CLEVELAND

Climate Resilience & Urban Opportunity Plan

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IN PARTNERSHIP WITH:

City of Cleveland, Mayor's Office of Sustainability
Cleveland Urban Design Collaborative
University at Buffalo
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1. EXECUTIVE SUMMARY

Cleveland, Ohio is taking an asset-based approach to planning for climate change. Some of the local assets we're building on include:

- A robust network of community development corporations that help to shape development efforts at the neighborhood level and public policies citywide.
- A dedicated team of neighborhood climate ambassadors to lead community outreach and engagement efforts.
- Established partnerships with the city, the county, the regional sewer district, faith-based institutions, and other non-profit organizations in advancing neighborhood-scale climate adaptation strategies.
- Extensive weatherization and energy efficiency programs–Cleveland has one of the earliest and most effective home weatherization programs in the country.
- A large inventory of vacant land (much of which is held in city and county land banks) that can be used to help buffer residents from the adverse impacts of climate change, while fostering more sustainable and resilient development in the future.

For Cleveland residents, adapting to the effects of climate change will require specific interventions that respond to our unique challenges. Temperatures in Cleveland are rising faster than in other Great Lakes cities, and the city is facing increased flooding risks and storms of greater frequency and intensity. Cleveland also has existing land use patterns and social conditions that exacerbate the adverse effects of climate change, particularly for low-income neighborhoods and communities of color.

Cleveland Neighborhood Progress, the Cleveland Urban Design Collaborative, and the University at Buffalo worked with a broad range of community stakeholders to complete this plan. The proposed projects, programs, policies, engagement strategies, and research recommended in the plan will help to lessen overall demand for energy, anticipate and prepare for climate changes, and foster social cohesion. The plan includes a detailed assessment of the anticipated effects of climate change in the Midwest, along with mapping and analysis of Cleveland's most vulnerable neighborhoods.

The plan builds on current local efforts to address the impacts of climate change, including *the Cleveland Climate Action Plan* (CAP), *Neighborhood Climate Action Toolkit,* and *Cleveland Climate Action Fund*. The plan also advances the recommendations of existing neighborhood plans, the city's *Complete & Green Streets* ordinance, and the *Re-imagining a More Sustainable Cleveland* framework for vacant land reuse. It also aligns closely with the on-going efforts of the Northeast Ohio Regional Sewer District to manage stormwater and reduce combined sewer overflows into Lake Erie.

The plan advocates for the implementation of innovative, community-driven strategies. We will continue to work closely with community development corporations in four target neighborhoods to coordinate community engagement and outreach efforts. Our goal is to empower a cohort of Neighborhood Climate Ambassadors to organize residents and help neighborhood-based grassroots organizations capitalize on funding opportunities made available through the Kresge Foundation, the City of Cleveland's Climate Action Fund, and the George Gund Foundation. The plan organizes the strategies generated from Ambassador-led community meetings by the specific outcomes these ideas are intended to achieve—particularly, reducing flooding and heat-related mortality, and addressing rising utility costs and anticipated energy shortages. Through strategies detailed in this plan, Cleveland and its residents will be better prepared to withstand the impacts of climate change.

2. OVERVIEW

Climate change has different implications in the Great Lakes region than along the coasts. Instead of dealing with sea level rise, we face higher temperatures and more high heat days. According to the Great Lakes Integrated Sciences and Assessments Program (GLISA), temperatures are rising three times faster in Cleveland than elsewhere in the US. We also face an increased number of heat waves, increased flooding risks, and storms of greater frequency and intensity.

Cleveland has social conditions and land use patterns that may exacerbate the adverse effects of climate change. At the regional level, sprawling development without population growth has led to concentrated poverty in core city neighborhoods, redundant infrastructure, an increase in impervious surfaces, and growing economic and racial segregation. Climate-related challenges will not be experienced uniformly across the city and region. Topography, tree cover, development patterns, and social factors lead to geographically specific vulnerabilities, documented in the maps in Appendix E.

TARGET NEIGHBORHOODS In this plan, we focus on four neighborhoods that are representative of conditions found in Cleveland and other Great Lakes cities:

- *Slavic Village:* As the neighborhood at the epicenter of Cleveland's foreclosure crisis, Slavic Village has many vacant houses and vacant lots, along with a high concentration of low-income households. Neighborhood assets include excellent transit and bike infrastructure and on-going programming that promote active lifestyles.
- *Central-Kinsman:* Perhaps the most distressed neighborhood in the city, Central-Kinsman has a high poverty rate; many abandoned buildings, vacant sites, and brownfields; and a sparse tree canopy. The neighborhood is home to one of the city's two eco-districts. It has a strong community development corporation with innovative programs to increase food access/food security and reduce public health disparities. The Cuyahoga Metropolitan Housing Authority has made significant upgrades to public housing in the neighborhood in recent years.
- *Glenville:* This neighborhood has some of the oldest housing in the city, including grand mansions, multi-family buildings, and small houses, along with pockets of new residential development. The neighborhood has highly engaged residents who meet at regularly scheduled Network Nights in order to advance local projects and address emerging concerns.
- *Detroit-Shoreway:* This neighborhood is economically diverse, including some of the poorest and most affluent households in the city. It has excellent transit access and a thriving cultural district. It is home to the city's other (and original) eco-district.

PLANNING APPROACH Our planning approach integrates local knowledge and community-based ideas with scientific expertise to help determine where programs and interventions will be most effective in combatting the adverse impacts of climate variability. Under the leadership of Cleveland Neighborhood Progress, four community development corporations each recruited four residents as neighborhood climate ambassadors. Four at-large climate ambassadors were also recruited to help extend this planning process beyond the four target neighborhoods.

The climate ambassadors received training in basic climate science and mitigation/adaptation strategies (see www.youtube.com/watch?v=EuJRkPXaKdY). They then served as resources throughout the planning process, recruiting participants for community workshops and helping to identify and prioritize ideas for projects, programs, policies, and future research that would help advance climate resiliency at the neighborhood scale.

RESEARCH Scientists from Kent State University (KSU), the University at Buffalo (UB), and the University of Michigan's Great Lakes Integrated Sciences + Assessments Center (GLISA) developed training materials for the climate ambassadors and conducted research as follows:

Historical Climatology (Appendix D) The climatology review prepared by GLISA documents the changes underway in Cleveland, including:

- *Rising average temperatures:* Annual average temperatures warmed by 2.4°F from 1956-2012, faster than the national and global rates. Average low temperatures have warmed faster than high temperatures.
- *Longer freeze-free season:* The freeze-free season (growing season), lengthened by 20 days from 1956-2012.
- *More precipitation:* Total annual precipitation increased steeply by 25.8% from 1956 through 2012, while summer precipitation remained relatively unchanged.
- *Heavier precipitation:* From the 1961-1990 period to the 1991-2010 period, the amount of precipitation falling during the heaviest 1% of precipitation events increased by 22.2%.

Of particular concern is the increase in heavy precipitation. A "very heavy" precipitation day, as defined by the National Climate Assessment, is in the top 1% of daily precipitation totals. These precipitation events are typically disruptive and can cause infrastructure damage. Cleveland has seen a 16.3% increase in heavy precipitation events. The cumulative change in the precipitation falling during these events was 22.2%. Another key finding is that the freeze-free season (growing season) lengthened by 20 days from 1956-2012. The average date of first freeze is arriving 9.4 days later and the average date of last freeze is arriving 10.6 days earlier.

Mortality Rates (Appendix F) Extreme weather threatens human life. Dr. Scott Sheridan (KSU) looked at mortality rates in the Cleveland/Cuyahoga County for the overall population and for demographic subsets of the population based on gender, age, and race. Overall mortality increases in the event of high heat days, with the most immediately observable impacts in cardiovascular-related mortality and those 75 and older, regardless of sex or race. Within these categories, there is a sharper increase in black mortality than white, and slightly higher for men than women. Looking at a 14-day period, in which the impacts are assessed in aggregate, a generally similar pattern is observed, although results are broader and more intense. The relative risk is greatest for cardiovascular and respiratory mortality. A greater risk is observed for blacks than whites, while across age and sex differences are minimal.

In cold weather, more mixed results emerge. Typically the most negative impacts are not immediately observed, but rather are observed several days to two weeks later, most notably with increases in respiratory diseases. For 14-day cumulative results, increases in mortality are observed in overall mortality. Blacks and whites, and males and females, are equally affected. Cardiovascular and respiratory mortality are greater than deaths from other causes. Those 75 and older are more affected than younger people.

Urban Heat Island and Land Cover Analysis (Appendix G) Dr. Pravin Bhiwapurkar (KSU) analyzed urban heat island effects and land cover in the four target neighborhoods of Slavic Village, Kinsman, Glenville, and Detroit Shoreway. Strategies to adapt for a changing urban climate are summarized at the following scales:

House and parcel-scale recommendations:

1. Use light colored shingles or paint roofs white to increase roof albedo values.
2. Increase insulation, especially in attics, and improve air tightness of buildings.
3. Promote natural ventilation during warm weather using operable windows.
4. Replace existing windows with energy-efficient windows.

5. Plant shade trees, shrubs, and vines on the west and southwest sides of the house; solar friendly deciduous trees to shade the east; an open understory to allow penetration of cool breezes; and evergreens to the northwest and west for protection from winter winds.
6. Shade air conditioners or place them on the north side of a building where feasible.
7. Reduce impervious surfaces.
8. Promote onsite green infrastructure strategies such as rain gardens, bioswales, water-smart gardening, and urban agriculture.

Neighborhood-scale recommendations:

1. Remove unneeded impervious surfaces, such as abandoned parking lots.
2. Maintain/expand existing tree canopy by providing funding and training for residents
3. Propose greening strategies for vacant land, like stormwater retention or urban farming, in locations where market demand for traditional real estate development is limited.

Urban-scale recommendations

1. Consolidate vacant parcels for urban forests and other green space uses, since larger green spaces offer a greater range of benefits than small, scattered-site greening efforts.
2. Concentrate greening efforts in neighborhoods where existing tree canopy is minimal; and in headwaters areas to capture stormwater runoff and improve water quality.
3. A variety of urban greening approaches should be considered. For example, large industrial properties provide opportunities for green roofs. Parking lots are suitable for green infrastructure. Transportation networks allow for increased street tree density and canopy cover. A diverse range of greening efforts improve the health of urban ecosystems and offer economic and social benefits.

Additional Research The team identified at least three additional studies that would be helpful for local climate change planning efforts. We plan to engage the university network formed through this initiative (Kent State University, University at Buffalo, University of Michigan) to pursue external funding for research that is targeted to local needs.

1. *Parcel-Level Vulnerability:* It may be possible to combine data from state and county sources, along with a survey of city residents, to map parcel-level vulnerability to climate impacts. The results would be helpful for targeting programs and outreach efforts, supporting first responders during extreme weather events, and coordinating demolition of abandoned houses. We are currently developing a proposal to the National Oceanic and Atmospheric Administration, and will also explore funding from Homeland Security, Health and Human Services, and the National Institutes of Health.
2. *Neighborhood Weather Stations:* While data gathered at the three airport weather stations begins to show how the urban heat island effect may impact Cleveland as a whole, additional weather stations in each of Cleveland's neighborhoods would provide temperature and precipitation data that could be analyzed against land cover maps to determine relationships among variables like land use, population density, and distance to Lake Erie. Potential funding sources include local foundations, the National Science Foundation, Health and Human Services, the National Oceanic and Atmospheric Administration, and the Environmental Protection Agency.
3. *Temperature in Weatherized Homes:* Investigating thermal environmental conditions in homes pre- and post-weatherization will help determine how insulation affects interior temperature and moisture levels, and reduces associated illnesses like hypertension and asthma. Potential funding sources include local foundations, University Hospitals, the Cleveland Clinic, Health and Human Services, and the National Institutes of Health.

3. CLIMATE CHANGE in CLEVELAND and the GREAT LAKES

Based on peer-reviewed scientific literature, climate projections, and assessments conducted for the U.S. Global Change Research Program (compiled in Appendix C), Cleveland can expect physical changes in temperature, precipitation, and extreme weather events, including:

- *Increased Temperatures:* From 1956 to 2012, the average annual temperature in Cleveland increased by 2.4°F. By 2070, the average annual temperature may warm by an additional 4°F. These higher temperatures will increase the number of heat-related deaths, reduce water quality in Lake Erie, strain food systems, degrade air quality, and put pressure on native plants and animals.
- *Changes in Precipitation:* From 1956 to 2012, the average annual precipitation in Cleveland increased by 25.8%. During the fall, the increase was greater at 57.4%. Heavy rain and lake effect snow are expected to increase. This may cause flooding, combined sewer overflows, a reduction in river and stream quality, and higher maintenance costs.
- *Extreme Weather Events:* Weather-related threats in Northeastern Ohio include severe storms, flooding, lake effect snow, tornadoes, temperature extremes, and erosion/landslides. A warming climate and decreasing ice cover on Lake Erie may cause an increase in the frequency and intensity of these extreme weather events, threatening human life and causing significant property damage.

These conditions may affect local sectors and systems, including:

- *Public Health:* Increased heat wave frequency and intensity, increased humidity, degraded air quality, reduced water quality, and change in vector borne disease patterns will increase public health risks.
- *Water Quality:* Climate change will exacerbate a range of risks to Lake Erie, including harmful algal blooms, an increased number of combined sewer overflows, and declining beach health.
- *Food Systems:* In the next few decades, longer growing seasons and rising carbon dioxide levels will increase yields of some crops, though those benefits will be progressively offset by extreme weather events. In the long term, climate change is expected to decrease agricultural productivity.
- *Forests and Land Cover:* The composition of forests is changing as the climate warms. Many tree species are shifting northward, with more southerly varieties replacing them. Many iconic tree species (e.g., Sugar Maple, Buckeye) will slowly be replaced by other species in the next century.
- *Energy:* Cleveland has an energy-intensive economy with per capita greenhouse gas emissions higher than the national average. The city has a lot of poor-quality housing, which increases household energy usage. Warmer temperatures will reduce building heating loads, but these gains may be offset by increased reliance on air-conditioning.
- *Transportation Systems:* Decline in ice cover will lengthen the commercial navigation season on Lake Erie. More freeze-thaw cycles, flooding, erosion, lake effect snow, and heat waves may cause significant damage to local transportation infrastructure.
- *Fish and Wildlife:* The effects of increased heat stress, flooding, drought, and late spring freezes on natural and developed ecosystems may be magnified by pest prevalence, increased competition from non-native or opportunistic native species, ecosystem disturbances, and land-use change.

4. DATA SOURCES

In an effort to identify specific areas of vulnerability in Cleveland, we mapped four physical factors and six social factors that research has shown to correlate closely with climate-related vulnerabilities. The four physical factors are:

1. Land coverage/impervious surface (Northeast Ohio Regional Sewer District; Cuyahoga County GreenPrint)
2. Land coverage/tree canopy (Cuyahoga County GreenPrint)
3. Buildings constructed before 1939 (Cuyahoga County Auditor's Office)
4. Flood zones (Federal Emergency Management Administration)

Areas with a high percentage of impervious surfaces and a sparse tree canopy are especially at risk during heat waves. Households in these areas may also experience higher energy bills on an on-going basis. Older housing is less likely to have air conditioning and less likely to be energy-efficient in both hot and cold weather.

Houses in flood zones are more likely to experience basement flooding and mold growth. However, the FEMA-designated flood zones within the city of Cleveland are not extensive because many creeks and streams were filled in or contained in culverts during the city's peak periods of development. Many parts of the city experience flooding problems, but this is not adequately reflected in the flood zone maps. Additional data needs on physical conditions include:

- Houses and streets in Cleveland most prone to flooding (determined by surveying residents city-wide or targeted to areas where the city receives frequent complaints)
- Insurance claim data at the parcel level (LexisNexis/Comprehensive Loss Underwriting Exchange database)
- Historical alignments of creeks and streams and locations of existing culverts (Cuyahoga County Planning Commission, historical maps and atlases)

The six social factors we chose to represent climate-related vulnerability are:

1. Residents without a high school diploma
2. Residents over age 65
3. Non-white residents
4. Households below poverty level
5. Living in rental property
6. Households without a vehicle

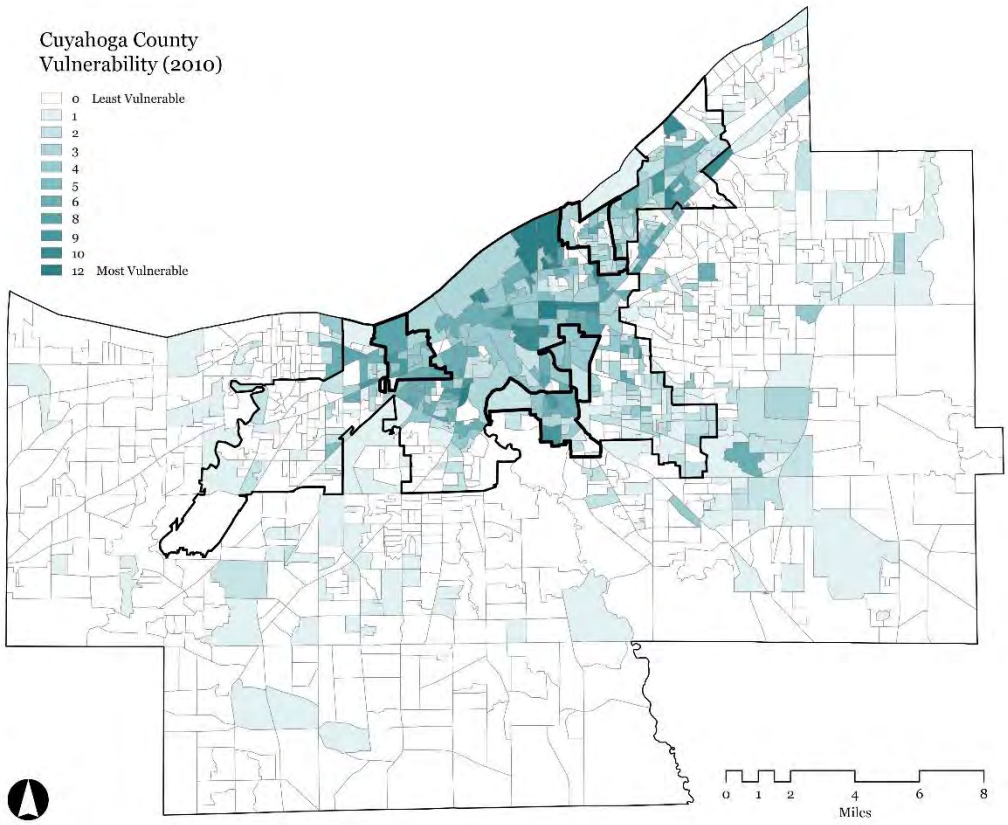
The 2010 US Census and Northeast Ohio Community and Neighborhood Data for Organizing (NEO CANDO) were the sources for social data. Additional factors that may affect social vulnerability in Cleveland include:

- Walkability/bikeability/transit connectivity of city neighborhoods as a measure of access (using Walk Score®, Bike Score®, and Transit Score® data)
- Average housing tenure as a measure of neighborhood stability (US Census)
- Percentage of people living alone, cross-referenced with residents over 65 (US Census)

5. CLIMATE VULNERABILITY + ASSETS

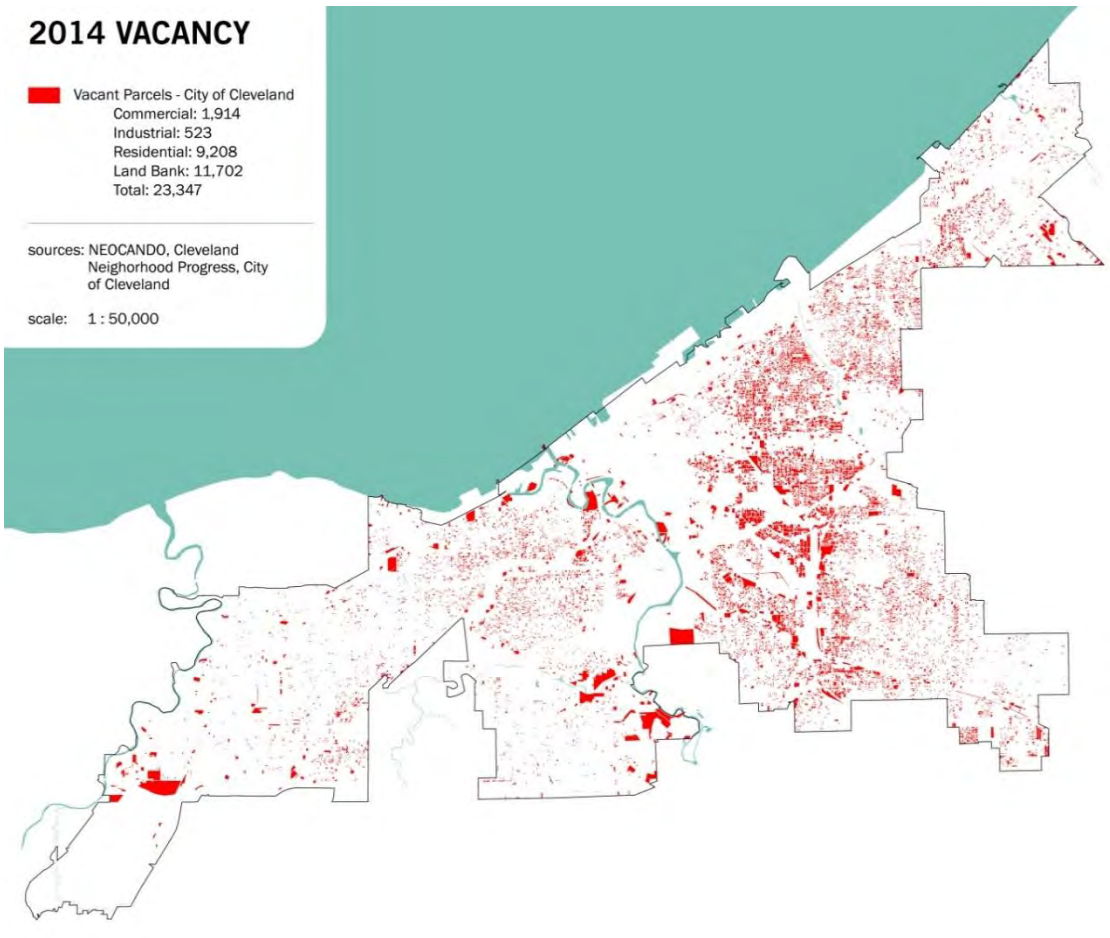
We investigated the geographical distribution of climate-related vulnerability to understand what strategies might be appropriate to increase resilience in each of the four neighborhoods. For example, mapping socio-economic variables that are known to increase vulnerability (e.g. income, housing age), against demographic variables (e.g. race, age), and physical variables (e.g. vegetation, flood zone), may provide a better understanding of what adaptation and resilience strategies to employ in each neighborhood. For instance, if socio-economic vulnerability is clustered in an area with low amounts of vegetation and high amounts of asphalt, an appropriate strategy might be to start a street tree-planting program to create jobs and shade pavement that contributes to the urban heat island effect. If these areas also have low levels of car ownership, solutions might point to increasing public transportation and opening cooling centers during extreme heat events. These combined social and physical approaches to building resilience in the City of Cleveland can complement other efforts by planners and emergency managers at the county- and city-level.

The matrix and maps (Appendix E) display correlations among six social variables and four physical variables that are known to increase vulnerability to climate change. These variables were adopted after a review of the vulnerability and environmental health science literature. They are also directly related to the expected impacts of climate change for Cleveland (Appendix D) and the temperature-related mortality analysis (Appendix F). Although we continue to refine the maps, preliminary results indicate that the four neighborhoods we are working with are more vulnerable to the effects of climate change when compared to the other neighborhoods of Cleveland and the suburbs of Cuyahoga County. However, each neighborhood has different factors that contribute to the vulnerability; we plan to use additional statistical analyses to unpack these data.



Although Cleveland neighborhoods have a higher degree of vulnerability than surrounding suburban jurisdictions, the city also has important assets, including:

- A robust network of community development corporations.
- A dedicated team of neighborhood climate ambassadors to lead community outreach and engagement efforts.
- Established partnerships with the city, the county, the regional sewer district, faith-based institutions, and other non-profit organizations in advancing neighborhood scale climate adaptation strategies.
- Weatherization programs–Cleveland has one of the earliest and most effective home weatherization programs in the country. Environmental Health Watch, a Cleveland-based non-profit, launched a Healthy Homes initiative in 1980, which is a model for similar programs across the country. Cleveland is also re-starting the Cleveland Energy $aver program which helps residents save upwards of 30% on energy bills.
- A large inventory of vacant land (much of which is held in city and county land banks) that can be used to help buffer residents from the adverse impacts of climate change and foster more sustainable and resilient development in the future.



This plan is designed to leverage the city's assets, target resources to the neighborhoods most likely to be affected by the adverse impacts of climate change, and build on recent planning efforts in the city, as described in the next section. The next step in our mapping efforts will be to identify these assets geographically, and look for opportunities to incorporate them into city- and county-level planning efforts.

6. LOCAL EFFORTS to ADDRESS CLIMATE CHANGE

The *Cleveland Climate Resilience and Urban Opportunity Plan* was developed in close collaboration with the Mayor's Office of Sustainability to build on the *Cleveland Climate Action Plan* (CAP). The CAP, completed in September 2013, serves as primary implementation framework for the Sustainable Cleveland 2019 initiative (Appendix I). Since 2009, Mayor Frank G. Jackson has hosted the initiative with the vision to build a thriving green city on a blue lake by 2019, the 50th anniversary of the infamous Cuyahoga River fire. Each year leading up to 2019 represents a different "Celebration Year" for the following topics: Energy Efficiency, Local Foods, Advanced & Renewable Energy, Zero Waste, Clean Water, Sustainable Mobility, Green Space, Vital Neighborhoods, and Thriving People. The CAP integrates all Celebration Year topics, while expanding upon Sustainable Cleveland's existing structure for community engagement.

The Mayor's Office of Sustainability convened a 50-member Climate Action Advisory Committee with representatives of leading Cleveland organizations from the commercial, industrial, educational, government, and non-profit sectors to inform and create the CAP. The Committee prioritized 33 actions to reduce greenhouse gas (GHG) emissions 80% below a 2010 baseline by 2050. The CAP includes interim goals of 16% by 2020 and 40% by 2030. The actions are split into six focus areas:

1. Energy Efficiency and Green Building
2. Advanced and Renewable Energy
3. Sustainable Mobility
4. Waste Reduction and Resource Conservation
5. Land Use and Clean Water
6. Community Engagement and Public Health

PRIORITIES While reducing GHG emissions is a driving force for many of the city's climate change efforts, the CAP includes 13 actions that build resilience to the impacts of climate change. Examples where implementation has already begun include:

- *Action 1:* Support programs and policies to retrofit residential buildings.
- *Action 8:* Increase distributed energy installations.
- *Action 20:* Make biking and walking easier and safer.
- *Action 27:* Develop and implement an urban tree plan to grow the canopy.
- *Action 29:* Implement green infrastructure to capture stormwater on-site.
- *Action 32:* Recognize capacity of neighborhoods and community groups to implement climate mitigation and adaptation initiatives.
- *Action 33:* Conduct climate change vulnerability assessment and integrate projected impacts into existing plans.

With funding from the World Wildlife Fund and the George Gund Foundation, the city and the advisory committee developed the *Neighborhood Climate Action Toolkit*, in partnership with community development corporations in the Kinsman, Glenville, and Detroit Shoreway neighborhoods. The toolkit is an asset-based approach that helps residents advance neighborhood priorities while also furthering Cleveland's climate action goals.

The toolkit is used to identify neighborhood-based projects and support their implementation through the *Cleveland Climate Action Fund,* which the Mayor's Office of Sustainability created with funding from Partners for Places, The Cleveland Foundation, and the George Gund

Foundation. In the last five months, climate action workshops were held in six neighborhoods. Thirteen neighborhood-led projects have been awarded grants over two grant rounds in 2015.

POLICIES and PROGRAMS The implementation framework provided by the CAP, the 50-member advisory committee, the toolkit, and the Climate Action Fund contribute substantively to the city's climate change efforts and help to ensure that policies and programs reflect the priorities of a diversity of residents. Areas of opportunity include:

1. Update of the Cleveland CAP in 2017 that reflects lessons learned from this initiative.
2. Integration of adaptation into the City Emergency Operations Plan and the Cuyahoga County All Hazards Mitigation Plan.
3. Establishment of policies related to land access and land banks.
4. Continued implementation of Cleveland's residential energy efficiency programs, including the Home Weatherization Assistance Program and Cleveland Energy $aver.

The Office of Sustainability plans to develop a more comprehensive protocol for integrating equity into sustainability planning and engaging citizenry in decision-making and self-determination. This protocol development is supported by ongoing participation in the Urban Sustainability Director's Network programs on integrating equity into urban sustainability.

NEIGHBORHOOD CLIMATE ACTION TOOLKIT PROTOCOL

Step	Tools
1. Learn about climate change & Cleveland Climate Action Plan	• Climate 101 and 102 Presentation • Climate Action Videos
2. Identify neighborhood assets and concerns; relate them to climate action	• Climate Action Visual Collages • Neighborhood Climate Action Case Studies • "I am Sustainable Cleveland" Poster Campaign • Neighborhood Carbon Footprint Calculator
3. Develop a Neighborhood Climate Action Project Idea	• Workshop Facilitator's Guide • Sustainable Cleveland website • Neighborhood Carbon Reduction Calculator
4. Implement a Neighborhood Climate Action Project	• Cleveland Climate Action Fund (www.clevelandclimateaction.org)

CLIMATE IMPACTS OF RECENT PLANNING RECOMMENDATIONS In addition to the CAP and Neighborhood Climate Action Toolkit, Cleveland has three recent plans that will also help neighborhoods adapt to climate change.

1. *Cleveland Tree Plan: Planting with Purpose* (Appendix M) builds on a recent urban tree canopy assessment and two grants the city recently received for targeted tree planting in five neighborhoods. The tree plan, to be completed in 2015, will articulate a unified vision for Cleveland's urban forest and provide a roadmap for achieving this vision.
2. *Re-imagining a More Sustainable Cleveland* (Appendix J) establishes a framework for vacant land reuse to stabilize and beautify city neighborhoods through targeted greening efforts, while also identifying areas for future redevelopment.
3. *Cleveland Complete & Green Streets Policy and Typology Plan* (Appendix L) classifies streets into 14 different types, each with its own priorities for pedestrians, vehicles, transit, cyclists and green infrastructure.

A summary of climate change-related recommendations from these plans is located in Appendix H.

7. ADAPTATION ACTIONS and STRATEGIES

Cleveland's *Climate Resilience and Urban Opportunity Plan* is intended to achieve safer and more resilient neighborhoods that will help buffer all residents, especially low-income and elderly residents, from the adverse impacts of climate change.

An array of engagement strategies, projects, programs, policies, and research questions were generated through climate ambassador training sessions, community workshops, and neighborhood mini summits (pictured) held in April through June of 2015. A matrix of these ideas is located in Appendix B.

Based on a detailed assessment of the anticipated effects of climate change and Cleveland's specific, climate-related vulnerabilities, the top three community-generated priorities to be addressed through the plan include:

1. Protecting residents and neighborhoods from flooding, increased precipitation, and extreme weather events.
2. Reducing the risk of heat-related mortality.
3. Reducing household energy usage and costs.

Addressing these three priority areas will help to achieve targeted and measurable improvements in climate resilience in Cleveland neighborhoods. Actions related to each of these three priority areas are described below. Almost every proposed action addresses all of the three priority areas in some way, but we listed each recommendations based on the primary outcome it is intended to address. At the end of this section, we included a series of actions that apply equally to all three priority areas.

FLOODING, INCREASED PRECIPITATION, AND EXTREME WEATHER

- *Climate Fairs:* Work with community development corporations and climate ambassadors to develop regular educational and community-building programs that emphasize accessible, hands-on education. Climate fairs would include face-to-face contact with climate action program coordinators, leadership development program intake, green job training intake, emergency response training stations and giveaways, and skill-building tutorials in urban agriculture and home weatherization. We will also focus on grassroots neighbor-to-neighbor outreach, finding trusted spaces for events, and providing free childcare, free transportation, and free lunch.
- *Green Party Crasher Program:* Bring outreach efforts to places where people already gather. Climate ambassadors would attend neighborhood celebrations and events to share information about climate change and community resilience in a fun and accessible way. This would bring the content of the Climate Fairs to new audiences.
- *Local Climate Documentaries:* Provide technical assistance, a camera crew, and film editing support to enable ambassadors to conduct interviews with Cleveland residents and public officials that shed light on Cleveland-specific climate impacts and actions. The documentaries would feature residents speaking about why climate change matters,

to help make these concepts real and relevant for more Clevelanders. Documentaries will be broadcast on websites, via social media, and at events.

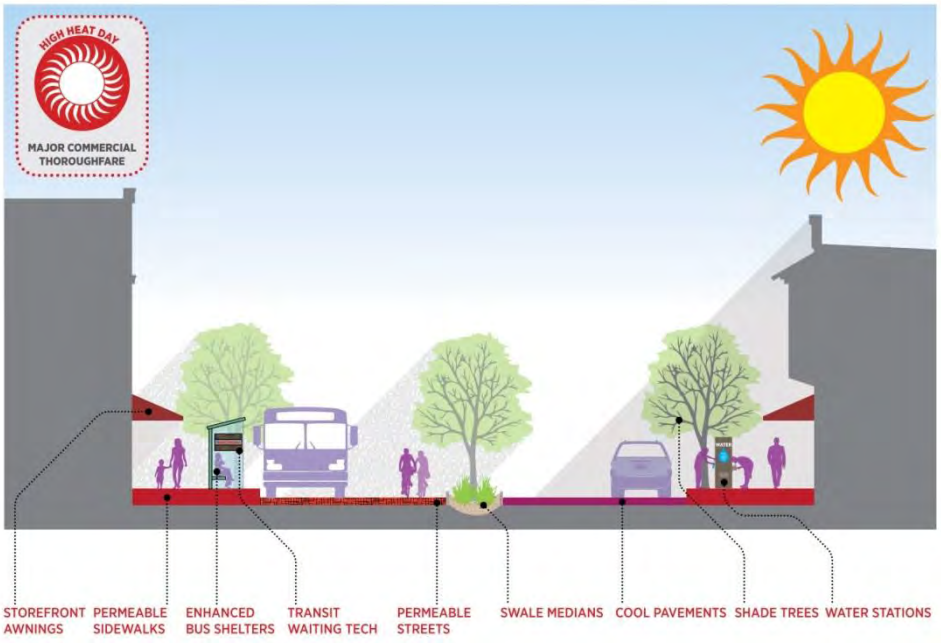
- *Vacant Land Care Skill Share and Co-Op Program (Slavic Village/Detroit-Shoreway)* Connect neighborhood volunteers with vacant land reuse projects through a co-op program. Participants would be trained on how to access vacant land, and construct and maintain various landscape treatments. They could then sign up for shifts to take care of vacant lots. The program will help activate and maintain shared green spaces that foster social cohesion, provide micro cooling effects, and manage stormwater.
- *Green Infrastructure Investments* Develop programmatic ties to the Northeast Ohio Regional Sewer District's green infrastructure grants initiative, which is currently oriented toward market-driven development. Determine whether the grant program can be expanded to incorporate neighborhood-scale climate resilience efforts.
- *Changing flood zones* Identify new/anticipated flood plain areas based on patterns of increased precipitation and develop a land use overlay and/or a land bank screening tool to discourage new construction in existing and expanded flood plain areas. A program could be created to install retrofits for houses that are prone to flooding.
- *Headwaters Reforestation* Concentrate neighborhood reforestation efforts on vacant parcels in the higher areas of Cleveland's watersheds (headwaters areas) to capture stormwater runoff and reduce flooding risks at low places in the watersheds.
- *Re-imagining a More Sustainable Cleveland* Establish a no-build zone over buried streams and culverts, to be created by designating land in the city/county land banks as 'non-buildable' if a buried waterway runs below the site. Neighborhood-scale greening efforts on vacant sites that align with buried waterways can become part of a comprehensive climate adaptation strategy.

HEAT-RELATED MORTALITY

- *Climate Emergency Dramatizations:* Most people don't prepare for climate emergencies because they're not aware of potential dangers or they don't feel a sense of urgency about what could happen at some point in the future. In order to make climate emergencies seem more real and immediate, some of the climate ambassadors would like to imagine

future climate scenarios (i.e. blackouts, heat waves, food shortages) and act them out in short video productions. The ambassadors stressed that these videos should not be heavy-handed or frightening. People are more likely to absorb the information if it is presented in a straightforward yet humorous way. The videos would be shown at community screenings, movie nights, and in the schools to spark community dialogues.

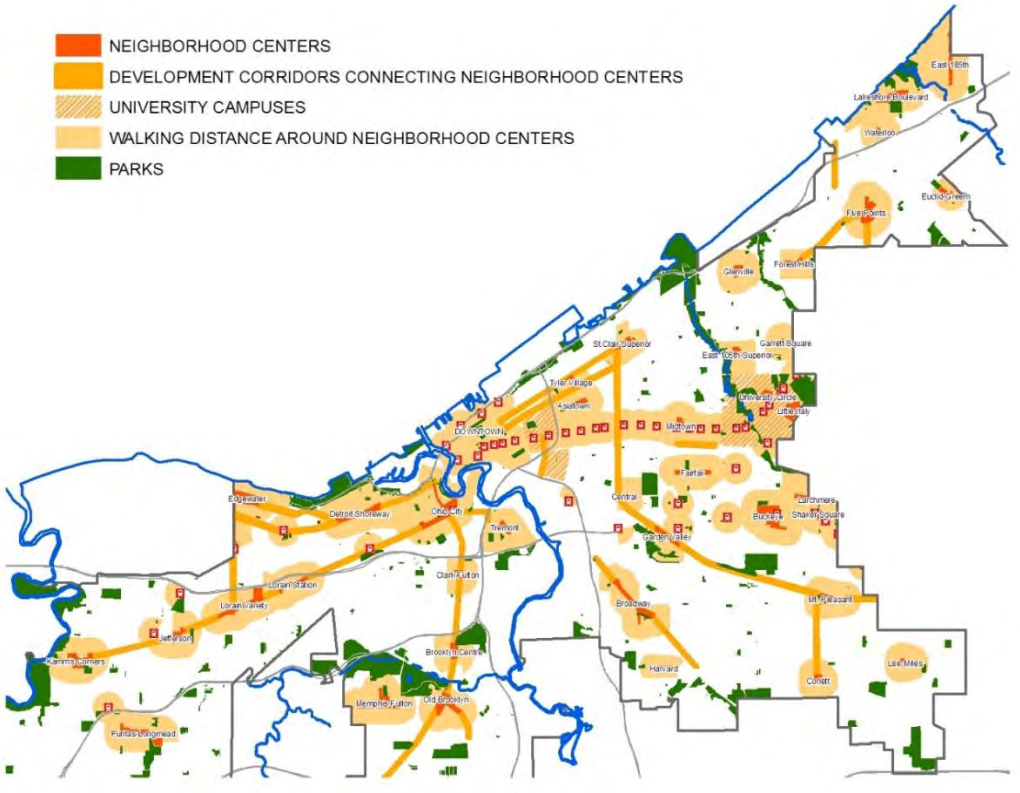
- *Intergenerational Landscaping Program (Glenville)* Adapt the existing Cleveland Youth Landscaping lawn care and snow shoveling program as a means to check on, monitor and connect seniors to support systems and resources to ensure their safety, health and well-being in the face of extreme weather. Through this program, young people will be trained and paid to provide lawn care and snow shoveling to low-income seniors.
- *City of Cleveland's Department of Aging's World Health Organization Age Friendly City Initiative* Collaborate on this existing initiative which is aimed at creating an inclusive and accessible environment for older adults with varying needs and capacities. This initiative will produce an Age Friendly Plan of Action. We will coordinate the climate resiliency aspects into the plan.
- *Mold Prevention* Provide public education about mold hazards, especially impacts on infants and children. Develop guidelines and educational materials about what to look for and where mold growth most frequently occurs. Provide tips for preventing mold growth before it starts, through waterproofing, ventilation and dehumidifiers; and for catching mold early, before it spreads. Provide information about who to call for help (City/County Health Departments).
- *Cooling Center Communication Network* Establish block-club-based mechanism to extend existing robo-call service to new neighbors and those who do not have landlines and therefore do not get notice of the cooling center locations and hours.
- *Complete and Green Streets:* Align implementation of the city's Complete & Green Streets ordinance and Typologies Plan (Appendix M) to help mitigate urban heat island effects and improve accessibility and thermal comfort for pedestrians, bicyclists, and transit riders in the city. Adopt climate resilient design guidelines (Appendix L) for new streetscape projects in the city.



REDUCED ENERGY USAGE AND COST

- *Home Weatherization* Focused expansion of home weatherization programs to low-income neighborhoods. Expand home weatherization efforts and investments in high-risk areas, as identified in the vulnerability mapping (Appendix E). Focus on insulation and air sealing, combined with operable windows, as a cost effective way to achieve comfortable interior temperatures in summer and reduce energy costs in winter. We will need to develop low cost security measures that will make residents more comfortable having operable windows.
- *Strategic Reforestation Efforts* to restore the urban tree canopy, especially in those neighborhoods most susceptible to urban heat island effects.
- *Coordination with Community Development Corporations on Neighborhood Plans* to achieve better land use choices that reduce energy demand, foster social cohesion, and make optimal use of the city's growing inventory of vacant land.
- *Climate-Ready Renters Training (Central-Kinsman)* Develop targeted programs and resources to help renters negotiate effectively with their landlords for home weatherization, energy efficiency upgrades, mold elimination, and other climate-related concerns. This initiative will also teach renters how to increase their comfort, protect their health, and prepare for climate challenges even if their landlord is unresponsive to their concerns. Empower Gas and Electric, the provider for the Cleveland Energy $aver program, will be piloting an energy efficiency program geared toward landlords which is a potential partnership for this action item.
- *Green Retrofit Model House (Any of the four neighborhoods where capacity exists)* Work with Environmental Health Watch and the Cleveland Housing Network to profile an acquisition and rehabilitation project as a showcase for cost effective sustainability strategies (e.g., water conservation, energy efficiency, etc.). Ideally, the model property would serve as a venue for hands-on workshops, seminars and educational sessions for community members.
- *Energy Saving Trees Program* In conjunction with the city's soon-to-be-completed tree plan, develop a tree planting strategy and online interface so residents can see the energy savings they could get with additional trees, to help increase public support for the restoration and maintenance of Cleveland's urban forest. The Arbor Day Foundation is a potential collaborator on this action item.
- *Transit-oriented development* Cleveland's more than 20,000 vacant lots create opportunities for urban greening and real estate development. Concentrating new development near existing transit may reduce overall household energy usage, provide mobility options in the event of energy shortages and power outages, and help foster social cohesion through walkable, transit-friendly neighborhoods.

SUSTAINABLE PATTERNS OF DEVELOPMENT
Cleveland City Planning Commission



ALL THREE PRIORITY AREAS

- *Funding Pool/Local Grant Program* to support neighborhood-generated projects and programs.
- *Applied Research Agenda* to help inform climate resilience efforts in Cleveland.
- *Professionals Initiative* (Citywide) Quarterly training for the community development corporation staff, city staff, and professional partners to share the latest information on anticipated climate change impacts, new programs and funding opportunities, and progress on implementation efforts from this work and Cleveland's Climate Action Plan.

COMMUNITY LEADERSHIP + ENGAGEMENT EFFORTS

In the implementation phase of this project, we will continue to work with four community development corporations (CDCs): Burten Bell Carr, Slavic Village Development Corporation, Famicos Foundation, and the Detroit-Shoreway Community Development Organization, along with a cohort of 20 neighborhood climate ambassadors. In partnership with Cleveland's CDC network, the ambassadors will serve three important roles:

- Community representatives on policy and advocacy matters – Examples include providing free registration to all 20 ambassadors to attend the City's Annual Sustainability Summit, as well as other events and trainings. Ambassador representatives will also join the Cleveland Climate Advisory Committee for the 2017 update of the CAP.

- Facilitators of workshops and presenters at community meetings on climate related topics – A main area of focus will be the dissemination of information related to program dollars for neighborhood-based climate strategies. Specifically, ambassadors would be trained to facilitate the Climate 101 workshops for the Cleveland Climate Action Fund that will integrate the implementation funds from this award. Along with CDC staff, the ambassadors will serve on the Selection Committee for prioritizing project awards. NOTE: There is a potential to offer Community Emergency Response Team (CERT) training as part of the ambassador training. CERT trains residents to respond to many climate-related emergencies such as flooding and high heat days.
- Cultivators of community engagement – Through their CDCs, the ambassadors will convene groups of neighbors, church groups, block clubs, students, and others to expand climate readiness and expand input into the prioritization of neighborhood-based climate mitigation, adaptation and social cohesion strategies.

This initiative will also take advantage of existing neighborhood leadership programs[1] and work towards introducing a Climate Awareness module into each program's curriculum.

ON-GOING RESEARCH

Recommendations for future research are described in the Overview section on page 4. Meetings with the climate ambassadors, residents, public officials, and the CAP advisory committee generated the following research questions—a list that we expect will grow as more Clevelanders become engaged in conversations about climate change.

- For stormwater infiltration on multiple vacant sites, how many sites, and in what configuration, are needed to achieve significant, measurable improvements in water quality?
- How do climate conditions vary between different Cleveland neighborhoods and what do we know about the microclimatology of each neighborhood? Installing weather stations in neighborhoods throughout Cleveland and Cuyahoga County would help with documenting variations in the urban heat island and enable more targeted strategies for heat emergencies and stormwater management over the long-term.
- What are the impacts of weatherization programs on actual houses in Cuyahoga County? Do these programs improve interior temperatures in real homes? How are the actual impacts and outcomes of weatherization efforts tied to existing programs like Home Weatherization Assistance Program?
- What are the current and anticipated economic impacts of climate change in terms of real dollars to real people?
- What are the potential health impacts of climate change actions (or inaction)? Can we link climate adaptation strategies to Cuyahoga County's new Community Health Improvement Plan (CHIP) or efforts by local hospitals to prepare for climate-related events like heat waves or heavy precipitation?
- Which programs and investments will have the greatest impact on the city's most vulnerable populations?
- How do pilot programs and projects scale up for neighborhood and city-wide impact? And which are most replicable in other cities?
- Which elements of the city's infrastructure networks are most vulnerable in the event of various climate emergencies?

[1] There are two in Cleveland: Neighborhood Leadership Development Program (NLDP) and the Neighborhood Leadership Institute (NLI). CNP and Kent State's CUDC are currently involved in both programs.

8. PROPOSED BUDGET

The proposed budget includes funding for on-going engagement and capacity-building efforts to implement neighborhood-scale climate resilience projects and programs.

YEAR ONE	
Community Engagement	
$10,000	Stipends for Climate Ambassadors (20 ambassadors X $500)
$10,000	Funding support for community development corporations (4 neighborhoods x $2,500)
$2,500	Climate fairs and other community engagement efforts
$10,000	Community-led public education efforts, educational videos and climate emergency simulation exercises
$7,500	Climate ambassador trainings
$2,500	Annual Stakeholder convening; annual plan assessment and update; printing
$42,500	*Subtotal*
Projects and Programs	
$123,500	Grant support for neighborhood-determined projects and programs (administered through Re-imagining Cleveland and the Cleveland Climate Action Fund)
$10,000	Pilot landscaping/snow removal initiative
$133,500	*Subtotal*
Administration and Technical Support	
$40,000	Administrative expenses: CNP @ $25K and Environmental Health Watch (EHW) @ $15K
$24,000	Technical assistance in developing program metrics, grant-writing, and “train the trainer” programs (UB, CUDC)
$20,000	Peer Learning expenses (travel, lodging, etc.)
$84,000	*Subtotal*
$260,000	**TOTAL**

During the first year, CNP and its partners will take full advantage of the results identified in the on-going research referenced on page 4 and 17. Based on what we learn, we will pursue matching support to grow the pool of funding available for the most efficacious community-generated projects and programs. We have already secured a $40,000 commitment for matching funds from the George Gund Foundation, allocated for grant support for neighborhood projects and programs. Community engagement efforts will both expand and refine the range of ideas, and establish priorities for implementation in years two and three.

Each funded project or program will have a schedule for implementation and clear metrics for evaluation. By the end of the first year, we will evaluate the first round of work and supporting engagement efforts. Based on this evaluation, we will prepare a detailed budget for year two and a preliminary budget for year three.

9. METRICS FOR EVALUATION AND KEY INDICATORS

A major component of Cleveland's *Climate Resilience and Urban Opportunity Plan* is a neighborhood grant program that will support projects and programs generated by residents for improving climate resilience. To ensure that grant-funded projects align with The Kresge Foundation and Island Press whitepaper entitled *Bounce Forward: Urban Resilience in the Era of Climate Change,* CNP, the university research team, the City of Cleveland, and the community development corporations will develop metrics to evaluate the adaptation strategies described in Section 7 to determine if they are:

- Lessening overall demand for energy;
- Helping Clevelanders anticipate and prepare for climate changes and shocks; and
- Fostering social cohesion.

CNP and the City of Cleveland have considerable experience in operating neighborhood-scale grant programs through the Re-imagining Cleveland vacant land initiative and the Cleveland Climate Action Fund.

We will establish a simple, but thorough process for grant submissions that includes community workshops and one-on-one technical assistance for community applicants. For each proposal, the university research team will assist grant applications in identifying clear, specific, and measurable outcomes based on the three priority areas (flooding, heat-related mortality, and reduced energy use) described in Section 7. For example, project metrics by category may include:

- Amount of reduction in impervious surfaces (flooding)
- Stormwater capture and infiltration (flooding)
- Amount of tree-canopy added (heat-related mortality)
- Number or percentage of elderly participants in an emergency preparedness program (heat-related mortality)
- Household energy usage before and after a proposed intervention (energy usage)
- Number or percentage of low income participants in a household energy audit program (energy usage)

We will pilot this process by evaluating the effectiveness of a sample of the 56 Re-imagining Cleveland vacant land reuse projects that have been implemented in Cleveland over the past five years. Although these projects were not intended as climate resilience strategies, they mirror many of the proposals put forward by residents during our community meetings.

For this pilot study, the projects will be placed into categories, including community gardens, orchards, rain gardens, parks and green spaces, bio-remediation areas, and side yard expansions. Depending on the project category, we will then develop measurement protocols to estimate physical changes such as impact on household energy use, stormwater infiltration, and air quality benefits. We will also try to estimate if the project has had a positive effect on community engagement and social cohesion by interviewing and/or surveying residents.

This pilot study will attempt to answer nine basic questions about the Re-imagining Cleveland vacant land reuse projects, consistent with the integrated framework for urban resilience:

1. Resilience of what? (What do we need? What do we value?)
2. Resilience to what? (Which natural hazards, environmental, or social changes?)
3. Resilience for whom? (Who is vulnerable? Who decides?)

4. Is the strategy diverse, redundant, and/or modular?
5. Does the strategy have tight feedbacks?
6. Does the strategy promote social capital, agency, equity, inclusiveness, and innovation?
7. Will the strategy help protect or restore systems in their current form?
8. Will the system be able to be modified to increase resilience?
9. How will the system transform over time to become more resilient?

Once we have completed this evaluation, we will then attempt to measure the resilience/social cohesion impacts of the ten Cleveland Climate Action Fund projects that were started in 2015. For these projects, we will work with the grantees to identify a range of metrics to assess physical change and social cohesion, such as local participation in events and programs, residents' opinions about the appearance of vacant land projects, and resident surveys to determine levels of neighborhood satisfaction and perceptions about safety. We will also ask the questions above of each project. We will use lessons learned from the Re-imagining work and the Cleveland Climate Action Fund projects to prioritize projects to go forward in each of the neighborhoods. Over the three-year lifespan of the project, we will continue to update these metrics, upload results to a database, and use the results to help tune the efficacy of the adaptation strategies. We will then share our results with other communities in the region to promote adaptation in cities facing similar challenges (e.g., Detroit, Toledo, Buffalo).

We will also attempt to measure the economic impacts of vacant land greening projects. Cleveland Neighborhood Progress has been awarded technical support from the Center for Community Progress to support this effort.

10. IMPLEMENTATION: PHASING + PRIORITIES

Priorities for implementation include:

- Expanding and amplifying community engagement efforts and develop new and innovative ways to bring more diverse participants into climate planning and adaptation initiatives. This includes expanding the climate ambassador program to include additional training, and possibly to offer a certificate program through the City of Cleveland to recognize efforts to increase climate resilience.
- Building on recommendations in existing plans, especially the Cleveland Climate Action Plan, the Climate Action Toolkit, the Cleveland Tree Plan, Re-imagining a More Sustainable Cleveland, and the Cleveland Complete & Green Streets Typologies plan. We have already started this process; an initial overlay that shows how each strategy intersects with a climate impact is included as Appendix H.
- Connecting with existing officials at the region-, county-, and city- level to coordinate climate change mitigation and adaptation efforts. These officials include staff from the County Board of Health, Emergency Management, City departments of Health and Aging, and local hospitals like University Hospitals and the Cleveland Clinic.
- Leveraging the city's growing inventory of surplus real estate, because it is a key resource for Cleveland and other older industrial cities in the Great Lakes region. The strategic reuse of vacant land can help mitigate the adverse impacts of climate change and convert the present liability of overgrown lots into a neighborhood asset that enhances property values and buffers residents against the adverse effects of climate change.
- Connecting with efforts ongoing in other Great Lakes Region cities through informal networking at climate change conferences but also through a new USDN Great Lakes Climate Adaptation Network that is co-chaired by Ann Arbor and Cleveland, and supported by the University of Michigan Climate Center. This network will help to help share lessons learned, avoid mistakes of other cities, and share successes from this project to help promote resilience at the regional level.

Cleveland has five existing mechanisms to fund these neighborhood-based projects, research, and outreach:

- Cleveland Climate Action Fund (Coalition of city, for-profit, and non-profit organizations)
- Re-imagining Cleveland (CNP)
- Green Infrastructure Grants (NEORSD)
- Research funding pursued by Kent State University, University at Buffalo, and the University of Michigan
- Neighborhood Connections grants, which foster social cohesion

We will use these funding mechanisms to support neighborhood-based projects, conduct research and evaluation of ongoing efforts, and distribute available resources to residents and community development corporations based on climate-related criteria.

Appendices

Appendix A:

Support Letters

Jenita McGowan, Chief of Sustainability, City of Cleveland

Terry Schwarz, Director, Kent State University Cleveland Urban Design Collaborative

Robert Shibley, Dean, University at Buffalo School of Architecture and Planning

Elizabeth Gibbons, Director, University of Michigan Climate Center

Timothy L. Tramble, Executive Director, Burten, Bell, Carr Development, Inc.

Jeff Ramsey, Executive Director, Detroit Shoreway Community Development Organization

John Anoliefo, Executive Director, Famicos Foundation

Christopher Alvarado, Executive Director, Slavic Village Development

City of Cleveland
Frank G. Jackson, Mayor

Office of the Mayor
Cleveland City Hall
601 Lakeside Avenue, Room 202
Cleveland, Ohio 44114
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www.cleveland-oh.gov

June 25, 2015

Mr. Joel Ratner
President and CEO
Cleveland Neighborhood Progress
11327 Shaker Boulevard, Suite 500W
Cleveland, Ohio 44104

Dear Mr. Ratner,

The City of Cleveland Mayor's Office of Sustainability is pleased to express support for Cleveland's Climate Resiliency and Urban Opportunity Draft Implementation Plan. We are confident that the recommendations outlined in this plan will increase Cleveland's climate resiliency, especially for our most vulnerable residents. We are eager to join Cleveland Neighborhood Progress and the other project partners in implementing this plan.

The Office of Sustainability leverages Cleveland's wealth of assets by collaborating with the community to improve the economic, environmental, and social well-being of its citizens. The Office, in partnership with its 50-member Cleveland Climate Action Advisory Committee, convenes stakeholders across sectors to help build thriving and resilient neighborhoods through climate action. Through the process of working on this grant, we are confident that the draft implementation plan aligns well with the Cleveland Climate Action Plan, as well as the Neighborhood Climate Action Toolkit that was developed in tandem. It has been exciting to see this toolkit used in the planning process as a basis for engaging with residents on adaptation, especially in low-income neighborhoods.

Throughout the six month planning process, the Office of Sustainability ensured appropriate links were made to the citywide Climate Action Plan as well as the larger Sustainable Cleveland 2019 initiative. Moving forward, The Office of Sustainability will help to align City of Cleveland departments with the implementation of the plan. I am particularly interested in leveraging the Cleveland Climate Action Fund as an implementation tool for this plan. Finally, the plan recommendations will go a long way toward further integrating climate resiliency into revisions of City policies, plans, and protocols.

I look forward to partnering with the implementation team to refine and begin implementation of the plan. It's crucial that we work together to make climate action at the neighborhood level reach its full potential in Cleveland.

Sincerely,

Jenita McGowan
Chief of Sustainability
City of Cleveland Mayor's Office of Sustainability

KENT STATE UNIVERSITY
CLEVELAND URBAN DESIGN COLLABORATIVE

1 July 2015

Mr. Joel Ratner
President and CEO
Cleveland Neighborhood Progress
11327 Shaker Boulevard, Suite 500W
Cleveland, Ohio 44104

Dear Mr. Ratner,

On behalf of Kent State University's Cleveland Urban Design Collaborative, I'm writing to my express support for the Cleveland Climate Resilience and Urban Opportunity Initiative.

As the outreach division for the College of Architecture and Environmental Design at Kent State, the CUDC works with neighborhoods and communities throughout northeast Ohio, with a particular emphasis on the city of Cleveland. As you know, we have a well-established and productive relationship with your organization. We see climate resilience as a critically important issue to the future of Cleveland neighborhoods and city residents. We welcome an opportunity to continue this work with Cleveland Neighborhood Progress.

Since January of this year, the CUDC has been working closely with CNP staff, faculty from the University at Buffalo and Kent State, the Cleveland Office of Sustainability, and several local community development corporations to engage residents in lively, neighborhood-specific conversations about how we can anticipate and adapt to the effects of climate change. We have an initial range ideas and strategies that will continue to evolve as we move toward implementation. As the work progresses, the CUDC is committed to helping with on-going community engagement, the development of performance metrics and evaluation tools, and revisions to the initial plan in response to new information and emerging priorities.

Thank you for giving us an opportunity to work with CNP on this exciting and timely project. We look forward to the next phases of the work.

Sincerely,

Terry Schwarz
Director

1309 Euclid Avenue, Suite 200 Cleveland, OH 44115 | P 216.357.3434 | F 216 357.3430 | *www.cudc.kent.edu*

University at Buffalo
The State University of New York

Office of the Dean
School of Architecture and Planning

July 1, 2015

Mr. Joel Ratner
President and CEO
Cleveland Neighborhood Progress
11327 Shaker Boulevard, Suite 500W
Cleveland, Ohio 44104

Dear Mr. Ratner,

The University at Buffalo (UB) Department of Architecture is pleased to express support for your proposal to The Kresge Foundation for the “Climate Resilience and Urban Opportunity Initiative.”

Our Department of Architecture is committed to the philosophy that architects have a role to play in the aesthetic, social, and cultural betterment of society. The UB curricula prepare students to see the full implications of what architecture does for the built environment. Through pedagogy, creative practice, and faculty research, we engage students in local and global issues to help them understand the human, ecological, material, and technological consequences of design.

One of our faculty members, Dr. Nicholas B. Rajkovich, has been actively engaged with the City of Cleveland, the Cleveland Urban Design Collaborative, and Cleveland Neighborhood Progress on their planning efforts since the beginning of this year. He has attended a number of community meetings in Ohio, defined climate change impacts for the region, mapped vulnerability to climate change, produced educational materials for your climate “ambassadors,” and provided training to local community leaders.

Dr. Rajkovich is actively engaged in this work because it is a logical extension of his research on heat wave morbidity and mortality in Cuyahoga County. Over the last five years, his work has quantified the impact of land uses and land cover on local temperatures, how energy efficiency programs might reduce exposure to high temperatures in homes, and how collaborative processes can help to overcome barriers in local adaptation planning. This research has complemented the expertise from the University of Michigan Climate Center and the Kent State University geography and architecture departments.

Should you receive additional funding from The Kresge Foundation, Dr. Rajkovich plans to continue to attend meetings in Cleveland to assist with your planning efforts. He will also work with the academic teams from Kent State and the University of Michigan to attract external support for research around the issue of climate change. He has also expressed interest in reviewing the projects, programs, and policies developed by the Cleveland Neighborhood Progress team as the project moves forward. I am confident that his expertise in environmental planning, building science, and climate change policy will continue to be a tremendous asset to your team.

We wish you the best of luck with your proposal.

Sincerely,

Robert G. Shibley, FAIA, AICP
Professor and Dean

114 Diefendorf Hall, Buffalo, New York 14214-8032
Tel.: (716) 829-3981 Fax: (716) 829-2297 Email: ap-dean@buffalo.edu

GLISA
A NOAA RISA TEAM

July 1, 2015

Mr. Joel Ratner
President and CEO
Cleveland Neighborhood Progress
11327 Shaker Boulevard, Suite 500W
Cleveland, Ohio 44104

Dear Mr. Ratner,

The University of Michigan Climate Center and the Great Lakes Integrated Sciences and Assessments Program expresses support for your proposal to The Kresge Foundation for the "Climate Resilience and Urban Opportunity Initiative."

Sponsored by the National Oceanic and Atmospheric Administration (NOAA), the Great Lakes Integrated Sciences and Assessments Program (GLISA) is part of a national network of regional centers focused on adaptation to climate variability and change. GLISA is a collaboration of the University of Michigan and Michigan State University and is housed at the University of Michigan Climate Center at the Graham Sustainability Institute. With a team of leading climatologists, social scientists, and outreach specialists, GLISA addresses a wide range of interconnected regional issues related to the Great Lakes—including agriculture, watershed management, natural resources-based tourism, and urban management.

Since the start of your project, we have been happy to provide you with up to date information like the climatology you have included with this plan to The Kresge Foundation. We have also provided your team with climate projections of temperature and precipitation, access to the Cities Impacts and Adaptation Tool (CIAT), and put you in contact with other adaptation efforts in the Great Lakes Region.

Should you be selected by The Kresge Foundation for the next round of support, we will continue to deliver climate data in a format useful for your decision-making processes. In addition, we are currently planning regional workshops to discuss climate specific impacts, challenges, and opportunities—at these events we will convene research leaders including atmospheric science, civil engineering, informatics, urban planning, public policy, public health, and natural resource management to share critical emerging lessons, resources, and technologies from the Great Lakes region. In addition, we pledge to work with the University at Buffalo and Kent State University to pursue research funding opportunities to support regional adaptation and resilience efforts. We hope that these activities will help your efforts in Northeast Ohio, and that lessons learned from your work will be useful to other cities in our region.

We look forward to continuing to work with you team. Best of luck with your proposal.

Sincerely,

Elizabeth Gibbons
Director, University of Michigan Climate Center
Program Manager, GLISA

CLIMATE CENTER
UNIVERSITY OF MICHIGAN

MICHIGAN STATE
UNIVERSITY

BURTEN, BELL, CARR
DEVELOPMENT, INC.

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www.bbcdevelopment.org

June 26, 2015

Mr. Joel Ratner, President and CEO
Cleveland Neighborhood Progress
11327 Shaker Boulevard, Suite 500W
Cleveland, Ohio 44104

Dear Mr. Ratner,

Burten, Bell, Carr Development, Inc. (BBC) is pleased to express support for Cleveland's Climate Resiliency and Urban Opportunity Draft Implementation Plan to be submitted July 1st for consideration by The Kresge Foundation. We are confident that the recommendations outlined in this collaboratively-generated plan will increase Cleveland's climate resiliency through vacant land strategies, land use adaptation and community network building. We are eager to join Cleveland Neighborhood Progress in the implementation of this plan..

BBC is committed to working with Cleveland Neighborhood Progress, the City of Cleveland, and numerous other community stakeholders to engage the public in and promote the local Climate Resilience dialogue through focus groups and community outreach events, as well as an information campaign aimed at raising awareness about climate concerns, refining strategies for neighborhood-scale actions with regional impacts, and building social capital to help communities withstand future challenges.

As the community development corporation for Kinsman, we envision climate resilience as an essential part of elevating the physical environment, neighborhood economy, culture, education, and social-fabric of the community. BBC strives to combine climate and economic resilience by collaborating with partners who will invest in the community, create jobs, and act as leaders in environmental stewardship. To date we have successfully chartered a 10 acre land assembly of the Green City Growers Hydroponic Greenhouse, and spearheaded the formation of the 23 acre Urban Agriculture Innovation Zone. Our organization helped design, plan, and develop Heritage View Apartments, a 207 unit redevelopment of an infamous public housing complex. Heritage View Apartments includes permeable driveways, and solar panels eliminating tenants' gas bills. BBC is also involved in the integration of a 5.5 million dollar investment in green infrastructure from the Northeast Ohio Regional Sewer District, which will remove over 1 million gallons of combined sewer overflows from entering Lake Erie.

BBC remains committed to expanding our network of community partnerships to help Kinsman residents thrive, and build effective ways to promote climate action. In 2012, BBC joined Detroit Shoreway Community Development, Enterprise Community Partners, and the Mayor's Office of Sustainability, in a collaborative working group to charter an EcoDistrict framework for Cleveland. Utilizing the framework to explore metrics planning, alignment of resources, and setting neighborhood scale strategies to achieve carbon, waste, energy and water reduction.

As you move from the planning into the implementation phase of this initiative, we will dedicate staff time to the coordination of new and improved community outreach and capacity building programs and will work to bring our neighborhood master plan into alignment with the plan recommendations. We are very interested in the outcomes of this work; particularly, empowering residents to play an active role in Climate Resilience. We look forward to partnering with you as we refine and begin to implement the plan recommendations.

Yours for a better community,

Timothy L. Tramble
Executive Director

DETROIT SHOREWAY COMMUNITY DEVELOPMENT ORGANIZATION
Gordon Square Arcade
6516 Detroit Avenue Suite 1
Cleveland, Ohio 44102
216-961-4242
216-961-8830 Fax
www.detroitshoreway.org

June 26, 2015

Mr. Joel Ratner
President and CEO
Cleveland Neighborhood Progress
11327 Shaker Boulevard, Suite 500W
Cleveland, Ohio 44104

Dear Mr. Ratner,

Detroit Shoreway Community Development Organization (DSCDO) is pleased to support Cleveland's Climate Resiliency and Urban Opportunity Draft Implementation Plan to be submitted for consideration to The Kresge Foundation. We are confident that the recommendations outlined in this collaboratively-generated plan will increase Cleveland's climate resiliency through vacant land strategies, land use adaptation and community network building. We are eager to join Cleveland Neighborhood Progress in the implementation of this plan.

Since 1998, DSCDO has been a leader in promoting environmentally focused neighborhoods through creation of the Cleveland EcoVillage, a place-based and transit-oriented approach to an ecological redevelopment, centered on a light rail transit station. Within the EcoVillage, DSCDO has successfully completed initiatives including development of 20 state of the art green built townhomes; rehabilitation of $3.5 million green transit station; development of two (2) green single family homes; and a $3.5 million redevelopment of the 20 acre Michael Zone Recreation Center greenspace, a storm water management demonstration project.

DSCDO remains committed to expanding our network of community partnerships to help EcoVillage residents thrive, and build effective ways to promote climate action. In 2012, DSCDO joined Burten, Bell, Carr Development, Inc., Enterprise Community Partners, and the Mayor's Office of Sustainability in a working group to charter an EcoDistrict framework for Cleveland. DSCDO is utilizing the framework to explore metrics planning, identify opportunities to align resources, and create neighborhood scale strategies to achieve carbon, waste, energy and water reduction.

As Cleveland Neighborhood Progress moves from the planning into the implementation phase of the Climate Resiliency and Urban Opportunity initiative, DSCDO is committed to engaging the public in and promoting the local Climate Resiliency dialogue through focus groups and community outreach events, as well as an information campaign aimed at raising awareness about climate concerns, refining strategies for neighborhood-scale actions with regional impacts, and building social capital to help communities withstand future challenges. We will work to bring our neighborhood master plan into alignment with the plan recommendations, and we are very interested in the outcomes of this work – particularly, empowering residents to play an active role in Climate Resiliency.

We look forward to partnering with you in the refinement and implementation of the plan recommendations.

Sincerely,

Jeff Ramsey
Executive Director

famicos FOUNDATION

Building Homes. Restoring Hope.

NeighborWorks® CHARTERED MEMBER

1325 Ansel Road
Cleveland, OH 44106
t.216.791.6476
f.216.791.6485
famicos.org

June 26, 2015

Mr. Joel Ratner
President and CEO
Cleveland Neighborhood Progress
11327 Shaker Boulevard, Suite 500W
Cleveland, Ohio 44104

Dear Mr. Ratner,

Famicos Foundation is pleased to express support for Cleveland's Climate Resiliency and Urban Opportunity Draft Implementation Plan to be submitted July 1st for consideration by The Kresge Foundation. We are confident that the recommendations outlined in this collaboratively-generated plan will increase Cleveland's climate resiliency through vacant land strategies, land use adaptation and community network building. We are eager to join Cleveland Neighborhood Progress in the implementation of this plan.

Famicos is committed to working with Cleveland Neighborhood Progress, the City of Cleveland, and numerous other community stakeholders to engage the public in and promote the local Climate Resilience dialogue through focus groups and community outreach events, as well as an information campaign aimed at raising awareness about climate concerns, refining strategies for neighborhood-scale actions with regional impacts, and building social capital to help communities withstand future challenges.
We believe, like Cleveland Neighborhood Progress, that by raising awareness about climate concerns and advancing effective Climate Resilience strategies, we will improve quality of life for current residents, and attract new residents to the Glenville neighborhood, and neighborhoods throughout the city.

Our climate action plan called "Greening Glenville" has to date;

- Distributed over 300 rain barrels and compost bins along with holding "how to" workshops
- Instituted resident based recycling programs at three of the apartment buildings that we own and manage
- Partnered with Glenville High School teachers to create a curriculum around sustainability issues

- Promoted the consumption of locally grown produce through a weekly farmers' market (thereby reducing transportation costs)
- Partnered with local bicycle advocacy groups to promote the use of bicycles as a viable means of transportation.

As you move from the planning into the implementation phase of this initiative, we will dedicate staff time to the coordination of new and improved community outreach and capacity building programs and will work to bring our neighborhood master plan into alignment with the plan recommendations. We are very interested in the outcomes of this work; particularly, empowering residents to play an active role in Climate Resilience. We look forward to partnering with you as we refine and begin to implement the plan recommendations.

Sincerely,

John Anoliefo
Executive Director

SLAVIC VILLAGE SVD DEVELOPMENT

June 26, 2015

Mr. Joel Ratner
President and CEO
Cleveland Neighborhood Progress
11327 Shaker Boulevard, Suite 500W
Cleveland, Ohio 44104

Dear Mr. Ratner,

Slavic Village Development (SVD) is pleased to express support for Cleveland's Climate Resiliency and Urban Opportunity Draft Implementation Plan to be submitted July 1st for consideration by The Kresge Foundation. We are confident that the recommendations outlined in this collaboratively-generated plan will increase Cleveland's climate resiliency through vacant land strategies, land use adaptation and community network building. We are eager to join Cleveland Neighborhood Progress in the implementation of this plan.

SVD is committed to working with Cleveland Neighborhood Progress, the City of Cleveland, and numerous other community stakeholders to engage the public in and promote the local Climate Resilience dialogue through focus groups and community outreach events, as well as an information campaign aimed at raising awareness about climate concerns, refining strategies for neighborhood-scale actions with regional impacts, and building social capital to help communities withstand future challenges.

We believe, like Cleveland Neighborhood Progress, that by raising awareness about climate concerns and advancing effective Climate Resilience strategies, we will improve quality of life for current residents, and attract new residents to Slavic Village as well as other neighborhoods throughout the city. To date, we have partnered with Northeast Ohio Regional Sewer District to construct seven natural stormwater retention sites and develop Fleet Avenue as Cleveland's first true "complete and Green Street" to handle increasing volumes of precipitation and encourage bicycle and transit use. We are also constructing a neighborhood-wide trail network to support walking and biking, pursued a strategy of neighborhood building based on walkability, and are leveraging our economically- and ethnically-diverse constituency to create stronger social ties and a more resilient neighborhood.

As you move from the planning into the implementation phase of this initiative, we will dedicate staff time to the coordination of new and improved community outreach and capacity building programs and will work to bring our neighborhood master plan into alignment with the plan recommendations. We are very interested in the outcomes of this work; particularly, empowering residents to play an active role in Climate Resilience. We look forward to partnering with you as we refine and begin to implement the plan recommendations.

Sincerely,

Christopher Alvarado
Executive Director

GREATER CLEVELAND COMMUNITY SHARES

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Appendix B:

Adaptation Actions and Strategies

Prepared by:

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		Mitigation	Adaptation	Social Cohesion		
	Category	Lessen overall demand for energy and increase renewable energy	Anticipate and prepare for climate changes and shocks	Foster social cohesion	**Timeframe**	**Cost**
Community Engagement						
Continuation/expansion of Climate Ambassador program	Program	Climate Ambassadors can help educate their neighbors about strategies for reducing energy usage.	A strong community network of knowledgeable Climate Ambassadors will help residents and neighborhoods respond to climate changes and shocks.	Climate Ambassador Program encourages neighbors to talk with neighbors about climate change and adaptation strategies. Ambassadors providing two-way communication: communicating about climate and programs from plan implementers to residents AND communicating resident priorities, questions and concerns back to the advisory committee that is implementing the plan.	On-going	
Climate Fair; Green Party Crasher Initiative	Program	Informed residents are more likely to think about their energy consumption and carbon footprint; i.e., knowledge is a powerful tool for changing behavior.	The sometimes scary possibilities of climate change will be easier to discuss with residents in a fun and non-threatening setting; more informed residents will mean greater preparedness in the event of a climate emergency.	People get to know one another the more they engage with their neighbors. Using fairs and various community events as forums for info sharing provides opportunities for building social cohesion.	Short-term, on-going	
Co-op program for vacant land stewardship	Program	Engaging neighbors near the sites they will be caring for reduces travel and gas consumption involved with hiring maintenance companies.	Relationships created through this program foster social cohesion, which enables community members to support each other in the event of climate .shocks	Community volunteers build relationships across neighborhoods by helping to maintain vacant lots and community green spaces	Mid-term	
Cleveland Youth Landscaping: Yard care/snow removal services for elderly residents in high vulnerability areas (based on vulnerability mapping)	Program	The shared provision of services is an energy efficient way to meet the needs of neighborhood residents. Also, the local company uses push and electric mowers. NOTE: They received a Cleveland Climate Action Fund grant to convert their equipment.	The program provides a built-in mechanism for checking on elderly residents and vulnerable households, which will be important in the event of an extended heat wave or other climate emergency.	Intergenerational relationships are created in a mutually beneficial way. Young people are paid for their work; older people receive landscaping and snow removal services.	Short-term, on-going	
Senior visitation program to check on the needs of seniors and increase social time	Program		The program provides a built-in mechanism for checking on elderly residents and vulnerable households, which will be important in the event of an extended heat wave or other climate emergency.	Building relationships with seniors improves community relations and fosters social cohesion. It also provides an important feedback loop to the Advisory Committee.	Mid-term	
Climate -ready renters training	Program		Renters may be especially vulnerable to the effects of climate change and the impacts of climate shocks. This program tailors a response strategy to their needs.	Helps renters know their rights when it comes to climate-related issues such as mold growth, ventilation, and other issues.	Short-term, on-going	
City of Cleveland Department of Aging/World Health Organization Age Friendly City Initiative	Program		CNP will work to coordinate the climate resiliency aspects into the plan.	Will create an inclusive and accessible environment for older adults with varying needs and capacities.	Short-term, on-going	
Professionals initiative (quarterly training)	Program	CDC staff, city staff, and others receive training and updates on climate issues and strategies for improving energy efficiency at the household, neighborhood, and citywide scale.	Builds a network of well-informed practitioners who can assist with the day-to-day realities of climate change and in the event of a climate emergency.	Fosters greater cohesion between CDCs and city staff, and the residents they serve.	Short-term, on-going	

		Mitigation	Adaptation	Social Cohesion		
	Category	Lessen overall demand for energy and increase renewable energy	Anticipate and prepare for climate changes and shocks	Foster social cohesion	**Timeframe**	**Cost**
Weatherization/Mold Prevention						
Expanded home weatherization efforts/investments in areas identified in the vulnerability mapping.	Program	Weatherization will improve the energy efficiency of existing housing stock.	Weatherization (especially insulation and operable windows) will keep indoor temperatures lower during heat waves and increase the passive survivability of the city's existing housing stock.	Weatherization fairs and outreach efforts will help build relationships between neighbors and may help to identify vulnerable households.	Short-term	
Mold Prevention Toolkit	Program		Increased precipitation and flooding will promote mold growth, which contributes to allergies and respiratory illnesses. The toolkit will help people identify, correct, and prevent the spread of mold in their homes.	Public education programs about where to look for mold growth and how to eliminate it will bring neighbors together around this prevalent public health issue.	Short-term	
Impacts of weatherization initiatives on actual houses in Cuyahoga County. Can we improve interior temperatures in real homes? How do these tie to existing programs like HWAP?	Research	Weatherization reduces energy demands, but we need more data about the effectiveness of weatherization programs in order to target funding to the interventions and households where weatherization improvements will be most effective. We also need data about anticipated and actual energy savings, since high utility bills, especially during the winter months, are a pressing concern for residents.	More research is also needed as to the effects of weatherization during extended periods of high heat. Are current weatherization efforts resulting in more comfortable indoor temperatures during extended periods of high heat and extreme cold? How do weatherized homes compare to non-weatherized homes?	High energy costs are a major concern for many city residents. Providing detailed information about the connection between weatherization and lower utility bills is a useful way to draw residents into broader conversations about climate change.	Mid-term	
Urban Heat Island Effects/High Heat Response						
Installation of weather stations in each of the neighborhoods of Cleveland/ Cuyahoga County to help with heat island/ heat emergency/ stormwater management over time.	Research	Understanding the variations in microclimates around the city will enable us to better target efforts to reduce urban heat island effects through reforestation, reduction in impervious surfaces, green roofs, and other means.	Anticipating and preparing for climate changes will be easier if we can monitor variations and fluctuations in temperature, rainfall, wind speeds, and other conditions at the neighborhood scale.	While many residents may be unaware or uninterested in issues of 'climate,' most Clevelanders engage in frequent conversations about the weather. Public education programs at weather stations can help residents better understand and prepare for the impacts of climate variability and change.	Mid-term	
Cooling Center communication network: establish block-club-based mechanism to extend landline robocall service to new neighbors and those who do not have landlines and therefore do not get notice of the cooling center locations and hours.	Program		Anticipating climate emergencies by establishing the communications network needed to protect the most vulnerable households	Developing a communications strategy at the block club level will strengthen relationships with neighbors and help to better target citywide efforts.	Short-term	

		Mitigation	Adaptation	Social Cohesion		
	Category	Lessen overall demand for energy and increase renewable energy	Anticipate and prepare for climate changes and shocks	Foster social cohesion	**Timeframe**	**Cost**
Reforestation						
Energy Savings Trees Program: Strategic tree planting and online interface for residents to see the energy savings they could get with trees	Program	Deciduous trees planted on the south and west sides of houses will help to keep interiors cooler and reduce energy costs.	Trees help absorb storm surges and reduce stormwater runoff, providing a protective buffer for city neighborhoods in extreme weather.	Some residents have concerns about tree planting and urban reforestation efforts, largely due to the damage caused by tree roots and falling limbs, and the maintenance efforts required for fall leaf removal. A program that targets trees to the areas where they can provide the most benefits and a toll that enables residents to measure energy savings will help build public awareness of the value of trees in urban neighborhoods.	Mid-term	
Target reforestation efforts to vacant lots in headwaters areas	Project	Capturing rainfall at the top of the watershed (headwaters areas) can help reduce combined sewer overflows and the amount of water in the sewer system. This in turn reduces the amount of rainwater that is processed through the city's water treatment plants. Pumping and treating water requires a lot of electricity, so reducing the amount of water moving through the sewers will lessen the overall demand for energy.	Trees help absorb storm surges and reduce stormwater runoff, providing a protective buffer for city neighborhoods in extreme weather.	Headwaters areas form linear paths throughout the city. Targeting reforestation efforts on vacant land in headwaters areas will create green connections throughout the city that can be used for walking, biking, and linking residents to neighborhood resources and amenities.	Long-term	
Tree planting initiative for side lot expansions, especially on south and west sides of houses	Program	Deciduous trees planted on the south and west sides of houses will help to keep interiors cooler and reduce energy costs.	Targeted tree planting will keep indoor temperatures lower during heat waves and increase the passive survivability of the city's existing housing stock.	A program to purchase trees in bulk, distribute to residents, and offer planting/watering instructions is a way to share information about the value of trees and initiate a broader conversation about climate change and preparedness strategies.	Mid-term	
Targeted reforestation effort for city parks and school sites.	Project	Parks and school properties can become green anchors in city neighborhoods, to help capture stormwater, reduce flooding risks, and reduce ambient air temperatures at the neighborhood scale, reducing overall energy demands.	Trees help absorb storm surges and reduce stormwater runoff, providing a protective buffer for city neighborhoods in extreme weather.	Increased tree canopy for parks and school sites may enable these spaces to function more effectively as neighborhood gathering spaces, particularly for older residents who may be more interest in passive recreation than programmed sports and activities.	Mid-term	
Identify tree species that produce less pollen	Research	Planting trees that procude less pollen means less allergic reactions and ashthma attacks, reducing trips to the drug store for medicine or the doctor/urgent care for treatment.	Climate changes may be impacting the amount of pollen trees are producing. Identifying low pollen tree species will enable us to expand the city's tree canopy while limiting public health concerns related to allergies and respiratory illnesses.	Public education about trees and pollen production will help residents make more informed choices when selecting trees and plants for their own properties.	Short-term	

		Mitigation	Adaptation	Social Cohesion		
	Category	Lessen overall demand for energy and increase renewable energy	Anticipate and prepare for climate changes and shocks	Foster social cohesion	**Timeframe**	**Cost**
Stormwater Management						
Wet-Weather Runoff Reduction Credit Program	Program	Reducing stormwater runoff lessens energy demands by reducing the amount of stormwater that has to be pumped to treatment plants.	Reducing impervious surfaces helps to reduce flooding risks and urban heat island effects.	Public education programs to promote the credit program are an opportunity to foster conversations about broader climate related issues.	Mid-term	
Complete & Green Streets Initiative: accelerated implementation of existing policy	Policy	Increased tree canopy over existing pavement and new roads (i.e. Opportunity Corridor) will lessen energy demand by reducing ambient air temperatures during heat waves; and also absorb stormwater at the source to reduce energy needs for pumping and treating stormwater.		Complete and green streets encourage mobility for all and increase residents' ability to access neighborhood amenities and resources by bike, on foot, and via public transit.	Long-term	
Climate resilience criteria for NEORSD green infrastructure grants	Policy	The sewer district's green infrastructure grants program focuses on reducing stormwater runoff, but the co-benefits of green infrastructure also include the mitigation of urban heat island effects and potential reductions in energy usage at the household and neighborhood level.		Green infrastructure grants provide an opportunity to engage residents in greening efforts and increase public understanding of the relationships between stormwater management and climate change.	Mid-term	
Stormwater management on scattered vacant sites. How many sites, and in what configuration, are needed to achieve a significant, measurable improvement in water quality?	Research	The sewer district's green infrastructure program is mostly focused on larger sites and projects. Complementing these projects with smaller, scattered site interventions could reduce the amount of stormwater that is conveyed through the sewer system and treated at water treatment plants. Less water being pumped and treated translates to reduced energy usage.	Large pipes and sewer interceptors have been designed based on current and anticipated wet weather flows. If the weather becomes increasingly unpredictable and stormwater volumes exceed projections, the sewer district's existing and planned gray infrastructure system may need to be adapted to changing circumstances. Complementing large installations with smaller scale, scattered-site green infrastructure may offer greater flexibility in adapting to changing circumstances.	Green infrastructure on scattered sites in city neighborhoods enable people to see, experience, and interact with these installations, increasing public understanding of stormwater management and providing community amenities and gathering places that foster social cohesion.	Mid-term	
Basement and street flooding survey	Research	Identifying problem areas for flooding may help alleviate future flooding projects and energy-intensive clean-up efforts.	Flooding issues are likely to worsen due to the effects of climate change. Getting a baseline understanding of problems today will help us prepare for the future.	Engaging residents in this survey process will open up new conversations about emergency preparedness.	Mid-term	

		Mitigation	Adaptation	Social Cohesion		
	Category	Lessen overall demand for energy and increase renewable energy	Anticipate and prepare for climate changes and shocks	Foster social cohesion	**Timeframe**	**Cost**
Urban Agriculture						
Small food producing sites within 1/4 mile of every resident	Project/Policy	Visible and nearby community gardens may encourage residents to eat less processed and energy-intensive foods.	Food producing sites may provide important nutritional support in the event of major weather events that interrupt the regional, national, or global food supply.	Community gardens provide a place for residents to gather and work together, while also increasing access to healthy food.	Short-term, on-going	
Larger food producing sites in strategic locations to offer greater food security	Project	Urban agriculture at the commercial scale may reduce energy demands by reducing the distance food has to travel before being consumed.	Food producing sites may provide important nutritional support in the event of major weather events that interrupt the regional, national, or global food supply.		Long-term, on-going	
Season-extending infrastructure (greenhouses, hoop houses) to offer year-round food security	Project	Greenhouses and hoop houses can help extend the growing season, although the net effect on energy demand is unknown, since year round food production will require supplemental heating in most cases.	Year-round food producing sites may provide important nutritional support in the event of major weather events that interrupt the regional, national, or global food supply.		Mid-term, on-going	
Urban agriculture research on the impacts of climate change and agricultural diseases	Research	If the weather becomes increasingly unpredictable, research and annual/seasonal alerts can help local growers better time their planting season and reduce crop losses due to late freezes or other weather-related problems.	Current best practices in urban agriculture may need change as the climate conditions change. Research into local changes will be needed to help local growers anticipate climate variations and maintain productive farms and food-producing gardens.	Local growers have established networks in Cleveland. Providing better data on local growing conditions will help foster stronger ties within the urban farming community and also allow for better outreach to home gardeners.	Mid-term	
Energy Generation						
Small scale solar farms on vacant land and at city recreation centers	Project	Dispersed green power generation will help reduce reliance on fossil fuels.	Dispersed green power generation could provide supplemental power in the event of widespread power outages.	Solar energy cooperatives could help build community networks based on shared green energy generation and usage.	Long-term	

		Mitigation	Adaptation	Social Cohesion		
	Category	Lessen overall demand for energy and increase renewable energy	Anticipate and prepare for climate changes and shocks	Foster social cohesion	**Timeframe**	**Cost**
Infill Development						
Concentrate new development near existing transit.(sustainable patterns of development map)	Policy	Greater density near existing transit will lessen overall energy demands by providing greater transit access for more residents, reducing greenhouse gas emissions.	Climate change is likely to lead to higher energy costs. Concentrating infill development near transit stations and major bus lines will increase mobility options for households of all incomes, but will be especially important for an increasing number of households that can't afford to own, maintain, and fuel a car.	Dense neighborhoods organized around transit create opportunities for social interaction.	Long-term, on-going	
Avoid new development on sites that align with culverts, buried streams, and headwaters	Policy	Building above buried waterways creates a future liability--if a culvert fails, this typically creates sink holes that threaten the stability of buildings in the vicinity. Discouraging construction over buried waterways limits the risk of building losses and the embodied energy they represent.	Heavy storms and volatile weather may accelerate the deterioration of older culverts. Choosing not to build (or re-build) on top of culverts anticipates the possibility of culvert failure and limits anticipated losses.	Culverted streams form linear paths throughout the city. Targeting reforestation efforts on vacant sites that align with culverts preserve opportunities for future stream restoration projects and create green connections throughout the city that can be used for walking, biking, and linking residents to neighborhood resources and amenities.	Long-term, on-going	
Map new/anticipated flood plain areas, based on patterns of increased precipitation.	Research		Increased rainfall may cause more frequent flooding, including some areas that were not previously prone to flooding risks. We need to understand how flood plains are changing, and anticipate how they will change, in order to better plan for new development and better protect	Public education about increased rainfall and expanded flood plains may help with emergency preparedness.	Mid-term	
Land use overlay/land bank tool for discouraging new construction in expanded flood plain areas.	Policy	Discouraging construction in flood plain areas may help prevent problems with flooding in the future and reduce energy expenditures associated with post-flood clean-up.	No-build zones in flood plain areas may prevent future flood damage by not putting people and buildings in harm's way.	Helping people understand the topography of greater Cleveland and the risks of building in flood zones will help foster a shared understanding of how to live with unpredictable weather and increased rainfall.	Long-term	
Retrofits for housing in areas that are prone to flooding.	Program	Although sump pumps consume energy, the targeted installation of these devices may result in a net energy savings if anticipated flooding damage is averted.	There are existing houses in areas that are prone to flooding, or likely to experience flooding in the future. Providing the most vulnerable households with the tools and knowledge to reduce flooding damage is one way to prepare for future climate changes and shocks.	Public education about increased rainfall and expanded flood plains may help with emergency preparedness.	Mid-term	

Appendix C:

Climate Change in Cleveland Literature Review

Prepared by:

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1. EXECUTIVE SUMMARY

Taking action around climate change is a key component of the Sustainable Cleveland 2019 initiative. By integrating sustainability into the City of Cleveland's municipal operations, residents' lives, and the priorities of local corporate and institutional partners, the city can reduce greenhouse gas emissions and grow the economy. However, while these efforts will help to slow global warming and create jobs, changes in the climate will continue for many decades because of the inertia of Earth's atmosphere. These climate impacts may add stress to vulnerable populations, infrastructure, and ecosystems.

This appendix describes how climate impacts may affect Cleveland, Ohio. The findings are based on current peer-reviewed scientific literature, climate projections, and assessments conducted for the U.S. Global Change Research Program (http://www.globalchange.gov/). After this brief introduction, the second section of this report outlines the physical changes in temperature, precipitation, and extreme weather events:

- *Increased Temperatures:* From 1956 to 2012, the average annual temperature in Cleveland increased by 2.4°F. By 2070, the average annual temperature may warm by an additional 4°F. These higher temperatures may increase the number of heat-related deaths, reduce water quality in Lake Erie, strain food systems, degrade air quality, and put pressure on native plants and animals.
- *Changes in Precipitation Patterns:* From 1956 to 2012, the average annual precipitation in Cleveland increased by 25.8%. During the autumn, the increase was greater at 57.4%. Heavy rain events and lake effect snow are expected to increase with a warming climate. This may cause flooding, a reduction in river and stream quality, and increased maintenance costs.
- *Extreme Weather Events:* Weather-related threats in Northeastern Ohio include severe storms, flooding, lake effect snow, tornadoes, temperature extremes, and erosion/landslides. A warming climate and decreasing ice cover on Lake Erie may cause an increase in the frequency and intensity of these extreme weather events, threatening human life and causing significant property damage.

The third, and final section of the report summarizes how the above increased temperatures, changes in precipitation patterns, and extreme weather events may affect local sectors and systems:

- *Public Health:* Increased heat wave frequency and intensity, increased humidity, degraded air quality, reduced water quality, and change in vector borne disease patterns may increase public health risks.
- *Water Quality:* Climate change may exacerbate a range of risks to Lake Erie, including harmful algal blooms, an increased number of combined sewer overflows, and declining beach health.
- *Food Systems:* In the next few decades, longer growing seasons and rising carbon dioxide levels may increase crop yields, though those benefits could be offset by extreme weather events. In the long term, climate change is expected to decrease agricultural productivity.
- *Forests and Land Cover:* The composition of forests is changing as the climate warms. Many tree species are shifting northward, with more southerly varieties replacing them. Iconic tree species (e.g., Buckeye) may slowly be replaced by other species in the next century.
- *Energy and Industry:* Cleveland has an energy-intensive economy with per capita greenhouse gas emissions higher than the national average. Warmer temperatures are expected to reduce building heating loads, but these gains may be offset by increased reliance on air-conditioning.

- *Transportation Systems:* Ice cover declines may lengthen the commercial navigation season on Lake Erie. An increased number of freeze-thaw cycles, flooding and erosion, lake effect snow, and heat waves may cause significant damage to local transportation infrastructure.
- *Fish and Wildlife:* The effects of increased heat stress, flooding, drought, and late spring freezes on natural and developed ecosystems may be magnified by pest prevalence, increased competition from non-native or opportunistic native species, ecosystem disturbances, and land-use change.

2. CLIMATE TRENDS

This section of the report outlines the physical changes in temperature, precipitation, and extreme weather events. Additional detail is available in Appendix D: a historical climatology of Cleveland, Ohio provided by the University of Michigan Climate Center.

2.1. Changes in Temperature

The average annual temperature in Cleveland increased by 2.4°F from 1956 through 2012, with 2012 considered Cleveland's warmest year on record (City of Cleveland Office of Sustainability 2013). The warming trend was greatest during the winter; from December through February the average temperature increased by 3.4°F (Table 1). Climate change projections indicate that the average annual temperature may increase by an additional 1.8 to 5.4 °F by the year 2050 (Great Lakes Integrated Sciences + Assessments, Michigan Office of the State Climatologist et al. 2012).

Table 1: Changes in Average Temperature in Cleveland from 1956 through 2012

Season	ºF	ºC
Winter (December – February)	3.4	1.9
Spring (March – May)	2.7	1.5
Summer (June – August)	2.6	1.5
Fall (September – November)	0.7	0.4
Annual	2.4	1.3

Source:GLISA (Great Lakes Integrated Sciences + Assessments, Michigan Office of the State Climatologist et al. 2012)

2.2. Changes in Precipitation Patterns

Annual precipitation increased by 25.8% from 1956 to 2012 (Great Lakes Integrated Sciences + Assessments, Michigan Office of the State Climatologist et al. 2012). The increase in precipitation varies by season, with both the winter and fall seasons showing the highest increase in total precipitation of 40.4% and 57.8% respectively (Table 2).

Table 2: Changes in Precipitation in Cleveland from 1956 through 2012

Season	Inches	Centimeters	%
Winter (December – February)	2.9	7.3	40.4
Spring (March – May)	1.4	3.5	14.3
Summer (June – August)	0.1	0.2	0.8
Fall (September – November)	5.3	13.3	57.4
Annual	9.8	24	25.8

Source:GLISA (Great Lakes Integrated Sciences + Assessments, Michigan Office of the State Climatologist et al. 2012)

The average number of days per year exceeding 1.25 inches of precipitation has increased by an average of 1.5 days per year (Great Lakes Integrated Sciences + Assessments, Michigan Office of the State Climatologist et al. 2012). In addition, heavy rainfall days (top 1% of daily precipitation totals) have increased by 16.3% (Great Lakes Integrated Sciences + Assessments, Michigan Office of the State Climatologist et al. 2012).

The impacts of changing precipitation levels varies across the United States, with some regions experiencing drought while other regions face flooding. Any changes in precipitation levels is accompanied by a modification of the water supply, mainly due to changes in groundwater recharge (Winkler, Andresen et al. 2014).

2.3. Extreme Weather Events

As atmospheric warming occurs, the likelihood of extreme weather events increases. This is due to increased energy in the atmosphere and a gradual warming of the Great Lakes.

To this end, the annual average ice coverage of the Great Lakes has declined by 71% from the year 1973 to 2010 (Great Lakes Integrated Sciences + Assessments, Michigan Office of the State Climatologist et al. 2012). For Northeastern Ohio, a warming Lake Erie and decreasing ice cover may cause an increase in the frequency and intensity of heavy precipitation and lake effect snow.

These expected changes have already been recorded by regional weather stations; heavy storm precipitation has increased by 37% from the year 1958 to 2012 in the Midwest (Great Lakes Integrated Sciences + Assessments, Michigan Office of the State Climatologist et al. 2012). Other extreme events like heat waves, flooding and associated erosion/landslides, are expected to continue (City of Cleveland Office of Sustainability 2013, Winkler, Andresen et al. 2014).

3. CLIMATE IMPACTS

This section of the report summarizes how the above increased temperatures, changes in precipitation patterns, and extreme weather events may affect sectors and systems in Cleveland.

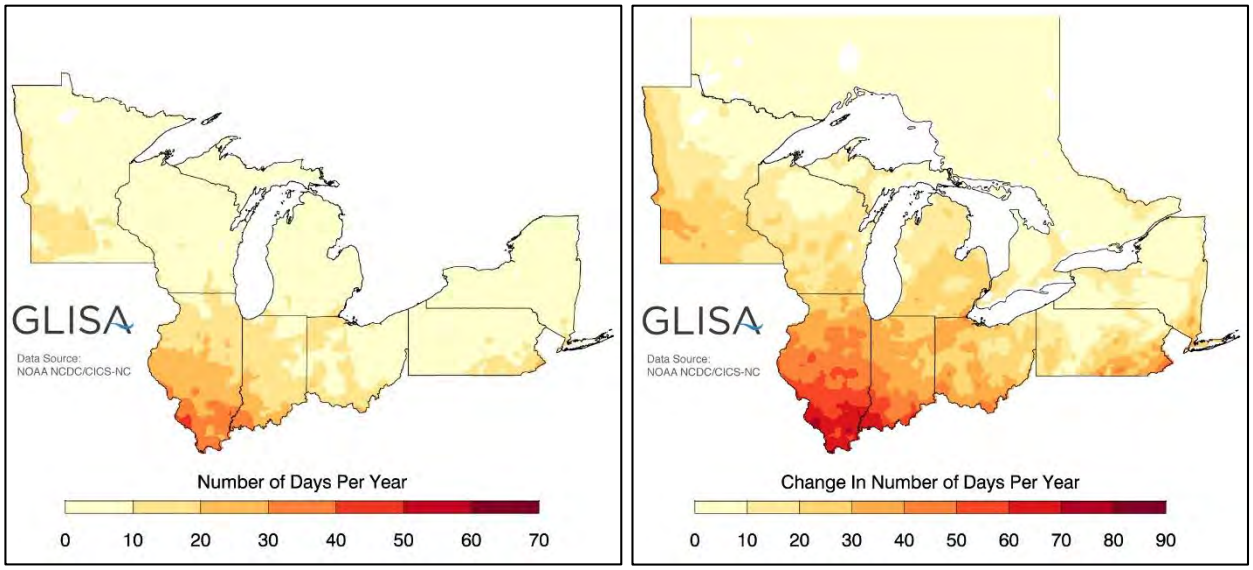
3.1. Public Health

Human vulnerability to the impacts of climate change has a health, social and economic dimension. Of those impacts, heat-related threats are commonly associated with climate change. In Cleveland, the number of days with temperatures over 90 °F has increased by 4.2 days from the year 1956 to 2012 (Great Lakes Integrated Sciences + Assessments, Michigan Office of the State Climatologist et al. 2012), it is projected that by the year 2070 the number of days will increase by an additional 20-30 days (Figure 2). Changes in vector borne disease patterns, such as the increased risk of the West Nile virus, have also been linked to a changing climate.

In addition to heat waves, increased humidity and degraded air and water quality both impact public health. These impacts are exacerbated if extreme weather events occur, as witnessed with the recent heat wave in India that resulted in the death of over a thousand people and hospitalizing hundreds (Liberto 2015), an event predicted in previous climate change research (Murari, Ghosh et al. 2015).

It is crucial to understand, though climate change is a challenge that faces everyone, the impact is not distributed proportionately. Minorities living in areas characterized by high poverty rates, aging infrastructure, air pollution, degraded urban spaces, lack of access to health care and basic

services are more vulnerable to the negative impacts of climate change. This indicates a need for community based responses that strengthen local ability to prevent morbidity and mortality.



Figures 1 & 2: Historical Number of Days Over 90°F (left) and Projected Change in the Number of Days Over 90°F, Emissions Scenario B1, 2041-2070 (right). S*ource: GLISA, NOAA NCDC/CICS-NC*

3.2. Water Quality

Climate change can have a variety of impacts on water quality. Warming water temperatures accompanied with increased evaporation rates, decreasing water levels intensifies the range of risks to Lake Erie's chemistry and ecology (Baule, Gibbons et al. 2014). This includes harmful algal blooms as a result of reduced water velocities and higher lake water residence time (Whitehead, Wilby et al. 2009). In addition, increased nutrient loading in the lake is intensified by stronger storms and runoff from impervious surfaces (Baule, Gibbons et al. 2014, Winkler, Andresen et al. 2014). Increases in water acidity as a direct consequence of the elevating carbon dioxide levels may also occur (Baule, Gibbons et al. 2014).

The competition for freshwater will also increase the challenges facing water managers to meet the varying needs of communities. Flooding and heavy precipitation events can cause uncontrolled sewer discharges from urban area to surrounding water courses. Erosion and increased storm-induced agricultural runoff can lead to non-point source pollution of watersheds (Winkler, Andresen et al. 2014). With older infrastructure in many neighborhoods of the city, reinforcing the city's overall aging sewer and water infrastructure is critical.

Pollution from agricultural runoff and wastewater discharges results in a decline of beach health, limiting the economic and recreational benefits of Lake Erie. Pollution of beaches also degrades beach habitat for animals and plants, increases public health risks, and reduces surrounding property values (EPA 2015).

3.3. Food Systems

The impacts of climate change on the food systems are complex, with direct correlation to the existing socioeconomic conditions. Existing research discusses the role of climate change on agricultural yields and food quality (Winkler, Andresen et al. 2014). In the Midwest, the frost-

free season has lengthened by a total of 9 days from 1958-2012 (Great Lakes Integrated Sciences + Assessments, Michigan Office of the State Climatologist et al. 2012). In the next few decades, longer growing seasons and rising carbon dioxide levels may increase the yield of some crops.

However, those benefits are expected to be progressively offset by extreme weather events such as flooding, wildfires, and drought. At the same time, spring freeze events during the initial stages of development of crops will increase over time, resulting in production losses. In the long term, climate change is expected to decrease agricultural productivity. The impacts of climate change on food systems also extend to livestock production through warming temperatures, drought, and limited water availability.

3.4. Forests and Land Cover

Changes in land cover is directly associated with impacts on the natural and built environment. While land cover consistently evolves over time as a result of social and economic conditions (Loveland, Mahmood et al. 2012), alterations that result from climate change need to be addressed. For example, the composition of forests is altering as the climate warms. Driven by higher temperatures and increasing concentration of carbon dioxide, changes in the ecological communities and processes of forest are more likely to occur (Winkler, Andresen et al. 2014). Continuous changes in land-use and invasive species can also diminish a city's tree canopy.

Species invasion is becoming more prevalent as a result of climate change. While many tree species are migrating northward to areas with more favorable climate conditions, with more southerly varieties replacing them, iconic tree species will slowly be replaced by other species in the next century (Baule, Gibbons et al. 2014, Winkler, Andresen et al. 2014). Moreover, outbreaks of pathogens, wildfires, and high winds aggravate the risks to the forest sector.

3.5. Energy and Industry

Cleveland has an energy-intensive economy with per capita greenhouse gas emissions higher than the national average (City of Cleveland Office of Sustainability 2013). Warmer temperatures will reduce building heating loads, but these gains may be offset by increased reliance on air-conditioning and cooling requirements for buildings.

Besides changing patterns of energy consumption, climate change will impact energy production. Decreasing hydropower and increasing demands for water used for cooling of power plants impact the efficiency of power generation. Increasing peak demand for electricity will most likely occur in the summer; this will require the need for investments in sufficient energy infrastructure and increased electric generating capacity (Whitehead, Wilby et al. 2009, Wilbanks, Fernandez et al. 2014). The combined effects of increased demand for electricity and depleting water supplies as a result of warming temperatures and evaporation rate place further pressures on existing water resources.

3.6. Transportation Systems

While most transportation system designs take into account extreme weather events by referring to historical records, the evolving impacts of climate change indicate the need for a more reliable predictor of future weather events (National Research Council . Transportation Research, National Research Council . Committee on Climate et al. 2008). Though damages to local transportation infrastructure are anticipated, the accumulated effect will increase the risk of disruption to land, air and marine based transportation systems on a national level (National

Research Council . Transportation Research, National Research Council . Committee on Climate et al. 2008, Baule, Gibbons et al. 2014, Winkler, Andresen et al. 2014).

On a local level, an increased number of freeze-thaw cycles, flooding and erosion, lake effect snow, and heat waves may cause significant damage to existing transportation infrastructure such as heat damage to pavements and rails. These changes require increased maintenance costs and may hinder the construction of new road and highway systems and disrupt traffic movement. On the positive side, reduced annual amounts of snowfall cover may improve mobility and reduce costs related to snow and ice removal.

Ice cover declines will lengthen the commercial navigation season on Lake Erie (Baule, Gibbons et al. 2014). Yet, declining water levels in the Great Lakes region pose new restriction on ship weights. Extreme precipitation events may impede shipping and navigation processes accompanied by physical damage to docks and harbor facilities (Winkler, Andresen et al. 2014).

3.7. Fish and Wildlife

The impact of climate change of fish and wildlife are numerous including habitat fragmentation, life cycle disruption, and the interaction with new species (Winkler, Andresen et al. 2014). Warmer air temperatures and changes in rainfall patterns place certain species at more risk than others. The effects of increased heat stress, flooding, and late spring freezes on natural and developed ecosystems may be magnified by pest prevalence, increased competition from non-native or opportunistic native species, ecosystem disturbances, and land-use change.

Aquatic ecosystems are equally or more sensitive to change in the climate system as humans. Increased water temperatures and atmospheric concentration of carbon dioxide have a direct impact on the fish populations and their life cycles. Some migrating species and hibernation patterns are connected to climatic conditions; with changes to these conditions, a disruption of these patterns is likely to occur. Stress on Lake Erie is also intensified due increased temperature stratification and hypoxic conditions (Winkler, Andresen et al. 2014). Therefore, fish and wildlife planning and management must take into account the impacts of climate change on these systems.

4. REFERENCES

Baule, W., E. Gibbons, L. Briley and D. Brown. (2014). "Synthesis of the Third National Climate Assessment for the Great Lakes Region." from http://glisa.umich.edu/media/files/Great_Lakes_NCA_Synthesis.pdf.

City of Cleveland Office of Sustainability. (2013). "Cleveland Climate Action Plan: Building Thriving and Healthy Neighborhoods." from http://www.sustainablecleveland.org/resources/climate-action-plan/.

EPA. (2015). "Beach Health." from http://www2.epa.gov/beaches/learn-beach-health#climate.

Great Lakes Integrated Sciences + Assessments, Michigan Office of the State Climatologist and Midwest Regional Climate Center. (2012). "Climate Change in the Great Lakes Region." from http://glisa.umich.edu/media/files/GLISA_climate_change_summary.pdf.

Great Lakes Integrated Sciences + Assessments, Michigan Office of the State Climatologist and Midwest Regional Climate Center. (2012). "Historical Climatology: Cleveland, Ohio."

Liberto, T. D. (2015). "India heat wave kills thousands." 2015, from http://www.climate.gov/news-features/event-tracker/india-heat-wave-kills-thousands.

Loveland, T., R. Mahmood, T. Patel-Weynand, K. Karstensen, K. Beckendorf, N. Bliss and A. Carleton (2012). "National climate assessment technical report on the impacts of climate and land use and land cover change." US Geological Survey Open-File Report **1155**: 87.

Murari, K. K., S. Ghosh, A. Patwardhan, E. Daly and K. Salvi (2015). "Intensification of future severe heat waves in India and their effect on heat stress and mortality." Regional Environmental Change **15**: 569-579.

National Research Council . Transportation Research, B., C. National Research Council . Committee on Climate, U. S. Transportation, E. National Research Council . Division on and S. Life (2008). Potential impacts of climate change on U.S. transportation. Washington, D.C Transportation Research Board.

Whitehead, P., R. Wilby, R. Battarbee, M. Kernan and A. J. Wade (2009). "A review of the potential impacts of climate change on surface water quality." Hydrological Sciences Journal **54**(1): 101-123.

Wilbanks, T. J., S. Fernandez, G. Backus, P. Garcia and K. K. Jonietz (2014). Climate Change and Infrastructure, Urban Systems, and Vulnerabilities: Technical Report for the US Department of Energy in Support of the National Climate Assessment, Island Press.

Winkler, J. A., J. A. Andresen, J. L. Hatfield, D. Bidwell and D. Brown (2014). Climate Change in the Midwest: A Synthesis Report for the National Climate Assessment. Washington, D.C., Island Press.

Appendix D:

Historical Climatology: Cleveland, Ohio

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Historical Climatology: Cleveland, Ohio

GLISA
A NOAA RISA TEAM

Overview and Geography

Cleveland, Ohio is located in Northeastern Ohio on the southern shore of Lake Erie. It's the county seat of Cuyahoga County, the most populous county in the state. Cleveland sits atop a series of bluffs that run perpendicular to the lake. As a result, the land rises quickly from the lakeshore to approximately 800 feet near the location of this climatology station at Hopkins airport.

Relative to the rest of the Great Lakes region, Cleveland typically experiences hot and humid summers and generally mild winters with cold snaps and abundant snowfall. Lake-effect snowfall is a frequent occurrence. By some measures, Cleveland is at the western end of the Lake Erie snow belt. Lake effect snowfall is more pronounced in eastern areas of the city than in western sections where the observations described here were taken.

Summary of Observed Changes

Rising average temperatures: Annual average temperatures warmed by 2.4°F from 1956-2012, faster the national and global rates. Average low temperatures have warmed faster than high temperatures.

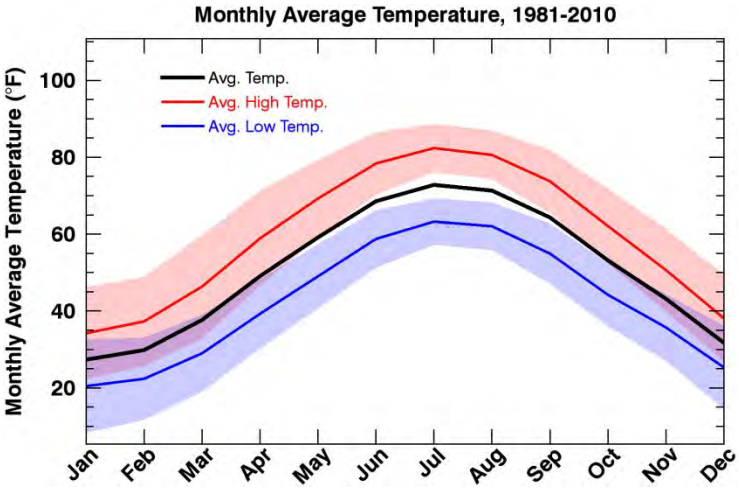
Longer freeze-free season: The freeze-free season (growing season), lengthened by 20 days from 1956-2012.

More precipitation: Total annual precipitation increased steeply by 25.8% from 1956 through 2012 while summer precipitation remained relatively unchanged.

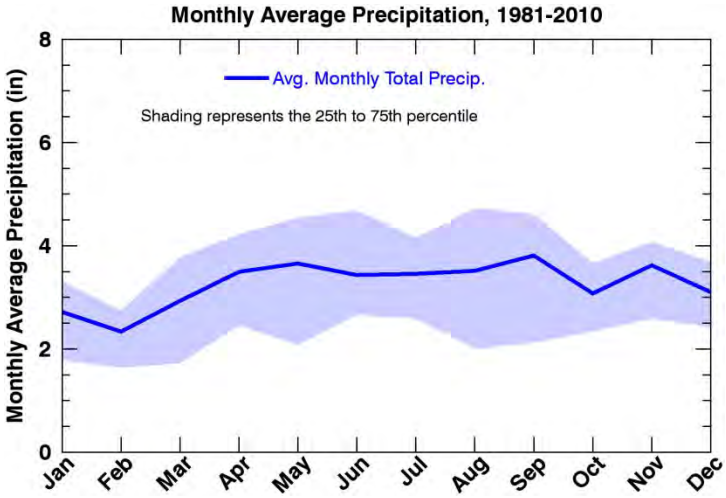
More heavy precipitation: From the 1961-1990 period to the 1981-2010 period, the amount of precipitation falling during the heaviest 1% of precipitation events increased by 22.2%.

Recent Climate Summary: 1981-2010 Temperature and Precipitation

Average Temperature	50.8°F
Average Low Temperature	42.1°F
Average High Temperature	59.4°F
Days/Year that exceed 90°F	7.4
Days/Year that fall below 32°F	108.5
Lowest Annual Average Temperature	48.9°F
Highest Annual Average Temperature	53.6°F
Average Annual Precipitation Total (in)	39.1 in
Lowest Annual Precipitation Total (in)	29.6 in
Highest Annual Precipitation Total (in)	53.9 in
Days/Year that exceed 1.25" of Precipitation	3.6

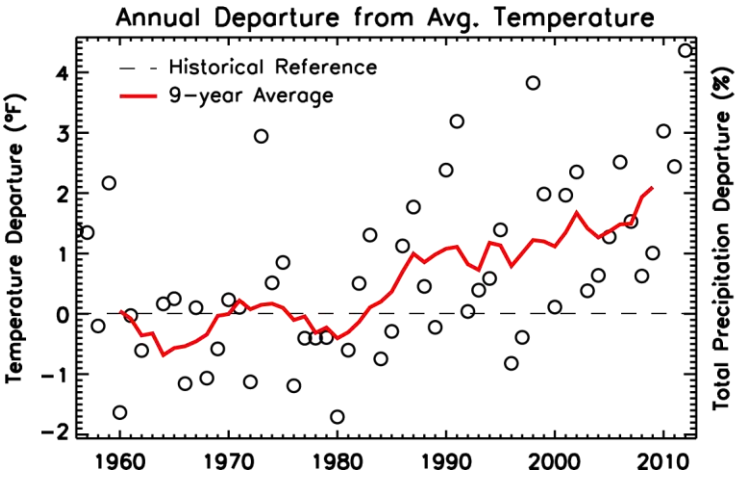


Average monthly temperatures during the 1981-2010 period. Shaded bands represent the standard deviation.

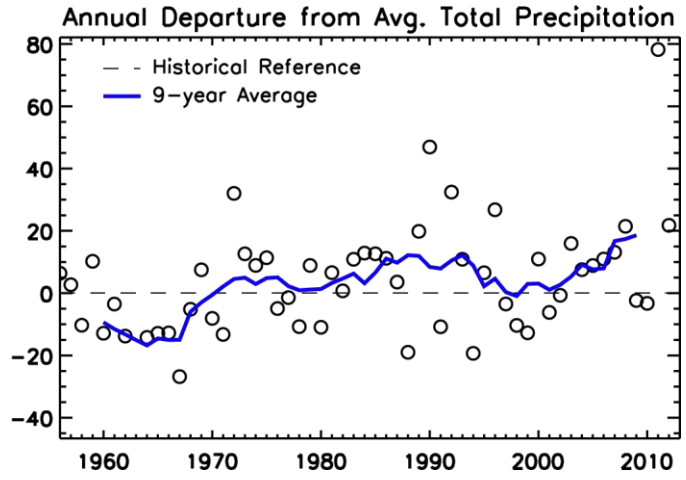


Average monthly total precipitation for the 1981-2010 period. The shaded band represents the 25th to 75th percentile.

Changes in Average Temperature and Precipitation



Annual departures from the 1961-1990 average annual temperature. The solid red line is the 9-year moving average. Open circles represent the departure for a single year.



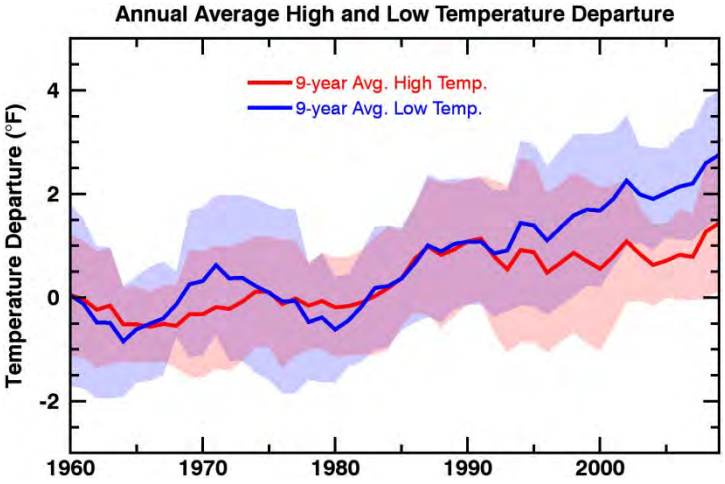
Annual departures from the 1961-1990 average of total annual precipitation. The solid blue line is the 9-year moving average. Open circles represent the departure for a single year.

Changes in Average Temperature from 1956 through 2012	°F	°C
Annual	*2.4*	*1.3*
Winter, December-February	3.4	1.9
Spring, March-May	2.7	1.5
Summer, June-August	2.6	1.5
Fall, September-November	0.7	0.4

Changes in Total Precipitation from 1956 through 2012	in	cm	%
Annual	*9.5*	*24*	*25.8*
Winter, December-February	2.9	7.3	40.4
Spring, March-May	1.4	3.5	14.3
Summer, June-August	0.1	0.2	0.8
Fall, September-November	5.3	13.3	57.4

Typical for the Midwestern United States, temperatures have been rising steadily since the 1960s. Annual average temperatures warmed by 2.4°F from 1956-2012, faster than the national and global rates. While all seasons have warmed, winter has warmed significantly faster and the fall significantly slower.

Annual precipitation totals rose steeply by 25.8% from 1956-2012, which is well above the trend for the surrounding region. Winter, spring, and fall have seen an increase in precipitation, with summer remaining relatively stable a noticeably smaller increase compared to the 1961-1990 average.

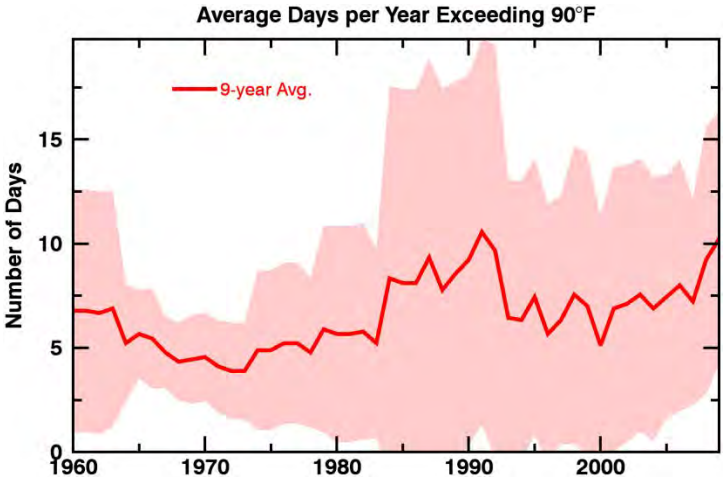


Changes in Average High and Low Temperatures from 1956-2012	°F	°C
Highs	**+1.8**	**1**
Lows	**+3.0**	**1.7**

Overnight low temperatures warmed faster than mid-day high temperatures from 1956 through 2012. This may mean that temperatures have been cooling less overnight than they have warmed during mid-day.

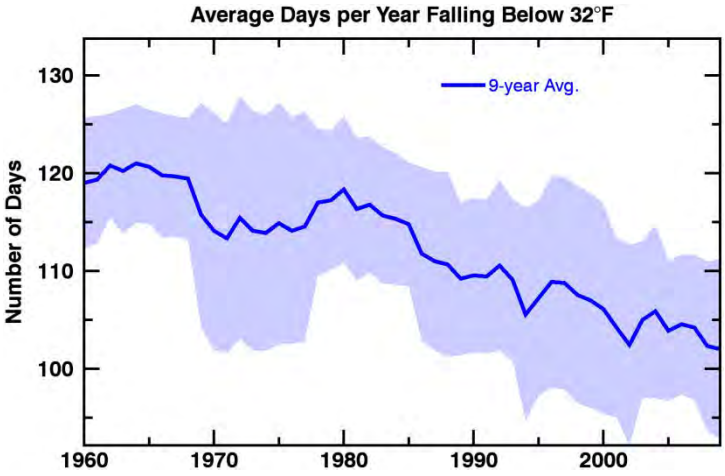
Left: Departures from the 1961-1990 average high and low temperatures. The red and blue lines are the 9-year moving averages. The shaded bands represent the standard deviations.

Changes in Hot and Cold Days



The red line represents the 9-year moving average of the number of days per year exceed 90°F. The shaded band represents the standard deviation.

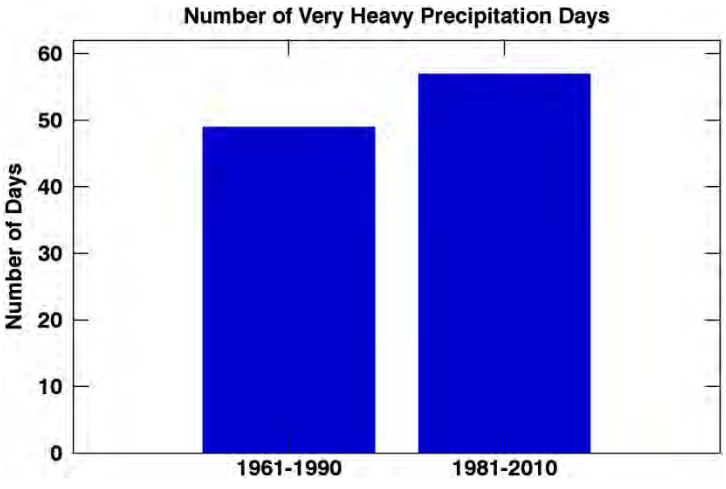
The number of days per year that exceed 90°F has increased slightly by 4.2 days from 1956 through 2012. Even as average temperatures have warmed across the region, the number of days per year exceeding 90°F remains variable throughout the region.



The blue line represents the 9-year moving average of the number of days per year falling below 32°F. The shaded band represents the standard deviation.

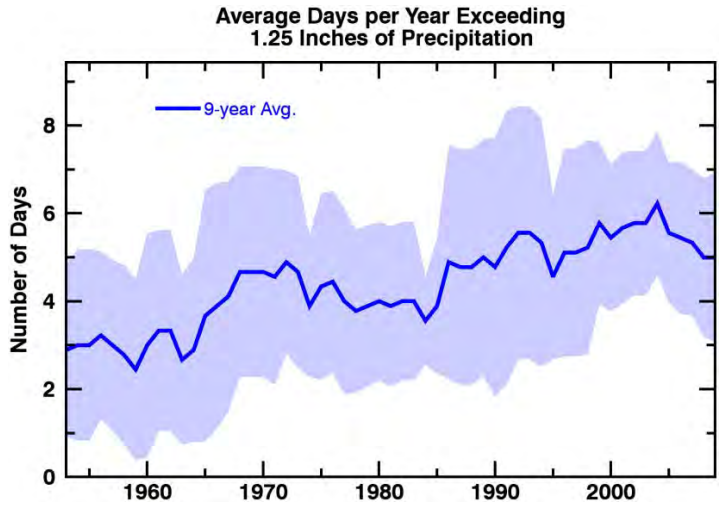
The number of days per year that record a freezing temperature dropped by 19.2 from 1956 through 2012, consistent warmer temperatures, an increase in the growing season and shorter winters.

Heavy Precipitation



The number of daily precipitation totals for the 1961-1990 and 1981-2010 periods that exceeded the size of the heaviest 1% of storms as defined by the 1961-1990 period.

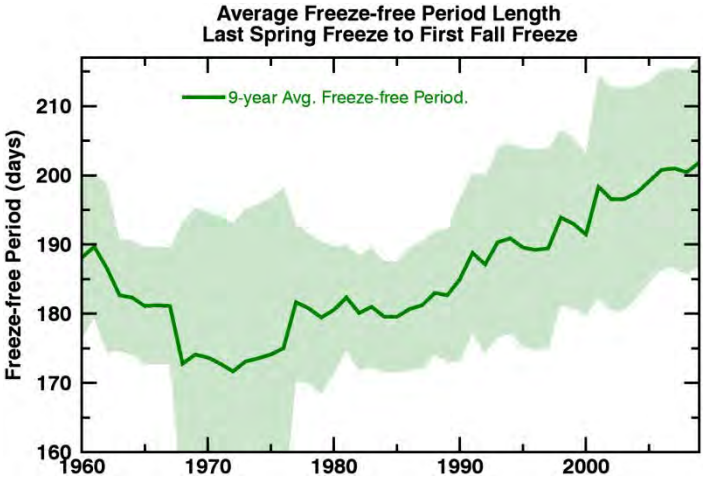
A "Very Heavy" Precipitation Day, as defined by the National Climate Assessment, is in the top 1% of daily precipitation totals. These precipitation events are typically disruptive and can cause infrastructure damage. Cleveland has seen a 16.3% increase in the number of these precipitation events (49 storms from 1961-1990 to 57 storms from 1981-2010). The cumulative change in the precipitation falling during these events was 22.2%.



The blue line represents the 9-year moving average of the number of days per exceeding a daily total of 1.25 inches of precipitation. The shaded band represents the standard deviation.

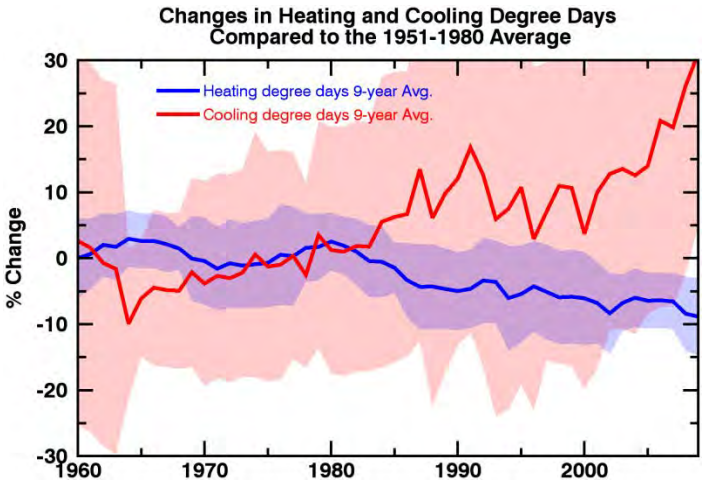
Daily precipitation totals that exceed 1.25" may lead to nuisance flooding and minor infrastructure impacts in some areas. Cleveland now sees approximately 3.6 such days per year, 1.5 more per year, on average, than in the past.

Changes in Seasonality



The freeze-free season (growing season), lengthened by 20 days from 1956-2012. The average date of first freeze is arriving 9.4 days later and the average date of last freeze is arriving 10.6 days earlier. An abnormally short freeze-free period in 1972 of 121 days is responsible for the short-term drop in the 9-year moving average through the late 60s and early 70s.

Left: The green line represents the 9-year moving average of length of the time between the last freeze of spring and the first freeze of fall, the freeze-free period. The shaded band represents the standard deviation.



The percent change in heating and cooling degree day units from the 1961-1990 average. The red and blue solid lines represent the 9-year moving average. The shaded bands show the standard deviation.

Heating and cooling degree days are indexed units, not actual days, which roughly describe the demand to heat or cool a building. Cooling degree days accumulate on days warmer than 65°F when cooling is required. Heating degree days accumulate on days colder than 65°F when heating is required. Extremely hot days accumulate heating degree day units faster than a mildly warm day, and similarly, bitterly cold days accumulate cooling degree day units much faster than a mildly chilly day. Cleveland sees far more days that require heating than it does days that require cooling, and so it accumulates far more heating degree days than cooling degree days in a given year.

From 1956 through 2012, total annual cooling degree days have increased by 28% while heating degree days have fallen by 11%, consistent with warming temperatures. Due to its relatively cool, Midwestern climate, however, the actual decline of 679 heating degree day units has outpaced the increase of 190 cooling degree day units.

Data was recorded at Hopkins Airport, WBAN ID: 14820. While the entire climate record is longer than what is presented here, the station was relocated in 1956 following other systemic changes. As a result, temperature data recorded before that time may be discontinuous with highly reliable data recorded during and after 1956, presented here.

Appendix E:

County and Neighborhood Vulnerability Maps

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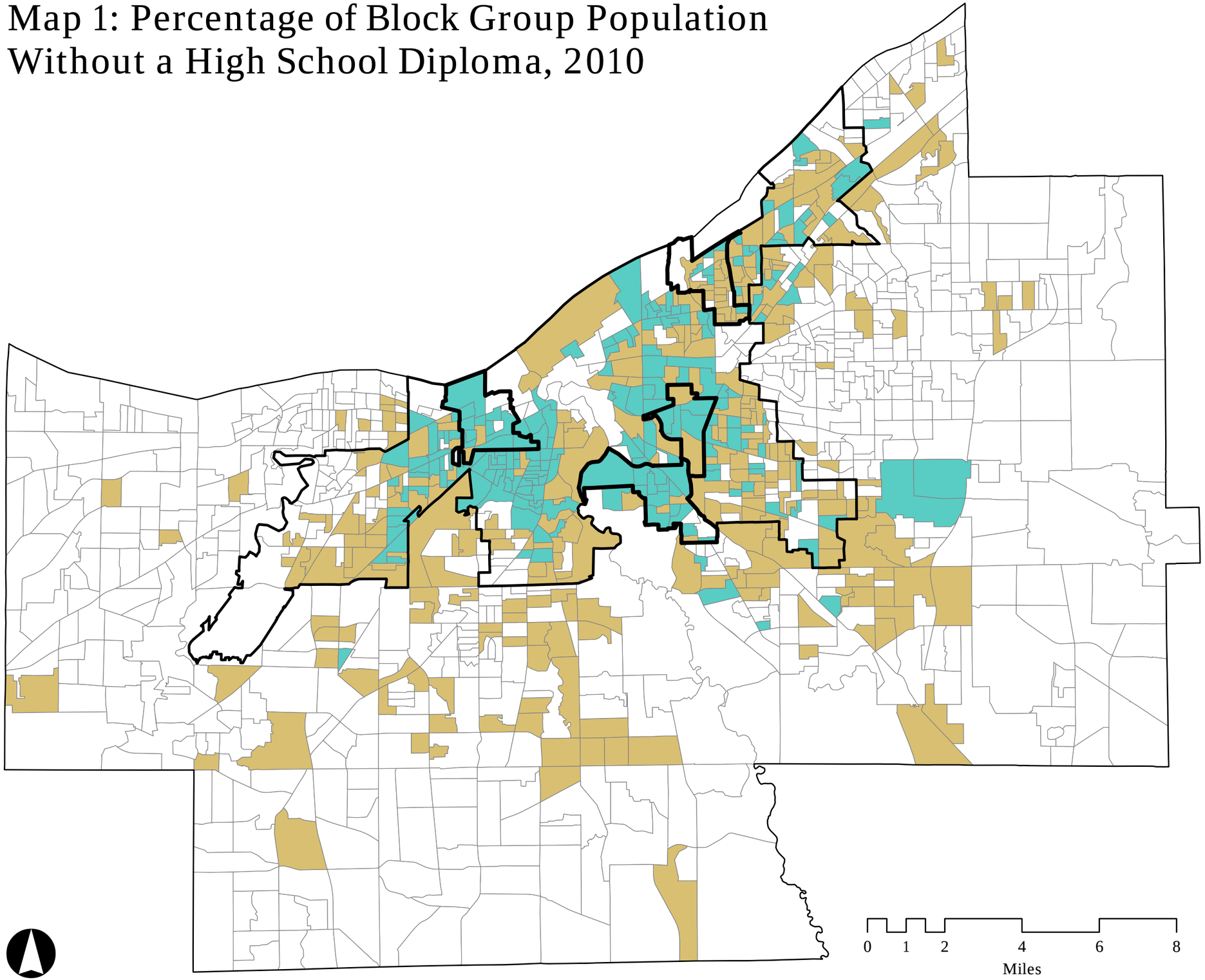
VULNERABILITY MAP MATRIX

				Social Factors					
				Map 1	Map 2	Map 3	Map 4	Map 5	Map 6
				Without a High School Diploma A percent of total population within block group	**Over the Age of 65** A percent of total population within block group	**Non-White** A percent of total population within block group	**Living Below Poverty Level** A percent of total population within block group	**Living in Rental Properties** A percent of total population within block group	**Without a Vehicle** A percent of total population within block group
				Low: 0% - 15% **Medium**: 16% - 28% **High**: 29% - 70%	**Low**: 0% - 15% **Medium**: 16% - 22% **High**: 23% - 67%	**Low**: 0% - 42% **Medium**: 43% - 78% **High**: 79% - 100%	**Low**: 0% - 18% **Medium**: 19% - 36% **High**: 37% - 100%	**Low**: 0% - 38% **Medium**: 39% - 64% **High**: 65% - 100%	**Low**: 0% - 14% **Medium**: 15% - 29% **High**: 30% - 88%
Physical Factors	Map I and I-A	**Land Coverage: Impervious Surface** A percent of total land cover within block group	**Low**: 0% - 43% **Medium**: 44% - 57% **High**: 58% - 89%	I-1	I-2	I-3	I-4	I-5	I-6
	Map T and T-A	**Land Coverage: Tree Canopy** A percent of total land cover within block group	**Low**: 0% - 28% **Medium**: 29% - 41% **High**: 42% - 76%	T-1	T-2	T-3	T-4	T-5	T-6
	Map B	**Buildings Constructed Before 1939** A percent of total buildings within block group	**Low**: 0% - 32% **Medium**: 33% - 60% **High**: 61% - 100%	B-1	B-2	B-3	B-4	B-5	B-6
	Map F amd F-A	**FEMA Flood Zone** A percent of total land cover witihin block group	**Low**: 0% - 3% **Medium**: 4% - 12% **High**: 13% - 82%	F-1	F-2	F-3	F-4	F-5	F-6

Map 1: Percentage of Block Group Population Without a High School Diploma, 2010



Legend:

Social:
Without a High School Diploma

Low	1	0% - 15%
Medium	2	16% - 28%
High	3	29% - 70%

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

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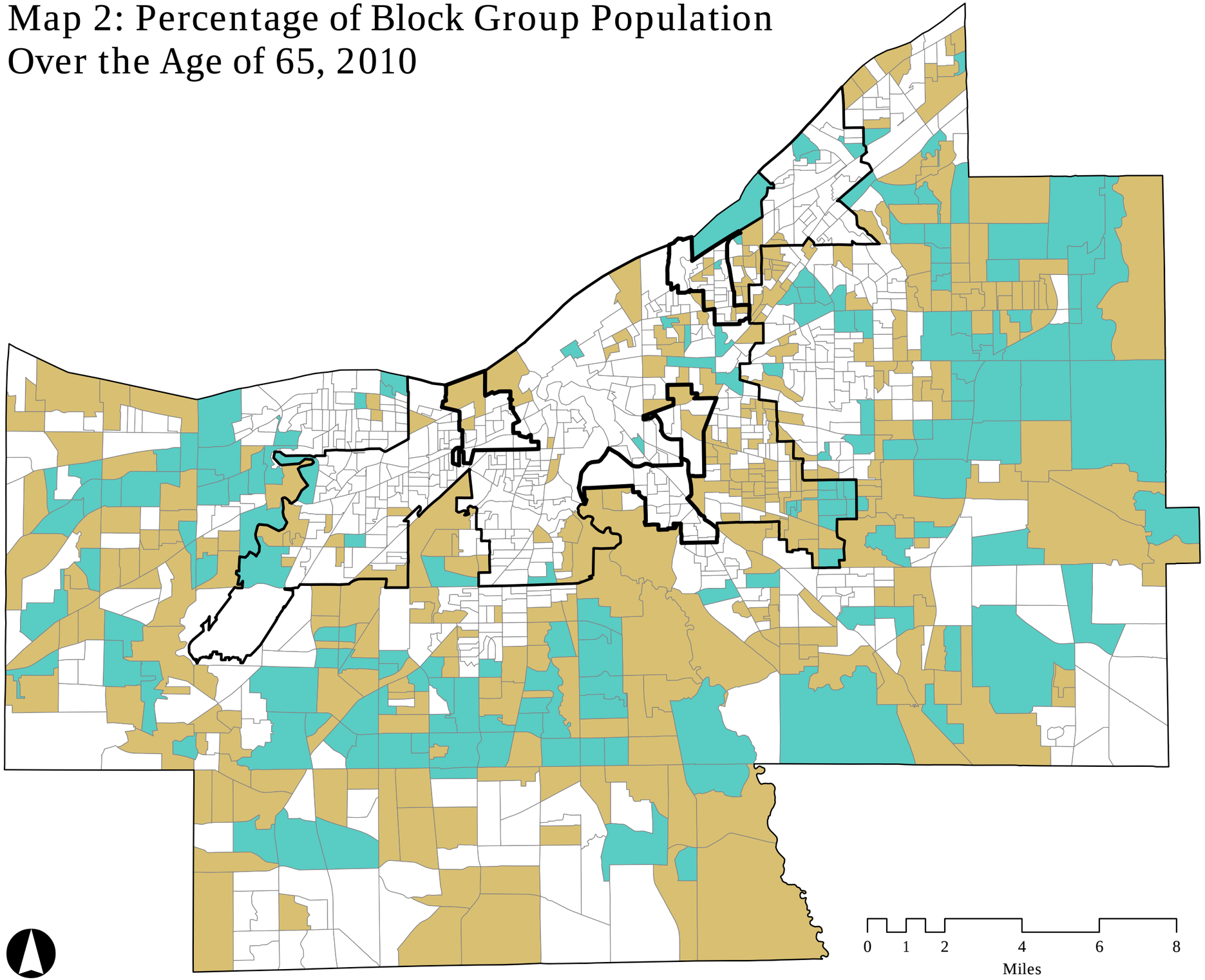
Maps Created:

Tuesday, June 23, 2015

Map 2: Percentage of Block Group Population Over the Age of 65, 2010



Legend:

Social:
Over the Age of 65

Low	1	0% - 15%
Medium	2	16% - 22%
High	3	23% - 67%

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

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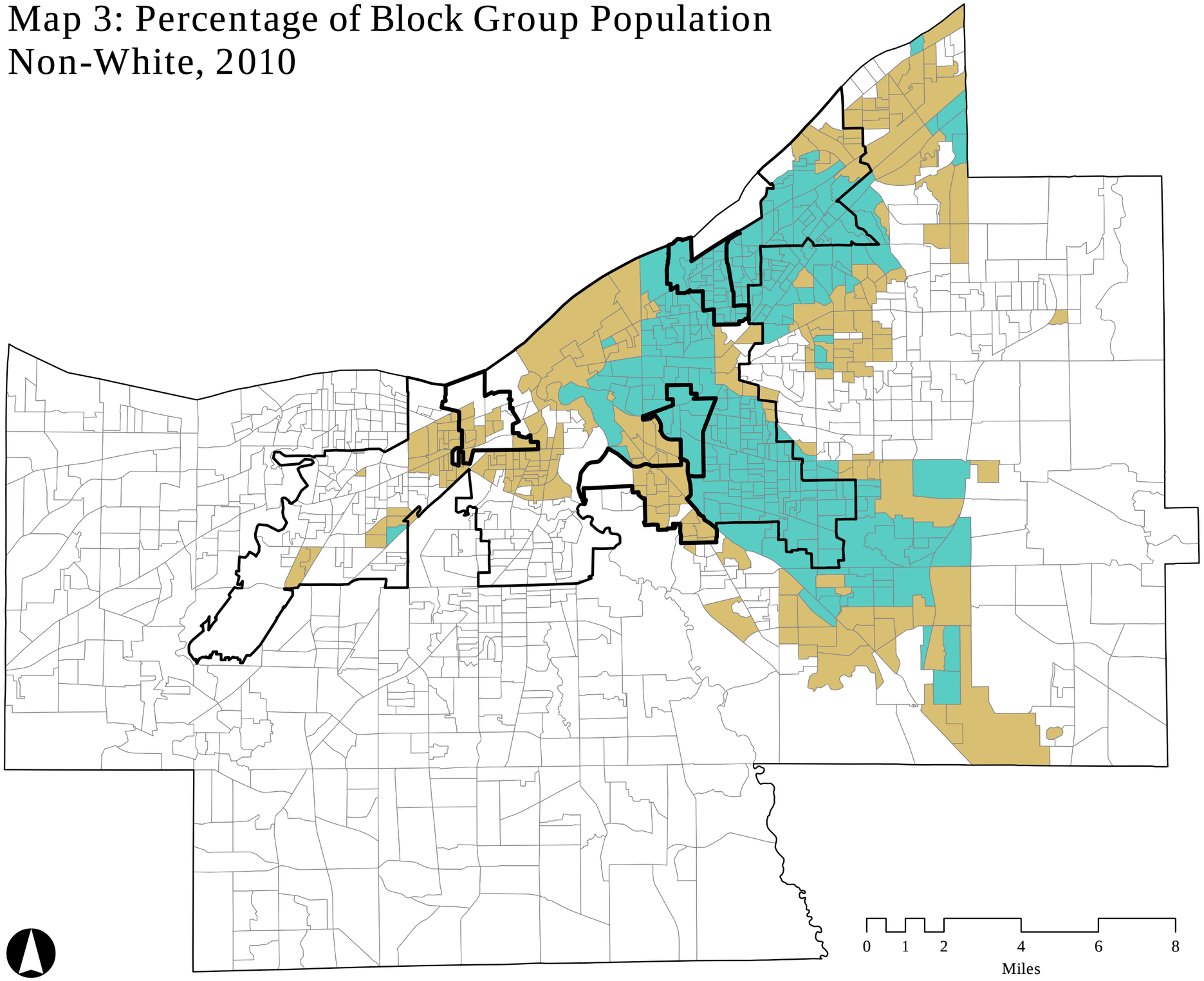
Contact: ResilientCleveland@gmail.com

Maps Created:

Tuesday, June 23, 2015

Map 3: Percentage of Block Group Population Non-White, 2010



Legend:

Social:
Non-White

Low	1	0% - 42%
Medium	2	43% - 78%
High	3	79% - 100%

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

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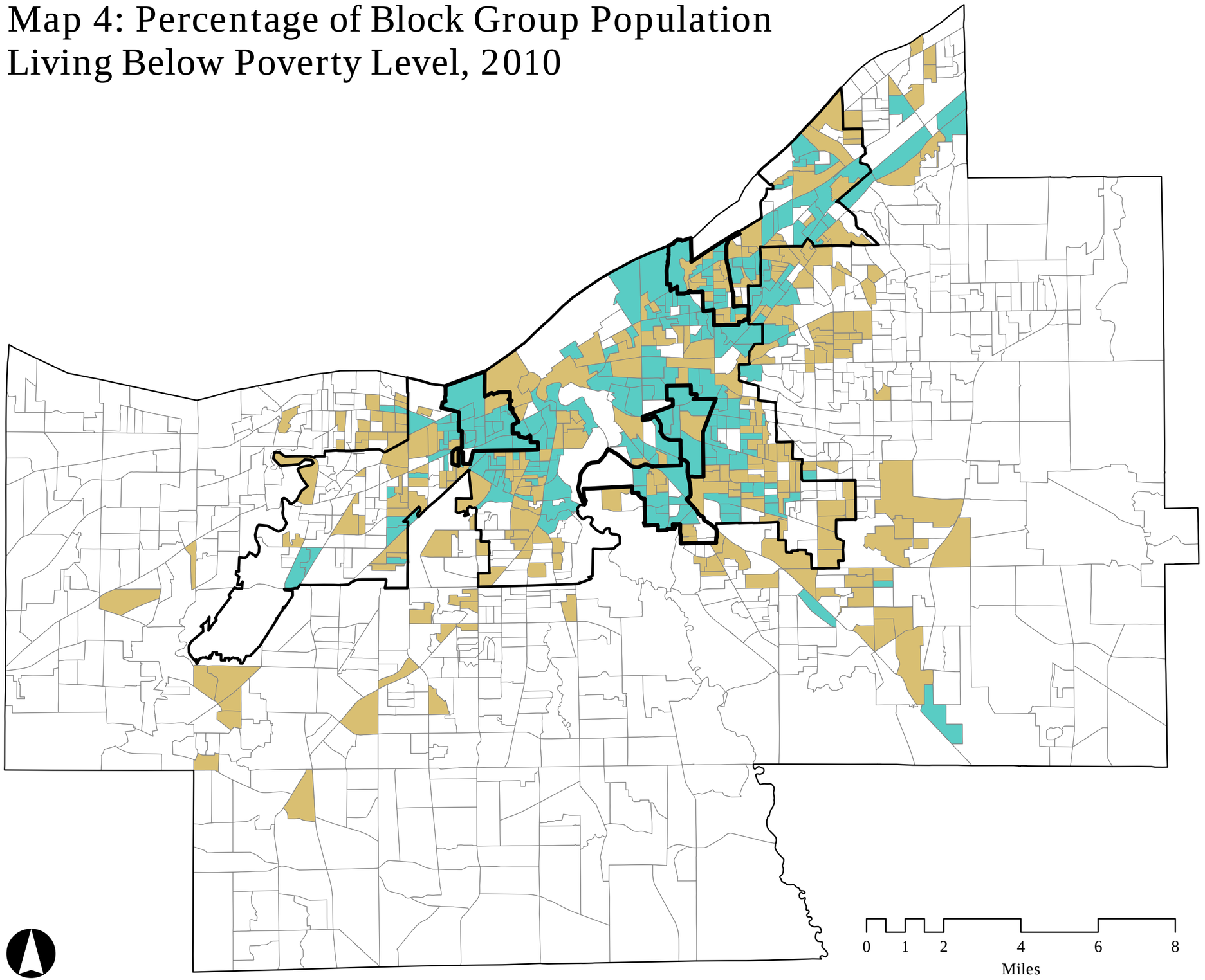
Maps Created:

Tuesday, June 23, 2015

Map 4: Percentage of Block Group Population Living Below Poverty Level, 2010



Legend:

Social:
Living Below Poverty Level

Low	1	0% - 18%
Medium	2	19% - 36%
High	3	37% - 100%

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

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Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
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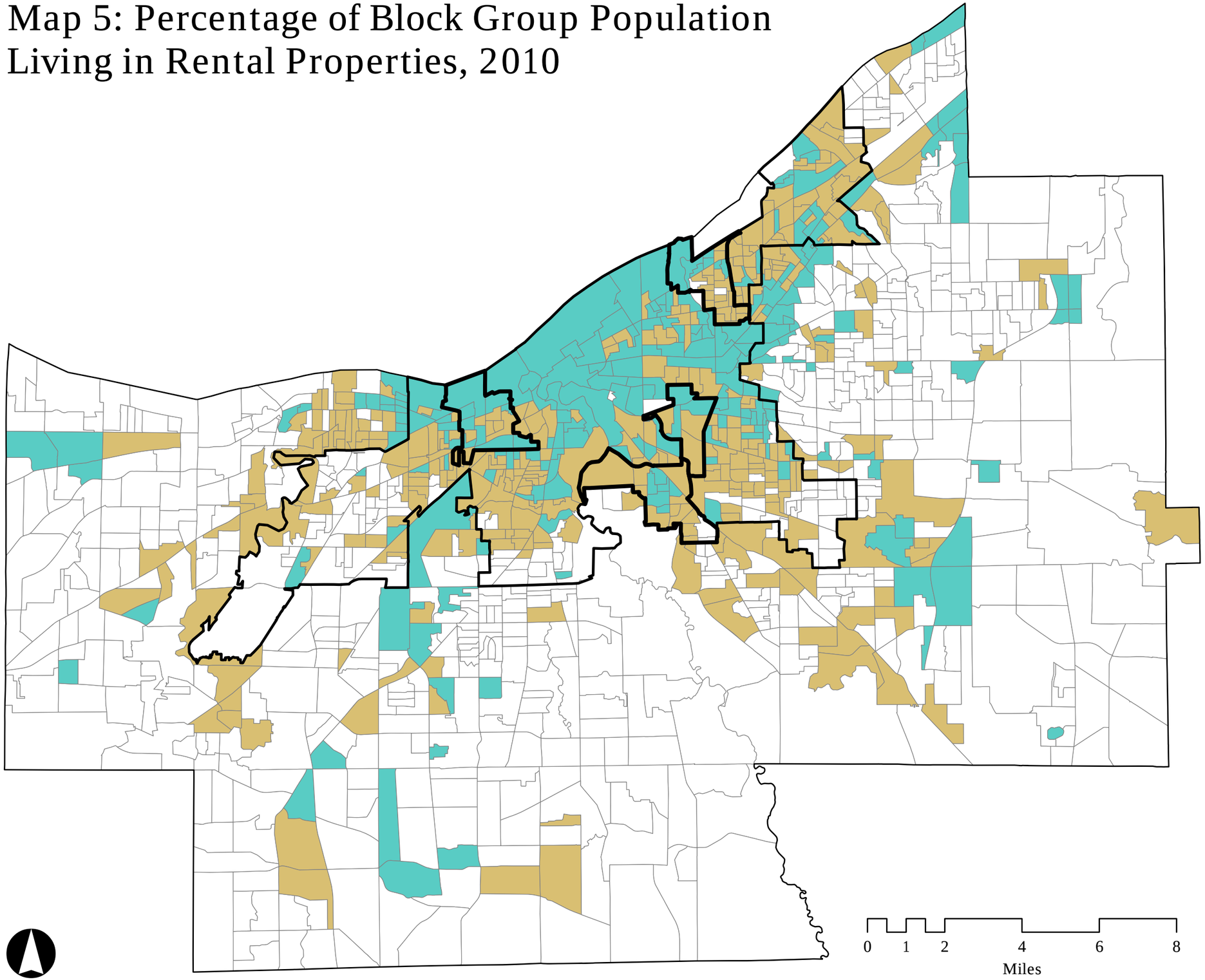
Contact: ResilientCleveland@gmail.com

Maps Created:

Tuesday, June 23, 2015

Map 5: Percentage of Block Group Population Living in Rental Properties, 2010



Legend:

Social:
Living Below Poverty Level

Low	1	0% - 38%
Medium	2	39% - 64%
High	3	65% - 100%

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
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FEMA Flood Map Service Center

Projection:

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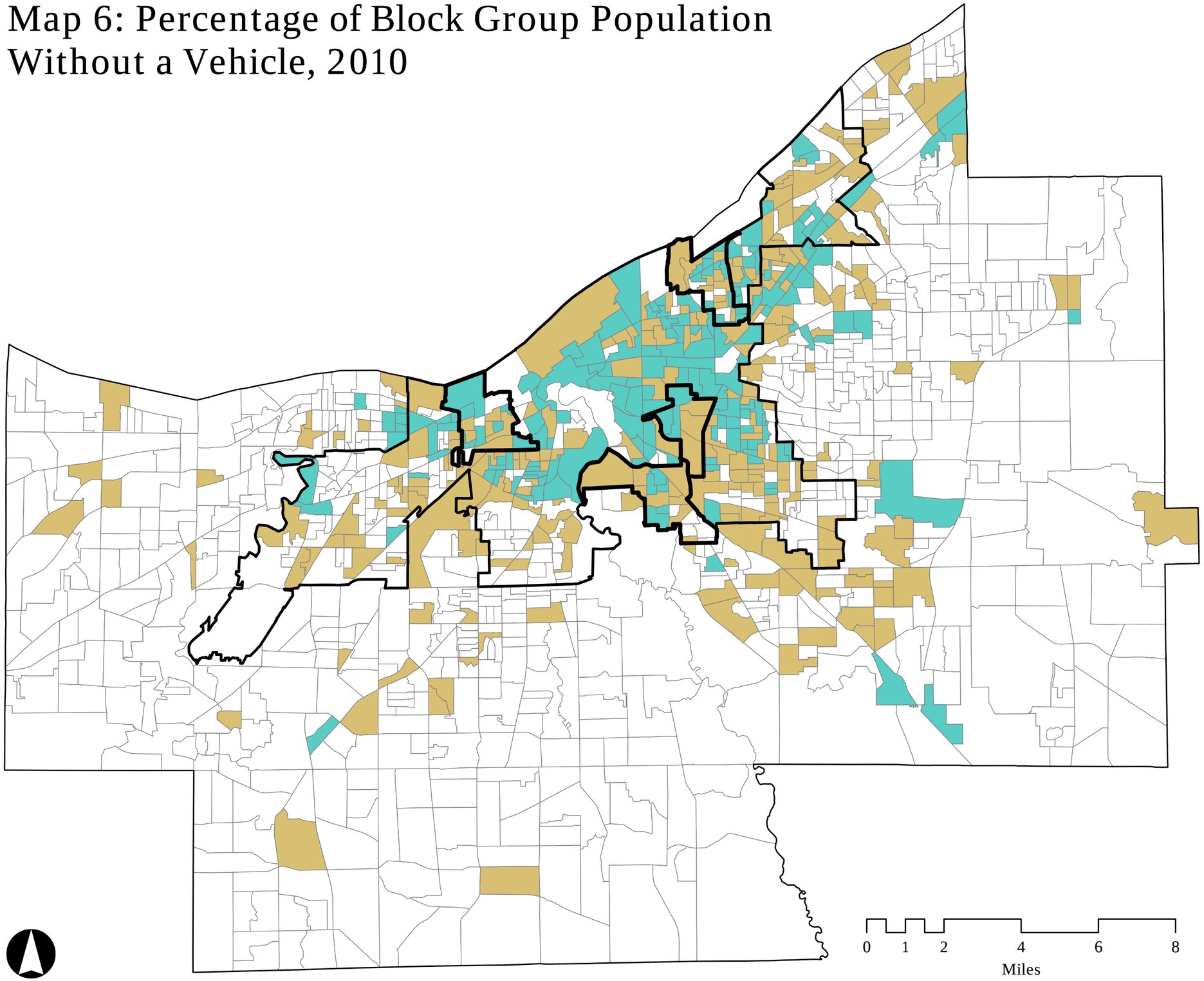
Contact: ResilientCleveland@gmail.com

Maps Created:

Tuesday, June 23, 2015

Map 6: Percentage of Block Group Population Without a Vehicle, 2010



Legend:

Social:
Without a Vehicle

Low	1	0% - 14%
Medium	2	15% - 29%
High	3	30% - 88%

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

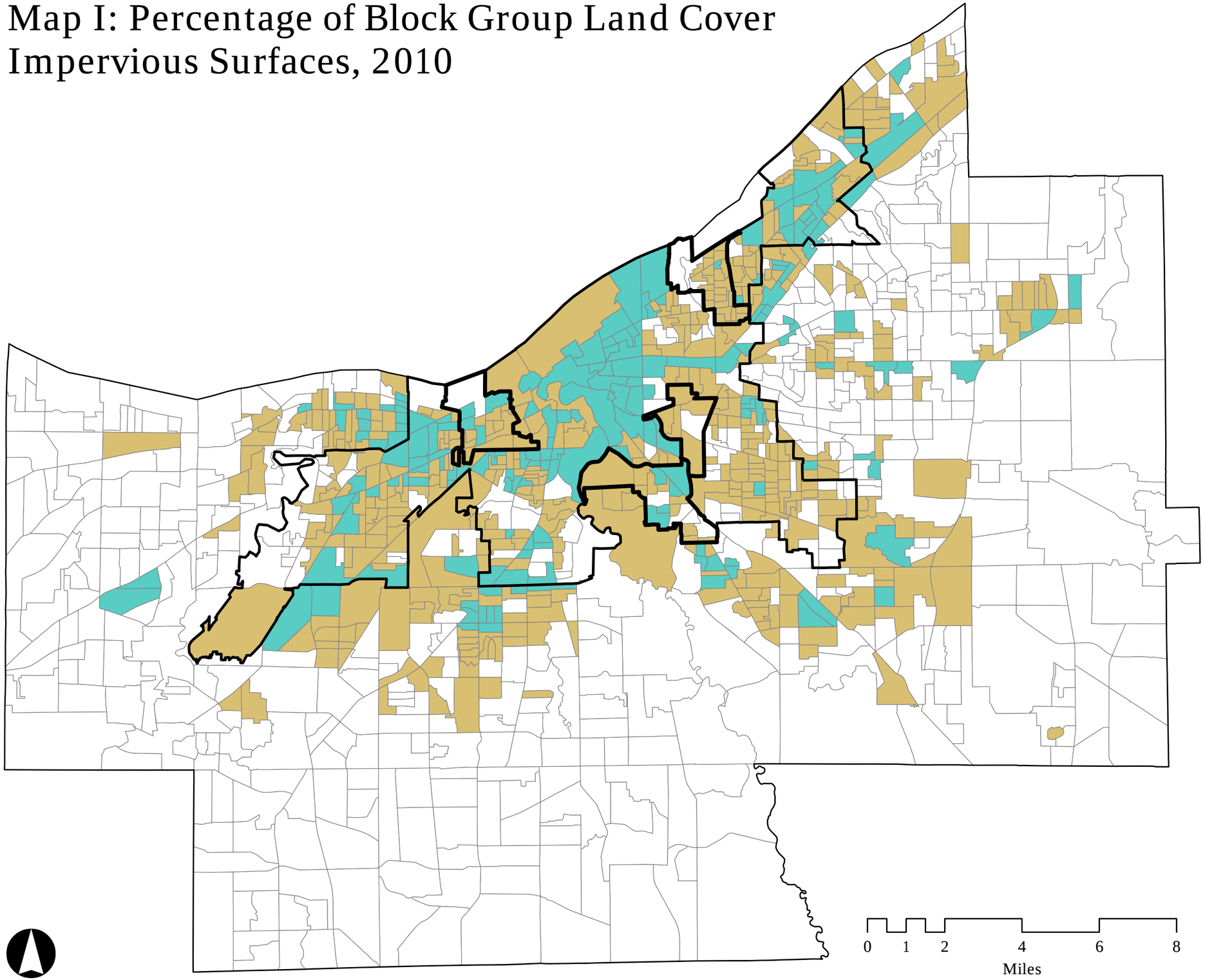
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Tuesday, June 23, 2015

Map I: Percentage of Block Group Land Cover Impervious Surfaces, 2010



Legend:

Physical:
Impervious Surfaces

Low	1	0% - 43%
Medium	2	44% - 57%
High	3	58% - 89%

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

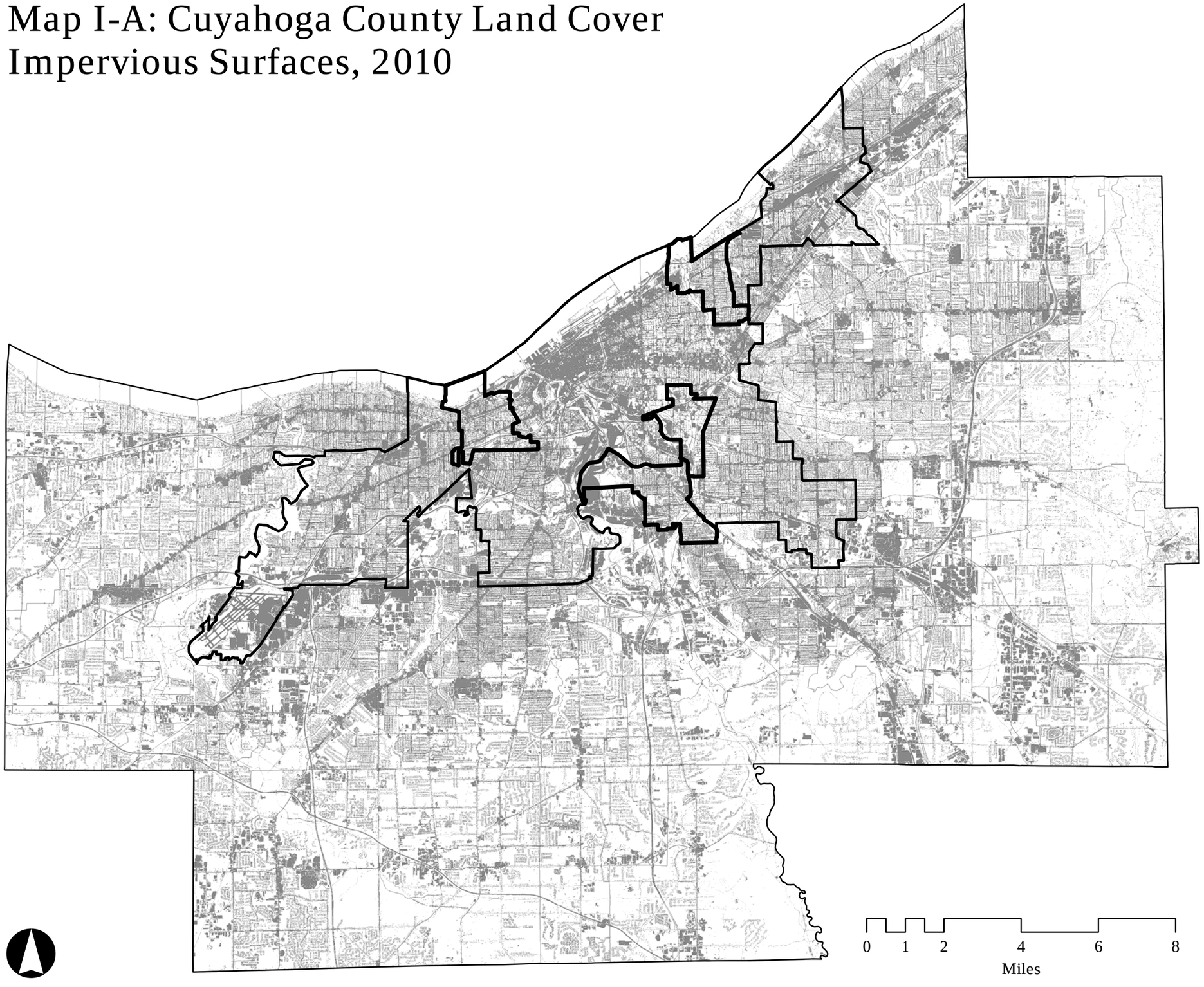
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Wednesday, June 24, 2015

Map I-A: Cuyahoga County Land Cover
Impervious Surfaces, 2010



Legend:

Impervious Surfaces

- Buildings
- Roads / Railroads
- Other Paved Surfaces

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
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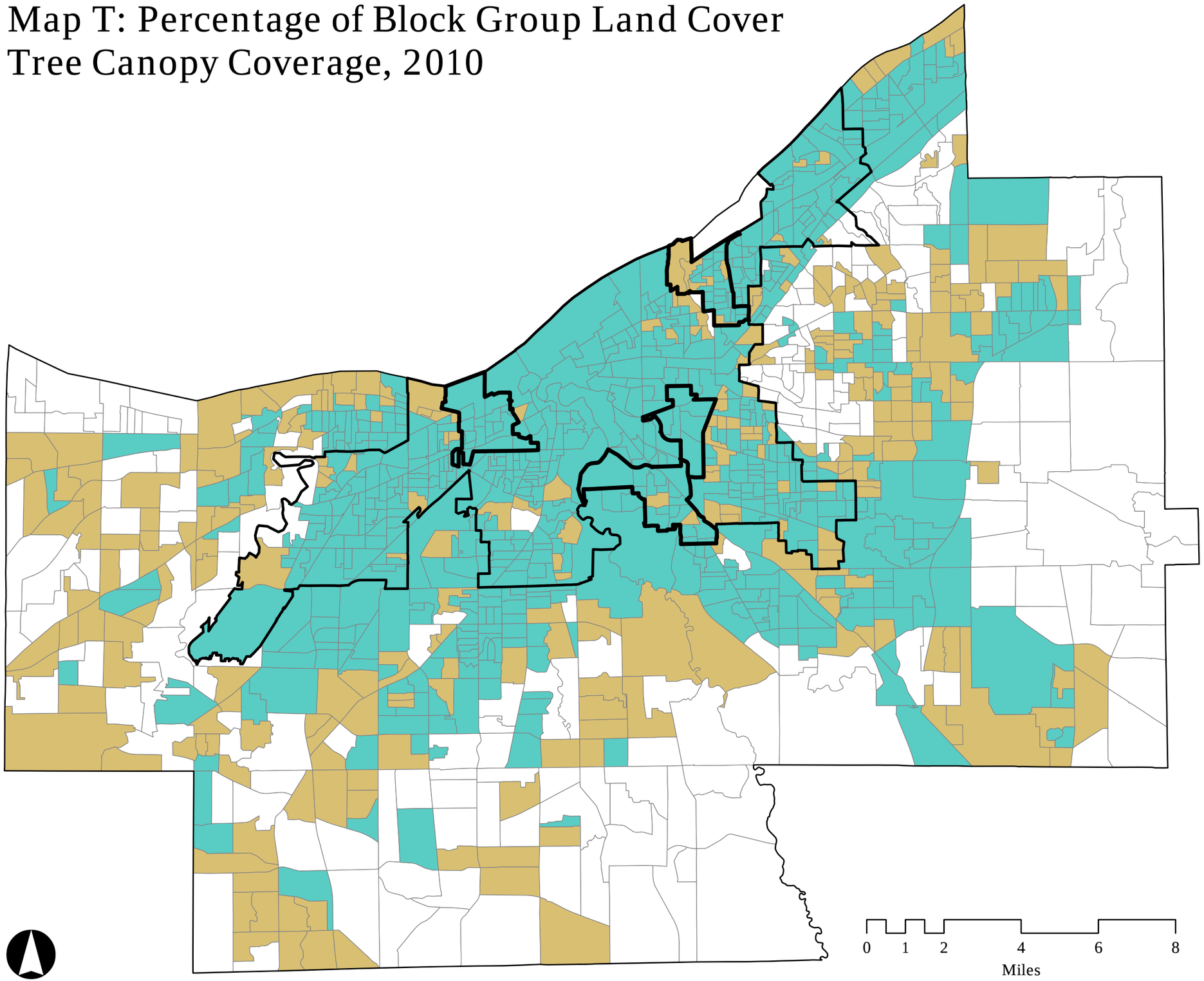
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Wednesday, June 24, 2015

Map T: Percentage of Block Group Land Cover
Tree Canopy Coverage, 2010



Legend:

Physical:
Tree Canopy Coverage

High	1	42% - 76%
Medium	2	29% - 41%
Low	3	0% - 28%

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

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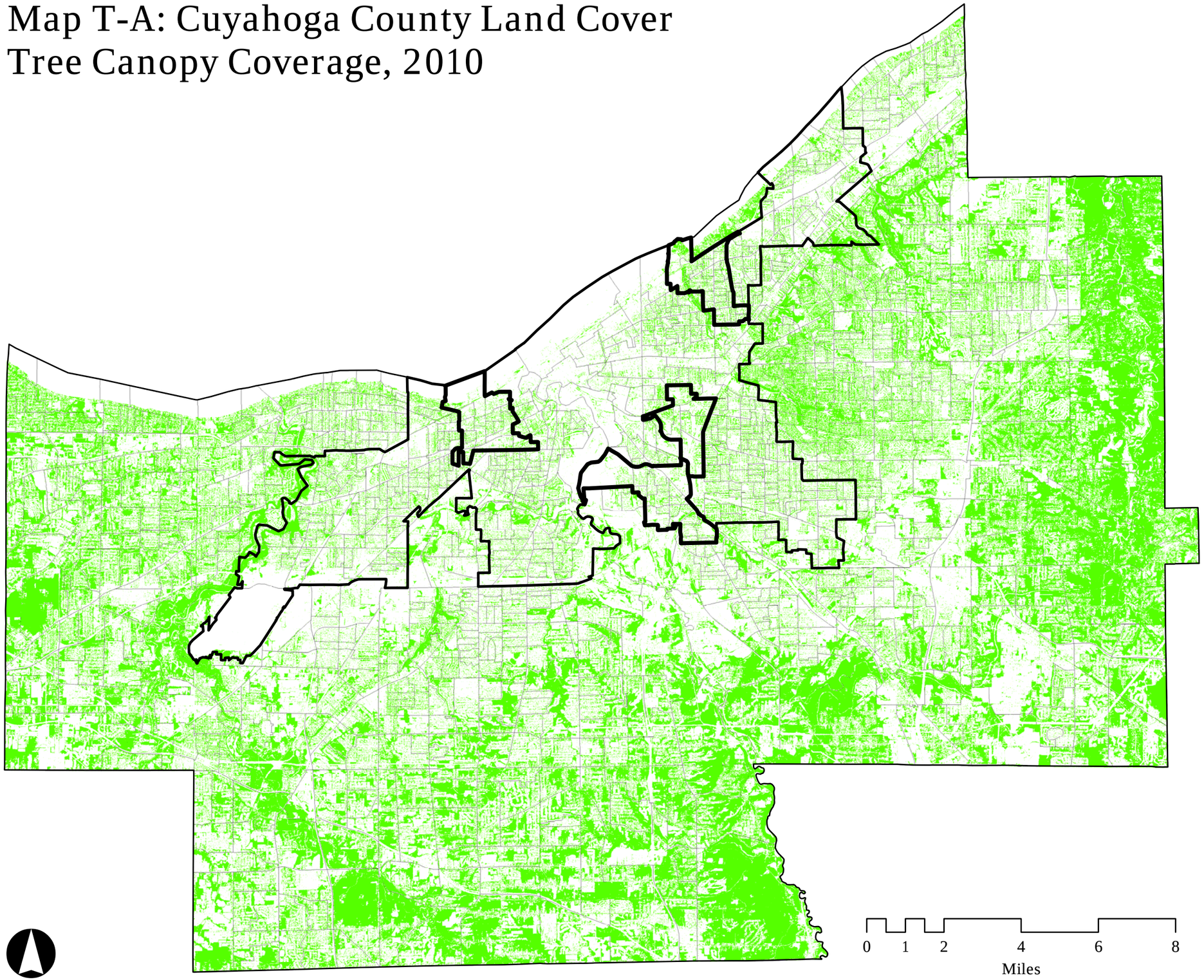
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Wednesday, June 24, 2015

Map T-A: Cuyahoga County Land Cover
Tree Canopy Coverage, 2010



Legend:

Tree Canopy Coverage

- Tree Canopy Over Vegetation
- Tree Canopy Over Building
- Tree Canopy Over Road
- Tree Canopy Over Paved Srf

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

Mike Tuzzo and Nick Rajkovich
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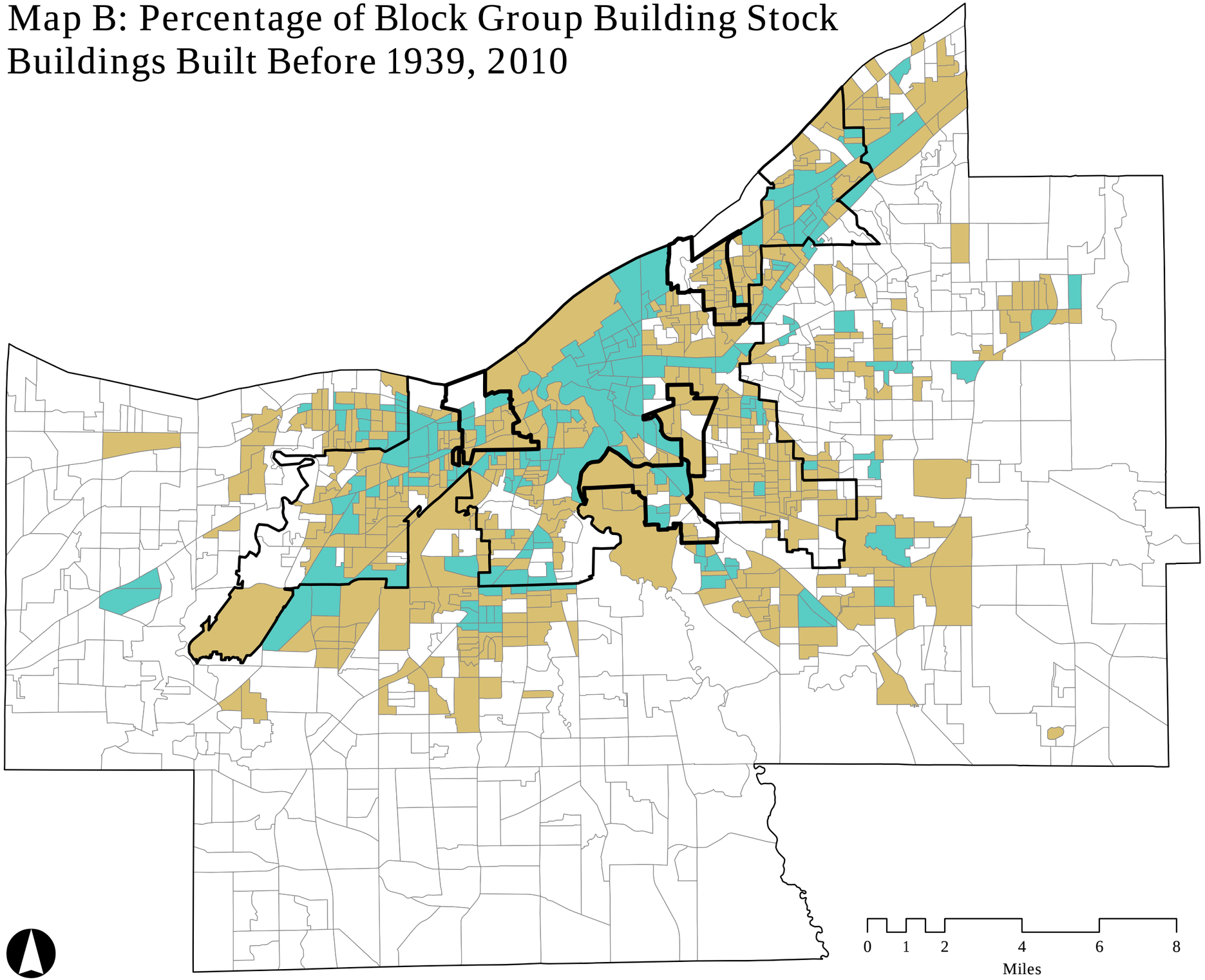
Contact: ResilientCleveland@gmail.com

Maps Created:

Wednesday, June 24, 2015

Map B: Percentage of Block Group Building Stock Buildings Built Before 1939, 2010



Legend:

Physical:
Buildings Built Before 1939

Low	1	0% - 32%
Medium	2	33% - 60%
High	3	61% - 100%

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

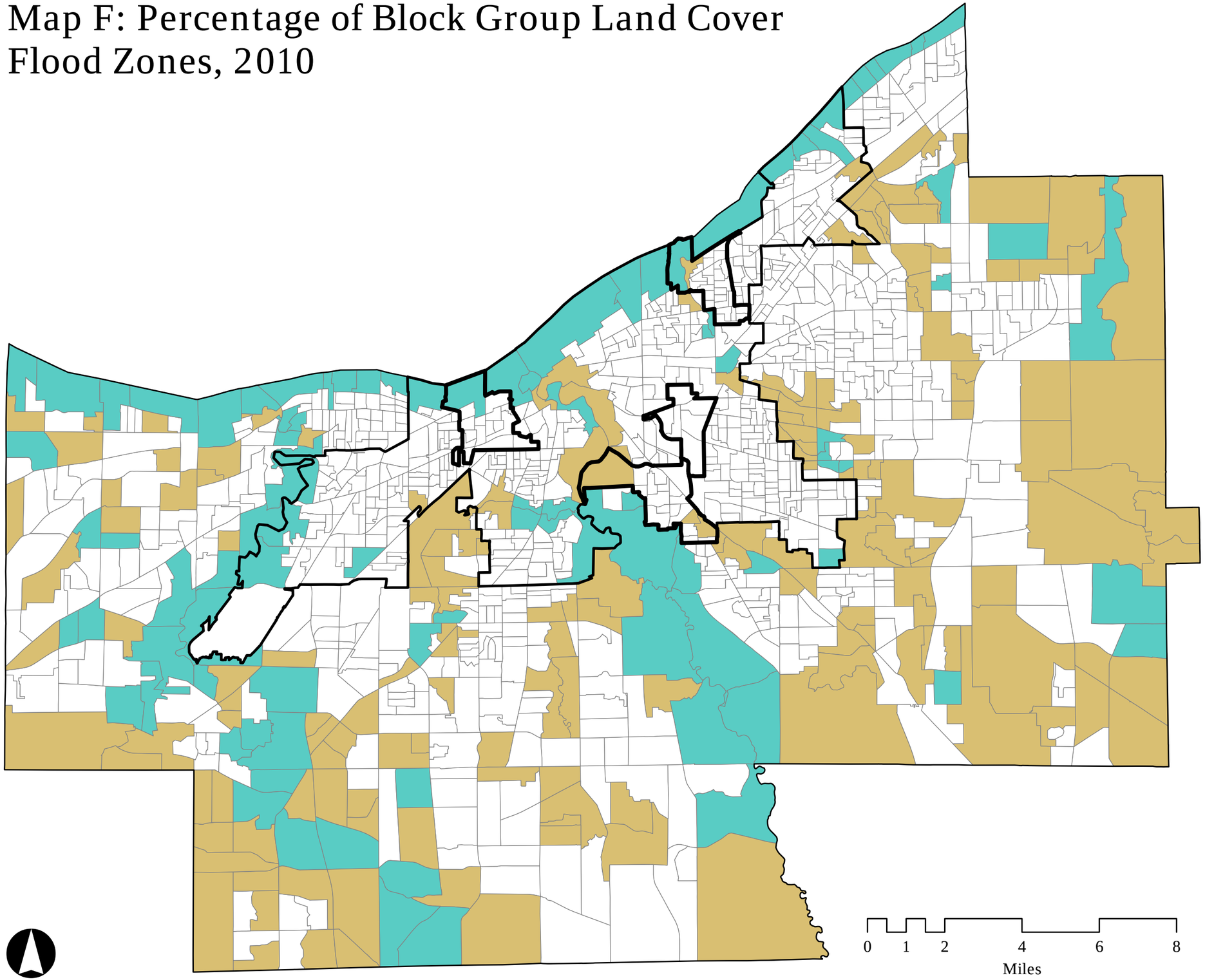
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Wednesday, June 24, 2015

Map F: Percentage of Block Group Land Cover Flood Zones, 2010



Legend:

Physical:
Flood Zones

Low	1	0% - 3%
Medium	2	4% - 12%
High	3	13% - 82%

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

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(University at Buffalo)
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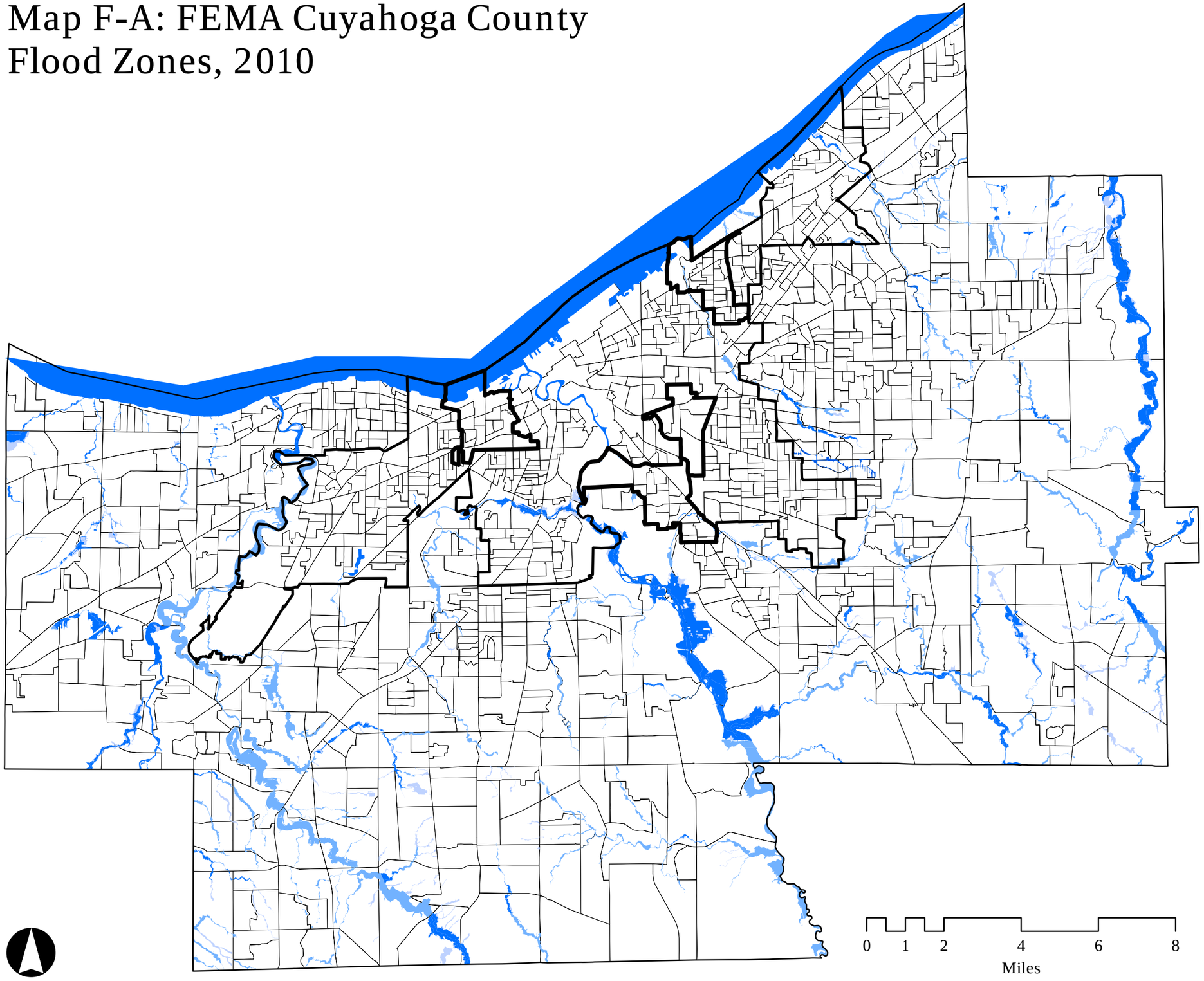
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Wednesday, June 24, 2015

Map F-A: FEMA Cuyahoga County Flood Zones, 2010



Legend:

FEMA Flood Zones

- 0.2 PCT Annual Chance
- A
- AE
- AH

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

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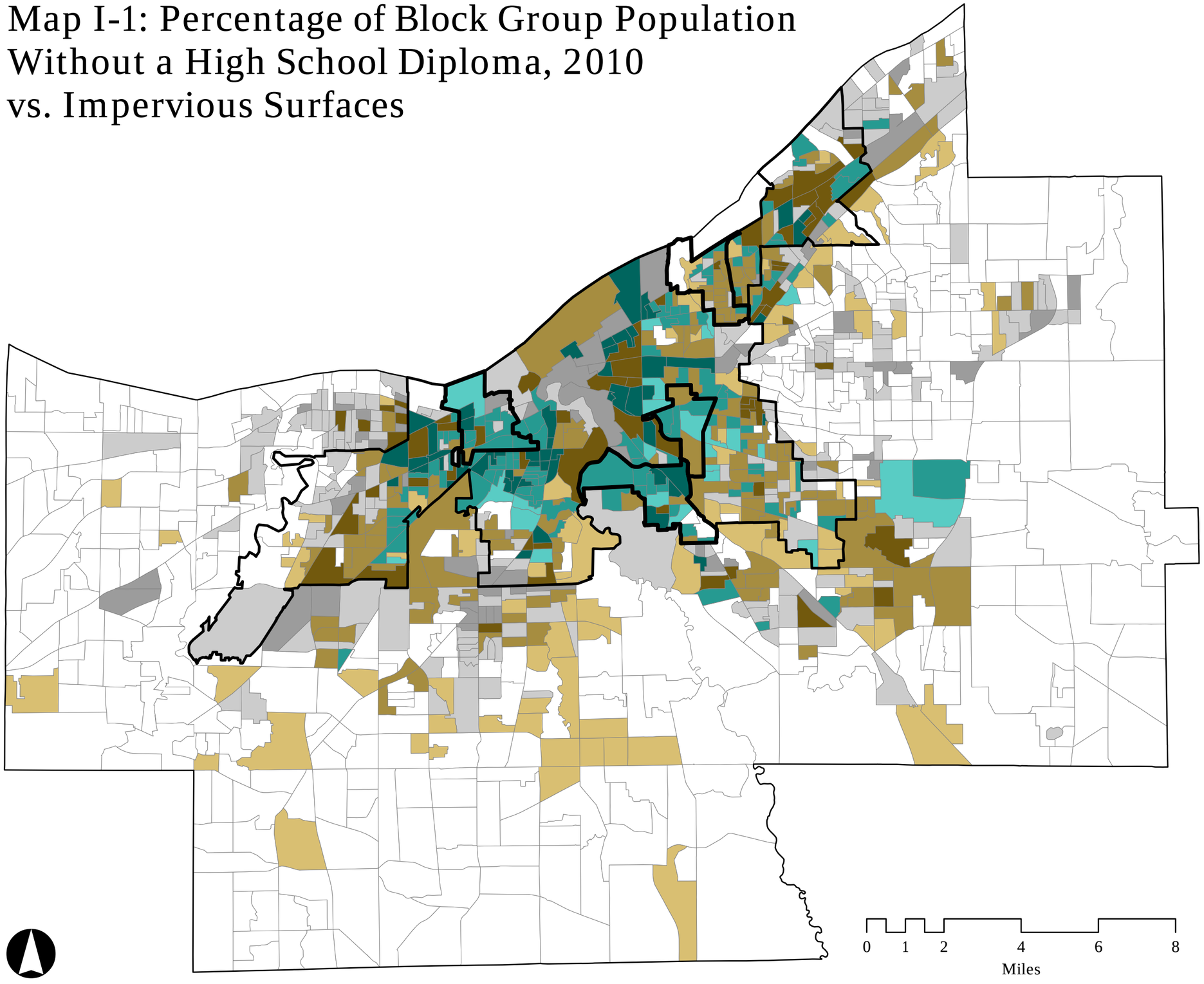
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Wednesday, June 24, 2015

Map I-1: Percentage of Block Group Population Without a High School Diploma, 2010 vs. Impervious Surfaces



Legend:

Social: Without a High School Diploma

Physical: Impervious Surfaces

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
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Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

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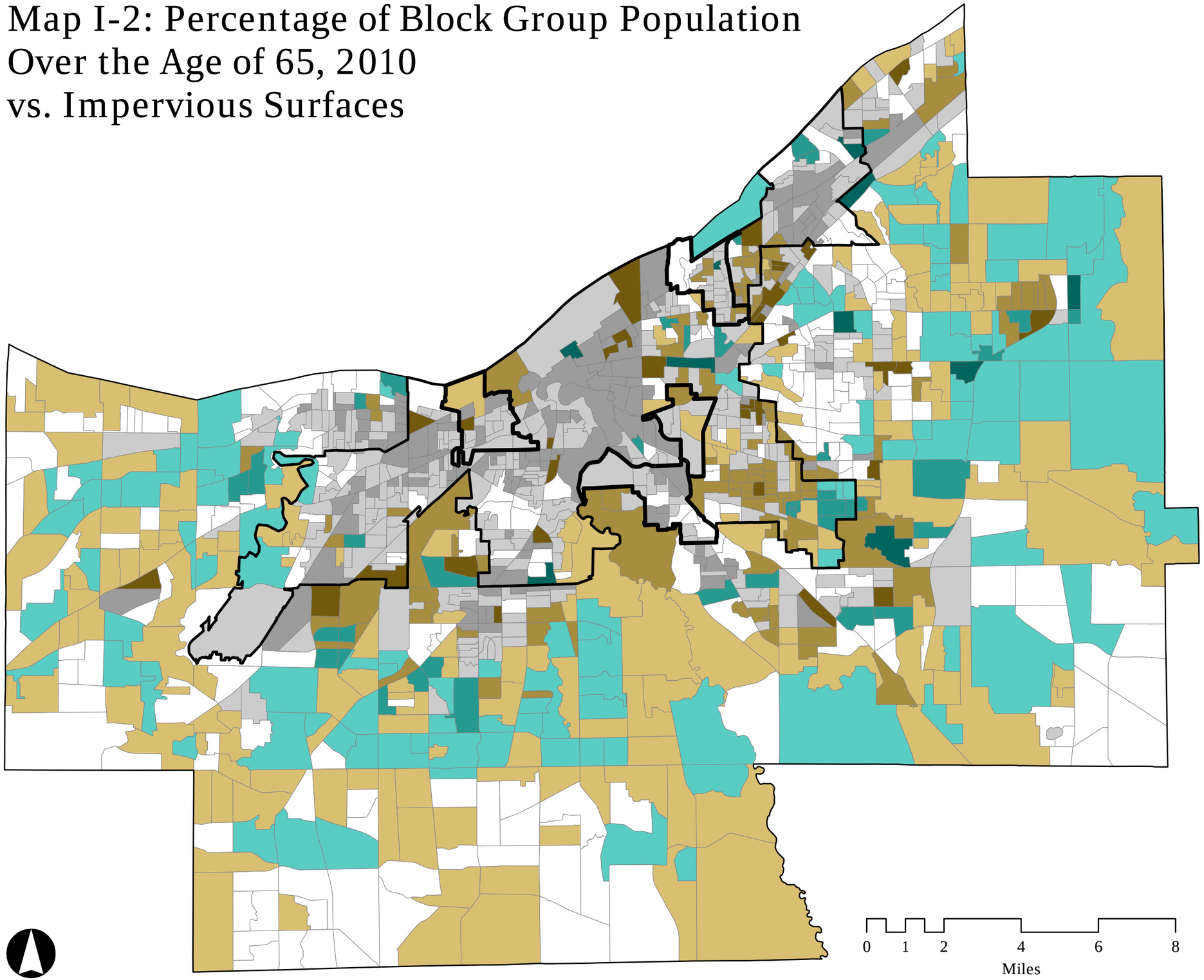
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map I-2: Percentage of Block Group Population Over the Age of 65, 2010 vs. Impervious Surfaces



Legend:

Social: Over the Age of 65

Physical: Impervious Surfaces

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
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Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

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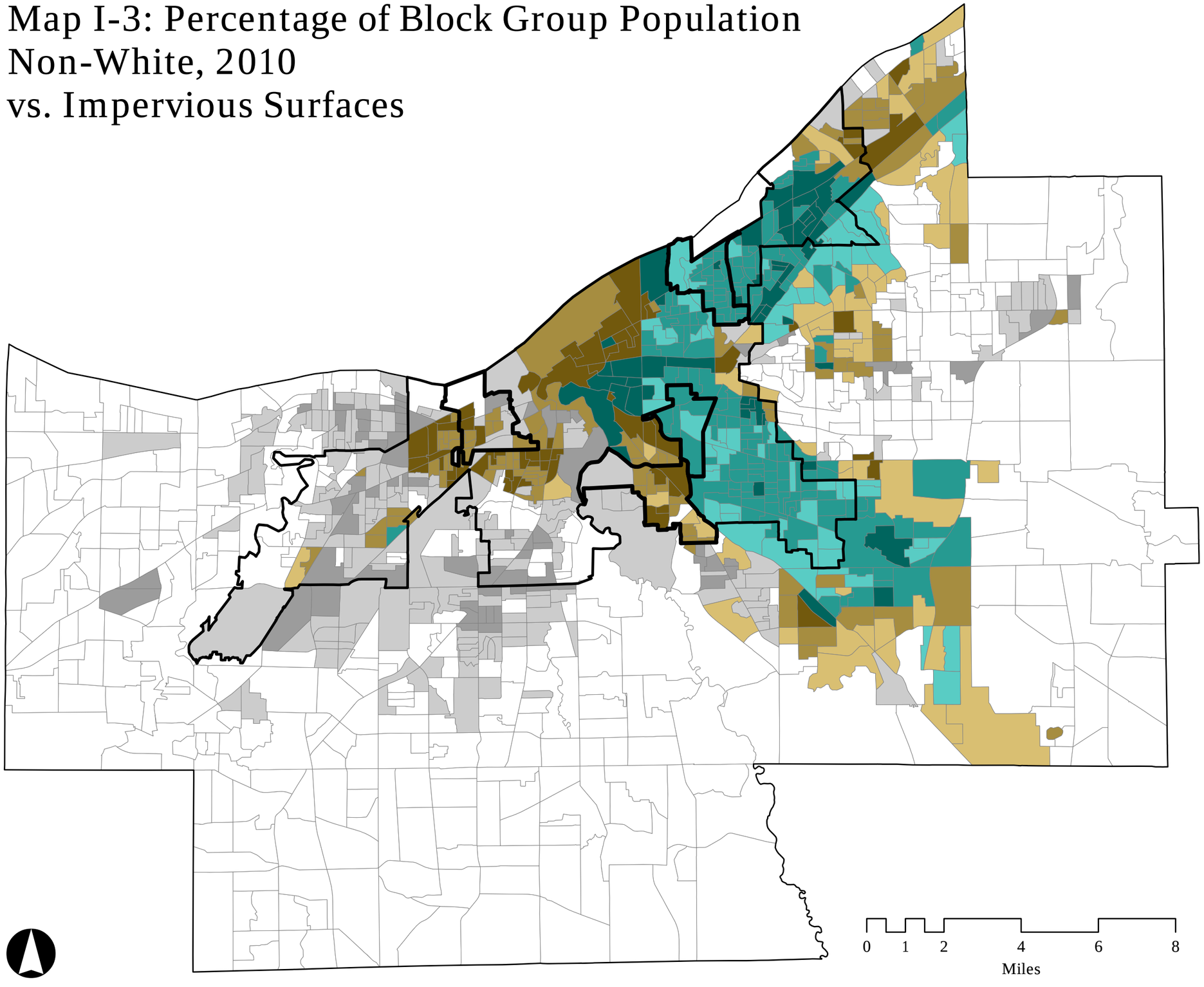
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map I-3: Percentage of Block Group Population Non-White, 2010 vs. Impervious Surfaces



Legend:

Social: Non-White

Physical: Impervious Surfaces

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

Mike Tuzzo and Nick Rajkovich
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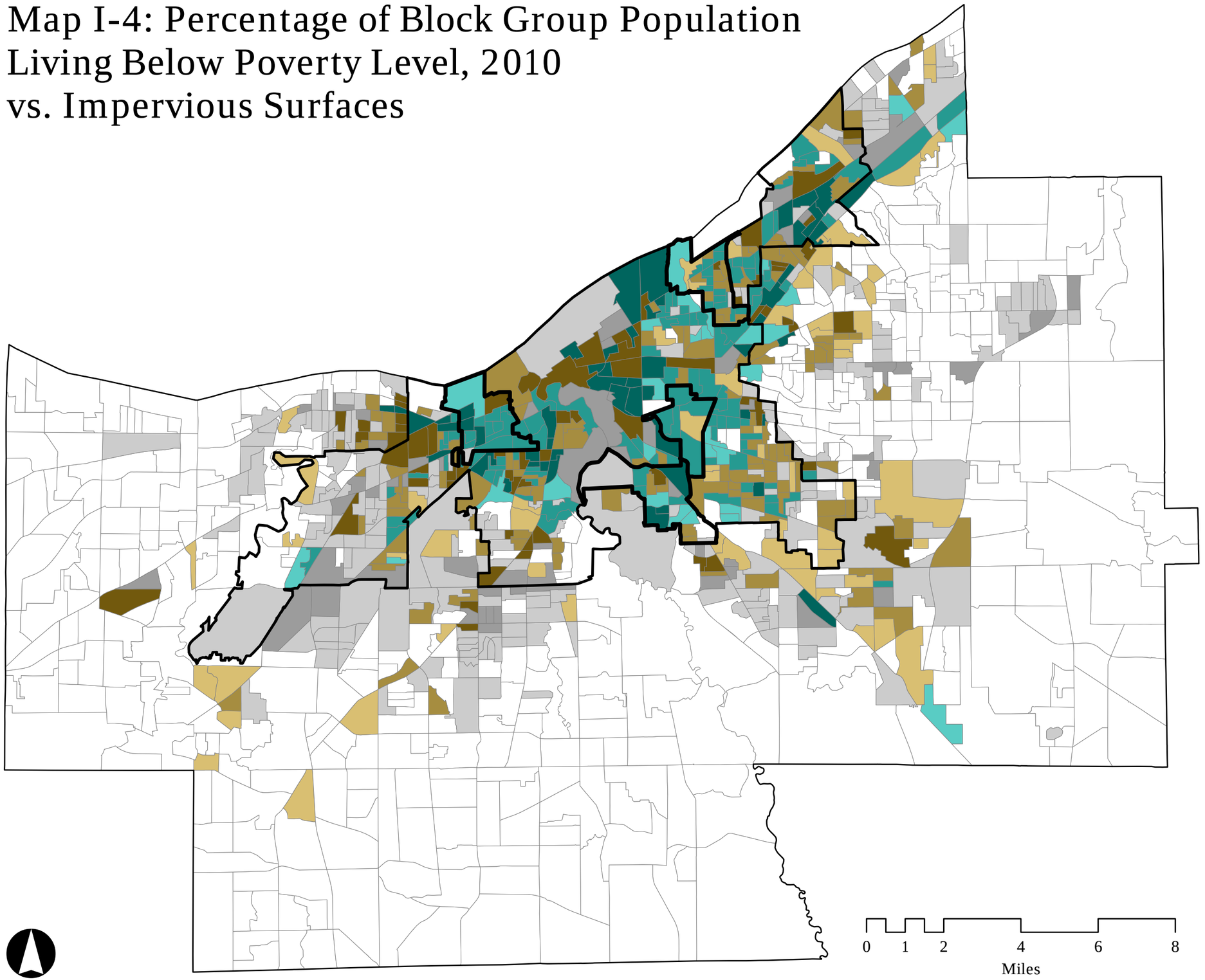
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map I-4: Percentage of Block Group Population Living Below Poverty Level, 2010 vs. Impervious Surfaces



Legend:

Social: Living Below Poverty Level

Physical: Impervious Surfaces

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
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FEMA Flood Map Service Center

Projection:

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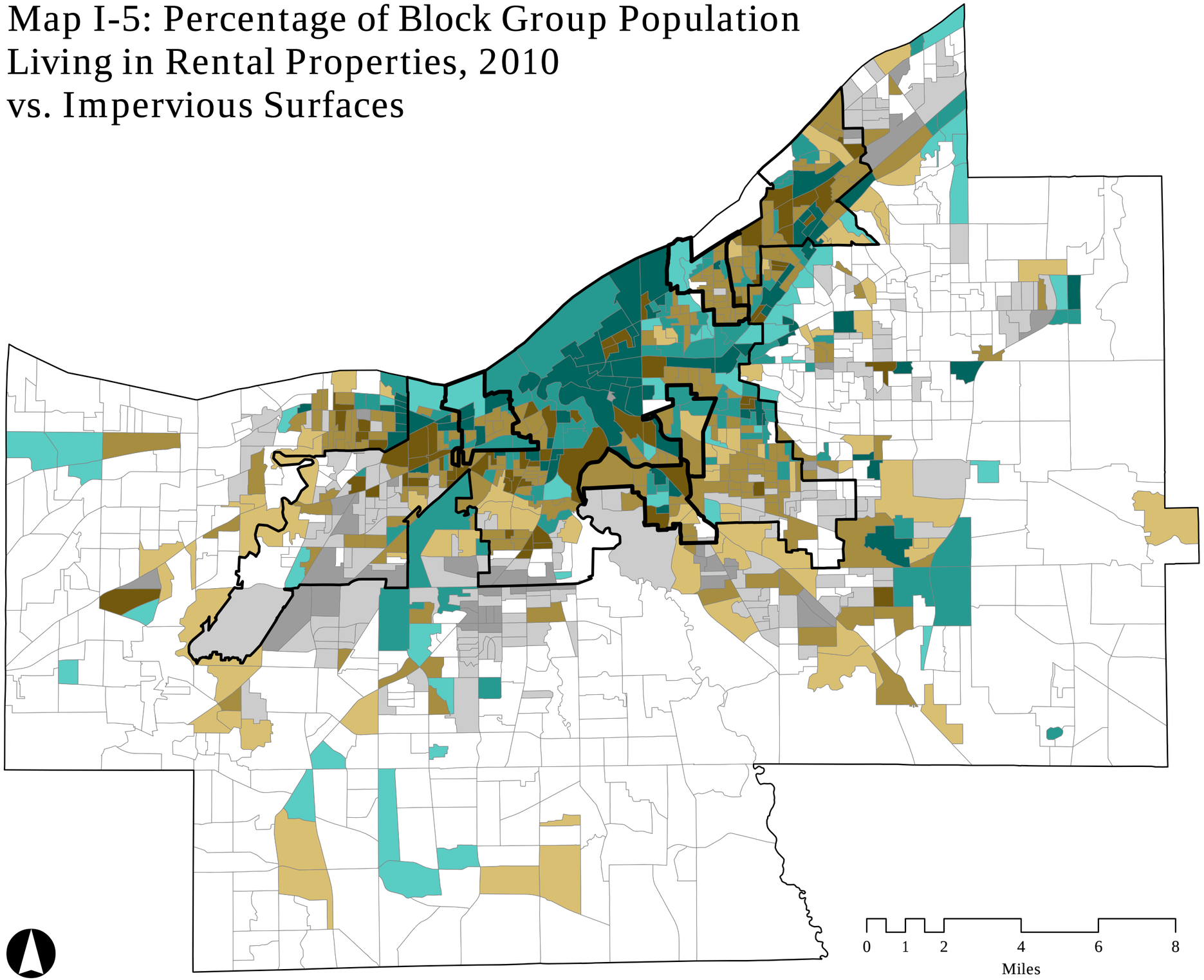
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map I-5: Percentage of Block Group Population Living in Rental Properties, 2010 vs. Impervious Surfaces



Legend:

Social: Living in Rental Properties

Physical: Impervious Surfaces

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

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(University at Buffalo)
Kristen Zeiber and Terry Schwarz
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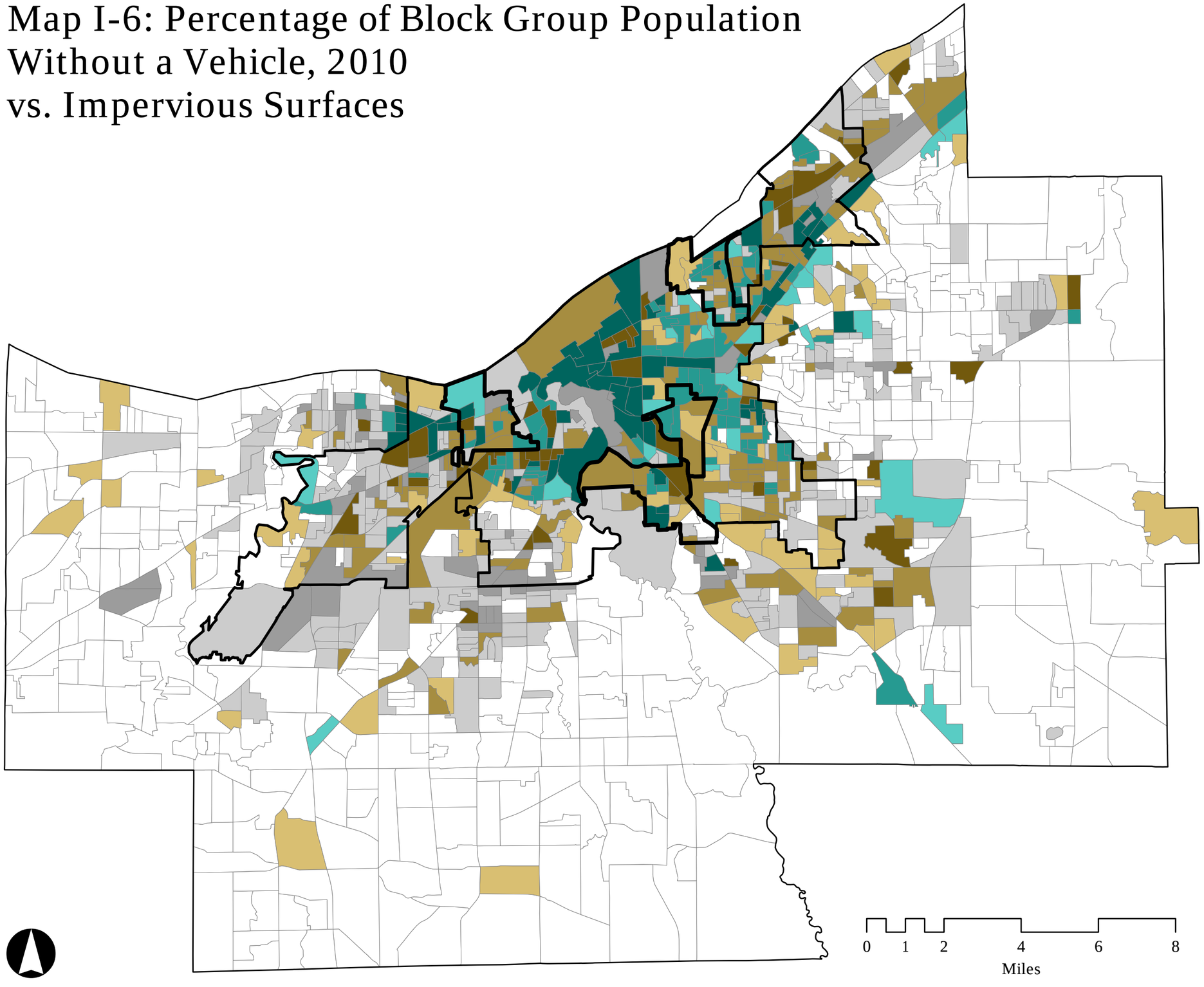
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map I-6: Percentage of Block Group Population Without a Vehicle, 2010 vs. Impervious Surfaces



Legend:

Social: Without a Vehicle

Physical: Impervious Surfaces

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
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Projection:

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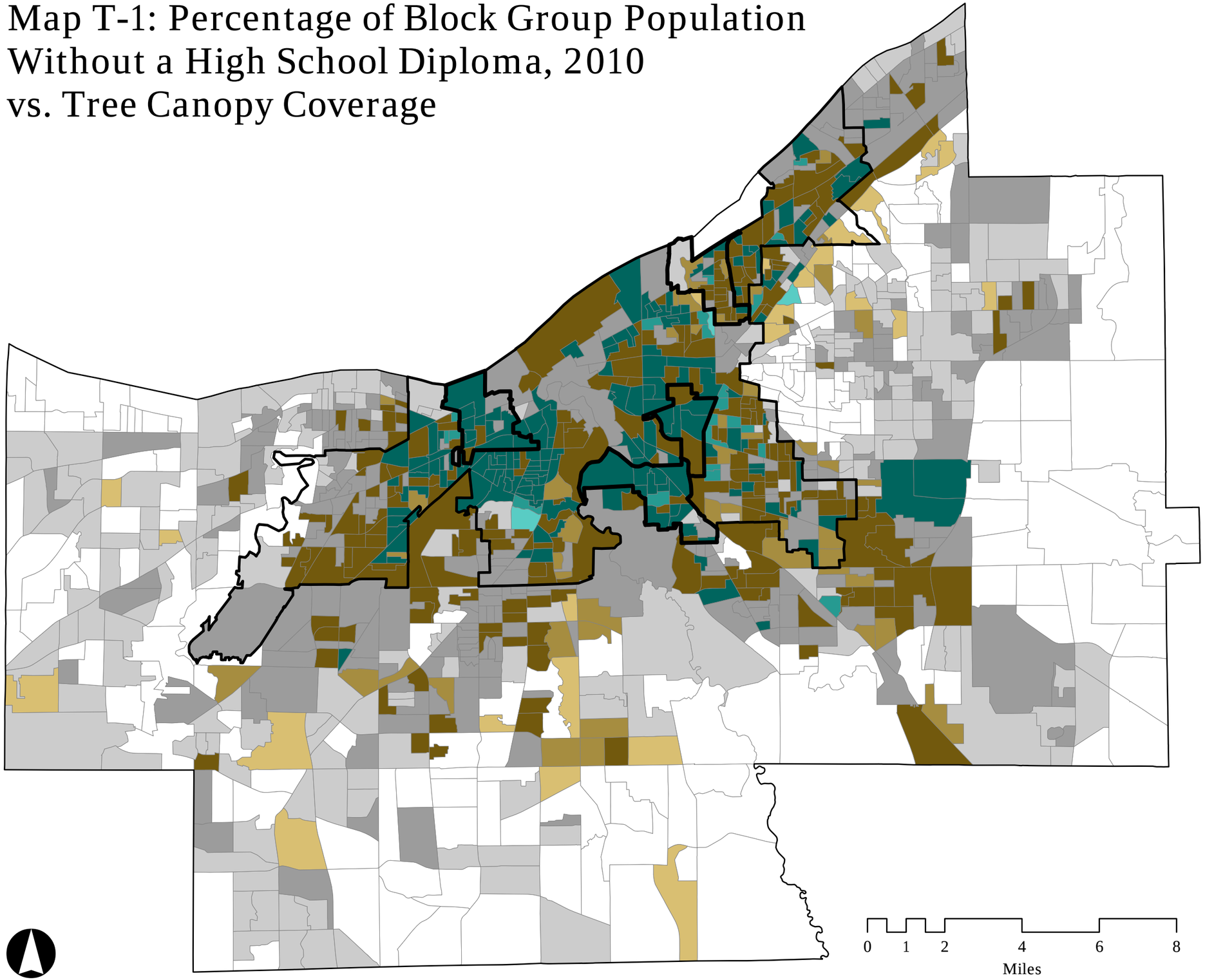
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map T-1: Percentage of Block Group Population Without a High School Diploma, 2010 vs. Tree Canopy Coverage



Legend:

Social: Without a High School Diploma

Physical: Tree Canopy Coverage

Low	1	High
	2	Medium
	3	Low
Medium	4	High
	5	Medium
	6	Low
High	7	High
	8	Medium
	9	Low

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

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Projection:

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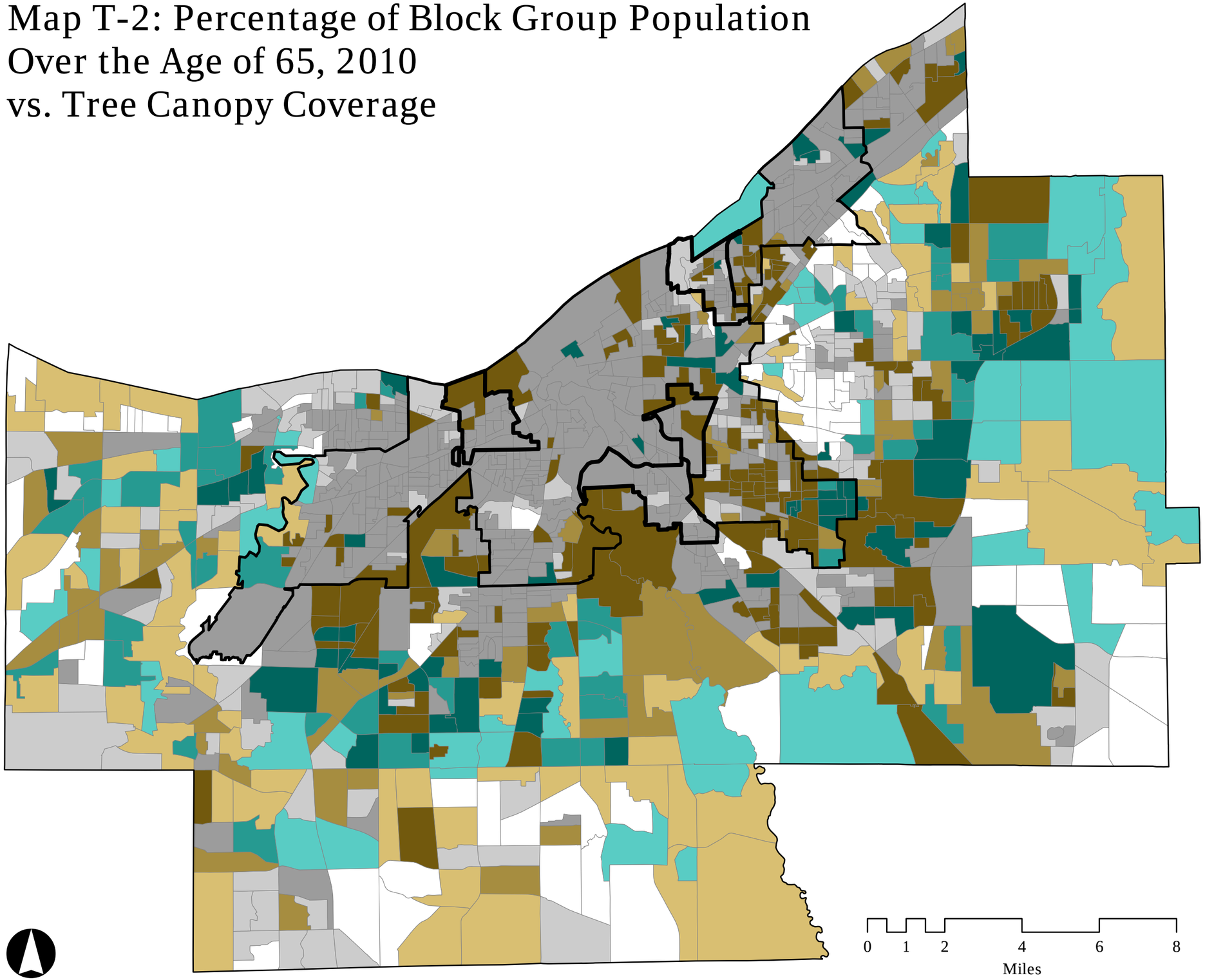
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map T-2: Percentage of Block Group Population Over the Age of 65, 2010 vs. Tree Canopy Coverage



Legend:

Social: Over the Age of 65		Physical: Tree Canopy Coverage
Low	1	High
	2	Medium
	3	Low
Medium	4	High
	5	Medium
	6	Low
High	7	High
	8	Medium
	9	Low

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

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Projection:

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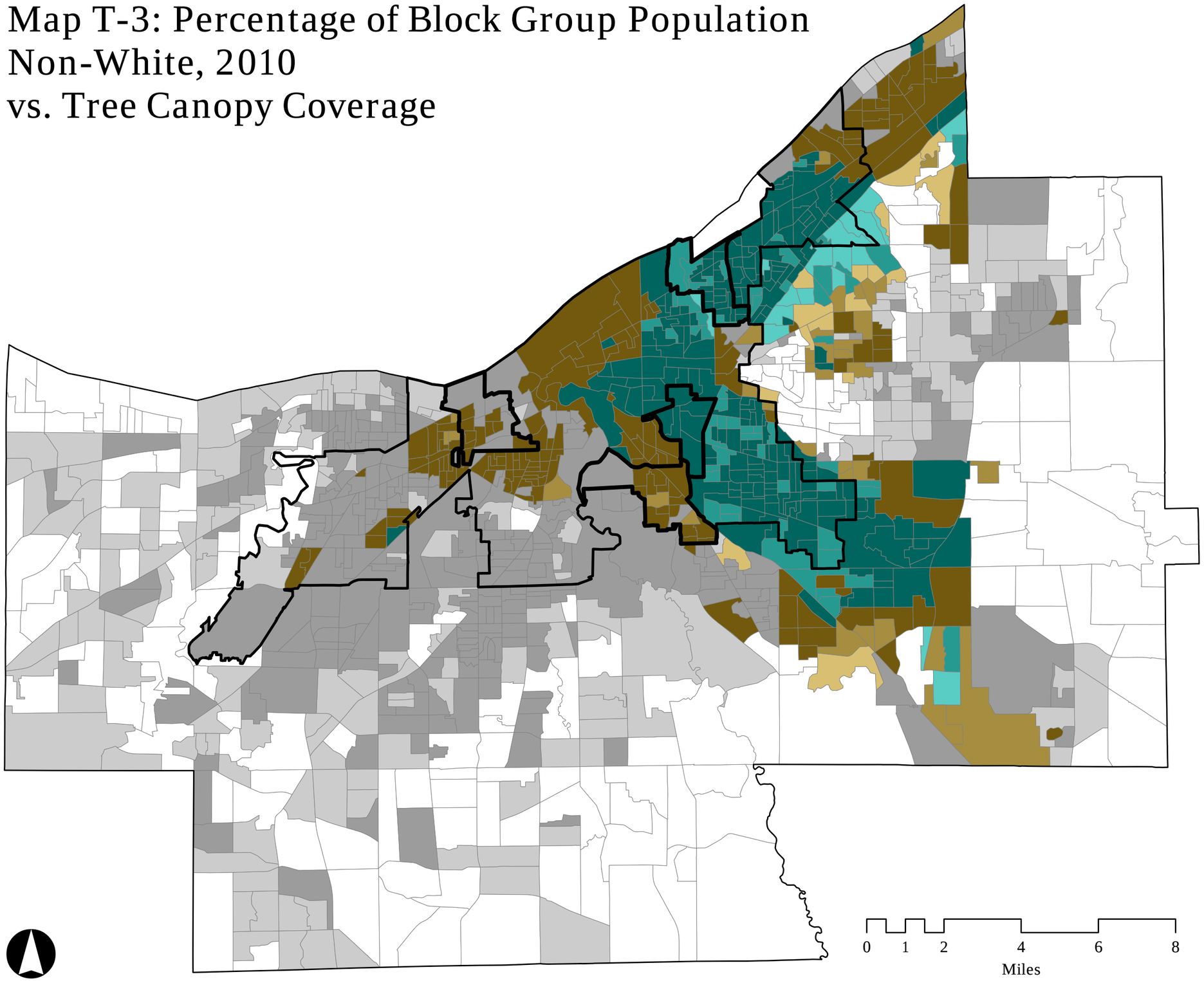
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map T-3: Percentage of Block Group Population Non-White, 2010 vs. Tree Canopy Coverage



Legend:

Social: Non-White

Physical: Tree Canopy Coverage

Low	1	High
	2	Medium
	3	Low
Medium	4	High
	5	Medium
	6	Low
High	7	High
	8	Medium
	9	Low

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
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Projection:

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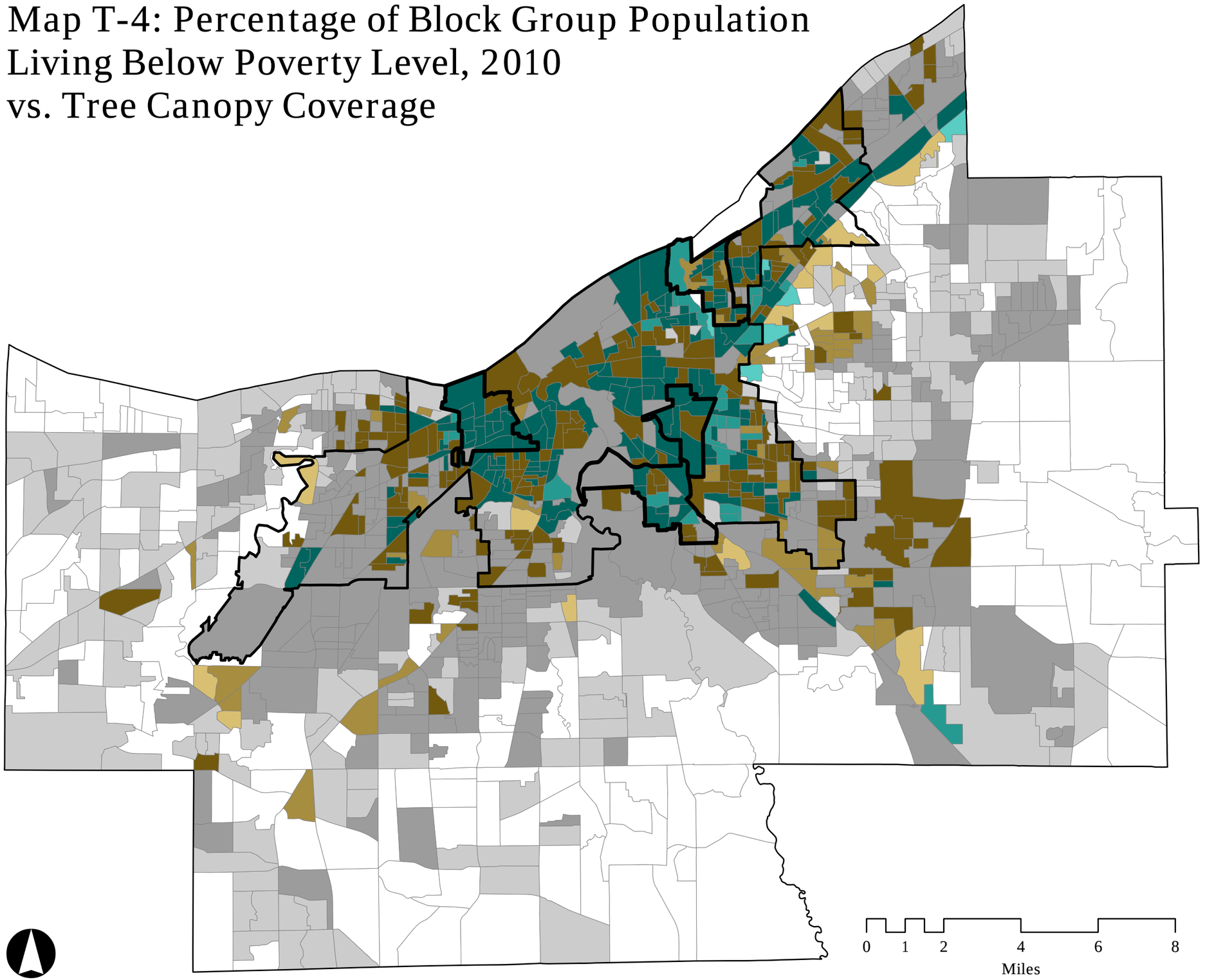
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map T-4: Percentage of Block Group Population Living Below Poverty Level, 2010 vs. Tree Canopy Coverage



Legend:

Social: Living Below Poverty Level		Physical: Tree Canopy Coverage
Low	1	High
	2	Medium
	3	Low
Medium	4	High
	5	Medium
	6	Low
High	7	High
	8	Medium
	9	Low

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
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FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

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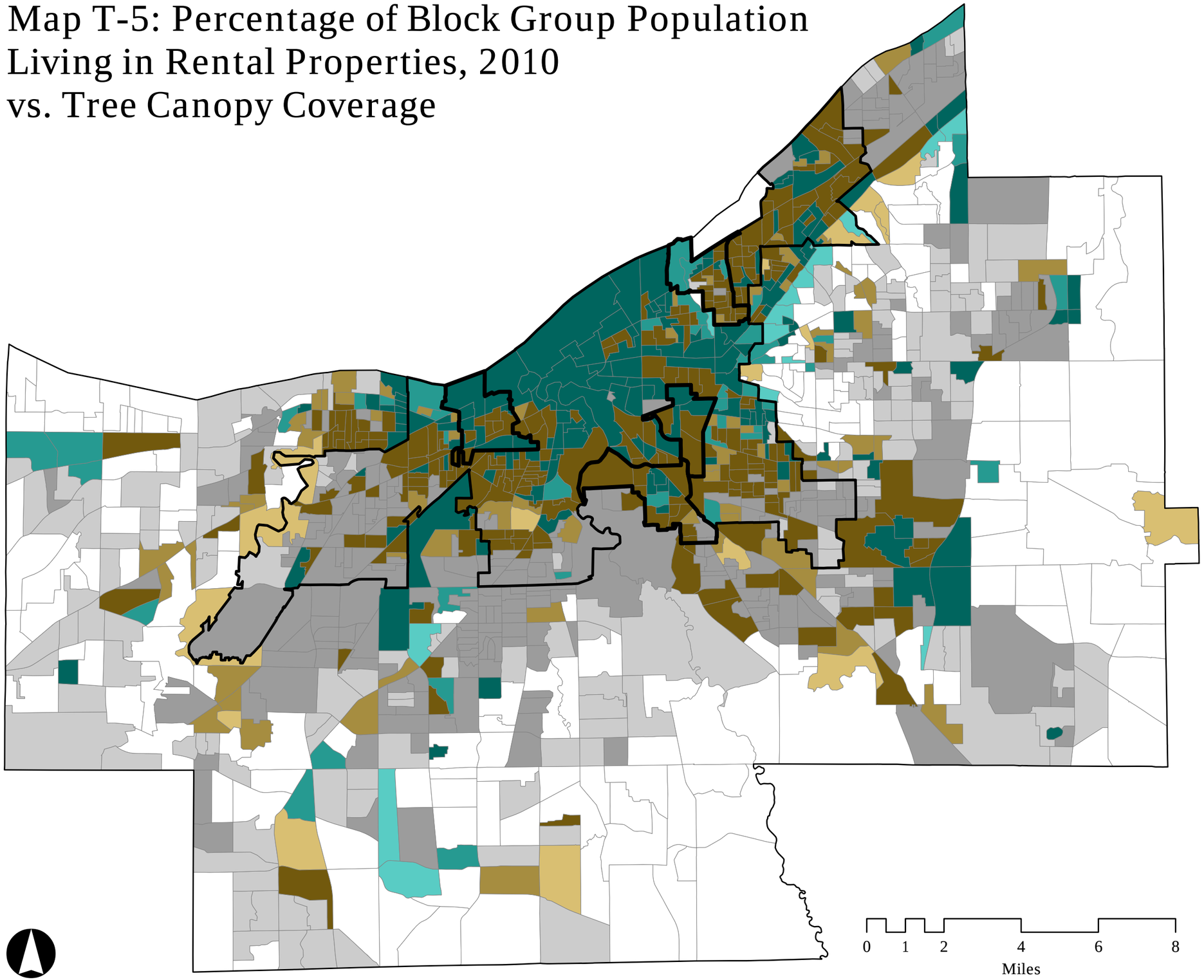
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map T-5: Percentage of Block Group Population Living in Rental Properties, 2010 vs. Tree Canopy Coverage



Legend:

Social: Living in Rental Properties

Physical: Tree Canopy Coverage

Low	1	High
	2	Medium
	3	Low
Medium	4	High
	5	Medium
	6	Low
High	7	High
	8	Medium
	9	Low

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
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Cuyahoga County GIS Department,
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Projection:

NAD 1983, Ohio State Plane North

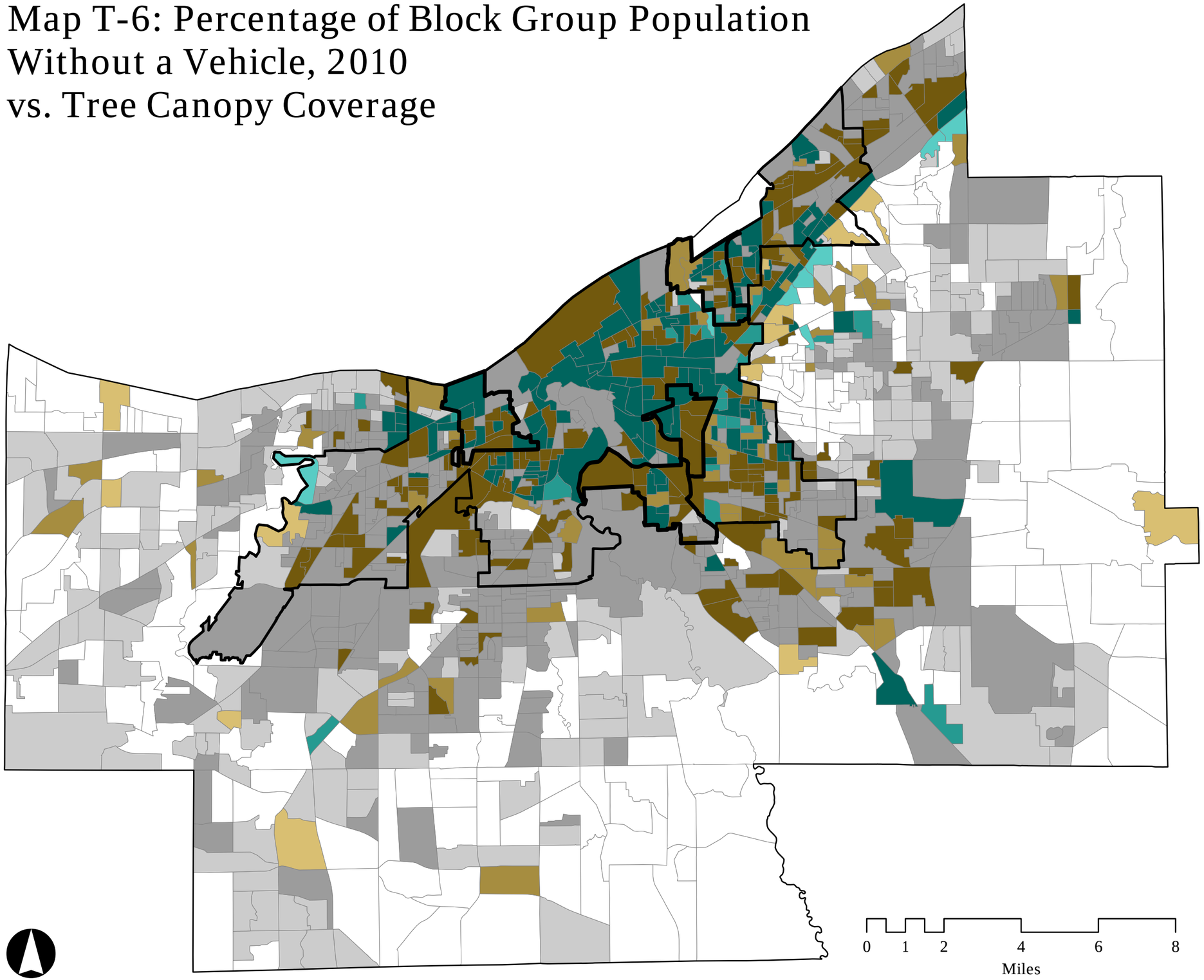
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map T-6: Percentage of Block Group Population Without a Vehicle, 2010 vs. Tree Canopy Coverage



Legend:

Social: Without a Vehicle

Physical: Tree Canopy Coverage

Low	1	High
	2	Medium
	3	Low
Medium	4	High
	5	Medium
	6	Low
High	7	High
	8	Medium
	9	Low

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

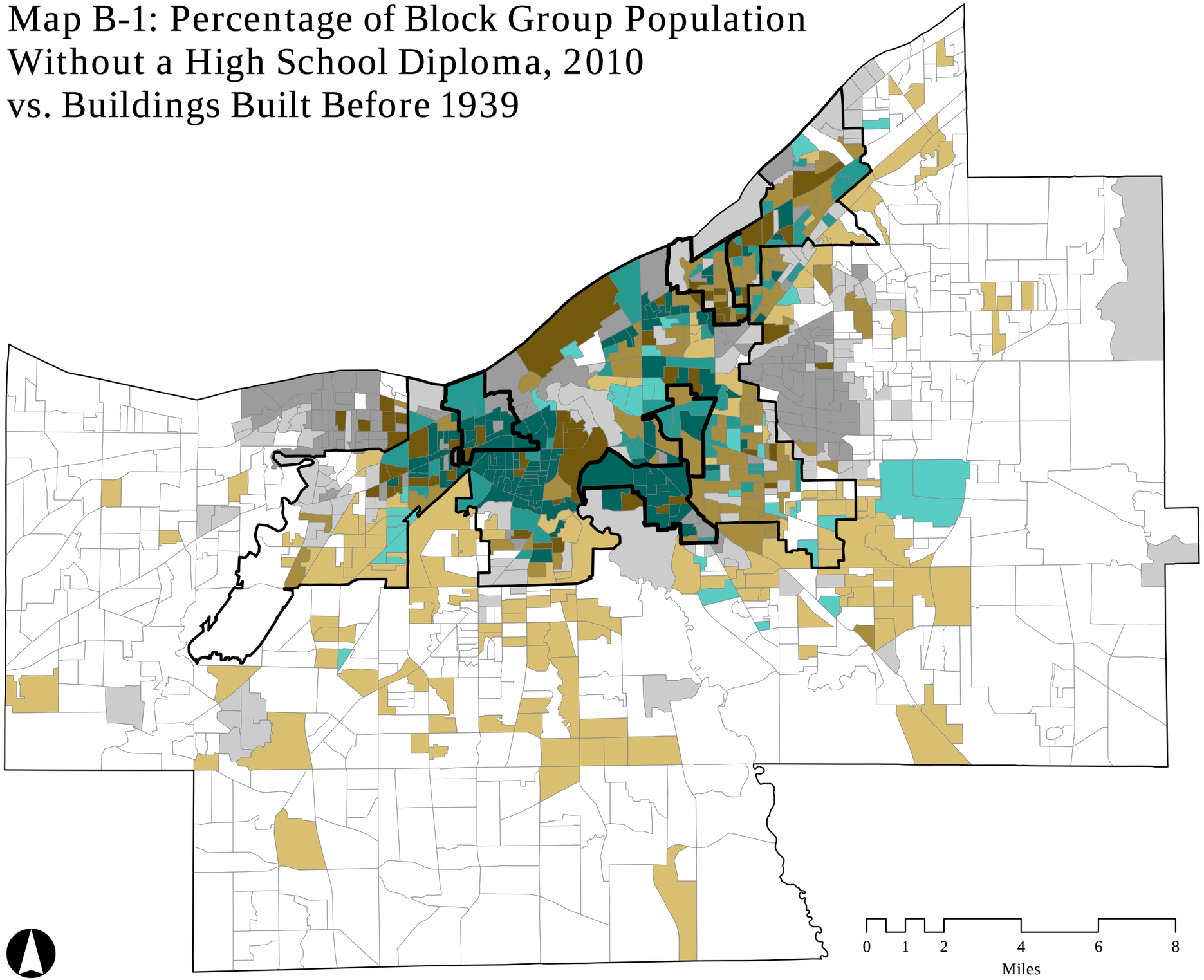
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map B-1: Percentage of Block Group Population Without a High School Diploma, 2010 vs. Buildings Built Before 1939



Legend:

Social: Without a High School Diploma

Physical: Buildings Built Before 1939

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

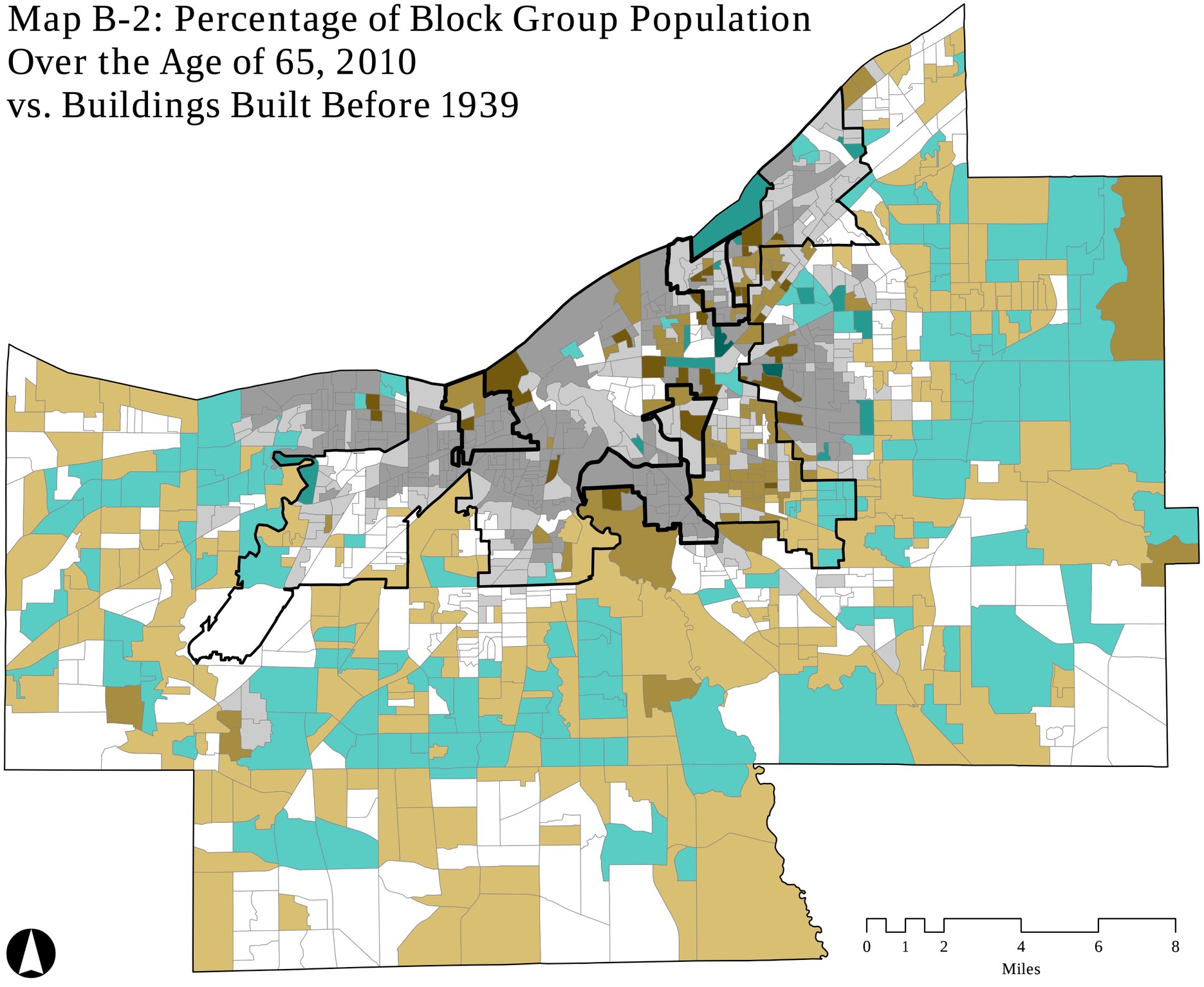
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map B-2: Percentage of Block Group Population Over the Age of 65, 2010 vs. Buildings Built Before 1939



Legend:

Social: Living in Rental Properties

Physical: Buildings Built Before 1939

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
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Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

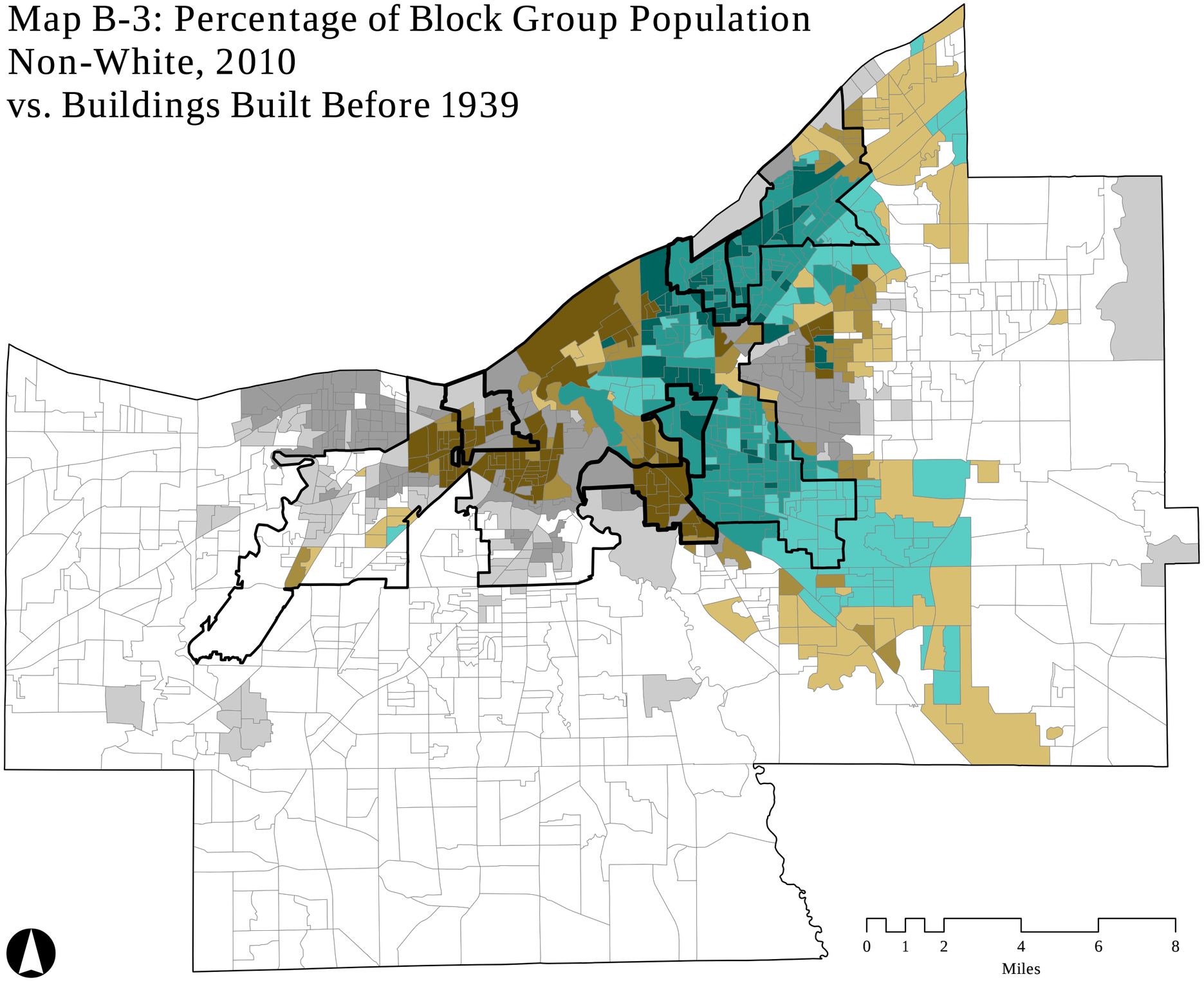
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map B-3: Percentage of Block Group Population Non-White, 2010 vs. Buildings Built Before 1939



Legend:

Social: Non-White

Physical: Buildings Built Before 1939

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

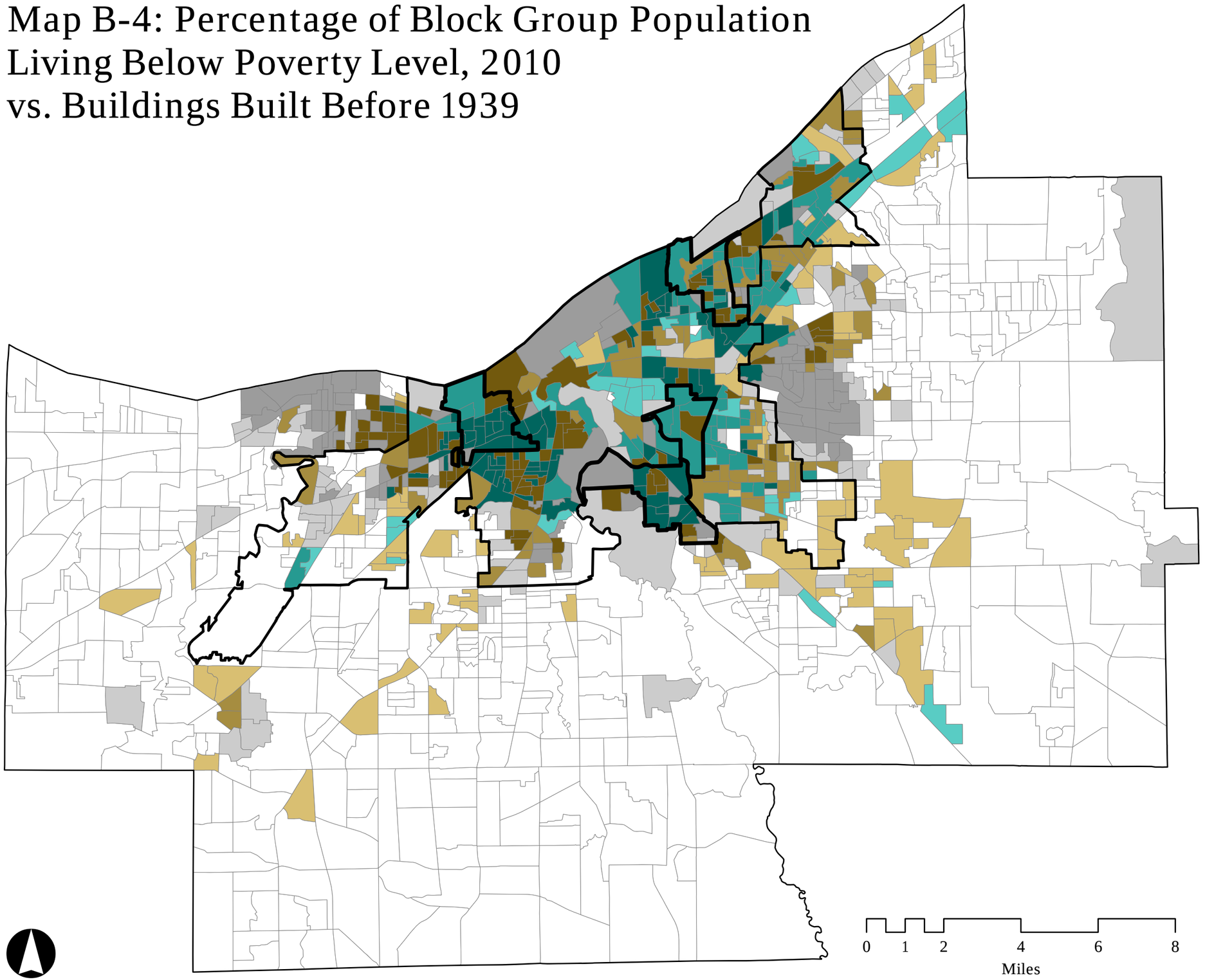
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map B-4: Percentage of Block Group Population Living Below Poverty Level, 2010 vs. Buildings Built Before 1939



Legend:

Social: Living Below Poverty Level		Physical: Buildings Built Before 1939
Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

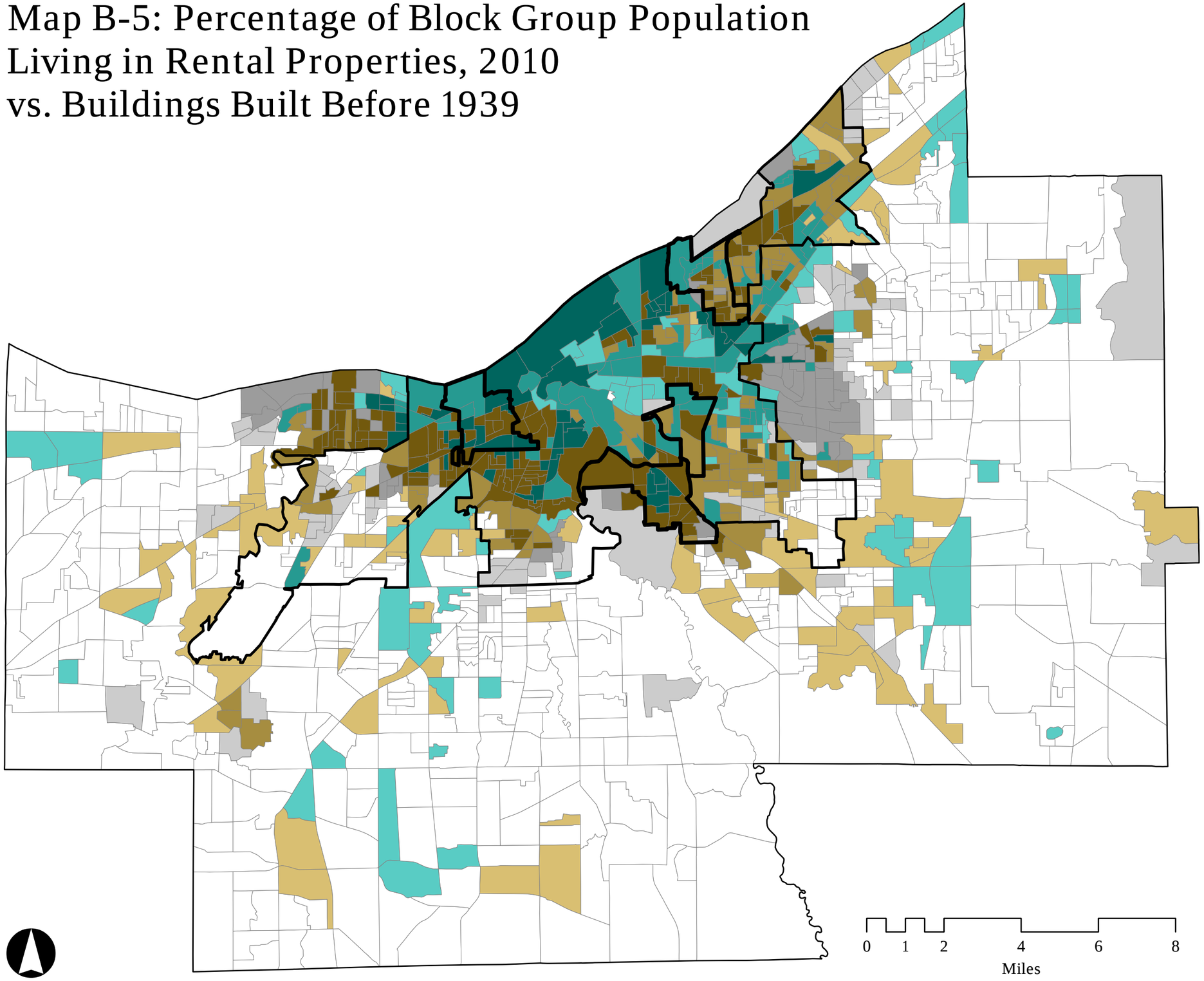
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map B-5: Percentage of Block Group Population Living in Rental Properties, 2010 vs. Buildings Built Before 1939



Legend:

Social: Living in Rental Properties	Physical: Buildings Built Before 1939
Low	1 Low
	2 Medium
	3 High
Medium	4 Low
	5 Medium
	6 High
High	7 Low
	8 Medium
	9 High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

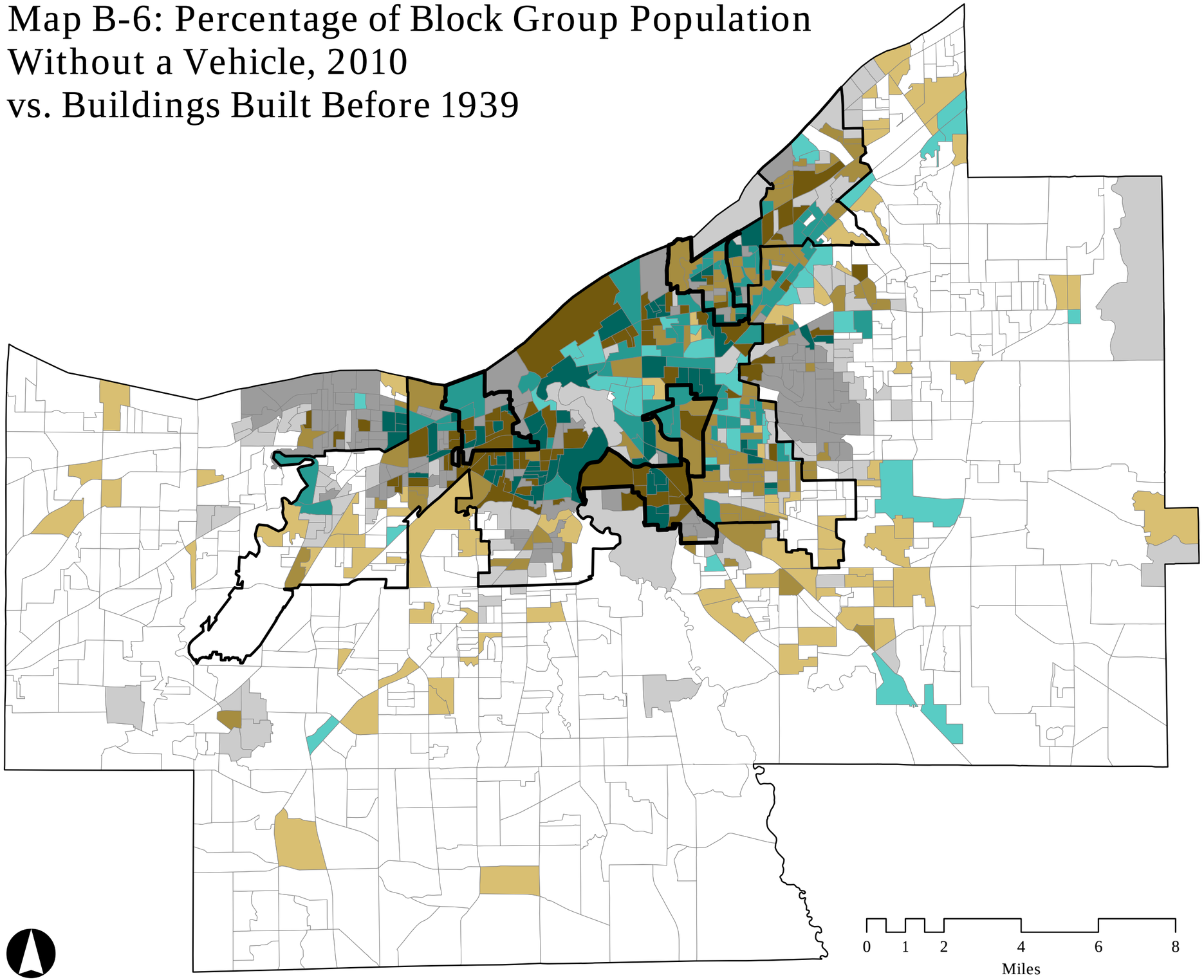
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map B-6: Percentage of Block Group Population Without a Vehicle, 2010 vs. Buildings Built Before 1939



Legend:

Social: Without a Vehicle

Physical: Buildings Built Before 1939

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

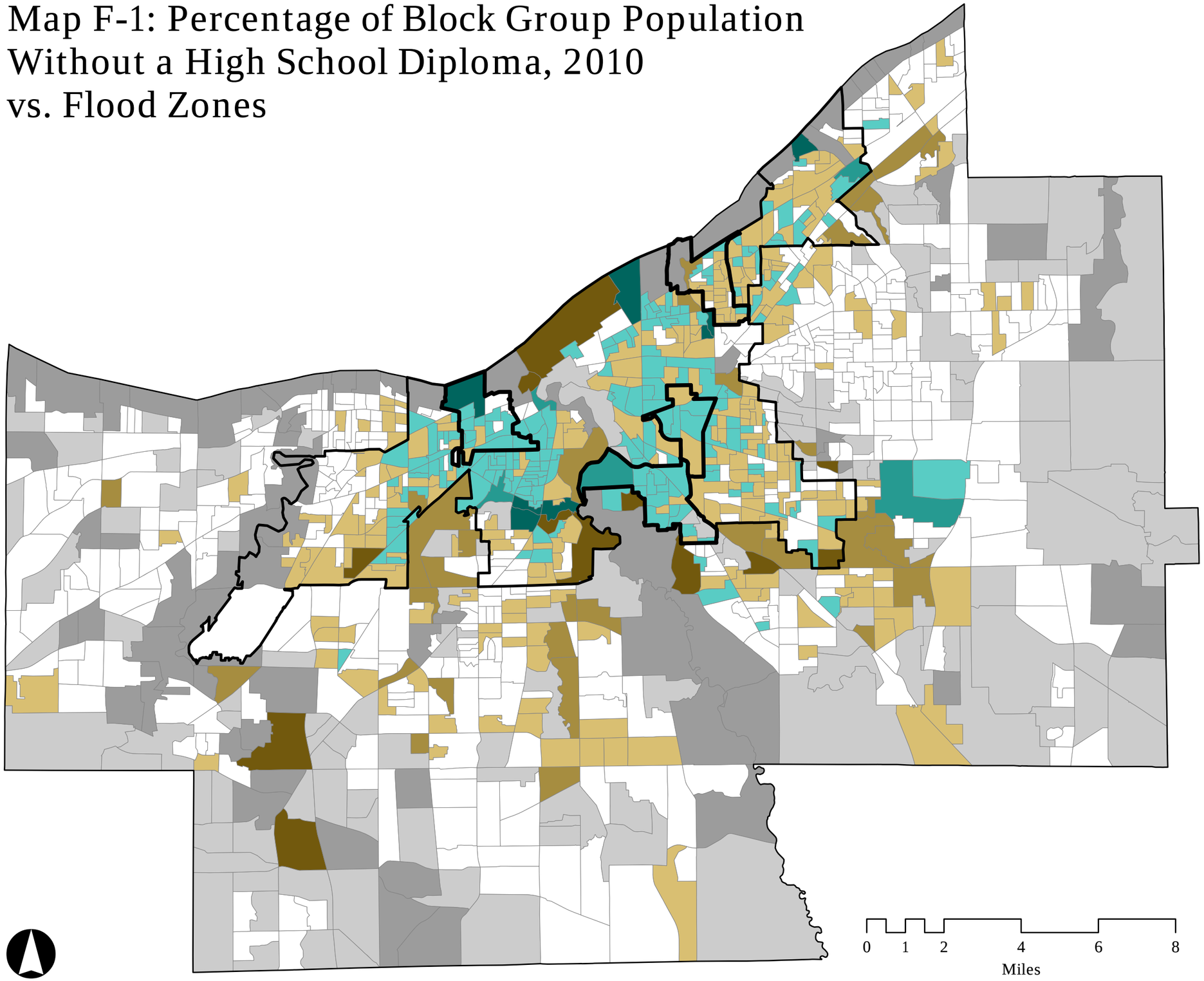
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map F-1: Percentage of Block Group Population Without a High School Diploma, 2010 vs. Flood Zones



Legend:

Social: Without a High School Diploma		Physical: Flood Zone
Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

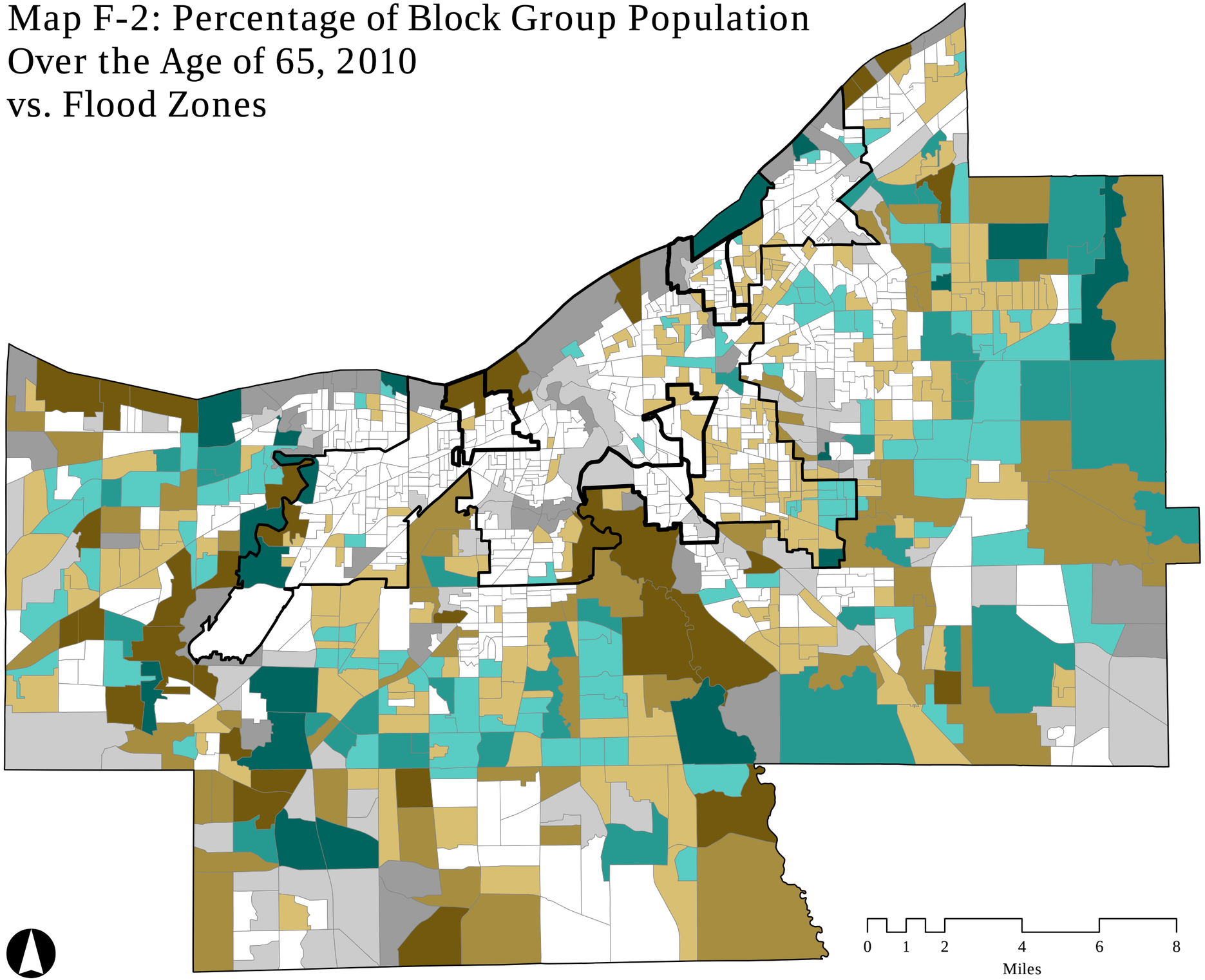
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map F-2: Percentage of Block Group Population Over the Age of 65, 2010 vs. Flood Zones



Legend:

Social: Over the Age of 65

Physical: Flood Zone

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

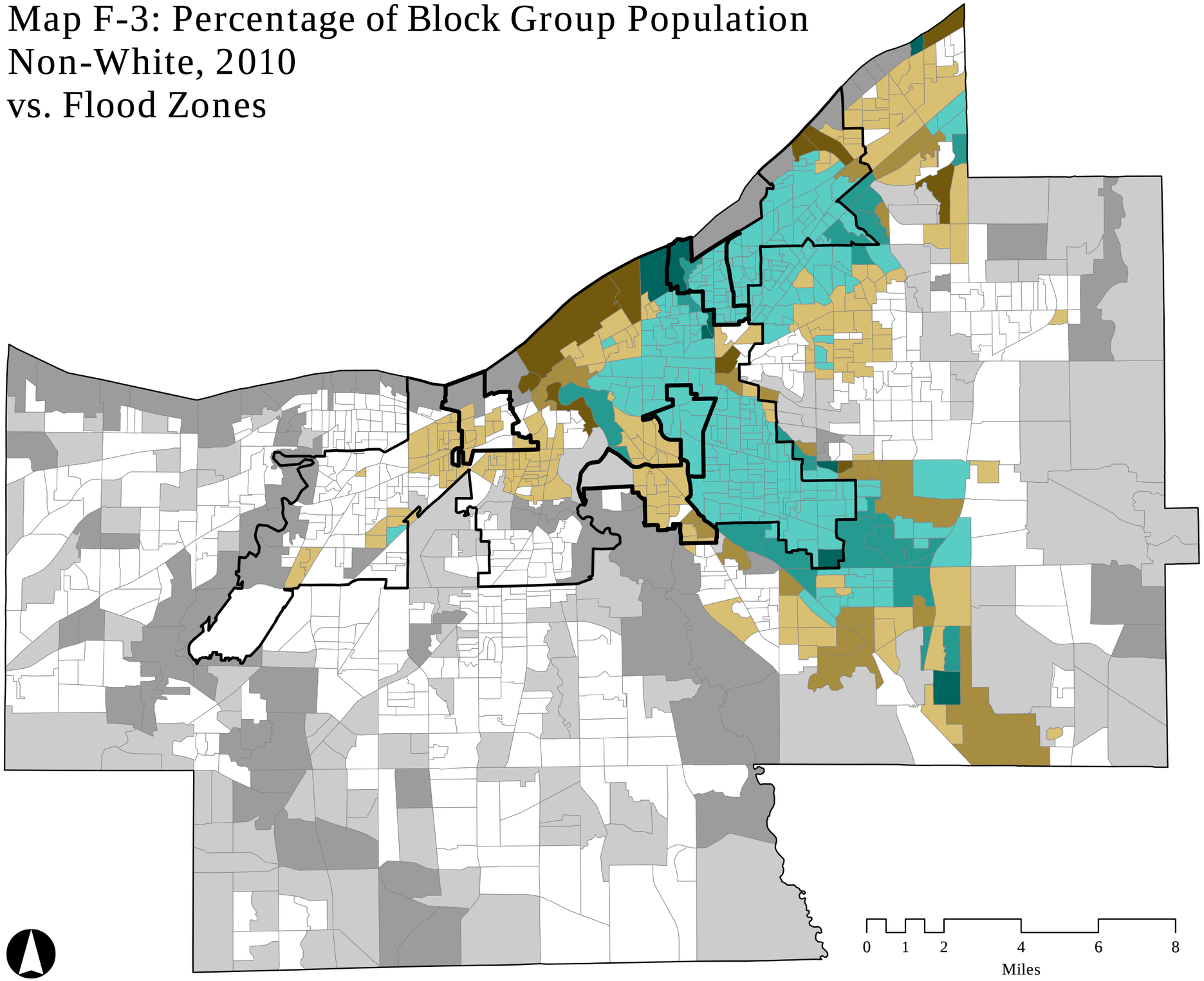
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map F-3: Percentage of Block Group Population Non-White, 2010 vs. Flood Zones



Legend:

Social: Non-White

Physical: Flood Zone

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
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FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

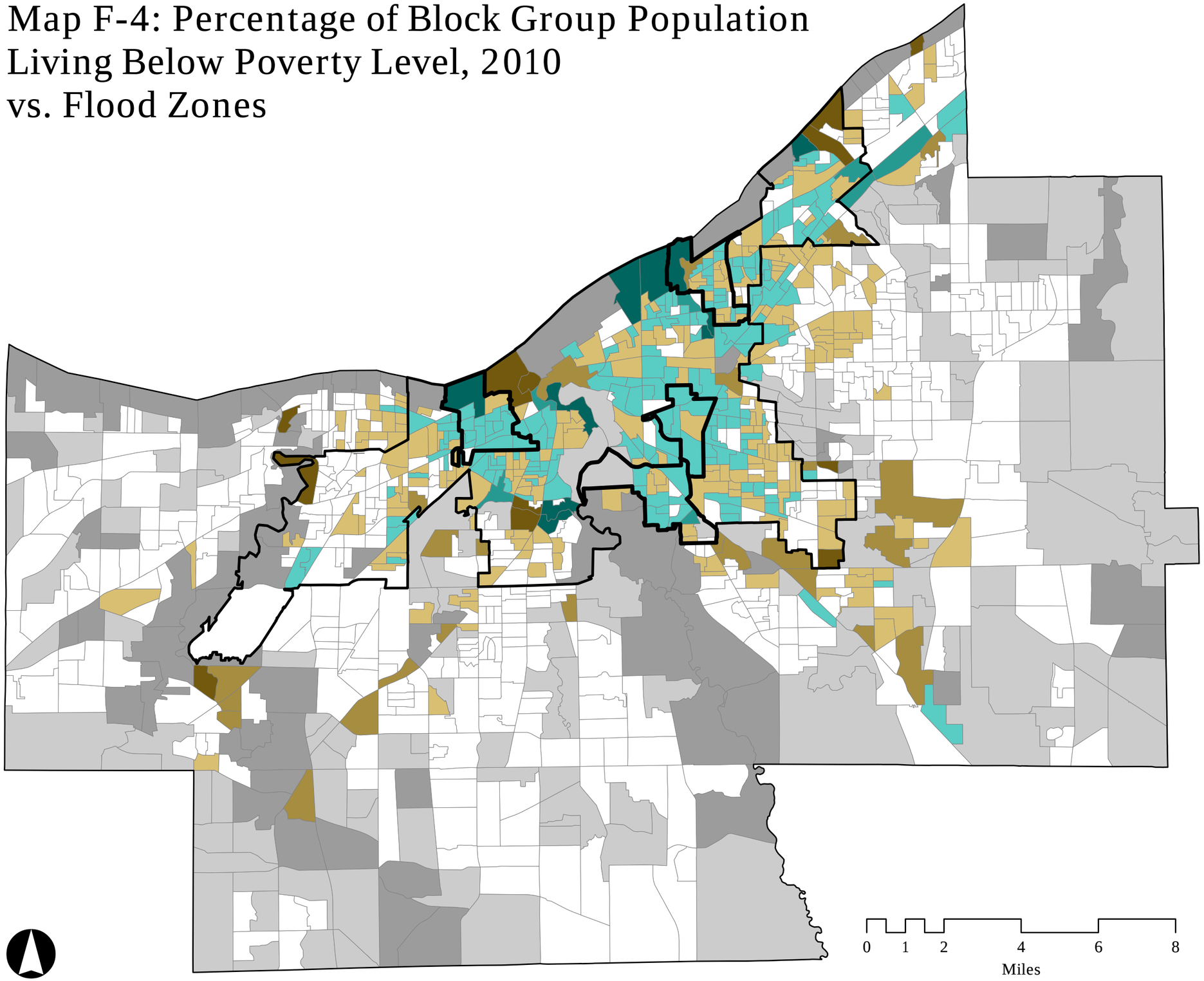
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map F-4: Percentage of Block Group Population Living Below Poverty Level, 2010 vs. Flood Zones



Legend:

Social: Living Below Poverty Level

Physical: Flood Zone

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

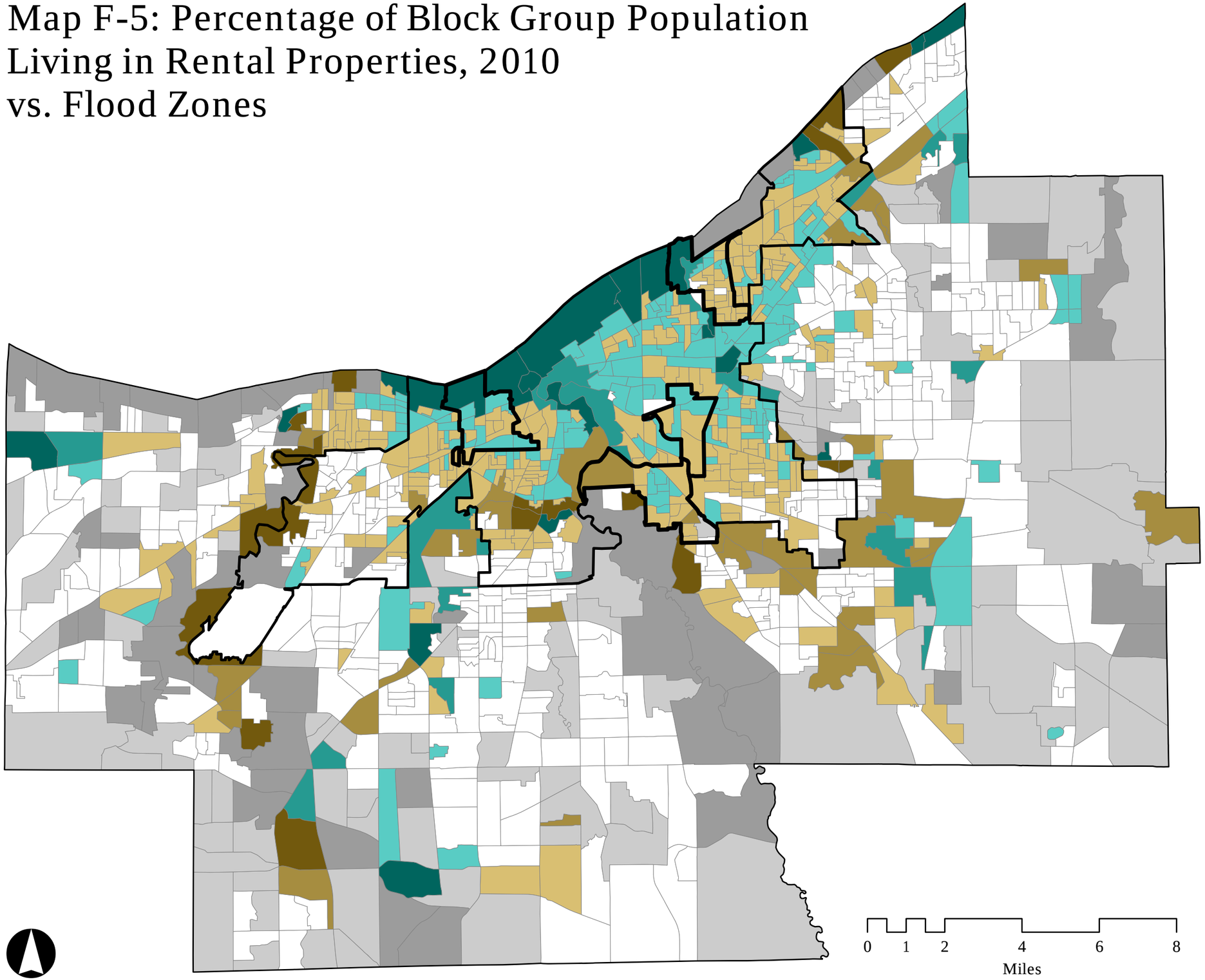
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map F-5: Percentage of Block Group Population Living in Rental Properties, 2010 vs. Flood Zones



Legend:

Social: Living in Rental Properties		Physical: Flood Zones
Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

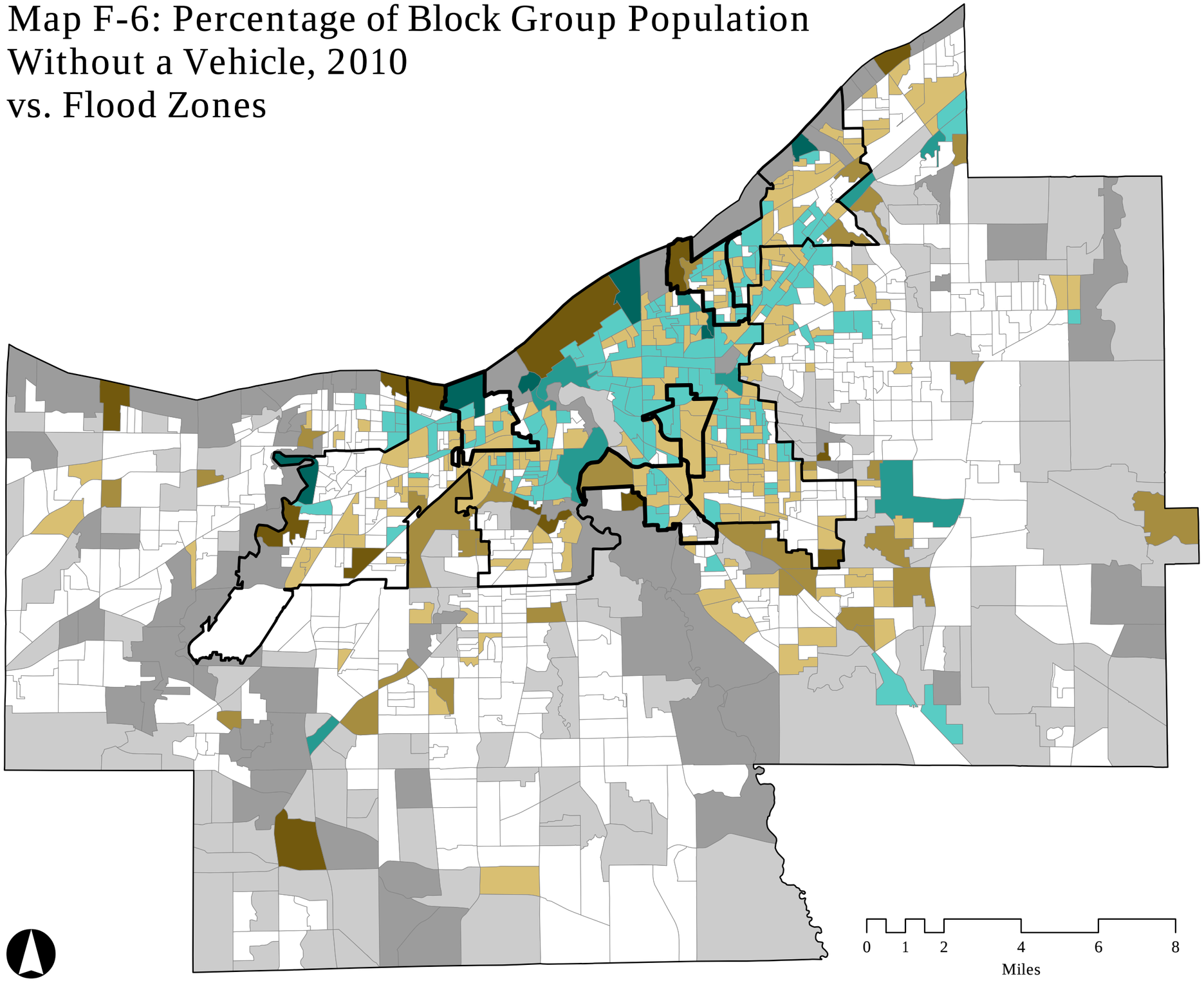
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map F-6: Percentage of Block Group Population Without a Vehicle, 2010 vs. Flood Zones



Legend:

Social: Living Without a Vehicle

Physical: Flood Zones

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:

Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above the mean.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
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FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

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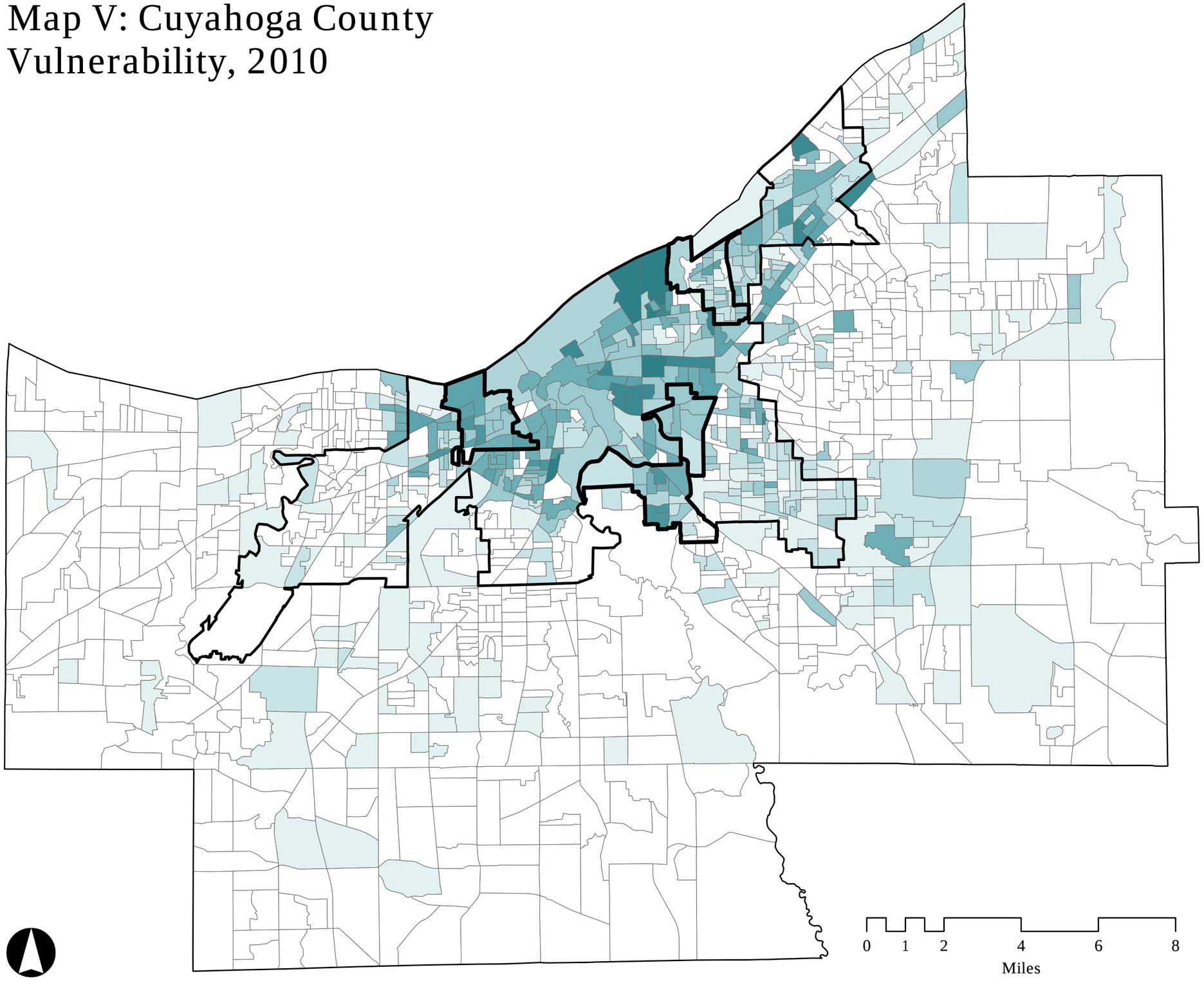
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Monday, June 22, 2015

Map V: Cuyahoga County Vulnerability, 2010



Legend:

Vulnerability

- 0 Least Vulnerable
- 1
- 2
- 3
- 4
- 5
- 6
- 8
- 9
- 10
- 12 Most Vulnerable

Note:

Vulnerability values for each block group are determined by the overall count of "High/High" values in the social and physical factor comparison. For example, a "High" value in the percent without a vehicle paired with a "High" value for impervious surfaces represents one vulnerability value.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

Mike Tuzzo and Nick Rajkovich
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Kristen Zeiber and Terry Schwarz
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Contact: ResilientCleveland@gmail.com

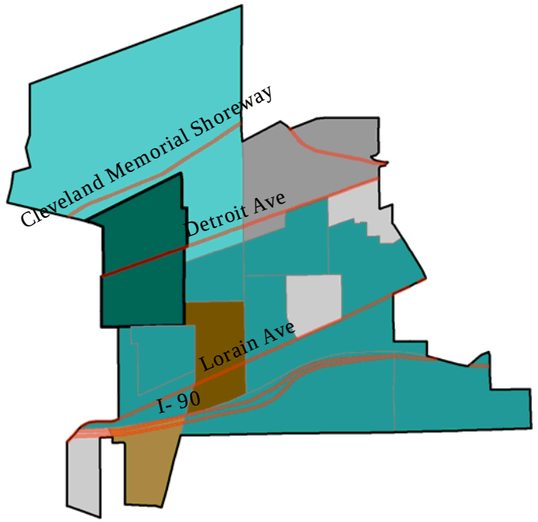
Maps Created:

Thursday, June 25, 2015

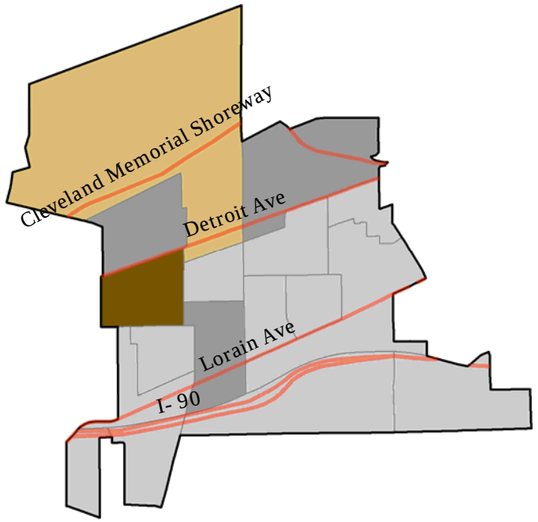
NEIGHBORHOOD VULNERABILITY MAP MATRIX

		Neighborhoods			
		Detroit-Shoreway	**Glenville**	**Kinsman**	**Slavic-Village**
Physical Factors vs. Social Factors	**Land Coverage: Impervious Surface vs. Social Factors**	D-1	G-1	K-1	S-1
	Land Coverage: Tree Canopy vs. Social Factors	D-2	G-2	K-2	S-2
	Buildings Constructed Before 1939 vs. Social Factors	D-3	G-3	K-3	S-3
	FEMA Flood Zone vs. Social Factors	D-4	G-4	K-4	S-4

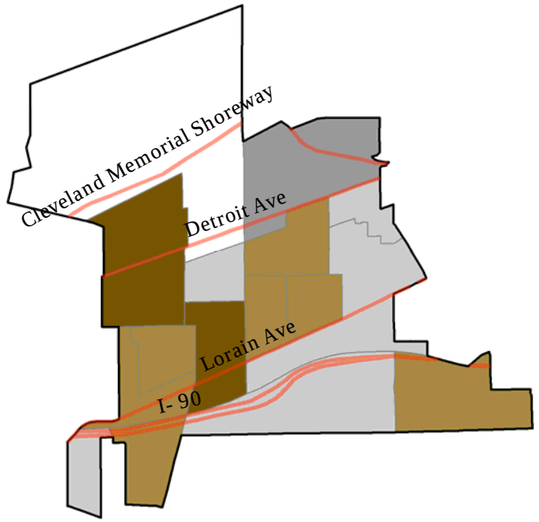
Map D-1: Detroit-Shoreway Impervious Surfaces



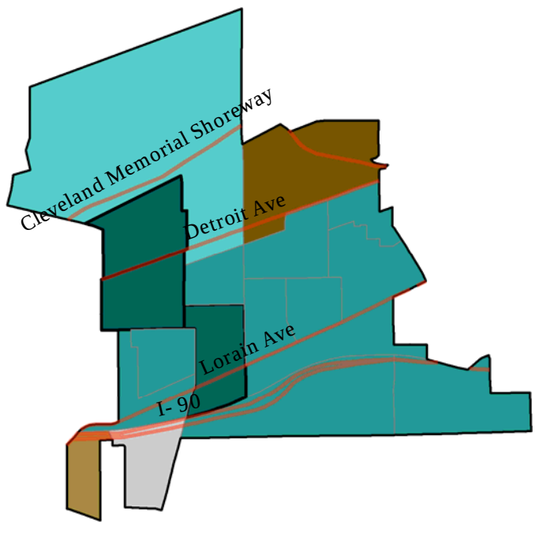
Percent Without High School Diploma



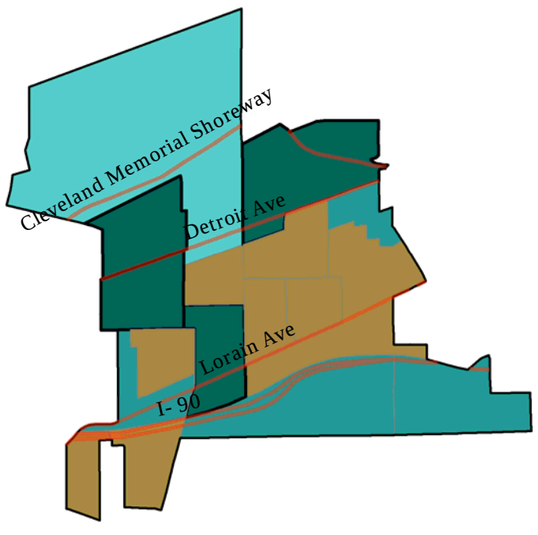
Percent Over the Age of 65



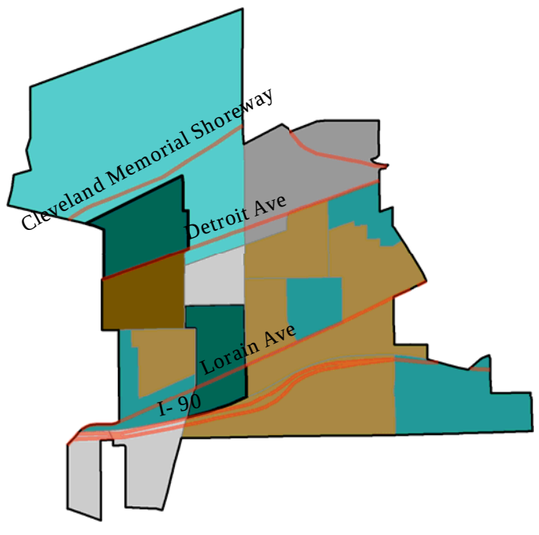
Percent Non-White



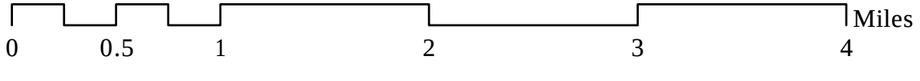
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Impervious Surfaces

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

Data Source:
NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

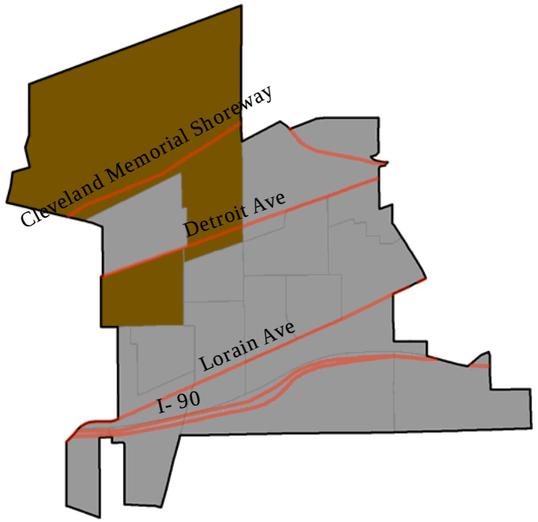
Projection:
NAD 1983, Ohio State Plane North

Maps Produced By:
Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

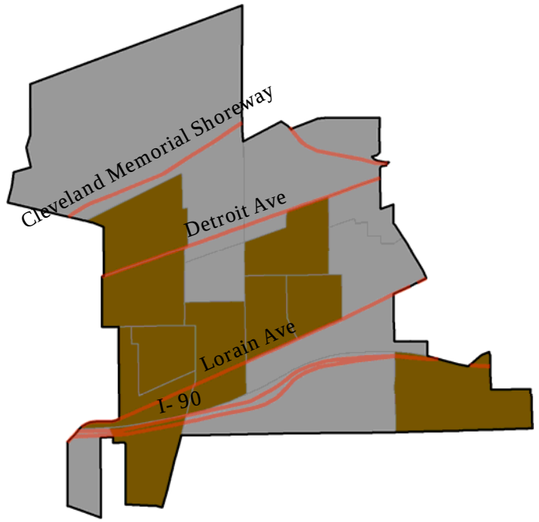
Maps Created:
Tuesday, June 23, 2015

Map D-2: Detroit-Shoreway Tree Canopy Coverage

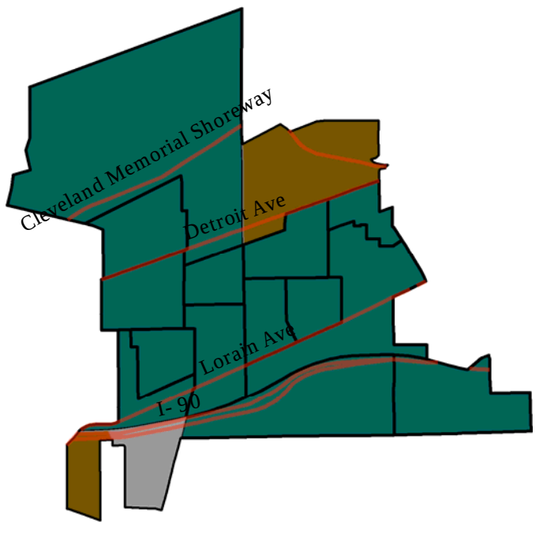
Percent Without High School Diploma



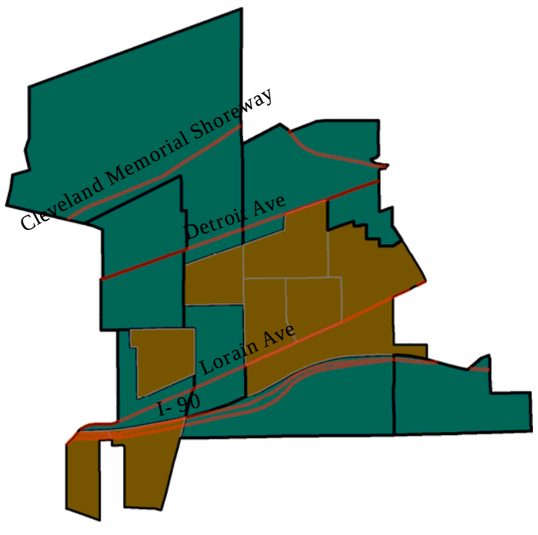
Percent Over the Age of 65



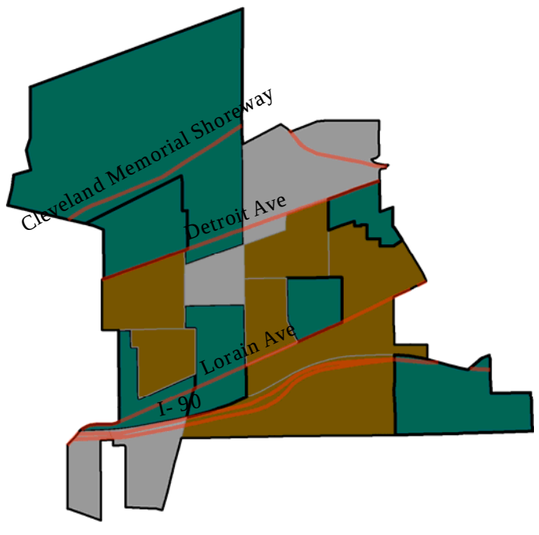
Percent Non-White



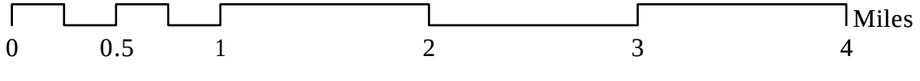
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Tree Canopy Coverage

Low	1	High
	2	Medium
	3	Low
Medium	4	High
	5	Medium
	6	Low
High	7	High
	8	Medium
	9	Low

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

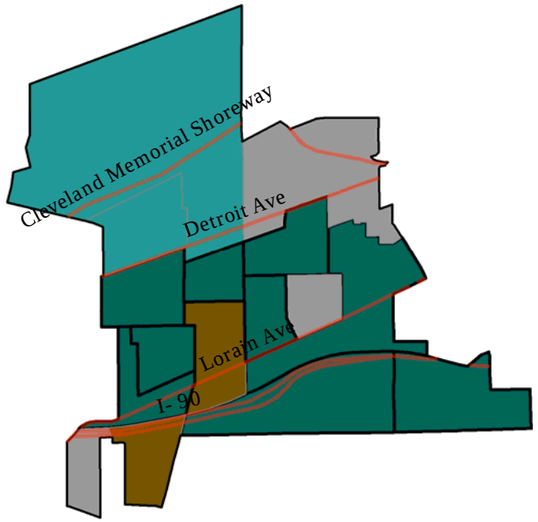
Data Source:
NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:
NAD 1983, Ohio State Plane North

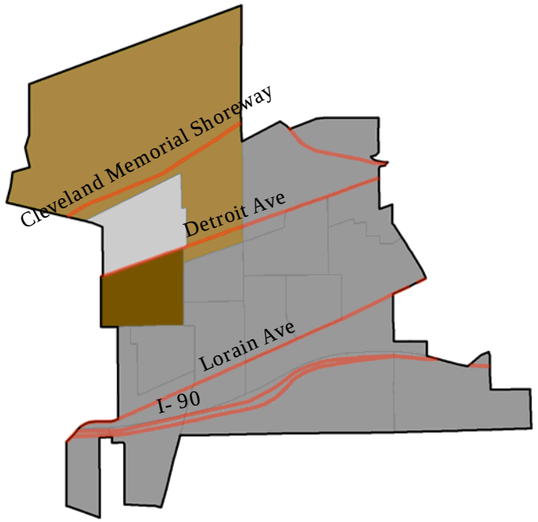
Maps Produced By:
Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:
Tuesday, June 23, 2015

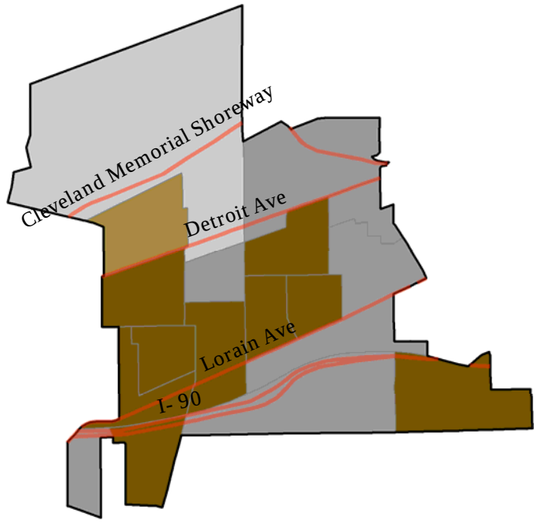
Map D-3: Detroit-Shoreway Buildings Built Before 1939



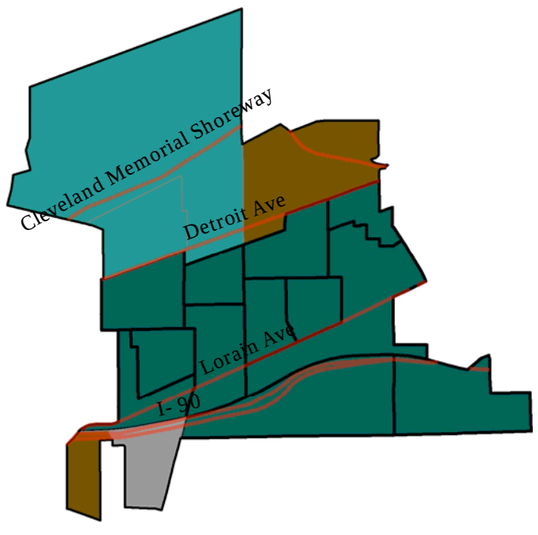
Percent Without High School Diploma



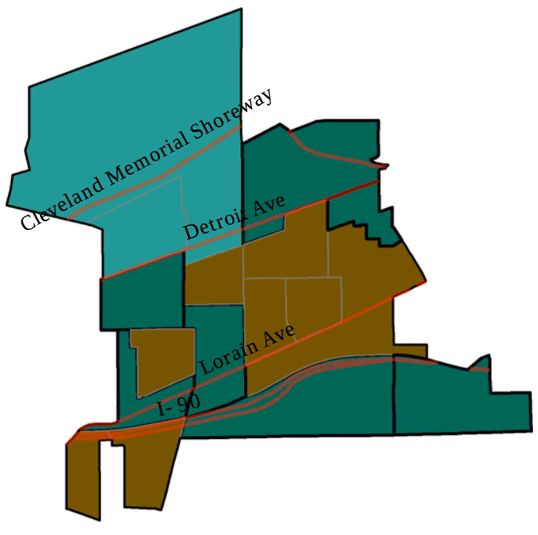
Percent Over the Age of 65



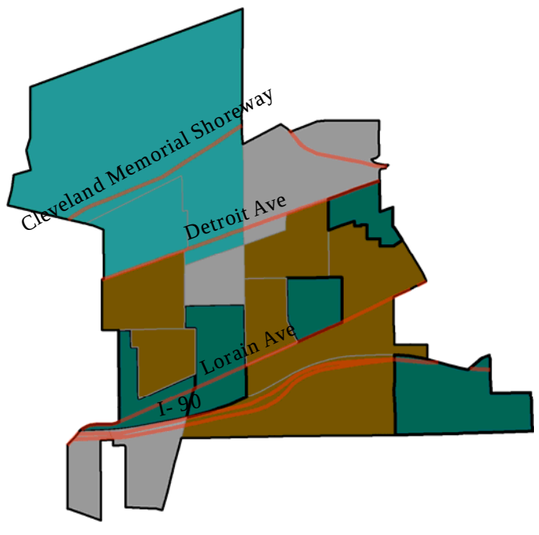
Percent Non-White



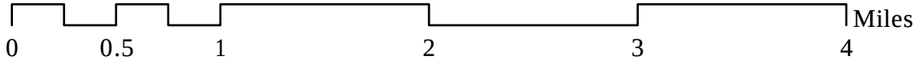
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Buildings Built Before 1939

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

Data Source:
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Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
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FEMA Flood Map Service Center

Projection:
NAD 1983, Ohio State Plane North

Maps Produced By:
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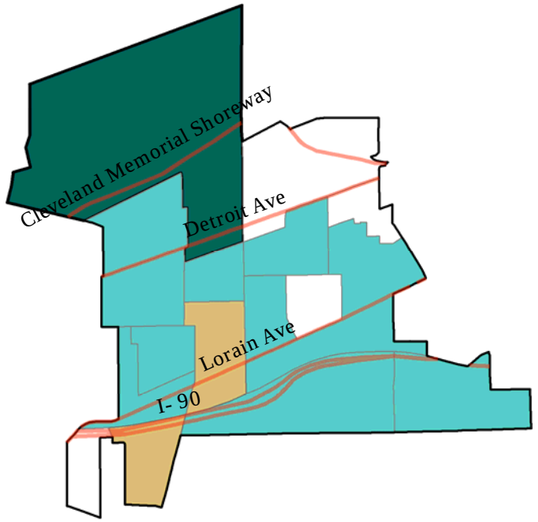
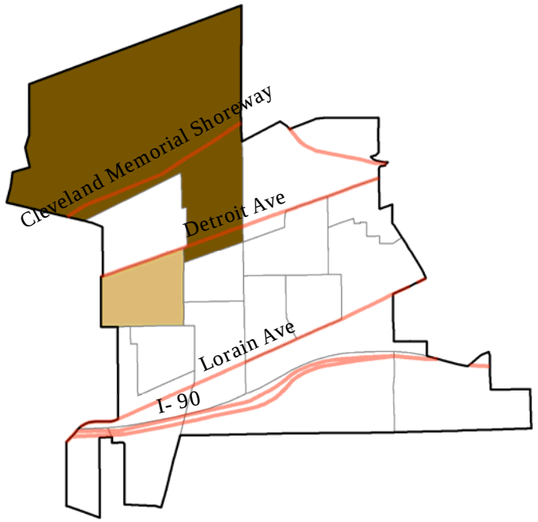
Contact: ResilientCleveland@gmail.com

Maps Created:
Tuesday, June 23, 2015

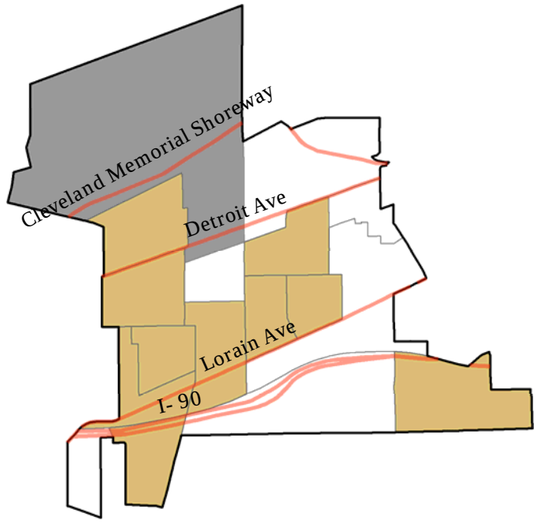
Map D-4: Detroit-Shoreway Flood Zones



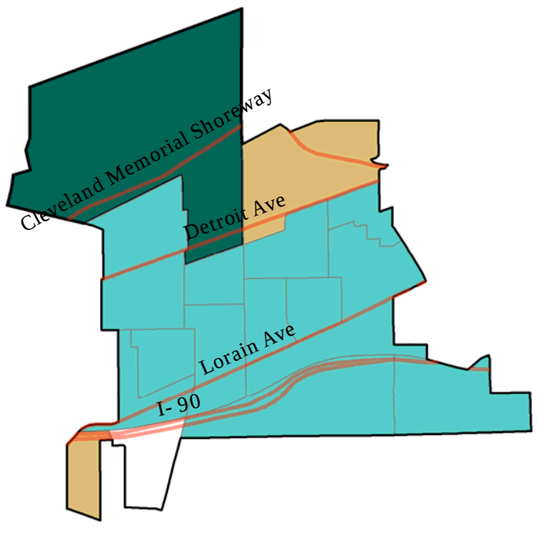
Percent Without High School Diploma



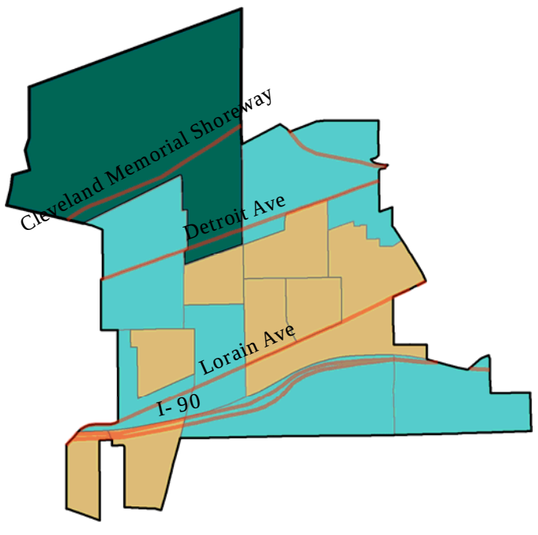
Percent Over the Age of 65



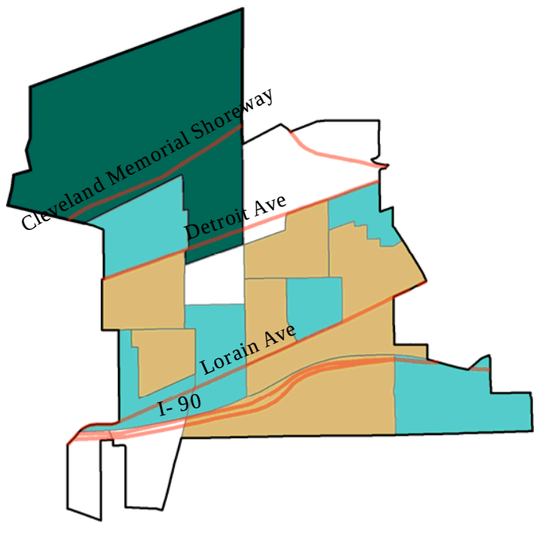
Percent Non-White



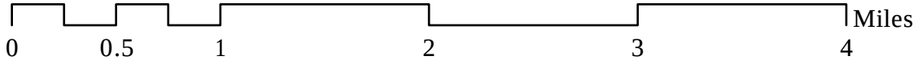
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Flood Zones

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

Data Source:
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U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:
NAD 1983, Ohio State Plane North

Maps Produced By:
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(University at Buffalo)
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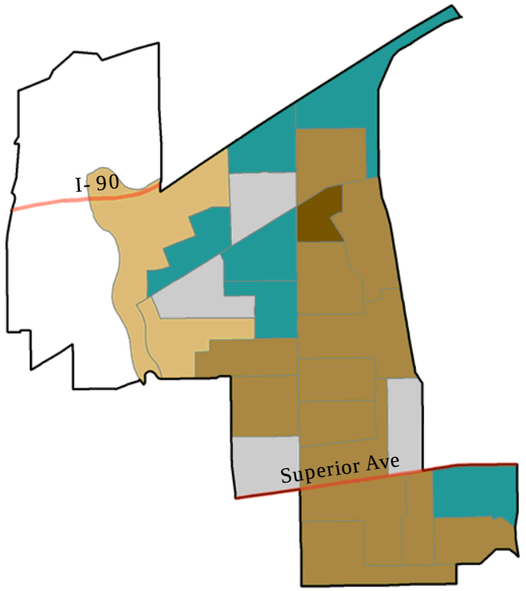
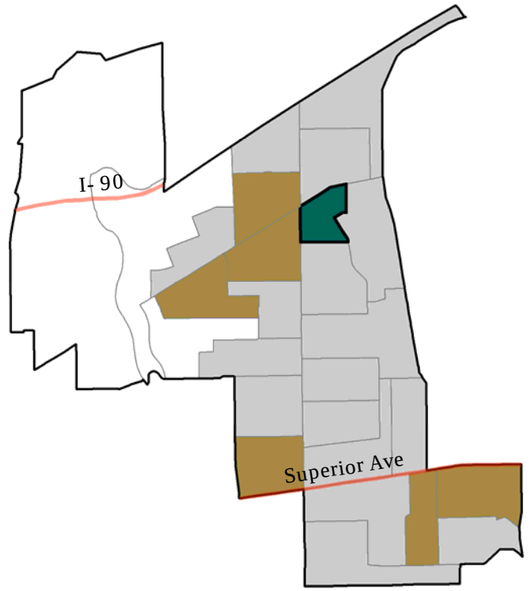
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:
Tuesday, June 23, 2015

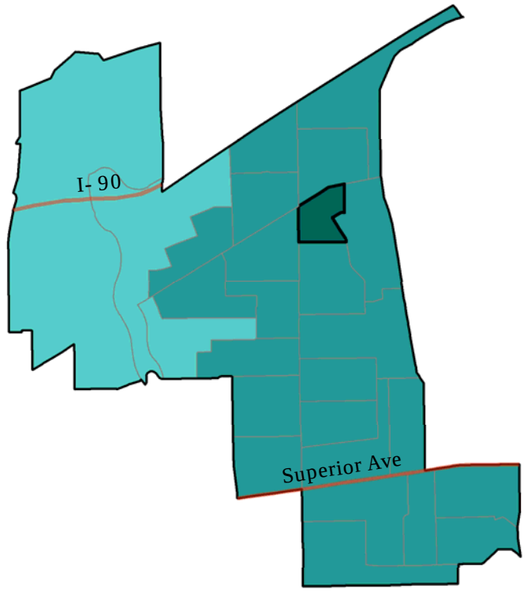
Map G-1: Glenville Impervious Surfaces



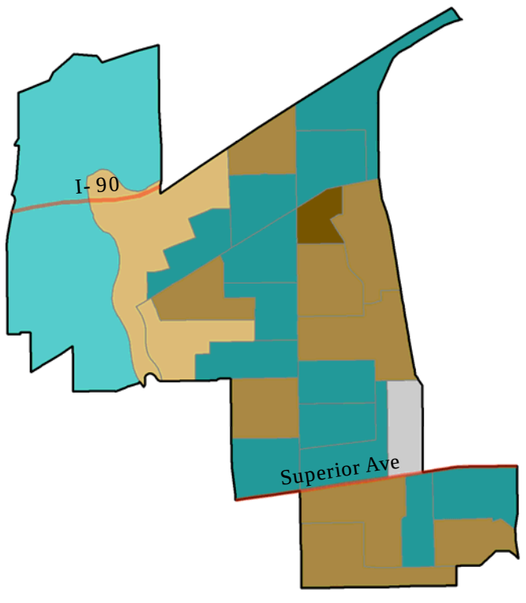
Percent Without High School Diploma



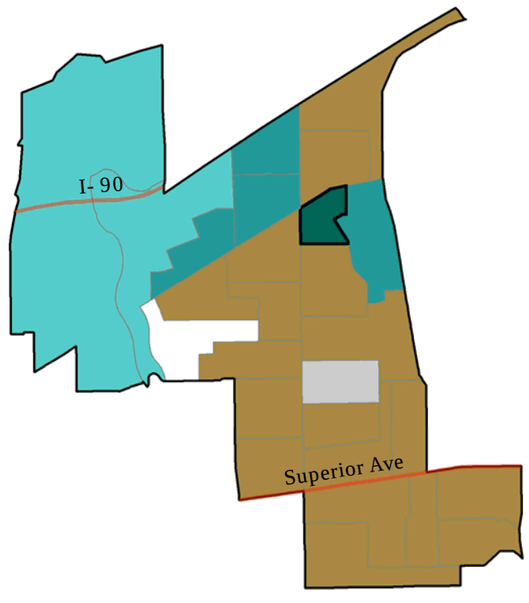
Percent Over the Age of 65



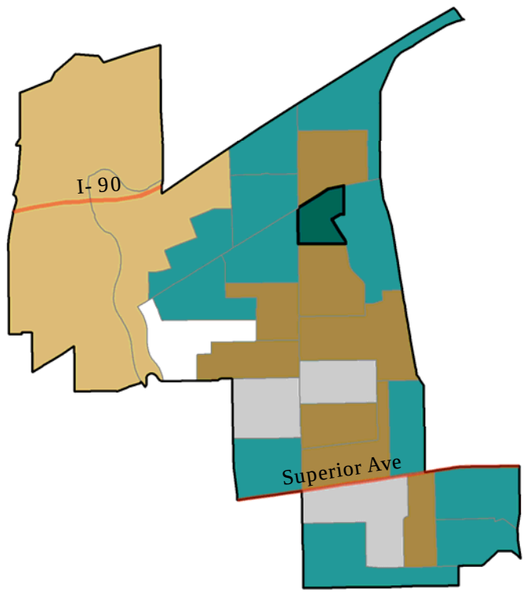
Percent Non-White



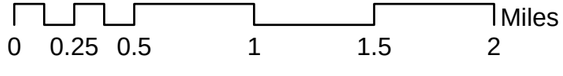
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Impervious Surfaces

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

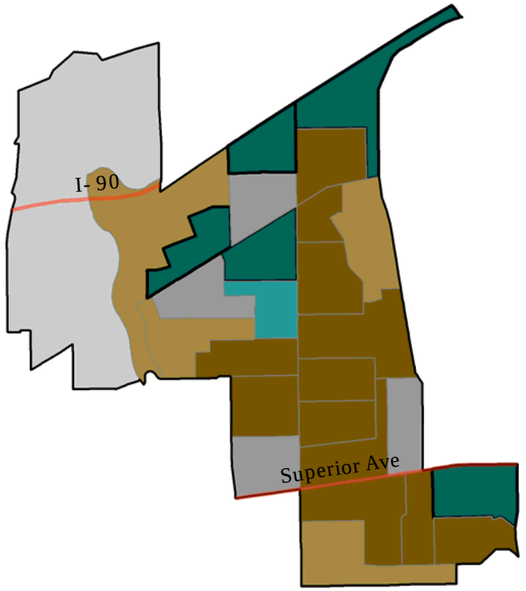
Data Source:
NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:
NAD 1983, Ohio State Plane North

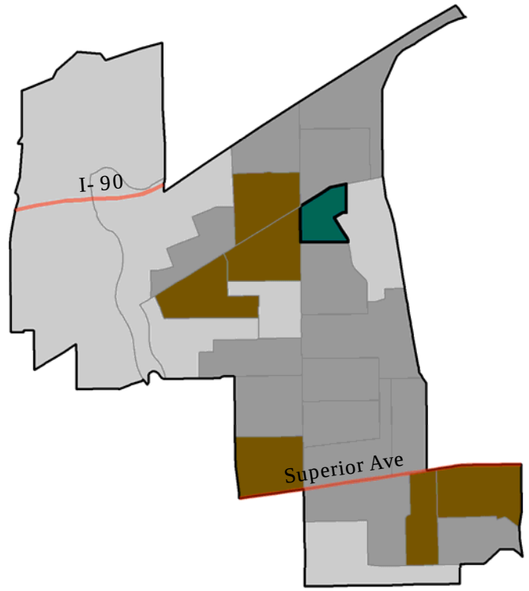
Maps Produced By:
Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
and Kristen Zeiber
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:
Tuesday, June 23, 2015

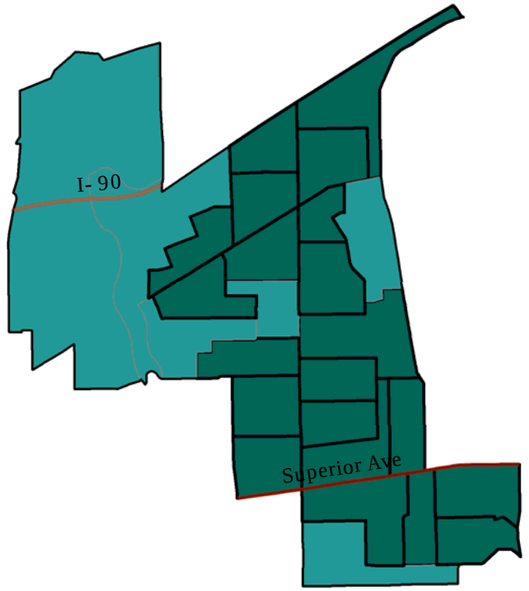
Map G-2: Glenville Tree Canopy Coverage



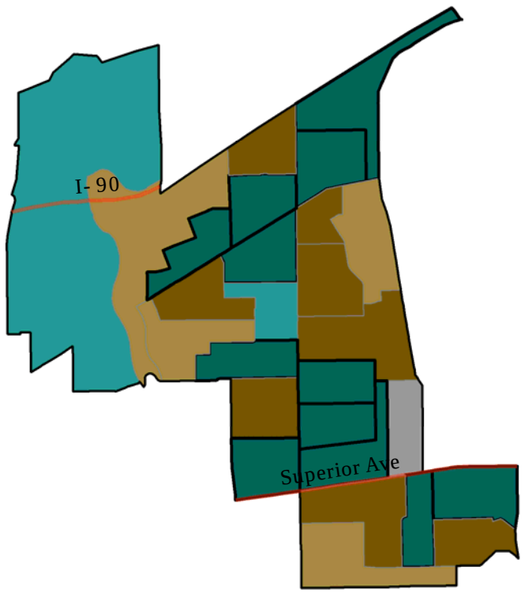
Percent Without High School Diploma



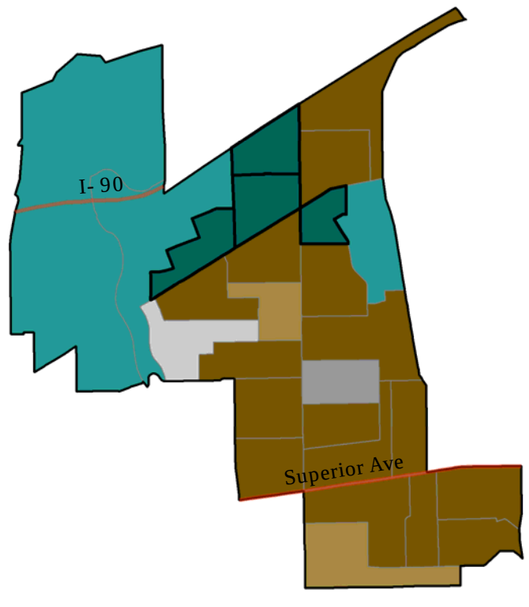
Percent Over the Age of 65



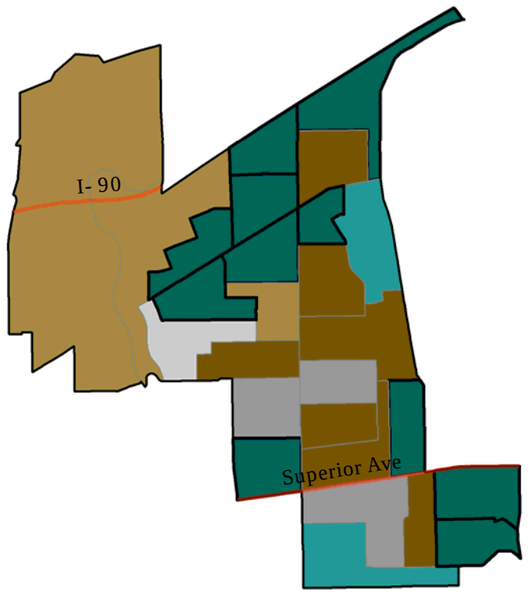
Percent Non-White



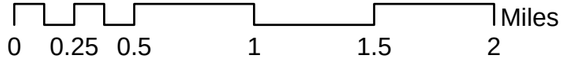
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Tree Canopy Coverage

Low	1	High
	2	Medium
	3	Low
Medium	4	High
	5	Medium
	6	Low
High	7	High
	8	Medium
	9	Low

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

Data Source:
NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:
NAD 1983, Ohio State Plane North

Maps Produced By:
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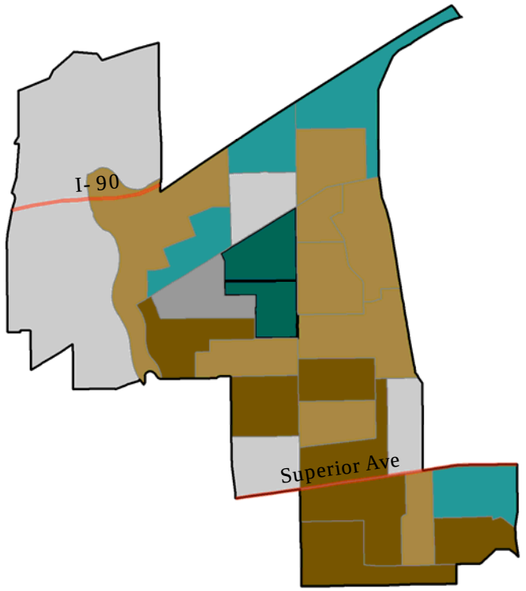
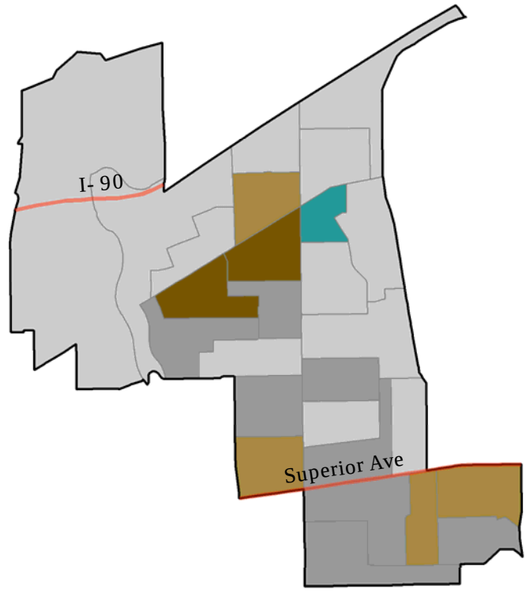
and Kristen Zeiber
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:
Tuesday, June 23, 2015

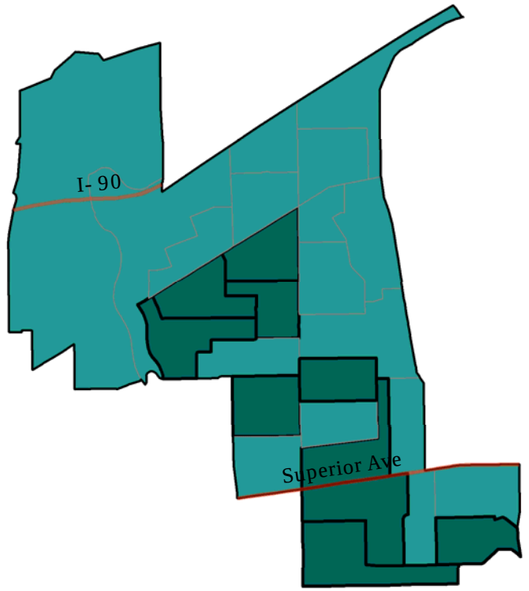
Map G-3: Glenville Buildings Built Before 1939



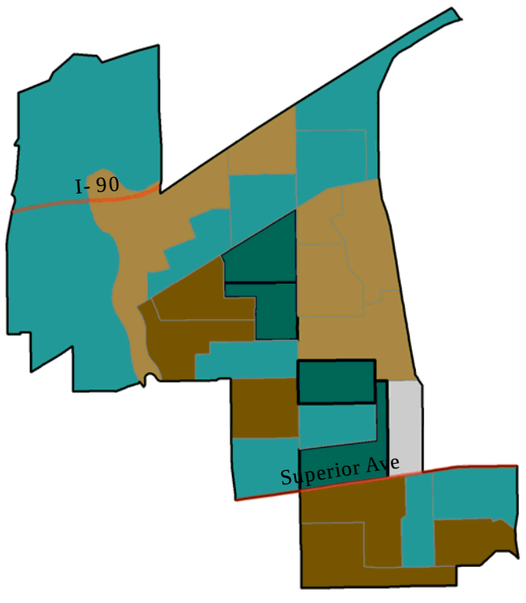
Percent Without High School Diploma



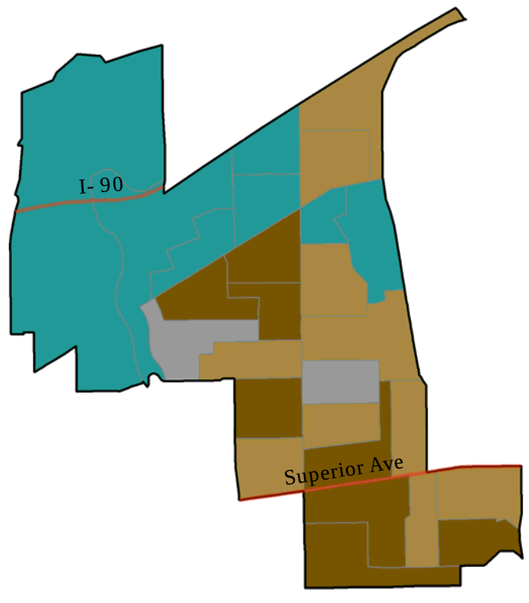
Percent Over the Age of 65



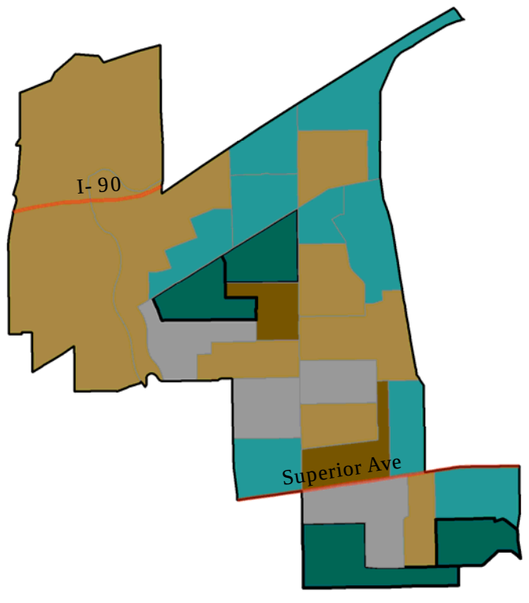
Percent Non-White



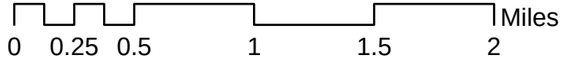
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Buildings Built Before 1939

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

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Projection:
NAD 1983, Ohio State Plane North

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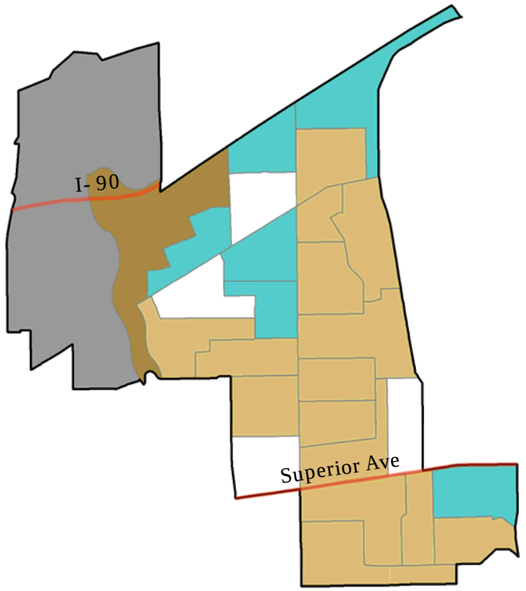
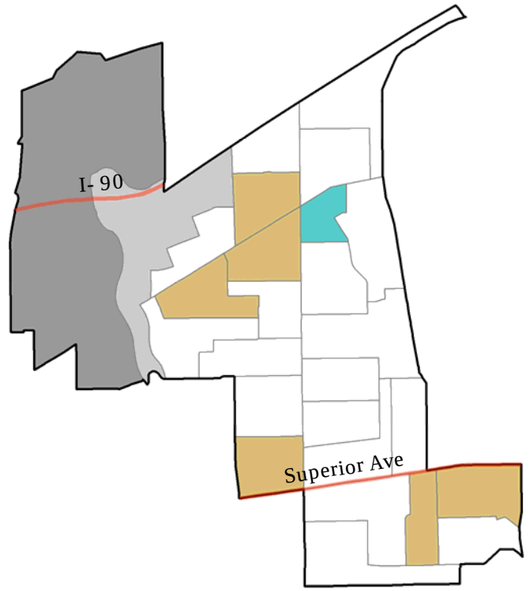
Contact: ResilientCleveland@gmail.com

Maps Created:
Tuesday, June 23, 2015

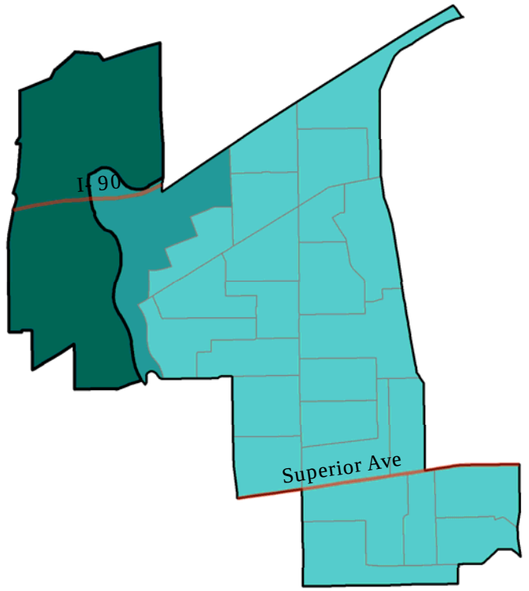
Map G-4: Glenville Flood Zones



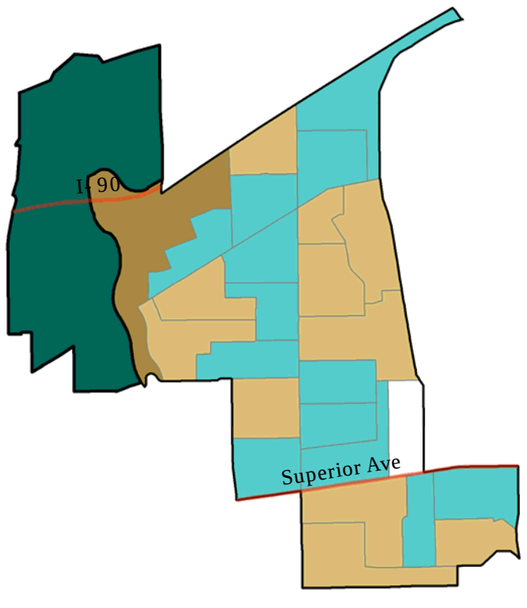
Percent Without High School Diploma



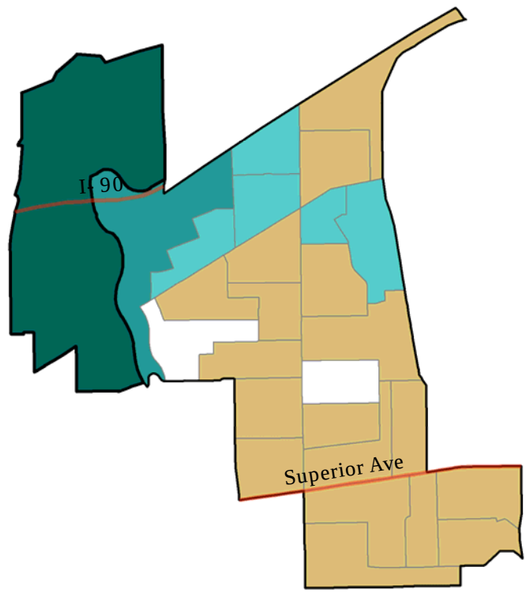
Percent Over the Age of 65



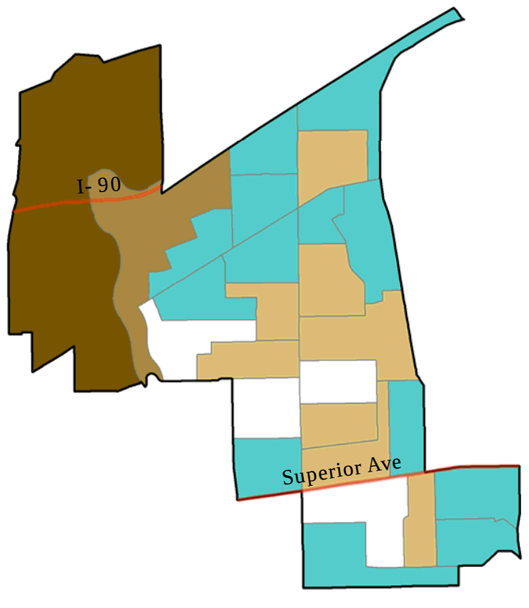
Percent Non-White



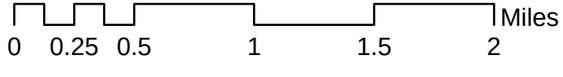
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Flood Zones

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

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U.S. Census,
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FEMA Flood Map Service Center

Projection:
NAD 1983, Ohio State Plane North

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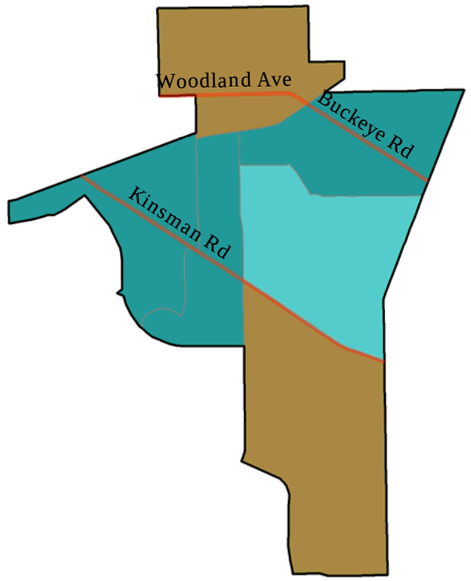
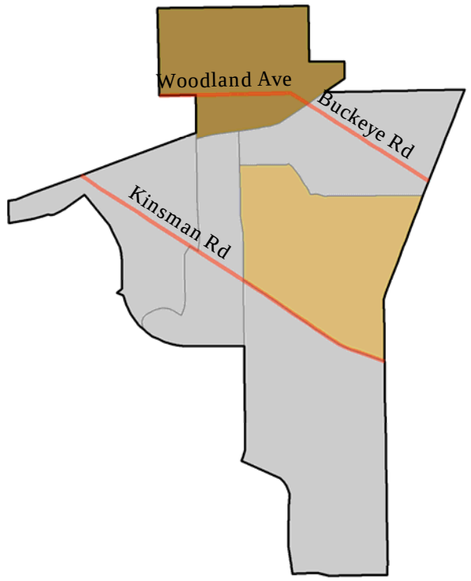
and Kristen Zeiber
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:
Tuesday, June 23, 2015

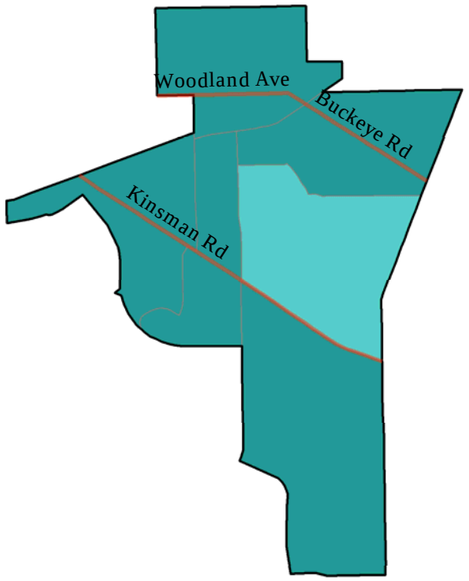
Map K-1: Kinsman Impervious Surfaces



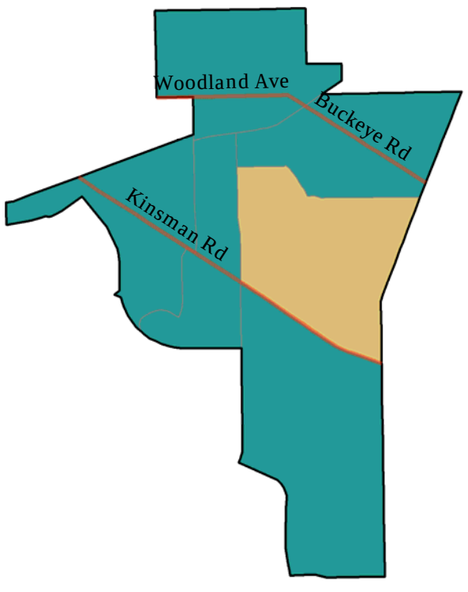
Percent Without High School Diploma



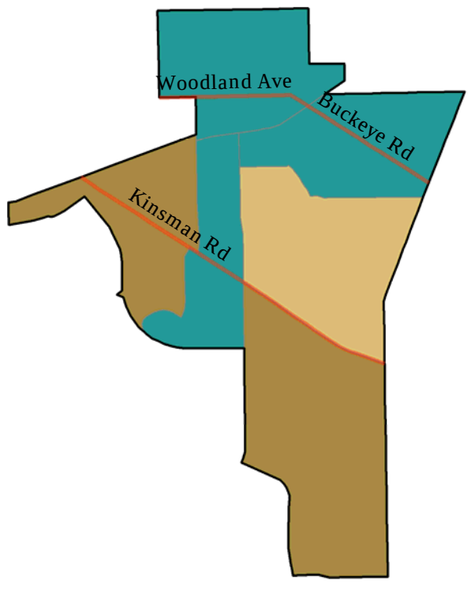
Percent Over the Age of 65



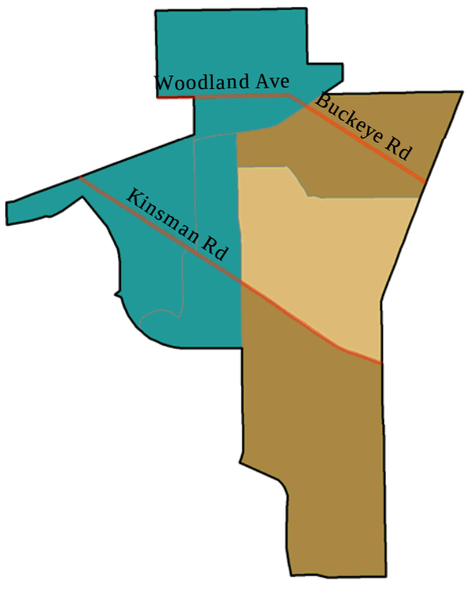
Percent Non-White



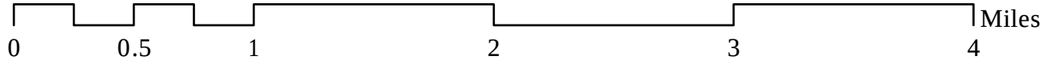
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Impervious Surfaces

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

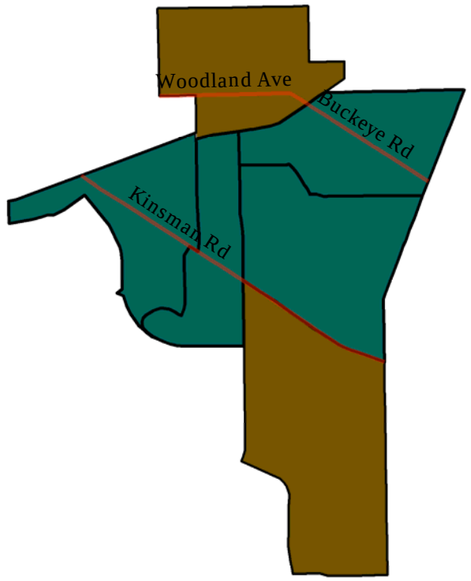
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

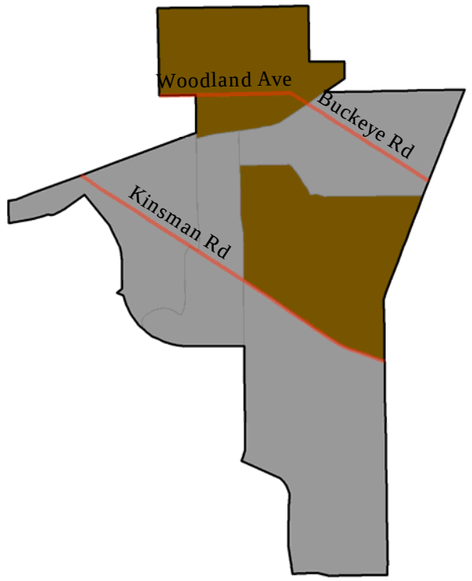
Maps Created:

Tuesday, June 23, 2015

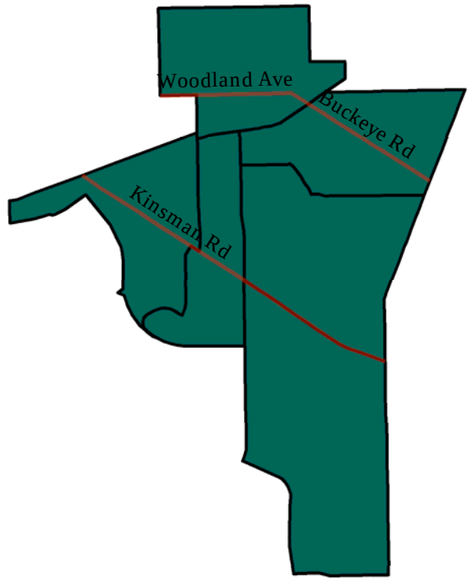
Map K-2: Kinsman Tree Canopy Coverage



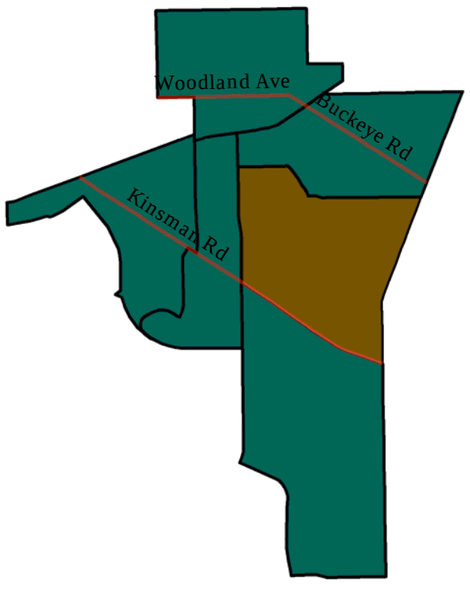
Percent Without High School Diploma



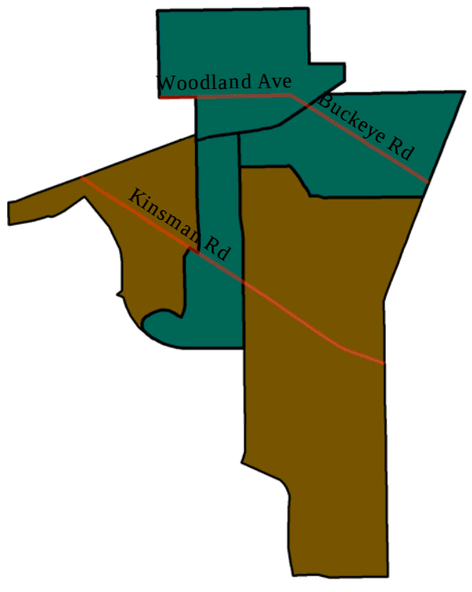
Percent Over the Age of 65



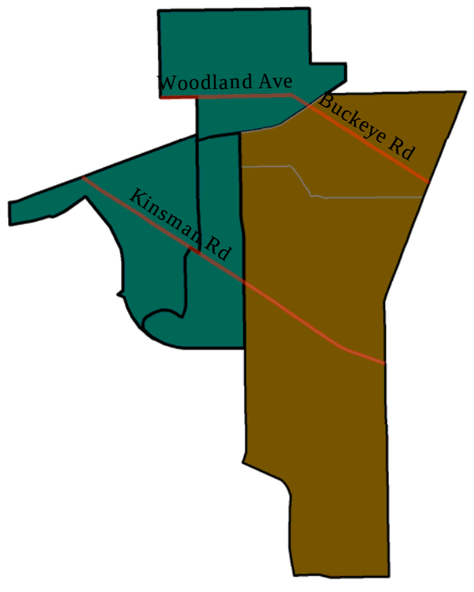
Percent Non-White



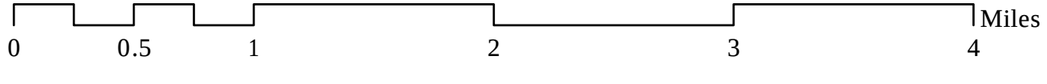
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Tree Canopy Coverage

Low	1	High
	2	Medium
	3	Low
Medium	4	High
	5	Medium
	6	Low
High	7	High
	8	Medium
	9	Low

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

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FEMA Flood Map Service Center

Projection:
NAD 1983, Ohio State Plane North

Maps Produced By:

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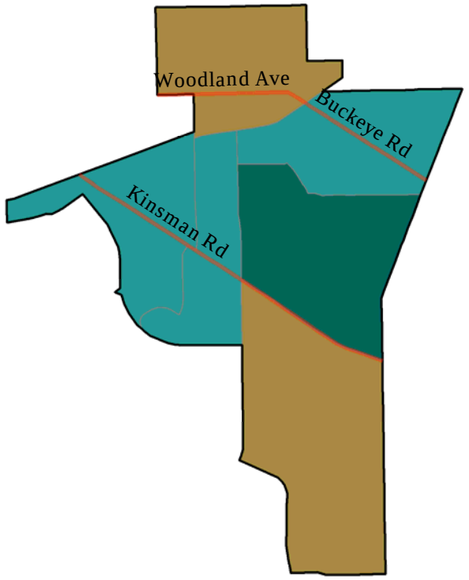
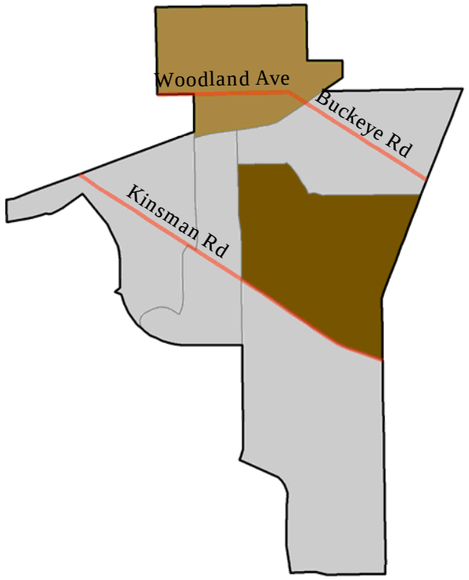
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:
Tuesday, June 23, 2015

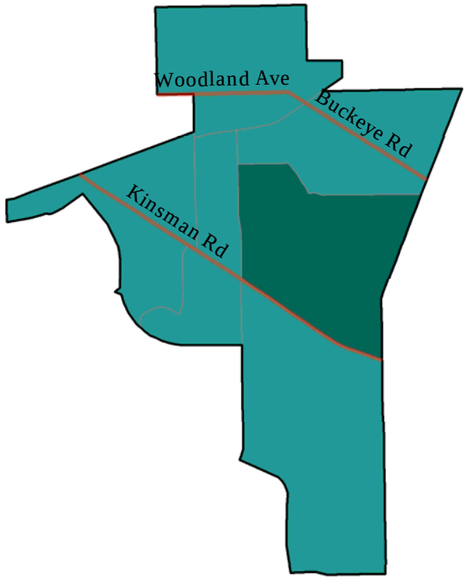
Map K-3: Kinsman Buildings Built Before 1939



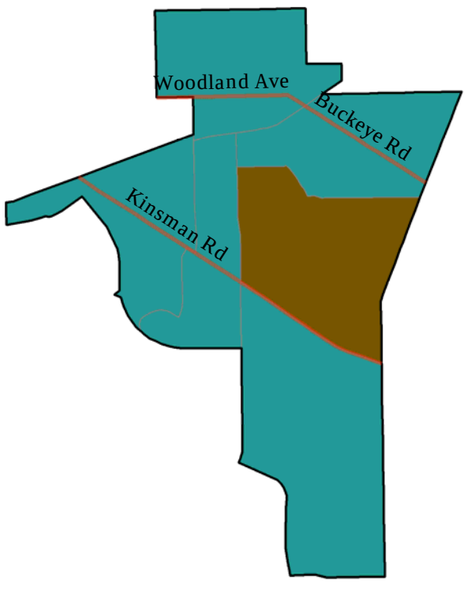
Percent Without High School Diploma



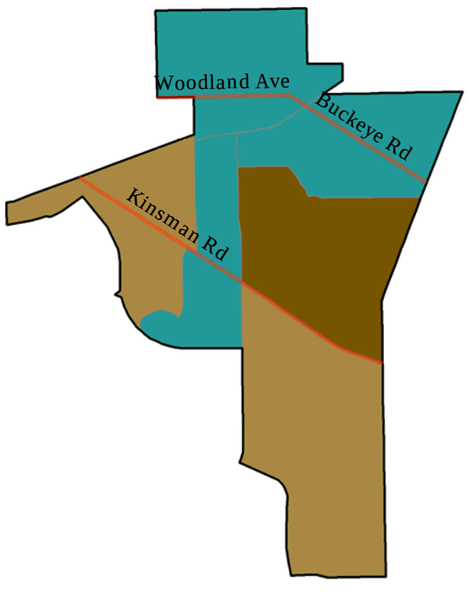
Percent Over the Age of 65



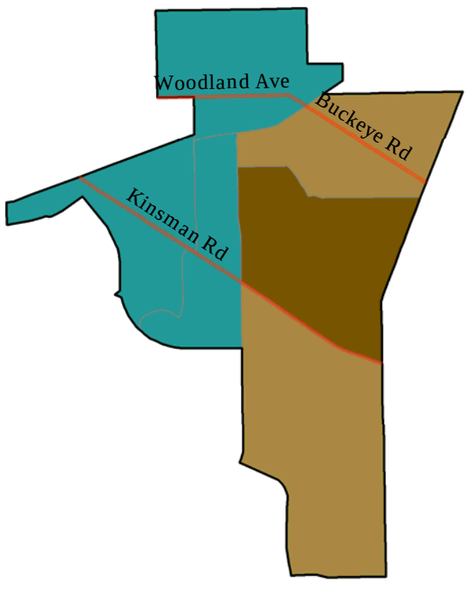
Percent Non-White



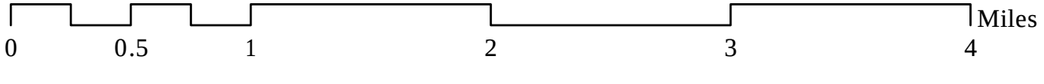
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Buildings Built Before 1939

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

Data Source:
NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
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FEMA Flood Map Service Center

Projection:
NAD 1983, Ohio State Plane North

Maps Produced By:
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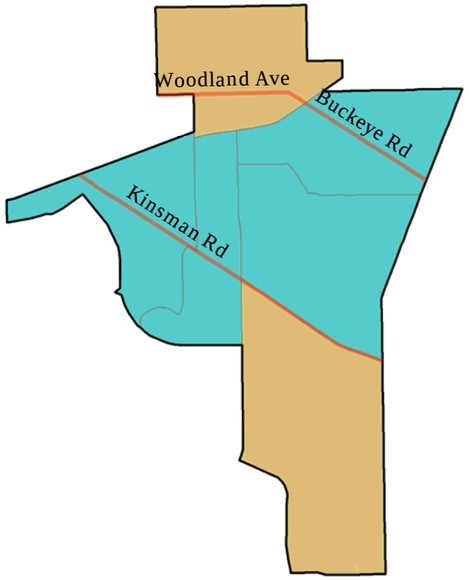
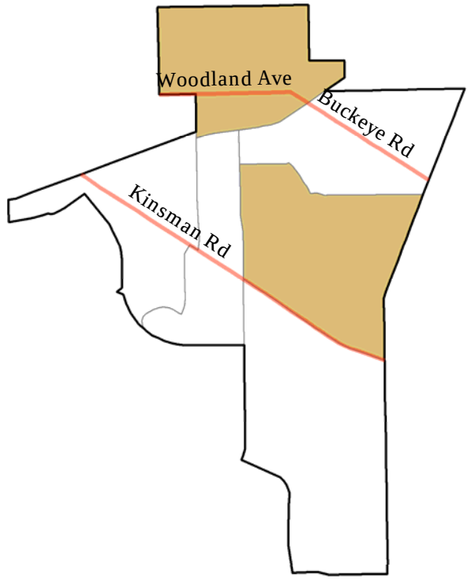
Contact: ResilientCleveland@gmail.com

Maps Created:
Tuesday, June 23, 2015

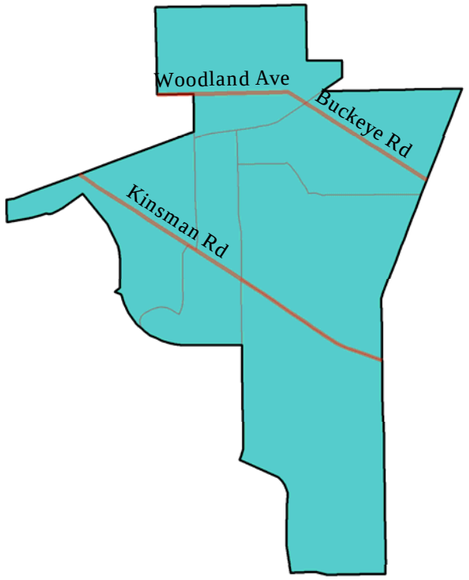
Map K-4: Kinsman Flood Zones



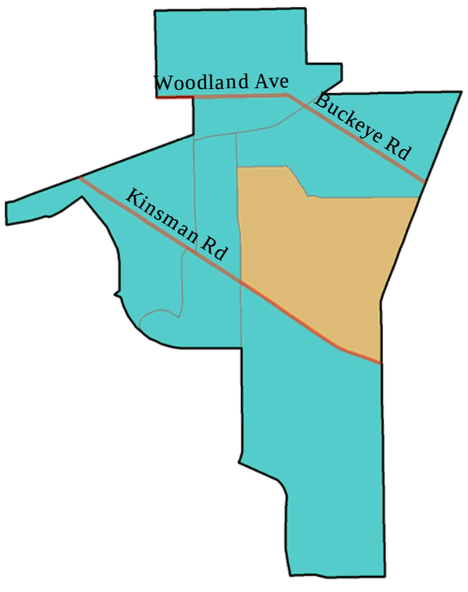
Percent Without High School Diploma



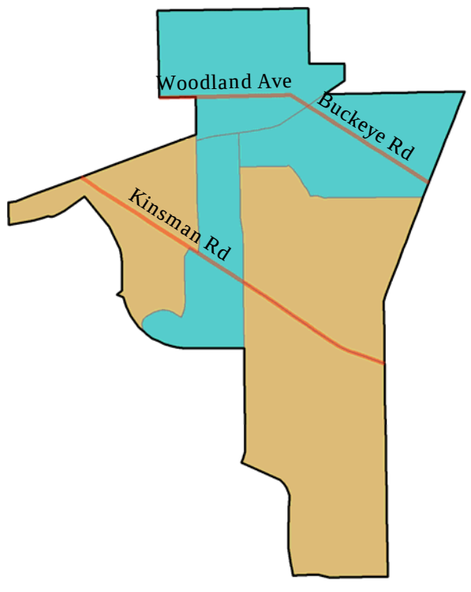
Percent Over the Age of 65



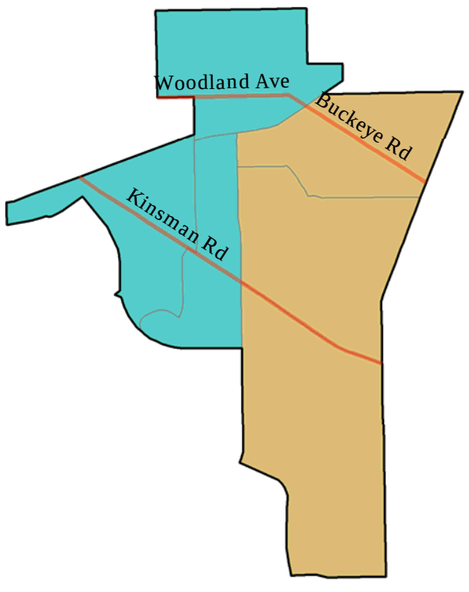
Percent Non-White



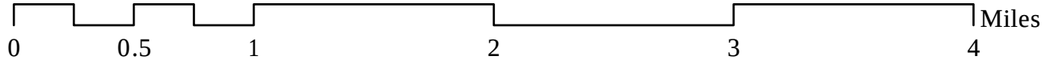
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Flood Zones

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

Data Source:

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U.S. Census,
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FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

Mike Tuzzo and Nick Rajkovich
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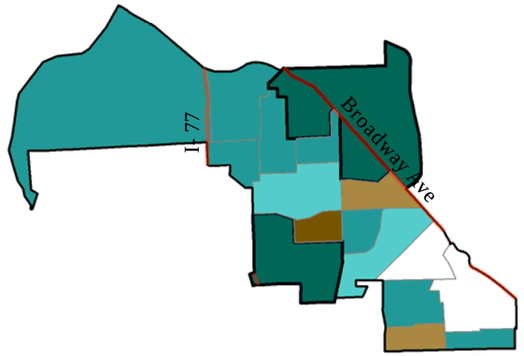
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

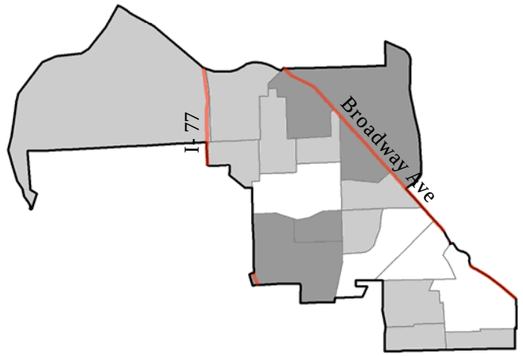
Maps Created:

Tuesday, June 23, 2015

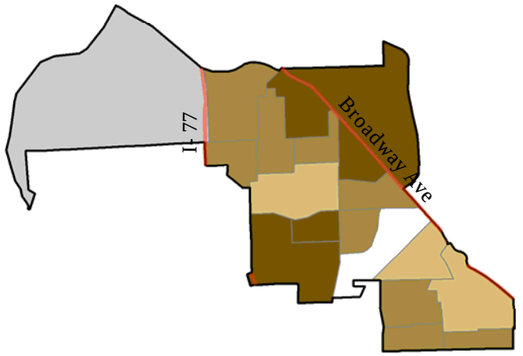
Map S-1: Slavic Village Impervious Surfaces



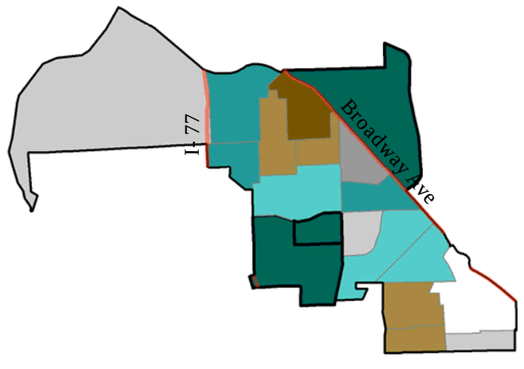
Percent Without High School Diploma



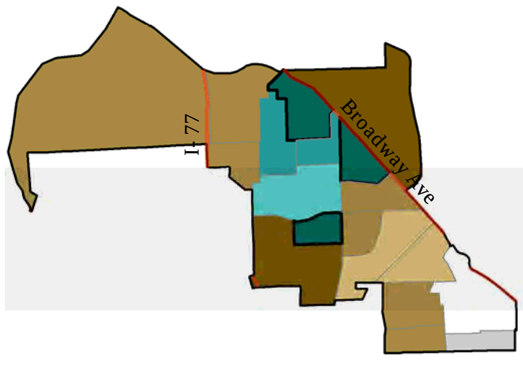
Percent Over the Age of 65



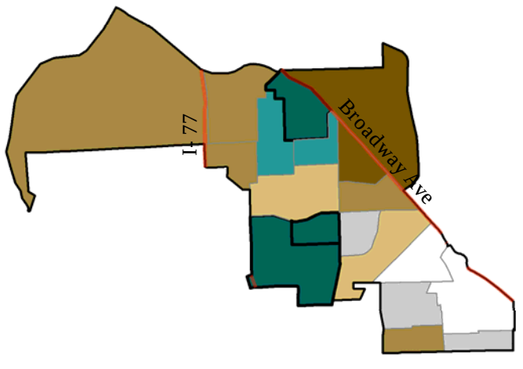
Percent Non-White



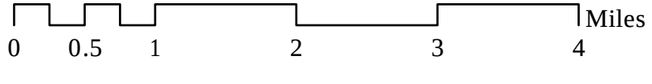
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Impervious Surfaces

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

Data Source:
NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:
NAD 1983, Ohio State Plane North

Maps Produced By:
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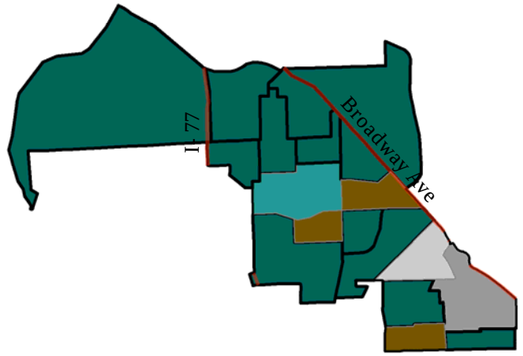
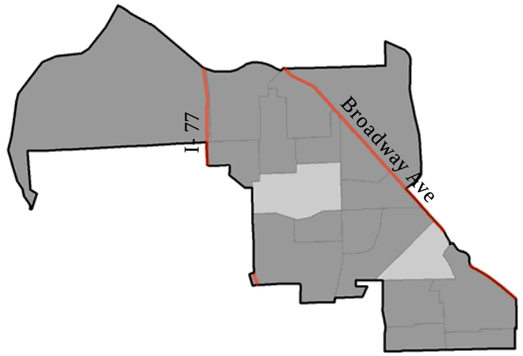
Contact: ResilientCleveland@gmail.com

Maps Created:
Tuesday, June 23, 2015

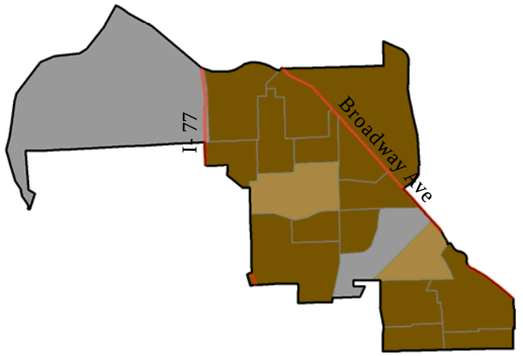
Map S-2: Slavic Village Tree Canopy Coverage



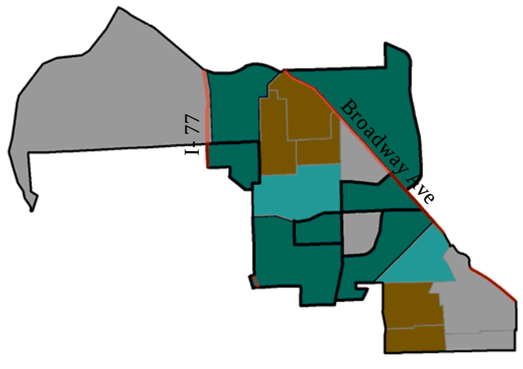
Percent Without High School Diploma



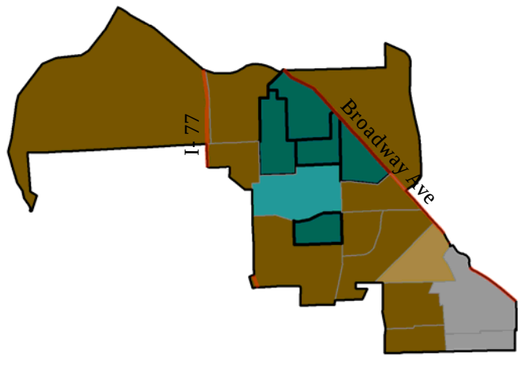
Percent Over the Age of 65



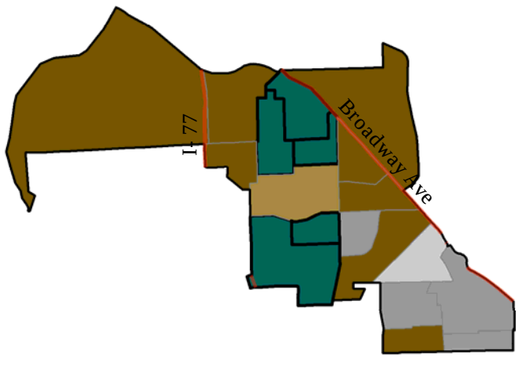
Percent Non-White



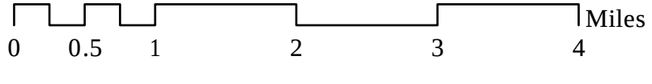
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Tree Canopy Coverage

Low	1	High
	2	Medium
	3	Low
Medium	4	High
	5	Medium
	6	Low
High	7	High
	8	Medium
	9	Low

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

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Projection:
NAD 1983, Ohio State Plane North

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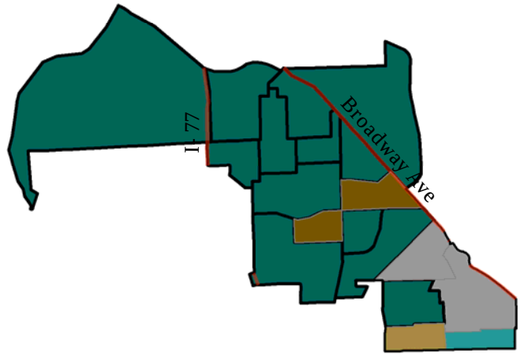
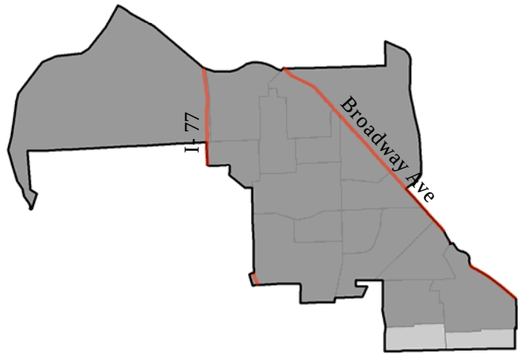
Contact: ResilientCleveland@gmail.com

Maps Created:
Tuesday, June 23, 2015

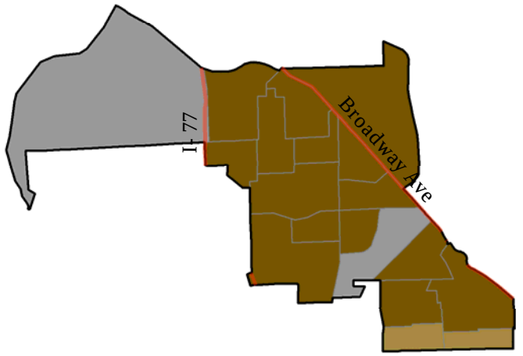
Map S-3: Slavic Village Buildings Built Before 1939



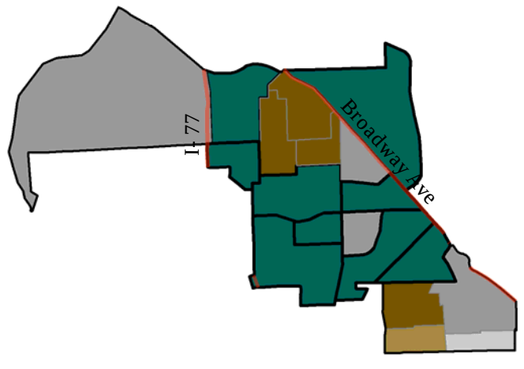
Percent Without High School Diploma



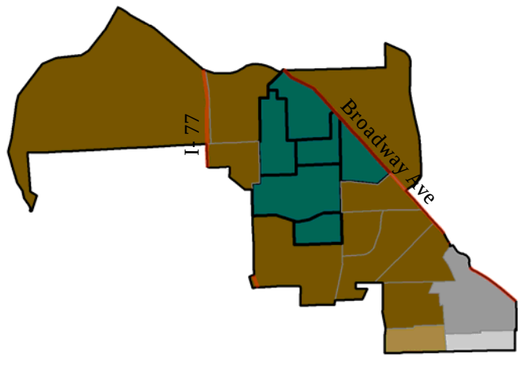
Percent Over the Age of 65



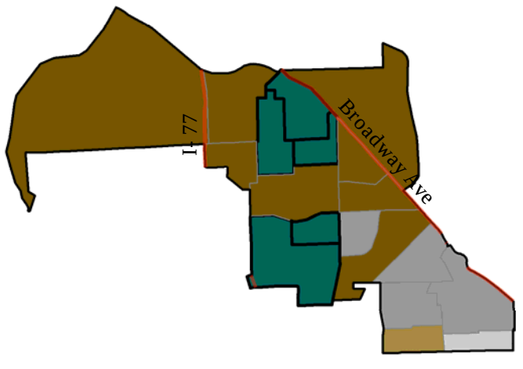
Percent Non-White



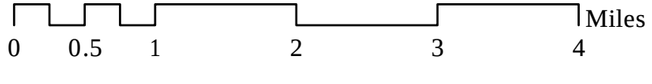
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Buildings Built Before 1939

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

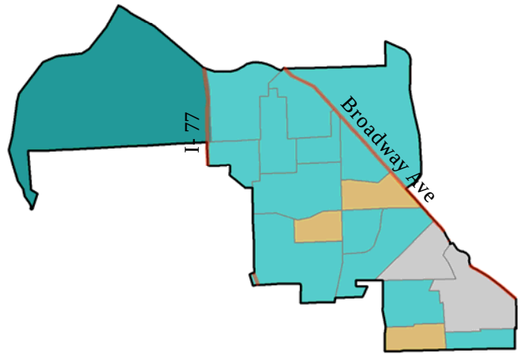
Data Source:
NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:
NAD 1983, Ohio State Plane North

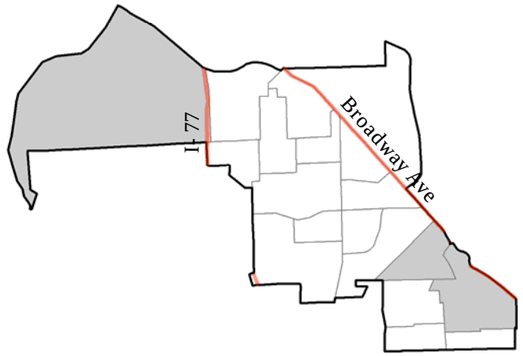
Maps Produced By:
Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
and Kristen Zeiber
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:
Tuesday, June 23, 2015

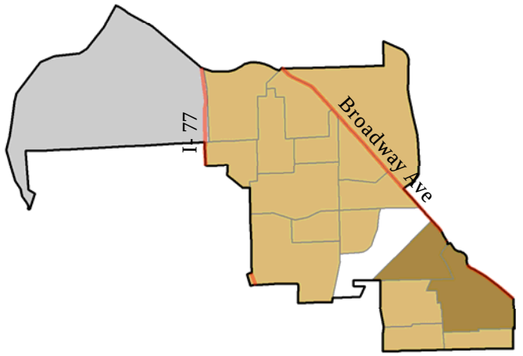
Map S-4: Slavic Village Flood Zones



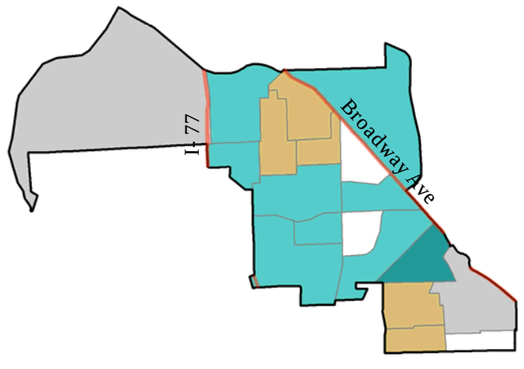
Percent Without High School Diploma



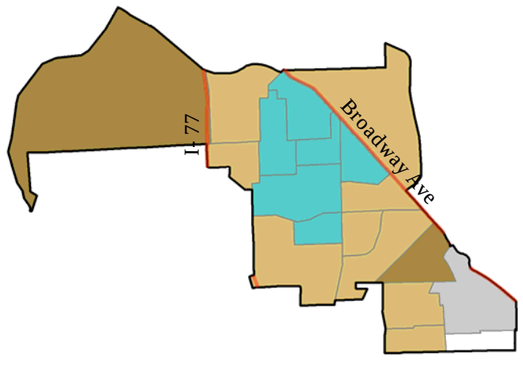
Percent Over the Age of 65



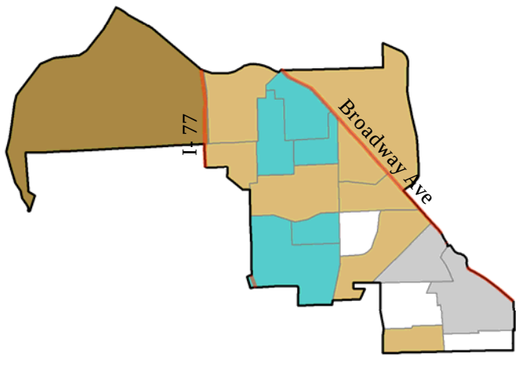
Percent Non-White



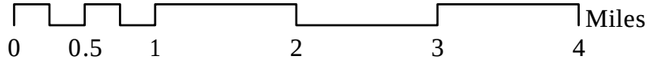
Percent Living Below Poverty Level



Percent Living in Rental Properties



Percent Without a Vehicle



Legend:

Social:
See Labels Below Each Map

Physical:
Flood Zones

Low	1	Low
	2	Medium
	3	High
Medium	4	Low
	5	Medium
	6	High
High	7	Low
	8	Medium
	9	High

Note:
Values labeled as "Low" include the lowest value up to and including the mean value. Values labeled as "Medium"are between the mean and one standard deviation above the mean. Values labeled as "High" include any value that is greater than one standard deviation above

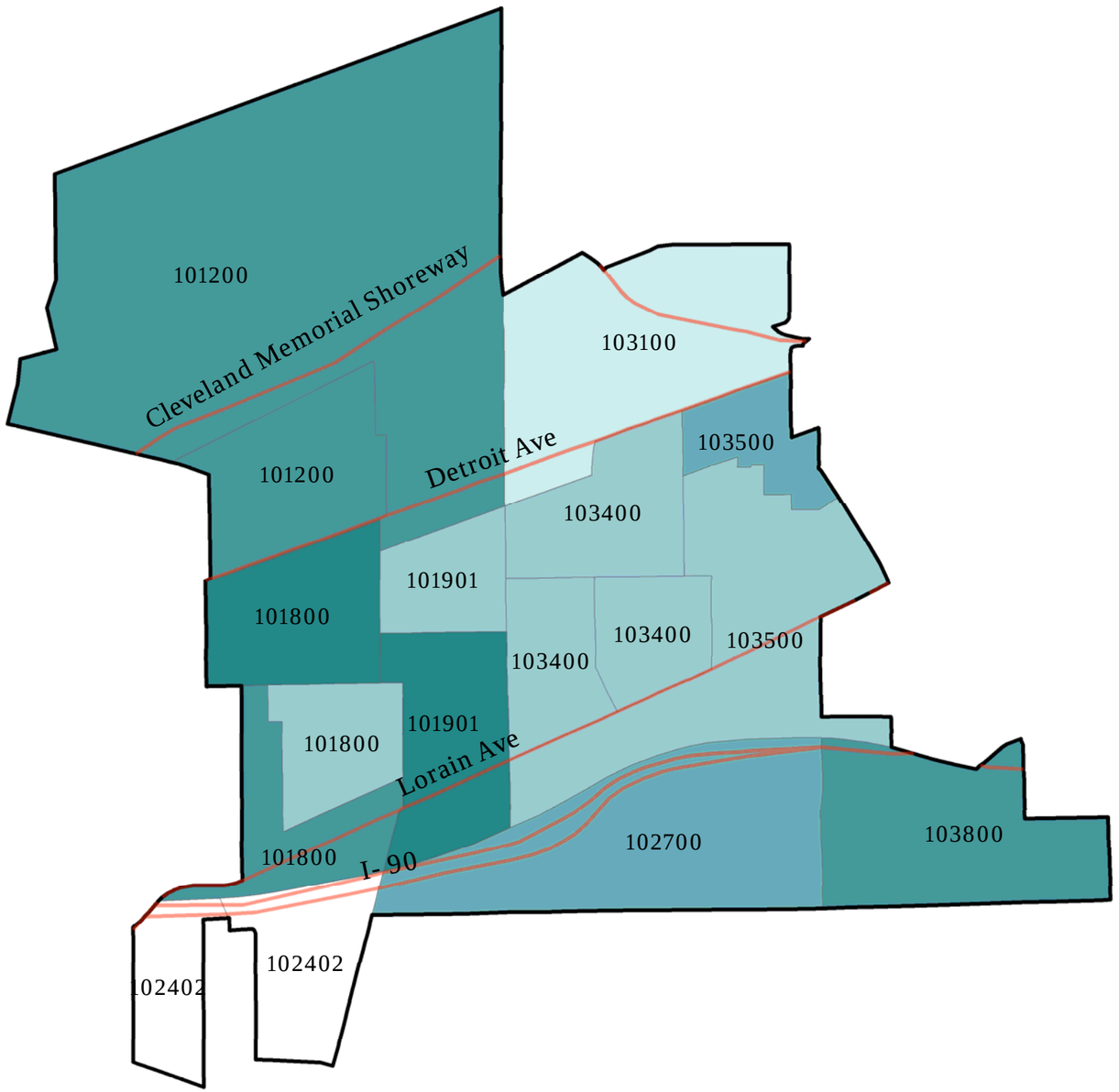
Data Source:
NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:
NAD 1983, Ohio State Plane North

Maps Produced By:
Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
and Kristen Zeiber
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:
Tuesday, June 23, 2015

Map D-V: Detroit-Shoreway Vulnerability



Legend:

- Major Roads
- Detroit-Shoreway

Vulnerability

- 0 Least Vulnerable
- 3
- 4
- 6
- 8
- 9 Most Vulnerable

Note:

Vulnerability values for each block group are determined by the overall count of "High/High" values in the social and physical factor comparison. For example, a "High" value in the percent without a vehicle paired with a "High" value for impervious surfaces represents one vulnerability value.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

Thursday, June 25, 2015

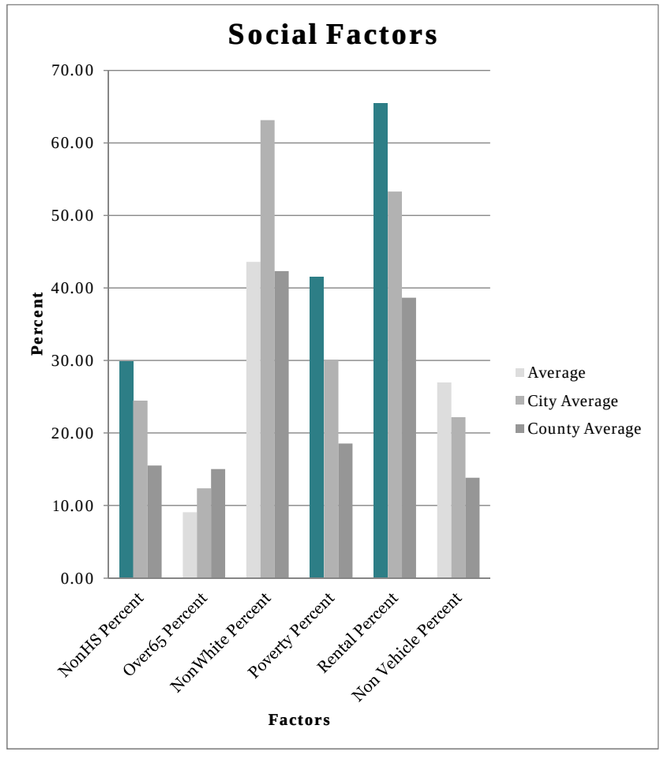
0 0.25 0.5 1 1.5 2 Miles

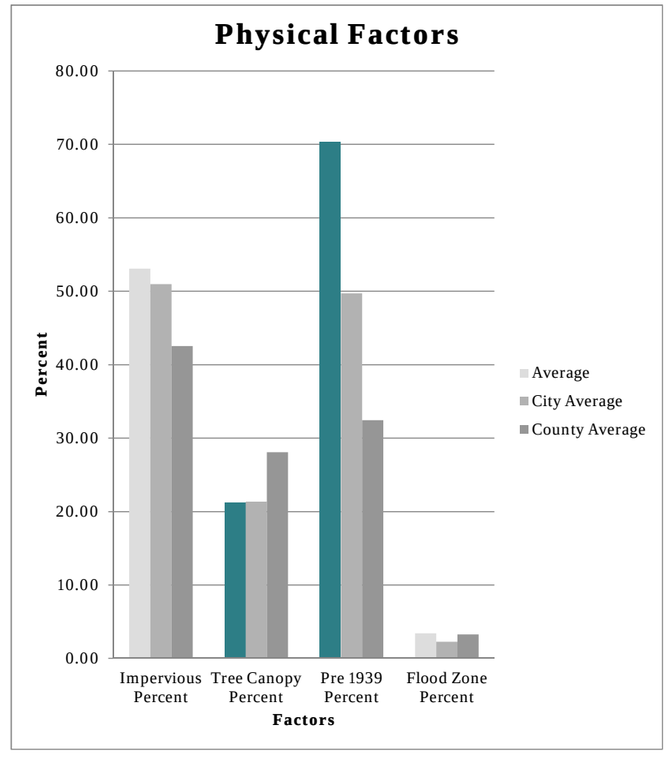
Detroit-Shoreway Social Data

GEOID	NonHS Percent	NonHS Number	Over65 Percent	Over65 Number	NonWhite Percent	NonWhite Number	Poverty Percent	Poverty Number	Rental Percent	Rental Number	Non Vehicle Percent	Non Vehicle Number
1012001	34.49	446	19.40	251	30.06	389	47.16	610	72.42	937	37.64	487
1012002	31.96	405	13.56	172	51.34	651	45.03	571	84.67	1074	47.68	605
1018001	31.12	335	19.07	205	48.19	518	43.75	470	70.48	758	21.72	233
1018002	37.24	322	6.12	53	46.88	406	42.47	368	68.65	595	32.38	280
1018003	38.40	384	7.49	75	48.55	486	58.30	584	59.48	595	21.66	217
1019011	30.90	231	7.21	54	36.98	277	46.26	346	61.46	460	7.46	56
1019012	25.44	240	7.53	71	55.04	519	47.90	452	66.03	623	60.90	574
1024022	12.33	98	6.03	48	41.21	328	28.61	228	61.75	492	11.90	95
1024023	17.18	185	6.79	73	42.51	457	16.36	176	52.96	569	10.66	115
1027004	53.57	524	6.64	65	40.04	392	50.61	495	65.29	639	15.61	153
1031001	14.38	152	6.55	69	40.89	431	19.45	205	66.88	705	10.23	108
1034001	35.10	412	6.99	82	47.91	562	48.85	573	63.74	748	24.63	289
1034002	11.50	94	7.98	65	48.10	392	41.06	335	59.50	485	33.33	272
1034003	36.94	289	11.00	86	42.07	329	37.97	297	63.67	498	22.16	173
1035001	37.54	563	6.94	104	41.89	628	46.15	692	62.37	935	24.54	368
1035002	13.24	64	7.68	37	35.06	169	43.43	209	69.40	335	38.91	188
1038001	45.86	484	7.48	79	44.22	467	41.79	441	64.11	677	37.11	392
Average	29.83		9.09		43.58		41.48		65.46		26.97	
City Average	24.48		12.38		63.15		30.11		53.28		22.19	
County Average	15.54		15.03		42.32		18.56		38.65		13.84	

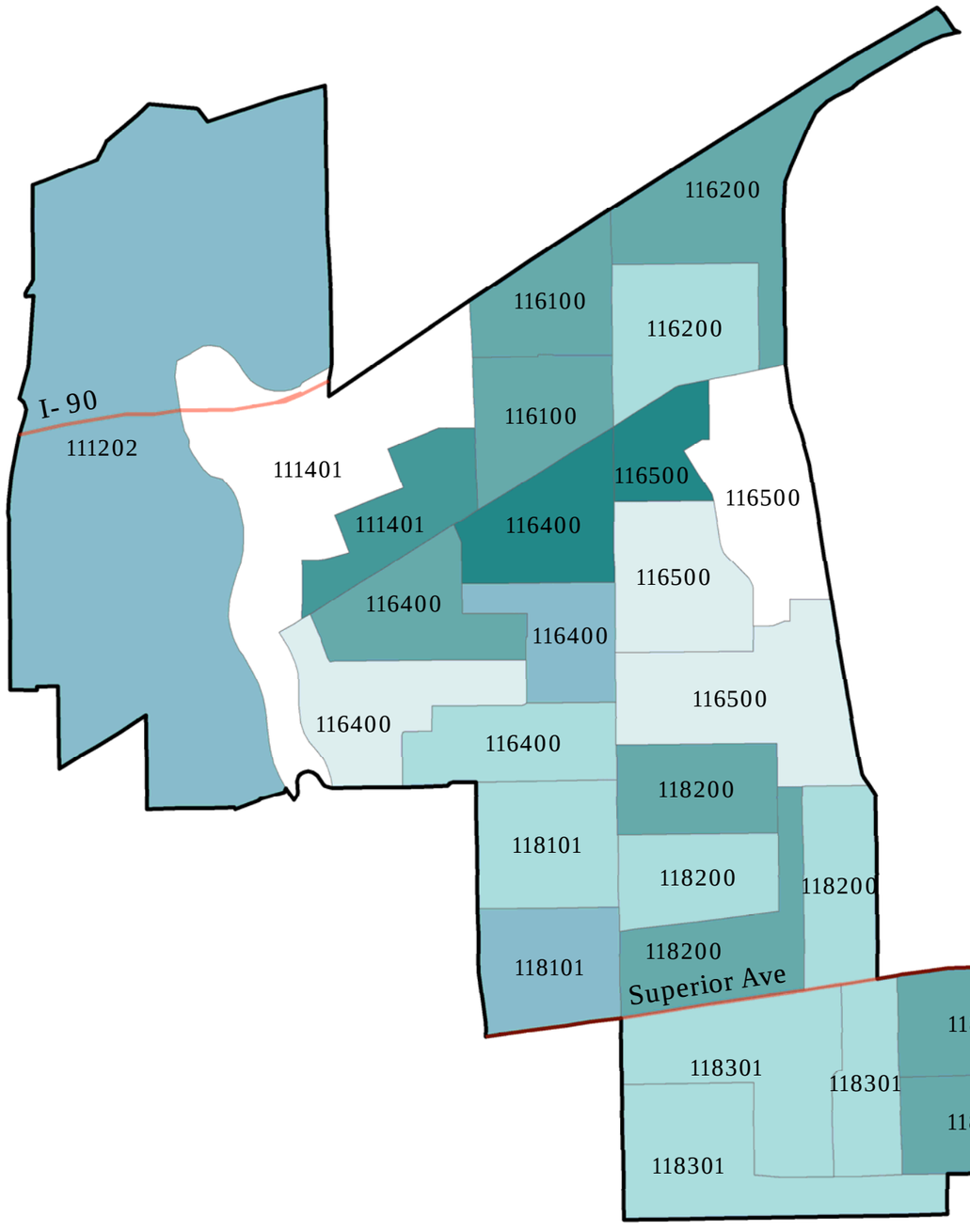
Detroit-Shoreway Physical Data

GEOID	Impervious Percent	Tree Canopy Percent	Pre 1939 Percent	Flood Zone Percent
1012001	40.00	18.00	59.71	57.00
1012002	67.00	16.00	49.62	0.00
1018001	64.00	16.00	78.01	0.00
1018002	54.00	21.00	77.25	0.00
1018003	46.00	25.00	72.85	0.00
1019011	56.00	23.00	86.46	0.00
1019012	58.00	20.00	62.16	0.00
1024022	56.00	20.00	74.53	0.00
1024023	48.00	24.00	70.53	0.00
1027004	51.00	14.00	69.30	0.00
1031001	58.00	16.00	68.94	1.00
1034001	54.00	25.00	73.38	0.00
1034002	52.00	25.00	67.87	0.00
1034003	50.00	27.00	67.15	0.00
1035001	43.00	22.00	72.13	0.00
1035002	52.00	27.00	73.21	0.00
1038001	53.00	22.00	72.66	0.00
Average	53.06	21.24	70.34	3.41
City Average	50.95	21.34	49.70	2.26
County Average	42.53	28.07	32.43	3.29





Map G-V: Glenville Vulnerability



Legend:

- Major Roads
- Glenville

Vulnerability

- 0 Least Vulnerable
- 1
- 2
- 3
- 4
- 5
- 8 Most Vulnerable

Note:
Vulnerability values for each block group are determined by the overall count of "High/High" values in the social and physical factor comparison. For example, a "High" value in the percent without a vehicle paired with a "High" value for impervious surfaces represents one vulnerability value.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:
NAD 1983, Ohio State Plane North

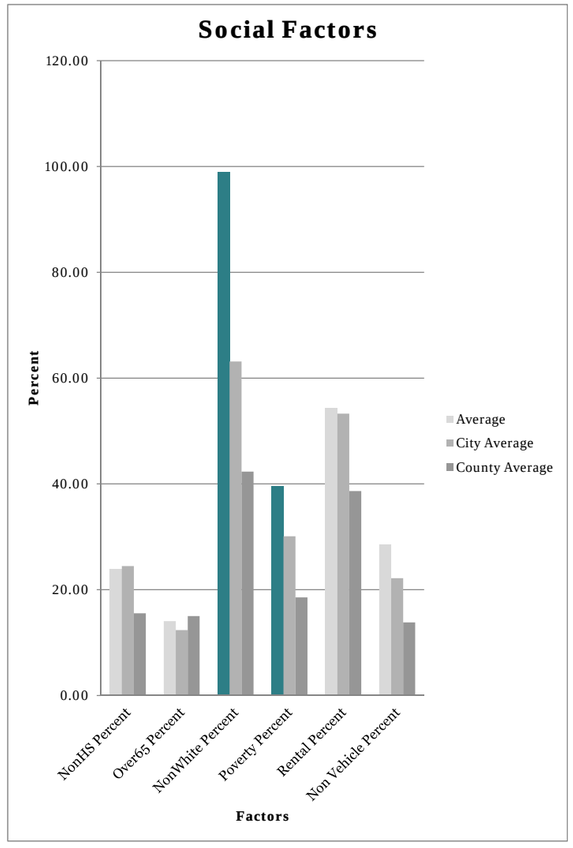
Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
and Kristen Zeiber
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:
Thursday, June 25, 2015

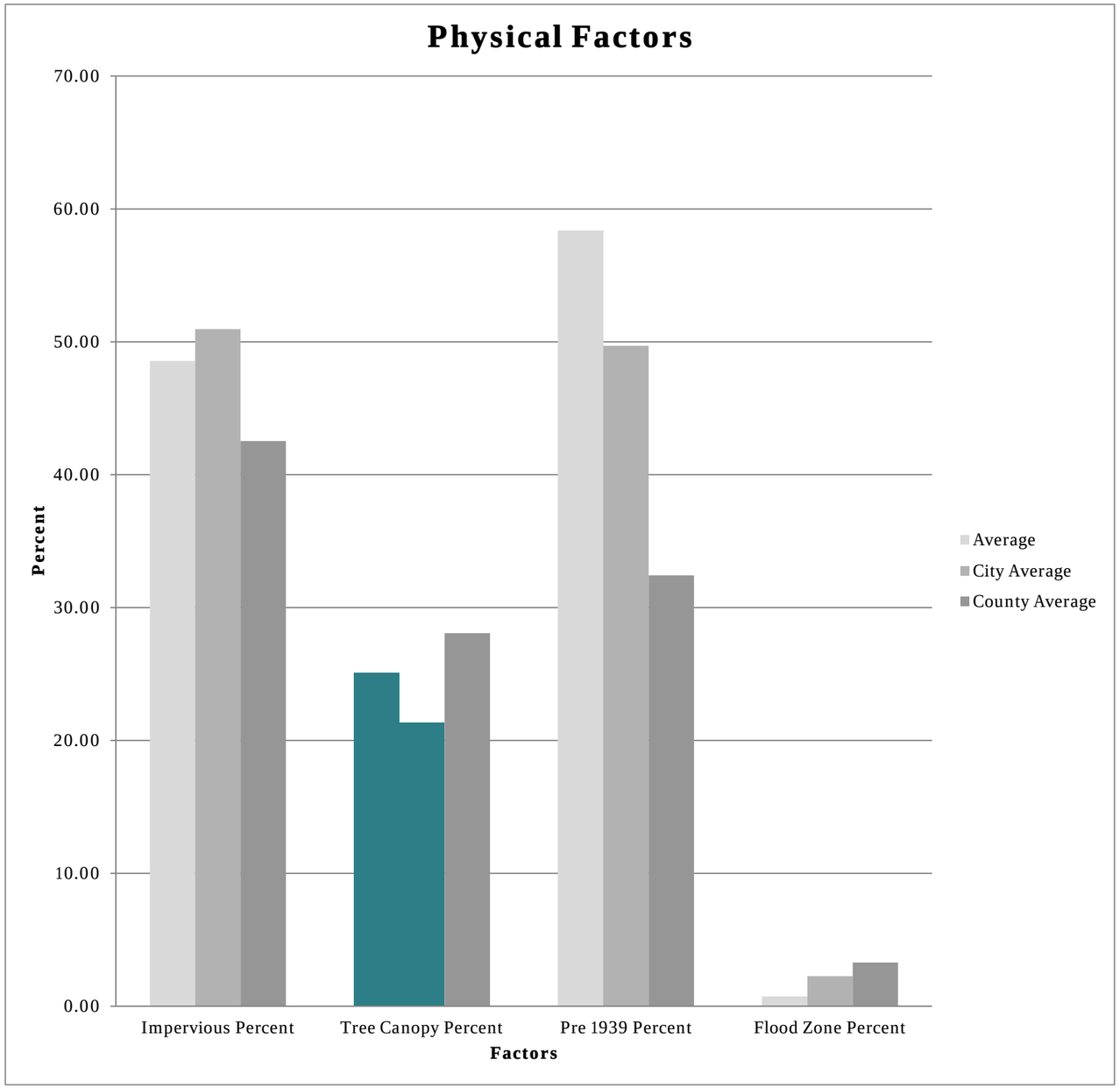
Glenville Social Data

GEOID	NonHS Percent	NonHS Number	Over65 Percent	Over65 Number	NonWhite Percent	NonWhite Number	Poverty Percent	Poverty Number	Rental Percent	Rental Number	Non Vehicle Percent	Non Vehicle Number
1112022	14.19	65	8.28	38	96.73	444	40.27	185	66.00	303	21.16	97
1114011	31.95	191	12.56	75	99.50	594	57.19	341	72.38	432	31.73	189
1114012	17.08	112	13.72	90	99.39	652	27.92	183	66.78	438	16.20	106
1161001	57.72	266	14.10	65	100.00	461	30.12	139	64.20	296	29.95	138
1161002	14.74	73	17.24	85	99.19	489	56.68	279	68.42	337	54.37	268
1162001	42.59	236	14.05	78	99.10	550	50.39	280	48.00	266	30.97	172
1162002	23.33	138	11.00	65	99.32	587	43.32	256	43.69	258	21.09	125
1164001	29.19	97	15.66	52	99.10	329	45.12	150	56.38	187	30.82	102
1164002	28.23	138	14.34	70	99.59	486	65.38	319	51.93	253	26.95	132
1164003	16.74	145	11.56	100	99.77	863	54.76	474	62.18	538	24.22	210
1164004	24.88	176	14.43	102	99.29	702	24.76	175	23.97	169	10.71	76
1164005	12.39	74	18.73	112	99.50	595	35.45	212	54.84	328	55.15	330
1165001	25.89	122	12.92	61	97.67	461	27.43	129	65.22	308	44.65	211
1165002	25.94	240	12.55	116	99.68	921	34.41	318	60.78	562	26.05	241
1165003	21.54	158	13.51	99	99.59	730	22.12	162	42.24	310	22.40	164
1165004	26.12	121	27.37	127	99.78	463	28.75	133	84.31	391	57.84	268
1181012	26.85	264	10.47	103	99.49	979	27.24	268	62.03	610	12.76	126
1181013	12.77	72	16.05	91	97.00	550	45.25	257	55.04	312	30.85	175
1182001	13.52	87	12.50	80	99.37	636	17.97	115	53.69	344	29.82	191
1182002	18.95	103	10.85	59	99.63	542	56.08	305	46.67	254	22.47	122
1182003	20.78	102	11.38	56	98.37	484	44.58	219	49.09	242	23.53	116
1182004	24.09	102	13.18	56	99.76	424	50.81	216	30.32	129	0.00	0
1183012	16.15	71	15.56	68	97.25	425	41.11	180	49.76	217	21.71	95
1183013	19.10	131	14.29	98	99.85	685	26.85	184	48.50	333	13.40	92
1183014	22.91	178	13.27	103	94.85	736	35.60	276	39.05	303	29.10	226
1185001	32.94	175	17.89	95	99.44	528	51.17	272	53.00	281	39.90	212
1185002	23.90	111	12.31	57	100.00	463	27.92	129	51.37	238	43.56	202
Average	23.87		14.07		98.97		39.58		54.44		28.57	
City Average	24.48		12.38		63.15		30.11		53.28		22.19	
County Average	15.54		15.03		42.32		18.56		38.65		13.84	

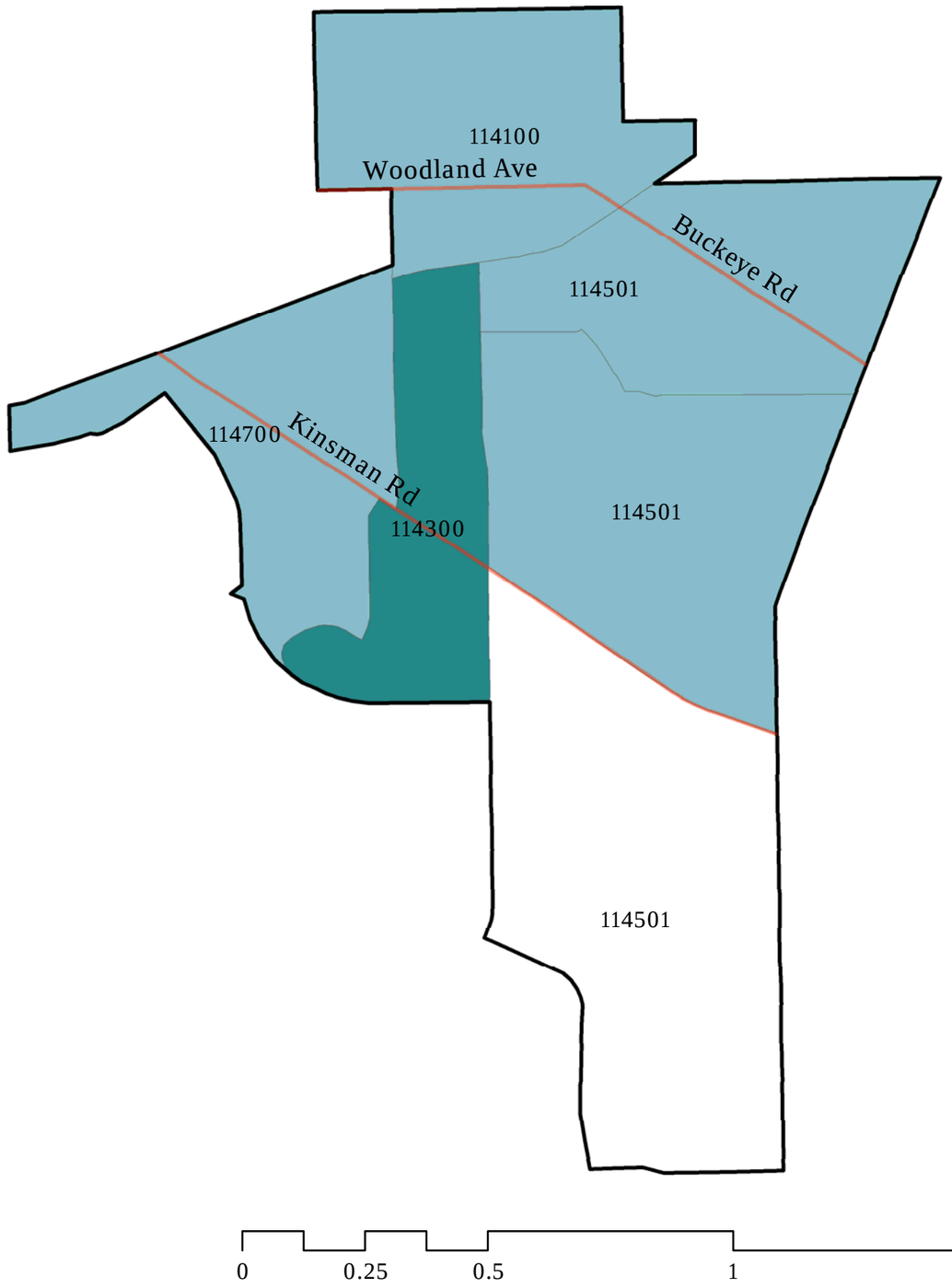


Glenville Physical Data

GEOID	Impervious Percent	Tree Canopy Percent	Pre 1939 Percent	Flood Zone Percent
1112022	36.00	29.00	43.30	15.00
1114011	54.00	23.00	40.00	0.00
1114012	36.00	35.00	50.87	5.00
1161001	53.00	20.00	40.59	0.00
1161002	50.00	27.00	59.92	0.00
1162001	48.00	23.00	54.11	0.00
1162002	53.00	17.00	50.70	0.00
1164001	56.00	20.00	61.51	0.00
1164002	44.00	30.00	72.70	0.00
1164003	48.00	25.00	54.96	0.00
1164004	42.00	35.00	80.20	0.00
1164005	54.00	25.00	74.61	0.00
1165001	46.00	29.00	58.30	0.00
1165002	49.00	23.00	50.69	0.00
1165003	48.00	26.00	51.78	0.00
1165004	63.00	17.00	40.52	0.00
1181012	53.00	22.00	69.71	0.00
1181013	49.00	24.00	59.40	0.00
1182001	50.00	24.00	49.34	0.00
1182002	48.00	26.00	67.59	0.00
1182003	49.00	24.00	57.14	0.00
1182004	46.00	26.00	71.90	0.00
1183012	44.00	27.00	57.48	0.00
1183013	52.00	23.00	68.04	0.00
1183014	46.00	28.00	70.18	0.00
1185001	50.00	22.00	52.10	0.00
1185002	44.00	27.00	67.51	0.00
Average	48.56	25.07	58.34	0.74
City Average	50.95	21.34	49.70	2.26
County Average	42.53	28.07	32.43	3.29



Map K-V: Kinsman Vulnerability



Legend:

- Major Roads
- Kinsman

Vulnerability

- 2 Least Vulnerable
- 4
- 5 Most Vulnerable

Note:
Vulnerability values for each block group are determined by the overall count of "High/High" values in the social and physical factor comparison. For example, a "High" value in the percent without a vehicle paired with a "High" value for impervious surfaces represents one vulnerability value.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
Kristen Zeiber and Terry Schwarz
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

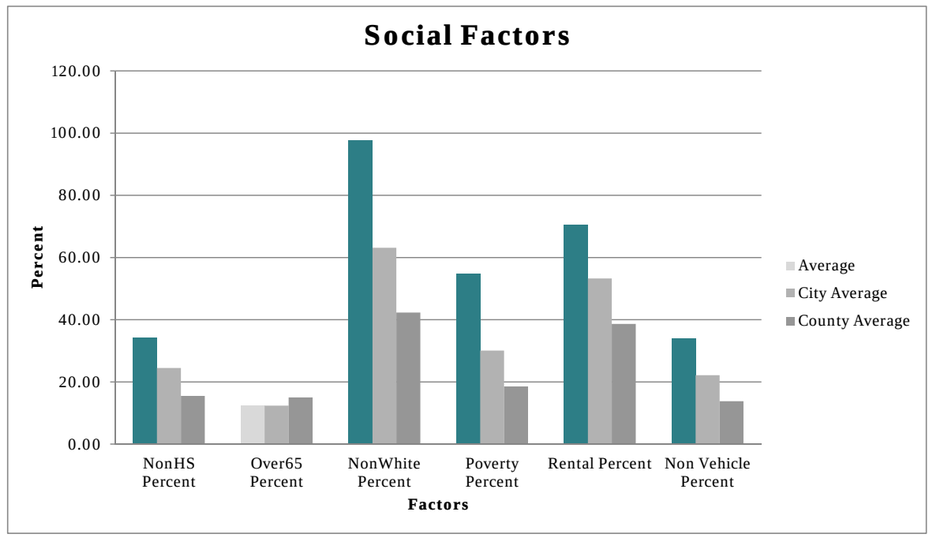
Thursday, June 25, 2015

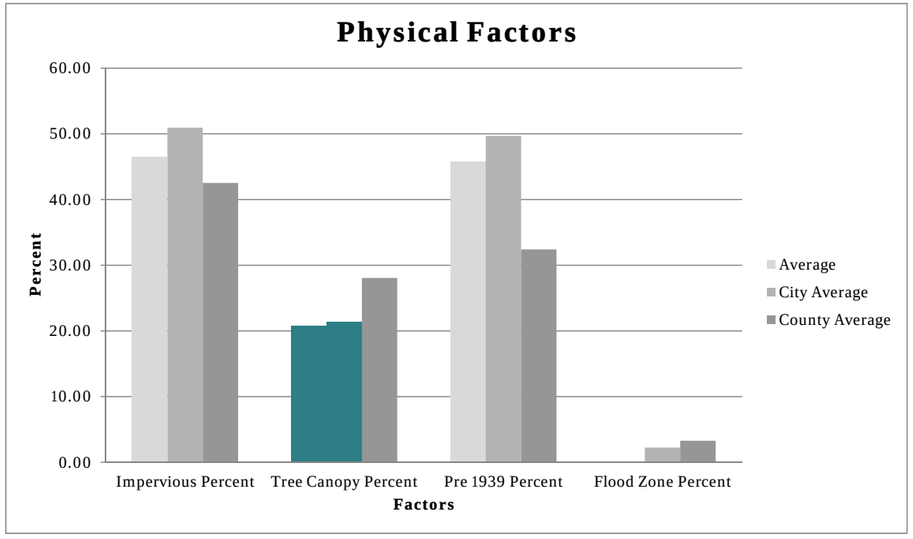
Kinsman Social Data

GEOID	NonHS Percent	NonHS Number	Over65 Percent	Over65 Number	NonWhite Percent	NonWhite Number	Poverty Percent	Poverty Number	Rental Percent	Rental Number	Non Vehicle Percent	Non Vehicle Number
1141001	25.13	282	17.84	200	99.55	1116	56.93	638	80.64	904	44.57	500
1143001	46.50	896	2.96	57	99.48	1917	81.15	1564	92.58	1784	38.08	734
1145011	32.48	173	10.90	58	95.68	509	59.24	315	64.09	341	19.72	105
1145012	43.34	124	16.84	48	96.14	274	26.42	75	62.41	178	25.15	72
1145013	27.69	153	11.05	61	95.29	526	67.48	372	59.92	331	23.90	132
1147001	29.86	72	14.17	34	100.00	240	37.23	89	63.00	151	51.88	125
Average	34.17		12.29		97.69		54.74		70.44		33.88	
City Average	24.48		12.38		63.15		30.11		53.28		22.19	
County Average	15.54		15.03		42.32		18.56		38.65		13.84	

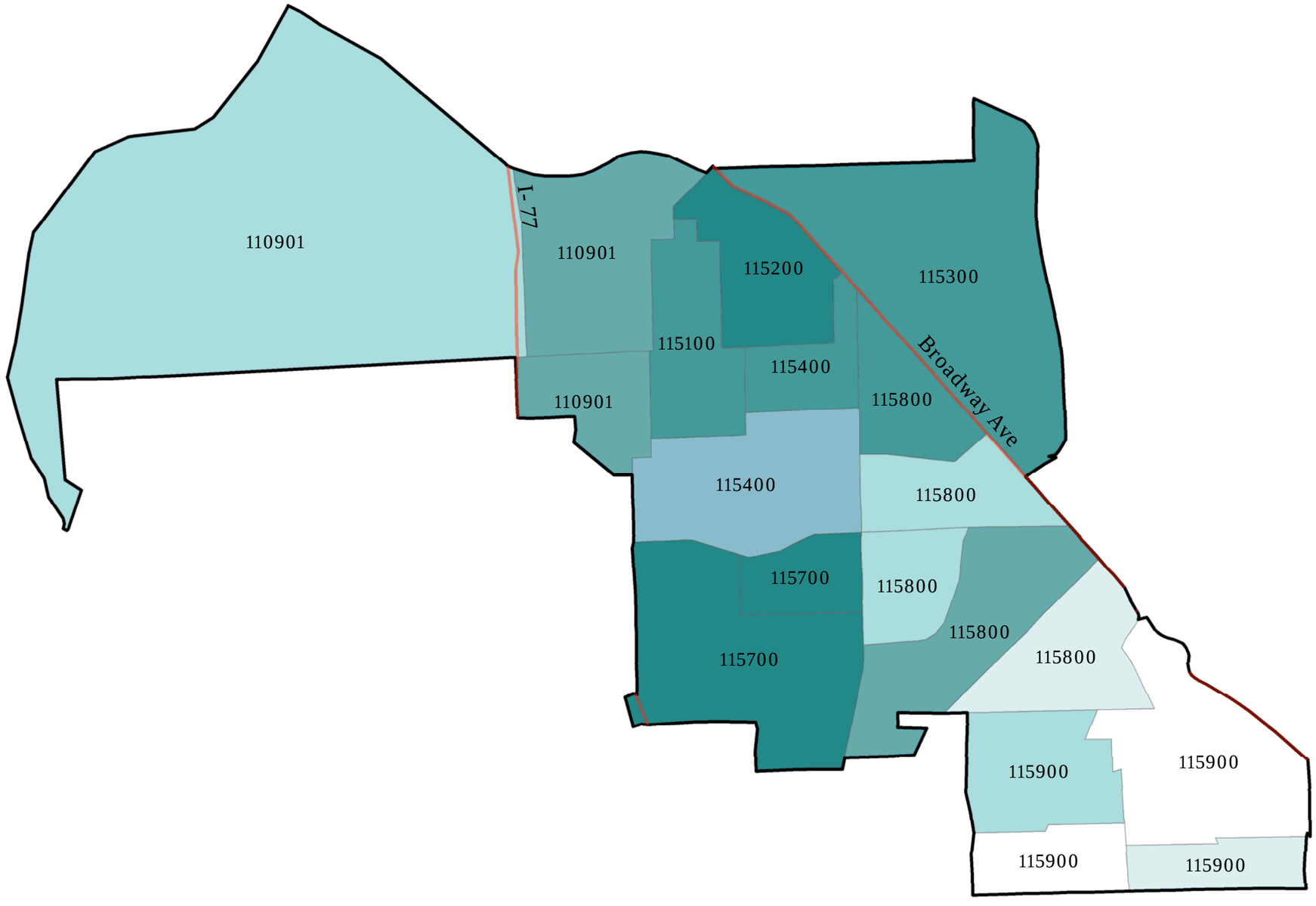
Kinsman Physical Data

GEOID	Impervious Percent	Tree Canopy Percent	Pre 1939 Percent	Flood Zone Percent
1141001	47.00	21.00	47.29	0.00
1143001	47.00	19.00	32.85	0.00
1145011	48.00	21.00	58.79	0.00
1145012	37.00	24.00	66.06	0.00
1145013	52.00	15.00	32.71	0.00
1147001	48.00	25.00	36.94	0.00
Average	46.50	20.83	45.77	0.00
City Average	50.95	21.34	49.70	2.26
County Average	42.53	28.07	32.43	3.29





Map S-V: Slavic Village Vulnerability



Legend:

- Major Roads
- Slavic Village

Vulnerability

- 0 Least Vulnerable
- 1
- 2
- 3
- 4
- 6
- 9 Most Vulnerable

Note:

Vulnerability values for each block group are determined by the overall count of "High/High" values in the social and physical factor comparison. For example, a "High" value in the percent without a vehicle paired with a "High" value for impervious surfaces represents one vulnerability value.

Data Source:

NEO CANDO,
Northeast Ohio Data Collaborative (http://neocando.case.edu/neocando/),
U.S. Census,
Cuyahoga County GIS Department,
FEMA Flood Map Service Center

Projection:

NAD 1983, Ohio State Plane North

Maps Produced By:

Mike Tuzzo and Nick Rajkovich
(University at Buffalo)
and Kristen Zeiber
(Cleveland Urban Design Collaborative)
Contact: ResilientCleveland@gmail.com

Maps Created:

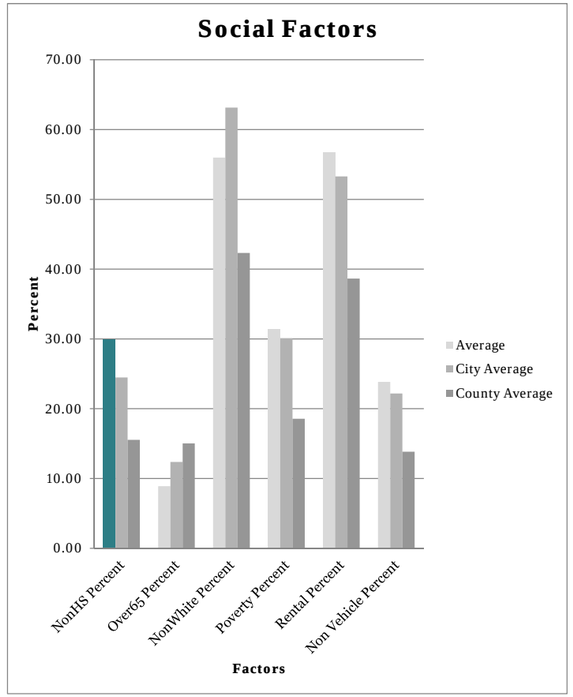
Thursday, June 25, 2015

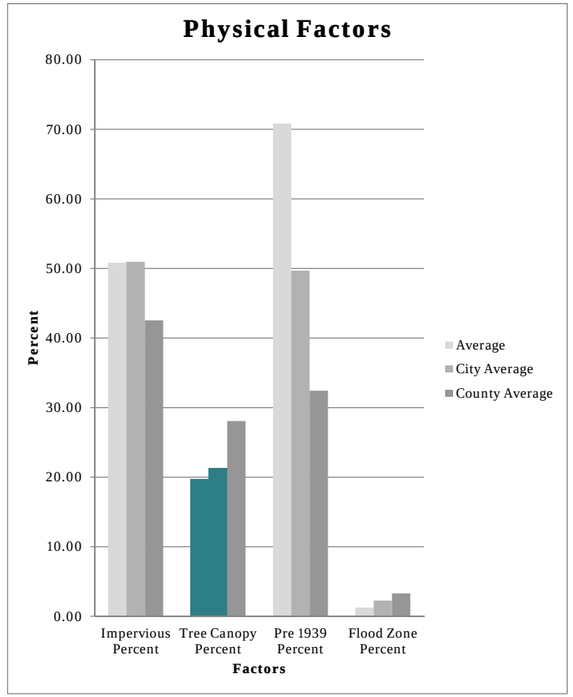
Slavic Village Social Data

GEOID	NonHS Percent	NonHS Number	Over65 Percent	Over65 Number	NonWhite Percent	NonWhite Number	Poverty Percent	Poverty Number	Rental Percent	Rental Number	Non Vehicle Percent	Non Vehicle Number
1109011	36.95	339	12.53	115	37.15	341	13.11	120	40.62	373	21.37	196
1109012	28.52	225	10.27	81	45.25	357	42.10	332	52.68	416	25.34	200
1109013	32.30	451	7.24	101	52.97	739	37.13	518	58.82	821	25.97	362
1151001	35.91	478	8.72	116	57.78	769	35.58	474	72.17	961	42.93	571
1152001	29.80	283	10.42	99	55.58	528	25.66	244	67.39	640	39.81	378
1153001	44.79	420	5.66	53	73.21	686	46.45	435	63.56	596	20.99	197
1154001	33.12	279	9.75	82	68.61	577	29.87	251	72.43	609	34.33	289
1154002	28.20	404	8.09	116	51.53	739	41.21	591	67.10	962	20.09	288
1157001	24.41	168	9.75	67	60.84	418	41.78	287	65.08	447	48.12	331
1157002	35.35	258	9.19	67	46.78	341	54.50	397	56.68	413	31.87	232
1158001	29.14	184	6.49	41	69.78	441	14.09	89	71.31	451	28.05	177
1158002	27.36	189	9.97	69	53.18	368	53.23	368	56.64	392	23.63	164
1158003	33.71	208	8.27	51	56.08	346	3.23	20	55.79	344	8.09	50
1158004	37.38	218	10.81	63	38.08	222	39.52	230	50.00	292	28.52	166
1158005	11.88	83	6.13	43	67.38	473	48.06	337	60.64	426	13.54	95
1159001	13.08	158	8.09	98	58.71	711	7.68	93	31.45	381	0.00	0
1159002	32.64	174	11.24	60	47.19	252	1.43	8	36.57	195	0.00	0
1159003	28.72	343	6.62	79	67.81	809	32.28	385	54.00	644	13.42	160
1159004	24.20	177	9.69	71	55.66	408	28.63	210	45.03	330	26.98	198
Average	29.87		8.89		55.98		31.34		56.73		23.84	
City Average	24.48		12.38		63.15		30.11		53.28		22.19	
County Average	15.54		15.03		42.32		18.56		38.65		13.84	

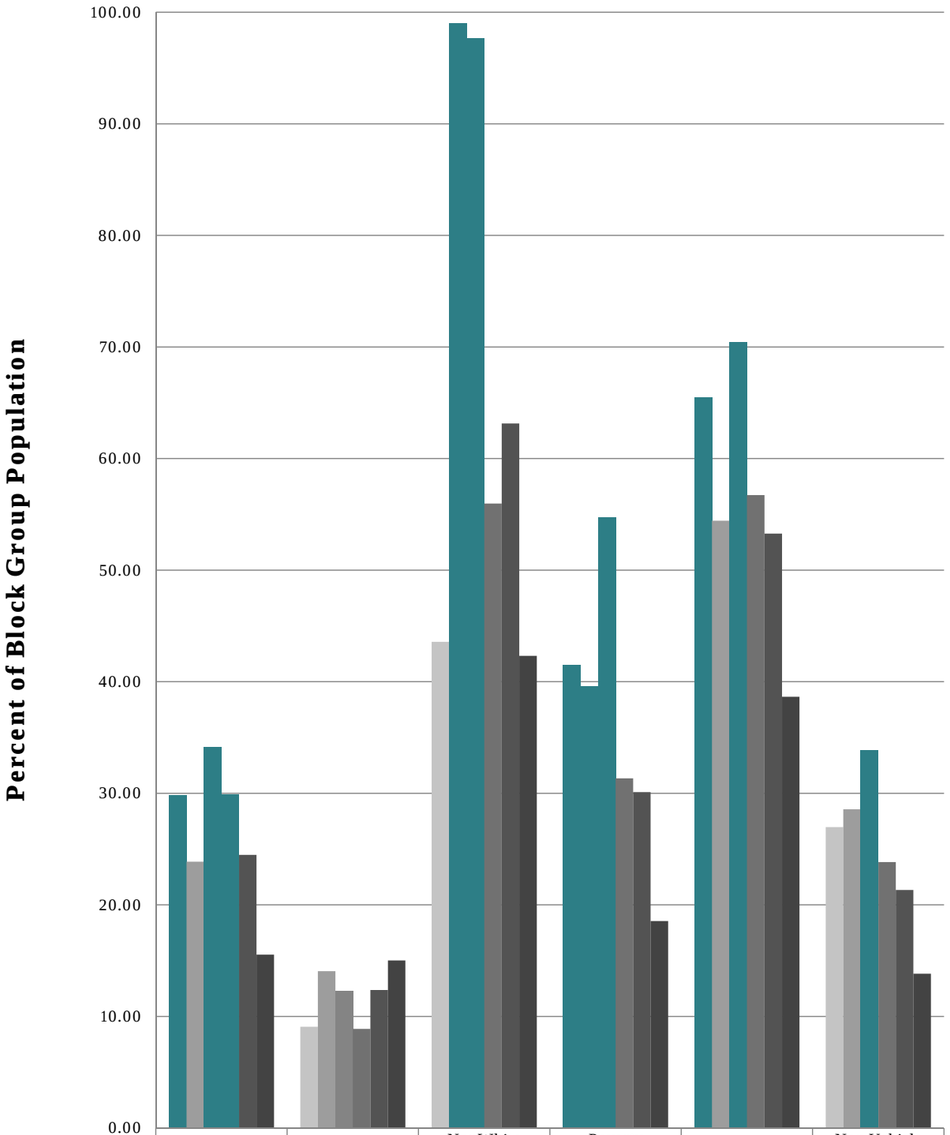
Slavic Village Physical Data

GEOID	Impervious Percent	Tree Canopy Percent	Pre 1939 Percent	Flood Zone Percent
1109011	52.00	7.00	71.84	7.00
1109012	50.00	26.00	88.62	2.00
1109013	44.00	19.00	77.84	0.00
1151001	54.00	21.00	80.74	0.00
1152001	58.00	17.00	66.67	0.00
1153001	61.00	12.00	64.67	0.00
1154001	54.00	23.00	71.76	0.00
1154002	41.00	29.00	78.39	0.00
1157001	60.00	19.00	68.54	0.00
1157002	64.00	11.00	85.00	0.00
1158001	58.00	18.00	68.21	0.00
1158002	55.00	19.00	76.96	0.00
1158003	51.00	25.00	67.73	0.00
1158004	34.00	24.00	71.66	2.00
1158005	37.00	28.00	65.55	5.00
1159001	42.00	23.00	60.21	7.00
1159002	46.00	17.00	57.58	0.00
1159003	49.00	19.00	73.67	1.00
1159004	54.00	17.00	50.27	0.00
Average	50.74	19.68	70.84	1.26
City Average	50.95	21.34	49.70	2.26
County Average	42.53	28.07	32.43	3.29



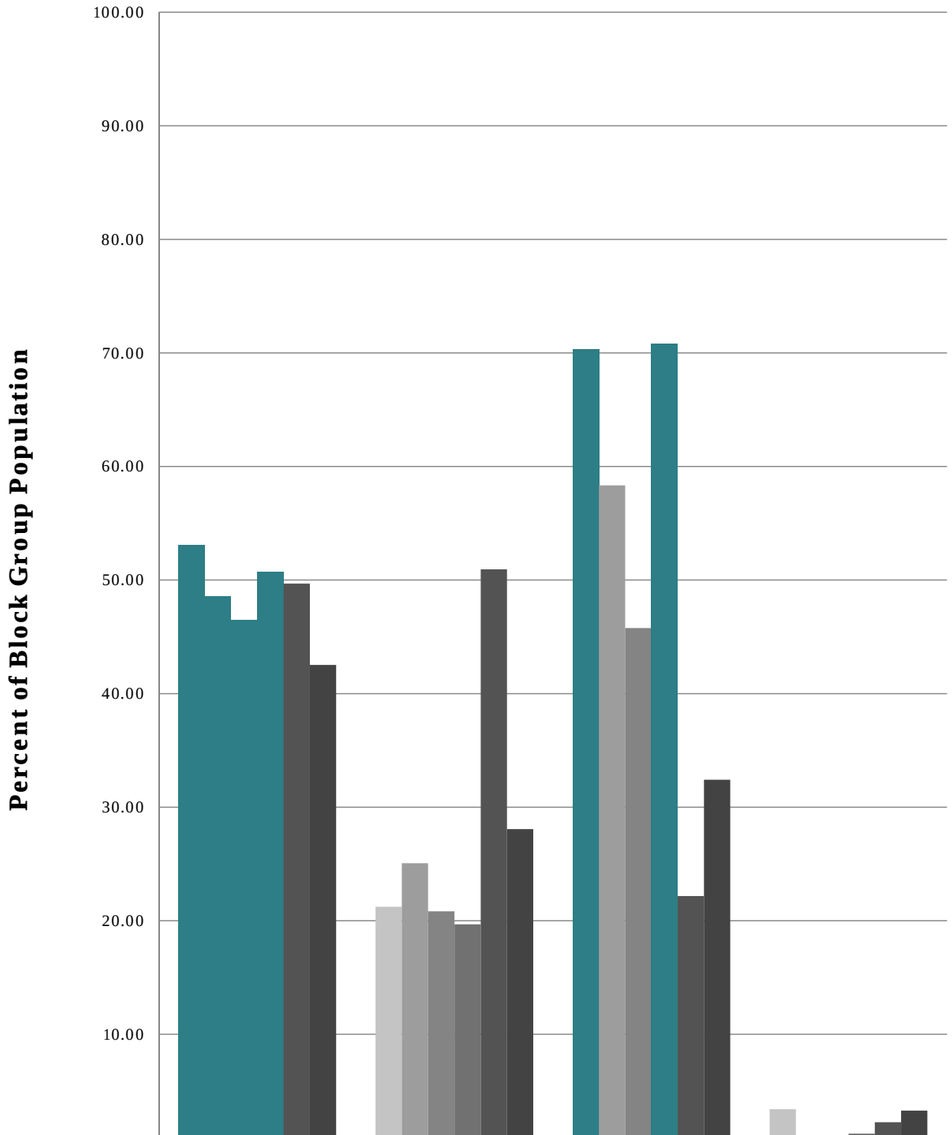


Social Factor Averages



	NonHS Percent	Over65 Percent	NonWhite Percent	Poverty Percent	Rental Percent	Non Vehicle Percent
Detroit-Shoreway	29.83	9.09	43.58	41.48	65.46	26.97
Glenville	23.87	14.07	98.97	39.58	54.44	28.57
Kinsman	34.17	12.29	97.69	54.74	70.44	33.88
Slavic Village	29.87	8.89	55.98	31.34	56.73	23.84
Cleveland Avg	24.48	12.38	63.15	30.11	53.28	21.34
County Average	15.54	15.03	42.32	18.56	38.65	13.84

Physical Factor Averages



	Impervious Percent	Tree Canopy Percent	Pre 1939 Percent	Flood Zone Percent
Detroit-Shoreway	53.06	21.24	70.34	3.41
Glenville	48.56	25.07	58.34	0.74
Kinsman	46.50	20.83	45.77	0.00
Slavic Village	50.74	19.68	70.84	1.26
Cleveland Avg	49.70	50.95	22.19	2.26
County Average	42.53	28.07	32.43	3.29

Appendix F:

An Assessment of the Impacts of Extreme Temperature on Mortality in Cuyahoga County

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Introduction:

Research assessing the impacts of extreme temperatures upon human health has shown considerable spatial variability, and that negative health impacts across a number of causes are observable. The assessment of these impacts is complicated by several factors: the seasonality or long-term changes in human mortality and morbidity can be confounding factors.

Delayed effects are another key uncertainty. For heat, typically the most intense effects on human health are acute, with increases in negative health outcomes most notable within 48 hours of the event. Further, there have been numerous observations of mortality displacement, as it has been observed that mortality falls below expected levels soon after a heat wave, suggesting a portion of those who died in a heat wave would have died soon thereafter. In the case of cold, conversely, typically the most negative impacts are not immediately observed, but rather are observed several days to two weeks later, most notably with increases in respiratory diseases.

Methods:

To analyze the impacts of extreme temperatures on health impacts in Cleveland, a long-term mortality data set was acquired from the National Center for Health Statistics for the period 1975-2010. As the data are aggregated to the county level, all of Cuyahoga County is collectively studied. Meteorological data are obtained for Cleveland-Hopkins Airport (CLE) to represent environmental exposure.

Mortality totals are available as a daily total, and several subsets of mortality data in addition to the total were analyzed. Subsets were created for cause of death (respiratory (ICD: J00-99), cardiovascular (ICD10: I00-99), and all other causes); age (0-64, 65-74, 75 and older), race (black, white), and sex (male, female).

For each subset of analysis, a distributed-lag model was used to assess the cumulative impact of weather on health outcome, using the *dlnm* package in statistical software package R. The model used in this research is:

$$\text{Log}\,(deaths) = intercept + weather + \text{ns}\,(year) + \text{ns}\,(day) + DOW.$$

Outcome is the daily count of deaths assuming a Poisson distribution of counts; *ns (year)* is a natural spline (4 df) fit to the years of study, to account for long-term changes in mortality; *ns (day)* is a natural spline (3 df) fit to the days of the year, to account for seasonal variability in mortality; and *DOW* is series of dummy variables representing day of week. *Weather* refers to the 5PM apparent temperature, which is a combined measure of temperature, humidity, and wind, similar to the heat index or wind chill.

In all analyses, relative risks (RR) are calculated to assess vulnerability. The effects of weather are assessed as zero-day, as well as cumulative 14-day lags, with the lags are constrained to fit a natural spline with 5 df. In all cases, the RR are calculated relative to a baseline 5PM apparent temperature of 75°F, which is the value at which overall mortality is least. RR graphics are presented on the following pages, with the zero-day and 14-day cumulative lag on the same page for each different subset. Note that to enable interpretability, the y-axis is different in each plot.

Results:

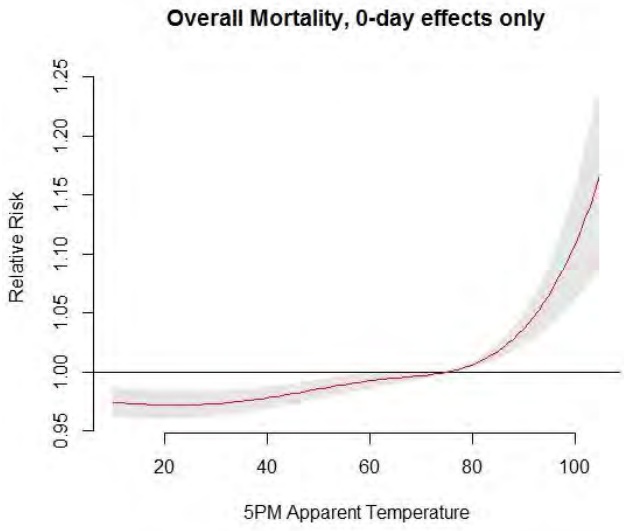
For heat, across all subsets, a clear difference is observed between the zero-day and 14-day cumulative lag graphs. For 0-day impacts, meaning, the weather-health impacts that are observed on the day of the particular weather conditions only, a clear heat signal is seen across overall mortality (RR=1.16 at 105°F) as well as most subsets.

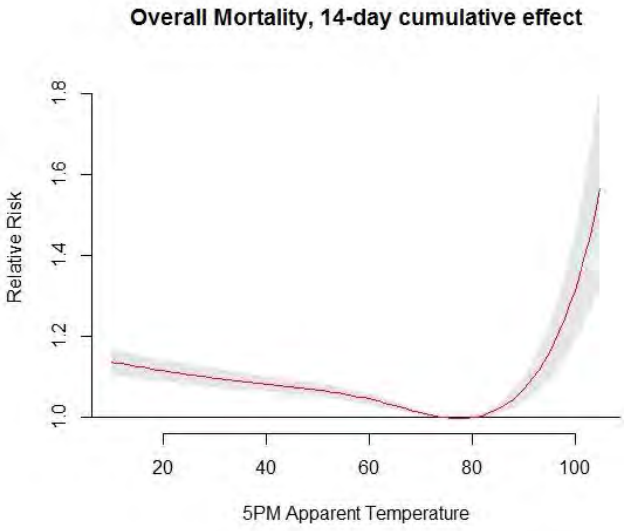
The only subsets for which increases are not statistically significant are respiratory mortality, other-cause mortality, and for those ages 0-64 and 65-75. *This suggests that heat's immediate impacts are most observable in cardiovascular-related mortality and those 75 and older, regardless of sex or race. Within these categories, there is a sharper increase in black mortality (RR=1.22 at 105°F) than white (1.15), and slightly higher for men (1.17) than women (1.15).*

Comparing the results to the 14-day cumulative results, in which the impacts are assessed in aggregate, a generally similar pattern is observed, although results are more intense and broader. Statistically significant results are observed with all subsets except for other-cause mortality; the relative risk is greatest for cardiovascular mortality (2.30 at 105°F) and respiratory (3.00). A greater risk is observed for blacks (1.70) than whites (1.55), while across age and sex differences are minimal.

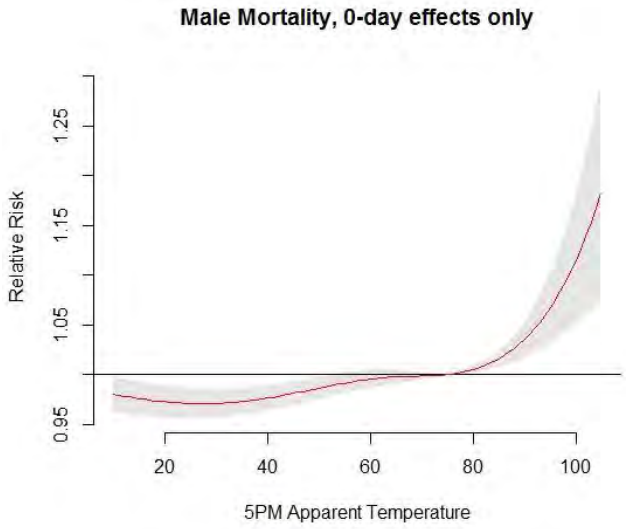
For cold, more mixed results emerge. There are no 0-day statistically significant increases in mortality observed across the subsets studied, with some subsets suggesting statistically significant decreases in mortality (albeit weak ones) at very cold temperatures. For 14-day cumulative results, statistically significant increases in mortality are observed in overall mortality (RR=1.15 at 5°F) all subsets. Overall increases in mortality are generally weaker than for heat, and broadly similar across subsets. Blacks and whites, and males and females, are equally affected (1.15); and cardiovascular and respiratory mortality (1.20) are both greater than other-cause (1.10). Those 75 and older are more affected (1.19) than those younger (1.10).

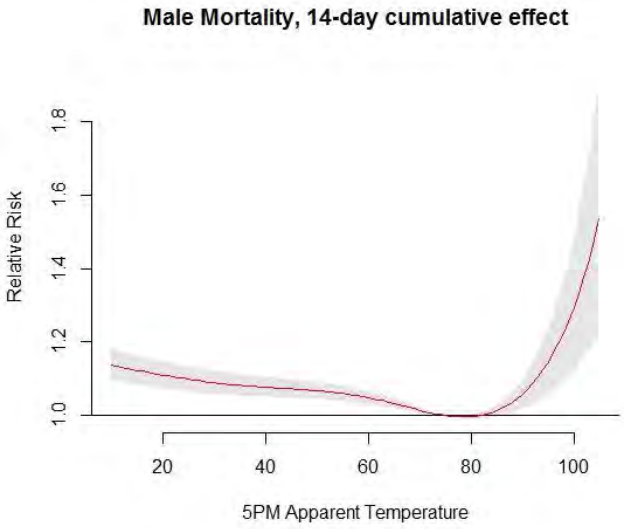
Overall Mortality, 0-day and 14-day Effects:

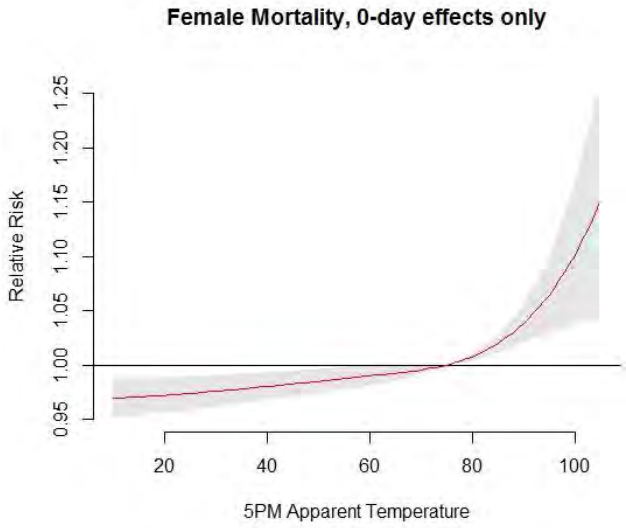


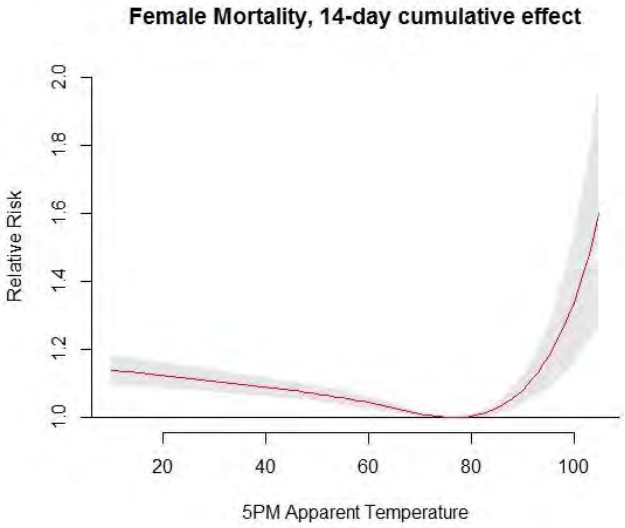


Overall Mortality by Sex, 0-day and 14-day Effects:

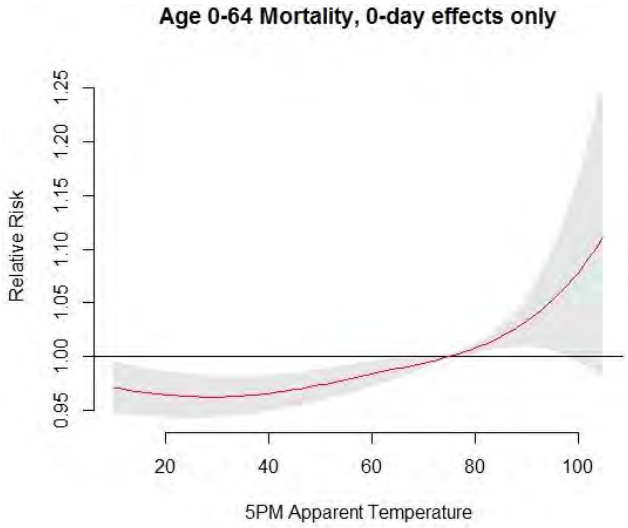


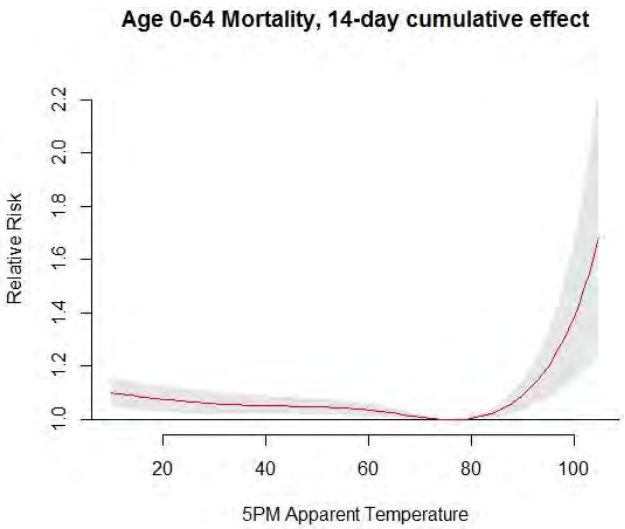


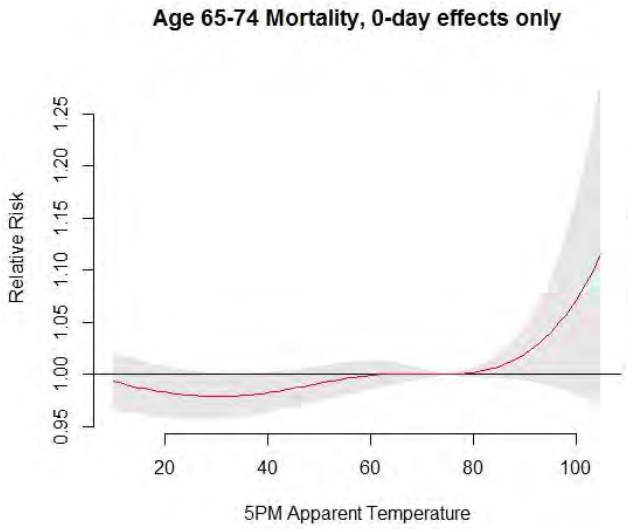


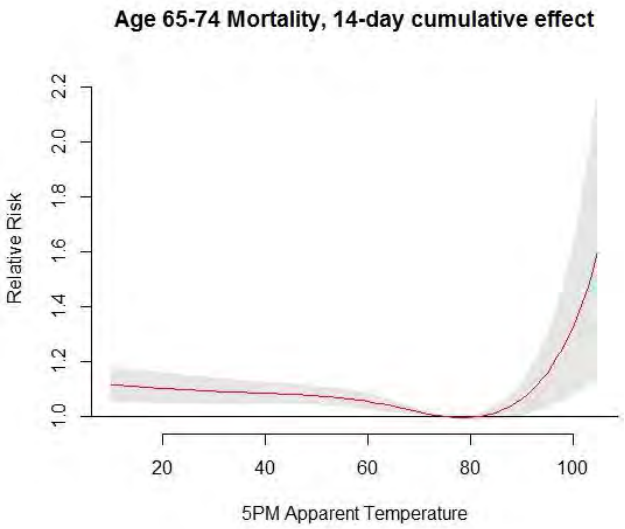


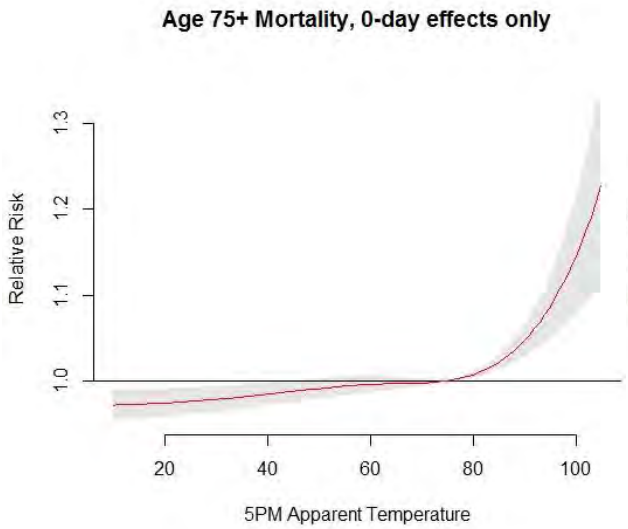
Overall Mortality by Age, 0-day and 14-day Effects:

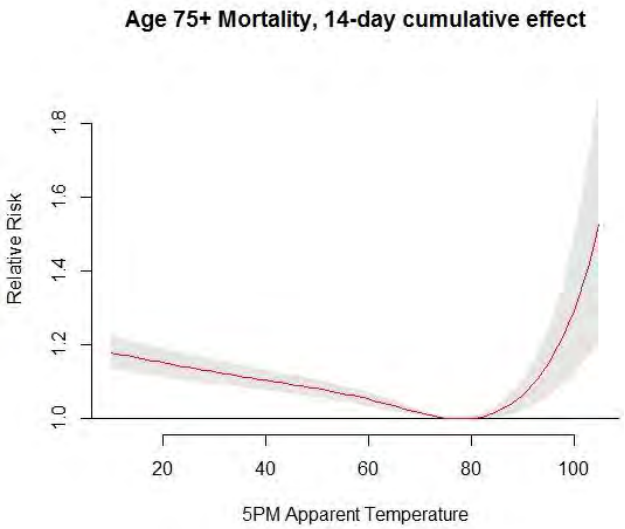




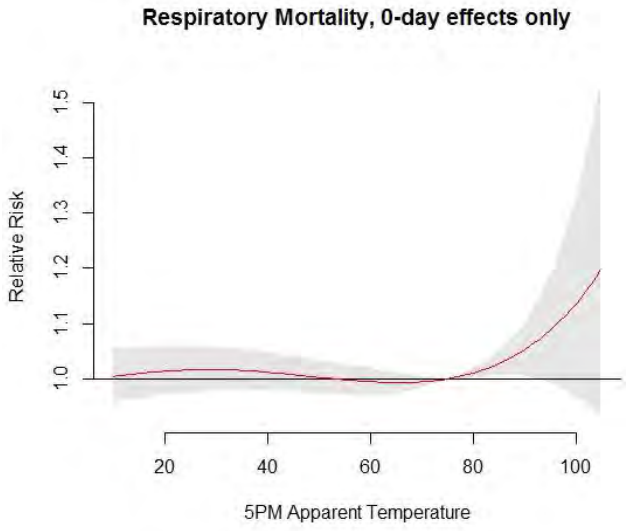


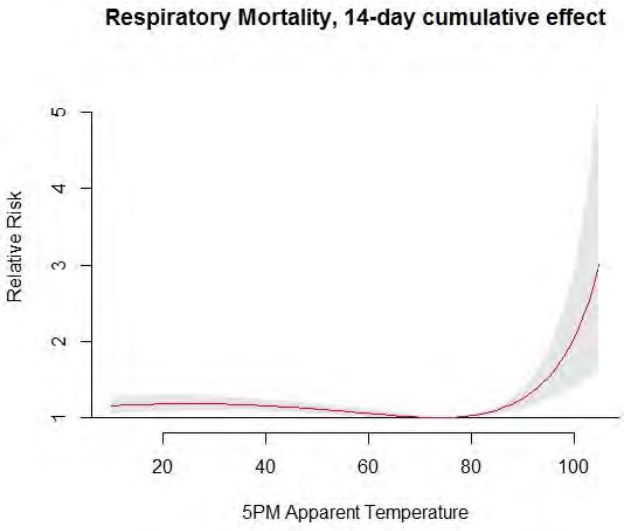


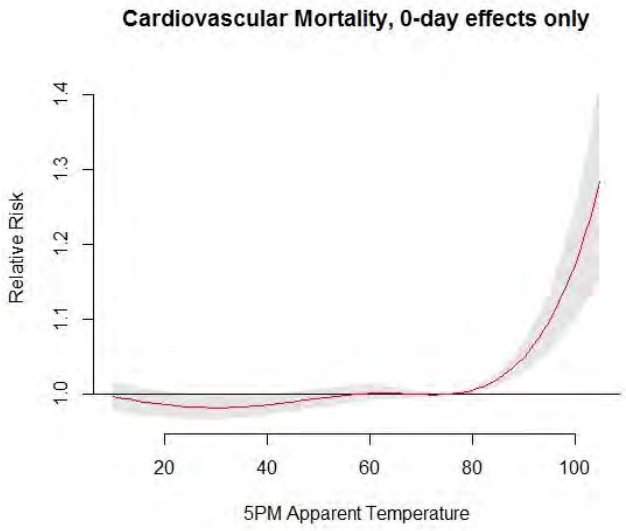


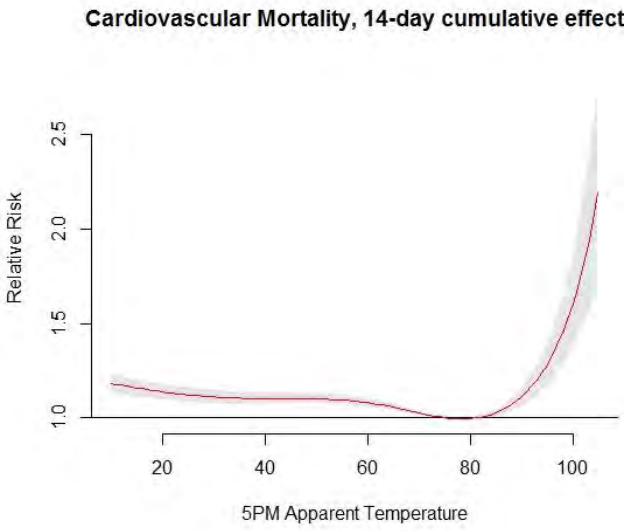


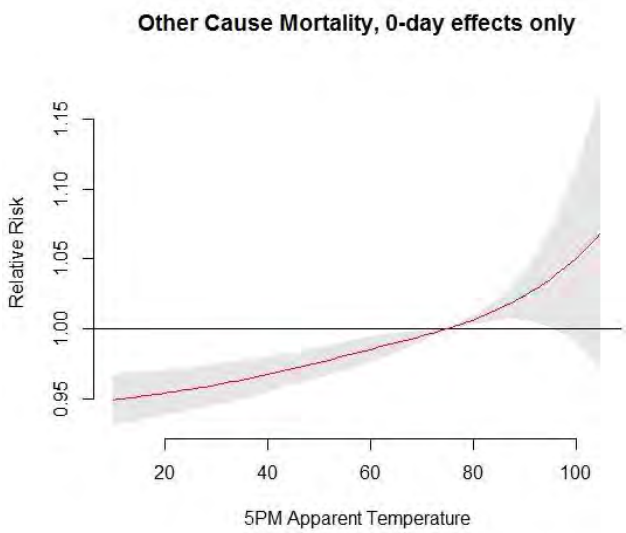
Overall Mortality for Various Causes, 0-day and 14-day Effects:

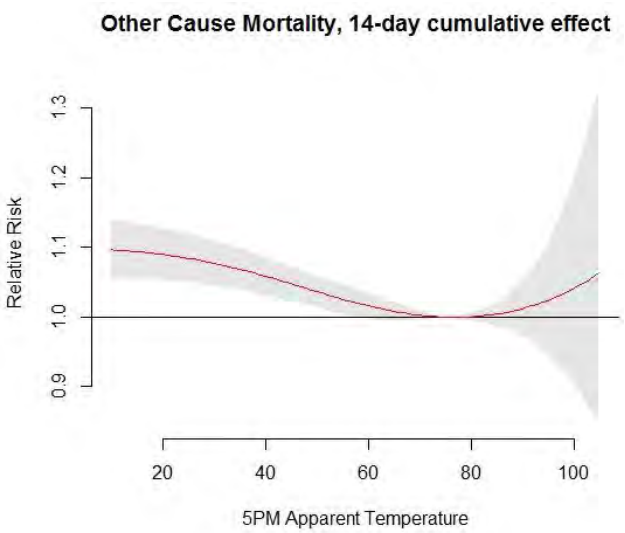




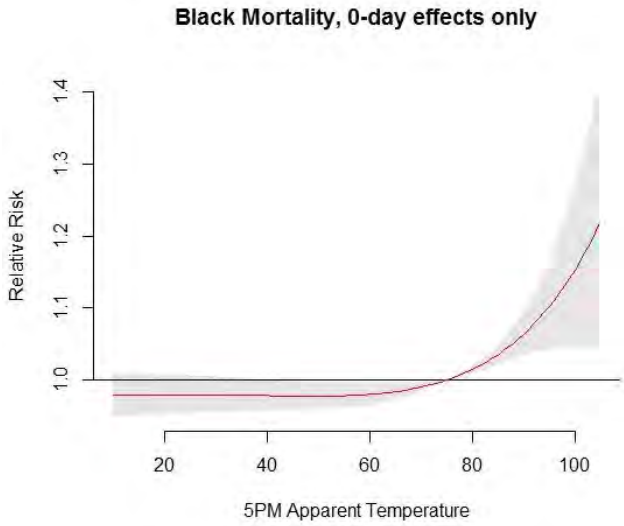


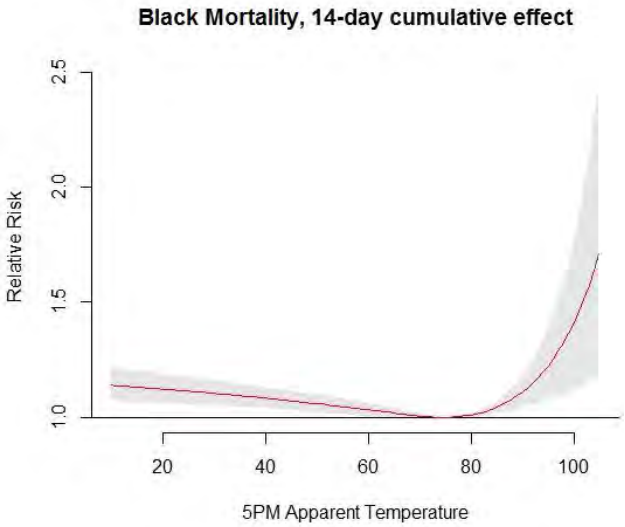


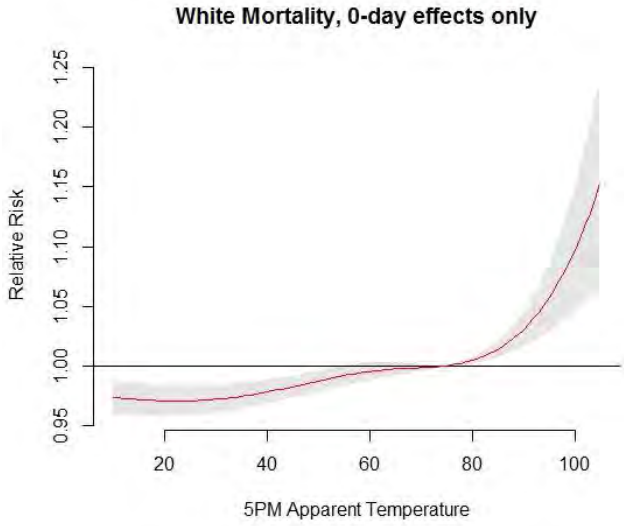


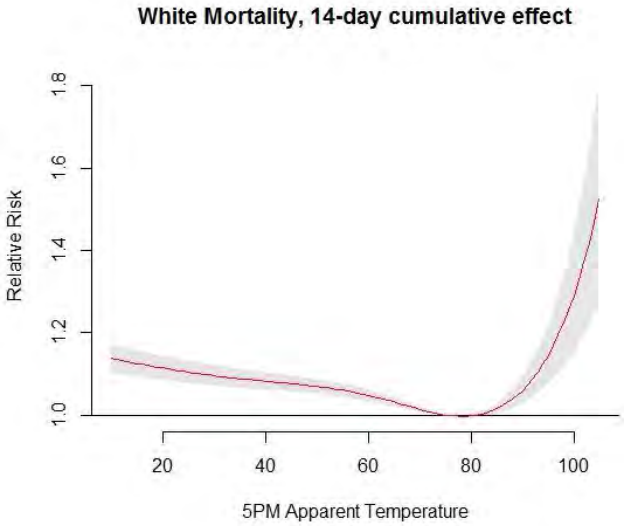


Overall Mortality by Race, 0-day and 14-day Effects:









Appendix G:

Urban Heat Island Effect and Land Cover Analysis

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Summary of Recommendations

Urban heat island (UHI) effect is the most documented phenomenon for climate change. It refers to the development of higher urban temperatures of an urban area compared to the temperatures of surrounding suburban or rural areas. Impervious surfaces, loss of vegetation, land use, and the built environment that are major sources of anthropogenic heat create such differences.

There is a significant variation in UHI intensities (maximum of 47.79ºF during winter, 37.58ºF during spring, 26.33ºF, and 32.67ºF during fall) among Cleveland neighborhoods: Slavic Village, Kinsman, Glenville, and Detroit Shoreway. The average daily temperature at Hopkins Airport data is used as a reference case during 2012 which is recorded as the hottest year in the region. These study areas are identified as the most susceptible neighborhoods to changing climate per Cleveland Climate Action Plan.

The land cover analysis of above neighborhoods shows a very high percentage of impervious surfaces that includes sidewalks, driveways, parking lots, roads/rail roads, and building roofs: Slavic Village (52%), Kinsman (42%), Glenville (49%), and Detroit Shoreway (55%). The average tree canopy cover ranges from 22% in Detroit Shoreway to 33% in Glenville neighborhood.

Based on UHI and land cover analysis following adaptation and mitigation strategies for climate resiliency are suggested. These strategies are applicable at policy as well as community project scale for all study areas. Such strategies are particularly geared towards energy efficiency in buildings, increasing urban tree canopy, and increase pervious water retaining paving.

Energy Efficient Buildings

- Make buildings airtight
- Increase envelope insulation, especially attic insulations in residential buildings
- Replace existing windows with energy efficient operable windows
- Increase roof albedo values or develop green roof strategies

Increase Urban Tree Canopy

- Increase tree canopy cover by increasing urban street tree density and biodiversity. A new policy level programs like planting a tree program similar to weatherization program can be promoted
- Plant shade trees on the west and southwest windows and walls
- Plant solar friendly deciduous trees to shade the east and an open understory to promote penetration of cool breeze
- Plant evergreen windbreaks to the northwest and west for protection from winter winds
- Promote green infrastructure strategies like rain water garden, bio swales, etc. and engage community members by providing necessary training and educations
- Maintain existing street trees by providing required training and education
- Propose new neighborhood parks, urban forests as well as urban agriculture on vacant parcels

Pervious pavers for sidewalks

- Replace impervious surfaces by permeable paving or green space

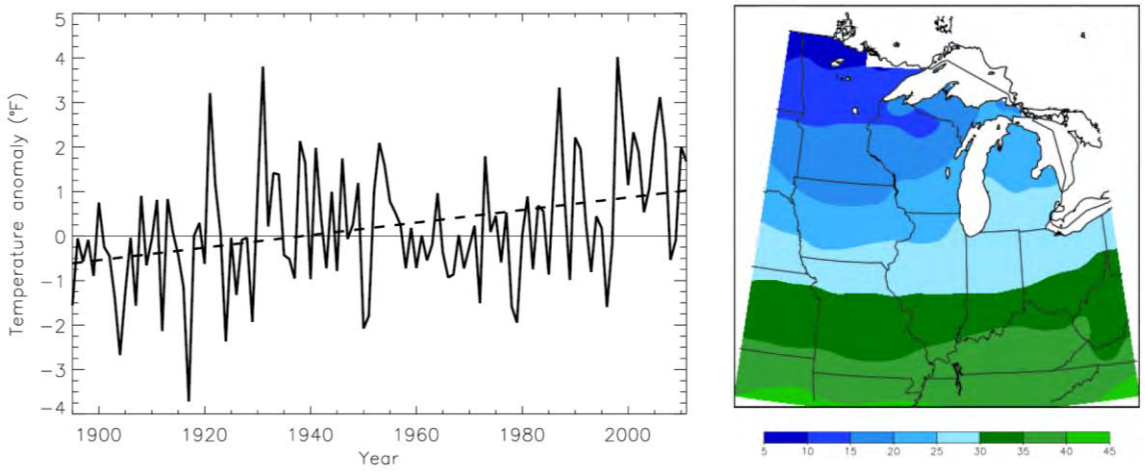
Urban Park and Forestry

- Initiate planting tree towards long-term urban forestry project

1.0 Climate Change in the Midwest Region

Historical Trends: During 1901-2005, Midwest region witnessed an increase of 0.14^{0}F per decade (Figure 1(a)). The temperature increase in the last 35 years is relatively higher with an increase of 0.49^{0}F per decade from 1979-2005(Kunkel et al. 2013). The International Panel on Climate Change (IPCC) reported the warmest 12 years on the record from 1995-2006. Since then additional warm years have occurred, including 2012, which was the warmest year on record in Cleveland.

The changes in temperature varies from North (cold) to South (warm) (Figure 1 (b)) and it is affected by lakes which keep lake cities cooler during summer and warmer during winter. However, the "lake effect" causes heavy snow in lake cities. In addition to lakes, local features, like built environment, vegetation, plays an important role in creating local climates that can vary among lake cities.



(a) (b)

Figure 1: (a) Temperature anomaly for the Midwest region (b) Average Temperature (^{0}F): December 1 to February 29 during 1981-82 to 2009-10 *(Source: (Kunkel et al. 2013))*

Future Projections: The North American Regional Climate Change Assessment Program (NARCCAP) predicts annual average temperature increase of 4 to 5 ^{0}F across the Midwest in this century. Three scenarios for time period 2021-2050, 2041-2070, and 2070-2099 are presented. The temperature change in winter is expected to range from 4.0 to 6.0 ^{0}F, 3.0 to 4.5 ^{0}F in spring, 4-6 ^{0}F in summer, and 4.5 to 5.5 ^{0}F in fall. These temperature trends are statistically significant (at the 95% level) and were estimated based on annual average temperature of 1971-2000 for high emission scenario.

The future warming trend in the Midwest is illustrated in the Figure 2 and it indicates that summers in these states will feel progressively more like summers currently experiences by the states to the Southwest under both higher and lower future emissions scenarios.

The multi-model means and standard deviations of simulated annual mean change indicates extended periods of extreme heat event and its increased likelihood of such occurrences (Table 1). Increased cooling degree days puts burden on existing infrastructure/utilities and results in increased greenhouse gas emissions. The heating energy needs are reduced and growing degree days are increased.

Temperature Variable	NARCCAP Mean	NARCCAP Standard Deviation	Daily_CMIP3 Mean
Freeze-free period	+24 days	5 days	+25 days
#days $T_{max} > 90°F$	+19 days	5 days	+26 days
#days $T_{max} > 95°F$	+15 days	6 days	+13 days
#days $T_{max} > 100°F$	+11 days	5 days	+4 days
#days $T_{min} < 32°F$	-22 days	4 days	-27 days
#days $T_{min} < 10°F$	-16 days	5 days	-13 days
#days $T_{min} < 0°F$	-10 days	5 days	-7 days
Consecutive #days > 95°F	+85%	37%	+232%
Consecutive #days > 100°F	+106%	50%	+562%
Heating degree days	-15%	2%	-17%
Cooling degree days	+66%	18%	+75%
Growing degree days (base 50°F)	+32%	5%	+33%

Table 1: Predicted temperature variables from NARCAP simulations for the Midwest region. *(Source: (Kunkel et al. 2013))*

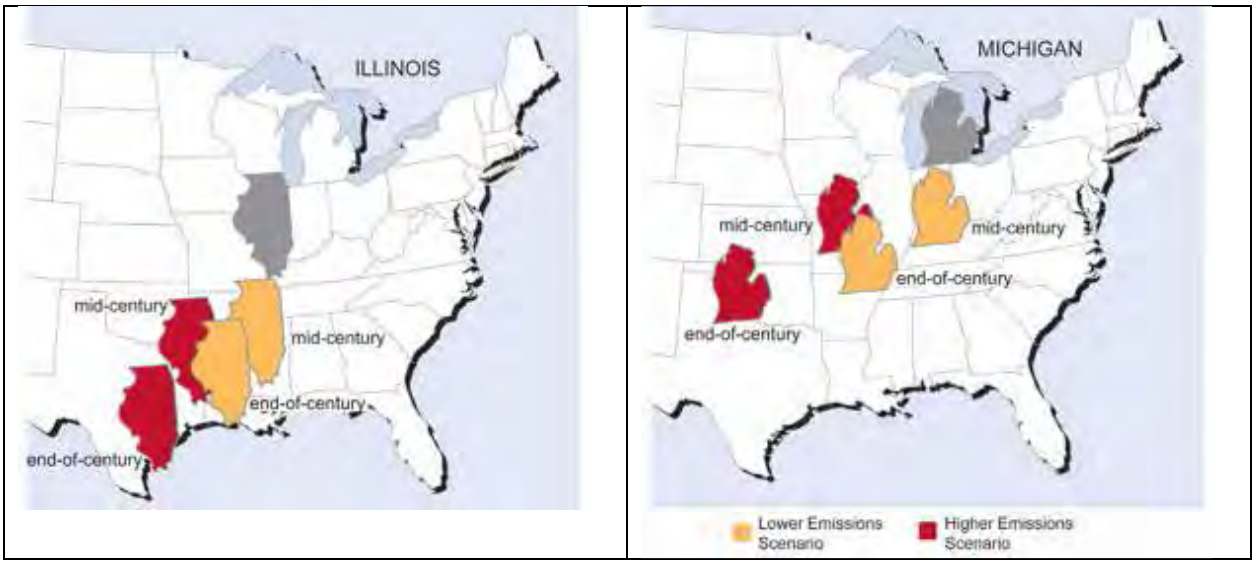


Figure 2: Migrating temperatures *(source: (Hayhoe et al.))*

Potential Impacts: The climate change related extreme events that makes communities vulnerable includes heat waves, resulting in excess urban mortality (O'Neill 2005) and affecting infrastructure and built environments. For example: the 1995 heat wave in Chicago, IL is the most deadly U.S. heat wave in decades and resulted in 700 fatalities. Maximum daily temperatures were equal to or greater than 90^0F and greater than 100^0F at the peak of the heat wave. Even more importantly, there was no relief in night, as nighttime minimum temperatures were over 80F during the hottest days. Heat waves also cause major power outage because of increased demand for power outstripping the infrastructure capacity, contributing to health issues and also disrupting economic activities.

Adaptation and Mitigation Strategies: In response to the 1995 heat wave, the City of Chicago put together an extreme weather operations plans that included mitigation steps for the city to take during heat waves. These were implemented during a 1999 heat wave that was nearly as hot as the 1995 event, but fatalities were far less numerous. The city has also put together an ambitious Climate Action Plan (Hayhoe and Wuebbles 1998) that outlines both adaptation and

mitigation strategies. Even though uncertainties around climate change persisted, the adaptation and mitigation initiatives focused on improving green infrastructure and replacing impervious surfaces as building energy efficiency continued to penetrate the market.

City of Cleveland

Major urban centers, including Cleveland, are more sensitive to some weather and climate events due to specific characteristics of the urban environment such as building density, land use, urban sprawl, and proximity to the Lake Erie. Extreme temperatures can have larger impacts on human health, particularly in the urban core where the heat absorbed by the urban surfaces (concrete, asphalt, etc.) elevates summer afternoon temperature and lessens the cooling rate at night. During the winter, cities such as Cleveland are susceptible to lake-enhanced snowfall. Extreme rainfall can cause host problems, including storm water overflows, flooding of home and roadways, and contamination of municipal water supplies. Climate extremes combined with the urban pollution sources can create air quality conditions that are detrimental to human health. Therefore, this study focused on neighborhoods that are most vulnerable to climate changes

2.0 Heat Island Effect

Heat island is the most documented phenomenon of climate change. Heat island refers to the development of higher urban temperatures of an urban area compared to the temperature of surrounding suburban and rural areas. The phenomenon is related to positive thermal balance created in the urban environment because of the increased heat gains like the high absorption of solar radiation and the anthropogenic heat, and the decreased thermal losses. The intensity of urban heat island may exceed several degrees over regional and temporal variability. The phenomenon is observed in specific areas of the cities presenting varying Land Use and Land Cover (LULC) including high density, and low environmental quality and results in a serious reduction of ambient thermal comfort levels and poor indoor thermal conditions.

Summertime UHI considerably increases the energy demand of a city and as a consequence of this energy increase, wide spread power outage may occur due to the increase of the air conditioning system usage. Low-income urban dwellers those who cannot afford air conditioners are more susceptible to the heat related illnesses, indoors as well as outdoors.

For this purpose, this study looked at weather data during the hottest year of Cleveland. The weather stations are located at the airport: Burke, Hopkins, and Cuyahoga County Airport. The Burke Airport is closer to the Lake Erie and it is a representative of weather conditions of Detroit Shoreway and the Cuyahoga County Regional Airport weather data is a representative of Glenville neighborhood. Not all study areas have National Climatic Data Center monitored weather stations nearby. In such cases, weather data available from the nearest Weather Underground network is used. A weather station located between Slavic Village and Kinsman is representing both these neighborhoods.

In order to estimate variations in temperature of these study areas, the Hopkins Airport is considered suitable baseline condition. Similar baseline conditions have been adopted for the Chicago metropolitan area (Coseo and Larsen 2014) where Midway Airport is used as a baseline condition to analyze UHI in selected urban neighborhoods. In order to get comparable data from weather stations, this study looked at 2012 weather data to demonstrate a snapshot of the warmest year.

There is a significant change in average daily temperatures among four locations in the Cleveland area (Figure 3). Slavic Village, Kinsman, and Glenville locations are warmer throughout the year (maximum up to 88-89ºF) in comparison to Hopkins airport location (74ºF) and Detroit Shoreway (78ºF). The average daily temperature (73ºF) of these locations during the summer months is 10ºF higher than Detroit Shoreway and Hopkins airport location (63ºF). Winter is 12-13ºF warmer at Slavic Village, Kinsman, and Glenville compared to the airport location. Following the similar trend, spring temperature at these locations is higher than 10ºF with reference to the airport. Winter months considered for this study are January, February, and March; Spring months are April, May, and June; Summer months are July, August, and September; and Fall season is represented by October, November, and December.

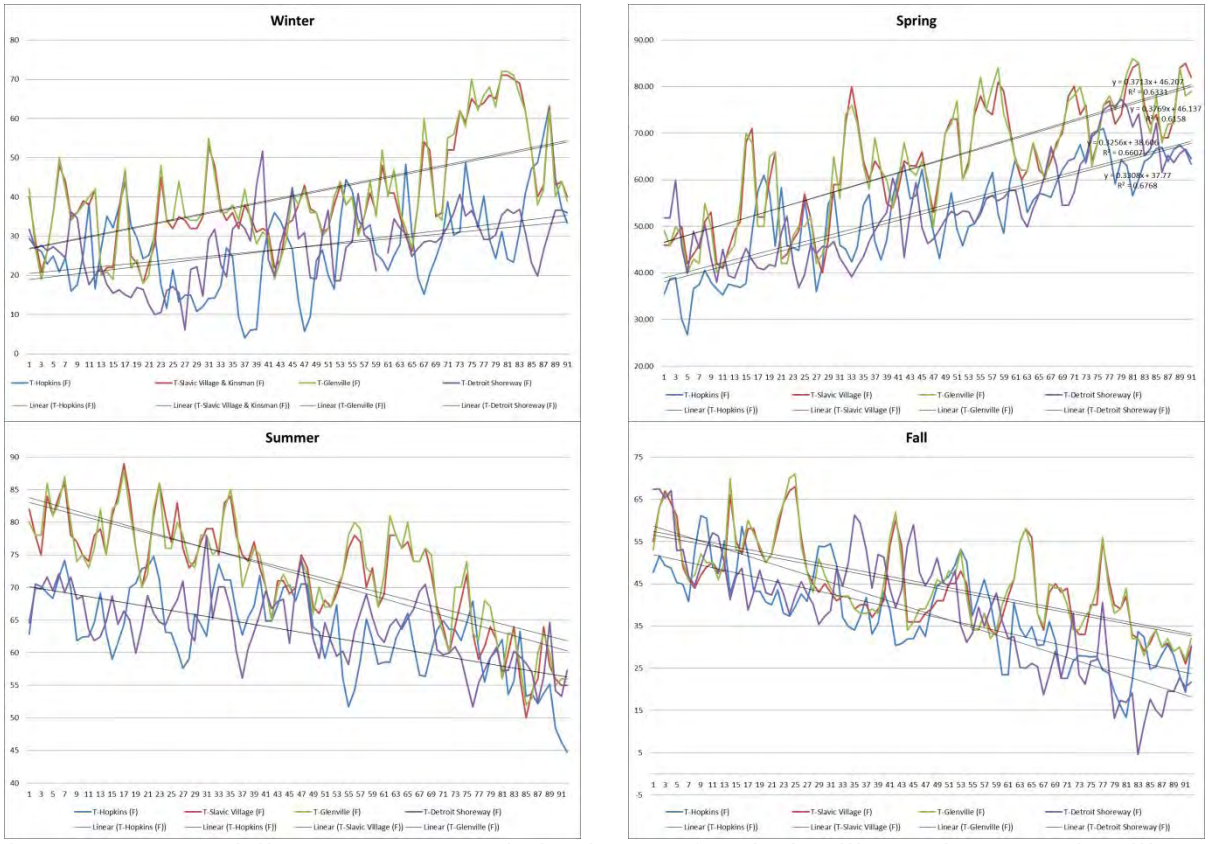


Figure 3: Average daily temperature variation in 2012 for Slavic Village, Kinsman, Glenville, and Detroit Shoreway

Seasonal UHI

Variations in UHI are significant in study areas when average daily temperature is compared with Hopkins Airport as a baseline condition. The maximum UHI intensity of 47.79ºF is observed during winter whereas summer shows minimal UHI intensity of 26.33ºF. Spring and fall UHI intensities are 37.58ºF and 32.67ºF respectively. The maximum daily temperature in these summer and spring seasons reached around 90ºF and UHI intensities during these seasons are particularly critical from health as well as energy perspective. High UHI intensities and large impervious surfaces can further increase such intensities on locations with less vegetation and shade. Therefore, following section looks into the land cover in study areas that may exacerbate such conditions and suggest possible adaptation and mitigation strategies.

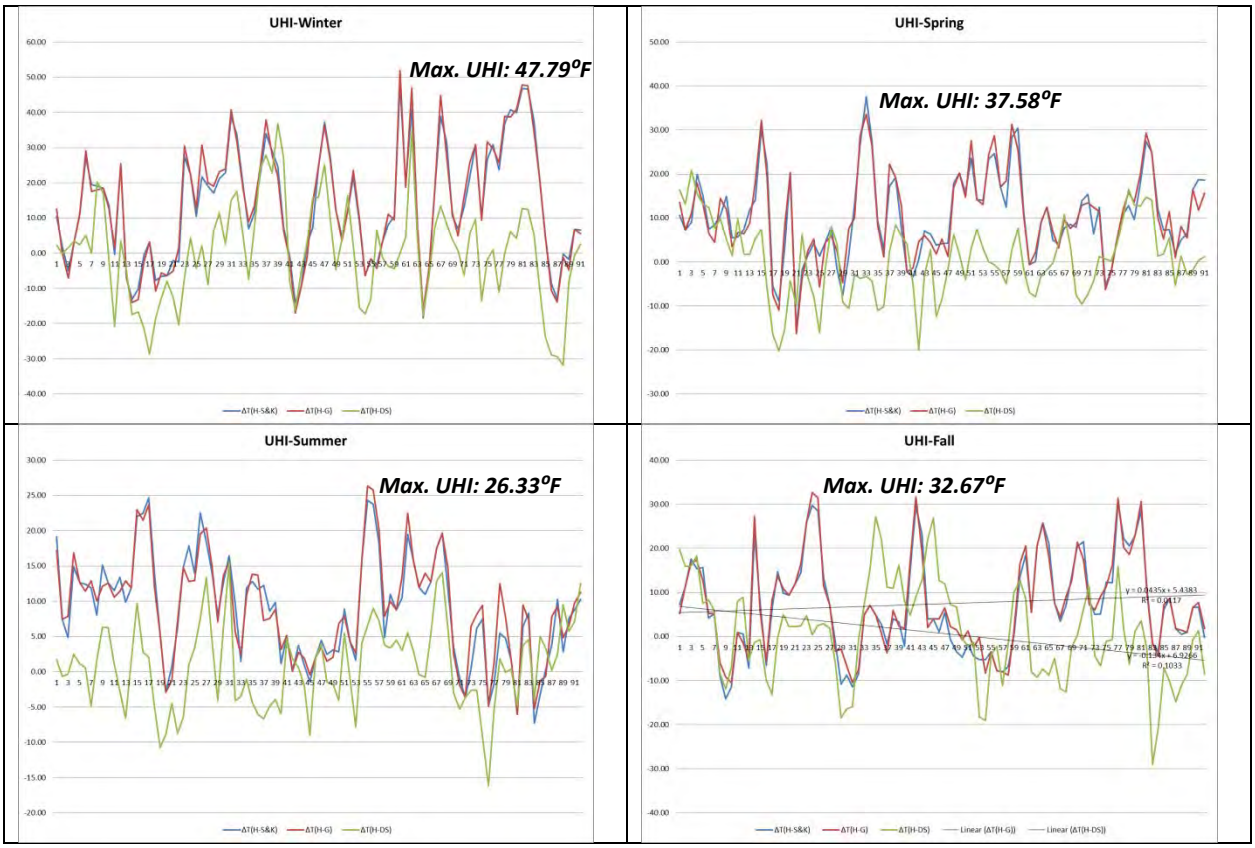


Figure 4: Seasonal UHI Variations with reference to the Hopkins International Airport (S&K: Slavic Village and Kinsman, G: Glenville, DS: Detroit Shoreway, and H: Hopkins Airport)

3.0 Land Cover Analysis

The Cuyahoga Country Planning Division completed an existing land use land cover analysis however it does not provide finer resolution at the neighborhood level. This study fills in such a gap by realizing and completing a need for detailed analysis. The primary source for the detailed land cover analysis is the state-of-the-art i-Tree program provided by the USDA Forest Service and it utilizes NOAA satellite imagery available from Google Maps. These images used for the study were captured in 2012 and it overlaps with the weather data used for UHI analysis.

In order to accurately identify land cover in a relatively larger area, each study area (Slavic Village, Kinsman, Glenville, and Detroit Shoreway) is divided in to small zones, 25-30 zones per study area (Figure 5). This facilitated selection of maximum points (100 per zone) for analysis using i-Tree program. In all, over 2500-3500 points were selected for each study area that increased the accuracy of land cover analysis as suggested by the program manual. Figure 5 shows a sample zoning approach adopted for all study areas.

The average tree canopy cover in all study areas is 27%, impervious surface area is 49%, and the grass/shrubs and bare soil area is 26%. Figure 6 shows the tree canopy cover ranges from 23-33% in the study area. Glenville (33%) shows the highest tree canopy cover whereas Detroit Shoreway (23%) shows minimum tree canopy cover. The impervious surfaces include Sidewalks, Driveways, Parking Lots, Roads/Rail Roads, and Building Roofs and their percentage is quite high in all study areas: Slavic Village (52%), Kinsman (42%), Glenville (49%), and Detroit

Shoreway (55%). Further current grass/shrub (19%) and bare soil (7%) accounts for almost quarter of the land cover.

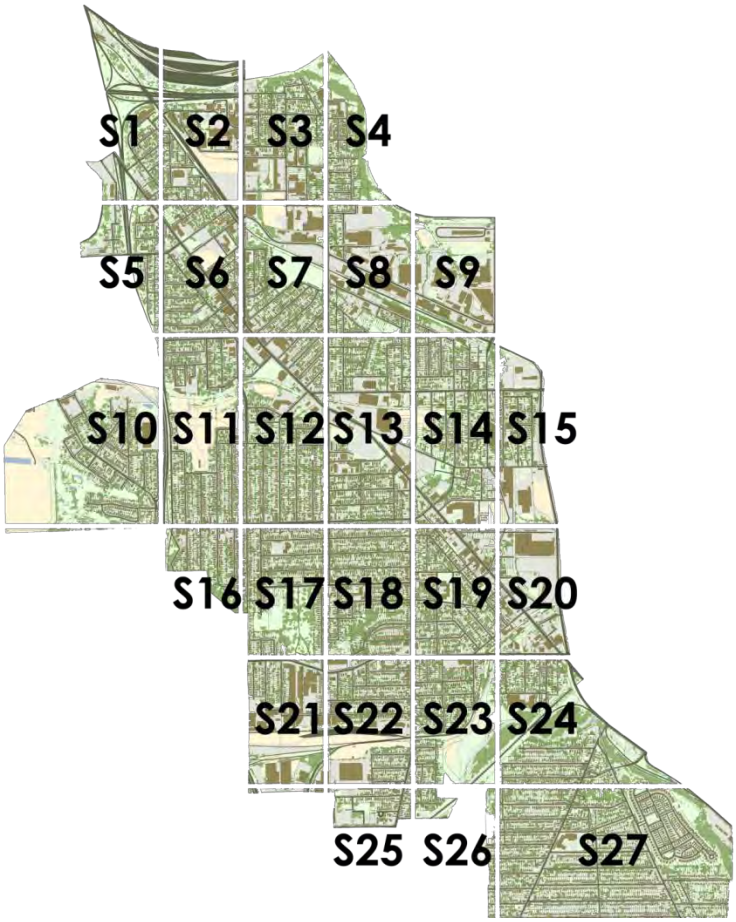
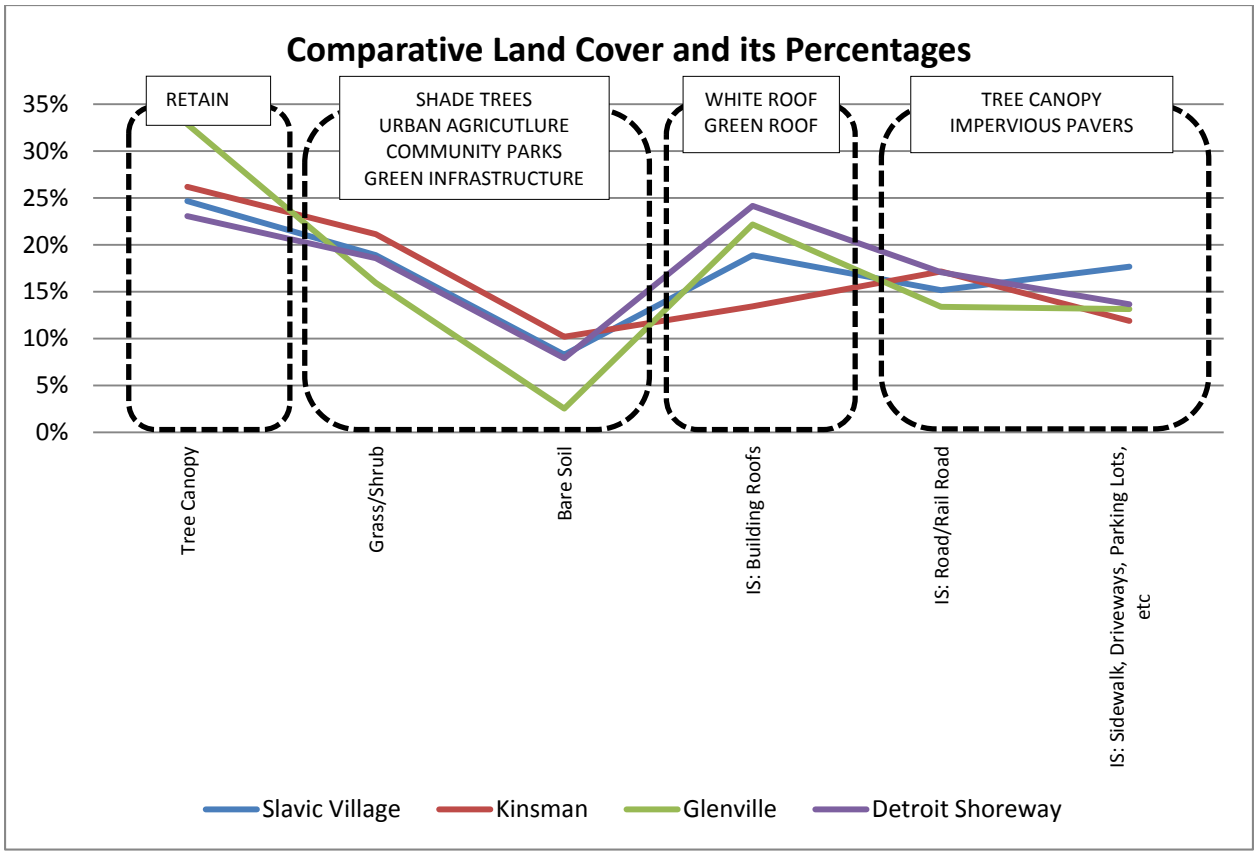


Figure 5: Zoning adopted for Land cover analysis for all study areas was analyzed using i-Tree program and it allowed for more accurate land cover analysis opportunities

Adaptation and Mitigation Strategies for UHI

Figure 6 shows the existing land cover categories (tree canopy, grass/shrubs, bare soil, and impervious surfaces) and it also illustrates the most appropriate strategies for existing land cover. All the study areas can benefit from few common strategies. For example: the most important step is to retain existing trees in the study area. Areas covered by grass/shrubs and bare soil provide opportunity for increasing tree density and canopy cover, urban agriculture, as well as implementing green infrastructure strategies depending upon its location in the neighborhood. Existing residential buildings roofs can be painted white whereas large industrial roofs are potential candidates for green roofs as well other green infrastructure strategies.

These study areas provide opportunities to promote a policy level strategy for adaption and mitigation of climate change like increase water retaining permeable paving and urban tree canopy layer. By providing training and education, community dwellers can be engaged in successful implementation of such policies. The replacement of impervious surfaces can also be integrated with green urban design strategies based on neighborhood specific projects where community dwellers are actively engaged.



*IS represents Impervious Surfaces and it is categorized as 1) Building Roofs, 2) Roads/Rail Roads, and 3) Sidewalks, Driveways, Parking Lots etc.
** Tree canopy cover presented in this graph does not distinguish vegetation type

Figure 6: Land cover analysis and potential climate resilient strategies

This analysis included available vacant land parcels under land cover category grass/shrub and bare soil. Such vacant parcels as well as available land on occupied parcel provide multiple opportunities to improve climate resiliency. For example: growing shade trees can cool buildings on occupied parcel and prevents heat absorption by impervious surfaces. This is important for reducing summertime cooling needs and outdoor thermally comfortable conditions. During winter time, strategically located deciduous trees can block winter breeze. Existing vacant land parcels provides opportunities for implementing green infrastructure that can improve tree canopy cover as well as provide storm water benefits.

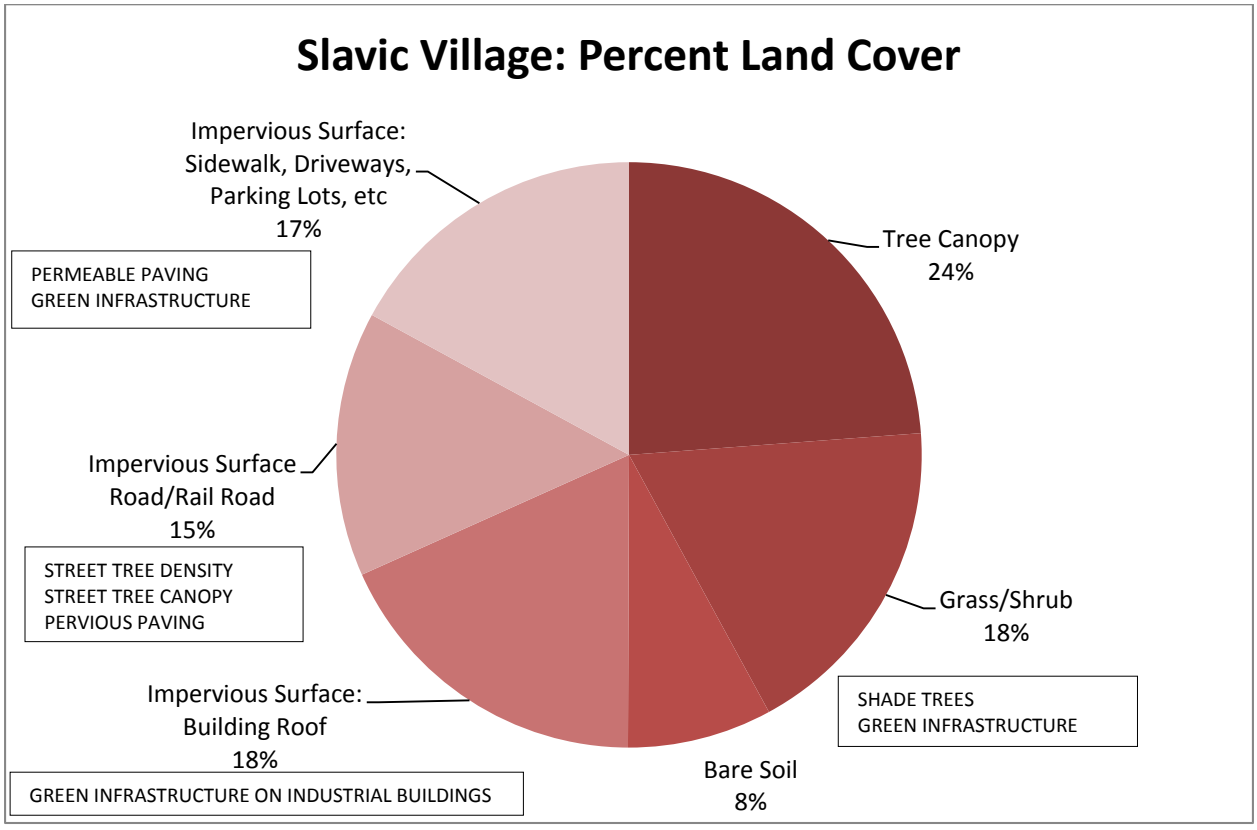
Since many environmental functions are related to leaf surface areas (eg. reduction in air temperature, air pollution, volatile organic emissions, carbon dioxide sequestrations), understanding the leaf-area contribution of various species is important to urban-forest researchers, managers, and planners. Further analysis of leaf areas and plant species and its applications at smaller scale will be helpful. In addition, the relationship between UHI and land cover can be further analyzed.

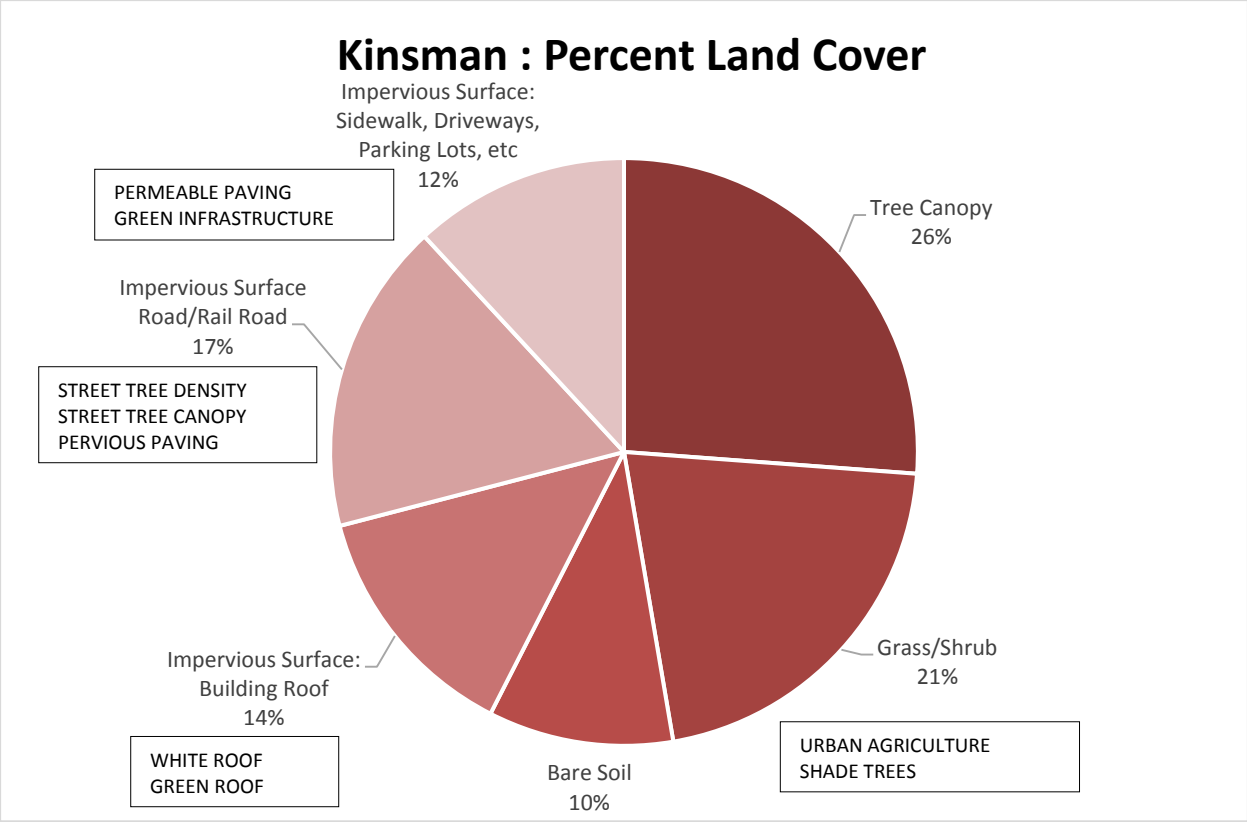
4.0 Applications for Study Areas

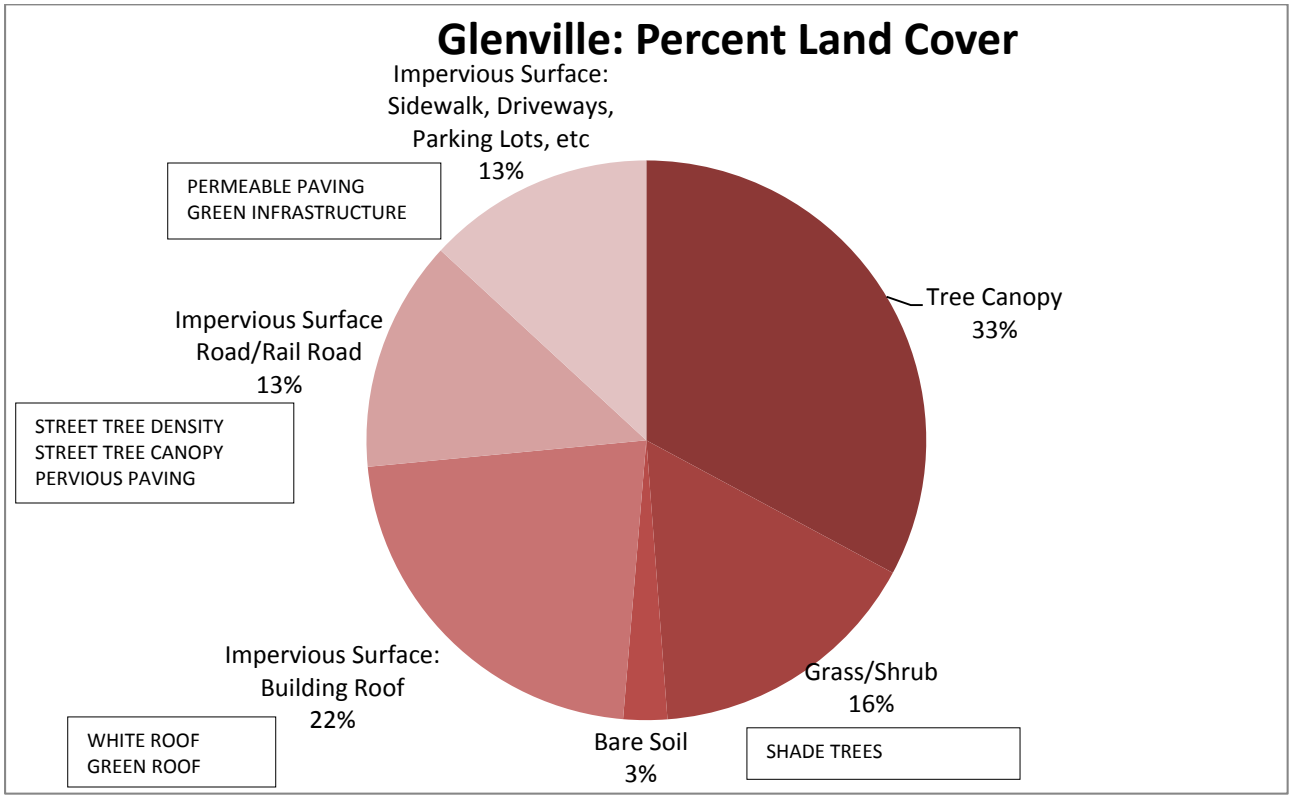
One of the major questions for this project is to identify appropriate use of vacant land parcels for developing climate resilient strategies. This section provides potential answers based on existing literature and its suitability for the study area.

Strategizing urban greening efforts

Greening efforts should be concentrated on various land uses (like industrial, warehouse, as well as residential) where current vegetation cover is minimal. There are multiple urban greening approaches suitable for each land uses. For example, large industrial and warehouse land uses in the Slavic Village provide opportunities for green roofs (Lin et al. 2013, Castleton et al. 2010) and large parking lots on these land uses are suitable for implementing green infrastructure for surrounding health and safety (Kondo et al. 2015). Land use dedicated to transportation, available in all study areas, provides an opportunity to increase street tree density and its canopy cover (Janhäll 2015). Use of local plant species (Sæbø 2012) that have high leaf area density will offer improved environmental (Panda, Amatya, and Hoogenboom 2014), ecological (McPherson et al. 1994), as well as social benefits (Bruton and Floyd 2014). Such urban greening efforts not only contribute towards healthy ecosystems but offers economic and social benefits as well (2009). In residential areas, parcel level vegetation strategies can provide maximum benefits to residents by offering reduced heat island effect, air pollution, thermal comfort, and energy efficiency in addition to health benefits (South et al. 2015).




Kinsman : Percent Land Cover
Impervious Surface: Sidewalk, Driveways, Parking Lots, etc 12%
PERMEABLE PAVING
GREEN INFRASTRUCTURE
Tree Canopy 26%
Impervious Surface Road/Rail Road 17%
STREET TREE DENSITY
STREET TREE CANOPY
PERVIOUS PAVING
Impervious Surface: Building Roof 14%
WHITE ROOF
GREEN ROOF
Grass/Shrub 21%
URBAN AGRICULTURE
SHADE TREES
Bare Soil 10%


Glenville: Percent Land Cover
Impervious Surface: Sidewalk, Driveways, Parking Lots, etc 13%
PERMEABLE PAVING
GREEN INFRASTRUCTURE
Tree Canopy 33%
Impervious Surface Road/Rail Road 13%
STREET TREE DENSITY
STREET TREE CANOPY
PERVIOUS PAVING
Impervious Surface: Building Roof 22%
WHITE ROOF
GREEN ROOF
Grass/Shrub 16%
SHADE TREES
Bare Soil 3%

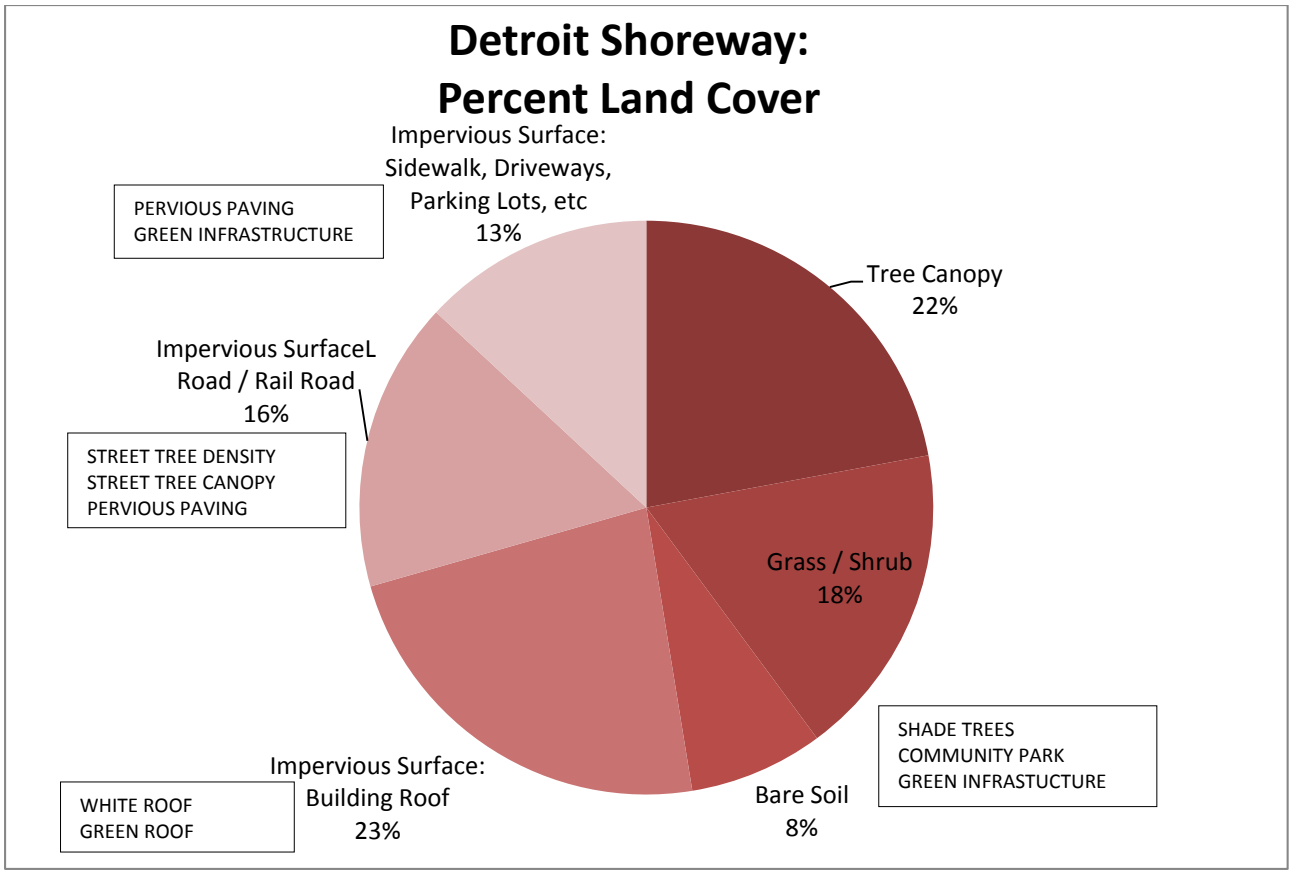


Figure 7: Land Cover and Potential Climate Resilient Strategies for study areas

Effect of Urban Trees on Wind and Air Temperature: By transporting water, blocking winds, shading surfaces, and modifying the storage and exchanges of hear among urban surfaces, trees affect local climate and consequently energy use in buildings, human thermal comfort, and air quality. Accurate estimation of the effect of urban trees on local wind speeds and air temperature at the height of people and residential buildings have been estimated in observational studies and by simulation models to explore the complexity of the multiple surfaces in urban areas. A study conducted in Chicago reported air temperature at below-canopy sites remained within 3.6^0 F of the temperature at the same height at the airport (McPherson et al. 1994). This study also reported higher air temperature in residential neighborhoods with less (10 percent) vegetation cover resulted in increased anthropogenic heat by paved surfaces.

While urban forest ecosystem study of Chicago provides closest reference for this project, there exists additional evidences on urban greening to cool towns and cities (Bowler et al. 2010) that reported cooling effects of ground and roof vegetation, urban trees and forests, and parks and green areas. Figure 8 shows a summary of various studies that compared air temperature differences between built up area and various greening strategies in a day. The average temperature reduction in the day is 0.94◦C (95% CI = 0.71–1.16), based on 26 effect sizes from 16 studies. Analysis on the subset of data measured at night (22:00–06:00) based on 12 effect sizes from 7 studies found a similar average temperature reduction of 1.15◦C (95% CI = 0.86–1.45). This result could be indicative of an extension of the park's cooling effect into its surroundings, which would reduce the temperature difference. Also, the results of these studies show that larger parks were either more likely to be cooler or that the cooling effect was greater.

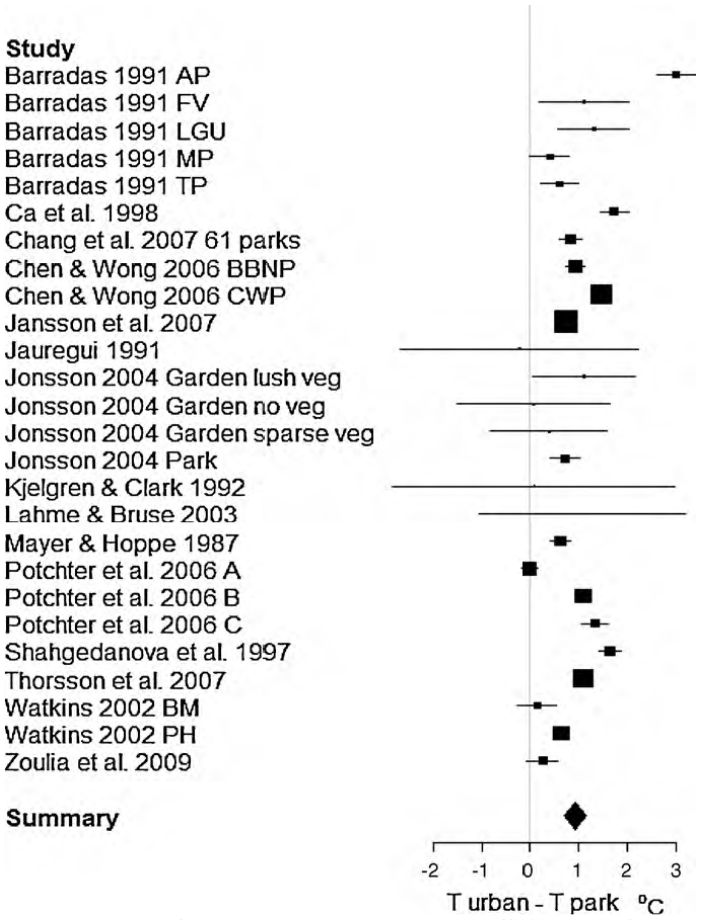


Figure 8: Black squares represent the average temperature difference between a built-up area and a park or green area in the day (the effect size; Turban –Tpark ◦C). The horizontal bars are the 95% confidence intervals for each effect size. The vertical axis line represents the line of no temperature difference; positive effect sizes indicate that the park was cooler. The average effect size ("Summary" shown as a diamond symbol) was calculated as a weighted average. The size of black squares reflects the "weight" given to each study (see Section 3) and was based on the inverse of the variance. *(source: (Bowler et al. 2010))*

Local-scale Energy and Water Exchanges: The complex mix of anthropogenic surfaces (like buildings, roads) and natural surfaces (like trees. Grass) in urban areas affects how energy and water are partitioned and cycles through the urban systems. The replacement of natural surfaces with anthropogenic surfaces alters the thermal and moisture properties of the area, thereby modifying the local atmosphere and generating an "urban climate" that is commonly characterized by increase air temperatures and poor air quality.

Potential Building Energy Savings from Urban Trees: Trees can reduce building energy use by lowering summertime temperature, shading buildings during the summer, and blocking the winter winds. However, trees also can increase building energy use by having their branches shade building during the winter, and an increase or decreased energy use by blocking summertime breezes. The energy-saving potential of trees in Chicago (McPherson et al. 1994) reported that increasing tree cover by 10 percent (or about 3 trees located in optimal energy-conserving locations per building, as shown in Figure 9) could reduce total heating and cooling energy use by 5 to 10 percent. On a per-tree basis of this mass planting, annual heating energy use can be reduced by about 1.3 percent, cooling energy use by about 7 percent, and peak cooling

demand by about 6 percent. Benefit-cost ratios of 1.40 for trees planted around typical two-story buildings and 1.96 for trees near energy-efficient wood frame buildings indicate that a utility-sponsored share tree program could be cost effective for both existing and new construction

Street trees can be a major source of building shade. Shade from a large tree located on west side of a typical brick residence can reduce the annual use of air-conditioning energy by 2 to 7 percent and peak cooling demand by 2 to 6 percent. Street trees that shade the east side of buildings can produce similar cooling savings, have a negligible effect of peak cooling demand, and can slightly increase heating costs. Shade from large trees to the south increase heating costs more than they decrease cooling costs.

Planting "solar friendly" trees to the south and east can minimize the energy penalty associated with blocking irradiance during the heating seasons. Features of energy-efficient residential landscape includes 1) shade trees, shrubs, and vines located for shade on the west and southwest windows and walls; 2) solar friendly deciduous trees to shade the east and an open understory to promote penetration of cool breeze; 3) evergreen windbreaks to the northwest and west for protection from winter winds; and 4) shade on air conditioners where feasible. Further, location specific design guidelines and recommendations on tree species for energy-efficient landscapes are suggested as future works.

Figure 9: Energy-efficient residential landscape design with east and west shade as well as wind protection to the west and northwest (source: Sand and Huelman, 1983)

Benefits and Costs of Urban Tree Planting and Care:

A benefits-cost ratio analysis for various greening strategies e.g. parcel to urban forest scale shows that small scale interventions like a yard-tree plantation strategies can have incremental impact in the beginning however it can catch up with larger scale urban parks that have higher impact in the early in the implementation stages. This analysis values the role small scale as well as large scale tree planting strategies.

5.0 Conclusions:

Various microclimatic conditions, UHI, exist within Cleveland neighborhoods. The observed maximum UHI intensity in based on average daily temperature of 2012 is 47.79^0 F in winter, 37.58^0 F in spring, 26.33^0 F in summer, and 32.67^0 F in fall. The UHI intensities are high during spring and summer months when average daily temperature is also high compared to other seasons.

The average tree canopy cover in all study areas is 27%, impervious surface area is 49%, and the grass/shrubs and bare soil area is 26%. The tree canopy cover ranges from 23-33% in the study area. Glenville (33%) shows the highest tree canopy cover whereas Detroit Shoreway (23%) shows minimum tree canopy cover. The impervious surfaces include Sidewalks, Driveways, Parking Lots, Roads/Rail Roads, and Building Roofs and their percentage is high in all study areas: Slavic Village (52%), Kinsman (42%), Glenville (49%), and Detroit Shoreway (55%). Further current grass/shrub (19%) and bare soil (7%) accounts for almost quarter of the land cover.

Based on the literature cited in this study, two most effective strategies to improve climate resiliency for the selected neighborhoods is; increasing tree density and canopy cover and replacing impervious surfaces by water retaining pervious surfaces. Both these strategies have a potential to be implemented as a policy as well as develop community engagement projects at parcel and urban scale alike.

Future scope of this study includes evaluate project specific adaptation and mitigation strategies to figure out most effective strategies for climate resiliency for studied neighborhood based on its energy, environmental, economic, as well as health and social relevance.

References:

2009. Street Trees And Urban Renewal: A Baltimore Case Study. Geographical Bulletin.

Bowler, Diana E., Lisette Buyung-Ali, Teri M. Knight, and Andrew S. Pullin. 2010. "Urban greening to cool towns and cities: A systematic review of the empirical evidence." *Landscape and Urban Planning* 97 (3):147-155. doi: http://dx.doi.org/10.1016/j.landurbplan.2010.05.006.

Bruton, Candice, and Myron Floyd. 2014. "Disparities in Built and Natural Features of Urban Parks: Comparisons by Neighborhood Level Race/Ethnicity and Income." *Journal of Urban Health* 91 (5):894-907. doi: 10.1007/s11524-014-9893-4.

Castleton, H. F., V. Stovin, S. B. M. Beck, and J. B. Davison. 2010. "Green roofs; building energy savings and the potential for retrofit." *Energy and Buildings* 42 (10):1582-1591. doi: http://dx.doi.org/10.1016/j.enbuild.2010.05.004.

Coseo, Paul, and Larissa Larsen. 2014. "How factors of land use/land cover, building configuration, and adjacent heat sources and sinks explain Urban Heat Islands in Chicago." *Landscape and Urban Planning*:117. doi: 10.1016/j.landurbplan.2014.02.019.

Hayhoe, Katharine, Jeff VanDorn, Vaishali Naik, and Donald Wuebbles. "Climate Change in the Midwest: Projection of Future Temperature and Precipitation." Accessed June 15. http://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/midwest-climate-impacts.pdf.

Hayhoe, Katherine, and Donals Wuebbles. 1998. Chicago Climate Action Plan.

Janhäll, Sara. 2015. "Review on urban vegetation and particle air pollution – Deposition and dispersion." *Atmospheric environment (1994)* 105:130-137.

Kondo, Michelle C., Sarah C. Low, Jason Henning, and Charles C. Branas. 2015. "The Impact of Green Stormwater Infrastructure Installation on Surrounding Health and Safety." *American Journal of Public Health* 105 (3):e114-e121. doi: 10.2105/AJPH.2014.302314.

Kunkel, Kenneth, Laura Stevens, Scott Stevens, Liqiang Sun, Emily Jansen, Donald Wuebles, Steven Hilberg, Michael Timlin, Leslie Stoecker, Nancy Westcott, and Greg Dobson. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment. In *Part 3. Climate of the Midwest U.S.* Washington, D.C.: National Environmental Satellite, Data, and Information Service.

Lin, B. S., C. C. Yu, A. T. Su, and Y. J. Lin. 2013. "Impact of climatic conditions on the thermal effectiveness of an extensive green roof." *Building and Environment* 67:26-33. doi: 10.1016/j.buildenv.2013.04.026.

McPherson, David J. Nowak, Rowan A. Rowntree, and Station Northeastern Forest Experiment. 1994. "Chicago's urban forest ecosystem : results of the Chicago Urban Forest Climate Project." *General technical report NE* (186):vi, 201 p.

O'Neill, Marie S. 2005. "Disparities by race in heat-related mortality in four US cities: the role of air conditioning prevalence." *Journal of urban health* 82 (2):191-197. doi: 10.1093/jurban/jti043.

Panda, S., D. M. Amatya, and G. Hoogenboom. 2014. "Stomatal Conductance, Canopy Temperature, and Leaf Area Index Estimation Using Remote Sensing and OBIA techniques." *Journal of Spatial Hydrology* 12 (1):29-29.

South, Eugenia C., Michelle C. Kondo, Rose A. Cheney, and Charles C. Branas. 2015. "RESEARCH AND PRACTICE. Neighborhood Blight, Stress, and Health: A Walking Trial of Urban Greening and Ambulatory Heart Rate." *American Journal of Public Health* 105 (5):909-913. doi: 10.2105/AJPH.2014.302526.

Sæbø, A. 2012. "Plant species differences in particulate matter accumulation on leaf surfaces." *The Science of the total environment* 427-428:347-354.

Appendix H:

Overlay of Climate Change Actions and Climate Impacts

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1. Introduction

Projected climate change impacts are expected to differ across the United States. While increased temperatures will impact all regions of the country, other climatic variables such as precipitation and extreme weather events will differ. Strategic climate change measures are required from state and local governments to reinforce a community's resilience to adverse climate change impacts.

Cleveland has placed focus and resources towards climate change mitigation and adaptation efforts through multiple actions plans and policy recommendations. These include the Cleveland Climate Action Plan and the Re-imagining a More Sustainable Cleveland Plan. Actions in both plans fall generally under similar focus areas, and the scope of these efforts address ten categories of climate impacts which are described in greater detail in Appendix C:

1- Increase temperatures
2- Changes in Precipitations
3- Extreme weather events
4- Public Health
5- Water Quality
6- Food Systems
7- Forests and Land Cover
8- Energy and Industry
9- Transportation Systems
10- Fish and Wildlife

The following document attempts to correlate the expected benefits and effects of these strategies in relation to the ten climate impacts presented in the literature review. This may help policy makers to prioritize the numerous mitigation and adaptation actions with regard to available financial and human resources, time, and desired outcomes.

2. Overlay of Cleveland Climate Action Plan (CAP) and climate impacts

Table 1 illustrates the various impacts of the Cleveland CAP proposed strategies on the numerous components of climate change that extend beyond decreasing greenhouse gases emissions. It is important to note, that besides the direct benefits of climate change policies, there are also co-benefits of climate change actions, which arise from the synergies of the various actions and policies. Identifying the potential benefits and co-benefits of climate change actions helps policy makers prioritize mitigation and adaptation strategies when resources are limited; however this requires a more precise analysis and assessment of the potential impacts. Therefore, the data in the table indicates only the direct benefits of climate actions.

Actions within the CAP are categorized into six different focus areas, each with a set of specific strategies. The focus areas include energy efficiency and green building, advanced and renewable energy, sustainable mobility, waste reduction and resource conservation, land use and clean water and community engagement and public health. Though the table attempts to simplify the complex interrelations between actions and benefits, it implies that certain actions result in a wide range of benefits. This helps at selecting actions that may be more promising than others.

The goal to lessen the pressures on energy demands and energy generation is at the center of most mitigation strategies in the CAP. In addition, it is clear from the table that the management

of the public health and energy and industry climate impacts require policies with input from various sectors of the government benefited by collaborations with local communities. This emphasizes the need for an integrated and multidisciplinary approach to tackling climate change and its adverse effects.

Energy efficiency and green buildings & advanced and renewable energy: The most promising actions are based on increasing energy efficiency and adapting advanced and renewable energy, by reducing energy demand and waste, accelerating renewable energy use, reducing vehicle emissions, and improving transportation options. Moreover, such strategies have a vast amount of co-benefits including improved water and air quality, stable temperatures, and reduce risks to public health.

Sustainable mobility: Improved air quality, reduced fuel consumption and vehicle miles traveled are the main objectives of sustainable mobility. The CAP strategies actions target climate impacts on public health and energy and industry; by cutting transport emissions it reduces the effects of traffic pollution on health. In addition to these benefits, green streets actions add co-benefits that include increased land cover, decreasing temperatures, providing more comfortable outdoor spaces, and managing stormwater runoff.

Waste reduction and resource conservation: Actions that promote the reduction, reuse and recycling of waste generated by Cleveland residents are important for controlling and reducing GHG emissions, extracting energy from organic wastes, extending the productivity of landfills and reducing disposal costs. A coordinated approach to waste management efforts targets the climate's impacts on public health, water quality, food systems, and energy production.

Land use and clean water: At a first glance, climate change actions within the land use and clean water focus area result in a more diverse set of benefits in comparison to the other focus areas. Land use and clear water issues intersect between climate change adaptation and mitigation efforts(City of Cleveland Office of Sustainability 2013). The actions included in the CAP address almost all components of climate impacts including water quality, temperature and precipitation patterns, public health, and energy.

Community engagement and public health: Actions targeting community engagements and public health can be characterized as having indirect benefits that result from the synergies of the actions of this category and the actions of the other focus areas.

Table 1: Overlay of Cleveland Climate Action Plan and Climate Impacts

Focus Area	Objective	#	Actions[1]	Mitigation (M) and/or Adaptation (A)[2]	Climate Impacts[3]									
					Increased Temperatures	Changes in Precipitation Patterns	Extreme Weather Events	Public Health	Water Quality	Food Systems	Forests and Land Cover	Energy and Industry	Transportation Systems	Fish and Wildlife
Energy efficiency and green building	Retrofit and renovate existing buildings	1	Retrofit residential buildings	**MA**	●		●	●				●		
		2	Retrofit commercial & industrial buildings	**M**	●		●	●				●		
	Make green building the standard for all new construction	3	Exceed existing building codes	**MA**	●		●	●				●		
	Implement neighborhood-level solutions	4	Make utility data easily accessible	**M**				●	●			●		
		5	Expand smart grid	**M**			●	●	●			●		
		6	Expand energy & green building challenges	**M**				●				●		
		7	Green Cleveland's existing schools	**MA**	●			●				●		
Advanced and renewable energy	Accelerate renewable energy use by Cleveland's residents and small businesses	8	Install renewable energy at homes & businesses	**MA**			●	●				●		
		9	Incorporate renewable energy into municipal aggregation	**M**			●	●	●			●		
	Use local projects to help meet or exceed the utility renewable energy standards	10	Install renewable energy projects on vacant land	**M**			●	●			●	●		
		11	Develop an offshore wind farm	**M**								●		
		12	Meet energy efficiency & renewable energy standards	**M**				●				●		
	Implement advanced energy technologies	13	Accelerate conversion of organic waste to energy	**M**					●			●		
		14	Create low-carbon district heating & cooling systems	**M**				●	●			●		
		15	Support businesses to reduce industrial emissions	**M**	●			●				●		
Sustainable Mobility	Reduce congestion and vehicle emissions	16	Drive more efficient vehicles	**M**				●				●	●	
		17	Encourage anti-idling citywide	**M**				●				●	●	
		18	Expand carpooling & car sharing	**M**				●				●	●	
		19	Increase the use of public transit	**M**			●	●				●	●	
	Create Complete and Green Streets	20	Make biking & walking easier & safer	**M**			●	●				●	●	
		21	Create complete & green streets	**MA**	●	●		●	●		●	●	●	
Waste reduction and resource conservation	Significantly reduce the amount of waste sent to landfills	22	Encourage waste reduction by residents & businesses	**M**				●	●	●		●		
		23	Increase deconstruction & recycling of demolished buildings	**M**								●		
		24	Develop an integrated waste management plan for Cleveland	**M**				●	●	●		●		
Land use and clean water	Encourage vibrant downtown and neighborhoods	25	Green Cleveland's codes to encourage sustainable development	**MA**	●	●		●	●		●	●	●	●
		26	Rightsize the City's infrastructure	**MA**	●	●		●	●			●	●	
	Restore and regenerate the natural environment	27	Develop & implement an urban tree plan	**MA**	●	●	●	●	●		●	●		●
		28	Scale up the local food system	**MA**	●	●	●	●	●	●		●	●	
		29	Implement green infrastructure to capture storm water	**MA**	●	●	●	●	●		●	●		
		30	Increase water conservation & efficiency	**MA**		●		●	●			●		●
Community engagement and public health	Organizations, neighborhoods, and individuals become climate leaders	31	Promote businesses striving to meet energy & carbon goals	**M**			●	●	●			●		
		32	Recognize neighborhood capacity to take climate action	**MA**	●	●	●	●	●	●	●	●	●	●
	Improve public health and resiliency to climate change impacts	33	Build resiliency against the impacts of climate change	**A**	●	●	●	●	●	●	●	●	●	●

Notes:

1. Actions are from the *Cleveland Climate Action Plan: Building Thriving and Healthy Neighborhoods* (City of Cleveland Office of Sustainability 2013).
2. Mitigation is defined as actions that reduce GHG emissions and help to slow climate change. Adaptation is defined as actions that help human society and natural systems prepare for and become less vulnerable to a changing environment (U.S. Environmental Protection Agency 2013).
3. Climate impacts are adapted from the *Synthesis of the Third National Climate Assessment for the Great Lakes Region* (Baule, Gibbons et al. 2014), and Climate Change in the Midwest: A Synthesis Report for the National Climate Assessment (Winkler, Andresen et al. 2014).

3. Overlay of Re-imagining a More Sustainable Cleveland and climate impacts

By examining where the actions and impacts overlap, Table 2 indicates that Re-imagining plan places emphasis on strategies that address climate change impacts on public health and water quality. While it is hard to pinpoint the co-benefits of each policy, the table indicated multiple benefits from all the 26 strategies, in particular the strategies targeting green infrastructure and urban agriculture. There are no clear direct benefits of the policies in relation to extreme weather events, however, it is expected that the benefits gained from reducing energy use, temperature and precipitation patterns would have an indirect impact on extreme weather events.

Actions within the Re-imagining plan are categorized into five different focus areas, each with a set of specific actions and strategies. The focus areas include land use, data, green infrastructure, urban agriculture, and energy generation.

Land use: Land use acquisition mechanisms and the implementation of methods to streamline the disposition of properties do not directly target climate impacts; however they aid in improving governmental process when it comes to the land use decision making and management of properties. The land reutilizations strategies task force targets climate impacts on temperature, public health and water quality, while the use of hydrological and soil data for land use and storm water management strategies is related to precipitation patterns, public health, water quality and land cover.

Data: Geocoding vacant land and parcel-based mapping of environmental contaminations aid in the management of vacant lands, with the latter targeting temperatures, public health, water quality and fish and wildlife climate impacts. Mapping and documentation of lead contaminated sites, wetland criteria and drainage patterns, soil properties and existing vegetative covers targets multiple climate impacts, more specifically public health, water quality and land cover.

Green infrastructure: The expansion of a green space network, restoring ecosystems, and the remediation of sites riddled with contamination provide the city with new recreation resources, management of storm water runoffs, and overall ecosystem restoration. Such actions can improve air and water quality and increase biodiversity. Ultimately a healthy ecosystem offers environmental benefits and improves the quality of life of residents by limiting the impact of climate change on public health.

Urban agriculture: Utilizing vacant land as productive landscapes that generate economic return benefits communities on various levels. Access to affordable produce through community gardens, market gardens, and commercial agricultures on larger areas of vacancy in the city adds to the potential economic development. Overall, improving the agriculture production of vacant lands directly affects the extent of climate impacts on temperature, water quality, food systems, and public health.

Energy generation: Solar, wind, geo-thermal and biofuel technologies can be used in vacant lands for energy generation, while more research is required to determine the most feasible option for Cleveland's dispersed vacant land, such polices provide incentives for generating and using alternative energy at local levels. In addition to energy conservation and optimization, these policies have a direct correlation to the climate impacts on energy and industry and public health. While multiple co-benefits are expected, identifying them is based on a more defined set of policies within this focus area.

Table 2: Overlay of Re-Imagining a More Sustainable Cleveland and climate impacts

Focus Area	#	Actions[1]	Climate Impacts[2]: Increased Temperatures	Changes in Precipitation Patterns	Extreme Weather Events	Public Health	Water Quality	Food Systems	Forests and Land Cover	Energy and Industry	Transportation Systems	Fish and Wildlife
Land Use	1	establish a task force for new vacant land reutilization strategies	●			●	●					
	2	Adopt land use decision-making mechanism										
	3	Streamline the disposition of properties in the city's land bank										
	4	Encourage use of hydrological data and soil characteristics for land use and storm water management strategies		●		●	●		●			
Data	5	Develop methods to classify and geo-code vacant land										
	6	Develop detailed parcel-based mapping of environmental contaminations	●			●	●					●
	7	Parcel-level mapping on sites where children have high blood-lead levels & connect to building demolition decision making				●				●		
	8	Map and document wetland criteria and drainage patterns		●		●	●					
	9	Map and document soil properties		●		●	●		●			
	10	Delineate areas of existing vegetative cover by using aerial photos	●						●			
Green Infrastructure	11	Expand green space and land preservation areas in the 2020 land use plan	●			●	●		●	●		
	12	Identify city-wide green infrastructure initiative	●			●	●			●	●	
	13	Adopt design guidelines for ecosystem preservation in riparian and headwaters areas					●		●			●
	14	Enhance, preserve and create wetland systems					●					
	15	Encourage or mandate use of bioswales and pervious paving	●	●		●	●					
	16	Encourage rain gardens on residential properties	●			●	●					●
	17	Link green infrastructure projects to the Cleveland Carbon Fund	●	●								
Urban Agriculture	18	Prioritize agricultural land uses and create land use category for urban agriculture	●			●		●	●	●		
	19	Establish a minimum half a mile radius between residents and community or market gardeners				●		●		●	●	
	20	Integrate permanent garden space in model block/neighborhood planning	●			●			●			
	21	Establish strategies for controlling use and new models for holding land										
	22	Develop policies and practices within the Cleveland Water Department to streamline farmers and gardeners access to water					●	●		●		
	23	Explore new ways of bringing water to site					●	●		●		
	24	Explore potential for municipal composting facility and community composting projects				●		●		●		
Energy Generation	25	Support the adoption of an Ohio renewable energy portfolio				●				●		
	26	Support efforts toward energy conservation, optimization and generation				●				●		

Notes:

1. Actions are from *Re-Imagining a More Sustainable Cleveland: Citywide strategies for reuse of vacant land (Collaborative 2008)*.
2. Climate impacts are adapted from the *Synthesis of the Third National Climate Assessment for the Great Lakes Region* (Baule, Gibbons et al. 2014), and Climate Change in the Midwest: A Synthesis Report for the National Climate Assessment (Winkler, Andresen et al. 2014).

4. Overlay of Cleveland CAP and Re-Imagining a More Sustainable Cleveland

Communities across the United States have become more aware of the need to address climate change, many have produced several mitigation and adaptation plans, with long-term and short term implications. While establishing climate change mitigation and adaptation strategies is crucial for any community, there is a need for collaboration between organizations, agencies, and communities at different levels to enable a more efficient approach to tackling climate change. By setting common goals, this helps to harmonize the various climate actions and strategies between the different levels, and with other community planning goals.

Table 3 below compares the Cleveland Climate Actions Plan strategies and the Re-imagining more sustainable Cleveland actions, identifying where various strategies overlap. An examination of these actions aid in understanding the direction of current climate change policies and provides us with a rationale for reinforcing and encouraging certain strategies within this report

It is clear that from this table that there are synergies between multiple actions from both plans, each reflecting the same broader goal of addressing climate change impacts. But at the same time the focus of these actions differ from a specific target such as vacant lands in the Re-imagining plan to city wide targets in the CAP. The main intersect between the two plans correlates with strategies in the water and land use focus areas. Energy efficiency and energy generation strategies in the CAP are more detailed and address different components of the focus area, while the same focus area in the Re-imagining plan is identified in a broader manner.

Actions 25 and 26 in the Re-imagining plan correlate with CAP actions 8-12 and 1 -14 respectively, while action 33 in the CAP correlates with almost all of the actions in the Re-imagining plan.

The Cleveland CAP reflects policies with broad targets in various fields, while the re-imaginings policies are concentrated on strategies applicable to vacant land within the city. Though similarities help in pointing out strategies that are agreed upon in both plans, looking at actions that don't intersect provides clues to strategies that need reinforcing. The Re-imagining Cleveland plan focuses on vacant land; therefore no emphasis was placed on vehicular use, public transportation and carpooling, an aspect of the sustainability mobility actions in the Cleveland action plan.

Table 3: Overlay of Cleveland Climate Action Plan and Re-Imagining a More Sustainable Cleveland

			Land Use				Data						Green Infrastructure							Urban Agriculture							Energy	
Focus Area	#	Actions	1 Establish a task force for new vacant land reutilization strategies	2 Adopt land use decision-making mechanism	3 Streamline the disposition of properties in the city's land bank	4 Encourage use of hydrological data and soil characteristics for land use and storm water management strategies	5 Develop methods to classify and geo-code vacant land	6 Develop detailed parcel-based mapping of environmental contaminations	7 Parcel-level mapping on sites where children have high blood-lead levels & connect to building demolition decision making	8 Map and document wetland criteria and drainage patterns	9 Map and document soil properties	10 Delineate areas of existing vegetative cover by using aerial photos	11 Expand green space and land preservation areas in the 2020 land use plan	12 Identify city-wide green infrastructure initiative	13 Adopt design guidelines for ecosystem preservation in riparian and headwaters areas	14 Enhance, preserve and create wetland systems	15 Encourage or mandate use of bioswales and pervious paving	16 Encourage rain gardens on residential properties	17 Link green infrastructure projects to the Cleveland Carbon Fund	18 Prioritize agricultural land uses and create land use category for urban agriculture	19 Establish a minimum half a mile radius between residents and community or market gardeners	20 Integrate permanent garden space in model block/neighborhood planning	21 Establish strategies for controlling use and new models for holding land	22 Develop policies and practices within the Cleveland Water Department to streamline farmers and gardeners access to water	23 Explore new ways of bringing water to site	24 Explore potential for municipal composting facility and community composting projects	25 Support the adoption of an Ohio renewable energy portfolio	26 Support efforts toward energy conservation, optimization and generation
Energy efficiency and green building	1	Retrofit residential buildings																●										●
	2	Retrofit commercial & industrial buildings																										●
	3	Exceed existing building codes	●																									●
	4	Make utility data easily accessible																										●
	5	Expand smart grid																										●
	6	Expand energy & green building challenges																										●
	7	Green Cleveland's existing schools																										●
anced and renewable ene	8	Install renewable energy at homes & businesses																									●	●
	9	Incorporate renewable energy into municipal aggregation																									●	●
	10	Install renewable energy projects on vacant land																									●	●
	11	Develop an offshore wind farm																									●	●
	12	Meet energy efficiency & renewable energy standards																									●	●
	13	Accelerate conversion of organic waste to energy																										●
	14	Create low-carbon district heating & cooling systems																										●
	15	Support businesses to reduce industrial emissions						●																				
Sustainable Mobility	16	Drive more efficient vehicles																										
	17	Encourage anti-idling citywide																										
	18	Expand carpooling & car sharing																										
	19	Increase the use of public transit																										
	20	Make biking & walking easier & safer											●					●										
	21	Create complete & green streets											●			●		●										
Waste reduction and resource conservation	22	Encourage waste reduction by residents & businesses																									●	
	23	Increase deconstruction & recycling of demolished buildings							●																			
	24	Develop an integrated waste management plan for Cleveland																									●	
Land use and clean water	25	Green Cleveland's codes to encourage sustainable development	●	●			●																●					
	26	Rightsize the City's infrastructure											●															
	27	Develop & implement an urban tree plan									●		●															
	28	Scale up the local food system																		●	●			●				
	29	Implement green infrastructure to capture storm water				●				●			●			●		●										
	30	Increase water conservation & efficiency										●					●							●	●			
Community engagement and public health	31	Promote businesses striving to meet energy & carbon goals																										●
	32	Recognize neighborhood capacity to take climate action														●											●	
	33	Build resiliency against the impacts of climate change		●		●		●		●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●		●

5. REFERENCES

Baule, W., E. Gibbons, L. Briley and D. Brown. (2014). "Synthesis of the Third National Climate Assessment for the Great Lakes Region." from http://glisa.umich.edu/media/files/Great_Lakes_NCA_Synthesis.pdf.

City of Cleveland Office of Sustainability. (2013). "Cleveland Climate Action Plan: Building Thriving and Healthy Neighborhoods." from http://www.sustainablecleveland.org/resources/climate-action-plan/.

Collaborative, C. U. D. (2008). "Re-imagining a more sustainable Cleveland." Kent State University, Cleveland.

U.S. Environmental Protection Agency. (2013). "Glossary of Climate Change Terms." from http://www.epa.gov/climatechange/glossary.html.

Winkler, J. A., J. A. Andresen, J. L. Hatfield, D. Bidwell and D. Brown (2014). Climate Change in the Midwest: A Synthesis Report for the National Climate Assessment. Washington, D.C., Island Press.

Appendix I:

Cleveland Climate Action Plan: Building Thriving and Healthy Neighborhoods

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Appendix J:

Re-Imagining a More Sustainable Cleveland: Citywide Strategies for Reuse of Vacant Land

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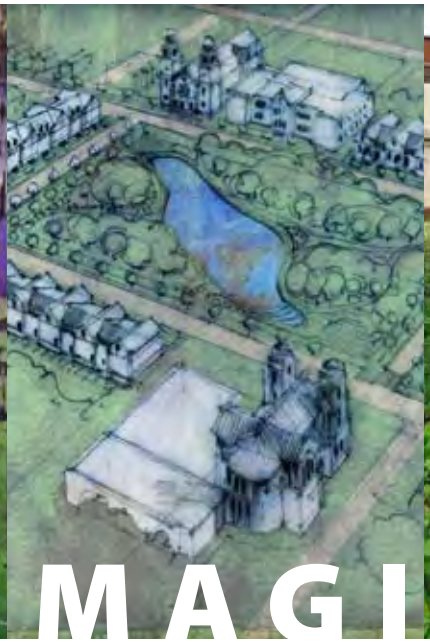


RE-IMAGINING

A MORE SUSTAINABLE CLEVELAND

RE-IMAGINING A MORE SUSTAINABLE CLEVELAND

Citywide Strategies for Reuse of Vacant Land

Adopted by the Cleveland City Planning Commission on December 19, 2008

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CONTENTS

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PURPOSE

Creating opportunities for all people, fair access to resources, commitment to healthy places for children, and using our ingenuity to capitalize on our assets are the values that are at the core of Re-imagining a More Sustainable Cleveland. This one year planning process explored strategies for reuse of vacant land with the goal of making Cleveland a cleaner, healthier, more beautiful, and economically sound city. The 30-member working group was convened by Neighborhood Progress in collaboration with the City of Cleveland and Kent State University's Cleveland Urban Design Collaborative with funding from the Surdna Foundation.

This report summarizes the goals, principles and strategies for returning vacant properties to productive use at the city-wide scale. It identifies policy changes that will enable the city to better make use of this growing resource. The report also includes a range of potential pilot projects meant to illustrate and test the principles, and to build capacity for the strategic management of vacant land throughout the city.

Going forward, the City of Cleveland has the opportunity to use its excess land in ways that:

- advance a larger, comprehensive sustainability strategy for the city,
- benefit low-income and underemployed residents,
- enhance the quality of neighborhood life
- create prosperity in the city
- and help address climate change.

With the support of community partners, the Surdna Foundation, and other funders, Neighborhood Progress, Inc. is committed to implementing pilot projects over the next several years and assisting the city and other partners in determining how to bring the most successful ones to scale.

FIG 1 **CLEVELAND POPULATION LOSS**[1]

Year	Population
1950	914,808
1990	505,616
2000	478,403
2007	438,042 (estimated)
2016	387, 039 (projected)

INTRODUCTION

Re-imagining a More Sustainable Cleveland starts from the premise that the loss of population over the last 60 years is not likely to be reversed in the near term and that Cleveland's future ability to attract and retain residents depends in large part on how the city adapts to population decline and changing land use patterns. The reuse of vacant land is crucial to Cleveland's potential to be a "green city on a blue lake."

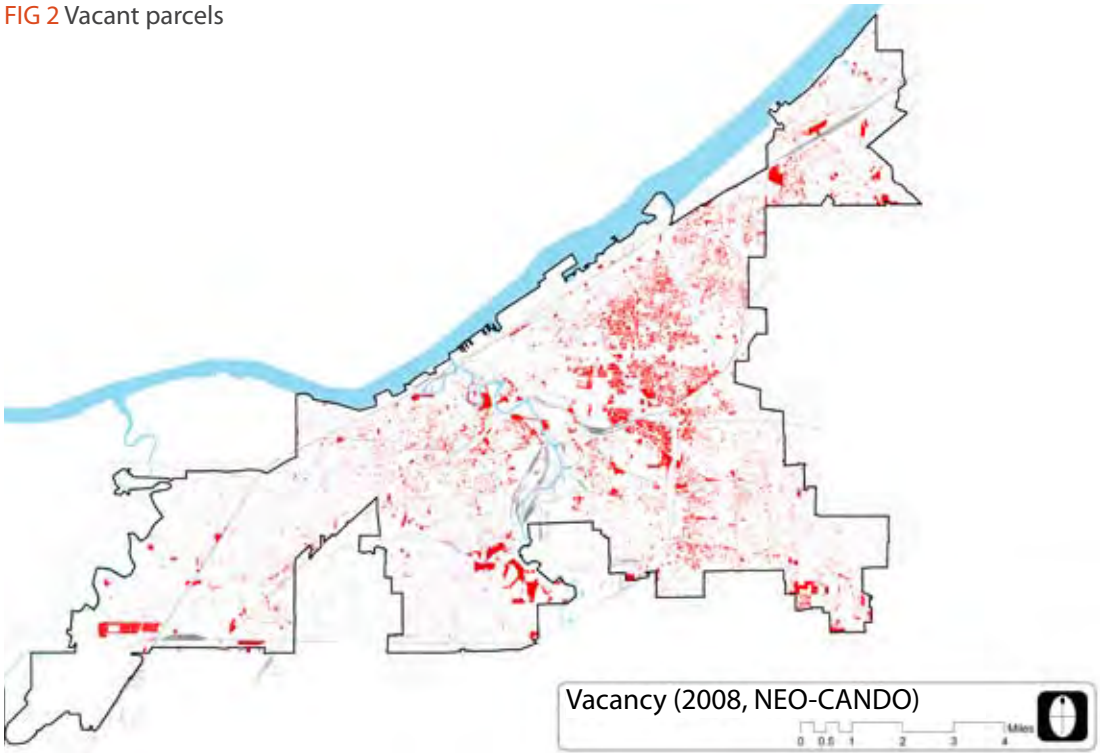
There are approximately 3,300 acres of vacant land within city limits, and an estimated 15,000 vacant buildings. Many of these vacant properties are poorly maintained and they diminish the value of the remaining, more viable buildings and neighborhoods in the city. The city demolishes about 1,000 vacant houses per year; private demolitions and fires are also reducing the number of derelict structures in the city. After demolition, surplus land becomes a raw asset for the city–a resource for future development as the city's population stabilizes and progress is made toward recovery. The *Re-imagining a More Sustainable Cleveland* working group was formed to explore ways to put this land to productive use. This includes short-term holding strategies to stabilize neighborhoods while we anticipate more permanent development solutions, and long-term reuse strategies for parts of the city where demand for traditional development is limited or non-existent.

The *Re-imagining a More Sustainable Cleveland* group included city staff, representatives from community development corporations, local non-profit organizations, the Cuyahoga County Planning Commission, the Northeast Ohio Regional Sewer District, and the Cleveland Metroparks. A complete list of participants is found in the Acknowledgements section.

The *Re-imagining a More Sustainable Cleveland* process was grounded in the principles of the Lake Erie Balanced Growth Initiative. This initiative encourages the establishment of priority development areas and priority conservation areas as a way of promoting smart growth while protecting Lake Erie and other natural resources in Northeast Ohio. Because of the growing supply of vacant land in Cleveland, the city is now in a position to make decisions about where development should occur and where land should be set aside and not developed.

1 The Northern Ohio Data and Information Service, February 2008.

FIG 2 Vacant parcels



The *Connecting Cleveland 2020 Citywide Plan* identifies Core Development Areas that concentrate development in catalytic locations along the lakefront and the river, Euclid Avenue and the opportunity corridor, and the downtown, airport, and University Circle [Figure 4]. These areas are, in effect, the priority development areas for the city of Cleveland. The *Re-imagining a More Sustainable Cleveland* process focuses on the parts of the city outside of the Core Development Areas, to identify ways to derive measurable benefits from vacant properties in these areas. These benefits include cleaner air and water, greater access to parks and recreation, improved local food security, and neighborhood-based economic development.

The lack of strong market demand and an abundance of vacant land create unprecedented opportunities to improve the city's green space network and natural systems. Capitalizing on this moment to set aside land for recreation, agriculture, green infrastructure, and other non-traditional land uses will benefit existing residents and help to attract new residents and development. By balancing current and future demands for new development with the conservation of key sites across the city, Cleveland can reinvent itself as a more productive, sustainable, and ecologically sound city.

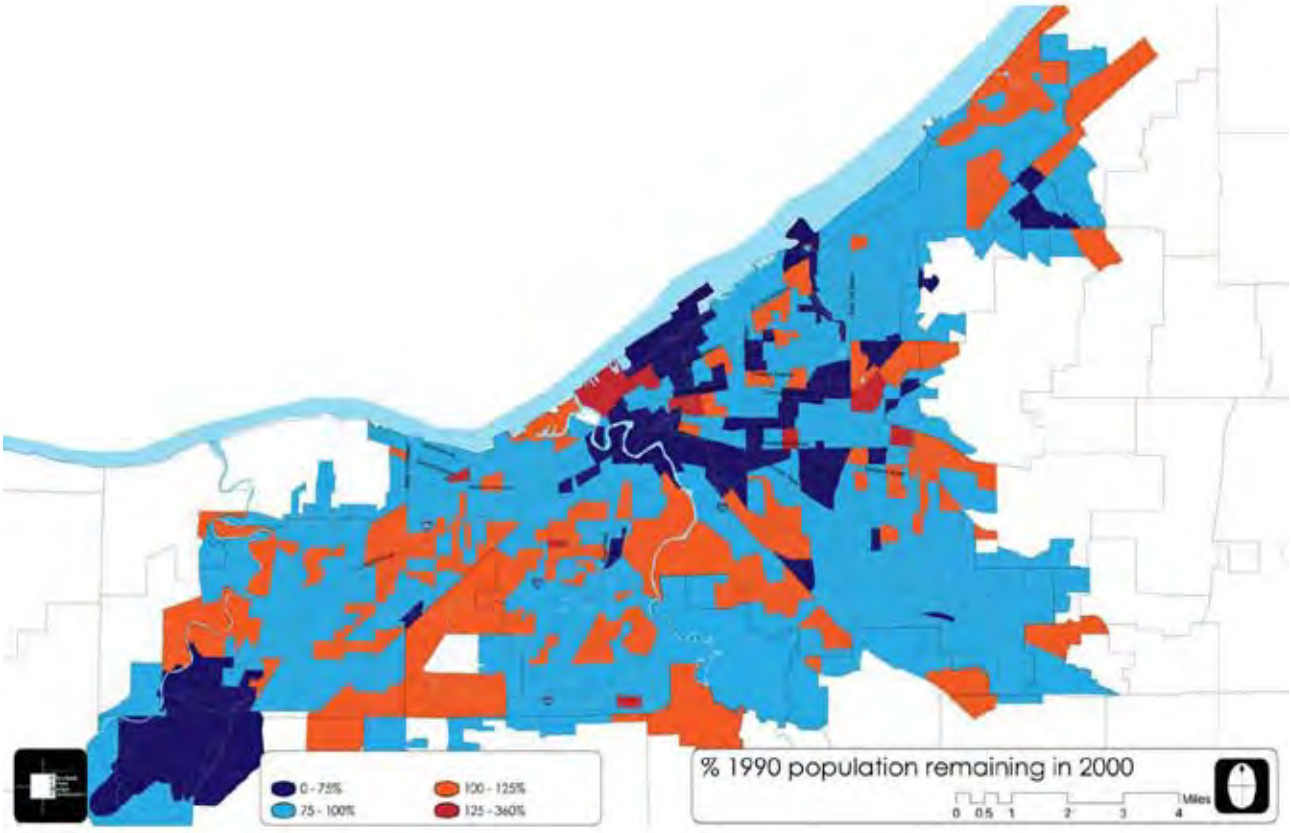


FIG 3 Population Change in Cleveland Neighborhoods

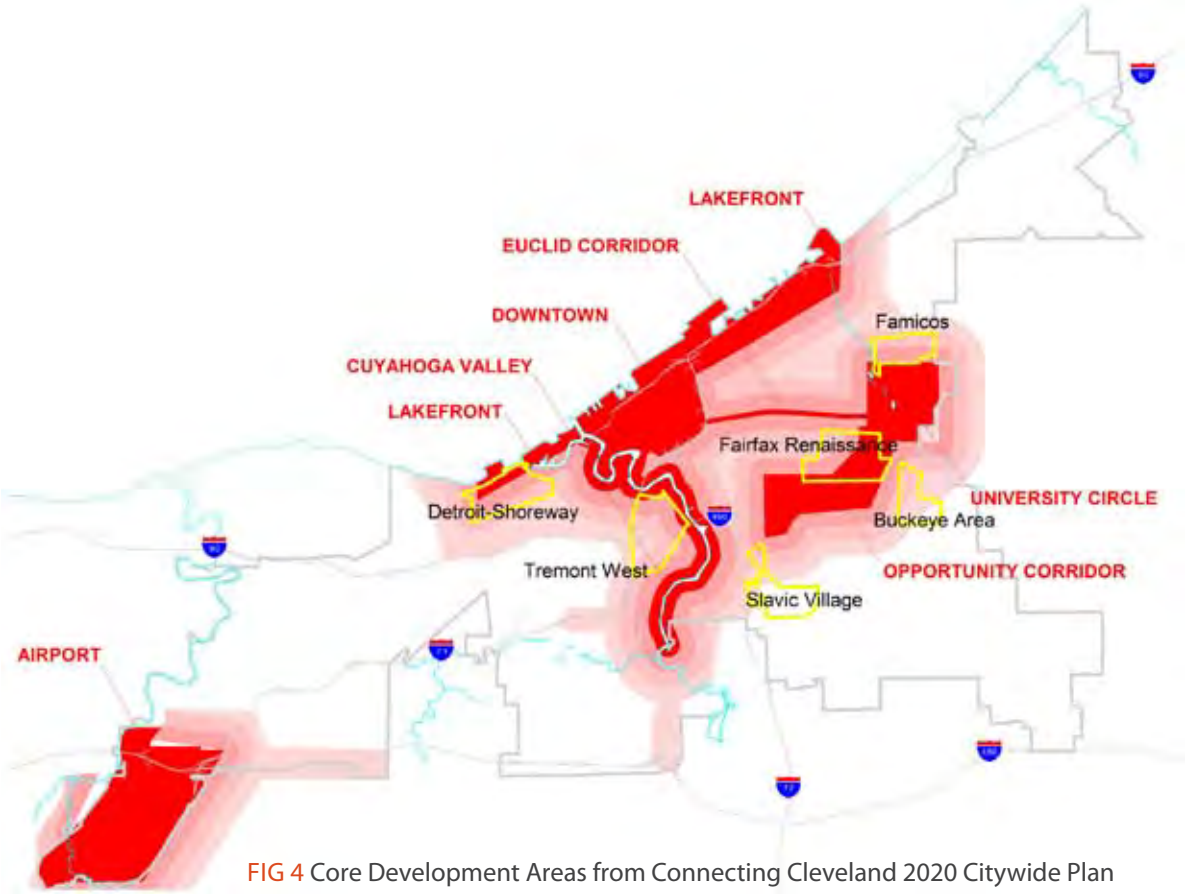


FIG 4 Core Development Areas from Connecting Cleveland 2020 Citywide Plan

EXECUTIVE SUMMARY

Given the large and growing inventory of vacant properties in the City of Cleveland, it is unlikely that all of the city's surplus land will be reused for conventional real estate development in the foreseeable future. The alternative land use strategies described in this document are intended to put vacant properties to productive use in ways that complement the city's long-term development objectives. Whatever the ultimate use of vacant properties in Cleveland will be, the following goals should be addressed:

PRODUCTIVE USE / PUBLIC BENEFIT Whether vacant properties are developed with buildings and infrastructure, preserved as open space, or put into productive use as agriculture or energy generation sites, they should provide an economic return, a community benefit, and/or an enhancement to natural ecosystems.

ECOSYSTEM FUNCTION Stormwater management, soil restoration, air quality, carbon sequestration, urban heat island effects, biodiversity, and wildlife habitat should be incorporated into future plans for vacant sites in the city.

REMEDIATION Remove the risk to human health and the environment from environmental pollutants at vacant sites, either with targeted remediation projects or with long-term incremental strategies.

This plan identifies a range of vacant land strategies including:

1. Neighborhood stabilization and holding strategies
2. Green infrastructure strategies to expand recreation opportunities and the green space network, improve ecosystem function and remediate contaminated properties
3. Productive landscapes (i.e. agriculture and energy generation)

The plan identifies criteria for implementing each of these strategies, as well as policy recommendations to support and promote the creative re-use of vacant properties throughout the city. The plan also describes a series of initial pilot projects and proposed research initiatives in support of a comprehensive citywide initiative to manage and reuse properties.

GOALS and STRATEGIES for VACANT LAND RE-USE

The goals of the *Re-imagining a More Sustainable Cleveland* process were to:

- Identify ways to derive quantifiable benefits from the city's growing inventory of vacant property;
- Promote opportunities for the strategic reuse of vacant sites that support redevelopment efforts in the City of Cleveland;
- Link natural and built systems within the city in ways that improve the quality of life and the long-term health of residents and the environment; and
- Increase community self-reliance for food and energy production

To achieve these goals, the working group explored a variety of strategies for using and managing vacant properties, including:

1. Neighborhood stabilization and holding strategies in prime development areas and transitional neighborhoods;
2. Green infrastructure strategies, including the expansion of parks and natural areas, and linkages between green space amenities within the city and region, ecosystem restoration to manage stormwater, reduce urban heat island effects, and enhance biodiversity, and remediation for contaminated sites; and
3. Productive landscapes as an economic development strategy;

NEIGHBORHOOD STABILIZATION and HOLDING STRATEGIES can be used to manage vacant and abandoned properties and establish a sense of stewardship and care in transitional neighborhoods. These strategies are intentionally low-cost and low maintenance. They are most effective in areas where development is likely in the near-term.

Neighborhood blocks with many unmanaged vacant lots result in lower residential property values. A study of property values in Philadelphia determined that derelict vacant sites caused a reduction in property values for surrounding houses of about 18%, while the clean-up and landscaping of vacant lots can increase adjacent property values by as much as 30%.[1]

Criteria for implementing holding strategies on vacant sites include:

- Site has strong development potential within the next five years.
- Property owner or community partner has the capacity to install and maintain landscape intervention.

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1 Susan Wachter, "The Determinants of Neighborhood Transformation in Philadelphia: Identification and Analysis—The New Kensington Pilot Study," Wharton School, University of Pennsylvania, the William Penn Foundation, and the Pennsylvania Horticultural Society, 2005.

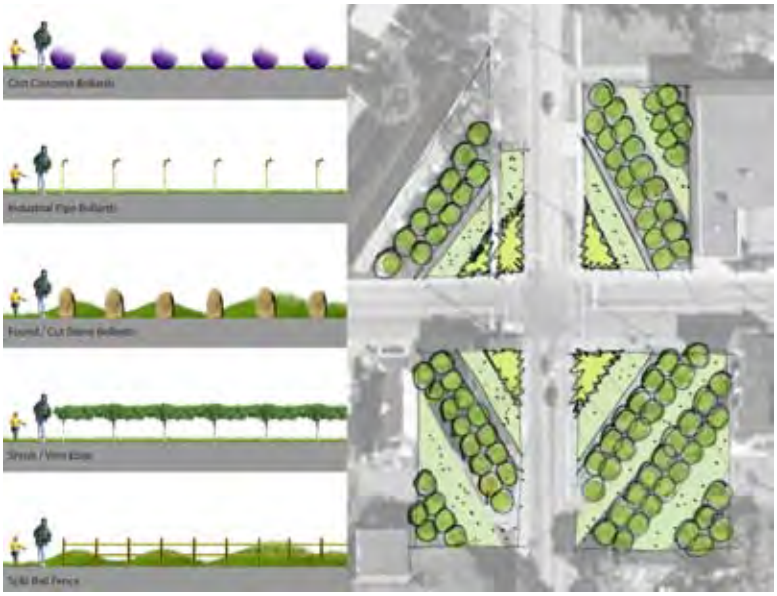


FIG 5 Trees and bollards on vacant sites enhance perceptions of maintenance and deter illegal dumping

FIG 6 Low-mow native plant materials create a patterned landscape as a holding strategy

In some neighborhoods where single vacant lots are scattered throughout residential blocks, lot consolidation and side yard expansion can be an effective way to achieve neighborhood stabilization. By encouraging existing property owners to take title to adjacent lots and become responsible for their maintenance, derelict sites are eliminated and these properties are returned to the city's tax rolls.

A variety of neighborhood stabilization and holding strategies are detailed in the *Vacant Land Pattern Book* produced by the Cleveland Urban Design Collaborative for Neighborhood Progress, Inc. These strategies include low-mow native landscapes that can be installed over large areas at a relatively low cost. Once established, low-mow landscapes require relatively little maintenance but reinforce a perception that vacant sites are being cared for. Trees can also be used as a holding strategy for vacant sites where development is anticipated. Rows of trees planted at distinct angles create a landscape that looks intentional, rather than neglected. These trees can be transplanted at the street edge when development occurs.

GREEN INFRASTRUCTURE

Green infrastructure is an interconnected network of open spaces that provides recreation resources, stormwater management, ecological benefits, and opportunities to remediate environmental toxins. Green infrastructure strategies for vacant sites in Cleveland are described below and include the expansion of the city's green space network, restoration of the city's ecosystems, and the remediation of contaminated sites.

GREEN SPACE NETWORK An abundance of vacant land and limited market demand provide opportunities throughout the city to create and enhance parks and green spaces. At the city-wide scale, vacant land can be assembled to create an integrated green space network that defines the city's physical form, preserves ecologically significant land, and makes key connections to green spaces and recreation opportunities elsewhere in the region. As vacant sites become available in the city's land bank, an assessment can be made as to whether the land is most suitable for development or whether it can best contribute to the overall green space network. Staff at the Cleveland Planning Commission have prepared a flow chart (Figure 7) to aid in making these decisions about the disposition of landbank lots. The flow chart establishes criteria to determine which sites should be preserved for a public purpose and which can be reallocated to private owners. The flowchart further distinguishes between short-term holding strategies for sites that have strong development potential, and long-term or permanent strategies for sites where development is less likely. Official adoption of this decision-making framework is the first step toward implementing a city-wide vacant land strategy.

The *Connecting Cleveland 2020 Citywide Plan* identifies locations for additional recreation and green space amenities throughout the city. The *Cuyahoga County GreenPrint* delineates a broader green space network for sites in the city and the region. These two plans are shown together in Figure 8 and they constitute a potential conservation zone for Cleveland. In the conservation zone, vacant land would be used for parks, recreation, reforestation, stormwater management, wildlife habitat, etc. Development would also be welcome in the conservation zone, but conservation easements and low-impact development strategies could be encouraged to maintain public access and protect sensitive natural resources.

Criteria for determining whether vacant land should become part of the city's parks and green space network include:

- Site is adjacent to or near an existing Cleveland Metroparks property or City of Cleveland park.
- Site is within an area designated as future green space in the 2020 Cleveland Citywide Plan and/or part of a greenway connection.
- Site contains a remaining forest stand that can provide a linkage to other areas and maintain/improve habitat migration patterns or the potential for natural habitat.
- Community partner has the capacity to install and maintain a public green space on the site.
- Neighborhood has insufficient amount of existing green space.

FIG 7 Land bank decision-making flow chart
(Cleveland City Planning Commission)

SHOULD THE SITE BE PRESERVED?

Does the site have characteristics that recommend it for a long-term green use?

decision factors

1. Culverted stream
2. Other riparian zone
3. Lack of nearby parks
4. Proximity to parks (existing or planned)
5. Land use in Citywide Plan
6. Connections to trails (existing or planned)
7. Scale

preservation strategy

yes enumerate unique characteristics
What treatment types are available for the site?

menu of treatments

1. energy generation: solar field
2. geothermal wells
3. energy generation: wind turbines
4. energy generation: ethanol production
5. clean fill cap (landfill sites)
6. storm water management: bio-retention
7. constructed wetland
8. riparian setbacks
9. green space: parks
10. green space: forest
11. green space: linkages
12. wildlife habitat
13. urban agriculture/commodity farming
14. tree nursury
15. bio-remediation, phyto-remediation, mycoremediation
16. storm water mangament: riparian setbacks, stream daylighting

choose a treatment

City, CDCs and other stakeholders conduct a qualitative review.
Make recommendations for implementing preservation strategy.

holding strategy

no

The new objective should be to return the vacant lot to a use that is consistent with the city's overall goals as articulated in the Citywide Plan.

What is the site's development potential?

[decision factors]

1. market typology
2. NPI Strategic Investment Areas
3. land bank hold areas
4. foreclosures
5. targeted demolition
6. proximity to schools and public buildings
7. proximity to core development areas
8. Who owns the property?
9. Is the land clean?
10. Has a plan been developed for the lot?
11. Has funding been commited to the project

strong development potential
(0 - 5 years)

menu of treatments

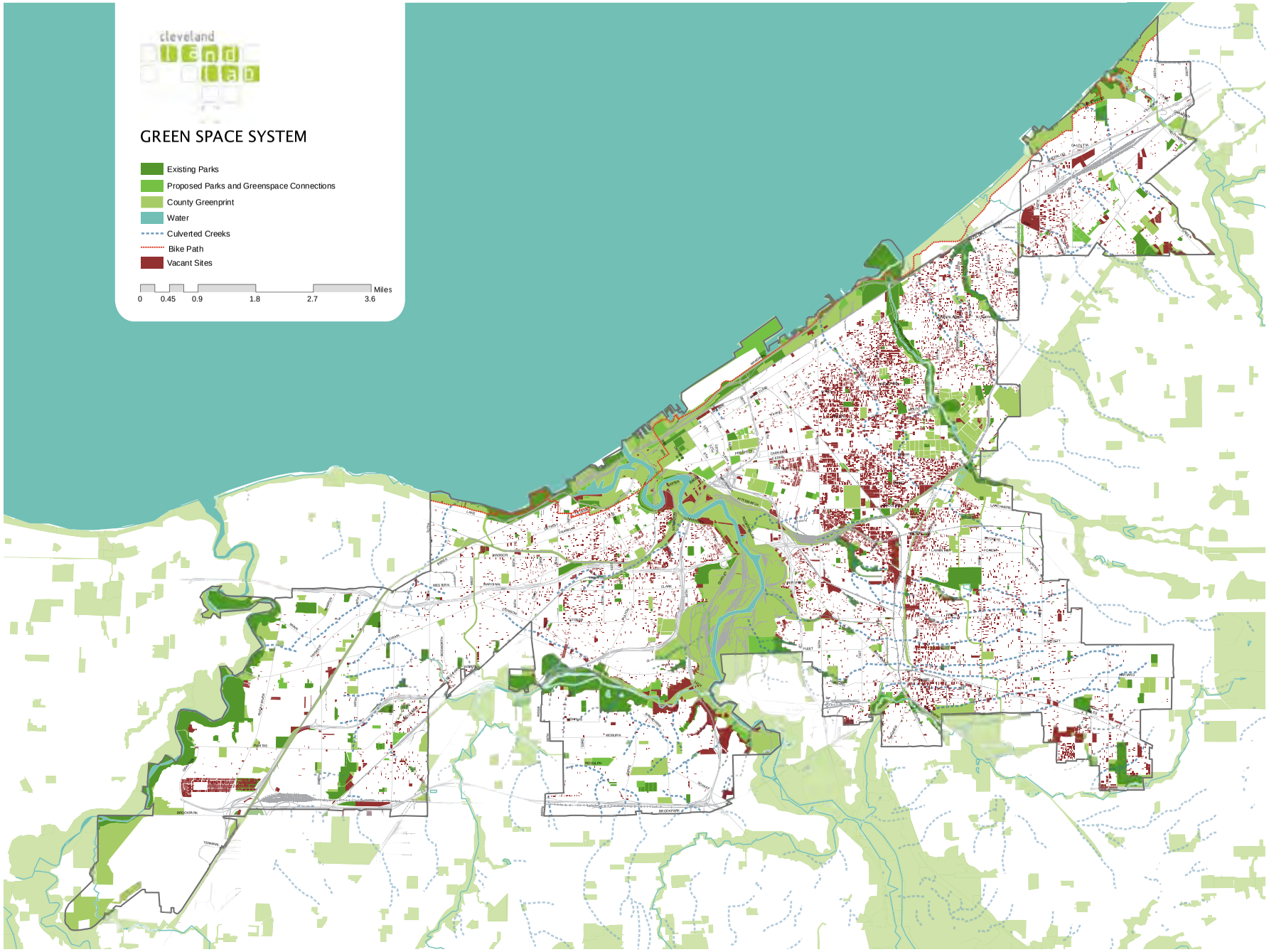
1. bio-remediation
2. landscape buffer
3. basic greening techniques

weak development potential
(5+ years)

menu of treatments

1. community garden
2. bio-remediation, phyto-remediation, myco-remediation
3. constructed wetland
4. deep tillage/pavement removal
5. basic greening techniques
6. solar field
7. urban agriculture/commodity farming
8. storm water management: riparian setbacks, stream daylighting

FIG 8 Green space system and existing vacant land



ECOSYSTEM RESTORATION/STORMWATER RETENTION Vacant land can be used to improve air and water quality, restore urban soils, increase biodiversity, and provide wildlife habitat. Urban development patterns tend to undermine local and regional ecosystems and limit the ability of nature to provide valuable services such as flood protection, air purification, climate regulation, erosion control, and biological habitat. But even in highly developed urban places like Cleveland, the functions of healthy ecosystems can be imitated and natural processes can be harnessed to provide quantifiable environmental benefits. [1]

Vacant land within the city can be used to recreate the functions of healthy ecosystems, so that natural processes are harnessed for environmental benefits. Ecosystem restoration can provide tangible benefits for the city. Water can be managed on vacant sites to imitate natural water cycling, vegetation can be introduced strategically to cool the air and filter water, and soils can be restored to support healthy vegetation and filter pollutants. For example, if trees were planted on vacant lots throughout the city, this could reduce the amount of stormwater runoff to be managed, since trees intercept rainwater and preventing it from entering the city's storm sewers. If done properly, this would reduce infrastructure costs and improve water quality.

Healthy ecosystems also contribute to the well-being of city residents. Studies show that access to nature—both the passive enjoyment of natural areas and active outdoor recreation—provide benefits such as better mental and emotional health, reduced stress, higher mental function and productivity, community cohesion and resilience, and increased safety. [2] Vacant land in Cleveland offers opportunities to integrate natural processes and human activity through the restoration of the city's ecosystems.

Soil and vegetation

Soil can take thousands of years to form but urban development often degrades soils so that they erode or are compacted. Soil ecosystems can be repaired gradually through targeted vacant land strategies.

Compaction is caused by buildings, construction equipment, and vehicular and foot traffic. Compaction damages soil structure and reduces infiltration rates, which increases runoff volume and flooding. Compaction also reduces spaces between soil particles for oxygen and water, making it difficult for vegetation to grow. Deep tillage and compost trenches can be used to reduce soil compaction on vacant sites, preparing them to support larger vegetation, accommodate agricultural uses, and increase stormwater infiltration.

Soil types and conditions vary across the city. An understanding of soil typologies should guide land use decision-making and strategies for vacant land reuse. *Hydric soils* are wetland soils; these soils developed under wet conditions and have the properties necessary to support wetland (hydrophytic) vegetation. Areas of the city with hydric soils are few, but if vacant land becomes available in these areas, they are ideal locations for constructing engineered wetlands.

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1 The Sustainable Sites Initiative, *Standards and Guidelines: Preliminary Report*. November 1, 2007.

2 Tzoulas, K., Korpela, K., Venn, S. et al., "Promoting Ecosystem and Human Health in Urban Areas Using Green Infrastructure: A Literature Review," *Landscape and Urban Planning* 81: 167-78 (2007), cited in The Sustainable Sites Initiative, *Standards and Guidelines: Preliminary Report*. November 1, 2007.

Soils are also classified by their ability to infiltrate water. Hydrologic soil types A and B offer the greatest potential for infiltration. Soil types C and D are heavier, clay soils. There are few areas in the city with A soils, but extensive areas with B soils (see Figure 9). Vacant areas with A and B soils are the most effective locations for implementing natural stormwater management practices such as bioswales and rain gardens. Soil compaction often reduces the infiltration capacity of A and B soils in urban settings, but this capacity can be restored as described above.

Vegetative cover improves soil structure and reduces sedimentation and erosion on vacant sites. Vegetation also provides wildlife habitat and increased biodiversity in urban settings. Vegetation provides shade and evapotranspiration to cool buildings and reduce energy costs. Vegetation also increases natural capacity for stormwater management and can filter pollutants from air and water. Vegetation, particularly in the form of a mature tree canopy, contributes to human health and well-being and has a measurable impact on residential property values.

Cleveland's patterns of urbanization have resulted in a significant loss of vegetation, as seen in Figure 10. Vacant land can be used to re-establish the city's tree canopy and other native vegetation (Figure 11). Design standards for new development on vacant sites can include requirements for re-establishing vegetation. And sites that have limited development potential can be used to re-establish the city's tree canopy. However, it is difficult to grow trees on compromised urban soils. Vacant land management should focus first on restoring soil structure through the planting of groundcovers and native low-mow grasses. As these plant materials become established, landscape strategies can mimic patterns of natural succession. Ground covers and low-mow grasses are a low-maintenance approach to managing short-term vacancy. Long-term vacancy can be used to recreate healthy soil ecosystems that will support trees and other larger vegetation on a permanent basis.

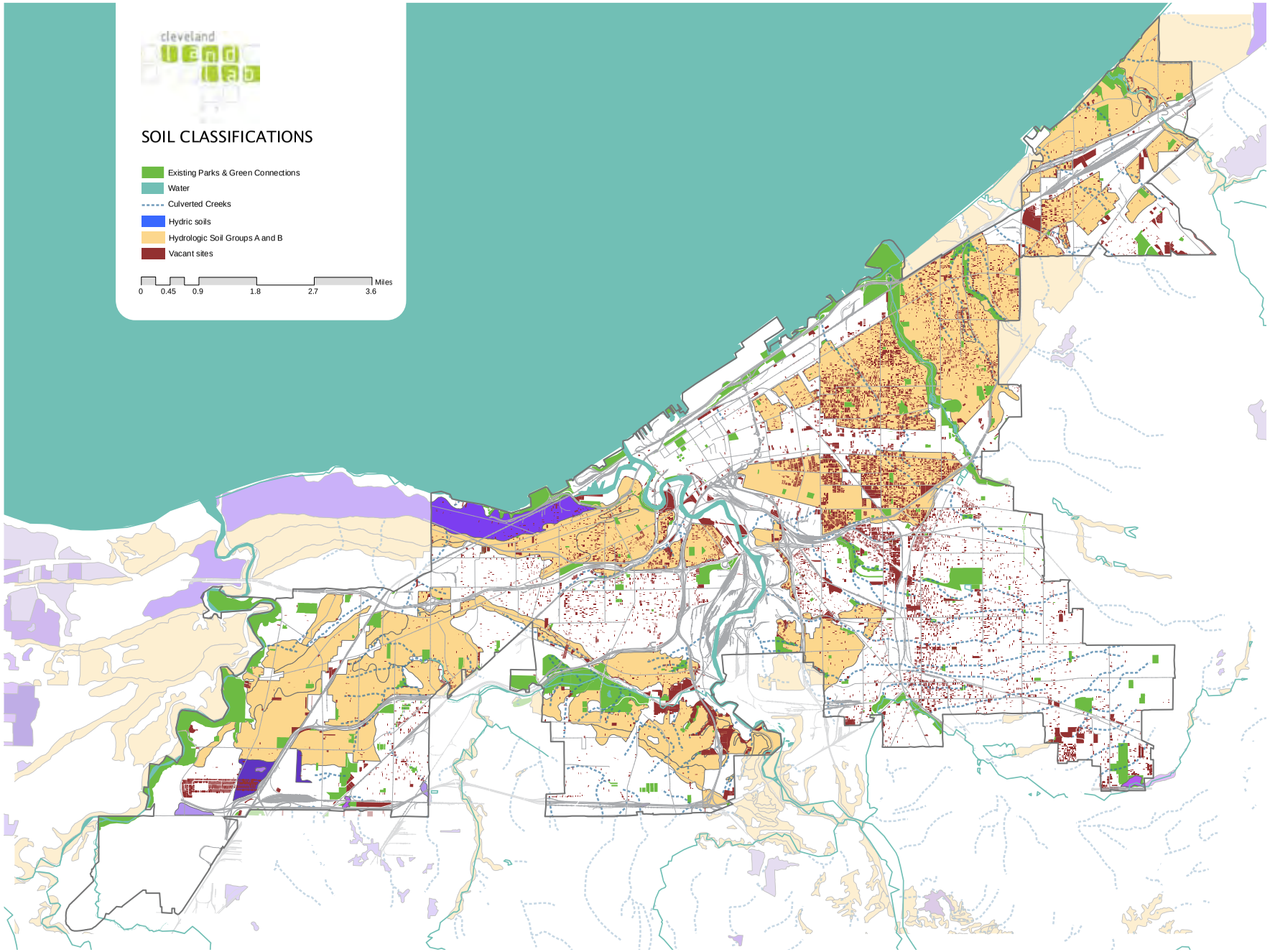
Water

Prior to urban settlement, the land in Cleveland was able to absorb much of the rain as it fell. Stormwater was absorbed and transpired by vegetation, or it slowly moved across the land and soaked into the soil. As the city grew, the percentage of impervious surfaces such as streets, sidewalks, and roofs within city limits increased dramatically. Today, much of the city's land consists of impervious surfaces. (Figure 12) This prevents the natural absorption of stormwater and results in increased runoff and compromised water quality.

As vacancy increases within the city, opportunities emerge to restore water balance by reducing impervious surfaces and restoring (or mimicking) natural hydrologic functions. The following criteria can be used to determine whether a vacant site can be used for stormwater management:

- Site is in a flood plain, an established riparian setback, or other flood-prone area and should not be developed.
- Site is identified in the Northeast Ohio Regional Sewer District's *Regional Intercommunity Drainage Evaluation* (RIDE) study as a problem area and should not be developed.
- Site is within an identified riparian area and can either be restored/conserved as open space or developed using conservation development practices.
- Site is within a headwaters area and can either be re-vegetated as open space or developed using conservation development practices.

FIG 9 Hydrologic Soil Groups



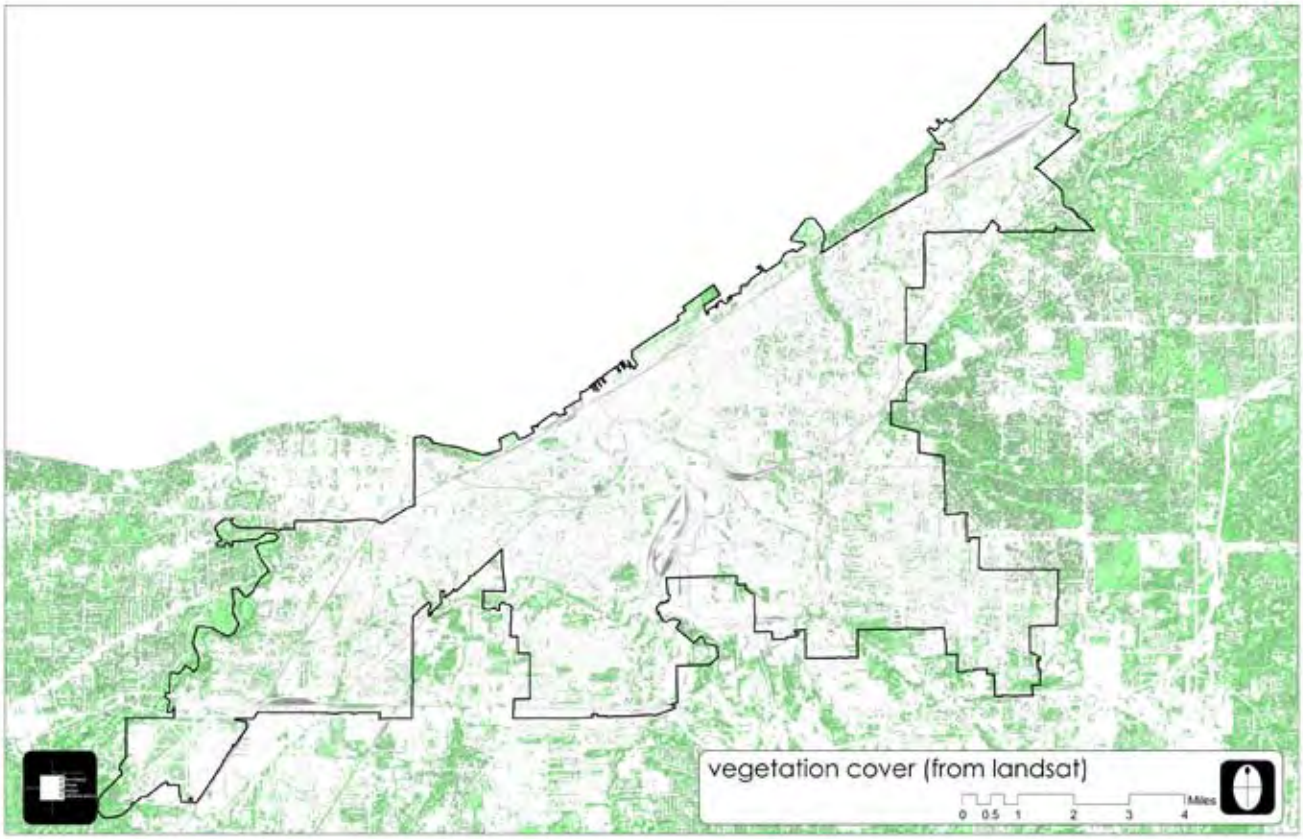


FIG 10 The tree canopy is sparse within the City of Cleveland

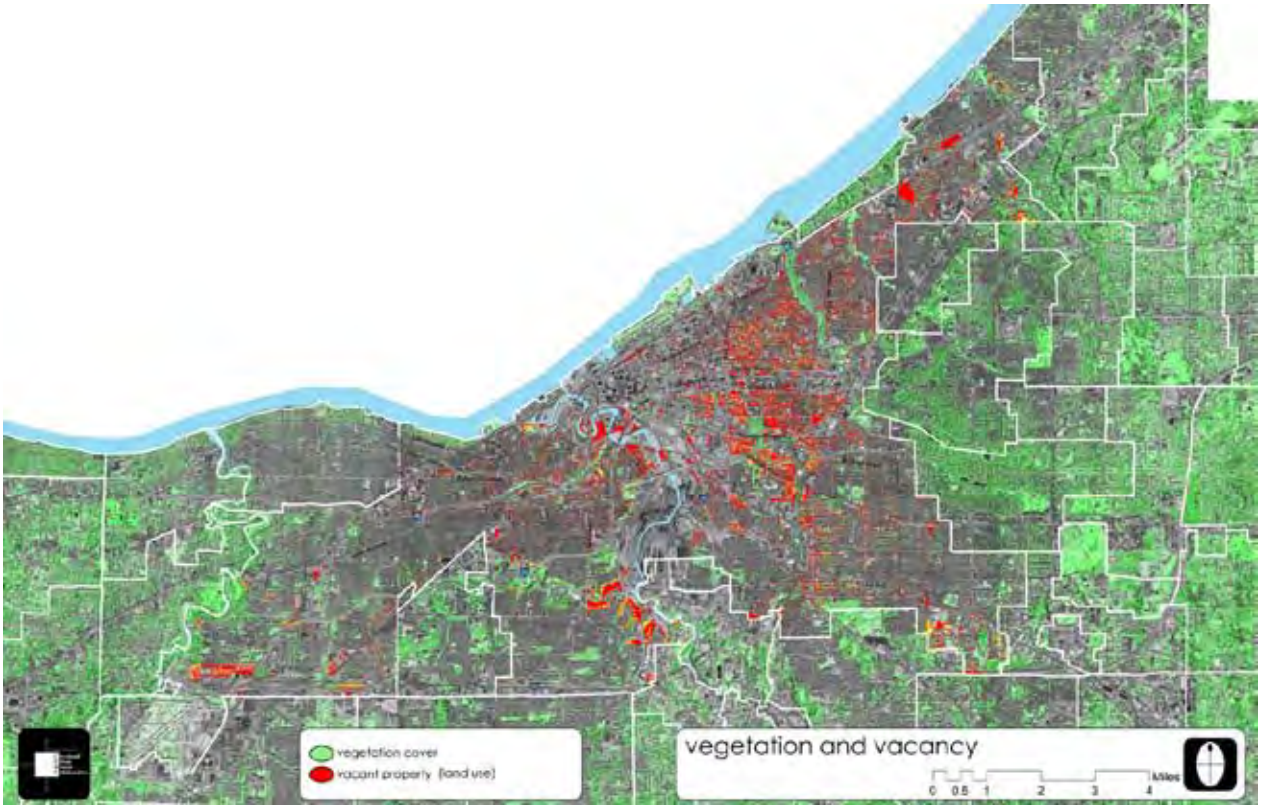


FIG 11 Vacant sites offer the potential to replenish vegetation and reestablish the tree canopy

- Site is identified in the Cuyahoga Soil and Water Conservation District's general wetland inventory of the County.
- Site can provide a linkage to other areas and maintain/improve habitat migration patterns and fish and aquatic habitats.

A more detailed and site-specific evaluation is needed to determine if vacant sites can be used to improve conditions in the following ecosystems:

Riparian Systems A riparian system is located along streams and rivers that occasionally flood and create unique ecosystems of soils, plant, and animals. In Cleveland, as in most urban areas, this system has been altered and it is not a healthy-functioning ecosystem. In many areas, streams have been culverted or completely buried and function primarily for water conveyance with marginal ecosystem value-function (See Figure 13). Vacant land can be used to establish or recreate heathy riparian systems within urban conditions. Riparian and headwaters areas for Cleveland are shown in Figure 14.

Recommended actions:

Streams: Identify opportunities to daylight buried streams, enhance existing streams, or recreate streams and their associated floodplains. Locate at existing or establish new pattern where appropriate. Ensure that system is connected and provides necessary hydrologic function (quantity and quality) to drainage area.

Riparian Corridors: Establish corridor limits using ecological principles (floodplains, soils, wetlands, slopes, and riparian vegetation). Create planning and design framework that allows either conservation or development projects within corridor.

Riparian Setbacks: Create regulations to establish minimal areas for ecosystem preservation. Determine appropriate method to define terms (setback distance, hydrologic functions, and environmental classifications) and means to administer regulations. Provide information to all stakeholders.

Conservation Design Strategies: Develop conservation guidelines integrating ecological principles into planning and design projects. Create document with goals/objectives and techniques, with monitoring/evaluation protocol.

Headwaters Systems A headwater system is located in the upper portions of a watershed and is where the drainage (surface and subsurface) patterns and processes begin for the watershed. Headwaters areas are critical for the efficient management of stormwater. Vacant land can be used to establish water quantity/quality objectives and initiate these strategies in the headwaters area. Headwaters and riparian areas for Cleveland are shown in Figure 14.

Recommended actions:

Low Impact Design-Stormwater Strategies: Establish objectives and techniques for low/minimal impacts to natural hydrologic system and existing site functions. Integrate strategies into planning and design process.

Wetland Systems: Map and document wetland criteria (hydric soils, hydrophytic vegetation, and water regime) and drainage patterns. Field verify wetlands and drainage patterns at site or local watershed level. Enhance existing lower quality, preserve existing higher quality, or create new wetland systems with appropriate vegetated buffers. Establish site design guidelines for development or conservation opportunities.

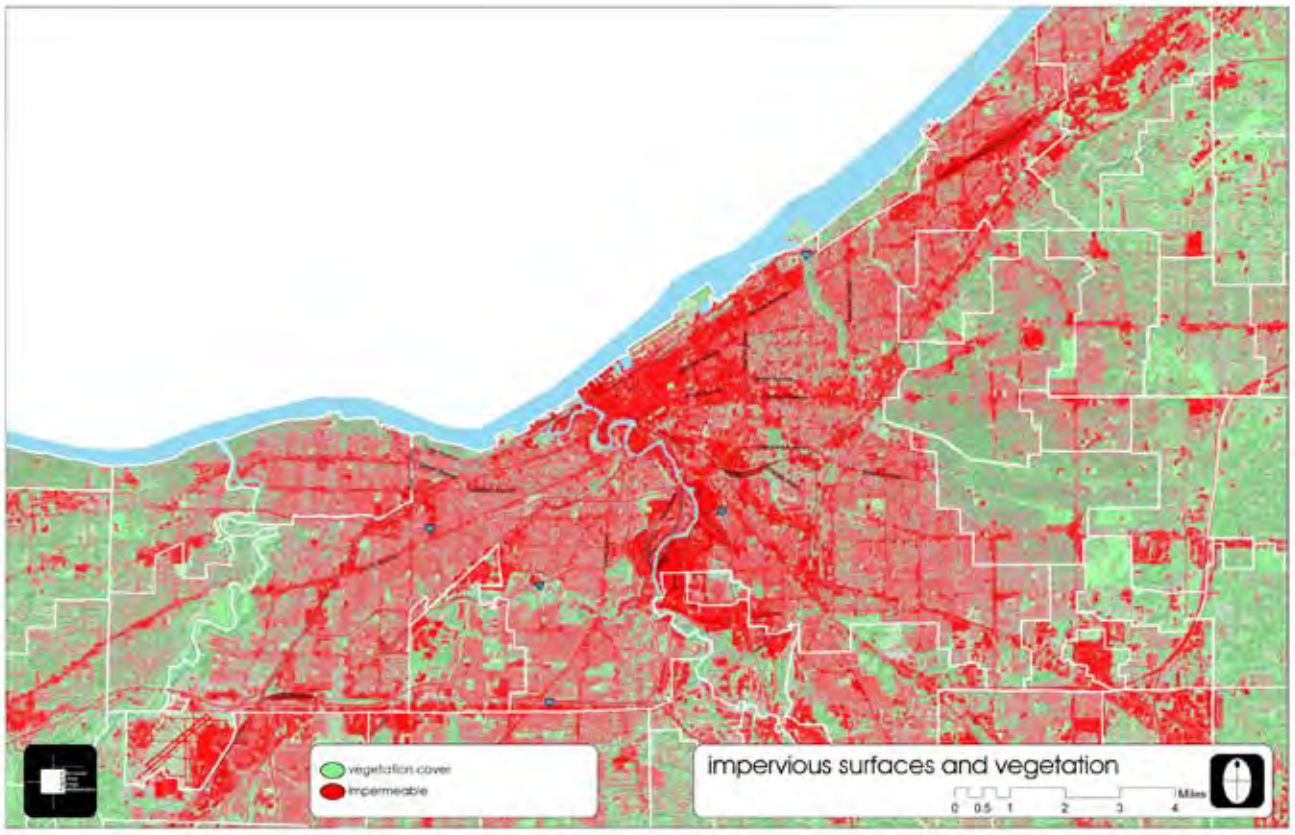


FIG 12 Impervious surfaces cover much of the land in the Cleveland.

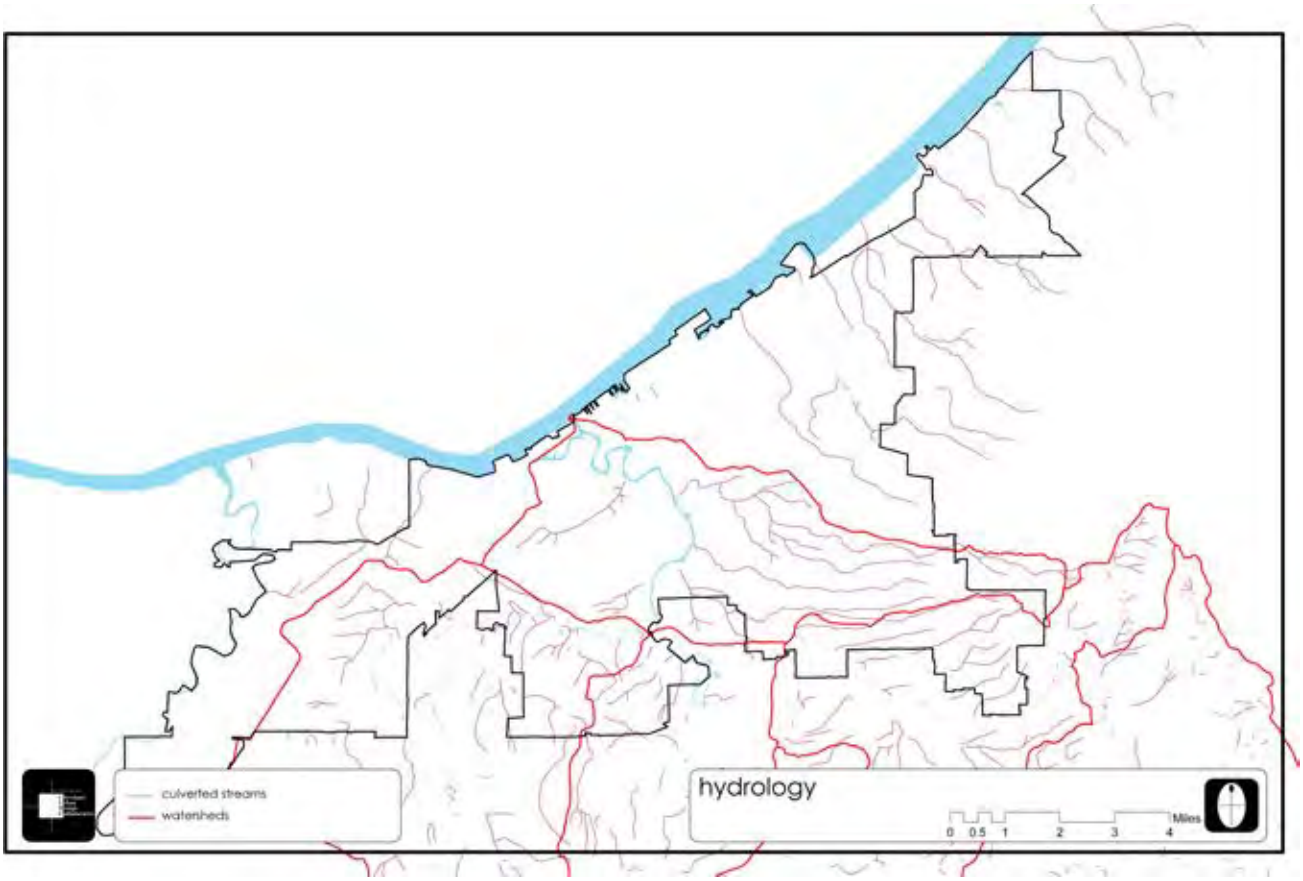


FIG 13 Creeks and streams throughout the city were culverted or buried to accommodate development.

FIG 14 Riparian and Headwaters System

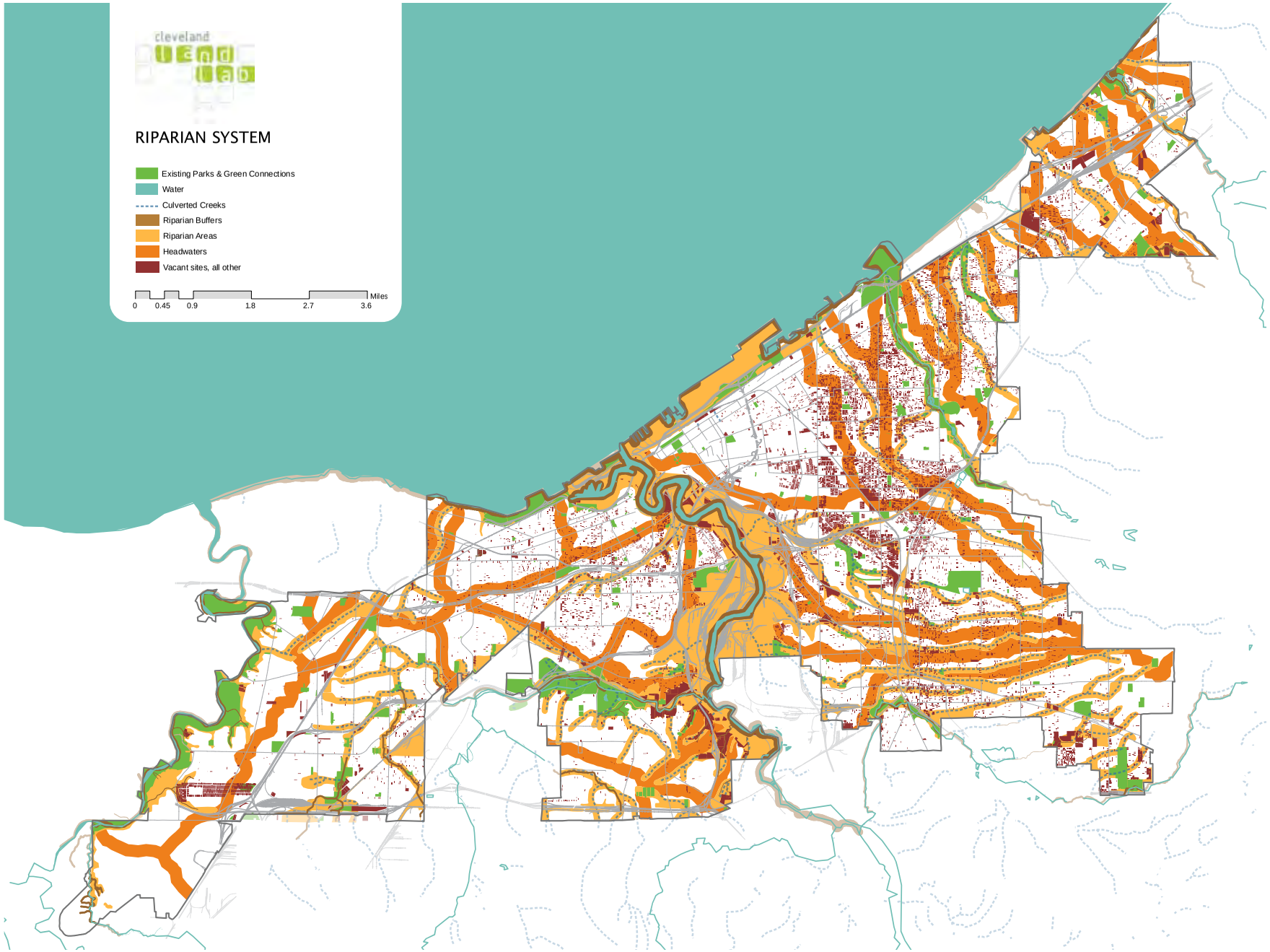


FIG 15 Low Impact Design for headwaters areas: bioretention swales

FIG 16 Swale for surface water conveyance. *Seattle Public Utilities drainage system project*

FIG 17 Rain garden for bioretention in residential areas.

Soil Systems: Map and document soil properties (HSG, water table, bedrock depth, permeability, moisture content, Ph, erosion, organic matter, and slope) from secondary sources. Field verify soil characteristics at site or neighborhood level. Establish preservation area boundaries and techniques.

Upland Vegetation Systems: Establish vegetation criteria (area, type, location, and quality), map/document relevant vegetated systems. Create guidelines for preservation, enhancement, or restoration of appropriate (native and naturalized) systems.

Engineered Naturalized Systems - Development Areas/Opportunity Sites Future development should be ecologically integrated into existing ecological systems, where this can be accomplished without excessive time or cost. The goal is to allow development as needed by the private market and incorporate ecological design principles as appropriate.

Recommended actions:

Low Impact Design – Stormwater Strategies: Establish objectives and techniques for low/minimal impacts to natural hydrologic system and existing site functions. Integrate strategies into planning and design process.

Engineered Ecosystems (streams, wetlands, riparian, upland, and managed turf systems): Establish ecosystem goals and criteria (area, type, and location) for application. Create guidelines for implementation of appropriate (native and naturalized) systems.

Hybrid Naturalized Systems–All Other Areas There will be areas within the City that are not initially designated for conservation or development. These areas can be used or altered over time as needed by local stakeholders. The important consideration should be that the changes benefit the local stakeholders and that there is a balance with conservation-development issues. These areas can be allowed to change as needed, with the application of standards and requirements in relation to the type and scale of the project.

Recommended actions:

Parcel(s) Level Hybrid Ecosystem (bioretention areas, rain gardens, upland meadows/prairie, naturalized woodlots, constructed wetlands, phytoremediation areas, low maintenance areas, and successional landscape management strategies): Establish ecosystem goals and criteria (area, type, function, and maintenance procedures) for application. Create guidelines for implementation of appropriate naturalized systems and provide evaluation standards.

FIG 18-19 Design concepts for vacant land in headwaters areas

Ecological Services

All landscapes provide ecological services (habitat, food production, air filtering, stormwater control, erosion control, and microclimate modulation). A natural or naturalized landscape can provide better and more efficient ecological services than a landscape dominated by impervious surfaces, turf, and minimal trees/shrubs. A general guideline should be to mimic natural landscape functions to the greatest extent possible, and that any additional vegetation and the more complex the ecosystem within a landscape – the more enhanced and beneficial the ecological services. To establish the planning and design framework of ecological services, six watershed scenarios were studied to determine the existing landscape functions and the potential benefits of vegetation strategies for ecosystem restoration on vacant sites. The study areas are not the only areas of the city where ecosystem restoration can occur; rather they represent a variety of urban conditions where different ecological benefits can be derived through vacant land management. Three of six study areas are included in this document.

The following land-cover descriptions were used in the watershed study areas:

- *Impervious Surfaces* Building, roads, roofs, parking areas, sidewalks, hardscape
- *Open Space – Scattered Trees (50-75% turf understory)* Active recreation parks, vacant lots (newly vacant-minimal trees), cemeteries (mostly turf)
- *Trees – Forest (native or naturalized shrub/groundcover understory)* Woods, wetlands, riparian areas
- *Trees – Grass/Turf* Passive recreation parks, cemeteries (mostly trees), wooded rear yards, wooded buffer areas, vacant lots (older vacant sites with trees, shrubs, grass)
- *Residential – Urban/Suburban (average .25 acre lot size)*

The following ecological services were modeled in each of the six study areas:

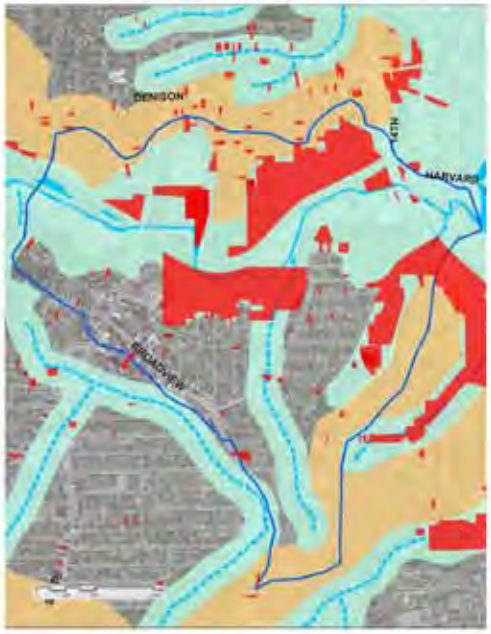
- Air Pollution Removal (carbon monoxide, ozone, nitrogen dioxide, particulate matter, sulfur dioxide)
- Carbon Storage and Sequestration
- Stormwater Control

Watershed Scenarios

St.Clair+E.105 (Figure 20)
Aggressive vegetation changes with all land-cover types. There is a variety of vacancy within the watershed so the intention is to equally apply land-cover changes in the watershed. Increase vegetation areas in all available land-covers with concentrations on vacant parcels. All of the vacant parcels were modeled for increased vegetation/re-vegetation and allowed for successional landscape changes. Predicted outcome: moderate to high increase to all ecological services in all land-cover areas.

Broadview+Harvard (Figure 21)
Vegetation changes in all land-cover types within the watershed with targeted concentrations to the existing impervious surfaces and residential areas. There are large existing vegetated vacant areas that will not be developed because of slope and soil conditions. These areas already provide ecological services so the intention was to increase these services in other land-cover areas. Predicted outcome: moderate increase to ecological services (major increase to stormwater services) in selected land-cover areas.

Harvard+Miles (Figure 22)
Vegetation changes with selected land-cover types because of smaller number and size of vacant lots available in watershed. The existing vacant lots relate more with the urban patterns than with ecosystem patterns, therefore land-cover changes dealing with vegetation will have to be designed to fit within the existing urban patterns in order to provide adequate ecological services. Predicted outcome: minor to moderate minor increases in ecological services (minor increase to stormwater services) in selected land-cover areas.



Watershed Study – Broadview+Harvard

Watershed Characteristics:

- Lower Big Creek Watershed with existing stream and culverted tributary
- Approximately 570 acres
- Majority of watershed is residential with commercial and industrial corridors of impervious surfaces
- Many areas of naturalized areas and public open spaces
- Majority of vacancy is industrial with environmental concerns and vegetated steep slopes
- Large areas of vacancy with a minimal scattered small lots

Watershed Analysis:

Current Land Cover Types

Impervious surfaces	143.3 acres (25.2 %)
Residential – medium density	233.2 acres (41.0 %)
Grass/scattered trees	26.7 acres (4.7 %)
Meadow/shrub	30.1 acres (5.3 %)
Trees/natural understory	135.6 acres (23.8 %)
Total Tree/Vegetation Canopy	135.6 acres (23.8 %)

Current Green Infrastructure Functions

- *Air Pollution Removal* — *14,017 lbs removed/yr ($32,378 value)*
- *Carbon Storage & Sequestration* — *5,833 total tons stored (45.41 tons annual)*
- *Stormwater – Quantity* — *193,906 CF storage ($387,813 savings)*

Watershed Recommendations:

Riparian Corridor Area (100 ft buffer): Limited potential of reestablishing main tributary surface hydrology (daylight or reconstruct stream channel (750 LF possible). Reestablish urban forest in all other vacant land in area should be higher priority.

Headwaters Area (500 ft buffer): Limited opportunity to construct stormwater wetlands or other stormwater collection facilities (raingardens etc...). Higher priority should be given for other vacant land to be vegetated and maintained as a successional landscape.

Vacant Land Available (approximate)

Riparian Corridor Area	78 acres
Headwaters Area	6 acres
All others areas	6 acres
Total Vacant Land	90 acres (16 %)
Total Tree/Vegetation Canopy	177 acres (31.0 %)

Projected Green Infrastructure Functions

- *Air Pollution Removal* — *18,238 lbs removed/yr ($42,128 value)*
- *Carbon Storage & Sequestration* — *7,590 total tons stored (59.09 tons annual)*
- *Stormwater – Quantity* — *624,648 CF storage ($1,249,296 savings)*

FIG 20 Broadview/Harvard Study Area

Watershed Study – St.Clair+E.105

Watershed Characteristics:

- Direct tributary to Lake Erie and entire watershed is culverted
- Approximately 513 acres
- Majority residential neighborhoods (240 acres) in middle and upper areas, with 2 commercial/retail corridors (St.Clair and E.105) that intersect watershed
- Minimal open space and natural areas
- Vacancy is a majority of residential parcels with commercial/retail and some industrial parcels
- Scattered vacancy with a range of medium and small lots

Watershed Analysis:

Current Land Cover Types

Impervious surfaces	150.2 acres (29.3 %)
Residential – medium density	239.8 acres (46.8 %)
Grass/scattered trees	50.1 acres (9.8 %)
Trees/grass+shrub understory	59.8 acres (11.7 %)
Trees/natural understory	12.7 acres (2.5 %)
Total Tree/Vegetation Canopy	72.5 acres (14.1 %)

Current Green Infrastructure Functions

- *Air Pollution Removal* — *7,495 lbs removed/yr ($17,312 value)*
- *Carbon Storage & Sequestration* — *3,119 total tons stored (24.28 tons annual)*
- *Stormwater – Quantity* — *85,453 CF storage ($170,907 savings)*

Watershed Recommendations:

Riparian Corridor Area (100 ft buffer): Limited potential of reestablishing main tributary surface hydrology (daylight or reconstruct stream channel (400 LF possible). Reestablish urban forest in all other vacant land in area should be higher priority.

Headwaters Area (500 ft buffer): Construct stormwater wetlands or other stormwater collection facilities (raingardens etc...) in as many areas as appropriate. All other vacant land should be vegetated and maintained as a successional landscape.

Vacant Land Available (approximate)

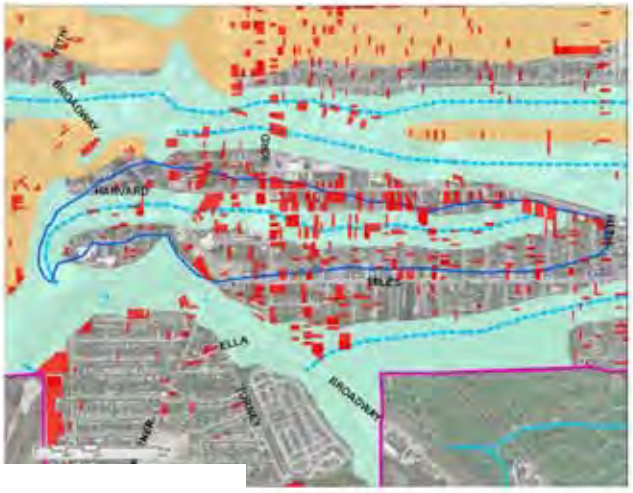
Riparian Corridor Area	18 acres
Headwaters Area	20 acres
All others areas	22 acres
Total Vacant Land	60 acres (12 %)
Total Tree/Vegetation Canopy	138 acres (27.0 %)

Projected Green Infrastructure Functions

- *Air Pollution Removal* — *14,313 lbs removed/yr ($33,061 value)*
- *Carbon Storage & Sequestration* — *5,956 total tons stored (46.37 tons annual)*
- *Stormwater – Quantity* — *160,085 CF storage ($320,171 savings)*

FIG 21 St. Clair and E 105 St. Study Area

Watershed Study – Harvard+Miles



Watershed Characteristics:

- Tributary to Mill Creek (Cuyahoga River) with entire watershed culverted
- Approximately 204 acres
- Majority of watershed is residential and impervious surfaces
- Minimal open space or natural areas
- Vacancy is a majority of residential parcels with minimal commercial/retail and industrial parcels
- Scattered and clustered vacancy with a range of medium and small lots

Watershed Analysis:

Current Land Cover Types

Impervious surfaces	69.2 acres (34.0 %)
Residential – medium density	74.1 acres (36.4 %)
Grass/scattered trees	22.0 acres (10.8 %)
Trees/grass+shrub understory	27.3 acres (13.4 %)
Trees/natural understory	10.8 acres (5.3 %)
Total Tree/Vegetation Canopy	38.1 acres (18.7 %)

Current Green Infrastructure Functions

• *Air Pollution Removal*	*3,941 lbs removed/yr ($9,102 value)*
• *Carbon Storage & Sequestration*	*1,640 total tons stored (12.77 tons annual)*
• *Stormwater – Quantity*	*216,402 CF storage ($432,804 savings)*

Watershed Recommendations:

Riparian Corridor Area (100 ft buffer): Potential of reestablishing main tributary surface hydrology (daylight or reconstruct stream channel (850 LF possible). Reestablish urban forest in all other vacant land in area should be higher priority.

Headwaters Area (500 ft buffer): Limited opportunity to construct stormwater wetlands or other stormwater collection facilities (raingardens etc...). Higher priority should be given for other vacant land to be vegetated and maintained as a successional landscape.

Vacant Land Available (approximate)

Riparian Corridor Area	20 acres
Headwaters Area	0 acres
All others areas	15 acres
Total Vacant Land	35 acres (17 %)
Total Tree/Vegetation Canopy	44.4 acres (21.8 %)

Projected Green Infrastructure Functions

• *Air Pollution Removal*	*4,591 lbs removed/yr ($10,605 value)*
• *Carbon Storage & Sequestration*	*1,911 total tons stored (14.87 tons annual)*
• *Stormwater – Quantity*	*50,436 CF storage ($100,872 savings)*

FIG 22 Harvard and Miles Study Area

REMEDIATION Environmental contamination is Cleveland's unfortunate legacy from the industrial era. Resources for cleaning up brownfields sites are typically tied to new development projects. This is a challenge for Cleveland, where environmental contaminants abound in places where development demand is very limited or in some cases, non-existent. Conventional brownfield clean-up, where tainted soils are removed and disposed of in toxic waste facilities, is cost-prohibitive without state and federal funding support. But this support is only available when a new development project is proposed for a polluted site, particularly a project that will create jobs or other economic development benefits.

Bio-remediation, phytoremediation, and mycoremediation are potential tools for environmental clean up in cases where conventional remediation is not feasible. Bio-remediation, phytoremediation, and mycoremediation allow natural processes to clean up harmful chemicals in the environment. With bioremediation, microscopic "bugs" or microbes that live in soil and groundwater are deployed to eat certain harmful chemicals, such as those found in gasoline and oil spills. When microbes completely digest these chemicals, they change them into water and harmless gases such as carbon dioxide. Phytoremediation and mycoremediation work in much the same way, with plants and fungi, respectively.

Sites where bio-remediation, phytoremediation, and mycoremediation techniques are most typically used include industrial and municipal landfills, agricultural fields, wood treating sites, military bases, fuel storage tank farms, gas stations, army ammunition plants, sewage treatment plants, and mining sites; the use of these techniques in residential areas is much less common. One important research project is being conducted in Portland, Maine. Dr. Samantha Langley-Turnbaugh is using spinach to extract lead from soils in city neighborhoods. The results of this works are to be published this fall.

These alternative remediation techniques take longer to work than conventional brownfield remediation. Plants, microbes, and fungi must be carefully selected and monitored in response to the specific toxins present in the soil and the condition of the soil itself. But research suggests that the following criteria can be used to identify potential sites for bio-remediation, phyto-remediation, or myco-remediation techniques:

- Sites tainted with lower levels of pollutants, contaminants, hazardous substances, petroleum products, or other wastes and debris.
- Sites that do not pose an immediate and significant hazard to adjacent residents.
- Sites that have limited short or long term development potential.
- Can be an interim or permanent solution, depending on the types of contaminants and the remediation period.

Lead is an especially pressing problem in Cleveland's neighborhoods. Vacant sites with exposed soil contribute to airborne lead levels in the city's neighborhoods, especially in the summer months. In many neighborhoods, over 30% of children test positive for lead poisoning each year (Figure 24). This is a public health crisis and a major social and economic challenge. Planting low-mow native turf grasses or other ground covers on vacant sites will reduce the amount of lead particles that become airborne and lessen the extent to which Cleveland residents are exposed to lead. These ground covers may not remediate lead through phyto-extraction, but they may help to contain lead and reduce exposure to airborne lead particles. As a singular treatment method, the usefulness of phytoremediation at a brownfield site in Cleveland is somewhat difficult to determine because there are numerous factors that could influence a contaminants bioavailability and/or the rate a hyperaccumulator can metabolize or degrade the contaminants. A site assessment will be a necessary component to predetermine if phytoremediation would benefit the site. Factors such as contaminant type, soil type, geological and hydrological conditions, weather, and site history will determine whether phytoremediation will be a constructive approach to removing soil contaminants.

FIG 23 Many properties in Cleveland have environmental contaminants

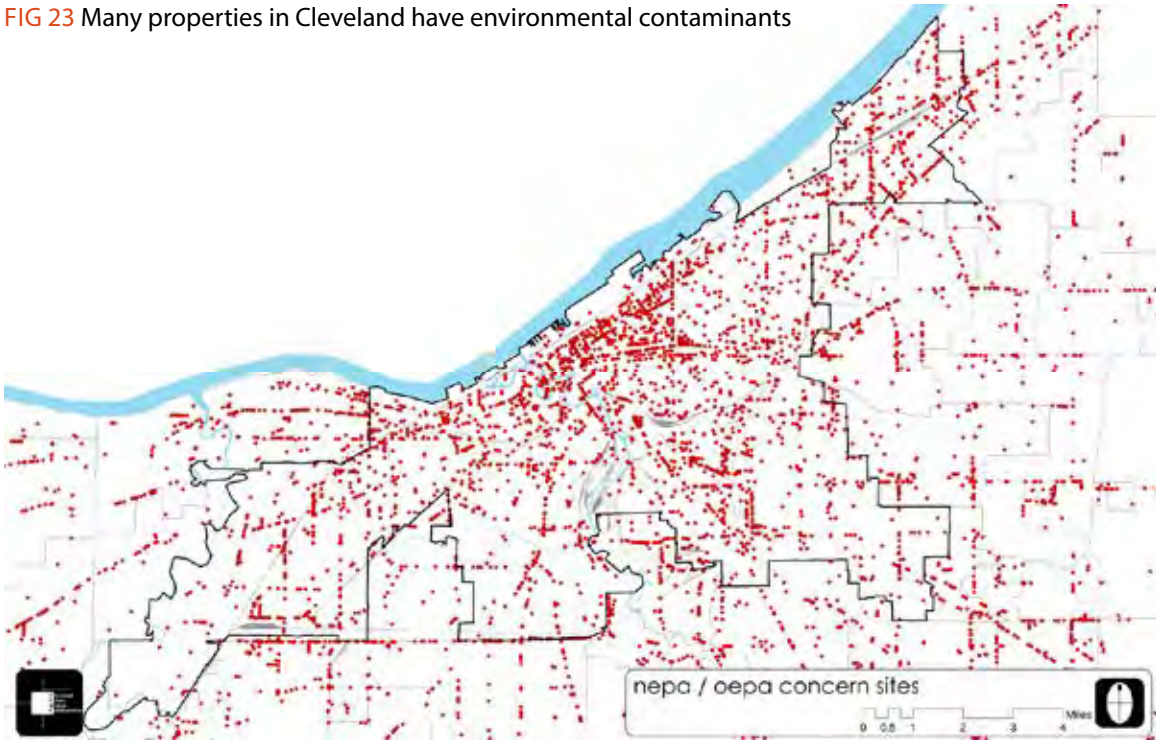
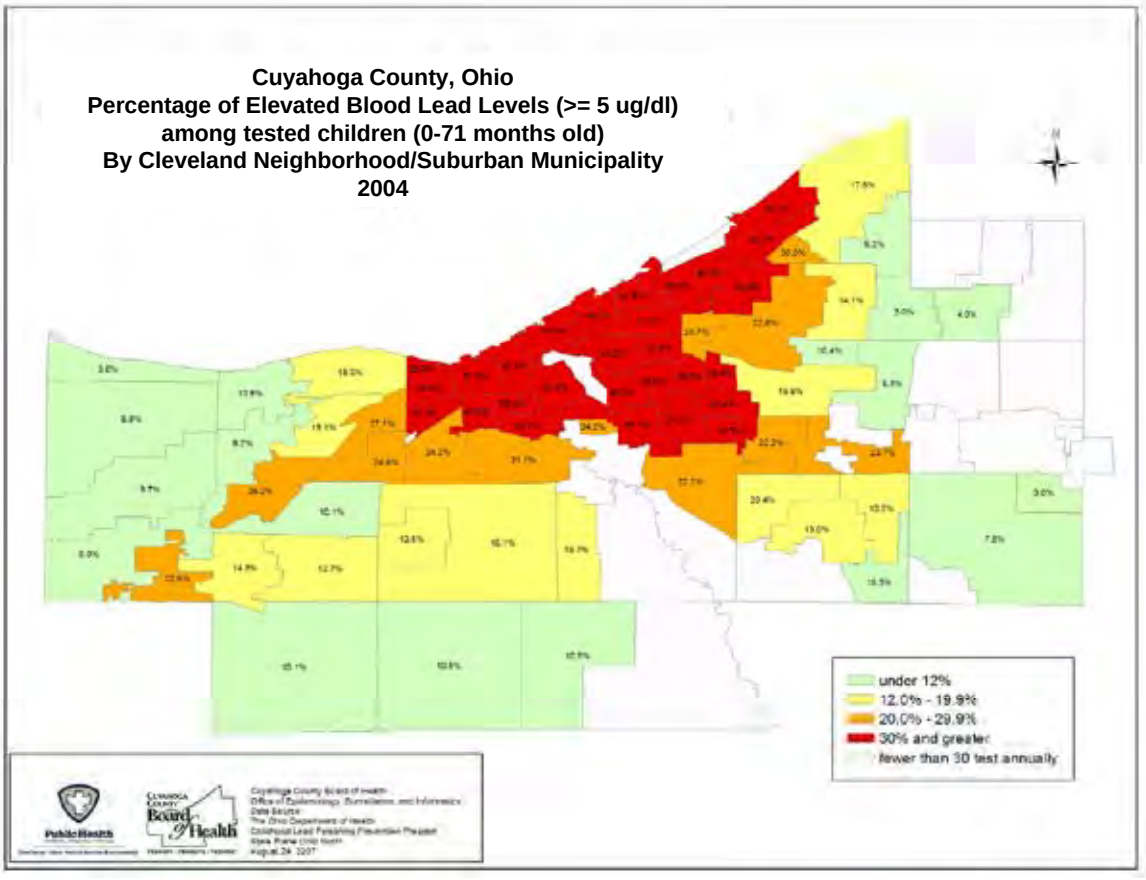


FIG 24 Lead contamination is a problem throughout the city



PRODUCTIVE LANDSCAPES Agriculture and energy generation are two ways that vacant land can be reused to generate an economic return.

Agriculture Access to fresh produce is limited in some parts of the city, as documented by the Cuyahoga County Planning Commission's recent mapping of food deserts–places where fast food restaurants are prevalent and grocery stores are few. Community gardens, market gardens, and urban farms are emerging throughout the city, providing access to affordable locally-grown produce for city residents (Figure 24).

There are more than 160 community gardens in Cleveland that engage 3,600 Cleveland residents. Community gardens increase the consumption of fruits and vegetables and they also bring neighbors together and make neighborhoods safer and more attractive. Vacant land can be used to expand this network of community gardens to provide greater access to healthy food. Seattle developed a benchmark of one community garden for every 2,500 residents. (Seattle Land Use Plan 1994). Based on Cleveland's current population this would equate to about 175 gardens in the city. A better and more ambitious standard would be to establish a community garden within a ½-mile radius of every city resident (Figure 25) or a ¼-mile radius (Figure 26). Criteria for siting community gardens include:

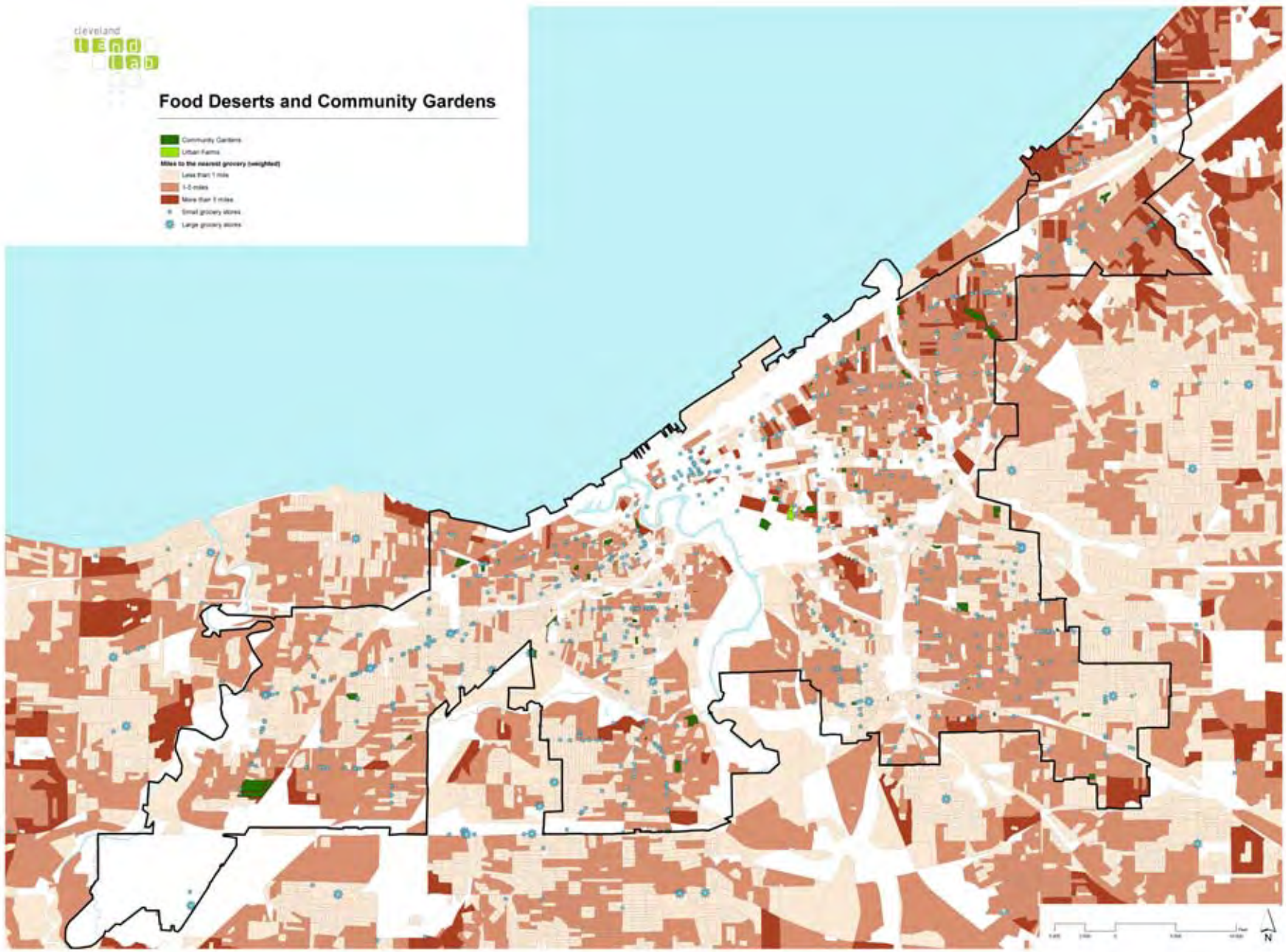
© Maurice Small, 2008

- Level site of approximately 4,000 square feet.
- Large trees or buildings on the north side of the plot.
- Receives 8 hours of full sun each day.
- Close to a fire hydrants for watering (on the same side of the street).
- Free of surface material (i.e. asphalt or gravel).
- Lead levels of less than 400-500 ppm (estimated total lead).
- In a residential neighborhood.
- Community support/local partner; eight to ten gardeners per garden.
- Site with limited development potential.
- Target of one community garden within a ½-mile or a ¼-mile radius of every city resident.
- Priority strategy for establishing community gardens in neighborhoods with residential density of greater than 20 households per acre, and in areas identified as food deserts in the Cuyahoga County Planning Commission's recent (2008) mapping of food availability.

Agriculture can extend beyond community gardens to include market gardens (growing produce to sell) and commercial farming operations. Commercial agriculture is a potential economic development strategy for larger areas of vacancy in the city. Criteria for commercial agriculture include:

- Site of at least one acre.
- Access to irrigation water.
- Large trees or buildings on the north side of the plot.
- Receives 8 hours of full sun each day.
- Soil tests that assess potential contamination based on location and previous use, including lead levels of less than 400-500 ppm (estimated total lead).
- Proximity to other urban agriculture sites to facilitate combined efforts in distribution and marketing and sharing of resources such as tools, water lines and water access, composting, small livestock, etc.
- Site with limited development potential (long-term use).
- Adequate due diligence, such as soil sampling and other environmental investigation activities, that assess potential contamination.

FIG 25 Community gardens and market gardens can expand food choices for residents in urban food deserts.



Note: Approximately 25% of the existing gardens are not for public use; many additional public gardens are planned for 2009.

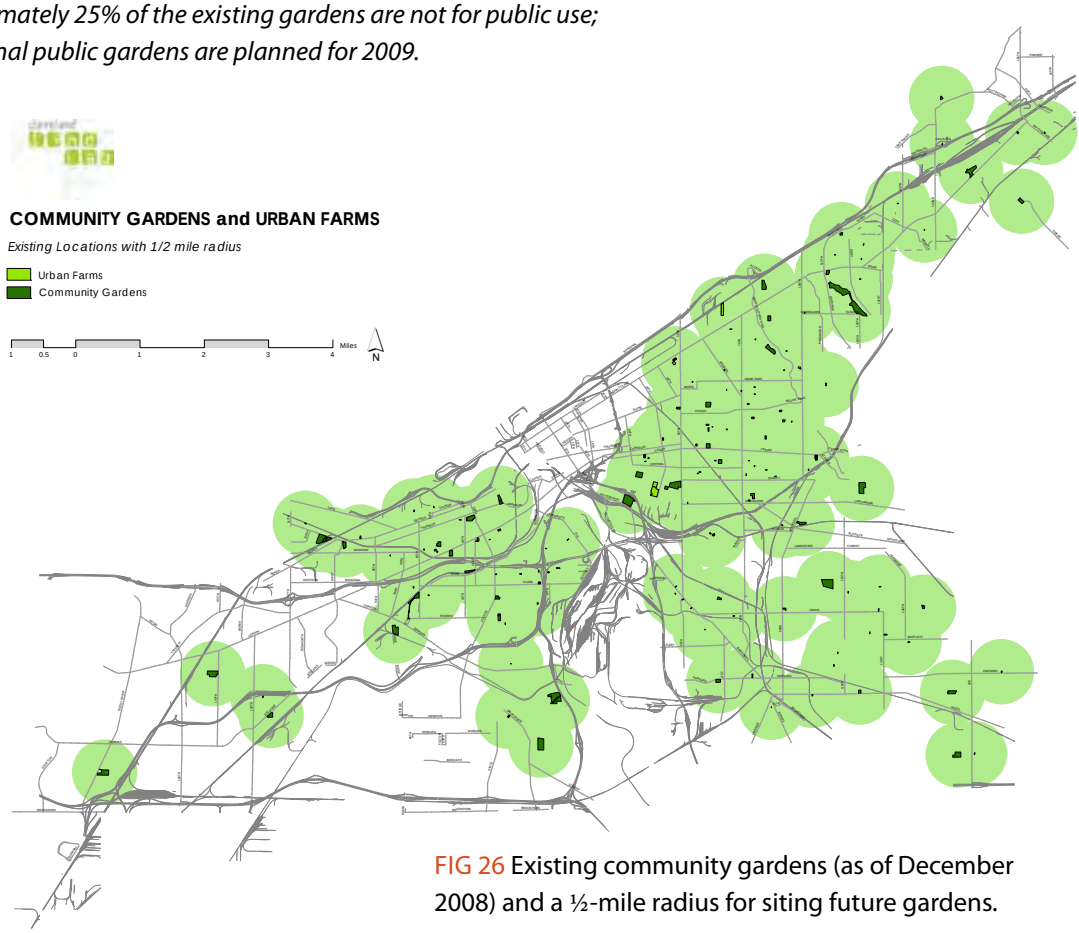


FIG 26 Existing community gardens (as of December 2008) and a ½-mile radius for siting future gardens.

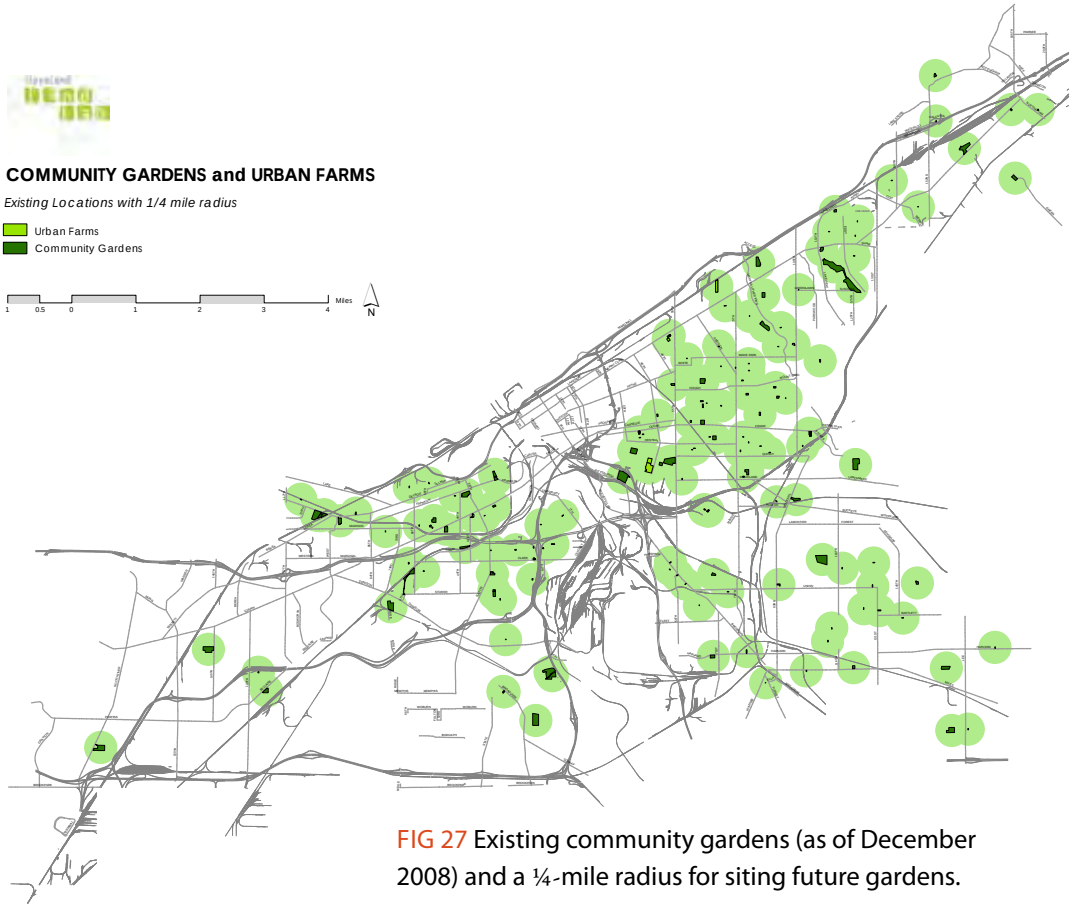


FIG 27 Existing community gardens (as of December 2008) and a ¼-mile radius for siting future gardens.

FIG 28 Blue Pike Farm established on a one-acre vacant lot in the St. Clair-Superior neighborhood *(photo by Carl Skalak)*

FIG 29 Heirloom chickens at Gather 'round Farm in the Ohio City neighborhood *(photo by Uma Kirkwood)*

FIG 30 Switchgrass, corn, or other plant materials can be converted to biodiesel through a commercial or home-based distillation process.

- Site with limited development potential (long-term use).
- Adequate due diligence, such as soil sampling and other environmental investigation activities, that assess potential contamination.

Commercial agriculture opportunities are not limited to food production. Trees and native plants can be grown be grown on vacant sites to supply wholesale or retail plant materials for new and existing development. Currently, all of the region's tree nurseries are located outside of Cuyahoga County and the nearest native plant nursery is in Hiram, Ohio. Growing plant materials on larger vacant sites in the city may prove to be a viable economic development strategy and will increase the availability of native plants that are hardy in urban conditions. Criteria for tree and plant nurseries include:

- Site of at least one acre for a native plant micro-nursery; at least 20 acres are needed for a tree nursery.
- Access to irrigation water.
- Large trees or buildings on the north side of the plot.
- Site with limited development potential (long-term use).
- Soil conditions and sun exposure conducive to the types of plants/ trees that will be grown on the site.

Additionally, there is a growing interest in including bees and chickens at community gardens and commercial agriculture sites. Cleveland City Council recently passed legislation approving this use.

ENERGY GENERATION Vacant properties also offer opportunities for the generation of alternative energy. Solar, wind, geo-thermal, and biofuel technologies can all be incorporated into urban settings where there is ample vacant land and reduced population density. For example, geothermal technology uses the earth's renewable energy, just below the surface, to heat and cool a home, and to help provide hot water. Geothermal energy is extremely cost effective and environmentally friendly. Although the cost of installing a geothermal well is higher than installing a conventional heating system, a geothermal system results in significantly lower utility costs. Geothermal wells can be installed on a vacant site to generate energy for two adjacent houses.

More research is needed to determine which energy strategies are most viable given Cleveland's dispersed pattern of vacancy, but general criteria for using vacant sites for energy generation include:

GeoThermal

- Underground utilities need to be avoided when establishing sites for geothermal energy production.
- 30 acres is an efficient size for a commercial geothermal energy plant; a smaller, neighborhood-scale plant may be feasible in some locations.
- A vacant residential lot can provide geothermal energy for two adjacent houses.

Wind Turbines

- Minimum one acre site for a residential-scale wind turbine.
- Site must have a minimum annual average wind speed of at least 11-13 mph.
- Proximity to existing transmission lines: a critical issue in keeping costs down in building a wind farm is minimizing the amount of transmission infrastructure that has to be installed availability and access to existing lines should be considered in selecting a site.
- Secure access to land: long term use.
- Is there high raptor activity in the area? Are there endangered or protected species that could be jeopardized by the presence of the facility?
- Is the site's geology suitable and appropriate for industrial development?
- Will noise and aesthetics be issues for the local community?
- Will the turbines obstruct the flight path of local air traffic?

Source: American Wind Energy Association

Ethanol Production

- 50+ acres for commercial-scale farms (including a large-scale processing facility).
- Multiple sites of 2-4 acres for neighborhood energy farms (can share a large-scale processing facility).
- Residential scale farms (on vacant lots); processing can occur in home-based processors, capable of producing 40-80 gallons of biofuel in 8-14 hours.
- Industrial hemp is a high-yielding multi-purpose fuel and fiber crop that has great potential for biomass energy. An acre of hemp yields 10 tons of biomass in four months, enough to make 1,000 gallons of methanol fuel (by pyrolytic distillation), with about 300 pounds of oil from the seed.
- Switchgrass plots produce up to 15 tons of dry biomass per acre, and five- year yields average 11.5 tons—enough to make 1,150 gallons of ethanol per acre each year.

Sources United States Department of Agriculture, National Agricultural Library

Solar Field

- Adaptable to various site sizes – the size of the photovoltaic array and installation method can be tailored to meet the site conditions. A rule of thumb is that a solar array that covers three acres can generate approximately one megawatt of power – enough for 200 homes
- Interim use option – relatively easy to move and install. An otherwise unused site could host a PV array that could later be moved to another location when the site is redeveloped.
- Compatible with diverse end uses – PV can be installed on a variety of commercial, industrial, and residential properties. PV arrays can also be installed directly on the ground on a brown-field without penetrating the surface of the property in situations where the soil should not be disturbed.
- No noise and minimal traffic generated by a PV array; can be sited near residential areas

Source: US Department of Energy

POLICY RECOMMENDATIONS for the RE-USE of VACANT PROPERTIES

LAND USE

- Establish a task force to assess and address barriers to new vacant land reutilization strategies, including zoning, building, and health codes, access to city land and water, etc. *[Cleveland City Planning Commission, Building and Housing Department, Public Service Department, Water Department, Economic Development Department]*
- Adopt land use decision-making mechanism for properties in Cleveland's land bank based on the flow chart in Figure 7, page 9. *[Cleveland City Planning Commission, Community Development Department, Economic Development Department City Council, Mayor's Office]*
- In response to the growing number of foreclosures and demolitions, determine and implement ways to streamline the disposition of properties in the city's land bank and make the process more objective; the goal would be to have a 2-3 month turnaround from when the site comes into the landbank until final disposition. *[Cleveland City Planning Commission, Community Development Department, City Council, Mayor's Office]*
- Encourage the use of hydrological data and soil characteristics as guiding factors for determining future land uses and stormwater management strategies at the city-wide level and in neighborhood master plans. *[Cleveland City Planning Commission]*

DATA

- Develop new ways to classify and geo-code vacant land in the city's GIS system to identify sites that have the strongest potential for real estate development, green space expansion, and the provision of specific ecosystem services, as well as sites that have environmental contaminants. *[Cleveland City Planning Commission, Cleveland Urban Design Collaborative]*
- Develop more detailed, parcel-based mapping of environmental contamination that distinguishes highly contaminated sites from those with lower levels of contamination; include this information in the city's GIS parcel data. *[Cleveland City Planning Commission, City and County Brownfields staff]*
- Develop parcel-level mapping of sites where children have tested positive for elevated blood-lead levels and factor this information into decision-making on building demolition. *[Cleveland Health Department, Building and Housing Department, Cleveland Urban Design Collaborative]*
- Map and document wetland criteria (hydric soils, hydrophytic vegetation, and water regime) and drainage patterns. *[Cleveland Urban Design Collaborative, Cuyahoga Soil and Water Conservation District]*
- Map and document soil properties (HSG, water table, bedrock depth, permeability, moisture content, Ph, erosion, organic matter, and slope) from secondary sources. *[Cleveland Urban Design Collaborative, Cuyahoga Soil and Water Conservation District]*
- Delineate areas of existing vegetative cover throughout the city using recent aerial photographs. *[Cleveland Urban Design Collaborative]*

GREEN INFRASTRUCTURE

- Expand the area devoted to green space and land preservation in the 2020 future land use plan to include riparian areas, headwater protection zones, and elements of the County GreenPrint; promote the use of Green Overlay District Zoning to protect these areas. *[Cleveland City Planning Commission, Cuyahoga County Planning Commission]*

- Identify one or two city-wide green infrastructure initiatives that will link neighborhoods, provide ecosystem and community benefits, and enhance Cleveland's image (e.g. inner "Emerald Necklace" of parks and trails connecting to the Cuyahoga River and the Ohio Canal Towpath Trail). *[Establish task force to explore].*
- Adopt design guidelines and review process to establish minimal areas for ecosystem preservation in riparian and headwaters areas. Determine appropriate method to define terms (setback distance, hydrologic functions, and environmental classifications) and means to administer regulations. *[Cleveland City Planning Commission]*
- Enhance existing lower quality wetlands, preserve existing higher quality wetlands, and create new wetland systems with appropriate vegetated buffers where feasible. *[Northeast Ohio Regional Sewer District, Cleveland Metroparks. Cleveland Water Department, Office of Sustainability]*
- Encourage or mandate the use of bioswales and pervious paving for all new off street parking lots. *[Cleveland City Planning Commission, Department of Engineering and Construction, Community Development Department, Economic Development Department]*
- Encourage the creation of rain gardens on residential properties, especially side yard expansions on vacant lots. *[Cleveland City Planning Commission, Building and Housing Department, Community Development Department]*
- Link green infrastructure projects to the Cleveland Carbon Fund, where appropriate. *[Cleveland Carbon Fund, GreenCityBlueLake Institute]*

URBAN AGRICULTURE

- Provide permanent support for local food production. Prioritize agricultural land uses in the city through the creation of a new land use category for urban agriculture to aid in long-term planning and land security for urban farmers and community gardeners.; revise Urban Garden District zoning classification as appropriate. *[Cleveland City Planning Commission]*
- Establish a goal that every Cleveland resident will be within a minimum ½-mile radius of a community garden or market garden (ideally within a ¼-mile). This will increase local food security, reinforce neighborhood relationships, beautify vacant lots, and promote local entrepreneurship. *[Cleveland City Planning Commission, Ohio State University Extension, Cleveland Botanical Garden, Community Development Corporations]*
- Integrate permanent garden space in model block/neighborhood planning.
- Establish strategies for controlling use and new models for holding land (i.e. re-zone to urban garden district, transfer ownership of land to community land trust, long term land leasing with ability to fence and secure). *[Cleveland City Planning Commission, Community Development Dept., Cleveland Land Bank, Community Development Corporations]*
- Develop policies and practices within the Cleveland Water Department that streamline farmers and gardeners access to water. Establish water rates that incentivize and promote agricultural uses. *[Cleveland Water Department, Community Development Department, Economic Development Department]*
- Explore new ways of bringing water to sites including maximizing the use of rainwater runoff from adjacent building roofs, leaving water lines to properties after demolition of buildings, etc. *[Cleveland Water Department, Community Development Department, Economic Development Department]*
- Explore potential for a municipal composting facility and community composting projects. *[Community Development Department, Cleveland Office of Sustainability, Department of Parks, Recreation and Properties]*

ENERGY GENERATION

- Support the adoption of an Ohio Renewable Energy Portfolio and consider incentivizing the generation and use of renewable energy at the local level. *[Cleveland Office of Sustainability, Cuyahoga County Office of Sustainability, Green Energy Ohio]*
- Support efforts toward energy conservation and optimization, as well as energy production, at a citywide level. *[Cleveland Office of Sustainability]*

PILOT PROJECTS

Pilot projects will be prioritized based on the availability of funding and partnerships for implementation. Benchmarks need to be established for all pilot projects so that benefits can be clearly quantified and monitored. This initial list of pilot projects was developed to test the ideas put forth in this place and determine the most feasible and effective approaches for vacant land reuse. The criteria for pilot projects include:

- Projects that break new ground
- Locations near primary development areas
- Ability to attract funding
- High visibility locations
- Local constituencies and implementation partners

LAND HOLDING STRATEGIES as described in the *Vacant Land Pattern Book*, will be implemented in prime development areas and growth neighborhoods. Land holding strategies will be piloted in prime development areas and other targeted investment areas. Potential partners include all of the community development corporations.

LAND REUSE PROJECTS in urban agriculture, energy generation, bio- and phyto-remediation, stormwater management strategies, and additional recreation/green space will be piloted in low-growth neighborhoods. Potential partners include community development corporations, the Ohio State Extension, the Cleveland Botanical Garden, ParkWorks, the Northeast Ohio Sewer District, and the Cuyahoga Soil and Water Conservation District.

LAND ACQUISITION and MANAGEMENT Develop an organizational model for acquiring and maintaining vacant land and redirecting it for the uses described in the criteria section.

- Pursue land acquisition and management strategies at the watershed-scale, rather than at a neighborhood- or citywide-scale.
- Work with existing local and regional land conservation organizations to develop an urban land conservation mechanism that targets small (<10 acre) sites in the city.
- Work with the City Land Bank and the County Land Bank (when it is established) to acquire strategic parcels for conservation through the foreclosure process.

MOW-TO-OWN PROGRAM Vacant lots can be absorbed into residential neighborhoods by encouraging adjacent property owners to acquire and maintain these sites as an expansion of their own properties. Currently, the city has a program that makes landbank available to adjacent property owners. The city could expand this effort into a Mow-to-Own program in which residents earn the ownership of a neighboring or nearby property in exchange for providing good maintenance of these properties according to city-established standards. A property owner who maintains a property for one year would receive title to the property with the condition that the property continue to be maintained to the same standards. If the property owner fails to maintain the property, ownership would revert to the city's landbank. At high-profile locations in targeted parts of the city, funding could be developed to provide minimal landscaping and fencing in order to make these sites cared for and attractive.

PHYTOREMEDIATION and BIOREMEDIATION for soil restoration and lead containment/remediation of vacant sites. Even if areas must be disturbed later, preserving or establishing vegetation on vacant sites will help restore soil structure and reduce the presence of airborne led in city neighborhoods.

- Vegetation strategies can become part of the city's demolition specifications and/or a separate initiative led by local community development corporations.
- Phytoremediation and bioremediation demonstration sites can be identified from the city's landbank; this would be a site for which remediation funding is not yet available through Clean Ohio, but could be used as an experimental site for phytoremediation strategies.

Potential collaborators include the City of Cleveland Brownfields Coordinator, Cleveland Heath Department, the Ohio State Extension Office, the Greater Cleveland Lead Advisory Council, the Cleveland Botanical Garden, the Cleveland Neighborhood Development Coalition, local community development corporations.

URBAN AGRICULTURE INCUBATOR could provide land and appropriate infrastructure for urban agriculture enterprises. Aspects of this pilot project would include:

- Develop a business plan, resources for start-up, and operating partnerships.
- Identify several sites of at least two-three acres within the city that would be available for long-term use as urban farms and re-zone as an Urban Garden District; conduct environmental assessment to determine whether soil at the preferred site(s) have environmental contaminants that could affect food production.
- Develop appropriate infrastructure at the site and agreements for the management of infrastructure, including access to water, utilities, packing shed/cooler, tool storage, rototiller, security, and soil remediation.
- Once long-term use of land is secured, infrastructure developed, and the project has the support and approval of adjacent land owners, the city, and other stakeholders, ½-acre parcels would be available to agriculture entrepreneurs.

NATIVE PLANT EXPERIMENTAL PLOTS AND NURSERIES /TREE NURSERY Several large-scale public investment projects will occur in the next three to five years, including the extension of the Ohio and Erie Canal Towpath Trail into the City of Cleveland, the creation of Canal Basin Park, and improvements to Wendy Park. Native plant materials in these areas will aid in preserving riparian functions along the Cuyahoga River, improve water quality in the River and Lake Erie, and enhance biodiversity wildlife habitat within the city. Appropriate native plant materials can be expensive and difficult to find. Vacant sites within the city of Cleveland can be used to grow different varieties of plants and to conduct tests to see which plant materials are the most resilient in an urban context. Establishing series of experimental plots will allow a wide range of plant materials to become established prior to transplanting them in permanent locations in public parks and natural areas. Surplus plant materials can also be sold to institutions, residents, and businesses to increase the overall plant diversity of the city. A larger vacant site (20-acres or more) could allow for the creation of a tree nursery.

Several steps are needed to determine the feasibility of a native plant nursery:

- Identify public improvements planned for the next five years
- Calculate the quantity of native plant materials needed for these improvements and determine the acreage that would be needed to cultivate these plant materials.
- Identify land bank lots or other vacant sites that would be most suitable and accessible for plant cultivation.
- Formulate a business plan to determine if it will be financially feasible to establish native plant experimental plots, based on the cost of setting up the experimental plots and cultivating the plant materials,

and well as the revenue that would be generated (or saved) by using these locally grown plant materials for public projects.

- The costs associated with a project of this scale; and
- The environmental, economic, and social benefits of the project.

Potential collaborators include the Cleveland Metroparks, Cleveland Botanical Garden, the Cleveland Municipal School District and South High School's Horticultural Program at Washington Park, and the Cleveland Department of Parks and Recreation, the Democracy Collaborative at the University of Maryland, and the Cleveland City Forester.

NEXT STEPS/IMPLEMENTATION

Moving the ideas of *Re-imagining a More Sustainable Cleveland* forward will require new partnerships and an ongoing commitment to addressing the growing challenge of vacancy in Cleveland. Initial resources for several pilot projects in the first year are available to support this work through Neighborhood Progress, the Surdna Foundation, and the City of Cleveland's federal Neighborhood Stabilization Funds. Additional potential resources include:

- Local and national foundations
- Unexpended NatureWorks funds from the Ohio Department of Natural Resources
- USEPA CARE Program
- Living Cities National Community Development Initiative
- Federal Resources Conservation Service funding through the US Department of Agriculture
- Partnership opportunities with the Northeast Ohio Regional Sewer District, in conjunction with the implementation of a regional stormwater utility
- Research funding from the Northeast Ohio Research Consortium and other sources.
- Private sector partnerships

NPI will work with partner organizations to raise a pool of $1 million for a pilot program which could support up to 100 projects in targeted areas of the city, transforming vacant, blighted land into projects that add value to communities as opposed to being a drain on home values and quality of life. To implement this aggressive agenda, NPI recommends that local community development corporations and other specialized non-profit organizations work with grassroots organizations and individuals to implement the various strategies. These specialized organizations could include: the Cleveland Botanical Garden, Cuyahoga Community Land Trust, Cuyahoga Soil and Water Conservation District, New Agrarian Center, North East Ohio Regional Sewer District, OSU Extension, ParkWorks, Shaker Lakes Nature Center, and the Trust for Public Land.

"We know what recovery looks like. We've done it before and we'll do it again" - Councilman Anthony Brancatelli, Ward 12, City of Cleveland. For the past 20 years, Cleveland has been a national leader in community development and can become a national leader in the reutilization vacant land for productive use. The principles and projects described in this report are the beginning of a new way of thinking about development and conservation across the city. The resources and expertise are now available to support the city's recovery and transform Cleveland into an innovative, sustainable, and radiant city.

For more information on implementation of pilot projects and next steps on policy recommendations, please contact Bobbi Reichtell at Neighborhood Progress: blr@neighborhoodhoodprogress.org or 216.830.2770.

Appendix K:

Cleveland Complete and Green Streets: Typologies Plan – 8/20/2013

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Appendix L:

Climate Resilient Street Sections

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HIGH HEAT DAY

MAJOR COMMERCIAL THOROUGHFARE

TIP: When going outdoors, don't forget to apply sunblock to reduce your risk of sun-related illnesses!

TIP: When possible, walk on the shady side of the street to reduce exposure to direct sun!

TIP: Always stay well-hydrated on days of high heat to prevent dehydration and heat exhaustion!

TIP: If cycling on a day of high heat, be sure to wear light-colored clothing and keep a bottle of water on you at all times! Additionally, if possible, ride along shaded streets and pathways!

STOREFRONT AWNINGS

Awnings provide shade for sidewalks and storefronts, saving energy on interior cooling and creating a refuge from the heat of the sun and heavy precipitation. Awnings can also add a welcoming, human-scale element to larger commercial buildings.

PERMEABLE SIDEWALKS

Paving sidewalks with coarse brick, small concrete block, or pourous concrete can reduce the heat that is soaked in by conventional concrete sidewalks, while allowing rainwater and other runoff to seep into the ground below rather than overburdening storm sewers.

ENHANCED BUS SHELTERS

To make transit waiting a more hospitable experience on days of high heat, glass can be tinted to reduce heat absorption Openings in the shelter enclosure should be oriented toward the north or on the face adjacent to a taller building to allow breeze and access while not letting direct sunlight pass through.

TRANSIT WAITING TECH

Digital screens that show upcoming bus arrival times are useful to allow riders to make informed decision as to whether waiting out in the elements or somewhere indoors is worth doing. Additionally, these boards can display the current outdoor temperature along with weather bulletins and alerts to keep riders alert and safe.

PERMEABLE STREETS

To reduce stormwater runoff, urban heat island effect, and groundwater pollution, permeable pavers such as brick, block, or pourous concrete can be used to pave streets. Materials should be chosen based on a road's traffic volume and the material's weight and wear capacity commensurate to that volume.

SWALE MEDIANS

On particularly wide thoroughfares, space can be used in the road's center for a swale median. These can soak up a lot of the road's water runoff, provide a place for air-cleansing plants to grow, and even a place where shade trees can be planted to further reduce the heat given off by streets. They also provide refuge for crossing pedestrians.

COOL PAVEMENTS

Where permeable pavers are less practical, a different spin on conventional road materials can be utilized. Using a white or similarly light-colored concrete or asphalt mixture instead of the conventional grey, for example, reflects much more heat from ground-level. Additionally, existing pavement can simply be painted a lighter color to similar [but less permanent] effect.

SHADE TREES

A continuous line of shade trees planted along sidewalks and roads can significantly reduce ground-level heat and create a much more pleasant pedestrian experience, while encouraging people to walk longer distances on higher heat days.

WATER STATIONS

Along major pedestrian routes, public water stations can be implemented to allow pedsetrians and cyclists to stay well-hydrated on hotter days. These stations can also have permanent signs and take-home brochures that provide information on actions one should take during times of extreme heat, both while outdoors and when at home.

EXTREME COLD DAY

MAJOR COMMERCIAL THOROUGHFARE

TIP: When possible, stay on the sunny side of the street to capture any warmth available!

TIP: If you have to travel outside on days of extreme cold, be sure to cover all exposed skin. Wear many layers on your body, a scarf, gloves, a hat and a face mask to prevent frost bite and other exposure-related health issues!

TIP: When shoveling sidewalks, be sure that you clear a path at least three (3) feet wide to allow pedestrians to easily walk and pass one another!

SIDEWALK PAVING

Paving sidewalks with coarser materials, like coarse brick or concrete block, can reduce slippage when sidewalks are wet or icy. Additionally, providing sidewalks with proper foundations to keep them level (with a slight tilt toward the road) can prevent water pooling which can turn to dangerous ice patches.

ENHANCED BUS SHELTERS

To make transit waiting a more hospitable experience on days of high heat, glass can be tinted to reduce heat absorption Openings in the shelter enclosure should be oriented toward the north or on the face adjacent to a taller building to allow breeze and access while not letting direct sunlight pass through.

TRANSIT WAITING TECH

Digital screens that show upcoming bus arrival times are useful to allow riders to make informed decision as to whether waiting out in the elements or somewhere indoors is worth doing. Additionally, these boards can display the current outdoor temperature along with weather bulletins and alerts to keep riders alert and safe.

SWALE MEDIANS

On particularly wide thoroughfares, space can be used in the road's center for a swale median. Snow melt and other precipitation can then collect here rather than in the roads, thus when freezing cold comes, the ice remains principally in the swale and not on the road itself. Plowed snow can also be piled here rather than on the sidewalks.

STREET TREES

A continuous line of trees planted along sidewalks and roads can diffuse frigid winds blowing across the landscape in times of extreme cold. This can protect pedestrians and buildings from the agressive cold.

SIDEWALK CLEARANCE

Business and property owners should be held accountable for clearing snow and ice from the public sidewalks adjacent to their property. On major roads running through areas of high pedestrian activity, local agencies may be created or utilized to plow or shovel sidewalks along a particular stretch of road on a regular basis.

HIGH HEAT DAY

NEIGHBORHOOD BUSINESS STREET

TIP: If your house is too hot, sitting outside in the shade can be a welcome relief, especially if you live on a higher floor.

TIP: When possible, walk on the shady side of the street to reduce exposure to direct sun!

TIP: Always stay well-hydrated on days of high heat to prevent dehydration and heat exhaustion!

PORCHES
Most historic homes have front porches that provide shade and refuge from the heat of the sun and allow residents to take advantage of outdoor breezes when indoor temperatures become too hot. For homes without porches, owners should consider adding some type of awning or covering over their doors and windows during the summer to lower indoor temperatures.

HOME SHADE TREES
Whether a home has porches or not, large trees around a building can significantly reduce indoor temperature by shading roofs, walls, and windows. This low-maintenance strategy also cleans the air surrounding a home and soaks up water during heavy rain that may otherwise flood a home's basement.

SWALE TREE LAWNS
The tree lawns abutting many residential streets is space that can be used for a swale or rain garden. These can soak up a lot of the road's water runoff, provide a place for air-cleansing plants to grow, and even a place where shade trees can be planted to further reduce the heat given off by streets.

PERMEABLE STREETS
To reduce stormwater runoff, urban heat island effect, and groundwater pollution, permeable pavers such as brick, block, or pourous concrete can be used to pave streets. Materials should be chosen based on a road's traffic volume and the material's weight and wear capacity commensurate to that volume.

COOL PAVEMENTS
Where permeable pavers are less practical, a different spin on conventional road materials can be utilized. Using a white or similarly light-colored concrete or asphalt mixture instead of the conventional grey, for example, reflects much more heat from ground-level. Additionally, existing pavement can simply be painted a lighter color to similar [but less permanent] effect.

SHADE TREES
A continuous line of shade trees planted along sidewalks and roads can significantly reduce ground-level heat and create a much more pleasant pedestrian experience, while encouraging people to walk longer distances on higher heat days.

WATER STATIONS
Along major pedestrian routes, public water stations can be implemented to allow pedsetrians and cyclists to stay well-hydrated on hotter days. These stations can also have permanent signs and take-home brochures that provide information on actions one should take during times of extreme heat, both while outdoors and when at home.

EXTREME COLD DAY

NEIGHBORHOOD BUSINESS STREET

TIP: When shoveling sidewalks, be sure that you clear a path at least three (3) feet wide to allow pedestrians to easily walk and pass one another!

HOME SHADE TREES

Larger trees and plantings placed close to homes can be of great benefit in the winter when harsh frigid winds blow through town. These plants can help to break up this biting wind and prevent much of it from pushing its way through poorly insulated walls and unsealed windows, thus keeping indoor temperatures more stable and slightly reducing heating costs.

SIDEWALK CLEARANCE

Private homeowners are responsible for clearing snow and ice from the sidewalks abutting their property, though for some this may be a difficult task due factors such as to age, ailment, or work schedule. To acommodate this and provide safe and clear sidewalks for neighborhood residents, block clubs and community organizations can assemble snow shoveling teams that mobilize before, during, and after snowfall to clear priority walking routes throughout their neighborhoods. These groups can also encourage local able-bodied youth to clear the sidewalks of their neighbors or nearby homes of less capable residents.

SIDEWALK PAVING

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WARMING STATIONS

When extreme cold occurs and pedestrians must either walk for long distances or wait longer for delayed buses, businesses and institutions can provide warming stations along the sidewalk to help people fight the bitter cold. These can be temporary or permanent, depending on funding and location.

HIGH HEAT DAY

LOCAL RESIDENTIAL STREET

TIP: If your house is too hot, sitting outside in the shade can be a welcome relief!

TIP: When engaging in outdoor activities, stick to the shade and dress lightly!

PORCHES

Most historic homes have front porches that provide shade and refuge from the heat of the sun and allow residents to take advantage of outdoor breezes when indoor temperatures become too hot. For homes without porches, owners should consider adding some type of awning or covering over their doors and windows during the summer to lower indoor temperatures.

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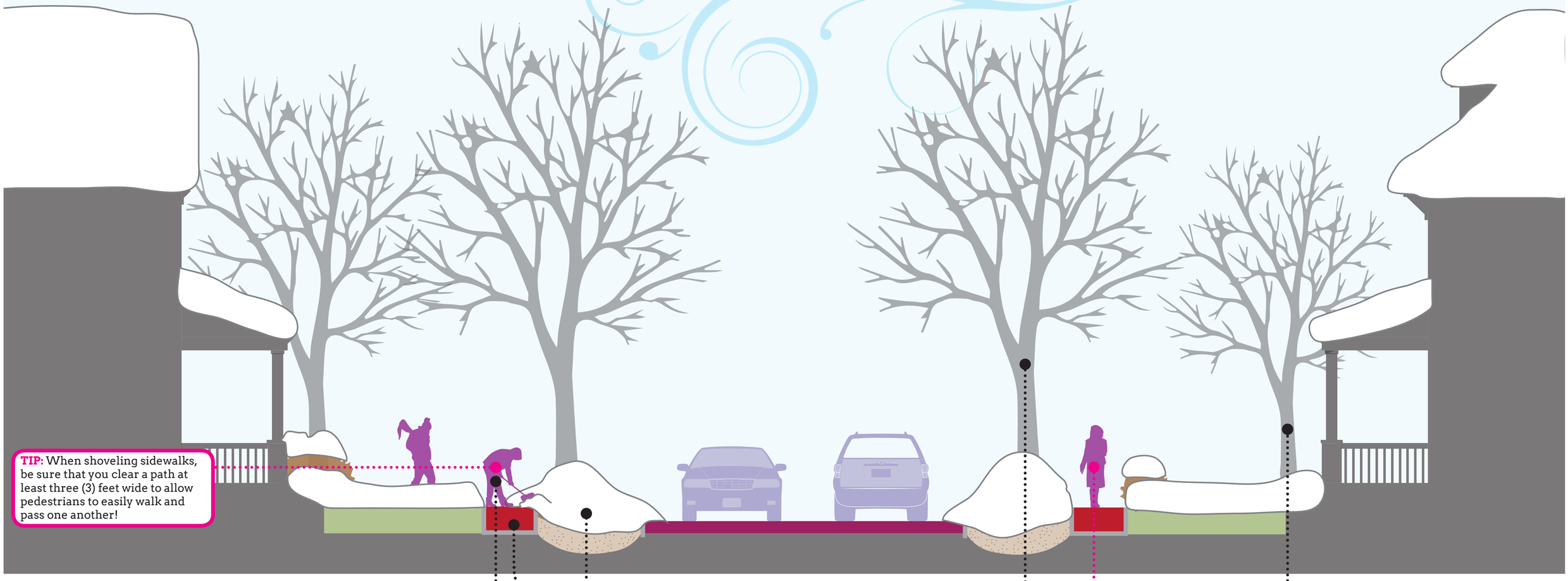
EXTREME COLD DAY

LOCAL RESIDENTIAL STREET



TIP: When shoveling sidewalks, be sure that you clear a path at least three (3) feet wide to allow pedestrians to easily walk and pass one another!

TIP: If you have to travel outside on days of extreme cold, be sure to cover all exposed skin. Wear many layers on your body, a scarf, gloves, a hat and a face mask to prevent frost bite and other exposure-related health issues!

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Appendix M:

Planting With Purpose: An Excerpt from the Draft Cleveland Tree Plan

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Planting with Purpose

"Right Tree in the Right Place" is an urban forestry concept that should guide decisions for every planting project. However, planting with purpose must also factor in to the planning process. What do we want our trees to do? What benefits do we need to realize from this planting project? Why are we planting trees?

Urban trees play an important role in our daily lives; they provide many economic, environmental, and social benefits and significantly improve Cleveland's quality of life. Trees reduce the urban heat island effect and help cool the atmosphere, reduce stormwater flooding and environmental damages, improve water quality, mitigate air pollution and improve human health, enhance the quality of life through environmental justice, save money and the environment through energy conservation, enhance property values and increase spending at shops and restaurants, provide wildlife habitat and provide educational opportunities, and provide psychological and aesthetic benefits for citizens and visitors. The amount and distribution of urban tree canopy determines many of these economic, environmental, and social benefits. Planting trees purposefully (meeting a benefit need) will ensure trees provide the greatest benefits to the community. Tree planting programs in Cleveland, citywide or by individual neighborhood, should plant the "Right Tree in the Right Place for the Right Purpose".

Strategies for Purposeful Planting

For each tree planting project, desired outcomes should be defined so that all efforts and expenses will yield desired long-term benefits. If desired outcomes are based on the potential benefits trees provide, planting projects can more directly link to improvements in the quality of life in the city.

Davey Resource Group has developed this tree planting strategies guide based on data from the 2013 urban tree canopy analysis, demographic data, and i-Tree. Potential objectives of planting trees identified as needing improvement in Cleveland include existing tree canopy, stormwater retention, energy savings, urban heat island mitigation, human health, economic development potential, equity, use of available vacant land, large land ownership cooperation, and neighborhood support. As shown in Table 1, the results were ranked by neighborhood and also grouped into 3 categories that reflect the degree of need (Red suggests high need, yellow moderate need, and green low need) by neighborhood. For example, air quality improvements and asthma reduction are two social benefits of trees described in Table 1. Objective-based planting may mitigate air pollutants and yield lesser rates of asthma.

The sections that follow help illustrate potential needs by neighborhood. Tree planting activity that is guided by this objective-based information will help Cleveland strategically determine why and where tree planting efforts should be concentrated. Purposeful planting means that Cleveland's urban forestry partners will use this information to prioritize needs that can be improved through tree planting, match neighborhood needs to funders' missions, and work to narrow the gap between neighborhood canopy cover and the need for benefits.

Different species can provide more efficient benefits and the i-Tree Species tool can assist with selecting suitable tree species for the desired tree function. Table 2 lists the top 10% of tree species (out of 1,600 in i-Tree Species database) recommended for planting in Cleveland, Ohio. A more comprehensive list can be created in i-Tree Species, but not all listed species should be planted in the northeast region of Ohio. Special consideration should be made for planting tree species suited for the northeast region of Ohio. Each of the species listed in Table 2 are recommended in recommended Species Selection list provided in this plan (see Appendix A).

Table 1. Cleveland neighborhood canopy cover compared to purposeful planting objectives and the relative need for benefits.

Neighborhoods	Canopy	Relative Canopy	Stormwater	Energy Saved	Urban Heat Island	Human Health			Property Value Hikes	Median Household Income	Factors of Equity			
						Air Quality	Asthma Prevalence	Elderly Population			Population Density	Unemployment	Child Poverty	Equity
Bellaire-Puritas	15.14%	20.70%	21	24	6	30	10.9%	23	26	24	7	11	13	9
Broadway-Slavic Village	18.29%	25.10%	24	30	15	29	11.0%	25	30	12	3	29	18	20
Brooklyn Centre	24.05%	32.30%	22	22	18	22	12.5%	10	15	20	26	18	26	24
Buckeye-Shaker Square	25.38%	35.40%	3	18	34	17	14.3%	27	19	22	34	8	6	13
Buckeye-Woodhill	24.01%	33.10%	5	11	24	6	14.3%	15	17	4	28	34	32	34
Central	12.90%	18.40%	7	5	8	21	14.2%	13	9	1	13	33	34	32
Clark-Fulton	19.65%	28.70%	9	19	19	3	12.5%	11	5	19	32	24	19	26
Collinwood-Nottingham	13.56%	19.20%	19	21	5	27	10.5%	22	24	21	6	20	15	12
Cudell	16.02%	23.70%	14	12	7	1	14.7%	6	6	14	31	21	21	27
Cuyahoga Valley	4.86%	7.30%	33	2	2	25	14.7%	1	2	5	2	12	20	7
Detroit Shoreway	18.56%	27.30%	16	16	22	5	14.7%	20	13	16	25	17	8	16
Downtown	4.06%	7.80%	32	1	3	8	14.2%	4	1	29	8	7	2	3
Edgewater	29.60%	39.50%	25	10	30	4	14.7%	9	12	23	33	2	3	8
Euclid-Green	39.11%	49.80%	31	20	23	18	10.5%	7	29	33	24	15	12	11
Fairfax	17.68%	24.90%	10	8	14	13	14.2%	19	16	6	14	26	30	22
Glenville	25.69%	35.00%	18	32	28	32	10.5%	34	32	8	10	23	27	29
Goodrich-Kirtland Pk	8.48%	14.90%	27	3	4	2	14.2%	8	3	15	9	9	7	4
Hopkins	8.61%	16.90%	34	4	1	15	10.9%	2	4	25	1	14	33	14
Hough	24.16%	32.70%	8	23	31	24	14.2%	26	25	10	27	28	29	33
Jefferson	17.30%	24.40%	4	29	11	11	10.9%	24	23	31	15	5	24	18
Kamm's	33.61%	43.60%	28	34	29	34	10.9%	31	34	34	5	3	5	5
Kinsman	21.89%	28.50%	1	13	16	23	14.3%	18	21	3	19	32	31	30
Lee-Harvard	19.85%	25.90%	2	26	32	12	11.0%	29	20	30	22	19	23	21
Lee-Seville	20.72%	26.20%	26	17	10	10	11.0%	17	18	27	16	30	14	17
Mount Pleasant	22.45%	30.70%	6	28	33	26	11.0%	30	28	13	21	22	17	23
North Shore Collinwood	22.27%	30.80%	20	25	26	28	10.5%	28	27	28	20	13	9	15
Ohio City	22.43%	33.60%	13	9	21	20	14.7%	5	8	7	29	10	11	10
Old Brooklyn	22.32%	29.20%	23	33	17	33	12.5%	33	33	32	4	6	10	6
St.Clair-Superior	19.19%	27.30%	29	14	12	16	14.2%	12	14	9	17	27	16	19
Stockyards	16.16%	21.80%	12	15	13	7	12.5%	16	11	11	23	25	22	25
Tremont	16.55%	23.70%	15	7	9	9	14.7%	3	10	18	12	1	4	1
Union-Miles	21.94%	29.30%	17	31	25	31	11.0%	32	31	17	11	31	28	31
University	26.20%	37.60%	30	6	20	14	14.2%	14	7	2	18	4	1	2
West Boulevard	20.19%	28.60%	11	27	27	19	12.5%	21	22	26	30	16	25	28

Table 2. Top 10% of species for selected benefit functions for Cleveland, Ohio.

Tree Species	Streamflow Reduction	Building Energy Reduction	Wind Reduction	Air Temperature Reduction	UV Radiation Reduction	Overall Air Pollutant Removal	Specific Air Polutant Removal					Carbon Storage	Low VOC Emissions	Low Allergenicity
							Carbon Monoxide	Nitrogen Dioxide	Sulfur Dioxide	Ozone	Particulate Matter			
Abies concolor			X		X						X			
Abies nordmanniana			X								X			*X*
Acer x freemanii	*X*	*X*		*X*		*X*		*X*	*X*	*X*		*X*		
Aesculus flava	*X*	*X*		*X*		*X*	*X*	*X*	*X*	*X*		*X*		
Aesculus glabra	*X*	*X*		*X*		*X*	*X*	*X*	*X*	*X*				
Asimina triloba														*X*
Carpinus betulus						*X*	*X*			*X*			*X*	
Celtis laevigata		*X*			*X*		*X*			*X*		*X*		
Cercidiphyllum japonicum														*X*
Cladrastis kentukea												*X*		
Diospyros virginiana														*X*
Fagus sylvatica		*X*			*X*	*X*	*X*			*X*		*X*		
Halesia tetraptera							*X*						*X*	*X*
Ginkgo biloba	*X*	*X*						*X*	*X*			*X*		
Gymnocladus dioicus												*X*		
Liquidambar styraciflua	*X*	*X*		*X*				*X*	*X*					
Liriodendron tulipifera	*X*	*X*	*X*	*X*		*X*	*X*	*X*	*X*	*X*		*X*		
Magnolia acuminata	*X*	*X*	*X*	*X*		*X*		*X*	*X*			*X*		
Metasequoia glyptostroboides	*X*	*X*		*X*		*X*		*X*	*X*	*X*				
Ostrya virginiana						*X*				*X*				
Pinus rigida			*X*		*X*									
Pinus virginiana					*X*									
Platanus x acerifolia	*X*	*X*		*X*	*X*			*X*	*X*			*X*		
Quercus bicolor												*X*		
Quercus imbricaria												*X*		
Quercus macrocarpa					*X*							*X*		
Quercus meuhlenbergii					*X*							*X*		
Quercus palustris												*X*		
Quercus robur					*X*							*X*		
Quercus rubra					*X*							*X*		
Quercus shumardii	*X*	*X*		*X*				*X*	*X*			*X*		
Taxodium distichum	*X*							X	X					
Tilia americana	*X*	*X*	*X*	*X*		*X*	X	X	X	X		*X*		
Tilia cordata	*X*	*X*		*X*		*X*		X	X					
Tilia tomentosa	*X*	*X*		*X*		*X*	X	X	X	X				
Ulmus americana	*X*	*X*	*X*	*X*		*X*	*X*	*X*	*X*	*X*		*X*	*X*	
Ulmus parvifolia						*X*	*X*			*X*			*X*	
Zelkova serrata	*X*	*X*		*X*		*X*	*X*	*X*	*X*	*X*		*X*		

Relative Canopy

To help compare neighborhoods to each other and account for the vast differences in land use and neighborhood character, relative canopy is used. Relative tree canopy can be expressed as a percent of tree canopy that exists compared to what is possible. For example, while Cleveland's total tree canopy cover is 19% across all city land, its relative tree canopy cover equals 27% of what is possible (71% is theoretically possible). The relative canopy percentages by neighborhood are presented in Table 1 and mapped in Figure 3. The neighborhoods with the lowest amounts of relative tree canopy may warrant greater planning, financial, technical, and implementation assistance towards increasing canopy. Cleveland neighborhoods with the greatest potential for increased canopy include: Bellaire-Puritas, Central, Collinwood-Nottingham, Cudell, Cuyahoga Valley, Downtown, Goodrich-Kirtland Pk, Hopkins, Stockyards, and Tremont. Coincidentally, all of these neighborhoods have the lowest amount of tree canopy across all 34 neighborhoods. Two neighborhoods, Kinsman and Union-Miles, have above average tree canopy (19%) and high potential for increased canopy.

A large-growing tree provides up to eight times the benefits of a small-growing tree planted in the same environment. The benefits large trees provide can far exceed the initial cost and long-term maintenance needs they require. While planting small-growing trees may reduce occurrence of associated risk potential, the long-term benefits of planting large-growing trees should not be overlooked. Planting large-growing trees on public and private land within residential and industrial land uses of Cleveland may result in the greatest change in canopy.

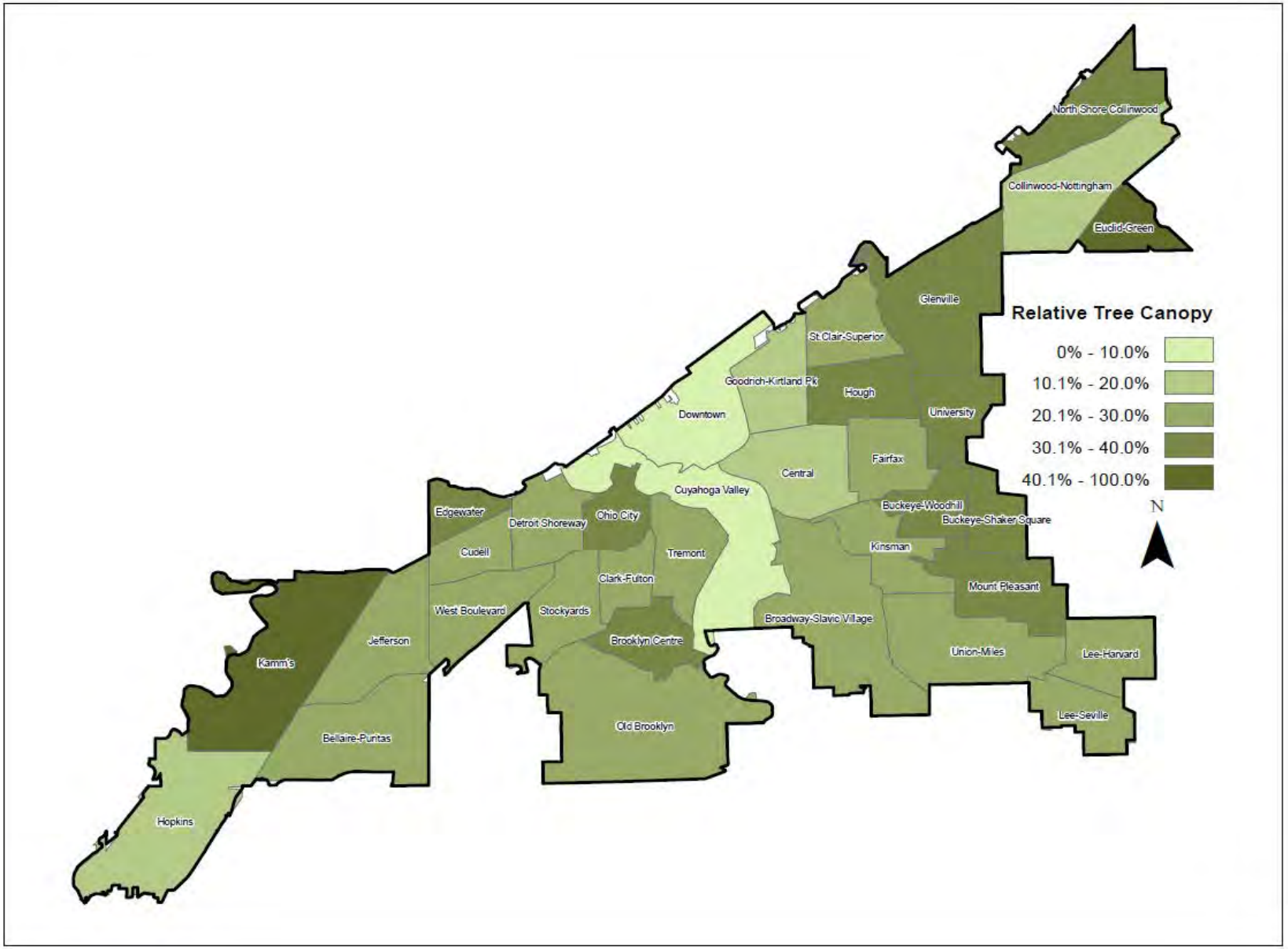

Figure 3. Relative tree canopy by neighborhood.

Stormwater Retention

The topography of the watershed, soil type and structure, and prevalence of impervious surfaces have an effect on stormwater, but trees play a major role too. Trees benefit stormwater management in urban areas by simply slowing the flow of stormwater during an average rain event. When rain does not hit impervious surfaces, it may soak into the soil where the water is filtered and becomes groundwater. In urban areas, there is a greater possibility in that the rainwater hits an impervious surface. The amounts of tree canopy and impervious surface within an urban watershed influences the quantity of stormwater that needs to be managed. Factoring in many of these considerations for the watershed, Figure 4 illustrates the need for stormwater management by neighborhood. Cleveland neighborhoods with the greatest need for increasing canopy, stormwater management, and decreasing impervious surfaces include: Buckeye-Shaker Square, Buckeye-Woodhill, Central, Clark-Fulton, Collinwood-Nottingham, Cudell, Detroit Shoreway, Fairfax, Glenville, Hough, Jefferson, Kinsman, Lee-Harvard, North Shore Collinwood, Ohio City, Stockyards, Tremont, Union-Miles, and West Boulevard. The neighborhoods with a high need for stormwater management may warrant financial, technical, and implementation assistance towards increasing canopy.

Trees reduce the volume and speed of rainwater during a rain event due to the amount of surface area in their trunk, branches, and leaves and their water-absorbing capabilities from the roots (directly) and surrounding soil (indirectly). Generally, planting large-growing trees creates the greatest stormwater management impact. There are a few tree species which perform this function best and the top 10% for Cleveland are listed in Table 3. Planting trees on public and private land within industrial, commercial, and institutional land uses of Cleveland may lead to the greatest change in water retention.

Table 3. Top 10% of species that can impact stormwater retention benefits for Cleveland, Ohio.

Species that retain rainwater best for improved performance in stormwater retention.
Acer x freemanii
Aesculus flava
Aesculus glabra
Ginkgo biloba
Liquidambar styraciflua
Liriodendron tulipifera
Magnolia acuminata
Metasequoia glyptostroboides
Platanus x acerifolia
Quercus shumardii
Taxodium distichum
Tilia americana
Tilia cordata
Tilia tomentosa
Ulmus americana
Zelkova serrata

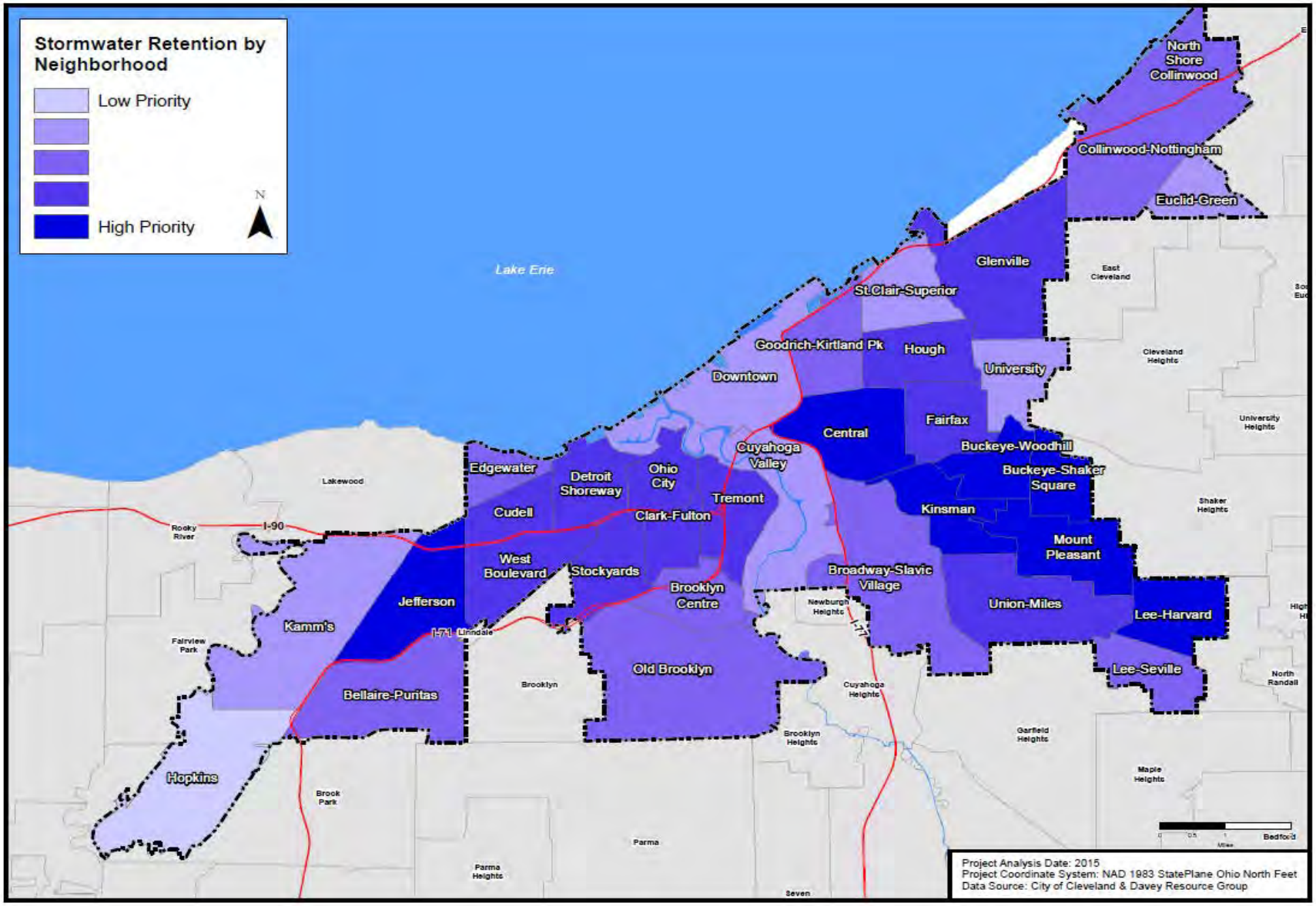

Figure 4. Stormwater retention needs by neighborhood.

Energy Savings

When trees are properly placed around houses, offices, and businesses, their shade and windbreak can reduce cooling and heating energy uses. Trees also reduce surrounding air temperatures by releasing water vapor, which further reduces the need for air conditioning. Factoring in the prevalence of real estate in correlation to the prevalence of canopy, Figure 5 illustrates estimated energy conservation benefits through tree canopy by neighborhood. Cleveland neighborhoods with the greatest need to increase canopy near buildings include: Buckeye-Woodhill, Central, Cudell, Cuyahoga Valley, Downtown, Edgewater, Fairfax, Goodrich-Kirtland Pk, Hopkins, Kinsman, Ohio City, St.Clair-Superior, Tremont, and University. The neighborhoods with a high need for energy conservation may warrant greater planning, and more financial and technical assistance to strategically implement more tree canopy.

Generally, planting large-growing trees will create the greatest impact because those trees provide the greatest amount of shade and wind block for air conditioned and heated spaces. The top 10% of species that perform this function the best for Cleveland are listed in Table 4. Planting trees on public and private land within residential, commercial, and institutional land uses of Cleveland may lead to the greatest change in energy savings.

Table 4. Top 10% of species that can improve energy savings for Cleveland, Ohio.

Species that reduce energy usage best for improved performance in energy savings.	Species best used to break penetrating winds for improved performance in energy savings.
Acer x freemanii	*Abies concolor*
Aesculus flava	*Abies nordmanniana*
Aesculus glabra	*Liriodendron tulipifera*
Celtis laevigata	*Magnolia acuminata*
Fagus sylvatica	*Pinus rigida*
Ginkgo biloba	*Ulmus americana*
Liquidambar styraciflua	*Tilia americana*
Liriodendron tulipifera	
Magnolia acuminata	
Metasequoia glyptostroboides	
Platanus x acerifolia	
Quercus shumardii	
Tilia americana	
Tilia cordata	
Tilia tomentosa	
Ulmus americana	
Zelkova serrata	

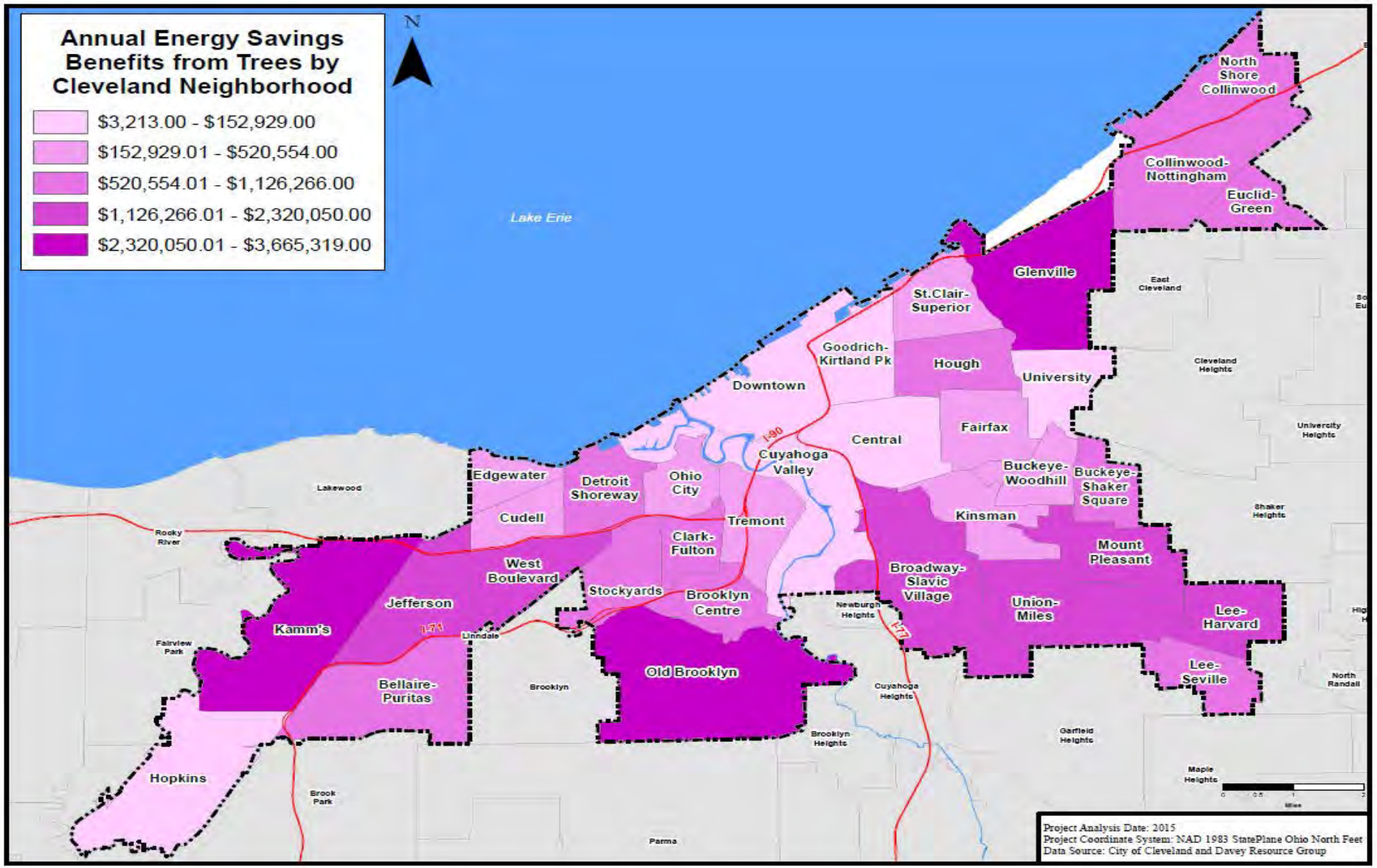

Figure 5. Energy savings benefits by neighborhood.

Mitigating Urban Heat Island Effect

Heat islands are caused by impervious surfaces including buildings, streets, driveways, and parking lots. Within one urban geographical area, large concentrations of impervious surface types and small concentrations of tree canopy cover negatively affect ambient air temperatures. When little to no shade is casted over heat absorbing surfaces, this causes higher temperatures and prolonged temperatures throughout the night. The following sunny day can compound the heat index because the air has not had the proper time to cool. Figure 7 illustrates where heat islands are greatest and lowest within Cleveland by neighborhood. Cleveland neighborhoods with the greatest need to reduce their heat island over impervious surfaces include: Collinwood-Nottingham, Cuyahoga Valley, Downtown, Goodrich-Kirtland Pk, and Hopkins. The neighborhoods with a high need to lower their heat island hot spots may warrant greater planning, and more financial and technical assistance to implement more tree canopy strategically.

Generally, planting large-growing trees will create the greatest impact because those trees will provide the greatest amount of shade over impervious surfaces. The top 10% of species that perform this function the best for Cleveland are listed in Table 5. Planting trees on public and private land within residential, recreational open spaces, and commercial land uses of Cleveland may lead to the greatest change in heat island.

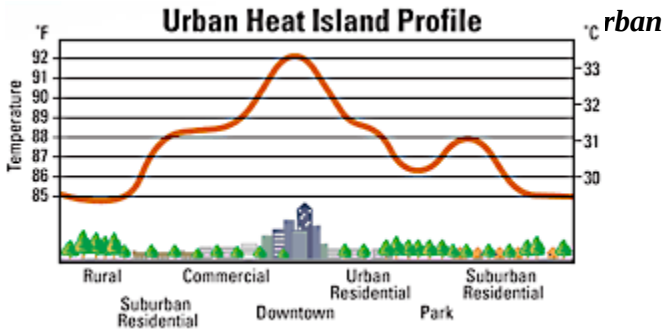

Figure 6. Urban heat island profile for typical urban-rural transect. (SOURCE)

Table 5. Top 10% of species that can mitigate urban heat island effect for Cleveland, Ohio.

Species that provide shade best for improved performance in cooling air temperatures.	Species that are best for improved performance in reducing UV radiation.
Acer x freemanii	*Abies concolor*
Aesculus flava	*Celtis laevigata*
Aesculus glabra	*Pinus rigida*
Liquidambar styraciflua	*Pinus virginiana*
Liriodendron tulipifera	*Platanus x acerifolia*
Magnolia acuminata	*Quercus macrocarpa*
Metasequoia glyptostroboides	*Quercus meuhlenbergii*
Platanus x acerifolia	*Quercus robur*
Quercus shumardii	*Quercus rubra*
Tilia americana	
Tilia cordata	
Tilia tomentosa	
Ulmus americana	
Zelkova serrata	

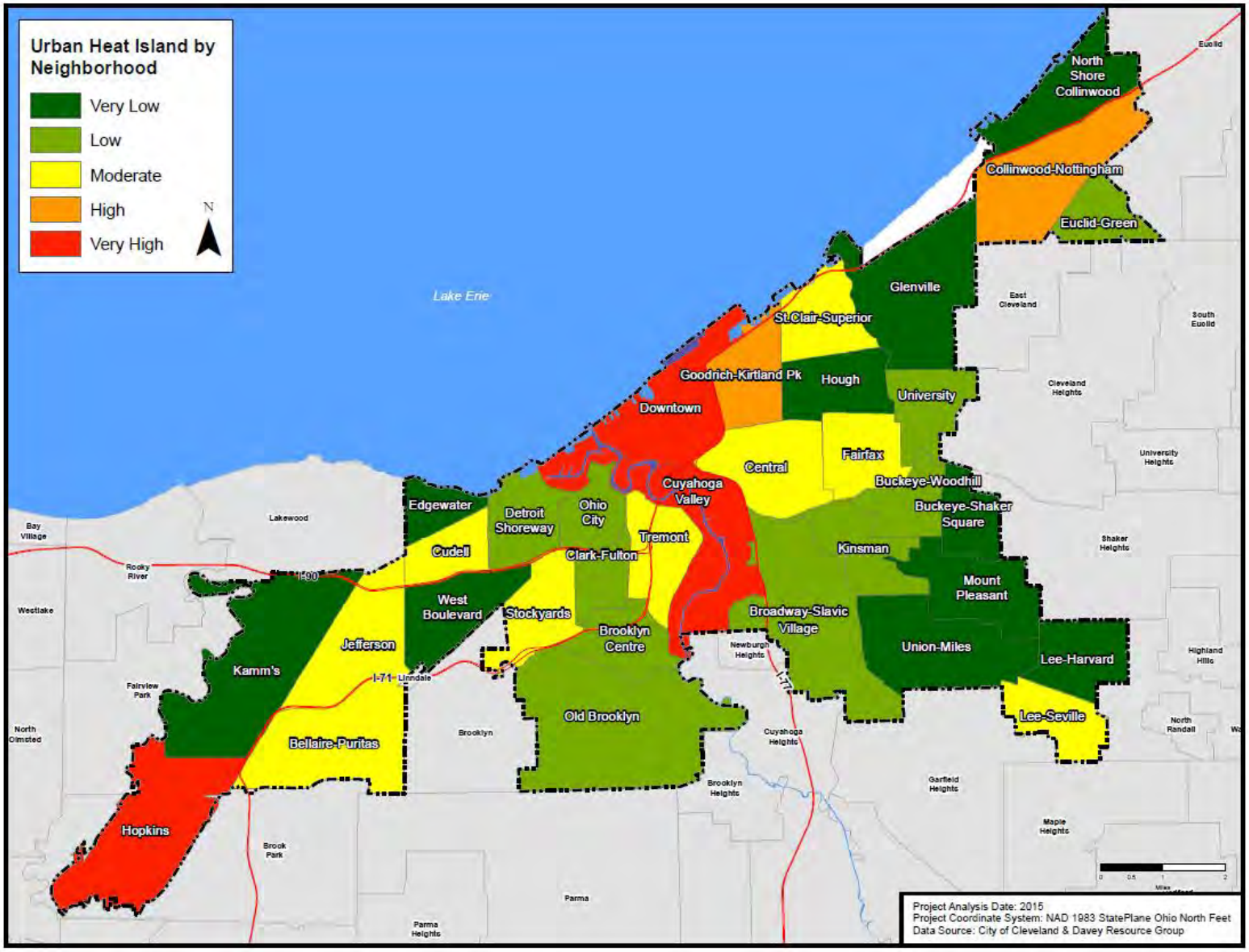

Figure 7. Urban heat island intensity by neighborhood.

Human Health

Trees create a healthier environment for people by improving air quality. Reductions in ozone, carbon, particulate matter, and other air pollutants lowers incidence of respiratory illnesses and hospital visits. The Cleveland neighborhoods with the greatest needs for air quality improvement include: Buckeye-Woodhill, Clark-Fulton, Cudell, Detroit Shoreway, Downtown, Edgewater, Edgewater, Stockyards, and Tremont. Additional consideration for increased canopy could be in neighborhoods where asthma rates are highest. The neighborhoods with a high need to improve air quality through increasing tree canopy are illustrated in Figures 8 and 9. These neighborhoods may warrant greater planning, along with additional financial, technical, and assistance in implementing more tree canopy strategically.

Generally, planting large-growing trees creates the greatest impact because those trees provide the most cooling effects, store the most carbon, collect the most pollutants, and produce the most oxygen. The top 10% of species that perform this function the best for Cleveland are listed in Table 6. Planting trees on public and private land within residential, recreational, and industrial land uses of Cleveland may lead to the greatest improvements in air quality, and thus, human health.

Additionally, trees largely influence the social health of the community. Trees create a natural calming effect on people and have been found to reduce incidence of domestic violence, crime, and abuse. Also, social ties with neighbors are strengthened because trees bring people outside and more frequent outdoor visits reinforce stronger bonds between neighbors. Trees benefit the neighborhood by making streets safer. Large-growing trees can cause moving vehicles to slow speeds. Tree-lined streets guard sidewalks and pedestrians from vehicles traveling off the road.

Table 6. Top 10% of species that positively impact human health for Cleveland, Ohio.

Species that best reduce air pollutants causing respiratory illness for improved performance in human health.	
Abies nordmanniana	*Ostrya virginiana*
Acer x freemanii	*Platanus x acerifolia*
Aesculus flava	*Quercus bicolor*
Aesculus glabra	*Quercus imbricaria*
Asimina triloba	*Quercus macrocarpa*
Carpinus betulus	*Quercus meuhlenbergii*
Carpinus betulus	*Quercus palustris*
Celtis laevigata	*Quercus robur*
Cercidiphyllum japonicum	*Quercus rubra*
Cladrastis kentukea	*Quercus shumardii*
Diospyros virginiana	*Taxodium distichum*
Fagus sylvatica	*Tilia americana*
Ginkgo biloba	*Tilia cordata*
Halesia tetraptera	*Tilia tomentosa*
Liquidambar styraciflua	*Ulmus americana*
Liriodendron tulipifera	*Ulmus parvifolia*
Magnolia acuminate	*Zelkova serrata*
Metasequoia glyptostroboides	

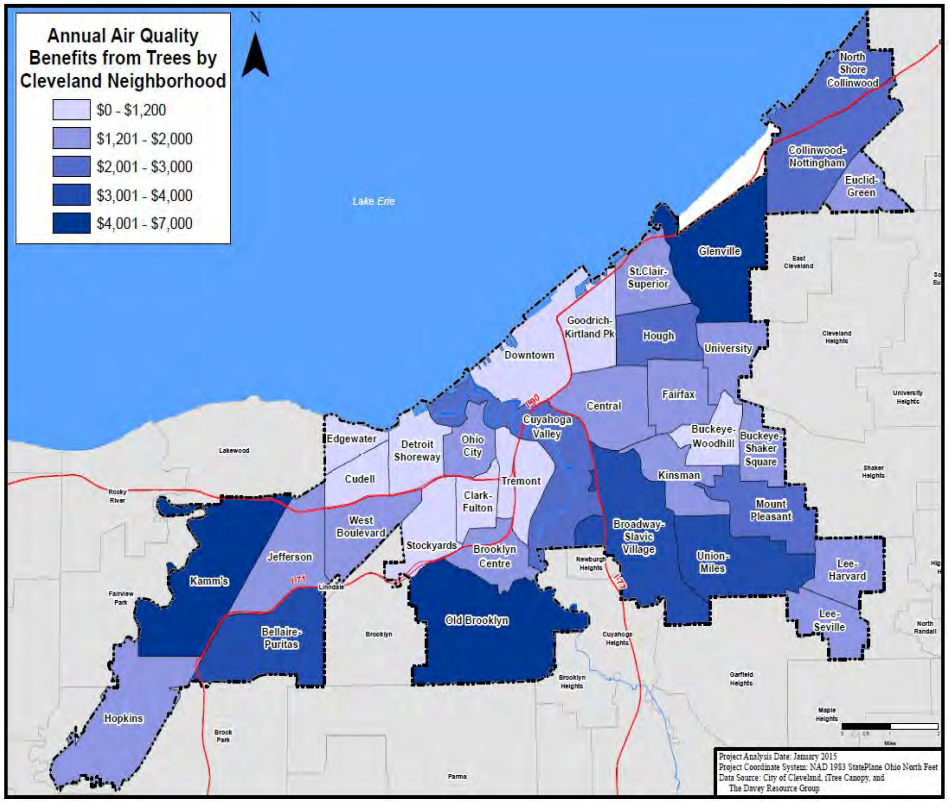

Figure 8. Air quality benefits by neighborhood.

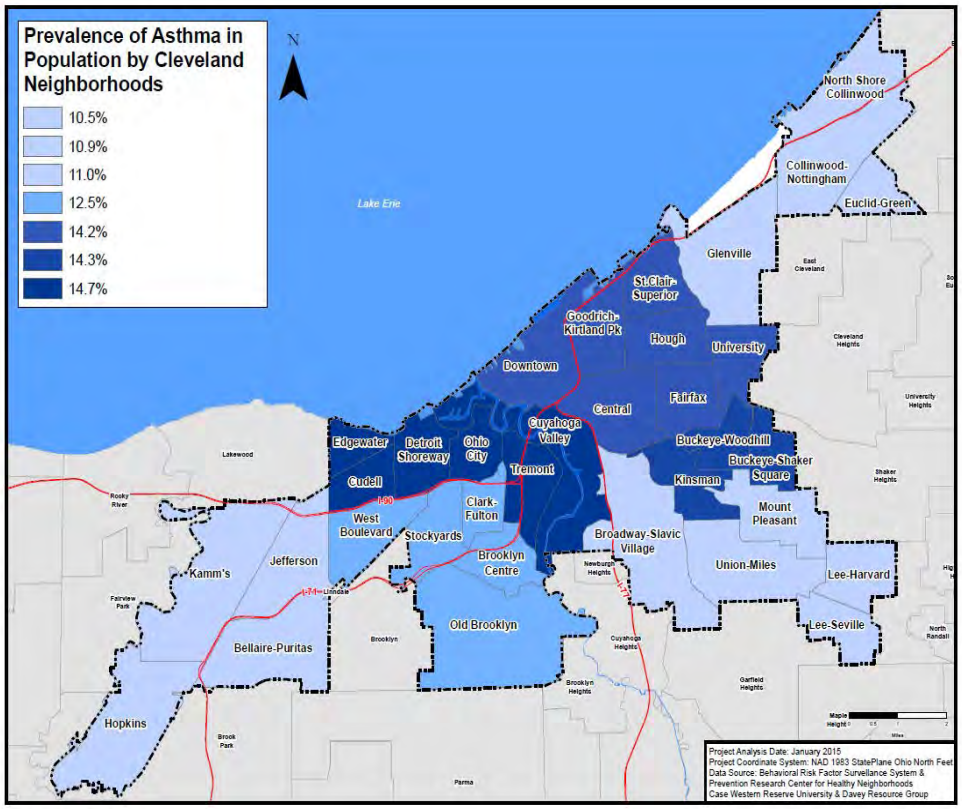

Figure 9. Asthma prevalence by neighborhood.

Economic Development Potential

Trees have an influence on a community's economy by way of job creation, worker productivity, frequency of shoppers and duration or time shopping, business or home vacancy prevalence, and property value increases. Studies show that the simple presence of trees around workers decreases the number of work days missed and soothes work related stress at a quicker rate than when comparing workers who do not see trees during the workday. The occurrence of vacant homes and businesses may be less due to the demand to live where trees are present in the landscape. Landscapes with trees also increase a buyer's willingness to pay more for a home than one without trees. Shoppers also spend more and potentially buy more merchandize or services in canopy covered commercial districts. Figures 10 illustrates where Cleveland may want to concentrate tree planting to increase property values. Cleveland neighborhoods with the greatest need to increase property values include: Brooklyn Centre, Buckeye-Woodhill, Central, Clark-Fulton, Collinwood-Nottingham, Cudell, Cuyahoga Valley, Detroit Shoreway, Downtown, Edgewater, Fairfax, Goodrich-Kirtland Pk, Hopkins, Ohio City, St.Clair-Superior, Stockyards, Tremont, and University. Neighborhoods with a high need to increase property values may warrant greater planning, and more financial and technical assistance to implement more tree canopy strategically.

Cleveland neighborhoods with the lowest average annual household income are illustrated in Figure 11 and include: Broadway-Slavic Village, Buckeye-Woodhill, Central, Cudell, Cuyahoga Valley, Detroit Shoreway, Fairfax, Glenville, Goodrich-Kirtland Pk, Hough, Kinsman, Mount Pleasant, Ohio City, St.Clair-Superior, Stockyards, and University. These neighborhoods may also warrant increased attention for tree planting based on the influence tree canopy can have economic development potential.

Planting a mix of large-growing and small- or medium-growing ornamental/flowering trees will create the greatest impact. Trees planted on public and private land within commercial, industrial, and institutional land uses of Cleveland may lead to the greatest changes in economic development.

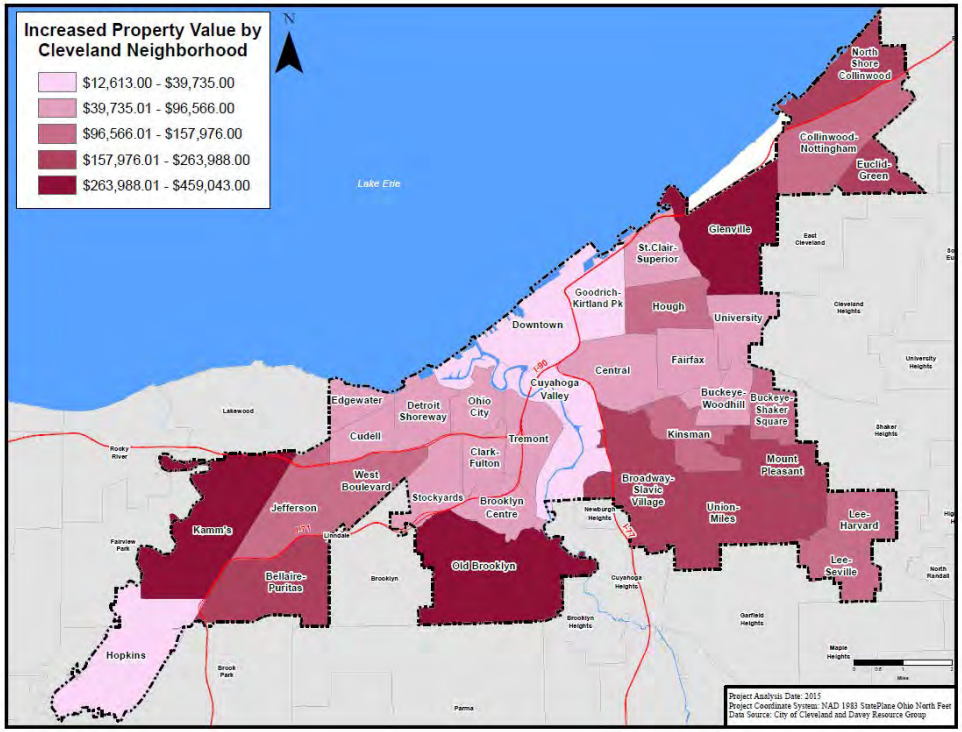

Figure 10. Property values increases attributed to canopy cover by neighborhood.

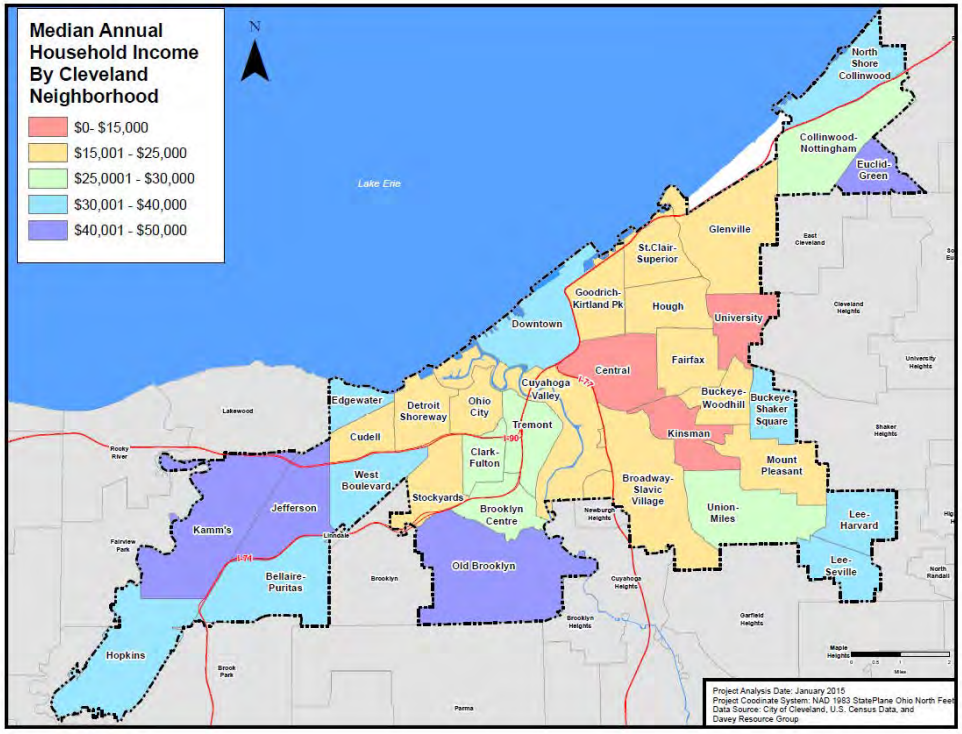

Figure 11. Median income by neighborhood.

Equity

An important part of tree planting is addressing the disparities in environmental justice. Equity in the urban forest is measured by the distribution of tree canopy benefits, specifically how those benefits influence population density, unemployment rates, and child poverty.

Inequality can be emphasized when one geographical area receives less canopy benefit than another, yet the need for canopy benefit is greater. With the guidance of Quentin Karpilow, Davey Resource Group utilized an equity ranking to help develop strategies for narrowing the gap in canopy, and thus benefits, at the neighborhood level. The equity ranking uses population density, unemployment rates, and child poverty rates to show the neighborhoods most in need of the benefits afforded by tree canopy (Figures 12-14). When aggregated, these equity indicators suggest where Cleveland may want to concentrate tree planting effort to lessen inequities in canopy cover (Figure 15). Cleveland neighborhoods with the greatest need to increase people's access to trees include: Broadway-Slavic Village, Brooklyn Centre, Buckeye-Woodhill, Central, Clark-Fulton, Cudell, Fairfax, Glenville, Hough, Kinsman, Lee-Harvard, Mount Pleasant, Stockyards, Union-Miles, and West Boulevard. The neighborhoods with a highest need for canopy-driven benefits may warrant greater planning, and more financial and technical assistance to implement more tree canopy strategically.

Planting a mix of large-growing and small- or medium-growing ornamental/flowering trees will create the greatest impact. The city, neighborhood organizations, and future funders could use the focus of tree benefits stated above to determine what tree species to plant and for what beneficial purpose. Trees planted on public and private land within residential, recreational, and vacant land uses of Cleveland may lead to the greatest changes in equity of environmental justice.

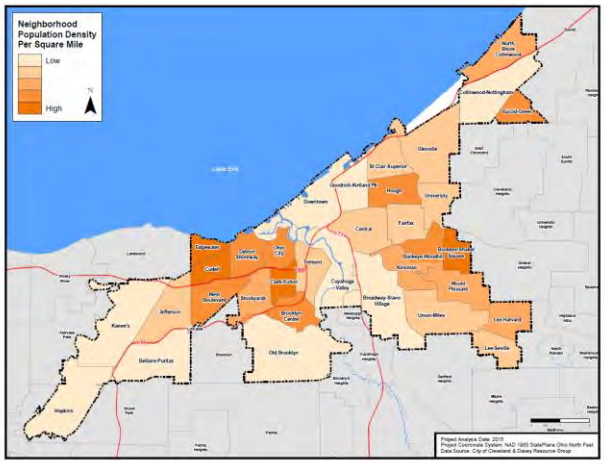

Figure 12. Population density by neighborhood.

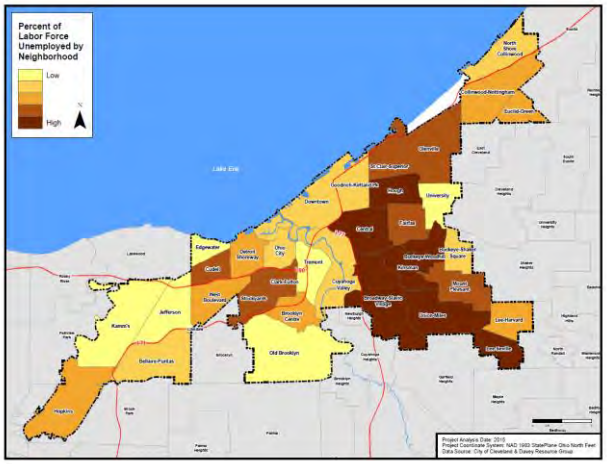

Figure 13. Unemployment rates by neighborhood.

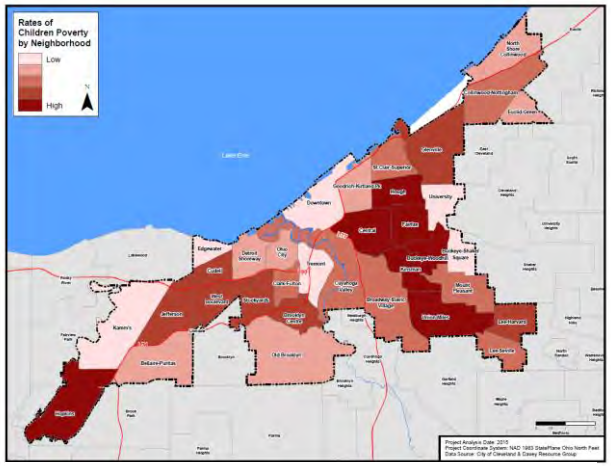

Figure 14. Property values increases attributed to canopy cover by neighborhood.

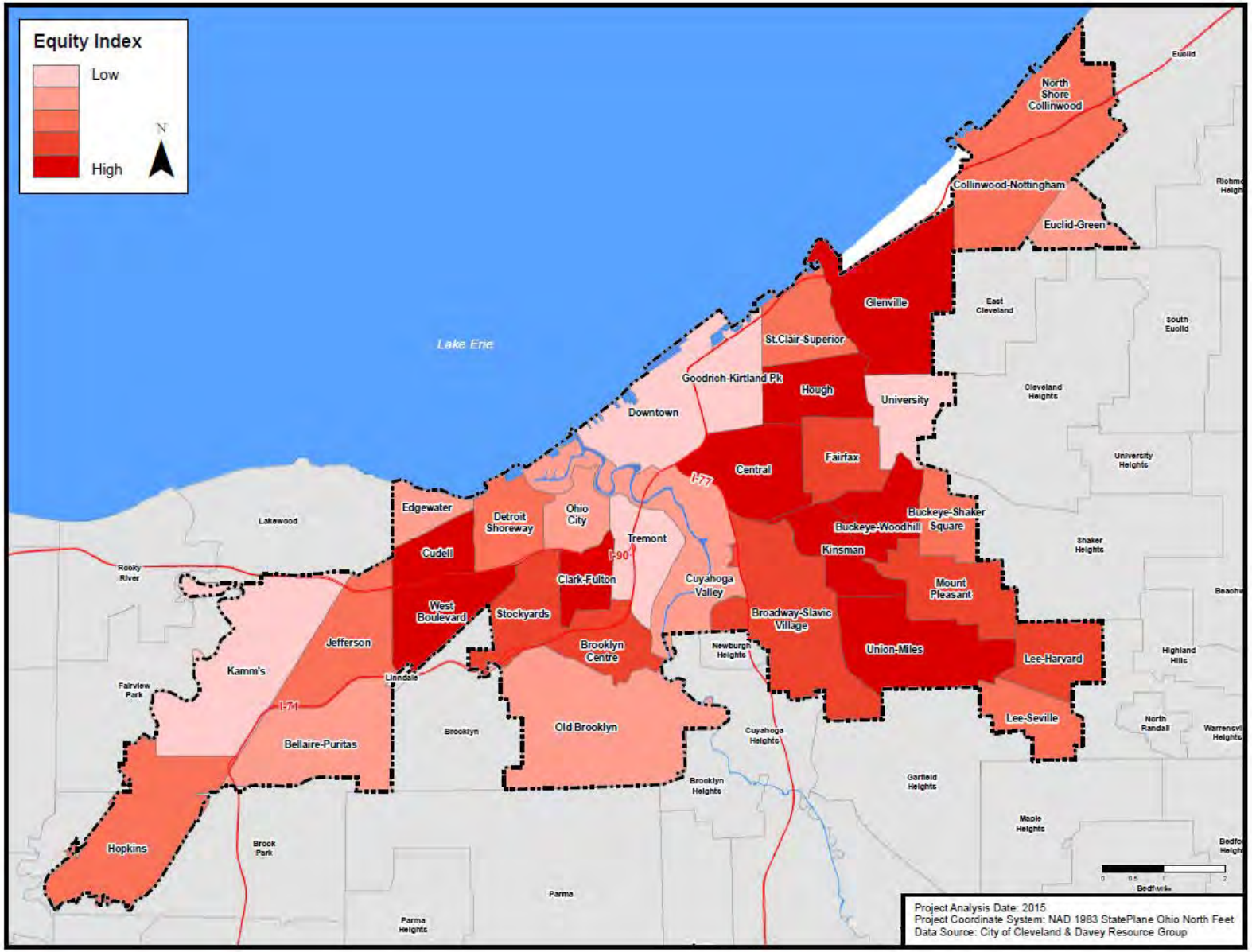

Figure 15. Equity index to indicate need for tree benefts by neighborhood.

Availability of Vacant Land

The urban ecosystem is extremely complex and diverse. Small, functional ecosystems together form a larger system, each of which may need to be managed differently. The overall health of the urban ecosystem depends on the ability of trees, plants, wildlife, insects, and humans to coexist as a whole. Often, the health and diversity of the overall canopy can be greatly improved by creating connections between multiple patches of forest. Planting vacant lands adjacent to contiguous canopy may help improve the distribution and composition of the canopy.

Davey Resource Group analyzed Cleveland's existing urban tree canopy for fragmentation. The analysis found the following:

- **862 acres of Core Canopy.** Tree canopy that exists within and relatively far from the forest/non-forest boundary (i.e., forested areas surrounded by more forested areas).
- **144 acres of Perforated Canopy.** Tree canopy that defines the boundary between core forests and relatively small clearings (perforations) within the forest landscape.
- **2,342 acres of Edge Canopy.** Tree canopy that defines the boundary between core forests and large non-forested land cover features. When large enough, edge canopy may appear to be unassociated with core forests.
- **6,159 acres of Patch Canopy**. Tree canopy that comprises a small forested area that is surrounded by non-forested land cover.

Using this forest fragmentation analysis, Davey Resource Group prioritized Cleveland's parcels of vacant land by adjacency to *core*, *edge*, *perforated*, and *patch* forests. Table 7 illustrates this prioritization of available land by land use and Figure 16 shows the availability of land by neighborhood. Neighborhoods with higher priority planting should plant native large-growing species within vacant parcels and determine whether parcels should be part of the maintained landscape (park-like area) or if natural forest regeneration should take place. Cleveland neighborhoods with the greatest potential to increase canopy by foresting vacant land include: Bellaire-Puritas, Broadway-Slavic Village, Brooklyn, Central, Collinwood-Nottingham, Cuyahoga Valley, Fairfax, Glenville, Hopkins, Hough, Kinsman, Old Brooklyn, and Union-Miles. The neighborhoods with a high potential to increase canopy through planting vacant land may warrant greater planning, and more financial and technical assistance to implement more tree canopy strategically.

Additionally, private landowners who own large tracts of land (over XXX acres) comprise 21% (11,092 acres) of all the land in Cleveland. Landowners are a mix of city, state, park, rail, civic, health, and utility organizations. The cooperation and partnerships with these organizations to plant trees on their properties will play a major role in reaching canopy goals. Large landowners could use the same principles as stated above to determine where and what to plant.

Planting a mix of large-growing and small- or medium-growing ornamental/flowering trees will create the greatest impact. The city, neighborhood organizations, and future funders could determine what tree species to plant for what beneficial purpose (maintained landscape versus natural area).

Table 7. Acres of Vacant Parcels by Land Use and Priority Level

General Land Use	Very Low Priority	Low Priority	Moderate Priority	High Priority	Very High Priority	Total
Agricultural	0	0	0	0	2	2
Commercial	122	246	109	250	221	947
Industrial	169	336	197	351	919	1,971
Institutional	12	20	14	14	23	84
Recreation/Open Space	6	4	1	3	47	61
Residential - Multifamily	43	102	61	133	227	565
Residential - Single Family	307	602	367	427	463	2,166
ROW	5	4	8	13	0	30
Transportation/Utilities	14	2	12	8	23	60
Total	679	1,317	768	1198	1,925	

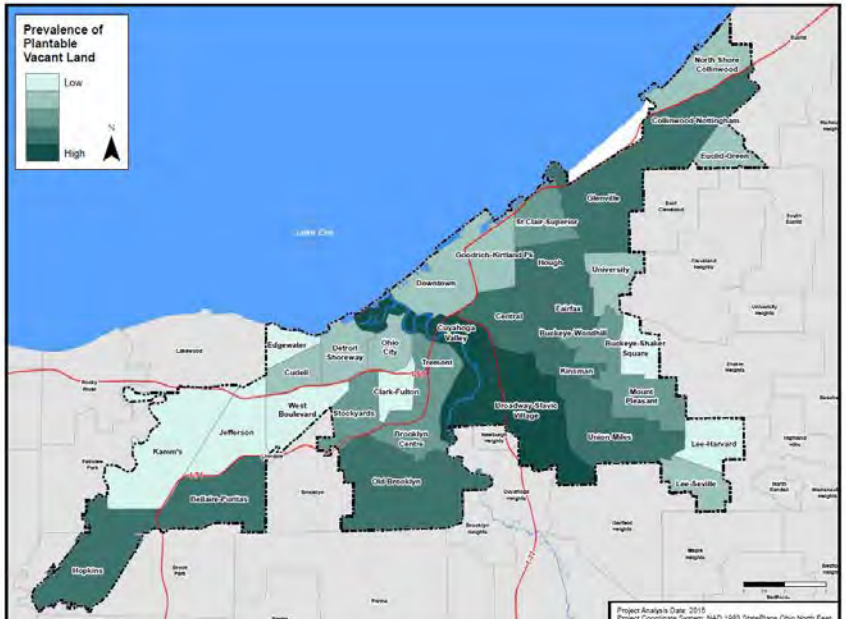

Figure 16. Prevalence of vacant land available for planting by neighborhood.

Conclusion

Achieving significant increases in canopy cover over the next 25 years may not be easy, which is why establishing canopy goals is essential for Cleveland. The City of Cleveland, Cleveland neighborhood groups, and future funders will need to work together in the development of new and innovative planting programs described in the action item section of this plan. Such planting programs are based on a centralized vision to achieve a canopy goal. The planting of street trees may encourage residents and business to plant trees on their property, a product of city leadership. The six neighborhoods with the highest need (Central, Clark-Fulton, Cudell, Fairfax, Stockyards, and West Boulevard) present the greatest potential for increased canopy cover. Neighborhoods can individually utilize these maps and data to strategically determine and prioritize tree planting needs. The investment of time and money in planting new trees and maintaining Cleveland's existing trees will more than pay for itself through the beneficial services that these trees provide.

Appendix N:

Climate Change and Urban Agriculture Literature Revew

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Urban areas in the Midwest will be impacted by climate change, exacerbating underlying socio-economic conditions. The main ways in which climate change will affect Cleveland is through heat waves, flooding, and other storm events. Urban agriculture has the potential to mitigate the urban heat island effect, and help the city adapt to a changing climate.

Urban agriculture consists of multiple forms of growing and producing food in urban areas such community gardens, school gardens, urban farms and even community supported agriculture (Raja et al. 2008). The activities range from growing fruits and vegetables, animal husbandry, bee keeping and creating value added products from raw produce (Raja et al. 2008). Though the food systems literature provides information on how urban agriculture contributes to the general well-being of society, there is very little evidence that documents urban agriculture's impact on the environment. Similarly, while the urban climate literature provides information on urban heat island abatement, urban agriculture is not typically considered as a land use to mitigate increased urban temperatures. This literature review investigates whether urban agriculture has the potential to reduce the urban heat island effect in Cleveland and Cuyahoga County, Ohio.

Urban agriculture's mitigation potential

To make the case for urban agriculture's potential to reduce urban heat island effect in urban spaces, we rely on literature that uses vegetation in mitigation scenarios. In most of these studies, vegetation simply refers to grass. Just as grass is capable of increasing local rates of evapotranspiration, providing a cooling effect or reflecting radiation from the sun, so is urban agriculture by its very nature of putting into the ground vegetation that provides the same environmental services.

Drawing from urban climate research we find that vegetation cools surfaces more efficiently than strategies that increase albedo (reflect instead of absorb radiation from the sun) (Rosenzweig, Solecki, and Slosberg 2006). The case study of Manhattan shows curbside planting to be the most effective cooling strategy per unit area of redevelopment (Rosenzweig, Solecki, and Slosberg 2006). A similar study in Nagoya, Japan found greening - planting with grass and alternatively planting a mix of trees and grass (30-70 ratio)-parking lots reduces spring and summer temperatures (Onishi et al. 2010). Urban temperatures decrease by 6.5°C in the spring and 8°C in the summer when parking lots are planted with grass and by 7.4°C and 9.3°C, respectively when planted with a mix of trees and grass (Onishi et al. 2010).

However the use of different strategies to reduce urban heat effect is context specific. In a tristate study –Atlanta, Philadelphia and Phoenix – analyzing heat related mortalities revealed that albedo enhancements were more efficient in arid areas like Phoenix and vegetative measures were more effective in humid regions like Philadelphia (Stone Jr et al. 2014). Overall the study found that a combination of vegetation and albedo enhancements offset projected heat related mortalities by 40-99% in all three study areas in a business as usual climate pathway for an average warm season and heat wave conditions in 2050 (Stone Jr et al. 2014).

Research also suggests that augmenting peri-urban areas has an effect on the temperatures in the City's core (Stone Jr et al. 2013). They found fully transitioning peri-urban areas around the city to a forested area to provide a cooling effect in a city's core. These results are suggestive that maintaining and protecting farmland in peri-urban areas will be more beneficial to urban climate management then progressing with suburban development (Qiu et al. 2013). Another mitigation benefit of urban vegetation is its pollution reduction properties. One of the effects of climate change has been a projected increase in urban aerosols and pollutants, which urban vegetation has been shown to reduce in densely populated areas like Newark and Camden, NJ (Solecki et al. 2005).

Additionally urban organic waste can be diverted to urban farms reducing land fill volume and emissions from landfills. Landfills constitute 18% of the United States methane emissions – third most significant contributor of methane emissions annually (EPA, 2015). Much effort has been spent on capturing methane on site and transforming it into an energy source. However diversion of organic waste away from landfills is more beneficial as it is more cost effective and will reduce greenhouse gas emissions. Urban farms can be instrumental in city wide curbside composting programs. The increased organic matter in the soils will improve soil hydrology and increase water retention properties (O'Neal et al. 2005).

While it is currently unsupported, the researchers also hypothesize that the carbon sequestration properties of agriculture will apply to urban agriculture. Urban agriculture's smaller size and non-mechanized production system saves it from the pitfalls of industrialized agriculture and hence mean emissions from small scale urban agriculture enterprises are probably offset by its mitigation properties.

Urban agriculture's adaptive potential

Beyond its urban heat and pollution reduction properties, urban agriculture can also play a role in flood and storm water management. The Midwest is expected to experience heavy precipitation events that will exacerbate poorly maintained CSO systems causing contamination of waterways and localized flooding events. As more and more precipitation is lost as runoff from built up spaces – as much as five time more precipitation is lost as runoff in urban spaces than in forested areas (EPA 2015), it reduces the rate of groundwater recharge adversely affecting water supply in arid regions and regions that rely primarily on groundwater (Barlage et al. 2002). Runoff increases the stress that city sewers face under storm events. Surface runoff from urban systems is one of the leading causes of lake and estuary health impairment in the Unites States (EPA 2015).

Research has shown vegetation and augmenting roofs as green spaces can help reduce surface runoff and reduce pressure on CSO's during precipitation events (Stovin 2010, Gómez-Baggethun and Barton 2013). Urban agriculture has been overlooked in this regard but we apply research from green roofs – roofs that have been retrofitted with soil layers and plants to intercept and hold precipitation – to illustrate urban agriculture's potential in storm water management.

Given that the structure and design of green roofs are similar to that of urban agriculture, it is appropriate to draw from this literature to demonstrate urban agriculture's potential beyond increasing food security. Green roofs intercept and store water, returning it to the atmosphere through evaporation and/or transpiration as would crop cover in urban agriculture (Stovin 2010, Carter and Jackson 2007).

Research into green roofs and ground vegetation shows that these measures are conducive to storm water management, and groundwater recharge. Green roofs reduced peak flow volumes by as much as 26% in a study in Athens, GA (Carter and Jackson 2007). Carter and Jackson (2006) also find that green roofs in the study had the same precipitation interception potential as forested areas. Similar results emanate from research in the U.K where vegetated roofs have been shown to retain as much as 34% of the precipitation on average over 11 precipitation events in the spring of 2006 (Stovin 2010). In the same study Stovin (2010) demonstrated a 59.6% reduction in peak flows using vegetated green roof technology.

Another experimental study in Detroit highlights the runoff attenuation property of vegetated green roofs (VanWoert et al. 2005). In all experimental setups the vegetated beds retained more precipitation – almost twice the amount than gravel beds - over the 14 months than the gravel beds (VanWoert et al. 2005). The vegetation also slowed down flow of runoff

which reduced the risks of flood events downstream (VanWoert et al. 2005). Evidence from research in Dayton, Ohio suggests that increasing vegetation reduced runoff into the city's storm sewer systems by as much as 7% (Sanders 1986). Sanders (1986) also finds that when existing vegetation is removed, runoff from storm events can increase by 2% in the city of Dayton. A study in Sweden found ground vegetation helped reduce runoff significantly. Without vegetation the city was losing up to 60% of precipitation as runoff – in vegetated areas only 5-15% of precipitation was lost as runoff, the remainder was intercepted and evaporated through natural process or infiltrated the soil (Bernatzky 1983). The reduced peak flows and runoff are important factors in abating flood events and sedimentation (Bernatzky 1983).

Increasing food security: Drawing from food systems literature we find urban agriculture provides numerous opportunities to increase food security within urban environments (Dubbeling and de Zeeuw 2011, Corrigan 2011, Armstrong 2000, Lovell 2010). The most famous example comes from Havana, Cuba where its urban gardens are documented to supply the city with 8,500 tons of agricultural produce, 4 million dozens of flowers, 7.5 million eggs, and 3,650 tons of meat (Altieri et al. 1999). Urban farming developed as a social response to alleviate incomes loses from trade embargos when the socialist bloc fell (Altieri et al. 1999). While urban farms do not produce all the food and nutritional requirements of the city, the farms buffer the city population against economic shocks and supply residents with a steady flow of nutrients. Qualitative assessment of urban agriculture's effect on food security in the United States has also produced similar results (Corrigan 2011, Armstrong 2000). A study of community gardens in Baltimore, Maryland showed that food security of all individuals involved in the community garden was improved (Corrigan 2011). The gardeners reported they obtain almost all their vegetables from the gardens and have not visited the markets for years (Corrigan 2011). The garden produces excess fruits and vegetables which is donated by gardeners to various service organizations in Baltimore – hence contributing to improving food security of not just the gardeners but other vulnerable populations in the city (Corrigan 2011).

Similarly survey of twenty rural and urban community gardens in upstate New York showed that the most prevalent reason for participation in the garden was access to fresh foods (Armstrong 2000). The gardens also served as the primary food source for low income households (Armstrong 2000). A quantitative analysis of urban agriculture and its impact on nutrition in 15 countries across Africa, Asia, Latin America and Europe showed that the presence of urban agriculture was associated with higher levels of calorie availability and greater dietary diversity (Zezza and Tasciotti 2010). The literature highlights that most of those engaged in urban agriculture come from low socio-economic backgrounds (Zezza and Tasciotti 2010, Corrigan 2011). In many instances urban agriculture offers individuals an opportunity to generate additional income. Zoning and garden policy prohibits selling produce in many localities (Armstrong 2000).Which is why strong linkages between urban agriculture and income generation has not been demonstrated empirically. Zezza and Tasciotti (2010) found that while urban agriculture shored up food security, there was minimal impact on income generation from these activities. Similarly in upstate New York very few gardeners in the study sold their produce, many were prohibited from doing so and others were more interested in growing food for personal consumption rather than retail (Armstrong 2000). However additional income that is generated by urban agriculture provides increased resiliency in times of economic and climatic shocks. The cross-section of studies presented illustrate the importance of urban agriculture to vulnerable urban populations by diversifying their food sources, increasing access to more healthful and nutritious food – especially in inner cities where choices are limited – and providing alternative sources of food during economic lulls and scarcity.

Urban agriculture: Beyond environmental services

Provision of environmental services in mitigating and adapting to climate impacts is only half the picture – benefits of urban farming transcends environmental flows. Engagement in urban farming has been shown to improve social cohesion, reclaim vacant lots to build positive and productive spaces within neighborhoods and provide numerous health benefits (Poulsen et al. 2014, Bellows, Brown, and Smit 2003, Brown and Jameton 2000, Brown et al. 2004, Hung 2004, Wakefield et al. 2007). Urban farming spaces offer communities a platform to build "a sense of unity", strengthen social bonds and reconstruct a positive narrative of their neighborhoods (Poulsen et al. 2014). This process of engagement and reclaiming neighborhoods brings with it a sense of pride and social empowerment (Poulsen et al. 2014). In neighborhoods marked by blight, turning vacant lots into productive spaces is useful in spurring economic investment (Raja et al. 2008).

As more people engage in gardening it brings more "eyes on the streets", creating positive and safe places within violent neighborhoods. Having a safe space for youths in these neighborhoods is especially important to counter the cycle of violence and poverty (Poulsen et al. 2014, Hung 2004). Urban farming spaces are also instrumental in improving health and nutrition of gardeners (Armstrong 2000, Bellows, Brown, and Smit 2003, Brown and Jameton 2000). Research has indicated that those who participate in gardening and growing food are more likely to eat more fruits and vegetables, and be more willing to try new foods than those who do not (Alaimo et al. 2008, Ober Allen et al. 2008, Lautenschlager and Smith 2007, Pothukuchi 2004). The literature also indicates gardening enhances physical and mental well-being as it triggers illness prevention and healing responses (Bellows, Brown, and Smit 2003, Brown and Jameton 2000). Urban farm programming have also been instrumental in developing youth self-efficacy and knowledge of food and nutrition (Pothukuchi 2004, Hung 2004). All in all urban agriculture presents to planners a low regret strategy that has a positive net effect on communities and their well-being.

Urban agriculture: A no regret strategy for climate mitigation and adaptation

The synthesis clearly demonstrates urban agriculture deserves recognition within the climate management regime for its mitigation and adaptation properties. The IPCC called on urban areas to use low regret strategies to deal with storm water management and urban heat abatement (Revi et al. 2014). Urban agriculture is clearly a winner. Urban agriculture is a no regrets measure that can help cities attend to multiple challenges. Cities do not need to invest in infrastructure to institute urban farming – most cities are teeming with interest from community groups to take up gardening. What cities need is a regulatory framework that is conducive to urban agriculture. This constitutes allowing urban agriculture to be a permitted land use in the city, recognizing the city's commitment to urban agriculture in its comprehensive plans, putting in place the necessary institutional support to fast track applications for use of vacant land for the purposes of growing food. For the purposes of climate management urban agriculture needs to be articulated within the CAP as a mitigation and adaptation measure to ensure the implementing agencies do not preclude it on the basis of an ongoing activity. Using Cleveland as an example the researchers demonstrate how one city is turning its problems into opportunities.

Cleveland's efforts in integrating urban agriculture in city planning

City of Cleveland occupies the northeast portion of Cuyahoga County – the most populous county in Ohio (Mayor's Office of Sustainability 2013). The city has lost approximately 50% of its population since 1950, with further population decreases persisting (Cleveland City Planning Commission 2007). More recently, Cleveland's population decreased further by 1.7% - dropping from 396, 697 in 2010 to 390,113 by 2013 (U.S. Census Bureau 2015). The population decline

creating high levels of vacancy has led to 17,000 vacant lots in the City encompassing 3,300 acres (Cleveland City Planning Commission 2007). The city is predominantly African American (53%), where median household income averages around $26, 217 and 35% live in poverty (U.S. Census Bureau 2015). Studies also demonstrate food insecurity to be a problem – 18.2% of Cuyahoga county residents were food insecure (Cuyahoga County Job and Family Services 2014) and the Cleveland food bank estimated 332,420 individuals in its service area to be in need. Given these statistics, social vulnerability ranks high.

Cleveland has been important in the evolution of planning practice. In a dispute involving Euclid – a suburb of Cleveland and Ambler reality, zoning first found legal standing (Korngold 2000). In Euclid v. Ambler (1926) the Supreme Court ruled in favor of Euclid declaring zoning ordinances were an act of police power that have been delegated to local jurisdictions for the protection of public welfare as required by the doctrine of nuisance (Korngold 2000). Almost a century later Cleveland recognizing the importance of urban agriculture to its urban fabric became the first municipality to recognize urban agriculture as a permitted land use (Cleveland/Cuyahoga County Food Policy Coalition). Currently Cleveland has more than 185 community gardens and 22 market gardens (Cleveland/Cuyahoga County Food Policy Coalition). Cleveland is also served by a food policy council since 2007: the Cleveland – Cuyahoga county food policy coalition. Support for urban agriculture is detailed in its zoning ordinances.

Zoning Ordinances

Cleveland is a home rule jurisdiction hence local government legislation, ordinances and policies have the greatest weight of the law. Cleveland gained national spotlight when it became the first city in the United States in 2007 to create an "Urban Garden District" (Cleveland/Cuyahoga County Food Policy Coalition) – the first zoning designation for urban gardens as captured in Section 336 of the city's zoning code - to "ensure that urban garden areas are appropriately located and protected to meet needs for local food production, community health, community education, garden-related job training, environmental enhancement, preservation of green space, and community enjoyment on sites for which urban gardens represent the highest and best use for the community."

The ordinance safeguards the parcels developed as gardens/farms from development requiring all future development proposals to be scrutinized by the public through a public dialogue process (2007). Though this does not assure permanence it puts in place safeguards that give gardener's tenure of the land more security. Tenure is a tenacious issue in urban agriculture which Cleveland has tried to support to the advantage of the farmers/gardeners. The city has also allocated resources to promote food production while the Cuyahoga Land Bank has given the residents 120 vacant lots to use for this purpose (Cleveland/Cuyahoga County Food Policy Coalition).

In 2010, Cleveland updated its zoning code allowing agriculture to become a permitted land use in all residential districts (2010). Sale of produce from farm stands in residential districts is permitted but is a conditional land use subject to approval from the Board of Zoning appeals (2010). The updated ordinance also permits composting onsite and the sale of value added products – processed value added products are subject to oversight from the Department of Health (2010). There is a height restriction of 15 feet for all farm infrastructure – sheds, greenhouses, coops, cages, beehives, hoop houses, cold frames, barns, rain barrels, composting, farm stands (2010).

The keeping of chickens, ducks, rabbits, goats, pigs, sheep and bees is regulated as a special use (2010, 2009). Section 347 governs the number of each of these animals that can be kept on residential properties and the required space requirements for each. The ordinance

allows for the slaughtering of chickens, ducks and rabbits on site but not sheep, goats and pigs (2009). For those with bee hives, the ordinance requires supply of fresh water on site (2009).

Cleveland is additionally currently considering legislating an Urban Agriculture Overlay (UAO) District (City of Cleveland). The language in the proposed UAO District combines the permitted uses of agriculture in residentially zoned areas with that of the urban garden district. The new overlay district will make it possible for parcels zoned residential or other wise to be used for urban farming (City of Cleveland). In the garden district keeping of animals, slaughtering and composting is restricted (City of Cleveland). Working with the food policy council Cleveland agreed to remove the $1 million commercial liability clause for the use of land bank lots (Cleveland/Cuyahoga County Food Policy Coalition). The Food policy council also worked with Cleveland Division of Water works to develop an urban agriculture water policy that secures water supply at low costs for Cleveland's urban farms and gardens (Cleveland/Cuyahoga County Food Policy Coalition). Cleveland has secured urban agriculture as a permitted land use and put in the necessary institutional supports through these measures promoting large scale agriculture within the city above and beyond most other rustbelt cities.

Comprehensive plan

Despite Cleveland's overt support for urban agriculture and a systemic view of food, the comprehensive plan has no mention of either. The plan calls for preserving land for community gardens but leaves room for speculation if that includes large scale urban farming efforts currently underway in Cleveland such as: Ohio City Farm, Stanard Farm, Kinsman Farm and Chateau Hough to name a few. While zoning codifies land uses, the comprehensive plan directs development and leverages dollars for development. Without clear articulation of urban agriculture and food systems in the plan, the comprehensive plan is a missed opportunity to establish Cleveland as a clear front runner in innovative planning.

Climate Action Planning in Cleveland

Cleveland is in the process of updating its climate action plan. Cleveland's CAP is innovative because it includes adaptation along with mitigation goals and recognizes urban agriculture as both a mitigation and adaptation measure ((Mayor's Office of Sustainability 2013). Inclusion of adaptation is considered innovative since evidence suggests municipal governments prioritize mitigation over adaptation despite evidence suggesting it is easier to get public buy in for adaptation – mitigation tends to include regulating industry and commerce while adaptation involves working with the public to increase resiliency (Baynham and Stevens 2014). Research shows cities preclude adaptation from plans due to lack of resources, information and expertise (Richardson and Horton, 2010). However given the increase in extreme events and high likelihood of the trend continuing throughout this century it is pertinent cities prepare to adapt.

In terms of mitigation Cleveland has pledged to reduce GHG by 80% below baseline emissions by 2050, with interim goals of 16% reduction by 2020 and 40% reduction by 2030 (Mayor's Office of Sustainability 2013). The plan additionally recognizes land based drivers of climate change and has a dedicated chapter on land use mitigation options. Stone et al (2012) suggest without integrating land-based drivers of climate change, CAP's will have little success in reducing warming in urban areas. The CAP does not state goals related to adaptation, however adaptation is integrated along with mitigation in each of its 6 focus areas: energy efficiency & green building, advanced & renewable energy, sustainable mobility, waste reduction & resource conservation, sustainable land use & clean water and community engagement & public health. Each measure is labelled as one or the other and where appropriate it is indicated that the action fulfills both goals.

The CAP recognizes scaling up local food production as an adaptation and mitigation action – Action 28 in the CAP. Mitigation under action 28 constitutes reduction of emissions from urban agriculture's sequestration properties and a reduction in food miles in transporting food into the city (Mayor's Office of Sustainability 2013). Adaptation is not explicitly referenced; while the action describes increased food access for city residents (determinant of food security), and storage and filtering of water, it does not explicitly describe these actions as being adaptive. This trend is visible throughout the plan – mitigation aspects are spelt out but adaptive aspects of the actions are not.

Takeaway for planning efforts

Synthesis of the literature along with Cleveland's experience in climate management details how urban agriculture can be a permitted land use. Political support for urban agriculture can be leveraged by demonstrating its multi-functionality as highlighted in this literature review. Urban agriculture is a low-regret strategy that can easily be implemented provided an enabling regulatory framework such as Cleveland's exists. More so the review points out planners need to pay attention to both aspects of climate management – mitigation and adaptation.

1. *Planners should be planning to mitigate and adapt urban environments to climate change:* All evidence points to a warming climate despite current and future efforts to reduce emissions. The inevitably of climate impacts is upon us as described in the review. In the U.S., cities have been the first to answer this call to action. While much progress has been in the development of CAP's or emission reduction plans, adaptation for the most part has been overlooked. The review demonstrates an urgency to act and protect the citizenry which cannot be achieved without actions for adaptation being articulated in the CAP's. Community action could bring about some adaptation but the scale and cost of most adaptation actions require long term planning.
2. *Urban agriculture is a low regret strategy for both mitigation and adaptation:* Adaptation measures can be expensive to institute especially when cities have the dual burden of mitigation and adaption. Low cost strategies that address both needs are critical for climate management within urban areas especially in resource poor cities. Urban agriculture embodies all of these aspects and has strong community support in most cities in the United States. Urban agriculture has been tried and tested unlike new technology, cities have guidelines that can help lay the ground work.
3. *Urban agriculture requires regulation not infrastructure:* While the city does not need to invest in expensive infrastructure it does need to create an enabling regulatory environment. Urban agriculture needs to be codified – CAP's can push for codification if it does not already exist – permitting process should be in place, tenure and liability issues need to be ironed out and water supply secured for local production of food. Cleveland has been at the forefront of the urban agriculture movement and other cities can use their experience to their advantage. Cleveland's CAP is also exemplary providing a roadmap for the next generation of CAP's to use.

References

1. *Cleveland, Ohio, Municipal Code*. 208-07.
2. *Cleveland, Ohio, Municipal Code*.
3. *Cleveland, Ohio, Municipal Code*.
4. Alaimo, Katherine, Elizabeth Packnett, Richard A Miles, and Daniel J Kruger. 2008. "Fruit and vegetable intake among urban community gardeners." *Journal of nutrition education and behavior* 40 (2):94-101.
5. Alkon, Alison Hope, and Julian Agyeman. 2011. *Cultivating food justice: race, class, and sustainability*: MIT Press.
6. Altieri, Miguel A, Nelso Companioni, Kristina Cañizares, Catherine Murphy, Peter Rosset, Martin Bourque, and Clara I Nicholls. 1999. "The greening of the "barrios": urban agriculture for food security in Cuba." *Agriculture and Human Values* 16 (2):131-140.
7. Angel, James R., and Kenneth E. Kunkel. 2010. "The response of Great Lakes water levels to future climate scenarios with an emphasis on Lake Michigan-Huron." *Journal of Great Lakes Research* 36, Supplement 2 (0):51-58. doi: http://dx.doi.org/10.1016/j.jglr.2009.09.006.
8. Armstrong, Donna. 2000. "A survey of community gardens in upstate New York: Implications for health promotion and community development." *Health & Place* 6 (4):319-327.
9. Baker, Lawrence A, Anthony J Brazel, Nancy Selover, Chris Martin, Nancy McIntyre, Frederick R Steiner, Amy Nelson, and Laura Musacchio. 2002. "Urbanization and warming of Phoenix (Arizona, USA): Impacts, feedbacks and mitigation." *Urban ecosystems* 6 (3):183-203.
10. Barlage, Michael J., Paul L. Richards, Peter J. Sousounis, and Andrew J. Brenner. 2002. "Impacts of Climate Change and Land Use Change on Runoff from a Great Lakes Watershed." *Journal of Great Lakes Research* 28 (4):568-582. doi: http://dx.doi.org/10.1016/S0380-1330(02)70606-0.
11. Barthel, Stephan, and Christian Isendahl. 2013. "Urban gardens, agriculture, and water management: Sources of resilience for long-term food security in cities." *Ecological Economics* 86 (0):224-234. doi: http://dx.doi.org/10.1016/j.ecolecon.2012.06.018.
12. Baynham, Maggie, and Mark Stevens. 2014. "Are we planning effectively for climate change? An evaluation of official community plans in British Columbia." *Journal of Environmental Planning and Management* 57 (4):557-587.
13. Bellows, Anne C, Katherine Brown, and Jac Smit. 2003. "Health benefits of urban agriculture." *Community Food*.
14. Bernatzky, A. 1983. "The effects of trees on the urban climate." *Trees in the 21st Century. Academic Publishers, Berkhamster*:59-76.
15. Brown, Kate H, and Andrew L Jameton. 2000. "Public health implications of urban agriculture." *Journal of public health policy*:20-39.
16. Brown, Victoria M, Aimee C Allen, Marci Dwozan, Ivey Mercer, and Kim Warren. 2004. "Indoor gardening older adults: effects on socialization, activities of daily living, and loneliness." *Journal of gerontological nursing* 30 (10):34-42.
17. Carter, Timothy, and C Rhett Jackson. 2007. "Vegetated roofs for stormwater management at multiple spatial scales." *Landscape and urban planning* 80 (1):84-94.
18. City of Cleveland, Ohio. Cleveland's Zoning for Urban Agriculture and Green Space.
19. Cleveland City Planning Commission. 2007. Connecting Cleveland: 2020 Citywide Plan. Cleveland, Ohio. Retrieved from: http://planning. city. cleveland. oh. us/cwp/contents. html.
20. Cleveland/Cuyahoga County Food Policy Coalition. Urban Land Use Cleveland-Cuyahoga County Food Policy Coalition Food Policy Brief.

21. Coleman-Jensen, Alisha. 2014. *Household food security in the United States in 2013*: BiblioGov.
22. Corrigan, Michelle P. 2011. "Growing what you eat: Developing community gardens in Baltimore, Maryland." *Applied Geography* 31 (4):1232-1241.
23. Cutter, Susan L, and Christina Finch. 2008. "Temporal and spatial changes in social vulnerability to natural hazards." *Proceedings of the National Academy of Sciences* 105 (7):2301-2306.
24. Cutter, Susan L, Jerry T Mitchell, and Michael S Scott. 2000. "Revealing the vulnerability of people and places: a case study of Georgetown County, South Carolina." *Annals of the Association of American Geographers* 90 (4):713-737.
25. Cuyahoga County Job and Family Services. 2014. "Food Assistance Program." https://cjfs.cuyahogacounty.us/en-US/FAP.aspx.
26. Dubbeling, Marielle, and Henk de Zeeuw. 2011. "Urban Agriculture and Climate Change Adaptation: Ensuring Food Security Through Adaptation." In *Resilient Cities*, edited by Konrad Otto-Zimmermann, 441-449. Springer Netherlands.
27. Gómez-Baggethun, Erik, and David N. Barton. 2013. "Classifying and valuing ecosystem services for urban planning." *Ecological Economics* 86 (0):235-245. doi: http://dx.doi.org/10.1016/j.ecolecon.2012.08.019.
28. Gray, Leslie, Patricia Guzman, Kathryn Michelle Glowa, and Ann G Drevno. 2014. "Can home gardens scale up into movements for social change? The role of home gardens in providing food security and community change in San Jose, California." *Local Environment* 19 (2):187-203.
29. Greene, Scott, Laurence S Kalkstein, David M Mills, and Jason Samenow. 2011. "An examination of climate change on extreme heat events and climate-mortality relationships in large US cities." *Weather, Climate, and Society* 3 (4):281-292.
30. Hayhoe, Katharine, Scott Sheridan, Laurence Kalkstein, and Scott Greene. 2010. "Climate change, heat waves, and mortality projections for Chicago." *Journal of Great Lakes Research* 36:65-73.
31. Hayhoe, Katharine, Jeff VanDorn, Thomas Croley II, Nicole Schlegal, and Donald Wuebbles. 2010. "Regional climate change projections for Chicago and the US Great Lakes." *Journal of Great Lakes Research* 36:7-21.
32. Hung, Yvonne. 2004. "East New York Farms: Youth participation in community development and urban agriculture." *Children Youth and Environments* 14 (1):56-85.
33. Kalkstein, Laurence S, and J Scott Greene. 1997. "An evaluation of climate/mortality relationships in large US cities and the possible impacts of a climate change." *Environmental health perspectives* 105 (1):84.
34. Korngold, Gerald. 2000. "Emergence of Private Land Use Controls in Large-Scale Subdivisions: The Companion Story to Village of Euclid v. Ambler Realty Co., The." *Case W. Res. L. Rev.* 51:617.
35. Kunkel, Kenneth Edward. 2013. *Regional climate trends and scenarios for the US National Climate Assessment*: US Department of Commerce, National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service.
36. Lautenschlager, Lauren, and Chery Smith. 2007. "Understanding gardening and dietary habits among youth garden program participants using the Theory of Planned Behavior." *Appetite* 49 (1):122-130.
37. Lobell, David, and Marshall Burke. 2009. *Climate change and food security: adapting agriculture to a warmer world*. Vol. 37: Springer Science & Business Media.
38. Lovell, Sarah Taylor. 2010. "Multifunctional urban agriculture for sustainable land use planning in the United States." *Sustainability* 2 (8):2499-2522.

39. Lwasa, Shuaib, Frank Mugagga, Bolanle Wahab, David Simon, John Connors, and Corrie Griffith. 2014. "Urban and peri-urban agriculture and forestry: Transcending poverty alleviation to climate change mitigation and adaptation." *Urban Climate* 7 (0):92-106. doi: http://dx.doi.org/10.1016/j.uclim.2013.10.007.
40. Mayor's Office of Sustainability. 2013. Cleveland Climate Action Plan: Building Thriving and Healthy Neighborhoods 2013.
41. Melillo, Jerry M, TC Richmond, and Gary W Yohe. 2014. "Climate change impacts in the United States: the third national climate assessment." *US Global change research program* 841.
42. Nelson, Gerald C, Mark W Rosegrant, Jawoo Koo, Richard Robertson, Timothy Sulser, Tingju Zhu, Claudia Ringler, Siwa Msangi, Amanda Palazzo, and Miroslav Batka. 2009. *Climate change: Impact on agriculture and costs of adaptation*. Vol. 21: Intl Food Policy Res Inst.
43. O'Neal, Monte R., M. A. Nearing, Roel C. Vining, Jane Southworth, and Rebecca A. Pfeifer. 2005. "Climate change impacts on soil erosion in Midwest United States with changes in crop management." *CATENA* 61 (2–3):165-184. doi: http://dx.doi.org/10.1016/j.catena.2005.03.003.
44. Ober Allen, Julie, Katherine Alaimo, Doris Elam, and Elizabeth Perry. 2008. "Growing vegetables and values: Benefits of neighborhood-based community gardens for youth development and nutrition." *Journal of Hunger & Environmental Nutrition* 3 (4):418-439.
45. Onishi, Akio, Xin Cao, Takanori Ito, Feng Shi, and Hidefumi Imura. 2010. "Evaluating the potential for urban heat-island mitigation by greening parking lots." *Urban forestry & Urban greening* 9 (4):323-332.
46. Patz, Jonathan A., Stephen J. Vavrus, Christopher K. Uejio, and Sandra L. McLellan. 2008. "Climate Change and Waterborne Disease Risk in the Great Lakes Region of the U.S." *American Journal of Preventive Medicine* 35 (5):451-458. doi: http://dx.doi.org/10.1016/j.amepre.2008.08.026.
47. Pothukuchi, Kameshwari. 2004. "Hortaliza: A youth "nutrition garden" in southwest Detroit." *Children Youth and Environments* 14 (2):124-155.
48. Poulsen, Melissa N., Kristyna R. S. Hulland, Carolyn A. Gulas, Hieu Pham, Sarah L. Dalglish, Rebecca K. Wilkinson, and Peter J. Winch. 2014. "Growing an Urban Oasis: A Qualitative Study of the Perceived Benefits of Community Gardening in Baltimore, Maryland." *Culture, Agriculture, Food and Environment* 36 (2):69-82. doi: 10.1111/cuag.12035.
49. Pryor, Sara C. 2012. *Climate Change in the Midwest : Impacts, Risks, Vulnerability, and Adaptation*. Bloomington, IN, USA: Indiana University Press.
50. Qiu, Guo-yu, Hong-yong Li, Qing-tao Zhang, Wan Chen, Xiao-jian Liang, and Xiang-ze Li. 2013. "Effects of Evapotranspiration on Mitigation of Urban Temperature by Vegetation and Urban Agriculture." *Journal of Integrative Agriculture* 12 (8):1307-1315. doi: http://dx.doi.org/10.1016/S2095-3119(13)60543-2.
51. Raja, Samina, Branden M Born, Jessica Kozlowski Russell, and American Planning Association. 2008. *A planners guide to community and regional food planning: Transforming food environments, facilitating healthy eating*: American Planning Association.
52. Revi, A., D. E. Satterthwaite, F. Aragón-Durand, J. Corfee-Morlot, R. B. R. Kiunsi, M. Pelling, D. C. Roberts, and W. Solecki. 2014. "Urban areas." In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change*, edited by C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O.

Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea and L. L. White, 535-612. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.
53. Rizwan, Ahmed Memon, Leung YC Dennis, and Chunho Liu. 2008. "A review on the generation, determination and mitigation of Urban Heat Island." *Journal of Environmental Sciences* 20 (1):120-128.
54. Romero-Lankao, P., J. B. Smith, D. J. Davidson, N. S. Diffenbaugh, P. L. Kinney, P. Kirshen, P. Kovacs, and L. Villers-Ruiz. 2014. "North America." In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change*, edited by V. R. Barros, C. B. Field, D. J. Dokken, M. D. Mastrandrea, K. J. Mach, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea and L. L. White, 1439-1498. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.
55. Rosenzweig, Cynthia, William Solecki, and Ronald Slosberg. 2006. "Mitigating New York City's heat island with urban forestry, living roofs, and light surfaces." *A report to the New York State Energy Research and Development Authority*.
56. Sanders, Ralph A. 1986. "Urban vegetation impacts on the hydrology of Dayton, Ohio." *Urban Ecology* 9 (3):361-376.
57. Schmidhuber, Josef, and Francesco N Tubiello. 2007. "Global food security under climate change." *Proceedings of the National Academy of Sciences* 104 (50):19703-19708.
58. Scholz-Barth, Katrin. 2001. "Green Roofs: Stormwater Management From the Top Down." *Environmental Design & Construction*, 2001/01//, 63.
59. Semenza, Jan C. 2014. "Climate Change and Human Health." *International Journal of Environmental Research and Public Health* 11 (7):7347-7353. doi: 10.3390/ijerph110707347.
60. Short, Michael, William Peirson, Gregory Peters, and Ronald Cox. 2012. "Managing Adaptation of Urban Water Systems in a Changing Climate." *Water Resources Management* 26 (7):1953-1981. doi: 10.1007/s11269-012-0002-8.
61. Smit, Jac, and Joe Nasr. 1992. "Urban agriculture for sustainable cities: using wastes and idle land and water bodies as resources." *Environment and Urbanization* 4 (2):141-152.
62. Solecki, William D, Cynthia Rosenzweig, Lily Parshall, Greg Pope, Maria Clark, Jennifer Cox, and Mary Wiencke. 2005. "Mitigation of the heat island effect in urban New Jersey." *Global Environmental Change Part B: Environmental Hazards* 6 (1):39-49.
63. Sousounis, Peter J., Christopher P. J. Scott, and Mark L. Wilson. 2002. "Possible Climate Change Impacts on Ozone in the Great Lakes Region: Some Implications for Respiratory Illness." *Journal of Great Lakes Research* 28 (4):626-642. doi: http://dx.doi.org/10.1016/S0380-1330(02)70610-2.
64. Stone, Brian, Jason Vargo, and Dana Habeeb. 2012. "Managing climate change in cities: Will climate action plans work?" *Landscape and urban planning* 107 (3):263-271.
65. Stone Jr, Brian. 2005. "Urban heat and air pollution: an emerging role for planners in the climate change debate." *Journal of the American planning association* 71 (1):13-25.
66. Stone Jr, Brian. 2012. *The city and the coming climate: climate change in the places we live*: Cambridge University Press.
67. Stone Jr, Brian, Jason Vargo, Peng Liu, Dana Habeeb, Anthony DeLucia, Marcus Trail, Yongtao Hu, and Armistead Russell. 2014. "Avoided heat-related mortality through climate adaptation strategies in three US cities." *PloS one* 9 (6):e100852.
68. Stone Jr, Brian, Jason Vargo, Peng Liu, Yongtao Hu, and Armistead Russell. 2013. "Climate change adaptation through urban heat management in Atlanta, Georgia." *Environmental science & technology* 47 (14):7780-7786.

69. Stovin, Virginia. 2010. "The potential of green roofs to manage urban stormwater." *Water and Environment Journal* 24 (3):192-199.
70. The United States Conference of Mayors. 2015. "U.S. Conference of Mayors Climate Protection Agreement." Accessed 04.30. http://www.usmayors.org/climateprotection/agreement.htm.
71. U.S. Census Bureau. 2015. State and County QuickFacts.
72. VanWoert, Nicholaus D, D Bradley Rowe, Jeffrey A Andresen, Clayton L Rugh, R Thomas Fernandez, and Lan Xiao. 2005. "Green roof stormwater retention." *Journal of environmental quality* 34 (3):1036-1044.
73. Vermeulen, Sonja Joy, PK Aggarwal, A Ainslie, C Angelone, Bruce Morgan Campbell, AJ Challinor, J Hansen, JSI Ingram, A Jarvis, and P Kristjanson. 2010. "Agriculture, food security and climate change: Outlook for knowledge, tools and action."
74. Wakefield, Sarah, Fiona Yeudall, Carolin Taron, Jennifer Reynolds, and Ana Skinner. 2007. "Growing urban health: community gardening in South-East Toronto." *Health promotion international* 22 (2):92-101.
75. Wallen, James. 1920. "Cleveland's Golden Story." *A Chronicle of Hearts that Hoped, Minds that Planned and Hands that Toiled to Make a City" Great and Glorious*.
76. Zezza, Alberto, and Luca Tasciotti. 2010. "Urban agriculture, poverty, and food security: Empirical evidence from a sample of developing countries." *Food policy* 35 (4):265-273.