Total Maximum Daily Loads (TMDLs) Analysis for Pocomoke River, Delaware

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EXECUTIVE SUMMARY

Section 303(d) of the Clean Water Act (CWA) as amended by the Water Quality Act of 1987, requires States to identify impaired waters and develop Total Maximum Daily Loads (TMDLs) for pollutants of concern. The Delaware Department of Natural Resources and Environmental Control (DNREC) has identified 11.8 miles of the Pocomoke River as impaired for dissolved oxygen, nutrients and bacteria. The Bald Cypress Branch is a tributary to the Pocomoke River and a part of the Pocomoke watershed. 3.5 miles of Bald Cypress Branch have been identified as impaired for nutrients, bacteria and habitat. The Pocomoke River was placed on the State's 303(d) lists in 1996, 1998, 2002 and 2004, thus targeting the river for TMDL development. Bald Cypress Branch was listed as impaired for nutrients on the 2004 303(d) list. (1)(2)(3)(4) This TMDL addresses the nutrient and dissolved oxygen impairments in the Pocomoke River and Bald Cypress Branch.

The Pocomoke River watershed is located centrally on the border between southern Delaware and Maryland. The mainstem of the Pocomoke is approximately 11.8 miles long and drains about 22,700 acres in Delaware before entering Maryland. Land use within the watershed is dominated by agricultural uses and wetland areas that take up 45 and 38 percent of the area respectively. There are no point sources in the Delaware portion of the watershed; therefore, all pollutants are generated from nonpoint sources within the Delaware portion of the watershed.

Development of the Pocomoke River watershed TMDLs was based on water quality assessments of the Pocomoke River under two different environmental conditions: 1) median stream flow and water quality conditions, and 2) summer low-flow critical conditions. Median conditions considered median water quality values during the period of 1997 – 2003. Summer low-flow critical condition modeled water quality under 7Q10 flow conditions and using June to September water quality data from the 1997- 2003 period to represent water quality condition during critical period. The U.S. EPA's Enhanced Stream Water Quality Model (QUAL2K) was used as the framework for this analysis.

The results of water quality modeling and analysis showed that under both median and summer low flow conditions, the daily average dissolved oxygen water quality standard of 5.5 mg/l and target value of 3.0 mg/l of total nitrogen were achieved in all segments of the Pocomoke River. Under median and critical conditions the minimum dissolved oxygen criteria of 4.0 mg/l at all times and the 0.2 mg/l target for total phosphorus were not met without nonpoint source load reductions of 55 percent for nitrogen inputs and 55 percent for phosphorus inputs.

The proposed TMDL scenario of fifty-five percent reductions in nopoint source nitrogen and phosphorus inputs results in net load reductions of 124.5 lbs/d from 226.4 lbs/d to 101.9 lbs/d of nitrogen. Similarly, phosphorus loads are reduced 7.4 lbs/d from 13.5

lbs/d to 6.1 lbs per day. See the table below.

Pocomoke River Baseline Delaware Load and TMDL Delaware Load Allocations

Condition		Total N (lbs/day)		Total P (lbs/day)	
		Point Source	Nonpoint Source	Point Source	Nonpoint Source
Baseline Median Load		0	226.4	0	13.5
TMDL Load Allocation	**Point Source (WLA)**	0	-	0	-
	Nonpoint Source (LA)	-	102.7	-	6.1
	TMDL	102.7		6.1	

The proposed TMDL scenario also calls for a nonpoint source bacteria load reduction of 69.2% from the 1997- 2005 baseline levels. This shall result in reducing a yearly-mean bacteria load from 4.2E+11 CFU per day to 1.3E+11 CFU per day.

1.0 Introduction

Section 303(d) of the Clean Water Act (CWA) as amended by the Water Quality Act of 1987, requires States to identify impaired waters and develop Total Maximum Daily Loads (TMDLs) for pollutants of concern. The Delaware Department of Natural Resources and Environmental Control (DNREC) has identified 11.8 miles of the Pocomoke River as impaired for dissolved oxygen, nutrients and bacteria. The Bald Cypress Branch is a tributary to the Pocomoke River and a part of the Pocomoke watershed. 3.5 miles of Bald Cypress Branch have been identified as impaired for nutrients, bacteria and habitat. The Pocomoke River has been placed on the State's 303(d) lists in 1996, 1998, 2002 and 2004, thus targeting the river for TMDL development. Bald Cypress Branch was listed as impaired for nutrients on the 2004 303(d) list. (1)(2)(3)(4) Figure 1-1 shows Delaware's portion of the watershed. The red lines on the map illustrate impaired stream segments that are on the 303 (d) Lists. Table 1-1 is excerpted from the 2004 303 (d) List for the Pocomoke River Watershed.

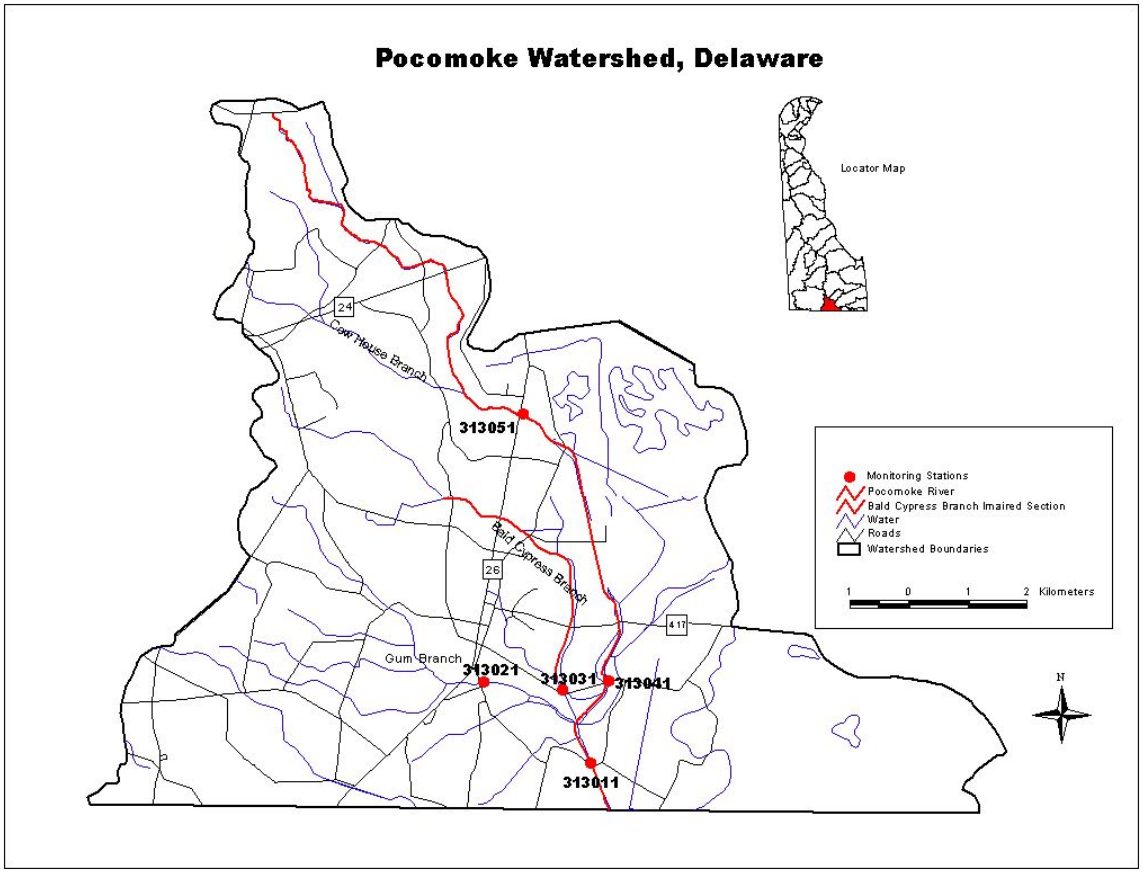

Figure 1 - 1 Pocomoke River Watershed Map

Table 1-1 Excerpt from 303(d) List of 2004 for Pocomoke River

WATERBODY ID	WATERSHED NAME	SEGMENT	Overall CALM Code	DESCRIPTION	SIZE	POLLUTANT OR STRESSOR	PROBABLE SOURCE(S)	YEAR LISTED	TARGET DATE FOR TMDL
DE250-001	Pocomoke River	Pocomoke River	5	Pocomoke River, from headwaters to the MD-DE State line	11.8 miles	Bacteria	NPS	1996	2005
						DO	NPS	1996	2005
						Nutrients	NPS	1996	2005
DE250-002	Pocomoke River	Tributaries from the headwaters to MD-DE State line	5	Bald Cypress Branch--from the confluence of the headwaters to the confluence with the next larger stream order	3.5 miles	Habitat	NPS	1998	2010
						Bacteria	NPS	2004	2005
						Nutrients	NPS	2004	2005

1.1 Pocomoke River Watershed

The Delaware portion of the Pocomoke River watershed is located centrally on the border between southern Delaware and Maryland. The mainstem of the Pocomoke is approximately 11.8 miles long and drains about 22,700 acres in Delaware before entering Maryland. The USGS describes the upper Pocomoke watershed saying: "Soils are generally moderately permeable but poorly drained (U.S. Department of Agriculture, 1970) and the water table is shallow (generally less than 2 m below land surface during wet periods). Tributaries are low gradient with sluggish flow and are typically channelized. Ditches to promote drainage of agricultural fields are common…". (5) Concerns in the watershed include nutrient overenrichment and high bacteria counts. There are no point sources in the watershed; therefore, all pollutants are generated from nonpoint sources within the watershed.

Land use within the watershed is dominated by agricultural uses and wetland areas that take up 45 and 38 percent of the area respectively. 2002 Delaware Office of Planning land cover data has been compiled to create Figures 1-2 and 1-3 to show the land use patterns in the watershed. (6)

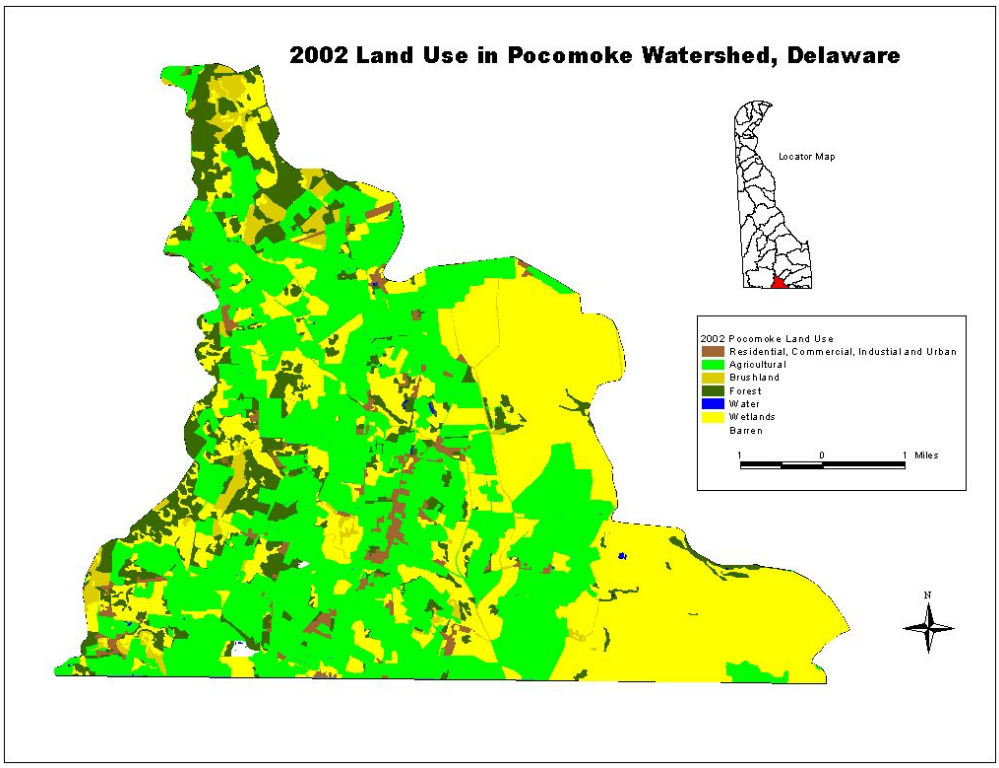

Figure 1 - 2 2002 Land Uses in Pocomoke River Watershed

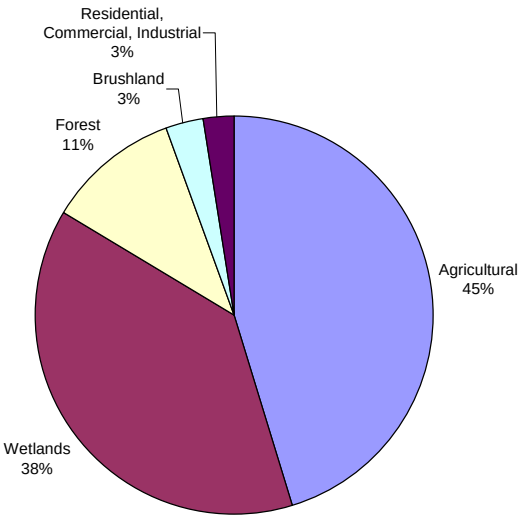

Figure 1 - 3 2002 Land Use Percentages in Pocomoke River Watershed

1.2 Designated Uses

The purpose of establishing TMDLs is to reduce pollutants to levels that result in meeting applicable water quality standards and support designated uses of the streams. Section 3 of the State of Delaware Surface Water Quality Standards, as amended, July 11, 2004, (7) specifies the following designated uses for the waters of Pocomoke Watershed:

Primary Contact Recreation

Secondary Contact Recreation

Fish, Aquatic Life, and Wildlife

Agricultural Water Supply

Industrial Water Supply

1.3 Applicable Water Quality Standards and Nutrient Guidelines

To protect the designated uses, the following sections of the State Delaware Surface Water Quality Standards, as amended July 11, 2004, provide specific narrative and numeric criteria concerning the waters in the Pocomoke Watershed:

Section 4 Criteria to Protect Designated Uses
Section 5 Antidegradation and ERES Waters Policies

Based on the above sections, the following is a brief summary of pertinent water quality standards that are applicable to the waters of the Pocomoke River Watershed:

Dissolved Oxygen (D.O.):

> Daily average shall not be less than 5.5 mg/l
> 4.0 mg/l instantaneous minimum

Nutrients:

> It shall be the policy of this Department to minimize nutrient input to surface waters from point and human induced non-point sources. The types of, and need for, nutrient controls shall be established on a site-specific basis.

Bacteria (enterococcus):

> 30 day geometric mean shall not exceed 100 CFU/100mL
> Single sample maximum shall not exceed 185 CFU/100mL

In the absence of numeric nutrient criteria, DNREC has used target thresholds of 3.0 mg/l for total nitrogen and 0.2 mg/l for total phosphorus as indicators of excessive nutrient levels in the streams. The above threshold values have been used as a guideline for 305(b) assessment reports and 303(d) listing of impaired waters, and are generally accepted by the scientific community to be an indication of over-enriched waters.

1.4 Stream Water Quality Conditions

The states of Delaware and Maryland and the United States Geological Survey (USGS) have been collecting water quality data in the Pocomoke River. Delaware sampled at 5 stations in the Delaware portion of the watershed while Maryland and the USGS sampled at a gaging station approximately 7.4 km south of the Delaware-Maryland border. Data from these stations were used to support this modeling and analysis effort. Sampling sites are listed in Table 1-2 and are shown in Figure 1-1 (excluding the USGS Gage). Figures 1-4 through 1-7 show the water quality data collected at four locations along Pocomoke River and one location each in the Bald Cypress and Gum branches, for water temperature, dissolved oxygen, total nitrogen, and total phosphorous. The data is shown on a station by station basis in Figures 1-8 through 1-11. The redlines and dots in figures 1-8 through 1-11 represent median values at each station.

Table 1-2 Pocomoke River Water Quality Monitoring Sites of Interest

Station ID	Station Location	Data Period
313011	Pocomoke River at Rt. 419 Bridge	1998-2003
313041	Pocomoke River at Rt. 417 Bridge	2000-2003
313051	Pocomoke River at Rt. 30 Bridge	2000-2003
313021	Gum Branch at Rt.413 Bridge	2000-2003
313031	Bald Cypress Branch at Rd. 60 Bridge	2000-2003
USGS Gage 01484985	Pocomoke River near Willards Maryland	1997-2002

The monitoring data collected at stations 313011, 313041 and 313051 in the Pocomoke from 1998 – 2003 period showed that out of 78 combined dissolved oxygen samples, dissolved oxygen concentration did not meet the 5.5 mg/l standard 9 times. For total nitrogen concentrations, there were 56 samples in the period from the same stations. Of

those, 40 were above 1 mg/l and 17 were greater than 3 mg/l. For total phosphorus, 41 of 80 samples from the same stations were above 0.05 mg/l and 5 were greater than 0.2 mg/l.

At stations 313021 and 313031 there were 12 samples taken at each station in the 2000-2003 period. Two samples at each station were below the 5.5mg/l dissolved oxygen average criteria. Of the 24 combined total nitrogen samples, 22 were above 1mg/l and 12 were also above 3 mg/l. Of the 24 combined samples for total phosphorus 21 were above 0.05 mg/l. One sample at each station was above the total phosphorus 0.2 mg/l target.

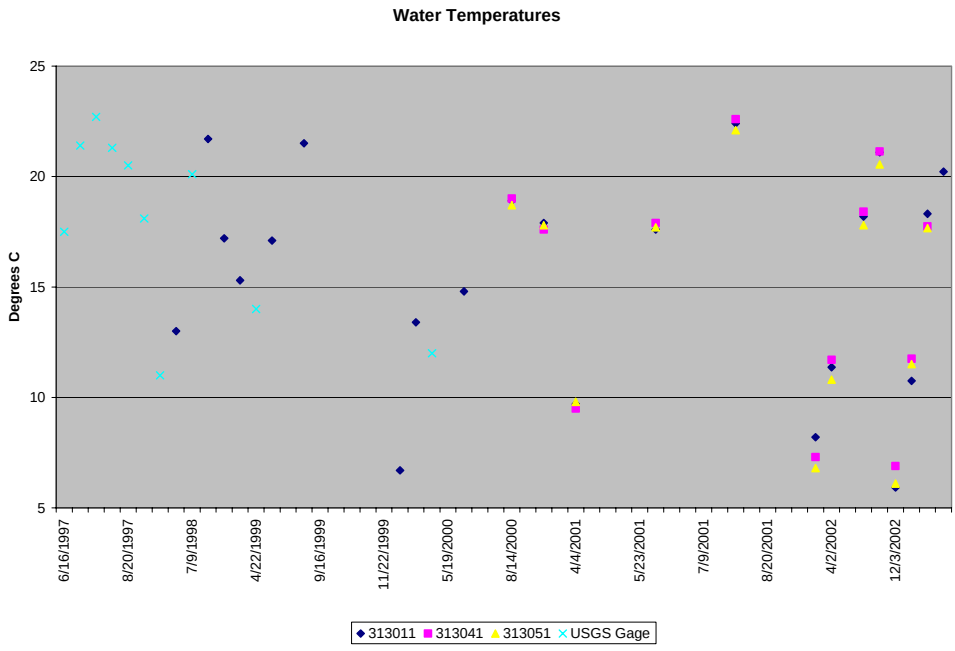

Figure 1 - 4 Water Temperatures at Stations in the Pocomoke River

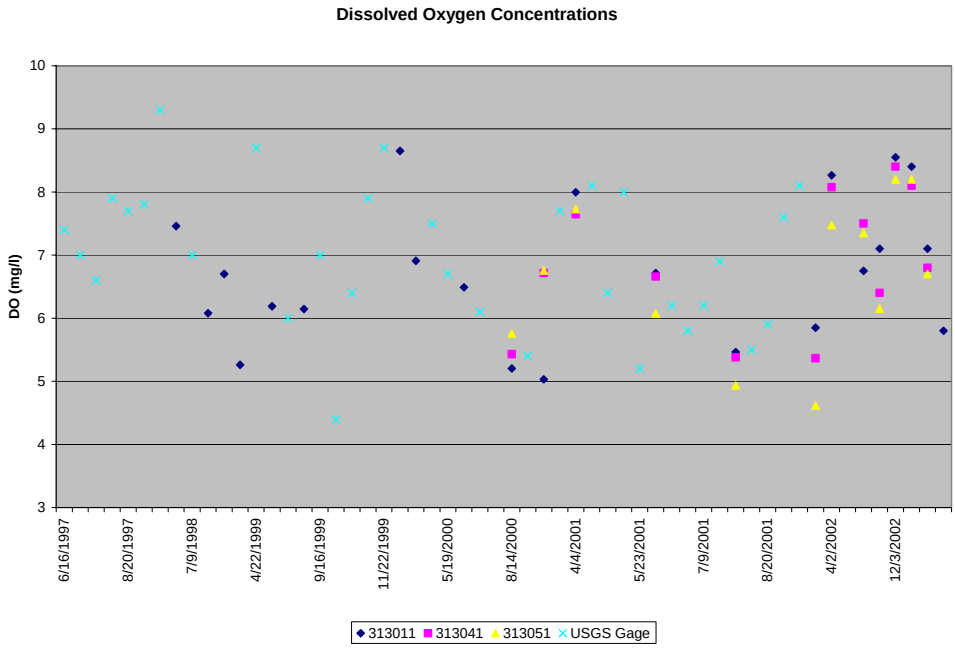

Figure 1 - 5 Dissolved Oxygen Concentrations at Stations in the Pocomoke River

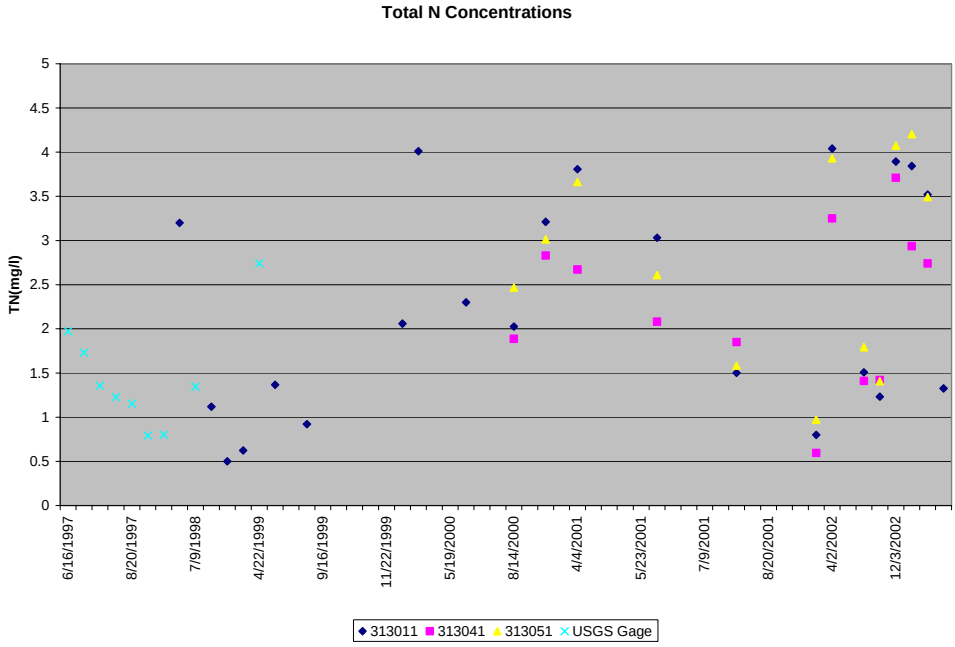

Figure 1 - 6 Total Nitrogen Concentrations at Stations in the Pocomoke River

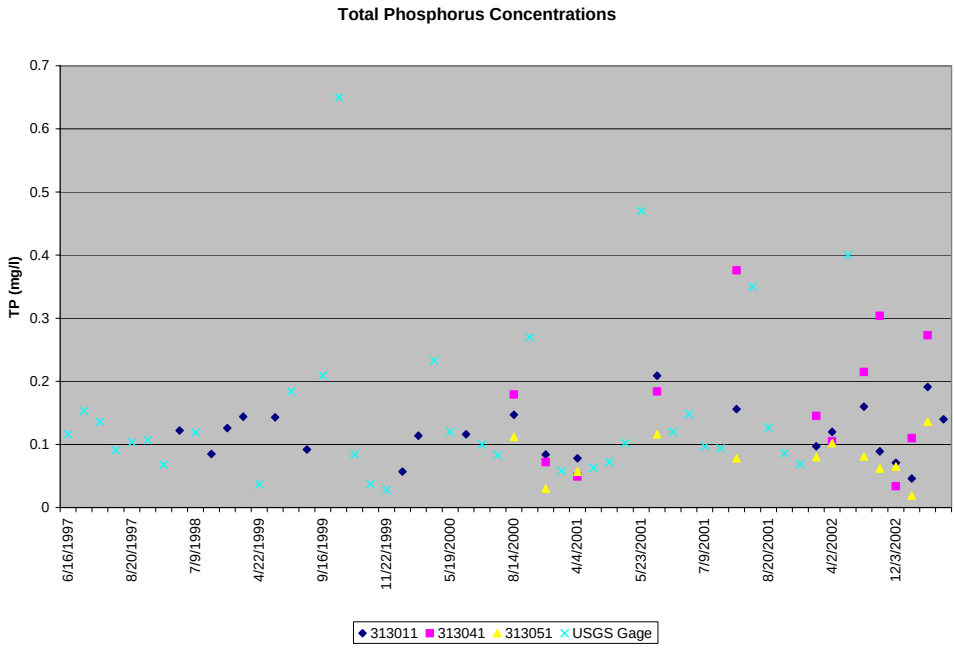

Figure 1 - 7 Total Phosphorus Concentrations at Stations in the Pocomoke River

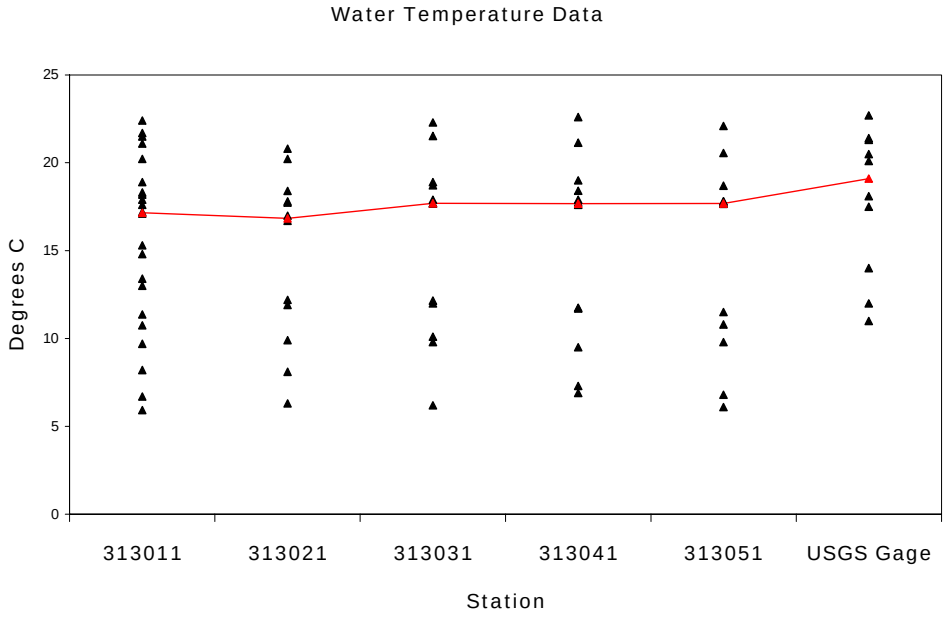

Figure 1 - 8 Temperature Data and Medians at Stations in the Pocomoke River

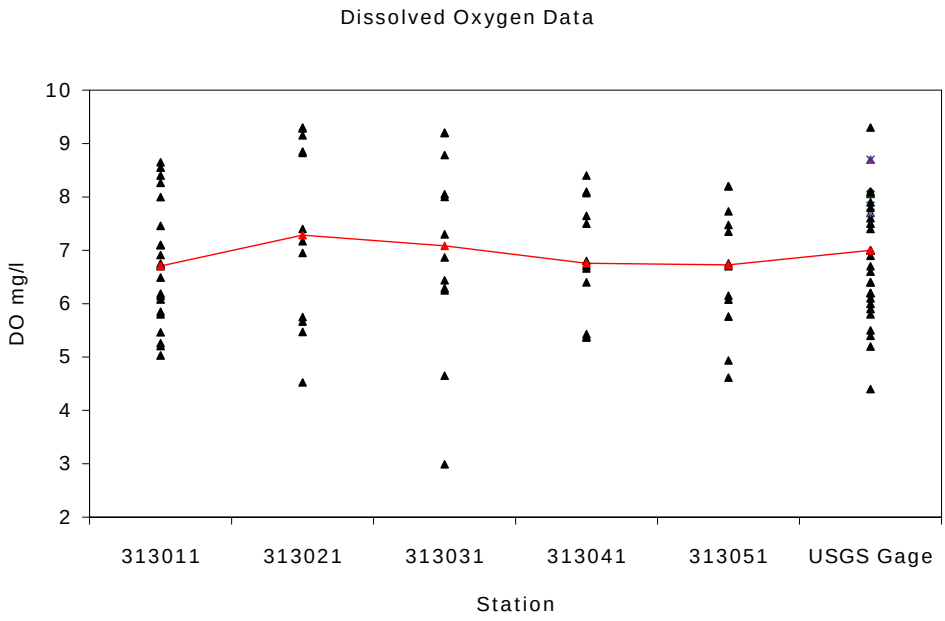

Figure 1 - 9 Dissolved Oxygen Data and Medians at Stations in the Pocomoke River Watershed

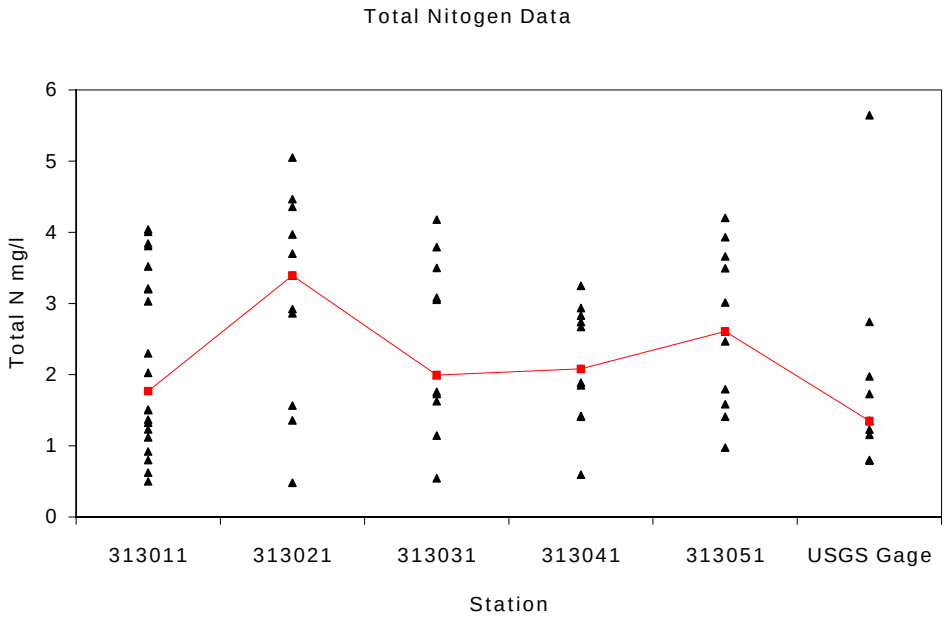

Figure 1 - 10 Total Nitrogen Data and Medians at Stations in the Pocomoke River

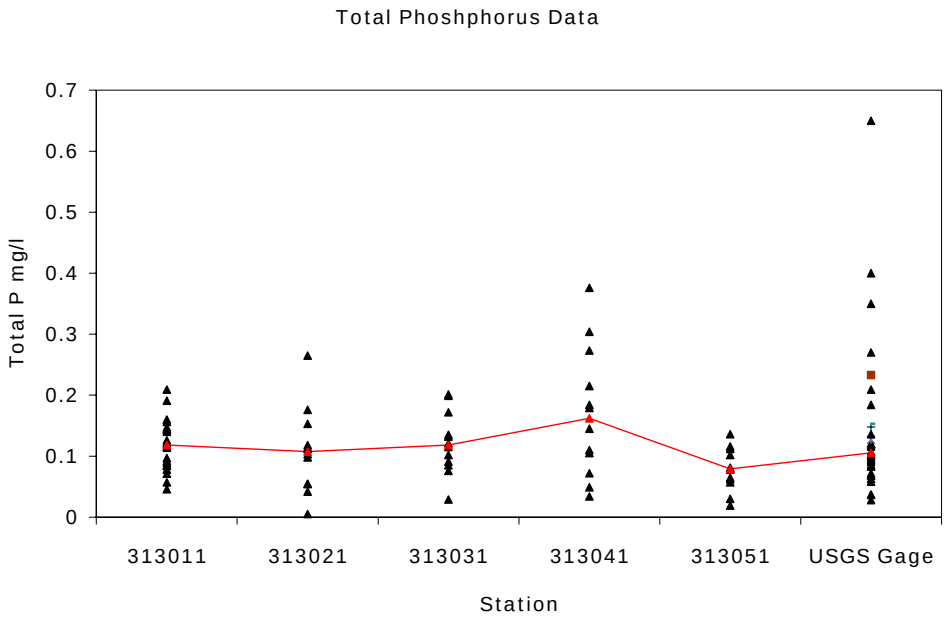

Figure 1 - 11 Total Phosphorus Data and Medians at Stations in the Pocomoke River

1.5 Sources of Pollution

No NPDES facilities are located in the Delaware potion of the watershed. Therefore, all of the pollutants considered in this analysis are generated from nonpoint sources such as surface runoff from agricultural and urban land use activities, septic tanks, and groundwater discharges loaded with nutrients.

1.6 Objective and Scope of the TMDL Analysis for Pocomoke River, Delaware

The objective of the TMDL analysis for the Pocomoke River Watershed in Delaware is to estimate the total maximum amount of dissolved oxygen consuming compounds and nutrients that the Delaware portion of the Pocomoke River can receive without violating water quality standards.

To achieve the above objective, DNREC has:

- Developed a water quality model for the Delaware portion of the Pocomoke River using the U.S. EPA's QUAL2K Model as a framework.
- Calibrated the Pocomoke River QUAL2K model to the 1997-2003 median water quality and 1983-2003 median flow conditions.
- Applied and evaluated summer loading conditions using the above calibrated

model with summer median loading data and low flow conditions.

- Estimated nutrient loads under median conditions of the 1997 – 2003 period.

Chapter 2 of this report provides a brief review of the Pocomoke River QUAL2K model. The results of calibration run and summer loading scenario run are presented in Chapter 3. An estimation of Pocomoke River's TMDLs and the rationale for acceptance of the loads as Pocomoke River TMDLs are discussed in Chapter 4.

2.0 Pocomoke River Watershed Water Quality Model

2.1 The Stream Water Quality Model (QUAL2K)

The Stream Water Quality Model (QUAL2K) was chosen as a framework for the Delaware portion of the Pocomoke River model development and TMDL analysis. QUAL2K is supported and distributed by the U.S. EPA (online at this URL: http://www.epa.gov/athens/wwqtsc/html/qual2k.html) and has been widely used for studying the impact of conventional pollutants on streams.

The QUAL2K model is suitable for simulating the hydrological and water quality conditions of a small river. It is a simple one-dimensional model that simulates basic stream transport and mixing processes. The processes employed in QUAL2K address nutrient cycles, algal growth, and dissolved oxygen dynamics. (8) Compared to other available models, QUAL2K is the one best suited for Pocomoke River's conditions. Therefore, QUAL2K was selected as the tool to develop the Pocomoke River water quality model and conduct the TMDL analysis.

The model was downloaded from the US EPA website and operated in the Microsoft Excel program as designed by the program authors. Data inputs in the Pocomoke River QUAL2K are discussed in the next section of this chapter.

2.2 Pocomoke River QUAL2K Model Input Data

The Pocomoke River QUAL2K Model is set up as a one-dimensional, steady-state model. It simulates instream water quality conditions including dissolved oxygen, BOD, algae as chlorophyll-a, as well as various forms of nitrogen and phosphorous. Water temperature and diurnal changes of algae are also simulated. The major input data groups for the Pocomoke River QUAL2K Model are summarized below.

Model Segmentation

The Pocomoke River QUAL2K model consists of seventeen 1km reaches and covers the lower portions of the Pocomoke River from its crossing at Rt. 30/26 (STORET Station 313051) to the USGS Gaging Station near Willards Maryland. The portion of the Pocomoke above station 313051 (approximately 8.4 kilometers) is treated as headwaters in the model. The Gum Branch and Bald Cypress Branch are treated as a single point source to the Pocomoke at their junction approximately 7 km from station 313051. Bald Cypress Branch has not been listed for dissolved oxygen impairments; it has however been listed for nutrient impairments. In order to meet dissolved oxygen criteria in the Pocomoke River, reductions in nutrient loads from Bald Cypress Branch were modeled in the Pocomoke river model. No model for dissolved oxygen endpoints was created for the Branch. In the final model, fifty-five percent reductions in total phosphorus and total nitrogen are expected to be protective of dissolved oxygen in the Pocomoke River. Figure 2-1 displays the reaches on a watershed map. A description of the modeled reaches is

presented in Table 2-1.

Table 2- 1 Pocomoke River Model QUAL2K Reaches

Segment	Length (km)	Description
1	1	The most upstream reach, starting from STORET Station 313051. Waters above this station are treated as headwaters
2	1	
3	1	
4	1	
5	1	
6	1	
7	1	The junction with Bald Cypress Branch and Gum Branch (treated as a point source in the model) and Station 313041 are in this segment
8	1	Station 313011 is near the end of this segment
9	1	The Delaware/Maryland border is at the end of this segment.
10	1	
11	1	
12	1	Junction with Green Run (treated as a point source in the model)
13	1	
14	1	
15	1	
16	1	
17	1	The most downstream reach. The USGS Gage is midway in this reach.

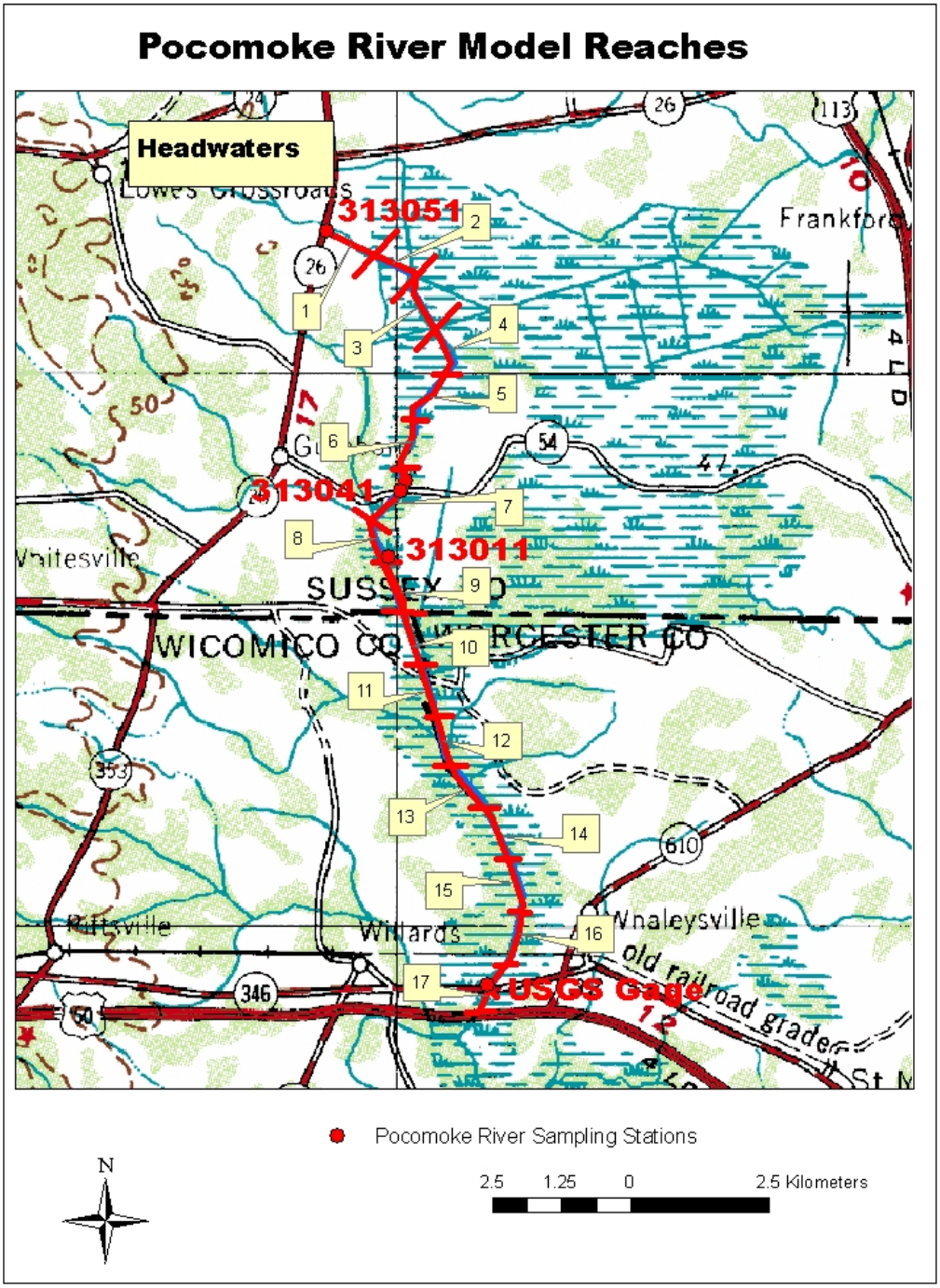

Figure 2- 1 Modeled Reaches of the Pocomoke River

Stream Flow

Both median and 7Q10 flows were considered for development of the Pocomoke River model and the TMDL analysis. 7Q10 flow is a low flow of 7-day duration with recurrence interval of 10 years. Median and 7Q10 flows were calculated using DFLOW 3 software for the period of 1983-2003. Median flow was used for model calibration while 7Q10 flow was used to simulate critical conditions of summer low flow and warm water temperatures.

The Pocomoke River is a small river with median flow for 1983-2003 at the USGS gage near Willards Maryland of 1.328 cubic meters per second (m^3/s). 7Q10 flow at the station is .05664 m^3/s. There is no gaging station in Delaware for the Pocomoke River. Flows in the Delaware portion of the watershed were estimated based on the area of the watershed that drained to each sampling station. Drainage areas were estimated using a GIS. See figure 2-2 and table 2-2 below for drainage areas and estimated flows under median and 7Q10 conditions.

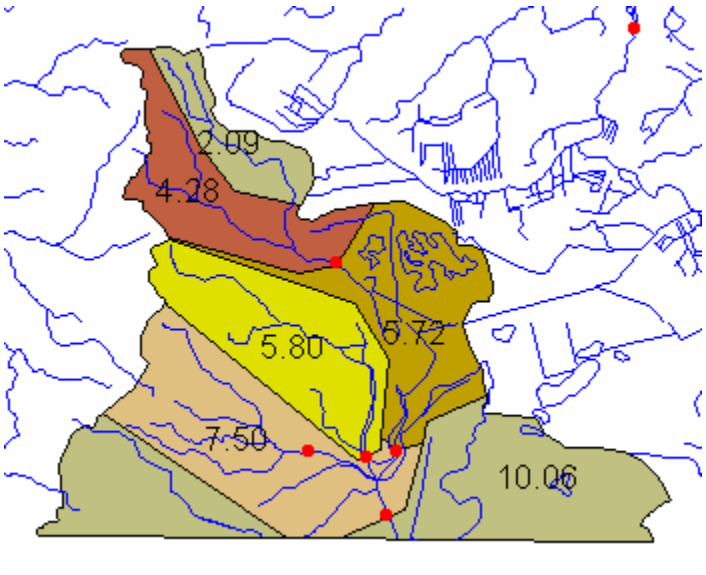

Figure 2- 2 Area (sq miles) Draining to Monitoring Stations in the Pocomoke River

Table 2- 2 Estimated Areas and Flows at Delaware Stations of the Pocomoke River

	Square Miles	% of Gage Area	Median Flow m^3/s	7Q10 Flow m^3/s
USGS Gage Drainage Area	60.5	100	1.133	.057
Area that drains to 313051	6.37	10.53%	0.119	.006
Area that drains to 313041	12.09	19.98%	0.226	.011
Area that drains to 313011	25.39	41.97%	0.475	.024
% of flow attributable to Delaware		57.27%		

Hydraulic Characteristics

The Pocomoke River QUAL2K model uses the Manning formula to describe stream hydraulic characteristics and assumes that stream has a rectangular channel cross-section.

A field visit to the river showed the river to be highly regular in depth and width due to management activities in the watershed. Estimates were made of the width and depth of flow in the river based on the visit. The width of the river ranges from 3-9 meters under normal flow conditions. The slope for the river was estimated based on topographic maps. A single slope was selected for the entire river. Stream characteristic inputs are shown in the table below.

Table 2- 3 Manning Equation Factors in the Pocomoke River Calibrated Medians Model

Reach Label	Downstream end of reach label	Segment Number	Reach length	Manning Formula				
				Bot Width (m)	Side Slope	Side Slope	Channel Slope	Manning n
	Station 313051	0		3.00	0.00	0.00	0.0003	0.05
		1	1.00	3.50	0.00	0.00	0.0003	0.05
		2	1.00	4.00	0.00	0.00	0.0003	0.05
		3	1.00	4.50	0.00	0.00	0.0003	0.05
		4	1.00	5.00	0.00	0.00	0.0003	0.05
		5	1.00	6.00	0.00	0.00	0.0003	0.05
		6	1.00	7.00	0.00	0.00	0.0003	0.05
Station 313041	BCB and GB Junction	7	1.00	7.70	0.00	0.00	0.0003	0.05
Station 313011		8	1.00	7.80	0.00	0.00	0.0003	0.05
	Md State Line	9	1.00	8.00	0.00	0.00	0.0003	0.05
		10	1.00	8.20	0.00	0.00	0.0003	0.05
		11	1.00	8.30	0.00	0.00	0.0003	0.05
Junction with Green Run		12	1.00	8.40	0.00	0.00	0.0003	0.05
		13	1.00	8.50	0.00	0.00	0.0003	0.05
		14	1.00	8.70	0.00	0.00	0.0003	0.05
		15	1.00	8.90	0.00	0.00	0.0003	0.05
		16	1.00	9.00	0.00	0.00	0.0003	0.05
USGS Gage	Model End	17	1.00	9.00	0.00	0.00	0.0003	0.05

System Parameters

The physical, chemical, and biological processes simulated by QUAL2K are represented by a set of equations that contain many parameters. Some are global constants, some are spatial variables, and some are temperature dependent variables. Detailed descriptions of these parameters and associated processes are available in the QUAL2K user's manual. Global rate constants used under median and 7Q10 conditions are in table 2-4.

Table 2- 4 Rate Constants in Pocomoke River QUAL2K model

Parameter	*Value*	*Units*	*Symbol*
Stoichiometry:			

Parameter	*Value*	*Units*	*Symbol*
Carbon	40	mgC	gC
Nitrogen	9	mgN	gN
Phosphorus	2	mgP	gP
Dry weight	100	mgD	gD
Chlorophyll	2	mgA	gA
Inorganic suspended solids:			
Settling velocity	1	m/d	v_i
Oxygen:			
Reaeration model	Internal		
Temp correction	1.024		θ_a
O2 for carbon oxidation	2.69	gO2/gC	r_{oc}
O2 for NH4 nitrification	4.57	gO2/gN	r_{on}
Oxygen inhib CBOD oxidation model	Exponential		
Oxygen inhib CBOD oxidation parameter	0.60	L/mgO2	K_{socf}
Oxygen inhib nitrification model	Exponential		
Oxygen inhib nitrification parameter	0.60	L/mgO2	K_{sona}
Oxygen enhance denitrification model	Exponential		
Oxygen enhance denitrification parameter	0.60	L/mgO2	K_{sodn}
Slow CBOD:			
Hydrolysis rate	3	/d	k_{hc}
Temp correction	1.047		θ_{hc}
Fast CBOD:			
Oxidation rate	5	/d	k_{dc}
Temp correction	1.047		θ_{dc}
Organic N:			
Hydrolysis	0.05	/d	k_{hn}
Temp correction	1.07		θ_{hn}
Ammonium:			
Nitrification	4	/d	k_{na}
Temp correction	1.07		θ_{na}
Nitrate:			
Denitrification	1	/d	k_{dn}
Temp correction	1.07		θ_{dn}
Sed denitrification transfer coeff	0.15	m/d	v_{di}
Temp correction	1.07		θ_{di}
Organic P:			
Hydrolysis	2	/d	k_{hp}
Temp correction	1.07		θ_{hp}
Phytoplankton:			
Max Growth	2.5	/d	k_{gp}
Temp correction	1.07		θ_{gp}
Respiration	0.1	/d	k_{rp}
Temp correction	1.07		θ_{rp}
Death	0	/d	k_{dp}

Parameter	*Value*	*Units*	*Symbol*
Temp correction	**1**		θ_{dp}
Nitrogen half sat constant	**15**	**ugN/L**	k_{sPp}
Phosphorus half sat constant	**2**	**ugP/L**	k_{sNp}
Light model	**Half saturation**		
Light constant	**57.6**	**langleys/d**	K_{Lp}
Ammonia preference	**25**	**ugN/L**	k_{hnxp}
Settling velocity	**0.15**	**m/d**	v_a
Bottom Algae:			
Max Growth	**60**	**gD/m^2/d**	C_{gb}
Temp correction	**1.07**		θ_{gb}
Respiration	**1**	**/d**	k_{rb}
Temp correction	**1.07**		θ_{rb}
Death	**0.25**	**/d**	k_{db}
Temp correction	**1.07**		θ_{db}
Nitrogen half sat constant	**300**	**ugN/L**	k_{sPb}
Phosphorus half sat constant	**100**	**ugP/L**	k_{sNb}
Light model	**Half saturation**		
Light constant	**50**	**langleys/d**	K_{Lb}
Ammonia preference	**25**	**ugN/L**	k_{hnxb}
Detritus (POM):			
Dissolution	**5**	**/d**	k_{dt}
Temp correction	**1.07**		θ_{dt}
Settling velocity	**1**	**m/d**	v_{dt}
Pathogens:			
Decay	**0.8**	**/d**	k_{dx}
Temp correction	**1.07**		θ_{dx}
Settling velocity	**1**	**m/d**	v_x
pH:			
Partial pressure of carbon dioxide	**347**	**ppm**	p_{CO2}

Boundary Conditions

QUAL2K model uses various data groups to define model boundary conditions. It uses the headwater data group to define upstream boundary conditions of model domain. Downstream boundary conditions can be defined by the user, or computed internally. The point source data group defines the condition of point source discharges from facilities or small tributaries that enter simulated stream segments.

Headwater conditions for the Pocomoke River QUAL2K Model were characterized by using monitoring data collected at station 313051. Tributaries were modeled as point sources based on water quality data from the Bald Cypress Branch and Gum Branch stations. Median concentrations were determined for all stations in the model and were used as calibration points for the model. Medians were determined for the applicable monitoring periods during the March-November sampling months. Median concentrations over the period were used along with median flows to calibrate the model for median conditions. Summer (June- September) median concentrations were then used as the inputs for simulations in critical 7Q10 summer conditions using the rates from the calibrated median conditions model.

The option of internally calculating downstream boundary conditions was selected for development of the Pocomoke River QUAL2K Model.

Diffuse Sources

The diffuse sources data group defines the condition of uniformly distributed flow over the entire length of the model reach. The uniformly distributed flow could be groundwater inflow and/or distributed surface runoff that is assumed constant over time. Water volumes for inflow were estimated by adding inflow volumes to estimated headwater and tributary water volumes to reach the total estimated flows at each of the monitoring stations. Concentrations of nutrients in the inflow were estimated by starting with headwater concentrations and adjusting them as necessary to account for the effect of groundwater input.

Input data for Pocomoke River QUAL2K model calibration and 7Q10 conditions are presented in the appendix.

3.0 Model Calibration and Scenario Analysis

3.1 Model Calibration

The Pocomoke River QUAL2K model was calibrated based on median water quality conditions observed during 1997-2003 using 1983-2003 median flows. Analysis of flow data for the Pocomoke River from USGS Gaging Station number 01484985 near Willards, Maryland showed that median flows occurred most often in the month of May. QUAL2K requires a date be set in the model, so, May 15, 2001 was chosen as a representative date to be the date of interest in the medians model. Inputs for the headwaters and tributaries were based on available data.. Reach specific decay rates and constants were set at levels consistent with other models, literature values and best professional judgment. Nonpoint source loads were then estimated and adjusted based on available water quality data. The input data for the Pocomoke River QUAL2K Model calibration are presented in Appendix A. In addition, selected parameter graphs output by the model are shown below.

Figures 3-1 to 3-3 display the model calibration results for water flow, depth and velocities in the model. Figures 3-4 to 3-8 show model calibration results for various forms of nutrients, dissolved oxygen, phytoplankton chlorophyll-a, and water temperature. Model calibration average results are presented as black lines. Dotted red lines represent minimum and maximum model results. Observed data at the monitoring sites are shown as symbols representing mean, maximum, and minimum values where shown by the model.

The calibration results show that dissolved oxygen, nitrogen, phosphorus and chlorophyll-a are calibrated reasonably well.

Model calibration results show that stream water quality at all modeled reaches meet the daily average dissolved oxygen standard of 5.5 mg/l, however, the 4.0 mg/l minimum dissolved oxygen standard is not met in six segments. Calibration results show that the nutrient target value of 3 mg/l for total nitrogen is met in all segments while the target of 0.2 mg/l for total phosphorous is not met in one segment.

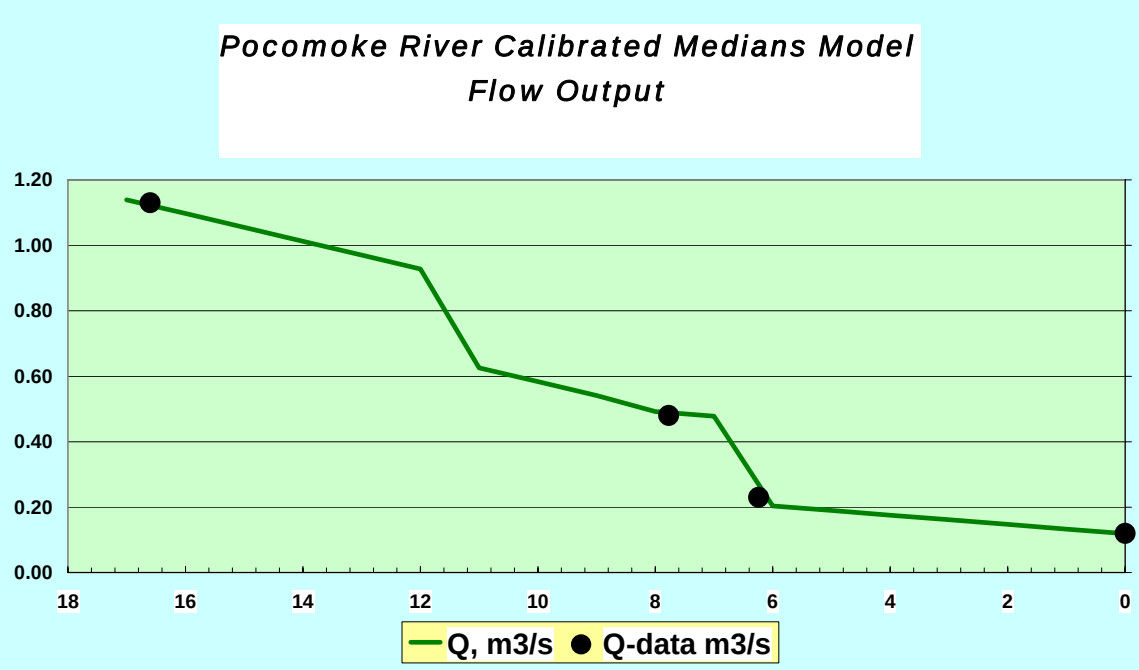

Figure 3- 1 Calibrated Median Model Flows in the Pocomoke River

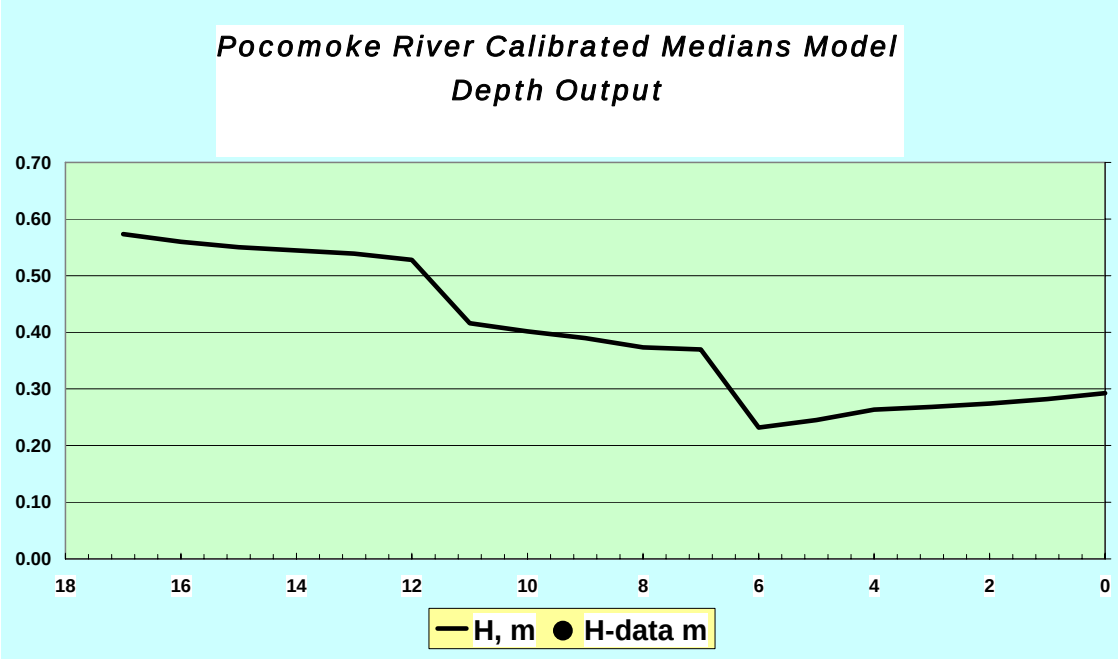

Figure 3- 2 Calibrated Median Model Depths in the Pocomoke River

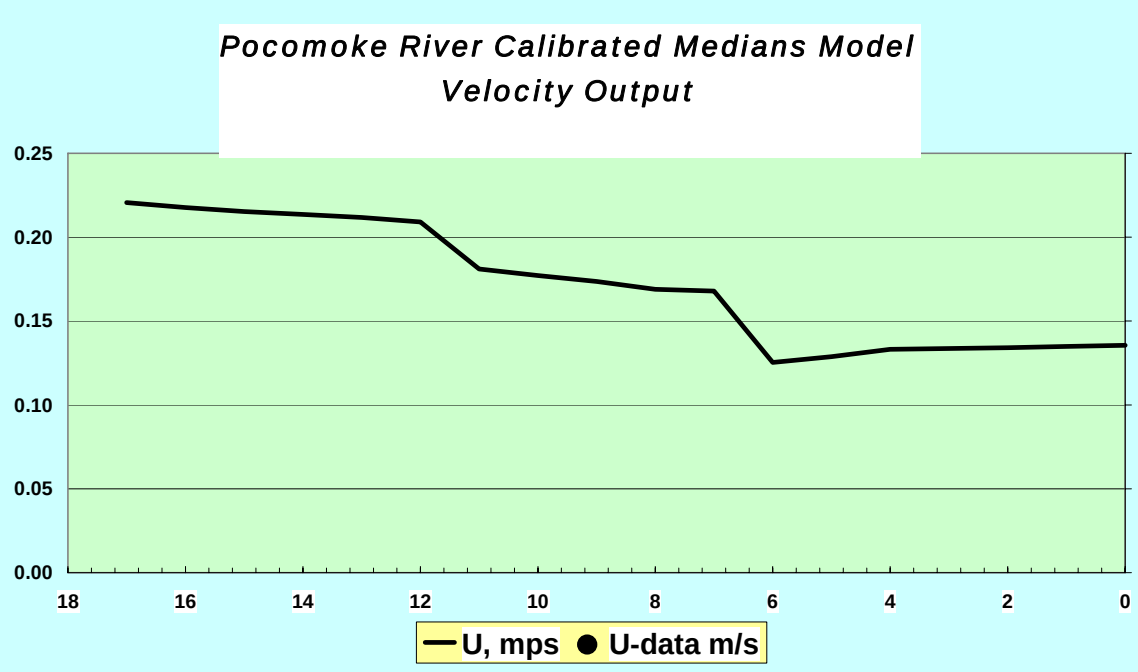

Figure 3- 3 Calibrated Median Model Velocities in the Pocomoke River

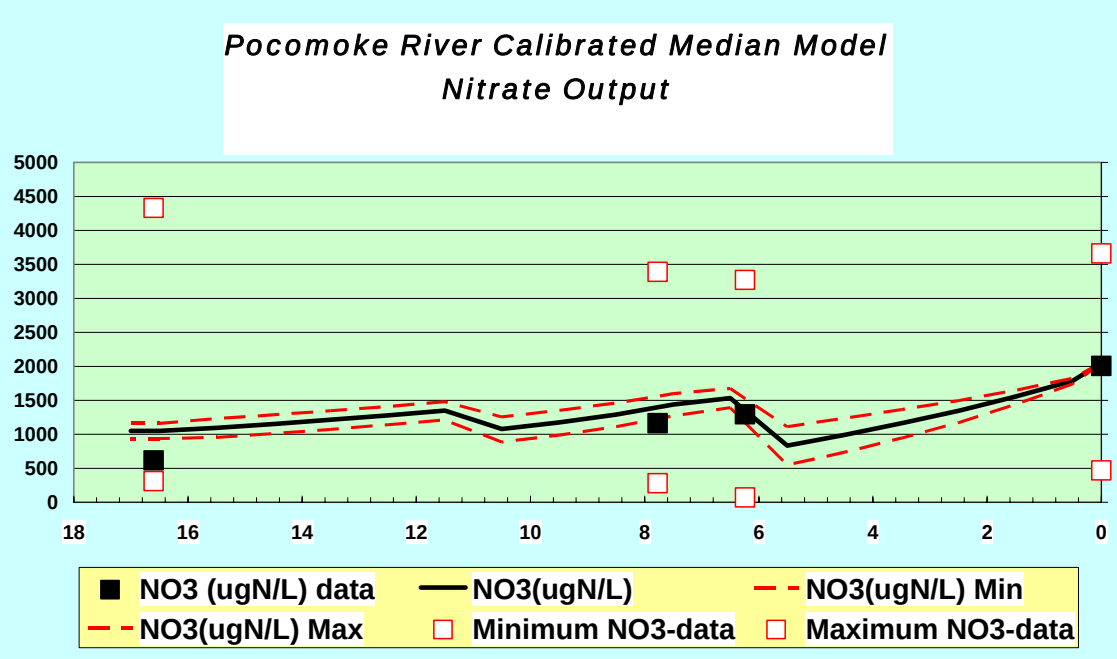

Figure 3- 4 Calibrated Model NO3 Levels for the Pocomoke River

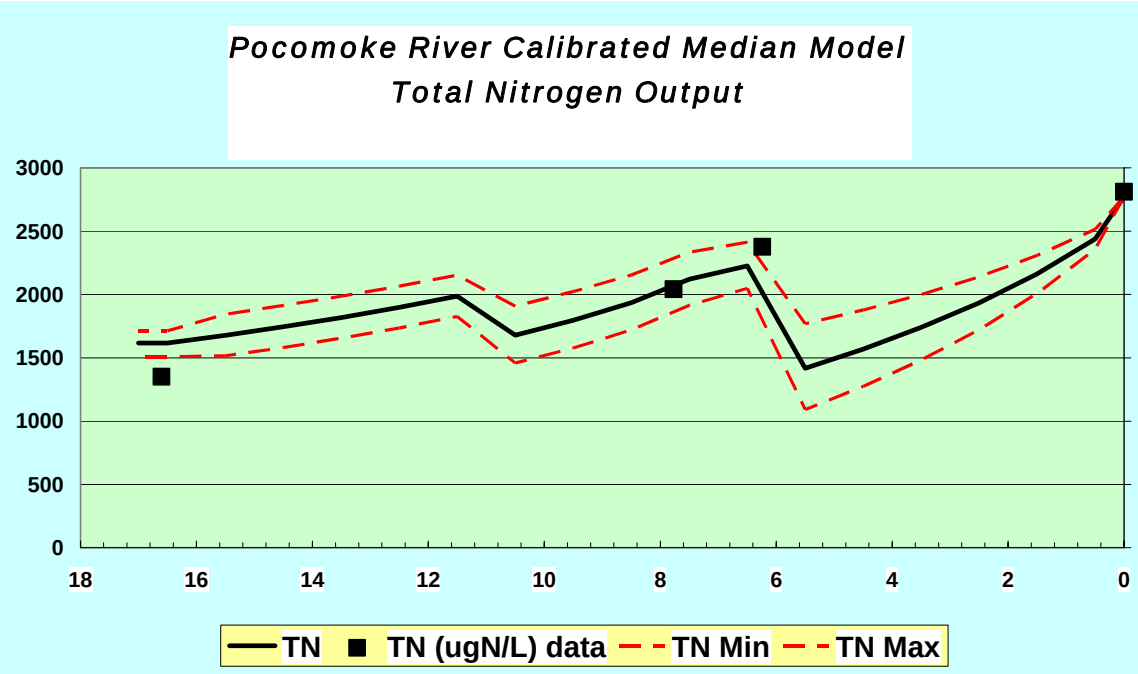

Figure 3- 5 Calibrated Model Total Nitrogen Levels for the Pocomoke River

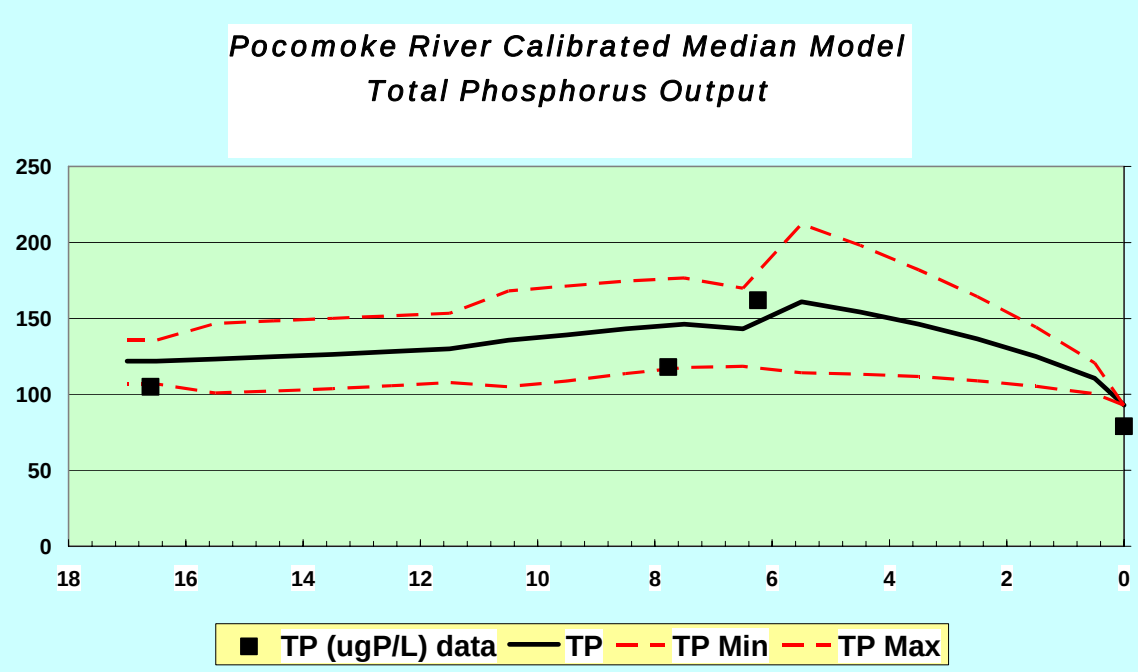

Figure 3- 6 Calibrated Model Total Phosphorus Levels for the Pocomoke River

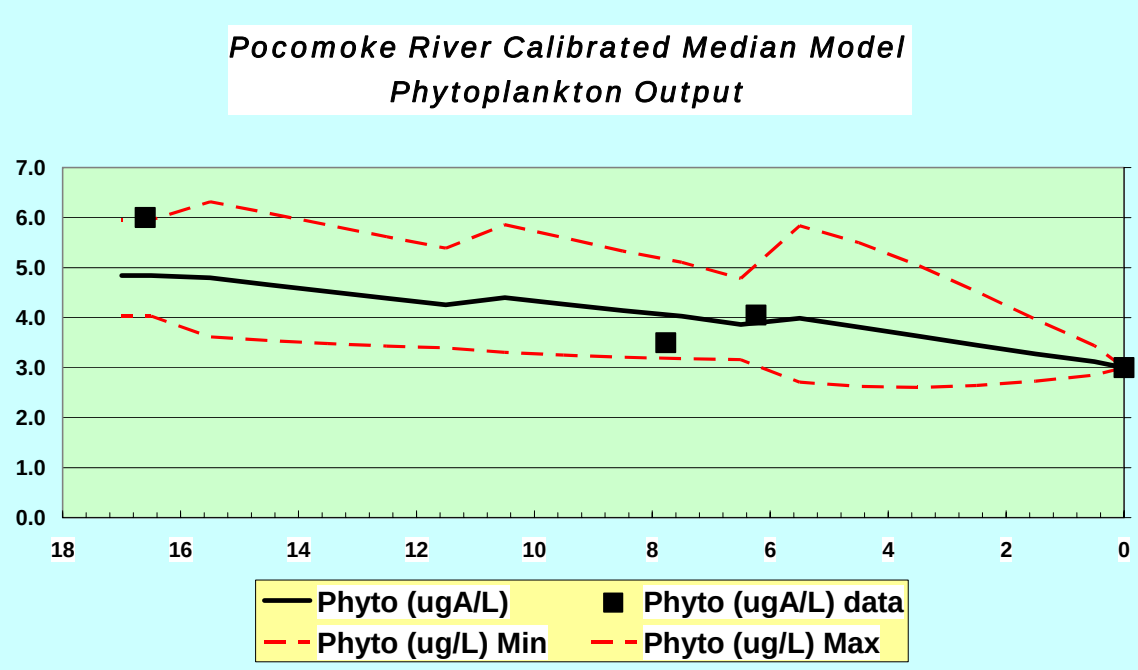

Figure 3- 7 Calibrated Model Phytoplankton Levels for the Pocomoke River

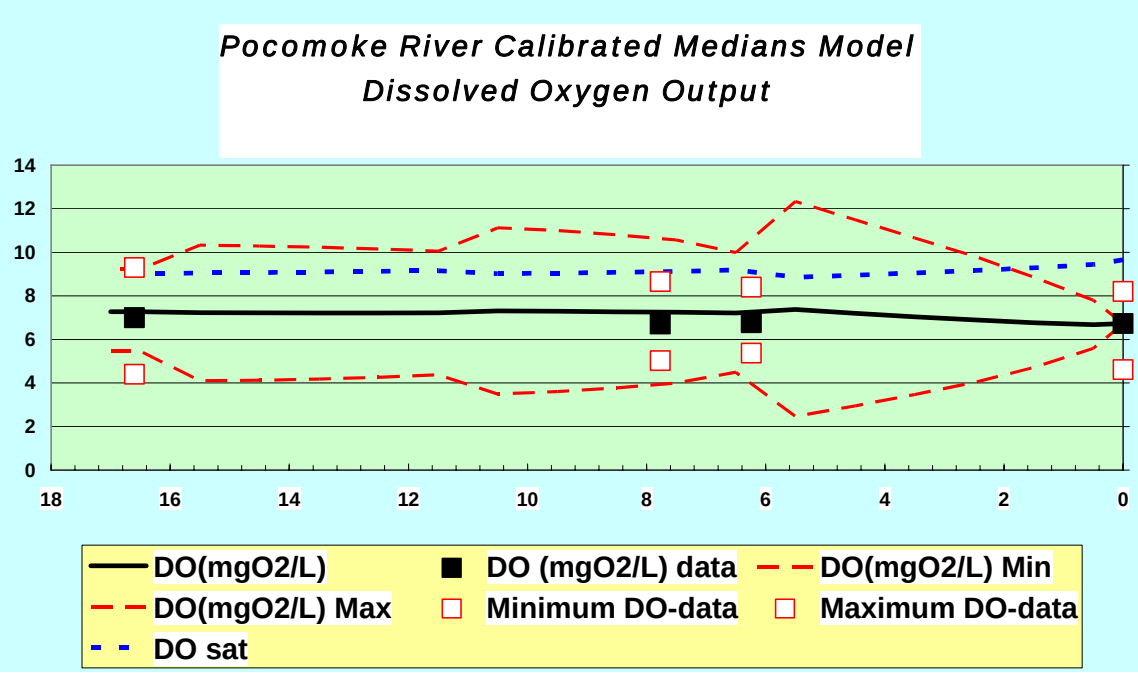

Figure 3- 8 Calibrated Model Dissolved Oxygen Levels for the Pocomoke River

3.2 Critical Condition Analysis

Calibrated model rates were used with summer (June- September) median water quality data to simulate water quality conditions of the Pocomoke River during the critical summer- month period. It was assumed that stream flow was at 7Q10 levels and water temperature at 22.32 ^{0}C (the 90th percentile of water temperature data for July and August). Median water quality conditions during summer months were also used in this scenario. The results of this analysis are presented in Figures 3-9 to 3-13 which show that, under summer low-flow (1983-2003) conditions, water quality in the Pocomoke River is expected to meet the standard of 5.5 mg/l for average dissolved oxygen and nutrient target values of 3 mg/l for total nitrogen. The model shows that under critical condtions, the dissolved oxygen minimum of 4.0 mg/l will not be met in many parts of the Pocomoke River. The model shows that the total phosphorus target value of 0.2 mg/l will be exceeded in a small portion of the river in model segment 8.

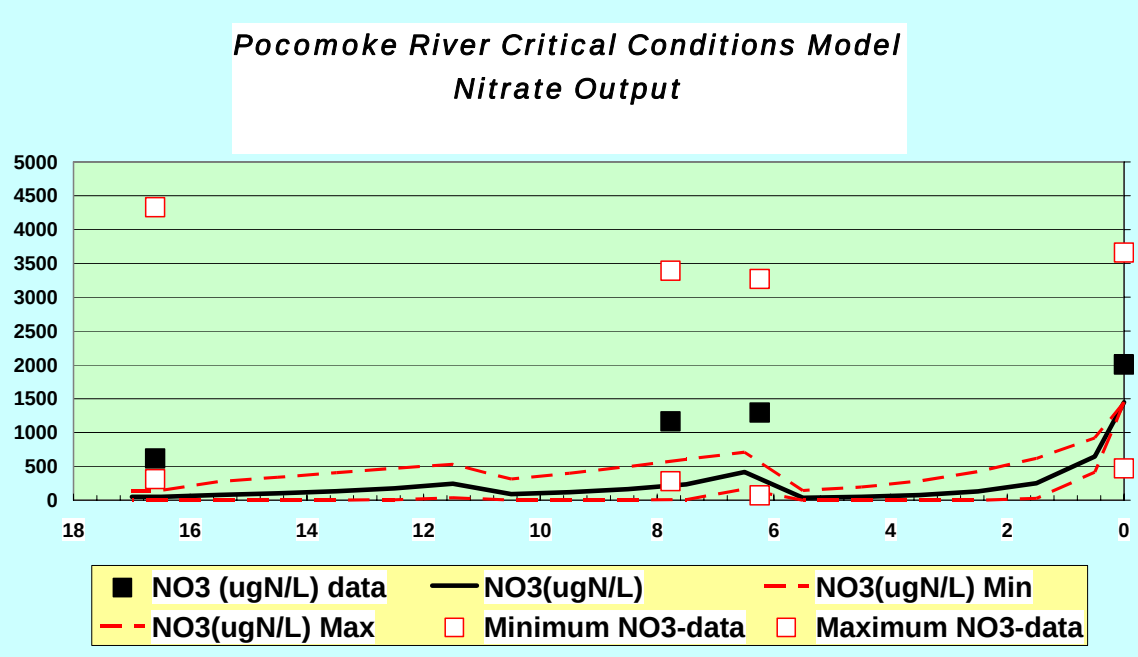

Figure 3- 9 Critical Condition Model NO3 Levels for the Pocomoke River

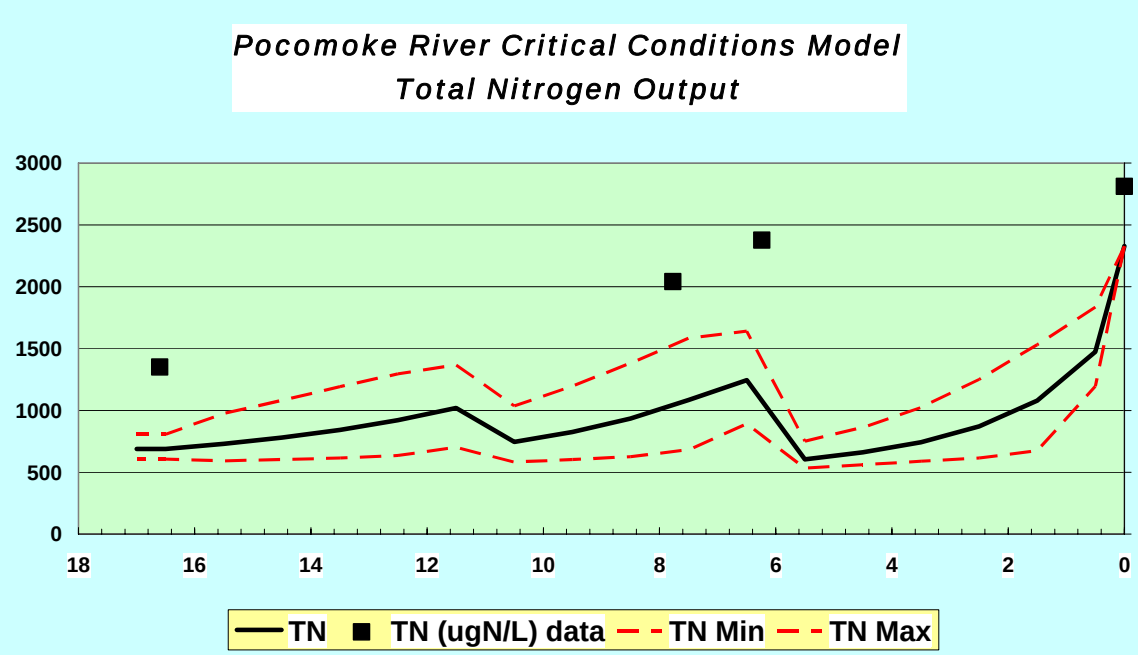

Figure 3- 10 Critical Condition Model total Nitogen Levels for the Pocomoke River

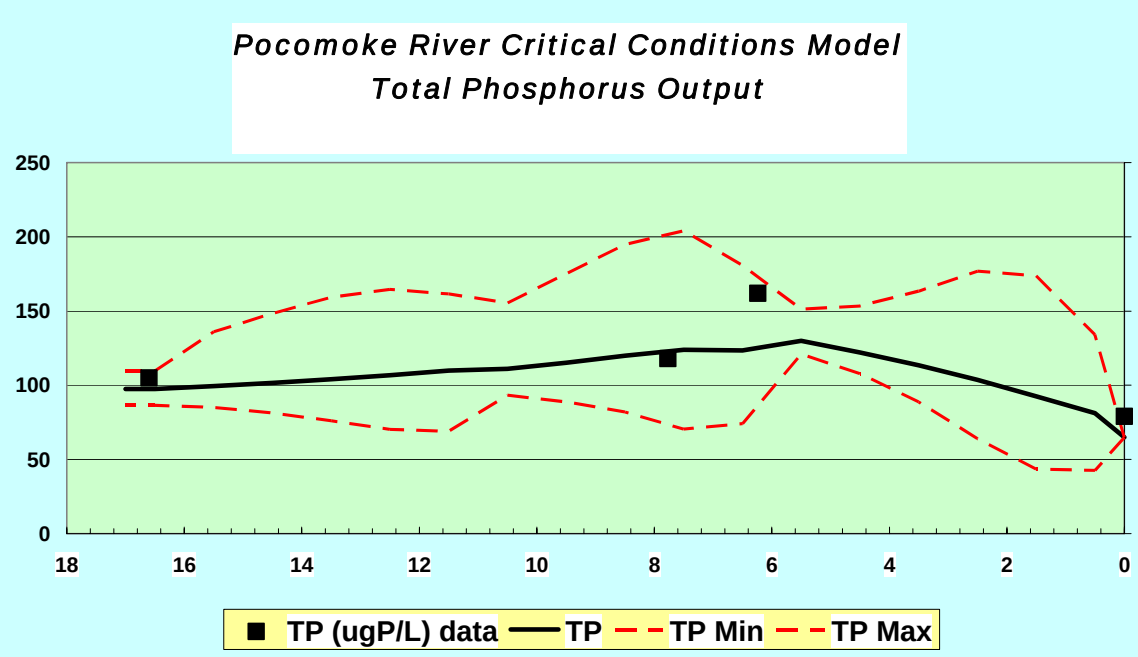

Figure 3- 11 Critical Condition Model Total Phosphorus Levels for the Pocomoke River

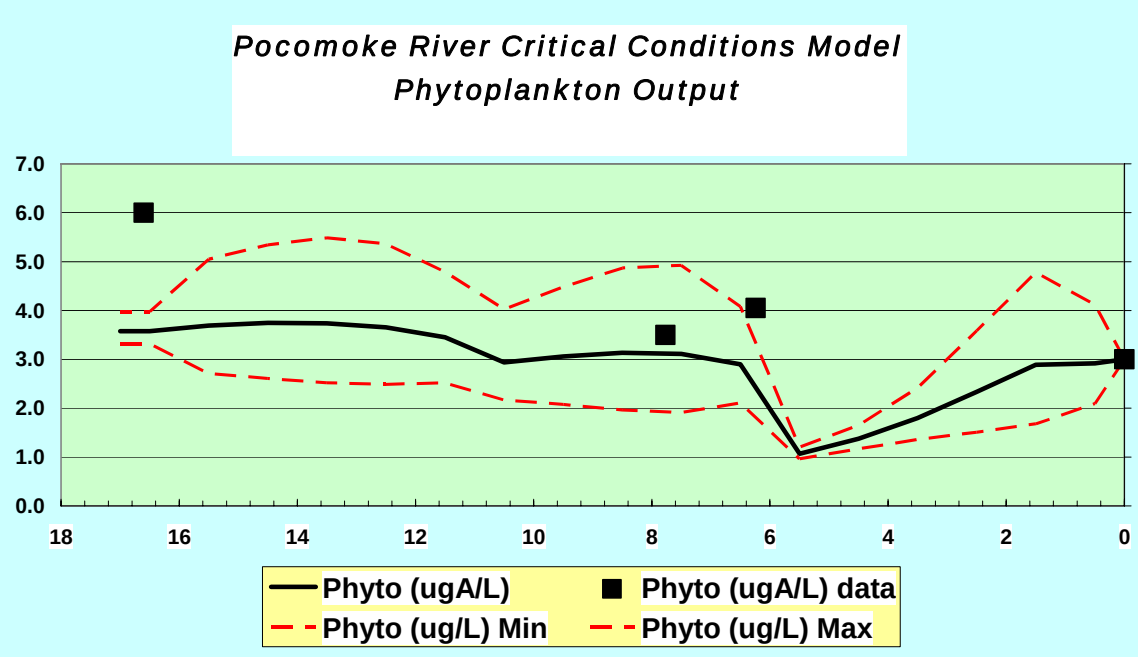

Figure 3- 12Critical Condition Model Phytoplankton Levels for the Pocomoke River

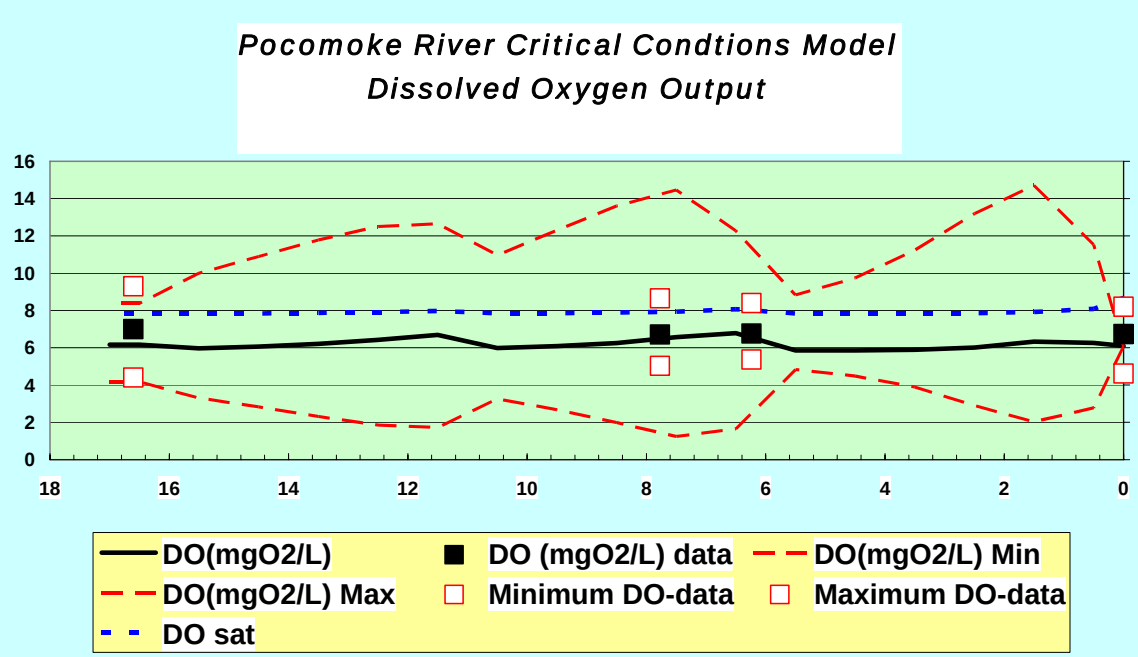

Figure 3- 13Critical Condition Model Dissolved Oxygen Levels for the Pocomoke River

4.0 ESTABLISHMENT OF THE NUTRIENT TMDL FOR THE POCOMOKE RIVER

4.1.1 Critical Condition Scenario Analysis

Using the critical conditions model, reductions were made in the headwater, point source and distributed source nutrient concentrations to reach four endpoints simultaneously: no dissolved oxygen concentrations below 4.0 mg/l, average dissolved concentrations above 5.5 mg/l, total nitrogen levels below 3.0 mg/l and total phosphorous levels below 0.2 mg/l. As part of each scenario modeled, prescribed sediment oxygen demand (SOD) was also reduced by the average nutrient reduction percent. The model showed attainment of the criteria when reductions of fifty-five percent for nitrogen and phosphorus constituents and prescribed SOD were applied. See the table of scenarios and results below and figures 4-1 to 4-5.

Table 4 - 1 The Pocomoke River Watershed Critical Condition TMDL Scenarios

Reduction (%)		Minimum DO (mg/l)	Minimum Average DO (mg/l)	Maximum Total N (mg/l)	Maximum Total P (mg/l)	All Goals met?
P	N					
0 (baseline)	0 (baseline)	1.24	5.86	1.835	0.204	N
30	30	2.81	6.40	1.308	0.150	N
40	40	3.39	6.56	1.434	0.132	N
50	50	3.92	6.67	1.211	0.114	N
55	55	4.17	6.71	1.099	0.105	Y
60	60	4.43	6.75	0.988	0.095	Y
55	30	3.58	6.53	1.658	0.108	N
30	55	3.50	6.53	1.099	0.139	N

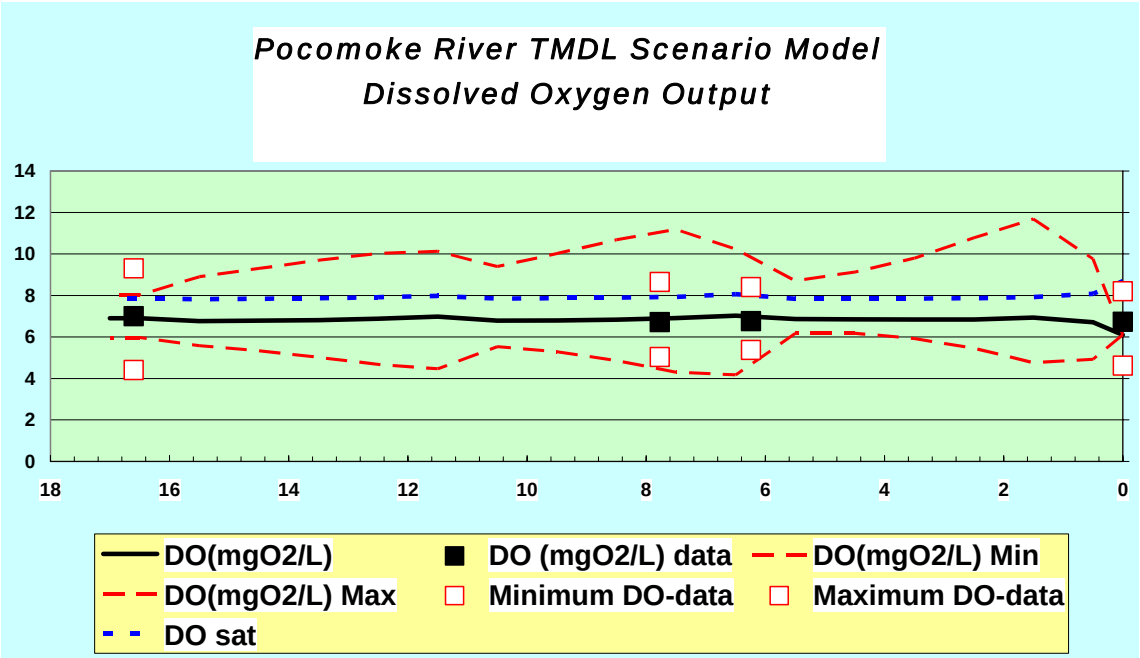

Figure 4- 1 Critical Conditions Dissolved Oxygen Levels under 55% N and 55% P Reduction Scenario

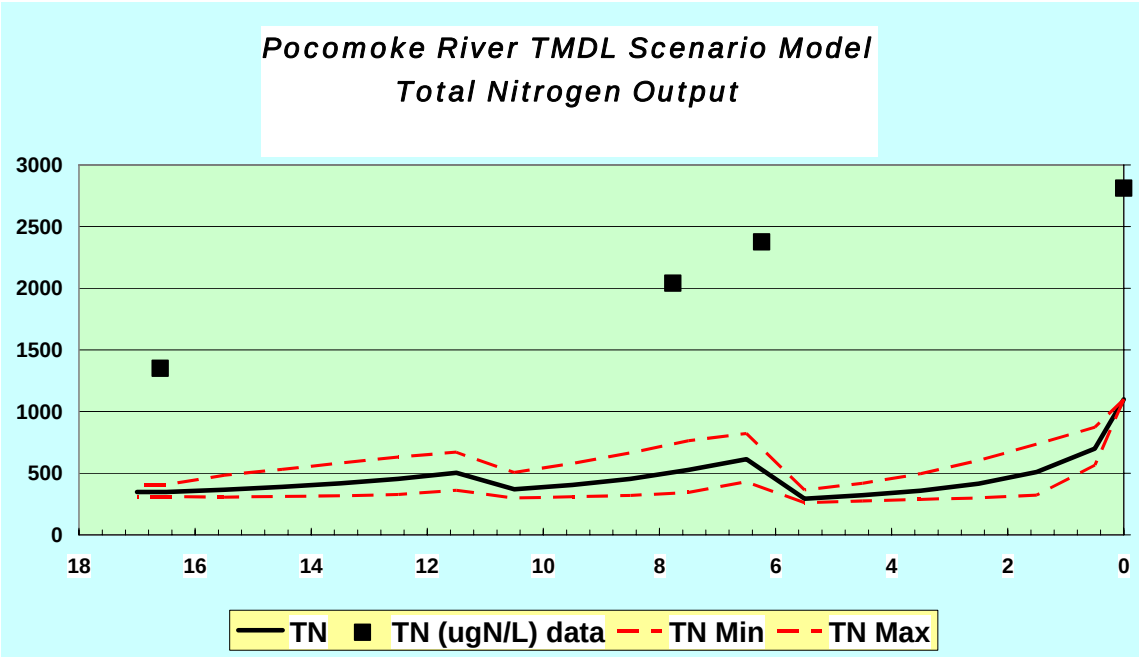

Figure 4- 2 Critical Conditions Total Nitrogen Levels under 55% N and 55% P Reduction Scenario

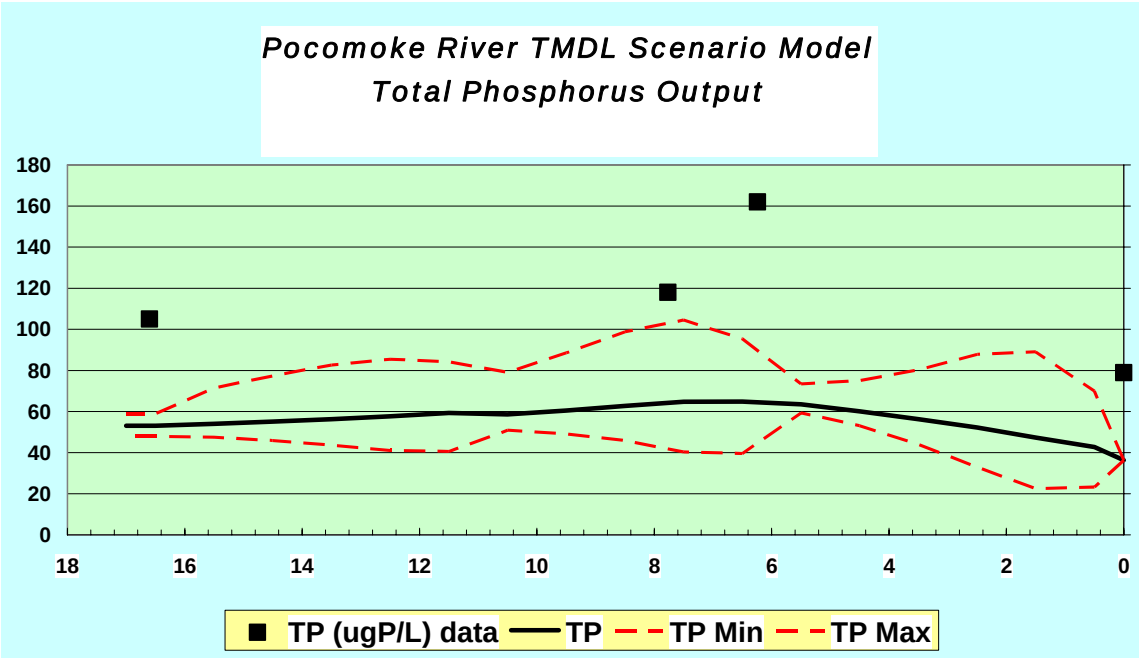

Figure 4- 3 Critical Conditions Total Phosphorus Levels under 55% N and 55% P Reduction Scenario

4.1.2 Median Flow and Water Quality Condtions Analysis under proposed TMDL Load Reductions Analysis

Application of fifty five percent reductions in nitrogen and phosphorus loads to the calibrated median model showed that under median conditions, the Pocomoke in Delaware should meet nutrient targets and dissolved oxygen standards as shown in the figure and table below.

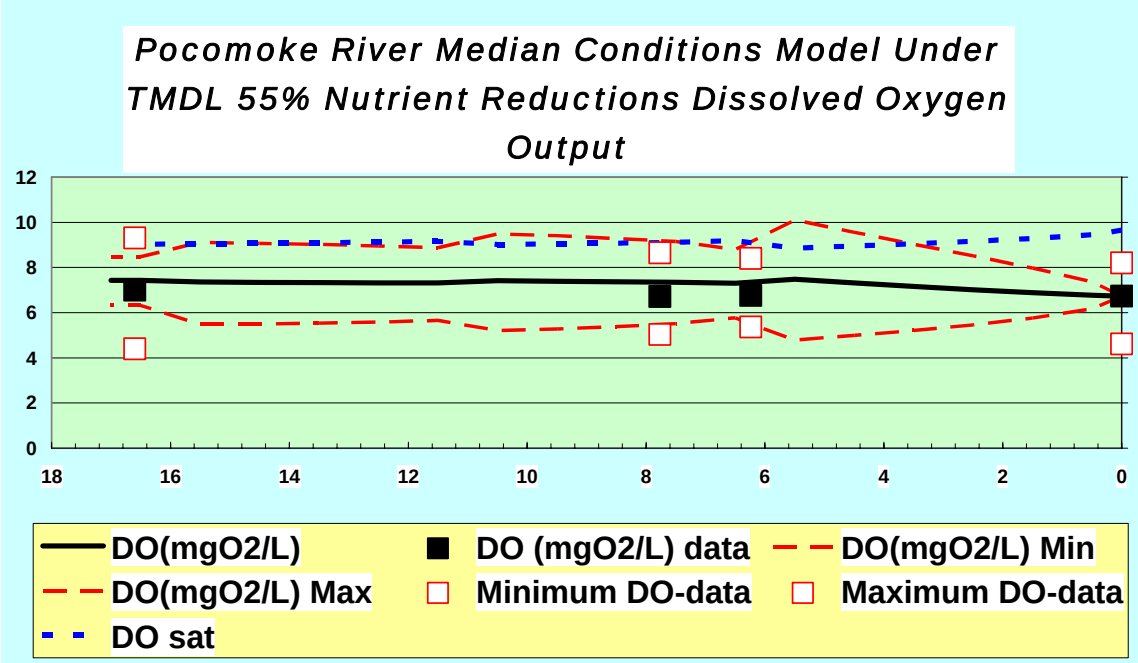

Figure 4- 4 Median Conditions Model Under 55% Nutrient Load Reductions Dissolved Oxygen Output

Table 4 - 2 Results for the Pocomoke River Watershed Median Conditions model with TMDL Reductions Applied

Minimum DO (mg/l)	Minimum Average DO (mg/l)	Maximum Total N (mg/l)	Maximum Total P (mg/l)	All Goals met?
4.79	6.77	1.299	0.107	Y

4.1.3 Chesapeake Bay Agreement Load Reductions Analysis

To recommit efforts and establish new and more comprehensive goals, the 2000 Chesapeake Bay Agreement was signed into effect by the states of Maryland, Pennsylvania, Virginia, the District of Columbia, the Chesapeake Bay Commission, and the US EPA. The improvement of water quality was cited as the "most critical element in the overall protection and restoration of the Chesapeake Bay and its tributaries" (9).

A 40% reduction in nutrient loads was originally agreed upon in 1987, and in 1992, the Bay Program partners further agreed to adopt tributary-specific reduction strategies. In the 2000 Agreement, additional objectives were outlined with the ultimate goal to "achieve and maintain the water quality necessary to support the aquatic living resources of the Bay and its tributaries and to protect human health" (9). One specific objective was to assign load reductions for nitrogen and phosphorus to each major tributary. As a

result, in June 2003, 46.8% and 43.5% reductions in nonpoint source nitrogen and phosphorus, respectively, were allocated to the Delaware watersheds draining to the Eastern Shore of Maryland (10).

Given that the proposed TMDL requires reductions that are higher than the agreed reductions, no further analysis of the Chesapeake Agreement goals was done.

4.2 Load Allocations for Nonpoint Sources

As discussed previously, there are no active point sources discharging nutrients within the Pocomoke River watershed; hence, the Pocomoke River TMDL contains only load allocation for nonpoint sources. The current nonpoint source loads are calculated for median conditions (using the calibration model results). Table 4-2 presents the proposed load allocations for total nitrogen and total phosphorous for the Pocomoke River watershed in Delaware.

Table 4 - 3 Pocomoke River Baseline Delaware Load and TMDL Delaware Load Allocations

Condition		Total N (lbs/day)		Total P (lbs/day)	
		Point Source	Nonpoint Source	Point Source	Nonpoint Source
Baseline Median Load		0	226.4	0	13.5
TMDL Load Allocation	**Point Source (WLA)**	0	-	0	-
	Nonpoint Source (LA)	-	102.7	-	6.1
	TMDL	102.7		6.1	

5.0 ESTABLISHMENT OF THE BACTERIA TMDL FOR THE POCOMOKE RIVER WATERSHED

Bacteria impairments were not included in the QUAL2K modeling but were evaluated at different flow conditions and vs. the single sample maximum to determine the reductions required in the Pocomoke River Watershed to achieve water quality standards (100 CFU enterococci/100mL geometric mean, 185 CFU enterococci/100 mL single sample maximum). As illustrated in Figure 5-1, the water quality current conditions exceed the standard.

The geometric mean at the 1st, 2nd, 3rd and 4th flow quartile are 211 CFU/100 mL, 200 CFU/100 mL, 188 CFU/100 mL, and 18 CFU/100 mL, respectively, the 90 percentile sample value is 600 CFU/100mL. An overall reduction of 15.9% in the bacteria loading is required for the water quality in Pocomoke River Watershed to meet the geometric mean of 100CFU/100 mL and a 69.2% reduction is required to meet the single sample maximum (185 CFU/100mL).

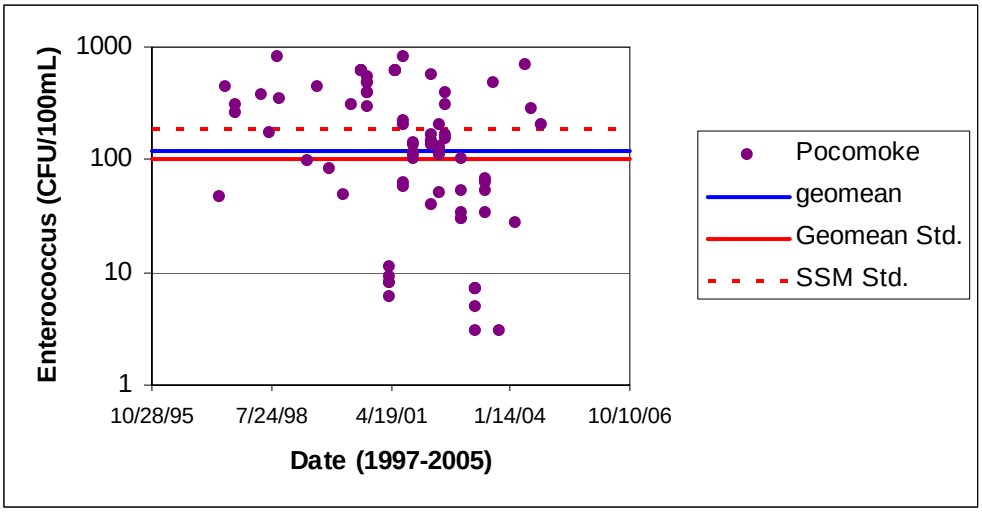

Figure 5-1 Bacteria Concentrations in the Pocomoke

5.1 Bacteria Concentrations and Loads vs. Flow Rates

The daily flow rates from USGS station 0148850 (pre 12/31/02) and USGS station 01487000 (post 12/31/02) were adjusted based on land area to estimate the flow rates in the Pocomoke River and divided into four ranges: the first, second, third and forth quartile with the first being the lowest 25%and the forth being the highest 25%. The geometric mean for all samples within each quartile was calculated and the baseline load was determined by multiplying the average quartile flow by the geometric mean concentration for that quartile. The TMDL load was calculated by multiplying the average quartile flow by the State water quality standard (100CFU/100mL). Required

reductions were calculated by evaluating the TMDL load against the baseline. Reductions were also calculated by evaluating the 90-percentile sample value vs. single sample maximum. In this case, in order to meet both the geometric mean and single sample maximum standards, the required reductions were driven by the single sample maximum value (Table 5-1).

Table 5-1 Pocomoke Flow, Bacteria Concentrations & Loadings, and Allocations

Pocomoke	Flow Range (ft^3/s)	Average Flow (ft^3/s)	Geomean (CFU/100mL)	Baseline Load (CFU/day)	TMDL Load (CFU/day)	90^{th}% Sample Value	% Reduction
Minimum	0.0						
First Quartile	< 17.3	28.1	211	1.5E+11	6.9E+10		52.7%
Second Quartile	17.3 - 35.0	71.6	200	3.5E+11	1.8E+11		50.1%
Third Quartile	35.0 - 59.8	132.4	188	6.1E+11	3.2E+11		46.7%
Forth Quartile	> 59.8	352.0	18	1.5E+11	8.6E+11		---
Maximum	2039.8						
Overall		146.0	119	4.2E+11	3.6E+11		15.9%
Single Sample Maximum					1.3E+11	600	**69.2 %***

*Reduction required to ensure 303(d) listing requirements that <10% of all samples are ≥185CFU/100mL

5.2 Bacteria Reductions and TMDL Waste Load Allocations

It is assumed that the only sources of bacteria entering the Pocomoke River are non-point sources (NPS: runoff, subsurface flow, failing septic systems, resuspension from sediment, direct deposition, etc.). All NPS sources are combined and are considered as one and a load allocation is determined by reducing the NPS baseline loading by an appropriate level to ensure the State water quality standards are met. Both the geometric mean and the single sample maximum must be met so an overall reduction of 69.2% from the 1997- 2005 baseline levels is required. This shall result in reducing a yearly-mean bacteria load from 4.2E+11 CFU per day to 1.3E+11 CFU per day.

5.3 Source Tracking Adjustment Factor

The Source Tracking Adjustment Factor (STAF) is a multiplier used to normalize human health risk associated with total fecal enterococci counts to enterococci counts derived exclusively from human sources. Bacteria source tracking (BST) data and the STAF, when available, will be used throughout the State to determine the sources of fecal contamination and in the development of pollution control strategies (PCSs).

6.0 DISCUSSION OF REGULATORY REQUIREMENTS FOR TMDLS

Federal regulations at 40 CFR Section 130 require that TMDLs must meet the following eight minimum regulatory requirements:

- The TMDLs must be designed to achieve applicable water quality standards.
- The TMDLs must include a total allowable load as well as individual waste load allocations for point sources and load allocations for nonpoint sources.
- The TMDLs must consider the impact of background pollutants.
- The TMDLs must consider critical environmental conditions.
- The TMDLs must consider seasonal variations.
- The TMDLs must include a margin of safety.
- The TMDLs must have been subject to public participation.
- There should be a reasonable assurance that the TMDLs can be met.

As will be discussed in the following, the Pocomoke River TMDL meets the above eight minimum regulatory requirements.

1. The TMDLs must be designed to achieve applicable water quality standards.

Section 1.3 describes the water quality standard for bacteria, dissolved oxygen and nutrient guidelines for total nitrogen and total phosphorous in the Pocomoke River. The enterococcus criteria are 100 CFU/100ml as 30-day geometric mean and 185 as single sample maximum. The criteria for dissolved oxygen for fresh water streams are 5.5 mg/l as a daily average and 4.0 mg/l as a minimum at any time. The TMDL nutrient target levels are 3.0 mg/l for total nitrogen and 0.2 mg/l for total phosphorous. The results of the TMDL scenario analysis indicate that these criteria and target values were met in all segments of Pocomoke River under both critical and conditions. For bacteria, the analysis shows that 69.2% reduction of bacteria loads in the watershed will result in achieving bacteria water quality standards. Therefore, it can be concluded that the proposed TMDL meets the applicable water quality criteria and target values.

2. The TMDLs must include a total allowable load as well as individual waste load allocations for point sources and load allocations for nonpoint sources.

The total allowable loads have been calculated, as presented in Table 4-1 for nutrients and Table 5-1 for bacteria. The TMDL proposed load allocations for bacteria, total nitrogen and total phosphorous are for nonpoint sources, as there is no point source discharging pollutants into the watershed Therefore, it can be concluded that the proposed TMDLs include allocations for point and nonpoint sources.

3. The TMDLs must consider the impact of background pollutants.

The Pocomoke River TMDL analysis was based on a calibrated QUAL2K water quality model. The model was developed using water quality data to represent model inputs for headwater conditions, tributary inflow conditions, and incremental inflow conditions. Since the monitoring data was reflective of background pollutant conditions, it can be concluded that the impact of background pollutants was accounted for in the model

4. The TMDLs must consider critical environmental conditions.

Low stream flow during summer months coupled with high water temperatures are critical conditions for the Pocomoke River and were considered in this TMDL analysis. For purposes of the TMDL, modeling scenarios that considered the low 7Q10 flow along with a high water temperature during summer months were used as the basis for the TMDL calculation. Under these scenarios, the headwater and tributary inflow conditions were defined using the data collected during the 1997-2003 period. Therefore, critical conditions for the Pocomoke River were considered in this analysis.

5. The TMDLs must consider seasonal variations.

Seasonal variations are considered in development of the Pocomoke River QUAL2K Model. The data used to define model inputs was collected during 1997-2003 period at different months and seasons, reflecting seasonal variations. In addition, the model was run under summer low flow (7Q10 flow) conditions. Therefore, seasonal variations were considered for this analysis.

6. The TMDLs must consider a margin of safety.

EPA's technical guidance allows consideration of margin of safety as implicit or as explicit. An implicit margin of safety relies on consideration of conservative assumptions for model development and TMDL establishment. An explicit margin of safety is considered when a specified percentage of assimilative capacity is reserved and unassigned to account for uncertainties, lack of sufficient data, or future growth.

An implicit margin of safety has been considered for this analysis. The Pocomoke River QUAL2K model was calibrated using conservative assumptions regarding reaction rates, pollutant loads, and other environmental conditions. Consideration of these conservative assumptions contributed to an implicit margin of safety.

An explicit margin of safety is incorporated in the Source Tracking Adjustment Factor (STAF), a tool that will be used in the implementation and BMP design following adoption of the TMDL, therefore an adequate margin of safety is included in the bacteria TMDL (waste) load allocations.

7. The TMDLs must have been subject to public participation.

A workshop and a public hearing will be held to present the Pocomoke River TMDL to the public and to receive comments prior to formal adoption of the TMDL Regulation. Notice of the public workshops and hearing will be published in several local and statewide newspapers.

8. There should be a reasonable assurance that the TMDLs can be met.

The Pocomoke River TMDL requires reduction of bacteria and nutrients loads from nonpoint sources within the watershed. Given the excessive pollutant loading in the watershed, BMPs are expected to achieve significant load reductions and meet the TMDL targets. The DNREC, in association with local citizen groups and other affected parties, will develop a Strategy to implement BMPs and meet the TMDL targets.

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9. CBP. 2000. Chesapeake Bay Program Chesapeake 2000 Bay Agreement.: http://www.chesapeakebay.net/agreement.htm.
10. CBP. 2004. Chesapeake Bay Program Tributary Strategy Tools: http://www/chesapeakebay.net/info/wqcriteriatech/tributary_tools.cfm.

Appendix

Input Data for Pocomoke River QUAL2K Models

Median QUAL2K file as ASCII

"Pocomoke River","Medians 7-13-05","C:\Documents and Settings\David.Wolanski\My Documents\Pocomoke TMDL\Qual2k","Pocomoke River (5/15/2001)"
5,15,2001
"Eastern",.000347,1.04166666666667E-02,5
17
"","Station 313051","",0,0,14.93,38,30,44.03,75,21,28.12,1.37731481481481E-06,3,0,0,.0003,.05,0,0,0,0,0,0,.00001,.00001,0,0,0,0,0
"Station 313051","","",1,14.9,14.6,38,30,21.78,75,20,53.37,1.54071350762527E-06,3.5,0,0,.0003,.05,0,0,0,0,0,0,.125,.5,1,1.25,0,0,0,0
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"","BCB and GB Junction","Station 313041",7,13.1,12.8,38,27,22.57,75,20,31.19,5.53036492374727E-06,7.7,0,0,.0003,.05,0,0,0,0,0,.125,.5,1,1.25,0,0,0,0
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"Gum Branch and Bald Cypress Branch",6.95,0,.26,17,0,0
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5.5,0,0
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.8,0,0
.4,0,0
626,0,0
80,0,0
2260,0,0
55,0,0
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12,0,0
6.8,0,0
"Green Run ",11.4,0,.26,17,0,4.16666666666667E-02
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2
"Groundwater/Nonpoint",0,8.5,0,.12,17
132.4
5.5
6.73
.6
.3
50
10
500
180
72
3
1
0
12
6
"Groundwater/Nonpoint",8,17,0,.38,17
132.4
5.5
6.73
.6
.3
50
10
500
40
40
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"WQ Data Min",4
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Median Headwater Inputs

Headwater Flow	0.119	m3/s
Prescribed downstream boundary?	No	
Headwater Water Quality	*Units*	*12:00 AM*
Temperature	C	17.00
Conductivity	umhos	132.00
Inorganic Solids	mgD/L	5.50
Dissolved Oxygen	mg/L	6.73
CBODslow	mgO2/L	1.20
CBODfast	mgO2/L	0.60
Dissolved Organic Nitrogen	ugN/L	511.00
NH4-Nitrogen	ugN/L	118.00
NO3-Nitrogen	ugN/L	2050.00
Dissolved Organic Phosphorus	ugP/L	40.00
Inorganic Phosphorus (SRP)	ugP/L	40.00
Phytoplankton	ugA/L	3.00
Detritus (POM)	mgD/L	1.00
Pathogen	cfu/100 mL	0.00
Alkalinity	mgCaCO3/L	12.00
pH	s.u.	7.03

Median Reach Inputs

Reach for diel plot	2						Hydraulic Model (Select One Option, Leave the Other Blank or Ze								
			Reach	Downstream	Elevation		Rating Curves							Manning Formula	
Reach	Downstream		length	location	Upstream	Downstream	Velocity		Depth		Bot Width	Side	Side	Channel	Manning
Label	end of reach label	Number	(km)	(km)	(m)	(m)	Coefficient	Exponent	Coefficient	Exponent	m	Slope	Slope	Slope	n
	Station 313051	0		0.000		14.930	0.0000	0.000	0.0000	0.000	3.00	0.00	0.00	0.0003	0.0500
		1	1.00	1.000	14.900	14.600	0.0000	0.000	0.0000	0.000	3.50	0.00	0.00	0.0003	0.0500
		2	1.00	2.000	14.600	14.300	0.0000	0.000	0.0000	0.000	4.00	0.00	0.00	0.0003	0.0500
		3	1.00	3.000	14.300	14.000	0.0000	0.000	0.0000	0.000	4.50	0.00	0.00	0.0003	0.0500
		4	1.00	4.000	14.000	13.700	0.0000	0.000	0.0000	0.000	5.00	0.00	0.00	0.0003	0.0500
		5	1.00	5.000	13.700	13.400	0.0000	0.000	0.0000	0.000	6.00	0.00	0.00	0.0003	0.0500
		6	1.00	6.000	13.400	13.100	0.0000	0.000	0.0000	0.000	7.00	0.00	0.00	0.0003	0.0500
Station 313041	BCB and GB Juncti	7	1.00	7.000	13.100	12.800	0.0000	0.000	0.0000	0.000	7.70	0.00	0.00	0.0003	0.0500
Station 313011		8	1.00	8.000	12.800	12.500	0.0000	0.000	0.0000	0.000	7.80	0.00	0.00	0.0003	0.0500
	Md State Line	9	1.00	9.000	12.500	12.200	0.0000	0.000	0.0000	0.000	8.00	0.00	0.00	0.0003	0.0500
		10	1.00	10.000	12.200	11.900	0.0000	0.000	0.0000	0.000	8.20	0.00	0.00	0.0003	0.0500
		11	1.00	11.000	11.900	11.600	0.0000	0.000	0.0000	0.000	8.30	0.00	0.00	0.00030	0.0500
Junction with Green Run		12	1.00	12.000	11.600	11.300	0.0000	0.000	0.0000	0.000	8.40	0.00	0.00	0.00030	0.0500
		13	1.00	13.000	11.300	11.000	0.0000	0.000	0.0000	0.000	8.50	0.00	0.00	0.00030	0.0500
		14	1.00	14.000	11.000	10.700	0.0000	0.000	0.0000	0.000	8.70	0.00	0.00	0.00030	0.0500
		15	1.00	15.000	10.700	10.400	0.0000	0.000	0.0000	0.000	8.90	0.00	0.00	0.00030	0.0500
		16	1.00	16.000	10.400	10.058	0.0000	0.000	0.0000	0.000	9.00	0.00	0.00	0.00030	0.0500
USGS Gage	Model End	17	1.00	17.000	10.058	9.700	0.0000	0.000	0.0000	0.000	9.00	0.00	0.00	0.00030	0.0500

ro)								
Prescribed Dispersion m2/s	Weir Height (m)	Prescribed Reaeration /d	Bottom Algae Coverage	Bottom SOD Coverage	Prescribed SOD gO2/m2/d	Prescribed CH4 flux gO2/m2/d	Prescribed NH4 flux mgN/m2/d	Prescribed Inorg P flux mgP/m2/d
0.00	0.0000							
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
0.00	0.0000	1.125	50%	100%	1.25	0.0000	0.0000	0.0000

Median Point Sources Inputs

		Point	Point	Temperature			Specific Conductance			Inorganic Suspended Solids			Dissolved Oxygen		
		Abstraction	Inflow	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of
Name	Location	m3/s	m3/s	°C	°C	max	umhos	umhos	max	mg/L	mg/L	max	mg/L	mg/L	max
Gum Branch and Bald Cypress Branch	6.95	0.0000	0.2600	17.00	0.00	12:00 AM	115.00	0.00	12:00 AM	5.50	0.00	12:00 AM	7.10	0.00	12:00 AM
Green Run	11.40	0.0000	0.2600	17.00	0.00	1:00 AM	115.00	0.00	1:00 AM	5.50	0.00	1:00 AM	7.10	0.00	1:00 AM

Slow CBOD			Fast CBOD			Organic N			Ammonia N			Nitrate + Nitrite N			Organic P		
mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of
mgC/L	mgC/L	max	mgC/L	mgC/L	max	ugN/L	ugN/L	max	ugN/L	ugN/L	max	ugN/L	ugN/L	max	ugP/L	ugP/L	max
0.80	0.00	12:00 AM	0.40	0.00	12:00 AM	626.00	0.00	12:00 AM	80.00	0.00	12:00 AM	2260.00	0.00	12:00 AM	55.00	0.00	12:00 AM
0.80	0.00	1:00 AM	0.40	0.00	1:00 AM	626.00	0.00	1:00 AM	80.00	0.00	1:00 AM	2260.00	0.00	1:00 AM	55.00	0.00	1:00 AM

Inorganic P			Phytoplankton			Detritus			Pathogen Indicator Bacteria			Alkalinity			pH		
mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of
ugP/L	ugP/L	max	ugA/L	ugA/L	max	mgD/L	mgD/L	max	cfu/100ml	cfu/100ml	max	mgCaCO3/L	mgCaCO3/L	max	s.u.	s.u.	max
55.00	0.00	12:00 AM	3.50	0.00	12:00 AM	1.00	0.00	3:00 PM	0.00	0.00	3:00 PM	12.00	0.00	12:00 AM	6.80	0.00	12:00 AM
55.00	0.00	1:00 AM	3.50	0.00	1:00 AM	1.00	0.00	4:00 PM	0.00	0.00	4:00 PM	12.00	0.00	1:00 AM	6.80	0.00	1:00 AM

Median Diffuse Sources

Name	Up (km)	Down (km)	Diffuse Abstraction m3/s	Diffuse Inflow m3/s	Temp C	Spec Cond umhos	Inorg SS mgD/L	Diss Oxygen mg/L	CBOD slow mgO2/L	CBOD fast mgO2/L	Organic N ugN/L	Ammon N ugN/L	Nitrate N ugN/L	Organic P ugP/L	Inorganic P ugP/L	Phyto plankton ug/L	Detritus mgD/L	athoge cfu/100 mL	Alk mgCaCO3/L	pH
Groundwater/Nonpoint	0.00	8.50	0.0000	0.1200	17.00	132.40	5.50	6.73	0.60	0.30	50.0	10.0	500.0	180.0	72.0	3.0	1.0	0.0	12.0	6.0
Groundwater/Nonpoint	8.00	17.00	0.0000	0.3800	17.00	132.40	5.50	6.73	0.60	0.30	50.0	10.0	500.0	40.0	40.0	3.0	1.0	0.0	12.0	6.0

Critical Conditions Inputs

Critical Conditions QUAL2K file as ASCII

"Pocomoke River","Final Critical Conditions 7-13-05","C:\Documents and Settings\David.Wolanski\My Documents\Pocomoke TMDL\Qual2k","Pocomoke River (7/15/2001)"
7,15,2001
"Eastern",.000347,1.04166666666667E-02,5
17
"","Station 313051","",0,0,14.93,38,30,44.03,75,21,28.12,5.78703703703704E-08,1.5,0,0,.0003,.05,0,0,0,0,0,0,.00001,.00001,0,0,0,0,0
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Critical Conditions Headwater Inputs

Headwater Flow	0.005	m3/s
Prescribed downstream boundary?	No	
Headwater Water Quality	*Units*	*12:00 AM*
Temperature	C	22.32
Conductivity	umhos	127.50
Inorganic Solids	mgD/L	5.50
Dissolved Oxygen	mg/L	6.10
CBODslow	mgO2/L	1.20
CBODfast	mgO2/L	0.60
Dissolved Organic Nitrogen	ugN/L	625.00
NH4-Nitrogen	ugN/L	162.00
NO3-Nitrogen	ugN/L	1448.00
Dissolved Organic Phosphorus	ugP/L	12.00
Inorganic Phosphorus (SRP)	ugP/L	40.00
Phytoplankton	ugA/L	3.00
Detritus (POM)	mgD/L	1.00
Pathogen	cfu/100 mL	0.00
Alkalinity	mgCaCO3/L	12.00
pH	s.u.	7.40

Critical Conditions Reach Inputs

Reach for diel plot	2								Hydraulic Model (Select One Option, Leave the Other Blank or Ze								
			Reach			Downstream	Elevation		Rating Curves				Manning Formula				
Reach	Downstream		length	Downstream		location	Upstream	Downstream	Velocity		Depth		Bot Width	Side	Side	Channel	Manning
Label	end of reach label	Number	(km)	Latitude	Longitude	(km)	(m)	(m)	Coefficient	Exponent	Coefficient	Exponent	m	Slope	Slope	Slope	n
	Station 313051	0		38.51	75.36	0.000		14.930	0.0000	0.000	0.0000	0.000	1.50	0.00	0.00	0.0003	0.0500
		1	1.00	38.51	75.35	1.000	14.900	14.600	0.0000	0.000	0.0000	0.000	1.50	0.00	0.00	0.0003	0.0500
		2	1.00	38.50	75.34	2.000	14.600	14.300	0.0000	0.000	0.0000	0.000	1.70	0.00	0.00	0.0003	0.0500
		3	1.00	38.49	75.34	3.000	14.300	14.000	0.0000	0.000	0.0000	0.000	1.90	0.00	0.00	0.0003	0.0500
		4	1.00	38.48	75.34	4.000	14.000	13.700	0.0000	0.000	0.0000	0.000	2.10	0.00	0.00	0.0003	0.0500
		5	1.00	38.47	75.34	5.000	13.700	13.400	0.0000	0.000	0.0000	0.000	2.30	0.00	0.00	0.0003	0.0500
		6	1.00	38.46	75.35	6.000	13.400	13.100	0.0000	0.000	0.0000	0.000	2.50	0.00	0.00	0.0003	0.0500
Station 313041	BCB and GB Juncti	7	1.00	38.46	75.34	7.000	13.100	12.800	0.0000	0.000	0.0000	0.000	2.70	0.00	0.00	0.0003	0.0500
Station 313011		8	1.00	38.45	75.34	8.000	12.800	12.500	0.0000	0.000	0.0000	0.000	2.90	0.00	0.00	0.0003	0.0500
	Md State Line	9	1.00	38.44	75.34	9.000	12.500	12.200	0.0000	0.000	0.0000	0.000	3.10	0.00	0.00	0.0003	0.0500
		10	1.00	38.43	75.33	10.000	12.200	11.900	0.0000	0.000	0.0000	0.000	3.30	0.00	0.00	0.0003	0.0500
		11	1.00	38.43	75.33	11.000	11.900	11.600	0.0000	0.000	0.0000	0.000	3.50	0.00	0.00	0.00030	0.0500
Junction with Green Run		12	1.00	38.42	75.32	12.000	11.600	11.300	0.0000	0.000	0.0000	0.000	3.70	0.00	0.00	0.00030	0.0500
		13	1.00	38.41	75.32	13.000	11.300	11.000	0.0000	0.000	0.0000	0.000	3.90	0.00	0.00	0.00030	0.0500
		14	1.00	38.40	75.32	14.000	11.000	10.700	0.0000	0.000	0.0000	0.000	4.10	0.00	0.00	0.00030	0.0500
		15	1.00	38.39	75.32	15.000	10.700	10.400	0.0000	0.000	0.0000	0.000	4.30	0.00	0.00	0.00030	0.0500
		16	1.00	38.38	75.33	16.000	10.400	10.058	0.0000	0.000	0.0000	0.000	4.50	0.00	0.00	0.00030	0.0500
USGS Gage	Model End	17	1.00	0.00	0.00	17.000	10.058	9.700	0.0000	0.000	0.0000	0.000	4.70	0.00	0.00	0.00030	0.0500

Number	ro)								
	Prescribed	Weir	Prescribed	Bottom	Bottom	Prescribed	Prescribed	Prescribed	Prescribed
	Dispersion	Height	Reaeration	Algae	SOD	SOD	CH4 flux	NH4 flux	Inorg P flux
	m2/s	(m)	/d	Coverage	Coverage	gO2/m2/d	gO2/m2/d	mgN/m2/d	mgP/m2/d
0	0.00	0.0000							
1	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
2	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
3	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
4	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
5	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
6	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
7	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
8	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
9	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
10	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
11	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
12	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
13	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
14	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
15	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
16	0.00	0.0000	0.125	50%	100%	1.2500	0.0000	0.0000	0.0000
17	0.00	0.0000	1.125	50%	100%	1.2500	0.0000	0.0000	0.0000

Critical Conditions Point Sources Inputs

		Point	Point	Temperature			Specific Conductance			norganic Suspended Solid			Dissolved Oxygen		
		Abstraction	Inflow	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of
Name	Location (km)	m3/s	m3/s	°C	°C	max	umhos	umhos	max	mg/L	mg/L	max	mg/L	mg/L	max
Gum Branch and Bald Cypress Branch	6.95	0.0000	0.0130	22.32	0.00	12:00 AM	112.00	0.00	12:00 AM	8.00	0.00	12:00 AM	6.45	0.00	12:00 AM
Green Run	11.40	0.0000	0.0130	22.32	0.00	1:00 AM	112.00	0.00	1:00 AM	8.00	0.00	1:00 AM	6.45	0.00	1:00 AM

Slow CBOD			Fast CBOD			Organic N			Ammonia N			Nitrate + Nitrite N		
mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of
mgC/L	mgC/L	max	mgC/L	mgC/L	max	ugN/L	ugN/L	max	ugN/L	ugN/L	max	ugN/L	ugN/L	max
0.80	0.00	12:00 AM	0.40	0.00	12:00 AM	529.00	0.00	12:00 AM	125.00	0.00	12:00 AM	1246.00	0.00	12:00 AM
0.80	0.00	1:00 AM	0.40	0.00	1:00 AM	529.00	0.00	1:00 AM	125.00	0.00	1:00 AM	1246.00	0.00	1:00 AM

Organic P			Inorganic P			Phytoplankton			Detritus			Pathogen Indicator Bacteria			Alkalinity			pH		
mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of
ugP/L	ugP/L	max	ugP/L	ugP/L	max	ugA/L	ugA/L	max	mgD/L	mgD/L	max	cfu/100ml	cfu/100ml	max	mgCaCO3/L	mgCaCO3/L	max	s.u.	s.u.	max
48.00	0.00	12:00 AM	48.00	0.00	12:00 AM	3.49	0.00	12:00 AM	2.10	0.00	3:00 PM	0.00	0.00	3:00 PM	19.10	0.00	12:00 AM	7.00	0.00	12:00 AM
48.00	0.00	1:00 AM	48.00	0.00	1:00 AM	3.49	0.00	1:00 AM	2.10	0.00	4:00 PM	0.00	0.00	4:00 PM	19.10	0.00	1:00 AM	7.00	0.00	1:00 AM

Critical Conditions Diffuse Sources

			Diffuse	Diffuse		Spec	Inorg	Diss	CBOD	CBOD	Organic	Ammon
			Abstraction	Inflow	Temp	Cond	SS	Oxygen	slow	fast	N	N
Name	Up (km)	Down (km)	m3/s	m3/s	C	umhos	mgD/L	mg/L	mgO2/L	mgO2/L	ugN/L	ugN/L
Groundwater/Nonpoint	0.00	8.50	0.0000	0.0050	22.32	132.40	5.50	6.73	0.60	0.30	50.0	10.0
Groundwater/Nonpoint	8.00	17.00	0.0000	0.0200	22.32	132.40	5.50	6.73	0.60	0.30	50.0	10.0

Nitrate	Organic	Inorganic	Phyto				
N	P	P	plankton	Detritus	Pathogen	Alk	pH
ugN/L	ugP/L	ugP/L	ug/L	mgD/L	cfu/100 mL	mgCaCO3/L	
500.0	180.0	72.0	3.0	1.0	0.0	12.0	6.0
500.0	40.0	40.0	3.0	1.0	0.0	12.0	6.0

Final TMDL Scenario Inputs

Final TMDL QUAL2K file as ASCII

"Pocomoke River","Final Critical Conditions 7-13-05","C:\Documents and Settings\David.Wolanski\My Documents\Pocomoke TMDL\Qual2k","Pocomoke River (7/15/2001)"
7,15,2001
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17
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Headwater Conditions

Headwater Flow	0.005	m3/s
Prescribed downstream boundary?	No	
Headwater Water Quality	*Units*	*12:00 AM*
Temperature	C	22.32
Conductivity	umhos	127.50
Inorganic Solids	mgD/L	5.50
Dissolved Oxygen	mg/L	6.10
CBODslow	mgO2/L	1.20
CBODfast	mgO2/L	0.60
Dissolved Organic Nitrogen	ugN/L	281.25
NH4-Nitrogen	ugN/L	72.90
NO3-Nitrogen	ugN/L	651.60
Dissolved Organic Phosphorus	ugP/L	5.40
Inorganic Phosphorus (SRP)	ugP/L	18.00
Phytoplankton	ugA/L	3.00
Detritus (POM)	mgD/L	1.00
Pathogen	cfu/100 mL	0.00
Alkalinity	mgCaCO3/L	12.00
pH	s.u.	7.40

Reach Conditions

Reach for diel plot	2								Hydraulic Model (Select One Option, Leave the Other Blank or Ze								
			Reach			Downstream	Elevation		Rating Curves				Manning Formula				
Reach	Downstream		length	Downstream		location	Upstream	Downstream	Velocity		Depth		Bot Width	Side	Side	Channel	Manning
Label	end of reach label	Number	(km)	Latitude	Longitude	(km)	(m)	(m)	Coefficient	Exponent	Coefficient	Exponent	m	Slope	Slope	Slope	n
	Station 313051	0		38.51	75.36	0.000		14.930	0.0000	0.000	0.0000	0.000	1.50	0.00	0.00	0.0003	0.0500
		1	1.00	38.51	75.35	1.000	14.900	14.600	0.0000	0.000	0.0000	0.000	1.50	0.00	0.00	0.0003	0.0500
		2	1.00	38.50	75.34	2.000	14.600	14.300	0.0000	0.000	0.0000	0.000	1.70	0.00	0.00	0.0003	0.0500
		3	1.00	38.49	75.34	3.000	14.300	14.000	0.0000	0.000	0.0000	0.000	1.90	0.00	0.00	0.0003	0.0500
		4	1.00	38.48	75.34	4.000	14.000	13.700	0.0000	0.000	0.0000	0.000	2.10	0.00	0.00	0.0003	0.0500
		5	1.00	38.47	75.34	5.000	13.700	13.400	0.0000	0.000	0.0000	0.000	2.30	0.00	0.00	0.0003	0.0500
		6	1.00	38.46	75.35	6.000	13.400	13.100	0.0000	0.000	0.0000	0.000	2.50	0.00	0.00	0.0003	0.0500
Station 313041	BCB and GB Juncti	7	1.00	38.46	75.34	7.000	13.100	12.800	0.0000	0.000	0.0000	0.000	2.70	0.00	0.00	0.0003	0.0500
Station 313011		8	1.00	38.45	75.34	8.000	12.800	12.500	0.0000	0.000	0.0000	0.000	2.90	0.00	0.00	0.0003	0.0500
	Md State Line	9	1.00	38.44	75.34	9.000	12.500	12.200	0.0000	0.000	0.0000	0.000	3.10	0.00	0.00	0.0003	0.0500
		10	1.00	38.43	75.33	10.000	12.200	11.900	0.0000	0.000	0.0000	0.000	3.30	0.00	0.00	0.0003	0.0500
		11	1.00	38.43	75.33	11.000	11.900	11.600	0.0000	0.000	0.0000	0.000	3.50	0.00	0.00	0.00030	0.0500
Junction with Green Run		12	1.00	38.42	75.32	12.000	11.600	11.300	0.0000	0.000	0.0000	0.000	3.70	0.00	0.00	0.00030	0.0500
		13	1.00	38.41	75.32	13.000	11.300	11.000	0.0000	0.000	0.0000	0.000	3.90	0.00	0.00	0.00030	0.0500
		14	1.00	38.40	75.32	14.000	11.000	10.700	0.0000	0.000	0.0000	0.000	4.10	0.00	0.00	0.00030	0.0500
		15	1.00	38.39	75.32	15.000	10.700	10.400	0.0000	0.000	0.0000	0.000	4.30	0.00	0.00	0.00030	0.0500
		16	1.00	38.38	75.33	16.000	10.400	10.058	0.0000	0.000	0.0000	0.000	4.50	0.00	0.00	0.00030	0.0500
USGS Gage	Model End	17	1.00	0.00	0.00	17.000	10.058	9.700	0.0000	0.000	0.0000	0.000	4.70	0.00	0.00	0.00030	0.0500

ro)								
Prescribed	Weir	Prescribed	Bottom	Bottom	Prescribed	Prescribed	Prescribed	Prescribed
Dispersion	Height	Reaeration	Algae	SOD	SOD	CH4 flux	NH4 flux	Inorg P flux
m2/s	(m)	/d	Coverage	Coverage	gO2/m2/d	gO2/m2/d	mgN/m2/d	mgP/m2/d
0.00	0.0000							
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	0.125	50%	100%	0.5625	0.0000	0.0000	0.0000
0.00	0.0000	1.125	50%	100%	0.5625	0.0000	0.0000	0.0000

TMDL Point Sources Inputs

		Point	Point	Temperature			Specific Conductance			norganic Suspended Solid			Dissolved Oxygen		
		Abstraction	Inflow	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of
Name	Location (km)	m3/s	m3/s	°C	°C	max	umhos	umhos	max	mg/L	mg/L	max	mg/L	mg/L	max
Gum Branch and Bald Cypress Branch	6.95	0.0000	0.0130	22.32	0.00	12:00 AM	112.00	0.00	12:00 AM	8.00	0.00	12:00 AM	6.45	0.00	12:00 AM
Green Run	11.40	0.0000	0.0130	22.32	0.00	1:00 AM	112.00	0.00	1:00 AM	8.00	0.00	1:00 AM	6.45	0.00	1:00 AM

Slow CBOD			Fast CBOD			Organic N			Ammonia N			Nitrate + Nitrite N		
mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of
mgC/L	mgC/L	max	mgC/L	mgC/L	max	ugN/L	ugN/L	max	ugN/L	ugN/L	max	ugN/L	ugN/L	max
0.80	0.00	12:00 AM	0.40	0.00	12:00 AM	238.05	0.00	12:00 AM	56.25	0.00	12:00 AM	560.70	0.00	12:00 AM
0.80	0.00	1:00 AM	0.40	0.00	1:00 AM	238.05	0.00	1:00 AM	56.25	0.00	1:00 AM	560.70	0.00	1:00 AM

Organic P			Inorganic P			Phytoplankton			Detritus			Pathogen Indicator Bacteria			Alkalinity			pH		
mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of	mean	range/2	time of
ugP/L	ugP/L	max	ugP/L	ugP/L	max	ugA/L	ugA/L	max	mgD/L	mgD/L	max	cfu/100ml	cfu/100ml	max	mgCaCO3/L	mgCaCO3/L	max	s.u.	s.u.	max
21.60	0.00	12:00 AM	21.60	0.00	12:00 AM	3.49	0.00	12:00 AM	2.10	0.00	3:00 PM	0.00	0.00	3:00 PM	19.10	0.00	12:00 AM	7.00	0.00	12:00 AM
21.60	0.00	1:00 AM	21.60	0.00	1:00 AM	3.49	0.00	1:00 AM	2.10	0.00	4:00 PM	0.00	0.00	4:00 PM	19.10	0.00	1:00 AM	7.00	0.00	1:00 AM

TMDL Diffuse Sources Inputs

			Diffuse	Diffuse		Spec	Inorg	Diss	CBOD	CBOD	Organic	Ammon
			Abstraction	Inflow	Temp	Cond	SS	Oxygen	slow	fast	N	N
Name	Up (km)	Down (km)	m3/s	m3/s	C	umhos	mgD/L	mg/L	mgO2/L	mgO2/L	ugN/L	ugN/L
Groundwater/Nonpoint	0.00	8.50	0.0000	0.0050	22.32	132.40	5.50	6.73	0.60	0.30	22.5	4.5
Groundwater/Nonpoint	8.00	17.00	0.0000	0.0200	22.32	132.40	5.50	6.73	0.60	0.30	22.5	4.5

Nitrate	Organic	Inorganic	Phyto				
N	P	P	plankton	Detritus	Pathogen	Alk	pH
ugN/L	ugP/L	ugP/L	ug/L	mgD/L	cfu/100 mL	mgCaCO3/L	
225.0	81.0	32.4	3.0	1.0	0.0	12.0	6.0
225.0	18.0	18.0	3.0	1.0	0.0	12.0	6.0

Bacteria data used in TMDL calculations:

Station Name	Station ID	Date	Time	CFU/100mL	Flow ft3/s
POCOMOKE RIVER @ RD. 419	313011	7/9/1997	10:25	445	3.1
Rd. 419	313011	10/6/1998	7:37	340	7.9
Rd. 419	313011	9/10/1998	9:24	800	8.7
Rd. 419 Bridge	313011	8/23/1999	10:43	450	9.4
Rd. 419	313011	10/7/1997	8:41	300	13.4
Rd. 419	313011	10/7/1997	8:42	260	13.4
Rd. 419	313011	7/17/1998	7:51	170	14.2
Rd. 419 Bridge	313011	5/27/1999	11:28	97	16.5
Pocomoke River at Rd. 419 Bridge	313011	10/29/2001	9:47	133	16.5
Gums Branch at Rt.413 Bridge	313021	10/29/2001	9:14	103	16.5
Cyprus Branch at Rd. 60 Bridge	313031	10/29/2001	9:37	113	16.5
Pocomoke River at Rt. 417 Bridge	313041	10/29/2001	9:24	110	16.5
Pocomoke River at Rt. 30 Bridge	313051	10/29/2001	8:57	140	16.5
Rd. 419 Bridge	313011	9/27/2004	9:11	200	17.5
Rd. 419 Bridge	313011	7/25/2002	10:05	167	18.1
Gum Branch at Rt. 413 Bridge	313021	7/25/2002	9:54	390	18.1
Cyprus Branch at Rd. 60 Bridge	313031	7/25/2002	10:27	160	18.1
Rt. 417 Bridge	313041	7/25/2002	10:41	300	18.1
Rt. 30 Bridge	313051	7/25/2002	9:38	150	18.1
Rd. 419 Bridge	313011	6/4/2002	9:56	110	19.7
Gum Branch at Rt. 413 Bridge	313021	6/4/2002	10:11	200	19.7
Cyprus Branch at Rd. 60 Bridge	313031	6/4/2002	9:43	130	19.7
Rt. 417 Bridge	313041	6/4/2002	10:22	50	19.7
Rt. 30 Bridge	313051	6/4/2002	9:25	123	19.7
Rd. 419 Bridge	313011	7/20/2004	8:42	280	19.8
Rd. 419	313011	5/12/1997	9:58	46	21.3
Rd. 419 Bridge	313011	11/30/1999	12:01	83	28.3
Pocomoke River at Rd. 419 Bridge	313011	6/5/2001	9:49	600	28.3
Gums Branch at Rt.413 Bridge	313021	6/5/2001	9:35	600	28.3
Cyprus Branch at Rd. 60 Bridge	313031	6/5/2001	9:24	600	28.3
Pocomoke River at Rt. 417 Bridge	313041	6/5/2001	9:16	600	28.3
Pocomoke River at Rt. 30 Bridge	313051	6/5/2001	8:59	600	28.3
Pocomoke River at Rd. 419 Bridge	313011	8/8/2001	10:10	220	28.3
Gums Branch at Rt.413 Bridge	313021	8/8/2001	9:58	200	28.3
Cyprus Branch at Rd. 60 Bridge	313031	8/8/2001	9:47	63	28.3
Pocomoke River at Rt. 417 Bridge	313041	8/8/2001	9:36	57	28.3
Pocomoke River at Rt. 30 Bridge	313051	8/8/2001	9:27	800	28.3
Pocomoke River at Rd. 419 Bridge	313011	8/14/2000	10:18	600	35.4
Gums Branch at Rt.413 Bridge	313021	8/14/2000	10:30	600	35.4
Cyprus Branch at Rd. 60 Bridge	313031	8/14/2000	10:39	600	35.4
Pocomoke River at Rt. 417 Bridge	313041	8/14/2000	10:47	600	35.4
Pocomoke River at Rt. 30 Bridge	313051	8/14/2000	11:01	600	35.4
Pocomoke River at Rt. 30 Bridge	313051	8/14/2000	11:02	600	35.4
Rd. 419 Bridge	313011	10/22/2003	9:31	3	35.9
Rd. 419 Bridge	313011	5/22/2000	10:45	310	36.2
Pocomoke River at Rd. 419 Bridge	313011	10/4/2000	10:29	470	38.6
Gums Branch at Rt.413 Bridge	313021	10/4/2000	10:16	470	38.6
Gums Branch at Rt.413 Bridge	313021	10/4/2000	10:17	540	38.6
Cyprus Branch at Rd. 60 Bridge	313031	10/4/2000	10:03	290	38.6

Pocomoke River at Rt. 417 Bridge	313041	10/4/2000	9:48	390	38.6
Pocomoke River at Rt. 30 Bridge	313051	10/4/2000	9:30	390	38.6
Rd. 419 Bridge	313011	5/17/2004	8:58	700	41.4
Rd. 419 Bridge	313011	8/27/2003	8:55	485	45.1
Pocomoke River at Rd. 419 Bridge	313011	4/2/2002	10:58	163	45.7
Gums Branch at Rt.413 Bridge	313021	4/2/2002	10:48	133	45.7
Cyprus Branch at Rd. 60 Bridge	313031	4/2/2002	10:27	40	45.7
Pocomoke River at Rt. 417 Bridge	313041	4/2/2002	10:19	570	45.7
Pocomoke River at Rt. 30 Bridge	313051	4/2/2002	10:12	147	45.7
Rd. 419 Bridge	313011	3/2/2004	10:16	27	46.0
Rd. 419 Bridge	313011	12/3/2002	11:32	52	55.1
Gum Branch at Rt. 413 Bridge	313021	12/3/2002	11:41	103	55.1
Cyprus Branch at Rd. 60 Bridge	313031	12/3/2002	11:18	30	55.1
Rt. 417 Bridge	313041	12/3/2002	11:51	30	55.1
Rt. 30 Bridge	313051	12/3/2002	11:02	33	55.1
Pocomoke River at Rd. 419 Bridge	313011	4/4/2001	10:28	9	75.6
Gums Branch at Rt.413 Bridge	313021	4/4/2001	10:16	11	75.6
Cyprus Branch at Rd. 60 Bridge	313031	4/4/2001	10:08	6	75.6
Pocomoke River at Rt. 417 Bridge	313041	4/4/2001	9:50	8	75.6
Pocomoke River at Rt. 30 Bridge	313051	4/4/2001	9:37	8	75.6
Rd. 419 Bridge	313011	4/2/2003	9:57	7	81.5
Gum Branch at Rt. 413 Bridge	313021	4/2/2003	9:48	5	81.5
Cyprus Branch at Rd. 60 Bridge	313031	4/2/2003	9:35	7	81.5
Rt. 417 Bridge	313041	4/2/2003	9:17	7	81.5
Rt. 30 Bridge	313051	4/2/2003	9:00	3	81.5
Rd. 419 Bridge	313011	6/23/2003	9:55	65	101.2
Gum Branch at Rt. 413 Bridge	313021	6/23/2003	9:45	67	101.2
Cyprus Branch at Rd. 60 Bridge	313031	6/23/2003	9:38	63	101.2
Rt. 417 Bridge	313041	6/23/2003	9:29	33	101.2
Rt. 30 Bridge	313051	6/23/2003	9:20	53	101.2
Rd. 419	313011	5/12/1998	8:38	370	112.6
Rd. 419 Bridge	313011	3/28/2000	10:37	49	345.6