NORTHEAST OHIO REGIONAL SEWER DISTRICT

2009 Lake Erie Bacteriological Results Compared to the State of Ohio Water Quality Standards

Prepared by
Water Quality and Industrial Surveillance's
Environmental Assessment Section

Introduction

During the 2009 recreation season, the Northeast Ohio Regional Sewer District[1] (NEORSD) conducted bacteriological sampling at designated sample sites on Edgewater Beach, Villa Angela Beach, Euclid Beach and Euclid Creek. This study monitored water quality at the beaches in order to communicate beach conditions to the public and to evaluate water quality standards attainment. Sampling at Euclid Creek was conducted to determine the impact the creek may have on the water quality at Villa Angela and Euclid Beaches as well as assess water quality standards attainment. The sampling was also conducted in support of the NEORSD 2009-2013 Strategic Plan, Strategic Initiative Number 1: Regional water quality improvement through effective conveyance and treatment of wastewater; Strategic Initiative Number 3: Develop a customer communication program to understand expectations and develop key performance indicators; and Strategic Initiative Number 18: Lead industry research and technology development, and regulatory and legislative advancements.

Microorganisms from urban runoff, combined sewer overflows (CSOs), wildlife, bather shedding, and non-point sources can be a contributing factor to illnesses for individuals utilizing the beaches. The U.S. Environmental Protection Agency has adopted *Escherichia coli* as one of the best indicator organisms at freshwater bathing beaches because its presence has been correlated to other pathogenic microorganisms that can cause illnesses. During this study, *E. coli* densities were monitored at these three beaches and Euclid Creek throughout the recreation season. The sample results from 2009 were compared to the Ohio Water Quality Standards to determine if the three beaches and Euclid Creek were in attainment of the recreational use criterion for *E. coli*.

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

[1] Sampling was conducted by NEORSD Level 3 Qualified Data Collectors certified by Ohio EPA in Chemical Water Quality as explained in the NEORSD study plan approved by Ohio EPA on May 12, 2009 (*2009 Lake Erie Bacteriological Sampling of Edgewater, Euclid and Villa Angela Beaches*).

Figure 1.
2010 Lake Erie Beach Monitoring Locations

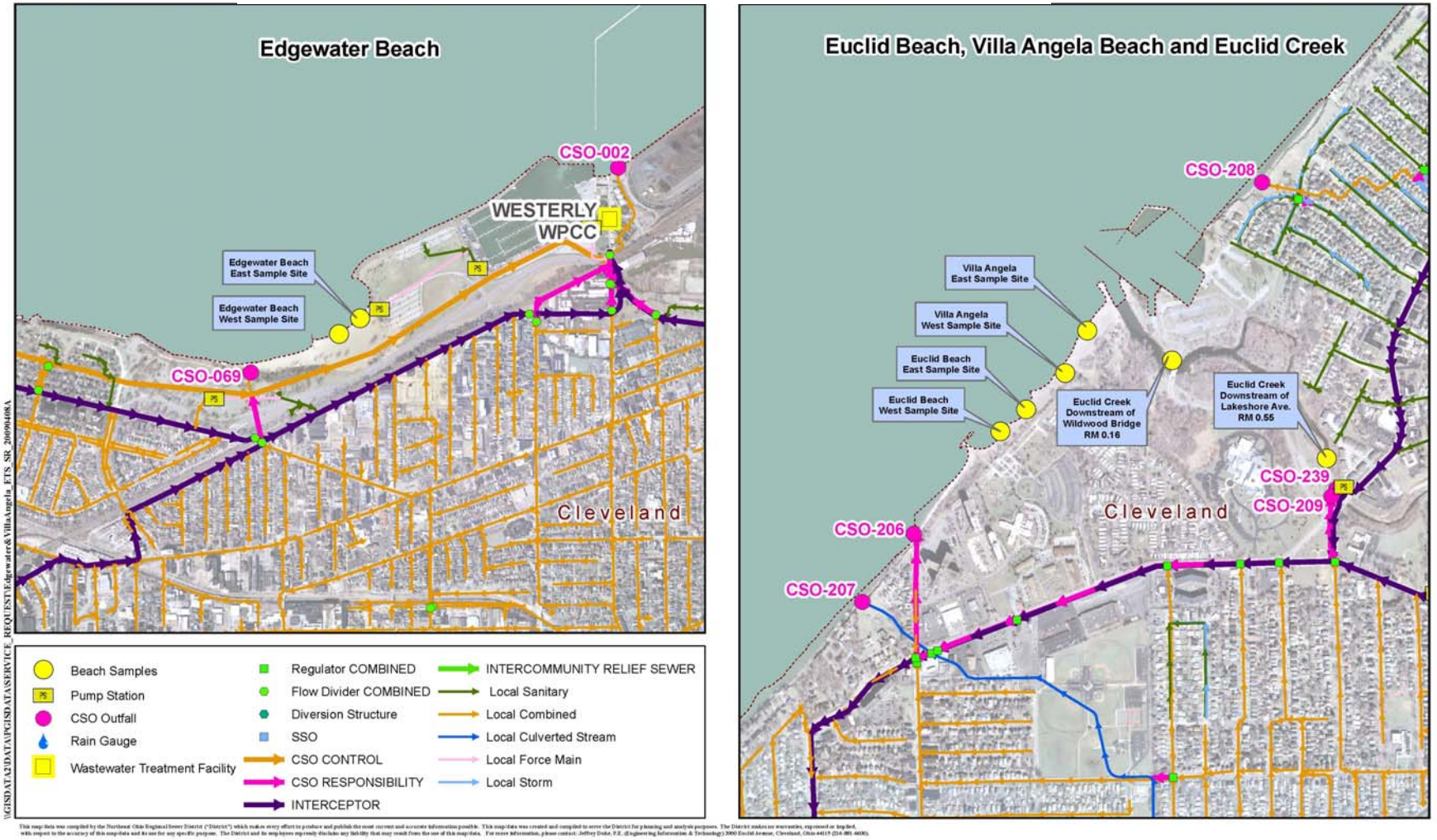


Table 1. List of Lake Erie Sampling Locations

Location	Site	Latitude	Longitude	Description	Quadrangle	Purpose
Edgewater Beach	East	N41.4893°	W81.7392°	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, determination of water quality standards attainment, determination of the impact of point and non-point sources
Edgewater Beach	West	N41.4887°	W81.7404°	Western half of the beach. In line with the large metal pole on the other side of the freeway.	Cleveland South	
Villa Angela Beach	East	N41.5851°	W81.5677°	Eastern half of beach, mid-distance between the 3rd and 4th break walls.	East Cleveland	
Villa Angela Beach	West	N41.5861°	W81.5667°	Western half of beach at the beginning of the 2nd break wall.	East Cleveland	
Euclid Beach	East	N41.5843°	W81.5686°	Eastern half of beach in line with the East side of the pile of stones on the beach.	East Cleveland	
Euclid Beach	West	N41.5838°	W81.5694	Western half of the beach, between the two break walls, at the second set of stairs.	East Cleveland	
Euclid Creek	RM 0.55	N41.5831°	W81.5594°	Downstream of Lakeshore Boulevard.	East Cleveland	
Euclid Creek	RM 0.14	N41.5854°	W81.5641°	Downstream of Wildwood Bridge.	East Cleveland	

Methods

Beach monitoring was conducted from May 4th, 2009 to October 29th and consisted of obtaining bacteriological samples, as well as field parameters. From May 4th through May 14th water samples were collected from each beach site four days a week (Monday through Thursday). Beginning May 18th and lasting through September 11th, samples were collected at each beach site seven days a week. From September 12th through October 29th, sampling returned to fours days a week (Monday through Thursday). A total of 918 samples were collected from all three of the beaches during 2009. The two sites on Euclid Creek were sampled daily, five times a week (Monday through Friday) from June 1st through September 11th. A total of 209 samples were collected from Euclid Creek RMs 0.55 and 0.14 during 2009. Field analyses included the use of a Hanna HI 98129 meter to measure pH, water temperature and conductivity. All water samples and field parameters were collected as specified in the most current NEORSD Beach Sampling SOP, *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 followed the *Manual of Ohio EPA Surveillance Methods and Quality Assurance* (2009).

Bacteriological grab samples were collected in a 1-liter sterilized polypropylene container. Samples were collected at a depth of 3 feet at each location and approximately 6-12 inches below the surface. At the time of collection, field parameters were taken and field observations were made pertaining to the beach and water conditions. All observations were recorded on a daily sampling form. All water samples and field parameters were collected as specified in NEORSD Beach Sampling SOP. All samples were placed in a cooler with ice and stored in a locked NEORSD vehicle until the samples were transferred to the NEORSD's Analytical Services (AS) sample receiving, and released to an authorized AS employee with a Chain of Custody (COC). Field forms, COCs and Certificates of Analysis (COA) are available upon request.

The quality assurance and quality control of water sample collections included obtaining one field blank once a month from a randomly selected beach. The field blanks that were collected showed no signs of contamination during the sampling and transporting process.

Ohio Water Quality Standards

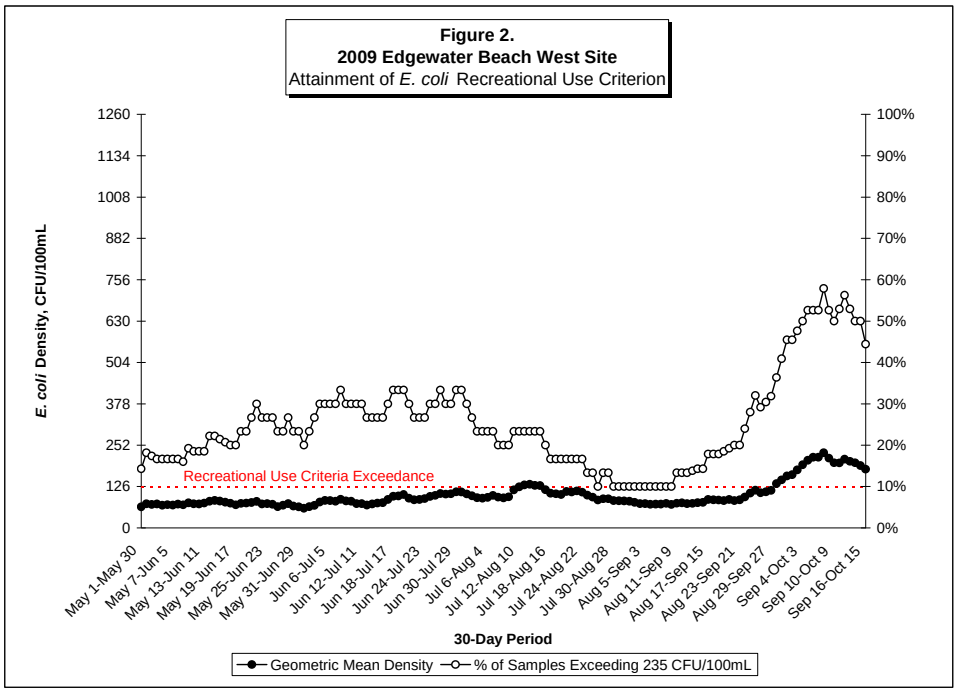
The recreational use designation for the three beaches is bathing waters, according to Ohio EPA's Lake Erie Standards (OAC 3745-1-31). The recreational use designation for Euclid Creek is primary contact recreation (OAC 3745-1-26). According to the Ohio EPA (2009), the bathing waters recreational use criterion for *E. coli* is, "a geometric mean *E. coli* content, based on not less than five samples within a thirty-day period, which shall not exceed 126 per 100 mL and *E. coli* content shall not exceed 235 per 100 mL in more than ten percent of the samples taken during any thirty-day period." The primary contact recreational use criterion for *E. coli* is, "a geometric mean *E. coli* content, based on not less than five samples within a thirty-day period, shall not exceed 126 per 100 ml and *E. coli* content shall not exceed 298 per 100 ml in more than ten per cent of the samples taken during any thirty-day period." The recreational use criteria are only in effect during the recreation season, which is defined as, "the period from May first to October fifteenth, for all water bodies except those designated seasonal salmonid habitat" (Ohio EPA, 2009).

Results and Discussion

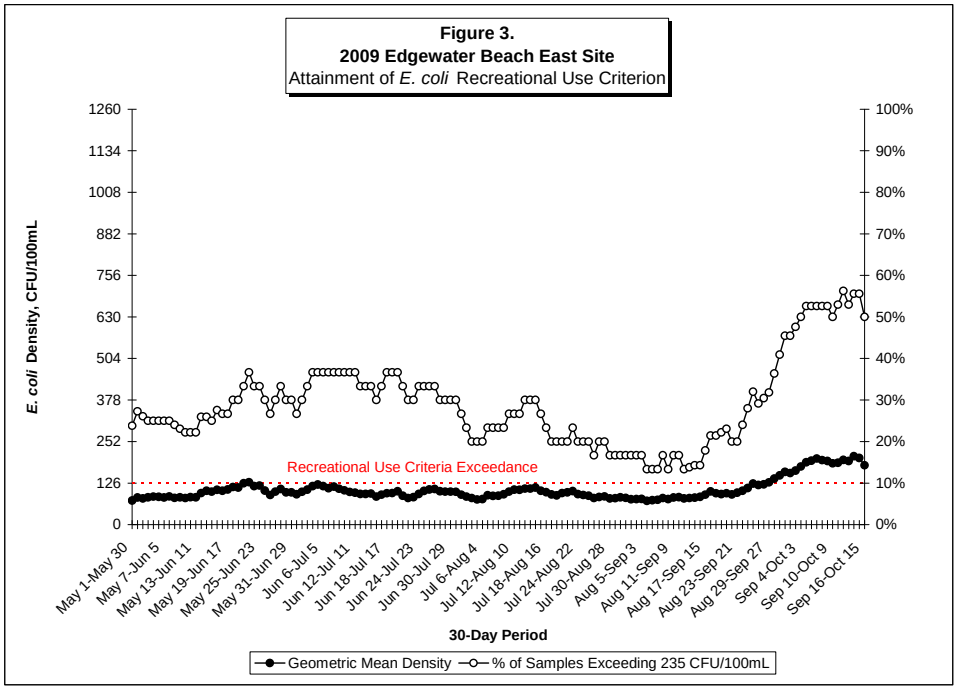
Edgewater Beach

At Edgewater Beach West, there was a total of 139 thirty-day periods[2] from May 1 to October 15, 2009. Thirteen thirty-day periods (9.4%) were in attainment of the recreational use criterion for *E. coli*, while 126 thirty-day periods (90.6%) were in non-attainment of the criterion (Figure 2).

There was a total of 139 thirty-day periods[2] at Edgewater Beach East with all thirty-day periods (100%) in non-attainment of the criterion (Figure 3).



[2] Based on not less than 5 samples collected within a thirty-day period.



Attainment of the bathing water recreational use criterion for *E. coli* was not met during the majority of the recreation season at Edgewater Beach (Table 2). A possible explanation for the non-attainment is wet weather. Wet weather is defined as: 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; for greater than 0.25 inches, the samples collected that day and the following two days were considered wet weather samples. Thirty-five percent of the recreation season at Edgewater Beach West and East was considered wet weather. Furthermore, wet weather events may cause Combined Sewer Overflows (CSOs), storm sewer runoff from various sources and other pollutant loads.

There are three CSOs in the vicinity of Edgewater Beach that overflowed a total of nine times during the recreation season that may have had an effect on *E. coli* densities at the sampling sites (Table 3). CSO 002, an overflow at NEORSD Westerly Water Pollution Control Center from the Combined Sewer Overflow Treatment Facility, discharged seven times during the sampling season. CSO 069 at upper Edgewater Beach and CSO 071 at Harborview Drive and West 117th Street each overflowed once. Although these CSOs are in close proximity to the beach, it is unknown if these overflow events had an impact on the water quality at Edgewater Beach. Other sources of contamination may include storm water, birds and wave height. Beach morphology can contribute to contamination as well.

In the study, "Evaluation of Avian Waste and Bird Counts as Predicators of *Escherichia coli* Contamination at Door County, Wisconsin Beaches" by Kleinheinz et

al. (2006), researchers counted avian waste along 13 beaches in Wisconsin, three times a week. The purpose was to evaluate avian *E. coli* density in beach water. Results indicated that at 30% of the beaches, the number of birds was positively correlated with *E. coli* densities in beach water. Therefore, the potential effect of bird feces on *E. coli* density at Edgewater Beach is significant. Edgewater Beach had the highest average number of birds of all the beaches (average west=74; average east=138) (Table 4).

Additionally, wave height may have an impact on *E. coli* densities. Fifty-three percent of the sampling season at Edgewater Beach contained wave heights greater than one foot, according to the National Oceanic and Atmospheric Administration (NOAA) (www.noaa.gov). Waves, which are significantly affected by wet weather, have the ability to stir up bottom sediment where bacteria may survive and re-grow, as well as wash in more bacteria from the sand on the shoreline, contributing to increased *E. coli* densities. Figure 4 shows that the relationship between log of *E. coli* density and wave height is positive, indicating that wave height may be a factor in increasing bacteriological densities at Edgewater Beach. However, it may be waves that helped Edgewater Beach West partially meet attainment more often than Edgewater Beach East.

Wave height, which is affected by wind, wet weather and the morphology of Edgewater Beach, may have contributed to the large difference in attainment of the Ohio Water Quality Standards between Edgewater Beach West (9.4%) and Edgewater Beach East (0.0%) during the 2009 recreation season. According to the report, "Characterization of *E. coli* levels at 63rd Street Beach" (Whitman *et al.* 2001), beach morphology has the potential to affect densities of *E. coli* by influencing "circulation patterns, waves, sediment deposition, re-suspension, and entrainment of contaminants and helps control the export of dilution of pollutants such as *E. coli*." In this report, Whitman *et al.* (2001) investigated the 63rd Street Beach in Chicago, Illinois and its continual problem with elevated *E. coli* densities. The 63rd Street Beach has a similar beach morphology to Edgewater Beach, with a large embayment area to the east that is approximately 280 feet by 360 feet. The Edgewater Beach East sampling site is located within the embayment area (Figure 5). It is possible that wind and/or wet weather in combination with waves cause bacteria in the embayment area to become trapped. If the bacteria are trapped, dilution of *E. coli* cannot occur since circulation in the embayment is limited. Additionally, the poor water circulation and calmer waves observed at the East site make it difficult for the bacteria to move out of the embayment.

The West site at Edgewater Beach does not contain an embayment area. Thus, better circulation patterns, waves and other related factors allow the bacteria at this site to become better diluted. Furthermore, these factors have the ability to move the bacteria away from the sampling location, producing bacteriological results consistently lower than the East site. Although this could possibly explain the discrepancy in attainment between Edgewater Beach West and East, more strategic sampling should be performed to confirm this hypothesis. Sampling in the embayment area along the east shoreline

while moving north should show *E. coli* densities that decrease as you move north. Samples taken further north and getting progressively further away from the core of the embayment area would have a better chance at dilution and movement.

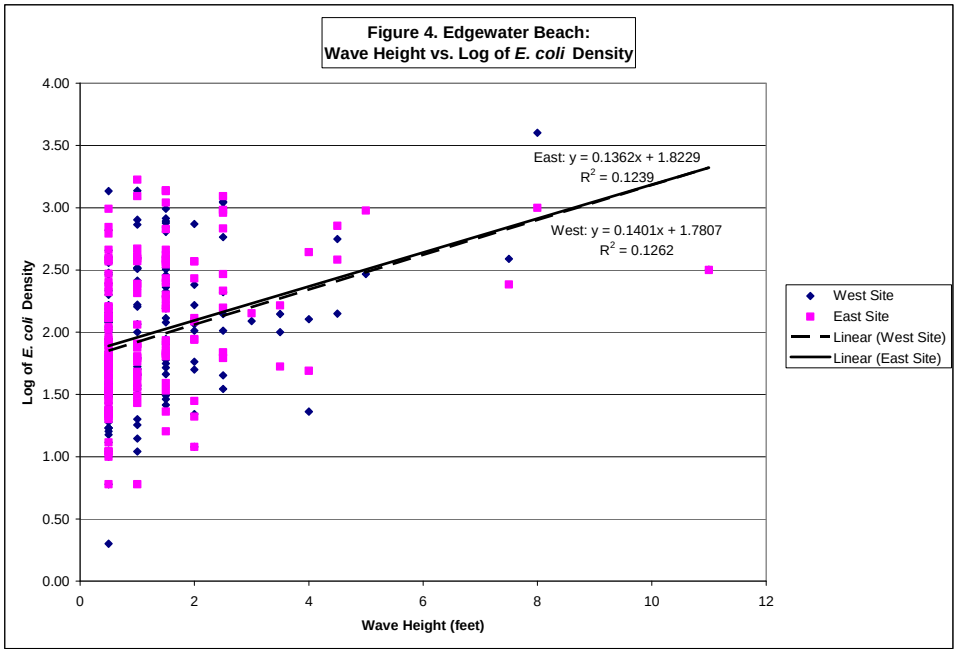


Figure 5. Map of Edgewater Beach

In 2008, Edgewater Beach West had a total of 135 thirty-day periods[2], in which 5 thirty-day periods (3.7%) were in attainment of the recreational use criterion for *E. coli* (Figure 6) compared to 9.4% in 2009. The higher percentage of thirty-day periods in attainment in 2009 could be due to lower amounts of rainfall that year. In 2009, 35% of the season contained wet weather days, compared to 57% in 2008 (Figure 7). At Edgewater Beach East, in 2008 and 2009, there were no thirty-day periods[2] in attainment (Figure 7), which is potentially due to the effects of the embayment area.

Figure 6.
2008 Edgewater Beach West Site
Attainment of *E. coli* Recreational Use Criterion

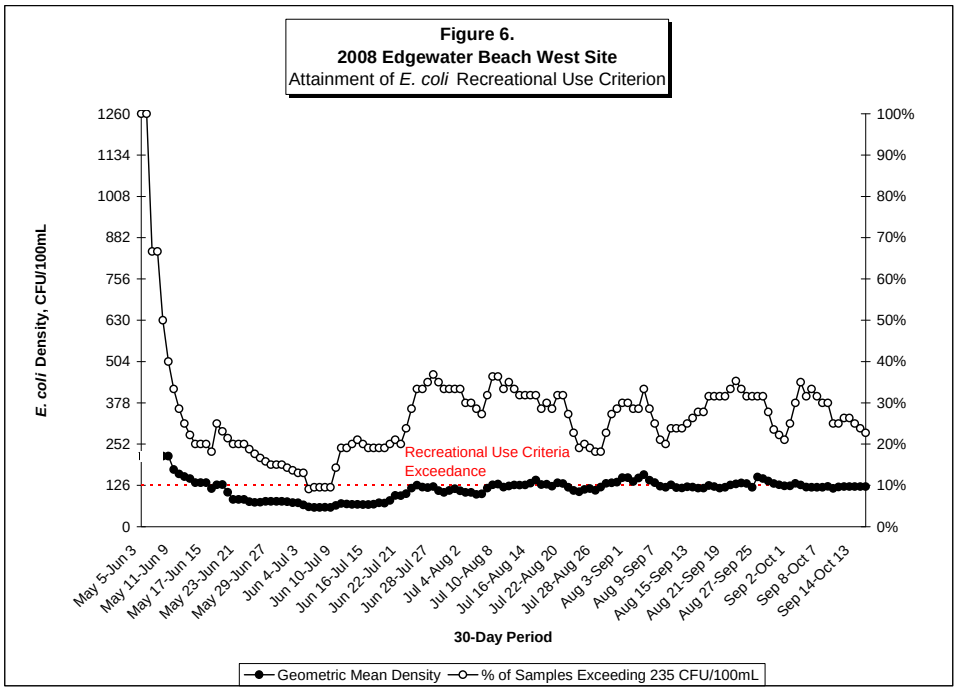
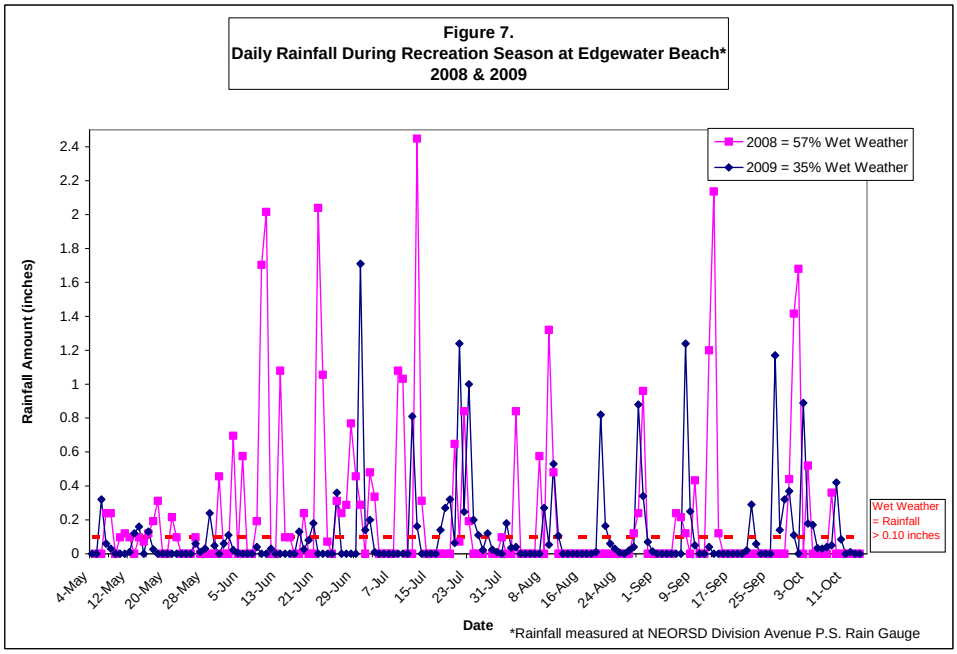
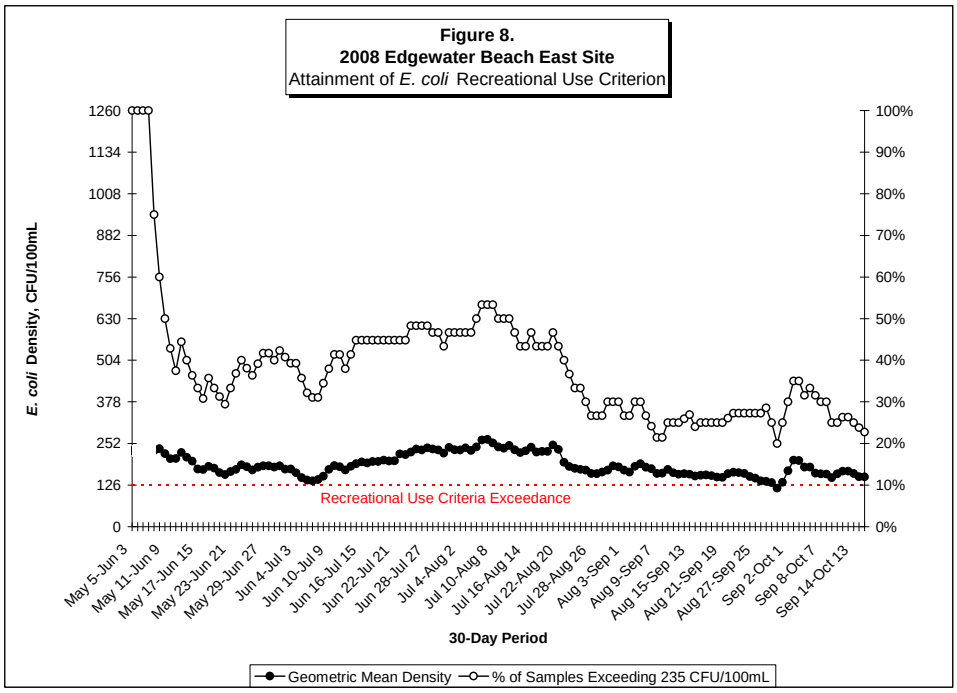


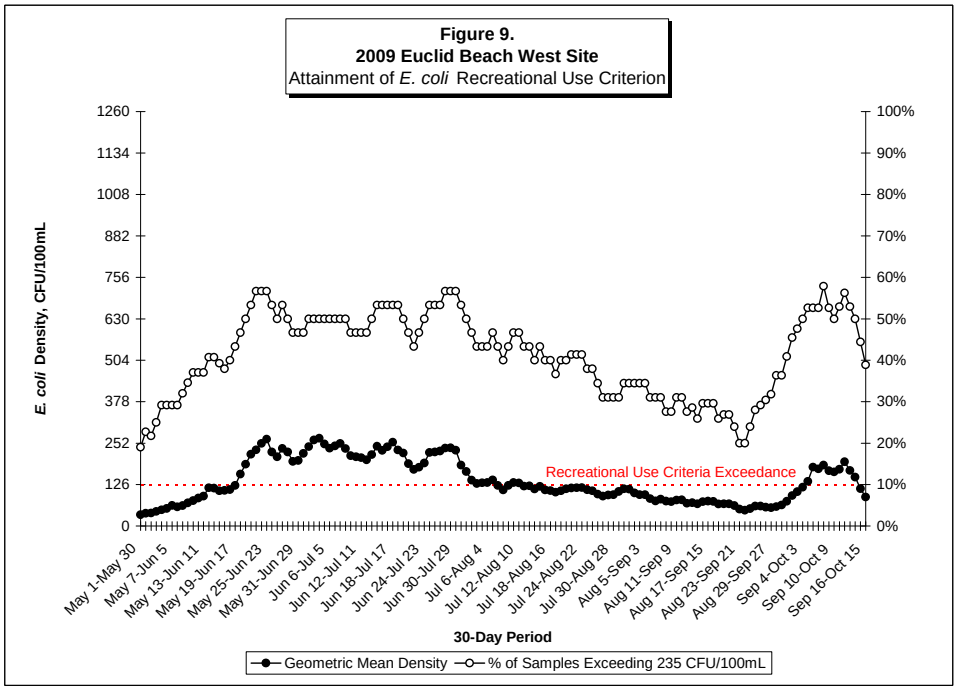
Figure 7.
Daily Rainfall During Recreation Season at Edgewater Beach*
2008 & 2009

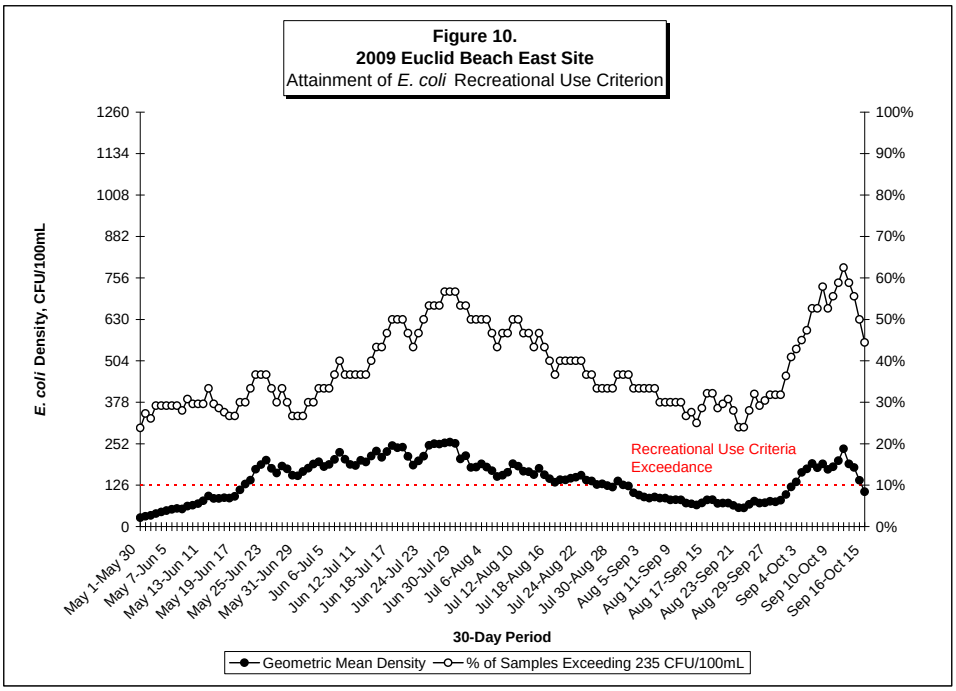




Euclid Beach

At Euclid Beach, there was 139 thirty-day periods[2] from May 1 to October 15, 2009. At both sites, all thirty-day periods (100%) were in non-attainment of the recreational use criterion for *E. coli* (Figures 9 & 10).





Euclid Beach West and East failed to meet attainment during the entire recreation season (Table 2). Wet weather may have contributed to increased *E. coli* densities at Euclid Beach West and East. Forty-one percent of the recreation season was considered wet weather. Additionally, there are four CSOs in the vicinity of Euclid Beach that may have an effect on *E. coli* densities (Table 3). There were a total of 71 overflows from these CSOs during the season. CSO 001, a storm overflow at Easterly Wastewater Treatment Plant, discharged 14 times to Lake Erie. CSO 206, at the north end of East 156th Street at Lake Erie, overflowed 21 times. CSO 242, at East 142nd Street and Lakeshore Boulevard, discharged 8 times to Lake Erie. CSO 239, on Lakeshore Boulevard at Euclid Creek, discharged 28 times. Although these CSOs are in close proximity to the beach, it is unknown if these overflow events had an impact on the water quality at Euclid Beach. Other CSOs (CSOs 200, 202, 207 and 208) which are located farther away from Euclid Beach, may impact water quality at Euclid Beach as well. However, due to their location in relation to Euclid Beach and predominant wind direction, it is unlikely.

Similar to Edgewater Beach, bird waste and beach morphology may play a role in *E. coli* densities at Euclid Beach. The bird community at Euclid Beach (average west= 16; average east= 19) leads to avian feces contamination and thus a potential increase in bacteriological density (Table 4). The morphology at Euclid Beach allows *E. coli* to be trapped near the sampling points with little possibility of dilution, in a similar way as the East sampling site at Edgewater Beach. Euclid Beach contains three horizontal break walls that are approximately 150-215 feet away from the sampling locations and approximately 180 feet long. Additionally, there are two vertical break walls to the

northeast (60 feet long) and southwest (125 feet long) of Euclid Beach that can further contain bacteria (Figure 11).

Another factor that may have caused Euclid Beach West and East to not meet attainment is increased wave height. According to the NOAA (www.noaa.gov), 46% of the season had waves greater than one foot at Euclid and Villa Angela Beaches. Wet weather, which has a significant effect on wave height, could potentially stir up bottom sediment and wash shoreline sand into the lake, influencing bacteriological densities. Figure 12 indicates that wave height is positively correlation with log of *E. coli* density at Euclid Beach in 2009, although the relationship is weak.

In 2008, Euclid Beach West had 139 thirty-day periods[2] with six thirty-day periods (4.3%) in attainment (Figure 13), compared to no attainment in 2009. In 2008, Euclid Beach East had one thirty-day period (0.7%) in attainment (Figure 14), while in 2009, no thirty-day periods were in attainment. It is unknown why the 2008 beach sampling season was in attainment during some thirty-day periods, when the 2009 season never met attainment. Unlike Edgewater Beach, wet weather was more prominent in 2008 than 2009 (Figure 15), therefore rainfall could not explain the discrepancy in attainment between the two sampling seasons.

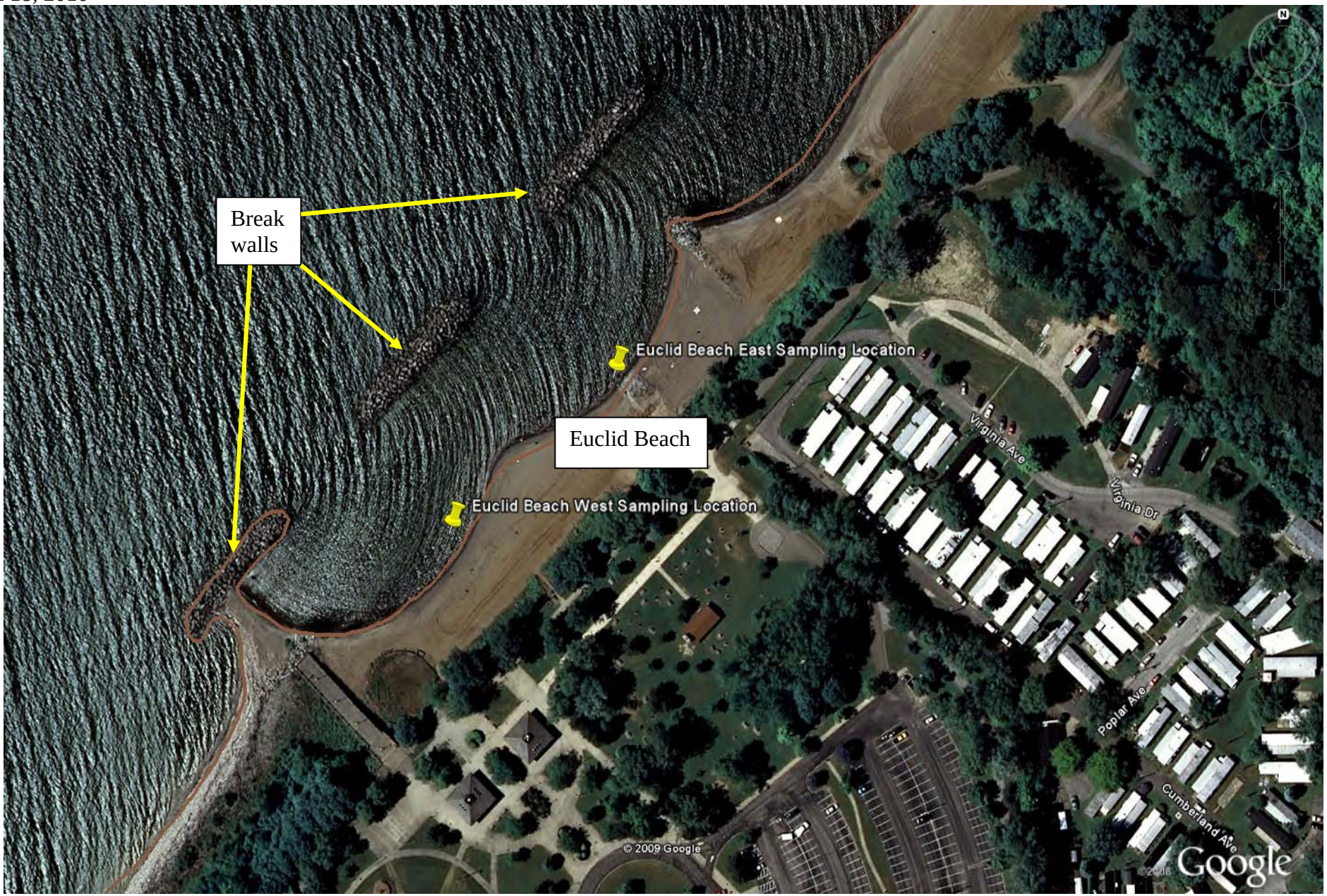


Figure 11. Map of Euclid Beach

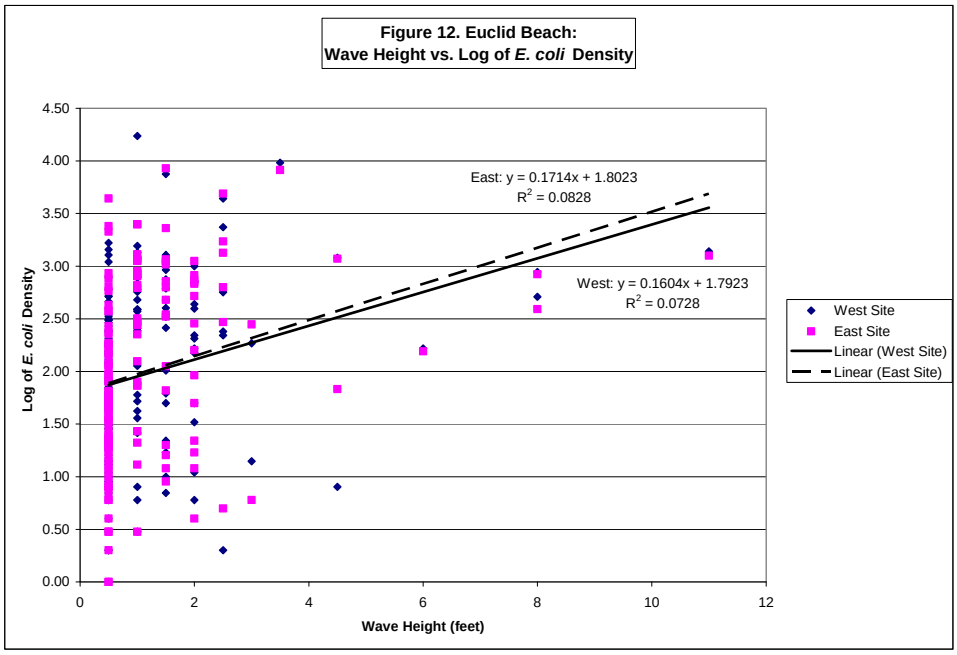


Figure 12. Euclid Beach:
Wave Height vs. Log of E. coli Density
East: y = 0.1714x + 1.8023
R2 = 0.0828
West: y = 0.1604x + 1.7923
R2 = 0.0728
Log of E. coli Density
Wave Height (feet)
West Site
East Site
Linear (West Site)
Linear (East Site)

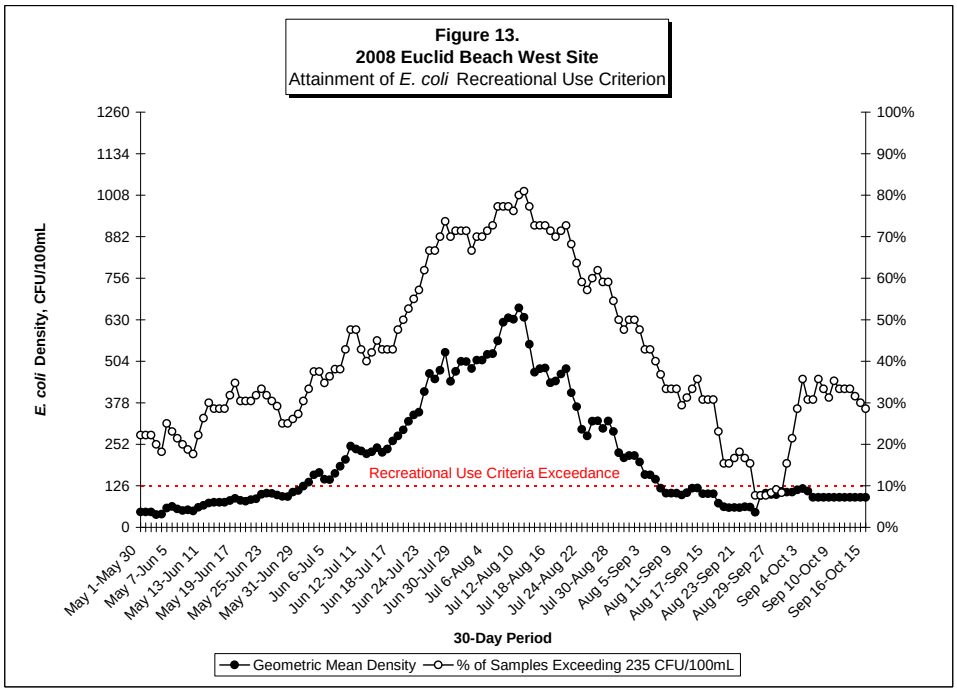


Figure 13.
2008 Euclid Beach West Site
Attainment of E. coli Recreational Use Criterion
E. coli Density, CFU/100mL
Recreational Use Criteria Exceedance
30-Day Period
Geometric Mean Density
% of Samples Exceeding 235 CFU/100mL

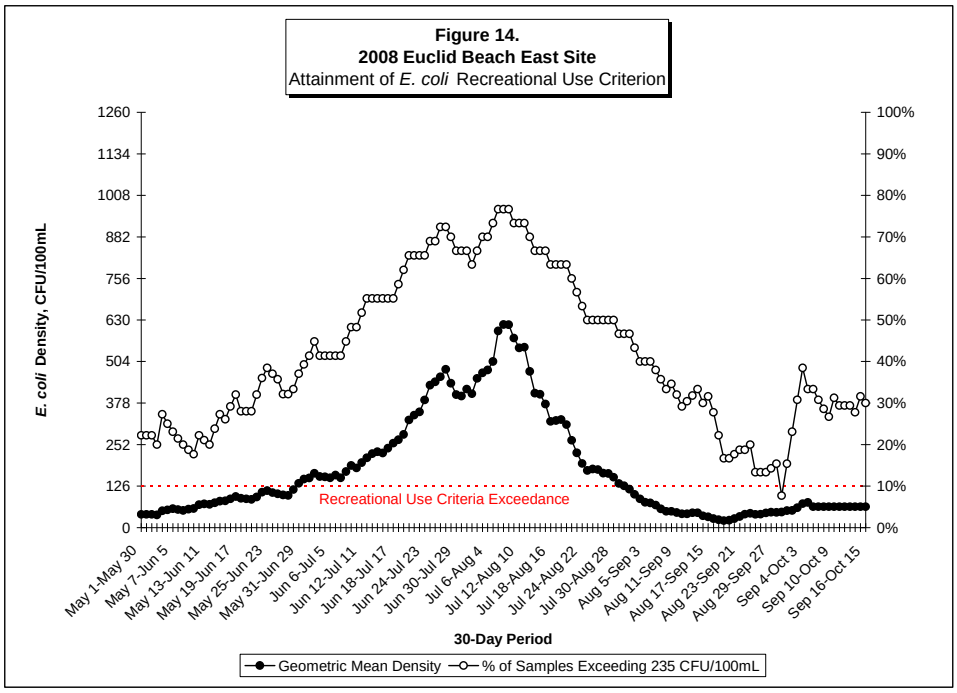


Figure 14.
2008 Euclid Beach East Site
Attainment of E. coli Recreational Use Criterion
E. coli Density, CFU/100mL
1260
1134
1008
882
756
630
504
378
252
126
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Recreational Use Criteria Exceedance
May 1-May 30
May 7-Jun 5
May 13-Jun 11
May 19-Jun 17
May 25-Jun 23
May 31-Jun 29
Jun 6-Jul 5
Jun 12-Jul 11
Jun 18-Jul 17
Jun 24-Jul 23
Jun 30-Jul 29
Jul 6-Aug 4
Jul 12-Aug 10
Jul 18-Aug 16
Jul 24-Aug 22
Jul 30-Aug 28
Aug 5-Sep 3
Aug 11-Sep 9
Aug 17-Sep 15
Aug 23-Sep 21
Aug 29-Sep 27
Sep 4-Oct 3
Sep 10-Oct 9
Sep 16-Oct 15
30-Day Period
Geometric Mean Density
% of Samples Exceeding 235 CFU/100mL

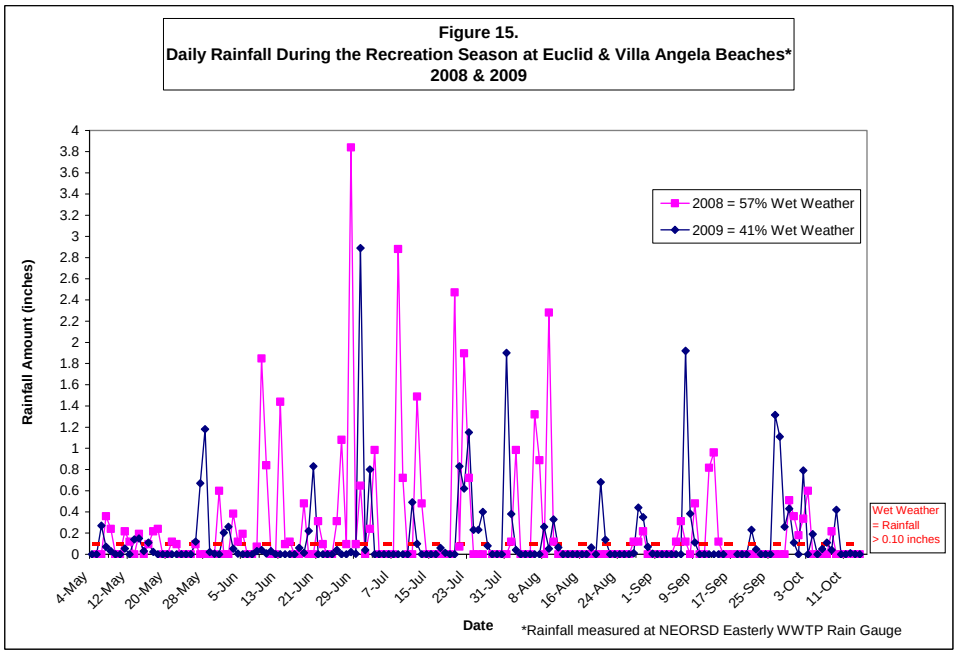
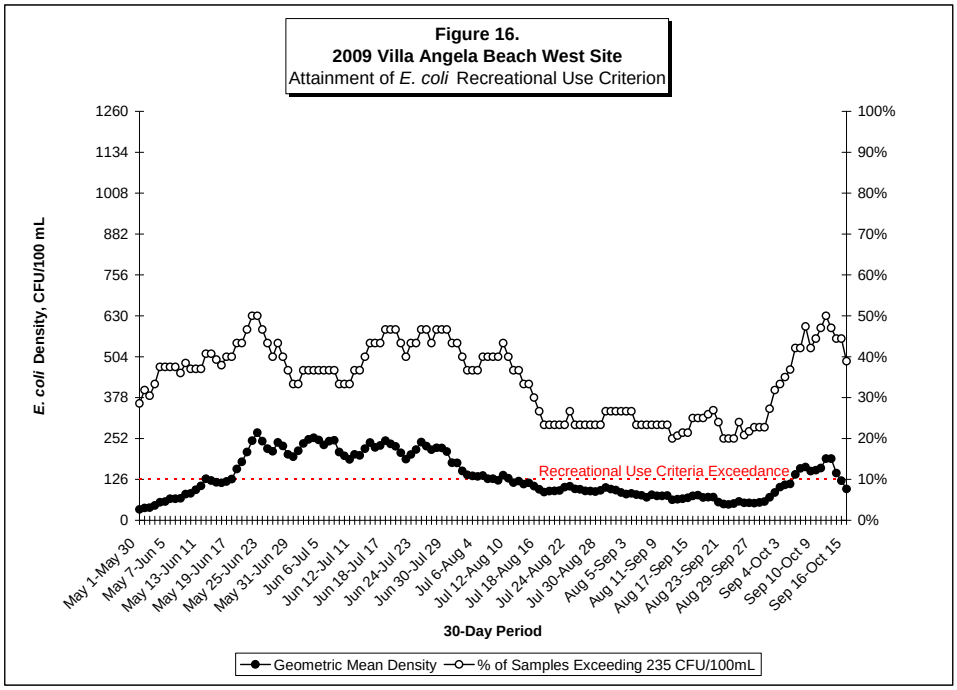
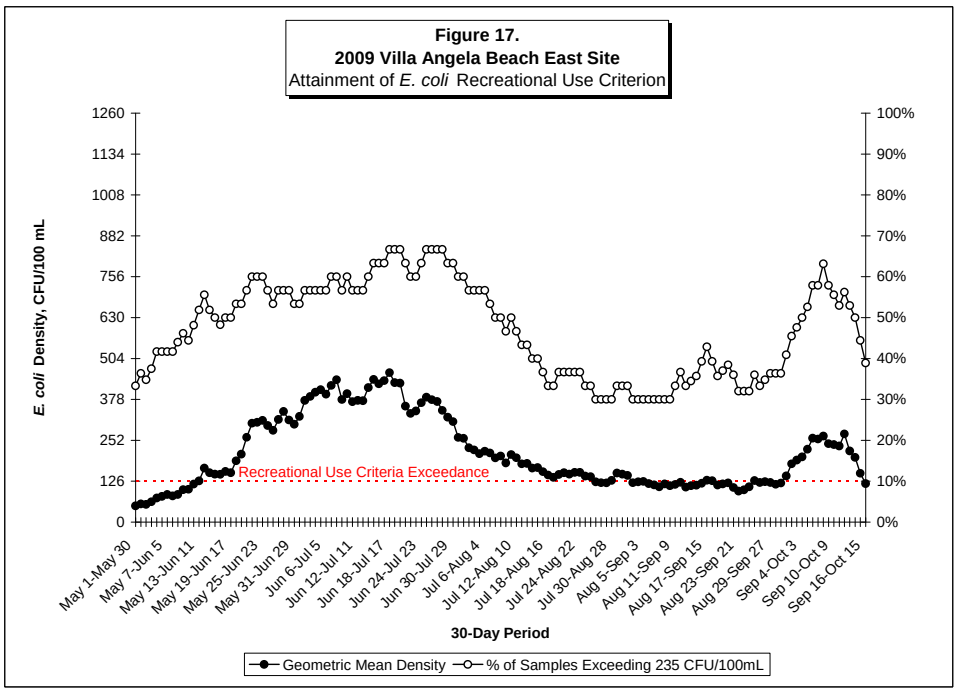


Figure 15.
Daily Rainfall During the Recreation Season at Euclid & Villa Angela Beaches*
2008 & 2009
Rainfall Amount (inches)
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
2008 = 57% Wet Weather
2009 = 41% Wet Weather
Wet Weather
= Rainfall
> 0.10 inches
4-May
12-May
20-May
28-May
5-Jun
13-Jun
21-Jun
29-Jun
7-Jul
15-Jul
23-Jul
31-Jul
8-Aug
16-Aug
24-Aug
1-Sep
9-Sep
17-Sep
25-Sep
3-Oct
11-Oct
Date
*Rainfall measured at NEORSD Easterly WWTP Rain Gauge

Villa Angela Beach

At both Villa Angela Beach West and East, there was a total of 139 thirty-day periods[2] from May 1 to October 15, 2009. At both sites all thirty-day periods (100%) were in non-attainment of the recreational use criterion for *E. coli* (Figures 16 & 17).





In 2009, Villa Angela Beach failed to meet attainment during the recreation season (Table 2). A possible explanation for this could be wet weather, which may have an effect on *E. coli* densities at Villa Angela Beach. Wet weather may cause CSO overflows and stormwater runoff from non-point sources to enter the lake that may contain elevated bacteriological densities (Table 3). As stated previously, there are four CSOs that NEORSD monitors in the vicinity of Villa Angela and Euclid Beach (as well as CSOs 200, 202, 207 and 208) that overflow into Lake Erie or Euclid Creek. 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.

The average number of birds on Villa Angela was 56 and 10 for the West and East site, respectively, during the sampling season (Table 4). Similar to Edgewater and Euclid Beaches, bird waste may be contributing to the elevated *E. coli* densities observed. Additional source tracking research is needed to identify the origin of the *E. coli* found at the beaches and Euclid Creek in order to determine if bird feces is genuinely contributing to increased *E. coli* densities.

The morphology of Villa Angela beach is similar to Euclid Beach (Figure 18). There are four horizontal break walls (approximately 180 feet long) that are approximately 150-215 feet away from the sampling locations. The northeast area of the beach contains a 255 foot long break wall where there is the confluence of Euclid Creek and Lake Erie. A shorter 60 foot long break wall is located southwest of the sampling locations. These break walls could allow bacteria to become trapped near the sampling sites with reduced possibility of dilution.

Again, another factor that may have caused Villa Angela Beach West and East to not meet attainment is increased wave height. According to the NOAA (www.noaa.gov), 46% of the season had waves greater than one foot at Villa Angela and Euclid Beaches. One foot waves could potentially stir up bottom sediment, wash shoreline sand into the lake and affect bacteriological densities. According to Figure 19, an increase in wave height corresponds to an increase in log of *E. coli* density, although the correlation is weak.

For comparison purposes, the 2008 Villa Angela Beach West site had 139 thirty-day periods[2] with all thirty-day periods (100%) in non-attainment of the criterion (Figure 20). In 2008, the Villa Angela Beach East site had 139 thirty-day periods[2] with 14 thirty day periods (10.1%) in attainment (Figure 21); compared to no thirty-day periods in attainment in 2009. It is unknown why there is a significant difference in attainment between 2008 and 2009 for Villa Angela Beach. In 2008, 57.0% of the recreation season was considered wet weather, while 41.0% of the 2009 recreation season was considered wet weather (Figure 15); therefore, wet weather cannot explain the difference in attainment.

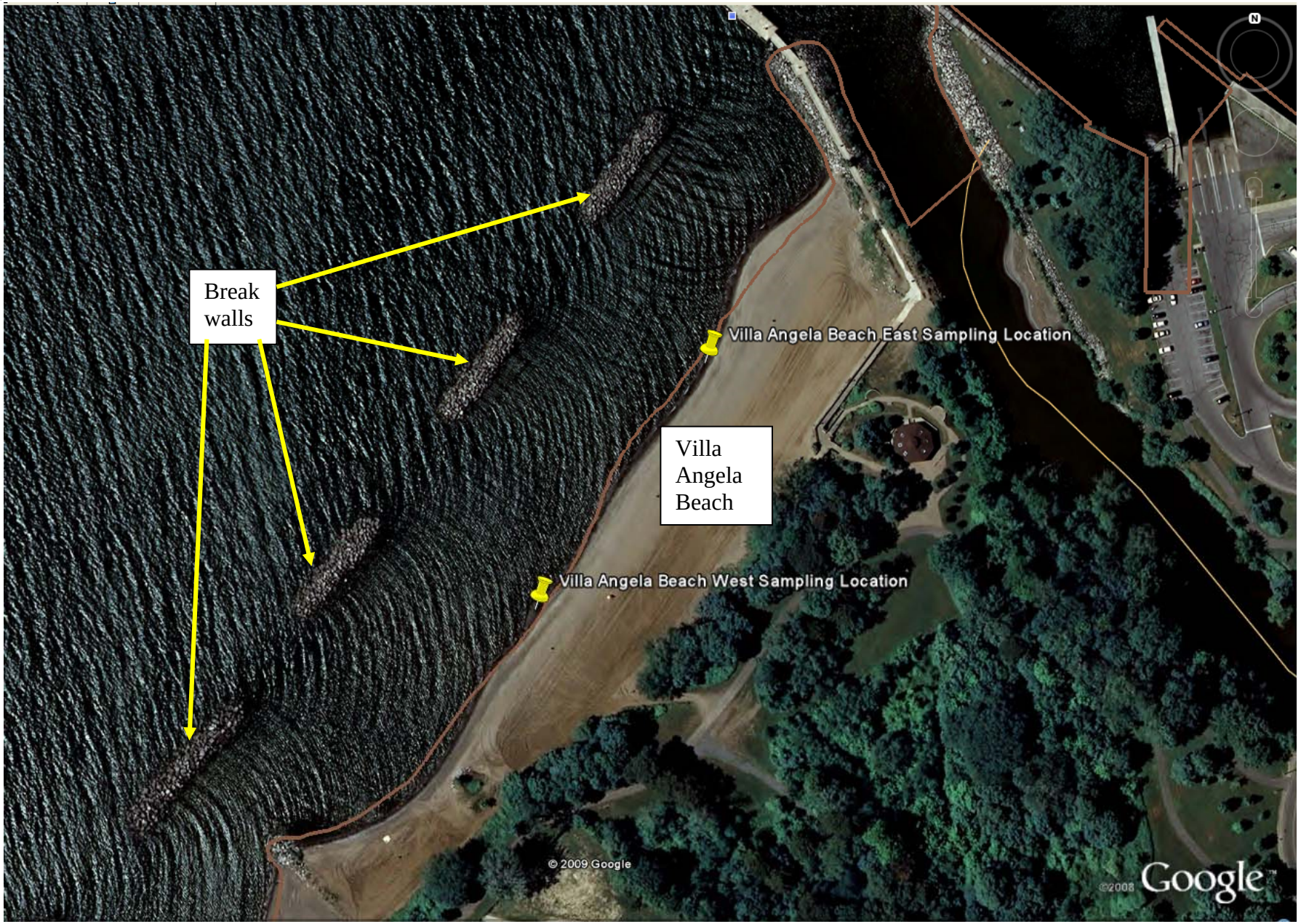


Figure 18. Map of Villa Angela Beach

**Figure 19. Villa Angela Beach:
Wave Height vs. Log of *E. coli* Density**

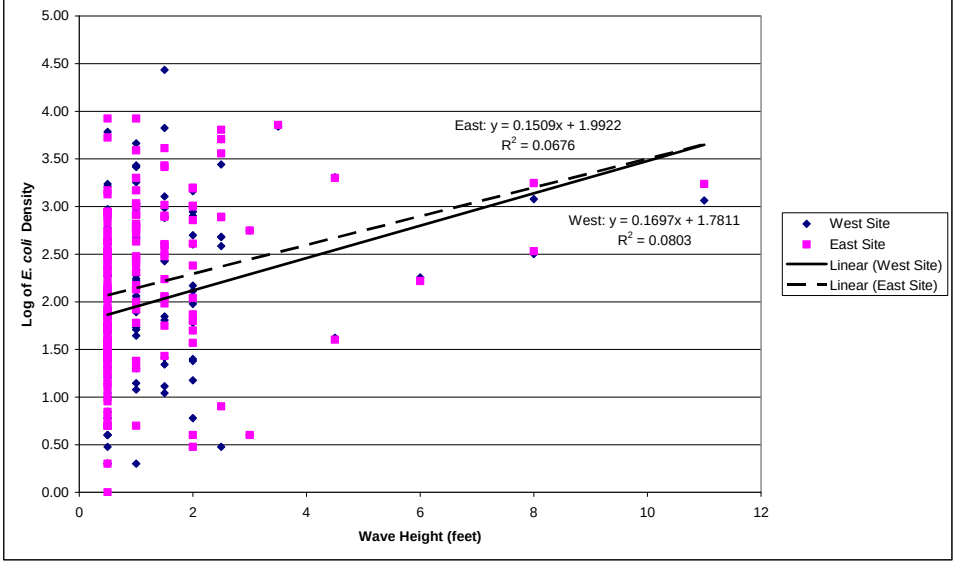
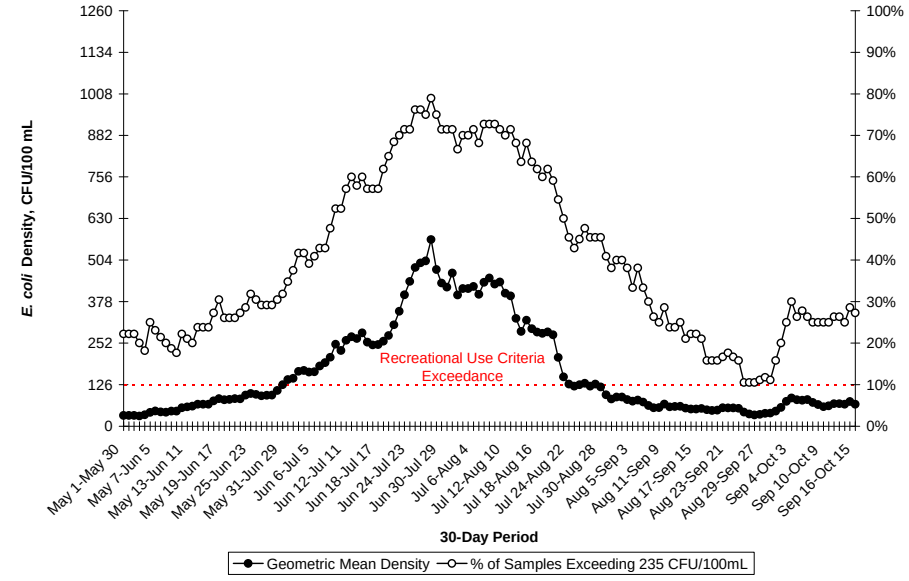
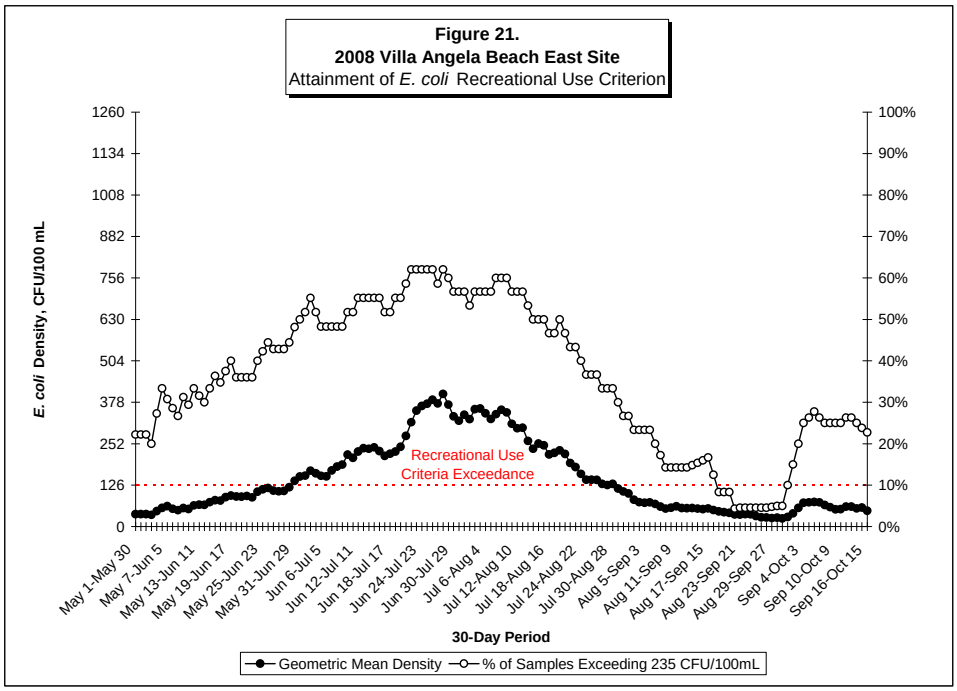


**Figure 20.
2008 Villa Angela Beach West Site**
Attainment of *E. coli* Recreational Use Criterion

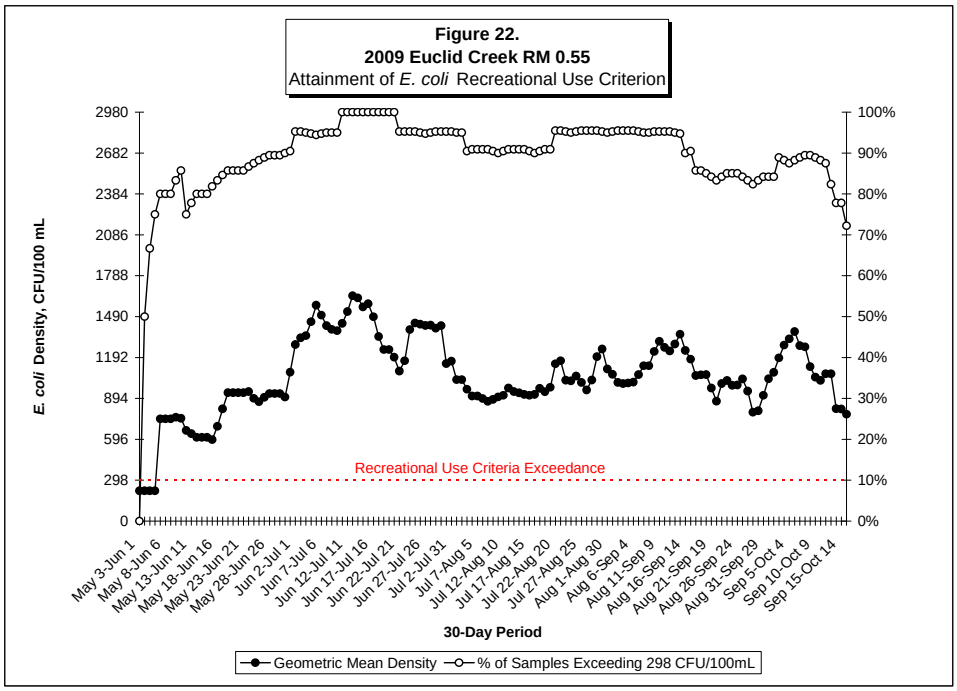


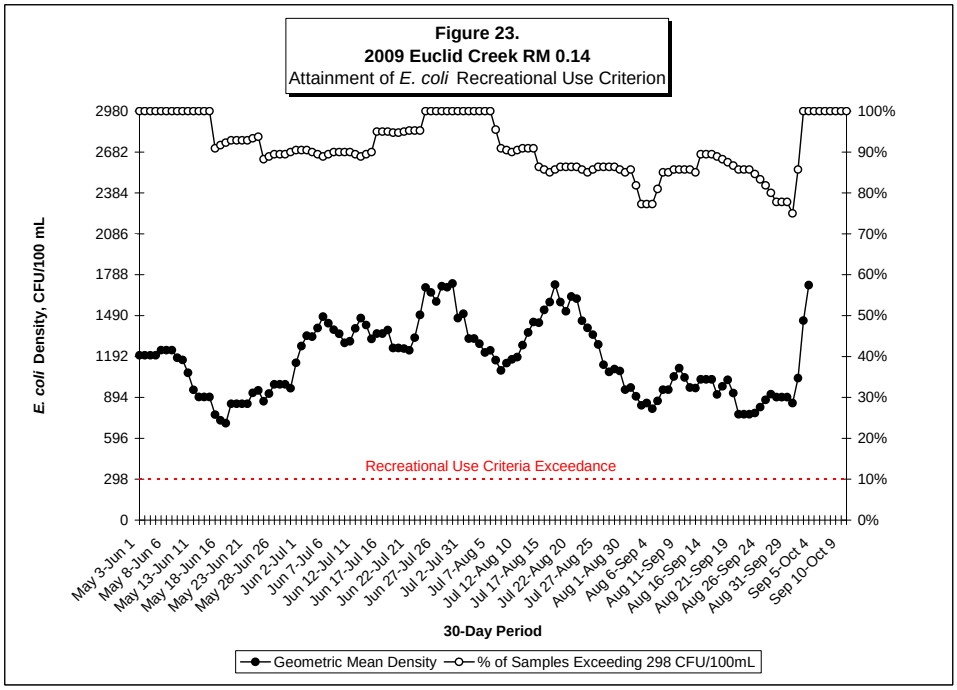


Euclid Creek

At Euclid Creek river mile (RM) 0.55, there was a total of 137 thirty-day periods[2] from May 3 to October 15, 2009. One thirty-day period (0.7%) was in attainment of the recreational use criterion for *E. coli*, while 136 thirty-day periods (99.3%) were in non-attainment (Figure 22).

At Euclid Creek RM 0.14, there was a total of 132 thirty-day periods[2] from May 3 to October 10, 2009. All thirty-day periods (100%) were in non-attainment of the criterion (Figure 23).





For nearly the entire 2009 recreation season, RMs 0.55 and 0.14 failed to meet attainment of the primary contact recreational use criterion for *E. coli* (Table 2). Again looking at wet weather occurrences in 2009, 28% of the recreation season was considered wet weather. Wet weather may cause CSO overflows and storm sewer runoff from non-point sources to enter the creek that may contain elevated bacteriological densities. There are four CSOs on Euclid Creek, but CSOs 239 and 209 are closest to the sampling sites.

(Figure 24). There were 28 overflows at CSO 239 and 2 overflows at CSO 209[α] during the 2009 recreation season (Table 3). Although these CSOs discharge to Euclid Creek, it is unknown if the overflow events had an impact on the water quality on Euclid Creek.

Discharges from storm sewers to Euclid Creek may also have an effect on *E. coli* densities at Euclid and Villa Angela Beaches. Investigations by WQIS personnel on Euclid Creek in 2005, 2006 and 2007 revealed at least six storm sewer outfalls just upstream of Euclid Creek RM 0.55 which had continuously elevated densities of *E. coli* entering the creek during dry weather.

Although CSO 239 discharges to Euclid Creek, bacteria that enter the creek through CSO 239 or storm sewer runoff during dry weather, may travel downstream eventually being released into Lake Erie. Once there, prevailing winds and currents may push the bacteria toward Euclid and Villa Angela Beaches and the sampling locations (Nevers et al. 2007). This idea can be supported with similar attainment percentages between Euclid Beach and Euclid Creek, as well as Villa Angela Beach and Euclid Creek. Thus, *E. coli* densities on Euclid Creek may impact *E. coli* densities, and thus attainment, at Euclid and Villa Angela Beaches.

Furthermore, because Villa Angela Beach is located closest to Euclid Creek, the Creek may be having a larger influence on bacteriological densities at Villa Angela Beach (Figure 25). Villa Angela Beach West had an average *E. coli* density of 664 CFU/100mL and 684 CFU/100mL for the East site; Euclid Beach West had an average *E. coli* density of 536 CFU/100mL and 503 CFU/100mL for the East site. Since Euclid Beach is located farther away from Euclid Creek, bacteria may not reach Euclid Beach in as high densities as seen at Villa Angela Beach, due to dilution and dispersion from currents. In the report titled "Interaction and Influence of Two Creeks on *Escherichia coli* Concentrations of Nearby Beaches: Exploration of Predictability and Mechanisms" (Nevers et al. 2007), it was discovered that *E. coli* contamination on creeks had the greatest affect 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. This report helps support the comparison of bacteriological data at Euclid Beach, Villa Angela Beach and Euclid Creek in 2009. However, other factors, such as sunlight which inactivates bacteria, should also be considered (Whitman et al. 2004).

[α] Estimated by NEORSD Sewer System and Maintenance Operations (SSMO) department.

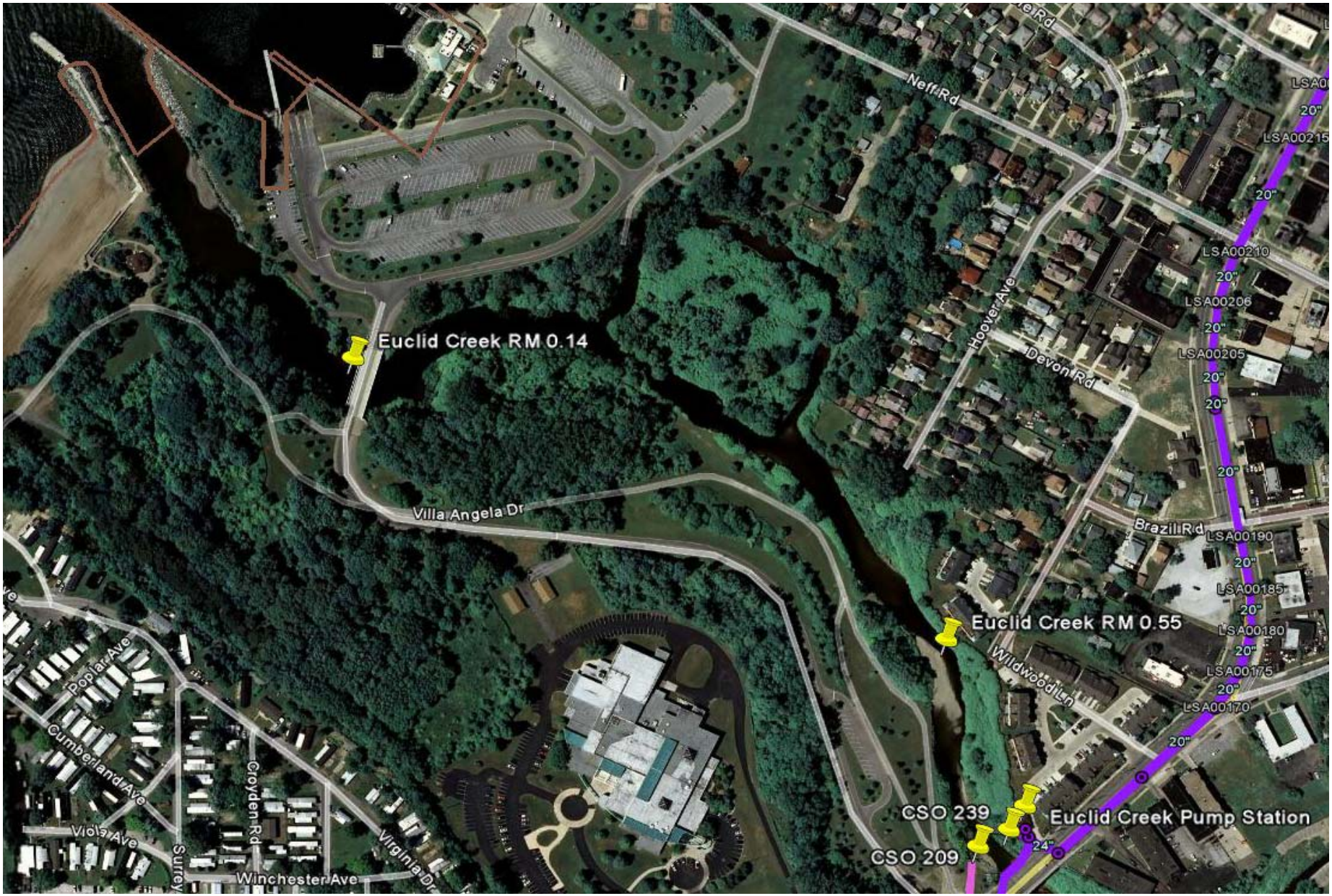
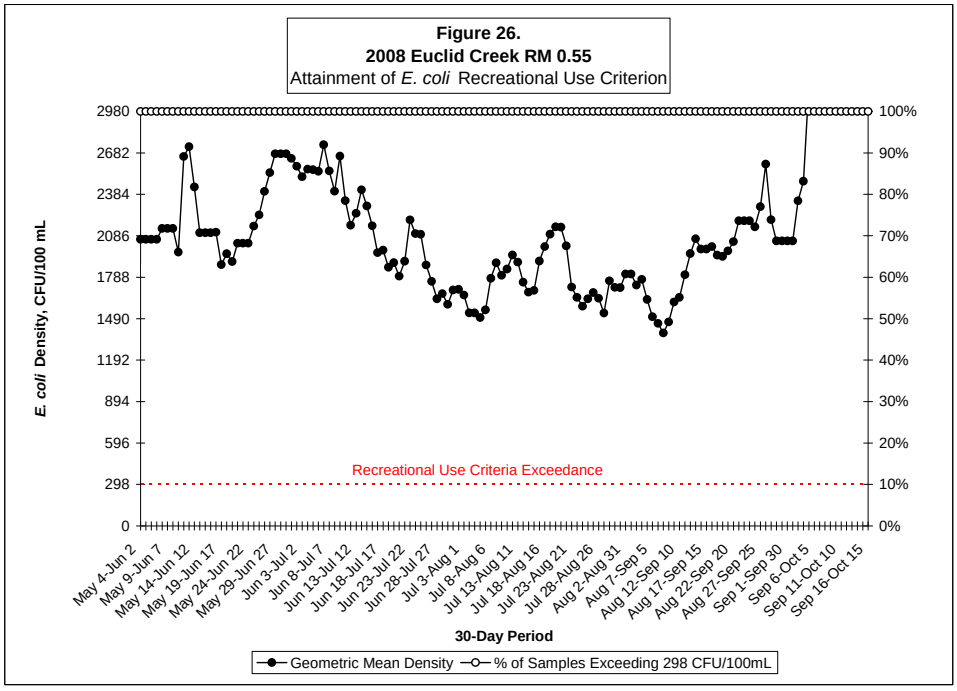
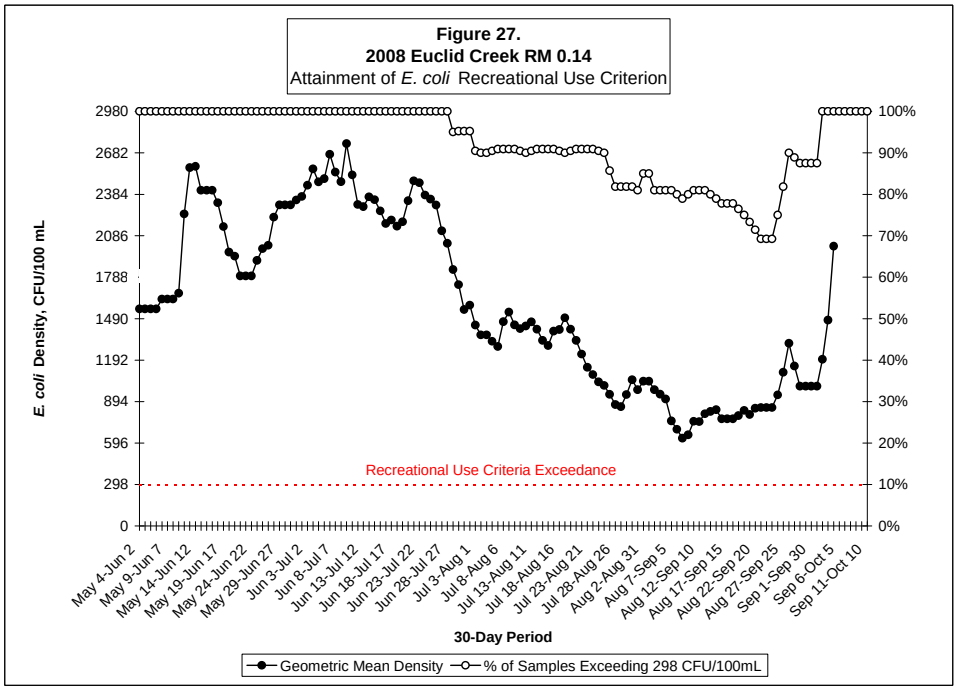


Figure 24. Map of Euclid Creek

Figure 25. Map of Euclid Beach, Villa Angela Beach and Euclid Creek

In 2008, Euclid Creek RM 0.55 had 136 thirty-day periods[2] with all thirty-day periods (100%) in non-attainment of the criterion (Figure 26). There was little change in the 2009 results, as 0.7% of the thirty-day periods were in attainment and 99.3% were in non-attainment. In 2008, Euclid Creek RM 0.14 had 131 thirty-day periods[2] with all thirty-day periods (100%) in non-attainment (Figure 27). There was no attainment at this site in 2009 as well. As is the case with all three beaches, there were more wet weather occurrences at Euclid Creek during the 2008 recreation season as compared to 2009 (Figure 28), but it does not appear to have affected attainment from year to year.





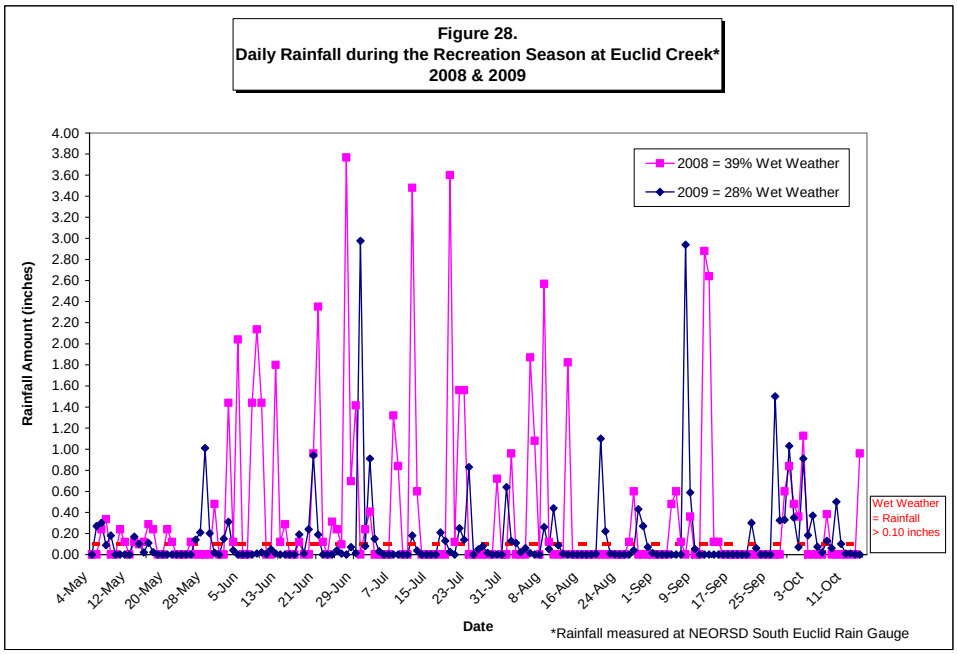


Table 2. 2009 Attainment & Non-Attainment Status of *E. coli* Criterion				
Beach	**Site**	**Thirty-day periods***	**% Attainment**	**% Non-Attainment**
Edgewater	West	139	9.4	90.6
Edgewater	East	139	0.0	100
Euclid	West	139	0.0	100
Euclid	East	139	0.0	100
Villa Angela	West	139	0.0	100
Villa Angela	East	139	0.0	100
Euclid Creek	RM 0.55	137	0.7	99.3
Euclid Creek	RM 0.14	132	0.0	100

*Based on not less than 5 samples collected within a thirty-day period.

Table 3. Number of CSO Overflows During 2009 Recreation Season			
CSO	**Location**	**Number of Overflows**	**Beach/ Creek Potentially Affected**
069	Upper Edgewater Beach	1	Edgewater
071	Harborview Drive and West 117th Street	1	Edgewater
002	NEORSD Westerly Water Pollution Control Center from the Combined Sewer Overflow Treatment Facility	7	Edgewater
001	Storm overflow at Easterly Wastewater Treatment Plant	14	Euclid Beach, Villa Angela

Table 3. Number of CSO Overflows During 2009 Recreation Season			
CSO	**Location**	**Number of Overflows**	**Beach/ Creek Potentially Affected**
206	North end of East 156th Street at Lake Erie	21	Euclid Beach, Villa Angela
242	East 142nd Street and Lakeshore Boulevard	8	Euclid Beach, Villa Angela
239	Lakeshore Boulevard at Euclid Creek	28	Euclid Beach, Villa Angela, Euclid Creek
209	West Side of Euclid Creek at Lakeshore Boulevard	2	Euclid Beach, Villa Angela, Euclid Creek

Table 4. 2009 Estimated Bird Counts		
Beach	**Site**	**Average Number of Birds**
Edgewater Beach	East	74
	West	138
Euclid Beach	East	16
	West	19
Villa Angela Beach	East	56
	West	10
Euclid Creek	RM 0.55	2
	RM 0.14	1

References

Kleinheinz, G.T., C.M. McDermott, V. Chomeau. 2006. Evaluation of Avian Waste and Bird Counts as Predicators of *Escherichia coli* Contamination at Door County, Wisconsin Beaches. Journal of Great Lakes Research 32(1): 117-123.

Nevers, M. B., R.L. Whitman, W.E. Frick., Z. Ge. 2007. Interaction and Influence of Two Creeks on *Escherichia coli* Concentrations of Nearby Beaches: Exploration of Predictability and Mechanisms. Journal of Environmental Quality 36(5): 1338–1345.

Whitman, R.L., T.G. Horvath, M.L. Goodrich, M.B. Nevers, M.J. Wolcott, S.K. Haack. 2001. Characterization of *E. coli* levels at 63rd Street Beach. Report to the City of Chicago, Department of the Environment and the Chicago Park District, Chicago, IL.

Whitman, R.L., M.B. Nevers, G.C. Korinek, M.N. Byappanahalli. 2004. Solar and Temporal Effects on *Escherichia coli* Concentration at a Lake Michigan Swimming Beach. Journal of Applied and Environmental Microbiology 70(7): 4276-4285.

Ohio Environmental Protection Agency. 2009. State of Ohio Water Quality Standards *Ohio Administrative Code* Chapters 3745-1-31, 3745-1-26, 3745-1-07. Revision: Adopted July 9, 2009; Effective October 9, 2009. Division of Surface Water, Standards and Technical Support Section. Columbus, Ohio.