

# Beach Closure Decision Tree

New data analysis helps refine Milwaukee Health Department's beach management plan

**Key Message:** Detailed analysis of beach and river data helped refine the decision process that precedes beach advisories and closures. River plume dynamics, *Escherichia coli* (*E. coli*) sources, pollutant peaks, and human fecal indicator bacteria were used to evaluate health risk associated with recreation at beaches in Milwaukee, Wisconsin.

## Good Safety, Good Swimming

Beach closings and recreational restrictions due to high bacterial levels is a beneficial use impairment (BUI) for Milwaukee's urban beaches in the Milwaukee Estuary Area of Concern (AOC). To lift the impairment and delist the beaches, each public swimming beach within the AOC must meet one of the requirements below:

- Be open for at least 90% of the swimming season (between Memorial Day and Labor Day) averaged over a previous 5-year period based on Wisconsin Coastal Beach monitoring protocols for *E. coli* with BMPs in place.

OR

- Public swimming beaches within the AOC are meeting EPA's 2012 recreational water quality criteria over a 3-year period.

Alternatives to the above conditions can be used when sources of bacterial contamination to the beaches are known and controlled through BMPs. These alternatives can be found in the 'Beach Closings' section of the [2020 Removal Target Updates for the Milwaukee AOC](#).

## Can current safety criteria be improved

### Questions

- When *E. coli* counts are at the advisory limit, are the sources of *E. coli* a risk to swimmers.
- How many inches of rain must fall before it is likely that the plume from Milwaukee's 3 rivers will reach the beaches.
- If rainfall is more than 2 inches, how long will it take pollutants from the rivers/harbor to reach the beaches.
- In what circumstances are human fecal indicator bacteria present at the beaches.

## Bacteria

*E. coli* is the fecal indicator bacteria used as a proxy to warn of possible sewage contamination in Wisconsin recreational waters. The Beach Action Value (BAV) that is used to inform the public of possible swimming risk is an *E. coli* count of  $\geq 235$  CFU/100 mL in beach water. In water samples from Milwaukee's AOC beaches we found that gulls, not humans, were the primary source of *E. coli* when counts were  $\geq 235$  CFU/100 mL. Gull indicator marker was present in 53-92 percent of samples dependent on beach. Additionally, we found that changing the *E. coli* BAV to  $\geq 500$  CFU/100 mL did not increase the chances that swimmers would come into contact with sewage contaminated water at these beaches. In future, a BAV of  $\geq 500$  CFU/100 mL would increase opportunity for people to recreate at beaches that are open more frequently.

## Regional Hydrodynamic Modeling

When it rains 1" or more within a 24-hour interval, Milwaukee beaches are posted with advisories for 2 days and advisories are removed the 3rd day at 5 PM. However, our modeling suggests that pollutants from the rivers will not reach the beaches at this level of precipitation. For rain of 1"-2" in a 24-hour interval, the advisory could be lifted the morning of the 3rd day as local runoff, not regional pollution, is the source of high *E. coli* counts in beach water. The low-risk sources of *E. coli* in local runoff are birds and other wildlife. An exception to this pattern is if there is a nearby stormwater outfall with sewage contamination; in this case, the water should be tested for human fecal markers before removing the advisory.

## Terms

- AOC = Area of Concern
- BAV = Beach Action Value
- BMP = Best Management Practice
- BUI = Beneficial Use Impairment
- CFU = Colony Forming Unit
- CSO = Combined Sewer Overflow
- MPN = Most Probable Number
- SSO = Sanitary Sewer Overflow

**Policy Recommendation:** Use revised decision tree for beach advisories and closures. When assessing the Beach Closings (Recreational Restrictions) BUI, use BAV of 500 MPN-or-CFU/100 mL for advisories instead of 235 MPN-or-CFU/100 mL.

## Pollutant Delivery

In heavier rains (>2" in 24 hours), river plumes can reach specific AOC beaches dependent on hydrodynamic conditions. After an intensive rain period it can take 2 days for bacterial pollutants from river plumes to reach beaches in Milwaukee. Therefore, the advisory should be not lifted until 5 PM on day 3 as pollution sources are not limited to local runoff and could contain dilute levels of undocumented upstream sewage overflow.

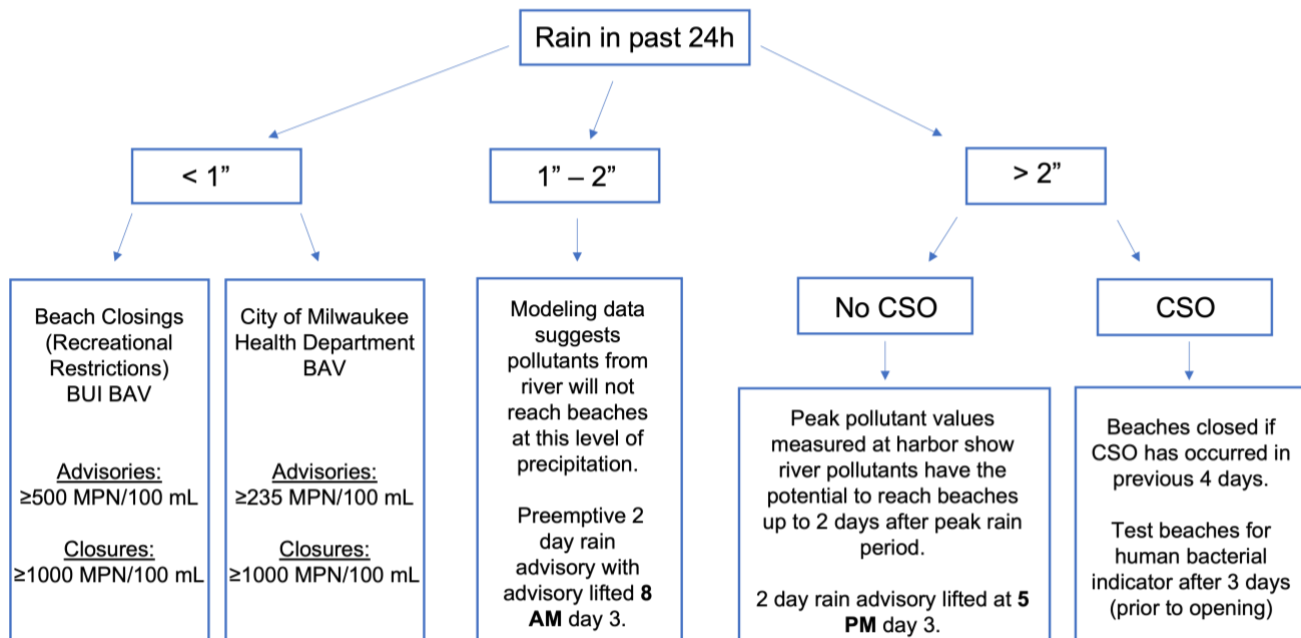
## Sewage Indicators and CSOs

Human fecal bacteria indicator markers warn of possible sewage contamination. After a CSO, human indicator markers can be found at Milwaukee beaches for up to 5 days after the overflow ends. CSOs are often

accompanied by SSOs. If these SSOs happen in upstream communities, they may not be reported to the City of Milwaukee but they can contribute to the human fecal indicator signal at Milwaukee's beaches. As sewage pollution carries a high risk to human health, a conservative approach should be taken after CSOs. Beaches should be closed if a CSO has occurred in the previous 4 days and beaches should be tested for human fecal bacterial indicators after 3 days (prior to opening the beach).

Beaches could be tested for human fecal indicator marker before 3 days when a CSO is considered a minor overflow in the river system ( $\leq 10$  MG). If no human signal is detected, the beach can be opened.

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## Conclusions

Following these revised guidelines will keep the recreating public safe while possibly reducing the number of days the beaches are in advisory or closed during the swim season. Reducing the number of advisory or closed days will move the AOC closer to removal of the beach closings (recreational restrictions) BUI.

## Additional Readings

- Dila et al., 2021. Beach Closings Management Actions Project. Final Report
- Wisconsin Department of Natural Resources, Office of the Great Waters, 2020. Removal Target Updates for the Milwaukee Estuary Area of Concern. Page 22
- McLellan et al., 2018. Sewage loading and microbial risk in urban waters of the Great Lakes. Elem Sci Anth, 6.
- Soller JA et al., 2014. Human health risk implications of multiple sources of faecal indicator bacteria in a recreational waterbody. Water Res, 66:254–264.



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Research was conducted by the McLellan lab at the University of Wisconsin-Milwaukee School of Freshwater Sciences. More information can be found in the **Beach Closings Management Actions Project** final report <https://sites.uwm.edu/mcllellanlab/publications/#special>