Update of Nitrogen Concentrations in Douglas E. Barr

Discharge from the Main Vent of Wakulla Springs. 07/02/2020

Below are updated plots of nitrogen concentrations in discharge from the main vent of Wakulla Springs. These were last updated in mid-2018. The plots include the instantaneous concentrations (individual samples), the mean annual concentrations and the min/max yearly concentrations.

The mean annual N concentrations are illustrated on Figure 1 below for the period 2000-2019. For the earliest years, data is limited. In 2001 only two months were sampled while in 2002 only 4 months were sampled. Sampling was more frequent in 2000 with 8 monthly samples. It should be noted that the concentration spike in 2001 is based on only two samples and may not be representative of the entire year. After 2002, 7-12 samples were obtained each year.

In 2003 the mean annual concentration had declined to 0.72 mg/L. The mean concentration further declined to of 0.67 and 0.66 mg/L in 2004 and 2005, respectively. The concentration then reached 0.6 mg/l in 2006 and remained at approximately this same concentration (+/- 0.01 mg/L) through 2010. The only project that I’m aware of at this time was the restoration of the Lake Henrietta stormwater treatment facility and excavation of sediments from Lake Munson near the Munson Slough discharge. Unfortunately, there is not sufficient data to evaluate any resulting reduction of nitrogen concentrations in Wakulla Spring.

Beginning in 2011 and continuing through 2014, average annual N concentrations in the spring discharge declined in an approximately linear manner from 0.6 to 0.4 mg/L. This period coincided with the planned decrease in N concentrations of treated wastewater effluent discharged to spray fields. This occurred in a stepwise fashion to less than 12 mg/L, less than 9.0 mg/L in 2011, less than 6.5 mg/L in 2013 and finally to 3.0 mg/L or less in 2014. The decline of N concentrations in the wastewater effluent resulted in a direct transient decline in the N levels of the spring discharge. This resulted from the high transport velocities of the limestones of the Florida Aquifer between the effluent spray fields and the spring. These are characteristic of large areas of the Wakulla Springs Basin north of the spring. For example, when the WW plant reached the design level of N reduction (≤ 3.0 mg/L) in 2014, the mean annual nitrogen stabilized and has remained at 0.40 to 0.42 mg/L from 2014 through 2019.

Figure 2 illustrates the N concentrations measured in individual samples collected from the spring from 2002 through March 2020. Of particular interest are the noticeable decline in the peak annual nitrogen concentration beginning in 2012 and the more general reduction in intra-annual variation beginning in 2013.

Figure 3 plots the maximum and minimum N concentration of the spring discharge from 2002 through 2019. The greatest decline in the intra-annual N concentration occurred in 2014 when the min and max concentrations differed by 0.17 mg/L. Since then (2014-1019), the yearly variation of the N concentrations has been only 0.15 to 0.17 mg/L.

In addition, the greatest decline in the minimum annual N level occurred in 2012 when the minimum concentration was 0.36 mg/L in comparison to a minimum of 0.45 mg/L in 2011. In contrast, the greatest decline in the maximum concentration occurred in 2014 when the annual maximum was 0.5 mg/L in comparison to 0.63 mg/L in 2013.

Over the short period from 2012 to 2014, significant declines in the both the maximum and minimum nitrogen concentrations occurred in the discharge of Wakulla Springs to Wakulla River. The minimum intra-annual concentration declined by the greatest amount (0.45 mg/L to 0.38 mg/L) over the two year period from 2011 to 2012. Subsequently, minimum concentrations have remained at or below this level. Maximum annual concentrations declined by the greatest amount (0.63 mg/L to 0.50 mg/L) over the two year period from 2013 to 2014. Over the last six years, therefore, the average annual nitrogen concentration has ranged from 0.40 to 0.42 mg/L with annual variations of +/- 0.15 to 0.17 mg/L.

The minimum nitrogen concentration has been reached for current N removal levels at the wastewater treatment plant and from other sources. The annual minimum concentration of the spring discharge has been stable for the last four years at 0.34 mg/L. The maximum concentration has exhibited slightly more variation and declined slightly at the rate of 0.01 to 0.02 mg/L for the last few years and was 0.47 mg/L in 2019. Slight additional decreases may occur as the annual maximum nitrogen concentration tends towards the minimum. Any decline, however, will be small.

As I’ve stated previously, the reduction and stabilization of nitrogen levels in Wakulla Springs discharge is attributable to the design and construction of advanced wastewater treatment (denitrification) by the City of Tallahassee (COT). The declines illustrated by Figures 1-3 coincide with the start of the new treatment process and the staged reduction of nitrogen in the plant effluent. As a result of the N reductions in wastewater effluent and the spring discharge, WSA Board Members and others have reported improvements in water clarity in the spring area, reappearance of wildlife species in the river and a reduction in the occurrence of invasive plants.

The Basin Management Action Plan prepared by DEP sets an average annual target concentration of 0.35 mg/L for discharge from Wakulla Springs. As described above, the average annual concentration for the six years from 2014 to 2019 ranged from 0.40 to 0.42 mg/L with an average of 0.41 mg/L over the six years. Reduction of the annual average nitrogen level to 0.35 mg/L, therefore, is unlikely at the current level of nitrogen loading upgradient of the spring.

Significant additional nitrogen removal from the City of Tallahassee wastewater stream is not feasible since the plant is already operating to lower the N levels to 3.0 mg/L or less in comparison to concentrations in excess of 12 mg/L prior to the plant improvements. In addition, current “restoration” projects being conducted will not result in significant reductions in nitrogen levels in the spring. By far the largest of these is a $20 million project being conducted by the Northwest Florida Water Management District to convert septic tanks to central sewer at two subdivisions well to the south of the spring. As I’ve previously shown, the project will not result in any measurable reduction in the nitrogen levels of Wakulla Springs or Wakulla River. I’ve updated this analysis to include more recent data and found that this project is even less effective in reducing the N levels of Wakulla Springs than previously determined.

Projects beneficial to Wakulla Springs should be focused on nitrogen sources north of Wakulla Spring. Conversion of septic tanks to central sewer or use of advanced types of onsite disposal systems is an obvious choice. In addition, stormwater loading of area lakes is another source of N loading of Wakulla Springs. Lake Munson, Lake Jackson and Lake Lafayette have all been shown to be directly to the spring and are potential sources of nitrogen. The lakes, however, have not been evaluated and considerable analysis is required to determine the contribution of nitrogen to Wakulla Spring.