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First section:

Nitrogen and phosphorus are the nutrients of life. As stated in *The Devil's Element* by Dan Egan, "phosphorus helps turn the meals we eat into the chemical energy that moves our muscles...phosphorus is also in our DNA. In fact, it *is* our DNA. From the corn we grow, to the animals that eat it, to the people who eat those animals, phosphorus is critical every step of the way" (Egan XXIII). Nitrogen on the other hand, "is a core component of amino acids, which are the building blocks of proteins, and of nucleic acids, which are the building blocks of genetic material (RNA and DNA). When other resources such as light and water are abundant, ecosystem productivity and biomass is often limited by the amount of available nitrogen. This is the primary reason why nitrogen is an essential part of fertilizers used to enhance soil quality for agricultural activities" as stated by [UC Berkeley's article on how the earth works.](#)

Nitrogen and phosphorus seem like great things, and they are to a certain degree. There is such a thing as too much of a good thing. Excess nitrogen and phosphorus creates harmful nutrient pollution, eutrophication, and hypoxia. In the United States, nutrient pollution primarily comes from agricultural activities in midwest states. According to the [EPA](#), "Nutrient pollution is one of America's most widespread, costly and challenging environmental problems, and is caused by excess nitrogen and phosphorus in the air and water".

The effects of nutrient pollution are intense and varied. These effects are on human health, the environment, and the economy.

The source of nutrient pollution that does the most harm to the environment is agriculture. Farms that use fertilizers and have livestock are not restricted by the Clean Water Act and can dump their waste into waterways. As stated in the New York Times opinion piece "Polluting Farmers Should Pay", "the 1972 Clean Water Act — whose stated goal is fishable and swimmable waters for all — has always exempted most agricultural pollutants from regulation". The Clean Water Act "prevents the federal government from employing a polluter-pays approach". Because of this, farms are creating more harm than ever but they don't have to deal with the consequences. Although farms are using heavy amounts of fertilizer, most of it gets washed away before the plants can use it. The Devil's Element discusses the "phosphorus paradox" where "so much of the phosphorus we mine today and spread as fertilizer gets flushed off farm fields before it ever gets picked up by crops, let alone livestock, not to mention us" (Egan XXV).

Because of the "phosphorus paradox", the nutrients flow into midwestern waterways into the Mississippi River Basin and flow out into the Gulf of Mexico. The excess nitrogen and phosphorus create 'dead zones' in the Gulf. The way a dead zone forms is displayed in this diagram. "1) During the spring, sun heated freshwater runoff from the Mississippi River creates a barrier layer in the Gulf, cutting off the saltier water below from contact with oxygen in the air. 2) Nitrogen and phosphorus from fertilizer and sewage in the freshwater layer ignite huge algae blooms. When the algae die, they sink into the saltier water below and decompose, using up oxygen in the deeper water. 3) Starved of oxygen and cut off from resupply, the deeper water becomes a dead zone. Fish avoid the area or die in massive numbers. Tiny organisms that form the vital base of the Gulf food chain also die. Winter brings respite, but spring runoffs start the cycle anew." This process is also known as hypoxia. The National Oceanic and Atmospheric Administration (NOAA) records that, "today, NOAA-supported scientists announced that this year's Gulf of Mexico "dead zone"— an area of low to no oxygen that can kill fish and marine life

— is approximately 3,275 square miles. That’s more than 2 million acres of habitat potentially unavailable to fish and bottom species — larger than the land area of Rhode Island and Delaware combined”.

As the Dead Zone gets bigger, life is more affected. Both humans and marine life alike need to move away from the dead zone to get what they need. [NPR podcast interview](#) with Marine ecologist Nancy Rabalais of Louisiana State University notes, “worms, snails, starfish...can’t escape. So they will eventually die off...these animals support the base of the food web for the fish and shrimp and crabs that feed on the bottom”. This leads to the migration of fish, shrimp, and crab which people depend on for their livelihoods. [The Nature Conservancy’s “Gulf of Mexico Dead Zone” details](#), “Because fish and other commercial species usually move out to sea in order to avoid the dead zone, fishermen are forced to travel farther from land—and spend more time and money—to make their catches, adding stress to an industry already hurt by hurricanes and the oil spill”.

By adding more environmental stress, we are disrupting natural systems. Climate change will only exacerbate this. [The Intergovernmental Panel on Climate Change \(IPCC\)’s 2022 report](#) states, “Global warming, reaching 1.5°C in the near-term [2021-2040], near-term warming and increased frequency, severity and duration of extreme events will place many terrestrial, freshwater, coastal and marine ecosystems at high or very high risks of biodiversity loss (medium to very high confidence, depending on ecosystem)”.

Additionally, [the article “The nitrogen problem: Why global warming is making it worse.”](#), [presents studies finding that climate change exacerbates the problem of nitrogen pollution](#). “A new study in *Science* projects that climate change will increase the amount of nitrogen ending up in U.S. rivers and other waterways by 19 percent on average over the remainder of the century — and much more in hard-hit areas, notably the Mississippi-Atchafalaya River Basin (up

24 percent) and the Northeast (up 28 percent). That's not counting likely increases in nitrogen inputs from more intensive agriculture, or from increased human population". We are seeing dramatic increases due to the "warmer temperatures and increased rainfall associated with climate change". Because of climate change "it will be necessary, . . . to cut agricultural nitrogen use . . . not by 32 percent, as the U.S. Environmental Protection Agency now proposes, but by almost double that amount."

Second Section:

Through this project, I was able to successfully be vegetarian for at least a week. I explored restaurants' different plant-based options and I will be trying them in the future. I also exposed my friends and family to how their diet is tied to water pollution/nutrient pollution. My family has already made significant changes that reduce our nitrogen footprint. I've converted my mom to drinking alternative dairy milk like soy and oat milk. We also get a wider variety of vegetables and fruits that we try. Through this project, I have discovered more plant based recipes that I can prepare throughout the week as well as how easy it is to find plant-based alternatives in restaurants.

To put my effectiveness in data form, I used a nitrogen footprint calculator called N-Print. I went vegetarian for a week and posted what I had for dinner on my instagram to hopefully inspire others to try more plant-based diets too. I compared the vegetarian weeks' servings to a normal week of eating for me vs the United States average.

In the beginning of my project, I learned about how watersheds carry nutrient pollution and flow into larger water sources and harm marine life. To demonstrate this I created a watershed

model. I presented this at my local library's "World Water Day" event. The turnout was very small but the kids that did show up had a good time and learned about water pollution. This event was all ages so all younger kids showed up. Even though they were younger the kids still had fun and were at least exposed to the topic of nutrient pollution.

As the most active part of my civic engagement project, I participated in SCARCE's storm drain medallion project. I took the medallions and placed them around COD's campus in areas with a lot of foot traffic. My team placed 5 medallions around the campus. Although COD has "no dumping" lettering in the metal of the storm drains, many people look past this because it isn't noticeable. By placing the bright medallions, people are able to pay attention and not dump their waste into storm drains. This decreases the amount of waste that flows into streams and rivers because the water that flows into those drains doesn't get treated like municipal waste water does.

Third Section:

The biggest recommendation I want to stress is dietary changes. In a world full of environmental issues, choosing more plant-based options is an easy way to be eco-friendly. Our diets are something we control every single day and the choices we make have impacts. According to the University Of Colorado Boulder, "about 1,850 gallons of water is needed to produce a singular pound of beef, comparable to only 39 gallons of water per pound of vegetables. A vegetarian diet alone could dramatically reduce water consumption by 58% per person!". Many environmentalists recommend you start with "meatless Mondays". Even one day a week with eating no meat can "Save 133 gallons of water with each meatless meal! Reduce your carbon footprint by 8 pounds each Meatless Monday you participate in. If you commit to participating in Meatless Monday every Monday, that is equivalent to skipping one serving of beef for a year would save the same amount of emissions as driving 348 miles in a car" CU

Boulder continues. By making small changes such as getting alternative dairy in your coffee, you are helping the planet and the amount of nutrient pollution that enters waterways.

The policy change I would recommend to reduce nutrient pollution is to change the Clean Water Act on a federal level. In the NYT article “Polluting Farms should Pay”, author Catherine Kling details that although this act bars the federal government from taxing farmers, individual states can. “[A] few have taken action. Iowa, Maryland, Minnesota, Vermont and Wisconsin ban the use of manure fertilizer on frozen ground, a practice known to prevent runoff”. It should not be up to individual states to reduce fertilizer runoff especially because it is a nationwide issue. We need to change the Clean Water Act to include all agricultural pollutants to be regulated and make responsible farmers pay for polluting. Only then will the effects of nutrient pollution decrease exponentially and uniform responsibility will be enforced. However getting to this point of federal legislation is intense and difficult. To begin this process, regional or state action is required. At this point the Clean Water Act, forces responsibility onto state and local officials. By discussing the [“tough measures that might address the water pollution problems that stem from farms and CAFOs”](#) to our local officials we may be able to reduce nutrient pollution.

Another individual action I highly recommend is getting educated! Through this project I found out more about water pollution than I ever have and I’m a biology major. I want to encourage other people to learn about this topic through different forms of media. The first is a junior graphic novel called *The Leak*. *The Leak* is a junior graphic novel that details a middle schooler (Ruth Keller) who discovers a strange black slime in a lake in her neighborhood. As a budding journalist, she decides to uncover the truth. This graphic novel goes over the complexities of environmental issues such as water pollution especially from the point of view of

a teen figuring out the world. This graphic novel is a quick and entertaining read that explores water pollution in an educational way.

Another read I recommend is "Tender is the Flesh" by Agustina Bazterrica that premises a future where people are bred and grown for regular consumption in place of animals due to a virus. This Soylent Green-esque book presents a hardened slaughterhouse employee that goes through the ins and outs of the human processing industry. When reading *Tender is the Flesh*, I have no choice but to draw a comparison between our food industry and empathize with the animals we consume daily. While pursuing my civic engagement project I was reading this book and it scared me into going vegetarian in the best way.