ENVIRONMENTAL Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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Fecal Coliform as an Indicator Organism

What is an indicator organism?

Fecal coliform bacteria are indicators of fecal contamination and of the potential presence of pathogens associated with wastewater or sewage sludge. Indicator organisms are typically used to demonstrate the potential presence or absence of groups of pathogens. The use of indicators is attractive because it reduces the complexity and cost of analyzing sludges or environmental media (soil, water, air) for individual pathogens. Indicator microbes are generally selected for the following reasons:

1) They are initially abundant in the matrix to be assayed.

2) A relatively rapid, accurate, and cost effective analytical method for enumerating the indicator exists or can be readily developed.

3) A reasonably strong correlation exists between the presence/absence of the indicator and a particular pathogen or group of pathogens. The strength of the correlation will determine the effectiveness and accuracy of the indicator as a measure of pathogen occurrence.

What are fecal coliform bacteria?

Fecal coliform bacteria are bacteria found in feces. Fecal coliforms are a subset of a larger group of organisms known as coliform bacteria. Coliform bacteria are described in *Standard Methods for the Examination of Water and Wastewater, 19th edition*, as facultative anaerobes (organisms which can survive in the absence of oxygen), gram-negative, non-spore forming, rod-shaped bacteria that ferment lactose (a type of sugar), producing gas and acid within 48 hours when cultured at 35^{o}C. Their lack of ability to form spores makes them more susceptible to destruction by environmental conditions.

Fecal coliforms normally reside in the intestinal tract of warm-blooded animals. Outside of a warm-blooded host, fecal coliforms are short-lived compared to the coliform bacteria that are free-living and not associated with the digestive tract of man or animals. The fecal category contains both pathogen (disease-causing) and nonpathogenic bacteria. An example of one group of fecal coliform bacteria is *Escherichia coli* or *E. coli*. The presence of fecal coliforms is indicative of fecal contamination and of the potential presence of enteric pathogens (disease-causing organisms which originate in the digestive system), especially bacterial pathogens.

How is the fecal coliform test used?

The N.H. Department of Environmental Services (DES) uses the fecal coliform analysis as an indicator in several situations in the administration of both the Sludge Management Rules (Env-Ws 800) and the Septage Management Rules (Env-Ws 1600). In particular:

1) The U.S. Environmental Protection Agency (EPA) has promulgated rules that require that certain treated sludges (biosolids) be tested for fecal coliforms or *Salmonella sp.* For class A biosolids, fecal coliform results must be less than 1000 MPN/gram dry weight ("MPN" stands for Most Probable Number and is a way of statistically enumerating organisms) of biosolids to demonstrate that the treatment process has been effective in reducing pathogen populations to below detectable levels or to assess the potential for pathogen regrowth after treatment.

2) In some situations, DES will test for fecal coliforms to determine if an area has been contaminated with wastes of fecal origin, regardless of whether it is domestic septage or municipal sewage sludge.

3) In the event of a sludge, biosolids or septage spill or where contamination is evident, fecal coliform analysis is used to assess the likelihood that pathogens are present, their persistence, and the potential for negative impacts to public health or the environment.

Are fecal coliform bacteria a reliable indicator of the presence or absence of pathogenic organisms?

The presence of fecal coliforms is a reliable indicator of fecal contamination. However, the absence of fecal coliforms does not equate to the absence of fecal contamination, which is one of the shortcomings of using fecal coliforms. The source of the contamination could be animal excreta, wastewater, sludge, septage, or biosolids. Each of these wastes is derived entirely or at least in part from the feces and urine of warm-blooded animals. Since enteric pathogens and fecal coliforms are also excreted by warm-blooded animals, detection of fecal coliforms indicates the potential presence of pathogens.

However, fecal coliform bacteria are not always a reliable indicator of the destruction of individual species or groups of pathogens during wastewater treatment processes. For example, during anaerobic digestion, viral pathogens appear to have a greater survivability than fecal coliforms. The rate of inactivation for viruses and fecal coliforms seems to be more comparable for lime stabilization and high heat processes such as composting. In contrast, helminth ova (eggs of parasitic worms such as *Ascaris lumbricoides*, the large intestinal roundworm) are extremely resistant to chemical treatments such as lime stabilization but can be inactivated by high temperatures. Consequently, the fecal coliform test may be an inadequate indicator of viruses and helminthes in anaerobically digested biosolids, but a good indicator of treatment efficiency during composting. According to the literature, fecal coliform enumeration is most reliable as an indicator of the presence of bacterial pathogens, especially *Salmonella sp*.

Regarding persistence in the environment, caution should be exercised when interpreting fecal coliform results. Fecal coliforms are a reliable indicator of the survival of most bacterial pathogens, but are less reliable as an indicator for the presence of viruses and parasites. Fecal coliform analysis is less relevant when pathogens are incorporated into the soil where viruses and helminth ova are less susceptible to the destructive forces of heat and desiccation.

Fecal coliform testing does appear to be a good indicator of pathogen regrowth. This results from the fact that viruses and parasites are unable to reproduce without a warm-blooded host. The only pathogenic group capable of multiplying in the environment is bacteria. Given that fecal

coliforms are a reasonably good indicator of pathogenic bacteria, conditions that would favor an increase in fecal coliform density may also be conducive to bacterial pathogen regrowth.

With potential limitations in mind, DES continues to use fecal coliform analysis as the best practical indicator of the presence and/or absence of pathogenic organisms. Given relative ease and low cost of the testing, fecal coliform analysis remains an effective tool for evaluating potential public health or environmental impacts.