Biosolids

THE CHALLENGE

In the United States alone, billions of gallons of water are used each day—flushed and rinsed down drains to be cleaned at wastewater treatment facilities. But once the water is clean, a different challenge remains: determining what to do with the solids that are removed during the treatment process. The resulting mixture is often a unique semi-solid blend of organic and inorganic materials, trace elements, chemicals, and even pathogens, so there is no across the board solution for handling and processing the combinations of constituents that may be present.

Weighing in at more than seven million dry tons per year, the sheer volume of solids is something many facilities struggle to manage. Because they are often rich in nutrients, like nitrogen and phosphorus—which also happen to be the perfect ingredients for promoting healthy soil and plant growth—many facilities have turned to land application. But before these solids can be put to use for things like fertilizing farmland, they must be safe—undergoing rigorous treatment to meet stringent regulations, at which point they become known as biosolids.

THE RESEARCH

Beginning in the 1980s, WRF emerged as an early leader in biosolids research. When the U.S. Environmental Protection Agency (EPA) released their standards for the disposal and use of sewage sludge a decade later, this research continued to provide much-needed tools and guidance. Since that time, WRF has taken on more than 100 projects in this area, building a $20-million body of research. Research focuses include disposal, thickening and dewatering, treatment optimization, biosolids quality, beneficial use, risk assessment, and communication.

WRF quickly realized that sound biosolids research requires involvement from a broad group of participants and has built long-lasting relationships with strategic partners, including state and federal agencies, universities, water facilities, biosolids management companies, conservation groups, and citizens. Key collaborators include EPA, the Water Environment Federation, the New York City Department of Environmental Protection, the California Association of Sanitation Agencies, the Northeast Biosolids and Residuals Association, and the Mid-Atlantic Biosolids Association.

In 2003, WRF and EPA took the first step in creating an inclusive, transparent research plan by hosting the National Biosolids Research Summit. The landmark event brought together a diverse group with a variety of views, including industry experts, academics, private citizens, as well as the Centers for Disease Control and Prevention. Together they laid out a five-year plan to address the most pressing biosolids issues. A group of WRF subscribers, including water facilities, consultants, and others then stepped forward to collectively fund more than 10 resulting projects.

Treatment and Management

Solids and residuals treatment and handling make up one of the biggest components of a treatment facility's budget, so making sure these processes are efficient and effective is a top priority. WRF has consistently led efforts to improve treatment methods with research that tackles

SOLUTIONS IN THE FIELD: DC Water

In the early 2000s, the District of Columbia Water and Sewer Authority (DC Water) was at a crossroads: double down on existing biosolids technology at their Blue Plains plant, which was in need of millions of dollars in upgrades, or completely innovate their biosolids program. They chose to innovate—but they wanted to be sure they had the science to back it up. The ground-breaking process they developed was a result of a decade of research from five WRF-funded projects and a unique collaboration with Bucknell University and Brown and Caldwell.

Going live in 2015, DC Water invested $470M in the project to dramatically transform the way wastewater solids are processed and managed. Applying some of the latest advances, it is the first installation of the Cambi™ thermal hydrolysis process in North America, and also integrates a state-of-the-art dewatering facility, combustion gas turbines, and four 80-foot anaerobic digesters. The resulting savings more than pays for the cost of the project, and the benefits are many. DC Water has cut their biosolids production in half, boosted the quality of their biosolids above class A levels, lowered their carbon footprint, and they are now generating enough electricity to meet about a third of Blue Plain's energy needs.

the issues from all angles—from ways to drive down treatment costs and waste products to processes that create higher-quality products.

Because hauling and disposal costs are tied directly to the amount of solids generated and their water content, WRF has made strides in identifying processes and technologies that reduce volumes and produce drier products. In 2000, WRF released the results from a comprehensive study on polymers, the additives used by facilities to boost thickening and dewatering. The report, *Analysis and Fate of Polymers in Wastewater Treatment* (94REM2), breaks down impacts of excessive chemical dosing and helps identify appropriate levels, significantly reducing polymer use in the dewatering process and leading to automated technology, which saves treatment facilities more than $20 million each year. *Evaluation of Processes to Reduce Activated Sludge Solids Generation and Disposal* (05-CTS-3), a multi-year study that evaluates some of the latest technologies, provides a framework for facilities to simulate these innovations at their sites and predict potential sludge reduction.

Risk Assessment

When it comes to land application and disposal of biosolids, public health and environmental protection are the ultimate goals. Reducing the potential impacts from trace organics and pathogens is key. WRF has been working to improve detection, monitoring, quantification, and treatment of these pollutants and to provide tools and information facility and industry managers need to determine treatment effectiveness.

The presence of trace organics in biosolids destined for land application has been well documented by a number of WRF studies. In 2010, WRF made significant progress in measuring the actual impact in *Trace Organic Chemicals in Biosolids-Amended Soils: State-of-the-Art Review* (SRSK5T09). The research pinpoints the highest-priority trace organics based on occurrence, bioaccumulation, and toxicity and details how each is affected by specific processes. Building on these findings, it creates a path to evaluate and model risks from human and ecological exposure.

Continuing this same line of research, WRF's project *Developing Exposure and Toxicity Data for Priority Trace Organics in Biosolids* (TOBI2R15) is studying three significant trace organic compounds: polybrominated diphenyl ethers, azithromycin, and ciprofloxacin. With the end goal of assessing risks for biosolids-amended soil, the research will answer many questions that will help guide decision makers, water facilities, regulators, product manufacturers, and consumers.

WRF has also significantly advanced the science behind assessing risk from pathogenic activity in bacteria, viruses, and other microorganisms. Because accurate microbial detection hinges on proper sampling, WRF released some of the water sector's first guidance on biosolids collection and handling in the field that is based on EPA-approved methods. Although sampling techniques previously had been verified in the lab, research showed that field practices varied widely. The field guide, *Biosolids Quality Control and Quality Assurance Procedures: Guidance for Samplers* (04-HHE-7FG), outlines consistent, effective protocols, resulting in more reliable microbial measurements.

As advancements in pathogen risk assessment continue to develop, WRF is helping facilities, land appliers, and regulators take advantage of this progress by developing tools based on the latest science. In 2011, WRF launched the SMART Biosolids tool (SRSK3R08a), which incorporates a microbial risk assessment model, allowing land appliers to gauge the potential for health effects related to biosolids land application and determine which local factors provide the best conditions for safe application.

Communication

While ensuring biosolids are safe is critical, it is only the first step. Building public trust and support is the second—and it requires thoughtful, effective communication. As early as the 1990s, WRF began providing some of the first scientifically based guidance in this area—changing the way the water sector communicates about issues that cause public concern, like potential risks and odors, and opening up a clear and transparent conversation.

In 2011, WRF released a suite of research that focuses on public perception, including *A Primer for Biosolids Professionals* (SRSK2R08a) and several tools to help in the development of outreach programs in communities where biosolids are applied. Adapted from processes in place at health agencies and piloted at several water facilities, the research outlines how to design, conduct, and evaluate effective communication efforts.

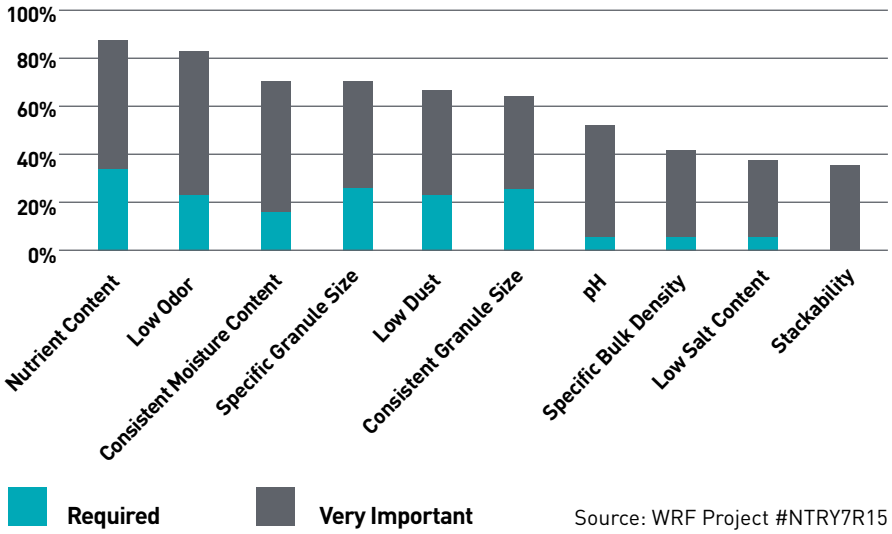
A Protocol for the Surveillance and Investigation of the Concerns Reported by Neighbors of Land Application (08-HHE-5PP), published in 2012, outlines one of the first approaches for biosolids-related human health investigations that relies on public partnering. Pooling expertise from public health organizations, regulating agencies, conservation groups, community leaders, private citizens, academics, water facilities, and others, the process is designed for use by a broad base who may not have a public health background. It helps the public accurately describe and document complaints, which can then be used to track trends in health symptoms and other concerns.

Resource Recovery

As facilities continue to labor over what to do with the byproducts of wastewater treatment, many are exploring innovative ways to give them new life. WRF is working to increase the quality of solids to open up new application options, as well as tapping into their potential as a clean, sustainable energy source.

Because higher quality biosolids have the potential for greater use, WRF has been helping to define what it takes to

WHAT ARE CUSTOMERS LOOKING FOR IN BIOSOLIDS PRODUCTS?



Source: WRF Project #NTRY7R15

meet the standards set in EPA's 40 CFR Part 503 regulation. Odor continues to be the most common reason for public complaints around land application—making it one of the biggest roadblocks for use. The project *High-Quality Biosolids for Wastewater* (NTRY7R15) has already taken a big step forward in this area, developing a method to measure odor concentration in relation to treatment methods, which can potentially be used to adjust treatment to get better results.

As stricter regulations drive water facilities to use increasingly energy-intense processes, WRF is helping to balance this need by harnessing the energy contained in biosolids. In 2010, WRF launched a research area dedicated to developing new opportunities for recovering resources from wastewater and solids, focusing on areas such as biogas production, co-generation of heat and energy, and thermohydrolysis.

Co-Digestion of Organic Waste Products with Wastewater Solids (OWSO5R07) was among some of the leading research to test co-digestion at full-scale, shedding light on the amounts and types of organic waste that can safely be added to anaerobic digestion without disrupting systems. It also identifies the type of wastes that have a synergistic effect when added to biosolids, such as fats, oils, grease, and glycerol, creating a significant boost in biogas production.

The recent *Intensification of Resource Recovery (IR2)* initiative also helped push this movement forward, finding new ways to recoup valuable resources and getting the technologies that can make it happen into the field quickly. As part of this effort, WRF evaluated more than 30 emerging technologies, including many that are helping to revolutionize anaerobic digestion and heighten the final products. The results include a ranking of each technology's readiness level, which can assist facilities in finding the right solution for their site.

LIFT

The Leaders Innovation Forum for Technology (LIFT) is an initiative that helps move water technology to the field quickly and efficiently. Because biosolids technologies offer one of the most mature opportunities for facilities to produce energy, they are a major program focus. The Biosolids to Energy Focus Group is actively exploring new and evolving technologies. Among the first innovations LIFT helped to advance is the application of hydrothermal processing to wastewater sludge. The thermochemical process uses water, heat, and pressure to turn solids into renewable energy. The group is also investigating pyrolysis, supercritical water oxidation, hydrothermal liquefaction, and gasification.

According to NEBRA, management of wastewater solids can account for up to 50% of a treatment facility's operating costs. WRF research is helping to improve dewatering, increase digester-loading rates, drive down solid amounts, and produce higher-quality products.

WHAT'S NEXT?

As biosolids continue to be a key issue for water resource recovery facilities, WRF will be at the forefront of researching technologies to increase digester-loading rates, improve dewatering, enhance pathogen reduction, and enrich the production of biogas. This means not only increasing research into high-tech solutions, but also low-cost, low-tech methods that facilities can easily integrate into their current processes to meet class-A standards.

Research will also continue to address long-standing concerns, such as odors, as well as areas that are gaining increased interest, like per- and polyfluoroalkyl substances (PFAS), in order to better measure impacts and provide more effective treatment options.

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