How to Do an Environmental Assessment in Your City

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ABSTRACT

Every city should have an environmental audit by neighborhood to expose the inequalities in air, water, and soil pollution. The people most affected are those living near industrial pollution, often in low-income and minority neighborhoods. They experience shortened lifespans, lower educational proficiency scores, abandoned housing, reduced housing equity, and higher rates of crime. City leaders must deal with what Albert Gore calls “inconvenient facts” when city audits bring attention to problems that need to be addressed. Reducing the toxic pollution emitted by local industries is one small step in recognizing the problem of chemical toxins as one of the biggest issues facing low income/minority neighborhoods. Environmental assessments are key to the concept of sustainable development and provide a basis for mitigation activities. This article reviews the origins of the environmental justice movement and advocates for the need to perform urban environmental audits. By assessing numerous sites in Louisville, Kentucky and identifying their key sources of pollution, it elaborates on the core energy, heath, and safety issues found in industrial manufacturing settings.

INTRODUCTION

Environmental justice has been defined as the pursuit of equal justice and equal protection under the law for all environmental statutes and regulations without discrimination based on race, ethnicity, and/or socioeconomic status [1-6]. This concept applies to governmental actions at all levels—local, state, and federal—as well as private industry activities. Lower-income communities and minority populations have historically been the targets of many sources of pollution: air pollution from industrial sites, toxic contamination from incinerators and brownfields, contamination of ground and source water, and lead exposure.

Origins of the Environmental Justice Movement

While the modern environmental movement began in 1962 with Rachel Carosn's *Silent Spring*, the environmental justice movement emerged 20 years later when when North Carolina conducted a study to identify a site for a hazardous waste landfill which contained concentrations of polychlorinated biphenyls (PCBs) [4]. The place selected was in Warren County, a poor and predominantly black community in the southern portion of the state. National studies of toxic waste vs. race found that race was a factor in siting hazardous waste facilities. They found that 60% of African Americans and Hispanics (15 million people) live in community housing near abandoned or unregulated toxic waste sites. Race was determined to be the most potent variable in predicting

where these facilities were located—a stronger indicator than poverty, land values, and home ownership [1,7,8]. The study found that:

- three out of five African Americans live in communities with abandoned toxic waste sites;
- three of the five largest commercial hazardous waste landfills are in predominately African American or Latino communities and they account for 40% of the nation's total estimated landfill capacity; and
- African Americans are heavily overrepresented in the population of cities with the largest number of abandoned toxic waste sites. Others point to New York states, Love Canal chemical dump in 1970 which caused hundreds to suffer serious illnesses and over 800 people to lose their homes.

In 1994, President Clinton signed EO 12898 requiring federal agencies make environmental justice part of their mission [9]. Understanding environmental justice issues requires an understanding of the history of how a site or area evolved to the point that public health risks increased to unacceptable levels, while the local environment deteriorated. To address environmental justice issues, the public must have an awareness of the causes and effects of the public health and environmental issues. The University of Louisville's (UofL's) Kentucky Institute for the Environment and Sustainable Development and Center for Sustainable Urban Neighborhoods prepared the following summary to explain environmental justice issues in Louisville. This document is used as a reference for tours conducted by the Institute for university classes, public interest groups, and government officials.

Environmental Issues in Louisville

Louisville, Kentucky is located on the Ohio River which floods periodically [10]. The most damaging flood on record occurred in January 1937. About 75% of the city was under water (150 square miles) and 230,000 people were forced from their homes. Ninety people died, with $54.3 million in financial losses attributed to the flood. The Ohio River crested at a record 57.2 feet (27.2 feet above flood stage) after record rains of 19.2 inches during the month. After this flood, the U.S. Army Corps of Engineers was authorized to construct a levee to protect Louisville which was completed in 1957. The flood protection works are now 29 miles long. To minimize the amount of land taken by the levee, a floodwall was constructed to protect the downtown area. This concrete floodwall has water-tight gates that are normally open to allow traffic to travel to the river; they are closed during flood events. There are 52 street openings in the floodwall and over 150 valves and gates which must be closed when the Ohio River goes into flood stage. When these openings are closed, the city relies on a system of 16 flood-pumping stations to pump rainwater falling inside the levee system up and over the levees into the river.

Buildings constructed between the river and levee must be resistant to periodic flooding. Recent floods in the Mississippi River and other rivers around the U.S. have demonstrated that levees do not guarantee protection from flood damage. Levee failures or flood heights that overtop levees can result in substantial monetary damage and loss of life. The current approach to flood protection focuses more on preventing the construction of homes and buildings in the floodplain.

POLLUTION ASSESSMENTS

Liquor Distilleries

Louisville has long been associated with bourbon. For over 200 years, distilleries have been a key economic driver. At one time, over 30 distilleries were located on Main Street. Today, 98% of the world's bourbon is produced in Kentucky and the city serves as a hub to the Bourbon Trail. This trail links 18 distilleries and attracted 1.2 million visitors in 2022. There are about a dozen distilleries in Louisville (see Figure 1), but there is a new trend to build micro-distilleries. This concentration of distilleries has local financial and possibly health consequences.

Bourbon is produced through a process that includes: 1) grinding grains (>51% corn and wheat, barley, and rye); 2) distilling the fermented mixture to create alcohol vapors which are condensed by cooling into a liquid; 3) maturing the liquid (alcohol content of 125 proof) for up to 20 years in new, charred oak barrels; and 4) bottling the beverage. It is in the maturing process that some of the alcohol vapors escape from the oak barrels. On average 2-4% of the liquid is lost each year through evaporation. The exact amount varies by the size of the oak barrels used, the climate, and the location of the barrel in the storage warehouse. The alcohol released into the atmosphere is known as the "angel's share" [11]. This airborne alcohol (ethanol) accelerates the growth and stimulates spore germination of a sac fungus named Baudoinia compniacensis. This fungus has been observed on a variety of substrates in the vicinity of distilleries, spirits maturation facilities, bonded warehouses, and bakeries. The fungus is a habitat colonist with a preference for airborne alcohol, earning it the nickname whiskey fungu**s.**

Baudoinia species can withstand high temperatures, allowing it to colonize roof habitats. The fungus is black in color and physically resembles a thick (up to 0.6 inches) crust. It can form on a wide range of substrates including trees, concrete, polyvinyl chloride (PVC), masonry, steel, stone, galvanized and shingle roofing, and outdoor furniture. It has been reported worldwide in areas adjacent to distilleries. A definitive study was conducted in 2007; the warehouse staining fungus was rediscovered during a survey commissioned by a Canadian distiller of fungal colonists on outdoor surfaces near spirit maturing warehouses.

The impact of the fungus on vegetation and public health remains unclear. Conflicting evidence on its impact on vegetation has been reported. Studies on the impacts of Baudoinia compniacensis on public health are nonexistent. There are no peer reviewed articles on the health impacts of this fungus. Nevertheless, Indiana public health officials recommend that removal of the black fungus requires an N95 mask, goggles, and gloves. Airborne ethanol has chronic non-cancer health effects at concentrations of 2,200 $\mu g/m^3$ or higher, as determined by the American Conference of Governmental Industrial Hygienists).

The impact on buildings and other structures is predominantly a cosmetic problem and does not seem to impact building integrity. Unlike other funguses which feed on the decay of building materials, Baudoinia compniacensis' mode of nutrition is derived from the atmosphere. The fungus anchors itself firmly to surfaces, making it difficult to remove. Power washing buildings with fungicide or disinfectant costs up to $1,000 for a residence, and the fungus may quickly reappear [11]. Property owners of homes adversely impacted by the fungus are subject to fines from aggressive local code enforcement (the city government views the fines as a source of revenue) or neighborhood associations. Throughout West Louisville you can see the damage of black fungus scarring buildings and lower property valuations, many of which are eventually abandoned. Mixed with black fungus and other pollutants, 5,000 housing units have been abandoned (see Figures 2 and 3) [11].

Distillers have argued that it would be too costly to control emissions of the ethanol that causes the fungal growth and mitigation could adversely affect the flavor of their products. In California,

legislation mandates that its wine and liquor industry use a machinery process to remove the airborne emissions that enable the create black mold to proliferate. This process has been used successfully in California for years and it has not affected the quality of wine, which is among the world's best.

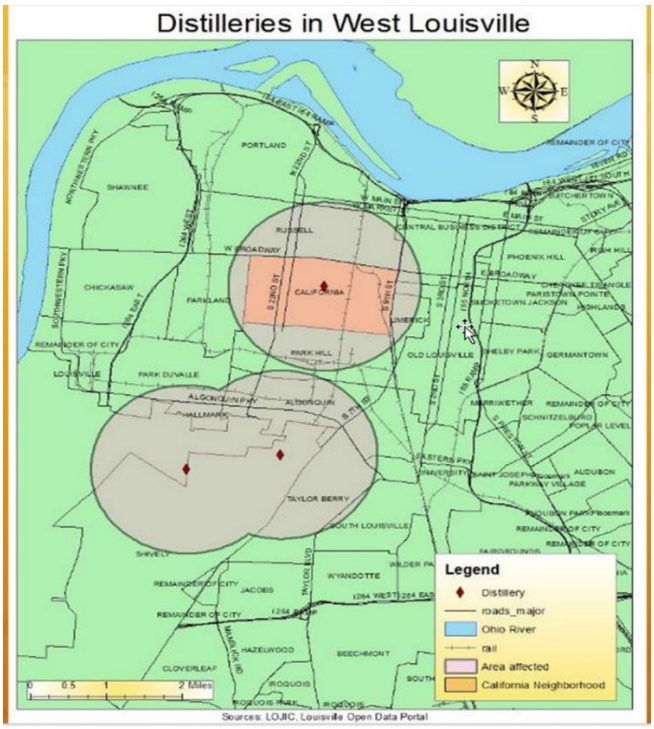

Figure 1. Location of distilleries (source: LOJIC, Louisville Open Data Portal).

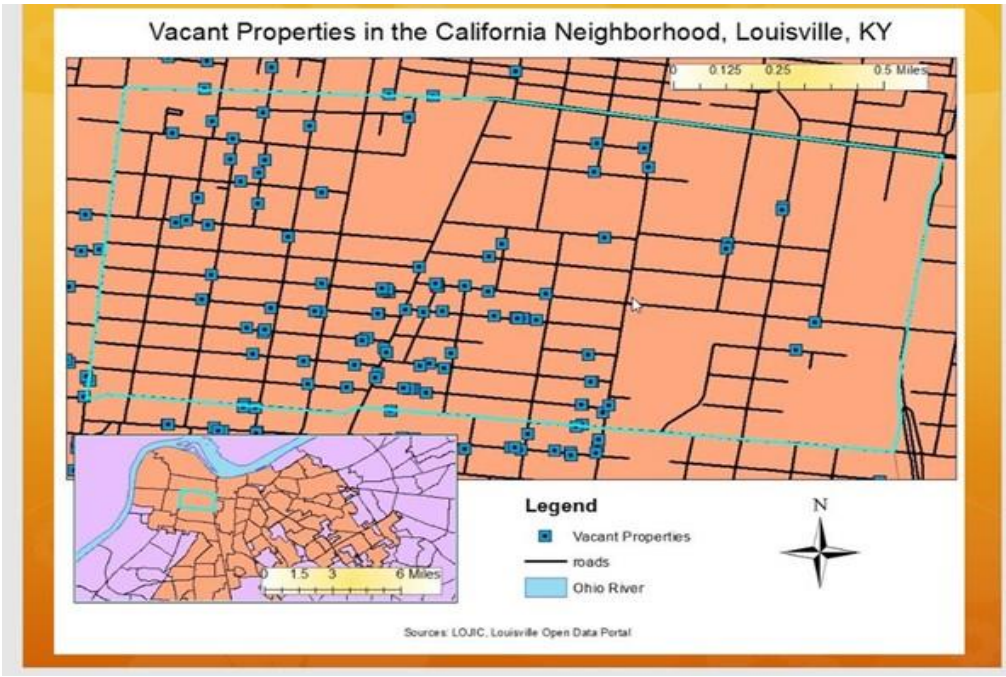

Figure 2. Locations of vacant properties (source: LOJIC, Louisville Open Data Portal).

Figure 3. Frame shotgun residence ruined by unregulated liquor distilleries (source: J. Gilderbloom).

Gallagher Power Plant

The Gallagher Station, located in Floyd County, Indiana, was initially a two-unit coal-fired generating facility operated by Duke Power Company. The plant's four 140 MW units came online between 1958-1961. The total aggregate capacity of the plant's four identical units was 560 MW. The plant remained online despite lacking a scrubber system to reduce air emissions. A baghouse was added in 2008. The prevailing winds are from the southwest, blowing most of the air pollutants from the plant into Kentucky. The plant is ranked the 62nd highest emitter of sulfur dioxide (SO_2) in the U.S. with almost 50,000 tons per year in emissions. New plants are permitted to release 1.2 pounds of SO_2 per million Btus. Gallagher's emission rate is 3.22 pounds per million Btus. The plant releases approximately 7,000 tons of nitrogen oxides (NOx). The Jefferson County Air Pollution Control District estimates that 8-9% of the NOx (a precursor to ozone) in the Louisville metropolitan area are attributable to the plant. New plants are permitted to release 0.15 pounds per million Btus; Gallagher releases 0.44 pounds. In March 2000, Gallagher was one of 28 plants in the Midwest cited for violations of the Clean Air Act for making improvements without installing required air pollution-control equipment.

The Gallager plant was retired from service in June 2021. Although closed, Duke Energy projects that final closure (removing structures and closing coal ash piles) will not be completed until 2050. The plant is across the Ohio River from Louisville's Shawnee Park, one of city's original parks designed by F.L. Olmsted.

Abundant experimental and epidemiological data show that air toxics from coal-fired facilities, including aldehydes, butadiene, vinyl chloride, and fine particles, have pronounced effects on cardiovascular function and disease. Kentucky's 2021 death rate from cardiovascular disease was the 8th highest in the nation at 217.5 deaths per 100,000. Cardiovascular diseases affect a large proportion of the human population; consequently, a small increase in risk could translate into a larger number of deaths than are caused by other diseases such as cancer or asthma. The susceptibility of the heart and the cardiovascular tissue to environmental pollutants is underscored by the spate of recent studies showing an association between air particulates and cardiovascular

deaths. Although the mechanisms by which particulates affect heart disease are not entirely known, it is likely that long-term mutagenic changes, which are key steps in carcinogenesis, are also relevant to the development and progression of cardiovascular disease. In addition, the pulmonary effects of environmental pollutants could indirectly impair cardiovascular health.

Kentucky appealed to the U.S. EPA in the early 1980's under Section 126 of the Clean Air Act about the interstate pollution allowed by Indiana. The appeal was rejected. In 1999, eight northeastern states complained about interstate pollution from coal-fired power plants in the mid-west that prevented them from complying with national ambient air quality standards. The EPA concurred and has ordered all plants in Indiana and Kentucky to reduce their NOx emissions by 65% by 2003. LG&E, a public utility which serves Louisville and is owned by PPL Corporation, has proposed installing catalytic converters (total cost $700 million) to meet NOx reduction requirements. Cynergy plans to meet these reduction requirements at their Gibson Power Plant (3,000 MW) in Indiana and take no action at Gallagher.

Chickasaw Park Lake

This small pond is used by residents for recreational fishing. The lake covers 1.5 acres (0.6 hectare) and is less than 6 feet in depth. In 1995 the state environmental protection agency tested the fish for dioxins (polychlorinated dibenzo-p-dioxin), a group of chemicals that are some of the most toxic man-made pollutants. Testing showed that the concentrations in some fish exceeded standards. All the fish were removed from the pond in 1996. The source of the dioxins is unknown. The water in the pond is from the public water supply system. Potential sources in the area such as the old Ashland Oil refinery across the road were removed decades ago. Another potential source could be from fish that were caught in the Ohio River by fishermen and released into the pond (a state violation).

Sediment samples showed that low concentrations of dioxin could be detected (124 to 358 ppt, background is 329 ppt). The pond was restocked in the fall of 1997 and the fish retested in 1998. The retested fish also showed levels above the one-in-a-million risk standard adopted by the state. Funds from the American Rescue Plan are being used for the restoration of the lake but some officials doubt the environmental issues will be permanently resolved. The Olmsted Parks Conservancy is coordinating with Louisville Parks and Recreation to install a large "butterfly and bee" pollinator meadow in the park.

Rubbertown

The petrochemical industrialization in west Louisville began in 1918 with the construction of the 2,000 barrel per day Standard Oil of Kentucky Refinery (now the Chevron Terminal and Tank Farm). Over the next two decades, two additional refineries were constructed (Aetna Oil and Louisville Refining) and both were eventually purchased by Ashland Oil.

With the outbreak of World War II, the demand for rubber became the impetus for the development of the complex [12]. The construction of a military airplane used one-half ton of rubber; a tank needed about one ton and a battleship, 75 tons. Each person in the military required 32 pounds of rubber for footwear, clothing, and equipment. Tires were needed for all kinds of vehicles and aircraft. Recognizing the important need for rubber, in June 1940 President Roosevelt formed the Rubber Reserve Company (RRC). The RRC set objectives for stockpiling rubber, conserving the use of rubber in tires by setting speed limits, and collecting scrap rubber for reclamation. Major world sources (90%) of natural rubber in southeast Asia were in Japanese control. The U.S. Office of Production Management eventually built 15 synthetic rubber plants

nationwide using German technology. The government either built the plants or purchased them from their original owners, investing $92.4 million in Louisville. The first plant to be built was National Carbide in 1941 which manufactured acetylene gas. LG&E constructed the Paddy's Run power plant to supply the electrical needs of National Carbide. Although Paddy's Run is now closed, National Carbide is the largest single user of LG&E produced electricity.

Figure 4. Rubbertown next to the Ohio River, including the water, soil, and air (source: Kentucky Institute for the Environment and Sustainable Development).

Acetylene gas was first used as feedstock for the neoprene synthetic rubber plant built by E.I. DuPont de Nemours & Company. The acetylene was piped over to the DuPont plant. DuPont manufactured a vinyl acetylene, which was then chlorinated to produce chloroprene. When polymerized, chloroprene is turned into neoprene which is a type of synthetic rubber.

The B.F. Goodrich plant also began construction in 1941. It produced a synthetic rubber product called Koroseal, which is made from vinyl chloride. Acetylene gas was piped from National Carbide as feedstock for the manufacture of a vinyl chloride monomer. B.F. Goodrich was joined by Phillips Petroleum Corp. and Hycar Chemical Corp. to make various types of "nitrile" rubber from acrylonitrile, butadiene, and styrene.

With the outbreak of war in December 1941, the federal government confiscated the DuPont plant and retained DuPont to manage the facility. The federal government constructed a plant to make butadiene from grain alcohol (the plant is now owned by Dow). Grain alcohol was piped in from nearby distilleries. In 1943, the federal government opened what is now the American Synthetic Rubber plant to make styrene-butadiene rubber for tires. The federal government had selected this type of rubber to be the standard for the Department of Defense; it is the principal type of rubber used in tires today. National Synthetic Rubber, a consortium of five tire companies, managed the plant.

In 1941 there were an estimated 38,000 workers employed in Louisville by defense industries. Housing, schools, hospitals, and public infrastructure were needed as rural Kentuckians moved to Louisville. Other plants in the metropolitan area included Curtis Wright (airplanes), Naval Ordinance (gun mountings), Westinghouse (naval guns), Howard Shipyards in Jeffersonville (L.S.T. crafts), and the Hoosier Ordinance Plant (munitions). By 1944 the number of industrial

employees reached a peak of 80,000. The area around Rubbertown was primarily truck farms in 1940. By the end of the war the area had changed to residential land uses. Peak synthetic rubber production was reached in 1944 with 195,000 tons of rubber produced, employing 4,000 workers, and Rubbertown became the world's largest producer of synthetic rubber (21% of national production of 920,000 tons) [13,14]. After the war, the federally-owned plants were sold back to private operators. DuPont purchased their old plant and land in 1949. American Synthetic Rubber, a consortium of 20 companies purchased the National Synthetic Rubber plant in 1955 [13].

The chief concern from the Rubbertown plants currently focuses on their release of airbourne toxics (see Figure 4). Early public concern resulted in the Rubbertown industries commissioning a survey of the dust problem in west Louisville in 1952. Louisville was studied by the U.S. Public Health Service in 1957-1958 to determine the health impacts from air pollutants. The study showed air releases as high as 22 million pounds per month, much greater than the 5 million pounds annually today. Air toxic monitoring is conducted through a collaborative effort of the Jefferson County Air Pollution Control District, the West Jefferson County Community Task Force, the UofL, Kentucky Division for Air Quality, Rubbertown Industries, and the U.S. EPA. The partners selected monitoring station locations and monitoring was initiated in May 1999. A total of 12 monitoring stations were established to monitor 78 volatile organic compounds (VOCs), 63 semi-volatile organic compounds, 20 metals, and 2 reactive aerosols (hydrogen fluoride and hydrochloric acid). The EPA provided monitors for six of the stations and conducted all the analyses using data collected from these stations. After May 2000, only seven monitoring stations were maintained by the UofL; however, the university no longer performs monitoring services. Twenty-four-hour samples are taken once every 12 days [13].

The data was analyzed by Science International to develop a risk assessment. The assessment showed that for the 250 chemicals analyzed, none were at concentrations high enough to have acute (immediate) health effects. However, all the monitors showed ambient concentrations at levels where cancer risks exceed a probability of 1 in 10,000. For other health impacts the data showed a slightly elevated risk. The chemicals posing potential health risks are listed in Table 1.

Table 1. Chemicals that pose potential health risks (source: Neighborhood Associates, Washington D.C.).

Chemical of concern	*Health effect*	*10^{-6} Risk*
1,3 Butadiene	carcinogen	500
Acrylonitrile	carcinogen	130
Chloroprene	kidney, dermal	110
Chloroform	liver, kidney	77
Chromium	neurotoxin	66
Formaldehyde	carcinogen	46
Perchloroethylene	carcinogen	39
Ethyl acrylate	carcinogen	33
Benzene	carcinogen	32

Carbide Industries

Carbide Industries is a privately owned company which also owns a plant in Calvert City, KY. Originally, the plant had seven electric-arc furnaces and was built for $1 million. It currently

operates one 50 MW furnace. Carbide Industries manufactures three products: calcium carbide, acetylene, and calcium hydroxide. Calcium carbide is used as an alternative energy source, providing improved furnace efficiency, increased furnace productivity, reduced costs, and a lower carbon footprint when used to make steel. They manufacture about two rail cars daily of calcium carbide.

The process of producing acetylene has remained unchanged since 1892: crushed limestone (abundant in central Kentucky) is mixed with petroleum coke (provided from refineries in the Ohio River basin) and heated to 3,800°F (using large electric arc furnaces). This produces calcium carbide ($3C+CaO \rightarrow CaC_2+CO$) which when mixed with water produces acetylene gas. Acetylene gas is used as a feedstock for vinyl chloride, as a fuel in metal cutting and welding, and for iron and steel desulfurization. Calcium hydroxide is a waste by-product. It is piped and disposed in the 10 acre (4.0 hectare) waste pile on the north side of the road. In 1963, the pile was significantly higher (100 ft). On February 25 of that year the pile sloughed off, covering a nearby roadway and adjacent parking lots. The material was sold to LG&E for use in their air pollution control scrubbers. LG&E sells the material after it has been used by wall board manufacturers as a raw material. A fire in June 2009 damaged the plant; a fire and explosion in March 2011 killed two people and destroyed the building. The plant has an annual revenue of $5-10 million and has 140 employees [13].

Lubrizol, Zeon, and PolyOne

These Louisville plants, originally owned by B.F. Goodrich, produce chlorinated polyvinyl chloride (CPVC) resins and compounds which are used in the manufacture of residential and industrial plumbing systems. Formulated first in 1835, from 1912 to 1950 vinyl chloride (VC) is prepared by reacting ethylene and chlorine. In the very first study about the dangers of VC, published in 1930, it was disclosed that exposure of test animals to just a single short-term high dose of VC caused liver damage. In 1970, Dr. P.L. Viola reported that test animals exposed to 30,000 ppm of VC developed a rare sarcoma of the liver. In 1972, Dr. Cesare Maltoni, a researcher for the European VC industry, found liver tumors (including angiosarcoma) from VC exposures as low as 250 ppm for 4 hours/day. Dr. John Creech from B.F. Goodrich discovered angiosarcoma in the liver of three workers at the B.F. Goodrich plant in Louisville, Kentucky. To date, 26 former B.F. Goodrich workers have died from this disease.

In May of 1974, the Occupational Safety and Health Administration (OSHA) proposed a maximum exposure level for vinyl chloride at a no detectable level, using equipment with an accuracy of 1 part per million. In 1972, the federal government imposed tighter emission standards and worker safety rules for VC after it was linked to a fatal liver cancer associated with workers at the plant. By 1997 the Center for Disease Control and Prevention (CDCP) found that worker exposure was completely eliminated. The EPA's 2001 updated Toxicological Profile and Summary Health Assessment for VC in its Integrated Risk Information System (IRIS) database lowers the EPA's previous risk factor estimate by a factor of 20 and concluded that “the liver is the most sensitive site, and protection against liver cancer will protect against possible cancer induction in other tissues.”

The plant also produces several vinyl and acrylic latex emulsions, which are used as coatings in industrial and consumer products. The vinyl chloride monomer used in the plants formerly was produced in Louisville. The companies now purchase VC from Westlake Monomers in Calvert City, hauling it to Louisville by rail. One of the waste products of Lubrizol is hydrochloric acid. Prior to 1998, this waste byproduct was disposed of as hazardous waste. The company is currently

transporting this waste to Carbide/Graphite Group, Inc. who uses the acid to treat wastewater from their calcium hydroxide storage piles. This beneficial use of waste reduces costs for both companies while improving the environmental quality within the community.

Cleveland's Lubrizol Corporation partnered with two separate companies, Zeon Chemicals (Japan) and PolyOne (Cleveland) who now operate portions of the original plant independently. Zeon Chemicals is engaged in the manufacture of nitrile rubber. The rubber is used in the manufacture of automotive parts, adhesive, plastic modification, wire and cable parts. The EPA has ruled they must reduce the toxins that are cancer causing [15].

Butadiene, acrylonitrile, styrene, and ethyl acrylate, are feedstocks used in the manufacture of the specialty rubber. PolyOne produces polyvinyl chloride in a powder or pellet form which is used in the manufacture of vinyl house siding, PVC pipe, vinyl windows, wire and cable insulation.

DuPont

In 1955 the Louisville's Dupont plant started manufacturing Freon-22® refrigerant and aerosol propellant. Freon 22 is used as a refrigerant in freezers and air conditioners. The plant is the nation's largest emitter of a climate super-pollutant known as hydrofluorocarbon-23 (HFC-23). As a greenhouse gas (GHG), the chemical is 12,400 times more potent than carbon dioxide (CO_2), the primary chemical compound primarily responsible for global warming. The company has pledged to reduce and eliminate the production of HFC-23 since 1992 but has not reached this goal. In 2015, DuPont spun off Chemours, and the new company took over the plant's fluorochemical production.

Louisville Mayor Greg Fischer declared a climate emergency in 2019, telling a youth climate strike gathering that "we must take action now." But the Jefferson County Air Pollution Control District has not pressed the company to eliminate the HFC-22 emissions, deferring instead to the state or federal government. The production and use of HFC-23 was banned in the U.S. and other developed countries on January 1, 2020, by the Montreal Protocol. However, Chemours is exempt from the ban because the HCFC-22 produced in Louisville is used as a feedstock to manufacture Teflon and other fluoropolymers that do not damage Earth's protective ozone layer.

Chemours vented 251 tons of HFC-23 in 2019. These emissions are equal to the annual GHG emissions of 671,000 automobiles based on a national average for annual vehicle miles driven. That eclipses the 519,000 cars and light-duty trucks currently registered in Louisville. Giffin reported that the EPA found Chemours to be one of Louisville's worst polluters [15].

In addition to refrigerants, DuPont Fluoroproducts produces Freon 23, 1,1-Difluoroethane (DFE), vinyl fluoride, and hydrochloric acid. Freon 23 is used as an electronic gas and a fire-extinguishing agent. DFE is used in aerosols and as blowing agent for foams. Vinyl fluoride is used in the manufacture of a plastic (Tedlar) whose properties include excellent resistance to weathering, outstanding mechanical properties, and inertness towards a wide variety of chemicals, solvents, and staining agents. It is used in the manufacture of aircraft, cars, graphic signs, and a variety of other uses including those in the solar PV industry. DuPont estimates that this market will expand by 50% in each of the next 5 years and has announced it will invest up to $178 million to double production. One of the byproducts in the manufacture of Freon is hydrochloric acid. The plant prior to 1992, disposed of this waste byproduct in two underground injection wells. In 1992, almost 30 million pounds of acid was disposed of in this manner. Since then, the company has found markets to sell the acid for beneficial reuse. McKenna and Bruggers found that this company creates annual GHG emissions that are equal to 650,000 cars circulating around Louisville [16]. The total GHG emissions produced by the 44 chemical companies in Louisville are greater

than any other U.S. city on a per capita basis. This fact came from the head of the Air Pollution Control District during a 2024 seminar on environmental management at University of Louisville.

The DuPont plant in the 1960's employed 2,400 workers and was one of Louisville's largest manufacturers. That number dropped in 2009 to 180 workers; today, the company is not among Louisville's 40 largest manufacturers.

Dow Chemical, Arkema

This site is now owned by Dow Chemical. They make PARALOID™ plastic additives to increase the high impact strength and natural weathering resistance of PVC (used in window frames); these thermoplastic acrylic resins are used for coating applications on metal and concrete and to make crude methyl methylacrylate for the manufacture of acrylic plastics, toner inks, printing inks, non-yellowing finishes, and general finishes. Although the plant in the 1990s employed over 800 employees, currently the company has 150 employees.

The main chemical feedstock used at the plant is methyl methacrylate, which is brought by barge from their plant in Texas. Arkema purchased the patent for Plexiglass® in July 1998 from Rohm and Haas who has owned this plant since 1960. The plant manufactures acrylic resin used in taillight lenses, backlit signage, lighting applications, dashboard panels, medical equipment, videodisks, and for plexiglass sheets.

American Synthetic Rubber Corporation

For most of its history, consortiums of rubber, chemical and tire companies have operated this plant. It is now wholly owned by Michelin Tire Company. Its management and operation have improved dramatically as a result. The plant produces synthetic rubber which is sold in solid 75-pound bales or in a liquid form that is shipped in tank trucks. The bales (styrene butadiene rubber) are shipped to tire manufacturing plants where they are mixed with other raw materials such as carbon black. The liquid rubber (polybutadiene-acrylonitrile-acrylic acid polymer) is shipped to Thiokol Space Operations where it is used as the binder for the solid fuel in the booster rockets for the space shuttle program. In December 2005, the company installed a $3 million thermal oxidizer to destroy 99.99% of the 1,3 butadiene emissions from the plant; data for 2006 shows an 80% reduction in ambient air concentration in west Louisville. The EPA has identified American Synthetic Rubber as one of the deadliest polluters causing cancer in humans [10,15].

Momentive Specialty Chemicals

Momentive Specialty Chemicals (Columbus, Ohio) is the world's largest producer of binder, adhesive, coating, and ink resins for industrial applications. The plant was constructed to produce formaldehyde and phenolic resins in 1979. These products are used in a wide variety of automotive, foundry, adhesive, and wood manufacturing plants. Formaldehyde is used in the manufacture of herbicides, fungicides, fabric softeners, oil and gas applications, particleboard, plywood, shingles, slow-release fertilizers, melamine formaldehyde (MF), phenol formaldehyde (PF) resins, and spandex fibers. The primary feedstock is methanol.

The facility is the world's largest and most modern foundry to produces resins (including 2.6 million pounds of formaldehyde annually). In February 2007, the company agreed to a $52 million settlement in response to a class action suit filed by nearby residents. The settlement includes payments to adjacent landowners for property devaluation, construction of a berm between loading docks and adjacent neighbors, and internal controls to reduce emissions. Momentive has a total of 223 employees on site and an annual payroll of $17 million per year.

Lee's Lane Superfund Site

Lee's Lane Landfill is a 112-acre (45.3 hectare) landfill and junkyard that lies in the Ohio River's floodplain [17]. Portions of the site flood annually. The site was originally a sand and gravel quarry with a pit over 120 feet deep. From the 1940's to 1975, the site was operated as a landfill by Joseph Hofgesang and received over 2 million cubic yards of domestic, commercial, and industrial waste (estimated to be 212,400 tons). The landfill is located on 100 feet of porous alluvium. Waste is in direct contact with groundwater and pollutants flow down gradient into the Ohio River. In 1975, residents living next to the site reported "blue sheets of flame" around their hot water heaters. Explosive levels of methane gas from the landfill were detected. Seven homes were evacuated and eventually purchased by local authorities. The state closed the landfill the same year. In 1980, the state discovered 400 exposed drums of hazardous materials on the riverbank. They identified more than 50 chemicals including phenolic resins, benzene, and a variety of heavy metals. Groundwater, soil, and surface water were contaminated with benzene, heavy metals (i.e., lead and arsenic), and inorganic chemicals. In 1982, the site was listed on the National Priority List for Superfund action [18,19].

Over $2.2 million was expended to clean up the surface of the site and it has been delisted for any further Superfund action. The property is now owned by the Hofgesang Foundation which settled with the EPA to pay $2.6 million to clean up the site.

Since 1991, Louisville's Metropolitan Sewer District (MSD) has maintained the site and conducted monitoring under a 29-year agreement (to 2020) with the EPA, which incidentally alleged that MSD was among the parties dumping toxic waste there. The presence of methane and other toxic gases were detected in the residential neighborhood east of the site. An underground collection system was designed to vent the volatile gas safely and prevent it from seeping into neighboring homes and yards. A cap was placed on the landfills and monitoring wells around the site were installed.

In 2004, an engineering consultant firm said the monitoring and gas collection system was beyond its useful life and required updating. The cost of repairing the methane gas collection systems was estimated to be more than $300,000. MSD resisted and took the case to court in 2007 but eventually agreed to budget $350,000 for repairs [20]. The site is largely abandoned although the city and other groups have studied proposals to reclaim the site into a solar farm, recreational park, or other uses.

Railroad Loading Yard

The most dangerous and deadly area in Louisville and perhaps the entire country is the railroad transportation loading yard where highly toxic chemicals are stored in the Rubbertown area for days or weeks. If not properly secured, industrial sabotage, terrorism, a drone attack, or a train derailment could be deadly.

If physical damage to the site released the toxins, they could potentially cause thousands of fatalities and more deaths in the long term. The death toll could potentially surpass that of the 1984 Bhopal, India disaster in which at least 10,000 people died instantly from a chemical accident. In April 2024, a train derailment in East Palestine, Ohio caused the deaths of 45,000 animals including fish and birds. Since 2015, we have raised these concerns about the railroad loading facilities with two recent Louisville mayors. No action has been taken to improve security measures such as adding wire fences, security cameras, or a police presence.

CONCLUSION

Every city should have an environmental audit to expose the pollution in the air, water, and soil of its neighborhoods near industrial sites. The most affected are often those living near industrial pollution in low-income and minority neighborhoods. This assessment considered numerous industrial sites in western Louisville, Kentucky. It found a history of environmental pollution at all considered locations. The audacity of these polluters is stunning. Pollution shortens human lifespans, lowers educational proficiency, facilitates abandoned housing, reduces housing equity, and causes higher rates of crime [21-24].

Contrarians such as Chetty et al. dismiss the idea that pollution has negative impacts and argue that lifespan is mostly associated with geography and income [25]. However, when using their data and inserting pollution measures, our analysis proves a strong correlation between pollution and lifespan. Additional proof is found in the Chetty et al. maps published in *The New York Times* and *Journal of the American Medical Association*. Lifespan is much shorter in areas with high rates of pollution as found in data from the EPA [26,27].

Versions of this environmental audit were previously published [28]. What Albert Gore calls inconvenient facts are surfacing. A nationwide group called Faculty Against Corporate Takeover of Schools (FACTS) has organized to fight for clean air, water, and soil. In the words of Rachel Carson, who wrote *Silent Spring* in 1962 and was posthumously awarded the Presidential Medal of Freedom, "The people have the right to know." The EPA responded by telling Louisville officials to reduce the 76,000 pounds of toxic pollution by 6,500 pounds. This was one small step in recognizing the problem of chemical toxins as the biggest problem facing low income/minority neighborhoods [15]. The U.S. Department of Justice cited the toxic neighborhoods in West Louisville as an underlying cause in the urban uprising that took place in 2020-2021 [29]. The uprising resulted in the devastating destruction of the downtown area and several other deaths.

With 44 chemical companies, numerous liquor distilleries, and a coal-fired plant, Louisville's air was toxic. This was a reason companies like to locate there: with numerous companies, it is difficult to pinpoint which chemicals and companies are responsible for causing health issues or poor school performance. It cannot be considered healthy for 60,000 West Louisville workers, students, and residents to be exposed to 75,000 pounds of environmental toxins. People who live in East Louisville, where the air is cleaner, live 12 years longer [21,30-33]. In a study of 144 mid-size cities, Louisville ranked number two for having the most toxic air [28, 23]. This toxic air not only reduced lifespan but had a major impact on the health of public schoolchildren's proficiency scores and their health, causing them to have high absenteeism. According to the CDCP data, toxic air is correlated with higher rates of COVID-19, cancer, liver disease, and asthma [16,31,32,34].

We need impartial data analysis from the CDCP, the Toxics Release Inventory, the EPA, Housing and Urban Development (HUD), and other reliable sources. We should not rely solely on biased corporate talking points. Universities need to get on the side of people who live in distressed communities and fight the polluters. Too often elected leaders tell communities to believe the propaganda and ignore the facts.

We hope that this article encourages action against the companies that release harmful toxins in the air for not taking appropriate action to reduce the heavy toll of pollution on people, places, and the planet [34]. Louisville is the only U.S. city with major environmental remediation problems. The map in Figure 5 shows places in the U.S. where chemical pollution threatens the health, livelihood, prosperity, and sustainability of communities. Pollution needs greater attention

from the people organizing at the local, state, and federal levels to ensure access to clean air, water, and soil.

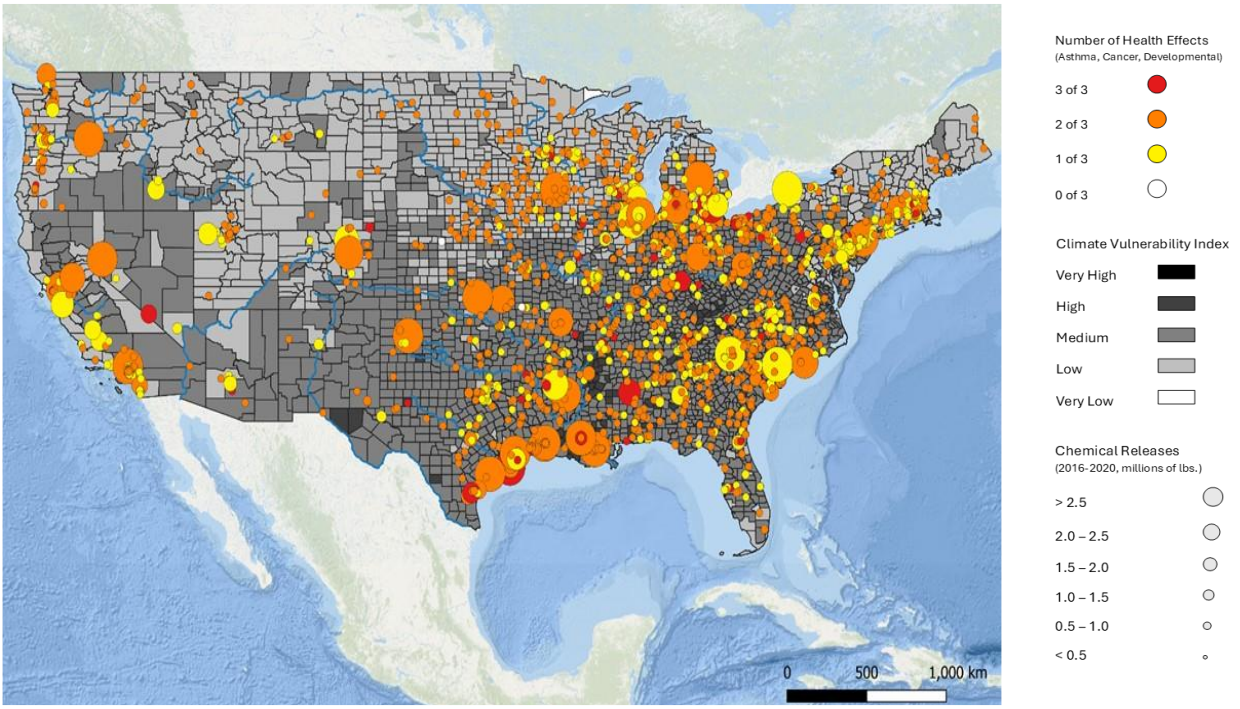

Figure 5. U.S. chemical exposure action map (source: Environmental Defense Fund, Collins and Proville, 2023).

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Note: A version of this article was previously posted on the UofL Kentucky Institute for the Environment and Sustainable Development website. It formed the basis for an environmental justice tour in West Louisville led by Russ Barnett. We revised this tour and published it in the forthcoming book: *Climate Chaos: Killing People, Places, and the Planet—& What to Do About It!* (Bloomsbury Press: London).

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