

**Evaluating Beneficial Use:
Recreation**

F1. Background

Prior to the 2002 Integrated Report (IR), the reporting of recreation use (RU) impairment in Ohio was sporadic. Clean Water Act (CWA) Section 305(b) reports (1998 and earlier) may have included an indication of the potential for RU impairment in various streams, but a comprehensive listing of recreational use impairment was not included. The 2002 IR employed a uniform methodology to examine readily available data on fecal coliform counts. This approach was based on counting the number of exceedances of the secondary contact RU maximum criterion [5,000 colony forming units (cfu)/100 mL fecal coliform or 576 cfu/100 mL *Escherichia coli* (*E. coli*)]. Any assessment unit with five or more samples over the last five years above these values was listed as having an impaired RU.

The 2004 IR adopted a more statistically robust methodology for assessing the RU attainment of the state's surface waters linked more directly to the applicable water quality standards. The methodology adopted in 2004 continued to be used through the 2008 IR. The 2008 IR also included a preview of changes anticipated at the time for the 2010 report based on the expectation that the watershed assessment unit (WAU) would change from a larger watershed size (11-digit HUC) to a smaller watershed size (12-digit HUC) and on four anticipated revisions to the water quality standards: 1) dropping the fecal coliform criteria; 2) creation of a tiered set of classes of primary contact recreation waters based on RU intensity; 3) revision of the geometric mean averaging period; and 4) extension of the recreation season. Revisions to the water quality standards pertaining to the RU were adopted on December 15, 2009. The linkage of the methodology to the Ohio water quality standards (WQS) is summarized in Table F-1 and subsequent text. The RU assessment method employed in this report is essentially the same as used in the 2010, 2012 and 2014 reports.

Table F-1. Summary of the RU assessment methods.

Bathing Waters		
Indicator	Criterion (Table 7-13, OAC 3745-1-07)	Assessment Method Summary
<i>E. coli</i>	Seasonal geometric mean <i>E. coli</i> content* based on samples from the recreation season within a calendar year is 126 cfu/100 mL; single sample maximum is 235 cfu/100 mL.	Applied to the three Lake Erie assessment units, exceedance of the geometric mean bathing water criterion or an exceedance of the single sample maximum for more than 10 percent of the recreation season is considered an impairment of the bathing water use.
Primary Contact and Secondary Contact		
Indicator	Criterion (Table 7-13, OAC 3745-1-07)	Assessment Method Summary
<i>E. coli</i>	Seasonal geometric mean <i>E. coli</i> content* based on samples from the recreation season within a calendar year is as follows: Primary Contact Waters Class A: 126 cfu/100 mL Class B: 161 cfu/100 mL Class C: 206 cfu/100 mL Secondary Contact Waters All: 1030 cfu/100 mL	Applied to streams and inland lakes. Data from a recreation season are assessed on a site-by-site basis and compared to the applicable geometric mean <i>E. coli</i> criterion whenever more than one sample result is available for a WAU. Assessment units (AUs) are considered to be in full attainment if all sites assessed within the AU meet the applicable geometric mean criterion and in non-attainment if one or more sites assessed within the AU exceed the applicable geometric mean criterion.

**E. coli* concentrations are expressed in colony forming units (cfu) per 100 milliliters (mL)

F2. Evaluation Method

Lake Erie (Shoreline)

Attainment of the RU designation for the three Lake Erie assessment units (LEAUs) was based upon examination of *E. coli* data from public bathing beaches provided by the Ohio Department of Health (ODH). Routine bacteria monitoring is performed by local health districts, ODH and the Northeast Ohio Regional Sewer District (NEORS) in order to monitor bacteria levels at public bathing beaches and advise the public when elevated bacteria are present that represent an increased risk of contracting waterborne illness as a result of exposure to pathogens while recreating in the water. This monitoring takes place at 65 public beaches in eight coastal counties. The public can access the ODH Beachguard website to view beach advisory postings and bacteria monitoring data from monitored beaches at <http://publicapps.odh.ohio.gov/BeachGuardPublic/Default.aspx>. The website is updated daily during the summer recreation season.

Since 2006, beach advisory recommendations have been based upon exceedance of the single sample maximum *E. coli* criterion of 235 cfu/100 mL, consistent with provisions of the 2004 federal Beaches Environmental Assessment and Coastal Health (BEACH) Act rule as well as the *E. coli* criterion applicable for bathing waters in Ohio's water quality standards. Bacteria data collected by local or state health agencies at public beaches during the recreation season from 2011 through 2015 were included in the analysis. Ohio's water quality standards define the recreation season as May 1 through October 31, though Lake Erie beach monitoring typically is focused between the Memorial Day and Labor Day weekends.

Each of the 22 public beaches that have traditionally been sampled as part of the Lake Erie bathing beach monitoring program (Figure F-1) was individually analyzed to evaluate the percentage of recreation days during which the bathing water single sample maximum criterion of 235 cfu/100 mL was exceeded, since this is the criterion used by health departments to post a health advisory at a given beach. The frequency of beach advisory postings is a direct measure of RU impairment, since potential users may often be discouraged from utilizing a beach on days when a health advisory is posted or to avoid certain beaches altogether that are prone to frequent advisories. The locations of beaches in Erie and Sandusky Counties are depicted in Figure F-2, while those beaches located in Cuyahoga and Lorain Counties are depicted in Figure F-3.

As of October 1, 2013, there were 169 public access locations in the eight coastal counties along Ohio's Lake Erie coastline. These public access points do not all include a swimming beach, as some are for boat access, fishing access, parks, wildlife viewing areas, etc. The Ohio Department of Natural Resources (ODNR) publishes a Lake Erie Public Access Guide that can be accessed from this web address: <http://coastal.ohiodnr.gov/gocoast>. This report used data collected from 65 different beaches along the coast as depicted in Figures F-1 through F-3.

The total number of recreation days in a recreation season for any particular beach was determined by adding the number of days beginning with the first day of sampling and ending with Labor Day, or the date the final sample was collected (whichever was later). The total number of days that a beach exceeded the single sample maximum *E. coli* criterion of 235 cfu/100 mL during the recreation season (as defined above) was tallied. A measured exceedance was assumed to continue until a subsequent sample documented that the criterion was not exceeded. Similarly, a beach was presumed to meet the criterion following a measurement that met the criterion until a subsequent sample was found to

exceed the criterion. Sampling frequency varied from year-to-year and from beach-to-beach. A sampling frequency of four times per week was typical, though some beaches were sampled daily while the two beaches in the Lake Erie Islands AU were sampled only once per week.

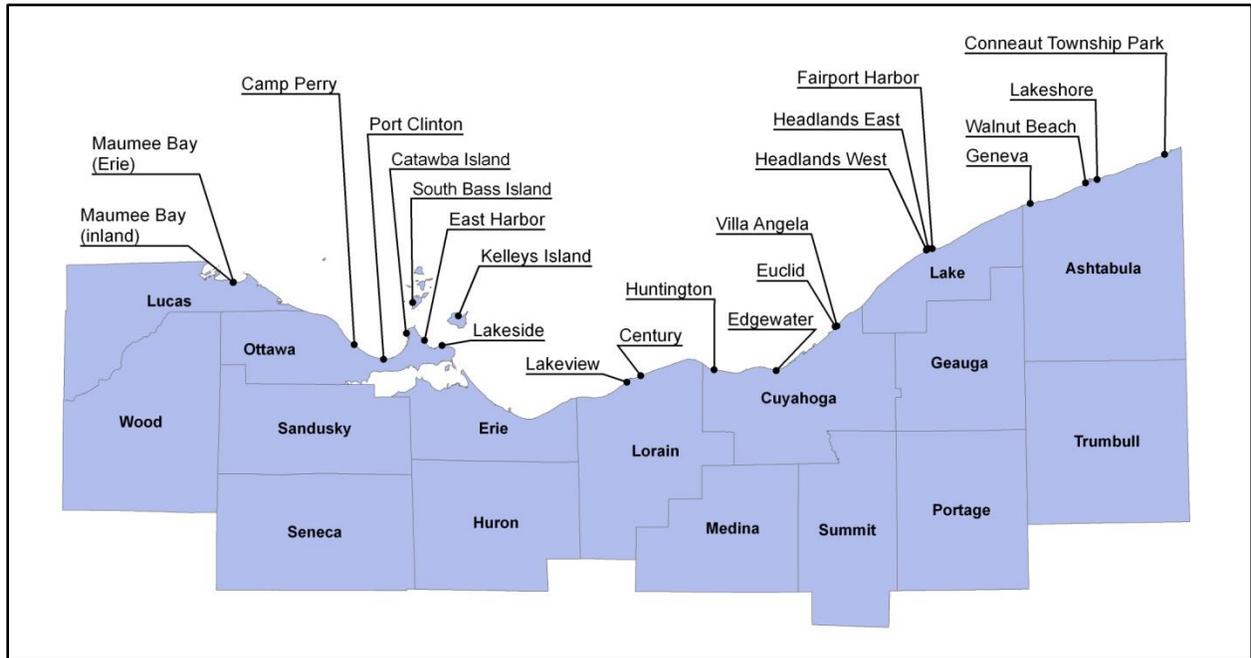


Figure F-1. Lake Erie public beaches sampled under Ohio's bathing beach monitoring program.

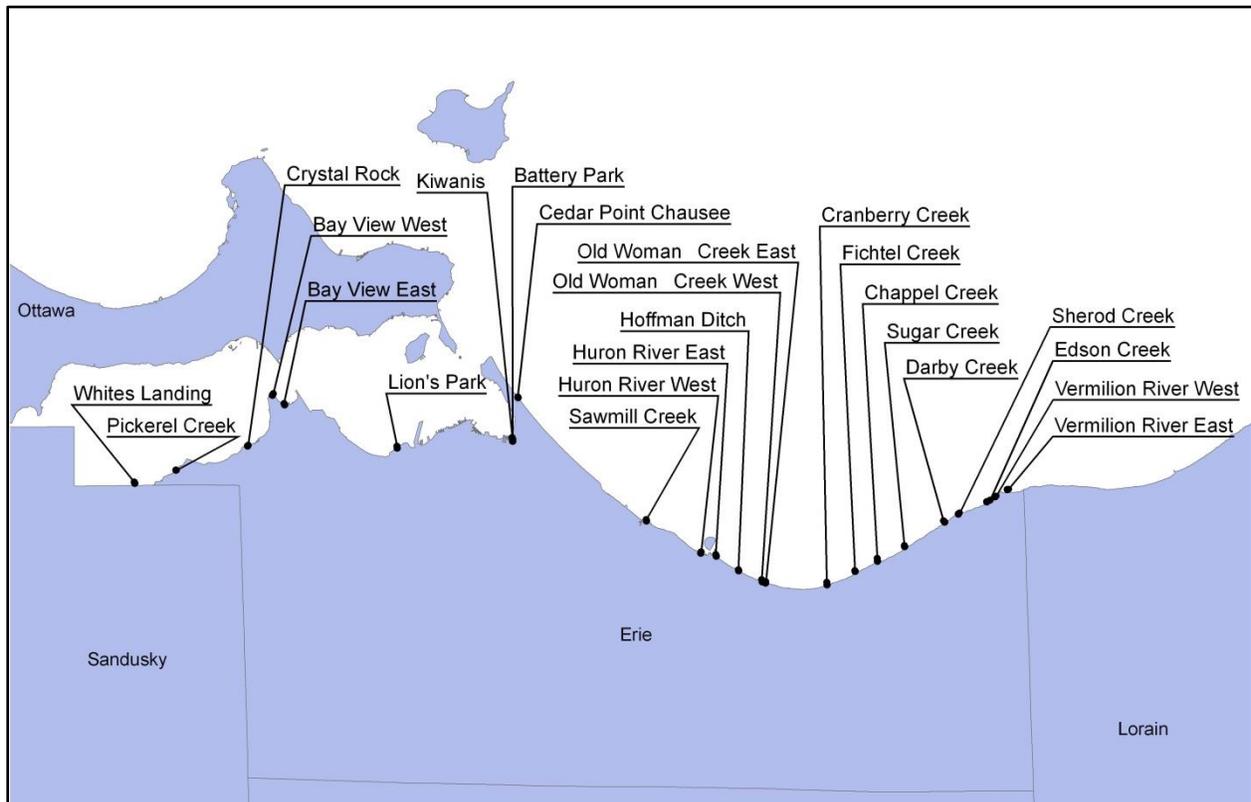


Figure F-2. Erie and Sandusky County public beaches sampled under Ohio's bathing beach monitoring program.

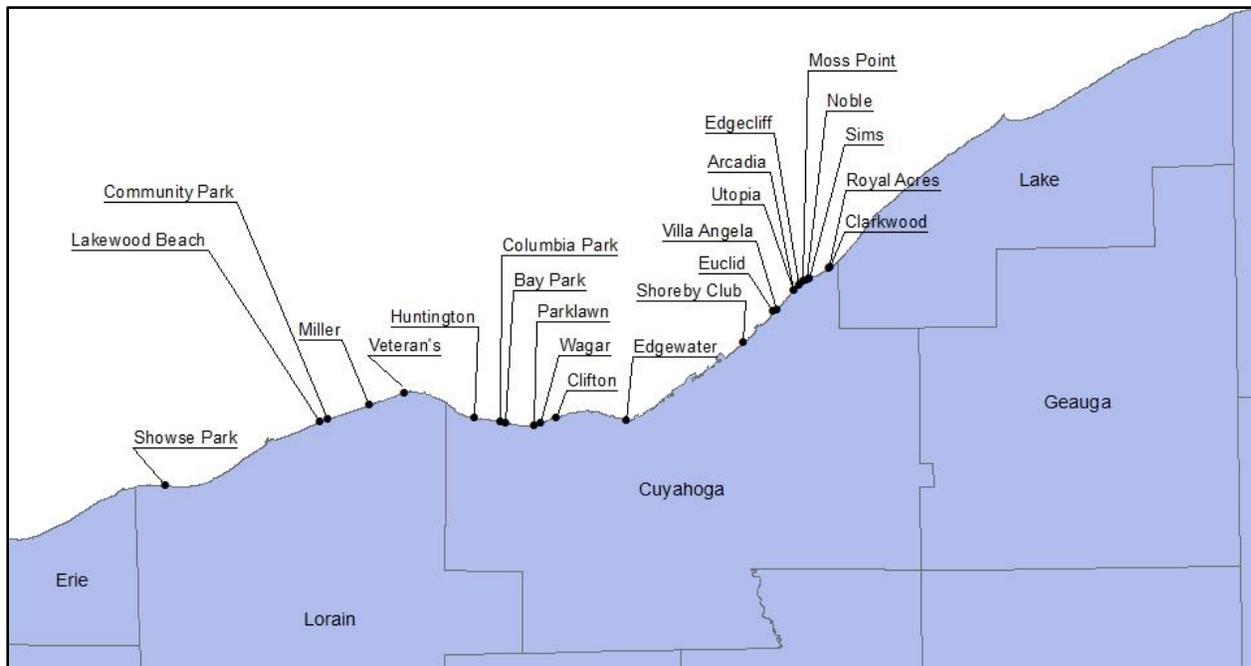


Figure F-3. Cuyahoga and Lorain County public beaches sampled under Ohio's bathing beach monitoring program.

The exceedance frequency of the bathing water criterion was determined for each beach over a five-year period (2011-2015) on an annual basis. Results for each individual beach were sorted into the corresponding LEAU for the purpose of determining the attainment status of each of the three LEAUs. The assessment status for each LEAU was based upon whether the frequency of exceedance of the single sample maximum *E. coli* criterion was greater than 10 percent of the recreation season, as described in the Table F-2 below.

Table F-2. Determining assessment status of Lake Erie shoreline AUs.

LEAU Status	Attainment Status of Individual Beaches
Full	Frequency of advisory postings less than 10 percent of recreation season for all of the beaches in the AU for all years assessed
Non	Frequency of advisory postings more than 10 percent of recreation season for one or more of the beaches in the AU for one or more of the years assessed

A 10 percent exceedance frequency was used as the threshold for attainment determination in the last five assessment cycles and has its origins in the water quality standards as well as Ohio's 1998 State of the Lake Report prepared by the Ohio Lake Erie Commission (Ohio LEC 1998). While the stated goal in the State of the Lake report for beaches is to have clean beaches all of the time (no days under advisement), the report considered having ten or fewer days under advisement to be "excellent" (note that ten days translates to 10 percent of the season based on a 100-day season). The Ohio Lake Erie Commission's latest edition of the State of the Lake Report (Ohio LEC 2004) continues to use these benchmarks in rating the swimmability of Lake Erie beaches along Ohio's 312-mile shoreline. The 2016 IR also continues to use these criteria in determination of impairment at the assessment unit level. In addition, statistical summaries are included in Tables F-5 and F-6 for individual beaches to provide more detail and allow performance comparisons among individual beaches.

Rivers and Streams

The 2016 RU impairment list was developed using ambient *E. coli* survey data collected from May 2011 through October 2015 by Ohio EPA as well as from ambient stream data provided by municipal dischargers that were collected at upstream and downstream monitoring stations relative to their primary discharge location as required by their National Pollutant Discharge Elimination System (NPDES) permit and reported in the Surface Water Information Management System (SWIMS) database. *E. coli* data from dischargers, while previously limited in quantity since permits had historically been based on monitoring for fecal coliform, has become more numerous as *E. coli* monitoring has replaced fecal coliform monitoring in most NPDES permits.

Approximately 18,400 *E. coli* bacteria records were evaluated in this analysis. Data were sorted into their respective 12-digit WAUs and large river assessment units (LRAUs) using a geo-spatial analysis of the latitude/longitude data (and other geographical data if needed) associated with each *E. coli* value. Data within a WAU were further sorted by sampling location and date (calendar year) on which they were collected. Figure F-4 demonstrates the sampling coverage that would be typical for part of a study area. In this case, there are five 12-digit WAUs depicted that drain to one LRAU, the Walhonding River. Each of the five WAUs was sampled in 2010 at one location (depicted by yellow dots) toward the downstream end of the primary tributary in the WAU. Four sampling locations (green dots) are dispersed along the 16-mile stretch of the Walhonding River depicted for an average sampling density of one site per four miles of river length for the Class A primary contact recreation water. Sites were generally sampled at least on five different occasions over the course the 2010 recreation season, though some sites were sampled more frequently.

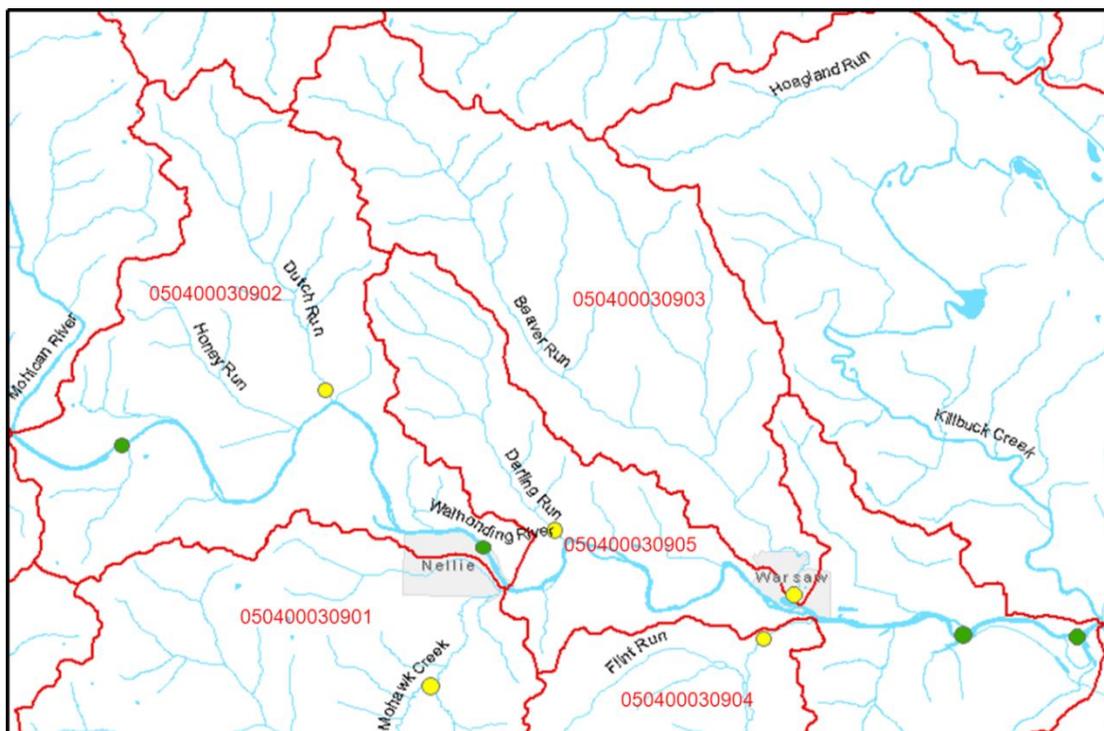


Figure F-4. Example of bacteria sampling locations, upper Walhonding River study area (2010).

RU assessment determinations for rivers and streams are based on the following two-step process: site-by-site analysis and assessment unit analysis.

Site-by-Site Analysis

E. coli data from each site were compared to the geometric mean *E. coli* criterion applicable to the particular site, considering the RU and class (for primary contact recreation or PCR). The geometric mean was calculated using the “geomean” function in Microsoft Excel 2010® on a site-by-site basis using the pooled dataset of all *E. coli* data (minimum of two data points required but typically composed of five samples) from the site during a single recreation season. When data were available for multiple recreation seasons, the data from each season were independently analyzed for each recreation season to determine the geometric mean for each season. Further details are listed as follows:

- Data collected outside of the recreation season as defined in Ohio’s WQS (May 1st through October 31st) were excluded from the analysis.
- Certain qualified values, such as sample results that exceeded proper holding time or those that have otherwise been indicated to have significant quality assurance deficiencies, were also excluded from the analysis.
- Values reported as “too numerous to count” (“TNTC”) were used in the analysis when it was possible to estimate a value based on the dilutions used and/or the maximum reporting limits.
- Values reported as “greater than” were also used in the analysis. A geometric mean calculated using one or more “greater than” or “TNTC” values in the data set was reported as a “greater than” geometric mean.
- Values reported as “less than” values of greater than 50 were excluded since acceptable test methods can detect much lower concentrations when appropriate dilutions are used in the analysis. Values reported as 50 or less were used in the analysis. The value used in statistical analysis was one-half the reported “less than” value. A value of one was substituted for the purpose of computing the geometric mean in any case where a value of less than one was reported. Geometric means cannot be calculated using data sets that contain a value of zero.
- Results from duplicate B were used for calculation of the geometric mean in cases where duplicate sample results were reported, except if the *E. coli* densities of the duplicate samples were more than five times apart from one another, in which case both values were rejected.

Assessment Unit Analysis

In the second step of the analysis, the assessment status of the WAU or LRAU was determined based on the attainment status of all the individual sites within the assessment unit and within the assessment period (2011-2015) as described in Table F-3 below.

Table F-3. Determining assessment status of WAUs and LRAUs.

AU Assessment Status	Attainment Status of Individual Locations
Full (Category 1)	Sufficient data exist to calculate a geometric mean for at least one location within the WAU (or a minimum of one site for every ~5-7 river miles of a LRAU); applicable geometric mean(s) attain applicable geometric mean criterion at all assessed sites within the AU
Non (Category 5)	Sufficient data exist to calculate a geometric mean for at least one location within the WAU (or a minimum of one site for every ~5-7 river miles of a LRAU); geometric mean(s) exceed applicable geometric mean criterion at one or more assessed sites within the AU
Insufficient Data (Category 3)	No data (category 3) or insufficient data (category 3i) to calculate a geometric mean for any site within the WAU (or for a minimum of one site for every ~5-7 river miles of a LRAU)

Inland Lakes

Inland lakes were assessed in a manner similar to that described above for the rivers and streams. Inland lake data were analyzed on a site-by-site basis, with each resulting geometric mean value compared to the geometric mean criterion applicable to each site. Lake sampling locations generally included a beach and/or open water location, with five to ten samples per location. Inland lakes are considered a component of the assessment unit(s) in which they are geographically located, so sample results from lakes may affect the assessment status of the AU(s) and the index scores for the AU(s).

ODNR, as part of Ohio's Bathing Beach Monitoring Program, monitors *E. coli* levels during the summer at public beaches of lakes located in state parks. While Ohio EPA was unable to establish the level of credibility of these data for use in official listing determinations for this report, a summary of the advisory postings for the 68 beaches monitored in the program is included in Table F-17. Though similar to the beach monitoring program along Lake Erie, there are several differences. Notably, the sampling frequency is much lower at the inland lake beaches compared to the Lake Erie beaches as a result of funding disparity. Secondly, because of the large geographic area, beach samples from inland lakes are analyzed by a multitude of consulting laboratories across the state.

RU Attainment Index Score

The RU attainment index score provides a way to compare the relative difference between the *E. coli* concentrations at sites sampled within an assessment unit and the RU geometric mean criterion that applies to each of the sampled sites. Those assessment units having *E. coli* concentrations that tended to be much greater than the applicable criteria had the lowest scores, while those assessment units having *E. coli* concentrations that attained the applicable criteria, or tended to only slightly exceed the applicable criteria, had the highest scores. An index score was assigned for each site having sufficient data to calculate a geometric mean (i.e., two or more samples) by comparing the geometric mean *E. coli* concentration at the site to the applicable geometric mean criterion based on the scale depicted in Table F-4.

Table F-4. Recreation index score matrix.

Site Geometric Mean	Index Score
Meets criterion	100
Exceeds up to 2x criterion	75
Exceeds more than 2x up to 5x criterion	50
Exceeds more than 5x up to 10x criterion	25
Exceeds more than 10x criterion	0

An average index score was computed for assessment units with multiple site index scores based on data from multiple sites and/or recreation seasons. Index scores are reported in Table F-11 for the LRAUs. When only one site index score was available for an AU, that index score was used to represent the assessment unit. The index score for the AU is based upon the same scale as described above for the index score for a particular site.

F3. Results

Using the methodology outlined in the previous section and available *E. coli* data collected from 65 public beaches along Ohio's Lake Erie 312-mile shoreline (14,294 samples); at hundreds of locations from Ohio's rivers and streams (11,450 samples) including nine of Ohio's largest rivers; and for 21 of Ohio's inland lakes (240 samples) results for the RU attainment analysis are presented in this section.

Samples used in this analysis were collected from 2011 through 2015 during the recreation season of May 1 through October 31.

F3.1 Lake Erie Public Beaches

Information about water quality conditions at Lake Erie public bathing beaches is summarized in Tables F-5 through F-8 and Figure F-5. The location of these beaches is shown in Figures F-1 through F-3. The methodology used for assessing the beaches along Ohio's Lake Erie shoreline is unchanged from the 2010, 2012 and 2014 reports.

Table F-5 contains the seasonal geometric mean *E. coli* levels for 17 public beaches along the coast of Lake Erie's western basin for the past five recreational seasons (2011-2015) while Table F-6 contains the seasonal geometric mean *E. coli* levels for 48 public beaches along the coast of Lake Erie's central basin for the past five recreational seasons (2011-2015).

The seasonal geometric mean *E. coli* criterion for bathing waters was exceeded at fourteen beaches in 2011, thirteen beaches in 2012, twenty-two beaches in 2013, eighteen beaches in 2014 and fifteen beaches in 2015. Six beaches exceeded the seasonal geometric mean bathing water criterion for the entire five year reporting period – Arcadia, Bay View West, Euclid State Park, Lakeshore Park, Lakeview and Villa Angela. Not surprisingly, these beaches had among the most days under a swimming advisory during the 2011-2015 reporting period. Highlighted cells in Table F-5 indicate impairment of the RU at a given beach in a given year. The table also indicates the number of beach advisories for each beach based upon exceedance of the single sample maximum *E. coli* criterion for beaches of 235 cfu/100 mL. This is the threshold that triggers the issuance of beach advisories and has been used since 2006. Use of the single sample maximum *E. coli* criterion for the purpose of issuing beach advisories complies with the federal Beaches Environmental Assessment and Coastal Health (BEACH) Act rule (*Water Quality Standards for Coastal and Great Lakes Recreation Waters*, 69 FR 67217, November 16, 2004), which became effective on December 16, 2004.

In Tables F-7 through F-9, the beaches are arranged alphabetically according to the LEAU in which they are geographically located. The table indicates the number of days (and the percentage for all years) when Ohio's Lake Erie public beaches exceeded Ohio's bathing water single sample maximum criterion compared to the total number of days in the recreation season sampling period.

As depicted in Figure F-5, the frequency with which individual beaches were recommended for a swimming advisory based on elevated bacteria levels above the state water quality standards for the entire five year reporting period (2011-2015) ranged from near zero at South Bass Island State Park and Battery Park beach to nearly 40 percent or more at Arcadia, Bay View West, Edson Creek, Euclid State Park, Lakeshore Park, Lakeview, Sherod and Villa Angela State Park beaches. Considerable variation in the frequency of advisories was observed between beaches and from season-to-season at many beaches. However, several beaches stand out as consistently good performers over the past several recreation seasons, including Battery Park, Bay Park, Catawba Island, Conneaut, East Harbor State Park, Kelleys Island, Lakeside and South Bass Island State Park, which all had a cumulative exceedance frequency under 10 percent. These beaches infrequently exceeded the goal of fewer than 10 days per season under advisement. There were also several beaches that performed consistently poor with four beaches including Bay view East, Edson Creek, Lakeview and Villa Angela beach under advisement approaching or over 50 percent of the time during the past five recreation seasons on a cumulative basis. High variation in bacteria levels was also seen between seasons for some beaches. For example,

Cranberry beach was under advisement for just six days in 2012, but under advisement for 34 days in 2013. Fichtel beach was under advisory eight days in 2012, but was under advisory for 32 days in 2013. The annual median number of days under advisement for all beaches by calendar year was highest in 2013 at 28 days compared to the rest of the reporting years, which had a median number of days under advisory ranging from 17-22 on an annual basis. The annual average geometric mean *E. coli* level for all beaches by year within this reporting cycle ranged from a low of 80.7 in 2011 to a high of 112.0 in 2014.

Impairment of the bathing water RU was determined by pooling data from beaches in each of the three LEAUs and calculating the percentage of days in the recreational season when the *E. coli* criterion was exceeded. A threshold of impairment was set at 10 days per season based upon the Ohio Lake Erie Commission's evaluation system (Ohio LEC 1998). This translates to a seasonal exceedance frequency of 10 percent, as the recreation season at Lake Erie's beaches in Ohio typically runs from Memorial Day weekend through Labor Day weekend. Results are shown in Table F-10. As in previous assessment cycles, the 2016 assessment results indicate that the Lake Erie Islands assessment unit fully supports the RU while the western basin and central basin assessment units do not support the RU. The overall total recreation days in exceedance of the bathing waters criterion on a percentage basis was 15.9 percent in the western basin (15 beaches) and 25.8 percent (48 beaches) in the central basin compared to just 3.1 percent for the Lake Erie Islands (two beaches).

Table F-5. Seasonal geometric mean *E. coli* levels and advisory postings at public Lake Erie shoreline beaches in the western basin.

Beach	2011		2012		2013		2014		2015	
	Seasonal geomean	number of days posted								
Battery Park	11	5	10	0	8	5	5	0	11	4
Bay View East	52	9	128	23	168	35	212	57	94	21
Bay View West	184	39	288	52	367	62	205	57	142	42
Camp Perry	200	16	481	48	42	9	155	14	84	26
Catawba Island	28	3	50	4	13	0	22	9	47	11
Crystal Rock	42	14	53	17	38	9	42	10	43	18
East Harbor	39	8	62	12	13	5	13	0	10	5
Kelleys Island	13	0	28	3	63	14	43	6	36	0
Kiwanis	67	7	108	24	145	25	98	20	141	44
Lakeside	12	5	8	0	17	4	15	1	12	7
Lion's Park	53	19	60	23	123	31	97	19	54	12
Maumee - Erie	50	16	65	22	97	35	105	40	167	45
Maumee - Inland	18	5	41	15	47	11	87	15	92	27
Pickrel Creek	45	18	83	18	53	12	36	10	68	24
Port Clinton	127	37	156	36	96	30	28	17	48	32
South Bass Island	5	0	7	0	10	4	6	0	7	2
Whites Landing	91	21	188	33	362	57	158	36	158	45

Shaded cells indicate impairment of the RU. Impairment is triggered by an exceedance of the geometric mean criterion on a seasonal basis (*seasonal geomean*) or if the single-sample maximum criteria (*SSM*) are exceeded more than 10 percent of the time during a season. The beach season is defined for this analysis as the time *E. coli* monitoring commences, typically in late May through the end of the Labor Day weekend. The number of days posted is determined by counting the number of days a criterion is exceeded. Days for which no monitoring data were collected are presumed to be in exceedance if the preceding day's bacteria level exceeded the criteria. Unmonitored days are presumed to meet the criteria when preceded by a monitored day that was below the criterion.

Table F-6. Seasonal geometric mean *E. coli* levels and advisory postings at public Lake Erie shoreline beaches in the central basin.

Beach	2011		2012		2013		2014		2015	
	Seasonal geomean	number of days posted								
Arcadia	189	30	362	56	141	34	209	34	279	39
Bay Park	25	13	42	7	31	14	40	2	59	13
Cedar Point	28	18	32	6	40	14	25	14	35	8
Century	44	18	45	14	36	15	61	33	110	34
Chappel Creek	47	23	16	12	137	46	160	50	110	27
Clarkwood	179	25	115	28	258	45	106	16	117	22
Clifton	81	24	100	28	67	25	112	28	49	22
Columbia Park	44	3	153	28	60	9	68	11	105	20
Community Park							105	41	108	29
Conneaut	29	14	20	3	52	21	32	8	24	3
Cranberry	17	9	18	6	54	34	40	28	39	20
Darby	111	32	33	13	182	40	242	66	86	30
Edgecliff	269	45	110	28	147	20	203	37	288	37
Edgewater	85	29	48	12	58	17	52	17	80	22
Edson	205	49	56	29	207	54	580	78	193	56
Euclid State Park	158	48	149	42	231	51	131	32	152	42
Fairport Harbor	57	18	66	18	83	26	77	23	96	28
Fichtel Creek	30	14	19	8	64	32	37	17	34	15
Geneva State Park	43	13	20	5	64	27	43	16	29	3
Headlands East	43	12	46	13	59	29	49	12	53	18
Headlands West	39	15	31	12	56	24	49	12	56	18
Hoffman Ditch	23	5	24	8	87	24	61	26	60	25
Huntington	62	13	54	11	71	26	52	34	68	30
Huron River East	51	14	43	16	72	29	62	18	57	28
Huron River West	96	40	70	15	119	46	102	38	161	28
Lakeshore Park	130	44	142	45	263	55	197	50	228	33
Lakeview	260	50	271	51	473	70	394	78	248	65
Lakewood Park							92	33	84	25

Beach	2011		2012		2013		2014		2015	
	Seasonal geomean	number of days posted								
Miller Beach			42	4						
Moss Point	182	34	108	40	140	33	200	30	113	21
Noble	98	30	91	28	131	35	296	37	96	25
Old Woman East	20	7	21	3	32	26	28	15	27	15
Old Woman West	17	2	20	5	59	26	72	24	56	24
Parklawn	49	19	38	21	42	9	46	6	47	9
Royal Acres	190	22	136	28	236	46	124	11	104	13
Sawmill Creek	61	5	55	18	72	30	34	17	42	11
Sherod Creek	114	36	75	27	156	41	217	65	89	49
Shoreby Club	88	26	48	21	68	14	77	9	90	14
Showse	37	22	17	11	62	32	73	33	44	24
Sims	150	34	111	28	214	52	328	32	184	32
Sugar Creek	69	28	28	13	180	58	104	52	60	30
Utopia	74	17	186	42	77	22	104	14	235	34
Vermilion East	47	20	45	18	129	39	109	41	65	26
Vermilion West	66	26	52	16	192	45	192	49	143	46
Veteran's Beach			40	15						
Villa Angela	195	57	127	44	231	55	160	40	231	54
Wagar	65	9	110	37	56	14	44	2	65	16
Walnut	16	14	29	8	29	11	32	15	16	14

Empty cells indicate no data were available for the beach during that year. Highlighted cells indicate impairment of the RU. Impairment is triggered by an exceedance of the geometric mean criterion on a seasonal basis (*seasonal geomean*) or if the single-sample maximum criteria (*SSM*) are exceeded more than 10 percent of the time during a season. The beach season is defined for this analysis as the time *E. coli* monitoring commences, typically in late May, though the end of the Labor Day weekend. The number of days posted is determined by counting the number of days a criteria is exceeded. Days for which no monitoring data were collected are presumed to be in exceedance if the preceding day's bacteria level exceeded the criteria. Unmonitored days are presumed to be below the criteria when preceded by a monitored day that was below the criterion.

Table F-7. The number of days per season (and the percentage for all years) when Ohio Lake Erie public beaches exceeded Ohio’s single sample maximum *E. coli* criterion compared to the total number of days in the sampling period, 2011 – 2015, for the Central Basin AU.

Beach	2011	2012	2013	2014	2015	All years (%)
Arcadia Beach	30/97	56/97	34/97	34/97	39/104	193/492 (39.2%)
Bay Park Beach	13/98	7/97	14/98	2/98	13/105	49/496 (9.9%)
Cedar Point Chausee	18/98	6/98	14/98	14/106	8/113	60/513 (11.7%)
Century Beach	18/98	14/97	15/98	33/106	34/113	114/512 (22.3%)
Chappel Creek	23/98	12/98	46/98	50/106	27/113	158/513 (30.8%)
Clarkwood Beach	25/97	28/97	45/97	16/96	22/104	136/491 (27.7%)
Clifton Beach	24/98	28/97	25/98	28/98	22/105	127/496 (25.6%)
Columbia Park Beach	3/98	28/97	9/98	11/98	20/105	71/496 (14.3%)
Community Park Beach				41/106	29/113	70/219 (32.0%)
Conneaut Township Park	14/98	3/78	21/98	8/102	3/92	49/468 (10.5%)
Cranberry Creek	9/98	6/98	34/98	28/106	20/113	97/513 (18.9%)
Darby Creek	32/98	13/98	40/98	66/106	30/113	181/513 (35.3%)
Edgecliff Beach	45/97	28/97	20/97	37/97	37/104	167/492 (33.9%)
Edgewater State Park	29/111	12/106	17/104	17/106	22/109	97/536 (18.1%)
Edson Creek	49/98	29/98	54/98	78/106	56/113	266/513 (51.9%)
Euclid State Park	48/112	42/106	51/104	32/106	42/109	215/537 (40.0%)
Fairport Harbor	18/99	18/106	26/100	23/102	28/112	113/519 (21.8%)
Fichtel Creek	14/98	8/98	32/98	17/106	15/113	86/513 (16.8%)
Geneva State Park	13/98	5/106	27/98	16/106	3/92	64/496 (12.9%)
Headlands State Park East	12/99	13/106	29/100	12/102	18/112	84/519 (16.2%)
Headlands State Park West	15/99	12/106	24/100	12/102	18/113	81/520 (15.6%)
Hoffman Ditch	5/98	8/98	24/98	26/106	25/113	88/513 (17.2%)
Huntington Beach	13/106	11/108	26/116	34/106	30/113	114/549 (20.8%)
Huron River East	14/98	16/98	29/98	18/106	28/113	105/513 (20.5%)
Huron River West	40/98	15/98	46/98	38/106	28/113	167/513 (32.6%)
Lakeshore Park	44/98	45/108	55/98	50/102	33/92	227/498 (45.6%)
Lakeview Beach	50/98	51/98	70/99	78/106	65/113	314/514 (61.1%)
Lakewood Beach				33/106	28/113	61/219 (27.9%)
Miller Beach		4/98				4/98 (4.1%)
Moss Point Beach	34/97	40/97	33/97	30/97	21/104	158/492 (32.1%)
Noble Beach	30/97	28/97	35/97	37/97	25/104	155/492 (31.5%)
Old Woman Creek East	7/98	3/98	26/98	15/106	15/113	66/513 (12.9%)
Old Woman Creek West	2/98	5/98	26/98	24/106	24/113	81/513 (15.8%)
Parklawn Beach	19/98	21/97	9/98	6/97	9/105	64/495 (12.9%)
Royal Acres Beach	22/97	28/97	46/97	11/97	13/104	120/492 (24.4%)
Sawmill Creek	5/98	18/98	30/98	17/106	11/113	81/513 (15.8%)
Sherod Creek	36/98	27/98	41/98	65/106	49/113	218/513 (42.5%)
Shoreby Club Beach	26/97	21/97	14/97	9/97	14/104	84/492 (17.1%)
Showse Park	22/98	11/98	32/98	33/106	24/113	122/513 (23.8%)
Sims Beach	34/97	28/97	52/97	32/97	32/104	178/492 (36.2%)
Sugar Creek	28/98	13/98	58/98	52/106	30/113	181/513 (35.3%)

Beach	2011	2012	2013	2014	2015	All years (%)
Utopia Beach	17/97	42/97	22/97	14/97	34/104	129/492 (26.2%)
Vermilion River East	20/98	18/98	39/98	41/106	26/113	144/513 (28.1%)
Vermilion River West	26/98	16/98	45/98	49/106	46/113	182/513 (35.5%)
Veteran's Beach		15/98				15/98 (15.3%)
Villa Angela State Park	57/112	44/106	55/104	40/106	54/109	250/537 (46.6%)
Wagar Beach	9/98	37/97	14/98	2/98	16/105	78/496 (15.7%)
Walnut Beach	14/98	8/106	11/98	15/102	14/92	62/496 (12.5%)

Table F-8. The number of days per season (and the percentage for all years) when Ohio Lake Erie public beaches exceeded Ohio's single sample maximum *E. coli* criterion compared to the total number of days in the sampling period, 2011 – 2015, for the Islands AU.

Beach	2011	2012	2013	2014	2015	All years (%)
Kelleys Island State Park	0/78	3/85	14/84	6/106	0/111	23/464 (5.0%)
South Bass Island State Park	0/78	0/85	4/84	0/106	2/113	6/466 (1.3%)

Table F-9. The number of days per season (and the percentage for all years) when Ohio Lake Erie public beaches exceeded Ohio's single sample maximum *E. coli* criterion compared to the total number of days in the sampling period, 2011 – 2015, for the Western Basin AU.

Beach	2011	2012	2013	2014	2015	All years (%)
Battery Park	5/98	0/98	5/98	0/106	4/113	14/513 (2.7%)
Bay View East	9/98	23/98	35/97	57/106	21/113	145/512 (28.3%)
Bay View West	39/98	52/98	62/97	57/106	42/113	252/512 (49.2%)
Camp Perry	16/78	48/89	9/84	14/64	26/113	113/428 (26.4%)
Catawba Island State Park	3/78	4/89	0/84	9/106	11/113	27/470 (5.7%)
Crystal Rock	14/98	17/98	9/98	10/106	18/113	68/513 (13.3%)
East Harbor State Park	4/78	12/91	5/84	0/106	5/113	30/472 (6.4%)
Kiwanis	7/98	24/98	25/98	20/106	44/113	120/513 (23.4%)
Lakeside	5/78	0/91	4/84	1/106	7/113	17/472 (3.6%)
Lion's Park	19/98	23/98	31/98	19/106	12/113	104/513 (20.3%)
Maumee Bay State Park (inland)	5/85	15/106	11/98	15/98	28/105	74/492 (15.0%)
Maumee Bay State Park (Erie)	16/85	22/106	35/98	40/98	45/105	158/492 (32.1%)
Pickereel Creek	18/98	18/98	12/98	10/106	24/113	82/513 (16.0%)
Port Clinton	37/78	36/91	30/84	17/106	32/113	152/472 (32.2%)
Whites Landing	22/98	33/98	57/98	36/106	45/113	193/513 (37.6%)

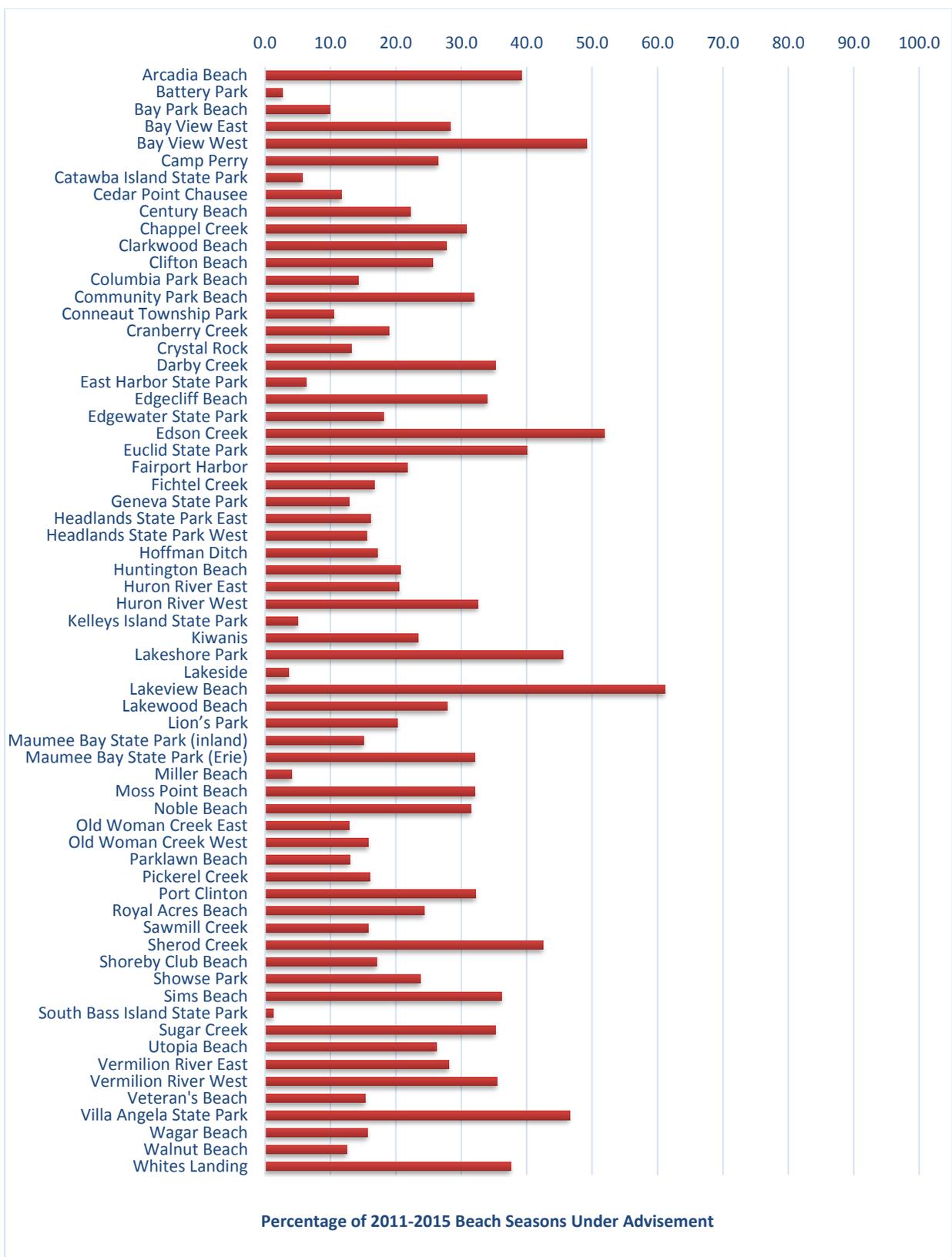


Figure F-5. Frequency of advisory postings at Ohio's Lake Erie public beaches.

Table F-10. Bathing water geometric mean *E. coli* exceedance frequency at 65 Lake Erie public beaches from 2011-2015 (pooled by LEAU to report use support).

	Western Basin	Central Basin	Lake Erie Islands
Number of beaches	15	48	2
Total recreation days	7,400	22,962	930
Total days in exceedance	1,549	5,926	29
Percentage of days in exceedance	15.9%	25.8%	3.1%
Average # of days <i>E. coli</i> criteria exceeded per beach per season ¹	20.9	26.2	1.0
Attainment status	Does not support	Does not support	Full support

¹Calculated by dividing the total days in exceedance in the basin by the total number of beach seasons in the basin. The total number of beach seasons in a basin is equal to aggregated sum of the total number of beaches for which monitoring was conducted during each season for the 2011-2015 reporting period.

F3.2 Rivers and Streams

Approximately 18,400 bacteria measurements were evaluated for the 2016 RU support analysis of streams, rivers and inland lakes in Ohio. Ohio’s RU support analysis is based on an examination of *E. coli* data collected in Ohio’s rivers, streams and inland lakes during the recreation season.

While the majority of the *E. coli* data used in previous assessment reports were collected by Ohio EPA, this is the first report in which the majority of the data used in the analysis has come from discharger generated data. This is a result of the transition from fecal coliform monitoring requirements to *E. coli* monitoring requirements in NPDES permits following the adoption of *E. coli* criteria in place of fecal coliform criteria in Ohio’s water quality standards in 2009. While few facilities were monitoring for *E. coli* shortly following the revised criteria, most facilities are now measuring and reporting *E. coli* values following the expiration of permit compliance schedules. As expected, the amount of data from NPDES sources has grown substantially. In this report, approximately 60 percent of the data are from NPDES dischargers while the remaining 40 percent was generated by Ohio EPA.

Table F-11 provides a summary of Ohio EPA’s RU monitoring effort and its translation to use assessment annually for the past five recreation seasons.

Table F-11. Annual Ohio EPA *E. coli* sampling effort and RU assessment (using Ohio EPA data) in Ohio streams, rivers and inland lakes, 2011-2015 recreation seasons.

	2011	2012	2013	2014	2015
number of samples collected by Ohio EPA	1,674	1,173	1,635	1,423	1,231
number of site geometric means computed	276	219	269	222	219
number of unique WAUs assessed	130	92	131	121	115
number of unique LRAUs assessed	3	5	2	1	0

The *E. coli* data used in this report from Ohio EPA was typically collected as part of routine ambient monitoring associated with annual drainage basin surveys conducted around the state. Using the methodology described in Section F2, it was possible to determine the RU attainment status of 697 of the 1,538 (45 percent) WAUs in Ohio based on current data (2011-2015). This figure includes those WAUs in which data were collected between 2011 and 2015, regardless of the category of the AU. Ohio has completed total maximum daily loads (TMDLs) for bacteria in 448 of the 1,538 WAUs in Ohio (29 percent).

On an annual basis, Ohio’s current effort typically allows the state to assess the RU of less than 10 percent of the WAUs in the state using data collected by Ohio EPA. At this rate, the maximum current assessment information that will be possible at any given time using Ohio EPA-generated data will be for about half of the state’s WAUs, assuming that there is no assessment duplication within any given WAU during any five-year data period and the sampling effort is limited to the minimal amount needed per WAU to make an assessment determination as described in Section F2.

Table F-12. Overall differences in the assessment of RU attainment, 2010-2016.

	2010 Report		2012 Report		2014 Report		2016 Report	
	Number	Percent	Number	Number	Number	Percent	Number	Percent
total AUs	1,576	100	1,576	100	1,576	100	1,576	100
assessed	487	31	588	37	680	43	713	45
not assessed	1,089	69	988	63	896	57	863	55
supporting use^a	65	13	88	15	130	19	73	10
not supporting use^a	422	87	500	85	550	81	640	90

^a Note: The percentage of AUs reported as supporting the RU and not supporting the RU are based on the total AUs that were assessed (e.g., 487 in the 2010 analysis).

The overall attainment and impairment rates and the changes between reporting years are summarized in Table F-12. Attainment and impairment rates in Table F-12 are based on the total number of watersheds for which sufficient data were available in the respective reporting cycle and not on the total number of assessment units in the state. For the 713 assessment units having sufficient data available to determine the RU assessment status in 2016, 10 percent fully supported the use while 90 percent did not support the use. These results are lower, almost half of the total supporting the recreational use in the 2014 cycle, but comparable to the results from previous cycles that consistently show that only a relatively small proportion of the state’s watersheds demonstrate full support of the RU.

Table F-13 contains *E. coli* RU geometric mean criteria attainment rates on an individual site basis for primary contact use Class A and Class B sites by year. While there does not appear to be any discernable trends, recreational use attainment on a site-by-site basis is typically around a quarter to a third of the assessed PCR Class A sites and around 15 percent to 30 percent for PCR Class B sites. Interestingly, the attainment rates are consistently higher for the past eight years for the Class A streams compared to the Class B streams, despite the fact that more stringent criteria apply to the Class A streams compared to the Class B streams. PCR Class C and secondary contact recreation sites were excluded from this table due to very limited sample size relative to the Class A and Class B sites.

Table F-13. Annual *E. coli* geometric mean criteria attainment rates by site.

RU ¹	Applicable Geometric Mean Criterion ²	Percentage of All Sites Attaining <i>E. coli</i> Geometric Mean Criterion by Recreation Season							
		2008	2009	2010	2011	2012	2013	2014	2015
PCR Class A	126 cfu/100 mL	37%	33%	30%	20%	30%	37%	28%	27%
PCR Class B	161 cfu/100 mL	30%	19%	17%	16%	24%	23%	17%	20%

¹ *E. coli* concentrations are expressed in colony forming units (cfu) per 100 milliliters (mL)

RU Attainment Index Score

Since assessment units can often be composed of monitoring sites having a range of *E. coli* geometric means and the range of impairment can be wide between assessment units, a RU index was developed to provide some differentiation between those assessment units composed of monitoring sites that

greatly exceed the criteria versus those where exceedances are comparably low. The index scores also serve as a useful tool in the TMDL prioritization process (see Section J1.1 for more details). Index scores were only assigned to those assessment units for which sufficient *E. coli* monitoring data were available to assess the RU support as described in Section F2. Index scores range from 0-100 depending on the magnitude of exceedance of the site(s) from the applicable criterion within the AU. An index score of 100 indicates that all sites sampled within the AU fully attained the applicable geometric mean *E. coli* criterion, while lower scores indicate a progressively greater average level of exceedance from the criteria for monitored sites within the AU. Figure F-6 summarizes the index scores for the WAUs. The median WAU index score for the 2016 reporting cycle slipped to 63, slightly lower than the median WAU index score of 70 for the 2014 reporting cycle and very similar to the medians of 63 and 65 for the 2012 and 2010 reporting cycles, respectively.

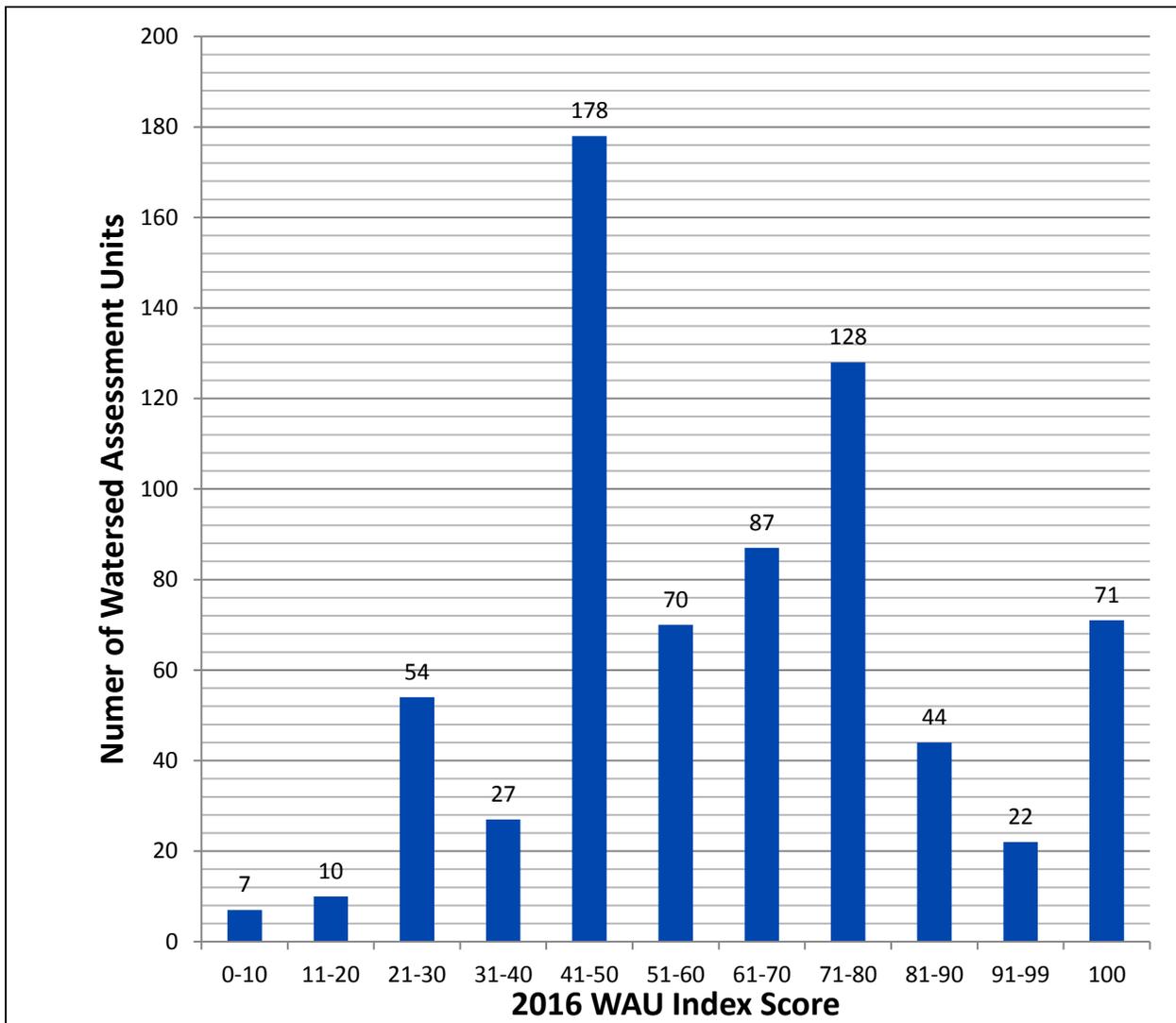


Figure F-6. Histogram of RU index scores for Ohio's WAUs.

The RU attainment status of Ohio's 1,538 WAUs is summarized in Table F-14. This table differs slightly from the summary presented in Table F-12 as this table accounts for those watersheds for which TMDLs have been completed and placed into category 4A and also include historic categorizations carried over from previous reporting cycles.

Table F-14. Summary assessment status of the RU in Ohio's WAUs by Assessment Cycle. See Table J-1 for assessment category descriptions.

Assessment Category	Number of Assessment Units Categorized				Percentage of Assessment Units Categorized			
	2010	2012	2014	2016	2010	2012	2014	2016
1	59	103	141	153	4%	7%	9%	10%
3	888	673	511	252	58%	44%	33%	16%
4	266	341	425	448	17%	22%	28%	29%
5	325	421	461	685	21%	27%	30%	45%
Total	1,538	1,538	1,538	1,538	100%	100%	100%	100%

There are also 23 large rivers in Ohio, eight of which are further divided into two or more subdivisions for a total of 38 large river assessment units. All of Ohio's large river assessment units are designated for Class A primary contact recreation with the exception of a portion of the Maumee River. Large river assessment units have drainage areas greater than 500 square miles and comprise in total 1,236 river miles in the state. The large river assessment units were analyzed independently of the WAUs through which they flow and LRAU data were not included in WAU assessments. Table F-15 summarizes the results of the analysis of *E. coli* data for the large river assessment units and the resulting RU support determinations and index scores. Sufficient data were available to determine the use support status for 17 of the 38 LRAUs (45 percent) in the 2016 reporting cycle, very similar to 16/38 or 42 percent of the LRAUs in the 2014 reporting cycle. These 17 LRAU subdivisions had an average spatial sampling frequency ranging from 2.9 to 7.6 stream miles. Ohio EPA would need to collect samples from 35 to 49 sites per year on large rivers (minimum of 175 to 245 samples) per year in order to be able to maintain up-to-date RU assessments and index scores for all of the LRAUs within the state.

The LRAU with the greatest sampling intensity in terms of sampling location frequency was the Stillwater River, with an average distance of 2.9 river miles between sampling stations. Of the 17 LRAUs having sufficient data to assess, three (Auglaize River, Sandusky River – Wolf Creek to Sandusky Bay, Scioto River – Paint Creek to Sunfish Creek) fully supported the use while the remaining 14 were not supporting the use. Three of the fourteen non-supporting LRAUs are in fact very close to reaching full attainment, having index scores of 90 or greater. The Little Miami River from O'Bannon Creek to the mouth had the lowest index score (40) followed by the Great Miami River from Fourmile Creek to the mouth (46) of all the index scores calculated for the 17 assessed LRAUs.

Table F-15. Summary assessment status of the RU in Ohio's LRAUs.

LRAU	Length (miles)	Number Sampling Stations	Avg Length per station (miles)	Index Score	Assessment Category
Auglaize River	12.86	3	4.3	100	1
Blanchard River	35.65	0	n/a	n/a	3
Cuyahoga River	25.34	6	4.2	67	4A
Grand River	41.28	0	n/a	n/a	4Ah
Great Miami River – Tawawa Creek to Mad River	48.93	6	8.2	n/a	5h
Great Miami River- Mad River to Fourmile Creek	43.10	4	10.8	n/a	5h

LRAU	Length (miles)	Number Sampling Stations	Avg Length per station (miles)	Index Score	Assessment Category
Great Miami River – Fourmile Creek to the mouth	38.38	6	6.4	46	5
Hocking River – Scott Creek to Margaret Creek	32.58	3	10.9	n/a	5h
Hocking River – Margaret Creek to the mouth	36.38	1	36.4	n/a	5h
Licking River	23.21	3	7.7	96	5h
Little Miami River – Caesar Creek to O’Bannon Creek	26.92	0	n/a	n/a	4Ah
Little Miami River – O’Bannon Creek to the mouth	24.00	5	4.8	40	4A
Mad River	18.38	4	4.6	81	5
Mahoning River	37.00	12	3.1	55	5
Maumee River – Indiana state border to Tiffin River	42.11	7	6.0	93	5
Maumee River – Tiffin River to Beaver Creek	34.44	8	4.3	97	5
Maumee River – Beaver Creek to Maumee Bay	31.32	8	3.9	86	5
Mohican River	27.58	1	27.6	n/a	5h
Muskingum River – Walhonding River to Licking River	34.94	0	n/a	n/a	5h
Muskingum River – Licking River to Meigs Creek	46.78	0	n/a	n/a	5h
Muskingum River – Meigs Creek to the mouth	29.42	0	n/a	n/a	5h
Paint Creek	39.17	1	39.2	n/a	5
Raccoon Creek	37.55	0	n/a	n/a	3i
Sandusky River – Tymochtee Creek to Wolf Creek	43.00	2	21.5	n/a	4Ah
Sandusky River – Wolf Creek to Sandusky Bay	22.73	3	7.6	100	1d
Scioto River – Little Scioto River to Olentangy River	32.70	2	16.4	n/a	3i
Scioto River – Olentangy River to Big Darby Creek	31.42	5	6.3	56	5
Scioto River – Big Darby Creek to Paint Creek	37.30	8	4.7	84	5
Scioto River – Paint Creek to Sunfish Creek	36.68	5	7.3	100	1
Scioto River – Sunfish Creek to mouth	26.82	0	n/a	n/a	3
Stillwater River	32.38	11	2.9	82	5
Tiffin River	19.67	4	4.9	69	5
Tuscarawas River – Chippewa Creek to Sandy Creek	30.12	3	10.0	n/a	5h
Tuscarawas River – Sandy Creek to Stillwater Creek	26.05	0	n/a	n/a	3
Tuscarawas River – Stillwater Creek to mouth	47.05	0	n/a	n/a	5h
Walhonding River	23.19	0	n/a	n/a	1h
Whitewater River	8.26	0	n/a	n/a	3
Wills Creek	44.06	9	4.9	78	5

F3.3 Inland Lakes

Data availability for inland lakes is relatively limited compared to that for streams and rivers. A total of 519 samples were collected from 46 different lakes in the period 2011-2015. Lakes were typically sampled at an open water location (L-1), with some larger lakes being sampled at multiple open water locations (L-2, L-3). Samples were collected at beach locations too for those lakes having a swimming beach. Samples were also collected at other locations of interest, such as boat ramps, marinas and water supply intakes. As Ohio’s inland lakes sampling program has been rejuvenated, there is more assessment data available compared to that reported in recent IR cycles. Still, the sampling effort at Ohio’s inland lakes remains relatively small compared to the monitoring resources for streams and rivers. ODNR maintains a sampling program at state park beaches and is described later in this section. Additional details on the inland lakes sampling program can be found in Section I2 of this report and on Ohio EPA’s web page at the following address: http://www.epa.ohio.gov/dsw/inland_lakes/index.aspx.

Table F-16 summarizes the assessment results for the RU of inland lakes at selected sample locations. These data were included as part of the assessment of the WAUs, they are reported below to provide an indication of the performance at individual lakes. Geometric means were generally found to be very low both at open water locations and at beach or other locations sampled. Based on the geometric means, the inland lakes sampled in 2011-2015 are attaining the applicable Class A and Bathing Water *E. coli* criteria at nearly all locations sampled, although it is notable that bacteria levels were observed to occasionally spike above the 235 *E. coli*/100 mL water single sample criterion typically used as the threshold for posting a swimming advisory at a beach.

Table F-16. Summary assessment status of the RU for inland lakes, 2011-2015.

Lake	Sample Location	Sample Year	Number of Samples	Geometric Mean	Maximum Value	Index Score
Alum Creek Lake L-1	Open Water	2013	5	11	20	100
	Open Water	2014	5	24	60	100
Alum Creek Lake L-2	Open Water	2014	4	40	290*	100
Archbold Reservoir #3	Open Water	2013	5	3	6	100
	Open Water	2014	5	4	16	100
Auglaize Power Reservoir	Open Water	2012	6	9	31	100
Barton Lake	Open Water	2013	5	2	3	100
	Open Water	2014	5	5	130	100
Burr Oak Reservoir	Beach	2011	5	47	100	100
Cambridge Reservoir	Open Water	2014	5	13	40	100
	Open Water	2015	4	7	5	100
Caesar Creek Lake	Boat Ramp	2011	5	<1	5	100
		2012	5	<1	1	100
	Beach	2011	5	4	17	100
		2012	5	5	101	100
	Open Water	2011	6	2	20	100
		2012	5	1	1	100
Caldwell Lake	Open Water	2011	5	25	260*	100
	Open Water	2012	4	91	3800*	100
	Beach	2011	5	118	1700*	100
	Beach	2012	4	116	6500*	100
Clendening Reservoir	Open Water	2012	2	<5	5	100
	Open Water	2013	5	10	10	100
Coe Lake	Open Water	2014	4	23	91	100
	Open Water	2015	4	14	72	100
Defiance Power Reservoir	Open Water	2012	6	12	46	100
Delta Reservoir	Open Water	2015	5	2	2	100
Deer Creek Lake	Open Water	2011	6	23	770*	100
	Beach	2012	4	12	20	100
Delphos Reservoir	Open Water	2014	5	2	8	100
	Open Water	2015	4	2	15	100
Evans Lake	Water Intake	2013	4	11	50	100
Findley Lake	Open Water	2012	5	6	12	100
	Open Water	2013	4	4	14	100
	Beach	2012	5	32	170	100
	Beach	2013	4	18	120	100
Forked Run Lake	Open Water	2015	7	16	50	100
Hargus Lake	Open Water	2011	5	14	30	100

Lake	Sample Location	Sample Year	Number of Samples	Geometric Mean	Maximum Value	Index Score
	Marina	2012	4	16	60	100
Hoover Reservoir L-1	Open Water	2013	4	32	500*	100
	Open Water	2014	5	23	200	100
Hoover Reservoir L-3	Open Water	2014	4	34	450*	100
Lake Hamilton	Water Intake	2013	3	8	69	100
Lake Olander	Open Water	2011	5	32	68	100
	Open Water	2012	5	26	56	100
Lake White	Open Water	2011	4	16	60	100
	Open Water	2012	4	<12	20	100
	Beach	2011	5	32	90	100
	Beach	2012	4	13	30	100
Madison Lake	Open Water	2011	6	26	60	100
	Beach	2012	4	13	30	100
McKelvey Lake	Water Intake	2013	4	9	28	100
McKarns Lake	Open Water	2013	5	2	3	100
	Open Water	2014	5	2	2	100
Meander Reservoir L-1	Open Water	2011	5	7	680*	100
	Open Water	2012	3	2	4	100
Meander Reservoir L-2	Open Water	2011	5	6	440*	100
	Open Water	2012	3	3	6	100
Meander Reservoir	Water Intake	2013	5	6	15	100
Metzger Reservoir	Open Water	2011	5	3	41	100
Mosquito Creek Reservoir L-1	Open Water	2013	4	9	30	100
	Open Water	2014	3	4	21	100
Mosquito Creek Reservoir L-2	Open Water	2013	4	4	5	100
	Open Water	2014	5	4	21	100
Mosquito Creek Reservoir L-3	Open Water	2013	4	5	10	100
	Open Water	2014	4	4	10	100
Mosquito Creek Reservoir at Dam	Open Water	2013	3	83	230	100
	Open Water	2014	4	23	190	100
Nettle Lake	Open Water	2013	5	3	8	100
	Open Water	2014	5	5	10	100
New Concord Reservoir	Open Water	2014	5	12	30	100
	Open Water	2015	5	8	10	100
Piedmont Reservoir	Open Water	2012	2	<7	10	100
	Open Water	2013	6	10	10	100
	Essex Bay	2013	5	14	30	100
Pike Lake	Open Water	2011	5	49	250*	100
	Open Water	2012	4	<7	20	100
	Beach	2011	5	92	380*	100
	Beach	2012	4	45	70	100
Ross Lake	Open Water	2011	5	9	20	100
	Open Water	2012	4	<10	20	100
Salt Fork Lake L-1	Open Water	2014	6	22	100	100
	Open Water	2015	5	31	350*	100
Salt Fork Lake L-2	Open Water	2014	6	10	10	100
	Open Water	2015	5	11	20	100
Senecaville Lake	Open Water	2014	6	13	50	100

Lake	Sample Location	Sample Year	Number of Samples	Geometric Mean	Maximum Value	Index Score
	Open Water	2015	4	26	40	100
Stonelick Reservoir	Open Water	2012	9	16	70	100
	Open Water	2013	5	28	5820*	100
Stewart Lake	Open Water	2011	5	25	110	100
Summit Lake	Open Water	2012	5	32	870*	100
	Open Water	2013	7	33	96	100
Tappan Lake	Open Water	2012	2	10	10	100
	Open Water	2013	5	11	20	100
	Beach	2012	3	506**	8400*	50
	Beach	2013	4	24	80	100
Van Wert Reservoir #2	Open Water	2014	5	2	5	100
	Open Water	2015	4	7	140	100
Veto Lake	Open Water	2015	3	15	70	100
Veto Lake-Plum Run Arm	Open Water	2015	8	59	2500*	100
Wallace Lake	Open Water	2014	4	33	110	100
	Open Water	2015	2	30	37	100
Waynoka Lake	Open Water	2015	5	6	28	100
	Beach	2015	3	18	44	100
Wellington Reservoir	Boat Ramp	2012	3	201**	740*	75
	Boat Ramp	2013	4	14	49	100
Wellington Reservoir	Open Water	2012	4	3	10	100
	Open Water	2013	5	2	6	100
Wills Creek Reservoir	Open Water	2014	5	25	100	100
	Open Water	2015	3	37	130	100
Winton Lake	Campground	2013	5	40	326*	100
	Campground	2014	5	43	1120*	100

*Value exceeds the single sample maximum bathing water criterion of 235 cfu/100mL.

**Value exceeds the geometric mean bathing water criterion of 126 cfu/100mL.

ODNR's Division of Parks and Recreation also conducts routine bacteria sampling of public bathing beaches at inland state park beaches pursuant to Ohio Revised Code sections 1541.032 and 3701.18. Advisory signs are posted whenever notified by the director of the Ohio Department of Health that the bacteria levels in the waters tested present a possible health risk to swimmers. Advisory postings are recommended whenever the *E. coli* density of a water sample exceeds the bathing water single sample maximum of 235 cfu/100 mL. Sampling frequency at the inland state park beaches is generally once every two weeks. This sampling frequency is much less intense compared to sampling frequency at many of the Lake Erie beaches, which is typically four or more days per week.

Table F-17 summarizes the advisory postings from 2011 through 2015 at 68 of the state's inland state park beaches. Beaches at which more than 10 percent of the samples collected over a recreation season exceeded 235 cfu/100 mL (the bathing beach criterion) are highlighted. The inland lake data from ODNR are presented in the IR for informational purposes and not for official use support determinations since the level of data credibility was indeterminate at the publication of this report. Its inclusion here is intended to notify readers of the existence of this sampling program for these popular recreational resources in Ohio and to provide some information as to the relative amount of data and relative water quality conditions with respect to bacteria indicators. Should Ohio EPA affirm the data as level 3 credible data in the future, it will be considered in the process for making official use support determinations.

Table F-17. Swimming advisory postings at Ohio's inland lake public beaches (2011-2015).

Park	Beach	County	2011 ^a	2012 ^a	2013 ^a	2014 ^a	2015 ^a	Total ^a
Alum Creek	Main	Delaware	8/57	4/60	2/10	3/10	2/9	19/146
	Camp	Delaware	1/36	--	0/9	2/10	1/8	4/63
Barkcamp		Belmont	0/4	0/8	1/8	0/8	0/12	1/40
Blue Rock		Muskingum	0/9	0/8	0/8	2/10	2/10	4/45
Buck Creek	Main	Clark	2/32	9/46	8/51	0/8	1/9	20/146
	Camp	Clark	0/15	0/12	0/5	0/9	0/8	0/49
Buckeye Lake	Crystal Beach	Fairfield	12/49	7/15	3/8	10/15	3/4	35/91
	Fairfield Beach	Fairfield	4/51	8/13	0/8	8/14	3/4	23/90
	Brooks Park	Fairfield	13/49	7/14	8/12	8/14	3/3	39/92
Burr Oak	Main	Athens	0/7	0/9	0/9	0/7	1/10	1/42
	Lodge	Athens	0/7	0/8	--	--	0/4	0/19
Caesar Creek	North	Warren	1/5	0/7	0/7	0/8	3/11	4/38
	South	Warren	1/5	1/8	6/10	3/9	1/11	12/43
Cowan Lake	Main (S)	Clinton	2/8	0/8	0/7	0/8	2/11	4/42
	Camp (N)	Clinton	1/7	0/8	0/7	1/9	1/10	3/41
Deer Creek		Pickaway	0/5	0/7	0/8	0/8	0/10	0/38
Delaware		Delaware	1/8	0/6	0/6	2/7	3/9	6/36
Dillon	Boaters	Muskingum	0/0	0/0	--	--	--	0/0
	Swimmers	Muskingum	2/9	2/10	4/10	5/12	6/11	19/52
East Fork	Main	Clermont	0/8	0/15	0/14	0/7	0/16	0/60
	Camp	Clermont	0/7	0/15	0/14	0/10	0/16	0/62
Findlay		Lorain	0/2	0/7	0/6	0/8	0/9	0/32
Forked Run		Meigs	0/4	0/8	0/8	0/7	2/12	2/39
Grand Lake St. Marys	Main East	Auglaize	6/49	2/37	1/7	2/10	2/9	13/112
	Main West	Auglaize	8/46	2/9	4/8	4/11	3/11	21/85
	Camp	Auglaize	8/49	2/36	1/7	3/10	1/9	15/111
	Windy Point	Auglaize	--	--	2/8	1/9	4/10	7/27
Guilford Lake	Main	Columbiana	0/6	1/7	1/7	1/8	0/7	3/35
	Camp	Columbiana	0/3	2/8	0/7	1/8	0/7	3/33
Harrison Lake		Fulton	0/0	0/0	0/3	1/9	1/10	2/22
Hueston Woods		Preble	0/5	0/3	1/12	2/13	1/9	4/42
Indian Lake	Fox Island	Logan	0/3	0/1	0/7	0/3	0/9	0/23
	Camp	Logan	0/3	0/1	0/7	0/3	1/9	1/23
	Oldfield	Logan	0/3	0/1	1/8	0/3	1/9	2/24
Jackson Lake		Jackson	1/8	0/8	1/6	1/9	2/10	5/41
Jefferson Lake		Jefferson	1/2	1/7	0/6	1/9	1/8	4/32
Kiser Lake		Champaign	0/1	1/7	0/7	2/8	2/9	5/32
Lake Alma	#1-West	Vinton	0/8	1/9	0/7	1/9	0/6	2/39
	#2-East	Vinton	1/8	0/8	--	--	0/4	1/20
Lake Hope		Vinton	0/8	0/8	2/8	0/7	0/8	2/39
Lake Logan		Hocking	2/11	0/8	0/8	1/11	0/8	3/46
Lake Loramie		Shelby	0/7	0/8	2/10	1/7	5/12	8/44
Lake Milton		Mahoning	1/7	0/7	0/5	2/11	0/8	3/38
Lake White		Pike	1/8	0/8	0/7	0/7	--	1/30
Madison Lake		Madison	1/7	5/9	1/7	1/9	6/12	14/44
Mosquito		Trumbull	1/6	0/8	3/8	0/7	3/9	7/38
Paint Creek		Ross	0/7	0/8	0/7	1/8	0/8	1/40
Pike Lake		Pike	0/8	0/8	1/8	--	2/7	3/31

Park	Beach	County	2011 ^a	2012 ^a	2013 ^a	2014 ^a	2015 ^a	Total ^a
Portage Lakes	Main	Summit	0/4	1/9	0/8	0/8	1/9	2/38
	Camp	Summit	0/4	0/7	0/8	0/8	1/4	1/31
Punderson		Geauga	0/0	0/3	0/1	0/5	0/7	0/16
Pymatuning	Main	Ashtabula	1/7	0/8	2/9	--	0/7	3/31
	Camp	Ashtabula	1/7	0/8	0/8	--	1/7	2/30
	Cabins	Ashtabula	0/5	0/8	0/8	--	0/6	0/27
Rocky Fork	North Shore	Highland	1/9	0/8	0/7	0/8	1/8	2/40
	South Shore	Highland	1/9	0/9	0/7	1/9	1/8	3/42
Salt Fork	Main	Guernsey	1/8	0/8	0/8	1/9	0/8	2/41
	Camp	Guernsey	0/8	0/8	0/8	0/8	0/8	0/40
	Cabins	Guernsey	0/8	0/7	0/8	0/8	0/8	0/39
Scioto Trail		Ross	5/12	6/13	0/6	6/11	1/8	18/50
Shawnee	Turkey Cr Lodge	Scioto	1/6	2/6	0/6	2/9	1/9	6/36
	Roosevelt-Camp	Scioto	2/8	1/5	1/6	--	0/6	4/25
Stonelick		Clermont	0/8	0/15	0/14	0/8	0/16	0/61
Strouds Run		Athens	1/6	0/8	0/8	0/7	2/10	3/39
Tar Hollow	Main	Ross	1/9	0/8	0/6	1/9	2/9	4/41
	Camp	Ross	1/8	0/8	2/9	0/9	1/8	4/42
West Branch	Main	Portage	1/10	0/10	1/5	2/12	0/8	4/45
	Camp	Portage	--	--	--	2/11	0/8	2/19
Wolf Run		Noble	0/0	0/0	0/8	0/7	0/8	0/23
Total Advisory Postings^a			96	65	59	85	81	386/ 3,113

^a Indicates the number of advisories posted, based on a measured *E. coli* density exceeding 235 cfu/100 mL, followed by the number of samples collected.

Beaches at inland state park lakes are tested for bacteria less frequently compared to those beaches along Lake Erie. Sampling was most frequent at Alum Creek Lake (2011-2012), Buck Creek Lake-main (2011-2013), Buckeye Lake (2011) and Grand Lake St. Marys (2011). Even at these beaches, the sampling frequency is roughly only half as intense as that of many Lake Erie beaches (Table F-7). The more intensive sampling that had been occurring at these beaches earlier in this reporting cycle tapered off during the later years of this reporting cycle.

The sample results in Table F-17 indicate that at most inland lake beaches, the bacteria criteria are not frequently exceeded, resulting in fewer postings compared to some of the beaches along Lake Erie. There were 45 inland lake beaches where the overall exceedance frequency was less than 10 percent for the five-year reporting period. Overall, the frequency of exceedances for all the inland lake beaches during the five-year reporting period was 12.4 percent, slightly higher than the 10.5 percent reported in the 2008-2012 reporting period. There were 23 inland lake beaches where the aggregated exceedance frequency was over 10 percent. The highest aggregated exceedance frequency of 42 percent was found at the Brooks Park beach at Buckeye Lake. Nine beaches exceeded the bathing water criteria over 25 percent of the time over the five-year reporting period total: Buckeye Lake Brooks Park, Fairfield and Crystal beaches; Grand Lake St. Mary's main beach (west) and Windy Point beaches; Dillon Lake swimmers beach, Caesar Creek (south beach), Madison Lake and Scioto Trail Lake. Sample results at some inland lake beaches indicated a need for posting an advisory much more frequently during certain years. For example, 67 percent of the samples collected during the 2014 recreation season at the Buckeye Lake's Crystal Beach exceeded the applicable single sample bathing water criterion. More frequent sampling, particularly at beaches where previous sampling data indicates an increased

likelihood of exceeding the recreation criteria, should be considered by beach managers so that the public can be adequately informed of actual water quality conditions at the time of their visit.