S. HRG. 118–755

IMPACTS OF PLASTIC PRODUCTION AND DISPOSAL ON ENVIRONMENTAL JUSTICE COMMUNITIES

HEARING

BEFORE THE

SUBCOMMITTEE ON CHEMICAL SAFETY, WASTE MANAGEMENT, ENVIRONMENTAL JUSTICE, AND REGULATORY OVERSIGHT

OF THE

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

UNITED STATES SENATE

ONE HUNDRED EIGHTEENTH CONGRESS

FIRST SESSION

JUNE 15, 2023

Printed for the use of the Committee on Environment and Public Works

Available via the World Wide Web: http://www.govinfo.gov

U.S. GOVERNMENT PUBLISHING OFFICE

62–383 WASHINGTON : 2026

COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS

ONE HUNDRED EIGHTEENTH CONGRESS

FIRST SESSION

THOMAS R. CARPER, Delaware, *Chairman*
SHELLEY MOORE CAPITO, West Virginia, *Ranking Member*

BENJAMIN L. CARDIN, Maryland
BERNARD SANDERS, Vermont
SHELDON WHITEHOUSE, Rhode Island
JEFF MERKLEY, Oregon
EDWARD J. MARKEY, Massachusetts
DEBBIE STABENOW, Michigan
MARK KELLY, Arizona
ALEX PADILLA, California
JOHN FETTERMAN, Pennsylvania

KEVIN CRAMER, North Dakota
CYNTHIA M. LUMMIS, Wyoming
MARKWAYNE MULLIN, Oklahoma
PETE RICKETTS, Nebraska
JOHN BOOZMAN, Arkansas
ROGER WICKER, Mississippi
DAN SULLIVAN, Alaska
LINDSEY O. GRAHAM, South Carolina

COURTNEY TAYLOR, *Democratic Staff Director*
ADAM TOMLINSON, *Republican Staff Director*

SUBCOMMITTEE ON CHEMICAL SAFETY, WASTE MANAGEMENT, ENVIRONMENTAL JUSTICE, AND REGULATORY OVERSIGHT

JEFF MERKLEY, Oregon, *Chairman*
MARKWAYNE MULLIN, Oklahoma, *Ranking Member*

BERNARD SANDERS, Vermont
SHELDON WHITEHOUSE, Rhode Island
EDWARD J. MARKEY, Massachusetts
JOHN FETTERMAN, Pennsylvania
THOMAS R. CARPER, Delaware *(ex officio)*

JOHN BOOZMAN, Arkansas
ROGER WICKER, Mississippi
DAN SULLIVAN, Alaska
SHELLEY MOORE CAPITO, West Virginia *(ex officio)*

C O N T E N T S

Page

JUNE 15, 2023

OPENING STATEMENTS

WITNESSES

ADDITIONAL MATERIAL

IMPACTS OF PLASTIC PRODUCTION AND DISPOSAL ON ENVIRONMENTAL JUSTICE COMMUNITIES

THURSDAY, JUNE 15, 2023

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
SUBCOMMITTEE ON CHEMICAL SAFETY, WASTE MANAGEMENT,
ENVIRONMENTAL JUSTICE, AND REGULATORY OVERSIGHT,
Washington, DC.

The subcommittee met, pursuant to notice, at 10 a.m. in room 406, Dirksen Senate Office Building, Hon. Jeff Merkley (chairman of the subcommittee) presiding.

Present: Senators Merkley, Mullin, Carper, Whitehouse, Markey, Boozman, Sullivan.

OPENING STATEMENT OF HON. JEFF MERKLEY, U.S. SENATOR FROM THE STATE OF OREGON

Senator MERKLEY. Welcome to the second in a series of hearings in the Chemical Safety, Waste Management, Environmental Justice and Regulatory Oversight Subcommittee on the Environmental and Public Health Dangers Involved in the Production, Use, and Disposal of Plastics.

I appreciate the support of Senator Carper and Ranking Member Capito for this set of hearings exploring these issues.

In our first hearing, we established that plastic has some unique and amazing properties. There are a lot of specialized applications where these may be important, and sometimes essential. The majority of plastic is single use plastic. There are significant challenges or harms caused by plastics to human health, to ecosystems, and to the environment.

Today we are going to hear from people who are impacted the most by plastic, those who live next to facilities where plastic is made, and facilities where it is disposed of, often by burning. The goal is to better understand why plastic facilities are clumped together and the effect that they are having.

We cannot tell the story of plastics without mentioning Cancer Alley in Louisiana. Cancer Alley is an 85-mile section covering 11 parishes along the Mississippi River between New Orleans and Baton Rouge that has high levels of toxic pollution. It accounts for some 25 percent of the Nation's petrochemical production and has the largest concentration of chemical plants in the western hemisphere.

The existence of 15 petrochemical plants in agricultural areas of Cancer Alley is the legacy of slavery. What was once plantations where enslaved Black Americans raised sugar cane has been replaced by petrochemical facilities. The free towns established when recently freed Black Americans lived as sharecroppers now sit right next door to these plants.

The State is not only not protecting them, it may in fact be discriminating. I quote from a letter that EPA sent to Louisiana's Department of Environmental Quality, LDEQ, "EPA has significant concerns that Black residents and school children living and/or attending school near the Denka facility have been subjected to discrimination through LDEQ's actions and inactions in the implementation of its air pollution control permit program."

Where does this plastic go when we are done with it? Too often, it goes to the municipal solid waste incinerators, where it is burned with air pollution emissions comparable to fossil fuel power plants. The burning of plastics releases toxic gases like dioxins, furans, mercury, polychlorinated biphenyls, and it causes a significant range of health maladies.

It is no surprise that 79 percent of the 73 incinerators in the U.S. are located in low-income communities or communities of color. Of these facilities, 48 incinerators are located in communities where more than 25 percent of the population is below the Federal poverty level. Policies that Congress included in the debt ceiling bill weakened the National Environmental Policy Act that will make it more difficult for overburdened front-line communities to protect themselves.

There is a lot of talk about jobs, so let's get some statistics on that. The cities and communities historically dominated by petrochemical production are overwhelmingly poor, and building petrochemical facilities does not lead to significant job benefits or economic prosperity for the surrounding communities.

Port Arthur is home to the Nation's largest oil refinery operation, but it has an unemployment rate twice as high as Texas' average. Port Arthur ranks as Texas' poorest city with a poverty rate of 27.2 percent, double the Texas average of 14.2 percent, or almost double.

A study by San Gabriel in Louisiana found that just 9 percent of full-time industry jobs were held by local citizens, in spite of the town having an annual per capita income of just $15,000, a third below the State average and half the national average.

Whether it is intentional discrimination or because of lack of qualifications for the work, the result is the same: the burden of these facilities are placed on communities that receive little to none of the benefits and receive all of the pollution. The jobs that are available come with the risk of serious health impacts. Workers producing plastic are at increased risk of leukemia, lymphoma, hepatic angiosarcoma, brain cancer, breast cancer, mesothelioma, neurotoxic injury and decreased fertility. Workers producing plastic textiles die of bladder cancer, lung cancer, mesothelioma, and interstitial lung disease at increased rates.

The Occupational Safety and Health Administration, known as OSHA, is tasked with ensuring protection for all workers. OSHA has a disclaimer on its website that it "recognizes that many of its permissible exposure limits, PELs, are outdated and inadequate to protect workers' health."

In Louisiana, local communities often have not even received the benefits of the tax revenue from these facilities. The State's industrial tax exemption program, ITEP, exempts major industrial facilities in Louisiana from most property taxes for up to a decade. ITEP cost local taxing bodies $1.48 billion in foregone taxes in 2018. That is 33 percent of property taxes collected by the State.

This is an issue of justice. That is why it is so important that are having the hearing. I look forward to hearing the insights that each of you bring from your lived experience.

With that, let me turn to opening comments from our co-leader of the committee, Ranking Member Mullin.

OPENING STATEMENT OF HON. MARKWAYNE MULLIN, U.S. SENATOR FROM THE STATE OF OKLAHOMA

Senator MULLIN. Thank you, Mr. Chairman.

As we discuss plastics, we got to talk about reality, too. I have a statement that I do want to read. I do want to say that I think understanding the plastics that we have, the reliability that plastics bring and the amount of technology that we use plastics in would say that everybody in this committee thinks this is an important topic.

I do want to point out that the reason why we are not having a lot of people here is because we have a lot of committees going on. In fact, we have a markup happening in another committee that I currently sit on. If it wasn't for so many different hearings going on, I think there would be a lot more people here, which we appreciate all the witnesses that are here and the people in the audience. I think we can all agree this is something we got to pay attention to but how do we do it without making us more reliant on other countries, how do we do this without limiting the ability for us to continue moving forward and society as a whole.

Everybody here relies on plastics. Everybody here has plastics either on your feet, on your clothes right now. Everybody here that has a cell phone has plastic. Everybody that was driven here by either a Metro or by vehicle relies on plastics. Every electric vehicle out there cannot be produced without plastics. Everyone that goes to bed and wakes up in the morning and takes a shower and dries off with a towel relies on plastics. Everybody that goes grocery shopping and buys your food relies on plastics.

It is not as though we can just limit, it is just how can we do it better. We got to have the open conversation where we are talking about this, Chairman, is how can we do it better. I will point this out also in my opening statement, I do not believe we have a plastic problem, we have a recycling problem. We have to learn how to make recycling valuable where it allows us to be able to use that as a value base.

If we ignore that issue, guys, then you are ignoring the reality. What is going to replace plastics? Someone has a solution for that, then we would probably already be there. There is not.

I would like to first start by thanking our witnesses here today for attending this subcommittee hearing, including Mr. Kevin Sunday and Ms. Donna Jackson. Today's hearing highlights an original novel idea called environmental justice that has been transformed away from its original intent of helping poor and marginalized communities with specific needs into a social movement Democrats have taken over to push progressive policies forward under the disguise of social and racial equality.

I think all of us in this community can agree to this, everyone deserves clean air and water and access to reliable energy sources that will help create a cleaner, healthier and safer future. What is missing from the discussion is that critical role the U.S. plays in manufacturing essential plastics, materials that are used in medical applications, helps deliver our clean water, can not get water delivered to you without plastic piping, and keeps our food fresh.

Some witnesses today might make statements that plastics are harmful to your health, but they ignore the fact that plastics are already heavily regulated in the U.S. and have to go through intense, rigorous standards guided by science to be used in applications especially when it comes in contact with your food and your medicine. When it comes to facilitating siting for these companies, they are not just investing in the buildings or the land, they are investing in the communities by providing jobs, health care plans, economic growth in the surrounding area. These benefits provide— you guys are welcome to be here, but whoever keeps interrupting us, they either need to behave or they need to be removed, Chairman.

Senator MERKLEY. I hold a lot of town halls in Oregon, and I do so in every county. We have what we call the Oregon way, which is listen thoughtfully and if you passionately disagree, still be very respectful of the person speaking. That includes members of the panel, of the Senate, and that includes those who are testifying. I really appreciate you all being here, because these are really important issues that have been totally under-examined by Congress. Again, please do be respectful. If you feel like you need to say something, go out in the hall and say it and then come back in. Thanks.

Senator MULLIN. I want to reiterate this. I enjoy the passion, passion is what drives this Country, guys. Respect is also there. I raise our kids on four things, honesty, hard work, respectful, and being responsible. I promise you I will respect you. That respect needs to be returned two ways.

When it comes to facilitating siting for these companies, I am going to restart this, they are not just investing in our buildings, they are investing in buildings or the land, they are investing in our communities by providing jobs, health care plans, economic growth in the surrounding areas. These benefits provide a widespread opportunity for access and stability to rural States like Oklahoma.

These are not short-term investments, either. It is in the manufacturing company's interest to ensure good relationships with the communities around them, not only because it is the right thing to do, but it is because the labor pool is likely from within the very community that they work in.

Something I want to make clear, it is that we do not have a plastic problem, we have a recycling handling problem. Instead of halting infrastructure projects or manufacturing development that results in U.S. job loss and more reliance on countries like China to produce critical material needed for modern life, why would we not refocus in improving recycling?

As I mentioned in our previous Plastics subcommittee hearing, recycling means plastics that get re-used, which is most productive through innovative technologies like advanced recycling. If we oppose a science-based solution that makes it possible to capture and re-use large volumes of used plastics that is currently going unrecycled, do we really care about plastic waste?

Thank you, Mr. Chairman. I yield back.

Senator MERKLEY. Thank you. Now we are going to turn to our witnesses. I am so appreciative that you all are bringing your knowledge and your lived experience to bear.

We are going to hear first from Angelle Bradford, who is currently a doctoral student in physiology and medicine at Tulane University School of Medicine. Ms. Bradford also serves as a volunteer of Sierra Club's Delta Chapter.

Ms. Bradford, please proceed.

STATEMENT OF ANGELLE BRADFORD, PH.D. STUDENT IN CARDIOLOGY, TULANE SCHOOL OF MEDICINE, VOLUNTEER CHAPTER SECRETARY, SIERRA CLUB, DELTA CHAPTER, NEW ORLEANS, LOUISIANA

Ms. BRADFORD. Thank you so much. Good morning. Thank you, Chairman Merkley and Ranking Member Mullin. I appreciate the invitation to speak today.

My name is Angelle Bradford. As you said before, I am a volunteer at the Delta Chapter of the Sierra Club and also a doctoral candidate earning my degree in cardiovascular physiology.

I love my life in south Louisiana, as my family has been in south Louisiana and Mississippi for generations, though it is a complicated life where basic human rights are always being challenged. We can do better. When I look out across Lake Pontchartrain near New Orleans or the Atchafalaya Basin, I am affirmed that we must do better.

Unfortunately, after decades of inaction, the climate crisis is fully evident in Louisiana. Our spring and summer nights and afternoons are getting hotter and more humid, which makes it harder to cool off at nighttime. I split my time between Baton Rouge and New Orleans, and it is only in recent years that Baton Rouge reached air quality attainment per Federal standards. We still struggle with an F rating by the American Lung Association, however, as recently as 2019, due to petrochemical plants and other emissions producing ozone that combine with increased temperatures. I experience frequent headaches and migraines and asthma attacks on those poor air quality days.

Our region has had many major hurricanes in the past years. There is no national insurance market prepared to serve as a safety net for any of us in this Nation. I would like to own a home and have a family soon. I am just not sure how responsible this is right now.

When it comes to my work as a biomedical researcher, weeks to months can be lost to a hurricane that quickly strengthens overnight and leaves me little time to power down my experiments.

Many of us in south Louisiana know all too well how the assurances made to our communities by energy and utility systems go out the window when we most need them.

Despite these realities, the same industry most responsible for knowingly exacerbating climate change, the industry that dominates public policy and politics in my home State of Louisiana is unleashing yet another catastrophe on this planet, this time in the form of plastics. In December of just last year, ExxonMobil Baton Rouge announced plans to double their capacity in polypropylene plastics, increasing the Gulf Coast capacity to 450,000 metric tons per year.

Per Defend Our Health's recent study, PET or polyethylene terephthalate plastic releases 1,4 dioxane, an industrial solvent and carcinogen, during production into drinking water. It can damage cells in the liver, kidney and respiratory system.

Their study also spoke to 150 chemicals out of 193 that they looked at that leach from our plastic bottles into the water or beverage that any one of us is drinking. As we discover chemicals produced from plastic processes, we recognize their power to damage organs and cells. Often, any given person does not live next to or breathe the air of just one plant's emissions, there may be multiple plants clustered together.

It has historically been difficult to study the cumulative effects of polluted air, soil, and water at the same time, particularly because it is unethical within a lot of contexts to just give people plastics-derived carcinogens and chemicals and see what happens. Also, people move and have different exposures and stressors that complicate understanding of disease processes.

Nonetheless, exposure over time means increased likelihood of chronic diseases in addition to cancer. When we think about life in this Country, something we often debate, we need to also think about the dignity of life we are offering when we are allowing these companies to carelessly raise our health care costs and poison our people.

While some folks may see oil and gas on the one hand and plastics on the other as very different issues that require different solutions, I see them as one and the same. That is, the same companies reaping profits from all ends of the supply chain, from cradle to grave of their products and of our bodies. I am left to wonder to which part of the plastics life cycle, to the oil and gas industry, are we ready to sacrifice our dreams and our lives.

I am no longer willing to offer up my life for any more industries, and the plastics industry must be stopped with no exceptions.

[The prepared statement of Ms. Bradford follows:]

Good morning, thank you Chairman Merkley and Ranking Member Mullin. I appreciate the invitation to speak today. My name is Angelle Bradford. I am a volunteer with the Delta Chapter of the Sierra Club and also a Doctoral Candidate earning my degree in the areas of physiology and medicine. I am a Southern girl in every way; I feel like my heart is always somewhere between New Orleans and Bay St. Louis, as my family has been in south Louisiana and Mississippi for generations. I love life in South Louisiana, though it is a complicated life, where basic dignity of life and human rights are always being challenged. It can be disorienting to juxtapose my life experiences and love for my home with my state's national rankings which are among the lowest in many quality-of-life metrics. But I believe we can do better. When I look out across the Pontchartrain or Atchafalaya Basin, I am affirmed that we must do better.

I am here today to talk with you about what a dear friend of mine calls "the illusion of separation." While some folks may see oil and gas on the one hand, and plastics on the other, as very different issues that require different solutions, I see them as one-and-the same: that is, the same companies reaping profits from all ends of the supply chain, from cradle to the grave. I mean that literally, in the sense of their product offerings, and morbidly, in the sense that it is we — the citizens of my state and this country — whom they are sacrificing in the process. And I'm left to wonder, to which part of the plastics life cycle, to the oil and gas industry, are we ready to sacrifice our dreams and desires? To which part are we ready to give up our health and our lives ? I am no longer willing to offer up our quality of life for the plastics industry.

Unfortunately, after decades of inaction, time is not on our side. In south Louisiana, climate change is already here. Our spring and summer nights and afternoons are getting hotter, which makes it harder to cool off at nighttime and prepare for the next hot day. I experience frequent migraines and asthma attacks from poor air quality days and beyond the sheer record number of major hurricanes that hit our state in the last few years, there is no national insurance market prepared to serve as a safety net for any of us and our different disasters. It is literally, already becoming unlivable in a state that is already unstable and a wild card in the Deep South. I would like to own a home and have a family one day. I am not sure how any of this is even reasonable or possible. When it comes to my work, I think about how weeks to months can be lost to a hurricane that quickly strengthens overnight and leaves me little time to prepare myself or power down my active experiments. . And I think about how much the affordances and assurances our communities are made around our energy and utility systems go out the window when we most need them most. Consequently, I am fully in agreement that we need to move away from integrating these industries and plastics into our everyday lives.

Now, the same industry most responsible for the knowingly exacerbating climate change — the industry that dominates public policy and politics in my home state — is unleashing yet another catastrophe on the planet: this time in the form of plastics.

Per Defend Our Health's recent study, PET (polyethylene terephthalate,) plastic releases 1, 4- dioxane during plastics production into drinking water. 1,4-dioxane is a heterocyclic ether used as a polar industrial solvent and is released as waste discharges (Kikani, et al, 2022). Besides being a carcinogen, it can damage cells in the liver, kidney, and respiratory system, according to the Minnesota Department of Health. Additionally in the report from Defend Our Health, they spoke to the dangers of ethylene oxide which is a known human carcinogen responsible for nearly 80% of cancer risk due to hazardous air pollutants. We talk a lot about cancer, but many diseases, such as kidney failure, lead to drastically different qualities of life. And as we discover new chemicals, we recognize their power to damage organs and cells, with more and more studies beginning to help decision makers and practitioners think through cumulative effects of exposure to these chemicals. Oftentimes, any given person does not live next to or breathe the air of just one plant's emissions, there may be multiple plants clustered together. And any one of us exposed to the water and discharges of that plant is also drinking from plastic bottles or swimming in polluted streams or eating food from soil that has been contaminated. It has historically been difficult to study the cumulative effects of polluted air, soil, and water at the same time particularly because it is unethical, within the lab context, to just give people plastics-derived carcinogens and chemicals and see what happens. But also, people move and have different exposures and stressors that complicate understanding of disease processes. But it does not take a rocket scientist or a chemist to have regard for the fact that risk and exposure over time mean increased likelihood of diseases that Americans are being diagnosed with each day. When we think about life in this country, something we often debate, we need to also think about the dignity of life we are offering when we are allowing these companies to inadvertently raise our healthcare costs and poison our people.

Senator MERKLEY. Thank you for your testimony.

We are going to turn now to Sharon Lavigne, the founder of RISE St. James. Ms. Lavigne has long served as an environmental justice advocate. I look forward to your statement.

STATEMENT OF SHARON LAVIGNE, FOUNDER, RISE ST. JAMES

Ms. LAVIGNE. Thank you. I would like to thank you for giving me this opportunity to speak to you today. My name is Sharon Lavigne, and I am a lifelong resident of St. James, Louisiana. I was a special education teacher for 38 years at St. James High School. I retired in 2019 to do this work. This was my high school, the one that my father, Milton Cayette, Sr., integrated in 1966 when he was the president of the NAACP's local chapter.

I am a mother of six and a grandmother of twelve. I live in the 5th district of my parish, which is 85 percent African American. On one side lies the Mississippi River. On the other lies sugar cane fields surrounded by petrochemical plants and refineries. It is making us sick. We cannot drink the water, plant a garden, or breathe clean air.

The place I remember being so beautiful and full of life is now called Cancer Alley, which runs from New Orleans to Baton Rouge. We call it Death Alley due to the high number of community members getting sick and dying from cancer.

In 2016, I was diagnosed with autoimmune hepatitis. In 2019, I was diagnosed with aluminum and lead in my body. My fruit trees no longer produce fruit. Members of my family and community say that their children have trouble breathing and they are experiencing skin rashes, nose bleeds, respiratory ailments, and cancer.

I have lost neighbors on both sides of me to different forms of cancer. Everyone here either has cancer or knows someone with cancer. It seems like I am now heading to funerals just about every week for another neighbor or friend.

In spring of 2018, Governor John Bel Edwards announced the approval of Formosa Plastics, a $9.4 billion petrochemical facility to be built two miles from my home. Community members said it was a done deal.

That did not sit well with me. In the fall of 2018, we formed RISE St. James, a faith-based organization focusing on protecting the air, water, and soil of St. James Parish from toxic industrial pollution.

Formosa Plastics would cover 2,400 acres with its chemical plants right on top of the former Acadia and Buena Vista slave plantations. If Formosa is built, it will be a death sentence for St. James residents. Formosa would double air pollution in my district and triple our exposure to cancer-causing chemicals like benzene and ethylene oxide.

We are fighting; we have fought all the approvals given to Formosa and stopped them. We must make sure it never gets built.

Many other toxic industries are trying to move in, but we must stop them. We are not leaving our community. We need industry to leave. They get tax breaks and we get sickness and death. For what? All in the name of profit.

These industries are big climate polluters. I survived Hurricane Ida, but my home didn't. I watched oil spill out of a holding tank.

I lived out of a trailer for many months, and I am still working to recover and rebuild.

President Biden, the EPA, the Army Corps and other agencies should use the tools they already have to protect us. You, Congress, could do so much by defending existing laws and passing new laws to protect communities and stop building petrochemicals and fossil fuel projects here in St. James and everywhere.

I am here today because we are still not safe. Once again, thank you for having me.

[The prepared statement of Ms. Lavigne follows:]

Sharon Lavigne, Founder, Rise St. James
Testimony

"Impacts of Plastic Production and Disposal on Environmental Justice Communities"
U.S. Senate Committee on Environment & Public Works
Subcommittee on Chemical Safety, Waste Management, Environmental Justice, and Regulatory Oversight
June 15, 2023, 10:00 AM ET
406 Dirksen Senate Office Building

I would like to thank you for giving me this opportunity to speak to you today. My name is Sharon Lavigne, and I am a lifelong resident of Saint James, Louisiana. I was a special education teacher for 38 years at St. James High School. I retired in 2019. This was my high school and the one that my father, Milton Cayette, Sr., integrated in 1966 when he was the President of the NAACP's local chapter.

I am a mother of six children and grandmother of twelve. I live in the 5th district of my parish, which is 85% African American. On one side lies the Mississippi River. One the other lies sugarcane fields surrounded by petrochemical plants and refineries. It is making us sick. We cannot drink the water, plant a garden, or breathe clean air.

The place I remember being so beautiful and full of life is now called Cancer Alley, which runs from New Orleans to Baton Rouge. We call it Death Alley due to the high number of community members getting sick and dying from cancer. In 2016, I was diagnosed with autoimmune hepatitis. In 2019, I was diagnosed with aluminum and lead in my body. My fruit trees no longer produce fruit. Members of my family and community say that their children have trouble breathing and they are experiencing skin rashes, nose bleeds, respiratory ailments, and cancer. I've lost neighbors on both sides of me to different forms of cancer. Everyone here either has cancer or knows someone with cancer. It seems like I am now heading to funerals just about every week for another neighbor or friend.

In spring of 2018, Governor John Bel Edwards announced the approval of Formosa Plastics, a $9.4 billion dollar petrochemical facility to be built two miles from my home. Community members said it was a done deal. That did not sit well with me. In the fall of 2018, we formed RISE St. James, a faith-based organization focusing on protecting the air, water, and soil of St. James Parish from toxic industrial pollution.

Formosa Plastics would cover 2400 acres with its chemical plants right on top of the former Acadia and Buena Vista slave plantations. If Formosa is built, it will be a death sentence for St. James residents. Formosa would double air pollution in my district and triple our exposure to cancer-causing chemicals like benzene and ethylene oxide. We've fought all the approvals given to Formosa and stopped them. We must make sure it never gets built.

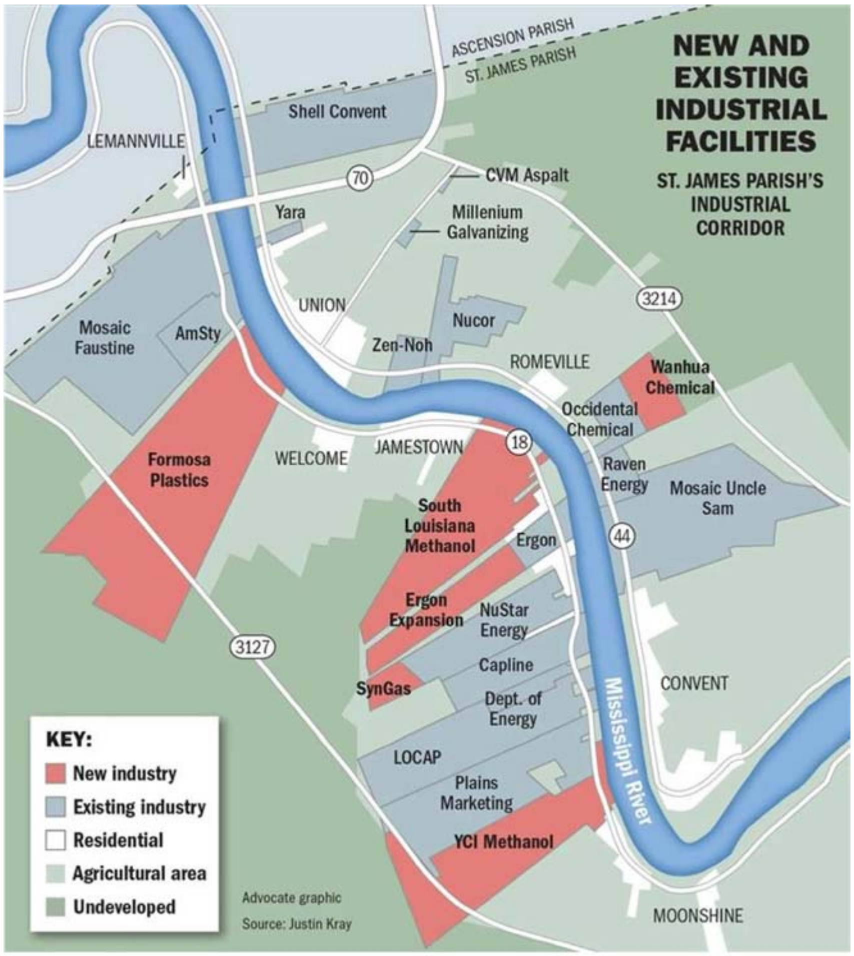
Many other toxic industries are trying to move in, but we must stop them. We are not leaving our community. We need industry to leave. They get tax breaks and we get sickness and death. And for what? All in the name of profit.

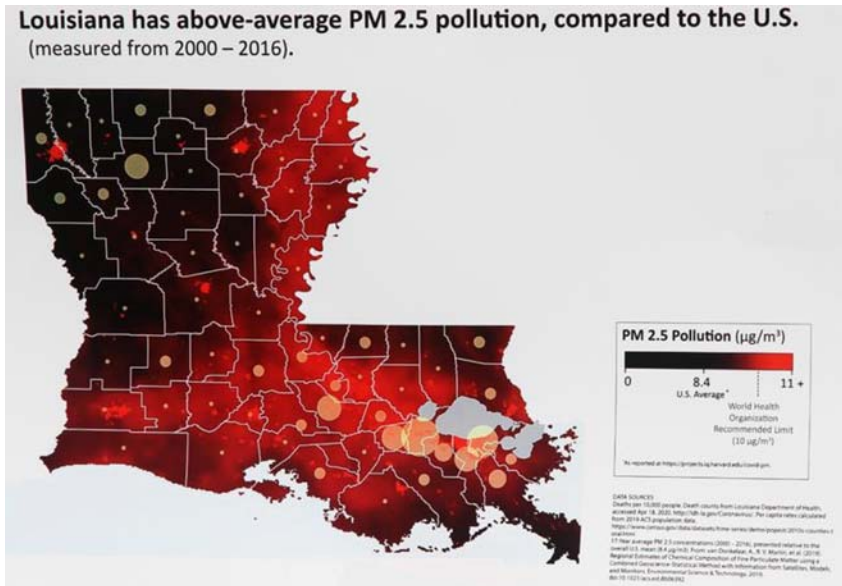
These industries are big climate polluters. I survived Hurricane Ida, but my home didn't. I watched oil spill out of a holding tank. I lived out of a trailer for many months, and I'm still working to recover and rebuild.

President Biden, the EPA, the Army Corps and other agencies should use the tools they already have to protect us. And you, Congress, could do so much by defending existing laws and passing new laws to protect communities and stop building petrochemicals and fossil fuel projects here in Saint James and everywhere.

I am here today because we are still not safe.

Once again, thank you for having me.


NEW AND EXISTING INDUSTRIAL FACILITIES
ST. JAMES PARISH'S INDUSTRIAL CORRIDOR
ASCENSION PARISH
ST. JAMES PARISH
Shell Convent
LEMANNVILLE
70
CVM Aspalt
Yara
Millenium Galvanizing
3214
UNION
Nucor
Mosaic Faustine
AmSty
Zen-Noh
ROMEVILLE
Wanhua Chemical
Occidental Chemical
Formosa Plastics
WELCOME
JAMESTOWN
18
Raven Energy
Mosaic Uncle Sam
South Louisiana Methanol
Ergon
44
Ergon Expansion
NuStar Energy
3127
Capline
SynGas
CONVENT
Dept. of Energy
Mississippi River
LOCAP
Plains Marketing
YCI Methanol
MOONSHINE
KEY:
New industry
Existing industry
Residential
Agricultural area
Undeveloped
Advocate graphic
Source: Justin Kray


Louisiana has above-average PM 2.5 pollution, compared to the U.S.
(measured from 2000 – 2016).
PM 2.5 Pollution (µg/m³)
0
8.4
U.S. Average*
11 +
World Health Organization Recommended Limit (10 µg/m³)

Senator MERKLEY. Thank you very much, Ms. Lavigne. Thank you for your previous work as a teacher, because education is so important to the next generation.

Our next witness is Chris Tandazo. Chris Tandazo serves as the statewide Environmental Justice Organizer with the New Jersey Environmental Justice Alliance. We are pleased to have you.

STATEMENT OF CHRIS TANDAZO, STATEWIDE ENVIRONMENTAL JUSTICE ORGANIZER, NEW JERSEY ENVIRONMENTAL JUSTICE ALLIANCE

Mx. TANDAZO. Good morning, thank you, buenos dias. Thank you, Senator Merkley, for the invitation to testify this morning.

My name is Chris Tandazo. I use they/them pronouns. I am the statewide Environmental Justice Organizer for the New Jersey Environmental Justice Alliance, NJEJA.

NJEJA is a 20-year-old statewide environmental justice organization in New Jersey. We collaborate with grassroots partners to identify, prevent, reduce, and/or eliminate environmental injustices in our communities. NJEJA is led and staffed by majority people of color, who are also members of the communities burdened by polluting facilities and toxic infrastructure.

NJEJA, alongside other environmental justice advocates, collectively advocated for and led the way in the passage of the landmark New Jersey Environmental Justice Law, S. 232. The primary purpose of the EJ law is to require the New Jersey Department of Environmental Protection to evaluate the environmental and public health impacts on overburdened communities when reviewing permit applications for certain facilities. NJDEP then has the authority to deny or condition certain permits due to the cumulative impacts of pollution.

The EJ law is a beacon of hope for communities like mine. I immigrated from Ecuador to Irvington, New Jersey when I was 15, where I lived until my late 20's. Living in Irvington, the presence of industrial facilities, trucks, and warehouses was and remains a regular everyday sight, which made me accustomed to living in pollution and seeing this as normal. It was so normalized that I didn't think to challenge the presence of industry.

It wasn't until I had the opportunity to attend graduate school that I learned about environmental injustice and was then introduced to the grassroots movement that has courageously fought for the health and safety of our communities. I realized how my life, my health, and the well-being of my family and my entire community had been and continues to be impacted by the presence of toxic pollutants that are detrimental to human health, to our health.

When I think of plastic waste, I think of the environmental justice communities at the front-line and backend of the plastic crisis that have directly and disproportionately experienced the harms of the entire life cycle of plastics. The plastic crisis starts and is particularly acute in places like Cancer Alley in Louisiana, like Ms. Sharon has just mentioned, where the petrochemical industry has exposed Black communities to high levels of toxins, causing extreme rates of cancer-related illnesses and deaths.

Some of these toxins come from the fossil fuels used to make plastic, but industry also adds many unnecessary toxins for color, rigidity, texture, increasing the toxicity of the plastic and making it impossible to recycle.

As plastic waste generation increases, so does the need to dispose of it. At this stage, the plastic crisis arrives at my front door in New Jersey. New Jersey is home to three incinerators. All of these incinerators are located in low-income communities of color, in Camden, Rahway, and Newark, where the incinerators burn the plastic waste from New Jersey, New York City, and many neighboring states, alongside all other types of waste.

Burning waste, specifically plastic waste, creates even more toxins and severely impacts the health of our communities, such as volatile organic compounds, nitrogen dioxide, sulfur dioxide, and particulate matter. These toxins are endocrine disruptors, damage reproductive and neurological systems, and increase the risk of cardiovascular and respiratory-related illnesses for our communities, which are already so overburdened by other polluting infrastructure and socio-economic challenges.

I myself deal with respiratory issues. I am congested most of the time, and it makes it hard to breathe when I am being active outside. Many people close to me have asthma. You know what makes this even sadder? According to a recent study by Earth Justice, from 2004 to 2022, New Jersey ratepayers, including myself, have paid over $60 million in renewable energy credit subsidies to the incinerators in New Jersey.

I do not know about you, but it does not sit well with me that our communities, my family, and myself, have been paying the incinerators in New Jersey to pollute us, to sacrifice us to a slow death.

The current disposal of plastic waste in our communities is a manifestation of environmental racism present in zoning policies that allow for the siting of incinerators and petrochemical industries in communities similar to mine throughout the Country. We collectively urge this body to take proactive steps toward plastic reduction to alleviate the burden our communities face.

Thank you for your time and for asking me to testify today.

[The prepared statement of Mx. Tandazo follows:]

Chris Tandazo's Testimony for Subcommittee Hearing on the Impacts of Plastic on Environmental Justice Communities

Senate Environment and Public Works (EPW)
Subcommittee on Chemical Safety, Waste Management, Environmental Justice, and Regulatory Oversight

Chair: Jeff Merkley

Thursday, June 15 2023

Good morning everyone. And thank you to Senator Merkley for the invitation to testify this morning. My name is Chris tandazo; I use they/them pronouns; I'm the Statewide Environmental Justice Organizer with the New Jersey Environmental Justice Alliance.

The New Jersey Environmental Justice Alliance, NJEJA for short, is a twenty-year-old statewide environmental justice organization in New Jersey that works in coalition with grassroots partners to identify, prevent, reduce, and/or eliminate environmental injustices in our communities. NJEJA is led and staffed by majority people of color, who are also members of the communities burdened by polluting facilities and toxic infrastructure.

NJEJA, alongside other environmental justice advocates, collectively advocated for and led the way in the passage of the landmark New Jersey Environmental Justice Law (S232). The primary purpose of the EJ law is to require the New Jersey Department of Environmental Protection (NJDEP) to evaluate the environmental and public health impacts on overburdened communities when reviewing permit applications for certain facilities. NJDEP has the authority to deny or condition certain permits due to the cumulative impacts of pollution.

I immigrated to Irvington, NJ, when I was 15, where I lived till my late 20s. Living in Irvington, the presence of industrial facilities, trucks, and warehouses was and remains a regular everyday sight, which made me accustomed to living in pollution and seeing this as "normal." It was so normalized that I didn't think to challenge the presence of these environmental injustices. It wasn't until I had the opportunity to attend graduate school that I learned about Environmental Justice and the grassroots movement that has courageously fought for the health and safety of our communities. I realized how my life, my health, and the well-being of my family and my entire community had been, and continue to be, impacted by the presence of toxic pollutants that are detrimental to human health, to our health.

When I think of plastic waste, I think of the environmental justice communities at the frontline and backend of the plastic crisis that have directly and disproportionately experienced the harms of the entire life-cycle of plastics, from the extraction of fossil fuels for plastic production, to the exposure of toxic chemicals when using plastics, to the disposal of plastic waste at landfills or incinerators in EJ communities. The plastic crisis is particularly acute in places like Cancer Alley in Louisiana, where the petrochemical industry has exposed Black communities to high levels of toxins, causing extreme rates of cancer-related illnesses and deaths. Some of these toxins come from the fossil fuels used to make plastic, but industry also adds many unnecessary toxins for color, rigidity, texture, etc., increasing the toxicity of the plastic and making it impossible to recycle. As plastic waste generation increases, so does the need to dispose of it. At this stage, the plastic crisis arrives at our front door in New Jersey. New Jersey is home to three incinerators. All of these are located in low-income communities of color, in Camden, Rahway, and Newark, where the incinerators burn the plastic waste from New Jersey and many neighboring states, alongside all other types of waste.

Burning waste, especially plastic waste, creates even more toxins that severely impact the health of our communities, such as volatile organic compounds, nitrogen dioxide, sulfur dioxide, and particulate matter. These toxins are endocrine disruptors, damage reproductive and neurological systems, and increase the risk of cardiovascular and respiratory-related illnesses for our communities, which are already overburdened by other polluting infrastructure and socio-economic challenges. Burning trash to generate a small amount of energy has incredibly high costs, including my health. Additionally, a recent study by Earth Justice noted that from 2004 to 2022, New Jersey ratepayers have paid over $60 million in renewable energy credit subsidies to the incinerators in New Jersey. I don't know about you, but it does not sit well with me that our communities, my family, and myself, have been paying the incinerators in New Jersey to pollute us, to sacrifice us to a slow death.

The current disposal of plastic waste in our communities is a manifestation of environmental racism present in zoning policies that allow for the siting of incinerators, waste infrastructure, and petrochemical industries in communities similar to mine throughout the country. Our communities have become a disposal site for plastic waste, a sacrifice zone. We don't need incinerators, and we can't live with plastics being burned or disposed of in our backyard. We collectively urge this body to take proactive steps toward plastic reduction to alleviate the burden our communities face.

Thank you for your time and for asking me to testify today.

Senator MERKLEY. Thank you very much for bringing your insights from New Jersey.

Our next witness is Kevin Sunday, the Director of Government Affairs at the Pennsylvania Chamber of Business and Industry. Mr. Sunday, the microphone is yours.

STATEMENT OF KEVIN SUNDAY, DIRECTOR OF GOVERNMENT AFFAIRS, PENNSYLVANIA CHAMBER OF BUSINESS AND INDUSTRY

Mr. SUNDAY. Thank you, and good morning, Chairman Merkley, Ranking Member Mullin, members of the committee and staff. It is an honor to appear before you this morning.

My name is Kevin Sunday, Director of Government Affairs with the Pennsylvania Chamber of Business and Industry. We are the largest broad-based business advocacy organization in the Commonwealth, representing nearly 10,000 members of all sizes and from all industrial and commercial sectors.

Our State is the No. 2 producer of natural gas and the largest exporter of electricity in the U.S. We are a major producer of construction materials, food, medicine, and other life-sustaining products. Several of our members have important advances underway to establish a circular economy that minimizes water and plastics waste.

As you deliberate on this issue, it is our position that policy must expand opportunities for all our citizens, advance sustainability and support economic growth. High energy prices are a regressive tax on the most vulnerable, and domestic energy development is paramount to addressing energy poverty here and abroad.

One of the key criteria in defining an environmental justice community is the percentage of households or individuals in poverty. These communities want jobs. We must embrace and pursue tax and regulatory policy that does not drive opportunity away from these communities.

The pandemic and recent supply chain shocks have made clear how important it is for Pennsylvania and our Nation to have a robust and reliable supply of energy and life-sustaining products. I am proud to represent a State that has dramatically improved the Nation's energy security and put it at the leaderboard for emissions reductions.

Not only is Pennsylvania now measuring attainment due to increased use of domestic energy for all NAAQS, National Ambient Air Quality Standards, criteria pollutants, but our diverse energy portfolio has positioned us as the second leading State for greenhouse gas emission reductions. Shell Gas Development, which has the lowest methane intensity of any production basin in the world, according to the Clean Air Task Force, is estimated to be responsible for more than 60 percent of the total domestic greenhouse gas reductions since 2005, putting the United States ahead of the next four countries combined for aggregate emissions reductions.

Our State's chemical industry supports more than $24 billion in annual economic output, and 55,000 jobs. Like most North American chemical manufacturers, they rely on natural gas and petroleum feedstocks for 99 percent of the building blocks for more than 70,000 different products, including a variety of medical devices, products, and vaccines. These feedstocks are also used to produce ammonia and fertilizer, which are necessary to provide food to a growing global population.

According to the USEPA, U.S. Environmental Protection Agency, manufactured goods from recycled materials typically requires less energy than producing goods from virgin materials, and thereby reduces emissions. Plastics play a key role in reducing greenhouse emissions, and ensuring resilience from natural disasters. Our State's energy, plastics, and chemical industry are a major economic driver.

It has not been the case that plastic production operations in our State have triggered environmental justice analyses and the associated enhanced public participation process, owing both to the geographies in which they operate and the nearby demographics. Nonetheless, there remains an extremely protective and stringent regulatory regime applicable to these facilities and operations.

Our members are leaning in, from a refinery in southeastern Pennsylvania being recognized by an historic leader in the environmental justice movement for the company's community engagement to an innovative zero-landfill plastics recycling facility in Erie that is empowering the community to increase their own waste minimization efforts, an initiative that is being undertaken in partnership with community groups, the USEPA, and with support from legislators across the aisle, including Senators Casey and Fetterman.

As State and Federal regulators define policy goals with respect to environmental justice, the implementation of these goals must come through clearly articulated and objective regulatory standards established by statute and through a rulemaking process that are applied fairly and allow communities to thrive. Pennsylvania's approach to environmental justice has to date established a process that has ensured public participation from impacted communities and a permitting process that has produced durable permitting decisions.

I want to reiterate that disadvantaged communities are in need of investment and that investment will not come without tax and regulatory policy that encourages it.

Let me close by saying that we at the Chamber strongly support the announcements from leaders on both sides of the aisle, including Chairman Carper and Ranking Member Capito, on legislation to enact meaningful permitting reform to drive more investment forward. Congress, in a bipartisan manner, has over the past several years implemented key regulatory and permitting reform provisions in defense, energy and infrastructure bills, and most recently the debt ceiling.

There is widespread agreement on both sides of the aisle, by business and by labor, that we can pursue further environmental progress while cutting red tape. In fact, it is the only way we are going to.

Thank you for the opportunity, and I look forward to answering any questions you may have.

[The prepared statement of Mr. Sunday follows:]

PA Chamber™
of Business and Industry

Testimony

Submitted on behalf of the
Pennsylvania Chamber of Business and Industry

The Impacts of Plastic Production and Disposal on Environmental Justice Communities

Before the:
United States Senate
Committee on Environment and Public Works
Subcommittee on Chemical Safety, Waste Management, Environmental Justice and Regulatory Oversight

Presented by:
Kevin Sunday
Director, Government Affairs

Washington, DC
June 15, 2023

417 Walnut Street
Harrisburg, PA 17101-1902
717.720.5443 phone
http://www.pachamber.org

Testimony of Kevin Sunday, Pennsylvania Chamber of Business and Industry
Before the United States Senate Committee on Environment and Public Works
Subcommittee on Chemical Safety, Waste Management, Environmental Justice and Regulatory Oversight
RE: Impacts of Plastic Production and Disposal on Environmental Justice Communities
June 15, 2023

Executive Summary of Testimony

Policy must expand opportunities for all our citizens, advance sustainability and support economic growth. High energy prices are a regressive tax on the most vulnerable, and domestic energy development is paramount to addressing energy poverty.

Pennsylvania is a major producer of energy, electricity, gas, construction materials, food, medicine, and products used to sustain life, with several major advances underway to establish a circular economy that minimizes water and plastics waste.

The state's chemicals industry supports more than $24 billion in annual economic output and 55,000 jobs.

The pandemic and recent supply chain shocks have made clear how important it is for our state and nation to have a robust and reliable supply of energy and life-sustaining products.

One of the key criteria in defining an environmental justice community is the percentage of households or individuals in poverty. These communities want jobs. We must embrace and pursue tax and regulatory policy that does not drive opportunity away from these communities.

North American chemical manufacturers rely on natural gas and petroleum feedstocks for 99 percent of the building blocks for more than 70,000 different products, including a variety of medical devices, products and vaccines. These feedstocks are also used to produce ammonia and fertilizer, which are necessary to provide food to a growing global population.

According to the United States Environmental Protection Agency, manufacturing goods from recycled materials typically requires less energy than producing goods from virgin materials and thereby reduces emissions, and plastics play a key role in reducing greenhouse gas emissions and ensuring resilience from natural disasters.

Pennsylvania's approach to environmental justice has, to date, established a process that has ensured public participation from impacted communities and a permitting process that produces durable permitting decisions.

Our state's energy, plastics and chemicals industries are a major economic driver, but it has not been our experience that plastic production operations have frequently triggered environmental justice analyses and the associated enhanced public participation process, owing both to the geographies in which they operate and the nearby demographics. Nonetheless, there remains an extremely protective and stringent regulatory regime applicable to these facilities and operations.

As state and federal regulators and legislators define policy goals with respect to environmental justice, the implementation of these goals must come through clearly articulated, objective regulatory standards, established by statute and through a rulemaking process, that are applied fairly and allow communities to thrive.

We strongly support the announcements from leaders on both sides of the aisle, including Chairman Carper and Ranking Member Capito, on legislation to enact meaningful permitting reform to drive more investment forward.

Testimony of Kevin Sunday, Pennsylvania Chamber of Business and Industry
Before the United States Senate Committee on Environment and Public Works
Subcommittee on Chemical Safety, Waste Management, Environmental Justice and Regulatory Oversight
RE: Impacts of Plastic Production and Disposal on Environmental Justice Communities
June 15, 2023

Good morning Chairman Merkley, Ranking Chairman Mullin, and members of the subcommittee,

My name is Kevin Sunday, director of government affairs for the Pennsylvania Chamber of Business and Industry, the largest, broad-based business advocacy organization in the Commonwealth. Our nearly 10,000 members are of all sizes and of all commercial and industrial sectors.

Thank you for the opportunity to take part in this important discussion. We are at a critical juncture in terms of setting policy that expands opportunities for all our citizens, while at the same time making progress on both sustainability and continued economic growth. High energy prices are a regressive tax on the most vulnerable, which is why responsible, robust domestic energy development is paramount to address energy poverty.

The abundant natural resources of our state have led this country through every major energy transition that has occurred in the past 165 years, from the first oil well drilled in this country in Titusville in 1859, to the first delivery of natural gas to a major metro in Pittsburgh in 1884, to the first commercial nuclear plant in Shippingport in 1958, to today's prolific production of shale gas and many exciting innovations in the circular economy, advanced recycling, advanced manufacturing and distributed energy resources.

We are presently the nation's largest exporter of natural gas and electricity, the second largest exporter of coal to international markets, and the second largest producer of electricity from nuclear power. We are a leading producer of aggregates, hardwoods, concrete, cement and the construction materials that are needed to build roads, bridges, schools and homes. We are home to top-tier universities that are producing globally recognized engineering talent and trade schools that train and develop highly in-demand technical talent. We are host to the headquarters of PJM, which manages delivery of power to 65 million Americans in 13 states across what is the world's largest organized grid from offices in southeastern Pennsylvania. We are also home to several of the last remaining refineries in the northeast, and are proud to count among the Chamber's members companies that are leading in areas like life sciences, advanced materials manufacturing, renewable power, distributed energy resources, robotics, electrified heavy trucking, carbon capture, and hydrogen production.

Our state's energy resources have helped dramatically improve the nation's energy security, as well as that of our allies, and significantly reduced our emissions. Among all states, we are second in the reduction of greenhouse gas emissions since 2005, and we are for the first time in decades monitoring attainment statewide for all but one of the federal ambient air quality standards.

In short, we represent a state that has from the outset of this nation been a leader in developing the natural resources, energy and manufacturing that has powered this nation through wars and several energy transitions. It is very clear, as per the significant interest we received in our recently conducted "Coolest Thing Made in PA" contest, that Pennsylvanians are very proud of the things we produce – and ready to do more.

The pandemic and recent supply chain shocks have made clear how important it is for our state and nation to have a robust and reliable supply of energy and life-sustaining products. It is vital to set policy that provides for these operations to be built and expanded in the United States, and not in countries who do not share our labor and environmental standards and who may not be trusted to be reliable trading partners.

Policy Must Foster Growth for Domestic Manufacturers and Opportunity Environmental Justice Communities

One of the key criteria to delineating an environmental justice community is the percentage of households or individuals in poverty. These communities want jobs. There is well-demonstrated literature on the long-term negative public health consequences of high unemployment in a community. Households in the lowest quintile of income pay proportionally the highest amount on energy and utilities.

Therefore, we must embrace and pursue tax and regulatory policy that does not drive investment and opportunity away from these communities. Nor should we deprive our allies in Europe and the citizens in developing nations throughout the global south access to reliant, responsibly developed American energy and materials – the export of which will require significant new construction of infrastructure in this country, as well as a streamlined permitting process and trade relations that support such a relationship.

Pennsylvania is, as noted above, a leading producer of gas and electricity, as well as with plastics, waste management and recycling. The state's chemicals industry, according to our peers at the Pennsylvania Chemical Industry Council, supports more than $24 billion in annual economic output and 55,000 jobs. Companies in Pennsylvania ship $4.68 billion in products to customers around the world and generate $209 million in state and local taxes and $398 million in federal taxes annually.

As we recognize the economic benefits of this industry to Pennsylvania, and we also note the industry's commitment to reducing waste and emissions. Limiting domestic output of this industry will produce negative economic and environmental costs and impacts, from raising the cost of goods and services for working families and sending more jobs overseas, to increasing global emissions and an increase in the amount of waste sent to landfills.

As Governor Josh Shapiro, like Governors Wolf and Corbett before him, has recognized, the state's plastics and petrochemical industry is going to be a key driver for the state's competitiveness and the economic vitality of the region and nation. Gov. Shapiro's inaugural address pointed to support for a hydrogen hub, supported by funding from the Infrastructure Investment and Jobs Act, and the expansion of advanced materials and innovative industries, which will require policy that encourages continued public-private partnership and investment into these sectors.

This is also an extremely energy-intensive business, and North American chemical manufacturers rely on natural gas and petroleum feedstocks for 99 percent of their manufacturing operations.

These feedstocks are used as the building blocks for more than 70,000 different products, including a variety of medical devices, products and vaccines. These feedstocks are also used to produce ammonia and fertilizer, which are necessary to providing food to a growing global population.

Further, our nation's ambitious climate and infrastructure goals require innovations and emerging technologies from sectors across the economy, including the petrochemical industry. Important elements supporting the energy transition rely on petrochemical sector technologies, products, and services.

According to EPA, manufacturing goods from recycled materials typically requires less energy than producing goods from virgin materials and reduces emissions. Plastics play a key role in renewable technologies and batteries – from light weighting automobiles to composite components of wind turbines and solar panels, so it is all the more important that we develop strategies for their responsible use and recycling.[1] In short, reducing greenhouse gas emissions in the United States requires making every tool in the toolbox available.

Pennsylvania's Chemicals, Manufacturing and Recycling Sectors Are Working Hand-in-Hand with Communities for Inclusive, Sustainable Growth

In Pennsylvania, we have seen tremendous growth in new manufacturing and recycling projects as we harness our abundant and diverse energy resources. I would like to bring a few of these to the committee's attention as you deliberate on this matter.

Among the many innovative endeavors currently underway in Pennsylvania is the International Recycling Group's proposed zero landfill plastics recycling facility that will be located on the redeveloped site of a former papermill that previously employed thousands in Erie, PA and moved overseas. As noted in letters of support from Senators Bob Casey and John Fetterman for an EPA grant for the new facility and an innovative alternative, community-based collection system sponsored by IRG, this facility "will be the largest and most technologically advanced plastics recycling plant in the United States." In a city whose municipal finances are challenged by declining population and deindustrialization, this project will support hundreds of local jobs in an economically disadvantaged Environmental Justice community, as well as empower local residents to take greater ownership in their neighborhood's environmental quality. The project is supported by a number of community groups, including the Urban Erie Community Development Corporation, and is a stellar example of how this industry is leaning in to empower local communities through responsible economic development.

In Pennsylvania, Monroe Energy's refinery, one of the few remaining refineries in the northeast, located outside of Philadelphia in Delaware County, has created and supports thousands of good paying, family sustaining jobs in the tristate region, in addition to the fuels necessary to power transportation and aviation markets. A 2012 study by the Pennsylvania Department of Labor and

[1] https://www.globalenergyinstitute.org/plastic-innovation-driving-climate-progress

Industry was commissioned following the closure of three refineries the year before. This study found the following: "The employment multiplier for these layoffs in southeastern Pennsylvania is substantial. An estimated 18.3 jobs will be lost for each layoff. The employment multipliers in this industry for the state and the nation are 22 jobs and 61 jobs, respectively." Monroe Energy provides significant economic benefits, which reverberate throughout the region, including to blue-collar workers in the skilled trades. The leadership and workforce at the facility also engage with local community groups, including the Chester Environmental Partnership (CEP). Led by Dr. Reverend Horace Strand, CEP has been at the forefront of the environmental justice movement for the past several decades. In 2021, CEP recognized the Monroe facility for its support and engagement with its company of the year award.

Finally, in southwestern Pennsylvania, Shell's world-class polymers manufacturing facility recently came online. Construction required an investment of more than $6 billion, and, at its peak, employed more than 6,500 workers. According to an analysis conducted by Robert Morris University, ongoing operations will require 600 full-time workers, many of them locally trained; support more than 11,000 jobs statewide; and increase economic activity in the state by nearly $82 billion. The facility uses locally produced natural gas liquids to make more than 1.6 million tons of polyethylene pellets, which are used in a variety of automotive, industrial, utility, and consumer goods. Marcellus Shale natural gas has the lowest carbon footprint of any basin in the world, according to the Clean Air Task Force.

The facility is also a proposed anchor of a hydrogen hub, in response to the Department of Energy's call for applications for projects around the country to receive a share of funding to stand up carbon capture and hydrogen hubs to develop the next generation of sustainable manufacturing and energy production.

A Strong Domestic Manufacturing, Energy and Chemicals Sector is Necessary for Growth, Food Security and Energy Independence

These case studies are exemplary reminders of the importance of Pennsylvania and American-made chemicals, plastics and, more broadly, a strong domestic manufacturing sector to meet the challenges of climate change and the needs of a growing global economy – one whose needs for energy, materials and products ought to come from free market democracies committed to the rule of law. Natural gas-derived products like ethylene and propylene can be used in a number of energy efficiency applications, such as advanced insulation and sealants. Plastic casing is used on a number of energy production and distribution technologies, including to improve weather resistance for renewable power generation.

The world will continue to need these products in this century and beyond. The only question will be where they are made. Restricted fossil fuel production into the manufacture of fertilizer and ammonia threatens to raise food insecurity globally, as the United Nations recently noted.

High energy prices impact everything from the manufacturing sector to the operations of schools and the healthcare system, but are regressive to lower income families. The average low-income household "spends three times more of their income on energy costs compared to the median spending of non-low income households," according to a 2020 analysis of energy burdens by the American Council for an Energy-Efficient Economy.[2] The gap is more pronounced for Native American, Black and Hispanic households in lower income deciles.

High energy prices also drive up the cost of the fertilizers needed to feed a growing world. Energy economist Vaclav Smil has estimated the process to manufacture synthetic fertilizer from ammonia and nitrogen, through petrochemical feedstocks, has allowed the world to feed more than 2 billion people more than it would have otherwise. The ability for the global economy to produce additional volumes of fertilizer is contingent on the availability of these feedstocks.

The United Nations' World Food Programme recently released a report on the on-going crisis of food affordability, owing in large part to disruption in energy and transportation from Russia's horrific and illegal invasion of Ukraine. Noted the UN, the "effects of the war in Ukraine, including higher natural gas prices, have further disrupted global fertilizer production and exports – reducing supplies, raising prices and threatening to reduce harvests. High fertilizer prices could turn the current food affordability crisis into a food availability crisis, with production of maize, rice, soybean and wheat all falling in 2022."[3] The UN estimates that a mere 1 percent increase in global food prices as a result of the energy price shock will jeopardize the food security of 10 million people in the developing world.

Due to extraordinarily high energy prices – ten and twenty-fold what we are facing here - major manufacturers in Europe of commodities and products, from chemicals to steel to fertilizer to batteries, have suspended production. Some have indicated they will relocate operations out of the Continent entirely. We should take steps to both deliver more energy to our allies in Europe and welcome relocated investment to American soil.

Pennsylvania's Approach to Environmental Justice Has Produced Effective Community Engagement and Durable Permitting Decisions

We suggest as this debate continues that Pennsylvania's history and approach to environmental justice be recognized. Twenty-five years ago, the Supreme Court mooted a first-of-its-kind case involving a community group of residents in Chester County (outside of Philadelphia) alleging discrimination from the proposing siting of a waste processing facility. Following the Court's decision, Gov. Tom Ridge convened an Environmental Justice Working Group which deliberated over the next two years to provide recommendations to the state over how to improve public participation for minority and low-income communities during the permitting process. The Pennsylvania Department of Environmental Protection created an Environmental Justice Advisory Board as well as an Office of Environmental Advocate to foster community involvement as recommended by the working group and, in 2004, developed a formal policy to ensure public participation by these communities. DEP is currently working on revising its public policy after

[2] How High Are Household Energy Burdens? American Council for an Energy-Efficient Economy, September 2020. https://www.aceee.org/sites/default/files/pdfs/u2006.pdf
[3] Global Hunger Crisis. United Nations World Food Programme, January 2023. https://www.wfp.org/global-hunger-crisis/

multiple rounds of stakeholder input listening sessions, and Acting Secretary Rich Negrin recently announced his intention to elevate the Office of Environmental Advocate to its own deputate within the agency, with additional staffing and resources to support the mission. In short, even if it may be said that the state's approach over-inclusively screens in projects for potential impacts on low-income and minority residents, Pennsylvania has, to date, established a process that has ensured public participation from impacted communities and a permitting process that produces durable permitting decisions from the agency.

We implore federal policymakers to recognize that this process was the result of extensive and deliberative discussions with Pennsylvania's industry, regulators, communities and local government; the last thing our state needs is a federally imposed process that discourages investment into our state, especially in communities in need of greater investment. To cite one example, the Obama administration's EJ 2020 plan stated a goal of achieving attainment with all PM 2.5 standards in low-income communities as soon as possible. According to EPA's design value map, Pennsylvania is measuring such attainment; lowering the PM 2.5 standards to 8 ug/m3, a level being considered by EPA and supported by advocates, would conflict with this goal and possibly lead to a restriction on new highway and bridge infrastructure in these communities – not to mention higher operating costs and discouragement in investing and expanding in commercial and industrial operations in the area, the closure of which would likely bring with it further negative economic consequences for the community. It must not be lost that even though the state is measuring attainment for PM and other criteria emissions, by virtue of our state being in the Ozone Transport Region, any new major source of emissions (or a major modification of an existing facility) will be required to acquire and surrender emissions credits at a greater than 1:1 ratio, as well as install and operate the most stringent pollution control technology, known as Lowest Achievable Emission Rate controls.

As noted before, the energy, plastics and chemicals industries are a major economic driver in our state, but it has not been our experience in Pennsylvania that plastic production operations have frequently triggered environmental justice analyses and the associated enhanced public participation process, owing both to the geographies in which they operate and the nearby demographics. Nonetheless, there remains an extremely protective and stringent regulatory regime applicable to these facilities and operations, and we encourage a balanced discussion that recognizes the important economic benefit of our state's energy, manufacturing and chemical sectors as well as any environmental impacts that need to be addressed.

It is also imperative that as state and federal regulators and legislators define policy goals with respect to environmental justice, the implementation of these goals must come through clearly articulated, objective regulatory standards, established by statute and through a rulemaking process, that are applied fairly and without excessive conditioning of permits and processes. Such procedural guardrails are in harmony with environmental justice principles regarding community and stakeholder engagement.

At the same time, we support the fair treatment and meaningful involvement of all people and processes and an equitable approach to addressing environmental challenges regardless of race, color, national origin, or income. Ensuring meaningful engagement of all impacted communities will help identify the most pressing issues and allow for development of locally-led, collaborative solutions that are responsive to concerns and allow communities to thrive.

To Expand Opportunity and Growth, We Encourage the Senate and Congress to Build on Recent Permitting Reforms

Over the past few years, Congress has enacted some very significant energy and permit streamlining policies, thanks to buy-in from both sides of the aisle in the U.S. House and Senate. In 2020, the defense bill included major provisions to support American leadership in the nuclear industry, including support for the next generation of safe and effective advanced reactor designs. A year-end spending bill also included support for carbon capture (which the U.S. Department of Energy has said must be part of the energy picture to achieve decarbonization goals) and a phasedown in the use of hydrofluorocarbons, a potent greenhouse gas. With support from the business community and many other stakeholders, President Biden signed into law the bipartisan infrastructure bill, which not only included billions for bridges, highways, clean water and broadband for Pennsylvania and other states, but also codified significant permitting reforms to federal environmental reviews. These reforms to cut red tape were a Trump administration policy that have become law with the signature of a Democratic president.

This progress on cutting federal tape has come as lawmakers on both sides of the aisle in Washington recognized that addressing the challenges of growing the economy, improving environmental quality, continuing the energy transition, and ensuring abundant, affordable energy will only happen when policy promotes innovation and building new projects in the United States. In addition, the non-partisan policy think tank Common Good estimates permitting delays on energy projects costs the nation trillions in public health costs.

Permitting delays impede the confidence of lending institutions to close a business loan, and the overall delay and uncertainty from our dysfunctional approach to building infrastructure and energy projects in this country leads to underinvestment into development of the resources needed to power our economy. A tax and regulatory approach that sends a strong signal to invest and that improves the efficiency of government will lead to greater opportunity for Pennsylvanian families and our businesses, helping them grow and expand here.

We were honored to attend the U.S. Chamber's Permit America to Build event in April and are encouraged to see both Senators Carper and Capito, the chairs of the Senate Environment Public Works, pledge at that event their commitment and support to working towards meaningful permitting reform. As noted above, both parties in both the House and Senate have enacted reforms to the permitting process over the past few years, including in the debt ceiling compromise, and have established clearly through legislation to bolster supply chains and domestic manufacturing. We strongly encourage the legislative branch to get permitting reform done, as well as establish tax and regulatory policy that encourages the projects to be built here.

As noted throughout this testimony, disadvantaged communities across our state and country want jobs, investment and sustainable development, and it is incumbent upon the House, the Senate and the administration to foster pro-growth policy that allows that to happen. As demonstrated by the projects I have highlighted, industry is leaning in, provided there is a path forward for investment in these communities.

Thank you for the opportunity to appear before you this morning, and I am happy to answer any questions you may have.

Senator MERKLEY. Again, I will please ask folks to take your comments outside in the hallway. Thank you.

We are going to dive into the questions. We are doing 5 minutes apiece, so we can have multiple rounds as desired.

Oh, I am sorry, Ms. Jackson.

Senator MULLIN. I promise he did not do that on purpose. We disagree on a lot of stuff, but he is not rude.

[Laughter.]

Senator MERKLEY. Let me back up here. Welcome. Ms. Jackson is the Director of Membership Development at Project 21's National Center for Public Policy and Research. Now you have the floor.

STATEMENT OF DONNA JACKSON, DIRECTOR OF MEMBERSHIP DEVELOPMENT, PROJECT 21, NATIONAL CENTER FOR PUBLIC POLICY AND RESEARCH

Ms. JACKSON. Chair Merkley, Ranking Member Mullin, and members of the subcommittee, thank you for allowing me to testify today.

My name is Donna Jackson and I am the Director of Membership Development for Project 21, the Black leadership network of the National Center for Public Policy Research. Project 21 is one of the oldest and largest Black conservative think tanks in the country.

Our members come from all walks of life, from small business owners to law enforcement to assembly line workers to teachers to energy producers to clergy to health care workers. Most of us are not career activists, lawyers, or lobbyists, and more than a few of us actually live in the communities we hope to improve.

We cover a wide range of issues, but our fundamental focus is lifting people out of poverty and dependence and into prosperity and self-sufficiency. I will make my main point up front and tell you that I think it is an overwhelmingly positive thing for struggling communities to have industrial facilities nearby, including plastics manufacturing. The high wage blue collar jobs that these employers provide are in many cases the best ones available for those without college degrees. If you look at the history of the creation of a Black middle class over the last century, it is these gateway jobs that lifted up millions of families and broke the cycle of poverty.

I know that in my own family history I can point to relatives who worked at Ford, General Motors, Chrysler, U.S. Steel, and General Dynamics. Not only were they able to provide for their families, but they were also able to become homeowners and save for retirement.

Perhaps most importantly, they were able to provide the educational opportunities that allowed the next generation to attend college and pursue various professions. As a result, their kids and now grandkids have never had to suffer even 1 day of poverty or helplessness.

To be blunt about it, it is downright crazy to suggest that my family would have been better off if these factories would have never allowed to be located near them. It is not just the direct jobs. Every big manufacturing facility supports many small businesses in the community, and quite a few of these vendors are minority owned. They also contribute to the tax base that pays for things like schools and police protection.

None of that can happen without the local industrial base, whether it is a plastics plant or a refinery or an automaker.

Now, we will hear a lot about the environmental dangers of living near or working in these facilities, including plastics plants. I think a sense of perspective is in order. American manufacturers are subjected to the most rigorous environmental standards in the world, including plastics plants, and industrial emissions have declined substantially over the last several decades.

For every study claiming a cancer cluster or a statistical association with some other disease, there are others that find that low-income people living near these facilities are no worse off than comparably poor people in general.

I think it is worth noting that the environmental justice activists who focus on weak correlations between industrial emissions and health impacts tend to ignore the undeniable and well documented improvements that come with the transition from poverty to well-paying employment.

Beyond reduced illness and disease, good jobs tend to lead to stronger families and substantially lower rates of domestic and sexual violence and other traumas. As far as my relatives who worked for big manufacturers are concerned, the only difference I could see in their health was the benefit of having better medical care that comes with a good salary.

I might add that several of my factory worker aunts and uncles and cousins are still with us and some have celebrated their 100th birthdays.

In conclusion, the enemy is not trace emissions in the air and water from industrial activity. The enemy is poverty. That is why any attempt to shut down good industrial jobs will do a lot more harm than good in the communities and people that need these jobs the most.

Thank you so much.

[The prepared statement of Ms. Jackson follows:]

PROJECT 21
Black Leadership Network

U.S. Senate Committee on Environment and Public Works
Subcommittee on Chemical Safety, Waste Management,
Environmental Justice, and Regulatory Oversight

Hearing on "Impacts of Plastic Production and Disposal on Environmental Justice Communities"

June 15, 2023

Remarks of Donna Jackson, Director of Membership Development, Project 21

Chair Merkley, Ranking Member Mullin, and members of the Subcommittee, thank you for allowing me to testify today. My name is Donna Jackson and I am the Director of Membership Development for Project 21 – the black leadership network of the National Center for Public Policy Research. Project 21 is one of the oldest and largest black conservative think tanks in the country. Our hundreds of members come from all walks of life, from small business owners to law enforcement to assembly line workers to teachers to energy producers to clergy to health care workers. Most of us are not career activists, lawyers, or lobbyists, and more than a few actually live in the communities we hope to improve. We cover a wide range of issues, but our fundamental focus is lifting people out of poverty and dependence and into prosperity and self-sufficiency.

I'll make my main point up front and tell you that I think it is an overwhelmingly positive thing for struggling communities to have industrial facilities nearby, including plastics manufacturing. The high wage blue collar jobs that these employers provide are in many cases the best ones available for those without college degrees. And if you look at the history of the creation of a black middle class over the last century, it is these gateway jobs that lifted up millions of families and broke the cycle of poverty.

www.NationalCenter.org
2005 Massachusetts Avenue NW • Washington, DC 20036

I know that in my own family history I can point to relatives who worked at Ford, General Motors, Chrysler, U.S. Steel, and General Dynamics. Not only were they able to provide for their families, but they were also able to become homeowners and save for retirement. Perhaps most importantly, they were able to provide the educational opportunities that allowed the next generation to attend college and pursue various professions. And as a result, their kids and now grandkids never had to suffer even one day of poverty or helplessness. To be blunt about it, it is downright crazy to suggest that my family would have been better off if these factories were never allowed to be located near them.

And it is not just the direct jobs. Every big manufacturing facility supports many small businesses in the community, and quite a few of these vendors are minority-owned. They also contribute to the tax base that pays for things like schools and police protection. But none of that can happen without the local industrial base, whether it's a plastics plant or a refinery or an automaker.

Now, we will hear a lot about the environmental dangers of living near or working in these facilities, including plastics plants. I think a sense of perspective is in order. American manufacturers are subjected to the most rigorous environmental standards in the world, including plastics plants, and industrial emissions have declined substantially over the last several decades. For every study claiming a cancer cluster or a statistical association with some other disease, there are others that find that low-income people living near these facilities are no worse off than comparably poor people in general. And I think it is worth noting that the environmental activists who focus on weak correlations between industrial emissions and health impacts tend to ignore the undeniable and well documented improvements that come with the transition from poverty to well-paying employment. Beyond reduced illness and disease, good jobs lead to stronger families and substantially lower rates of domestic and sexual violence and other traumas.

And as far as my relatives who worked for big manufacturers are concerned, the only difference I could see in their health was the benefit of having better medical care that comes with a good salary. I might add that several of my factory worker aunts and uncles and cousins are still with us and some have celebrated their 100^{th} birthdays.

In conclusion, the enemy is not trace emissions into the air and water from industrial activity. The enemy is poverty. And that is why any attempt to shut down good industrial jobs will do a lot more harm than good in the communities and people that need these jobs the most.

Senator MERKLEY. Thank you very much, Ms. Jackson.

Now we will begin our questions. Ms. Jackson, you noted that a number of your relatives worked for different automobile manufacturers, and so forth, as I listened to that list. Do you see a difference sometimes between manufacturing that involves, for example, making cars, and the type of plastics production plant that has a low number of jobs and a high level of emissions?

Ms. JACKSON. I think that all the manufacturers are subjected to stringent regulations. Our EPA is actually doing a great job. If there is really this high correlation, and I do not pretend to be an expert, if it is really this damaging, we should have Michael Regan in here answering to why they are not doing their job.

Senator MERKLEY. Thank you.

Ms. Bradford, in the community you live in, if we were talking instead of about a plastics plant, we were talking about an automobile plant, would you have a different sense? Is there something particularly dangerous and damaging about the chemicals in the plastics plant?

Ms. BRADFORD. Good question. First of all, I would say my concerns are about all emissions, regardless of the source and regardless of what is being produced. Just for today's topic, of course, it is plastics. I think with the research that we are seeing from independent researchers, from colleges and universities, from agencies around plastics, it is just becoming more shocking, the level of chemicals that are leaching.

For example, the recent Defend Our Health report that studied 193 chemicals and found 150 of them leached into plastic bottles, that is a big deal. Now that we know more about everything from the production of plastics to drinking out of plastic bottles to the waste discharges into the water, so on and so forth, microplastics in the ocean, all of these are confounding factors that are leading to some serious health consequences, not just environmental.

Senator MERKLEY. Thank you.

Ms. Lavigne, you noted that you suffered autoimmune disease and you are going to a lot of funerals. Is there a higher correlation of devastating diseases near these plants than far away from these plants?

Ms. LAVIGNE. Yes. I think there is higher, because it is like I said, we are called Cancer Alley. St. James and St. John Parish are the worst two parishes in this corridor between New Orleans and Baton Rouge, especially St. John Parish. They are suffering from chloroprene and the plant is called Denka Dupont. These people are suffering even worse than us.

More people have been diagnosed with cancer, and more people are dying with cancer. St. James is next to St. John. We are dying with cancer.

At one time, we had like two to three funerals in 1 week. Prior to me starting this work, I wondered why. Then I started doing the work and I found out about all the pollutants. We have 12 industries within a 10-mile radius. We are sandwiched in. People over there are sick, people have asthma, children are being born preemies, women are having miscarriages, and you can not breathe the air.

Just like on one of the slides, you can see that yellow sulfur is open. When you pass by that plant, you get a whiff of that odor, and it goes in your nostrils and goes down to your throat, and your throat is irritated. My daughter had to move because she was always going to the doctor for sinus, ear infections. My other daughter had to move because she was always having headaches.

I am still there. My three children are still there, the other three left. My neighbors, people are dying. Our little area is like a skeleton town, because our public officials allow industry to come in the Fifth District the most.

Senator MERKLEY. I will submit for the record, if there is no objection, a number of articles that show a much higher concentration of cancer rates and other disease rates near these facilities than far away. I think your observed experience is very well documented in the scientific literature.

[The referenced information follows:]

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

Office of Environmental Justice and External Civil Rights

October 12, 2022

In Reply Refer to:
EPA Complaint Nos. 01R-22-R6, 02R-22-R6, and 04R-22-R6

Dr. Chuck Carr Brown, Secretary
Louisiana Department of Environmental Quality
602 North Fifth Street
Baton Rouge, LA 70802
officesec@la.gov

Dr. Courtney N. Phillips, Secretary
Louisiana Department of Health
628 North Fourth Street
Baton Rouge, LA 70802
courtney.phillips@la.gov

Re: Letter of Concern

Dear Secretary Brown and Secretary Phillips:

The United States Environmental Protection Agency's (EPA) external civil rights compliance program appreciates the Louisiana Department of Environmental Quality's (LDEQ) and the Louisiana Department of Health's (LDH) (collectively, the Departments or the Recipients) willingness to informally resolve the administrative complaints filed with EPA under Title VI of the Civil Rights Act of 1964, as amended, 42 U.S.C. §§ 2000d et seq., (Title VI). The purpose of the Informal Resolution Agreement (IRA) negotiation process is to reach an agreement between LDEQ and EPA and an agreement between LDH and EPA that resolves the issues accepted for investigation.

As we discussed with LDEQ on September 23, 2022, and LDH on September 22, 2022, the purpose of this letter (Letter of Concern or Letter) is to convey the results of EPA's initial fact finding and analysis of the issues EPA accepted for investigation in Complaint No. 01R-22-R6 (*LDEQ and the Denka Facility*), 02R-22-R6 (*LDEQ and the Denka Facility*), and EPA Complaint No. 04R-22-R6 (*LDEQ and the Industrial Corridor and the Formosa Facility*) (collectively, Complaints) with respect to LDEQ's implementation of its air pollution control permit program and LDH's duty to inform, and make recommendations to the public about prevention and reduction of health threats and air toxics exposures. EPA's expectation is that the information contained in this Letter will help facilitate the IRA process and result in an expeditious resolution of each of these Complaints. We want to emphasize that EPA has not concluded its investigation of these Complaints and has not reached final conclusions of fact or law as to LDEQ's or LDH's compliance with the civil rights laws, including Title VI. Nevertheless, based on facts discovered thus far during EPA's investigation, EPA issues this Letter to present significant evidence suggesting that the Departments' actions or inactions have resulted and continue to result in disparate adverse impacts on Black residents of St. John the Baptist Parish, St. James Parish, and the Industrial Corridor.

As you know, EPA's investigation of these Complaints is being conducted under the authority of the federal civil rights laws, including Title VI, and EPA's nondiscrimination regulations at 40 C.F.R. Parts 5 and 7, and consistent with EPA's January 2021 Case Resolution Manual.[1] EPA's fact finding and analysis thus far has included a review of: information submitted by the Complainants; air monitoring data, the applicable air permits, health and scientific studies and other literature; census data, the Departments' responses to the Complaints; and interviews with residents of St. John the Baptist Parish. EPA looks forward to further discussions with the Departments in the near-term regarding EPA's initial fact finding set forth in this Letter and any questions you might have.

I. SUMMARY OF INITIAL FACT-FINDING AND ANALYSIS

EPA has conducted initial fact-finding and analyses to assess whether LDEQ's methods of administrating its air permitting program and LDH's actions/inactions related to its duty to inform and make recommendations to the public about prevention and reduction of health threats and air toxics exposures, have an adverse disparate impact on the basis of race. Specifically, EPA assessed whether LDEQ's and LDH's actions have an adverse disparate impact on residents who identify as Black living in or near the following areas: (1) the Denka Performance Elastomer LLC (Denka) facility in LaPlace, Louisiana; (2) the location of the proposed FG LA, LLC (Formosa) facility in St. James Parish; and (3) the Industrial Corridor.

LDEQ and LDH are both charged with the important mission of protecting the health of the people of Louisiana.[2] As demonstrated in the actions related to the Denka facility described below, LDEQ and LDH also have critical interrelated roles to play related to air pollution control permitting decisions in Louisiana. LDH provides LDEQ public health information, including, for example, health consultation letters, such as the letter conveying the results of the 2018 St. John the Baptist Parish cancer incidence review in relation to Denka.[3] In turn, LDEQ relies on

---

[1] U.S. EPA, Office of External Civil Rights Compliance (formerly, External Civil Rights Compliance Office) *Case Resolution Manual*, available at https://www.epa.gov/sites/default/files/2021-01/documents/2021.1.5_final_case_resolution_manual_.pdf.

[2] LDEQ's mission is "to provide service to the people of Louisiana through comprehensive environmental protection in order to promote and protect health, safety and welfare." LDEQ, *ABOUT LDEQ*, https://www.deq.louisiana.gov/subhome/about-ldeq (last visited Oct. 4, 2022). LDH's mission is "to protect and promote health and to ensure access to medical, preventive, and rehabilitative services for all citizens of the State of Louisiana." LDH, *Mission*, https://ldh.la.gov/page/1#:~:text=The%20mission%20of%20the%20Louisiana,of%20the%20State%20of%20Louisiana (last visited Oct. 4, 2022).

[3] Letter from Louisiana Department of Health, Office of Public Health to Louisiana Department of Environmental Quality (Mar. 2, 2018) (https://ldh.la.gov/assets/oph/Center-EH/envepi/PHA/Documents/DENKALetterHealthConsultCancerReview2018.pdf).

information and analysis provided by the medical health professionals at LDH in its decision making.[4] The quality of LDH and LDEQ decisions that impact residents' health and the risk of adverse health effects is determined by the quality and breadth of information used in the decision making.

EPA's initial investigation raises concerns that the Departments' methods of administering their programs and activities related to air pollution control and health risk mitigation and communication as described below may have an adverse and disparate impact on Black residents who live and/or attend school near Denka, who live near the proposed location for the Formosa facility, and those who live in the Industrial Corridor.

A. EPA Complaint No. 01R-22-R6 (LDEQ and the Denka Facility)

EPA's initial factual investigation strongly suggests that Louisiana residents who identify as Black and are living and/or attending school near the Denka facility have been subjected to adverse and disparate health impacts as a result of LDEQ's decisions. For decades, it appears that LDEQ's implementation of its air permitting program continuously exposed the residents who live near the Denka facility and the children who attend the St. John the Baptist Parish's Fifth Ward Elementary School to average annual concentrations of chloroprene in ambient air at levels associated with increased lifetime cancer risk. One hundred in one million (100-in-1 million)[5] generally represents the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime.[6] Specifically, residents of neighborhoods surrounding the Denka facility were routinely exposed to chloroprene concentrations that placed them at greater than an estimated 100-in-1 million risk of developing chloroprene-linked cancers over a 70-year lifetime.

EPA's initial investigation also revealed that many residents who are now adults living near Denka spent their childhood in the community as well. As explained in more detail below, individuals exposed to mutagenic carcinogens such as chloroprene starting in early life as infants and children are understood to be more susceptible than individuals exposed only as adults. As a result, adolescents and adults who spent their infancy and childhood in this community and who breathed chloroprene at levels measured near Denka, surpass a 100-in-1 million estimated lifetime cancer risk more quickly than an adult without childhood exposure to chloroprene.[7]

---

[4] Julie Demansky, *Secretary of the LDEQ Chuck Carr Brown, at Meeting 4/24/2018*, YouTube, at Minute 5:34-7:07. (Apr. 18, 2018), https://www.youtube.com/watch?v=cqBpydLGhJA (Dr. Brown stated at a public meeting in St. John the Baptist Parish on April 24, 2018, he was in contact "with medical professionals you heard one speak tonight. As long as they are telling us that we can continue to move forward as we are then that is what we will continue to do.") (last visited October 11, 2022).

[5] Although EPA recognizes that there are alternate ways to express 100-in-1 million, such as, 1-in-10,000 or 10^{-4}, for clarity, EPA will use 100-in-1 million in this document.

[6] As set forth in the *Residual Risk Report to Congress*, EPA will "consider the extent of the estimated risk if an individual were exposed to the maximum level of a pollutant for a lifetime, i.e., maximum individual risk (MIR)." "The EPA will generally presume that if the risk to that individual is no higher than approximately 1 in 10 thousand, that risk level is considered acceptable and EPA then considers the other health and risk factors to complete an overall judgment on acceptability." U.S. EPA, https://www.epa.gov/sites/default/files/2013-08/documents/risk_rep.pdf, page B-4

[7] The chloroprene inhalation risk unit (IUR) is 3×10^{-4} per $\mu g/m^3$ without Age Dependent Adjustment Factor (ADAF). Use of ADAFs results in an adjusted inhalation unit risk of 5×10^{-4} per $\mu g/m^3$ to account for childhood

For the same reason, the risk associated with childhood exposure to chloroprene also raises concerns about the children currently exposed to chloroprene concentrations that are associated with an estimated cancer risk greater than 100-in-1 million. As discussed in more detail below, these residents and school children are disproportionately Black as compared to both the state population and St. John the Baptist Parish population.

Chloroprene was identified by EPA as a likely human carcinogen twelve years ago, in 2010[8], and since that time, both EPA's and LDEQ's understanding of the exposures and consequently the risks that chloroprene emissions pose to exposed populations in Louisiana have evolved. EPA also recognizes LDEQ's efforts in negotiating an Administrative Order on Consent with Denka in 2017 (No. AE-AOC-17-00011) that required the facility to install air pollution controls discussed in more detail below, and resulted in substantial reductions in chloroprene emissions. There is no question, however, that elevated cancer risk for residents of all ages and school children still exists and has existed as a result of breathing air polluted with chloroprene and that this risk has impacted and currently impacts Black residents disproportionately.

As a result, EPA has significant concerns that Black residents and school children living and/or attending school near the Denka facility have been subjected to discrimination through LDEQ's actions and inactions as described below in the implementation of its air pollution control permit program.

B. EPA Complaint No. 02R-22-R6 (LDH and the Denka Facility)

EPA's initial factual investigation suggests that LDH may have failed to provide the predominantly Black residents living near the Denka facility and school children attending the Fifth Ward Elementary school with critical information about cancer risks associated with chloroprene levels in these areas. Additionally, EPA has concerns that LDH neither implemented the commitments it made in connection with reviews and studies of chloroprene exposure risk nor made meaningful recommendations to educate and protect community members from elevated cancer risks as indicated by its own research and required by its implementing regulations.[9] Moreover, LDH may not have satisfied its duty to make recommendations to agencies, such as LDEQ and the St. John the Baptist Parish School Board, to prioritize the reduction and prevention of chloroprene exposure. EPA believes that, as a result of LDH's actions and inactions, LDH may be causing and/or contributing to disproportionate and adverse impacts on the Black residents living and school children attending school near the Denka facility.

---

susceptibility to a mutagenic carcinogen. About half of the estimated excess lifetime cancer risk, from continuous lifetime exposure, is associated with increased susceptibility to cancer following exposures during childhood life stages between 0 years and <16 years. Application of ADAFs to IUR are shown on p. 18 of U.S. EPA, *Chemical Assessment Summary National Center for Environmental Assessment, Integrated Risk Information System (IRIS), Chloroprene* (CASRN: 126-99-8) (Sept. 2010) ("IRIS Chemical Assessment") (https://iris.epa.gov/static/pdfs/1021_summary.pdf).

[8] U.S. EPA, Toxicological Review of Chloroprene (CAS No. 126-99-8), *In Support of Summary Information on the Integrated Risk Information System (IRIS)* ("Summary Information on IRIS") (Sept. 2010).

[9] La. Rev. Stat. Ann. §36.258(B), *see also* La. Rev. Stat. Ann. §36:251(B).

C. EPA Complaint No. 04R-22-R6 (LDEQ and the Industrial Corridor and the Formosa Facility)

EPA's initial fact finding indicates that census tracts with the highest cancer risks from air toxics in Louisiana are almost exclusively within the Industrial Corridor and also have a high percentage of Black population. For this and other reasons described in detail below, EPA has reason to believe that the cancer risks from air toxics exposures may be borne disproportionately by the Black residents of the Industrial Corridor. Also, many residents living near the location of the proposed Formosa facility have lived in their homes for years and have in the past on average been exposed to levels of air pollution that, while below the 100-in-1-million upper bound increased lifetime cancer risk, were still above EPA's preferred 1-in-1 million cancer risk benchmark. Further, the proposed Formosa site is in a census tract where 90% of residents identify as Black which is disproportionate as compared to the Parish (49.6% Black) and State (33.5% Black) populations. As described below, EPA has significant concerns that LDEQ's methods of administering its air permitting program may be causing or contributing to the cancer and toxicity risk from air toxics for residents living near the proposed Formosa facility and that these risks appear to be borne disproportionately by the Black residents in St. James Parish, especially those who live closest the proposed Formosa facility.

RECOMMENDATIONS

For the reasons set forth more fully below, EPA recommends that LDEQ and LDH:

- Jointly host at least one community meeting, to be held virtually and in person, in Reserve, Louisiana[10] within 45 days of reaching a resolution of EPA's Complaint Nos. 01R-22-R6 and 02R-22-R6 to discuss the commitments made in the IRAs;
- Conduct cumulative impact analyses for:
  - the currently overdue permit renewals for Denka's Chloroprene Unit (No. 3000-V5), the Neoprene Unit (No. 2249-V9), and the HCl Unit (No. 206-V4) in St. John the Baptist Parish;
  - the Formosa Title V permits in St. James Parish to the extent LDEQ maintains the issuance of those permits or reconsiders and reissues new permits—as noted below, each of the fourteen permits issued by LDEQ to Formosa was recently vacated and remanded by a Louisiana state court, and that decision was subsequently stayed and appealed; and
  - the next significant CAA permitting action in each of the Industrial Corridor Parishes; the specific permit actions to be determined during informal resolution discussions.

[10] Reserve is the community closest to Denka and the location of the Fifth Ward Elementary School.

These cumulative impact analyses should, at a minimum:

- Consider input from stakeholders, including those impacted by permitting decision(s);

- Examine current, baseline cumulative risk burden or cumulative impact due to multiple pollutant exposures (via any media) and non-pollutant stressors, such as, income, race, employment, education, access to health care, and other social determinants of health;

- Consider impacts from any facility mutagenic carcinogen emissions on lifelong residents who have been exposed to such emissions starting in early-life as infants and children; and

- Provide evidence-based recommendations for maximizing potential positive health impacts and minimizing and/or avoiding potential adverse impacts especially those that are or will be borne disproportionately based on race, color or national origin, including consideration, where appropriate, of measures to reduce emissions below the current baseline.

- Each should hire a professional risk communicator to assist in providing residents complete and accurate health risk information (*e.g.*, cancer risk).

EPA recommends that LDEQ:

- Immediately conduct additional monitoring within St. John the Baptist Parish to determine where chloroprene concentrations are below 0.2 $\mu g/m^3$ and are otherwise appropriate locations to temporarily host the Fifth Ward Elementary School.

- Issue the renewed Denka permits by a date certain (to be agreed) after completion of the cumulative impact analysis described above.

- Develop and implement a process to identify and address potential adverse health and non-health effects (*e.g.*, traffic, odors, noise) of proposed air permitting decisions and the distribution of those effects based on race and/or national origin.

- Work to establish limits in Industrial Corridor air permits that appropriately take into account the risks faced by the affected populations.

- Work to establish limits in Industrial Corridor air permits that, in the aggregate, limit air emissions of carcinogens that have a mutagenic mode of action, including chloroprene and EtO. Given the long history of exposure in the area, the goal is to limit future air emissions of such pollutants to levels consistent with cancer risks below 100-in-1 million (based on 70 years of exposure) at sites where people live, and to reduce concentrations of such carcinogens even further if reasonably achievable. That being said, it is preferable to have the concentration for these chemicals as close to 1-in-1 million as reasonably achievable.

EPA recommends that LDH:

- Within 60 days of reaching a resolution with EPA for Complaint No. 02R-22-R6 *(LDH Denka Complaint)*, complete an updated health consultation report to evaluate the cancer risk to the children of the Fifth Ward Elementary School which:
  - Applies the current Agency for Toxic Substances and Disease Registry (ATSDR)[11] Public Health Assessment Guidance Manual including the recommendations to consider based on cancer risk thresholds;[12]
  - Addresses deficiencies of the June 2018 Report identified below;
  - Evaluates all potential protective measures including the relocation of the school children to alternate locations inside and outside the Parish; and
  - Provides recommendations on measures necessary to eliminate or reduce the children's chloroprene exposure while at school to levels protective of the children's health.

During our informal resolution negotiations, EPA intends to discuss additional recommendations, including those suggested by the Complainants and by the CRISP 2022 Report discussed below. EPA would like to explore with LDEQ and LDH opportunities for technical and funding assistance with respect to analytical tools, such as, for example cumulative impact assessments, including health impact assessments, which could be used as part of LDEQ's permitting program/process. EPA is also willing to participate with LDEQ and LDH in the community meeting(s) in Reserve as recommended above. In addition, EPA would also like to explore with the affected communities opportunities for technical assistance and/or funding.

LDEQ and LDH Procedural Safeguards

To comply with federal nondiscrimination obligations, all recipients of federal assistance must have in place procedural safeguards required under 40 C.F.R. Parts 5 and 7; implement specific policies and procedures to ensure meaningful public participation and access to the recipients' services, programs, and activities for individuals with limited English proficiency (LEP) and individuals with disabilities; and ensure that public involvement policies and practices are consistent with the federal civil rights laws.[13] This Letter does not specifically address whether

[11] Agency for Toxic Substances and Disease Registry (ATSDR), https://www.atsdr.cdc.gov/pha-guidance (last visited Oct. 5, 2022).
[12] ATSDR, https://www.atsdr.cdc.gov/pha-guidance/conducting_scientific_evaluations/indepth_toxicological_analysis/EvaluateEvidenceCancerEffects.html (last visited Oct. 5, 2022).
[13] *See* Title VI, 42 U.S.C. 2000(d) *et seq.*; Section 504 of the Rehabilitation Act of 1973, as amended, 29 U.S.C. § 794; *Lau v. Nichols*, 414 U.S. 563, 568-69 (1974) (finding that the government properly required language services

LDEQ or LDH have and are implementing these procedural safeguards; however, based on an initial review, EPA identified several deficiencies in the Departments' nondiscrimination programs in light of EPA's nondiscrimination regulations and applicable guidance. We look forward to working with LDEQ and LDH to address these deficiencies as part of the IRA process and commitments.

II. GENERAL BACKGROUND/OVERVIEW

Louisiana is one of the most heavily industrialized states in the nation.[14] The Industrial Corridor,[15] sometimes referred to as Cancer Alley, is an 85-mile stretch of land along the Mississippi River between Baton Rouge and New Orleans comprised of the two Parishes that have or will host the specific facilities at issue in these Complaints, St. John the Baptist and St. James, and five other Parishes: Ascension Parish, East Baton Rouge Parish, West Baton Rouge Parish, Iberville Parish, and St. Charles Parish.

A. History of Industrial Corridor

The historical context for the formation of the Industrial Corridor is important to understand as it forms the backdrop for the apparent racial disparities highlighted in this Letter. As LDEQ in its response to the Complaint stated, "beginning in the mid-20th century, many large tracts (previously plantations) of well-drained land along the Mississippi River were offered up for sale at reasonable prices."[16] A note in the Georgetown Environmental Law Review provides the following overview:

> Much of Cancer Alley is rural and made of unincorporated towns, meaning that these communities do not have local governance over their affairs. Thus, the parish they are located in has jurisdiction and can establish rules of governance in the town. Most unincorporated communities were created when slavery ended and groups of free black people, called "companies," were able to buy strips of land at the edges of plantations. The descendants of the original companies remained on the land and continued to subdivide the parcels, resulting in a series of small black communities living on small

---

to be provided under a recipient's Title VI obligations not to discriminate based on national origin); 40 C.F.R. § 7.35(a). *See also* U.S. EPA, *Guidance to Environmental Protection Agency Financial Assistance Recipients Regarding Title VI Prohibition Against National Origin Discrimination Affecting Limited English Proficient Persons*. 69 Fed. Reg. 35602 (June 25, 2004) (available at https://www.epa.gov/sites/production/files/2020-02/documents/title_vi_lep_guidance_for_epa_recipients_2004.06.25.pdf); U.S. EPA, *Title VI Public Involvement Guidance for EPA Assistance Recipients Administering Environmental Permitting Programs*, 71 Fed. Reg. 14207 (Mar. 21, 2006) (available at https://www.epa.gov/sites/production/files/2020-02/documents/title_vi_public_involvement_guidance_for_epa_recipients_2006.03.21.pdf); U.S. EPA, *Procedural Safeguards Checklist for Recipients* (rev. Jan. 2020) (available at https://www.epa.gov/sites/production/files/2020-02/documents/procedural_safeguards_checklist_for_recipients_2020.01.pdf (which provides a more detailed explanation of nondiscrimination obligations and best practices); U.S. EPA, *Disability Nondiscrimination Plan Sample* (2017) (available at https://www.epa.gov/sites/production/files/2020-02/documents/disability_nondiscrimination_plan_sample_for_recipients_2020.01.pdf).

[14] LDEQ, *TOXIC AIR POLLUTANTS FACT SHEET FAQS*, *Other Aspects of Air Pollution Regulation*, https://deq.louisiana.gov/faq/category/19 (last visited Aug. 30, 2022).

[15] LDEQ, Formosa Basis for Decision, p. 108.

[16] LDEQ Formosa Response to Administrative Complaint No. 04R-22-R6 ("Formosa Response"), p. 11.

> strips of land. The plantations directly adjacent to these black communities have either continued to be farming and sugar cane plantations or were sold to industries dependent on river access to ship goods, chemicals, and petroleum products.[17]

The above is reinforced in the following passage:

> In the period after the American Civil War of 1861-1865, known as 'Reconstruction', emancipated Black people formed small towns, which grew from the slave quarters on the plantations of their former enslavement. Over the course of the 20th century, large-scale industrial facilities have been constructed atop those plantations, and historical 'freetowns' have since become today's 'fenceline' communities.[18]

An article in *The Atlantic* adds:

> It's not by chance that 158 years after the signing of the Emancipation Proclamation, rural Black communities bear the environmental consequences of Louisiana's biggest industry. Overlay a map of southern Louisiana's petrochemical and petroleum plants with archival maps of the area's plantations, and you'll find that in many cases the property lines match up. "One oppressive economy begets another," Barbara L. Allen, a professor of science, technology, and society at Virginia Tech and the author of *Uneasy Alchemy*, a book on environmental justice in the region, told me over the phone. "The Great River Road was built on the bodies of enslaved Black people. The chemical corridor is responsible for the body burden of their descendants."
>
> Allen's research examines the extractive economy: how sugar monocropping transitioned to petrochemical manufacturing. During Reconstruction, the Freedmen's Bureau gave land grants to black maroons and the formerly enslaved along the lower Mississippi, parceling out slivers of large plantations to extended-family groups as part of reparations, while returning the bulk of the land to white owners. The result, Allen wrote in a 2006 article was "a pattern of large, contiguous blocks of open land under single ownership . . . separated by communities of freed blacks and poorer whites." Like plantations, petrochemical and petroleum plants benefit from large acreage and easy access to some of the world's busiest shipping lanes. When the oil industry moved in during the first half of the 20th century, corporations began buying up the intact plantations. More than a century later, the pattern established during Reconstruction is still visible, only instead of plantations, Louisiana's historic free towns share fence lines with plants.[19]

The article goes on to discuss St. James Parish:

---

[17] Julia Mizutani, *In the Backyard of Segregated Neighborhoods: An Environmental Justice Case Study of Louisiana*, 31 Geo. Env. L. Rev. 363, 373 (2019).

[18] Center for Constitutional Rights, et al. (2021, June 28). *Environmental Racism in Death Alley, Louisiana*. Forensic Architecture. https://forensic-architecture.org/investigation/environmental-racism-in-death-alley-louisiana.

[19] Groner, A. (2021, May 7). *Louisiana Chemical Plants are Thriving Off of Slavery*. The Atlantic. https://www.theatlantic.com/culture/archive/2021/05/louisiana-chemical-plants-thriving-off-slavery/618769/

> "St. James Parish, on its face, is hunky-dory: fifty-fifty Black and white," Anne Rolfes, the founder and director of the Louisiana Bucket Brigade, a nonprofit that partners with fence-line communities to advocate for environmental rights, said during the aforementioned bike tour. "However, the African American population is mostly at one end of the parish, in the Fourth and Fifth Districts. And where do you think the land-use plans put all the petrochemical plants?" Lavigne lives in the Fifth District, where nine plants are in operation, two are under construction, and four more, including Formosa's megaplex—which itself includes 14 unique facilities—are proposed." [20]

The 2016-2020 American Community Survey (ACS) found that Louisiana is 33.5% Black and 58.3% White. The population of the Industrial Corridor is 42.5% Black and 50% White. Only 16% of Louisiana's population lives in the Industrial Corridor; however, it is home to 20.3% of the state's Black population and 13.6% of the state's White population.[21]

III. LEGAL BACKGROUND

A. Title VI

Title VI prohibits discrimination on the basis of race, color, or national origin by recipients of federal financial assistance. It covers all of the operations of programs or activities that receive federal financial assistance without regard to whether specific portions of the program or activity are federally funded. The term "program or activity" means all of the operations of a department, agency, or the entity to which federal financial assistance is extended. [22] The part of the program or activity that receives assistance can be, and often is, distinct from the part that engages in the allegedly discriminatory conduct.[23]

Both LDEQ and LDH are recipients of EPA financial assistance.[24] As such, the prohibitions against discrimination based on race, color, or national origin (including limited English proficiency), disability, sex and age, apply to all LDEQ and LDH programs and activities regardless of whether those specific programs or activities receive EPA financial assistance.

Title VI prohibits both intentional discrimination and acts that have an unjustified disparate impact on the basis of race, color, or national origin. Under EPA's Title VI implementing regulations, discrimination may occur when a recipient's "criteria or methods of administering

---

[20] *Id.*

[21] U.S. Census Bureau, 2016-2020 American Community Survey, https://www.census.gov/newsroom/press-releases/2022/acs-5-year-estimates.html.

[22] *See 42 U.S.C. §§ 2000d, 2000d-4(a). 42 U.S.C. § 2000d-4a; Civil Rights Restoration Act of 1987, Pub. L. No. 100-259, 102 Stat. 28 (1988) (CRRA);* U.S. Department of Justice (DOJ), *Title VI Legal Manual.* https://www.justice.gov/crt/fcs/T6manual5 (discussing "Program or Activity").

[23] *See White v. Engler*, 188 F. Supp. 2d 730, 745–47 (E.D. Mich. 2001) (finding that plaintiffs could pursue a Title VI claim against a scholarship program, even though the program operated without federal financial assistance, because it was part of a department that received federal funds); *D.J. Miller & Assocs. V. Ohio Dep't of Admin. Servs.*, 115 F. Supp. 2d 872, 878 (S.D. Ohio 2000) (granting a preliminary injunction under Title VI regarding alleged discrimination in a state contract where the contract was administered by a department that received federal funds).

[24] EPA Complaint No. 01R-22-R6 Acceptance Letter, April 6, 2022; EPA Complaint No. 02R-22-R6 Acceptance Letter, April 6, 2022.

its program or activity . . . have the effect of subjecting individuals to discrimination because of their race, color, national origin, ...or have the effect of defeating or substantially impairing accomplishment of the objectives of the program or activity with respect to individuals of a particular race, color, [or] national origin . . . "[25] The focus in a "disparate impact" or "effects" case of discrimination is on whether the consequences of the recipient's policies, practices, decisions, and actions, or failure to act, has had or will have the effect of subjecting persons to discrimination, regardless of the recipient's intent.[26]

To establish an adverse disparate impact, EPA must: (1) identify the specific policy or practice at issue; (2) establish adversity/harm; (3) establish disparity; and (4) establish causation.[27] This is referred to as a *prima facie* case of disparate impact discrimination.[28] Here, EPA's initial evaluation of these factors included determining what the policy or practice is, who is being affected by LDEQ's and/or LDH's policies or practices, actions or inactions; how they are affected; and whether a disproportionate harm is borne by a population based on race. Below is a summary of EPA's initial *prima facie* disparate impact analysis based on its investigation thus far.

B. Federal and State Regulation of Air Toxics

Under the Clean Air Act[29](CAA), EPA is required to regulate emissions of hazardous air pollutants.[30] The CAA contains a list of 189 hazardous air pollutants (HAP), also known as toxic air pollutants or air toxics. These pollutants are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects. Chloroprene is a HAP.[31] EPA has developed technology-based and risk-based standards for controlling the emissions of air toxics from sources in most industry groups (or "source categories"). The technology-based standards, knows as maximum achievable control technology (MACT) are based on emission levels that are already being achieved by top performing industry sources. The risk-based standards, known as residual risk standards, are based on levels necessary to provide an ample margin of safety to protect public health, unless a

[25] *See* 40 C.F.R. § 7.35(b).
[26] *See* U.S. EPA, Office of External Civil Rights Compliance, *Compliance Toolkit* (*EPA Title VI Toolkit*) Chapter I (Jan. 18, 2017), available at https://www.epa.gov/sites/default/files/2017-01/documents/toolkit-chapter1-transmittal_letter-faqs.pdf. *See also* U.S. DOJ, *Title VI Legal Manual*, https://www.justice.gov/crt/fcs/T6manual5.
[27] *See EPA Title VI Toolkit*, p. 8, https://www.epa.gov/sites/production/files/2017-01/documents/toolkit-chapter1-transmittal_letter-faqs.pdf.
[28] If the evidence establishes a prima facie case of adverse disparate impact, EPA must then determine whether the recipient has articulated a "substantial legitimate justification" for the challenged policy or practice. EPA will generally consider whether the recipient can show that the challenged policy was "*necessary* to meeting a goal that was *legitimate, important, and integral to the [recipient's] institutional mission*" in order to establish a "substantial legitimate justification." The analysis requires balancing recipients' interests in implementing their policies with the substantial public interest in preventing discrimination. Once a substantial legitimate justification is established, the next step in the analysis is to evaluate whether there is a less discriminatory alternative available that would achieve the same legitimate objective but with less of a discriminatory impact. EPA utilizes the "preponderance of the evidence" (more likely than not) standard in its investigations to determine whether or not a recipient has violated federal civil rights laws. *Id.*
[29] *42 U.S.C. §7401 et. seq.*
[30] CAA §112.
[31] U.S EPA, *Initial List of Hazardous Air Pollutants with Modifications*, https://www.epa.gov/haps/initial-list-hazardous-air-pollutants-modifications (last visited Oct. 4, 2022).

more stringent standard is needed to prevent, taking into consideration costs, energy, safety and other relevant factors, an adverse environmental effect. Collectively, the standards for air toxics are known as National Emission Standards for Hazardous Air Pollutants (NESHAP).

Title V of the Clean Air Act Amendments of 1990, Public Law 101-549, requires EPA to promulgate regulations that require and specify the minimum elements of state operating permit programs. Section 502(d)(l) of the CAA, 42 U.S.C. § 766la(d)(l), requires each state to develop and submit to the EPA an operating permit program to meet the requirements of Title V of the CAA. State and local permitting authorities issue Title V permits pursuant to their EPA-approved Title V programs. The CAA requires states to develop and to submit to EPA programs for issuing operating permits to major stationary sources (including major sources of HAPs listed in section 112 of the Act), sources covered by New Source Performance Standards (NSPS), sources covered by emissions standards for hazardous air pollutants pursuant to section 112 of the Act and affected sources under the acid rain program.[32]

All major stationary sources of air pollution and certain other sources are required to apply for operating permits under Title V of the CAA, which combine all enforceable requirements, including emissions limits, monitoring, recordkeeping, and reporting requirements necessary to assure compliance with the CAA into one document.[33] The Title V operating permit program generally does not impose new substantive air quality control requirements.[34] One purpose of the Title V program is to "enable the source, States, EPA, and the public to understand better the requirements to which the source is subject, and whether the source is meeting those requirements."[35] Thus, the Title V operating permit program is a vehicle for ensuring that air quality control requirements are appropriately applied to facility emission units and for assuring compliance with such requirements.

In 1982, EPA granted Louisiana authority to implement the New Source Performance Standards program.[36] In 1995, LDEQ was granted full EPA approval to implement its Title V permit program.[37] LDEQ issues Part 70 operating permits (Title V operating permits) pursuant to its state regulations set forth at LAC 33:III. Chapter 5.

In 1989, the Louisiana Legislature established a state toxic air pollutant emission control program. LDEQ developed and promulgated the Comprehensive Toxic Air Pollutant Emission Control regulation[38] which incorporated the federal MACT standards and established emission reporting requirements for all major sources of toxic air pollutants and set an ambient air

[32] 57 Fed. Reg. 32250 (July 21, 1992).
[33] CAA § 502(a).
[34] 57 Fed. Reg. 32250, 32251 (July 21, 1992).
[35] *Id.*
[36] Effective April 7, 1995, EPA delegated to LDEQ the authority to implement and enforce the NESHAP program. *See* 60 Fed. Reg. 17,750 (Apr. 7, 1995); 60 Fed. Reg. 47296 (Sept. 12, 1995); 69 Fed. Reg. 15687 (Mar. 26, 2004); 71 Fed. Reg. 19652 (Apr. 17, 2006); 75 Fed. Reg. 19252 (Apr. 14, 2010); 80 Fed. Reg. 9,613 (Feb. 24, 2015). Effective in 1982, EPA delegated to LDEQ the authority to implement and enforce the NSPS program. *See* 47 Fed. Reg. 7665 (Feb. 22, 1982); 69 Fed. Reg. 15687 (Mar. 26, 2004); 75 Fed. Reg. 19252 (Apr. 14, 2010); 80 Fed. Reg. 9,613 (Feb. 24, 2015).
[37] Effective October 12, 1995, EPA approved Louisiana's Title V operating permit program. *See* 40 C.F.R. Part 70, Appendix A; 60 Fed. Reg. 47,296 (Sept. 12, 1995).
[38] Louisiana Administrative Code (LAC) Title 33: Part III. Chapter 51.

standard for each pollutant. Under this program, facilities must report annual emission totals to LDEQ's Toxic Emission Data Inventory.[39] Compliance with CAA procedural and substantive requirements does not necessarily establish compliance with Title VI requirements.[40]

IV. INITIAL FACT FINDING AND ANALYSIS

A. EPA COMPLAINT NO. 01R-22-R6 (LDEQ and the Denka Facility Complaint)

On January 20, 2022, EPA received a complaint filed on behalf of Concerned Citizens of St. John and Sierra Club alleging that LDEQ's implementation of its air pollution control program subjects Black residents of St. John the Baptist Parish to discrimination on the basis of race in violation of Title VI and EPA's nondiscrimination regulations found at 40 C.F.R. Part 7. The Complaint alleged that LDEQ's actions and failure to take action relative to the Denka facility in LaPlace, Louisiana, and other nearby industrial facilities subject Black residents to disproportionate levels of air pollution including chloroprene and ethylene oxide.

The Complaint also alleged that other LDEQ policies or practices resulted in discrimination including LDEQ's alleged failure to: (1) fulfill the terms of an EPA grant to assess the causes of higher cancer risk in St. John the Baptist Parish; (2) act on three Denka CAA Title V permit renewal applications; (3) conduct public notice and comment on the permit renewals; and (4) strengthen Denka's pollution control measures.

On April 6, 2022, EPA accepted, in part, for investigation:

> Whether LDEQ uses criteria or methods of administering its air pollution control program that have the intent and/or effect of subjecting persons to discrimination on the basis of race in violation of Title VI of the Civil Rights Act of 1964 and EPA's implementing regulation at 40 C.F.R. Part 7 §§ 7.30 and 7.35, including, but not limited and with respect to:
>
> > LDEQ's acts or failures to undertake certain actions related to the Denka facility in connection with its air pollutant emissions, and the predominantly Black residents of St. John the Baptist Parish.

On April 25, 2022, LDEQ agreed to engage in the informal resolution process.

1. LDEQ's Response to EPA's Acceptance of the Complaint for Investigation

Pursuant to EPA's regulations, EPA provided LDEQ an opportunity to make a written submission responding to, rebutting, or denying the allegations raised in the Complaints. 40

[39] *See,* LDEQ, *AIR TOXICS PROGRAM*, https://deq.louisiana.gov/resources/category/air-toxics-program (last visited Oct. 4, 2022).
[40] *See, e.g., EPA Title VI Toolkit.*

.

C.F.R. §7.120(d) (1). LDEQ submitted a response dated June 3, 2022. LDEQ's response failed to provide a reason for EPA to dismiss either Complaint, halt its fact finding, or identify within LDEQ's information or arguments a rationale that would diminish EPA's level of concern. It is beyond the scope of this Letter to respond to each of the arguments raised by LDEQ in its response; however, EPA has undertaken to address a number of LDEQ's points in an effort to ensure EPA's positions and rationales are clear to LDEQ.

2. Background on Denka and St. John the Baptist Parish

The Denka facility in St. John the Baptist Parish produces neoprene, and the chemical chloroprene, which is used during the manufacturing process.[41] The facility was originally operated by DuPont Pontchartrain Works (DuPont) beginning in 1964, and in 1968, DuPont announced that it would begin neoprene production at this facility. Since November 2015, the neoprene division of the facility has been owned and operated by Denka.

Chloroprene is emitted into the air from Denka's neoprene manufacturing operations which consist primarily of three chemical manufacturing process units: the Chloroprene Unit, the Neoprene Unit, and the HCl Recovery Unit. Chloroprene is produced using 1,3-butadiene and chlorine in the Chloroprene Unit.[42] Chloroprene, 1,3-butadiene, and chlorine, are all defined as HAPs under CAA Section 112(b)(1).[43]

In May 2016, in a memo discussing Denka's chloroprene emissions, the EPA's air toxics program explained to EPA Region 6:

> Under EPA's air toxics risk management framework, a cancer risk of 100-in-1 million is generally described as the upper limit of acceptability for purposes of risk-based decisions. Cancer risks at or below 1-in-1 million indicate little potential for cancer risk in the air toxics program. When existing source emissions are too high to achieve the 1-in 1 million level and controls are being considered, EPA is interested in controls that reduce off-site exposure concentrations associated with cancer risks to no higher than 1-in-1 million for as much of the nearby population as is feasible.[44]

With regard to Denka's emissions, EPA further stated:

> At a minimum, we recommend that this facility aims for emission reductions such that the maximum annual average chloroprene concentration is no higher than 0.2 ug/m3 at the highest modeled off-site location. That being said, it is preferable to have the

[41] U.S. EPA, *LaPlace, Louisiana – Background Information*, https://www.epa.gov/la/laplace-louisiana-background-information (last visited Oct. 4, 2022).
[42] LDEQ-EDMS, *Title V Permit Renewal Application* (Oct. 2016), https://edms.deq.louisiana.gov/app/doc/view?doc=10386907.
[43] 42 U.S.C. § 7412(b)(1).
[44] Letter from Kelly Rimer, Leader, Air Toxics Assessment Group, Health and Environmental Impacts Division, Office of Air Quality Planning and Standards, U.S. EPA to Frances Verhalen, P.E., Chief, Air Monitoring Grants Section, EPA Region 6, *Preliminary Risk-Based Concentration Value for Chloroprene in Ambient Air* (May 5, 2016).

> chloroprene concentrations at the highest modeled census block as close to 0.002 ug/m3 as reasonably achievable.[45]

Due to concerns about chloroprene emissions from the facility, LDEQ and Denka negotiated an Administrative Order on Consent (AOC), dated January 6, 2017, under which Denka installed the pollution controls with the goal of reducing facility wide chloroprene emissions by 85% (as compared to the facility's 2014 emissions).[46] Measures implemented pursuant to the AOC included the installation of a Regenerative Thermal Oxidizer (RTO), which continues to operate. By letter dated May 20, 2020, LDEQ informed Denka that an 85% (84.63% rounded) reduction in chloroprene emissions compared to 2014 reported emissions had in fact been achieved.[47] The monitoring data discussed below shows reductions in chloroprene concentrations, but the annual averages for many of the monitors continue to show chloroprene concentrations above the EPA recommended 0.2 $\mu g/m^3$ and the preferred 0.002 $\mu g/m^3$.[48]

In St. John the Baptist Parish, 58.5% of the population identifies as Black while 33.3% identifies as White. Ninety-three percent (93%) of the residents within one mile of the Denka facility identify as Black. The closest homes are approximately 700 feet away from the facility fence line, and the facility is approximately 1,500 feet from Fifth Ward Elementary,[49] a public school with 402 students, 75% of whom are Black.[50]

3. Cancer Risk from Chloroprene Exposure

EPA develops IRIS assessments to characterize the hazards to human health posed by environmental chemicals. Developing an IRIS assessment for a particular chemical involves identifying credible human health hazards associated with chemical exposure, then characterizing a quantitative relationship between chemical exposure and each credible health hazard. These quantitative relationships are then used to derive toxicity values. IRIS toxicity values for cancer from inhalation exposure are called inhalation unit risk (IURs) and represent estimates of the increased cancer risk from inhalation exposure to a concentration of 1 $\mu g/m^3$ over a lifetime. The IUR can be multiplied by an estimate of lifetime exposure (in $\mu g/m^3$) to estimate the lifetime cancer risk. EPA programs integrate the hazard information and cancer unit risks into their risk assessments.

---

[45] *Id.*

[46] *See* LDEQ, *Denka: The Path Forward*, https://www.deq.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=denka (last visited Oct. 4, 2022) and https://www.deq.louisiana.gov/assets/docs/Denka/DENKA_AdministrativeOrderOnConsentAOCJan2017.pdf (last visited Oct. 4, 2022).

[47] *See* Letter from Lourdes Iturralde, Assistant Secretary, LDEQ to Patrick Walsh, CIH/SHE Manager, Denka Performance Elastomer LLC (May 20, 2020).

[48] It bears noting that the LDEQ 8-hour short term workplace standard for chloroprene exposure was at the time, and continues to be, 857 $\mu g/m^3$. *See*, LAC Title 33: Environmental Quality Part III: Air. Section 5112-Table 51.2., April 2014.

[49] *See* Administrator's letter to Denka & DuPont (Jan. 24, 2020) (https://www.epa.gov/system/files/documents/2022-01/messrs.-toshio-imai-and-edward-d.-breen.pdf).

[50] National Center for Education Statistics, Fifth Ward Elementary School, St. John the Baptist Parish, 2020-2021 School Year, https://nces.ed.gov/ccd/schoolsearch/school_detail.asp?Search=1&SchoolID=220153002003&ID=220153002003 (last visited Oct. 12, 2022).

EPA's 2010 IRIS Assessment for Chloroprene[51] analyzed the cancer and other human health effects associated with chronic inhalation exposure to chloroprene over a 70-year lifetime. It concluded that chloroprene is "likely to be carcinogenic to humans" and that it acts through a mutagenic mode of action. The IUR for chloroprene is 5×10^{-4} per $\mu g/m^3$ when adjusted for exposure from birth and taking into account increased susceptibility during childhood.[52]

The IRIS IUR for continuous lifetime inhalation exposure can be used to calculate an estimated ambient air concentration associated with a particular lifetime excess cancer risk. For a lifetime excess cancer risk of 100-in-1 million from continuous exposure through inhalation over a 70-year lifetime, starting at birth, and taking into account increased susceptibility during childhood, the estimated air concentration is 0.2 micrograms of chloroprene per cubic meter ($\mu g/m^3$).

A mutagenic mode of action means that a chemical induces cancer by beginning to damage DNA and producing mutations. When a person breathes in chloroprene, it causes DNA damage in the body's cells. The resulting mutations increase the likelihood that a person will develop cancer over the course of their lifetime.

Individuals exposed to mutagenic carcinogens starting in early life as infants or young children are understood to be more susceptible than individuals exposed only as adults.[53] Reasons for this susceptibility include more rapid cell division during early life resulting in less time to repair DNA mutations; more rapid expansion of mutant cells lead to cancer. The contribution to lifetime cancer risk from a single year of exposure to chloroprene is greater if that year occurred during childhood. Childhood exposures to chloroprene may increase a person's risk of cancer later in life.

With publication of a peer reviewed IUR for chloroprene, it became possible to calculate cancer risks for populations exposed to that air pollutant.

---

[51] *See*, Summary Information on IRIS.
[52] *See*, IRIS Chemical Assessment, p. 18.
[53] U.S. EPA, *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens*, (Mar. 2005), p.30.

4. Status of Denka Air Permits

Currently, the Chloroprene, Neoprene, and Hydrochloric Acid (HCl) Recovery Units operate under the following permits each of which has expired:

Unit	Permit No.	Date Issued	Expiration Date	Renewal Application Date
Chloroprene Unit	3000-V5	09/09/2014	04/26/2017	10/26/2016[54]
Neoprene Unit	2249-V9	04/27/2017	05/15/2019	07/26/2018[55]
HCl Recovery Unit	206-V4	03/03/2017	06/18/2020	11/19/2019[56]

LDEQ has represented that it is presently reviewing Denka's renewal applications.[57]

5. Initial Disparate Impact Analysis

The following summarizes EPA's initial disparate impact analysis.

a) *Neutral Policy or Practice*

EPA's regulations prohibits LDEQ from administering its air pollution control program in a way that has the effect of subjecting the residents of St. John the Baptist living near the Denka facility to discrimination on the basis of race.[58] To determine compliance with the regulations, EPA must first identify what "facially neutral policies or practices," or actions, may have produced "a negative effect—looking at who is impacted and where the impact occurs—in order to identify the legally relevant policies or practices."[59]

A neutral practice need not be undertaken affirmatively, but in some instances could be the failure to act or to adopt an important policy.[60] During its fact finding, EPA found several specific LDEQ policies or practices, actions or inactions taken within the context of LDEQ's

[54] LDEQ-EDMS, https://edms.deq.louisiana.gov/app/doc/view?doc=10386907. On November 7, 2018, Denka submitted Addendum No. 1 and in December 2020 Addendum No. 2 to its renewal application (https://edms.deq.louisiana.gov/app/doc/view?doc=12489947).
[55] LDEQ-EDMS, https://edms.deq.louisiana.gov/app/doc/view?doc=11249049. On November 1, 2018, Denka submitted additional information on and addendums on January 28, 2020, and August 22, 2020. LDEQ-EDMS, https://edms.deq.louisiana.gov/app/doc/view?doc=12328494.
[56] LDEQ-EDMS, https://edms.deq.louisiana.gov/app/doc/view?doc=11954047. On June 2, 2020, Denka submitted an addendum. LDEQ-EDMS, https://edms.deq.louisiana.gov/app/doc/view?doc=12204487.
[57] Letter from Chuck Carr Brown, Secretary, Louisiana Department of Environmental Quality, to Lilian Sotolongo Dorka, Director, U.S. Environmental Protection Agency, External Civil Rights Compliance Office, *Re: Response to Concerned Citizens of St. John, et. al, Complaint Filed Under Title VI of the Civil Rights Act of 1964, 42 U.S.C. §2000d (Complaint No: 01 R-22-R6)* ("LDEQ Denka Response"), pp. 4 and 6 (June 3, 2022).
[58] 40 C.F.R. Part 7 §§ 7.30 and 7.35
[59] *See* U.S. DOJ *Title VI Legal Manual* (Identifying the facially neutral policy or practice, agency practice tip) https://www.justice.gov/crt/fcs/T6Manual7#E
[60] *See EPA Title VI Toolkit.*

methods of administering its air pollution control program that may be causing or contributing to adverse disparate impacts based on race as described below.

i. EPA is concerned that LDEQ's erroneous legal interpretation that its nondiscrimination obligations under Title VI and EPA's implementing regulations do not apply to its Title V program[61] results in LDEQ failing to properly identify and address disparate impacts resulting from its Title V program and to deny those impacted by LDEQ decisions the ability to raise concerns about discriminatory effects of those decisions. As explained above, *supra* at page 10, Congress made clear in the Civil Rights Restoration Act of 1987 that the Title VI nondiscrimination obligation applies to all the programs and activities of a recipient and courts have confirmed recipients' obligations in this regard.[62] Therefore, even if LDEQ's Title V permit program does not directly receive EPA financial assistance, because LDEQ receives EPA financial assistance, the Title VI nondiscrimination obligation applies to all programs administered by LDEQ, including its Title V program.

EPA is concerned that LDEQ's inaction on the Denka Title V operating permit renewal process coupled with the lack of an established process to assess whether its permit actions might cause or contribute to adverse disparate impacts in violation of Title VI that is accessible to the public denied LDEQ and the community the opportunity to work together to identify and address any adverse disparate impacts resulting from Denka's chloroprene emissions.

The Title V permit process is one, but not the only logical point for LDEQ to conduct an analysis to identify and address any adverse disparate impacts to which the renewal of a facility's operating permit may cause or contribute. Another would be through the grievance process LDEQ is required to have in place by EPA's nondiscrimination regulations.[63] The grievance process is another appropriate avenue to formally to raise concerns about disparate impact and the health risks posed by Denka's chloroprene emissions. If LDEQ has a grievance procedure, EPA was not able to find a way to access it on LDEQ's website which makes it essentially unavailable.

LDEQ's failure to acknowledge the applicability of Title VI and to make available the grievance process described above meant that residents—already struggling with the burden of harmful pollution—had to seek other means to prod action to secure an appropriate response to address the health risk posed by Denka's chloroprene emissions. In the past few years, residents petitioned EPA for enforcement action

[61] LDEQ Denka Response, pp. 1-2.
[62] EPA has also made this clear in its 2017 Toolkit (p. 2) a document that LDEQ quotes at length in its Basis For Decision's for the Formosa permits discussed below. *See also*, FAQ #4 in *January 18, 2017 FREQUENTLY ASKED QUESTIONS (FAQs) FOR CHAPTER 1 OF THE U.S. EPA'S EXTERNAL CIVIL RIGHTS COMPLIANCE OFFICE COMPLIANCE TOOLKIT*"
[63] 40 C.F.R. § 7.90.

under the CAA and rulemaking under the Toxics Substances Control Act;[64] filed this Complaint with EPA and the Civil Rights Division of the U.S. Department of Justice; and petitioned the Organization of American States.[65] They also organized protests including at the Denka facility, at the Fifth Ward Elementary School, at Denka's headquarters in Japan, and a five-day march from Reserve to Baton Rouge, Louisiana.[66]

In addition, when residents raised their concerns to EPA through the Title VI civil rights complaint process, LDEQ incorrectly argued it "was an improper vehicle for raising allegations of discrimination under the [t]itle V permitting program."[67] If allowed to stand, LDEQ's erroneously limited legal interpretation of its Title VI obligation would inappropriately deny the residents of Louisiana their right to file discrimination complaints with EPA.

Moreover, EPA is concerned that LDEQ's inaction on the Denka Title V operating permits renewal process denies the benefits of the permit process (*e.g.,* access to information about the facility; ability to influence operations through comment process; potential to appeal permit to EPA) to the residents impacted by Denka who disproportionately identify as Black. As explained above, one purpose of the CAA Title V program is to "enable the source, States, EPA, and the public to understand better the requirements to which the source is subject, and whether the source is meeting those requirements."[68]

ii. LDEQ's response to the Complaint provided several reasons for delaying the Title V operating permit renewal process, including asserting that there "was developing information and activities related to chloroprene emissions;"[69] and Denka's requests for reconsideration of the Integrated Risk Information System (IRIS) assessment for

[64] Petition to the Administrator, United States Environmental Protection Agency, *Petition for Emergency Action under the Clean Air Act, 42 U.S.C. § 7603 et seq., to Abate the Imminent and Substantial Danger to St. John the Baptist Parish, Louisiana Residents from Toxic Air Pollution and Petition for Rulemaking under the Clean Air Act, 42 U.S.C. § 7412, to Set Health-Protective Air Toxics Emissions Standards* (May 6, 2021).
[65] Petition from Concerned Citizens of St. John to the Organization of American States, Inter-American Commission on Human Rights, *Emergency Request for Precautionary Measures Pursuant to Article 25 of the Rules of Procedure of the Inter-American Commission on Human Rights on Behalf of Residents of St. John the Baptist Parish, Louisiana,* (undated).
[66] Dermansky, J. (2019, Nov. 1). *Environmental Justice Activists Arrested Amid Growing Concerns Over Louisiana's Cancer Alley Pollution.* DeSmog. https://www.desmog.com/2019/11/01/environmental-justice-arrests-louisiana-cancer-alley-pollution/ (*EJ Activists Arrested*); Dermansky, J. (2021, May 12) *Inspector General Directs EPA to Update Its Rules for Two Toxic Air Pollutant A Louisiana Cancer Alley community group responded by petitioning the EPA to take emergency action to reduce carcinogenic emissions.* DeSmog. https://www.desmog.com/2021/05/12/inspector-general-epa-chloroprene-ethylene-oxide-denka/ (*IG Directs EPA*); Blair, G. and Laughland, O. (2019, June 26). *Residents of America's Cancer Town confront chemical plant owner in Japan.* The Guardian. https://www.theguardian.com/us-news/2019/jun/26/cancer-town-denka-pontchartrain-works-reserve-louisiana; Lartey, J. and Laughland, O. (2019, May 30). *They've been killing us for too long': Louisiana residents march in coalition against 'death alley'.* The Guardian. https://www.theguardian.com/us-news/2019/may/30/toxic-america-louisiana-residents-march-against-polluting-plant.
[67] LDEQ Denka Response, pp. 1-2.
[68] 57 Fed. Reg. 32250, 32251 (July 21, 1992).
[69] LDEQ Denka Response, p. 6.

chloroprene.[70] In its response to the Complaint, LDEQ states that "it is EPA that bears the responsibility to update control standards for hazardous air pollutants under Section 112 of the CAA; this is not a state responsibility nor is it an element of the Title V permitting program."[71] While it is true that EPA has a role in regulating HAPs and has taken steps toward regulating chloroprene,[72] LDEQ fails to acknowledge its own authority and precedent for regulating chloroprene.[73] LDEQ's webpage devoted to explaining its TAP program states as mandated by Louisiana Revised Statute 30:2060:

> *". . . Louisiana DEQ developed and promulgated the Comprehensive Toxic Air Pollutant Emission Control regulation, one of the most stringent state air toxics rules in the country. The state regulation also surpasses the federal regulation. In addition to incorporating the control technology (MACT) standards, the state rule establishes emission reporting requirements for all major sources of toxic air pollutants and sets an ambient air standard for each pollutant."*[74]

Chloroprene is listed as a TAP in LAC 33:III. Chapter 51, Tables 51.1 - 51.3. As Denka explained in an undated FAQ, "The LDEQ ambient standard for chloroprene is 857 $\mu g/m^3$ on an 8-hour basis."[75]

Additionally, the rationale that it is waiting to see what other agencies might do related to Denka's chloroprene emissions is inconsistent with LDEQ's prior actions which raises questions about the reasonableness of such a claim. For example, in 2016, Chuck Carr Brown, the Secretary of the LDEQ (Dr. Brown), stated that rather than wait around for his counterparts at EPA to set a chloroprene standard, he was using the AOC to get reductions.[76]

iii. EPA is also concerned about LDEQ's interactions with the residents who live near the Denka facility. During the few public meetings held to discuss Denka's chloroprene emissions that LDEQ attended, when residents raised their concerns about Denka's failure to meet the maximum annual average chloroprene

---

[70] U.S. EPA, *RFC 21005 – Chloroprene*, https://www.epa.gov/quality/rfc-21005-chloroprene
[71] LDEQ Denka Response, p. 11.
[72] EPA will conduct a risk assessment on chloroprene emissions to support of the Group I Polymers and Resins: National Emission Standards for Hazardous Air Pollutants (NESHAP) and the Hazardous Organic NESHAP, that are scheduled for proposal in March 2023 and December 2022, respectively.
[73] Also, Denka noted in an FAQ issued sometime after 2017 that LDEQ had not ". . . set any new limits regarding chloroprene exposure as a result of the draft NATA study published in 2015." Denka, *FREQUENTLY ASKED QUESTIONS*, http://denka-pe.com/wp-content/uploads/2017/10/Denka-QA.pdf.
[74] LDEQ, *TOXIC AIR POLLUTANTS FACT SHEET FAQS*, https://www.deq.louisiana.gov/index.cfm/faq/category/19 (last accessed Oct. 2, 2022).
[75] Denka, *FREQUENTLY ASKED QUESTIONS*, http://denka-pe.com/wp-content/uploads/2017/10/Denka-QA.pdf
[76] Dermansky, J. *LDEQ Secretary Dr. Chuck Brown*, YouTube video imbedded within DeSmog, at approximately Minute 18:23 (Dec. 2016), https://www.desmog.com/2017/04/19/st-john-baptist-parish-fight-clean-air-louisiana-cancer-alley-denka-chloroprene/(*St. John Baptist Parish Fights*) (Dr. Chuck Carr Brown before the St. John the Baptist Parish Council).

concentration EPA recommended, LDEQ officials referred to those concerns as "fear mongering."[77]

In a 2016 public meeting to discuss the Denka facility and actions being taken to address the emissions, Dr. Brown spoke for several minutes with a councilmember who was trying to determine whether the implementation of the AOC pollution controls would reduce the chloroprene concentrations to "point 2." Dr. Brown repeatedly emphasized that the 0.2 was an EPA guidance, "just something EPA targeted as a goal,"[78] and that he wanted the speaker to "detach yourself from that number."[79] The message seemed to be that residents should focus on the amount of the predicted emissions reductions, not what was of concern to residents—whether the reductions would achieve cancer risks below EPA's upper limit of acceptability or meet EPA's preferred cancer risks of no higher than 1-in-1 million for as much of the population near Denka as is feasible.

LDEQ's website page "Denka: The Path Forward" also includes the Department's response to the question "What about .2?":

> Once the control measures are in place, LDEQ will again assess the emissions at the Denka facility. While there is currently no federal or state standard for chloroprene emissions, EPA has offered a number as guidance. It is not an emissions limit.[80]

While it is true that the 0.2 $\mu g/m^3$ concentration does not constitute an explicit emissions limit, the statement is confusing at best and misleading at worst since it does not provide any explanation of what the ".2" number is—EPA's scientific assessment of the upper limit of acceptable exposure to avoid elevated cancer risk. LDEQ's repeated reference to the lack of a federal standard and its description of the 0.2 $\mu g/m^3$ concentration as mere guidance could be interpreted as questioning the scientific basis and significance of the IRIS inhalation unit risk, and the advisability of reaching those concentration levels and risk levels.

At this same 2016 public meeting when discussing EPA's IRIS assessment for chloroprene, Dr. Brown stated that in 2015 EPA had reclassified chloroprene as a "possible carcinogenic."[81] He further stated that he hoped the audience would "key in

[77] Dr. Brown later said, "I'm not going to say I regret using the term. I just felt like I could've used a different term." Victor Blackwell, Wayne Drash and Christopher Lett, *Toxic tensions in the heart of 'Cancer Alley'*, CNN (Oct. 20, 2017), https://www.cnn.com/2017/10/20/health/louisiana-toxic-town/index.html.
[78] *Supra* footnote 76, *St. John Baptist Parish Fights*, Minute 16:41 (Dec. 2016).
[79] *Supra* footnote 66, *EJ Activists Arrested*, at Minute 15:33. Dr. Brown later stated in an interview with CNN, "That's why I've tried to tell everyone: Detach yourself from that number and let's work toward a solution that involves the best available control technology." Victor Blackwell, Wayne Drash and Christopher Lett, *Toxic tensions in the heart of 'Cancer Alley'*, (Oct. 20, 2017), https://www.cnn.com/2017/10/20/health/louisiana-toxic-town/index.html.
[80] LDEQ, *Denka: The Path Forward*, https://www.deq.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=denka (last visited Oct. 4, 2022).
[81] *Supra*, footnote 66, *EJ Activists Arrested*, Minute 2:14 (Nov. 1, 2019).

on the words" he was using "a possible carcinogenic."[82] In 2010, EPA concluded that chloroprene was a ***likely*** carcinogen. In general usage "possible" means something that may or may not occur,[83] while "likely" means having a high probability of occurring or being true.[84] Dr. Brown's mischaracterizing the category of carcinogen on behalf of LDEQ had the potential to confuse and mislead, even if that was not LDEQ's intention.

The community relies on LDEQ to provide accurate and complete information. EPA is concerned that on some important occasions including on a webpage specifically designed to provide information to the public about risks posed by Denka's chloroprene emissions, LDEQ has fallen short.

iv. EPA is also concerned that in assessing whether there are adverse health impacts from Denka's emissions, LDEQ relied upon LDH studies about which EPA has concerns as discussed below.

b) Adversity/Harm

EPA must evaluate the policies or practice identified above, to determine whether these "harm" to the Black residents living near Denka is enough to be actionable. This element is sometimes referred to as "adversity of the impact."[85] In the context of this Title VI investigation EPA could examine, not only the burdens or harms resulting from each individual policy, decision or action, and borne disproportionately on the basis of race, but also the total or cumulative burdens including exposures throughout a person's lifetime borne disproportionately by a community, especially in light of the characteristics of that community.[86] To date, EPA has not engaged in a cumulative impact analysis, but the information gathered to date suggests that such an analysis should have been performed by LDEQ.

---

[82] *Id.* at Minute 2:17. EPA notes that LDEQ's website *Denka: The Path Forward* accurately states: "EPA reclassified chloroprene as a likely carcinogen in 2010." (https://www.deq.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=denka) (last visited Oct. 4, 2022).
[83] https://www.merriam-webster.com/dictionary/possible.
[84] https://www.merriam-webster.com/dictionary/likely.
[85] E.g., *S. Camden Citizens in Action v. N.J. Dep't of Envtl. Prot.*, 145 F. Supp. 2d 446, 487, *opinion modified and supplemented*, 145 F. Supp. 2d 505 (D.N.J.) (discussing the methods used to "evaluate the 'adversity' of the impact" and considering whether the impacts at issue were "sufficiently adverse" to establish a prima facie case), *rev'd on other grounds*, 274 F.3d 771 (3d Cir. 2001). *See also Bryan v. Koch*, 627 F.2d 612, 617 (2d Cir. 1980) (indicating that adversity exists if a fact specific inquiry determines that the nature, size, or likelihood of the impact is sufficient to make it an actionable harm).
[86] EPA's Office of Research and Development defines cumulative impacts as "the totality of exposures to combinations of chemical and non-chemical stressors and their effects on health, well-being, and quality of life outcomes. Cumulative impacts include contemporary exposures to multiple stressors as well as exposures throughout a person's lifetime. They are influenced by the distribution of stressors and encompass both direct and indirect effects to people through impacts on resources and the environment. Cumulative impacts can be considered in the context of individuals, geographically defined communities, or definable population groups. Cumulative impacts characterize the potential state of vulnerability or resilience of a community." U.S. EPA, Cumulative Impacts Research: Recommendations for EPA's Office of Research and Development. *U.S. Environmental Protection Agency*, Washington, D.C., EPA/600/R-22/014a, 2022. p. 4, https://www.epa.gov/system/files/documents/2022-09/Cumulative%20Impacts%20Research%20Final%20Report_FINAL-EPA%20600-R-22-014a.pdf.

When assessing whether there are adverse health effects from air pollution, EPA has used as a benchmark the residual risk from air toxics for source categories that are subject to technology-based requirements under Section 112 of the Act. EPA generally seeks to prevent cancer risks in excess of 100-in-1 million (or 1-in-10,000). EPA applied this cancer risk benchmark in past Title VI investigations related to air pollution and has used it in this investigation as an initial benchmark.

A monitor provides actual concentrations in the area where the monitor is located. But computer models provide estimated concentrations across an entire community – not just at the monitor location. EPA was able to include both types of information in its analysis below.

(1) Defining the Affected Population

The National Air Toxics Assessment (NATA)/AirToxScreen[87] uses actual emissions data to estimate ambient concentrations of air toxics and resulting health effects around the country. NATA/AirToxScreen is designed by EPA as a screening tool for state and local governments to identify pollutants, emission sources, and places for further localized analysis of risks to public health. NATA/AirToxScreen features an online mapping application that presents emissions, concentrations, and cancer risks at the census tract level. EPA used NATA and AirToxScreen data, as described in more detail below, to assess the potential for adverse impacts from Denka in terms of the estimated human health risk of air pollution for different demographic populations.

The 2011 NATA/AirToxScreen estimated excess cancer risk for the census tract closest to the Denka facility (tract 708) was 770-in-100 million (more than 7 times the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime) the risk of developing cancer was significantly higher than the national average (the census tract was, in fact, the worst in the United States for cancer risk); more than 90% of that increased risk was due to chloroprene exposure; and the increased risk was attributable to Denka's chloroprene emissions.

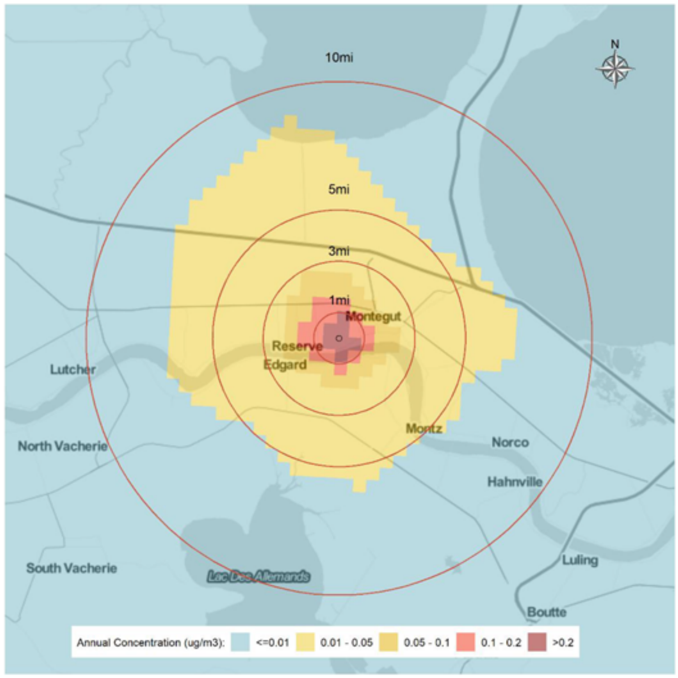
EPA's Risk-Screening Environmental Indicators model (RSEI) incorporates facility-reported information from the Toxics Release Inventory (TRI) on the amount of toxic chemicals released, together with factors such as the chemical's fate and transport through the environment, each chemical's relative toxicity, and potential human exposure. Modeling assumptions in RSEI are designed to reflect a worst-case scenario, and so in some cases actual air concentrations may be lower than modeled concentrations. RSEI model results can be used to help establish priorities for further investigation and to look at changes in potential human health impacts over time. RSEI Scores are designed to be compared to each other. A RSEI Score 10 times higher than another RSEI Score suggests that the potential for risk is 10 times higher.

As Figure 1 below displaying results from the RSEI model shows, those living closest to the Denka facility are most impacted by the chloroprene emissions. Modeled average annual chloroprene concentrations from Denka emissions were over 0.2 $\mu g/m^3$ in most of the region within 1 mile of the facility in 2020. The census tract that contains the centroid of the Denka

[87] The name NATA was retired and replaced with the name AirToxScreen for the emissions year 2017 (released March 2022).

facility from satellite imagery is 708. The other census tracts that fall within the 1-mile circle are 711 and 709.

Figure 1: Denka Modeled Average Annual Chloroprene Concentrations (2020)[88]



(2) Unacceptable Risk Levels Continue After 2018, Despite Installation of Pollution Control Equipment

(a) Estimated Cancer Risk

Cancer risks from air toxics in the St. John the Baptist Parish and in particular the census tracts located nearest the Denka facility declined after the AOC pollution control measures were installed but remain high. The 2018 AirToxScreen estimated lifetime cancer risks from exposure to air toxics in St. John the Baptist were 120-in-1-million. For tracts closest to Denka, the

[88] The dispersal pattern is based on the RSEI fate and transport model, which computes how the facility affects the continuous annual concentration of chloroprene in all 0.8 x 0.8 km gridded cells within 30 miles. For more information on the RSEI model, *see* U.S. EPA, *Risk-Screening Environmental Indicators (RSEI) Methodology*, https://www.epa.gov/system/files/documents/2022-06/RSEI%20Methodology%20V2.3.10.pdf

lifetime cancer risks in 2018 were even higher: tract 708 had a lifetime cancer risk of 400-in-1-million (four times the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime), and tracts 707 and 709 both had estimated lifetime cancer risks of 200-in-1-million (two times the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime).

(b) Cancer Risk Based on Monitored Chloroprene Concentrations

EPA's NATA, released on December 17, 2015, using 2011 data, estimated high levels of air toxics including chloroprene in the area close to Denka. At the time of the NATA release, these levels of chloroprene were predicted by the model, but not confirmed by actual air monitoring results. EPA and LDEQ conducted air monitoring in the community to determine whether there were chloroprene levels of concern in the ambient air from 2016 until the present. EPA calculated cancer risk to residents based on measured concentrations at monitors in and along the edge of the residential area near Denka.

Since March 2016, there has been a combination of discrete and continuous community-based and fence-line monitoring near Denka [89] The monitors discussed below were placed by EPA, LDEQ, and Denka. The most recent EPA fence-line monitoring data cover the period ending August 4, 2022, and the most recent Denka canister monitoring data was collected on August 29, 2022.

Across the various monitoring programs and sampling methods, the air quality measurements taken after Denka installed controls to reduce chloroprene emissions (after March 2018) consistently measure ambient chloroprene concentrations above 0.2 $\mu g/m^3$, and average concentrations at all monitors are above 0.2 $\mu g/m^3$, which represents the 100-in-1-million upper bound increased cancer risk from continuous exposure to this concentration for a lifetime.

Concentrations above 0.2 $\mu g/m^3$ were measured not only at fence-line monitoring locations, but also at community monitors located further away from the facility including the Fifth Ward Elementary School. These elevated concentrations were also detected during the time period when Denka had shut down its chloroprene production in the aftermath of Hurricane Ida in September 2021.

The past 6 years of data from EPA, LDEQ, and Denka monitors located in the census tracts near Denka with the modeled elevated levels of cancer risk in NATA/AirToxScreen and elevated RSEI toxicity scores prior to 2018, show that *even after the required pollution controls were operational in 2018, the levels of risk exceeding the 100-in-1-million cancer risk have persisted.*

From May 2016 through September 2020, EPA's Chad Baker air sampling station in the residential neighborhood west of Denka showed average concentrations of 2.13 $\mu g/m^3$ - more

[89] Discrete monitoring refers to the collecting of chloroprene samples on a fixed time interval (*e.g.*, for the 2016-2020 Community Ambient Air Monitoring Program, EPA/LDEQ started out collecting samples every third day). In contrast, continuous monitoring refers to use of a device that continuously measures chloroprene in the ambient air and collects a sample when the ambient chloroprene concentration exceeds a certain threshold.

than 10 times higher than 0.2 µg/m^3. From January 7 through August 4, 2022, the Denka fence-line monitor site 17, which is approximately 750 feet from the former location of EPA's Chad Baker air sampling station, showed average concentrations of 0.77 µg/m^3—close to 4 times 0.2 µg/m^3. From 2018 through September 2020, the chloroprene concentration averaging across readings from all of the EPA's air sampling sites was 1.44 µg/m^3—more than 7 times higher than 0.2 µg/m^3.

Denka's Western air sampling station is closest to the residential neighborhood west of the facility. The Fifth Ward Elementary School is approximately 1,000 feet from the Western monitor. From February 2, 2020, to February 1, 2022, the average chloroprene concentration at Denka's Western sampling station was 2.22 µg/m^3 which is more than 11 times 0.2 µg/m^3.

If someone was exposed continuously to 2.22 µg/m^3 of chloroprene for their lifetime (24 hours a day for 70 years), their estimated increased upper bound risk of developing cancer as a result of this exposure would be 600-in-1 million using the unadjusted IUR of 3×10^{-4} per µg/m^3 (6 times the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime). If that person is exposed continuously to 2.22 µg/m^3 of chloroprene for their lifetime *from birth* (24 hours a day for 70 years), and taking into account increased susceptibility during childhood, their estimated increased upper bound risk of developing cancer as a result of this exposure would be 1000-in-1 million using the adjusted IUR of 5×10^{-4} per µg/m^3 (10 times the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime).[90]

Over a lifetime of exposure (24 hours a day from birth to 70 years old) to the same concentration of chloroprene, approximately half of one's lifetime risk of cancer from chloroprene exposure would be attributable to childhood exposure (from birth to 16 years old).

The annual average for chloroprene at EPA's air sampling at the Fifth Ward Elementary School from October 2, 2019, to September 26, 2020, was 1.2 µg/m^3, including some shorter term (24-hour average) spikes as high as 16.6 µg/m^3 with a collocated sample showing15.3 µg/m^3.[91] The average concentrations for January 7 to August 4, 2022 at the two fence-line monitors[92] closest to the Fifth Ward Elementary School were 0.51 µg/m^3 and 0.77 µg/m^3, respectively. The highest detected concentrations at those monitors were 1.63 µg/m^3 (Apr. 14-28, 2022) and 2.91 µg/m^3 (Jan. 7-21, 2022), respectively, while only a few of the samples at those two locations were below 0.2 µg/m^3.[93]

In 2017, pursuant to the AOC with LDEQ, Denka implemented pollution control measures that significantly reduced chloroprene emissions in 2018 as compared to 2014 levels. While those reductions were significant in relation to past chloroprene emissions, the monitoring information above shows that Denka still continued to emit chloroprene at a rate that contributes to or causes

[90] *See,* IRIS Chemical Assessment, p. 18.

[91] Letter from Michael S. Regan, U.S. EPA Administrator, to Mr. Toshio Imai, Denka Corporation, and Mr. Edward D. Breen, DuPont (Jan. 24, 2022) (https://www.epa.gov/system/files/documents/2022-01/messrs.-toshio-imai-and-edward-d.-breen.pdf).

[92] Site 16 and 17. Note this is more recent data than depicted in Figure 3.

[93] Only four out of the fifteen samples at Site 16 and three out of the fifteen samples at Site 17 measured concentrations below 0.2 µg/m^3.

concentrations many times higher than 0.2 μg/m^3, which therefore results in an increased risk of developing cancer over a lifetime that is many times higher than the 100-in-1 million risk level.

Current chloroprene concentrations near Denka present a risk that is especially grave for infants and children under the age of 16. As stated above, approximately half of one's lifetime risk of cancer from chloroprene exposure would be attributable to childhood exposure. For example, sixteen years of exposure (24 hours a day, 7 days a week) to concentrations measured at the Western monitor beginning at birth and ending at age 16 would present a lifetime risk of approximately 600-in-1 million. Seventy (70) years of exposure beginning at birth to concentrations measured at the Western monitor would present a lifetime of risk of approximately 1000-in-1 million. As evidenced by this comparison, by year 16, approximately half of the lifetime risk is reached. As a result, infants continuously exposed to chloroprene at the average concentrations measured near the Western air monitor could potentially reach the upper bound of acceptable lifetime cancer risk (100-in-1 million) early in life.

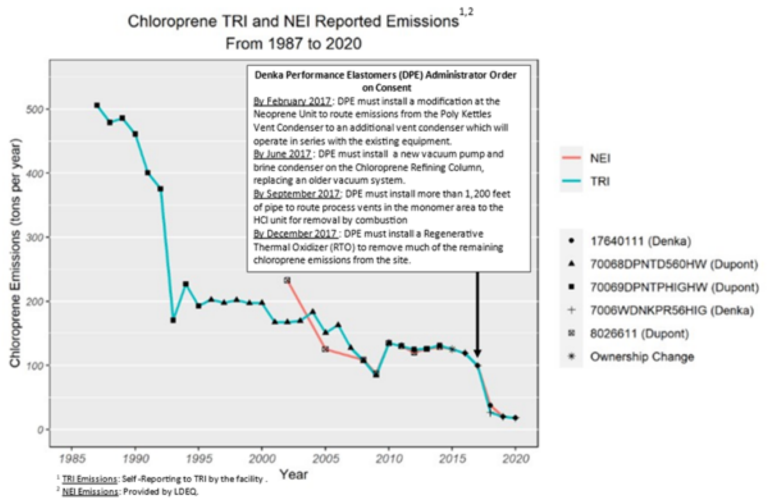
This is because chloroprene is a mutagen and children are more sensitive to it – one year of exposure to a child result in more risk than one year of similar exposure to an adult. If chloroprene was not a mutagen, then half a person's 70-year lifetime risk would happen at about year 35. Chloroprene is a mutagen; therefore, half the estimated lifetime cancer risk comes at year 16, not 35. The result is that adolescents and adults who experienced childhood exposure and who breathe chloroprene at levels measured at the Western monitor would surpass a 100-in-1 million excess cancer risk more quickly than an adult without prior childhood exposure.[94]

Moreover, as is shown by Figure 2 below, the residents living near the facility for the past 30 years, including children, were exposed to higher chloroprene levels than those measured after implementation of the emissions control measures, at least four times higher based on TRI and NEI data, which would elevate the excess cancer risk even higher above 100-in-1 million.

---

[94] *See supra* footnote 7.

Figure 2



During interviews, residents indicated that many of the homes have been occupied by members of the same families for several generations. For example, one resident indicated that he had lived in the community his whole life and that his neighbors had similarly been longstanding residents of the community. This resident further indicated that homes had stayed within families, with younger generations moving into homes previously owned by relatives. Another resident corroborated the pattern of intergenerational ownership by stating that houses were passed down within families from one generation to the next. A third resident further corroborated this by indicating that some neighbors had lived in the area for sixty years or more.

The U.S. Census data[95] confirms that many residents have lived in the community near the facility for many years. For the five census tracts nearest Denka, 61% of all residents have lived in the same home since 2009; 36% since 1999. For the Parish overall, about 60% of all residents have lived in the same home since 2009; about 32% since 1999.

As a result, adolescents and adults who grew up near the facility and breathe chloroprene at levels measured at monitors near Denka reach an exposure associated with a 100-in-1 million risk excess cancer risk faster than an adult without childhood exposure to chloroprene.[96]

---

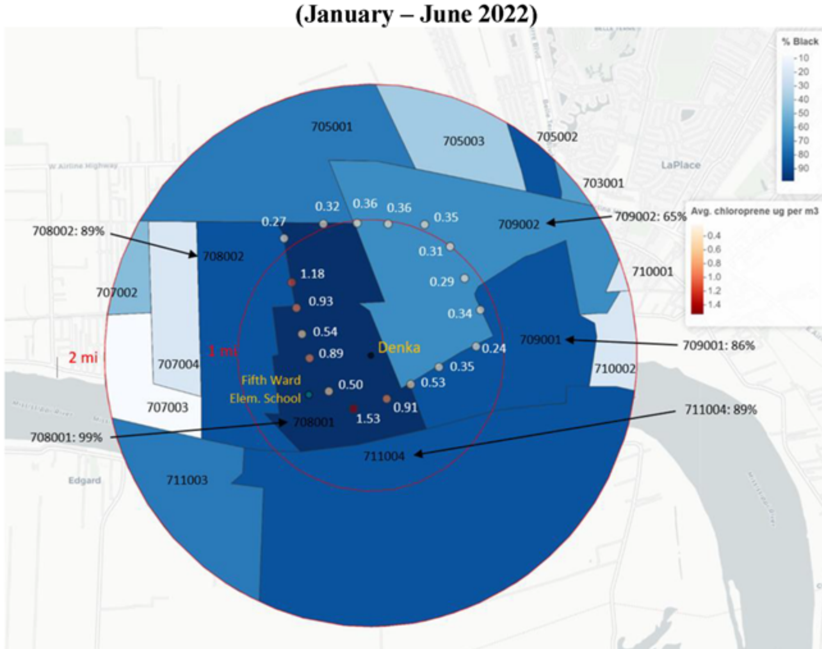
[95] U.S. Census Bureau, 2015 – 2019 American Community Survey, https://www.census.gov/newsroom/press-kits/2020/acs-5-year.html.

[96] *See, supra* footnote 7.

(3) Current Information Regarding Residents Near Denka as Compared to the State

In Figure 3 below, the monitoring data of chloroprene concentrations are overlaid with census block groups neighboring Denka. Each point represents one of the 18 monitors that EPA required Denka to place in January 2022 on its fenceline. The monitoring sites are labeled and colored by the average chloroprene concentrations (µg/m^3) measured at that location between January 7 – June 9, 2022.[97] The darker shade of red indicates a higher average chloroprene concentration measured at that location. The lifetime chloroprene concentration associated with a 100-in-1 million cancer risk is 0.2 µg/m^3. The concentric rings demarcate distances of 1 and 2 miles outward from the centroid[98] of the Denka facility.

Figure 3: Average Chloroprene Concentration at Denka Fence-line Monitors (January – June 2022)



97 U.S. EPA, Fence-line monitoring data from January – 2022, https://www.epa.gov/la/denka-air-monitoring-data-summaries (last visited Oct. 4, 2022).

98 The centroid coordinate is 30.056, -90.524.

c) *Disparity*

In analyzing disparity under Title VI, EPA looks at whether a disproportionate share of the adversity/harm discussed above is borne by individuals based on their race, color, or national origin. Disparity is a fact-specific inquiry that involves identifying an appropriate measure.[99] A typical disparity measure involves a comparison between the proportion of persons in the protected class who are adversely affected by the challenged practice and the proportion of persons not in the protected class who are adversely affected.[100] A disparity is established if the challenged practice adversely affects a significantly higher proportion of protected class members than non-protected class members.[101]

In this case, it appears the Black residents and children attending school nearest the Denka facility have been and continue to be impacted by the adversities or harms previously discussed, especially related to increased cancer risk, at comparatively higher rates than other racial groups impacted by LDEQ's methods of administering its air pollution control program. That is, the policies, practices, actions or failures to act related to the Denka facility, as previously discussed, appear to have a disparate impact on the basis of race.

Generally speaking, the statistical disparity must be "sufficiently substantial to raise an inference of causation."[102] In determining what is considered statistically significant or substantial, courts appear generally to have judged the 'significance' or 'substantiality' of numerical disparities on a case-by-case basis and based on all of the surrounding facts and circumstances.[103]

Here, the cancer risk from exposure to chloroprene emissions due to LDEQs actions and decisions clearly fall "substantially disproportionately" on the Black residents who live near the Denka facility, as compared to non-Black residents. When we examine the most adversely affected population, that is, the population living within one mile of Denka—where the risk of cancer from chloroprene exposure is and has been greatest, 93% of that population identifies as Black as compared to 7% identifying as non-Black.[104]

In addition, when we examine the affected and increasingly vulnerable population of children who attend the Fifth Ward Elementary School, 75% of the students identify as Black as compared to 25% who do not identify as Black.[105] Examining the disparity in a different light and based on a different "comparator," 93% of residents living within one mile of Denka identify

---

[99] *See, e.g., S. Camden Citizens in Action v. New Jersey Dept. of Envtl. Protec.*, 145 F. Supp. 2d 446, 493 (D.N.J. 2001), *opinion modified and supplemented*, 145 F. Supp. 2d 505 (D.N.J. 2001), *rev'd*, 274 F.3d 771 (3d Cir. 2001) (disparity analysis); *see also* DOJ *Title VI Legal Manual* at https://www.justice.gov/crt/fcs/T6Manual7#G.
[100] *Tsombanidis v. W. Haven Fire Dep't*, 352 F.3d 565, 576–77 (2d Cir. 2003).
[101] *Id.*
[102] *Smith v. Xerox Corp.*, 196 F.3d 358, 364 (2nd Cir. 1999), citing *Watson v. Fort Worth Bank & Trust*, 487 U.S. 977, 994-995 (1988), *NAACP v. Town of East Haven*, 70 F.3d 219, 225 (2nd Cir. 1995).
[103] *Teamsters v. United States*, 431 U.S. 324, 340, 97 S.Ct. 1843, 1856-1857, 52 L.Ed.2d 396 (1977); *Watson v. Fort Worth Bank and Trust*, 487 U.S. 977, 995 n.3 (1988); *see also Waisome v. Port Auth. of N.Y. & N.J.*, 948 F.2d 1370, 1376 (2d Cir. 1991).
[104] EJSCREEN ACS Summary Report dated August 30, 2022, indicates the population within 1 mile of location Denka self-reported to TRI.
[105] *See supra* footnote 50.

as Black while 58.5% of the residents of St. John the Baptist Parish identify as Black and only 33.5% of the State's population identifies as Black.

As stated earlier, the 2018 AirToxScreen estimated lifetime cancer risks from exposure to air toxics in St. John the Baptist were 120-in-1-million and was even higher in previous years. There are several additional methods of analyzing disparity, including the Threshold Risk Ratio, the Demographic Ratio, and the Relative Risk Ratio which also appear to conclude that the adverse impacts associated with LDEQs policies, practices, decisions, actions or inactions, have been and continue to be borne disproportionately on the basis of race.

EPA used the five-year ACS for 2016-2020 data when conducting the Threshold Risk Ratio and Demographic Ratio comparisons. During this time period, there were: 43,055 people in St. John the Baptist, 25,175 of whom identified as Black (58.5%) and 17,880 who identified as a race other than Black (41.5%).

(a) Threshold Risk Ratio

The Threshold Risk Ratio is defined in two ways. First, EPA examines the ratio of (1) the probability of a Black resident in Louisiana to be affected (*e.g.*, live in St. John the Baptist) to (2) the probability of a non-Black resident in Louisiana to be affected. Residents who are facing elevated estimated lifetime cancer risks are on average 3.03 times more likely to identify as Black than identify as other than Black. The Threshold Risk Ratio is statistically significantly greater than 1.0, meaning that the higher likelihood of Black residents to be exposed to average cancer risks from air toxics exceeding the 120-in-1-million risk level in 2018 as compared to the likelihood of non-Black residents is likely not by random chance.[106]

The Threshold Risk Ratio is also defined as the ratio of (1) the probability of a Black resident in Louisiana to be affected (*e.g.*, live within 1 mile of the Denka facility centroid) to (2) the probability of a non-Black resident in Louisiana to be affected. Residents who are facing elevated estimated lifetime cancer risks are on average 80 times more likely to identify as Black than identify as other than Black.[107]

(b) Relative Risk Ratios[108]

To capture the extent to which residents of St. John the Baptist Parish face disparate cancer risks and live in tracts with higher cancer risks from air toxics, EPA also calculated Relative Risk

---

[106] The Threshold Risk Ratio and Demographic Ratios are statistically significantly greater than 1, using the Fishers exact test, where the alternative hypothesis is that the odds ratio > 1. The p-value is <10e-50, which is less than alpha = 0.01.

[107] Population estimates within 1 mile of the Denka facility are taken from EJSCREEN which is based on 2015-2019 American Community Survey 5-year summary population estimates. Therefore, in generating the Threshold Risk Ratio and Demographic Ratio, we use the same 2015-2019 American Community Survey population data for the rest of the state.

[108] Relative risk measures are calculated as the ratio of population-weighted cancer risk across census tracts for Black residents within a specific Parish relative to a comparison group using information on cancer risk from the National Air Toxics Assessment (NATA; 2014), AirToxScreen (2017-2018) and population totals from the American Community Survey, 5-year estimates, 2015-2019. We could not use the most recent American Community Survey, 5-year estimate data (2016-2020) due to changes in tract definitions.

Ratios. A relative risk ratio measure is a common approach in epidemiology for comparing the risk of a specific outcome (typically, health related) among one group to the risk of the same outcome occurring among a second group. The risk of a specific outcome for the exposed group of interest is divided by the risk of the same outcome for the comparison, unexposed group. A relative risk of one means there is no difference between two groups in terms of their risk of a specific outcome (*e.g.,* cancer) due to exposure. A relative risk greater than one means that exposure to a certain substance or factor increases the risk of a specific outcome. A value less than one indicates a lower risk of that outcome. EPA used relative risk ratios as one method to assess potential disparities in risk of different populations defined by race.

(i) Cancer Relative Risk Ratio

When differences in census tract level estimated cancer risks from air toxics in the St. John the Baptist Parish, taken from NATA/AirToxScreen, are combined with ACS 2015-2019 tract-level data on where residents reside (*i.e.,* a relative risk measure), EPA found that population-weighted averages of cancer risks for all populations in St. John the Baptist Parish were:

9.7 times the average for all populations living elsewhere in Louisiana in 2014.
5.5 times the average for all populations living elsewhere in Louisiana in 2017.

The relative risk measure of the population-weighted averages of estimated cancer risks from air toxics for Black residents – as compared to non-Black residents, in St. John the Baptist Parish were:

1.2 times that of all other residents in the Parish in 2014.
1.3 times that of all other residents in the Parish in 2017.
1.1 times that of all other residents in the Parish In 2018.

Even within a Parish with estimated cancer risks that are many times higher than the estimated cancer risk of the rest of the State, the Black residents of St. John the Baptist have estimated cancer risks that are higher than all other residents of the Parish over time.

When differences in cancer risks from air toxics across census tracts in the St. John the Baptist Parish are combined with data on where residents of different races reside (*i.e.* a relative risk measure), EPA found that population-weighted averages of cancer risks for Black populations in St. John the Baptist were 4.2 times the average for people living elsewhere in Louisiana in 2018.

(ii) Toxicity Relative Risk

EPA's RSEI model incorporates facility-reported TRI information on the amount of toxic chemicals released, together with factors such as the chemical's fate and transport through the environment, each chemical's relative toxicity, and potential human exposure. The average RSEI tract-level toxicity scores decreased somewhat from 2016 to 2017 in St. John the Baptist Parish (from 608,594 in 2016 to 517,471 in 2017).

In 2016, when differences in RSEI toxicity scores across census tracts in the St. John the Baptist Parish are combined with data on where residents of different races reside (*i.e.,* a relative risk measure), EPA found that population-weighted averages of RSEI scores for all people residing in

St. John the Baptist are 71 times those for people residing elsewhere in Louisiana. For Black residents of the Parish, population-weighted averages of RSEI scores in 2016 were even higher at 80 times the score for people residing elsewhere in Louisiana.

RSEI toxicity scores have declined over time; however, disparities continue to exist. When differences in RSEI toxicity scores across census tracts in the St. John the Baptist Parish are combined with data on where residents of different races reside (*i.e.,* a relative risk measure), EPA found that average RSEI scores in 2020 for all people residing in St. John the Baptist are 36 times those for people residing elsewhere in the State, while for Black residents of St. John the Baptist Parish, the RSEI toxicity scores are 41 times those for people residing elsewhere in the State.

The population weighted averages of RSEI tract-level toxicity scores decreased from 2016 to 2020 in St. John the Baptist Parish. However, the gap in toxicity scores between Black residents and non-Black residents persists through 2020 in the Parish. When differences in RSEI scores across census tracts in the St. John the Baptist Parish are combined with data on where residents of different races reside (*i.e.* a relative risk measure), EPA found that Black residents lived in areas with population-weighted average RSEI toxicity scores that were 1.3 times (2016), 1.4 times (2017), and 1.3 times (2020) those of areas where non-Black residents in the Parish lived.

(c) Demographic Ratio

In addition to the Threshold Risk Ration and the Relative Risk Ratios, EPA considered the Demographic Ratio, which while not providing a direct comparison between Black residents and non-Black residents does provide additional insight and may allow one to infer that a particular burden is felt more heavily by one segment of the general population. The Demographic Ratio is defined in two ways. First, EPA examines the ratio of (1) the probability of an affected Louisiana resident (*e.g.,* living in St. John the Baptist Parish) to be Black to (2) the probability of a non-affected Louisiana resident to be Black. The proportion of Black residents in the Parish was 1.84 times the proportion of Louisiana's Black residents living outside the Parish. The Demographic Ratio is statistically significantly greater than 1.0, meaning that the proportion of Black residents living inside St. John the Baptist Parish being higher than the proportion of Black residents living outside the Parish is not due to random chance.[109]

The Demographic Ratio is also defined as the ratio of (1) the probability of an affected Louisiana resident (*e.g.,* living within 1 mile of the Denka facility centroid) to be Black to (2) the probability of a non-affected Louisiana resident to be Black. The proportion of Black residents within 1 mile of Denka was 6.63 times the proportion of Louisiana's Black residents living outside of 1 mile of the facility. The Demographic Ratio is statistically significantly greater than 1.0, meaning that the proportion of Black residents living inside St. John the Baptist Parish being higher than the proportion of Black residents living outside the Parish is not due to random chance.

---

[109] The Threshold Risk Ratio and Demographic Ratios are statistically significantly greater than 1, using the Fishers exact test, where the alternative hypothesis is that the odds ratio > 1. The p-value is <10e-50, which is less than alpha = 0.01.

d) Causation

As discussed above, it appears that, for years, LDEQ did not take appropriate action on Denka's permit renewal, failed to appropriately recognize the application of the federal nondiscrimination requirements to its Title V air program, failed to provide accurate and complete information to residents most affected by Denka's chloroprene emissions and relied on inaccurate and incomplete information regarding the cancer risk to the most affected residents. Based on EPA's initial fact finding, there appears to be a causal link between LDEQ's actions and inactions in administering its air permitting program and the adverse and disproportionate distribution of the cancer and toxicity risks from chloroprene exposure, by race. EPA has significant concern that LDEQ's methods of administering its air pollution control program may have subjected and continues to subject the predominantly Black residents and school children of St. John the Baptist Parish who live and attend school near Denka, to disparate impacts on the basis of race.

B. EPA COMPLAINT NO. 02R-22-R6 (LDH - DENKA FACILITY COMPLAINT)

On January 20, 2022, EPA received a complaint filed on behalf of Concerned Citizens of St. John (CCSJ) and Sierra Club alleging that LDH discriminates on the basis of race in violation of Title VI. The complaint alleges that LDH failed in its duty to provide the predominantly Black residents of St. John the Baptist Parish with necessary information regarding the health threats posed by air pollutants emitted from the facility owned by Denka and other nearby sources.[110]

The complaint also alleges that LDH failed to make necessary recommendations to "relevant government agencies" and affected communities regarding measures to reduce and prevent exposure to hazardous air pollutant emissions from these sources. Complainants were particularly concerned about LDH's failure to make recommendations to the St. John the Baptist Parish School Board (School Board) to relocate the Fifth Ward Elementary School, because the chloroprene-emitting Denka facility is located only three blocks away from the school.[111]
On April 6, 2022, EPA opened an investigation into:

> Whether LDH subjects Black residents of St. John the Baptist Parish, including students at the Fifth Ward Elementary School, to discrimination on the basis of race in violation of Title VI of the Civil Rights Act of 1964 and EPA's implementing regulation at 40 C.F.R. §§ 7.30 and 7.35, including by allegedly failing in its duty to provide Parish residents with necessary information about health threats, and to make necessary recommendations to all relevant government agencies and affected communities regarding measures to reduce and prevent exposure to hazardous air pollutant emissions from the Denka facility and other nearby sources of pollution.[112]

On May 16, 2022, LDH agreed to engage in the informal resolution process.[113]

---

[110] EPA Administrative Complaint No. 02R-22-R6 (*LDH Denka Complaint)*.
[111] *Id.*
[112] EPA Acceptance Letter for Administrative Complaint No. 02R-22-R6, April 6, 2022.
[113] LDH Email to EPA, May 16, 2022.

1. LDH's Response to EPA's Acceptance of Complaint for Investigation

Pursuant to EPA's regulation, EPA provided LDH an opportunity to make a written submission responding to, rebutting, or denying the allegations raised in the Complaint. 40 C.F.R. § 7.120(d)(1)(iii). On June 6, 2022, LDH responded to EPA's acceptance of the complaint for investigation. On September 7, 2022, LDH provided a supplemental response. LDH's responses failed to provide a reason for EPA to dismiss the Complaint or for EPA to halt its fact finding. The information and arguments provided by LDH did not serve to diminish EPA's level of concern. In general, LDH's initial response denied the allegations in the Complaint, stating, "all of the complained of actions/inactions taken or omitted by LDH were based upon the reasonable conclusions" and "upon the best evidence and science available."[114]

2. Initial Disparate Impact Analysis

The following summarizes EPA's initial disparate impact analysis.

a) *Neutral Policy or Practice*

EPA's regulation prohibits LDH from administering its public health program in a way that has the effect of subjecting the residents of St. John the Baptist living near the Denka facility to discrimination on the basis of race.[115] To determine compliance with the regulation, EPA must first identify what "facially neutral policies or practices," or actions, may have produced "a negative effect—looking at who is impacted and where the impact occurs—in order to identify the legally relevant policies or practices."[116] A neutral practice need not be undertaken affirmatively, but in some instances could be the failure to act or to adopt an important policy.[117]

To determine whether LDH's neutral policies, practices, actions or inactions taken within the context of LDH's methods of administering its public health program may be causing or contributing to negative effects on residents and school children on the basis of race, EPA reviewed four studies conducted by LDH since 2017 related to chloroprene and health effects. LDH conducted these studies on chloroprene emissions from the Denka facility in St. John the Baptist Parish pursuant to LDH's implementing regulation and as part of its Multipurpose Grant project.

These studies are:

- *The Report of the Expert Panel on Chloroprene Exposure in the Air in St. John the Baptist Parish,* September 6, 2017 (September 2017 Report).
- *A Reference Document for the Preliminary Assessment of Chloroprene Levels in St. John the Baptist Parish, June 14, 2018* (June 2018 Report).

---

[114] LDH Response to Administrative Complaint No. 02R-22-R6, June 6, 2022, p.1.

[115] 40 C.F.R. Part 7 §§ 7.30 and 7.35

[116] *See* U.S. DOJ *Title VI Legal Manual* (Identifying the facially neutral policy or practice, agency practice tip) https://www.justice.gov/crt/fcs/T6Manual7#E.

[117] *See EPA Title VI Toolkit*, at https://www.epa.gov/sites/default/files/2017-01/documents/toolkit-chapter1-transmittal_letter-faqs.pdf.

- *Cancer Reporting in St. John Parish (CRISP), Cancer Surveillance Project, Final Report 2021, March 1, 2021* (CRISP 2021 Report).
- *St. John the Baptist Parish Chloroprene Monitoring Demonstration Subproject of "Cancer Reporting in St. John Parish (CRISP)" Project*, April 11, 2022 (CRISP 2022 Report).

b) *Adversity/Harm*

In determining whether LDH's practices resulted in adversity or harm, EPA examined the following issues: (1) whether LDH examined all available data; (2) whether the data LDH relied on were accurate; (3) whether LDH employed the appropriate analysis to determine the cancer risk from exposure to chloroprene; and (4) whether LDH effectively communicated cancer risk information to residents, the School Board, and LDEQ to facilitate their ability to make well-informed decisions to avoid or reduce the nearby community's exposure to chloroprene.

(1) September 2017 Report

In 2017, Dr. LuAnne White of Tulane School of Public Health was contracted by LDH to convene the expert scientific panel on chloroprene.[118] The purpose of the panel was to produce a report that would "provide advice on the immediate public significance of the current levels of chloroprene in air in the community that surrounds the plant."[119] In particular, LDH sought advice from the panel on how results from the monitoring of chloroprene emissions in the LaPlace, Louisiana area could inform actions LDH could take to protect the public health of local residents. The expert panel also explored the role of medical monitoring and what public health messages LDH should provide to the community, health care providers, and public health officials.

The September 2017 Report was unclear in its conclusions about the chloroprene exposure in St. John the Baptist Parish. The September 2017 Report claimed that chloroprene exposure during the sampling period (*i.e.*, May 2016 to August 2017) was "intermittent" and in amounts that varied across the six air sampling sites. However, the report did not define "intermittent" and provided little to no support for these conclusions. From the inception of monitoring into September 2017, chloroprene was detected in about 75 percent of the samples at these sites, which EPA would not characterize as intermittent. These and other omissions raise questions about the reliability of the panel's results.[120]

Moreover, the September 2017 Report failed to provide straightforward conclusions about what measures residents and state agencies can take to avoid or reduce exposure, sidestepping direct recommendations by stating that no immediate action was necessary because the chloroprene exposure in St. John Parish did not constitute a "public health emergency," with no explanation of what that term means.[121]

---

[118] LDH Response to EPA's Acceptance of Administrative Complaint No. 02R-22-R6, June 6, 2006, p. 6.
[119] LDH *Report of the Expert Panel on Chloroprene Exposure in Air in St. John the Baptist Parish*, September 6, 2017, p. 3.
[120] *Id.*
[121] *Id.*

EPA's review has identified additional significant questions and concerns about the September 2017 Report. For example, the Report:

- Failed to identify the data the panelists relied upon to determine its conclusions;
- Failed to identify the author of the report and their credentials;
- Failed to define key terms, such as, what constitutes a "public health emergency" or "intermittent;"
- Failed to include relevant experts on its panel, for example, an environmental epidemiologist of cancer outcomes or an EPA expert involved in publishing an extensive review of chloroprene toxicity (*e.g.*, U.S. EPA, IRIS Chemical Assessment).
- Relied on inaccurate representations of monitoring results from the EPA 24-hour canister samples when EPA's data analysis from the same time frame showed that the arithmetic mean concentration at Fifth Ward Elementary School was 6.22 $\mu g/m^3$ (with a higher 95^{th} percentile upper confidence limit), at least ten times higher;[122]
- Relied on outdated data, such as the OSHA Chemical Sampling Information fact sheet, which predates the laboratory animal studies that informed the IRIS assessment;[123] and
- Failed to address the fact that chloroprene is a carcinogen with a mutagenic mode of action, which means, as per EPA cancer risk assessment guidance, the chemical has a much greater effect on lifetime cancer risk than late life exposure.[124]

The panel's recommendations included that LDH:

- Provide medical education about the potential health effects of chloroprene to local physicians and health care providers, as well as public health personnel; and
- Encourage community members to speak with their private physicians about how chloroprene exposure relates to their health.[125]

While LDH directed community members to speak with and rely upon their health care providers, LDH failed to follow through on commitments[126] to the community to educate local medical and public health providers on the health impacts of chloroprene.[127]

---

[122] LDH *Report of the Expert Panel on Chloroprene Exposure in Air in St. John the Baptist Parish*, September 6, 2017, p. 7.
[123] *Id* at p. 6.
[124] U.S. EPA, *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens*, (Mar. 2005), p.30.
[125] LDH *Report of the Expert Panel on Chloroprene Exposure in Air in St. John the Baptist Parish*, September 6, 2017, p. 3.
[126] LDH Response to EPA's Acceptance of Administrative Complaint No. 02R-22-R6, *see also* LDH Supplemental Response to EPA, September 7, 2022, although LDH, in the 2017 Report, encouraged community members to discuss their concerns regarding health-related impacts of chloroprene with their personal physicians, it acknowledged that it is "not aware" of any actions taken to follow the expert panel's recommendation to provide medical education on the health impacts of chloroprene to local physicians, other healthcare providers, and to the public personnel in the area.
[127] EPA conducted interviews with a group of community members as part of its initial fact finding in August 2022. A number of local residents told EPA they had followed LDH's recommendations to discuss concerns about chloroprene with their primary care physicians but their doctors did not or would not address chloroprene issues and health effects with them.

(2) June 2018 Report

On June 29, 2018, LDH issued the June 2018 Report in response to an inquiry from the St. John the Baptist Parish School Board.[128] The assessment examined the potential for reducing cancer risk associated with transferring children out of the Fifth Ward Elementary School, which is the closest public school to the Denka Facility.[129]

The June 2018 Report's main finding with regard to cancer risk was: "Based on data limited to the March-May 2018 sampling results, transferring children from the current Fifth Ward Elementary School location to another location within the community would 'not greatly decrease' their theoretical risks of developing excess cancers from exposure to chloroprene."[130] EPA has concerns regarding the information presented and how the public was informed of the findings. For example:

- LDH failed to prominently acknowledge the unacceptably high cancer risks which residents and students experience by limiting the document's focus to relative risk reductions associated with moving students from one chloroprene-impacted school to another.
- LDH failed to consider the possibility of appropriate mitigation, because LDH did not evaluate the cancer risk reduction benefits of transferring the Fifth Ward Elementary students to:
    - areas further from the Denka facility that would be expected to have considerably lower chloroprene concentrations;[131] or
    - a location in Edgard, Louisiana, where a Denka monitor had been in place since 2016 and was registering chloroprene concentrations significantly lower than the EPA monitors that LDH used in its analysis to reach the conclusion that transferring children from the current Fifth Ward Elementary School location to another location would 'not greatly decrease' their risks of developing excess cancers from exposure to chloroprene.
    - LDH failed to set criteria for risk reduction; for example, LDH does not define "not greatly decrease"[132] for purposes of deciding whether relocation is warranted.
    - LDH failed to acknowledge the significant limitations associated with using data of limited duration (*i.e.*, March 2018 through May 2018) to accurately assess whether relocation could result in cancer risk reduction.
    - LDH failed to include appropriate data and relied on inaccurate data in its analysis of the risk reduction benefits of relocation; for example, data related to correlations between chloroprene exposure and cancers other than lung and liver cancer, and omission of human epidemiological literature from its analysis.[133]

---

[128] LDH, *Health Department Provides Health Risk Data to St. John Officials*, June 29, 2018, available at https://ldh.la.gov/news/4668.
[129] LDH/SEET, *A Reference Document for the Preliminary Assessment of Chloroprene Levels in St. John the Baptist Parish: Evaluation of Potential Health Risks for Elementary School Students based on Early Sampling Results following Emissions Reductions*, p. 11, which "For purposes of this assessment, the other location is identified as East St. John Elementary School."
[130] *Id.* at p. 15.
[131] *Id.* at p. 11.
[132] LDH/SEET, *A Reference Document for the Preliminary Assessment of Chloroprene Levels in St. John the Baptist Parish: Evaluation of Potential Health Risks for Elementary School Students based on Early Sampling Results following Emissions Reductions,* June 14, 2018, p. 15.
[133] *Id* at p. 10.

- LDH failed to make recommendations to reduce emissions, exposure, or risk when its June 2018 Report found elevated cancer risks in the community.

The unsupported conclusions and failure to consider relevant data, some of which are contradictory to LDH's conclusions, potentially misinformed the School Board's analysis of the benefits of relocating the school children. In light of this, LDH's recommendation that no action was needed potentially may have caused additional hazardous air pollutant exposure for the students of Fifth Ward Elementary School.

(3) CRISP 2021 Report and CRISP 2022 Report

LDH contracted with the Louisiana State University School of Public Health (LSU) to conduct the CRISP 2021 Report[134] and CRISP 2022 Report.[135] The Reports assessed the health risks associated with chloroprene exposure in the community near Denka. The Reports were funded by an EPA Multipurpose Grant that LDH and LDEQ procured to respond to continuing community concerns about health effects of living in close proximity to Denka.

The CRISP 2021 Report addressed community concerns about whether LTR was completely and accurately reporting those rates.[136] The main objective was to verify the completeness of cancer reporting in St. John the Baptist Parish. The principal findings of the CRISP 2021 Report were that no reportable cancers were identified that were not a part of LTR data.[137]

LDH's CRISP 2022 Report[138] presented air monitoring results from nine locations around the Denka facility, including residences, school sites, a courthouse, and a park.[139] The 2022 Report also provided an analysis of urine testing for chloroprene metabolites and cancer risks.

The CRISP 2022 Report concluded there was a "likelihood of chronic exposure to low doses of chloroprene at levels [from the Denka facility] which may have potential health impacts on vulnerable populations." [140] The Report also stated that "Fifth Ward Elementary School students may potentially face unacceptably high cancer risks based only on the years of school attendance."[141] Finally, the CRISP 2022 Report found detectable levels of chloroprene even during periods of reported Denka facility shutdowns.

The CRISP 2022 Report made several recommendations to LDH, including:

---

[134] LDH, *Cancer Reporting in St. John Parish (CRISP), Cancer Surveillance Project, Final Report 2021*, March 1, 2021, available at https://louisianacancer.org/wp-content/uploads/2022/04/LSU_Chloroprene-Monitoring-Report_2022_FINAL-3.pdf.
[135] *Id.*
[136] *Id* at p. 3.
[137] *Id.* at pp. 12-13.
[138] LDH, *St. John the Baptist Parish Chloroprene Monitoring Demonstration Subproject of "Cancer Reporting in St. John Parish (CRISP)" Project*, April 11, 2022, available at https://louisianacancer.org/wp-content/uploads/2022/04/LSU_Chloroprene-Monitoring-Report_2022_FINAL-3.pdf.
[139] *Id* at pp 4, 6.
[140] *Id.* at pp 8-9, *see also* p. 14, while the Report does not define "vulnerable populations," it does refer to "vulnerable individuals" as "5th Ward Elementary School Students" and "vulnerable groups" as "school authorities, daycare operators, etc."
[141] *Id.* at p. 10-11.

- Engage in monitoring, mitigation and exposure prevention, including conducting health assessments and tracking health outcomes;
- Implement a school-based health surveillance system;[142]
- Use air monitoring and biomonitoring to quantify resident and child exposures to chloroprene; and
- Work with LDEQ to establish a relationship with the community and to adopt precautionary practices and policies preventing the future siting of industries next to residential and community spaces.[143]

The recommendations from the CRISP 2022 Report provided LDH and LDEQ with practical steps to potentially reduce and prevent chloroprene exposure in the St. John the Baptist Parish community. EPA is concerned that LDH has not provided evidence that it has taken any action to implement the CRISP 2022 Report's recommendations or to communicate findings to the community following the issuance of the study in April 2022.

(4) Community Engagement

LDH is responsible for providing accurate, relevant, and timely information about health risks associated with exposure to hazardous air pollutant emissions.[144] In fulfilling its mission, LDH is required to clearly communicate such information to exposed populations and government agencies, such as the School Board and LDEQ, which are empowered to make decisions significantly impacting the health and safety of Louisiana's communities. EPA is concerned that LDH has not taken and is not taking appropriate[145] actions to engage with the impacted community, School Board, and other local and State agencies during its planning for and conduct of the health impact studies.

EPA is especially concerned with the following deficiencies in LDH's public engagement on the health risks associated with chloroprene exposure:

- LDH failed to timely communicate the reports' findings on chloroprene to the impacted community and had minimal community-wide engagement after it released the

[142] *Id.* at p 14.
[143] *Id.*
[144] La. Rev. Stat. Ann. §36:251(B), stating that LDH is responsible for the "development and providing of health and medical services for the prevention of disease for the citizens of Louisiana;" *see also* La. Rev. Stat. Ann §36.258(B), stating that LDH is also tasked with "perform[ing] those functions of the state provided by law relating to environmental quality. . . pollution control [and] public health. . . which are specifically assigned to [LDH];" LDH website, available at https://ldh.la.gov/page/1, which states that LDH's public mission is "to protect and promote health and to ensure access to medical, preventive, and rehabilitative services for all citizens of the State of Louisiana"; and U.S. EPA, *EPA awards Louisiana over $311,000 to assess air pollutants in St. John Parish* available at https://www.epa.gov/newsreleases/epa-awards-louisiana-over-311000-assess-air-pollutants-st-john-parish, where LDH also represented its commitment to this mission with its acceptance of an EPA Multipurpose Grant in the amount of $86,081.
[145] 40 CFR § 7.35, states that [LDH] must not exclude persons from participation in or denied the benefit of its programs, activities and services, *see also* La. Rev. Stat. Ann. §36:251(B) and La. Rev. Stat. Ann §36.258(B).

September 2017 Report, June 2018 Report, CRISP 2021 Report and CRISP 2022 Report;[146]

- LDH also failed to effectively communicate the reports' findings including developing summary fact sheets that identify and explain the key findings of each report; and convening meetings with the community to explain those findings especially the technical issues involved in a way that residents could understand; and
- LDH has not consistently published all of its reports on its website, and as a result, public access to information is limited.

c) Disparity

In evaluating disparity under Title VI, EPA examined whether a disproportionate share of the adversity/harm is borne by individuals based on their race, color, or national origin. There are several methods of analyzing disparity, as discussed above, *supra* at pages 30-33.

d) Causation

There appears to be a causal connection between LDH's practices, decisions, actions and inactions in carrying out its public health mission and the harmful continued exposure to chloroprene by the predominantly Black residents and school children of St. John the Baptist Parish who live and attend school near the Denka facility. EPA notes that among LDH's deficiencies are:

- Failure to provide accurate and reliable information central to decision making;
- Failure to properly educate residents and health care professionals;
- Failure to implement study recommendations; and
- Failure to advise local and state entities such as the School Board and LDEQ on measures to reduce or prevent chloroprene exposure.

C. EPA COMPLAINT NO. 04R-22-R6 (LDEQ - FORMOSA COMPLAINT)

On February 2, 2022, EPA received a Title VI administrative complaint filed behalf of Stop the Wallace Grain Terminal, Inclusive Louisiana, RISE St. James, and the Louisiana Bucket Brigade alleging that LDEQ's implementation of its air pollution control program subjects Black residents of St. James Parish to discrimination on the basis of race. Specifically, the Formosa Complaint alleged Black residents are subjected to ongoing disproportionate and adverse health and environmental impacts which result in part from the lack of a procedure or policy to identify and address disproportionate impacts based on race of air permitting decisions and the failure to establish criteria and consistently follow them when conducting environmental justice analyses.

Further, the Formosa Complaint alleged that LDEQ's August 5, 2021, decision to reaffirm issuance of air permits to the Formosa facility allowing emissions of both criteria pollutants (*e.g.*,

[146] LDH Response to EPA's Acceptance of Administrative Complaint No. 02R-22-R6, June 6, 2022, *see also* LDH Supplemental Response to EPA, September 7, 2022, in its response, LDH states "several phone calls were held [by the project team] with representatives of [CCSJ]" including an in-person meeting on January 20, 2020, but failed to describe any community wide engagement initiatives.

$PM_{2.5}$, nitrogen dioxide, volatile organic compounds, carbon monoxide) and toxic and carcinogenic air pollutants such as ethylene oxide, benzene, and formaldehyde would add to the alleged existing adverse disparate impacts from air pollution. The Formosa Complaint also alleged that LDEQ fails to provide Black residents with meaningful involvement in air permitting decisions.

On April 6, 2022, EPA opened an investigation into:

> Whether LDEQ uses criteria or methods of administering its air pollution control program that have the intent and/or effect of subjecting persons to discrimination on the basis of race in violation of Title VI of the Civil Rights Act of 1964 and EPA's implementing regulation at 40 C.F.R. §§ 7.30 and 7.35, including, but not limited and with respect to, LDEQ's decision to reaffirm issuance of 14 new air permits for the Formosa facility, and the predominantly Black residents of St. James Parish.

On April 25, 2022, LDEQ indicated that it was interested in pursuing informal resolution for both of the Complaints. On June 20, 2022, LDEQ submitted a response to Complaint 04R-22-R6.

On September 8, 2022, the 19th Judicial District Court for the Parish of East Baton Rouge issued a decision in the matter of *Rise St. James et al. v. LDEQ (Rise)*, reversing LDEQ's decision to issue those permits, vacating the permits, and remanding the matter to LDEQ. On September 27, 2022, that decision was appealed by LDEQ and stayed. EPA has continued to investigate this matter as it relates to the Formosa permits since the lower court's decision—which EPA has reviewed carefully and taken into account for purposes of this Letter—did not finally resolve the concerns related to the issuance of the Formosa permits.

1. LDEQ's Response to EPA's Acceptance of the Complaint for Investigation Complaint Responses

Pursuant to EPA's regulation, EPA provided LDEQ an opportunity to make a written submission responding to, rebutting, or denying the allegations raised in the Complaints. 40 C.F.R. §7.120(d)(1). LDEQ submitted a response dated June 20, 2022. LDEQ's response failed to provide a reason to dismiss either Complaint or for EPA to halt its fact finding, nor has the information or arguments provided served to diminish EPA's level of concern. It is beyond the scope of this letter to respond to each of the arguments raised by LDEQ in its response, however, EPA has undertaken to address a number of LDEQ's points in an effort to ensure the Agency's positions and rationales are clear to LDEQ.

2. Initial Disparate Impact Analysis – Industrial Corridor

a) Neutral Policy or Practice

As explained previously, *supra* at pages 11-12, LDEQ regulates air toxics and operates the Title V permit program in Louisiana.[147] A neutral practice need not be affirmatively undertaken, but in some instances could be the failure to take action, or to adopt an important policy.[148]

b) Adversity/Harm

Similar to the analysis with respect to Denka described in more detail above, *supra* at pages 21-29, EPA evaluated whether there are adverse impacts from LDEQ's air permitting decisions that are borne disproportionately by persons on the basis of race.

(1) Defining the Affected Population

As LDEQ explained, the Industrial Corridor is an identifiable area where Louisiana's industrial development is concentrated. In its response to the Complaint, LDEQ identified several business-related factors that make the area attractive for industry (*e.g.,* railroads, highways, access to process and cooling water, large supply of oil and natural gas, access to foreign and domestic markets).[149]

In 2014, the estimated cancer risks from air toxics for all residents in the Industrial Corridor was at or above the 100-in-1 million estimated lifetime cancer risk benchmark. In 2018, it was above the 1-in-1 million estimated cancer risk benchmark while also being more than twice the median cancer risk of Louisiana residents living elsewhere.

EPA also used RSEI, *supra* at pages 23-24. Creating trends using RSEI Scores[150] illustrates the change in potential risk for that grouping over time. The RSEI toxicity score for the Industrial Corridor was 104,978 in 2016 and 63,330 in 2020, demonstrating a downward trend. However, EPA found that residents of the Industrial Corridor had population-weighted averages of RSEI toxicity scores that were 12 times those of residents living elsewhere in the state in 2016 and they were still 11 times those of residents living elsewhere in the state in 2020.

Therefore, for purposes of this analysis, EPA treats those living within the Industrial Corridor as the affected group – both Black and non-Black, and analyzes whether adversities fall disparately on one of those populations. In addition, for both Parish-specific and Industrial Corridor-wide measures of potential disparities, EPA also compared Black residents living in the Parish and the Corridor adversely affected by LDEQ policies or practices, actions or inactions with individuals living in Louisiana but outside of the Industrial Corridor.

---

[147] Effective October 12, 1995, EPA approved Louisiana's Title V operating permit program. *See* 40 C.F.R. Part 70, Appendix A; 60 Fed. Reg. 47,296 (Sept. 12, 1995). LDEQ's approved Operating Permit Program is located at LAC Title 33: Part III. Chapter 5 ("Permit Procedures").
[148] *See EPA Title VI Toolkit*, https://www.epa.gov/sites/default/files/2017-01/documents/toolkit-chapter1-transmittal_letter-faqs.pdf.
[149] LDEQ Formosa Response, p. 11.
[150] RSEI Score is a unitless value that accounts for the size of the chemical release, the fate and transport of the chemical through the environment, the size and location of the exposed population, and the chemical's toxicity. The chemical releases data come from the Toxics Releases Inventory.

c) Disparity

Here again, the cancer risk from exposure to HAP emissions which appear to be due to LDEQ's policies or practices, actions or inactions, clearly fall "substantially disproportionately" on Black residents. As with the residents in St. John the Baptist who live nearest to the source of harmful pollution (Denka), so too the proposed Formosa site is in the census tract with the highest percentage of Black residents in all of St. James Parish.

As previously stated, *supra* at pages 30-32, in the context of a Title VI disparate impact analysis, a typical disparity measure involves a comparison between the proportion of persons in the protected class who are adversely affected by the challenged practice and the proportion of persons not in the protected class who are adversely affected.[151] Based on the data examined to date in the Industrial Corridor – those who are exposed to more HAPs and face greater cancer risk as a result of LDEQ's permitting decisions are disproportionately Black as compared to the population of non-Blacks impacted by LDEQ's policies or practices, actions or inactions, whether in the Corridor or anywhere else in the State.

Using other methodologies previously discussed, *supra* at pages 31-33, we see that, although overall, the residents of the Industrial Corridor are predominantly non-Black (58%)[152], the highest cancer risk falls disproportionately on the Black residents of the Industrial Corridor who make up only 42.5% of the population. For example, when conducting the Threshold Risk Ratio and Demographic Risk Ratio comparisons[153] using the five-year ACS for 2016-2020 we continue to see adverse disproportionate impacts on Black residents in the Industrial Corridor.

Disparities for the Threshold Risk Ratio and the Demographic Ratio greater than 1 are statistically significant.[154] The Threshold Risk Ratio indicates that Black Louisiana residents – although comprising only 33.5% of the state population,[155] were on average 1.59 times more likely to reside in the Industrial Corridor than non-Black residents during 2016-2020. The Demographic Ratio indicates for residents of the Industrial Corridor, the proportion of Black residents was 1.34 times the proportion of Black residents living elsewhere in Louisiana during this period. This means a resident in the Industrial Corridor is 1.34 times more likely to identify as Black than elsewhere in Louisiana. As Black residents within the Industrial Corridor comprise

---

[151] *Tsombanidis v. W. Haven Fire Dep't*, 352 F.3d 565, 576–77 (2d Cir. 2003).

[152] There are 744,293 people living in the Industrial Corridor, 316,084 of whom identified as Black (42.5%) and 428,209 who identified as a race other than Black (58%). Note that of the 3,920,323 people living outside of the Industrial Corridor, 1,244,598 identified as Black (31.7%) and 2,675,725 identified as a race other than Black (68%).

[153] These are comparable to ratio calculations used to evaluate disparate impact under employment discrimination laws, such as Title VII. Such ratios are often used to evaluate the proportion of persons of a particular race or ethnicity in a selection category relative to a comparison population. The Threshold Risk Ratio corresponds to a "hypergeometric" analysis, while the Demographic Ratio corresponds to a "binomial" analysis (also known as a "pools analysis") (Biddle, 1995).

[154] The Threshold Risk Ratio and Demographic Ratios are statistically significantly greater than 1, which is the value if there were not disparity between the affected and unaffected group. The statistical test conducted was the Fishers exact test, where the alternative hypothesis is that the odds ratio is greater than 1. The p-value is $<10e-50$, which is less than the statistical significance threshold used (alpha = 0.01).

[155] There are 4,664,616 people in Louisiana, 1,560,682 of whom identified as Black (33.5%) and 3,103,934 who identified as a race other than Black (66.5%).

a disproportionate portion of its population when compared to areas outside of the Industrial Corridor, this fact is critically important to the disparity analysis as related to adversity or harm, because, from the 2014 NATA through until the most recent 2018 AirToxScreen data, the average estimated lifetime cancer risk from air toxics for residents of the Industrial Corridor was more than twice the median cancer risk from air toxics faced by residents living in other parts of Louisiana.

To capture the extent to which residents of the Industrial Corridor face disparate cancer risks and live in tracts with higher RSEI scores, EPA also calculated Relative Risk Ratios using estimated cancer risks from air toxics from NATA/AirToxScreen and RSEI scores by census tract. The Relative Risk Ratios compare the average cancer risks or RSEI scores of Black residents in the Industrial Corridor, adjusted for the proportion of the population they represent, to the average cancer risks or RSEI scores of a comparison population. The comparison populations used are: (a) non-Black residents in the Industrial Corridor, adjusted for the proportion of the population they represent; and (B) all others living outside the Industrial Corridor.

Relative Risk Ratios examine differences in cancer risks for Black residents compared to other residents within the Industrial Corridor indicate that Black residents had population-weighted averages of cancer risks from air toxics 1.1 times those of non-Black residents within the Industrial Corridor in 2014. As of 2018, Black residents of the Industrial Corridor faced similar population-weighted averages of cancer risks from air toxics as non-Black residents of the Industrial Corridor.[156]

Further, RSEI toxicity scores also reveal disparities in risks from facilities reporting chemical releases to the Toxic Releases Inventory. When differences in RSEI toxicity scores across census tracts in the Industrial Corridor are combined with data on where residents of different races reside, EPA found residents of the Industrial Corridor have population-weighted averages of RSEI toxicity scores that were 12 times that for residents living elsewhere in the state in 2016. In 2020, they were still 11 times that of residents living elsewhere in the state. Within the Industrial Corridor, Black residents had population-weighted averages of RSEI toxicity scores that were 1.3 times those of non-Black residents in the Industrial Corridor in 2016. In 2020, they were 1.1 times those of non-Black residents in the Industrial Corridor.

As shown below, when reviewing estimated cancer risks from air toxics in the Industrial Corridor it is apparent that while all residents of the Industrial Corridor faced increased risks, the burden seems to fall disproportionately on Black residents of the Industrial Corridor.

The estimated cancer risk from air toxics in the Industrial Corridor, which is the average of cancer risks of all census tracts that make up the Corridor, was:

- 100-in-1 million in 2014,
- 70-in-1 million in 2017, and

[156] Relative risk measures are calculated as the ratio of population-weighted cancer risks across census tracts for Black residents within the Industrial relative to a comparison group using information on cancer risk from the National Air Toxics Assessment (NATA; 2014), AirToxScreen (2017-2018) and population totals from the American Community Survey, 5-year estimates, 2015-2019. EPA could not use the most recent American Community Survey, 5-year estimate data (2016-2020) due to changes in tract definitions.

- 70-in-1 million in 2018.

The average estimated cancer risks from air toxics were at or above 100 in 1 million for all census tracts that make up the following Parishes:

- 2014:
  - St John the Baptist was 400-in-1 million (four times the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime) and 58% of the population identified as Black;
  - Iberville Parish was 110-in-1 million and 49% of the population identified as Black; and
  - St Charles Parish was 140-in-1 million and 27% of the population identified as Black.
- 2017:
  - Iberville Parish was 100-in-1 million; and
  - St John the Baptist was 200-in-1 million (twice the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime).
- 2018:
  - St. John the Baptist Parish was 120-in-1 million.

In 2014 NATA, 31 of the 1,128 Louisiana census tracts[157] have estimated cancer risks from air toxics at or above 100-in-1 million of which:

- 29 are in five of the seven Parishes that comprise the Industrial Corridor.[158]
- 20 had populations that are more than the 33.5% general Black population of the State.
- 12 had populations greater than 50% Black.

While 14 Louisiana census tracts, all in Industrial Corridor Parishes, had estimated cancer risks from air toxics at or above 200-in-1 million (twice the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime) of which:

- 11 had populations that are more than the 33.5% general Black population of the State.
- 7 had populations greater than 50% Black.

In 2014, the five census tracts with the highest estimated cancer risk from air toxics in Louisiana were all within the Industrial Corridor:

- tract 708 in St. John the Baptist Parish with 1,500-in-1 million (15 times the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime),
- tract 601 in St. Charles Parish with 800-in-1 million (8 times the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime),
- tract 709 in St John the Baptist Parish with 620-in-1 million (more than 6 times the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime),
- tract 707 in St. John the Baptist Parish with 510-in-1 million (more than 5 times the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime), and

---

[157] U.S. Census Bureau, https://www.census.gov/geographies/reference-files/2010/geo/state-local-geo-guides-2010/louisiana.html#:~:text=There%20are%201%2C148%20census%20tracts,204%2C447%20census%20blocks%20in%20Louisiana.

[158] St. John the Baptist, St. James, East Baton Rouge, West Baton Rouge, Iberville, St. Charles, and Ascension Parishes.

- tract 710 in St. John the Baptist Parish with 490-in-1 million (more than 4 times the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime).

The 2017 AirToxScreen showed 20 of the 1,128 Louisiana census tracts with estimated cancer risks from air toxics cancer risks at or above 100-in-1 million – 18 of which are in the Industrial Corridor and:

- 13 have populations that are more than the 33.5% general Black population of the State.
- 9 have populations greater than 50% Black.

A total of 10 Louisiana census tracts had estimated cancer risks from air toxics at or above 200 in a million (twice the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime):

- 6 have populations that are more than the 33.5% general Black population of the State.
- 5 have populations greater than 50% Black.
- 9 of the 10 census tracts are in three of the seven Parishes that comprise the Industrial Corridor, St. John the Baptist, St. Charles and Iberville parishes.

In 2017, the three census tracts with the highest estimated cancer risk from air toxics in Louisiana were all in St. John the Baptist Parish:

- tract 708 with 1,000-in-1 million (10 times the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime),
- tract 707 with 300-in-1 million (3 times the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime), and
- tract 705 with 300-in-1 million (3 times the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime).

The 2018 AirToxScreen data showed, of the 1,128 Louisiana census tracts with estimated cancer risks from air toxics, 14 tracts, all of which are in the Industrial Corridor, had risks at or above 100-in-1 million:

- 9 have populations that are more than the 33% general Black population of the State.
- 7 have greater than 50% Black populations.
- All five census tracts are in two of the seven Parishes that comprise the Industrial Corridor, St. John the Baptist.

In 2018, the highest estimated cancer risk from air toxics in Louisiana is 400-in-1 million (4 times the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime) in tract 708 in St. John the Baptist Parish. The four remaining tracts have an estimated cancer risk of 200-in-1 million (twice the upper bound of acceptability for estimated excess cancer risk over a 70-year lifetime) -- tracts 601 and 625 in St Charles Parish and tracts 707 and 709 in St John the Baptist Parish.

As LDEQ indicated in its response to the Formosa Title VI complaint, a number of "business-related factors make the Lower Mississippi River Corridor in Louisiana an attractive area for industry."[147] This statement is evident from an analysis of the 100 census tracts in Louisiana with the highest estimated cancer risks from air toxics; for 2014 all but 12 of the 100 were in the Industrial Corridor and for 2018 all but one of the 100 were in the Industrial Corridor.

Based on the 2016-2020 ACS data, the percentage of Blacks in the total population of the Industrial Corridor (42.5%) is higher than that of Blacks in the state's general population (33.5%). Also, a higher proportion of Louisiana's Black population (20.3%) lives in the Industrial Corridor as compared to the proportion of Louisiana's White population (13.6%). Moreover, as the above analysis of the census tracts within Louisiana suggests, the census tracts with the highest cancer risks from air toxics include those within the Industrial Corridor, which include census tracts with a high percentage of Black population. Therefore, EPA has reason to believe that the cancer risk from air toxics is disproportionately felt by the Black population.

d) Causation

It appears LDEQ's action and inaction in administering its air permitting program has allowed emissions from facilities in the Industrial Corridor to result in concentrations of air toxics as well as the distribution of associated cancer risks in the Industrial Corridor as described above and that Black residents of the Industrial Corridor are disproportionately impacted by LDEQ's actions and inactions.

3. Initial Disparate Impact Analysis – Proposed Formosa Facility

a) *Background*

On August 5, 2021, LDEQ reaffirmed the issuance of a Prevention of Significant Deterioration (PSD) construction permit and 14 Title V operating permits for the proposed Formosa facility. The proposed facility will be located in a predominantly industrial and agricultural area[159] on the west bank of the Mississippi River in St. James Parish near the unincorporated community of Welcome. According to Formosa, its "operational units will be 300 feet or more from the Formosa property boundary." [160] The communities closest to the Formosa site are Welcome and St. James.[161] "Welcome is a small community and has a 99% minority population, 87% of whom identify as Black."[162] According to Formosa, the closest residents and the nearest schools (St. James' Fifth Ward Elementary School and St. Louis Academy) are "over a mile away."[163]

The property and adjoining areas have been in agricultural use for decades, primarily in sugar cane production.[164] LDEQ identified Mosaic Fertilizer and American Styrenics plants as located in close proximity[165] to Formosa with eight other industrial facilities nearby in St. James Parish.[166]

[159] Formosa Prevention of Significant Deterioration Permit Application, Environmental Assessment Statement (EAS) July 19, 2018, p. 5, available at https://edms.deq.louisiana.gov/app/doc/view?doc=11230529.
[160] Formosa EAS July 19, 2018, p. 5.
[161] *Rise St. James, et.al. v. Louisiana Department of Environmental Quality*, 19th Judicial District Court Parish Of East Baton Rouge Docket Number: 694,029, Sept. 8. 2022 (*Rise*), pp. 16-17.
[162] *Rise*, p. 2.
[163] Formosa EAS July 19, 2018, pp. 7 and 39.
[164] Formosa EAS July 19, 2018, p. 5.
[165] Formosa EAS July 19, 2018, p. 5.
[166] Nucor Steel Louisiana, LLC; Zen-Noh Grain Corporation; Sunshine West Industrial Park; Coastal Bridge Company (Asphalt Plant); Marathon Pipe Line LLC (St. James Capline Station); NuStar Logistics, LP (St. James

Formosa will emit more than 3,800 tons per year of HAPs and Louisiana toxic air pollutants (TAPs) (*e.g.,* ethylene oxide, acetaldehyde, benzene, 1, 3 - butadiene, ethylene glycol, formaldehyde, n-hexane, and vinyl acetate).[167] The chemical of most concern in the Complaint is ethylene oxide (EtO). The permitted limit for EtO from Formosa is 7.7 tons per year, which would make it, based on a preliminary analysis of TRI data, the only EtO emitter in St. James Parish.

EPA lists EtO as a known carcinogen[168] and LDEQ lists it as a "known and probable human carcinogen."[169] The court in *Rise* found that "LDEQ's regulations contain a limit on airborne concentrations for ethylene oxide of 1.0 ug/m^3, but . . . this standard (or limit) has not been updated in 25 years and is 50 times less protective than the EPA limit."[170]

EPA's knowledge about EtO has changed over time. In December 2016, EPA updated the IRIS assessment for EtO. The updated inhalation unit risk incorporates new studies and reflects EPA's updated understanding that EtO is 60 times more toxic than the previous estimate. This includes the fact that children are more sensitive to EtO than adults.[171] This is because ethylene oxide can damage DNA, and growing children are more susceptible to DNA damage because their cells divide more rapidly than adults.[172] As with chloroprene, EPA recommends the application of ADAFs as described above in accordance with the EPA's *Supplemental Guidance* [173] for exposure scenarios that include early-life exposures.[174] The contribution to lifetime cancer risk from a single year of exposure to ethylene oxide is greater if that year occurred during childhood. [175]

In August 2020, EPA published revised regulations for Miscellaneous Organic Chemical Manufacturing facilities that require additional controls on certain equipment and processes that emit EtO in order to reduce risk to surrounding communities.[176] The proposed Formosa facility will be subject to several National Emission Standards for Organic Hazardous Air Pollutants

---

Terminal); Air Products and Chemicals, Inc. (Convent Facility); and Equilon Enterprises LLC. Formosa Basis For Decision (BFD), January 6, 2020, p. 15, available at https://edms.deq.louisiana.gov/app/doc/view?doc=11998452.

[167] Formosa BFD, at 4-5; Formosa EAS July 19, 2018, p. 8.

[168] U.S. EPA, *Evaluation of the Inhalation Carcinogenicity of Ethylene Oxide, Executive Summary* (CASRN 75-21-8) *In Support of Summary Information on the Integrated Risk Information System (IRIS)*, December 2016, p.8.

[169] LAC Title 33: Part III. Section 5112, Table 51.1.

[170] *Rise*, p. 19, *see,* LAC Title 33: Part III. Section 5112, Table 51.1.

[171] U.S. EPA, *Frequent Questions about Ethylene Oxide (EtO)* (https://www.epa.gov/hazardous-air-pollutants-ethylene-oxide/frequent-questions-about-ethylene-oxide-eto).

[172] *Id.*

[173] U.S. EPA, *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens*, (Mar. 2005).

[174] U.S. EPA, *Evaluation of the Inhalation Carcinogenicity of Ethylene Oxide, Executive Summary* (CASRN 75-21-8) *In Support of Summary Information on the Integrated Risk Information System (IRIS)*, December 2016, p. 8, note c.

[175] U.S. EPA, *Frequent Questions about Ethylene Oxide (EtO)*, https://www.epa.gov/hazardous-air-pollutants-ethylene-oxide/frequent-questions-about-ethylene-oxide-eto.

[176] *Id.*

(NESHAPS)[177] some of which are undergoing revision. For example, in August 2020, EPA published revised regulations for Miscellaneous Organic Chemical Manufacturing facilities that require additional controls on certain equipment and processes that emit EtO in order to reduce risk to surrounding communities. Formosa will be subject to the NESHAP provisions as outlined in any compliance deadline/applicability conditions of the NESHAP itself even if it is not currently listed as a requirement in the permits.

b) Status of Formosa Permits

On September 16, 2019, RISE St. James, Louisiana Bucket Brigade, Sierra Club, Center for Biological Diversity, Healthy Gulf, Earthworks, No Waste Louisiana, and 350 New Orleans petitioned EPA to object to LDEQ's draft Title V air operating permits for Formosa. The Title V petition is still pending. As noted above, a Louisiana state court has vacated those permits and the PSD permit issued by LDEQ, and remanded them to LDEQ, and LDEQ has appealed that decision.

c) Neutral Policy or Practice

EPA's regulation prohibits LDEQ from administering its air pollution control program in a way that has the effect of subjecting the residents of St. James Parish living near the proposed Formosa facility to discrimination on the basis of race.[178] As previously stated, a neutral practice need not be affirmatively undertaken, but in some instances could be the failure to take action or to adopt an important policy.[179] During its initial fact finding, EPA found that, although the Industrial Corridor and the demographic characteristics of both the Industrial Corridor as a whole and those living in closest proximity to certain sources clearly present significant risks, LDEQ failed to consider the potential for adverse and disproportionate impacts and did not take steps to ensure that its analysis of such was accurate and complete.

(1) Title VI and Environmental Justice Analyses

The Title VI Complaint alleged that LDEQ had no "procedure or policy for addressing disproportionate impacts of its air permitting decisions on predominantly Black communities."[180]

---

[177] Some of these include the following 40 C.F.R. Part 63 Subparts: F - National Emission Standards for Organic Hazardous Air Pollutants From the Synthetic Organic Chemical Manufacturing Industry; G - National Emission Standards for Organic Hazardous Air Pollutants From the Synthetic Organic Chemical Manufacturing Industry for Process Vents, Storage Vessels, Transfer Operations, and Wastewater; H - National Emission Standards for Organic Hazardous Air Pollutants for Equipment Leaks; FFFF- Miscellaneous Organic Chemical Manufacturing.

[178] 40 C.F.R. Part 7 §§ 7.30 and 7.35

[179] *See, e.g., United States v. Maricopa Cty*, 915 F. Supp. 2d 1073, 1079 (D. Ariz. 2012) (disparate impact violation based on national origin properly alleged where recipient "failed to develop and implement policies and practices to ensure [limited English proficient] Latino inmates have equal access to jail services" and discriminatory conduct of detention officers was facilitated by "broad, unfettered discretion and lack of training and oversight" resulting in denial of access to important services). *See also*, *EPA Title VI Toolkit*, https://www.epa.gov/sites/default/files/2017-01/documents/toolkit-chapter1-transmittal_letter-faqs.pdf.

[180] Title VI Complaint dated February 1, 2022, from Lisa Jordan, Tulane Environmental Law Clinic, to Lilian Dorka, Director, External Civil Rights Compliance Office, *Re: Complaint Under Title VI of the Civil Rights Act of*

Whether to consider environmental justice (EJ) in the decision-making process for an air pollution control permit is left to LDEQ's discretion.[181] LDEQ exercised that discretion for the Formosa permits. The Basis for Decision (BFD) documents prepared to support the issuance of the Formosa permits included discussions of LDEQ's EJ analyses and an assertion that the permitting of the facility would not violate Title VI.[182]

In its response to the complaint, LDEQ denied that it lacks procedure or policy for addressing disproportionate impacts of its air permitting decisions on predominantly Black communities. The support LDEQ provided for this statement is that its "Air-permitting decisions are made in accordance with federally promulgated emission control standards that EPA has delegated to the State of Louisiana."[183] As explained previously, compliance with environmental laws does not necessarily ensure compliance with Title VI or other federal nondiscrimination obligations. EPA was unable to find any published policies, guidance, criteria, or procedures regarding when and how LDEQ conducts EJ analyses or its Title VI analyses nor did LDEQ provide any. Instead, LDEQ's response to the Complaint provides a history of environmental justice initiatives in the 1990s in Louisiana and a multi-page discussion of the history of EPA's policy regarding Title VI and the NAAQS. This same discussion of the history of EPA's policy comprises about half of the 8-page Environmental Justice/Civil Rights Title VI Issues section of the first BFD for the Formosa permits. [184]

LDEQ further stated that it "has an internal environmental equity work group that meets regularly to discuss environmental justice and equity-related matters . . . which serves as "resource to identify potential concerns and provide feedback and recommendations to the LDEQ Secretary."[185] LDEQ concludes by stating it "believes its environmental justice best practices are adequate, are based on years of independent study, and follow EPA guidance."[186]

1964, 42 U.S.C. § 2000d, and 40 C.F.R. Part 7 against the Louisiana Department of Environmental Quality for Lack of Environmental Justice Procedures in its Air Permitting Program and Resulting Discriminatory Decision on Formosa Air Permits, p. 1.

[181] *Rise*, p. 23. The Court in *Rise* stated that the scope of the Louisiana Constitutional public trust doctrine, as interpreted by the Louisiana Supreme Court, requires that agencies determine "before granting approval of proposed action affecting the environment, [] that adverse environmental impacts have been minimized or avoided as much as possible consistently with the public welfare." *Rise* at 12, citing *Save Ourselves, Inc. v. La. Env't Control Comm'n*, 452 So.2d 1152, 1157 (La. 1984). Based on the facts before the Court in *Rise*, the Court found that, "an environmental justice analysis was mandatory under the constitutional provisions and *Save Ourselves*." *Rise* at p. 23

[182] *See*, Louisiana Department of Environmental Quality, Office of Environmental Services, *Basis for Decision Part 70 Operating Permit Nos. 3141-V0, 3142-V0, 3143-V0, 3144-V0, 3145-V0, 3146-V0, 3147-V0, 3148-Vo, 3149-V0, 3150-V0, 3151-V0, 3152-V0, 3153-V0, And 3154-V0 Prevention of Significant Deterioration (PSD) Permit PSD-LA-812 FG LA Complex, FG LA LLC, Welcome, St. James Parish, Louisiana, Agency Interest (Ai) No. 198351*, January 6, 2020; and *Supplement to the Basis For Decision, Part 70 Operating Permit Nos. 3141-V0, 3142-V0, 3143-V0, 3144-V0, 31 45-V0, 3146-V0, 3147-V0, 3148-V0, 3149-V0, 31150-V0, 3151-V0, 3152-V0, 31 53-V0, And 3154-V0 Prevention of Significant Deterioration (PSD) Permit PSD-LA-8 12 FG LA Complex FG LA LLC, Welcome, St. James Parish, Louisiana, Agency Interest (AI) No. 198351*, August 5, 2021.

[183] LDEQ Formosa Response, p. 4.

[184] Louisiana Department of Environmental Quality, Office of Environmental Services, *Basis for Decision Part 70 Operating Permit Nos. 3141-V0, 3142-V0, 3143-V0, 3144-V0, 3145-V0, 3146-V0, 3147-V0, 3148-Vo, 3149-V0, 3150-V0, 3151-V0, 3152-V0, 3153-V0, And 3154-V0 Prevention of Significant Deterioration (PSD) Permit PSD-LA-812 FG LA Complex, FG LA LLC, Welcome, St. James Parish, Louisiana, Agency Interest (Ai) No. 198351*, January 6, 2020, p. 35.

[185] LDEQ Formosa Response, p. 9.

[186] *Id.*

None of these statements is a written policy or procedure, much less a best practice that provides guidance to LDEQ staff on when and how to conduct either an EJ analysis or an appropriate analysis to evaluate Title VI compliance.

EPA's review of the "Environmental Justice/Civil Rights Title VI Issues" discussions in the two Formosa BFD documents[187] raises concerns about whether LDEQ is considering all relevant possibilities for adverse disproportionate impacts before making critical permitting decisions. The EJ and Title VI Issues section is a total of eight pages, four of which review the history of EPA's policy regarding Title VI and the NAAQS.[188] Only about two pages are focused on LDEQ's analysis, which mostly consisted of data showing apparent reductions over time in reported criteria pollutant emissions, TAP emissions, and TRI releases in St. James Parish and/or within a 5-mile radius of the proposed Formosa facility.[189]

LDEQ concludes the analysis by finding that, because the area is sparely populated and EJSCREEN showed no one living within a one-mile radius from the center of the proposed facility, there would be no "fenceline" community impacted. Yet, this conclusion is clearly contradicted by the exhibits attached to the permit. The maps provided by Formosa as Exhibits D and E in its EIS show that the school is about 1.02 miles from the fenceline near the proposed ethylene glycol plants which are sources of EtO emissions and that residential streets across the river in Union are closer than one mile.[190]

In sum, LDEQ concludes that the air pollution is less than it was years ago; there will be compliance with the federal National Ambient Air Quality Standards (NAAQS) health-based air standards; and the EtO emissions from Formosa will drop below 0.02 $\mu g/m^3$ concentration just shy of the school and nearby residences. There is no discussion in the EJ and Title VI section about the amount of TRI releases, emissions or baseline concentrations of pollutants currently in the area. While reducing pollution levels is desirable, the fact that there are emissions reductions does not mean there are no adverse impacts. The Denka monitoring results described above are evidence of that.

The court in *Rise* observed that—despite knowing the area near the proposed facility already experiences substantial amounts of toxic air pollutants and that cancer risk in Welcome's census tract is driven by ethylene oxide and benzene exposure—LDEQ did not consider this information

[187] Louisiana Department of Environmental Quality, Office of Environmental Services, *Basis for Decision Part 70 Operating Permit Nos. 3141-V0, 3142-V0, 3143-V0, 3144-V0, 3145-V0, 3146-V0, 3147-V0, 3148-Vo, 3149-V0, 3150-V0, 3151-V0, 3152-V0, 3153-V0, And 3154-V0 Prevention of Significant Deterioration (PSD) Permit PSD-LA-812 FG LA Complex, FG LA LLC, Welcome, St. James Parish, Louisiana, Agency Interest (Ai) No. 198351*, January 6, 2020 and Supplement to the Basis For Decision, Part 70 Operating Permit Nos. 3141-V0, 3142-V0, 3143-V0, 3144-V0, 31 45-V0, 3146-V0, 3147-V0, 3148-V0, 3149-V0, 31150-V0, 3151-V0, 3152-V0, 31 53-V0, And 3154-V0 Prevention of Significant Deterioration (PSD) Permit PSD-LA-8 12 FG LA Complex FG LA LLC, Welcome, St. James Parish, Louisiana, Agency Interest (AI) No. 198351, August 5, 2021.

[188] Louisiana Department of Environmental Quality, Office of Environmental Services, *Basis for Decision Part 70 Operating Permit Nos. 3141-V0, 3142-V0, 3143-V0, 3144-V0, 3145-V0, 3146-V0, 3147-V0, 3148-Vo, 3149-V0, 3150-V0, 3151-V0, 3152-V0, 3153-V0, And 3154-V0 Prevention of Significant Deterioration (PSD) Permit PSD-LA-812 FG LA Complex, FG LA LLC, Welcome, St. James Parish, Louisiana, Agency Interest (Ai) No. 198351*, January 6, 2020, pp. 36-39.

[189] *Id.* at pp. 40-41.

[190] Formosa EIS, exhibits D and E.

when issuing the permits that would allow Formosa "to emit a great deal more ethylene oxide and benzene."[191] In addition, the absence of written policies and criteria may result in inconsistent treatment of data of disproportionate health effects and ad hoc analyses. Based on this information, EPA believes LDEQ's analysis is too flawed in design and implementation to rely upon for Title VI compliance purposes.

This lack of written policies and/or procedures or potentially a misunderstanding or misapplication of guidance that was not provided to EPA in its response to the Complaint resulted in a permitting process the court in *Rise* characterized as arbitrary and capricious on numerous grounds.[192] "An arbitrary decision shows disregard of evidence or the proper weight thereof while a capricious decision has no substantial evidence to support it or the conclusion is contrary to substantiated competent evidence."[193] In addition, the court in *Rise* found that LDEQ had no support in the record for some of its conclusions.

d) Adversity/Harm

As mentioned earlier, in 2014 NATA, the cancer risk from air toxics for Louisiana was approximately 50-in-1 million and the median score was approximately 40-in-1 million. *See supra* at pages 46-47. St. James Parish had a cancer risk from air toxics of 80-in-1 million. Census tract 404 and 405 both had cancer risks of 70-in-1 million respectively. The 2018 AirToxScreen indicates that one of the air toxics responsible for the cancer risk in St. James Parish is EtO. EPA is not stating in this letter that the projected EtO emissions from Formosa are per se adverse. Given, however, the underlying environmental conditions and demographic characteristics of those most potentially impacted in the Industrial Corridor as a whole, and St. James Parish in particular, LDEQ's failure to do a proper analysis of the impacts, from a civil rights perspective, is concerning.

e) Disparity

Using the 2016 – 2020 ACS data, the population of St. James Parish is 49.9% Black and 48.1% White. The proposed Formosa facility will be located in census tract 405 which covers a large area of land. The population centers are along the Mississippi River. For census tract 405, 93.3% of the population identifies as Black and 5.7% as White. Directly across the River is census tract 404 which also includes a large area of land. As with census tract 405, the population centers are clustered near the river, directly across from the proposed location of the Formosa facility. Sixty-five percent (65%) of the population of census tract 404 identified as Black and 33.5% as White. The proposed Formosa site is in the census tract with the highest percentage of Black residents in all of St. James Parish. Using any comparison and test for statistical significance, those who would live near Formosa disproportionately identify as Black.

As discussed above, *supra* at pages 15-16, individuals exposed to mutagenic carcinogens starting in early-life as infants and children are understood to be more susceptible than individuals exposed only as adults. EPA's initial fact finding indicates that many residents living near the

---

[191] *Rise*, pp. 16-17.
[192] *Rise St. James, et.al. v. Louisiana Department of Environmental Quality*, 19th Judicial District Court Parish Of East Baton Rouge Docket Number: 694,029, Sept. 8. 2022
[193] *Rise*, at p. 4 quoting *Carpenter v. State, Dep 't of Health & Hosps.*, 2005-1904 (La. App. 1 Cir. 9/20/06); 944 So.2d 604, 612 (internal quotations and citations omitted).

location of the proposed Formosa facility have in the past on average been exposed to levels of air pollution that, while below the 100-in-1-million upper bound increased lifetime cancer risk, were still above EPA's preferred 1-in-1 million cancer risk benchmark. Moreover, census data indicates that many of the residents in the communities near the proposed Formosa site have lived in their homes for a while. Further, the proposed Formosa site is in a census tract where 90% of residents identify as Black which is disproportionate as compared to the Parish and State populations.

The *Rise* court found that LDEQ failed to analyze Formosa's ethylene oxide and benzene emissions in combination with such emissions from other facilities and only analyzed data about the proposed Formosa facility.[194] The *Rise* court further observed that "LDEQ cannot determine Welcome's full risk for cancer from exposure to toxic air pollutants if the agency does not consider [Formosa's] FG LA's ethylene oxide and benzene emissions in combination with such emissions from other facilities that the agency itself says drives EPA's cancer risk data for the area."[195] EPA agrees.

f) Causation

From a civil rights perspective, it appears LDEQ's action and inaction in administering its air permitting program with respect to the Formosa permits has proceeded without appropriate consideration of the factors which would be relevant to a Title VI analysis. Given the apparent existing disparities outlined in this Letter, EPA remains concerned that such a failure does not take into account the distribution of associated cancer risks in St. James Parish.

V. CONCLUSION

While emissions of air toxics have decreased in the Industrial Corridor Parishes, in some cases dramatically, many of the Black residents living near Denka, near the proposed Formosa facility, and elsewhere in the Industrial Corridor were born there, spent their childhoods there, and continue to live there. The vulnerabilities they carry because of past exposures do not go away because concentrations of air pollution have decreased. Critically, based on the data EPA has reviewed thus far, Black residents of the Industrial Corridor Parishes continue to bear disproportionate elevated risks of developing cancer from exposure to current levels of toxic air pollution.

Moreover, it is important that LDEQ and LDH provide those residents whose health and lives will be impacted by LDEQ and LDH decisions timely, complete, and accurate information related to those decisions. Without this information, residents are not able to make informed decisions about their health and lives, nor are local government officials. As explained in the Denka and Formosa discussions above, the failure to seek out, consider or analyze available information and data about health risks appears to have formed the basis for actions and/or

[194] *Rise*, p. 17.
[195] *Rise*, p. 18.

inactions by both LDEQ and LDH that may be subjecting Black residents of Louisiana to adverse disparate impacts.

We appreciate your cooperation in this matter and look forward to our continued collaboration with LDEQ and LDH as we work together to resolve these Complaints in a timely and effective manner. Please feel free to contact me at dorka.lilian@epa.gov, or (202) 564-9649.

Sincerely,

Lilian S. Dorka
Deputy Assistant Administrator
for External Civil Rights

Cc: Ariadne Goerke
Deputy Associate General Counsel
Civil Rights & Finance Law Office

Helena Wooden-Aguilar
Acting Deputy Regional Administrator
Acting Deputy Civil Rights Official
US EPA Region 6

James McGuire
Regional Counsel
US EPA Region 6

Emma Cheuse
Senior Attorney
Earthjustice
1001 G Street, N.W. Suite 1000
Washington, DC 20001
echeuse@earthjustice.org

Deena Tumeh
Associate Attorney
Earthjustice
1001 G Street NW, Suite 1000
Washington, DC 20001
dtumeh@earthjustice.org

Dorian Spence
Vice President of Strategy & Programs
Lawyers' Committee for Civil Rights Under Law
1500 K Street NW, Suite 900
Washington, DC 20005
dspence@lawyerscommittee.org

Lisa Jordan
Director, Tulane Environmental Law Clinic
Clinical Professor of Law
6329 Freret Street
New Orleans, LA 70118
lwjordan@tulane.edu

Environmental Challenges 10 (2023) 100672

Contents lists available at ScienceDirect

Environmental Challenges

journal homepage: www.elsevier.com/locate/envc

Discriminatory outcomes of industrial air permitting in Louisiana, United States

Kimberly A. Terrell[a,b,c,*], Gianna St. Julien[a]

[a] Tulane Environmental Law Clinic, Tulane University, 6329 Freret St., New Orleans, LA70118, United States
[b] School of Renewable Natural Resources, Louisiana State University, Baton Rouge, LA 70808, United States
[c] Department of Biological Sciences, University of Memphis, 3774 Walker Ave, Memphis, TN 38111, United States

ARTICLE INFO

Keywords:
Environmental justice
Cancer Alley
Environmental policy
Environmental racism
Emissions
Criteria pollutants

ABSTRACT

Overwhelming evidence indicates that communities of Color in the United States are disproportionately harmed by pollution. Yet, state environmental regulators, who permit industrial polluters under the U.S. Clean Air Act, do not universally recognize these disparities. In Louisiana, regulators have denied the existence of pollution disparities and have suggested that infrastructure explains why heavy industry is concentrated in certain neighborhoods. We used a multi-part approach to determine if there is a racial disparity in Louisiana's industrial emissions and, if so, whether infrastructure or state permitting drives this disparity. First, we evaluated race (% people of Color) among census tracts with industrial facilities relative to reported emissions of criteria pollutants from 2019-2021 using a quartile analysis and a linear model that accounted for spatial clustering of facilities. Second, we tested whether census tracts with infrastructure variables have higher-than-average populations of Color using one sample T-tests. Infrastructure variables included petrochemical pipelines, railways, ports, lower Mississippi River access, and a high proportion of the workforce in manufacturing. We found that over half (378 of 671) of Louisiana's industrial facilities were spatially clustered along a 184-mile, winding stretch of the lower Mississippi River known as "Cancer Alley." Overall, communities of Color had 7-fold to 21-fold higher emissions, depending on the pollutant, than predominantly White communities. Among industry subsectors, Chemical Manufacturing was the largest single contributor to emissions in communities of Color. Census tracts with industrial infrastructure were, on average, racially similar to Louisiana overall (absolute difference, <7% people of Color). Collectively, our findings reveal a stark racial disparity in industrial emissions that is driven by state permitting, particularly of chemical manufacturers, rather than by infrastructure or labor supply. Immediate action is needed to address the discriminatory outcomes of industrial permitting in Louisiana, and future research should focus on the role of state permitting in environmental injustice more broadly.

1. Introduction

Decades of research have firmly established that racial minorities and low-income populations in the United States are disproportionately harmed by pollution (Evans and Kantrowitz, 2002; Liu et al., 2021; e.g., United Church of Christ Commission for Racial Justice, 1987). This nationwide disparity has persisted over time (Kravitz-Wirtz et al., 2016; Colmer et al., 2020), and is part of a larger global pattern of environmental inequalities (reviewed in Hajat et al., 2015; Hamann et al., 2018; Rigolon et al., 2018). Yet, relatively few studies examine the underlying drivers of pollution disparities, particularly from a regulatory perspective. In the United States, the primary authority for environmental regulation is the U.S. Environmental Protection Agency (EPA). Like all U.S. federal agencies, EPA is mandated to "make achieving environmental justice part of its mission" (*Executive Order 12898*, 1994). Under EPA's definition, environmental justice requires that "no group of people, including a racial, ethnic or a socioeconomic group, should bear a disproportionate share of the negative environmental consequences from industrial, municipal and commercial operations or the execution of federal, state, local and tribal programs and policies" (U.S. EPA, 2022a). This definition relies on disproportionate outcomes, rather than discriminatory intent. Accordingly, EPA regulations prohibit practices that "have a discriminatory effect," even if those practices are "neutral on their face" (U.S. EPA, 2017).

The EPA delegates many of its authorities to state environmental agencies, including the permitting and compliance of industrial operations under the U.S. Clean Air Act (42 U.S. Code § 7411). This delegation means that some U.S. residents are afforded more stringent protections

* Corresponding author.
E-mail address: kterrell1@tulane.edu (K.A. Terrell).

https://doi.org/10.1016/j.envc.2022.100672
Received 7 October 2022; Received in revised form 22 December 2022; Accepted 26 December 2022

than other residents, as a result of different practices and regulations among states. For example, Massachusetts (310 CMR 7 app C) and New Hampshire (N.H. Code Admin. R. Env-A 101.115) have a more protective, 50 ton-per-year threshold for classification as a "major source" of volatile organic compounds (VOCs) under the Clean Air Act, while Louisiana (La. Admin. Code, tit. 33, § III-509) and Mississippi (11 Miss. Code. R. § 2-6.1) use the default, federally-mandated 100 ton-per-year threshold (40 C.F.R. § 52.21). A less protective threshold translates to higher emissions, because the Clean Air Act requires major sources to employ pollution control technologies (40 C.F.R. § 52.21). Notably, the more protective states in this example are overwhelmingly White (80 – 93%), while the less protective states have large proportions (38 – 41%) of Black, Hispanic, and other historically-marginalized groups (U.S. Census Bureau, 2022a). Clearly, U.S. state regulatory agencies play a central role in environmental justice, with the potential to create, perpetuate, exacerbate, reduce, or eliminate disparities in pollution exposure.

The relevance of pollution research to state environmental regulation is determined, in part, by the geographic scale and type of pollution sources evaluated. Most studies of pollution disparities in the U.S. are either nationwide (e.g., Tessum et al., 2021; Liu et al., 2021; Ash and Boyce, 2018) or highly localized (e.g., Nagra et al., 2021), with less research focused on individual states (but see, e.g., Lee and Park, 2020). This research gap means that state regulators can acknowledge the existence of nationwide pollution disparities while also claiming that systemic disparities do not occur in their state, akin to the principle of ecological fallacy in epidemiology (Selvin, 1958). Additionally, many pollution studies in the U.S. focus on ambient concentrations of pollutants from all sources (e.g., Liu et al., 2021; Colmer et al., 2020), as opposed to regulated sources (but see, e.g., Tessum et al., 2021; Ash and Boyce, 2018). This broader focus leaves open the possibility that non-regulated sources (e.g. agricultural burning or urbanization) are driving pollution disparities. Such opportunities for disconnect between research and regulation may partially explain why racial disparities in pollution exposure have persisted for decades in the U.S., despite overall improvements in air quality (Colmer et al., 2020; Liu et al., 2021). In the absence of state-specific evidence of pollution disparities from regulated sources, federal protections aimed at promoting environmental justice may have diminished impact, particularly in states with less protective environmental regulations.

Louisiana is a heavily industrialized state that is internationally recognized for longstanding allegations of environmental racism and regulatory capture (Achiume et al., 2021; Berry, 2003; Davies, 2018; Keehan, 2018; Maraniss and Weisskopf, 1988). There is ample evidence that Louisiana is overburdened with pollution: more tons of toxic air pollution are released annually from its industrial facilities compared to any other U.S. state (U.S. EPA, 2022b); the estimated risks of cancer and respiratory disease from point sources of toxic air pollution are more than triple the U.S. average (U.S. EPA, 2022c); and toxc air pollution contributes to the state's exceptionally high overall cancer rate (Terrell and Julien, 2022). There do not appear to be any peer-reviewed studies of racial disparities in Louisiana's industrial emissions, though there are a few related studies. Perera and Lam found that industrial facilities in a few southeast Louisiana parishes are clustered in low-income/minority communities (Perera and Lam, 2013), but the authors did not quantify emissions or include other heavily industrialized parts of the state (e.g. Lake Charles). James et al. found that low-income/Black communities in southeast Louisiana were overburdened with toxic air pollution from all sources combined using 2005 data (James et al., 2012), which leaves open the possibility that the disparity was driven by non-regulated sources (e.g. urbanization) and/or was eliminated by subsequent air quality improvements (U.S. EPA, 2022d). Finally, Terrell and James reported that Black communities across Louisiana are disproportionately impacted by fine particulate matter (PM2.5) from all sources combined (Terrell and James, 2020), which could be driven by urbanization. The authors also reported a correlation between race and estimated health hazards from point sources of toxic air pollution (Terrell and James, 2020); however, this analysis did not include criteria pollutants, which are abundant and subject to a unique set of Clean Air Act regulations. Criteria pollutants include coarse particulate matter (PM10), fine particulate matter (PM2.5), nitrogen oxides (NO2), sulfur dioxide (SO2), and volatile organic compounds (VOCs). Determining whether a racial disparity exists for industrial emissions of criteria pollutants in Louisiana has immediate relevance to an ongoing civil rights investigation by the EPA (U.S. EPA, 2022e) and to regulatory decision-making by the Louisiana Department of Environmental Quality (LDEQ), which issues hundreds of permits each year for new or expanding industry (Louisiana Legislative Auditor, 2021). The LDEQ has suggested, without evidence, that spatial patterns of industrial emissions in Louisiana are driven by access to supporting infrastructure (e.g. pipelines), rather than racial bias (LDEQ, 2022a).

The goal of our study was to determine whether communities of Color in Louisiana bear a disproportionate share of industrial emissions of criteria pollutants, and whether this potential disparity can be attributed to LDEQ permitting or to racial demographics among areas with industrial infrastructure. We addressed these questions through a three-part analysis of publicly-available state and federal data (Table 1). Additionally, we examined the relative contributions of different industry subsectors to emissions for top and bottom race quartiles and for Louisiana overall. Our study has direct relevance to industrialized communities in Louisiana and provides a framework for future research to elucidate the role of state regulation in perpetuating environmental injustice more broadly.

2. Materials and Methods

2.1. Data Sources

We obtained a list of LDEQ-regulated facilities with corresponding 2019-2021 emissions data from the LDEQ Annual Certified Emissions Dataset (accessed Jul 10, 2022) (LDEQ, 2022b). This inventory includes all pollution sources in Louisiana that are required to report annual emissions to LDEQ, such as power generating plants, landfills, petrochemical plants, and other types of industrial manufacturing facilities (e.g., lumber mills and steel plants). It does not include pollution sources that are exempt from LDEQ permitting (e.g., vehicles or agricultural burning) or emissions reporting (e.g. dry cleaners or other small sources). A small number of facilities contained multiple entries for a given year; in those cases, we obtained the correct values from Emissions Certification Statements via the LDEQ Electronic Database Management System (EDMS). We obtained the most recently-reported (2021) North American Industry Classification System (NAICS) code for each facility from LDEQ's emissions inventory (accessed Dec 1, 2022) (LDEQ, 2022b).

We accessed demographic data from the U.S. Census Bureau's 2015-2019 American Community Survey via Social Explorer, a tool that calculates percentage data where applicable (Social Explorer, 2022). Specifically, we obtained census tract-level data for race (Population of Color, which we calculated as 100% minus the percentage of residents identifying as White), occupation (percentage of workforce currently employed in manufacturing), and land area. We obtained the 2019 U.S. Rails National Shapefile and the 2010 Census Tract Boundaries Shapefile from the U.S. Census Bureau (U.S. Census Bureau, 2022b, 2022c). We identified ports in Louisiana with access to the Gulf of Mexico (i.e. excluding the inland ports of Natchez, Vicksburg, and Monroe) from the Ports of the United States dataset from the U.S. Geological Survey (U.S. Geological Survey, 2022). We accessed the most recent (2020) shapefiles for pipelines carrying crude oil, natural gas, or petroleum products from the U.S. Energy Information Administration (U.S. Energy Information Administration, 2022).

Table 1
Study Design to Evaluate Potential Racial Disparity in Air Pollution Burden.

Analysis[1]	Expected Associations by Scenario		
	No Disparity	Disparity Due to Infrastructure	Disparity Due to LDEQ Permitting
Linear model of emissions versus race	None	Emissions associated with race	Emissions associated with race
Emissions by race quartile (% people of Color)	None	Emissions highest in Q4	Emissions highest in Q4
T-tests of race in tracts with infrastructure	None	% people of Color above state mean	None

[1] Emissions analyses included only tracts with LDEQ-reporting facilities (i.e. excluding zero values).

2.2. *Geocoding Industrial Facilities*

Because the LDEQ emissions inventory does not include spatial data (i.e. GPS coordinates or addresses), we used a multi-step approach for geocoding facilities based on their Agency Interest (AI) number, a unique identifier assigned by LDEQ. First, we identified all facilities that were operational in 2020 from the emissions dataset (accessed July 11, 2022). We then used the radius search tool in LDEQ's Emissions Reporting and Inventory Center (ERIC) to obtain GPS coordinates for facilities within 25 miles of each major city in Louisiana (LDEQ, 2022c). This piecemealed approach was necessary because the ERIC tool does not return results for large geographic areas. Because the tool returns multiple coordinates per facility (one set for each emissions source), we used the GPS coordinates for the source with the highest VOC emissions at each facility. After combining the information from each city search, we had geocoded 423 of the 739 facilities represented in the 2020 emissions inventory (accessed July 11, 2022). We geocoded another 248 facilities manually in Google Earth Pro, after obtaining the physical address of the facility from LDEQ's EDMS using the AI lookup feature and confirming the presence of the facility based on satellite imagery (LDEQ, 2022d).

2.3. *Mapping and Spatial Grouping Industrial Facilities and Infrastructure*

We used QGIS (Version 3.6.3) for all mapping and spatial analysis, unless otherwise noted. We assigned census tracts to all geocoded facilities using a spatial join. We classified census tracts as containing railways or pipelines if they intersected with those respective map layers. We classified census tracts as being near a port if their centroid was located within 100 km of a coastal port (i.e. excluding the inland ports of Monroe, Natchez, and Vicksburg). We manually selected census tracts that bordered the Mississippi River below the Highway 90 Bridge in Baton Rouge (river mile 233.9) and classified these tracts as having Mississippi River access. We selected this cut off point because the bridge has relatively low clearance that restricts transportation via large marine vessels (U.S. Coast Guard, 2013), and satellite imagery reveals an obvious lack of industrial development upriver of the Hwy 190 Bridge.

We identified clusters of industrial facilities using density-based cluster analysis (DBSCAN) in QGIS (Version 3.6.3), with a minimum cluster size of 10 facilities and a maximum distance of 0.1 degree between facilities using the NAD83 projection. Given the highly irregular shape of many census tracts, we manually identified the tracts corresponding to each cluster of facilities. In doing so, we aimed to identify the minimum number of tracts needed to encompass all corresponding facilities without creating any "holes" (i.e. non-cluster tracts surrounded by cluster tracts).

2.4. *Analyses of Race versus Industrial Emissions*

We conducted all statistical analysis in R Statistical Software (R Core Team, 2020), unless otherwise noted.

For each pollutant (PM10, PM2.5, NOx, SO2, CO, and VOCs), we calculated normalized emissions per census tract as the sum of all emissions reported for 2019-2021 (tons), divided by three years, and divided by the land area (mi^2) of the census tract ($tons/yr/mi^2$). We used Imperial units (i.e. tons and miles) for consistency with LDEQ permitting and emissions inventory systems.

We used a separate linear regression model for each pollutant to determine whether normalized emissions ($tons/yr/mi^2$) were associated with population of Color (%) among industrialized census tracts (i.e. excluding tracts with zero emissions). Prior to this analysis, we transformed percentage data (arcsine transformation) and emissions data (natural log transformation) to improve normality, then scaled and centered these data. Exploratory analysis revealed significant spatial autocorrelation ($P < 0.0001$) in a linear regression of normalized VOC emissions with percent population of Color, as tested by a simulation with 10,000 replicates and measured by Moran's I (Hartig, 2021). To reduce spatial autocorrelation, we added facility cluster as a fixed effect to each pollutant model, as well as an interaction term between facility cluster and percent population of Color. This results in linear regressions with no statistically significant spatial autocorrelation ($P = 0.18$ for PM10, $P \geq 0.46$ for all other pollutants), which therefore may have appropriate standard errors for coefficient estimates.

To better understand the associations detected in the linear models, we analyzed emissions by race quartile using raw (i.e. untransformed) data. Specifically, we calculated median (non-zero) emissions ($tons/yr/mi^2$) for industrialized census tracts ($N = 276$) grouped by % people of Color.

Group thresholds corresponded to quartile breaks for % people of Color among all Louisiana census tracts ($N = 1{,}126$). To quantify emissions disparities, we calculated the ratio of emissions between census tract groups with the highest versus lowest percent people of Color (i.e., Q4/Q1).

To explore the geographic nature of emissions disparities, we mapped the locations of census tracts with industrial facilities ($n = 248$) in the highest and lowest emissions quartiles ($N = 62$ tracts per quartile), relative to the racial composition (% Color) of those census tracts, We excluded tracts that were unpopulated or had zero emissions reported for all pollutants.

2.5. *Analyses of Emissions by Industrial Subsector*

We evaluated the contribution of different industry subsectors to overall emissions, based on NAICS codes. We also examined subsector contributions to emissions among census tracts that were predominantly people of Color (>65%) or predominantly White (≤16.9% people of Color). We chose these racial percentages because they correspond to the quartile breaks (Q4 and Q1, respectively) when considering population of Color among all census tracts in Louisiana ($N = 1{,}126$).

2.6. *Analyses of Industrial Infrastructure*

To inform our study design, we evaluated collinearities among infrastructure variables and other potential predictors of industrialization using Pearson's correlation. These were binary variables coded to 0 or 1 and included access to pipelines, railways, the lower Mississippi River, a coastal port within 100 miles, an abundance of manufacturing labor (i.e. ≥10% of the workforce in manufacturing), and a majority population of Color among census tracts. We also included log-transformed land area of tracts in the correlation matrix, because we expected that binary variables were more likely to occur in larger tracts. This exploratory analysis revealed collinearities among a subset of predictor variables (Table A.1), which resulted in unreliable performance of zero-inflated negative binomial models of these variables versus facility counts. We therefore adopted a more straightforward approach of reporting odds ratios for each predictor variable, without making any causal inference. For each predictor, we calculated the odds (OR) of census tracts having industrial activity (i.e. at least one industrial facility) using Equation 1,

$$OR = (A/B)/(C/D) \tag{1}$$

where A = the number of tracts with the predictor variable and at least one industrial facility, B = the number of tracts with the predictor variable and without industrial facilities, C = the number of tracts without the predictor variable and with at least one industrial facility, and D = the number of tracts without the predictor variable and without industrial facilities. We calculated the corresponding 95% confidence intervals using Equation 2.

$$CI = e^{(log(OR) \pm 1.96 * \sqrt{(1/a+1/b+1/c+1/d)})} \tag{2}$$

For each infrastructure variable, we used One-Sample t-Tests to compare proportions of residents of Color among tracts with the variable against the state mean.

3. Results

3.1. Spatial Clustering of Geocoded Industrial Facilities

We successfully geocoded 671 of the 797 industrial facilities that reported emissions to the LDEQ in 2019, 2020, and/or 2021. The remaining 126 facilities could not be geocoded because a specific physical address was not listed in LDEQ's electronic database (EDMS). In most cases, these were relatively small emissions sources associated with oil and gas extraction that had general location information provided in lieu of an address (e.g. "15 miles southwest of Venice, LA"). Collectively, these non-geocoded sources represented < 5% of reported emissions for each criteria pollutant (Table A.2).

We found that 22% of Louisiana census tracts contained at least one geocoded industrial facility ($N = 248$ of 1,148 census tracts; Fig. 1). For simplicity, we subsequently refer to these as "industrialized census tracts." The density-based analysis identified eight distinct clusters of industrial facilities (from east to west): Lower, Middle, and Upper Industrial Corridor, Denham Springs, Lafayette, Vermillion Bay, Sterlington, and Lake Charles (Fig. 2). Collectively, these eight clusters represented nearly two-thirds of all geocoded facilities (422/671) and encompassed 347 census tracts, including some non-industrialized tracts that were surrounded by industrialized tracts (see Materials and Methods). Clusters varied in size, with the smallest (Sterlington) containing 10 facilities and representing three census tracts, and the largest (Upper Industrial Corridor) containing 255 facilities and representing 123 census tracts (Fig. 2). The Industrial Corridor, which is typically considered a continuous area, was broken into three clusters; a 16-km stretch of agricultural and residential land in eastern St. James Parish separated the Upper and Middle Industrial Corridor, while a 9-km stretch of commercial and residential development in Jefferson Parish separated the Middle and Lower Industrial Corridor (Fig. 2). Collectively, the Industrial Corridor clusters represented 378 facilities and 276 census tracts (including some tracts surrounded by, but not containing, industrial facilities – see Materials and Methods). Industrial Corridor facilities spanned 184.1 river miles, from the Louisiana Generating LLC - Big Cajun II Power Plant in Point Coupee Parish to the Chevron Oronite Co LLC - Oak Point Plant in Plaquemines Parish.

3.2. Race versus Industrial Emissions

Among all Louisiana census tracts, proportions of residents of Color averaged 42.4%, with a median of 34.5%. Of the 671 geocoded facilities, 651 reported non-zero emissions for at least one pollutant to LDEQ in 2019-2021, representing 246 census tracts. We excluded one of these tracts from the analysis because it was unpopulated, according to census data. A few facilities reported zero emissions for a subset of pollutants, resulting in slightly different sample sizes among pollutants ($N = 219$ to 244 census tracts; Table 2). Across all pollutants, race was a significant predictor of the magnitude of emissions from industrial facilities that reported non-zero emissions (summarized in Table 2; see Tables A.3-A.8 for results of individual pollutant models). There was no evidence of spatial autocorrelation in any model (P = 0.18 for PM10; P ≥ 0.46 for all other pollutants). Median emissions were 7.4 to 21.0 times higher, depending on the pollutant, among industrialized tracts with high proportions of residents of Color compared to industrialized tracts with high proportions of White residents (Q4 versus Q1 race, respectively; Table 3). For most pollutants ($PM_{2.5}$, SO_2, CO, and VOCs), median emissions of industrialized tracts increased consistently with increasing percentages of residents of Color (Table 3). Similar results were obtained when using mean (versus median) emissions (Table A.9) and when tracts with zero emissions were included (Table A.10). Mapping revealed that industrialized census tracts with very low emissions (Q1) were disproportionately White, while industrialized census tracts with very high emissions (Q4) were disproportionately of Color (Figs. 3-5 and B.1-B.3).

Table 2
Summary of Individual Linear Regression Models of Emissions versus Race*.

Modeled Pollutant	Census Tracts (N)**	Population of Color (%)		
		Estimate	T	P
PM_{10}	241	0.41	4.40	< 0.0001
$PM_{2.5}$	230	0.34	4.20	< 0.0001
NO_x	235	0.30	3.52	0.0005
SO_2	219	0.28	3.37	0.0009
CO	233	0.32	3.76	0.0002
VOC	244	0.40	5.16	< 0.0001

* All models included Facility Cluster and an interaction term with Race to account for spatial correlation (see Methods). Multiple $R^2 = 0.23$-0.35, Adjusted $R^2 = 0.17$-0.30; $F \geq 3.78$, $P < 0.0001$. Full results of each model are presented in Tables A.3-A.8.

** Corresponds to number of census tracts with non-zero reported emissions.

3.3. Emissions among Industry Subsectors

Chemical manufacturing facilities (NAICS Code 325) were responsible for more emissions of every pollutant than any other industry subsector, representing between 26.9% and 38.2% of industry-wide emissions of PM10, PM2.5, NOx, SO2, CO, and VOCs (Table A.11). Other major contributing industries for all (or most) pollutants were Petroleum and Coal Products Manufacturing (Code 324; 16.6% to 32.0%), Utilities (Code 221; 12.7% to 25.7%), and Paper Manufacturing (Code 322; 2.2% to 20.4%). Smaller, but significant, proportions of certain pollutants came from other subsectors, such as PM10 from Mining (Code 212; 12.1%) and VOCs from Pipeline Transportation (Code 486; 10.3%; Table A.11).

Chemical Manufacturing was the most common subsector represented among communities predominantly of Color (Q4, >65.0% people of Color), while Pipeline Transportation was the most common subsector represented among predominantly White communities (Q1, ≤16.9% people of Color; Table 4). In both groups, Chemical Manufacturing, Utilities, and Petroleum/Coal Products Manufacturing represented large proportions of emissions for most pollutants (Fig. 6; Tables A.12 and A.13). A notable difference was that Chemical Manufacturing was responsible for larger percentage of emissions in communities of Color (>65.0% people of Color) compared to mostly White communities (≤16.9% people of Color), while Utilities contributed a larger percentage of emissions in the latter versus former (Fig. 6; Tables A.12 and A.13).

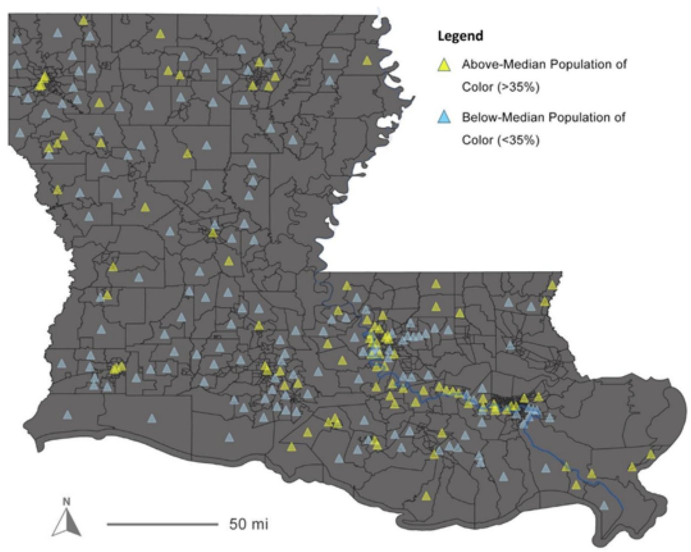


Fig. 1. Centroids of census tracts (N = 245) that contain at least one industrial facility, relative to the racial composition of those census tracts. Black lines represent tract boundaries. The dark blue line represents the lower Mississippi River (shown for consistency with other figures). Centroids are omitted for three census tracts that contain at least one industrial facility because they do not have a residential population.

Table 3
Median Emissions* versus Race among Census Tracts with Industrial Activity.

Census Tract Group** (% Population of Color)	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	VOC
Mostly People of Color (65.5 – 100%)	1.37	1.97	5.41	0.21	5.73	6.83
Disproportionately People of Color (34.6 – 65.4%)	1.56	1.00	6.16	0.12	3.54	1.45
Disproportionately White (17.0 – 34.5%)	0.13	0.11	1.29	0.04	0.89	0.88
Mostly White (0 – 16.9%)	0.13	0.10	0.73	0.01	0.64	0.53
Disparity Factor†	10.5	19.7	7.4	21.0	9.0	12.9

* Normalized reported emissions (tons/year/mi^2) for LDEQ-regulated facilities in 2019-2021.

** Group thresholds correspond to quartile breaks for % population of Color among all census tracts in Louisiana (see Methods); sample sizes vary by pollutant and range from 36 to 77 census tracts per group (see Table A.9).

† Calculated as the emissions ratio for tracts with mostly people of Color versus mostly White tracts.

3.4. *Racial Demographics around Industrial Infrastructure*

Odds ratios indicated that tracts were more likely to be industrialized if they intersected with a railway or petrochemical pipeline, bordered the lower Mississippi River, or had relatively high proportions (≥10%) of the workforce employed in manufacturing (Table 5; Figs. 2 & B.4). Mean percentages of residents of Color among tracts with industrial infrastructure were similar to, or lower than, the statewide mean (42.4%; Table 4), except for railways, which had 46.2% residents of Color (Table 6). As described in our Methods, collinearities among potential predictors of facility presence/absence prevented us from reliably analyzing these variables in a single model (Table A.1).

4. Discussion

Our study provides conclusive evidence that communities of Color are disproportionately burdened with industrial air pollution in Louisiana and that state environmental regulation is the driving force of this disparity. We found that the Louisiana Department of Environmental Quality (LDEQ) has permitted a pattern of industrialization wherein reported emissions of common industrial pollutants are 7 to 21-fold higher among industrialized communities of Color compared to industrialized White communities (Table 3). This disparity can be primarily attributed to the Chemical Manufacturing Industry, which represents more LDEQ-reporting facilities and more emissions in predominantly Black communities - and in Louisiana overall - than any other industry sub-

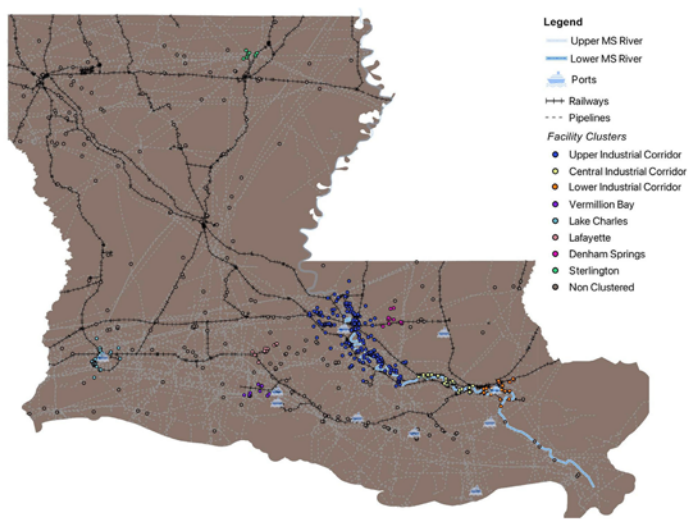


Fig. 2. Locations of industrial facilities (N = 671) and industrial infrastructure in Louisiana. Facilities are color-coded to illustrate results of the densitybased cluster analysis.

Table 4
Industrial Sectors Represented among Census Tracts Grouped by Race*.

Industry Subsector and Description		Number of Facilities in Census Tract Group	
		Mostly People of Color**	Mostly White†
114	Fishing, Hunting and Trapping	0	1
211	Oil and Gas Extraction	4	23
212	Mining (except Oil and Gas)	0	1
213	Support Activities for Mining	1	1
221	Utilities	6	16
311	Food Manufacturing	5	2
321	Wood Product Manufacturing	2	9
322	Paper Manufacturing	3	1
324	Petroleum and Coal Products Manufacturing	7	7
325	Chemical Manufacturing	32	26
326	Plastics and Rubber Products Manufacturing	0	1
327	Nonmetallic Mineral Product Manufacturing	3	0
331	Primary Metal Manufacturing	2	1
332	Fabricated Metal Product Manufacturing	4	5
333	Machinery Manufacturing	1	1
336	Transportation Equipment Manufacturing	2	5
424	Merchant Wholesalers, Nondurable Goods	9	4
483	Water Transportation	0	1
486	Pipeline Transportation	11	53
488	Support Activities for Transportation	3	1
493	Warehousing and Storage	3	0
531	Real Estate	1	0
562	Waste Management and Remediation Services	9	5
Total		108	164

* Industry subsectors designated by the North American Industry Classification System (NAICS). Census tracts are grouped by race, using quartile breaks (Q4, Q1) for the entire state and excluding tracts without industry (see Methods).
** Census tracts (n = 42) with >65.0% people of Color.
† Census tracts (n = 77) with ≤16.9% people of Color.

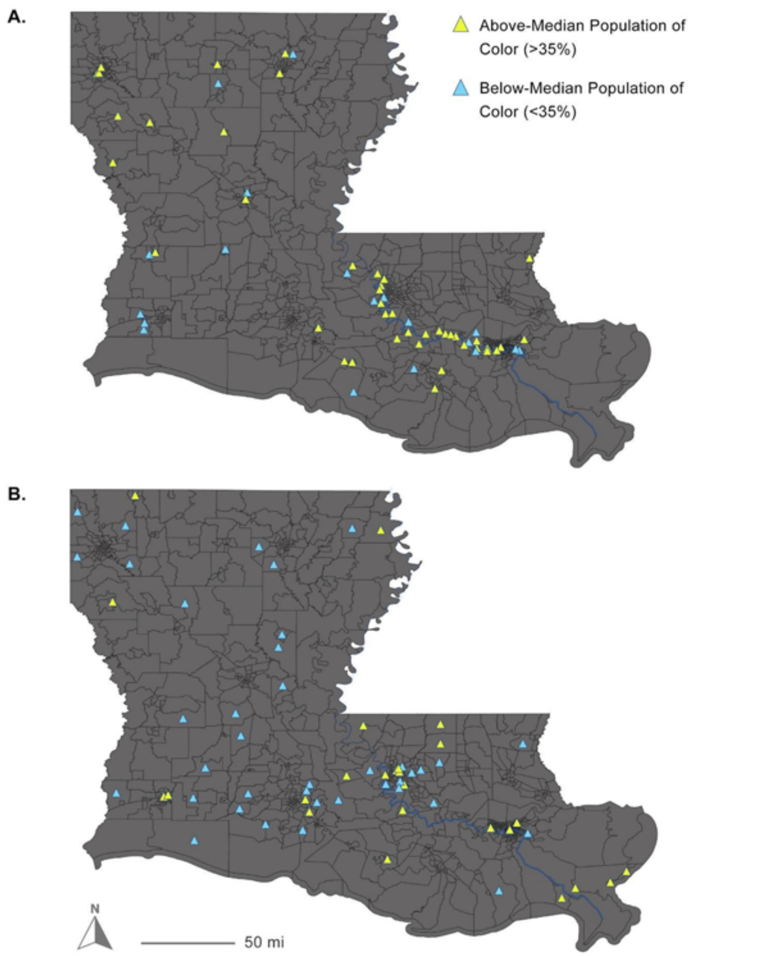


Fig. 3. Centroids of industrialized census tracts with the highest (A) and lowest (B) industrial emissions of fine particulate matter ($PM_{2.5}$), relative to the racial composition of the tract. Panels correspond to the top and bottom pollution quartile, respectively (N = 61 census tracts per quartile).

sector (Fig. 6, Tables A.11 – A.13). Petroleum and Coal Products Manufacturing also contributed to substantial emissions of most pollutants in communities of Color. Our analysis did not support LDEQ's speculation that Louisiana's racial disparity in pollution burden might be driven by differential access to industrial infrastructure (Table 6, Figs. 2 & B.1). Collectively, these findings indicate a need for systemic changes in U.S. state permitting to achieve compliance with national environmental justice policies.

Our findings are consistent with the longstanding perspectives of residents and advocates who contend that industrial operations dispropor-

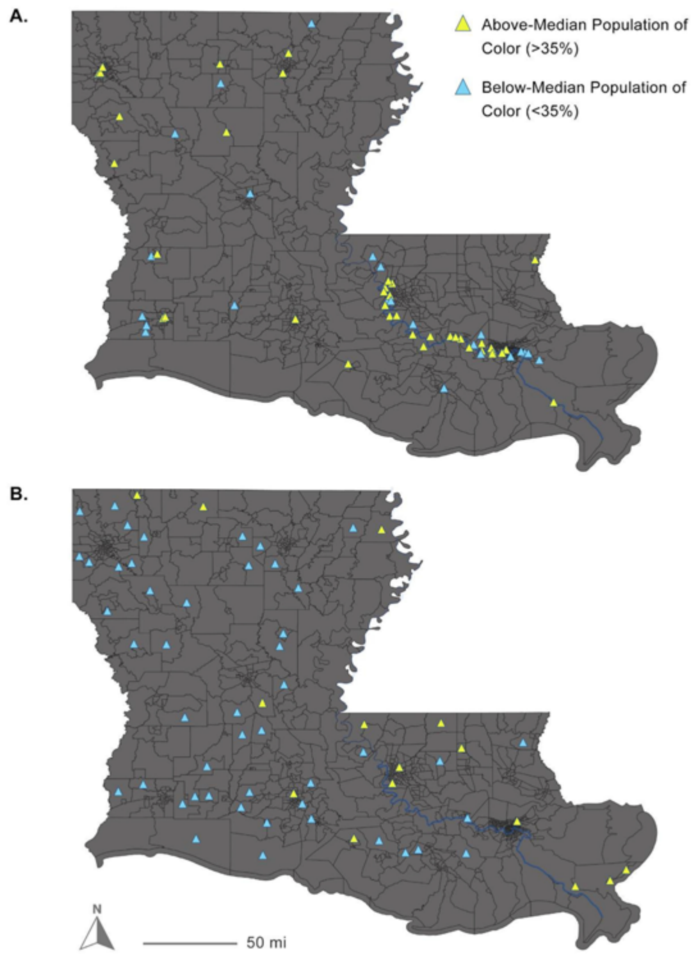


Fig. 4. Centroids of industrialized census tracts with the highest (A) and lowest (B) industrial emissions of nitrogen oxides (NO_x), relative to the racial composition of the tract. Panels correspond to the top and bottom pollution quartile, respectively (N = 61 census tracts per quartile).

tionately harm communities of Color in Louisiana (e.g., Achiume et al., 2021; Kruzman, 2022). While southwest Louisiana appears to be an exception, we recognize that the 2014 expansion of Sasol's chemical complex in Mossville displaced many Black residents, altering the area's demographics (University Network for Human Rights, 2021).) We found that the *magnitude* or *type* of industrial operations drives Louisiana's pollution disparity, as opposed to the presence of industry *per se*, given that every census tract in our analysis had at least one industrial facility. This disparity applied to all criteria pollutants, the health effects of which are relatively well studied. Exposure to particulate pollution

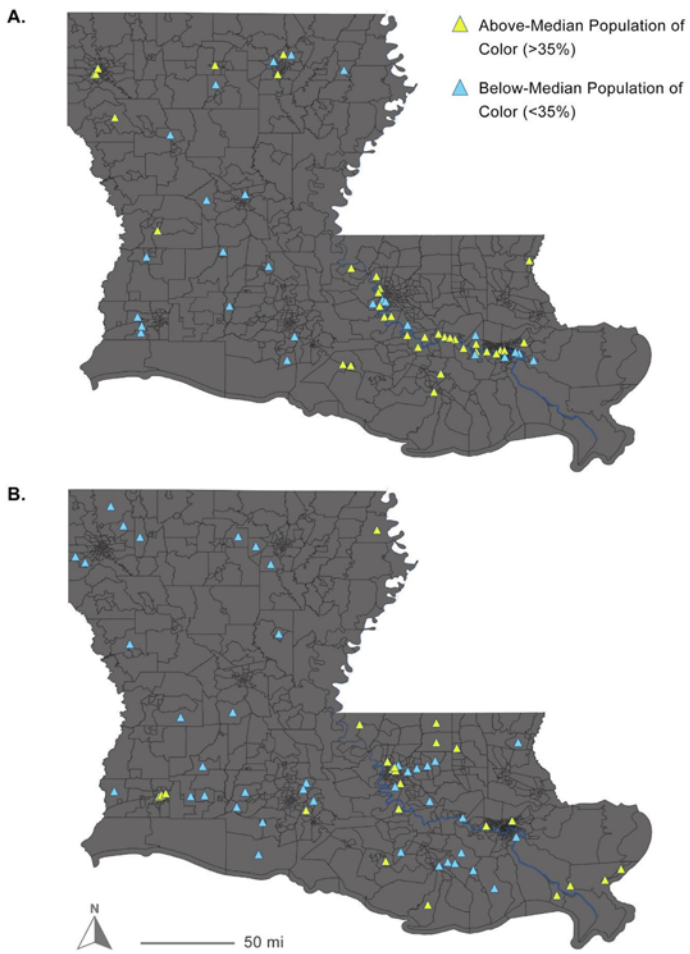


Fig. 5. Centroids of industrialized census tracts with the highest (A) and lowest (B) industrial emissions of volatile organic compounds (VOCs), relative to the racial composition of the tract. Panels correspond to the top and bottom pollution quartile, respectively (N = 61 census tracts per quartile).

(PM10 and/or PM2.5) can cause lung cancer, respiratory disease, cardiovascular disease, and cognitive impairment (reviewed in Yang et al., 2019; Dockery et al., 1989; Hamanaka and Mutlu, 2018). Exposure to gaseous pollutants (NOx, SO2, CO, and VOCs) can cause respiratory and cardiovascular disease (reviewed in Bernstein et al., 2004). Many VOCs are toxic and disrupt other bodily systems; for example, benzene causes blood disorders, various cancers, and reproductive problems (Wilbur et al., 2008). Although less studied, pollutant mixtures can be more harmful than their individual parts (e.g., Huang et al., 2012; Last, 1991). Industrial permits typically allow facilities to emit dozens of different

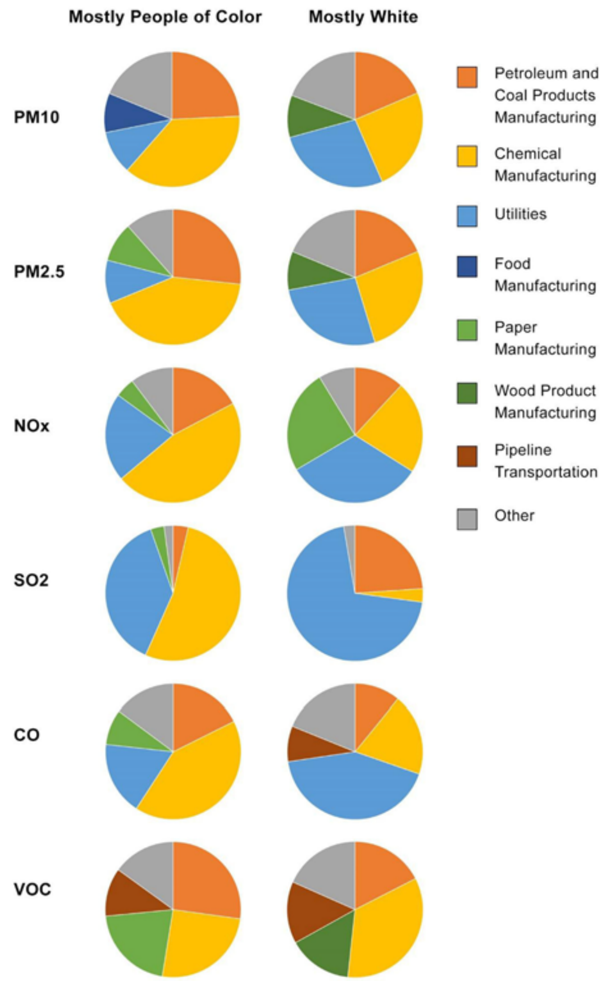


Fig. 6. Proportion of emissions by industry subsector among census tracts grouped by race. Groupings correspond to >65.0% or ≤16.9% people of Color (top and bottom statewide race quartiles), respectively. See Tables A.11 and A.12 for percentage values and sample sizes.

pollutants (e.g., LDEQ, 2020), the combined health effects of which are poorly understood. There are currently no state or federal regulations that limit the *total* risk from air pollution, and we are unaware of any such local regulations in Louisiana. For the past two decades, scientific advisors to the U.S. EPA have been recommending a more holistic, multipollutant approach to regulating air quality (National Research Council, 2004; Page, 2005; Air Quality Management Subcommittee, 2007). Our study reveals that this approach would also benefit environmental justice in Louisiana, where communities of Color are overburdened with all major types of industrial pollutants.

Table 5
Odds of Census Tracts Containing at Least One Industrial Facility Relative to Infrastructure Variables*.

Infrastructure	Tracts with Industry		Tracts w/o Industry		Odds Ratio (95% CI)
	+ Infrastructure (N)	- Infrastructure (N)	+ Infrastructure (N)	- Infrastructure (N)	
Pipeline Access	224	23	472	407	8.40 (5.36-13.16)
Rail Access	191	56	395	484	4.18 (3.02-5.79)
≥10% Workforce in Manufact.	108	139	150	729	3.78 (2.78-5.13)
Lower MS River Access	43	204	52	827	3.35 (2.18-5.16)
Coastal Port within 100 km	174	73	659	220	NS (0.58-1.09)

* Among census tracts with all data available (N = 1,126). NS = not significantly different from 1.0.

Table 6
Racial Demographics of Tracts with Industrial Infrastructure versus Louisiana Overall*.

Infrastructure	Tracts (N)	Mean Population of Color (%)	Versus LA overall (42.4%)	
			T	P
Pipeline Access	696	38.8	-3.47	0.0005
Rail Access	586	46.2	3.15	0.002
≥10% Workforce in Manufacturing	258	35.5	-4.28	<0.0001
Lower MS River Access	95	45.4	1.11	0.27
Coastal Port within 100 km	833	41.7	-0.64	0.52

* Among census tracts with all race data available (N = 1,126).

As the primary permitting authority, the LDEQ plays a central role in determining the distribution of negative impacts from Louisiana's industrial operations. In response to allegations of discriminatory decision-making, LDEQ recently cited "numerous factors unrelated to the demographics of the surrounding communities" to explain the spatial pattern of industrialization (LDEQ, 2022a). These factors include historical land prices, pipelines, railways, highways, and an abundance of minerals, petrochemicals, water, and labor (LDEQ, 2022a). We challenge LDEQ's claim that historical land prices or industrial infrastructure are unrelated to demographics, given that racist practices have shaped current patterns of residential segregation (reviewed in Charles, 2003), including with respect to industrial operations and zoning (Ard and Smiley, 2022; Morello-Frosch and Jesdale, 2006; Morello-Frosch and Lopez, 2006; Whittemore, 2017). Regardless, neither infrastructure nor labor explained the emissions disparity identified in our study. Four of the five infrastructure variables we examined were strongly associated with industrialization (Table 5), but only one of these variables (i.e. railways) was also associated with higher proportions of residents of Color, and this association was modest (Table 6). As further evidence that Louisiana's emissions disparity is unrelated to infrastructure, our linear model found an effect of race on emissions after controlling for spatial clustering of industrial facilities, which tends to occur around infrastructure (Tables 2 & A.3-A.8; Fig. 2).

Our study provides a framework for evaluating the role of state industrial permitting in pollution disparities. This framework could be easily adopted for other industrialized states where local pollution disparities have been identified but the relative contributions of regulated and non-regulated emissions sources are not fully understood, including New Jersey (Dressel et al., 2022) and Texas (Tiefenbacher and Iii, 1999). Future studies could use a similar approach to examine the efficacy of new state laws and regulations aimed at reducing or eliminating pollution disparities. For example, New Jersey passed a landmark environmental justice bill in 2020 (SB232), requiring that the state Department of Environmental Protection identify disproportionately polluted communities and take active steps to reduce these disparities through changes to the agency's industrial permitting program (Singleton et al., 2021). The most direct approach to determining the success of these and other emerging environmental justice policies would be to evaluate temporal changes in the magnitude of industrial emissions reported in state inventories. However, temporal studies that rely on state emissions inventories must account for changes in reporting requirements over time, and researchers should be aware that these requirements can vary dramatically among states. For example, Texas requires annual reporting for any facility that emits 100 tons per year (tpy) or more of a criteria pollutant (30 Tex. Admin. Code § 101.10), while Mississippi requires that only very large emitters (≥250 tpy) report annually, with facilities emitting 100-249 tpy of a criteria pollutant reporting their emissions once every 3 years (MDEQ, 2022).

A limitation of our study is that it relies on reported emissions by census tract as a proxy for the local, negative impacts associated with heavy industry. These impacts can include health problems from pollutant exposures (reviewed in Brisbois et al., 2019), depressed home values (Chay and Greenstone, 2005; Hanna, 2007), increased poverty (reviewed in Gamu et al., 2015), and loss of community resources (e.g. school closings; U.S. EPA, 2022e). We use reported emissions because it is a straightforward metric that is associated with each of these harms, and it is directly attributable to a specific regulatory action (i.e. industrial air permitting). Further, these emissions values are readily available for all criteria pollutants in Louisiana, whereas corresponding ambient concentrations and estimates of associated health risks are not currently available. Estimating these refined metrics for industrial emissions of criteria pollutants is a significant undertaking that is beyond the scope of this study, but which is a priority for future research.

While our study reveals a stark racial disparity in reported emissions, more research is needed to quantify corresponding differences in exposure and economic harm. Exposure disparities could differ significantly from emissions disparities if certain racial groups are more likely to spend time outdoors, live closer to (or more downwind of) industrial facilities in their census tract, live in dilapidated (i.e. less air tight) homes, or be exposed to emissions from adjacent census tracts (Baxter et al., 2013). Based on our direct knowledge of Louisiana's industrialized communities, we expect these factors to contribute to an exposure disparity that is similar to – or potentially more extreme than – the emissions disparity identified in our study. Regardless, quantifying pollutant exposures and economic harms from industrial operations in Louisiana is a major priority for future research. The latter is particularly challenging due to the lack of baseline economic data, since industrialization of most communities occurred many decades ago. Further, our firsthand experiences suggest that home sales are relatively infrequent in Louisiana's heavily industrialized areas, potentially limiting the utility of housing market data. Still, creative modeling approaches can overcome some of these challenges (e.g., Chay and Greenstone, 2005), and these research topics remain largely unexplored in Louisiana.

Another caveat of our study is that emissions reporting is subject to bias. State and federal emissions inventories in the U.S. are compiled from self-reported industry data, and companies may have incentives to underreport their emissions (Hausman and Stolper, 2021). A 2004 report by the Environmental Integrity Project and the Galveston-Houston Association for Smog Prevention estimated that actual emissions of toxic pollutants from industrial facilities are four to five times higher than the values reflected in EPA's national inventory (Environmental Integrity Project and the Galveston-Houston Association for Smog Prevention, 2004). More recently, peer-reviewed studies have identified underreporting of greenhouse gas emissions from cities (Gurney et al., 2021) and methane emissions from petrochemical extraction ("Assessment of methane emissions from the U.S. oil and gas supply chain," 2018), suggesting that emissions underreporting is a pervasive problem. In Louisiana, the LDEQ allowed industrial facilities to retroactively lower their reported emissions of ethylene oxide, after EPA determined that the pollutant was substantially more toxic than previously thought (U.S. EPA, 2022f). For example, in 2019, Sasol Chemicals USA (LLC) retroactively changed its 2014 ethylene oxide emissions to less than 6% of the original reported value, based on testing performed by Sasol (Sasol Chemicals USA (LLC), 2020). (This timing was significant from a regulatory perspective because a risk assessment using 2014 emissions data was used to inform EPA rulemaking in 2020 (U.S. EPA, 2020). Thus, state emissions inventories, including the one used in our study, are subject to reporting bias that may result in emissions disparities being underestimated.

Our findings add to a growing body of evidence that communities of Color are disproportionately harmed by pollution in Louisiana (James et al., 2012; Nagra et al., 2021; Perera and Lam, 2013; Terrell and James, 2020; Terrell and Julien, 2022), and we specifically identify industrial permitting as the driving force of this disparity. Yet, in permitting decisions and in response to allegations of discrimination, the LDEQ has concluded that pollution disparities are not meaningful if legally enforceable pollution limits are not violated, including the National Ambient Air Quality Standards (NAAQS; LDEQ, 2022a). There are two flaws in LDEQ's logic. First, LDEQ assumes that NAAQS are fully protective of human health and well-being, an assumption that is contradicted by evidence of synergistic harm from multipollutant mixtures and by periodic revisions to the NAAQS (U.S. EPA, 2022g). As other authors have noted, revisions of environmental standards (including the NAAQS) have generally resulted in more protective (i.e. lower) pollution limits, as new research has identified previously unknown mechanisms of toxicity (Hausman and Stolper, 2021). The second problem with relying on NAAQS to ensure environmental justice is that there are major spatial gaps in the NAAQS air monitoring network. For example, seven of the ten Louisiana parishes with the highest reported industrial emissions of PM2.5 do not have a NAAQS monitor for PM2.5 (LDEQ, 2022e). Current EPA practice incentivizes this lack of monitoring because, in the absence of information, EPA effectively assumes compliance with NAAQS (U.S. EPA, 2022h). As these observations illustrate and as other authors have noted, regulators tend to err on the side of false negatives with respect to identifying harm from pollution exposure (Gee and Krayer von Krauss, 2005).

5. Conclusions and Implications

Decades of research has demonstrated that environmental injustice is a pervasive and persistent problem in the U.S. and across the globe. While U.S. federal policies and regulations have attempted to address nationwide disparities in pollution exposure, there is no evidence that these efforts have been successful overall. Environmental justice in the U.S. has been undermined by a regulatory system that affords residents of certain states more stringent environmental protections and enables state environmental regulators, like in Louisiana, to concentrate industrial emissions in communities of Color. Our study identified, quantified, and characterized a racial disparity in pollution exposure that many residents have known about for decades. These findings highlight the need for systemic change in the implementation of the U.S. Clean Air Act, including more robust federal oversight to ensure that state permitting decisions avoid discriminatory outcomes, particularly with respect to chemical and petroleum manufacturing. As long as pollution disparities persist locally, environmental justice will remain an elusive goal in the United States.

Data availability

Data will be made available on request.

Acknowledgments

We thank Lisa Jordan for providing helpful comments on a draft of this manuscript.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.envc.2022.100672.

References

Achiume, E.T., Day, D., Reid, A., Balcerzak, M., Gumedze, S., Sunga III, R.A., Pesce, D., Deva, S., Karska, E., Muigai, G., Ramasastry, A., Boyd, D., Mofokeng, T., Orellana, M., 2021. USA: Environmental racism in "Cancer Alley" must end. Special Procedures of the Human Rights Council, United Nations, Geneva.

Air Quality Management Subcommittee, 2007. Phase II Recommendations to the Clean Air Act Advisory Committee.

Ard, K., Smiley, K., 2022. Examining the Relationship Between Racialized Poverty Segregation and Hazardous Industrial Facilities in the US Over Time. Am. Behav. Sci., 00027642211013417.

Ash, M., Boyce, J.K., 2018. Racial disparities in pollution exposure and employment at US industrial facilities. PNAS 115, 10636–10641.

Assessment of methane emissions from the U.S. oil and gas supply chain [WWW Document], 2018. URL https://www.science.org/doi/10.1126/science.aar7204 (accessed 7.24.22).

Baxter, L.K., Dionisio, K.L., Burke, J., Ebelt Sarnat, S., Sarnat, J.A., Hodas, N., Rich, D.Q., Turpin, B.J., Jones, R.R., Mannshardt, E., Kumar, N., Beevers, S.D., Özkaynak, H., 2013. Exposure prediction approaches used in air pollution epidemiology studies: Key findings and future recommendations. J Expo Sci Environ Epidemiol 23, 654–659.

Bernstein, J.A., Alexis, N., Barnes, C., Bernstein, I.L., Nel, A., Peden, D., Diaz-Sanchez, D., Tarlo, S.M., Williams, P.B., Bernstein, J.A., 2004. Health effects of air pollution. Journal of Allergy and Clinical Immunology 114, 1116–1123.

Berry, G.R., 2003. Organizing against multinational corporate power in cancer alley - The activist community as primary stakeholder. Organ. Environ. 16, 3–33.

Brisbois, B.W., Reschny, J., Fyfe, T.M., Harder, H.G., Parkes, M.W., Allison, S., Buse, C.G., Fumerton, R., Oke, B., 2019. Mapping research on resource extraction and health: A scoping review. The Extractive Industries and Society 6, 250–259.

Charles, C.Z., 2003. The dynamics of racial residential segregation. Annu. Rev. Sociol. 29, 167–207.

Chay, K.Y., Greenstone, M., 2005. Does Air Quality Matter? Evidence from the Housing Market. Journal of Political Economy 113, 376–424.

Colmer, J., Hardman, I., Shimshack, J., Voorheis, J., 2020. Disparities in PM2.5 air pollution in the United States. Science 369, 575–578.

Davies, T., 2018. Toxic Space and Time: Slow Violence, Necropolitics, and Petrochemical Pollution. Ann. Am. Assoc. Geogr. 108, 1537–1553.

Dockery, D.W., Speizer, F.E., Stram, D.O., Ware, J.H., Spengler, J.D., Ferris, B.G., 1989. Effects of Inhalable Particles on Respiratory Health of Children. Am Rev Respir Dis 139, 587–594.

Dressel, I.M., Demetillo, M.A.G., Judd, L.M., Janz, S.J., Fields, K.P., Sun, K., Fiore, A.M., McDonald, B.C., Pusede, S.E., 2022. Daily Satellite Observations of Nitrogen Dioxide Air Pollution Inequality in New York City, New York and Newark, New Jersey: Evaluation and Application. Environ. Sci. Technol..

Environmental Integrity Project and the Galveston-Houston Association for Smog Prevention, 2004. Who's Counting? The Systematic Underreporting of Toxic Air Emissions.

Evans, G.W., Kantrowitz, E., 2002. Socioeconomic Status and Health: The Potential Role of Environmental Risk Exposure. Annu. Rev. Public Health 23, 303–331.

Executive Order 12898, 1994.

Gamu, J., Le Billon, P., Spiegel, S., 2015. Extractive industries and poverty: A review of recent findings and linkage mechanisms. The Extractive Industries and Society 2, 162–176.

Gee, D., Krayer von Krauss, M.P., 2005. Late lessons from early warnings: towards precaution and realism in research and policy. Water Sci. Technol. 52, 25–34.

Gurney, K.R., Liang, J., Roest, G., Song, Y., Mueller, K., Lauvaux, T., 2021. Under-reporting of greenhouse gas emissions in U.S. cities. Nat Commun 12, 553.

Hajat, A., Hsia, C., O'Neill, M.S., 2015. Socioeconomic Disparities and Air Pollution Exposure: a Global Review. Curr Envir Health Rpt 2, 440–450.

Hamanaka, R.B., Mutlu, G.M., 2018. Particulate Matter Air Pollution: Effects on the Cardiovascular System. Front. Endocrinol. 9.

Hamann, M., Berry, K., Chaigneau, T., Curry, T., Heilmayr, R., Henriksson, P.J.G., Hentati-Sundberg, J., Jina, A., Lindkvist, E., Lopez-Maldonado, Y., Nieminen, E., Piaggio, M., Qiu, J., Rocha, J.C., Schill, C., Shepon, A., Tilman, A.R., van den Bijgaart, I., Wu, T.Gadgil, A., Tomich, T.P. (Eds.), 2018. Inequality and the Biosphere. Annual Review of Environment and Resources 43, 61–83.

Hanna, B.G., 2007. House values, incomes, and industrial pollution. Journal of Environmental Economics and Management 54, 100–112.

Hartig, F., 2021. DHARMa: Residual Diagnostics for Hierarchical (Multi-Level /Mixed) Regression Models. R package version 0.4.1.

Hausman, C., Stolper, S., 2021. Inequality, information failures, and air pollution. J.Environ.Econ.Manage 110, 102552.

Huang, Y.-C.T., Rappold, A.G., Graff, D.W., Ghio, A.J., Devlin, R.B., 2012. Synergistic effects of exposure to concentrated ambient fine pollution particles and nitrogen dioxide in humans. Inhal Toxicol 24, 790–797.

James, W., Jia, C., Kedia, S., 2012. Uneven Magnitude of Disparities in Cancer Risks from Air Toxics. International Journal of Environmental Research and Public Health 9, 4365–4385.

Keehan, C.J., 2018. Lessons from Cancer Alley: How the Clean Air Act Has Failed to Protect Public Health in Southern Louisiana Notes & Comments. Colo. Nat. Resources Energy & Envtl. L. Rev. 29, 341–372.

Kravitz-Wirtz, N., Crowder, K., Hajat, A., Sass, V., 2016. The Long-Term Dynamics of Racial/Ethical Inequality in Neighborhood Air Pollution Exposure, 1990-2009. Du Bois Rev 13, 237–259.

Kruzman, D., 2022. EPA to investigate racial discrimination in Louisiana's 'Cancer Alley.' Grist.

Last, J.A., 1991. Synergistic effects of air pollutants: ozone plus a respirable aerosol. Res Rep Health Eff Inst 1–32, 33–43 discussion.

LDEQ, 2020. Basis for Decision FG LA LLC Complex.

LDEQ, 2022a. Response to Stop the Wallace Grain Terminal, et al., Complaint Filed under Title VI of the Civil Rights Act of 1964, 42 U.S.C., Section 2000d (Complaint No: 04R-22-R6).

LDEQ, 2022b. Louisiana Department of Environmental Quality ERIC Annual Certified Emissions Data [WWW Document]. URL https://deq.louisiana.gov/page/eric-public-reports (accessed 6.30.22).

LDEQ, 2022c. Louisiana Department of Environmental Quality Emissions Reporting and Inventory Center: Permitted/Actual Emissions By Radius Report [WWW Document]. URL https://business.deq.louisiana.gov/Eric/EricReports/RadiusReportSelector (accessed 4.22.22).

LDEQ, 2022d. Louisiana Department of Environmental Quality Electronic Database Management System (EDMS): Agency Interest Lookup [WWW Document]. URL https://edms.deq.louisiana.gov/edmsv2/ai-lookup (accessed 4.22.22).

LDEQ, 2022e. Louisiana Department of Environmental Quality Ambient Air Monitoring Program [WWW Document]. URL https://deq.louisiana.gov/page/ambient-air-monitoring-program (accessed 7.25.22).

Lee, H.J., Park, H.-Y., 2020. Prioritizing the control of emission sources to mitigate PM2.5 disparity in California. Atmos. Environ. 224, 117316.

Liu, J., Clark, L.P., Bechle, M.J., Hajat, A., Kim, S.-Y., Robinson, A.L., Sheppard, L., Szpiro, A.A., Marshall, J.D., 2021. Disparities in Air Pollution Exposure in the United States by Race/Ethnicity and Income, 1990–2010. Environmental Health Perspectives 129, 127005.

Louisiana Legislative Auditor, 2021. Monitoring and Enforcement of Air Quality. Baton Rouge, LA.

Maraniss, D., Weisskopf, M., 1988. The Faces of Pollution : As Cancer, Miscarriages Mount, Louisiana Wonders If It Is a "National Sacrifice Zone. Los Angeles Times.

MDEQ, 2022. Mississippi Department of Environmental Quality Guidance on Emissions Inventories [WWW Document]. URL https://www.mdeq.ms.gov/air/emissions-inventories/(accessed 12.21.22).

Morello-Frosch, R., Jesdale, B.M., 2006. Separate and Unequal: Residential Segregation and Estimated Cancer Risks Associated with Ambient Air Toxics in U.S. Metropolitan Areas. Environ Health Perspect 114, 386–393.

Morello-Frosch, R., Lopez, R., 2006. The riskscape and the color line: Examining the role of segregation in environmental health disparities. Environmental Research 102, 181–196 IG000012.

Nagra, R., Taylor, R., Hampton, M., Hilderbrand, L., 2021. Waiting to Die": Toxic Emissions and Disease Near the Denka Performance Elastomer Neoprene Facility in Louisiana's Cancer Alley. Environmental Justice 14, 14–32.

National Research Council, 2004. Air Quality Management in the United States.

Page, S., 2005. Memorandum from EPA Office of Air Quality Planning and Standards to EPA Regional Air Division Directors RE: Consideration of Multiple Pollutants in Control Strategy Development.

Perera, P.K.P., Lam, N., 2013. An Environmental Justice Assessment of the Mississippi River Industrial Corridor in Louisiana, Us Using a Gis-Based Approach. Appl. Ecol. Environ. Res. 11, 681–697.

R Core Team, 2020. R: A language and environment for statistical computing.

Rigolon, A., Browning, M.H.E.M., Lee, K., Shin, S., 2018. Access to Urban Green Space in Cities of the Global South: A Systematic Literature Review. Urban Sci. 2, 67.

Sasol Chemicals USA (LLC), 2020. Letter to EPA RE: Amended 2014 Ethylene Oxide Emissions EIS ID: 8468011. Docket ID# EPA-HQ-OAR-2018-0746.

Selvin, H.C., 1958. Durkheim's Suicide and Problems of Empirical Research. American Journal of Sociology 63, 607–619.

Singleton, T., Weinberg, L., Ruiz, T.M., McKeon, J.F., Vainieri Huttle, V., Timberlake, B.N., 2021. Requires DEP to evaluate environmental and public health stressors of certain facilities on overburdened communities when reviewing certain permit applications.

Social Explorer, 2022. American Community Survey (ACS) 5-Year Estimates [WWW Document]. URL https://www.socialexplorer.com/tables/ACS2019_5yr (accessed 4.2.22).

Terrell, K., James, W., 2020. Racial Disparities in Air Pollution Burden and COVID-19 Deaths in Louisiana, USA, in the Context of Long-Term Changes in Fine Particulate Pollution | Environmental Justice. Environmental Justice.

Terrell, K.A., Julien, G.S., 2022. Air pollution is linked to higher cancer rates among black or impoverished communities in Louisiana. Environ. Res. Lett. 17, 014033.

Tessum, C.W., Paolella, D.A., Chambliss, S.E., Apte, J.S., Hill, J.D., Marshall, J.D., 2021. PM2.5 polluters disproportionately and systemically affect people of color in the United States. Science Advances 7 eabf4491.

Tiefenbacher, J.P., Iii, R.R.H., 1999. Environmental Equity in Urban Texas: Racem Income, and Patterns of Acute and Chronic Toxic Air Releases in Metropolitan Counties. Urban Geography 20, 516.

United Church of Christ Commission for Racial Justice, 1987. Toxic Wastes and Race in the United States: A National Report on the Racial and Socio-Economic Characteristics of Communities with Hazardous Waste Sites. New York, NY.

University Network for Human Rights, 2021. "They Didn't Pay Us for Our Memories": Environmental Racism, Forced Displacement, and the Industrial Buyout of Mossville.

U.S. Census Bureau, 2022a. QuickFacts: Mississippi; Louisiana; New Hampshire; Massachusetts [WWW Document]. URL https://www.census.gov/quickfacts/fact/table/MS,LA,NH,MA/RHI125221 (accessed 6.30.22).

U.S. Census Bureau, 2022b. 2010 TIGER/Line Shapefile, Census Tract Boundaries [WWW Document]. URL https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.2010.html (accessed 7.1.22).

U.S. Census Bureau, 2022c. TIGER/Line Shapefile, 2019, nation, U.S., Rails National Shapefile.

U.S. Coast Guard, 2013. Vessel Traffic Service Lower Mississippi River User Manual, Third Edition.

U.S. Energy Information Administration, 2022. Layer Information for Interactive State Maps [WWW Document.

U.S. EPA, 2017. U.S. EPA's External Civil Rights Compliance Office Compliance Toolkit [WWW Document]. URL https://www.epa.gov/sites/default/files/2017-01/documents/toolkit-chapter1-transmittal_letter-faqs.pdf (accessed 6.30.22).

U.S. EPA, 2020. National Emission Standards for Hazardous Air Pollutants: Miscellaneous Organic Chemical Manufacturing Residual Risk and Technology Review [WWW Document]. Federal Register. URL https://www.federalregister.gov/documents/2020/08/12/2020-12776/national-emission-standards-for-hazardous-air-pollutants-miscellaneous-organic-chemical (accessed 7.24.22).

U.S. EPA, 2022a. EJ 2020 Glossary [WWW Document]. URL https://www.epa.gov/environmentaljustice/ej-2020-glossary (accessed 6.30.22).

U.S. EPA, 2022b. Risk-Screening Environmental Indicators 2020 Data; Accessed via EasyRSEI Dashboard Version 2.3.10. [WWW Document]. URL https://edap.epa.gov/public/extensions/EasyRSEI/EasyRSEI.html (accessed 6.30.22).

U.S. EPA, 2022c. 2019 AirToxScreen [WWW Document]. URL https://www.epa.gov/AirToxScreen/2019-airtoxscreen-assessment-results}nationwide (accessed 1.6.23).

U.S. EPA, 2022d. Our Nation's Air: Trends through 2021 [WWW Document]. URL https://gispub.epa.gov/air/trendsreport/2022/}home (accessed 12.21.22).

U.S. EPA, 2022e. EPA Complaint Nos. 01R-22-R6, 02R-22-R6, and 04R-22-R6.

U.S. EPA, 2022f. Frequent Questions: Health Information About Ethylene Oxide [WWW Document]. URL https://www.epa.gov/hazardous-air-pollutants-ethylene-oxide/frequent-questions-health-information-about-ethylene-oxide (accessed 7.24.22).

U.S. EPA, 2022g. NAAQS Table [WWW Document]. URL https://www.epa.gov/criteria-air-pollutants/naaqs-table (accessed 7.25.22).

U.S. EPA, 2022h. NAAQS Designations Process [WWW Document]. URL https://www.epa.gov/criteria-air-pollutants/naaqs-designations-process (accessed 7.22.22).

U.S. Geological Survey, 2022. Ports of the United States.

Whittemore, A.H., 2017. The Experience of Racial and Ethnic Minorities with Zoning in the United States. J. Plan. Lit. 32, 16–27.

Wilbur, S., Wohlers, D., Paikoff, S., Keith, L., Faroon, O., 2008. ATSDR evaluation of health effects of benzene and relevance to public health. Toxicol. Ind. Health 263–398.

Yang, Yang, Ruan, Z., Wang, X., Yang, Yin, Mason, T.G., Lin, H., Tian, L., 2019. Short--term and long-term exposures to fine particulate matter constituents and health: A systematic review and meta-analysis. Environ. Pollut. 247, 874–882.

INHERITANCE

LOUISIANA CHEMICAL PLANTS ARE THRIVING OFF OF SLAVERY

The state's petroleum industry shows how slavery laid the groundwork for environmental racism.

By Anya Groner
Photographs by Stacy Kranitz

MAY 7, 2021

SHARE SAVED STORIES SAVE

This article is part of "Inheritance," a project about American history and Black life.

Sharon Lavigne was teaching a special-education class when her daughter called to tell her about the Sunshine Project. Named for its proximity to Louisiana's Sunshine Bridge, the operation, helmed by the Taiwanese behemoth Formosa Plastics, was on track to build one of the world's largest plastic plants. Already the air Lavigne breathed in her native St. James Parish was some of the most toxic in the United States. Now Formosa planned to spend $9.4 billion on facilities that would make polymer and ethylene glycol, polyethylene, and polypropylene—ingredients found in antifreeze, drainage pipes, and a variety of single-use plastics—just two miles down the road from her family home. The concentration of carcinogens in the atmosphere could triple.

"It hurt me like an arrow through my body," Lavigne told me when I visited her at her home in Welcome, Louisiana, last December. "Everyone else was saying we had to move." Within a few months of learning about the Sunshine Project in spring 2018, Lavigne, who's 69, organized a community meeting in her den. "Ain't gonna happen," Lavigne said. "We not gonna be moved out and bought out and throwed out the window." The group went on to found Rise St. James, a faith-based nonprofit with the mission of halting industrial development in the parish. "I was not a person who would speak up," Lavigne said. "Boy, did that change." That fall, Lavigne was spending so much time organizing marches and speaking publicly about Formosa that, after 39 years of teaching, she retired. Then two of Rise's members died—one of cancer, the other of respiratory distress and other medical problems, conditions Lavigne links to pollution from existing plants. Stopping Formosa became her full-time job.

In Louisiana—where more than a 12th of the country's estimated 4 million enslaved people lived prior to the Civil War—descendants have the right to visit their ancestors' graveyards. So when Lavigne learned in late 2019 that enslaved people from the Buena Vista Plantation, whom she believes she's descended from, may have been buried on Formosa's proposed building site, she tried to visit. Upon arriving, she said authorities told her she was trespassing and that if she returned, she'd be arrested.

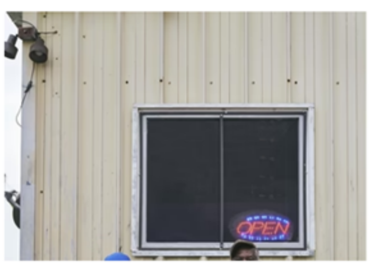
Back in July 2018, Coastal Environments, or CEI, an independent archaeological and environmental contractor, had alerted the Louisiana Division of Archaeology about two possible cemeteries on Formosa's land, based on historic maps of the Buena Vista and Acadia Plantations. Formosa's archaeological consultants had missed those sites in their initial survey, but after being instructed by the state to look again, they found and fenced off the Buena Vista cemetery. According to the Center for Constitutional Rights, a legal-advocacy nonprofit, Formosa made no public announcement of this discovery. Lavigne found out about its existence more than a year later via a public-records request submitted by Rise's lawyers. The Acadia cemetery, Formosa reported, had still not been located and may have been destroyed by a previous owner, but both CEI and the Center for Constitutional Rights dispute that claim, arguing that

Formosa's surveyors searched in the wrong area. In March 2020, CEI identified five additional anomalies on Formosa's territory that could also be slave cemeteries and have not yet been excavated. ("Archaeologists conducted thousands of shovel tests … no remains have been found other than at the Buena Vista site," Janile Parks, Formosa's director of community and government relations, wrote me via email. "When [Formosa] learned of remains at the Buena Vista site … the company immediately coordinated with the appropriate authorities. [Formosa's] archaeological investigations of the site have been transparent and are matters of public record.")

Rise formally requested access to the Buena Vista cemetery last year for Juneteenth, a holiday commemorating the day that enslaved people in Galveston, Texas, found out they were free—more than two years after the signing of the Emancipation Proclamation. Formosa denied the Juneteenth request, and Lavigne took them to court. In a statement to the Associated Press, the company's lawyers questioned the need for the ceremony on the basis that archaeologists couldn't confirm the ethnicity of the human remains. District Judge Emile St. Pierre sided with Rise, giving the group temporary access to the property. "We need healing," St. Pierre said at the end of the hearing. "Let's look at where we are in America."

The conflict between Rise St. James and Formosa comes at a time when many Americans are insisting the country acknowledge and address the horrors of slavery and its repercussions. Around the country, cities have debated whether to take down Confederate monuments, inciting protests. Down the river from St. James Parish, in New Orleans, several monuments have already been removed, and the city council is preparing to rename schools and streets that honor Confederate officials and segregationists. Yet what's happening with the Buena Vista grave site is unique. Unlike monuments, which are symbolic, the cemetery contains human remains, which have endowed the land with enough cultural capital to sway a judge, at least temporarily, in favor of the community that claims it. Like a time capsule, the graves link the petrochemical industry to the plantation economy, revealing how Louisiana's petroleum industry profits from exploiting historic inequalities and showing how one brutal system gave way to another.

Sharon Lavigne at home



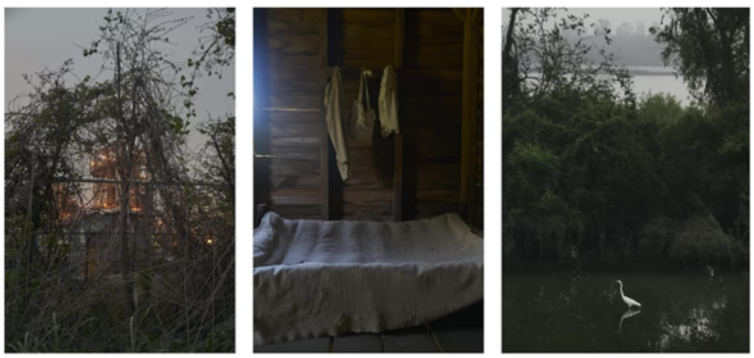
Left: Men sitting outside Blues Grocery, which is next to a new methane plant; *Right:* A storage facility in St. James Parish along River Road

Two hundred years ago, nearly every inch of Mississippi River–adjacent land south of Natchez was part of a plantation. Rich soil made for strong harvests, and river access allowed for the easy export of goods. In Louisiana, those plantations grew sugarcane, the "white gold" that propelled the southern economy. Arduous to harvest, grueling to press, and treacherous to boil, sugar had been a rare commodity, a crop barely worth the effort, until the transatlantic slave trade solved the problem of labor. In the half century preceding the Civil War, 1 million people were sold into the Deep South, relocated from Virginia, Maryland, and Kentucky to Alabama, Mississippi, and Louisiana. Along the lower Mississippi River, the population of enslaved people quadrupled despite their being worked so hard that death rates often exceeded birth rates. Nonconsensual laborers produced a quarter of the world's cane sugar, which became so lucrative as a crop that, for a time, the nation's highest concentration of millionaires lived between Baton Rouge and New Orleans. Back then, Louisiana was the second-richest state per capita, a staggering feat when you consider that almost half of its residents lacked legal ownership of their bodies.

Drive along the lower Mississippi River today in southern Louisiana, and you'll see vestiges of that history, though the state now has the second-highest poverty rate in the union. Houses are small and trailers abundant, but more than a dozen plantations still exist, offering tours, meals, wedding venues, and overnight stays, their advertising thick with honeyed narratives about an opulent white lifestyle long gone. Until two years ago, a sign at Rosedown, the most visited plantation in the state, described enslaved people as "happy" with a "natural musical instinct." Ormond Plantation's website laments the hard times suffered after "the war between the states." Only one plantation museum in Louisiana, the Whitney, focuses exclusively on the labor and culture of African and African-descended people. There, visitors can pay their respects at memorials for the enslaved, tour slave cabins, and peek in the overseer's shed, where the tools of chattel—neck braces, balls and chains, leg irons, and paddles—hang from the walls and ceiling.

The land adjacent to the Mississippi River bears the marks of another brutality, unmissable from a car, barge, or plane. Beside the restored plantation houses and acres of sugarcane that still stripe the landscape, a newer economy chugs and chuffs. More than 150 petrochemical plants operate along the 85-mile stretch of land from New Orleans to Baton Rouge. Stadium-size holding tanks, miles-long pipes, and flaring smokestacks create skylines reminiscent of cities, though, aside from the occasional security truck, few humans are visible. Names such as Syngas and American Styrenics make it difficult to tell what each plant makes, but whatever it is, you can smell it, cough it out, and sometimes see it falling, a soft yellow rain from a discolored sky. The sheer quantity of plastics, synthetic rubbers, electronic components, and fertilizers manufactured here is enough that experts call the area "the Silicon Valley of the petrochemical industry."

Houma House is one of many plantations open to the public for tours. The tour highlights the legacy of sugar barons and barely mentions the history of slavery.



From left: An ExxonMobil Chemical Company plastics plant seen through the brush; slave quarters at the Magnolia Mound plantation*; an egret near the river

The Sunshine Project has an unmistakable doomsday quality. According to a 2020 Pew Research Center poll, about two-thirds of Americans believe the federal government should do more to reduce global climate change, yet Louisiana's Department of Environmental Quality has written permits for the proposed facilities to emit more than 13 million tons of greenhouse gases a year, the equivalent of three and a half coal plants. In addition, extensive research on the damaging effects of plastics has spawned a global movement to ban single-use items such as bags, straws, and cups. Despite this, Louisiana's governor, John Bel Edwards, defends the Sunshine

Project, hailing its proposed facilities as an economic win. In addition to tax revenue, Formosa anticipates that it'll support an estimated 8,000 temporary ancillary positions in the construction and service industries and create 1,200 on-site jobs with an average yearly salary of $84,500, almost triple the median household income for St. James Parish's Fifth District, where the plants would be located.

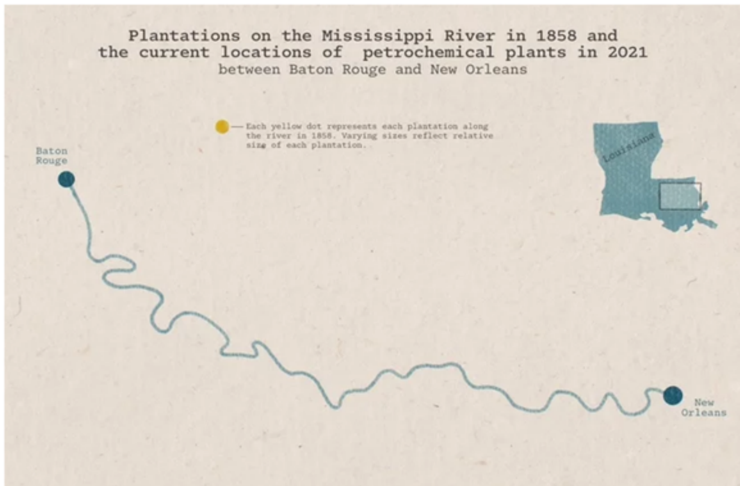
Lavigne thinks those numbers are spin. The state has often equated industry with progress, but petrochemical facilities have a documented history of outsourcing labor. Lavigne is doubtful that Formosa will hire people from her community, besides for low-paying security work—a perspective her parish councilman, Clyde Cooper, shares. "These new companies don't hire anyone from the community," Cooper told me over the phone. "People come, even from outside of the state, to work in construction and in the plants." (In 2018, Cooper voted to back the Sunshine Project, on the condition that the company agree to preferential hiring from within the parish, plus funding for a hurricane evacuation route and free cancer screenings for residents of the Fifth District.)

As for taxes, Louisiana's notoriety for corporate welfare has long made it a haven for refineries and manufacturers. Since the 1930s, the Industrial Tax Exemption Program has allowed a state-level board to make decisions about parish-level property-tax exemption. According to a study by Together Louisiana, a statewide network of community organizers, from 1997 to 2016 the ITEP board approved all but eight of 16,931 corporate-tax-exemption applications. In 2017 alone, those exemptions cost state parishes about $1.9 billion, money that could've been spent on local parks, libraries, and schools. In 2016, Edwards issued an executive order returning decision-making power on property-tax exemptions to the parishes, but he backtracked in 2020 when he gave corporations the option of appealing local decisions to a state board.

And yet, taxes and jobs are the least of Lavigne's worries. What keeps her up at night are emissions. In the entire U.S., only one plant emits chloroprene, an ingredient in wet suits and Koozies that's linked to liver and lung cancers. That it's in southeast Louisiana is no accident. As reported by ProPublica, the state has a reputation for having policy makers sympathetic to industry, and lax environmental regulation. Since the 1980s, residents have been documenting high rates of miscarriages and cancer, earning the parishes along the Mississippi River the nickname "Cancer Alley." "Ask anyone," Harry Joseph, the local pastor of the 114-year-old Mount Triumph Baptist Church, said during a bike tour highlighting environmental injustice. "There's not a household here that hasn't dealt with cancer." The region has improved considerably since the 1963 Clean Air Act and the 1972 Clean Water Act created federal pollution limits. But in the past decade, hydro-fracturing—the practice of injecting pressurized liquids into bedrock in order to extract fossil fuels—has produced a glut of natural gas that's fueled the establishment of new chemical plants, and environmental progress is expected to backslide.

Already under scrutiny for allegedly protecting the industry it's meant to regulate, Louisiana's Department of Environmental Quality has proposed an air-emissions allowance for the Sunshine Project that includes: 7.7 tons of ethylene oxide—a carcinogen linked to breast cancer, non-Hodgkin's lymphoma, leukemia, and miscarriages; 36.58 tons of the carcinogen benzene; and 1,243 tons of nitrogen oxides, which cause and exacerbate respiratory illnesses. (Formosa "has relied on sound science in design of the Sunshine Project and is confident it meets all regulatory criteria," Parks said in her email. "Protecting health, safety and the environment is a priority in project engineering, design and operations.") In a still-unresolved 2020 lawsuit, a coalition of environmental organizations allege that these quantities surpass federal air standards and that the Louisiana DEQ failed to consider existing air pollution and disproportionate racial impacts in its assessment. ("Our permits were issued in accordance with all applicable state and federal laws," Gregory Langley, the press secretary for the Louisiana DEQ, told me by email. "Great care is taken in the site selection process to identify a safe location for the plant that is protective of the adjacent communities and their residents.")

At the heart of the dispute is the Louisiana Tumor Registry, a project from Louisiana State University's School of Public Health meant to track cancer risk throughout the state. Although the registry reports no elevated cancer risk in St. James Parish, critics point out that its data neither take into account residents' proximity to plants nor measure the impact of new facilities. This missing information matters. The 824 residents of Welcome aren't the only ones in the immediate vicinity of the Sunshine Project. Fifth Ward Elementary is a mile away—nearly all of its 123 students are Black.



Klara Auerbach

It's not by chance that 158 years after the signing of the Emancipation Proclamation, rural Black communities bear the environmental consequences of Louisiana's biggest industry. Overlay a map of southern Louisiana's petrochemical and petroleum plants with archival maps of the area's plantations, and you'll find that in many cases the property lines match up. "One oppressive economy begets another," Barbara L. Allen, a professor of science, technology, and society at Virginia Tech and the author of *Uneasy Alchemy*, a book on environmental justice in the region, told me over the phone. "The Great River Road was built on the bodies of enslaved Black people. The chemical corridor is responsible for the body burden of their descendants."

Allen's research examines the extractive economy: how sugar monocropping transitioned to petrochemical manufacturing. During Reconstruction, the Freedmen's Bureau gave land grants to Black maroons and the formerly enslaved along the lower Mississippi, parceling out slivers of large plantations to extended-family groups as part of reparations, while returning the bulk of the land to white owners. The result, Allen wrote in a 2006 article, was "a pattern of large, contiguous blocks of open land under single ownership … separated by communities of freed blacks and poorer whites." Like plantations, petrochemical and petroleum plants benefit from large acreage and easy access to some of the world's busiest shipping lanes. When the oil industry moved in during the first half of the 20th century, corporations began buying up the intact plantations. More than a century later, the pattern established during Reconstruction is still visible, only instead of plantations, Louisiana's historic free towns share fence lines with plants.

The proliferation of petrochemical plants along the lower Mississippi is undoubtedly slavery's legacy. Before the Civil War, the state relied on the plantation economy. Today it relies on an industrial economy, which continues to disenfranchise residents. In her 2016 book, *Strangers in Their Own Land*, the sociologist Arlie Hochschild observes that many rural white Louisianans believe they must sacrifice environmental regulation in order to have jobs. For many rural Black Louisianans, that sacrifice is much starker. When industry moves in, descendants of the formerly enslaved get neither environmental security nor well-paying jobs. Like the plantations and land owners who came before them, petrochemical plants and their leadership have emerged as a new kind of "boss," determining what happens not only to the land but also to the people who live there. The court case about Juneteenth access to the Buena Vista cemetery illustrates just how much this is a struggle about ownership of bodies: who decides which bodies go where, who has access to the bodies of the deceased, and ultimately who determines which chemicals Black people are exposed to.

Politics in Louisiana often revolves around industry. “St. James Parish, on its face, is hunky-dory: fifty-fifty Black and white,” Anne Rolfes, the founder and director of the Louisiana Bucket Brigade, a nonprofit that partners with fence-line communities to advocate for environmental rights, said during the aforementioned bike tour. “However, the African American population is mostly at one end of the parish, in the Fourth and Fifth Districts. And where do you think the land-use plans put all the petrochemical plants?” Lavigne lives in the Fifth District, where nine plants are in operation, two are under construction, and four more, including Formosa's megaplex —which itself includes 14 unique facilities—are proposed. This concentration of industry is enabled by zoning laws. Typically, land-use plans separate residential areas from industrial ones, but in 2014, the St. James Parish council voted to change river-adjacent sections of the Fourth and Fifth districts from “residential” to “residential/future industrial.” “The council will fight to keep the petrochemical plants out of the white districts, but they roll out the red carpet … when it comes to the Fourth and Fifth” Districts, Rolfes said. “It's worse than redlining. It's shocking, really. The council has a written plan to wipe out Black communities.” Councilman Cooper acknowledged “biased consideration” in the council's zoning, but stopped short of calling it environmental racism. “I don't think it's strictly on being racist. They got big plots of unused cane and farmland on the river and there's a rail there and easier access because it's not as populated.”

Noranda Alumina, located on the Mississippi River in Gramercy, Louisiana, is the only major alumina refinery operating in the United States.

Left: The Bourgeois family lives in a predominantly white section of St. James Parish. *Right*: A mother, Geraldyn Shepard, waits with her daughter Tori-on for the school bus in St. James Parish.

Rolfe's assessment, however, is backed by the local historical record. In 1987, traces of vinyl chloride were discovered in the blood of children from nearby Reveilletown, a historic free town founded in the 1870s. Following a settlement, Georgia Gulf Corp., the owner of a neighboring plant, bought out the rest of that town for $3 million. Two years later, vinyl chloride had contaminated the groundwater in the historic free town of Morrisonville, and Dow Chemical Company spent $7 million buying out residents. In 2002, yet another free town, Diamond, sandwiched between two Shell Chemicals plants, was bought out decades after two fatal chemical explosions. In each case, Black families had little choice but to leave, giving up not only their houses, which pollution had rendered unsellable, but also their community. This repetition of buyouts has created what environmentalists believe is a dangerous precedent: Instead of remedying safety and environmental concerns, plants that pollute can pay their way out of trouble.

Even before the onset of the coronavirus pandemic, the river parishes' nickname had begun shifting from "Cancer Alley" to "Death Alley." The kinds of preexisting conditions that make COVID-19 especially deadly thrive here, giving one rallying cry against systemic racism—"I can't breathe"—haunting significance. Still, the environmental-justice movement, which combines a demand for racial equality with the push for environmental protection, has gained traction in St. James Parish during the pandemic. Shortly before Rise's Juneteenth ceremony, Formosa announced that it would halt construction on the Sunshine Project until COVID-19 rates dropped in the area. The decision coincided with an increase in negative media attention about its handling of the rediscovered grave sites and an impending environmental lawsuit, which was suspended when the Army Corps of Engineers announced that it was reevaluating Formosa's wetlands permits. Though the company resumed "preconstruction" activities such as road building and soil testing in October, Formosa said it would defer major construction until a COVID-19 vaccine was widely available. Work on the property is still halted today. ("The significant economic impact of COVID-19 has contributed to difficulty in evaluating construction," Formosa's Parks wrote. "Ongoing legal proceedings also contribute to the delay.") Meanwhile pressure is mounting to shut down the whole project.

Two U.S. representatives, the Democrats Raúl M. Grijalva of Arizona and A. Donald McEachin of Virginia, are pushing the Biden administration to permanently revoke the Sunshine Project's permits. (The congressman who had represented St. James Parish, Cedric Richmond, left his post in January to join President Joe Biden's cabinet. So far he's made no comment for or against Formosa.) Experts appointed by the UN's Human Rights Council have weighed in too, calling on "the United States and St. James Parish to recognize and pay reparations for the centuries of harm to Afro-descendants rooted in slavery and colonialism." Such support is hard-earned, but how much it will matter in the long run is unclear. "Industry [in Louisiana] has just exploded," Allen, the Virginia Tech professor, said. "In five or 10 years … I wonder if the region will even be livable."

A Rise St. James billboard on the road leading to the Sunshine Bridge

---

Oppression runs deep in southern Louisiana, but so does resistance. On January 8, 1811, a group of enslaved people marched from Woodlawn Plantation in St. John the

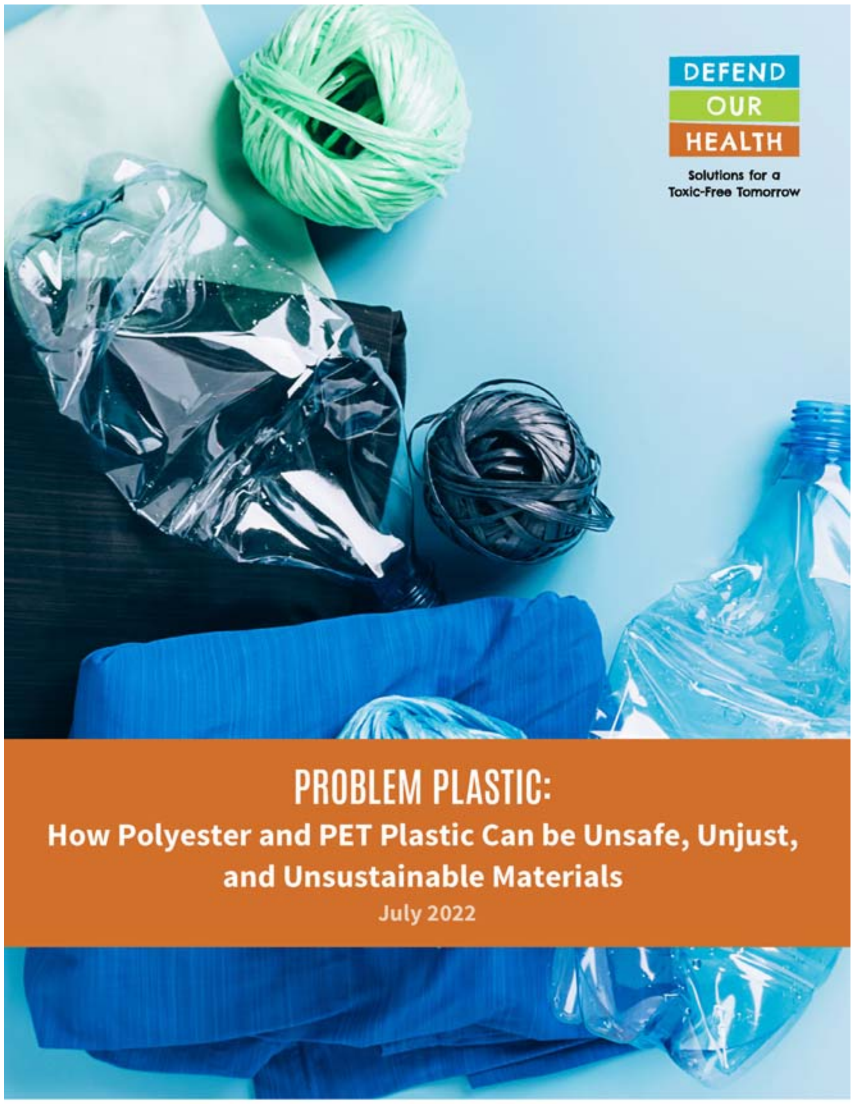
Baptist Parish toward New Orleans. With each plantation they passed, more people joined, armed with cane knives, hoes, clubs, and guns, until more than 500 people flowed downriver, bent on founding a new Black nation. Within days, the rebellion was quashed. Dozens of Black men and women were killed by federal troops and plantation militia, and many more were sentenced to death, their severed heads mounted on spikes and displayed along a 60-mile stretch of river.

For a time, knowledge of the revolt was lost, a victim of historical amnesia. Over the past decade, though, tours, book publications, and museum exhibits have restored the event to the popular imagination. In 2019, that history came alive when the artist Dread Scott led hundreds of mostly Black volunteers in period costume on a 24-mile march past plantations and petrochemical plants, ending the reenactment at a destination the original insurgence never reached: New Orleans's Congo Square. "Their rebellion is a profound 'what if?' story," reads Scott's website. "It had a small but real chance of succeeding."

In some ways, Lavigne's work with Rise isn't so different. When she and her peers organize, the odds are against them. They're a small group advocating for change in a region shaped by plantations, in a state where politicians consistently choose industry over environment, against a corporation they believe is determined to make plastics no matter the human cost. "We are here to acknowledge the evil of slavery and its aftermath," Lavigne announced to her online audience and to the few dozen people gathered in person at Buena Vista cemetery last Juneteenth. She placed a bouquet of roses near eight rediscovered grave shafts. "Those were their very bodies. Their very labor," one onlooker observed. "We honor our ancestors by thriving." The crowd swayed, singing, "I said, Lord, help me please / I got up singing—shouting!—victory."

The stories Louisianans tell about their history matter. The 1811 revolt ended in horrific violence, but today that history is often recounted with a kind of instructional reverence. Here were enslaved people who dreamed and organized and marched so that their children might experience a better life. Here were people who were beaten down and rose up anyway, knowing very well that their greatest hope for survival might end with the loss of their life. They strove—yes, they did—and look at how they nearly succeeded.

**A photo caption in this article previously mislabeled the location of slave quarters. The photo was taken at the Magnolia Mound plantation, not the Whitney plantation.*


DEFEND
OUR
HEALTH
Solutions for a
Toxic-Free Tomorrow
PROBLEM PLASTIC:
How Polyester and PET Plastic Can be Unsafe, Unjust, and Unsustainable Materials
July 2022

PROBLEM PLASTIC:
How Polyester and PET Plastic Can be Unsafe, Unjust, and Unsustainable Materials

July 2022

This report is published by Defend Our Health, a U.S.-based nonprofit organization working to create a world where all people have equal access to safe food and drinking water, healthy homes, and products that are toxic-free and climate-friendly.

How to cite this report: Defend Our Health 2022. Problem Plastic: How Polyester and PET Plastic Can be Unsafe, Unjust, and Unsustainable Materials. Full text at https://defendourhealth.org/campaigns/plastic-pollution/problem-plastic/

Authors:	Michael Belliveau, Executive Director, Defend Our Health Roopa Krithivasan, PhD, Research Director, Defend Our Health
Research:	Material Research, L3C (manufacturing supply chain) Roopa Krithivasan, PhD (product testing, chemical migration) Michael Belliveau (markets, antimony)
Product Testing:	Vanguard Laboratory, Olympia, WA Ecology Center, Ann Arbor, MI
Layout & Design:	Pine Street Publishing LLC, Portland, ME iilo Creative Alliance inc., Vancouver, BC
Project Management:	Roopa Krithivasan, PhD

We are very grateful to several reviewers who provided invaluable feedback on draft content, including the following: Shari Franjevic, Birgit Geueke, Patrick MacRoy, Gillian Miller, Taylor Moore, Roshi Pani, Maya Rommwatt, Renée Sharp, Jessica Trowbridge, Sophie Webb, and additional anonymous reviewers.

This report was made possible through the generous support of **Bloomberg Philanthropies** whose strategic investment in ending harm from petrochemical plastics will protect environmental health and ensure climate justice for all and for generations to come.

We also deeply appreciate those funders and donors whose program support further enables the work of Defend Our Health to prevent petrochemical plastic pollution, including:

Broad Reach Fund, Cedar Tree Foundation, Cloud Mountain Foundation, Colbert Family Fund, EarthSea Fund, Forsythia Foundation, Marisla Foundation, Orchard Foundation, Passport Foundation, Seed Moon Foundation, and **The Fine Fund**.

We also acknowledge with great respect the past investments of funders who spent down their assets to hasten the just transition to a safer, more sustainable planet and whose shoulders we stand on, including **Beldon Fund, John Merck Fund**, and **Kendeda Fund.**

DEFEND OUR HEALTH
Solutions for a Toxic-Free Tomorrow

DefendOurHealth.org

TABLE OF CONTENTS

EXECUTIVE SUMMARY

We believe that petrochemical plastics are unsafe, unjust, and unsustainable due to their lifecycle impacts. Plastic pollution is much more than a waste problem. Before being thrown away, petrochemical plastics can threaten human health, cause environmental injustice, and fuel the climate crisis.

This report investigates the impacts of one of the most widely-used plastics, known as PET (for polyethylene terephthalate) and as "polyester" in its fiber form. While PET is but one of several problematic plastics, it is emblematic of concerns that may exist with all petrochemical plastics.

We chose to closely examine PET (including polyester) because of its major production volume, its reliance on toxic chemicals and plastic additives that can threaten human health, and the mismanagement typical of the end of PET products' short life-cycle. Like other petrochemical plastics, PET can also contribute to environmental racism and increases greenhouse gas emissions. While chemistry and other details vary, many, if not most, petrochemical plastics implicate similar concerns.

PET is the most common material used to make plastic bottles, cuddly stuffed toys, and clothing. It can pose hidden health hazards to young children and other consumers. Our investigation of PET found unsafe levels of plastics-related chemicals in some beverages packaged in plastic bottles.

The toxic element antimony is a plastics processing aid used to speed up the final chemical reaction that produces PET resin and polyester fiber. Some of the antimony remains in the final PET product and can make its way into the food and beverages that are packaged in PET bottles and containers. Defend Our Health tested samples of twenty major brands of beverages packaged in PET plastic bottles to evaluate the amount of antimony present in the sampled beverages.

In nearly half of the PET plastic-bottled beverages we tested (40%), the concentration of antimony in the drink itself exceeded 1 part per billion (ppb), the California Public Health Goal for drinking water. Daily exposure above this amount may cause liver disease. Excess exposure to antimony compounds may also increase the risk of cancers, heart disease, and other organ toxicity.

Antimony in 90% of the beverages we tested exceeded 0.25 ppb, a more protective health limit recommended by Defend Our Health to better account for typical daily antimony exposures from other sources.

Higher amounts of antimony leach into food and beverages when PET plastic bottles and food trays are heated, stored, exposed to light, or used to package acidic beverages such as juices and carbonated soft drinks.

Babies and toddlers who suck on soft cuddly toys (such as stuffed animals), blankets, clothing, and other polyester items may also be exposed to unsafe levels of antimony.

PET plastic can threaten children's health because many kids are likely already exposed to unsafe levels of antimony from a combination of sources to which they are routinely exposed. Antimony is added to many other plastic products, including electronics and home furnishings, to enhance the effect of flame retardant chemicals. Those products can release antimony in the home, which builds up in house dust. Toddlers may then ingest household dust containing antimony from frequent hand-to-mouth activity. We calculate that young children are likely exposed to almost three times as much antimony per bodyweight as adults in the U.S.

This concept of "aggregate risk" from total exposure to all sources of a chemical is comparable to filling a bath for your child in the tub. You don't let the faucet run until the tub overflows and then keep adding water. Similarly, antimony exposure from PET plastic and polyester adds to health risks that may be already overflowing, worsening the overall impact.

PET plastic and polyester can contribute to environmental racism and injustice. On a nationwide basis, Latinx and Black consumers are exposed to higher levels of antimony in general than white Americans, and at nearly twice the amount in the highest exposure groups, according to the National Biomonitoring Program.

Production of petrochemical plastics, including PET, is concentrated near lower-income communities and communities of color. Black and Brown residents and poor people, in a greater percentage than the national average, are surrounded by more than twenty petrochemical manufacturing plants that directly supply petrochemicals used in PET plastic production in North America. PET plastics-related chemical plants near communities that are already heavily over-burdened with industrial pollution from many sources manifest an even greater injustice. The majority of PET plastics-related chemical plants in North America are located in Texas, Louisiana, Alabama, South Carolina, North Carolina, and Mexico.

Almost all petrochemical plastics, including PET, are unsustainable materials. More than 99% of PET plastic is made from non-renewable fossil carbon extracted from the earth by drilling and fracking for crude oil and natural gas. Greenhouse gases emitted by the production and disposal of petrochemical plastics are fueling the climate crisis.

Most PET plastic is used only once and then thrown away. Only about 11% of the PET and polyester produced has ever been recycled, and nine times out of ten it is recycled for just one more use. Although the recycling rate for plastic bottles has grown to almost 30%, two-thirds of all PET takes the form of polyester fiber. Less than 1% of clothing, where polyester dominates, is ever recycled. Most PET recycling simply turns plastic bottles into lower quality polyester fill, a phenomenon known as "down-cycling."

The petrochemical plastics industry profits from this extractive, one-time use model, and encourages ever-increasing plastics demand. The industry has grown exponentially since 1950, and recent petrochemical industry growth projections indicate plastics production will double by 2040.

Texas City petroleum refining & petrochemical manufacturing center | Jim Evans, CC BY-SA 4.0 <https://creativecommons.org/licenses/by-sa/4.0>, via Wikimedia Commons

Two proposed new chemical plants would worsen the adverse impacts of PET plastic

The proposed Corpus Christi Polymers plant in Texas would increase PET plastics production capacity in North America by nearly 25%, producing 1.1 million tons per year. A joint venture between three large existing PET producers – Indorama Ventures of Thailand, Alpek of Mexico, and Far Eastern New Century from Taiwan – this would be the largest PET plant in the world. Much delayed already, the plant could go online in 2024.

The proposed Formosa Plastics chemical plant planned for Welcome, St. James Parish, Louisiana would produce 1.6 million tons per year of monoethylene glycol (MEG), a building block chemical essential for PET production, as well as massive amounts of polyethylene plastic. Globally, 80% of MEG is used to make PET plastic and polyester.

Local residents and health advocates have vigorously opposed the siting of this chemical plant as environmentally racist and a threat to public health. Formosa's operations would drive up emissions of cancer-causing ethylene oxide, a byproduct of MEG production. Construction of this plant is on hold pending completion of a federal Environmental Impact Statement that must consider the cumulative impacts and environmental injustice faced by local residents from the many existing industrial polluters in "Cancer Alley".

Petrochemical pollution from PET and other plastics can and must be stopped

Preventing plastic pollution must begin at the source. Elimination of unnecessary uses and substitution with safer, more sustainable solutions should be the top priority. Recycling is a stopgap measure that alone cannot solve the plastic problem.

Corporate and government leaders, responding to demands from organized consumers and voters, should undertake a series of immediate and longer-term actions to prevent petrochemical plastic pollution. With the end goal in mind, these actions – many of which have been endorsed by scientists and market leaders – should include:

- ***By 2040, the use of virgin fossil PET plastic and polyester should be phased out***
- ***By 2030, replace 50% of PET bottles and packaging with reusable and refillable systems***
- ***By 2030, substitute 50% of virgin polyester with recycled clothing or natural fibers***
- ***By 2030, replace 50% of PET with 100% non-toxic biobased PET or bioplastics such as PEF***
- ***By 2025, meet the industry's Recycled Polyester Challenge to increase the recycled content of polyester to 45% (on the path toward achieving a 90% share by 2030)***
- ***By 2025, meet the industry pledge to eliminate unnecessary and problematic plastic materials (e.g. opaque or pigmented PET plastic bottles, and PETG in rigid packaging)***
- ***By 2025, assess the hazards of all chemical substances used or produced to make PET***
- ***By 2024, eliminate chemicals of high concern as PET plastic additives and processing aids***
- ***By 2023, end all use of antimony and cobalt compounds in PET plastic and polyester***

Through such actions, we can effectively transition away from dependence on PET and other petrochemical plastics in favor of safer and more just and sustainable materials and other solutions that meet the needs of society with less risk of harm to people and the planet.

Problem Plastic? Polyester and PET

PLASTIC POLLUTION IS IN OUR HOMES AND BODIES

Common plastic products made of **PET and polyester often contain antimony** that disproportionately harms the health of babies, children, and people of color. Everyday products made with antimony include many cuddly toys, soda and water bottles, and polyester clothing.

Your plastic bottle is more than just plastic.
It's a mix of all sorts of chemical additives and toxic byproducts, many of which can escape from the plastic. PET, also known as polyester, often contains **antimony, a toxic metal**. Health authorities try to limit our exposure to antimony, but too much is escaping from the plastics all around us.

PET plastic and polyester contribute to environmental racism and injustice. Nationwide, Latinx and Black consumers are exposed to higher levels of antimony than white Americans.

Why is PET harmful?
PET Plastic and Polyester are different forms of the same plastic *(polyethylene terephthalate)*. Antimony is one of many chemicals used to make PET; some of them are known to be toxic. These chemicals:

- can increase risk of liver and heart disease
- may cause lung and breathing problems
- are linked with cancers
- interfere with endocrine and hormone health

BABIES & KIDS AT HIGH RISK

Some **children are exposed daily to nearly double the safe limit for antimony** set by the US EPA, and six times the California standard.

How are kids exposed to so much antimony? One reason is likely the **antimony in many plastic products**, including **toys that babies suck on**. And due to their frequent hand-to-mouth activity, they may also ingest antimony shed from everyday plastics into household dust.

HIGH LEVELS OF ANTIMONY FOUND IN BEVERAGES

We tested drinks in plastic bottles from **Coca-Cola, Pepsi, Keurig Dr Pepper,** and other major brand owners.

40% **of the PET bottled beverage samples we tested had concentrations of antimony that exceeded the California Public Health Goal for drinking water.** Daily exposure above this amount may cause liver disease.

ANTIMONY IN POLYESTER CLOTHES

60% of all clothing currently produced has polyester.

Clothing and textiles can break down with use, which may **shed microplastics and antimony** in our homes, build up in dust, and may enter our bodies when we breathe, eat, and touch things around us.

We're making sure powerful corporations get rid of toxic antimony in their plastic products— it's a first step towards completely phasing out dangerous petrochemical plastics.

Will you join us? Read the report to learn more: https://defendourhealth.org/campaigns/plastic-pollution/problem-plastic/

DEFEND OUR HEALTH

CHAPTER 1

Tackling Petrochemical Pollution, One Plastic at a Time

Plastics are found everywhere in our homes and lives. Cheap, light-weight, and functional – petrochemical plastics made from crude oil and natural gas have displaced forest products, natural fibers, and common metals as the raw material of choice for many manufacturers. Plastics dominate much of our materials economy, with widespread use in building products, transportation, appliances, apparel and footwear, consumer goods, packaging, food processing and more.

About 475 million metric tons of plastic were produced globally in 2019. (See Table 1-2). It's hard to fathom the magnitude of such a number. What are some equivalent amounts?

Consider that more plastics are produced in just one year than the total weight of:

- **Every person[2] on Earth, with a global population of nearly 8 billion people[3];**
- **589 Golden Gate Bridges[4]; or**
- **91 Great Pyramids of Giza[5].**

But a one-year snapshot doesn't capture the ever-increasing volume of plastics produced every year, a phenomenon known as exponential growth. Twice as much plastics entered commerce in 2020 than were produced barely twenty years ago; but annual plastics production has increased ten times in less than 50 years and more than 200 times in the last 70 years[6]. If recent petrochemical industry growth projections hold, global plastics production will double again by 2040[7].

It's no wonder that plastic pollution has reached crisis proportions. About 70% of all plastics ever produced between 1950 and 2015 have become waste while 30% still remain in use; For that wasted plastic, only 9% has ever been recycled (usually only once) with 12% incinerated and 79% of all plastics discarded in landfills and the natural environment[6].

"I want to say one word to you. Just one word. ... Plastics!"

– The Graduate, 1967 [1]

Plastic waste dominates the public and political perception of plastic pollution

All plastic becomes waste over time (Table 1-1). Single-use packaging draws immediate attention for its extreme wastefulness and its large share of petrochemical plastics production. All other uses of plastics also add to the growing mountains of plastic waste every year, just on a more slowly unfolding timescale. Due to high production volumes, plastics used for building and construction materials, clothing and other textiles, and consumer goods, also generate huge volumes of plastic waste.

Most plastic waste is mismanaged. Globally, nearly 20% of single-use packaging and other short-lived plastics are directly discarded to land and ocean, with another 22% of this plastic waste openly burned [8], a major source of dioxins and other highly toxic air emissions [9]. Even "managed" plastic waste creates avoidable environmental impacts, with about 30% of short-lived plastic waste destined for landfills and another 13% to incinerators, both of which pollute surrounding communities.

Gut-wrenching images of sea turtles and birds choking to death from plastic waste have galvanized public outrage and global political response. Although much public attention has been focused on beaches littered with plastic packaging, other forms of plastic waste mismanagement also result in tragic consequences for human health and the environment.

A growing addiction to synthetic fibers and short-lived 'fast fashion' has fueled continuously burning piles of "waste" polyester clothing in the global south [10]. The nominal "recycling" of e-waste in Asian countries has poisoned children and pregnant women with lead, dioxins and other chemical pollutants when scrap electronics full of plastics are burned to recover precious metals [11]. Plastics, including highly-polluting polyvinyl chloride (PVC), make up a growing fraction of construction and demolition waste, which often ends up in unlined landfills or being openly burned [12].

Table 1-1. All uses of plastic generate waste

PLASTIC USE SECTORS	PRODUCTION SHARE, 2015	LIFESPAN AT PEAK WASTE (IN YEARS)
Packaging	**35%**	1
Consumer & Institutional	**11%**	3
Textiles	**16%**	5
Other Plastic Uses	**12%**	5
Electrical & Electronic	**4%**	8
Transportation	**5%**	13
Industrial Machinery	**<1%**	20
Building & Construction	**17%**	35

Adapted from Geyer et al. (2017) [5]

The shameful waste of plastics and its impacts does not tell the whole story. Even more harm occurs <u>before</u> plastic becomes trash.

Jemimus, CC BY 2.0 <https://creativecommons.org/licenses/by/2.0>, via Wikimedia Commons

Plastic pollution reframed: Environmental health and climate justice threat

Consider these trends and growing impacts from the production, use, and disposal of petrochemical plastics:

- **The plastics industry emissions of greenhouse gas emissions**, currently equivalent to about 200 coal-fired power plants, will continue to grow until plastics account for at least 10% to 15% of the entire fossil carbon budget by 2050 [13];
- Of the more than 10,000 **chemicals used to make plastics**, about 24% pose known **hazards to human health or the environment**, while data gaps leave us in the dark about the safety of another 39% of plastics-related chemicals [14]; and
- **In a classic case of environmental injustice, petrochemical manufacturing plants** in the United States are often located in communities that are home to mostly people of color and/or lower income residents who are already heavily over-burdened by industrial pollution, according to a recent analysis [15] and prior studies [16,17] of fossil fuel racism.

It's time to reframe plastic pollution as a critical environmental health and climate justice threat, not simply as an unsightly mess of plastic waste. The fossil carbon industry has bet its future growth prospects on rising demand for petrochemical plastics [18], hoping to offset their losses in other markets to electric vehicles and renewable energy.

The stark implications of this petrochemical industry vision mean ever-increasing climate change, harm to human health, environmental injustice, and plastic waste. But acting together, we can build an alternate future in which the materials we need for our daily lives and prosperity are truly safe, just and sustainable.

Getting there will require a radical reduction in the extraction, production, use, and disposal of fossil-carbon plastics. This report suggests that the leverage needed to drive change can be enhanced by better connecting the lifecycle impacts of plastics to specific market uses. By holding major brand-owners and institutional consumers accountable, we can slash demand for petrochemical plastics and achieve a truly sustainable future.

Why take a deep dive into one plastic, PET resin and polyester fiber?

This report launches the first in a series of independent investigations that take a lifecycle approach to better understanding the full impact of plastics on human health, social justice, climate change, and resource sustainability. Since not all plastics are created equal – they vary widely by chemistry and lifecycle impacts – separate lines of inquiry are needed for different plastics.

This report begins that process by examining just one major type of plastic known as **polyethylene terephthalate**, often abbreviated as **PET or PETE**, and commonly referred to as **polyester** when it's spun into fibers.

You know PET as the most common plastic used in beverage bottles and polyester clothing. Its resin identification code is the number "one" that's often stamped inside of a triangle on the bottom of the bottle and other packaging. Polyester dominates the fiber market for clothing and other textiles. Almost all "polyester" is actually PET plastic.

This report profiles the toxic hazards, environmental injustice, and climate impacts associated with PET/polyester plastic across its lifecycle with an emphasis on its manufacturing and consumer impacts. The methods pioneered here will be applied to characterizing other plastics in future reports.

By exposing the lifecycle impacts of PET plastic, we hope to spur action to eliminate unnecessary uses, and substitute its remaining use with materials and functional strategies that are safer, more just, and more sustainable for people and the planet.

For many people, PET plastic enjoys an undeserved reputation as a minor commodity plastic, the transparent clarity of which implies a seemingly clean and benign material. The fact that PET is highly recyclable, and that more plastic bottles are recycled than any other plastic packaging, add to its appeal. The public disconnect between PET plastic resin and polyester fibers, which are chemically the same plastic, helps to fragment our understanding of its impacts.

This misperception of PET as a perfect plastic belies the breadth and depth of its hazards. Here are three reasons that justify an in-depth investigation of the PET plastic lifecycle;

1. PET plastic is actually the highest volume plastic, contrary to some reporting

Accounting for all uses, more PET plastic is produced and consumed than any other single type of plastic. Table 1-2 shows that by accounting for all plastic fibers in addition to plastic resins, PET tops the chart. More than 83 million metric tons of PET were produced in 2019, accounting for about 19% of all plastics production. Two-thirds of all PET is used in the form of polyester fiber for clothing and other textiles.

Table 1-2. Polyester (PET) Dominates the Production of Petrochemical Plastics

TYPE OF PLASTIC			PLASTIC PRODUCTION (2019) (IN MILLION METRIC TONS)			
ACRONYM	SOME COMMON OR BRAND NAMES	CHEMICAL NAME	RESIN	FIBER*	TOTAL	PERCENT TOTAL
PET	Polyester	Polyethylene terephthalate	21.5	61.9	83.4	**19%**
PP	Polypro, Typar®	Polypropylene	70.7	4.5	75.2	**17%**
LDPE LLDPE	Poly	Low-density polyethylene Linear low-density polyethylene	52.3	-	52.3	**12%**
PVC	Vinyl	Polyvinyl chloride	49.2	-	49.2	**11%**
HDPE MDPE	Poly, Tyvek®	High-density polyethylene Medium-density polyethylene	46.1	Some Tyvek	46.1	**10%**
PS EPS HIPS	Styrofoam™	Polystyrene Expanded polystyrene High impact polystyrene	21.5	-	21.5	**5%**
PUR	Polyurethane	Polyurethane resins Polycarbamates	18.4		18.4	**4%**
ABS ASA SAN		Acrylonitrile butadiene styrene Acrylonitrile styrene acrylate Styrene-acrylonitrile copolymer	11.0	-	11.0	**3%**
PA	Nylon	Polyamides	3.7	5.4	9.1	**2%**
PLA	Bioplastics	Polylactic acid & other bioplastics	3.0	1.2	4.2	**1%**
PC		Polycarbonate	3.7	-	3.7	**1%**
-		Other fossil-based thermoplastics	14.7	2.2	16.9	**4%**
Other plastics: thermosets (other than PUR), elastomers, rubbers, adhesives, sealants, paints, and coatings			56.1	-	56.1	**13%**
	TOTAL Plastic Resin and Fiber Production		**366.5**	**75.2**	**441.7**	**100%**
	Total Plastic Additives Production:				33.2	
	TOTAL Plastics Production (million metric tons in 2019):				475	

* Excludes semi-synthetic cellulosic fibers, such as cellulose acetate and rayon

Sources: Englehardt (2020) [35], Geyer et al. (2017) [5], Nonwovens Industry (2016) [36], PlasticsEurope Market Research Group (2016) [32], PlasticsEurope (2020) [38], PlasticsEurope (2021) [33], Skoczinski et al. (2021) [43], Textile Exchange (2021) [41].

Yet most plastic waste reports undercount total production by including only plastic resins while ignoring the use of plastics to make fibers for clothing and other uses. For example, the annual PlasticsEurope market research report remains the go-to resource for reporting on the global production of plastics, yet it explicitly excludes plastic fibers. A full accounting of plastic and its impacts must examine all uses of plastics, including both resins and fibers.

Total production of PET exceeds that of each of the other major commodity plastics: polypropylene, low-density polyethylene (LDPE), polyvinyl chloride (PVC), and high-density polyethylene (HDPE).

2. PET, including polyester, is a major source of plastic waste

PET is the most commonly recycled plastic at the end of its short life as a consumer product. In North America, about 34% of all PET resin used for bottles, packaging, sheets, and strapping was recycled, more than any other plastic, in 2020 [19]. However, less than 1% of PET-based polyester fiber used for clothing and other textiles is currently recycled [20].

Therefore, the total PET recycling rate is only about 11%, when you take into account the fact that polyester fiber accounts for two-thirds of all PET production. As a raw material, recycled PET (rPET), almost entirely derived from plastic bottles, supplied nearly 14% of all PET fiber in 2020 [21]. The dominant use for rPET is polyester fiber, accounting for 41% of the entire rPET market [21].

That means that nearly 90% of all PET (including polyester) still ends up as plastic waste that's landfilled, burned, or discarded onto land and water.

In fact, PET remains the most common plastic waste that litters our landscape, beaches, and oceans. PET was the second most frequently collected type of plastic waste in 55 countries in a brand audit coordinated by Break Free From Plastic, a global NGO network [22]. (The mixed category of "other" plastics was number one.) Nearly 82,000 pieces of identifiable PET plastic were collected, with about 60% consisting of plastic bottles. The same audit found that plastic bottles, which are mostly made of PET, was the third most common plastic waste product collected (following small flexible packages commonly referred to as sachets, and cigarette butts.)

The clothing industry, whose fiber of choice is polyester, is terribly polluting and wasteful, with 73% of fiber ending up in being landfilled or incinerated with another 14% lost during production and processing [23].

3. Some chemicals involved in producing PET plastic are highly hazardous

"In the 60 years since PET was first synthesized, it has become one of the world's most widely used, versatile and trusted materials." — PET Resin Association [24]

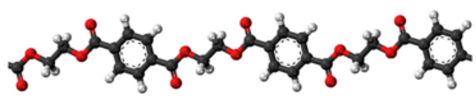
The chemical industry's confidence is unwarranted if one 'looks under the hood' of PET plastic. In fact, hundreds of hazardous chemicals are associated with the production, use, and disposal of PET plastics.

Consider a few selected facts, which are documented and discussed later in this report:

- Compounds of **antimony and cobalt, which are known to cause cancer** [25] **and organ toxicity** [25]**, are commonly used as processing aids or additives in PET and often escape from PET products** [26,27], resulting in human exposure from consuming plastic-bottled beverages [28] and when teething toddlers suck and chew on polyester cuddly toys, blankets, and clothing [28,29];

- Among several other carcinogens, **ethylene oxide and 1,4-dioxane** [32]**, are routinely emitted into the air and discharged as waste from PET-related chemical manufacturing plants**, which often disproportionately impact nearby communities of color and lower-income residents [30];

- A building block chemical used to make PET plastic, **ethylene glycol, is a reproductive toxicant** [32] that can harm development of a fetus or baby if pregnant chemical workers or fenceline community residents are exposed [31].



Model of a section of the polyethylene terephthalate polymer, also known as PET.
Jynto, CC0, via Wikimedia Commons

How this Report is Organized

This introduction (Chapter 1) summarizes the growing concern with plastic pollution and makes the case for a deeper examination of the lifecycle impacts of PET plastic resin and polyester fiber.

Chapter 2 provides a brief overview of the PET market, highlighting the major uses from a consumer perspective. The PET chemical supply chain in North America is mapped, while also highlighting some aspects of the global supply chain. The corporations that produce PET-related petrochemicals and PET plastic, both resin and fiber, are also identified.

Chapter 3 profiles what's known about the hazards of chemicals associated with PET plastic, with an emphasis on known human exposures and health risks from a consumer perspective. Many chemical substances are intentionally introduced into PET plastic to facilitate manufacturing, to add desirable properties, or to mitigate against undesirable properties. Here we take a close look at antimony, the dominant polymerization catalyst for PET, and cobalt. We reveal the results of our testing of PET plastic bottles and beverages for antimony and other additives.

Chapter 4 offers conclusions and recommendations based on our analysis. Some next steps are immediately actionable.

Future investigative reports will profile the toxic hazards and environmental injustice of the PET plastic manufacturing lifecycle and issues raised by over-reliance on PET recycling strategies. Other plastics will also be investigated.

A Note on Methodology

This report was prepared using the best data and other information readily available from reliable and authoritative sources.

Wherever practicable, we summarize and cite scientific research papers from peer-reviewed journals to back up the facts reported herein. We also relied on government technical reports and reference various public health goals or other health-protective measures adopted by authoritative government agencies. Some technical material and documentation are included in the Appendices.

For hazard characterization, we applied the GreenScreen® for Safer Chemicals [32], a comparative hazard assessment tool, and the Pharos chemical hazard database [33]. Both of these follow the Global Harmonized System of Classification and Labelling of Chemicals [34] and rely on authoritative lists of chemical hazards developed around the world.

Industry-reported data and other industry sources are also extensively referenced. Several governmental databases, often populated by industry-reported data, were also accessed, especially for mapping toxic hazards across the manufacturing lifecycle.

Portions of this report were reviewed by outside experts, and their comments incorporated. We strove for complete accuracy and take responsibility for any errors or critical omissions.

Endnotes

1. The Graduate (1967): Plastics [Internet]. shmoop. Accessed May 28, 2022. https://www.shmoop.com/the-graduate/plastics-symbol.html
2. Rettner, R. (2013) The Weight of the World: Researchers Weigh Human Population. Live Science.
3. World Population Clock: 7.9 Billion People (2022) - Worldometer [Internet]. Accessed May 28, 2022. https://www.worldometers.info/world-population/
4. (2012) 75th Anniversary of the Golden Gate Bridge: Fun Facts [Internet]. Accessed May 28, 2022. http://goldengatebridge75.org/assets/ggb75-pdfs-docs/golden-gate-bridge-fun-facts.pdf
5. (2019) How Much Does The Pyramid Of Giza Weigh? – Weight of Stuff [Internet]. Accessed May 28, 2022. https://weightofstuff.com/how-much-does-the-pyramid-of-giza-weigh/
6. Geyer, R., Jambeck, J.R. and Law, K.L. (2017) Production, use, and fate of all plastics ever made. Science Advances, 3, 3–8. https://doi.org/10.1126/sciadv.1700782
7. Gardiner, B. (2019) The Plastics Pipeline: A Surge of New Production Is on the Way. Yale Environment 360. https://e360.yale.edu/features/the-plastics-pipeline-a-surge-of-new-production-is-on-the-way.
8. The Pew Charitable Trusts. (2020) Breaking the Plastic Wave: A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution. 56.
9. Verma, R., Vinoda, K.S., Papireddy, M. and Gowda, A.N.S. (2016) Toxic Pollutants from Plastic Waste- A Review. Procedia Environmental Sciences, Elsevier. 35, 701–8. https://doi.org/10.1016/J.PROENV.2016.07.069
10. Bedat, M. (2021) See the horrifying place where your old clothes go to die [Internet]. Fast Co. Accessed May 28, 2022. https://www.fastcompany.com/90640931/see-the-horrifying-place-where-your-old-clothes-go-to-die
11. Whitacre, P.T. and National Institute of Environmental Health Sciences. (2013) E-Waste Recycling in China: A Health Disaster in the Making? [Internet]. Global Environmental Health Newsletter. Accessed May 28, 2022. https://www.niehs.nih.gov/research/programs/geh/geh_newsletter/2013/7/articles/ewaste_recycling_in_china_a_health_disaster_in_the_making.cfm

12. Office of Environmental Health Hazard Assessment (OEHHA) California Environmental Protection Agency (CalEPA). (2006) Health Concerns and Environmental Issues with PVC-Containing Building Materials in Green Buildings: Review of Current Practices and Trends in the Use, Recycling, and Disposal of PVC-Containing Building Materials. https://www2.calrecycle.ca.gov/Publications/Details/1228
13. Hamilton, L., Feit, S., Muffet, C., Kelso, M., Rubright, S.M. and Bernhardt, C. (2019) Plastic & Climate: The Hidden Costs of a Plastic Planet. https://www.ciel.org/wp-content/uploads/2019/05/Plastic-and-Climate-FINAL-2019.pdf
14. Wiesinger, H., Wang, Z. and Hellweg, S. (2021) Deep Dive into Plastic Monomers, Additives, and Processing Aids. Environmental Science and Technology, 55, 9339–51. https://doi.org/10.1021/acs.est.1c00976
15. Donaghy, T. and Jiang, C. (2021) Fossil Fuel Racism: How Phasing Out Oil, Gas, and Coal Can Protect Communities. www.greenpeace.org/usa/fossil-fuel-racism
16. Ash, M., Boyce, J., Chang, G., Pastor, M., Scoggins, J. and Tran, J. (2009) Justice in the air: tracking toxic pollution from America's industries and companies to our states, cities, and neighborhoods. Political Economy Research Institute.
17. Taylor, D. (2014) Toxic Communities: Environmental Racism, Industrial Pollution, and Residential Mobility. NYU Press.
18. Carbon Tracker Initiative. (2020 Sep) The Future's Not in Plastics: Why plastics demand won't rescue the oil sector. Carbon Tracker Initiative. https://carbontracker.org/reports/the-futures-not-in-plastics/
19. National Association for PET Container Resources (NAPCOR). (2021) NAPCOR'S 2020 PET Recycling Report Reveals an 800 Million Pound Increase of Recycled PET for End Market Use Over the Past Decade [Internet]. Accessed May 29, 2022. https://napcor.com/news/napcors-2020-pet-recycling-report-reveals-an-800-million-pound-increase-of-recycled-pet-for-end-market-use-over-the-past-decade/
20. Scott, A. Transforming textiles: how chemical recycling technologies could play a key role in slashing the textile industry's environmental footprint [Internet]. Accessed June 20, 2022. https://cen.acs.org/environment/green-chemistry/Transforming-textiles/100/i11
21. Schneider, S. (2021) US plastics recycling struggles to meet demand, highlighting investment gap. S&P Global Commodity Insights. www.spglobal.com/commodityinsights/en/market-insights/blogs/petrochemicals/022621-us-plastic-recycling-pet-bottles-packaging-waste-investment
22. Break Free From Plastic. (2020) Global Brand Audit Report 2020. https://www.breakfreefromplastic.org/globalbrandauditreport2020/
23. Ellen MacArthur Foundation. A New Textiles Economy: Redesigning Fashion's Future. https://ellenmacarthurfoundation.org/a-new-textiles-economy
24. PET Resin Association (PETRA). (2015) An Introduction to PET (polyethylene terephthalate) [Internet]. Accessed May 29, 2022. http://www.petresin.org/news_introtoPET.asp
25. Office of Environmental Health Hazard Assessment (OEHHA) California Environmental Protection Agency (CalEPA). (2022) Safe Drinking Water and Toxic Enforcement Act of 1986: Chemicals Known to the State to Cause Cancer or Reproductive Toxicity (Proposition 65 List). https://oehha.ca.gov/proposition-65/proposition-65-list
26. Filella, M. (2020) Antimony and PET bottles: Checking facts. Chemosphere, Elsevier Ltd. 261, 127732. https://doi.org/10.1016/j.chemosphere.2020.127732
27. Food Packaging Forum Foundation. (2022) FCCmigex Database [Internet]. Accessed June 21, 2022. https://www.foodpackagingforum.org/fccmigex
28. Belzile, N., Chen, Y.W. and Filella, M. (2011) Human exposure to antimony: I. sources and intake. Crit. Rev. Environ. Sci. Technol. https://doi.org/10.1080/1064338100360822729. Swedish Chemicals Inspectorate. (2008) European Union Risk Assessment Report: Diantimony Trioxide.
29. Laursen, S.E., Hansen, J., Drødahl, A., Hansen, O.C., Pommer, K., Pedersen, E., and Bernth, N. (2003). Survey of chemical compounds in textile fabrics. Danish Environmental Protection Agency, Survey of Chemicals in consumer products.
30. Joce Sterman, Alex Brauer and Andrea Nejman. Minority and low-income communities may face greatest threat from cancer-causing gas [Internet]. WCYB. Accessed June 22, 2022. https://wcyb.com/news/spotlight-on-america/minority-and-low-income-communities-may-face-greatest-threat-from-cancer-causing-gas
31. US Environmental Protection Agency (EPA). (2021) EPA Expands TRI Reporting Requirements for Ethylene Oxide and Ethylene Glycol by Requiring Reporting for 29 Sterilization Facilities [Internet]. Accessed June 22, 2022. https://www.epa.gov/newsreleases/epa-expands-tri-reporting-requirements-ethylene-oxide-and-ethylene-glycol-requiring
32. Clean Production Action - GreenScreen® for Safer Chemicals [Internet]. Accessed June 21, 2022. https://www.greenscreenchemicals.org/
33. Healthy Building Network - Pharos [Internet]. Accessed June 21, 2022. https://pharosproject.net/
34. United Nations Economic Commission for Europe. (2021) About the GHS | Globally Harmonized System of Classification and Labeling of Chemicals (GHS) [Internet]. GHS, Ninth Ed. Accessed June 7, 2022. https://unece.org/about-ghs
35. Engelhardt, A.W. (2020) The Fiber Year 2020 – Deceleration along the textile chain. International Fiber Journal. https://fiberjournal.com/the-fiber-year-2020-deceleration-along-the-textile-chain/
36. Nonwovens Industry. (2016) Report On Polypropylene Fiber Market Published [Internet]. Accessed June 7, 2022. https://www.nonwovens-industry.com/contents/view_breaking-news/2016-01-29/report-on-polypropylene-fiber-market-published/
37. PlasticsEurope Market Research Group and Consultic Marketing & Industrieberatung GmbH. (2016) World Plastics Production 1950-2015 (slides) [Internet]. p. 1–8. Accessed June 7, 2022. https://committee.iso.org/files/live/sites/tc61/files/The%20Plastic%20Industry%20Berlin%20Aug%202016%20-%20Copy.pdf
38. Plastics Europe. (2020) Plastics - the Facts 2020: An analysis of European plastics production, demand and waste data. Brussels. https://plasticseurope.org/knowledge-hub/plastics-the-facts-2020/
39. PlasticsEurope. (2021) Plastics - the Facts 2021: An analysis of European plastics production, demand and waste data. https://plasticseurope.org/wp-content/uploads/2021/12/Plastics-the-Facts-2021-web-final.pdf
40. Skoczinski, P., Carus, M., de Guxman, D., Käb, H., Chinthapalli, R., Ravenstijn, J. et al. (2021 Jan) Bio-based Building Blocks and Polymers - Global Capacities, Production and Trends 2020-2025. Hürth, Germany. https://renewable-carbon.eu/publications/product/bio-based-building-blocks-and-polymers-global-capacities-production-and-trends-2020-2025-short-version/
41. Textile Exchange. (2021) Preferred Fiber and Materials Market Report [Internet]. Accessed June 7, 2022. https://textileexchange.org/preferred-fiber-and-materials-market-report/

CHAPTER 2

The PET Plastic Market – from Petrochemicals to Fast Fashion and Plastic

Key Findings:

Polyethylene terephthalate (PET) is the same polymer in both polyester fiber used to make clothing and textiles and in plastic resin used for bottles and other packaging

About 99% of PET is derived from non-renewable **fossil carbon** extracted by drilling for crude oil (the source of 80% of PET's carbon) and fracking for natural gas (20%)

Making PET plastic requires use of large amounts of toxic petrochemicals, including:
- About 90% of all ***para*-xylene**, which is toxic to the nervous system
- About 80% of all **monoethylene glycol**, which can cause breathing problems
- About 50% of all **ethylene oxide**, known to cause breast cancer & lymphomas

More than 30 chemical plants directly supply petrochemicals used to make PET plastic in North America, with most located in the Gulf Coast states of **Texas** and **Louisiana**

Four companies manufacture PET or polyester at 12 plastics plants in North America: **DAK Americas** (Alpek is its parent company), **Indorama Ventures, Nan Ya Plastics** (Formosa Plastics Group), and **APG Polytech** (Far Eastern New Century Corp.)

North American PET production could increase by 23% if the ***proposed* Corpus Christi Polymers** plant - a joint venture of Indorama, Alpek and Far Eastern - goes on line

Globally, about 70 chemical plants produce PET plastic in twenty-four countries, dominated by **China**, which is the world's center of polyester fiber manufacturing

Polyester textiles dominate the PET market, accounting for about 64% of all use:
- Nearly two-thirds of all fiber is PET/polyester; cotton's share has fallen to 24%
- One-quarter of all PET is for polyester **clothing**, including short-lived 'fast fashion'
- Most brand-owners sell polyester clothing, but reporting transparency is lacking

Single-use packaging drives nearly one-third (31%) of all PET plastic usage:
- One-quarter of PET goes into **plastic bottles** for soda, water, juices & other liquids
- Major brand owners that use disposable PET bottles include **PepsiCo, The Coca Cola Company, Keurig Dr Pepper**, and **Blue Triton Brands** (formerly Nestlé Waters)
- About 5% of PET goes into clamshells, food trays, and other single-use packaging

What is PET plastic and how is it made?

Polyethylene terephthalate (PET) is a typically clear, strong, and lightweight plastic widely used as polyester fiber for clothing and other textiles, and as a plastic resin for bottles and other single-use packaging. More PET is produced, used, and disposed of than any other single type of plastic when both its resin and fiber forms are counted together [a].

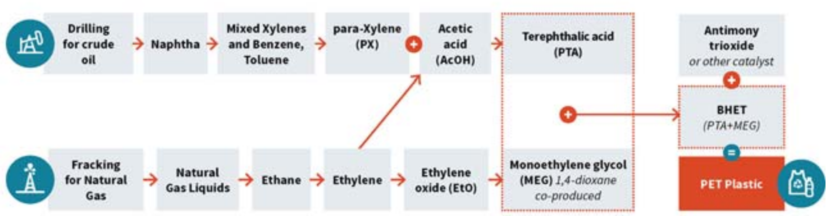
PET was first patented more than eighty years ago by British textile chemists. In 1951, the chemical company DuPont trademarked a polyester film known as Mylar. We're now approaching the 50th anniversary of the PET plastic bottle, which was invented by a DuPont engineer in 1973 [1].

As a polymer, PET is a linked chain of repeating chemical units known as monomers. The typical final building blocks of PET are the chemicals known as **monoethylene glycol** (MEG) and **purified terephthalic acid** (PTA), which are combined to form the monomer, **bis(2-hydroxyethyl) terephthalate** (BHET). With the addition of a catalyst, typically **antimony trioxide**, to speed up the reaction, the BHET monomer is polymerized, or linked together in a chain, to form PET plastic [2].

The chemical footprint of PET plastic, however, is much larger than just those substances. It also includes all the petrochemicals used to make those building block chemicals and the carbon sources they are derived from, typically crude oil and natural gas, as well as all the chemical additives and processing aids used to fine tune the properties of the final plastic products.

A simplified process flow diagram shows the steps used to make PET plastic (Figure 2-1). Multiple petrochemical plants located in many different communities are involved in PET plastic production. Some refine the crude oil or process the natural gas. Some use those fossil carbon extracts to manufacture the primary or intermediary chemicals. And some plants combine those final building block chemicals with additives to form PET resin or fibers.

Figure 2-1. Almost all PET Plastic is Made with Fossil Carbon from Oil and Gas



[a] See Chapter 1. PET has the highest volume production of any plastic when the two major types of polyethylene, high-density and low-density, which have very different applications, are counted separately.

Today, more than 99% of all PET plastic is originally derived from fossil carbon extracted from the ground as crude oil and natural gas [3]. Eighty-percent of the carbon in PET comes from drilling for crude oil used to make the para-xylene that's converted to PTA. Fracking for natural gas contributes the other 20% of PET's fossil carbon, generating ethane which is converted to ethylene, then to ethylene oxide to make MEG.

Despite more than a decade of hype about the climate-friendly "plant bottle," only a fraction of 1% of all PET is currently biobased, which means the carbon is sourced from renewable plant material such as corn starch or sugar cane. Biobased MEG is commercially available and used to manufacture a small amount of PET for bottles, making each "plant bottle" about 30% biobased by weight of raw materials; the rest of the raw materials are still petroleum-based. Renewable chemical companies are also working to commercialize biobased para-xylene in order to produce 100% biobased PET [4].

It takes large amounts of petrochemicals to produce PET plastic. In fact, this plastic accounts for more than 80% of the production and use of two toxic petrochemicals, para-xylene and monoethylene glycol (Table 2-1). PET plastic also consumes more than half (53%) of all ethylene oxide produced, a cancer-causing substance that's also used as a sterilant [b]. Further, about 6% of all antimony trioxide (ATO) produced is used as the dominant catalyst to speed the final reaction that produces PET resin and fiber [c]. Antimony is a metal-like element that's mined from the Earth as an ore and processed to produce antimony trioxide.

Table 2-1. Production of PET Plastic Drives the Market for Hazardous Petrochemicals

CHEMICAL NAME		USED FOR PET	SOME HUMAN EXPOSURE HAZARDS	VULNERABLE GROUPS
para-Xylene	**(PX)**	**80%** [5] **to 97%** [6]	Neurological and respiratory effects [7]	Workers, Children of Workers, Fenceline Community
Monoethylene glycol	**(MEG)**	**80%** [8] **to 84%** [9]	Respiratory irritation, fetal toxicity [10]	
Ethylene oxide	**(EtO)**	**53 %** [d]	Cancer (breast, leukemia, lymphomas) [11]	
Antimony trioxide	**(ATO)**	**6 %** [12]	Cancer (lung and other organs) [13] Systemic organ toxicity (liver, heart) [14]	Workers, Consumers, Fenceline Community

Who makes PET plastic and where do they do it?

A long chemical manufacturing supply chain exists between fossil carbon extraction and final production of PET plastic resin and polyester fiber.

More than 30 chemical plants are known to supply the petrochemicals that are essential to the production of PET plastic in North America (Table 2-2) [e]. PET-related petrochemical production is concentrated in the Gulf Coast states of Texas and Louisiana and in the Province of Alberta, Canada. Of these 30 plants that produce PET precursor chemicals, six also produce PET: The five petrochemical plants operated by DAK Americas (and owned by Alpek), and the Indorama Ventures chemical plant in Decatur, Alabama.

[b] Ethylene oxide is an intermediate chemical produced from ethylene and then converted to monoethylene glycol, an essential PET building block substance.
[c] About 60% of all uses of ATO are as a plastic additive, but mostly to boost the flame retardant properties of PVC plastic and other flame retardant chemicals added to many other plastics.
[d] See source at Endnote 9, which says that 72% of ETO is used to make ethylene glycol, 90% of which is MEG.
[e] This information was obtained from various government and industry sources in the public domain.

Fig 2-2. Locations of PET Plastic and Polyester manufacture and associated Petrochemical and Antimony Suppliers in North America

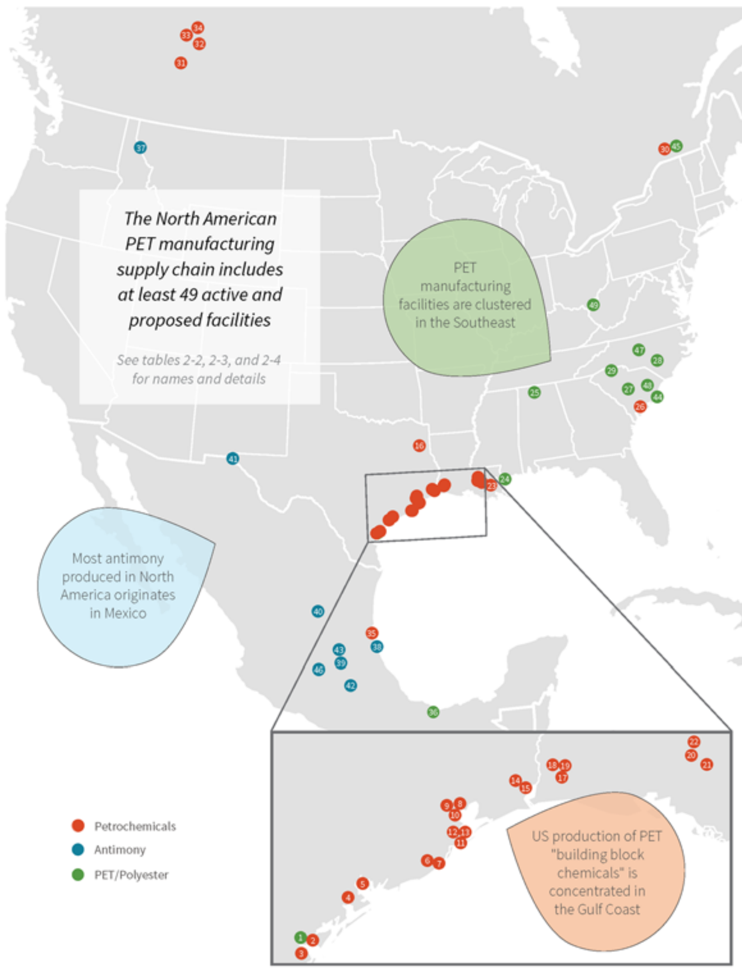


Table 2-2. Petrochemical Plants Known to Supply PET Plastic Production in North America

CHEMICAL COMPANY (Joint Venture Partners or Parent Company) *NOTE: Proposed chemical plants are highlighted in italics*	CHEMICAL PLANT LOCATION (City, State/Province, Country)			CHEMICAL PRODUCED					
				Eth	EtO	MEG	PX	AcOH	PTA
COASTAL BEND OF SOUTH TEXAS									
1. Corpus Christi Polymers (Alpek, Indorama, FarEast NC)	*Corpus Christi*	*TX*	*US*						*X*
2. Exxon Mobil / SABIC	Corpus Christi	TX	US	X	X	X			
3. Flint Hills Resources (Koch Industries)	Corpus Christi	TX	US				X		
4. Dow Chemical	Seadrift	TX	US		X	X			
5. Formosa Plastics	Point Comfort	TX	US		X	X			
GALVESTON BAY AREA / HOUSTON SHIP CHANNEL									
6. Dow Chemical	Freeport	TX	US	X					
7. MEGlobal (Dow Chemical / Petrochemical Industries)	Freeport	TX	US			X			
8. ExxonMobil Chemical	Baytown	TX	US				X		
9. Indorama Ventures	Clear Lake	TX	US		X	X		X	
10. Celanese	Pasadena	TX	US			X		X	
11. Ineos Aromatics	Texas City	TX	US				X		
12. Eastman Chemical	Texas City	TX	US					X	
13. Marathon Oil	Texas City	TX	US				X		
GOLDEN TRIANGLE (SOUTHEAST TEXAS) AND EAST TEXAS									
14. ExxonMobil Chemical	Beaumont	TX	US				X		
15. Indorama Ventures	Port Neches	TX	US		X	X		X	X
16. Eastman Chemical	Longview	TX	US		X	X			
LAKE CHARLES AREA OF SOUTHWEST LOUISIANA									
17. Indorama Ventures	Westlake	LA	US	X					
18. LACC (Lotte Chemical / Westlake Chemical)	Westlake	LA	US	X	X	X			
19. Sasol	Westlake	LA	US		X	X			
CANCER ALLEY, LOUISIANA AND GULF COAST MISSISSIPPI									
20. Dow Chemical	Plaquemine	LA	US		X	X			
21. Shell Chemical	Geismar	LA	US		X	X			
22. Formosa Plastics	*Welcome*	*LA*	*US*		*X*	*X*			
23. Dow Chemical	Taft	LA	US		X	X			
24. DAK Americas (Alpek)	Bay St. Louis	MS	US						X
NORTHERN ALABAMA AND THE CAROLINAS									
25. Indorama Ventures	Decatur	AL	US				X		X
26. Ineos Aromatics	Cooper River	SC	US				?		X
27. DAK Americas (Alpek)	Gaston	SC	US						X
28. DAK Americas (Alpek)	Fayetteville	SC	US						X
CANADA									
30. Indorama Ventures	Montréal-Est	QC	Can						X
31. Dow Chemical	Fort Saskatchewan	AB	Can	X					
32. MEGlobal (Dow Chemical / Petrochemical Industries)	Fort Saskatchewan	AB	Can			X			
33. MEGlobal (Dow Chemical / Petrochemical Industries)	Red Deer	AB	Can			X			
34. Shell Chemical	Scotford	AB	Can			X			
MEXICO									
35. DAK Americas (Alpek)	Altamira	TA	Mex						X
36. DAK Americas (Alpek)	Cosoleacaque	VC	Mex						X

KEY: Eth = Ethylene; EtO = Ethylene oxide; MEG = Monoethylene glycol; PX = para-Xylene; AcOH = Acetic acid; PTA = Purified terephthalic acid

Numbers correspond to points on map (Fig 2-2)

In addition to the building block chemicals used to make the PET monomer, many other chemical substances are added to PET plastic as additives and processing aids. One major processing aid involved in the PET life cycle is antimony trioxide (ATO), which is the dominant PET polymerization catalyst. Most of the antimony trioxide produced in North America starts as antimony ore that's mined and processed in Mexico, which is then used to produce ATO in Montana by the United States Antimony Corporation in amounts of up to 15 million pounds per year (Table 2-3) [15]. (See Chapter 3 for more on PET plastic additives including antimony compounds.)

The final PET plastic resin or polyester fiber is produced by reacting MEG and PTA together with a catalyst such as ATO, along with other additives and processing aids.

Table 2-3. A Sole Antimony Producer in North America Supplies PET Plastic Catalyst

COMPANY	FACILITY	LOCATION		
37. United States Antimony	Smelter	Thompson Falls	MT	United States
38. United States Antimony	Smelter	Madero	CH	Mexico
39. United States Antimony	Leach Plant	Puerto Blanco	GJ	Mexico
40. United States Antimony	Mine, Mills	Wadley	SL	Mexico
41. United States Antimony	Mine	Los Juarez	QE	Mexico
42. United States Antimony	Mine	Sierra Guadalupe	ZA	Mexico
43. United States Antimony	Mine	Soyatal	QE	Mexico

Numbers correspond to points on map (Fig 2-2)

In North America, four multinational corporations (headquartered in Asia and Mexico) manufacture PET plastic at 12 different chemical plants (Table 2-4). Two-thirds (8) are located in the Southeast U.S., close to the textile industry that produces polyester fabric. Two are based in the Gulf Coast in Mississippi and Veracruz, Mexico. Together they have the capacity to produce more than 4.7 million tons of PET plastic resin and fiber every year.

Globally, PET production and polyester textile manufacture is dominated by the chemical industry in China. Outside of North America, about 70 chemical plants produce PET plastic in twenty-four countries, with the largest number (16) of manufacturers located in China.

Table 2-4. Four Chemical Companies Dominate PET Plastic Production in North America

COMPANY NAME	PARENT COMPANY, (OWNER), COUNTRY	# MFG. PLANTS	PLANT LOCATIONS (WITH MAP NUMBER) (rank-ordered by production capacity)	TOTAL CAPACITY (1,000 TONNES/YEAR)	MARKET POSITION
DAK Americas LLC	Alpek S.A. de C.V. (owned in turn by Alpha S.A.B. de C.V.), Mexico	6	**27. Gaston, South Carolina, USA** **24. Bay St. Louis, Mississippi, USA** **28. Fayetteville, North Carolina, USA** **44. Cooper River, South Carolina, USA** **45. Montréal-Est, Québec, Canada** **36. Cosoleacacque, Veracruz, Mexico**	2,177	Main producer of polyester staple fibers in Americas; Major global PET resin producer
Indorama Ventures Public Company Ltd.	(Thailand): Canopus International, Mauritius (offshore)	4	**46. Santiago de Querétaro, QR, Mexico** **25. Decatur, Alabama, USA** **29. Spartanburg, SC, USA** **47. Asheboro, North Carolina, USA**	1,760	World's largest PET producer with 20 plants in 14 countries
Nan Ya Plastics Corporation USA	Formosa Plastics Group, Taiwan	1	**48. Lake City, South Carolina, USA**	450	Nan Ya's largest chemical plant; Taiwan's largest plastics maker
APG Polytech USA Holdings	Far Eastern New Century Corporation (Far Eastern Group), Taiwan	1	**49. Apple Grove, West Virginia, USA** [16]	360	A major producer of synthetic fibers and textiles in Asia
TOTAL PET CAPACITY IN NORTH AMERICA:		**12**	**PET manufacturing plants**	**4,747**	
Corpus Christi Polymers LLC	A joint venture of Indorama, Alpek, and Far Eastern NC	*1 planned*	**1. Corpus Christi, Texas, USA** [17]	*1,100*	***Proposed*** *plant would increase PET capacity by 23% in North America*

Numbers correspond to points on map (Fig 2-2)

"In North America, four multinational corporations manufacture PET plastic at 12 different chemical plants. Together they have the capacity to produce more than 4.7 million tons of PET plastic resin and fiber every year."

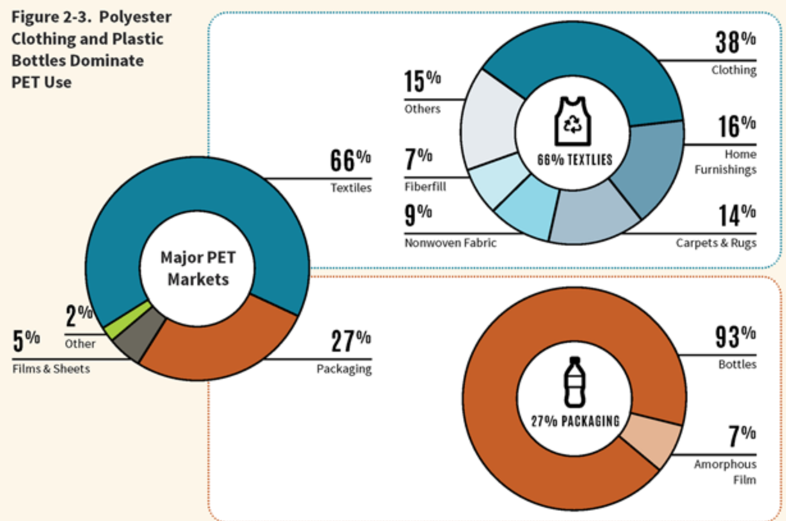
Petrochemical plastics production keeps expanding

Plastics production has grown exponentially in the last 70 years and doubled again in just the last 25 years [18]. Many industry analysts are bullish on an ever-increasing demand for petrochemical plastics, including PET. Polyester production is pegged to grow 8% annually through 2027 [19]. Others project a 4% to 6% annual growth rate for PET, including plastic bottles, through 2028 [20,21].

The petrochemical industry continues to bank on a radical expansion in the production and use of PET and other plastics. One of the largest PET manufacturing plants in the world has been proposed for Corpus Christi, Texas. A joint venture between the three PET market leaders, the Corpus Christi Polymers plant [22] would increase North American production capacity by 23% if construction is completed and the plant goes online.

The petrochemical industry expansion also fuels unnecessary growth in production of feedstock chemicals used to make PET plastic. For example, the Formosa Plastics chemical plant proposed for the community of Welcome in St. James Parish, Louisiana would produce ethylene oxide, as well as monoethylene glycol (at 1.6 million tons per year), an essential building block chemical for PET plastic production [23]. This chemical plant would become the third largest point source of emissions of ethylene oxide, a potent carcinogen. Its total chemical footprint would be enlarged by the production of several types of another plastic, polyethylene. The Formosa Plant is vigorously opposed by local residents and environmental health advocates [24].

Figure 2-3. Polyester Clothing and Plastic Bottles Dominate PET Use



Sources: Global Market Insights (2020) [19], Grand View Research (2019) [21]

What is PET plastic used for and who consumes it?

About two-thirds of all PET goes into polyester-based textiles and more than one-quarter is used for packaging (Figure 2-3). Within these major market segments, polyester clothing and plastic bottles (especially for water and soda) dominate the end uses for PET plastic, including polyester. These applications each account for about 25% of all PET use, or about half of all PET use combined.

These PET plastic markets also contribute to a disproportionate share of plastic waste. Most of the packaging is single-use for food and beverages, and polyester-based 'fast fashion' clothing is often used just a few times before discarding.

Polyester Fiber for Textiles

By major market segment, two-thirds of all PET in the form of polyester fiber is used in various textiles applications. Polyester is the dominant fiber among all synthetic fibers, which now account for nearly two-thirds of all fiber use. Polyester and other synthetic fibers have displaced natural fibers, with cotton's market share dropping to less than 25% [25].

Nearly 40% of all polyester is used to manufacture clothing, primarily in Asia. Sustainability concerns with polyester are rising with the expansion of "fast fashion" in which manufacturers release new collections much more frequently and outfits are worn fewer times before being discarded [26].

A recent report on the growing climate and waste impact of "fossil fashion" surveyed 46 brands and found that only 26 provided even partial responses about their use of synthetic fibers including polyester by percentage and weight.

For some brands, 85% of the items sold contained synthetic fibers, mostly polyester. Only six companies expressed an intent to reduce their use of synthetic fibers, but none had made a clear commitment to do so. The most intensive use of synthetic fibers was reported in the sportwear market [27].

Other polyester textile applications for PET include home furnishings, such as fabric for upholstered furniture, and carpet and rugs. Nonwoven polyester fibers have diverse uses from personal care products and industrial filters to building and construction materials. Polyester-based fiberfill is used to stuff sleeping bags, pillows, toys, and more. Industrial applications of polyester include cording to reinforce tires and for conveyor belts.

PET Plastic Resin for Packaging

Most PET plastic resin is used to make plastic bottles, but also a variety of other single-use disposal packaging.

Globally, about 500 billion PET plastic bottles are sold every year. Nearly half of those contain bottled water. About 20% are used for carbonated soft drinks [28]. Other PET plastic bottles are used to pack food and non-food products in bottles and jars, fruit juices and juice drinks, beer, and other products, each with about 6% market share [29].

In the United States, about 100 billion plastic bottles are sold every year. U.S. bottle manufacturers made nearly $1 billion in profits on $12 billion in sales in 2021 [30].

Other PET plastic film used for packaging is converted to plastic jars, pails, trays, and clamshells. Prepared meals ready to heat up in a microwave or oven are often packaged in plastic trays that are made of crystalline PET.

Table 2-5. The Biggest Corporate Consumers of Plastic Bottles in the United States

MARKET SEGMENT	BRAND OWNER	MARKET SHARE, US	SOME MAJOR BRANDS
Bottled Water[31]	PepsiCo	20%	Aquafina, Propel, SoBe, H2oh!, LIFEWTR, Bubly
	Blue Triton Brands	16%	Poland Spring, Deer Park, Arrowhead, Ice Mountain
	Primo Water	10%	The Mountain Valley Spring Water, Primo Water
	Coca-Cola	9%	Dasani, smartwater, vitaminwater, Topo Chico
	Danone	1%	AQUA, Evian, Volvic, Levits
Carbonated Soft Drinks (Soda)[32]	PepsiCo	40%	Pepsi, Mountain Dew, Diet Pepsi, Sierra Mist, Mirinda
	Coca-Cola	16%	Coca-Cola, Diet Coke, Sprite, Fanta
	Keurig Dr Pepper	13%	US: Dr Pepper, 7 Up, IBC, A&W, RC, Hires, Sunkist
	Refresco (KKR)	6%	Large private-label contract manufacturer & bottler
Juice & Juice Drinks[33]	PAI Partners	15%	Tropicana, Naked, KeVita, Izze, Dole, Copella, Punica
	Keurig Dr Pepper	14%	Hawiian Punch, Nantucket Nectars, Mott's, Clamato
	Coca-Cola	7%	Powerade, Minute Maid, Simply, innocent, Del Valle
	Campbell Soup	7%	V8 Vegetable Juice, V8 Fruit & Vegetable Blends

Conclusion

The rapidly growing market for PET plastic continues society's over-reliance on fossil-based oil and gas while driving expanded production of hazardous petrochemicals and scarce minerals needed for its production. About half of all PET is used to make polyester clothing, including quickly-tossed 'fast fashion,' and plastic bottles, most of which are disposed of after a single use. Nothing about this PET plastic market can be described as sustainable.


Photo by Tom Fisk: https://www.pexels.com/photo/yellow-heavy-equipment-on-landfill-5424854/

Endnotes

1. Parker, L. (2019) How the plastic bottle went from miracle container to hated garbage. National Geographic, Washington, DC.
2. Boustead, I. (2005) Eco-profiles of the European Plastics Industry Polyethylene Terephthalate (PET) (Bottle grade) I Boustead for PlasticsEurope Data last calculated. http://www.inference.org.uk/sustainable/LCA/elcd/external_docs/petb_31116f00-fabd-11da-974d-0800200c9a66.pdf.
3. Skoczinski, P., Carus, M., de Guzman, D., Käb, H., Chinthapalli, R., Ravenstijn, J. et al. (2021 Jan) Bio-based Building Blocks and Polymers - Global Capacities, Production and Trends 2020-2025. Hürth, Germany. https://renewable-carbon.eu/publications/product/bio-based-building-blocks-and-polymers-global-capacities-production-and-trends-2020-2025-short-version/
4. Coca-Cola, Suntory Debut 100% Plant-based Bottles | Packaging World [Internet]. Accessed May 13, 2022. https://www.packworld.com/issues/sustainability/article/22171823/cocacola-suntory-debut-100-plantbased-bottles
5. Paraxylene (PX) Market (2022 - 27) | Industry Report, Trends [Internet]. Accessed May 14, 2022. https://www.mordorintelligence.com/industry-reports/paraxylene-px-market
6. Paraxylene Market Size, Trends & Outlook | Industry Report, 2012-2022 [Internet]. Accessed May 14, 2022. https://www.grandviewresearch.com/industry-analysis/paraxylene-market
7. ATSDR (Agency for Toxic Substances and Disease Registry). (2007 Aug) TOXICOLOGICAL PROFILE FOR XYLENE. Atlanta, GA. https://www.atsdr.cdc.gov/toxprofiles/tp71.pdf
8. hell plc. Mono-ethylene glycol [Internet]. Accessed May 14, 2022. https://www.shell.com/business-customers/chemicals/factsheets-speeches-and-articles/factsheets/mono-ethylene-glycol.html
9. Ethylene Oxide & Ethylene Glycol Market by Applications, by Geography, Raw Materials, Price Trends and Global Forecasts (2011-2016), Market Research Report :Marketsandmarkets [Internet]. Accessed May 14, 2022. https://www.marketsandmarkets.com/Market-Reports/ethylene-oxide-398.html
10. OEHHA (Office of Environmental Health Hazard Assessment). (2008) Technical Supporting Document for Noncancer RELs, Appendix D3. Berkeley, CA. https://oehha.ca.gov/media/downloads/crnr/appendixd3final.pdf.
11. U.S. Environmental Protection Agency. (2016 Dec) Evaluation of the Inhalation Carcinogenicity of Ethylene Oxide In Support of Summary Information on the Integrated Risk Information System (IRIS). Washington, DC. https://cfpub.epa.gov/ncea/iris/iris_documents/documents/toxreviews/1025tr.pdf
12. Henckens, M.L.C.M., Driessen, P.P.J. and Worrell, E. (2016) How can we adapt to geological scarcity of antimony? Investigation of antimony's substitutability and of other measures to achieve a sustainable use. Resources, Conservation and Recycling, Elsevier B.V. 108, 54–62. https://doi.org/10.1016/j.resconrec.2016.01.012
13. National Toxicology Program. (2018 Oct) Report on carcinogens: monograph on antimony trioxide. Research Triangle Park, NC. https://ntp.niehs.nih.gov/ntp/roc/monographs/antimony_final20181019_508.pdf. https://doi.org/10.1007/BF02566856
14. Office of Environmental Health Hazard Assessment (OEHHA) California Environmental Protection Agency (CalEPA). (2016) Public Health Goal for Antimony in Drinking Water. https://oehha.ca.gov/media/downloads/water/chemicals/phg/antimonyphg092316.pdf
15. United States Antimony Corporation. (2018 Aug) Corporate Profile. Thompson Falls, MT. https://web.archive.org/web/*/https://www.usantimony.com/wp-content/uploads/2021/07/usac_corporate_profile-07272018-.pdf
16. Far Eastern Group. (2019) [FENC] buys into US recycling industry [Internet]. Accessed May 17, 2022. https://www.feg.com.tw/en/news/detail.aspx?id=6329
17. Offshore Technology. (2021) Corpus Christi Polymers Corpus Christi Complex, US [Internet]. Accessed May 17, 2022. https://www.offshore-technology.com/marketdata/corpus-christi-polymers-corpus-christi-complex-united-states/
18. Geyer, R., Jambeck, J.R. and Law, K.L. (2017) Production, use, and fate of all plastics ever made. Science Advances, 3, 3–8. https://doi.org/10.1126/sciadv.1700782
19. Global Market Insights. (2020) Polyester Fiber Market Size, By Grade (PET, PCDT), By Product (Solid, Hollow), By Application (Carpets & Rugs, Non-Woven Fiber, Fiberfill, Apparel, Home Textile, Others), Industry Analysis Report, Regional Outlook, Growth Potential, Price Trend, Competitive Landscape & Forecast, 2021 - 2027 [Internet]. Accessed May 17, 2022. https://www.gminsights.com/industry-analysis/polyester-fiber-market
20. Coherent Market Insights. (2022) PET Bottles Market Size, Trends and Forecast to 2028 [Internet]. Accessed May 18, 2022. https://www.coherentmarketinsights.com/market-insight/pet-bottles-market-2284
21. Grand View Research. (2019) Polyethylene Terephthalate Market Size, Share & Trends Analysis Report, By Application (Packaging, Films & Sheets), By Packaging Application And Segment Forecasts, 2019 - 2025 [Internet]. Accessed May 17, 2022. https://grandviewresearch.com/industry-analysis/polyethylene-terephthalate-market
22. Alpek, partners will likely decide to proceed with Texas PET plant | ICIS [Internet]. Accessed May 15, 2022. https://www.icis.com/explore/resources/news/2022/04/26/10757847/alpek-partners-will-likely-decide-to-proceed-with-texas-pet-plant/
23. Sanzillo, T. and Mattei, S. (2021 Mar) Formosa's Louisiana Project: Wrong Products, Wrong Time, Wrong Place, Wrong Finances. Lakewood, OH. https://ieefa.org/wp-content/uploads/2021/03/Formosa-Louisiana-Wrong-Products-Wrong-Time-Wrong-Place-Wrong-Finances_March-2021.pdf
24. Mufson, S. (2021) Huge plastics plant faces call for environmental justice, stiff economic headwinds. The Washington Post, Washington DC.
25. Textile Exchange. (2020) Preferred Fiber and Materials Market Report [Internet]. Accessed May 17, 2022. https://textileexchange.org/preferred-fiber-and-materials-market-report/
26. Remy, N., Speelman, E. and Swartz, S. (2016) Style that's sustainable: A new fast-fashion formula. McKinsey & Company.
27. Changing Markets Foundation. (2021 Jun) Synthetics Anonymous: Fashion brands' addiction to fossil fuels. New York, NY. https://changingmarkets.org/portfolio/fossil-fashion/
28. Packaging Europe. (2017) PET Plastic Bottle Consumption Set to Grow by 3.9% Over the Next Five Years. Packaging Europe,.
29. Expert Market Research. (2020) Global PET Bottles Market Share, Size, Industry Report, Forecast 2022-2027 [Internet]. Accessed May 17, 2022. https://www.expertmarketresearch.com/reports/pet-bottles-market
30. Hiner, J. and IBISWorld. (2021 Jul) Plastic Bottle Manufacturing in the US, Industry Report 32616.
31. Ross, G. and IBISWorld. (2021 Aug) Bottled Water Production in the US, Industry Report 31211B.
32. Rose, A. and IBISWorld. (2022 Apr) Soda Production in the US, Industry Report 31211A.
33. Diment, D. and IBISWorld. (2021 Oct) Juice Production in the US, Industry Report 31211C.

CHAPTER 3

Chemicals that Migrate from PET Plastic and Polyester May Threaten Your Health

Key Findings:

Many plastic additives, processing aids, and chemical byproducts migrate from PET plastic and polyester

Chemicals of concern found in PET include cancer-causing **antimony** and **cobalt**

Antimony escapes from plastic bottles & food packaging and threatens consumer health

Antimony in some beverage brands we tested **exceeded California's drinking water goal**

PET releases more antimony when exposed to heat, light, soda, juice, or storage time

Antimony exposure from all sources, including PET, **threatens children's health**

Young children are on average exposed to twice as much antimony as adults; toddlers who suck on polyester cuddly toys and clothing, and ingest house dust face higher risks

Antimony from plastics such as PET **contributes to environmental racism**; in the US, Latinx and Black communities are disproportionately exposed to antimony

Chronic antimony exposure increases lifetime risk of liver and heart disease, diabetes, and cancer

Safer alternatives to antimony are widely available, effective and affordable for industry

Other chemicals used to make PET products raise concerns but are full of safety data gaps

Photo by Pixabay: https://www.pexels.com/photo/...-plush-toy-220137/

This chapter examines toxic chemicals found in PET plastic and polyester. In particular, we focus on the most common catalyst used to make PET, antimony trioxide, a potential carcinogen that's known to migrate from PET and polyester products to food, beverages and the environment. We present the results of our independent testing for antimony in PET plastic bottled beverages, and discuss necessary steps to ensure the health and safety of consumers who are exposed to antimony compounds through PET plastics.

1. Many Additives May Escape from PET Resin and Fiber During Use

All plastics used every day are polymers – linked chains of organic chemical compounds. But plastic products also have many other chemicals present in them. These can include intentionally added chemicals that impart desirable qualities to the plastic (like color or flexibility), processing aids (like catalysts and lubricants), and monomers (which are the building block of polymers). PET products can also contain chemicals that breakdown from intentionally added chemicals, side products of intentional chemical reactions, impurities in chemicals used or added, and environmental contaminants. These chemicals can migrate from plastic into human bodies and the environment. The health impacts of plastics cannot be fully understood without considering the role of these little-discussed chemicals in the plastic life cycle.

Thousands of chemical additives, processing aids, monomers, and other chemicals have been reported in plastics. A recent peer-reviewed study found that over 10,000 chemical substances have been recorded for use with plastics [1]; of these, 2,400 were found to be substances of concern, meaning that they met one or more of the conditions of persistence (long-lived in the environment), bioaccumulation (build up in living tissues and transfer through the food web), or toxicity (harmful to health). Of these 2,400 substances, 901 are still approved for use in food contact materials in some jurisdictions. Yet most consumers know little to nothing of such chemicals in everyday products, or what their presence might mean for their health. Table 3-1 provides a snapshot of just some of the chemicals that may migrate from PET plastics.

The health impacts of plastics cannot be fully understood without considering the role of these little-discussed chemicals in the plastic life cycle.

Photo by Magda Ehlers: https://www.pexels.com/photo/close-up-photo-of-plastic-bottles-2547565/

A recent study investigated the migration of chemicals in PET beverage bottles, and found that ***150 out of 193 tested chemicals have been known to migrate from the bottles into the beverages.*** *Of these, 18 exceeded EU limits, and 109 are not authorized substances in the EU. The authors note that many other chemicals that may be present in PET bottles have never been evaluated for migration. Recycling PET may further concentrate potentially hazardous chemicals.*

For more, see: Gerassimidou, S., Lanska, P., Hahladakis, J.N., Lovat, E., Vanzetto, S., Geueke, B. et al. (2022) Unpacking the complexity of the PET drink bottles value chain: A chemicals perspective. Journal of Hazardous Materials, 430. https://doi.org/10.1016/j.jhazmat.2022.128410

Table 3-1. Many Chemical Substances May Migrate from PET Plastic and Polyester

CHEMICAL NAME OR CHEMICAL CLASS	CASRN	FUNCTION OR SOURCE	KNOWN TO MIGRATE FROM PET OR POLYESTER	CHEMICAL HAZARD
Antimony trioxide	1309-64-4	Catalyst, reheat additive	Yes	High
Antimony triacetate	6923-52-0	Catalyst	No known studies	High
Germanium oxide	1310-53-8	Catalyst	No known studies	unknown
Diethyl 3,5-di-tert-butyl-4-hydroxybenzylphosphonate	976-56-7	Stabilizer	No known studies	unknown
Cobalt compounds		Bluing agent, catalyst	Yes	High
Terephthalic acid	100-21-0	Monomer	Yes	Moderate
Dimethyl terephthalate	120-61-6	Monomer	Yes	unknown
Monoethylene glycol (MEG)	107-21-1	Monomer	No known studies	High
Diethylene glycol (DEG)	111-46-6	Impurity in precursor	Yes	High
1,4-Dioxane	123-91-1	Reaction product	No	High
Bis(2-hydroxyethyl) terephthalate	959-26-2	Monomer	Yes	unknown
Isophthalic acid	121-91-5	Co-monomer	No known studies	unknown
1,4-Cyclohexanedimethanol	105-08-8	Co-monomer	Yes	unknown
Drometrizole	2440-22-4	UV light stabilizer	No known studies	unknown
Titanium nitride	25583-20-4	Reheat additive	No known studies	unknown
Anthranilamide (+ reaction products)	88-68-6	Acetaldehyde scavenger	No known studies	unknown
Acetaldehyde	75-07-0	Degradation product	Yes	High
Formaldehyde	50-00-0	Degradation product	Yes	High
Titanium alkoxide complex		Catalyst	No known studies	Not assessed
Organo-aluminum compounds		Catalyst	No known studies	Not assessed
PET cyclic trimer	7441-32-9	Reaction product	Yes	Not assessed

The FCCmigex database was used to identify chemical substances known to migrate from PET plastic into food or food simulants based on peer-reviewed studies. "Yes" indicates that at least one study found migration of the chemical to food or food simulants. "No" indicates that studies tested for migration to food or food simulants, but did not observe migration. "No known studies" indicates that there are currently no known studies of migration of this chemical substance into food or food simulants. For more, see the Food Packaging Forum Foundation (2022) [2] and Geueke et al (2022) [3].

The chemical hazard rating is reported in the Pharos database based on a GreenScreen assessment, authoritative lists, or very similar compounds. "HIGH" hazard means the chemical is a known, likely, or possible Benchmark-1 chemical substance. "MODERATE" indicates that the chemical is a known, likely, or possible Benchmark-2 chemical substance. "Unknown" means that the chemical substance was assessed using the GreenScreen List Translator, but there is currently insufficient information to classify it as a Benckmark-1 chemical substance. For more see the GreenScreen® for Safer Chemicals Hazard Assessment Guidance (2016) [4], GreenScreen (2022) [5], and Pharos (2022) [6].

CASRN stands for Chemical Abstract Services Registration Number, a unique identifier for individual chemical substances.

Other sources: Kishi et al. (2019) [7]; ILSI Europe (2017) [8]; Franz and Welle (2008) [9]; Kassouf (2013) [10].

(Continued...) **Table 3-1. Many Chemical Substances May Migrate from PET Plastic and Polyester**

CHEMICAL NAME OR CHEMICAL CLASS	CASRN	FUNCTION OR SOURCE	KNOWN TO MIGRATE FROM PET OR POLYESTER	CHEMICAL HAZARD
Other chemical substance types used in PET				
Color pigments		Colorant		
Lubricants		Reduce friction (bottles)		
Oxygen scavengers		For O_2 sensitive products		
Nucleating agents		Increase crystallization		
Antioxidants		Increase PET shelf-life		
Impact modifiers		For added strength		
Mold release agents		Processing aids		

BOX 1: Antimony – A Plastic Additive of High Concern in PET/Polyester

Antimony trioxide is a very common plastics additive. In PET plastic, it's the preferred catalyst for speeding the final chemical reaction that produces the resin. Small amounts of antimony continually escape from PET during use and disposal of plastic bottles, food packaging, and from polyester clothing, children's products, and other textiles.

By taking a lifecycle approach, antimony hazards can be apportioned to various uses including as a PET catalyst. Assessing all uses also allows a determination of whether total human exposure to antimony from all sources currently exceeds safety thresholds.

Antimony is a metalloid, having properties similar to both heavy metals and non-metals. About 153,000 metric tons of antimony ore were mined globally in 2020 [44], mostly in the form of stibnite (antimony trisulfide). It also exists as jamesonite, which contains lead, and as two forms of oxides. Smaller amounts of antimony are extracted from ores of lead, arsenic, copper, silver and gold, and from secondary smelting of lead-acid batteries and lead-antimony alloys [45].

Antimony is a scarce element that's unsustainably mined, with easily extractable reserves expected to be depleted by 2040 [40]. In 2020, more than 52% of global mine production of antimony occurred in China, which also holds most of the world's reserves. No antimony was mined in the U.S., where imports account for about 80% of consumption, the balance produced mainly from recycling of lead-acid batteries and lead-antimony alloys [45].

Table 3-B1. 60% of Antimony is Used as a Plastic Additive

USE CATEGORY	MAJOR PRODUCTS	SHARE (2010)	MAJOR MARKETS	MARKET SHARE
Plastic Additive	**Flame Retardants**	52%	PVC (vinyl) plastic Other plastics * Rubber Textile back-coating	42% 40% 10% 8%
	PET Catalyst	6%	Polyester clothes, textiles PET plastic bottles Other PET packaging Other PET use	66% 24% 5% 5%
	Heat Stabilizer	1%	PVC (vinyl) plastic	
	Colorant	1%	Yellow-orange pigments	
Other Additive	**Glass**	1%	Solar cell glass Cathode ray tubes	
	Ceramics	1%	Construction	
Metallurgical	**Batteries**	27%	Lead-acid batteries	
	Lead Alloys	11%	Construction Ammunition	

* Includes acrylonitrile butadiene (ABS), polypropylene (PP), polybutylene terephthalate (PBT), polyamides (nylon), high-impact polystyrene (HIPS), unsaturated polyester resins (UPR), high-density and low-density polyethylene (HDPE/LDPE), epoxies, adhesives, paints and coatings.

Sources: Henckens et al. (2016) [40], EU (2008) [18], See also Chapter 2 Endnotes for Global Market Insights (2020) [13], Grand View Research (2019) [21].

About 60% of antimony is used a plastic additive, primarily in the form of antimony trioxide. The largest use is as a synergist that enhances the flame retardant properties of PVC plastic and brominated flame retardants added to other plastics. About 6% of antimony is added to PET plastic as a catalyst. Metallurgical uses in lead-acid batteries and lead alloys account for more than one-third of antimony consumption. See Table 3-B1.

Antimony exists in its pure form and as about a dozen commercially relevant chemical compounds. The element occurs in four valence (or oxidation) states that dictate its power to combine and form chemical products. These include -3, O (the pure metalloid); and +3 (trivalent) and +5 (pentavalent), the most common forms in the environment. Humans are often exposed to negatively charged ions of antimony rather than to specific compounds.

Antimony and its compounds are inherently hazardous. Trivalent forms are thought to be more toxic. As a metalloid, antimony is very persistent in the environment. However, it does not bioaccumulate. The presence of antimony in the body reflects recent or daily exposure. Conversion between its trivalent and pentavalent forms commonly occurs in a somewhat unpredictable manner in the environment and human body [10].

2. Antimony that Escapes from Plastic Packaging Threatens Consumers' Health

Antimony (in the form of antimony trioxide) is the preferred catalyst for speeding the final chemical reaction that produces PET plastic. Small amounts of antimony can continually escape from PET during use and disposal of plastic bottles, food packaging, and from polyester clothing, children's products, and other textiles (Box 1). Antimony has been known to adversely affect health for decades based on health studies of exposed people and laboratory animals (see Appendix 1).

Our independent testing found antimony in all beverages sampled from PET plastic bottles.

Defend Our Health independently tested samples of 20 popular beverages, purchased between February 24-28, 2022 in the greater Los Angeles, California area and the Las Vegas, Nevada area. Beverage volumes ranged from 8-ounce to 28-ounce. We confirmed that all of the beverage bottles were made of PET plastic.

Beverages were tested at Vanguard Labs in Olympia, Washington using inductively coupled plasma mass spectrometry (ICP-MS) using EPA method 200.7 [11] for analysis of heavy metals and trace elements in drinking water, waste water, surface water, food, and cosmetics, on March 23, 2022. Of particular interest were metals known to be used (either in their elemental form or as compounds) in PET additives or processing aids. These include antimony, cobalt, titanium, germanium, aluminum, and tin. Full test results can be found in the technical lab report [12]. Antimony results summarized below, and Box 2 summarizes results for cobalt.

In addition, bottles were retained for 14 out of the 20 tested products, and were tested at the Ecology Center in Ann Arbor, MI, on April 26, 2022 using X-Ray Fluorescence (XRF) [13]. We primarily report results of the XRF method for evaluating antimony concentration in PET plastic here, due to a high degree of confidence in these results. Bottles were also tested at Vanguard Labs using ICP-MS to detect concentration of antimony and other heavy metals and trace elements [12]. The concentrations of antimony detected in the PET bottles using ICP-MS was highly correlated with antimony concentrations detected using XRF (R-squared = 0.72), but the absolute values differed due to suspected interference with silicate compounds. We discuss the relative ICP-MS results for titanium and aluminum in this and later sections, as concentrations of these metals in PET plastic [7] are typically below the detection limit for the XRF method used.

BOX 2: Cobalt in PET

Without the use of coloring agents, PET is a yellow plastic; cobalt may be added to neutralize yellowness or to impart a blue color to the plastic and provide UV stability. Cobalt (II) diacetate is the primary bluing agent used in PET, though cobalt oxide may also be used. Cobalt diacetate is also used as a catalyst in the upstream PET process: it is used to convert p-xylene to terephthalic acid, the monomer of PET.

While cobalt naturally occurs in Cyanocobalamin, an essential vitamin (B-12), cobalt compounds used in PET processing are potential carcinogens that can migrate into food, beverage, and food contact products. Cobalt acetate is listed as a carcinogen in New Zealand and Japan. Cobalt metal powder and several cobalt compounds are listed under Proposition 65 as known to cause cancer. Elevated levels of cobalt can be toxic to the nervous system, thyroid, and heart [46]. In California, cobalt is a "potential priority metal" for biomonitoring [47]. Workers exposed to cobalt are especially at risk [46]. In PET plastics, the presence of cobalt increases the decomposition of acetaldehyde, a toxic organic compound [7].

In our testing of PET bottled beverage samples, cobalt was detected in eight out of twenty samples. Concentrations ranged from 0.29 to 4.89 [12] parts per billion (ppb). While there are currently no drinking water standards for cobalt, cobalt levels are less than 1–2 ppb in most drinking water [46].

All beverages tested had detectable levels of antimony (see Table 3-2). The antimony concentration in eight out of 20 beverages (40%) exceeded California's Public Health Goal for drinking water of 1 ppb (part per billion). Eighteen out of 20 beverage samples (90%) exceeded the more health protective limit of 0.25 ppb antimony in drinking water, recommended by Defend Our Health to better account for antimony exposure from other sources.

The highest concentration was found in the **Campbell's V8** vegetable juice sample, which had 3.45 parts per billion (ppb) of antimony, more than three times California's public health goal for antimony in drinking water. The soda sample with the highest antimony concentration was **Coca Cola** (packaged in 100% recycled PET) at 2.2 ppb. **Nestle's Perrier** water had the highest concentration of antimony among the sampled bottled waters, at 1.58 ppb.

The plastic from 11 bottles had concentrations of antimony in the range of 216 to 321 parts per million (ppm). These concentrations fall within or slightly above the previously documented range of 172 to 261 ppm in PET bottles known to use an antimony catalyst [7].

Three bottles tested had undetectable concentrations of antimony. These PET samples were Simply Lemonade, Mountain Dew, and 7up bottles. Titanium concentrations for these PET samples were found to be six to seven times higher than in the other tested bottle samples using the ICP-MS method for evaluating metal concentration in plastic samples (the XRF method did not detect any titanium in these samples). Aluminum levels were also elevated in the plastic from two of these samples (Simply Lemonade and 7-up), suggesting that these bottles may have been produced using a titanium- and/or aluminum-based catalyst.

Antimony in PET bottled beverages is unlikely to be caused solely by antimony in source water. Peer reviewed studies support the conclusion that antimony levels detected in bottled beverages are likely due to some combination of antimony-based catalysts, antimony additives, and other food contact sources, rather than from antimony occurring in the source waters. Belzile et al. (2011) [14] synthesizes antimony exposure data from dozens of peer-reviewed and government sources, and reports that antimony concentrations in tap or well water are usually below the 1 ppb level. Similarly, an earlier study by Filella (2002) [15] finds that concentrations of dissolved antimony in unpolluted surface waters are "well below" 1 µg/L (ppb), and Shotyk et al. (2006) [16] report an average antimony concentration of 0.002 ppb in "pristine" ground water, compared to 0.2 ppb for bottled water. In a review of antimony migration studies with "good analytical design", Filella (2020) [17] finds that "PET is the origin of antimony presence in bottled waters."

In addition to the antimony catalyst used to make PET, metallic antimony may be also added to the PET resin as a reheat additive in concentrations around 0.5-10 ppm (parts per million) in order to accelerate the heat-assisted stretching and blow-molding of PET preforms into plastic bottles (US Patent 7479517B). This may contribute to total antimony in the PET product and/or beverage stored in it. Antimony may also be used in plumbing materials and fittings (particularly copper pipes with tin-antimony solder), that water or other ingredients used in beverages, or raw beverage itself, may be piped through at some point in their processing [18]. **While we don't always know the exact source of antimony in bottled water, these uncertainties are not an excuse for industry to engage in foot-dragging or inaction.**

Table 3-2. Antimony was Detected in All Tested Samples of PET -Bottled Beverages

BRAND OWNER BEVERAGE BRAND	DRINK TYPE	ANTIMONY IN BEVERAGE (PPB)	ANTIMONY IN PLASTIC BOTTLE (PPM)
THE COCA-COLA COMPANY			
Coca Cola	Soda	**2.20**	Not tested
Diet Coke	Soda	**1.22**	238
Honest Tea (w/ lemonade)	Tea	**1.07**	255
Simply Lemonade	Juice	**0.96**	< 2.8
Powerade Fruit Punch	Energy	**0.88**	Not tested
Dasani	Water	0.17	265
PEPSICO, INC.			
Gatorade Blue Raspberry	Energy	**1.78**	Not tested
Mountain Dew	Soda	**1.38**	< 3.4
Diet Pepsi	Soda	**1.10**	310
Pepsi	Soda	**0.98**	Not tested
Tropicana Orange*	Juice	**0.56**	Not tested
Aquafina	Water	0.19	289
KEURIG DR PEPPER INC.			
Motts Apple Juice	Juice	**0.98**	264
Dr Pepper		**0.85**	300
7up	Soda	**0.82**	< 4.7
Diet Dr Pepper	Soda	**0.79**	296
Snapple Peach tea	Tea	**0.50**	216
NESTLÉ S.A.			
Perrier	Water	**1.58**	Not tested
OCEAN SPRAY CRANBERRIES, INC.			
Ocean Spray 100% Juice	Juice	**0.46**	309
CAMPBELL SOUP COMPANY			
V8	Juice	**3.45**	321

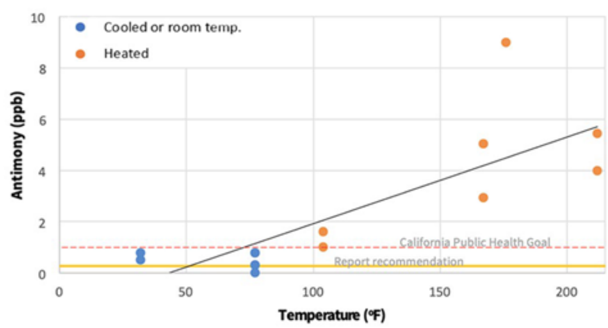
* Recently sold to PAI Partners

Values highlighted in **darker orange** text indicate antimony concentrations in beverages that exceed California's Public Health Goal of 1 part per billion (ppb) of antimony in drinking water. Values highlighted in lighter orange text indicate concentrations that exceed Defend Our Health's recommendation of no more than 0.25 ppb of antimony in drinking water. The antimony concentration in the plastic bottle is reported in parts per million (ppm). A value with a "less than" sign (<) indicates that antimony was not detected above the specified detection limit.

Antimony has been frequently reported in beverages and food packed in plastic

Peer-reviewed studies also document the migration of antimony from bottled beverages. Laboratory-based research on commercially available beverages and food and experiments using food and beverage simulants demonstrate that **antimony migrates into many common products under conditions of typical use**, at amounts that exceed recommended levels. In these studies, PET bottled beverages showed antimony levels that frequently exceeded Defend our Health's recommendation for safer drinking water, and also exceeded California's Public Health Goal for antimony in drinking water (see Appendix 2). Studies also show a strong correlation between antimony migration and temperature (Fig. 3-1), a moderate correlation between antimony migration and acidity, and greater migration in bottled water exposed to UV radiation and sunlight [19-21]. Research also demonstrates a positive correlation between increasing antimony concentration in bottled beverages with longer storage time [22].

Figure 3-1. Antimony Migration Increases with Temperature in Bottled Beverages



Data sources: Westerhoff et al. 2008 [19]; Cheng et al. 2010 [20] Chapa-Martinez et al. 2016 [21]. Each point represents one sample tested.

PET is also used as ready-to-eat meal packaging and oven bags. PET packaging is often labeled as "microwave save" or "oven safe", and microwave meals in PET trays are popular for their convenience. However, past studies [14,17] have found that even before heating, most PET-packaged food products contained high levels of antimony, possibly because containers were filled with hot prepared food during production, which may promote leaching from the plastic to food [20,23]. Antimony concentrations in foods increase further when these products are microwaved or cooked in the oven inside their PET packaging according to packaging directions [20,23].

Detailed summaries of peer reviewed findings of antimony migration from beverage and food can be found in Appendix 2.

1. Antimony Exposure from all Sources Threatens Children's Health

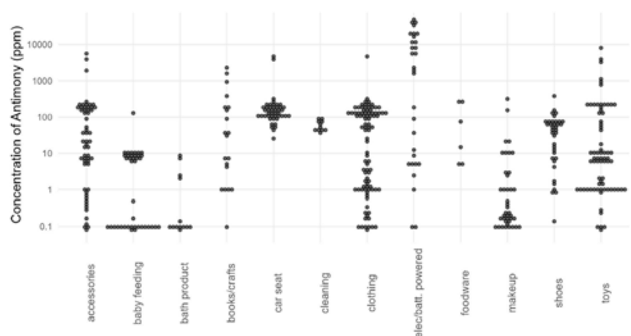
Children are exposed to multiple sources of antimony from its use as a plastic additive, including its common use with flame retardant chemicals, including in PET and polyester. In addition to exposure from food and beverages, antimony may be ingested from house dust and from the mouthing of polyester-based toys and clothing. This aggregate exposure to antimony by children appears to exceed the maximum daily dose established by the State of California to protect against chronic organ toxicity.

Antimony is present in many children's products that have components made of PET plastic and polyester fiber

Water bottles are not the only plastic products from which antimony migrates. Antimony is also found in many children's PET and polyester clothes and toys. Just as with bottles, antimony can escape other products made of PET resin or polyester fiber, and antimony can then be directly ingested when infants and toddlers mouth, suck, or chew these products [24]. Polyester textiles are commonly found in children's clothing. Polyester is also commonly used in the outer fabric and soft fills in cuddly toys. PET and other plastic components of hard plastic toys, electronic toys' casings, and costumes and accessories may contain antimony associated with fire retardants. Antimony and PET microplastics containing antimony also accumulate in household dust [25,26], which young children can then ingest from regular hand-to-mouth activity [27].

Results of testing by Washington's Department of Ecology, and independent car seat testing by the Ecology Center, show that antimony is present in nearly all tested children's products with PET or other plastic components (Figure 3-2).

Fig 3-2 - Antimony is present in most children's products with PET or other plastic components



All results of children's products component testing (except car seats) from Washington's Department of Ecology [28], downloaded May 12th, 2022. Data on car seats from Ecology Center (2022) [29].

Out of 476 product components tested, all but 15 (all car seat components) had detectable levels of antimony. Electronics and battery powered products had the highest levels (median = 2050 ppm, maximum = 45200 ppm), likely from use of antimony with flame retardants in casings. Products that might be mouthed by babies (soft toys, baby bottle components and pacifiers) had lower but detectable antimony levels. Antimony in children's products contribute to antimony exposure in children.

BOX 3: Endocrine disruptors are found in PET products

Endocrine disrupting chemicals (EDCs) are a major concern with all plastics [48]. In particular, chemicals called "xenoestrogens" mimic estrogens produced in the body and can interfere with processes moderated by this hormone. All humans are exposed to some xenoestrogens through normal dietary intake (e.g. in dairy, soy) but high levels of xenoestrogens can also be introduced through contaminants in plastics. Adverse effects include negative impacts on the development of reproductive and nervous systems in utero, and breast cancer in adults. Pregnant people, fetuses, and infants are especially vulnerable.

PET has long been considered a "safe" plastic - bisphenols (such as BPA) or phthalates, which are known classes of EDCs, are not typically intentionally added to PET. Yet there are two problems with the common perception that PET is a plastic free of endocrine disrupting chemicals. First, evaluations of PET have found both phthalates and bisphenols in PET plastics [49,50]. Second, some studies suggest that antimony can also contribute to estrogenic activity [51]. Finally, most studies of EDCs in plastics focus on evaluating the presence of just a small handful of known EDCs but do not evaluate other synthetic compounds that may mimic the activity of hormones [52]. As Wagner and Oehlman [53] note: "understanding the complexity of human exposure to manmade chemicals, including endocrine disruptors, is compromised by the overwhelming number of compounds in use and the technical limitations in their detection".

To overcome this shortcoming of compound-specific studies, some researchers have evaluated the total estrogenic activity of PET products and their contents. Multiple studies have found estrogenic activity in PET containers. Using bioassays (which evaluate effects of substances on living cells or tissue), Wagner and Oehlman [53] found estrogenic activity in seven out of nine brands of water bottled in PET. To confirm that the estrogenic activity was due to substances migrating from the bottle and not already present in the water, they also assessed estrogenic activity of the bottle themselves, and found that PET bottles caused significantly higher activity than glass bottles. A similar study by Pinto and Reali [54] also found detectable levels of estrogenic activity in all of nine PET samples tested, although Bittner et al. [55] did not find estrogenic activity in any of their stressed or unstressed PET bottled water samples. Yang et al.[48] found detectable estrogenic activity in 75% of the 57 PET bottles tested. All bottles were advertised as BPA free. Researchers also tested estrogenic activity after subjecting plastics to common stressors associated with typical use (UV, temperature, and microwaving), and found that a PETG baby bottle that did not show endocrine activity initially showed detectable levels after exposure to UV [56].

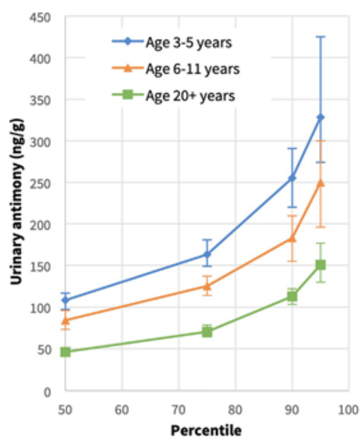
Humans may be exposed to significant levels of estrogenic compounds through PET bottled beverages. Adults meeting all of their hydration needs through bottled water (about 3 liters/day) would on average add an equivalent of 54 ng of estrogen to their total daily intake [52]. If they consumed water from a brand found to have the highest documented estrogenic activity, they could add the equivalent of 226 ng of estrogen to their total intake, effectively tripling their estrogen from external sources [52], far exceeding the level at which adverse estrogenic effects have been observed in animal subjects [57]. As bottled water consumption grows, even low-dose, long-term exposures to estrogen-mimicking compounds may adversely affect large segments of the global population, particularly infants, pregnant people, and people with breast cancer [52].

Young children are more exposed to antimony from all sources than adults

Large scale studies of human health indicate the disproportionate burden of antimony exposure on young children. The National Report on Human Exposure to Environmental Chemicals (2022) [30] summarizes data on antimony in the US population based on National Health and Nutrition Examination Survey (NHANES) responses and health examinations. This data includes tests for antimony in urine, which is an indicator of how much participants are exposed to antimony through different pathways. Higher levels indicate higher exposure, and can help reveal disparities in exposure for different demographic groups (Figure 3-3).

This National Biomonitoring Program report finds that, compared to teens and adults, children aged 3-5 years and 6-11 years show significantly higher levels of urinary antimony.

Figure 3-3. Children are More Exposed to Antimony than Adults



Creatinine-corrected urinary antimony concentration, from the National Report on Human Exposure to Environmental Chemicals (2022) [30]

Children's daily exposure to antimony from all sources far exceeds acceptable health limits. (See Table 3-3).

Based on the sources listed in Table 3-3, we estimate that the average child is exposed to upwards of 207 nanograms of antimony per kilogram of body weight per day. Compared to the estimated exposure for adults, an average child is exposed to over 2.5 times more antimony per kilogram of body weight per day than an average adult.

Based on our analysis, children's total exposure to antimony exceeds the daily dose adopted by state and federal environmental health agencies to protect against adverse health effects. Children in the highest exposure group are exposed to at least six times the Acceptable Daily Dose for antimony established by California's Office of Environmental Health Hazard Assessment. Even compared with the less protective reference dose used by the US EPA, a highly exposed child is exposed to 1.75 times the federal daily limit for antimony. This is without accounting for inhalation of antimony through indoor air, absorption through skin during dermal contact with surfaces treated with antimony-enhanced flame retardants, and inhalation of tobacco smoke, all of which contribute to total antimony intake and likely make children's exposure even higher.

Table 3-3. Total Daily Exposure of Children to Antimony Exceeds Safety Limits

Exposures reported below for plastic bottles, drinking water, food, and upholstered furniture are estimates for adult exposures from authoritative sources. Note that on a per unit body weight basis, children drink more fluids, eat more food, breathe more air, and have a greater skin surface area than adults [31]. Therefore, the values reported below are likely to be underestimates for children's exposure.

EXPOSURE PATHWAY	EXPOSURE SOURCE	DAILY EXPOSURE (IN NG/KG/D)		NOTES
		TYPICAL	HIGH	
INGESTION	PET Plastic Bottles	12	29	Based on migration into bottled water before and after six months of storage [16]. Greater migration likely from plastic-bottled soda and juices due to lower pH (higher acidity).
	Drinking Water	?	24	May be higher from antimony leaching from plumbing materials and fittings, including tin solder [18].
	Food	62	80	Based on a well-balanced diet. May be higher from migration from heated PET plastic food trays [23].
	Polyester Cuddly Toys	?	208	Children who suck or chew on cuddly toys, blankets, and other polyester or PET plastic items, extract antimony in their saliva, and/or ingest polyester particles or fibers.
	House Dust	133	500	About 100 milligrams per day of dust are ingested by children's frequent hand-to-mouth activity [33]. Sources include antimony used with flame retardants in plastics.
Estimated child exposure from ingestion only		**> 207**	**841**	
DERMAL	Polyester Fabric	?	?	Antimony can escape from polyester clothing during skin contact with perspiration [34]. Sleeping with cuddly toys may also cause antimony exposure from skin contact.
	Upholstered Furniture	?	1,500	Skin contact with textiles with antimony trioxide added to enhance effect of flame retardant chemicals.
INHALATION	House Dust	5	21	Assumes that a child aged 1 to <2 years old inhales eight meters cubed of air per day of air [33].
	Outdoor Air	?	21	
Estimated child exposure from all sources		**> 212**	**2,383**	
Daily Exposure Limit	California EPA, OEHHA:	140		Acceptable Daily Dose (ADD) of antimony for its Public Health Goal for Antimony in Drinking Water (2016) [35]
	Unites States EPA, IRIS:	430		Reference dose (RfD) for antimony adopted by U.S. Environmental Protection Agency, IRIS (1987) [36]

Source: Unless otherwise noted, all values are based on the European Union Risk Assessment Report: Diantimony Trioxide (2008) [24], an aggregate risk assessment developed for Europe by the Swedish Chemical Inspectorate. See pp. 362-384. Daily exposure values are expressed as nanograms of antimony per kilogram of bodyweight per day. About half the population is exposed at the "Typical" exposure level. "High" exposure represents a reasonable worst-case scenario for each source. Additional exposure not included above occurs during breastfeeding.

2. *Unjust Exposure to Antimony from Plastics Contributes to Environmental Racism*

Workers often face much higher levels of chemical exposure than the general population. And worker health studies are often the first to reveal the adverse effects of chemical substances in human populations (See Appendix 4). Disproportionate exposure to chemicals on the job is one type of environmental injustice, which is exacerbated for workers of color [37].

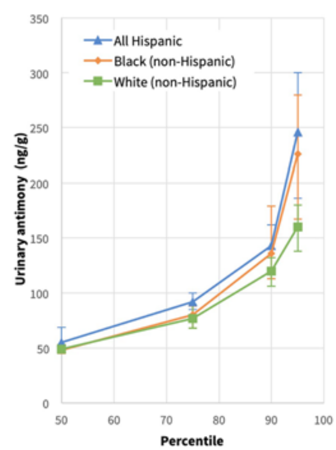
Latinx workers made up more than 90% of a large workforce at a large antimony smelter in Laredo, TX, where raw ore was transformed into antimony trioxide and other compounds. A well-conducted occupational health study [38] found a nearly 40% higher death rate from lung cancer among these workers compared to the general Latinx population. The study also found that the lung cancer death rate increased with years of employment.

Racial disparities in antimony exposure also affect the general American population. Antimony exposure is disproportionately higher in Hispanic and Black communities than among the white population. Nationally, Hispanic participants in the national biomonitoring program have higher urinary antimony levels compared to white or Asian participants (Fig 3-4). Hispanic community members with the highest exposure (at the 95th percentile level) had statistically significantly higher levels of antimony in urine – over 1.5 times more urinary antimony than white participants.

Biomonitoring data integrate exposure from all sources without revealing the relative contribution of each source or the cause of any resulting racial disparities. However, the existence of racial disparities in exposure points toward systemic racism [37]. Further investigation is needed to determine the factors that contribute to the greatest racial disparities in antimony exposure. Hypotheses to test include greater contact with flame-retarded plastics, polyester fabric, or plastic packaged food and beverages, among people of color.

Figure 3-4. Among the Most Highly Exposed Americans, Antimony Hazards Fall Heaviest on Hispanic and Black People

Creatinine-corrected urinary antimony concentration, from the National Report on Human Exposure to Environmental Chemicals (2022) [30]



*Note that the NHANES survey includes questions on self-identified race ethnicity categories. When discussing NHANES data, we follow NHANES conventions for race and ethnicity categories. Survey definitions can be found at https://wwwn.cdc.gov/Nchs/Nnyfs/Y_DEMO.htm

3. Potentially Safer Alternatives to Antimony Catalysts are Widely Available, Effective, and Affordable

Eliminating unnecessary uses of plastics and substituting with safer materials is the best way to prevent environmental release and exposure to all plastic-related chemicals. For continuing uses of PET plastic resin and polyester fiber, an alternatives assessment can reveal whether existing processing aids such as antimony can be replaced with safer substitutes.

Antimony trioxide remains the dominant polymerization catalyst used to manufacture polyethylene terephthalate (PET) plastic for beverage bottles, other packaging, and polyester fiber for clothing and other textile applications [39]. However, given the growing concerns about the hazards and scarcity of antimony [40], the market has begun to shift to alternative catalysts.

We conducted an alternatives assessment for PET catalysts based on readily available information (see Appendix 5). The results are summarized in Table 3-4, which shows that potentially safer alternatives to antimony are functionally equivalent, commercially available, and comparably affordable.

Table 3-4. Comparison of Alternative PET Catalysts to Antimony Compounds

CATALYST COMPOUNDS	SAFER	EFFECTIVE	AVAILABLE	COST
Organo-aluminum salt	MAYBE	YES	YES	LOWER
Germanium oxide	YES	YES	YES	HIGHER
Titanium alkoxide complex	YES	YES	YES	~ SAME
Dibutyltin oxide	NO	?	YES	HIGHER
Enzyme (biobased)	YES	YES?	?	HIGHER?

Question marks indicate insufficient data to make a definitive conclusion.
For a detailed comparison of known PET catalysts, see Appendix 5.

This conclusion is supported by other evidence. Sustainability researchers have determined that the use of antimony as a PET polymerization catalyst is 100% substitutable [40]. Germanium oxide is already widely as used a catalyst to produce PET for plastic bottles in Japan [7]. Suntory sells plastic-bottled beverages made from PET plastic catalyzed with an aluminum-based catalyst developed by Toyobo [41]. A substantial portion of polyester production in Asia has switched to antimony alternatives [42]. Prominent textile manufacturers, including Herman Miller now advertise that their products are made of antimony-free polyester [43].

Our testing results provide preliminary evidence to suggest that some PET plastic manufacturers may have already begun transitioning to non-antimony catalysts for use in plastic bottles sold in the US. In our laboratory analysis, antimony was not detected in three out of sixteen plastic bottle samples tested using XRF (with a detection limit of 3 to 5 parts per million). XRF did not detect titanium or aluminum in these samples, but results of the more sensitive ICP-MS suggest that three of those antimony-free plastic bottles may have the three highest titanium concentrations in the plastic (Mountain Dew, Simply Lemonade, and 7-up), and two of them may have the highest results for aluminum (Simply Lemonade and 7-up) [12]. Both titanium- and aluminum-based PET polymerization catalyst systems are now commercially available and may have been used in the production of PET used in these bottles.

4. Conclusion

PET and polyester manufacturers, and the companies that use their products, can act immediately to reduce harm from PET catalyzed by antimony. The health impacts of antimony are clearly established, and these negative effects are disproportionately borne by small children and people of color. Immediate action is necessary and possible, by transitioning to safe catalysts.

Replacing antimony catalysts in PET manufacture is a crucial step to reduce the harms posed by PET plastics. But it's just the beginning. Hundreds of additives, processing aids, and chemical byproducts in plastics remain understudied, and their continued use poses health hazards that we've barely begun to understand.

Detoxifying the chemicals used to make plastic products is a small but immediately actionable step. The ultimate solution to preventing all harm from PET plastic and polyester require that its use be phased down and out in favor of truly safer, just, and sustainable materials as determined across their entire lifecycles.

Photo by Le Vuko: https://www.pexels.com/photo/plastic-wrap-3615710/

Endnotes

1. Wiesinger, H., Wang, Z. and Hellweg, S. (2021) Deep Dive into Plastic Monomers, Additives, and Processing Aids. Environmental Science and Technology, 55, 9339–51. https://doi.org/10.1021/acs.est.1c00976
2. Food Packaging Forum Foundation. (2022) FCCmigex Database [Internet]. Accessed https://www.foodpackagingforum.org/fccmigex
3. Geueke, B., Groh, K.J., Maffini, M. V., Martin, O. V., Boucher, J.M., Chiang, Y.-T. et al. (2022) Systematic evidence on migrating and extractable food contact chemicals: Most chemicals detected in food contact materials are not listed for use. Critical Reviews in Food Science and Nutrition, 1–11. https://doi.org/10.1080/10408398.2022.2067828
4. Clean Production Action. (2016) GreenScreen® For Safer Chemicals — Hazard Assessment Guidance Version 1.3(e). https://www.greenscreenchemicals.org/static/ee_images/uploads/resources/1_GreenScreen_Guidance_v13_2016_3_8.pdf
5. Clean Production Action. GreenScreen® Method [Internet]. Accessed May 29, 2022. https://www.greenscreenchemicals.org/learn/full-greenscreen-method
6. Healthy Building Network. Pharos [Internet]. Accessed June 6, 2022. https://pharosproject.net/
7. Kishi, E., Ozaki, A., Ooshima, T., Abe, Y., Mutsuga, M., Yamaguchi, Y. et al. (2020) Determination of various constituent elements of polyethylene terephthalate bottles used for beverages in Japan. Packaging Technology and Science, 33, 183–93. https://doi.org/10.1002/pts.2497
8. (2017) ILSI Europe Report Series, Packaging Materials: 1. Polyethylene terephthalate (PET) for food packaging applications - updated version. http://ilsi.eu/wp-content/uploads/sites/3/2017/12/PET-ILSI-Europe-Report-Update-2017_interactif_FIN.pdf.
9. Franz, R. and Welle, F. (2008) Investigation of non-intentionally added substances (NIAS) in PET bottles and closures. Poster Presentation at the 4th International Symposium on Food Packaging, 85354.
10. Kassouf, A., Maalouly, J., Chebib, H., Rutledge, D.N. and Ducruet, V. (2013) Chemometric tools to highlight non-intentionally added substances (NIAS) in polyethylene terephthalate (PET). Talanta, Elsevier. 115, 928–37. https://doi.org/10.1016/j.talanta.2013.06.029
11. The United States Environmental Protection Agency (EPA). (1994) Method 200.7: Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry | US EPA. https://www.epa.gov/esam/method-2007-determination-metals-and-trace-elements-water-and-wastes-inductively-coupled-plasma.
12. (2022) PET bottled beverages lab report. https://defendourhealth.org/wp-content/uploads/2022/07/Lab-Reports-and-Results-FINAL.pdf
13. Methodology | Ecology Center [Internet]. Accessed June 7, 2022. https://www.ecocenter.org/our-work/healthy-stuff-lab/methodology
14. Belzile, N., Chen, Y.W. and Filella, M. (2011) Human exposure to antimony: I. sources and intake. Crit. Rev. Environ. Sci. Technol. https://doi.org/10.1080/10643381003608227
15. Filella, M., Belzile, N. and Chen, Y.W. (2002) Antimony in the environment: A review focused on natural waters I. Occurence. Earth-Science Reviews, 57, 125–76. https://www.sciencedirect.com/science/article/abs/pii/S0012825201000708?via%3Dihub
16. Shotyk, W., Krachler, M. and Chen, B. (2006) Contamination of Canadian and European bottled waters with antimony from PET containers. Journal of Environmental Monitoring, 8, 288–92. https://doi.org/10.1039/b517844b
17. Filella, M. (2020) Antimony and PET bottles: Checking facts. Chemosphere, Elsevier Ltd. 261, 127732. https://doi.org/10.1016/j.chemosphere.2020.127732
18. Health Canada. (2008) Guidelines for Canadian Drinking Water Quality. https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-guideline-technical-document-antimony.html. https://doi.org/10.1021/ba-1987-0214.ch035
19. Westerhoff, P., Prapaipong, P., Shock, E. and Hillaireau, A. (2008) Antimony leaching from polyethylene terephthalate (PET) plastic used for bottled drinking water. Water Research, 42, 551–6. https://doi.org/10.1016/j.watres.2007.07.048
20. Cheng, X., Shi, H., Adams, C.D. and Ma, Y. (2010) Assessment of metal contaminations leaching out from recycling plastic bottles upon treatments. Environmental Science and Pollution Research, 17, 1323–30. https://doi.org/10.1007/s11356-010-0312-4
21. Chapa-Martínez, C.A., Hinojosa-Reyes, L., Hernández-Ramírez, A., Ruiz-Ruiz, E., Maya-Treviño, L. and Guzmán-Mar, J.L. (2016) An evaluation of the migration of antimony from polyethylene terephthalate (PET) plastic used for bottled drinking water. Science of the Total Environment, Elsevier B.V. 565, 511–8. https://doi.org/10.1016/j.scitotenv.2016.04.184
22. Hansen, H.R. and Pergantis, S.A. (2006) Detection of antimony species in citrus juices and drinking water stored in PET containers. Journal of Analytical Atomic Spectrometry, 21, 731–3. https://doi.org/10.1039/b606367e
23. Haldimann, M., Blanc, A. and Dudler, V. (2007) Exposure to antimony from polyethylene terephthalate (PET) trays used in ready-to-eat meals. Food Additives and Contaminants, 24, 860–8. https://doi.org/10.1080/02652030701297511
24. Swedish Chemicals Inspectorate. (2008) European Union Risk Assessment Report: Diantimony Trioxide. https://echa.europa.eu/documents/10162/553c71a9-5b5c-488b-9666-adc3af5cdf5f
25. Rasmussen, P.E., Subramanian, K.S. and Jessiman, B.J. (2001) A multi-element profile of house dust in relation to exterior dust and soils in the city of Ottawa, Canada. Science of the Total Environment, 267, 125–40. https://www.sciencedirect.com/science/article/abs/pii/S0048969700007750?via%3Dihub
26. Zhang, J., Wang, L. and Kannan, K. (2020) Microplastics in house dust from 12 countries and associated human exposure. Environment International, Elsevier. 134, 105314. https://doi.org/10.1016/j.envint.2019.105314
27. Özkaynak, H., Glen, G., Cohen, J., Hubbard, H., Thomas, K., Phillips, L. et al. (2022) Model based prediction of age-specific soil and dust ingestion rates for children. Journal of Exposure Science & Environmental Epidemiology,. https://doi.org/10.1038/s41370-021-00406-5
28. Washington State Departmet of Ecology. Product testing Data [Internet]. Accessed July 6, 2022. https://apps.ecology.wa.gov/ptdbreporting/
29. Ecology Center. (2022) Toxic Inequalities: How an Outdated Standard Leads to Toxics in Low-Cost Children's Car Seats. https://www.ecocenter.org/our-work/healthy-stuff-lab/reports/toxic-inequities-2022-car-seat-report.
30. CDC. (2022) National Report on Human Exposure to Environmental Chemicals. https://www.cdc.gov/exposurereport/
31. World Health Organization. (2006) Principles for evaluating health risks in children associated with exposure to chemicals. https://apps.who.int/iris/handle/10665/43604.
32. Hahladakis, J.N., Velis, C.A., Weber, R., Iacovidou, E. and Purnell, P. (2018) An overview of chemical additives present in plastics: Migration, release, fate and environmental impact during their use, disposal and recycling. Journal of Hazardous Materials, Elsevier B.V. 344, 179–99. https://doi.org/10.1016/j.jhazmat.2017.10.014

33. United States Environmental Protection Agency. (2011) About the Exposure Factors Handbook [Internet]. Accessed June 20, 2022. https://www.epa.gov/expobox/about-exposure-factors-handbook

34. Biver, M., Turner, A. and Filella, M. (2021) Antimony release from polyester textiles by artificial sweat solutions: A call for a standardized procedure. Regulatory Toxicology and Pharmacology, Academic Press. 119, 104824. https://doi.org/10.1016/J.YRTPH.2020.104824

35. Office of Environmental Health Hazard Assessment (OEHHA) California Environmental Protection Agency (CalEPA). (2016) Public Health Goal for Antimony in Drinking Water. https://oehha.ca.gov/media/downloads/water/chemicals/phg/antimonyphg092316.pdf.

36. Integrated Risk Information System (IRIS). (1987) Chemical Assessment Summary: Antimony. https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0006_summary.pdf.

37. Centers for Disease Control and Prevention (CDC). Racism and Health [Internet]. Accessed June 14, 2022. https://www.cdc.gov/healthequity/racism-disparities/index.html

38. Schnorr, T.M., Steenland, K., Thun, M.J. and Rinsky, R.A. (1995) Mortality in a cohort of antimony smelter workers. American Journal of Industrial Medicine, 27, 759–70. https://doi.org/10.1002/ajim.4700270510

39. Filella, M., Hennebert, P., Okkenhaug, G. and Turner, A. (2020) Occurrence and fate of antimony in plastics. Journal of Hazardous Materials, Elsevier. 390, 121764. https://doi.org/10.1016/j.jhazmat.2019.121764

40. Henckens, M.L.C.M., Driessen, P.P.J. and Worrell, E. (2016) How can we adapt to geological scarcity of antimony? Investigation of antimony's substitutability and of other measures to achieve a sustainable use. Resources, Conservation and Recycling, Elsevier B.V. 108, 54–62. https://doi.org/10.1016/j.resconrec.2016.01.012

41. Toyobo. Press Release: Toyobo promotes global use of its aluminum catalyst technology through polymerization technology licensing contract with world's largest PET producer, Indorama Ventures Pcl [Internet]. Accessed June 15, 2022. https://www.toyobo-global.com/news/2017/release_11.html

42. Cooper, Alan T., Catalytic Technologies Ltd. Personal Communication. February 15, 2022.

43. Herman Miller Textiles. Product: Linen, 1FC2 [Internet]. Accessed June 15, 2022. https://www.hermanmiller.com/resources/materials/textiles/current/linen/1fc2/

44. USGS. (2021) Mineral Commodity Summaries - Antimony. https://pubs.usgs.gov/periodicals/mcs2021/mcs2021-antimony.pdf.

45. European Commission. (2014) Report of the Ad hoc Working Group on defining critical raw materials. https://ec.europa.eu/docsroom/documents/10010/attachments/1/translations/en/renditions/pdf.

46. Agency for Toxic Substances and Disease Registry (ATSDR). (2004) Toxicological Profile for Cobalt. https://www.atsdr.cdc.gov/toxprofiles/tp33.pdf. https://doi.org/10.1111/j.1464-410X.1956.tb04795.x

47. Biomonitoring California. (2014) Potential Priority Metals: Meeting of the Scientific Guidance Panel. https://biomonitoring.ca.gov/sites/default/files/downloads/PotenPriority-MetalsTable032714_2.pdf.

48. Yang, C.Z., Yaniger, S.I., Jordan, V.C., Klein, D.J. and Bittner, G.D. (2011) Most plastic products release estrogenic chemicals: A potential health problem that can be solved. Environmental Health Perspectives, 119, 989–96. https://doi.org/10.1289/ehp.1003220

49. da Silva Costa, R., Fernandes, T.S.M., de Sousa Almeida, E., Oliveira, J.T., Guedes, J.A.C., Zocolo, G.J. et al. (2021) Potential risk of BPA and phthalates in commercial water bottles: A minireview. Journal of Water and Health, 19, 411–35. https://doi.org/10.2166/WH.2021.202

50. Mihucz, V.G. and Záray, G. (2016) Occurrence of antimony and phthalate esters in polyethylene terephthalate bottled drinking water. Applied Spectroscopy Reviews, 51, 163–89. https://doi.org/10.1080/05704928.2015.1105243

51. Choe, S.Y., Kim, S.., Kim, H.G., Lee, J.H., Choi, Y., Lee, H. et al. (2003) Evaluation of estrogenicity of major heavy metals. Science of the Total Environment, 312, 15–21. https://doi.org/10.1016/S0048-9697(03)00190-6

52. Wagner, M. and Oehlmann, J. (2011) Endocrine disruptors in bottled mineral water: Estrogenic activity in the E-Screen. Journal of Steroid Biochemistry and Molecular Biology, Elsevier Ltd. 127, 128–35. https://doi.org/10.1016/j.jsbmb.2010.10.007

53. Wagner, M. and Oehlmann, J. (2009) Endocrine disruptors in bottled mineral water: Total estrogenic burden and migration from plastic bottles. Environmental Science and Pollution Research, 16, 278–86. https://doi.org/10.1007/s11356-009-0107-7

54. Pinto, B. and Reali, D. (2009) Screening of estrogen-like activity of mineral water stored in PET bottles. International Journal of Hygiene and Environmental Health, 212, 228–32. https://doi.org/10.1016/j.ijheh.2008.06.004

55. Bittner, G.D., Denison, M.S., Yang, C.Z., Stoner, M.A. and He, G. (2014) Chemicals having estrogenic activity can be released from some bisphenol a-free, hard and clear, thermoplastic resins. Environmental Health: A Global Access Science Source, 13, 1–18. https://doi.org/10.1186/1476-069X-13-103

56. Pinto, B. and Reali, D. (2009) Screening of estrogen-like activity of mineral water stored in PET bottles. Int J Hyg Environ Health, 212, 228–32. https://doi.org/10.1016/j.ijheh.2008.06.004

57. Soares, J., Coimbra, A.M., Reis-Henriques, M.A., Monteiro, N.M., Vieira, M.N., Oliveira, J.M.A. et al. (2009) Disruption of zebrafish (Danio rerio) embryonic development after full life-cycle parental exposure to low levels of ethinylestradiol. Aquatic Toxicology, 95, 330–8. https://doi.org/10.1016/j.aquatox.2009.07.021

CHAPTER 4

Conclusions and Recommendations

The negative impacts of polyethylene terephthalate (PET), used to make plastic bottles and packaging, and polyester fiber for clothing and textiles, justify action to reduce its harm.

Based on this report's analysis, we conclude that PET plastic resin and polyester fiber is:

Unsafe – because of its many toxic additives and the hazardous chemicals used in the manufacturing process, and the resulting aggregate and cumulative impacts from human exposure and environmental releases during production, consumer use, and disposal;

Unjust – due to elevated population-wide exposure of children and people of color to antimony – a common PET plastic additive, higher hazards faced by chemical workers, and the location of many chemical plants that supply PET production near communities of color and low-income residents who are already heavily over-burdened by industrial pollution;

Unsustainable – because PET plastic manufacturing relies on non-renewable fossil resources (oil and gas) and on extremely scarce minerals such as antimony; production and disposal of PET and polyester emits greenhouse gases that are fueling the climate crisis.

The continued expansion of the petrochemical plastics industry will worsen its impacts.

To reverse these trends, plastic pollution should be reduced at the source by eliminating unnecessary uses of plastics and substituting others with safer materials and more sustainable solutions. Rather than working backwards to reduce plastic waste by recycling more, as many in industry wish, the most preventative solutions should be pursued aggressively first. Due to all its inherent limits, recycling should be the option of last resort.

The Preferred Hierarchy for Safe, Just, and Sustainable Solutions to Plastic Pollution

1. **Eliminate unnecessary uses, such as through reusable and refillable packaging**
2. **Substitute with safer more sustainable materials, such as with natural fibers**
3. **Convert durable and semi-durable uses to renewable carbon, preferably derived from sustainably harvested biomass such as agricultural waste and forestry residues**
4. **Increase recycling of plastic bottles and polyester clothing, and avoid down-cycling**
5. **Prevent open burning and the discard of plastic waste to our land and waters**
6. **Halt incineration and avoid landfilling of plastic waste – zero waste remains the goal**

The problems created by PET (and other petrochemical plastics) cannot be solved overnight. A comprehensive road map is needed on how to make the transition to safer, more just and sustainable materials to meet society's needs for goods and services.

Although such a detailed plan is beyond the scope of this report, a broad outline of the necessary actions and timeline to reduce the harm has already emerged. And many of the following actions have been endorsed by leading scientists and corporate market leaders.

RECOMMENDATIONS:

The solutions to the problems of PET plastic and polyester are intertwined. Parallel actions should be pursued that phase down the use of fossil carbon and toxic chemicals, while simultaneously increasing recycled content and the use of renewable carbon. Radical transparency in information must be made available in all supply chains and will help drive down demand for petrochemical plastics. The goal is that all solutions should be non-toxic, climate-friendly, and environmentally just.

1. By 2040, the use of virgin fossil PET plastic and polyester should be largely phased out [1].

Except for truly essential uses for which there's no reasonable alternative, petrochemical plastics such as PET should be eliminated or safely substituted. Any residual use of PET plastic should be based on 100% recycled content or 100% renewable carbon sources.

2. By 2030, replace 50% of PET bottles and packaging with reusable and refillable systems [2].

The emerging reuse economy should be robust, universally accessible, and rely on sustainable materials that are free from toxic hazards and injustice.

3. By 2030, substitute 50% of virgin polyester with recycled clothing or natural fibers [3].

Downcycling of plastic bottles into lower quality polyester cannot be sustained. For circularity, clothing must be recycled into clothing. Recycling alone cannot reduce the fashion industry's carbon footprint enough to meet climate goals. Production of synthetic fibers must be reduced.

4. By 2030, replace 50% of PET with 100% non-toxic biobased PET [4] or bioplastics such as PEF [5].

Starting with renewable raw materials, rather than oil or gas, dramatically reduces the carbon footprint of plastics. Preference must be given to second-generation feedstocks, such as agricultural waste and forestry residues, which have greater climate benefits.

5. By 2025, meet the industry's Recycled Polyester Challenge to increase the recycled content of polyester to 45% (on the path toward achieving a 90% share by 2030) [6].

Recycling must be considered an interim step on the path to true sustainability, rather than a means of perpetuating continued reliance on fossil carbon and toxic additives. Down-cycling to inferior-quality, one-time uses – the current dominant practice – should end.

6. By 2025, meet the industry pledge to eliminate unnecessary and problematic plastic materials (e.g. opaque or pigmented PET plastic bottles, and PETG in rigid packaging [7]).

Both items impede the quality and efficacy of recycling, according to the U.S. Plastics Pact. Darkly-colored PET bottles reduce the clarity and value of the recycled plastic. PETG, which is glycol-modified PET, acts differently than pure PET, impairing effective recycling.

7. By 2025, assess the hazards of all chemical substances used or produced to make PET [8,9].

Conduct hazard assessments using the GreenScreen® for Safer Chemicals (or its equivalent) to score all chemicals used and/or produced across the manufacturing lifecycle of all PET. Act to fill any data gaps that prevent a hazard ranking from being determined by this time.

8. By 2024, eliminate chemicals of high concern [10] as PET plastic additives & processing aids.

Any substances scored as Benchmark 1 by GreenScreen® (or an equivalent hazard assessment method), or that appears on authoritative lists based on similar hazards, should be avoided. Brand-owners and PET manufacturers should know and choose safer chemistry when it comes to the many additives and processing aids available for PET.

9. By 2023, end all use of antimony and cobalt compounds in PET plastic and polyester.

These chemicals of high concern are not needed to make PET plastic. Safer alternatives to antimony [11] and cobalt compounds are available, effective and affordable. Antimony-free polymerization catalysts for PET are based on titanium, germanium or aluminum. Alternative blue toners or other strategies can achieve clear plastic without cobalt additives.

All those with agency to act should implement the above recommendations, including:

- **Brand owners with market pull, such as major beverage and clothing companies**
- **Market leaders whose sustainability innovation drives a competitive race to the top**
- **Local and state policy makers whose leadership often drives national policy actions**
- **The United Nations, poised to develop a global treaty to prevent plastic pollution**
- **The United States federal government, following the lead of the all pace-setters**
- **Organized consumer demand to drive corporate change and government policy**

It's past time to rethink PET and polyester, and take the business-as-usual scenario off the table. We can stop plastic pollution, one plastic at a time, beginning with PET and polyester.

Together, we can achieve a new materials economy that is virtually fossil-free and toxic-free, and steeped in the principles of environmental justice and sustainability.

Photo by Scott Webb: https://www.pexels.com/photo/green-grass-field-under-white-clouds-1048039/

Endnotes

1. Simon, N., Raubenheimer, K., Urho, N., Unge, S., Azoulay, D., Farrelly, T. et al. (2021) A binding global agreement to address the life cycle of plastics: To eliminate plastic pollution, a holistic approach is needed. Science, 373, 43–7. https://doi.org/10.1126/science.abi9010
2. World Economic Forum. (2021) Future of Reusable Consumption Models: Platform for Shaping the Future of Consumption. https://www3.weforum.org/docs/WEF_IR_Future_of_Reusable_Consumption_2021.pdf
3. Stand.earth. Fossil Free Fashion [Internet]. Accessed June 5, 2022. https://www.stand.earth/markets-vs-climate/fossil-free-fashion
4. García-Velásquez, C.A. and van der Meer, Y. (2020) Can we improve the environmental benefits of biobased PET production through local biomass value chains? A life cycle assessment perspective. https://arxiv.org/pdf/2107.05251.pdf
5. Bioplastics Magazine. (2022) LCA for Avantium's FDCS and PEF technology.
6. Textile Exchange. Preferred Fiber & Materials Market Report 2021. https://textileexchange.org/wp-content/uploads/2021/08/Textile-Exchange_Preferred-Fiber-and-Materials-Market-Report_2021.pdf
7. The U.S. Plastics Pact. (2022) Problematic and Unnecessary Materials Report. https://usplasticspact.org/wp-content/uploads/dlm_uploads/2022/01/U.S.-Plastics-Pact-Problematic-Unnecessary-Materials-Report-1.25.2022.pdf
8. Clean Production Action. GreenScreen® For Safer Chemicals [Internet]. Accessed May 29, 2022. https://www.greenscreenchemicals.org/
9. ChemFORWARD. Start SAFER [Internet]. Accessed May 29, 2022. https://www.chemforward.org/safer
10. Clean Production Action. GreenScreen® Method [Internet]. Accessed May 29, 2022https://www.greenscreenchemicals.org/learn/full-greenscreen-method
11. Henckens, M.L.C.M., Driessen, P.P.J. and Worrell, E. (2016) How can we adapt to geological scarcity of antimony? Investigation of antimony's substitutability and of other measures to achieve a sustainable use. Resources, Conservation and Recycling, Elsevier B.V. 108, 54–62. https://doi.org/10.1016/j.resconrec.2016.01.012

APPENDICES

Appendix 1. Antimony Toxicology

Exposure to antimony and its compounds can increase your risk of chronic disease

Authoritative government agencies have concluded that daily exposure to small amounts of antimony and some antimony compounds can pose serious health risks over one's lifetime. California's Office of Environmental Health Hazard Assessment lists antimony trioxide as a carcinogen [1]. The Department of Health and Human Services (HHS) lists antimony trioxide as "reasonably anticipated to be a human carcinogen" [2]. Similarly, the International Agency for Research on Cancer (IARC) has concluded that antimony trioxide is "probably carcinogenic to humans" [3].

Antimony has been known to adversely affect health for decades based on laboratory studies. Schroeder et al. (1970) [4] found evidence that antimony exposure led to early death, increases in blood sugar levels (a risk factor for diabetes), and changes in cholesterol levels (a risk factor for heart disease). Poon et al. (1998) [5] found evidence of changes in liver tissue that could lead to liver disease. The study also found histopathological changes to the thyroid, and elevated levels of antimony in the spleen even after a recovery period.

Antimony has also been shown to slow fetal and infant growth in test animals. A study by Miranda et al. (2006) [6] reported interference in fetal development and growth, reduced fetal weight gain, and variations in skeletal and soft tissue development in rats due to antimony exposure. Unpublished data from the chemical industry, submitted to Health Canada (2020) [7] found that antimony (in the form of sodium antimonate) can cause delays in fetal skeletal development.

Presumed safety thresholds for maximum daily exposure to antimony (from all sources) have been derived from toxicity studies assessed by the State of California, the United States, and other governmental jurisdictions. While these thresholds are intended to protect public health, they may fall short of their goals [See Appendix 3: U.S. drinking water standards].

Table A1-1. Daily Ingestion of Low Levels of Antimony May Threaten Human Health

The most authoritative maximum daily doses, with their agencies and studies, are highlighted in green below.

Human Health Protective Exposure Limits			Critical Toxicology Studies of Oral Exposure (Ingestion)	Basis for Hazard Assessment and Derivation of Acceptable Daily Dose		
Government Agency (Report Date)	Maximum Daily Dose (Name) µg/kg/day	Basis for Drinking Water Limit?	Researchers, Type, Species, Antimony Compound	HEALTH ENDPOINT Used to Derive Daily Limit	Point of Departure (Type of POD) (µg/kg/day)	Uncertainty Factor Applied
US EPA IRIS (1985) [8]	0.35 [or 0.4] RfD	YES	Schroeder et al. (1970) [4] Chronic oral toxicity Rat Potassium antimony tartrate (APT)	Decreased lifespan Decreased blood sugar Altered cholesterol levels	350 LOAEL	1,000
CalEPA OEHHA (2016) [9]	0.14 ADD	YES	Poon et al. (1998) [5] Subchronic (90-day) oral toxicity Rat Potassium antimony tartrate (APT)	Histopathological changes in liver	140 $BMDL_{10}$	1,000
Health Canada (2008) [7]	0.20 TDI	YES		Histopathological changes in thyroid	60 NOAEL	300
U.S. DHHS, ATSDR (2019) [3]	< 6 * MRL	NO		Decreased blood sugar	64 NOAEL	100
UN, WHO (2003)	6	YES	Data from Poon et al. (1998) [5] as re-interpreted in a chemical industry review by Lynch et al. (1999) [10]	Decreased body weight gain Decreased food and water intake	6,000 NOAEL	1,000
ICH (2019) (EU EMA with drug industry)	24	NO		Reduced mean body weight Reduced food consumption	6,000 NOAEL	250
Health Canada (2020) [7]	not derived	NO	Based on unpublished data of chemical industry submitted to ECHA as of Jan. 2017 Developmental toxicity Species not reported Sodium antimonate	Slight delay in fetal skeletal development	49,000 NOAEL	not applied
EU (2008) [11]	not derived	NO	Sungawa (1981) [12] and Hext et al. (1999) [13] Repeated dose toxicity (but not systemic toxicity) Rat Antimony trioxide (ATO)	Health endpoint basis for NOAEL not reported NOTE: Liver toxicity was suggested by a 10% increase in liver weight and significantly elevated ALP and ASAT levels, but rejected as not "adverse" based on absence of histological change or clinical signs of antimony toxicity	1,686,000 NOAEL	not applied

* This Minimal Risk Level of 6 µg/kg/day was established for an "Intermediate" frequency of oral exposure only. ATSDR said there's insufficient data to establish a Minimal Risk Level for "Chronic" (daily, long-term) oral exposure, which would be a lower value than the Intermediate MRL.

RfD Reference Dose, an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to human populations (including sensitive subgroups) that is likely to be without deleterious (non-carcinogenic) effects during a lifetime

ADD Acceptable Daily Dose, an estimate of the maximum daily dose of a chemical from all sources (aggregate exposure) that can be consumed by humans for an entire lifetime without adverse health effects

TDI Tolerable Daily Intake is the total intake by ingestion, to which it is believed that a person can be exposed daily over a lifetime without deleterious effect, based on non-carcinogenic effects

MRL Minimal Risk Level, an estimate of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure

LOAEL Lowest Observed Adverse Effect Level is the lowest exposure at which there are biologically significant increases in frequency or severity of adverse effects between the exposed population and its control

$BMDL_{10}$ The benchmark dose (BMD) is defined as the dose that corresponds to a specific change in an adverse response compared to the response in unexposed subjects. The benchmark dose level (BMDL) is the lower 95% confidence limit. The BMDL10 is that level associated with a 10% extra risk of adverse effect in the exposed test animals, as compared to the background levels of risk.

NOAEL No Observed Adverse Effect Level is the highest exposure at which there are no biologically significant increases in frequency or severity of adverse effects between the exposed population and its control

POD Point of Departure is the point on a toxicological experimental dose-response curve of low or no effect

UF Uncertainty Factors are applied to the POD to account for extrapolating across species and from subchronic to lifetime exposure, and for variations among humans in how chemicals are metabolized

Uncertainty Factor (UF) Applied	OEHHA	HC	ATSDR	WHO	ICH	EPA
Interspecies extrapolation from animals to humans	10	10	10	10	5 for rats	10
Variation in the human population (intraspecies variation)	30	10	10	10	10	10
Extrapolating from subchronic to chronic toxicity	√10	3	see note above	10	5	-
Severe toxicity, with fetal toxicity associated with maternal toxicity = 1	-	-	-	-	1	-
Point of departure. ICH = 1 for NOAEL when difference with NOEL was not investigated and the effects were not considered "adverse" at given dose. EPA = 10 because the effect level was a LOAEL and no NOEL was established	-	-	-	-	1	10
Total UF Applied	**1,000**	**300**	**100**	**1,000**	**250**	**1,000**

Note: OEHHA applied a UF of 30 for variation in the human population based on multiplying these two factors together:

• 10 for pharmacokinetics is applied due to concerns regarding variability in the human population related to absorption, distribution, tissue accumulation, excretion, and conversion of Sb(V) to Sb(III)
• √10 for pharmacodynamics (√10, the square root of 10 = 3.16)

OEHHA's application of an uncertainty factor of √10 for subchronic to lifetime exposure is based on the study's duration of 8 to 12% of estimated lifetime. See guidelines (OEHHA 2008) [15].

Endnotes

1. Office of Environmental Health Hazard Assessment (OEHHA) California Environmental Protection Agency (CalEPA). (2022) Safe Drinking Water and Toxic Enforcement Act of 1986: Chemicals Known to the State to Cause Cancer or Reproductive Toxicity (Proposition 65 List). https://oehha.ca.gov/proposition-65/proposition-65-list
2. National Toxicology Program. (2018 Oct) Report on carcinogens: monograph on antimony trioxide. Research Triangle Park, NC. https://ntp.niehs.nih.gov/ntp/roc/monographs/antimony_final20181019_508.pdf. https://doi.org/10.1007/BF02566856
3. Agency for Toxic Substances and Disease Registry (ATSDR). (2019) Toxicological Profile for Antimony. https://www.atsdr.cdc.gov/toxprofiles/tp23.pdf
4. Schroeder, H.A., Mitchener, M. and Nason, A.P. (1970) Zirconium, niobium, antimony, vanadium and lead in rats: life term studies. The Journal of Nutrition, 100, 59–68. https://academic.oup.com/jn/article-abstract/100/1/59/4776774?redirectedFrom=fulltext
5. Poon, R., Chu, I., Lecavalier, P., Valli, V.E., Foster, W., Gupta, S. et al. (1998) Effects of antimony on rats following 90-day exposure via drinking water. Food and Chemical Toxicology, 36, 21–35. https://www.sciencedirect.com/science/article/abs/pii/S0278691597801202?via%3Dihub
6. Miranda, E.S., Miekeley, N., De-Carvalho, R.R. and Paumgartten, F.J.R. (2006) Developmental toxicity of meglumine antimoniate and transplacental transfer of antimony in the rat. Reproductive Toxicology, 21, 292–300. https://doi.org/10.1016/j.reprotox.2005.09.010
7. Health Canada. (2008) Guidelines for Canadian Drinking Water Quality https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-guideline-technical-document-antimony. https://doi.org/10.1021/ba-1987-0214.ch035
8. Integrated Risk Information System (IRIS). (1987) Chemical Assessment Summary: Antimony. https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0006_summary.pdf
9. Office of Environmental Health Hazard Assessment (OEHHA) California Environmental Protection Agency (CalEPA). (2016) Public Health Goal for Antimony in Drinking Water. https://oehha.ca.gov/media/downloads/water/chemicals/phg/antimonyphg092316.pdf
10. Lynch, B.S., Capen, C.C., Nestmann, E.R., Veenstra, G. and Deyo, J.A. (1999) Review of subchronic/chronic toxicity of antimony potassium tartrate. Regulatory Toxicology and Pharmacology, 30, 9–17. https://doi.org/10.1006/rtph.1999.1312
11. Swedish Chemicals Inspectorate. (2008) European Union Risk Assessment Report: Diantimony Trioxide. https://echa.europa.eu/documents/10162/553c71a9-5b5c-488b-9666-adc3af5cdf5f
12. Sunagawa, S. (1981) Experimental studies on antimony poisoning (author's translation from Japanese). Igaku Kenkyu, 51, 129–42.
13. Hext, P.M., Pinto, P.J. and Rimmel, B.A. (1999) Subchronic feeding study of antimony trioxide in rats. Journal of Applied Toxicology, 19, 205–9. https://analyticalsciencejournals.onlinelibrary.wiley.com/doi/10.1002/(SICI)1099-1263(199905/06)19:3%3C205::AID-JAT567%3E3.0.CO;2-X
14. Karagas, M.R., Wang, A., Dorman, D.C., Hall, A.L., Pi, J., Sergi, C.M. et al. (2022) Carcinogenicity of cobalt, antimony compounds, and weapons-grade tungsten alloy. The Lancet Oncology, Elsevier. 23, 577–8. https://doi.org/10.1016/S1470-2045(22)00219-4
15. Office of Environmental Health Hazard Assessment (OEHHA) California Environmental Protection Agency (CalEPA). 2008. Air Toxics Hot Spots Risk Assessment Guidelines: Technical Support Document for the Derivation of Noncancer Reference Exposure Levels. Oakland, CA. https://oehha.ca.gov/media/downloads/crnr/noncancertsdfinal.pdf

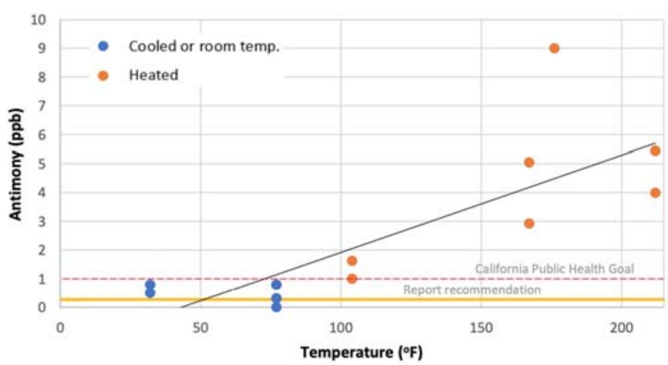
Appendix 2. Migration of Antimony from PET Plastic Bottles and Other Products

Antimony in beverages

According to an industry survey conducted by the International Bottled Water Association, 37% of adults in the US get their water mostly or entirely from bottled water – 21% say they mostly drink bottled water, and 16% say they drink only bottled water) [1]. That is, over a third of Americans are relying on beverages bottled in plastic, most of which are made of PET, to meet their water intake needs. These bottles are frequently stored improperly (such as at high temperatures or exposed to sunlight), often for long periods, resulting in increased concentrations of antimony in the beverage.

Temperature: Temperature increases migration of antimony in PET bottled waters. For bottles stored at 104 degrees Fahrenheit for a minimum of one day, migration exceeds California's Public Health goal of 1 ppb. Using data aggregated from three peer-reviewed studies, we find that for every 10° F increase in temperature, migration of antimony increases by 0.34 ppb [Figure A2-1].

Why this matters: Temperatures of 104 degrees F and above are common for cities in the US southwest; for example the average high temperature in Las Vegas in July is 107° F, and is 104° F in August. Water bottles left out under these conditions will on average have a concentration of 2.09 ppb, over double the California Public Health Goal of 1 ppb. Temperatures inside a car on a hot day can exceed 200° F; at these temperatures, antimony concentration is expected to average 5.3 ppb, over 5 times the CA public health goal. For the many in the US who rely mostly or entirely on bottled beverages to meet their hydration needs, particularly in the Southwest, regularly drinking PET bottled water left in these conditions is typical [4] and may result in chronic exposure to elevated concentrations of antimony.

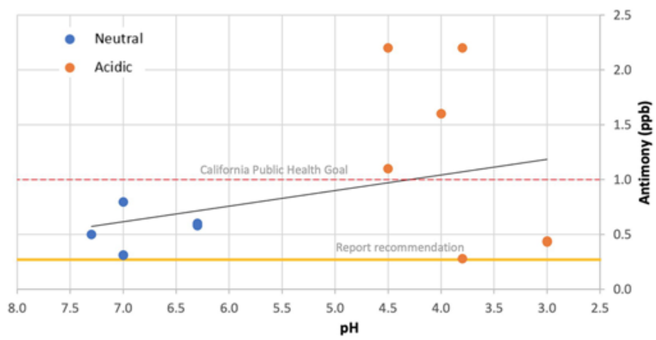


Data sources: Westerhoff et al. 2008 [2]; Cheng et al. 2010 [3]; Chapa-Martinez et al. 2016 [5]. Each point represents one PET bottled water sample. See sources for testing methods used in each study.

pH: At room temperature, acidic beverages including carbonated sodas (typically pH 4.5), citrus juices (pH 3.3-4.2), and other juices show elevated concentrations of antimony compared to water in similar containers. The storage time of acidic beverages in PET also affects migration: juice in expired bottles contained more Sb than juice in unexpired ones [5]. Heating and pH also have a compounding effect: acidic beverages heated in PET showed greater migration of total Sb4,5, and the total increase is mainly driven by inorganic Sb(III), known to be the more toxic of the two inorganic antimony species [5]. [Fig A2-2]

Why this matters: Carbonated beverages and juices bottled in PET are expected to have higher levels of antimony than bottled water kept under similar conditions.

Fig A2-2. Antimony migration increases in more acidic beverages

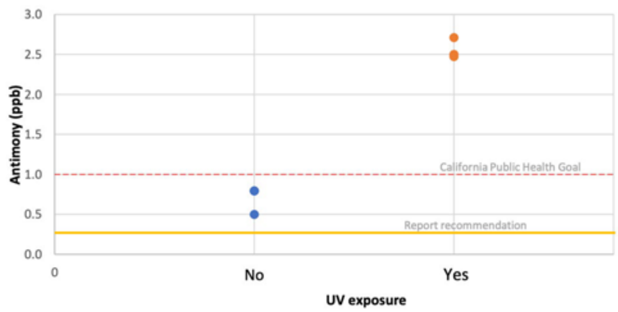


Data sources: Westerhoff et al. 2008 [2]; Cheng et al. 2010 [3]; Chapa-Martinez et al. 2016 [4]. Each point represents one PET bottled water sample. See sources for testing methods used in each study.

UV exposure: Bottled water is likely to be exposed to ultraviolet (UV) light during regular. One study (Cheng et al. 2010) found that antimony migration may triple or quadruple when exposed to UV irradiation for seven days. [Fig A2-3]

Why this matters: Bottled water and sports beverages are popular for athletes and others who engage in outdoor activities. Bottled water is also frequently stored in areas where it may be exposed to frequent UV radiation, including in sunlit homes and outdoor storage areas.

Fig A2-3: Antimony migration increases with exposure to UV radiation in bottled beverages



Data sources: Westerhoff et al. 2008 [2]; Cheng et al. 2010 [3]. Each point represents one PET bottled water sample.
See sources for testing methods used in each study.

Storage time: Antimony migration also increased with storage time. In a study evaluating migration based on time from expiration date, Hansen and Pergantis (2006) found that every 10-day increase in storage increased antimony concentration in beverages by 0.02 ppb, on average.

Why this matters: Stores routinely sell products nearing their expiration dates at discounted rates, making consumers trying to find more affordable products particularly vulnerable. Consumers often store bottled water for weeks or months after purchase.

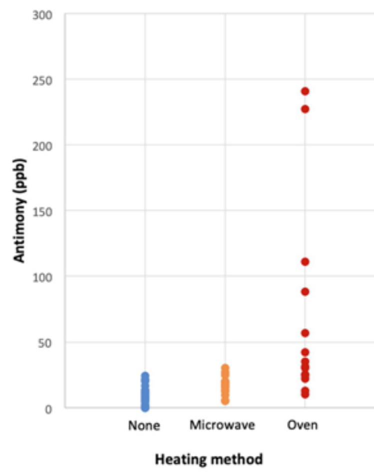
Heating food in “microwave/oven safe” PET containers may expose consumers to elevated concentrations of antimony

Haldiman et al. (2007) evaluated food products intended to be heated in PET containers, including trays, oven bags, and wrappers. In this study, all of the food items were packaged in PET and also intended to be reheated in the packaging. All products were tested straight out of the package, and replicates were reheated according to package instructions (either in the oven or microwave at the specified power/temperature for the specified time) after which antimony concentrations were evaluated. Results found that, even before heating, most food products contained high levels of antimony, possibly because containers were filled with hot prepared food during production. Antimony concentration in foods increase further when microwaved or cooked in the oven. In particular, baking in PET resulted in antimony concentrations as high as 241 ppb. [Fig A2-4]

Why it matters: Many PET products are labeled as “microwave save” or “oven safe” [6], and are a popular choice for convenient meals.

Antimony can migrate out of some polyester textiles, including clothes, cuddly toys (e.g. stuffed animals), other childcare articles, and polyester (fleece) clothing, especially when exposed to bodily fluids such as sweat [7]. For more on antimony in children’s products including toys and clothing, see Section 4 on children’s products in Chapter 3 of this report.

Fig A2-4. Heating food and beverages in PET containers, according to packaging instructions, can expose consumers to elevated concentrations of antimony.



Sources: Haldiman et al. 2007 [5]; Cheng et al. 2010 [3]. Each point represents one PET packaging sample. See sources for testing methods used in each study.

Endnotes

1. International Bottled Water Association. (2019) Consumers' preference for bottled water is growing and they want it available wherever drinks are sold. GlobeNewsWire, Alexandria, VA.
2. Westerhoff, P., Prapaipong, P., Shock, E. and Hillaireau, A. (2008) Antimony leaching from polyethylene terephthalate (PET) plastic used for bottled drinking water. Water Research, 42, 551–6. https://doi.org/10.1016/j.watres.2007.07.048
3. Cheng, X., Shi, H., Adams, C.D. and Ma, Y. (2010) Assessment of metal contaminations leaching out from recycling plastic bottles upon treatments. Environmental Science and Pollution Research, 17, 1323–30. https://doi.org/10.1007/s11356-010-0312-4
4. Chapa-Martínez, C.A., Hinojosa-Reyes, L., Hernández-Ramírez, A., Ruiz-Ruiz, E., Maya-Treviño, L. and Guzmán-Mar, J.L. (2016) An evaluation of the migration of antimony from polyethylene terephthalate (PET) plastic used for bottled drinking water. Science of the Total Environment, Elsevier B.V. 565, 511–8. https://doi.org/10.1016/j.scitotenv.2016.04.184
5. Hansen, H.R. and Pergantis, S.A. (2006) Detection of antimony species in citrus juices and drinking water stored in PET containers. Journal of Analytical Atomic Spectrometry, 21, 731–3. https://doi.org/10.1039/b606367e
6. Haldimann, M., Blanc, A. and Dudler, V. (2007) Exposure to antimony from polyethylene terephthalate (PET) trays used in ready-to-eat meals. Food Additives and Contaminants, 24, 860–8. https://doi.org/10.1080/02652030701297511
7. Biver, M., Turner, A. and Filella, M. (2021) Antimony release from polyester textiles by artificial sweat solutions: A call for a standardized procedure. Regulatory Toxicology and Pharmacology, 119. https://doi.org/10.1016/j.yrtph.2020.104824

Appendix 3. Drinking Water Standards for Antimony

Our analysis suggests that current drinking water limits may not be sufficiently protective of public health due to potentially faulty assumptions. Based on our analysis, a health protective standard for antimony in drinking water should be 0.25 parts per billion (ppb).

US agencies, including the US EPA, and California's OEHHA, determine acceptable concentrations of antimony (or any contaminant) in drinking water as:

Concentration = (ADD * RSC) / DWI

Where:

ADD = **Acceptable Daily Dose** [a] (Note that some agencies use **Reference Dose** (RfD) [b] instead of ADD)
RSC = **Relative source contribution**. This is the percentage of antimony that is assumed to come from water.
DWI = **Daily water intake**. This is the rate at which water is assumed to be consumed by an individual.

Table A3-1 [Antimony drinking water] shows drinking water limits calculated for different jurisdictions. Values range from 18 ppb (WHO) to 1 ppb (OEHHA); differing assumptions about antimony toxicity, how much water contributes to total antimony consumption, and daily water intake, results in vastly different recommended concentrations which may not be sufficiently protective of human health.

EPA's ADD value may be too high

Drawing primarily on the most recent and complete lab-based analysis of health impacts of antimony in drinking water, California Environmental Protection Agency adopted an Acceptable Daily Dose (ADD) of 0.14 micrograms (140 nanograms) of antimony per kilogram of body weight per day. However, US EPA uses an earlier study [c] to derive a value of 0.4 micrograms per kilogram of body weight per day as the RfD. This contributes to EPA's less health-protective maximum limit for antimony in drinking water.

RSC values overestimate drinking water contribution to total antimony

Both EPA and OEHHA assumed that 40% of one's exposure to antimony comes from drinking water. That percent is known as a "relative source contribution (RSC)". If other sources of antimony exposure are added up and account for more than the remaining 60% of total exposure, then the RSC for drinking water is pegged too high. The World Health Organization (WHO), for example, assumes that only 10% of antimony exposure comes from drinking water.

Applying a more protective RSC of 10%, the California and U.S. drinking water limits should be one-fourth their current value, or 0.25 ppb and 1.5 ppb, respectively. Our review supports this more protective approach on drinking water, given other significant sources of antimony ingestion from food, beverages, house dust and products, especially for young children.

---

[a] An Acceptable Daily Dose is defined as "an estimate of the maximum daily dose that can be consumed by humans for an entire lifetime without adverse health effects" (OEHHA 2016).

[b] A Reference Dose is defined as "an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime." https://www.epa.gov/iris/basic-information-about-integrated-risk-information-system.

[c] Schroeder, H.A., Mitchener, M. and Nason, A.P. (1970) Zirconium, niobium, antimony, vanadium and lead in rats: life term studies. The Journal of Nutrition, 100, 59–68. https://doi.org/10.1093/jn/100.1.59

Underestimated DWI values may be producing less-protective antimony standards

In setting its drinking water goal for antimony, OEHHA assumes that people drink almost twice as much water as USEPA does, based on a robust data set on water consumption rates for different age groups [4]. USEPA simplistically assumed that a 60-kilogram (132-pound) adult consumes 2 liters (slightly more than a half-gallon) of water per day. If the OEHHA consumption rates were applied to federal standard-setting, the national MCL for antimony would be reduced to about 3 ppb. Applying more realistic assumptions for both RSC and DWI would reduce the federal standard to 0.8 ppb, less than the current California Public Health Goal.

Defend Our Health's recommended standard

Based on OEHHA's ADD and DWI values, and WHO's RSC value, Defend Our Health recommends that antimony in drinking water should not exceed 0.25 ppb.

Government Agency (Action Date) Type of Limit	ADD Acceptable daily dose μg/kg/day	RSC Water relative source contribution [1]	DWI Drinking Water Intake L/kg/day	Water guidance value
United States EPA (1990) Maximum Contaminant Level [2]	0.4	40%	0.029	6 ppb
California EPA, OEHHA (2016) [3] Public Health Goal	0.14	40%	0.053 [4]	1 ppb
Defend Our Health recommended standard	***0.14***	***10%***	***0.053 [4]***	***0.25 ppb***
Health Canada (2008) [5] Maximum Acceptable Concentration	0.2	?	0.021	4 ppb
World Health Organization (2003) [6] Guideline Value (*calculated value*)	6	10%	0.033	18 ppb
European Commission (rev. 2020) [7] Quality standard – Water intended for human consumption	?	?	?	10 ppb
People's Republic of China (2006) Standard for Drinking Water Quality [8]	?	?	?	5 ppb
Japan Ministry of Health, Labour and Welfare (2003) – Target Value [9]	?	?	?	15 ppb

ppb Parts per billion, a concentration equal to micrograms of chemical per liter of water (μg/L)
L/kg-d Liters of water consumed per kilogram of body weight per day
μg/kg/d Chemical exposure metric expressed as micrograms of chemical per kilogram of bodyweight per day

[4] U.S. Department of Agriculture's Continuing Survey of Food Intake of Individuals 1994-1996, 1998 dataset, cited by OEHHA 2016.

Endnotes

1. The Relative Source Contribution (RSC) is the percent of the maximum daily dose assumed to be contributed by drinking water. A lower RSC results in a lower, more protective drinking water standard since less of the total exposure may be contributed by that one source.
2. A Maximum Contaminant Level (MCL) is an enforceable drinking water standard based on technological and economic feasibility. From: U.S. Environmental Protection Agency (EPA). (1990) Drinking Water Criteria Document for Antimony.
3. A Public Health Goal (PHG) is a limit on a chemical in drinking water that's based solely on scientific and public health considerations without regard to economic cost considerations. California's enforceable maximum contaminant level for antimony remains at 6 ppb. From: Office of Environmental Health Hazard Assessment (OEHHA) California Environmental Protection Agency (CalEPA). (2016) Public Health Goal for Antimony in Drinking Water. https://oehha.ca.gov/media/downloads/water/chemicals/phg/antimonyphg092316.pdf.
4. This is a time-weighted average over a lifetime based on a nationwide survey of food and beverage intake for approximately 20,000 individuals of different age groups. From: United States Department of Agriculture (USDA). The Continuing Survey of Food Intakes by Individuals and the Diet and Health Knowledge Survey, 1994–96. https://ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/food-surveys-research-group/docs/csfii-1994-1996-1998-and-dhks-1994-1996/
5. Health Canada's set its final Maximum Acceptable Concentration at the practical quantitation limit (PQL) of 6 ppb because the calculated level of 4 ppb was lower than the PQL. From: Health Canada. (2008) Guidelines for Canadian Drinking Water Quality. https://www.canada.ca/en/health-canada/services/publications/healthy-living/guidelines-canadian-drinking-water-quality-guideline-technical-document-antimony.html https://doi.org/10.1021/ba-1987-0214.ch035
6. The World Health Organization (WHO) rounded up its final Guideline Value to 20 ppb. WHO derived this guideline value from a chemical industry reinterpretation of the same toxicity study that informed the drinking water limits adopted later by both California and Canada.
7. The European Commission adopted a drinking water standard of 5 ppb for antimony in 1998. They revised it in 2020 in response to WHO. From Official Journal of the European Union (2020) Directive (EU) 2020/2184 of the European Parliament and of the Council of 16 December 2020 on the quality of water intended for human consumption (recast) (Text with EEA relevance). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32020L2184.
8. People's Republic of China (2006) Standard for Drinking Water Quality. http://tradechina.dairyaustralia.com.au/wp-content/uploads/2018/08/GB-5749-2006-Standards-for-Drinking-Water-Quality.pdf
9. Wakayama, H. Revision of Drinking Water Quality Standards in Japan. http://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0264pdf/ks0264011.pdf

Appendix 4. Antimony Hazards to Workers

Some workers face significant health risks from antimony exposure

Workers all along the antimony supply chain face health risks from lung damage and lung cancer due to inhalation of dust . This includes workers at antimony smelters, and those handling antimony-based powder for use as a catalyst for PET production, as a flame retardant to produce plastics, rubber and treated textiles; and from formulating pigments, paints, coatings and ceramics; and from the production and secondary smelting of lead-acid batteries and lead alloys [1].

Today, most antimony smelting and refining occurs in China. United States Antimony Corporation (USAC) operates the only two antimony smelters in North America. One is located 15 miles west of Thompson Falls, Montana in the U.S., and the other in Estación Madero in Coahuila, Mexico . USAC also extracts antimony ores at several mine sites in Mexico [2]. Studies have shown that workers exposed to antimony can experience occupational disease that kills or harms them and threatens their children's health (Table A4-1). At a former antimony smelter in Laredo, Texas [3], once the largest in the world, the mostly Latinx workforce died of lung cancer at a 40% higher rate than the general Spanish-surnamed population, and at three times the rate among workers employed longer than ten years [4].

Table A4-1. Antimony Exposure Can Seriously Harm the Health of Workers and Their Children

Workplace	Health Effect	# Workers	Severity	Source
Grinding stone production	Heart complications Altered electrocardiograms Sudden death	125	8 of 125 (6.4%) workers affected by exposure that lasted up to two years	Brieger et al. (1954)
	Ulcers	111	6.3% rate vs. 1.5% among 3,912 control workers; Odds Ratio (OR) of 4.2	
Antimony Smelters	Lung cancer Liver cancer Biliary cancer Gall-bladder cancer	1,014 men (91.5% Latinx) Texas, USA	Standard Mortality Ratio of 1.39 (lung) SMR of 2.99 for Latinx workers employed > 10 years	Schnorr et al. (1995)
	Menstrual disorders Miscarriage	women	75.5% incidence rate; OR of 1.38 12.5% incidence rate; OR of 3.05	Beliaeva (1967)
	Low birth weight Breastfeeding exposure	their infants	Significant at 1-year of age 3.3 ppm antimony in breast milk	
Textile Back-Coating	Oxidative DNA damage	23	Significant difference in FPG comet enzyme-modified bioassay 2.3 times higher exposure in affected group than control	Cavallo et al. (2002)

"Standardized Mortality Ratio (SMR) is a ratio between the observed number of deaths in a study population and the number of deaths that would be expected, based on the age- and sex-specific rates in a standard population and the population size of the study population by the same age/sex groups. If the ratio of observed:expected deaths is greater than 1.0, there is said to be "excess deaths" in the study population." Source: New Mexico's Health Indicator Data & Statistics. Accessed June 7, 2022. https://ibis.health.state.nm.us/resource/SMR_ISR.html

"An odds ratio (OR) is a measure of association between an exposure and an outcome. The OR represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. ... The odds ratio can also be used to determine whether a particular exposure is a risk factor for a particular outcome, and to compare the magnitude of various risk factors for that outcome. OR=1 Exposure does not affect odds of outcome; OR>1 Exposure associated with higher odds of outcome; OR<1 Exposure associated with lower odds of outcome." From Szumilas, M. (2010) Explaining odds ratios. Journal of the Canadian Academy of Child and Adolescent Psychiatry, 19, 227-9.

Endnotes

1. Swedish Chemicals Inspectorate. (2008) European Union Risk Assessment Report: Diantimony Trioxide. https://echa.europa.eu/documents/10162/553c71a9-5b5c-488b-9666-adc3af5cdf5f.
2. United States Antimony Corporation. (2019) 2018 Annual Report. https://www.annualreports.com/Company/united-state-antimony.
3. Cuellar, H. (2015) Press Release: Rep. Cuellar Announces Removal of Antimony from Former Anzon Smelter Site Office Locations [Internet]. Accessed May 13, 2022. https://cuellar.house.gov/news/documentsingle.aspx?DocumentID=398917
4. Schnorr, T.M., Steenland, K., Thun, M.J. and Rinsky, R.A. (1995) Mortality in a cohort of antimony smelter workers. American Journal of Industrial Medicine, 27, 759–70. https://doi.org/10.1002/ajim.4700270510
5. Brieger, H., Semisch, C.W., Stasney, J. and Piatnek, D.A. (1954) Industrial antimony poisoning. Industrial Medicine and Surgery, 23, 521–3.
6. Beliaeva, A.P. (1967) The effect of antimony on the generative function. Meditsina Truda I Promyshlennaya Ekologiya, 11, 32–7.
7. Cavallo, D., Iavicoli, I., Setini, A., Marinaccio, A., Perniconi, B., Carelli, G. et al. (2002) Genotoxic risk and oxidative DNA damage in workers exposed to antimony trioxide. Environmental and Molecular Mutagenesis, 40, 184–9. https://doi.org/10.1002/em.10102

Appendix 5. Alternatives to Antimony as a PET Polymerization Catalyst

Antimony trioxide is the dominant catalyst used to speed the final chemical reaction that produces polyethylene terephthalate (PET) plastic for beverage bottles and other packaging, and polyester fiber for clothing and other textile applications. (Other antimony compounds have also been used for this purpose, including antimony acetate and antimony glycolate.) Due to growing concerns about antimony, the market is beginning to shift to non-antimony catalyst systems for PET and polyester.

Henckens et al. (2016) [1] concluded that 100% of antimony use as a catalyst can be readily substituted. They argue that case on sustainability grounds, citing the extreme scarcity of recoverable antimony ore relative to its high demand, mostly as a plastics additive for use with flame retardant chemicals. They conclude that only about 25 years of extractable antimony ore is readily available at projected consumption rates, compared to their sustainability benchmark for the extraction rate of minerals, defined as providing at least 1,000 years of supply [2].

Based on a literature review using six comparative metrics, we conclude that safer alternatives to antimony as a PET catalyst are commercially available, effective (i.e. functionally equivalent), and affordable. Although there are some tradeoffs, these choices of catalysts for PET plastic and polyester production are preferable over antimony trioxide or other antimony compounds:

- **Germanium oxide**, has low toxicity, but the cost is higher and the element somewhat scarce;
- **Biobased enzymes** or other organic (non-metal) biocatalysts may be the safest and most sustainable solution but don't appear to be commercially available yet for PET polymerization;
- **Titanium alkoxide complex**, which appears more effective than antimony, is safer for consumers but may pose worker and fenceline community hazards during mining and refining;
- **Organo-aluminum salt**, the cheapest solution, creates hazards during mining and refining and may pose consumer hazards from migration from PET plastic; and

The table below (Table A5-1) summarizes the comparative benefits of the major PET catalyst systems that are in commercial use now, or are desirable (in the case of enzymes).

Here's a brief description of the six metrics compared under five categories in the table header for each catalyst alternative:

Safety – This measure is based on the inherent hazard properties of the element or compound reported in two related ways:

• **Consumer Health** profiles the catalyst hazard based on possible daily exposure and chronic human toxicity. This includes a consumer exposure scenario from migration of the catalyst or related metal compounds or ions from PET plastic or polyester items during use; and

• **Lifecycle Health** considers the hazards posed to workers during mining and refining of the metal ores. By extension similar concerns may be experienced as fenceline impacts on people who live or work next to mining, refining and related chemical manufacturing operation.

Table A5-1. Comparison of Alternative PET Polymerization Catalysts

Catalyst compounds	SAFER (HAZARDS) [a]		SUSTAINABLE	AVAILABLE	EFFECTIVE [b]	AFFORDABLE [c]
	Consumer Health	Lifecycle Health	Supply Scarcity [d]	Commercially Available	Amount Needed	2021 Price per Pound (raw)
Antimony trioxide	HIGH [e]	HIGH [f]	Extreme	YES	~ 250 ppm	$5.20
Organo-aluminum salt [g]	MAYBE [h]	HIGH [i]	Abundant	YES	Not Sure	$1.40
Germanium oxide	SAFER [j]	SAFER [k]	Moderate	YES	~ 25 ppm	$349 - $544
Titanium alkoxide complex [l]	SAFER [m]	HIGH [n]	Abundant	YES	~ 10 ppm	$5.31
Dibutyltin oxide	HIGH [o]	HIGH [p]	Moderate	YES	Not Sure	$15 - $16
Enzyme (biocatalyst) [q]	SAFER	SAFER	Unknown	NO?	Not Sure	High?

Color coding: RED = More problematic; GREEN = More preferable; YELLOW = Moderate concern or unknown status. Question marks indicate relatively high degree of uncertainty. "ppm" = parts per million in PET plastic. Sources are cited in the footnotes.

[a] This hazard assessment is informed by the GreenScreenTM [4] score for each element and/or its compounds, obtained from the Pharos [5] database, and further from information obtained from U.S. EPA's CompTox Chemicals Dashboard [6].

[b] Reviews of the relative effectiveness of PET polymerization catalysts include: antimony trioxide and germanium dioxide (Thiele 2001 [7]), organo-aluminum salt (Nakajima et al. 2006 [8], Toyobo 2017 [9]), titanium alkoxide complex (Schoennagel & Cooper 2016 [10], Catalytic Technologies Ltd. [11]) and dibutyltin oxide (Davies 2010 [12]).

[c] USGS Mineral Commodity Summaries (2022) [3]. Prices reported for various forms of the metals in various markets provide a relative gauge of the cost of the raw material rather than the actual cost of the specific compound or catalyst product.

[d] The European Chemical Society (2021) [13] and Henckens et al. (2014) [2] are in general agreement on the relative scarcity of these elements except for germanium. EuChemS says that the supply of germanium faces a "serious threat in the next 100 years," while Henckens says that its availability is "not scarce," and its supply will last more than 1,000 years.

[e] The acceptable daily dose for chronic human exposure to antimony ranges from 0.14 µg/kg/day (OEHHA 2016) [14] to 0.35 µg/kg/day (USEPA 1990) [15]. Antimony trioxide is a GS Benchmark [1] chemical and is reasonably anticipated to cause cancer in humans via inhalation (NTP 2021) [16].

[f] Workers face serious cancer risks from mining and refining of antimony, which is reasonably anticipated to be a human carcinogen from inhalation, according to NTP (2021) [16], Saerens et al. (2019) [17] and Schnorr et al. (1995) [18]. Occupational exposure to antimony is also associated with chronic organ toxicity of the liver, heart and lungs, per OEHHA (2016) 14, ATSDR (2019) [19], and Cavallo et al. (2002) [20]. Environmental impacts from antimony mining are documented by Bolan et al. (2022) [21].

[g] A patent has been assigned to Toyobo Co., Ltd. for the invention of an organo-aluminum salt of an organo-phosphonate compound for use as a PET catalyst (Nakajima et al. 2006) [8]. Toyobo has licensed a proprietary aluminum-based catalyst to Indorama Ventures Public Company Ltd., the world's largest PET producer (Toyobo 2017) [9].

[h] The acceptable daily dose for chronic human exposure to elemental aluminum ranges from 18 µg/kg/day (OEHHA 2001) [22] to 1 mg/kg/week (comparably expressed as 140 µg/kg/day) (EFSA 2008) [23] to 1,000 µg/kg/day (ATSDR 2008) [24]. Elemental aluminum is a GS Benchmark 1 chemical.

[i] Occupational asthma and other respiratory effects have been well documented in aluminum smelter workers in reviews by Wesdock and Arnold (2014) [25] and OEHHA (2001) [22].

[j] No limit has been established on chronic human exposure to elemental germanium or germanium dioxide. There is some evidence that germanium does not cause cancer (Gerber & Leonard 1997) [26]. The European Chemicals Agency lists one key study that established a No Observed Adverse Effect Level (NOAEL) of 30,000 µg/kg/day for developmental and reproductive toxicity of germanium dioxide based on subacute oral exposure to rats [27]. However, high-dose repeated exposure to germanium compounds in drugs and dietary supplements has been linked to kidney failure, liver toxicity, and death (Keith & Maples-Reynolds 2022) [28].

[k] There is limited evidence of mild kidney effects in workers exposed to airborne germanium dioxide but no significant effect on liver, blood, or respiratory function were identified (Swennen 2000) [29].

[l] Catalytic Technologies, Ltd. has patented a method for producing an organo-titanium-based catalyst that's complexed with an alpha-hydroxy carboxylic acid, such as citric acid, for the manufacture of polyester. This substance is highly purified and contains less then 0.1% titanium dioxide, a chemical of concern. In this complex, the acid chelates the titanium preventing the formation of titanium dioxide (Schoennagel & Cooper 2019) [10].

[m] No limit has been established on chronic human exposure to elemental titanium, titanium dioxide or other titanium compounds. However, titanium dioxide, which is commonly added to many food products as a white colorant, is no longer considered safe for use as a direct food additive based on concern about the effects of human ingestion of nanoparticles, which make up to 50% of the titanium dioxide (EFSA 2021) [30].

[n] For titanium tetrachloride, the primary chemical substance produced from titanium-bearing ore, the human exposure limit (inhalation, chronic toxicity) is 1 µg/m3/day for respiratory effects (ATSDR 1997, 2014). Titanium tetrachloride is a building block (intermediate chemical) for the production of titanium metal, titanium dioxide, and most titanium compounds. Titanium dioxide is a possible human carcinogen via inhalation (IARC 2010).

[o] No acceptable daily dose for chronic exposure to dibutyltin oxide has been established. However, many organo-tin compounds are known or possible GS Benchmark 1 chemicals, including dibutyltin oxide. For an intermediate frequency of exposure (less than chronic), ATSDR (2005) [31] set a Minimum Risk Level of 300 µg/kg/day for inorganic tin, 5 µg/kg/day for dibutyltin dichloride, and 0.3 µg/kg/day for tributyltin oxide.

[p] Tin miners die from lung cancer and suffer from silicosis at higher rates than comparable populations due to concurrent exposure to radioactive radon and its decay products, arsenic and silica dust, and other pollutants (Fox et al. 1981 [32], Xiang-Zhen et al. 1993 [33], Chen et al. 1994 [34]). Occupational exposure to organotin compounds may harm the liver, kidneys, lungs and central nervous system at low concentrations (NIOSH 1976) [35].

[q] Enzymes are currently used as biocatalysts to commercially produce some pharmaceuticals, fine chemicals, and bulk chemicals (Abdelraheem et al. 2019) [36]. Enzymes are being actively researched and developed for potential use in depolymerizing PET plastic [37], a controversial chemical recycling strategy for managing plastic waste.

Sustainability – This considers the relative scarcity of supply of the mined element or metal ores relative to projected global consumption. Henckens et al. (2014) proposed that mineral mining rates be considered "sustainable" if the readily extractable resource will last at least 1,000 years based on projected average global consumption rates 2. Reliance on scarce minerals contributes to conflict, economic injustice, and preventable environmental impacts from mining.

Availability – This refers to the commercial availability of the catalyst system. If we identified one or more major commercial vendors the sold the catalyst for PET polymerization, we concluded that the alternative was available.

Effectiveness – This is a qualitative measure how effective and efficient the catalyst is in polymerizing PET plastic and polyester. Systems that require lesser amounts of added catalyst for a functionally equivalent effect score higher.

Affordability – For the metals, we reported the price per pound of metal reported by the USGS (2021) 3 in its annual mineral survey. Although the reported form of the metal may be different than the final chemical formulation of the catalyst system, it provides a good basis for comparing the underlying costs.

Note that affordability is in the eyes of the beholder. Catalyst systems amount to a small fraction of the total cost of PET plastic or polyester, which in turn is a small fraction of the cost of a final product made from or packaged with PET or polyester. Any cost increase to a final consumer is likely to be miniscule. But in industrial manufacturing, where cost reduction pressures are high and fractions of a penny deemed important, the relative costs may have a bearing on catalyst choice.

Note also that more efficient use of catalysts, reported under effectiveness, will tend to lower total costs since less catalyst material is needed to produce the same amount of PET or polyester.

Conclusion

Safer alternatives to the use of antimony compounds as a PET (and polyester) polymerization catalyst are effective, available, and affordable. The use of antimony compounds should be immediately phased out due to their human health hazards across their lifecycle and for sustainability reasons related to the relatively extreme scarcity of this metalloid element.

Endnotes

1. Henckens, M.L.C.M., Driessen, P.P.J. and Worrell, E. (2016) How can we adapt to geological scarcity of antimony? Investigation of antimony's substitutability and of other measures to achieve a sustainable use. Resources, Conservation and Recycling, Elsevier B.V. 108, 54–62. https://doi.org/10.1016/j.resconrec.2016.01.012
2. Henckens, M.L.C.M., Driessen, P.P.J. and Worrell, E. (2014) Metal scarcity and sustainability, analyzing the necessity to reduce the extraction of scarce metals. Resources, Conservation and Recycling, Elsevier. 93, 1–8. https://doi.org/10.1016/J.RESCONREC.2014.09.012
3. United States Geological Survey. Mineral Commodity Summaries [Internet]. Accessed June 29, 2022. https://www.usgs.gov/centers/national-minerals-information-center/mineral-commodity-summaries
4. Clean Production Action. GreenScreen® For Safer Chemicals [Internet]. Accessed May 29, 2022. https://www.greenscreenchemicals.org/
5. Healthy Building Network. Pharos [Internet]. Accessed June 6, 2022. https://pharosproject.net/
6. United States Environmental Protection Agency. CompTox Chemicals Dashboard [Internet]. Accessed June 29, 2022. https://comptox.epa.gov/dashboard/
7. Thiele, U.K. (2001) The current status of catalysis and catalyst development for the industrial process of poly(ethylene terephthalate) polycondensation. International Journal of Polymeric Materials, 50, 387–94. https://doi.org/10.1080/00914030108035115
8. Nakajima, T., Tsukamoto, K., Gyobu, S., Moriyama, N., Kuwata, M., Matsui, Y. et al. (2006) United States Patent: Polyester Polymerization Catalyst, Polyester Produced by Using the Same, and Process for Producing Polyester. https://patents.google.com/patent/US7144614B2/en.
9. Toyobo (press release). (2017) Toyobo promotes global use of its aluminum catalyst technology through polymerization technology licensing contract with world's largest PET producer, Indorama Ventures Pcl [Internet].
10. Schoennagel, M. and Cooper, A.T. United States Patent 10442824B2 - Method for the production of a titanium containing catalyst, titanium containing catalyst, method for the production of polyester and polyester [Internet]. Accessed June 29, 2022. https://patents.google.com/patent/US10442824B2/en
11. Catalytic Technologies Limited (CTL). SSP (Solid state polymerisation) Processes [Internet]. Accessed July 1, 2022. https://ctl8.com/ssp-processes/
12. Davies, A.G. (2010) Organotin compounds in technlogy and industry. Journal of Chemical Research, 181–90. https://doi.org/10.3184/030823410X12698696585509
13. European Chemical Society. (2021) Element Scarcity - EuChemS Periodic Table [Internet]. Accessed July 1, 2022. https://www.euchems.eu/euchems-periodic-table/
14. Office of Environmental Health Hazard Assessment (OEHHA) California Environmental Protection Agency (CalEPA). (2016) Public Health Goal for Antimony in Drinking Water. https://oehha.ca.gov/media/downloads/water/chemicals/phg/antimonyphg092316.pdf
15. United States Environmental Protection Agency and Integrated Risk Information System (IRIS). Antimony CASRN 7440-36-0 [Internet]. Accessed June 19, 2022. https://iris.epa.gov/ChemicalLanding/&substance_nmbr=6
16. National Toxicology Program (NTP) and United States Department of Health and Human Services. (2021) Report on Carcinogens, Fifteenth Edition: Antimony Trioxide. https://doi.org/10.1016/B0-12-369400-0/00081-8
17. Saerens, A., Ghosh, M., Verdonck, J. and Godderis, L. (2019) Risk of cancer for workers exposed to antimony compounds: A systematic review. International Journal of Environmental Research and Public Health, 16, 1–24. https://doi.org/10.3390/ijerph16224474
18. Schnorr, T.M., Steenland, K., Thun, M.J. and Rinsky, R.A. (1995) Mortality in a cohort of antimony smelter workers. American Journal of Industrial Medicine, 27, 759–70. https://doi.org/10.1002/ajim.4700270510
19. Agency for Toxic Substances and Disease Registry (ATSDR). (2019) Toxicological Profile for Antimony. Atlanta, GA. https://wwwn.cdc.gov/TSP/ToxProfiles/ToxProfiles.aspx?id=332&tid=58.
20. Cavallo, D., Iavicoli, I., Setini, A., Marinaccio, A., Perniconi, B., Carelli, G. et al. (2002) Genotoxic risk and oxidative DNA damage in workers exposed to antimony trioxide. Environmental and Molecular Mutagenesis, 40, 184–9. https://doi.org/10.1002/em.10102
21. Bolan, N., Kumar, M., Singh, E., Kumar, A., Singh, L., Kumar, S. et al. (2022) Antimony contamination and its risk management in complex environmental settings: A review. Environment International, 158. https://doi.org/10.1016/j.envint.2021.106908
22. OEHHA (2001) Public Health Goal for ALUMINUM In Drinking Water. https://oehha.ca.gov/water/public-health-goal/public-health-goal-aluminum-drinking-water.
23. Aguilar, F., Autrup, H., Barlow, S., Castle, L., Crebelli, R., Dekant, W. et al. (2008) Safety of aluminium from dietary intake: Scientific Opinion of the Panel on Food Additives, Flavourings, Processing Aids and Food Contact Materials (AFC). The EFSA Journal, 754, 1–34.
24. Agency for Toxic Substances and Disease Registry (ATSDR). (2008) Toxicological Profile for Aluminum. Atlanta, GA. https://www.atsdr.cdc.gov/toxprofiles/tp22.pdf
25. Wesdock, J.C. and Arnold, I.M.F. (2014) Occupational and environmental health in the aluminum industry: Key points for health practitioners. Journal of Occupational and Environmental Medicine, Lippincott Williams and Wilkins. 56. https://doi.org/10.1097/JOM.0000000000000071
26. Gerber, G.B. and Léonard, A. (1997) Mutagenicity, carcinogenicity and teratogenicity of germanium compounds. Mutation Research/Reviews in Mutation Research, Elsevier. 387, 141–6. https://doi.org/10.1016/S1383-5742(97)00034-3
27. European Chemicals Agency (ECHA). Registration Dossier: Germanium dioxide [Internet]. Accessed June 29, 2022. https://echa.europa.eu/registration-dossier/-/registered-dossier/22635/7/9/1
28. Keith, L.S. and Maples-Reynolds, N. (2022) Germanium. Handbook on the Toxicology of Metals: Fifth Edition, Academic Press. 2, 289–316. https://doi.org/10.1016/B978-0-12-822946-0.00012-X
29. Swennen, B., Mallants, A., Roels, H.A., Buchet, J.P., Bernard, A., Lauwerys, R.R. et al. (2000) Epidemiological survey of workers exposed to inorganic germanium compounds. Occupational & Environmental Medicine, 57, 242–8. https://doi.org/10.1136/oem.57.4.242
30. Younes, M., Aquilina, G., Castle, L., Engel, K.-H., Fowler, P., Jose Frutos Fernandez, M. et al. (2021) Safety assessment of titanium dioxide (E171) as a food additive EFSA Panel on Food Additives and Flavourings. EFSA Journal, 19, 6585. https://doi.org/10.2903/j.efsa.2021.6585
31. Agency for Toxic Substances and Disease Registry (ATSDR). (2005 Aug) Toxicological Profile for Tin and Tin Compounds. Atlanta, GA. https://www.atsdr.cdc.gov/toxprofiles/tp55.pdf.
32. Fox, A.J., Goldblatt, P. and Kinlen, L.J. (1981) A Study of the Mortality of Cornish Tin Miners. British Journal of Industrial Medicine, 38, 378–80.
33. Xiang-Zhen, X., Lubin, J.H., Jun-Yao, L., Li-Fen, Y., Sheng, L.Q., Lan, Y. et al. (1993) A Cohort Study in Southern China of Tin Miners Exposed to Radon and Radon Decay Products. Health Physics, 64, 120–31.
34. Chen, W., Zhuang, Z., Attfield, M.D., Chen, B.T., Gao, P., Harrison, J.C. et al. (2001) Exposure to silica and silicosis among tin miners in China: exposure-response analyses and risk assessment. Occup Environ Med, 58, 31–7. https://doi.org/10.1136/oem.58.1.31
35. National Institute for Occupational Safety and Health (NIOSH). (1976) Criteria for a Recommended Standard: Occupational Exposure to Organotin Compounds. [Internet]. DHEW (NIOSH) Publication No. 77-115. https://doi.org/10.26616/NIOSHPUB77115Accessed July 1, 2022. https://www.cdc.gov/niosh/docs/77-115/
36. Abdelraheem, E.M.M., Busch, H., Hanefeld, U. and Tonin, F. (2019) Biocatalysis explained: from pharmaceutical to bulk chemical production. Reaction Chemistry & Engineering, 4, 1878. https://doi.org/10.1039/c9re00301k
37. van Hullebusch, E.D., Acero, E.H., Khare, S.K., Maurya, A. and Bhattacharya, A. (2020) Enzymatic Remediation of Polyethylene Terephthalate (PET)-Based Polymers for Effective Management of Plastic Wastes: An Overview. Frontiers in Bioengineering and Biotechnology, 8, 1–13. https://doi.org/10.3389/fbioe.2020.602325

DEFEND OUR HEALTH

Solutions for a Toxic-Free Tomorrow

Air pollution is linked to higher cancer rates among black or impoverished communities in Louisiana

IOP Publishing Environ. Res. Lett. 17 (2022) 014033 https://doi.org/10.1088/1748-9326/ac4360

ENVIRONMENTAL RESEARCH
LETTERS

OPEN ACCESS

RECEIVED
30 July 2021

REVISED
3 December 2021

ACCEPTED FOR PUBLICATION
15 December 2021

PUBLISHED
13 January 2022

LETTER

Air pollution is linked to higher cancer rates among black or impoverished communities in Louisiana

Kimberly A Terrell[1,2,3,*] and Gianna St Julien[1]

[1] Environmental Law Clinic, Tulane University School of Law, New Orleans, LA, United States of America
[2] Department of Biology, University of Memphis, Memphis, TN, United States of America
[3] School of Renewable Natural Resources, Louisiana State University, Baton Rouge, LA, United States of America
[*] Author to whom any correspondence should be addressed.

E-mail: kterrell1@tulane.edu

Keywords: Cancer Alley, toxic, environmental justice, public health, industrial corridor, petrochemical, industry

Abstract

Despite longstanding concerns about environmental injustice in Louisiana's industrialized communities, including the area known as Cancer Alley, there is a lack of environmental health research in this state. This research gap has direct consequences for residents of industrialized neighborhoods because state regulators have cited a lack of evidence for adverse health outcomes when making industrial permitting decisions. We investigated how cancer incidence relates to cancer risk from toxic air pollution, race, poverty, and occupation across Louisiana census tracts, while controlling for parish-level smoking and obesity rates, using linear regression and Akaike information criterion model selection. We used the most recent cancer data from the Louisiana Tumor Registry (2008–2017), estimates of race, poverty, and occupation from the US Census Bureau's American Community Survey (2011–2015), and estimated cancer risk due to point sources from the US Environmental Protection Agency's 2005 National Air Toxics Assessment (accounting for cancer latency). Because race and poverty were strongly correlated ($r = 0.69$, $P < 0.0001$), we included them in separate, analogous models. Results indicated that higher estimated cancer risk from air toxics was associated with higher cancer incidence through an interaction with poverty or race. Further analysis revealed that the tracts with the highest (i.e. top quartile) proportions of impoverished residents (or Black residents) were driving the association between toxic air pollution and cancer incidence. These findings may be explained by well-established disparities that result in greater exposure/susceptibility to air toxics in Black or impoverished neighborhoods. Regardless, our analysis provides evidence of a statewide link between cancer rates and carcinogenic air pollution in marginalized communities and suggests that toxic air pollution is a contributing factor to Louisiana's cancer burden. These findings are consistent with the firsthand knowledge of Louisiana residents from predominantly Black, impoverished, and industrialized neighborhoods who have long maintained that their communities are overburdened with cancer.

1. Introduction

Residents of Cancer Alley and other industrialized areas of Louisiana have long maintained that they are disproportionately impacted by cancer and other health problems from chronic exposure to industrial pollution (e.g. [1–4]). Cancer Alley has been defined as the ~130 mile, winding corridor along the Mississippi River between Baton Rouge and New Orleans [4], where, according to the state emissions inventory, more than 200 industrial facilities release significant amounts (i.e. >5 tons per year) of harmful air pollution [5]. Notably, this definition of Cancer Alley (alternatively labeled the Industrial Corridor) does not capture some of Louisiana's most heavily industrialized communities (e.g. Mossville [3]). In absolute terms, more pounds of industrial toxic air pollution are released annually in Louisiana than in any other state, based on 2019 data from the US Environmental Protection Agency (EPA) [6]. These emissions translate to a disproportionate burden of health risks for Louisiana's industrialized neighborhoods. Nearly every census tract between Baton Rouge and New Orleans ranks in the top 5% nationally for cancer risk from toxic air pollution and in the top 10% for respiratory hazards [7]. Concerns about Louisiana's pollution burden have been dismissed by state regulators and politicians, who maintain that there is no evidence of adverse health outcomes (e.g. [8]), or that lifestyle choices play a larger role in the state's cancer burden (e.g. [9]). Such perspectives fail to consider the lack of pollution-related research in Louisiana, or the complex and interactive pathways through which discrimination and inequities influence behaviors, toxic exposures, and health outcomes [10].

While cancer risk from air toxics is uniformly high across Louisiana's Industrial Corridor by national rankings, this burden is unevenly distributed among neighborhoods. Recent estimates of pollution-related cancer risk for census tracts from Baton Rouge to New Orleans range from 24.8 per million (Tract 279.02, Jefferson Parish) to 1505.1 per million (Tract 708, St John the Baptist Parish), with Black and impoverished tracts being disproportionately impacted [11–13]. (Louisiana parishes are equivalent to US counties.) This disparity is part of a larger pattern of inequities in pollution exposure across the United States [14–21] and globally (reviewed in [22]). In Louisiana, industrial facilities are often located on former plantation sites, where the adjacent neighborhoods are predominantly Black (i.e. African-American) and often include descendants of the emancipated settlers who founded the community [23]. The pollution risks faced by these and other Black communities are not simply products of their lifestyles; Black Americans are exposed to an estimated 56% more fine particulate ($PM_{2.5}$) pollution compared to the amount that would be generated by their consumption of goods and services, while White Americans benefit from 17% less exposure relative to their consumption [24]. Compounding this racial disparity, Black Americans do not receive a proportionate share of the economic benefits from industrial polluters, in terms of employment opportunities [17].

In Louisiana and across the United States, the most racially segregated neighborhoods tend to experience the highest cancer risks from air toxics [13, 16]. Racial residential segregation is considered to play a major role in health disparities, including those related to air toxics [25, 26]. This form of segregation is caused by structural mechanisms of discrimination that result in political, economic, legal, and social disparities [26, 27]. In turn, these disparities result in a complex network of factors in the built environment, social environment, and individual situation that can increase exposure or susceptibility to pollution [26]. For example, the lack of local grocery stores in the built environment and food insecurity in the social environment can contribute to poor nutrition in communities of color, increasing susceptibility to diabetes or heart disease [26]. These diseases can be triggered or worsened by chronic exposure to particulate matter pollution [28], which is consistently higher in communities of color across the United States [19, 29]. Existing disparities in segregated communities can be worsened by industrialization, for example, when grocery stores or recreational centers are closed to make way for petrochemical plants. In Louisiana, the dismantling of built and social environments for industrial development has led to the relocation of entire communities (e.g. Diamond, LA), while members of other communities (e.g. Mossville, LA) still seek equitable relocation [30]. Relocation can (theoretically) reduce or circumvent toxic exposures and certain other inequities in segregated communities; however, buyout programs present their own challenges with respect to distributive, procedural, and interactional injustice [31].

From a public health perspective, regulatory decisions related to air quality should be informed by information about emissions, exposures, risks, and corresponding health outcomes. The need for such information in Louisiana is particularly acute, where hundreds of new pollution sources are permitted each year [32] and where there is minimal data about health outcomes associated with pollution exposure. Even when faced with strong evidence of pollution disparities, Louisiana's political leaders and decision-makers may require evidence of disparate health *outcomes* before taking corrective action [33]. The few studies of health outcomes from residential exposure to environmental pollution in Louisiana have generally reported non-significant findings (but see [34]). However, these studies were statistically underpowered [35, 36] or lacked any quantitative measure of pollution exposure [37]. Despite being cited as evidence against pollution-related cancer disparities [8, 38], the annual reports from Louisiana's cancer registry do not quantify pollution exposure or control for confounding variables in their statistical comparisons of 'Industrial Corridor' cancer rates (e.g. [39–41]). To address the lack of empirical research about pollution-related health outcomes in Louisiana, we evaluated cancer incidence among Louisiana census tracts relative to estimated cancer risk from air toxics, while accounting for race, poverty, and certain health and occupational factors using publicly available data from state and federal agencies. Our goals were to elucidate the drivers of cancer rates in Louisiana and to determine whether the firsthand experiences of industrialized communities, which indicate a disproportionate burden of cancer, are evident in Tumor Registry data.

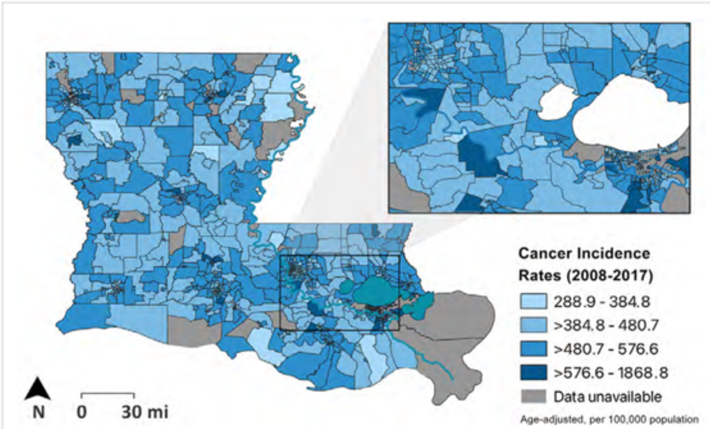


Figure 1. Age-adjusted annual cancer incidence rates, averaged from 2008 to 2017, as reported by the LTR. Data breaks correspond to quartiles. Inset depicts the Industrial Corridor from Baton Rouge to New Orleans. The Mississippi River and the Pontchartrain Lake System are shown in blue.

2. Methods

2.1. Cancer incidence rates

We used 10 year average annual cancer rates for all malignant tumors combined from the Louisiana Tumor Registry (LTR)'s most recent annual report, reflecting cases diagnosed from 2008 to 2017 [42]. We did not examine individual cancer types because these data are not published for most census tracts in Louisiana due to the relatively small numbers of cases [42]. Even for the most prevalent cancers (i.e. lung and breast), the low case counts (typically 2–5 cases per year) result in unreliable cancer rates, i.e. with extremely wide confidence intervals. Thus, our analysis is limited to overall cancer incidence, which is directly comparable to estimated cancer risk from air toxics. Notably, specific cancers that are excluded from reporting are still included in the overall cancer rate, which is available for 932 of 1148 census tracts in Louisiana (figure 1). These rates are age adjusted by the LTR and presented per 100 000 population. For simplicity, we subsequently refer to age-adjusted cancer incidence rates as 'cancer incidence'.

2.2. Pollution-related cancer risk

We used estimates of pollution-related cancer risk from the EPA's 2005 National Air Toxics Assessment (NATA), which reflect toxicity-weighted pollution levels in 2005 (figure 2). Because EPA improves its NATA methodology continually, the 2005 NATA provided more a refined approach compared to the previous NATAs (1996, 1999, and 2002), while still allowing a reasonable time gap relative to the 2008–2017 cancer rate dataset to account for cancer latency [43]. Additionally, in selecting the dataset, we considered that changes in census tract boundaries occur during each decennial census (e.g. 1990, 2000, and 2010). To account for these changes, we excluded significantly-changed census tracts from our analysis, as described below.

We used NATA's estimates of Point Source Cancer Risk because Louisiana's industrialized communities are characterized by a high density of point sources. These represent stationary sources for which locations are known, including industrial plants, electric utilities, and large waste incinerators [44]. In the 2005 NATA, Point Sources did not include airports, homes, wildfires, vehicles, or other mobile or diffuse sources of pollution [44]. For simplicity, we subsequently refer to 2005 NATA Point Source Cancer Risk as 'estimated cancer risk from air toxics' or, where a more concise descriptor is helpful, 'air toxics'.

2.3. Demographic and health indicators

Our analysis included 5 year estimates of race, poverty, and occupation at the census tract level from the US Census Bureau's 2015 American Community Survey (ACS; representing data collected from 2011 to 2015; figure 3). These estimates included percentages of Black or African-American residents (alone or in combination with another race), percentages of residents living below the federal poverty threshold,

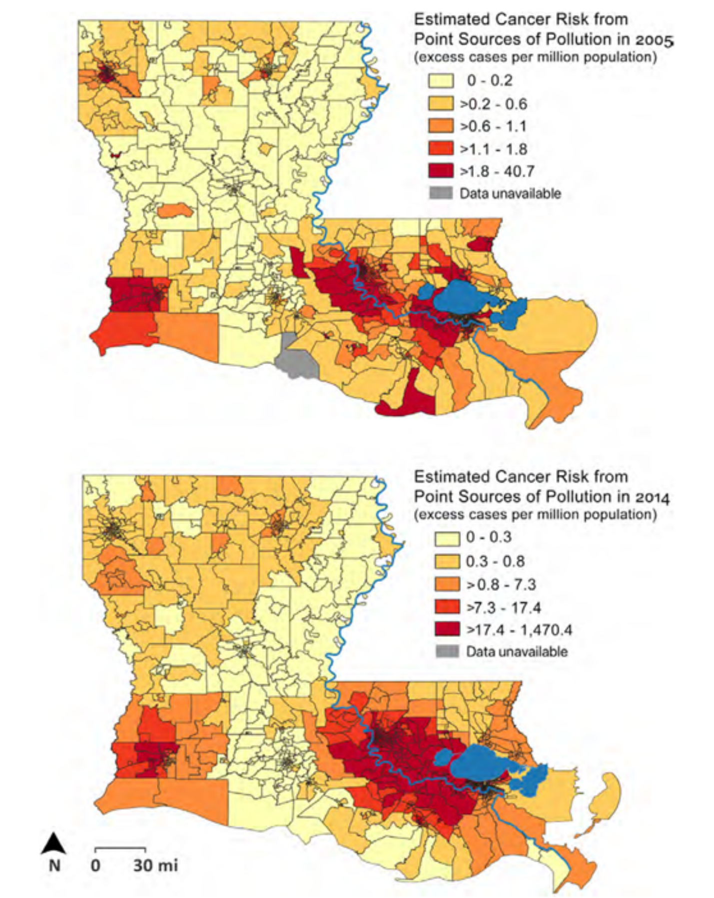


Figure 2. Cancer risk from point sources of pollution, as reported in the EPA's 2005 (top) and 2014 (bottom) NATA. Data breaks correspond to quintiles. Note that the methodology differed between these two assessments, so the resulting data are not directly comparable. The Mississippi River and the Pontchartrain Lake System are shown in blue.

percentages of the workforce employed by the construction industry, and percentages employed by the manufacturing industry. We chose these industries as proxies for occupational exposure to toxic air pollutants because they are the most likely to be consistently associated with air quality hazards.

Because smoking and obesity data were not available at the census tract level, our analysis included parish-level smoking and obesity data from the 2011 Louisiana County Health Rankings (figure 4) [45]. The 2011 County Health Rankings use 2003–2009 smoking data from the US Centers for Disease Control (CDC)'s Behavioral Risk Factor Surveillance System and 2008 obesity data from the CDC's National Center for Chronic Disease Prevention and Health Protection. By necessity, our analysis used the same average parish value for all census tracts within that parish.

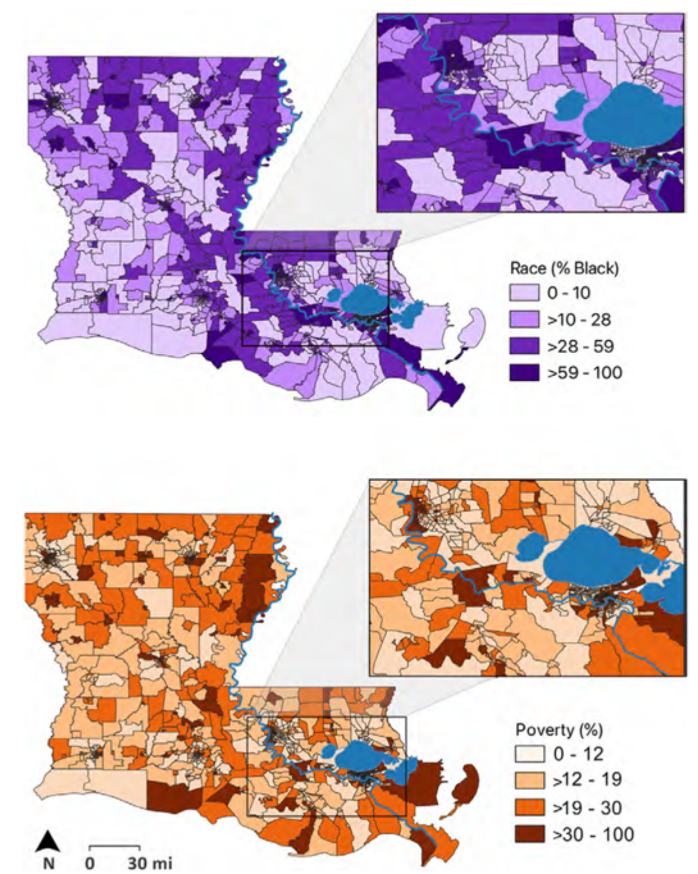


Figure 3. (Top) Percentage of Black residents (i.e. African American, one or more races). (Bottom) Percentage of families living below the US federal poverty threshold. Both datasets are 5 year estimates (2011–2015) from the US Census Bureau's ACS. Data breaks correspond to quartiles. The Mississippi River and the Pontchartrain Lake System are shown in blue.

2.4. Mapping

We mapped each dataset by percentile using QGIS Version 3.18 to visualize the geographic patterns of cancer (figure 1), toxic air pollution (figure 2), race and poverty (figure 3), and smoking and obesity (figure 4). Because our analysis relies on historical pollution values, but current pollution values are relevant from a health policy perspective, we included Point Source Cancer Risk from the most recent (2014) NATA (figure 2). Importantly, the results of different NATAs are not directly comparable due to methodological changes over time [46]. We did not use the 2014 NATA data in any statistical analysis; rather, we mapped the data for visualization only.

2.5. Data exclusions

Our statistical analyses excluded census tracts for which cancer rates were not available from the LTR ($n = 216$ out of 1148 total). Additionally, we

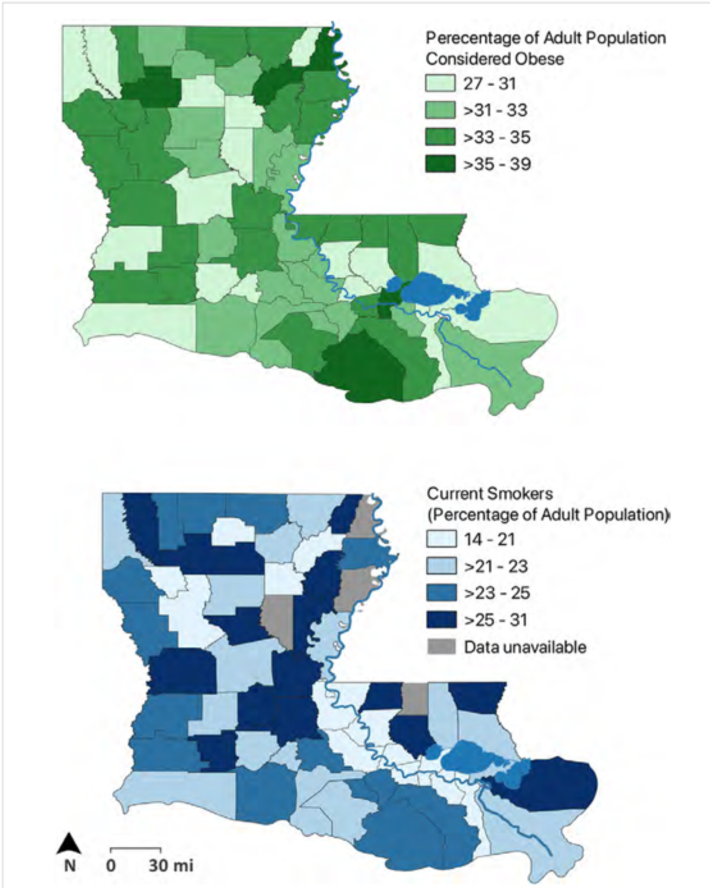


Figure 4. (Top) Percentage of adult population that is considered obese. (Bottom) Percentage of adult population that currently smoke tobacco products. Both datasets are from the 2011 county health rankings, which use 2003–2009 smoking data and 2008 obesity data. Data breaks correspond to quartiles. The Mississippi River and the Pontchartrain Lake System are shown in blue.

excluded tracts that the Tumor Registry designated as containing military bases ($n = 27$), because military personnel are likely to have different exposure histories compared to permanent residents. We also excluded census tracts ($n = 155$) with geographic boundaries that had changed substantially between the 2000 census and 2010 census, as identified by the US Census Bureau [47]. This exclusion was necessary because we used a pollution (i.e. estimated cancer risk) dataset that was based on the 2000 census and a cancer incidence dataset that was based on the 2010 census. After these exclusions, there were 750 census tracts remaining in the final dataset. Estimates of cancer risk from EPA's 2005 NATA were available for all of these tracts.

2.6. Statistical analysis

We performed all analyses in R Statistical Software [48]. With the exception of cancer rates, all variables in our datasets were non-normally distributed and were natural-log transformed (estimated cancer risk from air toxics) or arcsine transformed (race, poverty, and occupation) for analysis. Transformed data were mean centered [49].

Exploratory analysis revealed significant spatial autocorrelation ($p < 0.001$) in a model of cancer incidence rates with poverty, estimated cancer risk from air toxics, and the interaction of these terms, as tested by a simulation with 10 000 replicates and measured by Moran's i [50]. In order to reduce spatial autocorrelation, we include a fixed effect in the linear model for parish. This results in a model with no statistically significant spatial autocorrelation ($p = 0.40$), and therefore may have appropriate standard errors for coefficient estimates. In addition to controlling spatial autocorrelation, the addition of parish dummy variables in the model automatically controls for the combined effects of parish-level confounders, which are not of interest to this study.

We evaluated the performance of alternate linear models for predicting census tract-level cancer incidence rates using the step Akaike information criterion (AIC) function in the MASS package of R Statistical Software [51]. This function performs stepwise AIC [52] model selection through an iterative process that adds and removes variables sequentially to identify the best fit model. We chose AIC for model selection because it is a widely-used approach that performs well under a broad range of modeling scenarios, including for spatial data [53].

As described in the results, race and poverty were strongly correlated across our dataset. To avoid collinearity, we conducted parallel analyses with models that included poverty or, alternately, race. Our initial model of cancer incidence included the direct effects of air toxics, poverty, parish, construction employment, manufacturing employment, smoking, and obesity, as well as the interactive effect of air toxics and poverty. We used an analogous model to evaluate race (proportion of Black residents) in place of poverty. After identifying the top model from each analysis through stepwise selection, we used the base package of R to calculate model statistics. To determine the overall significance of air toxics in the top model, we used an F-test to compare versions of the same model with and without this risk.

To explore the interaction that was detected between poverty and air toxics, we calculated median cancer incidence rates for census tracts that were disproportionately impoverished versus disproportionately affluent (i.e. above or below median poverty rates, respectively). We further divided the impoverished group into air toxics quartiles, based on the full range of air toxics values represented in our dataset ($n = 750$ census tracts). We then calculated cancer incidence rates for each of the following air toxics groups: lowest quartile, below median, above median, highest quartile. We used t-tests to compare median cancer incidence of each of the above groups to the overall median cancer incidence for the entire dataset ($n = 750$ tracts). We generated quantitative estimates of the cancer burden from severe pollution by calculating the difference in mean cancer incidence rate for the most polluted versus least polluted census tracts (i.e. top versus bottom air toxics quartiles among tracts with above-median poverty), or, alternately, the top quartile versus the overall mean ($n = 750$ tracts). We then multiplied the result by the population represented by the corresponding data subset, to derive the total number of estimated excess cancer cases per year. Additionally, we divided the overall dataset by poverty quartile and used Pearson's correlation to test the relationship between air toxics and cancer risk for each data subset. We created scatterplots of the raw (i.e. untransformed) data to visualize these comparisons for the top and bottom quartiles by poverty. These plots included linear regression lines with 95% confidence intervals, calculated using the geom_line function in ggplot2 in R Statistical Software. We conducted parallel analyses using race instead of poverty.

3. Results

3.1. Quality assurance and data exclusions

After all exclusions (see section 2), data distributions were generally unchanged (table 1). One notable exception was maximum poverty rate, which was lower in our final dataset due to the exclusion of two census tracts in New Orleans with exceptionally high poverty rates (Tracts 44.02 and 48, with 87% and 100% poverty, respectively). Both tracts were geographically tiny ($\leqslant 0.16$ mi^2), contained fewer than 500 people, and were excluded because their boundaries changed substantially between 2000 and 2010. The other notable exception was maximum cancer rate, which was lower in our final dataset due to the exclusion of three outlying census tracts (Tracts 9507.02 and 9507.04 in Vernon Parish, Tract 109 in Bossier Parish) that contained military bases and had exceptionally high cancer rates (between 1125 and 1869 cases annually per 100 000 population). Regardless, there was no significant difference in cancer rates between census tracts that were excluded ($n = 182$) or included ($n = 750$) in our analysis ($t = -1.71$, df $= 193.11$, $P = 0.088$). If the three outlying tracts are ignored, there is even less statistical support for a difference in cancer rates between census tracts that were included versus excluded from our analysis ($t = -0.549$, df $= 236.05$, $P = 0.583$). Thus, our final dataset was representative of cancer, pollution, race, poverty, and employment in construction and manufacturing industries in Louisiana.

There were two census tracts in the dataset that were outliers, in terms of exceptionally high pollution (i.e. estimated cancer risk) values: census tract 22017023800 (Cedar Grove neighborhood, Shreveport, Caddo Parish) and census tract

Table 1. Sample sizes and summary statistics for each variable analyzed[a].

Variable	Dataset	# Census tracts	Minimum	1st quartile	Median	3rd quartile	Maximum
Cancer incidence	All available	932	288.9	443.6	481.4	514.1	1868.8
	Analyzed	750	288.9	442.8	480.7	513.7	845.5
Pollution-related	All available	1105	0.001	0.25	0.97	1.47	40.70
cancer risk	Analyzed	750	0.001	0.22	0.91	1.57	30.90
% Black	All available	1128	0	10.8	28.7	60.2	100
	Analyzed	750	0	10.6	27.6	55.3	100
% Poverty	All available	1127	0	12.1	19.5	30.2	100
	Analyzed	750	0.9	11.9	18.3	27.9	62.0
% Employed in	All available	1126	0	4.3	7.1	10.5	29.1
construction	Analyzed	750	0.3	4.7	7.5	10.8	24.3
% Employed in	All available	1126	0	3.9	6.7	10.2	28.5
manufacturing	Analyzed	750	0	4.4	7.4	10.9	28.5
% Current smokers	All available data	NA[b]	14.0	21.0	23.0	24.0	31.0
% Obese	were analyzed	NA[b]	27.0	30.0	31.0	34.0	39.0

[a] See section 2 for data sources.

[b] Parish-level data used ($n = 64$ parishes); census-tract-level data unavailable.

22089062500 (Norco, St Charles Parish). As a conservative approach, we retained these outliers in our main statistical analysis (figure 5), but excluded them in our quartile analysis for poverty (figure 6) and race (figure A1) quartile.

3.2. Relationships among untransformed predictor variables

Among census tracts ($n = 750$), race (% Black) and poverty were strongly correlated ($r = 0.69$, $P < 0.0001$; figure 3). Tracts with higher proportions of Black residents generally had lower percentages of the workforce represented in the construction ($r = -0.23$, $P < 0.0001$) or manufacturing industries ($r = -0.11$, $P = 0.003$). Similarly, tracts with higher poverty rates generally had lower percentages of the workforce represented in the construction industry ($r = -0.11$, $P = 0.003$) or manufacturing industries ($r = -0.08$, $P = 0.024$). Among all census tracts, estimated cancer risk from air toxics was not significantly related to poverty rate ($r = 0.05$, $P = 0.16$), percentages of Black residents ($r = 0.04$, $P = 0.24$), or percentages of the workforce in construction ($r = 0.06$, $P = 0.12$). However, this risk was positively correlated with the percentage of the workforce in manufacturing ($r = 0.07$, $P = 0.041$). Among Louisiana parishes, smoking and obesity rates were positively correlated ($r = 0.30$, $P < 0.0001$).

3.3. Relationship between cancer risk from air toxics and cancer incidence

As expected, cancer incidence varied throughout the state (figure 1). Estimated cancer risk from air toxics (i.e. 2005 NATA Cancer Risk from point sources) was elevated in southwest Louisiana and in the area known as Cancer Alley in southeast Louisiana (figure 2). The top model from AIC selection included the direct effects of parish, poverty, and cancer risk from air toxics, as well as the interaction between poverty and cancer risk from air toxics (table 2).

Model statistics revealed that cancer risk from air toxics was associated with cancer incidence through an interaction with poverty, as opposed to a direct effect (table 3). Results of race models were analogous to results of poverty models (tables A1 and A2). As further evidence of an overall effect of cancer risk from air toxics, a significant difference was observed after removing pollution from the poverty model ($F = 4.46$, $P = 0.012$) and from the race model ($F = 4.06$, $P = 0.018$). A scatterplot of the overall dataset confirmed that among predominantly Black and/or impoverished census tracts, those with more toxic air generally have higher cancer rates (figure 5).

3.4. Further analysis of interaction effects

As described in the methods, we conducted additional analyses to better understand the observed interaction of air toxics and poverty or air toxics and race. Among the most impoverished census tracts (i.e. fourth quartile), higher estimated cancer risk from air toxics was correlated with higher cancer incidence ($r = 0.25$, $P = 0.0005$). This relationship was not observed among less impoverished census tracts (third quartile: $r = -0.01$, $P = 0.85$; second quartile: $r = 0.03$, $P = 0.72$; first quartile: -0.11, $P = 0.13$).

A similar pattern was observed when the dataset was broken down by Race (fourth quartile: $r = 0.13$, $P = 0.07$; third quartile: $r = 0.03$, $P = 0.71$; second quartile: $r = 0.01$, $P = 0.87$; first quartile: $r = -0.10$, $P = 0.16$). Census tracts that were disproportionately Black or impoverished had higher cancer incidence rates compared to the entire dataset ($P \leqslant 0.016$; table 4). Within each of these disproportionate groups, cancer incidence was elevated among

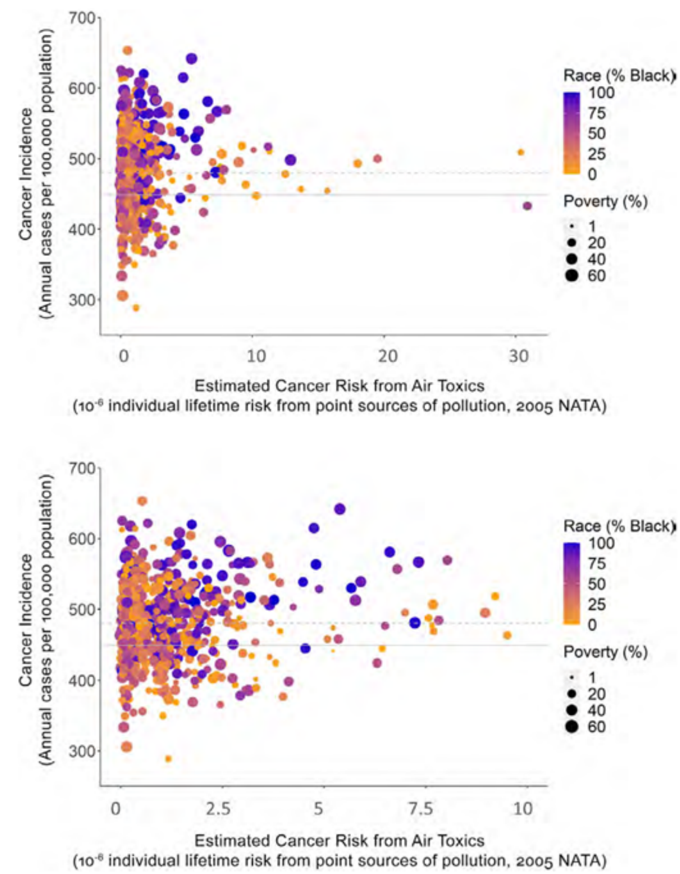


Figure 5. Relationships among toxic air pollution, cancer rates, poverty, and race for Louisiana census tracts ($n = 750$). The same dataset is presented in both panels, with a smaller scale on the bottom panel to better distinguish data points. All values (including poverty) are plotted on continuous scales. Solid gray line indicates US average cancer rate (448.7); dashed gray line indicates the Louisiana statewide average (481.0).

tracts with higher estimated cancer risk from air toxics ($P \leqslant 0.016$; table 4), but not among tracts with lower estimated cancer risk from air toxics (table 4; figures 6 and A1).

The (conservatively) estimated cancer burden from severe air pollution was 85 cases in Louisiana annually (among tracts with above-median poverty). More specifically, this value was 85.8 cases for the top-quartile-air-toxics versus global-average comparison ([501.7–480.3] × [400 788/100 000]), or 91.8 cases for top versus bottom-air-toxics-quartiles comparison ([501.7–478.8] × [400 788/100 000]).

4. Discussion

To our knowledge, this is the first statewide study of cancer incidence in Louisiana that accounts for interactions between air pollution and poverty or race. We found that higher estimated cancer risk from toxic air pollution was linked to higher cancer incidence

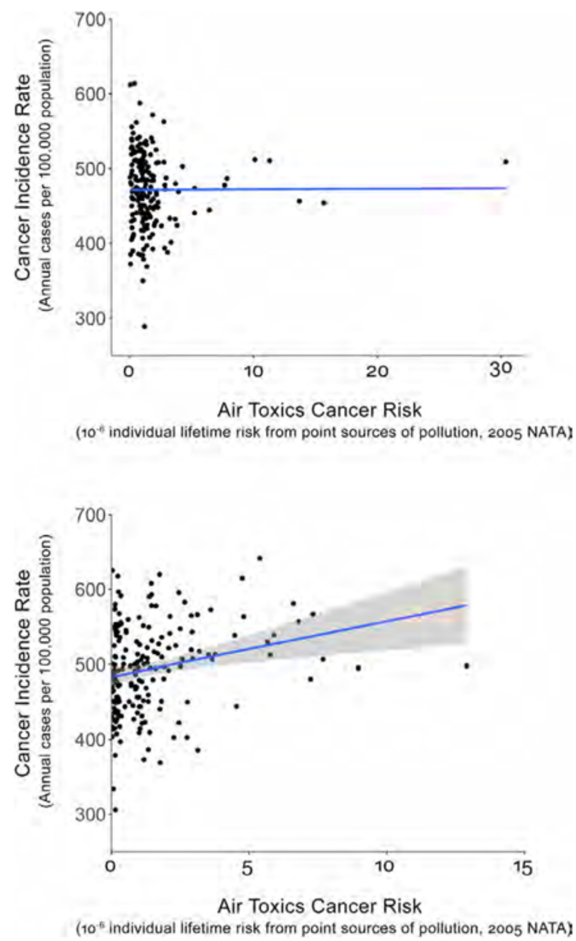


Figure 6. Comparison of pollution versus cancer rates for the most affluent census tracts (top panel; $r = -0.11$, $P = 0.13$) and most impoverished (bottom panel; $r = -0.25$, $P = 0.0005$) census tracts with two outliers removed (see section 3). See table 4 for quartile breaks and test statistics. Blue line represents a linear regression of untransformed data. Gray shading represents 95% confidence intervals.

among Louisiana's most impoverished neighborhoods. Because poverty and race were strongly correlated in our dataset (reflecting the disproportionate burden of poverty in Black communities), we could not reliably distinguish between the two factors in our statistical analyses. Regardless, the same patterns emerged for Black or impoverished neighborhood: higher levels of toxic air pollution were associated with higher cancer incidence.

There are multiple potential explanations for our finding that the link between air toxics and cancer incidence was observed in the most impoverished/Black neighborhoods, but not among more affluent/White neighborhoods. This finding

Table 2. Best-supported models of tract-level cancer incidence from AIC stepwise model selection.

Main effects[a] (all models)	Interaction terms	Other main effects	AIC	ΔAIC
Air toxics	Air toxics × poverty	None	5867.8	0
Poverty		Employed in manufacturing	5868.2	0.4
Parish		+ Employed in construction	5869.9	2.1
		+ Smoking	5869.9	2.1
		+ Obesity	5869.9	2.1

[a] Air toxics corresponds 2005 NATA Cancer Risk from point sources. See section 2 for other data sources.

Table 3. Statistics for best-supported cancer incidence model.

Variable	Coefficient estimate[a]	t	P
(Model intercept)	485.0	32.48	< 0.0001
Air toxics	−0.72	−0.26	0.79
Poverty	73.07	5.44	< 0.0001
Air toxics × poverty	29.14	2.98	0.003

[a] Coefficients correspond to transformed and mean-centered data (see section 2).

Table 4. Mean cancer incidence among different data subsets and results of t-test comparisons[a].

		Cancer incidence		Versus all-data mean (480.3)	
Subset of census tracts	Population	Mean	95% confidence interval	t	P
Disproportionately affluent[b]	1895 934	471.8	466.8–476.7	−3.39	0.0008
Disproportionately poor[b]	1542 402	488.8	483.2–494.5	2.97	0.003
Bottom-quartile pollution	461 887	478.8	468.8–488.8	−0.30	0.76
Below-median pollution	876 456	485.9	478.7–493.2	1.53	0.13
Above-median pollution	663 173	492.9	484.0–501.8	2.80	0.006
Top-quartile pollution	400 788	501.7	489.7–513.7	3.55	0.0006
Disproportionately white[c]	1818 620	473.4	468.4–478.4	−2.72	0.007
Disproportionately black[c]	1613 336	487.2	481.6–492.9	2.41	0.016
Bottom-quartile pollution	435 430	480.3	470.0–491.3	0.07	0.95
Below-median pollution	802 224	484.0	476.1–491.9	0.93	0.35
Above-median pollution	811 112	490.3	482.2–498.4	2.44	0.016
Top-quartile pollution	456 349	498.9	487.6–510.3	3.25	0.002

[a] Incidence is the number of newly-diagnosed cancer cases per 100 000 population and age-adjusted. Pollution categories are based on pollution values from the entire dataset ($n = 750$ census tracts). See section 2 for data sources.
[b] Census tracts with poverty values below (affluent) or above (poor) median poverty rate (18.25%).
[c] Census tracts with above-median values for corresponding race (Black, 27.6%; White, 67.7%).

may reflect the well-documented disparities in health risk factors and medical care that leave Black and impoverished communities more vulnerable to negative health outcomes [54–56]. For example, these communities are more likely to delay or forgo preventative medical visits due to the high cost of healthcare [57]. Empirical research indicates that physicians serving Black communities are often less effective at cancer education and cancer screening compared to physicians serving White communities [58, 59]. Ultimately, Black communities in Louisiana, like elsewhere in the US, are faced with a 'double disparity', in which they are overburdened by environmental pollution and medically underserved [60]. As an additional or alternative explanation, our dataset may have been inadequate to detect a link between air toxics and cancer incidence among affluent/White communities, perhaps because of their relatively greater geographic mobility [61]. Given the lack of widespread data on residential histories, this factor could contribute to uncontrolled variation in actual exposures and obscure a relationship between estimated exposure and cancer incidence.

While economic disparities were not the focus of our study, we found that Black residents appear to be underrepresented in the construction and manufacturing industries in Louisiana. Specifically, census tracts with higher proportions of Black residents had lower proportions of their workforce represented in the construction and manufacturing industries. Additional research is warranted to understand the full nature of this disparity, but our findings are consistent with previous research documenting that Black Americans are underrepresented in industrial employment, particularly for high-paying jobs [17].

It is important to recognize the limitations inherent to studying environmental health disparities in Louisiana. Like elsewhere, there is limited information about factors that influence cancer incidence (e.g. drinking water contamination, or residential history), particularly for smaller geographic areas, which are the most relevant with respect to ambient air quality [62]. Accordingly, many factors that influence an individual's cancer risk cannot be evaluated in our present study. However, this ecological analysis has the benefit of a larger sample size ($n = 750$ census tracts, representing a combined population of 3.4 million people), which allowed us to detect the cancer risk from toxic air pollution in cancer incidence rates, despite the 'noise' in the dataset [63]. Some unidentified factors that influence cancer risk likely differ by parish (e.g. availability of social services) or correlate strongly with poverty/race (e.g. education) and were thus accounted for in our analysis. Finally, not all cancer risk factors contribute to census-tract-level variation in cancer incidence. For example, occupational exposures can increase cancer risk, but our analysis determined that occupation in high-risk industries (i.e. construction or manufacturing) did not explain the *geographic* variation in cancer incidence among census tracts. While we would expect geographic variation in occupational exposure, it is possible that this variation was better represented by parish, which was included as a variable in our model. Regardless, it seems unlikely that occupational exposure could explain the putative link between air toxics and cancer incidence among predominately Black (but not predominantly White) communities in Louisiana, given that Blacks are underrepresented in jobs at polluting industrial facilities [17].

An additional consideration for our study is that the scientific understanding of cancer risk is continually improving. While we used the best available estimates of cancer risk from air toxics, NATA methods (including toxicity values) are continually refined and updated [44]. The strength of NATA is that it provides reliable information about *relative* risk, which is less influenced by changing methodology compared to *absolute* risk [44]. For example, after the release of the 2005 NATA, EPA substantially revised its toxicity values for chloroprene and ethylene oxide. As a result, Tract 708 (St John the Baptist Parish), which is impacted by both pollutants, is now estimated to have the highest NATA Cancer Risk in Louisiana by a wide margin [11]. While the absolute risk value for this tract changed dramatically, from 65 in a million to 1505 in a million, the relative risk remained similar (88th state percentile in 2005 versus 100th state percentile in 2014). The prospect of large changes in toxicity values may be one reason why EPA encourages NATA users to focus on relative risks, particularly with respect to census tracts [64]. The uncertainties involved in estimating toxicity values likely explain, at least in part, why the relationship we detected between cancer risk and cancer incidence was not more linear (figure 5). Regardless, our analysis and interpretation are robust to changes in the NATA methodology, including revisions to toxicity values, because we focus on variation in NATA Cancer Risk among a substantial number ($n = 750$) of census tracts.

Our study provides evidence that toxic air pollution is a significant driver of cancer rates in Louisiana's most vulnerable communities. We found no evidence that parish-wide smoking or obesity rates contributed to the observed link between estimated cancer risk from air toxics and cancer incidence. While it was not possible to account for smoking or obesity in this study of Louisiana census tracts, it seems improbable that average smoking/obesity rates for census tracts would vary in a pattern that correlates with toxic air pollution, but is unaccounted for by the inclusion of parish, poverty, race, and occupation in the model. Regardless, behavioral factors must be put into their appropriate social and environmental contexts because they are shaped by deeply-rooted structural inequities, such as disparities in the built environment (e.g. parks and recreational facilities) or access to quality healthcare [56]. These disparities make it more important, not less important, to understand and address the disproportionate burden of pollution in environmental justice communities. Our study contributes to this understanding by systematically documenting, for the first time, the increased cancer burden among the most polluted and marginalized communities in Louisiana. Future assessments of the industrial pollution burden in Louisiana must account for potential interactions among poverty, race, and exposure to air toxics. These conclusions are consistent with the firsthand experiences of Black residents from impoverished, industrialized neighborhoods who have long maintained that their communities are overburdened with cancer from toxic pollution.

Data availability statement

No new data were created or analyzed in this study.

Funding

This research was supported by the McKnight Foundation (Grant #17-487), Deer Creek Foundation (Grant #2012B), Tides Foundation (Grant #TF2005-091306), and Rockefeller Family Fund.

Acknowledgment

We thank three anonymous reviewers for suggestions that helped strengthen this manuscript.

Appendix

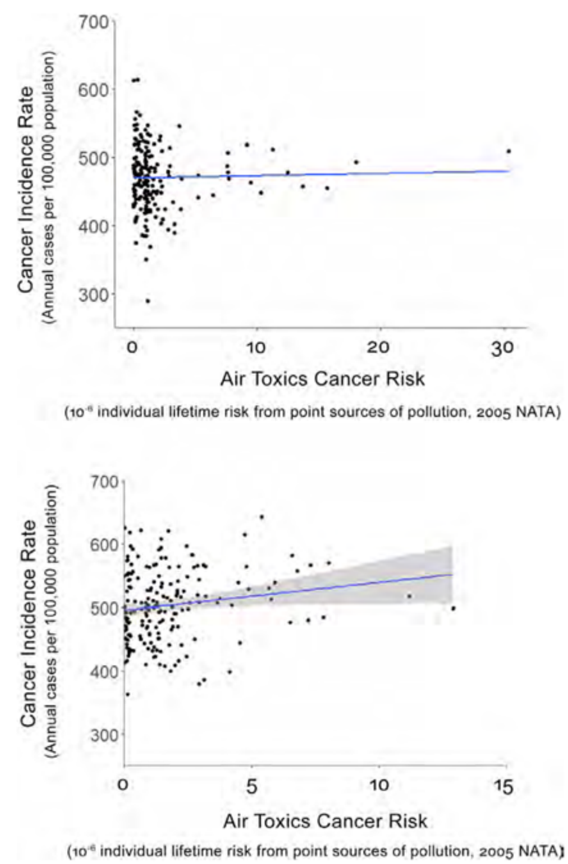


Figure A1. Comparison of pollution versus cancer rates among census tracts with the fewest (first quartile, top panel; $r = -0.10$, $P = 0.16$) and most (fourth quartile, bottom panel; $r = 0.13$, $P = 0.07$) Black residents as a proportion of the population. See table 4 for quartile breaks and test statistics. Blue line represents a linear regression of untransformed data. Gray shading represents 95% confidence interval.

Table A1. Stepwise selection results for alternate[a] cancer incidence model.

Main effects[b]	Interaction terms	AIC	ΔAIC	Rank
Air toxics	Race × air toxics	5854.3	0	1
Race parish	None	5864.4	10.1	2

[a] Model includes race (% Black residents) instead of poverty.

[b] Air toxics corresponds 2005 NATA Cancer Risk from point sources. See section 2 for other data sources.

Table A2. Statistics for best-supported alternate[a] cancer incidence model.

Variable[b]	Coefficient estimate[c]	t	P
(Model intercept)	489.95	33.66	< 0.0001
Race (% Black)	44.39	8.00	< 0.0001
Air toxics	−0.43	−0.16	0.871
Air toxics × race	12.75	3.35	0.0008

[a] Model includes race (% Black residents) instead of poverty.
[b] Air toxics corresponds 2005 NATA Cancer Risk from point sources. See section 2 for other data sources.
[c] Coefficients correspond to transformed and mean-centered data (see section 2).

ORCID iD

Kimberly A Terrell https://orcid.org/0000-0002-7729-3628

References

[1] Nelson-Horchler J 1987 Superfund poses major problems for industry *Ind. Week* 19
[2] Maraniss D and Weisskopf M 1988 The faces of pollution: as cancer, miscarriages mount, Louisiana wonders if it is a 'National Sacrifice Zones' *Los Angeles Times* (available at: www.latimes.com/archives/la-xpm-1988-01-24-mn-37913-story.html (Accessed 21 December 2021))
[3] Martin D 2010 Toxic towns: people of Mossville 'are like an experiment' *CNN* (available at: www.cnn.com/2010/HEALTH/02/26/toxic.town.mossville.epa/index.html (Accessed 21 December 2021))
[4] Baurick T 2021 Biden utters the words 'Cancer Alley', but will he help Louisiana's chemical corridor? | Environment *Times Picayune—Nolacom* (available at: www.nola.com/news/environment/article_0ced9da4-61b1-11eb-af00-fb2987cd8fb2.html (Accessed 21 December 2021))
[5] LDEQ 2021 ERIC annual certified emissions *Emissions Reporting and Inventory Center* (available at: www.deq.louisiana.gov/page/eric-public-reports (Retrieved 21 July 2021))
[6] US EPA Risk screening environmental indicators (RSEI) database (available at: https://edap.epa.gov/public/extensions/EasyRSEI/EasyRSEI.html# (Retrieved 1 July 2021))
[7] US EPA 2014 *EJScreen* (National Air Toxics Assessment) (available at: https://ejscreen.epa.gov/mapper/ (Accessed 1 July 2021))
[8] LDEQ 2020 Basis for decision FG LA LLC complex (available at: https://edms.deq.louisiana.gov/app/doc/view?doc=11998452%26ob=yes%26child=yes (Accessed 21 December 2021))
[9] Baurick T 2021 'It's a slam upon our state': Sen. Bill Cassidy rebukes Joe Biden over 'Cancer Alley' remarks *Time Picayune—NOLAcom* (available at: www.nola.com/news/environment/article_98b5dd56-665c-11eb-993d-ab9537e3b12f.html (Accessed 21 December 2021))
[10] Roux A V D 2012 Conceptual Approaches to the Study of Health Disparities *Annual Review of Public Health* vol **33** pp 41–58
[11] US Environmental Protection Agency 2018 2014 National Air Toxics Assessment (available at: https://www.epa.gov/sites/default/files/2018-08/nata2014v2_national_cancerrisk_by_tract_srcgrp.xlsx (Retrieved 15 March 2021))
[12] Perera P K P 2013 An environmental justice assessment of the Mississippi River industrial corridor in Louisiana, US using a GIS-based approach *Appl. Ecol. Environ. Res.* **11** 681–97
[13] James W, Jia C and Kedia S 2012 Uneven magnitude of disparities in cancer risks from air toxics *Int. J. Environ. Res. Public Health.* **9** 4365–85
[14] Paolella D A, Tessum C W, Adams P J, Apte J S, Chambliss S, Hill J, Muller N Z and Marshall J D 2018 Effect of model spatial resolution on estimates of fine particulate matter exposure and exposure disparities in the United States *Environ. Sci. Technol. Lett.* **5** 436–41
[15] Colmer J, Hardman I, Shimshack J and Voorheis J 2020 Disparities in PM2.5 air pollution in the United States *Science* **369** 575–8
[16] Morello-Frosch R and Jesdale B M 2006 Separate and unequal: residential segregation and estimated cancer risks associated with ambient air toxics in US metropolitan areas *Environ. Health Perspect.* **114** 386–93
[17] Ash M and Boyce J K 2018 Racial disparities in pollution exposure and employment at US industrial facilities *Proc. Natl Acad. Sci.* **115** 10636–41
[18] Mohai P, Lantz P M, Morenoff J, House J S and Mero R P 2009 Racial and socioeconomic disparities in residential proximity to polluting industrial facilities: evidence from the Americans' changing lives study *Am. J. Public Health.* **99** S649–56
[19] Mikati I, Benson A F, Luben T J, Sacks J D and Richmond-Bryant J 2018 Disparities in distribution of particulate matter emission sources by race and poverty status *Am. J. Public Health.* **108** 480–5
[20] Ard K and Smiley K 2021 Examining the relationship between racialized poverty segregation and hazardous industrial facilities in the US over time *Am. Behav. Sci.* 00027642211013417 (https://journals.sagepub.com/doi/full/10.1177/00027642211013417)
[21] Bullard R, Mohai P, Saha R and Wright B 2007 Toxic wastes and race at twenty 1987–2007 (A report prepared for the United Church of Christ Justice & Witness Ministries) (available at: www.nrdc.org/sites/default/files/toxic-wastes-and-race-at-twenty-1987-2007.pdf (Accessed 12 December 2021))
[22] Hajat A, Hsia C and O'Neill M S 2015 Socioeconomic disparities and air pollution exposure: a global review *Curr. Environ. Health Rep.* **2** 440–50
[23] Meaders J S 2021 Health impacts of petrochemical expansion in Louisiana and realistic options for affected communities *Tulane Environ. Law J.* **34** 113–47
[24] Tessum C W *et al* 2019 Inequity in consumption of goods and services adds to racial–ethnic disparities in air pollution exposure *Proc. Natl Acad. Sci.* **116** 6001–6
[25] Gee G C and Payne-Sturges D C 2004 Environmental health disparities: a framework integrating psychosocial and environmental concepts *Environ. Health Perspect.* **112** 1645–53
[26] Morello-Frosch R and Lopez R 2006 The riskscape and the color line: examining the role of segregation in environmental health disparities *Environ. Res.* **102** 181–96
[27] Morello-Frosch R A 2002 Discrimination and the political economy of environmental inequality *Environ. Plan. C: Gov. Policy* **20** 477–96
[28] Hamanaka R B and Mutlu G M 2018 Particulate matter air pollution: effects on the cardiovascular system *Front. Endocrinol.* **9** 1–15
[29] Tessum C W, Paolella D A, Chambliss S E, Apte J S, Hill J D and Marshall J D 2021 $PM_{2.5}$ polluters disproportionately and systemically affect people of color in the United States *Sci. Adv.* **7** eabf4491
[30] Smith M 2021 Vanishing Black community of Mossville set for visit by EPA head | Lake Charles News | theadvocate.com *The Advocate* (available at: www.theadvocate.com/lake_charles/article_28e9a968-47fb-11ec-bea6-d7d9fa153935.html (Accessed 21 December 2021))
[31] Kraan C M, Hino M, Niemann J, Siders A R and Mach K J 2021 Promoting equity in retreat through voluntary

property buyout programs *J. Environ. Stud. Sci.* **11** 481–92

[32] Louisiana Legislative Auditor 2021 *Monitoring and Enforcement of Air Quality* (Baton Rouge, LA) p 1–J.1 (https://app.lla.state.la.us/PublicReports.nsf/0/4F3372ABDDF0F271862586630067C25D/$FILE/00022660A.pdf?OpenElement&.7773098)

[33] Russell G 2019 Louisiana officials say they will conduct 'comprehensive study' of cancer risks near Denka plant *NOLA.com* (available at: www.nola.com/news/environment/article_4db9eede-cc14-11e9-9b64-2769f8ea794e.html (Accessed 21 December 2021))

[34] Nagra R, Taylor R, Hampton M and Hilderbrand L 2021 'Waiting to die': toxic emissions and disease near the Denka performance elastomer neoprene facility in Louisiana's Cancer Alley *Environ. Justice* **14** 14–32

[35] Simonsen N, Scribner R, Su L J, Williams D, Luckett B, Yang T and Fontham E T H 2010 Environmental exposure to emissions from petrochemical sites and lung cancer: the lower Mississippi interagency cancer study *J. Environ. Public Health.* **2010** 759645

[36] Gottlieb M S, Shear C L and Seale D B 1982 Lung cancer mortality and residential proximity to industry *Environ. Health Perspect.* **45** 157–64

[37] Tsai S P 2004 Mortality patterns among residents in Louisiana's industrial corridor, USA, 1970–99 *Occup. Environ. Med.* **61** 295–304

[38] LDEQ 2018 *Public comments response summary for Pin Oak Terminals, LLC* (https://edms.deq.louisiana.gov/app/doc/view?doc=11078480)

[39] Maniscalco L, Lefante C, Hsieh M, Yi Y, Pareti L, Mumphrey B, Lynch MA and Wu XC 2020 Cancer in Louisiana, 2013–2017 *Cancer in Louisiana, 2013–2017* vol 35 (New Orleans: Louisiana Tumor Registry) (https://sph.lsuhsc.edu/wp-content/uploads/2020/11/1-Cancer-in-LA_Vol-35_Full-Document.pdf)

[40] Maniscalco L, Rosales C, Lefante C, Hsieh M, Yi Y, Pareti L, Mumphrey B, Lynch MA and Wu XC 2019 Cancer in Louisiana, 2012–2016 *Cancer in Louisiana, 2012–2016* vol 34 (New Orleans: Louisiana Tumor Registry) (https://sph.lsuhsc.edu/wp-content/uploads/2020/10/1-Ca-in-LA-vol-34_full-monograph.pdf)

[41] Maniscalco L *et al* 2018 Cancer in Louisiana, 2011–2015 *Cancer in Louisiana, 2011–2015* vol 33 (New Orleans: Louisiana Tumor Registry) (http://sph.lsuhsc.edu/wp-content/uploads/2020/10/Vol33.pdf)

[42] Maniscalco L, Yi Y, Lefante C, Hsieh MC and Wu XC 2021 *Cancer incidence in Louisiana by census tract, 2008–2017* Louisiana Tumor Registry (https://sph.lsuhsc.edu/wp-content/uploads/2021/03/01_Cancer-Incidence-in-LA-by-Census-Tract-2008-2017.pdf (Accessed 6 April 2021))

[43] Nadler D and Zurbenko IG 2014 Estimating cancer latency times using a Weibull model *Adv. Epidemiol.* **2014** 1–8

[44] US Environmental Protection Agency 2011 (https://www.epa.gov/sites/default/files/2015-10/documents/2005-nata-tmd.pdf) (Accessed 22 December 2021)

[45] University of Wisconsin Population Health Institute 2011 county health rankings (available at: www.countyhealthrankings.org/app/louisiana/2021/downloads (Retrieved 15 April 2021))

[46] EPA United States 2018 2014 NATA: technical support document *US EPA* (available at: www.epa.gov/national-air-toxics-assessment/2014-nata-technical-support-document (Accessed 22 December 2021))

[47] US Census Bureau, Relationship Files 2010 Substantially changed census tracts (available at: www.census.gov/geographies/reference-files/2010/geo/relationship-files.html#par_textimage_19960473 (Retrieved 15 April 2021))

[48] Venables W and Ripley B 2002 *Modern Applied Statistics with S* 4th edn (Berlin: Springer)

[49] Iacobucci D, Schneider M J, Popovich D L and Bakamitsos G A 2016 Mean centering helps alleviate 'micro' but not 'macro' multicollinearity *Behav. Res. Methods* **48** 1308–17

[50] Hartig F 2021 DHARMa: residual diagnostics for hierarchical (multi-level/mixed) regression models. R package version 0.4.1 (available at: https://CRAN.R-project.org/package=DHARMa (Accessed 11 August 2021))

[51] R Core Team 2020 R: a language and environment for statistical computing (Vienna, Austria: R Foundation for Statistical Computing) (available at: www.R-project.org/ (Accessed 6 April 2021))

[52] Akaike H 1973 *Proceedings of the Second International Symposium on Information Theory* (Budapest: Akademiai Kiado) pp 267–81

[53] Lee H and Ghosh S K 2009 Performance of information criteria for spatial models *J. Stat. Comput. Simul.* **79** 93–106

[54] Institute of Medicine (US) Committee on the Review and Assessment of the NIH's Strategic Research Plan and Budget to Reduce and Ultimately Eliminate Health Disparities 2006 *Examining the Health Disparities Research Plan of the National Institutes of Health: Unfinished Business (The National Academies Collection: Reports funded by National Institutes of Health)* (Washington, DC: National Academies Press (US)) (available at: www.ncbi.nlm.nih.gov/books/NBK57043/ (Accessed 22 December 2021))

[55] US Centers for Disease Control 2004 The burden of chronic diseases and their risk factors; national and state perspectives (Atlanta, GA: Department of Health and Human Services) (available at: https://stacks.cdc.gov/view/cdc/11317 (Accessed 22 December 2021))

[56] Landrine H and Corral I 2009 Separate and unequal: residential segregation and black health disparities *Ethn. Dis.* **19** 179–84

[57] Ojinnaka C O and Bruening M 2021 Black-White racial disparities in health care utilization and self-reported health among cancer survivors: the role of food insecurity *Cancer* **127** 4620–4627

[58] Ashford A, Gemson D, Sheinfeld Gorin S N, Bloch S, Lantigua R, Ahsan H and Neugut A I 2000 Cancer screening and prevention practices of inner-city physicians *Am. J. Prev. Med.* **19** 59–62

[59] van Ryn M 2002 Research on the provider contribution to race/ethnicity disparities in medical care *Med. Care.* **40** I140–51

[60] Wilson S, Zhang H, Jiang C, Burwell K, Rehr R, Murray R, Dalemarre L and Naney C 2014 Being overburdened and medically underserved: assessment of this double disparity for populations in the state of Maryland *Environ. Health* **13** 26

[61] Quillian L 2003 How long are exposures to poor neighborhoods? The long-term dynamics of entry and exit from poor neighborhoods *Popul. Res. Policy Rev.* **22** 221–49

[62] Apte J S, Messier K P, Gani S, Brauer M, Kirchstetter T W, Lunden M M, Marshall J D, Portier C J, Vermeulen R C H and Hamburg S P 2017 High-resolution air pollution mapping with Google street view cars: exploiting big data *Environ. Sci. Technol.* **51** 6999–7008

[63] Hajian-Tilaki K 2011 Sample size estimation in epidemiologic studies *Casp. J. Intern. Med.* **2** 289–98

[64] US Environmental Protection Agency 2011 An overview of methods for EPA's national-scale air toxics assessment (Durham, NC) (available at: www.epa.gov/national-air-toxics-assessment/2005-nata-technical-methods-document (Accessed 22 December 2021))

Senator MERKLEY. Thank you.

I want to turn to Mx. Tandazo. You mentioned the burning of plastics as a strategy for disposal, and I think you said three incinerators in New Jersey. You also mentioned the New Jersey environmental law.

Is that law a response to some of these challenges? Did it improve the situation?

Mx. TANDAZO. Yes, thank you for that question. Yes, the EJ law was a response to the environmental justice communities in New Jersey, particularly, and are in Ironbound similar to what Ms. Sharon has mentioned. Ironbound has five-plus industrial facilities, all of which are located within a five-mile radius next to an entire neighborhood.

The folks and organizers that fought for the EJ law came out of these neighborhoods. It was a 20-year battle. Dr. Nicky Sheetz [phonetically] has been pushing for this law for cumulative impacts in the past in New Jersey. This landmark law, the rules just got passed this past Earth Week. Now we have regulations.

Right now, we are preparing to see what is going to happen. It seems the EJ law is triggering a lot of facilities that are trying to be sited all over New Jersey, and facilities are trying to be sited in communities of color, particularly. They are not going to the suburbs, they are not going to the rural areas. They are going to urban settings, where communities of color live.

We are preparing ourselves to fight these proposals. The EJ law now gives us the support to do that. The law will not allow any facility that adds any additional pollution to the area where they are trying to site.

Senator MERKLEY. Thank you.

My time is expired, but when I come back, I am going to pick up where we left off. What I will want to understand is how is it that these incinerators continued operating after violating their air permits more than 1,400 times. Also, why they would get $60 million in renewable energy subsidies for the purpose of burning plastic and creating pollution?

We will turn now to Co-Chair Senator Mullin.

Senator MULLIN. Thank you, Chairman.

Ms. Bradford, in your testimony, did I understand you right, that you want to end all plastic manufacturing?

Ms. BRADFORD. I said the plastics industry must be stopped.

Senator MULLIN. Does that mean end plastic manufacturing?

Ms. BRADFORD. In my dream world, sure. I think that the——

Senator MULLIN. I do not mean to be condescending here, I just point out, what is going to replace your glasses?

Ms. BRADFORD. I do know——

Senator MULLIN. Your glasses around your face. They are made of plastic.

Ms. BRADFORD. Maybe. I do not know what they are made of.

Senator MULLIN. They are. I am just pointing out some things here, because I just want to be realistic when we are having conversations. When statements are made like this, I just want to open people's eyes to say, OK, it is easy to say, but what is the solution. Your water bottle in front of you.

Ms. BRADFORD. This one.

Senator MULLIN. Yes. That plastic?

Ms. BRADFORD. No.

Senator MULLIN. The lid is. That is plastic.

Ms. BRADFORD. Right, so I would say to your question that I would first be concerned about single-use plastics. Then we can talk about alternatives.

Senator MULLIN. Your cell phone there. Is it plastic?

Ms. BRADFORD. The case is. It is glass because——

Senator MULLIN. Are the components inside of it not plastic? The components made out of it is not plastic? They are. The water that you filled that water bottle up with, where did you fill that water bottle up out of?

Ms. BRADFORD. A water filling station.

Senator MULLIN. It was delivered by a drink station that was plastic?

Ms. BRADFORD. I didn't check.

Senator MULLIN. The edges are. The piping coming to it, now you have a couple choices with the piping. We could go back to using wood, but then you have to have to line it in chemical. Or we could go back and use lead because we used to have water piping that was lead. That was harmful to us. We could go back to galvanized, but galvanized rusts and had discoloration. We could go back to copper, but copper has to be mined, and everybody wants to stop mining in the U.S. You use plastic to deliver piping that you filled that water bottle up today.

I point this out because the clothes you have on, I guarantee have plastic in it, the shoes you have on your feet, the soles of those shoes are plastic. We talk about any manufacturer, plastic manufacturing, and everybody in here cheered when you say that. Everybody here, it is an opinion on plastic as you said.

If you want to end it then quit using it. It is kind of like, I do not want to shop at certain places right now because I do not agree with some of their policies. I choose not to do that. You can choose to not use plastic, do your work. If you believe it, then live it that way. If not, then tell me what the solution is.

Mr. Sunday, can you manufacture a car today without plastic? We talked about manufacturing, the Chairman brought up manufacturing cars, is it as safe. The components that go into the cars today, can you do that without plastic?

Mr. SUNDAY. No, Senator, and increasingly so with the new mileage mandates, you increasingly need to use automotive components that are plastics derived.

Senator MULLIN. We wouldn't have manufacturing today, modern manufacturing, if we didn't have plastics, correct?

Mr. SUNDAY. Correct.

Senator MULLIN. Ms. Jackson, do you agree with that statement?

Ms. JACKSON. Yes.

Senator MULLIN. What is the alternative for manufacturing? The Democrats talk about middle-class wages. Middle-class wages typically come directly from manufacturing. What is it that we are manufacturing that does not have plastic in it today?

Ms. JACKSON. Nothing, and you know what? It would increase the cost of everything if we turned to an alternative and it would disproportionately impact low-income people who have lower incomes. It would be another regressive tax on the poor.

Senator MULLIN. According to your testimony, Ms. Jackson, it sounds like you are saying that the environmental justice agenda does more harm than good for low-income families. Is that correct?

Ms. JACKSON. Yes. You know, I have the unique opportunity to see both sides, when the industry comes in the area and when it does not. As an auditor, I worked on Nissan North America. Nissan North America moved to Smyrna, Tennessee, where it built the largest automotive manufacturing plant. The transformation was astonishing. It went from a community that was poor to a community that U.S. World News voted one of the top 10 places to retire.

You had poor people in areas that were poor that became middle-class. You had middle-class people that became upper middle-class, and a lot of upper middle-class people that became affluent. They have attractions, they have amenities, they have housing, affordability. The amount of prosperity in that area has resonated out three counties, three counties.

I have also had the opportunity to see when an industrial, and that wouldn't happen if you do not have an industrial complex moving into the area where you are talking about high economics.

I have also see the other side, where all of a sudden you have deteriorating buildings, empty storefronts, dilapidated housing, people standing on street corners, families that are broken.

We need to balance the fact that people's lives need economic upward mobility. We can not just say, we are going to take out an industry and leave people poorer than they were. Poverty causes the worst health care in this Country. Poverty is the one that destroys lives, it destroys health, it creates trauma.

We need to make sure that when we are talking about these issues, we take into account the human loss of life, not just the environmental impacts.

Senator MULLIN. Thank you. Thanks for your indulgence.

Senator MERKLEY. Senator Whitehouse.

Senator WHITEHOUSE. Thank you, Chairman, for your persistent focus on the plastics problem that we face.

Mx. Tandazo, the U.S. plastics recycling rate is less than 10 percent, once you actually put it in the blue bin. For single-use plastics, about 2 percent of the feedstock is recycled. The rest is all new. The industry is recommending that as an alternative, we go to high heat waste disposal facilities, like pyrolysis facilities.

Do you have a view on what dangers those facilities pose for adjacent communities?

Mx. TANDAZO. Thank you for the question. Yes, those are what I would consider schemes to deceive this body and anybody into thinking that they are actually doing some good. If you are burning plastic, you are still emitting the toxics and the chemicals. The chemicals that are used to make the plastic are still being burned. That happens whether you combust them in incinerators or you gas-fire through pyrolysis and gasification.

It does not matter which avenue you choose to process the plastic, it is still going to emit some sort of chemicals. What is important to think about that is, when we are thinking of where these so-called alternative recycling plastic-to-fuel industries are going to be sited at, I will most definitely bet you it is going to go to low-income communities of color, where the industry is already taking control over the zoning laws, so they have the support from municipalities to actually go ahead and continue to re-site it in these places.

That is why the EJ law is important, because the EJ law would allow communities themselves to hold the corporations accountable, actually through a process to prove that their operations are not going to harm our communities.

Senator WHITEHOUSE. Thank you.

Ms. Lavigne, I am getting ready to re-introduce my REDUCE Act bill, that puts a 20 cent per pound fee on the sale of new plastic that is destined for single-use products, to try to help put that 2 percent number where there is so little recycled plastic being put into single-use plastic.

The plastics industry was not very helpful in that regard, and ran ads against my bill in Washington with images of things like child car seats and bicycle helmets. I am not really sure that those are single-use items in real life. I am interested in your view on how the proliferation of single-use, throwaway plastic items implicates communities like yours, not only in the U.S. but around the world.

Ms. LAVIGNE. I think we can gradually get away from so much plastics. I think we have too much, and the health effects of making these plastics are killing the people, are making us sick, giving us cancer. When I was diagnosed with autoimmune hepatitis, I didn't know where it was coming from until I did my research. It said it came from industrial pollutants. I live in a cesspool of pollution.

I believe that that is where it came from. I feel we can gradually go back to the old days when we didn't have so much plastic, go back to glass. When I was a little girl, we didn't have so much plastic. We weren't sick.

Maybe we can get together, find solutions, find strategies, sit at the table and discuss these things. I would like to be a part of that discussion, because we need to find ways to reduce so much plastic, and also stop the industries from coming into poor communities to make these plastics.

Senator WHITEHOUSE. Mr. Chairman, there are some pretty reasonable minimum standards we should start pushing toward. One of them was put forward at the Oslo Oceans Conference by the European Company Unilever, which has pledged, I think starting in 2026, to take out of the world a pound of plastic for every pound of plastic that it puts out into the world through packaging and through products, to go plastics neutral, if you will.

If a company as big as Unilever can do that, that should not be asking too much for American companies. This is an announced policy. I think it would have a very positive effect. In fact, it would create a market for getting plastic out of the world. I think it would be particularly helpful in poorer countries to have an international market of waste plastic that people can take out of their communities and get paid for cleaning up their communities.

There are plenty of levels of engagement. Clearly, if a company as big as Unilever can make a commitment like that, that is not an unreasonable ask.

Thanks for your attention to this problem.

Senator MERKLEY. Thank you, Senator Whitehouse.

Senator Sullivan?

Senator SULLIVAN. Thank you, Mr. Chairman.

I want to begin by thanking my friend and colleague, Senator Whitehouse, on this topic of plastics and ocean cleanup, he and I have been tag-teaming for a number of years on the Save Our Seas Act 1.0, the Save Our Seas Act 2.0, which the congressional Research Service called the most comprehensive ocean cleanup, ocean debris legislation ever passed in the history of the Congress.

It was very bipartisan, Trump Administration, now Biden Administration. We are implementing that.

There is a lot of bipartisan work going on in this area of plastics and cleanup, particularly for our oceans, which I think literally everybody agrees with. I am looking forward to continuing to work with him and this committee on the next phase of that, which I think is very important.

The title of this hearing, though, I want to dig into the topic of environmental justice a little bit more from our witnesses. In my State, the great State of Alaska, there is a real double standard on environmental justice. The Biden Administration talks about how their report on environmental justice listed a number of projects that "will not benefit a community," including fossil fuel production, pipeline development, even possibly roads.

This is ridiculously naive, in my view. What I worry about sometimes is when we talk about environmental justice, the Native people, the indigenous people of my State always get left out of the Biden Administration's views. Maybe for the witnesses, should not environmental justice include indigenous people in Alaska? Does everybody agree with that?

Everybody is nodding. That is not a trick question, it is just a pretty basic question. I think the answer is yes, Mr. Chairman.

Yet, whether it is the King Cove Road, that is a road that would connect the community of King Cove, it is a Native community in Alaska, where they have been trying to build a 12-mile, single lane dirt road to an airport that would save lives, this Administration is now opposing it. Secretary Haaland, every radical lower 48 environmental group opposes that. That is not environmental justice.

We had a bill of mine, the Alaska Native Vietnam Veterans getting land, Native allotments to Alaska Natives who served in Vietnam. Secretary Haaland will not implement that at all because radical lower 48 environmental groups do not want Native Americans who served in Vietnam when most people were avoiding service to get land.

Is that environmental justice? Hell, no. That is not environmental justice.

The Ambler Road, which this Administration has now reversed, that was supported by a number of indigenous communities in Alaska, would create jobs.

My point, Mr. Chairman, is there is a lot of talk about environmental justice. When it comes to Alaska Native people, indigenous people in my State, almost 20 percent of the population, this Administration targets them so often. Their claims of environmental justice are just, I do not know. They are really harming the people of my State, particularly the Native people, the indigenous people.

I do not want an exception for environmental justice. Shouldn't be an exception. Do you guys agree? This is not a controversial statement. Indigenous people in Alaska should be getting the same benefits that everybody else does under this rubric of environmental justice. They do not.

I am just going to let that stand here, Mr. Chairman. It is a big issue for me. It is hypocritical by the White House, by the way.

Let me just ask a general question. Mr. Sunday, Ms. Jackson, and again, I worked hard on the issue of plastics and pollution and making sure we do not pollute our oceans. One thing I do worry about is that if we crack on plastics here, the production of that, it is just going to drive it overseas to China, places that do not have strong environmental standards like we do.

Is that a concern, and should we be making sure that any action or legislation we take does not have the perverse impact of driving operations and jobs to China where their environmental standards on the production of plastics are not nearly as high as ours? Do you have a view on that, Mr. Sunday?

Mr. SUNDAY. Yes, Senator, thanks for the question.

It is the right perspective. As I mentioned in my opening statement, the U.S. greenhouse gas emission reductions are greater than the next four countries combined. China's is greater than all the OECD, Organisation for Economic Co-operation and Development, nations.

Senator SULLIVAN. China's is going up the other way, and ours are going down.

Mr. SUNDAY. Right.

Senator SULLIVAN. The revolution in the production of natural gas, right?

Mr. SUNDAY. Yes, sir.

Senator SULLIVAN. Ms. Jackson, do you have a view on that? We do not want plastic production going to the dirtiest producer, which is China, and then taking our jobs away. Do you have a view on that?

Ms. JACKSON. Yes. It is our economy that is always being attacked, even though we are the least of polluters. China is the greatest polluter, but yet they are being able to get the benefit of when we attack our economy, when we kill our jobs, we push them over to the biggest polluter.

If you really believe that plastics are a danger to the planet, it should be a danger no matter where it is produced.

Senator SULLIVAN. Correct.

Ms. JACKSON. Somehow only Americans are being penalized.

Senator SULLIVAN. We do not want to kill jobs and then send production to China that will pollute the environment globally even worse?

Ms. JACKSON. I think it just goes to the narrative that we do not really believe this. It is this kind of where we want to just signal that we are good people. If you care about people, you care about all people. If you believe that plastics are harming individuals, why harm other people overseas? How come they are expendable? It should not be that way.

Again, this Country is subject to the most rigorous regulations. Those companies are actually meeting those standards. If they are not, why isn't Michael Regan in here talking about why we are not making sure that our companies are not adhering to those standards? Nobody really believes that.

Senator SULLIVAN. Thank you. Thank you, Mr. Chairman.

Senator MERKLEY. Thank you, Senator Sullivan.

We are going to have additional 5-minutes rounds as people would like.

One of the things I find interesting about the plastics conversation is when we identify some of the significant harms that have developed as the production of plastics has increased. It is often pointed out that, well, there are plastics in almost everything. This is pretty accurate. Nylon is a plastic in our clothes, Dacron, et cetera.

When you have harmful effects, it isn't the right answer to say, well, there is nothing that can be done. One of the conversations is, how do we distinguish between necessary uses of plastic and those that are not necessary. Maybe we can reduce those harmful effects by reducing how much we produce. When we produce it, how do we produce it in a way that is less harmful to the communities in which it is located? How do we reduce the emissions and reduce the cancer and the disease rates there?

When it is used in our consumer economy, how do we reclaim it in a fashion that it does not end up in our rivers and our oceans, affecting our ecosystems? How do we reduce the amount of microplastics? I can tell you in the health of our children, having the effect that we now consume the equivalent of a credit card of plastic a week through microplastics in our food and our water, that is a very serious health issue.

I want to encourage a conversation that is based in reality that there are real issues, that plastics have real roles. We may be able to work together through this set of hearings to develop a set of ideas on how we can keep the essential and necessary roles but eliminate the unnecessary, or at least eliminate the side effects or reduce them.

That is the conversation we are engaged in. Ms. Bradford, you mentioned single-use plastics. Is that an area you think is kind of ripe for us to target to try to reduce?

Ms. BRADFORD. Yes, for sure. We had human existence and efficiencies prior to single-use plastics. We can have that without them, after them. To the point that you were making, I think it is the responsibility of every industry in this Country to come together and figure out what actually makes sense. Yes, we can not power down everything immediately when it comes to plastics.

There are some medical uses, and of course, I use them in my lab. We have not always. There are many ways to go back to less dangerous, less harmful plastic or non-plastic material.

Also, we know from recent reports that have come out that there are alternatives to a lot of the chemicals that are being used that because maybe they are cheaper are not being replaced. We need industries, the petrochemical and plastics industries, to replace a lot of the chemicals that they are using.

Senator MERKLEY. One of the chemicals that gets significant attention in plastics are endocrine disruptors. Is that something you are familiar with?

Ms. BRADFORD. Yes.

Senator MERKLEY. Can you explain that for us?

Ms. BRADFORD. Yes, so when you think about the endocrine system, you are talking about hormones. Hormones regulate a lot throughout the body. Essentially, plastics are, their chemicals are disrupting the natural processes of your body. That can lead to autoimmune diseases or dysfunction of the kidney, liver, central nervous system. Endocrine disruptors have several different negative effects and can be carcinogenic as well.

Senator MERKLEY. There are various studies that have suggested that there is a link between plastics which we end up inhaling or eating and the effects upon breast cancer, prostate cancer, and for that matter sperm production. Should Americans be concerned about these types of health impacts?

Ms. BRADFORD. I will say, I would be concerned across the board with all these things. It is only now that a lot of researchers are thinking through not just the historical ways in which we thought maybe diabetes or cardiovascular disease or kidney disease develops, but what role does plastic now play in that. We are seeing that in our Country, we have a lot of chronic diseases that we have not gotten under control, that we are still seeing increased diagnoses for people. You do have to start to wonder, and hopefully we will see more money for research in the areas of determining the role that plastics plays in disease development.

Senator MERKLEY. Thank you.

I want to turn next to Mx. Tandazo, to the conversation about the new law in New Jersey. Is it kind of the bottom line that better regulation can reduce some of the harmful effects?

Mx. TANDAZO. Yes, that is right.

Senator MERKLEY. Is it a combination of Federal regulation and State regulation?

Mx. TANDAZO. I think it will vary depending on the situation we are talking about. At the State level it works for New Jersey, because it is a small State and it is fairly easy to regulate and have larger oversight over the State. At the Federal level, it would get a little more complicated because of the different zoning policies, the different municipalities all having different things.

Senator MERKLEY. The incinerators have violated their air permits more than 1,400 times since 2004. I think those air permits would have been State air permits, am I correct about that? Those are State enforcement?

Mx. TANDAZO. Yes.

Senator MERKLEY. Do we need better Federal regulation, to Ms. Jackson's point about, if we are concerned about States and places that are violating the emissions or have very high emissions, do we need more Federal supervision of how States enforce these toxic emissions from plastic production?

Mx. TANDAZO. I think there is an opportunity to do something at the Federal level. I think it would definitely be more efficient to do something State by State. I think the Federal Government can support by emphasizing different procedures and regulatory systems that can be implemented in different laws.

It is possible to do it at the Federal level. President Biden just signed an Executive Order for Environmental Justice this past Earth Month. It would be incredible if we can pass that Executive Order into law. Then we would have more Federal oversight over not just polluting industries that work at the State level, but also polluting industries that work at the Federal level. A lot of them do not have full oversight by the States, but they have Federal legislation, too.

Senator MERKLEY. Thank you. We have been joined by Senator Markey of Massachusetts.

Senator MARKEY. Thank you, Mr. Chairman. Thank you for this important hearing.

Here is what I know. Japanese women in Japan contract breast cancer at only one-third the rate of Japanese women once they move to the United States, and their daughters are growing up their whole lives. In other words, there is something in American culture that affects those Japanese women once they get here. Within the first generation, a Japanese American woman has breast cancer at twice the rate as a women of Japanese origin in Japan.

We are doing it to ourselves. Is it in our food? Is it in our air? Is it toxics? What are we doing to ourselves? What is it that is going inside of the people in our Country that has their genes misspell, so that now there is a disease which is induced in individuals?

We know historically that toxics have been identified as one of those real culprits. We know that all of you have spent your lives working in those issues. Mx. Tandazo, can you speak to some specific cost that you have seen as a result of plastic waste incinerators?

Mx. TANDAZO. Yes, we can talk about the costs to the ratepayers and the costs to their health. New Jersey folks in urban communities already face a lot of socioeconomic challenges that come from lack of access to proper health care, economic resources, healthy jobs.

Senator MARKEY. I will come back to you.

Let me come over to you, Ms. Lavigne. Cancer Alley, people are 50 times more likely on average to get sick than other people in America. Again, that is kind of an analogy over to the Japanese women in Japan, Japanese women here. You are a good example of what happens when there is some proximity.

Can you expand upon that, and what do you think are the causes of it and what the remedy has to be?

Ms. LAVIGNE. I think that when you come into Cancer Alley, you are susceptible to something. I had a young girl from New York who came to stay with me for about 5 months, and she became ill from breathing the air. She said when she wakes up in the morning, she had a headache sometimes. Then she started to feel dizzy or lightheaded. She is not from here, and for her to experience that, I can imagine what other people coming to Cancer Alley will experience there.

I always ask people to come to the area where I live, next to Donaldsonville, that is where the hotels are, and spend a night at the hotel and wake up the next morning and tell me if you smell something.

Senator MARKEY. Yes. When I was growing up in Malden, Massachusetts, I lived in Ward Two. I still live in Ward Two in Malden, Massachusetts. Every city has a sacrifice ward. The Malden River is in Ward Two, three blocks from my house.

My mother would always say to me, Eddie, whatever you do, do not swim in the Malden River. It was black with a pre-Jimi Hendrix purple haze over it. I knew I wasn't Tom Sawyer and Huck Finn on the Mississippi, reading those books, when your mother says, do not swim in the river three blocks from your house. It was the chemical companies, the coal companies, they all just dumped it all in the Malden River.

You live in that ward in Louisiana.

Ms. LAVIGNE. Yes.

Senator MARKEY. You live in the petrochemical sacrifice zone.

Ms. LAVIGNE. I sure do.

Senator MARKEY. Every city has that ward, where everyone thinks they can put all of those industries.

Ms. LAVIGNE. I do not think that should be. I think we have the right to breathe clean air and drink clean water. I do not think that we should be a sacrifice.

Senator MARKEY. Beyond the dollars, the human costs, the health care costs, can you just expand on that a little?

Ms. LAVIGNE. Yes. I think industry should pay for my illnesses. They made me sick.

Senator MARKEY. Thank you.

Ms. LAVIGNE. You are welcome.

Senator MARKEY. Do you agree with that, Ms. Jackson?

Ms. JACKSON. I think that I feel sorry for the illnesses that she is suffering. At the same time, I know that there are, some studies agree and some studies do not agree. I feel sorry and I hope that she feels better. That is all I can say. There are lots of studies out there, some say there is a direct correlation; some do not. I think we do not know enough information to be able to tell.

Senator MARKEY. At least from my perspective, I think there is a pretty clear correlation that has been established. I know up in Woburn, Massachusetts, when I was a young Congressman, this mother came to me with her little boy, Jimmy. He had leukemia. What she had done was then go door to door to door in her ward and she found another five children with leukemia, all within three or four blocks.

I helped to bring in the EPA to do the big study. It eventually became a movie called A Civil Action, that kind of spotlighted this Woburn case. All those children died. We were able to come in there and just make sure we cleaned up that site. They were dumping all of those chemicals, Monsanto and others, into the ground and into the water. Young children were being exposed to it.

Senator MERKLEY. Senator Markey, can you stay for another 5-minute session?

Senator MARKEY. Yes, I am sorry. I am sorry to run over.

Thank you all so much for your courage in standing up. We just have to do something about this. This is a crisis in our Country.

Thank you, Mr. Chairman.

Senator MERKLEY. Thank you.

Senator Mullin?

Senator MULLIN. I just want to followup with Ms. Bradford. You stated you are against single-use plastics. What specific are you pointing at for single use? What products are you talking about?

Ms. BRADFORD. Definitely straws, definitely plastic bottles. I will not say anything else because I can not think of anything else right now.

Senator MULLIN. Are you for recycling, and advanced recycling?

Ms. BRADFORD. No, because it does not work and it does not happen.

Senator MULLIN. Well, then, in your case and everything is single use at that point. If you are not for recycling, then you can not say you are against single-use and you are OK with everything else.

Ms. BRADFORD. I am for facts, and I think only 9 percent worldwide are actually recycled.

Senator MULLIN. That is why I say that we should focus more on recycling. If you can tell me you are for recycling, then maybe we can work to something. A while ago you did say you were for, you were not against all of it, because you have to be realistic. You are against single use, because that is what the Chairman asked you.

If you are for, or against single use, then you must be for recycling.

Ms. BRADFORD. No. It does not work.

Senator MULLIN. Well, then, that does not make any sense at all. You can not exist without plastic today. We have already pointed that out.

I do not know what the alternative is. We talk about this all the time. It is like Ms. Lavigne mentioned that glass is an alternative. If you remember, sir, at our last hearing we had on plastic, for the record I submitted the McKinsey and Company study that showed that actually plastic has a less carbon footprint than glass.

Where are we moving toward? What is it that we want to look to? If we are still for the middle class, we got to have manufacturing. We pointed that out, that we can not do without it. We are against it, but yet everybody here is using it. I just see a lot of people having a thought process because it sounds good, but no one is actually living by what you believe.

Ms. BRADFORD. I do not have any single-use plastics in my house.

Senator MULLIN. Do you know that for a fact?

Ms. BRADFORD. I know that for a fact. I go——

Senator MULLIN. What do you not have? What products? You just mentioned water bottles.

Ms. BRADFORD. I do not have water bottles like that in my house.

Senator MULLIN. Most of these water bottles actually recycle, including the one that I am having.

Ms. BRADFORD. I do participate in recycling, I just know that it does not work internationally. It is not adding up.

Senator MULLIN. Well, I would suggest you maybe doing your homework a little bit more when you come up here and you start talking about this stuff that you actually understand what it is the impact that you are talking about.

Ms. BRADFORD. I do my homework. I do understand the impact. I know I am wasting my time recycling because most of it is not recycled. That is because of the industry and the fact that plastic is in everything is because the industry forced us to have it.

Senator MULLIN. Well, then quit using plastics.

Ms. BRADFORD. The industry is just not making that possible.

Senator MULLIN. Well, if you feel that way, then quit——

Ms. BRADFORD. I do. I just told you, I do not have single-use plastic bottles in my house. I do what I can.

Senator MULLIN. Hold on a second. You are against all plastic but you have plastic all around you. If you are against plastic, then do not use it. Live by what you are saying. There is a lot of people around here that I disagree with, but if you would live it——

Ms. BRADFORD. I do live it.

Senator MULLIN [continuing]. I respect it—ma'am, you do not, because you have plastic on your face, you have plastic on the water bottle, you have——

Ms. BRADFORD. I do not own companies to create these things. I cannot make these things. Until they are available, we are stuck with some things. I do what I can.

Senator MULLIN. Do you believe in, do you believe that we should have solar systems, or not solar systems, but we should have solar panels on our house?

Ms. BRADFORD. I am here to talk about what is on the agenda.

Senator MULLIN. I mean, they are.

Ms. BRADFORD. They are also not single use.

Senator MULLIN. Neither is this bottle. Let's go to Mr. Sunday. In your opening statement, you mentioned Shell Gas was a big reason why United States have led the world in CO2 reduction, because the energy and natural gas liquids in their manufacturing is less emission intense than overseas manufacturing, especially compared to countries like China, is that correct?

Mr. SUNDAY. Yes, sir.

Senator MULLIN. Can you explain a little bit more about that?'

Mr. SUNDAY. Yes. As I mentioned, the Clean Air Task Force looked at the methane intensities and Shell Gas in Appalachia has the lowest leakage of any basin in the world. The increased use of natural gas produced in that region, including Pennsylvania, has been estimated to be about 60 percent of the reason why we led the world in reducing emissions as a Country since 2005.

Big picture, the issue is how do you reduce emissions, keep costs down and be reliable. That is the long-term challenge. The short-term challenge is every country out there that is relying on Russian oil and gas, we should be doing everything we can to get our energy over there because it is also going to be used more sustainably.

I can guarantee you, and you can see the Boston Globe feature from a couple years ago when an LNG tanker came into Boston, when we got Shell Gas in northeast Pennsylvania, the most prolific in the world. I definitely want the producer standards in my standards versus Putin's regime. We saw what that led to.

Senator MULLIN. You know what the difference between the two standards are?

Mr. SUNDAY. It is an order of magnitude. I mean, it is so much so that even if you count for transportation across a tanker, Shell Gas in the U.S. shipped across the seas is more sustainable than pipe coming in from Russia.

Senator MULLIN. They're not using electricity in the ships to bring them here? Or they have combustible motors in them?

Mr. SUNDAY. Right.

Senator MULLIN. That is what I was thinking. Trucks to get them from Point A to Point B, since we can not build pipelines in the east coast right now.

Mr. SUNDAY. Right.

Senator MULLIN. With that, sir, I yield back.

Senator MERKLEY. Thank you very much.

The Chair of the committee has arrived, Senator Carper.

Senator CARPER. Thank you, Mr. Chairman.

Before I start today, I want to thank all of you for joining us. I want to thank our witnesses for coming and speaking with us, sharing some ideas with us, responding to our questions.

People sometimes ask me, what is environmental justice all about anyway? I just met with a bunch of students earlier today from all over Delaware, Future Farmers of America. One of the things we talked about was, believe it or not, Matthew 25. Matthew 25 goes something like this, when I was hungry, did you feed me, when I was thirsty, did you give me to drink, when I was naked, did you cloth me, when I was sick and in prison, did you visit me, when I was a stranger in your land, did you welcome me.

I think we have a moral obligation to the least of these in our society. I think what environmental justice is all about is just how do we meet that moral obligation to treat other people the way we want to be treated. It is just that simple, the Golden Rule, treat other people the way we want to be treated.

It is an issue that it turns out environmental justice invokes quite a bit of passion, as evidenced by the hearing in this room today. We meet in this room, not every day of the week, but throughout the week, throughout the year. There are oftentimes great passions that are vented in this room, as you might imagine.

Environmental justice is also an issue that invokes strong emotions that come from the experiences that we have lived in our lives and have felt the impact, in some cases, of disparate government policies.

I thank our chairman, Chairman Merkley, I want to thank our Ranking Member, Senator Mullin, for inviting you to convene here to give you a chance to share your thoughts with us and to give us a chance to ask some questions of you. I believe that it is incredibly important to create productive space, if you will, for having an important discussion like the one here today.

I will close by saying, I will ask a question, we need to treat each other with kindness. We need to treat one another the way we wanted to be treated. That is what I try to do, as Chairman of this committee. I am sure that is the way Senator Merkley has chaired this committee hearing today.

A couple of questions, if I may. Going down the list first of all, Sharon, you go first. Where are you from?

Ms. LAVIGNE. I am from St. James, Louisiana.

Senator CARPER. Welcome.

Ms. LAVIGNE. Thank you.

Ms. BRADFORD. I'm Angelle Bradford, I split my time between Baton Rouge and New Orleans.

Senator CARPER. Yes, please.

Mx. TANDAZO. I am originally Ecuadorian, but currently living in Jersey City, New Jersey.

Senator CARPER. OK.

Ms. JACKSON. I am from Maryland, Kensington.

Senator CARPER. OK, a neighbor.

Ms. JACKSON. Not originally from here. San Diego, Nashville, several places around the Country.

Senator CARPER. I like the way you say Nashville.

Please?

Mr. SUNDAY. Harrisburg, Pennsylvania.

Senator CARPER. All right. Good to see you.

In April of this year, our President issued an Executive Order on environmental justice that directs Federal agencies to take steps to address cumulative impacts on environmental justice communities. That includes meaningful public participation in agency decision-making. I always have been a strong supporter of engaging with the communities early and often.

We had a great hearing here on permitting reform just a couple of weeks ago. Interestingly, the business community was the one that was most strong, the strongest on the idea that as we move forward with permitting reform, we have to reach out to communities that are at risk and follow through early on, get their opinion early on. I was very encouraged by that.

Here is my question. What would meaningful engagement look like for each of the communities you have worked with? What would meaningful engagement look like for each of the communities that you have worked with? How would you like to see agencies update their procedures in accordance with the Executive Order to foster more meaningful discussions with communities?

Ms. Bradford, would you answer that first, please? What does meaningful engagement look like for each of the communities you have worked with?

Ms. BRADFORD. Meaningful engagement, I think first things first, would be transparency. I do not want to say education, because we are not dumb in Louisiana, we understand a lot when it comes to environmental policies that exist. There are so many different agencies involved, it would be really helpful if at the Federal level there was more engagement in New Orleans and Baton Rouge and in between, all along the Gulf Coast, as it pertains to the different commenting periods and procedures for decisions around permits for these plants and for plastics in particular.

Senator CARPER. OK.

Ms. BRADFORD. I think another meaningful thing would be, and I often hear the pushback around, well, you can not prove this, Exxon pollution led to this, and just really starting from a place of understanding that our Country does not have a lot of things that other countries do. A lot of these studies do admit, being low-income, in poverty, does impact these things. Not having universal health care and access to health care that is not connected to your job, but also pollution. All of this comes together to lead to the outcomes that we see. We know that. We are not trying to say, and we need to make sure the communities understand that their voice still matters, that we can not silence them by saying, oh, you can not prove this was because of this, therefore what you are saying is not true.

Senator CARPER. Thank you, ma'am.

Sharon, how do you pronounce your last name?

Ms. LAVIGNE. Lavigne.

Senator CARPER. Lavigne, thank you. Same question, if you would. What would meaningful engagement look like for each of the communities that you have worked with, please?

Ms. LAVIGNE. I do not understand the question.

Senator CARPER. Let me go on, Chris, same question if you will. We will come back to you, Sharon. Chris, any thoughts?

Mx. TANDAZO. Yes, definitely. I think I would like to mention the Environmental Justice law again, because the Environmental Justice law actually has meaningful engagement. The Environmental Justice law in New Jersey actually has meaningful engagement as part of the policy.

The way it happens is when a facility wants to site a new, create a new industry in our community, they have to go through a process through the DEP. The DEP then analyzes whether this facility is going to have any sort of additional polluting, contributing more toxic pollutants to the community. Then it calls for a public hearing. The public hearing involves community members. The DEP is responsible, not the community, the DEP is responsible for holding community hearings in which they invite the facility that has the air permits, and they invite the community.

The community then hears the permits and they decide, this is what we want, or we do not want this. If we want it, we want it with certain, we want it to be healthy in certain ways. Then the DEP goes into it, analyzes that. Then the facility has to do an environmental justice report back to the DEP to make sure they are not actually adding any pollutants.

If they pass then they get approval for their permit. If they do not pass, the air permits get denied. Then they do not get constructed.

This is how the EJ law has made sure the community is 100 percent involved in the entire process of what facilities are going to go into our communities.

Senator CARPER. Thank you very much.

Sharon, we are going to come back to you, and I am going to pronounce your name correctly. Here is a new question. Through your testimony, you shared with us the impact that decades of pollution have had on your community. Is it St. James Parish?

Ms. LAVIGNE. Yes.

Senator CARPER. St. James Parish in Louisiana. Including the disparate health outcomes for communities of color. IN order to support the Louisiana Department of Environmental Quality in addressing these disparities, the EPA recently announced a grant to the State agency funded through the American Rescue Plan and the Inflation Reduction Act that would set up an air monitoring project in St. James Parish, your parish.

What kind of impact will this EPA grant have on you and on your community in St. James Parish? Additionally, are there other actions or engagement efforts from EPA that have been effective in helping your community in St. James Parish?

Ms. LAVIGNE. In my community in St. James Parish, the people do not have a voice. The politicians make the decisions. They do not follow protocol. We get the bulk of the impact of industry and the pollution.

If the people had a say-so in what is going on in our community, I do not think any of this would be happening to us. In Congress, we need to involve the people in making these decisions, the people that live in those communities that are impacted.

If you want to see what is going on, Congress, you need to come to the local communities and see what is going on for themselves before they make these decisions. It is killing the people. I think we should have people's lives protected instead of industry being protected. That is what is happening in St. James.

Senator CARPER. All right.

Mr. Chairman, my time has expired. You have been very generous with it, and I appreciate it.

Senator MERKLEY. Thank you very much, Mr. Chairman.

We are going to go to Senator Markey, and we can come back to you if you would like to ask more questions.

Senator CARPER. Go ahead, Eddie.

Senator MARKEY. Thank you, Mr. Chairman.

When Ms. Lavigne says that you are 50 times more likely to get cancer in Cancer Alley, that is a correlation. That is twice as much, 50 times as likely to get cancer if you are living in those areas.

Ms. LAVIGNE. Yes.

Senator MARKEY. Renewable energy is displacing fossil fuel energy in Texas and Louisiana and States all across the Country. The fossil fuel industry is actually looking for a new market for their product, and it is plastics that they are looking at, where they will use their fossil fuels. When we see an increase in plastic production, it does not benefit the communities. It actually benefits the oil and gas companies.

Ms. LAVIGNE. That is right.

Senator MARKEY. The bottom line is that we have a plastic bottle right here, they could use another substance to make the bottle. They used plastics. You really can not do a lot about it. You have plastic in your house, you have plastics right here on the dais. We do not get options. That is the problem.

In the same way that the auto industry didn't want to build in seat belts. Are you not going to drive? No, you have to drive to work. The auto industry didn't want to put in air bags. Are you not going to drive to work or to school? No, you have to drive. You want the safeguards, but the auto industry didn't want to put it in.

It took regulations in order to make sure that we would have those safeguards in place. By the way, the mining industry, they didn't want to put in safeguards for the workers. Black lung disease, you just have to run the risk. No protections.

We can see the whole trend here in terms of how these sacrifice zones are created here by those plants. Can you just expand a little bit more, Ms. Bradford, on your experience on this issues?

Ms. BRADFORD. Expand on——

Senator MARKEY. On the toxicology-related studies that do show the correlation to disease, when a human body is exposed to these toxic substances.

Ms. BRADFORD. Yes. There was a paper published late last year by Dr. Terrell and Dr. St. Julien around air pollution being linked to higher cancer rates among Black or impoverished communities in Louisiana. They concluded that regardless, our analysis, I will provide context. Just like I said before, they did speak to the fact that low-income communities, low-income Black communities in particular do not have access to health care and preventive care for sure.

In addition to that, they were able to provide evidence of a statewide link between cancer rates and a carcinogenic air pollution in marginalized communities, and suggest that toxic air pollution is a contributing factor to Louisiana's cancer burden.

The last time I checked, Louisiana's cancer burden, I believe we were second in the Nation and fifth for mortality, just for various reasons for those differences. Then I was trying to look up studies for Baton Rouge, with their major petrochemical complex, with Exxon and Formosa Plastics in Baton Rouge.

The studies are coming out more. It is hard to get the point source.

Senator MARKEY. Thank you. I agree with you 100 percent.

Mx. Tandazo, I have 1 minute left. Can I get your concluding thoughts?

Mx. TANDAZO. I will followup on this as well. Yes, I do think that we have a lot of, it is not just like one facility that we are being exposed to. It is not just one fossil fuel plant. It is several fossil fuel plants in one neighborhood. It would be different if we were like, there is one facility miles away from a neighborhood. This is literally sited right next to people's houses.

I think we often tend to forget how much people lack health care, to be able to take care of themselves. A lot of these communities have socioeconomic challenges and lack access to a lot of these resources that, if you actually had universal health care there probably wouldn't be as much death happening because folks would be able to go to the doctor and check themselves and be like, hey, something is happening. I am not feeling well. A lot of the people in our communities do not have that.

Senator MARKEY. This is such an important hearing. Thank you, Mr. Chairman, for bringing this great group together. We have to learn from them and then act. Thank you, Mr. Chairman.

Senator MERKLEY. Thank you very much, Senator Markey.

We are getting close to wrapping up, but I wanted to mention a couple of things. I like the analogy that my colleagues represented about cars. Cars are essential. When they were without seat belts or airbags or bumpers or crush zones, a lot more people died. In this case, we are trying to figure out how the pollution can really be limited, how the bad effects can be limited.

I was kind of struck by the conversation about water bottles. We have three examples up here. We have a glass, so it can be used a million times. We actually have a pitcher, and this pitcher is not glass. I am not sure about the one on your table there. They look like maybe those are glass, this is not. Both of them are reusable thousands of times.

Then my colleague had a plastic water bottle. It is designed for single use. Some States have deposits on those bottles. Oregon was the first to have a returnable deposit, and it massively decreased the pollution. At that time it was all glass, but it was often shattered, broken glass. As a kid, I was a Boy Scout, we were out picking up glass shards all the time.

When we did in Oregon the first return bill in the Nation, which was 5 cents, which would be equivalent to a quarter today, they just disappeared completely. If somebody else left one, you picked it up yourself. For the equivalent of 25 cents today, you didn't waste it.

Then we had another problem, which was the flip top on aluminum cans. Those little flip tops were sharp and they were being digested by animals and stepped on and feet were cut. Oregon said, you can not have detachable flip tops. The industry was like, that is crazy, it is impossible to solve. The day that went into effect, all the cans in Oregon had an attachable flip top. It was a solvable problem.

There are solvable problems in the plastic pollutions that we are suffering from, and that is what we are working to solve. There is a difference between a glass that we can use a million times, a plastic or glass pitcher, and using instead over the course of time, thousands of water bottles. Those water bottles, in the States that do not have a deposit on their water bottles, the recycling rate is often under 20 percent. The States that have a deposit, the rates are almost always over 60 percent.

Oregon increased its return from 5 cents to 10 cents, and we saw a jump. Five cents is not what it was back in the 1970's.

I want to conclude, I know we didn't get to the question, but a vote is underway and I guess I am one of the last to vote. I have a little bit of time, OK.

I think to the degree that we can recognize that plastics are going to be with us in many capacities, but we can seriously reduce the pollution that comes from the production, we can seriously decrease the roadside pollution that comes from plastic waste, we cannot site any more facilities in places where they are going to harm the surrounding communities. We can have better regulations on emissions and better, if you will, monitoring of those regulations.

Which brings me to my question. You mentioned in your testimony that these incinerators kept operating but they had like 1,400, I think it was since 2004, air violations. There is a standard, but when you were talking about 1,400 times it was documented, who knows how many thousands of times it wasn't documented.

Mx. TANDAZO. Right.

Senator MERKLEY. They just ignored them. It was just a cost of doing business, well, if we get fined, it does not really matter. The first time you get fined, it is like, well, shall we fix this problem? If you are getting cited over 1,000 times, it is clear you are just ignoring it.

Why did it not work? Why were they not brought into compliance with the emission regulations?

Mx. TANDAZO. It is just a lack of oversight or a lack of authority to have oversight from the DEP. It was just a lack of oversight that they didn't have before, and now they do because of the EJ law.

Senator MERKLEY. You mentioned that these plants are receiving, I thought you said $60 million of subsidies, recycling subsidies or renewable energy subsidies.

Mx. TANDAZO. Yes.

Senator MERKLEY. They are burning plastic, emitting toxic chemicals that harm the surrounding community, and getting money from the State?

Mx. TANDAZO. Yes, basically. This is because, again, I mentioned earlier the schemes of false solutions and different names and terminologies that these industries use, such as alternative recycling that was mentioned here today a couple of times. That is the same as chemical recycling. The incinerator industry uses waste-to-energy to label themselves, or municipal solid waste.

They label themselves this way, at the Federal level they have been recognized as a renewable energy resource. They are recognized at the Federal level under the renewable portfolio standards program, they receive Federal funding, Federal subsidies for renewable energy credits.

Basically, they lied about what operations they do in order to make it seem like they are actually green energy. The claim is that they are a renewable energy resource because they are able to generate energy from burning trash, which would then mean that the sources and resources they need in order to constantly generate electricity over the decades is trash.

It means they are dependent on trash. There is no incentive here to reduce the amount of trash or plastic pollution that goes into anywhere. They need this incentive. They are not trying to stop the production of plastic.

When we have policies like a set of bills on responsibilities that can hold them accountable and reduce the amounts of plastic, then they are going to have to be held accountable. We are actively working to get the incinerators removed from the removable portfolio standard, from the Federal program.

That is just $60 million for the New Jersey incinerators. We have also been paying out of State incinerators. Overall, it is like $160 million that we have paid from 2002 to 2024. I can give you the report on that.

On top of that, the amount of energy they produce is like 1 percent of energy. That is not renewable.

Senator MERKLEY. I recall when I was a kid and camping, someone said, whatever you do, do not throw any plastic into the campfire, because the fumes are toxic. Everybody knows the fumes from plastic are toxic. Yet here we are incinerating it and putting those toxic fumes out into the surrounding community where they are producing much higher cancer and disease rates. Also when the plastic is being made.

Ms. Lavigne, you mentioned, or the conversation came up about sacrifice zones. The idea that hey, we have low-income communities, they can not fight something effectively, so we will just put this toxic, polluting plant squat in the middle of them, and maybe they will get a few jobs. You have fought that successfully.

To what do you attribute your success?

Ms. LAVIGNE. I spoke to the Good Lord. The politicians do not help us, the Governor does not help us. Industry is poisoning us. I had to go to God to ask God what to do about the problems in my community, when I saw all these funerals I was going to and didn't know why.

I also wanted to say, when I was a little girl, we didn't have this problem. We didn't have pollution. We were never, ever sick. My parents, my grandparents, we lived off the land, we weren't sick.

There must be some type of solution that we can come to, come to the middle and figure out what we are going to do. We do not have to go through everything cold duck with plastic. We should gradually come to some conclusion where we can live and breathe clean air and drink clean water.

Senator MERKLEY. These zones where there is extensive emissions that are making people sick and killing them, so-called sacrifice zones, Mr. Sunday, would you like your family to live in a sacrifice zone?

Mr. SUNDAY. I want any facility to operate under the environmental conditions that have been done, enacted by a majority of the legislature, and then a rulemaking process that affords public comment, and then rigorously enforced.

Senator MERKLEY. Just to be clear, if you were aware that your child is moving to a new location and their proposed location is right next to a plant in which there are extremely high cancer rates and other disease caused from those emissions, you would say, that is just fine?

Mr. SUNDAY. This is the other part of public engagement. It is not just the voice of the communities where the facility is going to be, the discussion from the regulators about what the strict standards are going to be enforced at the facility. Armed with that knowledge, folks can make their decisions.

Senator MERKLEY. Yes, but what would your decision be?

Mr. SUNDAY. I think that people need to have economic mobility and make the decisions for themselves and be involved in the public process.

Senator MERKLEY. Well, my answer would be very different. I have two children who are just now starting out on their careers. They may well be moving a lot. If they were moving to a location next to a plant that had high cancer rates and emissions, I would say, do you really want to live there? You can not undo the damage that comes.

I think most every parent in the world would say the same thing. I realize you are here representing a point of view and you didn't want to really answer the question. I suspect you wouldn't want your children in that situation next to a toxic, death-creating production facility either.

Let's keep working toward understanding that we have to have conversations about the effects. We can not ignore them. There are very real health and pollution impacts on humans, on communities, on our ecosystems. Then let's figure out how to diminish the problem.

It isn't as simple as it was with no flip tops on cans. That was an easy fix. Industry fought that like crazy, absolutely cannot figure out how to do it. They had the solution instantly, as soon as they were required to do so.

I think if we create enough conversation about the need for change, then industry will help us work together to come up with solutions.

I want to thank you all for bringing your knowledge and your real experience to bear. This is an incredibly important conversation about one of the least understood yet most significant toxic challenges in America.

With that, the hearing record will remain open through the close of business on Thursday, June 29th. We will send questions out to our witnesses. We would appreciate a reply by Thursday, July 13th.

With that, the hearing is adjourned. Thank you.

[Whereupon, at 11:56 a.m., the hearing was adjourned.]

○