,000 feet

Miles 1

ELEVATION & RESIDENTIAL BUILDING TYPE DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

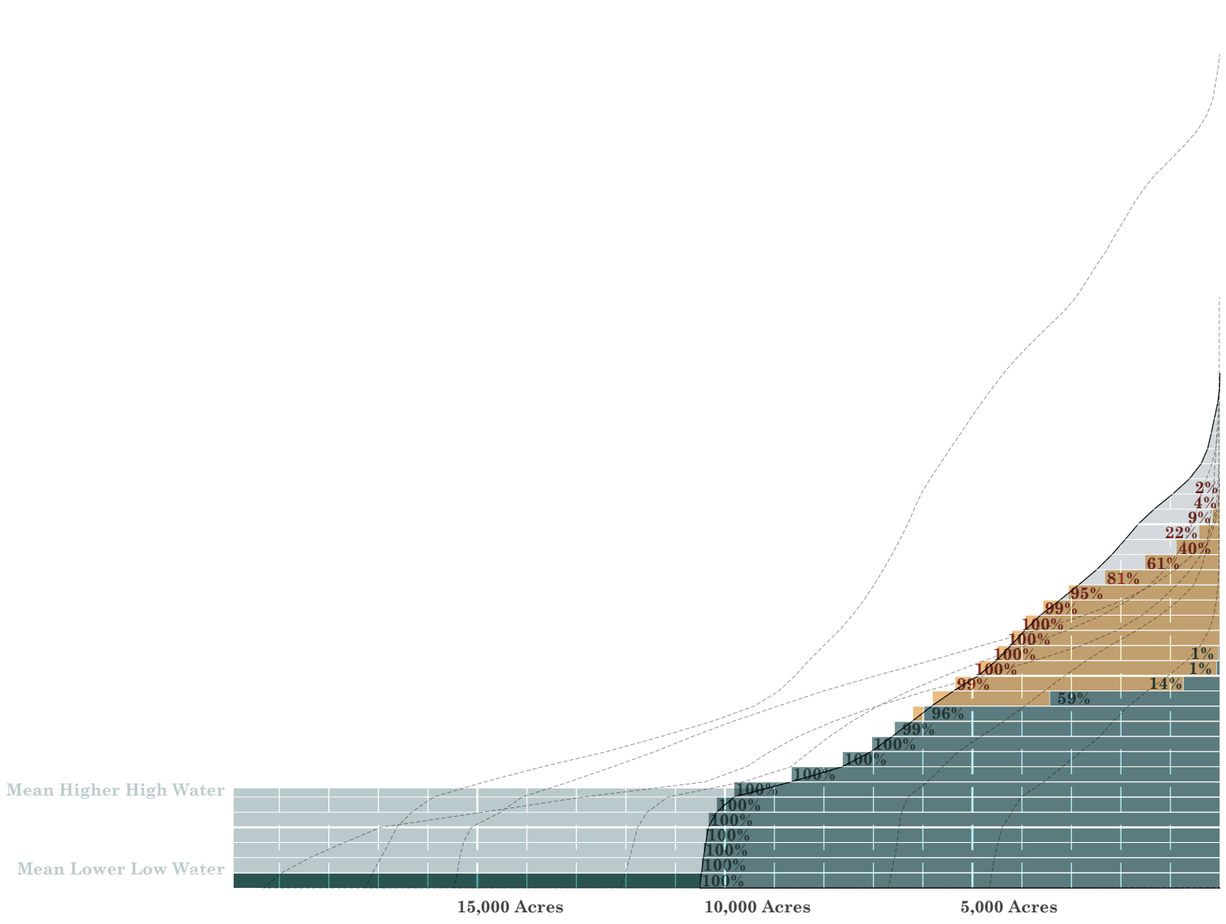
JOHNS ISLAND

Surface Elevation (NOAA, LiDAR)
% Of Elevation Range in the 100 Year Floodplain (FEMA, Flood Insurance Rate Map)
% Of Elevation Range in the Category 3 Max Storm Surge (NOAA, SLOSH Model)

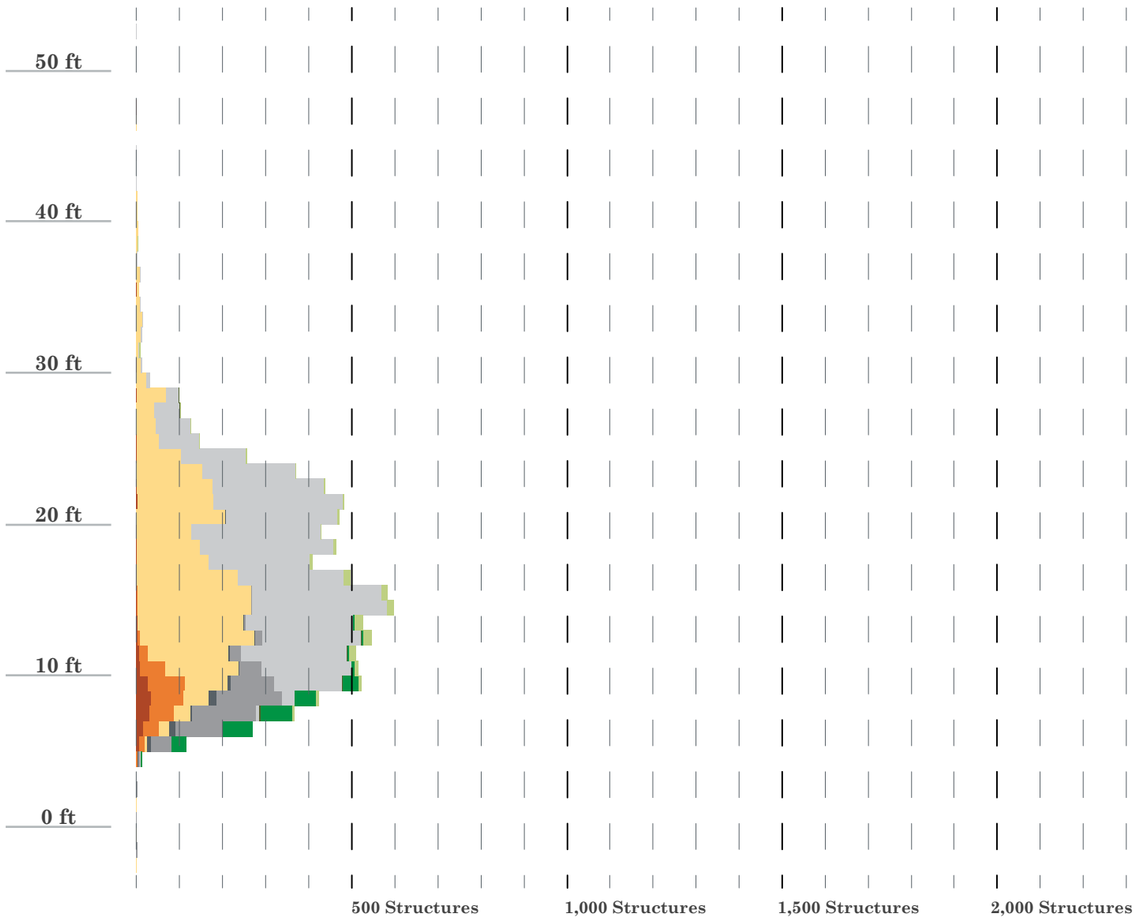
SURFACE ELEVATION

RESIDENTIAL STRUCTURES

Slab on Grade: inside 100 year floodplain before BFE requirement
Slab on Grade: inside 100 year floodplain rasied to BFE/BFE+1
Slab on Grade: outside 100 year floodplain
Unknown: inside 100 year floodplain before BFE requirement
Unknown: inside 100 year floodplain rasied to BFE/BFE+1
Unknown: outside 100 year floodplain
On Peirs: inside 100 year floodplain before BFE requirement
On Peirs: inside 100 year floodplain rasied to BFE/BFE+1
On Peirs: outside 100 year floodplain



ACRES
(STARTING AT MEAN LOWER LOW WATER)



STRUCTURE BASE ELEVATIONS
(STARTING AT MEAN LOWER LOW WATER)

SOIL TYPES

Most of the soils on Johns Island have a low infiltration capacity, however undisturbed topsoils function like natural sponges. Deeper beach sand layers may provide higher infiltration capacity.

map sources: USDA

HYDROLOGIC GROUPS

- A: ABSORBS THE MOST WATER
- B: ABSORBS SOME WATER
- C: ABSORBS LITTLE WATER
- D: POORLY DRAINED AND/OR ABSORBS BASICALLY NO WATER



1 inch = 4,000 feet

Miles 1

TREE CANOPY DENSITY & CHANGE

Tree canopy loss on Johns Island has been high in the last two decades due primarily to new development.

map sources: GLCF



Legend

Tree Canopy (2015)
- Dense
- Sparse

Canopy Change (2000-2015)
- High Gain
- High Loss

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

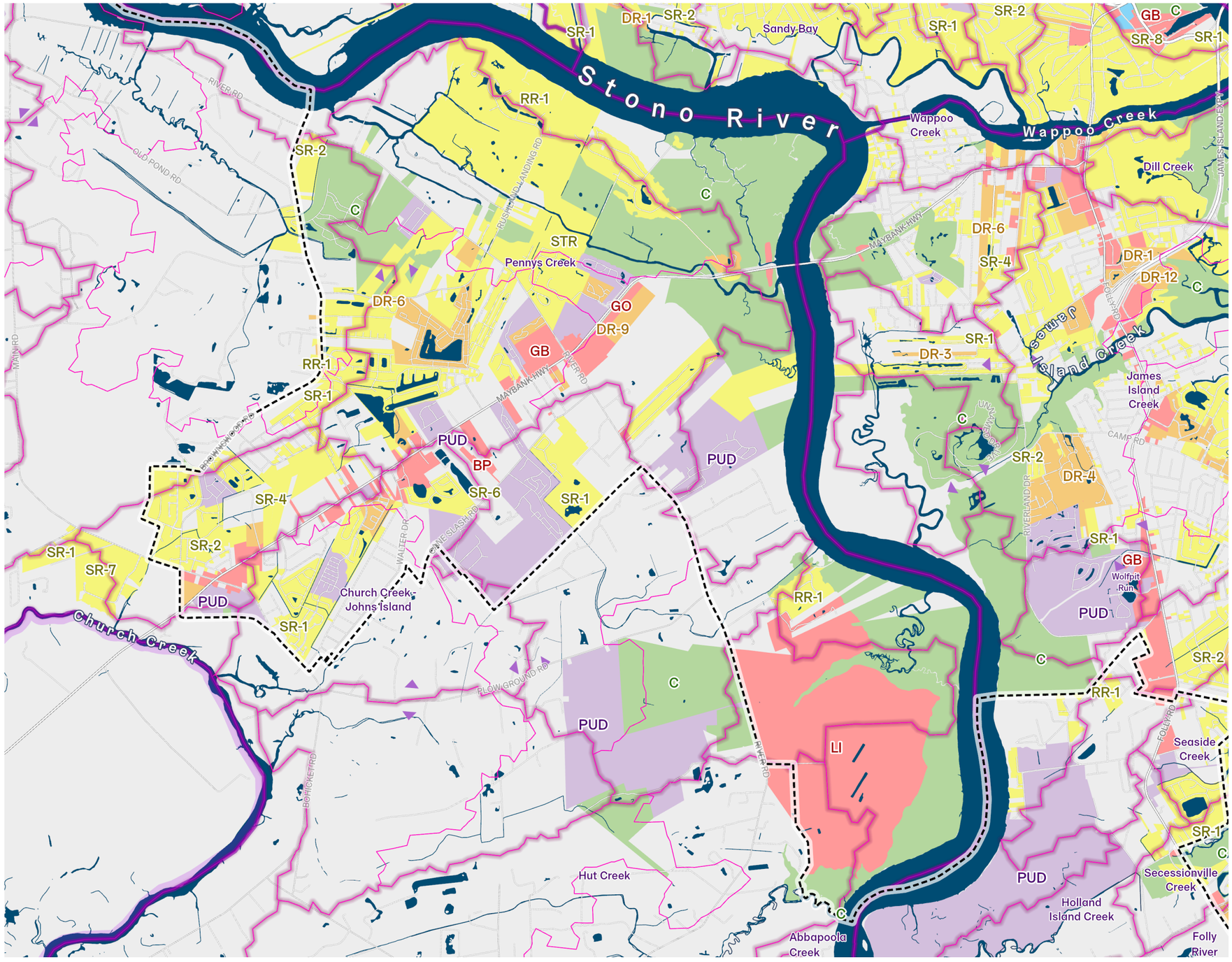
Water
- Water

1 inch = 4,000 feet

Miles 1

ZONING

The Maybank corridor is currently prioritized for higher density development.



Legend

Zoning

- Parks & Conservation
- Single Family Residential
- Diverse Residential
- Planned Development
- Mixed Use
- Business & Industrial

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

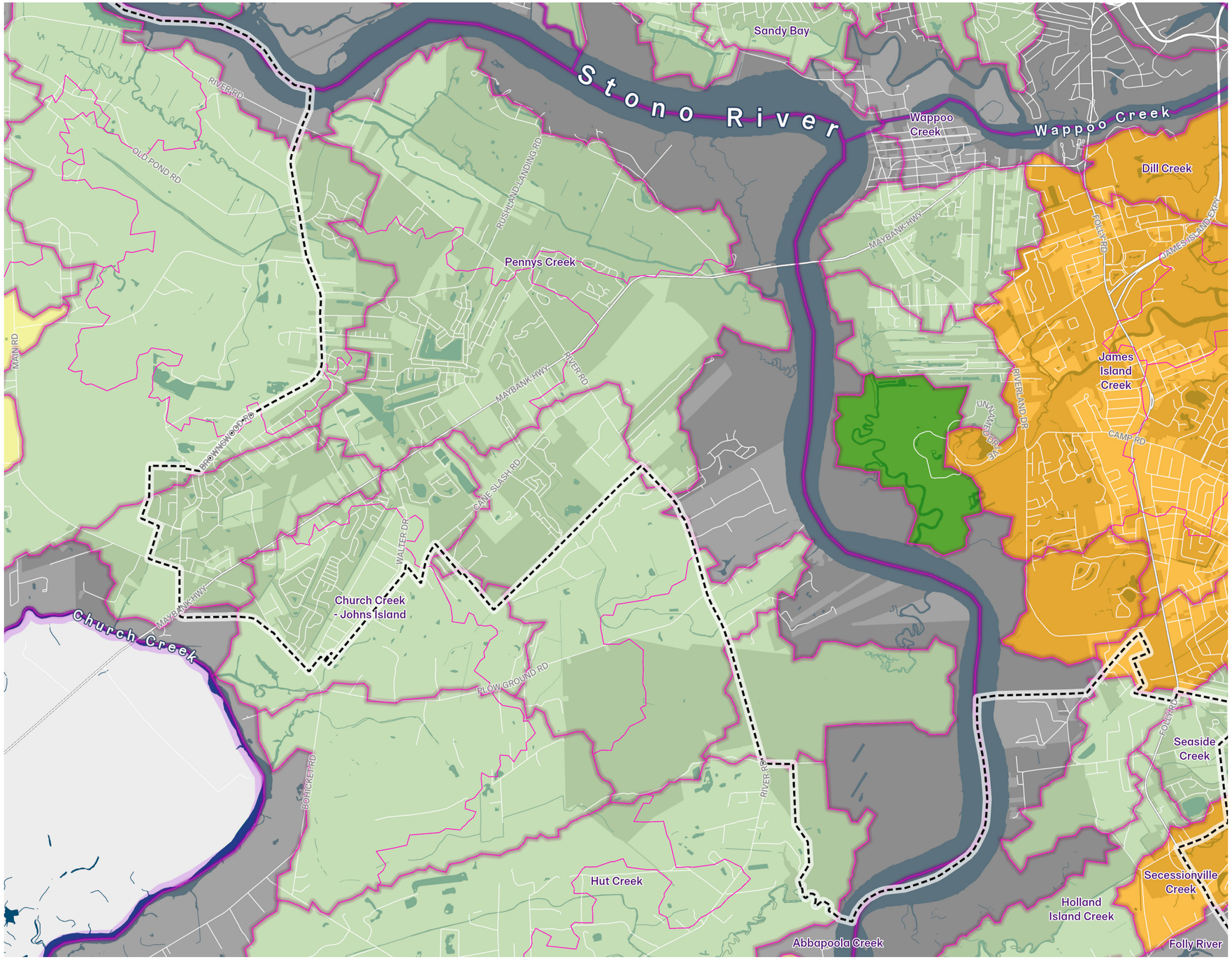
Water

1 inch = 4,000 feet

Miles 1

JURISDICTIONAL COMPLEXITY

Most of the watersheds criss-cross the patchwork of incorporated space in addition to flowing across the urban growth boundary.



Legend

Watershed Jurisdiction

- Entirely Within Charleston City
- Single-City, Single-County
- No City, Single-County
- Multi-City, Single-County
- Multi-City, Multi-County
- Excluded

Counties

Charleston City Limits

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

Water

1 inch = 4,000 feet

Miles 1

LAND & WATER IMPLICATIONS

ELEVATION RISK ZONES

ELEVATION RISK ZONES & WATERSHED SENSITIVITY

ENVIRONMENTAL SENSITIVITY

ELEVATION ZONES

Most of Johns Island is in the high ground or adapt zone.

HIGH GROUND

High ground is defined as land outside of the FEMA 100 year floodplain and above the NOAA max category 3 storm surge. High ground has the lowest flood risk and stormwater detention here has the greatest watershed benefit.

ADAPT ZONE

The adapt zone consists of land outside of the FEMA 100 year floodplain that is still within the NOAA maximum storm surge of a category 3 hurricane. Rain and storm surge flooding in this zone is infrequent but not impossible.

COMPOUND FLOOD RISK

This zone encompasses areas within the floodplain above the tidal flood risk zone where flood risk comes from a mixture of rainfall, runoff and tidal conditions.

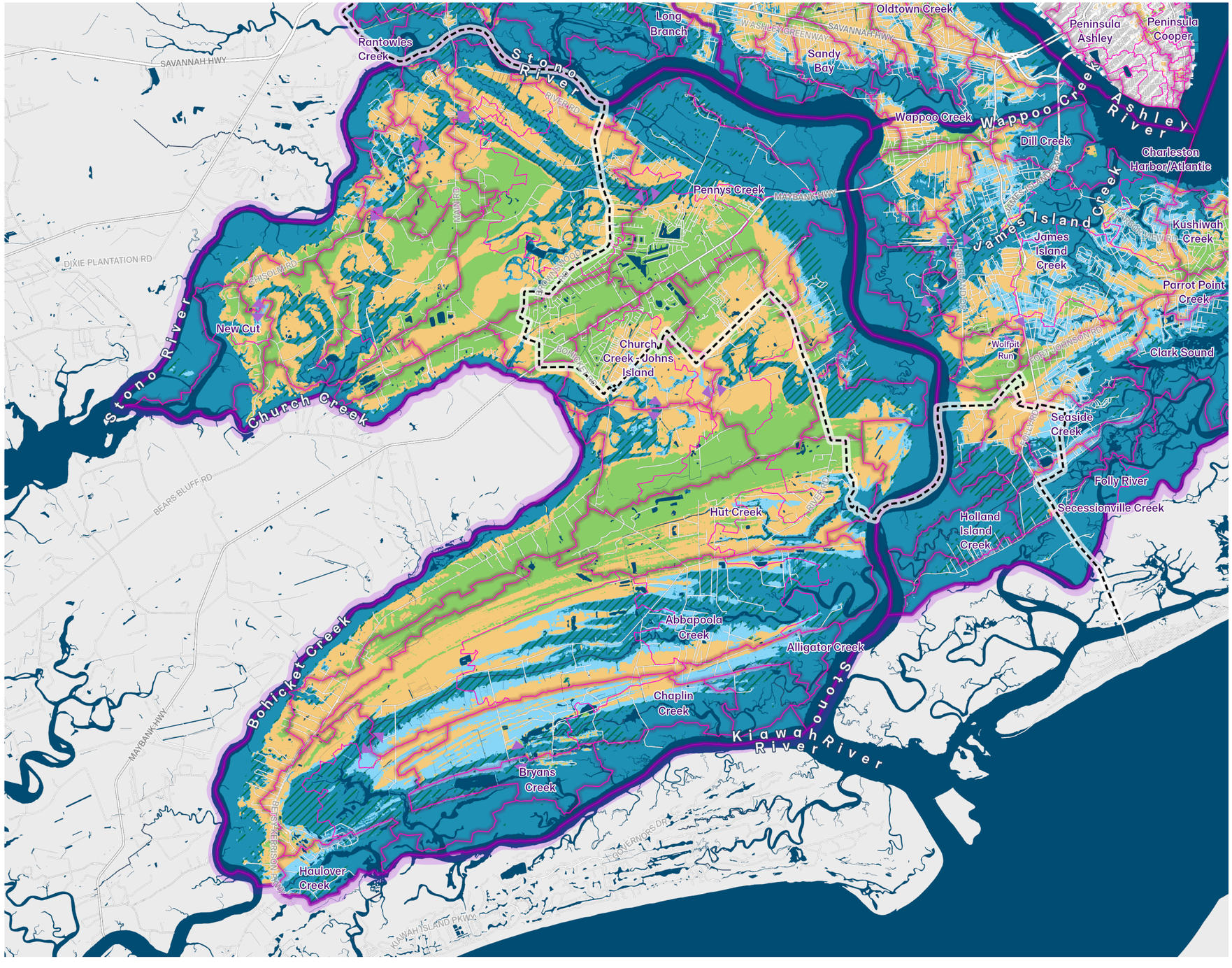
TIDAL FLOOD RISK ZONE

This zone encompasses the lowest land in Charleston. Nearly 100% of this zone is in the 100 year floodplain. Flooding is frequent and can come solely from tidal events independent of precipitation. Sea level rise driven marsh migration occurs in this dynamic zone.

Marsh Migration Zone

1 inch = 8,000 feet

Miles 1



ELEVATION ZONES

Within the urban growth boundary, most of Johns Island is in the high ground zone.

HIGH GROUND

High ground is defined as land outside of the FEMA 100 year floodplain and above the NOAA max category 3 storm surge. High ground has the lowest flood risk and stormwater detention here has the greatest watershed benefit.

ADAPT ZONE

The adapt zone consists of land outside of the FEMA 100 year floodplain that is still within the NOAA maximum storm surge of a category 3 hurricane. Rain and storm surge flooding in this zone is infrequent but not impossible.

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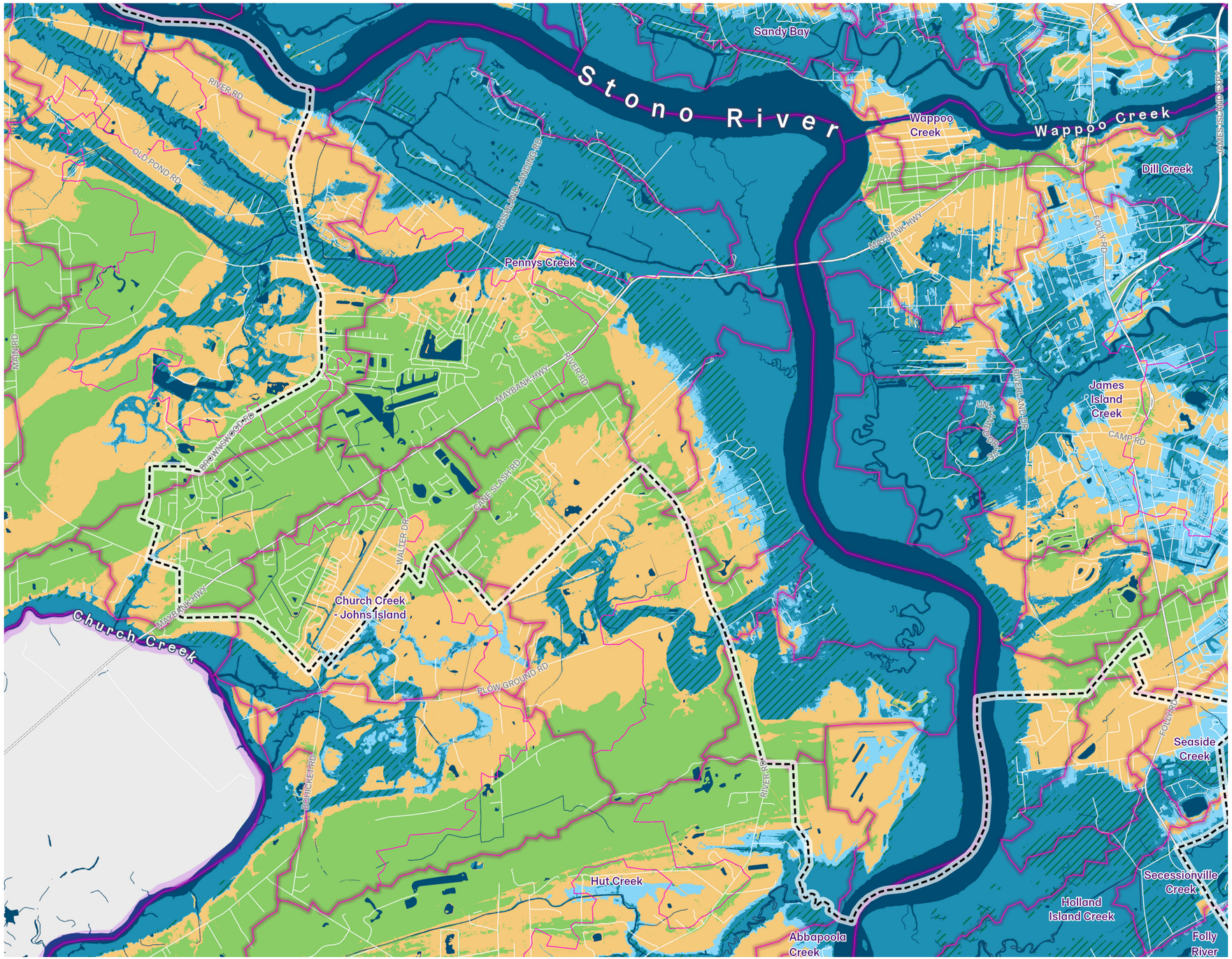
Marsh Migration Zone

1 inch = 4,000 feet

Miles 1



ELEVATION RISK + WATERSHED SENSITIVITY

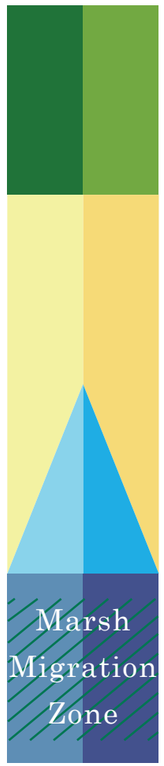
Johns Island has a wide range of watershed typologies, and level of development per watershed.

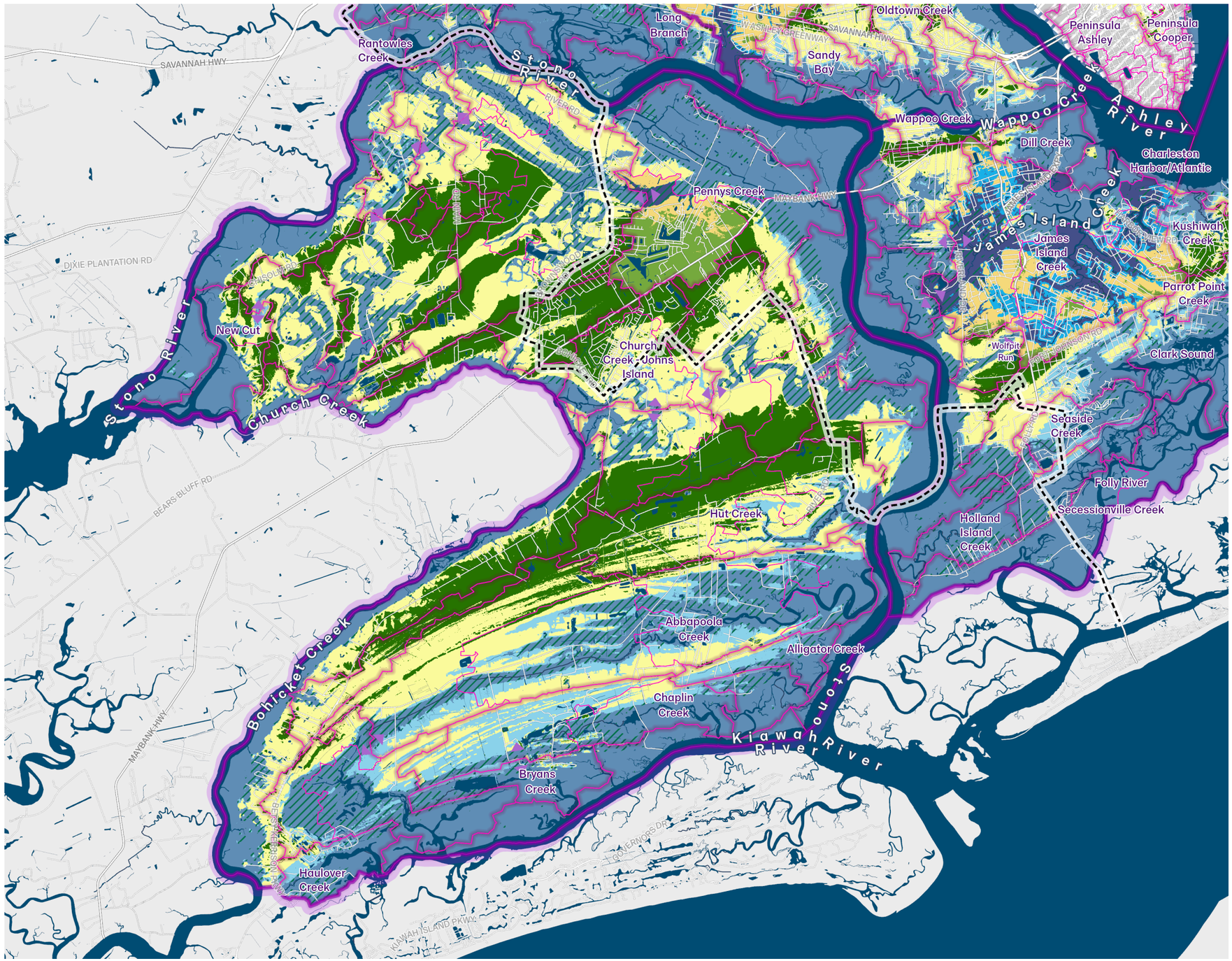
HIGH SENSITIVITY

Combination of more flood prone watersheds and a high number of vulnerable parcels. Typically larger tidal watersheds and/or watersheds where development happened before BFE regulations.

NORMAL SENSITIVITY

Combination of less flood prone watersheds and a low number of vulnerable parcels. Typically smaller and/or less developed watersheds.





1 inch = 8,000 feet

Miles 1

ELEVATION RISK + WATERSHED SENSITIVITY

Most of Johns Island is also in the low sensitivity zone, however pre-existing rural and historic properties are at risk from new upstream development.

HIGH SENSITIVITY

Combination of more flood prone watersheds and a high number of vulnerable parcels. Typically larger tidal watersheds and/or watersheds where development happened before BFE regulations.

NORMAL SENSITIVITY

Combination of less flood prone watersheds and a low number of vulnerable parcels. Typically smaller and/or less developed watersheds.

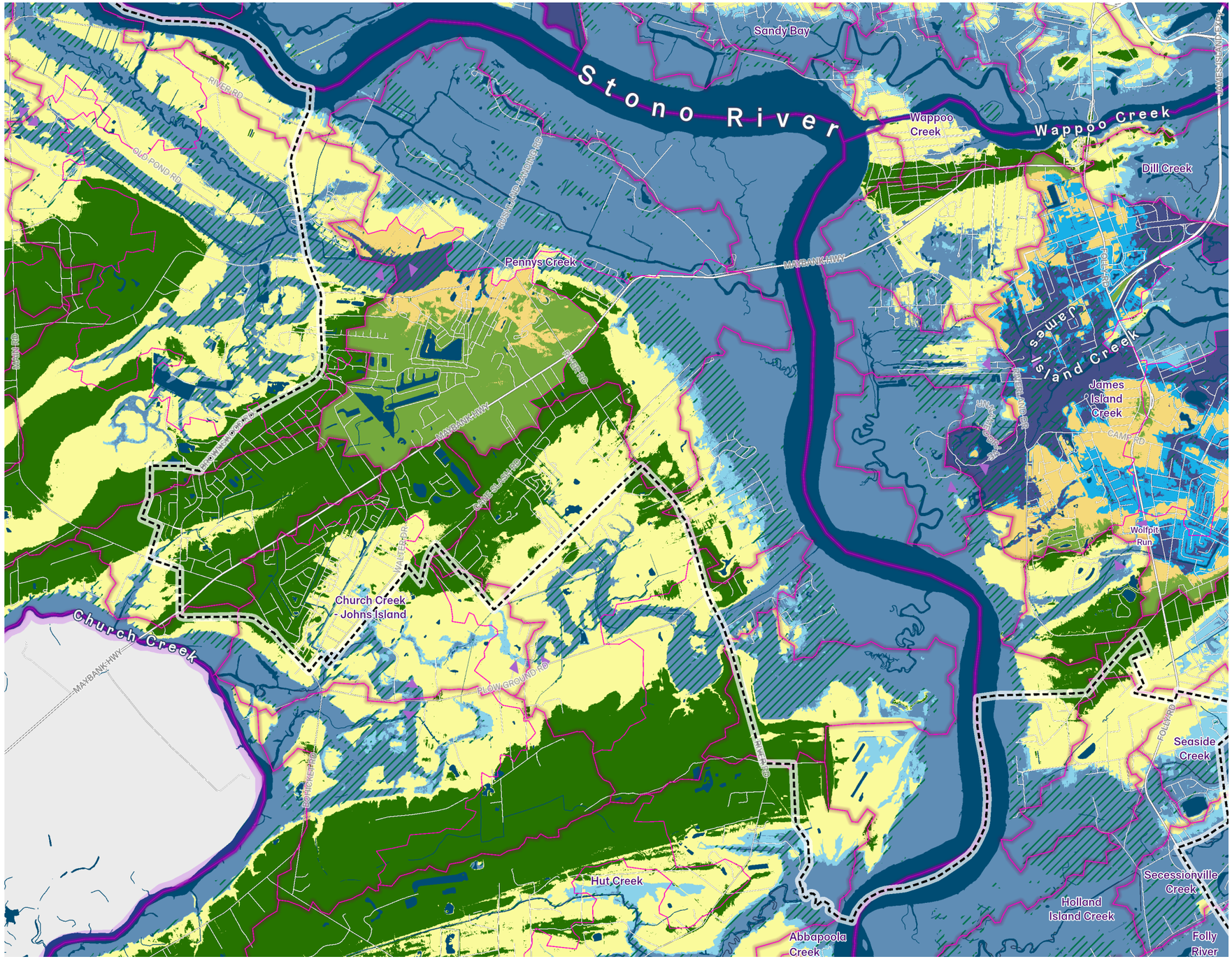
HIGH GROUND

ADAPT ZONE

COMPOUND FLOOD RISK

TIDAL FLOOD RISK ZONE

Marsh Migration Zone



1 inch = 4,000 feet

Miles 1

RISK + SENSITIVITY + ZONING

The Pennys Creek watershed is one of the only watersheds on Johns Island entirely within the urban growth boundary. It is also the only high sensitivity watershed.

Legend

Zoning

- Parks & Conservation
- Single Family
- Diverse Residential
- Planned Development
- Mixed Use
- Business & Industrial

Risk & Watershed Impact

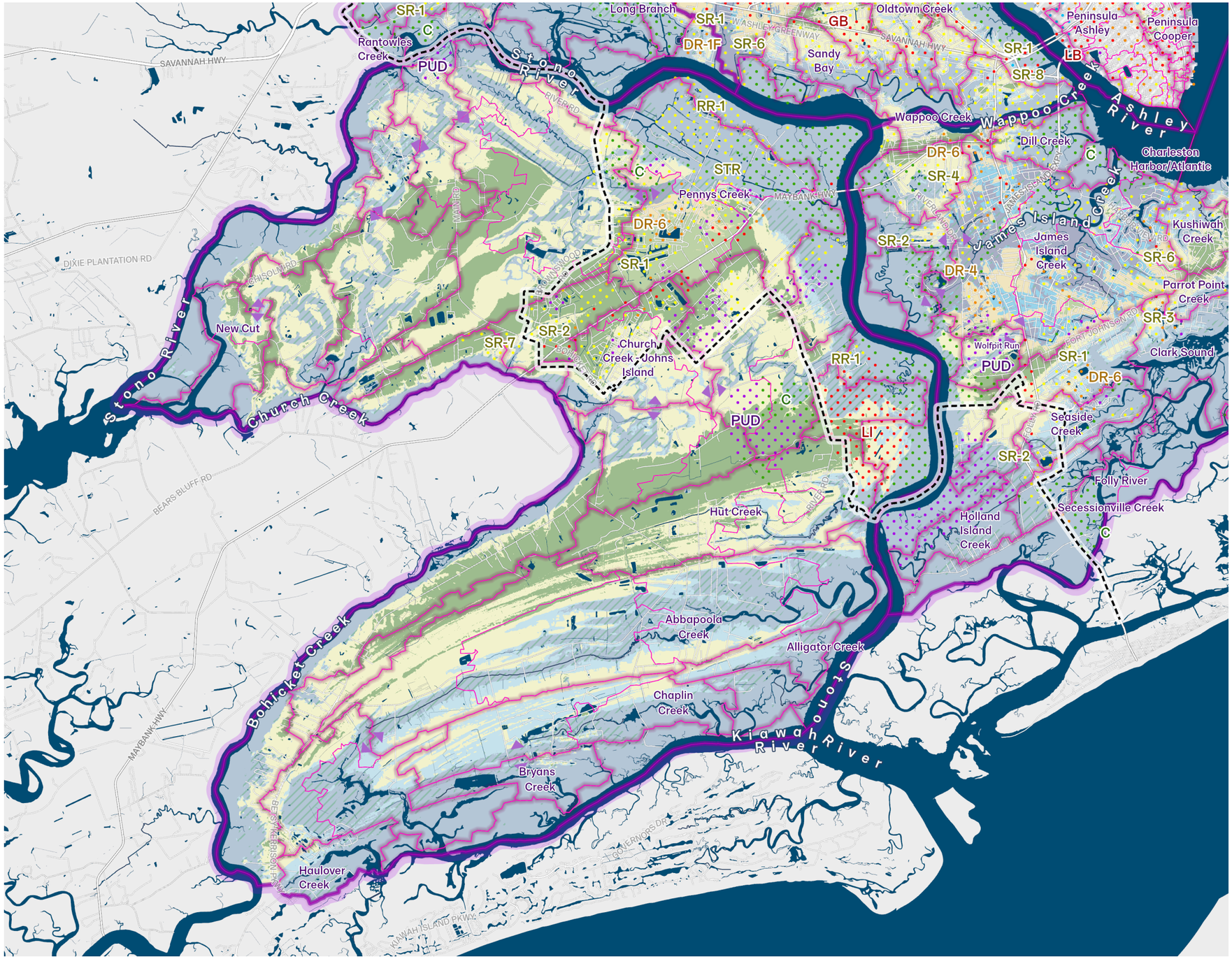
- High Ground, Normal Sensitivity
- High Ground, High Sensitivity
- Adapt Zone, Normal Sensitivity
- Adapt Zone, High Sensitivity
- Compound Flood Risk, Normal Sensitivity
- Compound Flood Risk, High Sensitivity
- Tidal Flood Risk, Normal Sensitivity
- Tidal Flood Risk, High Sensitivity
- Marsh Migration Zone

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary
- Water

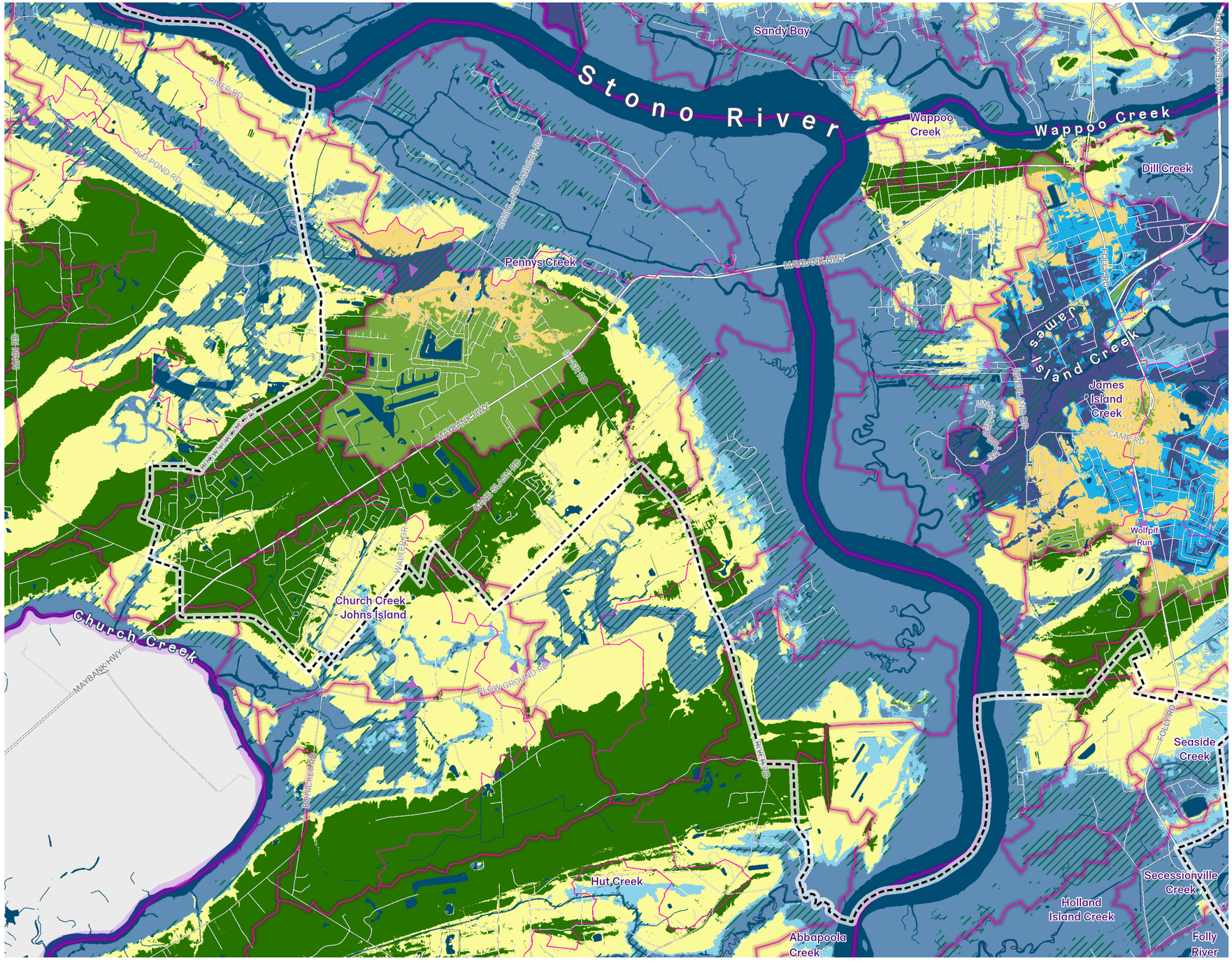
1 inch = 8,000 feet

Miles 1



LAND & WATER IMPLICATIONS

- High ground, low sensitivity zones occur throughout Johns island. However, sensitivity analyses underestimate potential impacts to low-density rural areas.
- Some areas zoned for higher density along Maybank are located upstream in highly sensitive watersheds with potential for significant downstream impacts.
- Much of the current development on Johns Island is outside of the tidal flood risk zone.
- While current vulnerability is low, the large tidal watersheds on Johns Island create a sensitive environment for future development.
- Surface soils are predominantly not well suited for infiltration, but native topsoil naturally absorbs runoff and sand strata exist below.
- Risk of wetland loss is high, with some room for migration upslope on river banks and along tidal creeks.



1 inch = 4,000 feet

Miles

1

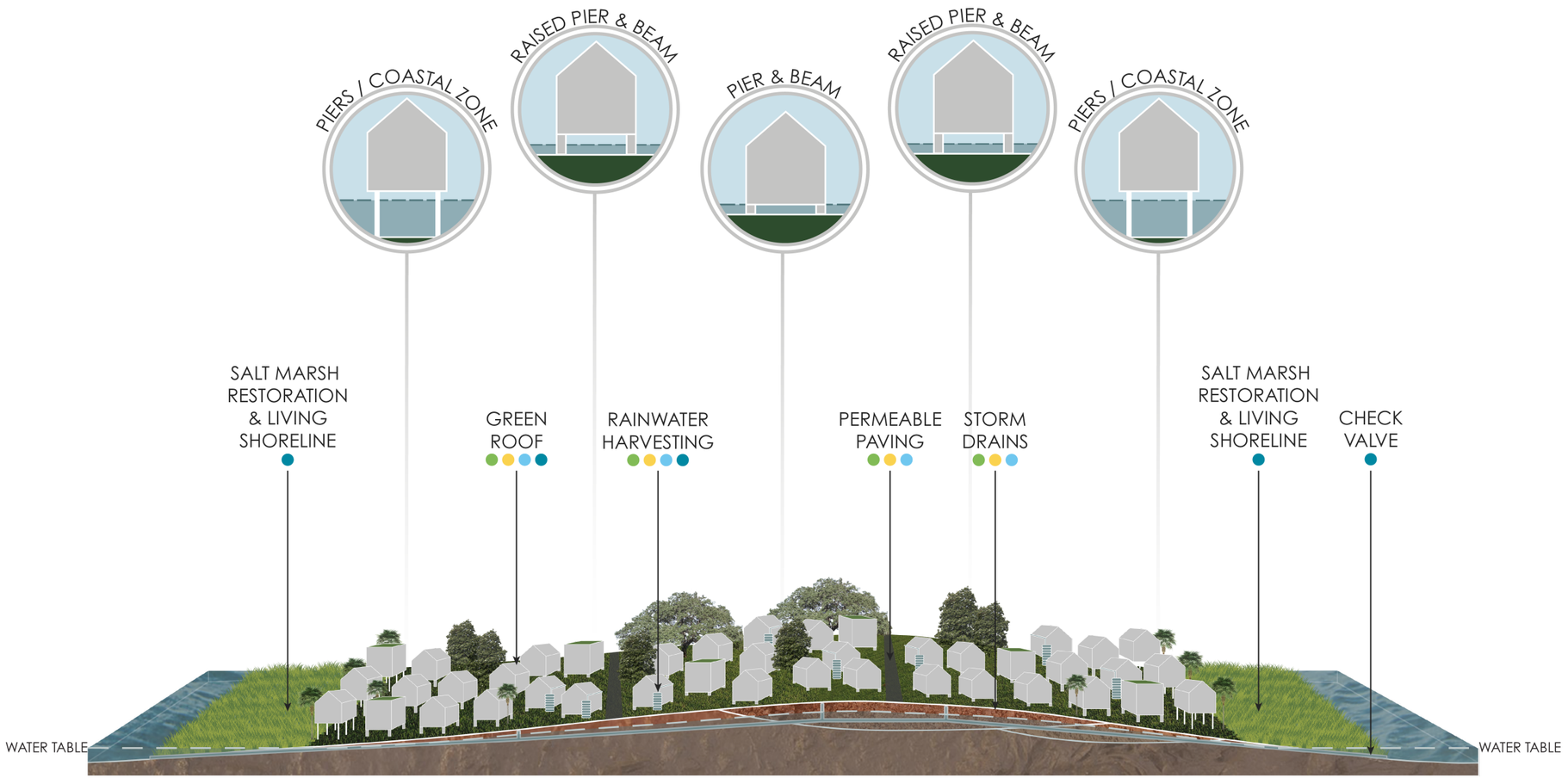
DANIEL ISLAND

WATER

LAND

RISK ZONES

RECOMMENDATIONS



DANIEL ISLAND TRANSECT

COOPER RIVER	GROUP D SOIL	GROUP C SOIL	GROUP B SOIL	D SOIL	WANDO RIVER

TIDAL FLOOD RISK	COMPOUND	ADAPT ZONE	COMPOUND	TIDAL FLOOD RISK

SURCULUS

WATER

WATERSHEDS

WATERSHED TYPES

WATERSHED VULNERABILITY

100 YEAR FLOODPLAIN

STORM SURGE

SEA LEVEL RISE

MARSH MIGRATION

WATERSHEDS

Water flows off Daniel Island into Nowell Creek, Beresford Creek, a small drainage ditch behind the spoil mound, Ralston Creek, and by sheet flow directly into the Wando River.



Legend

DFIRM

- 100 Year Floodplain
- VE Zone

Project Watersheds

Project Subwatersheds

- # Subwatershed Order (1 being closest to the outlet)
- Watershed Interconnectivity Point

1 inch = 4,000 feet

Miles

1

WATERSHED TYPES

Half of Daniel Island flows into Nowell Creek, a large tidal watershed with multiple tributaries and subwatersheds.



Legend

Subwatershed Type

- Small, Tidal
- Large, Outlet Tidal
- Large, Upstream Tidal
- Large, Upstream Inland

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

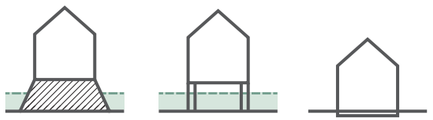
- Water

1 inch = 4,000 feet

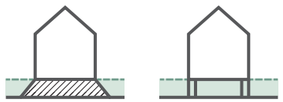
Miles

1

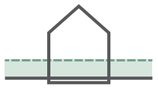
STRUCTURE VULNERABILITY
USING THE 2020 VULNERABILITY AND RISK ASSESSMENT DEFINITIONS



Low Combined Vulnerability & Risk
Outside the 100 year floodplain
Built after BFE+1 requirements

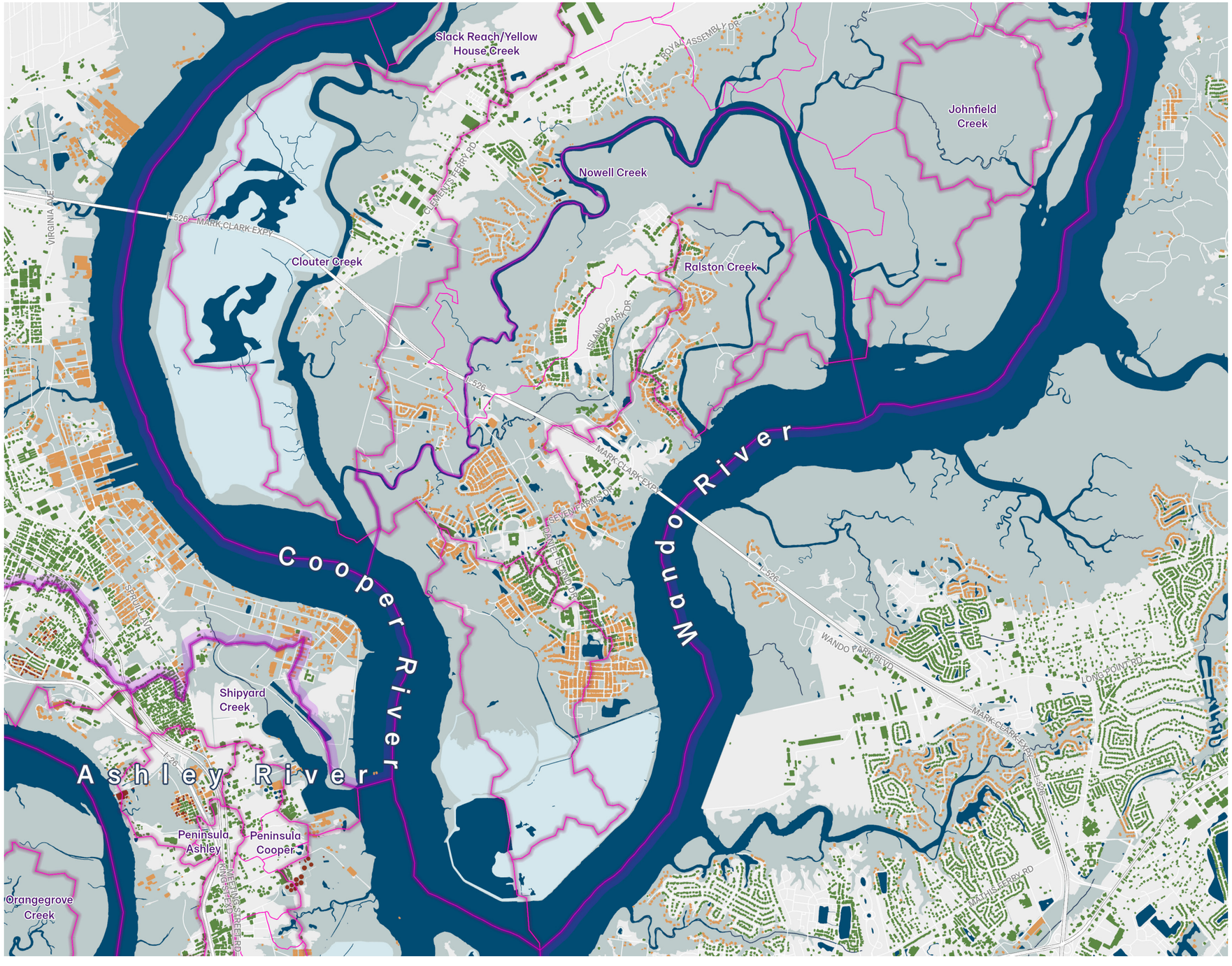


Medium Combined Vulnerability & Risk
In the 100 year floodplain
Built after BFE requirements or raised to BFE



High Combined Vulnerability & Risk
In the 100 year floodplain
Built before BFE requirements

*All heights relative to BFE need verification



100 Year Floodplain and BFE
- No BFE
- BFE

Watersheds Neighborhood
Project Watersheds
Project Subwatersheds
Urban Growth Boundary
Water
- Water

1 inch = 4,000 feet

Miles 1

NUMBER OF VULNERABLE PARCELS

Most of the Daniel Island's watersheds have a low to moderate number of vulnerable parcels.



Legend

Vulnerable Parcels Local & Downstream

- ≤10
- ≤250
- ≤500
- ≤1000
- ≤1500
- >1500
- <excluded>

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

Water

1 inch = 4,000 feet

Miles 1

100 YEAR FLOODPLAIN

Much of Daniel Island is in the 100 year floodplain.



Legend

DFIRM (**Blue #'s** are BFE in NAVD)

- 100 Year Floodplain
- VE Zone

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

1 inch = 4,000 feet

Miles 1

MAXIMUM CATEGORY 3 STORM SURGE

All of Daniel Island is in the maximum storm surge zone of a category 3 hurricane.

map sources: NOAA



Legend

Cat 3 Max Storm Surge (Above Ground)

- <5 ft
- 5-10 ft
- 10-15 ft
- >15 ft

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

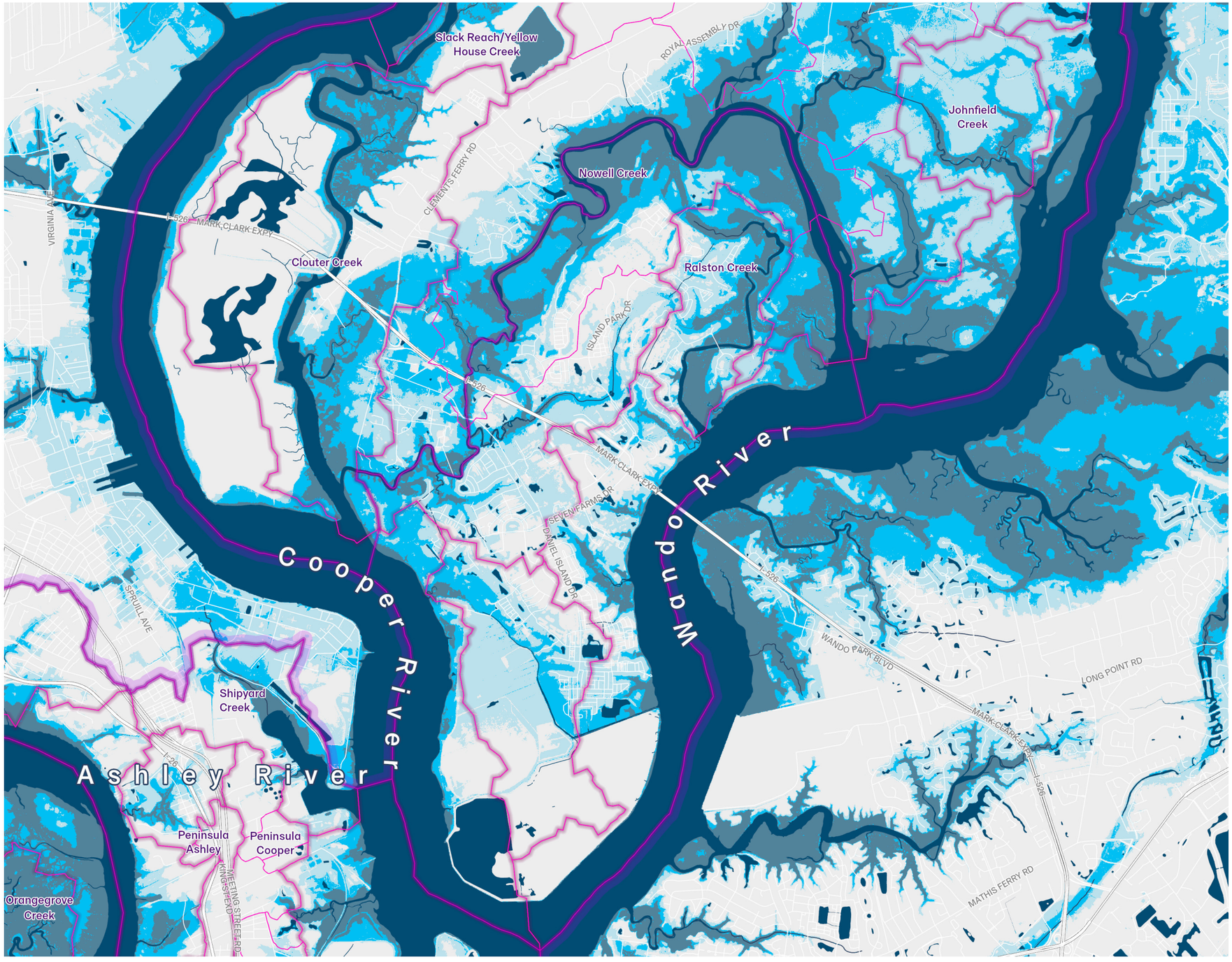
1 inch = 4,000 feet

Miles

1

TIDES AND SEA LEVEL RISE

3 feet of sea level rise has significant potential impacts along Nowell and Beresford Creek.



Legend

Tides and Sea Level Rise
- Current MHHW
- MHHW +3ft of Sea Level Rise
- Highest Recorded Water Level (Hugo)

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water
- Water

1 inch = 4,000 feet

Miles 1

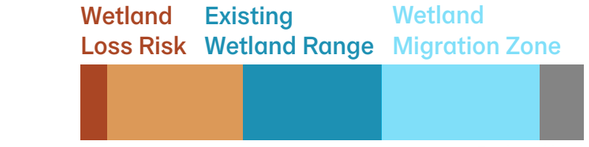
MARSH MIGRATION WITH 3FT OF SEA LEVEL RISE

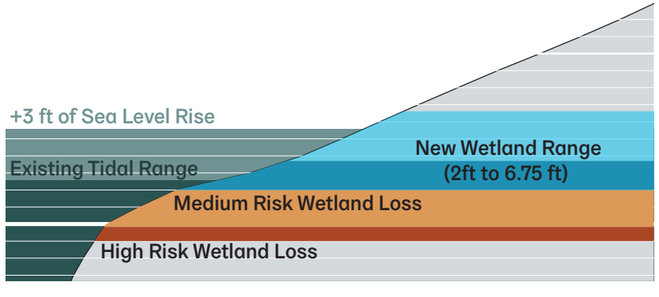
Risk of wetland loss is high along Nowell Creek.

map sources: USGS MLRC Consortium

EXISTING WETLAND RANGE
≈ -1 TO 3.75 FT (NAVD)

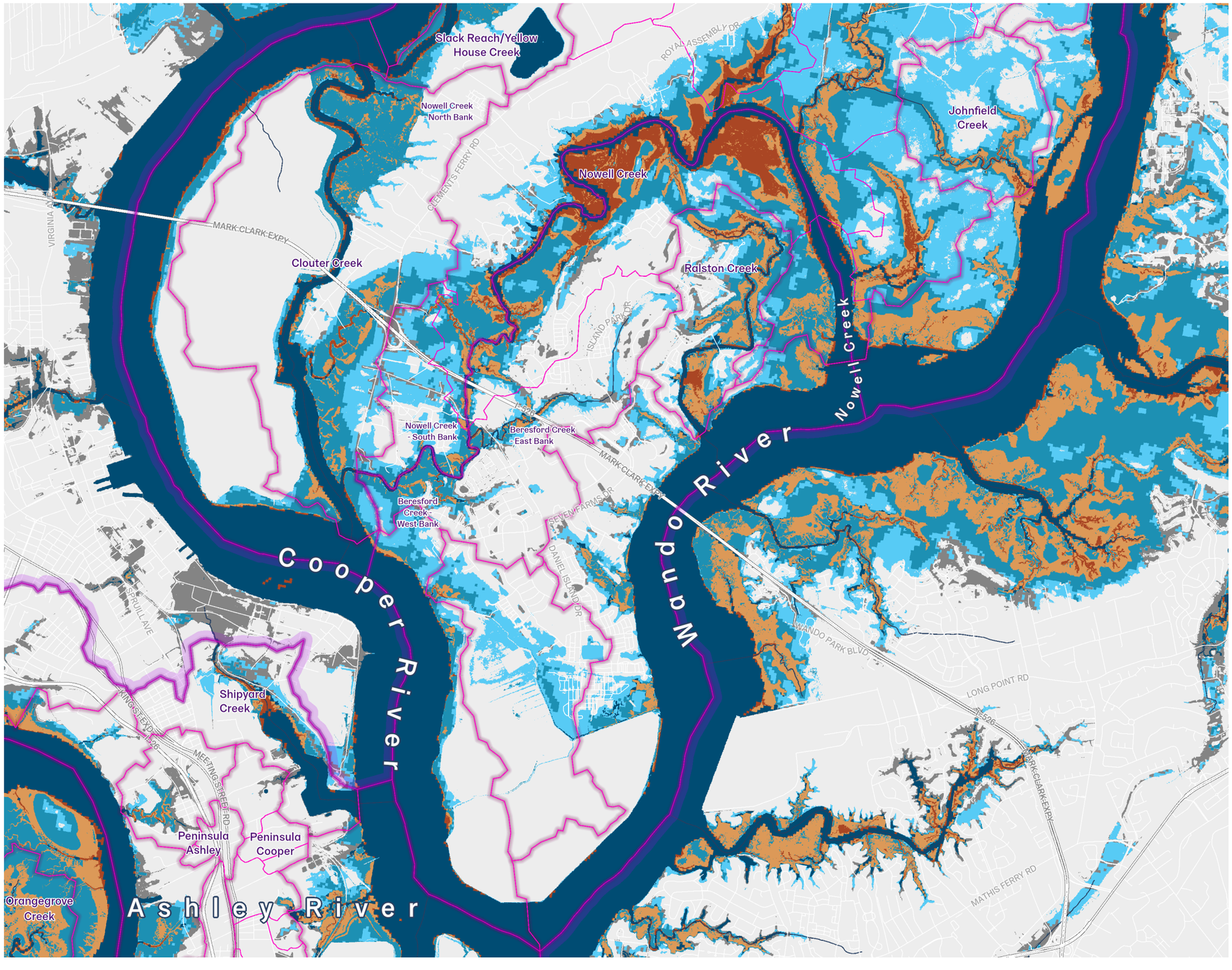
WETLAND MIGRATION ZONE
≈ 2 TO 6.75 FT (NAVD)





1 inch = 4,000 feet

Miles 1



LAND COVER IN THE MARSH MIGRATION ZONE

The forested creek edges on Daniel Island could possibly transition to herbaceous wetlands with future sea level rise.

map sources: USGS, MLRC Consortium

Legend

Land Cover in Wetland Migration Zone

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands

Wetland Migration

- High Risk Wetland Loss
- Medium Risk Wetland Loss
- Low Risk Wetland Loss
- Wetland Migration Zone
- Wetland Migration Zone - Developed

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary
- Water

1 inch = 4,000 feet

Miles 1



LAND

ELEVATION

LAND COVER

ELEVATION & LAND COVER DISTRIBUTION

SOIL

TREE CANOPY

JURISDICTIONS

ELEVATION

All of Daniel island is fairly low in elevation.

map sources: USGS



Legend

Elevation (NAVD88)

- >25 ft
- 20-25 ft
- 15-20 ft
- 10-15 ft
- 5-10 ft
- <5 ft

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

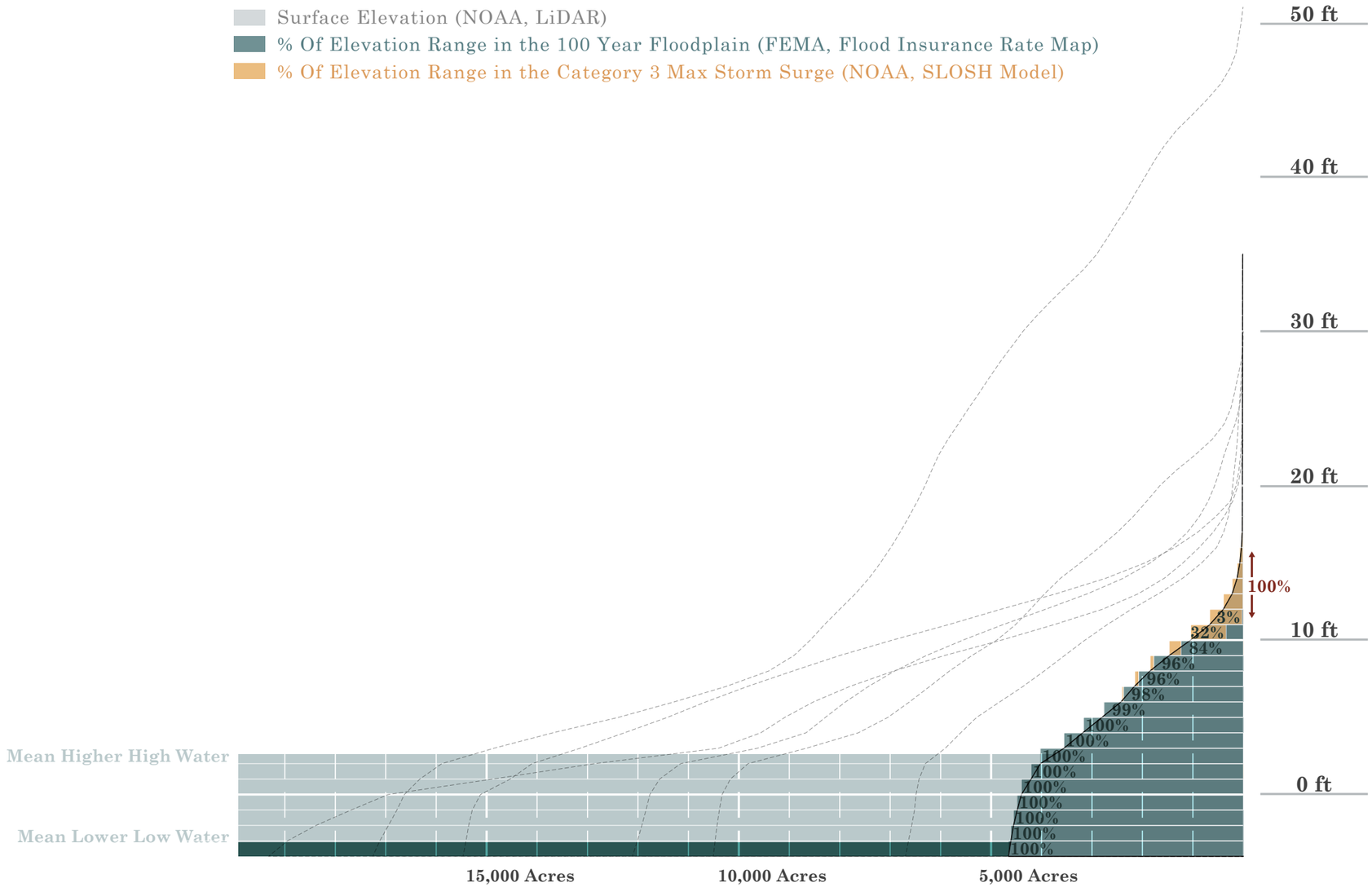
Water

1 inch = 4,000 feet

Miles 1

SURFACE ELEVATION DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

Most land surface at or below 10’ is in the floodplain. All of Daniel Island land surface is at risk from max category 3 storm surge.



ACRES
(STARTING AT MEAN LOWER LOW WATER)

LAND COVER

Daniel Island is almost completely developed.

map sources: MLRC Consortium

Legend

Land Cover 2016

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetland

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary

Water

- Water

1 inch = 4,000 feet

Miles 1



ELEVATION & LAND COVER DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

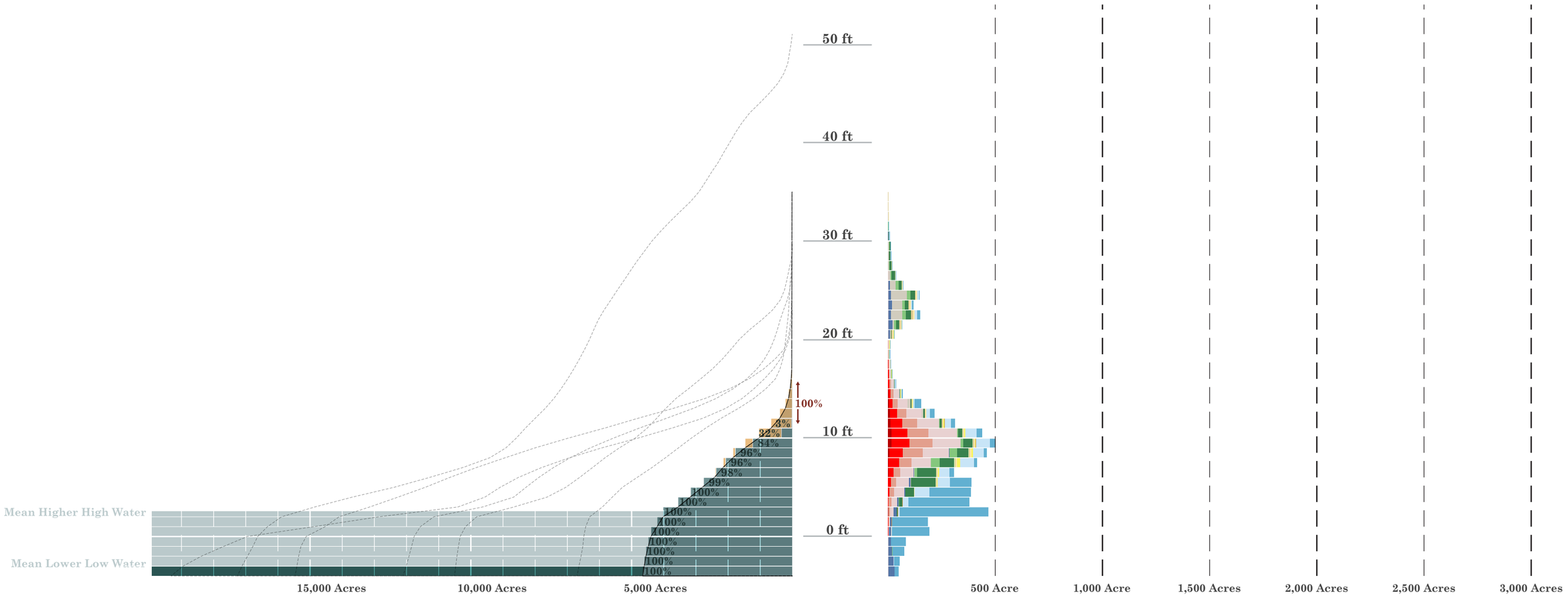
DANIEL ISLAND

Surface Elevation (NOAA, LiDAR)
% Of Elevation Range in the 100 Year Floodplain (FEMA, Flood Insurance Rate Map)
% Of Elevation Range in the Category 3 Max Storm Surge (NOAA, SLOSH Model)

SURFACE ELEVATION

LAND COVER

Developed High Intensity
Developed Medium Intensity
Developed Low Intensity
Developed Open Space
Open Water
Barren Land
Deciduous Forest
Evergreen Forest
Shrub/Scrub
Grassland
Pasture
Crops
Woody Wetland
Emergent Herbaceous Wetland
Outside Urban Growth Boundary



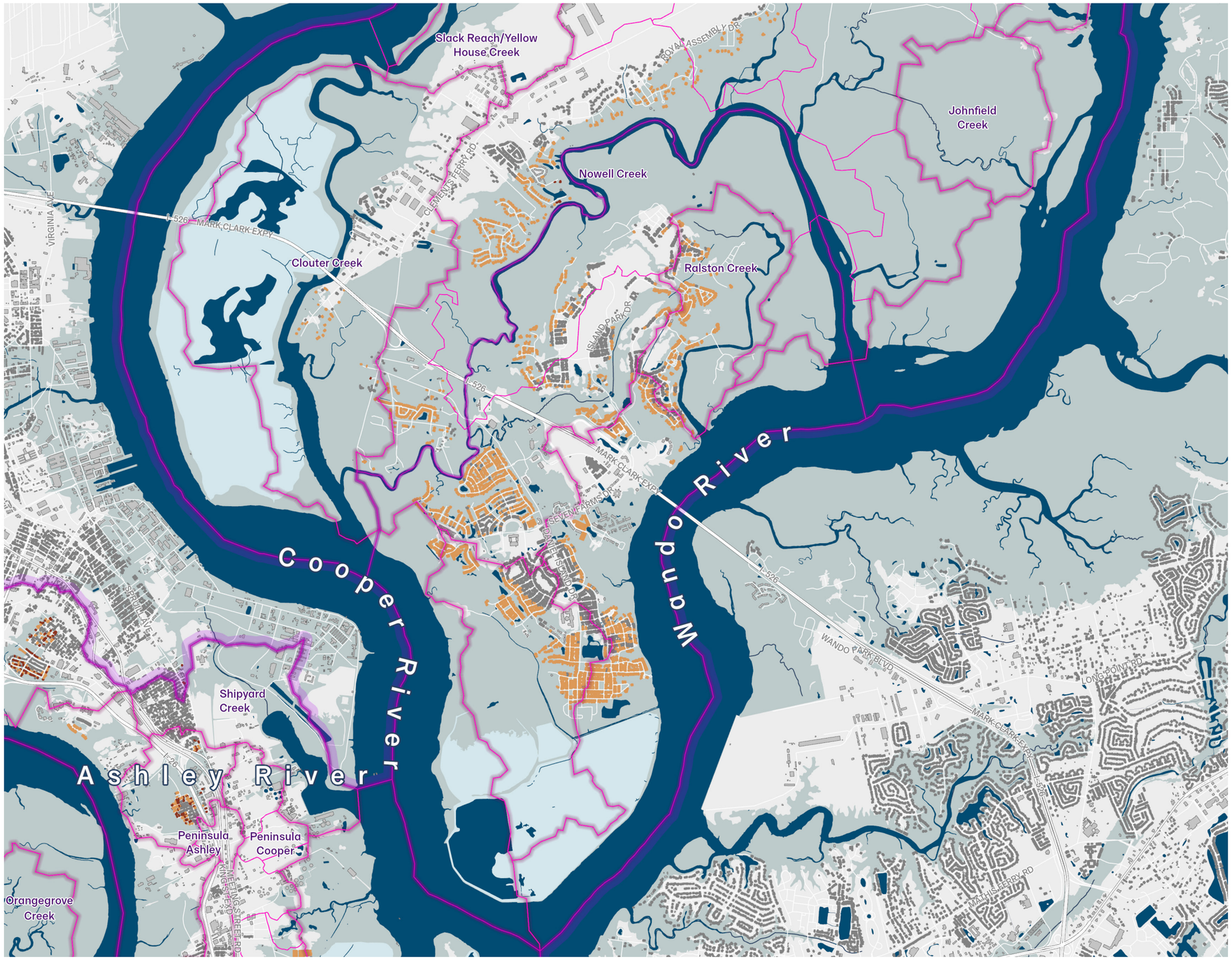
ACRES
(STARTING AT MEAN LOWER LOW WATER)

LANDCOVER DISTRIBUTION IN WATERSHED
(National Land Cover Database)

RESIDENTIAL BUILDING TYPE

Most of Daniel Island was built before BFE+1 regulation.

map sources: City of Charleston



Legend

Residential Structures
- Outside Floodplain, all footing types
- Built to BFE/BFE+2, Peirs
- Built to BFE/BFE+2, Slab-on-Grade or Unknown
- Built Pre-BFE Regulations
- Non Residential

100 Year Floodplain and BFE
- No BFE
- BFE

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water
- Water

1 inch = 4,000 feet

Miles 1

ELEVATION & RESIDENTIAL BUILDING TYPE DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

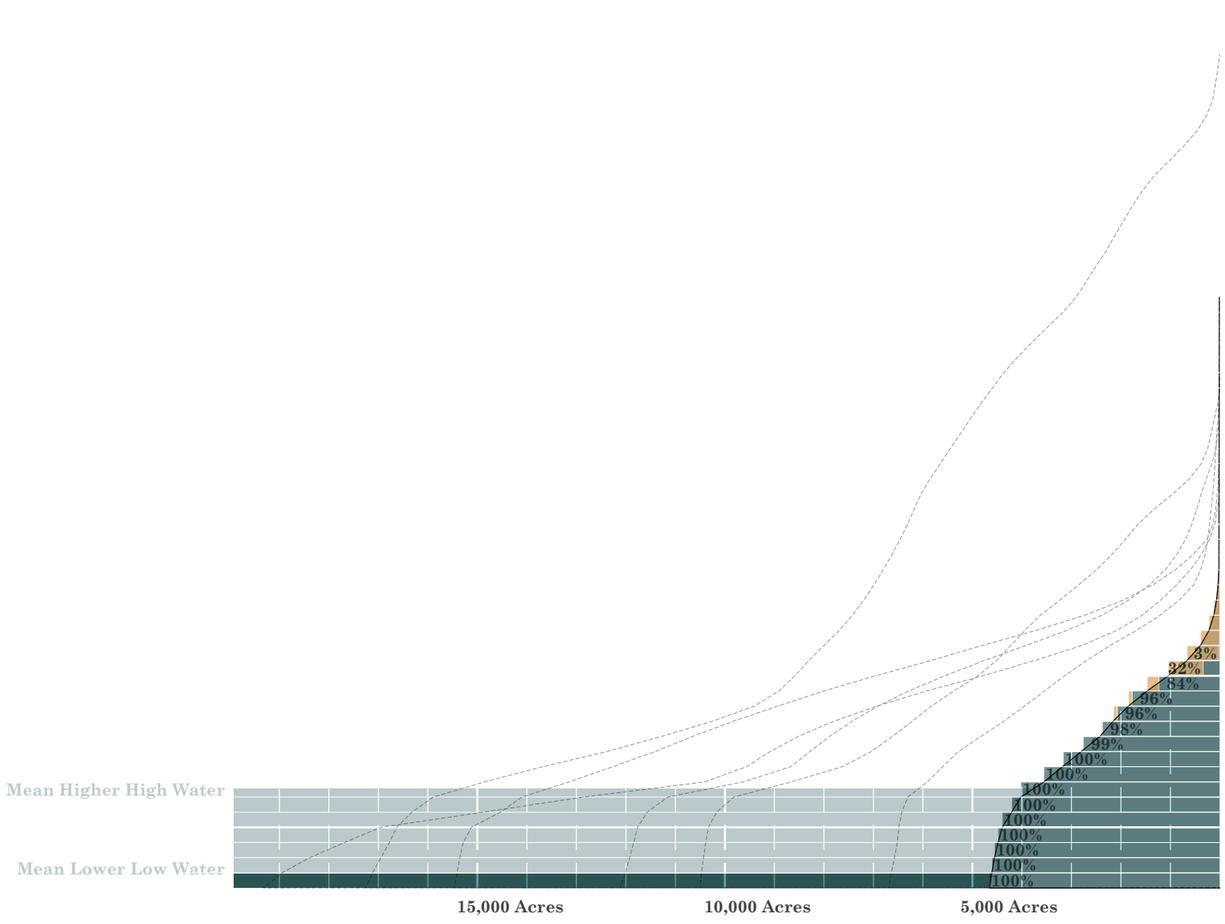
DANIEL ISLAND

SURFACE ELEVATION

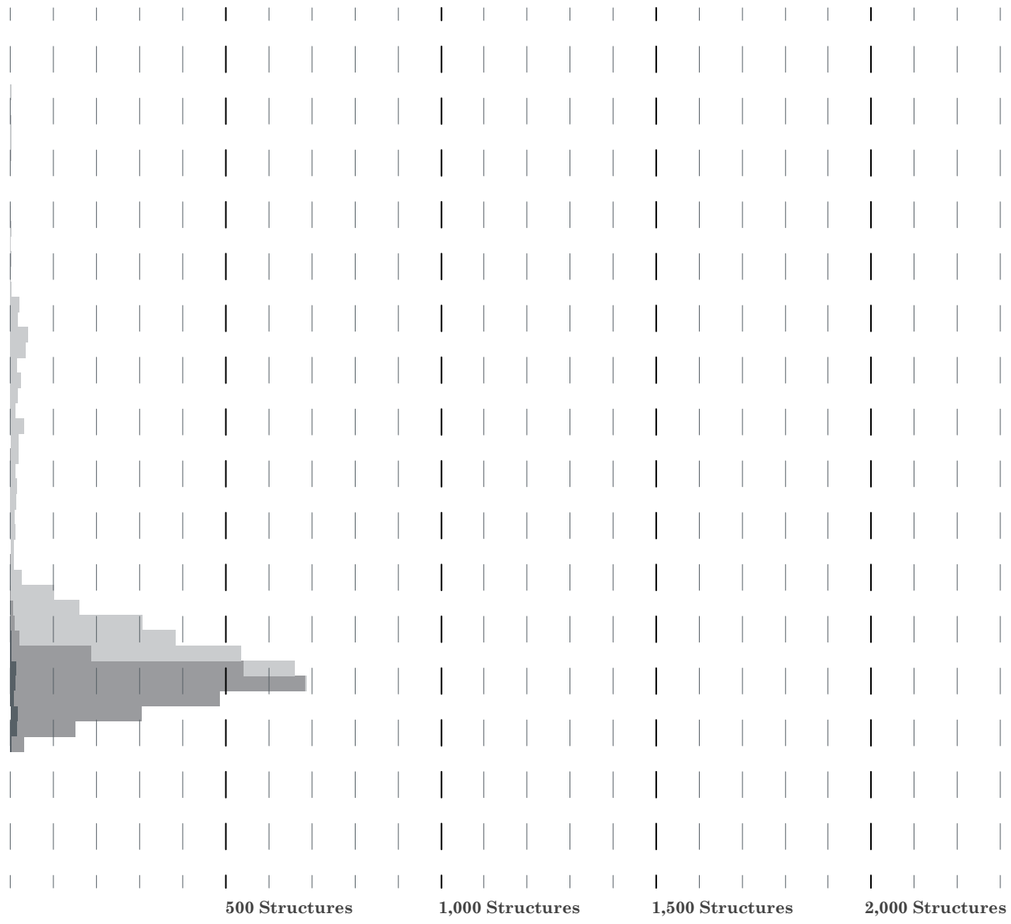
- Surface Elevation (NOAA, LiDAR)
- % Of Elevation Range in the 100 Year Floodplain (FEMA, Flood Insurance Rate Map)
- % Of Elevation Range in the Category 3 Max Storm Surge (NOAA, SLOSH Model)

RESIDENTIAL STRUCTURES

- Slab on Grade: inside 100 year floodplain before BFE requirement
- Slab on Grade: inside 100 year floodplain rasied to BFE/BFE+1
- Slab on Grade: outside 100 year floodplain
- Unknown: inside 100 year floodplain before BFE requirement
- Unknown: inside 100 year floodplain rasied to BFE/BFE+1
- Unknown: outside 100 year floodplain
- On Peirs: inside 100 year floodplain before BFE requirement
- On Peirs: inside 100 year floodplain rasied to BFE/BFE+1
- On Peirs: outside 100 year floodplain



ACRES
(STARTING AT MEAN LOWER LOW WATER)



STRUCTURE BASE ELEVATIONS
(STARTING AT MEAN LOWER LOW WATER)

SOIL TYPES

Most of the soil on Daniel island is poor for infiltration.

map sources: USDA



Legend

Soil Hydrologic Groups

- Group A
- Group B
- Group C
- Group D, /D

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

1 inch = 4,000 feet

Miles 1

TREE CANOPY DENSITY & CHANGE

Tree canopy loss is fairly high on Daniel Island through new development, with high gains on the spoil islands at the confluence of the Cooper and Wando Rivers. Overall Canopy density is patchy.

map sources: GLCF



Legend

Tree Canopy (2015)

- Dense
- Sparse

Canopy Change (2000-2015)

- High Gain
- High Loss

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary

Water

- Water

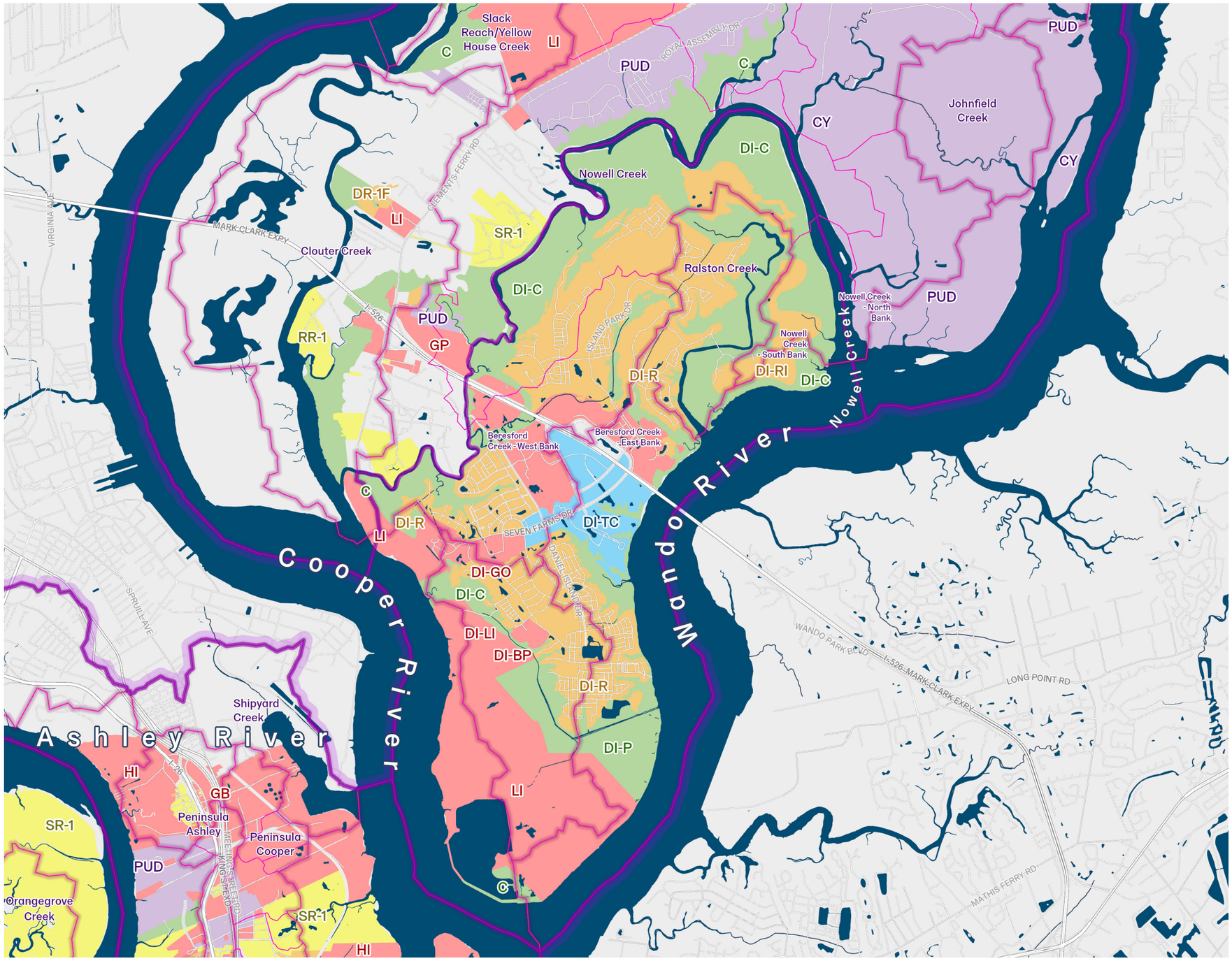
1 inch = 4,000 feet

Miles

1

ZONING

Daniel Island was zoned as a Planned Development and is located completely within the City of Charleston.



Legend

Zoning

- Parks & Conservation
- Single Family Residential
- Diverse Residential
- Planned Development
- Mixed Use
- Business & Industrial

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

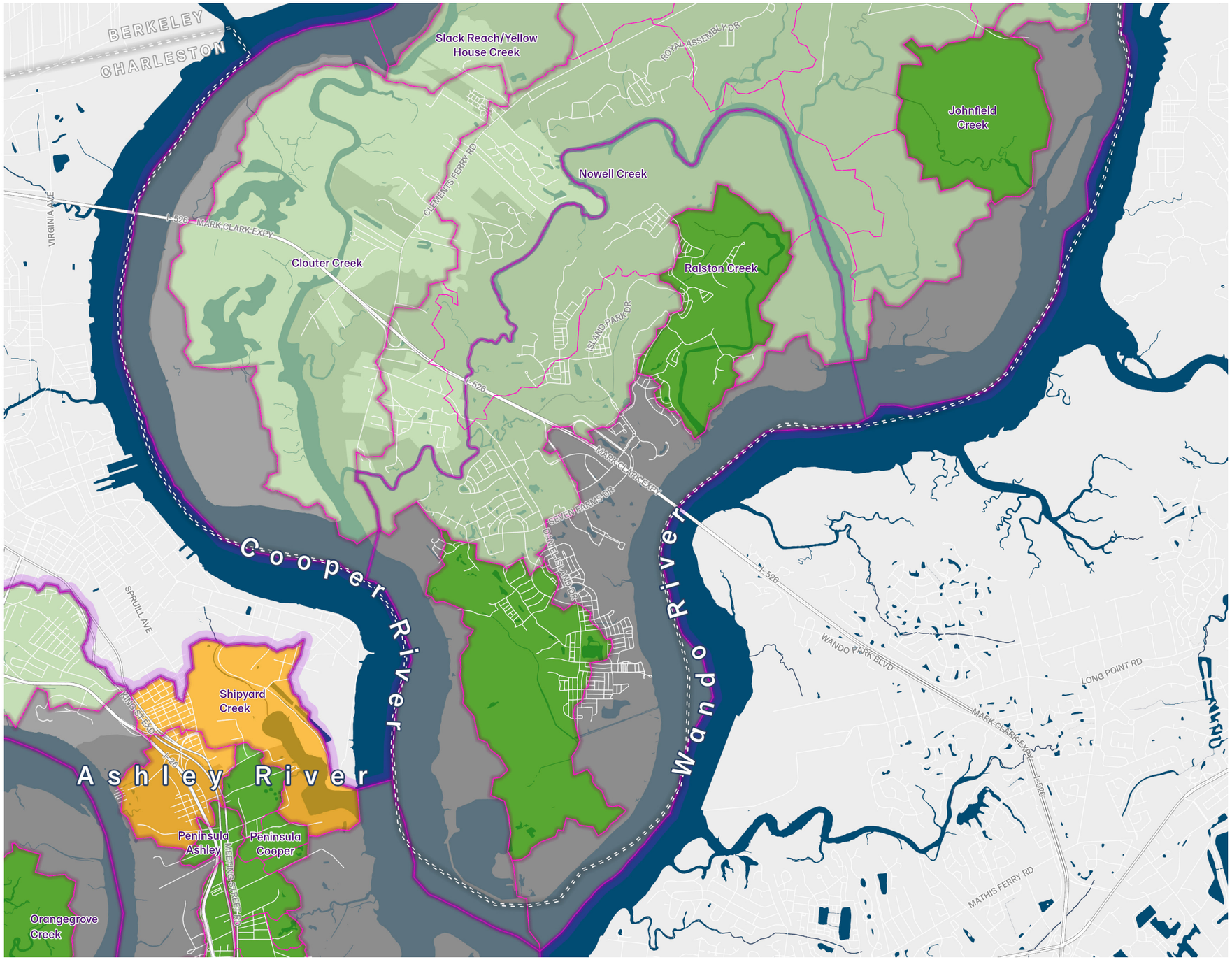
1 inch = 4,000 feet

Miles

1

JURISDICTIONAL COMPLEXITY

While all of Daniel Island is within the City of Charleston's jurisdiction, its watersheds are not.



Legend

Watershed Jurisdiction
- Entirely Within Charleston City
- Single-City, Single-County
- No City, Single-County
- Multi-City, Single-County
- Multi-City, Multi-County
- Excluded

Counties
- Charleston City Limits

Watersheds Neighborhood
- Project Watersheds
- Project Subwatersheds

Urban Growth Boundary

Water
- Water

1 inch = 4,000 feet

Miles 1

LAND & WATER IMPLICATIONS

ELEVATION RISK ZONES

ELEVATION RISK ZONES & WATERSHED SENSITIVITY

ENVIRONMENTAL SENSITIVITY

ELEVATION ZONES

Most of non-marsh land on Daniel island is in the adapt zone, with some areas in the tidal flood risk zone. Tidal and compound flood risk will grow with sea level rise.

HIGH GROUND

High ground is defined as land outside of the FEMA 100 year floodplain and above the NOAA max category 3 storm surge. High ground has the lowest flood risk and stormwater detention here has the greatest watershed benefit.

ADAPT ZONE

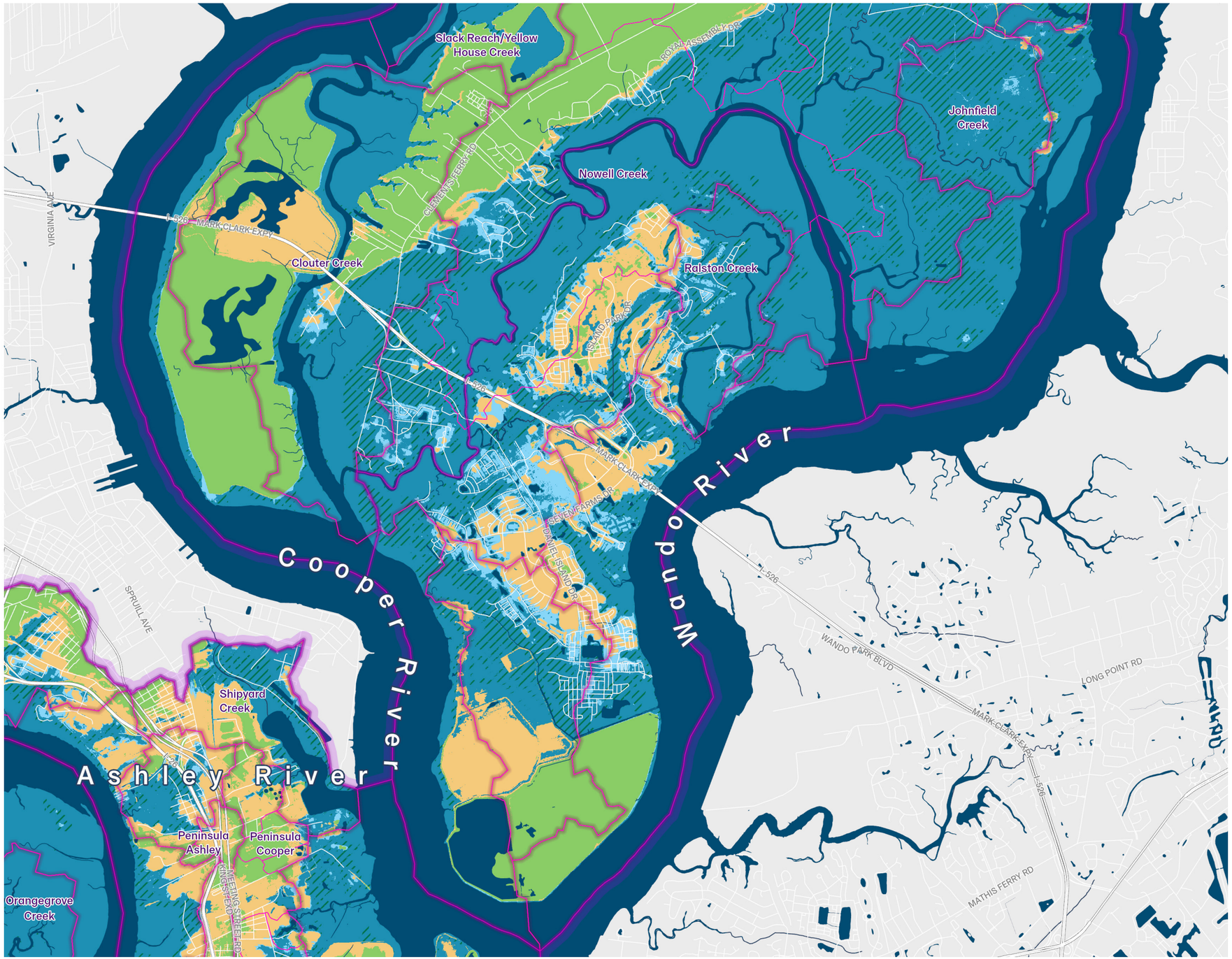
The adapt zone consists of land outside of the FEMA 100 year floodplain that is still within the NOAA maximum storm surge of a category 3 hurricane. Rain and storm surge flooding in this zone is infrequent but not impossible.

COMPOUND FLOOD RISK

This zone encompasses areas within the floodplain above the tidal flood risk zone where flood risk comes from a mixture of rainfall, runoff and tidal conditions.

TIDAL FLOOD RISK ZONE

This zone encompasses the lowest land in Charleston. Nearly 100% of this zone is in the 100 year floodplain. Flooding is frequent and can come solely from tidal events independent of precipitation. Sea level rise driven marsh migration occurs in this dynamic zone.



1 inch = 4,000 feet

Miles 1

ELEVATION RISK + WATERSHED SENSITIVITY

All of the watersheds on Daniel Island are low sensitivity. Depending on future change, the Nowell Creek watershed could see an increase in sensitivity given its size and tidal nature.

HIGH SENSITIVITY

Combination of more flood prone watersheds and a high number of vulnerable parcels. Typically larger tidal watersheds and/or watersheds where development happened before BFE regulations.

NORMAL SENSITIVITY

Combination of less flood prone watersheds and a low number of vulnerable parcels. Typically smaller and/or less developed watersheds.

HIGH GROUND

ADAPT ZONE

COMPOUND FLOOD RISK

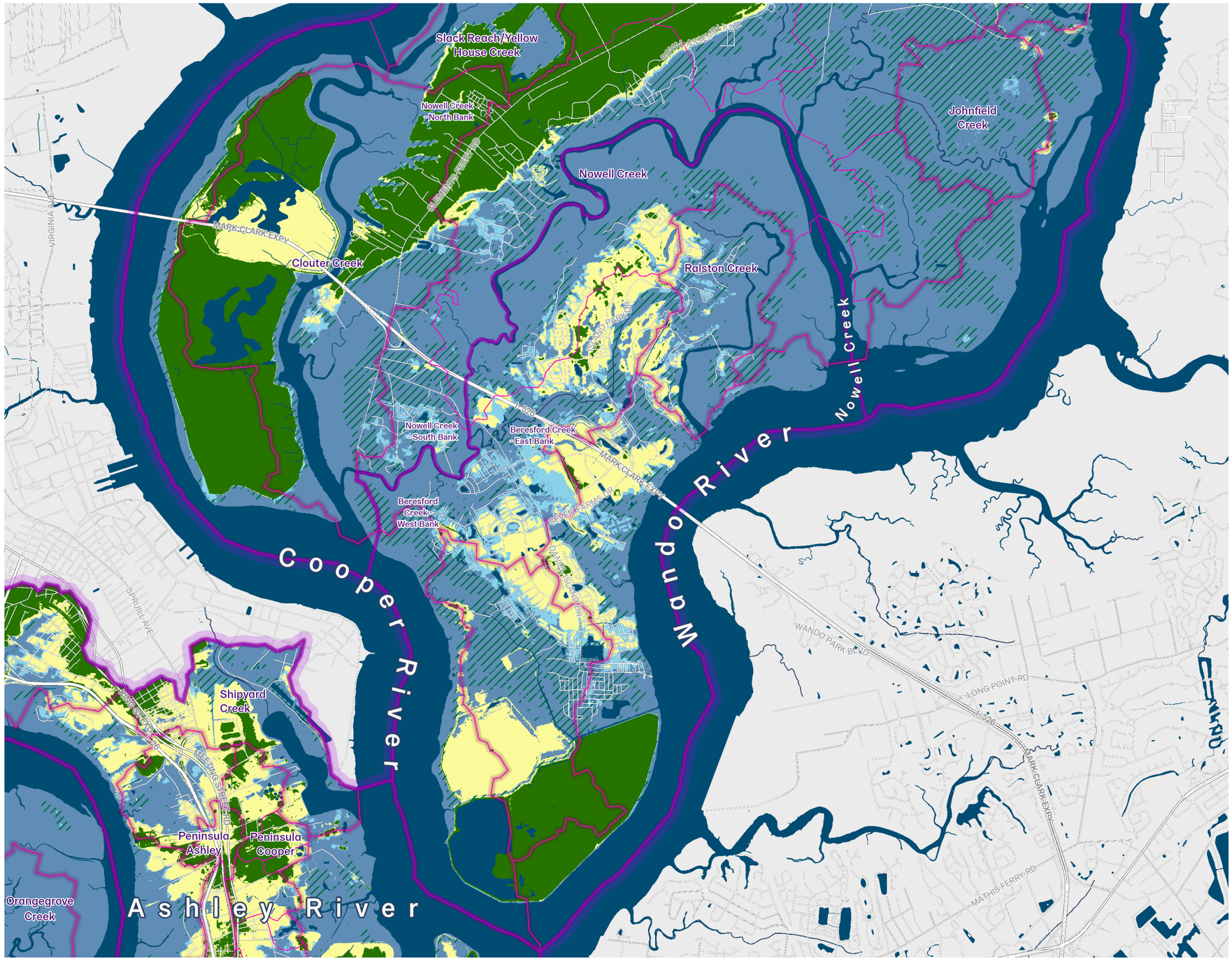
TIDAL FLOOD RISK ZONE



1 inch = 4,000 feet

Miles

1



RISK + SENSITIVITY + ZONING

Most of Daniel Island is zoned for diverse residential use with the lowest land zoned for conservation.

Legend

Zoning

- Parks & Conservation
- Single Family
- Diverse Residential
- Planned Development
- Mixed Use
- Business & Industrial

Risk & Watershed Impact

- High Ground, Normal Sensitivity
- High Ground, High Sensitivity
- Adapt Zone, Normal Sensitivity
- Adapt Zone, High Sensitivity
- Compound Flood Risk, Normal Sensitivity
- Compound Flood Risk, High Sensitivity
- Tidal Flood Risk, Normal Sensitivity
- Tidal Flood Risk, High Sensitivity
- Marsh Migration Zone

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary
- Water

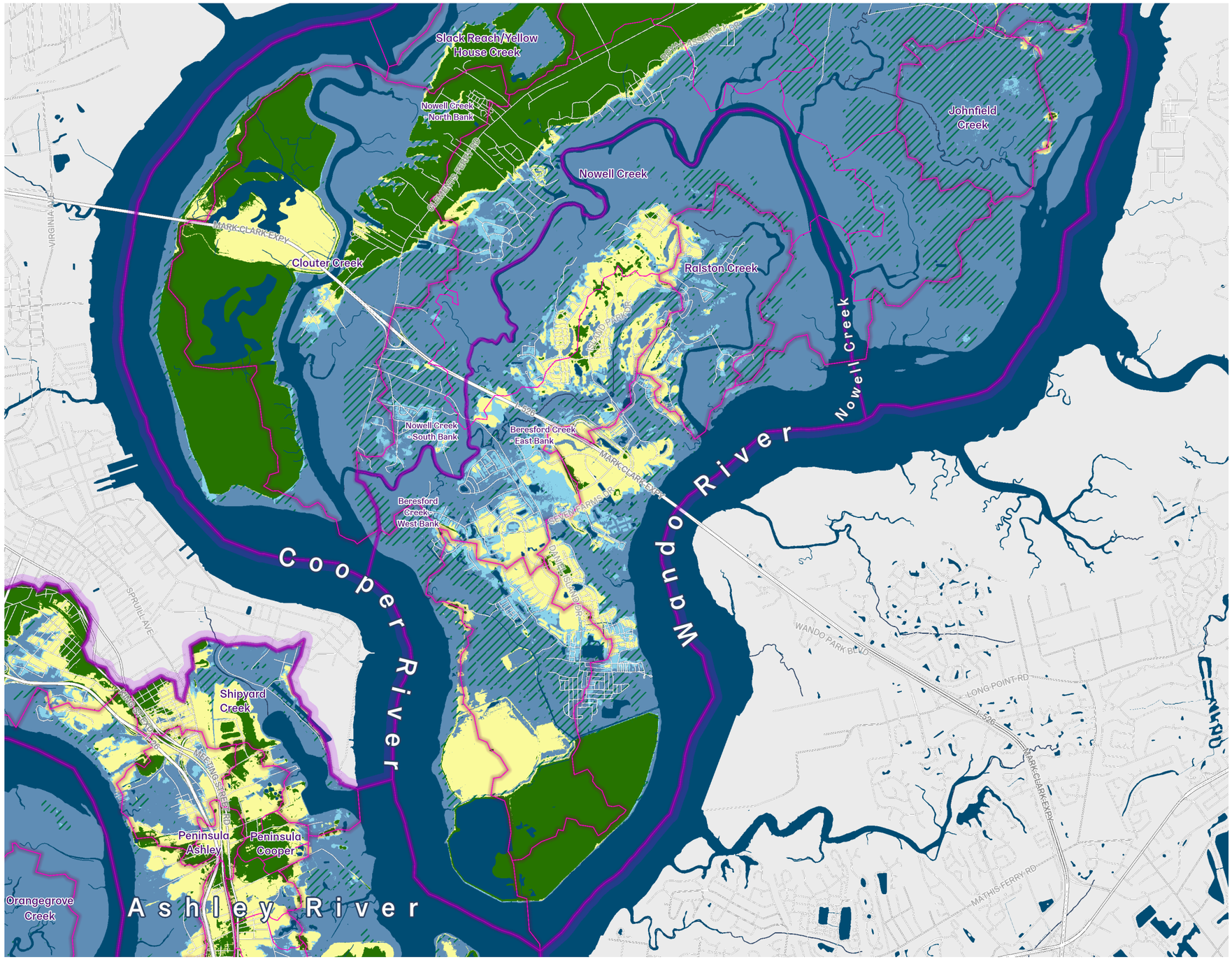
1 inch = 4,000 feet

Miles 1



LAND & WATER IMPLICATIONS

- There is virtually no high ground on Daniel Island (not including spoil islands).
- Most of the adapt zone on Daniel Island is just barely above the tidal flood risk zone.
- Around half of Daniel Island drains into the Nowell/Beresford Creek watershed, a large tidal watershed with multiple tributaries and a high potential watershed sensitivity but with a low number of vulnerable parcels.
- Risk of wetland loss from sea level rise is high along Nowell Creek.



1 inch = 4,000 feet

Miles

1

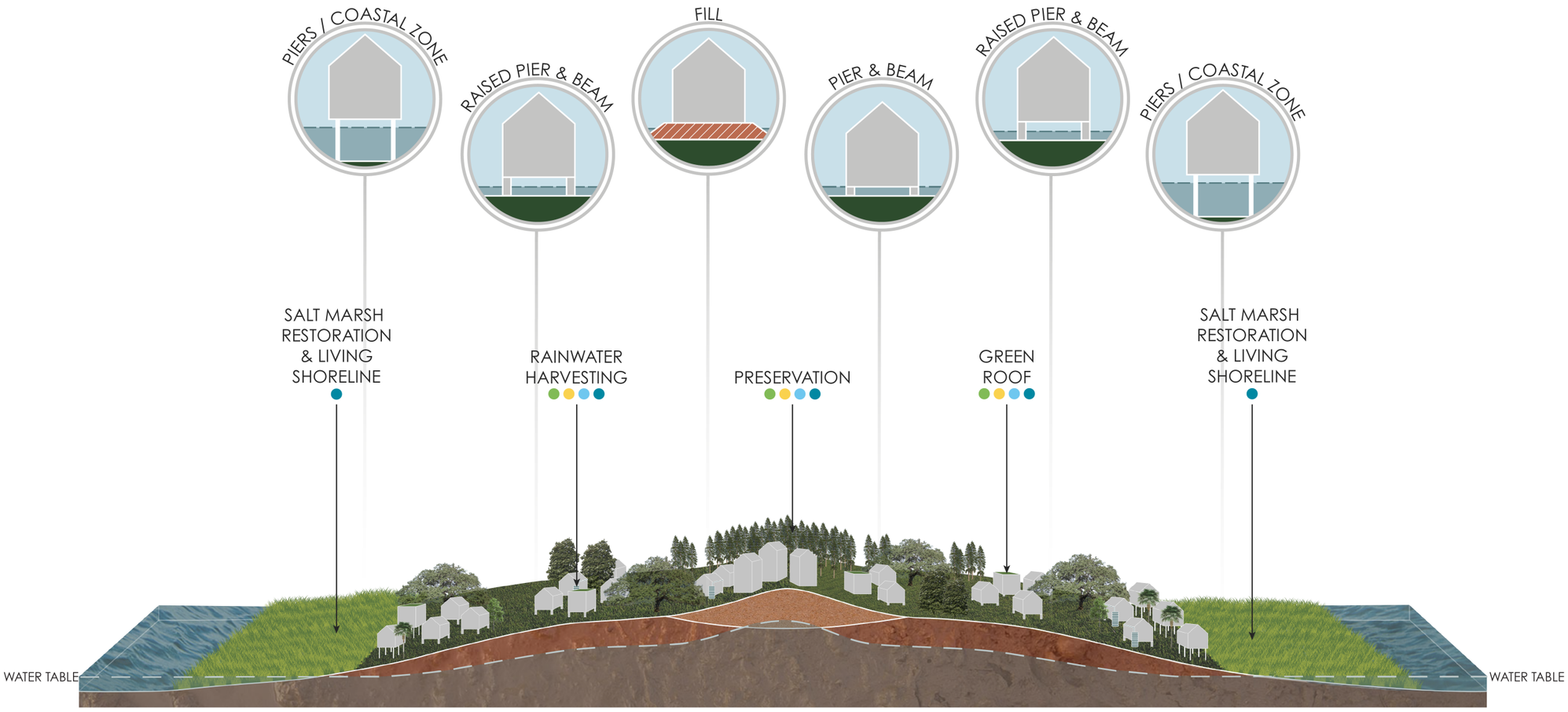
CAINHOY

WATER

LAND

RISK ZONES

RECOMMENDATIONS



CAINHOY PENINSULA TRANSECT

COOPER R.	MARSH	GROUP D SOIL	GROUP A SOIL	GROUP D SOIL	MARSH	WANDO R.
TIDAL FLOOD RISK	ADAPT ZONE	HIGH GROUND	ADAPT ZONE	TIDAL FLOOD RISK		

SURCULUS

WATER

WATERSHEDS

WATERSHED TYPES

WATERSHED VULNERABILITY

100 YEAR FLOODPLAIN

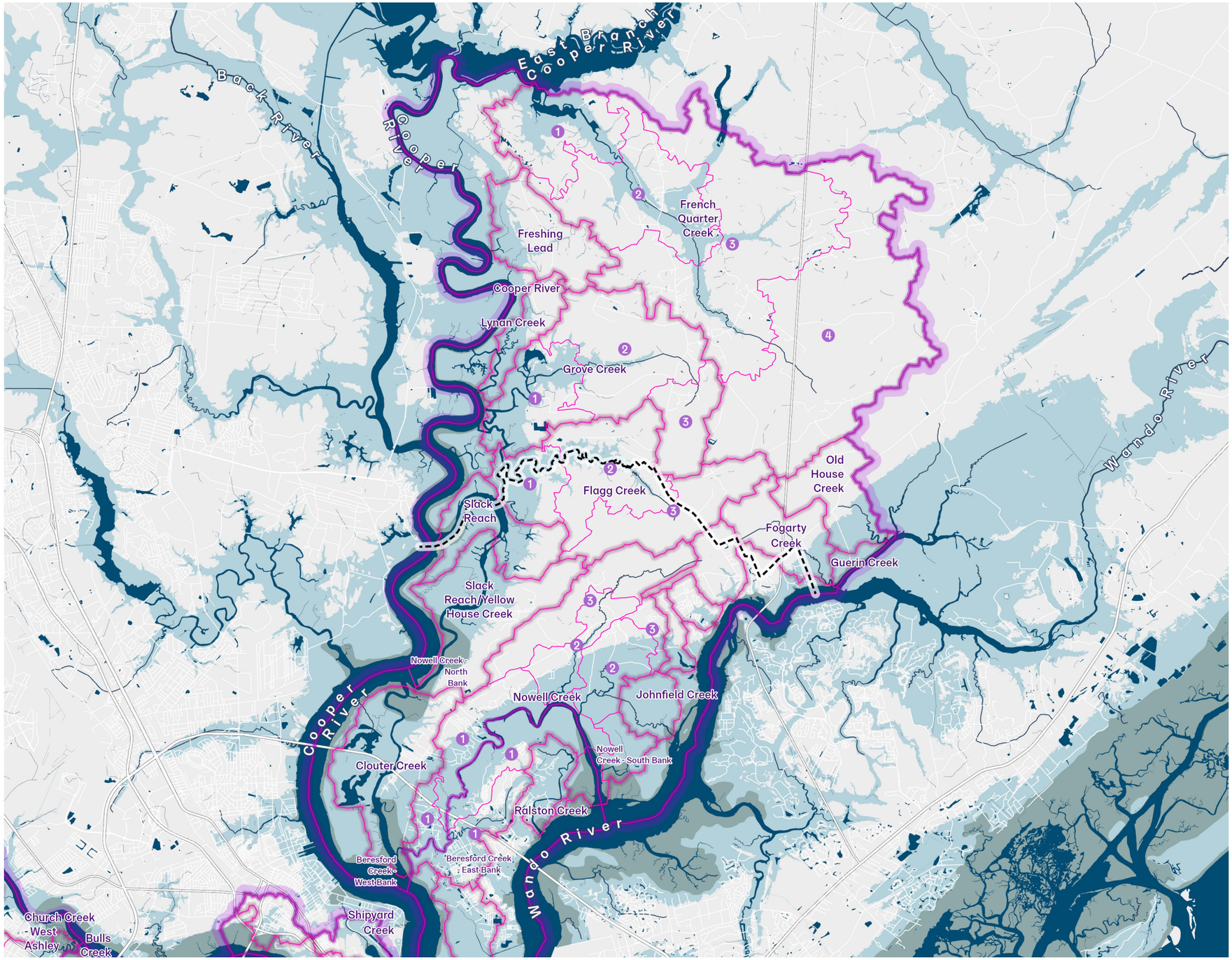
STORM SURGE

SEA LEVEL RISE

MARSH MIGRATION

WATERSHEDS

Cainhoy has 16 watersheds which flow from the spine of high ground along Clements Ferry Road to either the Cooper or Wando River. The Watersheds on the Wando side are typically smaller, while the watersheds on the Cooper side are larger with multiple subwatersheds.



Legend

DFIRM

100 Year Floodplain

VE Zone

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Subwatershed Order (1 being closest to the outlet)

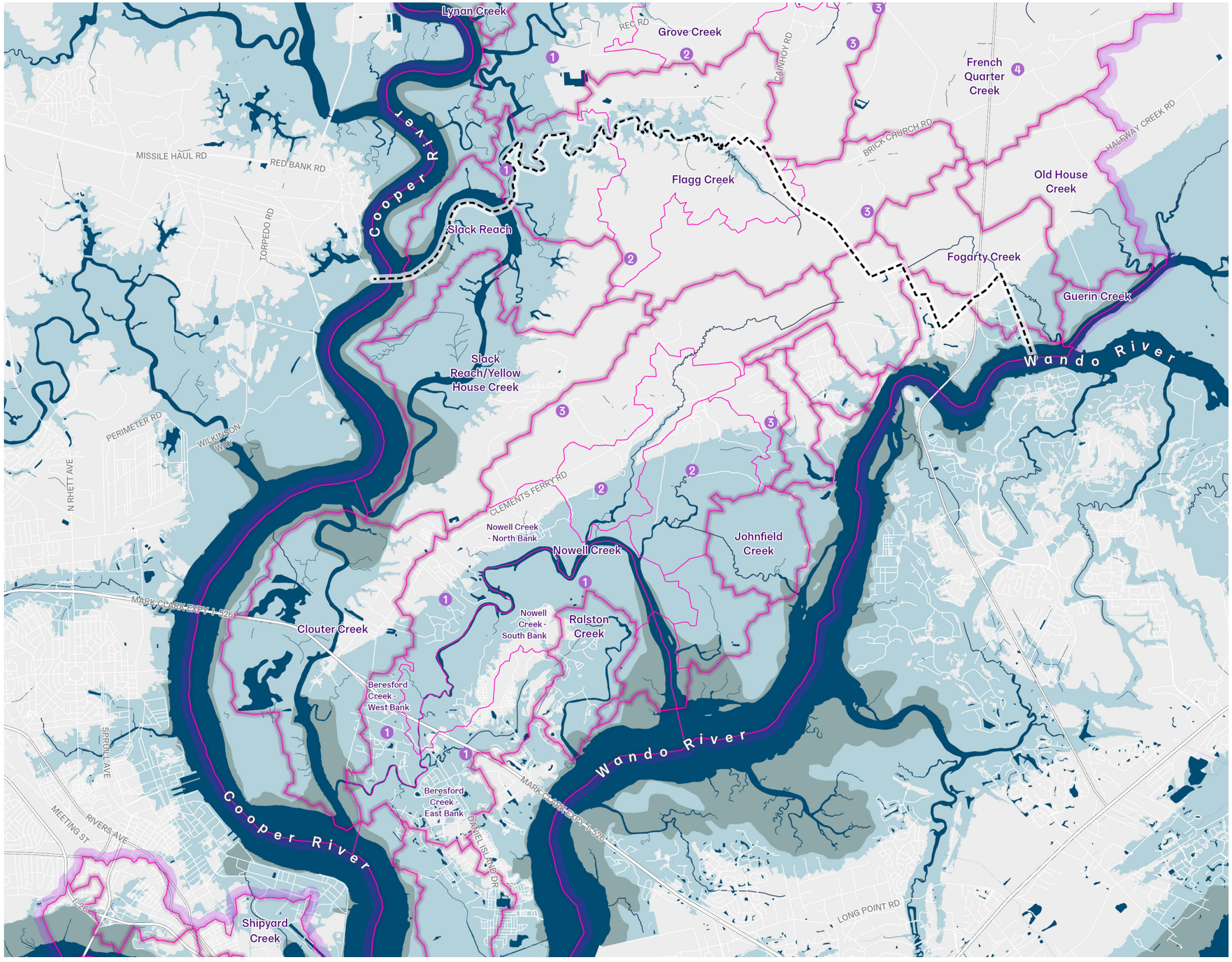
Watershed Interconnectivity Point

1 inch = 10,000 feet

Miles 1

WATERSHEDS

There are 9 watersheds within the urban growth boundary.



Legend

DFIRM

- 100 Year Floodplain
- VE Zone

Project Watersheds

Project Subwatersheds

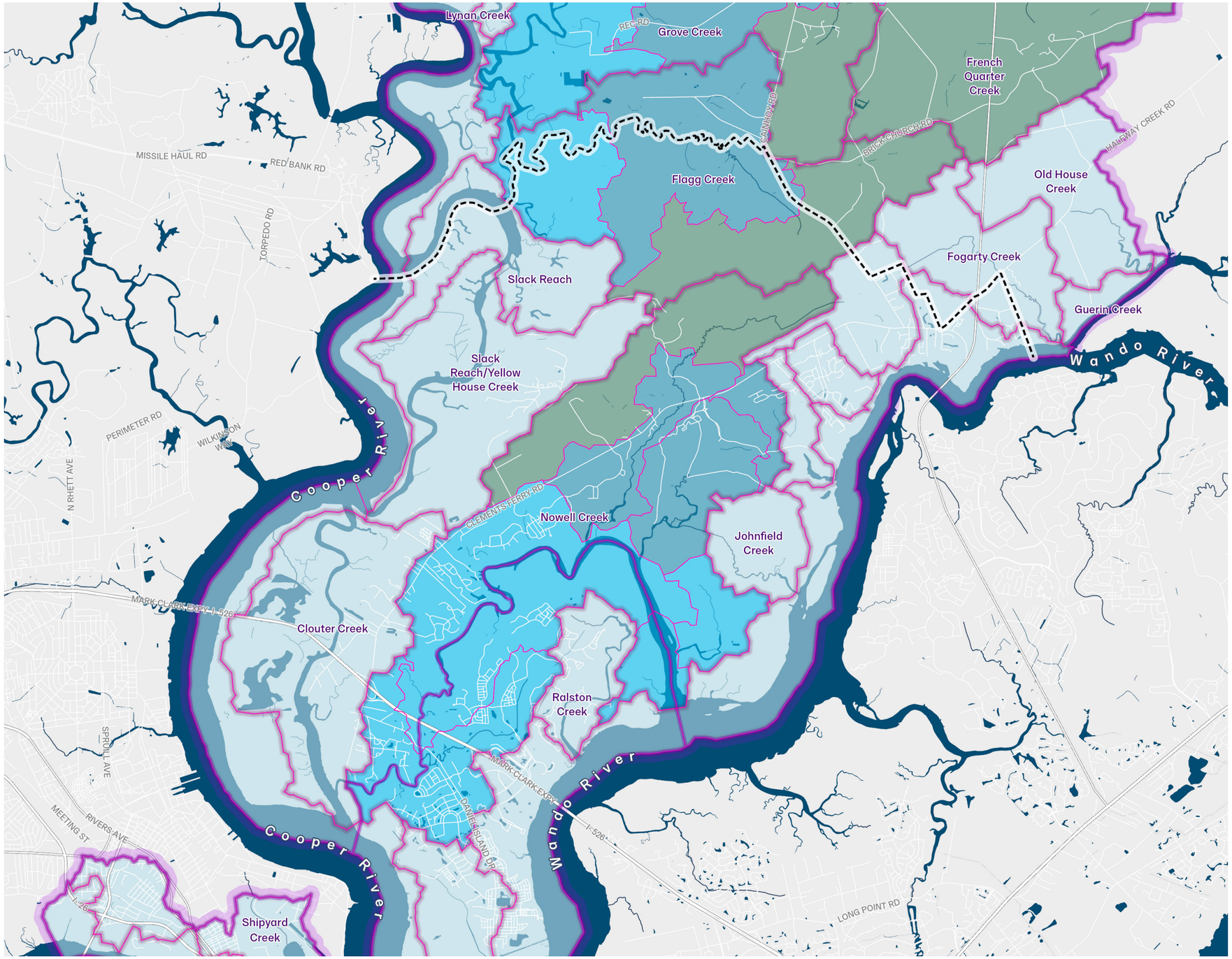
- # Subwatershed Order (1 being closest to the outlet)
- Watershed Interconnectivity Point

1 inch = 6,000 feet

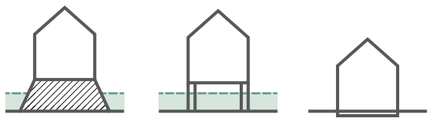
Miles 1

WATERSHED TYPES

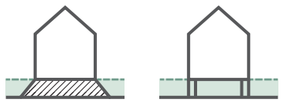
Many of the watersheds in Cainhoy are large, within some upstream subwatersheds substantially above tidal influence.



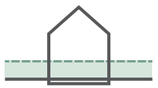
STRUCTURE VULNERABILITY
USING THE 2020 VULNERABILITY AND RISK ASSESSMENT DEFINITIONS



Low Combined Vulnerability & Risk
Outside the 100 year floodplain
Built after BFE+1 requirements

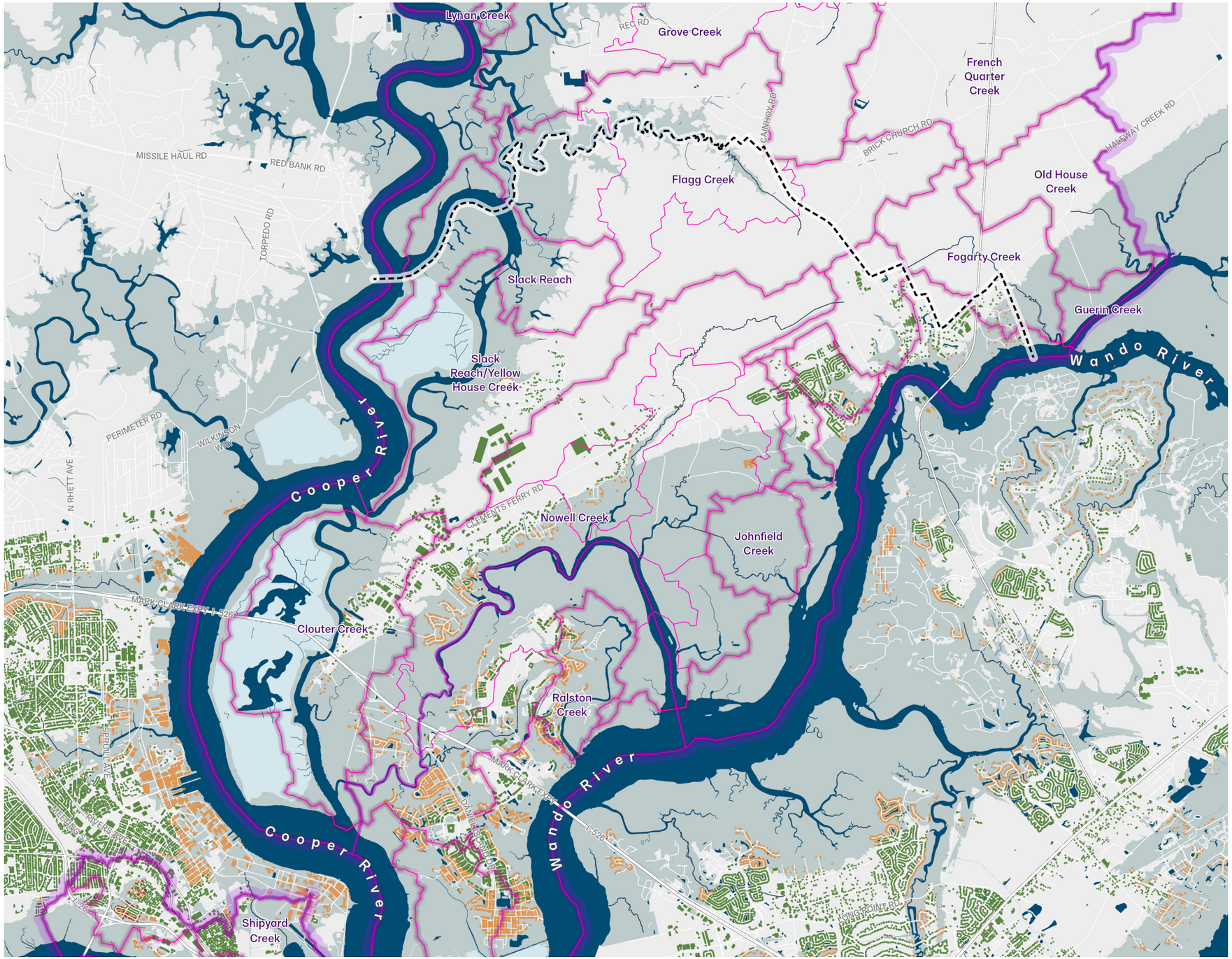


Medium Combined Vulnerability & Risk
In the 100 year floodplain
Built after BFE requirements or raised to BFE



High Combined Vulnerability & Risk
In the 100 year floodplain
Built before BFE requirements

*All heights relative to BFE need verification



100 Year Floodplain and BFE
- No BFE
- BFE

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

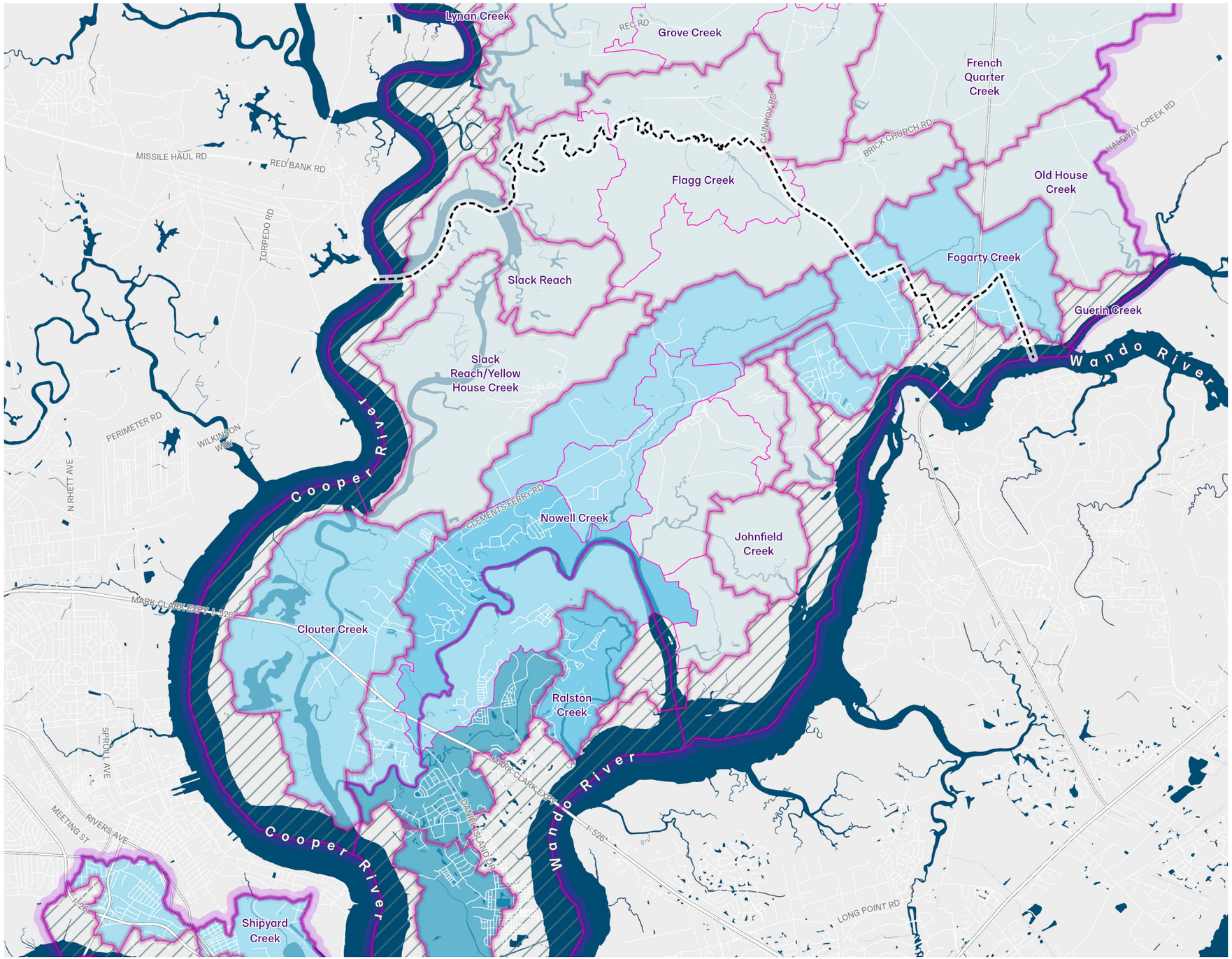
Urban Growth Boundary

Water
- Water

1 inch = 6,000 feet
Miles
1

NUMBER OF VULNERABLE PARCELS

The watersheds in Cainhoy have few vulnerable parcels primarily due to the low level of development.



Legend

Vulnerable Parcels Local & Downstream

- ≤10
- ≤250
- ≤500
- ≤1000
- ≤1500
- >1500
- <excluded>

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

1 inch = 6,000 feet

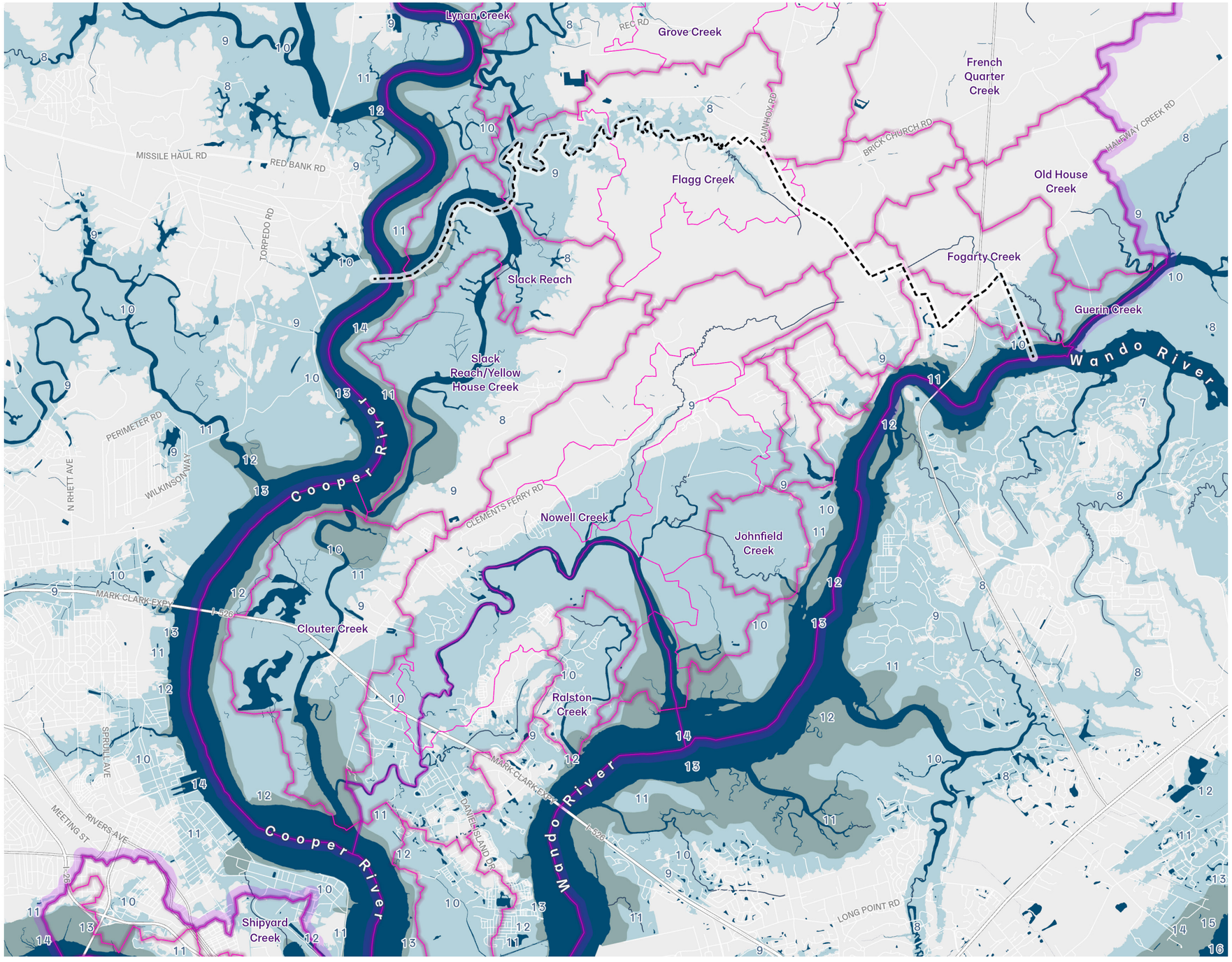
Miles

1

100 YEAR FLOODPLAIN

Most of Cainhoy is well outside the 100 year floodplain.

map sources: FEMA



Legend

DFIRM (**Blue #'s** are BFE in NAVD)

100 Year Floodplain

VE Zone

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

Water

1 inch = 6,000 feet

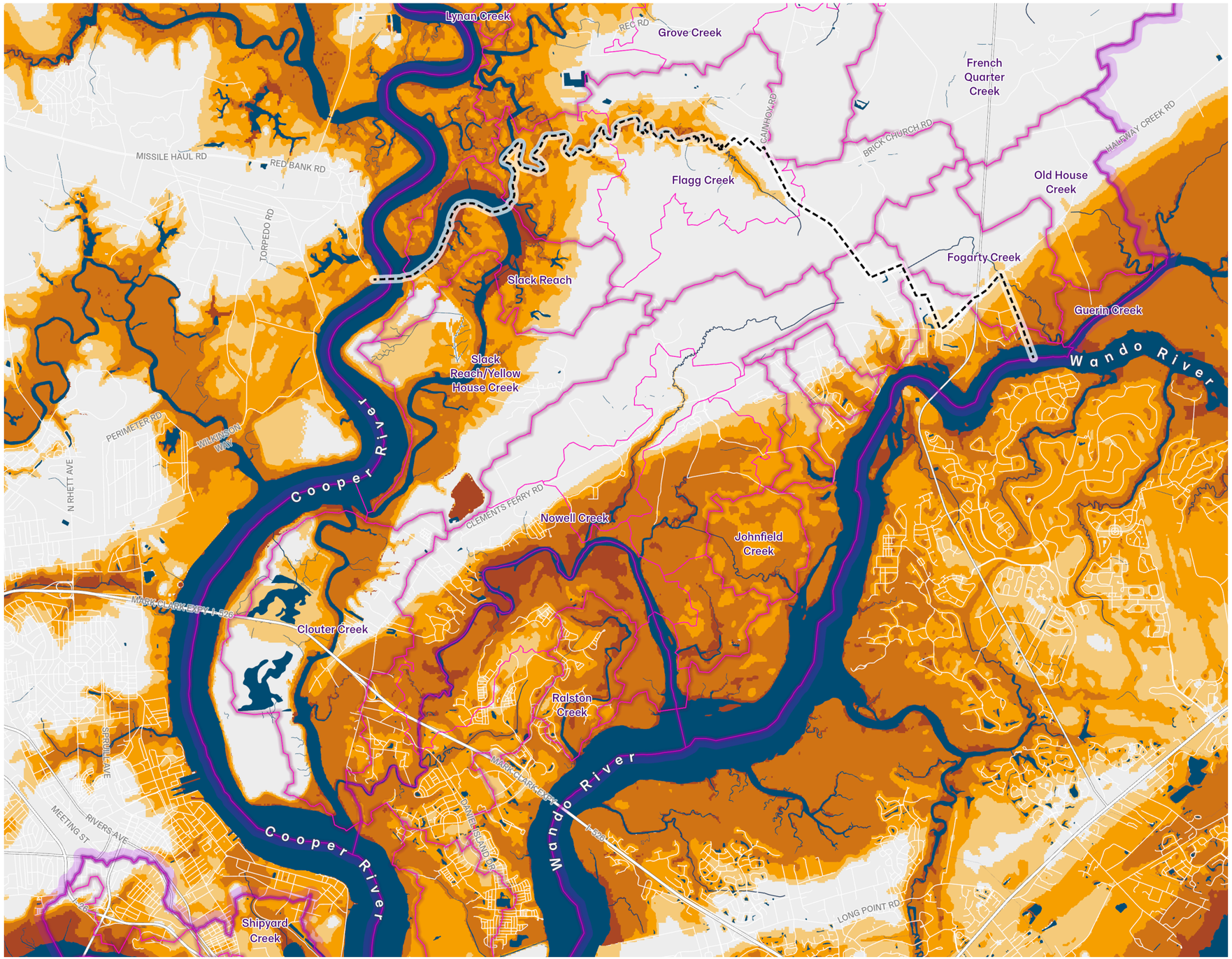
Miles

1

MAXIMUM CATEGORY 3 STORM SURGE

Much of Cainhoy is above the maximum storm surge zone of a category 3 hurricane.

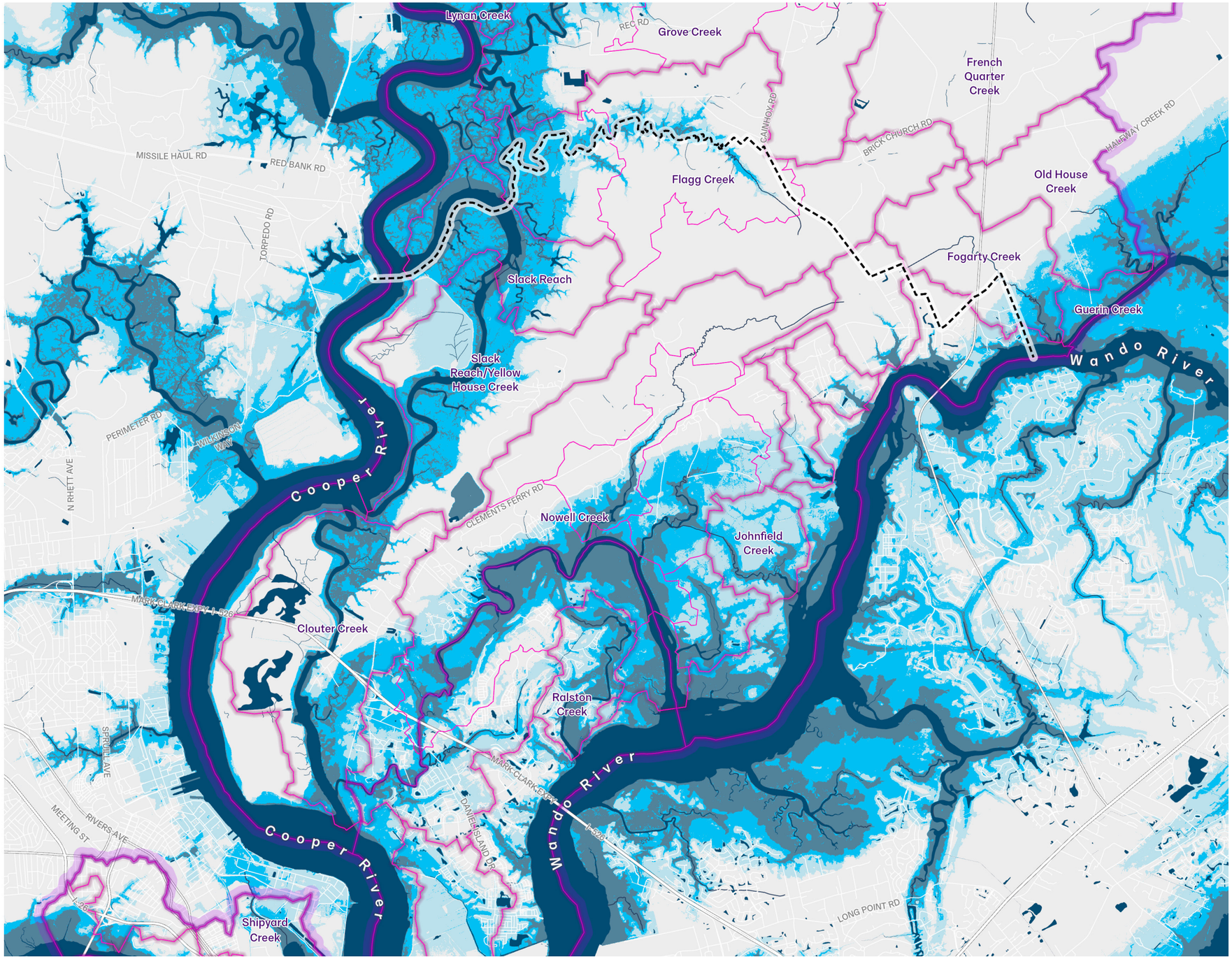
map sources: NOAA



TIDES AND SEA LEVEL RISE

Sea level rise will primarily affect the wetland edge around Cainhoy.

map sources: NOAA



Legend

Tides and Sea Level Rise

- Current MHHW
- MHHW +3ft of Sea Level Rise
- Highest Recorded Water Level (Hugo)

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

- Water

1 inch = 6,000 feet

Miles 1

MARSH MIGRATION WITH 3FT OF SEA LEVEL RISE

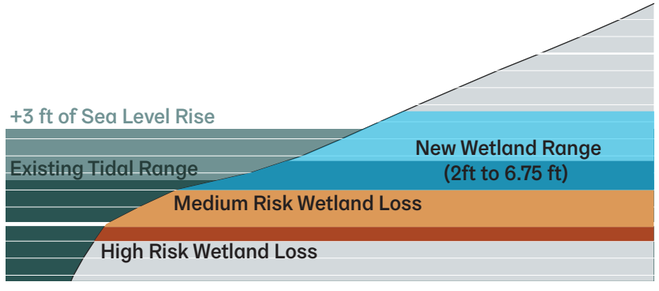
Risk of wetland loss is high along Nowell Creek, with some space for marsh migration around the Johnfield Creek watershed. Landscape succession in this area will be highly visible.

map sources: USGS MLRC Consortium

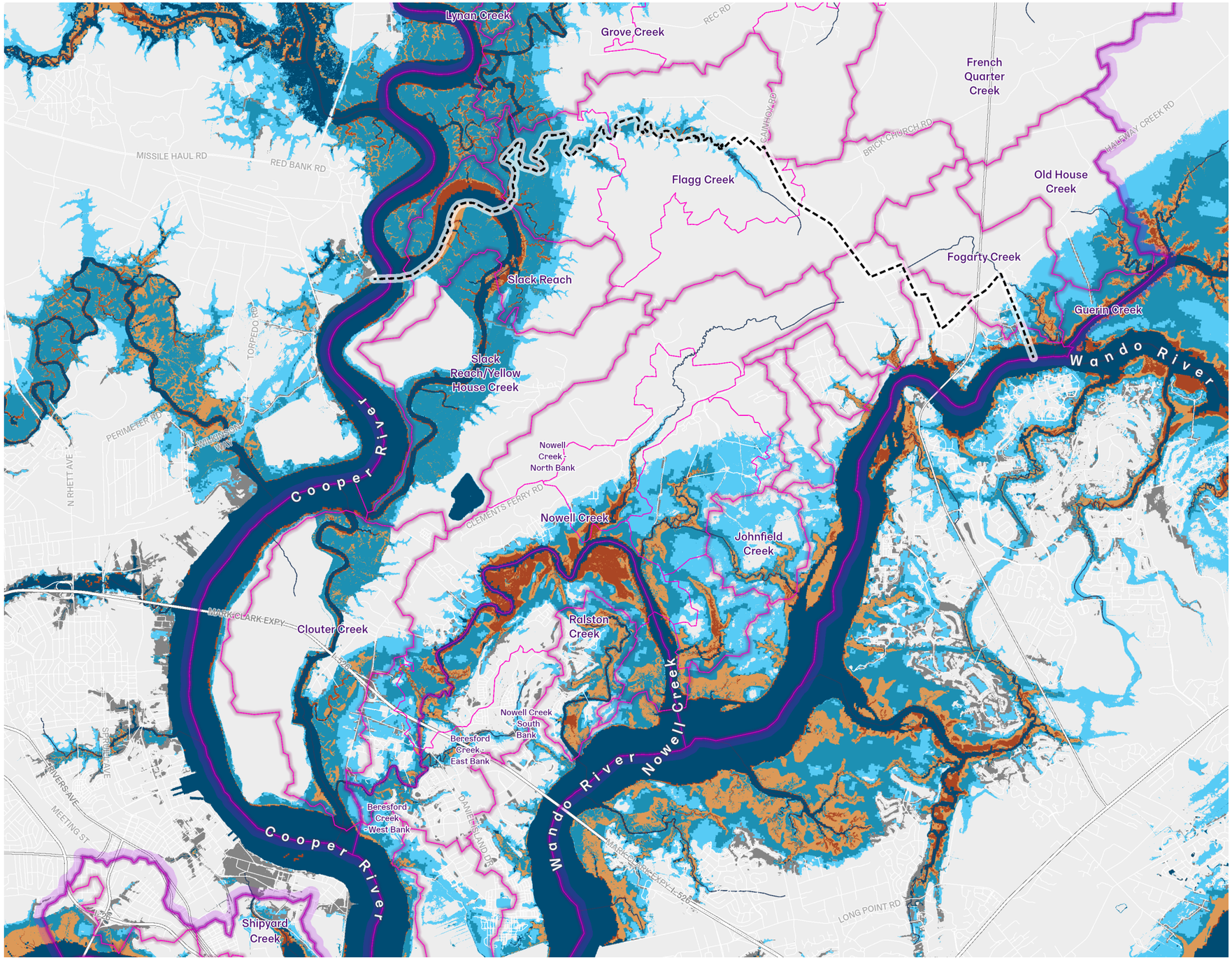
EXISTING WETLAND RANGE
≈ -1 TO 3.75 FT (NAVD)

WETLAND MIGRATION ZONE
≈ 2 TO 6.75 FT (NAVD)





1 inch = 6,000 feet
Miles
1



LAND COVER IN THE MARSH MIGRATION ZONE

The low lying evergreen forests around the Johnfield Creek watershed are all in the marsh migration zone. As this region develops in the near future, the landscape will likely change as well.

map sources: USGS, MLRC Consortium

Legend

Land Cover in Wetland Migration Zone

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands

Wetland Migration

- High Risk Wetland Loss
- Medium Risk Wetland Loss
- Low Risk Wetland Loss
- Wetland Migration Zone
- Wetland Migration Zone - Developed

Watersheds Neighborhood

Project Watersheds

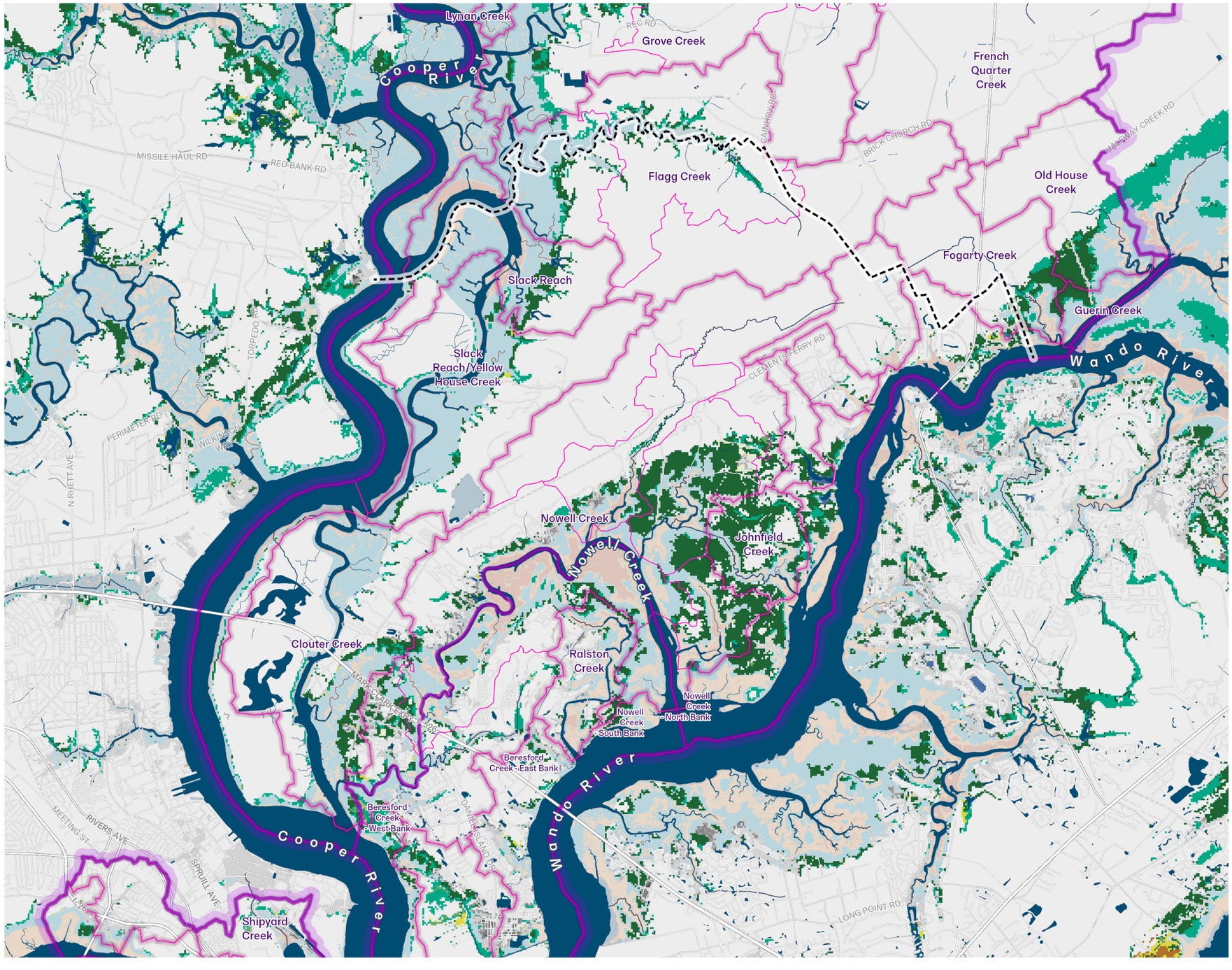
Project Subwatersheds

Urban Growth Boundary

Water

1 inch = 6,000 feet

Miles 1



LAND

ELEVATION

LAND COVER

ELEVATION & LAND COVER DISTRIBUTION

SOIL

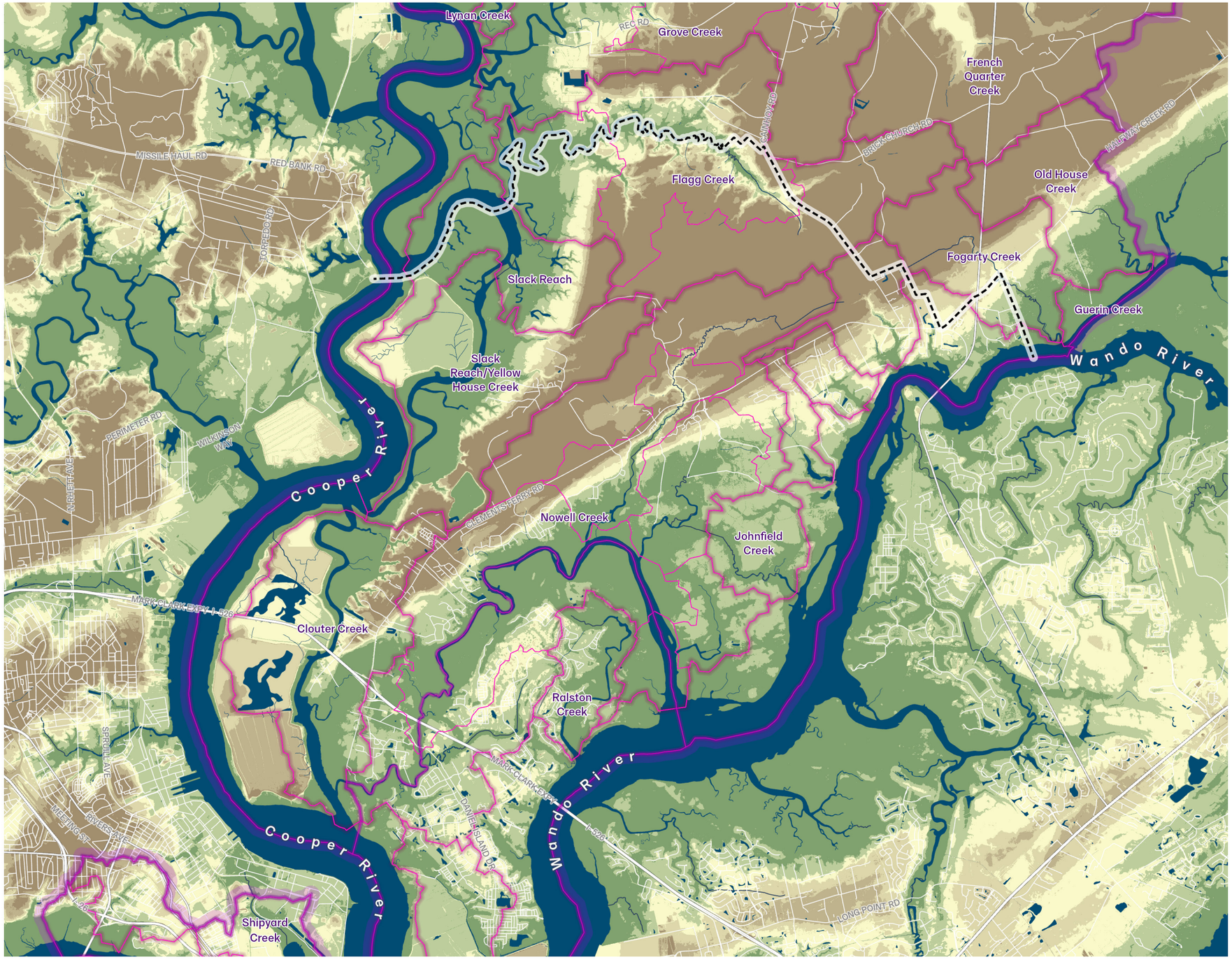
TREE CANOPY

JURISDICTIONS

ELEVATION

The highest ground in Charleston is in Cainhoy, with some areas as high a 50 feet above current sea level.

map sources: USGS



Legend

Elevation (NAVD88)

- >25 ft
- 20-25 ft
- 15-20 ft
- 10-15 ft
- 5-10 ft
- <5 ft

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

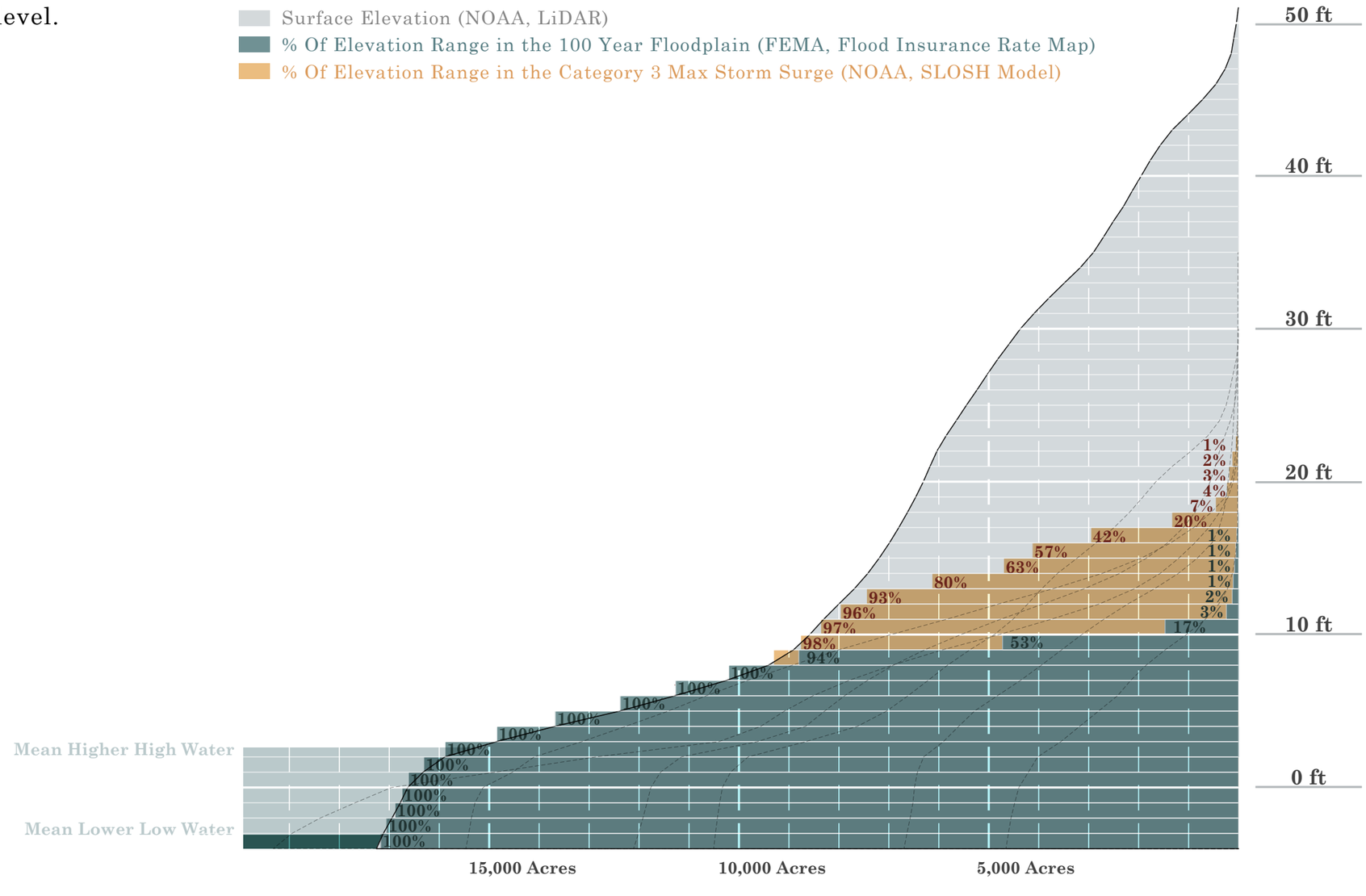
Water

1 inch = 6,000 feet

Miles 1

SURFACE ELEVATION DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

Most land surface at or below 10’ is in the floodplain. Most land surface at or below 16’ is at risk from max category 3 storm surge, however about half the land surface in Cainhoy is above this level.



ACRES
(STARTING AT MEAN LOWER LOW WATER)

LAND COVER

Most of Cainhoy is still undeveloped with a mixture of swamps and significant upland pine stands.

map sources: MLRC Consortium

Legend

Land Cover 2016

- Open Water
- Developed Open Space
- Developed Low Intensity
- Developed Medium Intensity
- Developed High Intensity
- Rock/Sand/Clay
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetland

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

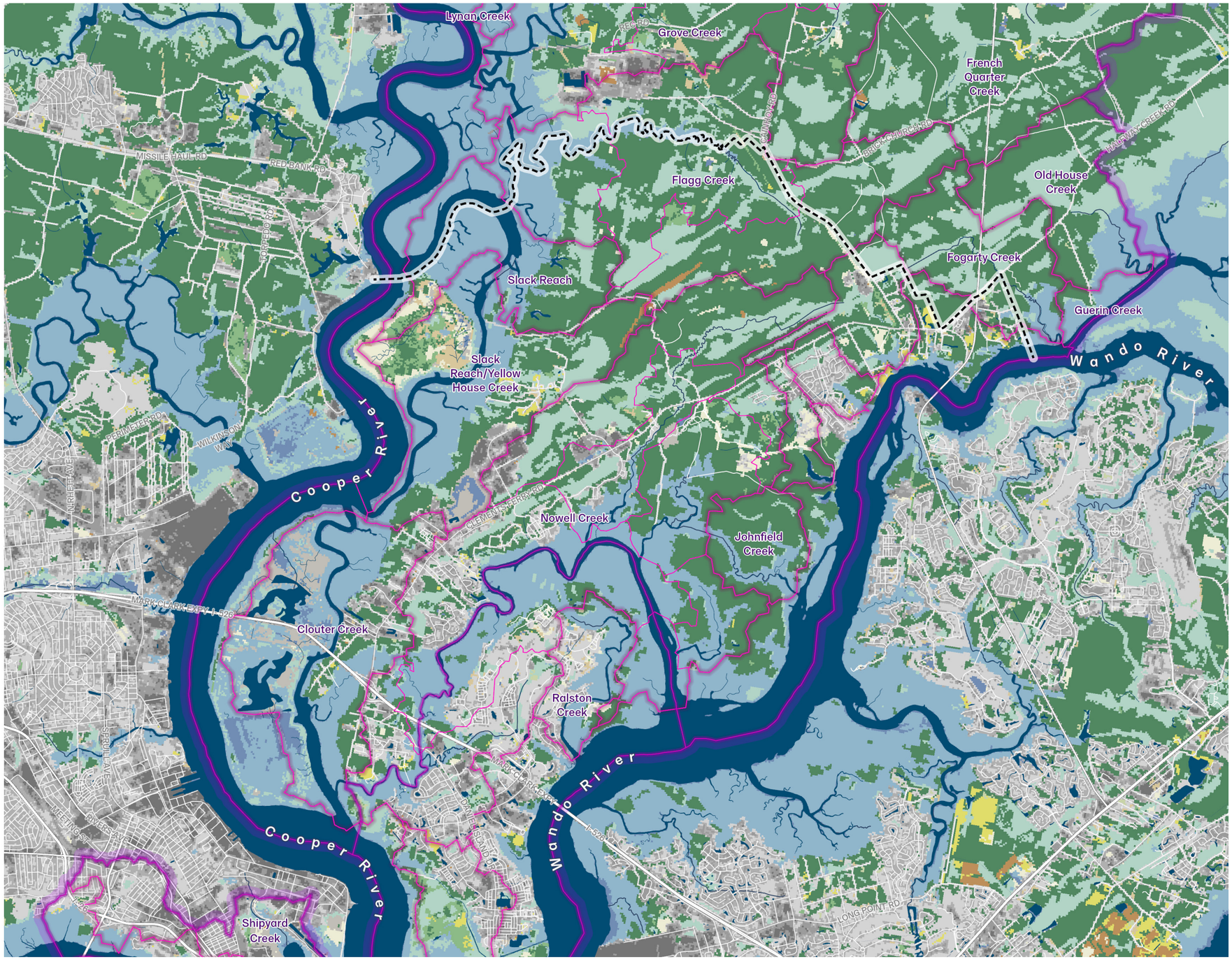
Urban Growth Boundary

Water

Water

1 inch = 6,000 feet

Miles 1



ELEVATION & LAND COVER DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

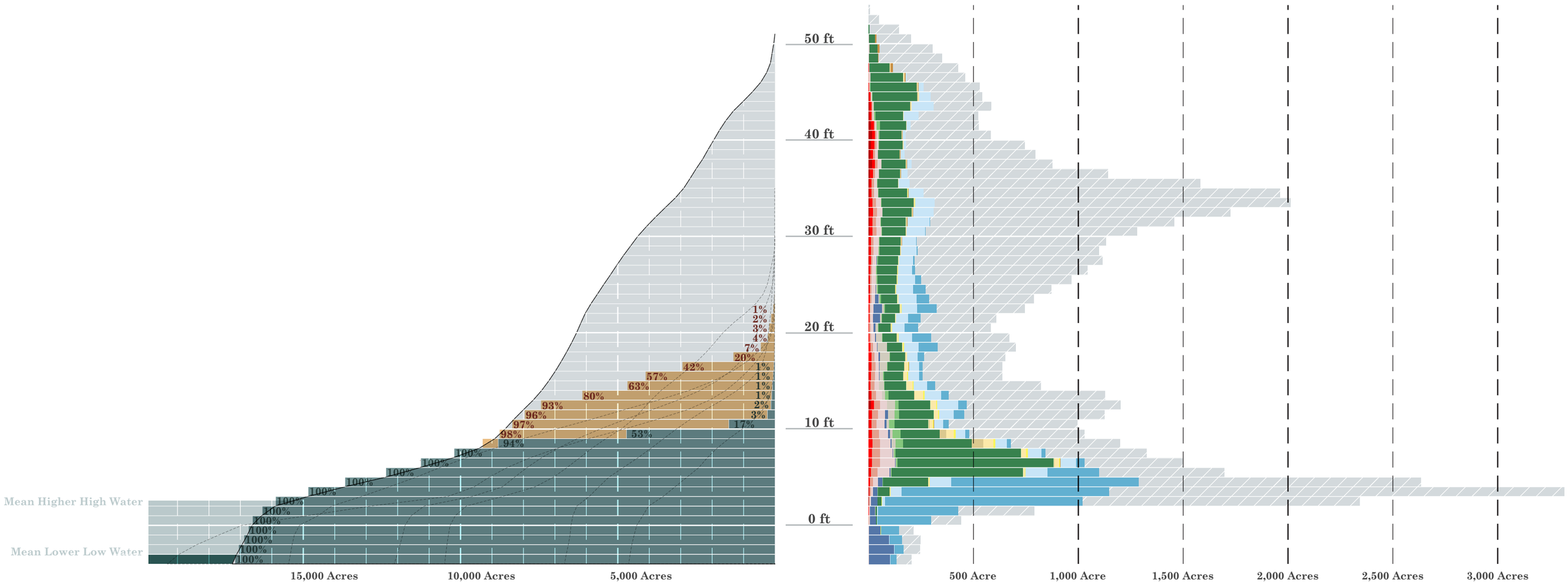
CAINHOY

SURFACE ELEVATION

- Surface Elevation (NOAA, LiDAR)
- % Of Elevation Range in the 100 Year Floodplain (FEMA, Flood Insurance Rate Map)
- % Of Elevation Range in the Category 3 Max Storm Surge (NOAA, SLOSH Model)

LAND COVER

- Developed High Intensity
- Developed Medium Intensity
- Developed Low Intensity
- Developed Open Space
- Open Water
- Barren Land
- Deciduous Forest
- Evergreen Forest
- Shrub/Scrub
- Grassland
- Pasture
- Crops
- Woody Wetland
- Emergent Herbaceous Wetland
- Outside Urban Growth Boundary

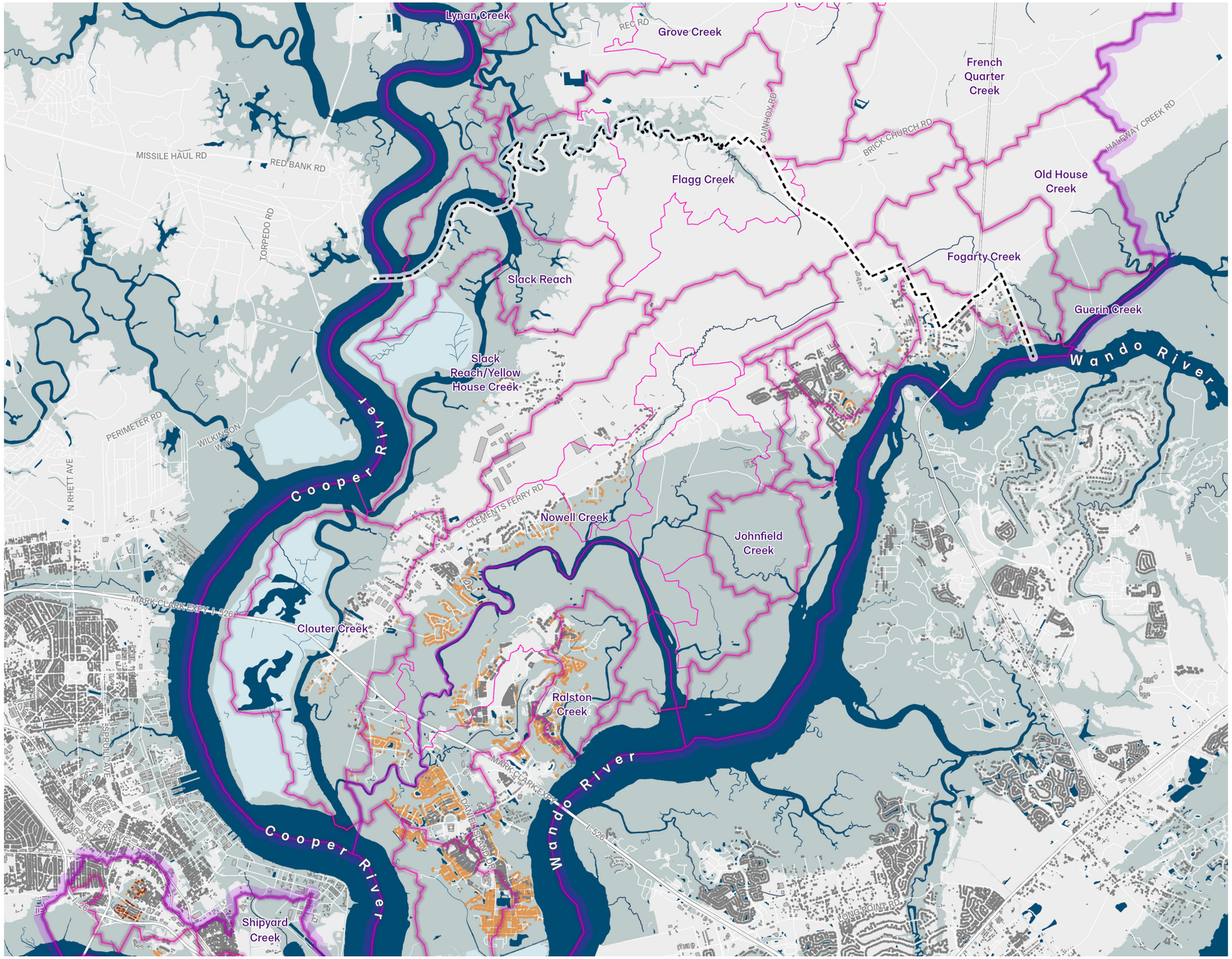


ACRES
(STARTING AT MEAN LOWER LOW WATER)

LANDCOVER DISTRIBUTION IN WATERSHED
(National Land Cover Database)

RESIDENTIAL BUILDING TYPE

Most of Cainhoy was built before BFE+1 regulation.



Legend

Residential Structures
- Outside Floodplain, all footing types
- Built to BFE/BFE+2, Peirs
- Built to BFE/BFE+2, Slab-on-Grade or Unknown
- Built Pre-BFE Regulations
- Non Residential

100 Year Floodplain and BFE
- No BFE
- BFE

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water
- Water

1 inch = 6,000 feet

Miles 1

ELEVATION & RESIDENTIAL BUILDING TYPE DISTRIBUTION
WITHIN THE URBAN GROWTH BOUNDARY

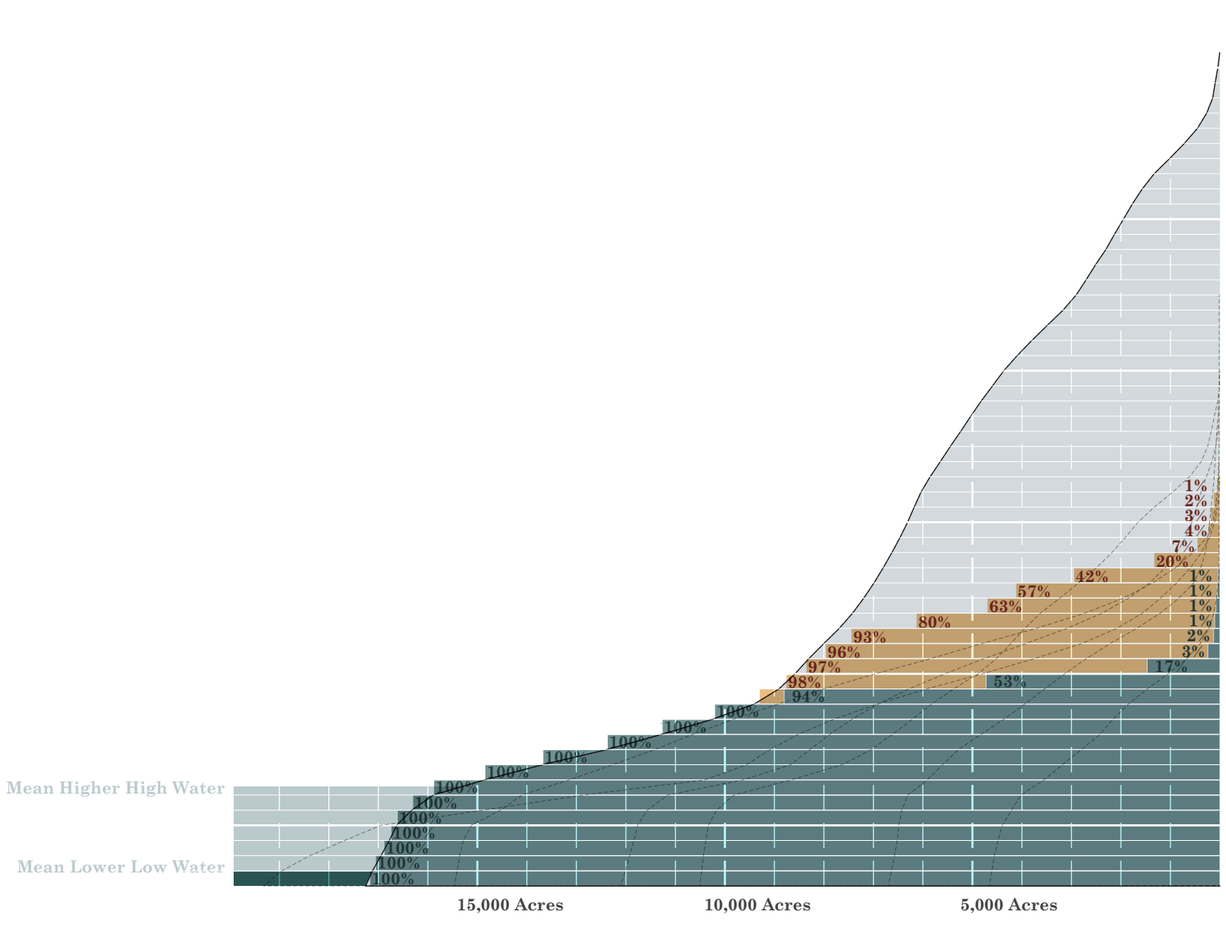
CAINHOY

SURFACE ELEVATION

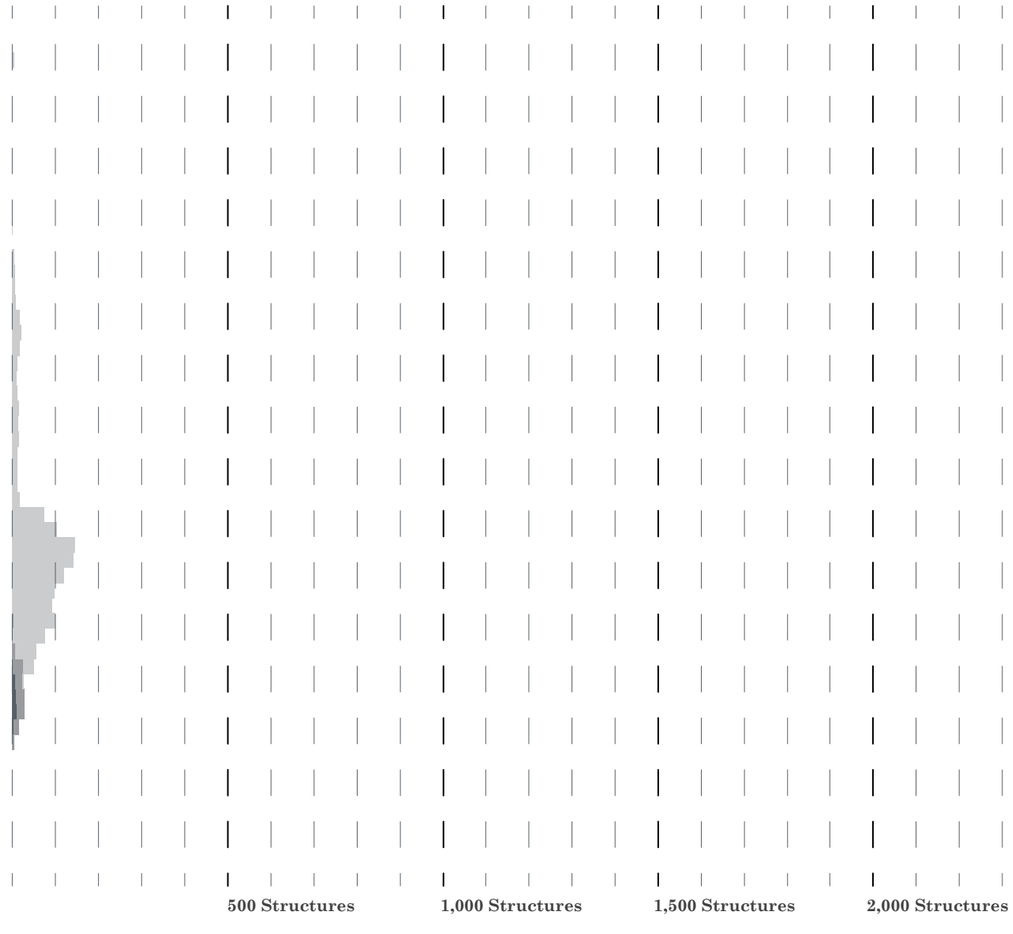
- Surface Elevation (NOAA, LiDAR)
- % Of Elevation Range in the 100 Year Floodplain (FEMA, Flood Insurance Rate Map)
- % Of Elevation Range in the Category 3 Max Storm Surge (NOAA, SLOSH Model)

RESIDENTIAL STRUCTURES

- Slab on Grade: inside 100 year floodplain before BFE requirement
- Slab on Grade: inside 100 year floodplain rasied to BFE/BFE+1
- Slab on Grade: outside 100 year floodplain
- Unknown: inside 100 year floodplain before BFE requirement
- Unknown: inside 100 year floodplain rasied to BFE/BFE+1
- Unknown: outside 100 year floodplain
- On Peirs: inside 100 year floodplain before BFE requirement
- On Peirs: inside 100 year floodplain rasied to BFE/BFE+1
- On Peirs: outside 100 year floodplain



ACRES
(STARTING AT MEAN LOWER LOW WATER)

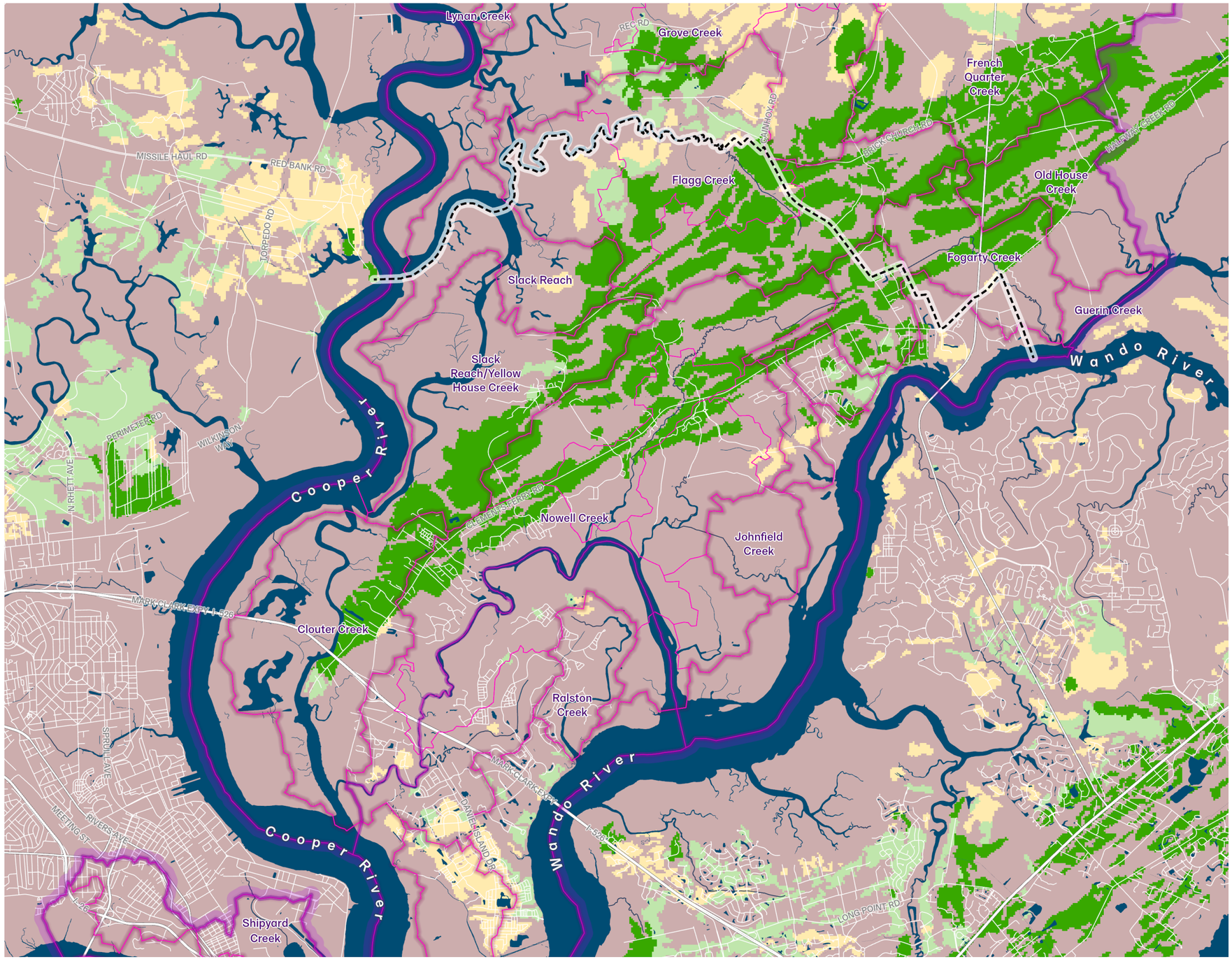


STRUCTURE BASE ELEVATIONS
(STARTING AT MEAN LOWER LOW WATER)

SOIL TYPES

The high ground typically has good soils for infiltration where it is not a swamp.

map sources: USDA



Legend

Soil Hydrologic Groups

- Group A
- Group B
- Group C
- Group D, /D

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

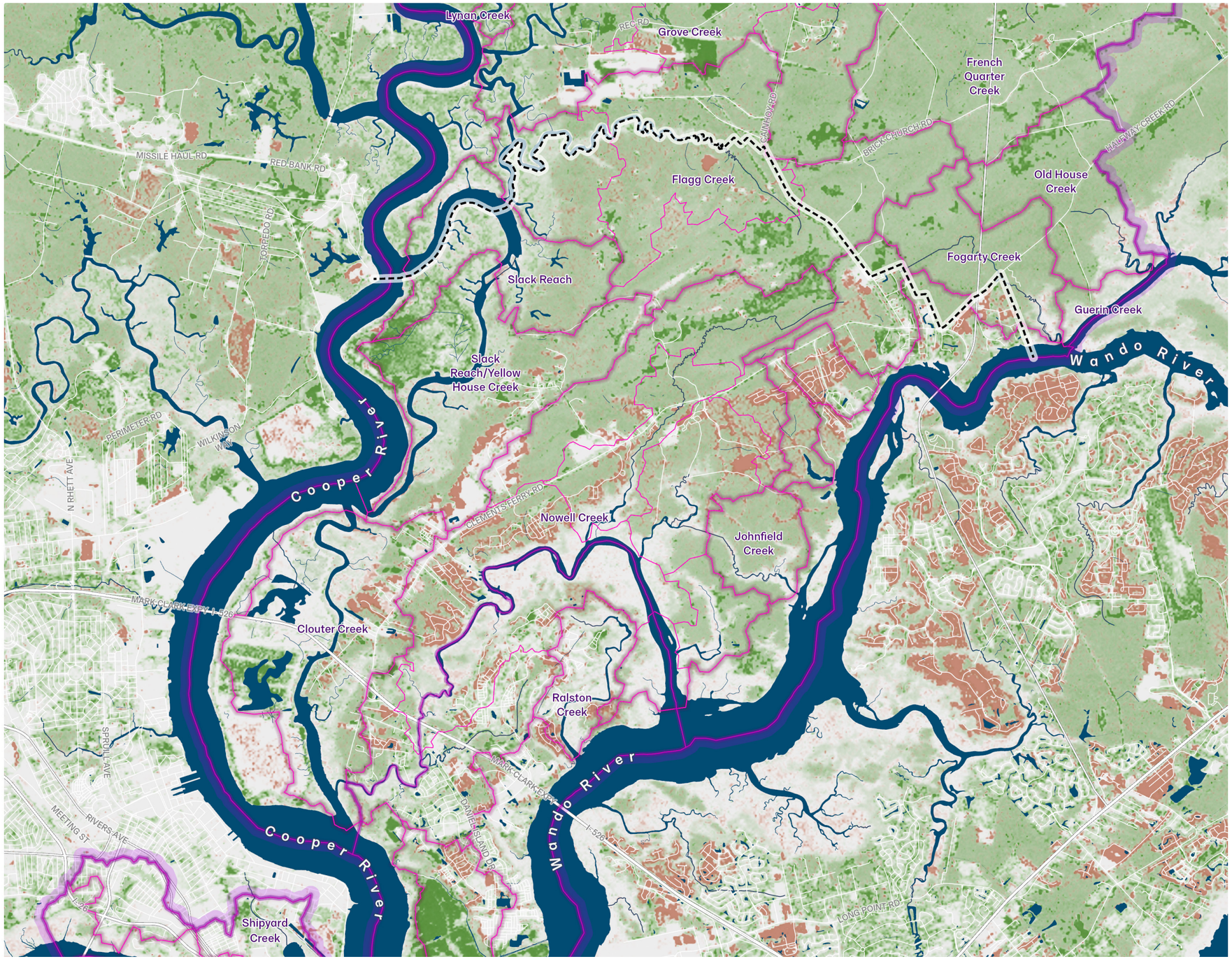
- Water

1 inch = 6,000 feet

Miles 1

TREE CANOPY DENSITY & CHANGE

Most of Cainhoy is still in a relatively natural condition with a dense growing canopy. Some loss has occurred on the Wando side of Clements Ferry Rd.



Legend

Tree Canopy (2015)

- Dense
- Sparse

Canopy Change (2000-2015)

- High Gain
- High Loss

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

Water

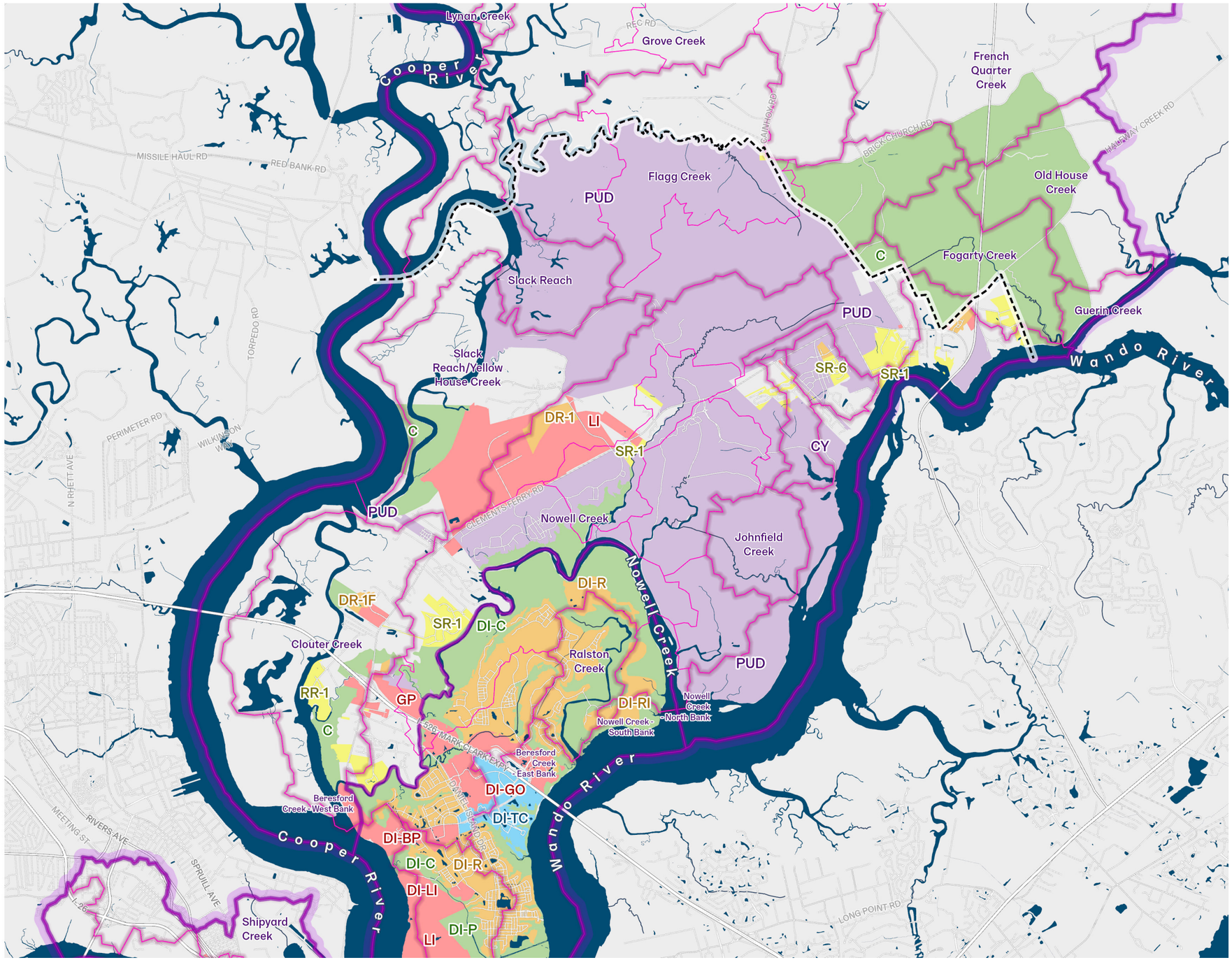
- Water

1 inch = 6,000 feet

Miles 1

ZONING

Much of Cainhoy is zoned as a Planned Development spanning the high and low ground.



Legend

Zoning

- Parks & Conservation
- Single Family Residential
- Diverse Residential
- Planned Development
- Mixed Use
- Business & Industrial

Watersheds Neighborhood

Project Watersheds

Project Subwatersheds

Urban Growth Boundary

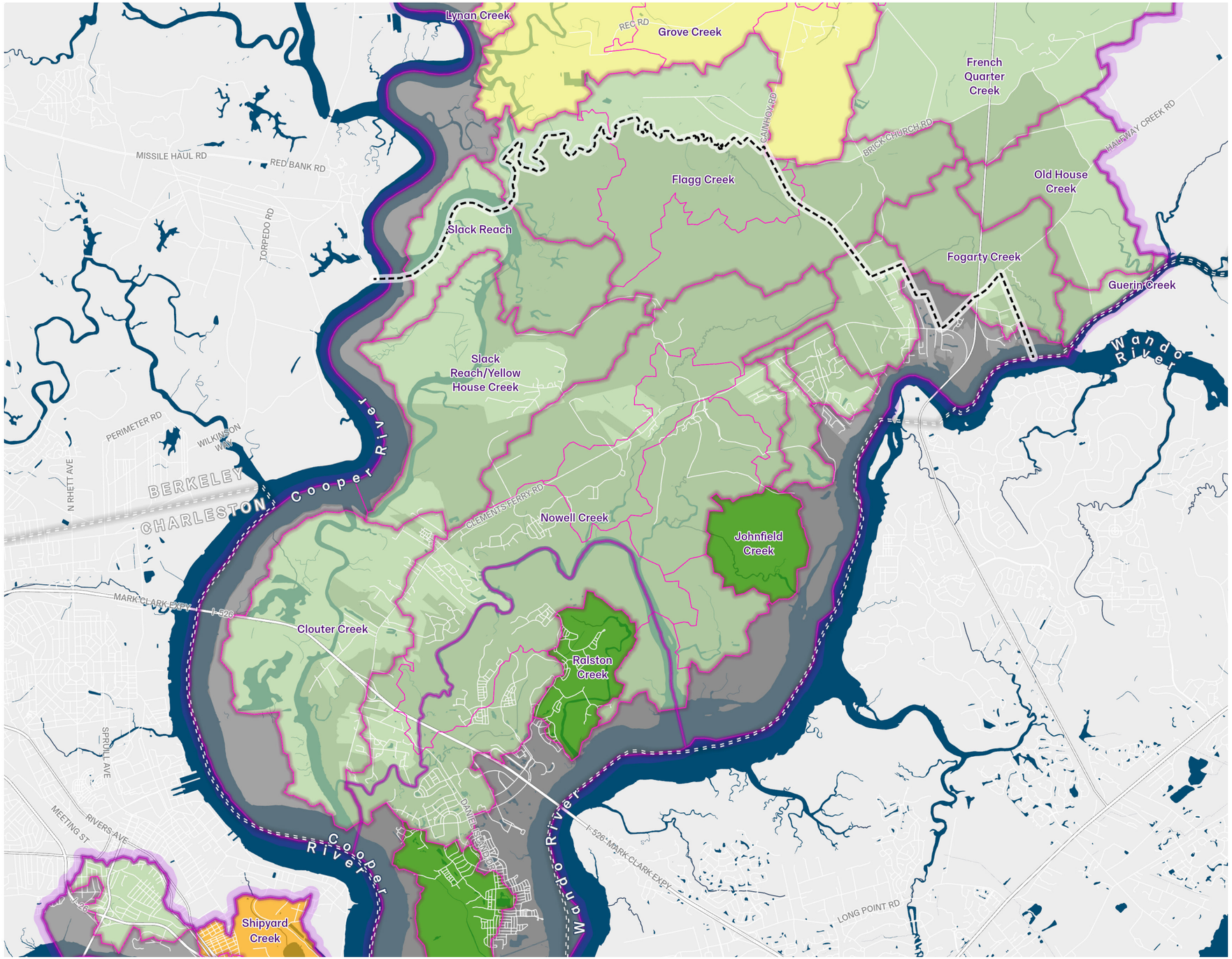
Water

1 inch = 6,000 feet

Miles 1

JURISDICTIONAL COMPLEXITY

A patchwork of incorporated areas is typical of Cainhoy, if less patchy than other watershed areas, and parcels have historically been annexed into the City.



Legend

Watershed Jurisdiction

- Entirely Within Charleston City
- Single-City, Single-County
- No City, Single-County
- Multi-City, Single-County
- Multi-City, Multi-County
- Excluded

Counties

- Charleston City Limits

Watersheds Neighborhood

- Project Watersheds
- Project Subwatersheds
- Urban Growth Boundary

Water

- Water

1 inch = 6,000 feet

Miles 1

LAND & WATER IMPLICATIONS

ELEVATION RISK ZONES

ELEVATION RISK ZONES & WATERSHED SENSITIVITY

ENVIRONMENTAL SENSITIVITY

ELEVATION ZONES

High ground is the dominant zone in the larger Cainhoy watershed area, and given its elevation can be expected to remain so into the foreseeable future.

HIGH GROUND

High ground is defined as land outside of the FEMA 100 year floodplain and above the NOAA max category 3 storm surge. High ground has the lowest flood risk and stormwater detention here has the greatest watershed benefit.

ADAPT ZONE

The adapt zone consists of land outside of the FEMA 100 year floodplain that is still within the NOAA maximum storm surge of a category 3 hurricane. Rain and storm surge flooding in this zone is infrequent but not impossible.

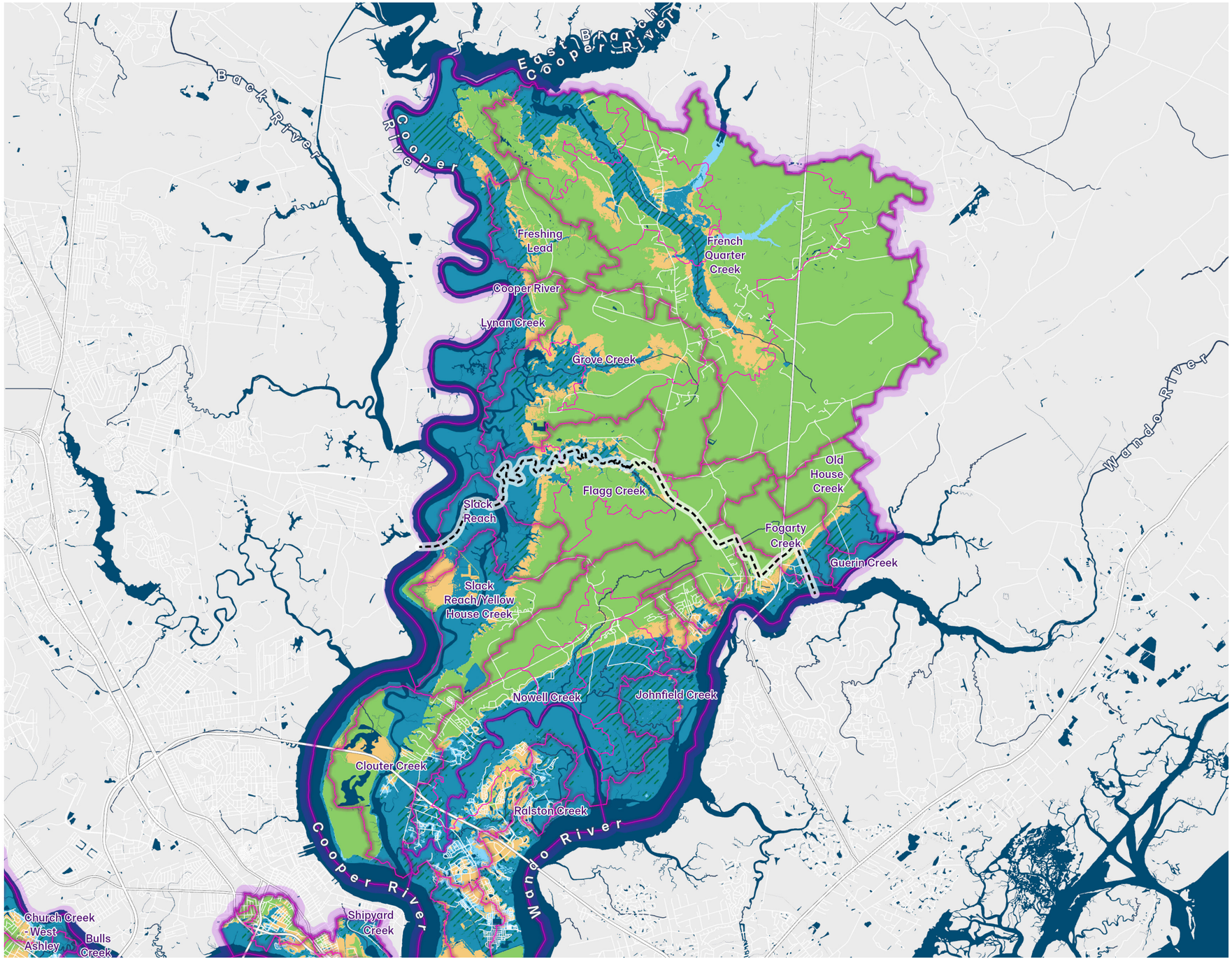
COMPOUND FLOOD RISK

This zone encompasses areas within the floodplain above the tidal flood risk zone where flood risk comes from a mixture of rainfall, runoff and tidal conditions.

TIDAL FLOOD RISK ZONE

This zone encompasses the lowest land in Charleston. Nearly 100% of this zone is in the 100 year floodplain. Flooding is frequent and can come solely from tidal events independent of precipitation. Sea level rise driven marsh migration occurs in this dynamic zone.

Marsh Migration Zone



1 inch = 10,000 feet

Miles 1

ELEVATION ZONES

Within the urban growth boundary, Cainhoy is characterized by a distinct split between high ground and tidal flood risk with little adapt zone in between.

HIGH GROUND

High ground is defined as land outside of the FEMA 100 year floodplain and above the NOAA max category 3 storm surge. High ground has the lowest flood risk and stormwater detention here has the greatest watershed benefit.

ADAPT ZONE

The adapt zone consists of land outside of the FEMA 100 year floodplain that is still within the NOAA maximum storm surge of a category 3 hurricane. Rain and storm surge flooding in this zone is infrequent but not impossible.

COMPOUND FLOOD RISK

This zone encompasses areas within the floodplain above the tidal flood risk zone where flood risk comes from a mixture of rainfall, runoff and tidal conditions.

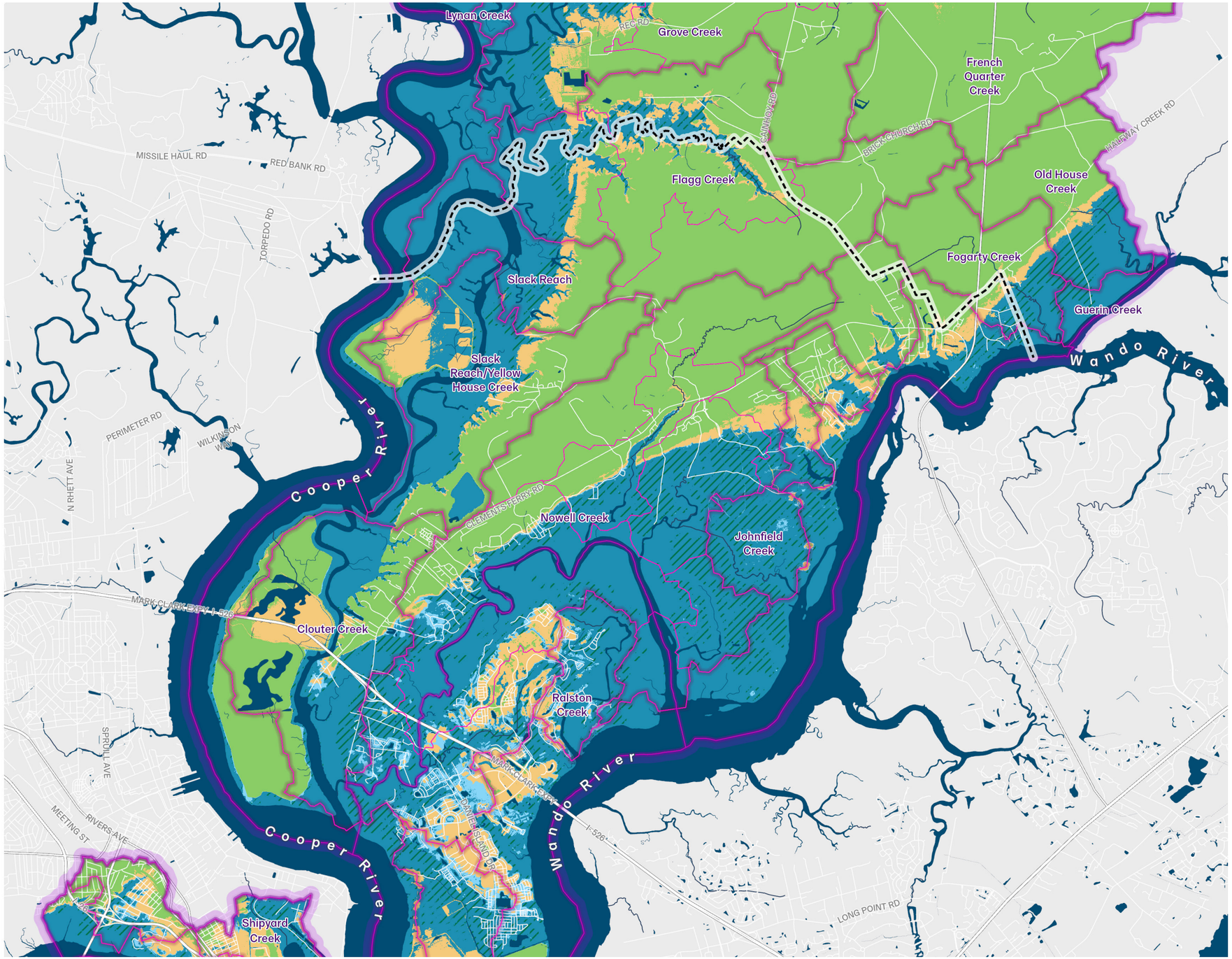
TIDAL FLOOD RISK ZONE

This zone encompasses the lowest land in Charleston. Nearly 100% of this zone is in the 100 year floodplain. Flooding is frequent and can come solely from tidal events independent of precipitation. Sea level rise driven marsh migration occurs in this dynamic zone.

Marsh Migration Zone

1 inch = 6,000 feet

Miles 1



ELEVATION RISK + WATERSHED SENSITIVITY

Low levels of overall development make all of the Cainhoy watersheds low sensitivity, despite their size and type. Ecological sensitivity may be cause to check development.

HIGH SENSITIVITY

Combination of more flood prone watersheds and a high number of vulnerable parcels. Typically larger tidal watersheds and/or watersheds where development happened before BFE regulations.

NORMAL SENSITIVITY

Combination of less flood prone watersheds and a low number of vulnerable parcels. Typically smaller and/or less developed watersheds.

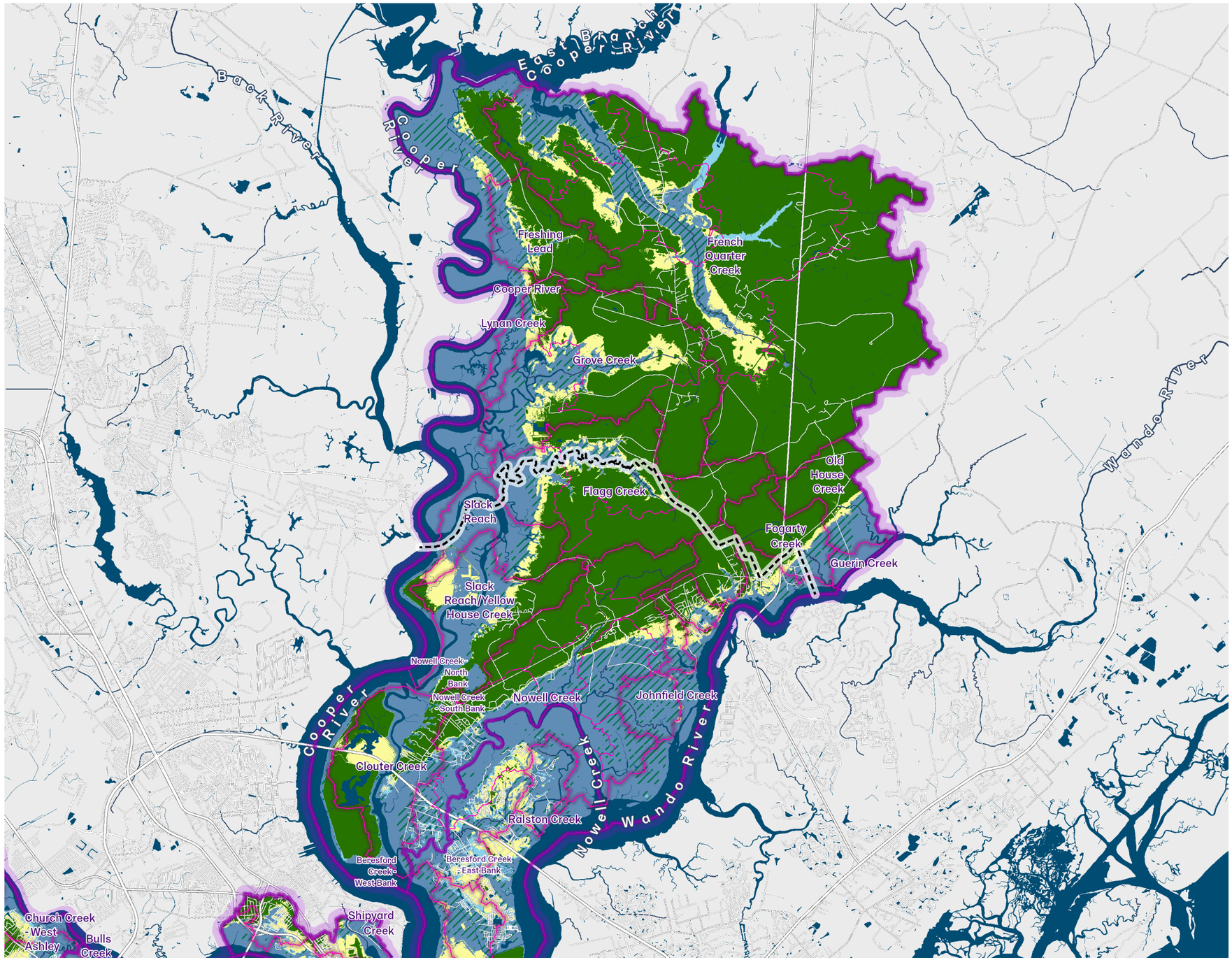
HIGH GROUND

ADAPT ZONE

COMPOUND FLOOD RISK

TIDAL FLOOD RISK ZONE

Marsh Migration Zone



1 inch = 10,000 feet

Miles 1

ELEVATION RISK + WATERSHED SENSITIVITY

Within the urban growth boundary, most of Cainhoy flows into either Nowell Creek to the south or Flagg Creek to the north.

HIGH SENSITIVITY

Combination of more flood prone watersheds and a high number of vulnerable parcels. Typically larger tidal watersheds and/or watersheds where development happened before BFE regulations.

NORMAL SENSITIVITY

Combination of less flood prone watersheds and a low number of vulnerable parcels. Typically smaller and/or less developed watersheds.

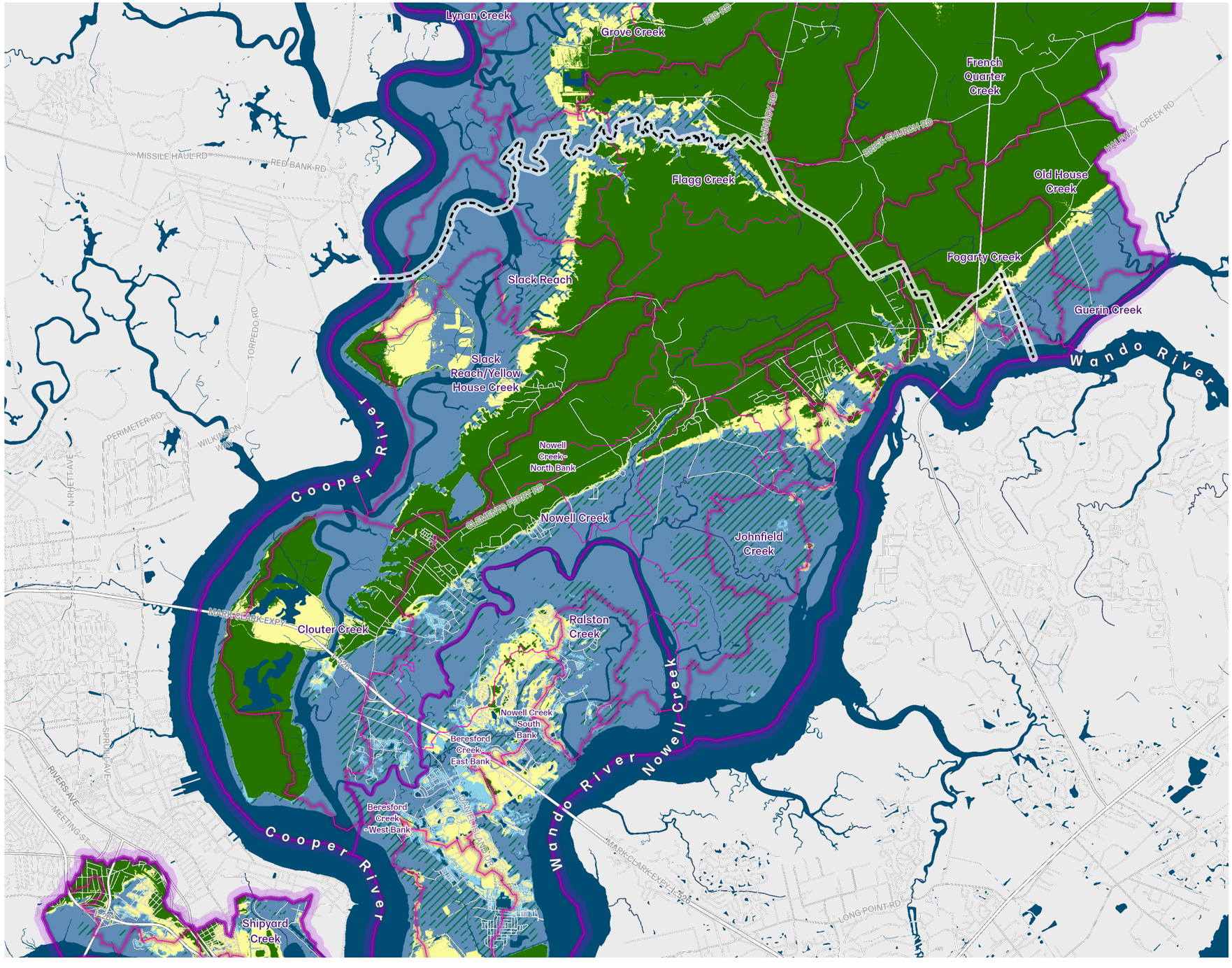
HIGH GROUND

ADAPT ZONE

COMPOUND FLOOD RISK

TIDAL FLOOD RISK ZONE

Marsh Migration Zone

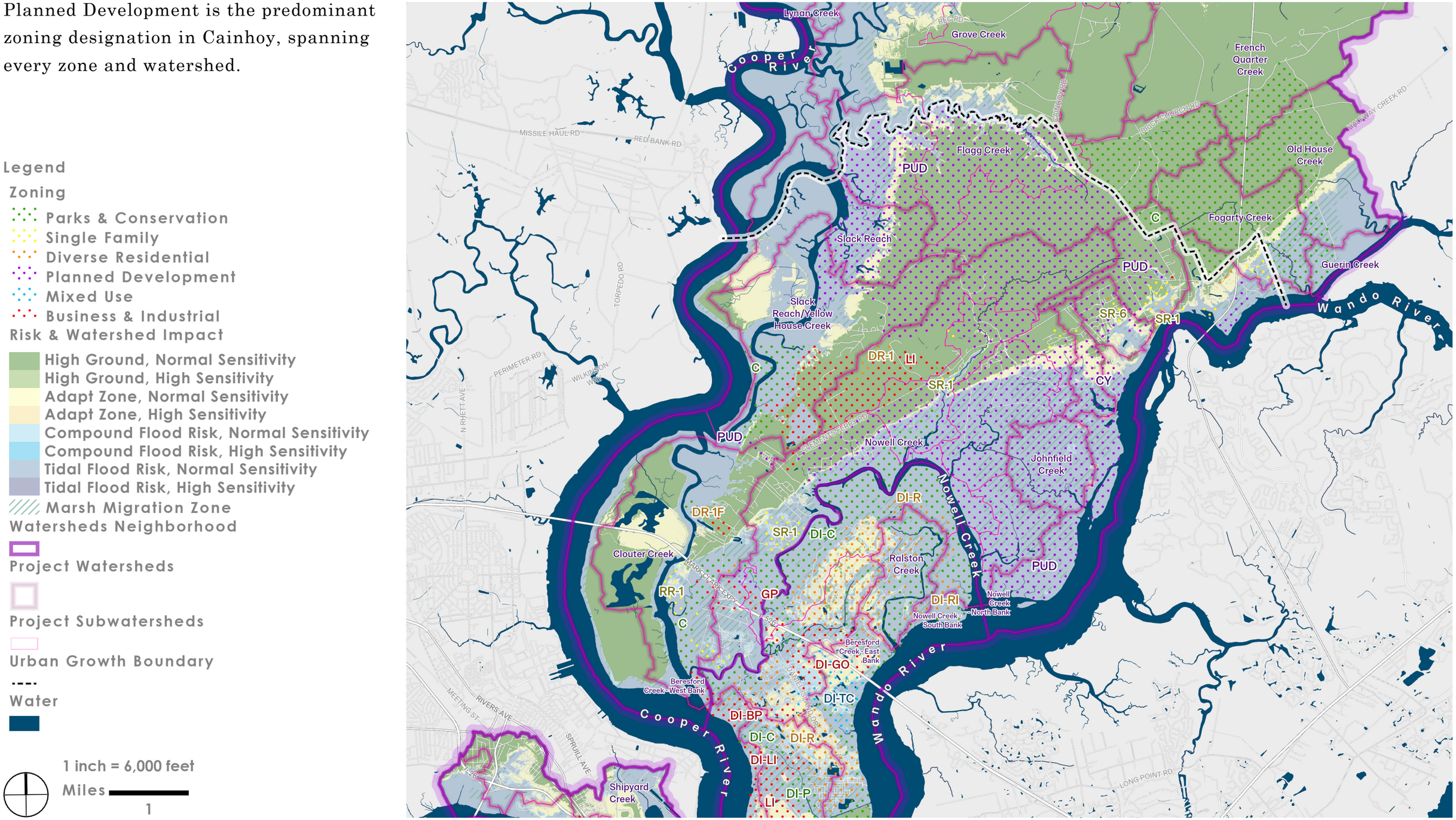


1 inch = 6,000 feet

Miles 1

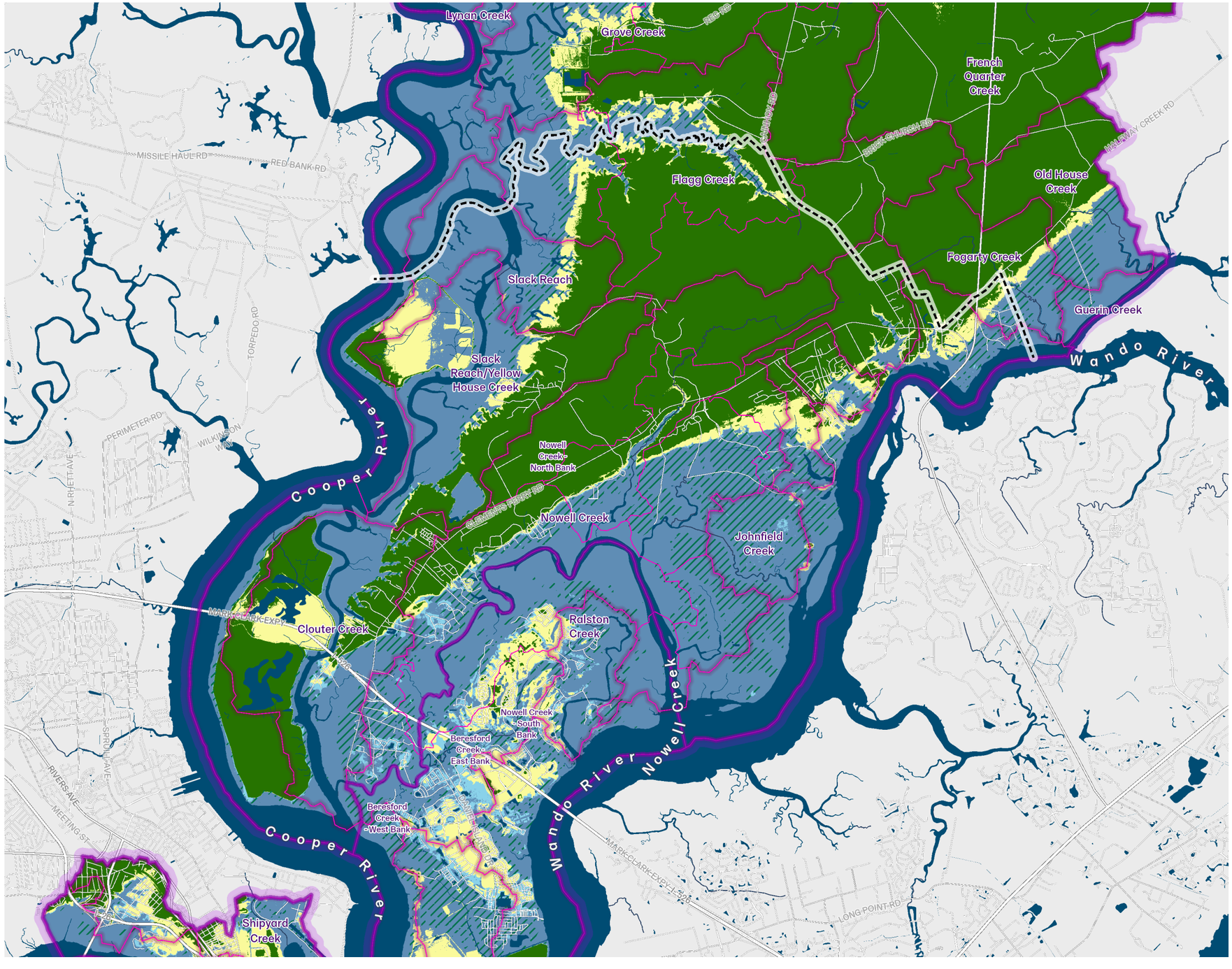
RISK + SENSITIVITY + ZONING

Planned Development is the predominant zoning designation in Cainhoy, spanning every zone and watershed.



LAND & WATER IMPLICATIONS

- Cainhoy has the largest continuous swath of high ground in Charleston, however that high ground is home to sensitive upland pine stand ecosystems.
- Most of the soil in Cainhoy has a high capacity for infiltration due to its sandy nature.
- Most of the watersheds are large, creating a moderate potential watershed sensitivity, although almost none of the watersheds are significantly developed to date. Future development in any area will significantly change risk and sensitivity.
- Significant potential marsh migration areas exist around the Johnfield Creek watershed. Currently forested, this low ground may experience highly visible ecological succession.



1 inch = 6,000 feet
Miles
1

APPENDIX

WATER MANAGEMENT MEASURES

WATERSHED WORKFLOW

ELEVATION DISTRIBUTION WORKFLOW

BIORETENTION FACT SHEET

SUMMARY

Bioretention areas, shallow depressional areas that are filled with an engineered soil media and are planted with trees, shrubs, and other herbaceous vegetation, are one of the most effective stormwater management practices that can be used in coastal South Carolina to reduce post-construction stormwater runoff rates, volumes, and pollutant loads. They are designed to capture and temporarily store stormwater runoff in the engineered soil media, where it is subjected to the hydrologic processes of evaporation and transpiration, before being conveyed back into the storm drain system through an underdrain or allowed to infiltrate into the surrounding soils.

IMPLEMENTATION SCALE

Bioretention areas can be implemented by individual landowners on their properties and by city and community leaders on a neighborhood or watershed area scale. Individual bioretention areas can only be used to manage runoff from relatively small drainage areas of up to 5 acres in size. However, a greater number of bioretention areas dispersed across the landscape means greater storage and treatment of stormwater.

APPROPRIATE ELEVATION ZONES

- High Ground
- Adapt Zone
- Compound Flood Risk

REFERENCES

"Low Impact Development in Coastal South Carolina" (2014 Ed.)

Hydrologic Function: Provides volume control and flow control

Pollutant Removal: Removes 80-90% of Total Suspended Solids, 55-90% of Total Phosphorus, 65-90% of Total Nitrogen, and 55-90% of Pathogens

Soil Type Suitability: Most soils; A separation distance of 0.5 feet is required between the bottom of the excavated bioretention area and the seasonally high groundwater table

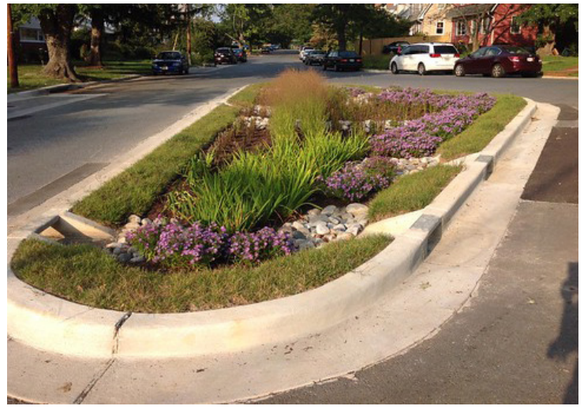
Community Amenity Value: Bioretention plants provide seasonal visual interest, help mitigate the urban heat island effect, and improve air quality

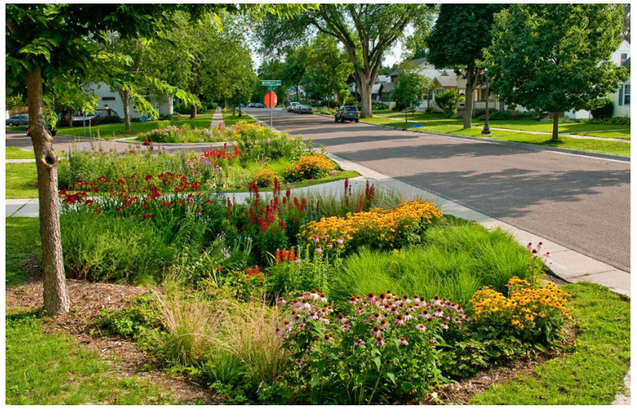
Habitat Value: Bioretention plants provide cover and food for birds and small mammals and pollen for pollinators

For More Info: Refer to p. 4-11 in "Low Impact Development in Coastal South Carolina" (2014 Ed.) and p. 3-35 in "City of Charleston Stormwater Design Standards Manual" (Jan. 2020 Ed.)









Top left: Bioretention at Tupelo Bend in Johns Island, SC (RDE Project)

Top Right: Bioretention at the North Carolina Arboretum (Image: Buncombe County Master Gardeners)

Lower left: Bioretention in a traffic island (Image: Montgomery County, MD)

Lower Right: Rain garden in a residential setting (Image: Capital Region Water District)

PERMEABLE PAVING FACT SHEET

SUMMARY

Permeable pavement systems represent alternative paving surfaces that capture and temporarily store the design volume by filtering runoff through voids in the pavement surface into an underlying stone reservoir. Filtered runoff may be collected and returned to the conveyance system, or allowed to partially infiltrate into the soil. This allows permeable pavement systems to provide measurable reductions in post-construction stormwater runoff rates, volumes, and pollutant loads. Examples of permeable pavement include porous asphalt, pervious concrete, and permeable pavers.

IMPLEMENTATION SCALE

Permeable paving can be implemented by individual landowners on their properties and by city and community leaders on a neighborhood or watershed area scale. The City of Charleston requires that the proportion of drainage area to permeable pavement footprint should be less than 10:1.

APPROPRIATE ELEVATION ZONES

- High Ground
- Adapt Zone
- Compound Flood Risk

REFERENCES

"Low Impact Development in Coastal South Carolina" (2014 Ed.)

Hydrologic Function: Provides volume control and flow control

Community Amenity Value: Permeable pavers and grass concrete pavers are an attractive alternative to typical asphalt and concrete

Pollutant Removal: Removes 80% of Total Suspended Solids, 60-80% of Total Phosphorus, 60-80% of Total Nitrogen, and 45-75% of Pathogens

Habitat Value: Provides no significant benefits

Soil Type Suitability: Most soils; Soils with low permeability require an underdrain; The distance from the bottom of the practice to the top of the seasonal high water table should not be less than 0.5 feet

For More Info: Refer to p. 4-43 in "Low Impact Development in Coastal South Carolina" (2014 Ed.) and p. 3-36 in "City of Charleston Stormwater Design Standards Manual" (Jan. 2020 Ed.)









Top left: Permeable paver parking spots in Hilton Head, SC (Image: Islanders Beach Park)

Top Right: Grass concrete pavers employed in a residential setting in Michigan (Image: Kettelkamp & Kettelkamp Landscape Architecture)

Lower left: Permeable paver sidewalk in Burbank, California (Image: AHBE Landscape Architects)

Lower Right: Permeable pavement at Robinson Nature Center (Image: University of Maryland Extension)

INFILTRATION BASIN FACT SHEET

SUMMARY

Infiltration practices are shallow excavations, typically filled with stone or an engineered soil mix, that are designed to intercept and temporarily store post-construction stormwater runoff until it infiltrates into the underlying and surrounding soils over a two day period. Runoff first passes through multiple pretreatment mechanisms to trap sediment and organic matter before it reaches the practice. As the stormwater penetrates the underlying soil, chemical and physical adsorption processes remove pollutants.

IMPLEMENTATION SCALE

Infiltration basins are typically implemented by city and community leaders on a neighborhood or watershed area scale. This practice can only be used to "receive" runoff from relatively small drainage areas of up to 5 acres in size.

APPROPRIATE ELEVATION ZONES

High Ground Adapt Zone

REFERENCES

"Low Impact Development in Coastal South Carolina" (2014 Ed.)

Hydrologic Function: Provides volume control

Community Amenity Value: Provides no significant benefits

Pollutant Removal: Removes 80-95% of Total Suspended Solids, 65-95% of Total Phosphorus, 55-90% of Total Nitrogen, and 65-95% of Pathogens

Habitat Value: Provides no significant benefits

Soil Type Suitability: Underlying soils must have an infiltration rate of 0.3 in/hr or more; The distance from the bottom of an infiltration practice to the top of the seasonal high water table must be 0.5 feet or more

For More Info: Refer to p. 4-64 in "Low Impact Development in Coastal South Carolina" (2014 Ed.) and p. 3-37 in "City of Charleston Stormwater Design Standards Manual" (Jan. 2020 Ed.)









Top Left: Infiltration basin with vegetation (Image: City of Bellingham, WA)

Top Right: Rectangular infiltration basin (Image: Susdrain)

Lower Left: Infiltration basin in Clark County, WA (Image: Minnesota Stormwater Manual)

Lower Right: Infiltration basin in a rural setting (Image: Wisconsin DNR)

GREEN ROOF FACT SHEET

SUMMARY

Green roofs are practices that capture and store rainfall in an engineered growing media that is designed to support plant growth. A portion of the captured rainfall evaporates or is taken up by plants, which helps reduce runoff volumes, peak runoff rates, and pollutant loads on development sites. Green roofs typically contain a layered system of roofing, which is designed to support plant growth and retain water for plant uptake while preventing ponding on the roof surface. The roofs are designed so that water drains vertically through the media and then horizontally along a waterproofing layer towards the outlet. Rooftop solar panels systems may be combined with green roofs. Policy incentives are an effective way to increase implementation of this water management measure.

IMPLEMENTATION SCALE

Green roofs can be implemented by individual landowners on their properties and by city and community leaders on a neighborhood or watershed area scale. Scale will also depend on the suitability of the structure for bearing weight, among other factors.

APPROPRIATE ELEVATION ZONES

- High Ground
- Adapt Zone
- Compound Flood Risk
- Tidal Zone

REFERENCES

"Low Impact Development in Coastal South Carolina" (2014 Ed.)

Hydrologic Function: Provides volume control

Pollutant Removal: Removes 80% of Total Suspended Solids, 45-60% of Total Phosphorus, 45-60% of Total Nitrogen, and 45-60% of Pathogens

Soil Type Suitability: As an on-structure practice, suitability depends on the structure instead of the soils

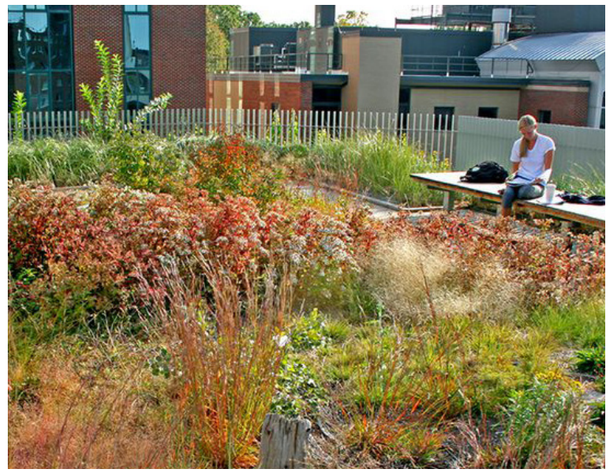
Community Amenity Value: Green roofs reduce the heat island effect and may lower energy bills; Green roofs increase the aesthetic value of a roof for people with roof access or people with views of the roof

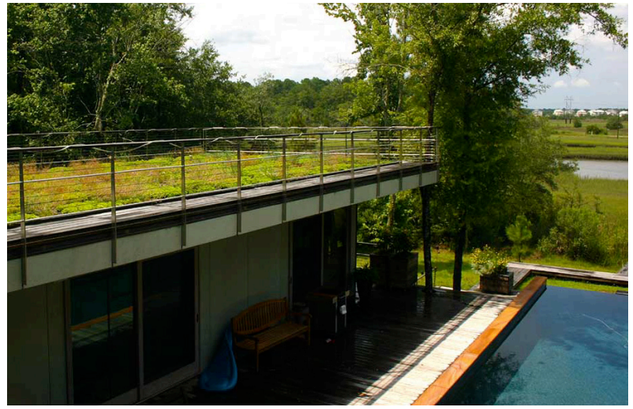
Habitat Value: Provides habitat for insects and migrating and breeding birds

For More Info: Refer to p. 4-83 in "Low Impact Development in Coastal South Carolina" (2014 Ed.) and p. 3-37 in "City of Charleston Stormwater Design Standards Manual" (Jan. 2020 Ed.)











Top Left: Green roof on a commercial building in Charleston, SC (Image: Green Roof Outfitters)

Top Center: Green roof with solar panels (Image: UrbanStrong)

Top Right: Green roof on an academic building in Syracuse, NY (Image: Michelle Sutton)

Lower Left: Green roof on a Johns Island, SC home (Image: Living Roofs Inc)

Lower Right: Green roof with agricultural use in Chicago (Image: Scott Shigley)

RAINWATER HARVESTING FACT SHEET

SUMMARY

Rainwater harvesting systems store rainfall for future use. Rainwater that falls on rooftops is collected and conveyed into an above- or below-ground storage tank (also referred to as a cistern), where it can be used for non-potable water uses and on-site stormwater disposal/ infiltration. Non-potable uses may include landscape irrigation, flushing of toilets and urinals, fire sprinkler systems, fluid coolers and chillers, distribution to a green wall or living wall system, among others. In many instances, rainwater harvesting can be combined with a secondary (down-gradient) stormwater practice to enhance stormwater retention and/or provide treatment of overflow from the rainwater harvesting system.

IMPLEMENTATION SCALE

Rainwater harvesting can be implemented by individual landowners on their properties and by city and community leaders on a neighborhood or watershed area scale. City initiatives and incentives can increase rainwater harvesting among businesses, institutions, and residences.

APPROPRIATE ELEVATION ZONES

- High Ground
- Adapt Zone
- Compound Flood Risk
- Tidal Zone

REFERENCES

"Low Impact Development in Coastal South Carolina" (2014 Ed.)

Hydrologic Function: Provides volume control

Pollutant Removal: Varies according to the storage capacity of the rainwater harvesting system and demand for the harvested water

Soil Type Suitability: Not dependent on soil type

Community Amenity Value: Rainwater that is stored can be used for many non-potable uses including landscape irrigation, exterior washing, flushing of toilets and urinals, and fire sprinkler systems

Habitat Value: Provides no significant benefits

For More Info: Refer to p. 4-97 in "Low Impact Development in Coastal South Carolina" (2014 Ed.) and p. 3-38 in "City of Charleston Stormwater Design Standards Manual" (Jan. 2020 Ed.)











Top Left: Painted cistern at an office park on Johns Island, SC (RDE project)

Top Center: Artful cistern in Seattle, WA (Image: Buster Simpson)

Top Right: Residential rain barrel (Image: Home Solutions of Iowa)

Lower Left: Water storage tank in Austin, TX (Image: Lady Bird Johnson Wildflower Center)

Lower Right: Community rain garden workshop (Image: Rain Barrels Pittsburgh)

OPEN CHANNEL SYSTEMS FACT SHEET

SUMMARY

Vegetated open channels are designed to capture and treat the water quality design storm, and safely convey larger storm events. Examples of vegetated open channels include: grass channel, dry swale (or bioswale), wet swale, two-stage ditch (may be used to provide detention for larger storm events), and regenerative stormwater conveyance. Open channel systems shall not be designed to provide stormwater detention except under extremely unusual conditions. Generally, open channel systems must be combined with a separate facility to meet these requirements.

IMPLEMENTATION SCALE

Grass channels, dry swales, and wet swales can be implemented by individual landowners on their properties, but may be more effectively implemented by HOA and POA organizations. City and community leaders can implement all types of open channel systems on a neighborhood or watershed area scale. The maximum contributing drainage area to most open channels should be 2.5 acres, and preferably less.

APPROPRIATE ELEVATION ZONES

- High Ground
- Adapt Zone
- Compound Flood Risk

REFERENCES

"Low Impact Development in Coastal South Carolina" (2014 Ed.)

Hydrologic Function: Provides flow control

Pollutant Removal: Removes 40% of Total Suspended Solids, 40-45% of Total Phosphorus, 20-35% of Total Nitrogen, and 30% of Metals

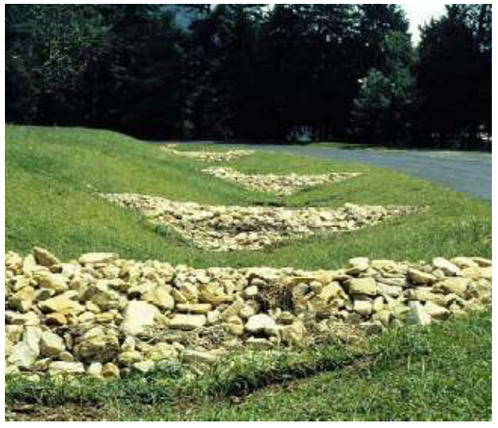
Soil Type Suitability: Most soils; Soil conditions dictate design considerations; The bottom of dry swales and grass channels should be at least 0.5 feet above the seasonally high groundwater table

Community Amenity Value: Plants in vegetated swales provide seasonal visual interest, help mitigate the urban heat island effect, and improve air quality

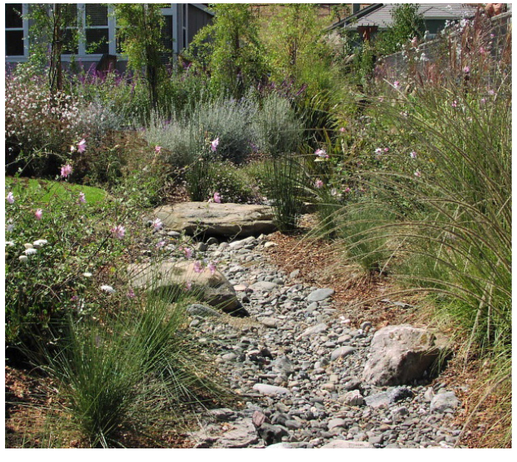
Habitat Value: Plants in vegetated swales provide cover and food for birds and small mammals and pollen for pollinators

For More Info: Refer to p. 4-130 in "Low Impact Development in Coastal South Carolina" (2014 Ed.) and p. 3-38 in "City of Charleston Stormwater Design Standards Manual" (Jan. 2020 Ed.)











Top Left: Wet swale in a neighborhood in James Island, SC (RDE project)

Top Center: Grass swale with stone check dams (Image: Unknown)

Top Right: Bioswale with grassed edging along a highway (Image: Inframanage)

Lower Left: Rock and vegetation swale in a residential setting (Image: Unknown)

Lower Right: Bioswale along a road (Image: Phyto Studio)

REFORESTATION FACT SHEET

SUMMARY

Site reforestation is a practice in which an impervious area is retrofit with or replaced (entirely or in part) with a combination of native vegetation and trees. This reduces the impervious area and consequently reduces the peak stormwater runoff flows and overall stormwater volume that discharges from a site. Site reforestation promotes infiltration; reduces the heat island effect, soil erosion, and stream temperatures; and can provide bank stabilization. When evaluating the feasibility of site reforestation, consideration should be given to land development code standards, a combination of site reforestation with other BMPs, the use of site reforestation as a visual buffer or a part of a filter strip, soil conditions, and the type of trees/ vegetation proposed.

IMPLEMENTATION SCALE

Reforestation can be implemented by individual landowners with larger properties. City and community leaders can implement reforestation on a neighborhood or watershed area scale. In general, the larger the reforested area, the higher the habitat quality.

APPROPRIATE ELEVATION ZONES

- High Ground
- Adapt Zone
- Compound Flood Risk
- Tidal Zone

REFERENCES

"City of Charleston Stormwater Design Standards Manual" (Jan 2020 Ed.)
"Pennsylvania Stormwater BMP Manual" (2006 Ed.)

Hydrologic Function: Provides volume control and flow control

Pollutant Removal: Removes 85% of Total Suspended Solids, 85% of Total Phosphorus, and 50% of Total Nitrogen

Soil Type Suitability: All soils; Soil conditions dictate plant species selected for reforestation

Community Amenity Value: Reforestation reduces the urban heat island effect, can create attractive visual buffers, and can be a community recreation resource if trails are integrated

Habitat Value: Forests support many types of wildlife; Reforesting can re-connect fragmented patches of forest habitat

For More Info: Refer to p. 3-39 in "City of Charleston Stormwater Design Standards Manual" (Jan. 2020 Ed.)









Top Left: Mount Pleasant Public Services planting trees (Image: Moultrie News)

Top Right: Longleaf pine saplings (Image: John Quarterman)

Lower Left: Tree planting event in Pittsburgh, PA (Image: Tree Pittsburgh)

Lower Right: The urban tree canopy of Atlanta, GA is getting bolstered by the One Million Trees Initiative (Image: Trees Atlanta)

DRY DETENTION PRACTICES FACT SHEET

SUMMARY

Dry detention practices, also called dry ponds, are explicitly designed to provide stormwater detention and are best suited for larger drainage areas. An outlet structure restricts stormwater flow so it backs up and is stored within the basin. The temporary ponding reduces the maximum peak discharge to the downstream channel, thereby reducing the effective shear stress on the bed and banks of the receiving stream. Detention vaults are box-shaped underground stormwater storage facilities typically constructed with reinforced concrete. Detention tanks are underground storage facilities typically constructed with large diameter metal or plastic pipe. Both serve as an alternative to surface dry detention for stormwater quantity control, particularly for areas where there is not adequate land area for a dry detention basin.

IMPLEMENTATION SCALE

Large property owners can implement dry detention practices for large land parcels. City and community leaders can implement dry detention practices on a neighborhood or borough scale. These practices are best suited to drainage areas greater than 10 acres.

APPROPRIATE ELEVATION ZONES

High Ground Adapt Zone

REFERENCES

"Low Impact Development in Coastal South Carolina" (2014 Ed.)

Hydrologic Function: Provides volume control

Community Amenity Value: Provides no significant benefits

Pollutant Removal: Minimal pollutant removal

Habitat Value: Provides no significant benefits; Above-ground detention may raise temperatures of streams they empty into, which can negatively impact aquatic biota

Soil Type Suitability: Most soils; Dry ponds are not allowed if the water table or bedrock will be within 0.5 feet of the floor of the pond

For More Info: Refer to p. 4-166 in "Low Impact Development in Coastal South Carolina" (2014 Ed.) and p. 3-39 in "City of Charleston Stormwater Design Standards Manual" (Jan. 2020 Ed.)









Top Left: Detention basin behind condos in West Ashley, SC (Image: Joshua Robinson)

Top Right: Detention basin in front of single family homes (Image: Lucy Rummler)

Lower Left: Detention basin with tree screening, which can lower detained water temperature in addition to blocking views of the feature (Image: SustainbleStormwater.org)

Lower Right: Installation of underground detention (Image: Sustainable Technologies Evaluation Program)

WET DETENTION POND FACT SHEET

SUMMARY

Wet detention ponds are stormwater storage practices that consist of a combination of a permanent pool, micropool, or shallow marsh that promote a good environment for gravitational settling, biological uptake, and microbial activity. Ponds are widely applicable for most land uses and are best suited for larger drainage areas. Runoff from each new storm enters the pond and partially displaces pool water from previous storms. The pool also acts as a barrier to resuspension of sediments and other pollutants deposited during prior storms. When sized properly, wet detention ponds have a residence time that ranges from many days to several weeks, which allows numerous pollutant removal mechanisms to operate. Wet detention ponds also provide storage above the permanent pool to provide increased water quality benefits and to meet stormwater management requirements for larger storms.

IMPLEMENTATION SCALE

Wet detention ponds can be implemented by individual landowners with larger properties. City and community leaders can implement wet detention ponds on a neighborhood or watershed area scale.

APPROPRIATE ELEVATION ZONES

High Ground Adapt Zone

REFERENCES

"Low Impact Development in Coastal South Carolina" (2014 Ed.)

Hydrologic Function: Provides volume control

Pollutant Removal: Removes 85% of Total Suspended Solids, 75% of Total Phosphorus, and 40% of Total Nitrogen, 40% of Metals, and 70% of Pathogens

Soil Type Suitability: Underlying soils of Hydrologic Soil Group (HSG) C or D should be adequate to maintain a permanent pool. Most HSG A soils and some HSG B soils will require a liner or groundwater interaction

Community Amenity Value: Wet detention ponds managed correctly are aesthetically pleasing and support fishing and nature viewing

Habitat Value: Wet detention ponds with a littoral shelf and native shoreline vegetation provide forage and habitat for birds, fish, and aquatic invertebrates

For More Info: Refer to p. 4-179 in "Low Impact Development in Coastal South Carolina" (2014 Ed.) and p. 3-40 in "City of Charleston Stormwater Design Standards Manual" (Jan. 2020 Ed.)









Top Left: Vegetated edge of a pond in Columbia, SC (RDE project)

Top Right: Pond with observation deck at the New York Botanical Garden (Image: UMass Amhearst)

Lower Left: Wet detention pond adjacent to a residential neighborhood (Image: Chesapeake Stormwater Network)

Lower Right: Wet pond encircled by a trail (Image: Lake County, IL)

STORMWATER WETLAND FACT SHEET

SUMMARY

Stormwater wetlands, sometimes called constructed wetlands, are shallow vegetated depressions that receive stormwater inputs for water quality treatment. Wetlands are typically less than 1 foot deep (although they have greater depths at the forebay and in micropools) and possess variable microtopography to promote dense and diverse wetland cover. Runoff from each new storm displaces runoff from previous storms, and the long residence time allows multiple pollutant removal processes to operate. The wetland environment provides an ideal environment for water quality improvement by gravitational settling, biological uptake, and microbial activity. They also provide storage above the permanent pool to provide increased water quality benefits and to meet stormwater management requirements for larger storms. Wetlands can be adapted for application in specific settings.

IMPLEMENTATION SCALE

Stormwater wetlands can be implemented by large property owners. City and community leaders can implement these on a neighborhood or watershed area scale. Stormwater wetlands normally require a footprint of about 3% of the contributing drainage area.

APPROPRIATE ELEVATION ZONES

High Ground
Adapt Zone
Compound Flood Risk
Tidal Zone

REFERENCES

"Low Impact Development in Coastal South Carolina" (2014 Ed.)

Hydrologic Function: Provides volume control and flow control

Pollutant Removal: Removes 80% of Total Suspended Solids, 50% of Total Phosphorus, and 30% of Total Nitrogen, 50% of Metals, and 70% of Pathogens

Soil Type Suitability: Underlying soils of Hydrologic Soil Group (HSG) C or D should be adequate to maintain a permanent pool. Most HSG A soils and some HSG B soils will require a liner or groundwater interaction

Community Amenity Value: With the right plant selection and maintenance, stormwater wetlands are attractive features that offer plentiful nature viewing opportunities

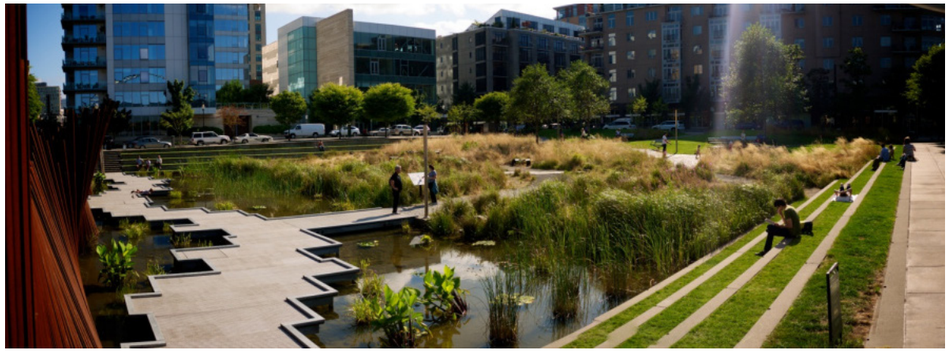
Habitat Value: Stormwater wetlands provide forage and habitat for birds, amphibians, fish, and aquatic invertebrates

For More Info: Refer to p. 4-196 in "Low Impact Development in Coastal South Carolina" (2014 Ed.) and p. 3-41 in "City of Charleston Stormwater Design Standards Manual" (Jan. 2020 Ed.)









Top Left: Stormwater wetland in a neighborhood on James Island, SC (RDE project)

Top Center: Stormwater wetland in a park in Columbia, SC (RDE project)

Top Right: Stormwater wetland in an HOA neighborhood setting (Image: Dragonfly Pond Works)

Lower Left: Stormwater wetland with public access in an urban setting (Image: Graham Ballantyne)

PRESERVATION FACT SHEET

SUMMARY

Preservation is the protection of both natural and cultural landscapes. Important areas to preserve include areas identified for marsh migration, forests, water recharge areas, headwaters, historic landscapes, working farms, nature based recreation areas, landscape features such as important views, and identified wildlife corridors.

IMPLEMENTATION SCALE

Individual landowners with large properties can preserve land through partnering with land trusts or other NGO's to establish conservation easements or private reserves. They may also donate land to city or county parks departments. City and community leaders can implement preservation on a neighborhood or watershed area scale by purchasing land or converting publicly owned land to a different land use type.

APPROPRIATE ELEVATION ZONES

- High Ground
- Adapt Zone
- Compound Flood Risk
- Tidal Zone

REFERENCES

Firehock, Karen. (2015). *Green Infrastructure Planning: A Multi-scale Approach*. Washington, D.C.: Island Press.

Hydrologic Function: Provides volume control and flow control

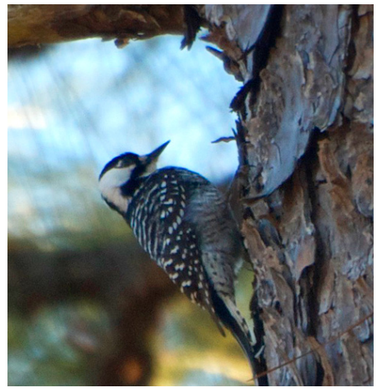
Pollutant Removal: Dependant on the type of preservation

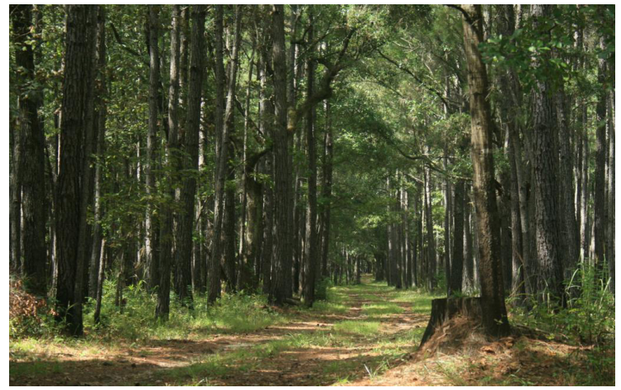
Soil Type Suitability: All soils

Community Amenity Value: Preserved areas maintain the attractive character of Charleston and provide opportunities for land and water trails and nature viewing

Habitat Value: Preservation coupled with a management plan is an effective way to maintain existing habitat











Top Left: Trails such as the West Ashley Greenway couple preservation and recreation (Image: Dave Moulton)

Top Center: Preservation maintains crucial habitat (Image: Coastal Conservation League)

Top Right: A preserved parcel of Cainhoy Plantation (Image: Post and Courier)

Lower Left: Oakland Plantation preserved parcel (Image: East Cooper Land Trust -ECLT)

Lower Right: The preserved Marsh View Trail (Image: ECLT)

SALT MARSH RESTORATION FACT SHEET

SUMMARY

Salt marsh restoration is the practice of altering a former or degraded salt marsh's physical, chemical, or biological characteristics to regain natural function. Salt marsh restoration projects may involve restoration of hydrology, such as mitigating the effects of ditching, culverting, and dikes. Restoration may also involve elevation enhancement to ensure marsh areas can support vegetation, planting of marsh vegetation, controlling invasive species, and managing wastewater and stormwater outflows near the salt marsh.

IMPLEMENTATION SCALE

City and community leaders can implement salt marsh restoration on a neighborhood or watershed area scale with the appropriate permitting and assistance.

APPROPRIATE ELEVATION ZONES

- Tidal Zone

REFERENCES

South Carolina Department of Natural Resources. (N.d.) *Dynamics of the Salt Marsh.* Retrieved from: https://www.dnr.sc.gov/marine/pub/seascience/dynamic.html

Maher, N. (2018). *Saltmarsh Restoration Regional Technical Workgroup: Final Report*. The Nature Conservancy.

Nelson JL, Zavaleta ES (2012). *Salt Marsh as a Coastal Filter for the Oceans: Changes in Function with Experimental Increases in Nitrogen Loading and Sea-Level Rise*. PLoS ONE 7(8): e38558.

Hydrologic Function: Provides flow control

Pollutant Removal: Salt marshes are a significant Nitrogen filter

Soil Type Suitability: Hydrologic soil groups C and D

Community Amenity Value: Salt marshes are an attractive and iconic viewshed in the Charleston area and are popular places for fishing and boating; Salt marshes support economically important fisheries

Habitat Value: Salt marshes are important habitat for fish, shellfish, and birds. Many types of wildlife are specialized to this type of ecosystem







Top Left: Salt marsh restoration is being led by the State Port Authority on the south end of Drum Island (Image: Andrew Whitaker)

Top Right: A volunteer group restoring an area of salt marsh in South Carolina (Image: SCDNR)

Lower Left: Salt marshes are an iconic viewshed in the Charleston area. Their cultural significance makes them even more important to restore and protect (Image: The Sumter Item)

WETLAND RESTORATION FACT SHEET

SUMMARY

Wetland restoration is the practice of altering a former or degraded wetland's physical, chemical, or biological characteristics to regain natural function. Wetland restoration projects may involve restoration of hydrology, such as mitigating the effects of ditching, culverting, and dikes. Restoration may also involve planting native wetland vegetation, managing invasive species, and managing wastewater and stormwater outflows near the wetland.

IMPLEMENTATION SCALE

Individual landowners with large properties can restore wetlands most effectively by partnering with government organizations or NGO's. City and community leaders can restore wetlands on a neighborhood or watershed area scale with the appropriate permitting and assistance.

APPROPRIATE ELEVATION ZONES

- Adapt Zone
- Compound Flood Risk
- Tidal Zone

REFERENCES

U.S. Environmental Protection Agency. (N.d.) *Wetlands*. Retrieved from https://www.epa.gov/wetlands/basic-information-about-wetland-restoration-and-protection

Hydrologic Function: Provides volume control and flow control

Pollutant Removal: Dependant on the type of wetland restoration

Soil Type Suitability: Hydrologic soil groups C and D

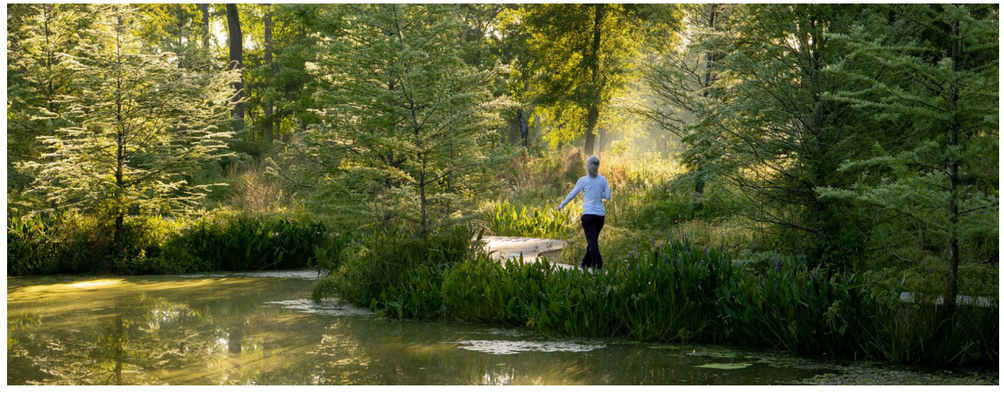
Community Amenity Value: Wetlands with trail access provide plentiful opportunities for wildlife viewing

Habitat Value: Healthy wetlands offer habitat, food sources, and breeding grounds to birds, shellfish, fish, amphibians, and aquatic invertebrates; They are critical for many species of migratory birds.









Top Left: Restoration of Four Holes Swamp upstream of Charleston (Image: Bo Peterson)

Top Center: Restoration of this cypress wetland in Georgia occurred with the coordination of a nonprofit organization (Image: Craig Tanner)

Top Right: Field work and analysis precedes wetland restoration activities, as in this work in the Church Creek Basin (Image: RDE)

Lower Left: Design of the Houston Arboretum involved extensive wetland restoration (Image: Design Workshop)

LIVING SHORELINE FACT SHEET

SUMMARY

Living shorelines are structures composed of natural materials to stabilize shorelines, prevent erosion, dissipate wave energy, and enhance habitat. Living shoreline projects in low-energy environments may involve solely vegetation establishment, but projects more commonly employ edging or sills parallel to the shore composed of bio-logs, organic fiber mats, rock, and/or bagged oyster shells. Offshore structures called breakwaters intended to dissipate wave energy are typically composed of precast concrete forms, rock, and oyster shells. Unlike hard shoreline structures such as bulkheads, living shorelines grow and become more effective over time.

IMPLEMENTATION SCALE

Landowners with properties with long coastlines can create living shorelines with adequate permitting and assistance from appropriate organizations. City and community leaders can implement living shorelines on a neighborhood or watershed area scale, also with appropriate permitting and collaboration.

APPROPRIATE ELEVATION ZONES

- Tidal Zone

REFERENCES

NOAA Fisheries. (N.d.). *Understanding Living Shorelines*. Retrieved from https://www.fisheries.noaa.gov/insight/understanding-living-shorelines.

Chesapeake Bay Foundation. (N.d.). *Oyster Fact Sheet*. Retrieved from https://www.cbf.org/about-the-bay/more-than-just-the-bay/chesapeake-wildlife/eastern-oysters/oyster-fact-sheet.html

Hydrologic Function: Provides flow control

Pollutant Removal: Dependant on the type of living shoreline; Living shorelines that employ marsh grass vegetation filter nitrogen, and live oysters filter nitrogen and suspended sediment

Soil Type Suitability: Applicable along shorelines, regardless of soil type

Community Amenity Value: Living shorelines are more attractive than the commonly used alternative, bulkheads; Living shorelines support economically important fisheries

Habitat Value: Living shorelines provide habitat for fish, shellfish, and birds









Top Left: A living shoreline with a rock reef (Image: Tracy Skrabal)

Top Right: A crew organized by The Nature Conservancy builds a living shoreline (Image: Clay Bolt)

Lower Left: A crew works on the intracoastal waterway near McClellanville (Image: Clay Bolt)

Lower Right: A living shoreline using oyster shells as structure (Image: Coastal Online Review)

CHANNEL NATURALIZATION FACT SHEET

SUMMARY

Channel naturalization is the practice of redesigning a waterway's course and re-grading and stabilizing its banks to regain natural functions. The course of action may involve re-grading the channel banks of the waterway to re-connect the waterway to its natural floodplain, stabilizing the banks with coil matting, rock, and vegetation establishment, and dissipating flow energy by introducing sinuosity or riffles into the waterway.

IMPLEMENTATION SCALE

Landowners with properties with long sections of hydrologic features can naturalize channels with adequate permitting and services by experts in the field. City and community leaders can naturalize channels on a neighborhood or watershed area scale, also with appropriate permitting and expert services.

APPROPRIATE ELEVATION ZONES

- Compound Flood Risk
- Tidal Zone

Hydrologic Function: Provides volume control and flow control

Pollutant Removal: Stabilization generally prevents excess sediment from entering waterways, and vegetation buffers filter nitrogen, phosphorus, sediments, pathogens, and metals

Soil Type Suitability: Applicable at impaired channel locations, regardless of soil type

Community Amenity Value: Naturalized channels are more attractive than their impaired alternatives, which may have eroded and denuded banks

Habitat Value: Naturalized channels with riffles and woody debris slowing flow velocity provide habitat for fish and aquatic invertebrates; Channels with riparian buffers provide superior habitat











Top Left: Bank stabilization on a creek in North Carolina (RDE project)

Top Center: A coastal stream at a restoration site near Charleston (RDE project)

Top Right: Re-graded banks of Crabtree Swamp Canal in Conway, SC (Image: Fuss et al. 2010)

Lower Left and Lower Right: Channel naturalization of Smith Branch Creek in Columbia, SC (RDE project)

FLOOD GATE FACT SHEET

SUMMARY

Flood gates are mechanical devices installed in tidal creeks or ditches and are used to prevent high tides from reaching lowland areas. Flood gates, or tide gates, are closed during incoming tides and opened during outgoing tides. These devices need to be designed with sea level rise in mind.

IMPLEMENTATION SCALE

City and community leaders can implement tide gates on a neighborhood or watershed area scale, with appropriate permitting and engineer services.

APPROPRIATE ELEVATION ZONES

- Compound Flood Risk
- Tidal Zone

REFERENCES

S.C. Sea Grant Consortium. (2015). *Sea Level Adaptation Report: Beaufort County, South Carolina.* Retrieved from https://www.scseagrant.org/wp-content/uploads/Sea-Level-Rise-Adaptation-Report-Beaufort.pdf

Hydrologic Function: Provides flow control

Community Amenity Value: No significant benefits

Pollutant Removal: No pollutant removal

Habitat Value: No significant benefits; Tide gates restrict water exchange, which negatively impacts salt marsh ecosystems and can impede fish passage

Soil Type Suitability: Suitability not dependent on soil type









Top Left: Tide gate in New Orleans (Image: U.S. Army Corp of Engineers)

Top Right: A tide gate in Oregon that blocks fish passage (Image: The Nature Conservancy)

Lower Left: Self-regulating tide gates at the Galilee Salt Marsh in Rhode Island (Image: D. Yizzo, B. Vittor, and Associates)

Lower Right: Tide gate designed to allow fish passage (Image: Scott and Associates)

FLOOD BARRIER FACT SHEET

SUMMARY

Flood barriers are gray infrastructure that prevent high tides or storm surge from reaching land areas, up to a certain level. Flood barriers types include floodwalls, levees, berms, and temporary, deployable barriers. Floodwalls are made of reinforced concrete, while levees and berms are composed primarily of earthen fill. Floodwalls have a smaller footprint than levees and berms.

IMPLEMENTATION SCALE

Landowners can implement berms or floodwalls encircling the structures they want to protect. City and community leaders can implement different types of flood barriers on a neighborhood or watershed area scale.

APPROPRIATE ELEVATION ZONES

Compound Flood Risk Tidal Zone

REFERENCES

Federal Emergency Management Agency. (2007). *Selecting Appropriate Mitigation Measures for Floodprone Structures*. Retrieved from https://www.fema.gov/multimedia-library

Hydrologic Function: Provides volume control

Pollutant Removal: No pollutant removal

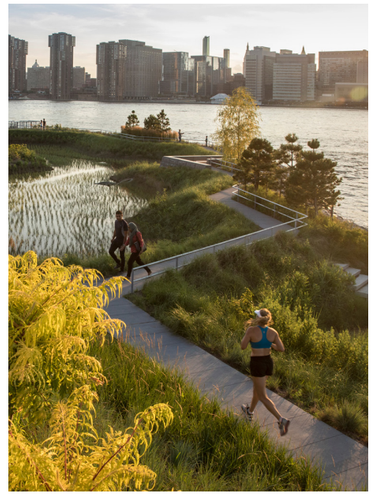
Soil Type Suitability: Soil type dictates design considerations

Community Amenity Value: No significant benefits unless integrated with an elevated greenway; Murals and embellishments can improve attractiveness, but ultimately barriers block water views

Habitat Value: No significant benefits; Flood barriers disconnect waterways from their floodplains, impairing ecosystem function. They can be especially detrimental to marsh ecosystems











Top Left: A section of the Charleston sea wall under repair (Image: City of Charleston)

Top Center: A muralist paints a flood wall in New Orleans (Image: Max Becherer)

Top Right: A New York City shoreline walkway is engineered as a protective berm (Image: Weiss Manfredi / SWA)

Lower Left: A stark canal levee and floodwall in New Orleans (Image: Mario Tama)

Lower Right: Heiligenhafen, Germany flood barrier (Image: BT Innovation)

STORM SEWER FACT SHEET

SUMMARY

Storm sewers are gray infrastructure that drain stormwater from impervious surfaces to waterways or treatment facilities. In the City of Charleston, wastewater and stormwater are handled in separate collection systems. Stormwater collected from storm drains is funneled to waterways in the Charleston area without water quality treatment. Tidal flooding can occur through the storm sewer system, which is sometimes reduced by installing stormwater pipe check valves.

IMPLEMENTATION SCALE

City and community leaders can determine where additional storm sewers are necessary based on drainage issues in a localized area.

APPROPRIATE ELEVATION ZONES

- High Ground
- Adapt Zone
- Compound Flood Risk

REFERENCES

Charleston Water System. (N.d.). *Wastewater vs. Stormwater*. Retrieved from https://www.charlestonwater.com/136/Wastewater-vs-Stormwater

Holleman, J. (2019, Winter). Designing for Water: Strategies to Mitigate Flood Impacts. *Coastal Heritage Magazine*. Retrieved from https://www.scseagrant.org/designing-for-water/

Hydrologic Function: Provides volume control

Community Amenity Value: No significant benefits

Pollutant Removal: No pollutant removal

Habitat Value: No significant benefits

Soil Type Suitability: All soils









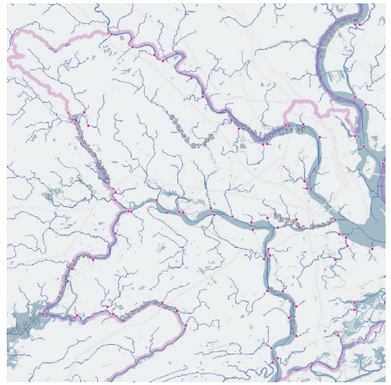
Top Left: Storm sewers involve significant underground infrastructure (Image: City of Charleston)

Top Right: Art can bring awareness that pollutants flow into waterways from storm drains (Image: City of Goshen)

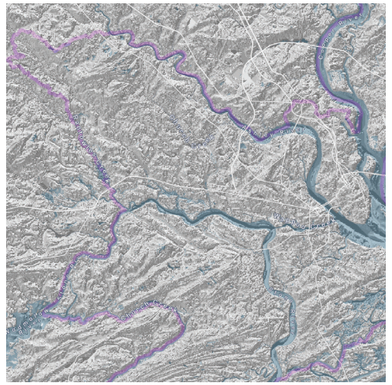
Lower Left: A storm drain in downtown Charleston (Image: Post and Courier)

Lower Right: Storm drains require maintenance to prevent clogging (Image: York County, SC)

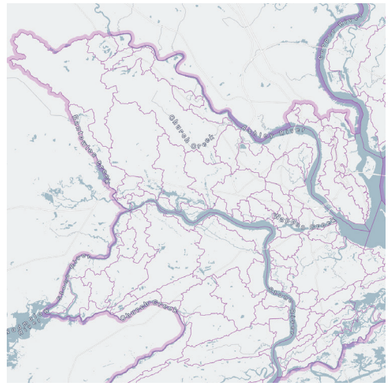
WATERSHED WORKFLOW

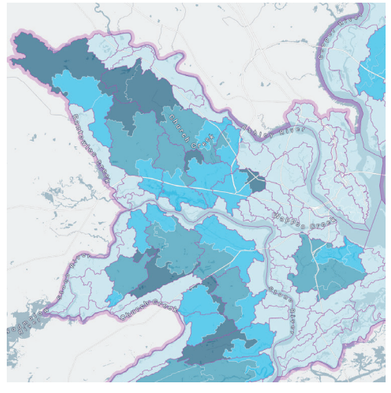


Flow Accumulation & Pour Points



Flow Direction





Analyzing Overland Flow Patterns

Generating Watersheds

Analyzing Upstream/Downstream Conditions

Generating Subwatersheds

DEM
2017 Topobathy LiDAR: SCDNR, NOAA Digital Coast

Downsampled from 9.84ft cells to 100ft cells

Fill
fills all of the depressions in the topobathy

Flow Direction

Flow Accumulation
Accumulated number of all cells flowing into every downslope cell

Flow Length
Distance from each cell to the outlet of the topobathy

Pour Points
Manually placed at points on flow accumulation raster where tributaries connect to major waterways: Stono River, Kiawah River, Long Island River, Clark Sound, Ashley River, Cooper River, Wando River, Nowell/Beresford Creek, Wappoo Creek, Rantowles Creek, Church Creek (Johns Island) and Bohicket Creek

Final Output
Watersheds

Zonal Statistics as Table
Minimum flow length per watershed used to calculate "distance to watershed outlet"

Join

Polygon to Raster

A-B
Raster calculator: Subtracts the minimum flow length from the total flow length to used to calculate "distance to watershed outlet"

Reclass
Classify using a defined interval of 16,000 Flow Length as the "upstream threshold". That threshold places most of the watersheds in the "small watersheds category" with no upstream condition (all watershed flow lengths under 16,000)

Polygon to Raster

Split
This was done manually

Final Output
Subwatersheds

ELEVATION DISTRIBUTION WORKFLOW

DFIRM
2017-21 Digital Flood Insurance Map: FEMA

CAT 3 Storm Surge
2018 Sea, Lake, and Overland Surges from Hurricanes Maximum Envelope of Water (SLOSHMOM): NOAA

Watersheds

DEM
2017 Topobathy LiDAR: SCDNR, NOAA Digital Coast

Urban Growth Boundary
City of Charleston

Polygon to Raster
Convert UGB to a raster

NLCD
2016 Land Cover: The Multi-Resolution Land Characteristics (MRLC) consortium

Housing Typology
City of Charleston, NEMAC, Fernleaf

Dissolve
Based on areas: Peninsula, Inner West Ashley, Outer West Ashley, Johns Island, James Island, Daniel Island, Cainhoy

Convert to Integer
Raster calculator used to create elevation ranges

Polygon to Raster
Convert watershed areas to a raster

Zonal Statistics as Table
Calculate elevation range for the building footprint

 # | ###
Raster calculator generates unique ID for each *Watershed Area - Elevation Range* combination

Clip
Raster calculator clips ID raster to inside the UGB

Clip
Raster calculator clips ID raster to inside the storm surge zone

Clip
Raster calculator clips ID raster to inside the 100 year floodplain

Spatial Join
Attach watershed area and UGB to building footprint

Mosaic
Add outside of UGB to NLCD raster

Summary Statistics
Watershed | Elevation | Footing | Risk
Generate unique ID for each *Watershed Area - Elevation - Footing Type - Risk* combination

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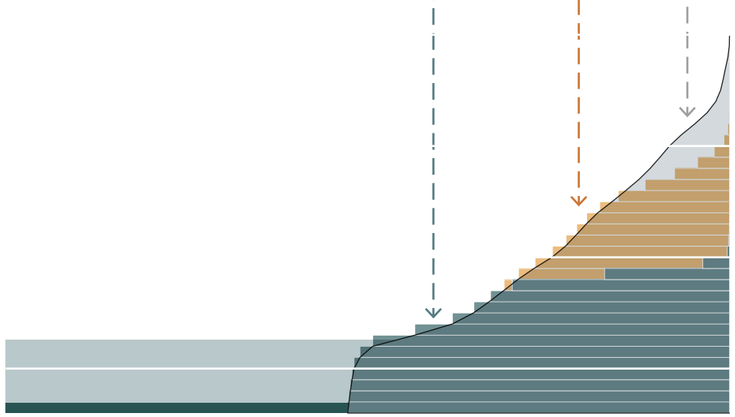
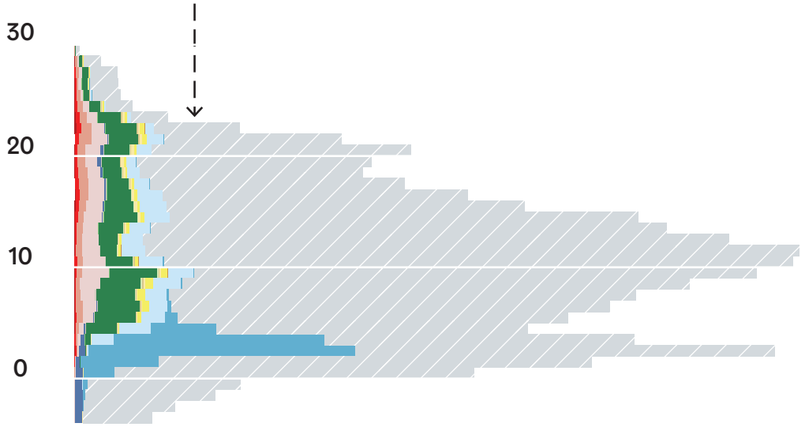
Raster calculator generates unique ID for each *Watershed Area - Elevation - Land Cover* combination

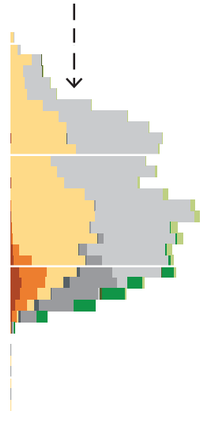
Parametric Sorting & Visualization



Elevation & Water Risk Distribution per Watershed Area



Land Cover Distribution by Elevation per Watershed Area



Housing Typology Distribution by Elevation