Chapter 14 — Dirty Water

What Goes In Must Come Out, A Fast Three Days, That's a Lotta Carbon, A Valuable Resource, So Many Ways to Pollute, Gag Me, Runaway Runoff, Now What?

What Goes In Must Come Out

Like with water, it's unrealistic to have a complete discussion of balanced sustainability on planet Earth without including wastewater. Just like water, wastewater is life and energy, and energy is wastewater. And *we* are wastewater. After all, what goes in must come out. The fact is, pretty much everything we flush, other than what we shouldn't flush (to be discussed later), enter our bodies through our mouths, then get processed by the natural biological systems within. Basically, the endless array of microbes that make up the microbial culture that drives the physiological processes in every living thing on Earth, including us. Those systems convert our food and drink into energy for all our daily activities and into new cells, like blood, muscle, and fat cells, depending on what our bodies need at the time. This is true of every living creature on our planet, from the simplest worms to insects to whales to elephants to us humans.

In a balanced world, what goes in and what comes out of animals is in balance with what goes into the plant life that animals consume as food. However, we no longer have a balanced world because we've grossly overpopulated it with us humans. This actually was already a problem to deal with more than a century ago, when it became obvious that the planet couldn't absorb all our waste. And, ironically, the waste isn't actually bad. It's full of nutrients and energy that's simply leftover from our bodies, that we don't need for energy or cell-building. It's really valuable stuff, at the end of the day.

There are two main problems with our waste, in addition to the fact that it stinks. For one thing, along with the nutrients, our bodies also discard unneeded microbes, including undesirable pathogens and such that can make us sick. The other problem is that when we overwhelm the land with too much waste, it can't be completely taken up by plants so it ultimately flows downhill to water bodies, where it leads to septicity that kills aquatic life and ruins drinking water sources for wildlife and for humans.

In 1972, the U.S. government got serious about cleaning our wastewater and enacted the Clean Water Act, which is administered by the EPA. These days, in the U.S. there are about 16,000 wastewater treatment plants[1] that serve about 76% of the population, treating about 34 billion gallons per day. The rest of the wastewater continues to be treated with septic systems in remote locations. In addition to the plants themselves, there's a vast network of collection pipes that convey wastewater from your toilet to underground pipe mains and ultimately to the treatment facility. In the U.S., every treatment facility is required to meet quality standards enforced by the EPA to ensure the treated water is safe to discharge into surface waters. In addition to nutrient and chemical limits in the discharges, the facilities must also prove that fish can survive in the water by literally placing fish in a quantity of the treated water and monitoring them in a laboratory.

In short, wastewater treatment is a big deal, and many trained professionals and a lot of energy and resources are involved in keeping our surface water resources clean by treating the wastewater. When we flush, the water goes somewhere. It doesn't magically disappear, much as we might like to think. These days, cities and towns are typically laid out with a drinking water source upstream and the wastewater plant downstream, so the wastewater effluent doesn't contaminate the drinking water, especially in cases of overflows and runoff.

> I followed in my dad's footsteps and pursued a career as a chemical engineer. Ironically, we both worked with synthetic polymers, from different angles. My dad began his career selling polymer to anyone who would buy it, working in both the oil industry and wastewater plants in the 50's. My first lab experience that got me hooked was when my dad would recruit me to help with polymer and chloride tests in the bathroom in our house, where he'd set up the lab equipment. I was about 10 years old. By the time I began working for TIORCO, the oilfield service company that he founded, he was using polymer to improve oil recovery, and that's where my career began. Later, when I left the oil industry and went to the Coors wastewater plants, I again found myself running flocculation tests, only this time it was with sludge. Talk about going full circle!

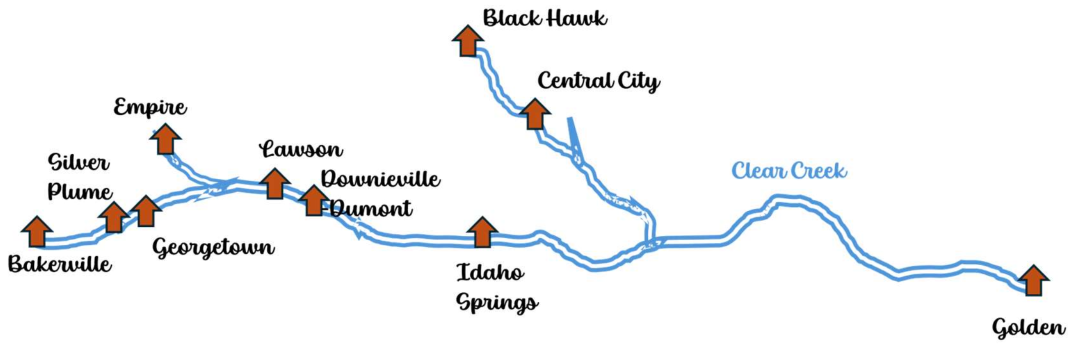


Figure 1 — There are 10 wastewater treatment facilities above Golden that discharge to Clear Creek.

Now that we have so many population centers these days, the treated wastewater may flow down just a few miles of stream or river before it reaches the intake of the drinking water plant for the next one. In the case of Golden, where I live, our drinking water comes from Clear Creek, which is only 60 miles from the original pristine source from the Continental Divide at the top of the Rockies. Yet, even after that relatively short distance from the source, by the time it reaches Golden, Colorado, it's been through 10 towns, which means it's been through 10 wastewater plants. And since toilet flushing is about ¼ of our water, that means it's been through a lot of human bodies by then. By the time the water reaches the Gulf of Mexico via the Mississippi River, it's been through about 300 wastewater plants, tracing from Clear Creek from the continental divide through the South Platte River, the Platte River, and the Missouri River to the Mississippi River, before it discharges to the Gulf of Mexico. And this is just the wastewater plants along these rivers, not all the other rivers that flow into the Missouri and Mississippi. That's even more human bodies.

All this wastewater treatment isn't free. Over the next two decades, the estimated funding needs are more than $4 trillion for drinking water and wastewater infrastructure and $271 billion for stormwater, assuming we're reckless enough to continue growing our population. If we get a clue sometime in there and back off on the population, these costs could be lower. Either way, it won't be cheap. Also, these numbers don't really include all the extra money we'll have to spend to meet increasingly stringent discharge limits if we grow our population, to accommodate increasing amounts of wastewater from more people, or for extra treatment if we don't stop flushing toxins, pharmaceuticals, hormone disrupters, and the like down the toilet. More about that later.

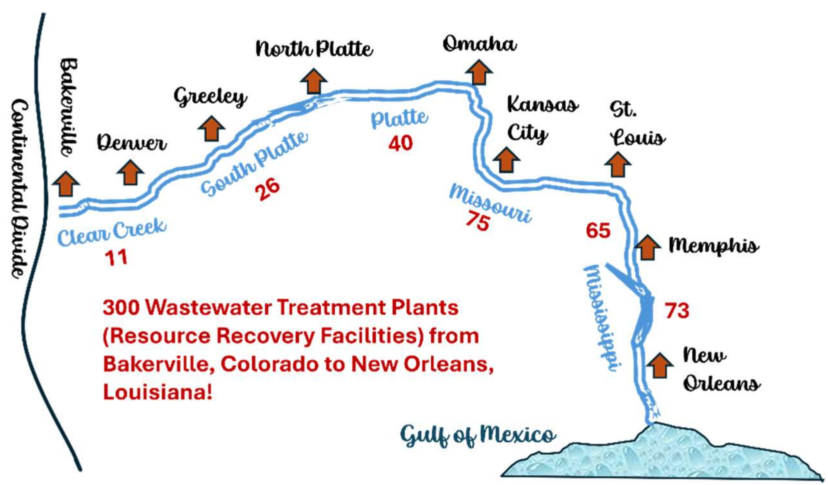


Figure 2 — There are 300 wastewater treatment plants between Clear Creek at the Continental Divide to the Gulf of Mexico.

Based on data from more than 100 countries, the world's population produces approximately 95 trillion gallons of wastewater annually. Out of this, about 52% is treated prior to discharge, and the rest flows into the environment untreated.[2] Not only is this gross beyond belief, given the sheer number of us, it's horrible for the wildlife that have to live with the receiving smarmed-out waters. It's no wonder we're losing so much wildlife, given this horror on top of everything else we do to them.

In the past decade, the traditional term "wastewater treatment plant" has been transitioning to a new term, "resource recovery facility" or RRF, to more accurately describe the valuable resources that are in our wastewater. Essentially all wastewater can be converted into useful materials, like fertilizer, energy and, of course, clean water. If we can continue to move in a direction towards a circular water economy, it will go a long way towards reducing the carbon footprint of humanity on our planet.

A Fast Three Days

So, how does an actual wastewater treatment process work? Well, it turns out to be simple and elegant in theory, yet it can be complicated and challenging in practice. Conventionally, human, or domestic, wastewater, in theory contains solely human excrement, any food waste that can go through a kitchen disposal, and any cleaning and personal care products that inevitably go down the drain as we clean our homes, clothes, dishes and ourselves. However, industries with different types of waste may be included in the mix, and customers are constantly finding ways to abuse the system by dumping toxins, pharmaceuticals, dyes, and other types of waste, thinking it's going to magically disappear if they simply flush it down the toilet. Given these challenges, every RRF is different. Also, sizes can vary radically, from tiny facilities that may treat 1,000 gallons per day to gigantic city facilities that treat millions of gallons.

Most RRFs use a process called "activated sludge," which uses a blend of microbes, or single-celled organisms, that literally eat, or consume, the waste. These microbial mixtures, or cultures, originate in human guts and are optimized for every RRF simply by running sewage to a new facility, growing the culture with a continuous flow of sewage, and then maintaining a mass balance of microbes that is sufficient to treat the waste by disposing of excess microbes. Like us, the microbes use oxygen in their metabolism as they consume the nutrients in the wastewater, and, like us, part of the nutrients are used to make more microbes and part is exhaled as carbon dioxide, or CO_2—the same CO_2 that we are warming our planet with. In addition to CO_2 exhaled by the sludge, for every gallon that we flush, 2.65 watt-hour (Wh) of energy is consumed, which works out to about 13 million tonnes/year of CO_2 emissions annually. This is what I mean when I say that we can't take a dump without emitting CO_2. This is yet another example of the impact of our sheer numbers on our atmospheric CO_2.

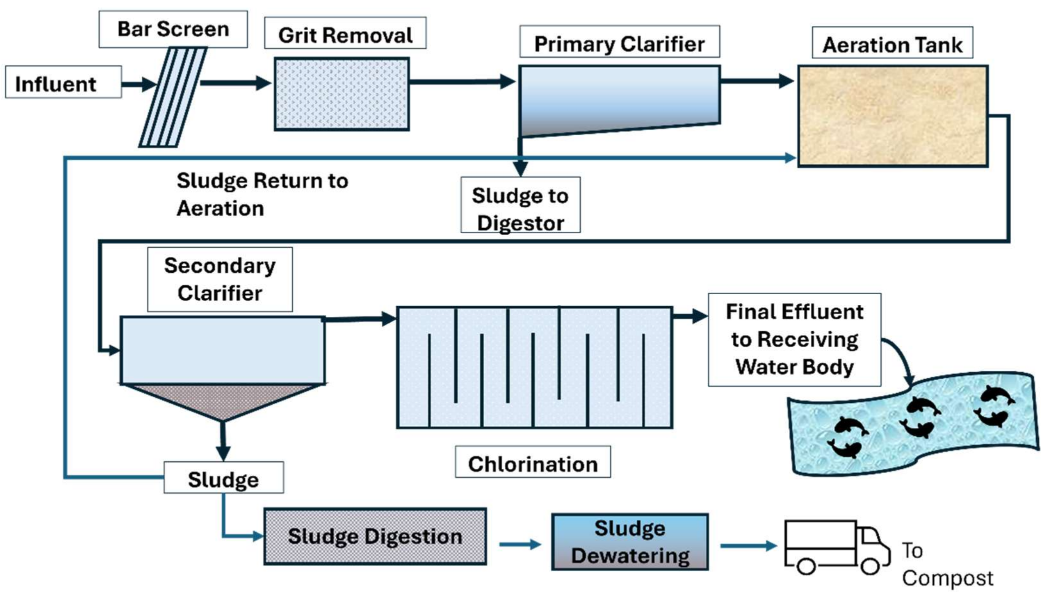


Figure 3 — Diagram of an activated sludge wastewater treatment plant process.

Figure 3 shows the basic steps in an activated sludge wastewater treatment process after it has been conveyed through the wastewater collection mains and reaches the entrance to the treatment plant.

- *Screening* at the front of the process removes large debris such as trash, rags, plant material and watermelons that may have found their way into the collection system either accidentally or on purpose. Pretty much anything that gets captured on the bar screens should never be in the sewer mains to begin with. This material is usually sent to landfill.
- *Grit Removal* removes sand, gravel, and similar sized solids, which are also usually taken to a landfill.
- The *Primary Clarifier* removes materials that settle or float, resulting in a relatively decent primary effluent that's mainly dissolved or extremely fine solids in the wastewater, that then proceeds to the aeration process. The solids that are removed in this process are typically treated separately in a sludge digestion and dewatering process, and sent to either a composting facility or a landfill.
- The *Aeration Process* is the first step of secondary treatment, where the primary effluent is mixed with the microbes, or sludge, that will literally consume the nutrients in the wastewater. This step requires a lot of oxygen to satisfy the high

demand of the sludge as it consume all that waste, and is the largest energy consumption in the process, since massive electrically driven air blowers are used to supply the oxygen.

- After the aeration step, the sludge has converted all the nutrients into CO_2, water, nitrogen gas, and more microbes, and the water is clean and meets federal and state specifications so that it's safe for discharge into a receiving water body. At this point, there are just two more steps before it can be discharged to surface waters.
- In the next step, the *Secondary Clarification* process, the sludge is separated from the clean water by settling. The sludge settles at the bottoms of the clarifiers, and the clean water flows over weirs at the tops of the clarifiers.
- Because of all the new microbes that grow during the aeration step, there is a lot more microbes (commonly called "sludge") after settling than there was to begin with, so a portion of the sludge is recycled to the front of the aeration train to treat more wastewater, while the extra sludge is sent to a separate process where it is digested and dewatered to reduce its volume, then "wasted" or removed from the process. The wasted sludge is an extremely valuable resource because it contains nutrients that can be used to fertilize food crops. The best place to take sludge is to an industrial composting facility, where it can be fully composted, then sent to farms to fertilize crops. Unfortunately, many plants in the U.S. continue to send sludge to landfill, which is a pathetic waste. Even worse than the waste of nutrients in the sludge, in landfills the sludge decomposes anaerobically, releasing methane gas, which is more than 20 times more potent than CO_2 as a greenhouse gas.
- *Sludge Dewatering* – Before the sludge can be hauled off the site, it must be dewatered to reduce the volume in a separate treatment process.
- After the microbes have been removed from the water, the final clean effluent water from the secondary clarifiers is disinfected, typically with chlorine or bleach, and discharged to the final receiving water body, usually over a spillway that re-aerates the water one last time.

Most plants use gravity as much as possible to move the water from one process to the next, but that's not always possible and large pumps are often required. In big cities, these will be on the order of a thousand horsepower in size. Practically all sludge transfer is done with pumps; aeration always requires blowers, and these blowers are typically the largest electricity consumer in wastewater plants.

While the process steps for treating wastewater are fairly basic, in practice it's a lot more complicated than treating drinking water. The biggest issue is the activated sludge, a living culture of microbes that responds, for good or bad, to any changes in its world, such as differences in the chemicals in the wastewater, the temperature of the wastewater, and the residence times in the different processes, to name a few. The operators who run the plants are constantly on watch and making adjustments to ensure a consistent effluent, inspecting the physical appearance and health of the wastewater and sludge, running chemical tests in the laboratory, and examining sludge cultures under microscopes. It's always been fascinating to me not only how well the activated sludge process works, but how quickly it works. The entire process takes no more than two to three days to convert raw disgusting wastewater into clean water that's safe for fish and wildlife. How amazing is that?

Personally, I think every U.S. citizen should have a decent understanding of what goes on in a wastewater plant. After all, we all defecate. When we understand things, we may be less likely to take them for granted. In the case of the wastewater process, it's the last barrier between our

When I first joined Coors in 2000, I was working in the wastewater lab, just beginning to learn the wastewater treatment process, when the unthinkable happened. A new night shift worker in the brewery set a valve incorrectly and dropped an entire tank of fermented beer to the drain instead of to aging, where it was supposed to go. The beer was much more concentrated than the normal wastewater, and when it reached the treatment plant, it immediately killed the entire biomass in the plant by consuming the oxygen so fast that the microbes died of asphyxiation. The horrified night operator contacted management, who immediately contacted the state and EPA to report the incident, as required by law. The public was notified to stay away from the creek.

There was nothing anyone could do to stop the destruction, because you can't simply turn off a wastewater plant. All brewing operations were immediately stopped, and fresh water was run through the plant to flush out the dead biomass, which floated and couldn't be collected. The overflow went to Clear Creek, where it continued to consume oxygen all the way to the Platte River, killing every living fish in the creek, similar to how concentrated nutrients from agriculture overflow create oxygen-depleted dead zones in the oceans. It was said that an estimated 1 million fish were killed that day, and that Coors had to pay $1 per fish, or $1 million in fines. I don't know if that's completely true, but I do know that a very nice bike path along Clear Creek was constructed soon after that. The entire incident was a reminder to us all to never take our wastewater treatment plants for granted, and to respect the sludge!

waste and the water that fish and wildlife depend on to survive, yet we're constantly abusing it by flushing things that can't be treated in the plant.

Many cities provide tours of wastewater plants, which is a great outing for, say elementary, middle, or high-school science classes, though adult groups are always welcome as well. When I was at Coors, we routinely gave tours to Colorado School of Mines students who were taking the wastewater treatment courses. If you have a green team in your town, think about doing a tour. Not only do these kinds of tours inform the public about the process, but they also inform about the amazing career opportunities in wastewater treatment, which most people are completely unaware of.

If you are an educator, you can get a lot of great ideas about how important wastewater is to environmental health, and how to educate about it, from Water's Worth It.[3]

That's a Lotta Carbon

The electricity to treat our wastewater in the U.S. runs more than 30 terawatt hours per year[4] and makes up 25–40% of the budget of most treatment facilities.[5] Wastewater is the biggest energy user in a municipal utility, typically more than 30% of the electricity. This is only the direct electricity, and doesn't include the various chemicals used in the treatment processes, like the chlorine, methanol, and coagulants, or any natural gas that might be used for heating in cold climates, or transportation for the fleets. Any way you look at it, wastewater treatment consumes a lot of energy.

And if we continue to grow our population and continue to run nontraditional pollutants like pharmaceuticals, synthetic additives in food and personal care products, and other toxins down the drains, increasingly stringent discharge limits and more intensive treatment processes will require yet more energy. More and more treatment plants will have to add tertiary treatment processes to take care of the kinds of synthetic chemicals that can't be consumed by the natural activated sludge. Of course, all this will not be cheap.

In addition to the actual energy used to treat the wastewater, reactions in the sewage collection network and in the treatment facility itself add significantly to greenhouse gas emissions. For one thing, the sewage goes septic as it moves through the collection system, releasing methane (the same as natural gas), which has 22 times the greenhouse gas potency of CO_2. This is significant when we have more than a million miles of sewers in the U.S. alone. Then there's the nitrogen oxides and sulfur oxides that get emitted during aeration, as well as the CO_2 itself, as mentioned previously. All in, these emissions, along with the electricity and chemicals used for wastewater treatment, account for around 2% of all U.S. CO_2 emissions.

Luckily, there are plenty of opportunities to improve operations in wastewater plants to reduce energy and chemical requirements, and since using less energy saves costs, more treatment plants are pursuing these opportunities. Also, as mentioned previously, wastewater is actually a valuable resource, and facilities are beginning to focus on harnessing it.

A Valuable Resource

As previously mentioned, traditional "wastewater treatment plants" are being renamed as "water resource recovery facilities," or WRRFs, sometimes shortened to RRF's. This new name sets a new definition of wastewater as a resource to be recovered and utilized beneficially rather than waste to be removed and eliminated. After all, when our bodies convert food into nutrients through metabolic processes, a lot of energy is consumed within us, and a portion of this energy remains embodied within the excrement that makes up the sewage. Something like the carbon that is held in a tree. In short, it's estimated that the energy contained within wastewater is about five times the amount of energy needed to treat it. Wastewater is being viewed as a circular economy, in which resources are extracted from it, turning the plants into profit centers instead of the CO_2 emitters they are now. In a way, it's like mining, and then recycling the material we mined after it's used for, say, an aluminum can. Only different. Instead of extracting finite resources that took millions of years to accumulate deep in the earth, we're taking an infinite resource and continuously reusing it, eliminating the need for mining fertilizers and such.

If all the resources were recovered from U.S. wastewater plants, emissions would be reduced by 95% and costs would be reduced by as much as $40 billion. One of the world's first energy neutral RRFs, in Marselisborg, Denmark, produces 50% more electricity than it needs to operate.[6]

Sludge

One of the simplest and most obvious resources to recover from wastewater is the sludge. Sludge is a precursor to compost and is a perfect slow-release fertilizer for growing crops and for building soil. It's full of nutrients, and if we used all the sludge from all wastewater plants, we literally wouldn't need synthetic ammonia fertilizers. This would help our land, water, and air a lot because ammonia fertilizer is a petrochemical that not only adds 3 million metric tonnes of CO_2e to our environment annually when it's manufactured, it also releases the nitrogen fast, with the excess running into our waterways, creating nutrient overload that's ruining water quality and killing aquatic wildlife. In contrast, the slow release of nutrients from compost made from sludge builds the soil and stays on the land as it's slowly released at a rate that the plants can take up. In short, using sludge can go a long way towards getting in balance with our carbon emissions and reducing the rate of wildlife loss.

So why don't we use sludge everywhere now? Well, part of the problem is the historical gag reflex, as people visualize pooping on food crops, like in the movie *The Martian*. Which is definitely valid. In fact, globally about 885 million people are exposed to food crops that are irrigated with untreated wastewater, more than 10% of the global population. This is not a great idea because it can lead to diseases transmitted by the pathogens that are inherently present in human feces. Luckily, it's pretty simple to get rid of these by simply heating the sludge to a temperature that kills the pathogens. Kind of like boiling water. Only with sludge. Once the sludge is pathogen free, it's fine to go through a composting facility and then apply to crops. And industrial composting facilities actually allow the sludge to heat to high enough temperatures to kill the pathogens. There could be a few leftovers in there, but most crops do have some sort of wildlife that will take a dump in there from time to time anyway, so what's the difference?

Another issue with sludge application are the microplastics and toxins that are present in sludge because of the irresponsible things that we use and flush. While heating the sludge may get rid of some of this, we're a long way from sludge that's completely free of toxins. A lot of effort is being directed at removing various kinds of toxins and microplastics in the treatment process, but none are simple, none are cheap, and all will consume more energy. The best way to guarantee clean sludge is to stop running this stuff down the drain. Use only simple, toxin-free products in your home. When it comes to microplastics, the story is the same: don't use plastics. However, it will take a much longer time to get rid of microplastics, which are everywhere in our environment and in us, so we may as well apply the sludge even though we know it contains microplastics. At the end of the day, the nasty pesticides and fertilizers that are applied to our industrial food crops are far worse anyway.

When sludge is heated sufficiently to kill the pathogens, it's classified as "Class A Biosolids," which typically contains about 4% nitrogen and 2% or more of phosphorous by weight, the remainder mainly made of up complex carbon and fiber that builds soils and decomposes slowly, releasing nutrients at a rate such that crops can take it up, so it doesn't tend to flow into waterways. In the U.S., wastewater from households alone generates about 180 million pounds/day of sludge. Biosolids have been in common use in the U.S. since about 1980 and are currently used on about 50% of U.S. crop lands.[7]

Some RRFs are making other types of fertilizers in addition to compost. Sludge can be pyrolyzed to produce biochar, another awesome soil builder, or pelletized for use as fertilizer or even an alternative fuel. A product called "struvite" is being produced from more and more RRFs, containing magnesium, ammonium and phosphate that releases the nutrients slowly. Even ammonia can be recovered as ammonium sulfate, another fertilizer. At the Atlanta RRF, they're producing 1,000 tons of fertilizer per year.[8] Biosolids are also a significant source of zinc, which is lacking in the diets of some 2 billion people globally.[9] Think about this: why would we ruin our environment by mining and refining all the separate metals and salts needed to make the fertilizers we use on crops when we can simply use biosolids and keep the nutrients within our agricultural system in a closed circular loop?

Biogas

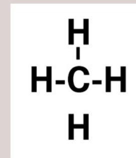
The largest consumer of electricity in a conventional activated sludge wastewater treatment plant is the aeration energy for the activated sludge. There is another way to treat wastewater, and to reduce sludge volume, and that is to treat it anaerobically. This process is seeing more and more use in RRFs for two reasons. For one, it reduces the amount of electricity that's needed, because aeration isn't used. For another, the process produces methane, or biogas, as a byproduct. The biogas can be used as a fuel to offset natural gas, and can help RRFs become a net generator of energy rather than a huge consumer of it.

Anaerobic processes are more expensive to construct and may be more challenging to operate, but they are worth it in the long run. Also, fats, oils, and grease (FOG) that can't be dumped down the drain to a sewer can be collected and dropped off separately to collection facilities, where they can be fed directly to a biogas plant, increasing biogas production. That's right: it's possible to convert waste oil and grease directly into methane gas without consuming very much energy in the process. It may sound too good to be true, but it's not. This keeps yet another important energy resource within the circular economy, yet less than 1% of all RRFs are doing this.[10] This can be done with food waste and scraps as well, and more RRFs are taking advantage of this opportunity to improve their bottom line. If all RRFs collected FOG and digested it anaerobically, about 800 billion cubic feet of methane would be produced, offsetting a portion of the fossil fuel natural gas we currently consume. Many plants are cogenerating electricity and steam on site, using biogas generated from anaerobic digestion.

Currently, only about 10% of wastewater plants use anaerobic digestion, and most of these are limited to reducing sludge volume rather than treating the wastewater, in addition to the sludge.[11] The average electricity consumption to treat 1,000 gallons of wastewater is about 2.6 kilowatt-hours (kWh), yet that same amount of wastewater contains about 7.6 kWh of potential chemical energy, that can be converted into more electricity than is needed to treat the wastewater, and that could be exported to the grid for other demands.[12] If all U.S. RRFs captured the potential energy in the wastewater, it would be equivalent to more than 120 terawatt-hours (TWh)/year (terawatt-hour) of electricity generation, offsetting about 50 million metric tonnes (mmt)/year of CO_2 from natural gas used to generate electricity. Think about that. Yet another significant portion our carbon footprint could be reduced.

What is biogas anyway?

Biogas is exactly the same as natural gas, or methane. The chemical formula is CH_4, where C stands for carbon, H stands for hydrogen, and the number 4 after the H means 4 hydrogens for every 1 carbon atom.



Methane that is produced as a fossil fuel that took millions of years to form is referred to as "natural gas".

Methane that is produced as a byproduct of wastewater treatment in endless supply (at least, as long as humans are around) is referred to as "biogas."

Methane is an odorless, extremely powerful source of energy, which is why we use so much of it to power our homes and produce electricity.

Algae

It turns out that, while runaway algae blooms are horrible for the environment when they're in open waterways, when done right, in RRFs algae can be extremely valuable. These days, it's used in everything from Beyond Burgers to animal and fish feeds to natural dyes to fertilizers. Algae, being a plant, can take up the CO_2 off-gas from wastewater plants and consume it in photosynthesis, which also reduces the CO_2 released to the environment from the treatment process for a win-win.

Heat Recovery

Since a significant portion of the wastewater we send down the drain has been heated for showers and cleaning and such, the heat can be recovered and reused to offset the energy that was used to heat the water in the home. A recent example of this in Denver is the National Western Complex, which has up to 90% of the complex's heating and cooling supplied by the nearby Metro Denver wastewater treatment plant, offsetting about 2,600 tonnes of CO_2 per year in one of the largest sewer heat recovery projects on the continent.[13] More and more RRFs are doing this. Of course, as mentioned previously, at home it's pretty simple to keep heated water in the house until it's cool for uses like shower and bath water. For dishes and laundry and even hand washing, we don't use heat at all in our house, because at the end of the day it's not necessary.

So Many Ways to Pollute

When most of us think of pollution, we tend to envision nasty big corp factories spewing gray smoke into the air and ugly black smarm into the water. Which is true. Or redneck losers tossing Budweiser cans and McDonald's containers out the windows of their oversized monster diesel trucks with big steel balls hanging off the trailer hitch. Also true. Not only is all this pollution ugly and disgraceful, it's poisoning our water and killing our wildlife. Yep.

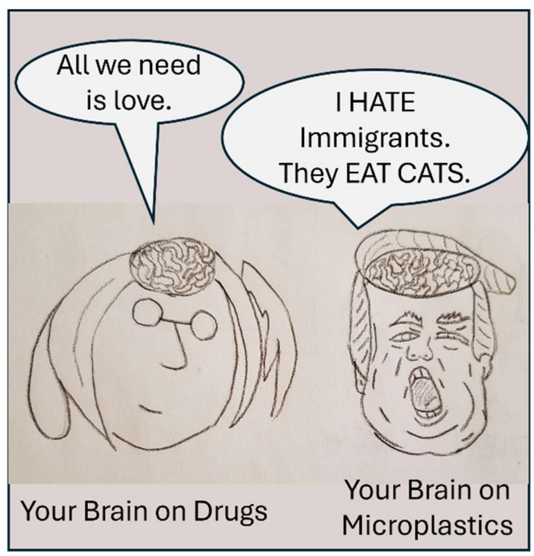
So, you're probably shaking your head in disgust, and telling yourself that you're not that kind of a person. Which also may be true. But what if I told you that you're probably as bad as any clueless climate denier when it comes to polluting our water and killing our wildlife and poisoning ourselves in the process? Calling bullshit? Good for you. So, does that mean that you never, ever use any cleaning or personal care products that contain synthetic dyes, fragrances, silicones, or PFAS? Does that mean that you never, ever take any kind of pharmaceuticals? Do you completely avoid anything in plastic containers? You don't own or wash any fabrics other than undyed wool, cotton, hemp or silk? No "flushable wipes" in your life? All your food is organic? No processed food? When was the last time you actually looked at the ingredients in products that you buy and rub all over your own body every single day? Have you ever even done that? Do you even know what you're flushing? Truly?

Or is the simple truth that you don't flush to sewer because you're on a septic system? Just so you know, these are worse, because a lot of the nasties get retained in the sludge in any septic tank, which gets pumped when full and hauled to—you guessed it—the nearest RRF. And while we're at it, home septic systems add significantly to our carbon footprint because they spew biogas directly into the environment, and that's 22 times as potent as CO_2. In Florida's St. Lucie River and Indian River Lagoon, scientists have found that properly functioning septic systems are a leading source of nutrient pollution because they release nitrogen into shallow groundwater.[14]

Now to my point: it's every single one of us, whether we want to admit it or not. We have been brainwashed by big corp advertising into thinking we need things we don't, as DuPont tries to differentiate its products from Procter & Gamble. Now here we are. We give big corp our money so they can make products that poison us and our environment, slowly dumbing us all down while keeping these greedy scumbags wealthier than the economies of most of the world's countries. Or even California. And while we can't undo the past, we can at least change our behavior going forward. We can refuse to buy irresponsible products and stick with simple products that aren't that perfect shade of blue but work just fine, and we can seek out local products that are refillable. While the technology is out there to remove synthetic non-traditional pollutants from our wastewater, it's extremely expensive and energy intensive. So, wouldn't it make just so much more common sense to simply stop buying this crap and dumping it down the drains? Think about that.

<u>Microplastics</u>

Not only are microplastics found in sludge, they have also been discovered downstream of RRFs, where they accumulate in fish and wildlife verifying that some of it passes through wastewater treatment processes.[15] Anything that is still in the river when it reaches the next drinking water treatment plant adds to the complexity, energy, and cost of treating the drinking water, creating a vicious circle of toxins in our water. Not only are the plastics and their leachates toxic, contaminants and pathogens tend to absorb on the microscopic surfaces, making the problem even worse. Examples are toxic metals like lead, chromium, mercury, cadmium, and cobalt as well as polycyclic aromatic hydrocarbons, polychlorinated biphenyls (PCBs), pesticides and other persistent organic pollutants, like polyfluorinated alkyl substances (PFAS).[16]



The main sources of microplastics turn out to be fibers from synthetic textiles, which make up about 45% of the microplastics, as well as fragments from plastic containers and packaging, and microbeads.[17] As with any of the other pollution we spew, the most effective solution of all is to not use plastic textiles or personal care products that contain plastic, and to make sure fragments from plastic containers never go down the drain. Or, better yet, avoid using plastic containers altogether.

Microbeads are yet another nasty way that big corp tries to make their products look special in comparison to others, and they've added microbeads to everything from toothpaste to makeup to bodywash to facial scrubs to deodorant to make the products look shinier or glossier, or with false claims that the scrubbing action is better for your teeth or skin. It's not. These products are a huge way that we now have microplastics in most of our bodies. Which, by the way, is horrible for our health, as it's implicated in everything from cancers to autoimmune reactions to respiratory disorders to inflammatory bowel diseases to endocrine disfunction to cardiovascular disease as it accumulates in pretty much all organs, including but not limited to, the liver, lungs, kidneys, bowels, heart, and even the brain.[16,18,19]. Some plastic additives have been found to interfere with brain development and disrupt hormone systems, and some chemicals that cling to plastic can cause cancer and birth defects.[20] Accumulation in the brain may be implicated in the "dumbing down" of our own species as well as in wildlife. Which might explain how so many people in the U.S. were literally stupid enough to actually vote in a treasonous fascist convicted criminal for president in the 2024 election.

In 2015, the U.S. passed a ban on microbeads as exfoliants in personal care products that can be rinsed off, any kind of toothpaste, and over the counter drugs. Then the sleazy companies that used them changed to metallic-plastic glitters to get around the ban. At the end of the day, it's up to us. Big corp will make these toxic products as long as we keep buying them and using them to poison ourselves and wildlife. You either choose to be a part of this or not.

So how do we avoid these products? Read the labels and see if there are any plastics in there. If you see things like polyethylene (PE), polyethylene terephthalate (PET), polypropylene (PP), Nylon or polymethyl methacrylate (PMMA), the product likely contains microbeads.[21]

Another bad is contact lenses. It turns out that 15–20% of contact wearers are flushing the lenses, up to 3 billion of them annually, which is about 20–23 metric tons. These break down into microplastics in the WRRFs due to incomplete destruction of the plastic and polymer bonds in the treatment process.[22]

PFAS

Have you ever heard of PFAS? If not, it might be because the problem is being downplayed by wastewater utilities that are tired of the bad press they get when their processes can't treat the newest toxins we toss down the drain. And who can blame them? After all, they're only the messengers trying to inform a clueless public that prefers to point fingers rather than look in the mirror.

Since we never seem to run out of ways to poison our land and water, PFAS have been discovered in recent years to be yet another hazard delivered by big corp. It's not that they haven't been around for decades. They have. It's just that researchers finally realized that they were hazardous to our health, after they were in and on everything, a lot like microplastics. They seemed like a good idea at the time, but it turns out they're not. Now that the cat is out of the bag, we're pretty much stuck with them for centuries to come.

Which is why we may as well use sludge for growing crops even though we know they're full of PFAS. If they're everywhere anyway, and we're not getting rid of them any time soon, then why waste an unbelievably useful and renewable resource over it? When it won't make a difference anyway? In my own opinion, the best thing we can do is stop the bleeding. Stop using them, knowing that over time they will gradually disappear. Even PFAS will eventually biodegrade over millennia.

What are PFAS anyway?

Per- and polyfluoroalkyl substances (PFAS) are chemicals that resist grease, oil, water, and heat. They were first used in the 1940s and are now in thousands of products including stain- and water-resistant fabrics and carpeting, cleaning products, paints, toilet paper, and fire-fighting foams. Certain PFAS are also authorized by the FDA for use in cookware, food packaging like pizza boxes, and food processing equipment.

Chemically, PFAS all have a carbon-fluorine bond, which is very strong and does not degrade easily.

PFAS can take hundreds to thousands of years to degrade, which is why they're referred to as "forever chemicals." The widespread use of PFAS and their persistence in the environment means that PFAS from past and current uses have resulted in increasing levels of PFAS in air, water, and soil.

Accumulation of certain PFAS has also been shown through blood tests to occur in humans and animals.[23]

Currently, the EPA lists about 15,000 chemicals that are classified as PFAS,[24] and the list continues to grow. They are in literally thousands of products. The list goes on and on, with the cell phones, waterproof boots, frying pans (Teflon seemed like a great idea at the time), house paint, dental floss, and fertilizers, to name just a few examples. PFAS have been found in the blood of 97% of Americans[25] and are linked to metabolic dysfunction and obesity, hormonal dysfunction, infant deformities, certain cancers, immunodeficiency, bone density, diabetes, and liver damage, as examples.[26] Obviously this poison is best avoided upstream in our homes and bodies long before it ever gets anywhere near wastewater treatment systems. Ya think?

Luckily, a diet high in fiber can move these highly absorbent toxins out of our bodies, and it turns out that folate (vitamin B9) may help boost immunity as well as reduce birth defects. Once we get ourselves purged of this venom, we need to be fanatical about avoiding additional exposure. Not easy, but a lot easier and cheaper than treating the wastewater and water after it's contaminated with PFAS.

Of course, these forever chemicals can be removed from the water, but as always not for cheap, with estimates floated of $1.2 billion to meet the EPA's PFAS removal proposal. We're talking about some pretty fancy technology, like granulated activated carbon, reverse osmosis, and anion exchange, all of which remove PFAS from wastewater but don't really get rid of them completely. Instead, the chemicals are concentrated and disposed of somewhere else, like through incineration. Oxidation is also an option; it involves extreme heat and pressure in a process that was originally designed for use against chemical warfare poisons. Which I guess getting rid of PFAS is, at the end of the day. What do you think? Wouldn't it be easier and cheaper to simply stop using these poisons so they don't go down the drain in the first place?

Pharmaceuticals

Yet another category of nasty chemicals that we can't get enough of are the pharmaceuticals (pharms). Some fraction of everything that goes down the pie-hole gets excreted and ends up in the sewer, from Advil to Benadryl to Prozac to antibiotics to statins to opioids to hormones, like insulin and contraceptives. At least we're no longer being encouraged by doctors to flush unused pharms down the drain, though I imagine there are morons among us who still do. Antibiotics are so ubiquitous that they're beginning to lose effectiveness, as pathogens are developing resistance to them, mainly from overuse in industrial livestock operations. Extreme filtration combined with oxidation and ultraviolet light treatment can remove a lot of these, but not all.

Fish and wildlife are suffering from all kinds of afflictions, from sickness and death to deformities and addiction. Yes. Addiction. In Puget Sound, where 160 different wastewater treatment plants discharge more than 90,000 pounds of pharms annually, the water that passes through the fishs' gills are loaded with pharmaceuticals.[27] As opioid use continues, the drugs break down in people's bodies into metabolites, often other forms of opioids, and then enter surface water via the wastewater.[28] Sadly, it turns out that humans aren't the only animals who respond to these drugs. In a 2017 study, researchers at the University of Utah found that zebrafish will willingly dose themselves with an opioid, and that the fish undergo withdrawal symptoms when the drug is removed.[29] Ouch. Intersex fish are also occurring as a result of exposure to hormones in water. Examples are estrogen and other hormone disrupters that enter the water through the wastewater treatment plants. Think about this. Do ya think our massive loss of wildlife might have something to do with our massive use of pharms, made worse by our sheer numbers? Hello?

Flushable NOT

Just when you thought you'd seen it all, big corp found yet another way to brainwash us into buying things we don't need and messing up our wastewater plants in the process. Now it's flushable wipes. They began to appear about 50 years ago and are now everywhere. Like we need constant wet sanitation on our bungs and hands, when in reality we don't need single-use anything for these purposes other than maybe toilet paper when traveling. Oh no, we absolutely must have little wet tissues with about ten times the environmental impact, all wrapped in yet more plastic. After we managed to survive as a species without them for the past 2 million years. Cheeeeezus. Please do me a favor and push back against the dumbing down and show a modicum of common sense.

To make things worse, big corp labels these stupid things as "flushable" because they are somewhat biodegradable. What a bunch of blatant lies. While it's true that they can be flushed, meaning that they will disappear down the toilet when you flush, they should absolutely NEVER be flushed. Once in the sewer system, they clog up the sewer lines and transfer pumps, clumping up with fats, oils, and grease that also shouldn't go down the drain, creating sewer monsters that are now known in the business as "fatbergs." You can just visualize what it looks like from this term. I hope.

The result is that sewers backup and flow into streets, rivers, homes, and buildings, and make a gigantic mess that the utility has to clean up, at great expense, which, naturally, must be passed on to the customers. The stress on the pumps causes them to wear out faster and use more energy. And, of course, the wastewater plant gets blamed. What a ridiculous bunch of rot.

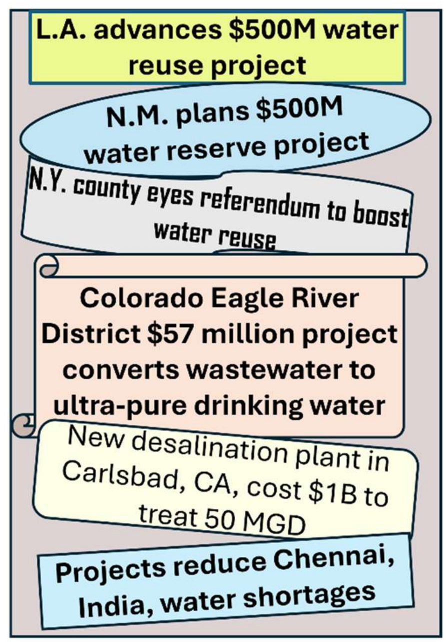
And people have absolutely no clue. A survey by the Metropolitan Washington Council of Governments found that one-third of residents don't even know where their drinking water comes from, and 44% said they dump fats, oils, and grease down the drain. We also flush other stupid stuff like feminine hygiene products, pop-off toilet cleaning scrubbers, and dental floss, which is blatantly plastic, and even if it's biodegradable, it sure as hell won't break down in the collection system.

Of course, greedy corporations like Kimberly Clark don't want to be inconvenienced with annoying issues like honest labelling, so they sued D.C. to stop a law that would have required honest labelling that the wipes aren't flushable. Meanwhile, the resulting fatbergs cost the U.S. utilities up to $1 billion annually and cause pumps to use more energy and eventually break down. Wipes can also clog homeowners' pipes, requiring homeowners to make expensive repairs. Does this make you want to trust slimy big corps that are just fine with sewage backing up into our homes and into waterways that wildlife depend on, just so they can make more money? Selling you something that you don't need and never did? Do you really need these things? Couldn't you just use a damp cloth and then wash it like they did 50 years ago? Or at least toss the wipes in the trash instead of flushing them? Would it kill you?

<u>Gag Me</u>

"I don't drink water. Fish fuck in it." W.C. Fields

As we continue to grow our population to unrealistic levels in water-scarce regions, reuse of wastewater is gaining ground. Many cities, including Denver, have been reclaiming wastewater for many years, though the reuse has been limited to non-food irrigation, like parks and golf courses and cleaning water for the Denver Zoo. The reuse water lines are nicknamed the "purple pipe," the color purple designating a separate distribution system for reclaimed water.



Direct reuse of wastewater, meaning for common household use and drinking, has been mainly avoided due to the completely understandable but slightly ill-informed gag factor that creeps into our psyche when we think of drinking treated wastewater. Yet, the truth is, we've been doing that all along. The only difference is that instead of treating the wastewater in the reclamation plant between the wastewater plant and the drinking water plant, we currently treat the wastewater in a drinking water plant that's a few miles downstream from the wastewater plant. Not much of a difference, when you think about it. Other than the river's a lot cheaper. Hell, by the time it reaches the drinking water plant, it has a fresh dose of bacteria in it from fish excrement, assuming any fish have managed to survive in the water. There's probably some duck poop involved too. Anyway.

Now that fresh drinking water sources are becoming scarcer than ever, out of sheer desperation we're beginning to rethink that whole gag factor thing. At a water conference I attended a few years ago, they were handing out plastic bottles of reused drinking water that were labelled "#Get OverIt." I did something I rarely do these days: I took a bottle for my tiny swag collection. I didn't drink it, not because of the water, but because of the plastic leachate from the inside of the bottle itself. Plus, I thought it would be cool to keep as a decorative memento. It now sits proudly on display on the shelf over our toilet, along with my poop emojis and my toilet bowl trivia contest awards. They also had some beer that was made with reused wastewater by Half Moon Bay Brewing Company in California as well as some wine. I did drink that. Good stuff.

Fact is, reuse of treated wastewater has been going on for decades in the Middle East, North Africa, Australia, and western Europe, which makes up about 30% of global reused water.[2] Reclaimed water has been used extensively to replenish ecosystems and recharge aquifers, and now climate change is driving reused drinking water. In the U.S., there are about 300 water recycling plants with about 600 more planned, driven largely by scarcity in western states. Obviously, reusing our water and keeping it in a closed loop is a good thing, but, again, the need to do that speaks to our overallocation of this finite resource that is driven at the end of the day by our extreme overpopulation across the planet. And, as always, the extra treatment and extra facilities and extra energy needed to construct and run all these plants is not cheap, in terms of costs and resources, which we're running out of.

Runaway Runoff

What do you think of if you hear the word "runoff"? Do you think of water running off your roof, through gutters, off yards onto sidewalks or streets? Or water that fills low spots on roads after a good rain? All true. In wastewater parlance, this kind of water is termed "stormwater." Technically, stormwater includes any water that runs off lands from cities and towns, including off vacant lots, buildings, and parking lots, and such, and typically through storm drains into the nearest water body, often the same water body, such as a river, that the local wastewater treatment plant discharges to. The stormwater contains all the pesticides, dog poop, trash, oils, tire flakes, and such from all our filthy irresponsible discards, so the RRF effluent discharge is definitely much cleaner than the stormwater.

Another thing we might think of could be the nasty ash-laden water that runs off mountainsides after an epic fire. Also true. Even the filth from the mudslides from naked hillsides denuded by fire and construction. Yep. That too.

But, do you ever think of agricultural runoff? The runoff from farm fields, pastures, barns, yards, parking lots, and streets? Are you aware that this type of runoff, the nastiest runoff of all, the runoff that's doing the most damage to wildlife, causing the massive deadly nutrient blooms in all our oceans, is 14 times as much as RRFs discharge? Well, it's true. It turns out that wastewater plants only treat about 7% of the total wastewater in the U.S., while the rest just runs off into the nearest surface waters, throwing all related ecosystems out of balance all the way to the receiving oceans, where the excessive nutrient pollution creates the algal blooms that are causing the massive dead zones that are killing the aquatic wildlife. Think about how bad that is. And the vast majority of this is from so-called "conventional" agriculture that uses pesticides and synthetic fertilizers, as well as from feedlots and concentrated animal operations. Not from organic and regenerative farming practices or from ethically raised livestock. So, it follows that, unless you only consume organic and ethical food, then you are a part of the nutrient pollution that's trashing our water and killing aquatic wildlife.

In the U.S., an estimated 860 billion gallons of untreated wastewater is released annually. Globally, the highest volumes of untreated wastewater runoff come from South and Southeast Asia.[2] Nutrient pollution may seem like kind of an oxymoron since all life needs nutrients to survive, but the problem is the incredibly huge food requirements of our incredibly huge population that's thrown the balance of nutrients out of whack. Nutrient pollution is one of the biggest water quality challenges on the planet, if not the biggest, and non-point runoff from farms as well as acid mine drainage are the biggest sources. The EPA estimates that more than 15,000 bodies of water have nutrient impairments in the U.S. alone.

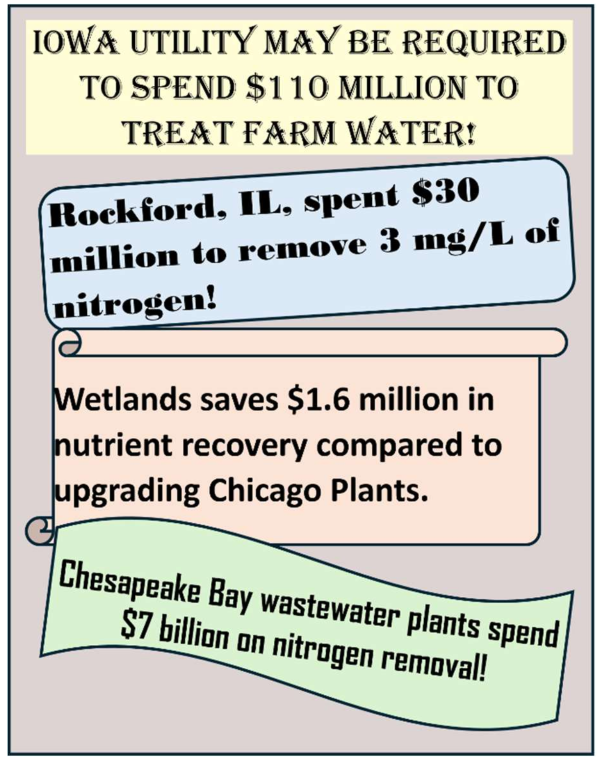
It's sad that wastewater treatment plants get blamed for nutrient pollution when wastewater discharge is only about 7% compared to runoff. The truth is that wastewater plants have an enormous beneficial impact on reducing nutrients because they remove all the nutrients in human wastewater. If it weren't for this contribution we'd have a far worse mess than we have. It turns out that the rest of the runoff, which is the real problem, isn't covered in the Clean Water Act, which only regulates point sources, like wastewater treatment plants and certain industries that treat their own wastewater. This is because these particular sources can be monitored and controlled, while general runoff from a farm is more of a challenge. Basically, agriculture gets a free ride, which is passed on in the form of artificially low costs for food at extreme cost to the environment and to wildlife. When we buy responsible food we are paying more at the cash register, but our environmental impact is less, by far, and we're not killing yet more wildlife. Make no mistake. Nutrient pollution is one of the costliest challenges we have. Pay me now or pay me later.

It turns out that the cost to remove nutrients from farm runoff is typically 4–5 times, and sometimes as much as 20 times, less than the cost to remove the same amount from municipal wastewater.[30] Meanwhile, since wastewater plants are regulated, increasingly more stringent limits are being placed on them, forcing them to upgrade to meet the lower limits. Like that's going to save the day. Which it won't. Do the third-grade math. Do you really think that reducing nitrogen limits from 7 to 3 milligrams/liter (mg/L) on 7% of the total flow is going to save the day when the other 93% of the flow contains more than 100 mg/L? Basically spending millions of dollars to decrease nutrients by no more than 1%, but increasing energy requirements and CO_2 emissions by 70%[31] while letting all the rest run free? Come on. Think about that. Does that even make sense?

Yet, when the EPA proposed effluent guidelines for meat and poultry producers that would make a huge difference, industrial growers instantly resisted and initiated legal proceedings. Even if farmers would *like* to implement better practices to protect water sources, they can't afford it because their margins are too tight due to the artificially low costs of the food they produce. Does that indicate that perhaps we're not paying fair prices for food? We're paying one way or the other. The next time you grab the cheap hamburger meat swathed in Styrofoam and plastic film at the grocery store, while ignoring the responsible meat that costs more, think about what you are doing. We're paying big to treat wastewater with our tax dollars and our utility bills, while killing wildlife and accelerating global warming, when we can stop that right now by buying responsible and organic food, and passing on the rot.

Chesapeake Bay is one example. There, about 500 sewage plants that discharge into water that flows into the bay were forced to spend $7 billion on upgrades even though they were only contributing 19% of the nutrients, while agriculture contributes 40%.[32] Slaughterhouse effluent is the worst part of the problem in the Great Lakes and Chesapeake Bay and could easily be regulated. Regulating agriculture could reduce nutrient loads by at least three fold. Metro Water Recovery in Denver was blamed for impairing the South Platte River and forced to upgrade nutrient removal at a cost of $211 million, which was passed on to customers, while increasing energy consumption to treat the water and ignoring the real problem of agriculture runoff. In Iowa, the Des Moines Lobe farming district is the largest soybean farming district in the world—and the largest contributor of nutrients to the Gulf of Mexico.[33] No matter how far, all water eventually reaches the ocean. Think about that. It all matters. And all we need to do is stop eating big corp meat and stick with organic food. Better for us and better for the planet.

In Iowa, 130 wastewater plants are being required to upgrade, paying $6,800/ton to reduce nitrogen by only 4%, while regulators are ignoring the farms. Farms can treat at far lower cost, with wetlands at $2,800/ton, bioreactors at $1,800/ton, or controlled drainage management and buffers for $3,000/ton.[34]



Other sources of untreated wastewater are stormwater and sewer overflows. Stormwater is excess water that flows from urban land, pavement, and buildings after storms. In addition to the general garbage tossed by loser litter bugs, the water contains toxic pesticides, nutrients from fertilizers used in lawns, pet waste as well as detritus from autos, like tire flakes, oil, and soap. You name it. It's in there. Several large cities are now collecting and treating stormwater separately, but that's not cheap, either. In Santa Monica, California, a new plant designed to treat and reuse 1.5 million gallons of polluted stormwater captured during a 24-hour storm cost about $100 million. New Jersey's beaches are getting pretty nasty and major investments are being investigated.

Sewer overflows also happen if the underground collection pipes get plugged with crap that shouldn't be down there, like the fatbergs mentioned above, as well as tree roots and other obstructions that may find their way into the pipe through cracks as the pipe ages. Just like anything else, nothing lasts forever. Which is why it's a bad idea to ignore infrastructure maintenance funding. Just saying. Open-air wastewater ponds as well as any open-air tanks aren't great either, because storms can cause those to overflow. In Florida, Hurricane Milton inundated a phosphate pile in Riverview and discharged more than 17,500 gallons into Tampa Bay. Mosaic, the owners, said it wasn't enough to hurt anything. Yeah right. That's what they all say. At Piney Point, Florida, open wastewater ponds are used to store coal ash and other hazardous substances, so it's just a matter of time before that will find its way to the ocean as well. In Fort Lauderdale, Florida, aging sewer pipes have burst and released more than 200 million gallons of untreated wastewater into multiple water bodies that will eventually find their way to the ocean after they've killed all the life in the receiving surface waters.

Now What?

Now that you know a bit more about what's really happening with our sewage, can you challenge yourself to make a difference in the impact of your sewage waste, for wildlife and for humanity? At the end of the day, it's not hard. It requires a bit of thought and a bit of behavior change. Is it so much to ask?

- Flush only the three Ps: poop, pee and paper. NOTHING ELSE. NO WIPES! NO CONTACT LENSES! EVER!
- Food waste is fine, if you have a disposal that grinds it up. NO FATS OR OILS. EVER!
- Don't litter. That should be really basic. If you can take the time to go to the store and buy something, you should damn well be able to take the time to dispose of the container responsibly. I mean, who's supposed to pick it up if you don't? Your mother?
- Pick up your pet's feces so it doesn't run into waterways. Same comments as above. If all dog crap is left on the ground, it's as bad as if all of us humans did it, as if we had no wastewater plants, which in half the world they still don't. Don't make things worse with your pets.
- Avoid single-use plastic packaging. Buy bulk. Recycle packaging you can't avoid. Kitchen plastic like chip and snack bags can be collected in a TerraCycle Box; you can get one online and one box will last a year or more for a family of four if you're careful about plastic.
- Don't buy personal care and cleaning products with nasty chemicals in them. Know what you're buying. When you wash up, they go down the drain to the sewer.
- Check with your landfill on where to dispose of any toxins in your home, get rid of what's left and then stop using them for good.
- Avoid buying plastic clothing to keep plastic fibers out of the wastewater stream.
- If you have a yard, don't apply poisonous pesticides and fertilizers. They run off into waterways and kill the wildlife—after they kill everything in your yard.
- Don't use poisons or toxins to remove fleas or keep them off your pet. Wash them with soapy water, and use a flea brush to get rid of the fleas and drown them in the water. The collars and poisons used to kill fleas are not good for the dog or the environment. And if fleas are on the dog they are in the house, and the house is what needs to be cleaned. Again, soapy water and diligence, not poison.
- Buy only organic food. It's the only food that's certified to be grown without poisons. All other food practices use poisons that run off into waterways after killing everything in fields where they're applied, and they also poison farmworkers. Most local food and food at farmer's markets are grown without chemicals, though they may not be certified because of the cost. Ask if you're uncertain.
- Don't buy industrial meat and dairy because the waste is running off and polluting waterways, leading to dead zones and the decimation of aquatic life in our oceans. Buy only responsibly raised meat. Certified grass-fed beef, for instance, is raised using practices that don't destroy land, wildlife diversity, and waterways. Search for it.
- Eat less beef and dairy. In the U.S., we consume far too much, and it's causing health problems. If we all stopped eating beef and dairy for even one year, it would go a long way towards recovery. Can you at least eat less? And only consume responsible products? Is that too much to ask?
- While we can't do a whole lot about pharms that run through our bodies, we can at least take care of ourselves by eating healthy so we're less likely to need them. Also, think twice about the instant gratification offered by BIG PHARM, which constantly deluges us with commercials about how wonderful and happy our lives can be if we take this or that or the other (if we can overlook the side-effects). Make sure you actually need it. And NEVER EVER flush pharms down the drain. They shouldn't go in a landfill either. These days, police stations are taking pharms annually and sending to incineration, where, done properly, they are burned down to CO_2 and water, which is better than poisoning and deforming wildlife with them.
- Try to get a tour of your local resource recovery facility/wastewater treatment plant to learn more. It's truly amazing how they work.
- If you're looking for a career, check out wastewater. The opportunities are really endless and it's an absolute blast!