Report on Nutrient Synoptic Surveys in the Isle of Wight Watershed, Worcester County, Maryland, April 2001 as part of the Watershed Restoration Action Strategy.

Maryland Department of Natural Resources
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Watershed Restoration Program
Watershed Evaluation Section

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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.

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Executive Summary

A nutrient synoptic survey was completed in the Isle of Wight watershed in late March 2001. Thirty-one sampling sites were identified. These including the sites sampled during the April 1999 synoptic completed in the St. Matins watershed, and additional sites in the Turville, Manklin, and Herring Creek watersheds. The watershed above Station 1 has produced some of the highest orthophosphate and nitrate concentrations during both 1999 and 2001 surveys. Buntings Branch, the watershed draining to Station 4, stands out for high nitrate concentrations, loads and yields during both surveys and a high orthophosphate load in 2001. The high nutrient values, coupled with its moderate size, make this watershed a consistently significant contributor of nutrients to the estuary. Church Creek (Station 15,) is a stand out with consistently high orthophosphate loads. The 1999 nitrate concentrations and loads were also some of the highest in the Isle of Wight watershed. Birch Branch (Stations 13 and 17) had nutrient concentrations and yields slightly lower than the preceding three, but still much higher than the remaining sites during both sampling episodes. Station 8 in the upper Birch watershed was only sampled in 2001, but had some of the highest nitrate concentrations, loads, and yields of any watershed. The stream corridor assessments of 1999 and 2001 indicate that channel alterations and inadequate buffers were very common and widespread in the Isle of Wight watershed, especially in the upper watershed and smaller tributaries. There are two main types of fish blockages in the Isle of Wight watershed. The majority are those that create a drop in the stream channel that is too high for fish to pass, such as a culvert pipe. Most of these appear to be clustered in the industrial and commercial development around the Rt 50 corridor. The second type are those that impound water with a small dam that blocks fish movement, such as a grade control structure associated with agricultural activity.

Table of Contents

List of Tables Page

List of Figures

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.*

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

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.

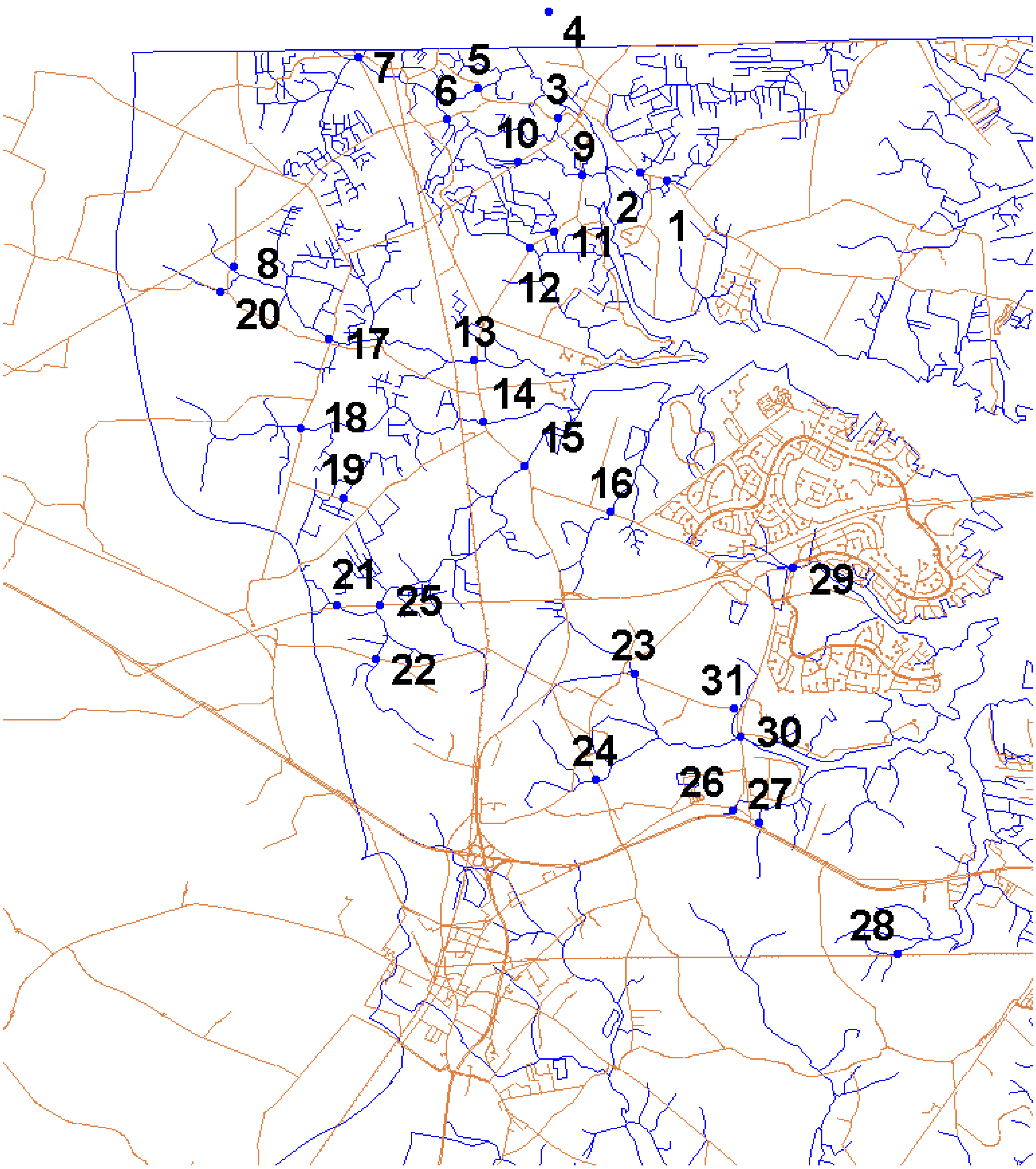
Results and Discussion

A nutrient synoptic survey was completed in the Isle of Wight watershed in late March 2001. Thirty one sampling sites were identified. These including the sites sampled during the April 1999 synoptic completed in the St. Matins watershed, and additional sites in the Turville, Manklin, and Herring Creek watersheds (Figure 1, and Table 2). Two sites (16, 19) were dry, and two sites (17, 28) were inaccessible. One other site sampled (26) was found to be tidal so flow could not be determined.

Results of the March 2001 synoptic are shown in Table 3.. The results from the April, 1999 St. Martins synoptic are also included in this table to provide comparisons and show similarity and continuity across time. The 1999 and 2001 nitrate concentration and yield data are presented spatially in Figures 2 through 5. Orthophosphate yields for 1999 and 2001 are show spatially in Figures 6 and 7. Variability between surveys is a result of different precipitation patterns prior to the surveys and the several week difference in collection dates. The graphic and tabular information indicate that five watersheds had some continuity for elevated nutrient concentrations, loads and/or yields over the course of the two surveys.

The watershed above Station 1 has produced some of the highest orthophosphate and nitrate concentrations during both 1999 and 2001 surveys. The relatively low flow in this watershed generally kept loads at moderate to low levels. Yields were also generally low with the exception of phosphate in March 2001. The Stream Corridor Assessments in 1999 and 2001 indicated that this watershed had considerable stream channel alteration and areas with inadequate riparian buffers. Additional visual inspection noted a concentration of chicken houses near the head waters.

Figure 1. Isle of Wight March, 2001 Synoptic Station Location.



Buntings Branch, the watershed draining to Station 4, stands out for high nitrate concentrations, loads and yields during both surveys and a high orthophosphate load in 2001. The high nutrient values, coupled with its moderate size, make this watershed a consistently significant contributor of nutrients to the estuary. Stream Corridor Assessments on the Maryland portion of Buntings Branch indicated several areas on tributaries with moderate to severe inadequate buffer and channel alterations. The Watershed Characterization noted a permitted discharge on an unnamed tributary to Buntings Branch, but any impact from this discharge would have been downstream of the sample site. The nutrient concentrations, loads and yields in Buntings Branch are similar to those found at Station 15 downstream of an industrial discharge, although no stream assessments were carried out in the Delaware portion of this watershed to confirm this supposition.

Table 2. Station Location for March 2001 Nutrient Synoptic Survey

Station #	LOCATION
1	Unnamed tributary at St. Martins Neck Rd.
2	Unnamed tributary at St. Martins Neck Rd.
3	Slab Bridge Prong at Hotel Rd..
4	Bunting Branch at Delaware Rt. 54 in Selbyville
5	Careys Branch at Hotel Rd..
6	Unnamed tributary to Careys Branch at Hammond Rd.
7	Careys Branch at Rt. 113.
8	Trib to Birch Br. at Murray Rd.
9	Unnamed tributary just south of Bishopville at Jarvis Rd.
10	Unnamed tributary just west of Bishopville at Rt. 367
11	Unnamed tributary to Perkins Creek at Jarvis Rd.
12	Perkins Creek at Jarvis Rd..
13	Birch Branch at Rt. 113.
14	Middle Branch at Rt. 113.
15	Church Creek at Rt. 113.
16	Windmill Creek at Rt 584
17	Birch Branch at Campbelltown Rd..
18	Middle Branch at Campbelltown Rd..
19	Unnamed tributary to Middle Branch at Shockley Rd.
20	South Trib to Birch Br. at Murray Rd.
21	Unnamed tributary to Church Creek at Rt. 90.
22	Church Creek at Careys Rd..
23	Crippen Br. at Adkins Rd.
24	Taylorville Cr. at Rt 452
25	Chirch Br. at Rt 90
26	Mud Cr at Rt 589
27	Trib to Mud Cr. at Rt 707
28	Unnamed trib to Herring at rr
29	Unnamed trib to Manklin at Ocean Pkwy
30	Taylorville Cr. at Rt 589
31	Ut to Taylorville Cr. at Adkins Rd.

Table 3. Comparison of St. Martin's Nutrient Synoptic results, 1999 and 2001.

SAMPLE SITE	PO4 Conc. mg/L April 99	PO4 Load Kg/day April 99	PO4 yield estimated kg/ha/yr April 99	PO4 Conc. mg/L March 01	PO4 Load Kg/day March 01	PO4 yield estimated kg/ha/yr March 01	NO2+NO3 Conc. mg/L April 99	NO2+NO3 Load Kg/day April 99	NO2+NO3 estimated kg/ha/yr April 99	NO2+NO3 Conc. mg /L March 01	NO2+NO3 Load kg /day March 01	NO2+NO3 estimated kg/ha/yr March 01	approx ha
STM 1	0.240	0.028	0.0956	0.051	0.051	0.1720	3.65	0.429	1.4534	6.19	6.16	20.8758	108
STM 2	0.022	0.004	0.0112	0.007	0.001	0.0028	3.40	0.641	1.7348	6.90	1.01	2.7244	135
STM 3	0.038	0.044	0.1399	0.012	0.062	0.1989	1.30	1.502	4.7869	4.53	23.56	75.0695	115
STM 4	0.024	0.521	0.2836	0.005	0.111	0.0607	3.61	78.359	42.6514	6.14	136.85	74.4887	671
STM 5	0.029	0.382	0.1178	0.004	0.004	0.0011	1.35	17.773	5.4858	4.92	4.37	1.3489	1183
STM 6	0.033	0.014	0.0567	0.019	0.004	0.0151	0.45	0.189	0.7729	1.75	0.34	1.3903	89
STM 7	0.047	0.311	0.1103	0.013	0.080	0.0283	2.30	15.200	5.3953	6.45	39.63	14.0650	1028
STM08	no sample			0.005	0.029	0.0403	no sample			8.65	49.46	69.6951	259
STM 9	0.031	0.062	0.6700	0.010	0.011	0.1205	1.09	2.194	23.5582	2.39	2.68	28.8112	34
STM 10	0.021	0.004	0.0777	0.005	0.003	0.0611	0.55	0.115	2.0346	4.03	2.78	49.2113	21
STM 11	0.049	0.006	0.0240	0.104	0.011	0.0489	0.14	0.016	0.0685	1.33	0.15	0.6251	86
STM 12	0.012	0.029	0.0531	0.003	0.008	0.0138	1.09	2.649	4.8274	1.67	4.22	7.6813	200
STM 13	0.017	0.321	0.0631	no sample			2.59	48.963	9.6210	no sample			1858
STM 14	0.018	0.069	0.0195	0.004	0.025	0.0071	1.67	6.376	1.8089	2.62	16.39	4.6489	1287
STM 15	0.043	0.649	0.1541	0.032	0.148	0.0352	3.52	53.149	12.6148	1.02	4.73	1.1231	1538
STM 17	0.013	0.152	0.0622	0.003	0.023	0.0095	3.22	37.594	15.4122	5.90	45.41	18.6178	890
STM 18	0.023	0.144	0.1081	0.004	0.022	0.0162	2.19	13.754	10.2948	2.98	16.13	12.0736	488
STM 19	0.021	0.002	0.0058	no sample			3.49	0.274	0.9619	no sample			104
STM20	no sample			0.003	0.005	0.0093	no sample			3.20	5.35	9.9655	196
STM 21	0.020	no flow		0.012	0.004	0.0473	0.65	no flow		1.18	0.38	4.6552	30
STM 22	0.103	0.161	0.2032	0.089	0.115	0.1443	0.51	0.799	1.0059	0.48	0.62	0.7783	290
STM23	no sample			0.008	0.012	0.0146	no sample			2.72	4.03	4.9643	296
STM24	no sample			0.007	0.001	0.0010	no sample			1.28	0.14	0.1744	295
STM25	no sample			0.075	0.082	0.1288	no sample			0.71	0.77	1.2196	232
STM26*	no sample			0.010	0.000	0.0000	no sample			0.16	0.00	0.0000	130
STM27	no sample			0.002	0.000	0.0001	no sample			1.87	0.02	0.0854	92
STM29	no sample			0.004	0.010	0.0197	no sample			0.32	0.78	1.5732	182
STM30	no sample			0.010	0.063	0.0183	no sample			3.09	19.48	5.6662	1255
STM31	no sample			0.003	0.001	0.0033	no sample			1.57	0.41	1.7226	86

Highlighted cells are 3 highest values.
kg/hectare/yr estimated from instantaneous value.

Church Creek (Station 15,) is a stand out with consistently high orthophosphate loads. The 1999 nitrate concentrations and loads were also some of the highest in the Isle of Wight watershed. This stream is noted both in the 2001 Stream Corridor Assessment and the Watershed Characterization as the receiving waters for a discharge from a poultry processing facility in Showell (Figure 8). Uncharacteristically high specific conductivity during both sampling episodes also distinguished this site. Station 22, in the upper Church Creek watershed, showed elevated orthophosphorus concentrations, loads, and yields as well. Nutrient yields (kg/hectare) to the estuary were moderated by the relatively large size of the watershed.

Birch Branch (Stations 13 and 17) had nutrient concentrations and yields slightly lower than the preceding three, but still much higher than the remaining sites during both sampling episodes. Station 8 in the upper Birch watershed was only sampled in 2001, but had some of the highest nitrate concentrations, loads, and yields of any watershed. Assuming these elevated values were present, but not sampled in 1999, they could have contributed to the high levels found further downstream in the 1999 synoptic. The dissolved nutrient concentrations and loads noted in the above watersheds are similar to those found in a similar size watershed in the upper Pocomoke watershed. The small and/or head water watersheds not mentioned above, including tributaries of Turville and Manklin Creeks, are relatively minor contributors to the nutrient yield of the watershed as a whole due to low nutrient concentrations and comparatively low discharge volumes. Many of these small headwater streams and ditches have only seasonal flow, with flowing water absent during the growing season.

The stream corridor assessments of 1999 and 2001 indicate that channel alterations and inadequate buffers were very common and widespread in the Isle of Wight watershed, especially in the upper watershed and smaller tributaries (see Figure 9). Because of the widespread nature of these problems, their impact to water quality becomes the back ground against which more severe impacts are noted. Figure 8 illustrates how the one pipe outfall identified during the 2001 Stream Corridor Assessment corresponds with the site with the highest orthophosphate (PO4) load (Station 15).

This situation also makes it possible to monitor the effect of restoration activities by using a paired watershed study. Two headwater subwatersheds of similar size and chemical, biological and physical attributes are chosen within the larger watershed, and restoration activity is carried out in one while the other remains as is. Comparative analysis of water, biological, and habitat quality within these watersheds over a number of years should provide evidence of the impact of the restoration activities. It is very important that the subwatershed size is such that whatever restoration activity is chosen can be successfully implemented on all areas identified as needing that particular restoration practice within the subwatershed. If the implementation is not 100% within the subwatershed, identifying significant changes that resulted from the implementation could be difficult.

There are two main types of fish blockages in the Isle of Wight watershed. The majority are those that create a drop in the stream channel that is too high for fish to pass, such as a culvert pipe. Most of these appear to be clustered in the industrial/commercial development around the Rt 50 corridor. The second type are those that impound water with a small dam that blocks fish movement, such as a grade control structure associated with agricultural activity (Figure 9). The restriction or elimination of fish movements within the watershed diminishes spawning areas for resident and anadromous fish species, and reduces diversity. The grade control structure fish blockages are thought of by some to be a method of treatment for improving water quality through sequestering and natural degradation of nutrients. These same impoundments can create water quality problems during low/no flow periods such as anoxic conditions that release sequestered nutrients, and greatly elevated temperatures. The anoxic conditions and elevated temperatures are also a major impact to the biological community. Changing long reaches from flowing water systems to pond systems eliminate numerous fish and macroinvertebrate families and genera not adapted to pond habitats. Additionally, the ponding can saturate ditch banks and make them subject to slumping and thus increased erosion potential during high flow situations.

Figure 2. Isle of Wight Synoptic April, 1999: NO23 Concentrations, Mg/L.

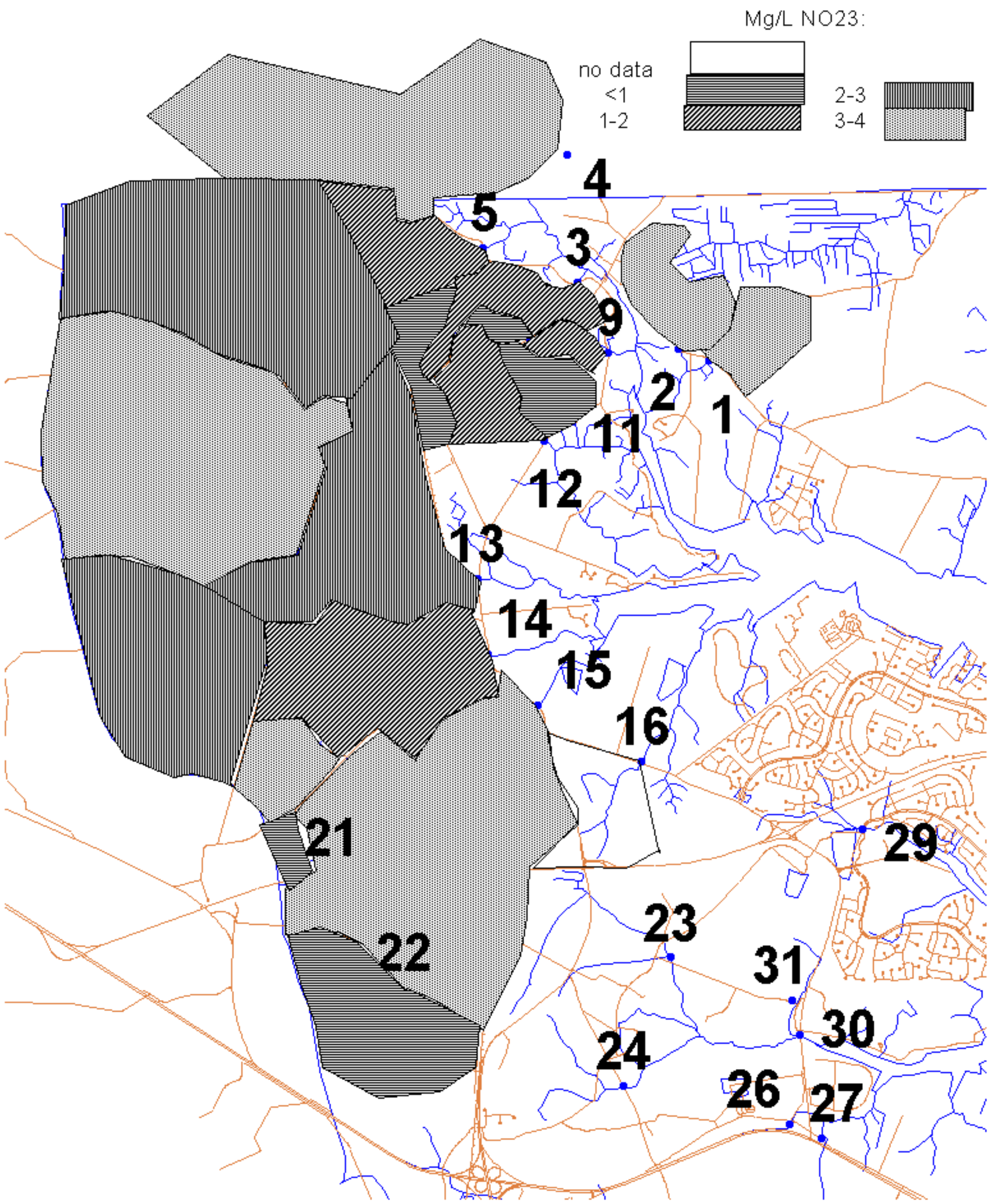


Figure 3. Isle of Wight Synoptic Stations March, 2001: NO23 Concentration, Mg/L.

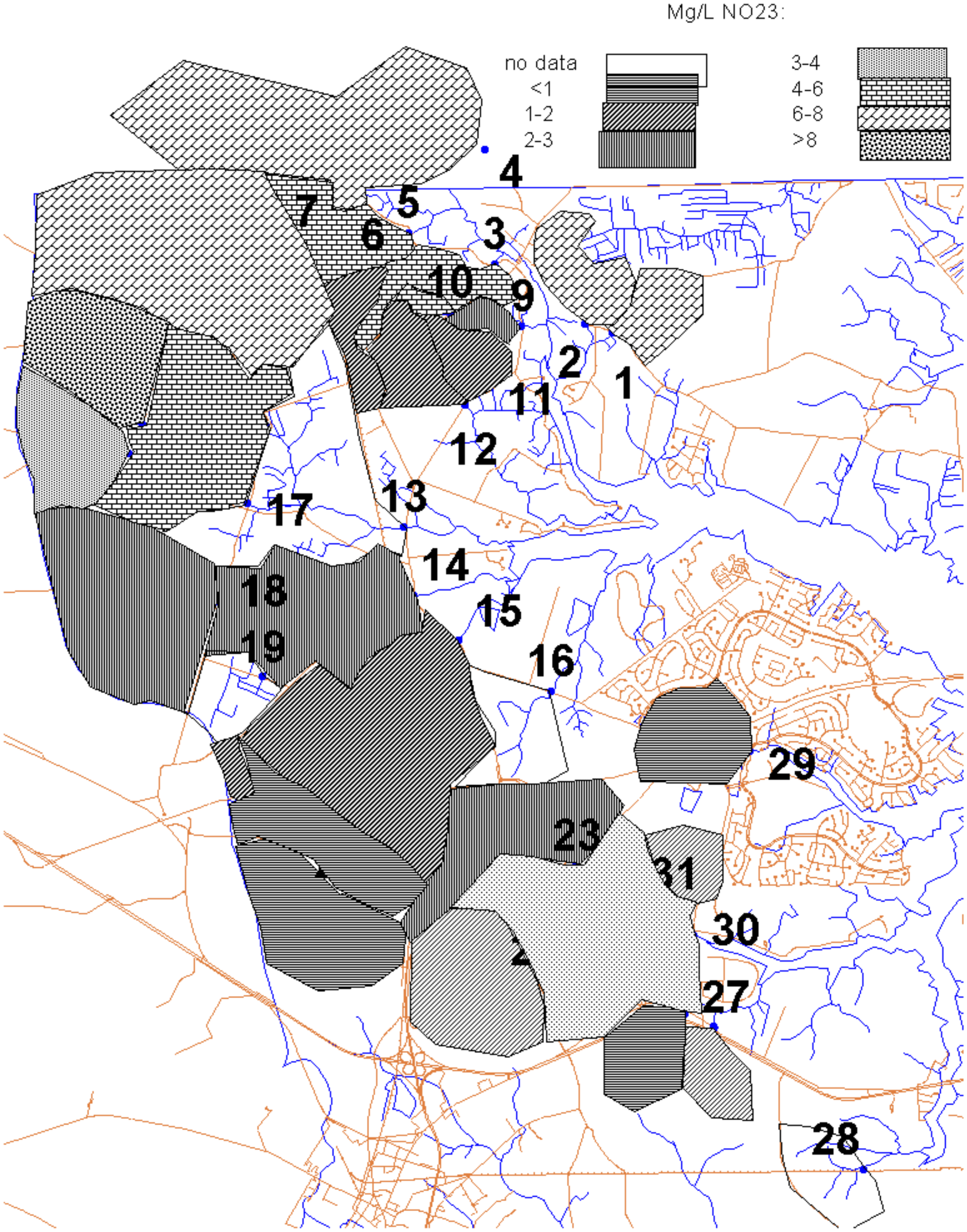


Figure 4. Isle of Wight April, 1999 Synoptic; NO23 Yields, Kg/hectare/yr.

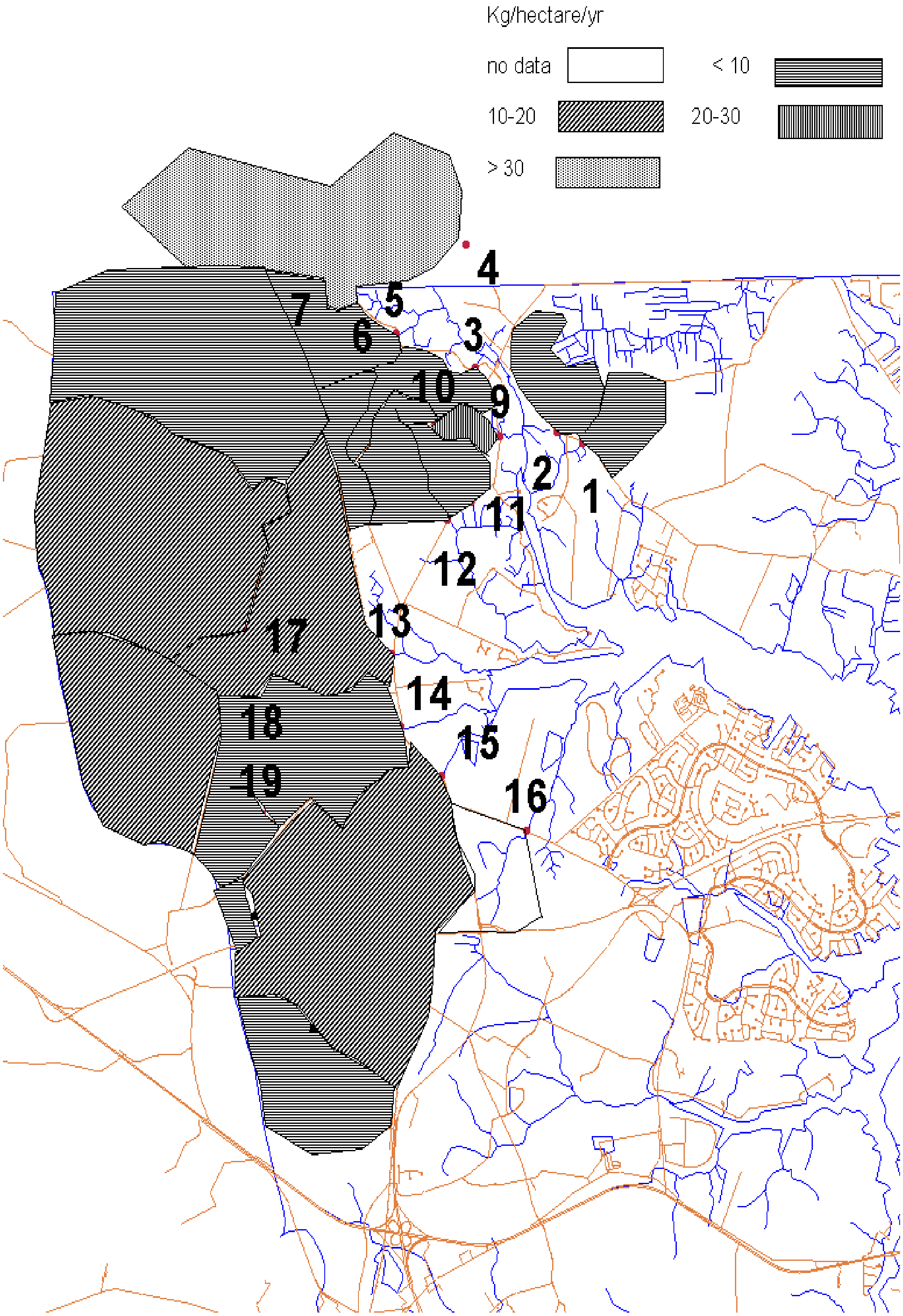


Figure 5. Isle of Wight March, 2001 Synoptic; NO23 Yields, Kg/hectare/yr.

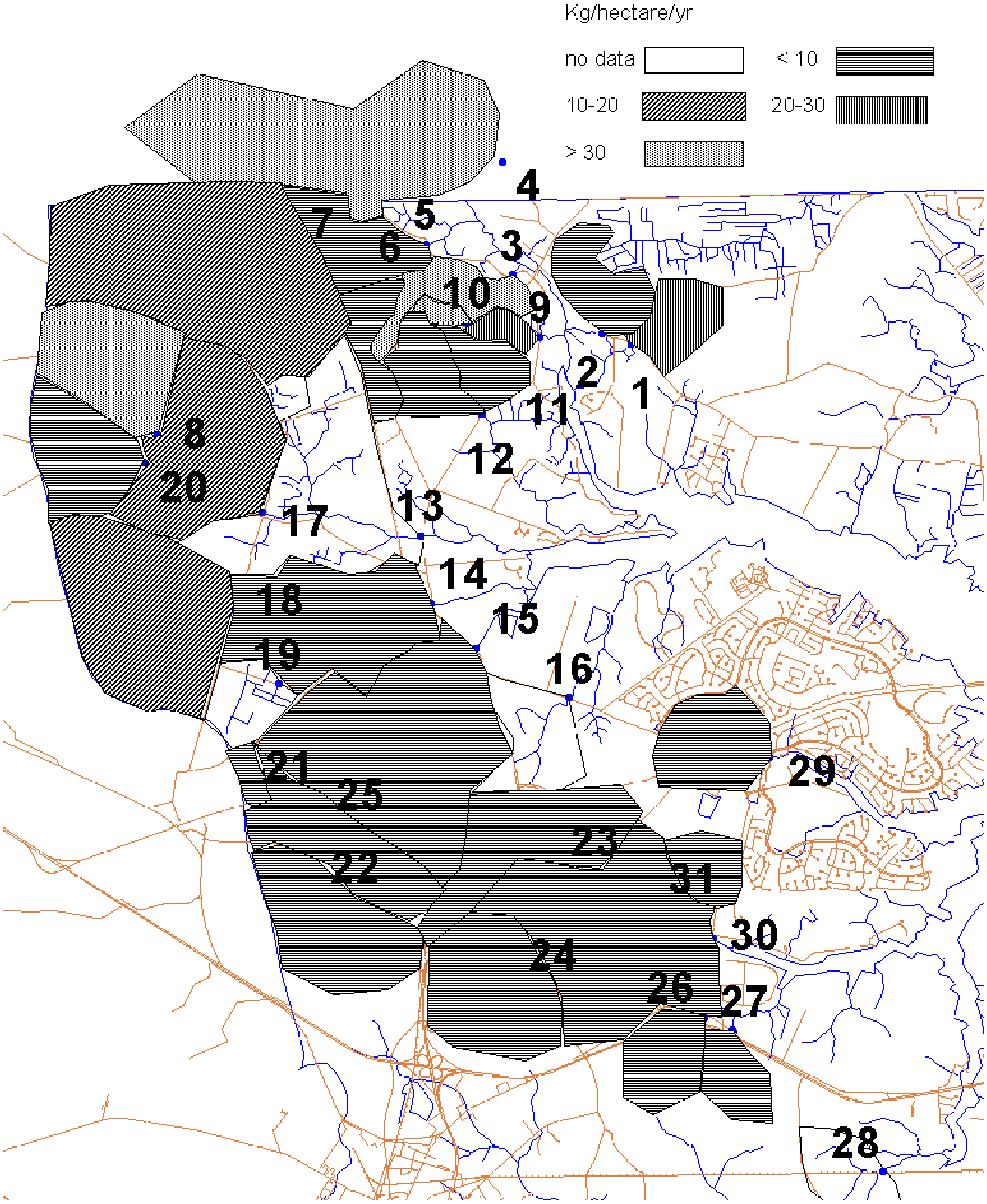


Figure 6. Isle of Wight Synoptic April, 1999: Phosphorus yields Kg/hectare/yr.

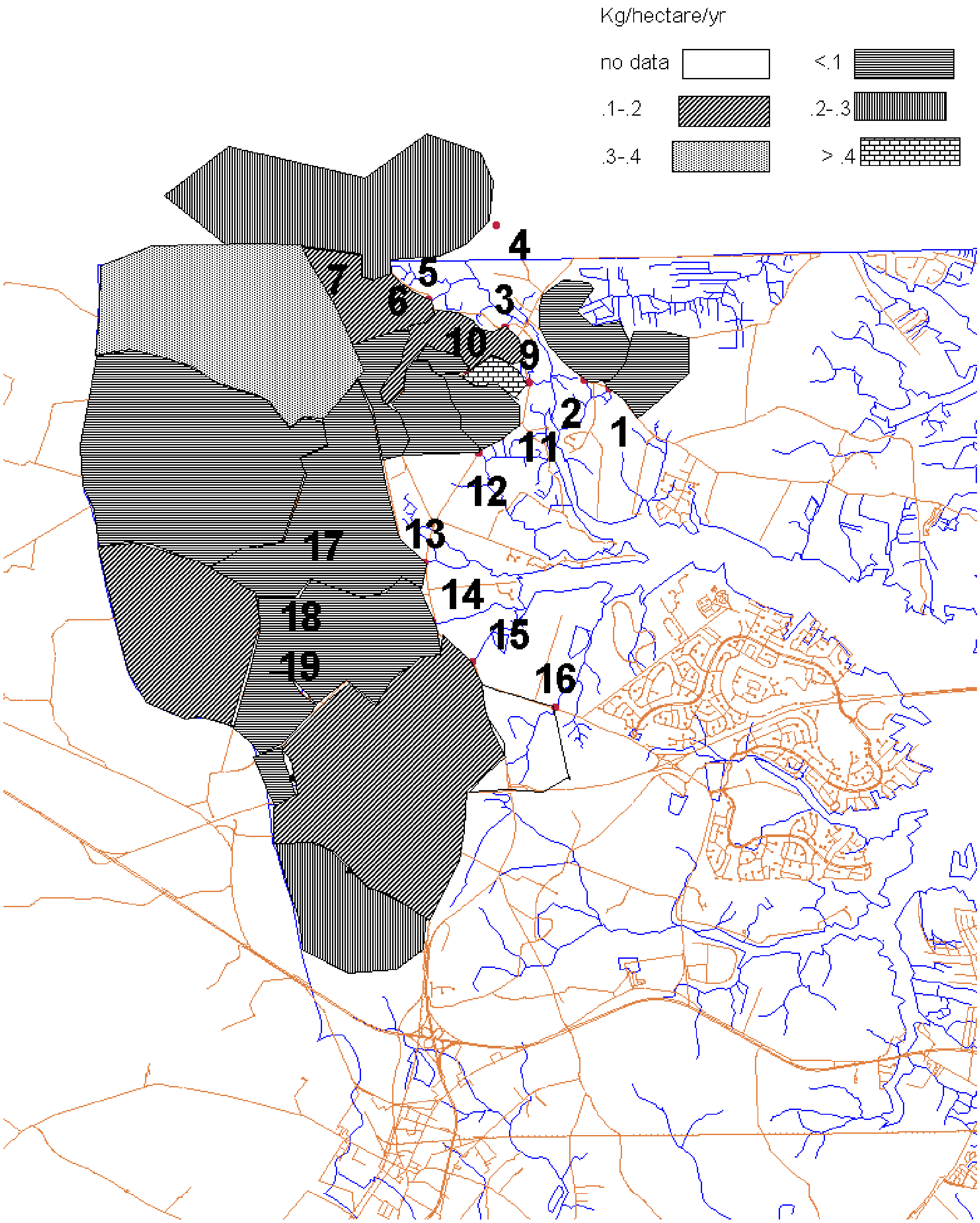


Figure 7. Isle of Wight Synoptic March, 2001: Phosphorus yields Kg/hectare/yr.

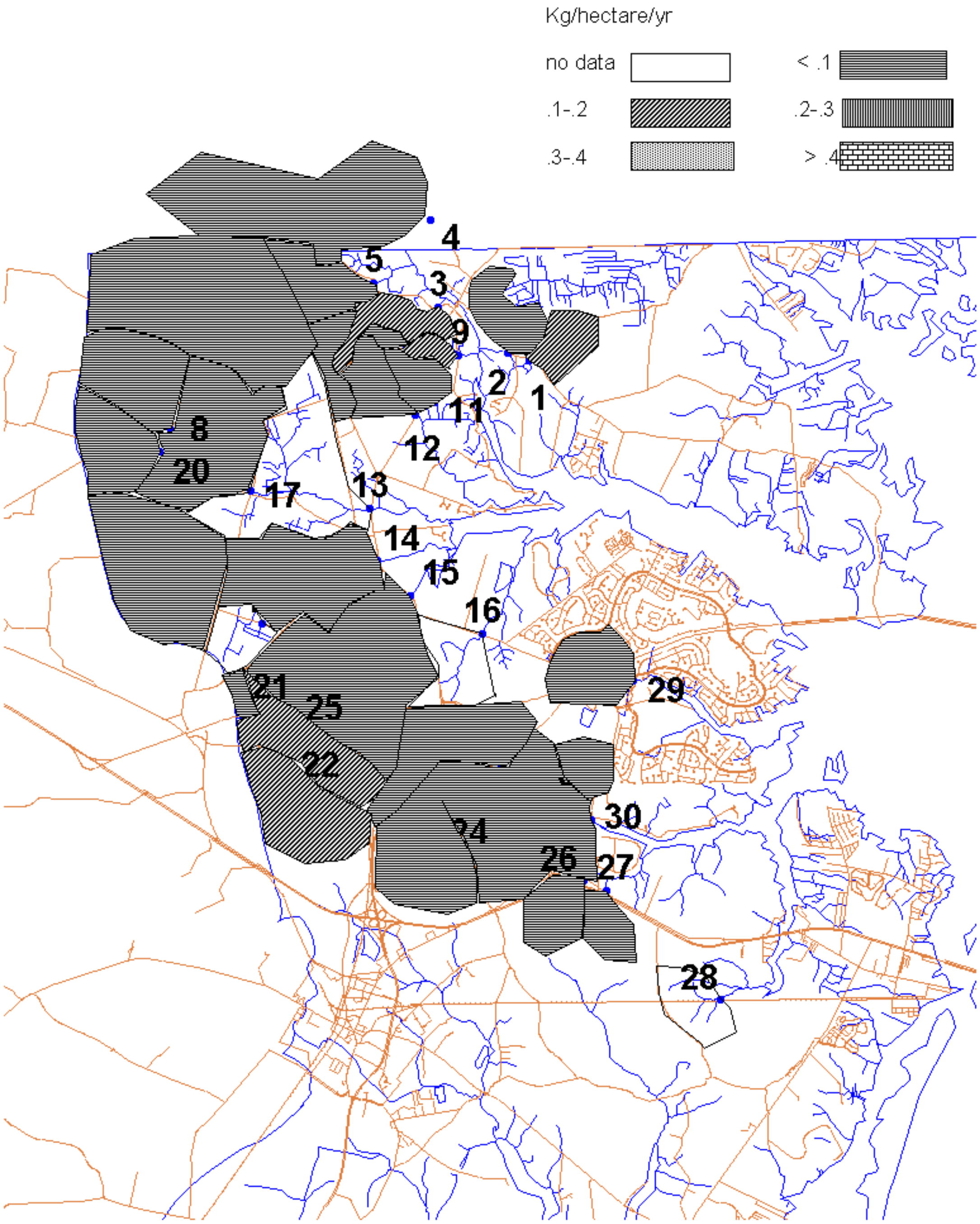


Figure 8: Location of high orthophosphate load and pipe outfall.

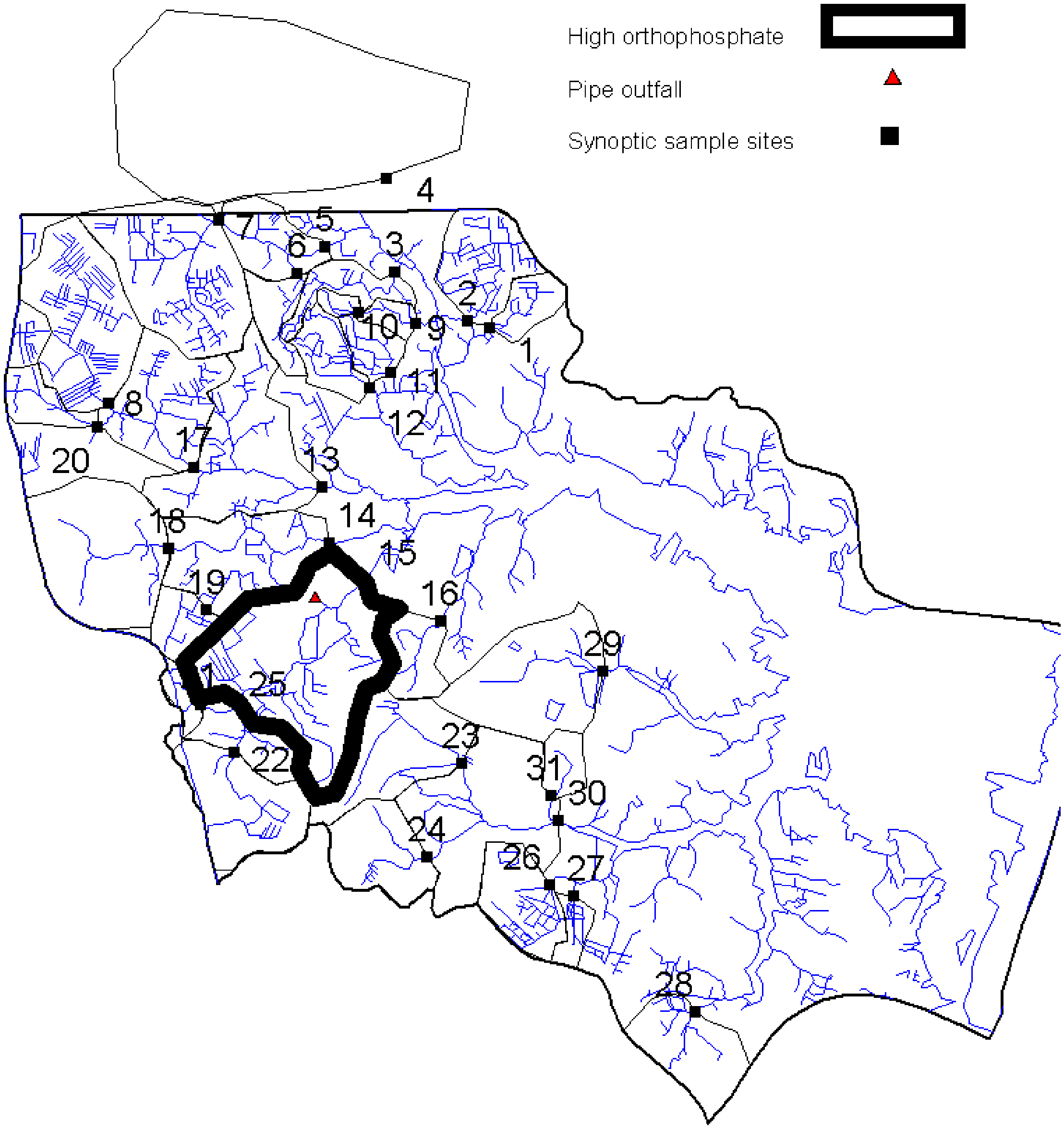


Figure 9. Example of inadequate buffer, channel alteration and fish blockage in Isle of Wight watershed.

Literature Cited

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