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Industrial Terroir Takes on the Yuck Factor

Reusing wastewater is a scientifically and technologically sound method of producing drinking water, and it may become necessary in water-stressed regions. But will the public accept it?

Would you drink water you knew was made from your own poop or pee? What if that water showed up in a glass of award-winning beer? Perhaps you've never asked yourself these questions. For attendees of Scottsdale, Arizona's annual Canal Convergence arts festival, the One Water Brewing Showcase offered an opportunity to try limited-edition craft beers made from highly purified wastewater. With each sip, drinkers found themselves tasting a speculative future not yet legally possible in Arizona—one where wastewater is immediately cleaned and returned to the municipal water supply system. Participating brewers donned their "water hero" capes, helping the municipal water utility's efforts to get the public to accept—and possibly even embrace—purified recycled water.

If you've been paying attention to the news about the dwindling Colorado River or seen the spectacular bathtub ring in Lake Powell demarking the reservoir's peak years, you're well aware that Arizona needs "water heroes." Since the 1980s, Arizona's water managers have proposed and deployed a range of techniques to mitigate dwindling water supplies. Some are fantastical, like a contested proposal to geoengineer the atmosphere. Other techniques seem more practical, including water augmentation (e.g., desalinization of brackish groundwater, reducing the number of trees in forests, groundwater recharge); improving current water use (e.g., conservation, reusing wastewater); and efforts to innovate in water augmentation (e.g., cloud seeding). Though all these water futures rely on technological intervention, reuse is the one that involves people's intimate, embodied experiences of smelling, tasting, and consuming water.

This question of water quantity and quality certainly hits close to home for me, as an inhabitant of Maricopa County, Arizona—one of the fastest growing metropolitan regions in the United States. My hometown has an average rainfall of only 8 inches per year. (Washington, DC, by comparison, receives more than 40 inches per year.) Meeting the water needs of the region's 4.95 million inhabitants is a struggle. Recent record-breaking heat, multiple dry monsoon seasons, significant migration to the area, and the enduring trend of planting lawns into the desert mean regulators, policymakers, and others responsible for supplying water to water-stressed regions are constantly searching for "new" sources of water. Water recycling, also known as reuse (utility managers are conscious of the positive associations of terms such as *recycled* or *reclaimed*), sits at the heart of these possible water futures.

Illustration by Shonagh Rae

Treat, treat, and treat again

Water reuse offers providers a pathway for transforming water, no matter its source, into whatever type of water is needed. Many people who live in water-scarce regions practice informal forms of reuse, such as using water from rinsing vegetables to water house plants. Using water containing discards is not new.

At the municipal scale, reuse falls into two categories: indirect and direct. In indirect reuse, wastewater treatment facilities return treated water to aquifers or other natural buffers. Indirect reuse has proved a politically palatable approach for introducing reuse to communities. For example, due to a 1989 Scottsdale mandate that golf courses use reclaimed water, courses partnered with the city to fund the building of an advanced wastewater treatment plant. Now all courses in Scottsdale are watered with reclaimed water. The city then uses any excess water left over by the golf courses to recharge its aquifers—a move that the city points to as helping it reach "safe yield" levels (the rate at which groundwater can be withdrawn without affecting long-term water levels) nearly 20 years before mandated by Arizona law.

In contrast, direct potable reuse (DPR) sends the treated wastewater directly back into the water delivery system. It does this either by putting the treated wastewater into raw water headed for a drinking-water treatment plant, or by blending the treated wastewater with finished water ready for distribution. For technologically minded folks who think of water in terms of its molecules, it's not a big leap to go from purifying wastewater enough for safely watering golf courses or recharging aquifers to purifying wastewater to the point that it is considered safe for human consumption. The transformation of wastewater back into drinking water relies on a combination of different advanced treatment techniques grounded in the philosophy of, as Scottsdale Water representatives explain it, "treat, treat, and treat again."

Potable reuse depends on proven technologies. Despite this, potable reuse remains in a liminal state, teetering at the inflection point of widespread adaption. This is in large part due to public resistance to the idea of using wastewater as a source for drinking water. Technological treatments and scientific analyses alone cannot completely transform wastewater into drinking water; Laws, regulations, and permits govern the ability for wastewater to be reclassified as drinking water in the absence of an environmental buffer. Only a small number of cities in the United States are set up for direct potable reuse. Yet a growing number of cities in states including Colorado, Texas, California, and Arizona are actively exploring a future with the technology. Advocates for potable reuse are still working out how to help the technology diffuse into legal and social realms using a variety of approaches, including development of master plans; early efforts to seek stakeholder input; public-facing education and outreach; and demonstration treatment systems.

One of the main hurdles to DPR water is what researchers call the "yuck" factor. Anthropologists and theorists such as Mary Douglas and Julia Kristeva have long been curious about what makes something disgusting or distasteful. They point out that moments when people think "yuck!" are often tied to socially and culturally defined risks. Sometimes the risk assessment activated by yuck is physiological, such as when someone recoils from a bitter substance. Sometimes it's psychological: when a caregiver physically recoils from an object a child picked up out of a garbage can, for example. As demonstrated by the range of fermented-food lovers and active communities of dumpster divers, yuck is not only innate—it's also learned, and can potentially be unlearned.

People who find their tap water tastes or smells "yucky" often opt out of using it as their drinking water by buying bottled water or using filtration systems. To water providers, the voiced and silent opting-out of people in their districts can appear irrational: it prioritizes an aesthetic reaction to the tastes, smells, textures, or temperature of water over trust in authorities, monitoring agencies, or science. I suggest that rather than approaching yuck as an irrational aesthetic quirk to be educated away, policymakers, water providers, and others consider this opting-out of using municipal water as drinking water as a rational choice based in personal and subjective experience that matters as much as water's quantifiable aspects. And this subjectivity is, in important ways, the result of more than a century of municipal water engineering—both liquid and social.

Making water taste like nothing

Over the twentieth century, the people in charge of producing municipal water worked very hard to make water's tastes and smells fade into the background so that consumers could ignore or overlook its flavor. Making water taste like nothing is still one of their core goals.

Water used to be a very different beverage. Sanitarian George Whipple, writing about the value of pure water in 1907, characterized drinking waters found in New England as having a moderate amount of color and significant cloudiness. In contrast, people from the Midwest, "where all the streams are muddy," Whipple noted, most often objected to unknown colors rather than color in general. Overall, he pointed out, most people could accept a small amount of cloudiness produced by small particles of clay. But the majority rejected water containing coarse sediment.

Municipal waterworkers in the early twentieth century worked not just to remove colors and particles, they also had to mitigate industrial contamination. Their success in making an acceptable municipal water depended on

the development of new forms of sensory and technical expertise. Erasing the distinctive flavors from raw water that tasted or smelled like phenol from iron works, for example, or that smelled musty, fishy, or sulfurous due to natural processes (or overgrowth of microorganisms caused by agricultural run-off), happened slowly. In fits and bursts, twentieth-century waterworkers got better at communicating with each other about how to identify, treat, and manage unwanted tastes and smells in the water they produced, alongside their more pressing work of making water safe to drink. In the early to mid-twentieth century, waterworkers tested new treatments and developed systems for quantifying how well these treatments reduced tastes and odors in water. They created shared vocabularies for describing tastes and odors. The introduction of new analytical methods in the 1960s allowed them to begin characterizing the molecules that cause tastes and smells in water. And the development of international collaborative networks, especially with researchers in France in the 1980s, resulted in additional tools for identifying and treating the molecular causes of unwanted tastes and odors.

With each improvement of their skills, waterworkers made it increasingly easy for drinkers to ignore the relationship between the water they drank and the natural and man-made environments it came from. In a sense, drinkers lost their awareness of the particular places their water came from. Instead, they came to expect that their water should taste of nothing and come from an idealized, pristine "somewhere" that is more of a nowhere in its lack of specificity. (There are exceptions: many New Yorkers, for example, proudly tout the Catskills watershed as the source of their drinking water.) I think that erasing the sensory connection between water and where that water came from put a wedge between how many individuals experience and understand the world surrounding them and how that environment really is.

Ironically, current efforts to make recycled water acceptable must face head-on where that water comes from and what it has come into contact with. Today, in trying to sell citizens on recycled water, advocates must grapple with consumer awareness that this water comes from their toilets, taps, and other sources often deemed "yucky."

Brewing support for wastewater reuse

Beer, promoters of DPR have realized, is a useful tool for transforming public perception of DPR from that of a liminal technology to that of an established technology. By partnering with beer brewers to produce tasty beverages, DPR proponents aim to create new, positive associations for consumers—consumers who may be soon asked to support infrastructural or legislative retooling of water provisioning. Organizers of tastings seek to sever the affective connections between past experiences and expectations around wastewater so that DPR can finally transition out of its liminal state.

For people attentive to numbers, the choice to use beer and its brewers as ambassadors for DPR may seem odd: it can take between 8 and 24 gallons of water to produce one pint of finished beer. On the other hand, beer is 90–95% water. In fact, beer quality and style depend in part on water quality. A water's mineral content, pH, and hardness have historically shaped the differing regional flavors and characteristics of beers. In the past, brewers relied on ground and surface waters located near their breweries, but contemporary beer brewers in the United States largely draw on municipal water. Brewers trying to produce a consistent product are most successful when they know what is in the water they are brewing with and can adjust for variations. For brewers interested in brewing different types of beer from the same municipal water source, and especially for brewers from regions where water sources vary seasonally, installing a water purification system such as reverse osmosis significantly improves their ability to consistently make any style of beer.

The idea that good water makes good beer explains the choice of beer as a launching point for making an ingestible argument to drinkers about the quality of DPR water. Organized efforts in the United States to use beer made with recycled water first started in 2014. That year Clean Water Services, a wastewater treatment organization that primarily serves Washington County in Oregon, partnered with the Oregon Brew Crew homebrew club to invite homebrewers to make beers out of recycled water. The initial water offered to brewers was 30% effluent—essentially, they obtained water from

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the river downstream of their discharge point, purified it, and sent it off to home brewers. The following year, Clean Water Services officially started the Pure Water Brewing Challenge. Media outlets responded: National Public Radio, the *Guardian,* and *Food & Wine* all covered the effort. Clean Water Services successfully demonstrated that going beyond a simple education campaign could open new avenues for talking about water recycling.

Scottsdale's One Water Brewing Showcase in 2019 was the first competition to be widely open to the public—previous beer brewing competitions had remained accessible only to people associated with municipal water production. In designing the event to engage a public audience, Scottsdale Water shifted the scale of the conversation about water reuse. When Marisa Manheim, then a graduate research assistant, and I interviewed brewers and Scottsdale Water officials, the utility's public information officer pointed out, "I'm not going to get 30,000 people to show up to drink water. But I can get 30,000 people to show up to drink beer." Scottsdale Water's public-facing approach is catching on: more recently, in collaboration with filtration membrane manufacturer Xylem, beers brewed from recycled water have appeared in Berlin (2019) and Calgary (2020). Good beer, especially good beer made from what was recently wastewater, makes for good press.

Just straight water

The aesthetic characteristics of the DPR water delivered to brewers told its own story about the water quality. "When you get [the water] right from the truck it tastes like nothing. It tastes like absolutely nothing," one brewer told us. A brewing team that participated in the 2017 AZ Pure Water Brew Challenge recalled pulling a sample glass of water from the tank when it was delivered. "This was pre-COVID," one of the brewers noted, "so we just stood around and passed this glass around, everybody drinking the same water. We don't do a whole lot of sensory on our water typically, but everybody was like … 'Wow, this is water.'" The communal tasting of the delivered water reinforced producers' technological claims about the purity and quality of DPR water. The water's visible clarity further highlighted the quality: "It would have been a really good picture because it was just so crystal clear," another brewer recalled. "Like, not what people associate with reclaimed water—at least, maybe what I didn't associate with reclaimed water." Aesthetic characteristics, analysis sheets, and for those who attended, tours of demonstration facilities, combined to persuade brewers that they had received what water providers had promised: high quality water ready for brewing with. All that remained was producing and sharing with the public the ingestible evidence in cups, cans, and bottles.

Making certain that consumers *knew* the beer was brewed with DPR water was central to the Arizona Department of Environmental Quality's regulatory restrictions. For those organizing Arizona brewers as DPR water ambassadors, the legal requirement to tell people the beer contained DPR water carried an added bonus: it meant that brewers were becoming outreach collaborators and were being pushed by regulatory restrictions to comply with that educational mission. By keeping the laminated analysis sheet of the DPR water either at the bar or visibly posted, taproom staff were able to immediately provide information. One brew team explained, "People might have been a little hesitant at first, but if you had the conversation—if you had the minute or two to sit and explain how good the water was, how clean it was, the whole process of it, why we chose to do the project—it was pretty easy to convert people."

The success of this approach relied on DPR water's pureness. That pureness showed up in the row of zeros on the analysis sheets provided to brewers upon the water's delivery. As one brewer told us: "We looked at the printout and it basically was H_2O, everything had been stripped down. There was no chemicals. There were no minerals.

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Everything was like 0.000 parts per million. So, it was just straight water." By using advanced water treatment processes, which in Scottsdale's case includes reverse osmosis, the DPR water delivered to brewers allowed them to precisely dial in the mineral makeup of the water used to reflect the naturally occurring levels of minerals from any desired (and chemically characterized) location.

At the same time, the complete removal of characteristic minerals normally found in municipal water challenged some brewers: it showed that for many small brewers, brewing is a constant give-and-take between the beer producer and the local environment shaping the characteristics of the water a municipality delivers. The variations brought on by that fluctuation can be valuable. But variations can also threaten the long-term viability of a business unless accompanied by a narrative that specifically valorizes variation. When it comes to producing consistent beer, DPR's blank-slate nature could potentially level the playing field—at least in terms of water supply—between cash-strapped microbrewers and larger, more established breweries.

Foods with "industrial terroir"—a riff on the French concept of *terroir,* which links food, taste, and place—have had the perceptible traces of the tastes of place minimized

and managed. DPR takes this premise further: DPR water, of the type that Scottsdale Water delivered to brewers, promises to transform the perceptible and imperceptible cues of a specific time and place into nothing. The water produced lacks the molecular marks made by any place, plant, or animal life. It is a blank slate, ready to be reinscribed with whatever locally or nationally identified flavor profile a beer brewer or utility wishes (or can afford) to recreate. DPR's industrial terroir, its ability to become whatever users need it to be, adds another layer of technological distance between everyday consumers and the systems and infrastructures shaping environmental quality. It says, "Everything is okay here. Put your attention elsewhere."

A radical reorganization

Proponents of DPR draw on a technocentric argument that "water should be judged by its quality, not its history." Their argument falls within an integrated water management movement called One Water, summarized in the idea that "water in all its forms has value," and as such "should be managed in a sustainable, inclusive, integrated way." Stakeholders within the movement aim to reorganize water governance. For example, rather than having one utility manage drinking water and another wastewater, a region adopting a One Water approach would integrate drinking water and wastewater management. The One Water approach is calling, in some senses, for a radical reorganization of deeply entrenched nineteenth- and twentieth-century ways of thinking about and managing water in the environment. In this framing, wastewater is no longer seen as separate and in need of being directed away from a community. Through interventions including water recycling for potable reuse and green infrastructures that direct water from storms to underground aquifers instead of sewers, people working in a One Water framework are trying to undo some of the consequences of earlier water management and governance.

The visceral nature of "yuck" threatens the goal of reorganizing water management. For proponents of DPR, finding a way to invite the consuming public to go from "yuck" to "yum" is the water utility equivalent of making gold from dross. In contrast to the yuck factor, the yum factor happens when something tastes good enough that one *wants* to consume it again. The yum factor is more than just an enjoyable taste; it connects the molecules that make up flavors with positive social, cultural, and aesthetic experiences to create new memories. Indeed, efforts to activate the yum factor rely heavily on not just a single moment of tasting, but also on the context around tastings. Beer made from recycled water and served at art festivals or scientific expo floors or water tastings at the end of a plant tour are designed to help drinkers create new, positive associations between bodily experiences and municipal water that move beyond what researchers call "pre-cognitive affective reactions." By working to activate the yum factor, organizers hope that participants will be able to set aside their hesitancies or suspicions around municipal water *and* recycled water.

Despite the significant buy-in from brewers who participated in the Arizona brew fests, hesitancy and suspicion still occasionally emerged to counteract the technological optimism and charisma of beer brewed with DPR. Though participating brewers generally embraced the overall project, not everyone was as easily persuaded. One brew team recalled their malt vendor's reaction: "He poured [the beer], and he's like, 'Oh, man it looks great,' and we're kind of talking about it a little bit. And, before he tried it, he was like, 'You did what?' And then he tried it. He was like, 'Wow, that's really clean. It's really good.' But then some other brewers came in, and he was like, 'Oh, you gotta try this poop beer!'"

The malt vendor's comment highlights both an appreciation of the shock factor associated with feces and a desire to share the experience with others. It also hints at the difficulty in relying on a tasting experience to undo culturally situated hesitancies. One brewery owner reported that he had a regular customer who refused to drink the beer brewed with DPR: "He just said he just couldn't because of working in sewage [treatment] for 30 years." (Anecdotally, people involved in promoting DPR in Arizona have reported that those working in the water industry have been some of the most challenging people to get to try DPR.) Hesitancy, suspicion, and even the little moments of humor—like "You gotta try this poop beer"—all point to how past experiences intersect with present and even future moments of sensing.

Efforts to activate the yum factor, playful as they may be, are political acts embedded within larger processes of decision making. By engaging inhabitants, policymakers, and members of the press in using their bodies to "taste" the future, proponents of DPR are asking different publics to actively support legislative, regulatory, and infrastructural changes to the status quo. As participants taste, they accept a physiological invitation to rewrite the connections between taste and memory, to erase past concerns not just about the quality of a single glass of water, but also about the capacity of technologies, regulators, experts, and governments to provide *all* people with access to safe and good water.

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