Wicomico Creekwatchers

Water Quality Monitoring Report
2003 – 2004

SUMMARY

This Water Quality Monitoring Report is the second annual release of data and analysis conducted by the citizen's group *Wicomico Creekwatchers*. *Wicomico Creekwatchers* is a community partnership between the Chesapeake Bay Foundation (CBF), the Salisbury Area Chamber of Commerce and Salisbury University. The mission of *Wicomico Creekwatchers* is to obtain objective, scientifically credible water quality data through the recruitment and mobilization of a grassroots volunteer force that monitors the waters of the Wicomico River and its tributaries on Maryland's Lower Eastern Shore. Creekwatcher volunteers monitor 28 sites throughout the Wicomico river system, generating approximately 2,000 data points on an annual basis. Data collection and sampling are on going.

Until the summer of 2002 when *Wicomico Creekwatchers* began regularly sampling the Wicomico River, water quality data collected for the Wicomico have been historically sparse and failed to provide a comprehensive, reliable assessment of river health. *Wicomico Creekwatchers* offers baseline data for identifying water quality conditions and trends over time. Wicomico tributaries and dammed water features for which data has been collected include Johnson Pond, Parker Pond, Schumaker Pond, the East Prong, Mitchell Pond, Coulbourne Mill Pond, Tony Tank Lake, Allen Pond, Shiles Creek and Rockawalkin Creek.

Data provided in this report can be used to identify river locations that express deteriorating water quality. Trends in river health can also be correlated with changes in land use and implementation of pollution control strategies occurring within the watershed. *Wicomico Creekwatchers* advances efforts of citizens, businesses and public officials to ensure that public policies and other management tools adequately protect and preserve Wicomico River water quality.

This report summarizes data generated from on-site measurements and analysis of water samples collected at four sections of the Wicomico River system (Johnson's Pond, Tony Tank Creek, Wicomico Creek and the Lower Wicomico) between September of 2003 and August of 2004. A preliminary trend analysis is also offered for evaluating changes in water quality over time since sampling began under the program in 2002. Following is a selection of key findings:

- **Nitrate** – None of the samples collected in 2003/2004 contained nitrate concentrations less than 1.0 mg/l. Only two percent of all samples contained nitrate levels less than 2.0 mg/l, down from nineteen percent last year.

- **Phosphate** – Each of the samples analyzed contained phosphate level in excess of 0.1 mg/l, the recommended level to prevent excessive plant growth. Seventeen percent of all samples contained phosphate levels less than 0.2 mg/l, down from fifty-five percent in 2002/2003.

- **Water Clarity** – None of the visual turbidity readings conducted at sites on Tony Tank Creek and Wicomico Creek were in the healthy range of 36" or above in both sampling years. Healthy water clarity readings were recorded less frequently in Johnson's Pond in 2003/2004.

- **Dissolved Oxygen (DO)** – The 2003/2004 sampling year showed a modest decrease in the number of samples containing healthy dissolved oxygen concentrations.

PROGRAM OVERVIEW

Interest among citizens in the health of the Wicomico River and other Chesapeake Bay tributaries is growing. By federal law, six Mid-Atlantic states, including Maryland, are required to develop and implement strategies for improving water quality in the Chesapeake Bay or face severe restrictions in levels and amounts of pollution that can be legally discharged into the estuary.

In 2000, elected officials formally committed to a comprehensive program for removing the Chesapeake Bay from the Environmental Protection Agency's dirty waters list by 2010. The plan, called the *Chesapeake 2000 Agreement (C2K)*, provides a roadmap for actions needed to reduce the amount of pollutants entering the Bay each year to a level sufficient to maintain the health of the estuary's living resources, including crabs, oysters and finfish.

Communities throughout the Chesapeake Bay watershed are responding to the call for action sounded in *C2K*. In Talbot County on Maryland's Eastern Shore, citizens working in partnership with CBF and the Chesapeake Bay Maritime Museum launched a volunteer-based water quality monitoring program to identify trends in the health of the county's rivers. *Wicomico Creekwatchers* is modeled after that successful program, which is receiving statewide recognition for its effectiveness in providing water quality data useful for facilitating local watershed management efforts. Recent information on the Talbot program can be accessed at www.cbf.org/publications.

Methods

In summer 2002, CBF, the Salisbury Area Chamber of Commerce and Salisbury University began working cooperatively with citizen volunteers to identify sampling locations along the Wicomico River. Twenty-eight sampling locations were selected for water quality monitoring (Appendix 2). Sampling sites were determined based on local knowledge of the tributary and equitable distribution throughout the river system. Site selection was also driven by the potential for long-term, regular access to ensure collection locations remain consistent in future years. Efforts were made to select locations having water approximately four feet in depth to conform to standard sampling protocol. A map (Appendix 3) indicating sampling site locations was generated and latitude/longitude coordinates were obtained for each site using GPS technology.

Volunteers were recruited for participation in *Wicomico Creekwatchers* in summer of 2002. Fifty-eight volunteers were trained in sampling techniques at an hour-long training session. Data collection procedures were demonstrated and sampling instructions were provided to all volunteers (Appendix 5).

A majority of volunteers recruited and trained in 2002 remain engaged in the program to date. Additional participants joining the effort since the initial training program received personal instruction in individualized sessions.

Environmental data were collected at regular two-week intervals throughout the sampling year. At each location, site conditions were recorded on a Water Quality Sampling Data Sheet (Appendix 4). Parameters measured included tide, weather, wind strength and direction, level of wave action, recent rainfall, and air and water temperature.

Water clarity was measured using a Secchi disk. The black and white disk was lowered into the water at the sampling location until it was no longer visible, at which point the distance from disk to water surface was recorded in feet.

Water samples were collected using a standard oxygen bottle. Empty oxygen bottles were submerged three inches below the water's surface at each sampling location until full. Care was taken to ensure no air bubbles were present when the stopper was inserted. Water samples were immediately put on ice and remained cool until they arrived at Salisbury University laboratories, where they were analyzed for levels of acidity, dissolved oxygen, nitrate and phosphate content.

RESULTS

Data compiled and analyzed in this report were derived from water clarity readings and samples collected at two-week intervals beginning on September 2, 2003 and ending on August 3, 2004. The data set builds on analysis conducted and reported on in the first annual *Wicomico Creekwatchers Water Quality Monitoring Report*, released October 7, 2003 (currently accessible at www.cbf.org/publications). Comparisons between earlier and current data sets are made as part of a preliminary trend analysis for evaluating changes in water quality conditions over time.

As in the earlier report, four regions were established that reflect geographic and hydrologic similarities to facilitate data analysis and interpretation. Slight modifications to the groupings of collection sites were made for building consistency with state-accepted watershed delineations (8-digit sub-watersheds) and related geographically based monitoring and natural resource management efforts. Names were also revised for the four sampling areas: Johnson's Pond, Tony Tank Creek, Wicomico Creek and the Lower Wicomico. This year, a total of 1,965 data points were generated, distributed as indicated in Appendix 2.

Reference Site

Spring-fed conditions at site 14 near Tony Tank Creek continue to contribute significant levels of relatively fresh ground water to the receiving surface waters. For the purposes of this study, site 14 was established as a reference site for providing baseline comparisons among the parameters analyzed.

Water Quality Parameters

The Environmental Protection Agency's Chesapeake Program and other regional research institutions establish criteria to identify levels of water quality needed to support the Bay's living resources, such as crabs, oysters, finfish, underwater grasses and other aquatic organisms. Scientists evaluating the health of the Bay and its tributaries compare empirical water quality data with a standard "healthy" range of several key water quality indicators, including acidity (pH), chlorophyll a, coliforms, dissolved oxygen, nitrate, phosphate, and water clarity. In general, water quality parameters are often influenced by wastewater treatment plant and industrial discharges, air pollution, run-off from agricultural, landscaped and urban areas, septic system effluent, and other anthropogenic sources.

Table 1 describes each parameter used to describe Wicomico River water quality and suggests the range parameter measurements should fall within to qualify a tributary as "healthy." Data outside the "healthy" range indicates poor water quality.

In the 2003/2004 sampling year, resource limitations prevented an analysis of chlorophyll a and coliform concentrations as had been evaluated in the earlier report. Arrangements are currently being developed to re-include chlorophyll a data analysis in 2004/2005.

Table 1: Water Quality Parameters

Acidity (pH): pH levels are directly related to the health of fish and aquatic plant populations, and in a healthy system, should be between 6.5 and 8.5. The most common causes of variations include stormwater runoff and air deposition of nitric and sulfuric acids discharged by industries, power plants, and automobiles.

Dissolved Oxygen: Dissolved oxygen is essential to all aquatic life. Readings greater than 5 mg/l indicate sufficient levels of oxygen to support aquatic organisms. Common causes of low readings include an increase in algae production, which consumes oxygen as algae decompose. Seasonal changes in water salinity levels can also influence dissolved oxygen levels.

Nitrate (NO_3) and Phosphate (PO_4): Though essential to all bay life, nitrogen and phosphorus, in excessive levels, are the most damaging pollutants in the Chesapeake. Nitrogen and phosphorus are natural fertilizers that stimulate algae blooms. These blooms block sunlight from underwater grasses and, when the algae die, lead to low dissolved oxygen levels. Some naturally occurring algae may be toxic or have toxic stages in their life cycles. Nitrate (NO_3) and Phosphate (PO_4) are the primary chemical compounds that express critical levels of nitrogen and phosphorus. Nitrate levels should be less than 1.0 mg/liter and phosphate levels should be less than 0.1 mg/liter.

Water Clarity: Water clarity measures the ability of light to pass through water. Poor water clarity indicated by a low visual turbidity reading indicates that water is not clear enough for light to penetrate to a depth to support the growth of underwater grasses. The healthy range for visual turbidity includes readings greater than 36 inches.

Wicomico River Water Quality

Using the criteria identified for healthy water, data collected was analyzed to determine the percentage of data points that fall outside the healthy range for each parameter measured. High percentages by parameter indicate potential water quality problems. Potential trends in water quality are indicated by health range percentages offered in the two sampling years, 2002/2003 and 2003/2004.

pH:

Over ninety-five percent of all samples analyzed were found to have pH levels within the healthy range in 2003/2004. A majority of samples tested had pH ranges between 6.5 and 7.0 in the most recent sampling year. 12.5 percent of samples taken at Wicomico Creek had pH levels below 6.5 (slightly lower than last year), while 3.1 percent of Lower Wicomico samples had pH levels below 6.5.

Table 2: Percent of pH Samples Inside "Healthy" Range

	2002/2003	2003/2004
Johnson's Pond	100%	100%
Tony Tank Creek	97.0%	100%
Wicomico Creek	86.7%	87.5%
Lower Wicomico	97.2%	96.9%

Dissolved Oxygen

The 2003/2004 sampling year showed a modest decrease in the number of samples containing healthy dissolved oxygen concentrations. Tony Tank Creek and the Lower Wicomico had healthy dissolved oxygen levels in 94.1% and 96.9% of the samples collected respectively. All samples collected in January through April had dissolved oxygen levels between 8.0 and 10.0 mg/l.

Table 5: Percent of Dissolved Oxygen Samples Within "Healthy" Range

	2002/2003	2003/2004
Johnson's Pond	100%	100%
Tony Tank Creek	100%	94.1%
Wicomico Creek	100%	100%
Lower Wicomico	100%	96.9%

Nitrate and Phosphate

None of the samples collected in 2003/2004 contained nitrate concentrations less than 1.0 mg/l. Only two percent of all samples contained nitrate levels less than 2.0 mg/l, down from nineteen percent last year.

Sample analysis revealed similarly excessive levels of phosphate. Each of the samples analyzed contained phosphate level in excess of 0.1 mg/l. Seventeen percent of all samples contained phosphate levels less than 0.2 mg/l, down from fifty-five percent in 2002/2003.

Table 6: Percent of Nitrate Samples Within "Healthy" Range

	2002/2003	2003/2004
Johnson's Pond	0%	0%
Tony Tank Creek	0%	0%
Wicomico Creek	0%	0%
Lower Wicomico	0%	0%

Table 7: Percent of Phosphate Samples Within "Healthy" Range

	2002/2003	2003/2004
Johnson's Pond	0%	0%
Tony Tank Creek	0%	0%
Wicomico Creek	0%	0%
Lower Wicomico	0%	0%

Water Clarity

None of the visual turbidity readings conducted at sites on Tony Tank Creek and Wicomico Creek were in the healthy range of 36" or above in both sampling years. Healthy water clarity readings were recorded less frequently in Johnson's Pond in 2003/2004 with 9.5 percent of samples occurring in the healthy range, compared with

42.9 percent the previous year.

As in 2002/2003, samples from sites where the water was too shallow to get a final reading were removed from the data set during statistical analysis. While effort is made to establish sampling sites in water approximately four feet in depth, some sampling locations contain a shallower water depth that prevents accurate water clarity measurement.

Table 8: Percent of Water Clarity Samples Within "Healthy" Range

	2002/2003	2003/2004
Johnson's Pond	42.9%	9.5%
Tony Tank Creek	0%	0%
Wicomico Creek	0%	0%
Lower Wicomico	8.7%	25.6%

CONCLUSIONS

In its second year of data collection and analysis, *Wicomico Creekwatchers* continues to reveal alarming water quality conditions in the Wicomico River and its tributaries.

Using scientifically accepted standards for surface water quality, *Wicomico Creekwatchers* shows a worsening trend for nitrate and phosphate concentrations in the Wicomico River system. As in the previous year of sampling, nitrate and phosphate levels exceeded the benchmark for healthy water quality in one hundred percent of analyzed samples. Nitrate levels were more than twice the healthy standard in ninety-eight percent of samples, up seventeen percent from 2002/2003. Similarly, phosphate concentrations were twice the healthy limit in as much as eighty-three percent of all samples, up forty-five percent from last year.

The incidence of excess nitrate and phosphate in surface waters is known to adversely impact aquatic species like crabs, oysters and finfish as nutrient-rich waters fuel algae growth that clouds waterways and reduces wildlife habitat. Measured visual turbidity levels confirmed poor water clarity conditions in most of the Wicomico system's headwater tributaries and in portions of the river's mainstem.

In addition to clouding waterways, algae growth and decay is also known to reduce availability of oxygen, often times below threshold levels required by aquatic species for survival. While measured dissolved oxygen concentrations revealed unhealthy levels in some Tony Tank Creek and Lower Wicomico samples, most other readings showed healthy levels, which is unusual given the measured excessive nutrient concentrations.

Dissolved oxygen samples are taken from just below the surface, near the "mixing zone," or the area where surface water and ambient air meet. , Samples taken from deeper water may provide different results.

Now in its second year, preliminary trend analysis conducted by *Wicomico Creekwatchers* is indicating deteriorating water quality. The findings of this report suggest that the health of the Wicomico and its tributaries is declining, and that pollution sources impacting water quality remain inadequately controlled.

EPA's Chesapeake Bay Program, the *Chesapeake 2000 Agreement* and other regional initiatives establish a framework for addressing pollution problems in Chesapeake Bay tributaries and can be leveraged to provide guidance in establishing strategies for improving management of pollution sources. *Wicomico Creekwatchers* provides the structure for measuring effectiveness of strategies put in place to control pollution as comprehensive assessments of local water quality are performed in future years.

Appendix 1: Distribution List

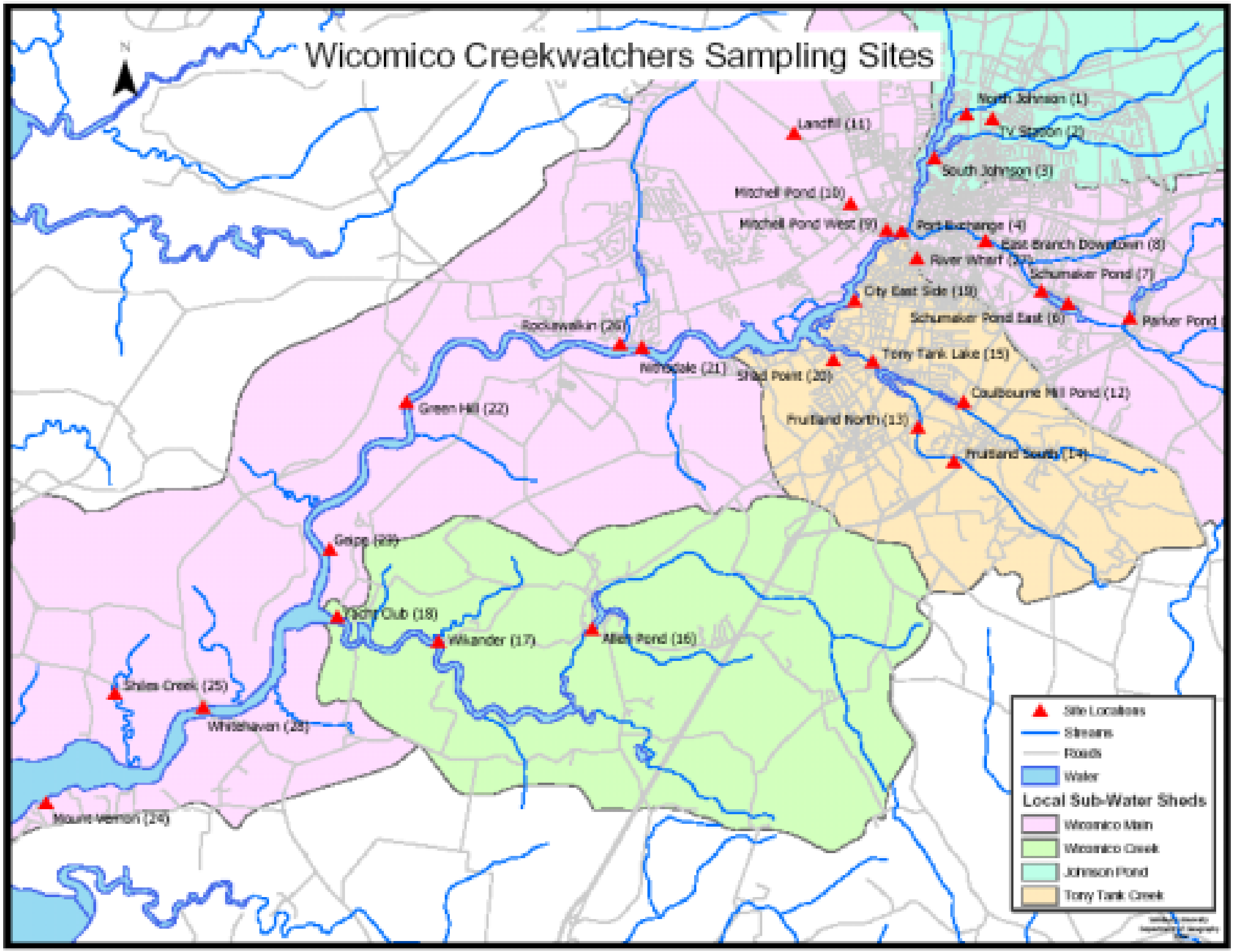
City of Salisbury Building, Housing and Zoning Department
City of Salisbury City Council
City of Salisbury Office of the Mayor
City of Salisbury Public Works Department
Congressman Wayne Gilchrest
Delegate Bennett Bozman
Delegate D. Page Elmore
Delegate Norman H. Conway
Delmarva Poultry Industry
Delmarva Water Transport Committee
Friend of the Nanticoke
Great Salisbury Committee
Lower Eastern Shore Tributary Team
Lower Shore Land Trust
Maryland Department of Agriculture
Maryland Department of the Environment
Maryland Department of Natural Resources
Maryland Department of Planning
Nanticoke Watershed Alliance
Nanticoke Watershed Preservation Group
Pemberton Historical Park
Salisbury Area Chamber of Commerce
Salisbury University Biology Department
Salisbury-Wicomico Economic Development, Inc.
Salisbury Zoo
Senator J. Lowell Stoltzfus
Somerset Board of County Commissioners
Somerset County Department of Solid Waste and Drainage
Somerset County Division of Planning and Zoning
Somerset County Economic Development Commission
Somerset County Health Department, Environmental Health
Somerset County Planning Commission
Somerset County Public Library
Somerset County Department of Tourism
The Nature Conservancy Nanticoke Field Office
Tri-County League of Women Voters
Ward Wildfowl Museum of Art
Wicomico County Council
Wicomico County Department of Planning, Zoning and Community Development
Wicomico County Department of Public Works
Wicomico County Department of Parks, Recreation and Tourism
Wicomico County Farm Bureau
Wicomico County Free Library
Wicomico County Health Department, Environmental Health Division
Wicomico County Planning Commission
Wicomico Environmental Trust
University of Maryland Center for Environmental Science
University of Maryland Cooperative Extension Wicomico County
Urban Salisbury

Appendix 2: Sampling Site Description

Site Number	Site Name	Site Location (Lat./Long.)	Number of Data Points
Johnson's Pond			
1	North Johnson	N38^0 23. 18.7' W75^0 35. 32.1'	105
2	TV Station	N38^0 23.025' W75^0 34.935'	91
3	South Johnson	N38^0 22.772' W75^0 35.856'	139
Lower Wicomico			
4	Port Exchange	N38^0 21. 874' W75^0 36. 382'	146
5	Parker Pond	N38^0 20. 750' W75^0 32. 832'	118
6	Schumaker Pond East	N38^0 20. 946' W75^0 33. 795'	118
7	Schumaker Pond	N38^0 21.106' W75^0 34.207'	104
8	East Branch Downtown	N38^0 21. 741' W75^0 35. 067'	97
9	Mitchell Pond West	N38^0 21. 53.4' W75^0 36. 46.9'	105
10	Mitchell Pond	N38^0 22. 218' W75^0 37. 171'	77
11	Landfill	N38^0 23. 101' W75^0 38.039'	111
19	City East Side	N38^0 21. 015' W75^0 37. 133'	174
20	Shad Point	N38^0 20. 285' W75^0 37.481'	139
21	Nithsdale	N38^0 20. 480' W75^0 40. 470'	118
22	Green Hill	N38^0 19. 835' W75^0 44. 166'	146
23	Geipe	N38^0 18. 02.4' W75^0 45. 31.5'	146
24	Mount Vernon	N38^0 14. 945' W75^0 49. 886'	118
25	Shiles Creek	N38^0 16. 286' W75^0 48. 788'	160
26	Rockawalkin	N38^0 20. 520'	98

		W75^0 40. 811'	
27	River Wharf	N38^0 21. 540' W75^0 36. 150'	97
28	Whitehaven	N38^0 16. 095' W75^0 47. 411'	160
Tonytank Creek			
12	Coulbourne Mill Pond	N38^0 19. 44.8' W75^0 35. 32.8'	125
13	Fruitland North	N38^0 19. 570' W75^0 36. 148'	119
15	Tony Tank Lake	N38^0 20. 265' W75^0 36. 869'	153
Wicomico Creek			
16	Allen Pond	N38^0 17. 00.0' W75^0 41. 28.2'	56
17	Wikander's	N38^0 16. 87' W75^0 43. 719'	111
18	Wicomico Yacht Club	N38^0 17.112' W75^0 45.178	126
Reference Site			
14	Fruitland South	N38^0 19. 00.0' W75^0 35. 59.2'	140
		Total Data Points:	3,397

<u>Appendix 3</u>: Site Location Map



Appendix 4: Data Sheet

Wicomico Creekwatchers
Water Quality Sampling Data Sheet

Site Number ______ Date: ______ Time: ______

Observers ____

Tide

1	High
2	Middle Falling
3	Low
4	Middle Flooding

Weather

1	Clear
2	Partly Cloudy
3	Overcast
4	Light Rain
5	Rain
6	Heavy Rain
7	Fog
8	Snow

Wind

1	Still
2	Light Wind
3	Medium Wind
4	Heavy Wind

Wind Direction

1	N
2	NE
3	E
4	SE
5	S
6	SW
7	W
8	NW

Water Surface

1	Calm
2	Ripples
3	Choppy
4	Heavy Chop

Rainfall in Previous 48 Hours

1	None
2	Trace
3	Light
4	Moderate
5	Heavy
6	Monsoon

Air Temperature _________

Water Temperature ____________

Secchi Disk Depth _______

Bottomed Out

1	No
2	Yes

Water Sample Bottle Number __________

Observations: _______________________

____

____

____

<u>Appendix 5</u>: Sampling Instructions

Wicomico Creekwatchers
Sampling Instructions

1. **At your sampling site, use the Water Quality Sampling Data Sheet to record the following:**

   - ✓ **Site Number**
   - ✓ **Date**
   - ✓ **Time**
   - ✓ **Observers**
   - ✓ **Tide Conditions**
   - ✓ **Weather Conditions**
   - ✓ **Wind Conditions**
   - ✓ **Wind Direction**
   - ✓ **Water Surface Conditions**
   - ✓ **Rainfall in Previous 48 Hours**

2. **<u>Air Temperature</u>: Use the thermometer to measure the air temperature and record it on the data sheet.**

3. **<u>Water Temperature</u>: Use the thermometer to measure the water temperature and record it on the data sheet. Insert the thermometer just under the water's surface, wait one minute before removing and record the measurement.**

4. **<u>Secchi Disk Depth</u>: Use the secchi disc to measure water clarity. Lower the disc into the water until you can no longer see it. Look away for a moment, then slowly raise the disc to the point where it just becomes visible. Note the mark on the rope closest to the water's surface. Marks are at 3-inch intervals. Record the secchi disk depth in feet and inches on the data sheet.**

   If the disc hits river bottom during lowering and you can still see it, record the secchi disc depth and circle "2 Yes" under "Bottomed Out" on the data sheet. Otherwise circle "1 No."

5. **<u>Water Samples</u>: On the data sheet, record the number located on the water sample bottle. Submerge the bottle 3 inches below the water's surface, top end up, until it fills. Remove the bottle from the river and insert the stopper. IF ANY AIR BUBBLES ARE PRESENT AFTER INSERTING THE STOPPER, EMPTY THE BOTTLE AND REPEAT THE PROCEDURE.**

   After collecting the water sample, bring it and the completed data sheet to CBF's Salisbury Office as soon as possible. Use a cooler or refrigerator to keep water samples cool during transport or short-term storage. When you arrive at CBF, exchange your water sample bottle and data sheet with new ones.

6. **<u>Observations</u>: Note anything you think might be of interest to those compiling and analyzing the data you have collected.**

<u>Appendix 6</u>: Mean Value for Acidity (pH) September 2003-August 2004

Site	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1	6.81	6.88	6.84	6.71	6.78	6.86	6.79	6.94	6.66	6.87		
2	6.92	6.83		6.91	6.86	6.78	6.66		6.86	6.75	6.82	
3	6.73	6.90	6.90	6.96	6.86		6.44	6.87	6.63	6.75	6.85	6.88
4	6.70	6.68	6.84	7.04	7.02	7.02	6.71	6.80	6.77	6.95	6.63	6.79
5	6.50	6.67	6.79	6.87	6.82	6.85	6.90	6.56	6.61	7.03	6.85	6.85
6	6.68	6.69	6.97	6.85	6.79		6.79	6.82	6.75	6.95		
7	6.75	6.84	6.79				6.77		6.75	6.92		6.70
8	6.70	6.66	6.75	6.88		6.76	6.61	6.70	6.73	6.87	6.85	
9	6.84											
10	6.73											
11	6.27	6.65	6.87		6.75	6.69	6.90	6.64	6.83	6.81	6.90	
12	6.85	6.83	6.83		6.80	6.92	6.80	6.81	6.82	6.78	6.73	6.92
13	6.65	6.73	6.85	6.84	6.77	6.87	6.65	6.83	6.91	6.92	6.50	
14	6.47	6.76	6.86	6.69	6.77	6.83	6.54					
15	6.54	7.03	6.84	6.92	6.80	6.87	6.82	6.83	6.69	6.68	6.58	6.84
16	6.74	6.79										
17	6.43	6.85		6.71	6.70	6.72	6.44	6.51	6.78		6.69	
18								6.77	6.72	6.80	6.72	6.71
19	6.66	6.70	6.77	6.71		6.84	6.64	6.81	6.55	6.75	6.61	6.93
20	6.87	6.75	6.80	6.92	6.90	6.90	6.62	6.60	6.57	6.77	6.84	6.49
21	6.56	6.72	6.72	7.03	6.88	6.97	6.70		6.55	6.84		6.61
22	6.53	6.82	6.66	6.82	6.79	6.83	6.52	6.77	6.83	6.86		6.73
23	6.27	6.78	6.82	6.98	6.97	6.94	6.83	6.93	6.32	6.79	6.82	6.86
24	7.01	6.71										
25	6.36	6.84	6.83	7.06	6.84	6.82	6.61	6.77	6.64	6.68	6.83	6.90
26	6.66	6.78	6.76	6.84	6.97	6.83	6.70	6.91	6.83	6.71		6.78
27	6.71	6.84	6.92	6.76	6.86		6.87					
28	6.86	6.94	6.97	6.92	6.93		6.90	6.87	6.81	6.88	6.90	6.90

Note: Blanks represent no data reported at site that month

Appendix 7: Mean Value for Nitrate (NO_3 mg/l) September 2003-August 2004

Site	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1	2.88	1.97	2.47	2.17	2.55	2.42	2.36	2.24	2.28	2.17		
2	2.43	2.14		2.01	2.51	2.43	2.18		2.36	2.24	2.35	
3	3.01	2.35	2.01	2.42	2.55		2.31	2.46	2.32	2.24	2.17	2.38
4	2.77	2.10	3.45	3.30	2.99	3.06	2.98	2.89	2.96	2.80	2.96	3.07
5	2.62	2.21	2.14	2.56	2.95	2.42	2.15	2.60	2.18		2.22	2.00
6	2.60	2.35	2.16	1.96	2.40		2.35	2.29	2.10	2.16		
7	2.71	2.43	1.92				2.25		2.12	2.41		2.41
8	2.64	2.45	2.14	2.70	2.47	3.31	2.34	2.40	2.21	2.39	2.62	
9	2.68											
10	2.78											
11	2.56	2.28	2.25		2.53	2.35	2.26	2.42	2.15	2.50	2.14	
12	2.54	2.32	2.30		2.61	2.46	2.14	2.57	2.30	2.27	2.09	2.48
13	2.52	2.45	2.05	2.02	2.58	2.09	2.19	2.35		2.35	2.27	
14	0.40	0.26	0.39	0.23	0.29	0.26	0.17					
15	2.74	2.62	2.66	2.19	2.59	2.38	2.14	2.34	2.41	2.37	2.17	2.75
16	2.75	2.55										
17	2.73	2.59		2.26	2.39	2.43	2.14	2.31	2.19		2.06	
18								2.35	2.55	2.54	2.42	2.93
19	3.46	3.32	3.51	2.57		3.07	2.93	2.96	2.92	3.15	3.19	3.26
20	3.50	3.50	3.17	3.14	3.21	3.14	2.95	3.16	3.14	3.16	3.08	3.19
21	3.68	3.45	3.19	2.86	3.00	3.34	3.14		3.14	3.30		3.30
22	3.53	3.57	3.27	2.81	3.06	3.29	3.02	3.23	3.08	3.08		3.38
23	3.84	3.19	3.31	3.08	3.28	3.57	2.98	3.12	3.16	3.09	3.16	3.27
24	3.37	3.17										
25	3.41	3.25	2.94	3.04	3.79	2.81	2.94	3.02	2.73	3.15	3.13	3.19
26	3.04	3.47	3.24	2.91	2.67	3.38	2.73	3.12	2.98	2.92		3.41
27	3.89	3.46	3.23	3.06	3.25							
28	2.82	2.85	2.46	1.61	2.60	2.02	2.50	2.90	2.37	2.59	3.06	2.21

Note: Blanks represent no data reported at site that month

Appendix 8: Mean Value for Phosphate (PO_4 mg/l) September 2003-August 2004

Site	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1	0.23	0.27	0.36	0.27	0.27	0.31	0.21	0.35	0.22	0.23		
2	0.19	0.39		0.49	0.50	0.37	0.49		0.52	0.54	0.55	
3	0.29	0.15	0.29	0.21	0.24		0.20	0.23	0.25	0.21	0.23	0.21
4	0.18	0.15	0.19	0.19	0.27	0.40	0.24	0.29	0.25	0.13	0.23	0.25
5	0.22	0.18	0.26	0.24	0.26	0.29	0.24	0.31	0.24	0.26	0.28	0.29
6	0.22	0.19	0.19	0.21	0.29		0.24	0.27	0.31	0.21		
7	0.24	0.12	0.31				0.31		0.26	0.22		0.22
8	0.22	0.13	0.25	0.35	0.19	0.31	0.24	0.21	0.28	0.25	0.28	
9	0.22											
10	0.25											
11	0.21	0.14	0.25		0.26	0.31	0.28	0.29	0.28	0.27	0.24	
12	0.20	0.20	0.22		0.25	0.42	0.27	0.25	0.33	0.27	0.26	0.27
13	0.27	0.18	0.24	0.33	0.24	0.33	0.25	0.28	0.27	0.24	0.23	0.22
14	0.10	0.02	0.03	0.03	0.03	0.02	0.02					
15	0.18	0.14	0.25	0.27	0.28	0.27	0.28	0.26	0.28	0.24	0.24	0.22
16	0.26	0.19										
17	0.21	0.19		0.29	0.27	0.30	0.28	0.21	0.23		0.23	
18								0.28	0.28	0.27	0.26	0.30
19	0.22	0.18	0.21	0.24		0.28	0.24	0.24	0.26	0.26	0.25	0.23
20	0.23	0.18	0.19	0.26	0.28	0.24	0.26	0.26	0.26	0.25	0.26	0.24
21	0.19	0.23	0.24	0.29	0.25	0.34	0.29		0.30	0.28		0.27
22	0.20	0.18	0.20	0.35	0.25	0.30	0.26	0.29	0.27	0.28		0.22
23	0.21	0.21	0.18	0.21	0.30	0.27	0.25	0.24	0.29	0.32	0.22	0.25
24	0.11	0.13										
25	0.18	0.19	0.27	0.18	0.25	0.28	0.24	0.34	0.25	0.25	0.20	0.28
26	0.19	0.16	0.21	0.21	0.31	0.28	0.23	0.29	0.28	0.23		0.22
27	0.14	0.16	0.20	0.19	0.24		0.22					
28	0.16	0.12	0.14	0.14	0.23	0.21	0.18	0.19	0.19	0.17	0.21	0.21

Note: Blanks represent no data reported at site that month

Appendix 9: Mean Value for Dissolved Oxygen (mg/l) September 2003-August 2004

Site	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1	6.51	6.73	7.81	8.27	8.71	9.37	8.94	8.93	8.21	7.91		
2	5.77	6.52		8.02	9.82	9.26	9.36		8.27	8.12	7.63	
3	5.61	6.90	7.92	8.40	9.14		9.11	8.94	8.29	7.95	7.78	7.22
4	5.83	6.60	7.75	8.31	9.79	9.65	9.82	8.85	8.15	8.14	7.65	7.16
5	6.02	7.12	7.64	8.25	9.25	9.86	9.68	8.59	8.11	7.92	7.65	7.30
6	5.73	4.50	7.69	7.88	8.63		9.49	8.79	8.05	7.75		
7	5.93	3.54	7.36				9.35		8.06	7.79		7.17
8	6.21	7.12	7.80	8.11	9.75	9.37	9.66	8.96	2.97	8.00	7.72	
9	6.17											
10	5.71											
11	6.04	7.11	7.64		8.91	9.21	9.58	8.81	8.09	7.81	7.61	
12	5.79	4.57	7.76		8.82	9.52	9.25	8.49	2.99	7.69	7.74	7.28
13	5.49	7.04	7.82	8.02	9.29	9.53	9.30	8.57	8.10	7.63	7.55	
14	5.85	7.18	7.61	7.91	9.46	9.65	9.14					
15	5.85	6.72	7.74	8.13	9.28	9.76	9.47	8.63	7.99	7.92	7.66	7.13
16	6.02	6.69										
17	6.26	7.28		8.03	8.65	9.64	9.47	8.76	7.95		7.71	
18								8.83	8.00	7.60	7.56	7.44
19	5.86	7.22	7.81	7.95		9.55	9.14	8.73	8.10	7.77	7.49	7.26
20	6.07	7.22	7.74	8.22	9.86	9.52	9.27	8.63	8.02	7.82	7.20	7.19
21	5.92	7.04	7.66	7.97	9.08	9.81	9.08		7.92	7.78		7.20
22	5.65	7.58	7.63	7.94	9.74	9.32	9.54	8.72	7.95	7.72		7.11
23	5.61	7.24	7.73	8.14	9.20	9.37	9.34	8.62	8.07	7.64	5.10	7.18
24	6.94	6.63										
25	5.86	7.07	7.66	8.29	9.66	9.64	9.45	8.68	8.07	7.68	7.27	7.35
26	5.79	7.03	7.69	7.86	8.92	9.50	9.26	8.74	7.88	7.79		7.19
27	6.11	7.04	7.80	7.90	9.20		9.14					
28	6.37	7.21	7.82	2.84	9.13	9.31	9.45	8.60	8.17	7.80	3.68	7.44

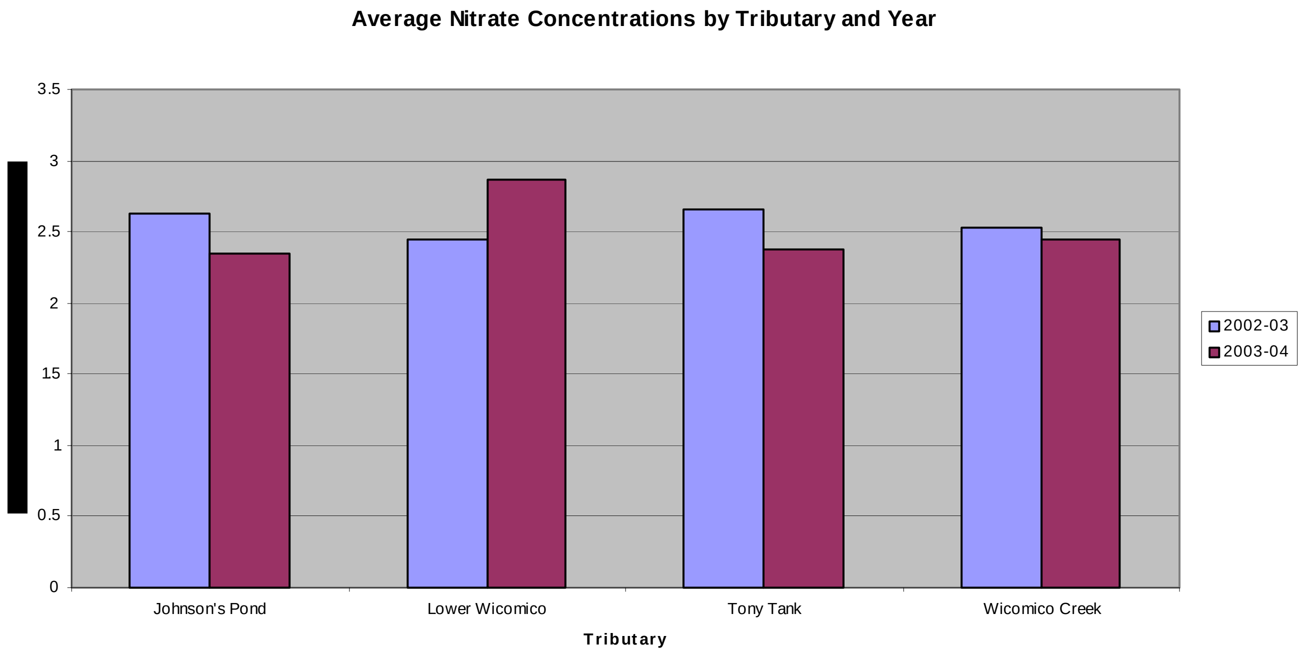
Note: Blanks represent no data reported at site that month

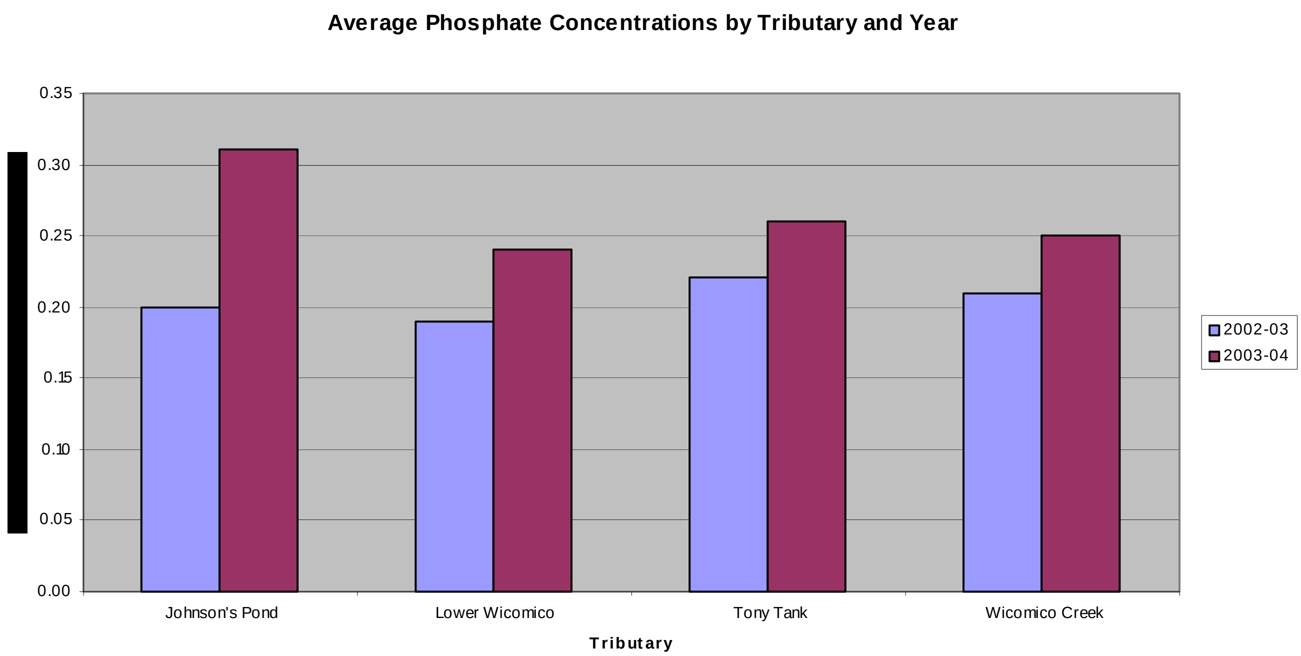
Appendix 10: Mean Value for Water Clarity (inches) September 2003-August 2004

Site	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1								24				
2	26	29		24	24	24	24		26	24	26	
3	30	35	30	45	31		51	27	26	30	33	30
4	27	39	24	39	30	33	54	41	31	36	30	36
5	26	51	39	60	56	63	60	48	48	39	50	31
6	48	65	36	39	36		44	20	39	61		
7	56	61	30				60		45	51		42
8	36	28	30	33	42	13	38	24	24	28	28	
9												
10	21											
11	9	11	16		9	9	9	6			36	
12	24	23	20		9	24	25	21	24	25	12	27
13												
14	31	29	48		60							
15	29	24	23	27	30	24	27	29	24	24	23	27
16												
17	15	17		12	9	8	13	9	12		12	
18								18	17	18	18	24
19	15	32	15	37		23	32	36	23	18	23	36
20	10	22	18	20	27	21	23	19	17	20	15	18
21	42	25	12	24	15	21	24		8	19	30	19
22	14	15	14	18	12	12	14	14	17	19	18	21
23	22	26	18	15	18	18	19	18	18	21	21	21
24	15	24										
25	22	24	24	14	9	12	20	23	15	27	50	15
26	13	14	12	9	14	10	12	12	16	20	13	17
27	36	43	33	39	44		44		42		27	
28	14	18	14	15	11	15	14	18	12	12	15	15

Note: Blanks represent no data reported at site that month and/or insufficient water depth to obtain secchi reading.

Appendix 11: Preliminary Trend Analysis – Nitrate and Phosphate





<u>Appendix 12</u>: Preliminary Trend Analysis – Water Clarity and Dissolved Oxygen