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22 October 2021

Ms. Gail Allyn
C/O Mt. Kemble Lake Association
10 Lake Trail West
Morristown, NJ -7960
Sent by Email

Dear Ms. Allyn:

This report summarizes my assessment of the lake's status as based on my review of the Solitude End of Year Reports prepared for 2020, 2019 and 2018 as well as any additional data that I could obtain via the internet.

1. Mt. Kemble Lake attains a maximum depth of approximately 20 feet. As per USGS StreamStat the Mt. Kemble Lake watershed encompasses 474 acres. The lake drains to Primrose Brook, which is part of the Passaic River drainage system.
2. As per NJDEP GeoWeb data base the land use immediately adjacent to the lake is categorized as urban, low/medium density development. The balance of the watershed consists of pockets of urban low density developed land interspersed within forested land and wetlands. Note that the mapped wetlands are unofficial and for the most part appear to border the lake's primary tributary and the small headwater streams that drain to it.
3. As per the USDA WebSoil Mapper, the predominant soils within the watershed are the Neshaminy gravelly, silt loam series, which are basically well drained, low runoff soils. The NJDEP within NJAC 7:9A, the NJ Septic Regulations, classify these soils as having limitations for use in the renovation of wastewater due to a hydraulically restrictive substrata.
4. Solitude is typically on the lake 10 times per year, starting in April and continuing into September. This time period is recognized as the weed and algae growing season. The majority of Solitude's site visits involve the qualitative assessment of lake conditions, the application of an herbicide or algaecide to control invasive or problem aquatic species and/or the inspection of the lake following a weed or algae treatment.
5. For the past three years, water quality data have been collected during the growing season, by Solitude on three of the 10 dates; once in the spring and twice during the summer. In 2019 and 2020, data were collected at a deep-water, in-lake station, that is sampled at the surface and near the bottom of the lake. In 2019 and 2020, the sampling program also included data collected at upstream inlet stations and at the lake's dam/outlet. The upstream and dam stations are sampled less frequently than the lake station (1 to 3 times per year). The upstream station data provide some insight into the quality of inflow entering the lake whereas the dam/outlet station data can be used to reflect how in-lake processes have affected the water leaving the lake as it flows into Primrose Brook. With respect to the in-lake data, the spring

sampling, conducted at the onset of the growing season, can be considered indicative of "base-line" conditions. Conversely, the in-lake summer sampling, conducted during the beginning and at the peak of the growing season, can be used to assess eutrophication related impacts to the lake's water quality.

6. During each of the in-lake water quality data collection dates, Solitude monitors the following parameters:

- Temperature
- Dissolved oxygen
- pH
- Transparency
- Alkalinity
- Hardness
- Conductivity
- Ammonia
- Nitrate
- Total Phosphorus
- Total Suspended Solids
- Phytoplankton and Zooplankton community composition

The temperature, dissolved oxygen (DO), pH and transparency data are measured in-situ, whereas the remaining parameters involve the collection of a water sample that is then analyzed later in a laboratory. The upstream and dam/outlet station monitoring is limited to the laboratory analysis of total phosphorus (TP).

7. Solitude's lake management efforts focus on the control of various aquatic plant species, specifically Potamogeton foliosus (Leafy Pondweed), Potamogeton crispus (Curly-leaf Pondweed), Lemna minor (Small Duckweed), and Najas guadalupensis (Southern Naiad). Of these four plants, Curly-leaf Pondweed is a recognized non-native, invasive species. However, both Southern Naid and Duckweed (which is often incorrectly identified as an algae bloom) can reach nuisance density proportions and impact lake use and lake aesthetics. Both species can therefore be considered at times invasive. Although the reports do not specifically state which algae/plankton species were targeted for control, as noted above the reports do provide a breakdown of the species observed during each monitoring date

8. Solitude's lake management program also involves the as needed treatment of the lake with a contact herbicide and a copper-based algaecide.

9. As best reflected in the 2020 data, the lake's deep water TP concentrations are elevated. This is indicative of internal phosphorus loading. The following can be interpreted from the deep-water 2020 data presented in the tables below:

Mount Kemble Lake Water Quality Results- Surface					
Parameter	Units	4/16/2020	6/23/2020	8/24/2020	Limits
Temperature	°C	12.1	27.0	26.6	NA
Dissolved Oxygen	mg/L	10.94	11.31	8.79	<4.0
pH	SU	7.50	8.50	8.50	9
Alkalinity	mg/L	76	76	80	NA
Total Hardness	mg/L	210	220	260	NA
Transparency	feet	5.0	4.0	6.0	<4'
Ammonia	mg/L	0.052	ND	0.098	0.3
Conductivity	umhos/cm	290	320	310	1500
Nitrate	mg/L	0.632	0.168	ND	0.3
Total Phosphorous	mg/L	0.057	0.028	0.021	0.03
Total Suspended Solids	mg/L	ND	ND	ND	25

Mount Kemble Lake Water Quality Results- Bottom					
Parameter	Units	4/16/2020	6/23/2020	8/24/2020	Limits
Temperature	°C	6.8	8.9	9.9	NA
Dissolved Oxygen	mg/L	8.50	0.15	0.40	<4.0
pH	SU	7.5	7.0	6.5	9
Alkalinity	mg/L	84	104	120	NA
Total Hardness	mg/L	160	160	140	NA
Transparency	feet	5.0	4.0	6.0	<4'
Ammonia	mg/L	0.183	1.25	2.37	0.3
Conductivity	umhos/cm	320	330	350	1500
Nitrate	mg/L	0.592	ND	ND	0.3
Total Phosphorous	mg/L	0.030	0.076	0.203	0.03
Total Suspended Solids	mg/L	ND	33.0	24.0	25

- Comparing the surface water temperatures and the bottom water temperatures recorded on each date, the lake becomes thermally stratified progressing from spring through summer. Note the significant differences in surface water and bottom water temperatures in June as compared to August.
- As the summer progresses the deeper waters of the lake become anoxic, that is depleted of dissolved oxygen. Again note the significant June and August differences in the concentration of DO measured at the surface relative to that measured at the bottom. The depletion of DO at the bottom of the lake is a function of the lake's thermal stratification, which inhibits the free, vertical mixing of the water column. Once stratified, the bottom waters are no longer mixed to the surface of the lake resulting in the rapid depletion of DO due to bacterial decomposition of organic sediments.
- Anoxic conditions, and the resulting reduced environment, cause chemical changes to occur to the lake's sediments leading to the liberation and recycling of sediment bound phosphorus into the water column, hence the significant increase in deep water TP concentrations.
- The effects of thermal stratification are best illustrated in the table below which shows DO dropping off rapidly at depths greater than 10 feet in June and at only 6 feet in August. This means that the majority of the lake in August does not have enough DO to support fish life. It also suggests that the lake has a very large internal phosphorus load.

	4/16/2020		6/25/2020		8/24/2020	
Depth (ft)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
Surface	12.1	10.94	27.0	11.31	26.6	8.79
2	12.1	10.94	26.0	11.09	26.3	8.74
4	12.0	11.00	25.5	11.45	26.3	8.70
6	11.9	11.00	24.0	11.68	25.0	5.25
8	11.8	11.00	21.1	8.58	24.5	3.81
10	11.7	10.82	17.4	11.29	23.8	0.50
12	11.6	10.82	13.7	4.80	20.0	0.33
14	9.5	9.00	12.8	1.20	16.5	0.29
16	8.8	8.47	10.1	0.16	12.9	0.25
18	8.7	8.70	8.9	0.15	11.6	0.21
20	6.8	8.50	NA	NA	9.9	0.40

- The reduced environment also leads to elevated deep water ammonia concentrations.
- However, even though the lake becomes thermally stratified, and deep-water ammonia and TP concentrations peak, the nutrient rich water appears to remain at the bottom of the lake, as reflected in

the low concentrations of TP, ammonia and nitrate measured at the surface in June and August. Thus, although the lake is experiencing a significant increase in internal nutrient loading, this does not appear to have a significant effect on lake productivity, as reflected in the relatively good lake transparency data recorded in June and August (4-6 feet). What this suggests is that the nutrient rich water remains segregated at the bottom of the lake during the summer. It is likely that this nutrient rich water is circulated to the surface of the lake in late-September to early-October when the lake's thermal stratification naturally breaks down. Evidence of this occurring would be reflected in a late-season algae bloom. There may also be some minor amount of upwelling of phosphorus rich water from the mid-depths of the lake (metalimnion) into the surface waters of the lake (epilimnion) in July and August leading to enough of an increase in phytoplankton densities to necessitate an algae treatment. More data is needed to confirm this occurrence of "metalimnetic" erosion or partial destratification of then lake's mid-depth layers leading to internally driven increases in cyanobacteria densities.

- Inflow concentrations of TP are somewhat to highly elevated. See the tables below taken from the 2020 Solitude report:

Mt. Kemble Lake Water Quality Results–Upstream Site C					
Parameter	Units	4/16/2020	6/23/2020	8/24/2020	Limits
Total Phosphorous	mg/L	0.036	0.083	0.056	0.03

Mt. Kemble Lake Water Quality Results–Upstream Site B					
Parameter	Units	4/16/2020	6/23/2020	8/24/2020	Limits
Total Phosphorous	mg/L	0.033	0.069	0.060	0.03

Mt. Kemble Lake Water Quality Results–Upstream Site C					
Parameter	Units	4/16/2020	6/23/2020	8/24/2020	Limits
Total Phosphorous	mg/L	0.036	0.083	0.056	0.03

Mt. Kemble Lake Water Quality Results–Upstream Site D					
Parameter	Units	4/16/2020	6/23/2020	8/24/2020	Limits
Total Phosphorous	mg/L	0.052	0.070	0.055	0.03

The 2020 data contrasts to some extent with the 2019 data (which for the most part reported lower in-stream TP concentrations). There was no 2018 in-stream data, but the TP concentrations measured at the north lake station in 2018 (presumably close to the point where the lake's primary tributary enters the lake) were consistently elevated[1]. As such, it would appear that there are significant sources of TP loading located in the lake's watershed. This needs to be investigated further.

TP concentrations in excess of 0.03-0.04 mg/L are great enough to stimulate an algae bloom. Concentrations greater than 0.05 mg/L exceed the State's water quality standard as per NJAC 7:9B.

The most likely sources of this external TP loading could be septic systems or stormwater runoff, or potentially horse stables. Based on the available land use information that I could obtain from various sources, one would not expect such elevated in-steam TP concentration. Given that there is no accompanying in-stream total suspended solids (TSS) data, I cannot determine if the elevated TP concentrations were associated with a storm event. However, because rainfall totals in April and June 2020 were either near average or below average, it would appear that the cause of these elevated concentrations may not be specifically linked to a storm event or stormwater runoff.

10. With respect to the phytoplankton data, the lake's phytoplankton community transitions from spring through summer from diatom to green algae to cyanobacteria (blue-green algae) dominance. This is a natural progression for most lakes, but I am concerned with the dominance of the lake by cyanobacteria in August, as cyanobacteria produce toxins and are the group of photosynthetic organisms responsible for harmful algae blooms (HABs). As there is no toxin data for the lake, and the cyanobacteria data is only

[1] It should be noted, that although referenced as Appendix C in all three reports, the Water Quality Sampling Station Map is missing from the 2018, 2019 and 2020 reports.

semi-quantitative, there is no way to determine whether the lake is experiencing a HAB great enough to generate elevated microcystin concentrations. Because the lake is used for swimming and is open to the public, the lake association should follow the NJDEP's cyanotoxin/HAB guidance protocol (https://www.nj.gov/dep/hab/). I also suggest the lake association conduct routine (at least weekly) measurement of cyanotoxins at the beach using the Abraxis test kit methodology (https://abraxis.eurofins-technologies.com/). Although the results are not as definitive as actual lab testing, the tests yield very good and reliable data, for a relatively small cost (< $100/sample), with the test results generated in less than two hours. Comparatively lab testing costs > $600/sample with the results not available for as much as 7-10 days. The Abraxis testing can be conducted by a trained volunteer.

11. With respect to the zooplankton data, focusing on the samples collected in 2020, the lake's zooplankton community is dominated by rotifers. These are filter feeding organisms that graze on bacteria and even cyanobacteria. Although a food source for young-of-year fish, a better source of food are the cladocerans, which are lacking in Mt. Kemble Lake. The low occurrence of cladocerans is likely a function of the dominance of cyanobacteria, which are a poor (and often rejected) food source for cladocerans.

12. Overall, Solitude's management program is working and as based on the reports' conclusions, seems to be effectively limiting the lake's water quality, weed, and algae problems. However, it is largely a reactive lake management program limited only to controlling or reducing the densities of aquatic plants and planktonic algae. Although the program is not proactive and does not address the causes of the lake's eutrophication, it is working for the Mt. Kemble community, especially in terms of maintaining acceptable (4-6 ft) summer lake transparency values.

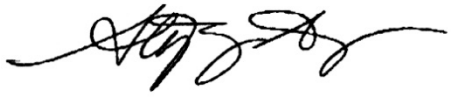
13. I am concerned about reliance on the use of copper sulfate. Although a cheap and effective algaecide, repeated use of copper sulfate can lead to cyanobacteria dominance and may even stimulate and sustain a HAB.

14. More needs to be done with respect to understanding the impacts of the lake's seasonal thermal stratification and subsequent deep-water DO depletion. This will require more data collection and water quality modeling. As noted, thermal stratification and DO depletion lead to internal TP loading. Although the internal TP load does not appear to be having a negative effect on lake water quality, specifically in terms of causing a documented HAB, there is not enough data to enable me to determine if the lack of a reported impact is a function of the database (not enough data and no lake turn-over data) or the result of the copper sulfate treatments. The lake's thermal stratification and internal TP load could be controlled via aeration, but again there is not enough data to recommend installing an aeration system. At a minimum though, increasing mid-summer bottom water DO would benefit the lake's fishery, given that in August the majority of the lake's water column and volume does not have enough DO to support fish life. Also, the lake's internal TP load could be controlled using alum or another nutrient inactivant, but again there is not enough data to recommend conducting such treatments.

15. As discussed above, more needs to be done to better assess the source(s) and quantify the elevated concentrations of TP entering the lake from the watershed.

16. As discussed above, the lake association should be conducting weekly Abraxis cyanotoxin testing from Memorial Day through Labor Day.

Sincerely,



Owner
Clean Waters Consulting, LLC