

E. Coli in our Beach Water – A Complex Issue

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Beach closings are frustrating! Beachgoers are disappointed, local officials dread reporting the closure and the public gets angry. Escherichia coli, or E. coli, is an uninvited guest that spoils the party. The negative impacts can be far reaching and the solution to the problem is rarely simple.

When water samples collected at Michigan beaches exceed the one-day standard concentration of 300 colonies of E. coli per 100 milliliters of water or the 30-day geometric average standard concentration of 130 colonies of E. coli per 100 milliliters, the beach is closed. It remains closed until water samples are collected that demonstrate the concentrations have returned to safe levels. Some beaches, like Blossom Heath Beach on Lake St. Clair, experience problems nearly all summer long adding to public frustration.

The source of the bacteria is officially listed as “unknown” for the vast majority of closings. What is widely known is that beach closures are generally preceded by heavy rain. According to the National Resource Defense Council's 2010 Testing the Waters Report, storm water runoff contributed to more than 80% of the closing/advisory days as a reported contamination source during the relatively dry 2009 beach season.

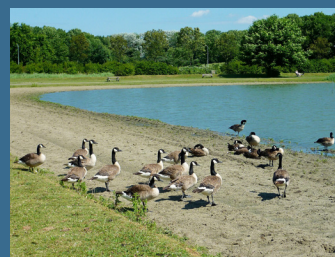
Storm water runoff contains higher levels of pollutants than most people realize. The National Storm Water Quality Database, funded by USEPA, estimates the median E. coli concentrations from storm water runoff in mixed residential areas to be 1,050 colonies per 100 milliliters, well above the daily water quality limit for beaches. This is surprising to many people since wastewater discharges and combined sewer overflows (CSOs) are commonly viewed as the major culprit for beach contamination.

Major investments have been made and are being made in southeast Michigan to eliminate or treat sources of human sewage overflows from CSOs, sanitary sewer overflows (SSOs) and wastewater treatment plants (WWTPs). The only remaining untreated CSOs are located along the Rouge and Detroit Rivers, and these discharges are not directly impacting any public beaches. Storm water management is the final step in controlling polluted discharges to our waterways.

What do we know about E. coli?

E. coli is a bacterium found in the lower intestine of warm-blooded animals. Most forms of E. coli are harmless – it is bacteria our body needs to function normally. However pathogenic strains, like E. coli O157:H7 from cattle can be deadly.

When E. coli is present, other viral, bacterial and protozoa pathogens can be present. For years, it was difficult to detect these other pathogens so scientists settled for using E. coli as an indicator of risk. The higher the level of E. coli, the more likely it is that other pathogens are present. Human waste has the potential to carry more pathogens that specifically infect other humans. However, in rural areas



Canadian Geese can contribute significant amounts of E. coli to Michigan beaches. Laboratory tests for E. coli do not indicate whether the bacteria came from wildlife, livestock or humans.



The green dye in this picture confirmed that an illicit discharge was occurring through this storm water outfall along the Clinton River. The dye was put into the sewer cleanout from a facility a half mile away indicating the restroom waste travels directly to the river. The red dye confirmed this marina was discharging sanitary wastewater directly into Lake St. Clair.

livestock waste brings significant risk of pathogens. Waste from local wildlife and domestic animals has much lower occurrence of pathogens that make humans ill. The problem is that laboratory tests don't tell you whether the E. coli is from a Canadian Goose, a cow or a human.

According to Garry Palmateer, a microbiologist with Early Warning, Inc., a company that is developing the first in-line instrument to detect pathogens in water, "Seagulls and Canadian Geese can contribute significant amounts of E. coli to beaches and are notorious for carrying pathogens. Seagulls actually bring in E. coli from other sources because they eat garbage and manure."

"E. coli from these birds and other sources can collect in beach sand and get dispersed in the water. On a calm day, E. coli counts will be down. If the wind picks up and the first inch of bottom sediment is resuspended, the E. coli counts can go way up," adds Palmateer.

A variety of conditions impact how E. coli survives in the natural environment. Sunshine, or solar radiation, kills E. coli. Rain storms bring in new bacteria colonies from contaminated runoff where it can survive in beach sand. Onshore winds keep water by the shoreline and kick up waves that wash residual E. coli from the sand and recontaminate the beach water. Warmer water temperatures provide more favorable conditions for survival and water circulation plays an important role.

There has been much debate over the continued use of E. coli as an indicator since science is producing new options to test directly for the pathogens that make people sick. The USEPA is currently conducting scientific studies to develop new recreational water quality criteria to find a better indicator than E. coli to determine when beaches should be closed. The new indicator will be published by October 2012.

Finding the sources of E. coli

Tracing an E. coli sample to its source is difficult. The genetics are complicated. "In areas with a pattern of E. coli, it is important to determine if the source was human," states Sandra McLellan, an Associate Scientist with the Great Lakes Water Institute in Milwaukee who has led numerous research studies on beach closings and urban storm water impacts. "One way to do this is through testing for bacteroides, another indicator of pathogens that is specific only to humans and frequently found in higher levels than fecal coliform."

"We have found that human sewage makes its way into storm sewers through a variety of routes. Once a human source is identified in an area, steps can be taken to determine where it is coming from and how to fix it," adds McLellan.

In a study McLellan conducted for the Milwaukee Metropolitan Sewerage District that monitored 62 municipal storm water outfalls over three years, she found that bacteroides and E. coli don't always travel together in the same proportions. The concentrations of E. coli did not correlate to the presence of bacteroides confirming that humans are just one of many sources that contribute E. coli to storm water.



Green infrastructure like Wayne County's grow zones in the Rouge River Watershed can increase the volume of storm water that infiltrates the land reducing the amount of polluted runoff reaching our waterways.



Blossom Heath Beach's physical location and lack of water circulation create water quality challenges.



Beneath this parking lot is the Chapaton RTB's 28-million-gallon storage compartment that prevents untreated combined sewage from overflowing into Lake St. Clair. The red brick pump station in the background is capable of pumping up to 700 gallons of combined sewage per minute into the facility. Typically, the average E. coli count per 100 milliliters is in the single digits for the discharge from this facility.

Failing septic tanks can contribute human E. coli to storm water and storm sewers can become contaminated by residents or businesses that incorrectly connect their sanitary sewer to the storm sewer system. Ongoing programs to identify and correct illicit connections are critical to keeping human sewage out of storm sewers.

“Over the last ten years, our monitoring team has removed 75 million gallons of annual sewage flow from the storm sewer systems in Macomb County,” states Cole Shoemaker, Supervisor with the Macomb County Health Department. The County’s team annually undertakes dye testing and follows up on complaints and referrals to address illicit connections.

How is the storm water problem being addressed?

E. coli is only one of a range of pollutants in storm water. Other bacteria, cadmium, copper, lead, nitrogen, phosphorus, suspended solids and zinc can also be present.

The volume of storm water runoff generated during rain events is larger than most people realize. For example, a small home with a 40’ x 100’ lot generates more than 50,000 gallons of storm water annually and a typical strip mall parking lot for 60 cars generates ten times that much – about a half million gallons per year. Add these up for a community, and then for a watershed, and the numbers can be staggering. Annual volumes of storm water runoff within the Rouge River Watershed that encompasses 36 communities in Wayne, Oakland and Washtenaw Counties has been estimated to total 33 billion gallons a year. This represents 36% of the volume of water that flows through the Rouge River each year.

Many communities are implementing programs to limit the amount of storm water that makes its way into the storm sewers like requiring new development to retain storm water runoff on site and through green infrastructure projects that increase the land’s ability to absorb runoff water. According to Noel Mullett from Wayne County’s Water Quality Management Division, “Green infrastructure projects can have an impact. We created 13 grow zones along Hines Drive in the Middle Rouge and then evaluated their performance. Open areas that had traditionally been mowed grass were replaced with native grasses, sedges, rushes and flowers. At the four largest sites, we saw an average 43% increase in storm water infiltration rates. The type of soil played a major role in grow zone effectiveness with the worst soils realizing the great percentage improvement.”

Wayne County has also implemented rain gardens and stream stabilization projects. “We think that together, all of these projects are having an impact and help to improve water quality along the Middle Rouge,” states Mullett. “Over the last four years, we have seen improvements in our benthic scores that tell us how well the benthic macro-invertebrate communities that require clean water to live in are thriving. Our scores are going up indicating that water quality is improving.”

Polluted storm water is also getting more attention under Municipal Separate Storm Sewer Systems (MS4) regulation under the Clean Water Act. The State of Michigan has more than 300 permitted MS4 communities that are implementing controls to meet federal standards. As part of this program, the Michigan Department of Natural Resources and Environment (MDNRE) has established Total Maximum Daily Loads, or TMDLs, for specific rivers with E. coli problems requiring communities to implement control measures to meet the established threshold.

Macomb County has several creeks and drains with E. coli TMDLs. According to Shoemaker, “We have concentrated our sewer dye testing to identify illicit connections in the areas that are having the hardest time meeting the E. coli TMDL. By starting out in areas with known problems, we focus on the biggest problems first.”

Why do beaches like Blossom Heath Beach experience repeated problems?

Every beach environment is unique but there are common elements that impact water quality. Proximity of storm sewer outfalls, adjacent land use, water circulation, wind patterns and Canadian Geese and seagull populations all impact a beach’s water quality. Some elements are easier to mitigate than others. Initial beach siting is important. Some of the beaches that have repeated problems probably would not be created as new public beaches today because one or more of these elements are too difficult to mitigate.

Blossom Heath Beach has experienced water quality problems for years. Located in St. Clair Shores along the Nautical Mile that boasts the largest concentration of boats in the Midwest, the beach's physical location and lack of water circulation create water quality challenges. The beach is completely surrounded by roads and parking lots except for a canal that provides access to Lake St. Clair. From an aerial view, it looks like another marina canal rather than a natural beach.

Storm water from the US side of the lake is discharged through 30 storm sewer outfalls along the shoreline as well as directly through overland flow. There are also three facilities that store, treat and disinfect combined sewage which previously overflowed directly into the lake. The Martin Retention Treatment Basin (RTB) is upstream of Blossom Heath, and the Chapaton and Milk River RTBs are downstream.

According to Brent Avery, CSO Supervisor for Macomb County who operates the Martin and Chapaton RTBs, "Our facilities are actually limiting the amount of pollution that makes its way into Lake St. Clair. They prevent untreated CSOs from entering the lake. Many people don't understand that we treat all of our discharges and we frequently store the entire storm and don't discharge at all."

Avery continues, "In fact, at both RTBs in 2009, we completely captured, stored and sent flow to the Detroit WWTP for 28 of the 40 storms that required us to operate the RTBs. We only sent treated RTB discharges to Lake St. Clair 12 times the entire year, and only two of these events were in the summer. Typically our average E. coli count per 100 milliliters is in the single digits. We have averaged less than 10 per event for several years now."

Further upstream, the New Baltimore and Mt. Clemens Wastewater Treatment Plants (WWTPs) discharge treated effluent into streams that discharge into Lake St. Clair. New Baltimore recently completed a \$20 million renovation to their WWTP and collection system. According to Craig Higgins, Superintendent at the plant, "The new process uses activated sludge treatment and ultraviolet disinfection to treat up to 1.75 million gallons of sewage per day. Our fecal counts were under 200 with the old process but now we are seeing counts as low as 4."

Storm water is the only untreated discharge directly into the lake and the likely source of E. coli contamination. Even though Blossom Heath Beach has problems, it does not mean Lake St. Clair as a whole is polluted. Cole Shoemaker sums the situation, "Beach advisories along Lake St. Clair are the result mainly of localized, near shore problems and do not reflect the overall quality of the lake. We've monitored off-shore and the E. coli levels are really low."

Understanding RTB discharge reporting and what treated discharges contain

Terms used on the MDNRE website in reporting discharges from CSO RTBs can be confusing. The term "partially treated sewage" is used to define flow that is comprised of storm water and sanitary sewage that has been screened, settled in an RTB for a designated period of time to remove solids, and then injected with a disinfectant. This level of treatment meets the facility's permit discharge requirements and water quality standards deemed protective of public health by MDNRE.

The MDNRE has changed the terminology in their annual report to RTB discharges to better define this type of discharge. This is part of an effort to educate the public concerning the differences between treated RTB discharges that meet permit limits and untreated CSO discharges.

RTBs and WWTPs report their discharge in terms of fecal coliform. E. coli is a subset of fecal coliform and the two parameters are not directly comparable. As shown in the chart below, fecal coliform counts are larger than E. coli counts in the same sample.

RTB discharges are cleaner than untreated storm water. Untreated CSO and untreated storm water runoff contribute a much higher concentration of E. coli and fecal coliform than treated RTB and WWTP discharges.

Comparison of Treated and Untreated Discharges

| Discharge type | Fecal coliform concentration (counts per 100 milliliters) | E. Coli concentration (counts per 100 milliliters) | Frequency of discharge per year |
|---|--|---|--|
| Untreated Combined Sewer Overflows (CSO) | 1-100 million | Untreated CSO as high as 250,000. Untreated SSO as high as 500,000. | Typically when receive greater than ½ inch of rain but varies. Can be up to 40 times a year. |
| Untreated storm water runoff | Can get as high as 100,000 | Median count nationally is 1,750 | 40 times or more a year depending rainfall. |
| Treated CSO RTB discharges | During the recreational season (April through October) must be equal to or less than 400. | | Typically less than 10 times a year depending on the facility. Some RTBs only discharge once a year. |
| Treated wastewater treatment plant discharges | Permit limits to 200 maximum for monthly average 400 maximum for 7-day average. Most plants achieve lower numbers. | | 365 days |

A shared responsibility to protect our waterways

What we do to our land determines the quality of our water resources. From volume and frequency perspectives, storm water runoff is the largest contributor of pollutants to our lakes, rivers and streams. From a pollutant loading perspective, storm water in urban areas has higher concentrations of E. coli than treated RTB discharges. Numerous federal, state, county and local governmental units have responsibility for protecting our waterways. The public also has a responsibility. Storm water runoff reflects how we live in our communities.

Continued focus on storm water management through green infrastructure restoration, illicit discharge elimination programs, ordinances, geese management programs and other best management practices will help improve our beach water quality. CSO RTB facilities are operating as planned to protect public health. The remaining untreated CSOs and SSOs are being addressed. Storm water runoff is a ubiquitous problem that requires the efforts of everyone to reduce pollution in our waterways.

Operation Clean Water features a series of articles on how combined sewer overflow (CSO) treatment facilities are helping to improve southeast Michigan's waterways.

Operation Clean Water is published on the DWSD Customer Outreach Portal at www.dwsdoutreach.org.