

water, and pathogens already in surface water can increase in number because of loadings of animal manure nutrients and organic matter.

More than 150 pathogens found in livestock manure are associated with risks to humans, including the six human pathogens that account for more than 90% of food and waterborne diseases in humans. These organisms are: *Campylobacter spp.*, *Salmonella spp.* (non-typhoid), *Listeria monocytogenes*, *Escherichia coli* O157:H7, *Cryptosporidium parvum*, and *Giardia lamblia*. All of these organisms may be rapidly transmitted from one animal to another in CAFO settings. An important feature relating to the potential for disease transmission for each of these organisms is the relatively low infectious dose in humans. The protozoan species *Cryptosporidium parvum* and *Giardia lamblia* are frequently found in animal manure. Bacteria such as *Escherichia coli* O157:H7 and *Salmonella spp.* are also often found in livestock manure and have been associated with waterborne disease. The bacteria *Listeria monocytogenes* is ubiquitous in nature and is commonly found in the intestines of wild and domestic animals.

e. Other potential contaminants. Animal wastes can contain other chemical constituents that could adversely affect the environment. These constituents include salts, trace elements, and pharmaceuticals, including antibiotics and hormones. Although salts are usually present in waste regardless of animal or feed type, trace elements and pharmaceuticals are typically the result of feed additives to help prevent disease or promote growth. Accordingly, concentrations of these constituents vary with operation type and from facility to facility. The other constituents present in animal wastes are summarized below. Additional information on animal wastes is presented in the preamble for the proposed rule (see 66 FR 2976–2979) and the *Technical Development Document*.

Salts. The salinity of animal manure is directly related to the presence of dissolved mineral salts. In particular, significant concentrations of soluble salts containing sodium and potassium remain from undigested feed that passes unabsorbed through animals. Other major constituents contributing to manure salinity are calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, and nitrate. Salt buildup may deteriorate soil structure, reduce permeability, contaminate ground water, and reduce crop yields. In fresh waters, increasing salinity can

disrupt the balance of the ecosystem, making it difficult for resident species to remain. Salts may also contribute to degradation of drinking water supplies.

Trace elements. The 2000 *Inventory* indicates that metals are the leading stressor in impaired estuaries and the second leading stressor in impaired lakes. Trace elements in manure that are of environmental concern include arsenic, copper, selenium, zinc, cadmium, molybdenum, nickel, lead, iron, manganese, aluminum, and boron. Of these, arsenic, copper, selenium, and zinc are often added to animal feed as growth stimulants or biocides. Trace elements can also end up in manure through use of pesticides, which are applied to livestock to suppress houseflies and other pests. Trace elements have been found in manure lagoons and in drainage ditches, agricultural drainage wells, and tile line inlets and outlets. They have also been found in rivers adjacent to hog and cattle operations. Trace elements in agronomically applied manures are generally expected to pose little risk to human health and the environment. However, repeated application of manures above agronomic rates could result in cumulative metal loadings to levels that potentially affect human health and the environment. There is some evidence that this is happening. For example, in 1995, zinc and copper were found building to potentially harmful levels on the fields of a hog farm in North Carolina.

Antibiotics. Antibiotics are used in AFOs and can be expected to appear in animal wastes. Antibiotics are used both to treat illness and as feed additives to promote growth or to improve feed conversion efficiency. Between 60 and 80 percent of all livestock and poultry receive antibiotics during their productive lifespan. The primary mechanisms of elimination are in urine and bile, so essentially all of an antibiotic administered is eventually excreted, whether unchanged or in metabolite form. Little information is available regarding the concentrations of antibiotics in animal wastes, or on their fate and transport in the environment. One concern regarding the widespread use of antibiotics in animal manure is the development of antibiotic-resistant pathogens. Use of antibiotics, especially broad-spectrum antibiotics, in raising animals is increasing. This could be contributing to the emergence of more strains of antibiotic-resistant pathogens, along with strains that are growing more resistant.

Pesticides and hormones. Pesticides and hormones are compounds used at AFOs and they can be expected to

appear in animal wastes. These types of pollutants may be linked with endocrine disruption. The 2000 *Inventory* indicates that pesticides are the second leading stressor in impaired estuaries. Pesticides are applied to livestock to suppress houseflies and other pests. There has been very little research on losses of pesticides in runoff from manured lands. A 1994 study showed that losses of cyromazine (used to control flies in poultry litter) in runoff increased with the rate of poultry manure and litter applied and the intensity of rainfall. Specific hormones are used to increase productivity in the beef and dairy industries. Several studies have shown hormones are present in animal manures. Poultry manure has been shown to contain both estrogen and testosterone. Runoff from fields with land-applied manure has been reported to contain estrogens, estradiol, progesterone, and testosterone, as well as their synthetic counterparts. In 1995, an irrigation pond and three streams in the Conestoga River watershed near the Chesapeake Bay had both estrogen and testosterone present. All of these sites were affected by fields receiving poultry litter.

2. How Do These Pollutants Reach Surface Waters?

Pollutants in animal waste and manure can enter the environment through a number of pathways, including surface runoff and erosion, direct discharges to surface water, spills and other dry-weather discharges, leaching into soil and ground water, and volatilization of compounds (e.g., ammonia) and subsequent redeposition to the landscape. These discharges of manure pollutants can originate from animal confinement areas, manure handling and containment systems, manure stockpiles, and cropland where manure is spread.

Runoff and erosion occur during rainfall when rainwater fails to be absorbed into the ground and when the soil surface is worn away by water or wind. Runoff of animal wastes is more likely when rainfall occurs soon after application (particularly if the manure was not injected or incorporated) and when manure is overapplied or misapplied. Erosion can be a significant transport mechanism for land applied pollutants, such as phosphorus, that are strongly bonded to soils.

Pollutants are directly discharged to surface water when animals are allowed access to water bodies and when manure storage areas overflow. Dry weather discharges to surface waters associated with CAFOs have been reported to occur through spills or other