EXECUTIVE summary

Water Environment Research Foundation

Stock No. 98REM1

BIOSOLIDS & RESIDUALS

Benefits

- Provides a structure for estimating risks that is consistent with current understanding of infectious disease processes.
- Provides a methodology for estimating the number of cases in a population that may be associated with biosolids exposure.
- Information can be used to develop risk-based regulations for biosolids-related exposures.
- The microbial risk assessment methodology provides useful estimates of uncertainty in risk.
- The flexible model allows for the incorporation of future data related to biosolids and/or pathogens.

Related Products

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Evaluating Risks and Benefits of Soil Amendments Used in Agriculture (stock no. 99PUM1)

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Related Ongoing Research

Quantification of Airborne Biological Contaminants from Land Applied Biosolids (project no. 02-PUM-1)

Available Formats

Soft cover and free online PDF.

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A Dynamic Model to Assess Microbial Health Risks Associated With Beneficial Uses of Biosolids: Phase 1

Regulators often use risk-based assessments to evaluate the potential health risks of exposing a person or population to a hazardous material or situation. In 1993, when the U.S. Environmental Protection Agency (EPA) published its Part 503 rule — which set limits on the amount of permissible pollutants in biosolids — the agency used risk assessments to set limits for *chemical* pollutants.

In 1993, though, methods to assess risks from pathogens in biosolids were not well-developed, so regulators set *pathogen* pollutant limits based on specific treatment methods, or other practices that had been shown to protect human and environmental health in the past.

Health-risk assessments, however, have a major advantage over these other approaches — they allow regulators and managers to consider how different control measures could be used to reduce the risk of disease.

Since 1993, researchers have advanced the science of microbial risk methodology. In this study, the project team built on those advances to develop a health-risk assessment method for exposure to pathogens from biosolids.

Methodology Development

The project team developed a microbial risk assessment framework that is consistent with the epidemiology of infectious disease transmission and the general approach recommended by U.S. EPA. The method has two components: an exposure assessment and a health effects assessment. The exposure assessment component quantifies the amount of pathogens to which individuals or populations are exposed (the dose). The dose is then input into the health effects component, which quantifies the associated health risks using a model that incorporates properties unique to infectious diseases, including person-to-person transmission and immunity (see Figure 1).

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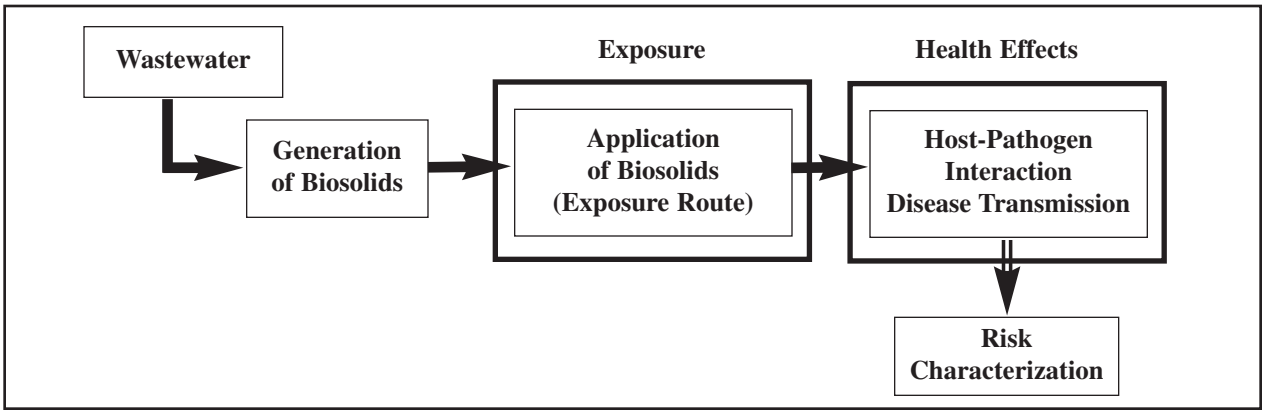

Figure 1. Risk Process Diagram

The project team applied this framework to pathogens in land-applied biosolids. First, they identified the factors that influence pathogen exposure and transmission rates. For exposure, factors include application rate of biosolids, concentration of pathogens in biosolids, additional sources of pathogens in soil, and pathogens' die-off or growth rate in soil.

Transmission factors include rate of person-to-person transmission, immunity in the population, percentage of carriers who are unaware that they are carrying the disease, and the disease's incubation period. The project team's model incorporates all of these factors and accounts for the interdependency of some of them.

The final model provides an estimate of attributable risk — the number of cases of an illness in a population associated with a particular exposure (in this case, exposure to biosolids).

Methodology Demonstration and Risk Characterization

The model identifies the data needed to estimate health risks from pathogens in biosolids. The project team's next step was to collect that data and demonstrate their model using a case study.

The team chose to use enteroviruses as a model pathogen, and conducted a literature review to find the necessary data. They also chose to focus on the simplest route of pathogen exposure — direct ingestion of biosolids-amended soil. Other routes of exposure to pathogens from land-applied biosolids could include surface water ingestion, groundwater ingestion, plant ingestion, and inhalation. Although the team chose to focus on only one route, their model is applicable for all of these routes if the data is sufficient.

The team used the model to map out high-risk and low-risk conditions for biosolids-based pathogen exposure. They found four important factors that strongly influenced the risk level:

1) Ratio of exposure due to biosolids, as compared with exposure due to other environmental factors;
2) rate of infectious individuals shedding pathogens into the environment;
3) rate of person-to-person transmission; and
4) duration of immunity.

The project team found that the risk of disease due to biosolids is low when 1) pathogen exposure from biosolids is small compared to exposure from other sources, 2) pathogen-shedding rate is either high or low (but not medium), and 3) secondary transmission rate is relatively high.

Conclusions and Recommendations

This project developed and demonstrated a risk-based methodology for assessing the risk to human health from exposure to pathogens via biosolids. The methodology will be useful at both the regulatory and operational levels — regulators will be able to use it to review and revise pathogen regulations in the Part 503 rule, and operators will be able to use it to quantify differences in the potential health impacts of various biosolids treatment processes.

However, further research is needed to test the model with scenarios that are more realistic than the simplified case study used in this research. WERF has begun work on a second phase of the project, which will use the model to characterize the risk associated with real world biosolids application scenarios.

The research on which this report is based was funded, in part, by the United States Environmental Protection Agency through Cooperative Agreement No. CR-825237 with the Water Environment Research Foundation (WERF). Unless an EPA logo appears on the cover, this report is a publication of WERF, not EPA. Funds awarded under the Cooperative Agreement cited above were not used for editorial services, reproduction, printing, or distribution.