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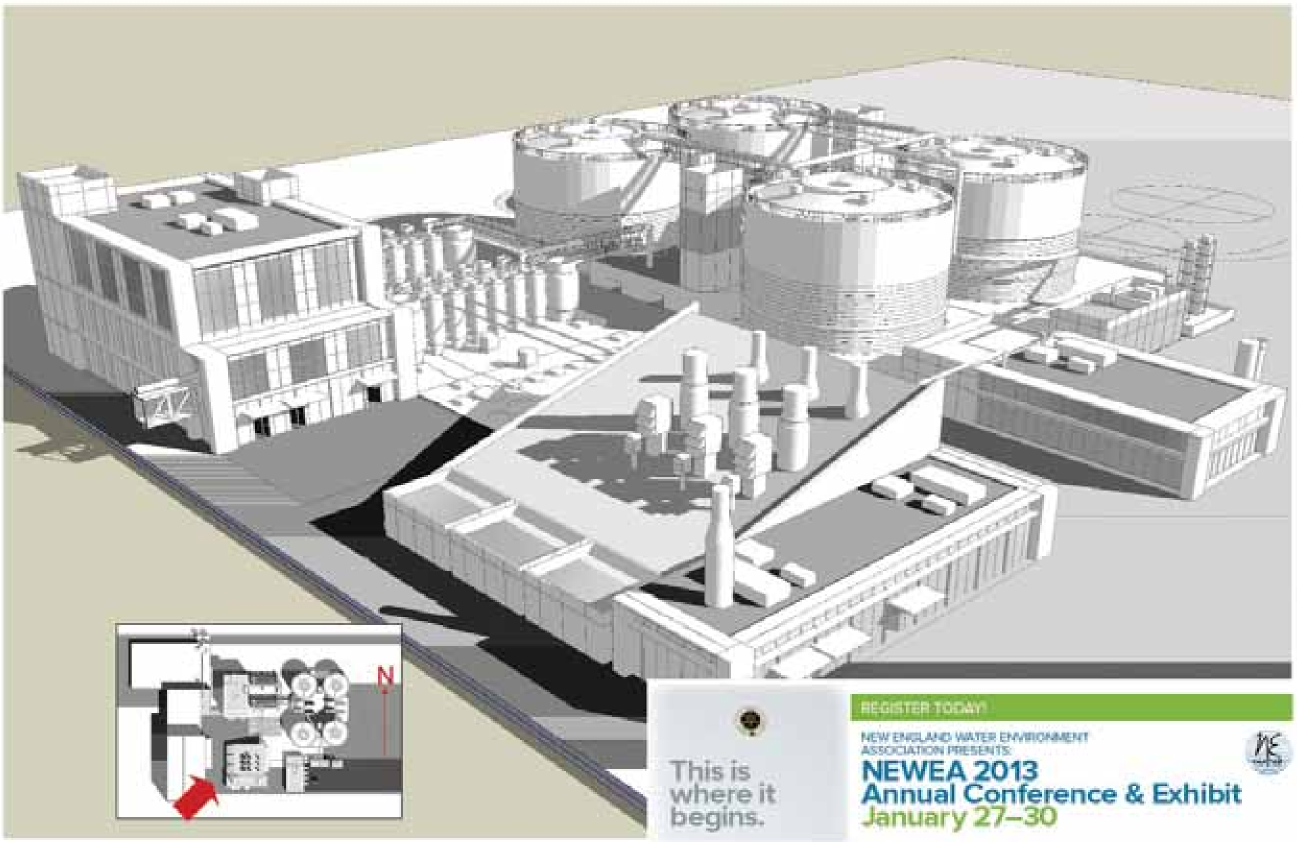

Biosolids

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Feature Article

Current Biosolids Use, Regulatory Trends, and Public Perceptions in New England

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Abstract

The following paper introduces this issue's themed section on biosolids management. It discusses current biosolids use and disposal, the regulatory environment for biosolids management and related areas such as sewage sludge incinerators and phosphorus, greenhouse gas emissions, and public perceptions. Also covered are several university research programs now studying biosolids treatment and use, along with summaries of the projects provided by the principal investigators.

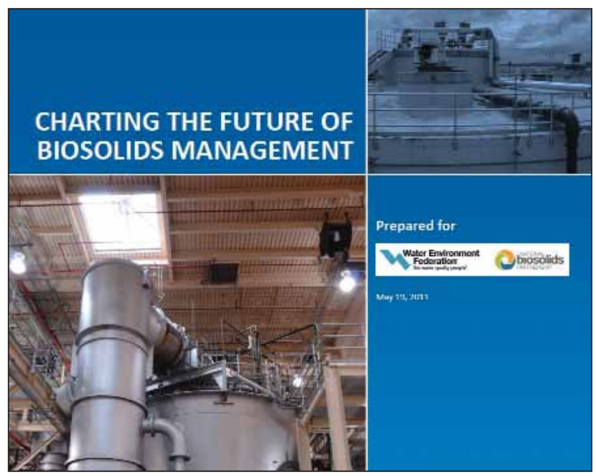
Key Words
New England, biosolids, sewage sludge, data, use, disposal, regulation

Management of wastewater solids is a continual challenge for wastewater treatment facilities, representing anywhere from 15 to 50 percent of operating costs. At the same time, there is growing recognition of the resources in biosolids, especially nutrients, organic matter, and energy – the recovery of which can lower net costs for biosolids management. Leading wastewater professional groups are emphasizing "resource recovery" from wastewater and biosolids. For example, the Water Environment Federation emphasized in its December 2011 policy statement that it "supports a comprehensive approach to wastewater treatment and solids management that ensures the recycling and recovery of valuable resources including water, nutrients, organic matter, and energy. In addition, WEF recognizes that biosolids, natural byproducts of the wastewater treatment process, are a renewable resource that is too valuable to waste…."

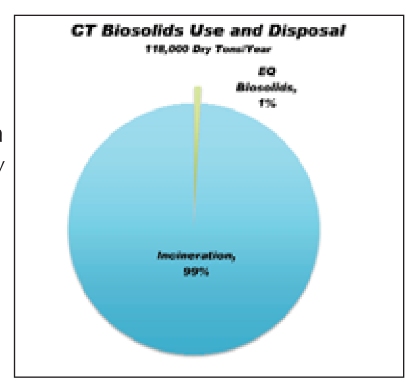
Current Biosolids Use and Disposal

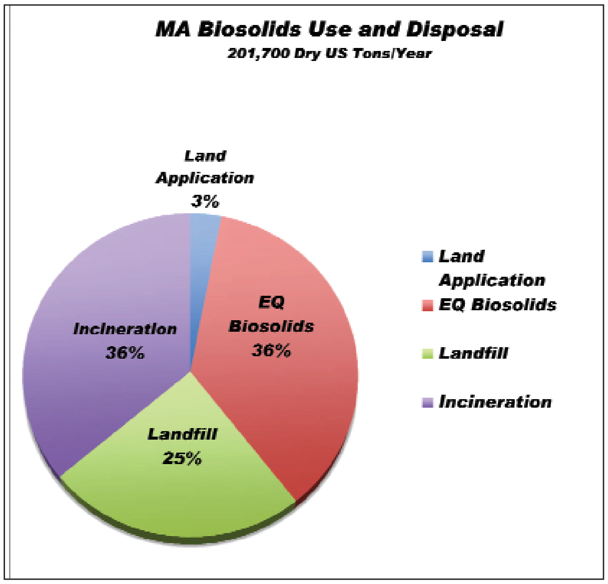
The management of biosolids in New England has not changed dramatically in the past decade: southern New England continues to incinerate most of the solids produced at its wastewater treatment facilities, while a diversity of disposal and beneficial uses are the norm in the three northern states. Updates on current use and disposal are provided below, with comparisons to the last formal presentation of such data, which was in 2004 (Beecher et al.)

Connecticut continues to incinerate nearly all of the solids produced in the state. Only one smaller facility continues to compost, down from three facilities in the mid-2000s. Because of limited tracking of this disposal, the estimated amount of solids produced remains the same as it was in 2004: 107,300 dry metric tons (118,000 dry U.S. tons). With increased interest in energy efficiency, incineration facilities are considering energy recovery systems; the New Haven facility (operated by Synagro) began electricity generation with a 512-kW turbine in 2009.



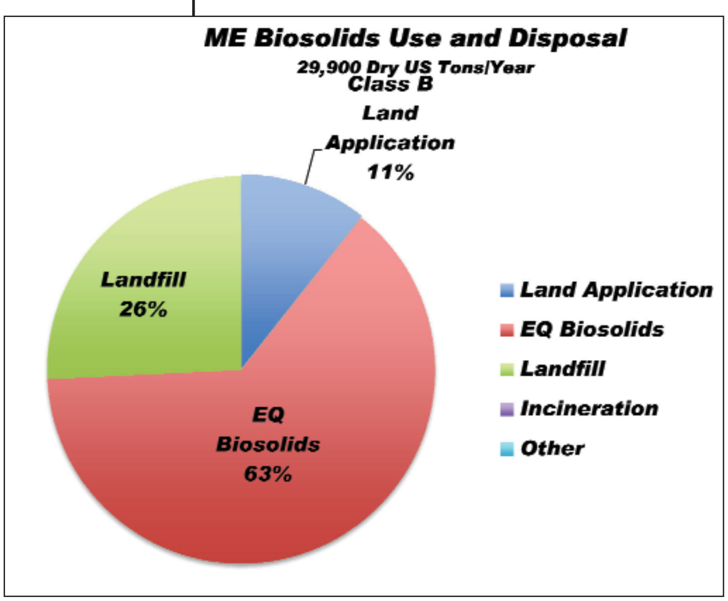
An excellent overview of biosolids management is available in this document from the National Biosolids Partnership (NBP), available from www.nebiosolids.org. NBP will soon publish a follow-on report, Enabling the Future of Biosolids.

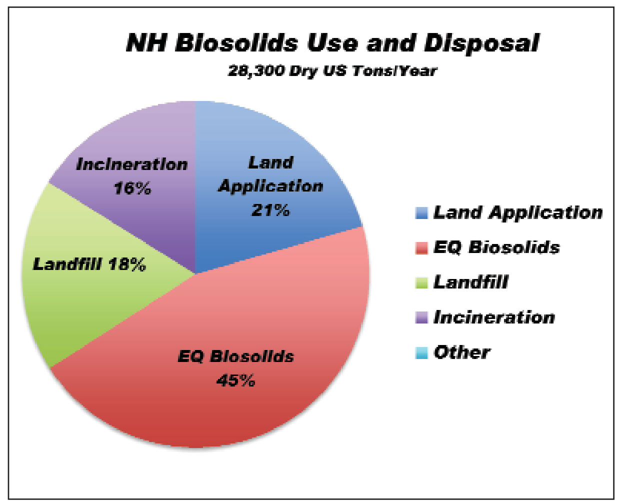




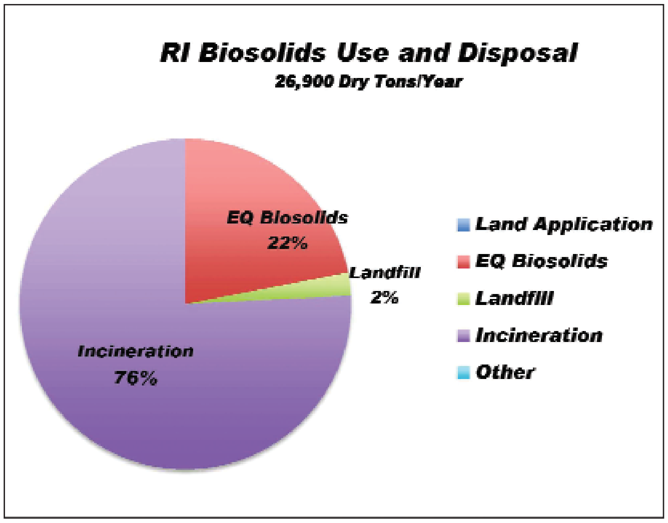
The total mass of solids managed in Massachusetts has increased from an estimated 139,400 dry metric tons (153,300 dry U.S. tons) in 2005 to 183,400 dry metric tons (201,700 dry U.S. tons) in 2011. As total production increased, the percentage beneficially used through application to soils – almost all of which is Class A EQ (Type 1) compost and heat-dried pellets (from MWRA/Boston and Greater Lawrence) – increased slightly, from 35 to 36 percent. The percentage combusted (e.g. Upper Blackstone/Worcester) decreased from 38 to 36 percent, and this decline will continue, as the Fitchburg incinerator closes in 2012. The amount combusted in 2011 includes about 3 percent (heat-dried pellets) that was used as an alternative fuel in cement kilns – a relatively new use. Landfill disposal has also decreased slightly, from 27 percent in 2005 to 25 percent in 2011.

Maine has long led the New England states in recycling of biosolids, but its rate has diminished some over the past eight years. In 2004, 79 percent of the state's 29,300 dry metric tons (32,200 dry U.S. tons) of biosolids were applied to soils, most after composting (e.g. at the Casella Organics facility in Unity) or treatment with advanced lime stabilization (e.g. NViro at the WeCare facility in Plymouth). The remaining 21 percent was landfilled. In 2011, the reported mass was 27,200 dry metric tons (29,900 dry U.S. tons) and the recycling rate had gone down to 74 percent, with 26 percent landfilled. The trend away from Class B land application has continued, from 3,700 dry metric tons (4,100 dry U.S. tons) in 2004 to 2,800 dry metric tons (3,100 dry U.S. tons) in 2011 (most by Lewiston-Auburn), while the percentage of EQ biosolids produced by the same methods is a little smaller.



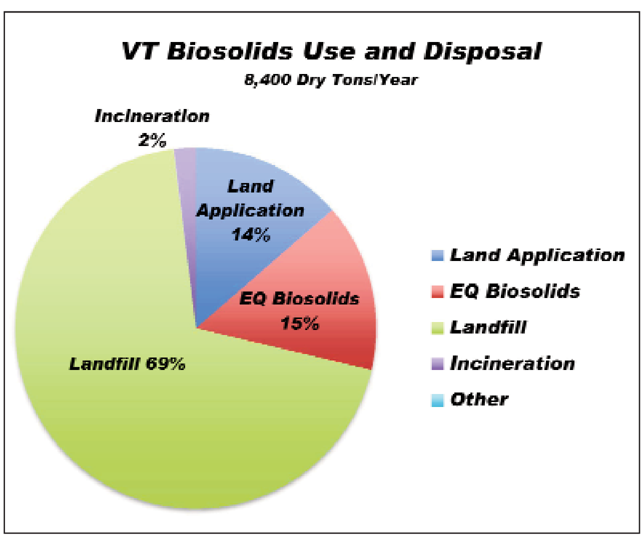


The production of biosolids in New Hampshire has increased from 24,500 dry metric tons (27,000 dry U.S. tons) in 2004 to 25,700 (28,300) in 2011. This state continues to have the highest rate of land application in the region, with 21 percent of the solids applied to farm and reclamation sites in 2011, up from 15 percent in 2004. Most of this is Class B, but some is advanced lime-stabilized Class A biosolids from Concord; most is managed by Resource Management, Inc. Class A EQ biosolids production has decreased in recent years – from 53 percent in 2004 to 45 percent in 2011, due to the cessation of some composting operations (e.g. Dover). Landfill disposal has increased slightly, from 15 percent in 2004 to 18 percent in 2011. Manchester continues to be the only incineration facility in the state, accounting for 16 percent of the state's solids.



Rhode Island has long relied on incineration for disposal of its wastewater solids an estimated 24,500 dry metric tons (26,900 dry U.S. tons) in 2009, down from 25,000 (27,500) in 2004. However, in the past few years, some of the solids produced at the Bucklin Point facility operated by Narragansett Bay Commission have been sent out of state for treatment and beneficial use. Therefore, the percentage of solids incinerated has gone down from 89 percent in 2004 to 76 percent in 2009, and EQ biosolids use has increased from 7 percent to 22 percent in the same period. The small amount of landfill disposal has been cut in half, from 4 to 2 percent.

Vermont reported production of about 8,200 dry metric tons (9,000 dry U.S. tons) of solids in 2004; that number was down to 7,600 (8,400) in 2011. Of that, 69 percent was landfilled and 2 percent was incinerated in 2011, a dramatic increase in disposal from 2004, when the state reported 61 percent EQ production and 9 percent land application. Most of the change came when the solids from Chittenden County (Burlington and surrounding communities) were no longer composted in Quebec, but instead began to be landfilled. The biosolids recycling rate is now just 29 percent, split equally between Class B land application and production of Class A EQ materials (composts).



Diverging Regulations Affecting Biosolids Management

Nationally, the 20-year-old 40 CFR Part 503 rule remains a consistent structure by which biosolids are managed. Over the past 15 years, two National Academy of Sciences reviews and regular biennial reviews have found biosolids recycling to soils to be reasonably protective of public health and the environment, and have not led to any changes to Part 503. However, there is ongoing discussion of potential future minor changes to the rule, including eliminating some options for pathogen reduction, updating some of the referenced analytical methods, and establishing an Exceptional Quality (EQ) biosolids numerical standard for molybdenum (Mo). Yet even with speculation about a future rule change, EPA continues to reduce staffing and budget for the biosolids program. For example, this year, EPA reduced the budget and staffing for biosolids monitoring by the Office of Enforcement and Compliance Assurance (OECA). EPA considers biosolids to be a relatively low risk, and the self-implementing Part 503 rule is widely considered adequate.

In New England, states have additional biosolids regulations that go beyond Part 503 and obviate reliance on EPA. These state regulations have stabilized in the past 10 years, with occasional updates only addressing minor issues. Each state, except Connecticut, has provisions that support beneficial use of biosolids on soils, and, as noted above, such uses are occurring (Connecticut has not addressed beneficial use comprehensively, because of its almost total reliance on incineration).

Rhode Island updated its biosolids regulations in 2011. New Hampshire will go through a required re-adoption of its rules in 2015. In Maine, the regulation was updated in 2011-12 and included reevaluation of arsenic risk, resulting in a change in the sludge screening concentration for arsenic from 10 to 34 mg/kg. In Massachusetts, where the "sludge" rules have been in place since before Part 503, there are occasional speculative discussions about updating the rules, but no definite time table has been set. Similar discussions have occurred in recent years in Vermont.

But even as the landscape of biosolids regulations has stabilized in many ways over the past decade, there has been a significant recent upheaval caused by new Clean Air Act sewage sludge incinerator (SSI) regulations from EPA and concerns raised by state legislative actions regarding nutrient management. In addition, reporting of greenhouse gas (GHG) emissions is a reality at the federal level and in Massachusetts. And Massachusetts and Vermont have acted to ban the landfill disposal of certain organic wastes. Each of these new regulations adds complexity to the biosolids regulatory landscape.

EPA's New SSI Regulations and Their Implementation in New England

The federal Part 503 rule includes sections applicable to sewage sludge incinerators (SSI). But in 2007, a court ordered EPA to apply to SSIs the Clean Air Act (CAA) Section 129 standards – the standards for facilities combusting solid waste. The resulting SSI regulations, finalized in February 2011, are of two parts: One change clarified that sewage sludge that is combusted is considered a non-hazardous solid waste.[1] Thus, sewage sludge is to be regulated under Section 129 of the CAA, rather than under the less stringent Section 112. Under Section 129, EPA created a second set of regulations: Maximum Achievable Control Technology (MACT) numerical standards for emissions from SSIs (40 CFR Part 60 Subparts LLLL and MMMM). One set of the MACT standards applies only to new SSIs, with different ceiling limits for multiple hearth or fluidized bed incinerators, and one set applies only to existing SSIs. The result is that SSIs are now regulated under both Part 503 and these new CAA Section 129 standards.

States may develop regulations to implement these new SSI standards; initial state plans were to be delivered to EPA earlier in 2012, but many states are behind schedule. All six New England states have begun to act. Maine and Vermont have submitted negative declarations to EPA, noting that they have no SSIs; they need not take any further actions. Connecticut and New Hampshire have agreed to adopt the federal regulatory program, once it is created by EPA; this relieves them from any responsibility for writing and submitting state-specific standards. EPA is developing its regulatory program, which is due to be published in 2013, with compliance required by March 2016; these are what will apply in Connecticut and New Hampshire. Rhode Island wrote and submitted its own draft plan to EPA in October 2011. Once Rhode Island's plan is approved by EPA, it will require compliance within three years. Massachusetts is discussing with EPA an approach that would not require the lengthy and costly process of rulemaking at the state level, but instead would rely on use of Mitigation of Air Pollution authority.

Even as states plan for implementation of the new SSI regulations, the regulations are being challenged in court by the National Association of Clean Water Agencies (NACWA) and the Sierra Club. A decision in that case is expected in mid-2013.

Southern New England has the greatest density of SSIs in North America. The full impacts of the new EPA standards are not fully known. What is clear is that incineration as an option for wastewater solids management is becoming more costly. Brockton's experience with an upgrade that resulted in compliance with the new emissions limits is discussed in a paper in this issue of the *Journal*. In contrast, the Fitchburg wastewater treatment plant is ceasing operations, due, in part, to the new regulations. This and any other shut-downs will significantly increase the supply of wastewater solids to be managed in the New England market, thus requiring additional beneficial use or landfill disposal capacity.

[1] Even biosolids used for energy generation have been deemed by EPA to be solid waste when combusted and not meet EPA's definition of "legitimate fuel." However, in the final rule, individual biosolids products may petition EPA to gain recognition as legitimate fuel and thus avoid being defined as a solid waste subject to CAA Section 129; nationwide, two products have successfully petitioned EPA in this way.

Note that there was also initial uncertainty as to whether, under the new SSI rules, EPA was going to consider biogas to be a "biosolids" – and thus a "solid waste" – meaning that when it is combusted, Section 129 permitting would be required. EPA clarified that this was not the intent, and regulation of the emissions from biogas combustion remains unchanged.

Tracking and Reporting Greenhouse Gas Emissions

In the last few years EPA's Office of Air and Radiation has also begun addressing greenhouse gas (GHG) emissions. A few larger wastewater treatment plants in the U.S., including the Deer Island treatment plant in Boston, have already begun annual reporting to EPA of GHG emissions. It is possible that, within the next five years, GHG reporting requirements will increase and may affect other wastewater treatment plants.

Besides the GHG reporting rule, the EPA Office of Air and Radiation is addressing GHGs under the existing Title V and Prevention of Significant Deterioration (PSD) standards. However, once again, only the largest facilities are required to comply at this time, according to this new and developing "tailoring rule." EPA has deferred inclusion in this new rule of biogenic GHG emissions (e.g. from biogas combustion) – until early 2014. At that time, EPA may require inclusion of biogenic GHG emissions, which is, by far, the largest GHG emissions category for a WWTP with anaerobic digestion. Further implementation of the tailoring rule will occur in 2016, so it remains something for WWTPs to monitor.

Massachusetts Moves Toward Landfill Ban on Organics

In mid-November, the Massachusetts Department of Environmental Protection (MassDEP) promulgated an initial set of rule changes to divert an additional 350,000 wet tons of certain organic wastes from landfills by 2020. These new regulations streamline the siting of moderate-sized facilities that will process source-separated organics (SSO) by composting or anaerobic digestion. MassDEP hopes that this additional capacity will be ready to handle the organic waste that will be diverted from landfills and MSW incinerators when a new landfill ban on SSO becomes effective in mid-2014. Part of MassDEP's multi-prong effort is to encourage wastewater treatment plants to take in SSO and process it using excess capacity in their anaerobic digesters. There are only six such facilities in Massachusetts. Further discussion of co-digestion of SSO and wastewater solids appears in another paper in this issue of the *Journal*.

Diverting more organic wastes from landfills is not unique to Massachusetts. Vermont has a new law imposing a ban on disposal of certain organic wastes. And similar programs are being discussed elsewhere. What these efforts mean for biosolids managers is that there will be more organic residuals in the market needing stabilization, processing, and end uses, and the expertise developed within the wastewater solids management field will be useful in dealing with these additional volumes of similarly putrescible organics.

Managing and Regulating Phosphorus

The wastewater management profession faces stricter limits on nutrients being discharged from wastewater treatment facilities. There are debates with regulatory authorities about how strict nitrogen and phosphorus limits should be in new NPDES permits – especially along the Connecticut River and in the Great Bay watershed.

In the last couple of years, states in this region have begun to impose strict limits on the same nutrients from other sources – the non-point sources, such as farms and fertilizers. And, at the end of 2011, the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) adopted new guidelines on nutrient management (the Code 590), which focus on controlling phosphorus run-off from non-point sources, such as farms and fertilizers. This action is aimed, in part, at reducing unnecessary enrichment of soils with phosphorus, which can result from use of fertilizers that contain P. Since biosolids used on soils usually have significant levels of phosphorus, they inevitably would be caught up in efforts to control applications of fertilizer-borne phosphorus: The new Code 590 specifically mentions biosolids.

Biosolids management is caught in the middle, in two ways:

- If there are going to be lower levels of nutrients in effluent, the result is higher levels in biosolids, at least with regards to phosphorus.
- Since P impacts on surface waters are real, at least in some areas, then reductions have to happen one way or the other. This makes it hard to argue against EPA's stricter standards for effluent nutrients and increased regulation of non-point sources.

The answer is to manage these nutrients with even more care and efficiency. Nitrogen has been a topic of focus for some time, and many wastewater treatment facilities have effective systems to reduce its levels in effluent. And the convenient fact with N is that it can be put into its largest reservoir – the atmosphere.

Phosphorus is different – and more complicated. When it goes through a treatment plant, there is no choice but for some to go out with the effluent and some to go out in the solids. There can be long debate about the correct balance. At the same time, the worldwide supply of phosphorus is finite, and it is vital to plants and animals. Thus phosphorus is one of the most important resources in wastewater and biosolids, and maximizing its recovery and use is becoming a hot topic in many states.

In the last few years New York, Connecticut, and Massachusetts have developed laws restricting the application of phosphorus-containing fertilizers on turf grass (e.g. lawns, parks, fields) unless a soil test demonstrates the need for phosphorus. In New York, biosolids and other organic forms of phosphorus are exempt, but in Connecticut no such exemption exists. In response to the sudden increase in state interest in this topic, the New England Interstate Water Pollution Control Commission (NEIWPCC) began a voluntary turf fertilizer initiative in 2011. The intention is to create a consensus approach to regulating fertilizer phosphorus, so that the different states end up with similar, appropriate, and balanced regulations. Those marketing and managing biosolids fertilizers and soil amendments have become engaged in these discussions.

There are solutions that address the issue of excessive phosphorus in wastewater effluent and biosolids directly: Sidestream treatments (e.g. Ostara) remove phosphorus in a mineral form, resulting in biosolids with a more balanced ratio of nitrogen to phosphorus that aligns better with crop uptake and removal. The phosphorus removed from the sidestream process can be sold as special phosphorus fertilizer for use where phosphorus is really needed. Use of such systems will improve the sustainability of phosphorus management.

Public Perceptions of Biosolids Management

Fifteen years ago, in the years immediately after the promulgation of Part 503, news headlines trumpeted local conflicts between farmers using biosolids and concerned neighbors, especially in New Hampshire, where the state regulatory agency had decided not to promulgate any state regulation. ("Part 503 is good enough for me.") At that time, biosolids land application programs were not managed as well as they are today, and public outcry led to emergency – and then permanent – regulations in New Hampshire and tightened standards in some neighboring states. The public outcry came to a head with a "sludge conference" at Boston University in 2002 and an October 2003 petition to EPA requesting a moratorium on land application of biosolids. EPA responded with a strong letter rebutting the petitioners' claims, and, over the years since, vocal public concern has diminished in this region. State biosolids regulations and the regulated programs have stabilized.

A few environmental groups, however, still provide "anti-sludge" information on their Web sites and when contacted (e.g. Clean Water Action, Toxics Action Center, Resource Institute for Low Entropy Systems). And, as Massachusetts begins to develop additional capacity for managing source-separated organics, as noted above, these groups are pushing for keeping food waste processing separate from biosolids, to not "contaminate" it.

The concerns of these groups and others are the same that have been researched and debated for decades:

- "Heavy metals," such as cadmium, lead, and mercury
- Chemicals, more recently, heightened

interest in chemicals from personal care products and pharmaceuticals, which may include endocrine-disrupting compounds (hormone mimicks) and others thought to possibly have negative biological impacts over the long term (collectively called "microconstituents")

- Pathogens – disease-causing microorganisms
- Odors and other nuisances

There is considerable research into these concerns – a focus of the 2002 National Academy of Science review of the Part 503 regulation that found no imperative to change the regulation.

Public attitudes toward wastewater and biosolids will continue to potentially affect state regulations and management of biosolids in New England. Those involved in biosolids management have a significant interest in ensuring a scientifically valid approach that protects the value and diversity of uses of their biosolids products. They must regularly and consistently provide information and education about the importance of wastewater treatment and solids management, to keep the public informed and to allay concerns.

New England Biosolids Research

Several university research programs are currently studying biosolids treatment and use. Synopses of these diverse projects are provided by the principal investigators.

Dr. Rebecca Brown, University of Rhode Island – Roadside Residuals Trial
This trial is evaluating a variety of urban residuals for use on roadsides and determining the best application rates. The optimal application rate will provide sufficient fertility – especially nitrogen – to enable standard turfgrass species to establish and persist for multiple years, without causing unacceptable levels of nitrate leaching.

The trial was established in September 2012 in the median of a limited access highway in North Kingstown, R.I. Seven different residuals were applied at three rates per residual, along with an untreated control. The experiment was laid out as a randomized complete block with three replications. Each plot is 105 square feet and runs from the edge of the pavement to the edge of the drainage swale at the center of the median. Residuals tested include yard waste compost, composted biosolids, blended yard waste and biosolids compost, heat treated biosolids, lime stabilized biosolids, ash-stabilized biosolids, and anaerobically digested biosolids. Biosolids were applied based on available nitrogen content at rates of 1, 3, or 6 pounds of nitrogen per 1,000 square feet. Materials containing yard waste compost were applied using mix ratios of 1:1, 1:2, and 3:2 compost:soil.

After all residuals had been spread and incorporated, the trial was hydro-seeded with a blend of red fescue, Kentucky bluegrass, and perennial ryegrass. This is the standard mix used along highways in Rhode Island. An ion exchange resin capsule was installed at the downhill end of each plot to collect leached nitrate. The resin capsules will remain in place until April 2013. Turfgrass growth and survival will be evaluated beginning in April 2013 and continuing for three years.

Dr. Jordan Peccia, Yale Univ. – Pathogens in Biosolids
Since 2006, our research group has studied pathogens emitted during biosolids land application. We have done so through the integration of field-based aerosol work with molecular-based toxicity and pathogen assessment studies to understand human exposure to and infective risk associated with biosolids aerosolized during land application of class B biosolids. Our field studies provide both a comprehensive treatment and a fundamental framework for estimating pathogen and chemical emission rates when biosolids are spread onto land and disk incorporated into soils.

Given our framework for translating bulk biosolids measurements to aerosol emission rates and the ability to predict biosolids inhalation exposure at off-site locations, a second thrust of this work includes predicting potential

Research on roadside stabilization applications of biosolids compost and other fertilizers (photo courtesy of Dr. Rebecca Brown)

health impacts to nearby residents. We have determined that PM10 emitted during land application resulted in a significantly greater cytotoxicity and inflammation potential to normalized human bronchial epithelial cells than did PM10 derived from agricultural soil or animal manures. Quantitative molecular-based identification methods and culturing have been applied to a broad diversity of samples obtained from U.S. wastewater treatment facilities to populate pathogen inhalation exposure and infective risk models, and to track indicator organisms and pathogens through the variety of contemporary sewage sludge stabilization methods. Beyond estimations of exposure and health impacts, these surveys have provided insight into how current and proposed sewage sludge stabilization technologies affect human pathogen exposure and risk. Over the last three years, high-throughput, low-cost, next-generation DNA sequencing methods have been used in our lab to deeply sequence into biosolids samples for identifying the diversity of bacterial pathogens in sewage sludge. Additionally, we have produced viral metagenomes, which allow for the first in-depth view into the broader diversity of human viruses contained in biosolids and carried in human populations. Our most recent study, which includes 10 metagenomes from large U.S. wastewater treatment facilities, has observed 18 different human viruses in the resulting biosolids, and has provided insight into pathogen removal during mesophilic anaerobic digestion.

Dr. Chul Park, University of Massachusetts/Amherst – Anaerobic Side-Stream Reactor

One way to reduce sludge generation at wastewater treatment plants is to incorporate an anaerobic side-stream reactor (ASSR) into the activated sludge system. In this process sludge wastage is minimized, as a portion of return sludge undergoes anaerobic treatment in the side-stream reactor and returns back to the aeration basin. The literature studying the ASSR process has increased, and it is generally well accepted that operation of the ASSR process leads to much greater sludge reduction than can be realized with traditional activated sludge modeling. Studies from Dr. John Novak's group at Virginia Tech and our research group at UMass Amherst have shown that achieving unusually high sludge reduction through the ASSR system is due to the combination of long solids retention time (SRT), resulting from limited sludge wastage, and degradation of subsets of activated sludge which can only be degraded under aerobic or anaerobic conditions. Despite extremely long SRT involved in the ASSR process, such as 50 to 200 days, wastewater treatment operations remain normal and consistent.

Recently, our UMass research team has developed a new ASSR system, in which a very small and completely mixed reactor is used. The small, high-rate ASSR could be used in this new process because we only want to adopt short (SRT = HRT< 2 days) anaerobic treatment of sludge in ASSR, rather than long anaerobic reaction used for earlier ASSR processes, including the CannibalTM process (SRT = 10 days). Our recent studies have demonstrated that unique sludge hydrolysis happens within a short period of anaerobic digestion, which happens simultaneously with fast solublization of key floc cations and extracellular enzymes. Our bench-scale research on this high-rate ASSR process showed that a new system could achieve approximately 65-percent sludge reduction compared to a control activated sludge system and about 25-percent reduction compared to a typical ASSR system that was operated with a 10-day SRT.

In the fall of 2011, we started our pilot ASSR system at the Amherst wastewater treatment plant with the support from the town of Amherst and UMass. The system is designed to treat 500 gallons of wastewater per day and includes a high-rate ASSR (1~2 day HRT) operated at 29 to 30°C. Although we initially faced several technical challenges (this is our first pilot trial), we overcame those problems and successfully operated the pilot system over the last three months. Our pilot ASSR process led to the observed sludge yield at 0.14 mg VSS/mg CODtotal, which is about 42 percent less than that of the full-scale Amherst activated sludge system. Effluent TSS values were in the range of 5 to 20 mg/L and effluent total COD was less than 30 mg/L. The sludge volume index (SVI) values were initially high, mainly due to the characteristics of the seed sludge, but continuous operation of the system led to clear improvement in SVI, and its value after 40 days of operation became less than 150 mL/g.

Anaerobic biogas was generated from this small ASSR. The HRT of the ASSR was only one to two days and temperature was lower than typical mesophilic digestion temperature; however, we found meaningful methane gas generation from our ASSR. The ASSR produced 170 mL CH_4/g VS reduction. This value is lower than a typical CH_4 yield from a normal mesophilic digester, but it should be noted that this reactor had very short HRT and low temperature. This result is consistent with our previous bench-scale study, and we expect that the gas yield would increase substantially if we were to feed more thickened sludge from the secondary clarifier to ASSR. Generation of CH_4 in our small ASSR indicates that the activated sludge in our pilot already contained a large fraction of the anaerobic microbial community; as soon as this sludge entered into the ASSR, it developed methanogenic conditions and produce biogas quickly.

We are revising the system flow and a secondary clarifier for better operation and further sludge thickening, and we look forward to observing continuous sludge reduction and consistent effluent quality. In addition, we continue to evaluate the production of CH_4 from this small anaerobic digester (i.e., ASSR), because this biogas production is a benefit above and beyond the considerable reduction in sludge volume achieved by this unique ASSR process. ■

About the Author

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Dr. Chul Park, left, explains the ASSR process to attendees of the North East Residuals & Biosolids Conference at UMass Amherst, October 23, 2012 (photo courtesy Charlie Tyler).