

NORTHEAST OHIO REGIONAL SEWER DISTRICT

2015 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 2015, the NEORSD continued these sampling efforts by monitoring the *Escherichia coli* (*E. coli*) densities at Edgewater, Villa Angela, and Euclid Beaches and Euclid Creek. In addition to monitoring for *E. coli*, the NEORSD also performed some limited harmful algal bloom (HAB) monitoring in response to recent increases in HABs in Lake Erie. 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 NEORSD Level 3 Qualified Data Collectors certified by Ohio Environmental Protection Agency (Ohio EPA) in Chemical Water Quality Assessment, as well as trained personnel, as explained in the NEORSD study plan *2015 Lake Erie Beach Monitoring*, which was approved by Ohio EPA on June 17, 2015. 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.

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	

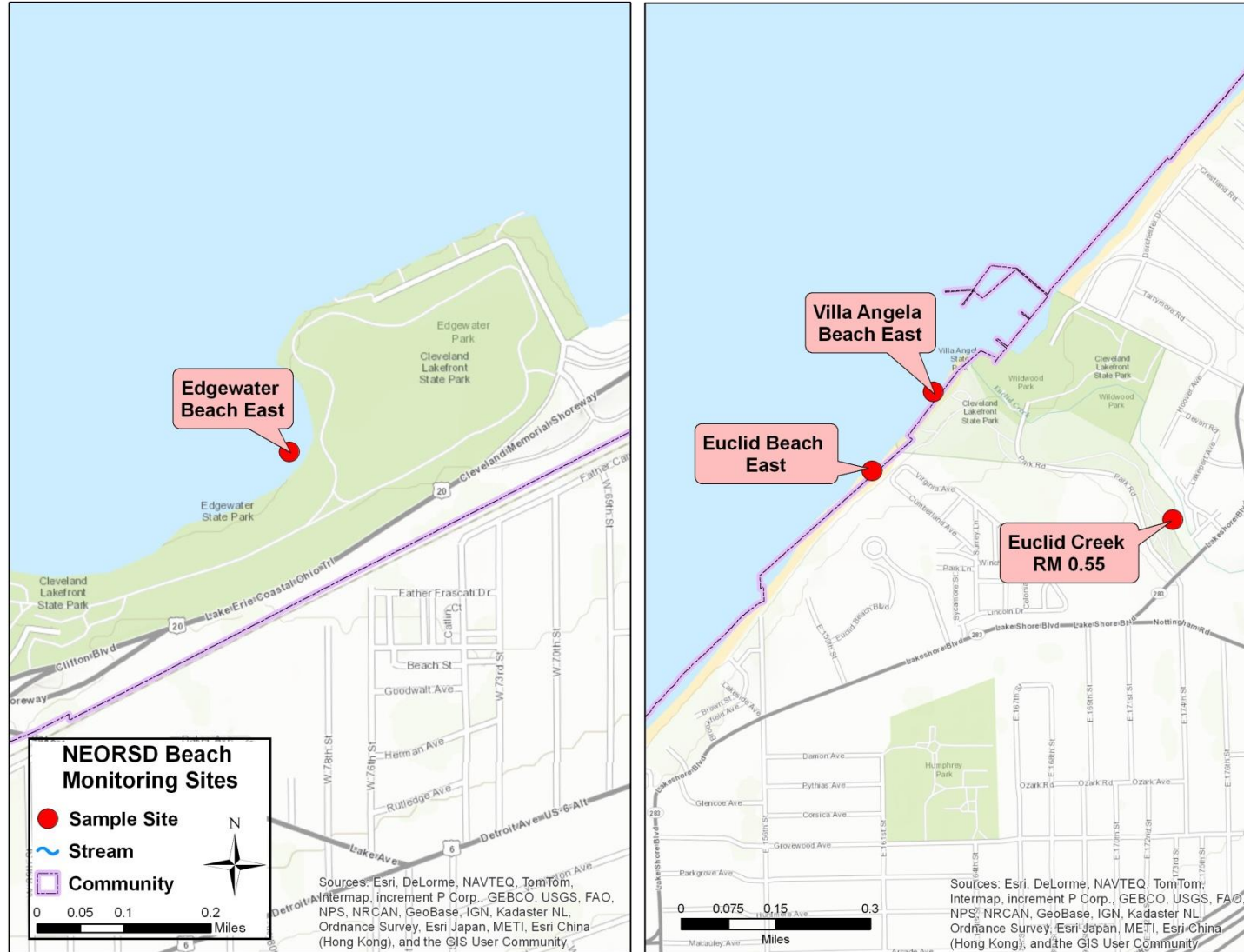


Figure 1. Map of Sampling Sites

Sampling Methods

Bacteriological sampling was conducted from May 4, 2015 to October 1, 2015. From May 4 through May 10, 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 11 and lasting through September 10, samples were collected at each beach and Euclid Creek seven days a week. From September 10 through October 1, sampling at all sites returned to four days a week (Monday through Thursday). Although the official beach recreational season lasts until October 31, NEORSD ceased sampling at all sites on October 1 due to staffing limitations. A total of 139 samples were collected at each site with the exception of Edgewater Beach for which 138 samples were collected. No sample was collected on Edgewater Beach on May 17, 2015, due to a road closure.

Field analysis included the use of a Hanna HI 98129 meter to measure pH, water temperature, and conductivity. Additionally, the Hach 2100Q Portable Turbidimeter was used to obtain field turbidity measurements. 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 chemistry, bacteria, and flows* (Ohio EPA, 2013).

Bacteriological grab samples were collected in a 2-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. Since field blanks are not required by method 1603 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. All duplicate samples collected were within the acceptable RPD of 133.3%. Therefore no data collected as a part of this study was rejected.

Sampling for the presence of HABs was performed in 2015 following visual observation of a potential bloom. HAB sampling was performed in accordance with the guidelines for single-sample grabs presented in the State of Ohio Harmful Algal Bloom Response Strategy for Recreational Waters (ODH, 2015). Samples were collected from the densest part of the visible bloom that could safely be approached by wading. All samples were collected in certified clean 1-Liter amber glass jars. Samples were kept protected from light, placed on 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. These samples were collected as a public service and were not intended for submittal to the Ohio EPA credible data program. Therefore, duplicate samples and field blanks were not collected for HAB sampling.

Beach Monitoring Results and Discussion

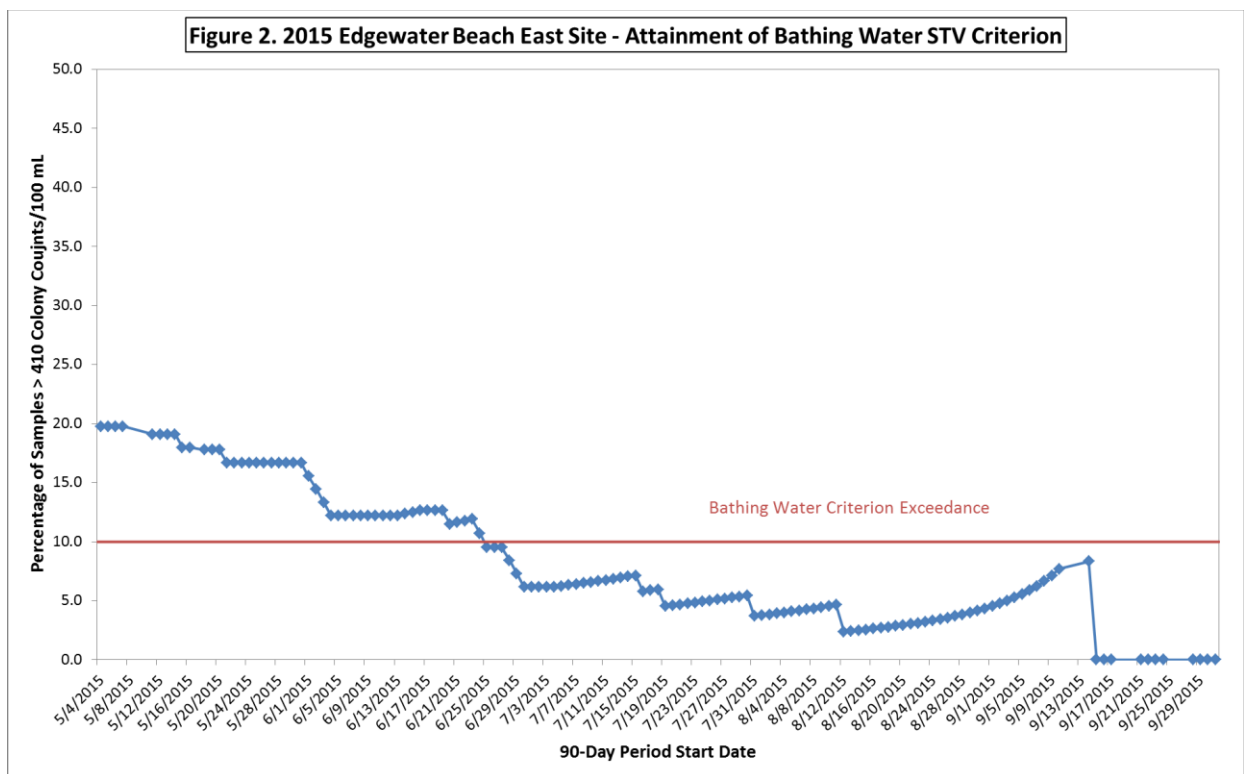
The Ohio Water Quality Standards Recreational Use Criteria were updated in 2016. The *E. coli* results from each beach site were compared to the current Ohio Water Quality Standards in order to determine recreation use attainment. From May 1st to October 31st, the three beaches are designated as Bathing Waters for the Protection of Recreational Use (Ohio EPA, 2016). The current Bathing Waters 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 current 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 (Ohio EPA, 2015). For comparative purposes only, the previous Bathing Waters criteria were also applied to the 2015 data. The historical Bathing Waters criteria include 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 thirty-day period and a seasonal geometric mean criterion of 126 colony counts/100mL (Ohio EPA,

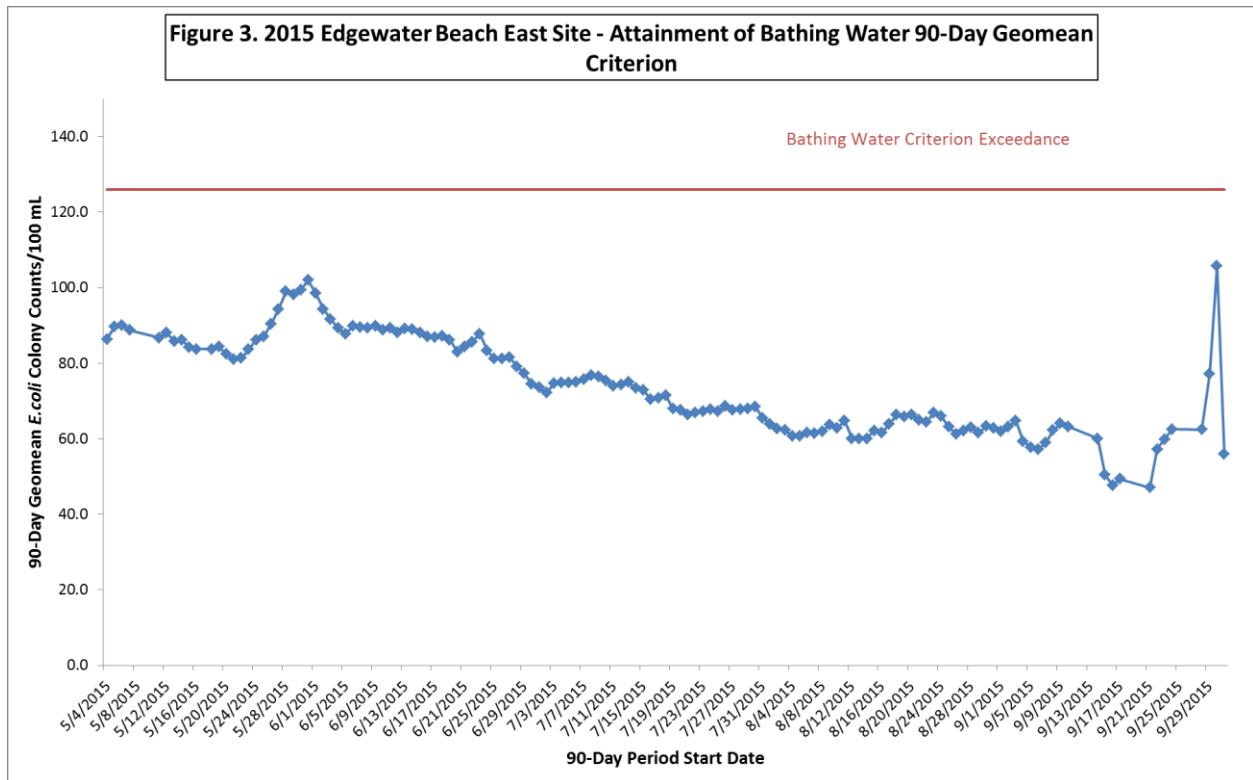
2010).

Edgewater Beach

Comparison to Current Recreational Use Criteria

The 2015 *E. coli* results for Edgewater Beach were compared to the current recreational use criteria in order to determine recreational use attainment. The water quality at Edgewater Beach was found to be in partial non-attainment of the Bathing Water recreational use criteria. Edgewater Beach met the Bathing Water STV criterion for only 65.2% of the 90-day periods for which samples were collected (Figure 2). All bacteriological exceedances of the STV criterion occurred during the 90-day periods beginning in May and June. Individually, 19 of the 138 samples collected, (13.8%) were found to be over the recreational use threshold limit of 410 colony counts/100mL. Edgewater Beach was in attainment of the 90-day geomean criterion for all 90-day periods in the 2015 recreational season (Figure 3).





Influence of Wet Weather and Combined Sewer Overflows

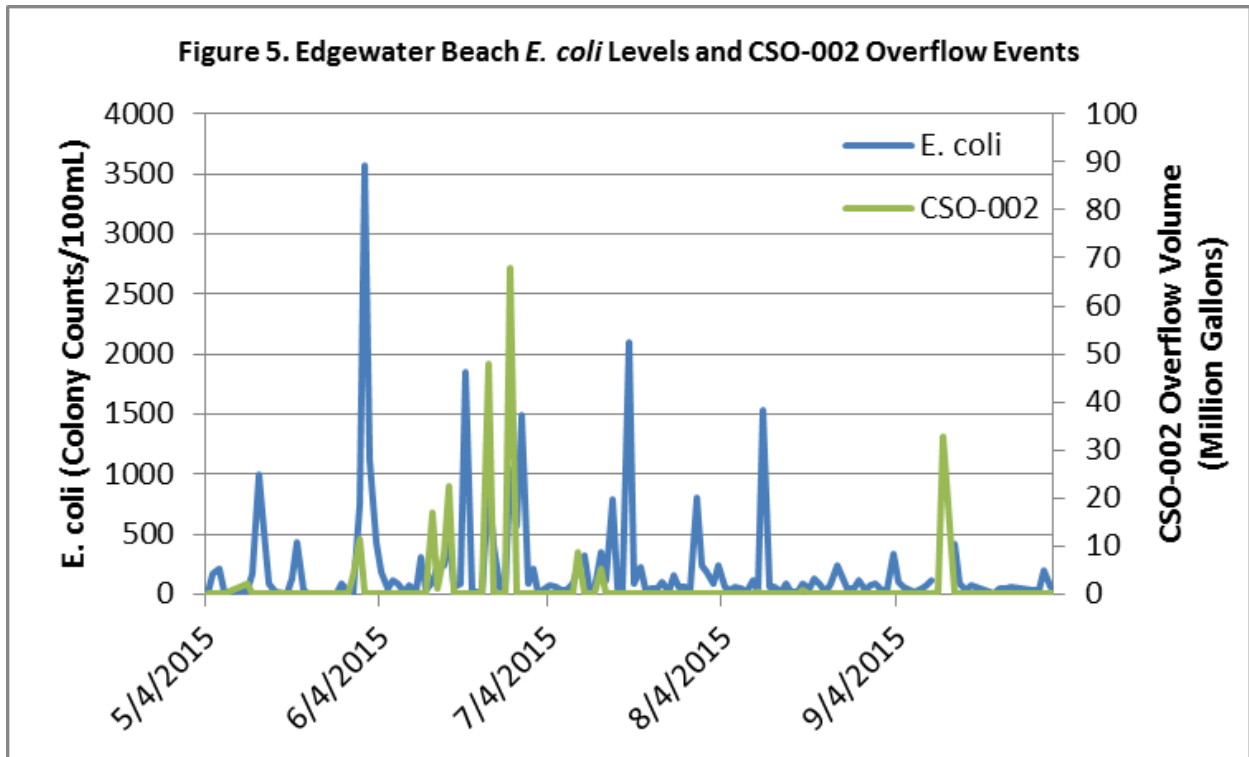
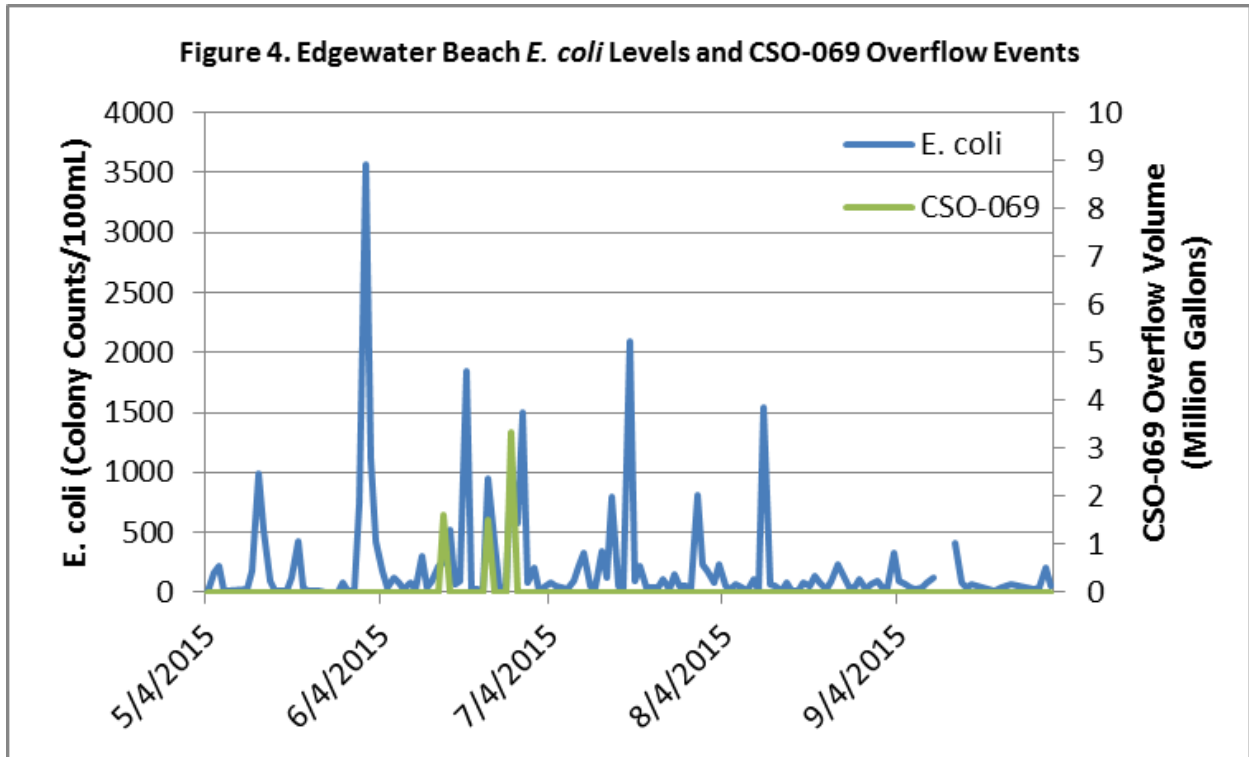
Some of the exceedances of the STV criterion may be partially attributed to wet weather¹. Wet-weather events may contribute to elevated bacteria levels by causing discharges from CSOs, storm sewer runoff, urban runoff, and runoff from contaminated beach sand to enter Lake Erie. Forty-one percent of the recreational season at Edgewater Beach met the definition of wet weather. Monthly total rainfalls for the 2015 field season according to the Division Avenue Rain Gauge are shown in Table 2. The STV criterion exceedances which occurred for the 90-day periods beginning in May and June may be partially attributed to the heavy rains which occurred during these months. Of the 19 samples collected during 2015 for which the *E. coli* density was greater than 410 colony counts/100mL, 73.0% were collected during wet weather while 27.0% were collected during dry weather, further indicating a positive correlation between wet weather and elevated *E. coli* densities.

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. Monthly Total Rainfall in Inches (Division Avenue Rain Gauge).				
May	June	July	August	September
5.0	7.1	3.3	2.2	3.7

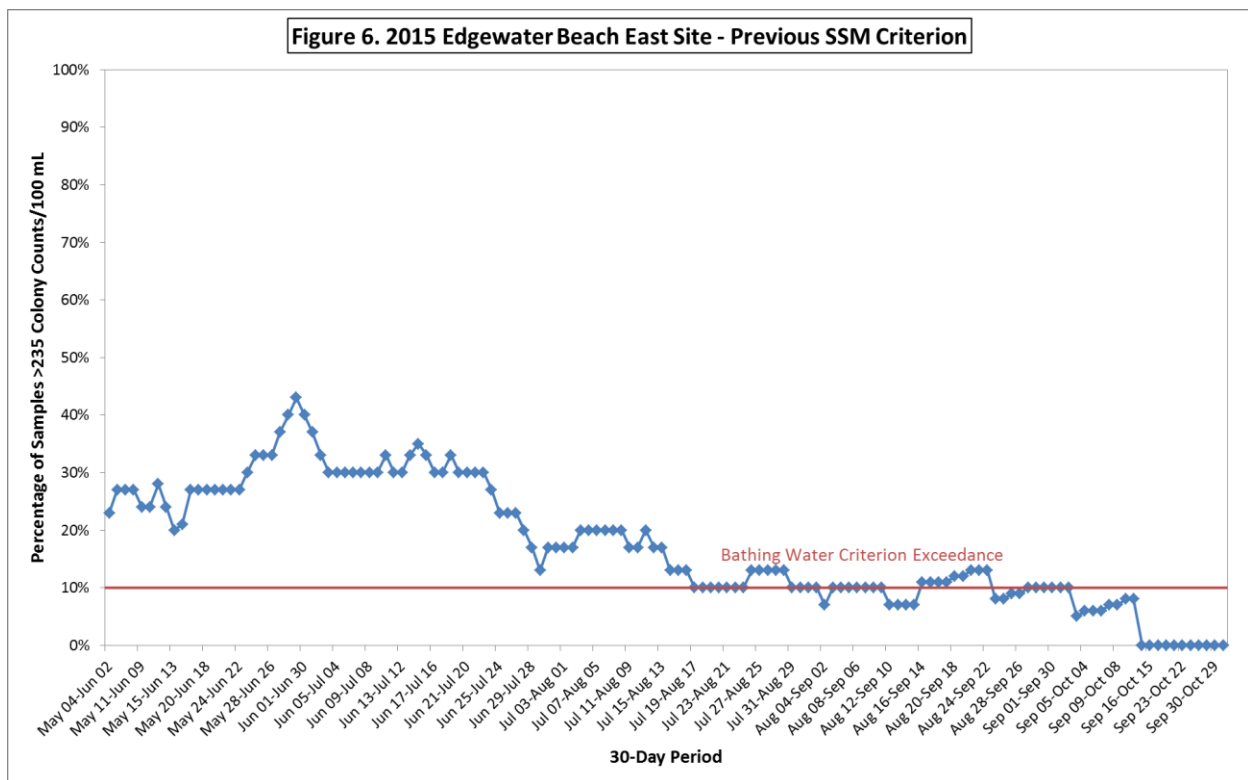
Table 3. Number of Monitored NEORSD CSO Overflows That have the Potential to Impact Edgewater Beach from May 1 to Oct 1, 2015.			
CSO	Location	Number of Overflow Events	Total Overflow Volume (Million Gallons)
002	NEORSD Westerly Water Pollution Control Center	16	235.2
069	Upper Edgewater Beach	3	6.48
071	Harborview Drive and West 117 th Street	5	*
*No flow metering equipment available. Inflatable Dam site, only number of events recorded.			

Three NEORSD CSOs in the vicinity of Edgewater Beach are monitored daily by NEORSD’s Sewer System Maintenance and Operation (SSMO) department. These CSOs discharged to Lake Erie a total of 24 times during the recreational season and may have had an effect on *E. coli* densities at the sampling site (Table 3). CSO-069 is in closest proximity to the Edgewater Beach swimming area, being located on the west side of Edgewater Beach. Three overflow events occurred from this outfall in 2015, all in the month of June. Elevated *E. coli* densities were observed at the Edgewater East Site on the same date or on the date immediately following these three overflow events. However, these elevated densities returned to below recreational criteria limits within several days (Figure 4). Sixteen overflow events occurred from CSO-002, which is located east of Edgewater Beach. As with CSO-069, elevated *E. coli* densities were also observed on dates with overflow events from CSO-002. It is worth noting in the case of either outfall that this correlation does not necessarily indicate that overflow events were the primary contributors to the elevated *E. coli* densities observed at the beaches. These overflow events all occurred during periods of wet weather which, as discussed above, may result in elevated *E. coli* densities through other mechanisms. As demonstrated in Figures 4 and 5, elevated *E. coli* densities were also observed at Edgewater Beach in the absence of CSO events during the months of July and August.



Comparison of current and previous criteria

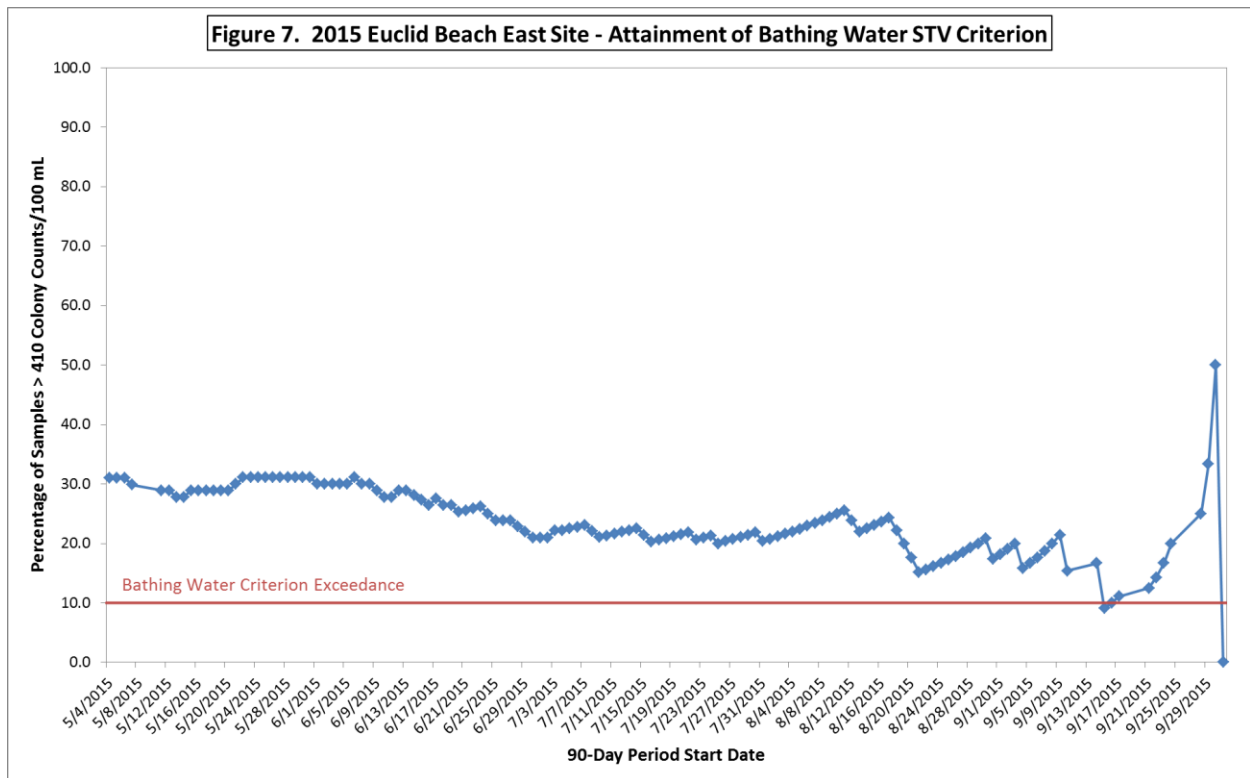
For comparative purposes only, the previous recreational use criteria were also applied to the 2015 data. This was performed in order to compare 2015 data to the historical data, and to compare the current and previous recreational use criteria. When comparing between the old and current geomean criteria, Edgewater Beach performs identically, with no exceedances to either criteria (Figure 3 and Table 7). In contrast, while Edgewater Beach met the current STV criterion for 65.2% of all 90-day periods, it would have only met the previous SSM criterion for 37.7% of all 30-day periods in the 2015 recreational season (Figures 2 and 6). The STV criterion was found to be easier to meet than the previous SSM criterion for several reasons. The threshold limit value for the previous SSM criterion was more stringent, at 235 colony counts/100mL, than the current STV criterion, at 410 colony counts/100mL. Additionally, the use of a 90-day period in the STV criterion appears to be more forgiving than the 30-day period used in the previous SSM criterion, at least for the data collected for Edgewater Beach in 2015. This is due to the fact that data collected near the end of the sampling season, in the cooler months leading up to autumn, fall within the same 90-day period as data collected during the warmer summer months. The decreased *E. coli* densities observed in the cooler months counteract the elevated *E. coli* densities from the hot summer months that fall within the same 90-day period. This phenomenon may vary year to year depending upon annual variations in surface water temperature and precipitation during the later months of the recreational season.



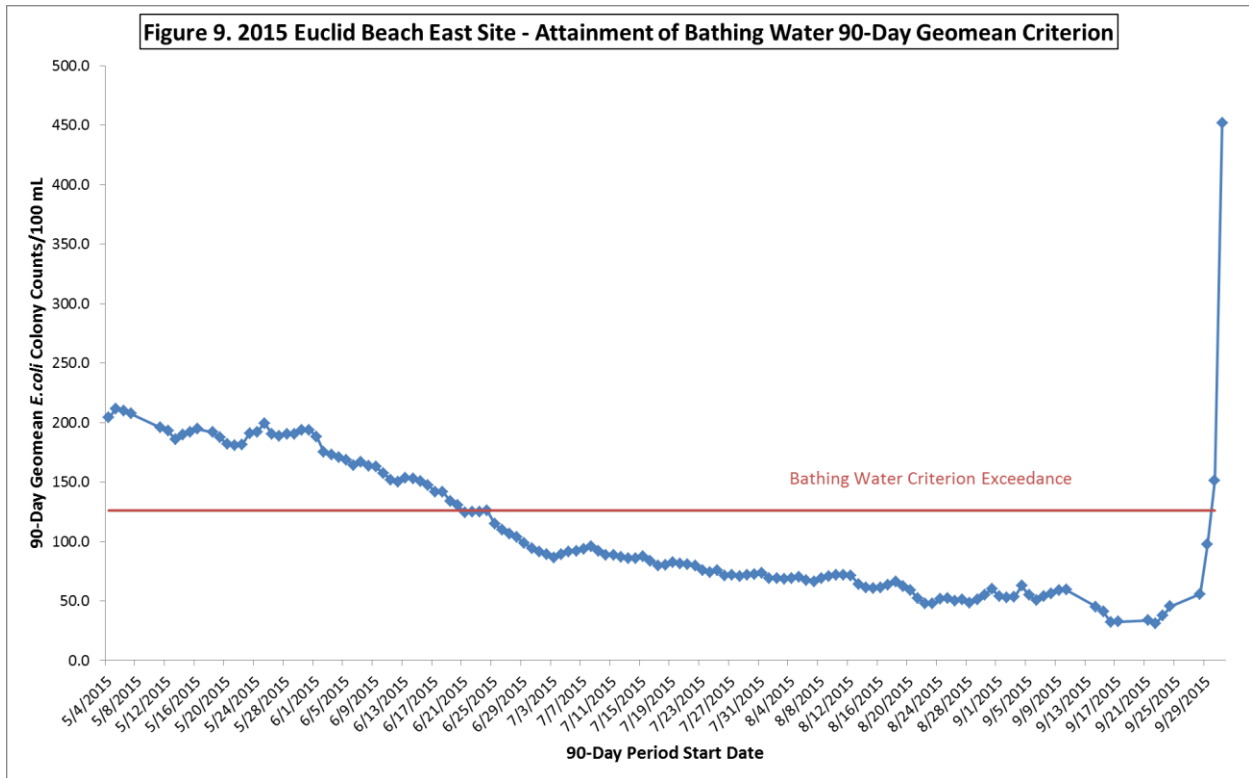
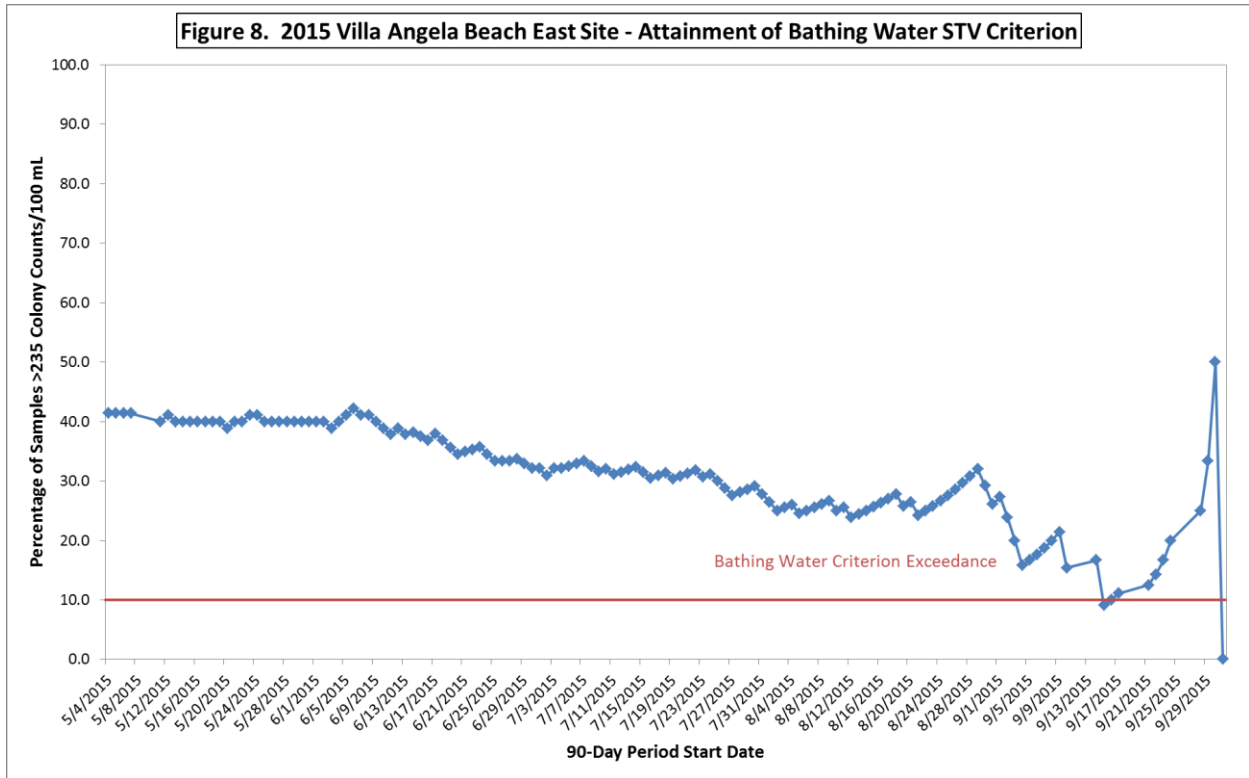
Euclid and Villa Angela Beaches

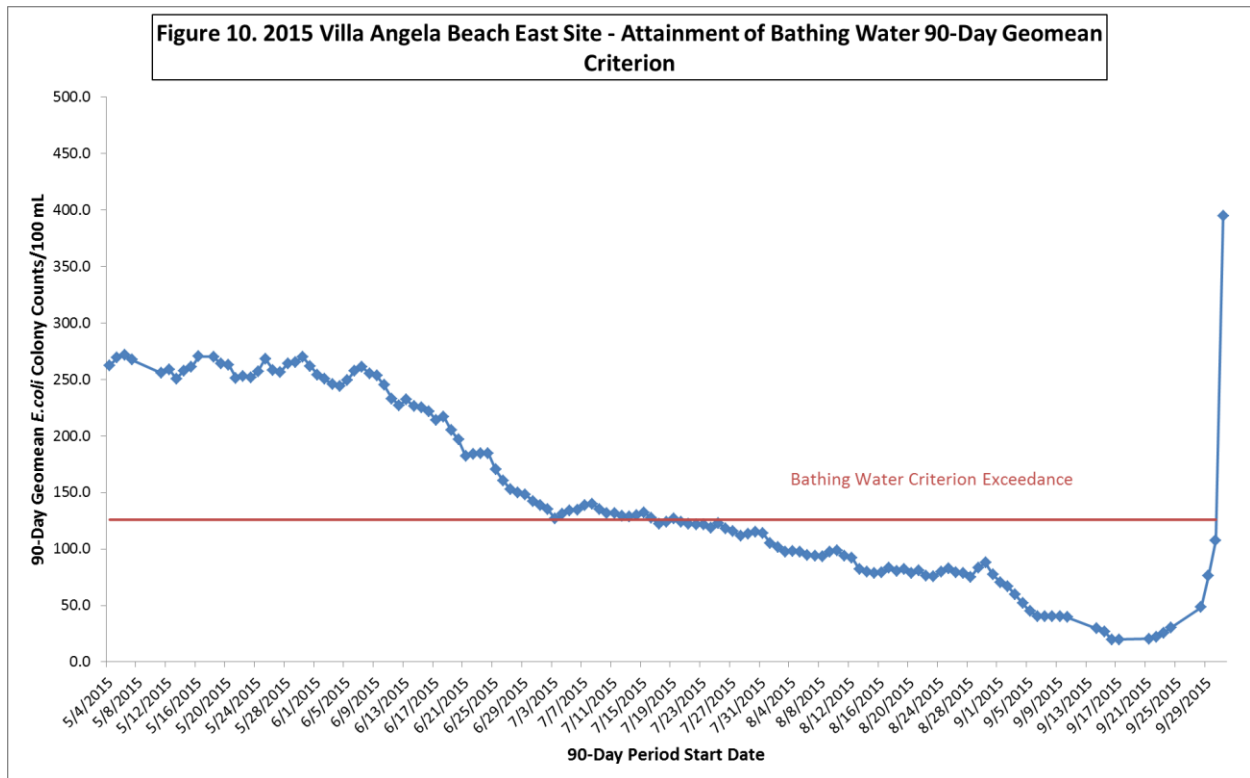
Comparison to Current Recreational Use Criteria

The 2015 *E. coli* results for Euclid and Villa Angela Beaches were compared to the current recreational use criteria in order to determine recreational use attainment. Neither beach was found to be in attainment of the Bathing Water recreational use criteria. Both Euclid and Villa Angela Beaches met the Bathing Water STV criterion for only 2.2% of the 90-day periods for which samples were collected (Figures 7 and 8 respectively). Euclid Beach and Villa Angela Beach were in attainment of the current geometric mean criterion for 66.2% and 48.2% of the 90-day sampling periods, respectively (Figures 9 and 10). Although the two beaches are connected, Villa Angela Beach was found to have more highly elevated *E. coli* densities throughout the sampling season than Euclid Beach. This trend also seems to be present in historical SGM data as well (Table 7).



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Influence of Wet Weather and Combined Sewer Overflows

Four NEORS D CSOs in the vicinity of Euclid and Villa Angela Beaches are monitored daily by NEORS D’s SSMO department. These CSOs discharged to Lake Erie or Euclid Creek a total of 107 times during the recreation season and may have had an effect on *E. coli* densities at the sampling sites (Table 4). Although all of these CSOs are in close proximity to the beach, it is unknown if these overflow events had a direct impact on the water quality at Euclid or Villa Angela Beach.

The relationships between wet-weather events and elevated *E. coli* densities at Euclid and Villa Angela Beaches were found to not be as strong as the same relationship at Edgewater Beach. Forty-six percent of the samples collected during the 2015 recreational season at Euclid and Villa Angela Beaches were collected during wet weather according to the Easterly Wastewater Treatment Plant Rain Gauge. For Euclid Beach, of the 38 samples for which the *E. coli* density was greater than 410 colony counts/100mL, 60.5% occurred during wet weather while 39.5% occurred during dry weather. For Villa Angela Beach, of the 49 samples for which the *E. coli* density was greater than 410 colony counts/100mL, 57.1% occurred during wet weather while 42.9% occurred during dry weather. A higher percentage of exceedances of the 410 colony counts/100mL limit were observed during dry weather at Euclid and Villa Angela Beaches than at Edgewater Beach. No individual parameter appears to clearly explain the high number of dry-weather

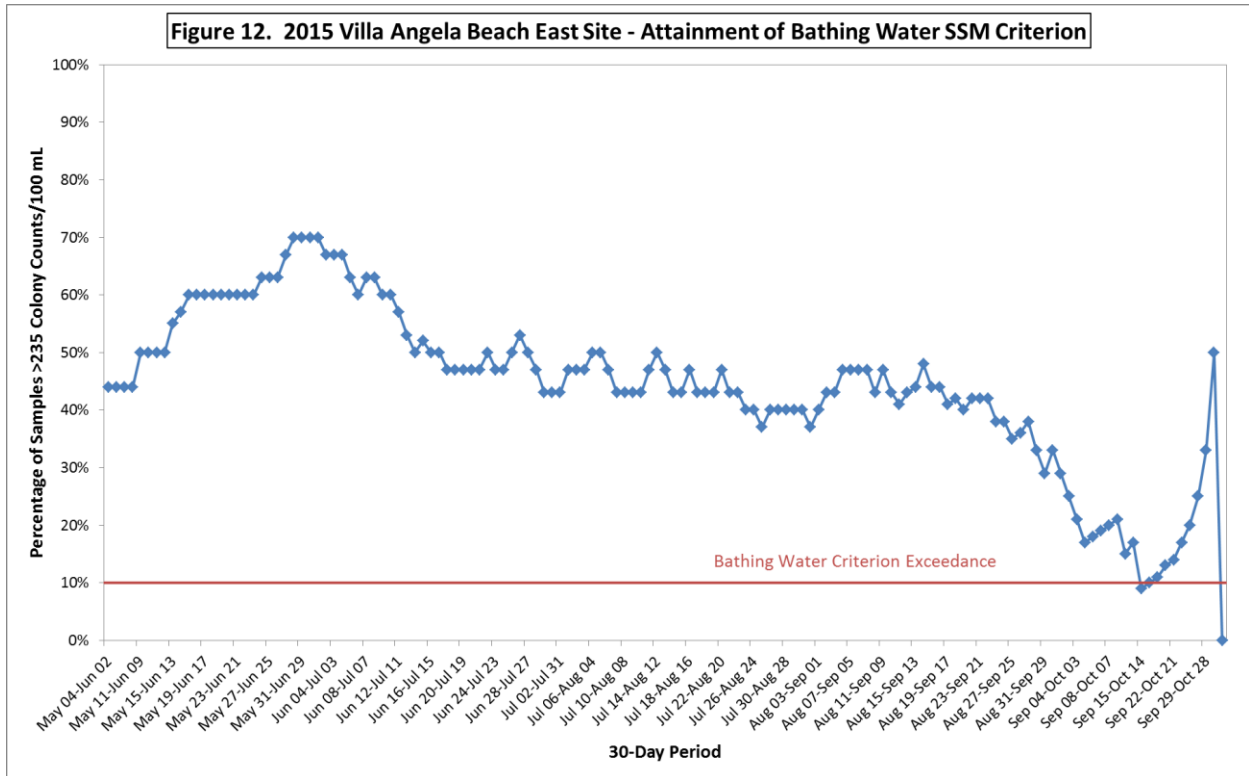
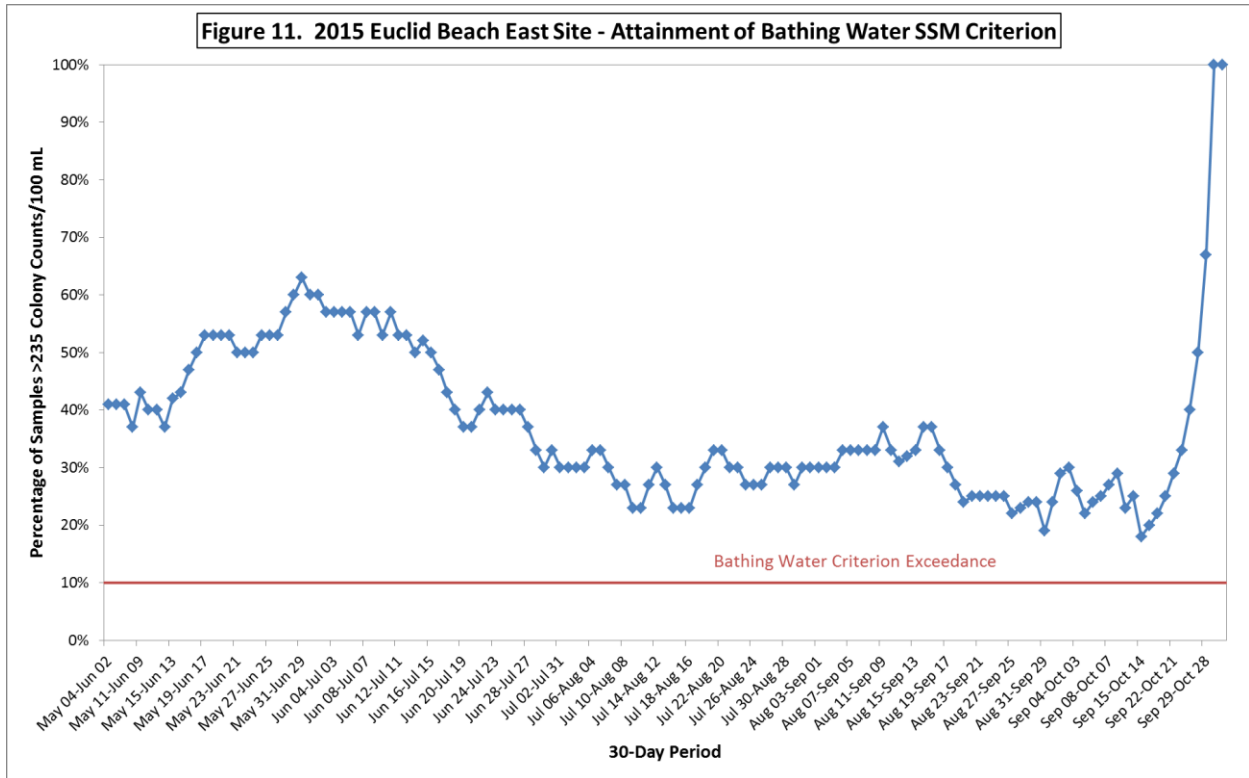
exceedances at Euclid and Villa Angela Beaches. These exceedances are most likely due to a complex set of conditions involving bacterial input from wildlife, illicit discharges, and CSOs, in conjunction with the proper conditions for bacterial proliferation and dispersal into the beach water including temperature, wave height, rainfall, and possibly other parameters.

Table 4. Number of Monitored NEORSD CSO Overflows During 2015 Recreation Season			
CSO	Location	Number of Overflows	Total Overflow Volume (Million Gallons)
001	Storm overflow at Easterly Wastewater Treatment Plant	31	2301.9
206	North end of East 156 th Street at Lake Erie	13	50.7
242	East 142 nd Street and Lakeshore Boulevard	17	20.7
239	Lakeshore Boulevard at Euclid Creek	46	60.0

Comparison of current and previous criteria

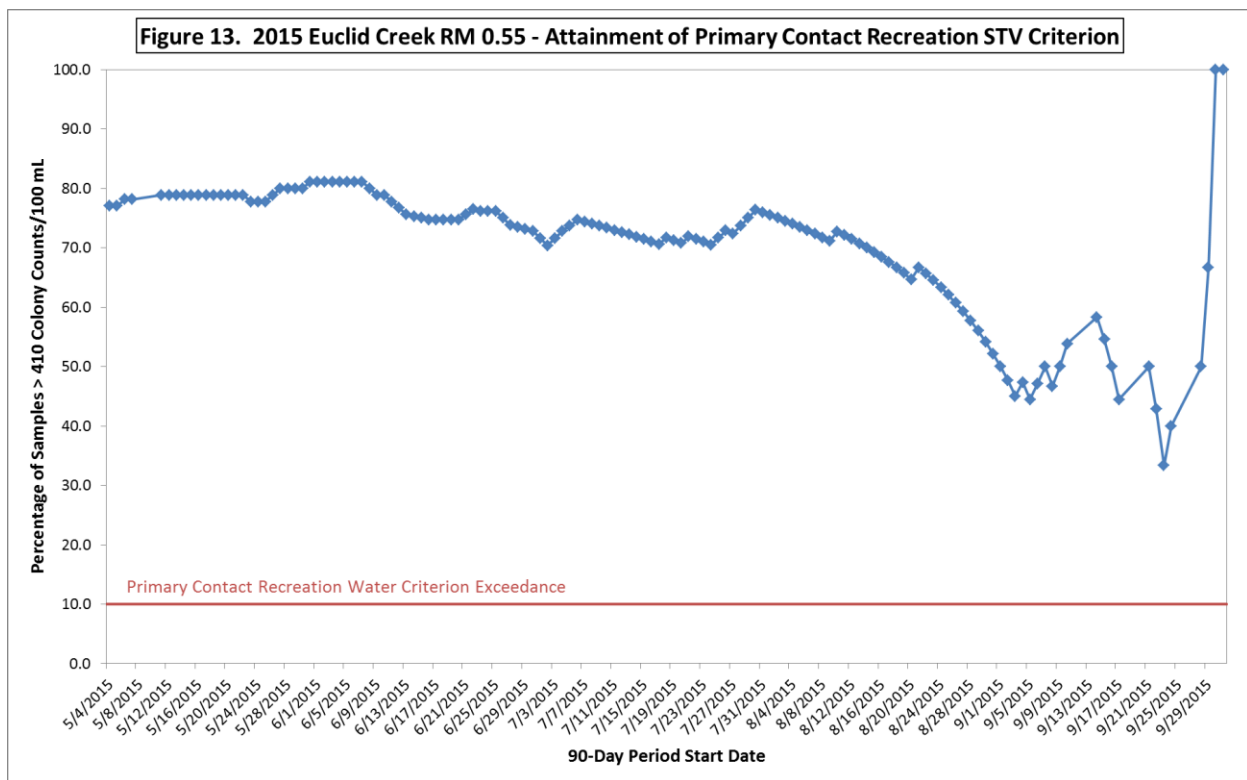
For comparative purposes only, the previous recreational use criteria were also applied to the 2015 Euclid and Villa Angela Beach data. This was performed in order to compare 2015 data to the historical data, and to compare the current and previous recreational use criteria. The *E. coli* densities at Euclid and Villa Angela Beaches were so highly elevated throughout the 2015 recreational season that there was very little difference between the current STV criteria and the previous SSM criteria for either beach. Using both methods, the beaches were in non-attainment for 97-100% of all 30 or 90-day periods (Figures 7, 8, 11, and 12). Both beaches were also found to be in non-attainment for both the current and previous geometric mean criteria (Figures 9 and 10 and Table 7).

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Euclid Creek RM 0.55 Results and Discussion

The *E. coli* results from the Euclid Creek site were compared to the Ohio water quality standards to determine recreational use attainment. Euclid Creek is designated as a Primary Contact Recreation stream for the Protection of Recreational Use (Ohio EPA, 2016). Primary Contact Recreation criteria include an *E. coli* criterion not to exceed an STV of 410 colony counts/100mL in more than ten percent of the samples taken during any 90-day period and a 90-day geometric mean criterion not to exceed 126 colony counts/100mL. Euclid Creek was in non-attainment of both the STV and geometric mean criteria for 100% of the 90-day periods for which samples were collected in 2015 (Figures 13 and 14). Results at this site in 2015 are similar to every previous year for which the NEORSD has performed sampling at Euclid Creek (Table 7). 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. In 2015, overflow events from CSO-239 occurred 46 times throughout the recreational season. In addition to this, the NEORSD has documented several storm sewer outfalls with elevated *E. coli* densities, indicative of illicit sanitary sewage discharges, occurring upstream of RM 0.55 during the 2015 recreational season (See Table 5). These flows also contributed to the elevated *E. coli* densities observed at Euclid Creek at RM 0.55 during the 2015 recreational season.



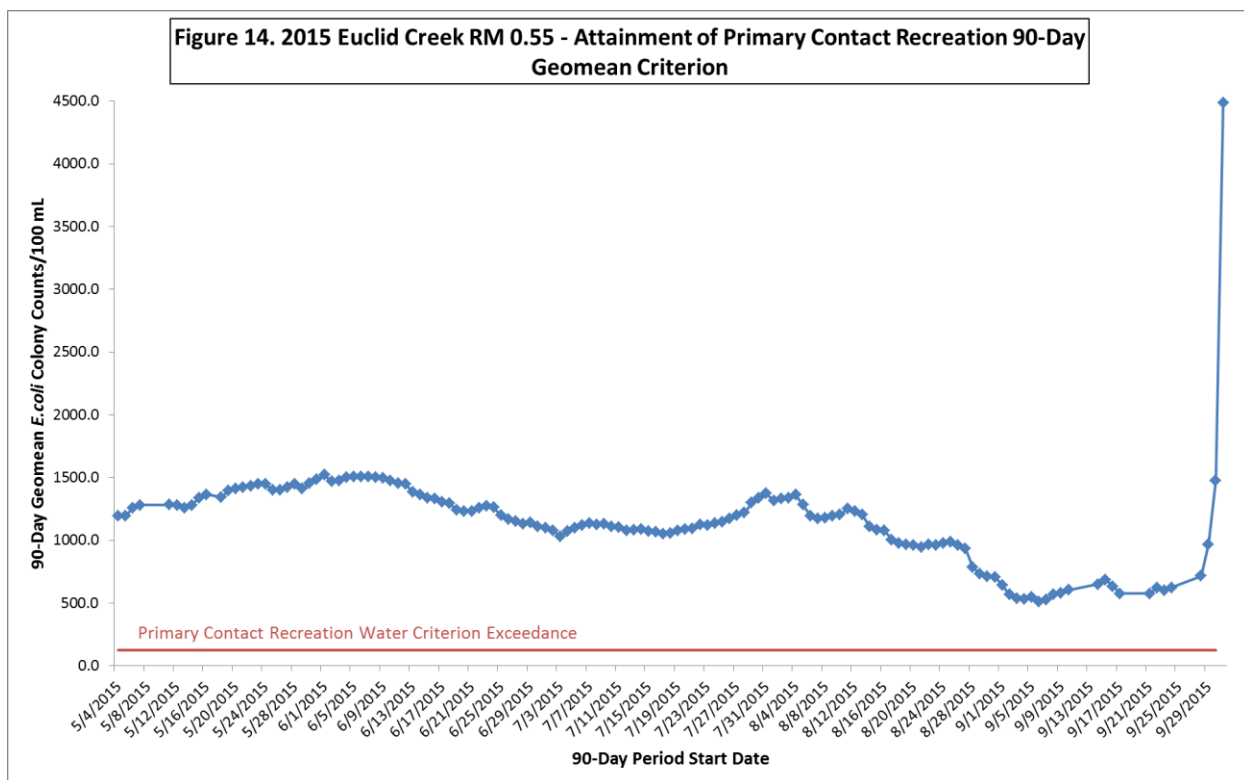


Table 5. 2015 Data from Euclid Creek Storm Sewer Outfalls			
Outfall ID	Date Collected	<i>E. coli</i> (MPN/100mL)	*Estimated Flow (GPD)
ECMB0220	04/13/2015	1,209,800	10,000
ECMB0290	04/13/2015	707	50,000
ECMB0300	04/13/2015	24,374	60,000
ECMB0350	04/16/2015	62,375	Not Measured
Data not collected as part of the Ohio EPA Credible Data Program			
*Flow estimated by bucket and stopwatch method			

Comparison with Historical Data

In order to compare to the historical data, the previous Bathing Water criteria were applied to all sites in 2015 (Table 1). The 2015 results for Edgewater, Euclid, and Villa Angela Beaches were similar to results observed in previous years from 2009-2014. Under the previous criteria, Edgewater Beach would have continued to be in partial non-attainment while Euclid and Villa Angela Beaches and Euclid Creek would have continued

to be in full non-attainment. No overall trend in water quality improvement or degradation was observed over time at all four sites monitored as part of this study.

Table 7. Comparison to Historical Data Using Previous Criteria.				
Site	Year	SSM % Attainment	SSM % Exceedance	EDGE SGM
EDGE	2015	38	62	77
	2014	7	93	60
	2013	34	66	53
	2012	41.1	58.6	41
	2011	7.8	92.2	98
	2010	27	73	56
	2009	9.4	90.6	107
EUBE	2015	0	100	136
	2014	2	98	126
	2013	3	97	144
	2012	0.68	99.32	118
	2011	0	100	149
	2010	10	90	110
	2009	0	100	112
VABE	2015	0	100	181
	2014	4	96	147
	2013	9	91	141
	2012	0	100	110
	2011	0	100	174
	2010	0	100	128
	2009	0	100	172
EC RM 0.55	2015	0	100	1246
	2014	0	100	1617
	2013	0	100	1092
	2012	0	100	973
	2011	0	100	1351
	2010	0	100	1047
	2009	0.7	99.3	852
SGM Criterion Exceedances in Bold				

2015 Harmful Algal Bloom Monitoring Results

The presence of HABs and total microcystin concentrations were selectively monitored at all beaches on days when a visible algal bloom was observed. Samples collected were analyzed for total microcystin by the ELISA method. Cyanobacteria taxa present were identified by microscopy by biologists certified in HAB identification through

the Ohio EPA. Results are presented in Table 6. The dominant cyanobacterial genus present was found to be *Microcystis* for all samples collected during the 2015 Beach Season. Levels of microcystin were found to be present above the recreational public advisory threshold of 6µg/L at Edgewater Beach on September 8, 2015, and at Euclid Beach on September 16, 2015. In accordance with the State of Ohio Harmful Algal Bloom Response Strategy for Recreational Waters (ODH, 2015), water quality advisories were posted for these beaches until two consecutive samples collected at least one week apart were found to be below the public advisory threshold limit. No levels of microcystin above the non-contact advisory threshold were observed during the 2015 recreational season. According to the National Oceanic and Atmospheric Administration (NOAA), the HAB which originated in the western basin of Lake Erie in 2015 was the most severe harmful algal bloom observed this century. The severity of the bloom has been linked to heavy, phosphorus laden discharges from the Maumee River in June and July which were a result of heavy rain events in June (NOAA, 2015).

Table 6. HAB Microcystin Concentrations and Predominant Genera

Date	Edgewater Beach			Euclid Beach		
	Microcystin µg/L	Predominant Genus	Other Genus Present	Microcystin µg/L	Predominant Genus	Other Genus Present
8/28/2015	0.27	Microcystis	Aphanizomenon	-	-	-
8/29/2015	0.6	Microcystis	-	0.33	Microcystis	-
8/30/2015	0.92	Microcystis	-	0.68	Microcystis	-
8/31/2015	0.95	Microcystis	Dolichospermum	0.38	Microcystis	Lyngbya
9/1/2015	0.57	Microcystis	-	0.36	Microcystis	-
9/2/2015	2.61	Microcystis	-	0.93	Microcystis	-
9/3/2015	0.33	Microcystis	-	2.05	Microcystis	-
9/4/2015	1	Microcystis	-	2.52	Microcystis	-
9/5/2015	1.27	Microcystis	-	1.36	Microcystis	-
9/6/2015	0.44	Microcystis	-	1.23	Microcystis	-
9/7/2015	4.04	Microcystis	-	3.24	Microcystis	-
9/8/2015	8.8	Microcystis	-	1.85	Microcystis	-
9/9/2015	3.2	Microcystis	-	0.75	Microcystis	-
9/15/2015	0.5	Microcystis	-	0.64	Microcystis	-
9/16/2015	j 0.17	Microcystis	-	9.53	Microcystis	-
9/22/2015	0.58	Microcystis	-	5.3	Microcystis	-
9/29/2015	-	-	-	3.1	Microcystis	-
j - value between MDL and PQL data qualified as estimated						
Public Advisory Threshold - 6µg/L						
No Contact Advisory - 20µg/L						

Conclusions

Edgewater Beach was found to be in partial attainment of the recreational water quality criteria for the 90-day periods beginning from May 4 to June 24, 2015. During this period, the beach failed to meet the STV criteria, but met the SGM criteria for Bathing Waters. This partial attainment was most likely due to contamination caused by heavy rains which occurred in May and June. For the remainder of the recreational season, Edgewater Beach was in full attainment of the recreational water quality criteria. Euclid Beach and Villa Angela Beach failed to meet the STV criterion for 98% of the recreation season and also failed to meet the SGM criterion for the majority of the 90-day periods beginning in May and June (as well as July in the case of Villa Angela Beach). Harmful Algal Blooms were observed at Edgewater and Euclid Beaches in late August through early September. The total microcystin concentrations exceeded the public advisory threshold on September 8 at Edgewater Beach and on September 16 at Euclid Beach, resulting in beach water quality advisory postings for HAB toxins. As it has in the past, Euclid Creek failed to meet both the STV and SGM criterion for 100% of the 90-day periods for which samples were collected as part of this study. It is anticipated that the Euclid Creek CSO Storage Tunnel, which will reduce CSO events from CSO-239, will be online in 2016. This may lead to future improvements in the water quality of Euclid Creek and Euclid and Villa Angela Beaches.

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Analytical Services Division – Completed analysis for all bacteriological sampling.

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