

***The purpose of this fact sheet is to define some key terms about microbial and human markers of fecal pollution in the environment, related to the work completed in the project “Increasing Preparedness in the San Diego River Watershed for Potential Contamination Events.” More information about these topics is available for free through the Global Water Pathogens Project ([www.waterpathogens.org](http://www.waterpathogens.org)).***

### **Microbial Markers:**

**Fecal indicator bacteria** are general indicators of fecal pollution which are commonly used worldwide to indicate the possibility of a human health risk due to the increased probability of the presence of fecal or sewage contamination and associated water pathogens. Fecal indicator viruses are less commonly used in practice. **Human-associated bacterial indicators** of fecal pollution, such as HF183, are becoming more commonly used in practice to distinguish different sources of fecal pollution. Human-associated viral indicators are less commonly used in practice, but they are gaining popularity in the realm of research. The purpose of all fecal indicators is to warn about the potential presence of human pathogens, which are excreted in feces. There are hundreds of different types of **human pathogens**, all with different abilities to infect humans, different shapes and sizes, different levels of persistence in the environment and different levels of resistance to treatment and disinfection processes. It is impossible to measure all possible human pathogens in the laboratory; therefore, fecal indicators are more commonly used.

### **General Fecal Indicator Bacteria**

*Escherichia coli* (*E. coli*) – A member of the coliform group, and a species of bacteria commonly found in intestines of humans and other animals. Its presence in water may indicate fecal contamination, either by human or animal sources. *E. coli* is ubiquitous in the normal intestinal community and feces of most warm-blooded animals, so it cannot be used to distinguish pollution by human waste or domestic wastewater from pollution originating from other animal sources. While most strains of *E. coli* are not pathogenic, some strains can cause potentially fatal illnesses, many of which are foodborne.

Enterococci – Group of bacteria found in human or other warm-blooded animals' intestines as well as the environment, which could indicate the presence of fecal contamination. It is not possible to differentiate among different sources of fecal contamination (human vs. animal) based on the presence of enterococci.

### **General Fecal Indicator Viruses**

PhiX174 and MS2 coliphage – These are viruses that are harmless to humans, but infect *E. coli* bacteria, so they are found in the normal intestinal community and feces of most warm-blooded animals, and generally found wherever *E. coli* is present. The key difference is that as viruses, they are much smaller than bacteria, and so compared to bacteria, they have different persistence in the environment, and a greater ability to

move through the environment. Coliphages are often used as surrogates to better understand the response of human viruses to environmental stresses and treatment or disinfection technologies.

### **Human-Associated Indicators of Fecal Pollution**

HF183 – A human-associated genetic marker located on the 16S rRNA gene cluster of *Bacteroides doreii*, which is among the most abundant species of bacteria in the intestines, and therefore is present in feces. HF183 is becoming more commonly used for the characterization of human-associated fecal contamination in ambient surface waters, rather than fecal contamination associated with domesticated animals or other wildlife. Unlike *E. coli* and enterococci, which have standardized methods that have been used in practice for years, the standard method for measuring HF183 in water samples was published in March 2019. Prior to that, there were many different variations of methods used in the laboratory to measure HF183.

Pepper Mild Mottle Virus (PMMoV) – a virus that is a pepper plant pathogen (causes disease for pepper plants), but is also proposed as a novel human-associated viral indicator of fecal pollution. It is commonly associated with human fecal pollution in aquatic environments because infected peppers that are harvested, tend to be processed and used for the production of sauces and spices, which are consumed exclusively by humans. Therefore, the viruses are present at high concentrations in feces and sewage. Relative to human viruses, PMMoV tends to be very persistent in the environment.

### **Human Pathogens**

Hepatitis A virus (HAV) – A pathogenic human virus causing a contagious and communicable disease that affects the liver. The virus can be transmitted sexually and can also be transmitted from person to person via direct contact and sharing needles. Other potential transmission pathways include contaminated water, shellfish, frozen fruits and vegetables and salads.

Norovirus GI – A pathogenic human virus which is a common cause of gastroenteritis and can be transmitted through water. Other potential transmission pathways include contaminated water, shellfish, frozen fruits and vegetables and salads and sharing close quarters.

*Campylobacter coli* and *Campylobacter jejuni* – Two different species of pathogenic bacteria that both cause human acute gastroenteritis. In addition to infecting humans, a wide variety of animals, especially poultry, wild birds, cattle and sheep can carry high numbers of *C. jejuni* and *C. coli* in their intestines. Fecal contamination of food, recreational water and drinking water contributes to human infections.

### **Chemical Markers:**

Caffeine - naturally occurring substance found in some plants, seeds and nuts that stimulate the central nervous system. More biodegradable than sucralose with a half-life as low as a few hours.

Sucralose - artificial sweetener that contains chlorine which inhibits metabolism by the digestive system. The molecule is more persistent in the environment than caffeine with a half-life of up to a couple months.