

NORTHEAST OHIO REGIONAL SEWER DISTRICT

2013 Lake Erie Bacteriological Sampling Results at Edgewater, Euclid and Villa Angela Beaches



**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 2013, 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 *E. coli* 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 *2013 Lake Erie Bacteriological Sampling of Edgewater, Euclid and Villa Angela Beaches*, which was approved by Ohio EPA on April 4, 2013. Sample analyses were conducted by NEORSD's Analytical Services division, which is accredited by the National Environmental Laboratory Accreditation Program.

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

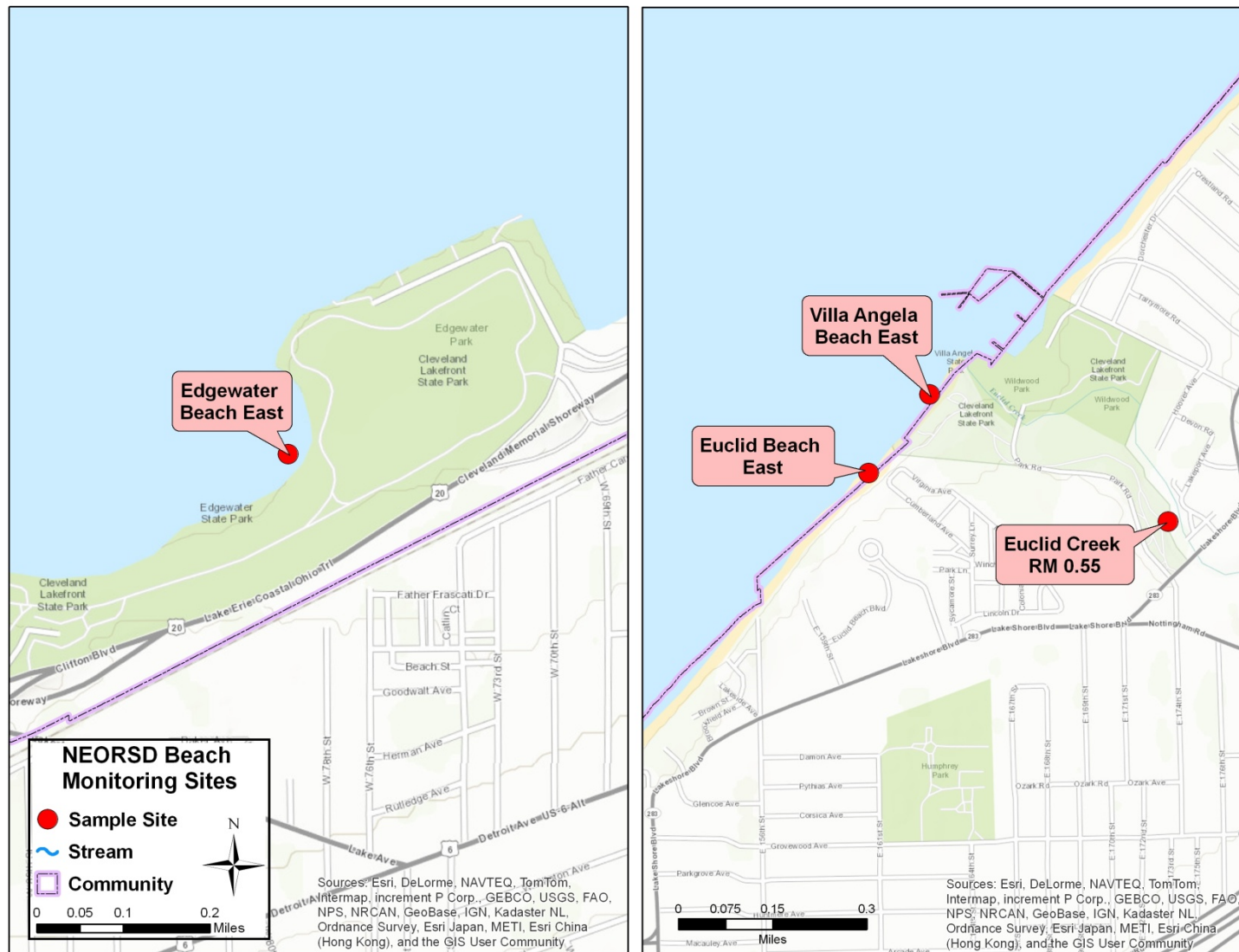


Figure 1. Map of Sampling Sites

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 Methods

Bacteriological sampling was conducted from May 1, 2013 to October 31, 2013. From May 1 through May 16, water samples were collected from each beach and Euclid Creek RM 0.55 four days a week (Monday through Thursday). Beginning May 20 and lasting through September 6, samples were collected at each beach site and Euclid Creek RM 0.55 seven days a week. From September 9 through October 31, sampling returned to four days a week (Monday through Thursday). Two (2) samples on Euclid Creek were not collected during the season due to high flow. A total of 456 samples were collected from all three of the beaches during 2013. A total of 150 samples were collected from Euclid Creek RM 0.55 during 2013.

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-EA016-17*), *The Ohio Department of Health Ohio Bathing Beach Monitoring Program Quality Assurance Project Plan, April 2009*, (effective dates of 9/29/08-9/28/11) and Ohio EPA's *Surface Water Field Sampling Manual for water chemistry, bacteria, and flows* (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 (Figure 2). 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 was not used for comparison to the water quality standards. In 2013, no unacceptable discrepancies were found during beach water chemistry sampling.

Figure 2. Example of the NEORS D Beach Sampling Field Data Form

NEORS D Beach Sampling Field Data Form

Location: _____ Date: _____ Time: _____ (hrs)

Samplers: _____

Meter(s) Used: _____

Sample ID: _____

General Observations

Weather: _____
1-Clear 2-Partly Cloudy 3-Overcast 4-Light Rain 5-Heavy Rain
Steady Rain 7-Heavy Snow Melt 8-Other

Water Surface Conditions: _____
1-None 2-Foam 3-Oily 4-Scum 5-Other

Lake Surface Conditions: _____
1-Calm 2-Ripple 3-Moderate Waves 4-White Caps

Color: _____
1-Clear 2-Muddy 3-Tea 4-Milky 5-Other

Odor: _____
1-Normal 2-Petroleum 3-Septic 4-Sewage 5-Chemical 6-Other

Algae: _____ Debris: _____
1-None 2-Some 3-Floating 4-Thick Layer 5-Multiple Layers

Fecal Matter: _____
1-None 2-Sparse 3-Some 4-Multiple Areas 5-All Along Shoreline

Number of Swimmers: _____

Number of Birds: Gulls _____ Geese _____ Duck _____ Other (ie, pigeons) _____ Total _____

Was the sample taken during or following a wet weather event? _____ (Yes/No)

Physical Parameters

Water Temp: _____ (°C)

pH: _____ (SU)

Turbidity: _____ (NTU)

Conductivity: _____ (umhos/cm)

Location: _____ Date: _____ Time: _____ (hrs)

Measurements

Wave Height: _____ (in)

Wave Run Up: _____ (1-5)

1 - ≤ 1 ft	2 - 1ft to 3ft	3 - 4ft to 6ft
4 - 7ft to 9 ft	5 - ≥ 10 ft	

Wind Direction: _____ (degrees)

Wind Speed: Max= _____ Avg= _____ (mph)

Fecal Contamination on Beach (%) _____

Debris on the Beach (%) _____

Comments

Air temp ($^{\circ}$ C)= _____

To be completed by Lab Personnel

Storm Water Effects on the Beach _____

0 - No Rain Event	1 - Wet Sand, No Run Off
2 - Wet Sand, Mild Scouring	3 - Wet Sand, Moderate Scouring
4 - Wet Sand, Major Scouring, No Standing Water	
5 - Wet Sand, Major Scouring, Standing and flowing Water	

[Place Label Here]

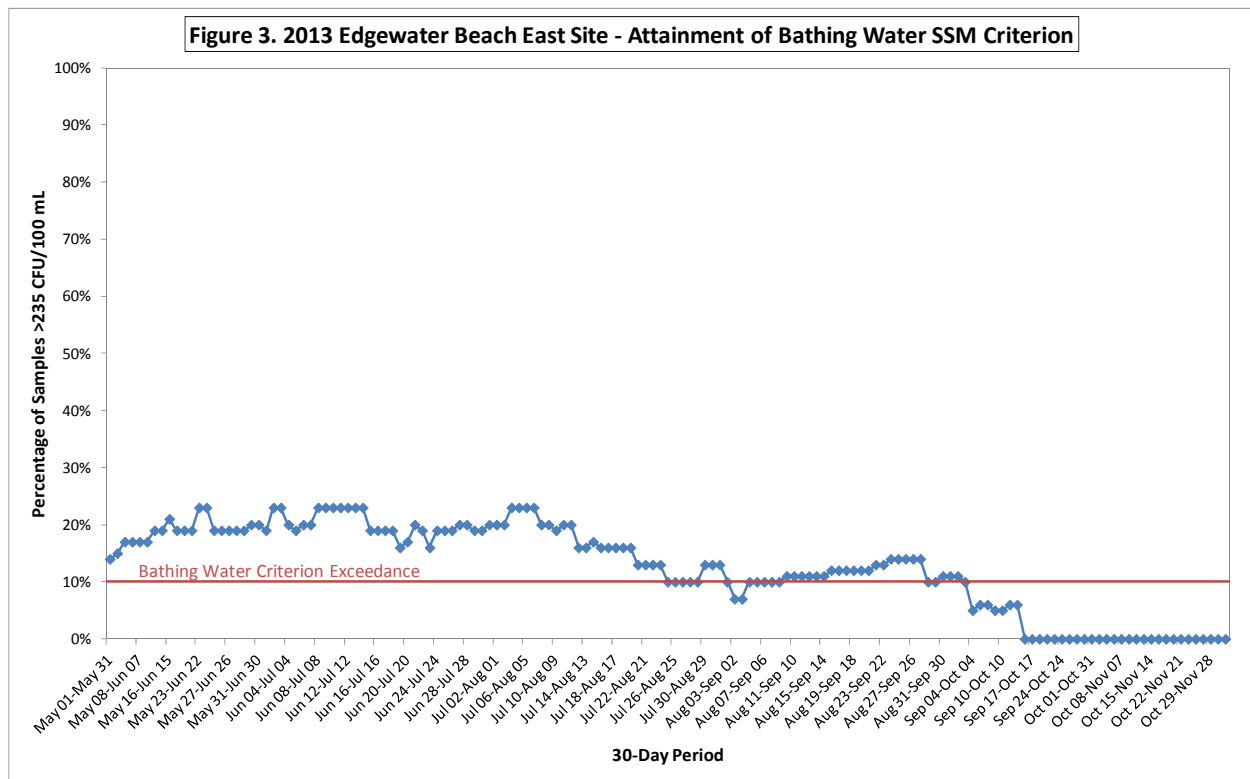
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Beach Results and Discussion

The *E. coli* results from each beach site were compared to the Ohio water quality standards to determine recreation use attainment. From May 1st to October 31st, the three beaches are designated as Bathing Waters for the Protection of Recreation Use (Ohio EPA, 2010). The Bathing Waters criteria include an *E. coli* criterion not to exceed a single sample maximum of 235 colony-forming units per 100 milliliters (cfu/100mL) in more than ten percent of the samples taken during any thirty-day period and a seasonal geometric mean criterion of 126 cfu/100mL.

Edgewater Beach

At Edgewater Beach East, 34% of thirty-day periods were in attainment of the single sample maximum (SSM) criterion, while 66% exceeded the criterion (Figure 3). Although there were multiple exceedances of the SSM criterion, this site was in attainment of the seasonal geometric mean (SGM) criterion (Figure 6).



A possible explanation for the exceedances of the SSM criterion is wet weather. According to NEORSD, a wet weather day is dependent on the amount of rainfall within the three previous days. A day is considered dry weather at least 48 hours after a total rainfall of 0.1 inches to 0.25 inches and at least 72 hours after a total rainfall exceeding 0.25 inches. Fifty-four percent of the recreation season at Edgewater Beach was

considered wet weather¹. Wet weather events may contribute to elevated bacteria levels by causing discharges from CSOs, storm sewer runoff and urban runoff to enter Lake Erie.

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 20 times during the recreation season and may have had an effect on *E. coli* densities at the sampling sites (Table 2). Although all of these CSOs are in close proximity to the beach, it is unknown if these overflow events had a direct effect on the water quality at Edgewater Beach.

Table 2. Number of Monitored NEORSD CSO Overflows During 2013 Recreation Season

CSO	Location	Number of Overflows	Beach/Creek Potentially Affected
069	Upper Edgewater Beach	0	Edgewater
071	Harborview Drive and West 117 th Street	4	Edgewater
002	NEORSD Westerly Water Pollution Control Center from the Combined Sewer Overflow Treatment Facility	16	Edgewater
001	Storm overflow at Easterly Wastewater Treatment Plant	18	Euclid Beach, Villa Angela
206	North end of East 156 th Street at Lake Erie	16	Euclid Beach, Villa Angela
242	East 142 nd Street and Lakeshore Boulevard	13	Euclid Beach, Villa Angela
239	Lakeshore Boulevard at Euclid Creek	37	Euclid Beach, Villa Angela, Euclid Creek

Growing evidence suggests that beach sand can often times be contaminated with bacteria, sometimes at concentrations higher than in the water. Beach sand may serve as a reservoir for pathogens that may be released into surrounding waters through wave action or runoff. Additionally, nutrients in the sand may promote survival and growth of bacteria (Sabino et al, 2014). In 2013, NEORSD in cooperation with the Cleveland Metroparks began improvements at the beaches, including extensive clean-up efforts, namely at Edgewater Beach. Part of the clean-up effort included a sand groomer (mechanical rake towed by a tractor) which raked the beach sand on a daily basis. The groomer was able to rake the sand at a maximum depth of eight inches (Picciano, 2013).

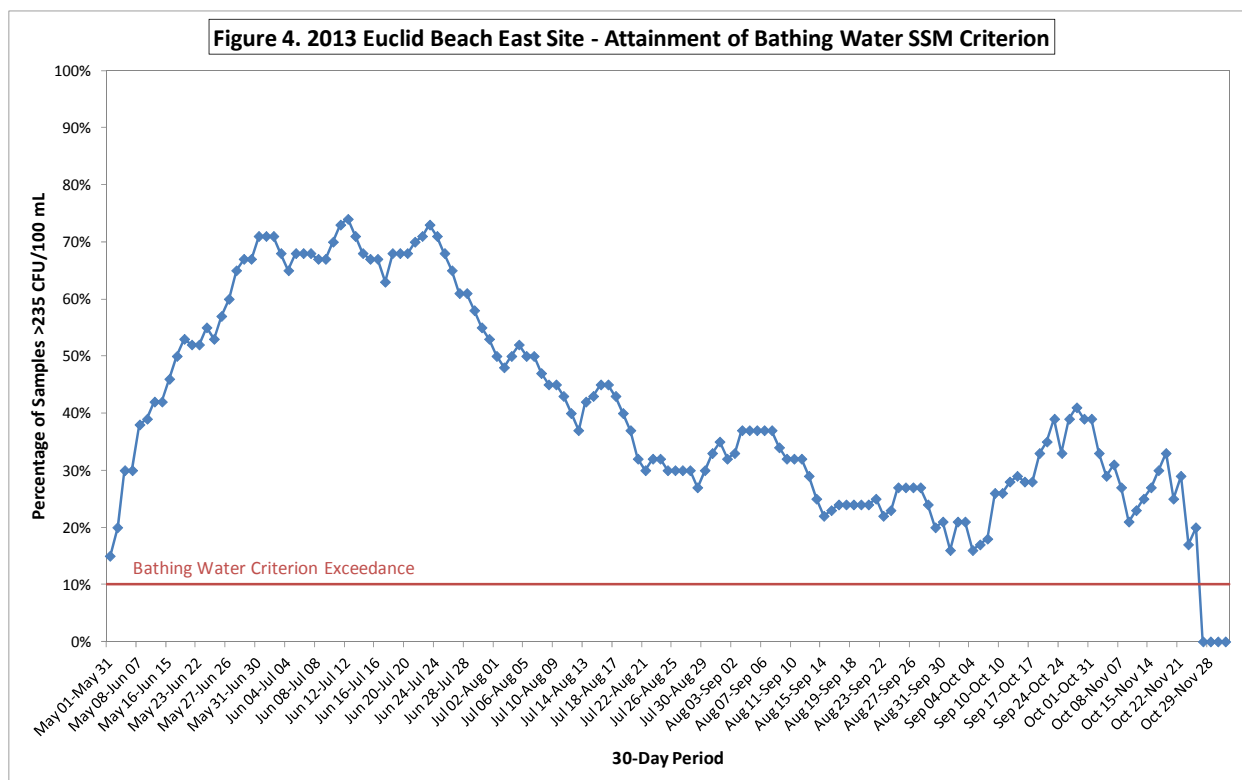
According to Kinzelman and Skalbeck (2006), deep grooming without leveling of the sand, such as what was performed at Edgewater Beach, was found to decrease *E. coli* densities in the sand, which may translate to decreased *E. coli* densities in the nearshore

¹ Rainfall data obtained from NEORSD’s Division Avenue Pump Station Rain Gauge. For days when this rain gauge did not record rainfall, rainfall data was obtained from accuweather.com

water. However, it was frequently noted that through the process of raking the beach sand at Edgewater Beach, the tractor often pushed sand into the shoreline water, which included the tractor itself sometimes driving into the water. This process may be inadvertently introducing potentially contaminated beach sand and potentially contaminated equipment into the nearshore waters, which may be negatively effecting the *E. coli* density at the shoreline and possibly at the sampling site. Grooming alone is unlikely to significantly reduce the number of thirty-day period water quality exceedances at Edgewater Beach (Kinzelman & Skalbeck, 2006). Other factors to consider include beach slope, avian waste, wind conditions, wave action and contaminated runoff.

Euclid Beach

At Euclid Beach East, all but four thirty-day period exceeded the SSM (97%)(Figure 4) and this site was in nonattainment of the SGM criterion (Figure 6).



A possible explanation for the exceedances of the SSM criterion and SGM criterion is wet weather. Wet weather may cause CSOs, storm sewer runoff, and urban runoff that might contain elevated *E. coli* densities to enter the lake. Fifty-three percent of the recreation season at Euclid and Villa Angela Beaches was considered wet weather². Four NEORSD CSOs in the vicinity of Euclid and Villa Angela Beach are

² Rainfall data obtained from NEORSD’s Easterly Wastewater Treatment Plant Rain Gauge. For days when this rain gauge did not record rainfall, rainfall data was obtained from accuweather.com.

monitored daily by NEORSD's SSMO department. These CSOs discharged a total of 84 times during the recreation season and may have had an effect on *E. coli* densities at the sampling sites (Table 2). Also, CSO 207, at East 156th Street and Lakeshore Boulevard, and CSO 208, north of Neff Road and East Park Drive, which are not monitored by the SSMO department, may have overflowed during the recreation season. Although these CSOs are in close proximity to the beaches, it is unknown if these overflow events had an impact on the water quality at Euclid Beach. Aside from CSOs, other sources and factors affecting contamination of the beach water may include wave height and direction, wind conditions, avian waste, runoff and contaminated beach sand.

Similar to Edgewater Beach, sand may or may not be having an impact on *E. coli* densities in the water at Euclid Beach. In the study, "Foreshore Sand as a Source of *Escherichia coli* in Nearshore Water of a Lake Michigan Beach" by Whitman and Nevers (2003), researchers discovered that *E. coli* densities in sand and water were significantly correlated, with the highest density being found in foreshore sand³, followed by those in submerged sediment and water of increasing depth. The study also stated that foreshore beach sand is an important non-point source of *E. coli* to lake water because it is capable of supporting high density bacteria for sustained periods, independent of lake, human, or animal input.

In 2013, Euclid Beach was not groomed to the extent that Edgewater Beach was. Therefore, potentially contaminated sand that may be increasing *E. coli* densities at Euclid Beach through wave action may be a bigger problem than at Edgewater Beach. Wave action must be taken into account at Euclid Beach as it may influence the early colonization and distribution of *E. coli* in beach sand and the subsequent release of sand or sediment-borne *E. coli* in lake water (Ischii, Hansen, Hicks & Sadowsky, 2007). Daily grooming at Euclid Beach should be considered to possibly help reduce the densities of *E. coli* in the sand and subsequently in the nearshore water.

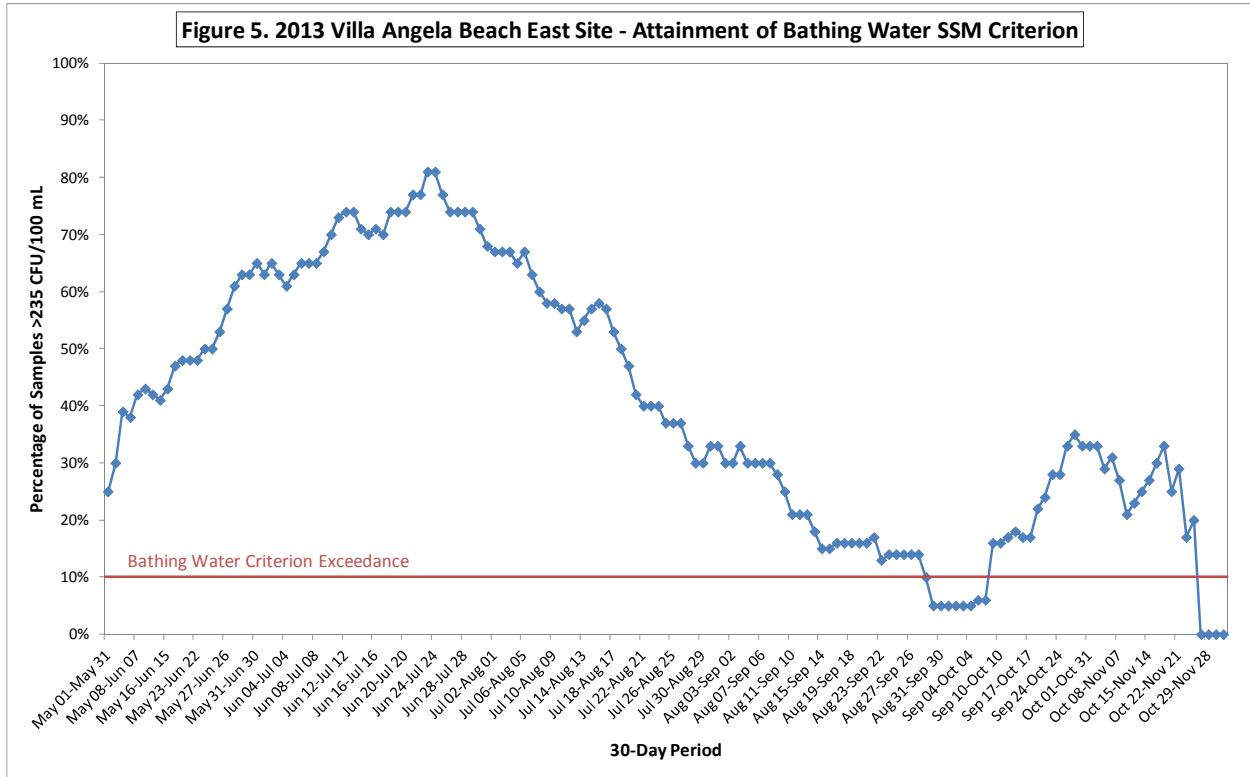
Villa Angela Beach

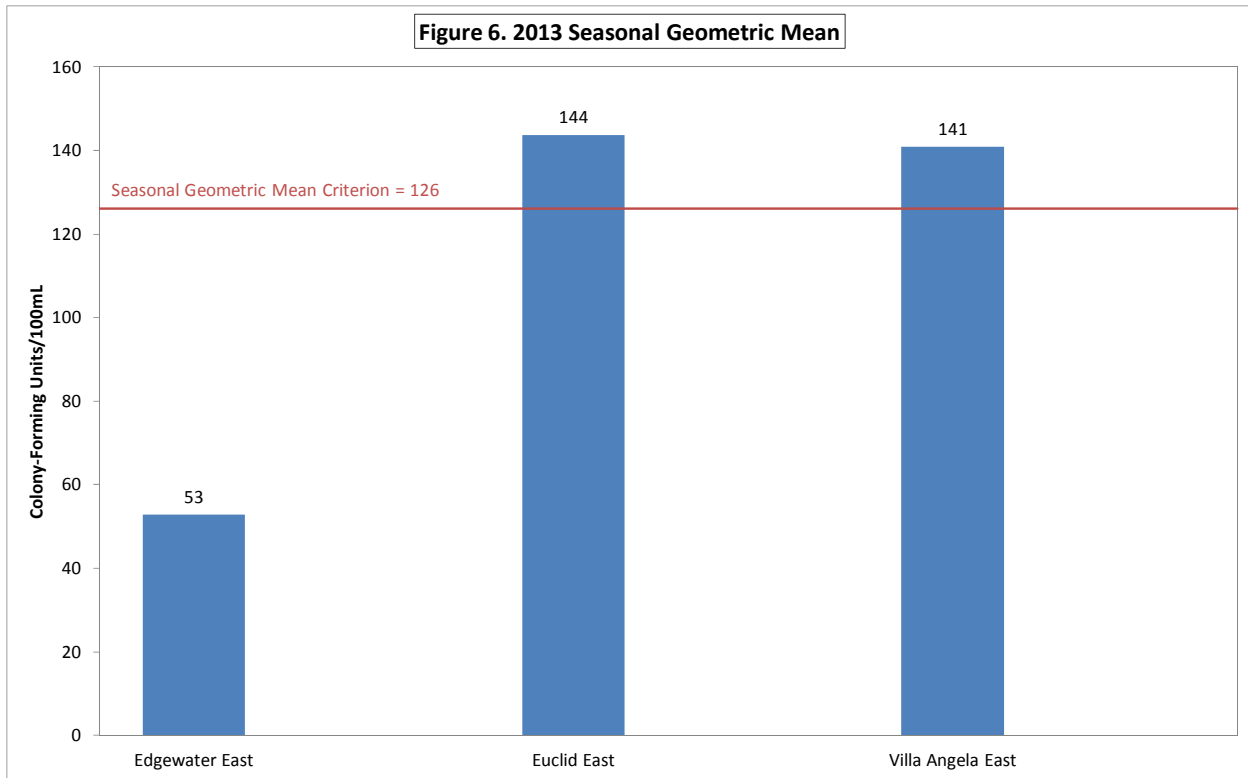
At the Villa Angela Beach East site, 91% of thirty-day periods exceeded the SSM criterion (Figure 5) and the site was in nonattainment of the SGM criterion (Figure 6). A possible explanation for the exceedances of the SSM criterion at both sites could be wet weather. Wet weather may cause CSOs, storm sewer runoff, and urban runoff to enter the lake that may contain elevated *E. coli* densities. As previously mentioned, there are four monitored NEORSD CSOs in the vicinity of Villa Angela and Euclid Beach that discharged a total of 84 times during the recreation season. Although these CSOs are in close proximity to the beach, it is unknown if the overflow events had an impact on the water quality at Villa Angela Beach. Similar to Euclid Beach, contaminated beach sand in conjunction with wave action, avian feces, wind direction and runoff, may also be

³ The area of shoreline that lies between the average high tide mark and the average low tide mark.

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having a negative effect on the water quality at Villa Angela Beach since this beach was not extensively groomed during 2013.

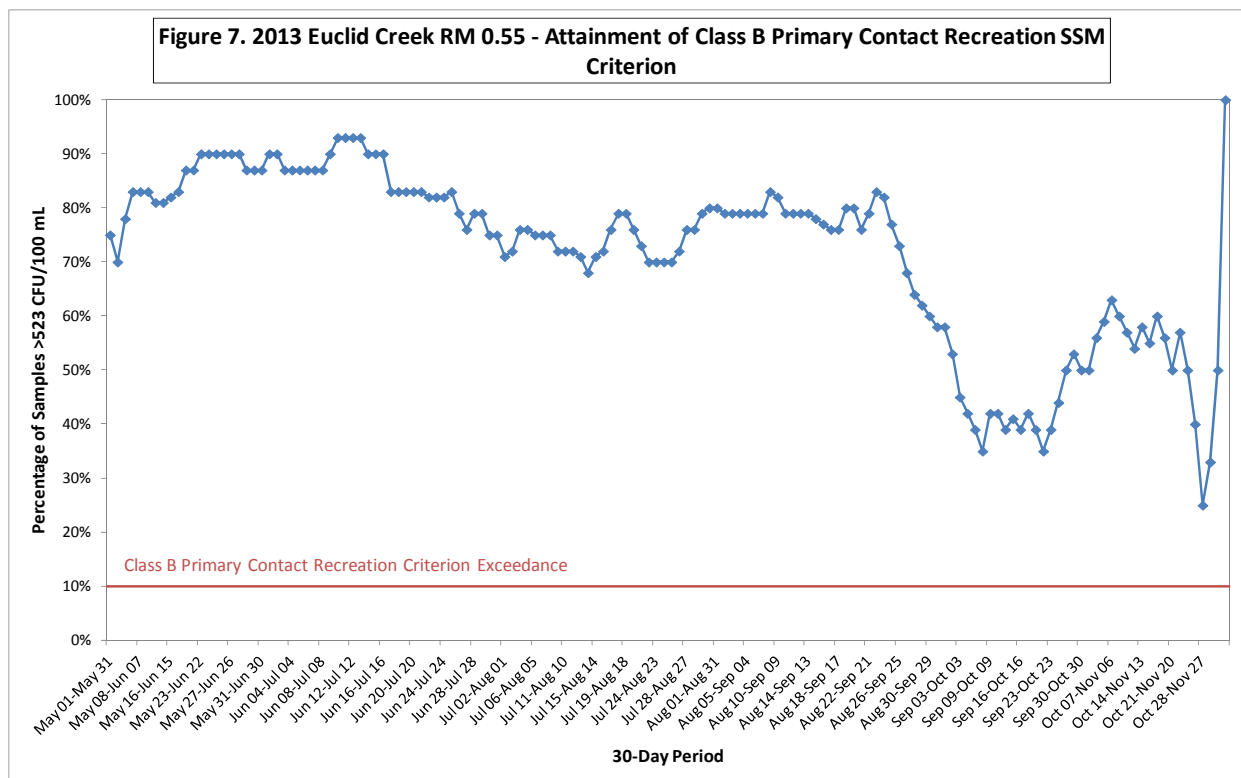




Euclid Creek Results and Discussion

The *E. coli* results from the Euclid Creek site were compared to the Ohio water quality standards to determine recreation use attainment. Euclid Creek is designated as Class B Primary Contact Recreation for the Protection of Recreation Use (Ohio EPA, 2010). The Class B Primary Contact Recreation criteria include an *E. coli* criterion not to exceed a single sample maximum of 523 cfu/100mL in more than ten percent of the samples taken during any thirty-day period and a seasonal geometric mean criterion of 161 cfu/100mL. The criteria are only in effect during the recreation season (Ohio EPA, 2010).

During the recreation season at Euclid Creek RM 0.55, all thirty-day periods (100%) exceeded the SSM criterion (Figure 7). Additionally, this site had an SGM of 1092 cfu/100mL and therefore failed to meet attainment of the SGM criterion.



A possible explanation for the exceedances of the SSM and SGM criterion could be wet weather. Looking at wet weather occurrences in 2013, 44% of the recreation season at Euclid Creek was considered wet weather⁴. Wet weather may cause CSO overflows, storm sewer runoff, and urban runoff to enter the creek that may contain elevated *E. coli* densities. As previously mentioned, CSO 239 overflowed 37 times to Euclid Creek during the recreation season. Also, CSO 210, located under the Saint Clair Avenue Bridge, and CSO 209, located just north of Lakeshore Boulevard, which are not monitored by the SSMO department, may have also overflowed during the recreation season. Although these CSOs discharge to Euclid Creek, it is unknown if the overflow events had an impact on the water quality in Euclid Creek or Villa Angela Beach.

Additionally, bacteriological contamination of the storm sewers in the cities of Cleveland and Euclid could have an impact on the *E. coli* densities. Contamination of the storm sewers was thoroughly investigated in 2012 and 2013 by WQIS personnel and when applicable, was communicated to the appropriate community for eventual remediation. Although the investigation is still ongoing, the issue of storm sewer bacteriological contamination remains a concern for the health of Euclid Creek. Finally, failing septic systems or urban runoff in the Euclid Creek watershed may also be impacting the water quality at RM 0.55.

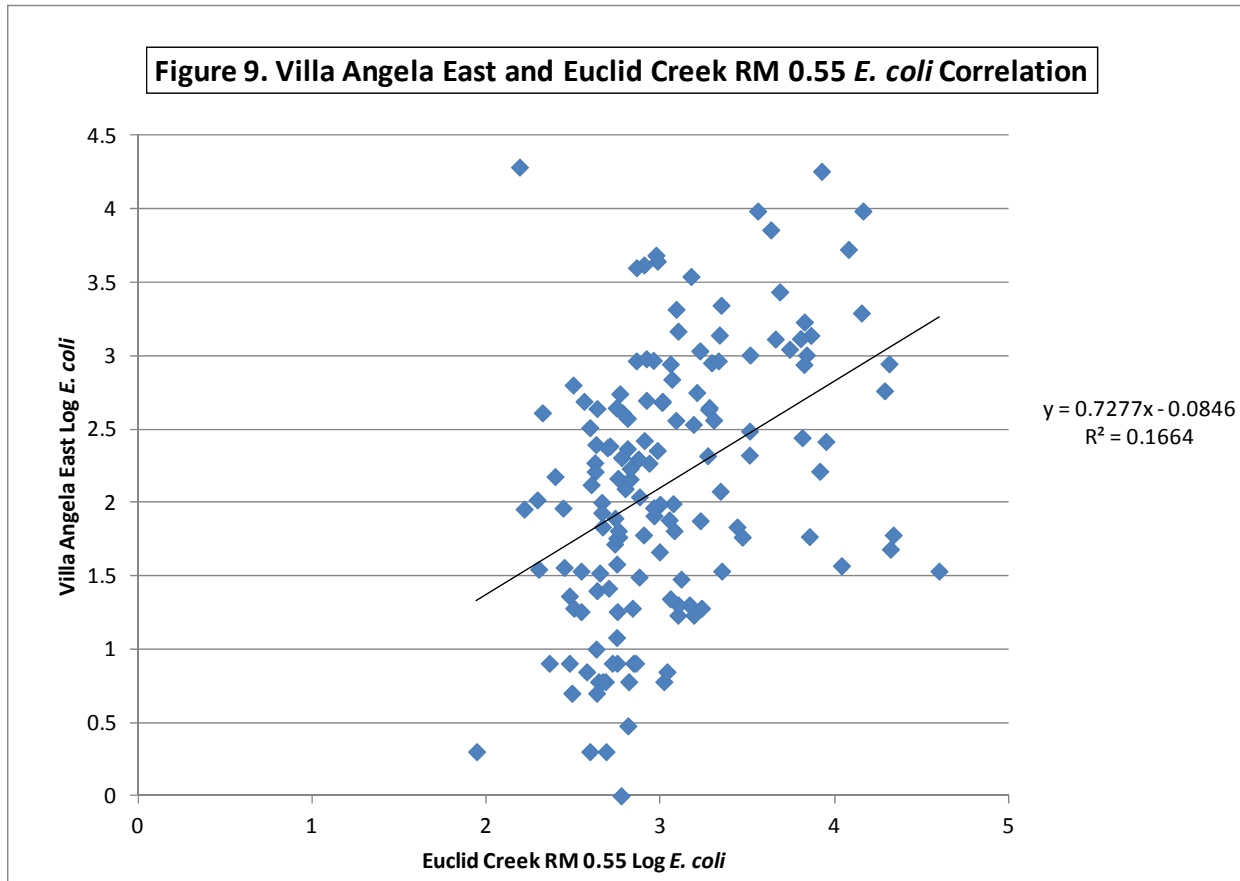
⁴ Rainfall data obtained from NEORSD’s Easterly Wastewater Treatment Plant Rain Gauge. For days when this rain gauge did not record rainfall, rainfall data was obtained from accuweather.com.

Impact of Euclid Creek on Villa Angela Beach

Due to its close proximity, *E. coli* densities measured in Euclid Creek may be impacting the sampling sites on Villa Angela Beach (Figure 8). In the report titled “Interaction and Influence of Two Creeks on *Escherichia coli* Concentrations of Nearby Beaches: Exploration of Predictability and Mechanisms” (Nevers, Whitman & Frick, 2007), it was discovered that *E. coli* contamination in creeks had the greatest effect on *E. coli* densities at surrounding beaches. The transportation of *E. coli* from the creeks to the beaches was significantly influenced by wind speed and direction, currents, wave height and shoreline orientation. Thus, it was hypothesized that bacteria that enter Euclid Creek may flow downstream and prevailing winds and currents may direct the bacteria toward Villa Angela Beach. However, the correlation between bacteriological densities at Euclid Creek RM 0.55 and bacteriological densities at Villa Angela Beach East prove to be weak (Figure 9), with an R^2 value of 0.1664. Conditions in the creek and at Villa Angela Beach, such as wind direction and current, may not have been conducive to show a strong direct effect. Additionally, bacteria from Euclid Creek may become diluted before reaching Villa Angela Beach. Although weak, this relationship should continue to be monitored to determine seasonal variability.

Figure 8. Orientation of Euclid Creek and Villa Angela Beach





Conclusions

Edgewater, Villa Angela and Euclid Beaches

In 2013, beach sampling sites exceeded the SSM criterion 66%, 97% and 91% of the time at Edgewater Beach, Euclid Beach and Villa Angela Beach, respectively. Edgewater Beach was the only beach in attainment of the SGM criterion.

In 2013 at Euclid and Villa Angela Beaches, a greater percentage of thirty-day periods were in attainment of the SSM criterion compared to the 2012 data (Table 3). Edgewater Beach decreased attainment of the SSM criterion by 7% from 2012. This reduction in SSM criterion attainment at Edgewater Beach in 2013 may be the result of the daily beach groomer, which could have been increasing *E. coli* concentrations by taking contaminated sand and equipment into the nearshore water where sampling occurs.

The SGMs in 2013 were higher than in 2012 (Table 4). Although both 2012 and 2013 had a similar percentage of wet weather days, 2013 experienced more total rainfall. At Edgewater Beach, over 17 inches of rain fell during the sampling season compared to 15 inches in 2012. At Euclid and Villa Angela Beaches, over 23 inches of rainfall occurred during 2013 compared to 14 inches in 2012. Increased rainfall may cause CSO

discharge events, stormwater runoff, urban runoff and other pollutant loads. These potential sources that could enter Lake Erie may contain elevated bacteriological densities. Additionally, differences may be attributed to seasonal variability (i.e., rainfall, wind speed, wind direction, wave height, and number of CSO discharge events, etc.) from year to year.

Table 3. 2012-2013 Beach SSM Criterion Attainment

Beach	Year	% Attainment	% Exceedance
Edgewater	2013	34%	66%
	2012	41%	59%
Euclid	2013	3%	97%
	2012	1%	99%
Villa Angela	2013	9%	91%
	2012	0%	100%

Table 4. 2012-2013 Edgewater Beach SGM Criterion Attainment

Beach	Year	SGM (cfu/100mL)	Attainment of Criterion
Edgewater	2013	53	YES
	2012	41	YES
Euclid	2013	144	NO
	2012	118	YES
Villa Angela	2013	141	NO
	2012	110	YES

Euclid Creek

The sampling site at Euclid Creek RM 0.55 exceeded the SSM criterion 100% of the time and exceeded the SGM criterion, corresponding to no attainment in 2013. The 2013 Euclid Creek data was identical to the 2012 data, as both years exceeded the SSM criterion 100% of the time and both years exceeded the SGM criterion (Tables 5 and 6). This site had a lower SGM in 2012 than 2013, which may be attributed to a variety of causes, such as less rainfall and fewer CSO discharge events in 2012. Additionally, the investigations on Euclid Creek have identified numerous improper connections within the Euclid Creek watershed that may be continually affecting the health of the creek.

Table 5. 2012-2013 Euclid Creek SSM Criterion Attainment

Year	% Attainment	% Exceedance
2013	0%	100%
2012	0%	100%

Table 6. 2012-2013 Euclid Creek SGM
Criterion Attainment

Year	SGM (cfu/100mL)	Attainment of Criterion
2013	1092	NO
2012	973	NO

All Sites

Elevated *E. coli* densities continue to be observed at the Edgewater, Villa Angela, and Euclid Beaches, as well as Euclid Creek. Many factors, such as CSOs, sanitary sewer overflows, storm sewer and urban runoff, wet weather and beach sand may be contributing to the elevated *E. coli* densities observed. Further monitoring at the beaches and creek will continue to characterize and help to identify the issues that may be impacting these sites.

In 2011, the NEORSD entered into a consent decree with the United States Environmental Protection Agency, Ohio EPA, Department of Justice, and the Ohio Attorney General's Office to reduce the volume of raw sewage that discharges into the environment during rain events. This 25-year CSO control program will help reduce the number of CSO overflows, and thus bacteria, into Lake Erie and Euclid Creek. Bacteriological sampling results from 2012 and 2013 will serve as baseline data for this program, as new CSO controls are implemented in the coming years. It is anticipated that the water quality at the beaches and Euclid Creek will improve as these CSO controls come online, which will help NEORSD to better identify other possible sources and causes of the elevated *E. coli* densities at the beaches.

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