NORTHEAST OHIO REGIONAL SEWER DISTRICT

2009 Cuyahoga River Chlorophyll *a* Sampling Results

Prepared by
Water Quality and Industrial Surveillance
Environmental Assessment Section

Introduction

The Ohio Environmental Protection Agency (EPA) is currently in the process of developing nutrient criteria for rivers in the state. Once the criteria are adopted, it is possible that chlorophyll *a* concentrations, one measure of algal production in a system, could be used in determining whether the criteria are being met. In 2009, benthic and water column chlorophyll *a* sampling was conducted at sites upstream and downstream of Southerly Wastewater Treatment Center (WWTC). Benthic chlorophyll *a* samples were collected to determine algal biomass that is attached to the stream substrate. Water column chlorophyll *a* samples were collected to determine algal biomass that has sloughed off from the substrate. The sites that were chosen for evaluation have been monitored in the past to determine dissolved oxygen diel swings resulting from algal production. The purpose of the sampling was to collect baseline data on chlorophyll levels in the river, establish the factors controlling algal production, determine any potential impacts from Southerly WWTC, and become more proficient in the sampling and analytical methods. The sampling was also conducted in support of the Northeast Ohio Regional Sewer District (NEORSD) 2009-2013 Strategic Initiative Number 5, Metric C: Demonstrate water quality improvement in the receiving streams.

Methods

Benthic and water column chlorophyll *a* sampling was conducted one time on the Cuyahoga River—on July 21, 2009. The average flow for this day, as measured at the USGS Independence Gauge Station, was 287 cubic feet per second. Samples were collected at river miles (RM) 16.20, 10.75, 10.10, and 7.00 (Figure 1). The methods used followed those detailed in the NEORSD *Chlorophyll a Sampling and Field Filtering Standard Operating Guidelines*. For the benthic samples, a total of fifteen rocks were collected from three locations in the river. The algal mass from a portion of each rock was scraped off and composited to form a slurry. The algal slurry was then filtered through a glass fiber filter. Water column samples consisted of grab samples collected from the river in the same vicinity as the benthic samples. These samples were also filtered. The filters for each sample were covered with aluminum foil and placed on ice to prevent degradation. Analysis of the samples involved extracting the chlorophyll *a* pigments from the filter in 90% acetone. The resulting filter slurry was then centrifuged, and aliquots of the supernatant were measured for fluorescence of chlorophyll *a*. After acidification, phaeophytin *a* was also measured.

In conjunction with the chlorophyll *a* sampling, water chemistry samples were also collected at each site and analyzed for nutrients, solids, and alkalinity. Techniques used for water chemistry sampling and chemical analyses followed the *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (2009).

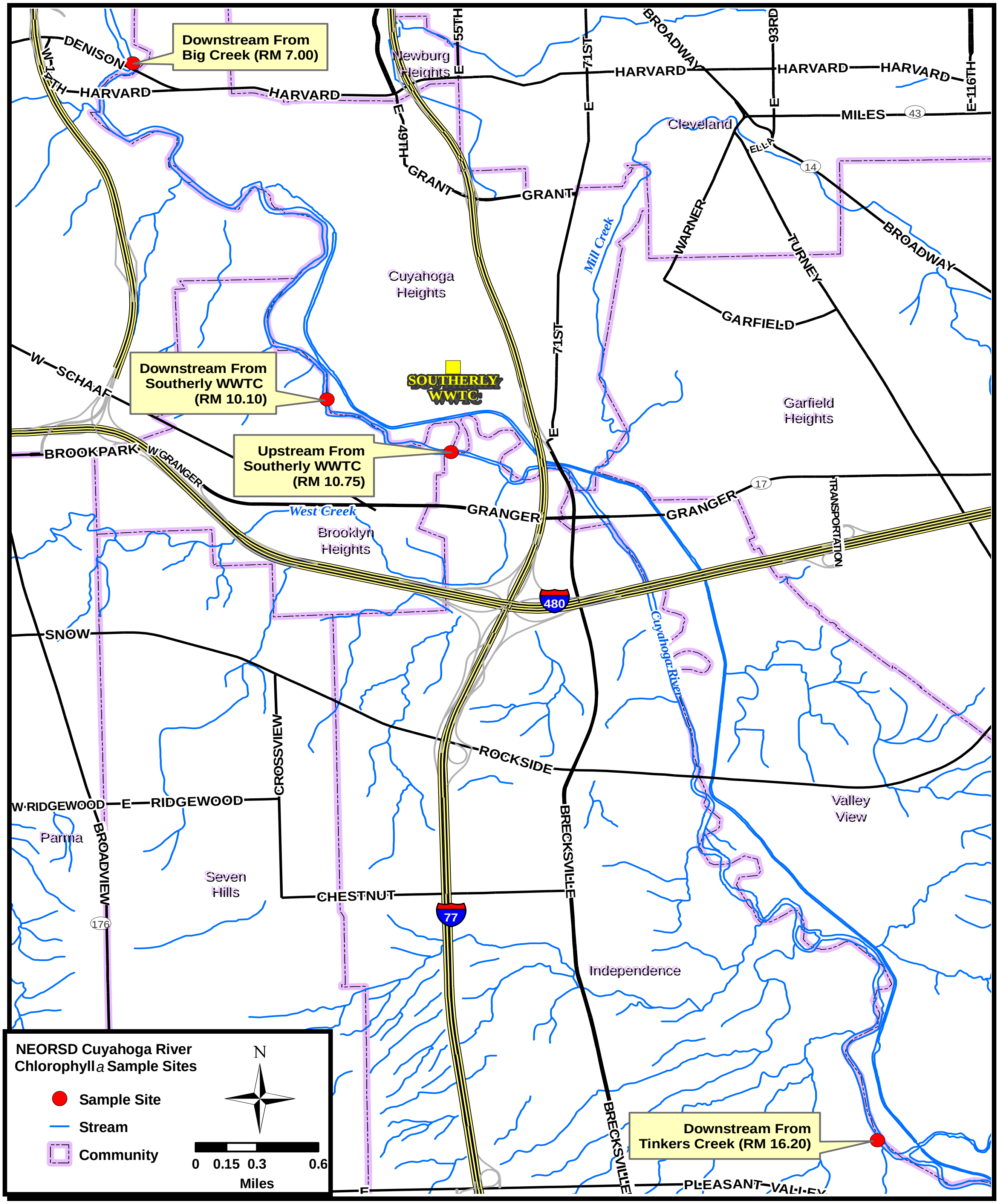


Figure 1. Sample Sites

Results and Discussion

The lowest benthic and water column chlorophyll *a* levels occurred at the site immediately downstream of Southerly WWTC at river mile (RM) 10.10 (Table 1). The highest benthic chlorophyll *a* levels were at the site downstream of Big Creek (RM 7.00). The highest water column chlorophyll *a* levels were at the site immediately upstream of Southerly WWTC (RM 10.75). These limited results suggest that Southerly WWTC is not noticeably having an impact on algal production in the river.

Table 1

	RM 16.20 DS Tinkers Creek	RM 10.75 US Southerly WWTC	RM 10.10 DS Southerly WWTC	RM 7.00 DS Big Creek
Benthic Chlorophyll *a* (mg/m^2)	81.6	93.6	60.5	102.5
Benthic Chlorophyll *a* (log (mg/m^2))	1.91	1.97	1.78	2.01
Water Column Chlorophyll *a* (mg/L)	11.38	14.76	9.3	10.53
Total Phosphorus (mg/L)	0.142	0.143	0.268	0.218
Dissolved Reactive Phosphorus (mg/L)	0.085	0.071	0.195	0.156
Nitrate (mg/L)	4.067	3.869	7.386	6.979
Nitrite (mg/L)	0.027	0.028	0.032	0.032
Alkalinity (mg/L)	144.6	148.5	131.4	128.3
Total Suspended Solids (mg/L)	9.9	22.1	16.8	6.7
Turbidity (NTU)	8.11	14.02	11.52	8.3
Canopy Cover (%)	9.3	26.1	39.1	39.4
Drainage Area (mi^2)	696	743	744	786

Based on the other parameters measured as part of the supplemental water chemistry sampling, the controlling factor for algal production in the river is unclear. Nutrient levels are typically assumed to directly influence algal production, and that is one reason why Ohio EPA may propose chlorophyll *a* criteria as a means of determining whether nutrient water quality standards are being met. Using the results collected from this limited sampling, this does not seem to be the case in the section of the Cuyahoga River that was sampled. The highest nutrient concentrations, in terms of both phosphorus and nitrogen, occurred at the site immediately downstream of Southerly WWTC. Since this was the site that had the lowest amounts of chlorophyll *a*, no direct link between the two is obvious.

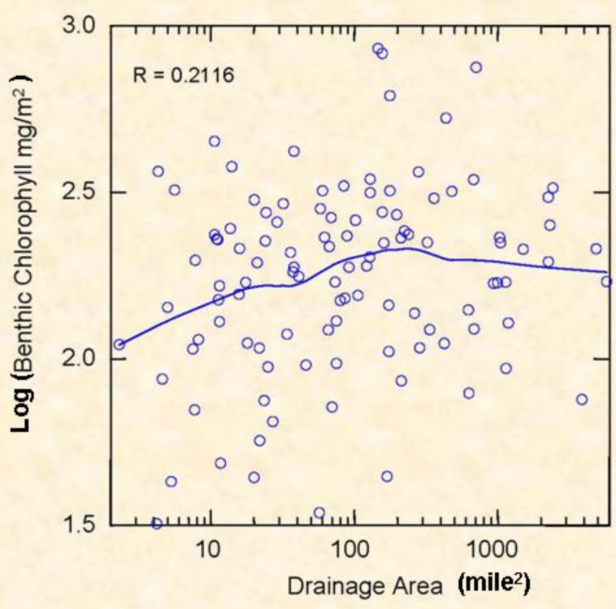
It has been hypothesized that, where nutrients are high, elevated suspended solids may reduce the nutrients' impact by blocking light penetration through the water column (Ohio EPA 2003). However, the sampling results indicate that this does not completely explain what is occurring in the Cuyahoga River. The highest and lowest suspended solids concentrations occurred at the two sites with the highest benthic chlorophyll *a* concentrations. Because of this, it does not appear that suspended solids in the water column are a predominant factor influencing the chlorophyll *a* levels observed.

Instead of nutrients or sediment having the most impact on algal production, canopy cover may be the controlling factor. A greater percentage of the stream width at the two downstream locations was shaded. This could help to explain the lower chlorophyll *a* levels at the site immediately downstream of Southerly WWTC, but does not explain the higher results at the site downstream of Big Creek. Therefore, it is likely that a variety of factors contribute to the algal production that occurs at a given site, but the mechanisms by which they interact is not yet understood based on this limited data set.

Another objective of the study was to determine how chlorophyll *a* levels in the river compared to other locations in Ohio. Using data compiled from Ohio EPA, the chlorophyll *a* concentrations measured in the Cuyahoga River are below the trendline for sites across the state with similar drainage areas (Figure 1). With additional supporting data, this may prove useful in demonstrating that, in comparison to other locations in the state, the Cuyahoga River is not significantly impaired by nutrients.

Figure 1

Drainage Area - Benthic Chlorophyll Relationship



Graph from Bob Miltner, Ohio EPA

Conclusions

Limited sampling for chlorophyll *a* conducted in 2009 does not indicate that Southerly WWTC is having an impact on algal levels in the Cuyahoga River. In addition, the chlorophyll *a* levels measured in the river were below typical levels found in locations throughout the state with similar drainage areas. However, these conclusions are based on only one sampling event and may not be adequate to fully characterize all trends in the river. Therefore, it is recommended that similar baseline sampling be conducted during the summer of 2010. At least three sampling events, conducted during dry weather when impacts from nutrients are expected to be the highest, should help to further determine chlorophyll *a* levels in the river and any other controlling factors. Doing this sampling while data sondes are installed at the four sampling locations may provide a more comprehensive picture of the relationship among algal production, nutrient levels, and dissolved oxygen diel swings in the river.

References

Ohio EPA. 2003. Total Maximum Daily Loads for the Lower Cuyahoga River. Ohio EPA, Division of Surface Water. Water Standards and Technical Support Section. Online, last accessed 11/3/05.

Ohio EPA. 2009. Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices. Divisions of Surface Water and Environmental Services.