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Assessing Cancer-Causing Carcinogens in Freight Facilities: A Case Study of Englewood Rail Yard in Houston, Texas

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ASSESSING CANCER-CAUSING CARCINOGENS IN FREIGHT FACILITIES

A CASE STUDY OF ENGLEWOOD RAIL YARD IN

HOUSTON, TEXAS

THESIS

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By

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This study provides a qualitative analysis and uses a cross-case comparison to highlight the contamination exposure of the Englewood rail yard in Houston, Texas to contamination exposure found in four (4) other rail yards: Conrail rail yard in Elkhart, Indiana, Union Pacific rail yard in Eugene, Oregon, Paoli rail yard in Paoli, Pennsylvania, and CSX rail yard in Waycross, Georgia. The research will show that a high level of cancer-causing toxins created a health problem in the Houston area communities of the city's Greater Fifth Ward, Denver Harbor, and Kashmere Gardens neighborhoods. Based upon the disposal practices by rail yard facilities, cancer-causing toxins formed plumes and contaminated the groundwater and soil that impacted the health of residents living nearby rail yards. The impact of these cancer-causing toxins creates an "urgency of need" to ensure that clean-up and environmental equity are established. To determine the facts, this study will examine the type of contaminant plaguing these communities; what caused the contamination; and what should be done to abate the suffrage of these communities adjacent to a rail yard. The key findings of this study revealed that the improper release of wastewater to nearby drainage ditches from operations of the Houston Wood

Preserving Works (HWPW), poor waste handling practices, leaks of two underground storage tanks, and spills/leakage from daily operations are all possible sources to the ongoing contamination in the above communities. Future studies should address expanding the rail yard websites to include links to technical documents that will inform the public of potential hazards and the exact location of contaminants. Allowing this information to be readily available will show rail yard accountability to the public.

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LIST OF ACRONYMS

Abbreviations and Acronyms Used:

1. Agency for Toxic Substances and Disease Registry (ATSDR)
2. Dense Non-Aqueous Phase Liquids (DNAPL)
3. Environmental Justice and Health Alliance for Chemical Policy Reform (EJHACPR)
4. Environment Resource Management (ERM)
5. Houston Health Department (HHD)
6. Houston Wood Preserving Works (HWPW)
7. Non-Aqueous Phase Liquids (NAPL)
8. Resource Conservation and Recovery Act (RCRA)
9. Southern Pacific Transportation Company (SPTC)
10. Southeast Vegetation Management (SEVM)
11. Technical Assistance Services for Communities (TASC)
12. Texas Commission on Environmental Quality (TCEQ)
13. Texas Department of State Health Services (DSHS)
14. Texas Environmental Justice Advocacy Service (TEJAS)
15. United States Environmental Protection Agency (U. S. EPA)
16. Union Pacific Railroad (UPRR)

LIST OF TERMS

1. **Dense Non-Aqueous Phase Liquid (DNAPL)** is a denser-than-water NAPL, i.e., a liquid that is both denser than water and is immiscible in or does not dissolve in water.
2. **Hazardous Materials** is any substance or material that is capable of posing an unreasonable risk to health, safety, and property when transported in commerce.
3. **Historic Wards** is an optional division of a city or town for administrative and representative purposes, especially for purposes of an election.
4. **Planned Communities** is any community that was carefully planned from its inception and is typically constructed on previously undeveloped land.
5. **Plumes of Contaminants** is a body of groundwater that has been affected by the presence of pollutants in the soil or aquifer.
6. **Non-Aqueous Phase Liquid (NAPL)** are organic liquid contaminants that do not dissolve in, or easily mix with water.
7. **Semi-volatile organic compounds (SVOC's**) are a subgroup of volatile organic compounds that have boiling points of 260ºC – 400ºC.
8. **Super Neighborhood** is a geographically designated area where residents, civic organizations, institutions, and businesses work together to identify, plan, and set priorities to address the needs and concerns of their community.
9. **Volatile Organic Compounds** are organic chemicals that have a high vapor pressure at room temperature.

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CHAPTER 1

INTRODUCTION

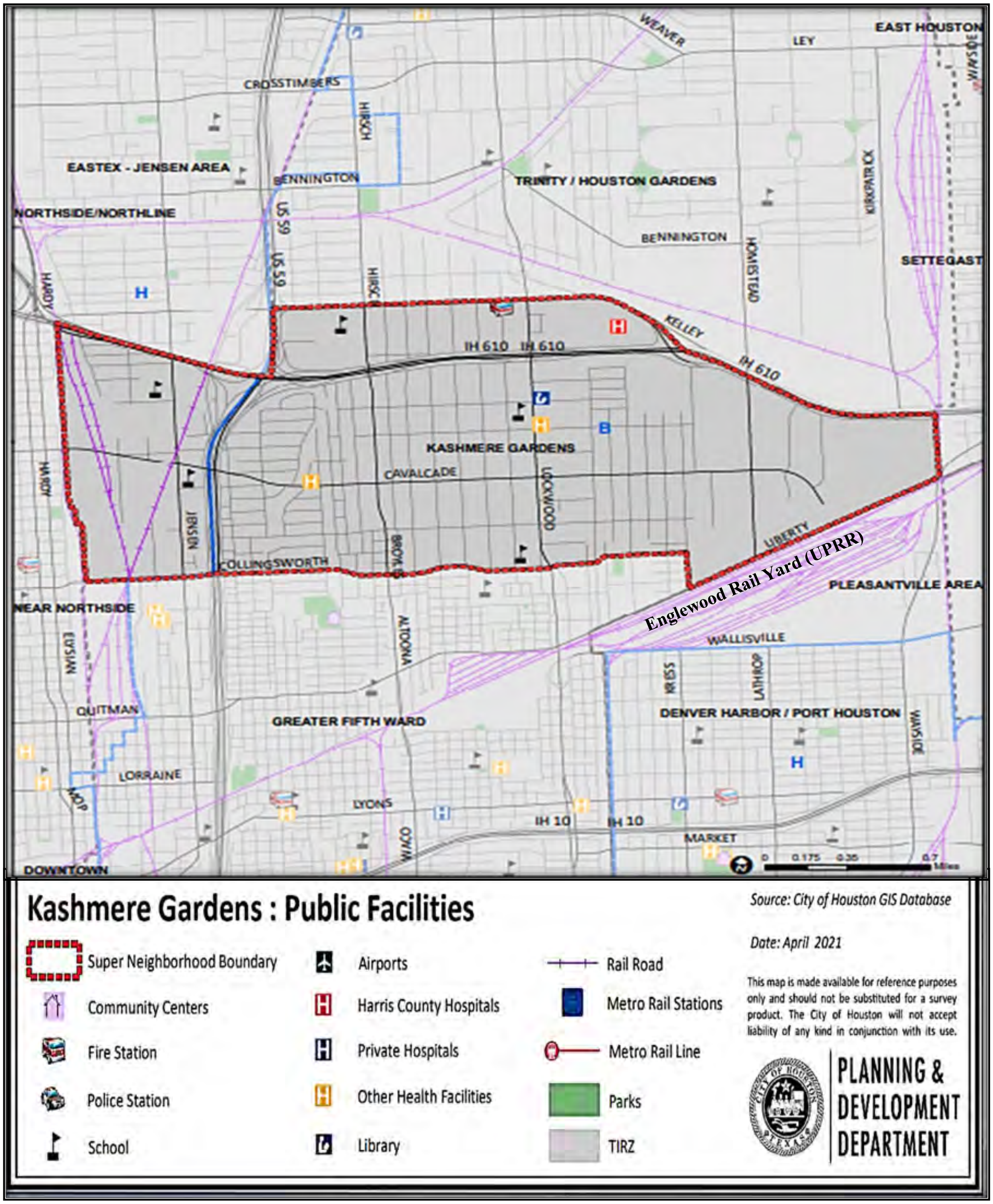
Rail yards can be considered the backbone to the operations of the railroad transportation industry. Filled with a complexity of patterns, rail yards contain a series of tracks that collect railcars for loading or unloading with freight, sorting freight into groups to determine destination, or just storing freight for later use. In addition to these functions, rail yards house locomotive engines that push and pull railcar containers and tankers (Stanford Research Institute, 1977).

Many rail yards provide fuel stations and maintenance garages for the railroad equipment. Most of the heavy equipment in rail yards use hazardous materials. These hazardous materials can be either used in the rail yard on railroad crossties, in locomotive engines, or stored in the compartment of tanker railcars stationed in the rail yard (Creosote Council, 2018). Depending upon a railroad company's business model, some rail yards may have various industries located on site (i.e., chemical plants, wood treatment plants, manufacturing plants, or oil refineries). These ancillary industries are deeply connected and many times, they are owned by railroad companies that own the rail yard. Having these additional industries within these rail yards has a caveat. The potentially dangerous by-products that these ancillary industries produce can be hazardous and toxic by nature (Cox, 2017).

Today, as different type of chemicals and hazardous contaminants flow in and out of these rail yards, communities in proximity to a rail yard prove vulnerable to environmental and individual health issues. The average person does not realize that they have come into contact with some type of perilous or harmful chemical from these rail yards that could affect their health. These health problems develop from exposure to toxic chemicals and may take years to metastasize before a person realizes the effects. Often times, “lifestyle” habits (i.e., drinking, smoking, and poor nutrition, etc.) are blamed for the failing health of people that live near rail yards (Pak, 2005). However, some studies show that “location” verses “habits” makes the difference in the quality of health. As reported by the California Air Resources Board, communities living near rail yards are exposed to an increased risk of 250 chances in a million of developing cancer (California Environmental Protection agency, 2007).

Background of Research Problem

For several years, concern arose regarding the health and well-being of the residents living in proximity to the Englewood rail yard in Houston, Texas, which is owned by Union Pacific Railroad (UPRR). The residents of the Greater Fifth Ward, Denver Harbor, and Kashmere Gardens communities have all been impacted by a cancer cluster arising in these areas. See Figure 1.



Source: (Houston Planning and Development Department, 2021b)

Figure 1: Englewood rail yard and adjacent communities

The health issues plaguing these communities revealed a slight growth rate of cancer over the expected cancer rates. Based on these cancer growth rates, many adults between the ages of 20 and older showed signs of acute myeloid leukemia, lung and bronchus, urinary bladder, and intrahepatic bile duct cancers (Texas Department of State Health Services, 2020b).

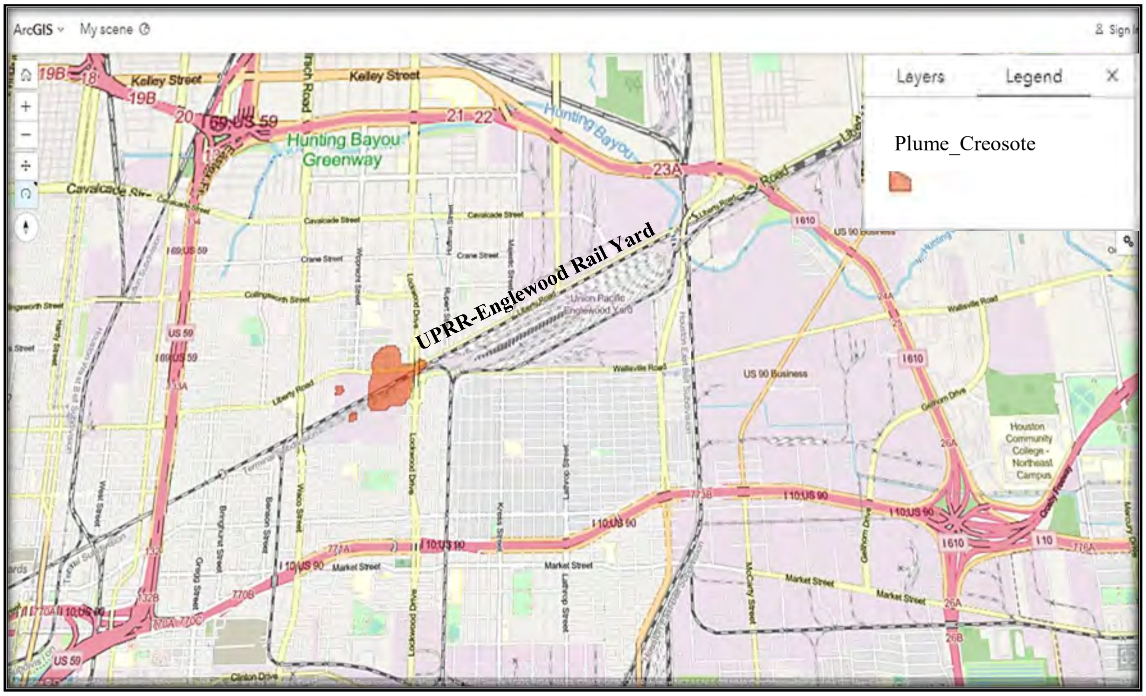
An analysis performed by the Houston Health Department (HHD) on the soil and groundwater of underground storm sewers located near Englewood rail yard revealed volatile and semi-volatile organic compounds in the storm sewers (Houston Health Department, 2020). In addition to these compounds, indications of non-aqueous phase liquids (NAPL) and dense non-aqueous phase liquids (DNAPL) were presented (Calvino, 2019). Further investigation by the Texas Department of State Health Services (DSHS), discovered elevated counts of cancers known to be associated with the kinds of chemicals of concern (COC) found at this UPRR yard sites (Texas Department of State Health Services, 2020b). See Table 1.

Table 1: Chemicals of Concern (COC) found at the UPRR Yard Site.

Chemical of Concern	Chemical Uses
1,2-Dichloroethane	Used in the production of vinyl chloride, which is used to make polyvinyl chloride (PVC) pipes, furniture and automobile upholstery, wall coverings, housewares, and automobile parts.
1,2-Diphenylhydrazine	Used in fabric dyes but now is only used to make certain medicines.
2,4-Dimethylphenol	Used as a perfuming agent in cosmetic industry. Also used in the production of high-viscosity phosphate esters, as a feedstock for hindered phenol antioxidant and specialty modified phenolic resin manufacture
2-Methylnaphthalene	Used in organic synthesis, insecticides, pesticide adjuvant. It is also used as dye carrier.
Arsenic	Used industrially as an alloying agent, as well as in the processing of glass, pigments, textiles, paper, metal adhesives, wood preservatives and ammunition.
Benzene	Uses include making plastics, synthetic fibers, rubber lubricants, dyes, resins, detergents, drugs, and is a major part of gasoline.
Benzo(a)pyrene	Only purpose of the production of the chemical is for research use
Bis(2-ethylhexyl) phthalate (DEHP)	Used in the production of polyvinyl chloride (PVC) and vinyl chloride resins, where it is added to plastics to make them flexible
Creosote	Used historically as a treatment for components of seagoing and outdoor wood structures to prevent rotting.
Fluorene	Used to make sulfur hexafluoride, the insulating gas for high-power electricity transformers
Fluoranthene	Used to make drugs and fluorescent dyes; Also used as a stabilizer in epoxy resins and in electrically insulating oils
Naphthalene	Used as an insecticide and pest repellent
Pentachlorophenol	Used as a industrial wood preservative; mainly to treat utility poles and cross arms
Phenol	Used in certain medical procedures and as an ingredient in numerous treatments and laboratory applications.
Pyrene	Used commercially to make dyes and dye precursors
Toluene	Used as a solvent for carbon nanomaterials, including nanotubes and fullerenes, and it can also be used as a fullerene indicator.
Vinyl chloride	Used primarily to make polyvinyl chloride (PVC); PVC is used to make a variety of plastic products, including pipes, wire and cable coatings, and packaging materials.

Source: (PBW Consulting Engineers and Scientists, 2013)

In addition to the DSHS investigation, toxic underground plumes of contaminants were found in the Greater Fifth Ward, Denver Harbor, and Kashmere Gardens areas. The contaminates were identified as carcinogenic chemicals, creosote and arsenic (TASC, 2021). See Figure 2.



Source: EPA's Environmental Justice Screening and Mapping Tool version 2.0

Figure 2: Map of Contamination within Englewood rail yard

The contaminates creosote and arsenic are known cancer-causing toxins that have been used for more than 100 years by railroad companies to preserve the integrity of the wooden beams on railroad cross ties. Additional investigation disclosed that the Englewood rail yard, which borders the Greater Fifth Ward, Denver Harbor, and Kashmere Gardens area, was once used as a centralized production wood preserving facility. At this UPRR yard site, creosote, arsenic, and other chemicals were by-products of this UPRR facility's production of railroad crossties. Although wood-preserving chemicals are no longer produced at this UPRR yard site, the toxic cancer-causing residue of creosote and arsenic still remains as an everlasting effect on neighboring communities and the environment. These contaminants can endanger human life, animal life, and the entire ecosystem bordering these rail yards, if this leaching to the soil and polluting of the water continues.

Statement of the Problems

From 1911 to 1984, Southern Pacific Transportation Company (SPTC), owned Englewood rail yard and conducted wood-treating operations at this location. Known as the Houston Wood Preserving Works (HWPW), this industry manufactured and disposed of highly hazardous and toxic chemicals on rail yard site over the period of approximately 75 years. See Figure 3.

Source: (TASC, 2021)

Figure 3: HWPW facility in Englewood rail yard

Subsequently to the closing of this ancillary industry, UPRR acquired the Englewood rail yard and adjacent property through a 1996 merger with SPTC. Prior to the closing of the HWPW and the merger of these railroad company, SPTC was responsible for cleanup efforts under the U.S. EPA's Resource Conservation and Recovery Act (RCRA). According to a 1993 RCRA Facility Assessment Report, SPTC filed a Notification of Hazardous Waste Activity in August of 1980 with the Texas Department of Water Resources (TDWR), and the HWPW facility was permitted on November 18, 1980. This notification and permit identified materials that would cause the rail yard facility to be classified as a producer of hazardous waste. That same year, SPTC built an on-site surface impoundment to dispose of creosote-contaminated soil and other toxic materials. However, four (4) year later in 1984, SPTC submitted a RCRA closure plan for the surface impoundment. This closure plan implemented a ground-water monitoring plan. Unfortunately, the analysis of the ground-water samples that were collected around the surface impoundment revealed the presence of high levels of creosote constituents. As a result of these data, SPTC submitted a post-closure care application and a ground water compliance plan on May 13, 1991. From 1991 until the 1996 merger with UPRR, SPTC was totally liable for all necessary cleanup of any creosote constituents and any other hazardous waste that was identified around the 16 problem areas within the Englewood rail yard (PRC Environmental Management, 1993).

Throughout 1995 to 2020, investigations by numerous local state agencies (i.e., Houston Health Department (HHD), Texas Department of State Health Services (DSHS), Texas Commission on Environmental Quality (TCEQ), and the United States Environmental Protection Agency (U.S. EPA)), show that hazardous and toxic chemicals (i.e., creosote and arsenic) from the Englewood rail yard have been seeping/migrating into the communities of the Greater Fifth Ward, Denver Harbor, and Kashmere Gardens via soil intrusion and groundwater contamination (TASC, 2021). To date of this study, efforts to decontaminate the above areas are in process and will take a collaborative effort by UPRR, State and Local agencies, and the affected communities.

The areas directly impacted by the toxic contaminations are low income and people of color. Many of the people in these communities that border the Englewood rail yard suffer with health illnesses that developed over time. The closer residents live to proximity of the rail yard, the more possible the exposure is to COC. These health illnesses are associated with the chemicals identified by the HHD, DSHS, TCEQ, and U.S. EPA seeping/migrating from this rail yard. According to Technical Assistance Services for Communities (TASC), certain COC's caused an increased risk of various human health effects, including specific cancers and noncancerous health effects (2021). The possible health effects that have been attributable to this Englewood rail yard COC's include the following:

1) The breathing of contaminated air can result in different types of cancers in the liver, lungs, blood, and gastrointestinal tract.
2) The breathing of contaminated air can cause immune disorders, developmental and neurological effects.
3) The ingestion of contaminates can result in different types of cancers such as in the liver, skin, and gastrointestinal tract.

4) The ingestion of contaminates can have noncancer effects on the liver, kidney, lungs, heart, nerves, skin, and blood (Technical Assistant Services for Communities, 2021).

These health effects are attributed to irregular methods in disposal of wastewater by-products in production of railroad crossties, the storage practices of hazardous chemicals, and the unsuccessful clean-up in and around the Englewood rail yard facility.

Objectives and Needs of the Study

The purpose of this study is to examine the impact that contaminates from the Englewood rail yard caused low income and minority communities in Houston, Texas. This research will investigate the practices of how and where this rail yard disposed of the hazardous and toxic material (creosote), and the connections between the buildup of creosote plumes and the health illness plaguing these nearby communities. The goal of this study is to address the contamination problems seeping from rail yards through intentional and unintentional methods. This study is to improve the transportation policies and guidelines geared toward bettering the public health and advancing environmental equity in communities that border rail yards in the United States.

Currently, there is a limited amount of research relative to rail yard contaminations, and an equal or even fewer studies on the health effects of living near a rail yard. Therefore a “spotlight” is needed for this subject matter. Hence, this study intends to add to the body of research. There is a legacy of the marginalization of minorities and low-income people facing hazardous and toxic environments especially, when they live near rail yards (Pak, 2005). Whether it is deliberate or accidental, the improper release of hazardous chemicals from rail yards negatively impact nearby communities. Research shows that most of time, these neighbors are low-income, and people of color impacted by such atrocities as exposure to toxic environments.

Research Questions

This research focuses on rail yard contaminations and their practice of disposal practices of toxic chemicals, and the impact on the human health, safety, and environmental equity of living nearby a rail yard. To help in this endeavor of study, the following questions are raised:

1. Who is affected by the Englewood rail yard contaminant? Are other communities affected by contaminants from other rail yard in the United States?

2. How dangerous are these contaminates when released into neighboring communities from rail yards? How has rail yard contamination impacted nearby communities?

3. What does it mean to be living near a contaminated rail yard? What are the health effects?

4. What are the best practices to dispose of wastewater (and storage of hazardous materials) by-products for rail yards?

5. Have Union Pacific Railroad's (UPRR) planners addressed the contamination of nearby communities?

6. How should rail yard facilities mitigate off-site soil and groundwater contamination? How has UPRR mitigated off-site soil and groundwater contamination around the Englewood Rail Yard?

Limitation of Research

This study is limited to only rail yards that have neighboring communities with a large population. Since rail yards operation includes many different railroad companies, no particular railroad company is studied. Also, this study did not examine geofencing or any buyout programs for residents being affected by contaminants. It is presumed that this study's techniques are transferable and can be used to analyze other areas cross the United States.

Summary

Chapter 1 of this study introduced the topic of rail yard contamination, discussed the background of the research problem, the statement of the problem, explained the objective and need of study, provided the research questions, and explained the limitation of the study. Also, the Introduction Section provided the context to various terms used throughout this study.

In Chapter 2, the Literature Review will be presented to establish the framework of this study. Chapter 3 builds upon the foundation of this literature with an explanation of the design of study. Afterwards, a profile for Englewood and the other four (4) study area will provide detailed and discussed in Chapter 4. Finally, Chapter 5 summarizes the findings, addresses the research questions, and offers recommendations

CHAPTER 2

LITERATURE REVIEW

In this chapter, a representation of studies, articles, peer-reviewed journals, and academic reports on rail yard contamination and how such contaminations have affected low-income and minority communities is examined. The discussion of health impacts and the environmental impact in these communities raises the concerns of living in close proximity to a rail yard. Moreover, a discussion of what creosote is, how it is used at rail yards, the routes of exposure, and the health effects of exposure to creosote from rail yards is listed.

Defining Health and Environment Impact, and Environmental Justice

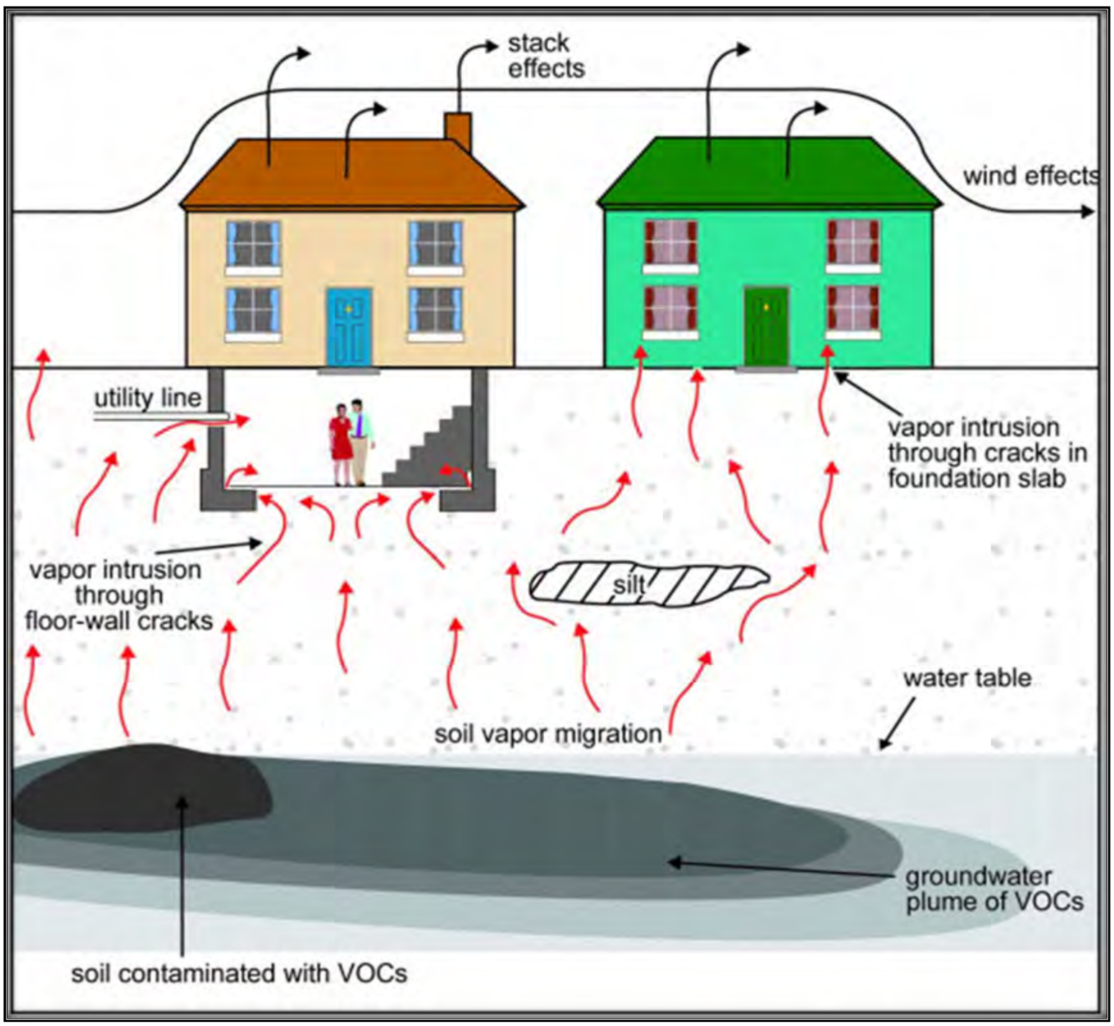
The definition of health impact involves a two-part description: (1) the state of being free from illness or injury, and (2) having a strong effect on someone or something ("Health". "Impact", 1993). However, defining environmental impact and environmental justice proves more intricated, having many complex interrelating parts or elements intertwined. Simply stated, environmental impact can be defined as 'the effect that the activities of people and businesses have on the environment' (Cambridge Dictionary, 2022). This definition of environmental impact aligns with how environmental justice can be further defined. According to U.S Environmental Protection Agency, environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income concerning the development, implementation, and enforcement of environmental laws, regulations, and polices (2021b). Under this definition, no group of people should bear a disproportionate share of the negative environmental consequences resulting from industrial, governmental, and commercial operations or policies.

Across the United States, railroad companies made strides and efforts on investing in rail yard infrastructure and technology that will help tackle the negative impacts freight-rail transportation have on the public health and nature's environment (Savage, 1981; Stanford Research Institute, 1977; Wong, 1981). Such negative impacts like water pollution, noise pollution, and air pollution from emissions of locomotives; yard types of equipment; and warehousing operations have disproportionally affected residents in disadvantaged communities. According to Hricko et al (2014) research study, titled: "Global Trade, Local Impacts: Lessons from California on Health Impacts and Environmental Justice Concerns for Residents Living near Freight Rail Yards" stated that living near a rail yard is an often-overlooked public health that leads to health disparities and environmental justice issues cross the U.S. Furthermore, this study found that there was a higher risk of cancer, with a higher percentage of non-white residents living near 17 of the 18 rail yards studied. This study concluded with an analysis done by the California Air Resources Board (CARB) that estimated rail yard health risk assessments of "living in close proximity to rail yards have a higher risk of cancer exposure" (Hricko et al, 2014).

The factors that chemical contamination have on neighboring communities from rail yards can be enormous. As Lisa Mosca points out in her thesis "Contaminated Communities: A video documentary of the Alberton, Montana mixed-chemical spill," when a contamination spill within a community is reconstructed, often times the residents' "feelings" or "perspective "is not taken into consideration. She further states that scientists tend to focus on measurable aspects of exposure, and often miss analyzing the synergistic effects of many different chemicals that are hard to measure or identify (Mosca, 1998). In the analysis of her study, she references a scientific article by Nicholas Ashford and Claudia Miller (1998), which explains that diseases related to chemical exposure remain difficult for the medical community to define and diagnose. She also states that illnesses from chemical exposures differ from classical disease symptomology, because of how the affected areas impact the human organs. Moreover, she explains that chemical exposures will affect the communication, immune or neurological systems over time. (Mosca, 1998).

Creosote: A Major Contaminant

Carcinogenic chemicals in and around rail yard facilities can take a vast array of forms. From solids to liquids and vapors, these carcinogenic chemicals can take any state of matter. Nevertheless, contamination proves imminent once these chemicals become exposed to the environment. For instance, creosote remains a substance that is widely used by the railroad industry as a wood preservative for railroad crossties. Creosote increases the life of the wooden crossties by controlling insects, fungi, and bacteria from destroying the railroad tracks. Unfortunately, creosote does not dissolve easily in water. Creosote presents as brownish yellow to a black tar-like substance and highly flammable with a smelly-like smokey, gasoline, and oil smell (Texas Commission on Environmental Quality, 2002). The release of creosote, whether intentional or unintentional, causes environmental problems. An estimated 24 million crossties were inserted into the railroad system in 2017 and 93 percent of crossties have been treated with creosote (Creosote Council, 2018). Southeast Vegetation Management (SEVM) stated that if railroad ties are old, creosote may ooze out, leeching the soil and killing plants, insects, and small animals. Creosote can also pollute the local water systems making it very dangerous to public health (SEVM, 2017). Often times, a plume is created when creosote soaks into the soil and moves downward. A plume is a mass of chemicals that begin to move deep enough into the soil where it can try to dissolve into groundwater. Generally, because of the slow movement, contaminants remain in a concentrated form; creating a plume. See Figure 4.

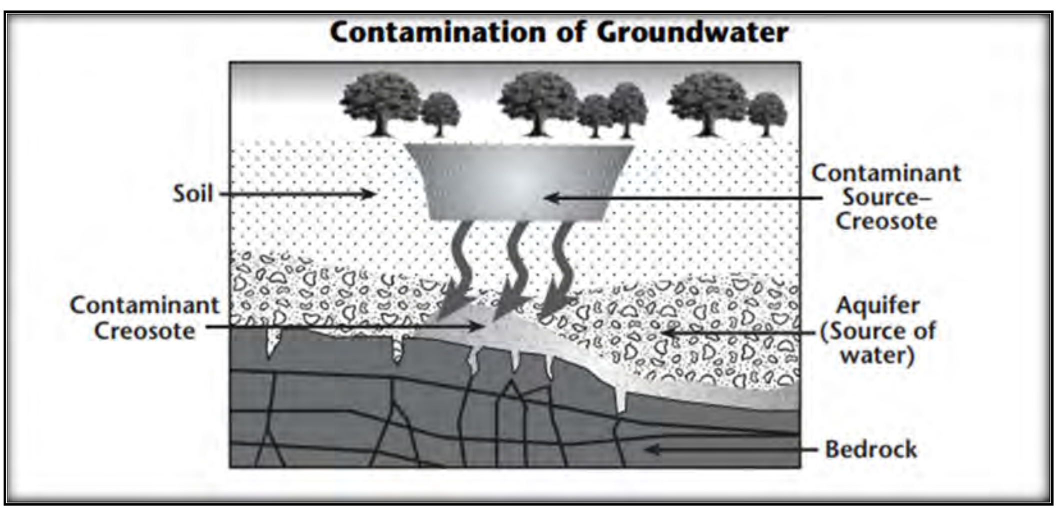


Source: EPA. What is Vapor Intrusion? https://www.epa.gov/vaporintrusion/what-vapor-intrusion

Figure 4: Effects of a contaminated plume

Environmental Impact

Creosote from rail yards can be released into the environment from wastewater by-products used in the wood treatment of railroad crossties. According to Environment Resource Management (ERM), often times this wastewater is discarded into a man-made reservoir or surface impoundment (2004). This reservoir or surface impoundment may be located inside or outside the perimeter of the rail yard. After release, the chemicals in creosote will separate into different locations of the environment and rail yard. Some of the creosote will evaporate into the air from treated wood, the remainder will contaminate soil, and water. The remaining creosote in the soil is broken down by fungi, bacteria, and other soil organisms such as worms, caterpillars, and maggots. This degradation process may take months to years for a complete breakdown into the environment (Agency for Toxic Substances and Disease Registry, 2006). Furthermore, creosote poses a huge risk to groundwater, particularly around rail yard sites with highly contaminated soil and a shallow water source. See Figure 5.



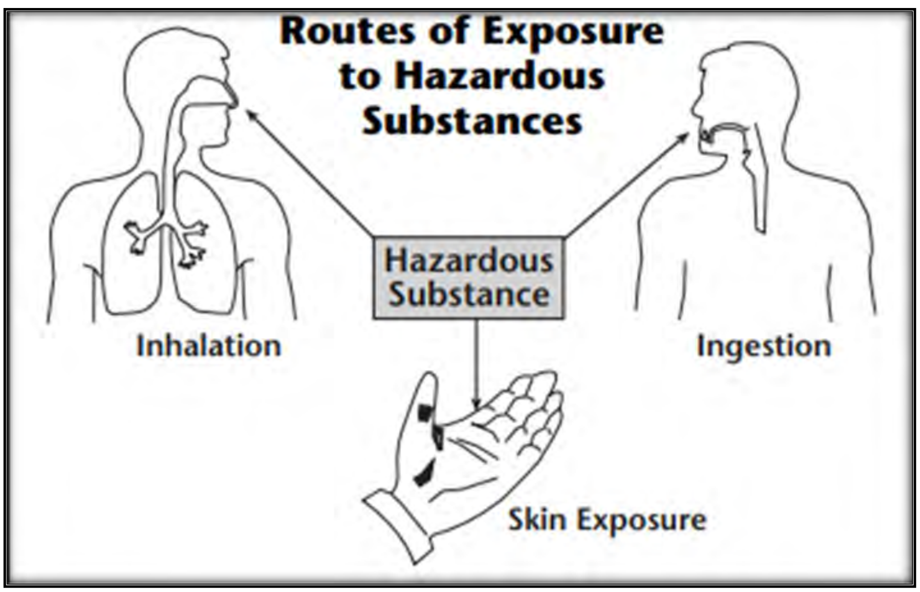
Source: (Texas Commission on Environmental Quality, 2002)

Figure 5: Contamination of groundwater

Since creosote does not dissolve easily in water, it will separate as it moves through rivers, streams, lakes, and any other water systems. The less-dense chemicals found in creosote will be found on the water surface, and the heavier chemicals will be on the bottom of the water body (Texas Commission on Environmental Quality, 2002).

Health Impacts

The effect of exposure to chemical contaminates around rail yards will differ for each individual. This often depends on the level of exposure and the routes of exposure. According to TCEQ (2002), routes of exposure to chemical contaminates such as creosote can enter the body when touch, breathe, or ingested. See Figure 6.



Source: (Texas Commission on Environmental Quality, 2002)

Figure 6: Routes of exposure

When touched, creosote can cause redness, swelling, irritation, and burning of the skin. Breathing vapors or swallowing creosote may irritate nose, throat, and stomach, as well as may cause cancer (TCEQ, 2002). Moreover, TCEQ explains that exposure to creosote at high levels could have an increased chance of having children with birth defects (2002). The Agency for Toxic Substances and Disease Registry (ATSDR), a federal public health agency of the U.S. Department of Health and Human Services, also agrees that exposure to small amounts of creosote over time by direct skin contact or by contact with creosote vapors will cause many health effects (2005). See Table 2 .

Table 2: List of Health Effects from Creosote Exposure

Health Effect	Definition
1. Body Weight	Changes in average body mass at critical time points
2. Cancer	The disease causes uncontrolled growth of cells in the body.
3. Cardiovascular	Referring to the heart and blood vessels. Effects may include irregular heartbeat (arrhythmia), changes in blood pressure, heart failure, and/or disorders of the blood vessels.
4. Dermal	Referring to the skin or scalp. Effects may include skin irritations, rash, blistering, and/or chemical burns
5. Developmental	Referring to the formation of and change in the body's organs and tissues. Effects may occur at any time from conception through sexual maturity and may include altered growth, structural abnormalities, and/or functional deficiencies.
6. Endocrine	Referring to hormones (chemicals that regulate how the body functions) and the glands that produce and release them. Effects may include changes in hormone production, secretion, transport, or signaling.
7. Gastrointestinal	Referring to all parts of the digestive tract. Effects may include inflammation, ulcers, reflux, and/or vomiting.
8. Hematological	Referring to the blood. Effects may include changes in blood composition, clotting, and/or the production and function of blood cells, e.g., red blood cell ability to carry oxygen.
9. Hepatic	Referring to the liver. Effects may include elevated liver enzyme levels, liver inflammation (hepatitis), severe scarring (cirrhosis), reduced-fat metabolism, and/or impaired removal of waste products from the blood.
10. Immunological	Referring to the immune system, which defends the body against foreign invasion. Effects may include changes in the functioning of white blood cells, lymph nodes, spleen, tonsils, and/or the thymus.
11. Metabolic	Referring to the biochemical breakdown of nutrients to produce energy. Effects may include changes in the metabolic rate, energy balance, or the ability to process specific nutrients.
12. Musculoskeletal	Referring to the muscles and bones. Effects may alter the structure, function, r coordination of the bones and muscles.

13. Neurological	Referring to the brain, spinal cord, or nerves. Effects may include impaired sensory and motor signaling.
14. Ocular	Referring to the eye. Effects may include eye irritation, itching, and impaired vision.
15. Renal	Referring to the kidneys. Effects may include decreased filtering capacity/efficiency, blood in the urine, and/or increased or decreased blood pressure.
16. Reproductive	Referring to the system required to produce offspring. Effects may include decreased ability to conceive offspring and/or carry to term.
17. Respiratory	Referring to the system that passes oxygen from the air into the blood and sends carbon dioxide and water from the blood into the air. Effects may include inflammation of the lungs or associated airways, increased, or decreased breathing rate, insufficient oxygen-carbon dioxide exchange, and/or respiratory failure.

Source: (U.S. Department of Health and Human Services, 2002)

From continuous studies, researchers found that children who play with creosote-contaminated soil tend to get more skin rashes than other children. In addition to these studies, it was found that creosote exposure can cause birth defects among babies born to mothers exposed to creosote during pregnancy (ATSDR, 2006).

Environmental Justice

The history of the U.S. railroad and the civil rights movement show crucial intersections. The reason for one of these intersections centers around environmental justice. Historically, inequality and inequity in all types of justice remain major issues in underserved communities across the United States. Research shows that underserved and disadvantaged communities of color can be burdened by the environmental hazards and unhealthy land uses. A high number of low-income and minority-Americans live near rail yards/facilities, hazardous waste facilities, landfills, industrial complexes, and other environmentally dangerous sites (Matsuoka et al, 2011). The disproportionate burden of pollution resulted in an increased exposure to harmful environmental conditions that affected communities of color. The constant exposure to these harmful conditions results in negative health outcomes that stressed communities and reduce the quality of life for the residents (Spencer-Hwang et al., 2014).

Not only is the quality of health affected, but residents' property values can also be affected as well. In a study done on "Analysis of the effects of contamination by a creosote plant on property values" by Douglas S. Bible, the researcher examined how creosote contamination from a wood treatment plant affected home values in Bossier City, Louisiana. This study revealed that the contamination reduced house values by $4,800, an approximation of a 9.5% drop in the average house price. Bible concluded for that it was expected that the closer the distance, the greater the adverse impact of contamination on the house value (Bible et al., 2005).

In a peer review article, "Double Jeopardy in Houston", the Texas Environmental Justice Advocacy Services (TEJAS) references Dr. Robert Bullard, former Dean of the Barbara Jordan-Mickey Leland School of Public at Texas Southern University, as asking the question of "Are environmental inequities a result of racism or class barriers or a combination of both?" (2016). Furthermore, this article explains there is compelling evidence that people of color and those living in poverty are exposed to higher levels of environmental pollution than whites or people not living in poverty (TEJAS, 2016.). It was also noted in this article that a study by the Environmental Justice and Health Alliance for Chemical Policy Reform (EJHACPR, 2014) agreed that a significantly greater percentage of people of color and people in poverty live near rail yard facilities that use, move, and store large quantities of toxic chemicals (TEJAS, 2016).

The health and environmental issues surrounding rail yards in communities of color and communities of low-income is not just a single city or community problem, but it is a national problem. Many other rail yards across the U.S experienced similar chemical contamination problems effecting neighboring communities, such as Union Pacific Rail Yard in Eugene, Oregon (ATSDR, 2007), Paoli Rail Yard in Paoli, Pennsylvania (U.S.EPA, 1992), CSX Rail Yard in Waycross, Georgia (Georgia Department of Public Health, 2019), and Conrail Rail Yard in Elkhart, Indiana (Ecology and Environment, inc., 1994).

Literature Summary

In conclusion, the reviewed literature indicated that contaminates in and around rail yards is a concern that should be a focus for environmentalists' governmental agencies, and railroad companies all over the U.S. Many researchers reported concerns about environmental equity and human health disparities in communities that are in proximity of particular rail yards. By addressing these gaps and understanding the long-term effects of certain released contaminants, a major overhaul in disposal practices; the storage practices of hazardous chemicals; and the clean-up efforts of toxics should mitigate exposure to rail yard contaminates. These efforts will improve the expectancy and quality of life within the communities nearby.

In summary, the reviewed literature offered evidence that certain contaminants (especially creosote) that are released into the environment may cause some type of ecological and societal afflictions. The various sources discussed the different ways people can be exposed and the studies done that shows who is being affected the most from rail yard contaminations. This reviewed literature will be used as a foundation to create a unique case study design that examines the impact that cancer-causing carcinogens from rail yard facilities have had on surrounding communities, especially the

Englewood Rail Yard in Houston, Texas. The main objective of the study is to generate an informative and comprehensive awareness of the health issues associated with residents living within a certain radius of particular rail yards. Furthermore, the additional aim of this study is to promote transportation policy improvements geared toward increasing the health and safety of the environment and communities surrounding U.S. rail yards.

CHAPTER 3

METHODOLOGY

This chapter presents the overall design of this research. The thesis studies the substantial connection between residents living in proximity to a rail yard that seeps carcinogens; the research also details the risks posed to human health and the environment, using the Englewood (UPRR) rail yard in Houston, Texas as a case study. This research will examine the practices of how and where Englewood rail yard disposed of the hazardous and toxic material (creosote), and the connections between the buildup of creosote plumes and the health illness plaguing these bordering communities.

This study uses a cross-case analysis to highlight those similarities of the Englewood Rail Yard contamination with four (4) other rail yards: Conrail Rail Yard in Elkhart, Indiana, Union Pacific Rail Yard in Eugene, Oregon, Paoli Rail Yard in Paoli, Pennsylvania, and CSX Rail Yard in Waycross, Georgia. This study also identifies key factors (gaps) that impacted the communities surrounding these rail yards like the Englewood rail yard. Furthermore, the aim of this study is to improve the transportation policies and guidelines geared toward improving the public health and advancing environmental equity in communities that border rail yards in the United States

The following sections review the research methods used in the study to collect and analyze data. The section also explains why the chosen method and design were preferred over others in conducting this study.

Research Method

The main research methods adopted in this study is the qualitative approach using a case study design (Yin, 2009). The preference for this qualitative approach; using a case study design in the current research, emphasizes the strengths advocated to this method by previous scholars. The works of Yin (2009) highlighted that case study design is advantageous in studies that aim at investigating a present-day phenomenon within a real-life context. According to Yin, case studies can explain, describe, or explore events or phenomenon in the everyday contexts in which they have occurred (2009). Although, quantitative approach may also measure these events or phenomenon numerically, it can only provide a surface level explanation to how low-income residents are succumbing to various illnesses and how nearby communities are deteriorating do to seeping hazardous wastewater by-products and toxic chemicals from rail yards. Whereas a qualitative approach could provide ample meaning to questions what, when, and where hazardous wastewater by-products and toxic chemicals were disposed, and how residents and nearby communities were impacted by the exposure of living nearby a rail yard (Denzin & Lincoln, 2005).

To further assist in this case study design, a cross-case analysis that involves the exploration of similarities and differences across the selected study areas is used to support empirical generalizability about contamination in the case study of the Englewood (UPRR) rail yard. According to Miles and Huberman (1994), a cross-case analysis relates to comparisons being made across different places or the same place across different times; or different places at different times but related to each other by the commonality of a theme identified by the researcher. Moreover, the development of this study can be characterized as instrumental and collective in nature. An instrumental case study uses a particular case to gain a larger appreciation of an issue or phenomenon, and collective case study involves studying multiple cases simultaneously or sequentially in an attempt to generate a clearer appreciation of a particular issue (Crowe et al., 2011).

To develop a thorough understanding of this research, the case study approach involved the collecting of multiple sources of evidence using a range of qualitative techniques. These techniques used data triangulation to increase the internal validity of this study, showing data collected in different ways and leading to a similar conclusion. In approaching the issue from this angle, a holistic picture helped in developing the theoretical framework needed to show the impact that rail yard contaminations have on low-income and minority communities like the communities surrounding Englewood rail yard.

Study Design

The data collected and examined consisted of reports from five (5) different rail yards areas of study. Data were collected on the Englewood rail yard in Houston, Texas, Conrail rail yard in Elkhart, Indiana, Union Pacific rail yard in Eugene, Oregon, Paoli rail yard in Paoli, Pennsylvania, and CSX rail yard in Waycross, Georgia. This rail yard study highlights that the differences rest in how rail yards are classified and what type of contaminants affected their adjacent communities. Yet, the similarities of operations, storage of hazardous chemicals, and disposal practices are parallel. Furthermore, what is evident is how the adjacent communities to each studied area were impacted by these disposal practices of hazardous chemicals or wastewater by-products from rail yard operations.

Step I develops the criteria for the study area selection, which includes examining rail yards with neighboring communities affected by groundwater and soil contaminations. Step II involves collecting data on type of contaminates and how they are stored, what issues these contaminate can cause, where the possible sources of contamination, what operations these contaminates being used for, and what disposable methods used to discard wastewater by-products produced from these toxic chemicals. Step III provides a cross-case analysis as the method of analysis used to highlight the differences and similarities of each studied area. Step IV generates neighborhood profiles based on data and information from each of the studied areas.

Overview of Study: (Step-by-Step Process)

Step I: Gather valid data

The case study includes a detailed review of literature relevant to the research topic. These data were tracked via internet and state databases (i.e., U. S. Environmental Protection Agency (U.S. EPA), Agency for Toxic Substances and Disease Registry (ATSDR), Texas Department of State Health Services (DSHS), U.S. Department of Health and Human Services (U.S. DHHS)). The related research included studies, cases, and articles written by other researchers, scholars, and governmental entities. In addition to the gathering of data on the Englewood rail yard, four (4) other rail yards areas of study (i.e., Conrail rail yard in Elkhart, Indiana, Union Pacific rail yard in Eugene, Oregon, Paoli rail yard in Paoli, Pennsylvania, and CSX rail yard in Waycross, Georgia) were examined and compared to the Englewood rail yard case study. After a thorough review of literature research, methodological steps for this study were identified.

Study Area I (Case Study). The Englewood rail yard in Houston, Texas was chosen as the case study because of the current cancer-cluster phenomenon that is being studied by federal and state environmental agencies. Nonetheless, the methodologies used in this study are transferable to any other rail yard with neighboring communities affected by groundwater and soil contaminations.

As indicated in the literature, issues of groundwater and soil contamination from the Englewood rail yard continuously plague the surrounding communities of the Greater Fifth Ward, Denver Harbor, and Kashmere Gardens communities. These communities are mostly low-income with large minority populations.

This rail yard began its operation in 1895 with a unique business model that shared its facility with a wood treatment plant. Known as the Houston Wood Preserving Works (HWPW), this industry manufactured and disposed of highly cancerous and toxic chemicals of creosote and arsenic during railroad crosstie preservation operations. For over 75 years, this rail yard site manufactured toxic wastewater by-products. Currently, the HWPW facility is closed, but the operations of moving, storing, loading, and unloading freight at the rail yard is still active. Many times, operations led to spills and leakage of hazardous chemicals. Also, there was a practice of releasing toxic wastewater by-products to nearby drainage ditches and man-made water lagoon. The clean-up process from the HWPW facility has been endless for over the past 30 years with more than 11,000 tons (25,000,000 lbs.) of creosote impacted soil removed and pumped from monitoring wells (Union Pacific, 2022). Unfortunately, there were more contaminants found in the communities adjacent to Englewood rail yard. These underground plumes of contaminants were identified as carcinogenic chemicals creosote and arsenic (TASC, 2021).

<u>Study Area II.</u> The Conrail rail yard in Elkhart, Indiana was chosen for the purpose of comparing the overall issues of groundwater and soil contamination that has plagued this rail yard. The surrounding communities of Baugo Township in Elkhart County and Penn Township in St. Joseph County display similar issues of groundwater and soil contamination comparable to the Englewood rail yard. These townships are low-income but has a large White population.

Conrail rail yard began its operation in the 1956. The rail yard is electronically controlled and operates as a classification and distribution yard for freight cars. The primary contaminants at the site are trichloroethylene (TCE) and carbon tetrachloride (CCl_4) in the groundwater and soil. The exposure to a wide range of levels of TCE and CCl_4 in the drinking water caused many concerns for the health and well-being for the neighboring communities. Reports by Health Department of Elkhart County revealed TCE concentrations were as high as 5,850 parts-per-billion (ppb) and CCl_4 concentration as high as 117 ppb in the soil samples. The maximum contaminant level for TCE and CCl_4 is 5 ppb, set by the EPA. According to the U.S EPA (1995) report, there was a history of poor waste handling practices at this rail yard. Further investigation identified the nature and extent of the source of the ground-water contamination being TCE and CCl_4. There were two identified groundwater contaminant plumes coming from the Conrail facility.

Study Area III. Like the Conrail rail yard, the Union Pacific rail yard in Eugene, Oregon was chosen for the purpose of comparing issues of groundwater and soil contamination that affected the residents of the River Road and Trainsong neighborhoods to similar issues at Englewood rail yard in Houston, Texas. These communities are low-income but has a large White population. The Union Pacific rail yard operates a rail yard in a mixed residential and industrial area in northwest Eugene, Oregon.

The railroad operations at this site began in the 1870s and was acquired in 1996 by UPRR from Southern Pacific Transportation Company (SPTC). Similar to Englewood rail yard, Union Pacific rail yard had a wood-treatment facility operational on site until 1962. Since the early 1900's, this rail yard operations at this facility comprised of maintenance, sorting, switching repair, and washing of railroad cars. Investigations by Oregon Department of Environmental Quality (ODEQ) concluded that decades of rail operations at this site of drips, spills, and operating practices associated with use and disposal of creosote, polycyclic aromatic hydrocarbons (PAH's), heavy metals, and volatile organic chlorinated solvents (VOC's) contaminated the soil and groundwater at this rail yard. The VOC's included very high levels of Trichloroethylene (TCE) (15.2 ug/l) and Tetrachloroethylene (PCE) (50.7 ug/l) in groundwater concentration (ATSDR), 2007).

Study Area IV. The Paoli rail yard in Paoli, Pennsylvania was chosen to compare the issues of groundwater and soil contamination that affected the town of Paoli in Chester County. This area contains a watershed with three tributaries; and two townships named Willistown and Tredyffrin that are also affected by the groundwater and soil contamination from the Paoli rail yard. This rail yard has similar drainage issues like the Englewood rail yard. This rail yard site is bordered to the north by residential areas and to the south by commercial developments. Both Paoli, Willistown, and Tredyffrin Townships are predominantly White communities with above national average median household income.

Since 1915, the Paoli rail yard operations consisted of a maintenance, storage, and repair facility for rail cars. According to U.S. Environmental Protection Agency, polychlorinated biphenyl (PCBs) was found in the soils and sediments at the rail yard; and is believed to have been released during servicing and operation of the rail cars (2011). The soil that was excavated from the rail yard was found to contain PCBs at concentrations greater that 10,000 mg/kg. The allowable maximum concentration level in drinking water set by the EPA is 0.0005 ppm and 6.0 ug/kg per day set by the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) (ATSDR, 2014) High concentrations of PCBs were detected in soils on the rail yard property; the residential areas; and in the sediments in nearby tributaries and streams. Fuel oil and BTEX compounds (benzene, toluene, ethylbenzene, and xylene) were also identified in the soil samples and groundwater beneath the rail yard (U.S. Environmental Protection Agency, 1992)

Study Area V. The CSX rail yard in Waycross, Georgia was chosen to compare the various of groundwater and soil contamination that affected people living in parts of Baugo Township in Elkhart County and people living in Penn Township in St. Joseph County. Operations began in 1897 at this facility and this yard is considered the second largest classification rail yard in the United States (Georgia Department of Public Health, 2018).

An investigative report by the Georgia Department of Public Health (2019) referenced a history of poor waste handling practices at this rail yard. Consequently, these poor practices led to two contaminated groundwater plumes, which had a negative impact on the residents living nearby. Operations produced a variety of solid wastes like halogenated and non-halogenated spent solvents, waste paint, spent paint strippers, and caustics from degreasing. The contaminants of concern were arsenic, benzo(b)fluoranthene, 1,1-dichloroethane, trichloroethene (TCE), and vinyl chloride. Over 4,393.30 tons of hazardous waste was removed from CSX rail yard in March and April 2004 (Georgia Department of Public Health, 2019)

Step II: Data Collection

Step II involves collecting data on type of contaminates, the issues these contaminate can cause, and the possible sources of contamination. Demographics of the adjacent communities to these rail yards were also collected. Data regarding the Englewood rail yard was collected from the U.S. EPA, ATSDR, DSHS, and U.S. DHHS databases and websites. Also, the studies and cases of the four (4) other rail yards (i.e., Conrail rail yard in Elkhart, Indiana; Union Pacific rail yard in Eugene, Oregon; Paoli rail yard in Paoli, Pennsylvania; and CSX rail yard in Waycross, Georgia) were used to comparatively show the theoretical points of rail contamination, were also collected from the above databases and websites.

Step III: Data Analysis

After collecting data from various entities, the data were processed and analyzed in a systematic approach of cross-case analysis. Cross-case analysis is commonly performed on data collected to explore the similarities and differences between selected study areas. When context tone, idiomatic expressions, and commonality of a themes are detected, that information is placed into a table for a comparative study. From this comparative study, a paradigm emerges to support this research. The parameters used in the dataset to create a table are labeled “name”, “location”, “rail yard operations”, “type of contaminates of concern”, “disposable practices”, “issues for nearby communities”, “years of contaminations”, “possible source”, “community impact”, and “remediation performed”. The completed table is located in Chapter 4.

Step IV: Conclusions and Recommendations

The results and recommendations of the research conducted in the data analysis section will conclude the study. The last part of this study will address the research goal, study’s results, and relative findings during the synthesis part of the study. In addition, future research, recommendations, and solutions will be given in this part of the study.

Tools and Techniques

This research will use a computerized-based method to collect data for each study area. Google Maps, Microsoft Word, the U.S. EPA, ATSDR, DSHS, and U.S. DHHS databases and websites were used to collect and helped in processing that data. Information was download from these databases and websites; evaluated for comparison between each study area.

CHAPTER 4

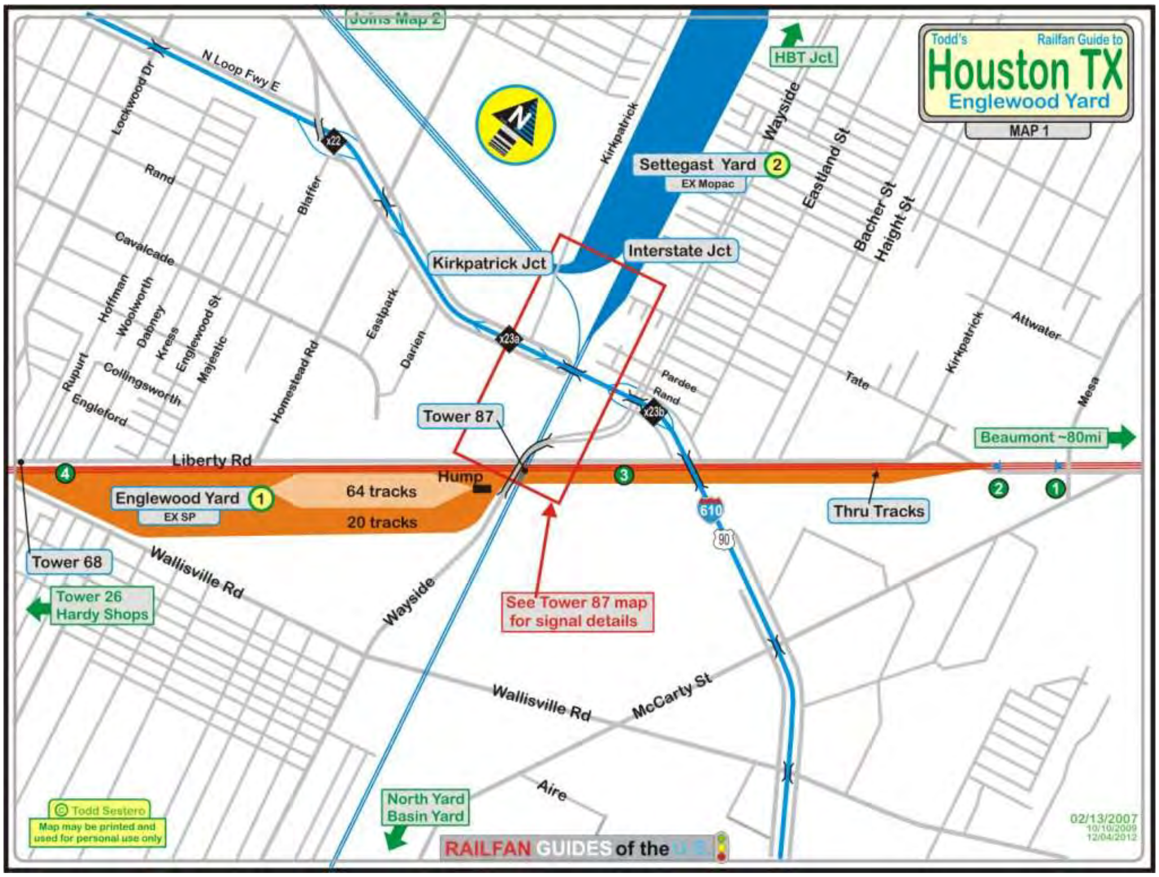
DISCUSSION & RESULTS

Before an analysis can be done for this study, all data must be examined to understand the logical linkage to low-income residents, various illnesses, and deterioration of the community's health of those that live near rail yards with seeping hazardous cancer-causing chemicals. A cross-case analysis uncovered similar themes and paradigms that aided in the understanding of this study.

Discussion of Rail Yards Data

Study Area I

Englewood rail yard. Main location address at 5500 Wallisville Rd. in the northeast side of Houston, Texas. This rail yard is the biggest rail yard in Houston and one of the largest in Union Pacific's system. Englewood was originally a Southern Pacific facility but was bought out by Union Pacific in 1996. Measure approximately 3.46 miles long, this rail yard shared its intermodal facility with the operations of the former Houston Wood Preserving Works facility (HWPW). Although, the HWPW facility is longer in operations, the Englewood rail yard is still in operation and used for the temporary parking of trailer mounted intermodal container boxers; moving and switching; and storing rail cars. See Figure 7.



Source: ("Englewood Yard Railfan Guide - Houston TX," n.d.)

Figure 7: Map of Englewood rail yard

During the operational active of HWPW at this rail yard, untreated wood was cut and trimmed, then pressurized into one of the five retort cylinders for the purpose of making railroad ties. The wood was treated with the toxic chemical-creosote, resulting in a waste stream containing acetic acid, sap water, and creosote. See Figure 8.

Source: ("Creosote Treated Timber - Bing Images," n.d.)

Figure 8: Creosote treated wood

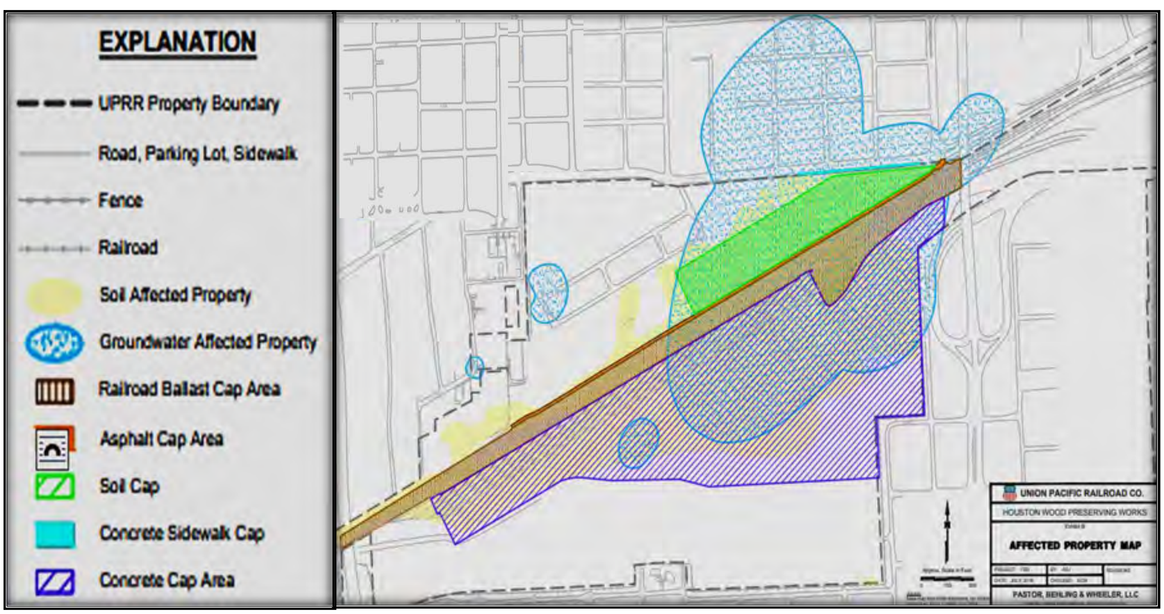
It has been reported that over 20,000 gallons per day of creosote-contaminated dilute acetic acid were generated as a by-product of the wood treatment process This wood-treating operations dates back to 1911 and ended around 1986. According to facility representatives, wastewater was discharged from the retort cylinders into nearby drainage ditches that ran along the southern boundary of the facility and next to the railroad tracks (PRC Environmental Management, 1993). The releases of toxic chemicals in the wood treatment process were limited to spills in the operating area from the retort cylinders and an occasional accident. Over the course of a 20-year span, there were at least three (3) major chemical tank spills. One of those spills happened on November 28, 1979, where high-flash naphtha was spilled onto Liberty Road (PRC Environmental Management, 1993).

In 1980, a surface impoundment was built for the purpose of disposing creosote-contaminated soil and debris from the wastewater lagoon on the southwest side of the rail yard. According to facility representatives, surface water runoff would accumulate in the surface impoundment and would be pumped out as needed. It is reported that over 5,056 cubic yards of toxic material were removed from this surface impoundment once it became inactive (U.S. Environmental Protection Agency, 2022a). A recovery pilot test was conducted between May and October of 2010 by PBW Consulting Engineers and Scientists (2013) and approximately 38 gallons of creosote were recovered. As reported by Golder (2021), an estimated cumulative total of 911 gallons of creosote has been recovered between February 2013 to March 2021.

In October 2019, an investigation by the City of Houston identified six manhole locations on the periphery of the Englewood rail yard. Samples were taken and benzene, naphthalene, and creosote were detected at very high levels. Additional testing discovered migrating plumes contaminant moving throughout the adjacent communities (i.e., The Greater Fifth Ward, Denver Harbor, and Kashmere Gardens neighborhoods) from the rail yard (Terracon, 2019) See Figures 1, 9 & 10.

Source: (Terracon, 2019)

Figure 9: Google map image showing the Union Pacific Railroad site. The red dots represent the locations where the City of Houston's underground storm sewers were sampled for possible contamination.



Source: (TASC, 2021)

Figure 10: Shows Affect area around Englewood rail yard

According to the Environmental Resources Management (2004) report, there were 16 areas identified as potential source of contaminations. Collectively, all these areas contributed to the toxic plumes in the adjacent communities. However, the main focus seems to be on the tie storage area, the former process area, and the inactive wastewater lagoon.

The tie storage area contains a solid waste management unit of two oil/water separators. This unit is used to separate oil and water by-products. Also, this area contains portions of the southern drainage ditch, which allows wastewater by-products to drain through a culvert.

The former process area consists of the original and recent process areas. In general, this area can be divided into “recent process area” to the east and the “original process area” to the west. This area also housed a number of storage tanks. These storage tanks included the tank car storage area, where two 12,500-gallon tank cars stored wood sap water for off-site disposal.

The inactive wastewater lagoon consists of a 0.28-acre area southwest corner of the HWPW site within the off-site area. Because of the natural topographic depression within the local drainage basin, this area tends to accumulate stormwater runoff. This lagoon also connected to the northern drainage ditch along the western property boundary (Environmental Resources Management, 2004).

Based on the Environmental Resources Management (2004) report, these three (3) main areas of concern posed the most hazardous risk to the communities adjacent to Englewood rail yard. The affects caused by these identifiable trouble areas have impacted the nearby communities with possible exposure leading to adverse health issues.

Communities adjacent to Englewood rail yard. When studying these communities of the Greater Fifth Ward, Denver Harbor, and Kashmere Gardens, there is a rich historical Black and Hispanic/Latino cultures that can be noticed by the overwhelming representation in these communities. See Figure 11.

Source: (Texas Department of State Health Services, 2021)

Figure 11: Location map of adjacent communities to Englewood rail yard

These communities have a powerful beginning with the Greater Fifth Ward and Kashmere Gardens being represented by Texas's 18th congressional district; and Denver Harbor represented by Texas's 29th congressional district of the United States House of Representatives.

- **The Greater Fifth Ward.** Located east of downtown Houston, the Greater Fifth Ward was settled by freedmen in 1866. At the time, the population comprised 561 white and 578 Black residents. In the 1880s, The Greater Fifth Ward enjoyed a boom following the construction of repair shops for the newly built Southern Pacific Railroad (City of Houston, 2022). Eventually, the Greater Fifth Ward population became predominantly Black. However, in recent years, there has been a population growth of Hispanics/Latinos in this area. In 2019, the population characteristics for this community were approximately 19,391; with a total of 3,887 persons per square mile and a median house of $27,668. Also, the Greater Fifth Ward area is approximately 51 percent Hispanic/Latinos; 43 percent Blacks; 4 percent White; 1 percent Asians, and 1 percent Non-Hispanic Others (Houston Planning and Development Department, 2021c). (See Table 3: Greater Fifth Ward)

Table 3: Greater Fifth Ward

Population Characteristics	**2000**	**Percentages**	**2019**	**Percentages**
Total Population	22,211	**100%**	19,391	**100%**
Persons per sq. mile	4,451	**20%**	3,887	**20%**
Ethnicity				
Non-Hispanic Whites	222	**1%**	776	**4%**
Non-Hispanic Blacks	13,993	**63%**	8,338	**43%**
Hispanic	7,774	**35%**	9,889	**51%**
Non-Hispanic Asians	0	**0%**	194	**1%**
Non-Hispanic Others	222	**1%**	194	**1%**
Median Household Income	**$14,720**		**$27,668**	
Housing and Households				
Total housing units	8,756	**100%**	8,376	**100%**
Occupied	7,618	**87%**	7,036	**84%**
Vacant	1,138	**13%**	1,340	**16%**
Total households	7,591	**100%**	7,060	**100%**
Family households	4,927	**65%**	4,048	**57%**
Median Housing Value	**$28,977**		**$90,165**	

Source: (Houston Planning and Development Department, 2021c)

- **Denver Harbor.** Located in the eastern part of the City of Houston near the Houston Ship Channel. First settled in the 1890s, this community is bounded by Wallisville Road, the Union Pacific Railroad, and the Port Terminal Railroad Association. Many early residents of Denver Harbor were White. These residents found work on the railroads and industrial companies that were established along the Houston Ship Channel. In 2019, the total population in this area was 16,667 with a total of 2,607 persons per square mile and a median household income of $35,684. Today's population is predominantly Hispanic/Latinos; being 90 percent of the total population. Whites only make up four percent (4 %); Blacks 6 percent; Asians and Non-Hispanic Others are at zero percent (0%) percent (See Table 4: Denver Harbor).

Table 4: Denver Harbor

Population Characteristics	**2000**	*Percentages*	**2019**	*Percentages*
Total Population	19,684	***100%***	16,667	***100%***
Persons per sq. mile	3,080	***16%***	2,607	***16%***
Ethnicity				
Non-Hispanic Whites	984	***5%***	667	***4%***
Non-Hispanic Blacks	591	***3%***	1,000	***6%***
Hispanic	17,912	***91%***	15,000	***90%***
Non-Hispanic Asians	0	***0%***	0	***0%***
Non-Hispanic Others	197	***1%***	0	***0%***
Median Household Income	**$29,846**		**$35,684**	
Housing and Households				
Total housing units	5,256	***100%***	5,766	***100%***
Occupied	4,888	***93%***	5016	***87%***
Vacant	368	***7%***	750	***13%***
Total households	4,888	***100%***	5,039	***100%***
Family households	4,333	***88%***	3,669	***73%***
Median Housing Value	**$41,405**		**$75,505**	

Source: (Houston Planning and Development Department, 2021d)

- **Kashmere Gardens.** Located in Houston's northern 610 loop area, tucked within a rail corridor and an industrial area. A historic Black community was established in 1937 under the Suburban Resettlement Administration program created during the New Deal program enacted by President Franklin D. Roosevelt. Between the years 2000 and 2019, the Hispanic/Latino population of Kashmere Gardens increased from around 13 percent of the population to around 36 percent as Hispanics/Latinos in the Houston area moved into majority-Black neighborhoods. In the same period, the Black population of the Kashmere area declined by 3,734 as majority-Black neighborhoods in Houston have declined in their populations. In 2019, the total population was 9,930 of this community with a total of 2,461 persons per square mile and a median household income of $28,768. This community is still predominantly Black; being 59 percent of the total population in this area. Whites make up 3 percent; Hispanic/Latino 36 percent; Asians 1 percent; and Non-Hispanic Others at 1 percent. (See Table 5: Kashmere Gardens).

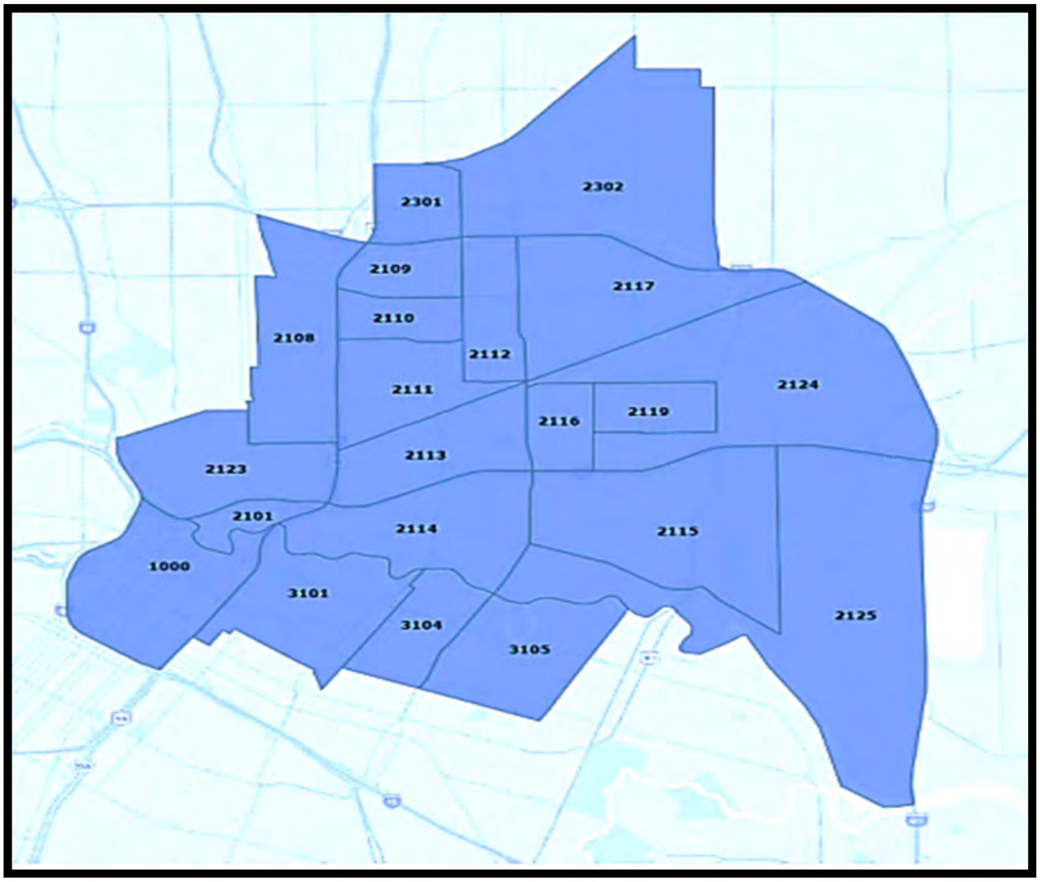
Table 5: Kashmere Gardens

Population Characteristics	**2000**	***Percentages***	***2019***	***Percentages***
Total Population	11,286	**100%**	9,930	***100%***
Persons per sq. mile	2,800	**25%**	2,461	***25%***
Ethnicity				
Non-Hispanic Whites	113	**1%**	298	***3%***
Non-Hispanic Blacks	9,593	**85%**	5,859	***59%***
Hispanic	1467	**13%**	3,575	***36%***
Non-Hispanic Asians	0	**0%**	99	***1%***
Non-Hispanic Others	113	**1%**	99	***1%***
Median Household Income	**$20,360**		**$28,768**	
Housing and Households				
Total housing units	4,784	**100%**	4,605	***100%***
Occupied	4,210	**88%**	3822	***83%***
Vacant	574	**12%**	783	***17%***
Total households	4,208	**100%**	3,836	***100%***
Family households	2,760	**66%**	2,282	***59%***
Median Housing Value	**$35,581**		**$65,317**	

Source: (Houston Planning and Development Department, 2021b)

Community Impact. A survey of residents in 110 properties located near the Englewood rail yard was done by the Houston Health Department (HHD). While there were 110 properties, 30 properties were vacant lots/homes. The prospective households for surveys were seventy-two. HHD interview teams successfully conducted 30 interviews and yielded a completion rate of 41.6% (30/72). Forty-three percent of (13/30) households surveyed reported some type of cancer diagnosis. Furthermore, HHD reported that 22 individuals were diagnosed with cancer from those 13 households, of which 15 were deceased. Lung cancer was the highest category among the respondents and reported family members. Each cancer diagnosis was identified as associated with the chemicals of concern at Englewood rail yard. Of the 13 households with a cancer diagnosis, seven (7) households reported depleted savings, five (5) households reported gone into debt, six (6) households reported unpaid medical bills, and five (5) households reported services cut off for not paying bills (Houston Health Department, 2020).

A study, spanning from 2000 through 2016, was conducted by the Texas Department of State Health Services (2021) included 21 census tracts located within two (2) miles of Englewood rail yard. DSHS concluded that when all 21 census tracts were evaluated, the observed number of childhood acute lymphoblastic leukemia (ALL) cases was greater than expected based on cancer rates in Texas. Moreover, the observed number of childhood ALL cases was also greater than expected for the only census tract (2111) able to be analyzed on its own. See Figure 13.



Source: (Texas Department of State Health Services, 2021)

Figure 12: Selected Census Tract (2010) for Houston, Texas

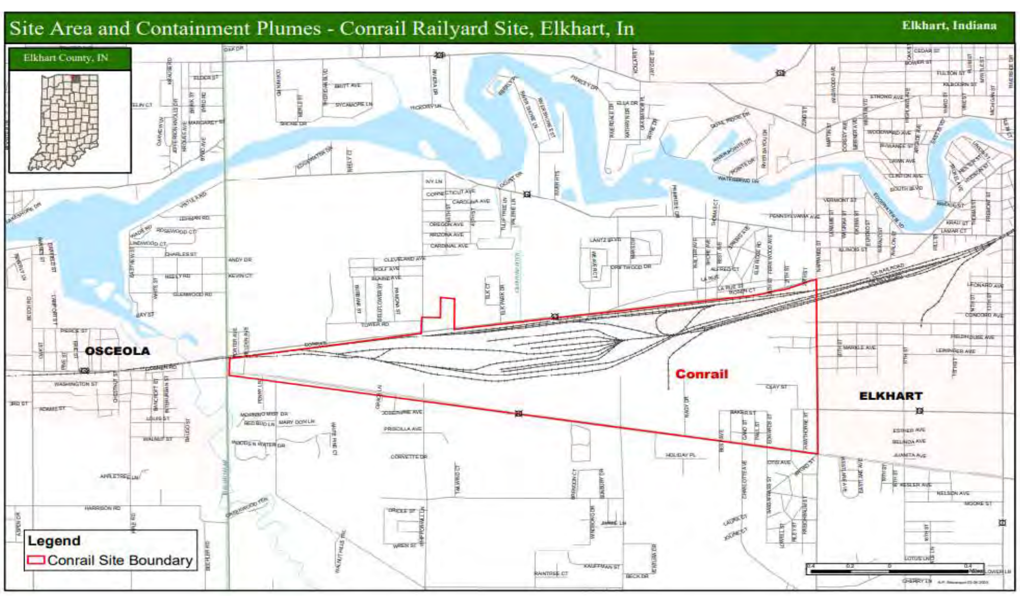
Additionally, the cancer rates for adult (ages 20 years and older) acute myeloid leukemia, lung and bronchus, esophagus, larynx, and liver cancers were statistically greater than expected in the 21 census tracts analyzed together between 2000-2016 (Texas Department of State Health Services, 2020b).

Remediation Performance. According to the Environmental Resources Management (2004) report, there have been four (4) separate remediations performed at this site. Beginning in 1984, approximately 5,065 cubic yards of contaminated material was removed for this rail yard. In 1990, two (2) underground storage tanks were removed from the site. A 2,000-gallon tank and a 3,700-gallon tank were removed from service, excavated, and disposed. In 1995, a portion of the Southern Drainage Ditch was remediated by the removal of approximately 125 tons of affected ditch material. In 1997, affected soil was excavated from the southwest corner of the rail yard. A total of 71 truckloads of material and approximately 850 cubic yards of soil was transported to the Atascocita Landfill for disposal. To date, the clean-up process at this rail yard has been endless for over the past 30 years with more than 11,000 tons of creosote impacted soil removed and pumped from monitoring wells. That equals to approximately 17 standard size 20ft. x 40ft. x 5ft. swimming pools (Union Pacific, 2022).

Study Area II

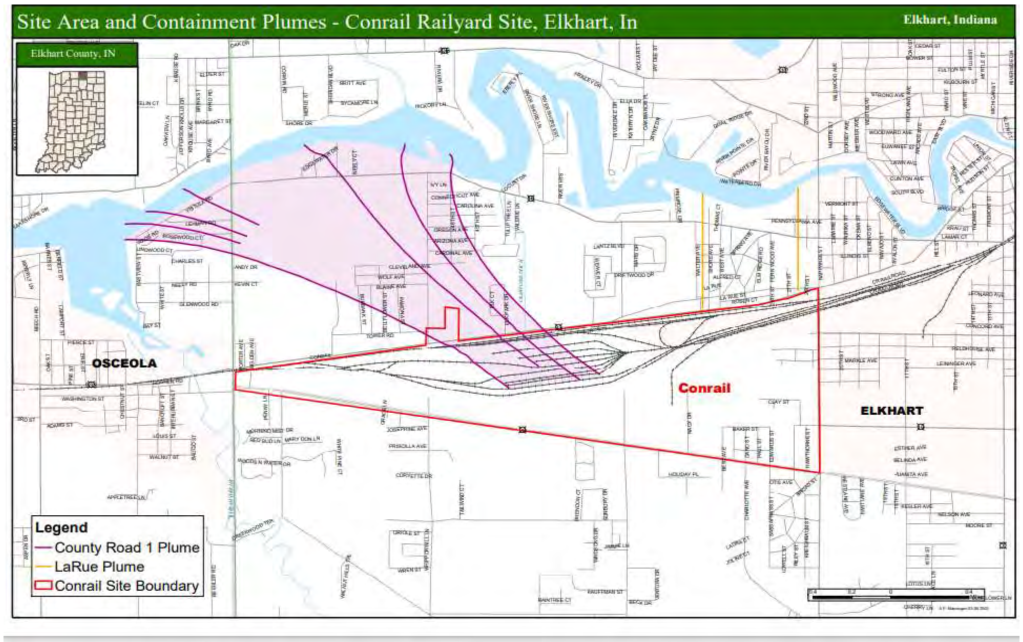
Conrail rail yard. Main location address at 2600 West Lusher Avenue in Elkhart, Indiana. This rail yard sits north of U.S. Route 33, with Nappanee Streeting running along the east side, Mishawaka Road to the south, and State Route 219 borders from the west of this facility. This is a 675-acre facility that began operations in 1956 as part of the New York Central Railroad. It continued operations as a subsidiary of the Penn Central Transportation Company until 1976. In 1976, operations at the rail yard were transferred to the Consolidated Rail Corporation (Conrail). ATSDR considers this rail yard to be the second largest classification yard in the United States, with 72 classification tracks which processes about 74 trains each day (2007).

Complaints about oil spills polluting the St. Joseph River and Crawford Ditch began in 1962. The Crawford Ditch originates at the rail yard and flows occasionally to the St. Joseph River. Around the end of the 1960's, a tank car containing carbon tetrachloride collided with another car during operations, causing the release of approximately 16,000 gallons of carbon tetrachloride. In addition to this spill in 1978, the Health Department of Elkhart County and Indiana's State Board of Health investigators found evidence of a caustic soda solution leak, a hydrochloric acid spill, a grain alcohol spill, a hydrofluoric gas leak, and diesel fuel spills. In 1986, confidential information was received by the Health Department of Elkhart County that toxic waste that included "track cleaner" had been (often) buried on the site for the purpose of disposal. This informant stated that the drinking water from this facility had tasted bad for over 10 years. The Elkhart County Health Department tested the drinking water at the Conrail facility and found small amounts of toluene and xylenes in the water. Further investigation found "higher than the maximum contaminant levels of TCE and CCI4 allowed in public water supplies" in the resident's well water. Confirmation by the U.S. EPA's investigation of the rail yard showed that contamination of groundwater extended into two specific areas. The area North of the rail yard is called the LaRue Street area. See Figure 13. The contamination also affected people living in parts of Baugo Township in Elkhart County and people living in Penn Township in St. Joseph County. See Figure 14 and 15.



Source: Agency for Toxic Substances and Disease Registry, 2005)

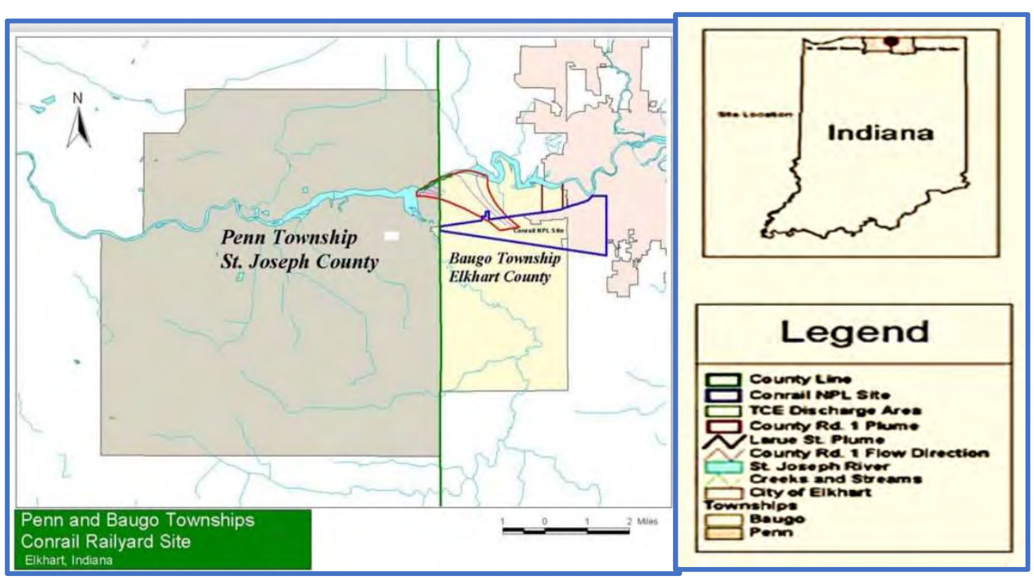
Figure 13: Location map of Conrail rail yard



Source: (Agency for Toxic Substances and Disease Registry, 2005)

Figure 14: Map of site area and containment plumes at Conrail rail yard

<u>Communities adjacent to Conrail rail yard.</u> When studying these communities of Baugo Township in Elkhart County, Indiana and Penn Township in St. Joseph County, Indiana, there is a deep history of Native Americans and immigrant White settlers.



Source: (Agency for Toxic Substances and Disease Registry, 2005)

Figure 15: Map of Penn and Baugo Townships

These communities have a historic beginning with both Baugo Township and Penn Township represented by Indiana's 2nd Congressional District of the United States House of Representatives.

- **<u>Baugo Township.</u>** One of sixteen townships in Elkhart County, Indiana, this area was inhabited by the Potawatomi tribe of Native America in the early days of settlement. Baugo Township derives its name from the Baugo Creek, which originates from the Indian name Baubaugo that means "devil river". After the completion of the Erie Canal in 1821, a surge of White immigrants forcefully occupied Elkhart County (Chapman, 1881). According to the 2020 United States Census Bureau (2020c), Baugo Township in Elkhart County total population was 9,473 with 8.8 percent of that population below the poverty level and a median household income of $48,917. There were 8,048 (85%) Whites; 226 (2.4%) Blacks; 758 (8%) Hispanics; 70 (.7%) Asians; and 371 (3.9%) Non-Hispanic Others.

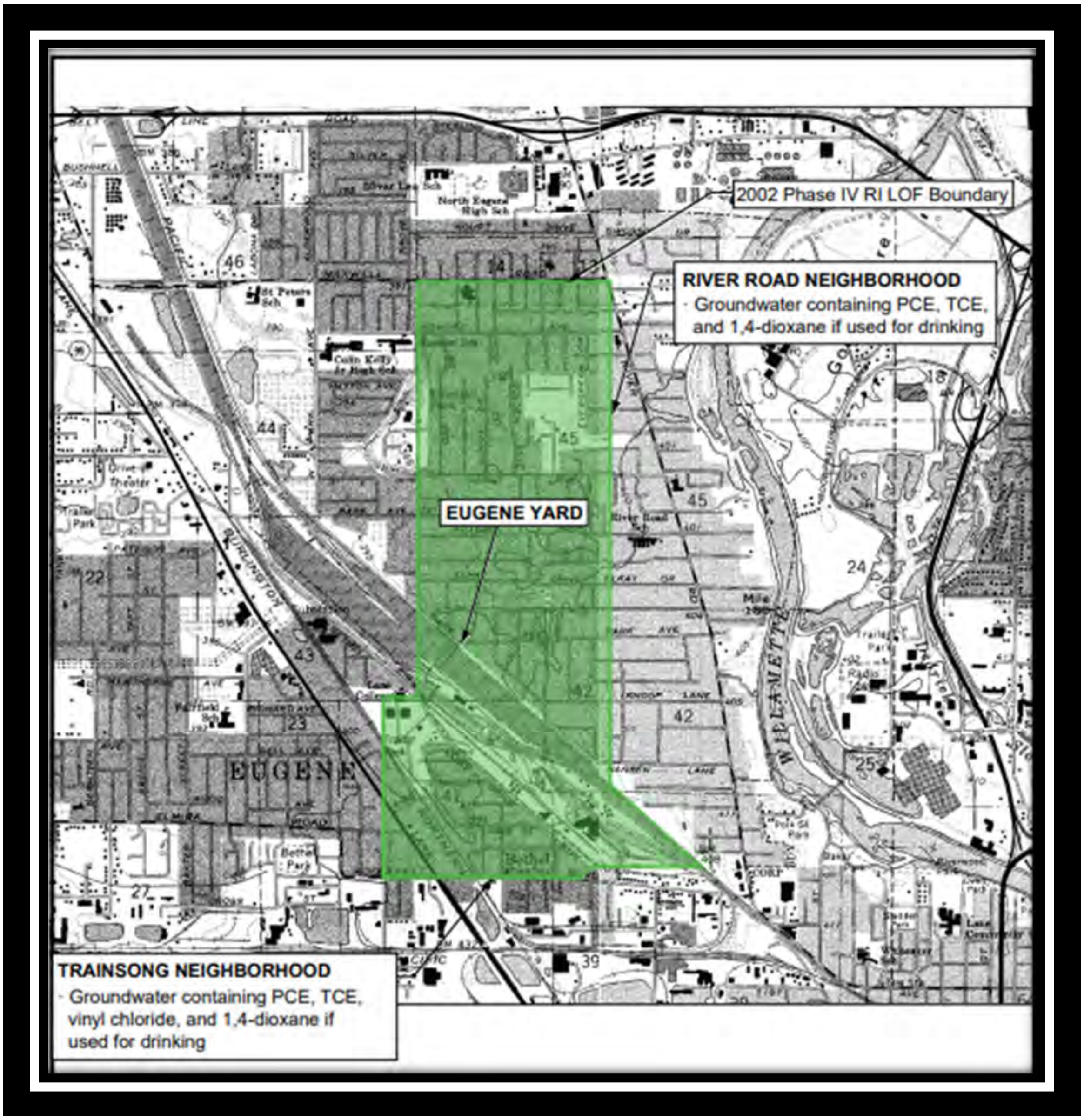
- **<u>Penn Township.</u>** One of thirteen townships in St. Joseph County, Indiana, this area was once considered as a timbered country. Formed in 1832, this township has the Mishawaka Reservoir Caretaker's Residence listed National Register of Historic Places (Chapman, 1880). According to the 2020 U. S. Census (2020d) total population for Penn Township in St. Joseph County was 68,698 with a 12 percent of that population below the poverty level and a median household income of $54,433. There were 58,354 (85%) Whites; 4,675 (6.8%) Blacks; 3,586 (5.2%) Hispanics; 1,146 (1.7%) Asians; and 937 (1.3%) Non-Hispanic Others.

Community Impact. Prior to the public health assessment done by ATSDR (2005), an investigative report by the U. S. EPA (1995) reference that there was a history of poor waste handling practices at this rail yard. It was also determined that the path of the ground-water contamination plume had originated from the CCl_4 source at track 69 and further investigation linked the burial of tank cars to the ground-water contamination plumes in Baugo and Penn Townships. These two ground-water contaminant plumes originating from Conrail rail yard affected the adjacent communities and had a negative impact on its residents. Data from private wells of 598 homes and businesses revealed that a large number of people came in contact with hazardous contaminants from Conrail rail yard. Of the 598 wells sampled, 258 (43%) contained contamination. It was estimated that on average, four people living in homes or working every day at one of the businesses was served by a contaminated well. Another 1,032 people contracted the contamination from Conrail rail yard every day (ATSDR, 2005). Residents exposed to high levels of TCE and CCl_4 on a regular basis, run the risk of developing cancer and other health problems such as liver, kidney, and heart arrhythmias. Although previous attempts to clean the contamination both on and off the rail yard occurred, there was a limited success. There is still the possibility of migration of these identified plumes that could potentially further contaminate the ground water. Furthermore, the risks to the residents in Baugo Township and Penn Township were from ingestion, dermal exposure, and vapor inhalation of ground water. The selected remedy to mitigating exposure was providing an alternative water supply to all residents living nearby the Conrail rail yard (U.S. Environmental Protection Agency, 1995).

Remediation Performance. Public health investigation for Conrail rail yard dates back to the first documented complaints in 1976. In 1988, Conrail was placed on the National Priorities List and classified as a Superfund site (ATSDR, 2005). During this time of classification, five-year review reports were done. On June 6, 2014, the U.S. Environment Protection Agency released the final and Fourth Five-Year Review report. The report listed the remedial actions taken to clean up the contamination soil and groundwater at the Conrail rail yard. The major components of the action plan was for Elkhart municipal water department to extend water lines to over 500 residences and business for the purpose of having clean water. In addition, groundwater extraction and treatment system were installed, and the groundwater treated with air stripping. After being treated, this groundwater was proposed to discharged into the St. Joseph River (U.S. Environmental Protection Agency, 2014)

Study Area III

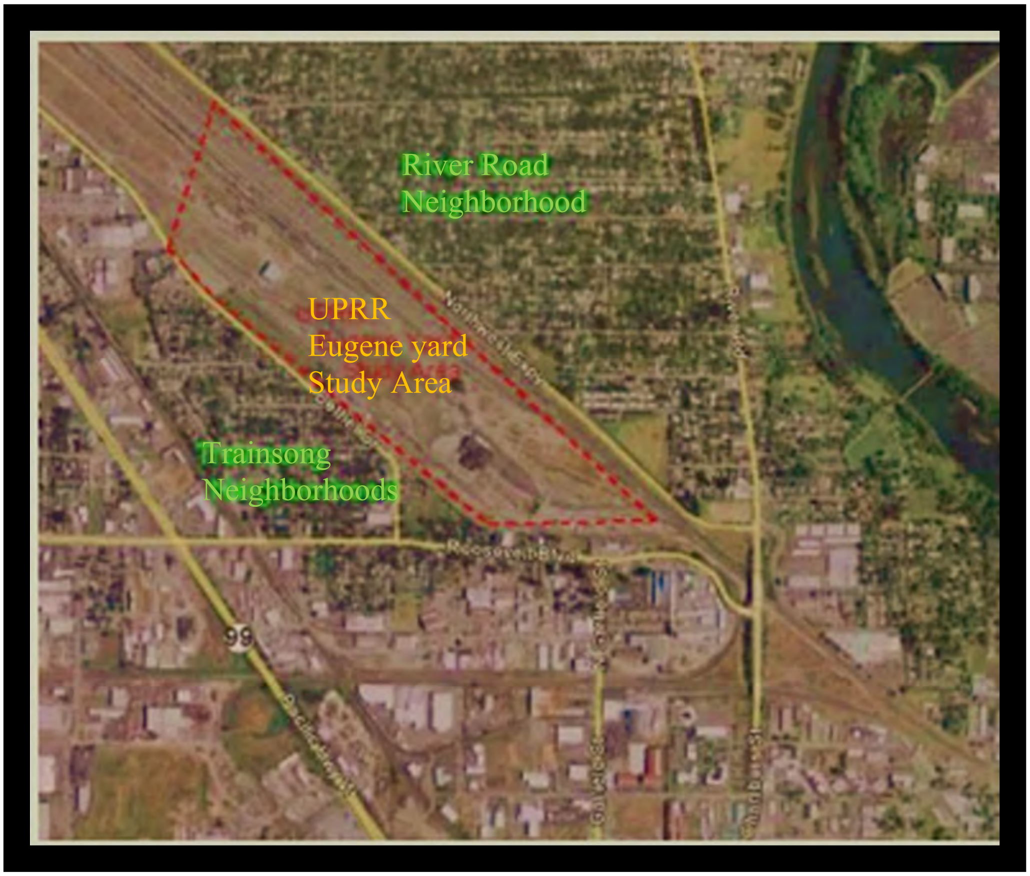
Union Pacific rail yard. Located at 341 Bethel Drive, Eugene Oregon, this rail yard began operations in the late 1800's as a small regional railroad. In 1907, the former Southern Pacific Transportation Company (SPTC) operated a wood-treatment facility until 1962. Along with the operations of this wood-treatment facility, locomotive maintenance and fueling, railcar repair, wood treatment, and wastewater treatment and disposal were also part of the functions of this rail yard. In 1999, UPRR took control of the Eugene rail yard and restored operations. In October 2006, an investigation done by the Oregon Department of Environmental Quality (ODEQ), concluded that throughout the decades of rail operations at this rail yard, drips, spills, and operating practices associated with use and disposal of creosote, polycyclic aromatic hydrocarbons (PAH's), heavy metals, and volatile organic chlorinated solvents (VOC's), contaminated the soil and groundwater at the rail yard (ATSDR, 2007). The migration of these contaminates flowed into the groundwater off site, affecting the neighborhoods adjacent to the railyard. Data that was collected indicate that a VOC contaminated plume extended north into River Road neighborhood and south into the Trainsong neighborhood. See Figure 16.



Source: (Jacobs Solutions, 2019)

Figure 16: Map of Contamination Plumes in River Road and Trainsong Neighborhoods

<u>Communities adjacent to Union Pacific rail yard.</u> When studying these communities of the River Road neighborhood and the Trainsong neighborhood, there is a strong historical roots of Native Americans and Euro-American settlers. See Figure 17.



Source: (Oregon Department of Environmental Quality, 2018)

Figure 17: Map of River Road and Trainsong Neighborhoods

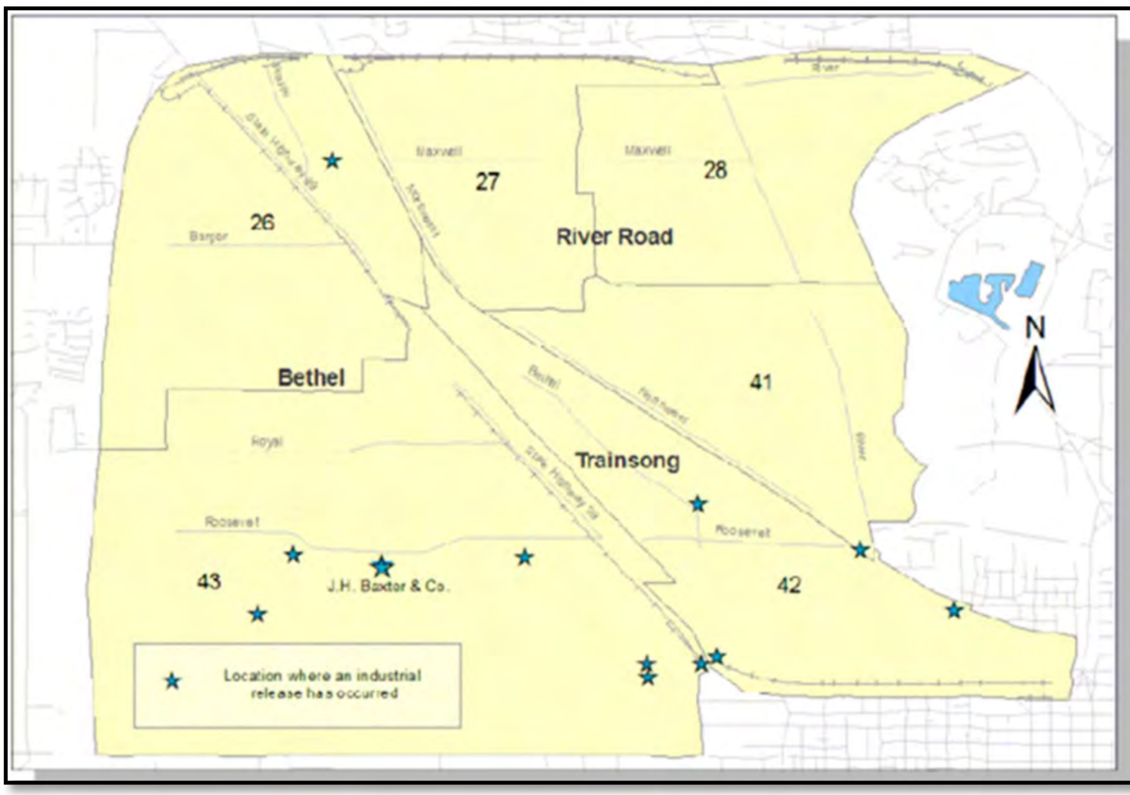
Both of these communities are vibrant neighborhoods with a unique history and culture. Also, both communities are represented by the Oregon's 4th congressional district of the United States House of Representatives.

- **<u>River Road Neighborhood.</u>** Located adjacent to the UPRR Eugene rail yard in Lane County, Oregon. This community was first inhibited by the Kalapuya tribe long before the arrival of Euro-American settlers. Today, River Road is an extremely car-dependent area (Historic Preservation

Northwest, 2006). As reported by U.S. Census bureau (2020e), River Road community has a total population of 8,732 with 12.7 percent of that population lives below the poverty level and reports a median household income of $61,703. There are 7,850 (89.9%) White; 87 (1%) Black; 576 (6.6%) Hispanics; 244 (2.8%) Asian, and 8 (.1%) Non-Hispanic Others.

- **Trainsong Neighborhood.** Located just south of the UPRR Eugene rail yard, this community contains a mixture of zoning types. The zones found in this neighborhood are agricultural, heavy industrial, and a limited medium-density residential. According to the 2011 Neighborhood Analysis Report by the city's Neighborhood services, 1,569 people live within the neighborhood boundaries (Flormoe et al., 2011). Since that time, the Trainsong community has grown to a population of 2,389 with 38.4 percent of the population below the poverty level and a median household income of $30,882 (City of Eugene Neighborhood Services, 2011). There are 1,835 (76.83%) White; 57 (2.39%) Blacks; 215 (9%) Hispanics; 5 (0.21%) Asian; and 275 (11.5%) Non-Hispanic Others (AreaVibes Inc., 2020).

Community Impact. According to Oregon Department of Human Services (ODHS), the environmental data determined that the most significant threat to local residents is from the contamination of shallow groundwater with VOC's (2010). ODHS reviewed the possible exposures that residents would experience and identified that the use of shallow groundwater from contaminated irrigation wells and inhalation of these contaminates would in likelihood have a negative impact and increasing the risk for damage to the central nervous system, immune system, kidney, and liver. Further study by ATSDR, found that exposure to this high level contaminates like creosote, PAH's and VOC's can cause reproductive, developmental effects, and cancer (2007). Further investigate by ODHS (2006) analyzed and compared the number of cancer cases (the "observed" cases) in each identified census tract with the number of "expected" cases for each census tract during the years between 1996 and 2003. See Figure 18.



Source: (Oregon Department of Human Services, 2006)

Figure 18: Map of Census tracts and Industrial Sites in River Road and Trainsong Neighborhoods, Eugene, OR.

The conclusion of ODHS' investigation identified a significantly greater number of acute myelogenous leukemia, lung, and brain cancer cases in all of the census tracts. There were six (6) cases of brain cancer observed in census tract 26 when state average expected to see three (3) cases. In census tract 27, there were 24 cases of lung cancer observed when state average expected to see 19. In census tract 28, there were four (4) cases of brain cancer observed when state average expected to see (2). In census tract 41, there were 19 cases of lung cancer observed when state average expected to see 15. In census tract 42, there were 21 cases of lung cancer when state average expected to see nine (9). In census tract 43, there were six (6) cases of acute myelogenous leukemia observed when state average expected to see only three (3). See Table 6: Summary of Cancer cases in Six Census Tracts in Eugene, OR**. Note:** there was a very high rate of cancer in census tract 27, 41 and 42, where Union Pacific rail yard operates.

Table 6: Summary of Cancer cases in Six Census Tracts in Eugene, OR

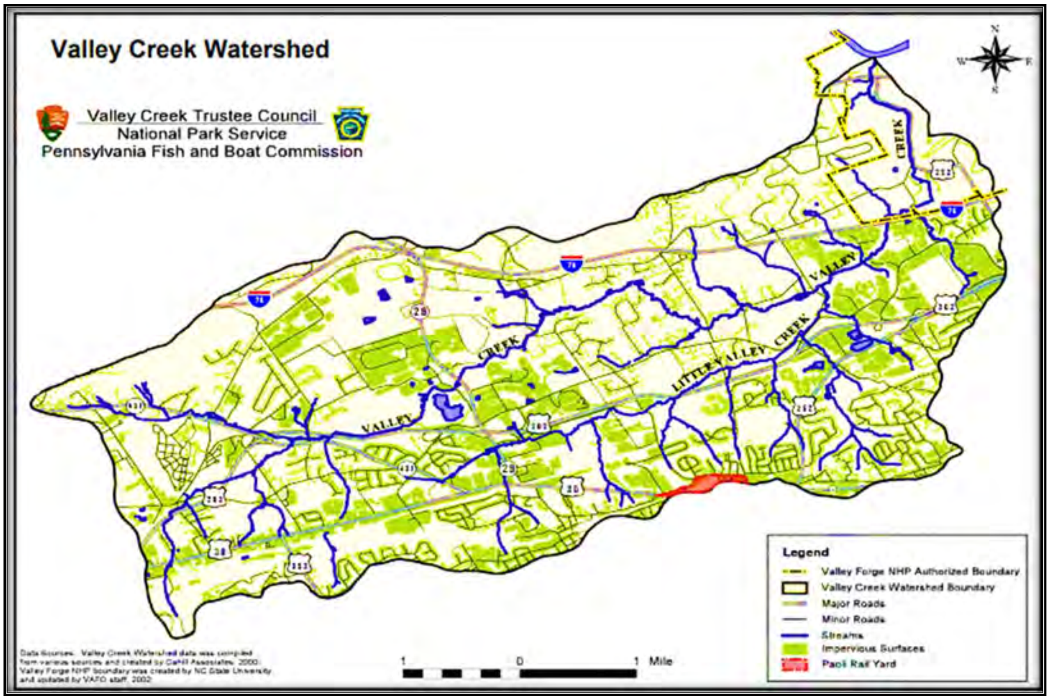
Census Tract	1996 – 2003					
	Acute Myelogenous Leukemia		Lung		Brain	
	Observed	Expected	Observed	Expected	Observed	Expected
26	*******	*******	*******	*******	6	3
27	*******	*******	24	19	*******	*******
28	*******	*******	*******	*******	4	2
41	*******	*******	19	15	*******	*******
42	*******	*******	21	9	*******	*******
43	6	3	*******	*******	*******	*******

Source: (Oregon Department of Human Services, 2006)

Remediation Performance. According to the Oregon Department of Environmental Quality (2018a) report, there has been over 300 cubic yards of petroleum and metals contaminated soil removed from the rail yard. Also, there has been installation of vapor barriers beneath nine (9) homes.to prevent possible vapor intrusion. Excavation of groundwater and the testing soil sampling for evaluation were some of the steps in the remediation plan. Finally, UPRR submitted a completion report and Oregon Department of Environmental Quality gave approval in December of 2015

Study Area IV

Paoli rail yard. Main located is 13 Lancaster Avenue, in Paoli, Pennsylvania. This rail yard included 28 acres and has a surrounding of a 400-acre watershed. The watershed includes three tributaries (Cedar Hollow, Hollow and North Valley) that runs into Little Valley Creek and Valley Creek. A residential area is north of the rail yard and a commercial development is to the south. The rail yard is located in both Willistown and Tredyffrin Townships. See Figure 19.



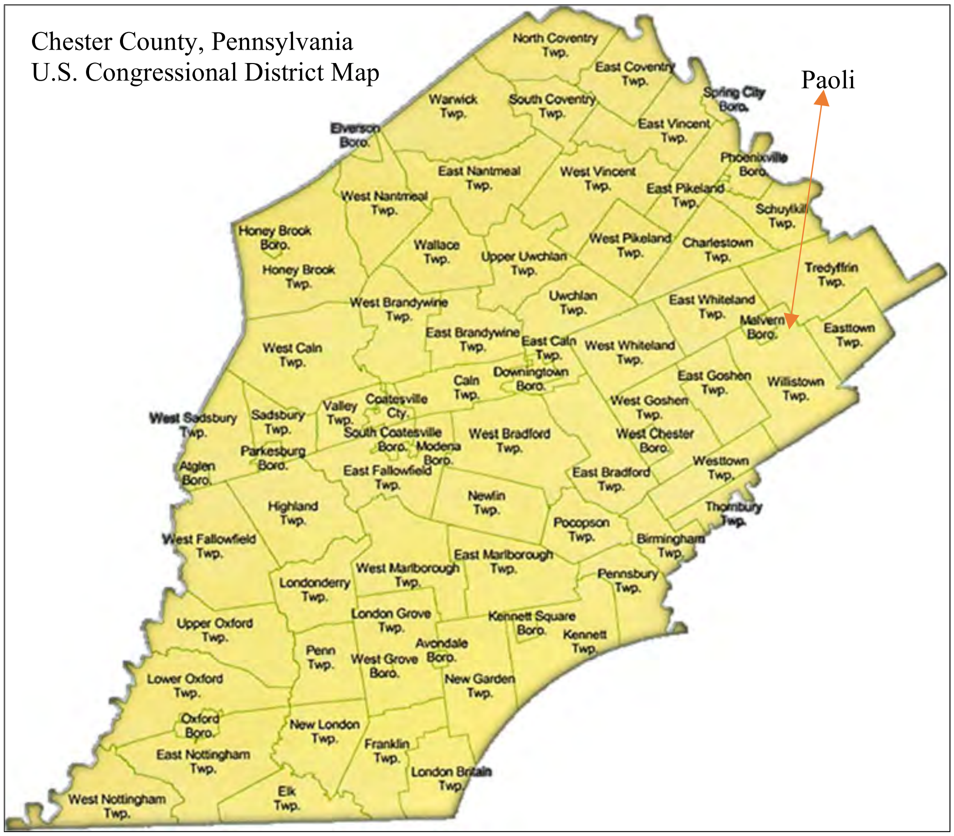
Source: (Valley Creek Trustee Council, 2004)

Figure 19: Map of Valley Creek Watershed

The Paoli rail yard operations by the Southeastern Pennsylvania Transportation Authority (SEPTA) dates back to 1915 and was used for storage and maintenance of passenger rail cars. This rail yard was designed to accommodate the repair of steam powered rail cars. Later, the rail lines in the rail yard were converted to electric power and mineral oil was used to insulate the electronics within the transformers of the rail cars. In the 1950’s a group of synthetic compounds referred to as polychlorinated biphenyls (PCB) replaced the mineral oil in the transformers. In 1979, the EPA restricted the use of PCB and replaced the fluids with other coolants (U.S. EPA, 2011).

In the late 1970s, Pennsylvania Department of Environmental Resources inspected the rail yard and identified several areas of contamination. PCBs were found in the soils and sediments at the rail yard. It was determined that the likely toxic release was during the servicing and operation of the rail cars. Over the years, PCB-laden transformer oil used during maintenance and repair activities was released during operations. Furthermore, there was a practice of stock piling railroad ties and other railroad hazardous debris near tracks in the rail yard that caused contamination of ground water systems. Hazardous debris was often generated during operation in the car shop building (U.S. EPA, 1992). In 1990, SEPTA installed and began operating a ground water treatment and fuel oil recovery system to address contamination that had seeped into the nearby communities. The two main contaminants of concern were PCBs and benzene that migrated from the rail yard and other drainage pathways into nearby residential communities. The EPAs risk assessment determined that the PCB concentration in the rail yard soil and in surrounding areas were in high rang of 1,000 to 6,000 ppm. The environmental risk associated with these levels of toxics in the soil was of great concern because the contaminated areas provided habitat resources for wildlife and had a negative effect on aquatic organisms and nearby communities (U.S. EPA, 2011).

Communities adjacent to the Paoli rail yard. When studying these communities, such as Paoli, Willistown Township, and Tredyffrin Township, there is a wealth of history that is tied the American Revolutionary War. Each of these communities have very influential beginnings, starting with the fact that they are locate in Chester County and represented by the Pennsylvania's 6th congressional district of the United States House of Representatives. See Figure 20.



Source: (Chester County Association of Township Officials, 2006)

Figure 20: Location map of Paoli, Tredyffrin, and Willistown Townships

- **Paoli.** A census designated place (CDP) located Chester County, Pennsylvania and is situated in portions of Tredyffrin and Willistown Township. The town of Paoli was found in 1769 by an inn keeper name Joshua Evans (Heathcote, 1932). As reported by U.S. Census Bureau (2020b), there is a population of 6,002 in the town of Paoli with 10.4% percent of that population below the poverty level and a median household income of $83, 466. There were 4,783 (79.7%) White, 192 (3.2%) Black, 768 (12.8%) Asian, 78 (1.3%) Hispanic, 181 (3%) Non-Hispanic Others.

- **<u>Tredyffrin Township.</u>** A township located in eastern Chester County, Pennsylvania. In the center of the Township sits the rich and fertile Valley Creek that branches off into three tributaries. The earliest settlers were of Welsh descent, and to them this Township owes its name. The Welsh's word for town is Tre, and along with the word Dyffrin, which means 'a wide cultivated valley, combined into the name Tredyffrin, meaning a township in a wide cultivated valley (Heathcote, 1932). According to the 2020 U.S. Census (2020f), the population of Tredyffrin Township was 31,798 with 2.9 percent of the population below the poverty level and a median household income of $137,675. The were 23,912 (75.2%) White, 795 (2.5%) Black, 5,723 (18%) Asian, 826 (2.6%) Hispanic, and 540 (1.7%) Non-Hispanic Others

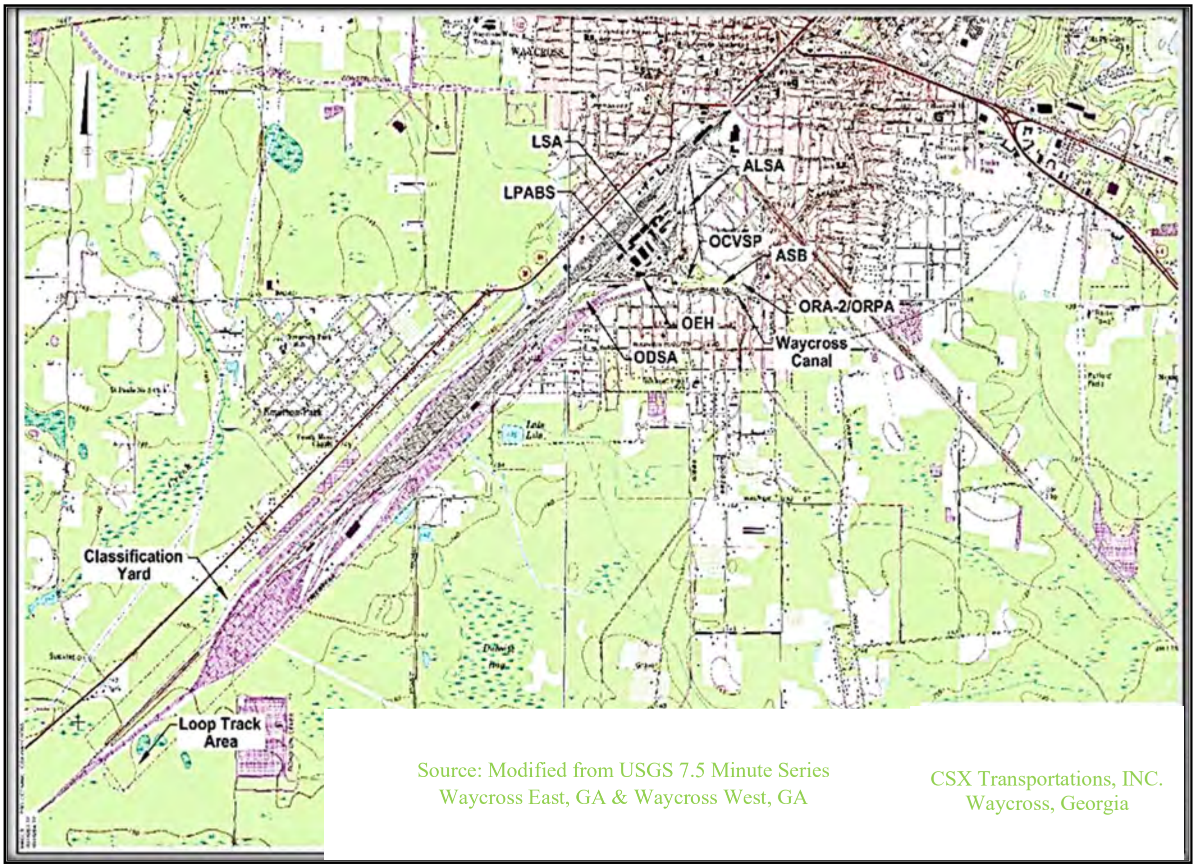
- **<u>Willistown Township.</u>** A township located in Chester County, Pennsylvania. Willistown was organized into a township in 1704. Originally occupied by the Lenape Native Americans, this township was developed agriculturally with advanced farming techniques and machinery. According to the 2020 U.S. Census (2020h), the population of Willistown Township was 11,260 with three-point one percent (3.1) percent of the population below the poverty level and a median household income of $128,239. There were 9,987 (88.7%) White, 259 (2.3%) Black, 833 (7.4%) Asian, 67 (0.6%) Hispanic, and 112 (1%) Non-Hispanic Others.

Community Impact. Fishing restrictions were place on residents that caused a decline in the number of fishing trips taken by the public to the three tributaries areas around Little Valley Creek and Valley Creek. These restrictions caused a lost in sales for the Valley creek fishery industry (Valley Creek Trustee Council, 2004). In addition, 290 residents filed civil cases in the Court of Common Pleas of Chester County, Pennsylvania, alleging injuries due to exposure to PCBs. Expert medical witnesses testified that plaintiffs, who lived near the Paoli Rail Yard "more than likely" will experience future development of serious diseases, because of toxic exposure to chemical released from the Paoli Rail Yard (United States Court of Appeals, Third Circuit, 1994).

Remediation Performance. According to the U.S. Environmental Protection Agency (1992) report, officials became aware of elevated levels of PCB contamination offsite in February of 1986. Over the course of many year, a final Fourth Five-Year report was released on April 22,2021. This plan highlighted the steps taken to address the contamination issue coming from the Paoli rail yard. Twenty-eight thousand (28,000) cubic yards of soil was excavated and treated. Erosion and sedimentation controls were set in place to manage and control storm water runoff. Decontamination of buildings and rail yard structures were done. Along with the pumping of groundwater that had been contaminated with fuel oil. (U.S. Environmental Protection Agency, 2021a)

Study Area V

CSX rail yard. Located in Waycross, Georgia, this rail yard extends approximately 5 miles along U.S. Highway 84. The 755-acre rail yard is own by CSX Transportation, Inc. and is the largest railroad switching and maintenance facility in the southeastern part of the United States. The areas West and South of the rail yard is primarily residential, while industrial, commercial, and other residential properties are to the north and east of rail yard. See Figure 21.

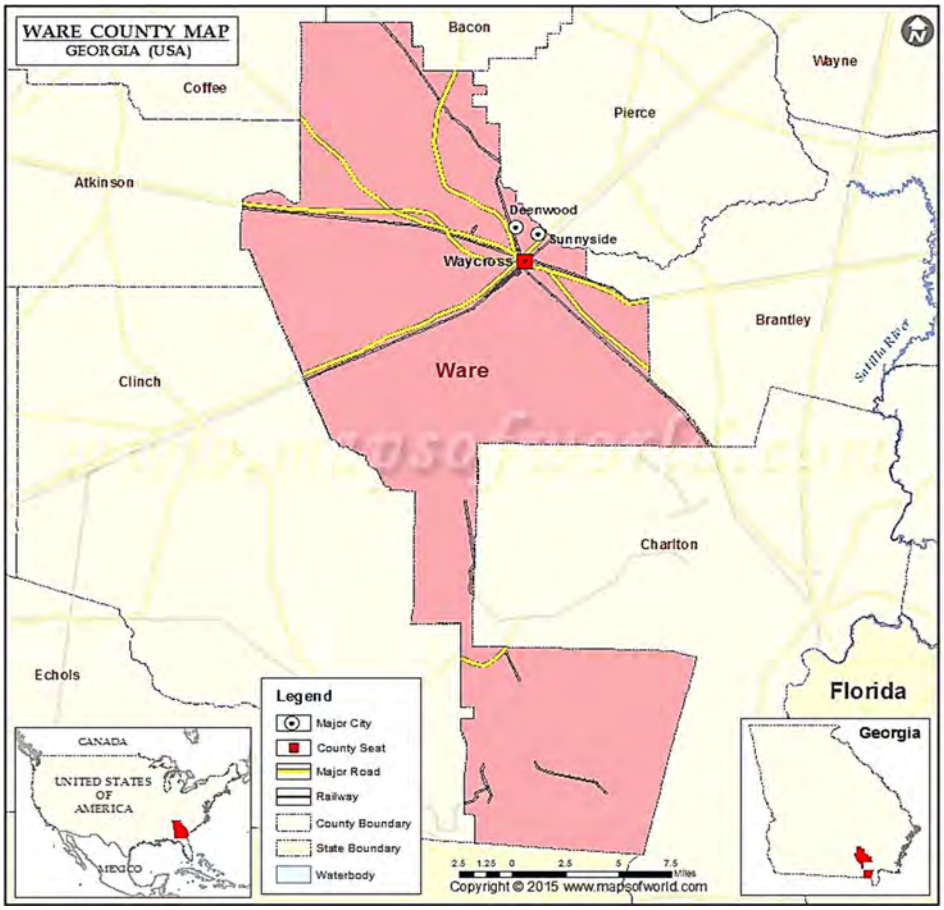


Source: Georgia Department of Public Health, 2018)

Figure 21: Map of CSX rail yard

Investigations led by the Georgia Department of Public Health (DPH) and ATSDR identified potential health effects of toxic chemical releases from the Waycross, Georgia CSX Rail Yard. The concentrations of toxic chemicals in surface water (dichloroethane, dichloroethane, and trichloroethene) and sediment (arsenic and benzo fluoranthene) in the soil were very high in exposure and could result in cancer for children and adults who came in contact with these chemicals. In 1988, groundwater investigations found contamination under the CSX Rail Yard. It was discovered that contaminated groundwater had migrated south of the Waycross Canal due to leakage from storage drums and disposal of comminates by the practice of releasing minor amounts to the ground at three locations: 1) An old drum storage area groundwater plume; 2) from the locomotive paint and air brake shop groundwater plume; 3) from the locomotive ship area/old cleaning vat sludge pit groundwater plume. These plumes migrated into the residential areas located approximately 500 feet from the rail yard (Georgia Department of Public Health, 2018).

Community adjacent to CSX rail yard. When studying the community of Waycross, there is an amazing history on how this city began. This community dates back to year 1820, and "Waycross" become incorporated 54 years later. Waycross is the only incorporated city in Ware County and is represented by Georgia's 1st congressional district of the United States House of Representatives. See Figure 22.



Source: ("Ware County Map, Georgia," 2022)

Figure 22: Location of Waycross, Georgia

- **Waycross.** Located in Ware County, Georgia, this community includes two (2) historic districts and several other properties that listed on the National Register of Historic Places. From the Historic Downtown to the swamplands of the Okefenokee, this city has many attractions to Waycross Tourism Bureau and Visitor Center busy. Also, Waycross has the largest CSX computerized rail yard on the East Coast. According to 2020 U.S. Census (2020g), there is a total population of 13,759, in which 40.2% (5,531) Whites; 56.6% (7,788) Blacks; 2.5% (343) Hispanics; 0.2% (28) Asian; and 0.5% (69) Non-Hispanic Others. Waycross Georgia has a median household income of $30, 367; with a $18,358 per capita income in the past 12 months; and a poverty percentage rate of 29.8%.

Community Impact. In 2015, the Georgia Department of Public Health (2019) conducted a survey which collected self-reported health information on persons with health conditions that lived near CSX rail yard. Reported symptoms and diseases included:

Allergies	Digestive disorders
Anxiety disorders	Memory problems
Autoimmune diseases	Miscarriages
Benign tumors	Neurological impairments
Different types of cancer	Respiratory infections

According to the Georgia Department of Public Health (2018), a grassroot organization called the Silent Disaster have made claims that an increase in the number of cancer cases and other health problems are the result of exposure to environmental contamination from the CSX rail yard. Numerous investigations were conducted by the Georgia Department of Public Health, ATSDR, and the U. S. EPA. The data analyzed and reports provided the media, community leader, and residents upon request. However, There were inconclusive finds, because there were four (4) cancer cases in the investigation that the environmental risk factors were not known.

Remediation Performance. The remedial investigation and clean up for this facility is currently in progress. Note: The Georgia Department of Public Health has completed an evaluation for the health impacts from the listed exposure.

Results of Cross-Case Analysis

In examination of the Englewood rail yard area and the four (4) study areas, a recurring theme and similarities emerged that displayed a need for improvement in guidelines of disposing of hazardous waste and by-products produced in rail yards. Table 7 shows how each study area parallels in comparison to each other. See Table 7: Rail Yard comparable table.

Table 7: Rail Yard Comparable Table

Name	Study Area I Englewood Rail Yard	Study Area II Conrail Rail Yard	Study Area III Union Pacific Rail Yard	Study Area IV Paoli Rail Yard	**Study Area V** CSX Rail Yard
Location	Houston, Texas	Elkhart, Indiana	Eugene, Oregon	Paoli, Pennsylvania	Waycross, Georgia
Rail yard Operations	Wood Tmt. Plant (closed) Classification Yard Tanker storage facility	Classification Yard Distribution Yard	Locomotive maintenance and fueling Railcar repair Wood Tmt. Plant Wastewater treatment and disposal	Distribution Yard Locomotive maintenance Tanker storage Repair Facility	Distribution Yard Maintenance facility Storage facility
Type of contaminates of concern	Arsenic Benzene Benzo(a)pyrene Bis(2-ethylhexyl) phthalate (DEHP) Creosote 1,2-Dichloroethane 1,2-Diphenylhydrazine 2,4-Dimethylphenol 2-Methylnaphthalene Fluorene Fluoranthene	Chloroform Tetrachloromethane - CCL4, 1,1 – dichloroethane 1,2 – dichloroethane, Trichloroethylene – (TCE) Tetrachloroethylene – (PCE) Vinyl chloride	Creosote 1,1 – dichloroethylene – (DCE) polycyclic aromatic hydrocarbons – (PAH) Trichloroethylene – (TCE) Tetrachloroethylene – (PCE) Vinyl Chloride	Benzene Biphenyls (PCB) Ethylbenzene Polychlorinated Toluene Xylenes	Arsenic Benzo(b)fluoranthene 1,1-Dichloroethane 1,1-Dichloroethene cis-1,2-Dichloroethene Trichloroethene trans-1,2-Dichlorethene Vinyl Chloride
Disposable Practices	Improper release of wastewater to nearby drainage ditches	Improper disposal of track cleaner by burning waste Improper disposal of tank cars by underground burial	Improper release of wastewater to nearby drainage ditches	Improper storage of railroad ties and hazardous debris in rai yard	Improper storage & accident releases to the ground
Issues for nearby Communities	Groundwater contamination Soil Contamination	Groundwater contamination Soil Contamination	Groundwater contamination Soil Contamination	Groundwater contamination Soil Contamination	Groundwater contamination Soil Contamination
Years of Contamination	1984 to present day	1976 to 2014 Superfund	1990 to 2015	1986 to 2021 Superfund	1988 to Present
Possible Source	Spills and leakages from operations Improper release to nearby drainage ditches,	Spills and leakages from operations Tank car collision Poor waste handling practices Improper disposal of track cleaner	Spills and leakages from operations Improper disposal of contaminants Leakage from wastewater treatment plant	Spills and leakages from operations Improper release to nearby drainage ditches Leakage from fuel oil recovery system	Spills and leakages from operations Improper disposal of contaminants
Community Impact	Exposure to high levels of contaminate creosote & arsenic High levels of cancer rates near rail yard Large plums of contaminates under residents' homes	Exposure to high levels of contaminates TCE & CCL4 Two large plums of contaminates identified under residents' homes and coming from Conrail rail yard Numerous health illnesses	Exposure to high levels of contaminants creosote, PAH's & VOCs Large plums of contaminates in multiple areas in communities nearby High levels of cancer rates near rail yard	Exposure to high levels of contaminants PCB & benzene Contaminated habitat resources for wildlife Created fishing restrictions for nearby communities Numerous health illnesses	Exposure to high levels of contaminants arsenic & benso-fluoanhene Three plumes of contaminants identified and migrated into nearby residential area Numerous health illnesses
Remediation Performed	More than 11,000 tons of creosote removed (Soil Excavation) Continue to conduct significant and widespread sampling of groundwater monitoring wells Concrete and asphalt barrier to the	Elkhart municipal water lines extended to 500 residences and business Groundwater extraction and treatment system installed Collected ground water treated with air stripping and discharged to the St. Joseph River	Over 300 cubic yards of petroleum and metals contaminated soil removed from pond Wastewater impoundments decommissioned and stabilized with lime Extraction of groundwater and	Excavation and on-site treatment of 28,000 cubic yards of soil Erosion and sedimentation controls to manage and control storm water runoff and sediment Decontamination of buildings and structures on the rail yard	Remedial investigations and clean up at this facility is currently in progress The Georgia Department of Public Health has completed an evaluation for potential health impacts of exposures.

	Legend
	Rail Yard Table
	Rail yards with creosote remediation
	Rail yards classified as a Superfund
	Rail yards in process of remediation

Sources: Table created from (ATSDR, 2007), (U.S.EPA, 1992), (U.S. EPA, 2004), and (Ecology and Environment, inc., 1994)

As the table indicates , the necessity of continuous cleanup of dangerous spills and leakages from operations that occur intentionally or accidentally in rail yards is apparent. Each study area has triggered the similar issues for nearby communities, creating soil and groundwater contamination. The impact of these rail yards on neighboring communities show exposure to high levels of various contaminates and toxic waste can cause numerous types of illnesses. Many of these communities that reside adjacent to these study areas have commonalities of low-income residents battling with health anomalies and deteriorating eco-environments. However, it should be noted that the communities adjacent to the Paoli rail yard (Willistown and Tredyffrin Township) does not meet the same income commonality but does parallel in the issues and negative impacts place upon these communities. The data identified those rail yard with seeping hazardous cancer-causing chemicals and possible sources of the seepages. Although the types of contaminates and toxic waste may differ from rail yard to rail yard, the impact on nearby residents shows the same health concerns from the disposable practices of rail yard operations.

CHAPTER 5

SUMMARY, CONCLUSIONS, & RECOMMENDATIONS

The primary purpose and significance of this study was to examine the impact that contaminates from the Englewood Rail Yard have on low income and minority communities in Houston, Texas. The thesis aimed to study the considerable connection between residents living in proximity to a rail yard that has seeping carcinogens, and the risk it poses to human health and the surrounding environment. This research investigated the practices of how and where this rail yard disposed of hazardous and toxic material (creosote), and the connections between the buildup of creosote plumes and the health illnesses plaguing the bordering communities. This study used a qualitative research method with a case study approach and a cross-case analysis to highlight similarities of the Englewood rail yard contamination with the four (4) other rail yards with parallel issues but uses different hazardous chemicals . The results of the comparison showed that improper release of wastewater to nearby drainage ditches, water lagoons, and improper disposal of contaminates can cause groundwater and soil contamination to neighboring communities, which will lead to high levels of contaminate exposure, and possible health anomalies. The methods used in this study created a model that is transferable and can be used to analyze other areas in the region and other cities.

Revisiting the Research Questions

Chapter 1 explained the reasons why this study was needed. This study focused on the Englewood Rail Yard's practices of how and where this rail yard disposed of hazardous and toxic material (creosote), and the connections between the buildup of creosote plumes and the health illnesses plaguing the nearby communities. The following provides responses to the research questions presented in Chapter 1:

<u>Question 1: Who is affected by the Englewood rail yard contaminant? Are other communities affected by contaminants from other rail yard in the United States?</u>

Nearby residents who are exposed to site chemicals of concern (COC) show signs of greater health challenges. The closer residents lived; the higher chances of exposure were increased. This exposure can happen when residents come into contact with contaminants by (1) touching or accidentally ingesting contaminated soil (e.g., during outdoor activities), (2) drinking or skin contact with contaminated groundwater, and (3) indirect exposure through breathing contaminated dust or vapor.

And Yes, similar health and environmental issues are affecting other communities from rail yard with seeping contaminants. In this research, there were four (4) other study areas that have affected their adjacent communities, similarly.

<u>Question 2: How dangerous are these contaminates when released into neighboring communities from rail yards? How has rail yard contamination impacted nearby communities?</u>

Hazardous and toxic contaminates reck havoc on communities. Many of the health effects are not noticed until years later; unfortunately, as the years pass, this incubation period can be deadly. Measurable aspects of exposure to these poisonous contaminates are often-times overlooked and missing out on the synergistic effects of many different contaminates that are hard to measure and identify.

Many studies found that there was a higher risk of cancer, when living near rail yards with seeping carcinogens. Often times, diseases related to contamination exposure is difficult for the medical community to define and diagnose. Illnesses from contamination exposures differ from classical disease symptomology, because of how the affected areas impact the human organs. Contamination exposures will affect the communication, immune or neurological systems over time. However, depending on the level of exposure and the routes of exposure, contaminates from rail yards may affect each individual differently. The constant exposure to these harmful conditions results in negative health outcomes that stressed communities and reduce the quality of life for the residents.

Question 3: What does it mean to be living near a contaminated rail yard? What are the health effects?

Living near a contaminated rail yard could cause a series of long term financial setbacks. Starting with the depreciation of home values and accumulation of medical expenses. There are many health effects that can possibly occur from exposure to soil and groundwater contaminates. It all depends on the type of contaminants, the concentrations of the contaminants, and the frequency of exposure from the rail yard. The health effects attributable to the COC from Englewood Rail Yard are (1) breathing contaminated air may cause different types of cancers in the liver, lung, blood, gastrointestinal tract, immune disorders, developmental and neurological effects and (2) ingestion of contaminates may cause different types of cancers in the liver, skin, kidney, lungs, and blood.

Question 4: What are the best practices to dispose of wastewater (and storage of hazardous materials) by-products for rail yards?

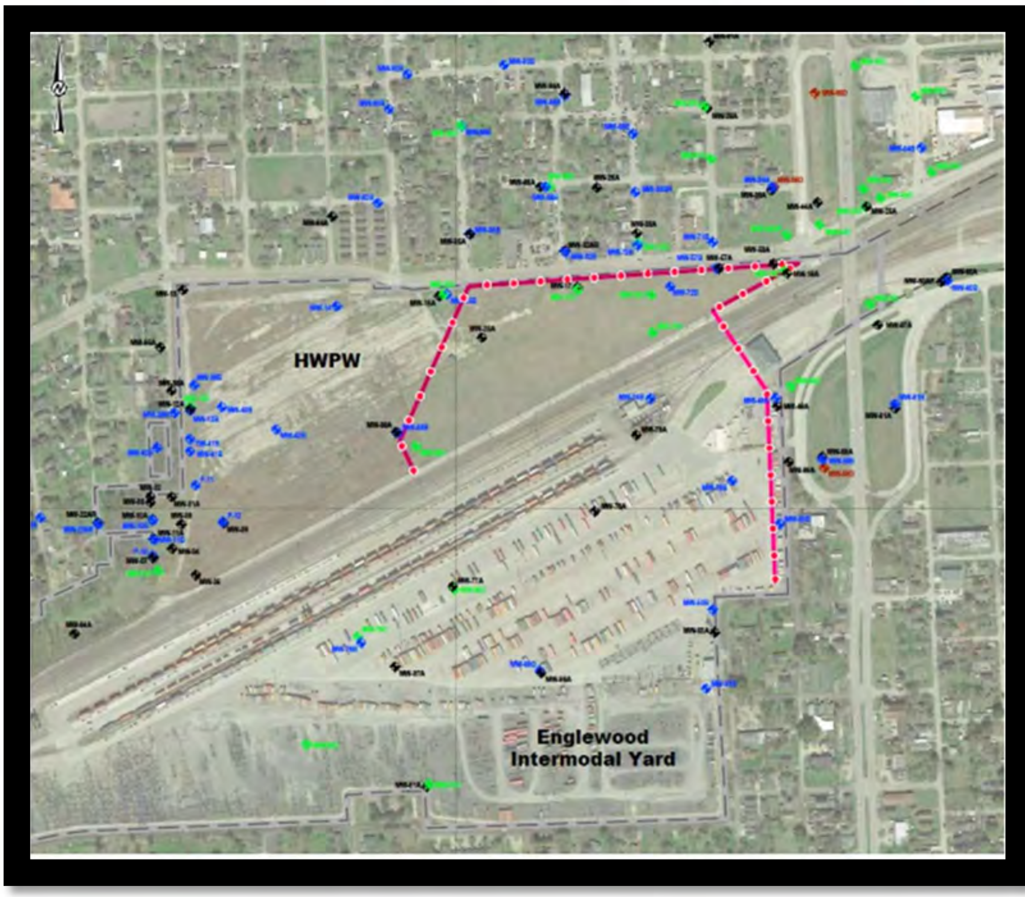
Clean water is essential to life and many industrial processes. There should be an established water treatment process where wastewater must be sent to a water treatment plant through a series of pumps and valves. Inside the treatment plant, the wastewater is filtered and chemically treated. After disinfection and in accordance with the Clean Water Act, 33 U.S.C. §1251 et seq. (1972), the filtered water can then be distributed to nearby lakes, rivers, or transported to hazardous disposable facilities (Clean Water Act, 1972). Storage of hazardous materials and by-products should be stored above ground and monitored on a periodic basis.

Question 5: Have Union Pacific Railroad's (UPRR) planners addressed the contamination of nearby communities?

Generally, the answer to this question is yes. UPRR's Response Action Plans (RAP) outlines how soil and groundwater contamination will be cleaned up. However, more needs to be done. The last monthly status update was completed on September 15, 2021, for the Englewood rail yard. In this report, non-aqueous phase liquid (NAPL) Collection System was installed in the Englewood Intermodal Yard to address the tar-like substance seeping within the parking slots of B100 to B109 container trailers. Over 11,000 tons of creosote impacted soil has been removed from Englewood rail yard, but there is still remnants of contaminates in the area (Union Pacific, 2022).

Question 6: How should rail yard facilities mitigate off-site soil and groundwater contamination? How has UPRR mitigated off-site soil and groundwater contamination around the Englewood Rail Yard?

In UPRR's report, the cleanup activities have (1) restricted the use of groundwater from the contaminated area, (2) proposed to install an underground vertical wall (known as a slurry wall) below ground to contain the highest groundwater contamination at the facility. See figure 21.



Source: (TASC, 2021)

Figure 23: Proposed Underground Slurry Wall

In addition, two (2) underground tanks were removed from service, excavated, and disposed. These efforts are continuously being monitored and update.

CONCLUSIONS

A through literature review on rail yard contamination and its health and environmental impact on nearby communities was conducted in this study. The aim was to identify key factors (gaps) that have impact the communities surrounding those rail yards. Furthermore, the goal of the study is to improve the transportation policies and guidelines geared toward improving the public health and advancing environmental equity in communities that border rail yards in the United States. This study identified five (5) study areas with the similar soil and groundwater contamination that affect neighboring communities.

The key findings revealed by the literature review include:

Disposable Practices

- Improper release of wastewater to nearby drainage ditches from operations
- Improper disposal of track cleaner by burning waste
- Improper disposal of tank cars by underground burial
- Improper storage of railroad ties and hazardous debris in rail
- Improper storage of chemical and accidental releases to the ground

Possible Sources

- Spills and leakage from operations
- Improper release to nearby drainage ditches
- Poor waste handling practices
- Tank car collision
- Leakage from wastewater treatment plant
- Leakage from fuel oil recovery systems

Community Impact

- Exposure to high levels of contaminates/hazardous chemicals
- High levels of cancer rates near rail yards
- Numerous health illnesses
- Water, air, and ground pollution throughout the community

RECOMMENDATIONS

The operations of rail yards and the different industries within these rail yards impacts the health and quality of life in adjacent communities. The railroad industry and its policy makers need to act responsibly to reduce impacts from rail yard contamination. Policy recommendations to mitigate exposure to contaminates should be considered important interim steps towards achieving zero contact with the public. Suggestive policies and solutions that can be implemented include:

1. Strengthen federal regulation disposal of contaminates and wastewater in rail yards

   - The Federal Government should strengthen federal regulations of proper disposal of wastewater from the railroad industry operations. The 1972 Clean Water Act and the 1990 Clean Air Act amendments give the U.S. EPA the power to adopt standards for treating and disposing of wastewater. Existing regulations have given too much time to the railroads to clean up released contaminates. Railroads have total discretion to the timeline cleanup of their choosing.

2. Strengthen borders around rail yard operations

   - Mandate half-mile perimeter around rail yard operation. No resident should live across the street from a rail yard. Existing resident and sensitive receptors (schools and hospitals) should be relocated outside of perimeter. Although, this may be difficult because of zoning laws or lack thereof, yet stronger perimeters should strengthen rail yard borders.

3. Strengthen Federal Railroad Administration (FRA) railroad safety management systems

   - In addition to the current FRA's safety management systems, create a system where railroad workers complete a risk-assessment exercise in which they have to identify the major safety risks to the public. RR workers should appraise the probability and severity of these risks, rate the risks, and provide plans for improving those risks that were high to the public.

4. Establish a delinquency system

   - This system would be the alternative to the "performance standards" system that is currently in place. The objective of a delinquency system is to identify those railroads providing poor-quality service or those whose safety record is dangerously declining.
   - Design an information system that provides an early warning or railroads who may not be completely forthright on self-assessments.
   - Design a system of waning flags that could trigger inspections in rail yards

Future Research

The following is a recommendation for future research to expand the findings of this study:

- Expand rail yard websites to include links to technical documents that will inform the public of potential hazards. Allowing this information to be readily available will show rail yard accountability to the public.

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