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Environmental Pollutants and Adverse Health: An Environmental Health Perspective on Living Conditions in Rubbertown, Kentucky

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Abstract: Rubbertown, located in west-end downtown Louisville stretching along the Ohio River started producing synthetic rubber during World War II in the 1940s has since evolved into a span of 19 facilities, with the majority of which being chemical plants. The population surrounding Rubbertown has expanded with the adjacent neighborhoods housing approximately 5,000 people, and has been projected to continue to gain population. Those living near Rubbertown are prone to a variety of environmental factors due to the large emittance of products, ranging from oil products, calcium carbide, plastics, paint products, polymers, rubbers, and many more. These volatile compounds can be directly related to health concerns, specifically cancer. However, despite the history of concern from the residents of Rubbertown, there has been minimal action for change. In this thesis, the researcher will investigate environmental factors that have direct correlations to premature death such as air pollutants and hazardous waste sites in the area. Components of environmental injustice will also be explored with the breakdown of demographics in the area, both in relation to race and educational opportunities. Because of these factors and their connection to environmental and public health, this thesis will argue that environmental pollutants are causing adverse health effects in Rubbertown, which can be tied with environmental injustice in the population.

Keywords and Phrases: air pollutants, environmental injustice, adverse health, hazardous waste

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Rubbertown Beginnings

The start of Rubbertown began with the United States involvement in World War II. At the start of 1942, the Japanese invaded the Dutch West Indies, resulting in a lack of accessibility to specific products in the U.S. The first of these products was rubber, which quickly became a rationed item by President Franklin Roosevelt. Americans were encouraged to reduce travel to preserve rubber tires, and by the end of 1942 a gas restriction was instituted in all states. In addition, rubber drives and donations occurred.

However, with uncertainty of when the war would be ending, it was decided to begin production of synthetic rubber in the United States. According to Louisville Magazine, Louisville, Kentucky, which was rapidly growing at the time, was selected to house the first synthetic rubber facility called DuPont Co. The facility was built in the west end of downtown, and ran directly next to the Ohio River. Production came quickly, and with a plethora of workers available from the influx of population in the growing city, a second facility by B. F Goodrich announced their arrival, along with the National Synthetic Rubber Co. just two months afterwards. Because of this immediate growth in the production of rubber in downtown

Louisville, the group of facilities was soon dubbed “Rubbertown,” with over 195,000 tons being produced in 1944.

The history of synthetic rubber began with the development of the synthetic chemical industry can be credited to Germans during post WWI, when the gaseous hydrocarbon butadiene was created. Butadiene was relatively simple to derive from multiple materials, such as coal, agricultural alcohol, or oil, which could then be combined to form a physical matter. This solid product was both chemically and physically the same as rubber, and started to become an alternative in practical uses (Howard, 3). Although synthetic rubber was more expensive to produce, with the hold on rubber from the Dutch West Indies in WWII, America turned its eyes toward these new methods for extracting the product (Solo, 66).

In tangent with the creation of Rubbertown was the movement of African Americans to Louisville from the 1920s to 1970s as they searched for better employment opportunities. For many, the appeal of Louisville was the “northern” feel that came with it. Although technically a southern city, Louisville offered more economical and educational opportunities due to being considered progressive for the time, with many similarities to places such as Nashville or Memphis. While schools were still segregated and jobs mostly focused on the labor industry for African Americans, this situation was considered an optimal opportunity at the time when compared to other states. Overall, the African American population in Louisville began to expand by 20,000 at the time, and with the creation of Rubbertown, an increase in 80,000 jobs opened up as well (Adams, 380-381).

Throughout World War II, Rubbertown continued to provide Americans with a source of rubber and created a new economic boom in Louisville. As the population continued to grow, employment in Rubbertown increased along with the neighborhoods surrounding the facilities. Many single-family homes were built, specifically for those that wanted an easy commute over to work. However, as time passed on and the need for synthetic rubber began to decline after the war, it was clear that new operations needed to be adopted in Rubbertown, thus leading into present times.

Rubbertown Today

Since its start as a producer of synthetic rubber in the 1940s, Rubbertown has since expanded into a variety of different operations. Today, Rubbertown houses 19 facilities according to the Louisville Metro Air Pollution Control District. In terms of specific location, these operations stretch along the Ohio River in the west end of downtown Louisville. Below is a list of the facilities with the materials produced:

- **MPLX Terminals- Algonquin Gas Terminal:** Network of crude oil and refined product pipelines.
- **Morris Foreman Water Quality Treatment Center:** Kentucky's largest water quality treatment center.
- **Buckeye Terminals, LLC Gas Terminal:** Transportation, storage, processing, and marketing of liquid petroleum products.
- **Valero Gas Terminal:** The largest independent petroleum refiner in the world.
- **Chevron Gas Terminal:** The second largest integrated energy company in the United States. Producer of crude oil, natural gas, and many other essential products.
- **Carbide Industries Chemical Manufacturing:** A manufacturer of calcium carbide.
- **Lubrizol Advanced Materials Plastic and Resin Manufacturing:** Producer of plastic products such as PVC piping, engineered polymers, health/beauty/home products, and performance (paint) coatings.
- **Zeon Chemicals Synthetic Rubber Manufacturing:** Producer of specialty elastomers, polymers, and specialty chemicals.

- **Recast Energy Industrial Energy Service Provider:** A biomass-to-energy plant that delivers industrial steam and power
- **The Chemours Company Chemical Manufacturing:** Has a large number of assorted products, from automobiles, paints, and plastics to electronics, construction, energy, and telecommunications. The world's largest producer of high-quality titanium dioxide.
- **Eckart America Corporation Aluminum Smelting and Alloying:** Producer of coatings, printings, cosmetics, plastics, functional applications, aerosols, and paints.
- **The Dow Chemical Company:** Formerly Rohm & Haas Chemicals as depicted in Figure 1. Among the three largest chemical producers in the world, specifically in the manufacturing of plastics and agricultural products.
- **Altuglas International Acrylic Manufacturing:** Polymethylmethacrylate (PMMA) manufacturing.
- **American Synthetic Rubber Co. Synthetic Rubber Manufacturing:** Produces various grades of synthetic rubber for the Michelin Group.
- **MPLX Terminals- Kramer's Lane Gas Terminal:** A network of crude oil and refined product pipelines.
- **Citgo Gas Terminal:** Storage and distribution of petroleum products such as gasoline, diesel, heating oil, and jet fuel.
- **Hexion Specialty Chemicals Plastics and Resin Manufacturing:** Producer of coatings, composites, and adhesions.

- **TransMontaigne Gas Terminal:** Provides terminating, storage, transportation, and related services for petroleum and other liquid products.
- **DuPont Specialty Products USA Chemical Manufacturing:** A manufacturer of a large number of various products such as construction materials, packaging materials, personal protective equipment, medical devices, adhesives, and resins.

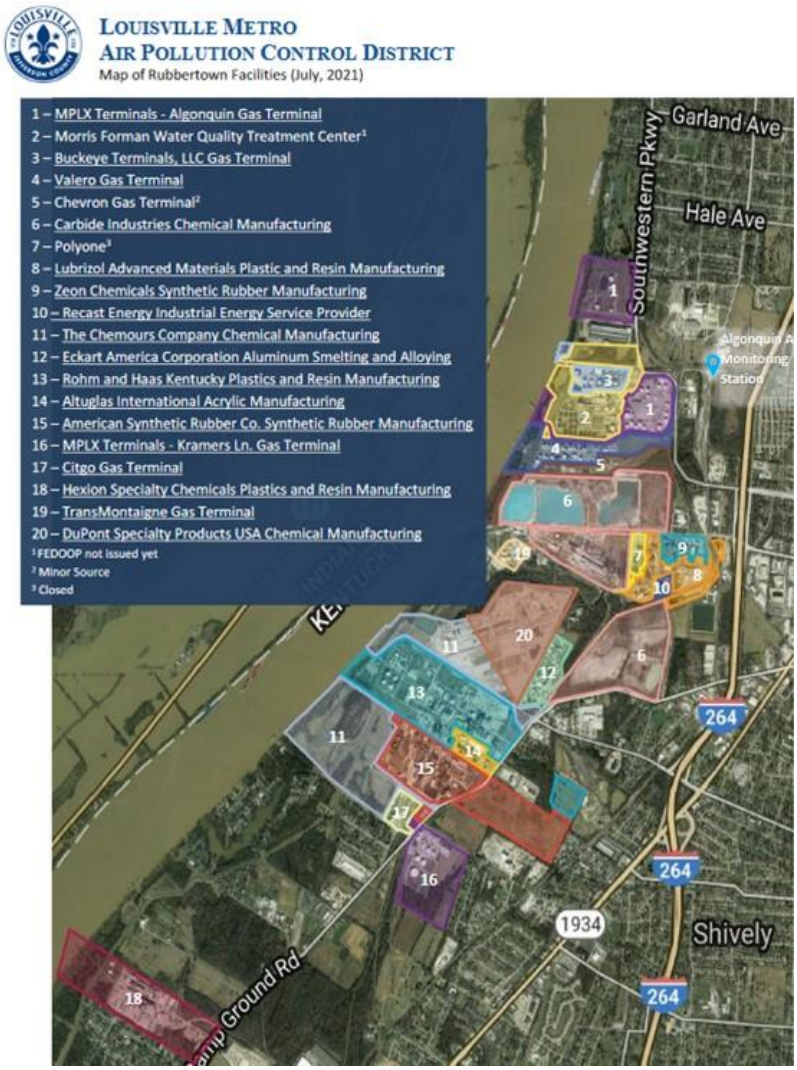

Figure 1: A map of Rubbertown facilities as of July 2021 (Louisville Metro Air Pollution Control District)

In addition to a growth in manufacturing, the area surrounding these facilities has also seen a boom in population. In 2017, according to the Rubbertown Neighborhood Profile, there were an estimated 5,275 living adjacent to the area, with 2,269 of those being of a household or family setting. The population projection is also indicating a continued growth in the coming years, with an estimated 7,000 living in Rubbertown by 2040, as indicated by Figure 2.

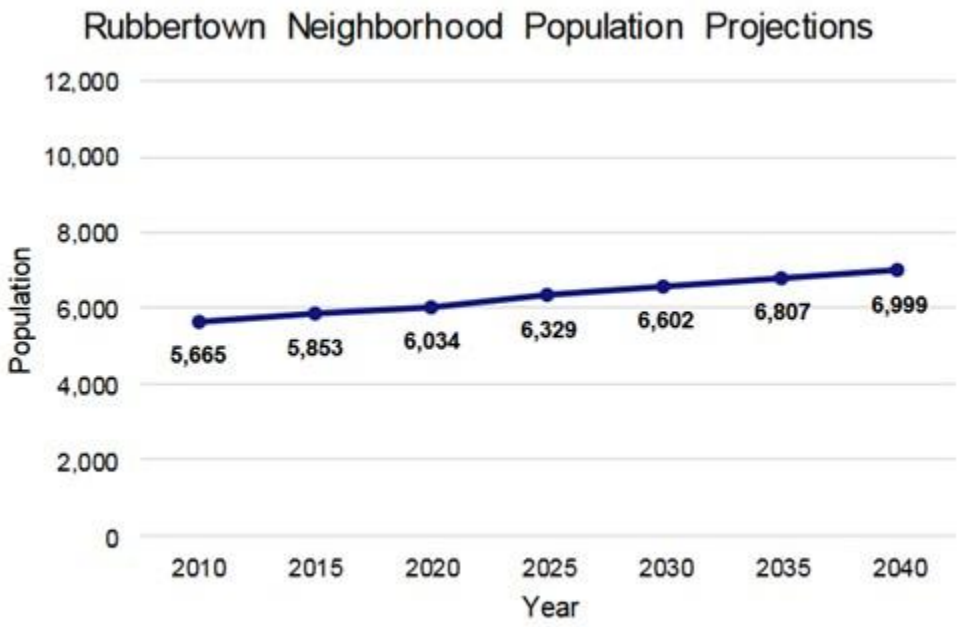

Figure 2: A projection of Rubbertown population growth from the years 2010-2040 (Louisville Metro Demographic and Economic Projections)

The major concern of this population growth in the area is the potential adverse health effects associated with the adjacent manufacturers. Many of the products, especially those made by chemical manufacturers, have some form of byproduct termed volatile

organic compounds, or VOCs released into the air. According to the American Lung Association, continually breathing in VOCs located in the ambient (outdoor) air can irritate the nose, eyes, and throat, lead to nausea or difficulty breathing, and can cause damage to the central nervous system along with other organs. Some VOCs have a direct correlation to developing cancer. Other compounds of concern for those in Rubbertown are persistent organic pollutants (POPs), which can be formed from plastic-associated chemicals such as polychlorinated bisphenols. As mentioned above, many facilities in Rubbertown develop or produce plastic products, which become POPs when released into the atmosphere. POPs have similar health concerns to VOCs, and recent studies linking them to cardiovascular diseases and similar risk factors such as hypertension and obesity (Lind and Lind, 537).

Another issue connected to these facilities is the potential for improper hazardous waste disposal. Hazardous waste has a number of concerns connected to them, both for the environment and those exposed to them. Abandoned hazardous waste sites, termed Brownfield sites, are seen in disproportionate amounts in lower socio-economic neighborhoods compared to the remainder of the county. Brownfields ultimately cause a financial burden to the community by decreasing the housing values and increasing the rates of foreclosures, making it more difficult for those affected to move elsewhere. Depending on the waste, they can also cause health effects similar to air pollutants, such as irritation, nausea, difficulty breathing, damage to organs, and in severe cases, cancer.

Demographics of Rubbertown

The demographics of the current population in Rubbertown are a strong indicator of the potential environmental injustice that is prevalent. For the sake of this study and to highlight the vast differences between the two groups, a comparison will be made between Rubbertown and the remainder of Jefferson County in this section. Jefferson County can be described as the area in Kentucky surrounding and extending past Rubbertown, and overall is the largest county in the state, with a population of 768,419 according to the 2020 census. Rubbertown is considered to be a part of Jefferson County, however, the two will be excluded from each other for sake of comparison. The specific statistics have been taken from Rubbertown Neighborhood Profile, provided by the University of Louisville and Metro United Way, and published in July of 2017.

In terms of population characteristics, Rubbertown is vastly smaller when compared with the rest of the county; however, the numbers are increasing steadily, and the area is projected to grow up to 7,000 by 2040. In terms of age and sex, Rubbertown is generally similar to the rest of the county, being about half male and half female. The majority of residents, 67%, are between the ages of 18 and 64. In the analysis of race and ethnicity discrepancies between Rubbertown and the rest of the county begin to appear.

As discussed in the previous section, a history of African American migration can be traced back to even before the creation of Rubbertown from the 1920s to 1970s (Adams, 380). Even in post-production of synthetic rubber, the population rise continued and reached into the new industries. Much of this move is references as the “white-flight,” as the white population tended to flee towards the eastern suburbs, while African Americans tended to stay near the west end and continue working in blue collar industries provided

by Rubbertown (Hanchette et al., 231). Today, however, a clear line of demographic discrepancies can be observed in west end Louisville as a whole. In 2017, in Rubbertown, the population was 56% white, non-Hispanic and 39% Black, non-Hispanic. While these numbers may not appear alarming at first glance, when compared to the rest of Jefferson County, there is a vast difference. In the rest of the county, the population was 70% white, non-Hispanic and 20% Black, non-Hispanic. In all, this is a 19% difference in the African American population between Rubbertown and the remainder of Jefferson County.

This glance into the race differences can also be reflected with income. It was determined in 2015 that the median household income of Rubbertown was $33,477. In comparison, the median household income of the remainder of Jefferson County was $48,695, resulting in a difference of $15,218 between the two populations. The Supplemental Nutrition Assistance Program, or SNAP Benefits, can be reflected in these income characteristics as well, with 28% of households in Rubbertown receiving care, while only 15% of the remainder of the county do. Overall, it can be highlighted that these exponential differences in financial abilities between the two populations result in injustice to the residents of Rubbertown, and ultimately leave them with minimal opportunity to move to a new location.

These discrepancies are not only putting adult residents of Rubbertown at risk, but also the youth. In terms of school enrollment and attainment in education, the students of Rubbertown are lacking the support they need to succeed. Focusing first on school options, students attending Jefferson Country Public Schools (JCPS) are given an assignment choice based off of their home address, which are considered their “reside”

school. However, of the elementary, middle, and high school options, which is a total of ten schools that are reside choices for Rubbertown, nine of the schools are rated at "Needs Improvement." This insufficient education is continued over the years, and results in a poor graduation and college or career ready status, as highlighted in Figure 3. Testing scores in the "reside" schools for Rubbertown are below the average of the rest of the county, highlighting the discrepancy from elementary through high school years for these students. Even if the argument that standardized testing is a poor form of rating a student's knowledge, the overall below-average in scores is a strong indicator that the "reside" schools in Rubbertown are in need of improvement when in comparison to the rest of JCPS.

Student Achievement - School Year 2015-2016

Elementary "Resides" Schools	Proficient and Distinguished Scores		Kindergarten Readiness
	Reading	Math	
Cane Run	20%	28%	35%
Crums Lane	38%	52%	38%
Kennedy	49%	44%	65%
Shacklette	35%	38%	33%
Wellington	36%	30%	35%
District Total	49%	49%	48%

Middle "Resides" Schools	Proficient and Distinguished Scores	
	Reading	Math
Conway	29%	20%
Farnsley	54%	53%
Frost	24%	20%
Stuart	22%	12%
District Total	46%	39%

High "Resides" Schools	Proficient and Distinguished Scores		Graduation Rate	College and Career Ready
	Reading	Math		
Western	27%	20%	72%	50%
District Total	51%	48%	80%	63%

Figure 3: School standardized testing results in Rubbertown "reside" school compared to the rest of Jefferson County Public Schools (Rubbertown Neighborhood Profile)

The difference in racial profiles is relevant in these reside schools for Rubbertown. All of the reside elementary schools are reported to be 60% or more non-white, with one being as high as 87% non-white, and the sole high school available is documented to be 76% non-white. These demographics can be observed more in-depth in Figure 4 below. Another factor is the number of free or reduced lunches at these schools, which can be connected to the discrepancy in income between Rubbertown and the rest of Jefferson County. Out of all reside school options, the lowest percent of free/reduced lunch is 63%, and the highest is 91%. Overall, the reside schools in Rubbertown have a pattern of lack of support in education, racial discrimination, and a minimal opportunity to succeed past graduation.

Student Demographics - School Year 2016-2017

Rubbertown "Resides" Schools	% Non-White	% Free/Reduced Lunch
Cane Run Elementary	87%	89%
Crums Lane Elementary	83%	91%
Kennedy Montessori Elementary	85%	64%
Shacklette Elementary	61%	81%
Wellington Elementary	64%	79%
Conway Middle	44%	77%
Farnsley Middle	45%	63%
Frost 6th-Grade Academy	59%	82%
Stuart 7th– and 8th-Grade Academy	56%	83%
Western High	76%	79%
District Total	54%	62%

Figure 4: The student demographics of "reside" schools for Rubbertown (Rubbertown Neighborhood Profile)

The neighborhood profile of Rubbertown in comparison to the rest of Jefferson County highlights the major burden that the residents are experiencing. A statistic encompassing the injustice at hand is the housing costs. In Jefferson County, the median reported value of owner-occupied housing units in 2015 was $150,400. In Rubbertown, it was $88,490; a difference of $61,910. For median assessed value of single-family housing units in 2016, it was reported to be $139,440 in Jefferson County, and $67,195 in Rubbertown, resulting in a difference of $72,245. These housing cost differences for those in the Rubbertown neighborhood that are wishing to leave making it exceedingly difficult for them, especially when taking the income differences into account. The people of Rubbertown are in a place of inequity, and overall, because of this, are subjected to not only financial discrimination, but also the environmental impacts that result from residing in the area.

An additional component of this observation into demographics is the topic of premature death. It was found from the Kentucky Cabinet for Health and Family Services Department of Public Health that the years of potential life lost before age 75 per 100,000 population (age-adjusted) in Jefferson County was 8,229. In Rubbertown, there were 13,144 years of potential life lost, a 4,915 difference in potential life lost. This is especially concerning when considering the smaller population of Rubbertown to the rest of Jefferson County.

Although environmental factors are of the main concern of this thesis, one factor to consider is the potential correlation between income and life expectancy. One study conducted between 1999 and 2014 obtained the tax records of 1.4 billion U.S residents, along with mortality data from the Social Security Administration. The analysis from the

study concluded that there was a gap in life expectancy between the top 1% and bottom 1% of income. In specifics, there was a difference in 14.6 years for men and 10.1 years for women. Overall, it was determined that between the years 2001 and 2014 in the U.S, higher income was associated with greater longevity, and differences in life expectancy across income groups increased overtime (Chetty & Others, 1). While this study may be a far stretch for the specifics of Rubbertown by looking at the upper and lower most incomes in the U.S, it gives a solid backing for the potential years of life lost due to a lower income.

While the Chetty study looked at solely income and life expectancy, different research conducted by Health Affairs observed the overall effects that low-income can have not only on life expectancy, but the overall quality of one's life and health. It was determined that the overall factors of poverty piled into a combination of discrepancies, due to the living situations at hand. One argument made was that the majority of low-income housing situations were associated with higher rates of obesity and chronic diseases. This is due to a combination of less access to fresh food options, high density of fast-food restaurants, and lack of safe green space for physical activity (Khullar, 3). Another contenting factor is the inability to afford health care, as even with the implementation of the Affordable Care Act, more than twenty-seven million Americans are uninsured, with the majority of which being considered low-income (2).

Another component of this study highlighted the role of race in relation to income. The majority of African Americans have an overall lower income and shorter life expectancy, which can be contributed partly by the history of segregation and discrimination that has a negative effect on mental and physical health. Another aspect of

this is family income, as it was concluded that young African American boys were more likely to become poor adults, and the opposite for young white boys (4). In terms of Rubbertown, while this study was a broad geographic look at the impact of income and life expectancy, comparisons can be made that these aspects are similar in west end Louisville. Rubbertown has an overall lack of nearby grocery stores and next to no green space for exercise. Crime rates in the west end also have a history of being high, which can contribute to a person's ability to exercise outside without worry. As earlier mentioned, Rubbertown has a sizable number of African Americans, which further relates to the income-based disparities that are observed in the area. In preparation to looking into the environmental factors associated with living in proximity to Rubbertown, it is essential to keep in account these major discrepancies in the demographics to further consider the environmental injustices, and how the subject of income can contribute to overall health in a community.

Air Pollutants

The central issue of environmental concern to Rubbertown is the large emittance of air pollution. The Clean Air Act of 1970 is described by the Environmental Protection Agency as "the comprehensive federal law that regulates air emissions from stationary and mobile sources." It also gives the EPA power to establish the National Ambient Air Quality Standards (NAAQS) with the purpose of attending to public health concerns across the country. The act itself involves seven titles, including a range of topics:

- Title I- Air Pollution Prevention and Control
- Title II- Emission Standards for Moving Sources
- Title III- General
- Title IV- Noise Pollution
- Title IV-A- Acid Deposition Control
- Title V- Permits
- Title VI- Stratospheric Ozone Protection

The requirement of permitting from companies is an important consideration, as the majority of air pollutants in Rubbertown stem from the differing facilities adjacent to residents. Even with these permitting systems in place, the current standards may not be strict enough to prevent premature health issues arising in nearby citizens. Even for the facilities in compliance residents are exposed to a variety of pollutants in higher concentrations than other parts of Jefferson County.

Recent lax enforcement of regulations has led some researchers to question the efficacy of the Clean Air Act, specifically the effectiveness of air quality regulations. In a

study by Henneman and others, it discussed the need for accountability in the form of a chain which can help to see the repercussions of potential air quality issues both in real time and future studies. This idea of an accountability chain will help with understanding the direct causes for broken requirements, and help to keep companies in check with the Clean Air Act (23-24). However, in recent years, the EPA and Clear Air Act has had a lack of backing, mostly stemming from a switch back and forth in governing parties. Thus, due to being a federally run program, many of their initiatives may be potentially paused or decreased in priority, making it difficult for them to keep track of all permitting and regulations. Even with the assistance of local public and environmental health programs, the sheer number of companies that produce emittance in the country may outweigh the Federal agency's ability to regulate.

Despite some of these recent issues with the EPA, there has been backing supporting improvement in air quality due to the Clean Air Act. In a study looking back on the 50 years since it was first implemented, it was concluded in the years 1980-2019, the concentration of the six most common air pollutants had decreased by an average of 69% (Aldy et al., 179-180). It was also determined that fine particles had declined by 43% since 2000. However, another note by the study was the vast increase in industry and products produced in the U.S having notable pollutants associated with them, which have nearly tripled since 1980 when the act was still young. In conclusion, despite the Clean Air Act having highlights in the past 50 years in terms of the overall lower number of pollutants, consider the ever-increasing number of companies emitting pollutants. In addition, since these studies account for all of the country as a whole, it is difficult to know if areas like Rubbertown have received the same improvements.

While most of the public compartmentalizes air pollution and the Clean Air Act as a concern more for the environment and effecting global warming, it is of concern for those exposed from a health perspective as well. As mentioned in a previous section, air pollutants have a variety of effects, ranging in levels of concern from irritation of the nose, eyes, and throat, nausea or difficulty breathing, and damage to the central nervous system along with other organs. The continual exposure to air pollutants has direct links to multiple forms of cancer as well, as many air pollutants are known carcinogens.

There are a few key factors to consider in regard to air pollution, the first being amount of time exposed, or in another way of putting it as phrased by the early toxicologist Paracelsus, “the dose makes the poison.” Essentially, any pollutant, even ones considered harmless, can cause adverse effects in a human if received in an amount above a safe threshold. This harmful effect can take place either from repeated exposures to a smaller dose, or single exposure to a larger dose. Typically, in places of work, employers are required to comply with mandates under the OSHA prohibiting workers from exceeding certain permissible limits of these toxic air pollutants. However, as seen in an area such as Rubbertown, these permissible limits are not considered for those living in residential areas nearby. While they may not be as directly exposed as the workers, they are more prone to lower ambient levels over an extended period of time, in this instance multiple years.

Even though the EPA has risk assessments in place for citizens, most of the process depends on the weight of the evidence for health problems of concern from the specific toxic pollutant in question. These studies are typically limited, as according to the EPA Air Toxics Web Site, “Because human information is very limited for most toxic air

pollutants, scientists often conduct studies on laboratory animals, such as rats." While these studies are beneficial, they are not considering the confounding variables that appear from being outside of a lab setting, and thus may be improperly labeled as not a concern. Another consideration for these risk assessments is the overall variety of people living in the area, as age and sex can have a large effect on how pollutants can affect one's health. For example, younger populations have undeveloped immune systems, and due to their smaller size retain toxins at a much faster rate. These environmental toxins can then have an impact on children's health and neurological development, along with future issues with the nervous system (Jurewicz et al., 185). Health conditions of a population are a factor as well, such as elevated levels of cardiac disease or obesity, which as before mentioned can be of concern to Rubbertown due to the lack of fresh food options, affordable health care, and green space for exercise.

An additional factor is the mixing of toxic air pollutants. While one on its own may be deemed safe by these EPA risk assessments, it is difficult to know how multiple pollutants may interact with each other. This would be the case for Rubbertown, as with the vast difference in facilities and each of their corresponding pollutants, it is difficult to predict exactly what type of harm could be created from their association with one another. One study conducted with the European Commission included a toxicity and assessment of chemical mixtures. The overall purpose was to determine if substances may act jointly in a way that could affect the overall level of toxicity in the body. In conclusion, it was observed that "Chemicals with common modes of action may act jointly to produce combination effects that are larger than the effects of each mixture component applied singly" (SCHER, 34). In the application of Rubbertown, this means

that toxicants with similar compounds, most likely those from chemical manufacturers, may combine to create a more harmful effect to the nearby community.

In relation to the standards mentioned that are set by the Clean Air Act, a consideration to make are the National Ambient Air Quality Standards (NAAQS), which are set by the EPA for six criteria air pollutants. These six pollutants include Carbon Monoxide (CO), Lead, (Pb), Nitrogen Dioxide (NO_2), Ozone (O_3), Particle Pollution/Matter (PM), and Sulfur Dioxide (SO_2). These NAAQS include both primary standards and secondary standards, with primary providing public health protection, and secondary providing public welfare protection. Although standards are put in place for these primary and secondary levels, they are minimally regulated or revised. . One factor can be the idea that high levels of standards equate to higher costs overall, both for companies emitting criteria pollutants and Federal agencies required to regulate these levels. Even if these criteria pollutants are regulated, they can still lead to adverse effects, as these standards are argued by many to be outside of scientific range. NAAQS also do not take other factors into consideration such as age or health conditions of the population.

According to one analysis of NAAQS, the topic of "how low is low enough" is one to consider (McClellan, 255). This statement highlights the current debate over scientific approaches to standards versus the costs of policy implementations (243). By having standards be higher, for example in parts per million instead of parts per billion, cost effects lower; however, it leaves for a concern of public health as these numbers are often above a safe threshold. Thus, determining a lower and more stringent standard, while more costly, can allow for a greater margin of safety for those exposed. Another

consideration is the regulatory differences among state, local, and tribal air agencies in the country, as all may follow differing guidelines or have multiple ways of controlling standards. Thus, while these ambient air quality guidelines were created for the standardization of regulations for the criteria pollutants, they often become unclear and are left unmanaged (Joss et al., 453). In the scope of Rubbertown, these NAAQS provide little comfort for residents in the area. Being near a plethora of industry makes it difficult to pinpoint the exact emittance of criteria pollutants, thus making accountability difficult. They also fail to consider the pre-existing health conditions of populations, or the age range of those living in a certain area.

The main criteria pollutant of concern in Rubbertown in recent years are $PM_{2.5}$ and $PM_{10.}$ Humans can be exposed to PM through inhalation, ingestion, and possibly absorption through the skin, which can be linked to millions of years of premature deaths when studied globally (Thompson, 392). Other health concerns of PM exposure include possible associations with attention deficit hyperactivity disorder (ADHD), autism, cognitive issues, anxiety, asthma, chronic obstructive pulmonary disease (COPD), hypertension, and stroke (392). Specific data can be taken from the Louisville Air Watch website, which has readings from Algonquin Parkway, which is located in the heart of Rubbertown facilities. Before analyzing the Louisville reports, it is crucial to understand the EPA NAAQS primary and secondary standards set, which can be highlighted below in Figure 5. Standards are measured in micrograms per cubic meter, and have two sections either pertaining to 1-year exposures, or 24-hour exposures.

Particle Pollution (PM)	$PM_{2.5}$	primary	1 year	12.0 µg/m^3	annual mean, averaged over 3 years
		secondary	1 year	15.0 µg/m^3	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 µg/m^3	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24 hours	150 µg/m^3	Not to be exceeded more than once per year on average over 3 years

Figure 5: The NAAQS for Particle Pollution set by the EPA (EPA)

The Louisville Air Watch readings from the past year were analyzed in comparison. A challenge for interpreting the data is difficulty to understand this information from an uneducated viewpoint. The data is taken at the start of each hour every day, meaning that there are 24 readings for each day, which is compiled with every reading for a month. In addition to PM, there is also a test of Sulfur Dioxide, Hourly Maximum of 5-Minute $SO_{2,}$ Vector Wind Speed, Vector Wind Direction, Relative Humidity, and Ambient Temperature. Thus, in the month of September of 2022, there were 5,907 readings to differentiate between. This lack of user availability is concerning as it tends to steer off public awareness of issues that may be present. The typical resident of Rubbertown may find this amount of information overwhelming, before even considering the interpretation that may need to come with it. In terms of analyzing the data at hand, comparisons were made between the 1st reading on the 1st of each month, for each month that data was made available for 2022. Refer to Table 1 below, which highlights each month with its correlating PM readings.

Table 1: 2022 levels for $PM_{2.5}$ and PM_{10} from January-August. Readings are taken from the 1st hour on the 1st of each month from the Algonquin Parkway location (Louisville Air Watch)

Month	**$PM_{2.5}$**	**PM_{10}**
January	12.4 ug/m^3	17.3 ug/m^3
February	29.1 ug/m^3	42.5 ug/m^3
March	11.7 ug/m^3	22.8 ug/m^3
April	6.3 ug/m^3	8.1 ug/m^3
May	10.7 ug/m^3	23.1 ug/m^3
June	10.9 ug/m^3	19.3 ug/m^3
July	12 ug/m^3	22.6 ug/m^3
August	7.6 ug/m^3	22.6 ug/m^3

It can be concluded besides the two lower readings during April and August, the rest of 2022 had rates of PM similar to that of the primary NAAQS annual standard threshold. While this analysis only takes into consideration one specific reading over the course of each month, it highlights the consistency in which Rubbertown residents are exposed to higher rates of PM in their lifetime. While these rates also fluctuate by the month, one may also consider the average of $PM_{2.5}$ from this set of data, which equivalates to 12.6 ug/m^3, and thus if continued over the suggested NAAQS mean of three years, would be above safe primary standards. Even if the readings were to come out slightly below range, it is still of concern, as these residents are exposed to these fluctuating PM exposures.

A potential precursor to these signs of toxic air contaminants is odors. Odors can not only be bothersome for the community, but also are indicators of hazardous air pollutants that may be in the area. A specific study on odors takes a direct look at the complaints in Rubbertown to determine the correlation between public odor complaints and toxic air pollutants. The scope included 77 toxic chemicals that are measured at 6 different monitoring stations in the west end of Louisville every 12th day. Of these 77 chemicals, 20 compounds were of special interest, which included hydrocarbons, aromatic compounds, and some chlorinated hydrocarbons. They determined that during the years of 1999-2005, there was a total of 424 odor complaints in Louisville, with the majority of which stemming near the air monitoring sites. To determine the correlation between complaints and toxic pollutants, odor thresholds provided by the American Industrial Hygiene Association were utilized to perform a Pearson statistical analysis. In the conclusion of the study, it was determined that the Pearson coefficient values for the correlations suggest that 10-54% of the complaints can be connected to the levels of toxic air in the city (Muezzinoglu and Dincer, 973).

While this correlation percentage is quite a wide range, the takeaway from the study is the considerable amounts of complaints in the area. In the six documented years, there were 424 odor complaints, all of which originated from near west end air monitoring sites. This creates a strong correlation between potential air pollutants and close distances to the west end, which can include Rubbertown. Although the direct conclusion that Rubbertown is the reason for the odors cannot be made without additional proof, it can be inferred that it is of high likelihood, as according to the study, the chemical plants in Rubbertown account for about 20% of Kentucky's total air toxins, and 42% of all

industrial air emissions in Jefferson County (Muezzinoglu and Dincer, 971). Thus, it is probable that the majority of the odor complaints are a result of these toxic air pollutants. These odors also pinpoint to some common byproducts of chemical companies, such as 1,3-Butadiene and vinyl chloride, which can be directly linked to synthetic rubber production and are known to have adverse health effects associated with them.

The byproduct to further consider first is 1,3-Butadiene. By definition, 1,3-Butadiene, or BD, is a colorless gas that is produced in high levels, mainly for the use of synthetic rubber and thermoplastic resins. It is considered to be a volatile organic compound that is commonly monitored in most states, and beginning in 2002 was determined to be a human carcinogen by the U.S EPA. In particular, BD can be known to cause lymphohematopoietic cancer, such as leukemia, especially in workers exposed in their occupation. Another potential adverse effect is higher rates of cardiovascular disease (Chen and Zhang, 1-2). In terms of regulation, the occupational limit for workers is set at 1 ppm per 8-hour workday, or a short-term limit of 5 ppm for 5 minutes (OSHA). However, standards are once again unclear for those outside of occupational health circumstances, such as those living in Rubbertown.

Consider the OSHA standards for workers. Those exposed for 8 hours at a time in the workforce are given 16 hours to recover from the exposure, along with weekends. These are for their working lifetime, which is considered 30 years, and studies have indicated that those in the workforce are typically the healthiest in the population. These standards can then be compared to the non-regulated residents of Rubbertown. Those living in the area are exposed to pollutants for up to 24 hours a day when home, and get minimal time to recover from exposure. Residents of Rubbertown also reach a greater range of age

groups and health conditions, which can affect the absorption, distribution, and excretion of the toxicant in the body. As mentioned in previous sections, those in Rubbertown overall experience higher rates of cardiovascular disease due to a lack of access to healthy foods and green spaces for exercise. Consequently, they may develop adverse health effects from toxic pollutants at a higher rate than those in the workforce. This can then be applied specifically to byproducts such as BD that are regulated for workers, but not those in residential areas.

To continue with an analysis of BD, past human studies have shown that the rate of absorption via inhalation of 2 ppm of BD for 20 minutes varied vastly from 18% to 74, a wide variance (Nieto et al., 371). In general, studies on BD are limited, despite it having a strong correlation to cancer in humans and animals. In fact, until recent years, no studies had been published observing BD on a population scale, until it was discovered that urinary markers were an accurate way of assessing toxin levels in the body, as the liver oxidizes BD in detectable amounts (Nieto et al., 372). One of these studies using urinary markers was conducted by Chen and Zhang in 2022, which looked at both occupational and non-occupational exposures of BD around the world. While this study is broad in relation to Rubbertown, it has key findings that can be directly traced back to those living in the area.

A first observation from the study was that exposure to BD was dependent on socio-demographic characteristics, meaning that populations with a higher percentage of ethnic or racial minorities and/or low income have high exposure levels to BD (Chen and Zhang, 5). As mentioned before in Rubbertown, the demographics represent a mainly African American population with high rates of low income in comparison to the rest of

the county. This study thus links the population of Rubbertown with retaining higher amounts of BD. In addition, it was determined that the cancer risks are overall higher near industrial sites due to the common emittance of BD. For example, although based in China, it was found that a petrochemical facility near the Yangtze River Delta had the largest cancer risk due to the BD production (Du et al., 2014). This can relate to the chemical production manufacturers in Rubbertown which also produce levels of BD. If a China comparison is not an indicator, another example of cancer levels can be directly linked to synthetic rubber in North America. One epidemiological study of synthetic rubber industry workers at six separate plants displayed an association between BD exposure and lymphoid leukemia (Sathiakumar et al., 2019).

While these studies may be more of a broad implication of the potential adverse effects of BD in terms of Rubbertown, it gives a clear indication of multiple reports worldwide that exposure to BD can directly correlate to disease. Specifically, these inhaled exposures come from chemical and synthetic rubber manufacturers, both of which are predominate in Rubbertown. Another byproduct associated with chemical manufacturers is vinyl chloride, which is used in the production of polyvinyl chloride, or PVC. These are considered to be a form of microplastic, which can have multiple adverse health implications associated with it. While microplastics are an everyday exposure for most due to the world's heavy reliance on plastics, those in Rubbertown may be inhaling more than the typical person due to being in close contact with multiple chemical companies that produce PVC and other forms of vinyl chlorides. Although studies are still limited on long-term effects of microplastics, some have observed human cell cultures to determine the potential physical and chemical implications in the body from a

toxicological viewpoint. According to one study completed by Vethaack and Legler, in vitro observations in humans and rodents with exposure to microplastics result in a variety of biological effects, such as physical toxicity, which in turn leads to oxidative stress secretion of cytokines, cellular damage, inflammatory and immune reactions, DNA damage, as well as neurotoxic and metabolic effects (673).

Although these studies of microplastics are limited, they are recently becoming more prevalent as researchers have made the connection to adverse health effects in humans both in and outside of an occupational setting. Yet, the residents of Rubbertown are exposed to these toxins on a regular basis, with little to no repercussions for the facilities. A strong reason for fear of these toxins as well is how they may affect children. While adults may be able to pass these toxins easier due to having more body mass and fully developed immune systems, young children and into teenage age experience air emittance effects at a higher and faster rate. One adverse effect that is becoming increasingly prevalent in Jefferson County is asthma. In fact, according to the CDC 2020 Asthma Data, 11.5% of adults in Kentucky have asthma. While some of this is a result of being located in the Ohio River Valley, which has high humidity and pollen levels, volatile air pollutants can contribute to these levels as well.

A major concern of these high asthma levels is how they are prevalent in children. One specific study used to observe childhood asthma rates in west end Louisville titled "Asthma, Air Quality and Environmental Justice in Louisville, Kentucky" helps to make a compelling argument that the high levels of air pollutants coming from Rubbertown have resulted in higher levels of childhood asthma. In the study, geographic information systems (GIS) were utilized to examine the correlation between air quality and asthma

occurrences among children living in west end Louisville, specifically by looking at rates of asthma hospitalizations in the area. The hospital discharge rates were strikingly high in the northernmost zip codes of Jefferson County, indicating the high rates from being near Rubbertown's industrial complexes. This can be visualized in Figure 6 below. It can be noted that when looking at the rest of the county, asthma hospitalization rates were significantly lower, specifically in the east-end, which is associated with higher income and majority white population (Hanchette et al., 228).

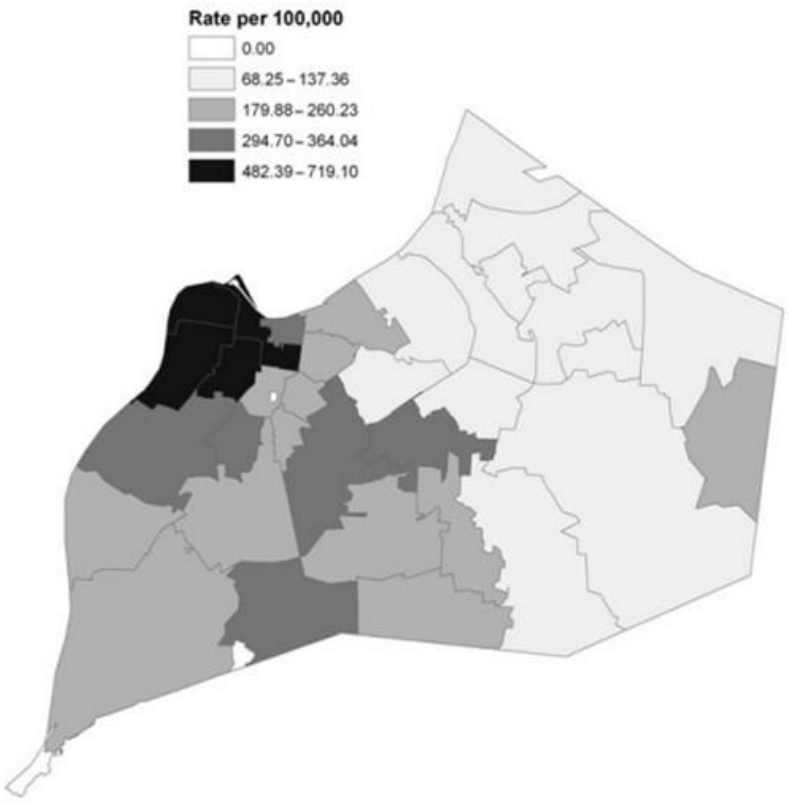

Figure 6: Childhood asthma hospital discharge rates, Jefferson County zip codes, 2005-2008 (Hanchette et al., 228)

Hanchette and others also argue how this study relates to the environmental injustices of Louisville's west end, which includes Rubbertown, stating that they hold an unequal burden of the county's Toxic Release Inventory Sites. This is especially prevalent as the majority of these residents have shifted to majority African American and impoverished, which is termed as the "minority move-in hypothesis" (232). Looking again at their asthma levels compared to the rest of Jefferson County, in the years 2005-2008, there were 832 asthma hospitalizations in ages 0-19 in west-end Louisville, while levels in the east end were significantly lower. These statistics and their relation to environmental injustice in Rubbertown are irrefutable. Since these children are exposed to a larger range of toxic air pollutants, they are thus more likely to get asthma. In this study too, it can be inferred that these cases of asthma are inhibiting quality of life, as it results in hospitalization for many. This in turn brings high health care costs, which as mentioned before cannot be afforded by most that live in Rubbertown. It can reduce quality of life for these children's lives from a small age, as asthma can make physical activity difficult, which in turn can make it harder for those that may want to participate in sports. Going into adulthood, asthma can increase obesity rates, again from the difficulty of achieving physical activity.

An additional study looking into pediatric asthma shows a broader scope of the country and the repeating patterns of environmental injustice that can be observed. Aligne and others examined the 1988 Child Health Supplement (CHS) to the National Health Interview Survey (NHIS), which provided a population of civilian, non-institutionalized households throughout the United States. One child from each household was then randomly selected to look into risk factors of pediatric asthma such as current

health issues and demographic information (873). In the conclusion of their study, they determined that there was a disturbingly higher rate of asthma in African American children in the United States. In addition, it was found that children living in an urban setting were at an increased risk for asthma. Overall, the assumption can be made that the higher levels of African American children with asthma can be attributed by the overall theme of a higher rate of African Americans living in urban, poor neighborhoods all throughout the United States (876). Although this study is slightly dated, being from 2000, it has a few highlights to mention. First would be the overarching theme of children in urban areas, predominately African Americans, having asthma. The second would be that when compared to the more recent study conducted by Hanchette and others, these continual patterns can still be observed. Although this study is not specific to Rubbertown, it provides for a repeating offense towards the United States habits of poor air quality in urban areas, which in turn leads to environmental injustice for those living there. It also highlights the cycle that these families go through, as the children are put into an adverse health situation early on which can immediately put them at a disadvantage.

A counter to these prevalent issues in Rubbertown has been made by The Agency for Toxic Substances and Disease Registry (ATSDR), who beginning in 1992 published a report due to the public concern from residents over the air quality and potential exposure to toxic substances. This report was originally inconclusive, and in response, the Jefferson County Community Task Force was established in 1999, which was a citizen founded group committed to identifying environmental concerns in west-end Louisville. Samples of over 50 different volatile organic compounds were monitored between the

years of 2000 to 2005, which ended up in collaboration with Louisville Metro Air Pollution Control District, the University of Louisville, and the Commonwealth of Kentucky. This resulted in the West Louisville Air Toxics Study, which was completed in 2006. This study brought about the creation of the Strategic Toxic Air Reduction, or STAR Program (Hanchette et al., 232-233). However, the initiatives set forth by STAR have come with minimal changes of the overall air quality. As pointed out by Hanchette, the childhood asthma rates in west end Louisville had not lowered since the study was conducted in years after the establishment of the program. This can be applied to more recent studies as well, which will be discussed further in the later pieces of this thesis, which involve the high premature death rates in Rubbertown. In addition, there has not been a more recent edition of the West Louisville Air Toxics Study, which was done 16 years ago, making it seem likely Louisville Metro has challenges in developing further actions needed to take place in order to improve the overall air quality for those in Rubbertown.

Overall, it can be observed that the air quality of Rubbertown needs improvement in the coming years for the sake of the residents, meaning that stricter enforcement needs to be made on the chemical manufacturers in the area. Those living in Rubbertown are exposed to major toxic air pollutants of concern such as 1,3-butadiene and vinyl chlorides. These can lead to overall adverse health issues, and more concerning, can negatively affect childhood health in the population. These adverse health issues further contribute to the environmental injustice at hand, as those in west end Louisville are given a disproportionately high level of Toxic Release Inventory Sites when compared to the rest of the county, specifically east end Louisville. This can result in higher health

care costs, more hospitalizations, and health issues that may inhibit a person's ability to regularly exercise, contributing to higher rates of obesity in the area.

Hazardous Waste

An additional factor to consider for the residents of Rubbertown is hazardous waste. In simple terms, hazardous waste is any waste that has components in it that give it the potential to hurt the environment and/or human health. Hazardous waste can come in many different forms, ranging from industry to household waste, and can be in liquids, sold gases, and sludges (EPA). Similar to the Clean Air Act, there are regulations in place for the proper disposal of hazardous waste, called the Resource Conservation and Recovery Act, or RCRA. RCRA encompasses the idea of "cradle-to-grave" practices, which proposes that hazardous waste should be responsibly managed through its creation, while it is transported, treated, or stored, and until it is completely disposed of.

Along with RCRA, the EPA also implements the Comprehensive Environmental Response, Compensation and Liability Act, or CERCLA. More commonly, CERLA is referred to as Superfund. Superfund began in 1980 due to concerns over hazardous waste being dumped, left in the open, or improperly managed, specifically through the incidents of Love Canal and Valley of the Drums. This act allows for the EPA to provide funds for the cleanup of these contaminated sites, with the end goal of returning the areas to safe use for the community at hand. To date, there are 1,334 Superfund sites on the National Priorities List (NPL), meaning they are of top concern for the EPA. While these sites on the NPL come first, there are still other smaller cleanup areas called Brownfield sites. These areas are not necessarily proven harmful enough to deem EPA intervention through Superfund, yet they still complicate the use of an area due to the presence or potential presence of hazardous waste. Often, these Brownfield sites are abandoned workplaces or facilities.

While there are no Superfund sites in proximity to Rubbertown, there are still a plethora of Brownfield sites which are of concern. These sites can have an effect on housing costs, rates of foreclosures, and relate to premature death in the area. However, due to their lack of funding through the EPA, it is often left to communities to determine the financials for proper cleanup of these sites. Although there has been some gain in recent years through development incentives put out by the federal government in hopes of private sector manufacturers to re-develop Brownfield sites, often times the costs and governmental hoops to jump through outweigh the benefit of using the space (Jaconetty, 56). Often times with Brownfields, it also becomes difficult to understand from a legal standpoint if a company still owns the space or not, as the EPA does not enforce liability of cleanup. In other words, the cleanup of a Brownfield site may come with difficulties associated with determining what company, if any, owns the space.

A main reason for concern for living in proximity to Superfund sites is that they are linked to health hazards. One of these health hazards that has been studied is associated with cancer risk due to being located near Superfund sites. In one study, cancer incidence rates in the years 2007-2011 were compared to the 2013 list of Superfund sites in order to determine if there was a correlation between the location of Superfund sites and increased rates of cancer (Amin at al., 1). In their conclusion, it was determined that there was a significant positive relationship between the amount of Superfund sites and overall cancer rates across all of the United States. It was also observed that in these states, there was also a higher number of sites in counties with elevated rates of minority populations, and thus higher cancer rates. The study noted that this correlation between minorities and

close proximity to Superfund sites may be linked to the lower real estate values in the area, thus making it more accessible for rent (Amin et al., 8).

Although the study by Amin and others looks specifically at Superfund sites, it can still be relevant for the observation of Brownfields in Rubbertown. While these Brownfield sites are considered less of a concern by the EPA, they are in much larger quantities in the country when compared to Superfund sites. In fact, according to the EPA, there is estimated to be more than 450,000 Brownfield sites in the U.S, with 204 being located in Kentucky. Although there have been minimal studies done on the health concerns associated with living near Brownfields sites, one may expect the findings to be similar to that of a Superfund site due to their large prevalence in the country.

Another consideration beyond health concerns is the impact that these sites have on foreclosures and housing values in the area. A source by Gilderbloom and others looks at correlations such as neighborhood housing values and foreclosures in downtown Louisville (Gilderbloom et al., 1). The study overall focuses on clusters of Brownfield sites, most of which are found in the Rubbertown area, which can be highlighted in Figure 7. In correlation to these clusters of Brownfield sites, a link of high percentages of African American population could also be accounted for, typically from 60%-100% in the areas of highest concentration (Figure 8).

The study looked directly at housing values, which concluded that in the year 2000, houses within a half-mile radius of a Brownfield site were worth $10,342 less than houses outside the area, with similar patterns continuing to the year 2008 when the study concluded. Living near Brownfield sites also had an impact on foreclosures, with neighborhoods within a half-mile radius of a site seeing 10 more foreclosures than

neighborhoods outside of it. In addition to housing and foreclosures, Gilderbloom and others also analyzed the potential for premature death, which concluded that people in Louisville are more likely to die prematurely when living in neighborhoods with Brownfield sites. Specifically, it was found that per 100,000 residents there were approximately 169 years of potential life lost (12).

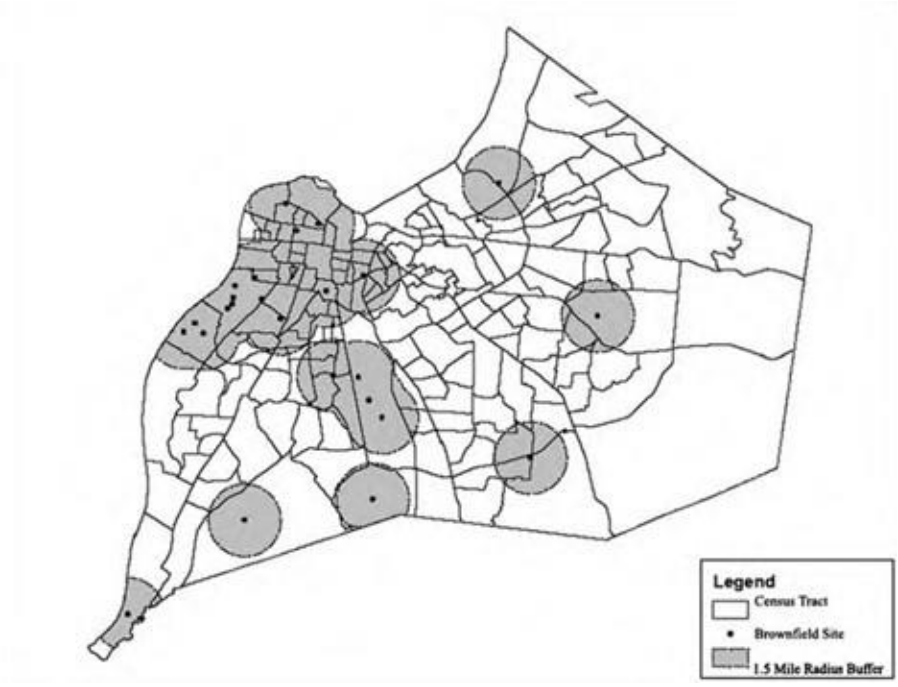

Figure 7: Locations of Brownfield sites in Jefferson County, Kentucky (Gilderbloom, 7)

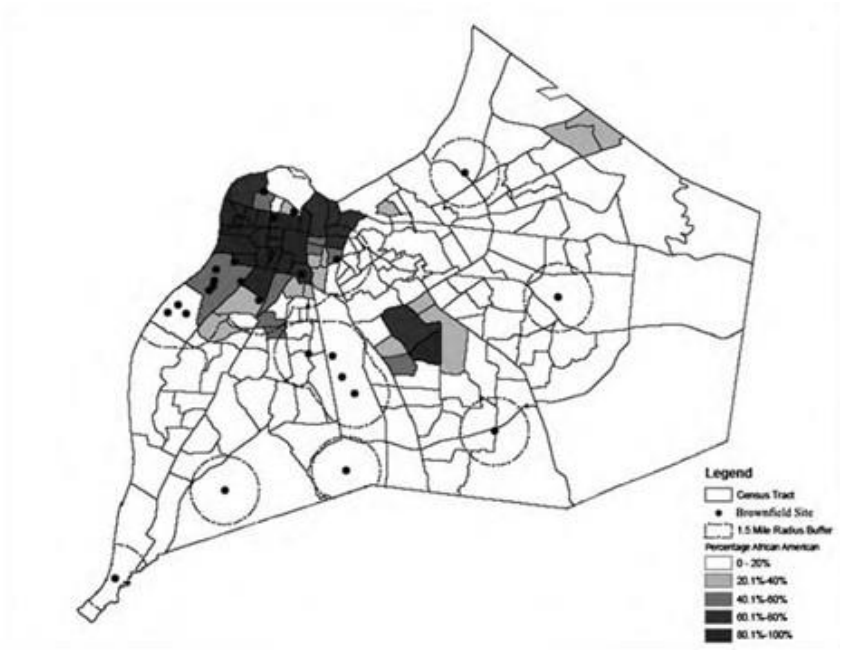

Figure 8: Locations of Brownfield sites and their relationship with percentage of American Americans in Jefferson County, Kentucky (Gilderbloom, 8)

This study shows the social and economic considerations of living in areas in or around Rubbertown, and thus near Brownfield sites. For those living in the area, they feel stuck in the cycle. Beginning typically with a poor education, which can result in lower income, residents in the area become trapped in these neighborhoods. With housing prices being lower, it is easy to buy into the area but difficult to leave. Thus, leading to prolonged rates of environmental exposures in these areas, and ultimately resulting in potential premature death. Racial inequalities can also be highlighted in this study, as the majority of the population is shown to be African American.

To switch back to the issue of financial ability by communities to cleanup Brownfield sites, the source by Gilderbloom and others gives a great counter for how if successful, these revitalizations of Brownfield sites can have a high economic return and overall

positive moral for a community. One specific example in Louisville that the study presents looks at an area near the west end that is referred to as East Russell. According to the University of Louisville's Center for Environmental Policy and Management, the neighborhood of Russell covers 1.4 square miles, and has 100 Brownfield sites of interest within in. The area also shows a correlation to environmental justice concerns similar to Rubbertown, as the poverty rate before COVID-19 was at 60%. However, the neighborhood of East Russell has a success story from the cleanup of one of their Brownfield sites, the Trolley Barn.

The Trolley Barn was once used in 1880s, predominately for mule-drawn trolleys, and over the years became contaminated with fuel, pesticides, and other hazardous chemicals, before being abandoned (Gilderbloom et al., 13). However, through a grant awarded by the EPA, the Brownfield site was restored over multiple years, and is now the Kentucky Center for African American Heritage. Other efforts have been taken throughout Louisville, such as at Waterfront Park, which inspired additional neighborhood cleanup efforts that resulted in a better housing rate. The source also shows however that while East Russell can be an example of successful Brownfield cleanup, not all sites can have the same end result. For most sites, there may be multiple properties that are owned by a number of individuals, making it difficult to pinpoint how to get permission to begin cleanup. In addition, the Trolley Barn was a special case as it was granted monetary support through the EPA, which is not the same for the majority of other locations. Although the idea of Brownfield cleanup sounds attainable, in reality there are many governmental hoops to jump through, leading to a slow process that takes a large contribution from the community.

Premature Death

A specific component that needs its own defense is the overall potential for premature death due to living in proximity to Rubbertown. While air pollutants and hazardous waste have their own statistics and relations to health concerns and premature death, compiling the environmental issues allows to view the issue as a whole. In the past years, officials in Louisville have given little to no research on the impact on lifespan that environmental factors can have on a population. For example, in a 2013 study titled the Greater Louisville Project, which was conducted by Louisville Metro, concluded that there was a 13-year difference in potential years of life depending on one's place of residence, which can be highlighted in Figure 9. It was further determined that the cause of raised premature death rates are not contributed to environmental contaminants, but instead lifestyle choices. A study conducted by Gilderbloom and others however forms a counter argument on the Greater Louisville Project's reason for premature death. It can be noted that Rubbertown, which not featured by name in the figure, is located within miles to Russell and Portland neighborhoods, and thus sits in the lowest rate of approximate years of life

Figure 9: The predicted life expectancy for residents in neighborhoods throughout Louisville, Kentucky (Greater Louisville Project)

The Greater Louisville Project, which fails to correlate environmental factors to life expectancy differences in Louisville neighborhoods, is taken into consideration as Gilderbloom and others devises an analysis to evaluate all possible variables to early death. The study takes two main test variables into consideration- proximity to Brownfield sites and proximity to Rubbertown, by utilizing geo-coding techniques to track years of potential life, along with other neighborhood factors as control variables. Past research regarding zip codes and premature death is also taken into consideration for the creation of the analysis. In conclusion, the authors discovered significant causes of

premature death to be linked to proximity of Rubbertown's toxic contaminants, thus disproving the initial ideas made by the Greater Louisville Project, and directly correlating environmental measures to premature neighborhood deaths.

Conclusion

Working in the environmental health field, all factors of a situation should be taken into consideration, including personal choices of a community. Yet as the Gilderbloom study counters with the Greater Louisville study, focus should foremost be on preventing what cannot be cured, which begins with creating a clean and safe environment for all communities, no matter the racial identity. While individual choices of the population are not of control, the problem can be expanded to consider environmental factors. The right to a clean-living environment, no matter education, income, or race, is a consideration on an individual's life expectancy- both in a physical and mental health perspective. By pushing these issues off to other factors, and making inconclusive direct correlations, it takes away from the true problems as displayed by the Greater Louisville Project depicted by Gilderbloom.

Looking into the future for Rubbertown, history may continue to repeat itself without some form of new intervention. While it is difficult to pinpoint one clear solution for the residents of Rubbertown, small steps overtime may be key to create a long-term resolution. One study conducted by Sarr and others looks to these implications that need to be made in Rubbertown, and argues that despite current air quality improvements that can be observed throughout the county, it is unclear if these benefits have stretched to the residents of Rubbertown. Even if air quality has improved slightly, however, steps need to continue to be taken to prevent continual upward trends. It is also important to note that improvements in quality may not necessarily mean that they are now at compliance levels. The connection between community groups, the government, and the 19 differing facilities in Rubbertown will be key in finding long-term goals in order for Rubbertown

residents to achieve not just threshold living conditions, but ones that they may thrive in. From an environmental health perspective, one must continually reach the balance of helping the community and being financially savvy for the parties involved. However, in more recent years, specialists have moved towards understanding the environmental injustices present in communities throughout the nation. Rubbertown is just a single example of these unequal environmental burdens that minorities carry, with hopes that as education continues to grow in the professional field, awareness will soon begin to spread to other effected communities as well.

Through this thesis, research was able to be analyzed and overall reach the conclusion that residents in the Rubbertown area are exposed to higher rates of environmental pollutants, such as air pollution and hazardous waste, which then relates to higher levels of premature death. This can be connected to the patterns of environmental injustice in the area, specifically by observing the demographics of the population. Specifically, there are discrepancies in race and income, which can correlate to higher health care costs, lack of healthy food options, and minimal green space for exercise. In future years, the hope is for further studies to be made, in order to draw more concrete conclusions that include updated statistics.

Works Cited

Adams, J. L. (2001). African American Migration to Louisville in the Mid-Twentieth Century. *The Register of the Kentucky Historical Society*, *99*(1), 363-384.

Aldy, J. E., Auffhammer, M., Cropper, M., Fraas, A., & Morgenstern, R. (2022). Looking Back at 50 Years of the Clean Air Act. *Journal of Economic Literature*, *60*(1), 179–232.

Aligne CA, Auinger P, Byrd RS, & Weitzman M. (2000). Risk factors for pediatric asthma: contributions of poverty, face, and urban residence. *American Journal of Respiratory & Critical Care Medicine*, *162*, 873–877

Amin, R., Nelson, A., & McDougall, S. (2018) A Spatial Study of the Location of Superfund Sites and Associated Cancer Risk. *Statistics and Public Policy*, *5*(1), 1-9.

Centers for Disease Control and Prevention. (April 2022). Most Recent State or Territory Asthma Data. Retrieved from https://www.cdc.gov/asthma/most_recent_data_states.htm

Chetty, R., Stepner, M., Abraham, S., Lin, S., Scuderi, B., Turner, N., Bergeron, A., & Cutler, D. (2016) The association between income and life expectancy in the United States, 2001-2014. *Jama*, *315*(16).

Du, Z., Mo, J., Zhang, Y. (2014). Risk assessment of population inhalation exposure to volatile organic compounds and carbonyls in urban China. *Environmental International*, *4*, 33-45.

Elson, M. (March 2015). Our History- Gas rationing and Rubbertown boom. *Courier Journal*. Retrieved from *https://www.courier-journal.com/story/news/local/neighborhoods/2015/03/27/history-gas-rationing-rubbertown-boom/70533778/*

Gilderbloom, J., Meares, W., & Riggs, W. (2016) How brownfield sites kill places and people: an examination of neighborhood housing values, foreclosures, and lifespan. *Journal of Urbanism, 9*(1), 1-18.

Gilderbloom, J., Meares, W., & Squires, G. (2020) Pollution, place, and premature death: evidence from a mid-sized city. *Local Environment, 25*(6), 419-432.

Hanchette, C., Lee, J., & Aldrich, T. (2011) Asthma, Air Quality and Environmental Justice in Louisville, Kentucky. *Geotechnologies and the Environment, 4,* 224-242.

Henneman, L., Liu, C., Mulholland, J., & Russell, A. (2017) Evaluating the effectiveness of air quality regulations: A review of accountability studies and frameworks. *Journal of the Air & Waste Management Association, 67*(2), 144-172.

Howard, F. A. (1941). Synthetic Rubber. *Harvard Business Review, 20*(1), 1.

Jaconetty, T. (1999) Revitalizing Urban Brownfields- A National, State, and Local Effort to Reclaim Blighted Properties. *Assessment Journal, 6*(4), 56

Joss, K. M., Eeftens, M., Gintowt, E., Kappeler, R., Kunzli, N. (2017). Time to harmonize national ambient air quality standards. *International Journal of Public Health, 62,* 453-462.

Jurewick, J., Polanska, K., Hanke, W. (2012). Exposure to Widespread Environmental Toxicants and Children's Cognitive Development and Behavioral Problems. *International Journal of Occupational Medicine and Environmental Health, 26*(2), 185-204.

Kentucky State Data Center at the University of Louisville & Metro United Way. (July 2017). Rubbertown Neighborhood Profile. 1-17. Retrieved from http://ksdc.louisville.edu/wp-content/uploads/2018/06/Rubbertown.pdf

Khullar, D. (2018). Health, Income, And Poverty: Where We Are And What Could Help. *Health Affairs Health Policy Brief,* 1-6.

Lind, P. M., & Lind, L. (2020). Are Persistent Organic Pollutants Linked to Lipid Abnormalities, Atherosclerosis and Cardiovascular Disease? A Review. *Journal of Lipid and Atherosclerosis*, *9*(3), 334–348.

Louisville Air Watch. (Updated Daily). Louisville's Air Quality Index. Retrieved from https://airqualitymap.louisvilleky.gov/basic

McMlellan, O. R. (2012). Role of science and judgement in setting national ambient air quality standards: how low is low enough? *Air Quality and Atmospheric Health, 5,* 242-258.

Muezzinoglu, A., & Dincer, F. (2005) Correlation between the public odor complaints and toxic air pollutants. *14th IUAPPA Regional Conference.*

Nieto, A., Zhang, L., Bhandari, D., Zhu, W., Blount, BC., De Jesus, VR. (2021). Exposure to 1,3-butadiene in the U.S population. *National Health and Nutrition, 266,* 129-149.

Sarr, S., Hayes, B., & DeCaro, D. (2021) Applying Ostrom's Institutional Analysis and Development framework, and design principles for co-production to pollution management in Louisville's Rubbertown, Kentucky. *Land Use Policy,* 104.

Saithakumar, N., Bolaji, B., Brill, I., Chen, L., Tipre, M., Leader, M., Arota, T., Delzell, E. (2019). Mortality among men and women in North American synthetic rubber industry. *Journal of Occupational and Environmental Medicine, 61*(11), 887-897.

Scientific Committee on Health and Environmental Risks. (2012). Opinion on the Toxicity and Assessment of Chemical Mixtures. *Directorate-General for Health & Consumers,* 1-50.

Sciences International Inc. (October 2003). West Louisville Air Toxics Study Risk Assessment. 1-133. Retrieved from https://louisvilleky.gov/air-pollution-control-district/document/west-louisville-air-toxics-study-october-2003pdf

Solo, R. (1954). Research and Development in the Synthetic Rubber Industry. *Quarterly Journal of Economics, 68*(1), 61–82.

Thompson, E. J. (2018). Airborne Particulate Matter. *American College of Occupational and Environmental Medicine, 5*(60), 392-423.

United States Census Bureau. (2020). KENTUCKY: 2020 Census. Retrieved from https://www.census.gov/library/stories/state-by-state/kentucky-population-change-between-census-decade.html

United States Environmental Protection Agency. (August 2022). Overview of the Clean Air Act and Air Pollution. Retrieved from https://www.epa.gov/clean-air-act-overview

United States Environmental Protection Agency. (April 2022). NAAQS Table. Retrieved from https://www.epa.gov/criteria-air-pollutants/naaqs-table

United States Environmental Protection Agency. (February 2022). Hazardous Air Pollutants. Retrieved from https://www.epa.gov/haps

United States Environmental Protection Agency. (May 2022). Overview of EPA's Brownfields Program. Retrieved from https://www.epa.gov/brownfields/overview-epas-brownfields-program

University of Louisville Center for Environmental Policy & Management (2022). Brownfield Area Benefits Estimator Toolbox Guidebook. Retrieved from https://louisville.edu/cepm/pdf-files/babe-guidebook

Vethaak, A., Legler, J. (2021). Microplastics and human health. *Science, 371*(6530), 672-674.

Zhang, X. & Chen, W. (2022) 1,3-Butadiene: a ubiquitous environmental mutagen and its associations with diseases. *Genes & Environment*, *44*(1), 1-22