Long Term Goal 4: Tools and methods to assess and reduce human health risks from biosolids contaminants

Introduction

Biosolids are sewage sludge that has been generated from wastewater treatment plants (WWTPs) and undergone treatment to meet federal and state standards for use and disposal. Biosolids are generated in large volume and are either disposed of by incineration or landfilling or reused as agricultural fertilizer providing a source of nitrogen and phosphorus. Today, the majority of biosolids are applied to land. The chemical and microbial contaminants in of wastewater treatment plant residuals pose a potential threat to human health and the environment. As the nature of the products society uses evolves, so does the content of society's wastewater. As a result, the nature of the chemical and microbial contaminants in biosolids present evolving challenges to the environment. For example, antibiotic resistant bacteria are of growing concern as the result of the number of antibiotic household products and medications exerts evolutionary pressure on the microbiota in the nation's wastewater stream. Antibiotic resistant bacteria are commonly found near sewage treatment plant outfalls and may be present in biosolids. Endocrine disrupting chemicals (EDCs) are also a concern.

EPA began regulating sewage sludge disposal or beneficial use in 1979 (40 CFR, Part 257), updating the regulations in 1993 (40 CFR, Part 503). These regulations set risk-based concentration standards for chemical contaminants in biosolids and operational standards for pathogens that require adequate sewage sludge treatment and, in some cases, restrictions on how land application is conducted. In 2002 the National Research Council (NRC) published a report[1] at the request of the USEPA that evaluated the technical basis of the chemical and pathogen regulations applicable to sewage sludges that are applied to land to see if they adequately protected public health. As a result, EPA developed an action plan which included a set of near-term research activities to be conducted by ORD[2]. Since sewage sludge disposal is regulated under the CWA, ORD added LTG 4 to the WQ MYP to describe the research that is being done.[3] However, this Biosolids Research Program only addresses human health impacts, since that is the EPA priority. LTG 4 research resources are small relative to those in any of the other three MYP LTGs.

ORD has been conducting research on biosolids since the late 1960s, and supported OW in the development of the 1979 and later 1993 regulations and in Agency actions that followed, some of which were required by Congress or litigation. The level of research in the late 1990s and through 2002 was modest, but important activities, such as the chairing of the Pathogen Equivalency Committee continued, as will be discussed below. The current ORD Biosolids Research Program is focused on assessing and controlling exposure to stressors associated with biosolids land application. There were four MYP Science Questions initially described for LTG 4:

[1] *Biosolids Applied to Land: Advancing Standards and Practices* (2002)
[2] 68 FR 7553
[3] Since 2003, biosolids risk assessment studies have been moved to the ORD Human Health Risk Assessment Research Program. For completeness, that limited work is described here.

1. Do contaminants in biosolids pose a significant health risk to the public when applied in compliance with current regulations?
2. What additional models, tools and methods are needed to identify, measure, and assess aggregate exposure pathways and risks?
3. What improved analytical techniques can be developed to adequately determine pathogen and priority toxic chemicals in or released from biosolids?
4. What is the current state of management practices for biosolids production and application, and how can those be made more effective?

Based on an assessment of research uncertainties, available ORD expertise and EPA needs, ORD decided to focus primarily on pathogen issues, although some chemical issues are being considered. ORD is not currently conducting any research that *directly* addresses the first Science Question, but has supported OW in discussions with the CDC about setting up a means of working with local health officials to respond to complaints arising in communities close to biosolids application sites. ORD is also working with the Water Environment Research Foundation (WERF) on the development of a health response protocol. Also, the results of addressing the other three questions may help the Agency address the first question.

Research Framework

ORD's Biosolids Research Program is addressing the last three of these science questions, focusing particularly on pathogens issues because of ORD's established expertise in microorganism analysis, treatment and health risk assessment.

Science Question #2 – Two approaches to determine the significance of exposure in communities near biosolids application sites are a) modeling of the transport and fate of pollutants after land application occurs and b) measurement of pollutant concentrations in proximity to individuals in the community. ORD is addressing the viability of both.

Studies have been conducted over the years by EPA to understand the significance of routes of exposure from biosolids land application. Exposure via the air pathway has not been well studied to date. In addition, confirmation was needed that the fate of pathogens in soils was such that 1993 site restrictions for application of Class B biosolids are adequately protective. As a result of the NRC report, ORD started addressing these issues in 2003. Using an ORD-developed sampling and analysis protocol, one field study has been conducted to collect air and soil samples. Based on the results of that study smaller, more focused field studies will be conducted to refine and optimize the sampling protocols. ORD is also working with the Water Environment Research Foundation (WERF) to identify an optimal protocol for exposure assessment and will hold an exposure measurement workshop. In addition, ORD is reviewing the availability of models and data for assessing exposure and risk of infection from exposure to biosolids-borne pathogens. WERF and others have several ongoing studies to develop risk assessment methodologies and EPA will be evaluating the results. If current assessment methods are adequately robust, they may allow for substitution of risk-based criteria for

existing process-based criteria which would help to address the uncertainty about the protectiveness of existing regulations.

Science Question #3 – A critical aspect of studying the fate of contaminants during sewage sludge treatment and land application is being able to measure pollutants in treated and untreated sewage sludge. Proper analytical techniques are also needed. Analysis for pollutants in sludge matrices is inherently difficult, and this is particularly true for microorganisms. The 1993 regulations specify indicators that must be used to demonstrate effective sewage sludge treatment, depending upon the end use of the resultant biosolids.[4] ORD has been conducting research to develop improved methods for detecting these indicators. In 2004 ORD completed standardization and validation of draft methods for fecal coliform and *Salmonella* and provided them to OW to promulgate as standard methods. Research is underway to develop revised methods for detection of enteric viruses and viable Helminth Ova in biosolids. Studies are also underway on how to measure specific pharmaceutical and personal care products (PPCPs). In addition, in collaboration with the ORD EDC Research Program, the WQ Research Program is developing methods to characterize EDCs in biosolids.

There is an ongoing effort to look for new and better indicators of both the possible presence of pathogens and the disinfection effectiveness within biosolids. An international conference was held in Cincinnati in 2001 and recently the EPA's Pathogen Equivalency Committee (PEC) held a retreat with numerous international experts to identify emerging pathogens and issues associated with their presence in biosolids used in land application.

Science Question #4 – To minimize any potential health effects of biosolids land application ORD has been conducting research and providing technical support to EPA Regional Offices, States and others on how to optimize the effectiveness of conventional treatment techniques. ORD has also been supporting the development of innovative treatment options by chairing the PEC.

Research is underway to evaluate the effectiveness of Class B disinfection and vector attraction reduction processes and how to optimize them. Based on technical support activities, workshops and in-plant research, guidance is in preparation for alkaline treatment of sewage sludge that describes how to maximize pathogen and vector attraction reduction while minimizing objectionable odors and alkaline usage. An EPA process design manual for sewage sludge treatment, use, and disposal is being updated in collaboration with the Water Environment Federation and the Water Environment Research Foundation.

The EPA created the PEC in 1985 to make recommendations to EPA Regional and State managers on the equivalency of innovative and alternative sewage sludge disinfection technologies and processes ands currently consists of members from several EPA offices and the CDC. The PEC plays the very important role of assessing the efficacy of

[4] Class A biosolids must undergo more extensive treatment for pathogens than Class B biosolids, but there are site restrictions that must be met when Class B biosolids are land applied.

innovative treatment techniques and thereby helping to keep cutting-edge, cost-effective treatment options available to industry. Since 1989 the PEC has authored the document *Environmental Regulations and Technology: Control of Pathogens and Vector Attraction in Sewage Sludge*, which is the primary reference for regional, state, and local regulators.

Future Research

Future research by ORD in biosolids will include a continuation of the development of guidance on appropriate techniques to characterize biosolids and assess pollutant releases during land application, as well as research on improved application of treatment options, chairing the PEC and providing technical support to the Office of Water and EPA Regions.