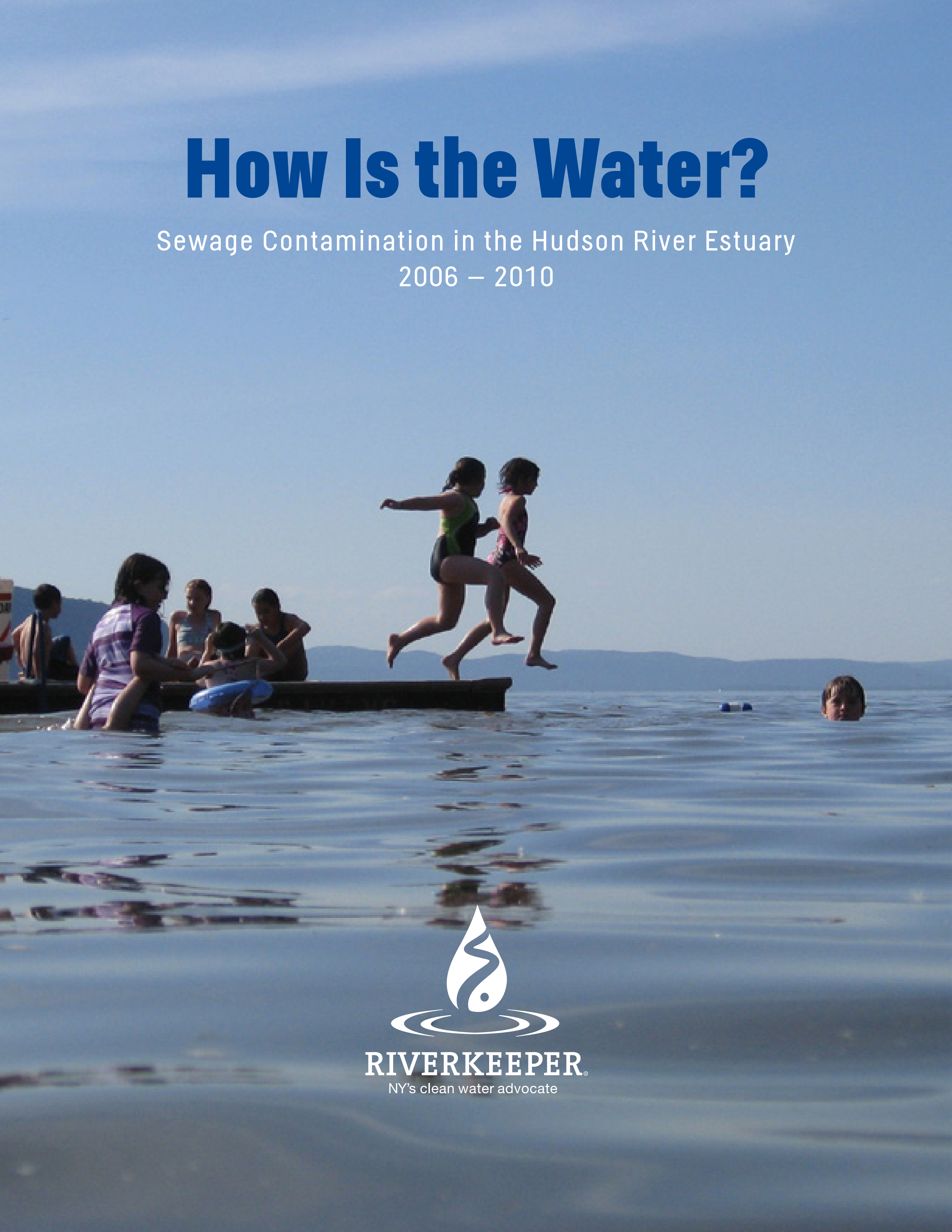
How Is the Water?

Sewage Contamination in the Hudson River Estuary
2006 – 2010



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Sewage Contamination in The Hudson River Estuary

Findings from
the Riverkeeper
Water Quality Study,
2006-2010

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Cover Photo: Swimming in Sleepy Hollow




How Is the Water?

The question Riverkeeper is most often asked when patrolling the Hudson is: "How is the water?"

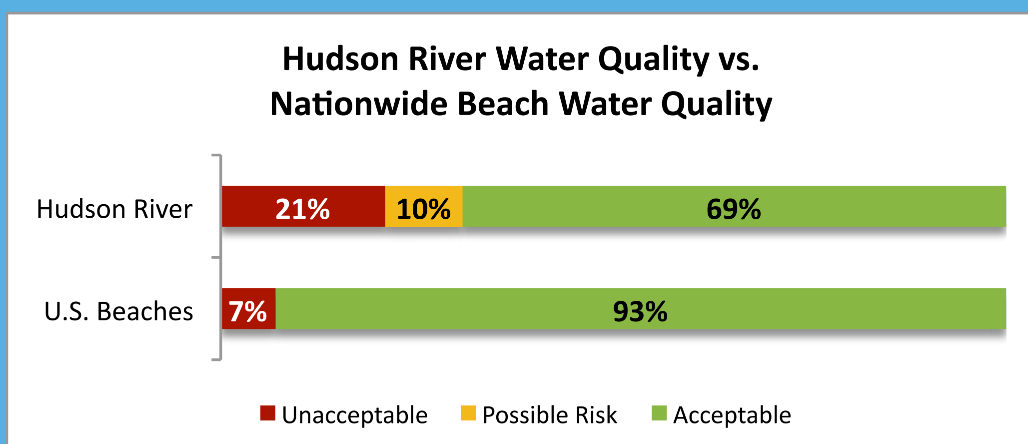
After five years of sampling, our quick answer is: "Not nearly good enough."

Since the late summer of 2006, we have collected approximately 2,000 samples from 75 set locations throughout the 155-mile long estuary. Our water quality study has found sewage contamination from New York Harbor to above the Troy dam.

Viewed as a whole, water quality in the Hudson failed the U.S. Environmental Protection Agency (EPA) guidelines for safe swimming 21% of the times we sampled. That is equivalent to 1½ days a week on average.[i]

By comparison, water quality samples collected at beaches nationwide (including ocean, bay and Great Lake beaches) failed the EPA safe swimming standard 7% of the times sampled over the same time period. [ii]

Figure 1: Hudson River compared with Beaches Nationwide: Percent Samples Unacceptable



Acceptable meets EPA single sample guideline for safe swimming. Unacceptable fails EPA single sample guideline for safe swimming. Possible Risk meets EPA single sample guideline but would fail geometric mean guideline if sustained over time.

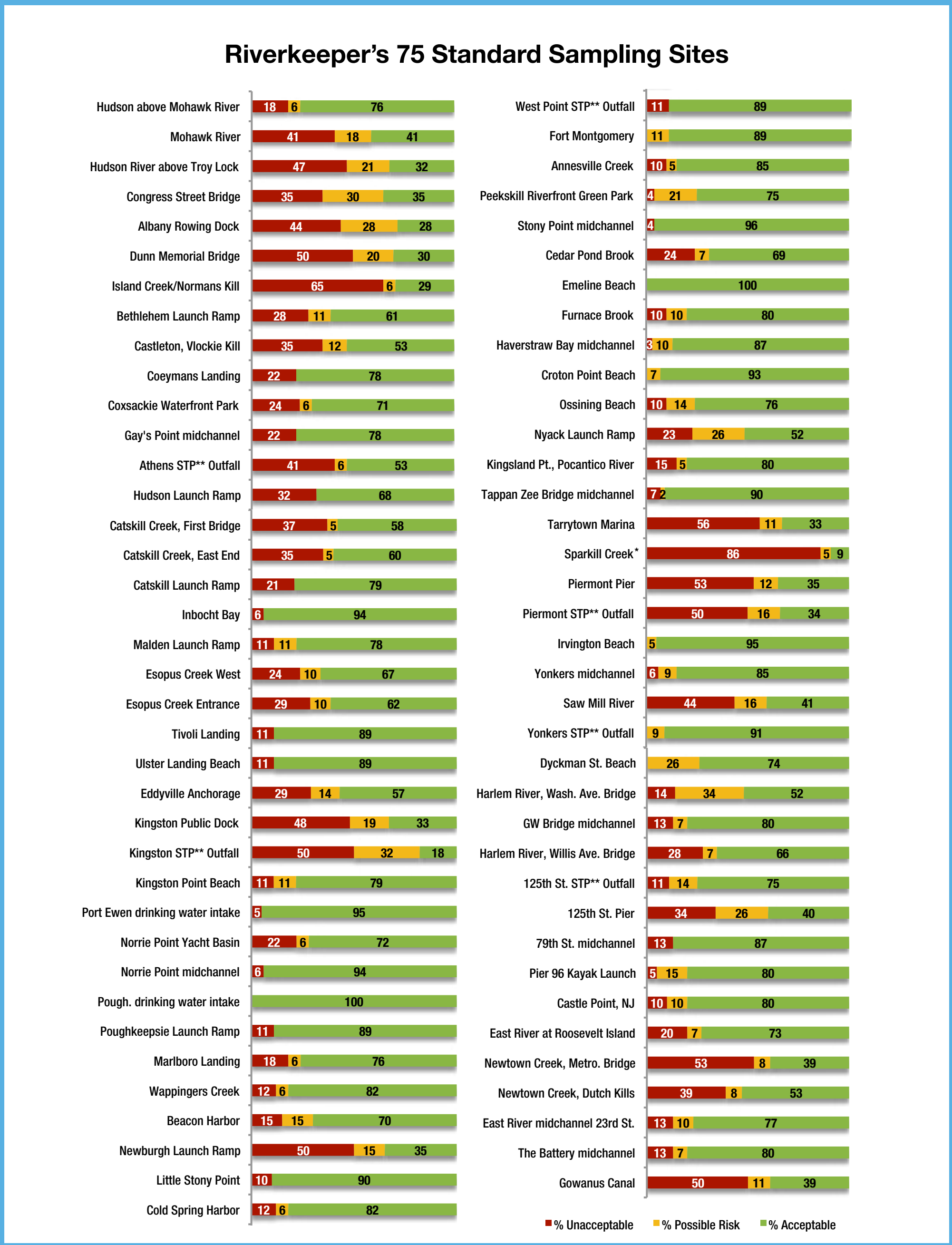
But people don't swim, or kayak, or go tubing, on an average day. They get in the water at a specific time and place. And those places are spread throughout the estuary – far outnumbering the four official swimming beaches designated in the estuary.

Our data clearly shows water quality varying widely location by location and day by day. Some of the most frequently contaminated sites are surprisingly close to some of the least contaminated ones. This suggests that there are many sources of sewage contamination – and that they can often be traced to a specific local source.

Local sources can often be remedied with local solutions.

Clockwise from top left: Swimmers in the Harlem River, in the Hudson at Sleepy Hollow, on the Coxsackie waterfront, and completing the annual "Swim For Life" swim across the Tappan Zee Bay

Figure 2: Site Findings: Percent of Samples Unacceptable, Possible Risk and Acceptable



*** Sparkill Creek is an inland site that is sampled more frequently**
**** STP = Sewage Treatment Plant**

Our findings highlight the need to greatly reduce the amount of sewage entering the Hudson. A frequency of sewage contamination 3 times the average at beaches nationwide is not acceptable.

The first critical step towards cleaner water is to inform the public about the scale of the problem. The strong response to the water quality information we share online, in emails and at public meetings shows that the public is extremely interested. A large and growing constituency enjoys the river and wants to make sure they're swimming in the cleanest water possible.

In this report, we share some of the patterns we are seeing in Hudson River water quality, highlight examples of sewage contamination, and call for specific actions that can help clean up the river we love.

"Swimmability"

Clean water has been and always will be an issue of great importance to the public. The Clean Water Act of 1972 was the result of public outrage over declining water quality. Since then, investments in our local wastewater infrastructure have gone a long way towards cleaning up our river. The Hudson River has undergone a renaissance as a destination for recreation, tourism and water sports.

While there are only four official swimming beaches on the Hudson, a New York State survey from 2000 confirms that the river has more than 100 unofficial sites.[iii] From our patrol boat we see people in the water along all 155 miles from NY Harbor to Troy.

So what determines whether water quality is safe? There are a number of factors such as currents, temperature, underwater hazards, turbidity and pollution. One of the most important factors is pollution from raw or partially treated sewage, which can carry disease-causing pathogens and parasites.

According to a report from the Natural Resources Defense Council, in 2009 seventy-four percent of beach closings and advisories were due to high levels of sewage contamination.[iv] That number has been rising as our population continues to grow and our wastewater infrastructure fails to keep pace with increasing demand.[v]

Each year more than 860 billion gallons of raw or partially treated sewage are dumped into U.S. waterways.[vi] New York City alone dumps 27 billion gallons of combined sewage and wastewater into its harbor each year.[vii]

[For information on waterborne pathogens and their health effects, see Appendix I.]

HELPFUL TERMINOLOGY

Effluent: The outflowing mixture of water and waste from a treatment plant, sewer, or outfall into a body of water.

Enterococcus ("Entero"): A sewage indicating bacterium that lives in the intestines of humans. See Appendix III for information on how Entero is used to assess water quality.

Geometric mean: A method for analyzing bacterial concentrations that dampens the effect of very high or very low values.

Pathogens: Any disease-causing microbe.

Predictive models: Creating a model to predict the probability of an outcome.

Tributaries ("tribs"): A stream or river that flows into a main stem, or primary downstream portion, of a river. Tributaries do not flow directly into the ocean.

Turbidity: A measure of the suspended solids in a solution, and an indicator of water quality.

Microbe/Microorganism (microbial): A microscopic organism, such as a bacterium, not easily observed without the aid of a microscope unless it occurs in a large colony consisting of many cells.

Sewage indicator: Any element that points to an input of sewage into a body of water.

Wastewater: Water that has been mixed with waste due to anthropogenic activity.

Watershed: The geographical area drained by a river and all of its tributaries.

You Can't Manage What You Don't Measure

There is little testing, or modeling and prediction, for sewage contamination in the Hudson River Estuary. Before Riverkeeper's study, there was no regular testing for sewage contamination that crossed county lines. While we collect eight samples a year at most stations, that's not frequently enough to tell the public where and when it's safe to swim. Our study has begun to uncover important patterns in water quality, but its most important finding may be the need for regular water quality monitoring of the Hudson.

Of the ten counties on the estuary, only four test for sewage contamination at their shorelines, and that testing is limited in scope and frequency.[viii] None of these report their findings to the public.

New York City has been collecting water quality data on New York Harbor since 1909. This record shows that over time, investments in NYC's wastewater infrastructure has led to improved water quality in New York Harbor. The NYC Department of Environmental Protection (DEP) publishes its findings once a year in the form of an annual report, but the raw data is not easily available and reports are only available after a delay of a year or two.[ix]

Despite this lack of critical data, the Department of Environmental Conservation (DEC) has classified Hudson River waters from north of the Bronx Borough line all the way to the northern end of Columbia County as acceptable for swimming.

The Clean Water Act mandated that the waters of the United States be swimmable and fishable by 1983 and that there be zero discharge of pollutants in our nation's waterways by 1985. New York State also set clean water goals, including that the Hudson River be swimmable by 2009. When that date passed, the state set a new goal for a swimmable Hudson by 2020, except following rainstorms.

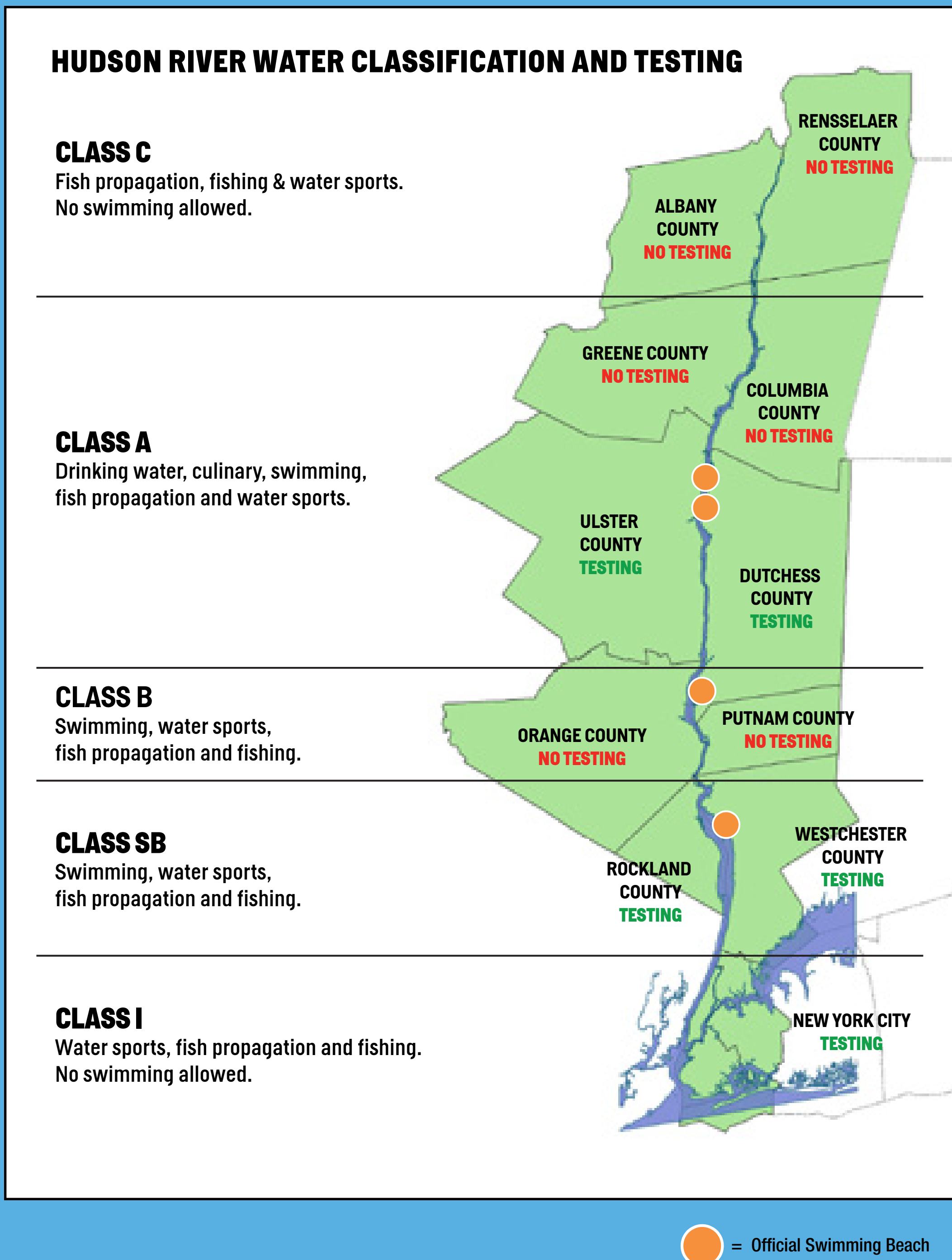
As a nation and as New Yorkers we have failed terribly to meet these goals. A critical step towards eliminating pollution sources is establishing a consistent and appropriate system for water quality testing.

It is very important to set national and local clean water goals. It's more important to achieve them. A critical step towards attaining our water quality goals is establishing a consistent and appropriate system for water quality testing. Without water quality data, pollution sources and impacts cannot be identified.

You can't manage what you don't measure.

[For other Hudson River pollutants see Appendix II.]

Figure 3: NY State Water Classification and County Water Quality Testing

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Riverkeeper's Water Quality Study

Riverkeeper started the Water Quality Program in 2006, its primary goal testing for sewage contamination. Other important variables that relate to water quality, such as temperature, salinity, turbidity and chlorophyll and oxygen concentrations are also measured.

Our Science Partners

This project is conducted in collaboration with scientists from Columbia University's Lamont-Doherty Earth Observatory and Queens College, City University of New York. Our Co-Principal Investigators, Gregory O'Mullan, Ph.D. and Andrew Juhl, Ph.D., contribute their expertise in environmental microbiology and oceanography to the project. They developed our testing protocol and oversee our field sampling, environmental sensor measurements and microbiological analyses.[x]

MEASURING SEWAGE CONTAMINATION

Riverkeeper tests for the sewage-indicating microbe of the genus *Enterococcus* ("Entero"). It is the only group of microbes recommended by the Environmental Protection Agency (EPA) for use as sewage indicators in both salt and fresh water - the Hudson River contains salt, fresh and brackish (mixed) water.

The EPA describes Entero in its testing guidelines as follows:

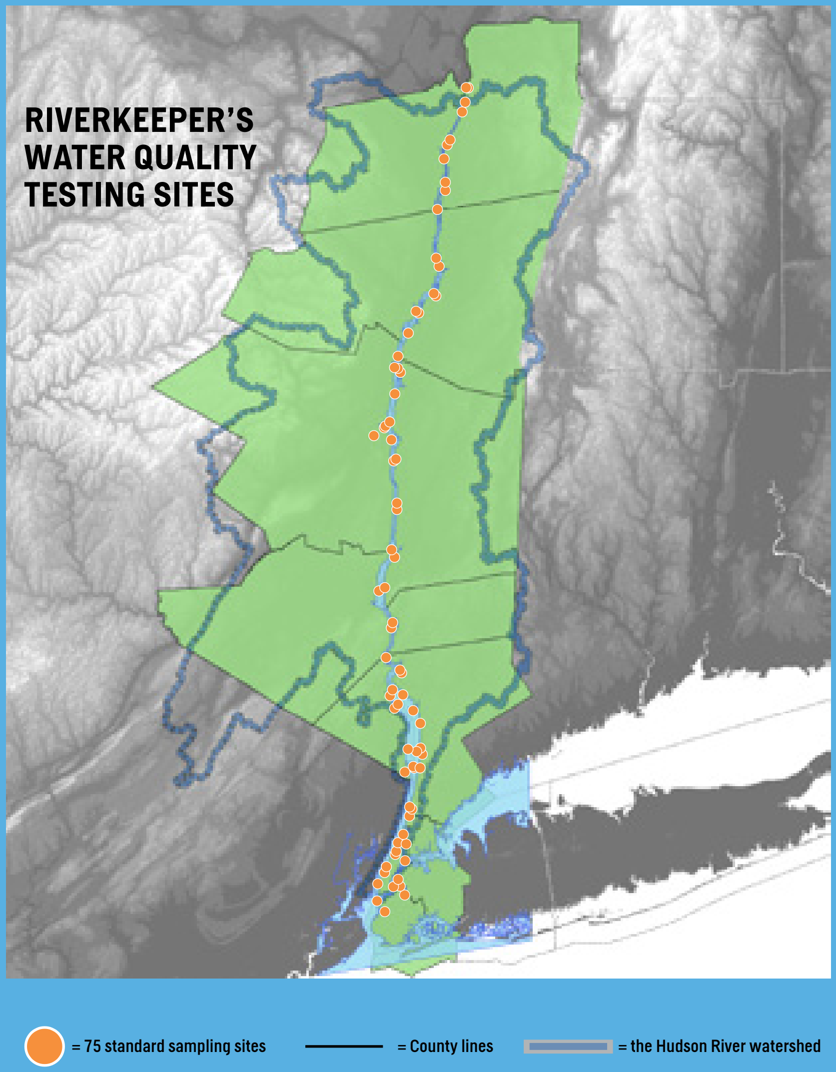
> "*Enterococci* are commonly found in the feces of humans and other warm-blooded animals. The presence of *Enterococci* in water is an indication of fecal pollution and the possible presence of (pathogens found in intestines)." [xi]

We have based our assessment of water quality on the EPA federal guidelines outlined in the 2000 Beaches Environmental Assessment and Coastal Health (BEACH) Act. [xii]

[See Federal Guidelines for *Enterococcus* in Appendix III]

Clockwise from top left: Sampling water quality from the Riverkeeper patrol boat, Andy Juhl, Carol Knudson, John Lipscomb and Greg O'Mullan

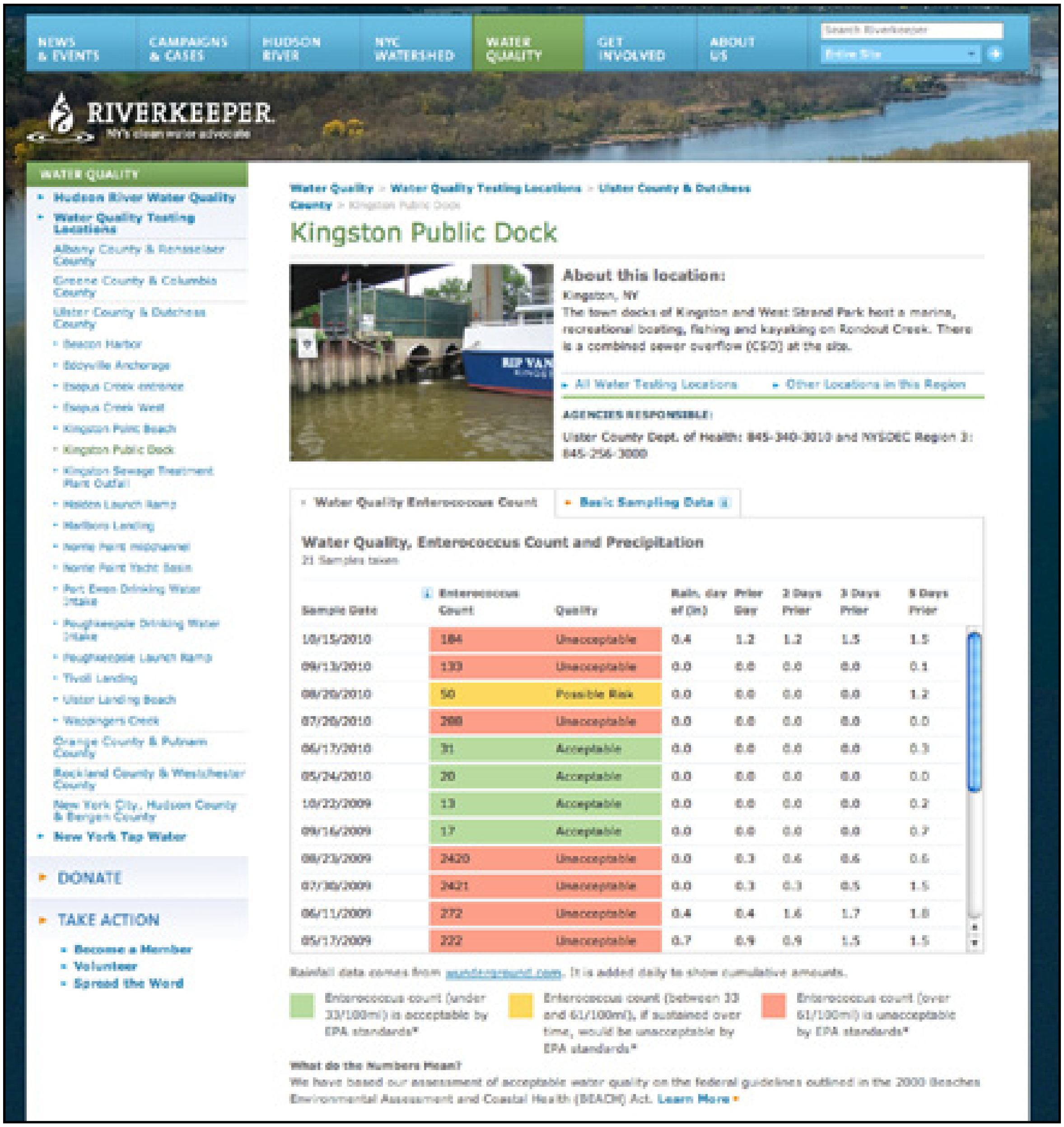
Figure 4: Riverkeeper's 75 Standard Sampling Sites



In 2006 and 2007 Riverkeeper sampled sites from NY Harbor to Peekskill. In 2008 we expanded the study north to Troy. We now sample at 75 set locations, once a month, from May through October. The Riverkeeper patrol boat, R. Ian Fletcher, is equipped with a mobile lab that allows us to collect, process and incubate the samples onboard.

Our sites fall into four categories– near-shore, mid-channel, tributaries, and wastewater treatment plant outfalls.

[See Appendix IV for a list of our regular sampling sites with descriptions. In addition to the sites listed, we conduct exploratory sampling at a variety of locations to investigate specific events and problem areas.] [xiii]



A sampling site page from Riverkeeper's online water quality database: www.riverkeeper.org/water-quality/locations

Sharing Data with the Public

To distribute our water quality data to the public we have created an online database at www.riverkeeper.org/water-quality/locations that is updated within days of our monthly sampling patrols. We also publish a monthly Water Quality Report based on each sampling patrol that is available as an e-letter. In addition to online publishing, we offer live presentations about our water quality findings that have been given at conferences, at community events and to agencies involved in water quality management.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Sewage Contamination in the Hudson River

Riverkeeper has processed more than 2,000 water quality samples from the Hudson River since 2006. Based on that number of samples, and the expert analyses of our science partners, we are now able to start identifying patterns of sewage contamination in the Hudson River. Although we have found evidence of sewage contamination at every one of our 75 testing locations, the levels of contamination vary enormously over time and by location.

Overall our 75 sampling sites had unacceptable water quality 21% of the times that we tested, which is equivalent to 1½ days a week on average.

WATER QUALITY ASSESSMENT

Riverkeeper's water quality assessment is based on EPA guidelines for safe swimming.

"Acceptable" samples meet the EPA single sample guideline.

"Unacceptable" samples fail the EPA single sample guideline.

"Possible Risk" samples meet the EPA single sample guideline but if sustained over time they would fail the EPA geometric mean guideline.

Clockwise from top left: Combined Sewer Overflow (CSO) in Troy, floatables and sewage in the Hudson, Combined Sewer Overflow (CSO) in New York City, Separate Sewer Overflow (SSO) at the Nyack waterfront

Through 2006-2010, there were 7 sites where we never collected an unacceptable sample.

7 BEST LOCATIONS
with unacceptable Entero counts 0% of the times sampled — '06-'10

Dyckman Street, Manhattan
Yonkers Wastewater Treatment Plant Outfall, Yonkers
Irvington Beach, Irvington
Croton Point Beach, Croton-on-Hudson
Emeline Beach, Haverstraw
Fort Montgomery, Highlands
Poughkeepsie Drinking Water Intake, Poughkeepsie

Unfortunately there were 10 other sites that had unacceptable counts 50%, or more, of the times we sampled.

10 WORST LOCATIONS
with unacceptable Entero counts at least 50% of the times sampled — '06-'10

Gowanus Canal, Brooklyn - 50%
Newtown Creek, Metropolitan Ave. Bridge, Brooklyn - 53%
Sparkill Creek, Sparkill - 86%
Sewage Treatment Plant Outfalls at Piermont - 50%
Piermont Pier, Piermont - 50%
*Tarrytown Marina, Tarrytown - 56%
Newburgh Launch Ramp, Newburgh - 50%
Kingston Wastewater Sewage Treatment Plant Outfall, Kingston - 50%
*Island Creek/Normans Kill, Glenmont - 65%
Dunn Memorial Bridge, Albany - 50%

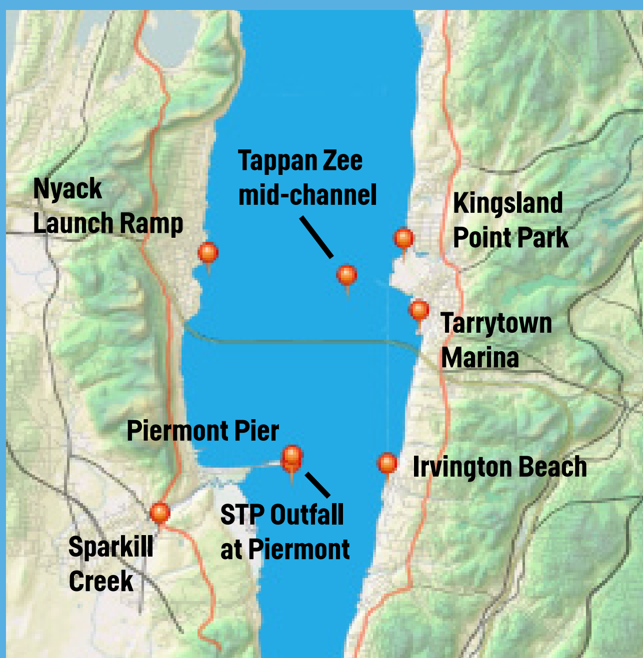
*These sites were added to the study in 2008 and therefore have a smaller number of samples (we sampled Tarrytown Marina 9 times and Island Creek/Normans Kill 17).

Each group contains sites from different regions of the Hudson. Some of the cleanest sites we found are surprisingly near some of the most contaminated sites, such as the Tarrytown Marina and Irvington Beach.

Sewage Impacts Are Localized

One of our most significant findings is the high variability of water quality throughout the estuary. At locations within a quarter mile of each other, we found very different levels of sewage contamination – on the same day. In most of the river, we've found sites that are frequently acceptable as well as sites that fluctuate between acceptable and unacceptable. Usually the poor water quality at one site is not evident at other nearby sites.

Figure 6: Tappan Zee Bay Sampling Sites



Take for example the Tappan Zee Bay water between the shores of Rockland and Westchester County. On a wet day in October 2010, the Entero counts in and along the Bay varied from an acceptable low of less than 10/100 ml to an unacceptable high of greater than 24,200/100 ml (the upper limit of our testing ability for a dilution sample).[xiv]

That day the highly contaminated water on the eastern shore in the Tarrytown Marina was not affecting the Tappan Zee mid-channel site only one mile away, or Kingsland Point Park, one mile to the north. The Irvington Beach site, 2.5 miles to the south was also acceptable. The sewage contamination we found at the Nyack Launch Ramp on the western shoreline was also localized, while Piermont Pier, 3.5 miles south of Nyack, was acceptable.

Table 2: Highly Variable by Location, Example, Tappan Zee Bay

River Mile	Site Name	Sample Date	*Enterococcus* Count	Quality
25.9	Irvington Beach	October 13, 2010	<10	Acceptable
26.1	Piermont Pier	October 13, 2010	<10	Acceptable
27	Tarrytown Marina	October 13, 2010	>24200	Unacceptable
27.5	Tappan Zee Bridge mid-channel	October 13, 2010	10	Acceptable
28	Kingsland Point Park and Pocantico River	October 13, 2010	20	Acceptable
28.1	Nyack Launch Ramp	October 13, 2010	73	Possible Risk

Wide and deep sections of the river, like Tappan Zee Bay and NY Harbor, have greater dilution and mixing for clearing up sewage hot spots. However, even in locations where the river is narrower we still see sewage contamination tending to stay localized at the shoreline.

For example around Poughkeepsie on the same October 2010 patrol, the Entero count went from a low of 7/100 ml to a high of 2420/100 ml (the upper limit of our testing ability for an undiluted sample [xv]) within a nine mile stretch of river.

These examples and others like them show that the Hudson's sewage contamination is typically a local problem. The good news it that once these sources are identified, they can often be remedied with local solutions.

Communities that invest in clean water can produce direct water quality improvements.

Figure 7 Poughkeepsie Area Sampling Sites

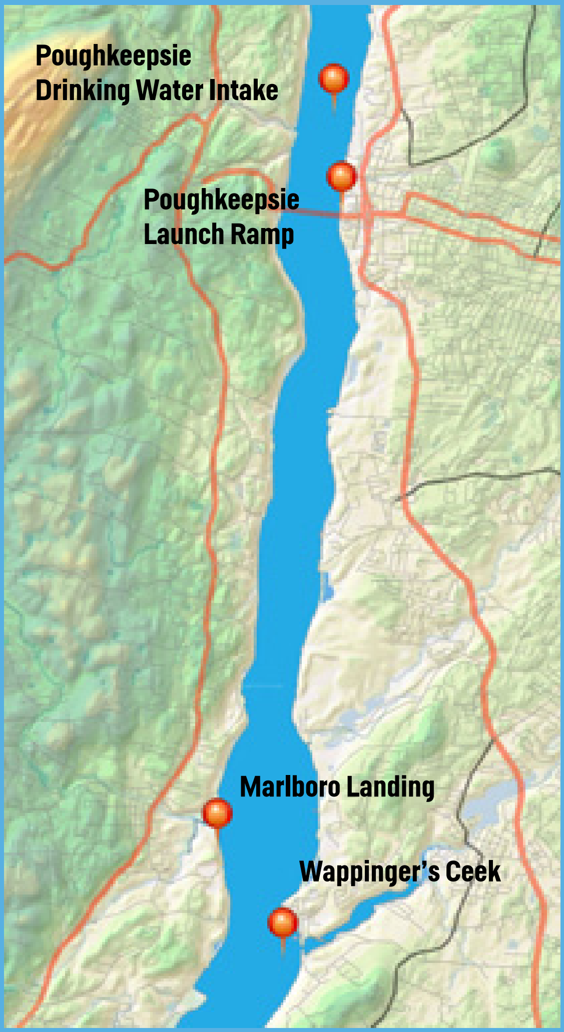


Table 3: Highly Variable by Location, Example, Poughkeepsie Area

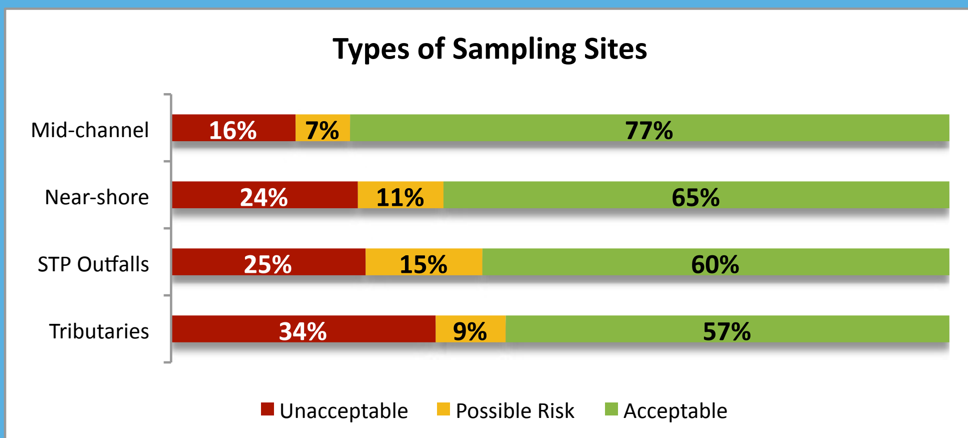
River Mile	Site Name	Sample Date	*Enterococcus* Count	Quality
66.5	Wappingers Creek	October 15, 2010	22	Acceptable
68	Marlboro Landing	October 15, 2010	>2420	Unacceptable
75	Poughkeepsie Launch Ramp	October 15, 2010	78	Unacceptable
77	Poughkeepsie Drinking Water Intake	October 15, 2010	7	Acceptable

Contamination Is Highest at the Shoreline and Near Tributaries

To better understand patterns of sewage contamination we have grouped our sampling sites into four location categories:

1) Mid-channel sites
2) Near-shore sites
3) Tributaries (sites where a stream, creek or brook joins the Hudson) [xvi]
4) Sewage Treatment Plant (STP) outfalls.

Figure 8: Percent Acceptable by Type of Sampling Site



When we view the percent of unacceptable samples by type of location we find the mid-channel sites were the least contaminated category. This isn't surprising given that the sources of sewage are typically at the shorelines. The mid-channel also tends to be the deepest and fastest moving part of the river so dilution, mixing and the self-flushing power of our tidal river have the greatest impact here.

Sewage Treatment Plant (STP) outfalls, where the partially treated wastewater from the plant enters the river, are on average more frequently unacceptable than the full system. But this doesn't tell the full story because we get a wide variety of results at the STP outfalls where we test. Some of the outfalls, like ones at Kingston and the combined Orangetown and South Rockland County STP outfalls at Piermont Pier, have a lot of variability in test results, ranging from acceptable single digit Entero counts to highs exceeding the upper limit of our testing system.

Other plants, like Yonkers and 125th Street in Manhattan, have consistently low Entero counts at their outfalls however the infrastructure that feeds these and other plants often fails to get the sewage to the plant, especially during wet weather. Combined Sewer Overflows (CSOs), Sanitary Sewer Overflows (SSOs) and infrastructure breaks are some other ways in which sewage treatment plants fail to properly treat the sewage in their systems.

[You can read more about our sewer infrastructure in the "What Now" section.]

Water quality at the near-shore sites is not as good as mid-channel or as the full system. This is because the shoreline is where the people are – and where the sewage typically enters the river. As mentioned earlier, we find acceptable water quality at many of these sites a vast majority of the time and at some sites every time we have sampled. However, some of these sites are very heavily sewage laden at times and others have a consistent low-level sewage signal whenever we test. You can see the variable near-shore findings in Figure 2 and on the Regional Maps.

The unexpected bad news is the high frequency of sewage contamination entering the Hudson from our tributaries (tribs). Our study contains 15 standard tributary sites; most are located at the mouth of the trib where the tributary flow enters the main stem of the Hudson.

These tributary sites were unacceptable 34% of the times we sampled, or the equivalent of 2 days a week on average. We have found that some streams and brooks in our communities can be chronic sources of sewage contamination – meaning that they are a source of sewage contamination for the shoreline and the river no matter what the weather. When it rains, even more sewage enters the Hudson from tributaries. Our study found a fourfold increase in the frequency of unacceptable samples at our tributary sites after wet weather.

Figure 9: Tributary Sampling Sites

TRIBUTARIES OF THE HUDSON WHERE WE SAMPLE:

Gowanus Canal – Brooklyn

Newtown Creek – Dutch Kills – Brooklyn

Newtown Creek – Metropolitan Ave. Bridge – Brooklyn

Pocantico River – Kingsland Point Park – Sleepy Hollow

Furnace Brook – Cortlandt

Cedar Pond Brook – Stony Point

Annesville Creek – Peekskill

Rondout Creek – Kingston Public Dock – Kingston

Rondout Creek – Eddyville Anchorage – Eddyville

Esopus Creek – entrance – Saugerties

Esopus Creek – west – Saugerties

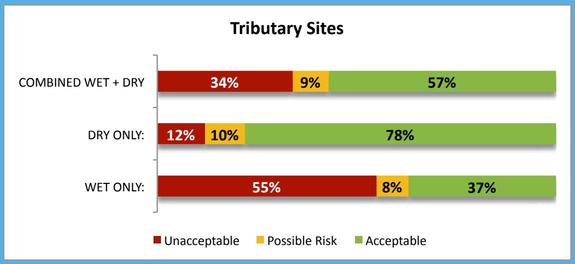
Catskill Creek – launch ramp – Catskill

Catskill Creek – east end – Catskill

Catskill Creek – First Bridge – Catskill

Island Creek/Normans Kill – Glenmont

Figure 10: Wet Weather Impact on Tributary Water Quality



Wet weather is classified as more than 0.25 inches of rain in the three days prior to sampling.

The pattern we find is consistent with a recent water quality study in the Albany Pool section of the Hudson. In that study, five tributaries were sampled and their water quality rated using a geometric mean. All failed to meet the geometric mean guideline in wet weather. In dry weather, three of the five failed, and all had at least one sample that failed to meet the EPA single sample guideline.[xvii]

So what is happening in our community streams, brooks and creeks? Individual tributary studies are needed to answer this question and the answers will likely vary somewhat by waterway and watershed. Sewage could be entering our local waters from any number of sources including contaminated groundwater from leaking septic systems and chronic leaks from sewer pipes; illegal sewage hook-ups; or agricultural sources. In wet weather add to that list contaminated overflowing sewer systems.
[See “What are Sanitary Sewer Overflows?” on page 21].

The next phase of Riverkeeper’s Water Quality Study includes looking more closely at contamination in our tributaries. We are partnering with the public on sewage mini-studies on Sparkill Creek, the Pocantico River, Esopus Creek, Catskill Creek and Stockport Creek. Our preliminary sampling is finding some very high Entero counts in wet weather and intermittent high counts in dry weather.

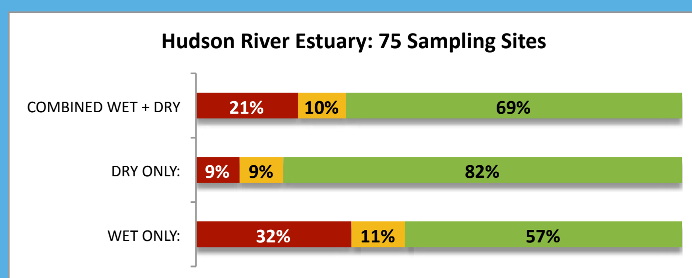
[You can read about our tributary studies in the “What Now” section.]

Wet Weather Spikes: The Rainfall Connection

During and shortly after rainfall the frequency of unacceptable Entero counts increases in all the regions and at all the types of sites where we sample, but not at every individual location. Overall the percent of samples that were unacceptable increased from 9% in dry weather to 32% in wet weather – a threefold increase.

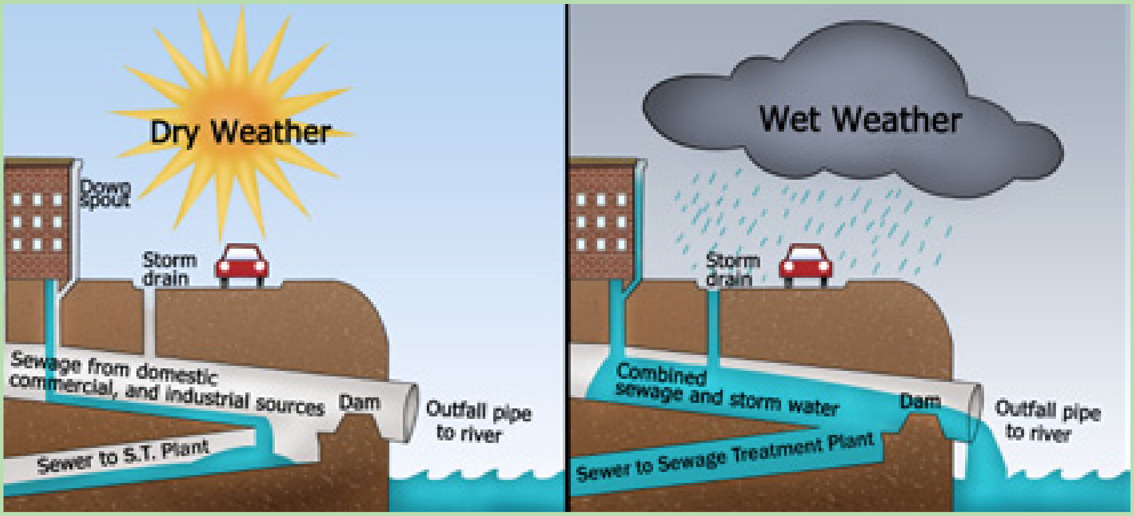
There are several sources that can contribute to rain-related sewage contamination. One contributor is contaminated groundwater entering streams, brooks and rivers. Another factor is rain-triggered overflows from our sewage infrastructure. These overflows fall into two categories - Combined Sewer Overflows (CSOs), which happen by design, and Sanitary Sewer Overflows (SSOs), which are the result of faulty or overloaded sewer systems.

Figure 11: Impact of rain on percent of unacceptable samples, averaged across all sites



Wet weather is classified as more than 0.25 inches of rain in the three days prior to sampling.

Figure 12: What Are Combined Sewer Overflows (CSOs)

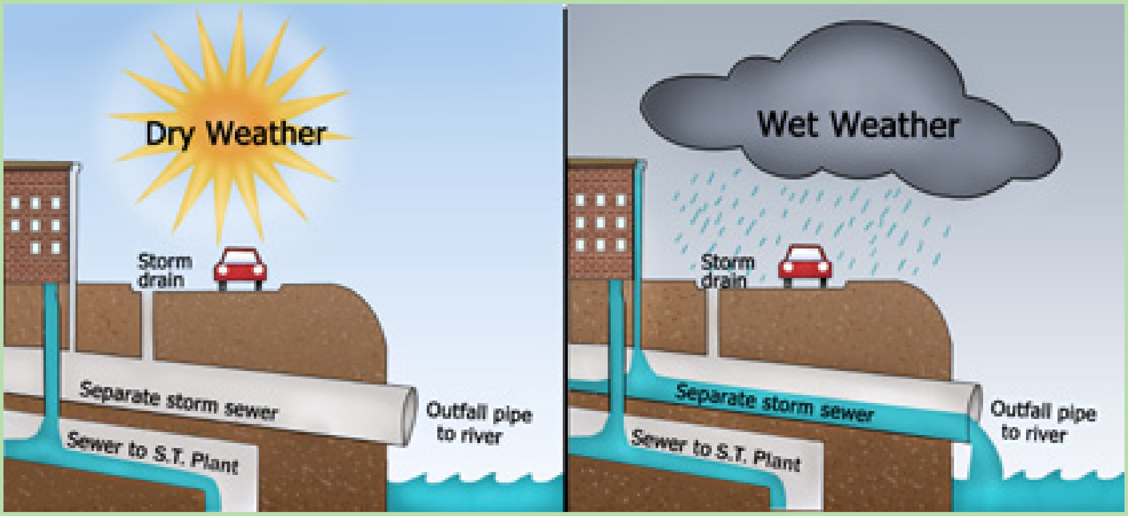


WHAT ARE COMBINED SEWER OVERFLOWS (CSOs)?

CSOs are remnants of the country's early infrastructure. In the past, communities built sewer systems to collect both stormwater runoff and sanitary sewage in the same pipe. During dry weather, these "combined sewer systems" transport wastewater directly to the sewage treatment plant. In periods of rainfall or snowmelt, however, the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, lakes, or estuaries. Combined sewer overflows (CSOs) contain not only stormwater but also untreated human and industrial waste, toxic materials, and debris. This is a major water pollution concern for cities with combined sewer systems. CSOs are among the major sources responsible for beach closings, shellfishing restrictions, and other water body impairments.

- U.S. Environmental Protection Agency

Figure 13: What Are Sanitary Sewer Overflows (SSOs)



WHAT ARE SANITARY SEWER OVERFLOWS (SSOs)?

Properly designed, operated, and maintained sanitary sewer systems are meant to collect and transport all of the sewage that flows into them to a publicly owned treatment works (STP). However, occasional unintentional discharges of raw sewage from municipal sanitary sewers occur in almost every system. These types of discharges are called sanitary sewer overflows. SSOs have a variety of causes, including but not limited to blockages, line breaks, sewer defects that allow storm water and groundwater to overload the system, lapses in sewer system operation and maintenance, power failures, inadequate sewer design and vandalism.

- U.S. Environmental Protection Agency

Together these rain-triggered overflows dump tens of billions of gallons of combined sewage and stormwater into the Hudson River each year. In some communities, like New York City, as little as ¼ inch of rain can trigger an overflow.

Water Quality Can Vary Greatly at a Single Location

We've found many examples of locations that have a high variability in sewage contamination due to wet weather.

One example is the Catskill Launch Ramp located just north of Catskill Creek. The water quality there varies from acceptable single digit Entero counts to highs in the hundreds, with one exceeding 2,420/100 ml.[xviii]

When you view the sewage contamination spikes at this site along with the more frequently contaminated Catskill Creek you can see that when it rains the Creek brings contaminated water into the Hudson and as a result water quality at the launch ramp fluctuates greatly.

Figure 14: Catskill Launch Ramp and Catskill Creek

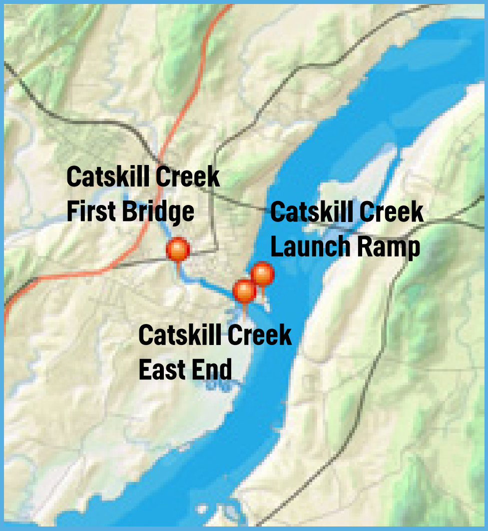


Table 4: Variable Over Time: Wet Weather Examples

		Catskill Creek – East End		Catskill Launch Ramp	
Sample Date	**Cumulative Rain 3 days prior (in.)**	**Entero Count**	**Water Quality**	**Entero Count**	**Water Quality**
22-May-08	0.19	15	Acceptable	1	Acceptable
18-Jun-08	1.07	12	Acceptable	9	Acceptable
17-Jul-08	0.11	3	Acceptable	6	Acceptable
9-Aug-08	1.48	197	Unacceptable	23	Acceptable
16-Sep-08	0.34	1	Acceptable	4	Acceptable
23-Oct-08	0.23	10	Acceptable	4	Acceptable
15-May-09	0.51	4	Acceptable	3	Acceptable
12-Jun-09	1.15	387	Unacceptable	29	Acceptable
31-Jul-09	1.88	1986	Unacceptable	>2420	Unacceptable
24-Aug-09	2.78	>2420	Unacceptable	488	Unacceptable
17-Sep-09	0	14	Acceptable	16	Acceptable
23-Oct-09	0	12	Acceptable	3	Acceptable
25-May-10	0	4	Acceptable	2	Acceptable
18-Jun-10	0.25	261	Unacceptable	6	Acceptable
19-Jul-10	0.66	4	Acceptable	2	Acceptable
21-Aug-10	0.21	51	Possible Risk	8	Acceptable
23-Aug-10	0.48	>2420	Unacceptable	435	Unacceptable
14-Sep-10	0	21	Acceptable	31	Acceptable
16-Oct-10	1.28	1986	Unacceptable	192	Unacceptable

There are also sites where we find highly variable water quality that's not connected solely with wet weather.

The Newburgh Launch Ramp, another popular spot for public access, is located next to a CSO pipe and a few hundred yards south of a sewage treatment plant outfall. This site has single digit, and thus acceptable counts, but there are still many counts in the hundreds, and even one greater than 2420 count. There are unacceptable samples on dry days and acceptable ones on wet. Across the river in the Beacon Harbor we find better water quality overall (lower high counts and fewer of them) but still rain is not the only factor.

Table 5: Variable Over Time: Dry Weather Examples

		Newburgh Launch Ramp		Beacon Harbor	
Sample Date	Cumulative Rain 3 days prior (in.)	Entero Count	Water Quality	Entero Count	Water Quality
21-May-08	0.18	19	Acceptable	3	Acceptable
17-Jun-08	1	41	Possible Risk	17	Acceptable
16-Jul-08	0.64	10	Acceptable	1	Acceptable
6-Aug-08	0.28	27	Acceptable	4	Acceptable
20-Sep-08	0	1	Acceptable	3	Acceptable
22-Oct-08	0.02	19	Acceptable	22	Acceptable
14-May-09	0.06	2	Acceptable	6	Acceptable
9-Jun-09	0.93	1046	Unacceptable	104	Unacceptable
30-Jul-09	0.54	225	Unacceptable	12	Acceptable
3-Aug-09	1.7	115	Unacceptable	8	Acceptable
22-Aug-09	0.58	687	Unacceptable	8	Acceptable
16-Sep-09	0.01	36	Possible Risk	23	Acceptable
21-Oct-09	0.18	184	Unacceptable	107	Unacceptable
23-May-10	0	41	Possible Risk	7	Acceptable
17-Jun-10	0.02	225	Unacceptable	50	Possible Risk
20-Jul-10	0.03	1300	Unacceptable	28	Acceptable
19-Aug-10	0.96	328	Unacceptable	48	Possible Risk
13-Sep-10	0	17	Acceptable	20	Acceptable
14-Oct-10	0.34	326	Unacceptable	56	Possible Risk
15-Oct-10	1.45	>2420	Unacceptable	816	Unacceptable

Four Regional Views

For a regional perspective we have divided our sampling sites into four geographic groups – New York City, Westchester-Rockland, Bear Mountain to Catskill and the Albany Region. All four regions suffer from intermittent sewage contamination but to varying degrees.

The northernmost and southernmost regions, each defined by a major waterfront city, had lower water quality overall compared with the predominantly suburban and rural areas in between. However it may surprise some to see New York City, with 8 million residents, achieving better water quality than the Albany region which has closer to 1 million. Read "A Tale of Two Cities" on page 30 to get a better understanding of the factors influencing these results.

It was also unexpected to find the more densely populated Westchester and Rockland County region had lower sewage contamination levels than the more sparsely populated region to the north that spans from Bear Mountain Bridge to Catskill. Based on our preliminary findings we believe this difference may be attributed to the higher number of tributaries in the Bear Mountain-Catskill region. Our study findings indicate that these tribs increase contamination at the near-shore sites in their vicinity including high spikes in wet weather.

When we view the data categorized as wet weather and dry weather samples, the picture for each region becomes clearer. It's important to note that all regions include some older towns and cities with combined sewer systems and CSOs however the volume of combined stormwater and sewage that each releases varies greatly.

New York City has the best water quality in dry weather of all four regions but sewage contamination increases fivefold when it rains. It has a big CSO problem – 480 CSO pipes discharging 27 billion gallons of combined sewage and stormwater into its surrounding waters each year.

Bear Mountain-Catskill region has a surprisingly similar weather-to-sewage pattern to NYC. It has a rain problem too, but its cannot be blamed on a giant CSO system.

Westchester-Rockland has the lowest variability between dry and wet weather conditions of all the regions with a doubling of unacceptable water quality counts following wet weather. This relatively low wet weather spike accounts for Westchester-Rockland having the best overall percent acceptable – 75%. But there is also a lot of variability in this region. Remember it is home to 4 of the best sites in our study and 3 of the worst.

Figure 15: Findings by Region: Percent Acceptable, Possible Risk and Unacceptable

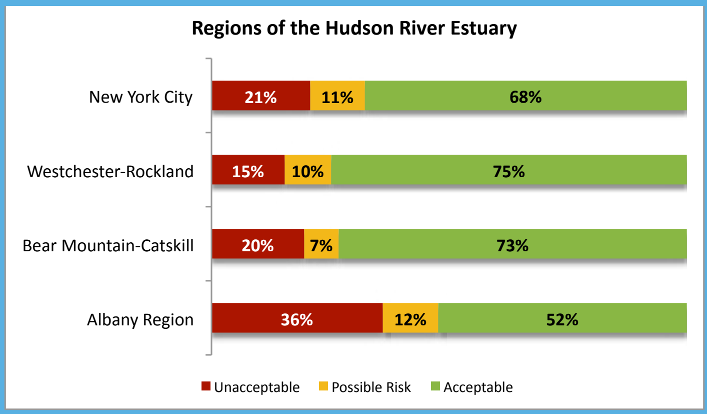
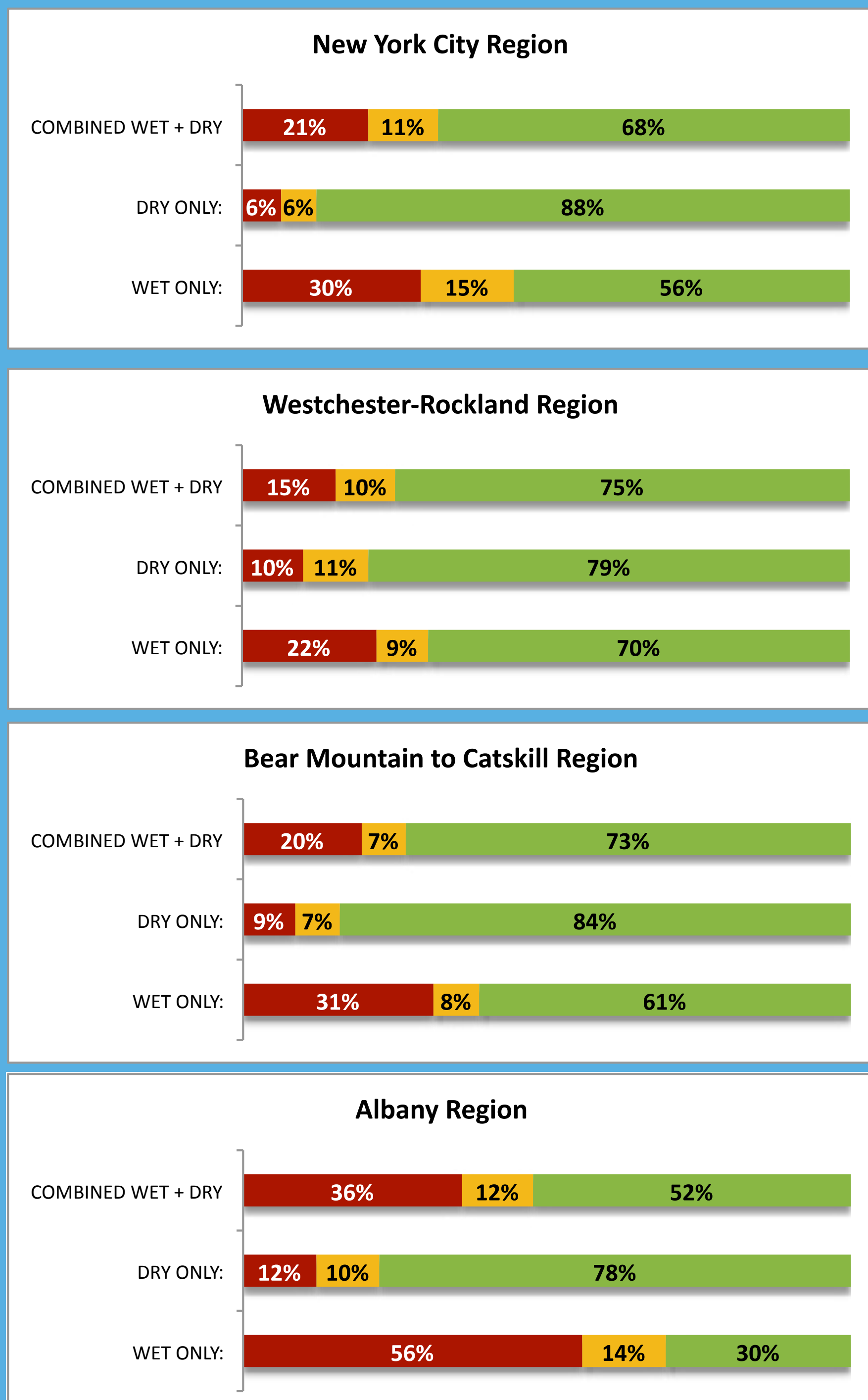
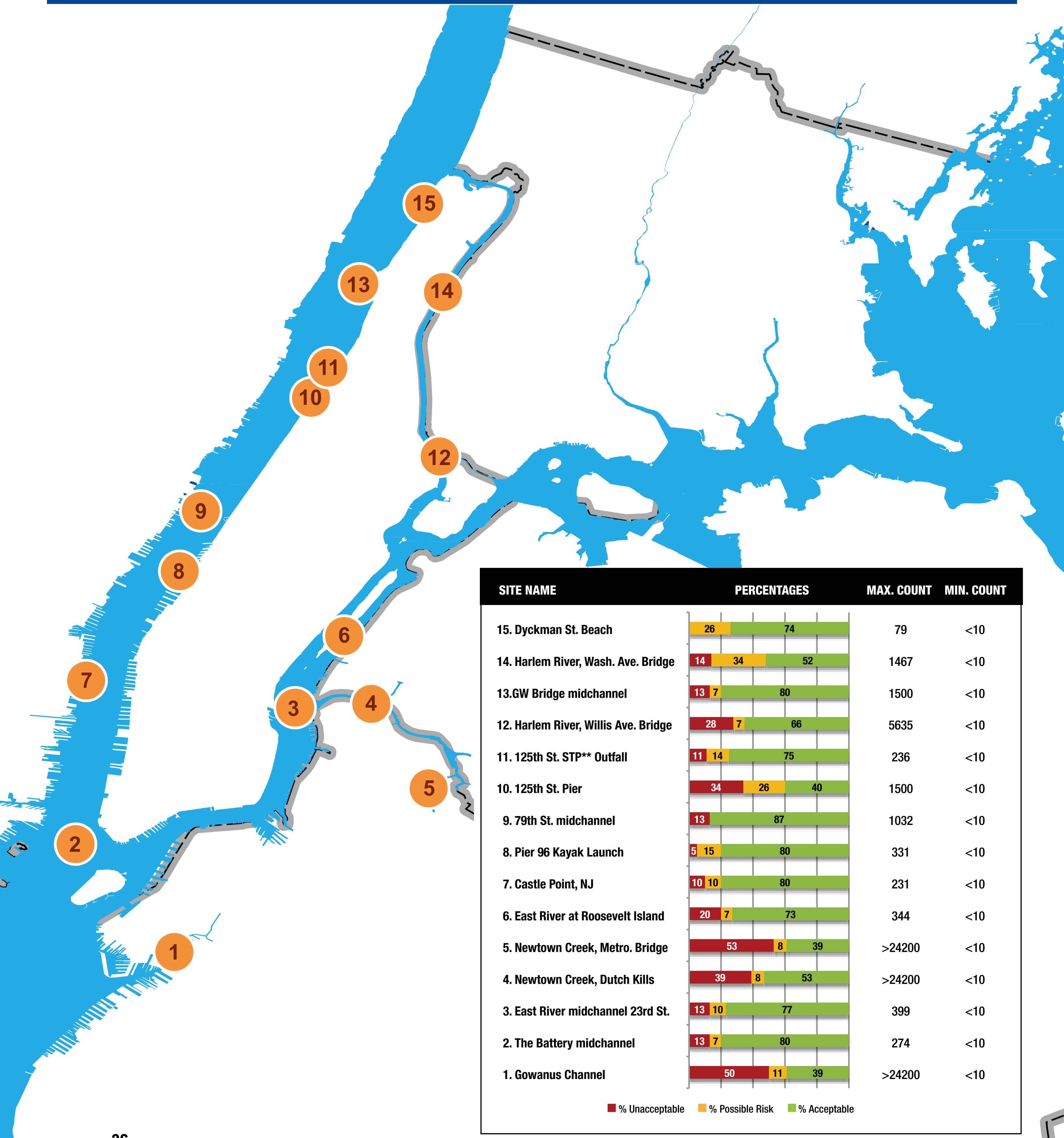


Figure 16: Weather Impacts by Region



Wet weather is classified as more than 0.25 inches of rain in the three days prior to sampling.

Region 1: New York City
(Gowanus Canal to Dyckman Street Beach)

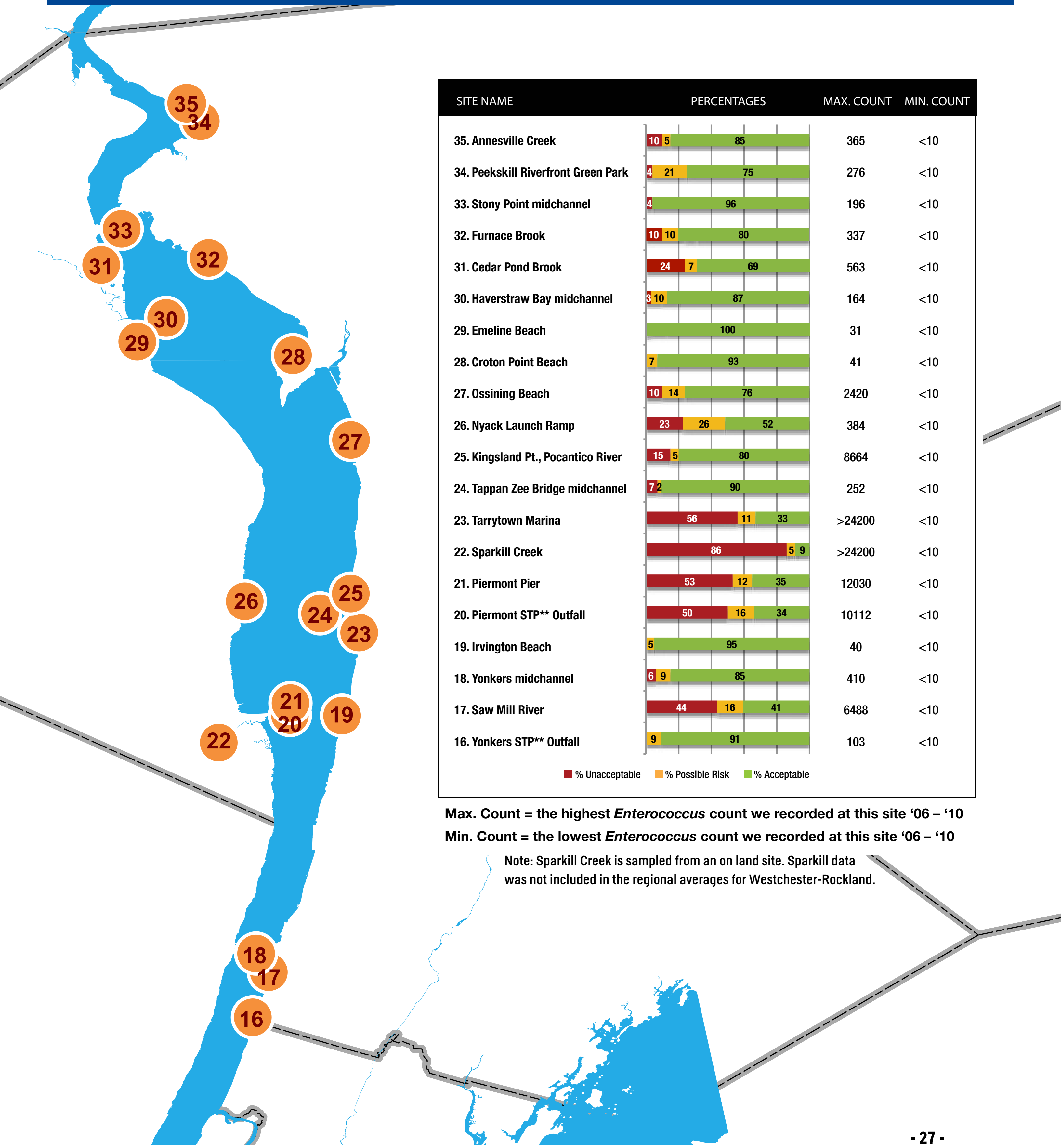


SITE NAME	% Unacceptable	% Possible Risk	% Acceptable	MAX. COUNT	MIN. COUNT
15. Dyckman St. Beach		26	74	79	<10
14. Harlem River, Wash. Ave. Bridge	14	34	52	1467	<10
13.GW Bridge midchannel	13	7	80	1500	<10
12. Harlem River, Willis Ave. Bridge	28	7	66	5635	<10
11. 125th St. STP** Outfall	11	14	75	236	<10
10. 125th St. Pier	34	26	40	1500	<10
9. 79th St. midchannel	13		87	1032	<10
8. Pier 96 Kayak Launch	5	15	80	331	<10
7. Castle Point, NJ	10	10	80	231	<10
6. East River at Roosevelt Island	20	7	73	344	<10
5. Newtown Creek, Metro. Bridge	53	8	39	>24200	<10
4. Newtown Creek, Dutch Kills	39	8	53	>24200	<10
3. East River midchannel 23rd St.	13	10	77	399	<10
2. The Battery midchannel	13	7	80	274	<10
1. Gowanus Channel	50	11	39	>24200	<10

% Unacceptable % Possible Risk % Acceptable

Max. Count = the highest *Enterococcus* count we recorded at this site '06 – '10
Min. Count = the lowest *Enterococcus* count we recorded at this site '06 – '10

Region 2: Westchester-Rockland
(Westchester STP at Yonkers to Annesville Creek)



SITE NAME	PERCENTAGES: % Unacceptable	PERCENTAGES: % Possible Risk	PERCENTAGES: % Acceptable	MAX. COUNT	MIN. COUNT
35. Annesville Creek	10	5	85	365	<10
34. Peekskill Riverfront Green Park	4	21	75	276	<10
33. Stony Point midchannel	4		96	196	<10
32. Furnace Brook	10	10	80	337	<10
31. Cedar Pond Brook	24	7	69	563	<10
30. Haverstraw Bay midchannel	3	10	87	164	<10
29. Emeline Beach			100	31	<10
28. Croton Point Beach		7	93	41	<10
27. Ossining Beach	10	14	76	2420	<10
26. Nyack Launch Ramp	23	26	52	384	<10
25. Kingsland Pt., Pocantico River	15	5	80	8664	<10
24. Tappan Zee Bridge midchannel	7	2	90	252	<10
23. Tarrytown Marina	56	11	33	>24200	<10
22. Sparkill Creek	86	5	9	>24200	<10
21. Piermont Pier	53	12	35	12030	<10
20. Piermont STP** Outfall	50	16	34	10112	<10
19. Irvington Beach		5	95	40	<10
18. Yonkers midchannel	6	9	85	410	<10
17. Saw Mill River	44	16	41	6488	<10
16. Yonkers STP** Outfall		9	91	103	<10

% Unacceptable % Possible Risk % Acceptable

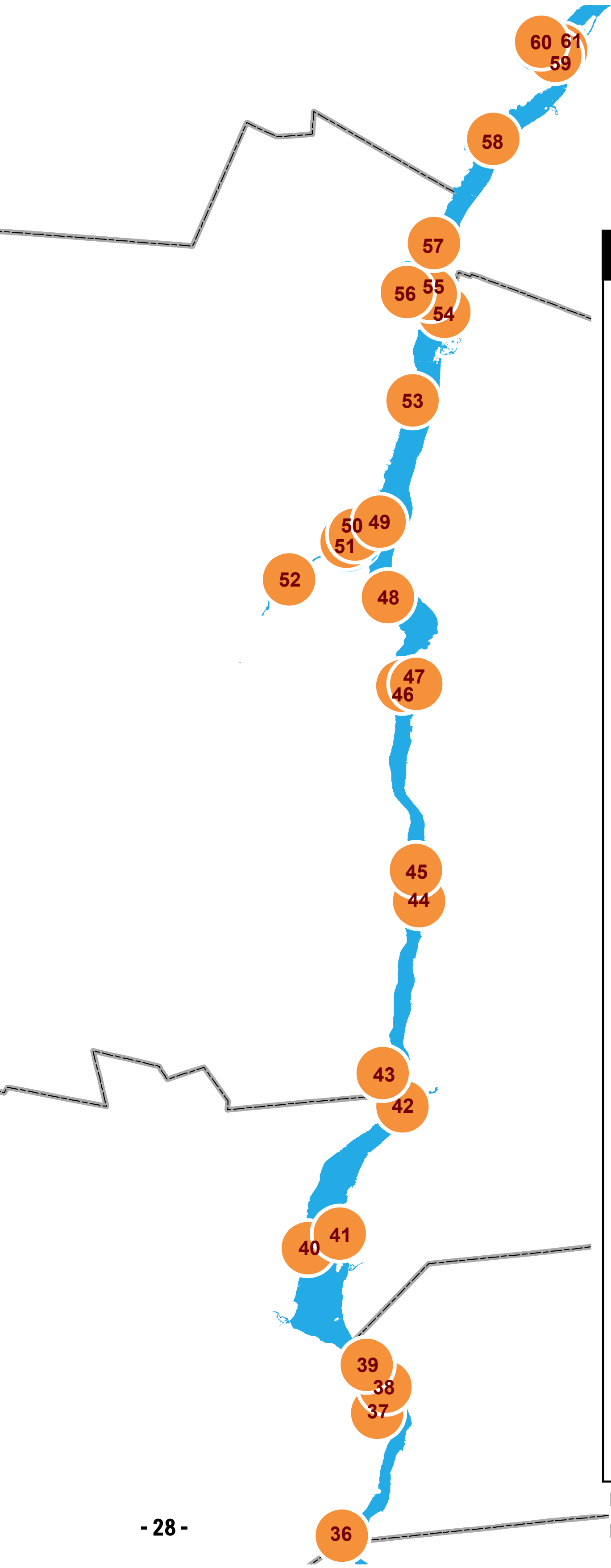
Max. Count = the highest *Enterococcus* count we recorded at this site '06 – '10

Min. Count = the lowest *Enterococcus* count we recorded at this site '06 – '10

Note: Sparkill Creek is sampled from an on land site. Sparkill data was not included in the regional averages for Westchester-Rockland.

Region 3: Bear Mountain to Catskill

(Fort Montgomery to Catskill)

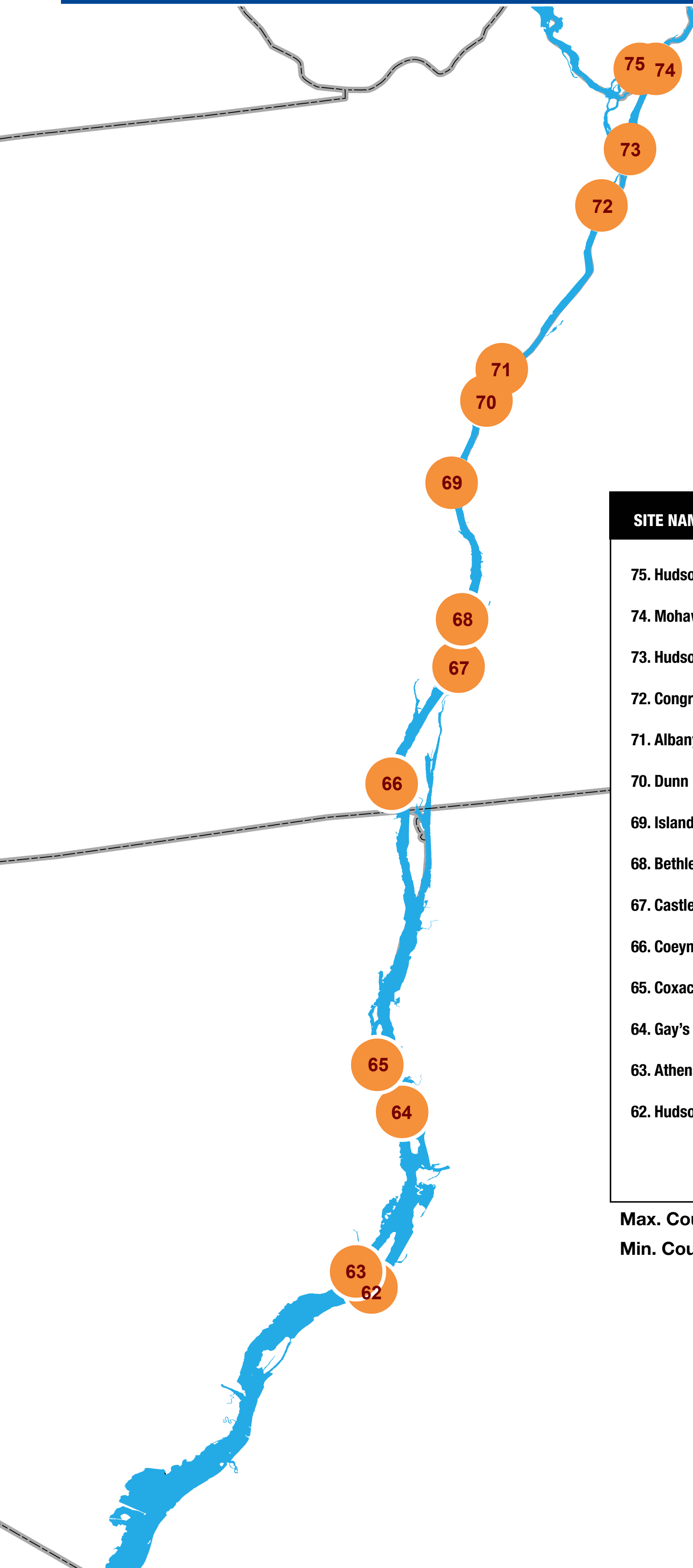


SITE NAME	PERCENTAGES: % Unacceptable	% Possible Risk	% Acceptable	MAX. COUNT	MIN. COUNT
61. Catskill Creek, Launch Ramp	37	5	58	>2420	1
60. Catskill Creek, First Bridge	35	5	60	>2420	1
59. Catskill Creek, East End	21		79	>2420	1
58. Inbrocht Bay	6		94	>2420	1
57. Malden Launch Ramp	11	11	78	1986	2
56. Esopus Creek West	24	10	67	>2420	<1
55. Esopus Creek Entrance	29	10	62	>2420	2
54. Tivoli Landing	11		89	>2420	<1
53. Ulster Landing Beach	11		89	>2420	<1
52. Eddyville Anchorage	29	14	57	>2420	1
51. Kingston Public Dock	48	19	33	>2420	6
50. Kingston STP** Outfall	50	32	18	>2420	4
49. Kingston Point Beach	11	11	79	147	<1
48. Port Ewen Drinking Water Intake	5		95	1733	<1
47. Norrie Point Yacht Basin	22	6	72	921	2
46. Norrie Point midchannel	6		94	1203	<1
45. Pough. Drinking Water Intake			100	23	<1
44. Poughkeepsie Launch Ramp	11		89	78	3
43. Marlboro Landing	18	6	76	>2420	1
42. Wappingers Creek	12	6	82	91	1
41. Beacon Harbor	15	15	70	816	1
40. Newburgh Launch Ramp	50	15	35	>2420	1
39. Little Stony Point	10		90	166	<1
38. Cold Spring Harbor	12	6	82	184	1
37. West Point STP** Outfall	11		89	291	<1
36. Fort Montgomery		11	89	36	2

% Unacceptable % Possible Risk % Acceptable

Max. Count = the highest *Enterococcus* count we recorded at this site '08 – '10
Min. Count = the lowest *Enterococcus* count we recorded at this site '08 – '10

Region 4: Albany Region
(Hudson Launch Ramp to the Mohawk River)



SITE NAME	PERCENTAGES: % Unacceptable	% Possible Risk	% Acceptable	MAX. COUNT	MIN. COUNT
75. Hudson above Mohawk River	18	6	76	>2420	<1
74. Mohawk River	41	18	41	>2420	8
73. Hudson River above Troy Lock	47	21	32	>2420	4
72. Congress Street Bridge	35	30	35	>2420	7
71. Albany Rowing Dock	44	28	28	>2420	3
70. Dunn Memorial Bridge	50	20	30	>2420	6
69. Island Creek/Normans Kill	65	6	29	>2420	2
68. Bethlehem Launch Ramp	28	11	61	1120	1
67. Castleton, Vlockie Kill	35	12	53	770	1
66. Coeymans Landing	22		78	770	<1
65. Coxackle Waterfront Park	24	6	71	1733	2
64. Gay's Point midchannel	22		78	>2420	1
63. Athens STP** Outfall	41	6	53	>2420	5
62. Hudson Landing Ramp	32		68	>2420	4

% Unacceptable % Possible Risk % Acceptable

Max. Count = the highest *Enterococcus* count we recorded at this site '08 – '10

Min. Count = the lowest *Enterococcus* count we recorded at this site '08 – '10

Hudson River enthusiasts in Brooklyn

A Tale of Two Cities: CSOs in New York City and Albany

New York City has a Combined Sewer System that dumps an estimated 27 billion gallons of combined sewage and stormwater into its surrounding waters. [xix] With a population of 8 million that is 3,375 gallons of combined sewage and stormwater per person. That's the bad news.

The good news is that NYC has 14 sewage treatment plants and in recent years has invested in upgrading and maintaining that system. As a result, in dry weather the city's sewer system appears to be handling the demands of its 8 million customers. On some dry weather sampling patrols we find acceptable and/or possible risk water quality at 100% of our NYC sampling sites. This does not mean that it is safe to swim at all of these locations. As mentioned earlier there are other factors to consider before getting into the water. Still, with some notable exceptions, NYC residents can feel good about their dry weather sewage levels.

When it rains, this picture can change quickly and dramatically. On our rainy patrol of October 12, 2010, 13 of 15 sites around NYC were unacceptable.

New York City is working to reduce the amount of stormwater getting into its combined sewer system with an investment in "green infrastructure" – a system of natural landscapes, and engineered systems that mimic natural systems, which together collect and divert stormwater, keeping it out of the storm drains and sewers. In 2011 New York City DEP is providing $3.8 million in grant money to fund green infrastructure projects such as green roofs, constructed wetlands and rain barrels. Money invested in green infrastructure will lead to further improvements in NYC's water quality and has been shown to be a cost effective way to reduce the impacts of combined sewer overflows (CSOs). [xx]

Rowing in Albany

The Capital District at the northern end of our study is a different story. The Capital District includes the city of Albany and parts of Rensselaer, Saratoga, Schenectady and Albany Counties. This area has 92 CSOs that dump an estimated 1.2 billion gallons of combined sewage and wastewater into the Hudson each year. [xxi] That mix is entering a narrower and shallower section of the Hudson River, without the volume and mixing benefits of close proximity to the Atlantic Ocean that NYC enjoys.

Another important difference between Albany and NYC is that the three sewage treatment plants serving the Capital District do not use disinfection. So in the Capital District the rain-triggered CSOs provide a spike of contamination on top of a chronically sewage-laden section of the estuary.

The Clean Water Act requires disinfection at sewage treatment plants (STPs), but by issuing special permits (called “SPDES”), New York State has allowed Albany to stay out of compliance for almost 40 years. The lack of disinfection at the STPs is one reason Albany’s water quality in all weather is worse than New York City – though the latter is a giant metropolis with far greater sewage and CSO volumes.

In recent years the New York State DEC finally required the Capital District to develop a Long Term Control Plan for its CSOs. The plan currently under development includes adding seasonal disinfection at the three sewage treatment plants in this region – a step in the right direction for water quality in the Capital District.


B P C

What Now? Improving Our Water Quality

Frequent Monitoring and Notification

New Yorkers are getting into the Hudson River with increasing frequency each year however only four counties on the river, plus NYC, test Hudson River water quality. Of those testing, only the NYC DEP publishes their water quality data, which is included in the annual New York Harbor Water Quality Report, typically released one to two years after collection. The report shows patterns in water quality using geometric means but does not share the single sample data that allows the variability of sites to be easily evaluated. [xxii]

When you ask the people swimming at the many access points along the river if the water is safe for swimming you will often hear "If it wasn't safe they wouldn't let us swim in it." Getting in the water based on this false assumption is putting the public at risk of contracting any number of waterborne illnesses, some with serious long-term health consequences.

People who enjoy swimming in the Hudson River deserve the same protection from their local Department of Health as their neighbors swimming in the Long Island Sound and the Atlantic Ocean. On these waterfronts there is regular water quality testing and beaches are closed when the water quality fails to meet the EPA guideline for safe swimming, or is expected to fail based on historical data and modeling.

Clockwise from top left: Beautiful day at the beach in Sleepy Hollow, citizens investigating a sewage overflow in the Saw Mill River, summer fun at the Palisades Boat Club, swimming up north near Castleton

Predictive Models Provide Real-Time Water Quality Reporting

The best practices in water quality monitoring include frequent testing in all weather conditions followed by timely public notification of the results.

Once a sufficient number of samples has been collected at a location, in combination with measurements of other environmental conditions, a water quality model can be developed that enables real-time predictions of water quality conditions. This is important because the standard tests for sewage contamination require an incubation of 24 hours before results are available. The use of a model allows for predictive, rather than reactive, public notification and water quality management.

The popular "unofficial" beach at Little Stony Point

A good predictive model can take into account the factors that impact water quality at a given location such as the correlation between rainfall and sewage/pathogen levels, the flow rates and water quality of nearby tributaries, turbidity and algae to name a few. Combining these factors with historic water quality data, and checking the predictions against real time samples, would enable our government agencies to protect public health and close our beaches when the swimming conditions are not acceptable.

Predictive water quality models for the Hudson would not be unusual; there are many examples of communities that provide timely water quality information to the public this way. For example the Philly Rivercast system reports water quality on the Schuylkill River in Philadelphia in real time via a website www.phillyrivercast.org/. New York State is already using predictive models to manage beaches on the Atlantic Ocean and the Long Island Sound.

The Capital District is considering creating a predictive model for water quality in the "Albany Pool" section of the Hudson using the water quality data gathered during the development of a CSO Long Term Control Plan. Assuming that the water quality will be published online for real time use by the public, this would be the first system of its kind on the Hudson River Estuary. We hope more will follow covering all the locations where the public is getting into and enjoying the water.

A "Single Sample Standard" Must Be Adopted on the Hudson

Currently New York State evaluates Hudson River water quality using an average called a "geometric mean." This approach to averaging greatly reduces the influence of extremes (very high microbial counts and very low microbial counts). While a geometric mean is a useful estimator of long term changes to water quality, it does not accurately reflect the extreme spikes of sewage contamination that are also critically important to track. As average water quality improves, it is the episodic spikes, like those following rainfall and CSOs that are most important to consider in protecting public health.

This is why the EPA single sample standard for acceptable water quality is recommended for use at recreation waters nationwide and should be employed on the Hudson River Estuary. EPA considers the single sample maximum level to be "especially important for beaches and other recreation waters that are infrequently monitored or prone to short-term spikes in bacteria concentrations, e.g., water that may be affected by combined sewer overflow outfalls." [xxiii]

Riverkeeper urges New York State to adopt the EPA recommended single sample standard for the Hudson River in addition to the geometric mean standard and to support county-level high frequency testing and public notification of water quality at locations where the public is getting into the river.

Wastewater Infrastructure Upgrades

Addressing the Source of the Problem

The early gains in water quality that were achieved in the 1970s after the passage of the Clean Water Act (CWA) are now at risk of being lost because our federal, state and local governments have not continued to maintain and update our wastewater infrastructure. Nationwide sewage contamination in our waterways is on the rise.[xxiv]

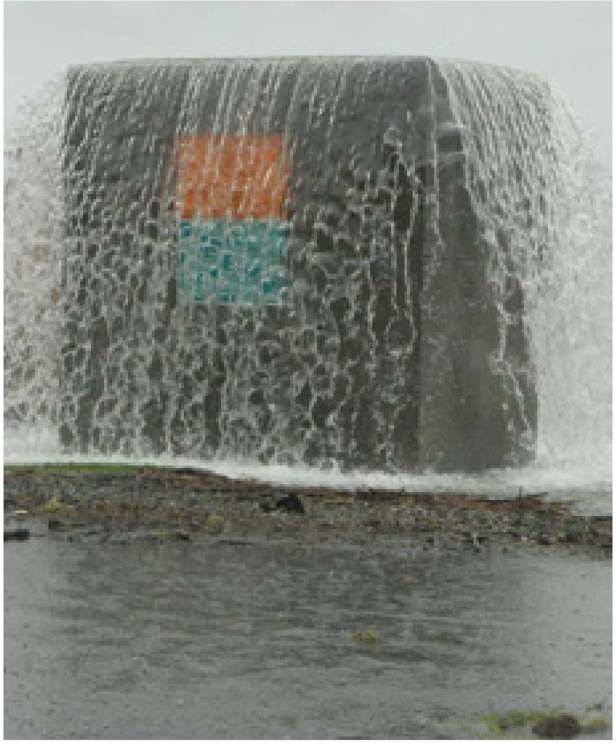
New York State ranks "Aging and Inadequate Wastewater Infrastructure" as issue #2 on its "Top 10 Water Quality Issues in New York" list, right after "Urban Stormwater Runoff." The related infrastructure issue of failing sewage treatment systems on personal property, such as septic systems, is also on the list - #10 "Inadequate Onsite Wastewater Treatment." [xxv]

According to the DEC's own report, "Wastewater Infrastructure Needs of New York," many wastewater facilities in NY are past their expected useful lives and maintenance and upgrades at these facilities is lagging far behind where they need to be to keep up with increasing demand. Statewide more than 30% of the systems are in excess of 60 years old, while they were designed to last 30 to 40 years. [xxvi] The report goes on to make the case for how important a fully functioning wastewater infrastructure is and calls for funding solutions to this worsening problem:

> "The importance of modern, reliable, and efficient wastewater treatment systems is self-evident. The health of our communities, the protection of our waterbodies, and the prospects for future economic growth and development, are linked to our ability to maintain, and as necessary, upgrade these facilities. As described in this report, however, aged systems are failing, and municipalities do not have the funds to adequately repair and replace the necessary infrastructure. There is no disputing that the cost of ensuring proper wastewater treatment is larger than what local governments and the state can address on their own. Clearly, there is a compelling need for a sustainable wastewater infrastructure funding program, yet no mechanism presently exists for that funding, and the federal government has largely turned its back on the needs of the states and local governments for this purpose."
>
> – New York State DEC Infrastructure Workgroup

Sewage Overflowing at Our Rivertowns

The decline in federal funding for infrastructure upgrades has impacted waterways in every state across the nation. However when you compare the Hudson River to other locations you get a sense of just how overloaded our local wastewater system is. For example, in 2010 Westchester County alone dumped more sewage into the Hudson River as a result of infrastructure failures than the entire state of California dumped into the Pacific Ocean that year from similar breaks. Westchester's system dumped upwards of 19.5 million gallons of raw and partially treated sewage into its rivertown waterfronts in 2010. California's combined municipal sewer systems dumped less than 15 million gallons as a result of infrastructure failures.[xxvii]



Orangetown and South Rockland sewer districts pipe overflowing during rain

Some of the discharge pipes where sewage spills occur are situated in newly revitalized waterfront parks, beaches, kayak launches and marinas. For example in Sleepy Hollow millions of gallons of sewage flowed from a pipe near a kayak launch at the newly renovated waterfront park at Horan's Landing in 2010. At the Newburgh Launch Ramp sewage overflows are commonplace. There are many other examples of overflows from failing infrastructure diverting raw sewage to our community waterfronts. It's an unwelcome vestige of the industrial past of our waterfronts.

Law Enforcement and Public Engagement

In New York State we have yet to muster the political will to use the Clean Water Act to its full effect as an enforcement tool. That law has the stated goals of achieving swimmable and fishable rivers that are free of pollution discharges by 1985 across the country. In New York, through good economic times and bad, we have continued to issue thousands of permits allowing businesses and municipalities to continue discharging pollutants into our waters.

According to the New York Times 2010 series "Toxic Waters" on our failure as a nation to comply with the Clean Water Act, there were 10 sewage treatment plants on the Hudson River that had been out of compliance with the CWA for more than three years at the time of publishing (Red Hook, Newtown Creek, Yonkers, Ossining, New Windsor, Beacon, Poughkeepsie, Hudson, Rensselaer, Waterford). This sad state of affairs will not change until the public and our elected officials call on the NYS DEC to fully enforce the laws that regulate our wastewater systems, requiring private and municipal plants to come into compliance with the CWA.

New York needs a well-funded DEC with public and political support to enforce the Clean Water Act and other regulations that protect our shared waters. New housing and business development should not be allowed in communities where the local wastewater infrastructure is unable to handle the new or existing demands. Our state and federal governments need to provide funding mechanisms for renewed investment in our wastewater infrastructure. Laws governing the installation and maintenance of private septic systems must be enacted and enforced.

Public Notification and Sewage Right to Know Laws

The key to turning the tide of sewage contamination in the Hudson and elsewhere is public awareness. If the public doesn't know that sewage is still being discharged into our rivers and streams, nothing will be done to stem the flow. And if we don't know about sewage releases – planned, accidental or chronic – we're unable to make an informed decision about where and when we get in the water.

More than 20 states have already passed Sewage Right to Know (SRtK) laws that require timely public notification of sewage contamination in public waterways. New York is not one of those states.

Some of the Sewage Right to Know laws in other states only address accidental releases from infrastructure failures and planned releases for infrastructure repairs. In New York State Riverkeeper has proposed a SRtK law that will address both of those, as well as the wet weather releases caused by CSOs, and public notification at sites that suffer from chronic sewage contamination. Currently, if there is a release of raw sewage into the Hudson, no matter how large or how close it is to a recreation site, there is no state law requiring public notification.

In October 2010 a main break caused an estimated 4.4 million gallons of raw sewage to flow into the Hudson from a pipe in the Saw Mill River at Yonkers. While that sewage was flowing groups of students from the Yonkers High School were in the water at the Yonkers waterfront, less than ¼ mile from the discharge pipe, participating in the DEC's annual River Day event. State, county and city officials all knew about the hazardous sewage in the water but the parents of the students and the teachers responsible for their safety were unaware. They were deprived of the facts they needed to make an informed decision on behalf of their student's health and safety that day.

Two years prior, in October 2008, Westchester County issued a press advisory about a planned release of approximately 2 million gallons of sewage connected to a repair at a pump station in Yonkers. That advisory was well broadcast and the public took real notice. Riverkeeper sampled the water quality in the area the night before, the morning and afternoon on the day of the release, and then again the following morning. Those tests found Entero counts above the federal standard, so it was good that Westchester issued the warning. However, almost 50% of our water quality samples at the Yonkers waterfront between 2006 and 2009 had cell counts equal to, or higher than, those measured during the planned release. So if the planned release merited a warning to the public, why not the chronic unplanned ones?

If we warn sometimes we should warn all the time because the public has a right to assume that if we warn them once, we'll warn them again when it's needed. They fairly assume that if there is no warning posted then no warning is needed, but in fact that is not the case.

We have to start using the information we have at our disposal today to begin warning the public of all sewage discharges into the Hudson and other waterways that the public has primary contact with. This is what we have come to expect with storm warnings, ozone warnings, traffic alerts, boil water alerts and even pollen warnings. The systems are in place to get information to the public when needed, let's add water quality to that list of expected information.

Local Solutions and Engaged Citizens

When Riverkeeper started to post the findings of our Water Quality Testing Program we were concerned that the response of the public would be to turn their backs on the Hudson, discouraged or disgusted. Instead we are experiencing the opposite reaction. As people realize that their water quality is a local issue that can be addressed with local solutions they become interested in finding those solutions and making it better. Riverkeeper is fortunate to be working with many committed individuals and groups on the estuary and the waterways around NYC engaged in improving the water quality for their communities. Here are some examples of how local communities and interested individuals can get involved.

John Lipscomb testing water in the Sparkill Creek with campers from Strawtown Studio

Tributary and Watershed Programs

Each sub-watershed within the larger Hudson River watershed has an impact on our water quality. There are citizen and NGO groups that exist to study and improve the major tributaries of the Hudson and their associated watersheds. But no tributary is too small to have an impact and to warrant local attention. For example a little creek in Rockland County, Sparkill Creek, has inspired residents along its path to form the Sparkill Watershed Alliance. These citizens were motivated in part by terrible water quality results that Riverkeeper found while sampling this creek inland (86% unacceptable samples; see Figure 2). With this group we are developing a pilot tributary water quality study that we plan to offer on other sewage impaired tributaries of the Hudson. We have similar efforts already underway on the Pocantico River, Catskill Creek, Esopus Creek and Stockport Creek.

There are other approaches and techniques for monitoring local waterways and improving water quality. Many counties facilitate stream-monitoring programs in their communities, as do some parks and nature centers. The Hudson River Estuary Program at the DEC offers a number of programs that support watershed and tributary health such as tree planting for bank restoration and eel and amphibian monitoring.

Green Infrastructure Projects

Green infrastructure is a system of natural landscapes, and engineered systems that mimic natural systems, working together to collect and divert stormwater, keeping it out of the storm drains, sewers and waterways. Green infrastructure projects large and small can alleviate pressure on strained sewer systems and divert stormwater from CSOs, reducing the volume of sewage overflows and urban runoff entering our waters. Citizens can work with their local governments to promote the development of green infrastructure solutions in their communities.

Water Conservation

Individuals, towns and businesses can further reduce the pressure on their sewer system by reducing water use. After all it's not only sewage that flows through our wastewater treatment plants, it's also the water from our sinks, showers and in some instances our storm drains and basement sump pumps. Individuals and businesses need to be educated on the importance of water conservation even in non-drought situations, improve their water usage habits and implement long-term solutions such as low flow sinks and toilets and grey water systems.

Septic Field Maintenance

According to the NYS DEC about 25% of New York businesses and residents use onsite sewage treatment systems such as septic tanks and fields. [xxviii] When installed and maintained properly they are an effective and economical wastewater treatment system. However improper installation, the overuse of small systems, an increase in the density of systems, and the widespread lack of proper maintenance has turned these systems into a significant water quality problem, earning them a place on the DEC's "Top 10 Water Quality Issues in NYS" list. [xxix]

Based on the high sewage contamination we have found coming from our tributaries, we believe that overloaded septic fields could be one of the culprits. Many people install these systems and then forget them, not knowing or perhaps not caring when they overload and start to contaminate groundwater and surface water with sewage.

Currently New York State lacks the laws needed to require the inspection and maintenance of private septic systems. As a result counties are starting to address the problem with county regulations such as the pump out rule that Westchester County put into effect in March 2011. More counties need to follow suit and all businesses and homeowners who have septic systems need to do the right thing and conduct regular maintenance.

Join Riverkeeper and Support the Water Quality Program

Achieving and maintaining clean water in today's world requires measurement, notification, smart planning and investing, good water use habits and vigilance. Riverkeeper is committed to continuing our Water Quality Study on the Hudson and expanding our efforts to engage the many capable water quality advocates in our communities, and recruiting more to their ranks.

We encourage you to join this movement!

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Appendix I: Waterborne Illnesses and Human Health

Most waterborne disease-causing microorganisms come from human and animal fecal waste. A small drop of fecal matter can contain millions of microorganisms of many types, some of which are disease-causing pathogens. Exposure to the microbial pathogens found in sewage can lead to short-term and chronic illnesses. [xxx]

The most common types of waterborne illnesses are short-term gastrointestinal infections that cause stomach-aches and/or diarrhea. The elderly, children, pregnant women, and people with compromised immune systems are at greater risk of contracting chronic illnesses from sewage-contaminated water.

A survey by the Center for Disease Control reported over 4,000 documented illnesses from recreational waters in the U.S. in 2005-2006. [xxxi] However this number is assumed to be low because waterborne illnesses are notoriously underreported. People often associate the most common ailments, stomach and digestive system problems, with what they ate for lunch instead of contact with water. Still, reports of illness resulting from swimming are on the rise.

TYPE	AGENT	ACUTE EFFECTS	CHRONIC OR ULTIMATE EFFECTS
Bacteria	E. coli O157:H7	Diarrhea	Adults: death (thrombocytopenia)
	Legionella pneumoniae	Fever, pneumonia	Elderly: death
	Helicobacter pylori	Gastritis	Ulcers and stomach cancer
	Vibrio cholerae	Diarrhea	Death
	Vibrio vulnificus	Skin & tissue infection	Death in those with liver disorders or problems
	Campylobacter	Diarrhea	Death: Guillain-Barré syndrome
	Salmonella	Diarrhea	Reactive arthritis
	Yersinia	Diarrhea	Reactive arthritis
	Shigella	Diarrhea	Reactive arthritis
	Cyanobacteria (blue-green algae) and their toxins	Diarrhea	Potential cancer
	Leptospirosis	Fever, headache, chills, muscle aches, vomiting	Weil's Disease, death (not common)
	Aeromonas hydrophila	Diarrhea	
Parasites	Giardia lamblia	Diarrhea	Failure to thrive, Severe hypothyroidism, Lactose intolerance, Chronic joint pain
	Cryptosporidium	Diarrhea	Death in immune-compromised host
	Toxoplasma gondii	Newborn syndrome, Hearing and visual loss, Mental retardation, Diarrhea	Dementia and/or seizures
	Acanthamoeba	Eye infections	
	Microsporidia, (Enterocytozoon & Septata)	Diarrhea	
Viruses	Hepatitis viruses	Liver infection	Liver failure
	Adenoviruses	Eye infections, diarrhea	
	Caliciviruses, small round structured viruses, Norwalk virus	Diarrhea	
	Coxsackieviruses	Encephalitis, Aseptic meningitis Diarrhea, Respiratory disease	Heart disease (Myocarditis), reactive insulin-dependent diabetes
	Echoviruses	Aseptic meningitis	

Source: Centers for Disease Control and Prevention. Emerging Infectious Diseases, vol. 3, no. 4, Oct-Dec 1997.

Appendix II: Other Pollutants in the Hudson River

Sewage is just one of the pollutants found in the Hudson River Estuary. As the pollutant most frequently linked to waterborne illnesses it is the focus of Riverkeeper's Water Quality Program and Swimmable River Campaign.

Other pollutants found in the Hudson include PCBs, radioactive contaminants such as tritium and strontium-90, nutrients such as nitrogen and phosphorus, heavy metals and a variety of toxins. Some of the toxins in the Hudson come from our wastewater treatment plants, which also treat water from industrial facilities and factories in river communities. Other toxins come from our bodies and homes, via wastewater. These are the byproducts of the medicines, beauty care products, household cleaners, disinfectants, insecticides and other products we use, many of which are not efficiently removed with current wastewater treatment technology and therefore end up in the river.

Our water quality study, and this report, address only microbial sewage pollution.

Appendix III: Federal Guidelines for Enterococcus

We have based our assessment of water quality on the EPA federal guidelines outlined in the 2000 Beaches Environmental Assessment and Coastal Health (BEACH) Act. Unacceptable water is based on an illness rate of 19 or more illnesses per 1,000 swimmers in salt water, and 8 or more illnesses per 1,000 swimmers in fresh water. The concentration of *Enterococci* (the "Entero count") has been correlated to the occurrence of swimming related illnesses. The EPA reports *Enterococcus* counts as colonies (or viable cells) per 100 ml of water. [xxxii]

There are two standards for water quality in the waters we sample, one for marine water (salt or brackish water) and one for freshwater.

Marine Water

For saltwater the federal standard for unacceptable water quality is a single sample value of greater than 104 *Enterococcus* cells/100 ml, or five or more samples with a geometric mean (a weighted average) greater than 35 *Enterococcus* cells/100 ml. We apply this standard to our sampling sites from NY Harbor in the south up to and including Peekskill (northern Westchester and Rockland County) in the north.

Freshwater

For freshwater the federal standard is a single water sample with a value of greater than 61 *Enterococcus* cells/100 ml, or five or more samples with a geometric mean greater than 33 *Enterococcus* cells/100 ml. We apply this standard to our sampling sites from Fort Montgomery north to Waterford.

Appendix IV: Riverkeeper Sampling Site Descriptions

River Mile	Name	Description
155.1	Hudson above Mohawk River	The Hudson River, above the lock at Troy, is no longer part of the estuary. This site has boating, kayaking, recreational and subsistence fishing, and occasional swimming.
155	Mohawk River	This site is below the last Erie Canal lock. It has boating, kayaking, subsistence and recreational fishing from boats and the shore. There is also occasional swimming.
152.5	Hudson River above Troy Lock	This site has boating, kayaking and fishing. The Waterford drinking water intake is in the vicinity.
151.5	Congress Street Bridge	This site has boating and kayaking as well as recreational and subsistence fishing from boats and shore.
146	Albany Rowing Dock	At the Albany Rowing Dock, there is water contact from kayaking, team rowing, recreational boating and fishing.
144.5	Dunn Memorial Bridge	In the heart of the port of Albany, contact includes kayaking, team rowing, and swimming from recreational boats. The site also has fishing from shore and from boats.
142	Island Creek/Normans Kill	The two creeks enter the Hudson at this sampling site. There are no facilities, but there is recreational boating and some kayaking through the industrial portion of the Port of Albany.
138	Bethlehem Launch Ramp	The Bethlehem Launch Ramp has kayaking, recreational boating, and fishing from boat and shore.
137	Castleton, Vlockie Kill	Near the mouth of Vlockie Kill this site has recreational boating, kayaking and fishing from vessels and the shore.
133	Coeymans Landing	This sampling site is at a village park that has a fishing pier, a marina, and a launch ramp for kayaks.
124	Coxsackie Waterfront Park	The park at Coxsackie has an unofficial beach, a launch ramp and a fishing area. Kayaking, recreational boating, and casual water contact occur here.
122.5	Gay's Point mid-channel	A state park with camping, recreational boating and swimming is directly east of this sample site. It is a relatively undeveloped portion of the estuary.
117	Athens STP Outfall	The Athens Sewage Treatment Plant Outfall is in close proximity to the village waterfront, which has recreational boating from small marinas, kayaking, and fishing.
116.5	Hudson Launch Ramp	The launch ramp and boat club at Hudson host kayaking, fishing and recreational boating. There is swimming in the area.
113.2	Catskill Creek, First Bridge	Near the first bridge over the Catskill Creek, there are marinas, recreational boat traffic, kayaking and fishing. There is swimming in the vicinity.
113.1	Catskill Creek, East End	Near the entrance of the Catskill Creek, this sampling site has recreational boating, kayaking, fishing, and swimming.
113	Catskill Launch Ramp	The Launch Ramp at Catskill has kayaking, casual water contact from recreational boats, and fishing.

River Mile	Name	Description
108.5	Inbocht Bay	This sampling site has recreational boating, kayaking, and fishing.
103	Malden Launch Ramp	There is a sewage treatment plant outfall near this public launch ramp, which has kayaking, fishing, and casual water contact from recreational boats and jet skis.
102.1	Esopus Creek West	This site has boating, kayaking, occasional swimming and fishing. There is a sewage treatment plant outfall nearby to the west.
102	Esopus Creek Entrance	Just in from the lighthouse, there is kayaking, boating, and occasional swimming and fishing.
99	Tivoli Landing	There is an unofficial kayak launch from the rocky shore, as well as boating and fishing.
97	Ulster Landing Beach	This official beach has water contact from swimming and kayaking, as well as some fishing in the vicinity.
92.3	Eddyville Anchorage	This site in Rondout Creek is heavily used for boating, kayaking, rafting, swimming and fishing.
92.2	Kingston Public Dock	The town docks of Kingston and West Strand Park host a marina, recreational boating, fishing and kayaking on Rondout Creek. There is a combined sewer overflow (CSO) at the site.
92.1	Kingston STP Outfall	The sewage treatment plant discharges into Rondout Creek at Kingston. Rondout Creek is heavily used for boating, tubing, team rowing, kayaking and fishing.
92	Kingston Point Beach	This official beach has swimming, fishing from the shoreline, kayaking and recreational boating in the vicinity.
88	Port Ewen drinking water intake	The drinking water intake at Port Ewen is used by a number of communities. Use of the area includes fishing from boats and from shore, boating, kayaking and swimming.
85	Norrie Point Yacht Basin	The yacht basin is located at the mouth of a small tributary. There is boating, kayaking and fishing.
84.5	Norrie Point mid-channel	This deep-water site has boating, kayaking and fishing.
77	Poughkeepsie drinking water intake	This area has boating, kayaking, team rowing, and fishing.
75	Poughkeepsie Launch Ramp	This site has a launch ramp, boating, kayaking, fishing, and some swimming from boats.
68	Marlboro Landing	The landing at Marlboro has a marina, as well as kayaking, fishing, and swimming from boats. There is a tributary in close proximity.
66.5	Wappingers Creek	This sample site has swimming from recreational boats, kayaking and fishing.
61	Beacon Harbor	The Beacon Harbor sampling site has recreational boating, kayaking, and fishing. There is a seasonal public “river pool” to the north, and a storm drain overflow in the vicinity.
60	Newburgh Launch Ramp	This area is heavily used for boating, kayaking and jet skis, with team rowing and fishing in the vicinity. Next to the ramp is a combined sewer overflow (CSO) and a few hundred yards south is a sewage treatment plant outfall.

River Mile	Name	Description
54	Little Stony Point	At Little Stony Point there is an unofficial swimming beach, as well as recreational boating, kayaking, and fishing.
53.5	Cold Spring Harbor	The town docks of Cold Spring host a fishing pier, a yacht club, and a village waterfront where fishing, kayaking, and recreational boating are all sources of human contact with the water.
52.5	West Point STP Outfall	This area is used for boating, kayaking, team rowing and fishing.
46	Fort Montgomery	This site has recreational boat traffic, fishing and kayaking. A small sewage treatment plant discharges here as well.
44	Annesville Creek	Annesville Creek is a tributary near Peekskill that is popular with kayakers.
43	Peekskill Riverfront Green Park	At this site there is a launch ramp, boating, kayaking and fishing. Swimming at the beach nearby is prohibited but casual contact with the water has been observed.
40.5	Stony Point mid-channel	This deep-water sampling site has boating, kayaking and fishing.
40	Cedar Pond Brook	Cedar Pond Brook is a tributary that has boating, kayaking and fishing.
39	Emeline Beach	Swimming at the beach at Emeline Park is prohibited, yet casual contact with the water has been observed. The site has shore-based fishing, kayaking and recreational boating.
38	Furnace Brook	The Hudson, off Furnace Brook, has recreational and subsistence fishing, as well has kayaking, and swimming from recreational boats.
35.5	Haverstraw Bay mid-channel	Near the ship channel in Haverstraw Bay, this deep-water sampling site has recreational boating and fishing.
35	Croton Point Beach	Croton Point Park has a designated public swimming beach, operated by Westchester County. There is also a high volume of recreational boats, kayaking and fishing.
34	Ossining Beach	Swimming at Ossining beach is prohibited, yet casual contact with the water has been observed. The beach is immediately north of a sewage treatment plant outfall. There is fishing, boating and kayaking at this site.
28.1	Nyack Launch Ramp	This public launch ramp is adjacent to a waterfront park, village marina and private boat club. There is boating, kayaking, windsurfing and jet skiing, as well as fishing and some swimming.
28	Kingsland Pt., Pocantico River	This beach, located at a public park in Sleepy Hollow, was once a public swimming beach and the bathhouse remains however swimming is now prohibited. A small private boat club and official swimming beach are approximately 400 yards north of the sample site. Site uses include boating, kayaking, fishing.
27.5	Tappan Zee Bridge mid-channel	This deep-water site at the Tappan Zee Bridge has boating, kayaking and fishing.
27	Tarrytown Marina	This large marina has boating and fishing.
26.5	Upper Sparkill Creek	At this tributary there is canoeing, kayaking and fishing.
26.1	Piermont Pier	Piermont Pier is used heavily for recreational and subsistence fishing and crabbing. There is also boating and kayaking.
26	Piermont STP Outfall	There are two sewage treatment plant outfalls at this sampling site. Use includes boating, kayaking and fishing.

River Mile	Name	Description
25.9	Irvington Beach	This beach is located between a boat club and a village park. The site has kayaking, casual water contact, recreational boating and fishing. There's a combined sewer outflow (CSO) approximately 100 yards to the south.
18.5	Yonkers mid-channel	This deep-water site has boating and fishing.
18.4	Saw Mill River	The Saw Mill River enters the Hudson at Yonkers. There is boating, kayaking, recreational and subsistence fishing in this area.
17.5	Yonkers STP Outfall	This wastewater treatment plant treats sewage from much of Westchester County. The area has boating, kayaking and fishing.
14	Dyckman St. Beach	The sample site at Inwood Hill Park has fishing, kayaking, team rowing, recreational boating and casual water contact at the beach. There is a combined sewer overflow (CSO) under the pier at this site.
12.1	Harlem River, Wash. Ave. Bridge	The Harlem River at the Washington Avenue Bridge is an industrial waterway connecting the Hudson with the East River. Contact includes recreational boating and jet skiing, kayaking, as well as recreational and subsistence fishing from the shore. There is increasing activity from community and college crew teams.
12	GW Bridge mid-channel	This deep-water sample site at the George Washington Bridge has recreational boating, jet-skiing, kayaking and occasional swim events.
8.1	Harlem River, Willis Ave. Bridge	The Harlem River at the Willis Avenue Bridge is an industrial waterway, connecting the Hudson with the East River. Contact includes recreational boating and jet skiing, kayaking, as well as recreational and subsistence fishing from the shore.
8	125th St. STP Outfall	The Hudson in the vicinity of this wastewater treatment plant has recreational boating, kayaking and fishing.
7.9	125th St. Pier	The Pier at 125th St. is a new access point for recreational and subsistence fishing. There is a New York City combined sewer overflow (CSO) immediately to the south.
7	79th St. mid-channel	This deep-water sample site off 79th St. has recreational boating and occasional swim events.
6	Pier 96 Kayak Launch	The Kayak Launch at Pier 96 is in the vicinity of New York City combined sewer overflows (CSOs).
4.7	Castle Point, NJ	This sample site is located at the HRECOS research buoy of the Stevens Institute of Technology in Hoboken, New Jersey.
4	East River at Roosevelt Island	This site has boating, fishing, kayaking and occasional swim events.
2.7	Newtown Creek, Metro. Bridge	Newtown Creek at the Metropolitan Avenue Bridge is an industrial waterway and a tributary of the East River.
2.6	Newtown Creek, Dutch Kills	Newtown Creek at Dutch Kills is a tributary where subsistence fishing, as well as increasing kayak activity has been observed.
2.5	East River mid-channel 23rd St.	The deep-water sampling site around 23rd St. has mostly transitory boat traffic.
0.1	The Battery mid-channel	The deep-water sample site at Battery Park has recreational boat traffic, as well as some kayaking and occasional swim events.
-1	Gowanus Canal	The Gowanus Canal is an industrial waterway with limited dockage for recreational boats, and some kayaking and canoeing.

Acknowledgments

The extensive field research underlying this report is being conducted by:

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Riverkeeper wishes to acknowledge the following individuals for their contributions to this report:

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Photography provided courtesy of John Lipscomb, Tracy Brown, Rob Friedman, Robert Sullivan and Bard Porchaska. CSO and SSO artwork courtesy of Nora Handleman.

Funding for the 2007-2010 data collection for this ongoing collaborative project between Riverkeeper, Lamont-Doherty Earth Observatory, and Queens College was provided by a grant from the *Wallace Research Foundation*. We are extremely grateful to have benefited from the foundation's generosity in launching Riverkeeper's Water Quality Testing Program.

For their ongoing support of this and other important Riverkeeper projects we would like to thank the *Austen-Stokes Ancient Americas Foundation*.

We wish to thank the *Brinson Foundation, Lamont-Doherty Earth Observatory* and the *Columbia Earth Microbiology Initiative* for providing critical funding to purchase necessary equipment and collect data for the 2006-2007 pilot study, and their continuing support.

Riverkeeper thanks the *Kowitz Family Foundation* for generous support of our Water Quality Testing Program in 2011-2012.

Riverkeeper is thankful to our members without whom our work would not be possible.

Riverkeeper is an independent environmental organization dedicated to protecting the Hudson River, and its tributaries, and the New York City drinking water supply. Riverkeeper is a founding member of the Waterkeeper Alliance (www.waterkeeper.org) an international organization that works with over 180 Waterkeepers to protect waterways around the globe.

Endnotes

[i] We have based our assessment of acceptable water quality on the federal guidelines outlined in the 2000 Beaches Environmental Assessment and Coastal Health (BEACH) Act. There are two federal standards for water quality in the waters we sample, one for salt water and one for freshwater. See Appendix III for EPA guidelines.

[ii] Dorfman, M. and K.S. Rosselot. Testing the Waters: A Guide to Water Quality at Vacation Beaches, Natural Resources Defense Council, New York, NY, 2010, p. 5.

[iii] Lawler, Matusky & Shelly Engineers, The Hudson Group, Swimming in the Hudson River Estuary: Feasibility Report on Potential Sites, Hudson River Estuary Program, New York State Department of Environmental Conservation, 2005, p. 16. http://www.dec.ny.gov/lands/5452.html

[iv] Dorfman, M., and K.S. Rosselot, p. 9.

[v] Ibid.

[vi] Hewes, W., and K. Baer. What's In Your Water? The State of Public Notification in 11 U.S. States, American Rivers, Washington D.C., 2007, p. 7. http://www.americanrivers.org/assets/pdfs/reports-and-publications/arswg-all-8_16_07_opta842.pdf

[vii] NYC Green Infrastructure Plan: A Sustainable Strategy For Clean Waterways, Department of Environmental Protection, New York, NY, 2010, p. 8. http://home2.nyc.gov/html/dep/pdf/green_infrastructure/NYCGreenInfrastructurePlan_HighRes.pdf

[viii] Riverkeeper survey of county water quality testing in the Hudson River Estuary, 2010.

[ix] New York Harbor water quality reports are available online – http://www.nyc.gov/html/dep/html/news/hwqs.shtml

[x] For more information on our science partners visit http://www.riverkeeper.org/water-quality/hudson/our-partners/

[xi] Method 1600: *Enterococci* in Water by Membrane Filtration Using membrane-*Enterococcus* Indoxyl-$-D-Glucoside Agar (mEI), U.S. Environmental Protection Agency, Washington D.C., 2002, p. 1.

[xii] Riverkeeper characterizes our water quality samples into three categories: acceptable, unacceptable and possible risk. Acceptable: meets EPA single sample guideline for safe swimming. Unacceptable: fails EPA single single sample guideline for safe swimming. Possible risk: meets single sample guideline, but would fail geometric mean guideline if sustained over time.

[xiii] We have shore-based sites where we collect samples at higher frequency (e.g. Sparkill Creek). Since the sampling dates and frequency for the shore-based stations differ from the monthly patrol boat sampling, these sites have been excluded from regional analyses. However, data from these sites is available on the project website – www.riverkeeper.org/water-quality/locations

[xiv] 24,200 is the maximum Entero count per 100 ml obtained with a dilution sample. Note: all samples above 2,420 are dilution samples.

[xv] 2,420 is the maximum Entero count per 100 ml obtained with a standard sample. With a dilution sample one can count up to 24,200 Entero per 100 ml. Note: all samples above 2,420 are dilution samples.

[xvi] Please note that our tributary sites are generally located near the shoreline as well. However we separated those sites from the non-tributary near-shore sites to assess the influence of the tributaries on water quality.

Endnotes (continued)

[xvii] Albany Pool Tributary Water Quality Assessment, Albany Pool Joint Venture Team, August 2010.

[xviii] See endnote xv.

[xix] NYC Green Infrastructure Plan, 2010, p. 8.

[xx] Sustainable Raindrops: Cleaning New York Harbor by Greening the Urban Landscape, Riverkeeper, Ossining, NY 2008. http://www.riverkeeper.org/wp-content/uploads/2009/06/Sustainable-Raindrops-Report-1-8-08.pdf

[xxi] R. Ferraro, Director, Capital District Regional Planning Commission, personal communication, July 5, 2011.

[xxii] New York Harbor Water Quality Report, Department of Environmental Protection, New York, NY. http://www.nyc.gov/html/dep/pdf/hwqs2009.pdf

[xxiii] U.S. EPA, Water Quality Standards for Coastal Recreation Waters: Using Single Sample Maximum Values in State Water Quality Standards, Office of Water, EPA-823-F-06-013 (2006).
http://www.epa.gov/waterscience/beaches/rules/singe-sample-maximum-factsheet.htm

[xxiv] Progress in Water Quality: An Evaluation of the National Investment in Municipal Wastewater Treatment, U.S. Evironmental Protection Agency, June 2000.

[xxv] "Top 10 Water Quality Issues in NYS." New York State Department of Environmental Conservation. http://www.dec.ny.gov/chemical/69240.html

[xxvi] "Wastewater Infrastructure Needs of New York" New York State Department of Environmental Conservation, 2008, http://www.dec.ny.gov/docs/water_pdf/infrastructurerpt.pdf

[xxvii] Susie Santilena, Water Quality Scientist, Heal the Bay, personal communication, June 3, 2010.

[xxviii] "Inadequate Onsite Wastewater Treatment." New York State Department of Environmental Conservation. http://www.dec.ny.gov/chemical/69653.html.

[xxix] "Top 10 Water Quality Issues in NYS."

[xxx] Rose, J.B., et al., Microbial Pollutants in Our Nation's Waters: Environmental and Public Health Issues, American Society for Microbiology, Washington, D.C., 1999, p. 8. http://www.asm.org/images/docfilename/0000005987/waterreport[1].pdf http://www.cdc.gov/mmwr/pdf/ss/ss5709.pdf

[xxxi] Yoder, J., et al., Surveillance for Waterborne Disease and Outbreaks Associated with Recreational Water Use and Other Aquatic Facility-Associated Health Events, Center for Disease Control, Washington D.C., 2008. http://www.cdc.gov/mmwr/pdf/ss/ss5709.pdf

[xxxii] Data from 2006-2007 were collected using a plate count described in EPA method 1600. Data from 2008 and later are based on the EPA approved IDEXX Enterolert method.

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