Making sense of sewage sludge as a renewable resource in the urban U.S.

Fazer sentido do lodo de esgoto como recurso renovável nos Estados Unidos

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Abstract Prior to industrialization, human excrement was commonly employed as a resource for agricultural production. Following the advent of the hydraulic sanitation system, however, it became increasingly directed into waterways rather than reincorporated into terrestrial agro-ecosystems. To counter this trend, many industrial cities are seeking to use of treated sewage sludge, or "biosolids", as a renewable resource that can be applied as a soil amendment in urban recreational settings, including parks, gardens, and golf courses. This article examines how the use of biosolids in the American city of Chicago comes to "make sense" — experientially, economically, and ecologically — to users and wastewater experts. Furthermore, it considers how sanitation infrastructures, socio-cultural norms, and health considerations both contour and constrain such usage. Finally,

Resumo Antes da industrialização, os excrementos humanos eram frequentemente utilizados como recursos para produção agrícola. Após o advento do sistema de saneamento hidráulico, no entanto, o esterco humano tornou-se cada mais vez direcionado para hidrovias, em vez de ser reincorporado nos agroecossistemas terrestres. Para contrariar esta tendência, muitas cidades industriais procuram utilizar o lodo de esgoto, ou "biossólidos", como um recurso renovável que pode ser aplicado enquanto corretivo do solo em ambientes recreativos urbanos, incluindo parques, jardins e campos de golfe. Neste artigo, examina-se o uso de biossólidos na cidade americana de Chicago e como isso chega a "fazer sentido" — experimentalmente, economicamente e ecologicamente — para usuários e especialistas em saneamento. Além disso, considera-se como as infraestruturas de saneamento,

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this article identifies how direct sensorial experiences (particularly of odors or their absence) as well as notions of economic and ecological "good sense" contribute to the social acceptability of biosolids usage. However, contaminants of emerging concern that are barely perceptible in sanitation waste raise more profound questions about the challenges of urban sustainability in this period known as late industrialism.

Keywords: Human waste; sanitation; sense-making; urban sustainability; late industrialism.

as normas socioculturais e as considerações de saúde influenciam e restringem esse uso. Finalmente, este artigo identifica como as experiências sensoriais (particularmente de odores ou sua ausência), bem como as noções de "bom senso" económico e ecológico, contribuem para a aceitabilidade social do uso de biossólidos. No entanto, os contaminantes de preocupação emergente, que são quase impercetíveis nos resíduos de saneamento, levantam questões mais profundas sobre os desafios da sustentabilidade urbana neste período conhecido como industrialismo tardio.

Palavras-chave: Dejetos humanos; saneamento; fazer sentido; sustentabilidade urbana; industrialismo tardio.

Introduction

Is human waste really just "waste" or might it be something more? Prior to industrialization, human excrement was commonly employed in agrarian communities as a resource for agricultural fertilization. This practice has a deep history in many parts of the world — from the Amazon to East Asia — dating back thousands of years (Kawa et al., 2019). Following the advent of the hydraulic sanitation system, however, human bodily excesses became increasingly channeled into sewers and waterways rather than reincorporated into terrestrial agro-ecosystems (Benidickson, 2011). To counter this trend, many industrial cities have sought to utilize treated sewage sludge — now referred to as "biosolids" — as a renewable resource. While most beneficial use of biosolids is for application on rural agricultural lands, this article examines how the city of Chicago (among other cities in United States) has begun to direct more and more of its biosolids into urban recreational settings, including public and private golf courses, municipal sports fields, urban landscaping, and city parks. What this research seeks to address is how the adoption of treated sewage sludge as a renewable resource comes to "make sense" experientially, economically, and ecologically for both urban users and wastewater treatment experts.

In this article, I situate and theorize the use of biosolids within a growing body of scholarship known as "discard studies". Max Liboiron (2018) characterizes this area of study as centering on the "wider systems, structures, and cultures of waste and wasting" rather than fixating on individual forms of waste or trash as primary objects of study (see also Arefin, 2015). Discard studies thus prompts inquiry into social norms and cultural logics that perpetuate distinct forms of wasting as well as investigation into the broader political economy of waste, including how late capitalist markets find new forms of value in human-produced discards. One might note that social scientific researchers are not following far behind, discovering new sources of scholarly value in the analysis of diverse forms of waste and the social systems that produce them, including many that until recently were either ignored or overlooked: e-waste (Lepawsky, 2018), dumps and landfills (Millar, 2018; Rathje and Murphy, 2001; Reno, 2016), residential garbage collection (Nagle, 2013), marine plastics (Liboiron, 2021), and desiccated fecal dust from factory farms (Blanchette, 2019), among many others (see Hawkins, 2006).

This article seeks to contribute to this body of scholarship by examing how distinct forms of sense-making, including embodied sensory experience (e.g., Harrison, 2000; Kiechle, 2017) but also social values and cultural logics (Douglas, 1966; Reno, 2018), work to either support or contest the use of treated sewage sludge as a resource. Specifically, I ask: how do embodied sensory perceptions — primarily smell, but also sight and sound — contour biosolids use in urban recreational settings? Furthermore, how do users' understandings of what is economically and ecologically "sensible" influence their willingness to adopt and use this resource? Lastly, how do safety threats present in sewage sludge that are only barely perceptible (e.g., industrial chemical compounds and contaminants of emerging concern) represent challenges to biosolids use and social acceptability?

I approach these questions through the examination of three sites: an urban golf course, a biosolids compost pick-up location, and a multi-use city park. These three sites capture some of the diversity of biosolids use in Chicago as the city moves beyond a strict reliance on rural agricultural application toward wider urban usage. At these sites, I draw upon participant observation and semi-structured expert interviews (n = 10) with golf course superintendents, wastewater treatment workers, soil scientists, and environmental chemists to discuss the productive applications and practical problems encountered when using biosolids in urban settings. Through this examination, I show how biosolids-enriched landscapes can serve to extend the pleasures of urban outdoor recreation and ecological appreciation. This is largely possible through Chicago's

expanded production of "exceptional quality" (EQ) biosolids compost that significantly reduces unpleasant odors and is made freely available to users — from park districts and golf courses to individual homeowners and city residents. Despite the appeal of the EQ compost and the ways that its use makes "good sense" to adopters, the application of biosolids also raises alarms from some urban dwellers, particularly in relation to emerging contaminants and unregulated industrial compounds that can be present in these materials. While the potential impacts of these contaminants on human health are uncertain (and sometimes wildly speculative), the use of treated sewage sludge as a resource in urban green spaces raises broader questions about sustainability under late industrialism — a period that Kim Fortun (2014) describes as significantly limited by existing constructs to capture "the complexity and current state of ecological systems" as well as the "complex relationship between ecosystem and human health" (Fortun, 2014: 311). To put it succinctly, late industrialism exceeds our conceptual grasp in large part due to the very excesses and accelerated outputs of industrial capitalist production. Finally, I argue that while treated sewage sludge can offer many benefits to urban residents and makes "good sense" in many ways, it is all the other anthropogenic residues in our sanitation systems — the increasingly complex and diverse composition of late industrial wastes — that should give us pause. By combining an ethnographic approach to the study of late industrial waste with theoretical insights from discards studies, I highlight how the former helps to make sense of users' perceptions of value in waste while the latter makes clear the politico-economic and structural limitations of contemporary efforts to recycle sewage sludge and introduce new visions of urban ecological sustainability.

The "invention" of biosolids

In the period leading up to industrialization, many cities in Europe and Asia relied on "night soil" collectors to remove excrement from cesspits and privies, and then spread this nutrient-rich material on agricultural fields in the rural countryside. In the mid-19th century, however, a series of cholera epidemics in rapidly urbanizing Europe — largely caused by fecal contamination of drinking wells — prompted new approaches to the management of human bodily waste, including the development of the hydraulic sanitation system. As sewage treatment became the focus of intensive scientific inquiry, another major break-through occurred in the early 20th century with the invention of the activated sludge method. Under this process, sewage was placed in aeration tanks with large populations of bacteria

and within a few hours of treatment, the bacteria-laden sludge would settle out, leaving nutrient-rich solids and a clear liquid effluent. Similar to a sourdough starter, some of the settled material would then be added back into the aeration tank to treat incoming sewage. This became known as the "activated sludge process" and shortly after its invention, cities across Europe and North American began to experiment with it (see Schneider, 2012: 172). Of course, a significant problem remained: what to do with all the remaining residues?

American cities like Milwaukee and Chicago quickly identified the potential value of treated sewage sludge as an agricultural fertilizer and began to use it as such. Many other metropolitan areas resorted to landfilling, incineration, or dumping of this material into waterways. However, when the United States Congress passed the Clean Water Act in 1972 and then later the Ocean Dumping Ban Act in 1988, the disposal of sewage sludge into oceans and waterways was prohibited and use of sewage sludge became more highly regulated (EPA, 2014). Agronomists and soil scientists argued that returning this material to the soil could offer many productive benefits, but its origins and surrounding stigmas presented obstacles for marketing.

The term "biosolids" was introduced in the early 1990s by the Water Environment Federation as an attempt to rebrand sewage sludge and promote beneficial use of it, particularly as a soil amendment. The term was adopted by the US Environmental Protection Agency (EPA) in 1992 and it has stuck ever since. Under US federal guidelines, there are two distinguishable grades of biosolids: Class A and Class B (EPA, 2014). With Class A biosolids, pathogens must be reduced to undetectable levels and strict standards are applied concerning the regulation of heavy metals and offensive odors. This class of biosolids can be applied to land without restrictions and is frequently sold as a fertilizer or compost to ordinary homeowners and gardeners. Class B biosolids undergo treatment and must meet the same regulations with regards to heavy metals, but they are allowed to contain marginal levels of detectable pathogens and odors. For this reason, they also require EPA permits for their use on agricultural lands. Still, many large-scale agricultural operations use Class B biosolids, particularly for the production of commodity crops, such as corn and soy.

Today, many different US cities have marketed their own distinct brands of Class A biosolids, including Milorganite from Milwaukee (Wisconsin), Tagro from Tacoma (Washington), and Dillo Dirt from Austin (Texas). Recently, the Metropolitan Water Reclamation District of Chicago has developed its own class A compost product, referred to as EQ ("exceptional quality") biosolids. With the introduction of the EQ compost, more and more of the city's biosolids are being directed not

to farmer's fields but rather to outdoor recreation areas and green spaces in the heart of the city. In the sections that follow, I examine how this use has come to make sense for different urban users in Chicago, including those managing golf courses, home gardens, and city parks.

Site 1: The golf course

The day before the world entered into lockdown due to the novel coronavirus pandemic, I was on the phone with Steve[1], a superintendent of a public golf course on the southside of Chicago. Steve had been indicated to me by an environmental scientist working for the city and I was told he was someone with expertise in the practical application of biosolids. Although my initial research interests centered on the use of biosolids in agriculture and urban gardening, I had begun to find more and more cases of it being applied on recreational sites in the city, including social spaces marked by distinctive class privilege, such as country clubs and golf courses. The simple idea that the city's shit was working to sustain elite forms of recreation, like golf, seemed to call for further investigation.

At the onset of our interview, Steve told me: "I kind of come to golf course management from an environmental perspective". He elaborated on this point, noting his advocation for planting native prairie grasses and other vegetation in "the roughs" of the golf course while also committing to minimal use of pesticides. "You know, we still have to have a golf course", he joked, "so, you can't get away from using pesticides, but you can make your footprint as light as possible". And through this environmental approach, Steve had developed something of reputation in his professional field.

In 2005, Steve's golf course had become part of a biosolids study, led by a researcher from the University of Illinois along with soil scientists from the Metropolitan Water Reclamation District (MWRD) of Chicago. The District funded the study and provided the resources to comparatively assess the application of synthetic fertilizers alongside the city's biosolids. Steve explained that the golf course he managed had disturbed soils with heavy clays and very little topsoil, and ultimately what the research showed was that biosolids served not only as a good fertilizer, but also a good soil amendment. It even helped, he noted, with some diseases that were more prominent on the course in areas that suffered from low fertility. And, best of all, it was free: "The fact that I was able, and still am able to call up the water reclamation district and say 'hey, send over 13 semi[-truck] loads' and it literally would show up in a couple days in our parking lot. And it wouldn't cost me a dime."

However, Steve did elaborate on some of the problems he experienced

[1] All names of interviewees in the text are pseudonyms.

with biosolids use too. Specifically, we got into the issue of managing odors. While the city had worked diligently to minimize undesirable odors in biosolids — because this is widely known to be a primary barrier to adoption and acceptance of use (see Lu et al., 2012) — Steve told me that there were marked differences between the city's different biosolids products. Biosolids that were only air-dried had a better profile for use as a fertilizer — or at least, the effects were more noticeable — but the odors posed a significant problem. "The air-dried, when it gets wet… [it gives off] a total barnyard, cattle lot smell", he observed. Steve explained that he could not reasonably use air-dried biosolids during the golfing season because, in his words, "it's objectionable to our players". Not to mention, he said, golf shoes pick it up and golf cart tires do too, which can end up making a mess. For this reason, Steve and his team made the decision to only apply air-dried biosolids in the off-season when golfers were not present. This contrasted significantly with the EQ biosolids compost Steve told me "smells like any other compost", and does not call negative attention to itself. For that reason, it could be applied during the active golf season without concern.

I then asked Steve if the use of biosolids was something that many golfers at his course knew about. Or, like most people in the city, "are they largely unaware of its presence"? I wondered out loud. He responded by saying: "We tout the fact that we use it." In fact, Steve told me further: "if you visit the course's webpage, you can find information about biosolids application", along with other efforts the golf course is making to "go green".

These latter comments from Steve demonstrate how the ethos of environmentalism, or "going green", can be leveraged to justify the use of biosolids on the golf course, or other similar recreation sites in the city. But as his other comments also revealed, such environmental or ecological arguments are supported by the political economy of sanitation waste management in the city in which biosolids are provided free of cost to users, including golf courses, park districts, community gardens, and individual residents. This may also help the water reclamation district reduce some of its operating costs over the long-term by applying more of its material within the Chicago metropolitan area rather than transporting it to more distant rural areas. Not to mention, MWRD's compost program — and the infrastructural investments that came with it — have rendered biosolids more acceptable for general public use. Or, at the very least, composted EQ biosolids rarely raise any direct concerns related to the presence of noxious or unwanted odors. In the context of Steve's golf course, it would seem that as long as the application of biosolids does not disrupt players' enjoyment of the course, then the use of biosolids allows the

course and its superintendent to promote an ethic of ecological sustainability and do so "for free".

Site 2: The "bring-a-bucket" compost pile

A year after COVID-19 had disrupted nearly all facets of life, I made a brief visit with a group of environmental scientists at the Metropolitan Water Reclamation District in Chicago to understand how the pandemic was affecting their work and operations. I was received by Walter, a soil scientist who had been working with MWRD for over a decade, and he was eager to show me a recent development on a lot adjacent to the city's largest wastewater treatment plant: the "bring-a-bucket" compost pile (Figure 1).

There, EQ biosolids compost was made freely available to residents in the area. People were able to come with their buckets and fill as much as they could fit into their cars, trucks, and SUVs. Prior to the pandemic, Walter explained, the district had upwards of three years of compost that had been stored and stockpiled. But as people spent more time in their homes and gardens during the pandemic — planting vegetables, flowers, ornamentals, and landscaping — the demand for the EQ compost grew very quickly. Within a year, the stockpiled compost had been completely exhausted.

Figure 1. The "bring-a-bucket" compost pile — a site where the Metropolitan Water Reclamation District (MWRD) of Chicago provides free exceptional quality (EQ) biosolids compost to residents of the area.

It seemed that word had finally gotten out into the community. "Of course, the fact that it is free definitely helps", Walter was quick to note.

While Walter and I were visiting the bring-a-bucket compost pile, a man who had driven over in a blue Honda CRV was methodically scooping compost with a shovel and loading several large black bags in the back of his car. From the perspective of the water reclamation district, Walter explained, the free compost had created a sense of goodwill in the community, providing local residents with a product of recognizable value and utility. He told me that the long-term plan was to have similar sites at all seven facilities that MWRD managed, with the hope of making the EQ compost more accessible to residents all across the city. Previously, he mentioned, residents were able to make bulk orders and have compost delivered to their homes. But as demand had risen, the piles would save the district the hassle and cost of transporting the material and now residents could come and pick it up on their own.

Prior to our visit to the compost pile, Walter and I had met with two other researchers — Chen and Erica — from MWRD to discuss the district's biosolids program and its long-term vision. Chen told me that there was "a paradigm shift" in how they engaged with the public on questions related to biosolids, with much greater emphasis on outreach. He mentioned, for example, how they had begun producing quarterly public newsletters and giving out annual awards to notable community partners. The district also provided teaching materials for elementary schools about the city's sanitation system and the management of water resources. With the COVID-19 pandemic, they even provided virtual public tours of the facilities, guided by senior wastewater treatment workers and managers. Erica, the most recent member of the biosolids team at MWRD, added how the president of the District was active on social media too, reaching out to new audiences on platforms like Twitter. These were all different ways, Erica shared, in which the District was trying to make public outreach a bigger part of the work they do.

I then asked the researchers to what extent the expansion of urban application was part of their long-term goals. Chen explained that the bulk of biosolids (at least half produced by MWRD) would continue to be directed to rural agricultural applications, but in the past decade or two, urban use had increased significantly, including application at parks, sports fields, and golf courses. Still, Erica told me that "there can be some hesitancy" when discussing the possibility of applying biosolids at park districts where they have not worked before. "Odor is a big concern", especially for park districts, she observed. For example, one contact at a

local park district accompanied them to another park district's facility to get her own exposure to the material (and its potential odors) before committing to applying biosolids in her own district. Another district, Erica told me, was going to apply it near their town hall but wanted to make sure that "the smell wouldn't offend the mayor".

For those reasons, "it's important to have a good spreading contractor", Erica told me. She explained how one community partner had praised the "meticulousness" of their contractors after they applied material on some athletic fields in a local park district — the contractors ensured that walkways and pathways were cleared and that all that material ended up strictly on the grass. Attention to these little details were important for maintaining a good public image of biosolids. "It's not just where it is applied but how it is applied that matters", Erica suggested.

Our conversation then returned to the EQ compost and why it was important for biosolids use and "sensemaking" in the community. Walter explained to me: "the compost is really critical to our program. Its grassroots based… the residents come and pick it up, and those same residents recommend it to the park districts". Erica interjected to underscore that "it doesn't smell either". To which she added a striking assessment: "I feel like it's an ambassador for us… it's more expensive to produce but it creates a good image for us, and it really speaks for itself."

If EQ compost is understood as a kind of ambassador or representative of the district's biosolids, then it is worthy of underscoring not only what it offers for residents but also what it does not do, particularly as potential users weigh its risks and benefits. As described above, it is a free resource for gardening and landscaping, which is especially welcome at a time when many households are facing isolation and economic insecurity due to the coronavirus pandemic. But it is also experienced, in a direct sensuous way, as an "ordinary" mulch that is free of undesirable odors that might otherwise turn off users. In this manner, it is socially acceptable because it makes "good sense" both economically and experientially.

Site 3: Maggie Daley park

While researchers at MWRD have sought to promote the use of biosolids through new forms of public outreach and free EQ compost, it is important to also recognize that many recreation areas in Chicago that rely on biosolids rarely publicize or even necessarily acknowledge their use of it. Still, biosolids have served as the foundation for several new urban redevelopment projects that are reshaping Chicago and its image in the early 21st century. Perhaps the most central and iconic recreational space in downtown is Millennium Park, with its now-famous "bean" or Cloud Gate sculpture, designed by Anish Kapoor, that stands as a key focal point (Figure

2). Adjacent to it is Maggie Daley Park — a 10-hectare green space largely populated with native prairie grasses planted in over 4500 cubic meters of Chicago's EQ biosolids compost.

The biosolids used in these landscapes most certainly do not smell. Unless you read about their presence on MWRD's website, you would not really be able to "see" them either. But what do they sound like? Shortly after arriving in Chicago to begin research in August of 2019, I had stopped in an independent bookstore and purchased two booklets with exercises and experiments in "deep listening" (Bloom, 2017; 2019; Oliveros, 1974). On the train back to my Airbnb, I thumbed through these sonic meditations, wondering how attention to sound rather than smell might open

Figure 2. Cloud Gate ("The Bean") by Anish Kapoor at Millennium Park in downtown Chicago.

new lines of inquiry for me. In other words, what might "deep listening" at Maggie Daley Park tell us about the use of biosolids in urban recreational spaces as well as the social worlds that have, at least in part, been created through them?

The following day, strolling through Maggie Daley Park with my audio recorder in hand, I attempted to apply these lessons in deep listening. There I heard:

1. Drums from the Frank Gehry-designed amphitheater boom across the space as people — more like ants with smartphones — crawl around and snap pictures of loved ones to share with other loved ones (and maybe also enemies?) on the internet.
2. Water trickles in from the Lurie Gardens. Then more water trickling, falling, flowing. My breathing (?).
3. A man leads a tour of visitors and points out to the gardens and says "[the great thing is that] these plants inhabited the Great Plains and this area".
4. At Maggie Daley Park's western entrance, the wind blows through the microphone, rumbling. A woman asks a companion: "Wanna go this way?"
5. Sounds of sprinklers tending to the thirsty grass. A helicopter flies over head. Car traffic on Columbus Drive. In the distance, footsteps.
6. The quiet chirp of crickets grows until it's not so quiet at all, but ringing loudly, brightly.
7. A sprinkler's stream hits the trunk of a skinny tree. A bird chirps. The wind comes at the little microphone in my recorder even harder.
8. I stop to jot down notes, scratching on to paper: "sprinklers, car traffic, helicopter, crickets, Spanish & English & Japanese, the breeze".
9. A long line of preschool children in yellow vests. One of the children: "Are we going this way?" An adult: "Watch out friends, move over."
10. Long strides. Crickets with different pitches, rhythms. Car traffic. The air.
11. A white man in scrubs walks by, talking about the overcast sky to someone on the phone. The sun has yet to come out. He tells the person on the phone: "[But] yesterday it did while I was out on the boat and so I got a good, nice… what works for me is a sun tan. Which is really a red, you know, I get red".
12. People walk by, chatting. "Gimme water" one says.
13. "I have an imaginary pet", a young girl states plainly. I don't catch her comment on my audio recorder. I later write it down.
14. More chatter from people. "Yeah, yeah." "I mean, we are, but like mainly…"
15. The rumble-rumble of the wind in the microphone. Crickets. Cars. Crickets. Chatter. Children's voices. Adult's voices. All indistinct.
16. "Where are we going to?"

At the end of my recordings, I find a public art piece that is painted on the ground in black and white in a long

swoosh-like shape. It defies audio capture, but shares the following sequence of statements:

"ASSUMING A POSITION"
"PRESUME A DESTINATION"
"ONE CAN ONLY IMAGINE THE POWERS THAT BE"
"IMAGINED THINGS CAN BE ALTERED TO SUIT"
"SPIT INTO THE WIND. HOPE FOR THE BEST"
"THE DESTINATION IS STRAIGHT ON"
"OUT OF SIGHT"

Of course, I cannot help but think what remains out of sight is not just our individual or collective destinations, but also the biosolids that sustain the prairie grasses, trees, and other landscape features of this urban park (Figures 3 and 4). Admittedly, these sounds and snippets of conversation and word-images might not really expose anything about biosolids in any directly meaningful way. But they might reveal something about the types of environments that biosolids can create, or the conditions that they can enable for urban recreation. In concrete terms, they provide a foundation for spaces of environmental and ecological appreciation, including the sensuous sway of native prairie grasses and sweeping sounds of insects. At the same time, an examination of biosolids in such a recreational setting invites reflection on all that is obscured. This includes

Figure 3. A view of the Chicago skyline from Maggie Daley Park, where over 4500 cubic meters of exceptional quality biosolids compost was used in the park's landscaping.

public concerns over biosolids due to the presence of emerging contaminants as well as the much broader challenges of sustainability in a time of ecological crisis, not to mention the questions of who shoulders such burdens and who has the privilege to ignore them.

The uncertainties of biosolids & their afterlives

On the train ride back from Maggie Daley Park, I listen to my interview with an environmental scientist named Dan whom I previously met in Chicago to discuss the safety of biosolids. Following the US Environmental Protection Agency's guidelines, all biosolids produced in the US need to be treated to eliminate pathogens and reduce the presence of heavy metals. However, some critics have argued that the complex composition of sanitation waste — which includes diverse unregulated industrial compounds that have unknown long-term impacts on human and environment health — should prompt greater restrictions in their usage (Clarke and Smith, 2011; Langdon et al., 2010). In Dan's research, however, he has demonstrated that urban soils are often compacted and unproductive, and they can be contaminated too, especially with lead. He has shown that biosolids can also help to immobilize heavy metals in soils due to their interactions with iron and aluminum oxides. Depending on the environmental history of a site, it appears

Figure 4. *Out of sight* — public art at Maggie Daley Park.

that biosolids can offer other benefits for urban application, including the ability to contend with existing pollutants in city soils. But convincing the general public of this point is a different story.

In our interview, Dan told me "I've seen the whole gamut — from people who say that 'Yeah, this makes a lot of sense' to others who say 'I don't want to touch the stuff' because they see it no differently than raw sludge. Some will then get into the nitty gritty of the composition of biosolids, but this can lead down the rabbit hole of trace contaminants and distinguishing parts per million from parts per billion…"

He continued on, stating: "the conversations always come down to that, what do those trace concentrations really mean, and then, you know, I always tell them the tool for understanding them is risk assessment… which can also be a pretty complex conversation, when you start talking about dose response and exposure pathways. You know, some people go right along with that, and they'll engage the conversation. And other people, as soon as you start talking about risk assessment, they're done. Anything greater than zero is problematic".

Dan recognized that he was different from most of the general public in that he had ample opportunity to reflect on and assess the variable dangers within the chemical soup of late industrial life as well as the calculus of its associated risks. He told me: "Having studied so much environmental chemistry and having been involved in risk assessments and doing so many risk assessments, it all makes logical sense to me." "But", he noted further, "for someone in the general public, maybe who has had a minimal amount of general chemistry or hasn't seen or heard of risk assessment processes, all they see are a list of chemicals and concentrations, so then someone tells them, 'Hey, this is toxic waste', it's easy to draw that conclusion".

I told Dan that even for someone like myself who had advanced degrees but lacked a background in chemistry, it can be hard to fully grasp the complexity of the chemical make-up of late industrial life. I then probed further, asking him if there were any contaminants that he, with his professional training and expertise, did have worries about. He responded in the following manner: "So the argument I would say if I'm coming from that perspective of critiquing biosolids is that while many things are analyzed, there are many that we are not testing." He went to elaborate on the metabolites that are not tested for. He also noted that while testing for individual compounds may occur, we don't necessarily know about their synergistic effects — whether they enhance their toxicity or diminish it through interaction. Interestingly, he noted that there is a cultural difference between the US and Europe. He shared that "In the US, we wait to see if something is harmful, and then we regulate it. In

Europe, something has to been proven to *not* be harmful". But, he concluded, "we've been using biosolids in this way for 30 to 40 years".

Ultimately, Dan did not seem especially concerned by the debates surrounding emerging contaminants in biosolids, including the most recent attention toward PFAS (per- and polyfluoroalkyl substances). Most of the city's analyses and tests, he assured me, show that any emerging contaminants present in biosolids occur at relatively low concentrations, even in lower concentrations than you might find in your home. But it still made me wonder about the hundreds of thousands of unregulated industrial chemicals that course through the hydraulic sanitation system as well as and the potential synergies among them. Of course, it would be nearly impossible to build and mobilize a scientific apparatus that could test and account for all of such compounds, residues, and their relations. The question that Dan posed to me is that if people demand to know "whether biosolids are safe", in such simplified terms, then they should also be asking:

- "Is my flame-retardant mattress safe?"
- "Is the triclosan in my toothpaste safe?"
- "Are the dioxins in the dust bunnies hiding under the couch in my living room safe?"

His point was that in most individuals' consumptive lives in the US, one is continuously exposed to these potential problems and the deep uncertainties they pose. They are all potential threats to human and environmental health. And yet the answer to whether they are safe or not, really asks for other questions — ones that are less straightforward or intuitive. What is the exposure and dose rate? What is the weight of evidence that it has clear effects on human health? What are the trade-offs for having a flame-retardant mattress in the event of a fire when 60 seconds can mean the difference between saving your child's life or not?

In her conceptualization of "late industrialism", Kim Fortun (2014: 311) describes it as a time marked by "the limits of available critical constructs for explaining issues of particular concern within environmental politics" which include "the complexity and current state of ecological systems; the complex relationship between ecosystem and human health […] [and] the longue durée in which environmental problems become manifest". Following Fortun's lead, it is worthwhile to consider how late industrial ecologies of excess have produced ecological conditions far different from those of industrial life only a few hundred years ago. As Fortun insists, today's conditions require negotiation with a wide array of different concerns and modern messes that are not so easily cleaned up. As Alex Blanchette (2019) describes in chilling detail, this includes the increasing complexity of late industrial excreta, such as that of industrially-produced hogs — treated

with elaborate cocktails of antibiotics — whose unruly waste inevitably escapes the industrial farm and poses uncertain impacts, on human and non-human communities alike. The composition of late industrial sewage sludge is surely no less complex and its potential long-term impacts when returned to the land are no more certain. Wastewater researchers and other experts fully acknowledge that PFAS and many other persistent environmental pollutants run through the sanitation system as do residual amounts of Viagra, Vicodin, Xanax, Prozac, and a wild diversity of other pharmaceuticals and personal care products that individuals consume and excrete. But with a growing ecological crisis facing humanity, environmental chemists like Dan — and many wastewater treatment workers I have met — seem to suggest that humanity simply cannot afford to hide from its wastes anymore. And here a subtle irony begins to reveal itself. Biosolids applied on urban golf courses, municipal sports fields, and city parks enable people to experience the joys of urban nature and its flourishing. But these pleasures conceal and obscure much deeper uncertainties about late industrial ecologies that define contemporary urban life.

Discussion and Conclusion

In this article, I have tracked three different dimensions of sensemaking in the use of biosolids in urban Chicago: the embodied sensorial experiences of it (and specifically smells or their absence), the economic sensibility of its use, and the ecological or environmental logics that justify its application as making "good sense". I will address each of these in turn.

First, regarding the embodied sensorial experience of biosolids, my interviews with users and wastewater treatment experts highlight the significance of odor as a potential deterrent for users and conversely, the absence of odor as an attractive feature of EQ biosolids compost. As one interviewee memorably told me (who spoke English as a second language): "even odor is in the sight". What he sought to convey is that sometimes the mere presence (or visual awareness) of biosolids can heighten a person's ability to sense odors emanating from the material. In a related vein, a representative for a waste-to-energy company commented to me that his company always placed trees along the perimeter of the manure lagoons they operated "so people can't smell with their eyes". The point he was making is that the senses can have synergies or mutually reinforcing effects. The EQ biosolids compost is an important ambassador for biosolids in the city of Chicago for this same reason. The process of composting and curing the material stabilizes it and reduces the production of noxious odors. Furthermore, the compost consists in

large part of wood chips, which give the final product both the appearance and texture of "ordinary" compost. These factors together heighten the social acceptability of its use as well as potential users' willingness to experiment with it. While EQ compost may be derived in part from treated sewage sludge, it does not smell like, look like it, or feel like what most residents would imagine to be sewage sludge — and, for this reason, it does not raise alarm bells for users (c.f. Spackman and Burlingame, 2018).

Second, the use of biosolids makes good sense economically to its users. This is because it is free to park districts, golf courses, or any individuals in the city that find value in its application. Several golf courses in the city have long relied on biosolids as a soil amendment and the first widely marketed biosolids product from the city of Milwaukee, known as Milorganite, had found a specific niche in golf course management as early as the 1930s (Schneider, 2011). However, with the coronavirus pandemic, an increasing number of residential users in Chicago have begun to see the value of the free EQ compost for landscaping around their homes as well as use in community gardens. Many other cities in the US — from Tacoma, Washington to Washington, D.C. — have been doing the same. The extent to which compost production is economical for individual wastewater treatment districts is another question, and one that has been actively debated. Still, most districts involved in the beneficial use of biosolids are hoping that this approach can help to minimize their operating costs — either now or in the future — including savings on tipping fees at landfills as well as phasing out aging incinerators that are costly to replace. It is also evident that cities like Chicago are seeking to expand urban application and distribute their biosolids closer to treatment districts to reduce their transportation and logistical costs. Furthermore, offering biosolids compost products free of charge to local residents is one visible strategy for wastewater treatment districts to increase community engagement and build a sense of goodwill.

Third, the use of biosolids as a renewable resource can be justified by some users and wastewater treatment experts as an important practice for working toward urban sustainability. By taking so-called waste and transforming it into a resource, this aligns with broader calls to "close the loop" in wastewater management. For golf course superintendents, like Steve, biosolids can also fit into their sense of what it means to be environmentally conscious in urban landscape management. Not to mention, such biosolids-enriched landscapes can support distinct forms of urban nature-enjoyment, as evidenced in places like Maggie Daley Park where local residents and visiting tourists experience green spaces planted with native prairie grasses, right in the heart of the city.

But whether the use of biosolids fully fits into this ethos of ecological sustainability is also actively contested. While sewage sludge undoubtedly holds great potential as a renewable resource that is rich in organic matter and valuable nutrients, critics are quick to note that it is also constituted by many other unwieldy wastes that are not actively monitored under current environmental protection regulations in the US. To be sure, Steve, Walter, Chen, Erica, and others whom I interviewed have argued convincingly about the benefits of biosolids as a soil amendment in urban areas while also detailing at length how public concerns over biosolids typically stem from misunderstandings of the science or simply reflect larger cultural taboos or social anxieties surrounding the disposal of human excreta. Environmental scientists like Dan have also illustrated how concerns linked to emerging contaminants are not unique to biosolids but rather ubiquitous problems that characterize late industrial urban ecologies. Perhaps then, to paraphrase Max Liboiron (2021), we should start not by examining these problems at the end of the pipe, but begin a much deeper examination of how they got into the pipe to begin with.

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