SCCWRP FACT SHEET

Using HF183 to detect human fecal contamination

HF183, a genetic marker that distinguishes human from animal fecal sources, is a key tool for managing water quality

The many types of animal feces that can contaminate beaches are associated with different levels of illness risk. Human fecal sources are more likely to sicken humans, as they carry pathogens that are infectious to humans. That's why the genetic marker HF183 has become an important tool for the region's water-quality management community: HF183 distinguishes human from non-human sources of fecal pollution, enabling managers to prioritize the contaminated sites that pose the greatest public health risk.

What is HF183?

HF183 is a specific fragment of genetic material found in a ubiquitous human gut bacterium known as *Bacteroides*. When water-quality managers detect HF183 in waterways, it provides evidence – with 95% accuracy – that human fecal contamination is present.

How HF183 became a key tool for managing fecal contamination

Human fecal pollution is pervasive across Southern California waterways during wet weather, and isolated instances are found during dry weather as well. When managers initially focused on this challenge in the 1990s and early 2000s, their priority was reducing total fecal contamination levels – without regard for which animals are the major sources of contamination.

But this management paradigm fundamentally shifted following a landmark 2003 study that found that DNA-based methods could be used to reliably identify animal-specific sources of contamination.

As subsequent work zeroed in on HF183 as the most effective genetic tool for detecting human fecal sources, managers recognized that their limited resources would be better spent using HF183 to focus on human sources.

In 2019, following two decades of work to rigorously vet HF183's performance, the U.S. Environmental Protection Agency (EPA) formally approved an HF183-based method for detecting human fecal contamination at beaches and similar recreational environments.

The EPA's published HF183-based method for detecting human fecal sources

Photo credit: Port of Los Angeles

Water-quality managers use the genetic marker HF183 to help determine if fecal contamination at beaches like Inner Cabrillo Beach in Los Angeles County, above, has a human signature. Human fecal sources present a significantly higher public health risk than most other animal sources.

Key management use cases for HF183

HF183 helps water-quality managers in two key ways:

» **Prioritize sites for cleanup**: Because human fecal contamination presents a greater public health concern than fecal contamination from other animals, managers use HF183 to help identify which beaches and other sites should become priorities for clean-up and remediation actions.

» **Target source reduction actions**: The types of actions that managers take to clean up contaminated sites depend on what type(s) of animal feces are present. Actions taken to reduce bird sources, for instance, are very different than if the fecal material is human. Thus, when HF183 and other genetic markers are used to identify different animal sources of fecal contamination, managers are able to take actions that effectively target the specific type(s) of animal sources present.

Pathogenicity of human fecal contamination

» Scientists estimate that human fecal contamination is at least 100 times more pathogenic than the feces of other animals commonly found in urban settings, including wildlife, birds and household pets.

» Cow feces is a notable exception: It is nearly as pathogenic as human fecal contamination.

HF183 vs. other fecal contamination indicators

Water-quality managers historically have relied on *Enterococcus* and *E. coli* as bacterial indicators of fecal contamination. Over the past decade, HF183 has emerged as an important complement to these traditional methods, generating additional management insights.

	HF183	*Enterococcus* and *E. coli*
Human-specific indicator?	**Yes**, with about 95% accuracy *(see box at right)*	**No**, found in the digestive systems of all warm-blooded animals
Can proliferate outside of animal hosts in aquatic environments?	**No**	**Yes**, which can lead to false positives and thus overestimation of health risk
Thresholds developed to quantify health risks associated with human fecal exposure?	**Not yet**	**Yes**

How accurate is HF183?

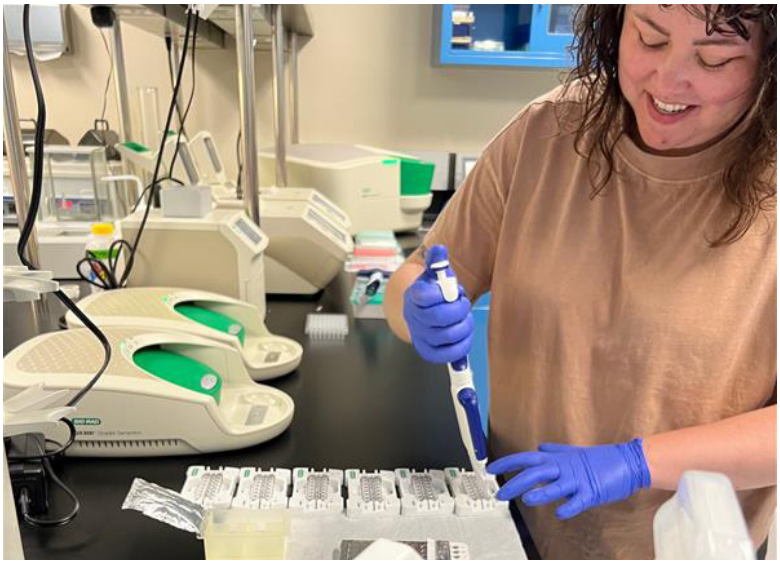
HF183's accuracy for detecting human fecal sources is about 95%. Because this genetic marker is occasionally detected at lower concentrations in other animals, including chickens, dogs and deer, HF183 has the potential to produce false-positive results. To boost confidence in HF183 results, managers can use confirmatory methods in parallel with HF183, including:

1. Other genetic markers for fecal contamination, including emerging indicators like **CrAssphage**, that work similar to HF183
2. Measuring viruses like **coliphage** that are fairly specific to human fecal material

Readiness to do routine HF183 measurements

Fecal contamination is traditionally measured using bacteria culturing methods in a laboratory. The most common bacterium targeted in Southern California is a ubiquitous type of gut bacterium known as *Enterococcus*, which is traditionally grown overnight to measurable levels. HF183, as a genetic marker for fecal contamination, cannot be measured using these culturing methods.

Fortunately, over the past decade, many Southern California laboratories have invested in building capacity to measure HF183 using DNA-based methods, as these are the same basic genetic methods that are increasingly being used to measure *Enterococcus* and other targets.



The DNA-based method commonly used to measure HF183 is known as droplet digital polymerase chain reaction (ddPCR), above.

Can recycled water affect HF183 results?

Golf courses and other parklands in Southern California are often irrigated with treated wastewater that has been reclaimed for non-potable uses, known as recycled water. While recycled water does not pose an illness risk, it can contain fragments of DNA, including HF183, that have not yet fully degraded – creating the potential for false positives when HF183 is being used to detect fecal contamination. However, even when remnant HF183 fragments are detected in recycled water, they are typically at low concentrations. Moreover, when there's concern that recycled water could trigger a false positive, managers can turn to other methods, such as measuring pathogens themselves for confirmation.

Next-generation fecal source identification

HF183 offers insights into whether a water body contains human fecal contamination, but not what are the specific origins of this contamination. The emerging next generation of source-identification research is aimed at identifying specific sources:

» **Community fingerprinting** enables researchers to pinpoint specific human fecal contamination sources by looking for genetic patterns of the microbial community that is growing alongside the different potential sources being investigated.

» **Chemical fingerprinting** takes the same basic approach as community fingerprinting, but instead of genetic patterns, researchers focus on differences in the chemical makeup of different specific potential sources.

More reading

Overview of SMC study examining HF183 and human health risk in stormwater

Study comparing HF183 vs. traditional methods for understanding health risks

Study quantifying HF183 levels at Southern California coastal sites