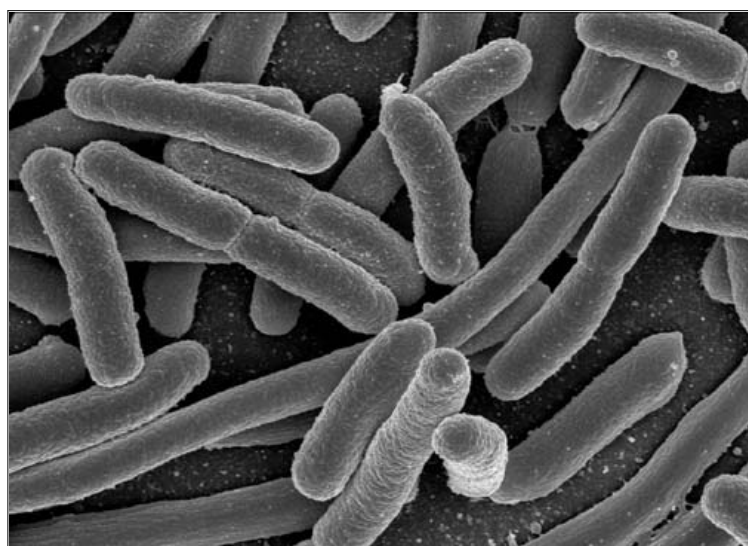


## E. Coli: A Permanent Resident of Our Beaches?

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E. coli . . . during the past few years this simple word has evoked both fear and confusion in shoreline residents and people swimming at the beaches of Tiny Township. Why do unacceptable levels of E. coli continue to occur at the beaches, resulting in beach postings by the District Health Unit? What is the health risk associated with swimming in lake water containing elevated levels of E. coli? What is the source of this E. coli?

E. coli, or more precisely *Escherichia coli*, is a subgroup of fecal coliform bacteria. It is naturally found in the intestines of warm-blooded animals, such as cows, chicken, pigs, dogs, cats, birds, and people too. It enters the environment through feces. There are thousands of different strains of E. coli. Fortunately very few strains are pathogenic. The O157H strain that caused the tragic loss of life at Walkerton is an example of one pathogenic strain of E. coli. The E. coli present in humans do not cause diseases in people.



Since the mid-1980's health units in Canada, the US, and many other countries around the world test for E. coli in drinking water and recreational waters as evidence of the presence of recent fecal contamination. Recreational waters are lakes, reservoirs and rivers, etc. where people come into contact with the water through activities such as swimming, boating, and wading. There are potentially many pathogenic micro-organisms (pathogens are disease-causing organisms such as bacteria, viruses, protozoa) associated with fecal contamination. Health units have neither the capability nor the resources to test for the presence of every possible pathogen, so E. coli is tested as an "indicator" for the possible presence of pathogens. Indicator organisms, such as E. coli, are associated with pathogens but are more easily and safely sampled and measured. It is a truer indicator of fecal contamination than total coliform or fecal coliform bacteria. Although for the most part E. coli is not pathogenic, its presence in recreational water, especially at elevated levels, has been taken to indicate fecal contamination and the likelihood that pathogens such as Salmonella, Streptococci, Cryptosporidium, Giardia, Enterovirus, etc. could be present. Numerous epidemiological studies have shown the higher the level of indicator bacteria such as E. coli, in recreational water, the greater the level of fecal contamination, the greater the chance that pathogens may be present, and the greater the health risk to swimmers.

In Ontario, regular monitoring of public beaches is undertaken by municipal or county health units. For the beaches of Tiny Township, the monitoring is undertaken by the Simcoe-Muskoka District Health Unit, and their results are posted during the summer on their web site. This web site also provides a lot of information about their testing procedures and the beaches sampled. The frequency of sampling varies among jurisdictions, but all health units follow the same protocol for how to sample (number of samples to collect,

depth of water, sampling volume and procedure), how to analyze and count the samples, and when to recommend beach postings (swimming advisories). Unfortunately, the E. coli testing does not distinguish between very hazardous strains (e.g., O157H) or benign strains of E. coli, it simply indicates how many are present, nor does the testing identify the presence of pathogens.

Ontario has the world's most strict recreational water quality guidelines for posting beaches due to elevated levels of E. coli; beach postings occur when the geometric mean of the five sampling results exceeds 100 E. coli per 100 mL of lake water (but see Report on Council - page 12). Health Canada's recreational water quality standard is a geometric mean of five sampling results exceeding 200 E. coli per 100 mL of lake water; this guideline has been adopted by all other provinces. The US Environmental Protection Agency's guideline for postings is 236 E. coli per 100 mL of lake-water. And the European Union classifies fresh water beaches as having poor quality water if levels of E. coli exceed 900 E. coli per 100 mL. Imagine how many fewer beach closures we would have if Ontario adopted the US or EU guideline!

However, scientists have discovered recently that greatly elevated levels of E. coli may also exist in the shallow groundwater below the beach adjacent to the shoreline, the area where children build their sand castles! The sand protects the E. coli from the harmful effects of UV radiation in sunlight, provides sand grains on which the E. coli can attach themselves, and is a stable source of nutrients. Levels of E. coli in such areas can exceed 150,000 E. coli per 100 mL, or many, many times higher than a bad day in the lake water! And levels of E. coli in the sand adjacent to the shoreline remain consistently high regardless of the E. coli levels in the adjacent lake water. These extremely high levels of E. coli are restricted to within several metres of the shoreline, and correspond to the area, known as the swash zone, where waves run up the beach during a storm. Once past this area of wave runup, E. coli levels in the groundwater below the beach rapidly fall to 0 or less than 100 E. coli per 100 mL. The E. coli in the swash zone sand survives much longer than in lake water -- months vs. days -- and in fact even frozen beaches sampled in February still may exhibit high levels of E. coli in the groundwater! Currently there is much discussion and research focused on why the E. coli is surviving here. What is the source of this E. coli? Are selective strains able to adapt to this environment? And is the E. coli actually replicating here?

Studies at various beaches throughout the Great Lakes indicate that E. coli in the lake water originates from a variety of sources, with the primary sources being birds (especially geese and gulls at the beach), humans (faulty septic systems and sewage treatment plants along the shoreline), urban runoff (storm sewers and road discharges to the lake), and agriculture (manure spills and runoff from fields reaching the shoreline via rivers). The proportion of E. coli from these sources varies from beach to beach depending on the extent of urban development and agricultural activity within the watershed adjacent to the shoreline, shoreline residential development, and bird populations. Because E. coli evolves within specific hosts, such as pigs, cows, people, geese, gulls, etc., to adapt to the host-specific environment, the DNA of E. coli or the resistance of E. coli to human and veterinarian antibiotics, can be used with varying degrees of success to track E. coli found at the shoreline to their source hosts. In the ankle-depth to chest-depth lake water along the Canadian shores of Lake Huron, the primary sources of E. coli are agriculture, geese and gulls. The primary sources of E. coli at Toronto and Hamilton beaches are gulls and geese in the ankle-depth to chest-depth water, and municipal waste water in the deeper water. DNA source tracking of E. coli along the beaches of Tiny Township has not been undertaken.

E. coli in the ankle-depth lake water and in the groundwater below the swash zone shows a more complicated pattern. Because E. coli enters the swash zone as infiltrating lake water, any E. coli that is in the lake water, whether originating from geese, gulls, dogs, cows, or people, will be the source of this E. coli. If E. coli is surviving, adapting, and replicating within the swash zone, then its DNA will probably no longer represent its original source host. In fact E. coli source-tracking studies, based on its DNA, now consider the E. coli within the swash zone as a distinct source. Based on the properties of their DNA, the E. coli found in the ankle to knee depth lake water at the shoreline more closely matches the E. coli from the sand/groundwater than E.

coli from geese, gulls or people.

It appears that the beach itself may in fact be the primary source of E. coli found in the ankle to knee depth lake water at the beaches of the Great lakes. The sand along the shoreline is susceptible to erosion from waves and currents. The E. coli that enter the groundwater at the swash zone during wave run up and are able to adapt and replicate there are released into the lake-water and transported along the shoreline. Thus, beach sand acts as both a reservoir that accumulates and stores E. coli and a source of E. coli when released into the lake water.



Should we be concerned about health risks associated with the high levels of E. coli in the beach sand and groundwater? Throughout the summer, our children play in the sand adjacent to the shoreline at Tiny Township's beaches. But rarely do we hear of cases of gastrointestinal illnesses. As noted earlier, the strains of E. coli found along the shoreline are for the most part harmless, and most E. coli itself will not cause gastrointestinal illnesses. The new Health Canada Guidelines for Recreational Water Quality (3rd edition) makes note that high levels of E. coli exist in the sand and groundwater at the swash zone, but it does not provide any limits with respect to health risks due to exposure to this E. coli. Not enough information is available to assess whether pathogenic organisms are actually present and if there is a positive relationship between the elevated levels of E. coli here and pathogen numbers. Researchers have just started looking for pathogens in the beach sand and groundwater at a few beaches around the Great Lakes, and have on occasion found some pathogens but at very low levels. Unfortunately, health units, including the Simcoe-Muskoka District Health Unit do not test for the presence of pathogens; they do not have the resources or the mandate to do this. Although we know our beaches have high levels of indicator E. coli in the beach sand and groundwater at the swash zone, we do not know if this means there are actually pathogenic organisms present. Research is currently being undertaken to assess the health risks associated with E. coli in the swash zone. And until these studies indicate that there is an actual health risk, our children should continue to enjoy the beach and build sand castles at the shoreline.