Multi-Criteria Decision Analysis of Chicago Pedestrian and Cyclist Fatalities

By Lucas Seibold

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Research Questions

1.0: Where should Chicago be prioritizing their Vision Zero infrastructure improvements to prevent the most traffic related fatalities from occurring in the future?

2.0: How do individual factors correlate to traffic related fatalities and how can the city use this information to inform their Vision Zero strategy?

2.1: Are there fewer traffic related fatalities in close proximity to speed limit and red light enforcement cameras?
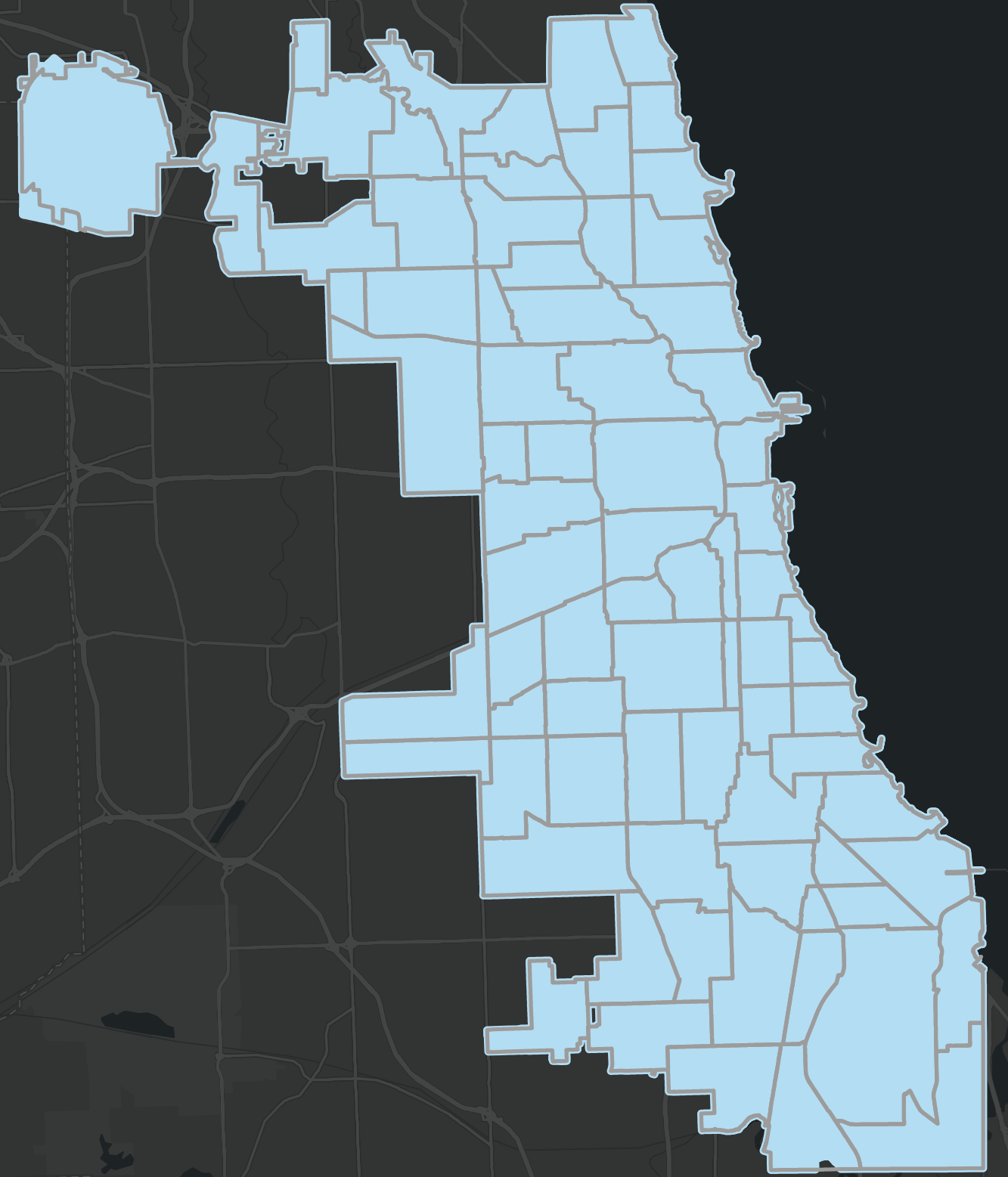
2.2: Is there a correlation between ZIP codes with high er non-white populations and high levels of pedestrian and cyclist fatalities?

2.3: Is there a correlation between census tracts with a low median income and higher levels of pedestrian and cyclist fatalities?

2.4: Are there higher levels of pedestrian and cyclist fatalities in close proximity to bus stops?

2.5: Are there higher levels of pedestrian and cyclist fatalities in close proximity to CTA stations?

2.6: Do census tracts with more bike lanes see higher levels of pedestrian and cyclist fatalities?
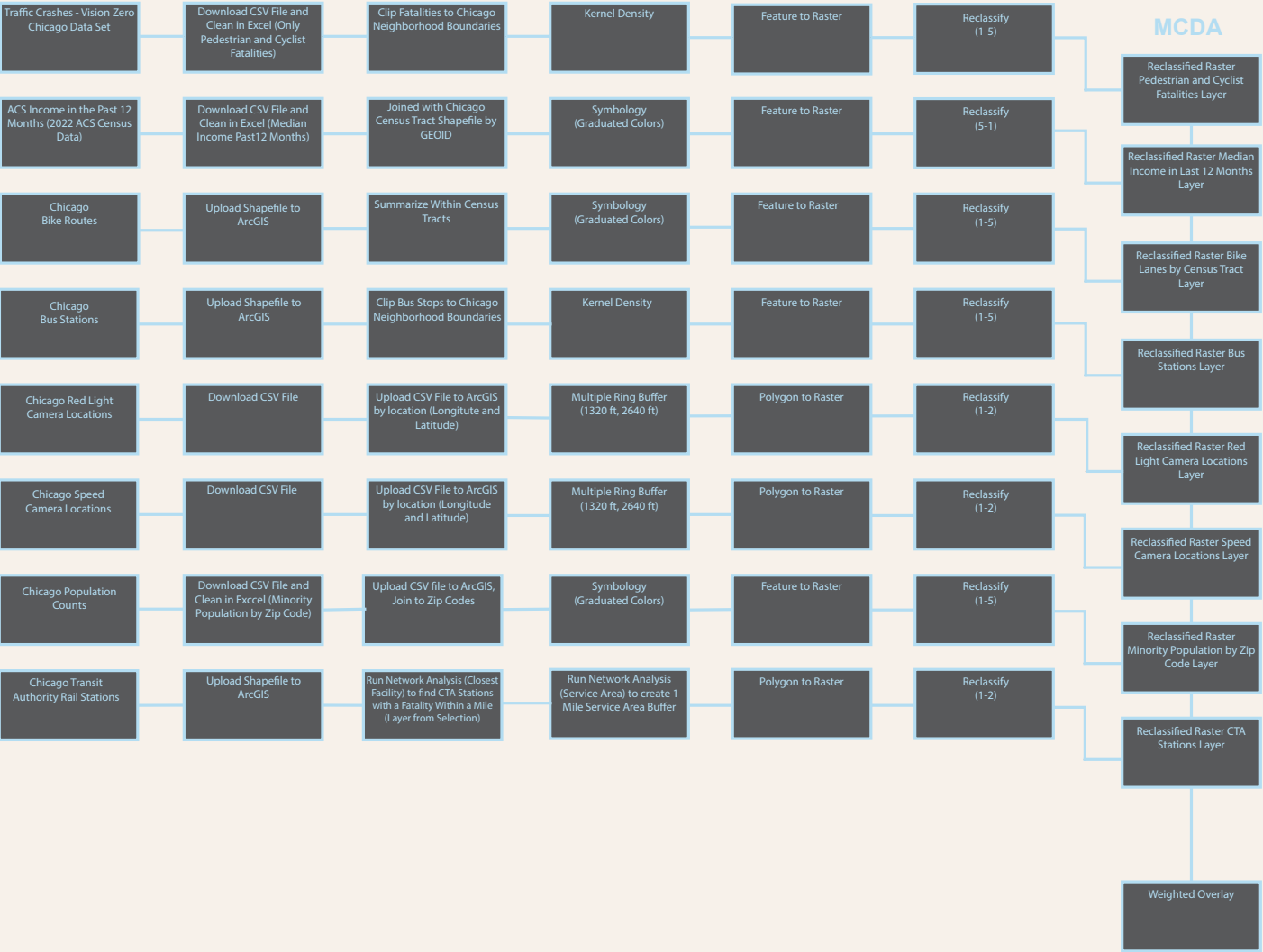
Methodology

Regression Analysis Methodology

MCDA
Methodology

Traffic Crashes - Vision Zero Chicago Data Set	Download CSV File and Clean in Excel (Only Pedestrian and Cyclist Fatalities)	Clip Fatalities to Chicago Neighborhood Boundaries	Kernel Density	Feature to Raster	Reclassify (1-5)	**MCDA**
ACS Income in the Past 12 Months (2022 ACS Census Data)	Download CSV File and Clean in Excel (Median Income Past12 Months)	Joined with Chicago Census Tract Shapefile by GEOID	Symbology (Graduated Colors)	Feature to Raster	Reclassify (5-1)	Reclassified Raster Pedestrian and Cyclist Fatalities Layer
Chicago Bike Routes	Upload Shapefile to ArcGIS	Summarize Within Census Tracts	Symbology (Graduated Colors)	Feature to Raster	Reclassify (1-5)	Reclassified Raster Median Income in Last 12 Months Layer
Chicago Bus Stations	Upload Shapefile to ArcGIS	Clip Bus Stops to Chicago Neighborhood Boundaries	Kernel Density	Feature to Raster	Reclassify (1-5)	Reclassified Raster Bike Lanes by Census Tract Layer
Chicago Red Light Camera Locations	Download CSV File	Upload CSV File to ArcGIS by location (Longitude and Latitude)	Multiple Ring Buffer (1320 ft, 2640 ft)	Polygon to Raster	Reclassify (1-2)	Reclassified Raster Bus Stations Layer
Chicago Speed Camera Locations	Download CSV File	Upload CSV File to ArcGIS by location (Longitude and Latitude)	Multiple Ring Buffer (1320 ft, 2640 ft)	Polygon to Raster	Reclassify (1-2)	Reclassified Raster Red Light Camera Locations Layer
Chicago Population Counts	Download CSV File and Clean in Exccel (Minority Population by Zip Code)	Upload CSV file to ArcGIS, Join to Zip Codes	Symbology (Graduated Colors)	Feature to Raster	Reclassify (1-5)	Reclassified Raster Speed Camera Locations Layer
Chicago Transit Authority Rail Stations	Upload Shapefile to ArcGIS	Run Network Analysis (Closest Facility) to find CTA Stations with a Fatality Within a Mile (Layer from Selection)	Run Network Analysis (Service Area) to create 1 Mile Service Area Buffer	Polygon to Raster	Reclassify (1-2)	Reclassified Raster Minority Population by Zip Code Layer

Reclassified Raster CTA Stations Layer
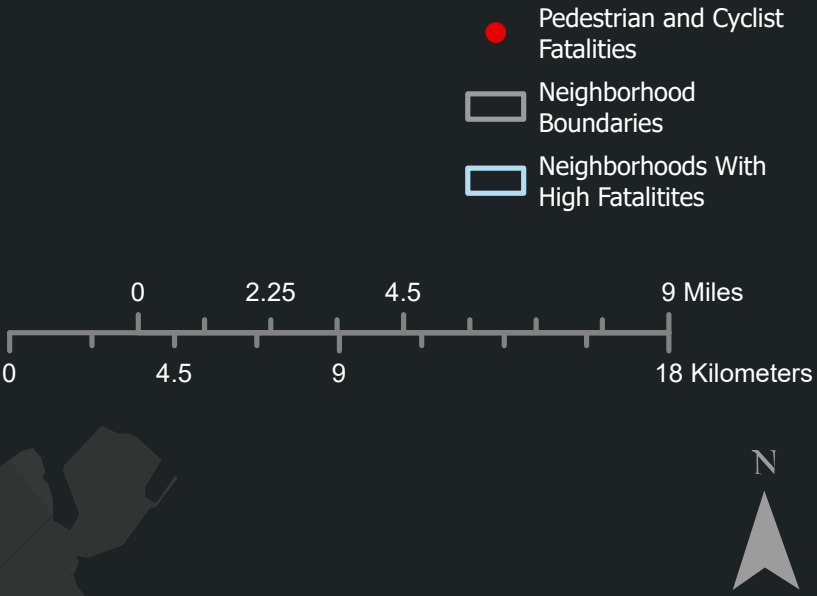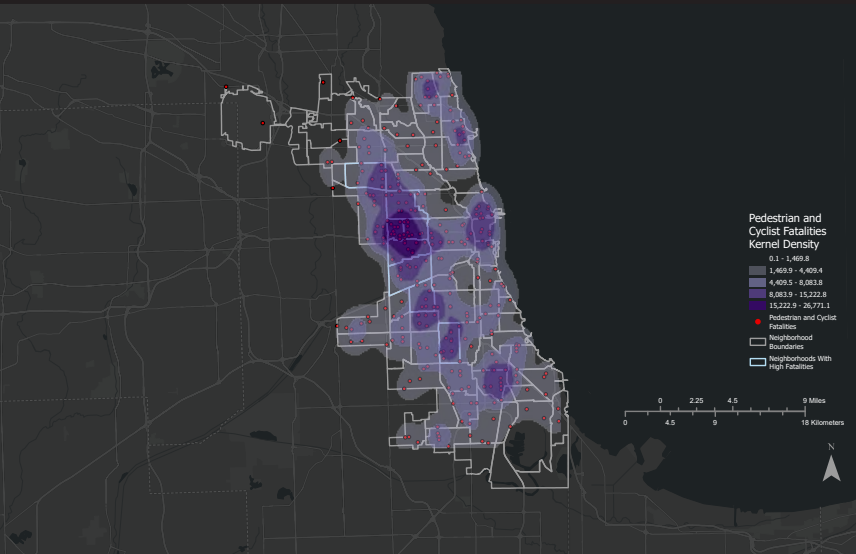
Weighted Overlay

History and Background

Pedestrian and Cyclist Fatalities

Between January 1, 2019 and September 29, 2024 (data set last updated) Chicago has experience 326 pedestrian and cyclist fatalities as a result of traffic related accidents.

Pedestrian and Cyclist Fatality Point Map with Kernel Density

The neighborhoods seen highlighted in blue clearly have a higher density of fatalities. This sparks a question of what could these neighborhoods have in common that may be cause for such density. The neighborhoods include Belmont Cragin, Brighton Park, East Garfield Park, Humboldt Park, North Lawndale, South Lawndale, West Englewood, and West Englewood. What was found is that these communities are all predominantly black or hispanic and have a low median income.

Belmont Cragin: 77.8% Hispanic, 41.7% below $49,999
Brighton Park: 80.0% Hispanic, 47.9% below $49,999
East Garfield Park: 83.8% Black, 65.4% below $49,999
Humboldt Park: 49.8% Hispanic, 34.6% Black, 49.0% below $49,999
North Lawndale: 77.7% Black, 63.0% below $49,999
South Lawndale: 81.8% Hispanic, 58.0% below $49,999
West Englewood: 79.6% Black, 69.5% below $49,999
West Garfield Park: 91.9% Black, 66.4% below $49,999

Pedestrian and Cyclist Fatalities

Neighborhood Boundaries

Neighborhoods With High Fatalitites

0   2.25   4.5   9 Miles

0   4.5   9   18 Kilometers

N

Chicago's Demographic Makeup
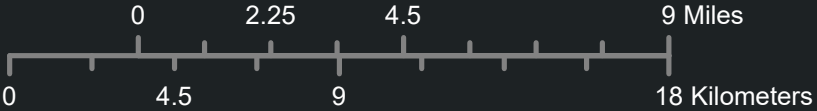
Median Income by Census Tract

For each variable a scatter plot was created to question the correlation between the variable and pedestrian and cyclist fatalities. In this scatter plot, it shows that in census tracts with high incomes pedestrian and cyclist fatalities are less likely to occur with an R^2 value of 0.02. The West and South Sides of Chicago, which is where the neighborhoods previously identified to contain high densities of traffic accidents, have a low-median income. This data makes sense with what was found before, these neighborhoods have a great amount of familes making below the median anaual salary. The reasoning these communities are hit harder with this issue is likely due to a lack of investment in infrastructure and other resources. Also, low-income and minority communities historically were ripped apart to build highways in the past and this legacy still has an impact.

Regression Analysis

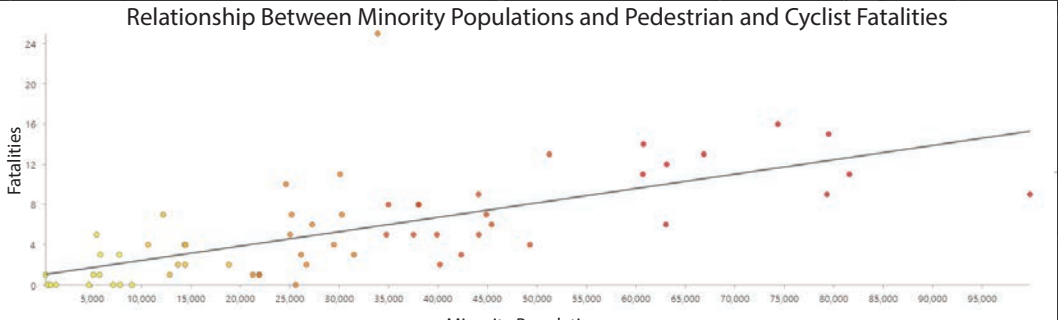Relationship Between Earnings in Last 12 Months and Pedestrian and Cyclist Fatalities

Fatalities

Earnings in Last 12 Months
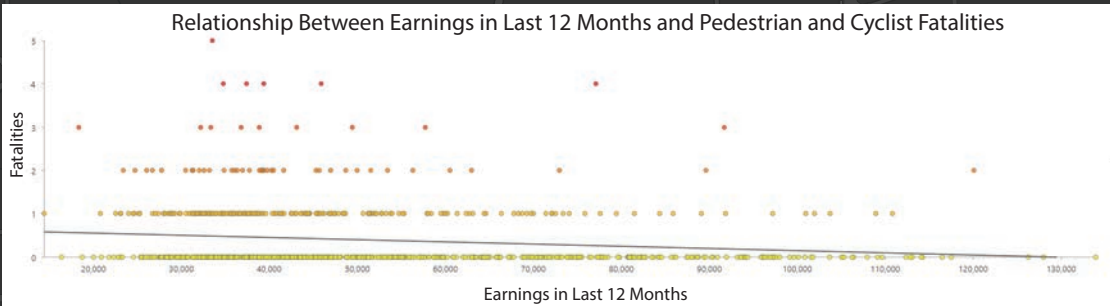
$R^2 = 0.02$

Earnings Within the Last 12 Months

- 14402 - 36518
- 36519 - 49536
- 49537 - 66369
- 66370 - 89375
- 89376 - 133929
- No Data

| 0 | 2.25 | 4.5 | 9 Miles |

| 0 | 4.5 | 9 | 18 Kilometers |

N

Non-White Population by ZIP Code

In this scatter plot, it shows that in census tracts with high non-white populations pedestrian and cyclist fatalities are more likely to occur with an R^2 value of 0.46. Similar to the median income maps, the West and South Sides of the city are where the highest non-white populations are located. This is a very significant correlation, showing how Chicago's history of segregation, urban renewal, and displacement for infrastructure, still leaves a lasting legacy to this day. A correlation of this magnitude also shows a significant lack of investment in minority communities for the Vision Zero Project.

Regression Analysis

Relationship Between Minority Populations and Pedestrian and Cyclist Fatalities

$R^2 = 0.46$

Minority Population by ZIP Code

- 309.1 - 10,676
- 10,676.1 - 21,904
- 21,904.1 - 34,963
- 34,963.1 - 51,230
- 51,230.1 - 99,837
- Neighborhood Boundaries

0   2.25   4.5   9 Miles

0   4.5   9   18 Kilometers

N
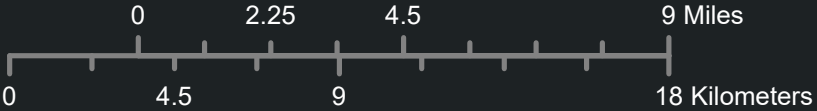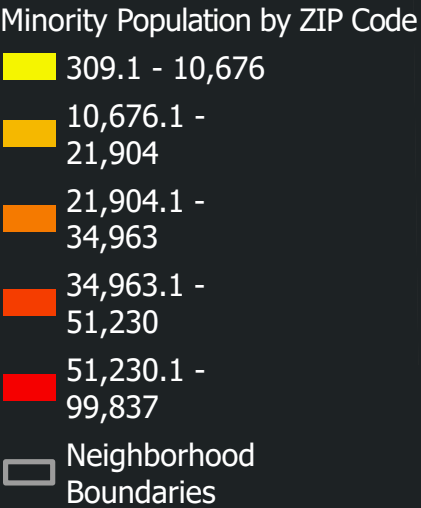
Additional Variables

Kernel Density of Bus Stops

In this scatter plot, it shows that in census tracts with more bus stops pedestrian and cyclist fatalities are more likely to occur with an R^2 value of 0.08. Using a kernel density map to show where bus stops are most prominent throughout the city helped illustrated the correlation with the kernel density of fatalities. Bus Stops Attract walking pedestrians who are seeking public transportation, these individuals have to cross streets, interacting with cars and are put in dangerous situations. This makes the area surrounding a bus stop more likely to have a fatality or accident involving a pedestrian occur because a pedestrian is more likely to be in the area.

Regression Analysis

Relationship Between Bus Stops and Pedestrian and Cyclist Fatalities

Number of Fatalities

Number of Bus Stops
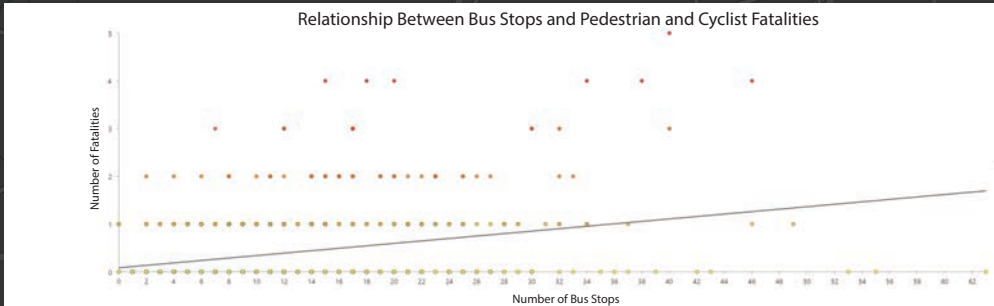
$R^2 = 0.08$

Bus Stops Kernel Density

- 0.1 - 11.6
- 11.7 - 32.8
- 32.9 - 51.8
- 51.9 - 72.5
- 72.6 - 134.9

Neighborhood Boundaries

0   2.25   4.5   9 Miles

0   4.5   9   18 Kilometers
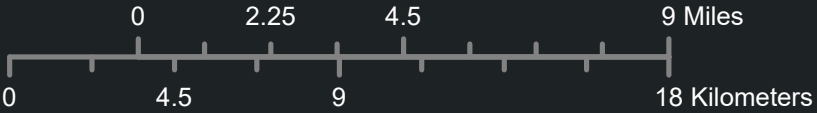
N
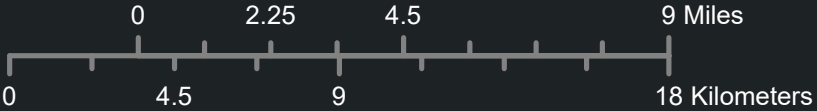
Miles of Bike Lanes by Census Tracts

In this scatter plot, it shows that in census tracts with more miles of bike lanes pedestrian and cyclist fatalities are more likely to occur with an R^2 value of 0.02. Bike lanes serve as a key form of transportation, however, if they are not separated from car traffic they can be putting cyclists in very dangerous situations. Additionally, more bike lanes attracts more cyclists making the chance for an accident to occur even higher.

Regression Analysis

Relationship between Bike Lanes and Pedestrian and Cyclist Fatalities

Fatalities
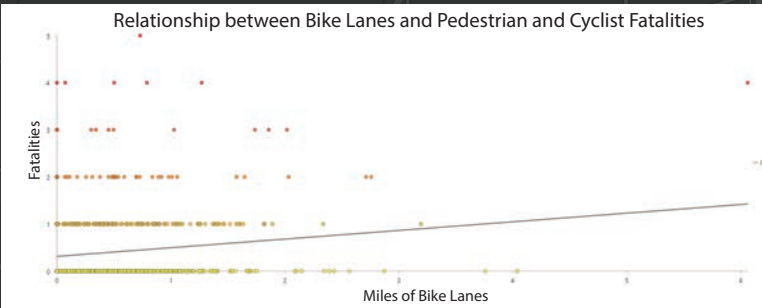
Miles of Bike Lanes

$R^2 = 0.02$

Miles of Bike Lanes Within Each Census Tract

- 0.001 - 0.261
- 0.262 - 0.737
- 0.738 - 1.283
- 1.284 - 2.139
- 2.14 - 6.061
- Neighborhood Boundaries

0   2.25   4.5   9 Miles

0   4.5   9   18 Kilometers
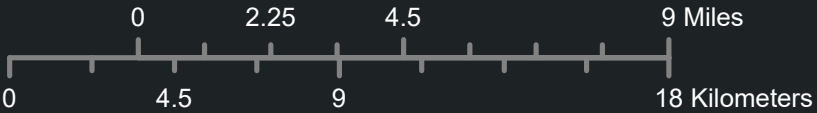
N

CTA Stations with 1 Mile Service Area Buffer

In this scatter plot, it shows that in census tracts with more CTA stations pedestrian and cyclist fatalities are more likely to occur with an R^2 value of 0.02. The map shows CTA stations that had a fatality occur within one mile with a one mile service area buffer. CTA stations, similar to the bus stops, attract pedestrians who are seeking use of public transportation. Within the vicinity of these stops, there is likely to be more pedestrians due to those who are walking to use the transit system. This could increase the potential for an accident to occur within this one mile buffer of each station.

Regression Analysis

Relationship Between CTA Stations and Pedestrian and Cyclist Fatalities

Fatalities

Number of CTA Stations
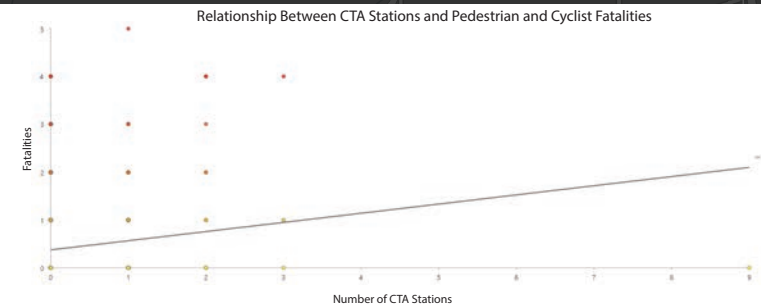
$R^2 = 0.02$

CTA Stations With Fatality Within 1 Mile

2640

5280

Neighborhood Boundaries

0   2.25   4.5   9 Miles

0   4.5   9   18 Kilometers

N

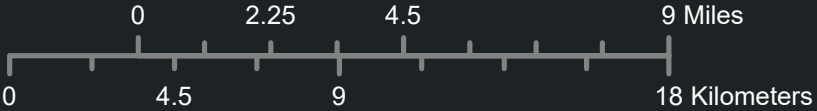# Red Light Cameras with 1/2 Mile Multi-Ring Buffer

In this scatter plot, it shows that in census tracts with more red light cameras pedestrian and cyclist fatalities are more likely to occur with an R^2 value of 0.02. However this could be misleading and be caused due to the city installing the cameras at intersections where there was already a high percentage of fatalities, skewing the data. Red light cameras are meant to be a tool to enforce traffic laws and encourage safe driving.
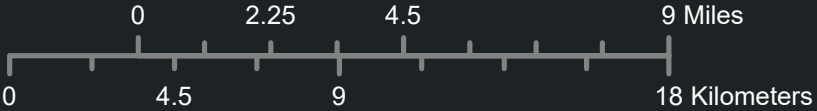
Regression Analysis

Relationship Between Red Light Cameras and Pedestrian and Cyclist Fatalities

Fatalities

Number of Red Light Cameras

$$R^2 = 0.02$$

Red Light Camera
Miltiple Ring Buffer
1320
2640
Neighborhood
Boundaries

0   2.25   4.5   9 Miles

0   4.5   9   18 Kilometers

N

Speed Cameras with 1/2 Mile Multi-Ring Buffer

In this scatter plot, it shows that in census tracts with more speed cameras pedestrian and cyclist fatalities are more likely to occur with an R^2 value of 0.01. Similar to the red light cameras, this is could be misleading as the city likely installed these in places where fatalities where already high. These are used to slow speeds which could save lives in the case of a traffic accident, especially involving pedestrians and cyclists.

Regression Analysis

Relationship Between Speed Cameras and Pedestrain and Cyclist Fatalities

Fatalities

Number of Speed Cameras
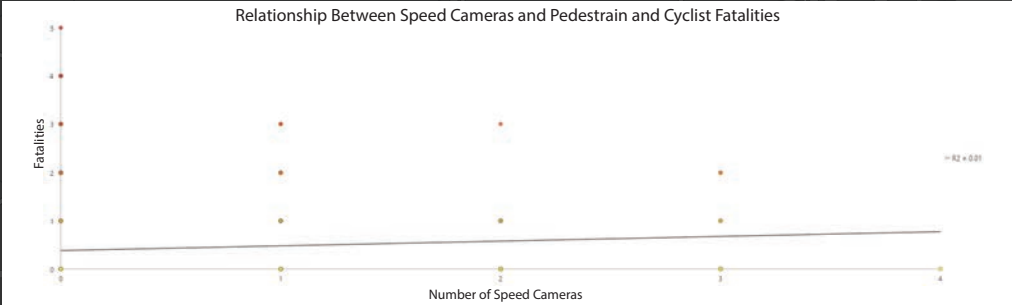
$R^2 = 0.01$

Speed Camera Multiple Ring Buffer

- 1320
- 2640
- Neighborhood Boundaries

0   2.25   4.5   9 Miles

0   4.5   9   18 Kilometers

N

Multi-Criteria Decision Analysis

MCDA

Kernel Density of Pedestrian and Cyclist Fatalities: 25%
Minority Population by ZIP Code: 20%
Kernel Density of Bus Stops: 15%
Miles of Bike Lanes Summarized Within Census Tracts: 9%
Median Earnings Over 12 Months by Census Tract: 9%
CTA Stations With 1 Mile Service Area Buffer: 9%
Red Light Cameras with 1/2 Mile Multi-Ring Buffer: 9%
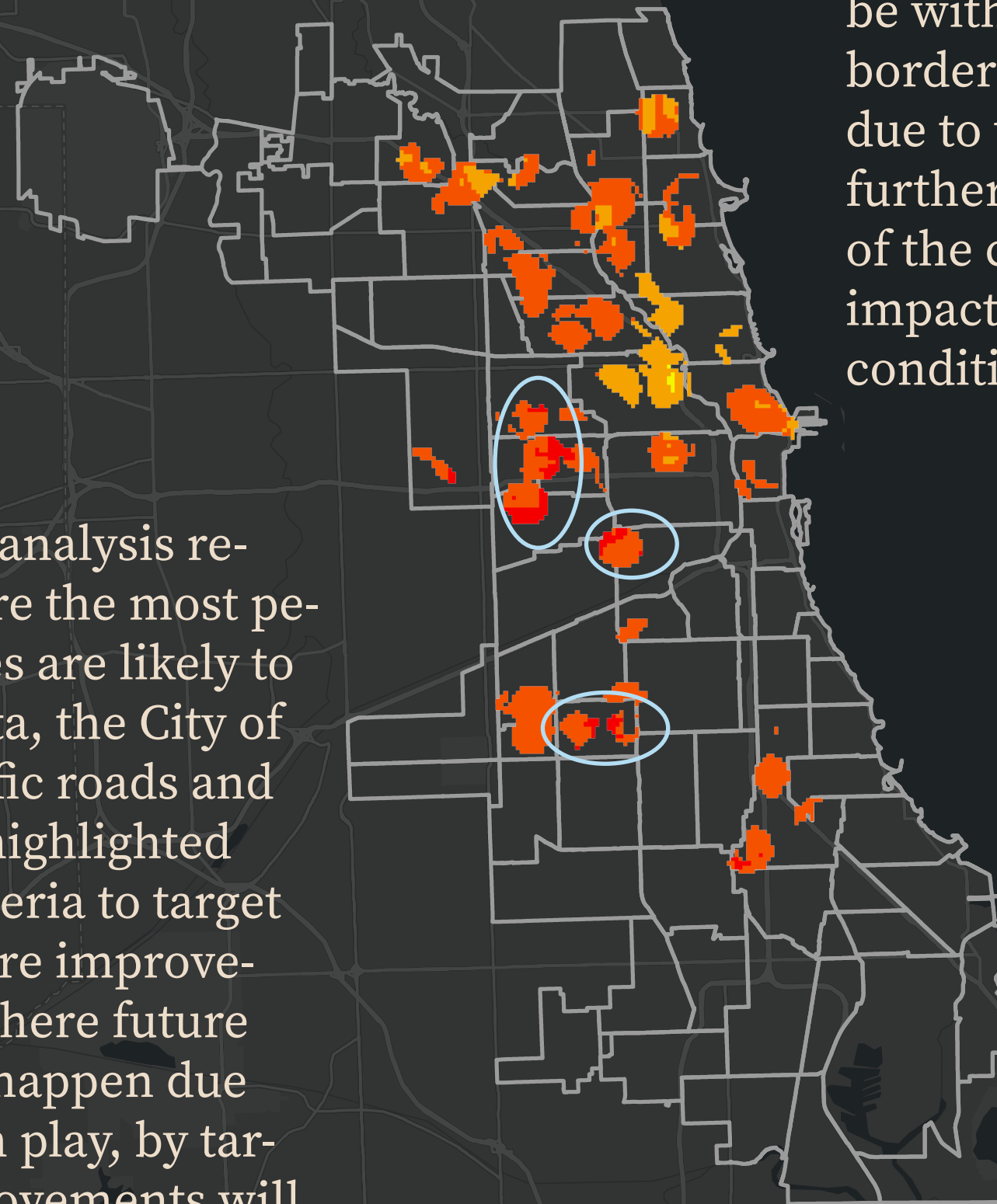Speed Cameras with 1/2 Mile Multi-Ring Buffer: 4%

    100%

Weighted Overlay percentages determined by the R^2 values returned from the regression analyses run for each variable. Pedestrian and Cyclist Fatalities is the main variable being researched so it was assigned the highest value, 25%. Minority population received a R^2 value of 0.46 and was assigned 20%, Bus Stops received a R^2 value of 0.08 and was assigned 15%. Bike Lanes, Median Earnings, CTA Stations, and Red Light Cameras all received an R^2 value of 0.02 and were assigned 9% leaving Speeding cameras which received a R^2 value of 0.01 to be assigned 4%.
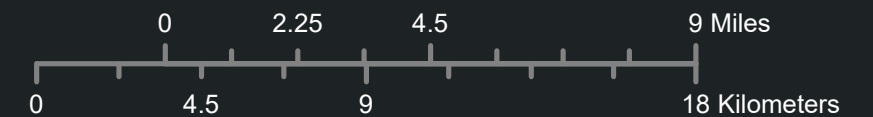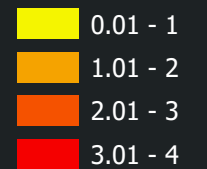
MCDA Results
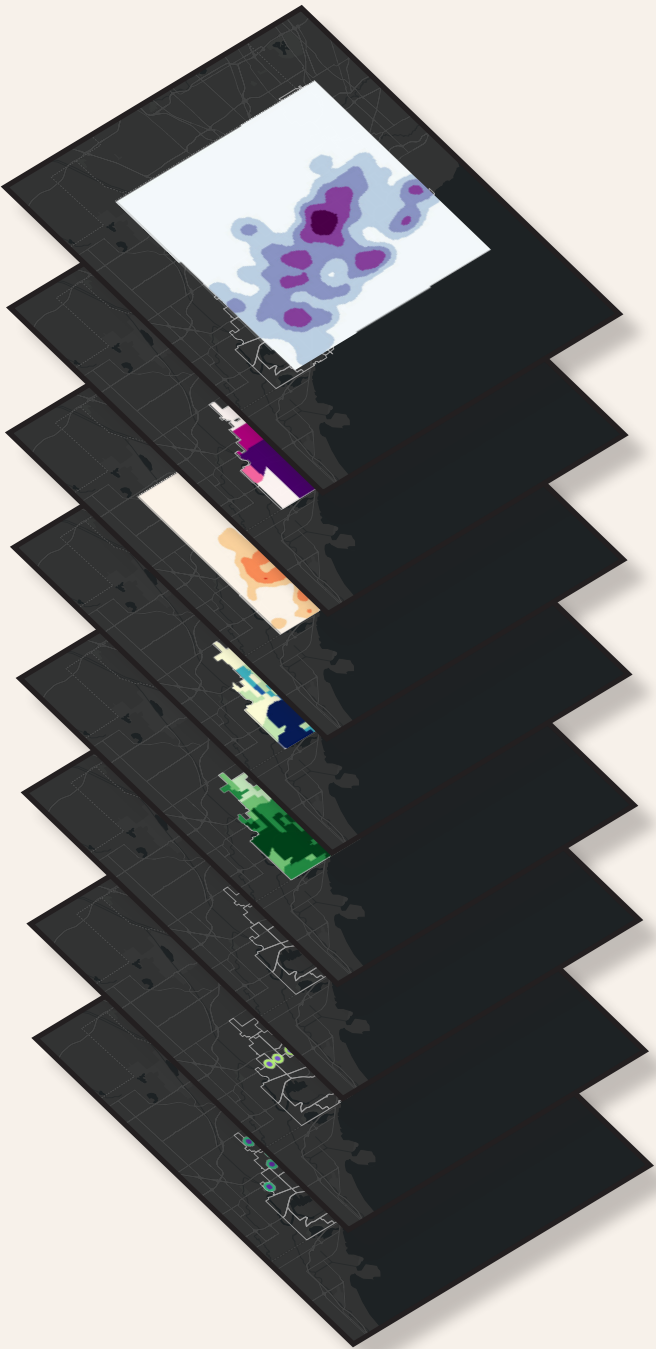
The three zones that appear to be the most potentially dangerous all happen to be within the West and South Sides, in or bordering neighborhoods examined prior due to their high density of fatalities. This further proves the disparity in these parts of the city and how these areas are impacted by dangerous road and traffic conditions.

The multi-criteria decision analysis results provide a veiw of where the most pedestrian and cyclist fatalities are likely to take place. By using this data, the City of Chicago can pinpoint specific roads and intersections within these highlighted zones that meet certain criteria to target for Vision Zero infrastructure improvements. Because these are where future fatalities are most likely to happen due to the variety of variables in play, by targeting these areas the improvements will have the most impact and benefits.

Neighborhood Boundaries

MCDA
0.01 - 1
1.01 - 2
2.01 - 3
3.01 - 4

0   2.25   4.5   9 Miles

0   4.5   9   18 Kilometers

N

MCDA Results

These three intersections are each within the dark red zone of the MCDA map. Understanding what thses areas have in common can help identify what to look for when targeting communities for Vision Zero improvements. Within two blocks of each of these inter sections there is a school, a church, multiple bus stops, CTA stations, bike lanes, and multiple stores. Additionally, each of these has one of the following essential services, the Illinois Department of Human Services, a dental office, and an urgent care. Each intersection provides necessary resources that the community must have access to such as health care, education, food, worship space, and transportations. This provides a guide for the city going forward, target intersections that lack infrastructure that protects pedestrians and cyclists, creating a safe environment. But also target the intersections they cannot avoid, there is no avoiding going to school or the doctor so even if this road is unsafe, you still may have to make the journey putting your life at risk. This is how the city should be making their Vision Zero improvements going forward to ensure they are having the most benefit on communities in need.

W Madison St & N Kedzie Ave
East Garfield Park, Chicago
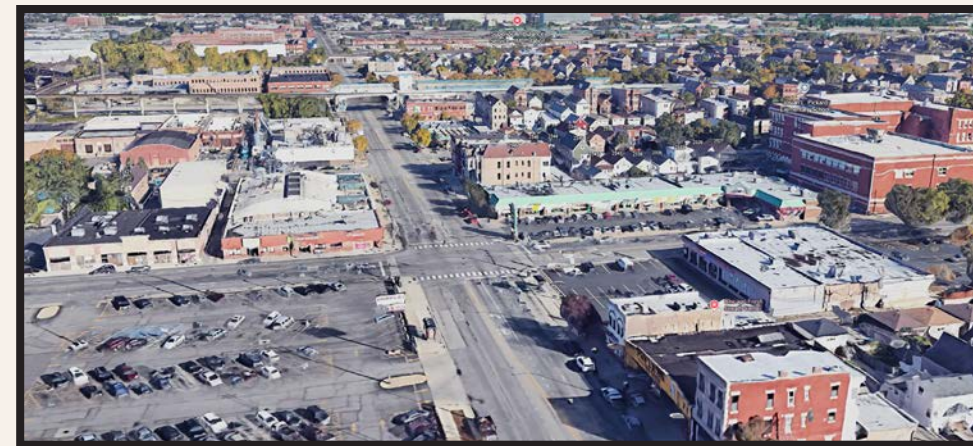
S Western Ave & W Cermark Rd
Bordering South Lawndale, Chicago
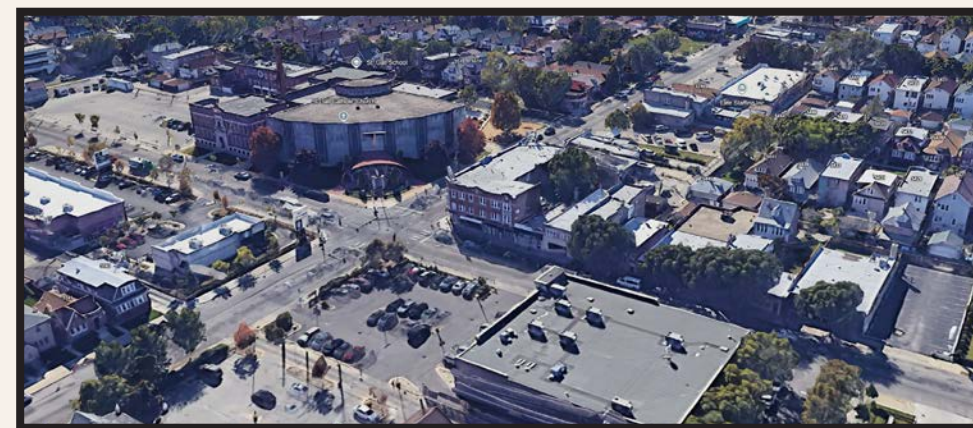
W 55th St & N Kedzie Ave
Gage Park, Chicago

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