The Dirty Secret of America's Clean Dishes

ProPublica reports on emissions from U.S. BASF plants that elevate cancer risks for an estimated 1.5 million people.

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Mapping Cancer-Causing Industrial Air Pollution

Hollie Walker cherished the simplicity of her life in White Stone, South Carolina, a tiny community on the outskirts of Spartanburg. In the quiet of the country, she and her husband raised their two sons in a yellow house on 37 acres of secluded land, where they hiked in the woods and swam in their lake. Today, the area is home to a one-room post office, two churches, and a shooting range open three days a week. For years in the 1990s, Walker worked behind the counter at the post office.

There used to be a bar called the White Stone Mall on the same stretch of highway, where Walker would sip beers, shoot pool and chat with workers getting off their shifts from a chemical plant across the street. She didn't know much about the German-owned company, BASF, that operated the plant. After BASF expanded its site in the 2000's, demolishing the bar in the process, she had little reason to stop along that highway, except when the railroad gates halted

traffic.

The passing trains carried tank cars of chemicals bound for White Stone's BASF plant, a fleeting moment in an epic multi-state journey during which BASF transforms natural gas into specialized, secretive compounds that are the building blocks of ubiquitous cleaning products. BASF isn't a household name like Procter & Gamble, but the ingredients it creates are essential to the success of that company's products, allowing dirt stains to be lifted from clothes and egg yolk to be washed off plates.

The long, winding path from shale rock to the kitchen cabinet contributes to massive sales for BASF, the world's largest chemical maker. But for the company's neighbors, the journey leaves behind a trail of toxic pollution that has placed hundreds of thousands of people — including Walker — in harm's way.

The U.S. Environmental Protection Agency aspires to minimize the number of people exposed to emissions that increase excess cancer risk above 1 in 1 million.

That risk level means that if 1 million people in an area were exposed to toxic air pollutants over a presumed lifetime of 70 years, there would likely be at least one case of cancer on top of those from risks people already face. But a ProPublica analysis found that the EPA effectively allows two dozen BASF plants nationwide to expose an estimated 1.5 million Americans to elevated cancer risks greater than 1 in 1 million. EPA rules also say that plants should never expose people to an additional lifetime cancer risk that exceeds 1 in 10,000. Yet an estimated 2,800 people who live near BASF plants around the country face risks at least that high because of the company's emissions, according to our analysis. Our analysis is based on an EPA screening tool that uses data reported by companies such as BASF. It cannot be used to assess the cause of individual cancer cases, but can identify geographic areas of potential concern.

BASF's footprint of cancer-causing air pollution is larger than that of any other foreign-owned company in the U.S. and is the fourth-largest toxic footprint among all companies operating in this country, according to our analysis.

Bob Nelson, a spokesperson for BASF, declined to answer ProPublica's questions about its chemical manufacturing and its emission of cancer-causing air pollutants. In a statement, he said that the "safety and well-being of employees, contractors, neighbors, and their families is the foundation of all we do." Procter & Gamble spokesperson Maytal Levi, who declined to answer our questions, said in a statement that the company expects its "suppliers and business partners to uphold high standards that include consideration for the health and wellbeing of the communities where they operate."

BASF, a multibillion-dollar corporation that employs over 110,000 people worldwide, is part of a larger story about the hidden costs of our nation's supply chains. ProPublica pieced together the supply chain — and the environmental impact — of a single BASF-produced chemical found in one common household cleaning product during the period of our analysis, which examined data from 2014 to 2018. We reviewed thousands of pages of corporate filings; obtained internal documents through nearly 100 public records requests; and interviewed dozens of workers, supply chain experts and residents living near BASF plants.

Our reporting offers a rare look at how the production of a single consumer good — Cascade dishwasher detergent — contributes to elevated cancer risk for an estimated nearly 1 million people in multiple communities across the South.

By the time millions of consumers purchase Cascade each month, the crucial chemicals that end up in the detergent have been crafted over the course of an 800-mile journey from a BASF facility in Port Arthur, Texas, to one in Geismar, Louisiana, to the one across from the post office in White Stone. From there, a final chemical product is hauled to an assembly line at a giant plant in St. Louis, Missouri, ending up in bold green packages that line grocery store aisles nationwide. By the time Walker pulls a container of Cascade off the shelf, she will have already paid an even higher price: chronic exposure to one of America's most dangerous air pollutants, a sacrifice in order to manufacture the most popular dishwasher detergent in the nation.

The Cracking
Port Arthur, Texas

The story of BASF's dramatic American expansion began in Texas following the darkest chapter in the company's history. Founded as a dye maker in the 1860s, BASF employed scientists who invented thousands of chemicals, from synthetic indigo, which enabled the mass production of blue jeans, to chlorine gas, which was used to poison soldiers in the trenches during World War I. In 1925, BASF helped found IG Farben, a German chemical cartel that would not only supply raw materials for the Nazi war machine but also operate a synthetic rubber and oil factory dependent on slave labor from Jewish people imprisoned at the Monowitz concentration camp. Among the cartel's contributions to the Nazis was a pesticide known as Zyklon B, which they used to exterminate more than 1 million people during the Holocaust. At one of the Nuremberg trials, a prosecutor described the two-dozen IG Farben executives indicted for war crimes as the "magicians who made the fantasies of Mein Kampf come true." (BASF declined to answer ProPublica's questions about its past, but wrote on its website that IG Farben became part of an "autarkic, coercive system" that aided the Nazi regime.)

After 13 of its executives were found guilty, IG Farben was broken up into several companies. In 1949, an executive with the newly reformed BASF toured Dow Chemical's plant in Freeport, Texas. Less than a decade later, BASF broke ground on a chemical plant there, the first the company opened outside of its homeland after World War II.

In the decades that followed, U.S. communities hungry for jobs courted the company, which was able to grow its profits at an unprecedented pace thanks in part to regulations that allowed its plants to operate with more lenient environmental protections than comparable plants in Germany. The extent of pollution allowed by U.S. regulators was particularly grave in southeast Texas. By the time BASF opened a plant in the coastal town of Port Arthur in 2001, nearby communities were so inundated with poisonous air that the arrival of BASF hardly stood out.

"There are plenty of places in the state of Texas where these industries could have been placed," said Hilton Kelley, a local environmental justice advocate. "Why Port Arthur? It's the area of least resistance."

Standing on the top floor of Port Arthur's City Hall, John Beard Jr. looks up from under his black wide-brimmed hat toward a horizon dotted with hulking industrial facilities. Six percent of America's crude oil gets refined in this 54,000-person city along the Gulf Coast, where neighborhood subdivisions, elementary schools and playgrounds border petrochemical plants. Eighteen different facilities emit a variety of cancer-causing pollutants such as benzene, butadiene and naphthalene into the air of Port Arthur and its neighboring towns.

After clocking in at a refinery for 38 years, Beard Jr. came to realize that the industry had jeopardized the health of Port Arthur, a working-class community where the percentage of Black residents is nearly triple the national average. Since retiring in 2017, Beard Jr., founder and CEO of the Port Arthur Community Action Network, has sounded the alarm by demanding better emissions controls and challenging companies' attempts to pollute more. He also offers a guided "toxic tour"

to anyone interested in seeing the high price of living in “Energy City.” One of his stops, on the north side of town, is BASF’s steam cracker.

Inside BASF’s plant, a colorless, odorless gas known as ethane flows into a towering structure called a cracker, where the gas is moved through a tube, diluted with steam and pushed through a furnace heated to around 1,500 degrees. Within a second, heat “cracks” the bonds of each ethane molecule. The final product, ethylene, has been called the “world’s most important chemical,” a raw material for ingredients found in everything from plastics and PVC pipes to foam insulation and synthetic rubber, antifreeze and airplane wings.

The cracking process emits benzene, a carcinogen that studies have linked to leukemia. While the German government has long required BASF’s plants to be outfitted with pollution-reduction equipment, the EPA did not issue rules to adequately control toxic releases until the late 1990s. Instead of requiring larger chemical plant operators to regularly monitor benzene emissions like German facilities did, federal and state environmental agencies in the U.S. often took companies that operated chemical plants at their word that they would not emit more benzene than their permits allowed. Carroll Muffett, president and CEO of the Center for International Environmental Law, says that American environmental rules “have been out of step with the science of human health for decades.”

In the U.S., experts say the development of the rules governing how much pollution chemical companies can emit has been a notoriously fraught process. The EPA often allows engineers employed by the companies the agency regulates to help develop these rules. As an EPA engineer told Cary Coglianese, a University of Pennsylvania law professor who directs the Penn Program on Regulation: “We help them; they help us.”

U.S. environmental advocates say they are sidelined in the earliest stages of the EPA’s rulemaking process. To influence a rule, they often must sue the agency, alleging that its rule updates have failed to adequately protect the public’s health. By contrast, European environmental officials require advocacy organizations, trade groups and industrial engineers to work together to develop more protective standards for emissions-control technologies. Both the U.S. and Europe require rules for those technologies to be reviewed every eight years, but the EPA often chooses not to update its rules, while European officials require that new and more protective standards are passed during each review.

The EPA declined to comment on comparisons of its rule-making process with those in Germany. Nelson, the BASF spokesperson, said in a statement that the company “meets or exceeds applicable operating permit requirements established by regulatory authorities.”

But there is one major loophole that may further undermine pollution limits: accidental discharges. Such discharges happen regularly and may expose communities to much higher levels of chemicals than allowed under a plant’s permit. An Environmental Integrity Project report found that BASF’s Port Arthur cracker had emitted more than 887,000 pounds of air pollutants during unpermitted discharges from 2015 to 2018, the seventh highest out of 90 Texas plants analyzed.

Last year, BASF's steam cracker released 2,308 pounds of benzene in unpermitted events, fifth-most statewide.

Since the beginning of 2017, regulators have fined BASF $456,000 for air regulation violations at the plant. But advocates say that fines are issued for less than 3% of all accidental discharges in Texas, and those fines are small given the level of unauthorized emissions. The Texas Commission on Environmental Quality determines fines by the size of an unpermitted release, potential harm caused to human health, and whether the company properly notified the agency, said Tiffany Young, a spokesperson for the TCEQ. In a statement, Young also said: "Funding and staffing resources limit the agency's ability" to monitor emissions from accidental discharges at many individual plants.

Driving past the BASF plant, Beard Jr. spots steam billowing from the chimneys. On some days, he says, those clouds can get so thick that they can obscure the view of the adjacent state highway. He points out that some residents see the plant as a "necessary evil" to make the chemicals that support our everyday lives.

"When you know better, you do better," Beard says. "But we've been doing this for so long that people don't think there's any other way."

The Conversion

Geismar, Louisiana

From its plant in Port Arthur, BASF pipes its ethylene past Texas marshlands and Louisiana bayous, to a rural community more than 150 miles east, the next stop in the supply chain.

Inside BASF's plant in Geismar, Louisiana, workers manufacture ethylene oxide by heating Port Arthur-made ethylene and mixing it with oxygen, then passing the mixture through a reactor packed with a silver catalyst. Once the reactor has cooled, the chemical product is purified and processed. The plant, capable of making 220,000 metric tons of ethylene oxide each year, generates one of the country's largest footprints of cancer-causing air pollution — exposing more than an estimated 800,000 Louisianans to excess cancer risk greater than 1 in 1 million. (The real number is certainly higher, but the plant's emissions are estimated to disperse far beyond the geographic limits of the EPA's modeling.) It also elevates the excess cancer risk above 1 in 10,000 for an estimated 180 of Geismar's roughly 7,000 residents.

Malaika Favorite, who is exposed to an estimated excess cancer risk of 1 in 16,000, wasn't aware of the specific threat when she moved back to Geismar after decades away. But the foreboding scale of the industrial development in her hometown was immediately clear. The rural community, which sits at the heart of a 85-mile-long industrial corridor of Louisiana, hardly resembled the place in which she was raised. The levee overlooking the Mississippi River where she used to play had been blocked off by private roads and sown with natural gas pipelines. The trees that had lined the long road to her childhood home, forming a canopy overhead, had been replaced by barbed wire fences encircling chemical plants.

Favorite, a 72-year-old artist, was so dismayed by the changes that she decided to get involved in the decisions driving them. This past winter, she attended a public meeting to discuss the renewal and modification of a Louisiana Department of Environmental Quality permit for BASF's Geismar complex, the company's largest U.S. operation. She said that eight people attended the meeting, including several company spokespeople, and that when she asked about the air pollution that would be allowed by the permit renewal, a spokesperson underscored the importance of the company's production of chemicals, including ethylene oxide. The versatile chemical is used not only to make products to clean households, but also to sterilize roughly half of the U.S. healthcare system's medical equipment.

She also said that the spokesperson acknowledged that if BASF didn't make its chemicals there, it would emit pollutants somewhere else. (Asked about Favorite's recollections of the meeting, company spokesperson Nelson said: "BASF would not support such a comment you allege a BASF spokesperson made.")

Chemical companies had transformed Favorite's bucolic hometown into one of the nation's largest "sacrifice zones," a term advocates use to describe industrial corridors where certain communities bear disproportionate health costs from the manufacturing of products used across the country. According to ProPublica's analysis, ethylene oxide contributes to more cancer risk than any other toxic air pollutant emitted by American industry. Our demand for ethylene oxide creates excess cancer risk above 1 in 1 million for an estimated 3.7 million people in south Louisiana. Studies have linked the chemical to higher rates of breast cancer, lymphoma and leukemia.

The LDEQ's ethylene oxide standard, which allows concentrations of up to one microgram per cubic meter of air in communities near chemical plants, is 50 times the maximum concentration advised by the EPA. This allows companies to emit volumes of pollution that could elevate excess cancer risk to a level 30 times the EPA's 1 in 10,000 standard. As a result, BASF's Geismar plant emits more than nine times as much ethylene oxide as its larger plant that makes the same chemical in its hometown of Ludwigshafen, Germany. At that plant, companies licensed by German regulators conduct annual inspections to ensure that concentrations of the cancer-causing chemical at each emission point are below 0.5 milligrams per cubic meter — a rule designed to limit the pollutant's spread into neighboring communities.

When asked why LDEQ approves permits that can enable cancer risk levels that high, department spokesperson Gregory Langley told ProPublica that cancer rates in the census tract where BASF operates are below the state average. The census tract where Geismar is located encompasses 66 square miles, and stretches into the neighboring rural communities of Dutchtown and Burnside.

Kimberly Terrell, a research scientist at the Tulane Environmental Law Clinic, said that in rural communities like Geismar it's difficult to identify cancer patterns in the population, given the small sample size.

"If I survey the people on my block who smoke, I'm unlikely to see a link with lung cancer. But if I survey people across the U.S. who smoke, I most definitely am going to see a link with lung

cancer," Terrell said. "The LDEQ is basically using the fact that these communities are small against them."

Favorite didn't realize the specific threat posed by ethylene oxide until the LDEQ meeting. As she left the courthouse that evening earlier this year, she couldn't stop thinking back to a time when BASF's activity drew the attention of more than a small handful of locals. In the 1980s, environmentalists and labor organizers had traveled to Geismar to protest the company's treatment of its workers. At the bargaining table, leaders of the Oil, Chemical and Atomic Workers International Union had voiced concerns about BASF's safety record, which included a history of fires, spills and leaks that the union feared jeopardized the well-being of 370 members. When negotiations finally broke down in the summer of 1984, the company locked workers out of the Geismar plant and hired short-term contractors.

In the following years, union members applied for unemployment and struggled to feed their families. To pressure BASF, OCAW produced a 53-minute video on the locked-out workers and the company's membership in a chemical cartel with links to the Nazis. One evening, as they batted around ideas of how to advance their campaign, the organizers discussed the area's cancer rates. From that day forward, they described south Louisiana's industrial corridor as "Cancer Alley," and plastered the phrase on a billboard near the plant. The name stuck, and the organizers' strategy prevailed.

After five years, BASF allowed the union members to return to the Geismar plant. To safeguard the workers, OCAW leaders built a coalition with environmental advocacy groups and longtime residents, including Favorite's father, Amos, a World War II veteran and former chemical plant worker. While many of BASF's workers resided in neighboring towns, Amos Favorite lived in Geismar's predominantly Black community. White supremacists had tried to bomb Amos' house after he supported Malaika's decision to become the first Black student in the parish's all-white high school. If he could face Ku Klux Klan sympathizers, he thought, he could stand up to BASF.

Together with OCAW, Amos Favorite secured funds not only to install an air monitor near BASF's plant, but also to deliver clean water from Baton Rouge, so that his community would no longer have to rely on wells contaminated by industrial companies. But by the time Amos died in 2002, the momentum generated by the lockout had slowed. Two of the union's chief leaders died from cancer. Funds for the union's coalition building efforts dried up. The OCAW merged with a larger union that prioritized labor concerns over environmental issues.

Today, thin strips of neighborhoods are sandwiched between sprawling chemical plants. Ethylene oxide billows invisibly from BASF's plant toward the Favorite household. Shortly before Malaika Favorite moved back home in 2016, the EPA declared the chemical to be 30 times more toxic to adults and 60 times more toxic to children than the agency previously thought. In the following years, communities across the country began learning that they had been exposed for decades to one of America's most potent industrial chemicals. Residents of a Chicago suburb protested until the medical sterilization plant emitting ethylene oxide near their homes was forced to shut down. But in Favorite's corner of Cancer Alley, the protests have long quieted even as regulators have

recently cleared the way for more industrial development.

Once the right hand of her father's activism, typing up letters and speeches as he dictated them, Malaika now paints for a living. Much of her art is inspired by the winding Mississippi River that borders Geismar and the industries that have encroached on her hometown. After the LDEQ meeting with BASF, she painted an abstract pastoral, blending thick coats of greens and blues to reflect the vibrant landscape of her childhood. In the lower left corner of the painting, a faceless group of observers stares out over the land they hope to profit from. These observers inspired the name of the painting, "The Committee Will Decide."

When Geismar residents develop cancer, they often feel torn about whether to blame the plants. In a local Rotary Club speech in 2017, a BASF executive downplayed concerns about the rates of cancer in the Geismar area, saying that "you can turn statistics any way you want." A decade ago, one of Favorite's brothers battled lymphoma. Another brother and his wife worked in the chemical industry in Geismar for most of their careers. When her brother's wife died of cancer, Favorite said, he didn't believe that her workplace had anything to do with it.

As BASF finishes making batches of ethylene oxide, workers load them onto rail cars that move the highly flammable product past Favorite's art studio to chemical plants around the country, including the one near Hollie Walker's house outside Spartanburg. Favorite knows these chemicals end up in consumer goods across the country, but doesn't understand why that journey must imperil her community's health.

"What is Geismar getting for all our suffering?" Favorite wondered aloud. "We are dying so that the chemical industry can exist here."

The Cooking

Spartanburg, South Carolina

South Carolina's booming chemical industry lured the Walkers to Spartanburg. In the 1980s, Hollie Walker's husband, Reed, received a job offer from Milliken & Company, where he stayed for the next three decades. He traveled around the world promoting Millad, a chemical product that is used to make plastic goods like Tupperware see-through. He sold so much of the chemical that his colleagues called him "Mr. Millad."

By the time the Walkers settled into their home in the woods, about 10 miles southeast of Milliken headquarters and a few minutes down the road from BASF's facility, BASF already was decades into the lucrative American expansion it had first launched in Texas. That expansion would help lead to billions of dollars of annual sales globally and earn BASF a spot on the Fortune 100.

In the 1960s, a sharp-dressed businessman named Hans Lautenschlager traveled across America to sell a more prosperous life. To civic boosters, he pledged better jobs. To farmers, he assured greater yields. To politicians, he promised stronger economies. They could achieve their American dreams, he explained, if they opened their towns to BASF. In selling those dreams, Lautenschlager helped BASF become one of the world's largest chemical makers. To keep BASF expanding,

Lautenschlager convinced South Carolina officials to let the company build a $100 million petrochemical plant near its coast, just outside the burgeoning tourist town of Hilton Head.

But an unlikely alliance of working-class Black shrimpers and rich white real estate developers emerged in the early 1970s to fight the BASF plant and its potential pollution. They protested, launched a national media campaign and threatened legal action. On the heels of their lobbying, a member of President

Richard Nixon's administration warned the company that he would oppose the plant unless the company's plans protected South Carolina's Lowcountry. BASF dropped the project, sparing Hilton Head from that threat. Soon after, though, a PR exec representing BASF told South Carolina Gov.-elect John West that the company hoped to operate a different chemical plant elsewhere in the state. West supported the plans. (He died in 2004.) With minimal fanfare, BASF acquired a chemical plant on the outskirts of Spartanburg, an inland city once nicknamed "Textile Town." Since many of the region's mills had shuttered, local officials embraced the chemical makers because they preserved jobs and tax dollars.

The plant marked a turning point in BASF's national expansion strategy, a way for the company to avoid controversial plant constructions. Between 1970 and 2000, the company went from owning a handful of facilities across the country to operating more than two dozen, many of them occupying the footprint of former plants and some located in Southern states with more lax environmental regulations. BASF also divested from its manufacturing of consumer goods like cassette tapes. Now focused on chemicals, BASF aired a wave of TV commercials during the 1990s, in which the company proclaimed: "We don't make a lot of the products you buy. We make a lot of the products you buy better."

At its Spartanburg plant, BASF uses its Geismar-produced ethylene oxide to manufacture different kinds of surfactants, a type of chemical used in products that pave roads, fuel cars and wash clothes. Invented by a BASF scientist in 1916, the chemical reduces surface tension between two substances, enabling grime to come off of countertops and coffee rings to disappear from mugs. Freight trains traveling from Geismar pull cylindrical rail cars full of ethylene oxide past the tiny post office where Walker once worked, toward the BASF plant reactors. Inside, BASF workers mix the ethylene oxide with an alcohol and a catalyst, "cook" the batch for hours at a high temperature and cool it off. Surfactants known as alcohol alkoxylates are formed.

Each year, the plant releases hundreds of pounds of ethylene oxide into White Stone's air. According to ProPublica's analysis, the BASF plant emissions cause an estimated 96,000 South Carolinians to experience an elevated cancer risk level above the EPA's target limit of 1 in 1 million. But because the EPA allows states to administer the federal Clean Air Act, its implementation varies widely across the nation. Some states have taken steps to reduce the number of people exposed to elevated cancer risk; Massachusetts, for instance, does not allow industrial pollution to generate an excess cancer risk above 1 in 1 million. Other states, including Louisiana and South Carolina, have permitted plants to emit cancer-causing pollutants at levels beyond the 1-in-10,000 limit that the federal government deems acceptable.

Ron Aiken, spokesperson for the South Carolina Department of Health and Environmental Control, downplayed concerns about cancer risk found by ProPublica's analysis. He also praised the company for its "well-monitored pollution control systems" and said that "no measured scientific data supports the assertion of increased cancer risk for residents living near the BASF facility."

There is no measured data because the federal government doesn't require companies to measure emissions leaving their smokestacks and does not routinely monitor the air in impacted neighborhoods for cancer-causing chemicals, leaving states to decide whether they will. State regulators in South Carolina have installed two monitors in Spartanburg, but the closest one is roughly four miles from the BASF facility, near a small medical sterilization plant.

EPA spokesperson Madeline Beal said in a statement that the agency intends to "advance the science around monitoring technology" and collect better emissions data. The agency has pledged $20 million in new funding for monitors.

"Only with that kind of information can you figure out how it's going to impact the surrounding communities," said Richard Peltier, associate professor with the University of Massachusetts' environmental health sciences department. "If you don't have that access to that data, or you refuse to get that kind of data, you're really just guessing in the dark."

Walker didn't know about the elevated cancer risk in White Stone — or the lack of monitoring near the BASF plant — until ProPublica showed her our findings this past spring.

But it made sense. In the mid '90s, Walker learned that a malignant tumor had formed in her right breast. Three years later, another malignant tumor appeared nearby. Not only did she opt for a double mastectomy to dramatically reduce the possibility of another recurrence of the cancer, she also underwent testing to rule out a genetic predisposition and changed her lifestyle to incorporate activities linked to reducing breast cancer risk, eating vegetables grown in her own raised beds and training for long-distance races.

There was another risk she didn't know to avoid. In the years between her first and second cancer diagnoses, Walker worked day after day in the one-room post office directly across from the BASF plant, which is subject to an estimated excess cancer risk of 1 in 3,200, three times the level that EPA considers unacceptable. Peltier said that continued exposure to ethylene oxide "is only going to amplify the risk" of a breast cancer recurrence.

In April 2019, one month after she ran a 10K race to celebrate her 60th birthday, Walker's doctor spotted another tumor in a sliver of breast tissue under her left armpit that had not been removed during the double mastectomy.

"A part of your mind says, 'I'm done with this, I've dealt with this,"' Walker said. She hadn't spent time worried about the possibility of a recurrence: "You don't keep it in the foreground. You just keep on living. When it came back, 20 years later, that really threw me for a loop."

In the weeks following, Walker found comfort in her routine walks with her husband around their

lake. Ever since they'd gone on their first date nearly 40 years earlier at a University of Florida football game, he had always been there, from cooking her Italian food to driving her to doctor appointments. Now, he constantly worried about her and was at her side during those early months of treatment. "He was with me all the way, all the times when I was getting radiation," Walker said. "He was worried about me, thinking how long am I going to live."

Four months after her recurrence, a blood clot blocked one of Reed Walker's arteries. He died unexpectedly of a pulmonary embolism. Pulmonary embolism is the third leading cause of death brought on by cardiovascular disease, which researchers have linked to higher exposure of ethylene oxide. Walker now believes her husband's risks could have been increased by air pollution from his decades in the chemical business, which included spending time in plants nationwide, including one in South Carolina that has emitted ethylene oxide. "Of course, it crosses your mind," she said. "He may have been exposed more than the common person."

And now, suddenly, she would have to fight cancer alone.

The Mixing

St. Louis, Missouri

Once BASF cooks surfactants, the company ships batches of them to one of its most loyal customers. The shipment travels across the Mississippi River, past the Gateway Arch in St. Louis, to an industrial district near the city's riverfront. This is where Procter & Gamble operates a large cleaning product manufacturing site, where it turns raw chemical ingredients into such well-known brands as Mr. Clean, Febreze and Swiffer. The chemical whose creation pollutes the air in Geismar and Spartanburg is ready to become part of one of America's most recognizable household products: Cascade.

To Procter & Gamble employees, the company's nearly-century-old plant resembles a giant kitchen. When BASF's surfactants arrive at the St. Louis facility, workers transfer the chemicals into a vessel large enough to hold several backyard pools' worth of liquid. The surfactant vessel stands near dozens of other ingredients, each waiting to be used in a recipe for different household cleaning products. As one former employee explained: "The products are easy to make. It's literally just mixing. … You just stir it with your spoon, your big old manufacturing spoon."

The Fortune 500 company — which makes Tide, Crest, Bounty, Pampers, Old Spice, Tampax and dozens of other popular brands — relies on petroleum-derived surfactants to manufacture its household cleaning products. ProPublica spent months identifying consumer goods that contain specific BASF surfactants; we were able to trace a full supply chain for Cascade, thanks in part to Procter & Gamble's centralized production of its dishwasher detergent. Records obtained by

ProPublica show that BASF surfactants typically compose a tiny fraction of Cascade products. But that small amount plays a large role in removing grime without producing a lot of foam, which is crucial for a detergent to limit suds from forming in a dishwasher. In addition, the surfactants allow for water to better clean glasses without leaving spots and help glasses sparkle more.

BASF's surfactants are a crucial part of the recipe that differentiates Cascade from other detergents — and help Procter & Gamble control more than 60% of the nation's $1.4 billion dishwasher detergent market, according to Chicago-based market research firm IRI. (Procter & Gamble declined to answer questions about

Cascade's formulation. Former employees say that the company typically uses multiple chemical suppliers to minimize supply chain disruptions. Records obtained by ProPublica show that Procter & Gamble has stored BASF surfactants at its plant over much of the past two decades.)

The rise of Cascade mirrors BASF's nationwide expansion. In the 1950s, Procter & Gamble unveiled a "miracle" green powder, which it claimed could outperform all other dishwasher detergents. The earliest Cascade formulations were developed at a time when American products were beginning to incorporate surfactants, a technology that a Procter & Gamble scientist originally heard about during a meeting with IG Farben before World War II. Thanks in part to those surfactants, Cascade quickly became America's most popular dishwasher detergent brand. Decades later, Procter & Gamble faced a major business threat when competitors first introduced liquid detergents, touted as more convenient than powder formulations. When Procter & Gamble finally debuted its liquid formulation in the late 1980s, the company began to consolidate Cascade production at its St. Louis plant.

Procter & Gamble has faced safety concerns regarding its cleaning products. In the 1970s, federal regulators required Cascade, along with other phosphate-based detergents, to have labels warning that people could be harmed if they swallowed the detergent or got it in their eyes. Lawmakers from Illinois to Florida then began to restrict the use of phosphates — a chemical that was effective at stripping grime from dirty plates but also polluted waterways — in dishwasher detergent. By 2010, 17 states had banned high-phosphate formulations, forcing detergent manufacturers to phase out the chemical nationwide. Customers grew so unhappy with the performance of the resulting dishwasher detergents that some bought trisodium phosphate from hardware stores — marketed as a mildew remover for patios, siding and other home exteriors — and mixed it with the phosphate-free detergent. Following those complaints, BASF representatives touted in 2011 multiple ingredients, including a low-foaming surfactant, that together could replace phosphate.

Procter & Gamble, which declined to answer ProPublica's questions about its use of BASF surfactants, says on Cascade's website that its employees are "improving product formulas to not just work better, but to be more in harmony with the world we live in (and love)." After a Procter & Gamble research director called for the company "to reduce its dependency on the use of petroleum" found in surfactants, its executives pledged in 2010 to "substitute top petroleum-derived raw materials with renewable materials as cost and scale permit." Eight years later, Procter & Gamble told investors it had developed the ability to phase out its petroleum-derived raw materials. But ProPublica's review of the company's permit records found that petroleum-based ingredients remain widely used at some of its plants. For instance, the company still relies on surfactants made with petroleum-derived materials, which, as BASF's plants in its products' supply chain show, can elevate cancer risk for its neighbors.

Over the past three decades, consumer goods companies have begun to replace raw materials derived from petroleum with ones from agricultural sources, including oil from the kernel of palm fruit. That shift has slowed in part because the plantations that grow palm fruit have faced charges of human rights violations and environmental concerns over the deforestation of millions of acres of old-growth trees. America's fracking boom has further "paused the swing" toward non-petroleum-based surfactants, said Neil Burns, a chemical industry veteran who organizes an international surfactant conference. He estimates that 60% of America's surfactants still include raw materials derived from fossil fuels. Martin Wolf, director of sustainability for Seventh Generation, a cleaning product company owned by Unilever, one of Procter & Gamble's competitors, told ProPublica the current production levels of surfactants derived from kernels of palm fruit are inadequate to immediately replace those derived from petroleum.

"You would need to have a transition — just like with electric cars," Wolf said.

Procter & Gamble also declined to answer questions about how far along it is in phasing out petroleum-derived raw materials. Nelson, the BASF spokesperson, said in a statement that the company is focused on "creating chemistry for a sustainable future."

But according to records obtained by ProPublica, BASF has expressed doubt about the possibility of a quick shift away from petroleum-based raw materials. In a 2014 meeting with investors, a BASF executive said that "it's completely unrealistic to believe that this renewable piece will really change our industry in any dramatic fashion very, very soon."

On a Monday afternoon in late October, Hollie Walker pushed her grocery cart down the detergent aisle of her local Ingles supermarket. The Cascade products she eyed had traveled by truck from Procter & Gamble's St. Louis plant to the east side of Spartanburg. Staring at the wall of green packaging, she tried to figure out which product to buy this time. The powder boxes sat on the bottom. Right above them were the gel bottles. And at eye level were the individual pouches.

Walker found herself locked in an inescapable part of modern domestic life. She relied on detergent almost as much as she relied on the meals that dirtied her plates. She did everything she could to keep her cancer at bay, including taking medication daily to block hormones that could lead to a future tumor, but she still needed to clean the dishes.

Walker felt powerless to break the cycle of her own loyalty to a brand she had bought for decades. A "libertarian by heart," she nonetheless believed that regulators need to better protect small rural communities like White Stone from "the brunt of this pollution."

After a few moments in the detergent aisle, Walker headed to the register. She placed chickpea burgers on the conveyor belt, followed by a bag of organic red pears. After that came a shiny silver bag of Cascade "ActionPacs." She made the best choices she could.

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