Government/Urban Working Group #3 Handout

James River and Tributaries – Richmond TMDL Implementation Plan Development
Goochland, Powhatan, Henrico, Chesterfield Counties and City of Richmond, VA

Residential Waste Treatment BMPs Needed

The Tuckahoe Creek impairment was specifically added to this IP project. The estimated values were derived from subwatersheds 26, 27, and 28 of the James River (riverine). The estimates were taken out of the previous JR riverine values, then added here as the Tuckahoe values.

Table 1. Updated Estimated Residential Waste Treatment BMPs Needed (non-cumulative).

Impairment	Number of Homes	Potential Failing Septic Systems	Potential Straight Pipes	Estimated Septic Systems Repairs	Estimated New Septic Systems Needed	Estimated Alternative Systems Needed	Estimated Sewer Hook-ups Needed	Estimated Septic System Pump-Outs Needed
Almond	3,262	35	2	10	25	2	?	148
Bernards	2,266	43	3	12	32	2	?	601
Falling	45,811	152	7	43	108	8	?	2,853
Gillies	17,768	81	21	23	75	4	?	281
Goode	7,758	4	2	1	5	0	?	37
JR (riverine)	26,353	505	53	144	389	25	?	2,626
JR (tidal)	52,927	470	60	134	372	24	?	4,797
No Name	869	6	1	2	5	0	?	51
Powhite	11,053	44	4	13	33	2	?	644
Reedy	9,311	5	4	1	8	0	?	59
Tuckahoe	36,455	274	60	78	242	14	?	1,241
Total	213,833	1,619	217	**388**	**1,126**	**69**	?	**13,338**
JR (riverine) Richmond	10,065	2	1	1	2	0	?	9

ATTENTION: The JR (tidal) segment TMDL did not require bacteria reductions to residential land-based loads. However, it is assumed that stakeholders want the number of failing septic system estimates and costs to repair these in the IP.

Questions for the group:

- Do any municipalities have information or estimates that would help determine which areas would be feasible for Sewer Hook-up?
- Do any municipalities have estimates for the number composting toilets or other "Alternative" Residential Waste Treatment systems already installed in each watershed?

- Is City of Richmond and VDH looking into the differences in homes with septic systems in VDH data (~140) and homes with only water connections in Richmond data (~1300)?

Potential measures to address urban sources of bacteria and/or stormwater volume

Table 2 shows a list of potential BMPs, that filter/store/prevent stormwater runoff from residential and/or commercial land uses. Discuss which of these BMPs are most likely to be implemented in the project watershed and which stakeholders would like to see in the IP. The right-most column shows how we can include these BMPs in the Plan. Either the treated area can be 'Quantified' using the bacteria load model or we would simply 'Promote' the BMP within the IP project watershed knowing it will have a positive impact on the watershed.

Table 2. Potential Residential and Urban SW BMPs to include in this IP project.

Practice	Difficulty of Installation	Runoff Treated from	How to Include in IP
Urban Trees	Easy	Residential/Commercial	Promote
Riparian Forest Buffer	Easy	Residential/Commercial	Quantify
Upland Reforestation	Easy	Residential/Commercial	Promote
Gutter Disconnect	Easy	Residential/Commercial	Quantify
Rain Barrel	Easy	Residential	Quantify
Bay Scape	Medium	Residential/Commercial	Promote
Simple Raingarden	Medium	Residential	Quantify
French Drain	Medium	Residential	Promote
Dry Well	Medium	Residential	Promote
Level Spreader	Medium	Commercial	Promote
Pervious Pavers	Medium	Residential/Commercial	Quantify
Grassed Swale	Medium	Commercial	Promote
Infiltration Trench	Medium	Residential/Commercial	Quantify
Cistern	Difficult	Residential/Commercial	Quantify
Bioretention	Difficult	Commercial	Quantify
Engineered Raingarden	Difficult	Residential/Commercial	Quantify
Retention Ponds	Difficult	Residential/Commercial	Quantify
Retro-fitted Green Roofs	Difficult	Commercial	Quantify
Other Innovative Projects	?	Residential/Commercial	Promote

Low Impact Development (LID) BMPs can be used to reduce stormwater volumes and peak flows in urban landscapes and reduce the likelihood and degree of combined-sewer overflows. These various practices include green roofs, bioretention basins, and roof runoff detention systems, and permeable pavement.

Green Roofs

Extensive green roofs, defined as having 3-4 inches of soil (engineered substrate), can be installed on large flat rooftops like those of commercial and industrial buildings of adequate structural integrity. Extensive green roofs have the potential to retain up to one inch of rainfall. A green roof allows for the complete retention of smaller storms, as well as detention and attenuation of flows, in excess of its capacity.

Roof Runoff Detention Systems

Roof runoff detention systems, such as rain barrels and cisterns used for residences, capture rainwater from rooftops and keep it from flowing into combined sewer systems. The water can then be applied to lawns and gardens or allowed to slowly drain, ideally infiltrating into a pervious surface over time. By allowing the runoff detention system to drain, it guarantees that all the capacity is available for the next storm event. Each runoff detention system on its own represents a small reduction of stormwater volume to the combined-sewers, but collectively, on the scale of a neighborhood, can be substantial. Cisterns also capture gray water and can be set up to reuse collected water for toilets and other gray water needs.

Permeable Pavement

Permeable pavement is an alternative to asphalt or concrete surfaces, which allows rainwater to infiltrate, thus reducing stormwater runoff. There are various types of permeable pavement, including porous concrete, grid pavers, and reinforced turf grids. Permeable pavement is best suited in low-volume areas, such as walkways and parking lots.

Table 2. Potential Stormwater BMP cost and volume efficiency estimates.

SW BMP	Unit	Cost/Unit	Cost/ ft^2-treated	Rainfall Retention/ Detention Capacity [1]	Annual Rainfall Retained/ Detained [2]
Urban Trees					
Riparian Forest Buffer	acre	$900			
Upland Reforestation					
Gutter Disconnect					
Rain Barrel	50-gal barrel	$100 - 150	$0.40 - 0.60	0.32"	48%
Bay Scape					
Simple Raingarden	acre-treated	$5,000			
French Drain					
Dry Well					
Level Spreader					
Pervious Pavement	ft^2	$10 - 15	$10 - 15	0.75"	73%
Grassed Swale					
Infiltration Trench	acre-treated	$5,285			
Cistern					
Bioretention	acre-treated	$10,000 - 90,000	$0.23 - 2.07	0.38"	53%
Engineered Raingarden					
Retention Ponds	acre-treated	$3,400			
Retro-fitted Green Roofs	ft^2	$15 - 30	$15 - 30	1.0"	81%

[1]This depth of rainfall is a function of what the practice is designed to retain/detain with full available storage capacity.
[2]This calculated percentage is per-unit area, and is a function of precipitation and the practice's ability to recharge its storage capacity.

Table 3. Potential control measure efficiencies in removing bacteria.

Control Measure	Bacteria Removal Efficiency	Reference
Buffer Efficiency*		
Vegetated Buffer	50%	2,4
Runoff Treatment Efficiency		
Retention Ponds	70%	6
Rain Garden	59%	4,6
Bioretention Basins	59%	4,6
Submerged Gravel Wetland	78%	7
Sand Filter	36% - 83%/65%	7/8
Shallow Marsh	55% – 99%	7
Wet Extended Detention Pond	46% - 99%	7

*Buffer efficiencies shown here apply to runoff generated outside of the buffer area, but within a distance equal to twice the buffer width. Additional reductions result from the conversion of land from its existing condition to the buffer area.

1 Removal efficiency is defined by the practice.

2 Commonwealth of Virginia. 2005. Chesapeake Bay Nutrient and Sediment Reduction Tributary Strategy for the James River, Lynnhaven and Poquoson Coastal Basins. http://www.richmondregional.org/Publications/Reports_and_Documents/Planning/2005_james_river_tributary_strategy.pdf

3 Swann, C. 1999. A survey of residential nutrient behaviors in the Chesapeake Bay. Widener Burrows, Inc. Chesapeake Bay Research Consortium. Center for Watershed Protection. Ellicott City, MD. 112pp.

4 Bacteria removal efficiency estimated based on sediment and nutrient removal efficiency.

5 Based on measurements of bacteria density as excreted and after storage.

6 Center for Watershed Protection. 2007. National Pollutant Removal Performance Database Version 3. http://www.richmondregional.org/Publications/Reports_and_Documents/Planning/2005_james_river_tributary_strategy.pdf

7 Appendix A: STP Pollutant Removal Database; various studies

8 Barrett, M. E., 2003. Performance, Cost, and Maintenance Requirements of Austin Sand Filters. DOI: 10.1061/(ASCE)0733-9496(2003)129:3(234)

Questions for the group:

- Of these Stormwater BMPs, are any more likely to be installed than others?
- Are any Stormwater BMPs missing from this list?
- Do you have costs for any SW BMPs?
- Are there any stormwater BMPs (not part of the Richmond LTCP) installed in the watershed? How much/many?
- Do any Counties/City have mandatory Pet Waste Pick-up Programs? Enforced? Can improve? At what Parks/Highway Rest stops/Common areas?

Green Roofs Modeling Assumptions

- Consider all buildings (private and publicly owned) greater than 10,000 ft^2
- Assume the buildings were structurally sound and capable of supporting the green roof materials
- Assume 3 inch deep extensive green roof
- Assume capability of retaining 1 inch of rainfall

- Use evapotranspiration rates to calculate "recharge" of storage capacity

Table 4. Overall In-Stream Bacteria Load Reduction from Modeling 100% of Potential Green Roofs Installed (See Table 5 for total areas used).

Impairment	In-stream Bacteria Load Reduction
Almond Creek	0.68%
Bernards Creek	1.65%
Falling Creek	0.36%
Gillie Creek	0.93%
Goode Creek	--
JR (riverine)	0.65%
No Name Creek	4.45%
Powhite Creek	2.48%
Reedy Creek	--
Tuckahoe Creek	0.13%

-- Negligible impact

Table 5. Potential Stormwater BMP acres available for all areas (with provided data).

Impairment	Total Drainage Area (acres)	Potential Roof Runoff Detention areas Buildings 800 - 3,600 ft2		Potential Green Roof areas Buildings > 10,000 ft2		Potential Permeable Pavement areas Sidewalks, Parking Lots, etc.		Total acres that have potential for these SW BMPs All areas	
		acres	% of total DA	acres	% of total DA	acres	% of total DA	acres	% of total DA
Almond Creek	3,465	117	3.4%	41	1.2%	156	4.5%	314	9.1%
Bernards Creek	10,932	139	1.3%	29	0.3%	400	3.7%	568	5.2%
Falling Creek	38,943	1,449	3.7%	520	1.3%	5,090	13.1%	7,059	18.1%
Gillie Creek	10,383	450	4.3%	249	2.4%	954	9.2%	1,653	15.9%
Goode Creek	4,137	166	4.0%	342	8.3%	682	16.5%	1,190	28.8%
James River (riverine)	67,606	976	1.4%	248	0.4%	1,482	2.2%	2,706	4.0%
James River (tidal)	102,094	764	0.7%	1,431	1.4%	1,983	1.9%	4,178	4.1%
No Name Creek	1,101	25	2.3%	101	9.2%	210	19.1%	336	30.5%
Powhite Creek	7,433	299	4.0%	132	1.8%	1,039	14.0%	1,470	19.8%
Reedy Creek	3,108	171	5.5%	79	2.5%	457	14.7%	707	22.7%
Tuckahoe Creek	40,206	770	1.9%	327	0.8%	1,989	4.9%	3,086	7.7%
Total	**289,408**	**6,214**	**2.1%**	**3,498**	**1.2%**	**18,584**	**6.4%**	**28,296**	**9.8%**

Table 6. Potential Stormwater BMP acres available within the City of Richmond.

Impairment	Potential Roof Runoff Detention areas Buildings 800 - 3,600 ft2		Potential Green Roof areas Buildings > 10,000 ft2		Potential Permeable Pavement areas Sidewalks, Parking Lots, etc.		Total acres that have potential for these SW BMPs All areas	
	acres	% of total DA	acres	% of total DA	acres	% of total DA	acres	% of total DA
Almond Creek	22	0.6%	0	0.0%	21	0.6%	43	1.2%
Falling Creek	208	0.5%	44	0.1%	298	0.8%	550	1.4%
Gillie Creek	118	1.1%	17	0.2%	153	1.5%	288	2.8%
Goode Creek	165	4.0%	335	8.1%	682	16.5%	1,182	28.6%
James River (riverine)	463	0.4%	174	0.2%	917	0.9%	1,554	1.4%
James River (tidal)	580	0.6%	610	0.6%	1,761	1.7%	2,951	2.9%
Powhite Creek	82	1.1%	53	0.7%	203	2.7%	338	4.5%
Reedy Creek	171	5.5%	76	2.4%	438	14.1%	685	22.0%
Total	**1,809**	**0.6%**	**1,308**	**0.5%**	**4,473**	**1.5%**	**7,590**	**2.6%**

Roof Runoff Detention Systems (rain barrels) Modeling Assumptions

- Consider all buildings with 800 – 3,600 ft^2 footprint
- Assume a 50 gallon capacity for every 250 ft^2 of roof space
- Assume that detention system drains completely each day
- This analysis is the maximum potential CSO reductions possible from the installation of rain barrels
- A Cistern analysis would yield the same results

Impairment	CSOs Analyzed	With Alternative E Total gal	With Alternative E # CSO days	Estimated Rain Barrels Number	With Alternative E and Maximum Rain Barrels Total gal	With Alternative E and Maximum Rain Barrels # CSO days	% Reduction Total gal
Almond	12	1.29E+09	268	20,505	1.25E+09	214	3.2%
Gillie	39,24,26, 25,31,4	8.19E+09	297	3,561	8.02E+09	271	2.1%
JR riverine	7,10,11,15, 16,18,19	5.83E+09	36	31,201	5.81E+09	32	0.4%

Maps

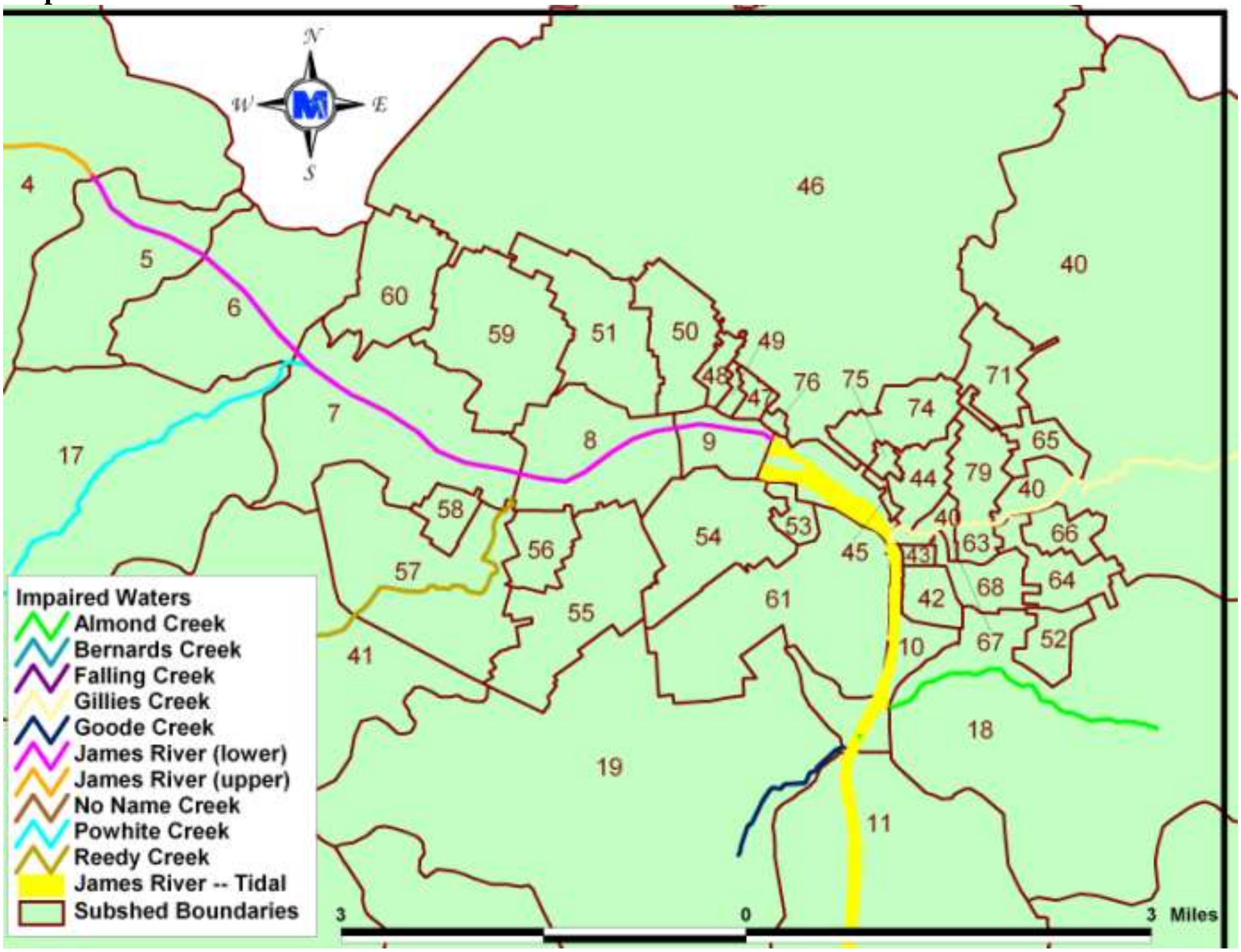

Figure 1. Subwatersheds in the IP study area zoomed into Richmond.

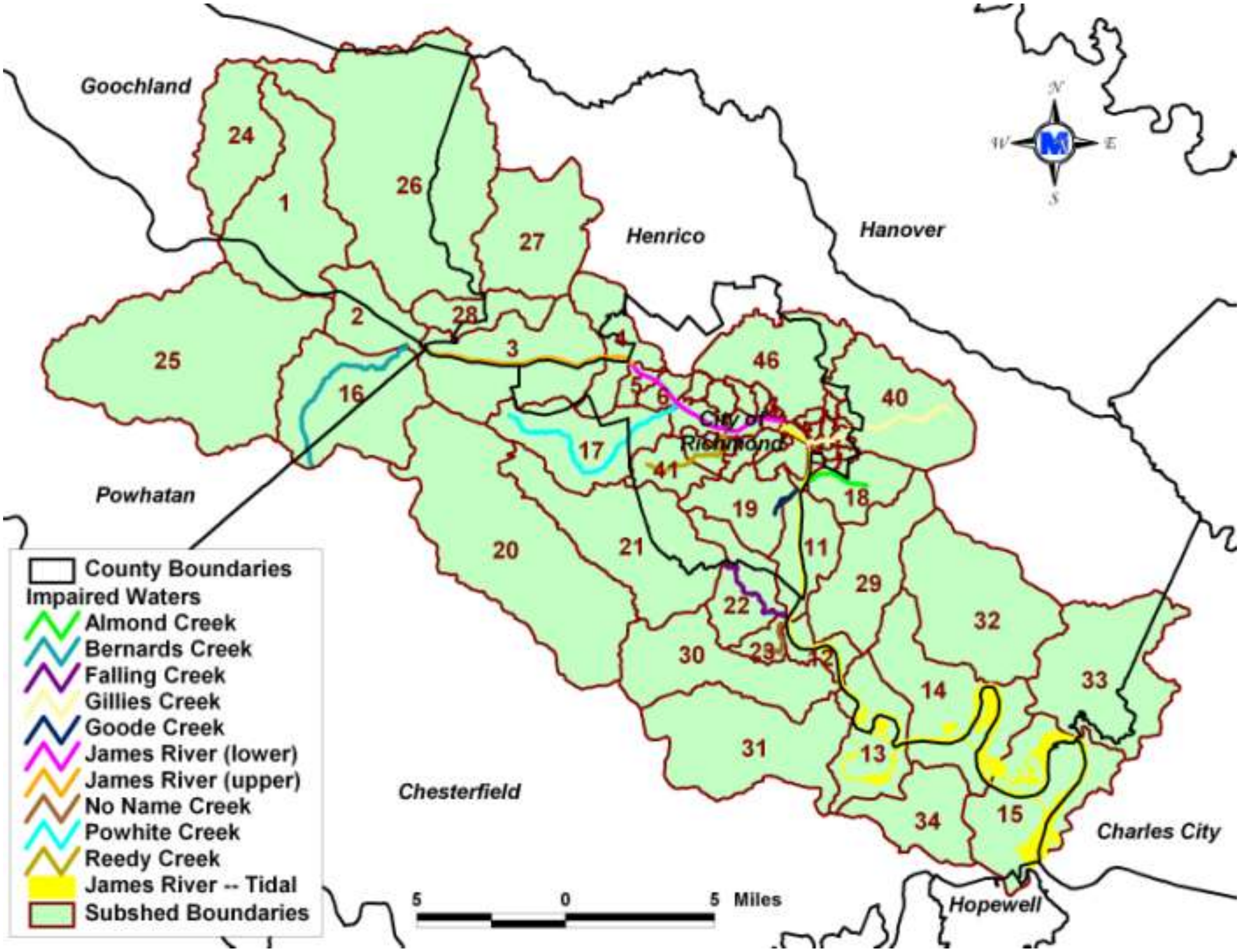

Figure 2. Subwatersheds and County boundaries in the IP study area.

Tuckahoe Creek will be added to all maps.

Table 7. Subwatershed numbers with Stream Name and Counties within the subwatershed.

Sub#	Stream name	Counties	Sub#	Stream name	Counties
1	JR riverine	Goochland, Powhatan	**40**	Gillies Creek	City of Richmond, Henrico
2	JR riverine	Goochland, Powhatan	**41**	Reedy Creek	City of Richmond, Chesterfield
3	JR riverine	City of Richmond, Goochland, Henrico, Powhatan	**42**	JR tidal	City of Richmond, Henrico
4	JR riverine	City of Richmond, Chesterfield, Henrico	**43**	JR tidal	City of Richmond
5	JR riverine	City of Richmond	**44**	Gillies Creek	City of Richmond
6	JR riverine	City of Richmond	**45**	JR tidal	City of Richmond
7	JR riverine	City of Richmond	**46**	JR tidal	City of Richmond, Henrico
8	JR riverine	City of Richmond	**47**	JR riverine	City of Richmond
9	JR riverine	City of Richmond	**48**	JR riverine	City of Richmond
10	JR tidal	City of Richmond, Henrico	**49**	JR riverine	City of Richmond
11	JR tidal	City of Richmond, Chesterfield, Henrico	**50**	JR riverine	City of Richmond
12	JR tidal	Chesterfield, Henrico	**51**	JR riverine	City of Richmond
13	JR tidal	Chesterfield, Henrico	**52**	JR tidal	City of Richmond, Henrico
14	JR tidal	Chesterfield, Henrico	**53**	JR tidal	City of Richmond
15	JR tidal	Charles City, Chesterfield, Henrico, Hopewell	**54**	JR tidal	City of Richmond
16	Bernards Creek	Chesterfield, Powhatan	**55**	JR riverine	City of Richmond
17	Powhite Creek	City of Richmond, Chesterfield	**56**	JR riverine	City of Richmond
18	Almond Creek	City of Richmond, Henrico	**57**	Reedy Creek	City of Richmond
19	Goode Creek	City of Richmond	**58**	JR riverine	City of Richmond
20	Falling Creek	Chesterfield	**59**	JR riverine	City of Richmond
21	Falling Creek	City of Richmond, Chesterfield	**60**	JR riverine	City of Richmond
22	Falling Creek	City of Richmond, Chesterfield	**61**	JR tidal	City of Richmond
23	No Name Creek	Chesterfield	**63**	Gillies Creek	City of Richmond
24	JR riverine	Goochland	**64**	Gillies Creek	City of Richmond, Henrico
25	JR riverine	Powhatan	**65**	Gillies Creek	City of Richmond
26	Tuckahoe Creek	Goochland, Henrico	**66**	Gillies Creek	City of Richmond, Henrico
27	Tuckahoe Creek	Henrico	**67**	Gillies Creek	City of Richmond
28	Tuckahoe Creek	Goochland, Henrico	**68**	Gillies Creek	City of Richmond
29	JR tidal	Henrico	**71**	Gillies Creek	City of Richmond
30	JR tidal	Chesterfield	**74**	JR tidal	City of Richmond
31	JR tidal	Chesterfield	**75**	JR tidal	City of Richmond
32	JR tidal	Henrico	**76**	JR riverine	City of Richmond
33	JR tidal	Charles City, Henrico	**79**	Gillies Creek	City of Richmond
34	JR tidal	Chesterfield			

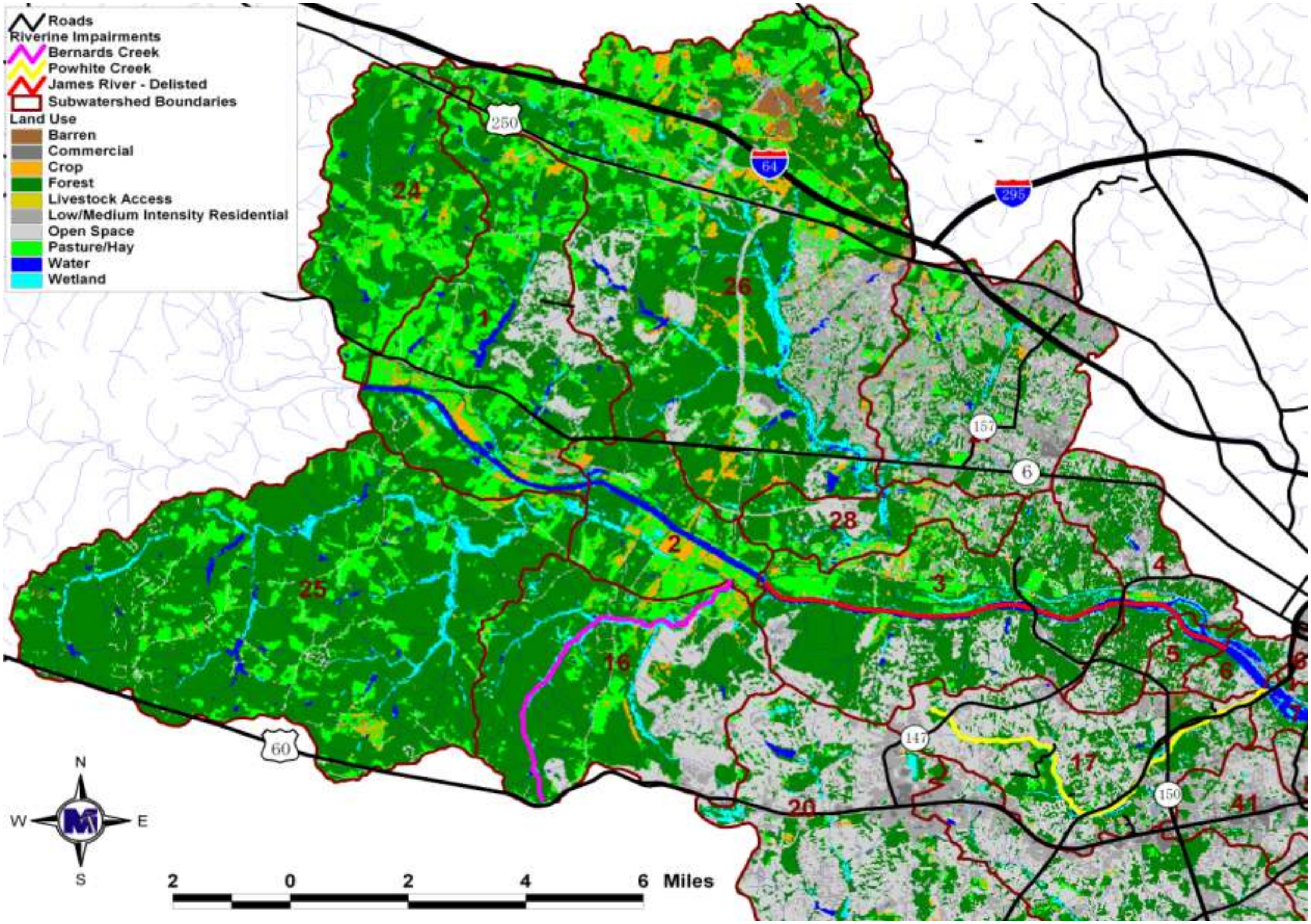

Figure 3. Subwatersheds and Land use zoomed into Bernards Creek, Powhite Creek, Tuckahoe Creek, and JR-delisted.

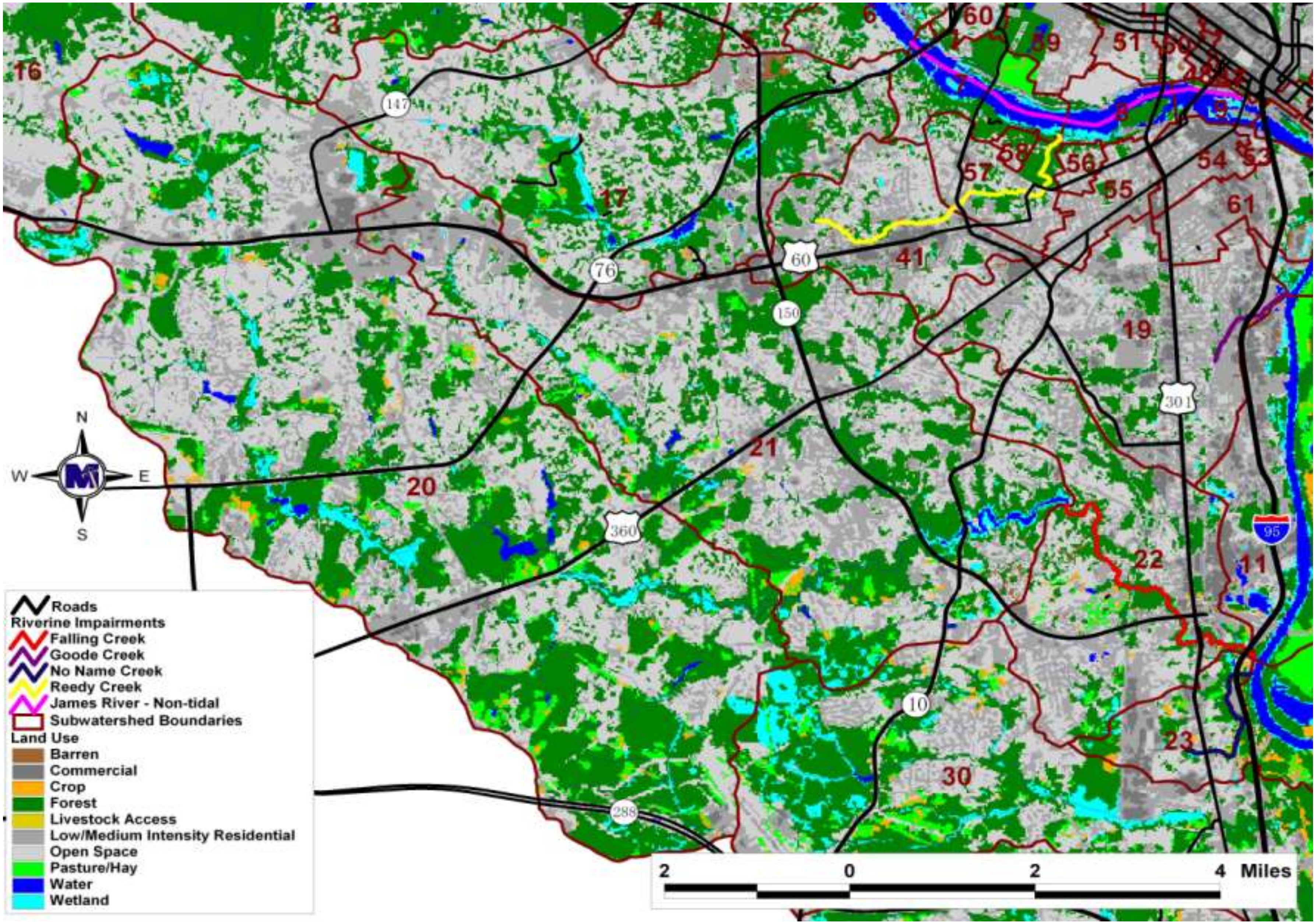

Figure 4. Subwatersheds and Land use zoomed into Reedy Creek, Falling Creek, Goode Creek, No Name Creek, and James River riverine.

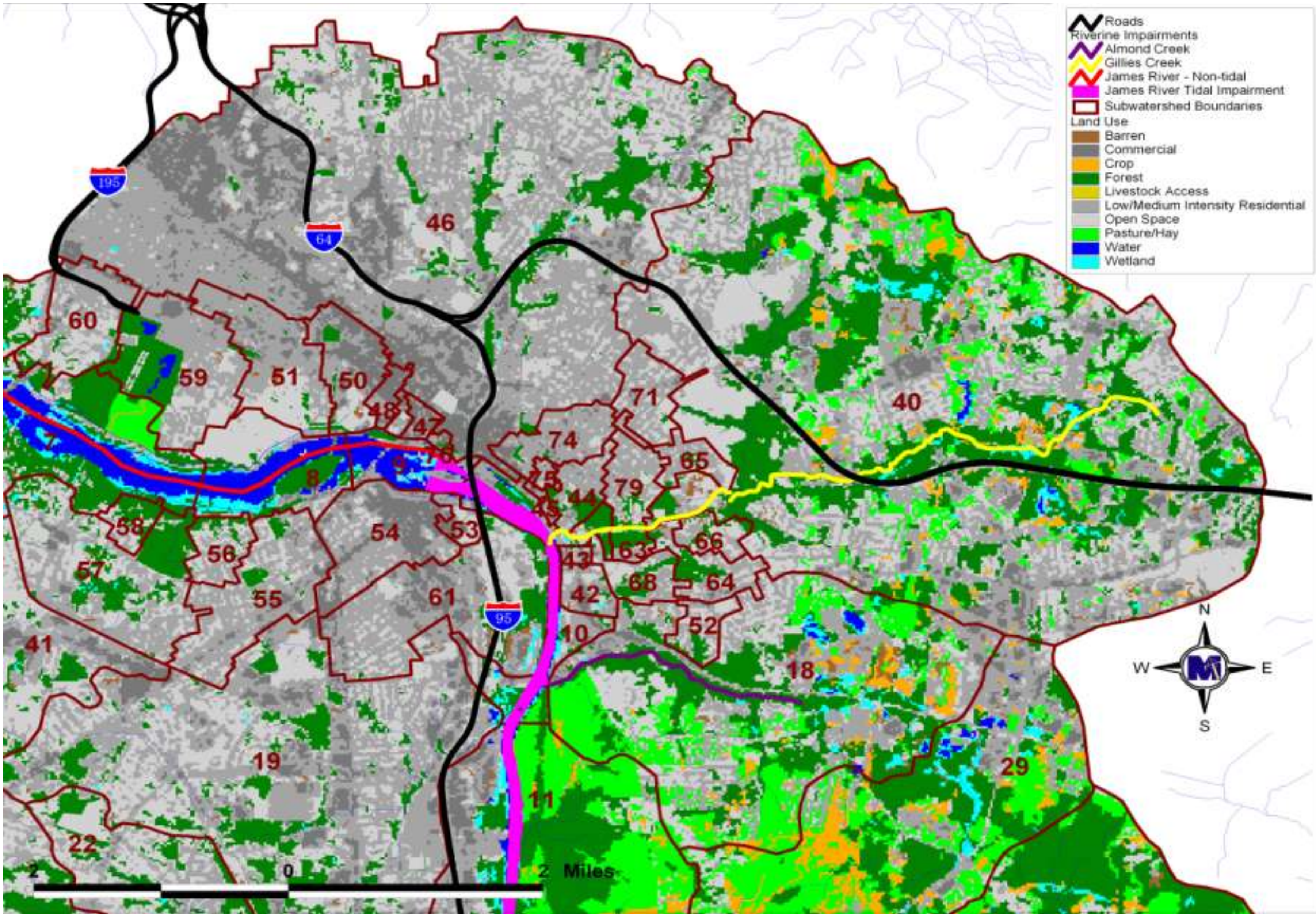

Figure 5. **Subwatersheds and Land use zoomed into Gillie Creek, Almond Creek, and James River riverine.**

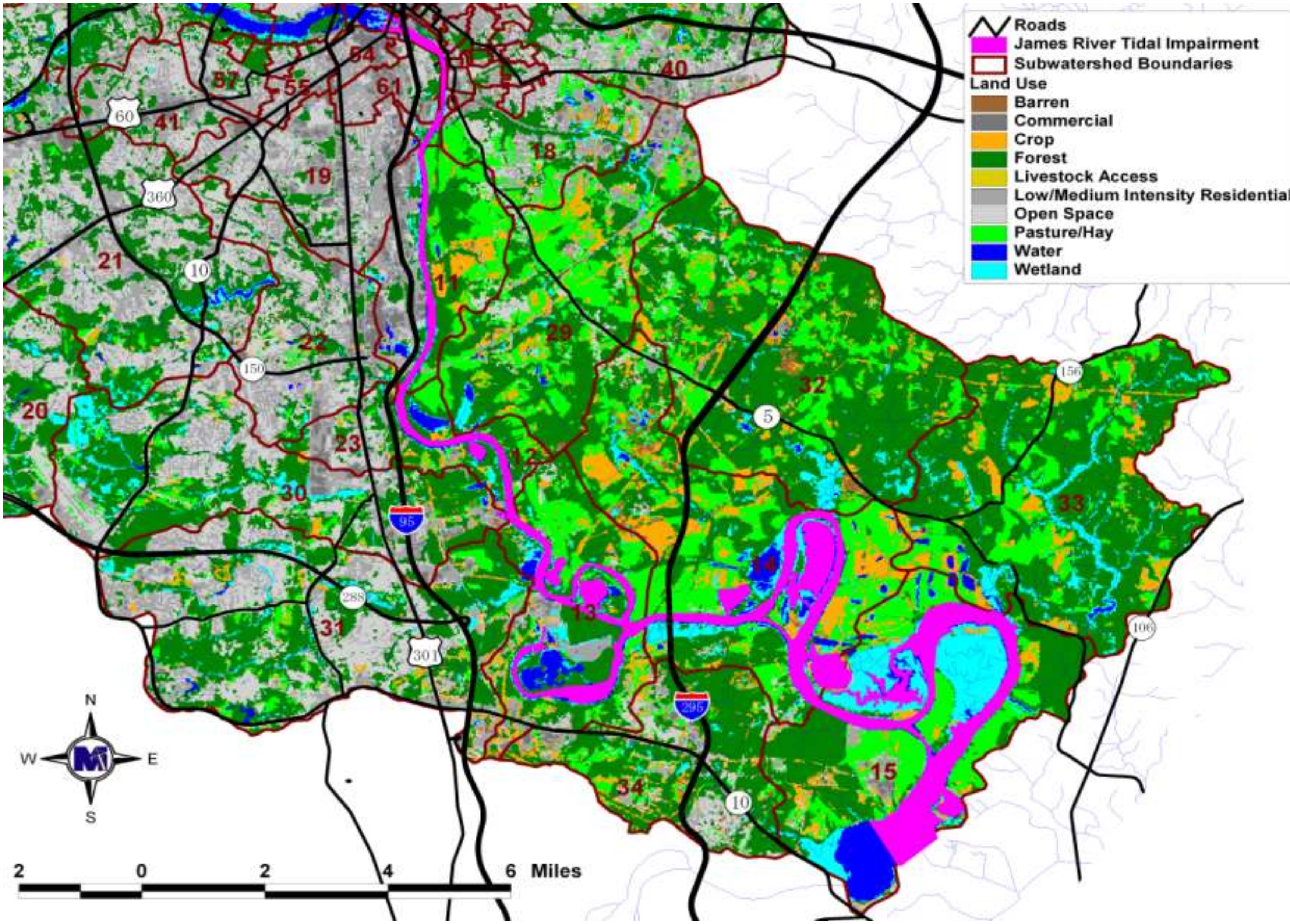

Figure 6. **Subwatersheds and Land use zoomed into James River tidal.**