



Urban Soil Health and Income Disparities. Let's talk about it.

How can the relationship between socioeconomic status and soil health as it relates to quality of life, be understood and remediated to improve the quality of life in various neighborhoods within the Greater Cincinnati region?



Emily R. Evans



Figure 1: Nutritious Soil, 1994

Urban Soil Health and Income Disparities. Let's talk about it.



How can the relationship between socioeconomic status and soil health as it relates to quality of life, be understood and remediated to improve the quality of life in various neighborhoods within the Greater Cincinnati region?



Emily R. Evans

Bachelor of Science in Horticulture

Certificate of Sustainable Landscape Design

Certificate of Green Roof Design

Certificate of Urban Agriculture

University of Cincinnati

College of Design, Architecture, Art, Planning (DAAP)

Faculty Advisory Professor Stevie Famulari G.d.s.

April 2025

Table of contents

Identification & Relevant Coursework.....	1-3
Keywords.....	4
Abstract.....	5
Problem Statement.....	6
Project Justification.....	6-7
Maps.....	8-11
User & Client Description.....	12-13
Major Project Elements.....	14-16
Site Information, Inventory & Analysis, Quantitative & Qualitative.....	17-27
Site Summary.....	28-29
Case Studies & Literature Review.....	30-36
Case Study Summary.....	37
Historical Context of the Topics of the Research.....	38-41
Programmatic Requirements.....	42-45
Process Documentation.....	46-62
Project Solution.....	63-65
Reference List.....	66-72
Appendix.....	73

Student Identification



Figure 2: Photograph of Emily R. Evans, Michael Everett, UC DAAP

Emily R. Evans

Contact Information: emilyevans201804@gmail.com



“If you want to be happy for a year, get married. If you want to be happy for a decade, get a dog. And if you want to be happy for the rest of your life, make a garden.” - Martha

Stewart

Relevant Coursework

Horticulture Capstone

HORT 4092

Professor Stevie Famulari G.d.s

Spring 2025

Project: Senior Capstone

Urban Landscapes IV: Roofs & Facades

HORT 3044

Professor Rose Seeger & Professor Wendy Ellis

Spring 2025

Project: Final Roof Design Project

Sustainable Landscape Design

HORT 2040

Professor Stevie Famulari G.d.s

Fall 2024

Project: Final Design Project

Horticulture Crop Physiology

HORT 4020

Dr. Dan Petterson

Fall 2024

Lecture: Soil Capacity & Properties

Edibles for Sustainable Landscape Design I

HORT 3030

Professor Stevie Famulari G.d.s

Spring 2024

Project: Final Design Project

Agriculture Ecology

HORT 2012

Professor James Hensel

Spring 2023

Lecture: Sustainable Land Management Practices

Soil Science & Plant Nutrition

HORT 3010

Dr. Tania Burgos-Hernandez & Dr. Dan Petterson

Spring 2023

Lecture: Cation Exchange Capacity & Soil Fertility

Landforms & Soils

GEOG 1012

Professor Hayden Owens & Professor Nicholas Dunning

Spring 2022

Lecture: Types of Soils & Their Properties & Landform Formation

Environmental Geology

GEOL 1005

Professor Wesley Parker

Spring 2022

Lecture: Anthropogenic Climate Impacts

Keywords

Cation Exchange Capacity (CEC), Cincinnati, Contamination, Food Desert, Low-Income, Socioeconomic Status, Soil Health, Urban Agriculture

Defining of Keywords

Cation Exchange Capacity (CEC): A measure of how soil retains nutrients and makes those nutrients available for plants' use.

Cincinnati: A city located in southwest Ohio, composed of 52 neighborhoods, and a population of approximately 311,097 residents, as of 2020. (Census.gov, 2020)

Contamination: Refers to pollution, especially in the case of soils, foreign materials or compounds that inhibit the health of soil.

Food Desert: Defined by the USDA as an [area], "...with limited access to affordable and nutritious food, particularly such an area composed of predominantly lower-income neighborhoods and communities." (USDA, June 2021)

Low-Income: Refers to those living at or below the poverty line, as defined by the U.S. Department of Health and Human Services, as "a family of four at an annual income of \$27,750." as of 2022. (ASPE, 2025)

Socioeconomic Status: "...encompasses not only income but also educational attainment, occupational prestige, and subjective perceptions of social status and social class." (APA, n.d.)

Soil Health: As defined by the USDA as "...the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans..." (USDA, n.d.)

Urban Agriculture: As defined by the USDA; "Urban agriculture includes the cultivation, processing, and distribution of agricultural products (food or non-food) in urban and suburban areas." (USDA, n.d.)

Abstract

In the urban landscape of Cincinnati, Ohio, lies a variety of neighborhoods, ranging in culture, ethnicity, socioeconomic class, and other qualities. Within each of these diverse neighborhoods though, a disparity is hiding in plain sight, soil health, or the lack thereof. This research investigates if there is a meaningful correlation between those living in low-income areas, and the state of the soil's health. Specifically, the neighborhoods of Lower Price Hill, Winton Hills, and Walnut Hills in Cincinnati, Ohio are examined regarding socioeconomic class related to environmental factors. Additionally, the quality of life for those living in these neighborhoods is being investigated to determine if any quantifiable disparities in the aforementioned neighborhoods are perpetuated by, or a direct result of poor soil health.

In some neighborhoods, especially those that fall at or below the poverty line, a phenomenon commonly referred to as "food deserts" exists. A food desert is defined as a lack of access to fresh foods such as produce, creating stark inaccessibility to healthy, nutritious foods, to a myriad of people which in turn raises the potential of serious health issues, including but not limited to diabetes and obesity. This is one example of an environmental injustice that may be directly correlated or perpetuated by environmental issues. This research investigates if there is a correlation between soil health and the overall quality of life for those living in impoverished neighborhoods suspected of having poor soil health.

Problem Statement

How can the relationship between socioeconomic status and soil health as it relates to quality of life, be understood and remediated to improve the quality of life in various neighborhoods within the Greater Cincinnati region?

Project Justification

On just a quick drive through some of Cincinnati's most prominent neighborhoods and unsettling disparity will quickly rear its head. In one such neighborhood, one may have a choice of lush farmers markets and specialty organic stores, whereas in another neighborhood one may be lucky to find one large chain grocery store.

Discrepancies such as this; access to food, is only one example of various disparities commonly found in urban areas. Higher reported rates of respiratory illness, heart disease, kidney disease, lower life expectancy, usage of government assistance programs, and number of people living at or below the poverty line are all reported in



Figure 3: A farmer tends to his field amidst high-rise buildings, 2007

neighborhoods such as Lower Price Hill, Winton Hills, and Walnut Hills (Cincinnati-oh.gov, 2021). It is also pertinent to note that all of these neighborhoods have a predominantly black population, with the exception of Lower Price Hill whose black population is approximately 35% (Cincinnati-oh.gov, 2021). This research is relevant and

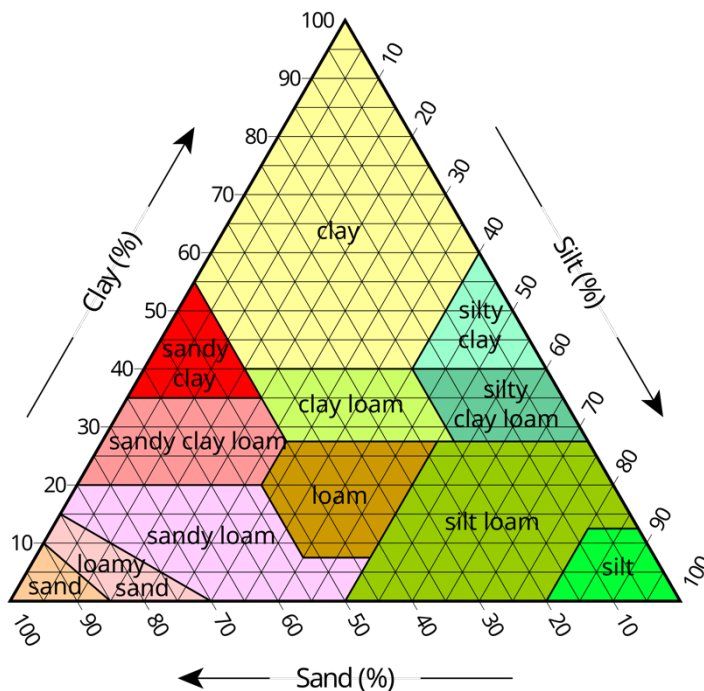


Figure 4: USDA Soil Textures Triangle

pertinent, as there is little existing research regarding socioeconomic status and soil health in urban settings. While it is true that soil in an urban setting does not have to be the caliber to produce a large agricultural yield, that is not to say that having contaminated soils is desirable. Those who live in urban settings deserve an environment devoid of as many

pollutants as possible. Moreover, when these environmental issues such as soil health aid to perpetuate the decline of quality of life and living experience for low-income and marginalized communities, it is just that investigation and proper advocacy are put in order.

Maps

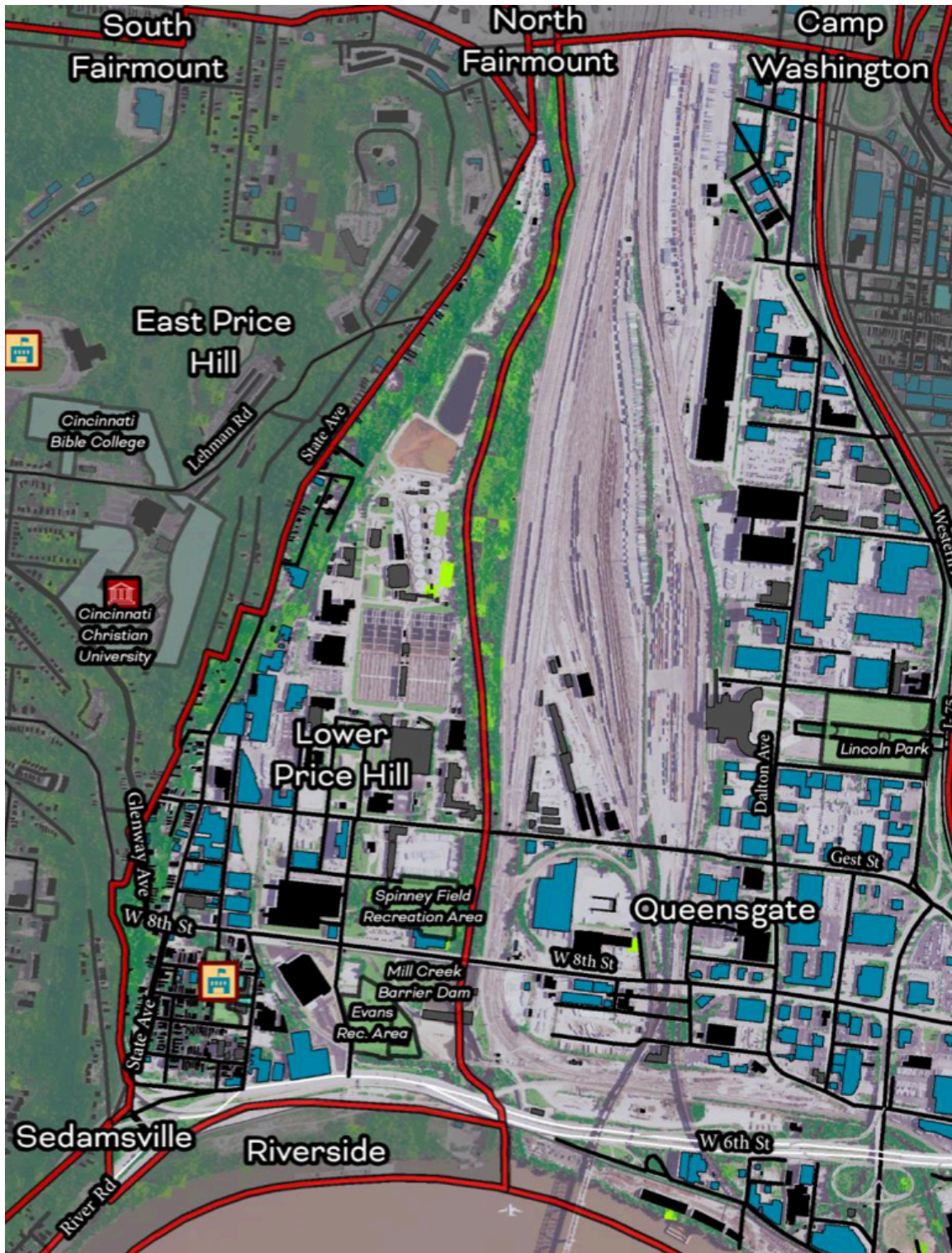


Figure 5: Map of Lower Price Hill & surrounding areas. The red line denotes neighborhood boundaries.

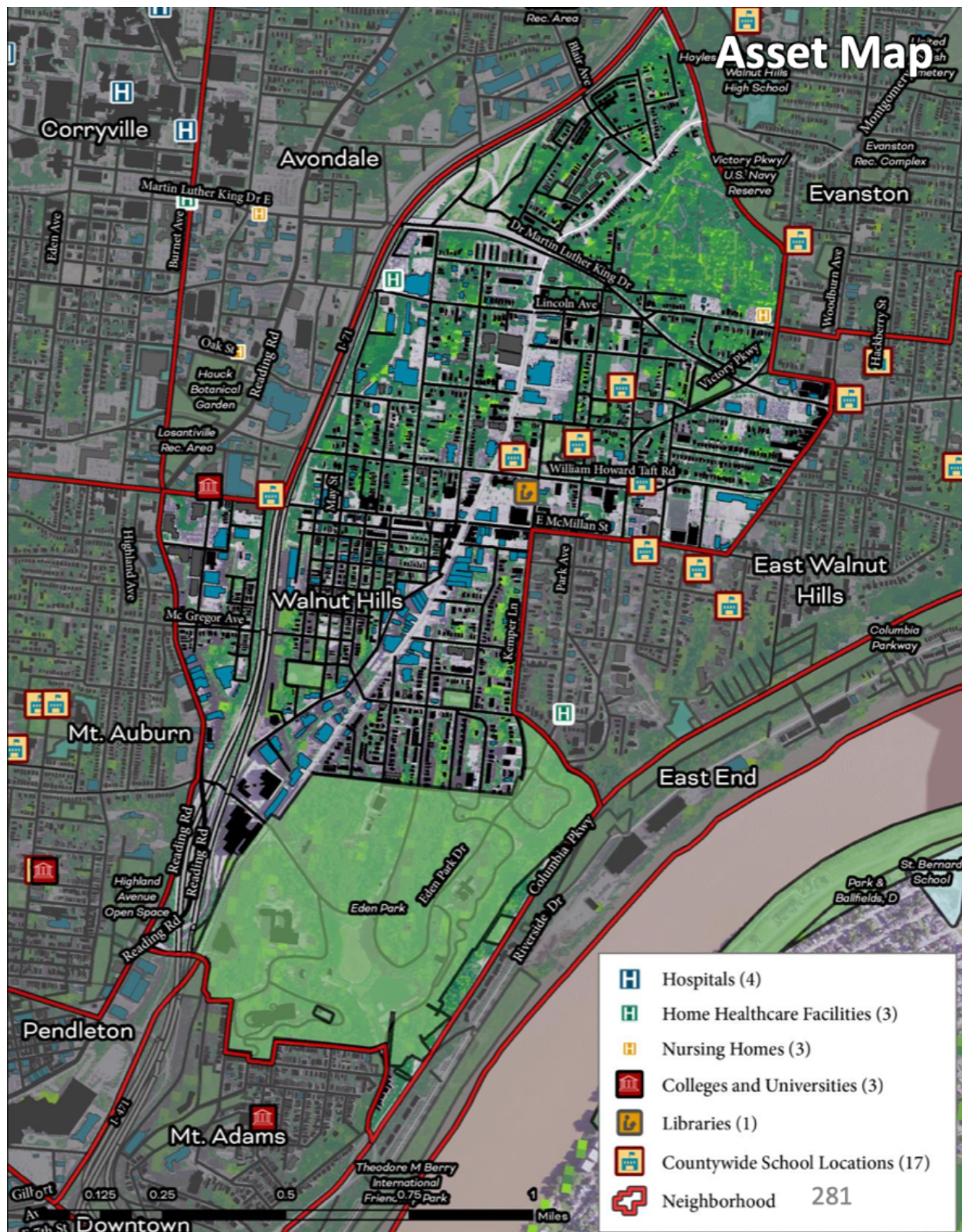


Figure 6: Map of Walnut Hills & surrounding areas.. The red line denotes neighborhood boundaries.

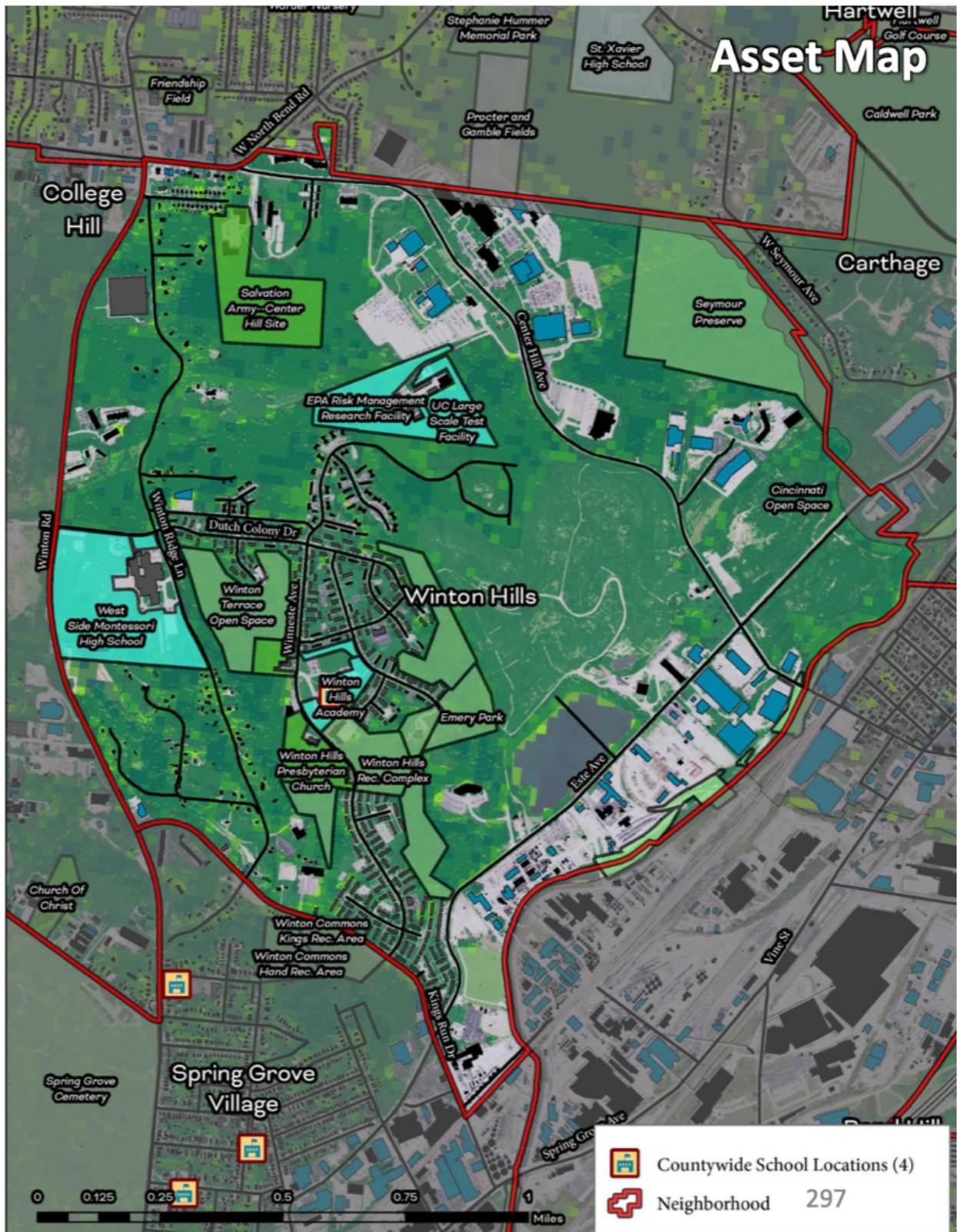


Figure 7: Map of Winton Hills & surrounding areas. The red line denotes neighborhood boundaries.

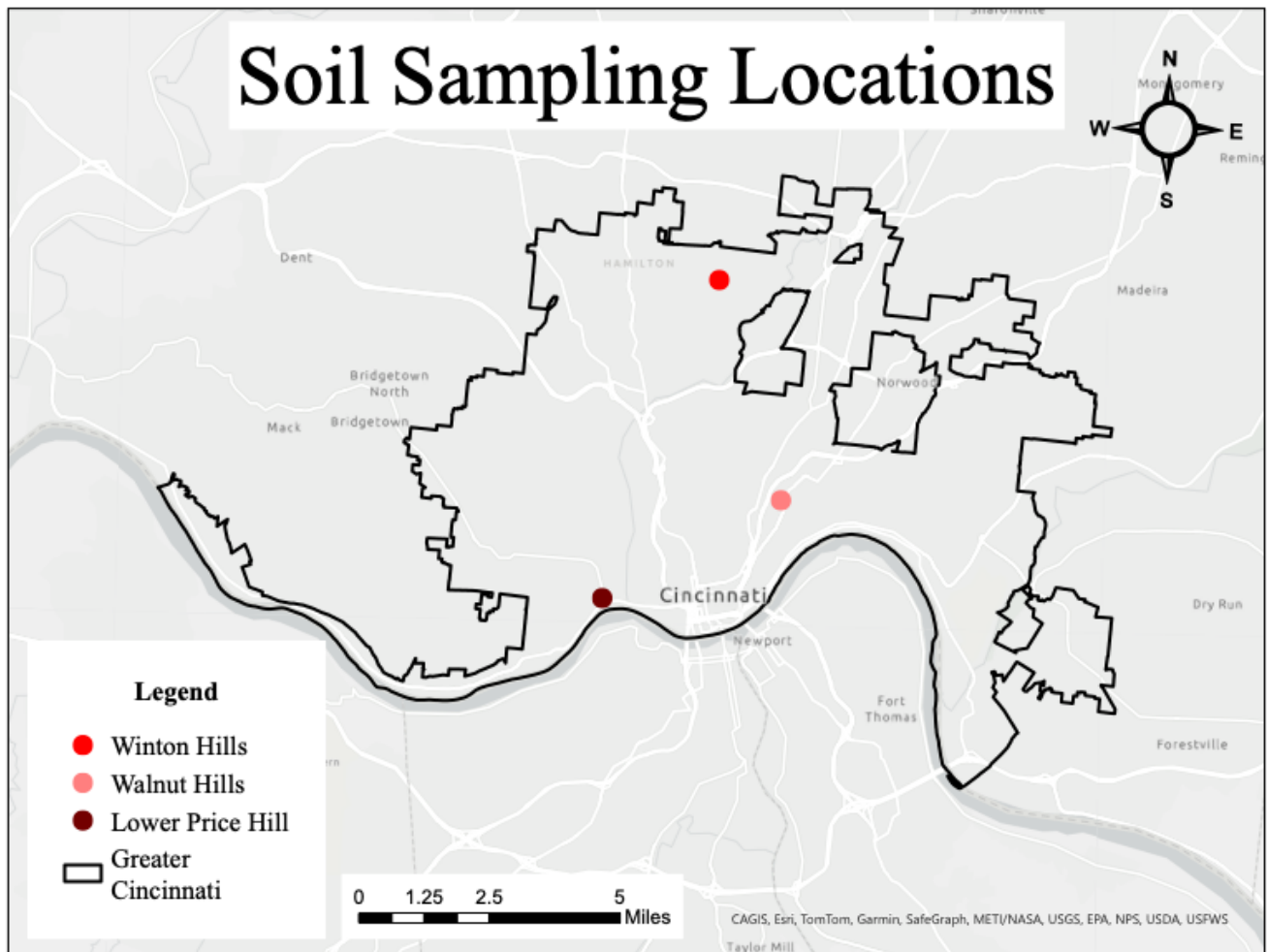


Figure 8: Map of Soil Sample Collection Sites

User & Client Description

The purpose of this research is to determine the correlation between soil health in low-income neighborhoods and, if there is, how it affects the quality of life for those living in these neighborhoods. The following neighborhoods are examined in this research: Lower Price Hills, Winton Hills, and Walnut Hills. Each of these neighborhoods displays at least 40% of residents living in poverty¹, and at least 40% of residents utilizing the supplemental nutrition assistance program, or SNAP (Cincinnati-oh.gov, 2021). Additionally, higher reported cases of diabetes, obesity, and asthma are found in these neighborhoods. Across all three neighborhoods, at least 16% of residents live with diabetes, 42% of residents are considered medically obese, and at least 14% of residents live with asthma (Cincinnati-oh.gov, 2021).

¹ The 2025 U.S Federal Poverty Guideline defines a family of 4 living on an annual income of \$32,150 or less as impoverished. (ASPE, 2025)

The findings of this research help to better illustrate the relationship between socioeconomic status and soil health as it relates to the quality of life and living experiences within these neighborhoods. The findings of this research will act as a basis on which meaningful and actionable steps can be taken by residents and municipalities alike to lessen the burden of environmental contaminants. This research serves not only those living in the affected areas discussed in this work but also any other neighborhoods similar to them. Additionally, this work serves as an educational tool for those interested in how soil health may impact various aspects of everyday life.

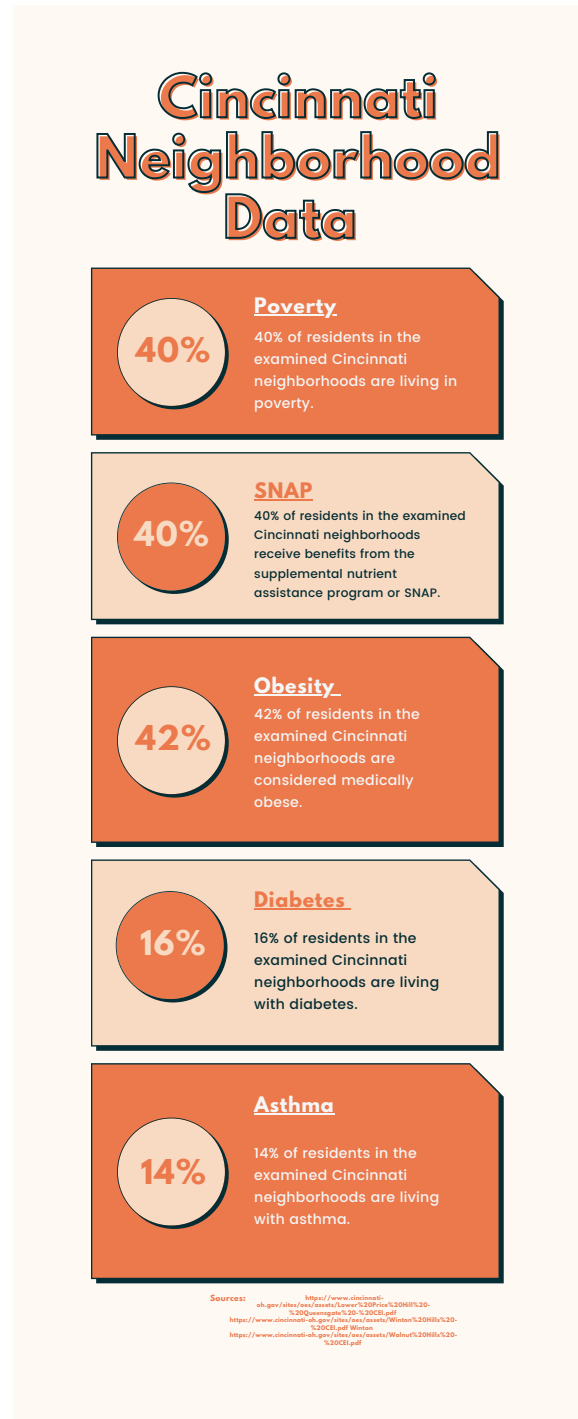


Figure 9: Cincinnati Neighborhood Statistic Graphic

Major Project Elements

The neighborhoods observed in this work; Lower Price Hill, Walnut Hills, and Winton Hills, are all located in Cincinnati, Ohio. Though all of these neighborhoods are found within the Greater Cincinnati area, their origins, cultures, demographics, and other qualities make each of these neighborhoods uniquely diverse. However, stark similarities can be found in these neighborhoods including higher reported cases of food-related health issues such as diabetes and obesity (Cincinnati-oh.gov, 2021).

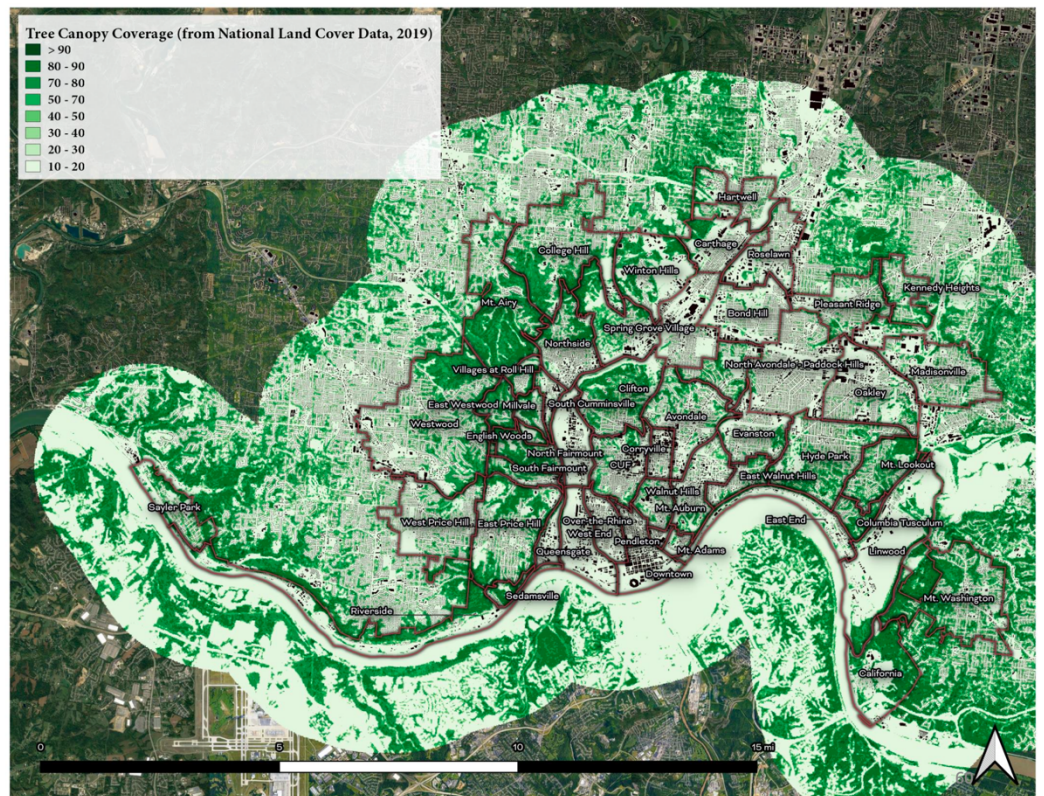


Figure 10: Tree Canopy Coverage Data for Cincinnati by Neighborhood, 2019

Socioeconomic issues such as the number of residents living in poverty, utilizing SNAP and spending more than 30% of their monthly income on rent and utilities², can also be observed amongst each of these neighborhoods (Cincinnati-oh.gov, 2021). Compounding

² It is a common ideal within financial discourse that one should not exceed 30% of one's monthly income on rent and utility payments alone, ensuring that there are adequate funds to cover all monthly costs. Exceeding 30% of one's monthly income on rent and utilities is an indicator that one may be in danger of becoming or being impoverished. (Quicken.com, October 2024)

environmental issues are observable in these neighborhoods, including but not limited to lack of tree canopy coverage, the greenness of land surfaces, greenspace available, proximity to EPA superfund sites, exposure to other known pollutants, and other environmental qualities (Cincinnati-oh.gov, 2021) .

To examine how these environmental issues are affecting residents in reference to soil, soil samples are taken from each of the neighborhoods to then be analyzed. The soil samples are taken from tree wells in a mixed residential, or residential street with sidewalk access in each of the neighborhoods. In Lower Price Hills a soil sample was taken from a tree well on Neave Street near both residential and small business properties. In Walnut Hills a soil sample was taken from a tree well on Melrose Avenue,



Figure 11: Soil Testing Image

directly outside of a private residential property, and adjacent to a public school. In Winton Hills a soil sample was taken on a residential street from a tree well, on Winneste Avenue.

Each of these soil samples was collected on February 28, 2025. These soil samples are then mailed to the Hamilton County Soil and Water Conservation District of Indiana. Once they are received, the soil samples are tested for organic matter, phosphorus, potassium, calcium, magnesium, boron, copper, iron, manganese, sulfur, zinc conductivity, CEC, pH, and

buffer pH (hamiltonswcd.org, n.d.). All these items will aid in better determining the overall health of the soil, any major contaminants found, and what actionable steps are next needed.

Having then analyzed the selected neighborhoods and interpreted the results of the soil sample findings, a conclusion may then be drawn regarding the belief that poor soil health in areas of lower socioeconomic class is prevalent.

Site Information, Inventory & Analysis, Quantitative & Qualitative

Lower Price Hill, Cincinnati, Ohio

Price Hill was founded in 1791, once a praised neighborhood nestled on the outskirts of bustling Cincinnati, a hub for Appalachian immigrants wanting to experience urban living. Over time, however, industrial pollution transformed the area, and environmental hardship has burdened



Figure 12: Lower Price Hill Street Art

Lower Price Hill since roughly the 1980's (uacvoice.org, July 2021). Today, the neighborhood ranks 43 out of 52 total neighborhoods for tree canopy coverage: approximately in the 82nd percentile, or a total of 6% tree canopy coverage. Lower Price Hill also ranks 42 out of 52 for greenness of land surface (26.4%), and 41 out of 52 for heat island exposure. Proximity to water pollution sources is deemed "extreme", and proximity to potentially toxic industrial activity is considered "very high". (Cincinnati-oh.gov, 2021)

Tree Canopy Coverage & Greenness of Land Surface in California, Cincinnati, Ohio & Lower Price Hills, Cincinnati, Ohio

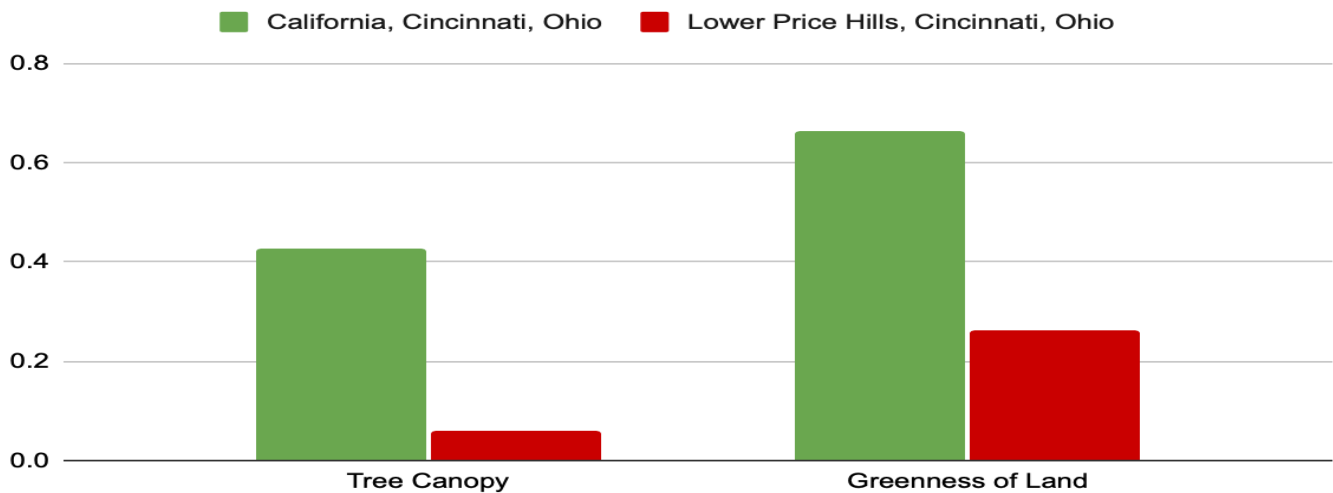


Figure 13: Tree Canopy Coverage & Greenness of Land Surface in California & Lower Price Hills, Cincinnati, Ohio, Bar Graph

When analyzing Cincinnati's most prominent neighborhood, however, California [Cincinnati, Ohio], the inverse of many of these factors and statistics can be seen. The neighborhood of California ranks 8 out of 52 total neighborhoods for tree canopy coverage: which is in the 15th percentile, or a total of 42.6% tree canopy coverage (Cincinnati-oh.gov, 2021). Contrastingly, California ranks 12 out of 52 for greenness of land surface (66.4%), and 4 out of 52 for urban heat island exposure (Cincinnati-oh.gov, 2021). Similarly to Lower Price Hill, proximity to water pollution sources is also deemed "extreme", though proximity to potentially toxic industrial activity is deemed "moderate" (Cincinnati-oh.gov, 2021).

In terms of socioeconomic factors, 72.1% of residents live in poverty in Lower Price Hill, and 48.3% of households receive SNAP (Cincinnati-oh.gov, 2021). 38.3% of residents spend more than 50% of their income or more on rent and utilities per month,

when it is recommended not to exceed 30% of your monthly income on these items in Cincinnati (Cincinnati-oh.gov, 2021). In addition to these factors, 51.1% of residents are considered medically obese, and 17.8% of residents are living with diabetes (Cincinnati-oh.gov, 2021).

Socioeconomic & Health Related Statistics of California, Cincinnati, Ohio and Lower Price Hills, Cincinnati, Ohio

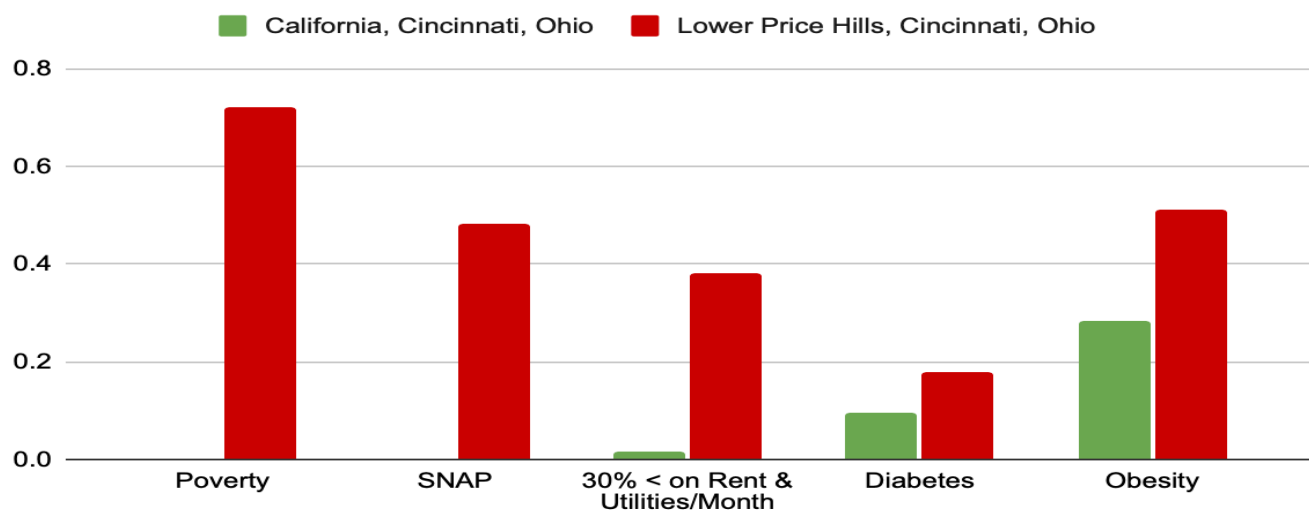


Figure 14: Socioeconomic & Health Statistics in California & Lower Price Hills, Cincinnati, Ohio
Bar Graph

Again, examining California in comparison, 0% of residents live in poverty, and 0% of households receive SNAP (Cincinnati-oh.gov, 2021). Only 1.6% of residents exceed the threshold of spending 30% of their monthly income or more on rent and utilities alone in California (Cincinnati-oh.gov, 2021). In addition, 28.5% of residents are considered medically obese in California, and 9.4% of residents are living with diabetes (Cincinnati-oh.gov, 2021). Both of these metrics are nearly half of what those living in Lower Price Hill are experiencing.

The stark differences in environmental and public health between Lower Price Hill and California are clear. Moreover, what is made evident is also a difference in socioeconomic standing. One neighborhood is subject to significantly more aggressive environmental and socioeconomic disparity, and its counterpart holds the inverse to be true. Is it then reasonable to deduce that the two factors; money and environmental health, are indeed connected? Further examination of additional neighborhoods as well as data regarding soil testing is necessary to make this claim wholly irrefutable.

Walnut Hills, Cincinnati, Ohio

Walnut Hills is also being examined in this research, first settled in 1804 by Reverend James Kemper who adopted land for agricultural purposes. Throughout the 1800's, Walnut Hills acted as a vital part of the Underground Railroad, as it was the



Figure 15: Image of Walnut Hills

home to abolitionist Harriet Beecher Stowe

(wearewalnuthills.org, n.d.). Today, the neighborhood houses over 6,000 residents. Of these 6,000 residents, 23.5% of

them live with diabetes, which

ranks as 44 out of 52 Cincinnati neighborhoods. Additionally, 48.7% of individuals are considered medically obese, ranking 40 out of 52 Cincinnati neighborhoods (cincinnati-oh.gov, 2021). In addition to the prevalence of health issues in Walnut Hills, 41.4% of people are living in poverty and 41.2% of households receive SNAP, ranking 37 out of 52 and 40 out of 52, respectively (cincinnati-oh.gov, 2021). Of those who rent homes in Walnut Hills 38.7% of residents are spending more than 30% of their monthly income on rent and utilities, and 20.3% of residents are spending more than 50% of their monthly income on the same expenses (cincinnati-oh.gov, 2021). As previously discussed, it is recommended not to exceed more than 30% of one's monthly income on rent and utility payments alone, ensuring that there are adequate funds to cover all monthly costs.

Neighborhood Statistics for Walnut Hills, Cincinnati, Ohio

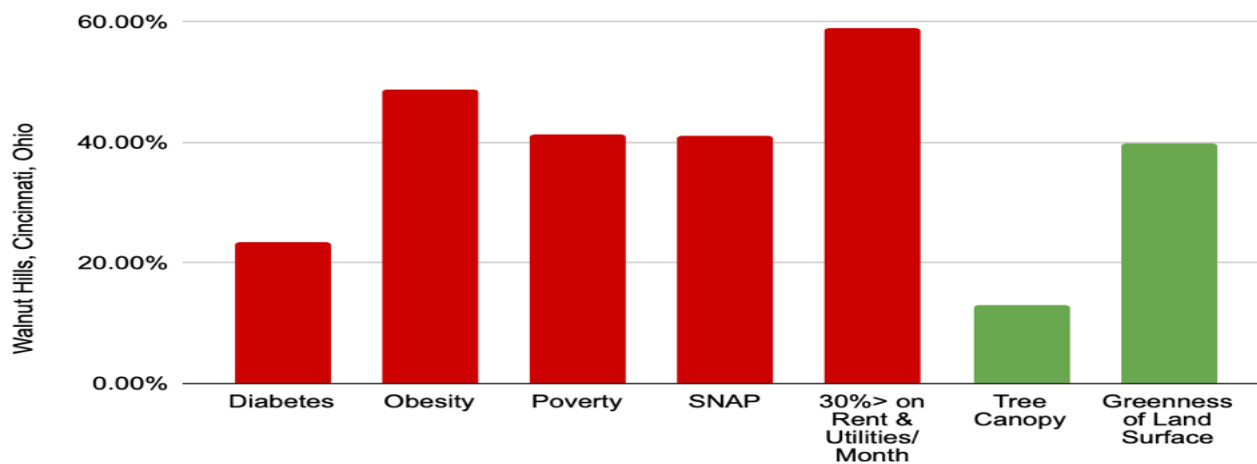


Figure 16: Neighborhood Statistics for Walnut Hills, Cincinnati, Ohio

Exceeding 30% of one's monthly income on rent and utilities is an indicator that one may be in danger of becoming or being impoverished (Quicken.com, October 2024).

In terms of environmental factors affecting the neighborhood of Walnut Hills, tree canopy coverage is ranked 36 out of 52, with a total tree canopy coverage of 13.1%. Greenness of land surface is ranked 39 out of 52 or 39.8%, and heat island exposure is ranked as 33 out of 52 (cincinnati-oh.gov, 2021). Beneficially however, Walnut Hills does allocate 21.2% of its land to greenspaces and parks, earning it the rank of 10 out of 52.

"Proximity to hazardous waste treatment and disposal facilities" is considered "very high" according to the Cincinnati Neighborhood Index (cincinnati-oh.gov, 2021). Proximity to superfund sites, abandoned areas containing hazardous waste, is considered "high" (cincinnati-oh.gov, 2021). While these are statistics gathered in 2021 by the City of Cincinnati regarding the environmental and socioeconomic state of Walnut Hills, these are not definitive parameters that this community must forever operate under. Rather,

these are areas that are being highlighted as they are most in need of imminent attention to better the lives and living experiences for those who call Walnut Hills home.

Winton Hills, Cincinnati, Ohio

Winton Hills is one of Cincinnati's 52 neighborhoods, annexed in 1903. Most prevalent history includes the construction of Winton Terrace, a Cincinnati Metropolitan Housing Authority (CMHA) project that first opened in 1940, providing housing to low-income residents in Cincinnati. It was not until the mid 1950's however that black residents were able to secure housing in this development, due in part to redlining³, or racial segregation

regarding housing

(cintimha.com, n.d.).

Today, Winton Terrace is still standing and serves as housing for the approximate 5,500

residents of Winton Hills.



Figure 17: A Man Tends to a Community Garden in Winton Hills, Cincinnati, Ohio

Of these people, 61.5% of them live in poverty and 59.7% of households receive SNAP; a 46th and 45th ranking out of 52, respectively (cincinnati-oh.gov, 2021). Further regarding socio economics, 45.3% of residents are spending more than 30% of their monthly income on rent and utilities, and 23.2% of residents are spending more than 50% of their monthly income on the same expenses. As discussed above, it is not recommended to exceed more than 30% of one's monthly income on rent and utilities, as

³ "Redlining" refers to the systemic denial of property or bank loans, largely to black people and other marginalized groups. (federalreservehistory.org, 2023)

this leaves a disproportionate amount of a budget left to cover additional monthly expenses and is often considered an indicator of poverty when exceeding this threshold (Quicken.com, October 2024).

Environmental hazards are also prevalent in the neighborhood in various forms, including but not limited to proximity to hazardous waste treatment and disposal facilities, potentially toxic industrial activity, superfund sites, and water pollution sources. Proximity to both superfund sites and potentially toxic industrial activity are deemed “extreme”, proximity to hazardous waste treatment and disposal sites is considered “very high”, and exposure to water pollution is considered “high”. (Cincinnati-oh.gov, 2021.). This is pertinent information not only to Winton Hills, but to all of the aforementioned neighborhoods, as these environmental conditions pose great risks to the health, wellbeing, and overall living experience for those in this neighborhood. Moreover, these factors are relevant to note as they may further aid in the contamination and pollution of soils.

Nearhood Statistics for Winton Hills, Cincinnati, Ohio

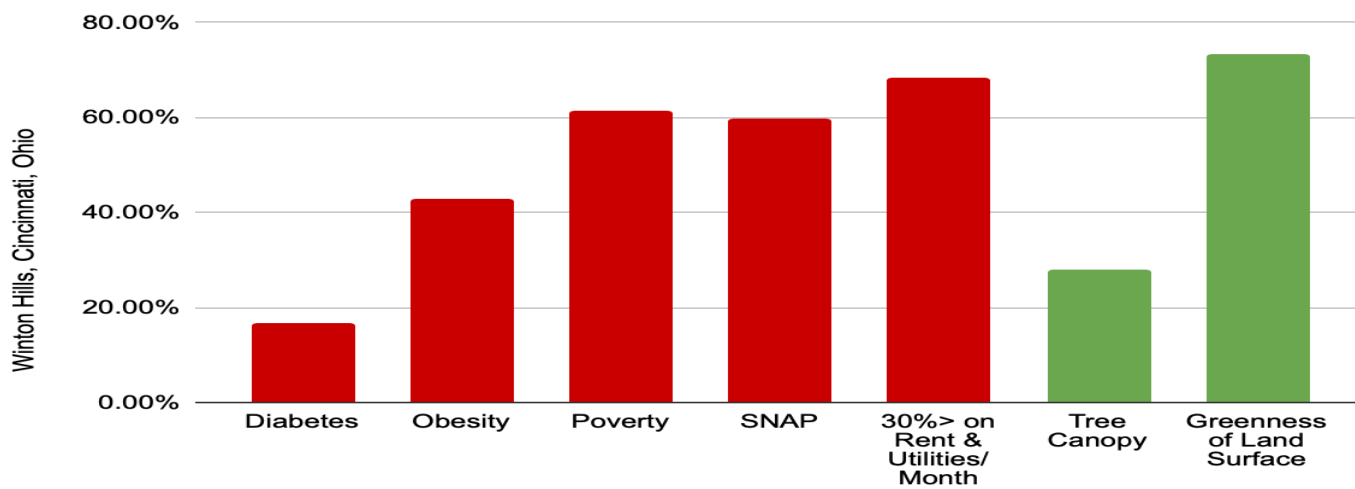


Figure 18: Neighborhood Statistics Graph for Winton Hills, Cincinnati, Ohio

In terms of the neighborhood ecosystem, however, Winton Hills has the best statistics of any neighborhood examined thus far [with the exception of California, Cincinnati, Ohio.]. Total tree canopy coverage percentage is 28.1%, ranking 21st (Cincinnati-oh.gov, 2021) The greenness of land surface is also a whopping 73.3%, ranking 6th out of all Cincinnati neighborhoods (Cincinnati-oh.gov, 2021). Additionally, 21.8% of all land in the neighborhood is dedicated to greenspaces and parks, ranking 9th overall, and heat island exposure is ranked as 26th (Cincinnati-oh.gov, 2021).

Though positive qualities are demonstrated regarding the environmental health in Winton Hills, public health is still an area that the community deserves to see improvement in. 16.8% of all residents are living with diabetes, ranking 30 out of 52 total neighborhoods in Cincinnati, and 42.8% of all residents are considered medically obese, ranking 31 out of 52 (Cincinnati-oh.gov, 2021). While these statistics are not as high as

the other two neighborhoods examined in this research, the numbers are indeed, still too high. Simply too many residents of one neighborhood are affected by the same

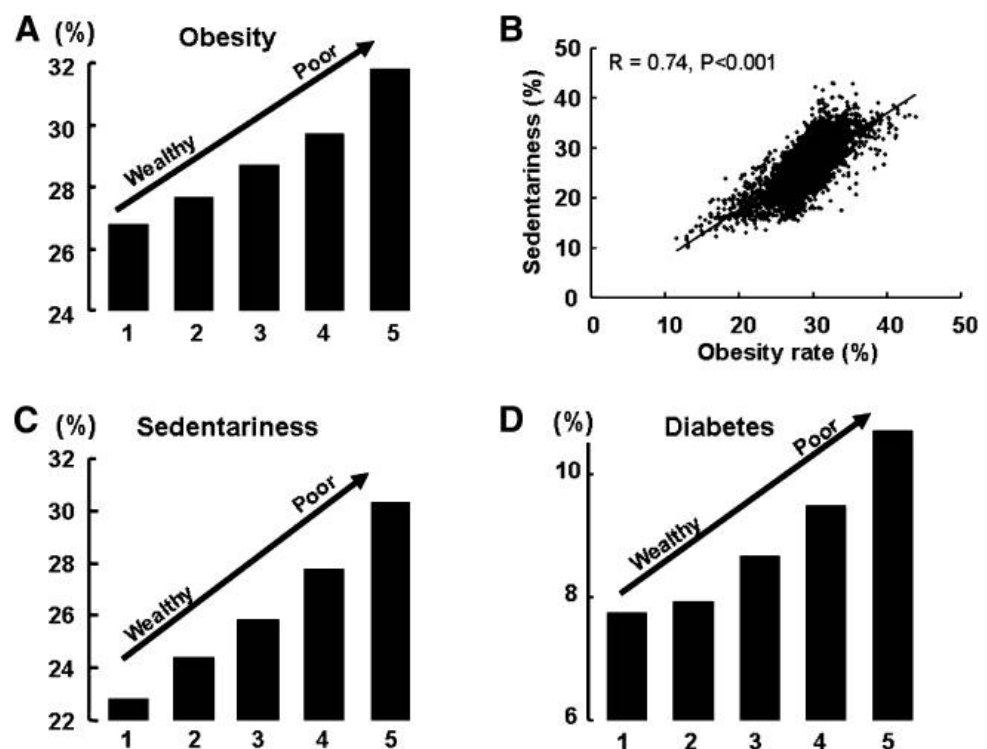


Figure 19: Graph of Food Related Conditions & Socioeconomic Class (NIH.org, 2011)

conditions; conditions that are directly related to food and an access to healthy foods.

This claim is substantiated by the National Institute of Health, which conducted research regarding the prevalence of obesity and diabetes in low income counties within America compared to wealthier counties. The findings concluded that “In contrast to international trends, people in America who live in the most poverty-dense counties are those most prone to obesity” (Levine, 2011). Figure 18 also helps to better illustrate the findings of this same research. Conclusively, it is indisputable to affirm that neighborhoods such as those examined in this research, are subject to a worse standard of living regarding health and environmental state compared to their wealthier counterparts. Moreover, socioeconomic status and wealth are contributing factors to these disparities. The truth of the matter is that a zip code should not permit nor allow for hardship and disparities of this scale to persist without refute.

Site Summary

Lower Price Hills, Walnut Hills, and Winton Terrace are three of the fifty-two neighborhoods within the Greater Cincinnati landscape. Each of these neighborhoods, face compounding issues of environmental contamination, public health, and socioeconomics. While the severity and complex relationships between each of these issues in each neighborhood present differently, the similarity lies in the fact that each of the aforementioned neighborhoods is experiencing heightened severities and extremes regarding their socioeconomic and environmental states. This reality holds true, especially when compared to their wealthier counterparts who are not experiencing these same issues (Cincinnati-oh.gov, 2021.).

In totality, each neighborhood displayed higher than average exposure to toxic, hazardous, or otherwise dangerous environmental contaminants and waste sites (Cincinnati-oh.gov, 2021.). Across all examined neighborhoods, on average, 58.3% of residents are living in poverty, and an average of 47.5% of residents receive SNAP. Additionally, an average of 47.5% of residents are considered medically obese, and 19.4% of residents are living with diabetes.

These issues of environmentalism, poverty, and health, in conjunction, make life in these neighborhoods less favorable compared to their more affluent counterparts. More so, they are being done a gross disservice by the city of Cincinnati, and they deserve the same access to resources, namely healthy soils, that are afforded to others.

Neighborhood Statistics Averages

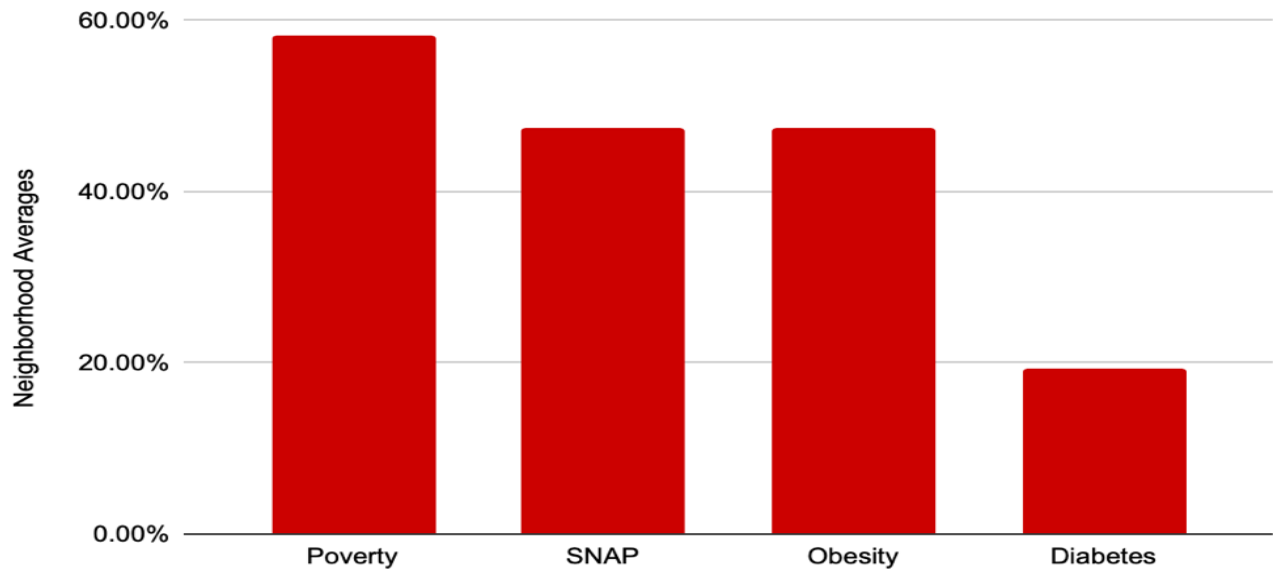


Figure 20: Statistic Averages Amongst All Examined Neighborhoods

Case Studies & Literature Review

Authors, researchers and academics have published work relating to soil fertility or health and low-income neighborhoods, and how these topics intersect with or affect one another. All of the articles included in the following literature review address how the quality of life for those living in neighborhoods facing socioeconomic challenges presents challenges affecting the living experience within them.

“It's Always Hungry in Cincinnati: The Food Desert in Kroger's Backyard” Julia C. Yingling, 2021

One such article entitled “It's Always Hungry in Cincinnati: The Food Desert in Kroger's Backyard”, written by Julia C. Yingling in 2021, tackles the subject of food deserts in low-income neighborhoods in Cincinnati. This article highlights just one of the areas in which quality of life and living experiences are affected by socioeconomic status, such as food deserts. Two Cincinnati neighborhoods are examined in this work; Over-The-Rhine (OTR), and North Fairmount. Through her work she examines how even though Kroger, “the



Figure 21: Horse Drawn Kroger Grocery wagon in 1890

largest grocery retailer in the United States” is headquartered in Cincinnati and operates over 2,300 stores, over 70 of which are in Cincinnati; systemic racism and racial injustice are perpetuated by the conglomerate by their strategic placement of stores in certain neighborhoods as opposed to others (J. Yingling, 2021). Additionally, it is highlighted that only after the gentrification and removal of black people from certain neighborhoods such as Over-The-Rhine (OTR), was a Kroger store opened in 2019 (J. Yingling, 2021). Similarly, Lower Price Hill, Walnut Hills, and Winton Hills are all neighborhoods with either a predominantly black



Figure 22: Common landscape found in the USA & food deserts

community, or largely other marginalized demographics. Yingling writes “The building of a new supermarket in a considerably wealthier and whiter version of OTR confirms the notion that those residents deserve food access, whereas the non-White and poorer former residents of OTR did not.” (J. Yingling, 2021). This excerpt supports the idea that food deserts are systemic, and purposeful in both their creation and perpetuation. This declaration suggests that poorer neighborhoods and communities aren’t given the same resources that affluent neighborhoods are.

Another excerpt from the text states, “This delineation also had the effect of marking which cultures were acceptable in the eyes of the Europeans and deserved access

to proper nutrition.” (J. Yingling, 2021). The same can be evidently said about the reality of food deserts in Cincinnati, and how various neighborhoods with primarily non-white people are subjected to an access to nutritious and healthy foods. This body of work is not only in agreement that neighborhoods subject to food deserts are primarily composed of marginalized peoples, but also that the socioeconomic status of these neighborhoods, and in turn the people, perpetuate the issue of food deserts.

“The Science of Soil Security and Food Security”, Liana E. Pozza, 2020

Food security, the inverse of food deserts, is considered to be one of the “seven inter-linked global existence challenges” (L. E. Pozza, 2020). Soil health is also considered one of these challenges, and it is obtuse to assume the two are mutually exclusive. Moreover, the relationship between soil degradation and food insecurity are intimately intertwined, often seen to exacerbate one another. Liana E. Pozza writes in *The Science of Soil Security and Food Security*, published in 2020, that “Despite the presence of nutrients within the soil, they may not be available to plants, which in turn reduces



Figure 23: Agricultural laborers examining soil in a field

nutrient intake by the consumer - a concept known as hidden hunger.” (L. E. Pozza, 2020). Adopting this understanding when discussing urban

communities and their soil health, another problematic issue presents. If those living in food deserts wished to tackle the issue via a community garden for example, it is probable that because the soil is worse than that of wealthier neighborhoods, the harvest of a community garden in one of these neighborhoods would subsequently also be worse.

In addition to nutrient viability and availability in soils, “Without secure soil, nutritious food will be much harder to produce into the foreseeable future, and how we access food influences the relationship individuals and communities have with the soil.” (L. E. Pozza, 2020). This excerpt is primarily in reference to large scale agriculture, though it is still applicable to urban communities. Urban agriculture, such as the

aforementioned
community
gardens, are only
as successful as the
soil that they are
in. Therefore, to



Figure 24: A green roof, an example of an urban agriculture initiative

combat the issue of

food deserts, it is asinine to suggest that community gardens or other urban agricultural initiatives are a “one size fits all” solution. Rather, it is more productive to examine a community's environmental scope at large and address the problem at the source; the soils. Pozza writes “The condition of the soil ensuring sufficient access involves the adopting of sustainable management and adapting to the changing climate and is

achievable, but more work and support is needed to aid in the adoption of these practices.” (L. E. Pozza, 2020). This excerpt agrees that current climate and environmental management practices are not sufficient for the current landscape. Moreover, aggressive urbanization and the introduction of more impervious surfaces than ever are only expediting soil health issues from bad to worse, which are commonly characteristic of neighborhoods most affected by food deserts (L. E. Pozza, 2020).

“Soil Fertility and Poverty in Developing Countries”, Kitchen Kim & Leah Bevis, 2019

As discussed in the previous articles, soil nutrient availability is highly desirable in the eyes of both governments and settlements. Historically, people have built homes and towns in areas that have good soil, as this is the basis for the production of the food that makes life in any given area viable (K. Kim & L. Bevis, 2019). This is especially true in



Figure 25: Drawing of a neolithic civilization farming

the article, *Soil Fertility and Poverty in Developing Countries*, published in 2019. While their work targets entire countries, the findings are applicable to communities facing

farming communities, though what happens when one lives in an urban setting with poor soil health? Kichan Kim and Leah Bevis examine the relationship between soil health and human settlement and development in

similar soil fertility and socioeconomic issues. Bevis writes, “-the mineral concentration of local crops is critical for dietary mineral intake and human mineral status. This directly links the “health” of the soils to the “health” of the people living on them.” (L. Bevis, 2019). Similar to Pozza, Bevis is referencing large scale agriculture, or more specifically farming communities, though the same conclusion can be drawn from this excerpt as Pozza’s. This conclusion is that even if food crops are to be grown in neighborhoods with poor soil health, that food will only be as nutritious as their soils. This is troublesome however, as environmental contamination that often affects soils is seen at disproportionate rates in these communities, suggesting that their soils are also, in turn, contaminated.

Furthermore, “lower-fertility soils often support initially lower-density human settlements, which eventually makes it more expensive for governments to provide supporting infrastructure in the form of roads, electricity, and telecommunications.” (Bevis and Barrett, 2015). This excerpt suggests a frightening conclusion that in areas of low soil fertility and health, governments see less of a reason to allocate resources to them, when in reality these communities are those in need of the most. This supports the idea that government neglect is taking place in Cincinnati. The neighborhoods examined in this body of work are suspected to have lower-fertility and



Figure 26: A dilapidated town, devoid of its citizens

health than that of their wealthier counterparts, and in turn are confined to their reality that is systemic neglect from the government, as resources to remediate issues regarding quality of life in these neighborhoods are being withheld. The suggestion that the impoverished are kept impoverished by a myriad of environmental and socioeconomic injustices performed by the government onto their own citizens is not only blatant and grossly negligent in this regard, but iniquitous.

Case Study Summary

The examined articles discuss the intersectionality of socioeconomics and soil health, and how the two subjects aid in worsening the living experience for those in affected neighborhoods. In these articles, gentrification, the removal of marginalized communities, and the perpetuation of environmental injustices are discussed; all factors that further aggravate the living experiences of those within Cincinnati neighborhoods. Soil health, fertility, and nutrient availability are also discussed, as these items impact the viability and quality of life for those living in these communities. Resource allocation in terms of development, dependent upon soil health, is revealed to be just one of the factors that perpetuate low-income communities. Additionally, the health of those in areas with poor soil health is also found to be relatively poor when compared to human health in areas with good soil health. Conclusively, the articles examined within this case study support conclusions that soil health is not only integral to the health and well-being of those living in a given community, but a lack of soil health only serves to perpetuate and further exacerbate the issues resource inequity and inequality, especially in that of low-income areas.

Historical Context of the Topics of the Research

Soil science has been in existence in one form or another since around 9000 BCE. While the methods of this science largely included trial and error when determining the best soil to plant crops in, observations regarding soil pertaining to agricultural use have been exhibited since earliest known civilizations (E. Brevik, 2017). It was not until sometime in the 1880's however, that the term "soil science" was coined, and began to be recognized as its own independent discipline (E. Brevik, 2017). At the time rudimentary soil tests were in their infancy, and gave scientists a limited idea of nutrients presents in



Figure 27: Image of two people taking soil samples for testing, n.d.

soils. A need for more knowledge regarding soils quickly arose, and in the 20th century soil testing regarding "soil fertility and recommended fertilizer application rates" became available (J. Nix, 2022).

Eventually, soil testing advanced alongside technology, and by the 1970's new areas of soil were able to be tested including soil pH, organic matter content and macronutrient availability (J. Nix, 2022). Today, soil testing technology has advanced to new heights including "DNA sequencing eco computing, which can identify the types of microbes present in the soil

and reveal which are active in the soil microbiome” (J. Nix, 2022). Soil testing provides insights as to what is occurring in soils and how this affects the things that we grow in them. Additionally, soil testing provides data regarding any problem areas in soils and how they can be amended. The introduction and subsequent advancements in soil testing technology have not only deepened our understanding of the natural world around us but also revolutionized agriculture across the globe.

Compared to most scientific disciplines, soil science is relatively young, only having been considered a true scientific discipline for approximately the last 200 years. Its importance and use, however, continue to show beyond doubt, as soil testing improves agricultural crop yields, and nutrient deficiencies can be tested for and addressed, ensuring that crops are given the best possible chance at growth, in turn increasing crop yields (J. Nix, 2022). Soil health is also able to be improved with insights provided by soil testing, as deficient areas are able to be addressed and amended quicker than ever before, resulting in better water



Figure 28: Modern soil testing laboratory

retention, nutrient cycling, and soil structure (J. Nix, 2022). Productive and sustainable environmental stewardship is also another benefit of soil testing, as the overuse of fertilizers and chemicals is reduced when one has data regarding soils to make

amendment use decisions. Additionally, nutrient runoff and other environmental issues associated with fertilizer over usage can be dramatically reduced due to soil testing, resulting in productive and healthy soils (J. Nix, 2022).

Today, available soils tests range in variety from the most basic of tests concluding if soil is healthy or not, to intricate tests determining the microbiological makeup of soil. Some of these test types include physical soil tests, chemical soil tests, total nutrient digestion (TND), pH or soil acidity tests, salinity tests, PLFA tests, and microscopy tests (J. Nix, 2022). The variety of soil tests available ensure that an understanding of soil can be adopted for a myriad of users and situations.

Common Soil Tests & Application

- **Physical Soil Test** - Assess the “soil structure, texture, and other physical characteristics like density, permeability, porosity, temperature, plasticity, aggregate stability, and more.” (J. Nix, 2022). Best application for this test would be to gain an understanding of water movement and behaviors in soil.
- **Chemical Soil Test** - Assess the “pH, phosphorus, potassium, magnesium, and calcium” found in soils, in addition to “bioavailability of the key macronutrients, like N, P, K, and micronutrients, Ca, Cl, Mg, Fe, Mn, Zn, and Cu), organic matter, and CEC” (J. Nix, 2022). Best application for this test would be to gain an understanding of overall nutrient availability in a soil, and to determine if amendments (fertilizers) are needed.

- **pH or Soil Acidity Tests** - A pH test (or soil acidity test) may be used to determine the pH of a soil, which is a measure of hydrogen ions (J. Nix, 2022). While some plants are not as “picky” as others, there is an ideal pH for every plant. This test can be used for nearly all planting uses, as all plants have a general pH which they prefer.

Programmatic Requirements

Soil Testing & Related Expenses

Soil testing for this research is conducted by the Hamilton County Soil and Water Conservation District of Indiana (Hamilton County SWCD). The mailing address to which soil samples were mailed is 1717 E. Pleasant Street, Suite 100, Noblesville, Indiana 46060. The soil testing itself is completed by A&L Great Lake Laboratories, located at 3505 Conestoga Drive, Fort Wayne, Indiana 46808.

Hamilton County SWCD offers two different types of tests: a basic test and a complete test. The basic test costs \$35 and “includes organic matter, phosphorus, potassium, calcium, magnesium, CEC, pH, and buffer pH.”

(hamiltonswcd.org, n.d.). The Complete test costs \$45 and includes everything the basic test includes as well as, “conductivity, boron, copper, iron, manganese, sulfur and zinc.”



Figure 29: Soil Sample Site of Walnut Hills

(hamiltonswcd.org, n.d.). For the purposes of this research the complete test was utilized, as this test gives a clearer indication as to the overall health of the soil at large. Since the complete test was utilized and three soil samples were collected, this brings the cost of the testing alone to \$135. Additional costs include shipping, which was \$19.95 for standard shipping at a local United States Post Office.

Sample Collection

In order to send soil to the Hamilton County SWCD, soil samples must first be collected. As previously discussed, soil samples were taken from Winton Hills, Lower Price Hills, and Walnut Hills on Winneste Avenue, Neave Street, and Melrose Avenue,



Figure 30: Winton Hills Soil Sample Site

respectively. Each of the samples are collected from a tree well on a street that has sidewalk access, street parking, and is at minimum a mixed residential or primarily residential area. The samples are collected using a hand trowel and a

soil knife. First, surface debris such as leaves, sticks, rocks, or any trash is removed from the surface of the soil. Then, utilizing a hand trowel, a hole is dug approximately six

inches below the soil surface. Then, utilizing the soil knife, a sample of approximately 3 cups of soil is collected. This sample is then placed in a clean Ziplock style bag and labeled with the street name it is collected from, neighborhood it is collected from, and the date it is collected. This process is then repeated in the remaining two neighborhoods.

Sample Processing & Preparation

After the initial sampling date, the soil samples are transferred into plastic containers and allowed to air dry for approximately 72 hours. After drying time is complete, any large soil aggregates are manually broken or removed, as well as any rocks, sticks, or other debris present in the sample. The soil samples are then returned to new Ziplock style bags and labeled in the same fashion as when they were collected. A

soil sample order form from the Hamilton County SWCD is then filled out, and payment is submitted through their website. All three of the soil samples, individually bagged

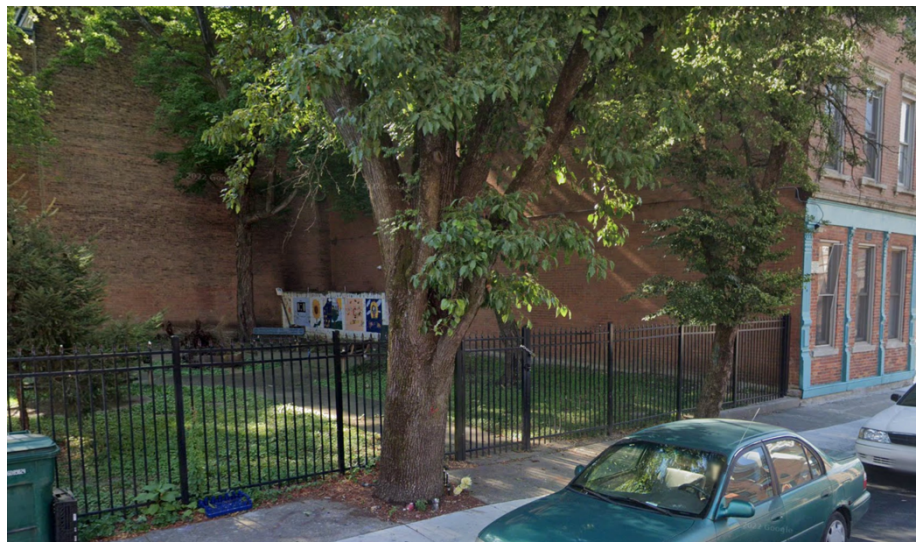


Figure 31: Lower Price Hill Soil Sample Site

and labeled, are then placed into a box with the soil sample order form. This box is then shipped to the Hamilton County SWCD, where soil tests will be performed on the

samples. Approximately one week from the date that the samples are received by the Hamilton County SWCD, test results will be made available via email, as well as physical mail.

Once the soil test result is received, this data will then be used to determine if the soil health in the neighborhoods it was collected in, is of poor health. Since the utilized tests will indicate if there are any deficiencies in major macronutrients, the soil's pH, major issues regarding contamination, and other qualities, these tests serve as a basis to make this conclusion upon. Furthermore, given the nature of the tests being performed, the test results are further validity to make a conclusion regarding the overall soil health of these neighborhoods, since the tests give an indication as to the soil health at large.

Process Documentation

Soil samples were collected on February 28, 2025, in the fashion previously outlined (figures 35-37). The soil samples are then allowed to air dry for approximately 72 hours, after which they are prepared to be shipped to the Hamilton County SWCD for testing, as previously discussed. On March 25, 2025, the soil test results are received via email. The results are delivered in the following fashion, as well as being accompanied by an interpretation guide, courtesy of the Hamilton County SWCD (Figures 32-34). The Hamilton County SWCD also provides specified amendment recommendations relevant to what a customer intends to grow in their soil. In this case, a vegetable garden was selected, as edible plants are proposed to be grown in these neighborhoods. Moreover, when growing edible plants, it is integral to know if soils are contaminated, as growing edible plants in contaminated soils is not ideal and can not only lead to health issues for those who consume these foods, but also edible plants are generally more sensitive to contaminated soils as opposed to ornamental landscape plants.

Soil Test Vocabulary Defined

- **Organic Matter:** Organic matter is both integral to a soil's health but also serves as an indicator to the overall health of a soil. Organic matter, "measures the amount of plant and animal residues in the soil. Usually, the darker the color of the soil the more organic matter is present.". Ideal values of organic matter are between 3% and 5% (hamiltonswcd.org, n.d.).
- **Soil pH:** Soil pH is a measure of how alkaline or acidic a soil is. A pH of 7 is considered neutral (think filtered water), a pH of 1 is extremely acidic (stomach acid) and a pH of 14 is more alkaline than bleach. Most plants prefer soil between 6.0 and 7.0, though soil pH can range from 5.0 to 8.0. pH is incredibly important to a soil's health, as certain nutrients are only made available at specific pH levels. Lime can be added to a soil in order to raise the pH, whereas sulfur can be applied to lower the pH (hamiltonswcd.org, n.d.)
- **Cation Exchange Capacity (CEC):** CEC is a measure of a soil's ability to retain nutrients; though a higher CEC value is not an indication of a more productive soil, simply a greater capacity to retain. Soils with a CEC value exceeding 25 are peat soils; "heavy clay soils have CECs from 15 to 25; loamy soils from 5 to 15; and sandy soils below 5." (hamiltonswcd.org, n.d.).

- **Lime:** A soil amendment available to the public (does not require a license to purchase or administer) that aids in raising a soil's acidity by introducing hydrogen ions to the soil, effectively making the soil more alkaline.
(hamiltonswcd.org, n.d.)
- **Nitrogen (N):** One of the most important elements for plants, as without it, like all living things, won't survive! Nitrogen plays rolls in ensuring plants are green and growing lush. Nitrogen should be applied regularly, and not all at once as nitrogen quickly washes out of soils. Overapplication can also result in a lack of flower and fruit production in most plants. (hamiltonswcd.org, n.d.)
- **Phosphate (P2O5):** A key nutrient vital to the flowering and fruiting processes of plants. Therefore, it is integral to ensure phosphate levels are adequate in spaces where edible or showy plants, such as flowers, are wanted. Phosphate is easily maintained in soils, meaning that it does not need to be applied as commonly as other nutrients, such as nitrogen, and is found in most common commercial fertilizers. (hamiltonswcd.org, n.d.)
- **Sulfur (S):** A nutrient responsible for many of the proteins found in plants. Organic matter is generally the source of most sulfur found in soils. If organic matter concentration is low however, sulfur may be needed. "Sulfur may also be used as a soil amendment to help lower soil alkalinity when it is excessively high.

Elemental sulfur, ammonium sulfate, iron sulfate and aluminum sulfate may be used for this purpose” (hamiltonswcd.org, n.d.).

- **Phosphorus (P):** An essential macronutrient required for plant health, as it aids in cell division and plant growth. It is commonly made available in soils via fertilizer and organic matter. A rating of “high or very high, either no fertilizer is needed or just enough to maintain the current nutrient level is necessary.” (hamiltonswcd.org, n.d.).
- **Potassium (K):** An essential macronutrient required for plant health, as it aids in plant growth processes such as metabolism and photosynthesis. It is commonly made available in soils via fertilizer or manure (hamiltonswcd.org, n.d.).
- **Calcium (Ca):** An essential nutrient needed for ensuring the structural integrity of a plant’s cells. Calcium is also closely related to magnesium in the sense that generally, if one is deficient or found in excess, so will the other. The ideal range for calcium is between 6.0 and 7.0, and anything below this can be amended with lime, which is rich in calcium. (hamiltonswcd.org, n.d.).
- **Magnesium (Mg):** An essential nutrient needed to ensure that the chlorophyllin process (the chemical that makes plants green!) is happening. Magnesium is also closely related to calcium in the sense that generally, if one is deficient or found in

excess, so will the other. The ideal range for magnesium is between 6.0 and 7.0, and anything below this can be amended with lime, which is a good source of magnesium (hamiltonswcd.org, n.d.).

Data Interpretation – Walnut Hills

The amount of organic matter found in this soil sample is 4.9%. Ideal values of organic matter are between 3% and 5%. Values of phosphorus (51 ppm), potassium (246 ppm), calcium (2800 ppm), and manganese (52 ppm) found in this sample are all considered to be “very high”, which indicates that no fertilizers for these specific nutrients are needed. Magnesium, however, is considered “low” (180 ppm), and may be introduced to the soil with lime. Sulfur in this sample is considered “low” (7 ppm) and may be introduced with fertilizer. Other nutrients found in the soils such as zinc (20.6 ppm), iron (17 ppm), copper (5.4 ppm), and boron (1.8 ppm) are all considered to be “high” apart from zinc and copper, which are deemed “very high”.

The cation exchange capacity (CEC) of this sample is measured at 16.3 meq/100g, indicating the presence of clay in the soil. The pH of this soil is also 7.8, which is slightly above the “ideal” range of 6.0 to 7.0, though there are plants that can certainly still grow and thrive in this pH. The amount of soluble salts in this sample is considered “very low” (0.1 mmho/cm). This is desirable as a high presence of soluble salts inhibits a plant’s ability to uptake water from the soil and eventually causes the plant to be water-stressed. (V. Parent & R. Koenig, 2010).

The Hamilton County Soil and Water Conservation District provides recommendations for amendments at the bottom of each soil test result page (see Figure 32). The recommendation of nutrients for the Walnut Hills sample is 4 pounds of nitrogen per 1,000 square feet and 1 pound of sulfur per 1,000 square feet. These can be achieved by applying ammonium sulfate ((NH₄)₂SO₄) to the soil at a rate of 20 pounds

per 1,000 square feet. Alternatively, a fertilizer containing a similar amount of nitrogen, phosphorus, and potassium may be selected (this is referred to as an NPK analysis). In this case, a fertilizer with an NPK analysis of 21-0-0 is also suitable. It is recommended to apply half of the recommended amount of fertilizer prior to planting or seeding, which would be 10 pounds. Then, after plants are established, the other half of the fertilizer may be applied. It is important not to add all of this fertilizer at once due to its high concentration of nitrogen. Doing so may inhibit the production of fruiting or flowering in some edible plants, as previously discussed. (hamiltonswcd.org, n.d.).

Report Number: F25080-0765
Account Number: 86380



Hamilton County SWCD
1717 East Pleasant Street
Noblesville, IN 46060
317-773-2181
hamiltonswcd.org

SOIL TEST REPORT											
REPORTED TO			SAMPLE INFORMATION				CUSTOMER				
Hamilton Co. SWCD STE 100 1717 PLEASANT ST NOBLESVILLE, IN 46060-3626			Report Number	F25080-0765			EMILY EVANS 				
			Report Date	3/25/2025							
			Lab Number	17546							
			Sample ID	WALNUTHILLS							
			To Be Grown	Vegetable Garden							
ANALYSIS RESULTS											
ANALYSIS			RESULT		RATING						
					Very Low	Low	Medium	High	Very High		
Organic Matter, %			4.9								
Phosphorus (Bray-1 Equiv), ppm P			51								
Potassium, ppm K			246								
Magnesium, ppm Mg			180								
Calcium, ppm Ca			2800								
Sodium, ppm Na			38								
Cation Exchange Capacity, meq/100g			16.3								
pH			7.8								
Soluble Salts (1:2), mmho/cm			0.1								
Sulfur, ppm S			7								
Zinc, ppm Zn			20.6								
Iron, ppm Fe			17								
Manganese, ppm Mn			52								
Copper, ppm Cu			5.4								
Boron, ppm B			1.8								
ANNUAL NUTRIENT REQUIREMENT											
POUNDS PER 100 SQUARE FEET						POUNDS PER 1,000 SQUARE FEET					
Lime	Nitrogen (N)	Phosphorus (P2O5)	Potassium (K2O)	Magnesium (Mg)	Sulfur (S)	Lime	Nitrogen (N)	Phosphorus (P2O5)	Potassium (K2O)	Magnesium (Mg)	Sulfur (S)
0.0	0.4	0.0	0.0	0.0	0.1	0.0	4	0	0	0	1
SUGGESTED FERTILIZER APPLICATION											
	NPK FERTILIZER GRADE	DESCRIPTION				ANNUAL APPLICATION RATE					
						lbs per 100 sq. ft.		lbs per 1,000 sq. ft.			
Product	21-0-0	Ammonium Sulfate				2.0		OR	20.0		
						0.0		OR	0.0		
COMMENTS											
Use the fertilizer listed above or another material of similar NPK analysis. Apply and incorporate 1/2 the recommended amount prior to planting or seeding. Spread the remaining 1/2 after plants are established and rapidly growing. Application of nitrogen in excess of the suggested amount could result in excessive growth of vegetation and poor yield of fruit for some garden plants.											
Analyses by: A & L Great Lakes Laboratories, Inc. • www.algreatlakes.com											

Figure 32: Walnut Hills soil sample results, Hamilton County SWCD

Data Interpretation – Lower Price Hills

Organic matter found in this soil sample is reported at 9.6%, nearly double the recommended value. This isn't necessarily a negative quality, especially at this value, rather an indication that microbial activity may be heightened as a result, especially compared to the other samples in this work. In terms of nutrients phosphorus (128 ppm), potassium (268 ppm), zinc (111 ppm), iron (58 ppm), and copper (10.9 ppm) are all considered "very high". Calcium (3100 ppm), manganese (40 ppm), and boron (2.5 ppm) are all considered "high". Magnesium (230 ppm) and sulfur (12 ppm) are both ranked medium, and sodium (44 ppm) is the only element considered "very low".

Cation exchange capacity is measured to be 18.3 meq/100g, indicating the presence of clay in the soil. The pH of this soil is measured to be 7.3, which is closer to the ideal range of 6.0 to 7.0 than Walnut Hills. Again, a slight deviance from this range does not mean that no plants will grow here, rather more sensitive plants may not be best suited for this area if raising or lowering the pH is not a goal. Like Walnut Hills, the soluble salts found in this sample are 0.1 mmho/cm, which is an ideal quality.

The recommended nutrient amendments for Lower Price Hill are also 4 pounds of nitrogen per 1,000 square feet and 1 pound of sulfur per 1,000 square feet. Like Walnut Hills, this can be achieved by applying ammonium sulfate ((NH₄)₂SO₄) to the soil at a rate of 20 pounds per 1,000 square feet. It is also recommended to apply the fertilizer (or one with a similar NPK analysis) in the same fashion of half (10 pounds) prior to planting, then the other half (10 pounds) after plants are established.

(hamiltonswcd.org, n.d.).

Report Number: F25080-0765
Account Number: 86380



Hamilton County SWCD
1717 East Pleasant Street
Noblesville, IN 46060
317-773-2181
hamiltonswcd.org

SOIL TEST REPORT											
REPORTED TO			SAMPLE INFORMATION			CUSTOMER					
Hamilton Co. SWCD STE 100 1717 PLEASANT ST NOBLESVILLE, IN 46060-3626			Report Number	F25080-0765		EMILY EVANS 					
			Report Date	3/25/2025							
			Lab Number	17547							
			Sample ID	LPRICEHILLS							
			To Be Grown	Vegetable Garden							
ANALYSIS RESULTS											
ANALYSIS		RESULT		RATING							
				Very Low	Low	Medium	High	Very High			
Organic Matter, %		9.6									
Phosphorus (Bray-1 Equiv), ppm P		128									
Potassium, ppm K		268									
Magnesium, ppm Mg		230									
Calcium, ppm Ca		3100									
Sodium, ppm Na		44									
Cation Exchange Capacity, meq/100g		18.3									
pH		7.3									
Soluble Salts (1:2), mmho/cm		0.1									
Sulfur, ppm S		12									
Zinc, ppm Zn		111.									
Iron, ppm Fe		58									
Manganese, ppm Mn		40									
Copper, ppm Cu		10.9									
Boron, ppm B		2.5									
ANNUAL NUTRIENT REQUIREMENT											
POUNDS PER 100 SQUARE FEET						POUNDS PER 1,000 SQUARE FEET					
Lime	Nitrogen (N)	Phosphorus (P2O5)	Potassium (K2O)	Magnesium (Mg)	Sulfur (S)	Lime	Nitrogen (N)	Phosphorus (P2O5)	Potassium (K2O)	Magnesium (Mg)	Sulfur (S)
0.0	0.4	0.0	0.0	0.0	0.1	0.0	4	0	0	0	1
SUGGESTED FERTILIZER APPLICATION											
	NPK FERTILIZER GRADE	DESCRIPTION	ANNUAL APPLICATION RATE								
			lbs per 100 sq. ft.	lbs per 1,000 sq. ft.							
Product	21-0-0	Ammonium Sulfate	2.0	OR 20.0							
			0.0	OR 0.0							
COMMENTS											
Use the fertilizer listed above or another material of similar NPK analysis. Apply and incorporate 1/2 the recommended amount prior to planting or seeding. Spread the remaining 1/2 after plants are established and rapidly growing. Application of nitrogen in excess of the suggested amount could result in excessive growth of vegetation and poor yield of fruit for some garden plants.											
Analyses by: A & L Great Lakes Laboratories, Inc. • www.algreatlakes.com											

Figure 33: Lower Price Hills soil test results, Hamilton County SWCD

Data Interpretation – Winton Hills

The organic matter percentage found in the Winton Hills sample is 3.9%. This value is satisfactory, though it can be amended to include additional organic matter. The pH of this soil is 7.6, which is slightly elevated, though it should not pose any significant issues. Cation Exchange Capacity (CEC) is measured at 14.3 meq/100g and is considered “medium”, indicating that this is a loam soil.

Regarding nutrients, potassium (291 ppm) is the only nutrient that is ranked as “very high”. Calcium (2350 ppm), iron (22 ppm), manganese (47 ppm), copper (1.9 ppm), and boron (1.3 ppm) are all considered “high”. Sulfur (11 ppm) and zinc (3.8 ppm) are both considered “medium”, with phosphorus (14 ppm) and magnesium (170 ppm) both considered “low”. The value of soluble salts found in the sample is 0.2 mmho/cm, which is slightly elevated compared to the other samples, but is still a good value.

Regarding nutrient amendments, it is recommended to apply 4 pounds of nitrogen per 1,000 square feet, 6 pounds of phosphorus per 1,000 square feet, and 1 pound of sulfur per 1,000 square feet. Alternatively, a fertilizer described as “lawn starter” with an NPK analysis of 18-24-6 can also be applied at a rate of 22 pounds per 1,000 square feet. Due to the high concentration of nitrogen in this fertilizer, it is recommended to be applied in the same fashion as the previous two samples; half of the amount (11 pounds) prior to planting, and then the other half (11 pounds) after plants are established.

Report Number: F25080-0765
Account Number: 86380



Hamilton County SWCD
1717 East Pleasant Street
Noblesville, IN 46060
317-773-2181
hamiltonswcd.org

SOIL TEST REPORT											
REPORTED TO			SAMPLE INFORMATION				CUSTOMER				
Hamilton Co. SWCD STE 100 1717 PLEASANT ST NOBLESVILLE, IN 46060-3626			Report Number	F25080-0765			EMILY EVANS 				
			Report Date	3/25/2025							
			Lab Number	17550							
			Sample ID	WINTONHILLS							
			To Be Grown	Vegetable Garden							
ANALYSIS RESULTS											
ANALYSIS			RESULT		RATING						
					Very Low	Low	Medium	High	Very High		
Organic Matter, %			3.9								
Phosphorus (Bray-1 Equiv), ppm P			14								
Potassium, ppm K			291								
Magnesium, ppm Mg			170								
Calcium, ppm Ca			2350								
Sodium, ppm Na			93								
Cation Exchange Capacity, meq/100g			14.3								
pH			7.6								
Soluble Salts (1:2), mmho/cm			0.2								
Sulfur, ppm S			11								
Zinc, ppm Zn			3.8								
Iron, ppm Fe			22								
Manganese, ppm Mn			47								
Copper, ppm Cu			1.9								
Boron, ppm B			1.3								
ANNUAL NUTRIENT REQUIREMENT											
POUNDS PER 100 SQUARE FEET						POUNDS PER 1,000 SQUARE FEET					
Lime	Nitrogen (N)	Phosphorus (P2O5)	Potassium (K2O)	Magnesium (Mg)	Sulfur (S)	Lime	Nitrogen (N)	Phosphorus (P2O5)	Potassium (K2O)	Magnesium (Mg)	Sulfur (S)
0.0	0.4	0.6	0.0	0.0	0.1	0.0	4	6	0	0	1
SUGGESTED FERTILIZER APPLICATION											
	NPK FERTILIZER GRADE	DESCRIPTION	ANNUAL APPLICATION RATE								
			lbs per 100 sq. ft.		lbs per 1,000 sq. ft.						
Product	18-24-6	Lawn Starter	2.2		OR	22.0					
			0.0		OR	0.0					
COMMENTS											
Use the fertilizer listed above or another material of similar NPK analysis. Apply and incorporate 1/2 the recommended amount prior to planting or seeding. Spread the remaining 1/2 after plants are established and rapidly growing. Application of nitrogen in excess of the suggested amount could result in excessive growth of vegetation and poor yield of fruit for some garden plants.											
Analyses by: A & L Great Lakes Laboratories, Inc. • www.algreatlakes.com											

Figure 34: Winton Hills soil sample results, Hamilton County SWCD

Data Interpretation – Final Notes

Having analyzed the results of each soil test, it is apparent that there are no imminent threats or areas in need of immediate care regarding the contents of each of these soils. Rather, regular seasonal fertilizer application can be implemented to amend the soils and simply make them more productive. Additionally, lime can be applied to any of the discussed soils to lower their pH, as each of the soil's pH is slightly elevated, though this isn't necessary. Further, no notable contamination or issues with productivity and nutrient availability are reported.

In totality, the soils examined in this work have room for improvement, though they should not be classified as “bad”. It is also important to note that the areas from which these samples were collected, tree wells, may have contributed to a skewed analysis and not reflect the soil health in these neighborhoods at large. Additionally, each of the tree wells from which these samples were collected housed trees that appeared to be in good health. This is notable, as healthy trees help to create healthy soils, further supporting the idea that these analyses may not be a true reflection of the soil health at large. Alternatively, taking soil samples for analysis in an area where edible plants are already growing, may provide a better indication of soil health for this work, or one like it. Additionally, soil samples were not collected or analyzed from affluent neighborhoods to serve as a contrasting data set due to the budget available for this project. Doing so, however, may have served as a further basis on which to definitively say that the soil quality in the examined neighborhoods is lesser than that of wealthier neighborhoods.

Though this work hypothesizes that the examined neighborhoods would exhibit characteristics of poor soil health, and the data does not entirely support this claim, there are still areas in which improvements can be made. The application of fertilizer and overall productive land stewardship could be all these neighborhoods need to see an improvement in soil health.



Figure 35: Materials Needed for Soil Sample Collection



Figure 36: Soil Samples Collected in the Field



Figure 37: Soil Samples Placed in Containers to Air Dry for 72 Hours

Project Solution

After interpreting the data provided by the soil tests, a conclusion regarding the health of the soils within each of these neighborhoods can be made. This conclusion is that none of the examined neighborhoods, based on the soil testing data, are in an imminent soil health crisis. Given that the socioeconomic class of each of these neighborhoods has been analyzed, and the role that each of their unique histories has played in its current landscape, the relationship between the soil test results and socioeconomic class can be investigated. While soil health in these neighborhoods was found to not be particularly bad, there is no data regarding affluent neighborhood's soil health. Therefore, making a claim regarding soil health in conjunction with socioeconomic status is moot. What conclusion can be made, however, is that those living in poverty in Cincinnati do experience environmental inequity, as lower tree canopy coverage, higher rates of air pollution, proximity to water pollution, and other environmental issues, disproportionately affect those living in poverty (Cincinnati-oh.gov, 2021). With this conclusion being made, it is sensible to suppose that soils may then be contaminated as well. Though this is not substantiated by the soil test results in this work, further investigation into this claim should be made, at a much larger scale, given the pattern of environmental inequity and who is affected most.

Though the data does not indicate the examined soils are indeed contaminated, solutions regarding poor soil health in low-income communities and how this affects the quality of life for those living in them must still be investigated. Because this is a matter that will require funding, labor, and potentially even policy revisions regarding environmental stewardship, it is evident that this is not a situation that those who are experiencing can work themselves out of alone. For this reason, advocacy for policy change in the form of protesting or community organization may be a great first step in bringing awareness to the subject. Only then, through assistance by the City of Cincinnati or another local municipality such as Hamilton County, can meaningful

change be made on the scale which it is needed. In order to further address the inequity of poor soil health found in these communities, the



Figure 38: A protestor holds up a sign

Cincinnati municipal governments should be urged to allocate resources towards environmental improvements. Amendments, fertilizers, further testing, and ultimately rehabilitation are needed for the soils in these communities.

Additionally, public education programs such as those already organized by the Civic Garden Center of Greater Cincinnati could be implemented. Educating those living in the affected neighborhoods about environmental stewardship, gardening, and the

importance of having a healthy environment could serve as a step in the right direction. Moreover, education regarding soil health itself should be implemented, as there is a lack of knowledge in this area, even by those who work and study horticultural sciences and related fields. The topic is complex and, for this reason, may seem unapproachable to many. Soil science is the basis of all successful gardens, as without good soil, there certainly will not be good plants. Therefore, for there to be a lack of community education initiatives or programs regarding the subject is just further perpetuating the overall dissonance regarding gardening as a whole, and where soil science fits into this discussion.

The purpose of this work is to begin the discussion about soils and their importance. While solutions to the problem have been outlined, there is still much work to be done to see if this is a deeper problem. Further investigation needs to be done in Cincinnati, but the ideals and sentiments expressed in this work are applicable to other urban environments as well. The bottom line is that those experiencing poverty disproportionately experience environmental inequity on multiple fronts and seldom work exists exploring soil health in this context. This work serves as a catalyst to this conversation, and an example of the work that can be done to investigate it.

Reference List

Case Studies

Yingling, C. Julia (2021) *It's Always Hungry in Cincinnati: The Food Desert in Kroger's Backyard*. The Undergraduate Journal of Public Health At The University of Michigan. Retrieved from:
<https://quod.lib.umich.edu/cgi/t/text/idx/u/ujph/17872072.0005.012/--it-s-always-hungry-in-cincinnati-the-food-desert-in-krogers?rgn=main;view=fulltext> Accessed February 2, 2025

Kim, Kichan & Bevis, Leah (2019) *Soil Fertility and Poverty in Developing Countries*. Agricultural & Applied Economics Association. Retrieved from:
https://www.choicesmagazine.org/UserFiles/file/cmsarticle_696.pdf Accessed February 2, 2025

Pozza, E. Liana (2020) *The Science of Soil Security and Food Security*. Science Direct. Retrieved from:
https://www.sciencedirect.com/science/article/pii/S2667006220300022?ref=cra_js_challenge&fr=RR-1 Accessed on February 2, 2025

Other Resources Referenced in Text

Even, T. L., Trott, C. D., Gray, E. S., Roncker, J., Basaraba, A., Harrison, T., Petersen, S., Sullivan, S., & Revis, S. (2021). Climate Equity Indicators Report - 2021, City of Cincinnati. The American Cities Climate Challenge Equity Capacity Building Fund, Bloomberg Foundation.

Soil Health. (n.d.) Natural Resources Conservation Service. United States Department of Agriculture. Retrieved from: <https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/soils/soil-health> Accessed on February 3, 2025

American Psychological Association. (n.d.). American Psychological Association. <https://www.apa.org/topics/socioeconomic-status> Accessed on February 3, 2025

Residents. Home - City of Cincinnati. (n.d.). <https://www.cincinnati-oh.gov/cityofcincinnati/residents/#:~:text=Cincinnati%20is%20a%20city%20of,landmarks%2C%20green%20living%20and%20more> Accessed on February 3, 2025

U.S. Census Bureau quick facts: Cincinnati City, Ohio. (n.d.). <https://www.census.gov/quickfacts/fact/table/cincinnati-city-ohio/PST045223> Accessed on February 3, 2025

Poverty guidelines. ASPE. (n.d.). <https://aspe.hhs.gov/topics/poverty-economic-mobility/poverty-guidelines> Accessed on February 3, 2025

Defining low-income, low-access food areas (food deserts). (n.d.). <https://crsreports.congress.gov/product/pdf/IF/IF11841> Accessed on February 3, 2025

Lower Price Hill & Queensgate. (2021). <https://www.cincinnati-oh.gov/sites/oes/assets/LowerPriceHill> Accessed on February 8, 2025

Price Hill Historical Society, Price Hill history. Price Hill Historical Society. (n.d.). <https://pricehill.org/Price-Hill-History/Beginnings> Accessed on February 8, 2025

Sweet, E. (2021, July 25). *Lower price hill: Struggles, transitions, and victories in one of Cincinnati's key Appalachian neighborhoods by Mike Templeton.* Welcome to UACC. <https://uacvoice.org/2021/07/lower-price-hill-struggles-transitions-and-victories-in-one-of-cincinnati-key-appalachian-neighborhoods-by-mike-templeton/> Accessed on February 8, 2025

Cincinnati-oh. (2021). <https://www.cincinnati-oh.gov/sites/oes/assets/California%20-%20CEI.pdf> Accessed on February 8, 2025

Redfin. (n.d.). *How much rent can I afford?* <https://www.redfin.com/how-much-rent-can-i-afford> Accessed February 11, 2025

About. We Are Walnut Hills! (2019, October 9). <https://wearewalnuthills.org/about/> Accessed February 11, 2025

What is a superfund site?. Eastwick Lower Darby Creek Area Community Advisory Group. (n.d.). https://www.eldcacag.org/?page_id=114#:~:text=Superfund%20is%20the%20name%20given.Act%20of%201980%2C%20as%20amended. Accessed February 11, 2025

Cincinnati-oh. (2021). [https://www.cincinnati-oh.gov/sites/oes/assets/Winton Hills](https://www.cincinnati-oh.gov/sites/oes/assets/Winton%20Hills%20Terrace%20Apartments.pdf)
Accessed February 15, 2025

CMHA. (n.d.-a). <https://cintimha.com/apartments-and-townhomes/winton-terrace/>
Accessed February 15, 2025

Ished J. (n.d.). *Redlining*. Federal Reserve History.
<https://www.federalreservehistory.org/essays/redlining> Accessed February 15, 2025

Poverty guidelines. ASPE. (n.d.-a). [https://aspe.hhs.gov/topics/poverty-economic-](https://aspe.hhs.gov/topics/poverty-economic-mobility/poverty-guidelines)
[mobility/poverty-guidelines](https://aspe.hhs.gov/topics/poverty-economic-mobility/poverty-guidelines) Accessed February 15, 2025

Quicken. (2024, October 4). *How much should you spend on rent when budgeting?*.
Quicken Blog. [https://www.quicken.com/blog/how-much-should-you-spend-rent-when-](https://www.quicken.com/blog/how-much-should-you-spend-rent-when-budgeting/#:~:text=The%2030%25%20rule%20has%20become,your%20rent%20and%20Utilities%20combined)
[budgeting/#:~:text=The%2030%25%20rule%20has%20become,your%20rent%20and%20](https://www.quicken.com/blog/how-much-should-you-spend-rent-when-budgeting/#:~:text=The%2030%25%20rule%20has%20become,your%20rent%20and%20Utilities%20combined)
[Utilities%20combined](https://www.quicken.com/blog/how-much-should-you-spend-rent-when-budgeting/#:~:text=The%2030%25%20rule%20has%20become,your%20rent%20and%20Utilities%20combined). Accessed on February 9, 2025

Levine, J. A. (2011, November). *Poverty and obesity in the U.S.* Diabetes.
[https://pmc.ncbi.nlm.nih.gov/articles/PMC3198075/#:~:text=In%20contrast%20to%20int](https://pmc.ncbi.nlm.nih.gov/articles/PMC3198075/#:~:text=In%20contrast%20to%20international%20trends,1A)
[ernational%20trends,1A](https://pmc.ncbi.nlm.nih.gov/articles/PMC3198075/#:~:text=In%20contrast%20to%20international%20trends,1A) Accessed on March 3, 2025

Brevik, E. C., & Cerdà, A. (n.d.). *A general overview of the history of soil science*.
ADS.
<https://ui.adsabs.harvard.edu/abs/2017EGUGA..19...68B/abstract#:~:text=Scientific%20>

[methods%20began%20to%20be,of%20study%20until%20the%201880s](#). Accessed on March 3, 2025

Complete guide to soil testing. (n.d.). <https://biomemakers.com/complete-guide-to-soil-testing> Accessed on March 3, 2025

Lower Price Hill & Queensgate. (2021). <https://www.cincinnati-oh.gov/sites/oes/assets/LowerPriceHill> Accessed on February 6, 2025

Cincinnati-oh. (2021). <https://www.cincinnati-oh.gov/sites/oes/assets/Walnut%20Hills%20-%20CEI.pdf> Accessed on February 6, 2025

Cincinnati-oh. (2021). <https://www.cincinnati-oh.gov/sites/oes/assets/WintonHills> Accessed February 6, 2025

Vernon Parent & Rich Koenig (December 2010) *Solutions to Soil Problems I. High Salinity (soluble salts*. Utah State University Extension Yard and Garden. <https://extension.usu.edu/yardandgarden/research/solutions-to-soil-problems-i-high-salinity-soluble-salts#:~:text=As%20soluble%20salt%20levels%20increase,water%2C%20they%20become%20water%20stressed>. Accessed on April 9, 2025

Images Citations

Youshen Wang. (1994). *Nutritious Soil* [Soil].

<https://jstor.org/stable/community.9882395> Accessed February 4, 2025

Photograph by Michael Everett, UC DAAP, of Emily R. Evans, Accessed April 2, 2025

Mads Nissen. (2007). *A farmer weeds a field that has been surrounded by partial built highrise blocks*. <https://jstor.org/stable/community.12158094> Accessed February 4, 2025

Wikimedia. (n.d.).

https://upload.wikimedia.org/wikipedia/commons/8/89/USDA_Soil_Texture.svg

Accessed March 4, 2025

Medium. (n.d.). https://miro.medium.com/v2/resize:fit:1358/0*-8J1o-TEsj43lDFj

Accessed March 4, 2025

Remediation of Quanta Resources Superfund Site - Home. (n.d.).

<http://www.quantaremediation.com/> Accessed February 22, 2025

Kroger Wagon. (ca. 1890). <https://jstor.org/stable/community.33074075> Accessed February 22, 2025

Agricultural laborers (n.d) [15813184534_cd5971e957_k-e1562784277271.jpg](https://www.flickr.com/photos/15813184534_cd5971e957_k-e1562784277271.jpg)
Accessed February 22, 2025

East Walnut Hills - East Walnut Hills, a unique Cincinnati neighborhood. (n.d.).

<https://eastwalnuthills.org/> Accessed March 4, 2025

Admin-Risepoint. (2024, December 10). *History of urban agriculture and urban farming policies*. AU Online. <https://online.aurora.edu/history-of-urban-agriculture/>

Accessed March 4, 2025

Excavating Canadian Soil Science History. The Channel. (n.d.).

<https://ingeniumcanada.org/channel/articles/excavating-canadian-soil-science-history>

Accessed March 4, 2025

Appendix

Urban Soil Health and Income Disparities. Let's talk about it.

How can the relationship between socioeconomic status and soil health as it relates to quality of life, be understood and remediated to improve the quality of life in various neighborhoods within the Greater Cincinnati region?

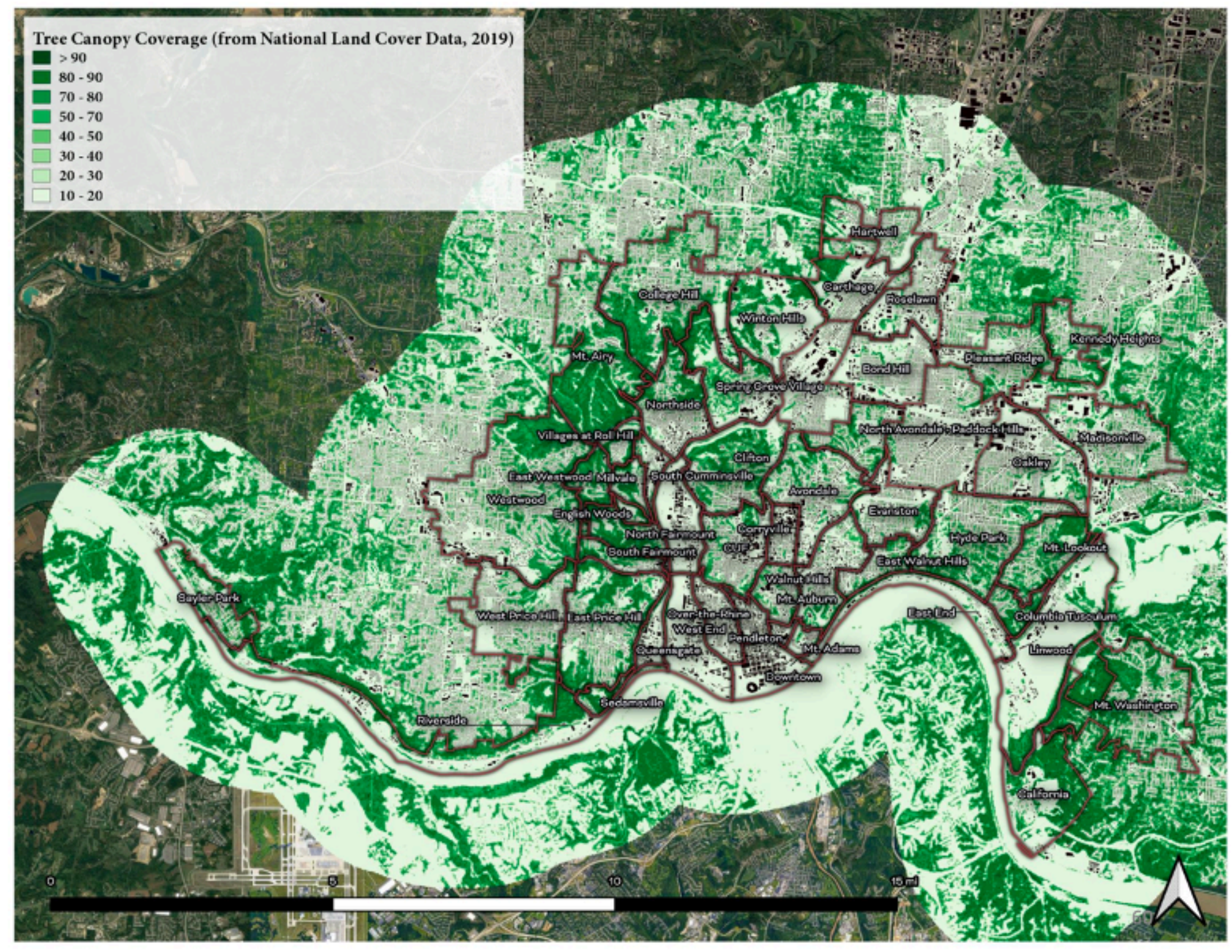


Figure 1 : Tree canopy coverage of Cincinnati, Ohio 2019

Abstract

In the urban landscape of Cincinnati, Ohio, lies a variety of neighborhoods, ranging in culture, ethnicity, socioeconomic class, and other qualities. Within each of these diverse neighborhoods though, a disparity is hiding in plain sight, soil health, or the lack thereof. This research investigates if there is a meaningful correlation between those living in low-income areas, and the state of the soil's health. Specifically, the neighborhoods of Lower Price Hill, Winton Hills, and Walnut Hills in Cincinnati, Ohio are examined regarding socioeconomic class related to environmental factors. Additionally, the quality of life for those living in these neighborhoods is being investigated to determine if any quantifiable disparities in the aforementioned neighborhoods are perpetuated by, or a direct result of poor soil health.

In some neighborhoods, especially those that fall at or below the poverty line, a phenomenon commonly referred to as “food deserts” exists. A food desert is defined as a lack of access to fresh foods such as produce, creating stark inaccessibility to healthy, nutritious foods, to a myriad of people which in turn raises the potential of serious health issues, including but not limited to diabetes and obesity. This is one example of an environmental injustice that may be directly correlated or perpetuated by environmental issues. This research investigates the correlation between soil health and the overall quality of life for those living in impoverished neighborhoods suspected of having poor soil health.



Figure 2: A farmer tends a garden amidst high rise buildings, 2007

Project Hypothesis & Results

This work hypothesizes that the examined neighborhoods will exhibit characteristics of poor soil health. This claim is substantiated by a myriad of preexisting environmental issues already plaguing these neighborhoods, including but not limited to a lack of tree canopy coverage, impermeable surfaces, contaminated waterways, proximity to hazardous waste treatment facilities, and more. Additionally, the socioeconomic relationships found in each of these neighborhoods are hypothesized to contribute to a lack of soil health, as there would be a lack of funding allocated to less affluent neighborhoods for environmental initiatives such as soil remediation efforts.

Following data interpretation from the soil test analysis, the reviewed data does not entirely support this claim. The soils examined in this work have room for improvement, though they should not be classified as “bad”. It is also important to note that the areas from which these samples were collected, tree wells, may have contributed to a skewed analysis and not reflect the soil health in these neighborhoods at large. Moreover, these soils have room for improvement, as opposed to being in a health crisis, as previously hypothesized. The application of fertilizer and overall productive land stewardship could be all these neighborhoods need to see an improvement in soil health.

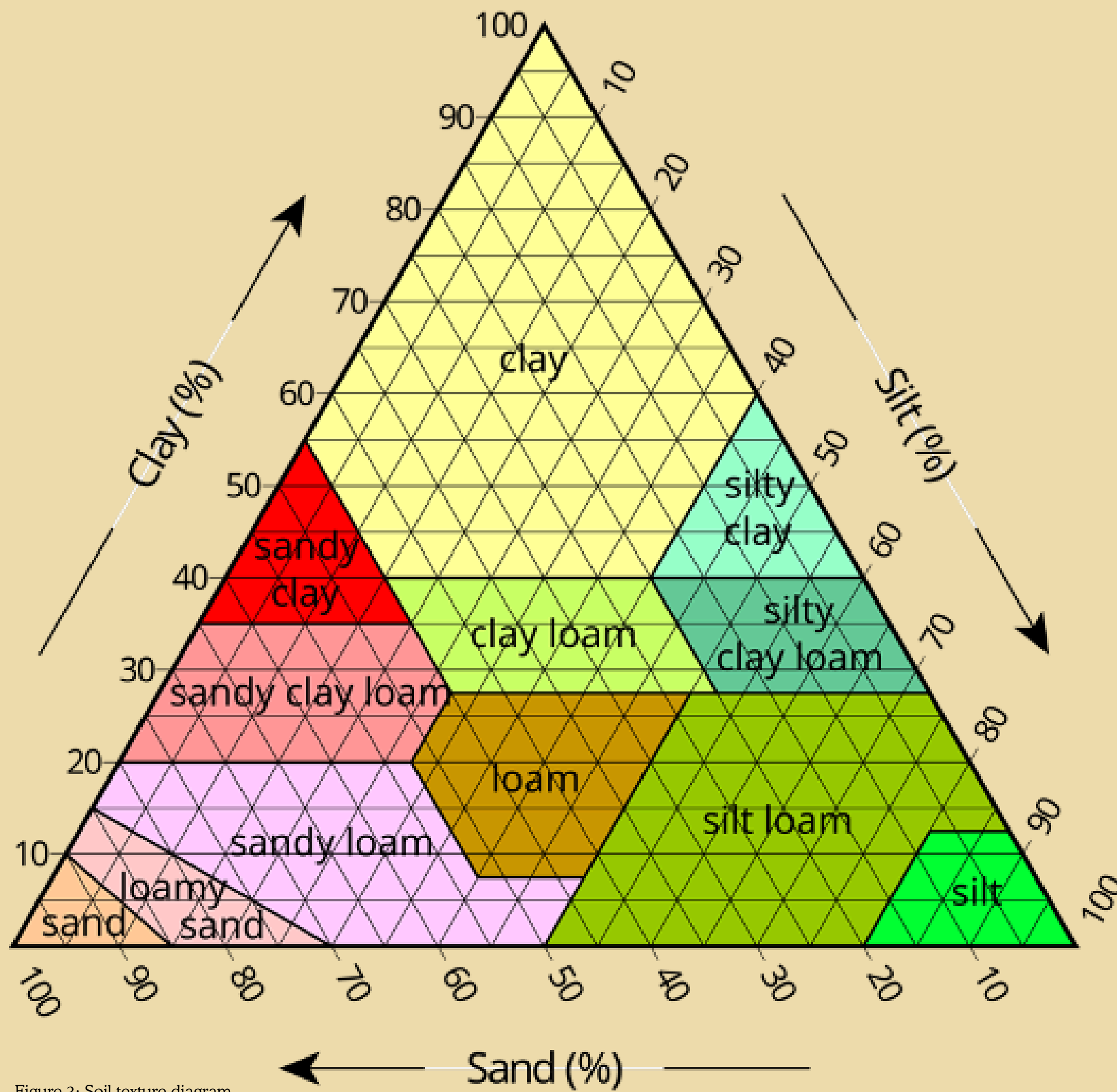


Figure 3: Soil texture diagram

User & Client Description

The purpose of this research is to determine the correlation between soil health in low-income neighborhoods and, if there is, how it affects the quality of life for those living in these neighborhoods. The following neighborhoods are examined in this research: Lower Price Hills, Winton Hills, and Walnut Hills. Each of these neighborhoods displays at least 40% of residents living in poverty[1], and at least 40% of residents utilizing the supplemental nutrition assistance program, or SNAP (Cincinnati-oh.gov, 2021). Additionally, higher reported cases of diabetes, obesity, and asthma are found in these neighborhoods. Across all three neighborhoods, at least 16% of residents live with diabetes, 42% of residents are considered medically obese, and at least 14% of residents live with asthma (Cincinnati-oh.gov, 2021).

The findings of this research help to better illustrate the relationship between socioeconomic status and soil health as it relates to the quality of life and living experiences within these neighborhoods. The findings of this research will act as a basis on which meaningful and actionable steps can be taken by residents and municipalities alike to lessen the burden of environmental contaminants. This research serves not only those living in the affected areas discussed in this work but also any other neighborhoods similar to them. Additionally, this work serves as an educational tool for those interested in how soil health may impact various aspects of everyday life.

[1] The 2025 U.S Federal Poverty Guideline defines a family of 4 living on an annual income of \$32,150 or less as impoverished. (ASPE, 2025)



Figure 4: Lower Price Hills



Figure 5: Winton Hills



Figure 6: Walnut Hills

Studies that Support Project Theory

Soil health, fertility, and nutrient availability are all discussed, as these items impact the viability and quality of life for those living in these communities. Resource allocation in terms of development, dependent upon soil health, is revealed to be just one of the factors that perpetuate low-income communities. Additionally, the health of those in areas with poor soil health is also found to be relatively poor when compared to human health in areas with good soil health.



Figure 7: A man tends a community garden located in Lower Price Hills

The Science of Soil Security and Food Security, Liana E. Pozza, 2020

Food security, the inverse of food deserts, is considered to be one of the “seven interlinked global existence challenges” (L. E. Pozza, 2020). Soil health is also considered one of these challenges, and it is obtuse to assume the two are mutually exclusive. Moreover, the relationship between soil degradation and food insecurity are intimately intertwined, often seen to exacerbate one another. Liana E. Pozza writes in The Science of Soil Security and Food Security, published in 2020, that “Despite the presence of nutrients within the soil, they may not be available to plants, which in turn reduces nutrient intake by the consumer - a concept known as hidden hunger.” (L. E. Pozza, 2020). Adopting this understanding when discussing urban communities and their soil health, another problematic issue presents. If those living in food deserts wished to tackle the issue via a community garden for example, it is probable that because the soil is worse than that of wealthier neighborhoods, the harvest of a community garden in one of these neighborhoods would subsequently also be worse.

In addition to nutrient viability and availability in soils, “Without secure soil, nutritious food will be much harder to produce into the foreseeable future, and how we access food influences the relationship individuals and communities have with the soil.” (L. E. Pozza, 2020). This excerpt is primarily in reference to large scale agriculture, though it is still applicable to urban communities. Urban agriculture, such as the aforementioned community gardens, are only as successful as the soil that they are in. Therefore, to combat the issue of food deserts, it is asinine to suggest that community gardens or other urban agricultural initiatives are a “one size fits all” solution. Rather, it is more productive to examine a community's environmental scope at large and address the problem at the source; the soils. Pozza writes “The condition of the soil ensuring sufficient access involves the adopting of sustainable management and adapting to the changing climate and is achievable, but more work and support is needed to aid in the adoption of these practices.” (L. E. Pozza, 2020). This excerpt agrees that current climate and environmental management practices are not sufficient for the current landscape. Moreover, aggressive urbanization and the introduction of more impervious surfaces than ever are only expediting soil health issues from bad to worse, which are commonly characteristic of neighborhoods most affected by food deserts (L. E. Pozza, 2020).



Figure 8: A green roof, which is an urban agriculture initiative



Emily R. Evans
HORT 4092: Horticulture Senior Project
Faculty Advisor Stevie Famulari G.d.s
Spring 2025

Lower Price Hill



Price Hill was founded in 1791, once a praised neighborhood nestled on the outskirts of bustling Cincinnati, a hub for Appalachian immigrants wanting to experience urban living. Over time, however, industrial pollution transformed the area, and environmental hardship has burdened Lower Price Hill since roughly the 1980’s (uacvoice.org, July 2021).

Environmental factors

- 43 out of 52 total neighborhoods for tree canopy coverage
- 42 out of 52 total neighborhoods for greenness of land surface
- 41 out of 52 total neighborhoods for heat island exposure
- “Extreme” proximity to water pollution sources
- “Very high” proximity to potentially toxic industrial activity

Socioeconomic factors

- 72.1% of residents live in poverty
- 48.3% of households receive SNAP
- 38.3% of residents spend more than 50% of their income or more on rent and utilities per month
- 51.1% of residents are considered medically obese
- 17.8% of residents are living with diabetes

Winton Hills



Winton Hills is one of Cincinnati’s 52 neighborhoods, annexed in 1903. The most prevalent history includes the construction of Winton Terrace, a Cincinnati Metropolitan Housing Authority (CMHA) project that first opened in 1940, providing housing to low-income residents in Cincinnati. It was not until the mid-1950s however that black residents were able to secure housing in this development, due in part to redlining[1], or racial segregation regarding housing (cintimha.com, n.d.). Today, Winton Terrace is still standing and serves as housing for the approximately 5,500 residents of Winton Hills.

Environmental Factors

- 21 out of 52 total neighborhoods for tree canopy coverage
- 6 out of 52 total neighborhoods for greenness of land surface
- 26 out of 52 total neighborhoods for heat island exposure
- “Extreme” proximity to superfund sites & abandoned areas containing hazardous waste
- “Extreme” proximity to potentially toxic industrial activity
- “Very high” proximity to hazardous waste treatment and disposal sites
- “High” exposure to water pollution

Socioeconomic Factors

- 61.5% of residents living in poverty
- 59.7% of households receive SNAP
- 45.3% of residents are spending more than 30% of their monthly income on rent and utilities
- 23.2% of residents are spending more than 50% of their monthly income on rent and utilities
- 42.8% of residents are considered medically obese
- 6.8% of residents are living with diabetes

Walnut Hills



Price Hill was founded in 1791, once a praised Walnut Hills was first settled in 1804 by Reverend James Kemper who adopted land for agricultural purposes. Throughout the 1800’s, Walnut Hills acted as a vital part of the Underground Railroad, as it was the home to abolitionist Harriet Beecher Stowe (wearewalnuthills.org, n.d.). Today, the neighborhood houses over 6,000 residents.

Environmental Factors

- 36 out of 52 total neighborhoods for tree canopy coverage
- 39 out of 52 total neighborhoods for greenness of land surface
- 33 out of 52 total neighborhoods for heat island exposure
- “Very high” proximity to hazardous waste treatment and disposal facilities
- “High” proximity to superfund sites & abandoned areas containing hazardous waste

Socioeconomic Factors

- 41.1% of residents live in poverty
- 41.2% of households receive SNAP
- 38.7% of residents are spending more than 30% of their monthly income on rent and utilities
- 20.3% of residents are spending more than 50% of their monthly income on rent and utilities
- 48.7% of residents are considered medically obese
- 23.5% of residents are living with diabetes

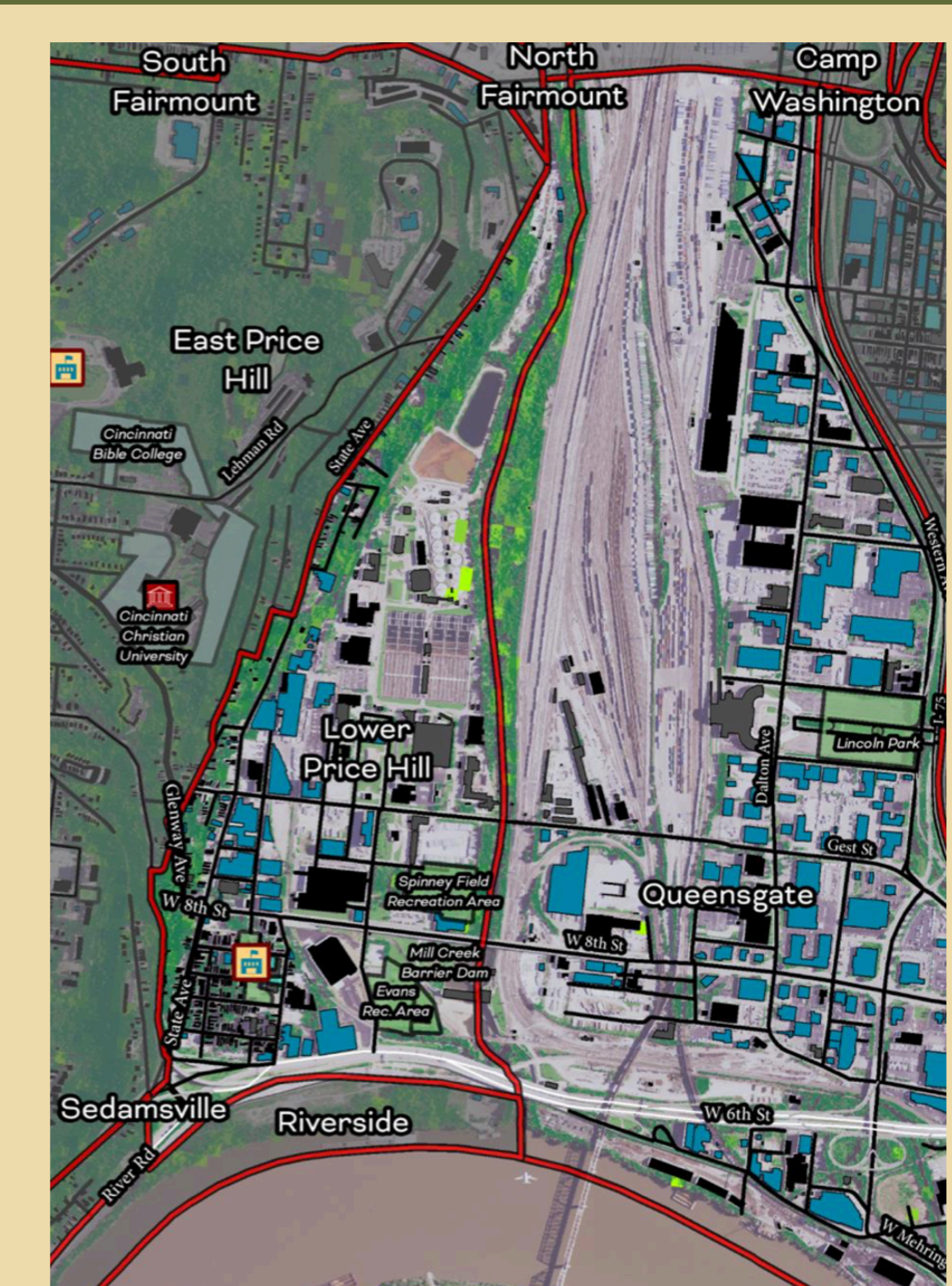


Figure 9: Map of Lower Price Hills, red line denotes neighborhood boundary

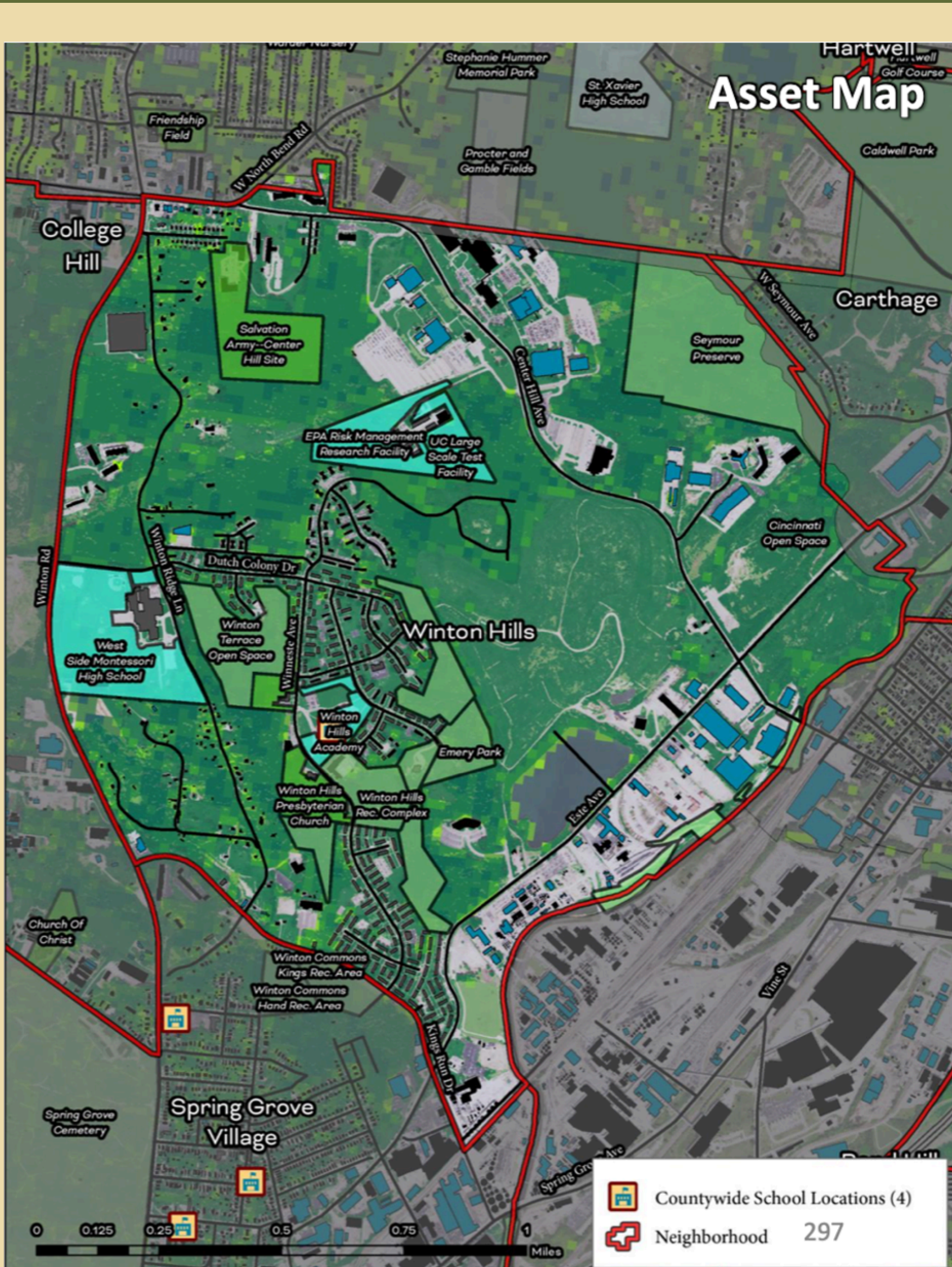


Figure 10: Map of Winton Hills, red line denotes neighborhood boundary

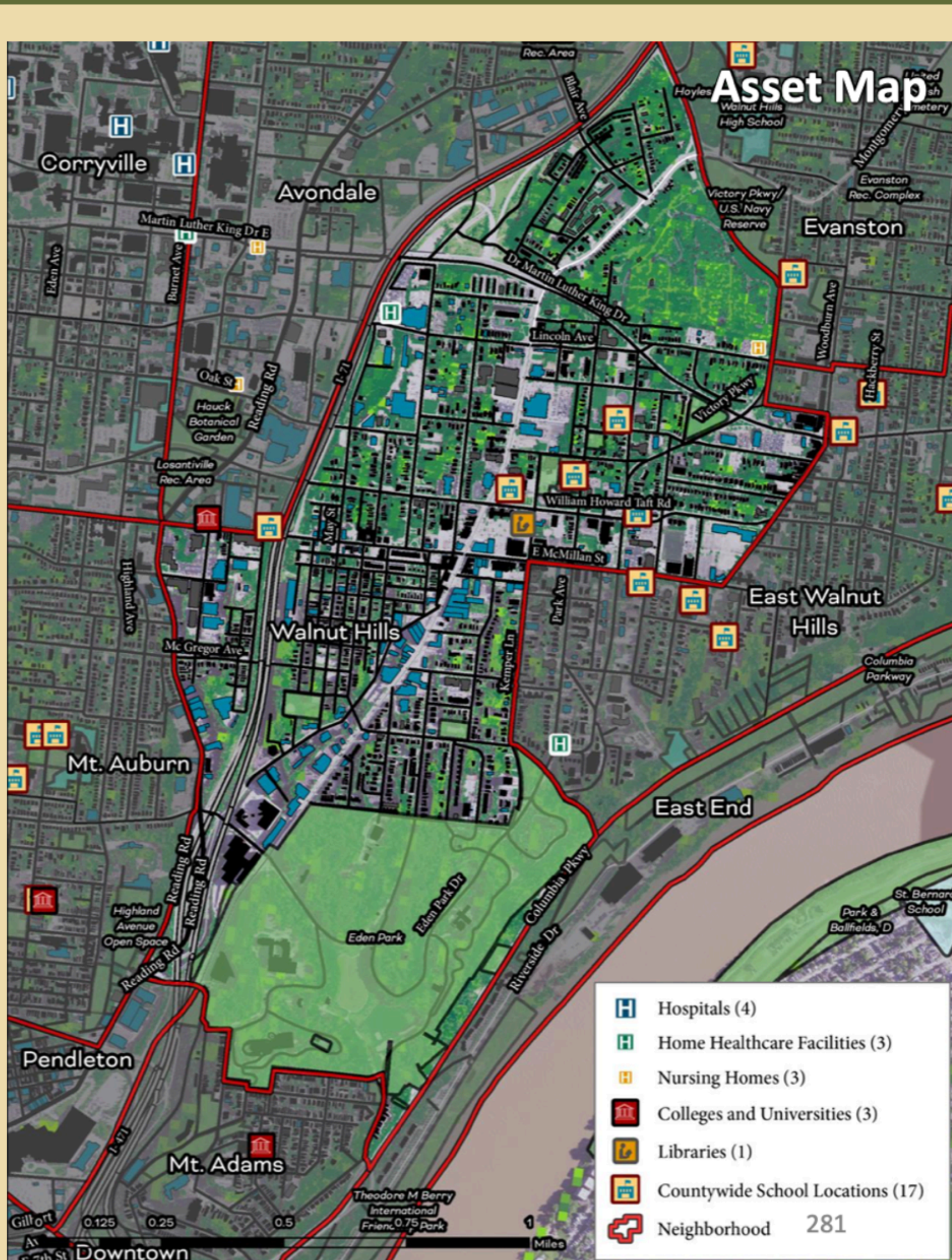


Figure 11: Map of Walnut Hills, red line denotes neighborhood boundary

ANALYSIS	RESULT	RATING				
		Very Low	Low	Medium	High	Very High
Organic Matter, %	9.6					
Phosphorus (Bray-1 Equiv), ppm P	128					
Potassium, ppm K	268					
Magnesium, ppm Mg	230					
Calcium, ppm Ca	3100					
Sodium, ppm Na	44					
Cation Exchange Capacity, meq/100g	18.3					
pH	7.3					
Soluble Salts (1:2), mmho/cm	0.1					
Sulfur, ppm S	12					
Zinc, ppm Zn	111.					
Iron, ppm Fe	58					
Manganese, ppm Mn	40					
Copper, ppm Cu	10.9					
Boron, ppm B	2.5					

Figure 12: Lower Price Hills soil test results

ANALYSIS	RESULT	RATING				
		Very Low	Low	Medium	High	Very High
Organic Matter, %	3.9					
Phosphorus (Bray-1 Equiv), ppm P	14					
Potassium, ppm K	291					
Magnesium, ppm Mg	170					
Calcium, ppm Ca	2350					
Sodium, ppm Na	93					
Cation Exchange Capacity, meq/100g	14.3					
pH	7.6					
Soluble Salts (1:2), mmho/cm	0.2					
Sulfur, ppm S	11					
Zinc, ppm Zn	3.8					
Iron, ppm Fe	22					
Manganese, ppm Mn	47					
Copper, ppm Cu	1.9					
Boron, ppm B	1.3					

Figure 13: Winton Hills soil test results

ANALYSIS	RESULT	RATING				
		Very Low	Low	Medium	High	Very High
Organic Matter, %	4.9					
Phosphorus (Bray-1 Equiv), ppm P	51					
Potassium, ppm K	246					
Magnesium, ppm Mg	180					
Calcium, ppm Ca	2800					
Sodium, ppm Na	38					
Cation Exchange Capacity, meq/100g	16.3					
pH	7.8					
Soluble Salts (1:2), mmho/cm	0.1					
Sulfur, ppm S	7					
Zinc, ppm Zn	20.6					
Iron, ppm Fe	17					
Manganese, ppm Mn	52					
Copper, ppm Cu	5.4					
Boron, ppm B	1.8					

Figure 14: Walnut Hills soil test results

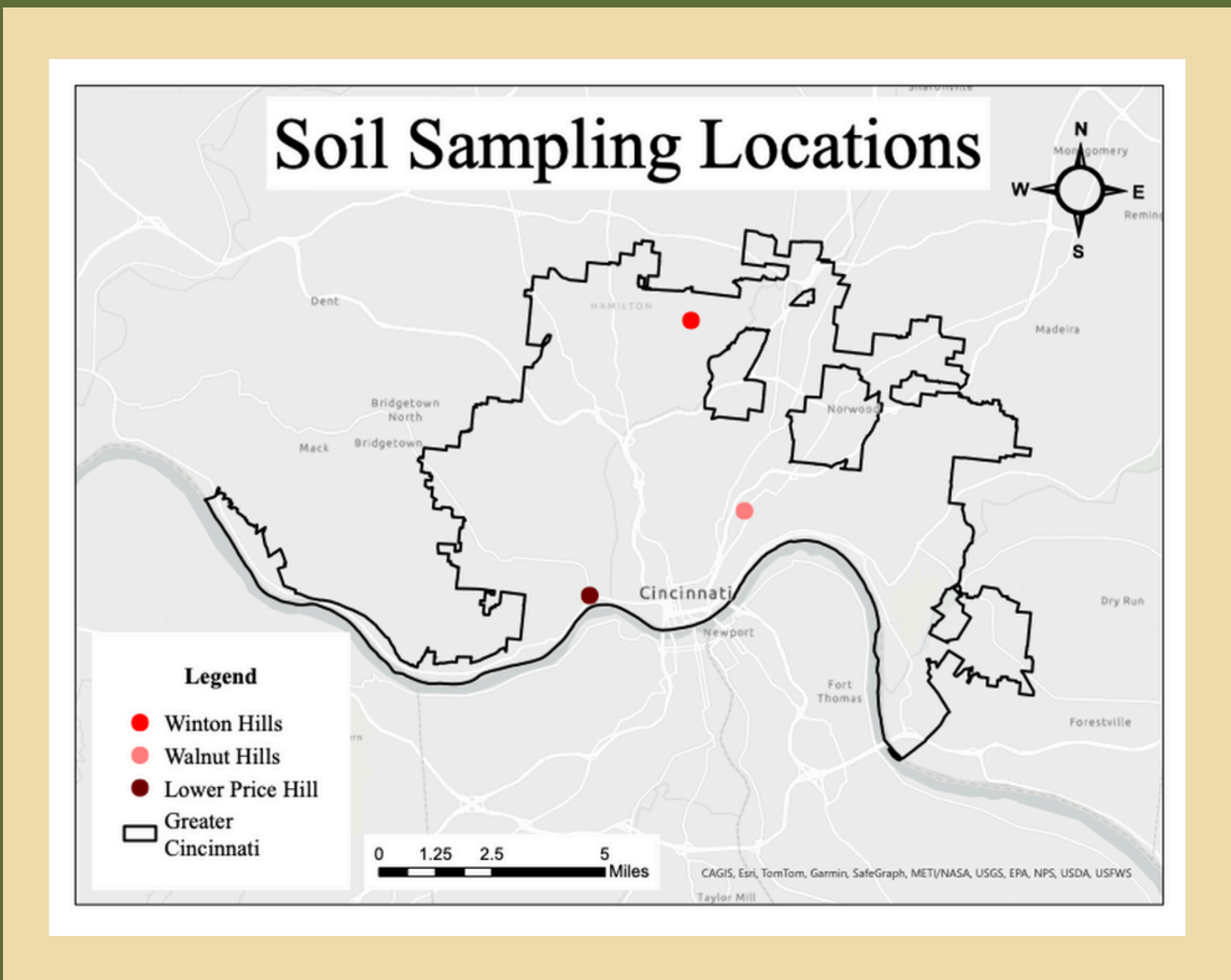


Figure 15: Soil sampling locations

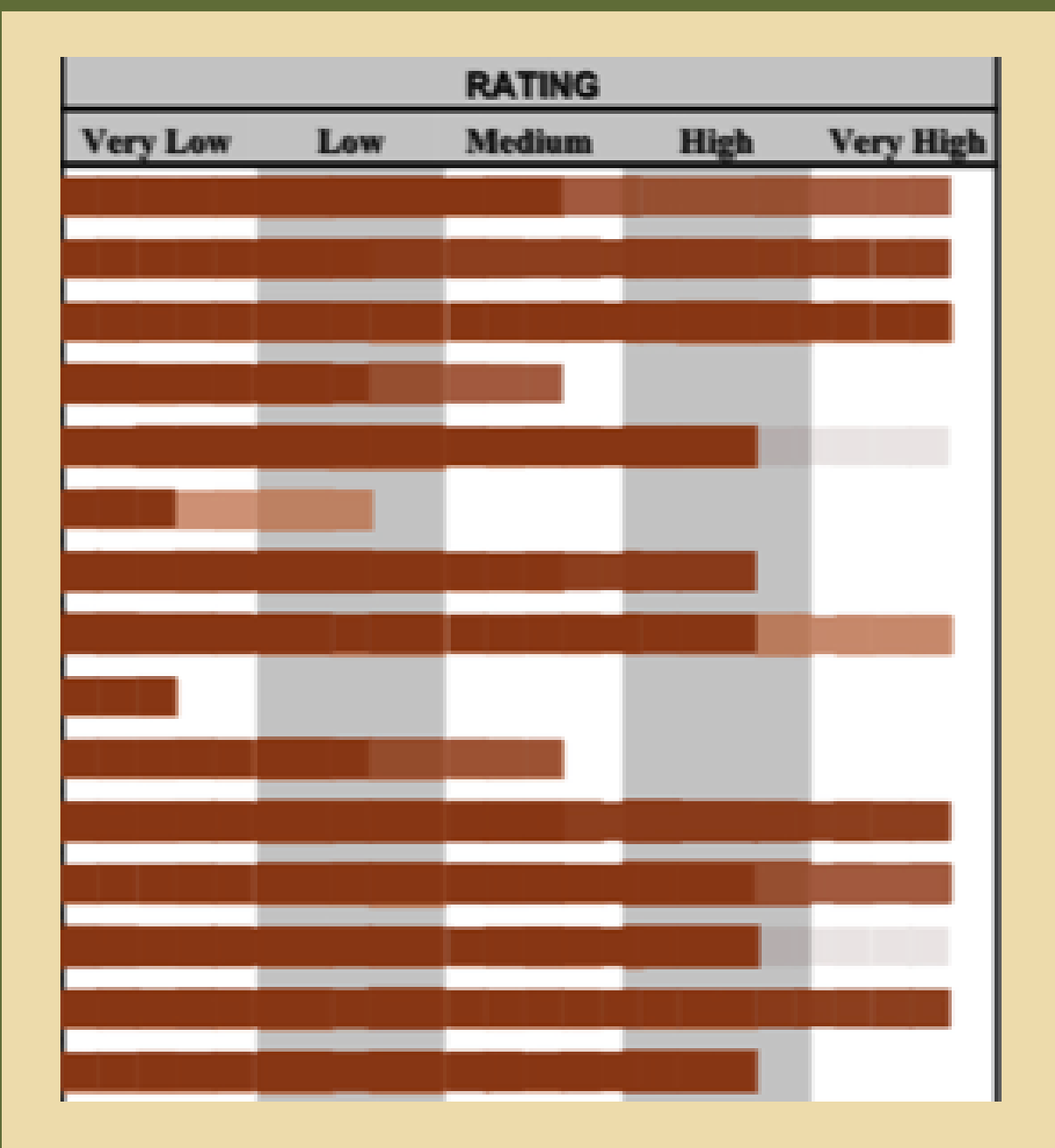


Figure 16: Soil analysis overlay



Figure 16.B: Legend for the soil analysis overlay

Figure 16 illustrates the relationship between the soil test results, across all three neighborhoods. This data is overlaid to show that there is little to no discernable difference between the three soil test results, and in fact, the results are very similar among all three samples.



Emily R. Evans
HORT 4092: Horticulture Senior Project
Faculty Advisor Stevie Famulari G.d.s
Spring 2025

Project Solution

After interpreting the data provided by the soil tests, a conclusion regarding the health of the soils within each of these neighborhoods can be made. This conclusion is that none of the examined neighborhoods, based on the soil testing data, are in an imminent soil health crisis. Given that the socioeconomic class of each of these neighborhoods has been analyzed, and the role that each of their unique histories has played in its current landscape, the relationship between the soil test results and socioeconomic class can be investigated. While soil health in these neighborhoods was found to not be particularly bad, there is no data regarding affluent neighborhood’s soil health. Therefore, making a claim regarding soil health in conjunction with socioeconomic status is moot. What conclusion can be made, however, is that those living in poverty in Cincinnati do experience environmental inequity, as lower tree canopy coverage, higher rates of air pollution, proximity to water pollution, and other environmental issues, disproportionately affect those living in poverty (Cincinnati-oh.gov, 2021). With this conclusion being made, it is sensible to suppose that soils may then be contaminated as well. Though this is not substantiated by the soil test results in this work, further investigation into this claim should be made, at a much larger scale, given the pattern of environmental inequity and who is affected most.

Though the data does not indicate the examined soils are indeed contaminated, solutions regarding poor soil health in low-income communities and how this affects the quality of life for those living in them must still be investigated. Because this is a matter that will require funding, labor, and potentially even policy revisions regarding environmental stewardship, it is evident that this is not a situation that those who are experiencing can work themselves out of alone. For this reason, advocacy for policy change in the form of protesting or community organization may be a great first step in bringing awareness to the subject. Only then, through assistantship by the City of Cincinnati or another local municipality such as Hamilton County, can meaningful change be made on the scale which it is needed. In order to further address the inequity of poor soil health found in these communities, the Cincinnati municipal governments should be urged to allocate resources towards environmental improvements. Amendments, fertilizers, further testing, and ultimately rehabilitation are needed for the soils in these communities.

Additionally, public education programs such as those already organized by the Civic Garden Center of Greater Cincinnati could be implemented. Educating those living in the affected neighborhoods about environmental stewardship, gardening, and the importance of having a healthy environment could serve as a step in the right direction. Moreover, education regarding soil health itself should be implemented, as there is a lack of knowledge in this area, even by those who work and study horticultural sciences and related fields. The topic is complex and, for this reason, may seem unapproachable to many. Soil science is the basis of all successful gardens, as without good soil, there certainly will not be good plants. Therefore, for there to be a lack of community education initiatives or programs regarding the subject is just further perpetuating the overall dissonance regarding gardening as a whole, and where soil science fits into this discussion.

The purpose of this work is to begin the discussion about soils and their importance. While solutions to the problem have been outlined, there is still much work to be done to see if this is a deeper problem. Further investigation needs to be done in Cincinnati, but the ideals and sentiments expressed in this work are applicable to other urban environments as well. The bottom line is that those experiencing poverty disproportionately experience environmental inequity on multiple fronts and seldom work exists exploring soil health in this context. This work serves as a catalyst to this conversation, and an example of the work that can be done to investigate it.

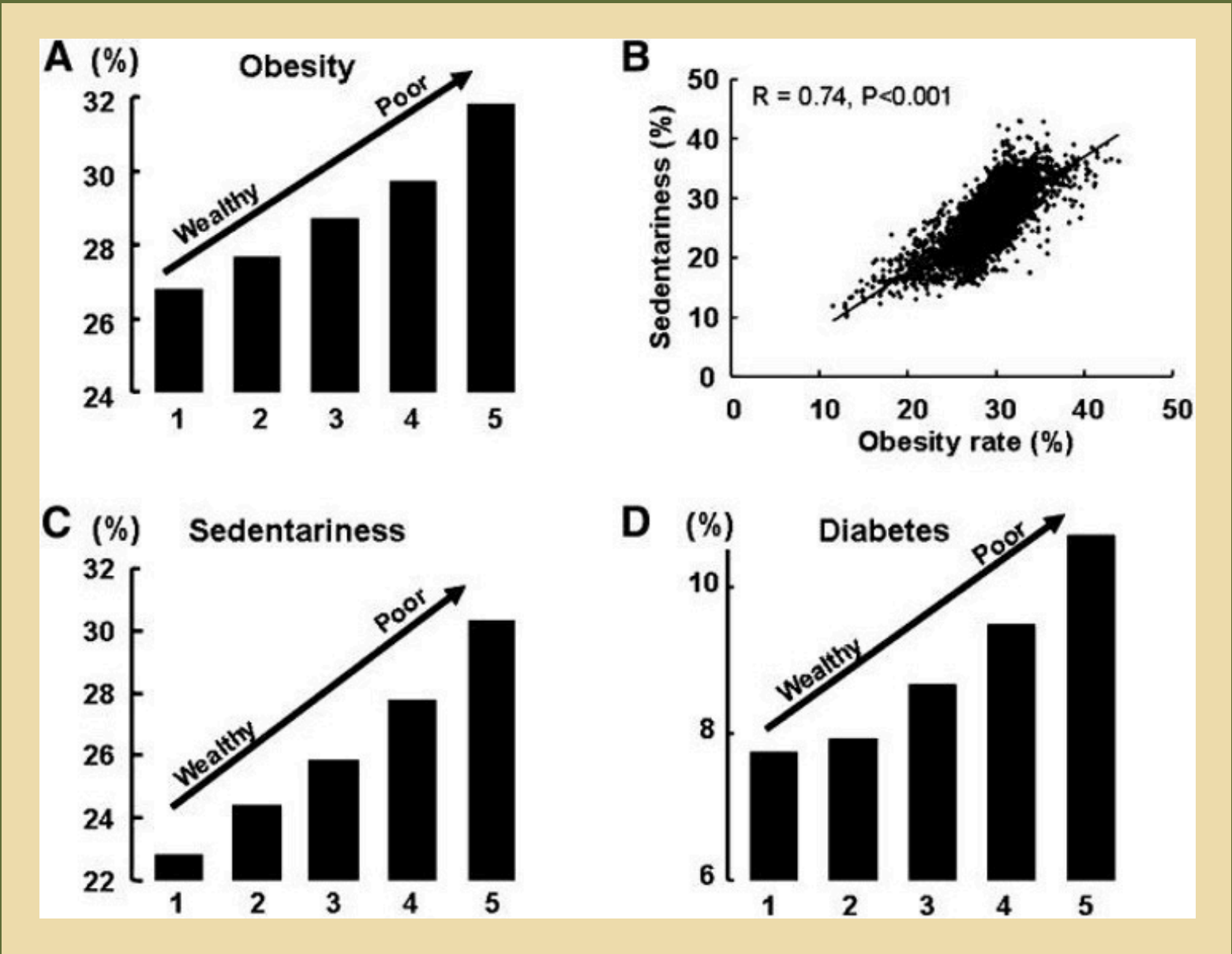


Figure 17: Graph of food related conditions & socioeconomic class (NIH.org, 2011)

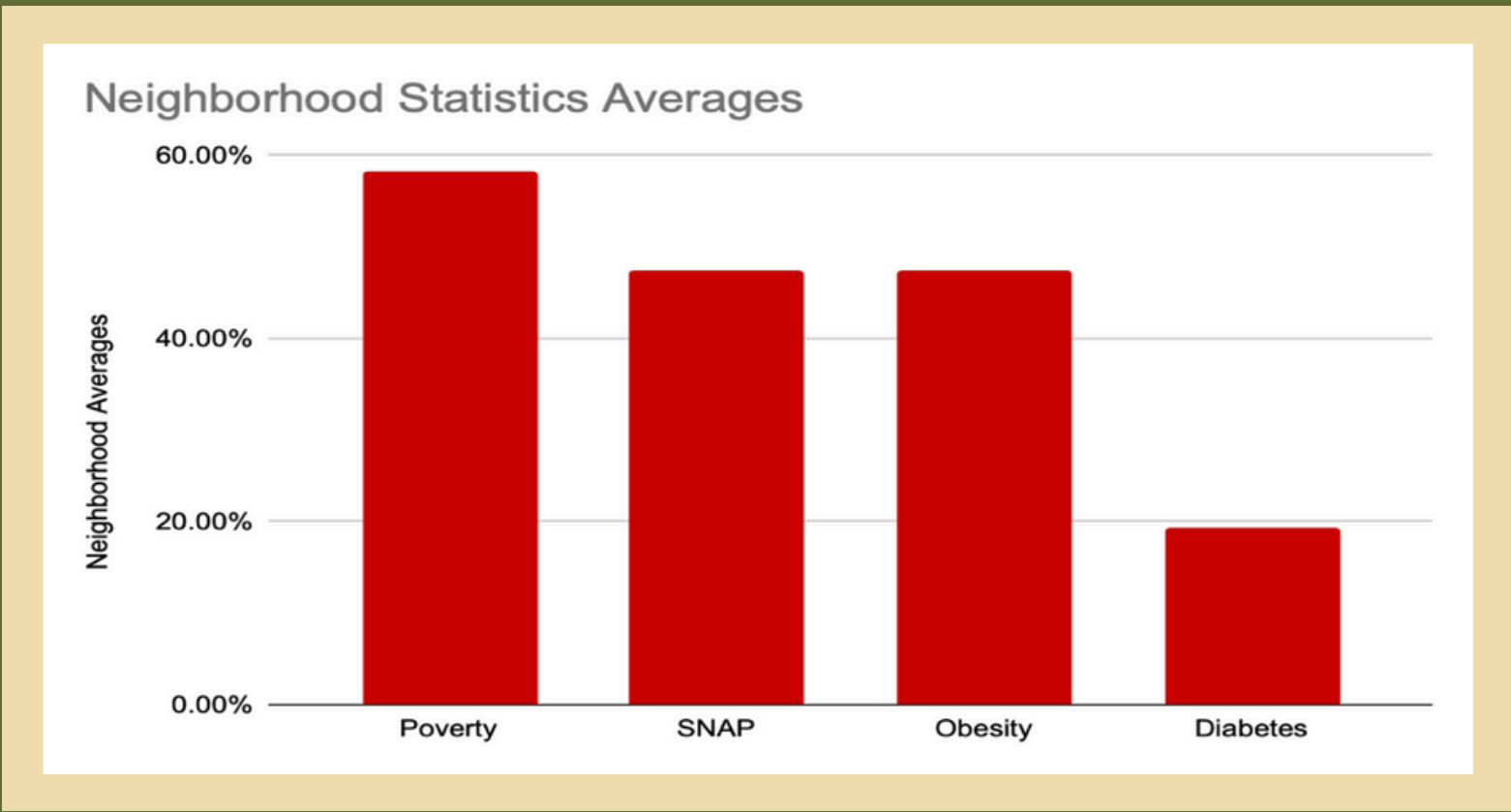


Figure 18: Statistic averages amongst all examined neighborhoods

Soil Testing & Related Expenses

Soil testing for this research is conducted by the Hamilton County Soil and Water Conservation District of Indiana (Hamilton County SWCD). The mailing address to which soil samples were mailed is 1717 E. Pleasant Street, Suite 100, Noblesville, Indiana 46060. The soil testing itself is completed by A&L Great Lake Laboratories, located at 3505 Conestoga Drive, Fort Wayne, Indiana 46808. Hamilton County SWCD offers two different types of tests: a basic test and a complete test. The basic test costs \$35 and “includes organic matter, phosphorus, potassium, calcium, magnesium, CEC, pH, and buffer pH.” (hamiltonswcd.org, n.d.). The Complete test costs \$45 and includes everything the basic test includes as well as, “conductivity, boron, copper, iron, manganese, sulfur and zinc.” (hamiltonswcd.org, n.d.). For the purposes of this research the complete test was utilized, as this test gives a clearer indication as to the overall health of the soil at large. Since the complete test was utilized and three soil samples were collected, this brings the cost of the testing alone to \$135. Additional costs include shipping, which was \$19.95 for standard shipping at a local United States Post Office.

Sample Collection

In order to send soil to the Hamilton County SWCD, soil samples must first be collected. As previously discussed, soil samples were taken from Winton Hills, Lower Price Hills, and Walnut Hills on Winneste Avenue, Neave Street, and Melrose Avenue, respectively. Each of the samples is collected from a tree well on a street that has sidewalk access, street parking and is at minimum a mixed residential or primarily residential area. The samples are collected using a hand trowel and a soil knife. First, surface debris such as leaves, sticks, rocks, or any trash is removed from the surface of the soil. Then, utilizing a hand trowel, a hole is dug approximately six inches below the soil surface. Then, utilizing the soil knife, a sample of approximately 3 cups of soil is collected. This sample is then placed in a clean Ziplock-style bag and labeled with the street name it is collected from, the neighborhood it is collected from, and the date it is collected. This process is then repeated in the remaining two neighborhoods.

Sample Processing & Preparation

After the initial sampling date, the soil samples are transferred into plastic containers and allowed to air dry for approximately 72 hours. After drying time is complete, any large soil aggregates are manually broken or removed, as well as any rocks, sticks, or other debris present in the sample. The soil samples are then returned to new Ziplock-style bags and labeled in the same fashion as when they were collected. A soil sample order form from the Hamilton County SWCD is then filled out, and payment is submitted through their website. All three of the soil samples, individually bagged and labeled, are then placed into a box with the soil sample order form. This box is then shipped to the Hamilton County SWCD, where soil tests will be performed on the samples. Approximately one week from the date that the samples are received by the Hamilton County SWCD, test results will be made available via email, as well as physical mail.

Once the soil test result is received, this data will then be used to determine if the soil health in the neighborhoods it was collected in, is of poor health. Since the utilized tests will indicate if there are any deficiencies in major macronutrients, the soil’s pH, major issues regarding contamination, and other qualities, these tests serve as a basis to make this conclusion upon. Furthermore, given the nature of the tests being performed, the test results are further valid to conclude the overall soil health of these neighborhoods, since the tests give an indication as to the soil health at large.



Figure 19: Materials needed for soil sample collection



Figure 20: Soil samples placed in containers to air dry for 72 hours



Figure 21: Soil samples collected in the field

Soil Testing Vocabulary Defined

- Organic Matter: Organic matter is both integral to a soil’s health but also serves as an indicator to the overall health of a soil. Organic matter, “measures the amount of plant and animal residues in the soil. Usually, the darker the color of the soil the more organic matter is present.”. Ideal values of organic matter are between 3% and 5% (hamiltonswcd.org, n.d.).
- Soil pH: Soil pH is a measure of how alkaline or acidic a soil is. A pH of 7 is considered neutral (think filtered water), a pH of 1 is extremely acidic (stomach acid) and a pH of 14 is more alkaline than bleach. Most plants prefer soil between 6.0 and 7.0, though soil pH can range from 5.0 to 8.0. pH is incredibly important to a soil’s health, as certain nutrients are only made available at specific pH levels. Lime can be added to a soil in order to raise the pH, whereas sulfur can be applied to lower the pH (hamiltonswcd.org, n.d.).
- Cation Exchange Capacity (CEC): CEC is a measure of a soil’s ability to retain nutrients; though a higher CEC value is not an indication of a more productive soil, simply a greater capacity to retain. Soils with a CEC value exceeding 25 are peat soils; “heavy clay soils have CECs from 15 to 25; loamy soils from 5 to 15; and sandy soils below 5.” (hamiltonswcd.org, n.d.).

Symbol Legend

- Education
- Nutritious Soil
- Contaminated Soil
- Socioeconomic Status
- Green Infrastructure
- Quality of Life
- Health

Citations

1. Even, T. L., Trott, C. D., Gray, E. S., Roncker, J., Basaraba, A., Harrison, T., Petersen, S., Sullivan, S., & Revis, S. (2021). Climate Equity Indicators Report - 2021. City of Cincinnati. The American Cities Climate Challenge Equity Capacity Building Fund, Bloomberg Foundation.
2. Soil Health. (n.d.). Natural Resources Conservation Service. United States.
3. Mads Nissen. (2007). A farmer weeds a field that has been surrounded by partial built highrise blocks.https://stor.org/stable/community.12158094 Accessed February 4, 2025
4. Wikimidia. (n.d.). https://upload.wikimedia.org/wikipedia/commons/8/89/USDA_Soil_Teature.svg
5. https://www.urbanarchy.com/wp-content/uploads/2014/03/Lower-Price-Hills.jpg
6. https://media.gannett-cdn.com/cdn/35546123001/201403/571/35546123001_3590804369001_VDHousing2.jpg?puId=35546123001&wId=666&hId=370&format=png&auto=webp
7. https://images.cdn.homes.com/2/8/WqGNR-PxKKweNM6YUaaMDx2d51eMtpLXcvSHs/102/east-walnut-hills-cincinnati-oh.jpg?hp=1
8. Medium. (n.d.). https://info.medium.com/22/esicentf1353073d107f5d3d0f1
9. Even, T. L., Trott, C. D., Gray, E. S., Roncker, J., Basaraba, A., Harrison, T., Petersen, S., Sullivan, S., & Revis, S. (2021). Climate Equity Indicators Report - 2021. City of Cincinnati. The American Cities Climate Challenge Equity Capacity Building Fund, Bloomberg Foundation.
10. Even, T. L., Trott, C. D., Gray, E. S., Roncker, J., Basaraba, A., Harrison, T., Petersen, S., Sullivan, S., & Revis, S. (2021). Climate Equity Indicators Report - 2021. City of Cincinnati. The American Cities Climate Challenge Equity Capacity Building Fund, Bloomberg Foundation.
11. Even, T. L., Trott, C. D., Gray, E. S., Roncker, J., Basaraba, A., Harrison, T., Petersen, S., Sullivan, S., & Revis, S. (2021). Climate Equity Indicators Report - 2021. City of Cincinnati. The American Cities Climate Challenge Equity Capacity Building Fund, Bloomberg Foundation.
12. Hamilton County Soil and Water Conservation District https://www.hamiltonswcd.org
13. Hamilton County Soil and Water Conservation District https://www.hamiltonswcd.org
14. Hamilton County Soil and Water Conservation District https://www.hamiltonswcd.org
15. Soil Sampling map created by Emily R. Evans utilizing GIS, 2025
16. Soil Analysis Overlay created by Emily R. Evans utilizing photoshop, 2025
17. Levine, J. A. (2011, November). Poverty and obesity in the U.S. Diabetes. https://pmc.ncbi.nlm.nih.gov/articles/PMC3198072/#:~:text=Int%20contrasts%20of%20international%20trends,IA
18. Neighborhood Statistics graph created by Emily R. Evans utilizing Microsoft Excel, 2025
19. Image taken by Emily R. Evans, 2025
20. Image taken by Emily R. Evans, 2025
21. Image taken by Emily R. Evans, 2025
Education symbol: https://png.pngtree.com/png-vector/20220615/ourmid/pngtree-education-icon-png-image_5048342.png
Nutritious soil symbol: https://png.pngtree.com/png-vector/20190411/ourmid/pngtree-vector-soil-plant-icon-png-image_925363.jpg
Contaminated soil symbol: https://thumbs.dreamstime.com/2/soil-degradation-line-icon-soil-degradation-line-icon-linear-style-80p-mobile-concept-web-design-soil-cracks-304509979.jpg
Socioeconomic status symbol: https://cimg.giphy.com/media/173bf20633762782826089875763544447e1b1346f8f9291/bw68747470733n2Zl663c6336cd75642ee6769746875622eb36fd62f6173736574732333236333137382f3639353736332f60356262613239652d6d46364382d31316532d396365632d653562303134383764e264332e6a70e7
Green infrastructure symbol: https://www.shutterstock.com/image-vector/material-permeability-linear-icon-breathability_260rw-2363548617.jpg
Quality of life symbol: https://www.shutterstock.com/image-vector/hands-holding-heart-icon-illustration_260rw-546937804.jpg
Health symbol: https://media.istockphoto.com/id/1004243378/vector/caduceus-health-symbol-asclepius-ward-icon-black-color-illustration-flat-style-image.jpg?from_view=detail&from_openview=0&w=2000&h=2000&format=webp&auto=compress&cs=tinysrgb&maxw=512&maxh=512&crop=1



Emily R. Evans
HORT 4092: Horticulture Senior Project
Faculty Advisor Stevie Famulari G.d.s
Spring 2025