Prepared for:

Town of East Hampton, Connecticut

LAKE POCOTOPAUG 2003 IN-LAKE WATER SAMPLING RESULTS

March 2004

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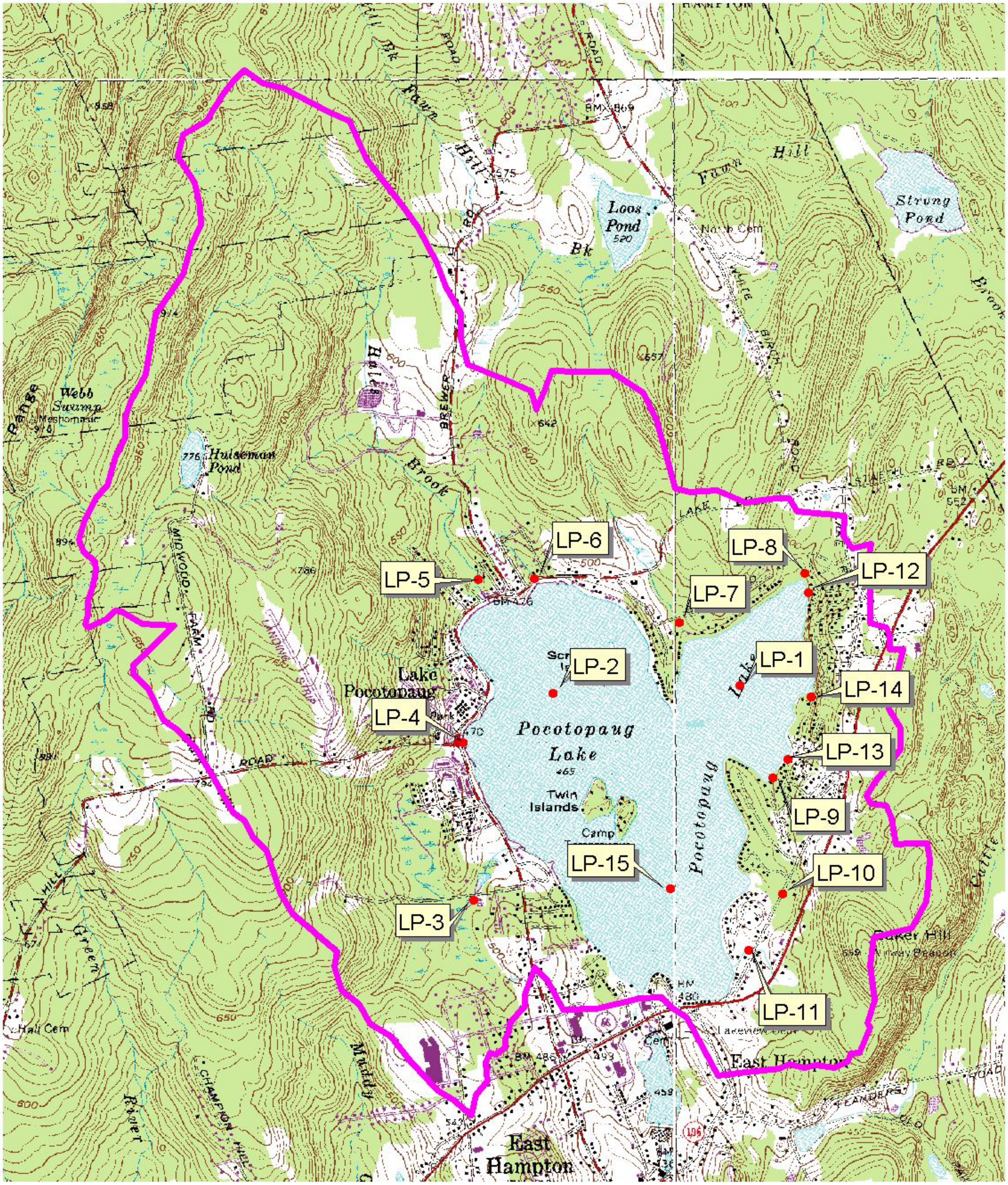
2003 IN-LAKE SAMPLING

Lake Pocotopaug was sampled at one in-lake station in 2003 (Figure 1), located in the western deep basin (Oakwood Basin; LP-2), on a monthly basis from April until September (the July sample was collected on August 1st). Sampling occurred at two depths (surface and bottom) in April, May and June and at three depths (surface, mid-depth, and bottom) for the remainder of the sampling period. Samples were analyzed for nutrients (total and dissolved phosphorus, ammonium nitrogen, nitrate nitrogen and total Kjeldahl nitrogen), conductivity, turbidity, and pH. Secchi disk transparency (SDT) and temperature/dissolved oxygen profiles were recorded during each sampling event. Two algal samples were collected on each date (surface and bottom) and analyzed by an ENSR taxonomist. Additional phytoplankton samples were taken during the summer months in an effort to detect an onset of an algal bloom. Three zooplankton samples were collected at LP-2 and analyzed by an ENSR taxonomist.

Dry, wet and post-wet weather tributary and storm drain sampling occurred during September 2003. Dry weather was categorized as 72 hours without a precipitation event. Wet weather sampling (first flush) was conducted using passive storm samplers during a precipitation event yielding at least 0.2 inches of rainfall following a period of dry weather. Details regarding the passive samplers are provided in *Lake Pocotopaug Lake and Watershed Restoration Evaluation East Hampton, Connecticut* (ENSR, 2002). The post-wet sampling occurred during the waning hydrograph (period of reduced flow) of the wet weather event sampled. Together, these samples provide insight into which time period presents the worst possible conditions (i.e., high nutrient loading) for the lake.

The efficacies of the two Stormceptors®, recently installed by the Town of East Hampton, were tested in 2003. Runoff was sampled at two locations, one at the treatment device inlet and one at the outlet. Unfortunately, the point at which samples could be taken from the outlet of each treatment device contained incoming water from another source. It would be preferable to sample the outlet of each device upgradient of the additional discharge but this could not be accomplished without direct access to the storm septor. These devices are located along or in the middle of a public street and access by ENSR personnel without a traffic detail would be unsafe.



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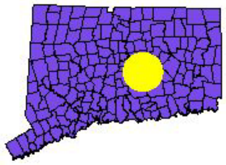

Lake Pocotopaug
2001-2002 Sampling Locations

Source:
Base Map: Scanned USGS Topographic Map from http://magic.lib.uconn.edu/
Watershed delineation: From topography, field reconnaissance and previous reports

300 0 300 600 Meters

Figure 1

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CHEMICAL AND PHYSICAL RESULTS

In-Lake

Temperature profiles for Lake Pocotopaug in 2003 indicate that the lake began to stratify in May and was stratified in August (Figure 2). Profiles from previous years indicate strong thermal stratification during the months of July and August and sometimes late June. Dissolved oxygen concentrations followed roughly the same pattern as temperature. Anoxia was present above the thermocline in August and September.

Lake Pocotopaug 2003 pH and conductivity values were comparable to previous years. The pH in 2003 ranged from 6.0 to 7.6 SU (Table 1), with higher values reported in surface samples. Conductivity was relatively consistent throughout the water column and sampling period with one value greater than 200 umhos/cm occurring at the bottom in September. Values ranged from 74 to 252 umhos/cm with a surface water average of 96 umhos/cm. Values from 1991 to 2002 ranged from 44 to 174 umhos/cm.

Surface water turbidity in 2003 ranged from 1.3 to 6.0 NTU, with an average of 3.2 NTU (Table 1). Surface turbidity values in previous years (1991-2002) ranged from 0.5 – 13.0 NTU. Values at or above 5.0 NTU (threshold for "clean" New England lakes) were reported at the surface during late August and September. Bottom samples were higher, ranging from 1.6 to 20.2 NTU, which is typical for bottom waters with increased suspended solids.

Total Kjeldahl nitrogen (TKN) is a measure of organic nitrogen and ammonium. Ammonium and nitrate nitrogen are inorganic forms which are readily available for algal uptake. The sum of TKN and nitrate is the total nitrogen content. Levels of TKN greater than 3.0 mg/L are generally considered high while levels less than 0.3 mg/L are considered low. Similarly, levels of ammonium nitrogen greater than 1.0 mg/L are generally considered high while concentrations less than 0.1 mg/L are considered low.

TKN at the surface water stations ranged from 0.2 to 0.6 mg/L, with an average of 0.5 mg/L in the moderate range (Table 1). Bottom water samples ranged from 0.5 to 2.9 mg/L, with an average of 1.3 mg/L. Surface water values in 1991-2002 ranged from 0.3 to 0.9 mg/L. Nitrate concentrations were low; 67% of the samples were below the 0.01 mg/L detection limit. Nitrate levels in 2003 were comparable to previous years. Ammonium nitrogen was low at the surface (<0.1 mg/L) but elevated at the bottom (>1.0 mg/L). Average 2003 surface water ammonium concentration was comparable with previous years.

Average summer surface water phosphorus was higher in 2003 than in 2002 (0.024 vs. 0.022 mg/L, respectively). However, this difference was not significantly different ($P>0.05$). Summer surface water total phosphorus concentrations were significantly higher in 2003 than in 2001 and several previous years ($P<0.05$; Figure 3). Summer bottom total phosphorus concentrations in 2003 were not significantly different than previous years ($P>0.05$; Figure 4). Overall surface total phosphorus concentrations were low on average and were not at levels that normally cause frequent or intense algal blooms. Average bottom total phosphorus concentration for the 2003 sampling period was 0.129 mg/L. Surface dissolved phosphorus concentrations in 2003 were also generally low, ranging from 0.012 to 0.022 mg/L, with an average of 0.015 mg/L. Dissolved phosphorus concentrations at the bottom were slightly elevated, ranging from 0.016 to 0.202, with an average of 0.078 mg/L; higher than the last three years (Figure 5). The highest concentrations were recorded during late August and September.

Figure 2. Lake Pocotopaug Temperature and Dissolved Oxygen Profiles 2003.

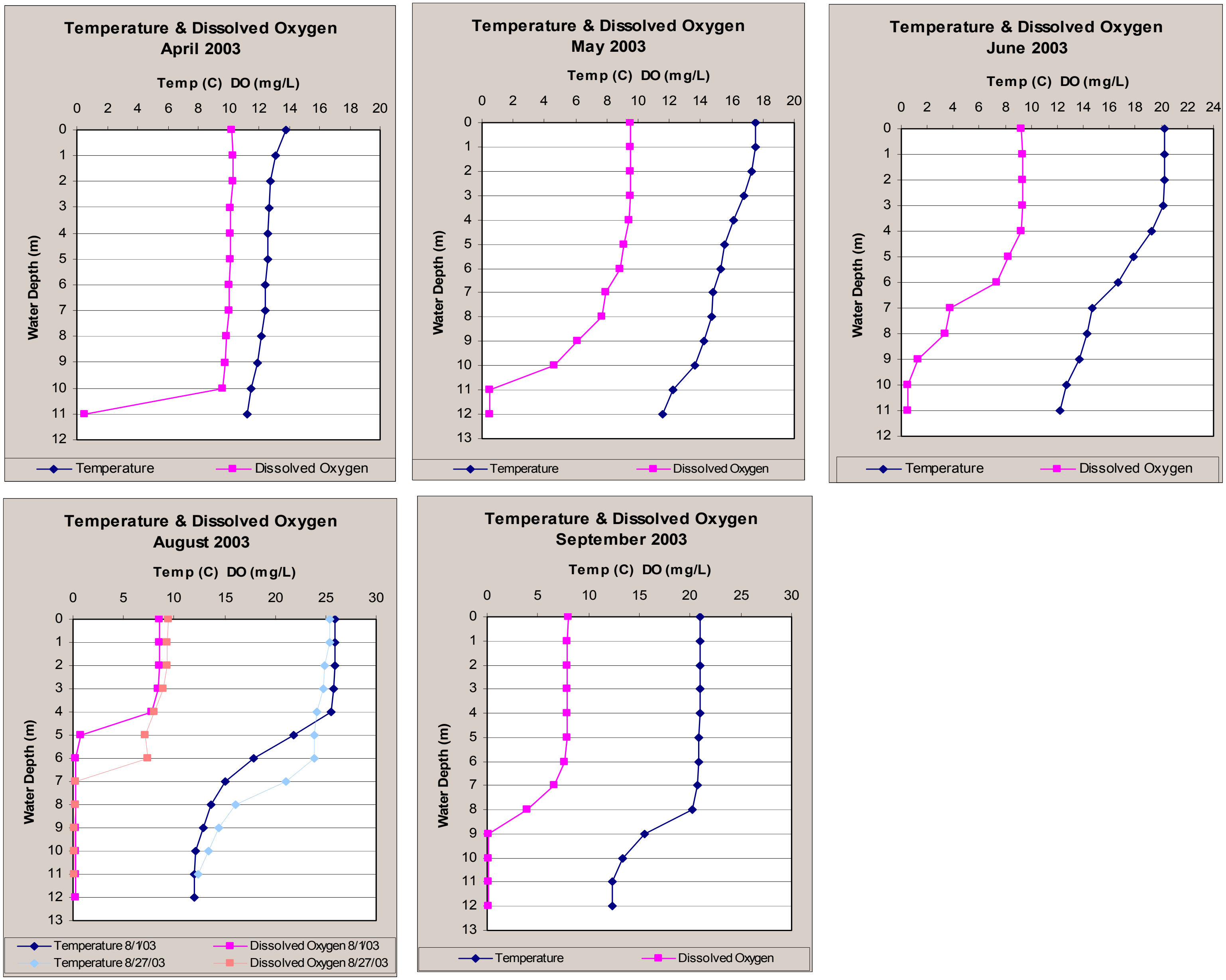


Table 1. Water Quality Sampling Results during 2003.

		4/29/2003	5/30/2003	6/16/2003	8/1/2003	8/27/2003	9/26/2003		Min	Max	Mean
pH (SU)	LP-2S	6.7	6.8	7.0	7.6	7.6	7.1		6.7	7.6	7.1
	LP-2M	NS	NS	NS	6.0	7.3	6.9		6.0	7.3	6.7
	LP-2B	6.5	6.2	6.3	6.7	6.7	7.4		6.2	7.4	6.6
Conductivity (umhos/cm)	LP-2S	74.4	105.9	88.7	98.0	103.0	103.0		74.4	105.9	95.5
	LP-2M	NS	NS	NS	106.0	100.0	104.0		100.0	106.0	103.3
	LP-2B	104.8	111.3	103.0	173.0	177.0	252.0		103.0	252.0	153.5
Turbidity (NTU)	LP-2S	1.58	1.93	1.30	3.64	5.99	5.00		1.30	5.99	3.24
	LP-2M	NS	NS	NS	2.59	7.44	5.80		2.59	7.44	5.28
	LP-2B	3.61	3.83	1.60	6.04	7.56	20.20		1.60	20.20	7.14
Ammonium (mg/L)	LP-2S	0.02	0.03	0.01	0.02	0.02	0.02		0.01	0.03	0.02
	LP-2M	NS	NS	NS	0.04	0.04	0.02		0.02	0.04	0.03
	LP-2B	0.05	0.10	0.54	0.34	3.13	1.90		0.05	3.13	1.01
Nitrate (mg/L)	LP-2S	0.12	0.06	0.02	<0.01	<0.01	<0.01		<0.01	0.12	0.07
	LP-2M	NS	NS	NS	<0.01	<0.01	<0.01		<0.01	<0.01	<0.01
	LP-2B	0.12	0.02	<0.01	<0.01	<0.01	<0.01		<0.01	0.12	0.07
TKN (mg/L)	LP-2S	0.60	0.20	0.20	0.50	0.60	0.60		0.20	0.60	0.45
	LP-2M	NS	NS	NS	0.30	0.60	0.50		0.30	0.60	0.47
	LP-2B	0.70	0.50	0.60	0.60	2.60	2.90		0.50	2.90	1.32
Total Nitrogen (mg/L)	LP-2S	0.72	0.26	0.22	0.51	0.61	0.61		0.22	0.72	0.49
	LP-2M	NS	NS	NS	0.31	0.61	0.51		0.31	0.61	0.47
	LP-2B	0.82	0.52	0.61	0.61	2.61	2.91		0.52	2.91	1.34
Total Phosphorus (mg/L)	LP-2S	0.022	0.025	0.022	0.025	0.016	0.034		0.016	0.034	0.024
	LP-2M	NS	NS	NS	0.019	0.033	0.042		0.019	0.042	0.031
	LP-2B	0.048	0.041	0.036	0.066	0.325	0.257		0.036	0.325	0.129
Dissolved Phosphorus (mg/L)	LP-2S	0.013	0.014	0.022	<0.010	0.014	0.012		0.012	0.022	0.015
	LP-2M	NS	NS	NS	<0.010	<0.010	<0.010		<0.010	<0.010	<0.010
	LP-2B	0.016	0.030	0.027	0.038	0.202	0.156		0.016	0.202	0.078
Secchi Disk Transparency (ft)		4.8	7.0	8.0	3.5	3.2	2.8		2.8	8.0	4.9

NS = not sampled

Figure 3. Surface (Epilimnetic) Water Total Phosphorus at Oakwood Basin (LP-2).

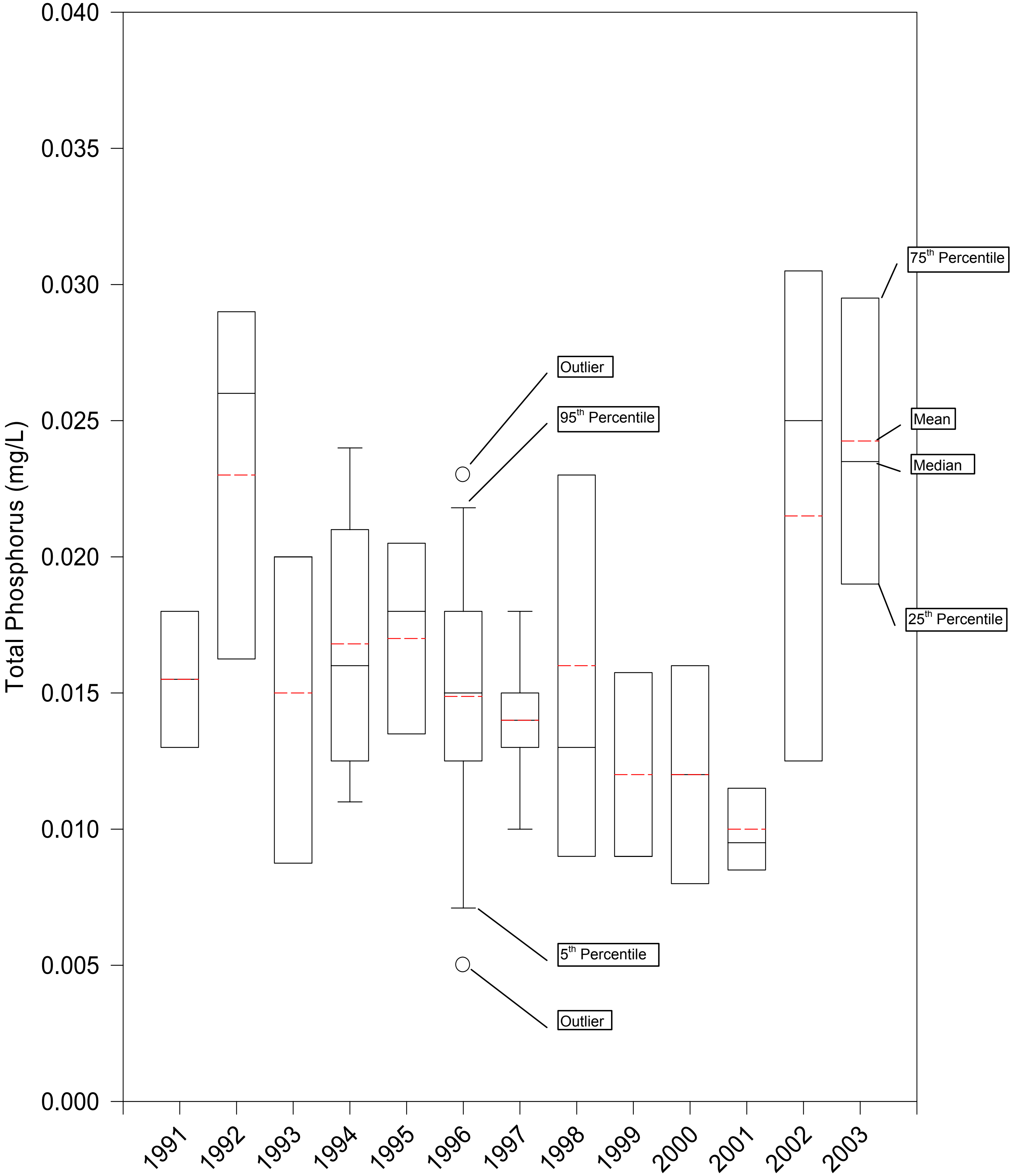


Figure 4. Bottom (Hypolimnetic) Water Total Phosphorus at Oakwood Basin (LP-2).

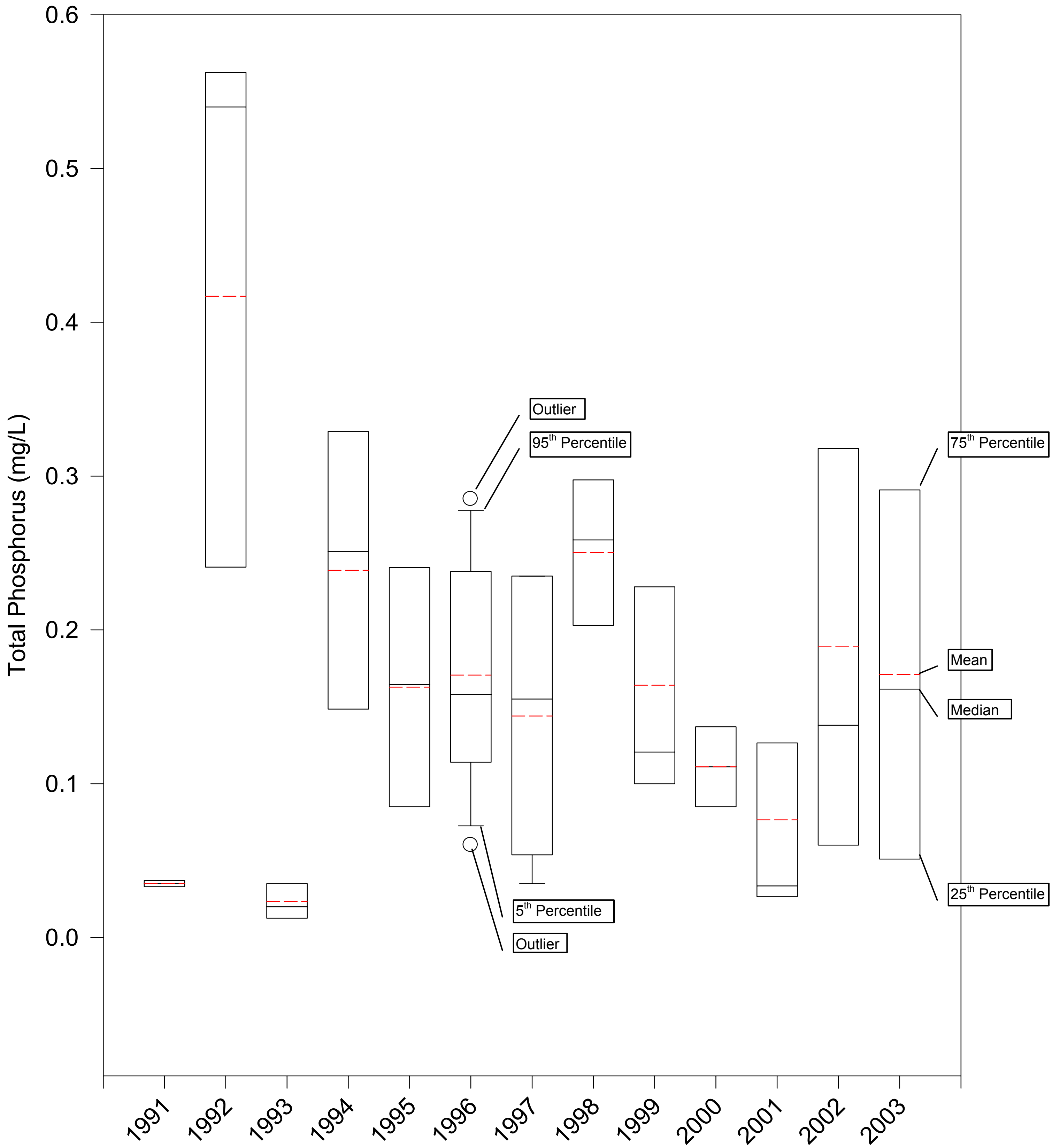
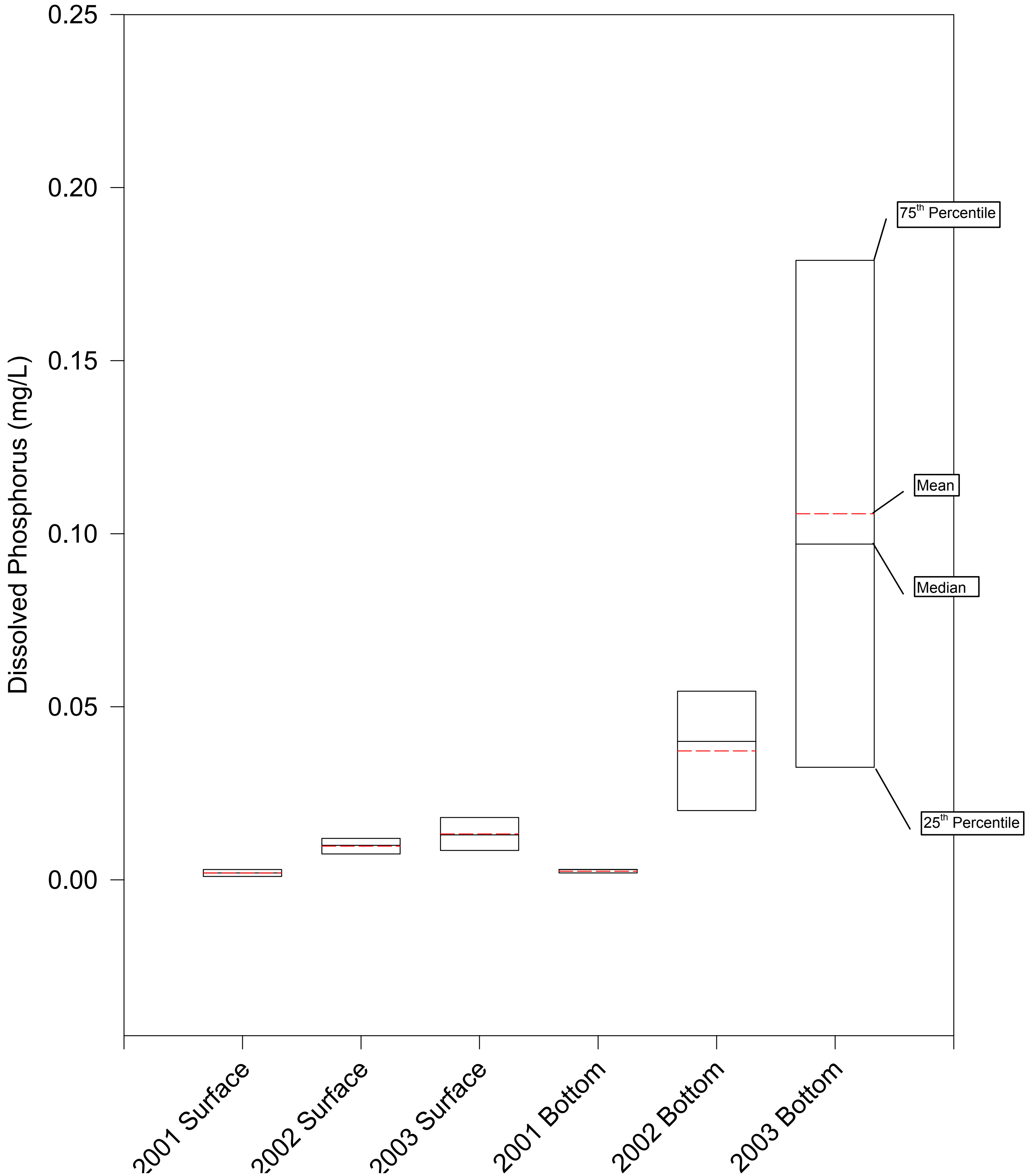


Figure 5. Lake Pocotopaug Dissolved Phosphorus at Oakwood Basin (LP-2) 2001-2003.



Secchi disk transparancy (SDT) ranged from 2.8 to 8.0 feet. The maximum Secchi depth in 2003 was higher than the maximum in 2002 (6.0'). Historically August and September have the lowest Secchi Depth Transparencies (Figure 6).

Watershed

Dry weather watershed sampling occurred at three locations (LP-3, LP-5, and LP-10) on September 22, 2003. Additional tributary and stormwater sampling locations (LP-4, LP-7, and LP-11) were dry on September 22, 2003 and were therefore not sampled. Dry weather nitrogen and phosphorus concentrations were low to moderate at these three locations (Table 2). Turbidity was also low. Conductivity was elevated at LP-10 (O'Neil's Brook). Values for pH were within the normal range.

Two passive stormwater samplers were set at each location (all six sites) during the dry weather sampling event. Unfortunately, due to heavy rain (Hartford, CT received 1.3 inches of rain on September 23, 2003) samplers at two stations washed away (LP-7 and LP-11). Nutrient concentrations during wet weather were excessive. Total nitrogen concentrations ranged from 4.4 to 25.3 mg/L. The highest concentration was recorded at LP-5 (Hales Brook). Total phosphorus concentrations ranged from 2.1 to 3.8 mg/L. Dissolved phosphorus concentrations ranged from 0.03 to 0.23 mg/L. The highest dissolved phosphorus concentration was recorded at LP-4 (Clark Hill storm drain). Turbidity values were excessive (>150 NTU). Conductivity and pH values were generally lower under wet conditions than under dry. The samplers were picked up the morning of September 24, 2003. A post-wet sample was collected at this time if flowing water was present in the tributaries or storm drains. Five post-wet samples were collected (LP-4 was not flowing). Post-wet total nitrogen and total phosphorus concentrations were generally higher than dry weather samples but lower than wet-weather. The post-wet sample at LP-10 contained a higher concentration of dissolved phosphorus than the wet or dry sample, indicating that phosphorus loading is still substantial at this location at the end of the storm. Post-wet turbidity values were acceptable at all location except LP-10. Post-wet conductivity values were comparable to dry weather, except at LP-10 where post-wet conductivity was more similar to wet weather conditions. Based on these data, one might expect the watershed size of LP-10 to be quite large, however, this sub-watershed is rather small and the continued release of high nutrient concentrations is like due to retention basins within this drainage area. Although these basins can provide efficient remove of suspended sediment, it is unlikely that they provide substantial attenuation of dissolved particles such as dissolved phosphorus and nitrate nitrogen. The Clark Hill storm drain contained the highest concentration of nutrients overall.

In an attempt to quantify the removal capacity of the Stormceptor® devices (Clark Hill and proximal to Ola Avenue) installed by the Town of East Hampton, sampling during a precipitation event occurred at the inflow and outflow of these devices. Upon inspection during the precipitation event on December 11, 2003, it was noted that the outlet of each device could not be sampled upgradient of additional discharges. A storm drain outfall enters into the Clark Hill effluent beneath North Main Street. Therefore, the man-hole cover in the middle of North Main Street would have had to be removed in order to sample the Clark Hill storm septor discharge without the secondary storm drain influence. The Ola Avenue storm septor discharge was influenced by surface runoff from the residential area along North Main Steet and Ola Avenue. The surface flow is channeled beneath North Main Street. The confluence of the Ola Avenue and surface flow is beneath North Main Street and not easily accessible by ENSR personnel.

Figure 6. Average Secchi Disk Transparency 1991-2003 at Oakwood Basin (LP-2)

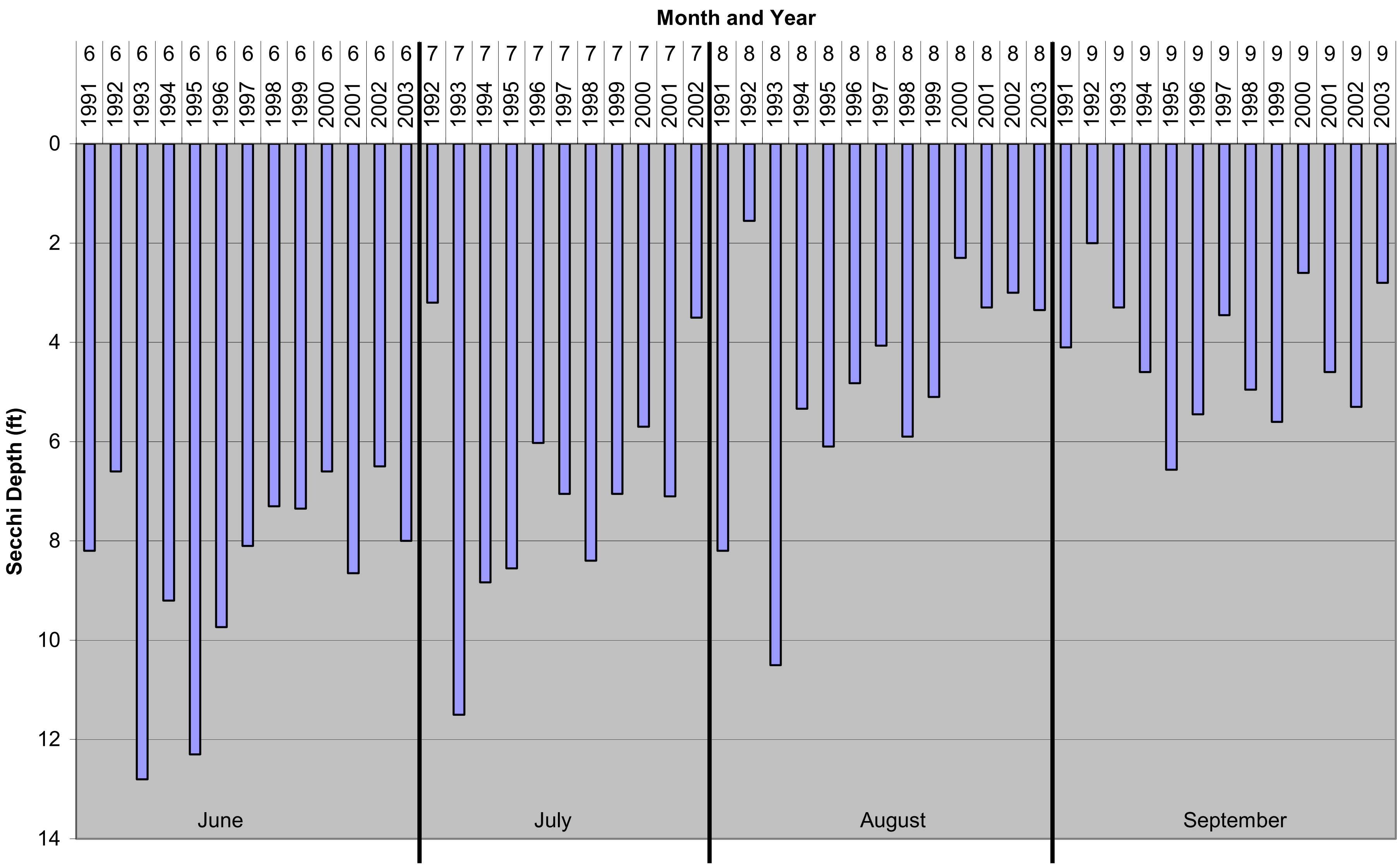


Table 2. Lake Pocotopaug 2003 Watershed Sampling Results

	LP-3			LP-5			LP-10			LP-4	LP-7	LP-11
	9/22/03	9/23/03	9/24/03	9/22/03	9/23/03	9/24/03	9/22/03	9/23/03	9/24/03	9/23/03	9/24/03	9/24/03
	Dry	Wet	Post-Wet	Dry	Wet	Post-Wet	Dry	Wet	Post-Wet	Wet	Post-Wet	Post-Wet
Ammonium (mg/L)	0.06	0.04	0.03	<0.01	0.02	<0.01	0.14	0.05	0.08	0.05	0.01	0.04
Nitrate (mg/L)	0.25	0.18	0.18	0.16	0.08	0.08	0.4	0.48	0.43	0.38	0.02	0.04
TKN (mg/L)	0.5	16.4	0.7	0.2	25.2	0.3	0.4	8.2	0.8	4	0.3	0.7
Total Nitrogen (mg/L)	0.75	16.58	0.88	0.36	25.28	0.38	0.8	8.68	1.23	4.38	0.32	0.74
Total Phosphorus (mg/L)	0.027	2.1	0.031	<0.010	3.09	0.02	0.03	2.5	0.156	3.76	0.022	0.031
Dissolved Phosphorus (mg/L)	0.022	0.042	0.022	<0.010	0.031	0.017	0.027	0.042	0.045	0.230	0.022	0.028
Turbidity (NTU)	2.3	300	1.5	0.8	290	1.5	2.9	250	11	180	1.9	1.5
Specific Conductivity (umhos/cm)	133	84	84	60	40	40	343	150	179	53	39	52
pH (SU	6.7	5.7	5.9	7	6.2	6.4	6.8	6.6	6.6	7.4	5.9	5.6

Two sets of samples were taken (one at the beginning of the storm and one near the end). Hartford, CT received 0.7 inches of rain during this precipitation event. Precipitation started around 6:00 am and ended around 1:30 pm. The first sample was collected around 10:00 am and the final sample was collected around 2:00 pm (Table 3). Generally, nutrient levels at the Clark Hill device were slightly lower at the outlet than at the inlet during this event. The percent total nitrogen concentration difference in inlet verses outlet ranged from 43-50%. The Ola Avenue device outlet had higher total nitrogen concentrations than the inlet. Total phosphorous concentrations were 7-24% lower at the Clark Hill outlet. The Ola Avenue total phosphorus concentration in the outlet was 40-59% lower. Outlet dissolved phosphorus concentrations for both the Clark Hill and Ola Avenue were between 10-72% lower than inlet concentrations. Turbidity was 10-66% lower at the outlet than the inlet from these devices. These data should be viewed with caution, however, since the percent difference could be related to dilution from additional discharges and not removal capacity of the devices.

BIOLOGICAL RESULTS

2003 Phytoplankton

Phytoplankton were collected on 12 dates between late April and late August, with the intent of tracking the rise of any blooms, especially of the problem cyanophyte (blue-green) *Anabaena aphanizomenoides*. Samples were preserved in gluteraldehyde and viewed under a microscope after at least 3 days of settling and sample concentration to a factor of about 10. This way, the dominant plankton were immediately evident and other species present were encountered in less than half an hour of sample examination. Results are reported on a semi-quantitative scale: present, common and abundant, with abundant indicating phytoplankton at a level that might warrant closer observation and possible management action.

During spring and summer of 2003, the phytoplankton of Lake Pocotopaug underwent a transition from a diatom-dominated community to one with abundant *Anabaena aphanizomenoides* (Table 4). It was a relatively slow transition, with moderate levels of the diatom *Tabellaria* encountered in April through early July, and higher levels of *Anabaena* not detected until early August (in the last sample). A variety of green algae were present with the diatoms, but the phytoplankton assemblage was not considered to represent a threat to recreational water use or to aquatic fauna. Indeed, the diatoms and green algae are important components of the open water food web. *Anabaena aphanizomenoides* first appeared in mid-July, in a surface sample, but did not become abundant for several weeks and even then did not reduce clarity to the low levels observed in some other years.

Anabaena aphanizomenoides was detected in some summer bottom samples, but only as a few scattered filaments, so the intended early warning of a possible bloom was never given. *A. aphanizomenoides* was especially low in pigment in 2003, resulting in limited water coloration and loss of clarity. Although the presence of algae was evident in August, it was not sufficient to discourage swimming. Few akinetes were observed on filaments of *A. aphanizomenoides* in any sample; akinetes are the resting stages that are deposited on the lake bottom and from which new algae "hatch" in subsequent years.

Chlorophyll a concentrations ranged from 1.0 to <4.0 ug/L through mid-July, an acceptable range for contact recreation. As a consequence, Town government decided not to perform the permitted treatment with copper. Without any apparent public complaint late in the swimming

Table 3. Lake Pocotopaug 2003 Storm Septor Sampling Results

12/11/2003	Clark Hill				Near Ola Ave			
	Initial 10:15		Final 13:10		Initial 10:45		Final 13:55	
	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
Ammonium (mg/L)	0.05	0.06	0.04	0.04	0.13	0.05	0.07	0.03
Nitrate (mg/L)	<0.01	<0.01	0.15	0.17	0.22	0.23	0.6	0.31
TKN (mg/L)	1.4	0.8	0.2	0.1	0.6	0.6	0.2	0.9
Total Nitrogen (mg/L)	1.405	0.805	0.35	0.27	0.82	0.83	0.8	1.21
Total Phosphorus (mg/L)	2.158	1.635	0.335	0.313	1.041	0.629	0.319	0.131
Dissolved Phosphorus (mg/L)	0.267	0.21	0.163	0.147	0.191	0.057	0.093	0.026
Turbidity (NTU)	500	398	81	73	290	100	55	23
Specific Conductivity (umhos/cm)	293	359	352	348	417	158	326	62
pH (SU	6.8	6.8	6.7	6.7	6.9	6.1	7.1	6
Ammonium Difference %	-20		0		62		57	
Nitrate Difference %	0		-13		-5		48	
TKN Difference %	43		50		0		-350	
Total Nitrogen Difference %	43		23		-1		-51	
Total Phosphorus Difference %	24		7		40		59	
Dissolved Phosphorus Difference %	21		10		70		72	
Turbidity Difference %	20		10		66		58	

Table 4. Lake Pocotopaug 2003 Phytoplankton

X =present, XX=common, XXX=abundant	LP-2S	LP-2B	LP-2S	LP-2B	LP-2S	LP-2B	LP-2S	LP-2B	LP-2S	LP-2B	LP-2S	LP-2B	LP-2S	Beach	LP-2S	LP-2	Beach	LP-2S	LP-2S	LP-2B
TAXON	4/29	4/29	5/30	5/30	6/16	6/16	6/26	6/26	7/07	7/07	7/16	7/16	7/23	7/24	8/01	8/01	8/11	8/15	8/27	8/27
BACILLARIOPHYTA																				
Centric Diatoms																				
Aulacoseira	xx	xx	xx	xx						xx		x				x	x	x	x	x
Cyclotella																				
Stephanodiscus										x										
Araphid Pennate Diatoms																				
Asterionella	xx	xx	x	x	x			x		x	x	x		x						
Synedra	x	x																		
Tabellaria	xx	xx	xx	xx	xxx	x	xxx	x	xx	xx	x	x	x	x	x	x	x	x	x	x
Monoraphid Pennate Diatoms																				
Biraphid Pennate Diatoms																				
Eunotia		x								x										
Nitzschia										x					x		x			
Pinnularia										x										
Surirella										x										
CHLOROPHYTA																				
Flagellated Chlorophytes																				
Gonium							x													
Coccoid/Colonial Chlorophytes																				
Closteriopsis	x				x			x							x					
Dictyosphaerium					x			x							x					
Elakatothrix			x	x	x													x		
Scenedesmus											x									
Schroederia					x		x													
Sphaerocystis		x		x											x					
Filamentous Chlorophytes																				
Desmids																				
Staurodesmus	x	x													x	x	x			
CHRYSOPHYTA																				
Flagellated Classic Chrysophytes																				
Dinobryon	x	x	x	x			xx	x		x					x					

Table 4 continued. Lake Pocotopaug 2003 Phytoplankton

X =present, XX=common, XXX=abundant	LP-2S	LP-2B	LP-2S	LP-2B	LP-2S	LP-2B	LP-2S	LP-2B	LP-2S	LP-2B	LP-2S	LP-2B	LP-2S	Beach	LP-2S	LP-2	Beach	LP-2S	LP-2S	LP-2B
TAXON	4/29	4/29	5/30	5/30	6/16	6/16	6/26	6/26	7/07	7/07	7/16	7/16	7/23	7/24	8/01	8/01	8/11	8/15	8/27	8/27
Non-Motile Classic Chrysophytes																				
Haptophytes																				
Tribophytes/Eustigmatophytes																				
Raphidophytes																				
CRYPTOPHYTA																				
Cryptomonas							x				x									
CYANOPHYTA																				
Unicellular and Colonial Forms																				
Aphanothece									x											
Chroococcus									x											
Coelosphaerium					x													x		
Filamentous Nitrogen Fixers																				
Anabaena sp.							x		x						x		x	xxx		
Anabaena aphanizomenoides									x		xx	x	xx	xx	xxx	x	xxx	xxx	xxx	x
Filamentous Non-Nitrogen Fixers																				
Lyngbya													x		xx	x	xx	xx	xx	
EUGLENOPHYTA																				
Trachelomonas	x	x	x	x			x									x	x			
PYRRHOPHYTA																				

season, it was perceived that the risks of impacts to non-target organisms (mainly fish) were greater than any benefit that would be realized at that time.

There is some perception that the intensity of blooms is subsiding, and it is possible that the reduction in available surficial sediment phosphorus produced by the alum treatment is causing a gradual improvement of conditions. However, it is also possible that observed conditions in 2003 are a function of weather, including greater flushing and lower incident light (more cloudy days). Further monitoring of algae is warranted.

2003 Zooplankton

Zooplankton were sampled in Lake Pocotopaug on three spring dates in 2003. Zooplankton were present but not abundant on each date, and abundance declined through the spring, presumably as fish predation increased (Table 5). No especially large-bodied forms were detected, although some *Daphnia* were common in the April sample and were present in the May and June samples. Smaller cladocerans were found in each sample, along with cyclopoid and calanoid copepods. Rotifers were generally sparse, with a peak at moderate levels in the May sample. Overall, body size was low to moderate, suggesting that the stocking of walleye has not yet had a major effect on panfish abundance and related predation on zooplankton. That stocking program has only been going on for two years, while effects are more commonly noted after about five years, when the stocked walleye have achieved a larger size. Good growth has been reported for walleye stocked in the first year of the program, but the population is simply not large enough yet to control small white and yellow perch.

Table 5. Lake Pocotopaug 2003 Zooplankton.

	ZOOPLANKTON DENSITY (#/L)		
	LP-2	LP-2	LP-2
TAXON	4/29/03	5/30/03	6/16/03
ROTIFERA			
Kellicottia		XX	
Polyarthra			X
COPEPODA			
Copepoda-Cyclopoida			
Cyclops	XX	X	
Mesocyclops	X	X	X
Copepoda-Calanoida			
Diaptomus	XX	X	X
Other Copepoda-Nauplii	XX	X	X
CLADOCERA			
Bosmina	XX	XX	X
Ceriodaphnia	X		
Daphnia ambigua	XX	X	X
Diaphanosoma		X	X

DISCUSSION AND RECOMMENDATIONS

2004 phytoplankton sampling of the lake should proceed in an effort to determine the onset of an algal bloom, much as was attempted in 2003. This will enable the Town to perform an algaecide treatment (copper) if it becomes necessary based on collected data, although another application for a permit appears necessary. Sampling of phytoplankton should continue to include sampling within the hypolimnion, beginning in June and extending until any bloom develops. This would provide data regarding algae near the sediment water interface, presumably where the *Anabaena* gets its start. Algae that lay dormant in the hypolimnetic sediments are still believed to be responsible for the summer blooms, although we saw no evidence of any population growth in deep water before the bloom in 2003. Luxury uptake of phosphorus in those sediments with migration of phytoplankton to the photic zone could be causing the blooms observed at Lake Pocotopaug during periods of low phosphorus concentration in the epilimnion, although the watershed inputs in 2003 were larger than in recent years and may account for higher nutrient levels.

The hypolimnion of the lake could be treated with an algaecide if a bloom onset is detected, specifically a form of copper. Copper algaecides disrupts photosynthesis, nitrogen metabolism, and membrane transport. It can be applied in liquid or granular form. In Lake Pocotopaug, the liquid form could be applied with an injection system, like those used to apply alum at depth, concentrating the algaecide in the hypolimnion, or a pelletized form could potentially be applied to yield similar results. Copper compounds can be toxic to aquatic fauna. However, concentrating the algaecide in the hypolimnion during anoxia would mitigate toxicity since nearly all organisms of concern reside in metalimnetic and epilimnetic layers where oxygen is plentiful. In addition, hypolimnetic injection would reduce the impact of any toxicity or nutrient recycling from lysing cells since cell material would likely be contained in this stratified layer where few biota are found.

It is envisioned that a late spring or early summer treatment in both deep basins (Oakwood and Markham) would occur before algal migration to the photic zone. Hypolimnetic water should be sampled for phytoplankton on a weekly basis starting in June. Application of the algaecide is to commence as soon as a substantial increase in phytoplankton numbers is observed. State permits would be necessary, so a permit should be in hand by late June 2004. Hypolimnetic monitoring should occur on a monthly basis after treatment to assess the effectiveness and any secondary release of algae from the bottom sediments. ACT has supplied the Town with a memorandum outlining how such a treatment could be conducted, with associated costs. This is a relatively inexpensive experiment that could disrupt the life cycle of the problem alga. The best case scenario would be that less resting stages are laid down each year and the population disappears over time. Certainly there were less resting stages observed in 2003 than in 2002 or 2001. It is possible that the relief will be only temporary, but this approach is worth pursuing.

Alternatives are limited at this time. Additional alum treatment may further inactivate P in the sediment such that extraction by algal resting cells is not possible, but this is highly speculative and would require considerable additional testing. Aeration of the bottom waters would greatly enhance deep water habitat and typically disrupts blue-green algal growth, but would be very expensive on capital (about $300,000) and operational (about $10,000/yr) bases. The continuing biomanipulative approach using walleye to control panfish, encourage zooplankton, and potentially control algal biomass has merit, but is not likely to provide consistent and strong control of this algal species. The copper treatment is therefore recommended.

In light of the watershed and in-lake water quality monitoring results from 2003, it does appear that more attention should be paid to watershed inputs. The levels of phosphorus in first flush storm water is quite high, although most of this is in particulate form and not readily available to support algae growth. However, those particulate inputs can decay and release the associated phosphorus, and the rise in bottom phosphorus levels since the alum treatment in 2001 is a concern. Additionally, the dissolved phosphorus in first flush storm water is high enough to be a concern, particularly in the Clark Hill storm discharge and in Hales Brook (and possibly in the Ola Ave storm drain as well, since dilution may be a factor in observed concentrations). Although the quantity of inputs still does not seem adequate in any one storm to affect lakewide nutrient levels, the very wet summer of 2003 did supply higher than average loading and increases in nutrient levels in the lake were observed.

It does appear from the storm water data that there is at least a modified first flush effect in this watershed. Peak concentrations did not persist for more than a few hours, and while the associated volume of storm water was not measured, it represents only a fraction of the total load. Values later in storms were not negligible, but there is indication in the data that the bulk of at least the phosphorus load is associated with the first flush from multiple small drainage areas around the lake. While more distant areas may indeed contribute, the available data suggest that the primary sources of phosphorus and probably nitrogen are fairly close to the lake, arriving in the earliest runoff. This matches well with the pattern of land use in the watershed, and suggests that more effort needs to go into addressing these nearby sources.

The storm water management devices are clearly a step in the right direction, but the data do not indicate an especially large reduction in nutrient loading as a result of the two installations done to date. It may be that the flow into those devices is more than they can handle, and that more devices are needed elsewhere in the same drainage system. The measurement approach applied in this investigation was not ideal, but it is apparent that the nutrient loads to the lake are still higher than desirable. Expanding the load estimate to the other input points around the lake, water quality in 2003 could be explained by watershed inputs. Considerably more progress must be made in the management of first flush storm water to protect the lake.

The value of a longer term data base is not to be underestimated, especially in a lake with the features of Lake Pocotopaug. We now have over a decade of seemingly reliable measurements, at least in the lake, and more analysis is facilitated. The improvement related to alum treatment is evident, but so is the gradual rise of phosphorus levels since that treatment. As the treatment only addressed about a third of the bottom of the lake, some influence from the remaining two thirds is possible, but the available data suggest longer term influences from the watershed. Again, the need for more watershed management is stressed, while in-lake approaches are used to seek interim relief.