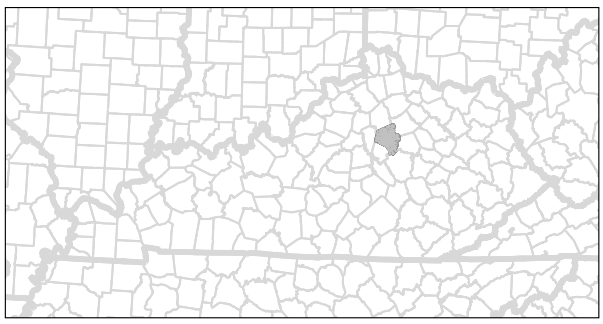
Workshop in Geospatial Technologies (GEO509)

Fall 2025
Final Report

Soils and crop suitability, Sharmin Akther
What if, Lexington?, Daniel Dilger
Mixed signals, Nick Gray
Bike and pedestrian safety, Finn Haight
Disability and transportation, Connor Hibbard
Stormwater exposure and building risk, KM Nafee
Zoning and residential tree canopy, Charles Petty
Flooding and property values, Evan Sinor-Huggins
Food access in Davis Bottom, Tristan Taylor
Home prices in Cardinal Valley, Ryan Zuber

Instructor: Matthew Wilson

Census Tracts of Lexington, Kentucky



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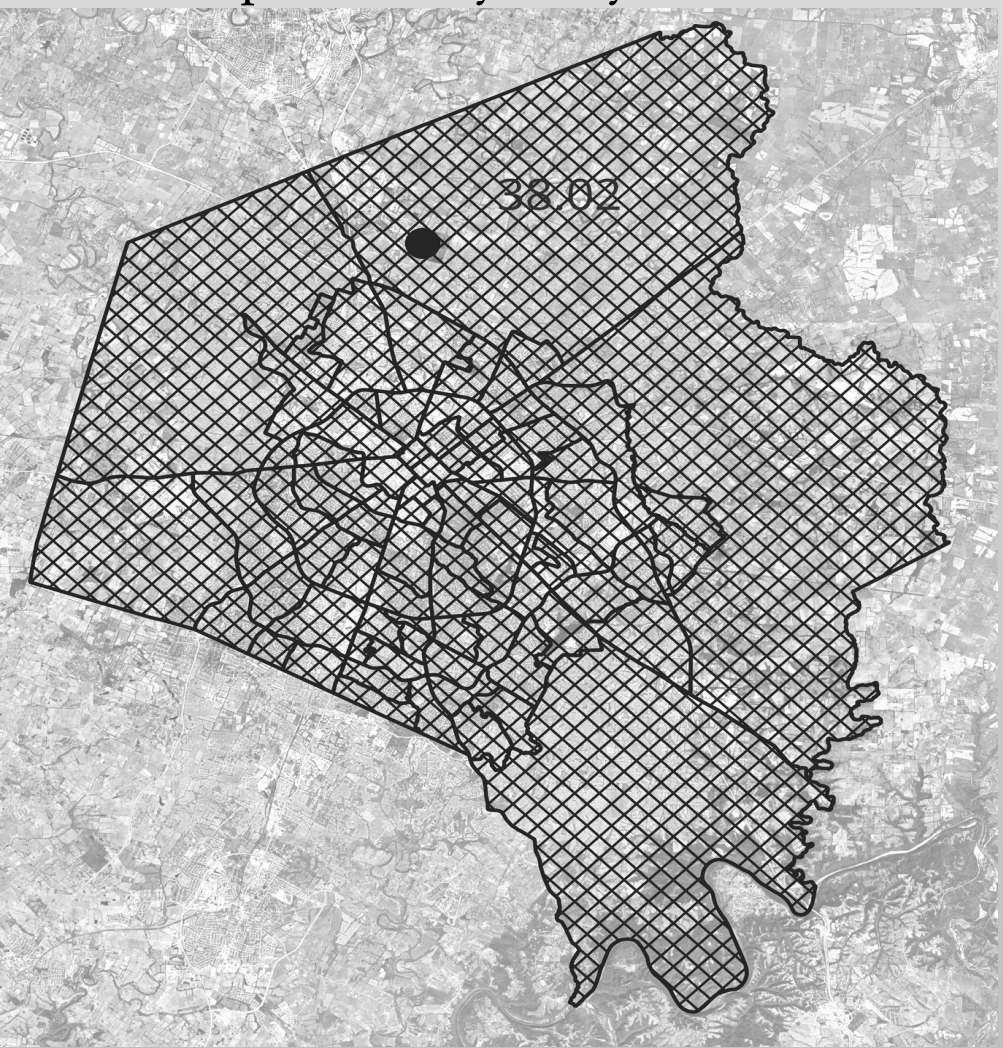
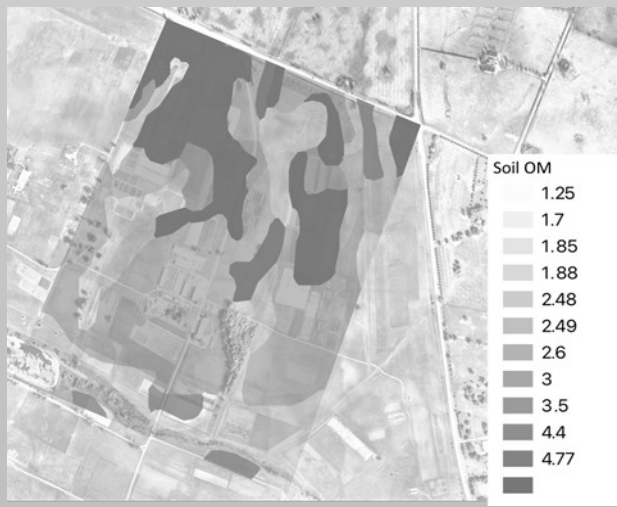
Soil Property Mapping and Cover crop Suitability Assessment at Spindletop Farm, Lexington, Kentucky

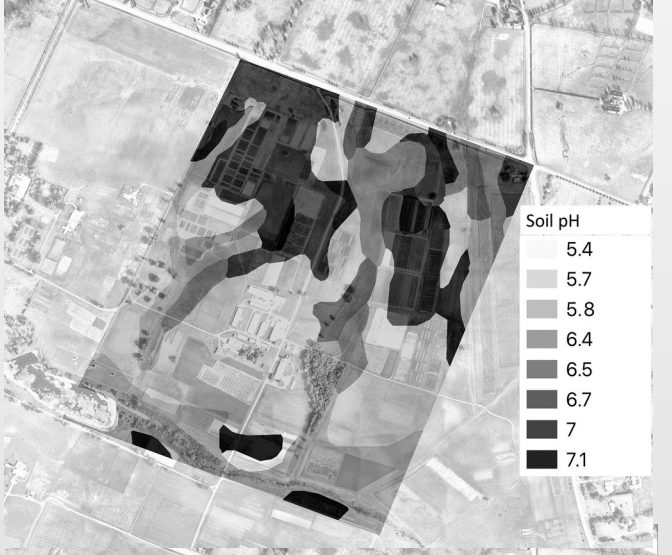
Sharmin Akther, Department of Plant and Soil Sciences, University of Kentucky

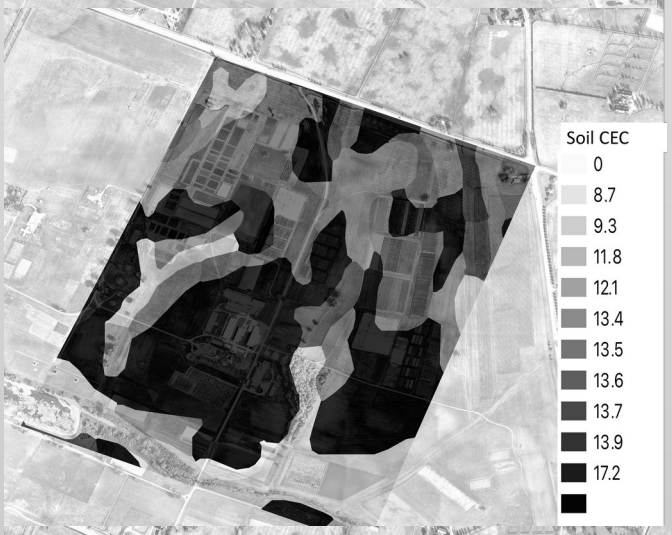
Spindletop Farm, located in Lexington, Kentucky (38.13° N, −84.49° W), lies within Census Tract 38.02, an area where urban development transitions into productive agricultural land. This setting makes it ideal for studying spatial variability in soil properties. Compared to the University of Kentucky's North and South Farms, which focus on large-scale experiments, Spindletop offers diverse slopes, soil types, and micro-landscape features suited for GIS-based soil mapping and cover crop suitability analysis.

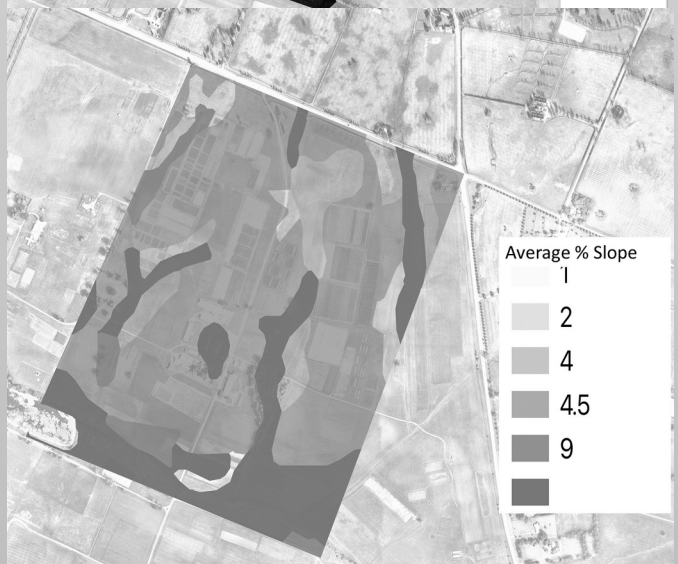




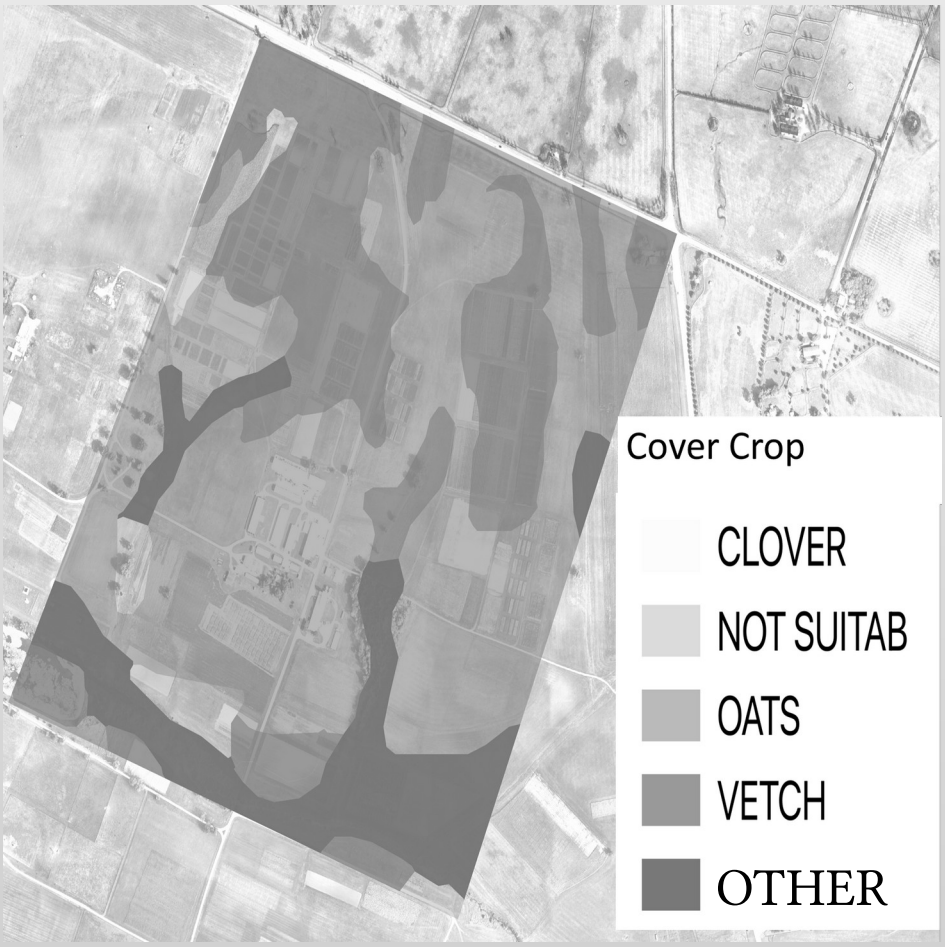
Six key soil properties were selected and mapped in this project: Bulk Density, Soil pH, Cation Exchange Capacity (CEC), Organic Matter (OM), Soil Type, and Slope. These properties were chosen because they are directly related to soil health and strongly affect cover crop performance. From these maps, it became clear that soil conditions vary significantly across Spindletop Farm, with certain areas showing higher fertility and better structure while others exhibit compaction, lower OM, or steeper slopes patterns that directly guided the identification of which cover crops are most suitable in each specific location.







Cover Crop	Soil pH	Bulk Density (g cm^{-3})	Organic Matter (OM %)	Average Slope (%)	CEC (cmolc kg^{-1})
Cereal rye	5.6	>1.65	2–4%	2–6%	10–25
Oats	5.5	>1.65	2–4%	2–6%	8–20
Clover	5.5	>1.65	3–6%	2–6%	15–30
Vetch	5.5	>1.65	3–6%	2–6%	12–25
Radishes	5.5	>1.65	2–4%	2–6%	8–18



A cover crop suitability map is essential because it helps to determine which areas of a farm can best support specific cover crop species. The final suitability map for Spindletop Farm shows clear spatial variation in where each cover crop is most appropriate.

Overall, the suitability map demonstrates that no single cover crop fits the entire farm; rather, each species performs best in specific zones, highlighting the importance of site-specific management for improving soil health and maximizing ecological benefits.

References:

1. White, C. M., & Weil, R. R. (2010). Forage radish cover crop effects on soil properties. Agronomy Journal, 102(2), 635–644.
2. USDA–NRCS. (2001–2023). Soil Quality Indicators: Soil Organic Matter, Cation Exchange Capacity, Bulk Density.
3. Web of Soil Survey

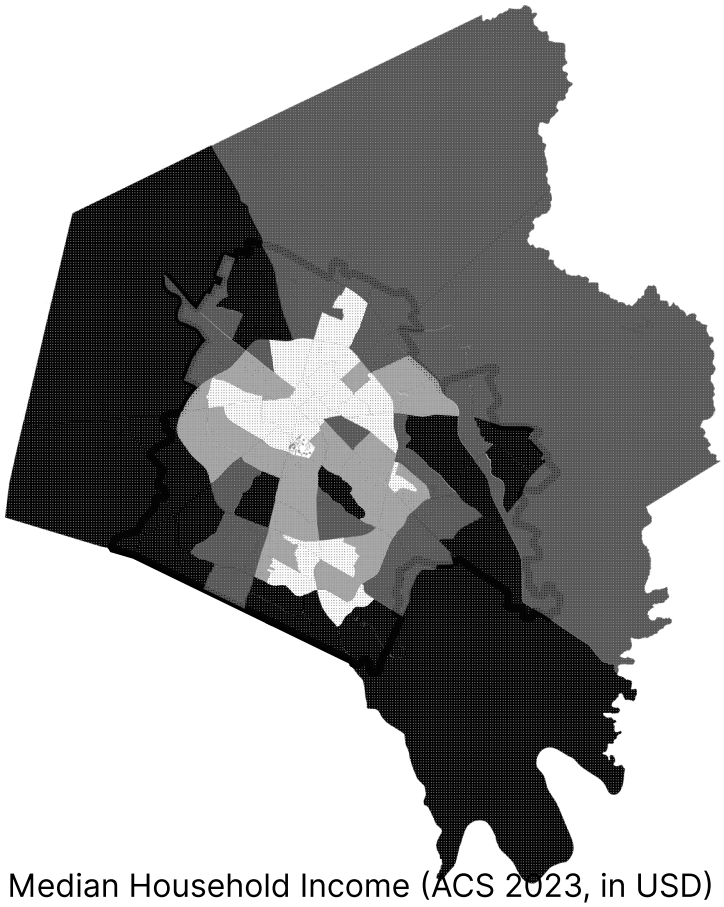
What if, Lexington?

Speculative Maps on the Future of the Lexington Commons
by Daniel Dilger

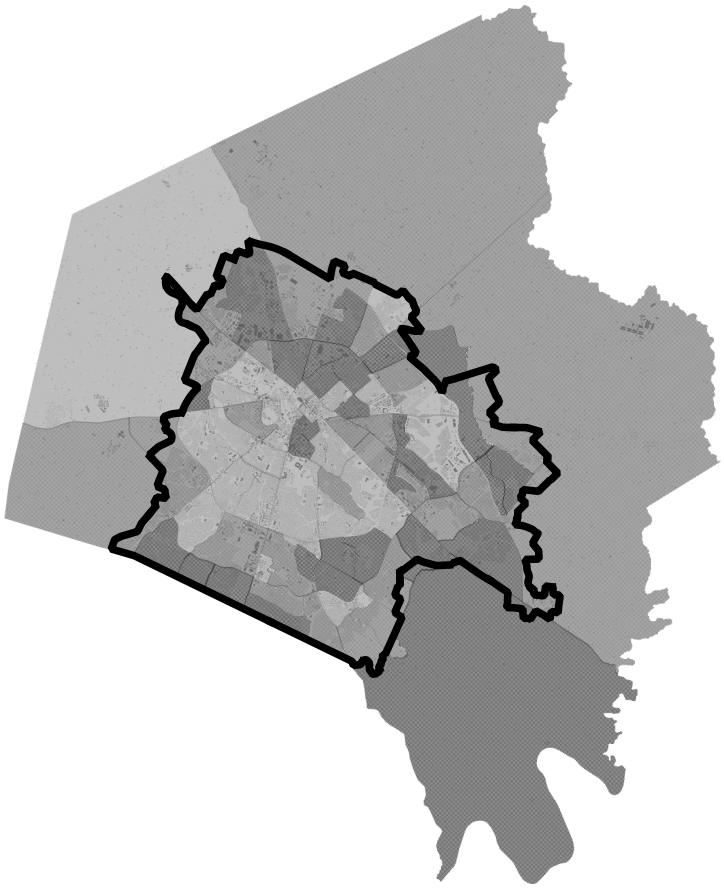
These maps explore water and cooling as urban commons. By shifting everyday infrastructures into speculative scenarios — a sudden water shortage, or a heat emergency — they reveal how long-standing socio-spatial divides shape access to basic environmental needs in Lexington. What if the future of the city depended on making these resources shared, equitable, and accessible?

1. Spatial Inequality – Setting the Scene

Median household income in Fayette County shows a striking spatial contrast: the historic core and northside tracts remain among the lowest-income areas in the city, while they are surrounded by some of Lexington's highest-income areas. This pattern reflects long-standing layers of disinvestment, racialized housing history, and concentrations of wealth that continue to shape the city's socio-spatial landscape. The downtown/northside areas also hold a considerable amount of the youngest population of the city.



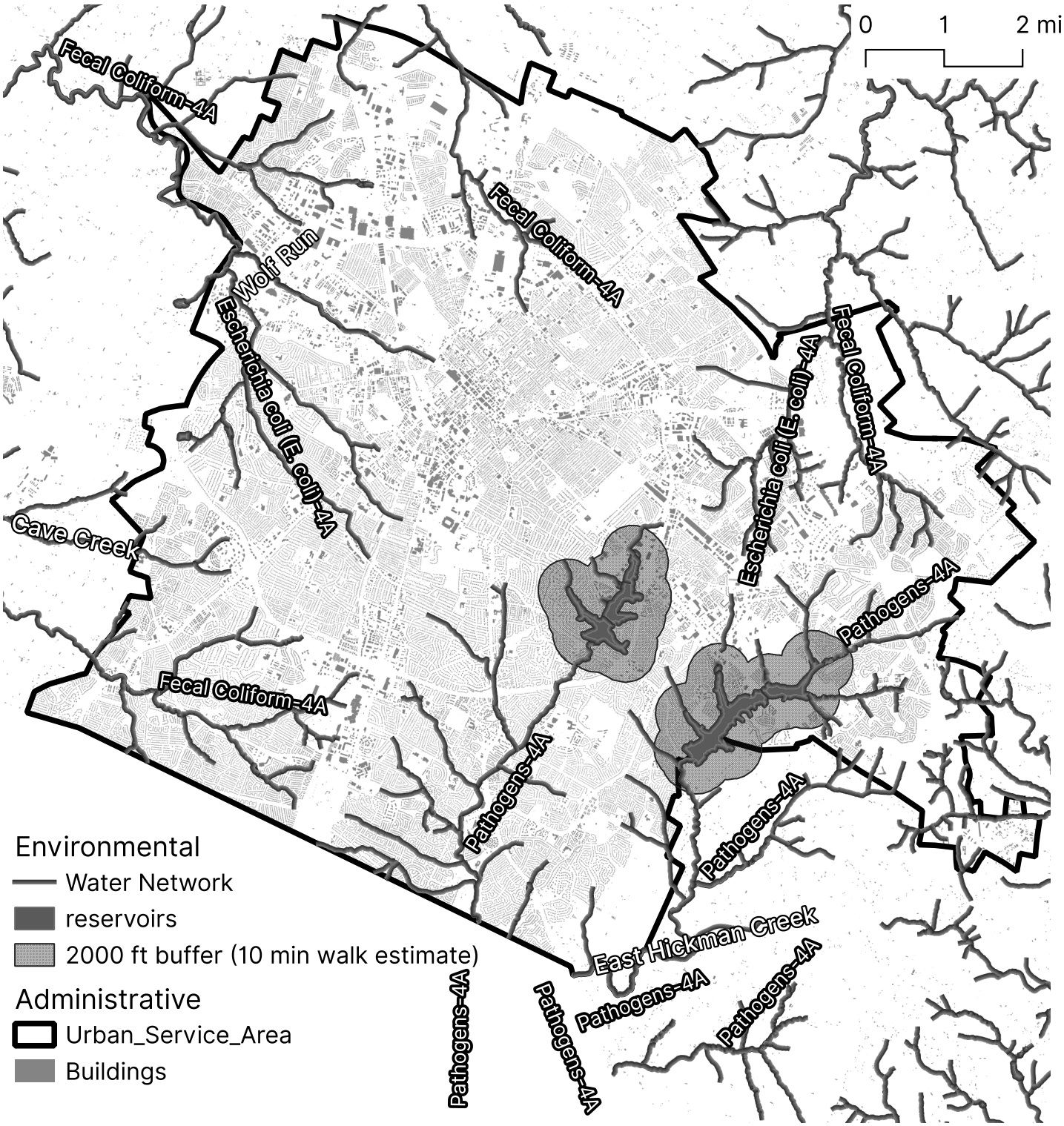
Median Household Income (ACS 2023, in USD)
- 22526 - 51190
- 51190 - 66979
- 66979 - 90727
- 90727 - 245189
- Urban Service Boundary



% of youth (0-19 yo)
- 0,029 - 0,211
- 0,211 - 0,264
- 0,264 - 0,838

What if the water system fails?

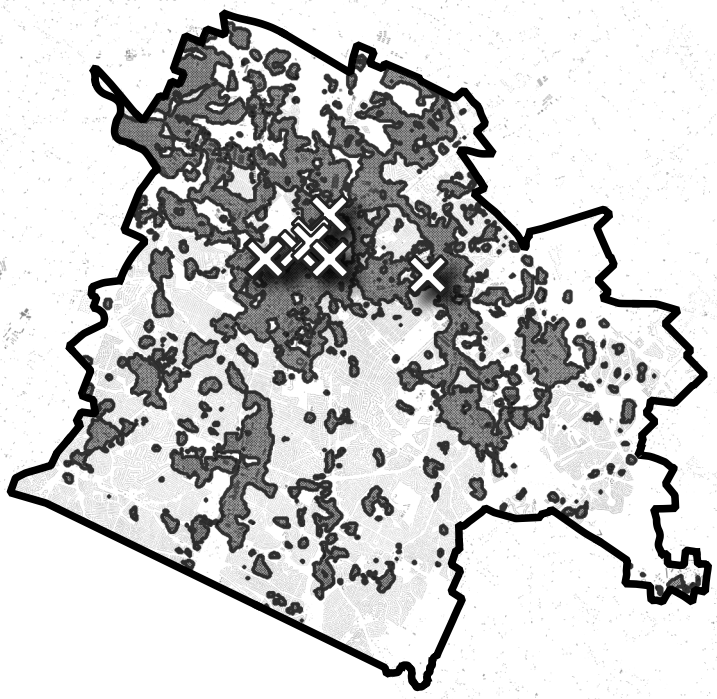
Lexington's water system is stable — until it isn't. Despite usually good rainfall, the karst geology complicates water storage. This speculative scenario imagines a breakdown in the treated water supply. Using walking-distance buffers from the city's major water reservoirs and observed pollutants in local streams, the map highlights who could reach usable water within 10 minutes of walking, and who relies on degraded waterways. The infrastructure of water, usually invisible, becomes a mirror of existing inequalities.



What if urban heat becomes extreme?

Heat in Lexington is not evenly distributed. Nighttime and summer heat islands concentrate north of downtown — areas historically shaped by racial segregation, disinvestment, and limited tree canopy. Cooling centers offer relief, but are unevenly placed. This mapping treats cooling as a commons: if heat emergencies intensify, who already has access, and where are the gaps?

Urban Heat Islands



Cooling Centers

Environmental

Heat Islands (Aug 2024)

Administrative

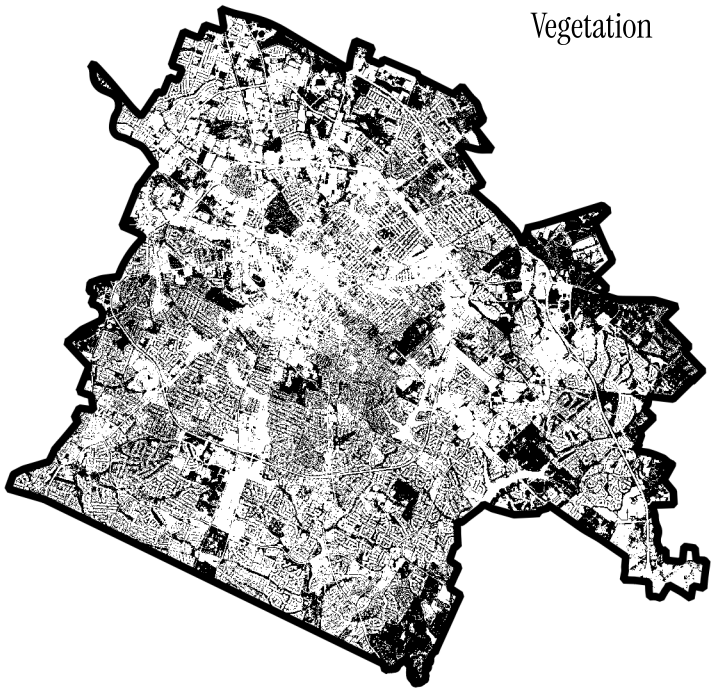
Urban_Service_Area

<< Note the concentration of urban heat islands in the Northside and downtown. This may be attributed to the lack of tree canopy, high degree of impervious surface, and increased density. Large traffic infrastructure (e.g. Nicholasville Road) also concentrate pockets of heat.

>> Lexington's canopy follows long-standing social and spatial divides. Affluent southern neighborhoods such as Chevy Chase and Ashland benefit from mature street trees and extensive private green space, producing cooler microclimates. In contrast, the northside shows sparse vegetation and limited canopy, reinforcing higher heat exposure and reduced environmental comfort.

The NDVI (or vegetation index) was fetched at a scale of 1:10 and analyzed for the urban service area. To simplify reading, only high vegetation values (<0.4) have been visualized. White areas are to be understood as fully impervious surfaces.

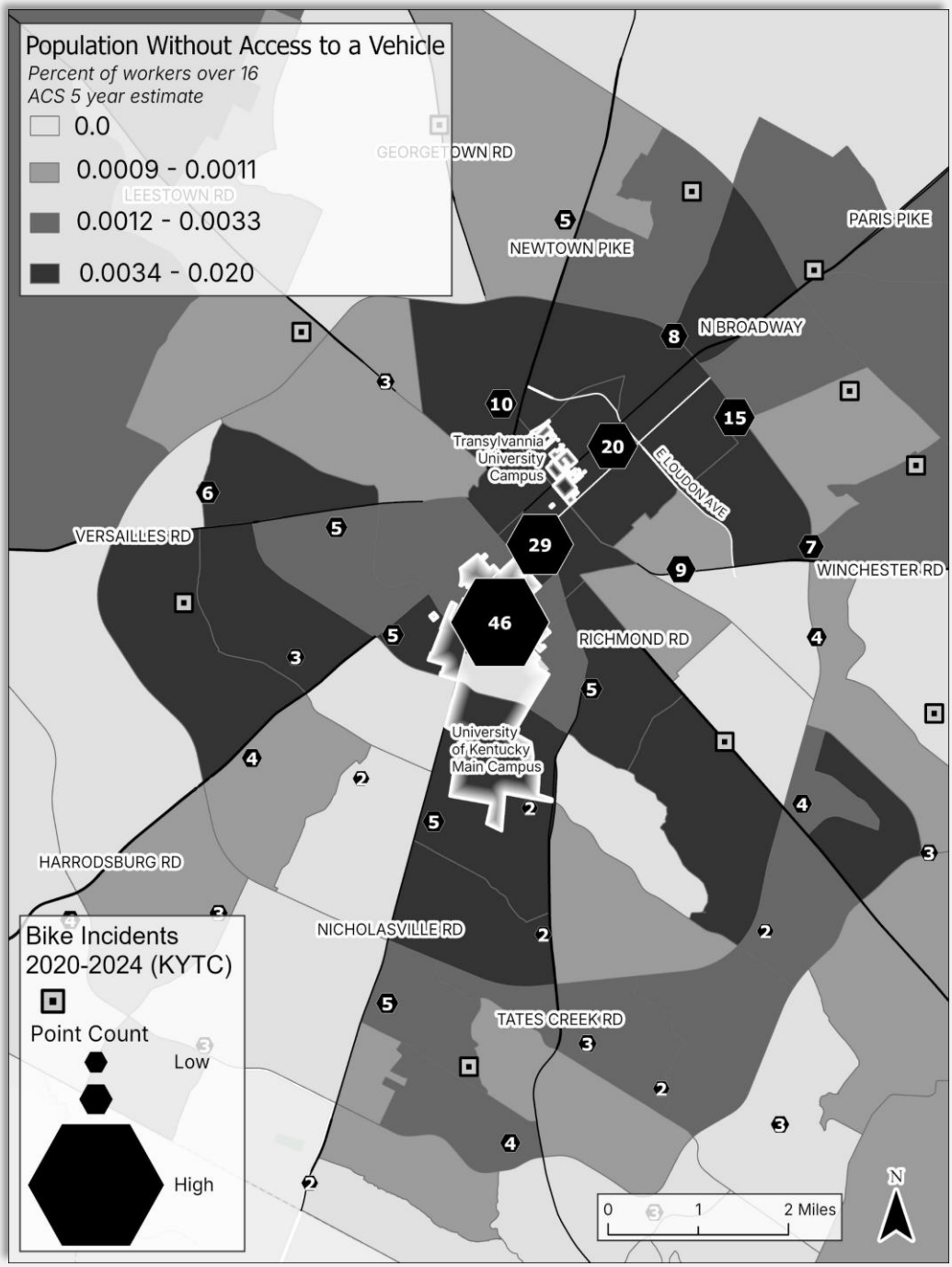
Vegetation



Mixed Signals: How infrastructure can send the wrong message

By Nick Gray

Credits: LFUCG, KYTC, ESRI, ACS, US Census



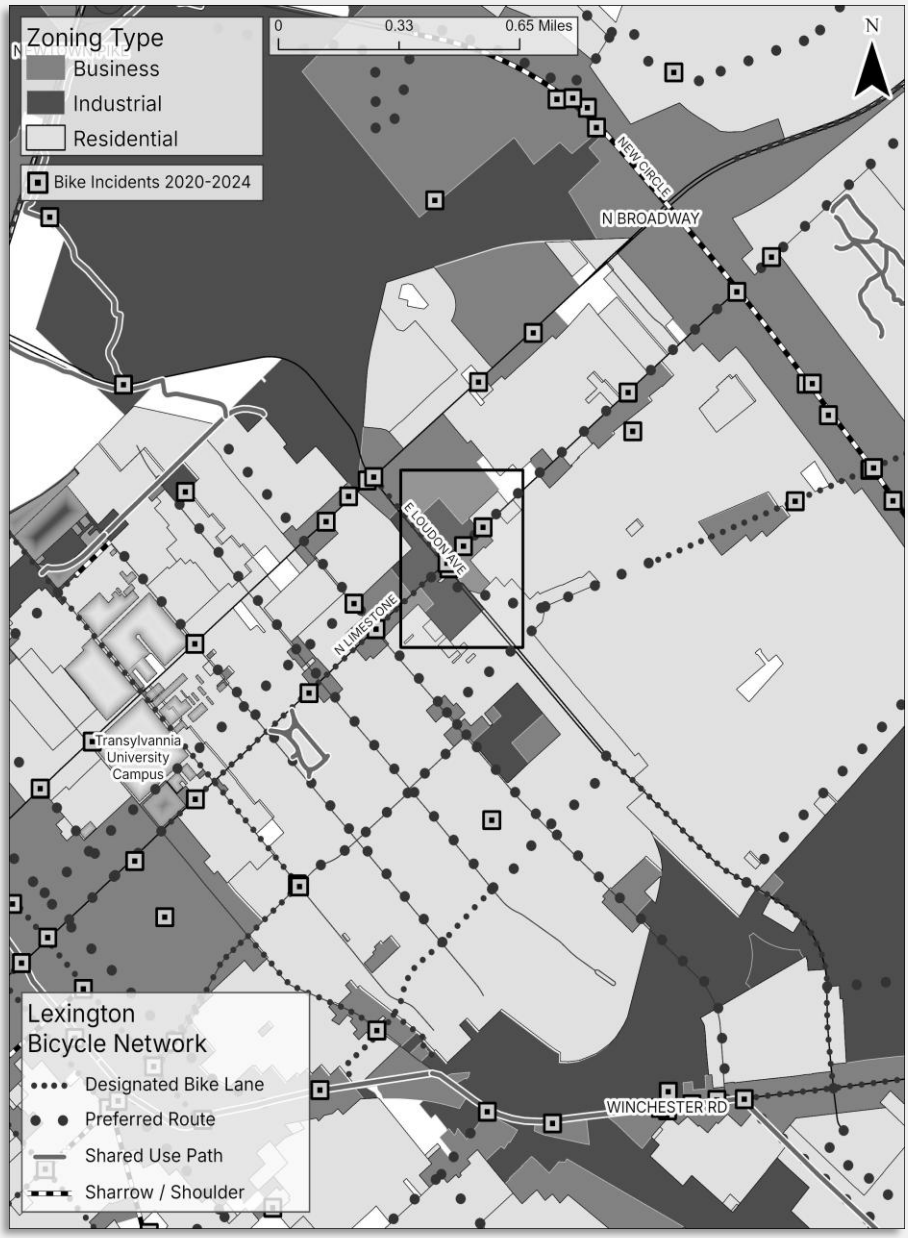
We see a higher number of accidents occurring in the Northeast section of the city, an area with a greater percentage of people without vehicles.

Bike safety in Lexington is one of the city's chief concerns. Lexington is notorious for its dubious biker-friendliness; with narrow, shared one-way lanes and haunting right hooks, it can be daunting to navigate the city via bike.

In recent years, the city has taken steps to increase the number of bike lanes in the city and create "a safer and more pedestrian friendly city" (LSAP).This means identifying key corridors and neighborhoods in need of attention based on biker, pedestrian, and motor vehicle safety, as well as socioeconomic need, present and historic.

As we look ahead to projects like Imagine New Circle and other infrastructural changes that attempt to correct for our unevenly developed physical spaces, we must look back to ensure we don't make the same mistakes. In particular, we look to the intersection of N Limestone and Loudon and the newly developed Greyline Station highlighted in white above.

The industrial zoning type flanking the residential areas of North Lime contributes to the lack of safety by adding a variety of large vehicles accessing these areas.

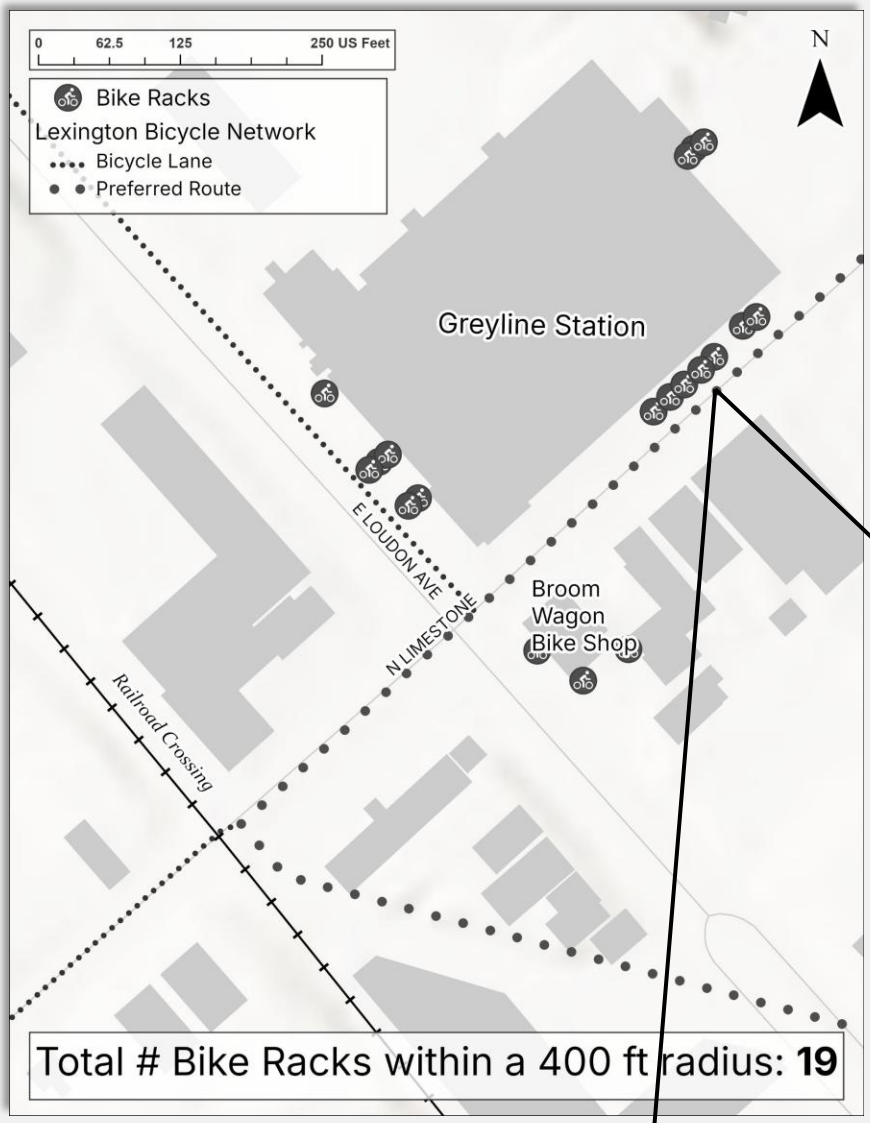


The dedicated bike lane is difficult to distinguish through the web of "preferred routes" scattered between Second and Seventh streets.

Whether you approach from Winchester Rd, Broadway – which many attempt – New Circle, or Downtown, you are met with discomfort and danger due to confusing bike lanes and narrow, neglected roadways.

The view before crossing the railroad track Eastbound on the N Limestones "Designated Bike Lane"

The view after crossing the railroad track Eastbound on the N Limestones "Designated Bike Lane"



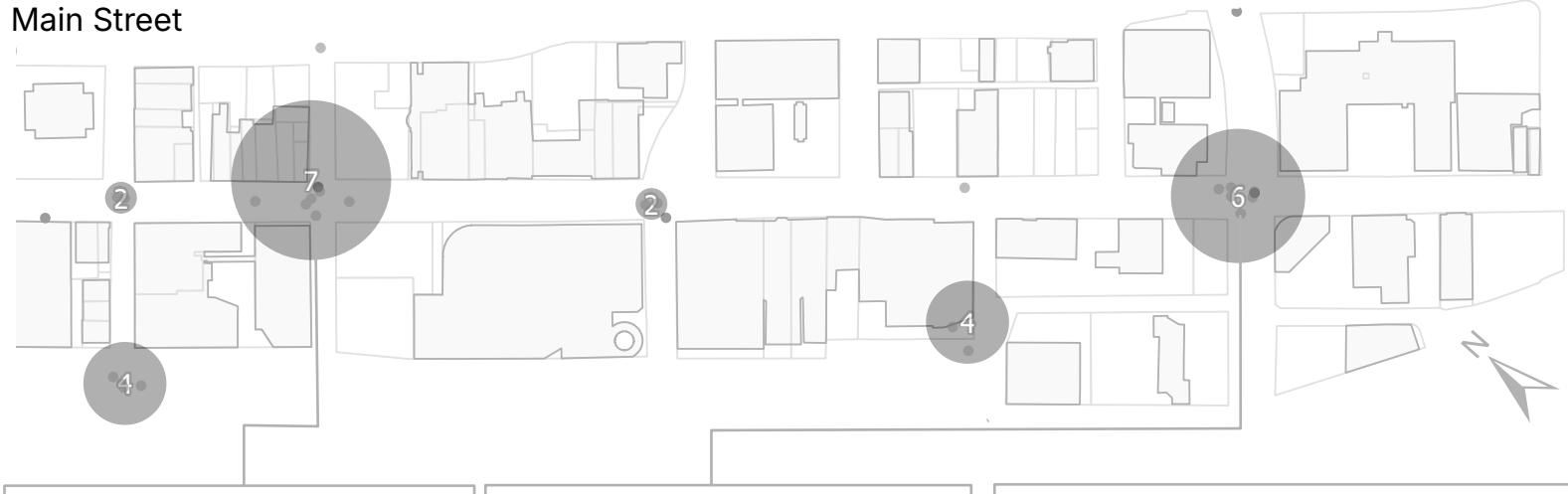
The inability to safely and easily access the Greyline Station commerce hub via bike conflicts with the suggestion by the Official Lexington Bicycle Network Map and the abundance of bike racks around the building that this area is easily accessible by bike.

This conflict creates a dangerous and confusing situation for bikers, represented by the elevated number of bike accidents in this area. Greyline Station is a symptom of hasty development practices that ignore the material conditions of residents and creates dangerous situations for cyclists and residents.

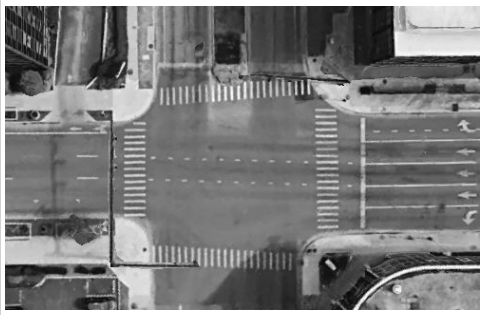
The overabundance of bike racks surrounding this building is already egregious but becomes laughable when the road conditions leading to this area are considered.

Biking and Pedestrian Safety in Lexington, KY

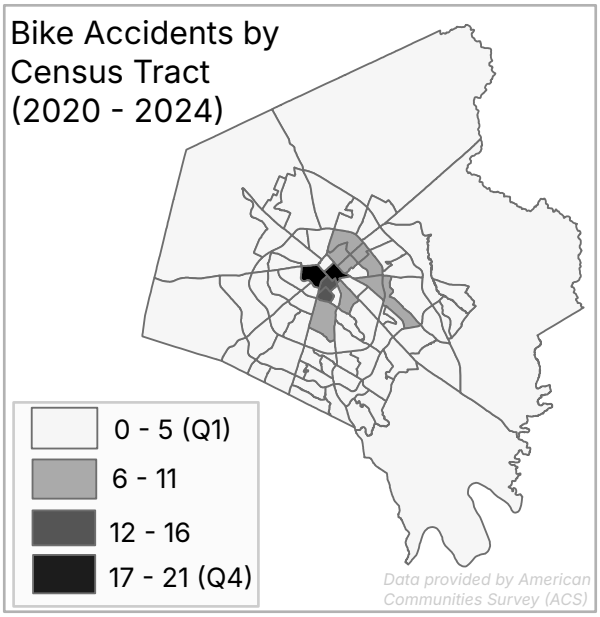
Bike and Pedestrian Accidents Along Main Street



South Limestone and Main - This intersection saw 7 collisions between 2020 and 2024. Main Street's bike lane ends abruptly after crossing Limestone, and traffic from both roads is one way.



Elm Tree Ln and Main - This intersection saw 6 collisions between 2020 and 2024. While a bike lane runs along main street, multidirectional traffic from Elm Tree comes from both sides as the road splits.



What areas of Fayette County are the safest to bike in, and which have the most bike related accidents? These maps examine the areas with the highest density of bike collisions, with a focus on Lexington.

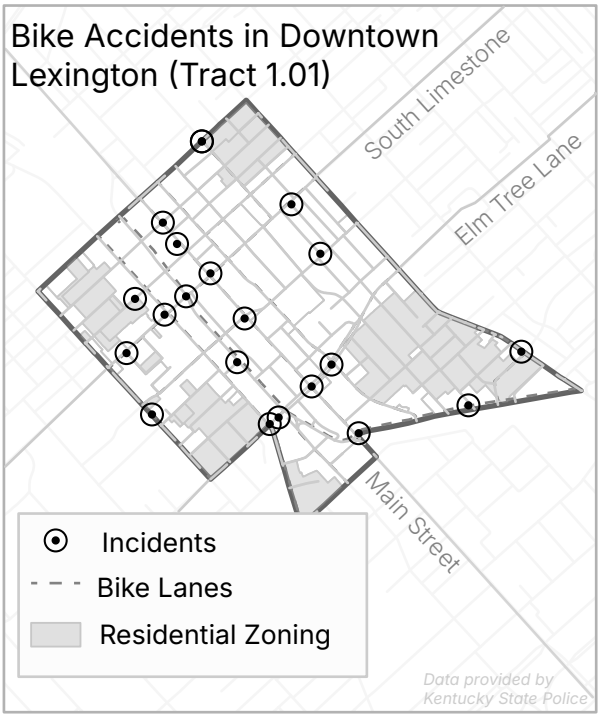
Census data shows that tract 1.01, comprising of Lexington's city center, is in the top quartile for bicycle collisions. Despite this, no collisions were reported in residential areas.

Instead, data suggests that most collisions happen in areas zoned for business and other uses.

Areas where bike accidents most commonly occur also tend to be near intersections. These areas tend to be dangerous for cyclists, especially in urban areas, where there are more frequent instances of distracted driving.

Additionally, downtown Lexington has many one-way roads, and bike lanes are largely unprotected from motor traffic.

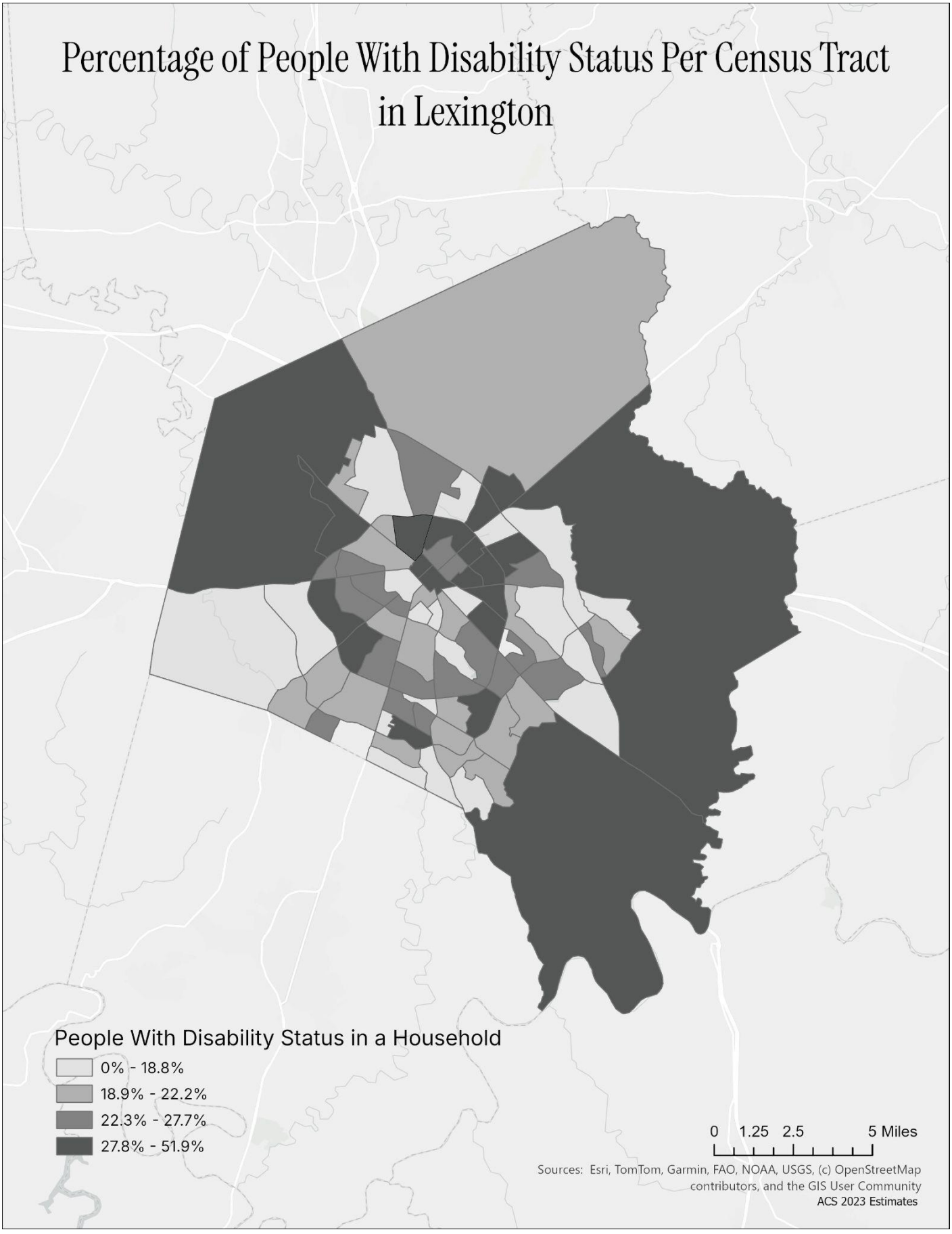
Based on the data, it is clear that Main street is one of the most dangerous areas for cyclists in Lexington, as well as pedestrians.



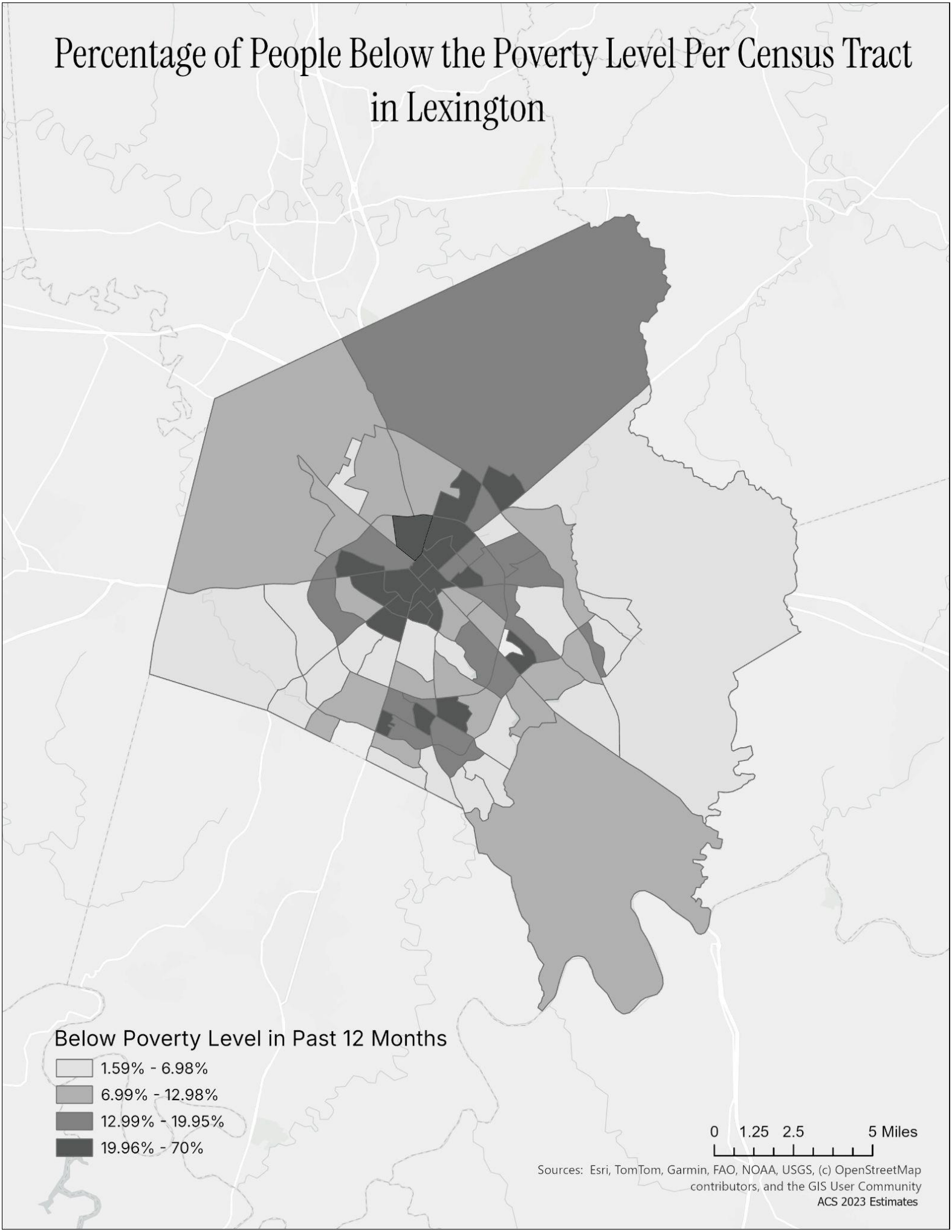
Map and Layout by Finn Haight

By Connor Hibbard

Disability and Transportation in Lexington

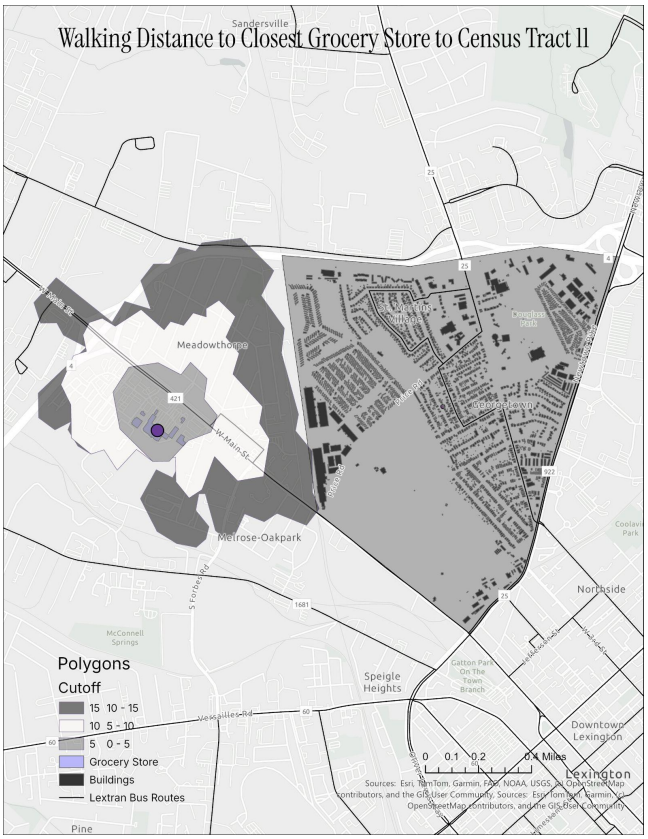


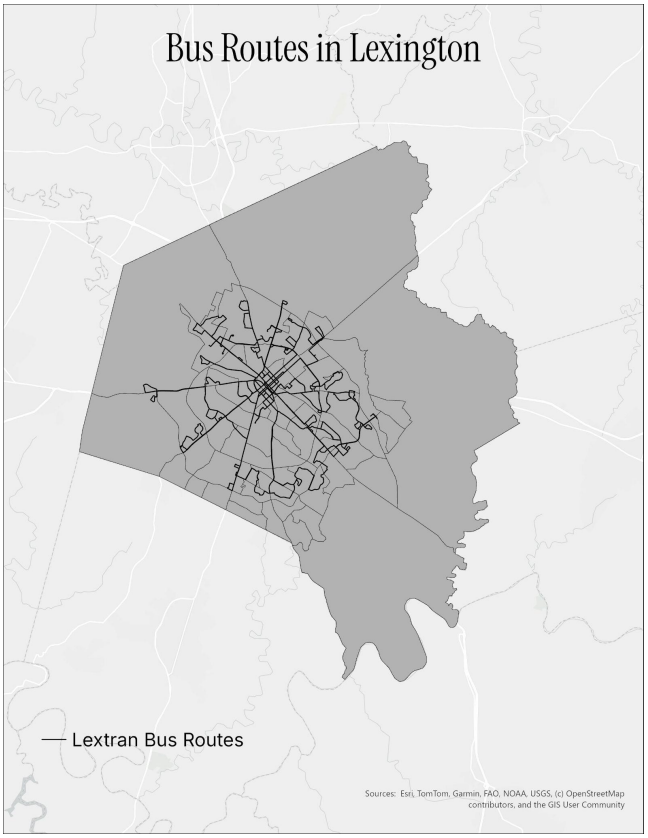
Percentage of People Below the Poverty Level Per Census Tract in Lexington



Census Tract 11

- Census tract 11 has some of the highest disability rate in the city with over 40% of the census tract having at least 1 disabled person in a household.
- It also has some of the highest poverty in Lexington with over 20% of the population being below the poverty line.
- The closest grocery store is over a 15 minute walk from census tract 11 with bus routes that go in roundabout ways to get there. Making getting to the grocery store hard for those that are disabled or without a car.



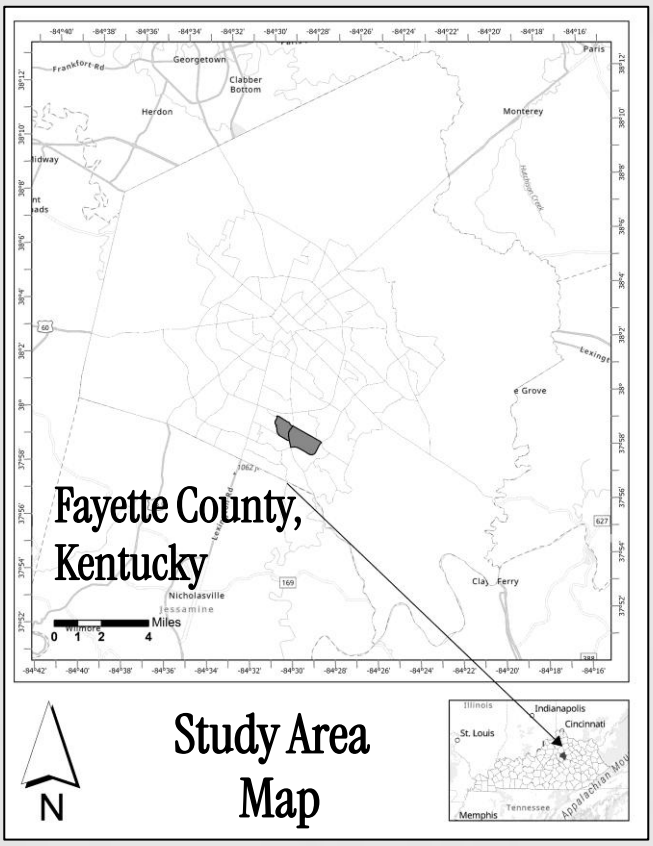


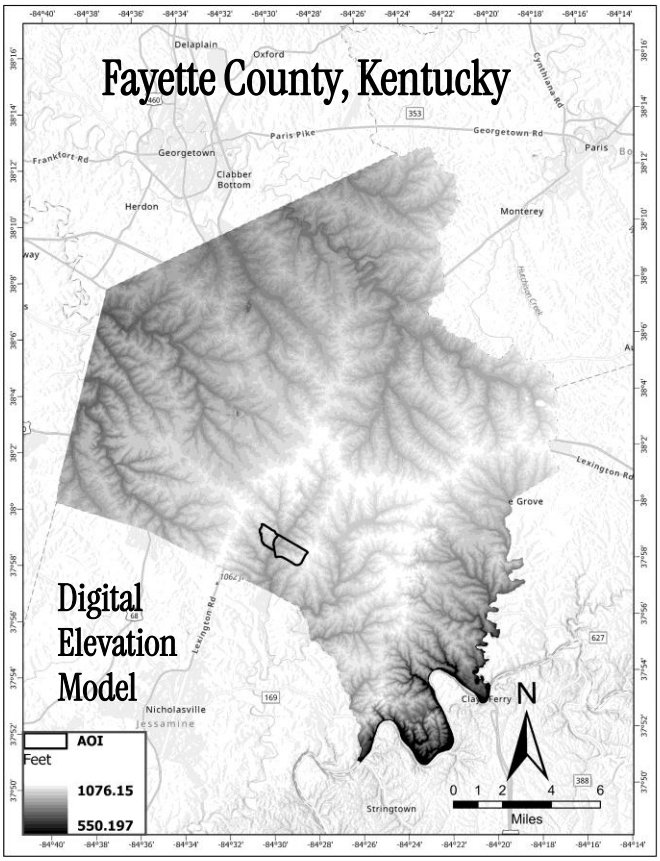
Stormwater Exposure and Building Risk Assessment Using GIS: A Case Study of Census Tracts 35.04 & 40.01

Prepared by K M Nafee

Stormwater exposure refers to the degree to which an area is subjected to potential stormwater accumulation or runoff. Because of having impermeable surfaces, depressions of land and other factors, water tends to accumulate more than the capacity of drainage. This leads to areas being flooded or having water quality related issues. The purpose of this project is to assess the stormwater exposure and building-level risk within two census tracts with the goal to support stormwater management planning.

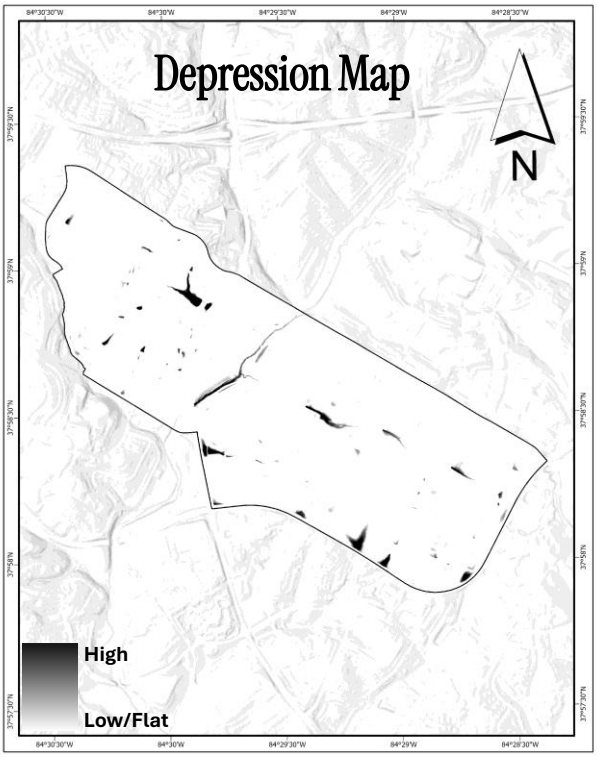
Census Tract 35.04 and 40.01 was selected as the study area for the project.

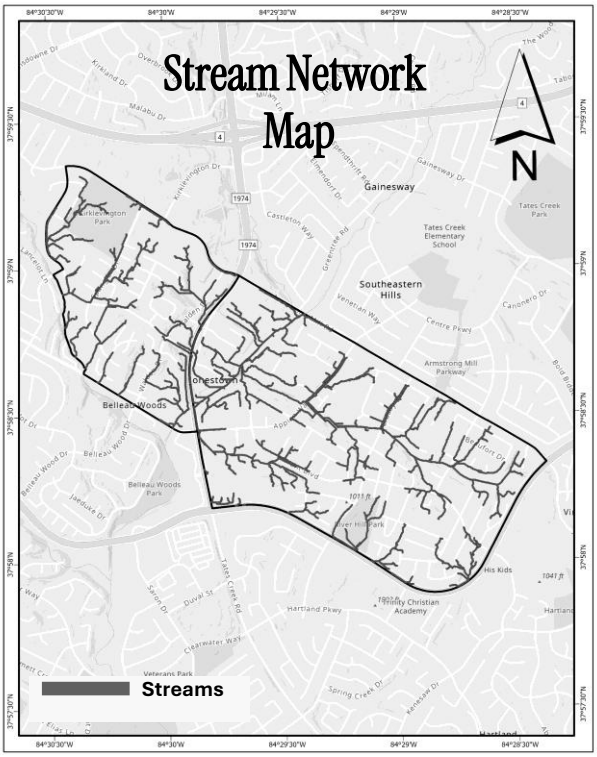


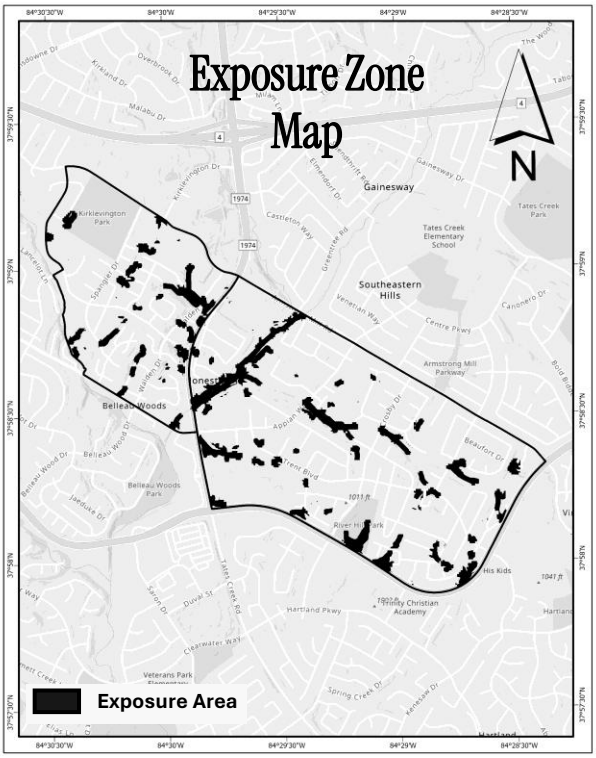


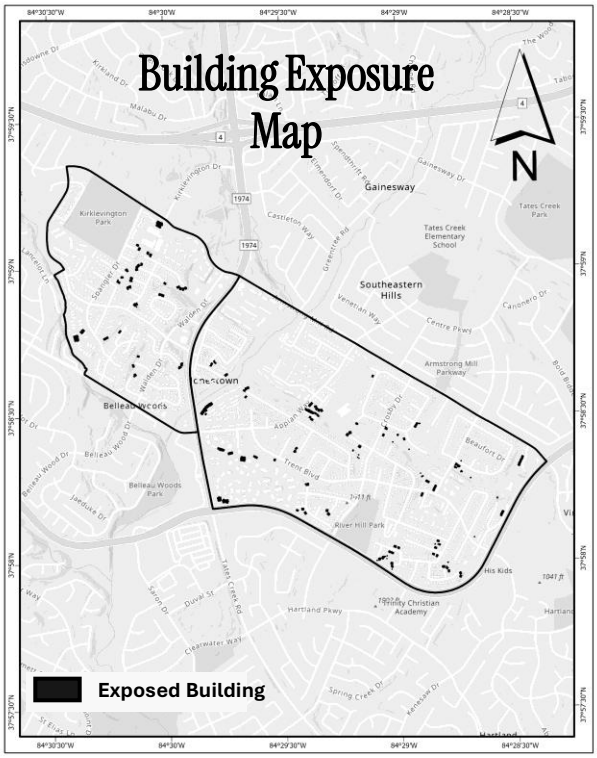
The neighborhoods within these census tracts has a combination of low, medium and high-income households.

The map on the left shows the digital elevation model (DEM) of Fayette county, Kentucky. The data was downloaded from *kyraster.ky.gov.* The lighter shades represents areas with higher elevation, and the darker ones shows lower elevation. The branching ridges and channels visible across the map helps to show how stormwater moves through the terrain. The DEM serves as the foundation for the next stages of analysis. The stream network and depression raster layers were extracted from the DEM using some hydrological tools in Arc GIS Pro.









The depression map shows that most parts of the area have little to no ponding potential, meaning water is generally able to drain away. However, a few spots especially those close to creeks and stream corridors show deeper depressions where stormwater is more likely to collect. The stream network map highlights the pathways that stormwater tends to follow as it moves across the landscape. Additional derived datasets from these two variables were generated using Euclidian distance and Reclassification. Overlaying these newly generated data, an exposure map was created to show where stormwater is most likely to accumulate. The results indicate that areas near West Hickman Creek, Walden Drive, Tates Creek Road, Appian Way, and Crosby Drive face higher stormwater exposure compared to surrounding neighborhoods.

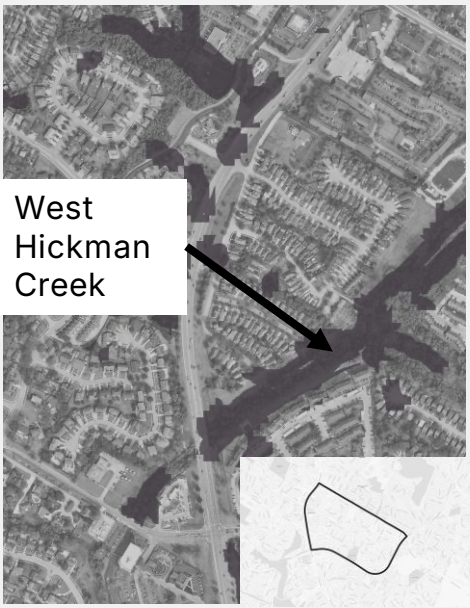
Out of roughly 3,100 buildings in the census tract, 145 are located in areas where stormwater is likely to collect or flow. This doesn't mean these buildings will be damaged. It simply means they sit in places that are more vulnerable to stormwater influence. The remaining 2,985 buildings fall outside these zones. The point out some of the specific places where exposure occurs. Areas around Kirkevington Park, West Hickman Creek, Tatesbrook Drive, Appian Way, and Crown Circle show examples of buildings and streets that intersect with these stormwater-prone zones. Looking at these locations helps illustrate how natural drainage paths and low-lying terrain shape patterns of exposure across the community.

The neighborhoods within the census tracts studied for this project include a mix of low-, medium-, and high-income households, which means stormwater exposure does not affect all residents in the same way. In areas where resources may already be limited, even the possibility of stormwater influence can add additional stress or risk. Understanding who lives in these exposed zones will help highlight the uneven ways environmental conditions can overlap with social and economic realities

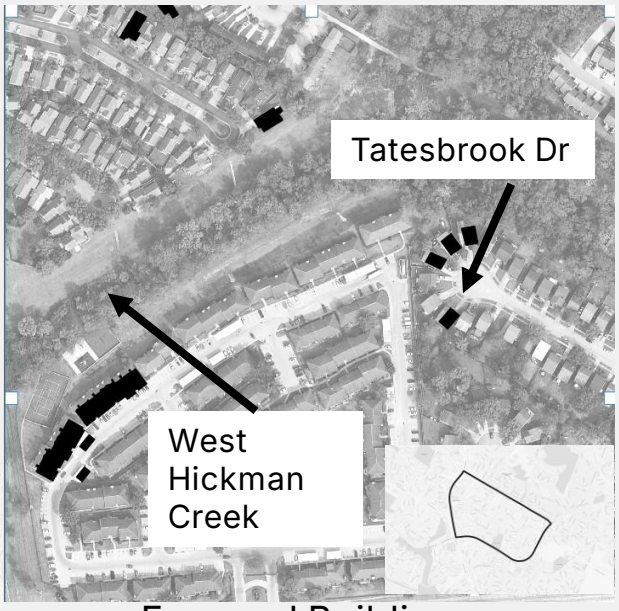
Class	Building Count
Exposed	145
Unexposed	2985

Census Tract	Building Count
35.04	37
40.01	108

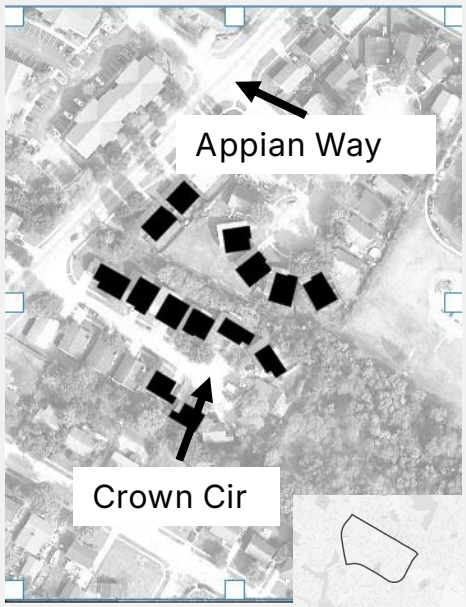
Exposed Zones
(Census Tract 35.04)



Exposed Zones
(Census Tract 40.01)

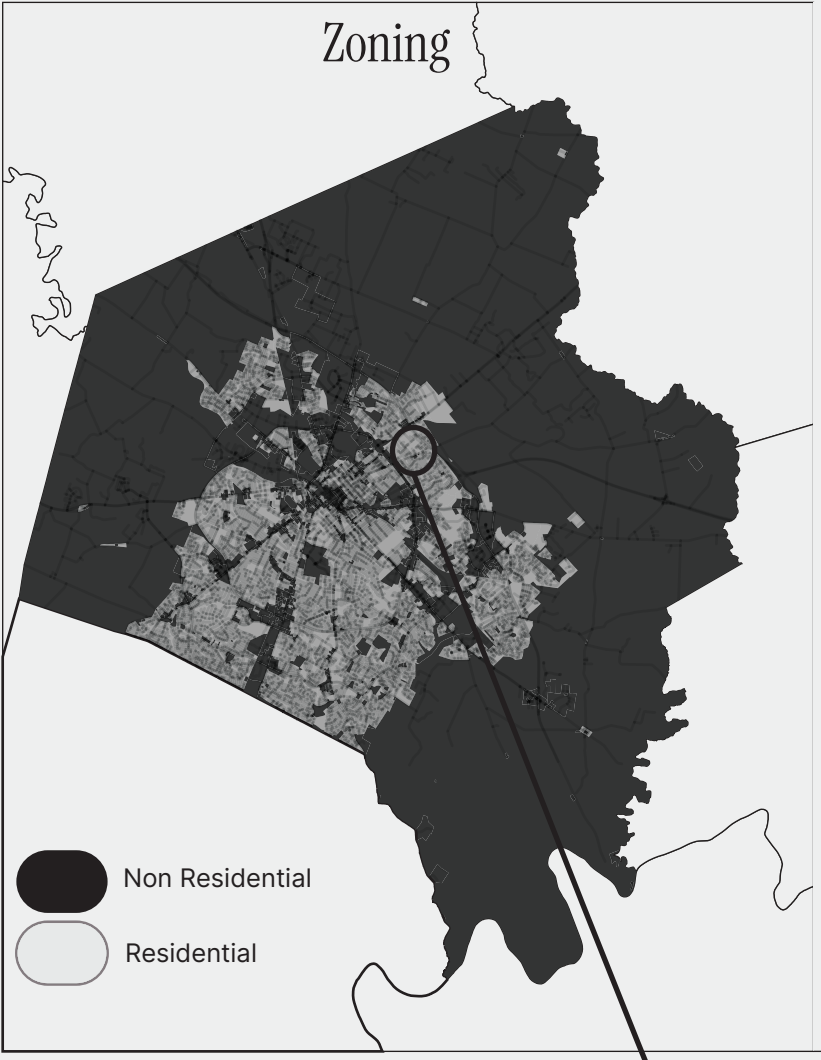


Exposed Buildings
(Census Tract 40.01)

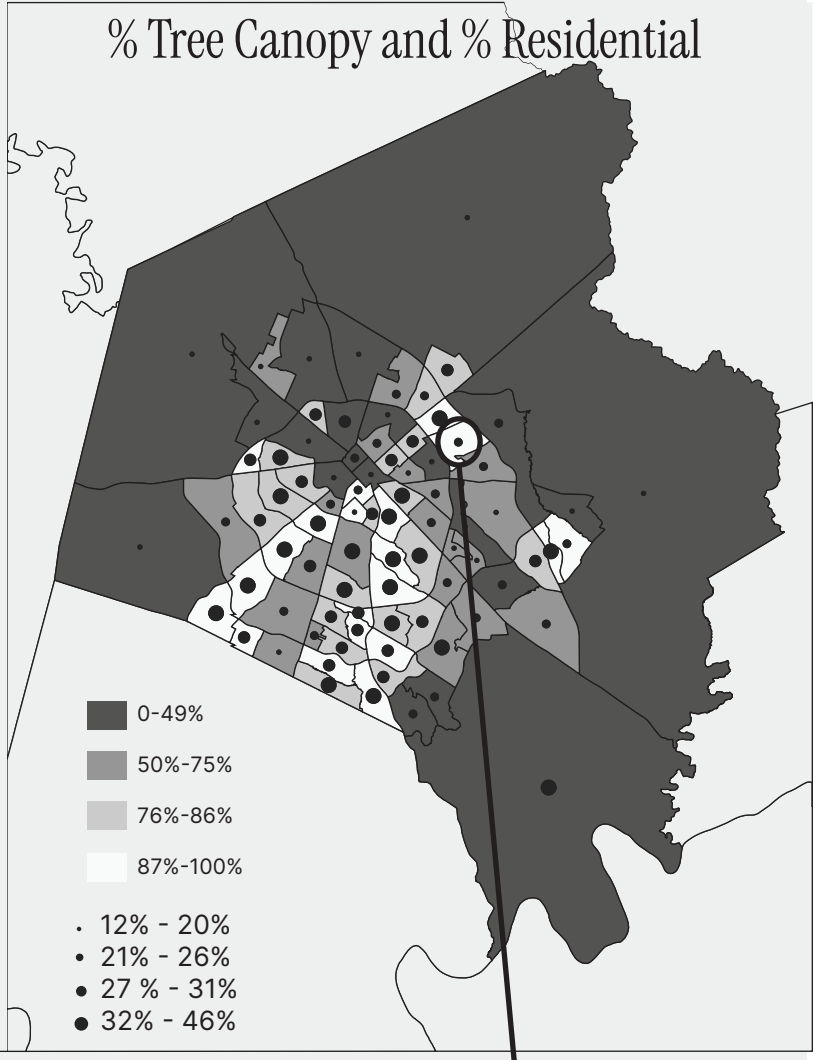


Exposed Buildings
(Census Tract 40.01)

Zoning



% Tree Canopy and % Residential



This map displays the relationship between tree canopy and what percentage of Fayette County Census Tracts are zoned residential.

This map displays zoning split into Residential and Non-Residential

Census Tract 32.02
Tree Canopy:
88% Residential
Median income: 46185 +/- 9234
22% Tree Canopy

Charles Petty
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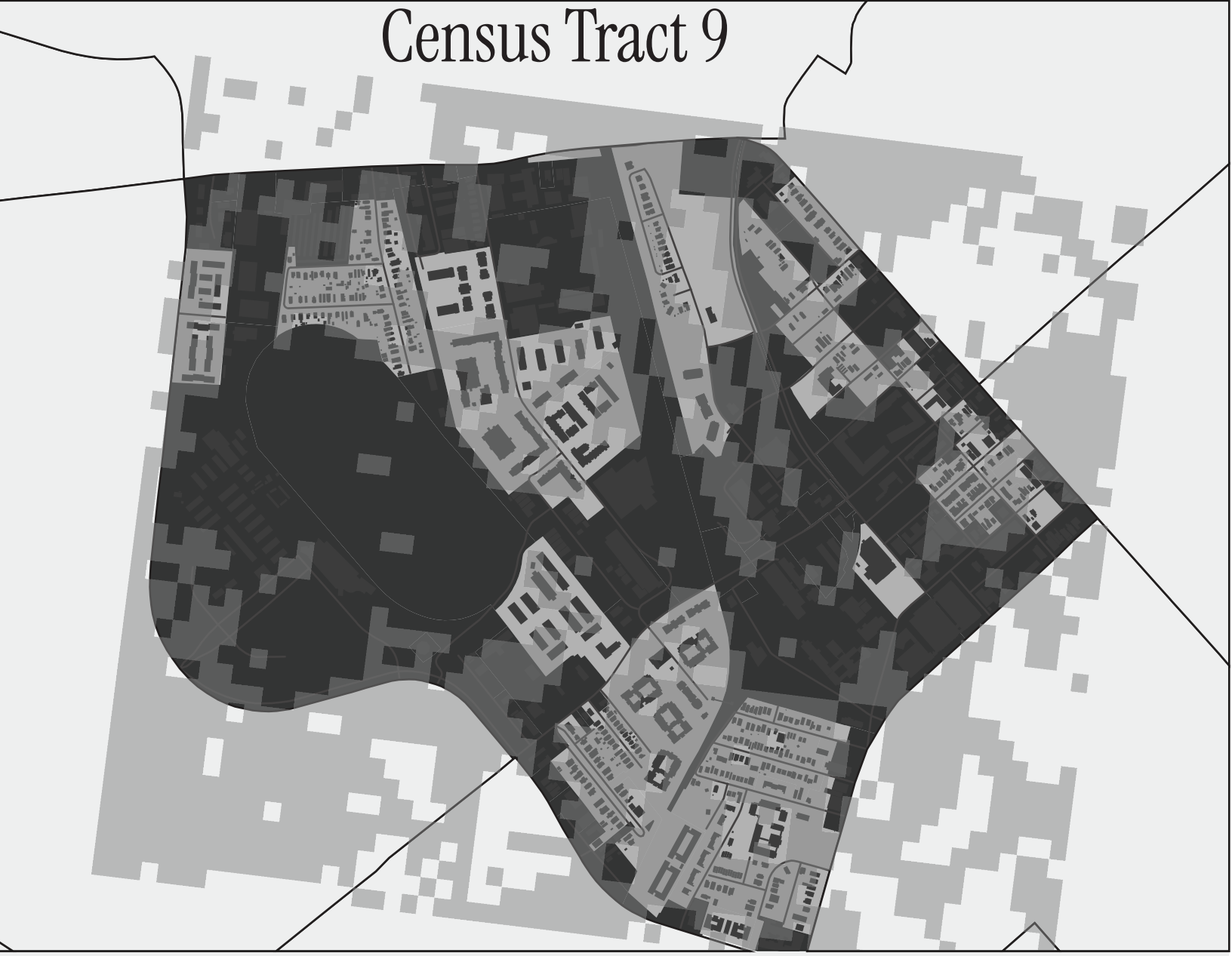
Census Tract 9



Non Residential

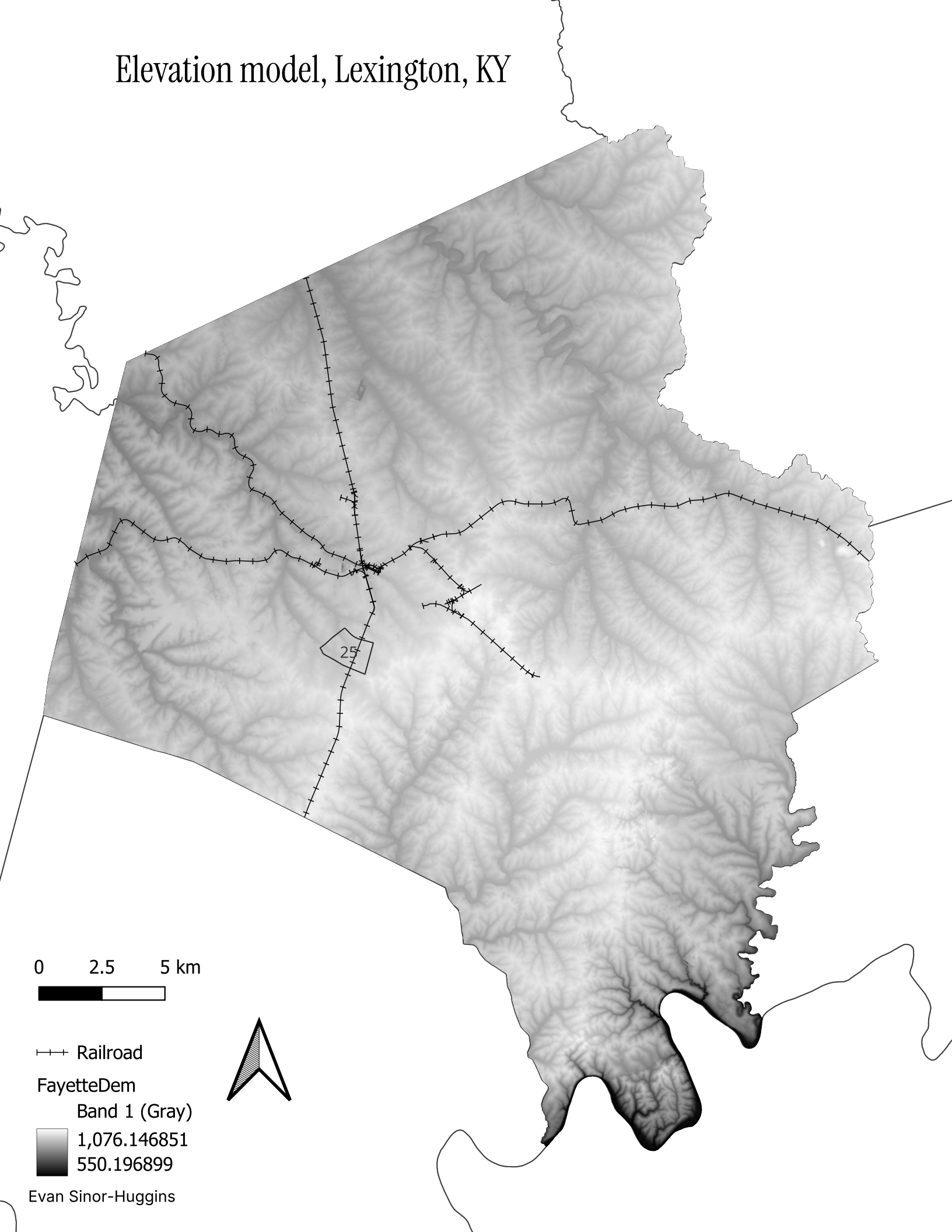
Residential

Census Tract 9 is located in the east of Lexington near Red Mile and Rupp arena It is categorized by being primarily Non Residential. An intresting thing to look at is how tree canopy is most present in residentially zoned areas.

Below are the minimum tree canopy requirments for Lexington per the zoning ordiance.

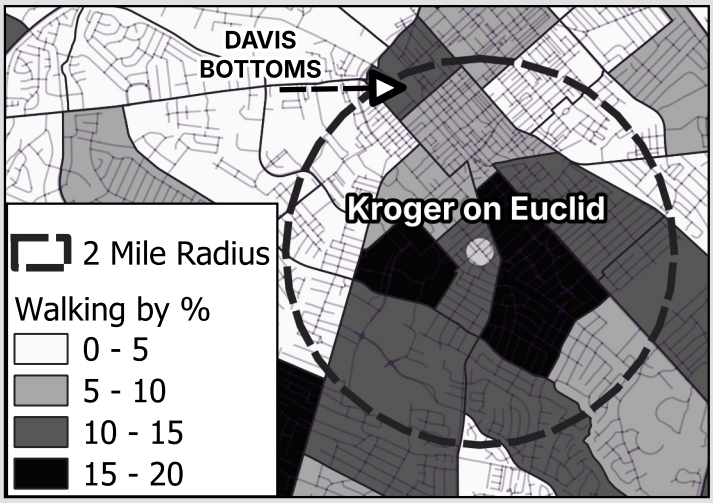
Residential	30%
Non-Residential	0-20%

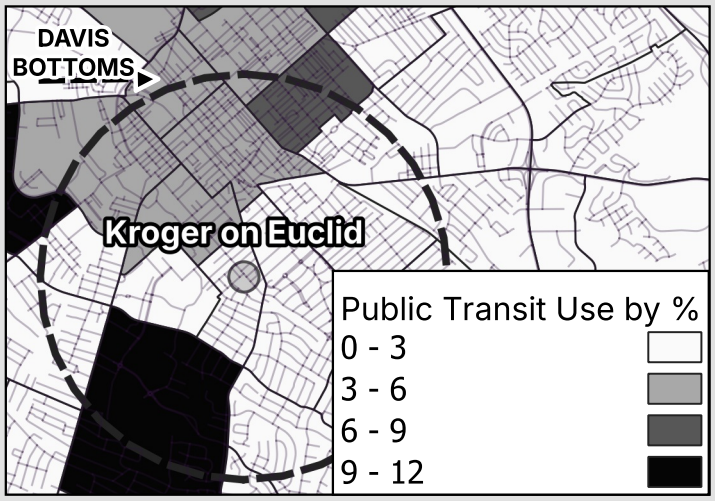
Elevation model, Lexington, KY



Low lying properties to the west of the railroad tracks displayed have been designated as flood prone by city officials, yet land to the east of the tracks have been spared the same designation. Despite this discrepancy, the elevation of properties to the east of the tracks is comperable to that of those within the flood prone designation. To the east of the tracks, elevation steadily increases with the distance of a given property from the tracks. This relationship may serve as a factor in the culmination of the variety in property values relative to the tracks seen in the map. Counter to intuitition, the amount of water basins meant to deter flooding increase with distace to the tracks. Therefore, more basins are located at higher elevations than lower. This may worsen flood risks to the homes east of the tracks.

Socioeconomic Conditions and Food Access in Davis Bottoms



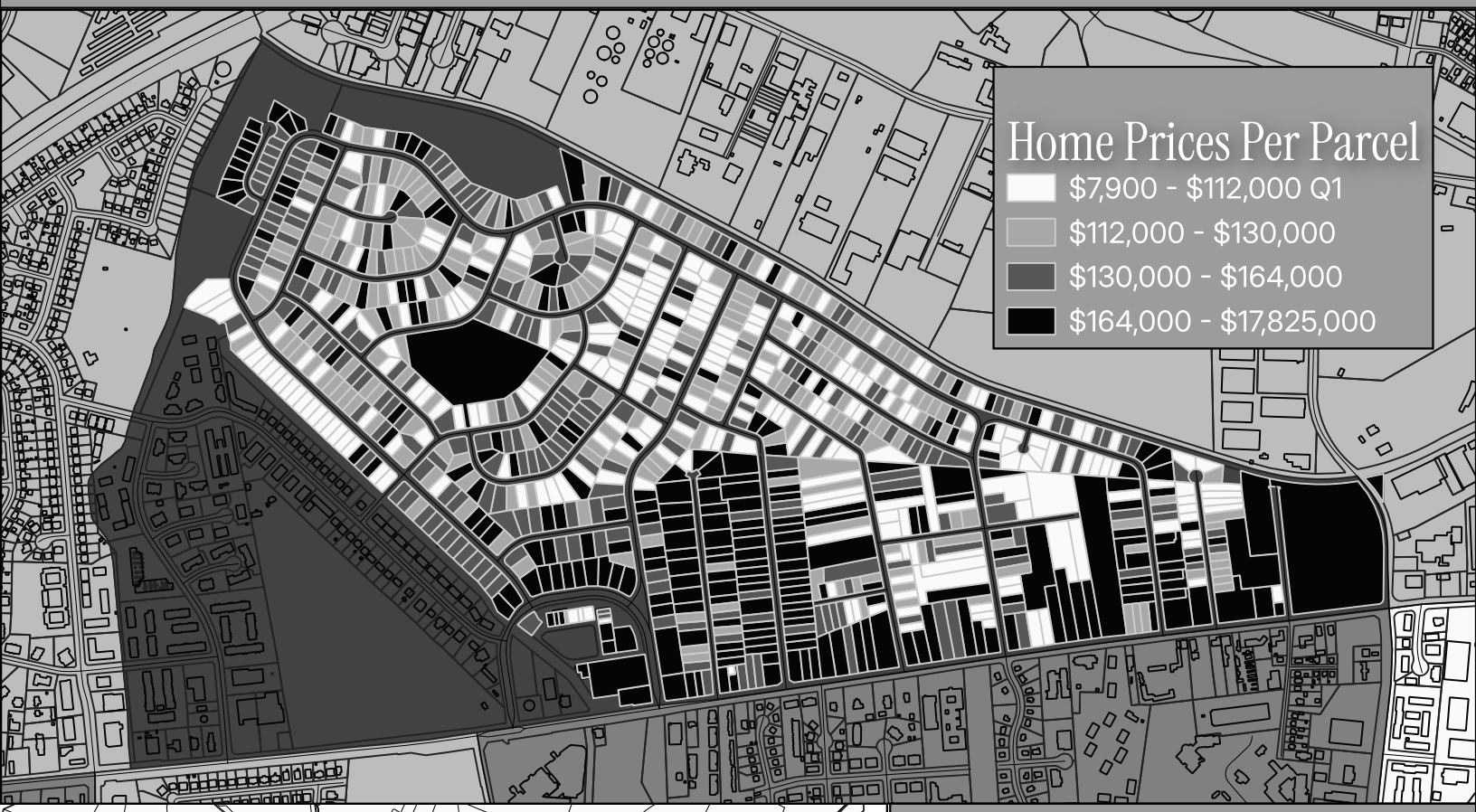


Davis Bottoms has long been one of Lexington's most historically disadvantaged neighborhoods. The area developed on low lying land that wealthier residents avoided, and its residents have faced decades of underinvestment, limited infrastructure, and persistent socioeconomic barriers. These conditions create environments where access to healthy food is often limited.

Neighborhoods with lower socioeconomic status, including Davis Bottoms, are more likely to experience food deserts, where full service grocery stores are farther away and fewer affordable options are available. These maps show how Davis Bottoms fits within broader county wide socioeconomic patterns and how local conditions relate to food access in surrounding tracts.

LFUCG Street Centerline; CDC SVI 2022; ACS 2024; OSM:
SegergatedLexington - https://www.segregatedlexington.com/
Projection: EPSG: 2891 - NAD83(HARN) / Kentucky North
Created by: Tristan Taylor for GEO509 -20256

Cardinal Valley Home Prices



These two maps show the Home Prices of Lexington and Cardinal Valley. Map at the top shows Home prices per parcel ranging from $7,900 to $1,782,480. Homes closer to Versailles Road were cheaper. The map at the bottom is percentages of home prices per census tract of all of Lexington, Kentucky. Home Prices for each census tract is mostly mixed, but that northen part of Lexington have lower home Prices. The data I used is from the Census Bureau, PVA Fayette County, and Lexington's Data Hub.

Home Prices between $150,000 to $174,000

- 0.0% - 3.0%
- 3.0% - 8.2%
- 8.2% - 14.3%
- 14.3% - 22.6%
- 22.6% - 30.9%

ACS 2023 5 year estimates