Development of Bacterial TMDLs for Poquoson and Back Rivers in Virginia

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Public Meeting
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Virginia Department of Environmental Quality
William & Mary VIMS

Why We Are Here

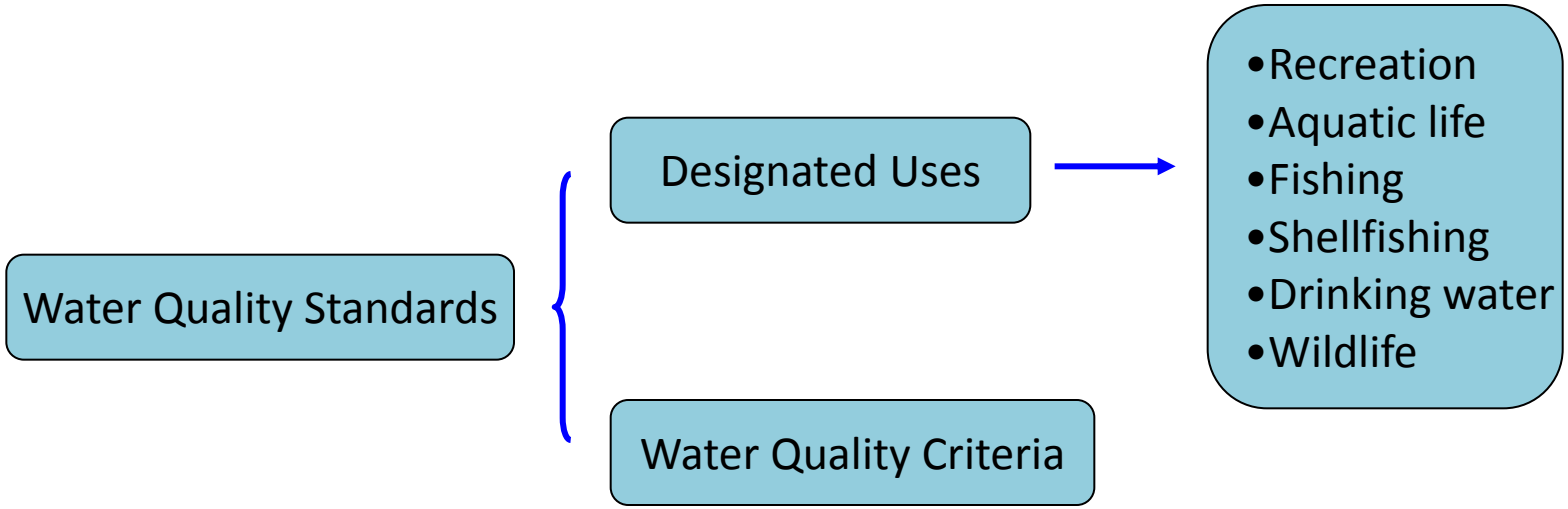
1. To learn about water quality of the rivers
2. To discuss the Total Maximum Daily Load (TMDL) development
3. To gather comments and encourage public participation

Outline

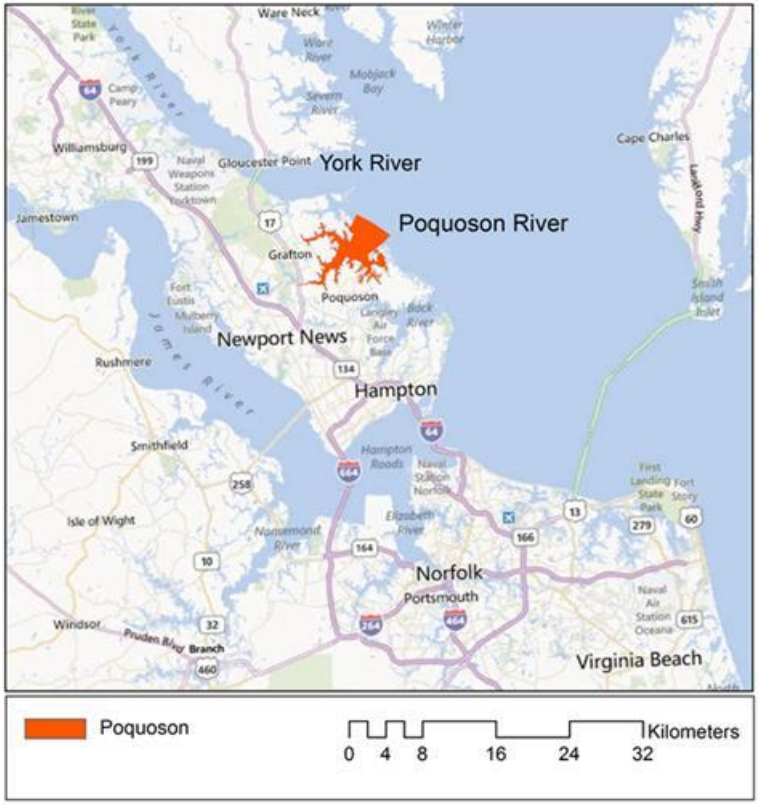
- The TMDL process
- Impaired waters and pollutants
- Procedures of pollutant source assessment
- Developed modeling approach
- Preliminary TMDL results
- Comments

The TMDL Process

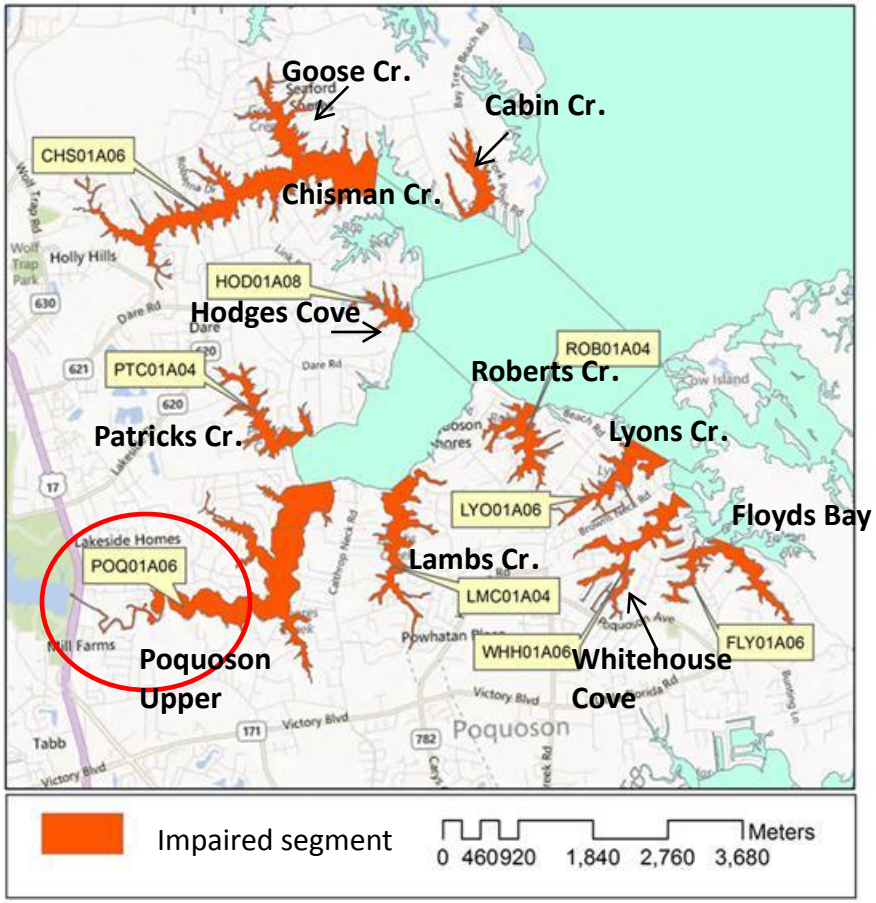
- DEQ routinely monitors the quality of waters across the state and publishes a list of impaired waters every 2 years
- Virginia is required by law to establish a TMDL for each pollutant causing an impairment
- A TMDL is the amount of a particular pollutant that a stream can receive and still meet Water Quality Standards

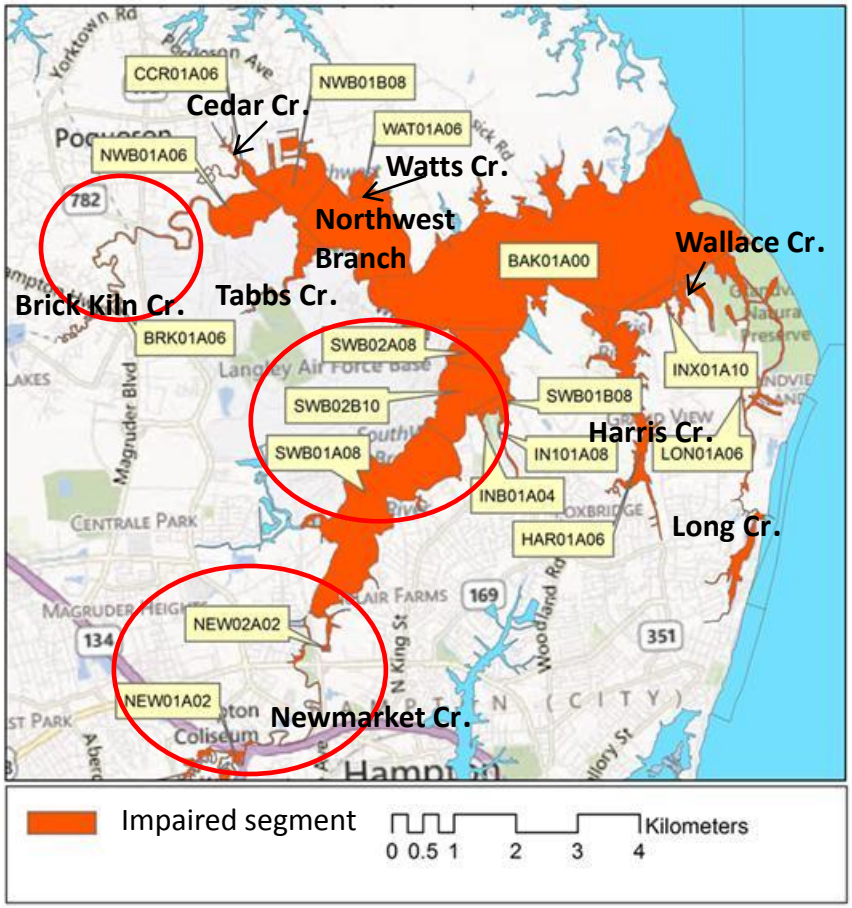


Location of Impaired Waters



Impaired Waters

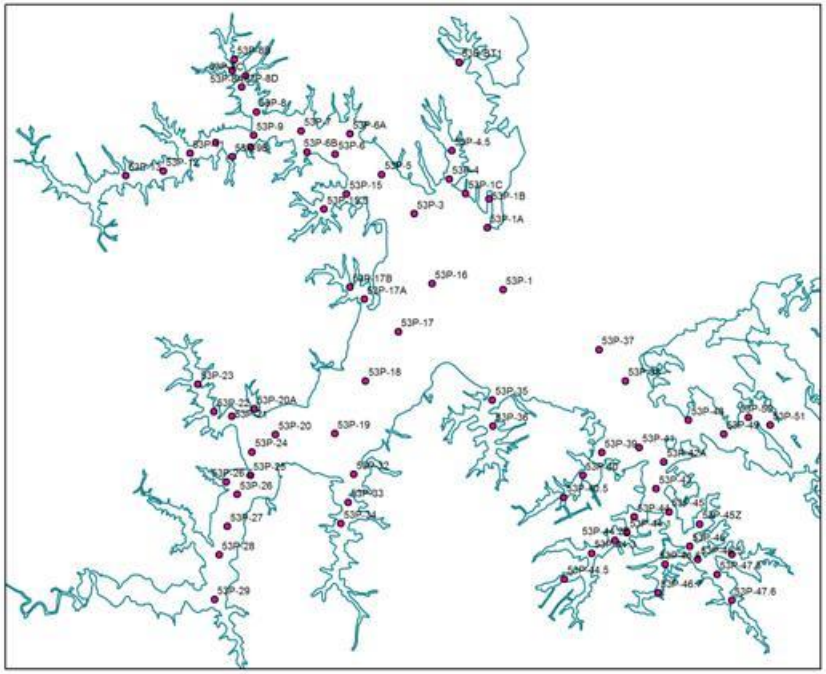


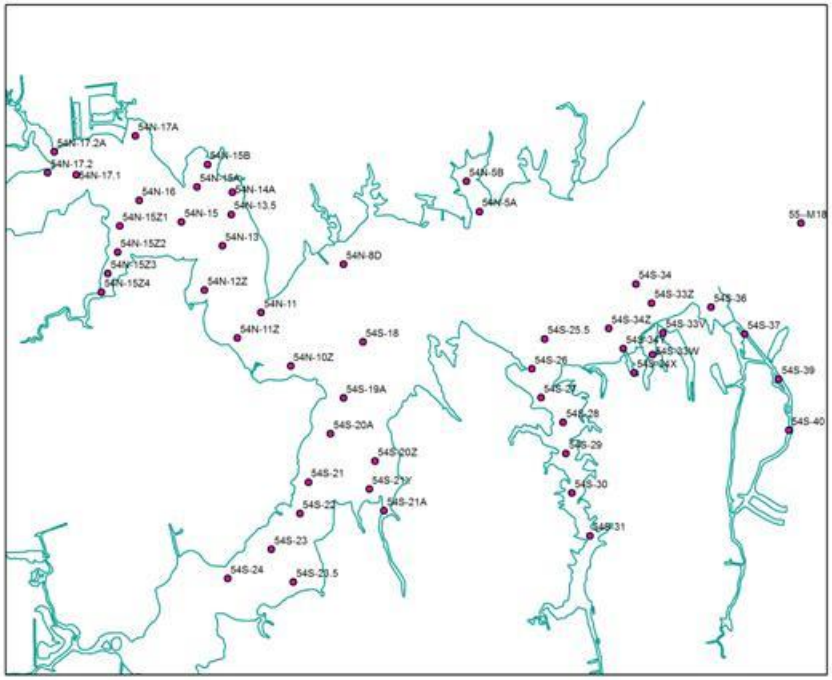


Water Quality Criteria

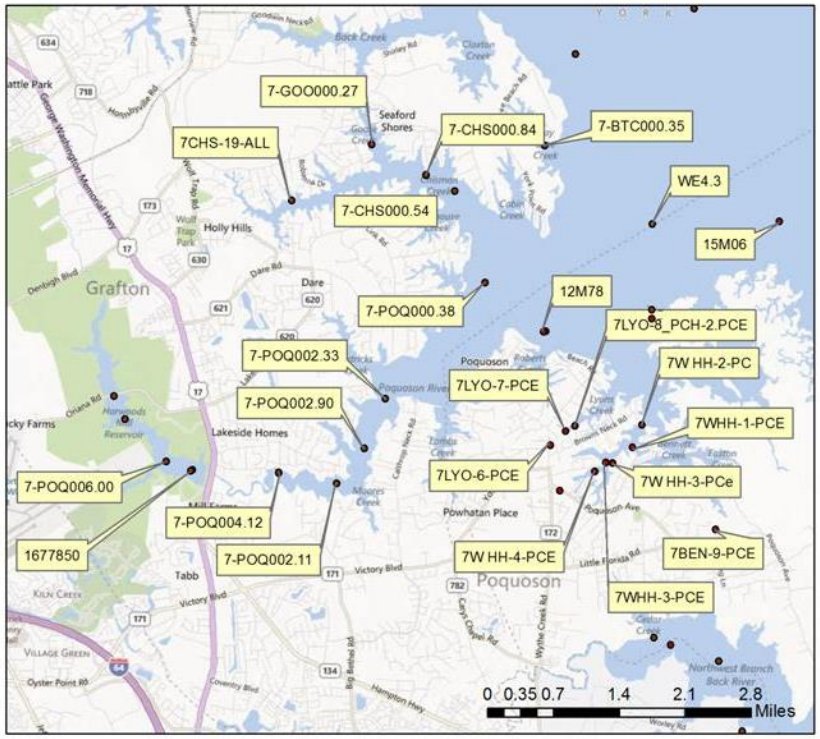
Water Type		Criteria
Class II (tidal water)	Fecal coliform	Geomean 14 counts/100ml 90th percentile: 49 counts/100ml
Class III (freshwater)	E. Coli (freshwater)	Geomean 126 counts/100ml Single Sample Max. 235 counts/100ml
	Enterococci (salt water)	Geomean 35 counts/100ml Single Sample Max. 104 counts/100ml

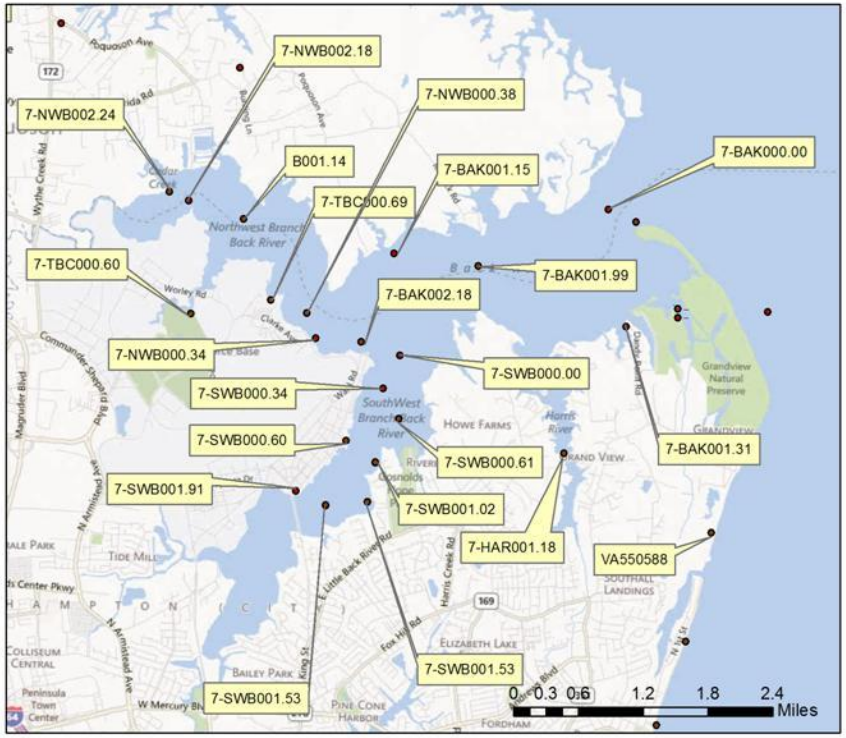
Observation Stations (DHS-DSS)



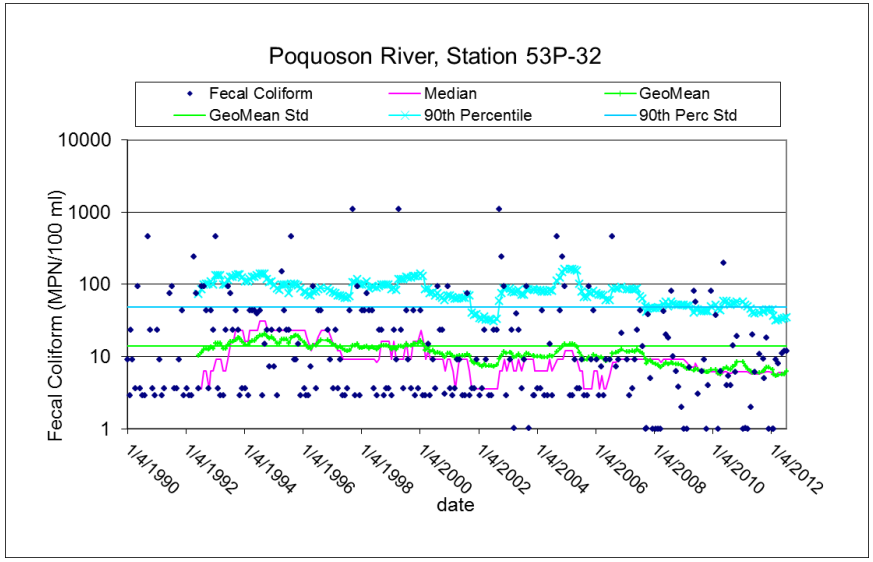


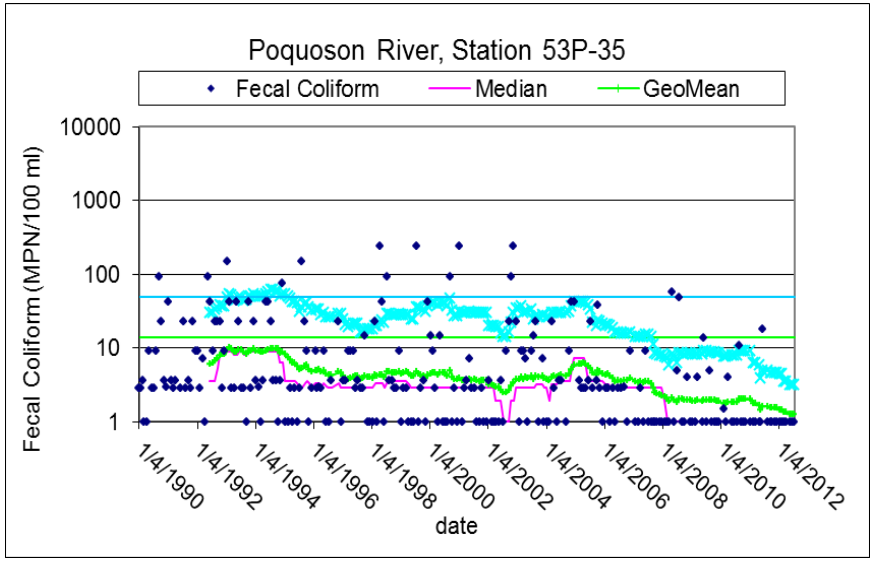
Observation Stations (DEQ)

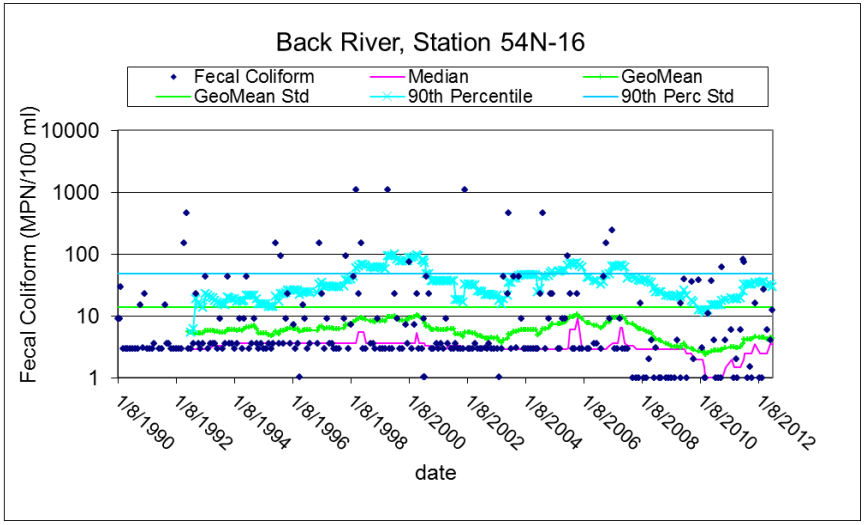


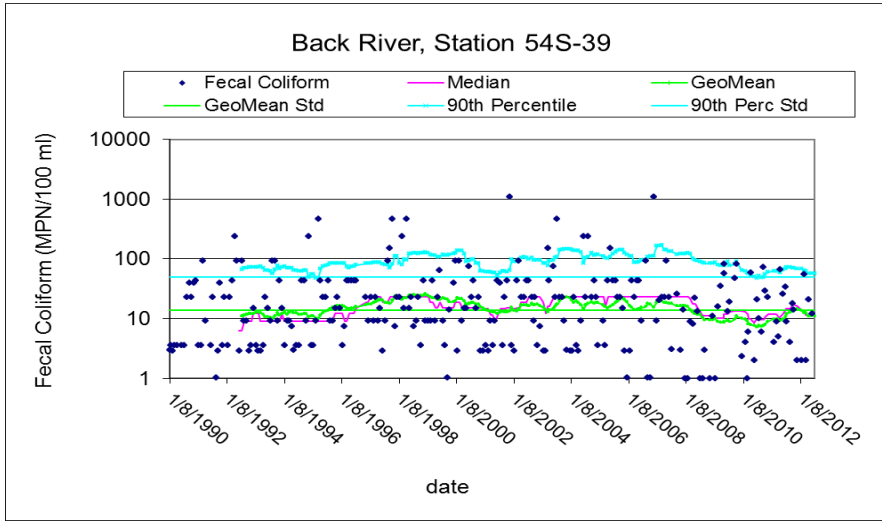


Example of Violation Assessment









Exceedance Percentages

- Poquoson (1990-2011)

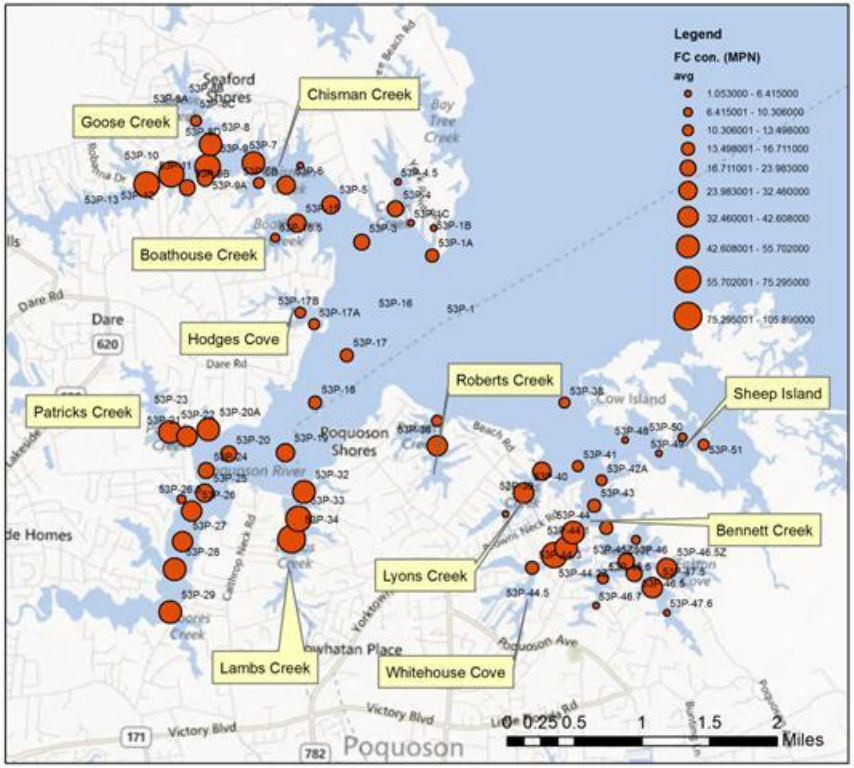
Station	Number of Samples	Geomean Criterion	Geomean Exceedance Percentage	90th Percentile Criterion	90th Percentile Exceedance Percentage
53P-22	259	14 MPN/100 ml	71.4%	49 MPN/100 ml	88.8%
53P-24	259	14 MPN/100 ml	1.2%	49 MPN/100 ml	14.7%
53P-25	259	14 MPN/100 ml	9.7%	49 MPN/100 ml	43.2%
53P-26	259	14 MPN/100 ml	7.7%	49 MPN/100 ml	44.8%
53P-26.5	259	14 MPN/100 ml	3.1%	49 MPN/100 ml	17.0%
53P-27	259	14 MPN/100 ml	3.1%	49 MPN/100 ml	76.8%
53P-28	259	14 MPN/100 ml	56.4%	49 MPN/100 ml	86.9%
53P-29	259	14 MPN/100 ml	80.3%	49 MPN/100 ml	88.8%
53P-32	259	14 MPN/100 ml	23.9%	49 MPN/100 ml	72.2%
53P-33	259	14 MPN/100 ml	68.0%	49 MPN/100 ml	88.8%
53P-34	259	14 MPN/100 ml	80.7%	49 MPN/100 ml	88.8%
53P-35	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	7.3%
53P-36	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	32.0%
53P-37	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	0.0%
53P-38	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	0.0%
53P-39	259	14 MPN/100 ml	0.8%	49 MPN/100 ml	15.4%
53P-40	259	14 MPN/100 ml	13.1%	49 MPN/100 ml	67.2%
53P-40.5	259	14 MPN/100 ml	5.4%	49 MPN/100 ml	54.1%
53P-41	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	0.0%
53P-42A	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	0.0%
53P-43	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	10.4%
53P-44	259	14 MPN/100 ml	13.9%	49 MPN/100 ml	60.2%
53P-44.1	259	14 MPN/100 ml	37.1%	49 MPN/100 ml	71.4%
53P-44.2Z	259	14 MPN/100 ml	54.1%	49 MPN/100 ml	86.5%
53P-44.3	259	14 MPN/100 ml	5.4%	49 MPN/100 ml	29.7%
53P-45	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	3.5%
53P-45Z	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	2.7%
53P-46	259	14 MPN/100 ml	2.7%	49 MPN/100 ml	36.3%
53P-46.5	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	13.1%
53P-46.5Z	259	14 MPN/100 ml	5.0%	49 MPN/100 ml	56.8%
53P-46.6	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	13.9%
53P-46.7	259	14 MPN/100 ml	0.8%	49 MPN/100 ml	11.2%
53P-47.5	259	14 MPN/100 ml	5.8%	49 MPN/100 ml	53.7%
53P-47.6	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	9.3%
53P-48	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	0.0%
53P-49	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	0.0%
53P-50	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	0.0%
53P-51	259	14 MPN/100 ml	0.0%	49 MPN/100 ml	0.0%

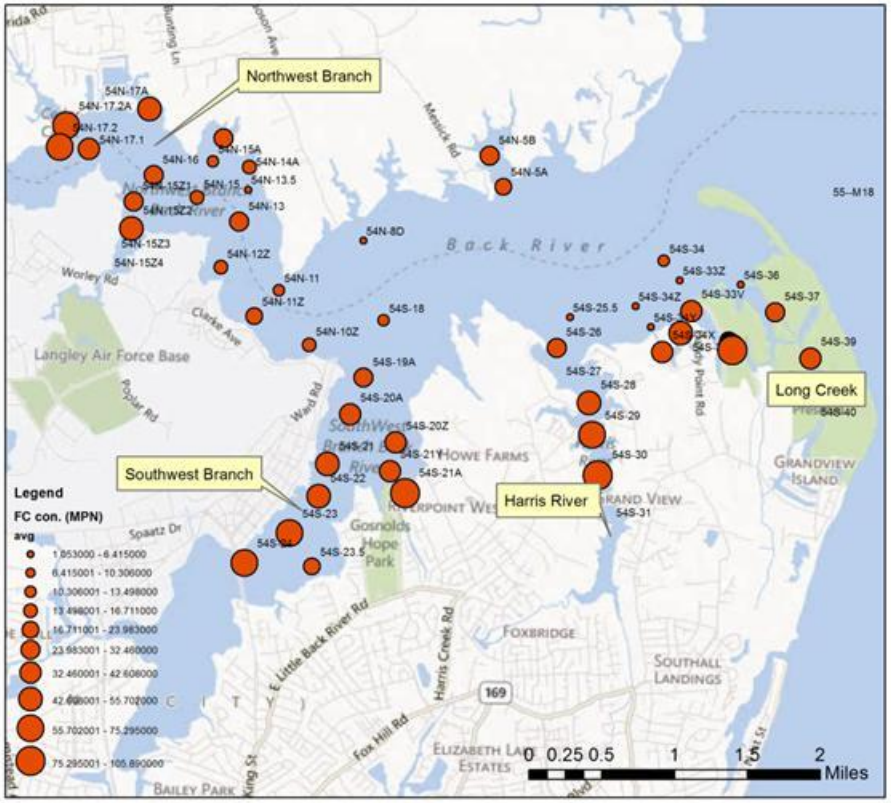
Exceedance Percentages

- Back River (1990-2011)

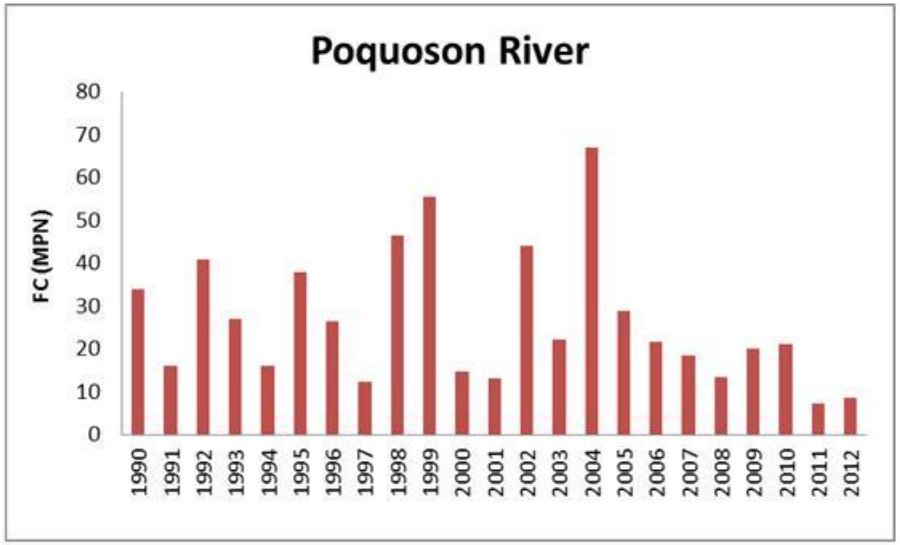
Station	Number of Samples	Geomean Criterion	Geomean Exceedance Percentage	90th Percentile Criterion	90th Percentile Exceedance Percentage
54N-5A	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	7.4%
54N-5B	256	14 MPN/100 ml	8.6%	49 MPN/100 ml	48.4%
54N-8D	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	0.0%
54N-10Z	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	3.1%
54N-11	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	0.0%
54N-11Z	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	5.1%
54N-12Z	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	3.5%
54N-13	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	12.5%
54N-13.5	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	0.0%
54N-14A	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	10.9%
54N-15	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	7.4%
54N-15A	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	12.5%
54N-15B	256	14 MPN/100 ml	5.5%	49 MPN/100 ml	29.3%
54N-15Z1	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	32.4%
54N-15Z2	256	14 MPN/100 ml	13.3%	49 MPN/100 ml	57.4%
54N-16	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	18.8%
54N-17A	256	14 MPN/100 ml	20.3%	49 MPN/100 ml	78,1%
54N-17.1	256	14 MPN/100 ml	9.0%	49 MPN/100 ml	59.4%
54N-17.2	256	14 MPN/100 ml	41.4%	49 MPN/100 ml	80.9%
54N-17.2A	256	14 MPN/100 ml	34.8%	49 MPN/100 ml	73.0%
54S-18	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	5.1%
54S-19A	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	30.9%
54S-20A	256	14 MPN/100 ml	6.3%	49 MPN/100 ml	53.9%
54S-20Z	256	14 MPN/100 ml	6.3%	49 MPN/100 ml	53.9%
54S-21	256	14 MPN/100 ml	14.1%	49 MPN/100 ml	56.3%
54S-21A	256	14 MPN/100 ml	33.6%	49 MPN/100 ml	62.5%
54S-21Y	256	14 MPN/100 ml	6.3%	49 MPN/100 ml	40.6%
54S-22	256	14 MPN/100 ml	27.0%	49 MPN/100 ml	59.0%
54S-23	256	14 MPN/100 ml	44.9%	49 MPN/100 ml	67.2%
54S-23.5	256	14 MPN/100 ml	5.1%	49 MPN/100 ml	27.3%
54S-24	256	14 MPN/100 ml	56.3%	49 MPN/100 ml	73.8%
54S-25.5	256	14 MPN/100 ml	0.0%	49 MPN/100 ml	0.0%
54S-26	256	14 MPN/100 ml	3.5%	49 MPN/100 ml	33.6%
54S-28	256	14 MPN/100 ml	12.1%	49 MPN/100 ml	55.1%
54S-29	256	14 MPN/100 ml	19.5%	49 MPN/100 ml	69.1%

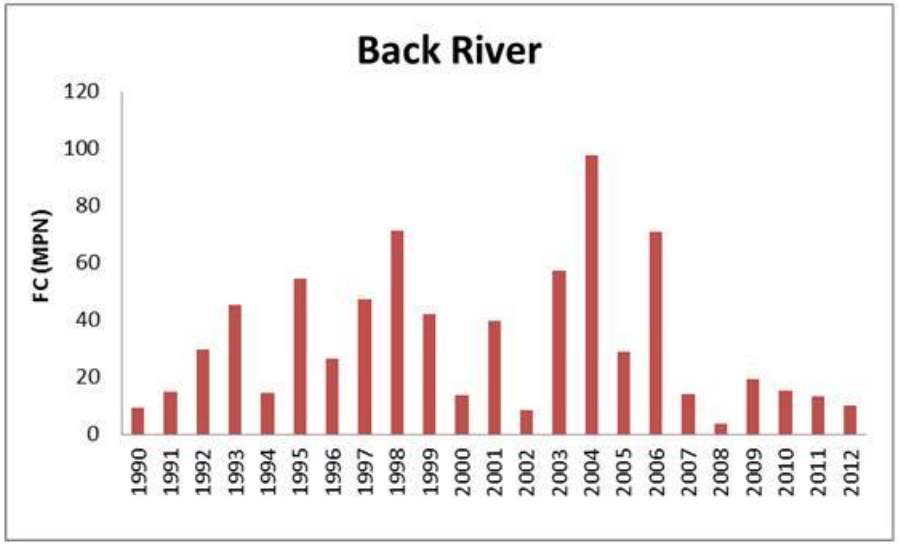
Distribution of Fecal Coliform

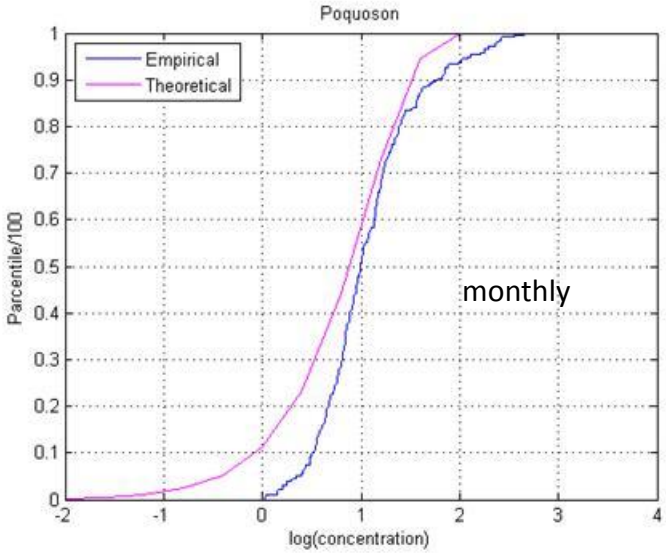


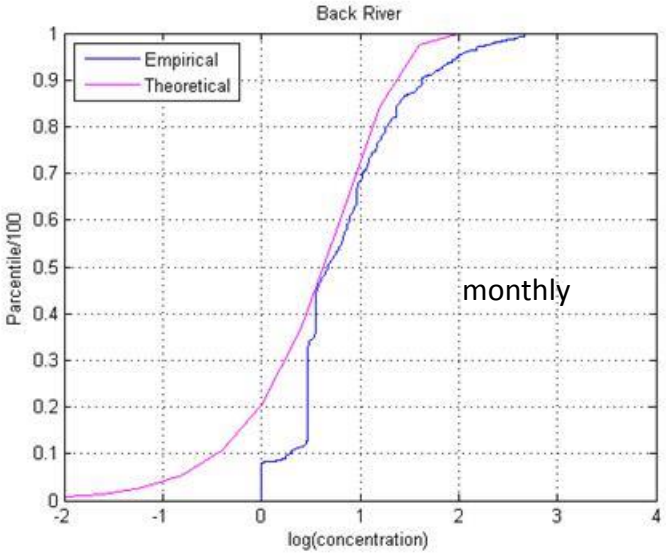


Annual & Monthly FC Distribution

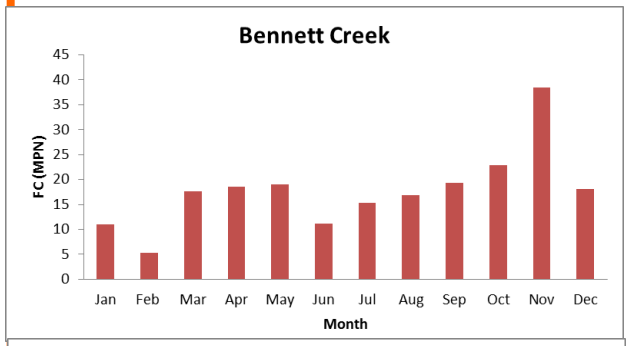


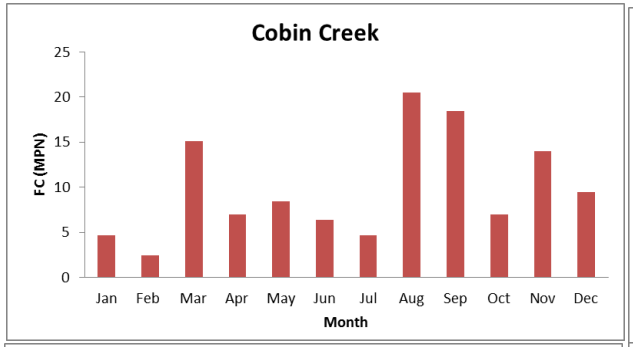


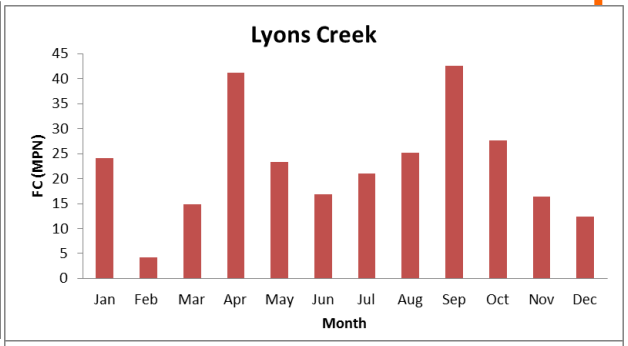


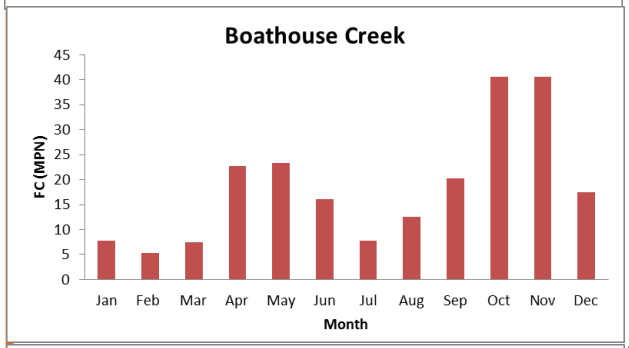


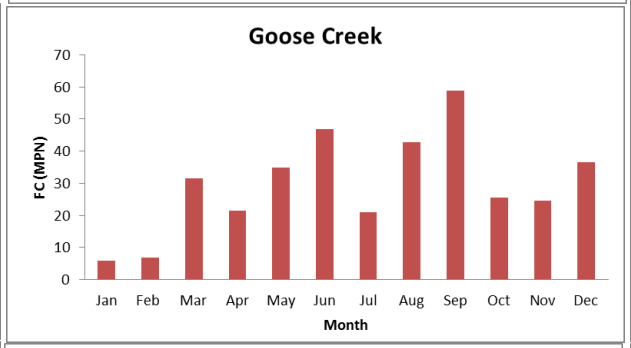
Seasonal Variations (Poquoson)

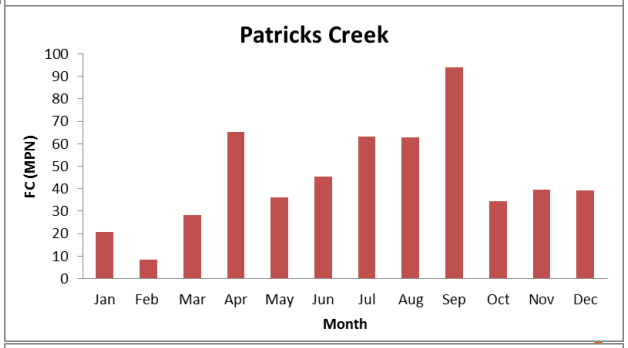


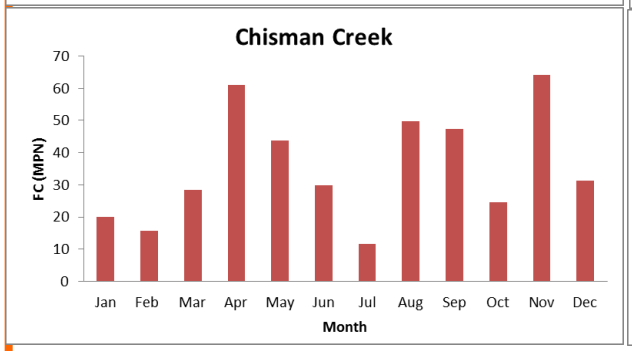


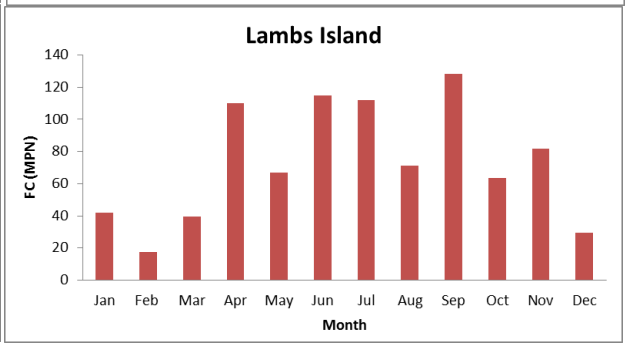


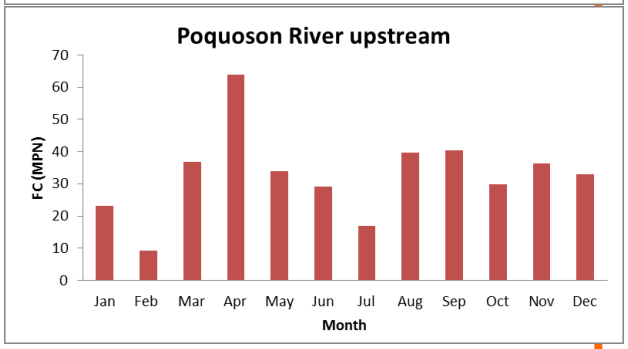




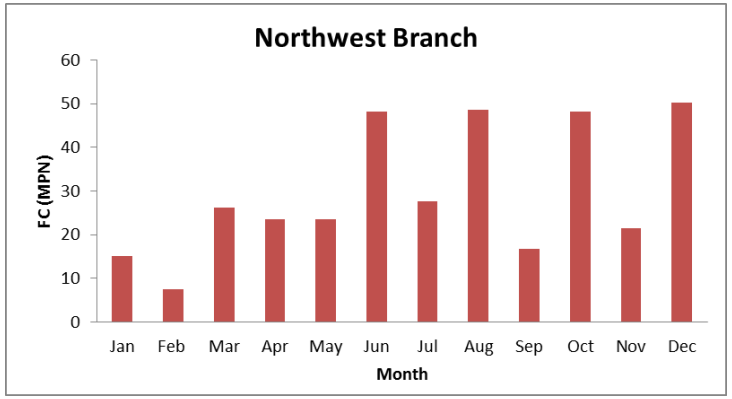


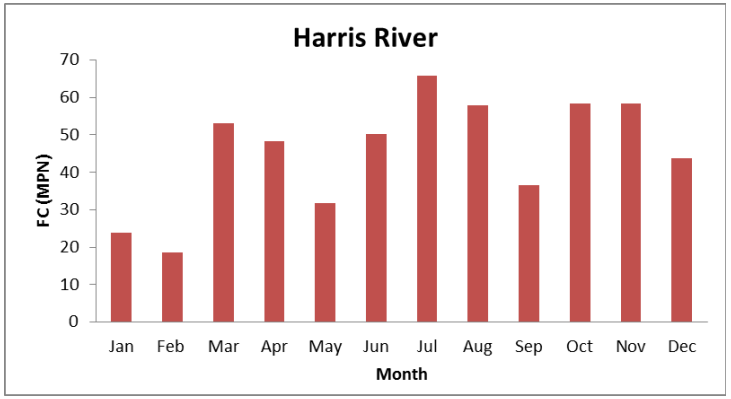


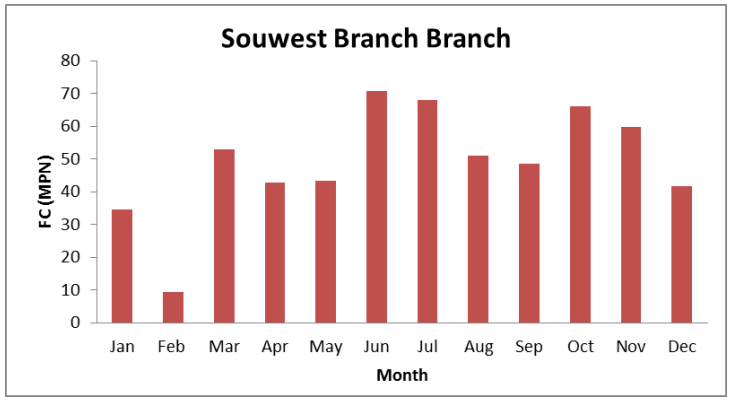


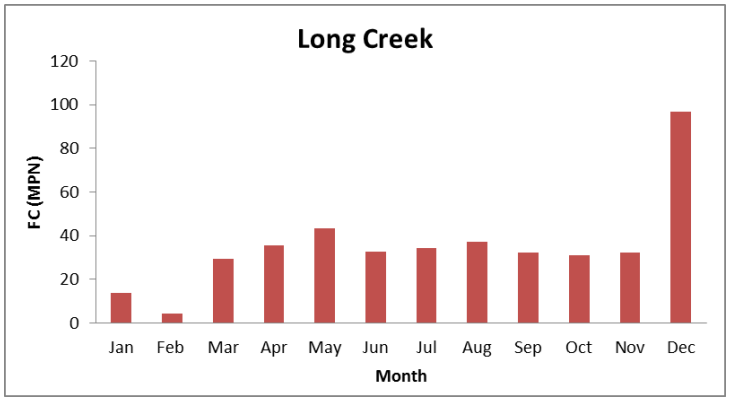


Seasonal Variations (Back River)





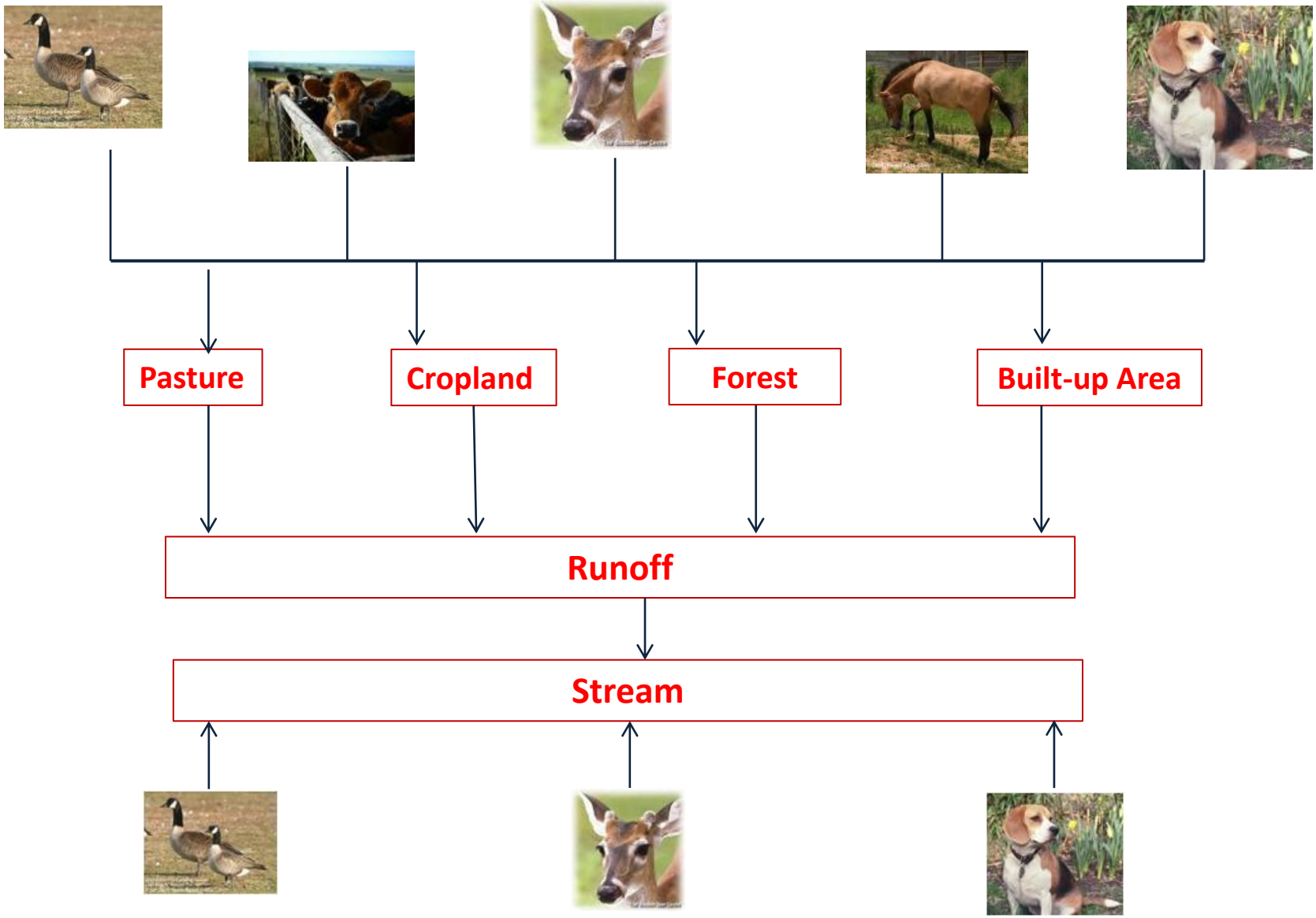




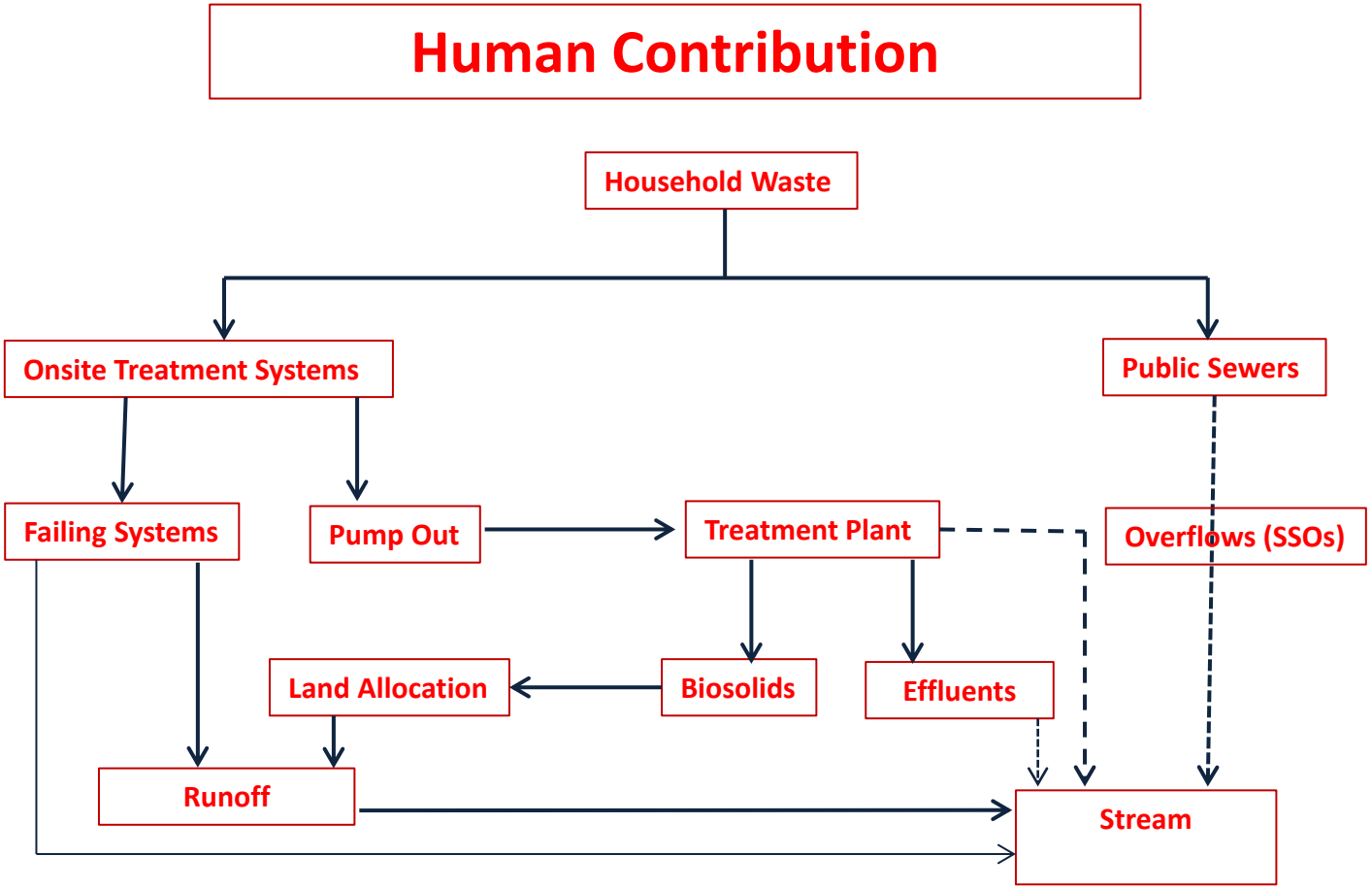
Procedures of Pollutant Source Assessment

- Sources
  - Agricultural
  - Humans
  - Pets
  - Livestock
  - Wildlife
- Approach
  - GIS (roads, buildings, sanitation boundaries, septic systems, etc.)
  - Land Use Data (NOAA's Coastal Change Analysis Program (C-CAP))
  - Wildlife survey data (animal density, animal habitat)
  - Shoreline survey data
  - Field survey
  - Public inputs
  - Public meeting
  - Interview

Potential Sources: Wildlife, Livestock, and Pets



Source Assessment

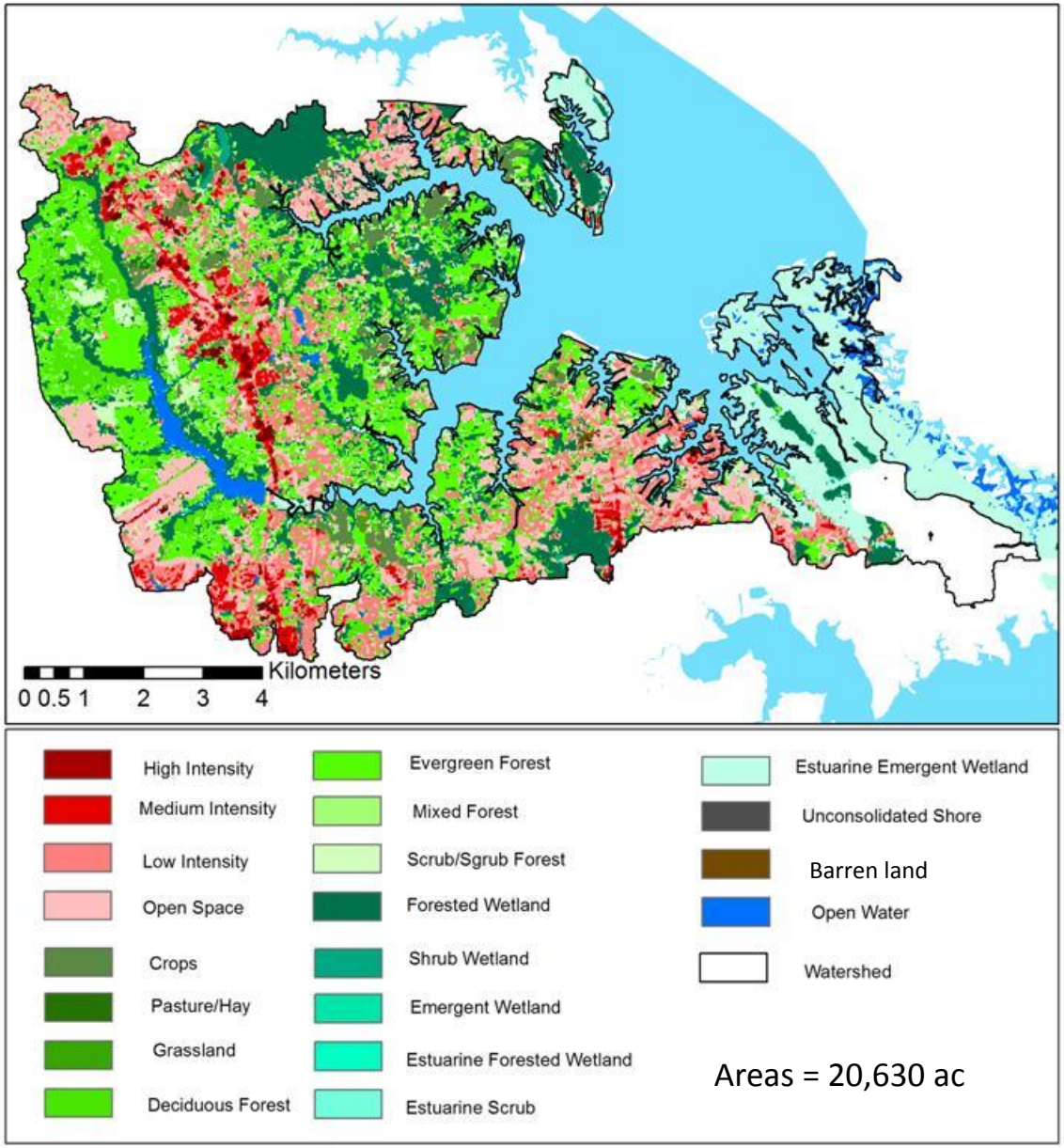


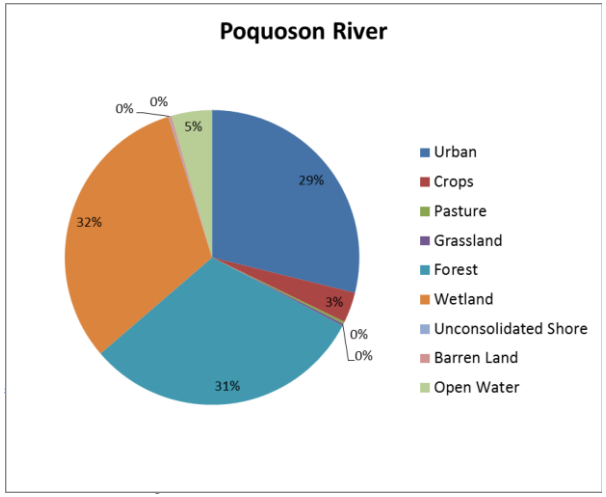
GIS and Land use data

- NOAA's Coastal Change Analysis Program (C-CAP)
- DEM (digital elevation model)
- GIS data provided by York County, City of Poquoson, NASA etc.
- USGS stream data
- NOAA sounding data

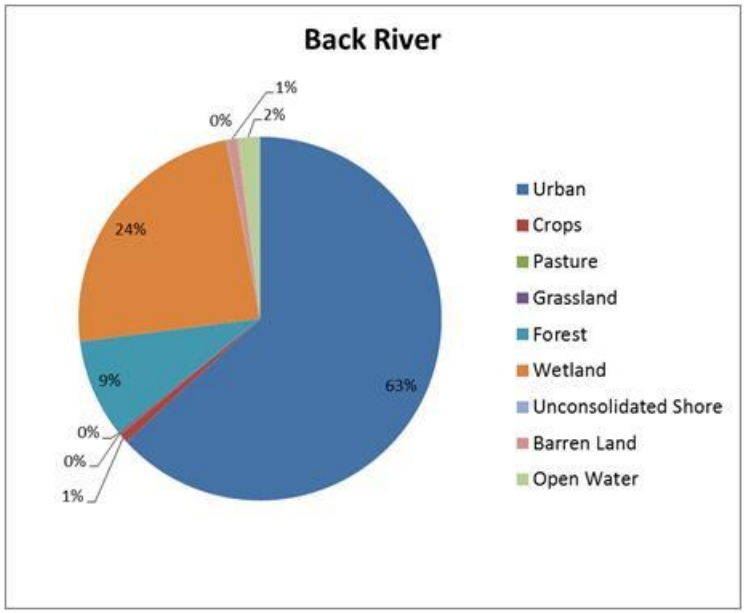
Poquoson Land Use

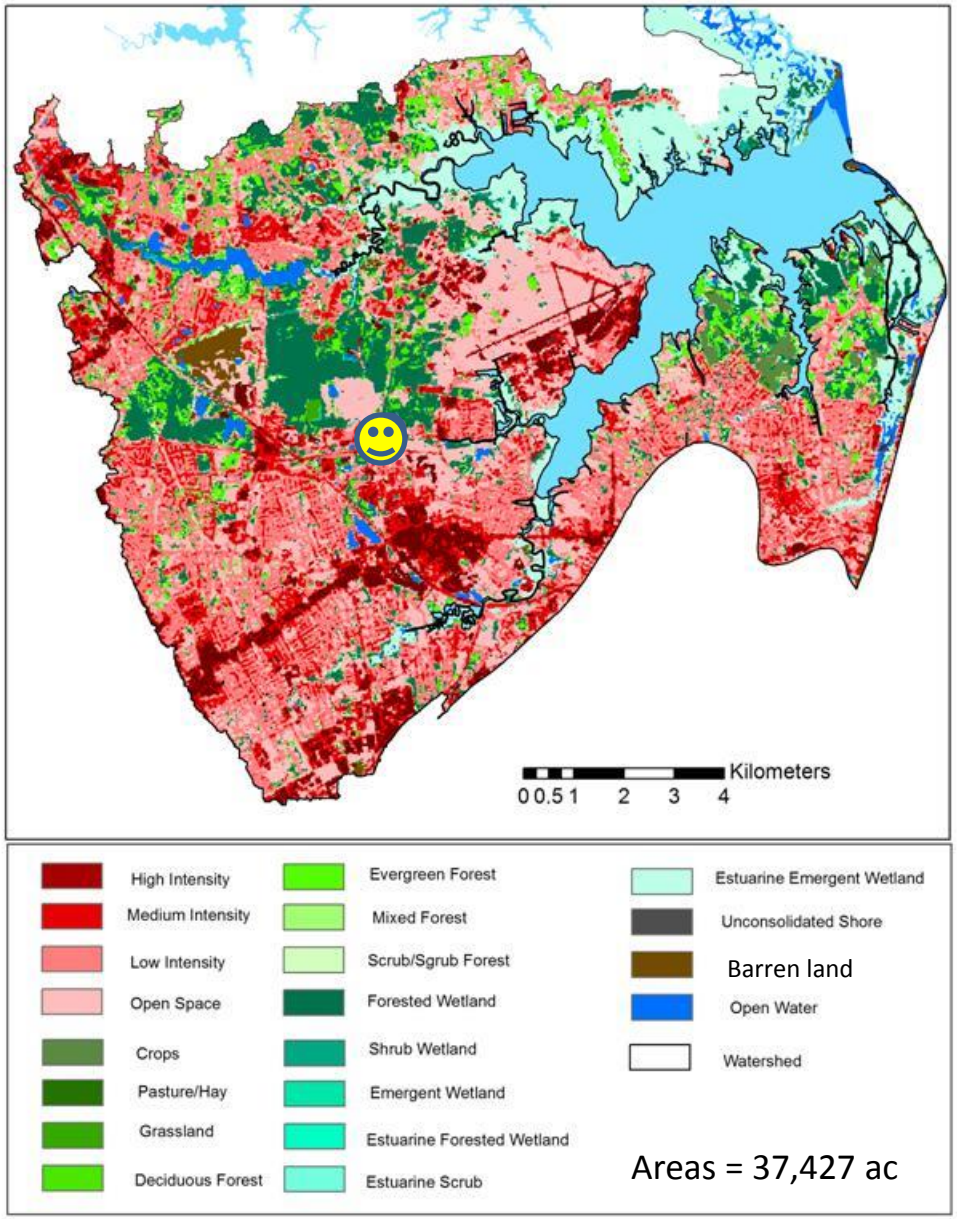
NOAA's Coastal Change Analysis Program (C-CAP)



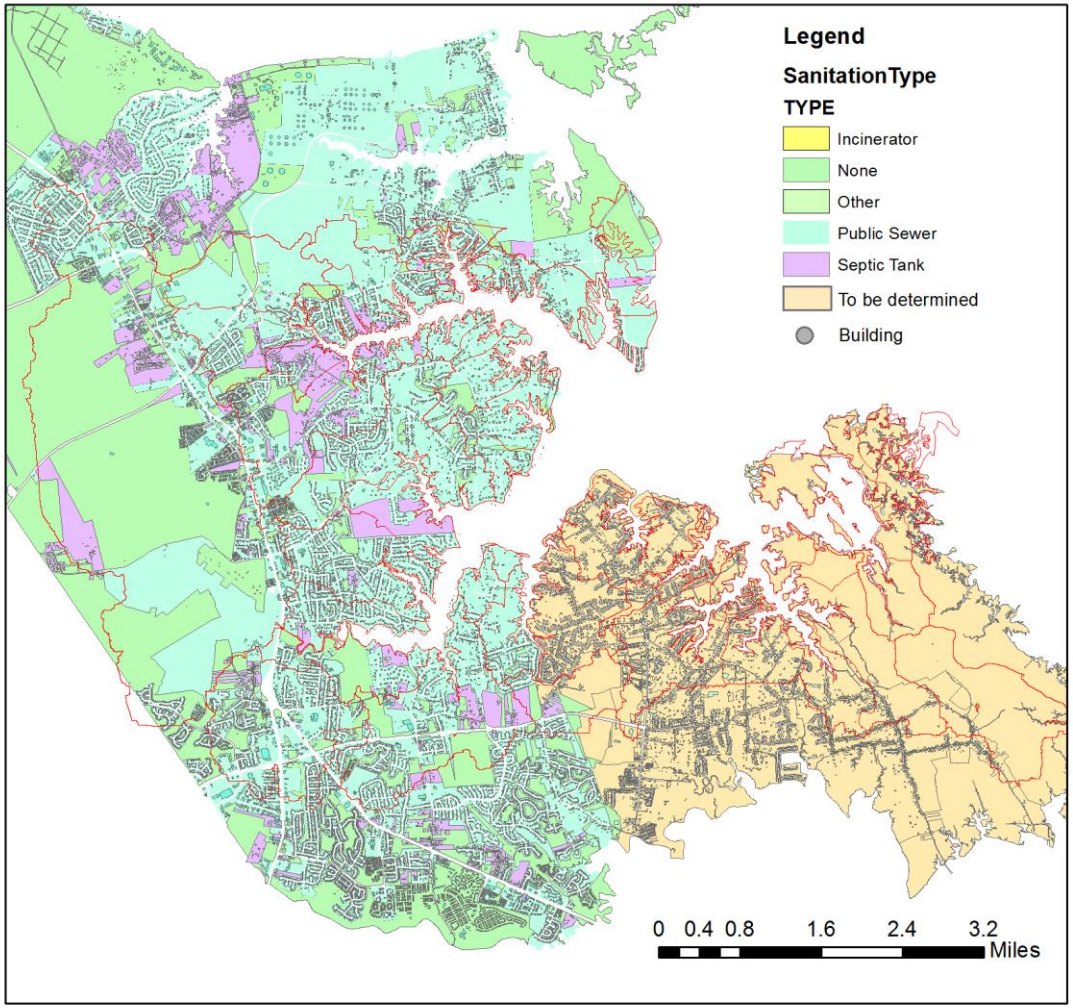


Back River Land Use



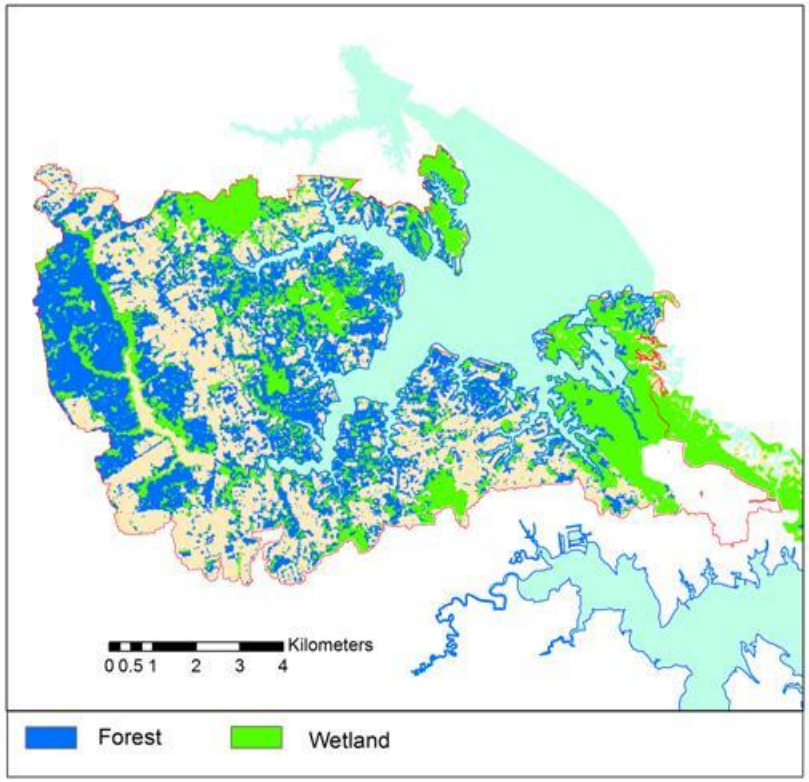


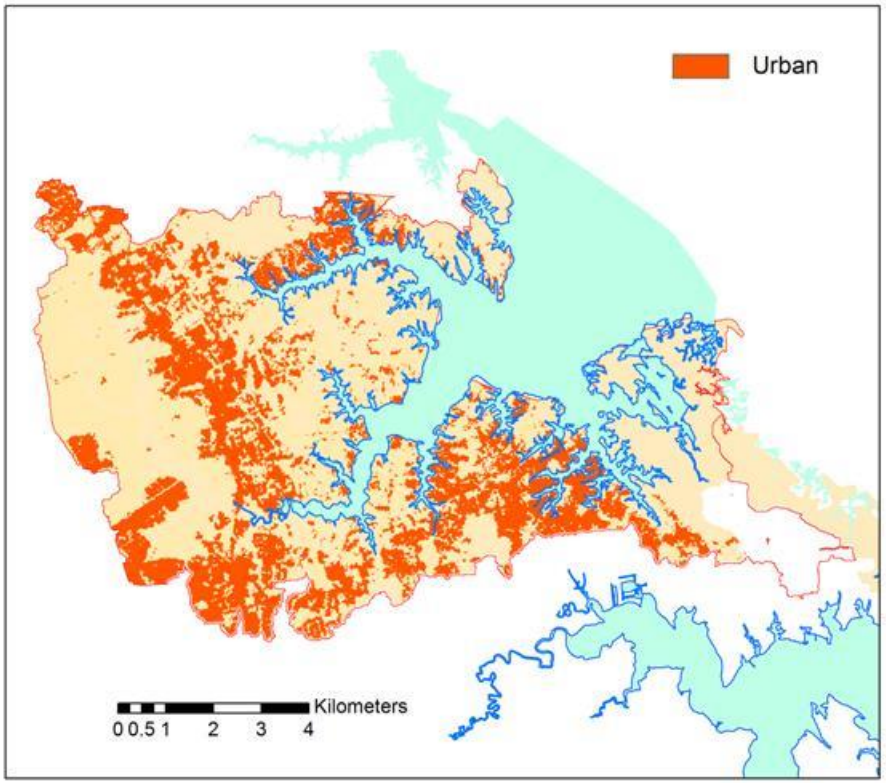
Sanitation Type



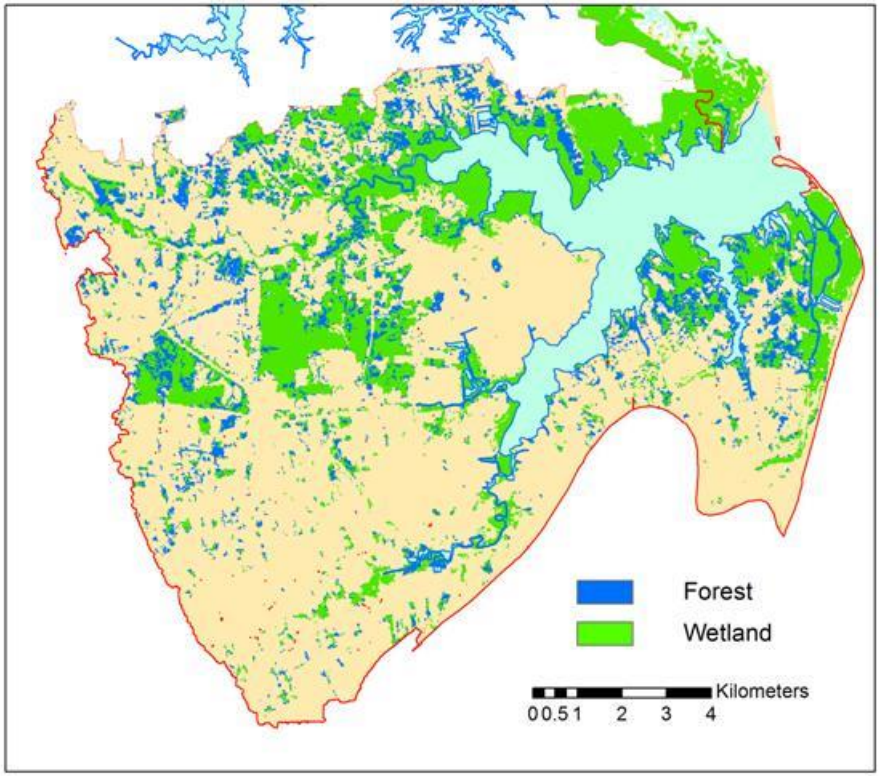
Courtesy of York County
Newport News, Poquoson City

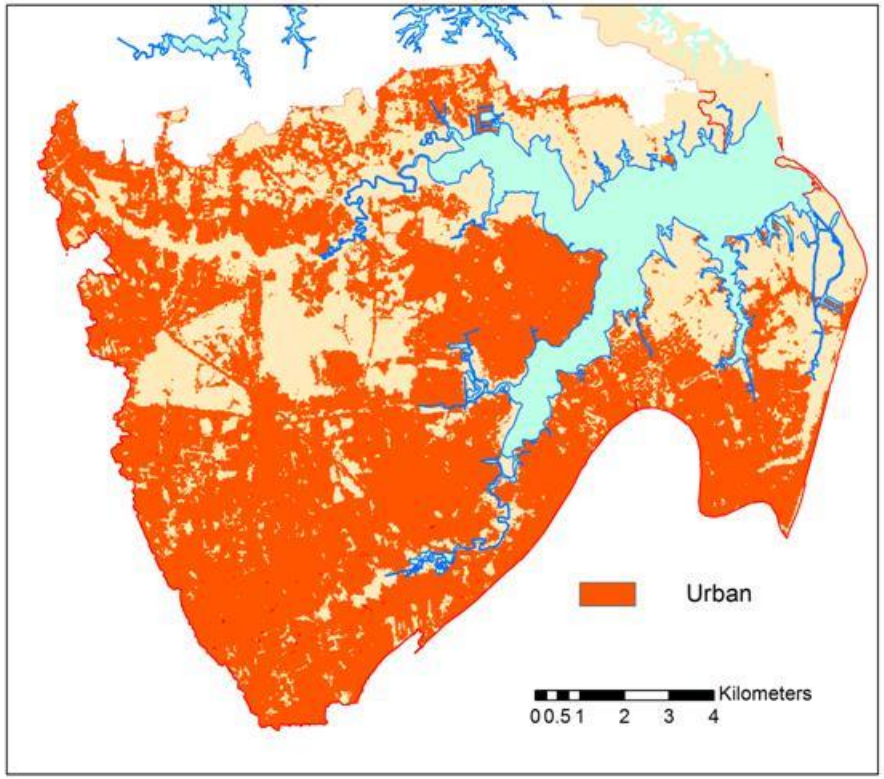
Forest, Wetland, and Urban Land for Poquoson River Watershed





Forest, Wetland, and Urban Land for Back River Watershed





Modeling Approach

- Conduct source analysis
  - Estimate bacteria sources
  - Use Loading Simulation Program C++ (LSPC) to simulate watershed processes: flow and bacteria
- Use 3D hydrodynamic fluid environmental computation code (EFDC)
  - Simulate bacteria transport and fate

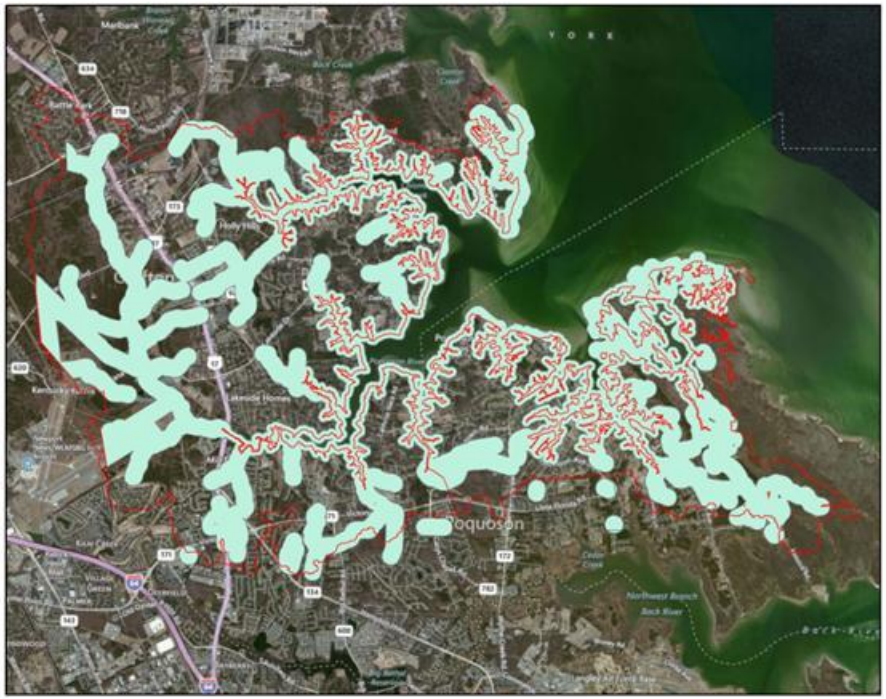
Wildlife Habitat

Wildlife Densities		
Wildlife type	Population Density	Habitat Requirements
Deer	0.047 animals/acre	Entire watershed, except open water and urban development
Raccoon	0.078 animals/acre	Forest and Wetland within 600 feet of streams and ponds
Raccoon	0.016 animals/acre	Upland Forest
Muskrat*	50/mile	Streams and Rivers
Nutria*	18.5/mile	Streams and Rivers
Residential Geese	0.02 animals/acre*	Entire Watershed
Waterfowl	0.002 animals/acre**	Entire Watershed

Bacteria Production

Name	FC (count/animal/day)
Ducks	2,430,000,000
Geese	49,000,000,000
Deer	500,000,000
Raccoons	125,000,000
Muskrat*	250,000,000
Nutria	250,000,000
Dog (Fraction available for runoff 23%)	4,086,000,000

Wildlife Habitat



600 feet habitat near the streams.

Preliminary Source Estimation

Poquoson River

Name	Urban	Crops	Pasture	Grassland	Forest	Wetland	Shore	Barren Land	Open Water	Total	Bacteria/day
Raccoon					102	507				609	7.616E+10
Deer		32	2	2	301	305				606	3.031E+11
Waterfowl	119	14	1	1	128	130	0	1	18	258	1.290E+11
Muskrat						1383				1383	3.457E+11
Dog	8,561									8561	8.045E+12
Total											8.900E+12

Back River

Name	Urban	Crops	Pasture	Grassland	Forest	Wetland	Shore	Barren Land	Open Water	Total	Bacteria/day
Raccoon					52	702				754	9.423E+10
Deer		15	1	3	153	423				576	2.881E+11
Waterfowl	473	6	0	1	65	180	1	7	15	245	1.226E+11
Muskrat						1916				1916	4.790E+11
Dog	33,286									33286	3.128E+13
Total											3.226E+13

Working progress: Septic system overflow (SSOs)

Shellfish Sanitation Survey

- Shellfish Sanitation Survey, Department of Health
  - Sewage pollutant source
  - Marinas
  - Contributes animal pollutants
    - 150-200 chickens, 9 horses, 20 cattle (Poquoson/Back)

Survey 1994-1995

INDEX	TYPE	HORSES	CATTLE	PIGS	CHICKENS	CATTLE	DOGS	GOATS	LARGE_BIRD	BRANCH
116	direct	1								Chisman Creek
129	direct				40					Chisman Creek
135	direct				18					Chisman Creek
152	direct	5								Chisman Creek
154	direct	1			40					Chisman Creek
161	direct		5							Chisman Creek
165	direct		67							Chisman Creek
168	direct	3					12			Chisman Creek
186	direct							3		Patricks Creek
188	direct	1								Patricks Creek
253	direct	1								Poquoson Rive
266	direct	2	4	30	40	4			36	Lambs Creek
302	direct	4								Floyds Bay
63	indirect	5								
106	indirect	5								Chisman Creek
178	indirect	10								ditch
180	indirect				20				10	Hodges Cove C
223	indirect	5						25		ditch
226	indirect	30								Poquoson Rive
227	indirect	5						25		ditch
235	indirect			5	30					Moores Creek
239	indirect	25							30	Moores Creek
321	indirect									
Total		103	76	35	188	4	12	53	76	

Point Source

Permit Number	Permit Type (ie Domestic, Industrial, Seafood…)	Facility Name	Are there limits in the permit for the TMDL pollutant? (*TMDL pollutant is given in parentheses*)	Max Design Flow	Permit Writer	Notes (from CEDS)
VAG110151	GP CONCRETE	TCS Materials - Hampton	no	43200 max daily flow (4hr/day;5days/wk)	Thomas	Process water is collected in a series of pits. Water is reused for truck washout and in fresh concrete.
VAG250121	GP COOLING	Howmet Casting and Services Inc	no	4000 max daily flow	Thomas	OF-002 Cooling Tower & Storm Water –intermittent discharge
VAG523004	GP SEAFOOD	ET Firth Wholesale Seafood	no	50 gal/day (?)	Austin	Small Oyster & Clam shucking operation and shell stock washdown for packaging and shipment
VAG523024	GP SEAFOOD	Seaford Scallop Co	no	500 gal/day(?)	Austin	Buy scallops from trawler boat, box and ice them and wholesale them to customers
VAR050472	GP SWIND	Riggins Co	no		Austin	Fabricated metal products
VA0081311	VPDES	HRSD - York River Sewage Treatment Plant	**YES** (Fecal coliform/enterococci)	15.03 MGD	Austin	
VA0089320	VPDES	US DOE - Thomas Jefferson National Accelerator Fac	no	0.027 MGD	Austin	TJNAF will discharge groundwater and cooling water from two permitted outfalls. The following parameters will be limited to protect water quality: gross beta activity, pH, total residual chlorine, tritium.
VAG750138	GP CARWASH	Enterprise Rent a Car	no	50 g/d	Thompson	Fleet vehicle washing
VAG750152	GP CARWASH	Triangle Rent a Car	no	100 g/d	Thompson	Fleet vehicle washing
VAR050240	GP SWIND	Highway Motors of Hampton Virginia Incorporated	no		Thompson	Auto salvage yard
VAR050475	GP SWIND	Howmet Casting and Services	no		Thompson	Primary metals
VAR051654	GP SWIND	Frito Lay-Hampton Bins	no		Thompson	Terminated 10/2011 Land transportation warehousing
VAR051742	GP SWIND	Insurance Auto Auctions-Tidewater	no		Thompson	
VA0005975	VPDES	Newport News City -	no	1.97 MGD	Thompson	The discharge is process

Additional Permits

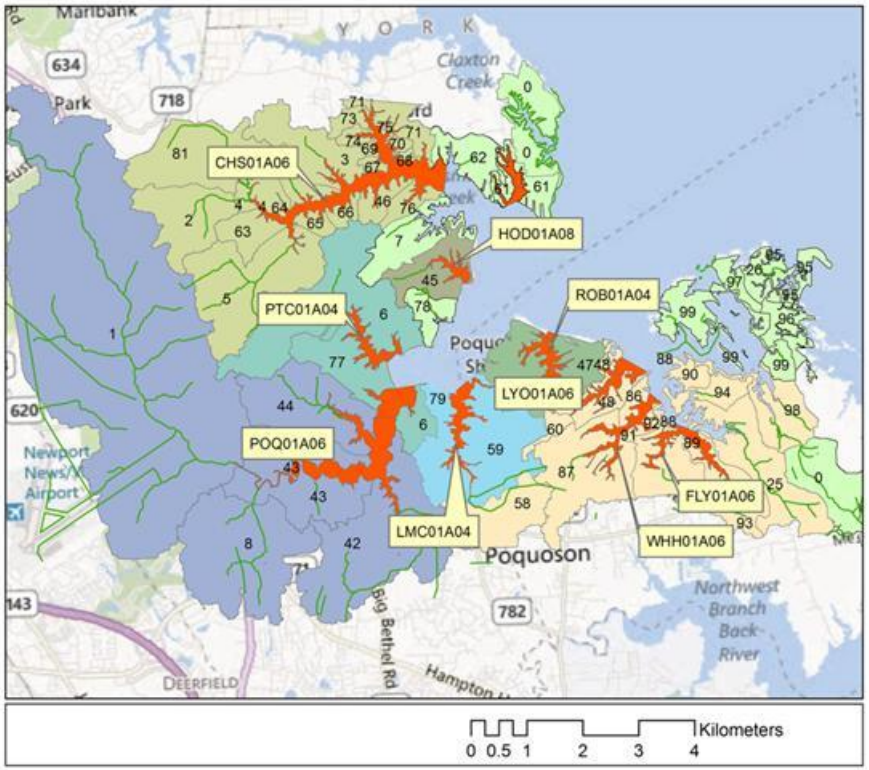
- MS4 – Phase I (Newport News and Hampton)
- MS4 – Phase II (York and Poquoson Counties)
- Other MS4 Phase II (Thomas Nelson Community College, NASA Langley Research Center, DOE Thomas Jefferson Accelerator Facility, Newport News-Williamsburg Airport, and VDOT)

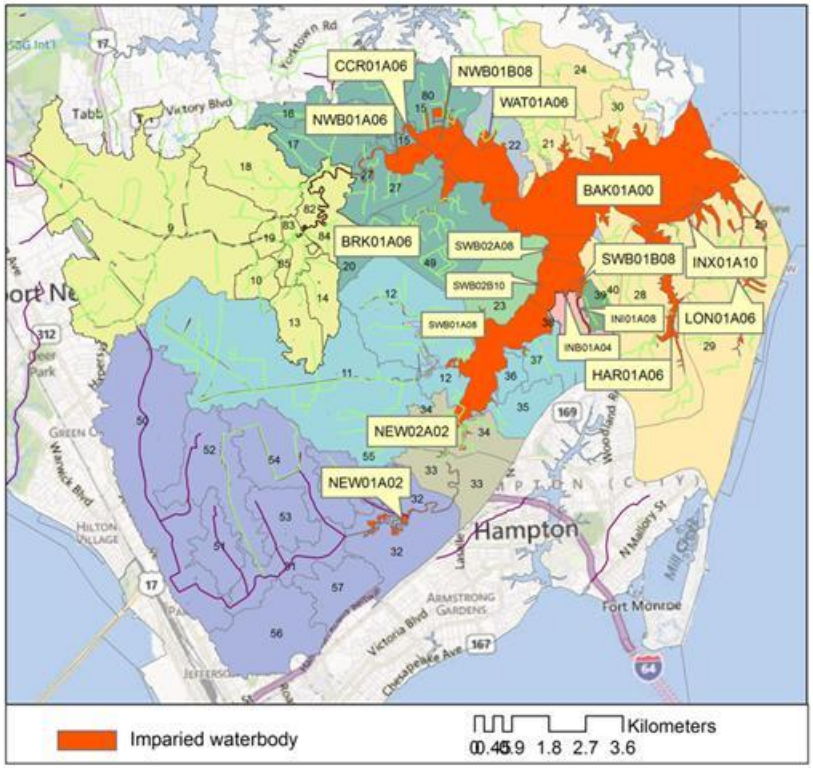
Model Simulation

- Watershed Segmentation
  - Simulation flow, loading using Loading Simulation Program C^{++} (LSPC)
- Receiving water
  - grid generation
  - Simulate pollutant transport using Environmental Fluid Dynamic Computer Code (EFDC)
- Both models are supported by USEPA

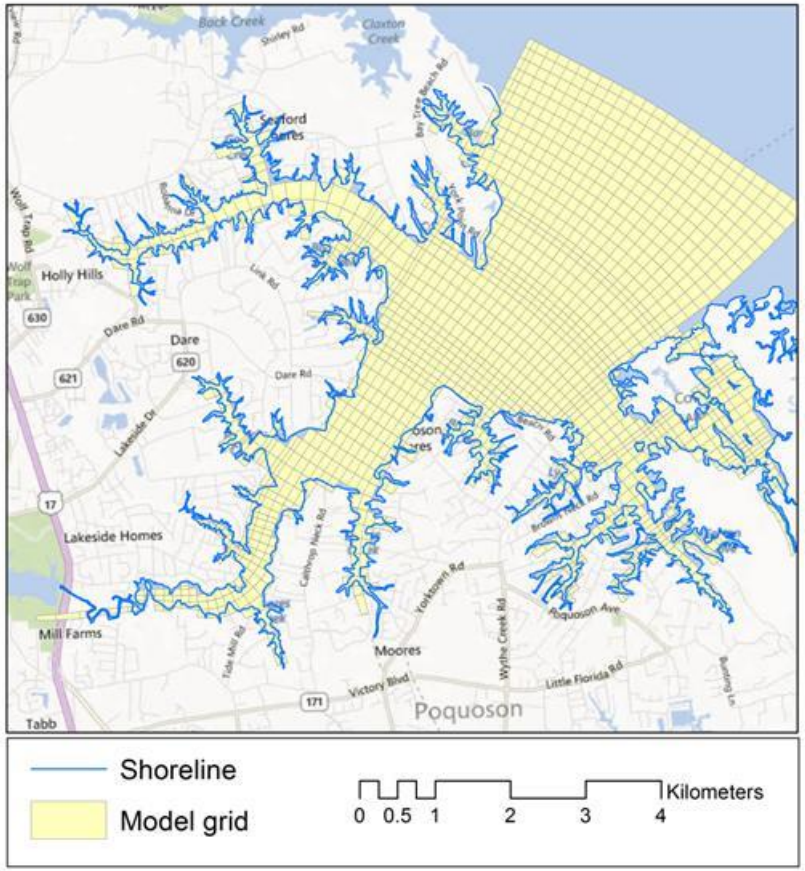
Watershed Segmentation

Poquoson River: 51 sub-watersheds
Back River: 40 sub-watersheds

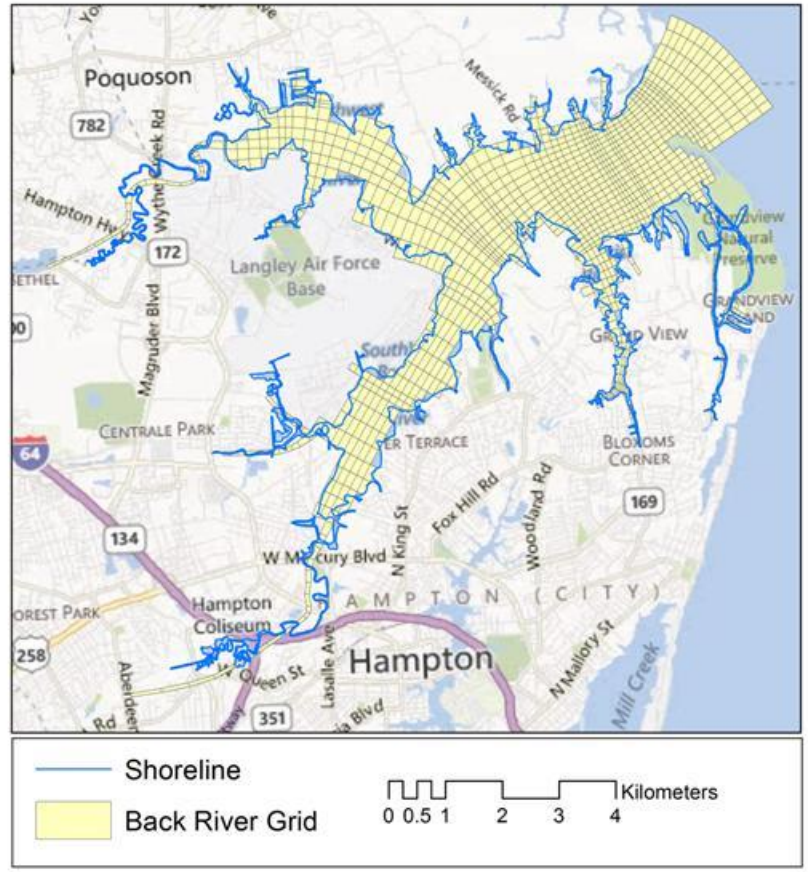




Three-dimensional Model Grid



1595 horizontal grids and 3 vertical layers.



1264 horizontal grids and 3 vertical layers

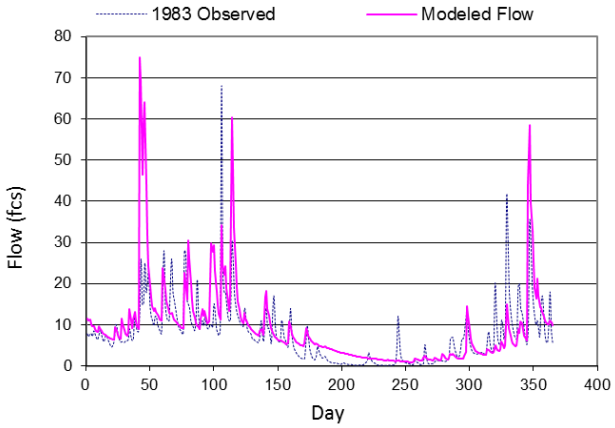
TMDL Development

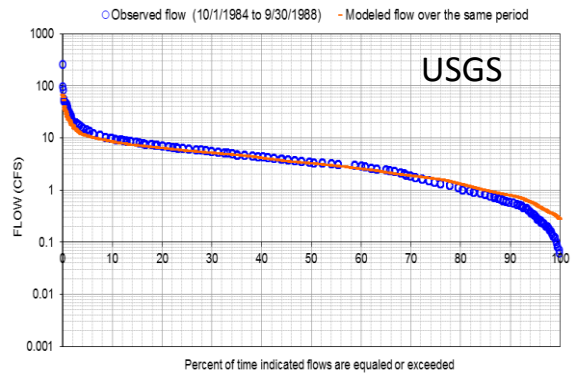
- Perform source analysis
- Use linked watershed and in-stream modeling approach
- Develop watershed model
- Simulate daily bacteria loadings from watershed
- Conduct watershed model calibration
- Discharge loads to in-stream model
- Use in-stream water quality model for simulating bacteria transport and fate
- Calibrate bacteria transport model
- Compute allowable loads and determine load reduction

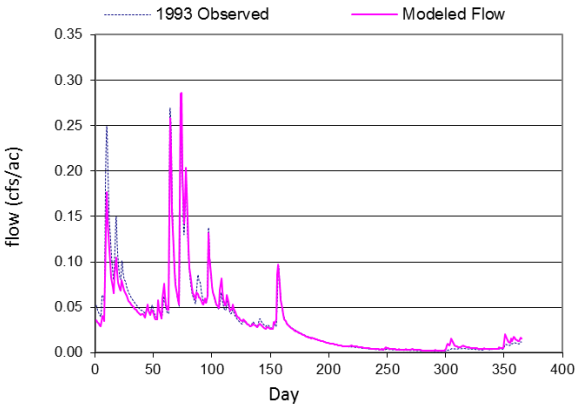
Preliminary Model Results

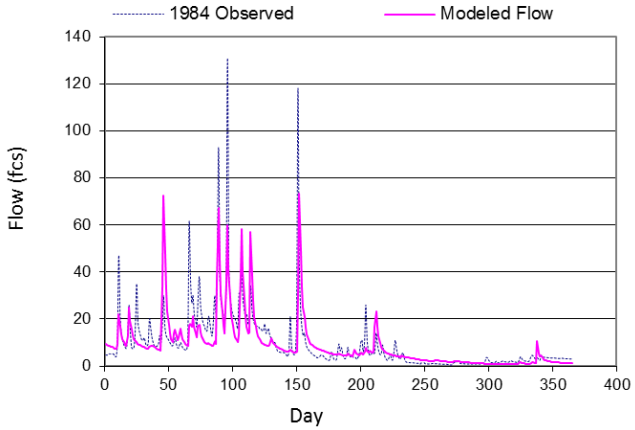
Watershed Model Calibration

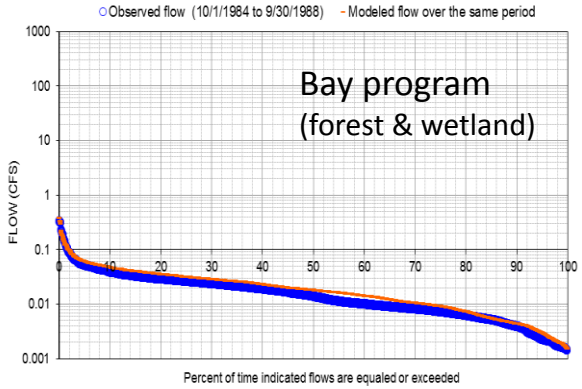
- Compare model results to nearby USGS station (USGS 01670000 BEAVERDAM SWAMP NEAR ARK, VA, 80-88)
- Compare to Bay Program watershed model results

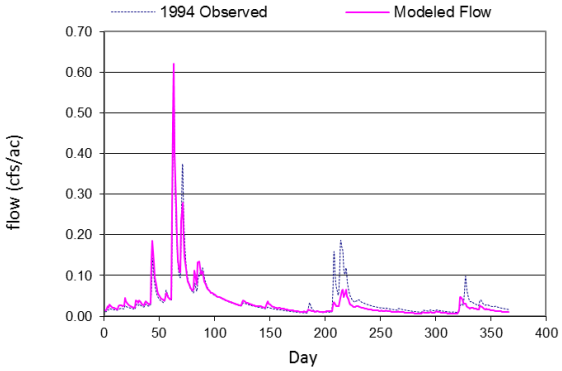




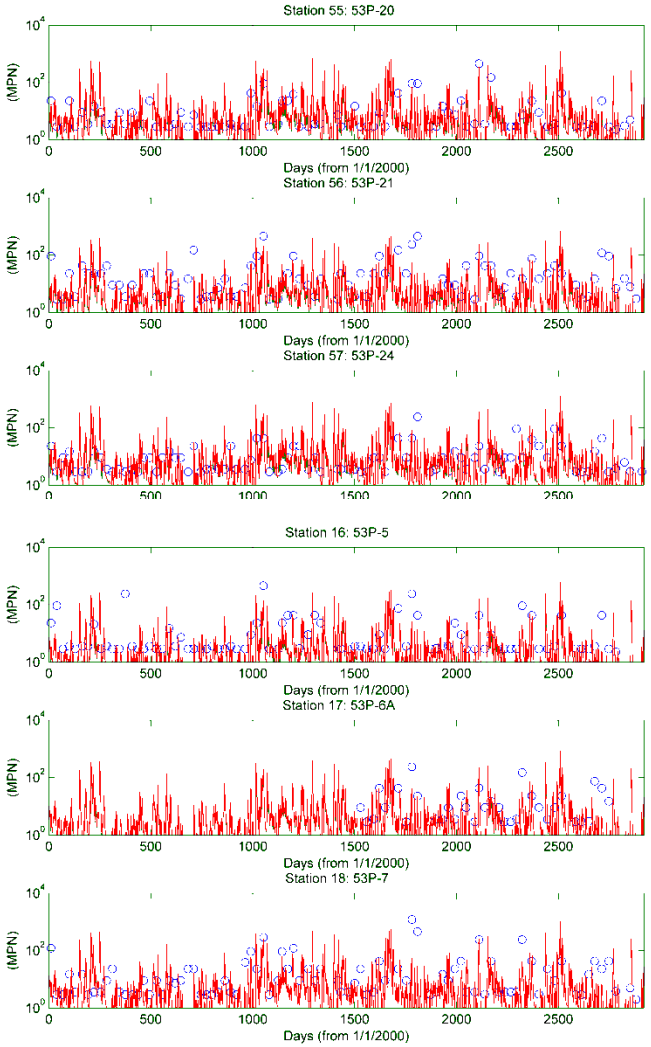


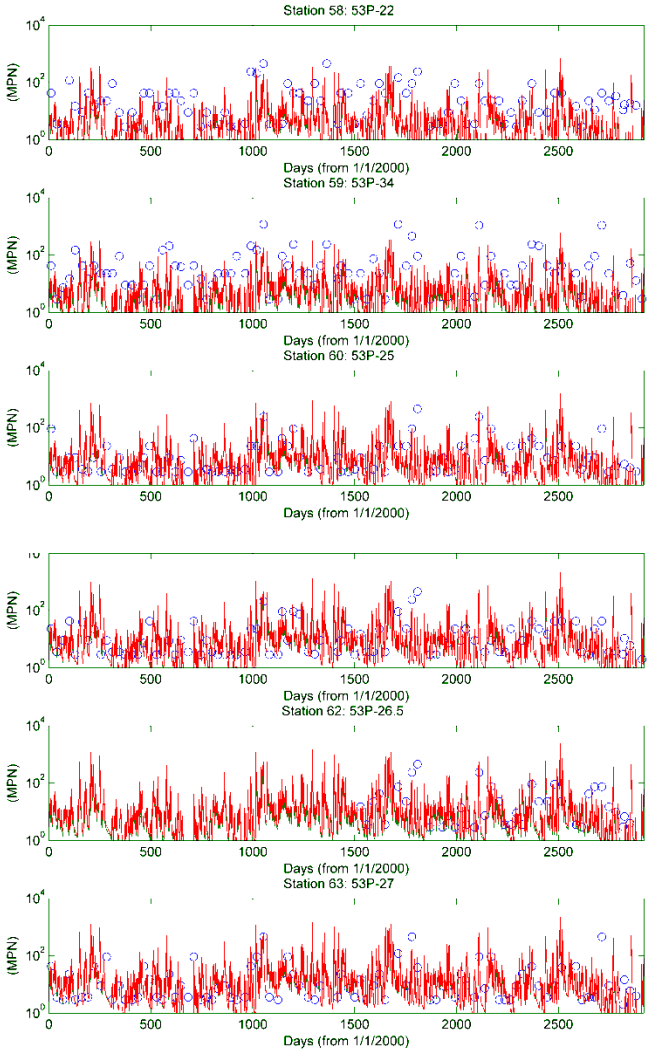




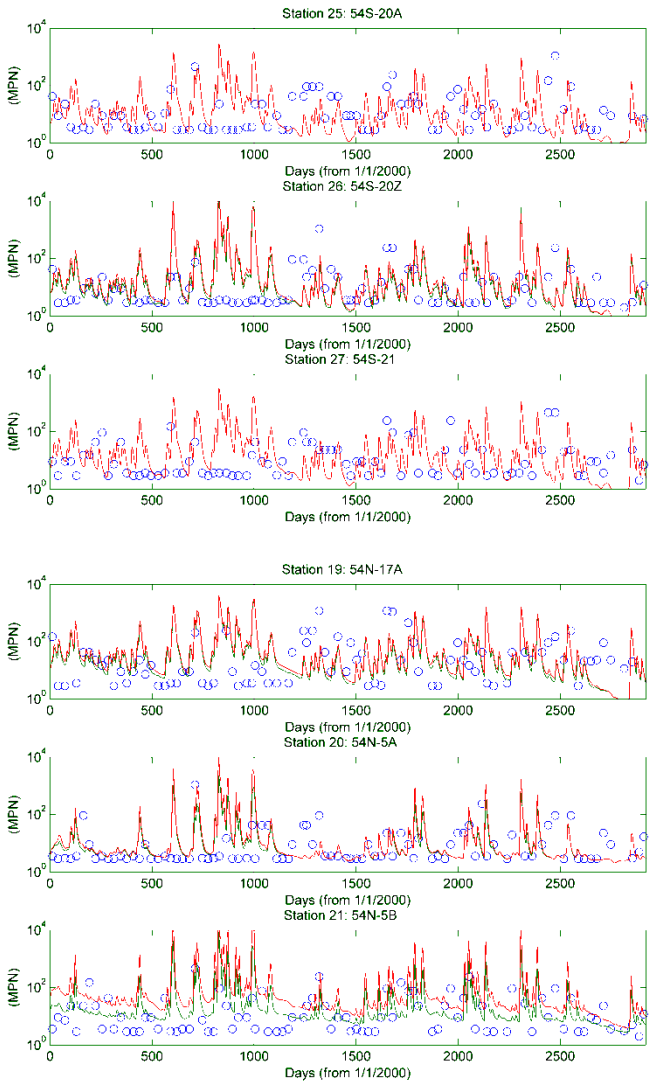


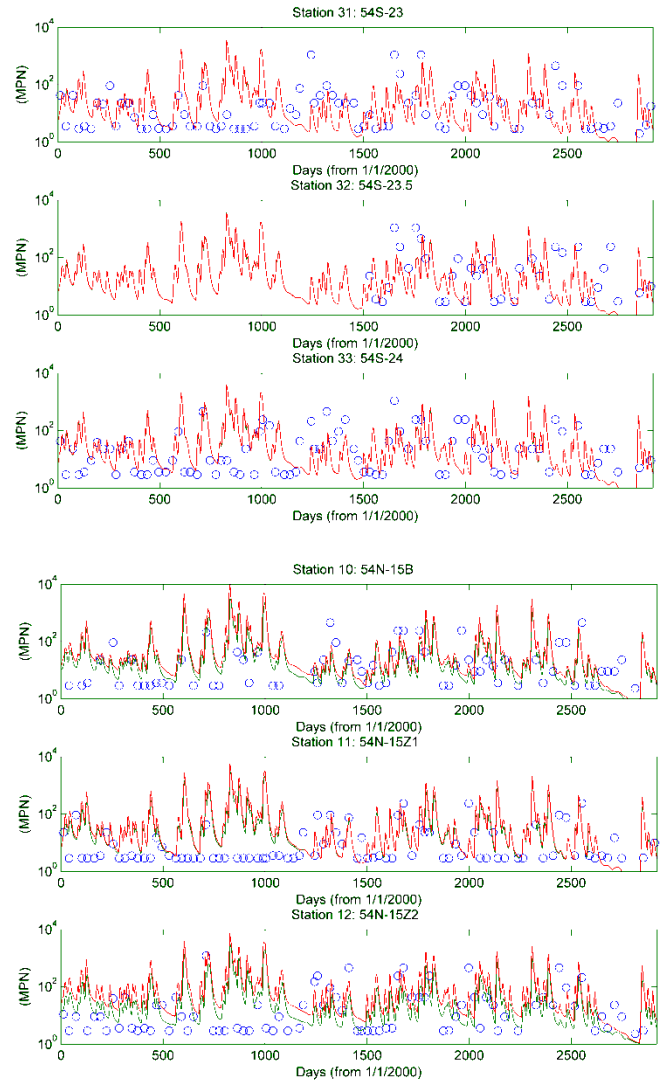
Example of Bacterial Model Results (Poquoson River)





Example of Bacterial Model Results (Back River)





Questions and Comments

(comment period March 19- April 17)

- Source estimation ?
- Loading estimation ?
- TMDL calculation ?
- Other questions/comments ?

Thanks!

Comments send to:
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Virginia Beach, VA 23462