Report on Nutrient Synoptic Survey in the Assawoman Bay Watershed, Worcester County Maryland March, 2005 as part of a Watershed Restoration Action Strategy.

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Cover photo: Unnamed tributary to Greys Creek at Del Rd. 387 by Niles Primrose

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Executive Summary

A nutrient synoptic survey was conducted during March, 2005 in the Assawoman Bay watershed as part of the Assawoman Bay Watershed Restoration Action Strategy (WRAS). Water samples were analyzed from 20 fresh water free flowing sites throughout the watershed. Eighteen of the twenty subwatersheds were in Delaware. Nitrate/nitrite concentrations were found to be excessive (>5 mg/L) in ten subwatersheds. Three of these ten had concentrations over eight mg/L and were labeled 'Excessive plus'. High concentrations (3 – 5 mg/L) were found in seven subwatersheds, and baseline (<1 mg/L) in the remaining three subwatersheds. Instantaneous nitrate/nitrite yields were found to be excessive (>.03 Kg/Hectare/day) in eleven subwatersheds, high (.02-.03 Kg/Hectare/day) in two, and baseline (<.01 Kg/Hectare/day) in the remaining seven. Excessive concentrations (>.015 mg/L) of orthophosphate were found in seven subwatersheds, high concentrations (.01-.015 mg/L) in three, moderate concentrations (.005 -.01 mg/L) in four, and the remaining six below baseline (<.005 mg/L). Orthophosphate yields were found to be high (.001-.002 Kg/Hectare/day) in two watersheds, and baseline (<.0005 Kg/Hectare/day) in the remaining eighteen. The elevated nitrate/nitrite concentrations and yields may be associated with row crop agriculture and communities on well and septic. Poultry litter appears to be used extensively as a nutrient source for crops. The elevated orthophosphate concentrations in the Assawoman watershed may be associated with sediment from the considerable construction and mining activities. The average nutrient concentration from the Assawoman Bay watershed was high compared to other WRAS watersheds. No significant anomalies were found in the insitu measurements of temperature or pH. Specific conductivity at five sites was greater than 300 mS/cm. This could have been from road salts contaminating the surface water, or salt tide water coming upstream from the estuary. One site had an anomalously high dissolved oxygen reading apparently caused by a heavy growth of filamentous green algae fueled by an excessive plus nitrate/nitrite concentration.

Table of Contents

List of Tables Page

List of Figures

Introduction

A nutrient synoptic survey was conducted during March, 2005 in the Assawoman Bay watershed as part of the Assawoman Bay Watershed Restoration Action Strategy (WRAS).

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 (Table 1) 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 benchmark, 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.

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.*

METHODS

Synoptic water chemistry samples were collected in early spring throughout the watershed. Sampling was halted for a minimum of 24 hours after rainfall events totaling more than .25 inches. 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 selected sites at the time of 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

A nutrient synoptic survey was conducted during March, 2005 in the Assawoman Bay watershed as part of the Assawoman Bay WRAS. Water samples were collected and analyzed from 20 fresh water free flowing sites throughout the watershed. Sampling site locations are noted in Table 2 and mapped with subwatersheds in Figure 1. Eighteen of the twenty subwatersheds sampled were in Delaware due to the extent of tidal influence and paucity of roads in the Maryland portion of the watershed. Dissolved nutrient concentrations and yields from all sites are noted in Table 3. Nitrate/nitrite concentrations were found to be excessive (>5 mg/L) in ten subwatersheds. Three of these ten had concentrations over eight mg/L and were labeled 'Excessive plus'. High concentrations (3 – 5 mg/L) were found in seven subwatersheds, and baseline (<1 mg/L) in the remaining three subwatersheds (Figure 2). Instantaneous nitrate/nitrite yields were found to be excessive (>.03 Kg/Hectare/day) in eleven subwatersheds, high (.02-.03 Kg/Hectare/day) in two, and baseline (<.01 Kg/Hectare/day) in the remaining seven (Figure 3). Excessive concentrations (>.015 mg/L) of orthophosphate were found in seven subwatersheds, high concentrations (.01-.015 mg/L) in three, moderate concentrations (.005 -.01 mg/L) in four, and the remaining six below baseline (<.005 mg/L) (Figure 4). Orthophosphate yields were found to be high (.001-.002)

Kg/Hectare/day) in two watersheds, and baseline (<.0005 Kg/Hectare/day) in the remaining eighteen (Figure 5). Insitu readings of temperature, dissolved oxygen, pH, and specific conductivity are noted from all sites in Table 4. One site had an anomalously high dissolved oxygen reading of over 16 mg/L (Figure 6). Specific conductivity at five sites was greater than 300 mS/cm (Figure 7).

Table 2. Assawoman Bay WRAS Nutrient Synoptic Survey March, 2005 Sampling Site Locations

Station	Location	Latitude	Longitude
0	UT to Greys Cr at unnmarked rd	38.45916	-75.16127
1	UT to Greys Cr - Del side MD Line Rd	38.45114	-75.16152
2	UT to Greys Cr at MD Line Rd	38.45122	-75.15224
3	Greys Cr at Rt 54	38.46548	-75.17050
4	UT to Greys Cr at Del rd 387	38.46284	-75.17816
5	UT to Greys Cr at Muskrattown Rd (396A)	38.44315	-75.13091
12	UT to Greys Cr at Del Rd 364A	38.46027	-75.10960
14	UT to Greys Cr at Williamsville/Del Rd 395	38.45314	-75.10574
16	UT to Assawoman at of the Sun Rd	38.46929	-75.11731
17	UT to Assawoman at of the Sun Rd (W)	38.46277	-75.12868
18	Greys Cr at Line Rd	38.45404	-75.13792
19	Greys Cr at unnamed Rd off Rt 54	38.45994	-75.14519
20	UT to Greys Cr at Del Rd 387	38.46120	-75.17813
21	Greys Cr at unnamed rd off Rt 54	38.46006	-75.16719
22	UT to Greys Cr at unnamed rd off Rt 54	38.46006	-75.16719
23	UT to Greys Cr at unnamed rd off Rt 54	38.46221	-75.16567
24	UT to Greys Cr at Rt 54	38.46373	-75.15030
27	UT to Assawoman at Del Rd 394 (E)	38.45331	-75.09394
28	UT to Greys at Murphy Rd	38.46358	-75.18880
31	UT to Greys Cr at Rt 54	38.46493	-75.17413

Figure 1. Assawoman Bay WRAS Nutrient Synoptic Survey, March 2005
Station Location and Subsheds

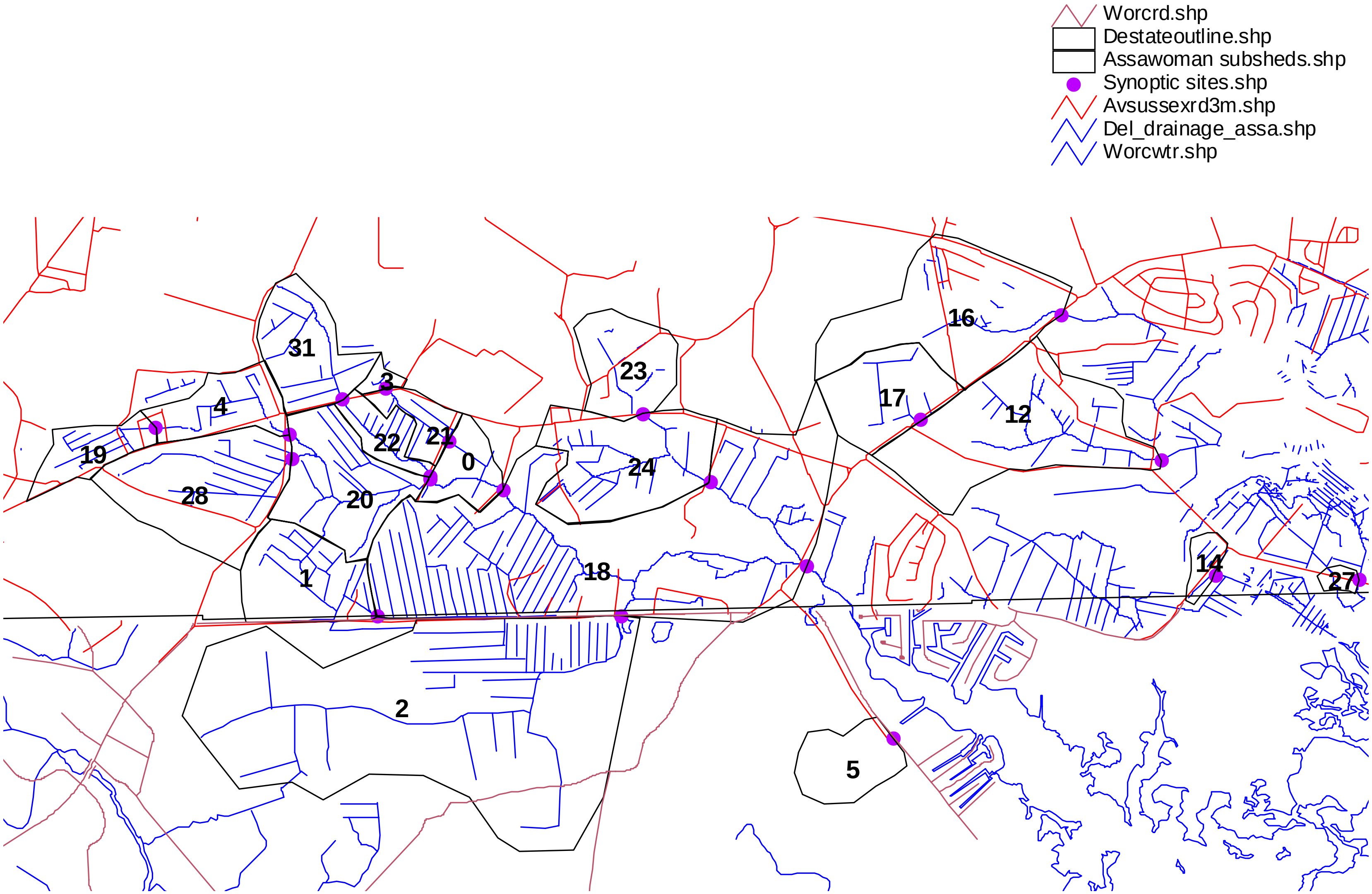


Table 3. Assawoman Bay WRAS Nutrient Synoptic Survey March, 2005
Dissolved Nutrient Concentrations and Yields

Station	Date	Time	PO4 Conc. (mg/L)	NO2+NO3 Conc. (mg/L)	Discharge L/sec	Subshed Area Hectares	PO4 yield Kg/H/day	NO2+NO3 yield Kg/H/day
0	03/11/05	1030	0.007	5.070	73.21	308	0.000144	0.104126
1	03/11/05	1415	0.003	6.410	18.06	50	0.000093	0.198960
2	03/11/05	1345	0.003	5.540	91.19	358	0.000066	0.121883
3	03/10/05	1000	0.182	10.400	0.11	4	0.000433	0.024743
4	03/10/05	1140	0.013	4.560	64.80	57	0.001277	0.447897
5	03/11/05	1230	0.003	3.250	2.50	32	0.000020	0.022172
12	03/10/05	1300	0.011	3.980	55.64	156	0.000339	0.122650
14	03/11/05	1250	0.035	0.080	0.32	8	0.000116	0.000264
16	03/11/05	1105	0.002	0.210	1.41	97	0.000003	0.000265
17	03/11/05	1125	0.061	15.600	2.15	46	0.000247	0.063055
18	03/11/05	1145	0.003	3.820	400.14	1095	0.000095	0.120608
19	03/11/05	0920	0.005	8.380	21.49	24	0.000389	0.651301
20	03/10/05	1150	0.017	5.820	333.06	250	0.001957	0.669909
21	03/10/05	1050	0.013	5.520	4.95	23	0.000242	0.102705
22	03/10/05	1055	0.009	4.700	32.50	63	0.000401	0.209469
23	03/10/05	1020	0.006	4.990	0.25	41	0.000003	0.002616
24	03/11/05	0945	0.028	4.130	1.90	117	0.000039	0.005801
27	03/10/05	1240	0.057	0.090	0.49	4	0.000589	0.000929
28	03/11/05	1010	0.002	5.760	1.61	82	0.000003	0.009733
31	03/10/05	1120	0.021	6.380	0.25	45	0.000010	0.003067

Figure 2. Assawoman Bay WRAS Nutrient Synoptic Survey March, 2005
Nitrate/Nitrite (NO2+NO3) Concentrations (mg/L)

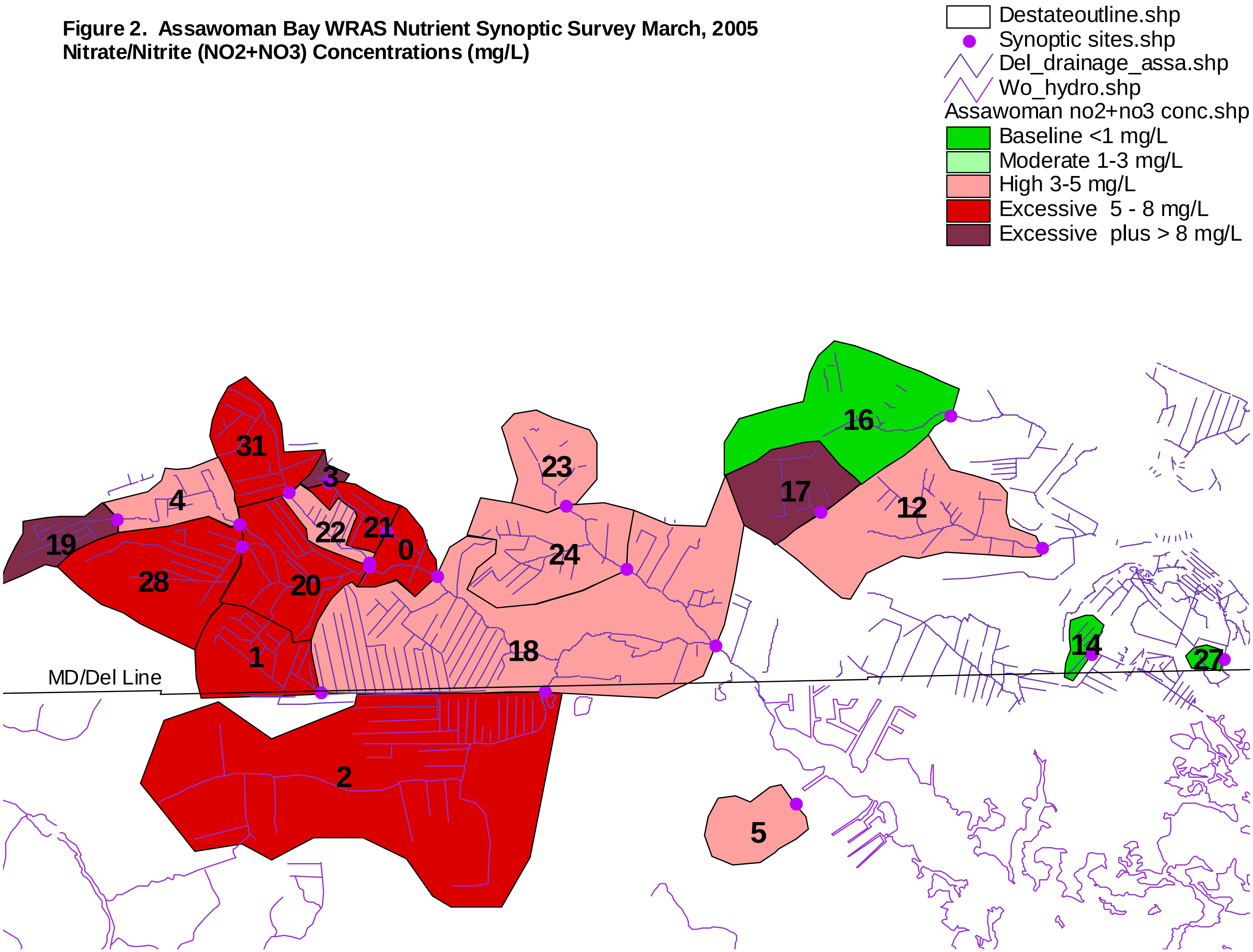


Figure 3. Assawoman Bay WRAS Nutrient Synoptic Survey March, 2005
Nitrate/Nitrite (NO2+NO3) Yield (Kg/H/day)

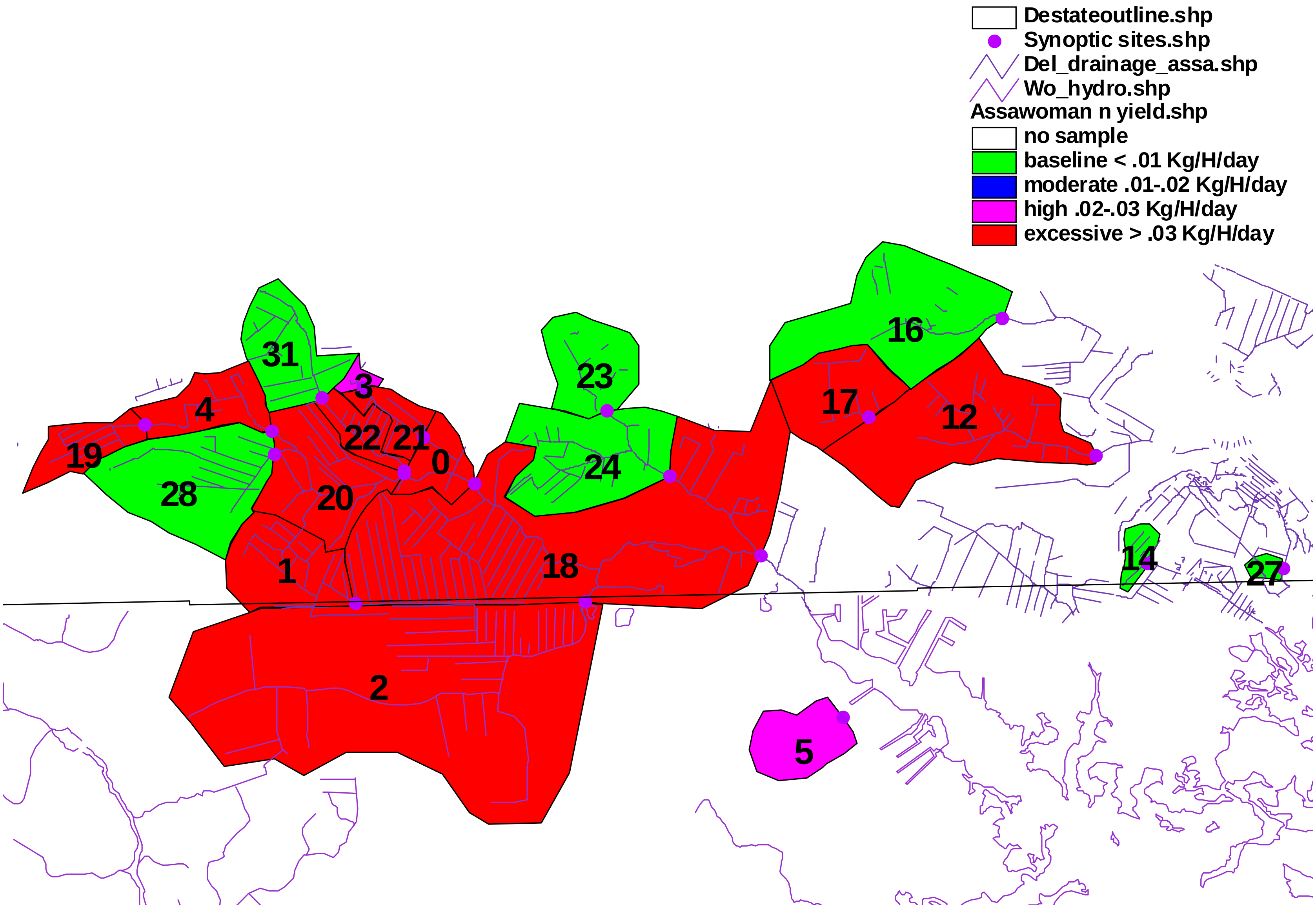


Figure 4. Assawoman Bay WRAS Nutrient Synoptic Survey March, 2005
Orthophpsphate (PO4) Concentration (mg/L)

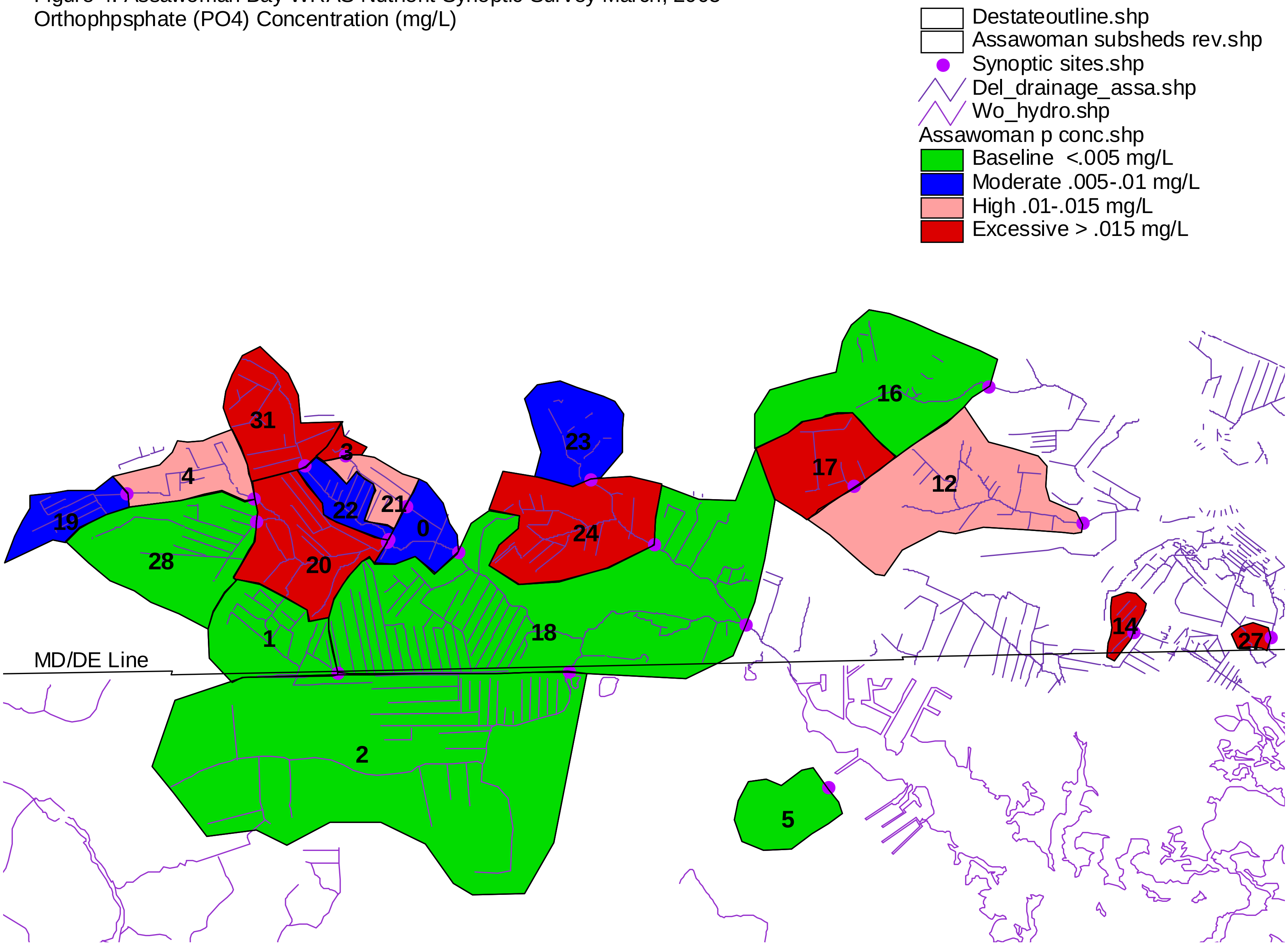


Figure 5. Assawoman Bay WRAS Nutrient Synoptic Survey March, 2005
Orthophosphate (PO4) Yield (Kg/H/day)

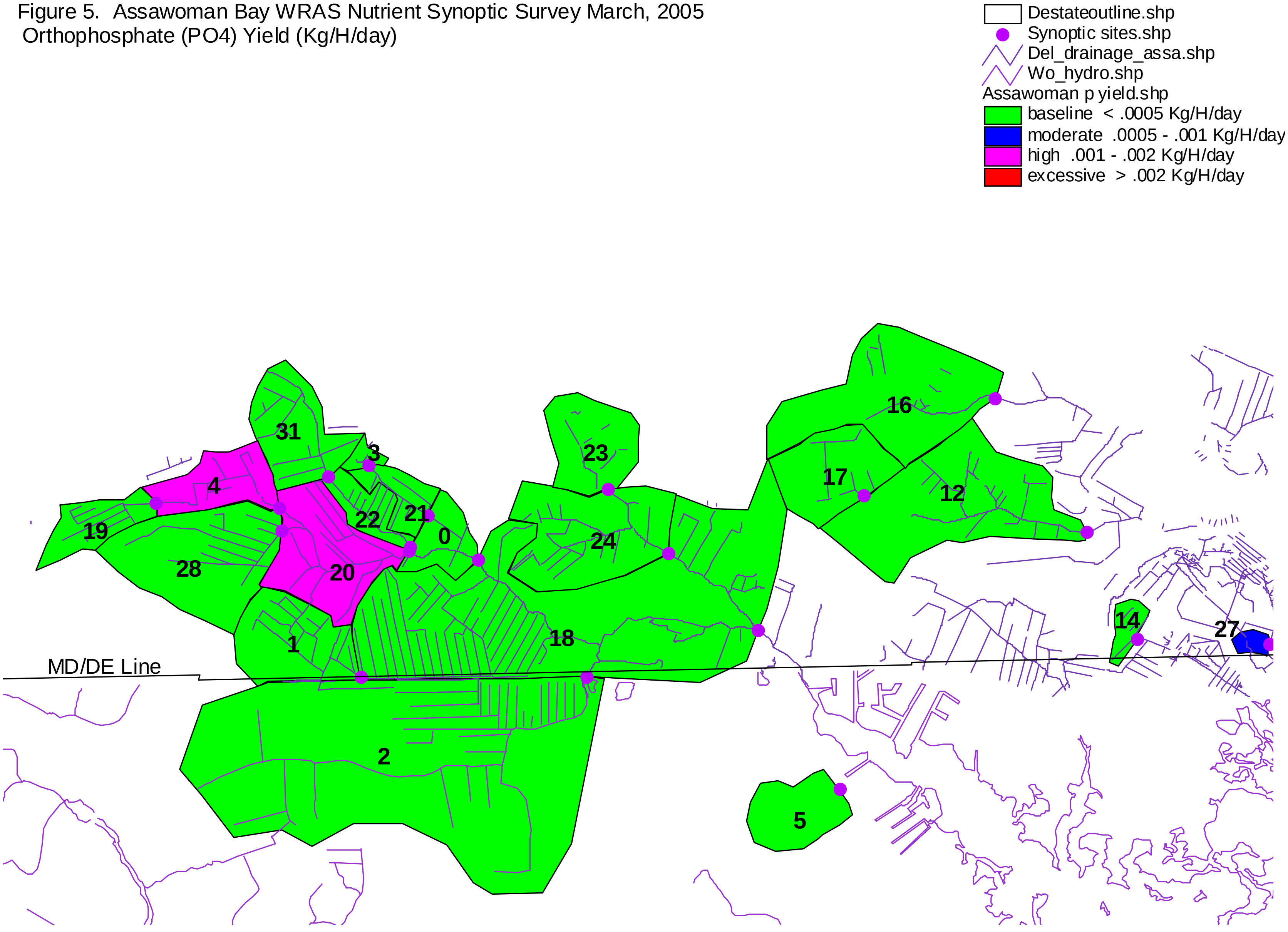


**Table 4. Assawoman Bay WRAS Nutrient Synoptic Survey March, 2005
Insitu Water Quality Parameters**

Station	Date	Time	Temp oC	pH	Dissolved O2 mg/L	Specific Conductivity mS/cm
0	11-Mar-05	1030	6.56	6.47	11.1	227
1	11-Mar-05	1425	10.41	5.86	13.4	218
2	11-Mar-05	1345	9.63	5.65	12.3	201
3	10-Mar-05	1000	5.70	6.70	10.5	500
4	10-Mar-05	1140	6.20	6.20	11.9	210
5	11-Mar-05	1230	7.22	5.68	8.2	145
12	10-Mar-05	1300	6.20	6.90	11.8	1980
14	11-Mar-05	1255	9.75	5.84	9.8	134
16	11-Mar-05	1105	6.23	5.48	7.2	110
17	11-Mar-05	1125	9.49	6.85	16.7	347
18	11-Mar-05	1145	7.32	6.32	11.7	199
19	11-Mar-05	920	8.36	6.37	11.2	217
20	10-Mar-05	1150	6.00	6.10	12.1	200
21	10-Mar-05	1050	3.80	7.03	11.9	270
22	10-Mar-05	1055	4.10	6.20	11.4	190
23	10-Mar-05	1020	4.10	7.00	13.4	380
24	11-Mar-05	945	7.87	5.71	8.6	177
27	10-Mar-05	1240	7.80	6.90	11.1	620
28	11-Mar-05	1010	5.73	6.11	8.7	216
31	10-Mar-05	1120	8.30	6.30	10.9	260

Figure 6. Assawoman Bay WRAS Nutrient Synoptic Survey March, 2005
Insitu Dissolved Oxygen (mg/L).

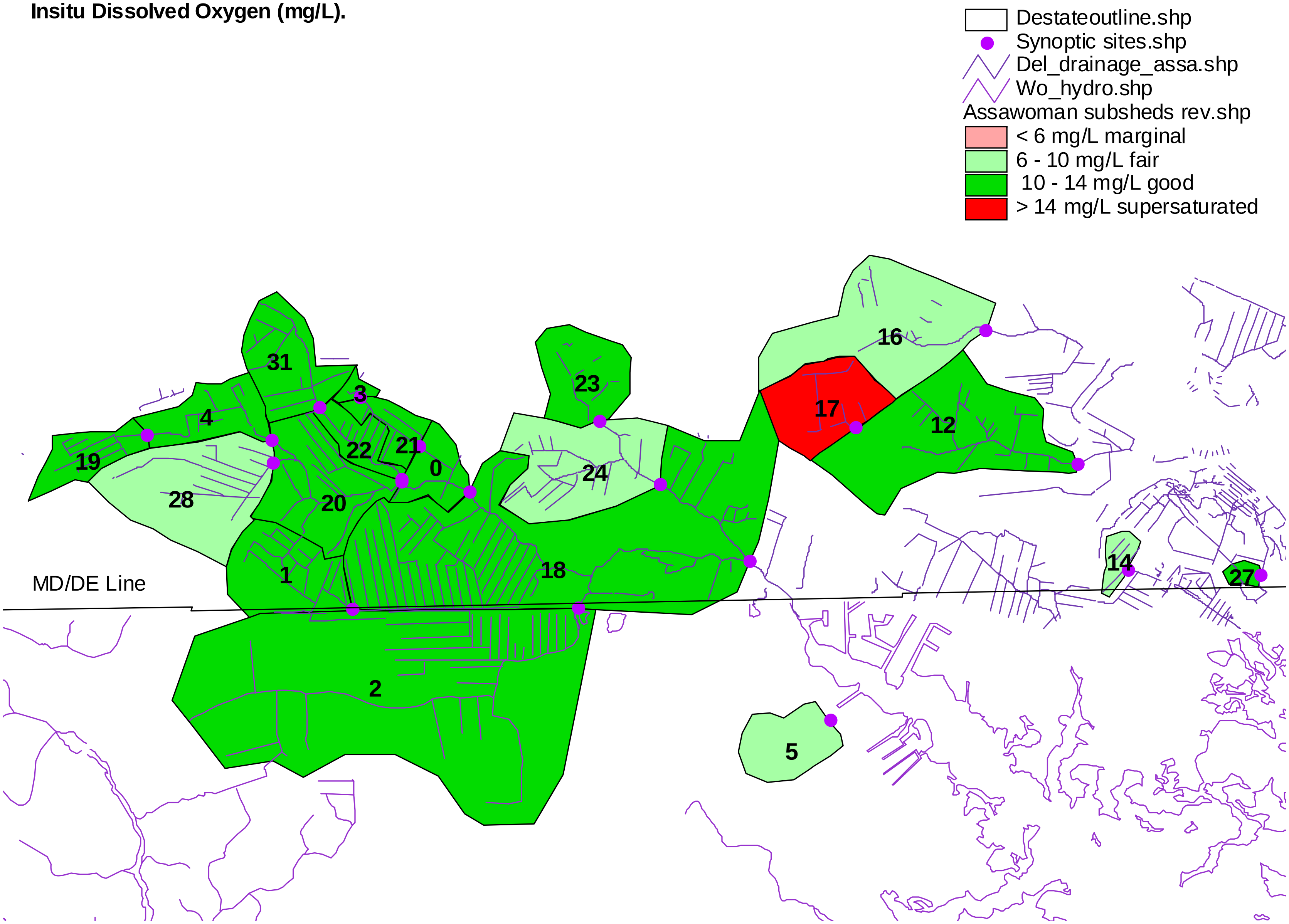
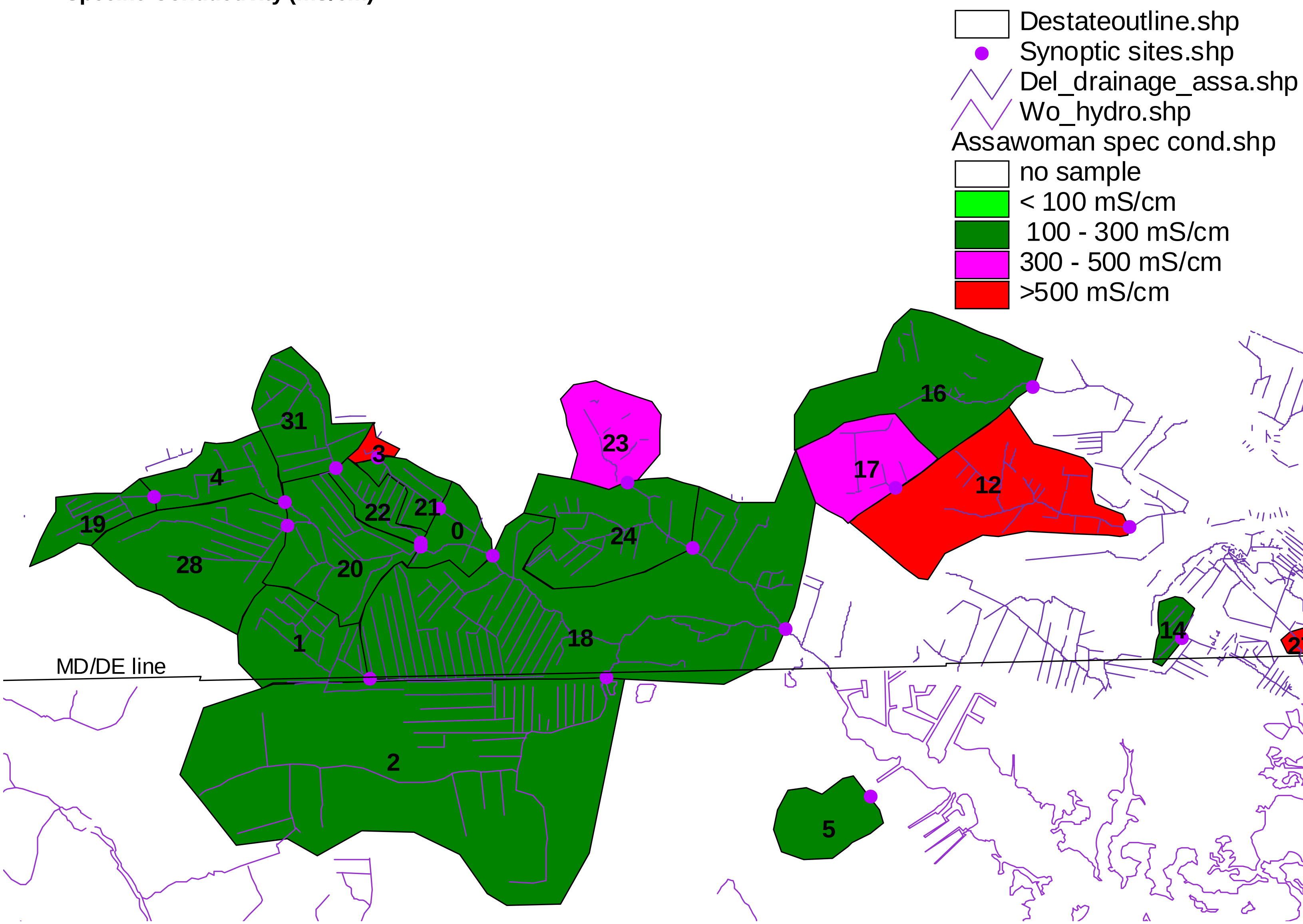


Figure 7. Assawoman Bay WRAS Nutrient Synoptic Survey March, 2005
Specific Conductivity (mS/cm)



Discussion

The elevated nitrate/nitrite concentrations and yields appear to be associated with row crop agriculture with substantial poultry litter use as a nutrient source. Residential communities with on-site sewage disposal (septic systems) have also been shown to be a contributing factor in elevated surface water nitrate/nitrite concentrations and yields. The elevated orthophosphate concentrations in the Assawoman watershed may be associated with suspended sediment from the considerable construction and mining activities. The average nutrient concentration from the Assawoman Bay watershed was high compared to other WRAS watersheds (Table 5). No significant anomalies were found in the insitu measurements of temperature or pH. The unusually high dissolved oxygen found in subwatershed 17 was apparently caused by a heavy growth of filamentous green algae. This heavy algae growth was being fueled by excessive nutrient concentrations in this subwatershed. As noted above, specific nutrient sources for this, or any of the other subwatersheds, are difficult to pinpoint from a single sample and have to be generalized. The elevated specific conductivity found at sites 12 and 27 is due to salt from tidewater influence. Both of these sites were tidal, but were sampled near the end of an ebb tide so flow direction was towards the coastal bay. Road salts contaminating the surface water is a definite possibility for site 3, due to a curve in the road at the culvert. The source of the elevated specific conductivity at the two other sites is unclear.

Table 5. Average Nutrient Concentrations from Other Nutrient Synoptic Surveys

Mg/L	**Piney**	**German Br.**	**Pocomoke**	**Isle of Wight**	**Chincoteague Bay**	**Newport Sinepuxent**	**Assawoman Bay**
NO2+NO3 Spring	3.742	3.832	3.734	3.11	**2.29**	**1.93**	**5.23**
NO2+NO3 Annual	4.823	4.704	2.384				
PO4 Spring	0.800	0.043	0.028	0.019	**0.018**	**0.03**	**0.023**
PO4 Annual	1.177	0.067	0.022				

Literature Cited

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