Development of DO TMDLs of Little Mosquito and Assawoman along Virginia's Eastern Shore

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Public Meeting
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Why We Are Here

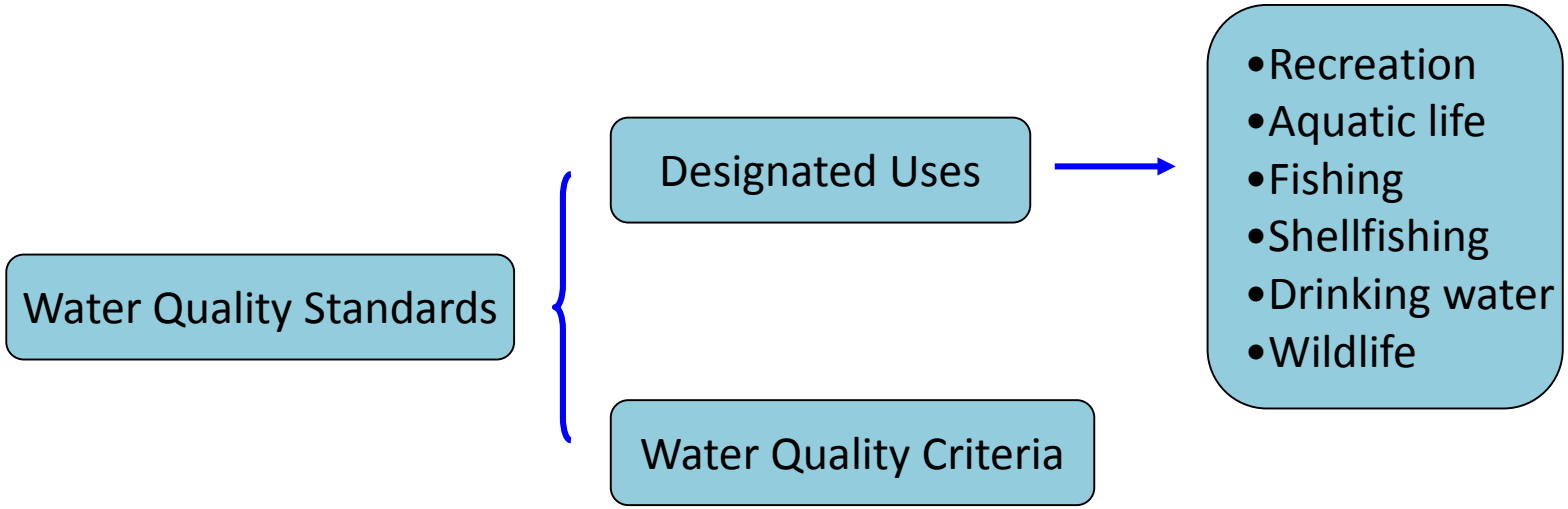
1. To examine water quality conditions for these creeks
2. To discuss the Total Maximum Daily Load (TMDL) development
3. To review the procedures of source assessment
4. To discuss the next steps of TMDL development
5. To gather comments and encourage public participation

Outline

- The TMDL process
- Impaired waters and pollutants
- Procedures of pollutant source assessment
- Developed modeling approach
- 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 impaired water body
- A TMDL is the amount of a particular pollutant that a stream can receive and still meet Water Quality Standards
- Water quality standards are regulations based on federal or state law that set numerical or narrative limits on pollutants



What is a TMDL ?
Total Maximum Daily Load

A TMDL is the amount of a particular pollutant that a stream can receive and still meet Water Quality Standards
AKA "Pollution Diet"

TMDL = Sum of WLA + Sum of LA + MOS

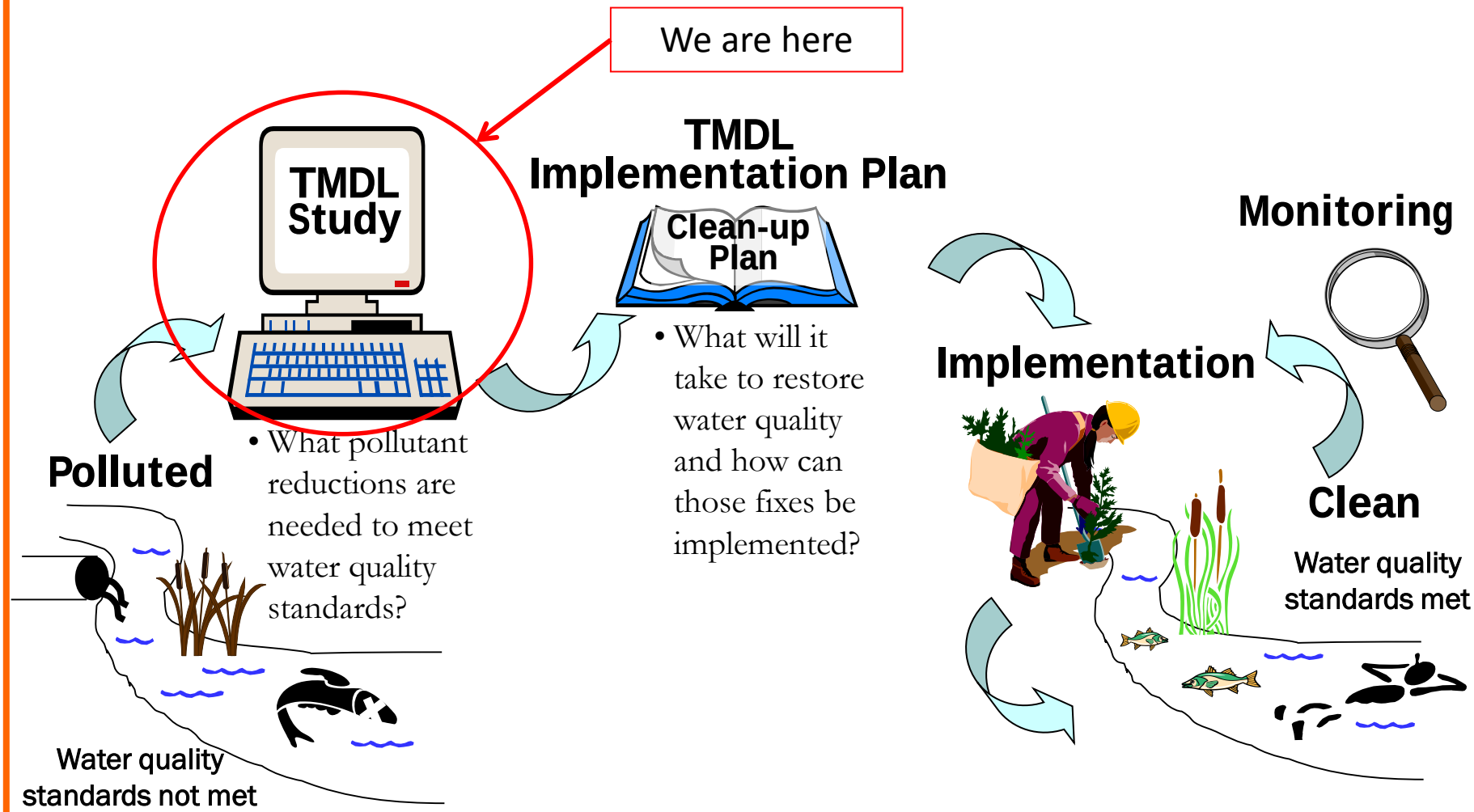
Where:

TMDL = Total Maximum Daily Load
WLA = Waste Load Allocation (point sources)
LA = Load Allocation (nonpoint sources)
MOS = Margin of Safety

Current Load = current loads discharged to the water body, which will be determined during this study

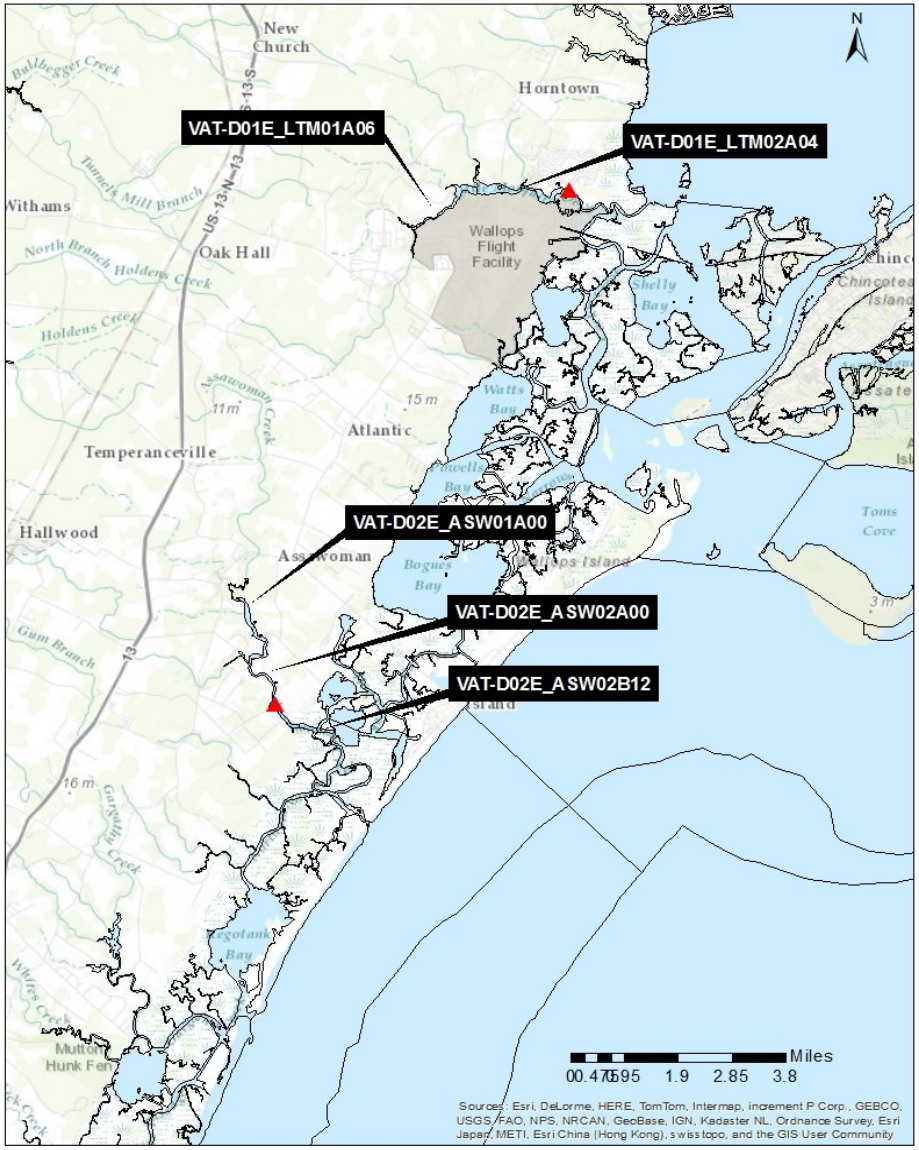
Reduction % = (current load –TMDL)/ current load x 100%

Overview of TMDL Process



Graphic adapted from Dr. Robert Brent, Virginia DEQ

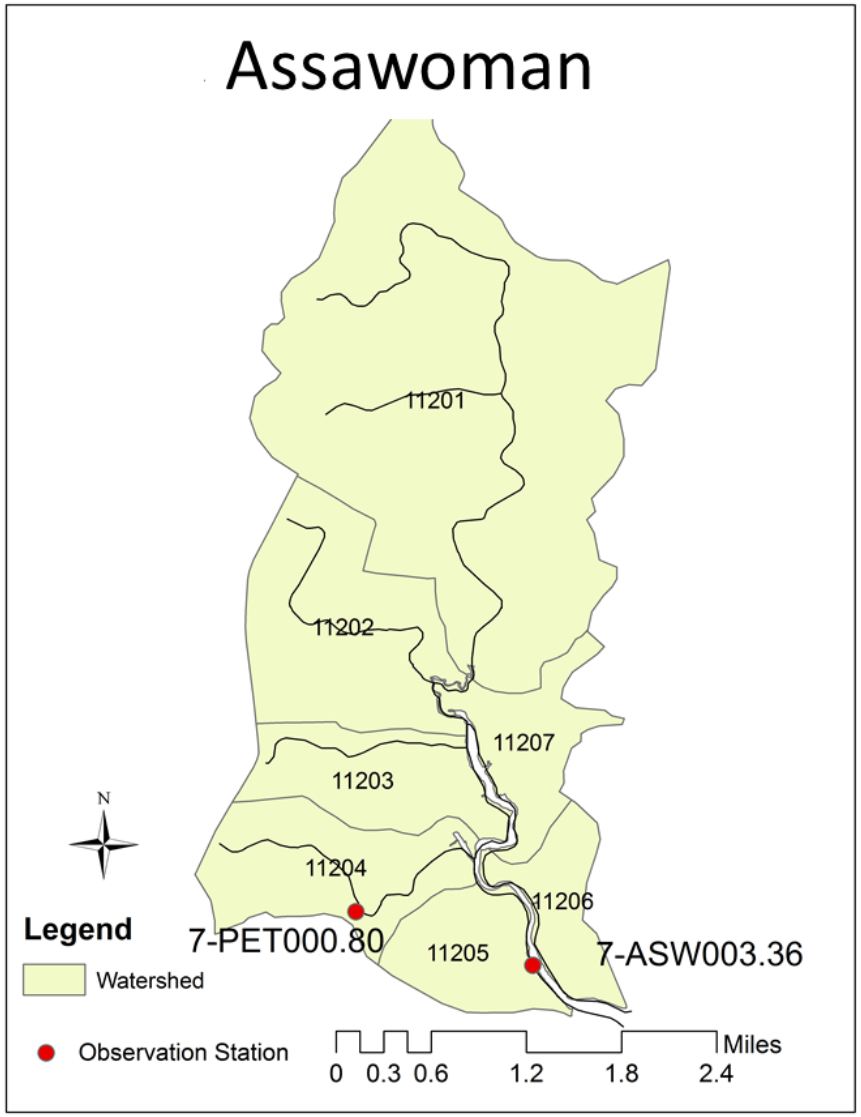
Impaired Waters of Little Mosquito and Assawoman

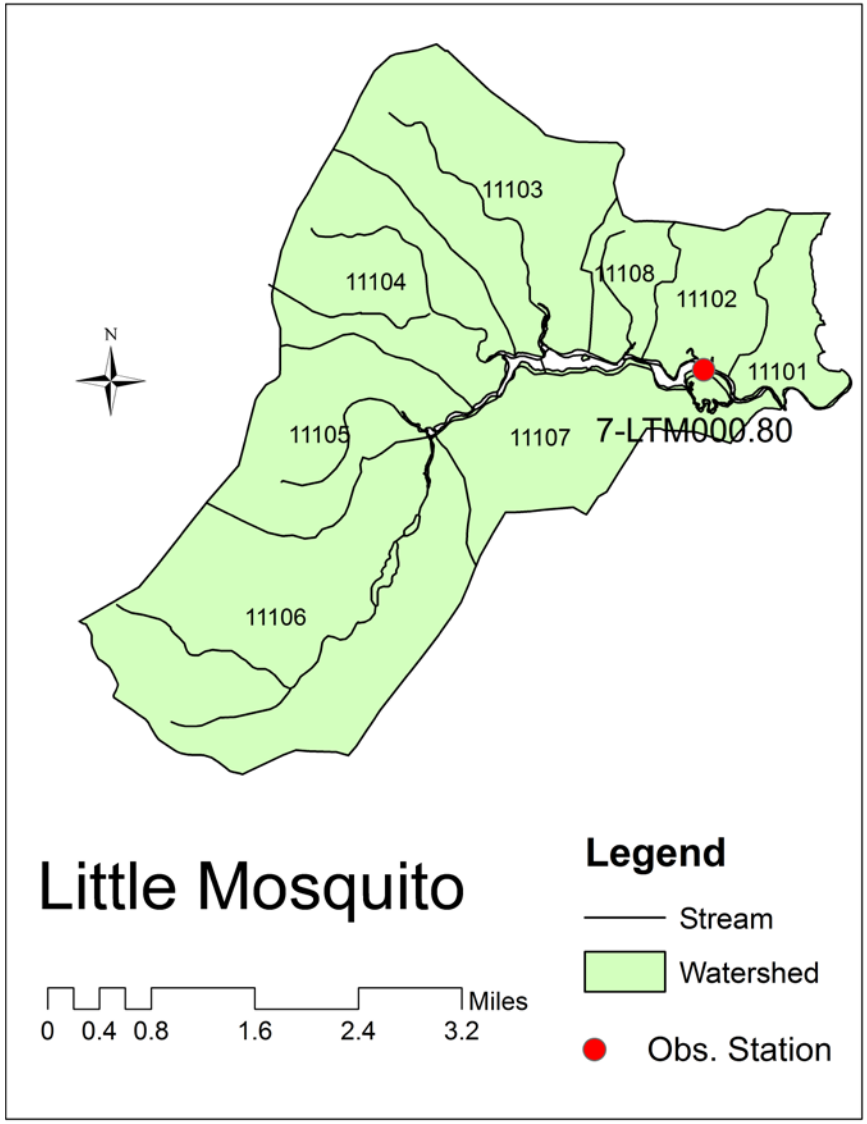


Water Quality Criteria

- Dissolved Oxygen Criteria (9VAC25-260-50)
  - Instantaneous minimum of 4.0 mg/L
  - Daily average minimum of 5.0 mg/L

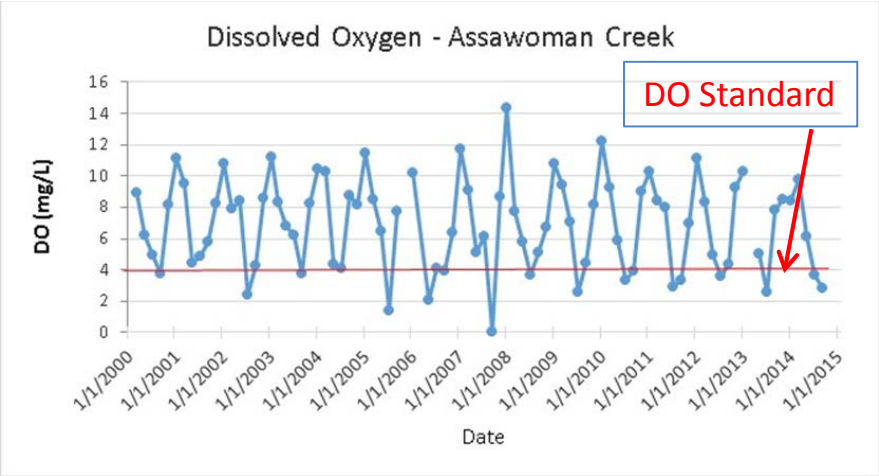
Observation Stations (DEQ)

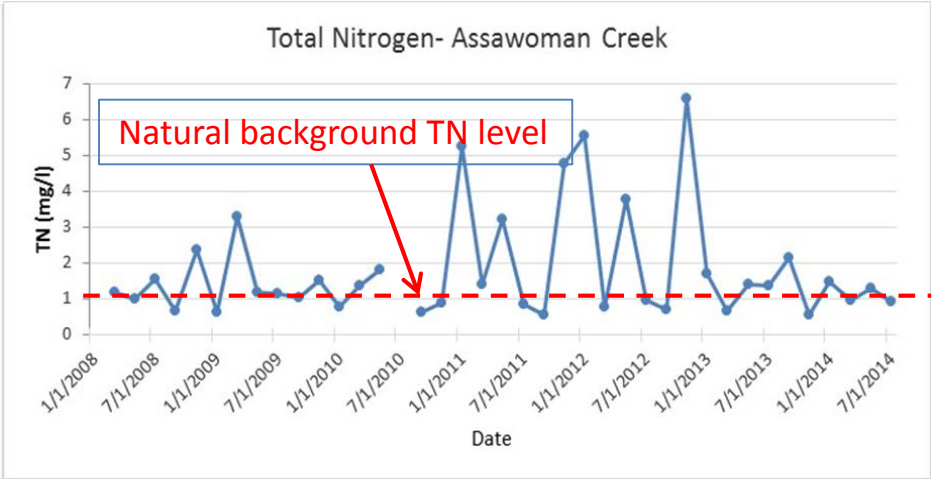


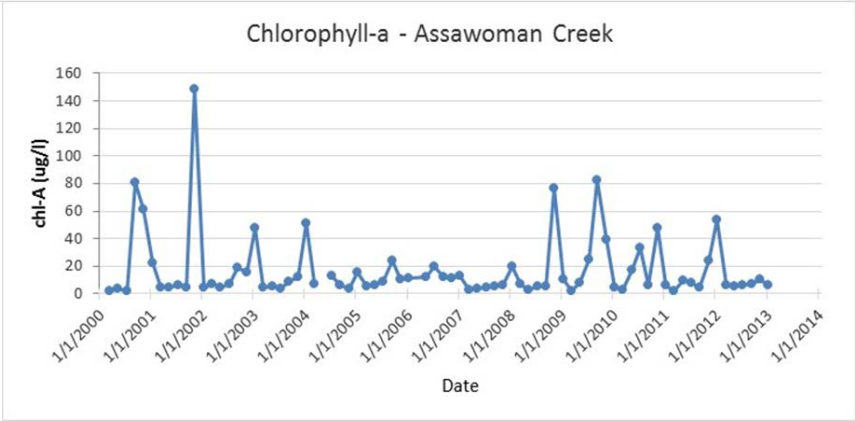


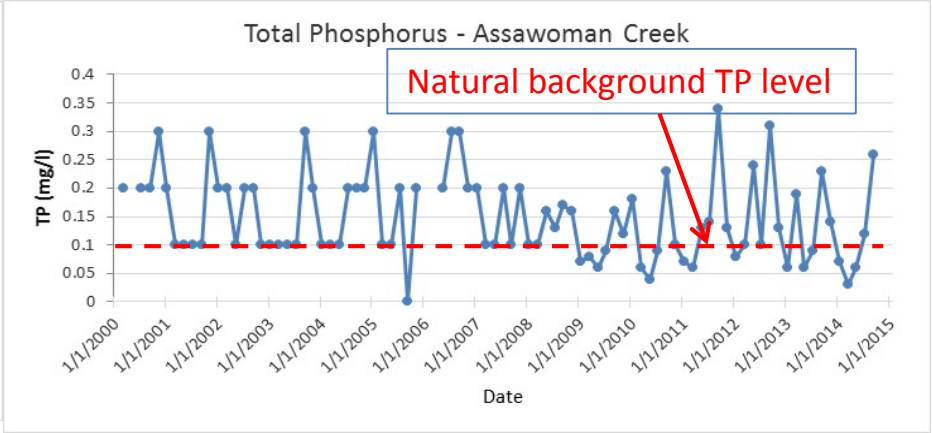
Impairment Assessment

Water Quality Variable Distribution

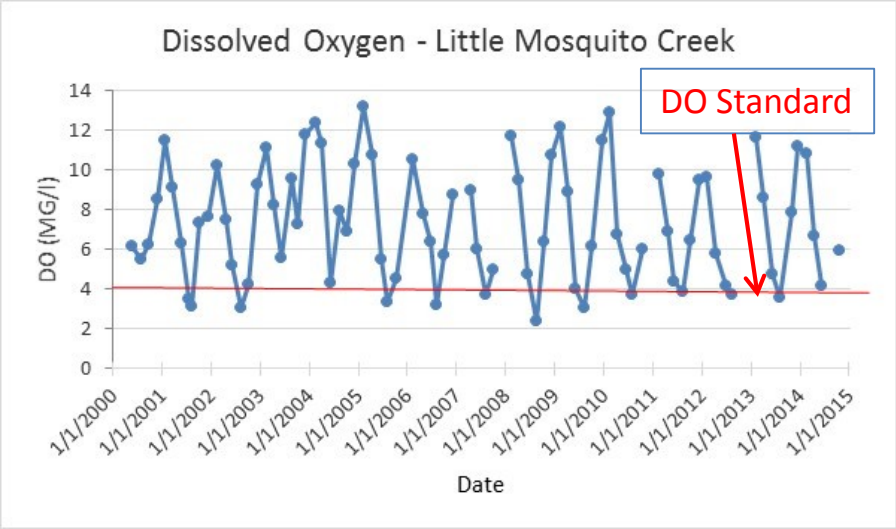


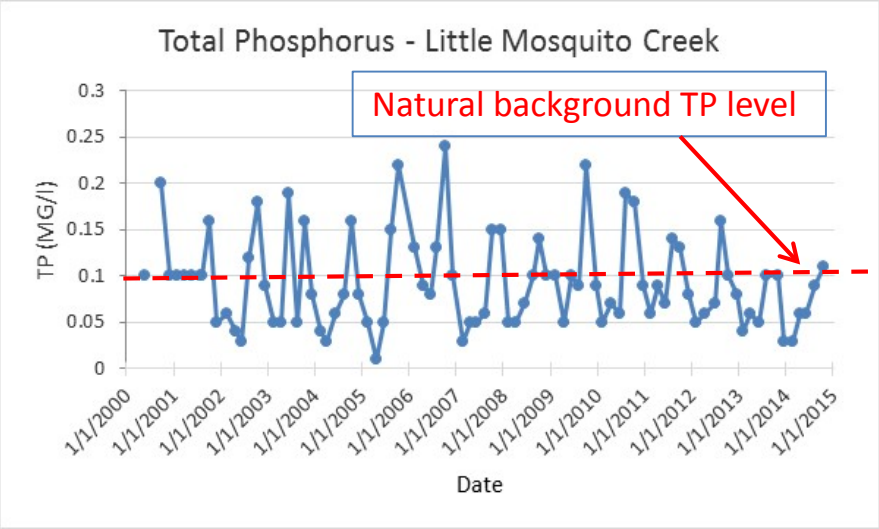


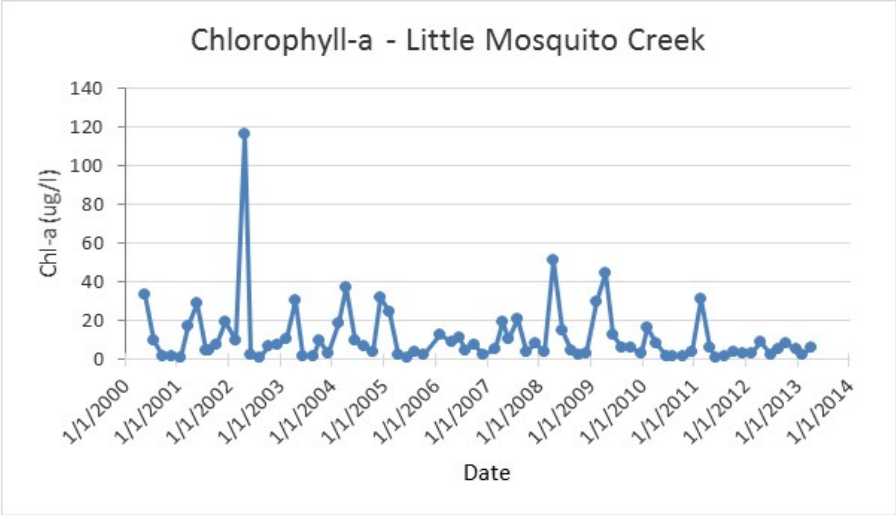


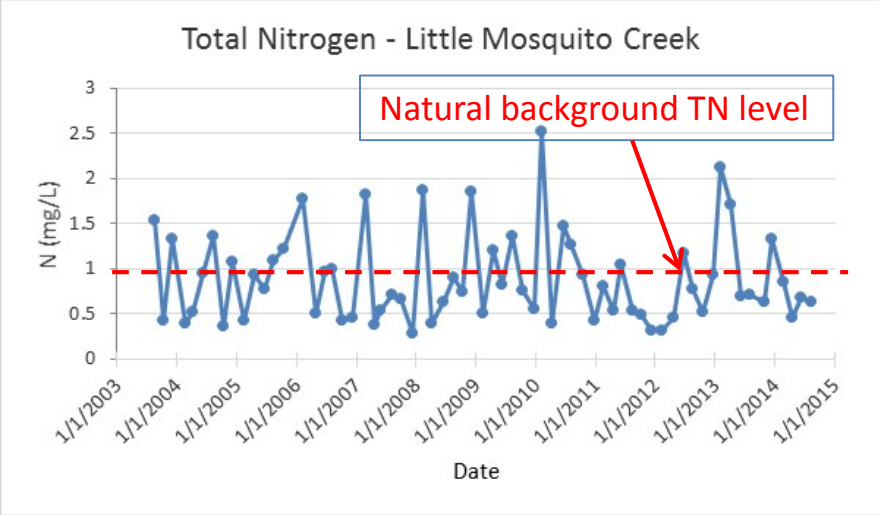


Water Quality Variable Distributions





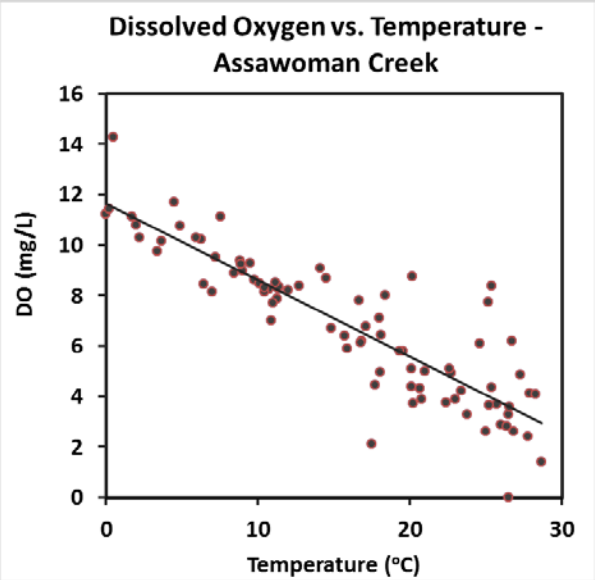


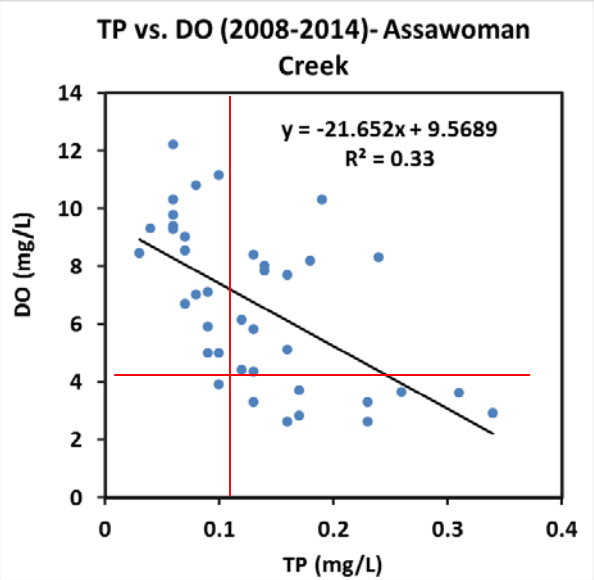


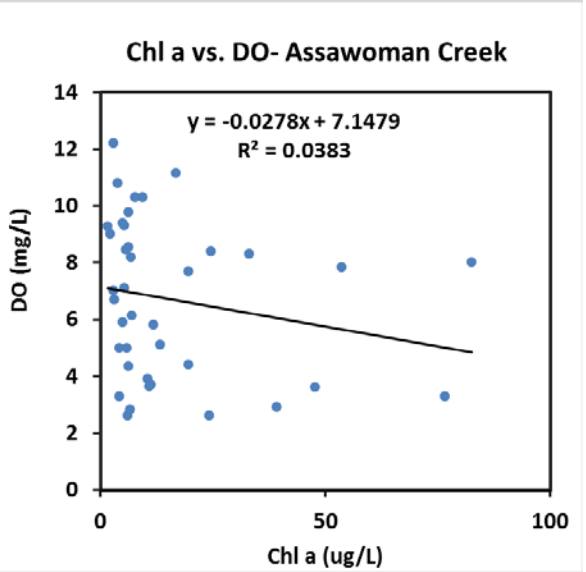
Procedure of TMDL development

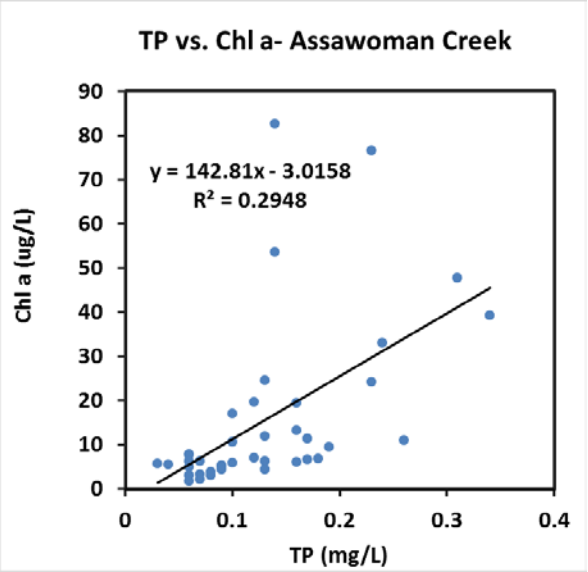
- Conduct data analysis
  - Evaluate the causes of low DO
- Conduct source analysis
  - Land use analysis
  - Estimate nutrient sources (human, agriculture, livestock, wildlife, atmospheric deposition, etc.)
  - Estimate loadings from each source
- Model Study
  - Use the watershed model to simulate watershed processes: flow and nutrient discharges
  - Use the 3D hydrodynamic model to simulate eutrophication processes
- TMDL and load allocation
  - Determine TMDLs (allowable pollutant loads)
  - Determine load reduction
  - Determine load allocation

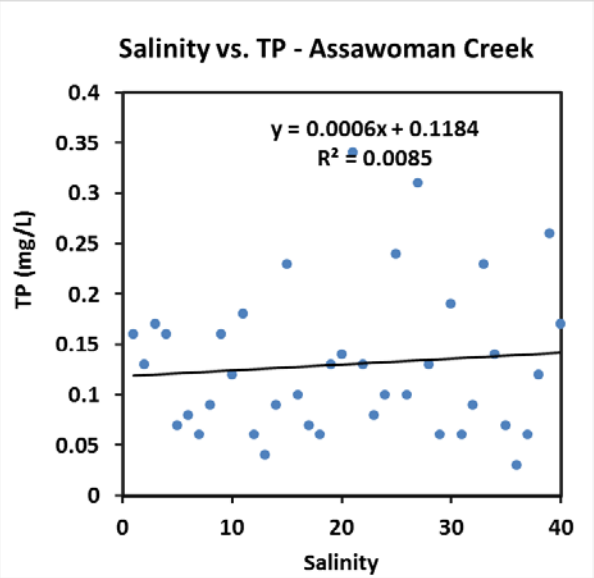
Data Analysis - Correlation Analysis

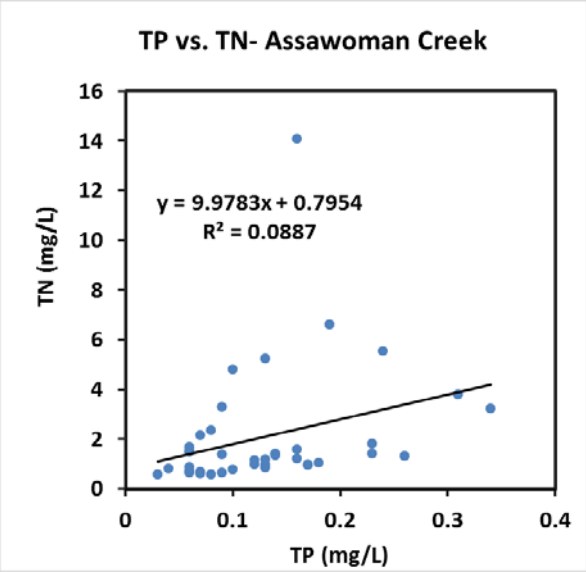












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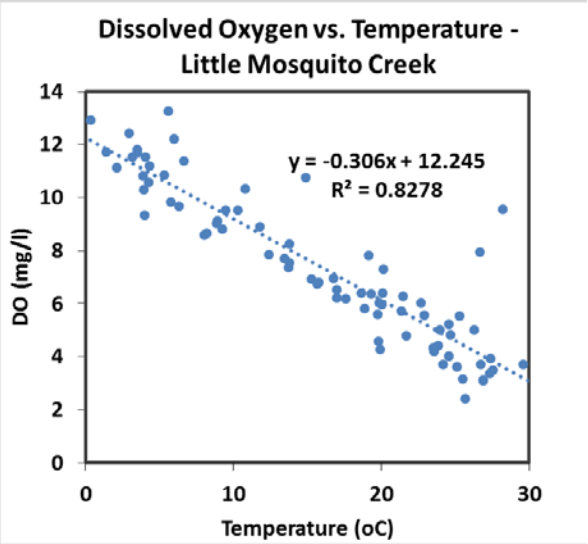
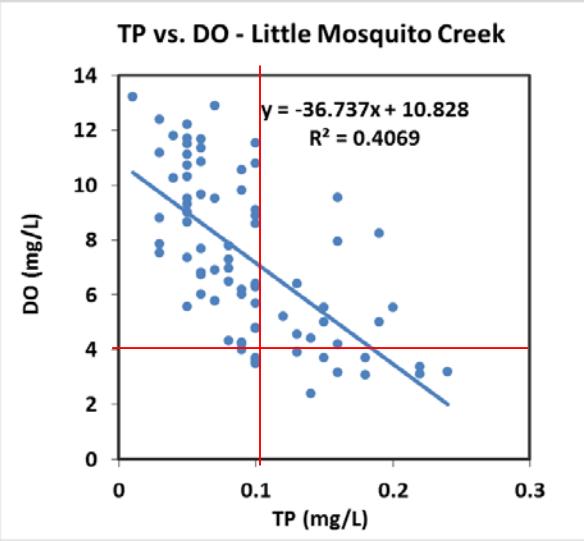
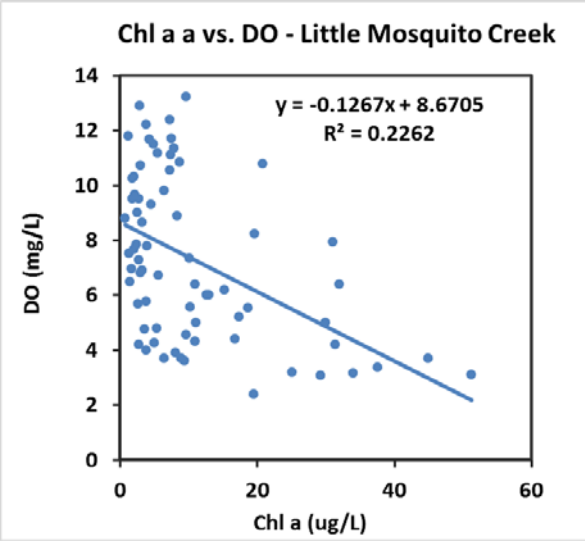
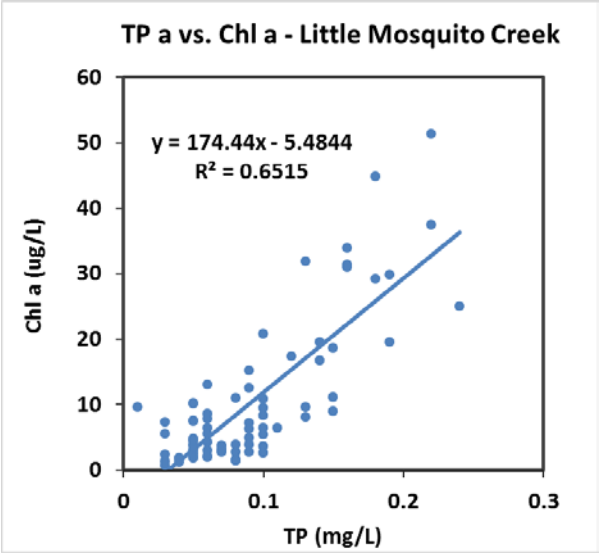
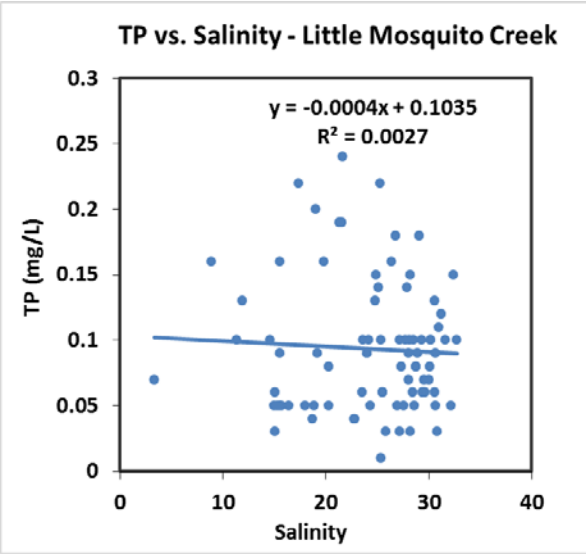
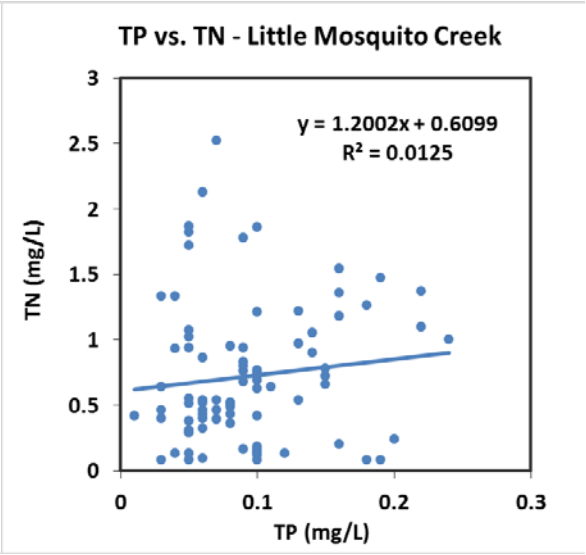




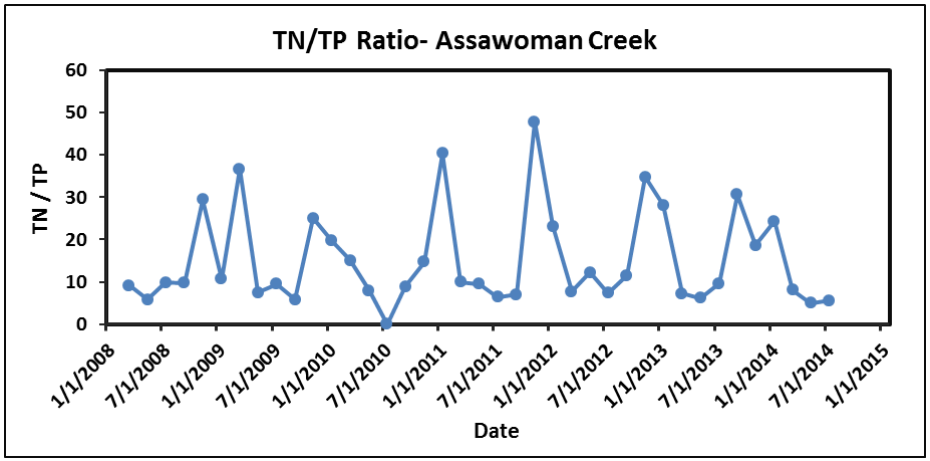


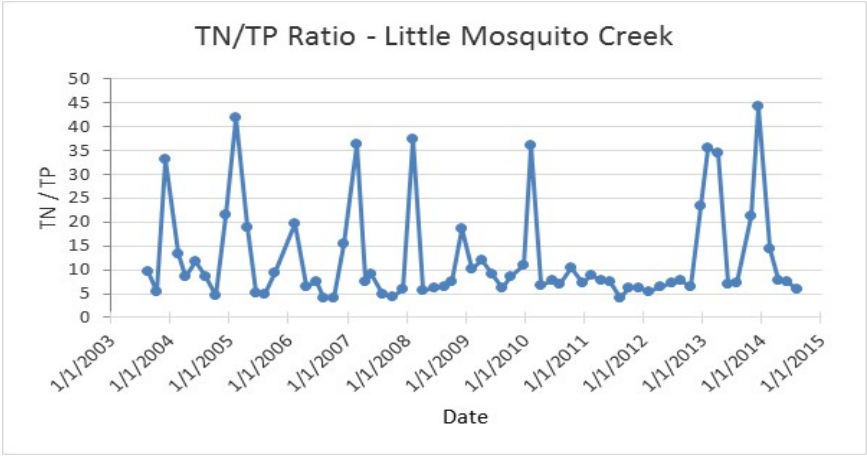


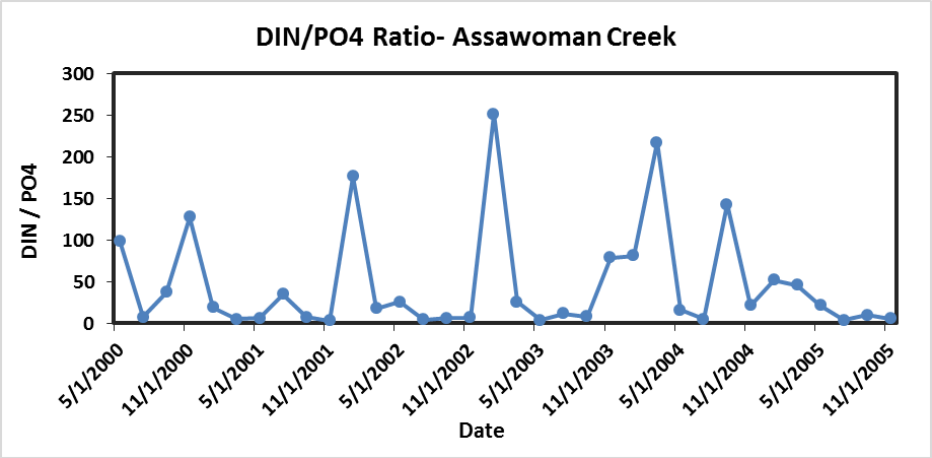


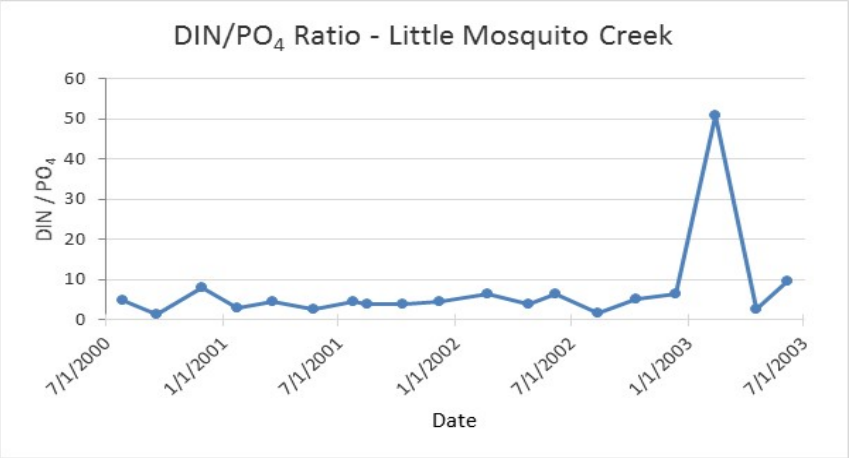


Data Analysis- Nutrient Limitation









Summary of Data Analysis

- The national background concentration (average nutrient concentration (USGS, 1999)
  - 0.6 (mg/L) for nitrate (NO_3^-)
  - 1.0 (mg/L) for total nitrogen (TN), 0.7 (EPA)
  - 0.1 (mg/L) for total phosphorus (TP), 0.03 (EPA)

- Impaired segment
  - TP and TN both > natural background or EPA assessment criteria
  - TN:TP > 7.2 (a theoretical TN:TP ratio), indicating that P is limited. Algae growth requires use both nutrients N and P. If P is limited, it suggests that phosphate will be consumed first. Therefore, reduction of P is more useful for reducing algal blooms than reduction of N.

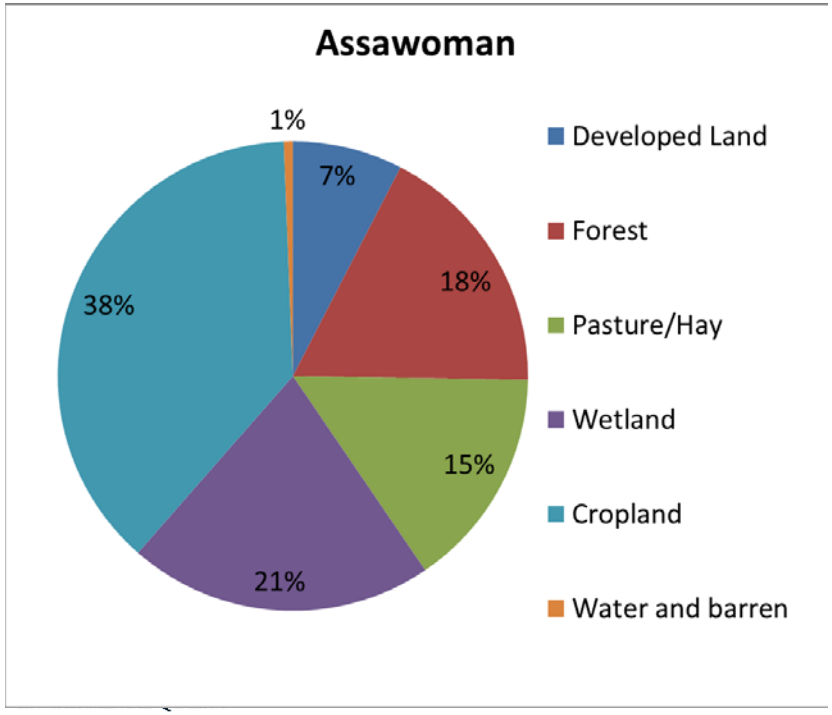
Probable Causes of Low DO

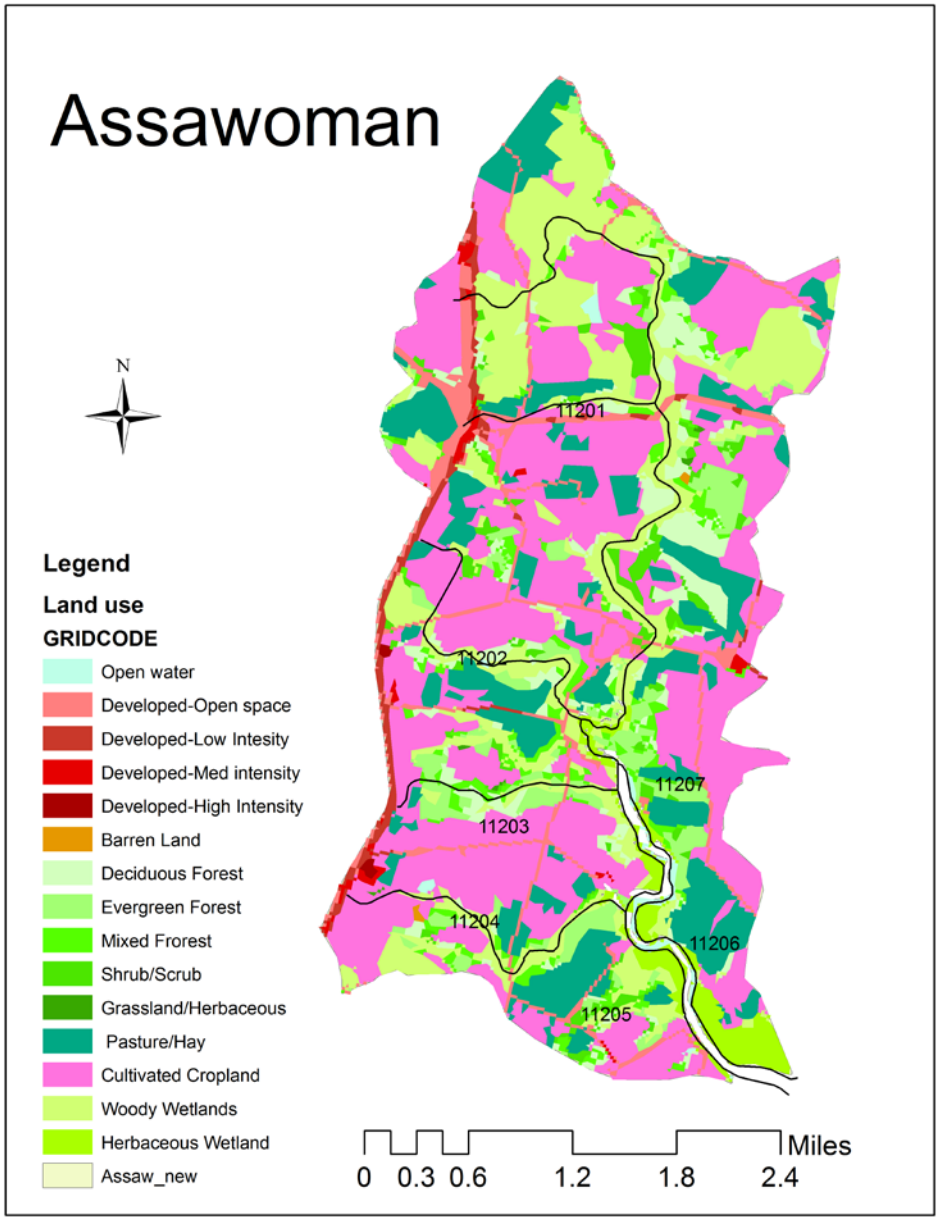
- DO decreases as temperature increases (high correlation)
- DO decreases as TP increases
- DO decreases as salinity increases (no significance)
- Chl-a increases as TP increases
- No linear correlation between DO and Chl-a (proxy for algae)

- High nutrients and organic carbon are transported to the estuary, which cause algal blooms. Both organic carbon discharge from runoff and that generated from algal blooms will deposit to the bottom. When temperature is high and the estuary is stratified, high sediment oxygen consumption and water column oxygen consumption cause lower DO.
- It appears the P is limited in both creeks. The fact that TP does not correlate with salinity indicates that most of the TP is transported from the watershed or sediment flux when DO becomes low.
- Because high algal concentration does not occur each year, the input of organic carbon can also affect DO. The organic carbon input needs to be investigated.

Land Use
(USGS NLCD 2011 data)

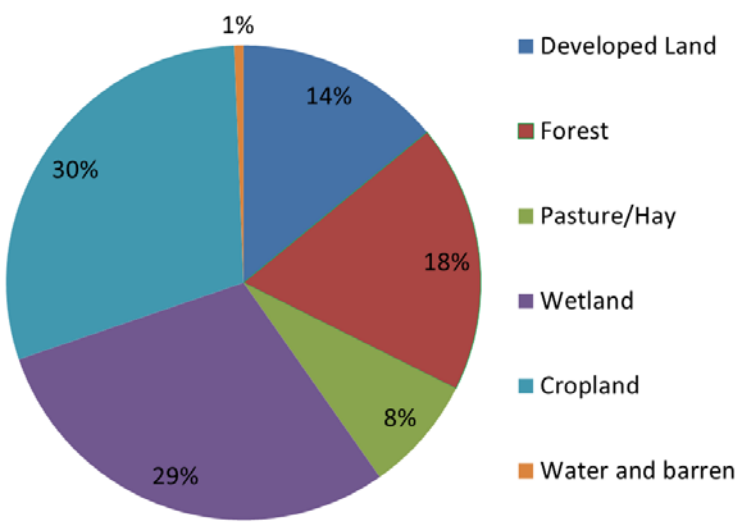
Total area: 6775 acres

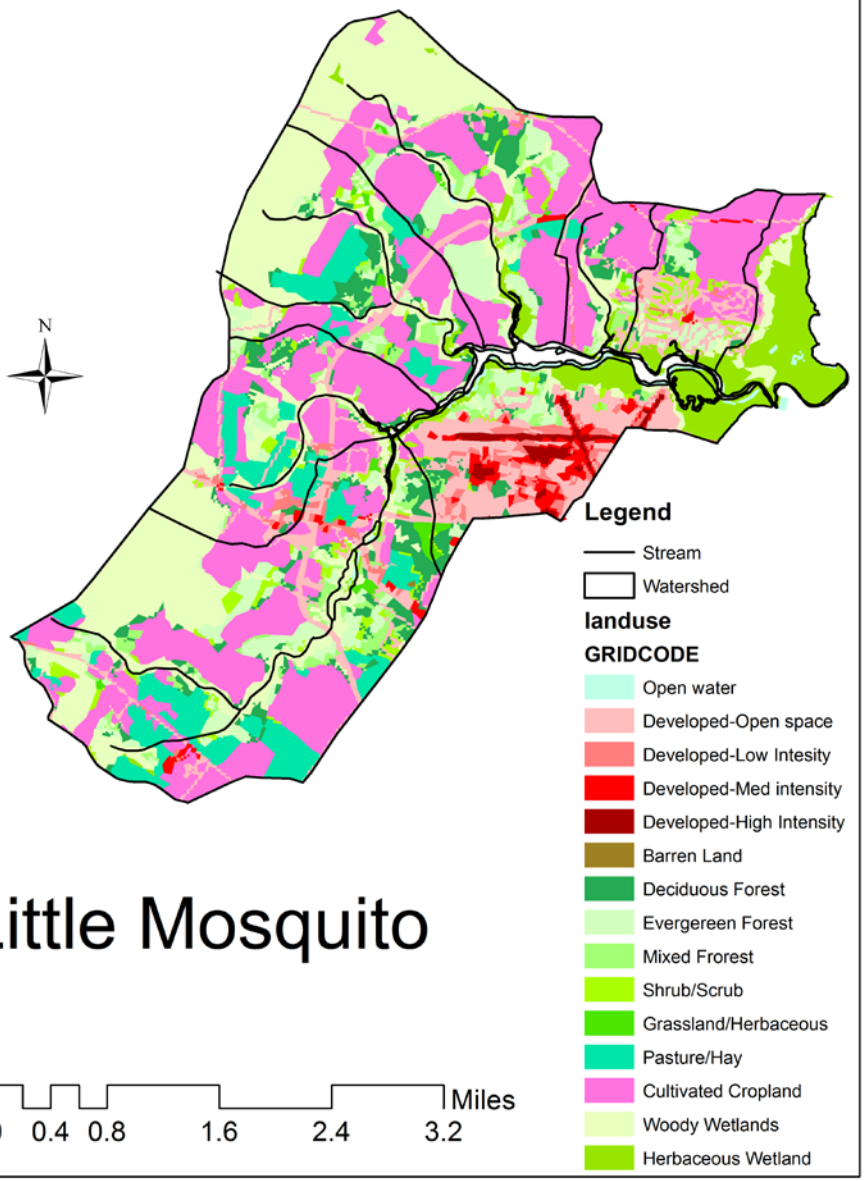




Land Use
(USGS NLCD 2011 data)

Total area: 9577 acres





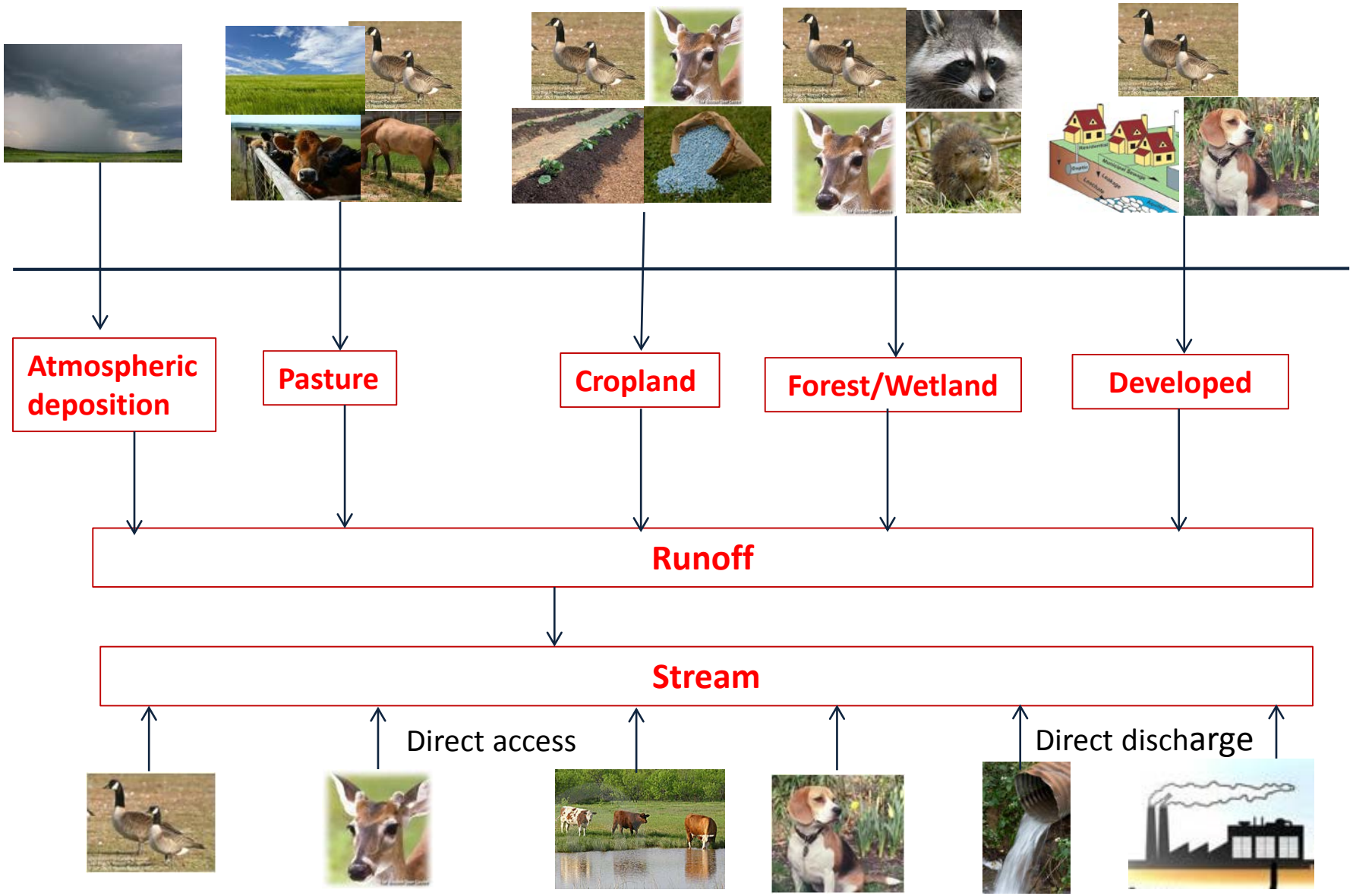
Procedures of Source Assessment

- Sources
  - Point Source: any discernible, confined and discrete conveyance, from which pollutants are or may be discharged.

  - Non-point Source: any source of water pollution that does not meet the legal definition of "point source".
    - Agricultural/Livestock
    - Humans
    - Pets
    - Wildlife

- Approach
  - GIS data (land use, population, pets, septic systems, pervious and impervious, roads, etc.)
  - Field survey
  - Virginal Health Department (SSO, shoreline survey)
  - Census of Agriculture data
  - DEQ and DCR database (point source, nutrient management, AFO, CAFO)
  - Wildlife survey data (animal density, animal habitat)
  - Public inputs/Public meeting/Interview with local citizens

Potential Sources



Human Contribution-Septic Systems

- Population, household, septic estimation
  - Method 1: Use land use data and county statistics

	Assawoman	Little Mosquito	Accomack County (2014)*
Population	824	2,166	33,021
Household units	357	940	14,333
Persons per household	2.25	2.25	2.25
House Public Sewers	N/A	N/A	
Septic Systems	321	889	
Dog	208	549	

- According to DSS-Sanitary Shoreline Survey, there are approximately 2500 lots in the Trails End Campground (Little Mosquito), which are not shown in the population estimation.

  - Method 2: Use house addresses (we are working on it)
    - Obtain house addresses from County
    - Convert these addresses to a GIS layer (geo-referenced)
    - Assume each house has a septic system (excludes public sewer areas)

Septic Failing and Loading Estimation

1. # Failing septic tank = # septic tanks * failure rate (5% is used based on local VDH and Hungars-Mattawoman IP)
2. Nutrient concentration and flow used for the estimation of loading (USEPA TMDL tool)
   - Total nitrogen 60.0 mg/L
   - Total phosphorus 23.5 mg/L
   - Organics (BOD) 290.0 mg/L
   - Flow of 70 gallons/person/day

Nutrient Application and Inputs

- N-fertilizer applied to cropland is ~ 125 lbs/acre/year (Chesapeake Bay Program)
- Lawn fertilizer is 44 lbs/acre/year (44-132) (Rosen et al., http://www.extension.umn.edu/garden/yard-garden/lawns/fertilizing-lawns/, EPA)
- N:P=7:3
- Chicken manure application rate is 1-2 tons/acre/year (Bay estimation for county)?
  - Total area with permitted land-applied manure is about 1355.6 ac and 425 ac, respectively, for Assawoman and Little Mosquito Creeks.
    - Based on the recent NMP manure Spreading Summary since 2011 only 2 farms had poultry litter application: 4 tons over 50 acres.
- Atmospheric deposition TN=11.5 lb/ac/year and TP=0.2 lb/ac/year.

Livestock Estimation

- USDA only reports county total livestock
- Estimation
  - Use county data and agriculture landuse data
  - Use shoreline survey data
  - Use CAFO and AFO database (with permits)
    - 2 permitted poultry farms in Little Mosquito watershed
    - 9 permitted poultry farms in Assawoman watershed
  - Local inputs

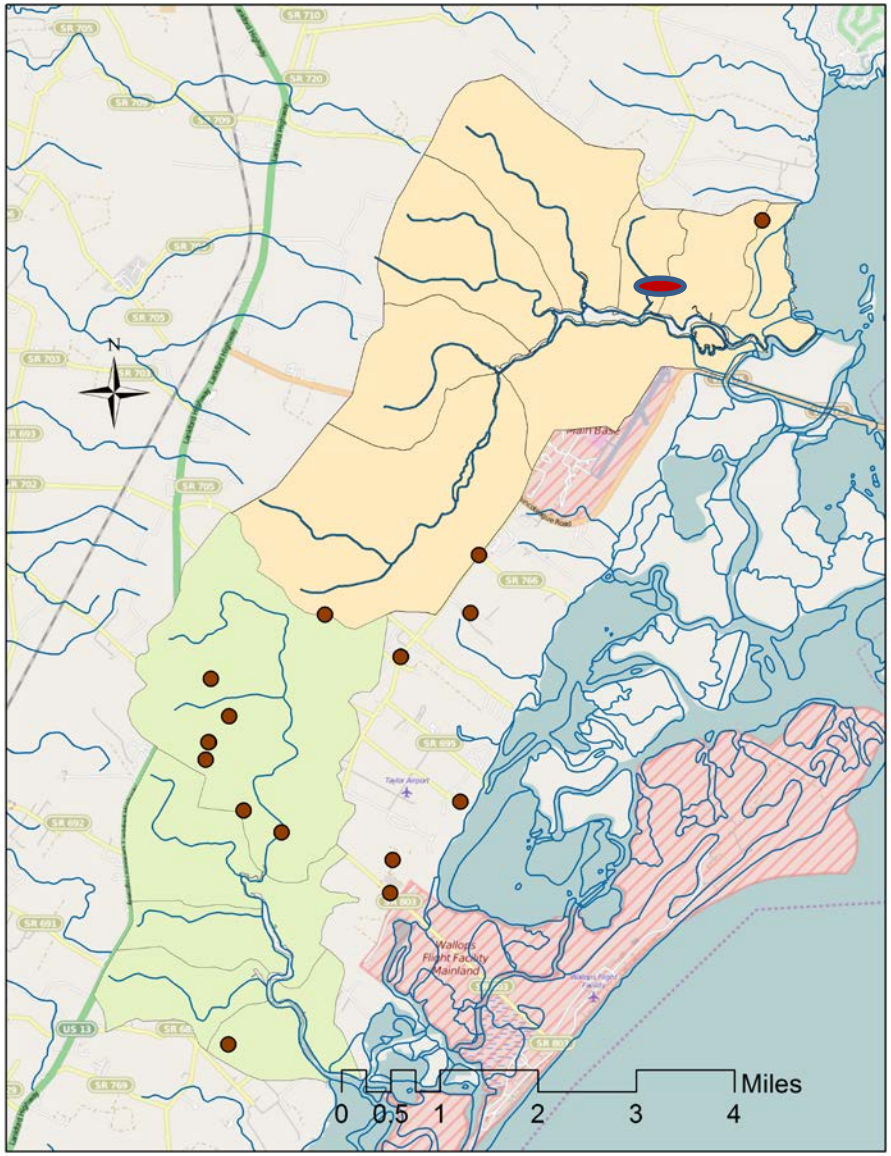
DSS Shoreline Survey Data

- Use shoreline survey data and local inputs to identify the potential causes of problems

	Assawoman	Little Mosquito
Chickens	657000*	98000*
Goats	4	5
Cattle	100	
Horses	30	12

•See poultry permit for additional #s

Note that chicken farming causes no problems if manure is stored appropriately

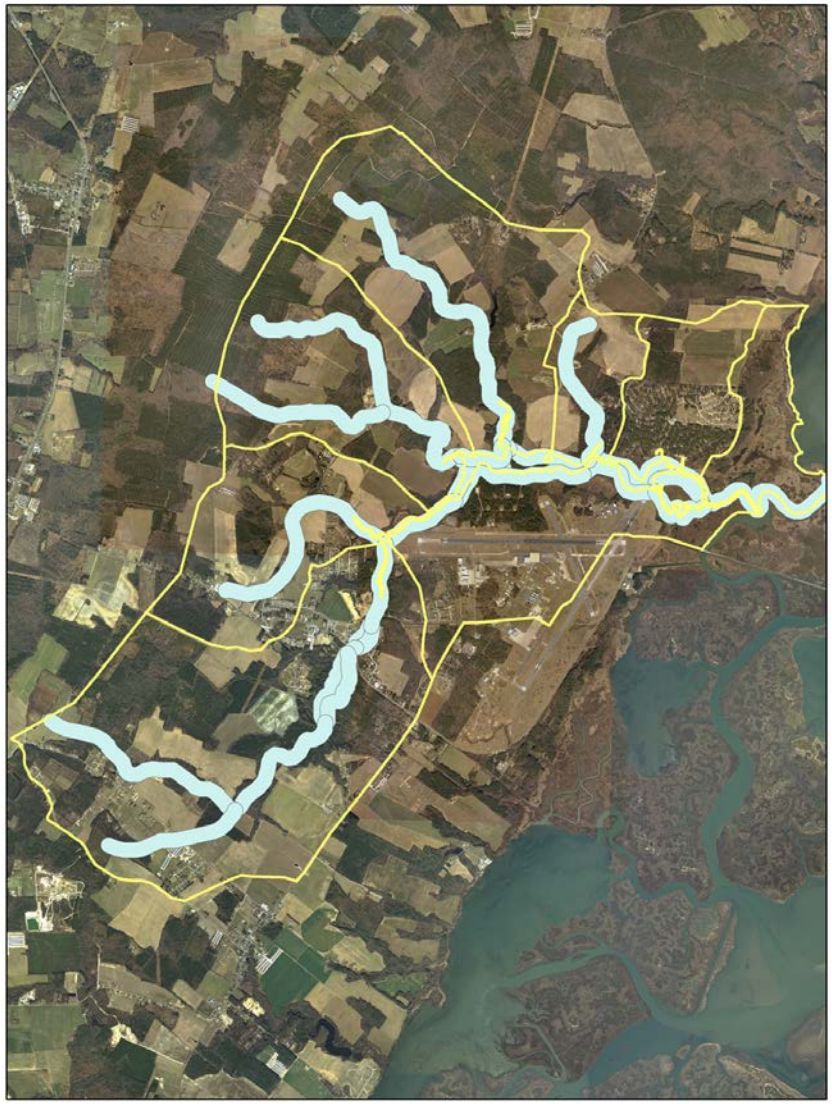


Wildlife Habitat

Wildlife Densities *		
Wildlife type	Population Density	Habitat Requirements
Deer	0.1032 animals/acre	Entire watershed
Raccoons	0.0703 animals/acre	Entire watershed
Muskrats	0.3128 animals/acre	300 feet buffer for primary habitat/600 feet buffer for secondary habitat
Geese	0.032 animals/acre	300 feet buffer for primary habitat /600 feet buffer for secondary habitat
Ducks	0.0652 animals/acre	300 feet buffer for primary habitat/600 feet buffer for secondary habitat

*Hungars-Mattawoman IP study

Wildlife Habitat



600-ft buffer near the streams.

Wildlife Estimation

	Assawoman	Little Mosquito
Deer	695	982
Raccoons	474	669
Muskrats	2,107	2,978
Geese	128 / 280*	136 / 308*
Ducks	261 / 444*	276 / 627*

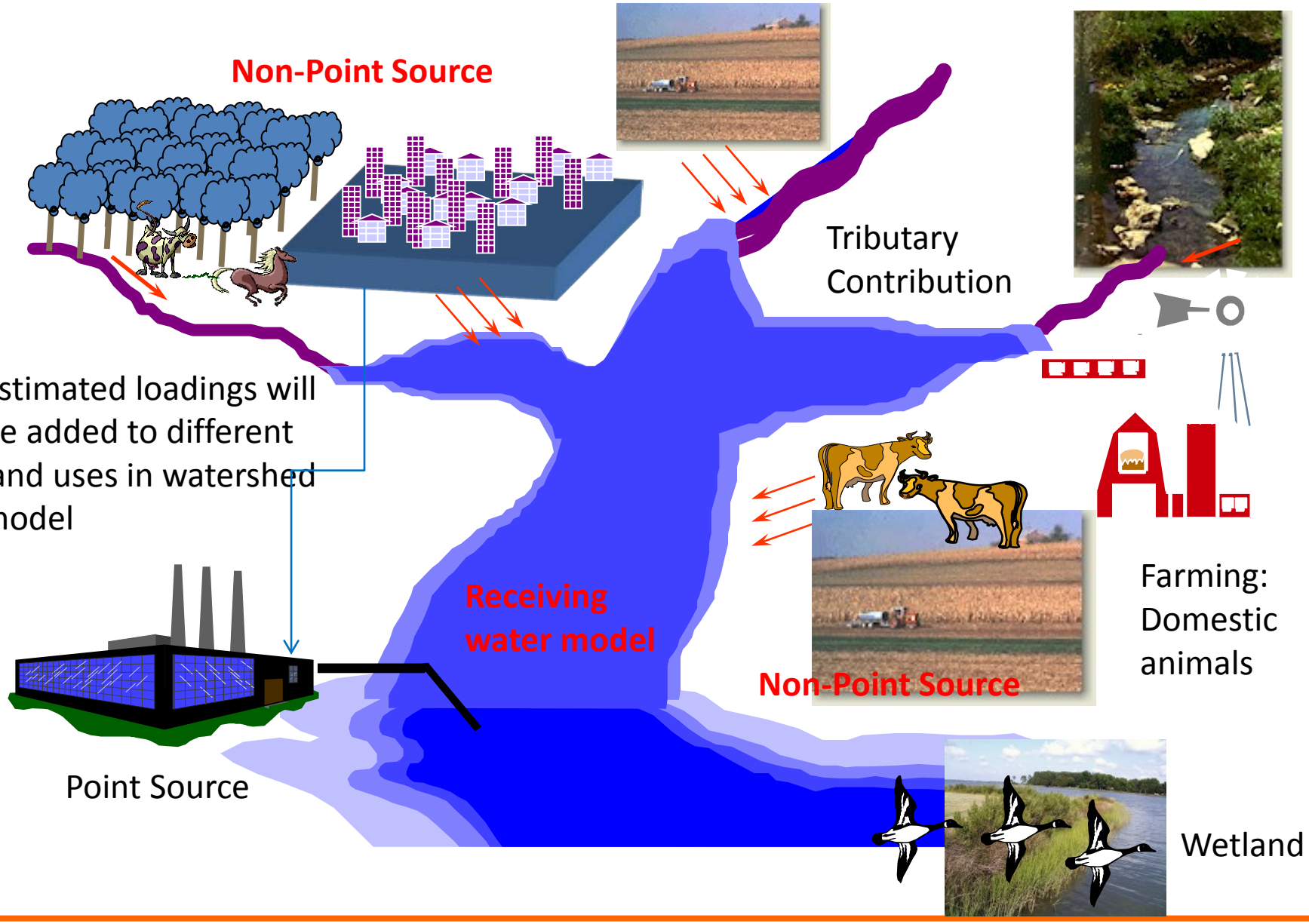
	Production (per day)
Wildlife type	
Deer	5.000E+08
Raccoons	1.250E+08
Muskrats	9.500E+07
Geese	4.900E+10
Ducks	2.4300E+09

* 2nd number denotes seasonal peak population

Point Sources

Permit	Facility Name			Monthly average (mg/L)		
			Flow	CBOD5	TKN	NH3-N
VA0024457	U.S. NASA-Wallops Flight Facility	Little Mosquito	NL	10	3	
VA0091529	Accomack County Leachate Treatment Facility	Assawoman	NL	10		4.9
VAR051367	Accomack County Northem Landfill	Assawoman	NL	37		4.9

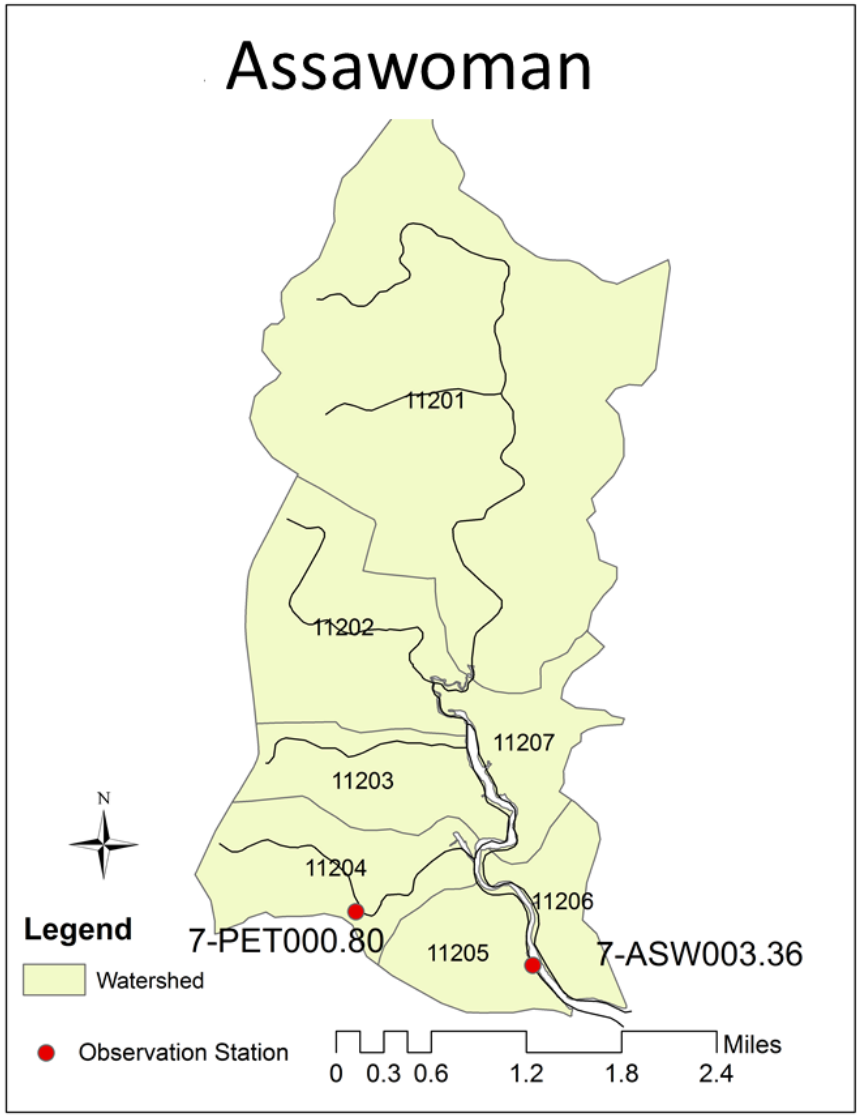
Watershed Model Approach

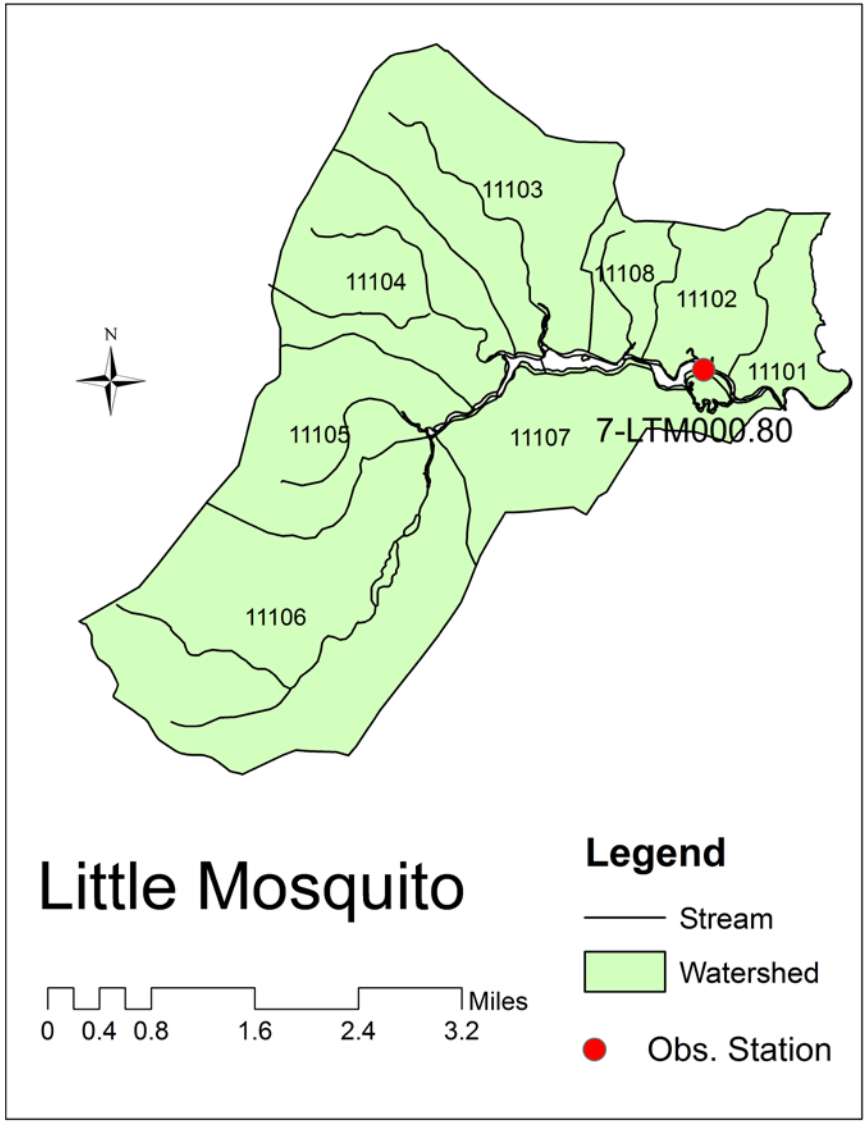


Model Simulation

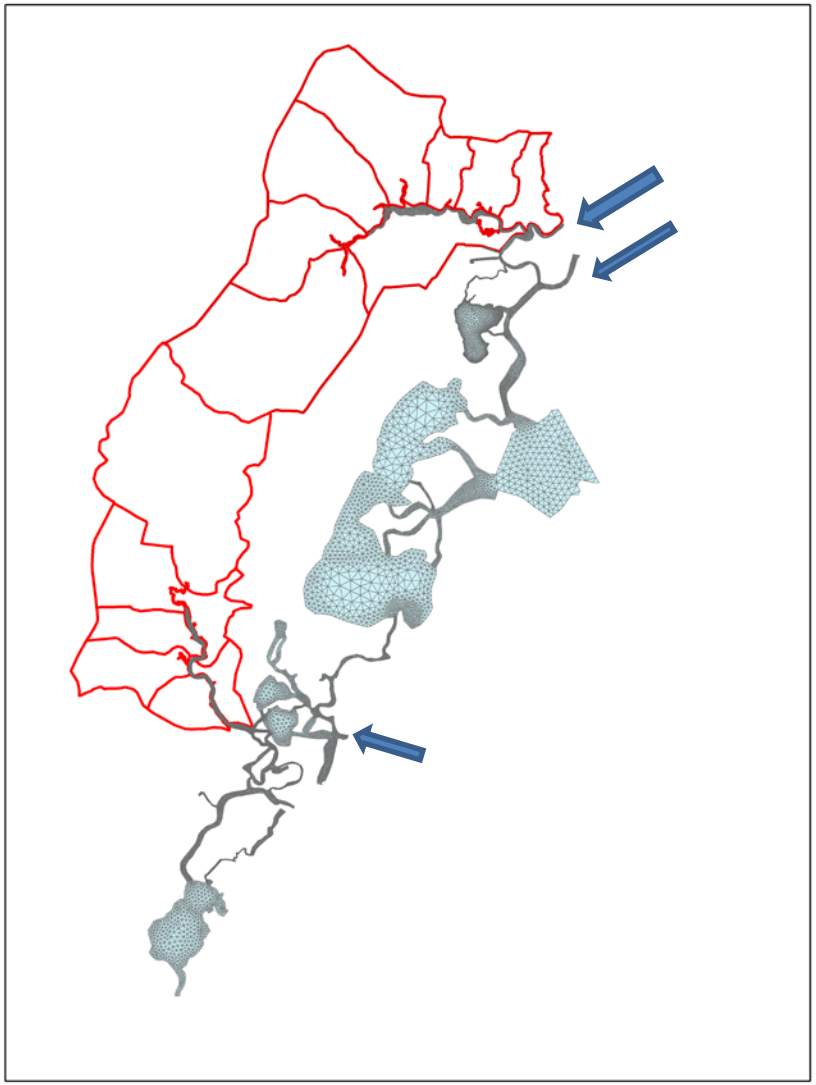
- Watershed Segmentation
  - Simulation flow, loading using Loading Simulation Program C^{++} (LSPC)
- Receiving water
  - grid generation
  - Simulate pollutant transport using Environmental Fluid Dynamic Computer Code (HEM3D/EFDC)
  - Boundary condition of tide is provided by VIMS large domain model (SELFE model)
  - Both models are supported by USEPA

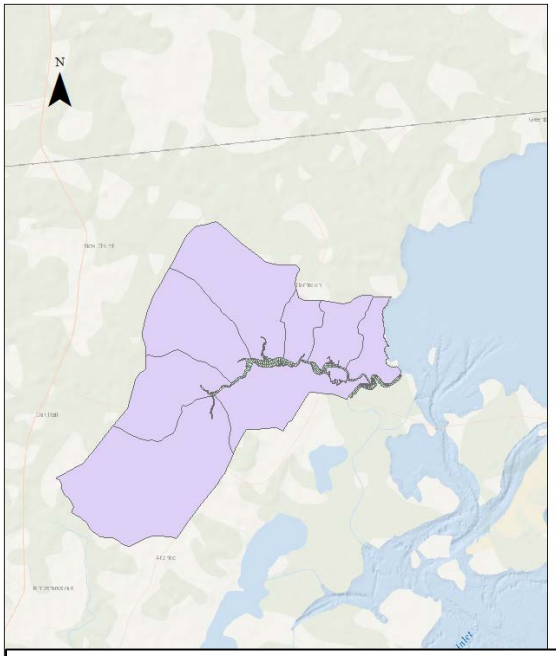
Watershed Segmentation

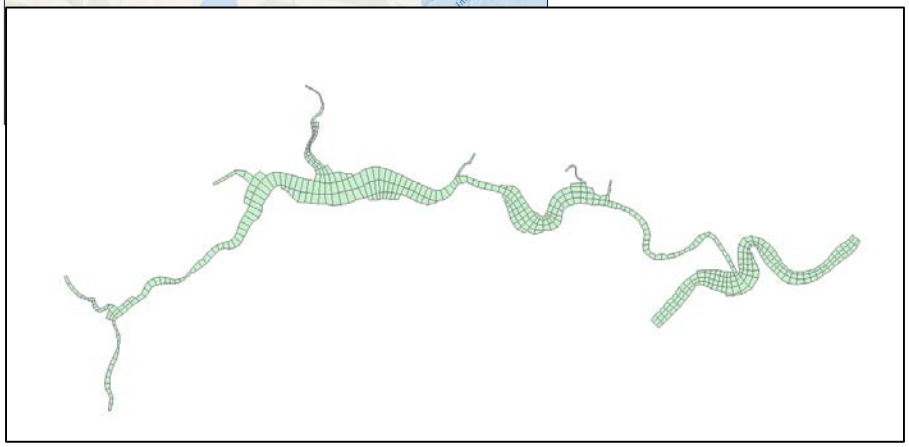




Three-dimensional Model Grid

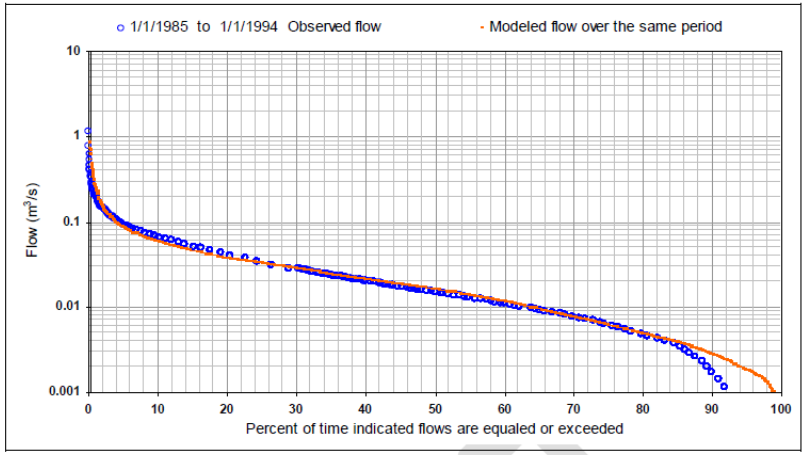


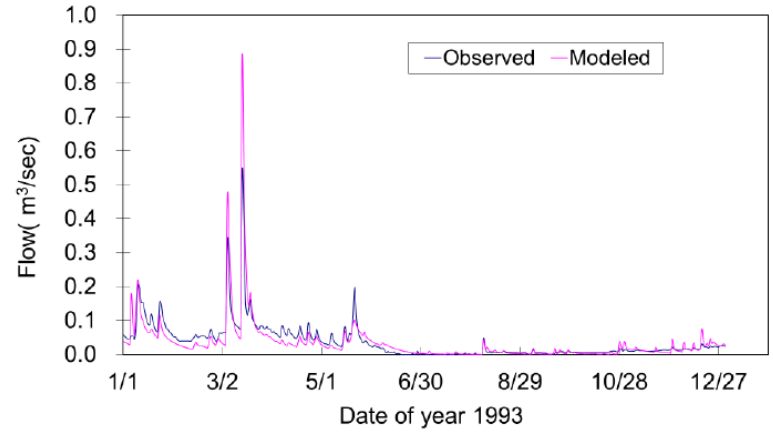


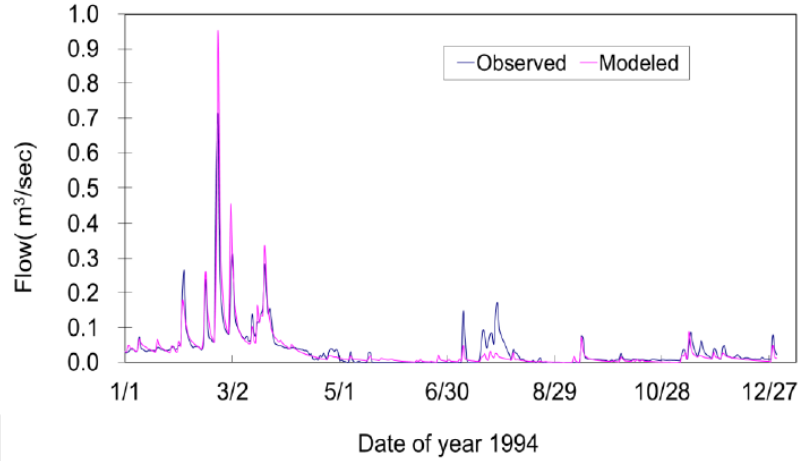


Watershed Model Calibration

- Compare model results to nearby USGS station
- USGS Gage 01484800, Guy Creek near Nassawadox, VA

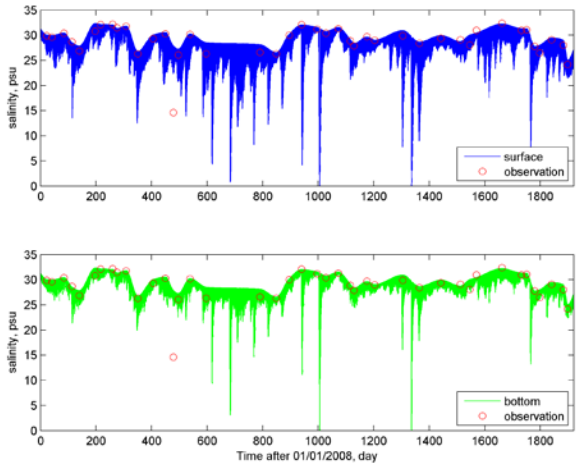




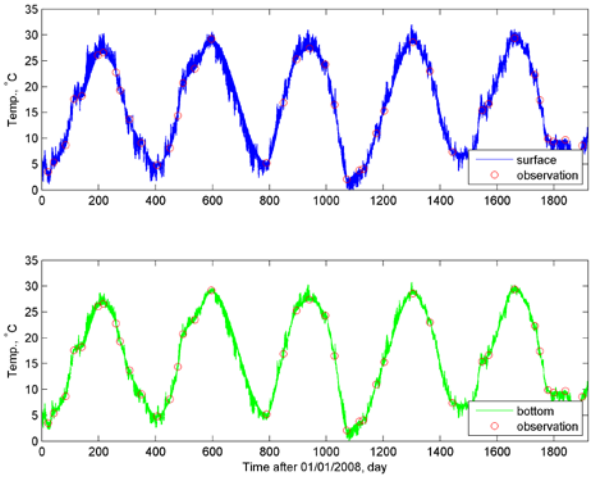


Examples of Receiving Waters Model Results

Salinity



Temperature



Questions and Comments

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

Thanks!

Comment Period Oct. 16th – Nov. 16th

Comments send to:
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Tidewater Regional Office, 5636 Southern Blvd
Virginia Beach, VA 23462