Report on Nutrient and Biological Synoptic Surveys in the Upper Patuxent Watershed, Anne Arundel and Prince George's Counties, Maryland, April 2002 as part of the Watershed Restoration Action Strategy.

Maryland Department of Natural Resources
Chesapeake and Coastal Watershed Service
Watershed Restoration Program
Watershed Evaluation Section
November, 2002

Acknowledgements

This work was supported by the 2002 319(h) grant from U.S. Environmental Protection Agency # C9-00-3497-02-0.

This work supports Department of Natural Resources Outcomes –
#2 Healthy Maryland watershed lands, streams, and non-tidal rivers.
#3 A natural resources stewardship ethic for Marylanders.
#4 Vibrant local communities in balance with natural systems.

Significant field collection assistance was provided by Beth Habic, Jennifer Jaber, Kevin R. Coyne, and John McCoy of MD Dept of Natural Resources, Chesapeake and Coastal Watershed Services, Watershed Restoration Division, Watershed Evaluation Section.

Comments or questions about this report can be directed to :
Niles L. Primrose
MD Dept of Natural Resources
Chesapeake and Coastal Watershed Services
Watershed Restoration Division
Watershed Evaluation Section.
nprimrose@dnr.state.md.us
410-260-8804

Executive Summary

The Upper Patuxent watershed is divided into Anne Arundel and Prince George's County jurisdiction. Anne Arundel County focused on eight subwatersheds with a total of 33 sampling sites, and Prince George's County focused on nine subwatersheds with a total of 25 sampling sites. Grab samples for dissolved nutrient analysis were collected at 31 sites in Anne Arundel Co., and all 25 sites in Prince George's Co.. Benthic samples were collected at a subset of 7 sites in A.A. Co. and 6 sites in P.G. Co.. Fish where collected at 6 site in A.A. Co. and 4 sites in P.G. Co.. Two sites where not sampled in Anne Arundel Co. due to access problems at one, and no flowing water at the time of sampling in April, 2002 at the other. Nutrient loads and yields within the Upper Patuxent watershed where generally very low as compared to other watersheds around the state. The highest nitrate/nitrite concentrations were only slightly above the 1 mg/L threshold at 4 of the sampling sites in A.A. Co. and 1 in P.G. Co.. Per hectare nitrate/nitrite yields from the subwatersheds were also very low, with no yields above the lowest threshold of .01 Kg/Ha/day . Orthophosphate concentrations were highest in the A.A. Co. watersheds, with almost the entire Stocketts Run watershed having 'excessive' concentrations. Rain several days prior to sampling is suspected as the cause. Orthophosphate yields were below the baseline threshold in all watersheds, with the exception of one site. The macroinvertebrate communities found at the 6 A.A. Co. and 4 P.G. Co. sites sampled had IBI scores ranging from "fair to "very poor". Habitat assessments that accompanied the macroinvertebrate sampling fell within the "suboptimal" category, with the exception of one site in P.G. Co. noted as "marginal". The major habitat problems were stream bank erosion and excessive sediment in the prime macroinvertebrate habitat areas such as riffles. In situ measurements of temperature, dissolved oxygen, conductivity and pH taken at the time of water sample collection showed only one significant low pH anomaly in P.G. Co.. Observations during sampling found one major fish blockage at one site due to a waterfall.

Table of Contents

	Page
Acknowledgements	i
Executive Summary	ii
List of Tables	iv
List of Figures	iv
Introduction	1
Methods	2
Results/ Discussion	3
Literature Cited	20
Appendix A	21

List of Tables Page

Table 1. Nutrient Ranges and Rating 1
Table 2. Upper Patuxent WRAS, Anne Arundel County Synoptic Sampling Station Locations 4
Table 3. Upper Patuxent WRAS, Prince George's County Synoptic Sampling Station Locations 6
Table 4. Anne Arundel County Upper Patuxent Watershed Nutrient Synoptic Survey Results, March/April 2002 8
Table 5. Prince George's County Upper Patuxent Watershed Nutrient Synoptic Survey Results, April 2002. 9
Table 6. Annual & Spring Nutrient Concentration (mg/L) Averages from Other Nutrient Synoptic Surveys 9
Table 7. Anne Arundel County Upper Patuxent Watershed, InSitu Water Quality, March/April 2002 18
Table 8. Prince George's County Upper Patuxent Watershed, InSitu Water Quality, April 2002 19
Table 9. Fish Communities at AA and PG Co. Sites

List of Figures

Figure 1. Upper Patuxent WRAS Anne Arundel County Nutrient Synoptic Sampling Sites 5
Figure 2. WRAS Sampling Sites April 2002, Upper Patuxent Prince George's Co. Watersheds 7
Figure 3. WRAS Nutrient Synoptic Survey, April 2002 Upper Patuxent Anne Arundel Co. Watersheds Nitrate/Nitrite (NO2+NO3) Concentrations (mg/L) 10
Figure 4.WRAS Nutrient Synoptic Survey, April 2002 Upper Patuxent Prince George's Co. Watershed Nitrate/Nitrite (NO2+NO3) Concentrations (mg/L) 11
Figure 5. WRAS Nutrient Synoptic Survey, April 2002 Upper Patuxent Anne Arundel Co. Watersheds Nitrate/Nitrite (NO2+NO3) Yield (Kg/ha/day) 12
Figure 6.WRAS Nutrient Synoptic Survey, April 2002 Upper Patuxent Prince George's Co. Watershed Nitrate/Nitrite (NO2+NO3) Yield (Kg/ha/day) 13
Figure 7.WRAS Nutrient Synoptic Survey, April 2002 Upper Patuxent Anne Arundel Co. Watershed Orthophosphate (PO4) Concentrations (mg/L) 14
Figure 8.WRAS Nutrient Synoptic Survey, April 2002 Upper Patuxent Prince George's Co.. Watershed Orthophosphate (PO4) Concentrations (mg/L) 15
Figure 9.WRAS Nutrient Synoptic Survey, April 2002 Upper Patuxent Anne ArundelCo. Watershed Orthophosphate (PO4) Yield (Kg/ha/day) 16
Figure 10.WRAS Nutrient Synoptic Survey, April 2002 Upper Patuxent Prince George's Co. Watershed Yield Orthophosphate (PO4) (Kg/ha/day) 17

Introduction

Nutrient synoptic sampling was scheduled for early spring to coincide with the period of maximum nitrogen concentrations in the free flowing fresh water streams. The major proportion of the nitrogen compounds are carried dissolved in the ground water rather than in surface runoff. The higher nitrogen concentrations in the late winter and early spring reflect the higher proportion of nitrogen rich shallow ground water present in the base flow at this time of year. Nitrogen concentrations are reduced in summer as the proportion of shallow ground water is reduced through plant uptake, and replaced by deeper ground water that may have lower nitrate concentrations, or has been denitrified through interaction with anoxic conditions in the soils below the streambed. Point sources can also contribute to in stream nitrate concentrations.

Orthophosphate is generally transported bound to suspended sediments in the water column. In stream orthophosphate concentrations can also be produced through mobilization of sediment bound phosphorus in anoxic water column and/or sediment conditions, sediment in surface runoff from areas having had surface applied phosphorus, ground water from phosphorus saturated soils, and point source discharges.

Ranges used for nutrient concentrations and yields were derived from work done by Frink (1991). The low end values are based on estimated nutrient exports from forested watersheds, and the high end values are based on estimated nutrient exports from intensively agricultural watersheds. As an additional bench mark, the Chesapeake Bay Program uses 1 mg/L total nitrogen as a threshold for indicating anthropogenic impact. The dissolved nitrogen fraction looked at in these synoptic surveys constitutes approximately 50% to 70% of the total nitrogen. For ease of discussion, the four divisions within the concentration and yield ranges will be considered *background, moderate, high,* and *excessive* (Table 1.).

Table 1. Nutrient Ranges and Rating

Rating	NO2+NO3 Concentration mg/L	NO2+NO3 Yield Kg/ha/day	PO4 Concentration mg/L	PO4 Yield Kg/ha/day
Baseline	<1	<.01	<.005	<.0005
Moderate	1 to 3	.01 to .02	.005 to .01	.0005 to .001
High	3 to 5	.02 to .03	.01 to .015	.001 to .002
Excessive	>5	>.03	>.015	>.002

A Note of Caution

Estimates of annual dissolved nitrogen loads/yields from spring samples will result in inflated load estimates, but the relative contributions of subwatersheds should remain reasonably stable. More accurate nitrate/nitrite load/yield estimates need to include sampling during the growing season to account for potential lower concentrations and discharges. Storm flows can also significantly impact loads delivered to a watershed outlet.

The tendency of orthophosphate to be transported bound to sediments makes any estimates of annual orthophosphate loads/yields derived from base flow conditions very conservative. More accurate estimates of orthophosphate loads/yields in a watershed must include samples from storm flows that carry the vast majority of the sediment load of a watershed. Residual suspended sediments from recent rains, or instream activities of livestock or construction can produce apparently elevated orthophosphate concentrations and yields at base flow.

Biological (macroinvertebrates and fish) sampling and habitat condition information are collected on a limited basis within the WRAS watersheds. Analysis of the biological data in conjunction with the nutrient and Stream Corridor Assessment information can provide good insight into the location, severity, and causes of water quality problems within a watershed.

Additional analysis that draws in existing and planned land use, and tax map information, can be a useful watershed planning tool to determine what areas might be targeted for protection or remediation.

METHODS

Water Chemistry Sampling

Synoptic water chemistry samples were collected in early spring throughout the watershed. Grab samples of whole water (500 ml) were collected just below the water surface at mid-stream and filtered using a 0.45 micron pore size (Gelman GF/C) filter. The samples were stored on ice and frozen on the day of collection. Filtered samples were analyzed by the Nutrient Analytical Services Laboratory at the University of Maryland's Chesapeake Biological Laboratory (CBL) for dissolved inorganic nitrogen (NO_3, NO_2), and dissolved inorganic phosphorus (PO_4). All analyses were conducted in accordance with U.S. Environmental Protection Agency (EPA) protocols. Stream discharge measurements were taken at the time of all water chemistry samples. Water temperature, dissolved oxygen, pH, and conductivity were measured in the field with a Hydrolab Surveyor II at the time of all water quality collections. Watershed areas used to calculate nutrient yields per unit area were determined from a digitized watershed map using Arcview software.

Where sites are nested in a watershed the mapped concentration data for the downstream site is shown only for the area between the sites. Yield calculations for a downstream site are based on the entire area upstream of the site, but are mapped showing just the area between sites. The downstream sites therefore illustrate the cumulative impact from all upstream activities.

Benthic Macroinvertebrate Sampling

Aquatic macroinvertebrates were collected at the time of water chemistry samples during the spring to be within the MBSS spring index period. Macroinvertebrate collections were made over a $2m^2$ area of the best available habitat using a 0.3m wide dip net with a mesh size of 500 microns. The best available habitats include: gravel riffles, snags, submerged vegetation and root mats. Habitats were sampled in the proportion to their occurrence at the station. Samples were composited in a sieve bucket, fine sediments washed out, and large debris rinsed and discarded. The remaining sample was preserved in 70% ethanol and returned to the laboratory for subsampling. Subsampling was done using a gridded tray. Grids were chosen at random until the grid with the 100th organism had been completed. Organisms were identified to genus, recorded on a bench sheet, and archived future reference. Insitu water quality data (dissolved oxygen, pH, conductivity, temperature) were collected during each sampling episode with a Hydrolab Surveyor II. A macroinvertebrate index of biotic integrity (IBI)(MD DNR, 1998) was calculated to facilitate ranking of site quality.

Macroinvertebrate Habitat Assessment

A habitat assessment was completed at the time of the macroinvertebrate collections to provide a qualitative measure of the in stream and riparian habitat quality. The assessment, modified from Plafkin et al. (1989) to focus on macroinvertebrate habitat, rates the in stream structure, channel and lower bank morphology, and the upper bank and riparian zone using a series of metrics. The metrics are weighted to provide more scoring potential to the parameters more directly influencing the in stream

macroinvertebrate community. The macroinvertebrate habitat score is weighted by the number of equally scored metrics in each category.

The primary metrics rate in stream habitat quality and quantity available for use by the macroinvertebrate community. This includes the amount and type of woody debris, prevalence of undercut banks, degree of embeddedness (siltation) in riffles, pool depth, and water velocity and flow. These metrics are given the most weight because of their direct importance to the health and diversity of the in stream macroinvertebrate communities. Secondary metrics assess channel morphology, rating the quality of the lower stream bank and the structure of the channel. These metrics include relative measures of riffle extent, channel sinuosity, and extent of channel alterations caused by high flow events. These metrics are weighted less than the primary because of their less direct impact on the in stream macroinvertebrate communities. The tertiary metrics rate the quality of the upper banks and adjacent riparian areas. These metrics include scoring of the type and amount of bank vegetation, amount and frequency of bank erosion, and land use in the riparian area. These characteristics of the watershed are given the least weight because they are less important to the in stream macroinvertebrate community.

Fish Sampling

Fish were sampled during the summer to coincide with the MBSS index period for fish sampling. Backpack electroshockers were used for two passes through a 75 meter reach of stream with block nets at each end of the reach. All species were enumerated and weighed to obtain taxa richness and biomass estimates.

Results

Anne Arundel and Prince George;s Counties identified a total of 58 sites in the upper Patuxent watershed for nutrient sampling. The 33 Anne Arundel site locations are described in Table 2 and mapped in Figure 1. The 25 Prince George's sites locations are described in Table 3 and mapped in Figure 2, .

Nutrient loads and yields within the upper Patuxent watershed where generally very low as shown in Tables 4 and 5, and as compared to other watersheds around the state (Table 6). The highest nitrate/nitrite concentrations were only slightly above the 1 mg/L threshold at 4 A.A. Co. sites (UPS 1-001, 6-003, 9-002, 10-003) (Figure 3) and at 3 P.G. Co. sites (02-034A, 02-032, 39-079B) (Figure 4). Per hectare nitrate/nitrite yields from the subwatersheds were also very low, with only one A.A. Co. site (UPS 9-004) with a moderate yield (Figures 5 & 6)). Orthophosphate concentrations were excessive in the Stocketts Run (A.A. Co.) watershed, and elevated in several other small subwatersheds (Figures 7 & 8). The high orthophosphate concentrations did not translate to elevated yields, with the exception of one site in A.A. Co. (Figures 9 & 10). Moderate rains several days prior to sampling produced sediment that probably persisted in the water column of the streams to create the elevated PO4 concentrations.

Table 2. Upper Patuxent WRAS, Anne Arundel County Synoptic Sampling Station Locations

Station	Road Crossing	Decimal Degrees Latitude	Longitude	Sample Type (Benthic, Nutrient, Fish)
UPN 01-001	Unnamed trib to Patuxent at Brock Bridge Rd.	.	.	.
UPN 01-002	Unnamed Trib to Patuxent off River Bridge Way	39.08411	-76.83053	N
UPN 07-001	Unnamed Trib to Patuxent at Wildlife Loop Rd.	39.04347	-76.75997	N.B
UPS 01-001	Unnamed Trib to Patuxent at Patuxent River Rd.	38.98586	-76.69900	N.B
UPS 01-002	Unnamed Trib to Patuxent at Nancarles Dr.	38.99175	-76.68189	N
UPS 01-003	Unnamed Trib to Patuxent at Rt 450	38.99211	-76.67856	N
UPS 01-004	Unnamed Trib to Patuxent off Home Farm Ct.	38.98378	-76.68742	N
UPS 03-001	Unnamed Trib to Patuxent at Rt 50	38.95603	-76.68672	N.B
UPS 03-002	Unnamed Trib to Patuxent off Governors Br. Rd.	38.95378	-76.69081	N
UPS 03-003	Unnamed Trib to Patuxent at Bottner Rd.	38.96461	-76.67528	N
UPS 04-001	Unnamed Trib to Patuxent at Governors Br. Rd.	38.95231	-76.67619	N.B
UPS 04-002	Unnamed Trib to Patuxent off Sunshine Ave.	.	.	N
UPS 04-003	Unnamed Trib to Patuxent off Governors Br. Rd.	.	.	N
UPS 04-004	Unnamed Trib to Patuxent off Ben Watkins Rd.	.	.	N
UPS 04-005	.	.	.	.
UPS 06-001	Unnamed Trib to Patuxent at Patuxent River Rd.	38.93058	-76.67086	N.B
UPS 06-002	Unnamed Trib to Patuxent at Double Gate Rd.	38.93422	-76.66936	N
UPS 06-003	Unnamed Trib to Patuxent at Double Gate Ct.	38.93264	-76.65511	N
UPS 09-001	Stocketts Rn at Sands Rd.	38.88392	-76.66286	N.B
UPS 09-002	Stocketts Rn at Harwood Rd.	38.88728	-76.64081	N.B
UPS 09-003	Stocketts Rn at Stocketts Rn Rd.	38.89367	-76.63839	N
UPS 09-004	Unnamed Trib to Stocketts Rn off Dodon Rd.	38.88944	-76.62722	N
UPS 09-005	Unnamed Trib to Stocketts Rn at power line ROW	38.89422	-76.61100	N
UPS 09-006	Stocketts Rn at Birdville Rd.	38.89531	-76.60517	N
UPS 09-007	Unnamed Trib to Stocketts Rn at power line ROW	38.88906	-76.61339	N
UPS 09-008	Unnamed Trib to Stocketts Rn at power line ROW	38.89225	-76.61044	N
UPS 09-009	Stockets Rn off private dr.	38.88719	-76.62083	N
UPS 09-010	Unnamed Trib to Stocketts Rn off Lankford Rd,	38.87942	-76.64467	N
UPS 10-001	Unnamed Trib to Patuxent off Patuxent Manor Rd.	.	.	N.B
UPS 10-002	Unnamed Trib to Patuxent at Patuxent Crossover Rd.	38.91075	-76.66722	N
UPS 10-003	Unnamed Trib to Patuxent at Patuxent River Rd.	38.91069	-76.66122	N
UPS 11-001	Unnamed Trib to Patuxent off Rt 214	.	.	N.B
UPS 11-002	Unnamed Trib to Patuxent at Patuxent River Rd.	38.90667	-76.66231	N

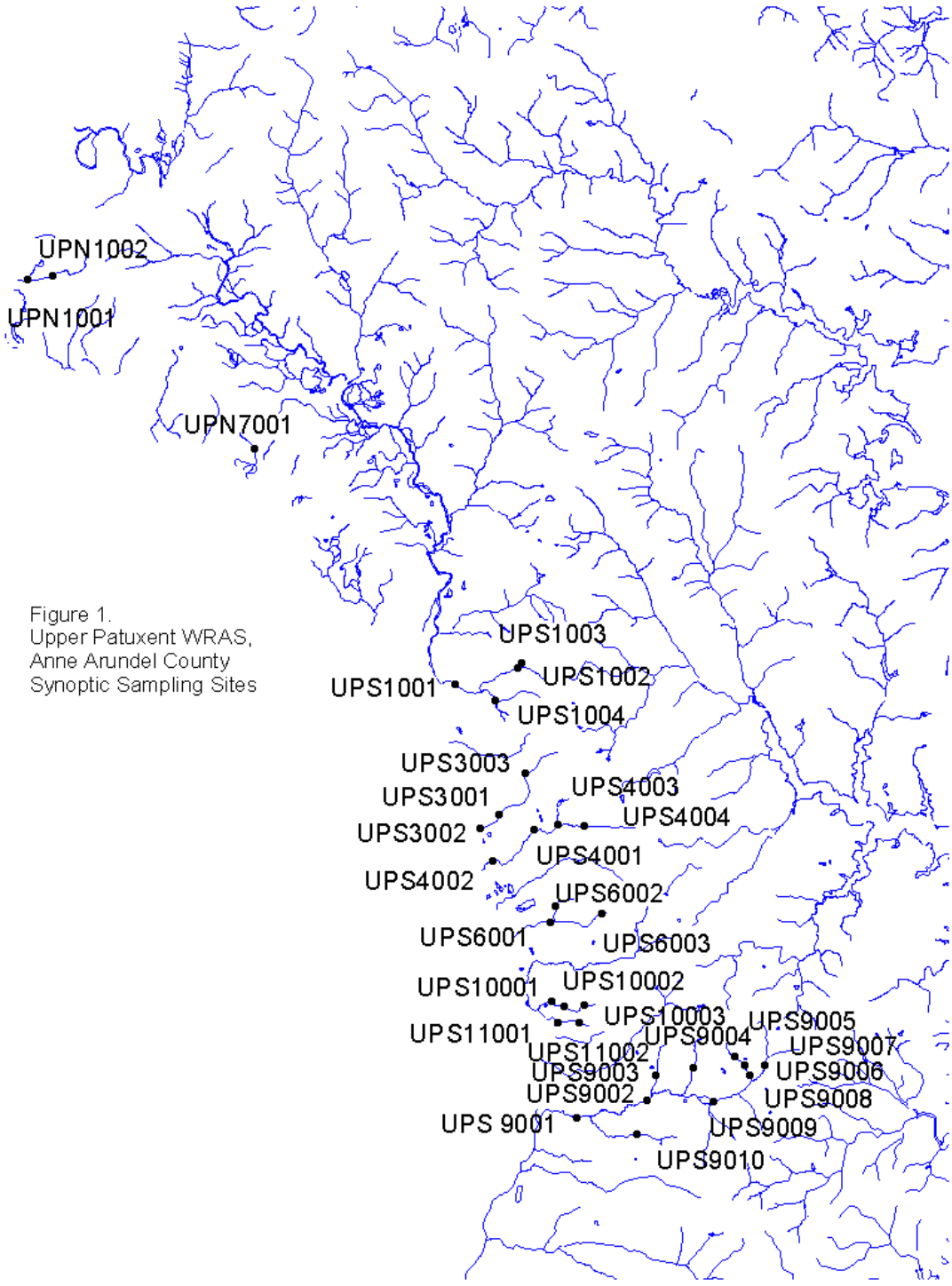


Figure 1.
Upper Patuxent WRAS,
Anne Arundel County
Synoptic Sampling Sites

Table 3. Upper Patuxent WRAS, Prince George's County Synoptic Sampling Station Locations

Station	Road Crossing	Latitude	Longitude	Sample Type (Benthic, Nutrient, Fish)
PG 02-002	Green Br at stadium	38.94647	-76.71133	N
PG 02-019	Unnamed Trib to Pax. off Scarlet Tanager Way	39.03794	-76.81314	N.B
PG 02-029	Unnamed Trib Tto Pax. off Canadian Way	39.05811	-76.83103	N
PG 02-032	Unnamed Trib to Pax. off Montpelier Dr.	39.09036	-76.88522	N
PG 02-034A	Pax. off bottom of Main St.	39.10183	-76.83992	N
PG 02-034B	Pax. off Post Office Rd	39.10919	-76.84997	N.B
PG 03-001	Unnamed Trib to Pax. at Brooklyn Br. Rd.	39.10903	-76.86608	N
PG 03-005	Unnamed Trib to Pax. at Bond Mill Rd.	39.11150	-76.89042	N
PG 04-005	Unnamed Trib to Pax. off Bowie Rd.	39.09394	-76.84631	N
PG 04-005B	Unnamed Trib to Putuxent at Pax. Greens G.C.	39.08967	-76.83783	N
PG 04-009	Horsepen Br off Fletchertown Rd.	39.09878	-76.85467	N
PG 06-008	Bear Br. At Contee Rd.	39.09036	-76.88522	N
PG 10-001	Horsepen Br off Fletchertown Rd.	38.99008	-76.78133	N
PG 10-009	Horsepen Br off Fletchertown Rd.	38.99108	-76.77933	N.B
PG 10-015A	Unnamed Trib to Horsepen Br. at Hillmeade Rd.	38.99078	-76.79881	N
PG 10-017A	Newstop Br. off Quill Pt. Dr.	38.99797	-76.78556	N.B
PG 10-017B	Newstop Br. off Quill Pt. Dr.	38.99942	-76.79067	N
PG 10-017C	Newstop Br. off Hillmeade Rd.	.	.	N
PG 39-072A	Unnamed Trib to Pax. off King James Ct.	38.88383	-76.70825	N
PG 39-072B	Unnamed Trib to Pax. off King James Ct.	38.88322	-76.70997	N
PG 39-072C	Unnamed Trib to Pax. off King James Ct.	38.88169	-76.71006	N
PG 39-077A	Honey Br. Off Rt. 214	38.95611	-76.68797	N.B
PG 39-079A	Honey Br. Off Rt. 214	38.90653	-76.69236	N
PG 39-079B	Honey Br. Off Federal Hill Ct.	38.90522	-76.71119	N
PG 39-102A	Unnamed Trib to Pax. off Morningside La.	38.98422	-76.73547	N.B

Figure 2.
WRAS Sampling Sites, April, 2002
Upper Patuxent, Prince George's Co., Watersheds

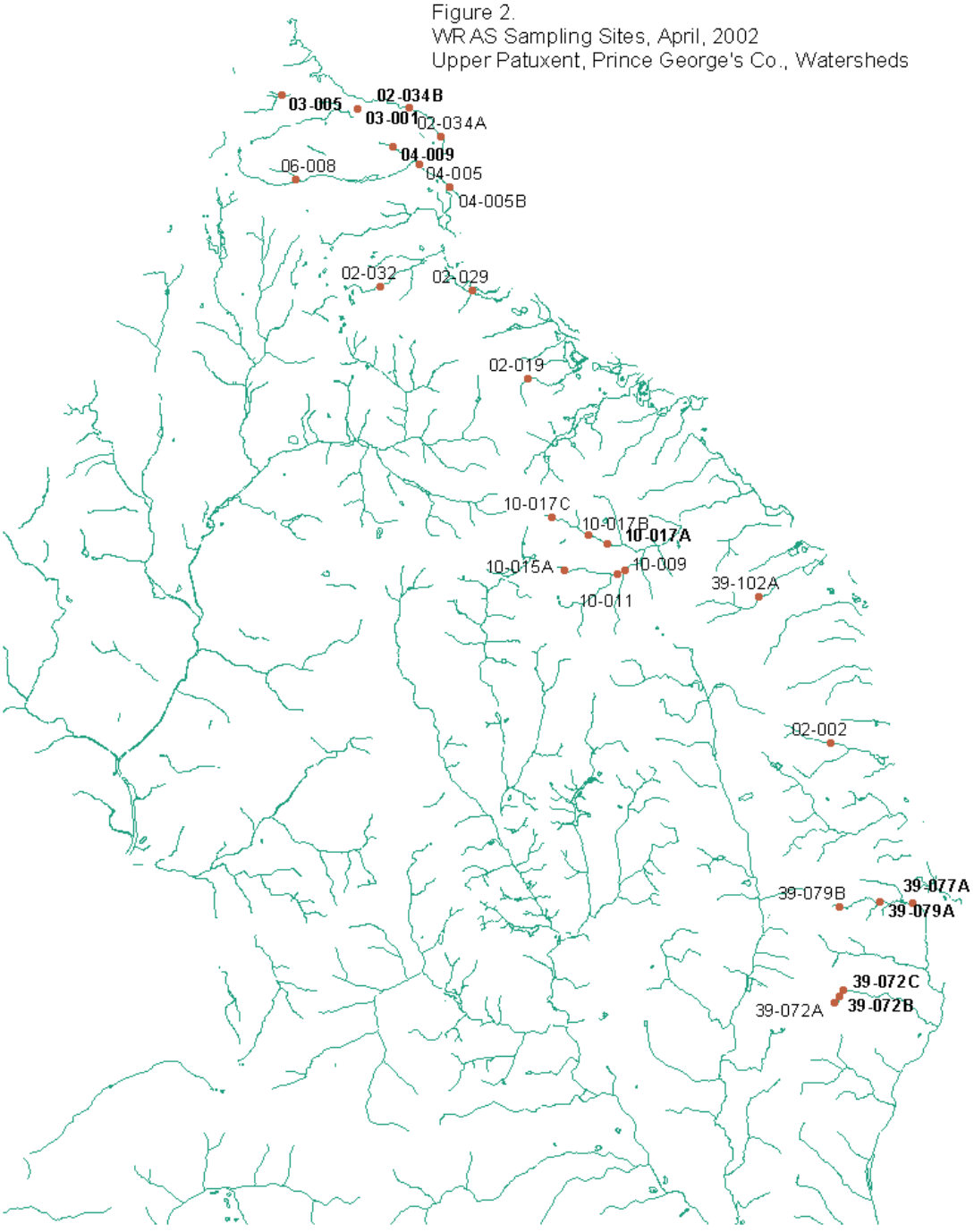


Table 4. Anne Arundel County Upper Patuxent Watershed Nutrient Synoptic Survey Results, March/April 2002.

		Concentration			Daily Loads		Area	Nutrient Yields/Hectare		
DATE	STATION	PO4 (mg P/L)	NO23 (mg N/L)	Discharge (L/s)	PO4 (kg/day)	NO23 (kg/day)	Hectares	PO4 (kg/day/ha)	NO23 (kg/day/ha)	Notes
04/17/02	UPN 01-001	.	.	0.00	.	.	187	.	.	dry
04/17/02	UPN 01-002	0.004	0.01	0.10	0.000035	0.000086	254	0.000000	0.000000	
03/12/02	UPN 07-001	0.001	0.01	3.06	0.000264	0.002643	85	0.000003	0.000031	
03/12/02	UPS 01-001	0.002	1.07	14.94	0.002581	1.380806	377	0.000007	0.003665	
03/12/02	UPS 01-002	0.002	2.26	3.12	0.000539	0.608598	92	0.000006	0.006625	
03/12/02	UPS 01-003	0.004	0.92	0.28	0.000096	0.022167	30	0.000003	0.000730	
04/17/02	UPS 01-004	0.008	0.29	7.35	0.005077	0.184056	53	0.000095	0.003446	
03/12/02	UPS 03-001	0.001	0.29	22.39	0.001935	0.561047	262	0.000007	0.002139	
03/12/02	UPS 03-002	0.001	0.42	13.78	0.001191	0.500031	308	0.000004	0.001626	
03/12/02	UPS 03-003	0.005	0.01	0.34	0.000149	0.000298	120	0.000001	0.000002	
03/12/02	UPS 04-001	0.003	0.56	11.21	0.002906	0.542494	381	0.000008	0.001425	
04/12/02	UPS 04-002	0.006	0.15	29.39	0.015233	0.380836	538	0.000028	0.000708	
04/12/02	UPS 04-003	0.010	0.01	1.71	0.001476	0.001476	127	0.000012	0.000012	
04/12/02	UPS 04-004	0.011	0.06	5.09	0.004834	0.026366	172	0.000028	0.000153	
04/12/02	UPS 04-005	.	.	.	.	.	76	.	.	no access
03/13/02	UPS 06-001	0.004	0.88	12.74	0.004404	0.968859	233	0.000019	0.004164	
03/13/02	UPS 06-002	0.014	0.77	0.72	0.000865	0.047582	83	0.000010	0.000571	
04/17/02	UPS 06-003	0.005	1.44	0.25	0.000106	0.030614	25	0.000004	0.001220	
03/13/02	UPS 09-001	0.022	0.49	124.50	0.236652	5.270888	1681	0.000141	0.003135	
03/13/02	UPS 09-002	0.027	1.00	99.84	0.232897	8.625827	1259	0.000185	0.006849	
03/13/02	UPS 09-003	0.018	0.71	6.26	0.009734	0.383953	95	0.000103	0.004055	
04/18/02	UPS 09-004	0.053	0.58	28.32	0.129673	1.419059	109	0.001187	0.012987	
04/18/02	UPS 09-005	0.008	0.06	1.32	0.000912	0.006837	48	0.000019	0.000143	
03/13/02	UPS 09-006	0.030	0.27	10.68	0.027680	0.249123	212	0.000131	0.001177	
04/18/02	UPS 09-007	0.062	0.39	3.03	0.016239	0.102149	68	0.000239	0.001502	
04/17/02	UPS 09-008	0.032	0.08	2.32	0.006422	0.016055	90	0.000071	0.000178	
04/17/02	UPS 09-009	0.077	0.09	18.44	0.122666	0.143376	585	0.000210	0.000245	
04/17/02	UPS 09-010	0.157	0.08	1.59	0.021584	0.010998	153	0.000141	0.000072	
04/12/02	UPS 10-001	0.009	0.74	2.19	0.001701	0.139877	98	0.000017	0.001428	
03/13/02	UPS 10-002	0.003	0.68	5.14	0.001332	0.301904	76	0.000018	0.003968	
03/13/02	UPS 10-003	0.010	1.07	2.30	0.001984	0.212315	30	0.000067	0.007187	
04/12/02	UPS 11-001	0.005	0.29	2.91	0.001256	0.072819	50	0.000025	0.001451	
03/13/02	UPS 11-002	0.004	0.24	0.36	0.000124	0.007415	27	0.000005	0.000273	

Table 5. Prince George's County Upper Patuxent Watershed Nutrient Synoptic Survey Results, April 2002.

		Concentration			Daily Loads		Area	Nutrient Yields/Hectare	
DATE	STATION	PO4	NO23	Discharge	PO4	NO23	Hectares	PO4	NO23
		(mg P/L)	(mg N/L)	(L/s)	(kg/day)	(kg/day)		(kg/day/ha)	(kg/day/ha)
04/12/02	PG 02-002	0.003	0.01	11.55	0.002993	0.009977	151	0.000020	0.000066
04/16/02	PG 02-019	0.004	0.02	0.08	0.000027	0.000136	111	0.000000	0.000001
04/16/02	PG 02-029	0.002	0.01	0.10	0.000016	0.000082	45	0.000000	0.000002
04/16/02	PG 02-032	0.002	1.15	0.52	0.000090	0.051506	92	0.000001	0.000558
04/16/02	PG 02-034A	0.001	1.19	623.03	0.053830	64.057606	683643	0.000000	0.000094
04/16/02	PG 02-034B	0.002	0.27	573.18	0.099045	13.371123	684800	0.000000	0.000020
04/16/02	PG 03-001	0.002	0.04	17.24	0.002980	0.059596	251	0.000012	0.000238
04/16/02	PG 03-005	0.003	0.56	3.14	0.000813	0.151835	173	0.000005	0.000877
04/16/02	PG 04-005	0.002	0.83	35.33	0.006106	2.533918	524	0.000012	0.004835
04/16/02	PG 04-005B	0.001	0.92	36.36	0.003141	2.890046	600	0.000005	0.004819
04/16/02	PG 04-009	0.001	0.20	9.03	0.000780	0.156047	80	0.000010	0.001947
04/16/02	PG 06-008	0.001	0.12	9.16	0.000791	0.094955	265	0.000003	0.000359
04/12/02	PG 10-009	0.002	0.02	24.92	0.004306	0.043058	215	0.000020	0.000200
04/12/02	PG 10-011	0.004	0.10	18.98	0.006561	0.164020	412	0.000016	0.000399
04/16/02	PG 10-015A	0.002	0.10	1.33	0.000230	0.011480	42	0.000006	0.000275
04/16/02	PG 10-017A	0.004	0.50	4.41	0.001524	0.190453	274	0.000006	0.000694
04/16/02	PG 10-017B	0.003	0.21	2.92	0.000757	0.052980	210	0.000004	0.000252
04/16/02	PG 10-017C	0.003	0.24	0.26	0.000068	0.005443	40	0.000002	0.000137
04/12/02	PG 39-072A	0.006	0.14	2.24	0.001163	0.027145	118	0.000010	0.000231
04/12/02	PG 39-072B	0.006	0.15	1.48	0.000765	0.019134	102	0.000008	0.000188
04/12/02	PG 39-072C	0.003	0.18	0.86	0.000222	0.013317	87	0.000003	0.000154
04/12/02	PG 39-077A	0.012	0.06	4.52	0.004681	0.023407	379	0.000012	0.000062
04/12/02	PG 39-079A	0.007	0.06	3.69	0.002234	0.019151	177	0.000013	0.000108
04/12/02	PG 39-079B	0.003	1.47	0.26	0.000068	0.033335	54	0.000001	0.000619
04/12/02	PG 39-102A	0.002	0.14	7.71	0.001332	0.093260	310	0.000004	0.000301

Table 6. Annual & Spring Nutrient Concentration (mg/L) Averages from Other Nutrient Synoptic Surveys

	Piney	German Br.	Pocomoke	Bush	Breton Bay	Patuxent	Choptank	Liberty
NO2+NO3 Spring	3.742	3.832	3.734	1.944	0.223	0.439	2.892	3.410
NO2+NO3 Annual	4.823	4.704	2.384					
PO4 Spring	0.800	0.043	0.028	0.006	0.004	0.012	0.023	0.004
PO4 Annual	1.177	0.067	0.022					

Figure 3.
WRAS Nutrient Synoptic Survey, April 2002
Upper Patuxent, Anne Arundel Co. Watersheds
Nitrate/Nitrite (NO2+NO3) Concentration (Mg/L)

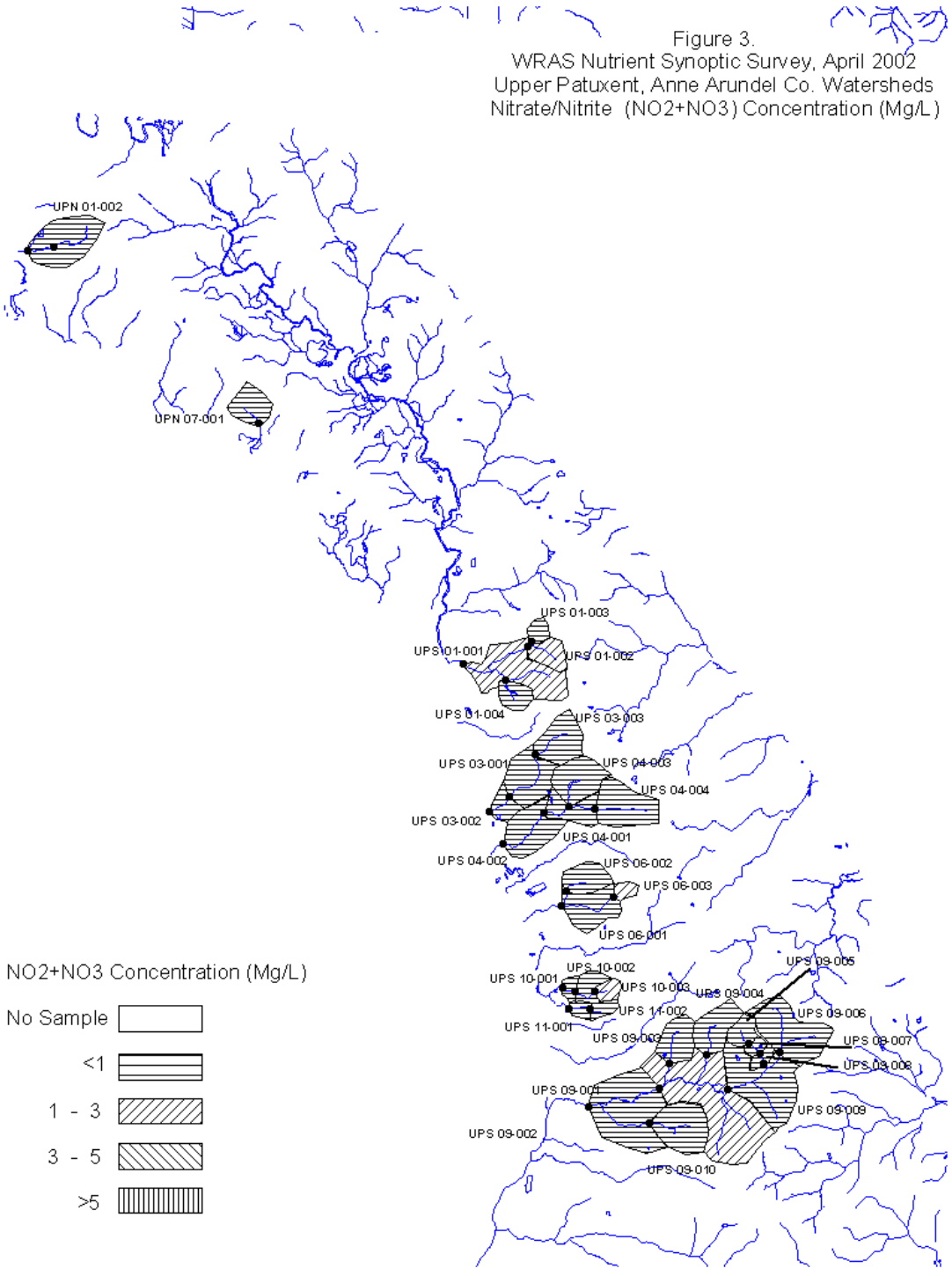
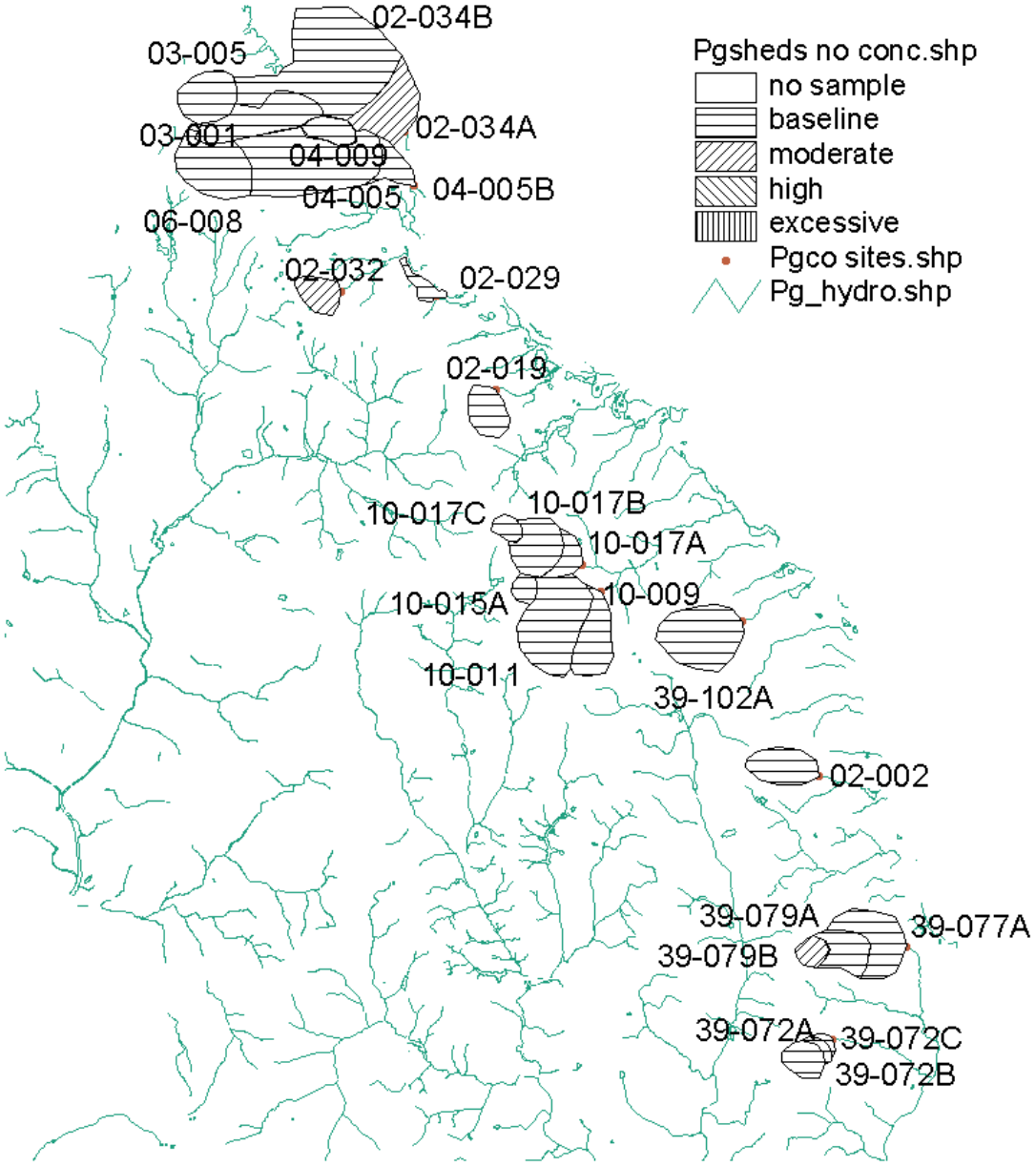


Figure 4.
WRAS Nutrient Synoptic Survey, April 2002
Upper Patuxent, Prince Georges Co. Watersheds
Nitrate/Nitrite (NO2+NO3) Concentration (Mg/L)



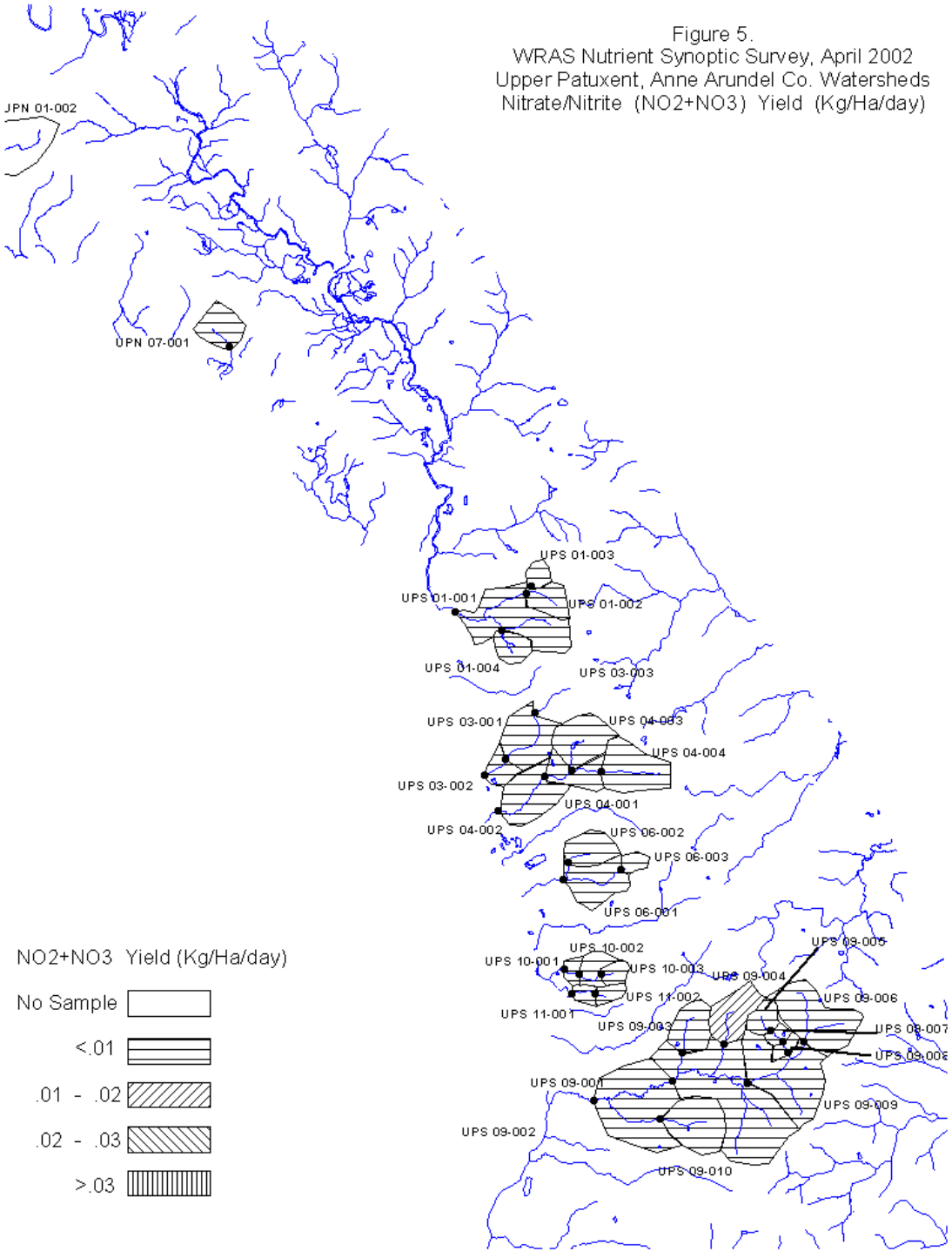


Figure 5.
WRAS Nutrient Synoptic Survey, April 2002
Upper Patuxent, Anne Arundel Co. Watersheds
Nitrate/Nitrite (NO2+NO3) Yield (Kg/Ha/day)
JPN 01-002
UPN 07-001
UPS 01-003
UPS 01-001
UPS 01-002
UPS 01-004
UPS 03-003
UPS 03-001
UPS 04-003
UPS 04-004
UPS 03-002
UPS 04-001
UPS 04-002
UPS 06-002
UPS 06-003
UPS 06-001
UPS 10-002
UPS 10-001
UPS 10-003
UPS 09-004
UPS 09-005
UPS 11-002
UPS 09-006
UPS 11-001
UPS 09-003
UPS 09-007
UPS 09-008
UPS 09-001
UPS 09-009
UPS 09-002
UPS 09-010
NO2+NO3 Yield (Kg/Ha/day)
No Sample
<.01
.01 - .02
.02 - .03
>.03

Figure 6.
WRAS Nutrient Synoptic Survey, April 2002
Upper Patuxent, Prince georges Co. Watersheds
Nitrate/Nitrite (NO2+NO3) Yield (Kg/Ha/day)

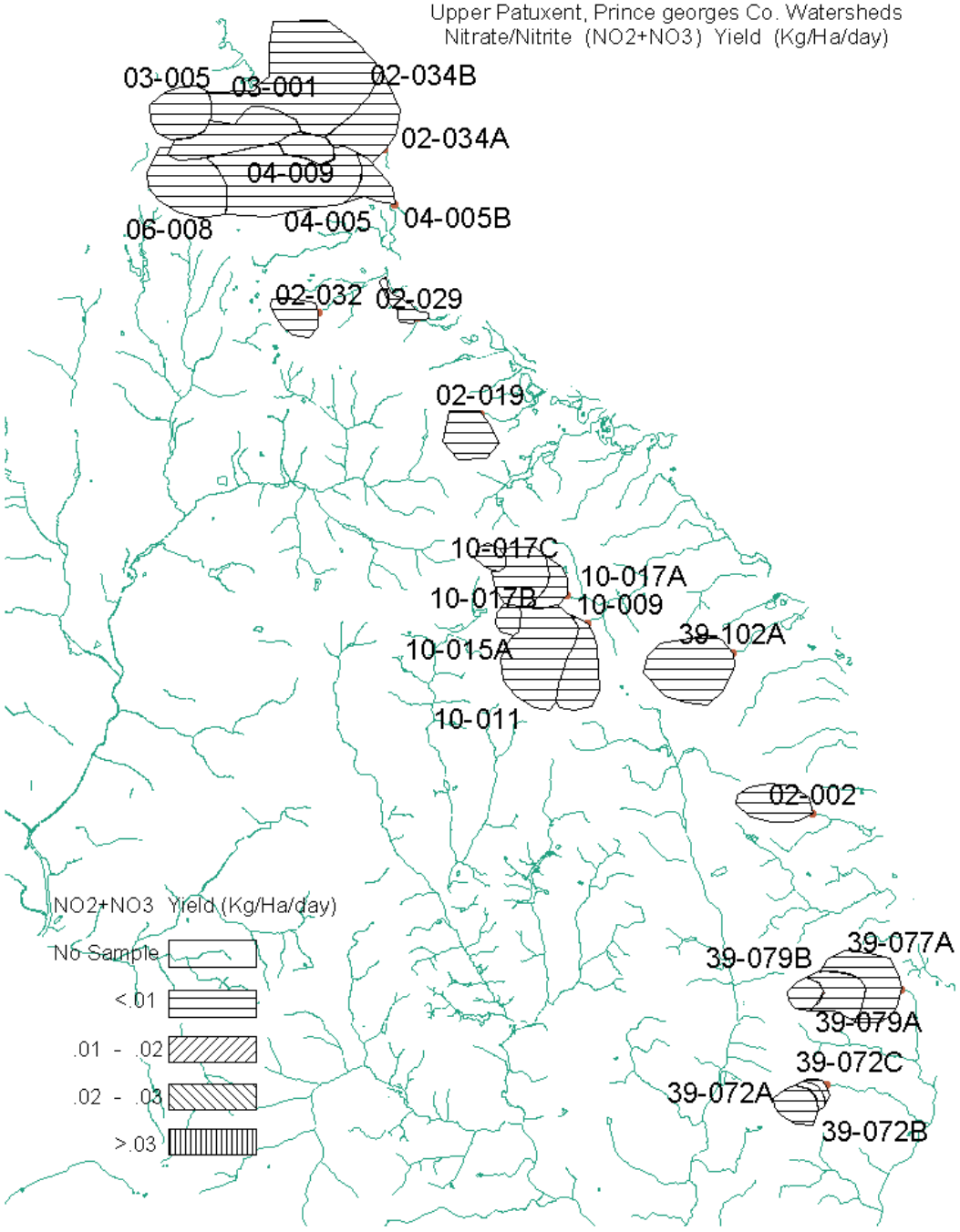
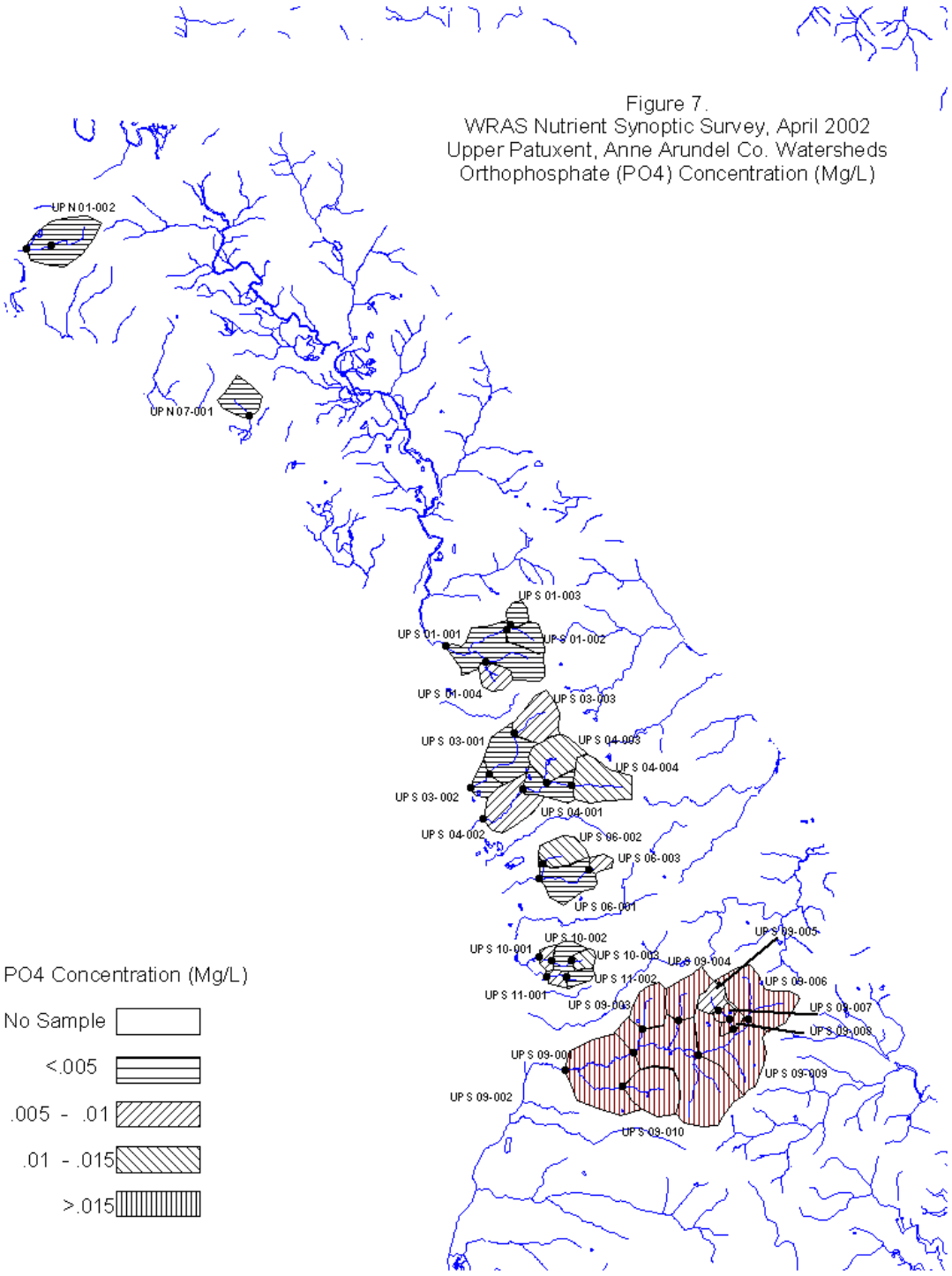


Figure 7.
WRAS Nutrient Synoptic Survey, April 2002
Upper Patuxent, Anne Arundel Co. Watersheds
Orthophosphate (PO4) Concentration (Mg/L)



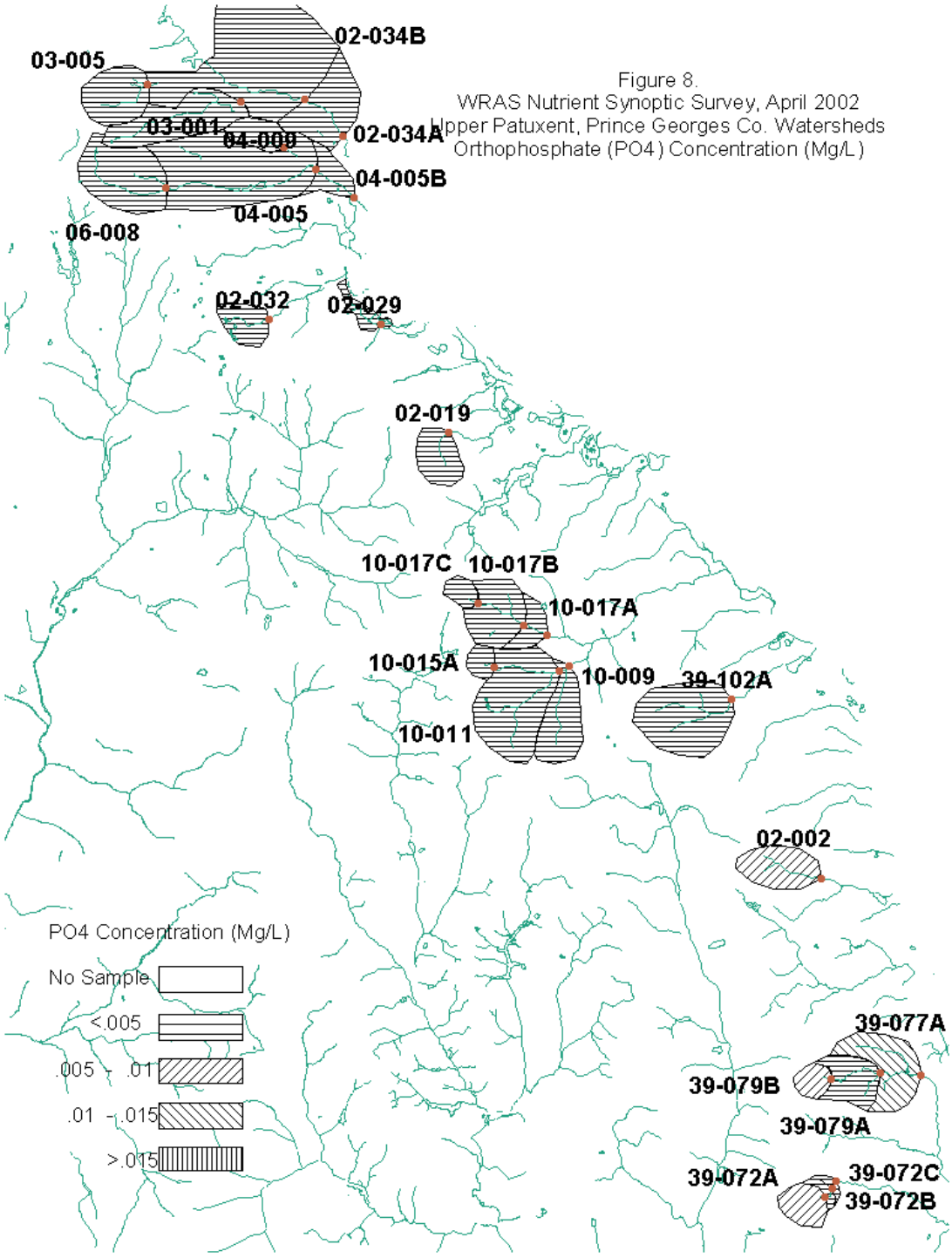


Figure 8.
WRAS Nutrient Synoptic Survey, April 2002
Upper Patuxent, Prince Georges Co. Watersheds
Orthophosphate (PO4) Concentration (Mg/L)
02-034B
03-005
03-001
04-000
02-034A
04-005B
04-005
06-008
02-032
02-029
02-019
10-017C
10-017B
10-017A
10-015A
10-009
39-102A
10-011
02-002
39-077A
39-079B
39-079A
39-072A
39-072C
39-072B
PO4 Concentration (Mg/L)
No Sample
<.005
.005 - .01
.01 - .015
>.015

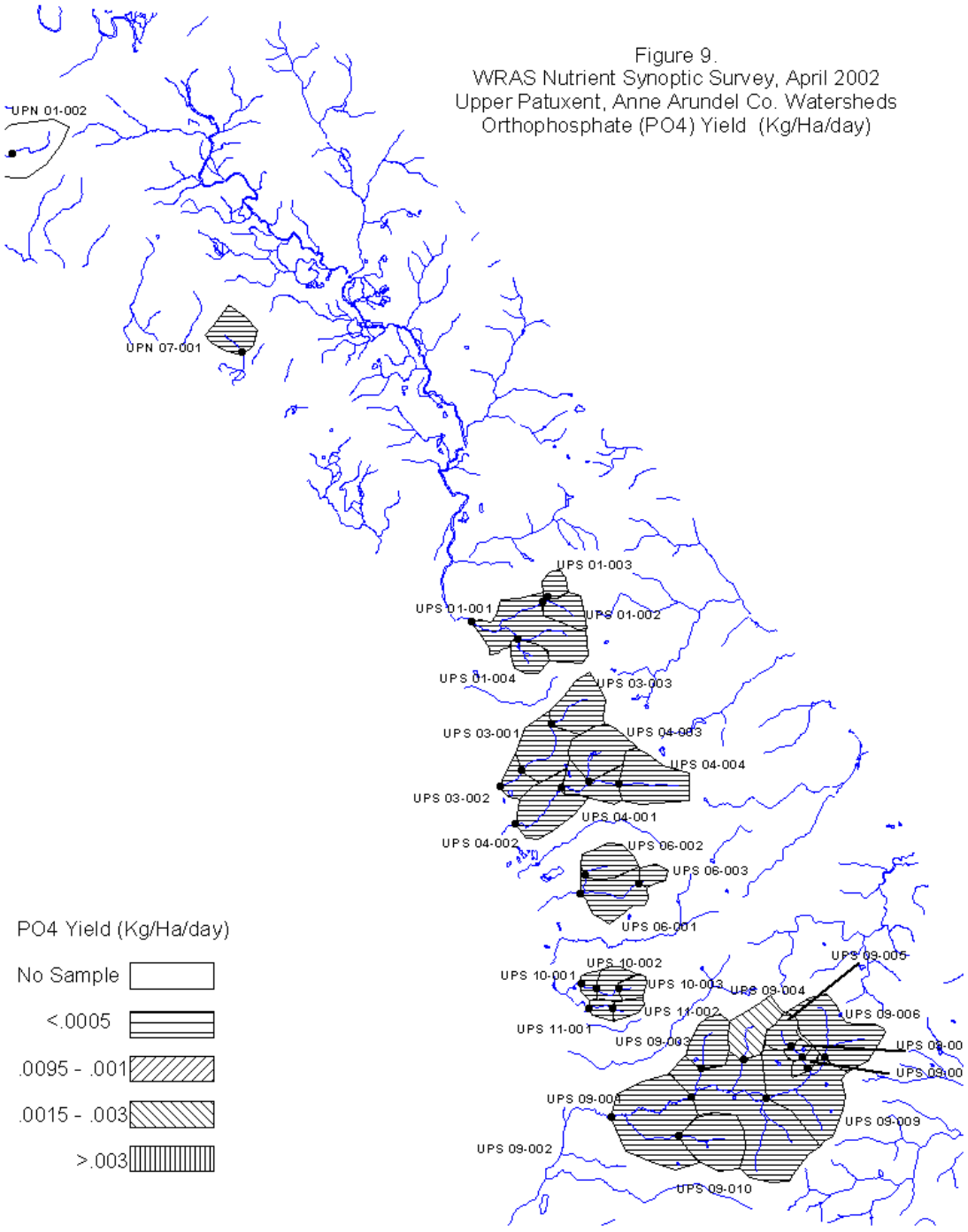


Figure 9.
WRAS Nutrient Synoptic Survey, April 2002
Upper Patuxent, Anne Arundel Co. Watersheds
Orthophosphate (PO4) Yield (Kg/Ha/day)
UPN 01-002
UPN 07-001
UPS 01-003
UPS 01-001
UPS 01-002
UPS 01-004
UPS 03-003
UPS 03-001
UPS 04-003
UPS 04-004
UPS 03-002
UPS 04-001
UPS 04-002
UPS 06-002
UPS 06-003
UPS 06-001
UPS 10-002
UPS 10-001
UPS 10-003
UPS 09-004
UPS 09-005
UPS 11-002
UPS 09-006
UPS 11-001
UPS 09-003
UPS 09-00
UPS 09-00
UPS 09-008
UPS 09-009
UPS 09-002
UPS 09-010
PO4 Yield (Kg/Ha/day)
No Sample
<.0005
.0095 - .001
.0015 - .003
>.003

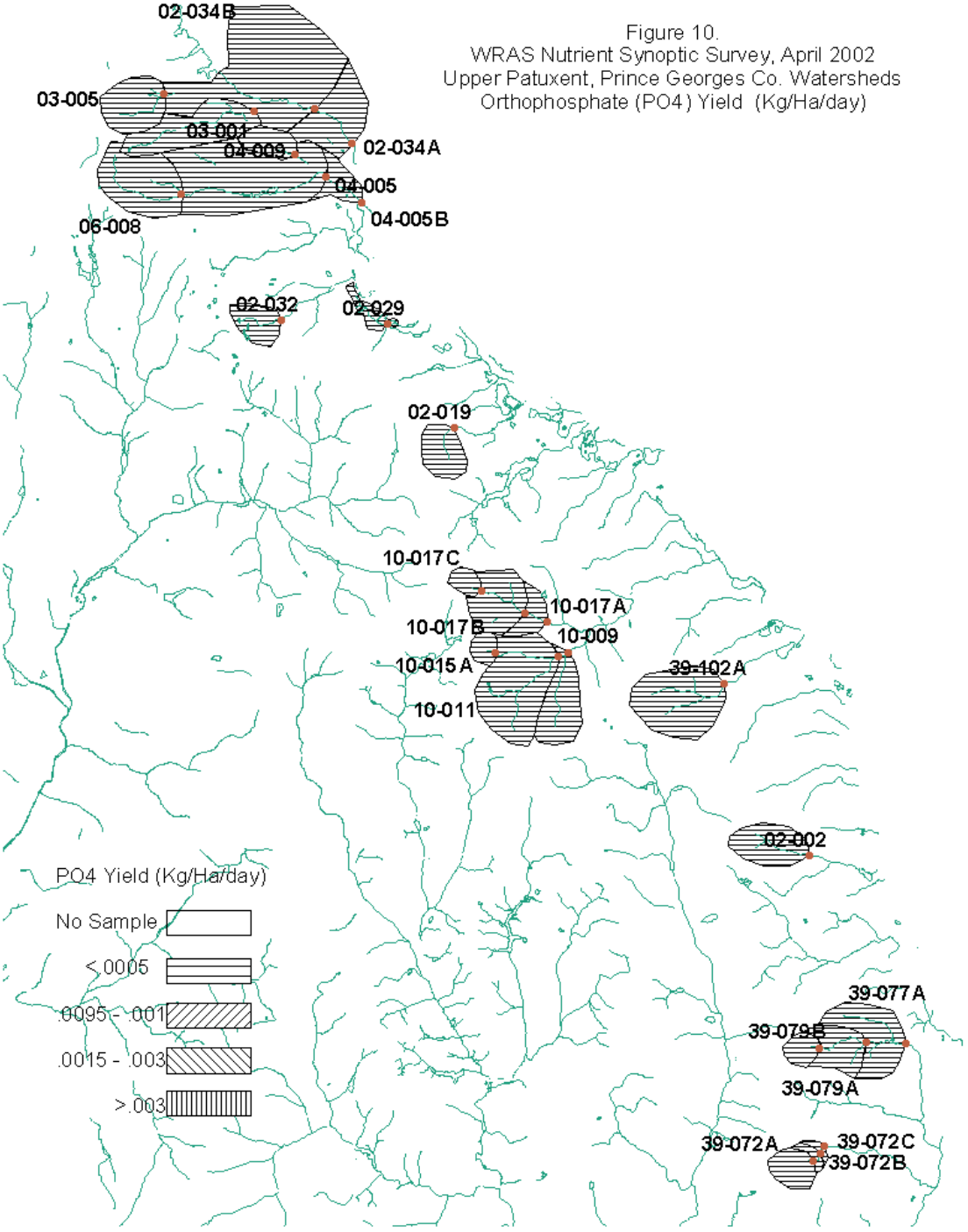


Figure 10.
WRAS Nutrient Synoptic Survey, April 2002
Upper Patuxent, Prince Georges Co. Watersheds
Orthophosphate (PO4) Yield (Kg/Ha/day)

Insitu water quality readings in the Anne Arundel County watersheds are noted in Table 7. No significant anomalies were noted at the time of sampling. The low dissolved oxygen reading at station UPN 01-002 came from the only water in the reach, a residual (almost no flow) pool. Table 8 provides the insitu water quality found at the Prince George's County sites. One site, 02- 019 on the Patuxent Wildlife Refuge, had very low pH and dissolved oxygen due to the extremely low flow originating in a boggy seep and traveling several hundred meters through extensive leaf litter to the sampling site. While the substrate and flow at this site were conducive to poor to very poor macroinvertebrate and fish communities, the low pH values could also be detrimental to the biological communities in the system. This stream dried up later in the season.

Table 7. Anne Arundel County Upper Patuxent Watershed, InSitu Water Quality, March/April 2002

			InSitu Hydrolab Readings			
DATE	STATION	TIME	Temp.	pH	Cond.	DO
03/12/02	UPN 01-001	915	.	.	.	.
04/17/02	UPN 01-002	925	18.81	6.78	0.392	0.53
03/12/02	UPN 07-001	1000	6.94	5.82	0.044	9.87
03/12/02	UPS 01-001	1320	6.14	6.92	0.200	11.41
03/12/02	UPS 01-002	1200	7.37	5.93	0.259	9.99
03/12/02	UPS 01-003	1220	6.04	6.48	0.273	10.27
04/17/02	UPS 01-004	1045	19.81	7.42	0.114	8.07
03/12/02	UPS 03-001	1300	6.46	6.63	0.094	11.11
03/12/02	UPS 03-002	1420	6.75	6.86	0.117	11.04
03/12/02	UPS 03-003	1230	7.04	6.70	0.135	10.18
03/12/02	UPS 04-001	1450	7.12	6.90	0.246	10.60
04/12/02	UPS 04-002	1150	12.16	6.91	0.219	12.25
04/12/02	UPS 04-003	1050	11.69	6.64	0.359	5.26
04/12/02	UPS 04-004	940	11.08	6.94	0.255	9.75
04/12/02	UPS 04-005	.	.	.	.	.
03/13/02	UPS 06-001	940	8.16	7.57	0.238	9.25
03/13/02	UPS 06-002	920	8.49	6.68	0.171	8.27
04/17/02	UPS 06-003	1225	20.24	5.47	0.402	6.84
03/13/02	UPS 09-001	1230	6.80	6.06	0.185	10.55
03/13/02	UPS 09-002	1150	6.90	6.02	0.188	10.74
03/13/02	UPS 09-003	1300	7.86	5.58	0.205	9.81
04/18/02	UPS 09-004	800	19.15	7.40	0.203	7.19
04/18/02	UPS 09-005	845	17.35	6.31	0.176	7.30
03/13/02	UPS 09-006	1330	7.87	5.76	0.242	10.19
04/18/02	UPS 09-007	800	18.54	6.49	0.179	8.03
04/17/02	UPS 09-008	1445	22.87	7.23	0.162	9.14
04/17/02	UPS 09-009	1400	22.35	7.76	0.194	10.24
04/17/02	UPS 09-010	1310	23.96	6.75	0.164	7.08
04/12/02	UPS 10-001	1315	12.77	6.85	0.542	13.45
03/13/02	UPS 10-002	1045	7.54	6.23	0.639	9.09
03/13/02	UPS 10-003	1025	7.06	5.95	0.169	8.62
04/12/02	UPS 11-001	1400	13.86	7.19	0.305	10.30
03/13/02	UPS 11-002	1100	7.26	5.47	0.322	8.13

Table 8. Prince George's County Upper Patuxent Watershed, InSitu Water Quality, April 2002

			InSitu Hydrolab Readings			
DATE	STATION	TIME	Temp.	pH	Cond.	DO
04/12/02	PG 02-002	755	12.27	6.65	0.281	9.39
04/16/02	PG 02-019	1345	22.25	3.64	0.104	2.95
04/16/02	PG 02-029	1250	23.00	7.32	0.447	9.66
04/16/02	PG 02-032	1130	20.70	6.98	0.250	5.70
04/16/02	PG 02-034A	930	12.16	6.79	0.173	10.10
04/16/02	PG 02-034B	950	12.15	6.90	0.169	12.21
04/16/02	PG 03-001	1020	18.87	7.09	0.374	10.57
04/16/02	PG 03-005	1040	19.15	7.19	0.259	11.19
04/16/02	PG 04-005	905	10.80	6.93	0.388	9.69
04/16/02	PG 04-005B	1220	21.06	7.35	0.414	10.48
04/16/02	PG 04-009	835	17.24	7.19	0.326	12.57
04/16/02	PG 06-008	1105	19.19	7.04	0.510	10.40
04/12/02	PG 10-001	1335	13.55	6.71	0.242	8.78
04/12/02	PG 10-009	1355	13.56	7.08	0.230	9.84
04/16/02	PG 10-015A	1450	22.35	6.01	0.277	7.70
04/16/02	PG 10-017A	1535	23.59	7.24	0.315	10.58
04/16/02	PG 10-017B	1505	23.95	6.81	0.336	11.27
04/16/02	PG 10-017C	1430	22.65	6.06	0.448	5.87
04/12/02	PG 39-072A	1120	12.23	6.82	0.221	10.67
04/12/02	PG 39-072B	1135	12.35	6.89	0.215	11.16
04/12/02	PG 39-072C	1145	12.16	6.25	0.224	9.45
04/12/02	PG 39-077A	900	11.14	7.11	0.151	9.30
04/12/02	PG 39-079A	1020	11.36	6.47	0.149	9.61
04/12/02	PG 39-079B	945	12.12	5.30	0.271	8.56
04/12/02	PG 39-102A	1235	13.00	5.58	0.259	7.70

Macroinvertebrate and habitat data from 9 sites in Anne Arundel and 6 sites in Prince George's County was turned over to the respective county subcontractors for inclusion in their reports. Historic macroinvertebrate sampling of Stocketts Run at Sands Rd. found good macroinvertebrate communities. Historic sampling of Horsepen Branch at Racetrack Rd. found very poor macroinvertebrate communities (Primrose, pers.com.). Site descriptions of the Anne Arundel County sites are attached in Appendix A.

Fish were collected at 6 sites in Anne Arundel County and 4 sites in Prince George's County. The results are provided in Table 9.. The paucity of fish at all of the Anne Arundel sites is indicative of at least partial blockages down stream. Site 6-001 has a major blockage approximately 75 meters downstream of the road crossing. Watersheds of less than 125 hectares with very limited amounts of water have naturally limited fish communities. The PG site 39-102A is in a very urbanized area with many possibilities for limiting fish passage. Limited or no fish passage combined with high potential for lethal conditions from anoxia, contaminated storm water, etc. could account for no fish being present at this site.

Table 9.Fish Communities at AA and PG Co. Sites

			Anne Arundel Co.						Prince George's Co.			
Site number			**USP 1001**	**USP 3001**	**USP 4001**	**USP 6001**	**USP 10001**	**USP 11001**	**10-011**	**10-017A**	**39-072A**	**39-102A**
Watershed area	hectares		377	262	381	233	98	50	412	274	118	310
Common name	**Genus**	**species**										
least brook lamprey	*Lamptera*	*appendix*		37	6		126		19	19	38	No Fish
sea lamprey	*Petromyzon*	*marinus*							15	7		
american eel	*Anguilla*	*rostrata*		1					4	1	8	
fallfish	*Semotilus*	*corporalis*							23	57		
blacknose dace	*Rhinichthys*	*atratulus*	87	61	48	190	344	10	23	17	14	
rosyside dace	*Clinostomus*	*funduloides*							50	143		
white sucker	*Catostomus*	*commersoni*							2	8		
creekchub sucker	*Erimyzon*	*oblongus*							2	5		
bluegill	*Lepomis*	*macrochirus*					7		2	5		
eastern mudminnow	*Umbra*	*pygmaea*		8	19				1	2		
tessellated darter	*Etheostoma*	*olmstedi*	1		66				77	37		
green sunfish	*Lepomis*	*cyanellus*									1	
		TOTAL #	88	107	139	190	477	10	218	301	61	0

Literature Cited

Chesapeake Bay and Watershed Programs, Monitoring and Non-Tidal Assessment, 1998. *Development of a Benthic Index of Biotic Integrity for Maryland Streams*. CBWP-MANTA – EA-98-3

Frink, Charles R.. 1991. *Estimating Nutrient Exports to Estuaries*. Journal of Environmental Quality. 20:717-724.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross, R.M. Hughes. 1989. *Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish*. United States Environmental Protection Agency. EPA/440/4-89/001

Primrose, Niles L.. MD Dept of Natural Resources, Chesapeake and Coastal Watershed Services, Watershed Restoration Division, Watershed Evaluation Section.

APPENDIX A
Anne Arundel County Benthic Collection Site Descriptions

UPN1-001
Site was immediately upstream of Brock Bridge Rd. in a mature floodplain forest with moderate to heavy understory. The stream was dry on the date of the site visit (3/12/02), therefore no macroinvertebrate sample was collected. Significant sand and gravel deposits both in and out of the stream channel and up to 60% eroded banks indicate this stream is subject to flashy heavy storm flows during rain events.

UPS1-001
Site was immediately upstream of Patuxent River Rd. in a mature flood plain forest with moderate shrubby understory. Commercial structures were visible approximately 200 meters away at the top of the 25 to 30 meter high hills to the north of the stream. No structures were visible on the south side. The majority of the stream banks were cut banks up to one meter high, and instream substrate was dominated by soft sand with minimal gravel riffles and woody debris. All indicative of heavy storm water flows through the reach. The macroinvertebrate community had good representation in the EPT. This, coupled with the rather poor habitat, indicates there must be areas of good refugia upstream of the sampling site. Insitu water quality parameters (temp, D.O., pH, conductivity) indicated no unusual conditions.

UPS3-001
Site was immediately upstream of Rt 50 in an area of mature poplar/beech/oak forest with little understory. No structures, other than a simple foot bridge, where visible upstream of the site. Sediment deposition in the channel was heavy. Stream banks were eroded along 40 to 50% of the reach, with cut banks up to one meter high. Instream substrate was dominated by sand with scattered shallow small diameter (<15mm) gravel riffles and woody debris. ATV traffic along stream bank and in the stream channel contributes heavily to habitat degradation. The IBI for the macroinvertebrate sample was in the "fair" range due to a high percentage of EPT (>50%) in the subsample. The IBI score is misleading in this case because of the overwhelming dominance of the relatively tolerant *Baetis sp*. mayflies within the EPT and the total sample. The short life cycles of the majority of the macroinvertebrate community is indicative of unstable and frequently disturbed habitat. Insitu water quality parameters (temp, D.O., pH, conductivity) indicated no unusual conditions.

UPS4-001
Site was immediately upstream of Governors Bridge Rd.. Over the sample reach, and for several hundred meters upstream, the entire west side was active horse pasture with access to the stream. Residential lawn came to the top of the 3 to 4 meter high east bank. Mature trees along the stream bank shaded the stream, but there was very little understory or herbaceous stream side cover. In stream substrate and characteristics where adequate for macroinvertebrates and fish. There was some evidence of sand movement and scour at obstructions. Tolerant Chironomidae (Diptera) larvae were the dominant macroinvertebrate, and tolerant *Baetis sp*. and *Hydropsyche sp*. were the dominant EPT taxa, both typical of this type of impact. Insitu water quality parameters (temp, D.O., pH, conductivity) indicated no unusual conditions.

UPS6-001
Site was immediately upstream of Patuxent River Rd. in mature woodland with thick shrubby understory. The area was large lot residential, but none impacted the immediate riparian area. The instream substrate was relatively good with mixed gravel size riffles and moderate amounts of woody debris. The macroinvertebrtate community was consistent with the available habitat. The most significant feature of this area was a 2+ meter high waterfall down stream of the sample site. Insitu water quality parameters (temp, D.O., pH, conductivity) indicated no unusual conditions.

UPS7-001
Site was within the Patuxent Wildlife Refuge upstream of Wildlife Loop Rd. in mature hardwood forest with little understory. Beaver activity had severely impacted this site, although dam had been removed. Stream channel was 100% leaf litter, with no exposed mineral substrate, and very little water. Insitu water quality parameters (temp, D.O., pH, conductivity) indicated no unusual conditions. The macroinvertebrtate community was dominated by Chironomidae which is consistent with the available habitat.

UPS9-001
Site was immediately upstream of Sands Rd.. The channel was deeply incised with one to two meter high cut banks on both sides. Residential development was visible on the north side of the stream but was not within the 18 meter buffer. There were several good gravel riffles within the reach, but woody debris was at a minimum, and unstable sand dominated the remainder of the stream bed. Insitu water quality parameters (temp, D.O., pH, conductivity) indicated no unusual conditions. The macroinvertebrtate community was consistent with the available habitat.

UPS9-002
Site was immediately upstream of Harwood road in mature poplar/beech/oak forest with very sparse understory, and large lot residential development. Stream was very incised with one to one and a half meter high cut banks on both sides. Substrate was dominated by sand with scattered woody debris and shallow riffles of small gravel. Prevalence of sand and gravel bars, and cut banks, indicated considerable storm flows through the area. Insitu water quality parameters (temp, D.O., pH, conductivity) indicated no unusual conditions. The macroinvertebrtate community was consistent with the available habitat.

Prince George's County Benthic Site Descriptions

PG 02-019
Site was a forested headwater stream on the Patuxent Wildlife Refuge. At the time of sampling in March, there was minimal flow and the sand/mud substrate was entirely covered with leaves. The stream banks where stable, but showed indication of past erosion.

PG 02-034B

Site was on the mainstem of the Patuxent in Laurel. Riffle quality was good, and there was minor bank erosion.

PG 10-009

Site was in a large lot area of Bowie. Benthic substrate was limited to occasional riffles and minor woody debris. Channel was deeply incised (up to 1.5 meters) and subject to heavy storm flows from adjacent and upstream roads. Riparian area within reach was wooded, but with little understory.

PG 10-017A

Site was in a forested flood plain area with moderately heavy shrub understory in riparian area of reach. Benthic substrate was limited to occasional riffles and minor woody debris. Channel was moderately incised due to storm flows from adjacent parking lots and upstream roads.

PG 39-077A

Site was in suburban/small agriculture area with minimal forested riparian zone. Benthic substrate was poor, being dominated by soft sediment and with no riffles and moderate amounts of woody debris. Although channel was not deeply incised due to functional flood plain, there was evidence of storm flow erosion.

PG 39-102A

Site was in an urbanized portion of Bowie. Benthic substrate was minimal, being restricted to coarse sand or riprap and scattered woody debris. Substrate scouring from storm flows was extensive. Banks were stable only because of extensive armoring.