



RAPIDAN RIVER / RAPPAHANNOCK RIVER BASINS BACTERIA TMDL DEVELOPMENT

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

FINAL PUBLIC MEETING
March 19, 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

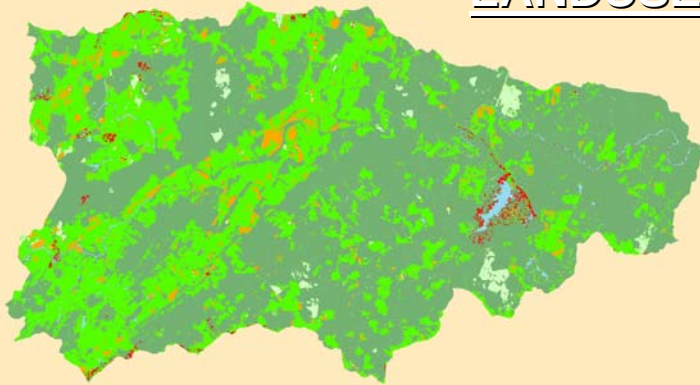
● ALLOCATION

- Develop and evaluate reduction scenarios



WATERSHED HISTORY

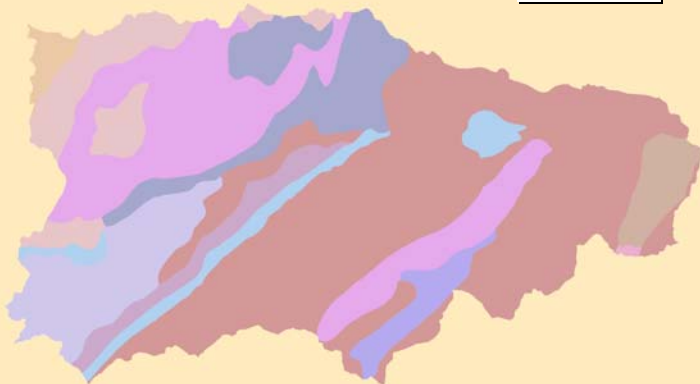
LANDUSE



ELEVATION



SOILS

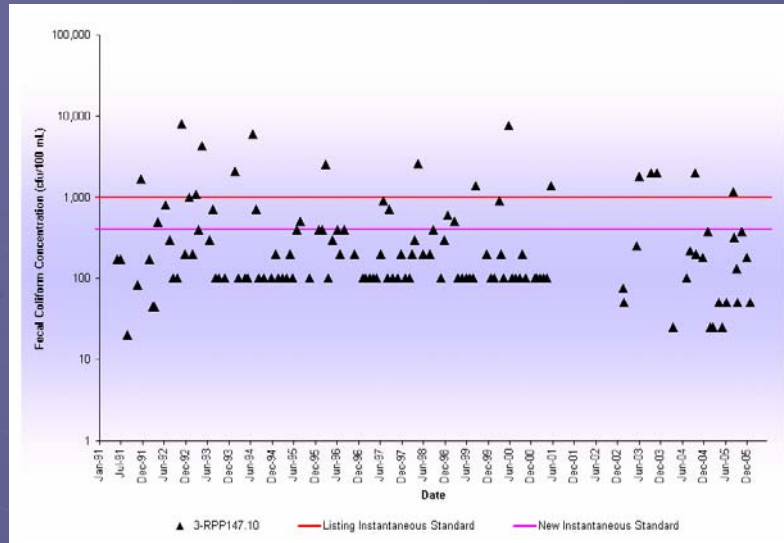


ECOREGION

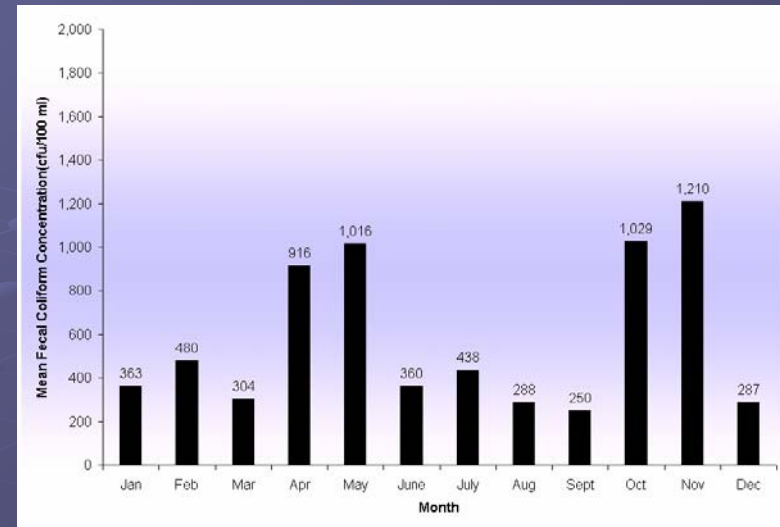




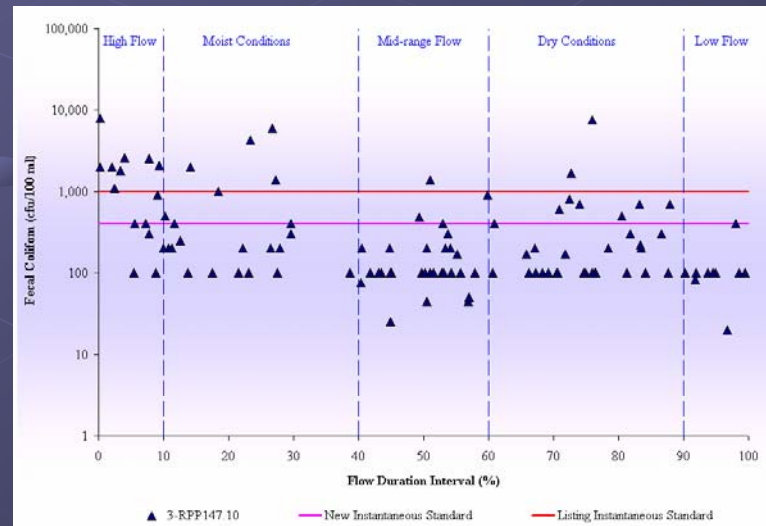
WATERSHED HISTORY



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
Wildlife	Deer
	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

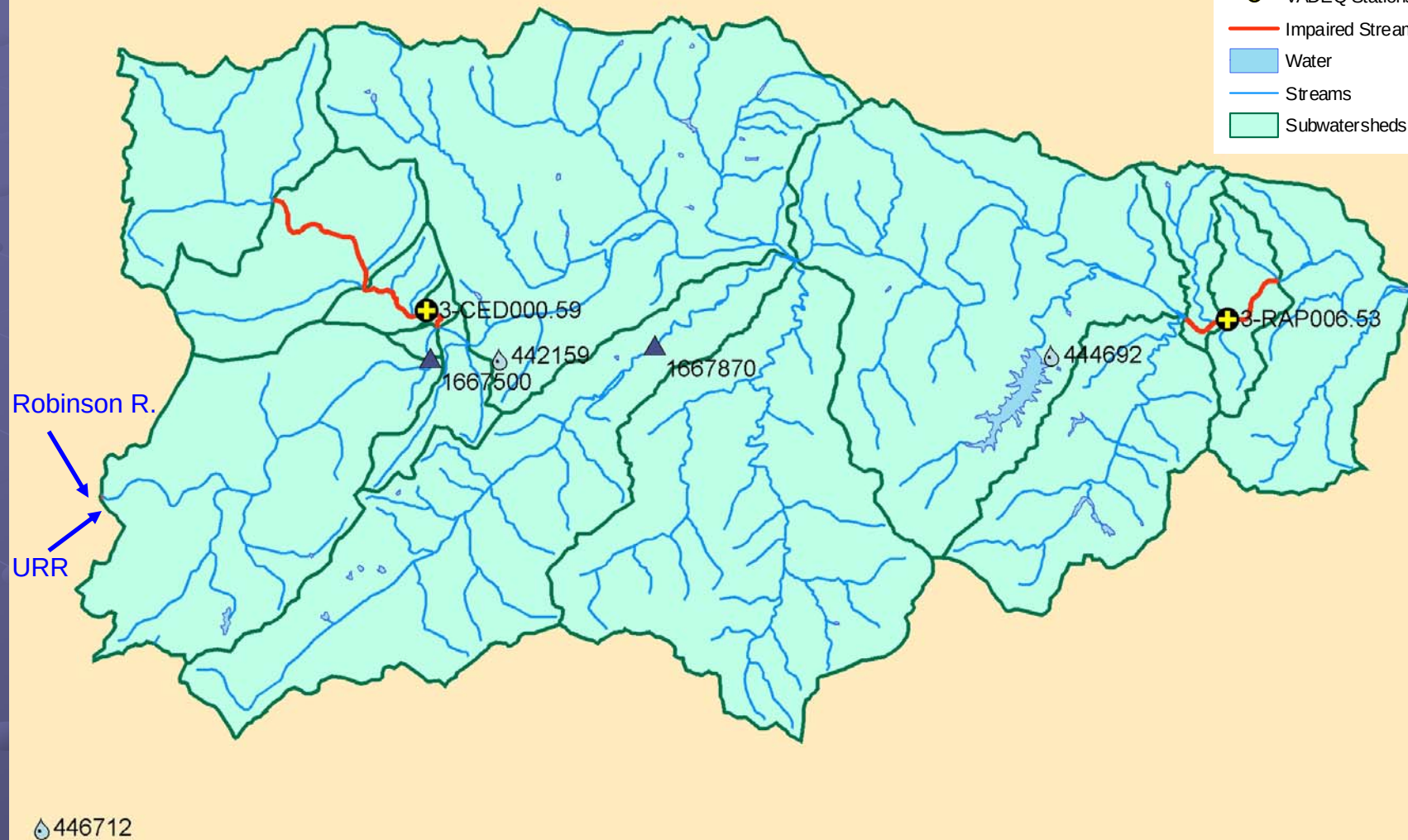


MODELING

Lower Rapidan River Model

Legend

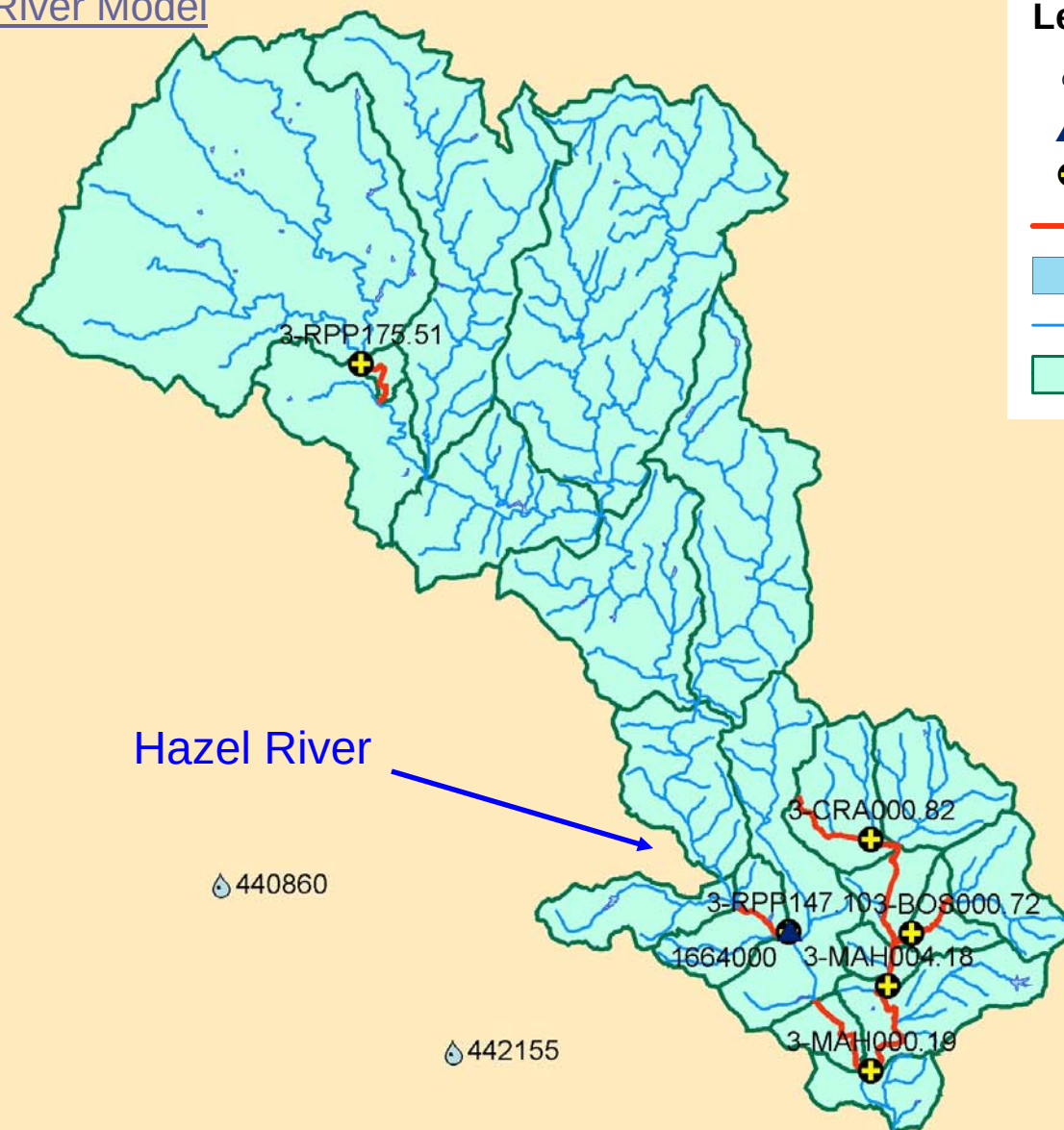
- Precipitation Stations
- USGS Stations
- VADEQ Stations
- Impaired Streams
- Water
- Streams
- Subwatersheds





MODELING

Rappahannock River Model



Legend

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

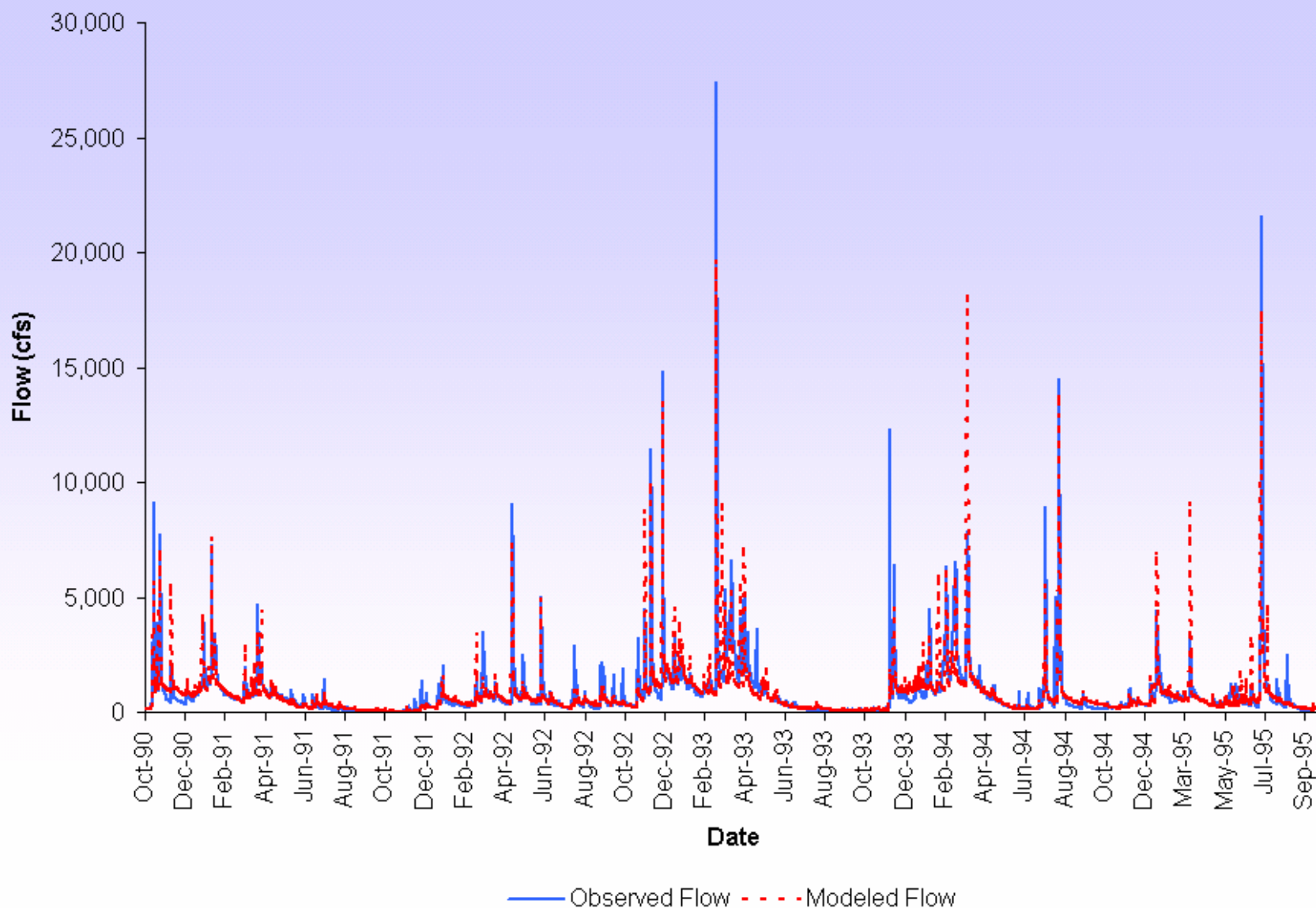


HYDROLOGIC CALIBRATION

- Hydrograph shape
- Flow duration / cumulative frequency curve
- Flow partition
- Summary statistics

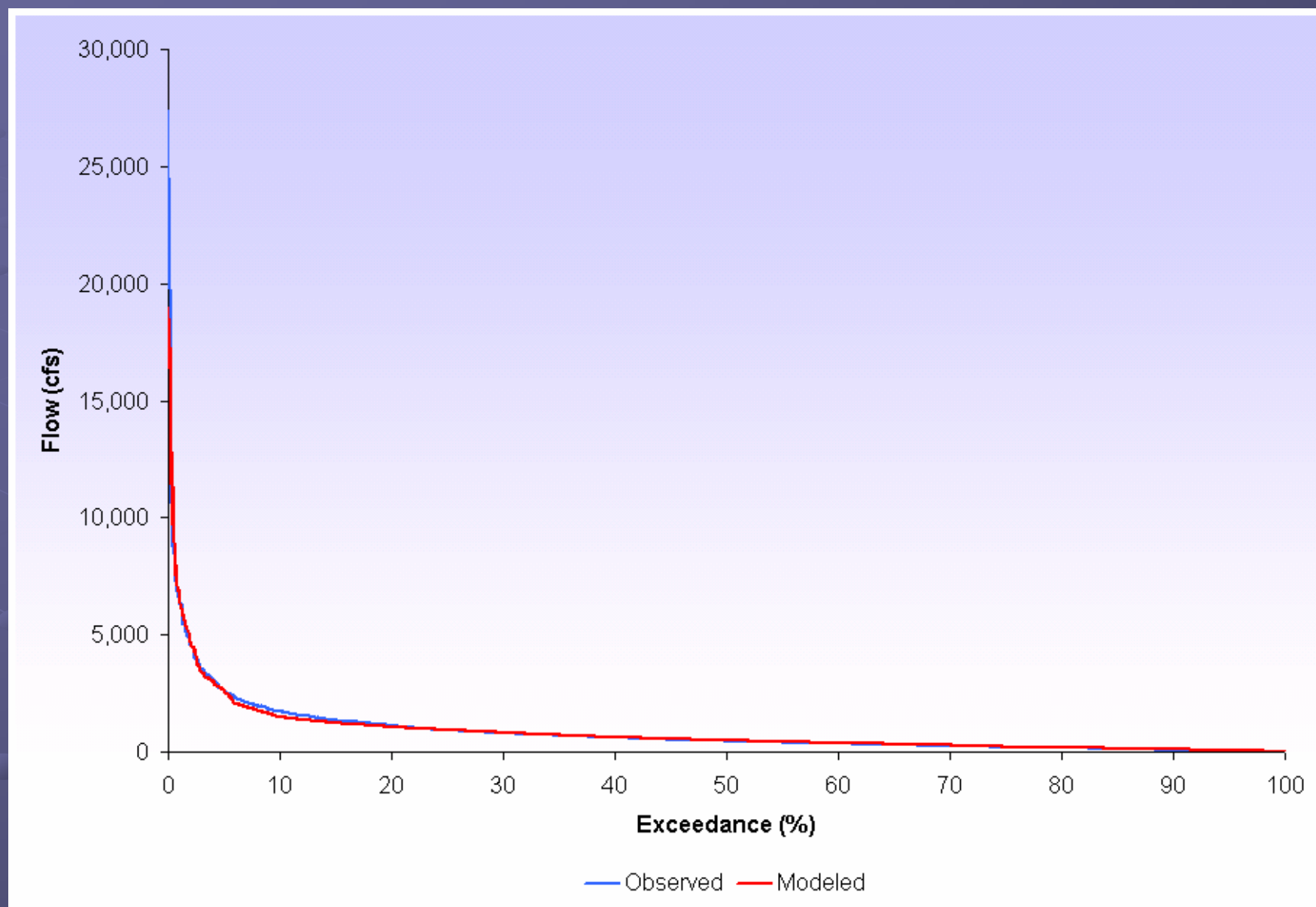


RAPPAHANNOCK RIVER HYDROLOGY CALIBRATION RESULTS





RAPPAHANNOCK RIVER HYDROLOGY CALIBRATION RESULTS





RAPPAHANNOCK RIVER HYDROLOGY CALIBRATION RESULTS

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



RAPPAHANNOCK RIVER HYDROLOGY CALIBRATION RESULTS

	Observed	Modeled	Criterion	Calculated 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			

Period: 10/1/90 – 9/30/95

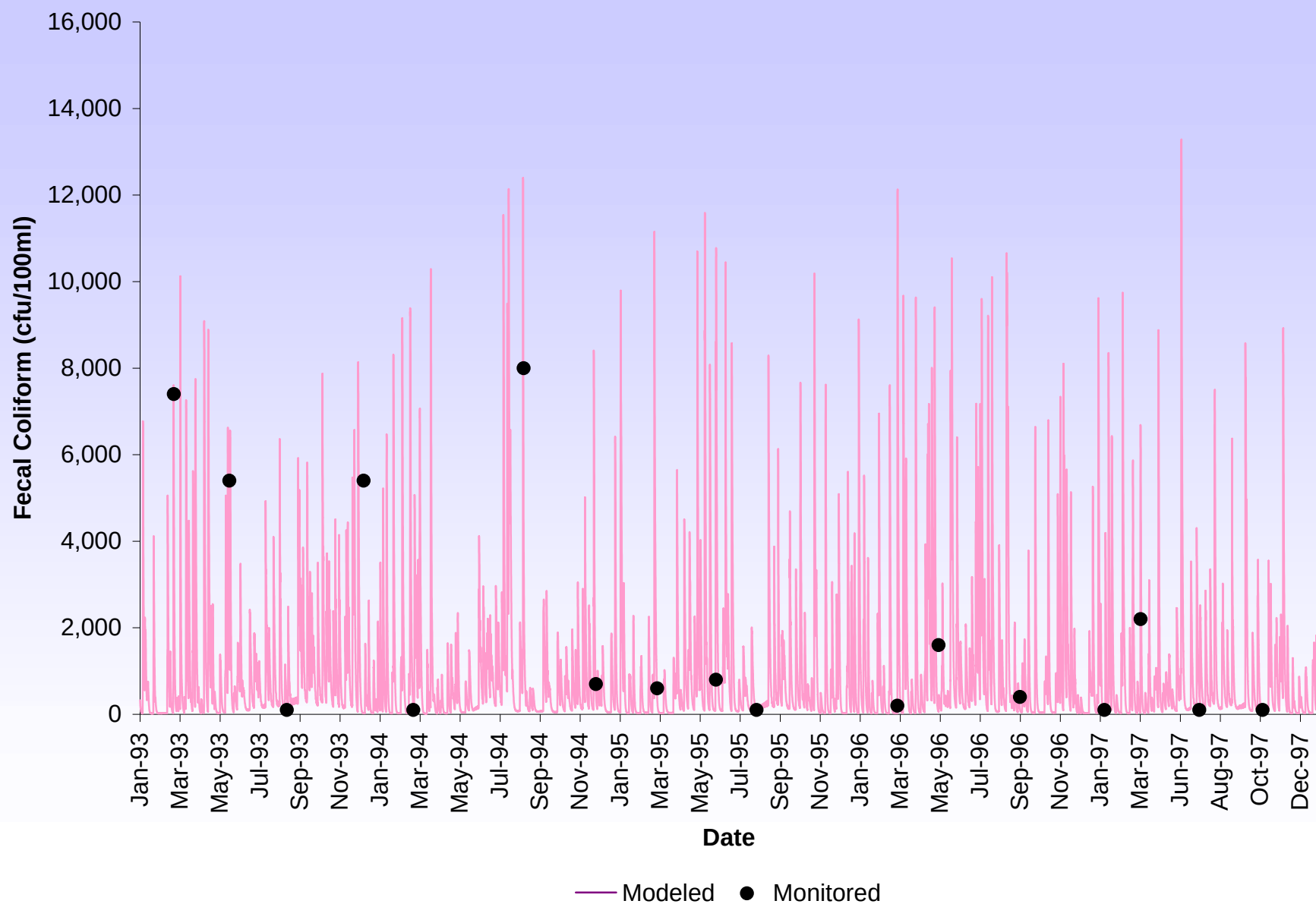


WATER QUALITY CALIBRATION

- Qualitative - visual inspection
 - Hourly bacteria concentration from model versus grab sample collected by VADEQ
- Quantitative comparison
 - Geometric mean
 - Water quality standard exceedance rate



MARSH RUN WQ CALIBRATION





MARSH RUN WQ CALIBRATION

Parameter	Calibration
Geometric mean of VADEQ values (cfu/100mL)	599
Geometric mean of modeled values (cfu/100mL)	541
Fecal coliform instantaneous water quality standard (1,000 cfu/100mL) exceedance rate of VADEQ values (%)	35
Fecal coliform instantaneous water quality standard (1,000 cfu/100mL) exceedance rate of modeled values (%)	24
Fecal coliform instantaneous water quality standard (400 cfu/100mL) exceedance rate of VADEQ values (%)	53
Fecal coliform instantaneous water quality standard (400 cfu/100mL) exceedance rate of modeled values (%)	53



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



BROWNS RUN ALLOCATION

Point Source	Permit #	Design Flow (MGD)	Existing Condition Load (cfu/yr)
Colonial Pipeline - Remington	VA0051675	0.001	0.00E+00
Residence	VAG406119	0.001	1.69E+09
Residence	VAG406232	0.001	1.69E+09
Residence	VAG406145	0.001	1.69E+09
Residence	VAG406312	0.001	1.69E+09



BROWNS RUN ALLOCATION

Non-point Source	Existing Condition Load (cfu/yr)
Direct Deposition	
Straight Pipes	4.49E+12
Livestock	8.84E+12
Wildlife	1.52E+13
<i>Total</i>	<i>2.86E+13</i>
Land-based	
Residential	2.78E+14
Cropland	3.13E+13
Pasture	8.59E+15
Forest	5.99E+13
<i>Total</i>	<i>8.96E+15</i>



BROWNS RUN ALLOCATION

Scenario Number	Percent Reduction in Fecal Coliform Loading from Existing Conditions							% Violations of <i>E. coli</i> Standard	
	Straight Pipes	Residential	Livestock DD	Cropland	Pasture	Wildlife DD	Forest	GM	SSM
0	0	0	0	0	0	0	0	5.0	20.2
1	100	0	100	0	0	0	0	0.0	19.4
2	100	75	100	75	75	0	0	0.0	7.9
3	100	90	100	90	90	0	0	0.0	3.2
4	100	96	100	96	96	0	0	0.0	0.0
5	100	96	96	96	96	0	0	0.0	0.0



BROWNS RUN ALLOCATION

Facility Name	Permit #	Existing Condition Load (cfu/yr)	Loading Reduction (%)	Allocation Condition Load (cfu/yr)
Colonial Pipeline - Remington	VA0051675	0.00E+00	0	0.00E+00
Residence	VAG406119	1.69E+09	0	1.69E+09
Residence	VAG406232	1.69E+09	0	1.69E+09
Residence	VAG406145	1.69E+09	0	1.69E+09
Residence	VAG406312	1.69E+09	0	1.69E+09



BROWNS RUN ALLOCATION

Non-point Source	Existing Condition Load (cfu/yr)
Direct Deposition	
Straight Pipes	4.49E+12
Livestock	8.84E+12
Wildlife	1.52E+13
<i>Total</i>	<i>2.86E+13</i>
Land-based	
Residential	2.78E+14
Cropland	3.13E+13
Pasture	8.59E+15
Forest	5.99E+13
<i>Total</i>	<i>8.96E+15</i>

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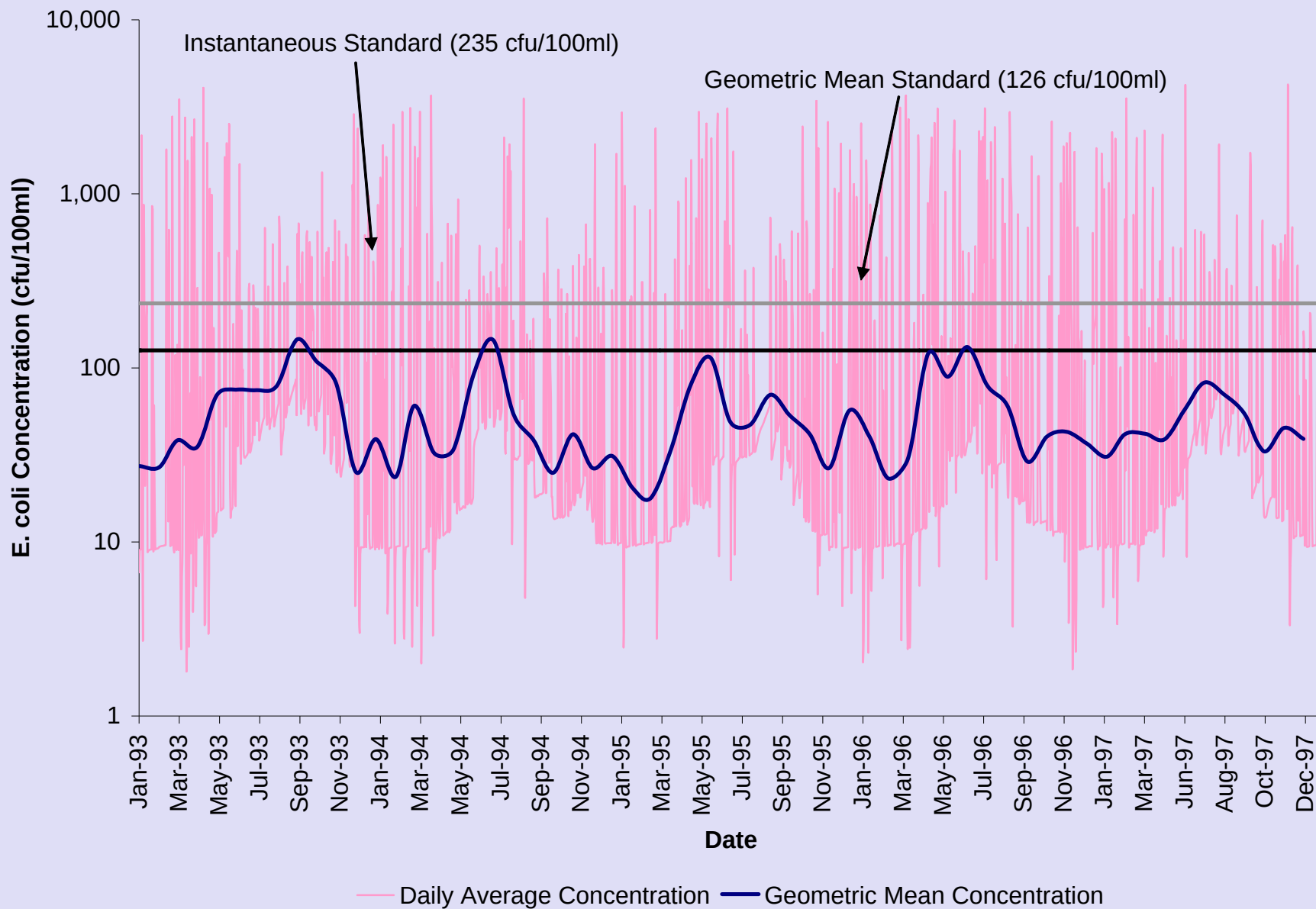
Scenario 5 Reduction (%)
100
96
0
96
96
96
0

=

Non-point Source	Allocation Condition Load (cfu/yr)
Direct Deposition	
Straight Pipes	0.00E+00
Livestock	3.54E+11
Wildlife	1.52E+13
<i>Total</i>	<i>1.56E+13</i>
Land-based	
Residential	1.11E+13
Cropland	1.25E+12
Pasture	3.44E+14
Forest	5.99E+13
<i>Total</i>	<i>4.16E+14</i>

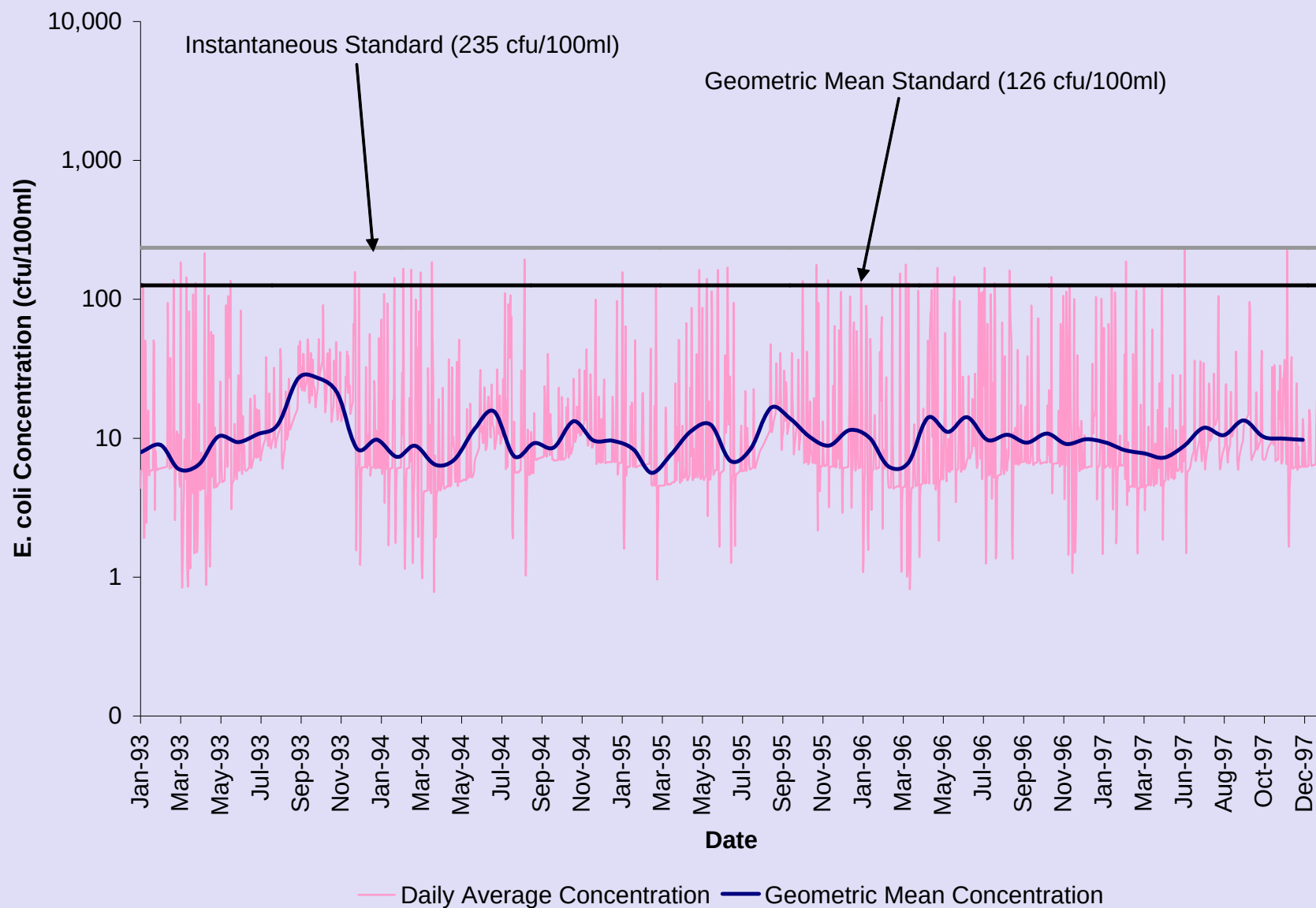


BROWNS RUN EXISTING CONDITIONS





BROWNS RUN ALLOCATION CONDITIONS





ALLOCATION REDUCTIONS

Impairment	Percent Reduction in Fecal Coliform Loading from Existing Conditions						
	Straight Pipes	Livestock DD	Wildlife DD	Residential	Cropland	Pasture	Forest
Cedar Run (VAN-E16R-01)	100	98	0	98	98	98	0
Rapidan River (VAN-E18R-01)	100	96	0	96	96	96	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



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
Cedar Run (VAN-E16R-01)	100	89	0	89	89	89	0
Rapidan River (VAN-E18R-01)	100	75	0	46	46	46	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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