

Report to White Lake Town Board November, 2020

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LIMNOSCIENCES

Rainfall for the month of October totaled 3.35 inches, bringing the total for the year to date to 66.8 inches:

Monthly Rainfall (inches) for White Lake 2012-2020

Month	2020	2019	2018	2017	2016	2015	2014	2013	2012	Monthly Average for Region
January	4.5	2.75	4.20	7.0	3.0	2.5	2.0	1.75	2.75	3.81
February	6.7	2.25	2.00	1.5	10.7	5.5	1.5	2.5	4.0	3.44
March	3.7	3.25	3.95	3.7	1.55	4.15	ND	1.0	7.0	3.91
April	5.1	7.25	6.75	6.75	6.75	4.55	ND	1.75	2.25	3.12
May	12.25	1.20	7.70	2.7	4.5	4.20	ND	2.25	9.25	3.67
June	7.15	5.25	10.00	4.5	3.65	8.70	3.0	17.0	2.0	4.70
July	6.85	6.00	4.75	6.75	3.75	3.0	4.65	11.25	8.6	5.75
August	7.55	5.35	6.25	5.6	4.12	9.4	9.75	8.25	9.75	5.95
September	5.95	5.00	29.45	5.2	15.0	4.7	7.0	1.0	5.0	5.29
October	3.35	3.60	2.25	2.95	14.25	9.75	1.7	1.75	2.25	3.38
November		4.90	4.25	1.0	0.50	7.25	4.15	0	2.25	3.16
December		6.00	7.5	5.45	5.1	6.5	3.7	5.75	4.25	3.14
Total		52.80	89.05	52.8	72.87	70.20		54.25	59.35	49.32

Lake Levels

The lake level started and ended the month at 64.5 feet in elevation (NAVD 88). By comparison, it was 63.7 feet (NAVD 88) at the end of October 2019, and 64.3 feet on January 1, 2020.

Aquatic Vegetation Surveys

No hydrilla was found in the summer surveys, and a rare aquatic plant was found for the first time in the lake—it is described as characteristic of acidic habitats.

Water Quality Comparisons Over Time and Among Bay Lakes

There has been a lag in getting lab results back, but it is now possible to look at September data and compare it to previous years. This is an important month for making comparisons, as it was in September of 2017 that the algae community had drastically changed, and a filamentous cyanobacterial bloom took hold, and the aquatic weed Hydrilla was found in 85% of the lake. Nutrient levels—Total Nitrogen and Total Phosphorus—were higher than they had ever been, as were chlorophyll a levels (= the amount of algae in the water column). Water clarity had been on a downward trend all summer.

Because of Hurricane Florence in September of 2018, no data could be collected, so data for the month of October is included in the table. There was no noticeable change in clarity, algae levels or nutrients that month that could be attributed to a “beneficial flushing effect” on the lake as a result of the very high rainfall.

Results in September 2020 were very similar to what was found in 2013, with the exception of the increase in Total Nitrogen concentration, a trend which was seen in 2017, 2018 and 2019 as well. Total Phosphorus levels have been stable over time, with the exception of the bloom year of 2017. The pH levels have remained very stable since the mitigation of the cyanobacterial bloom by the alum treatment.

A Comparison of White Lake Water Quality Data for September, 2013-2020

	9/3/13	9/26/2017	10/18/18	9/12/2019	9/16/2020
Mean Temperature (F)	75	77.7	73	84	77.5
Water Clarity, Measured as Secchi Depth (ft)	7.9	2.6	4.1	4.1	4.9
Turbidity (NTU)	2.6	4.5	3.2	1.4	1.7
Mean Algal Abundance, Measured as Chlorophyll a Concentration (µg/L)	11	55.5	11	6.7	7.8
pH Range (std. units)	7.2	7.8-8.1	6.5-7.0	6.8-7.0	6.8-6.9
Dissolved Oxygen (mg/L)	7.9	7.8	8.5	7.9	8.2
Mean Total Nitrogen (mg/L)	0.37	1.01	0.8	0.613	0.768
Mean Total Phosphorus (mg/L)	<0.02	0.04	<0.02	0.023	0.019
Number of Samples	3	3	7	6	3

Sampling of several of the other Bay Lakes was done in September as well. I was interested in nutrients and algae in particular and have written up a white paper comparing the data with historical data for the lakes. There are two points to make from this comparison: 1) nitrogen levels have increased in all of the Bay Lakes; and 2) **algae levels were very similar between the acidic lakes—Bay Tree and Singletary—and White Lake (circled in red in the table below)**. Acidic conditions do not equate to no algae, and there is no scientific evidence for the idea that lowering the pH of White Lake would benefit water clarity, or that it would even be possible.

	2013, 2016 (Wacc)		2020			
	pH	Chlorophyll a	pH	Chlorophyll a	Phaeophytin a	DOC
Bay Tree	4.3-4.7	2.5-16.0	4.4	6.9-7.5	2.6-3.5	1.15-1.29
Singletary	3.8-5.6	3.8-16.0	4.1	6.9-8.0	5.8-8.0	16.2-16.6
White	5.6-8.3	3.4-30.0	6.8	7.5-8.0	1.3-1.9	5.06-5.66
Waccamaw	6.5-8.0	3.2-33.0	6.4-6.9	3.3-4.0	1.3-2.2	15.4-15.8

Groundwater Studies and FAQs About Springs

Some months ago, it was suggested that a one-page FAQs could be of help with the communications about the springs at White Lake, and what studies had been done. I am including that here, as board members were not aware of its existence (it was posted to the White Lake Watch web site). I am also including some graphics from the Shank and Zamora groundwater study that was supported by the Town.

White Lake Springs: Frequently-Asked Questions

Q: What studies have been done of the springs?

Frey (1949): Dr. Frey examined springs areas in 1947, and found the centers to be about 8” lower than the edges, with hard sand bottoms, with no detectible chemical evidence of any volume of water entering the lake through these depressions, although he noted that “at a time of higher lake level and more favorable ground water conditions there might be visible evidence of inflowing water”. He also noted that rainfall on the lake surface and watershed was the primary source of water to the lake.

NC DNRCD (1982): Newly-installed groundwater wells provided “evidence of a semi-confined groundwater aquifer which is probably the source for the springs that have been reported near the northeastern shore in the lake”; this report goes on to state: “the exact relationship between rainfall, groundwater levels, and the lake level should become more clear as monitoring continues” (which did not, as there was no funding). The US Geological Survey definition of a water table, or unconfined aquifer is “an aquifer whose upper water surface (water table) is at atmospheric pressure, and thus is able to rise and fall. Water-table aquifers are usually closer to the Earth’s surface than confined aquifers are, and as such are impacted by drought conditions sooner than confined aquifers” (<https://www.usgs.gov>).

USGS (2010): hydrogeological mapping based on well data shows that the surficial aquifer includes a shallow layer of groundwater above and below the shallow “hardpan” clay layer.

NC DEQ (2017): Groundwater level monitoring noted the association between levels in a shallow onshore well and a shallow in-lake well. A deeper in-lake well installed by DEQ at a springs site had the same pH and nutrient levels as the lake water.

Shank and Zamora (2019):

- Groundwater inputs to the lake are low, because the groundwater capture zone feeding the lake is relatively small. Inflow comes primarily from the north and east, with outward groundwater flow along the west and southwestern edge of the lake.
- There was no evidence (from an isotope study) that springs from deeper confined aquifers are contributing water to the lake.
- High-volume rainfall and infiltration could create flow through “preferential groundwater flow paths” such as fractures in the hardpan clay layer that produce freshwater springs, with the chemical characteristics of the surficial aquifer groundwater.
- Lake water loss to groundwater was determined to be 5 times greater than the amount of groundwater flowing into the lake.
- There was no evidence found that blueberry farm pond pumping is affecting groundwater flow into White Lake. Most of these ponds are located in areas where groundwater flow is naturally away from the lake (so they are outside the groundwater capture zone for the lake).

Q: Are the springs and the groundwater surficial aquifer one and the same?

A. Yes, here at White Lake they are. Artesian flow into the lake can occur when the water table is high.

Q: Do low lake levels mean the springs are not working?

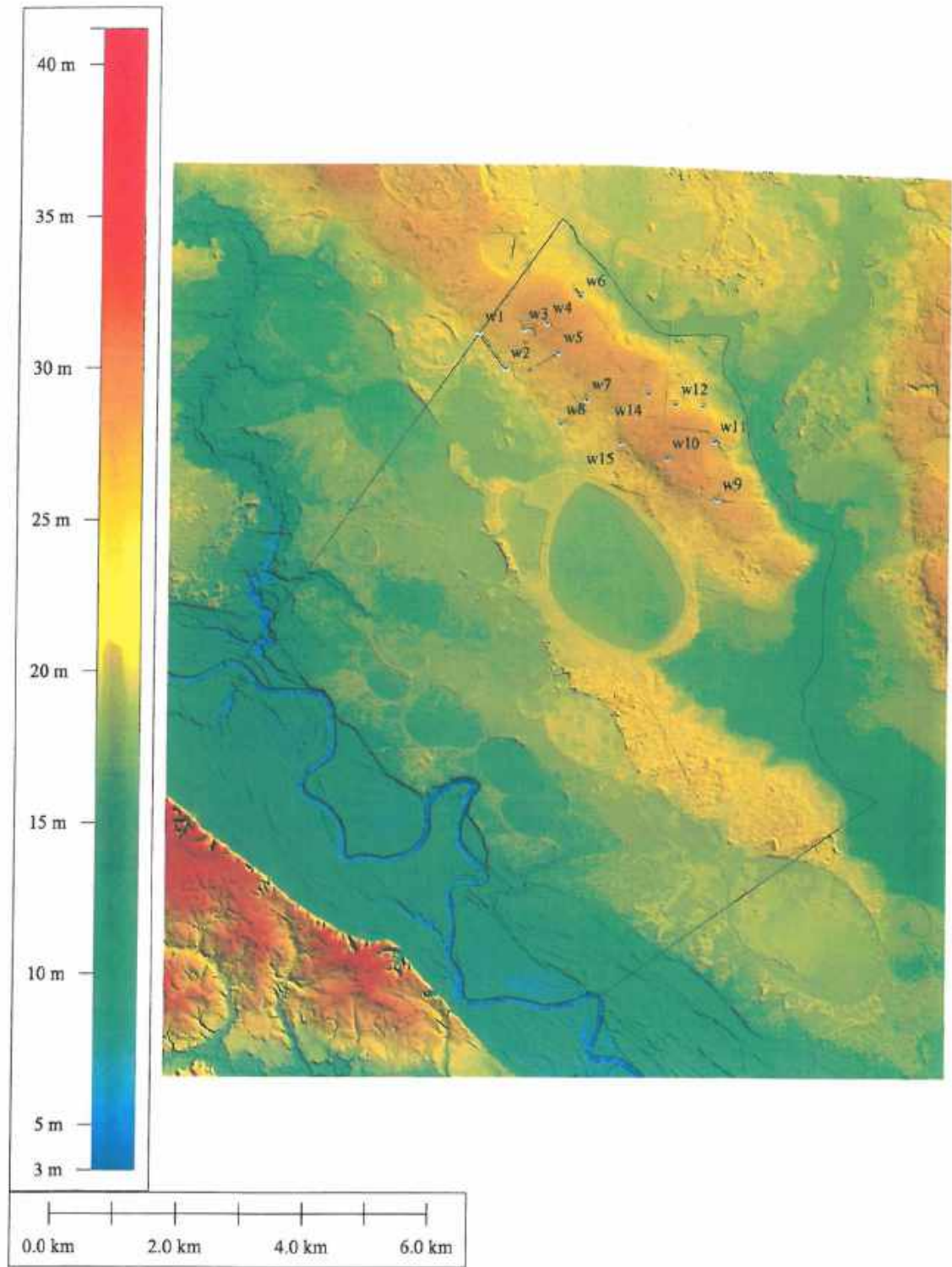
A: No, the hydrology of the lake is influenced by rainfall, so lake levels and groundwater levels (and therefore groundwater flow rates) fluctuate naturally. **Groundwater flow is highest when the water table is high, which happens when it rains a lot.** Rainfall amounts can vary quite a bit from year to year. Lake water can also flow from the lake into the groundwater as well as exiting from Turtle Cove.

Q: Does the higher pH of the lake mean the springs are not working?

A. No. The pH of the lake is dictated by rainfall pH, as every inch rainfall is equivalent to a volume of 29 million gallons of water added to the lake. The pH of rainfall had been around 4.5 (= “acid rain”) and is now averages around 5.8. Atmospheric pollutants that created acid rain have been substantially reduced, over the same time period as the pH of the lake changed.

Rainfall rules both lake levels and lake chemistry

The following figure is a LIDAR map of the area, showing the blueberry ponds that were included in the development of the Shank and Zamora groundwater model (a mathematical simulation):



One of the products of the modeling work was the development of a map of the groundwater contributing area for White Lake. This is the region where rainfall infiltration feeds the surficial aquifer, resulting in groundwater flow towards the lake:

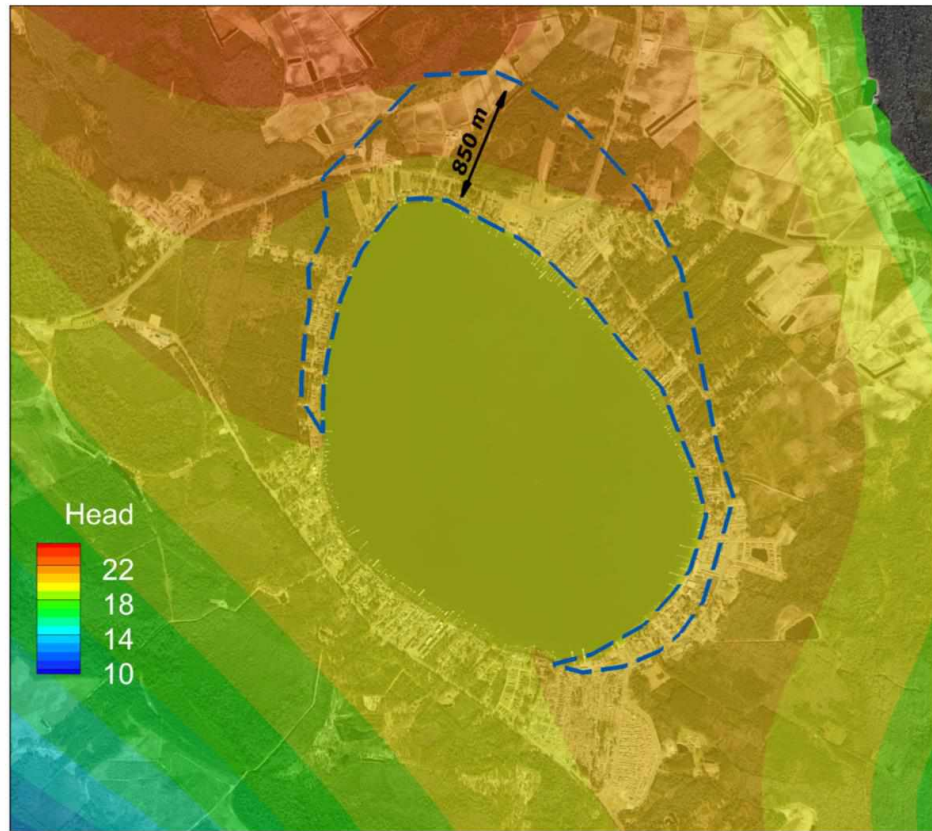


Figure 23. Groundwater contributing zone for White Lake showing the widest section in the northeastern sector.

Pumping shallow groundwater into the lake would override the natural hydrology—what nature is doing for free. However, we can look at augmenting infiltration, directing stormwater to areas where it can recharge the groundwater. This has the additional benefit of improving water quality. Working with Mother Nature, rather than against her, is always a better choice.