June 2000

United States
Department of
Agriculture

Natural
Resources
Conservation
Service

**Watershed
Science
Institute**

Waterborne Pathogen Information Sheet

Principal Pathogens of Concern

Escherichia coli O157:H7

What is *Escherichia coli* O157:H7?

Escherichia coli (E. coli) O157:H7 is a potentially deadly fecal bacteria that can cause bloody diarrhea and dehydration in humans. Bacteria are a group of micro-organisms (fig. 1) that live in soil or water and on plants and animals. The combination of letters and numbers in the name of this bacterium refers to the specific molecular markers found on its cell surface that distinguish it from other types of E. coli.

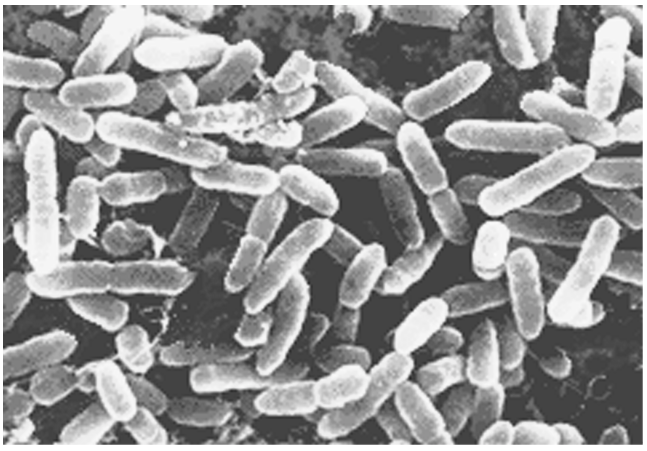


Figure 1 Bacterial cells as seen with a scanning electron microscope (cells about 1 to 2 micrometers long)

Why be concerned about *E. coli* O157:H7?

Although most strains of *E. coli* are harmless and live in the intestines of healthy humans and animals, the O157:H7 strain produces a powerful toxin capable of causing severe kidney failure and can break down the lining of the intestine in humans. The total number of cases in the United States annually is estimated to be about 20,000 with about 250 resulting in death. As few as 10 cells of this unusually infectious organism are needed to initiate an infection.

E. coli O157:H7 can be waterborne and a management concern at the watershed scale. These organisms do pose a threat to bathers or others with bodily contact in contaminated water.

How is one infected with *E. coli* O157:H7?

Infection is usually acquired by eating food or drinking liquids containing the bacteria. The bacteria are associated with the slaughtering process. Eating undercooked meat, especially undercooked ground meat, is the most common way of being infected. Person-to-person transmission occurs frequently by infected persons who do not wash their hands. Drinking unpasteurized milk or fruit juice, or swimming in or drinking sewage-contaminated water can also cause infection. Vegetables and fruits may be contaminated by fresh manure applications containing this bacterium.

Foodborne vs. waterborne

Disease outbreaks from *E. coli* O157:H7 are associated with both food (foodborne) and water (waterborne) contamination of drinking water. There is a distinction between foodborne and waterborne illness. Crop irrigation water may have pathogens however, once the water is applied to the crop, it becomes a foodborne issue rather than a waterborne issue.

Role livestock have with *E. coli* O157:H7

Although this organism is not pathogenic to cattle themselves, calf water troughs and moist mixed cattle rations have been cited as sources of *E. coli* O157:H7 on farms. *E. coli* O157:H7 has been shown to persist in water trough sediment for at least 4 months and may even grow in the environment. Two surveys of dairy and beef cattle showed wide-spread distribution of this organism in feedlots, ranging from 63 to 75 percent of the 100 herds sampled. However, the data also showed that the entire herd was not affected; i.e., only a few cows in any given herd carried *E. coli* O157:H7, ranging from 1 to 2 percent of the total herd.

E. coli O157:H7 appears to be only a transient member of the bacterial flora of a cow, colonizing cattle from 1 to 2 months, rather than being a long-term resident. One study showed that this organism increased with dietary stress. Other influences on the *E. coli* O157:H7 are related to season, cow age, and herd size. This organism is found in cattle more frequently after May 1 and is more common in cows 3 to 18 months old. According to the National Animal Health Monitoring System, *E. coli* O157:H7 is more common in larger herds. *E. coli* O157:H7 has not been associated with manure application to grazing lands.

General measures for the control pathogens in manure

A multiple-barrier approach can be used to help control pathogen transport and proliferation. The four control points illustrated in figure 2 are:

- Pathogen import to the farm, which is intended to prevent the initial infection by these organisms.
- Breaking the cycle of pathogen amplification or proliferation in the animal operation.
- Appropriate waste management
- Pathogen export or transport from the farm.

These control points should not be treated separately. For example, waste management is an important part of the amplification/proliferation control point when feed becomes contaminated with waste. Waste management also is an important part of the export control point; adequate treatment, such as composting, may kill the pathogens before they leave the farm.

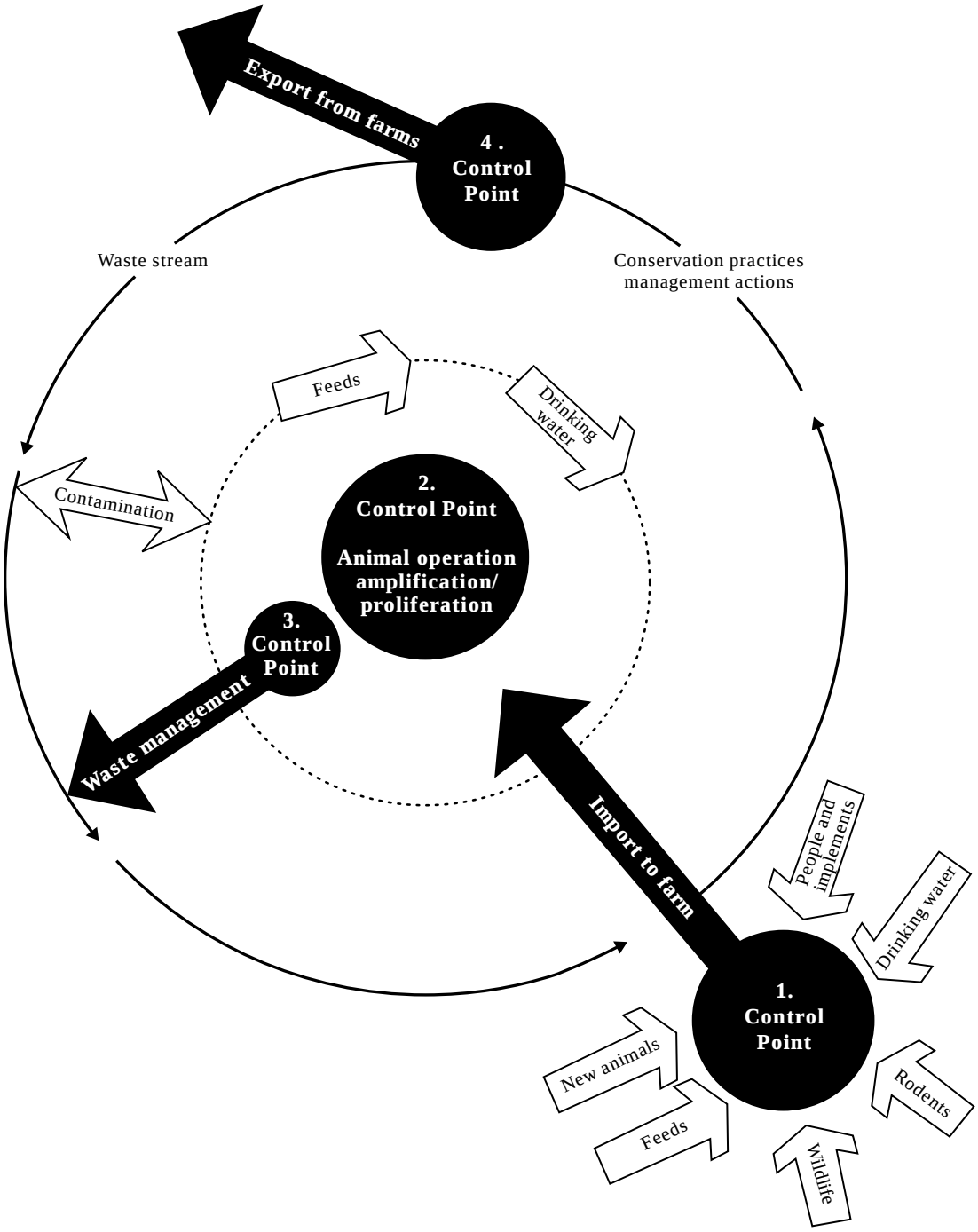
Land application of waste

The main strategy for managing the waste stream following storage and/or treatment is to control the release of pathogens from the waste application areas. Climatic conditions, application technique and timing, and where applications are made are major considerations for minimizing the loss of micro-organisms in runoff and leaching. For a detailed review of restricting features that need to be considered during waste application, the Agricultural Waste Management Field Handbook, chapter 5, table 5-3 should be consulted.

On cropland, two approaches should be considered depending on the field conditions that will most likely follow application. When storm events are anticipated, the waste should be incorporated into the soil. This allows the reduction of potentially harmful organisms through adsorption, filtration, and attack from predator organisms. Direct incorporation also reduces the potential for surface applied waste to be carried away by surface runoff. Incorporating surface-applied waste or injection of waste effectively moves organisms into the soil profile.

A second approach to waste application can be taken when soils are dry and at summer temperatures. Surface application without incorporation allows significant pathogen die-off because of exposure to UV light and desiccation.

Figure 2 Multiple-barrier points for pathogen control in agricultural operations



Conservation practices

Several conservation practices have a role in reducing pathogen load in a watershed (table 1). Details on each conservation practice are available from the NRCS National Handbook of Conservation Practices. From a watershed perspective, any practice that reduces runoff and erosion will reduce the transport of pathogen directly to surface water.

For more information, see *Waterborne Pathogens in Agricultural Watersheds*—a Watershed Science Institute Technical Note

Visit the Watershed Science Institute Website:
http://gneiss.geology.washington.edu/~nrcs-wsi/

Table 1 Multiple-barrier approach and selected conservation practices that can reduce pathogen loading to watersheds

Practice*	Import control (source)	Amplification/ proliferation	Waste management	Export control (transport)
Composting Facility (317)		**x**	**xxx**	**x**
Constructed Wetland (656)			**x**	**xxx**
Filter Strip (393) and Grassed Waterway (412)				**xxx**
Residue Management (329 & 344)			**x**	**xxx**
Riparian Buffers (390 & 391)				**xxx**
Nutrient Management (590)			**xxx**	
Sediment Basin (350)				**xxx**
Waste Management System (312) including Waste Storage Facility (313) Waste Treatment Lagoon (359) Waste Utilization (633)		**xxx**	**xxx**	
Irrigation Water Management (449)				**xxx**
Prescribed Grazing including Use Exclusion (472) and Fence (382)			**xxx**	**xxx**

* Example practices selected from the NRCS National Handbook of Conservation Practices (number indicated). A single **x** indicates an indirect relation to pathogen control, while **xxx** indicates a direct relationship between a practice and pathogen control. Additional practices may also be appropriate.