



UPPER RAPPAHANNOCK RIVER BASIN BACTERIA TMDL DEVELOPMENT

Virginia Department of Environmental Quality
Rappahannock-Rapidan Regional Commission
Engineering Concepts, Inc.

TECHNICAL ADVISORY COMMITTEE MEETING
February 27, 2007



TMDL DEVELOPMENT PROCESS

● WATERSHED HISTORY

- Characterize watershed and identify critical contamination conditions

● SOURCE ASSESSMENT

- Identify and quantify pollutant sources

● MODELING

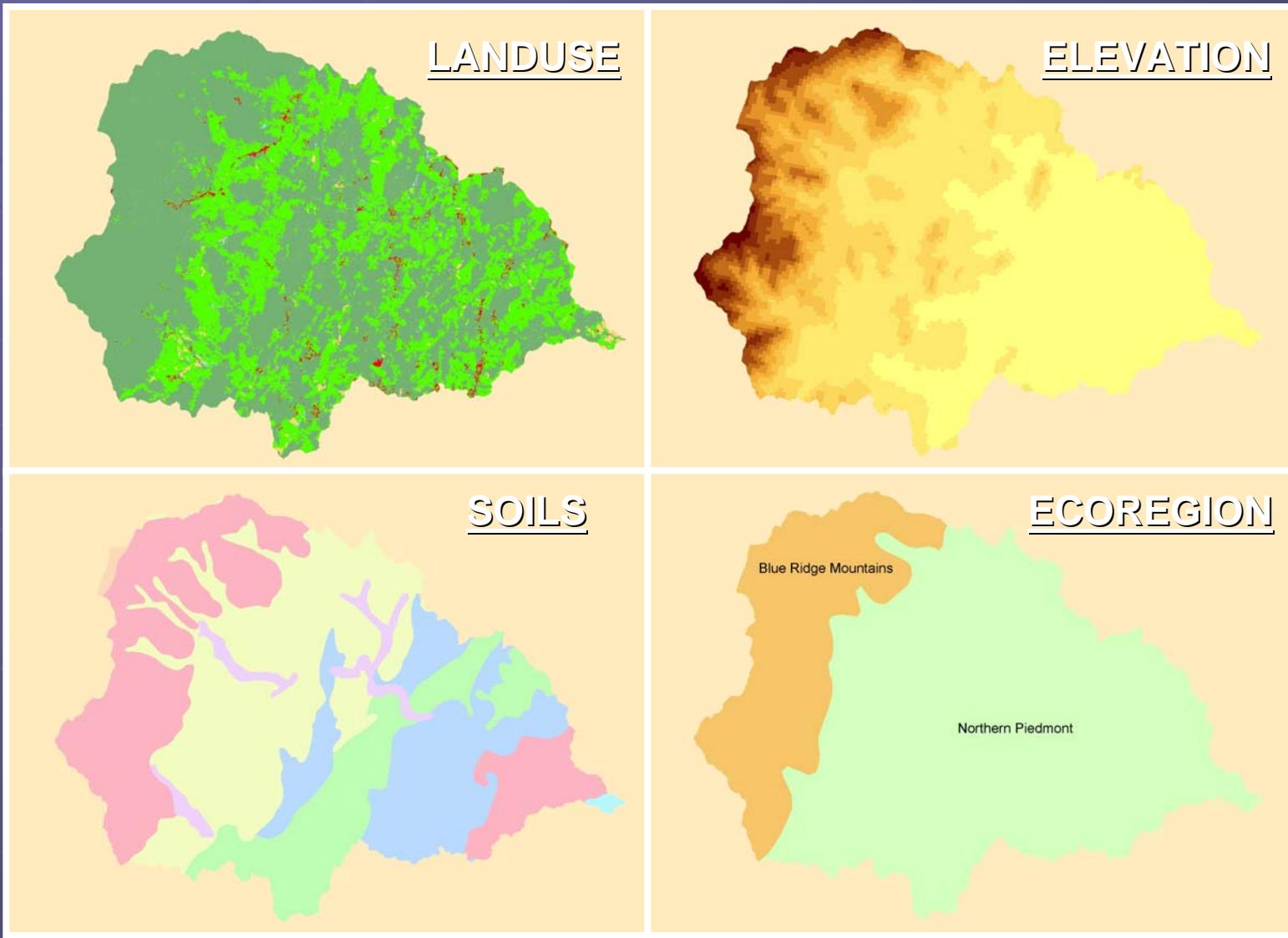
- Link pollutant sources to stream water quality

● ALLOCATION

- Develop and evaluate reduction scenarios

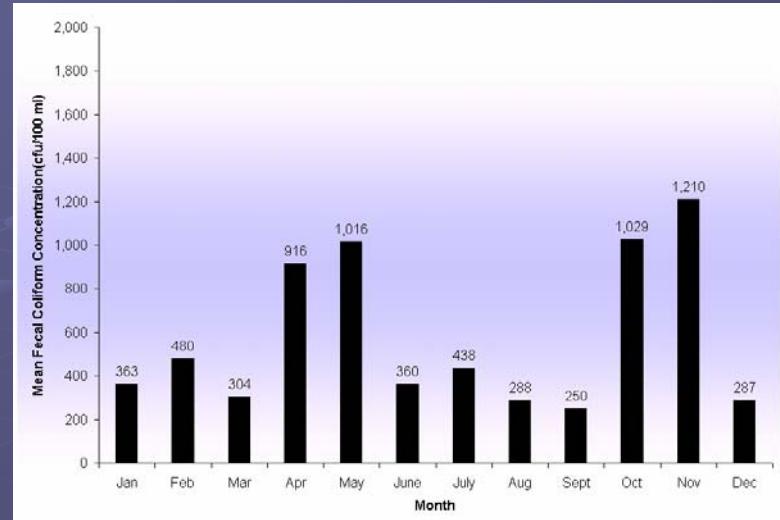
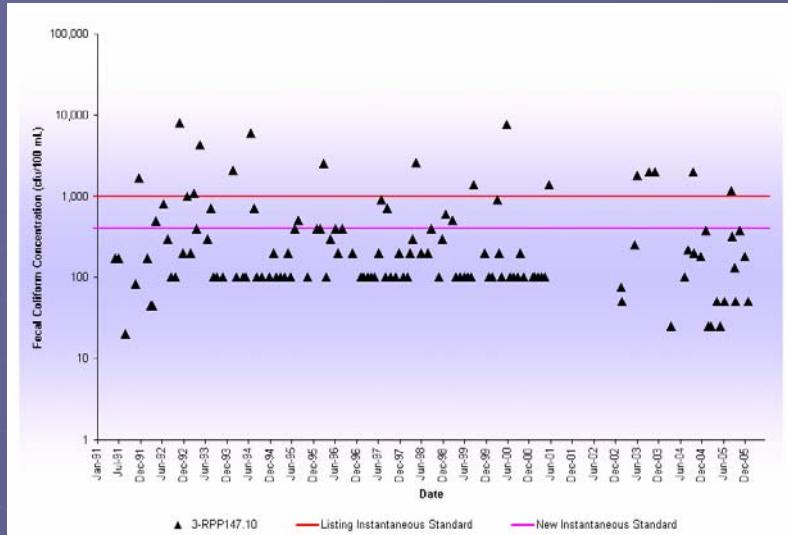


WATERSHED HISTORY

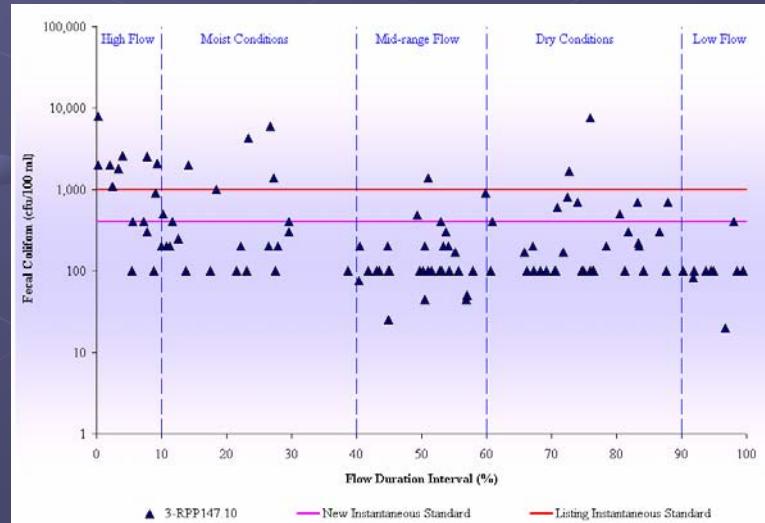




WATERSHED HISTORY



TIMESERIES



SEASONALITY

BACTERIA VS. FLOW



SOURCE ASSESSMENT

Source Category	Source / Animal Type
Human and Pets	Permitted Discharges
	Straight Pipes
	Failing Septic Systems
	Biosolids Applications
	Dogs / Cats
Agricultural	Dairy & Beef Cattle
	Horses
	Sheep
	Poultry
	Deer
Wildlife	Raccoons
	Muskrats
	Beavers
	Turkeys
	Geese
	Ducks
	Bears



MODELING

- Link pollutant sources to stream water quality
- Mathematically represent processes that are occurring in the watershed
- Processes
 - Hydrology – water balance
 - Water quality - pollutant fate and transport
- Accuracy Evaluation
 - Based on observed data
 - Flow: USGS gauge = model output
 - Bacteria: VADEQ station = model output

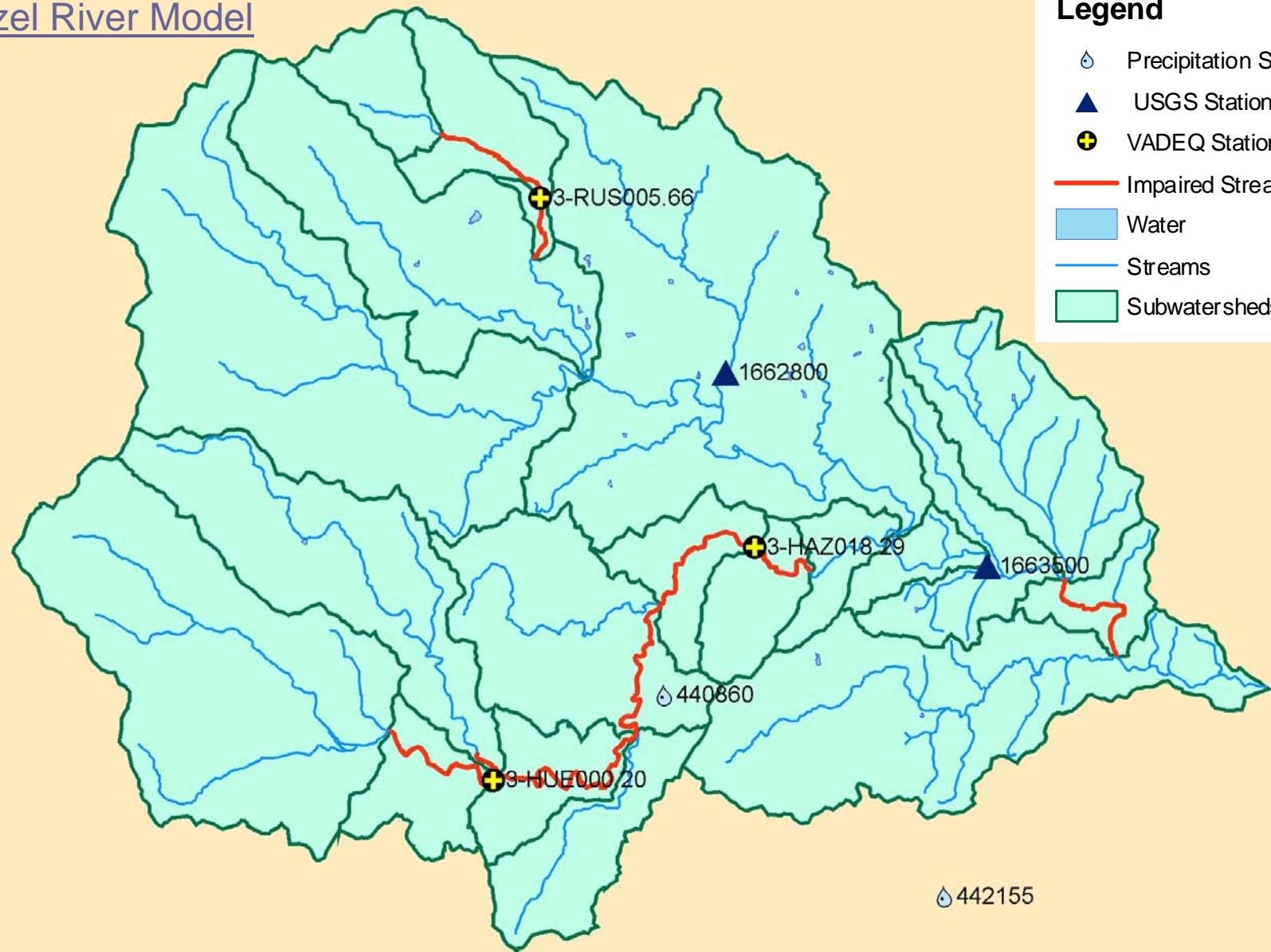


MODELING

Hazel River Model

Legend

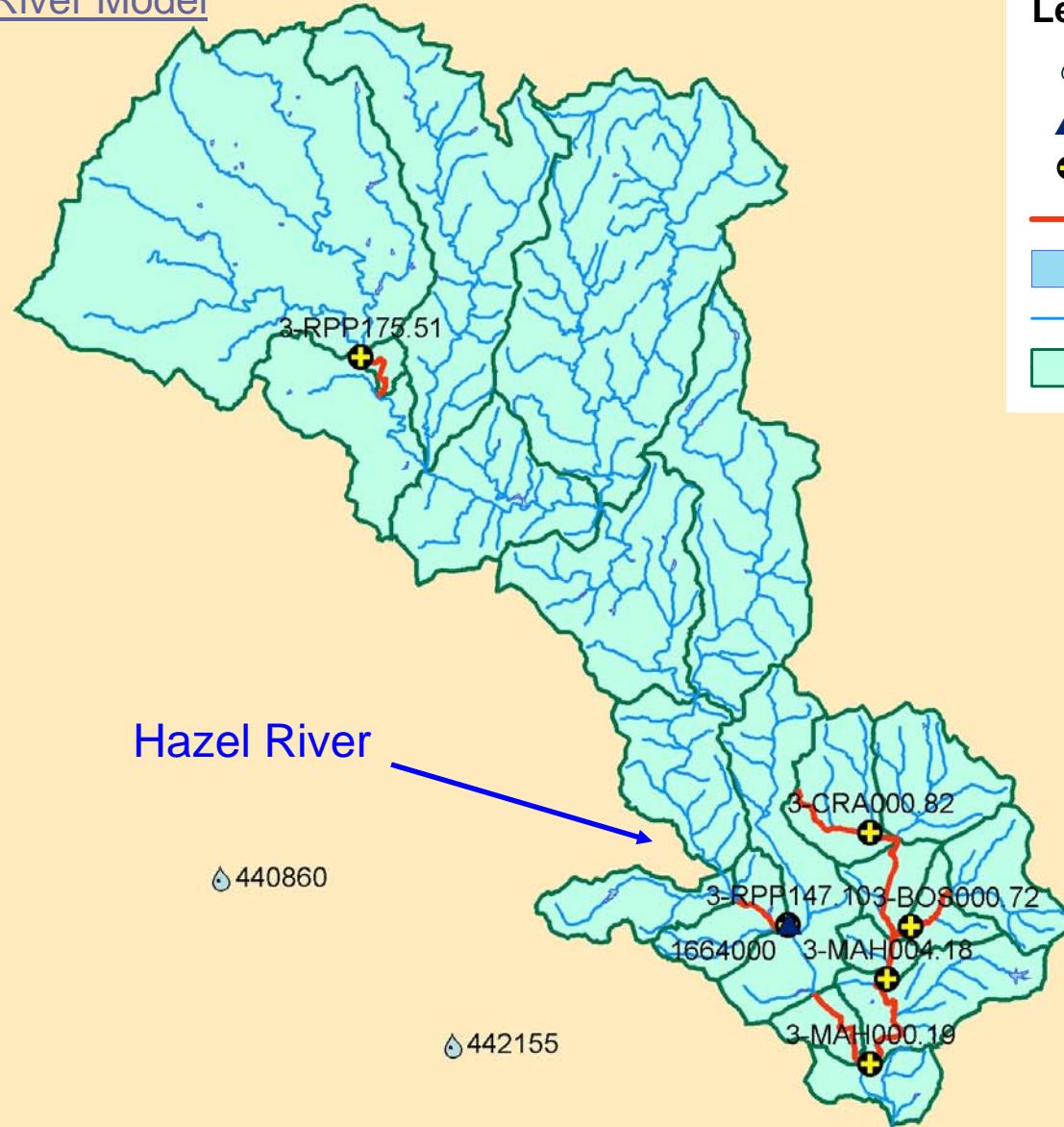
- Precipitation Stations
- USGS Stations
- VADEQ Stations
- Impaired Streams
- Water
- Streams
- Subwatersheds





MODELING

Rappahannock River Model

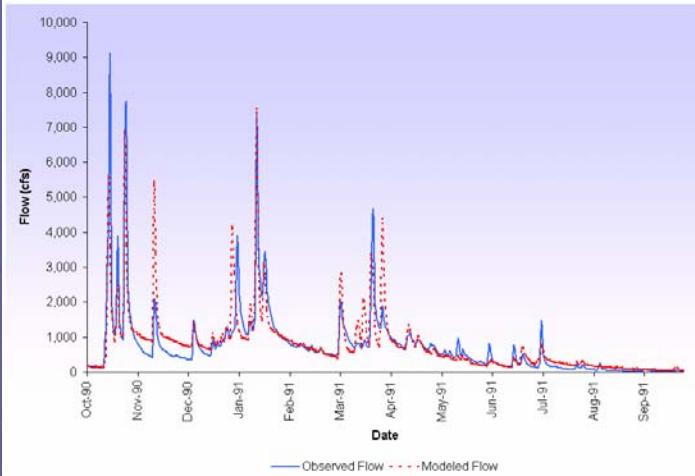


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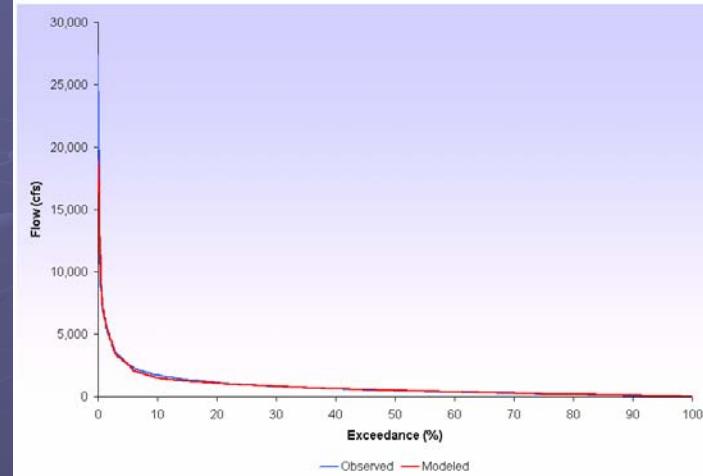
- 💧 Precipitation Stations
- ▲ USGS Stations
- ⊕ VADEQ Stations
- ▬ Impaired Streams
- ▬ Water
- ▬ Streams
- ▬ Subwatersheds



HYDROLOGY CALIBRATION



Hydrograph Shape



Flow Duration Curve

Flow Pathway	Volume (in)	Volume (%)
Surface runoff	17	22
Interflow	15	19
Baseflow	46	59

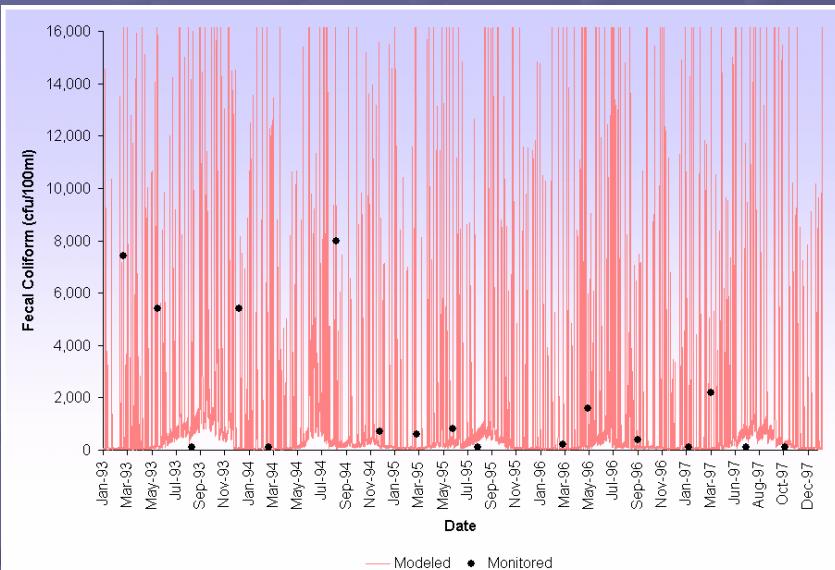
Flow Partition

	Observed	Modeled	Criterion	Error
Total Runoff (in)	90.7	90.1	10%	-0.7%
Total of Highest 10% Flows (in)	40.3	39.4	15%	-2.3%
Total of Lowest 50% Flows (in)	11.9	13.0	10%	8.5%
Total Winter Runoff (in)	36.3	38.1	20%	4.7%
Total Summer Runoff (in)	11.1	11.4	20%	2.6%
Total Storm Runoff (in)	87.7	86.1	20%	-1.9%
Coefficient of Determination, r^2	0.83			

Summary Statistics



WATER QUALITY CALIBRATION



Qualitative Comparison

Parameter	Calibration	Validation
Geometric mean of VADEQ values (cfu/100mL)	599	213
Geometric mean of modeled values (cfu/100mL)	569	327
Fecal coliform instantaneous water quality standard (1,000 cfu/100mL) exceedance rate of VADEQ values (%)	35	21
Fecal coliform instantaneous water quality standard (1,000 cfu/100mL) exceedance rate of modeled values (%)	35	29
Fecal coliform instantaneous water quality standard (400 cfu/100mL) exceedance rate of VADEQ values (%)	53	21
Fecal coliform instantaneous water quality standard (400 cfu/100mL) exceedance rate of modeled values (%)	53	36

Quantitative Comparison



ALLOCATION

- Calculate design loads for point sources and existing loads for non-point sources
- Create load reductions scenarios controlling anthropogenic sources first
- Run model with scenarios
- Calculate geometric mean and instantaneous water quality standard (WQS) exceedance rate
- Select scenario with 0% geometric mean and instantaneous water quality WQS exceedance rate



HAZEL RIVER ALLOCATION

Point Source	Permit #	Design Flow (MGD)	Existing Condition (cfu/yr)
Boston Water and Sewer Company STP - New Facility	VA0088749	0.450	1.24E+12
Washington Town Water Treatment Plant	VA0087581	0.006	0.00E+00
Rush River Waste Water Treatment Plant	VA0091651	0.060	1.66E+11
Rappahannock County Elementary School	VA0022471	0.008	2.21E+10
Rappahannock County High School	VA0064181	0.005	1.38E+10
Panorama Sewage Treatment Plant	VA0024449	0.015	4.14E+10
Sperryville Sewage Treatment Plant	VA0062880	0.055	1.52E+11
Residence	VAG406399	0.001	2.68E+09
Residence	VAG406377	0.001	2.68E+09
Residence	VAG406383	0.001	2.68E+09



HAZEL RIVER ALLOCATION

Non-point Source	Existing Condition Load (cfu/yr)
Direct Deposition	
Straight Pipes	5.80E+14
Livestock	1.86E+14
Wildlife	2.35E+14
<i>Total</i>	1.00E+15
Land-based	
Residential	4.70E+15
Cropland	4.38E+13
Pasture	1.82E+17
Forest	1.42E+15
<i>Total</i>	1.88E+17



HAZEL RIVER ALLOCATION

Scenario Number	Percent Reduction in Fecal Coliform Loading from Existing Conditions							% Violations of E. coli WQS	
	Straight Pipes	Livestock DD	Wildlife DD	Residential	Cropland	Pasture	Forest	GM	Instant.
0	0	0	0	0	0	0	0	31.7	23.8
1	100	100	0	0	0	0	0	5.0	21.7
2	100	100	0	75	75	75	0	0.0	4.8
3	100	100	0	90	90	90	0	0.0	0.6
4	100	100	0	94	94	94	0	0.0	0.0
5	100	94	0	94	94	94	0	0.0	0.0



HAZEL RIVER ALLOCATION

Point Source	Permit #	Existing Condition (cfu/yr)	Loading Reduction (%)	Allocation Condition (cfu/yr)
Boston Water and Sewer Company STP - New Facility	VA0088749	1.24E+12	0	1.24E+12
Washington Town Water Treatment Plant	VA0087581	0.00E+00	0	0.00E+00
Rush River Waste Water Treatment Plant	VA0091651	1.66E+11	0	1.66E+11
Rappahannock County Elementary School	VA0022471	2.21E+10	0	2.21E+10
Rappahannock County High School	VA0064181	1.38E+10	0	1.38E+10
Panorama Sewage Treatment Plant	VA0024449	4.14E+10	0	4.14E+10
Sperryville Sewage Treatment Plant	VA0062880	1.52E+11	0	1.52E+11
Residence	VAG406399	2.68E+09	0	2.68E+09
Residence	VAG406377	2.68E+09	0	2.68E+09
Residence	VAG406383	2.68E+09	0	2.68E+09



HAZEL RIVER ALLOCATION

Source	Existing Condition Load (cfu/yr)
Direct Deposition	
Straight Pipes	5.80E+14
Livestock	1.86E+14
Wildlife	2.35E+14
<i>Total</i>	1.00E+15
Land-based	
Residential	4.70E+15
Cropland	4.38E+13
Pasture	1.82E+17
Forest	1.42E+15
<i>Total</i>	1.88E+17

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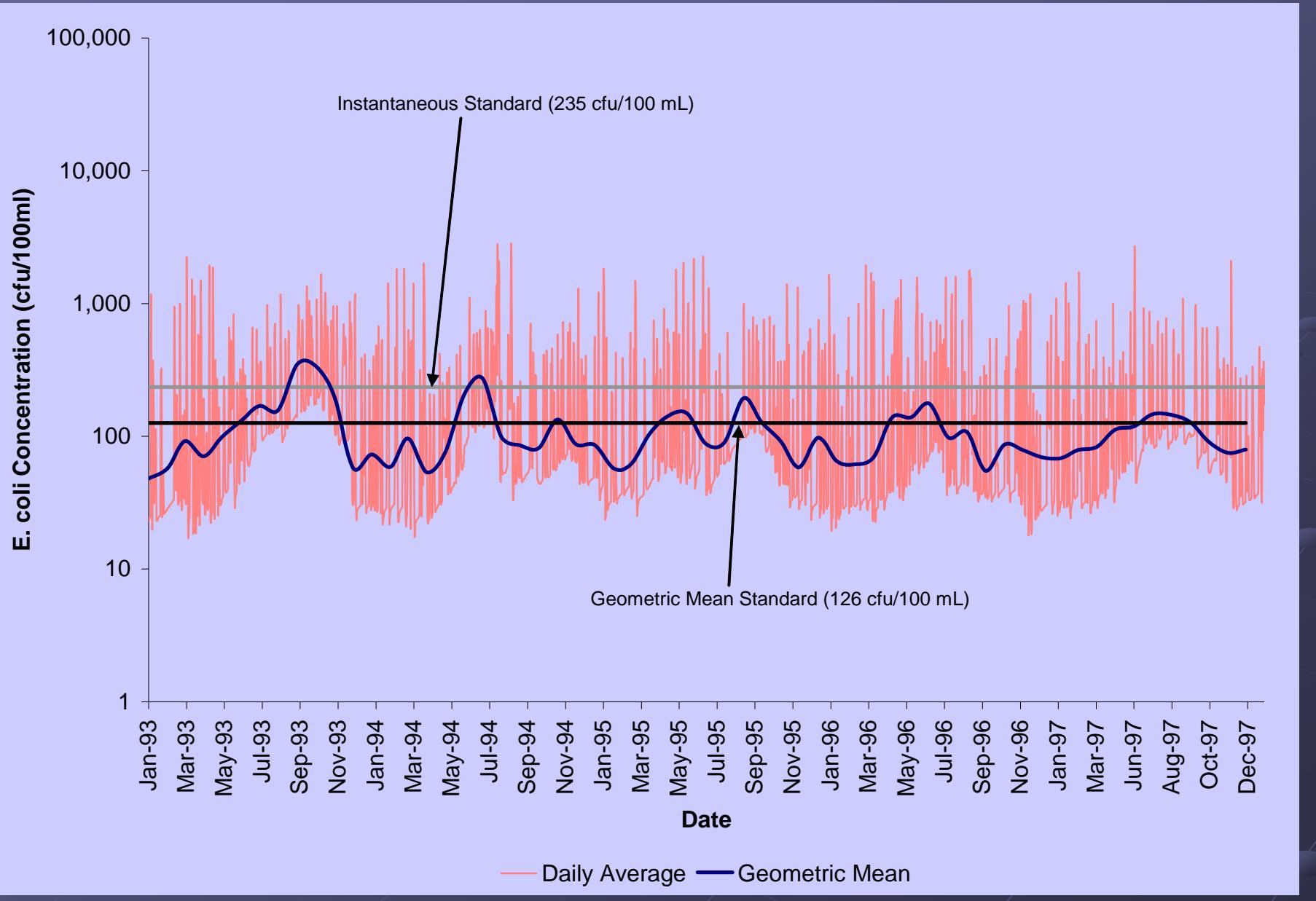
Scenario 5 Reduction (%)
100
94
0
94
94
94
0

=

Source	Allocation Condition Load (cfu/yr)
Direct Deposition	
Straight Pipes	0.00E+00
Livestock	1.12E+13
Wildlife	2.35E+14
<i>Total</i>	2.46E+14
Land-based	
Residential	2.82E+14
Cropland	2.63E+12
Pasture	1.09E+16
Forest	1.42E+15
<i>Total</i>	1.26E+16

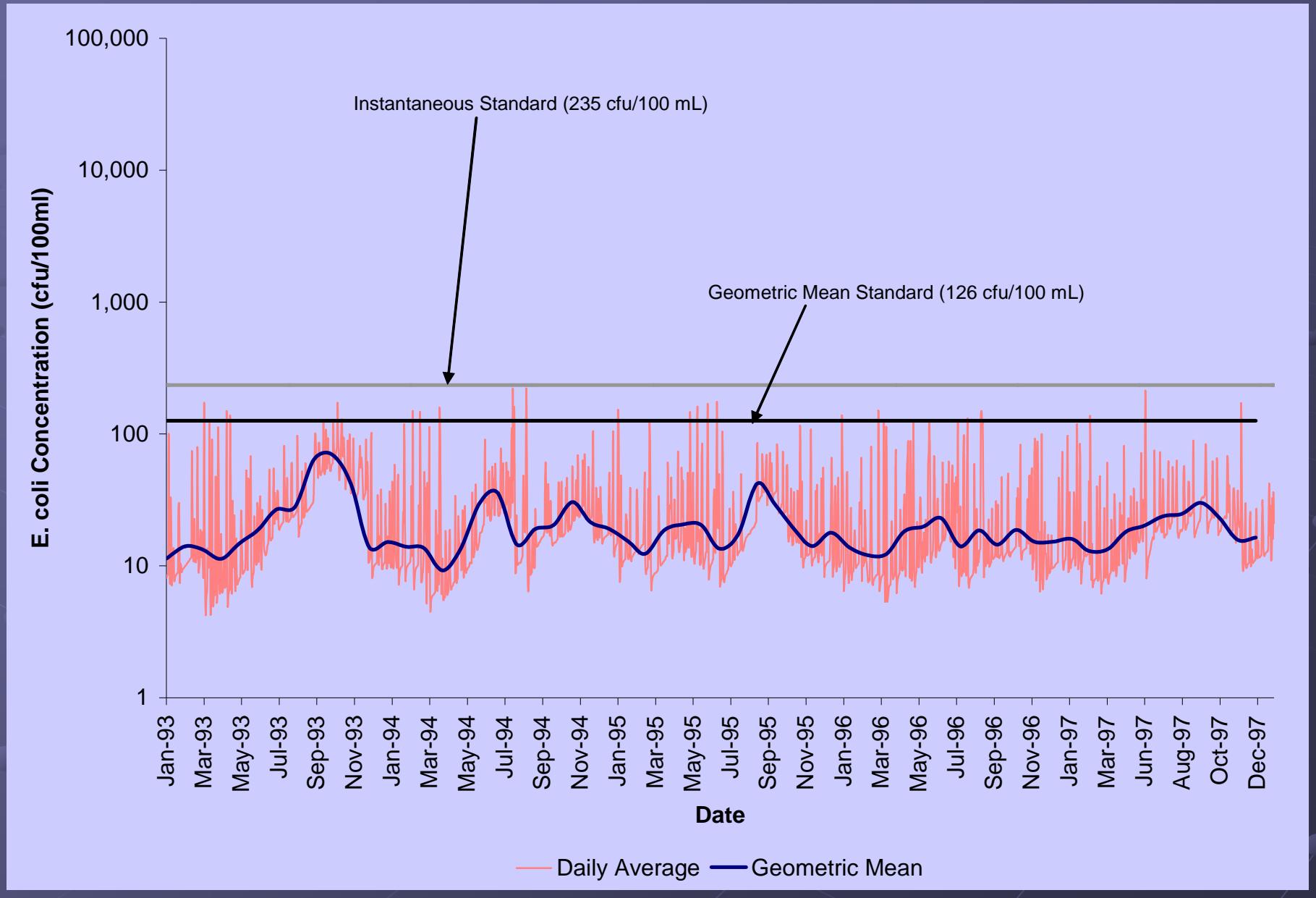


HAZEL RIVER EXISTING CONDITIONS





HAZEL RIVER ALLOCATION CONDITIONS





ALLOCATION REDUCTIONS

Impairment	Percent Reduction in Fecal Coliform Loading from Existing Conditions						
	Straight Pipes	Livestock DD	Wildlife DD	Residential	Cropland	Pasture	Forest
Hughes River (VAN-E03R-01)	100	90	0	90	90	90	0
Hazel River (VAN-E04R-01)	100	97	0	97	97	97	0
Rush River (VAN-E05R-01)	100	99	0	100	99	99	0
Hazel River (60076)	100	94	0	94	94	94	0



ALLOCATION REDUCTIONS

Impairment	Percent Reduction in Fecal Coliform Loading from Existing Conditions						
	Straight Pipes	Livestock DD	Wildlife DD	Residential	Cropland	Pasture	Forest
Rappahannock River (VAN-E01R-03)	100	99	11	99	99	99	0
Rappahannock River (VAN-E08R-04)	100	97	0	97	97	97	0
Rappahannock River (60081)	100	99	0	99	99	99	0
Craig Run (VAN-E08R-03)	100	97	0	97	97	97	0
Browns Run (VAN-E08R-02)	100	96	0	96	96	96	0
Marsh Run (VAN-E08R-01)	100	97	0	97	97	97	0



IMPLEMENTATION PLAN DEVELOPMENT

- Next phase of TMDL process after USEPA TMDL approval
- Outlines plan to link load reductions specified in TMDL Development Study to corrective actions (e.g., BMPs)
- Project schedule governed by criteria outlined by VADCR
 - Local interest one of the criteria



TMDL IMPLEMENTATION

- Stage I:

- Attain water quality standard enabling delisting of streams from Section 303(d) List of Impaired Waters

- Stage II:

- Attainment of TMDL source load allocations required under WQMIRA and USEPA to receive Section 319 grant funds to fund implementation



STAGE 1 IMPLEMENTATION

- Calculate design loads for point sources and existing loads for non-point sources
- Create load reductions scenarios controlling anthropogenic sources only
 - Goal: 0% reduction in wildlife DD and forest land use
- Run model with scenarios
- Calculate instantaneous WQS exceedance rate
- Select scenario with less than 10% instantaneous WQS exceedance rate



STAGE 1 REDUCTIONS

Impairment	Percent Reduction in Fecal Coliform Loading from Existing Conditions						
	Straight Pipes	Livestock DD	Wildlife DD	Residential	Cropland	Pasture	Forest
Hughes River (VAN-E03R-01)	100	75	0	20	20	20	0
Hazel River (VAN-E04R-01)	100	75	0	71	71	71	0
Rush River (VAN-E05R-01)	100	80	0	60	60	80	0
Hazel River (60076)	100	80	0	59	59	59	0



STAGE 1 REDUCTIONS

Impairment	Percent Reduction in Fecal Coliform Loading from Existing Conditions						
	Straight Pipes	Livestock DD	Wildlife DD	Residential	Cropland	Pasture	Forest
Rappahannock River (VAN-E01R-03)	100	75	0	66	66	66	0
Rappahannock River (VAN-E08R-04)	100	75	0	48	48	48	0
Rappahannock River (60081)	100	90	0	90	90	90	0
Craig Run (VAN-E08R-03)	100	81	0	81	81	81	0
Browns Run (VAN-E08R-02)	100	75	0	67	67	67	0
Marsh Run (VAN-E08R-01)	100	90	0	90	90	90	0



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