

NORTHEAST OHIO REGIONAL SEWER DISTRICT

2018 Lake Erie Beach Monitoring



Prepared by
Water Quality and Industrial Surveillance Division

Introduction

Since 1992, the Northeast Ohio Regional Sewer District (NEORSD) has conducted bacteriological sampling on Lake Erie at Edgewater Beach, Villa Angela Beach, and Euclid Beach, in an effort to monitor bacteriological densities at the beaches. In 2005, sampling at Euclid Creek was added to determine the impact the creek may have on the water quality at Villa Angela and Euclid Beaches.

In 2018, the NEORSD continued these sampling efforts by monitoring the *Escherichia coli* (*E. coli*) densities at Edgewater, Villa Angela, and Euclid Beaches and Euclid Creek. The purpose of this sampling was to communicate beach conditions to the public and evaluate water quality standards attainment. In this report, an evaluation of water quality standards attainment will be made from the results from each sample site.

The sampling was completed by interns trained by NEORSD Level 3 Qualified Data Collectors (QDCs) certified by Ohio Environmental Protection Agency (Ohio EPA) in Chemical Water Quality Assessment, or by NEORSD Level 3 QDCs, as explained in the NEORSD study plan *2018 Lake Erie Beach Monitoring*, which was approved by Ohio EPA on February 20, 2018. Sample analyses were conducted by NEORSD's Analytical Services division, which is accredited by the National Environmental Laboratory Accreditation Program.

Table 1 indicates the sampling sites with respect to location, site or river mile (RM), latitude/longitude and description. Figure 1 is a map of the sampling locations at Edgewater, Euclid and Villa Angela Beaches and Euclid Creek.

In addition to monitoring for *E. coli*, the NEORSD has also performed limited harmful algal bloom (HAB) monitoring in the past several years, in response to recent increases in HABs in Lake Erie. In response to visual observation of HABs, the NEORSD performed additional sampling for identification of cyanobacterial genera and toxin concentration. Monitoring for chlorophyll and phycocyanin using the YSI EXO Total Algae Sensor was also performed. Comparisons of pigment concentrations as measured by the sensor with microcystin toxin concentrations are discussed. No quality assurance, quality control sampling was performed for HAB toxins. Therefore, the presented HAB monitoring data does not qualify for the Ohio EPA QDC Level 3 program. The resulting data from HAB monitoring is only included in this report as supplementary information.

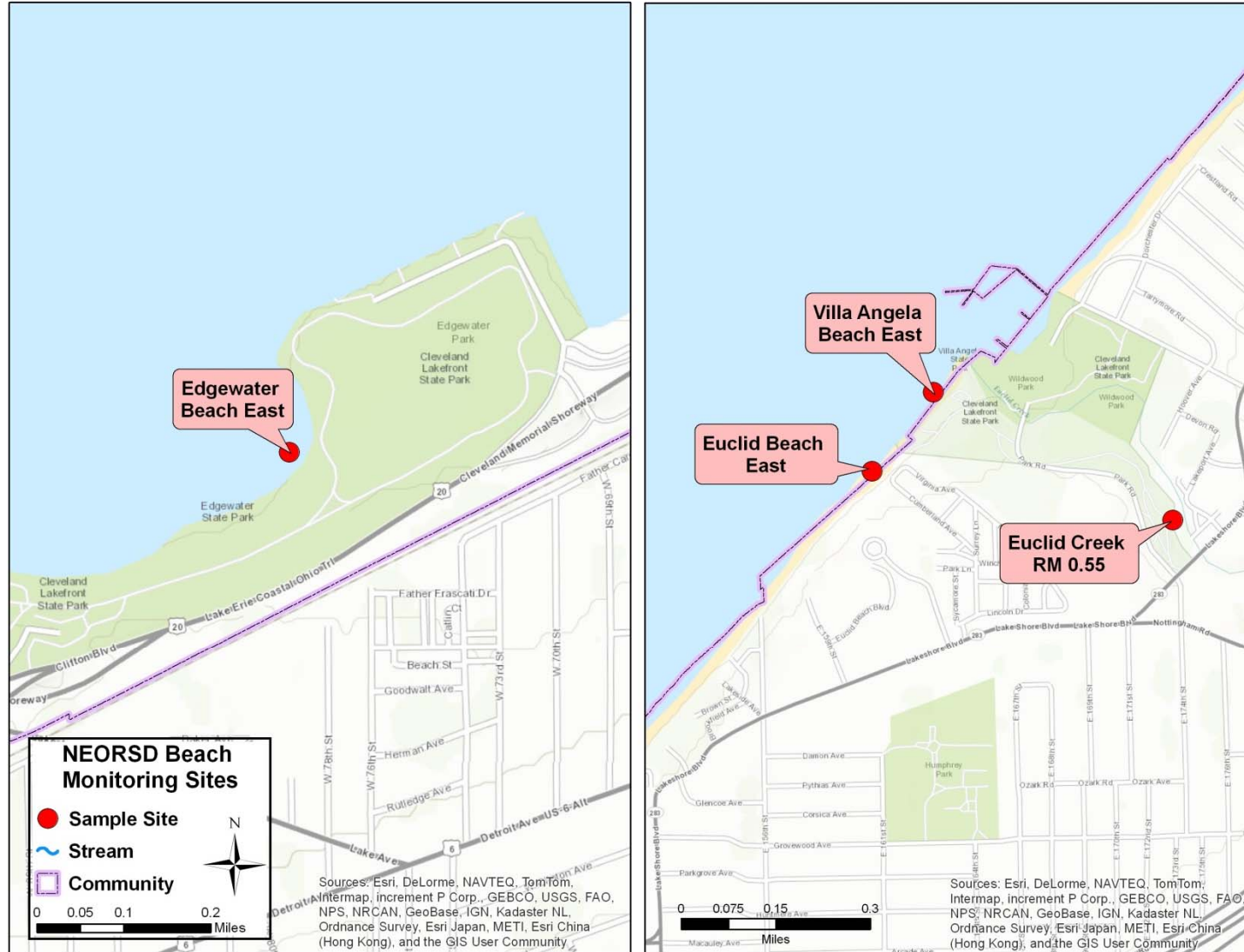


Figure 1. Map of Sampling Sites

Table 1. List of Lake Erie and Euclid Creek Sampling Sites

Location	Site	Latitude	Longitude	Description	Quadrangle	Purpose
Edgewater Beach	East	41.4893	-81.7392	Eastern half of the beach. In line with the brick stack on the other side of the freeway	Cleveland South	<ul style="list-style-type: none"> • Public notification of water quality conditions at bathing beaches • Determination of water quality standards attainment • Evaluation of the impact of point and non-point sources
Villa Angela Beach	East	41.5851	-81.5677	Eastern half of beach, mid-distance between the 3 rd and 4 th break walls	East Cleveland	
Euclid Beach	East	41.5843	-81.5686	Eastern half of beach in line with the East side of the pile of stones on the beach	East Cleveland	
Euclid Creek	RM 0.55	41.5831	-81.5594	Downstream of Lakeshore Boulevard	East Cleveland	

Sampling Schedule and Methods

Bacteriological sampling was conducted from May 1, 2018, to October 31, 2018. From May 1 through May 17, water samples were collected from each beach and Euclid Creek RM 0.55 (further referred to simply as Euclid Creek) four days a week (Monday through Thursday). Beginning May 21, and lasting through September 6, samples were collected at each beach and Euclid Creek seven days a week. From September 11 through October 31, sampling at all sites returned to four days a week (Monday through Thursday). A total of 151 samples were collected at each site, except for Edgewater Beach (132 samples). No sample was collected at Edgewater Beach on July 7, 2018, due to the activity of a search and rescue crew at the beach. The sampling season, which typically concludes at the end of September, was extended to the end of October for Euclid Creek, Villa Angela, and Euclid Beaches, but not Edgewater Beach, in order to study the influence of the completion of the Euclid Creek Tunnel. Overall, a total of 617 samples including 32 duplicates were collected throughout the course of this study.

Field analysis included the use of a Hanna HI 98129 meter to measure pH, water temperature, and conductivity. The Hach 2100Q Portable Turbidimeter was additionally used to obtain field turbidity measurements. Also, the EXO1 sonde equipped with a total algae sensor was used to take field measurements of chlorophyll and phycocyanin pigments. All water samples, field parameters and analyses were collected as specified in the most current NEORSD Beach Sampling Standard Operating Procedure (*SOP-EA016-18*) and Ohio EPA's *Surface Water Field Sampling Manual for water quality parameters and flows* (Ohio EPA, 2015).

Bacteriological grab samples were collected in a 1-liter sterilized polypropylene container. Samples at each location were collected approximately 6-12 inches below the surface, in water that was approximately three-feet deep. At the time of sample collection, field parameters were measured, and field observations and water conditions were documented at each beach site. All data that was collected was recorded on an NEORSD Beach Sampling Field Data Form. All samples were placed in a cooler with ice and stored in a locked NEORSD vehicle until the samples were transferred to NEORSD's Analytical Services sample receiving with a Chain of Custody. All Beach Sampling Field Data Forms, Chains of Custody and Certificates of Analysis are available upon request from the Water Quality and Industrial Surveillance Division, and the Analytical Services Division.

The quality assurance and quality control of bacteriological water sample collections included field duplicates that were collected at a frequency not less than 5% of the total samples collected. A total of 28 duplicate samples were collected for a final duplicate frequency of 5%. Since field blanks are not required by method SM 9223 or by the National Environmental Laboratory Accreditation Conference (NELAC) for bacteria analysis, no bacteriological field blanks were collected during the study. Analytical Services has procedures in place which are required by NELAC to demonstrate that the sample containers are clean and sterile.

Relative percent difference (RPD) was used to determine the degree of discrepancy between the primary and duplicate sample (Formula 1).

$$\text{Formula 1:} \quad \text{RPD} = \left(\frac{|X-Y|}{((X+Y)/2)} \right) * 100$$

X= is the concentration of the parameter in the primary sample
Y= is the concentration of the parameter in the duplicate sample

For bacteriological samples, the acceptable RPD is 133.3%. Those RPDs that are higher than acceptable may indicate potential problems with sample collection and, as a result, the data would not be used for comparison to the water quality standards.

HAB grab samples were collected in accordance with the State of Ohio Harmful Algal Bloom Response Strategy for Recreational Waters (State of Ohio, 2016). Samples were collected at the densest part of the bloom that could be safely reached by wading and therefore represent the worst-case scenario for public exposure to HAB toxins. HAB grab samples were analyzed for toxin producing genera by microscopic identification, and for total microcystin toxin by ELISA following EPA Method 546.

Results and Discussion

The *E. coli* results from each beach site were compared to the Ohio Water Quality Standards in order to determine recreational use attainment. From May 1st to October 31st,

the three beaches are designated as Bathing Waters for the Protection of Recreational Use, while Euclid Creek is designated as a Primary Contact Recreation stream (Ohio EPA, 2018). Both the Bathing Waters and Primary Contact Recreation criteria for *E. coli* include a statistical threshold value (STV) criterion not to exceed 410 colony counts units per 100 milliliters (colony counts/100mL) in more than ten percent of the samples collected during any 90-day period and a 90-day geometric mean criterion of 126 colony counts/100mL. The Bathing Waters criteria also maintain the use of the previous single sample maximum limit of 235 colony counts/100mL as the beach action value for the purpose of posting daily water quality advisories.

Duplicate samples collected at Villa Angela Beach were outside of the acceptable RPD on July 1, and September 13, 2018 (Table 2). Data from these dates were therefore qualified as rejected. It should be noted that all data from these duplicate samples were well below criterion limits.

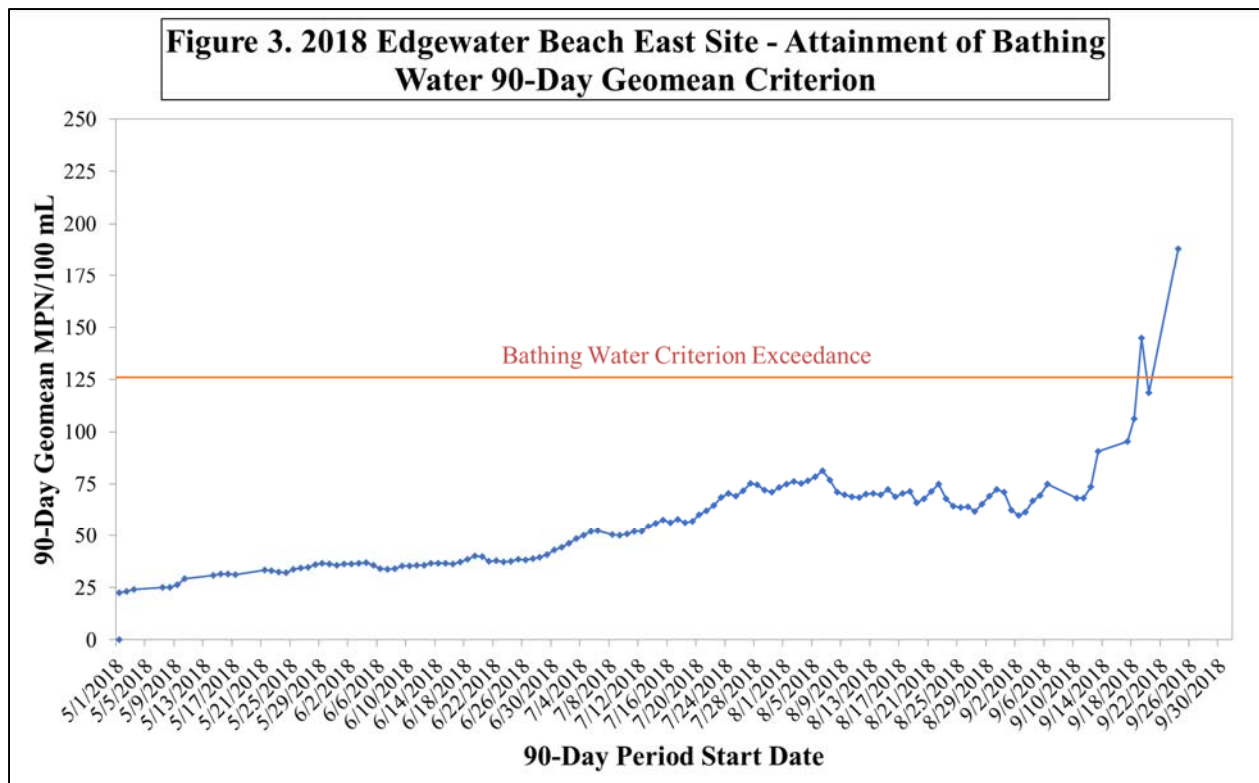
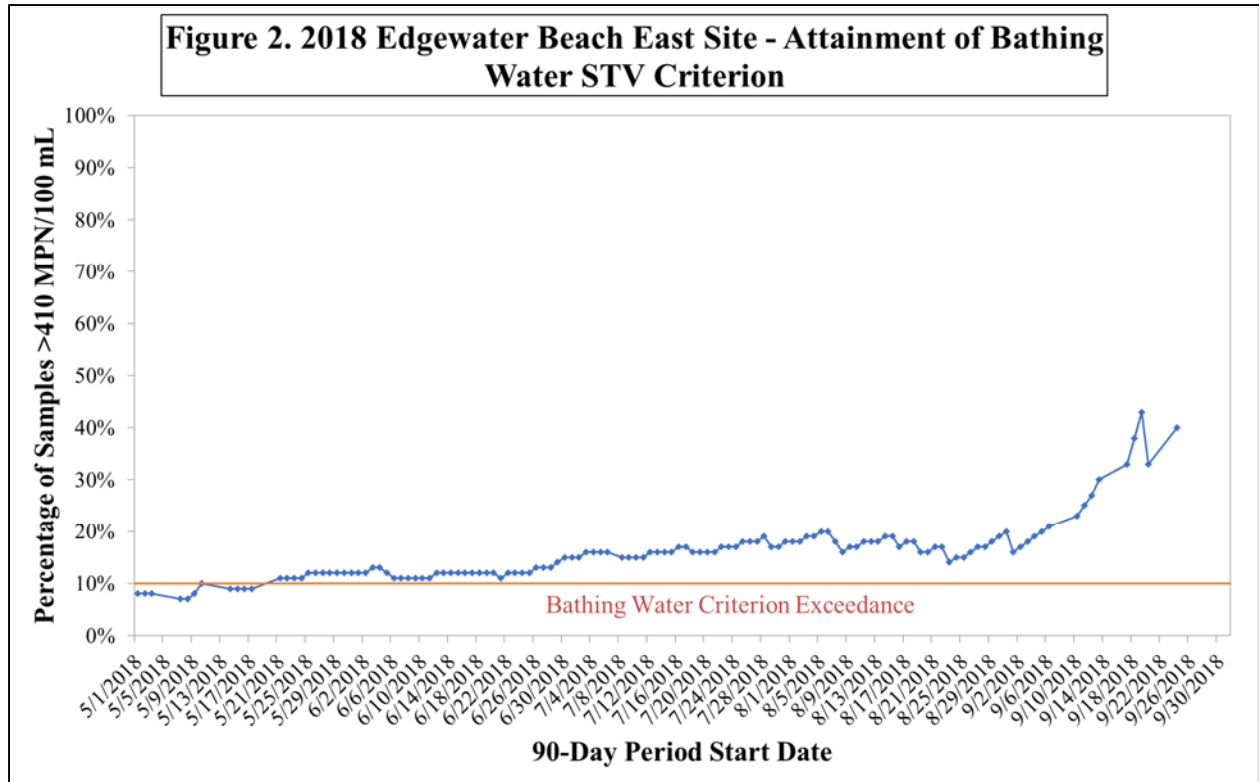
Table 2. Rejected Data from Villa Angela Beach Due to Unacceptable RPDs.

Date	Result (MPN/100mL)	RPD	Acceptable RPD
07/01/2018	2	144.3	133.3
	10		
09/13/2018	178	163.3	133.3
	18		

Recreational Use Attainment Status

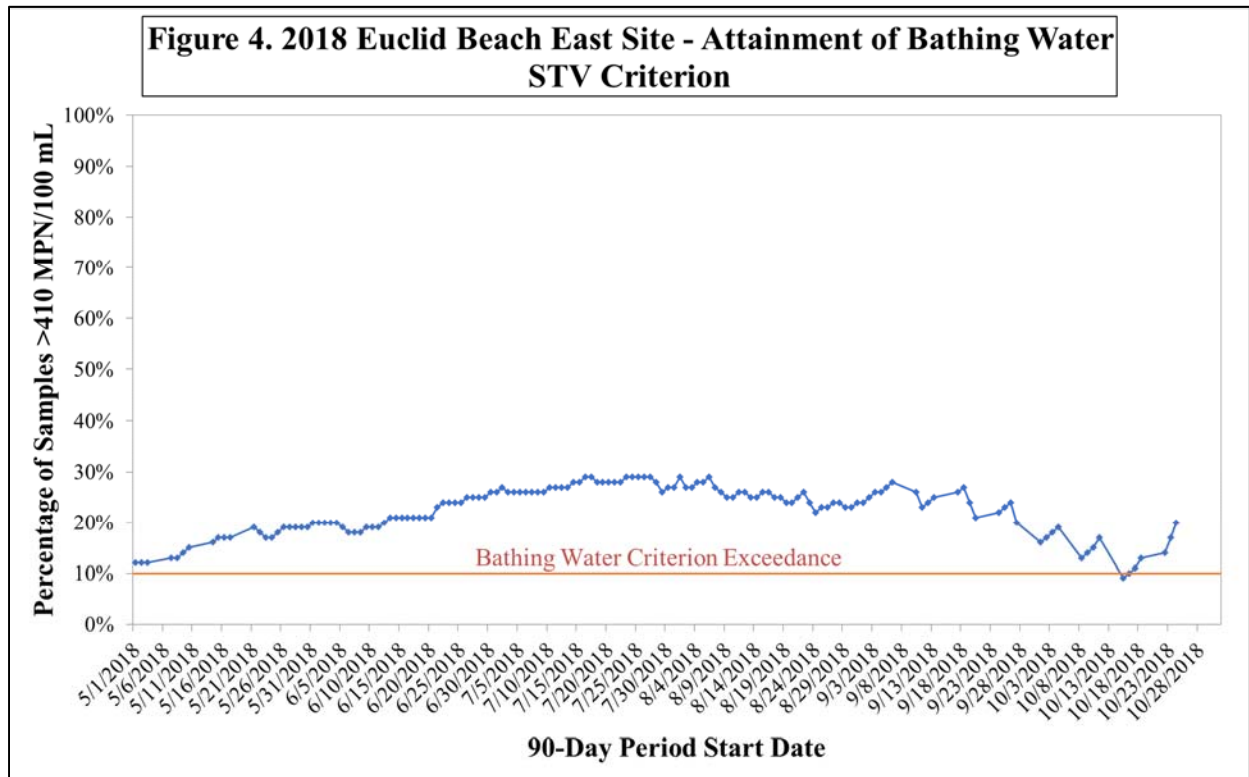
Edgewater Beach

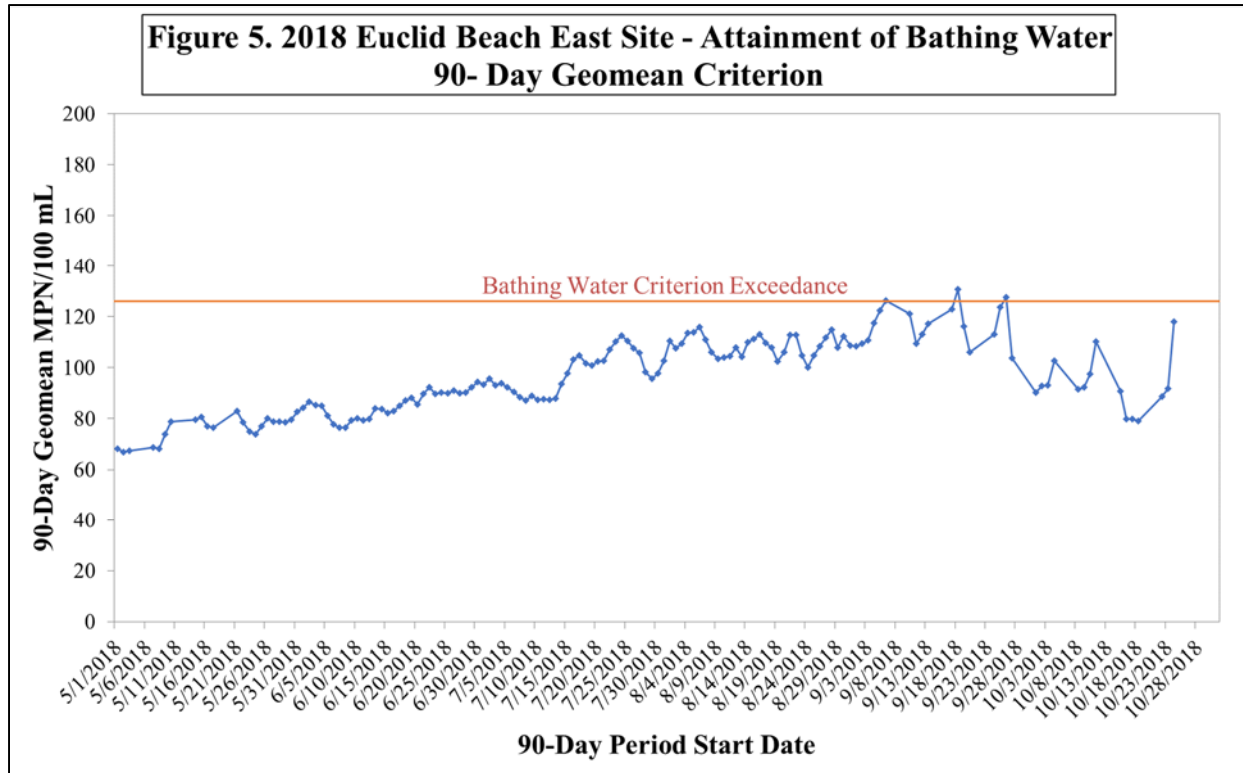
Water Quality Standards attainment status of Edgewater Beach for Bathing Water recreational use criteria are shown in (Figures 2 and 3). The STV criterion was exceeded at Edgewater Beach for 91.4% of the 90-day periods in 2018. The geometric mean criterion was exceeded for only two 90-day periods near the end of the sampling season, an exceedance frequency of 1.6%. Single samples exceeded the Beach Action Value of 235 colony counts/100mL for 18 of the 132 sampling events, a frequency of 13.6%. Twelve of the 18 exceedances of the beach action value (66.7%) occurred within 48 hours of a rain event with a total rainfall greater than 0.10 inches.



Euclid Beach

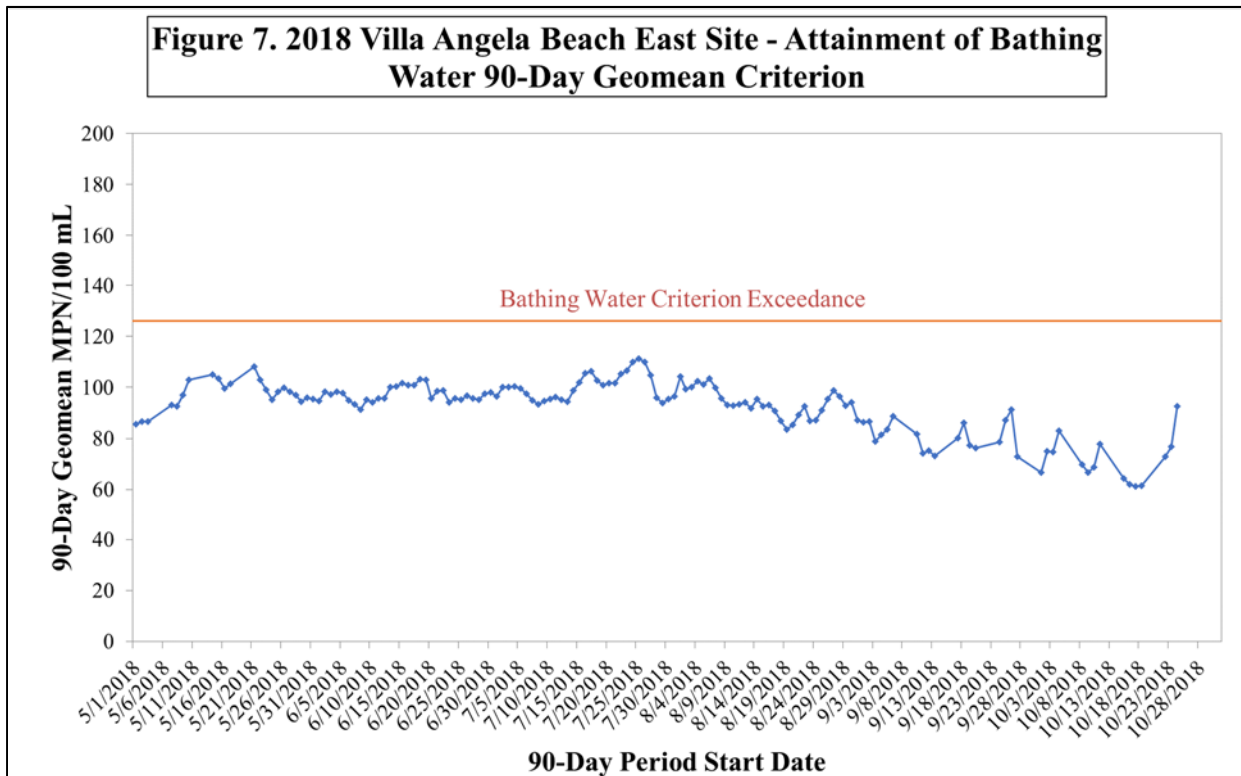
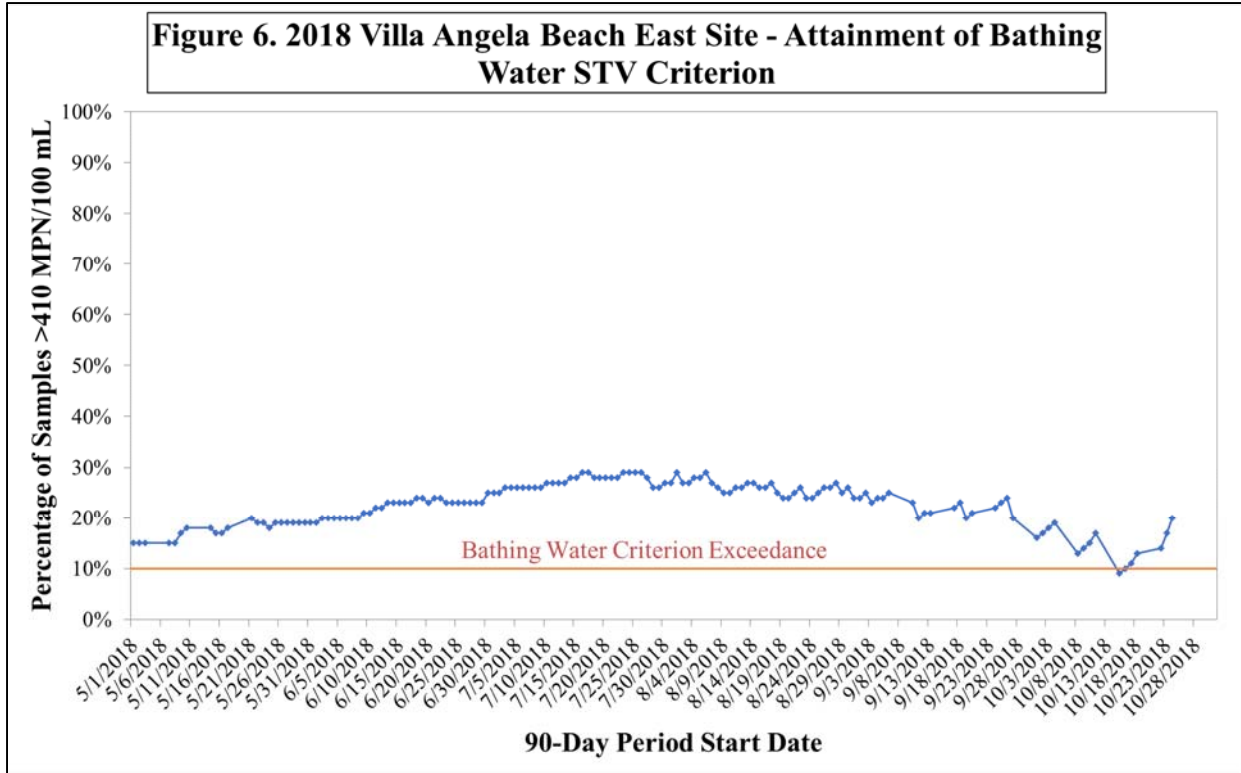
Euclid Beach was in non-attainment of the Bathing Water recreational use criteria in 2018 (Figures 4 and 5). Euclid Beach was in non-attainment of the STV criterion for 98.6% of the 90-day periods. Euclid Beach was also in non-attainment of the geometric mean criterion for two of the 90-day periods, an exceedance frequency of 2.0%. Single samples exceeded the Beach Action Value of 235 colony counts/100mL for 45 of the 151 sampling events, a frequency of 29.8%. Twenty-nine of these 45 exceedances (64.4%) occurred within 48 hours of a rain event with a total rainfall greater than 0.10 inches.





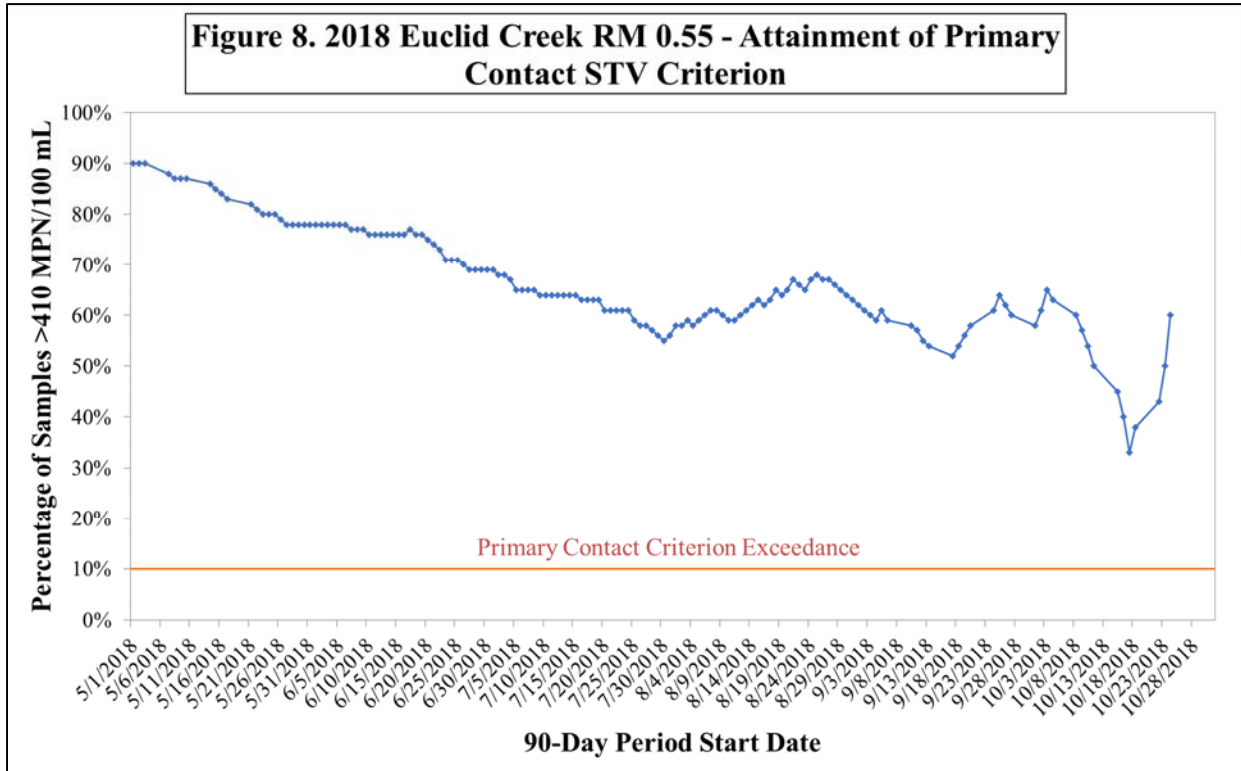
Villa Angela Beach

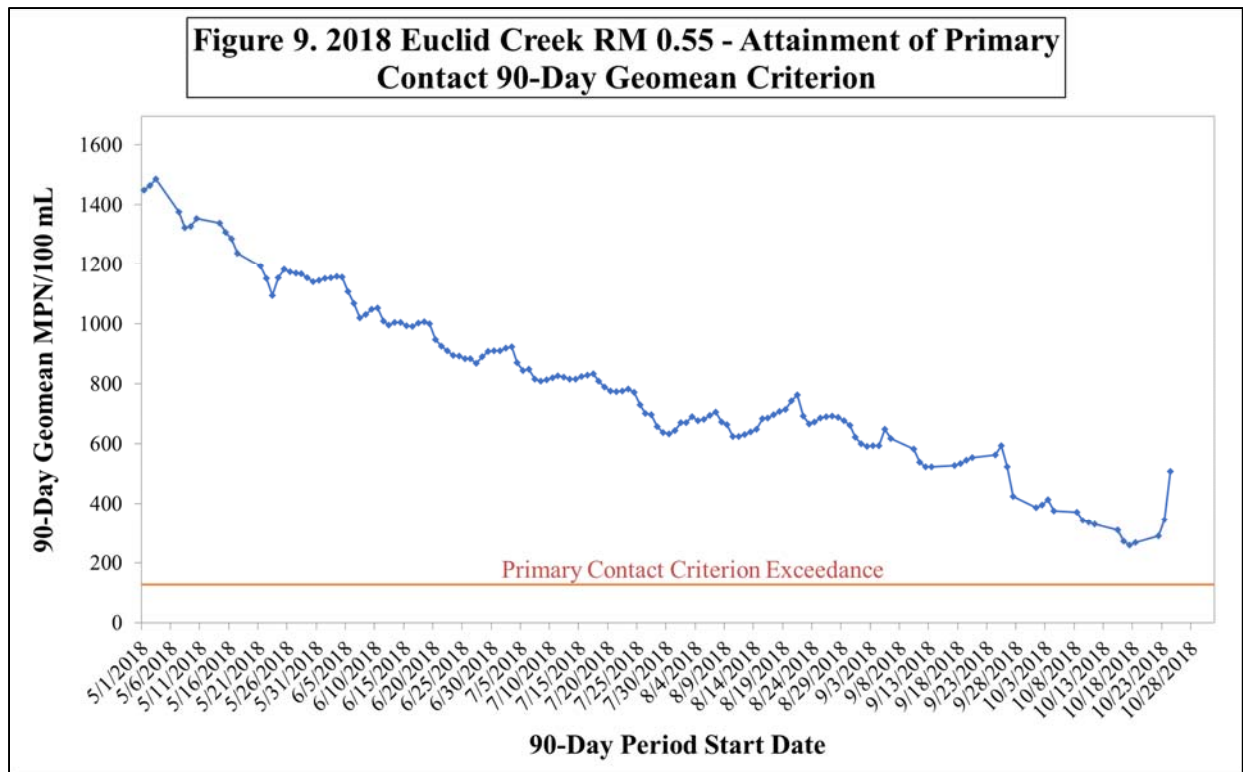
Villa Angela Beach was in non-attainment of the STV Bathing Water recreational use criterion in 2018, but was in attainment of the geomean criteria (Figures 6 and 7). Villa Angela exceeded the STV criterion for 98.6% of the 90-day periods, but met the geomean criteria for all 90-day periods in 2018. Single samples exceeded the beach action value of 235 colony counts/100mL for 46 of the 151 sampling events, a frequency of 30.5%. Twenty-six of these 33 exceedances (56.5%) occurred within 48 hours of a rain event with a total rainfall greater than 0.10 inches.



Euclid Creek RM 0.55

Euclid Creek was in non-attainment of both Primary Contact recreational criteria in 2018 (Figures 8 & 9). Euclid Creek exceeded both the STV and geometric mean criteria for 100% of the 90-day periods. As further discussed below, Euclid Creek RM 0.55 has displayed this degree of exceedance for as long as monitoring has been performed by the NEORS.





Comparison with Historical Data, Rainfall, and CSO Occurrence

Table 3 presents historical data on the recreational use criteria exceedances for all of the sites included in this study. The NEORSD began submitting beach monitoring data to the Ohio EPA Credible Data Program in 2009. Therefore, prior data is not included in this comparison. It should be noted that the recreational use criteria have been modified within the presented timeline. From 2009 to 2014, the applicable Bathing Waters recreational use criteria included an *E. coli* criterion not to exceed a single sample maximum (SSM) of 235 colony counts/100mL in more than ten percent of the samples collected during any 30-day period, and a seasonal geometric mean (SGM) criterion of 126 colony counts/100mL (Ohio EPA, 2010). The current 90-day STV and geometric mean criteria took effect in 2015. The data presented in Table 3 represents exceedances of the criteria that were applicable at the time of sample collection. For comparative purposes only, the SGM *E. coli* density was also calculated from data collected from 2015-2018, even though it does not apply to data collected from these years. Additionally, the beach action value of 235 colony counts/100mL used to post public advisories has remained constant for the entire period of record. The seasonal percent exceedance of the beach action value for each beach site is also presented in Table 3 for historical comparison

E. coli densities at all three beaches were found to be elevated compared to the previous two years. This may be due to the above average amount of precipitation that occurred throughout the 2018 recreational season. Table 4 presents total rainfall in inches

during the past seven years of recreational seasons (May 1st to October 31st) as measured at the Division Avenue (located near Edgewater Beach) and Easterly WWTP rain gauges (located near Euclid and Villa Angela Beaches and Euclid Creek). Wet-weather¹ events have been known to contribute to elevated bacteria levels by causing discharges from CSOs, storm sewer runoff, urban runoff, and runoff from contaminated beach sand to enter Lake Erie. Therefore, the relatively rainy season that occurred in 2018 is most likely the primary factor responsible for the increased number of exceedances of the recreational water quality criteria in comparison to the past two years.

Table 3. Historical Recreational Use Criteria Exceedances.					
Site	Year	SSM/STV % Exceedance	Geometric Mean % Exceedance	Beach Action Value %	SGM
EDGE	2018	91.4	1.6	13.6	35*
	2017	0.0	0.0	6.9	30*
	2016	0.0	0.0	8.3	35*
	2015	34.8	0.0	18.8	77*
	2014	93.0	N/A	20.0	60
	2013	66.0	N/A	13.9	53
	2012	58.6	N/A	11.6	41
	2011	92.2	N/A	26.6	98
	2010	73.0	N/A	13.3	56
	2009	90.6	N/A	28.1	107
	Average	60.0	0.4	16.1	59.2
EUBE	2018	98.6	2.0	29.8	84*
	2017	66.1	1.5	25.4	79*
	2016	89.5	0.0	24.8	71*
	2015	97.8	33.8	37.7	136*
	2014	98.0	N/A	32.2	126
	2013	97.0	N/A	41.1	144
	2012	99.3	N/A	36.9	118
	2011	100	N/A	43.6	149
	2010	90.0	N/A	36.3	110
	2009	100	N/A	36.6	112
	Average	93.6	9.3	34.4	113

¹ Wet-weather sampling events: greater than 0.10 inches of rain but less than 0.25 inches, samples collected that day and the following day are considered wet-weather samples; greater than 0.25 inches, the samples collected that day and the following two days are considered wet-weather samples.

Table 3. Historical Recreational Use Criteria Exceedances.					
Site	Year	SSM/STV % Exceedance	Geometric Mean % Exceedance	Beach Action Value %	SGM
VABE	2018	98.6	0.0	30.5	93*
	2017	79.2	8.4	29.2	89*
	2016	91.7	5.3	33.1	99*
	2015	97.8	51.8	46.4	181*
	2014	96.0	N/A	34.4	147
	2013	91.0	N/A	41.7	141
	2012	100	N/A	41.5	110
	2011	100	N/A	46.0	174
	2010	100	N/A	34.9	128
	2009	100	N/A	43.8	172
	Average	95.4	16.4	38.2	133
EC RM 0.55	2018	100	100	N/A	1006*
	2017	100	100	N/A	1510*
	2016	100	100	N/A	907*
	2015	100	100	N/A	1246*
	2014	100	N/A	N/A	1617
	2013	100	N/A	N/A	1092
	2012	100	N/A	N/A	973
	2011	100	N/A	N/A	1351
	2010	100	N/A	N/A	1047
	2009	99.3	N/A	N/A	852
	Average	99.9	100	N/A	1134
Exceedances of historical SGM criterion in Bold (>126 colony counts per 100mL)					
*SGM does not apply. Calculated for comparative purposes only.					

Table 4. Total Rainfall (Inches) from May 1st to October 31st.		
Year	Division Ave Rain Gauge	Easterly Rain Gauge
2018	27.56	25.32
2017	16.56	20.30
2016	13.87	16.23
2015	23.40	23.41
2014	24.50	25.12
2013	21.35	28.31
2012	26.46	24.80
Average 2012-2018	21.96	23.36

Combined sewer overflow discharges may have contributed to the elevated *E. coli* densities observed at Villa Angela and Euclid beaches in 2018. Proximity of nearby CSO outfalls to Edgewater, Euclid, and Villa Angela Beaches are shown in Figures 10 and 11. The number of overflow events and total volume of discharge from each of the listed CSOs from May 1 to October 31, is presented in Table 5.

In the proximity of Edgewater Beach, 24 overflow events occurred during the 2018 recreational season. Nineteen of these events occurred from CSO-002, the Westerly Wastewater Treatment Center Overflow. The remaining 5 occurred from CSO-069 and CSO-071.

Seventy-four overflow events occurred in the proximity of Euclid and Villa Angela Beaches in 2018. These events most likely contributed to the elevated *E. coli* densities observed at these beaches. The Euclid Creek Tunnel, a CSO storage tunnel designed to capture CSO discharges, was brought online in September 2018. It is expected that the future reduction of CSO events resulting from this new infrastructure will have a positive influence on water quality at these beaches with respect to recreational criteria.

Elevated *E. coli* densities at Euclid and Villa Angela Beaches are additionally influenced by the proximity of these beaches to Euclid Creek. Euclid Creek has been in 100% exceedance of the recreational water quality criteria for nine continuous years. Local water current studies have demonstrated that the discharge of Euclid Creek flows to Euclid and Villa Angela beaches and therefore directly impacts beach water quality (USGS, 2013). The elevated *E. coli* densities present at Euclid Creek are most likely due to a combination of sanitary sewage contamination from illicit discharges and combined sewer overflows, as well as contamination from fecal matter from companion animals, urban wildlife, and park wildlife from the surrounding urban community. NEORSD projects including illicit discharge remediation efforts, microbial source tracking efforts, and the completion of the Euclid Creek Storage Tunnel, are expected to lead to improvement of the water quality of Euclid Creek in the coming years. It is therefore expected that these programs will also have a positive impact on the water quality of Euclid and Villa Angela Beaches.

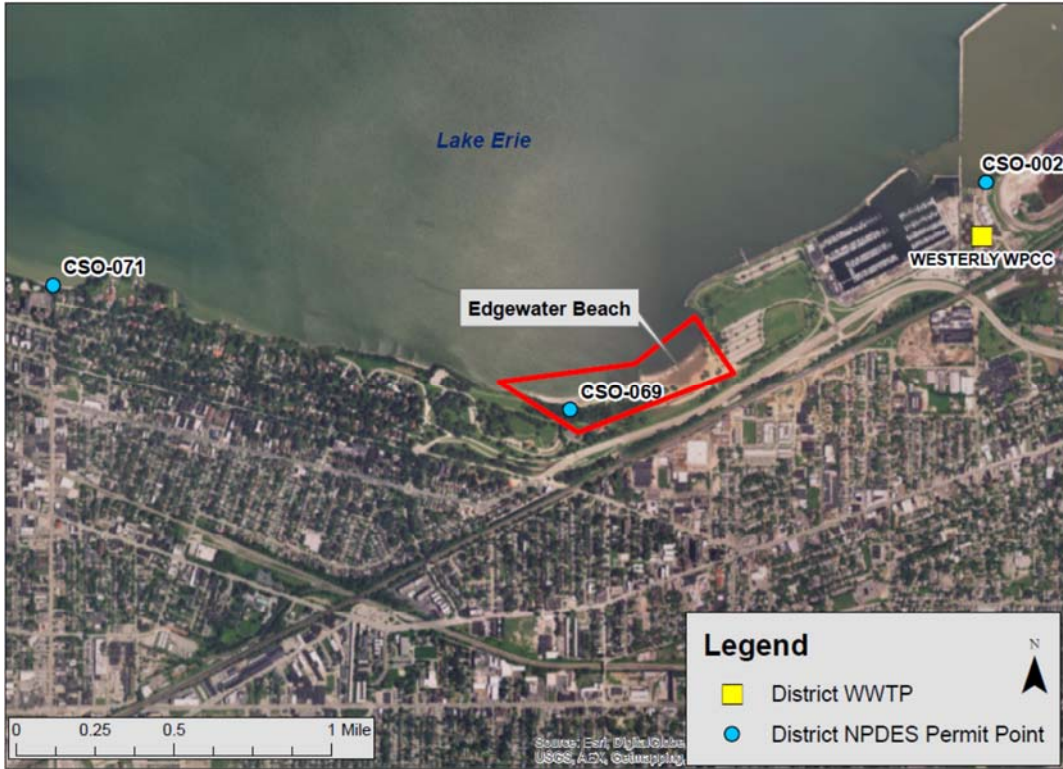


Figure 10. Proximity of CSO Outfalls to Edgewater Beach

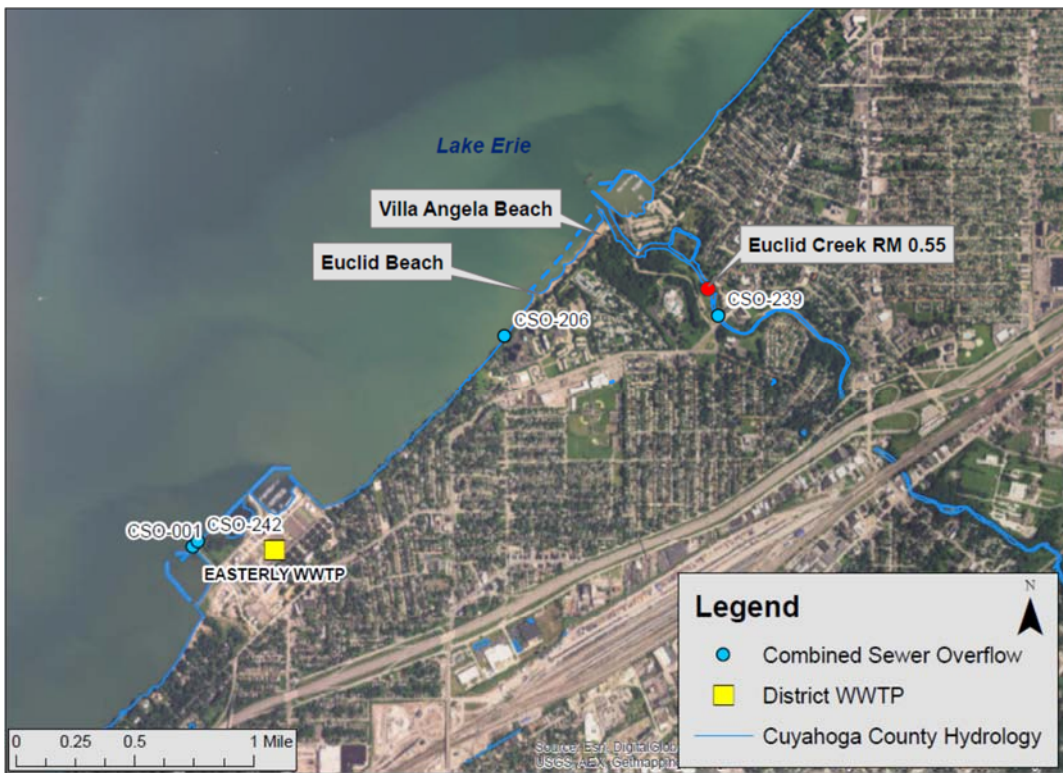


Figure 11. Proximity of CSO Outfalls to Euclid and Villa Angela Beaches

Table 5. CSO Events from May 1 to October 31.

Outfall ID	Nearest Beach	Number of Overflow Events				Total Overflow Volume (Million Gallons)			
		2018	2017	2016	2015	2018	2017	2016	2015
CSO-002	Edgewater	19	8	9	16	277.7	180.3	125.3	235.2
CSO-069	Edgewater	2	0	0	3	0.1	0.0	0.0	6.48
CSO-071	Edgewater	3	0	0	5	No Flow Gauge	0.0	0.0	No Flow Gauge
CSO-001	Euclid/Villa Angela	23	17	28	31	670.5	614.6	1,346.7	2301.9
CSO-206	Euclid/Villa Angela	18	22	13	13	65.3	37.4	18.3	50.7
CSO-239	Euclid/Villa Angela	27	31	39	46	33.5	18.0	26.7	60.0
CSO-242	Euclid/Villa Angela	6	5	7	17	10.5	4.5	9.0	20.7

Harmful Algal Bloom Monitoring

On June 29, 2018, Cleveland Metroparks staff contacted NEORSD to request additional sampling of a potential HAB. No signs of a bloom were observed during routine sample collection at 0630 hours that morning. Cleveland Metroparks staff noticed the green coloration of the bloom at approximately 1200 hours and contacted NEORSD at 1336 hours to request additional sampling. At 1435 hours, NEORSD Investigators arrived on scene and confirmed the presence of a potential HAB (Figure 12). Sampling was immediately performed in accordance with the State of Ohio Harmful Algal Bloom Response Strategy for Recreational Waters (State of Ohio, 2016). A second crew was immediately deployed to Villa Angela Beach and performed sampling at this beach as well. The cyanobacterial genera *Microcystis* and *Anabaena* were confirmed in samples from both beaches by NEORSD Analytical Services at approximately 1600 hours. The beach postings were then updated to public advisory status at approximately 1620 hours.

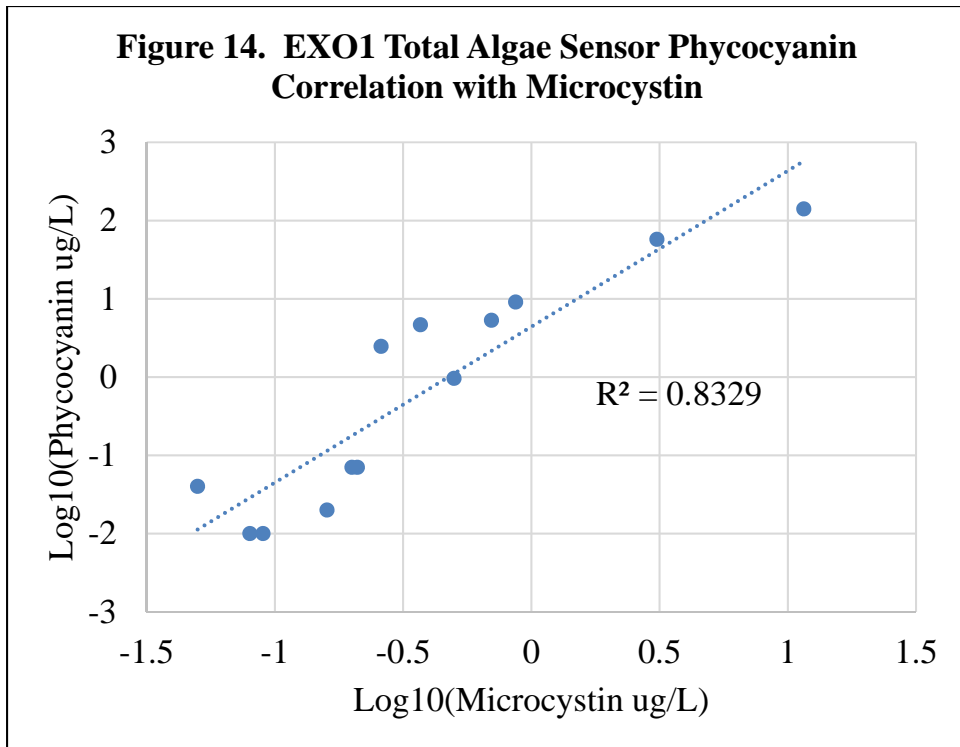
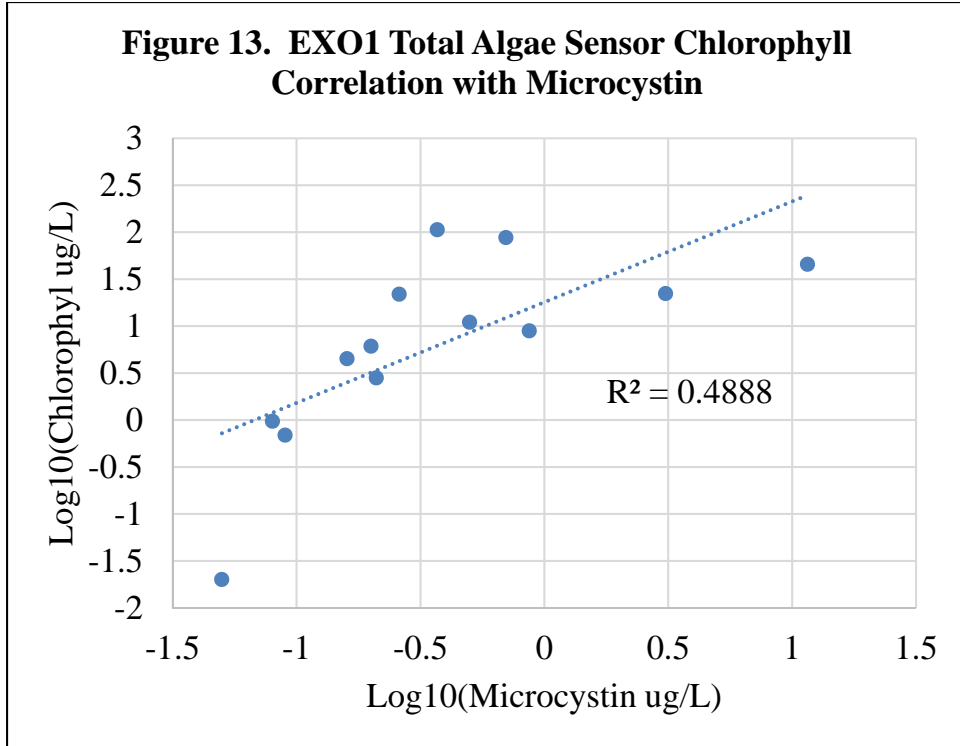


Figure 12. HAB at Edgewater Beach at 1435 hours on June 29, 2018.

Microcystin concentrations were found to be elevated above the public advisory threshold of 6 $\mu\text{g/L}$ at Edgewater Beach but not Villa Angela Beach (Table 6). Additional samples were collected for microcystin analysis on a daily basis from June 29 until July 8, 2018. No further samples were found to have toxin concentrations above the public advisory threshold. The public advisory posting was lifted on July 9, 2018, following a full week of consecutively low HAB toxin results at both beaches. Throughout the course of HAB sampling, additional field measurements were taken using the EXO1 total algae sensor to detect the algal pigments chlorophyll and phycocyanin. Chlorophyll is ubiquitous to all algae, while phycocyanin is specific to HABs. Both chlorophyll and phycocyanin showed a positive correlation with microcystin concentration ($R^2=0.49$ and 0.83 respectively, Figures 13 and 14). Phycocyanin had the best correlation as expected, as this pigment is specific to HAB genera capable of producing toxin. The total algae sensor probe was able to detect and quantitate HAB pigments with sufficient sensitivity to predict the presence of toxin above the public advisory threshold for the bloom that occurred on June 29, 2018. It should be noted that this data set is weak in that it is a limited data set from a single HAB occurrence. It is possible that the ratio of toxin to pigment concentration may vary in future blooms depending on multifactorial environmental conditions. However,

this preliminary data demonstrates that this sonde probe is a useful screening tool for determining when toxin producing species are present. This may provide a useful quantitative method for determining when additional sampling should be performed for the protection of public health. This would be an improvement in the current procedure which relies on subjective visual observation to identify potential HABs.

Date	Edgewater	Villa Angela
6/29/2018	11.55	3.09
6/30/2018	0.26	<0.14
7/1/2018	<0.14	<0.14
7/2/2018	0.7	<0.14
7/3/2018	0.37	<0.14
7/4/2018	0.21	0.87
7/5/2018	0.50	<0.14
7/6/2018	0.20	0.16
7/7/2018	0.10	0.08
7/8/2018	0.09	0.05



Conclusions

Edgewater, Euclid, and Villa Angela Beaches were all found to be in non-attainment of the Bathing Water recreational criteria in 2018. The elevated *E. coli* densities at these beaches compared to the previous two years is most likely due to the elevated precipitation that occurred in 2018. A single exceedance of the public advisory threshold for microcystin toxin also occurred at Edgewater Beach in 2018. The HAB was short-lived, and toxin levels dropped below the public advisory threshold within 24 hours. Algal pigment data collected using the EXO1 total algae sensor showed a strong correlation with microcystin toxin throughout the course of this HAB event. This sensor may be a useful tool for daily screening to determine whether HAB sampling is necessary for the protection of public health in the future.

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Analytical Services Division – Completed analysis for all bacteriological sampling.

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