



Northeast Ohio Regional Sewer District

2021 Lake Erie Beach Monitoring



**Water Quality and Industrial Surveillance
Environmental Assessment Group
April 2022**

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Introduction

Since 1992, the Northeast Ohio Regional Sewer District (NEORS) 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 2021, the NEORS 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 either NEORS Level 3 Qualified Data Collectors (QDCs) certified by the Ohio Environmental Protection Agency (Ohio EPA) in Chemical Water Quality Assessment or other individuals in the Water Quality and Industrial Surveillance Division trained by Level 3 QDCs as explained in the NEORS study plan *2021 Lake Erie Beach Monitoring*, which was approved by Ohio EPA on May 25, 2021. Sample analyses were conducted by NEORS'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.

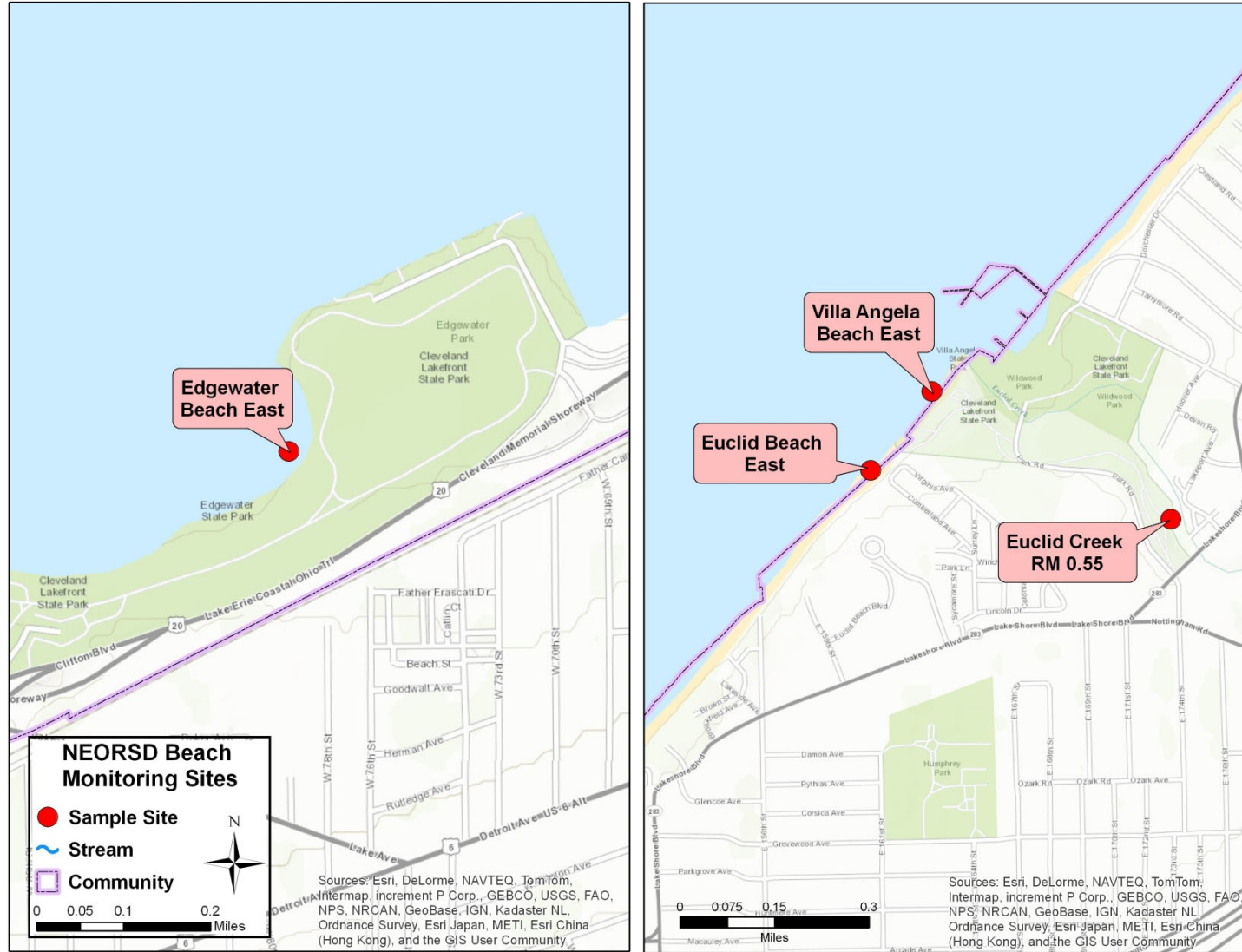


Figure 1. Map of Sampling Sites

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	• Public notification of water quality conditions at bathing beaches
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	• Determination of water quality standards attainment
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 4, 2021, to September 30, 2021. From May 3 through May 20, 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 14, and lasting through September 5, samples were collected at each beach and Euclid Creek seven days a week. From September 6 through September 30, sampling at all sites returned to four days a week (Monday through Thursday). A total of 133 samples were collected at each site. Overall, a total of 566 samples including 34 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 specific conductivity. The Hach 2100Q Portable Turbidimeter was additionally used to obtain field turbidity measurements. A long-term EXO2 sonde installed along the eastern break wall collected field measurements of chlorophyll *a* and phycocyanin pigments, pH, turbidity, temperature, and turbidity. The data sonde measurements were primarily used as a predictive tool for HAB monitoring. All water samples, field parameters and analyses were collected as specified in the most current NEORSB Beach Sampling Standard Operating Procedure (SOP-EA016-19) and Ohio EPA's *Surface Water Field Sampling Manual for water quality parameters and flows* (Ohio EPA, 2019).

Bacteriological grab samples were collected in a 250-mililiter 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. 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.

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.

Throughout the study, a total of 34 duplicate samples were collected for a final duplicate frequency of 6%. No duplicate samples collected at any of the four sites were outside of the acceptable RPD during the 2021 season.

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. Edgewater Beach was in attainment of the recreational use criteria for most of 2021. There were no exceedances of the geometric mean criterion for any of the 90-day periods. Edgewater Beach was in non-attainment of the STV criterion for four of the 90-day periods, an exceedance frequency of 3.8%. Single samples exceeded the Beach Action Value of 235 colony counts/100mL for 10 of the 135 sampling events, a frequency of 7.5%. Eight of the 10 exceedances of the Beach Action Value (80%) occurred within 48 hours of a rain event with a total rainfall greater than 0.10 inches.

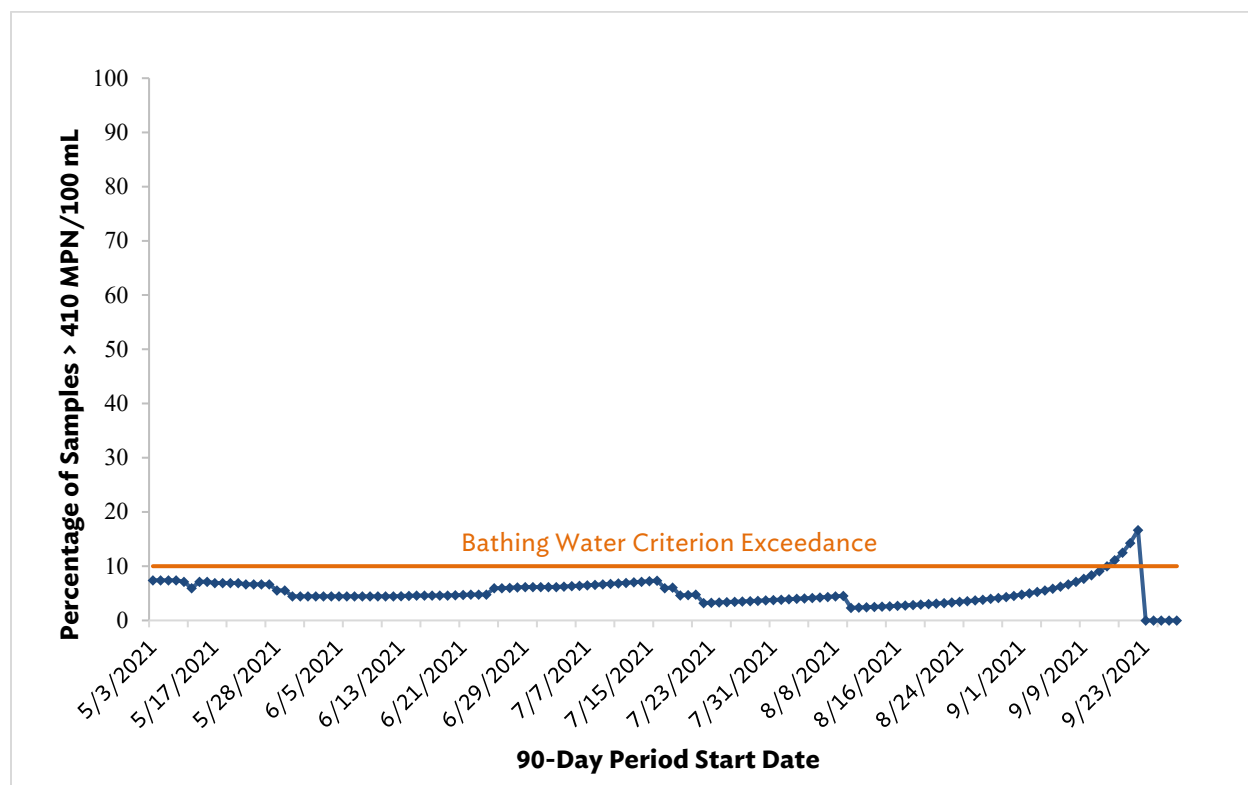


Figure 2. 2021 Edgewater Beach East Site - Attainment of Bathing Water STV Criterion

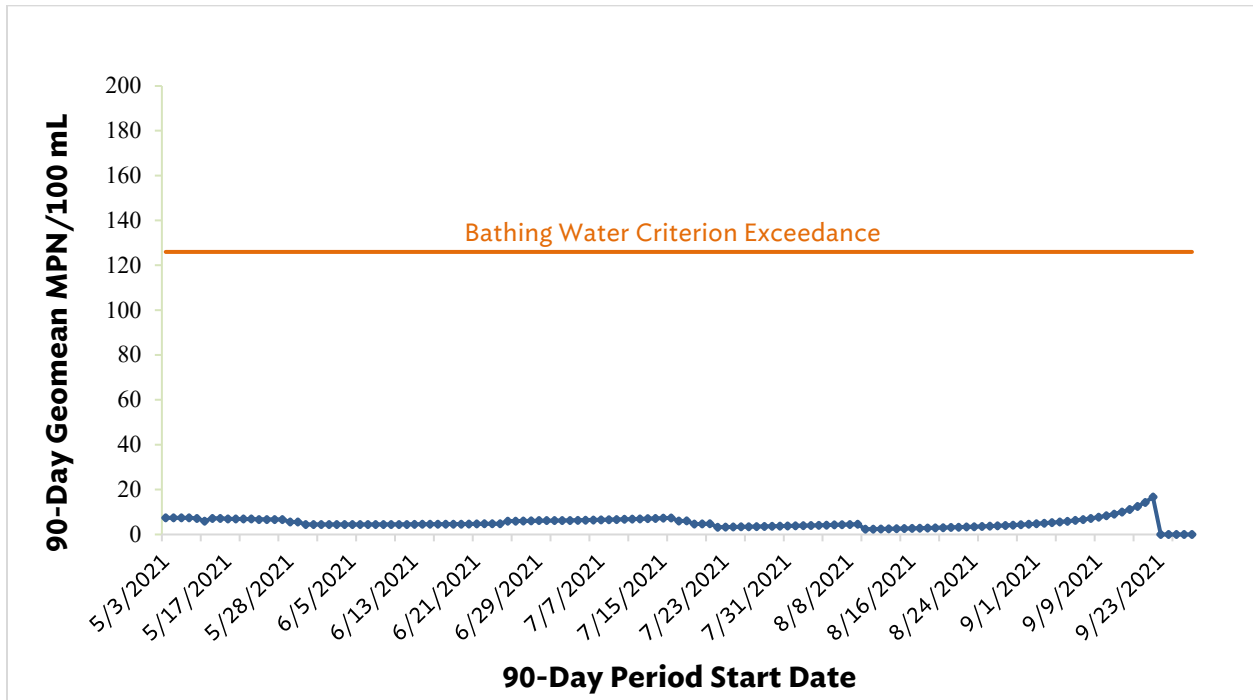


Figure 3. 2021 Edgewater Beach East Site - Attainment of Bathing Water 90-Day Geomean Criterion

Euclid Beach

Euclid Beach was in non-attainment of the Bathing Water recreational criteria for most of the recreation season in 2021 (Figures 4 and 5). Euclid Beach was in non-attainment of the STV criterion for 94.7% of the 90-day periods. Euclid Beach was also in non-attainment of the geometric mean criterion for 12 of the 90-day periods, an exceedance frequency of 9.0%. Single samples exceeded the Beach Action Value of 235 colony counts/100mL for 34 of the 133 sampling events, a frequency of 25.6%. Twenty-two of these 34 exceedances (64.7%) occurred within 48 hours of a rain event with a total rainfall greater than 0.10 inches.

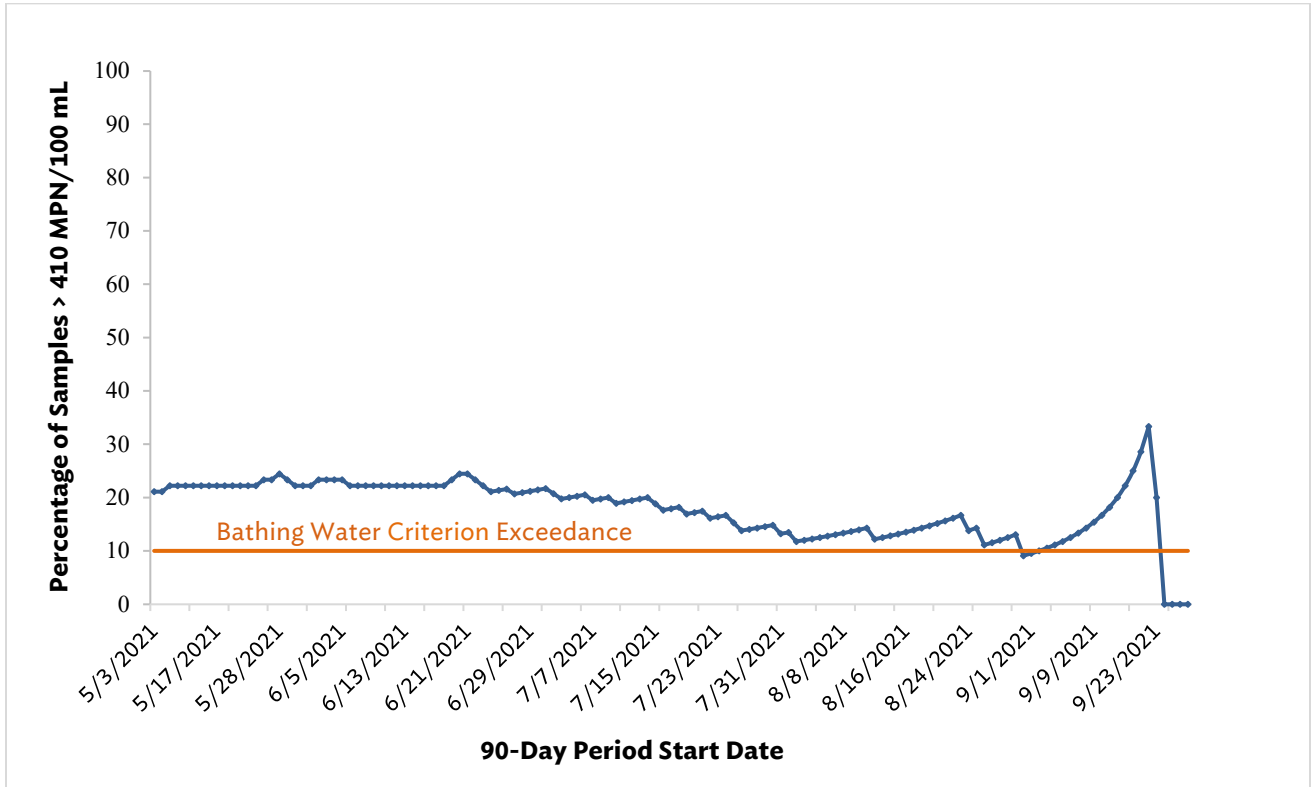


Figure 4. 2021 Euclid Beach East Site - Attainment of Bathing Water STV Criterion

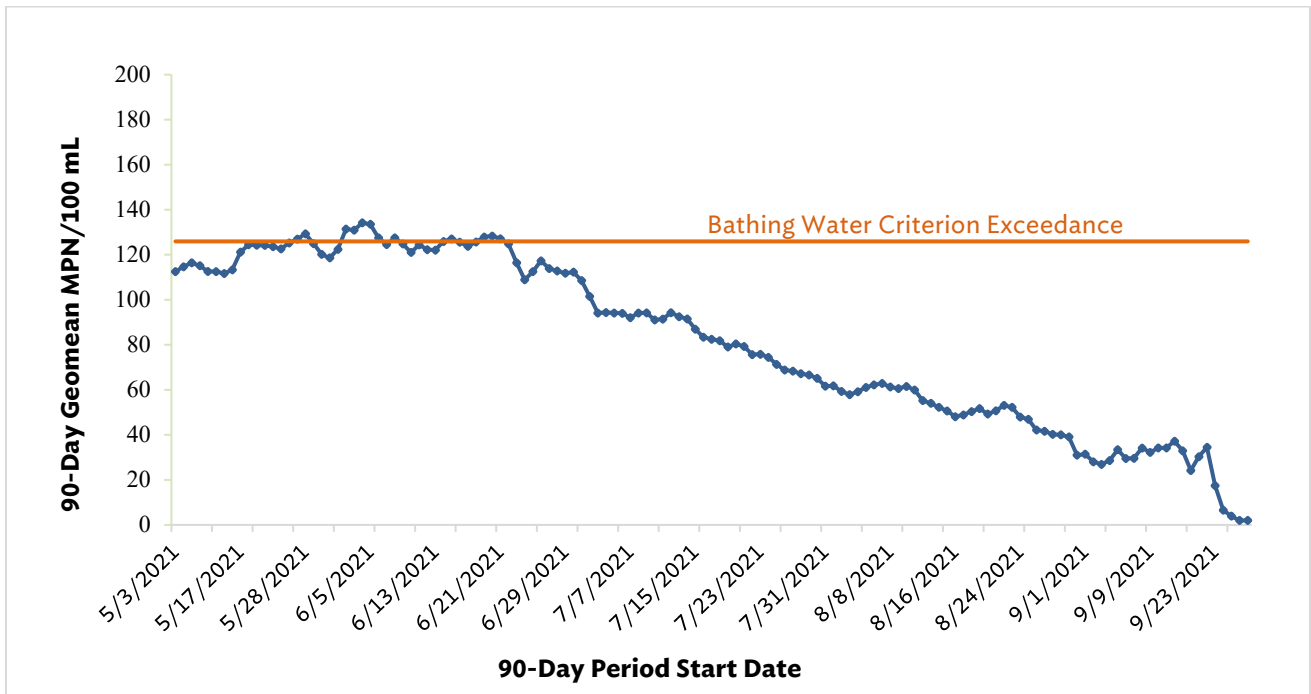


Figure 5. 2021 Euclid Beach East Site - Attainment of Bathing Water 90-Day Geomean Criterion

Villa Angela Beach

Villa Angela Beach was also in non-attainment of the Bathing Water recreational use criteria for most of 2021 (Figures 6 and 7). Villa Angela exceeded the STV criterion for 94.0% of the 90-day periods and exceeded the geomean criterion for 6.8% of the 90-day periods in 2021. Single samples exceeded the beach action value of 235 colony counts/100mL for 40 of the 133 sampling events, a frequency of 30.7%. Twenty-six of these 40 exceedances (65.0%) occurred within 48 hours of a rain event with a total rainfall greater than 0.10 inches.

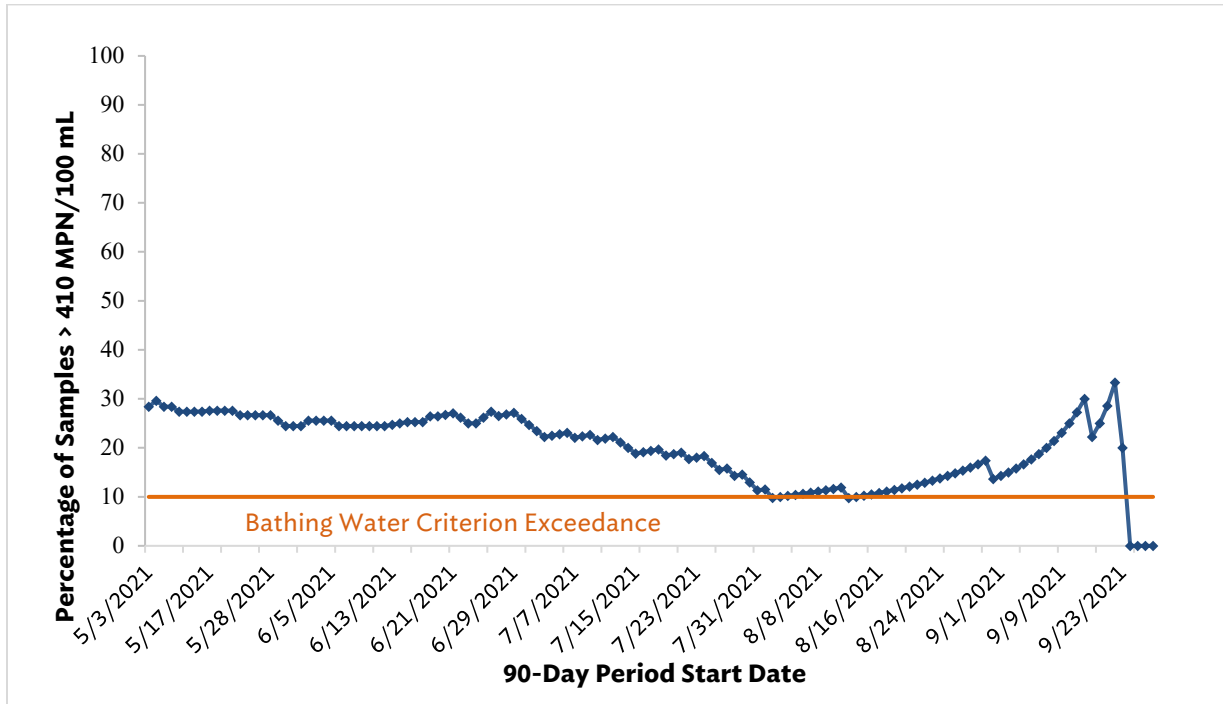


Figure 6. 2021 Villa Angela Beach East Site - Attainment of Bathing Water STV Criterion

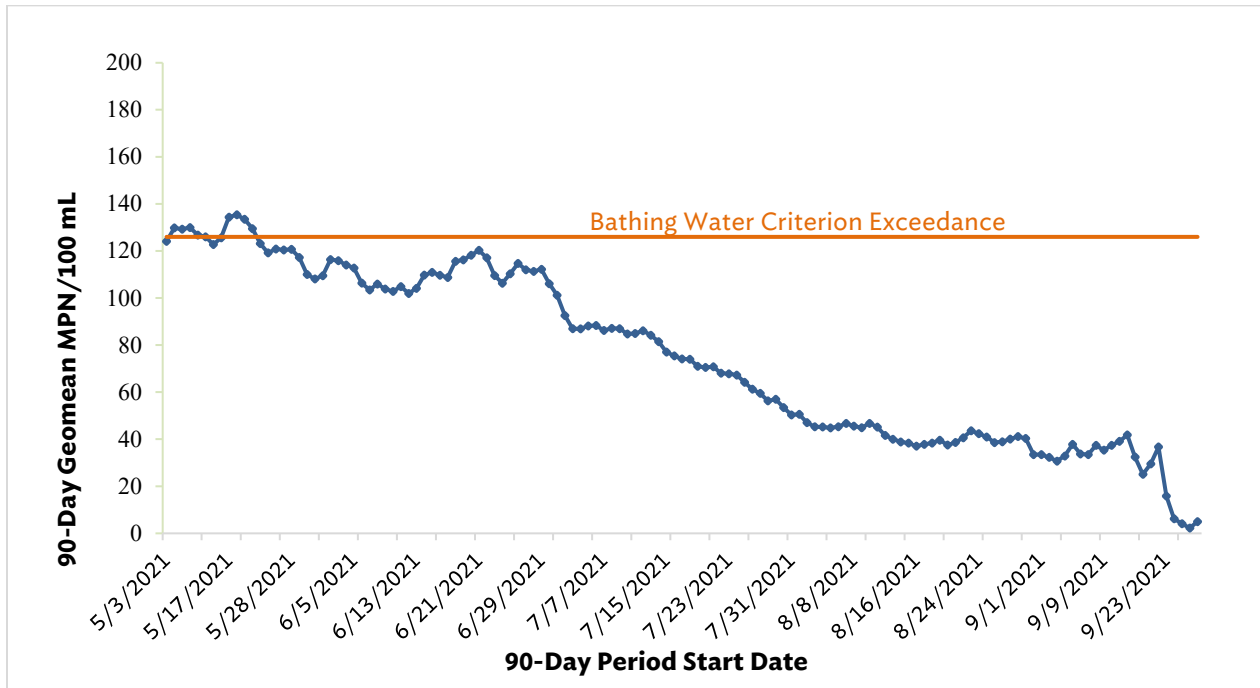


Figure 7. 2021 Villa Angela Beach East - Attainment of Bathing Water 90-Day Geomean Criterion

Euclid Creek RM 0.55

Euclid Creek was in non-attainment of both Primary Contact recreational criteria in 2021 (Figures 8 and 9). Euclid Creek exceeded both the STV and geomean criterion 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 NEORSD.

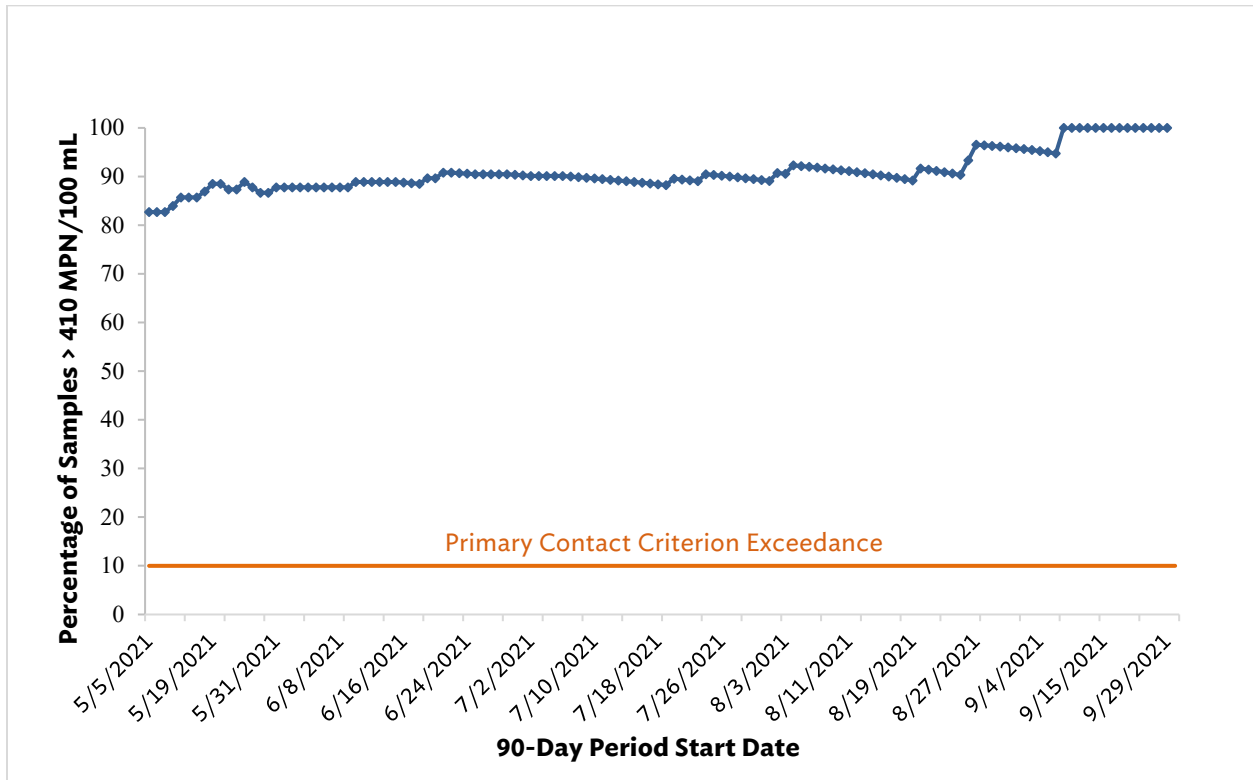


Figure 8. 2021 Euclid Creek RM 0.55 - Attainment of Bathing Water STV Criterion

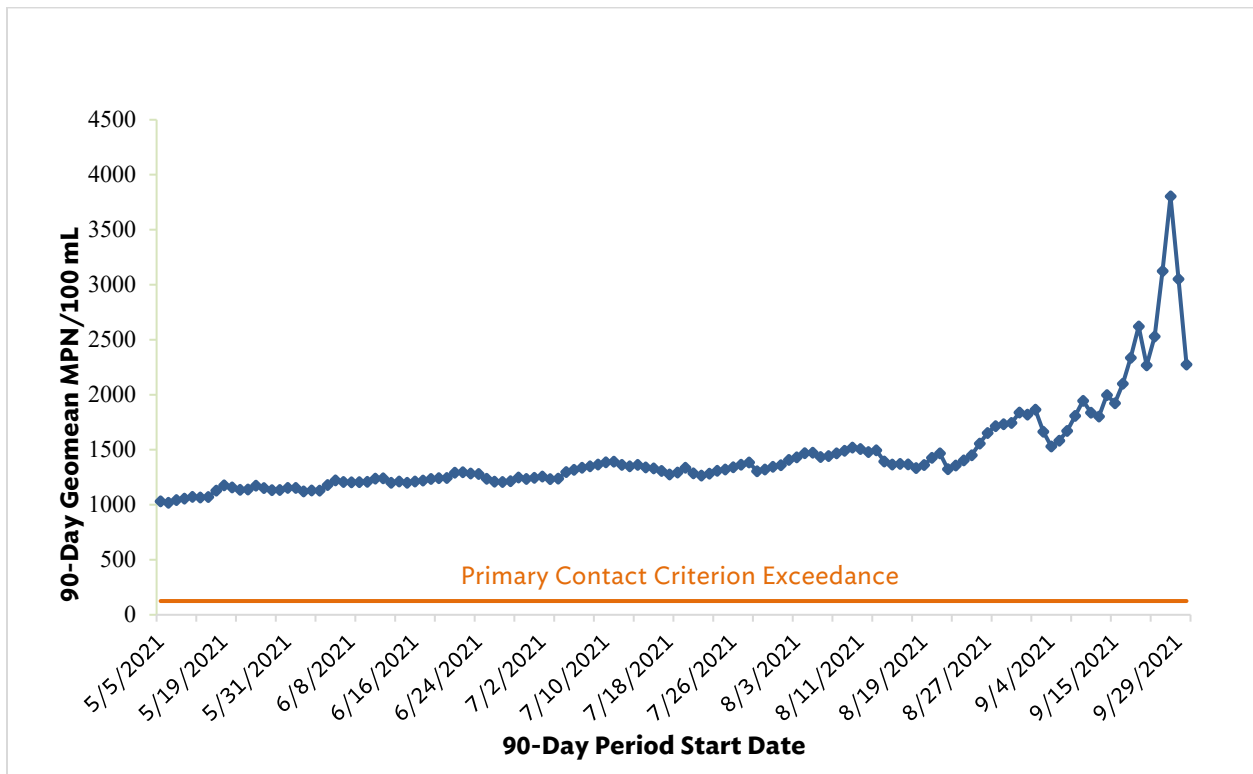


Figure 9. 2021 Euclid Creek RM 0.55 - Attainment of Bathing Water 90-Day Geomean Criterion

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 NEORS D 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 2015-2021, 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.

The SSM/STV value percentages at all three beaches were found to be higher compared to the previous year. Additionally, the geometric mean and beach action percentages were found to be higher at Villa Angela and Euclid beaches compared to the previous year. The increase in *E. coli* densities was observed even though the total rainfall during the 2021 recreation season was the lowest since 2017. Table 4 presents total rainfall in inches during the past ten 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 combined sewer overflows (CSOs), storm sewer runoff, urban runoff, and runoff from contaminated beach sand to enter Lake Erie.

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 2. Historical Recreational Use Criteria Exceedances					
Site	Year	SSM/STV % Exceedance	Geometric Mean % Exceedance	Beach Action Value % Exceedance	SGM
EDGE	2021	3.8	0	7.5	33*
	2020	0	0	12.6	30*
	2019	3.8	0	13.7	52*
	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	46.7	0.2	15.0	54.4	
EUBE	2021	94.7	9.0	25.6	89*
	2020	79.3	3.7	17.1	68*
	2019	89.4	15.2	26.5	63*
	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	92.3	9.3	31.8	103.7	
VABE	2021	94.0	6.8	30.7	87*
	2020	74.8	3.7	20.0	77*
	2019	84.1	20.5	28.8	100*
	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	92.9	13.8	35.5	122.9	

Table 2. Historical Recreational Use Criteria Exceedances					
Site	Year	SSM/STV % Exceedance	Geometric Mean % Exceedance	Beach Action Value % Exceedance	SGM
EC RM 0.55	2021	100	100	N/A	1185*
	2020	100	100	N/A	1168*
	2019	98.5	99	N/A	1241*
	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	99.8	100	N/A	1168.8
Exceedances of historical SGM criterion in Bold (>126 colony counts per 100mL) *SGM does not apply. Calculated for comparative purposes only.					

Table 3. Total Rainfall (Inches) from May 1st to October 31st		
Year	Division Ave Rain Gauge (West Side)	Easterly Rain Gauge (East Side)
2021	24.00	24.60
2020	29.50	26.30
2019	31.80	27.70
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 2012-2021	23.90	24.21

Combined sewer overflow discharges may have contributed to the criteria exceedances at Villa Angela and Euclid Beaches in 2021. 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, 19 overflow events occurred during the 2021 recreational season. Fourteen of these events occurred from CSO-002, the Westerly Wastewater Treatment Center Overflow, one from CSO-069, and two from CSO-071.

Twenty overflow events occurred in the proximity of Euclid and Villa Angela Beaches in 2021, down from 24 overflow events in 2020 and 80 overflow events in 2019. 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. As a result of this, there were zero overflow events at CSO-239 and CSO-206 between May 1 and October 31. In total, the Euclid Creek Tunnel captured 301.62 million gallons of sewage and stormwater during that time period.

Elevated *E. coli* densities at Euclid and Villa Angela Beaches are additionally influenced by the proximity of these beaches to Euclid Creek. Euclid Creek was in 100% exceedance of the recreational water quality criteria for 12 of the past 13 years. A one-way ANOVA was conducted to compare the annual differences of *E. coli* densities at Euclid Creek, from 2013 through 2021. The analysis determined there was not a significant difference in annual *E. coli* densities from 2013 through 2021 ($F(8, 1164) = 1.946, p = 0.841$). *E. coli* densities did not vary significantly in 2021 from the previous years, even with the completion of the Euclid Creek Storage Tunnel (Figure 12).

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 within and outside of the NEORSD service area, as well as contamination from fecal matter from companion animals and wildlife from the surrounding urban community. NEORSD projects including illicit discharge remediation efforts, microbial source tracking efforts, and 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.

Another explanation for the lack of water quality improvements at Euclid Creek is that *E. coli* is being introduced upstream of CSO-239 and the NEORSD service area. Between 2019 and 2021, Field Biologist Eric Soehnlén conducted a study to evaluate the presence of *E. coli* in Euclid Creek. Samples were collected at several locations downstream and upstream of CSO-239 during wet and dry weather events. Results from the study show that there is not a significant difference in *E. coli* densities downstream and upstream of CSO-239, and that the elevated *E. coli* densities in Euclid Creek may originate from outside of the service area.



Figure 10. Proximity of CSO Outfalls to Edgewater Beach

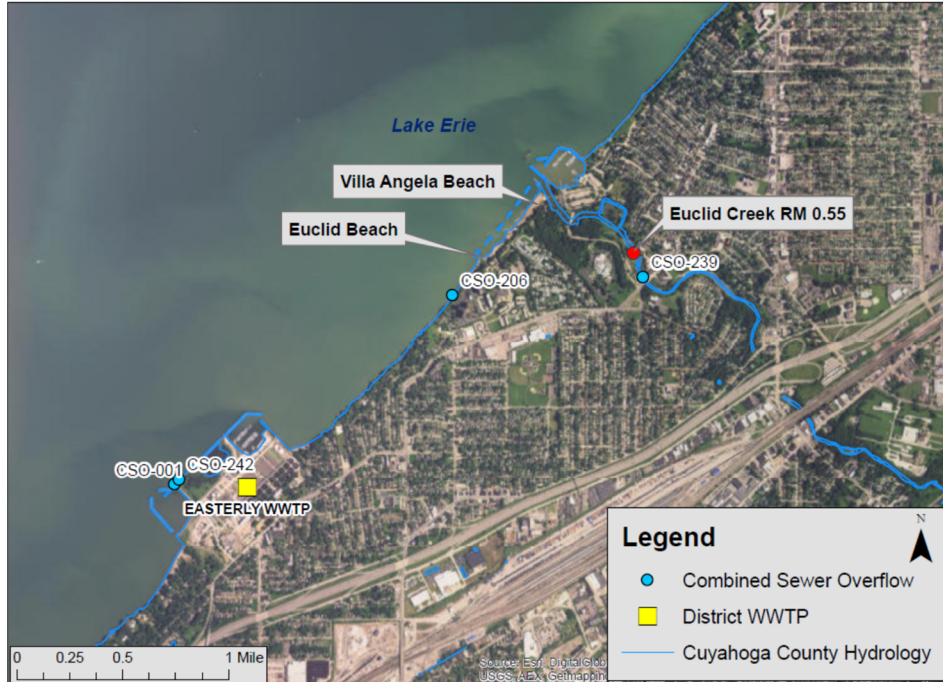


Figure 11. Proximity of CSO Outfalls to Euclid and Villa Angela Beaches

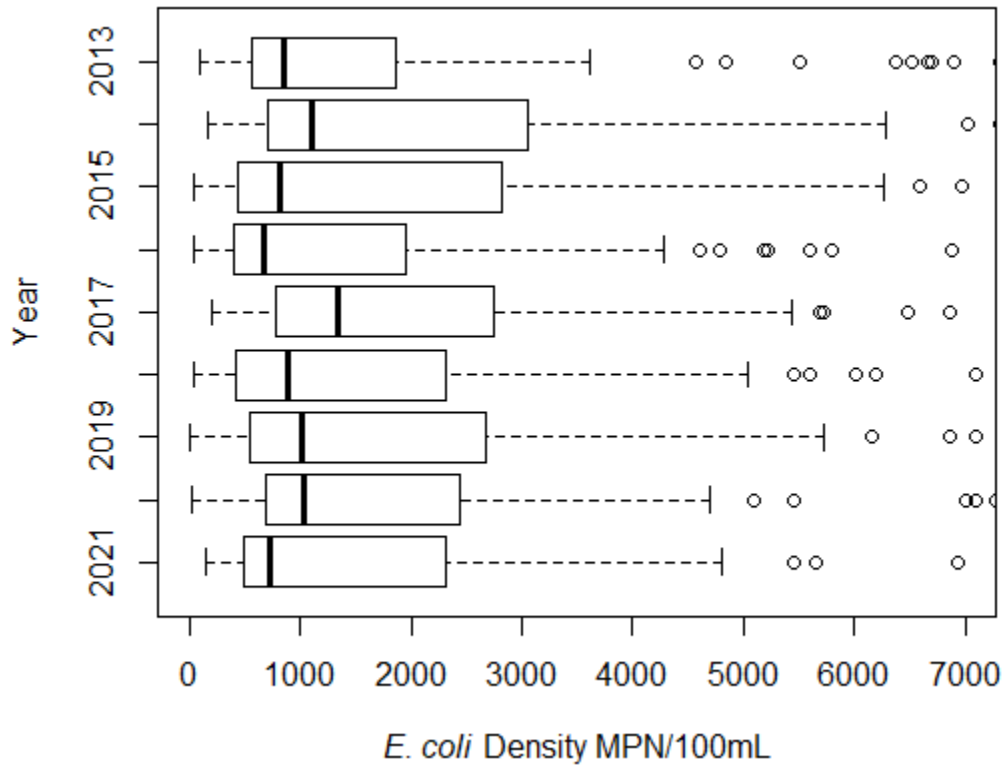


Figure 12. Comparison of Euclid Creek *E. coli* densities from 2013-2021

Table 4. CSO Events from May 1 to October 31

Outfall ID	Nearest Beach	Number of Overflow Events							Total Overflow Volume (Million Gallons)						
		2021	2020	2019	2018	2017	2016	2015	2021	2020	2019	2018	2017	2016	2015
CSO-002	Edgewater	16	14	15	19	8	9	16	250.2	466.1	155.8	277.7	180.3	125.3	235.2
CSO-069	Edgewater	1	3	2	2	0	0	3	0.3	1.7	0.2	0.1	0.0	0.0	6.5
CSO-071	Edgewater	2	3	0	3	0	0	5	No Flow Gauge	No Flow Gauge	0	No Flow Gauge	0.0	0.0	No Flow Gauge
CSO-001	Euclid/Villa Angela	19	21	19	23	17	28	31	394.3	637.9	294.8	670.5	614.6	1,346.7	2301.9
CSO-206	Euclid/Villa Angela	0	0	49	18	22	13	13	0	0	21.0	65.3	37.4	18.3	50.7
CSO-239	Euclid/Villa Angela	0	0	0	27	31	39	46	0	0	0	33.5	18.0	26.7	60.0
CSO-242	Euclid/Villa Angela	1	3	12	6	5	7	17	2.5	1.2	21.8	10.5	4.5	9.0	20.7

Harmful Algal Bloom Monitoring

No HABs were visually detected by or reported to WQIS personnel during the 2021 recreational season. The National Oceanic and Atmospheric Administration (NOAA) conducted a bloom analysis and determined that the cyanobacteria bloom in the western basin of Lake Erie was considered moderately severe (Figure 13). The 2021 bloom in the western basin was large in spatial extent but had a lower bloom density than the 2019 and 2017 blooms (NOAA, 2021).

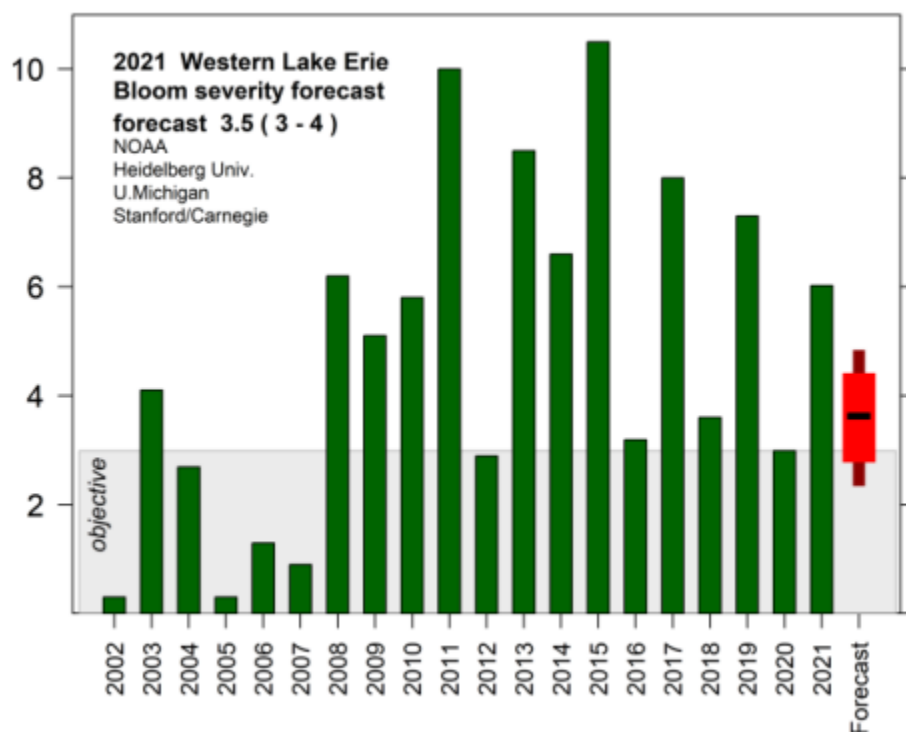


Figure 13. NOAA Bloom severity index for 2002-2021

Conclusions

In 2021, Euclid and Villa Angela Beaches were found to be in non-attainment of the Bathing Water recreational criteria, while Edgewater Beach was in attainment of the criteria for most of the season. Exceedances of the water quality criteria were closely related to occurrences of wet-weather events. Potential sources of *E. coli* that lead to elevated densities during wet-weather events include CSOs, storm sewer runoff, urban runoff, and runoff from contaminated beach sand to enter Lake Erie. An increase in *E. coli* densities at Euclid and Villa Angela beaches was observed in 2021 compared to 2019 and 2020. It is unclear what caused the increase in *E. coli* densities, though it is possible that lower lake levels and increased discharge from Euclid Creek were contributing factors. The Euclid Creek Tunnel eliminated all CSO events from CSO-239 and CSO-206 and captured 301.62 million gallons of sewage and storm water between May 1 and October 31, 2021. It is possible that the water quality may improve at Euclid Creek and Euclid and Villa Angela Beaches over time as a result of the storage tunnel, though the improvements may be

limited by the introduction of bacteria upstream of the service area. During the 2021 recreational season, no HABs at any of the beaches were observed.

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Ron Maichle	Francisco Rivera	

Analytical Services Division – Completed analysis for all bacteriological sampling.

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