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MEMORANDUM

September 26, 2026

To: Patrick Trouba, Bobby Evans
Organization: Mid-America Regional Council
From: Scott Harris, Hugh Kelley, Lucas Yu
Project: MARC Greater Kansas City Regional Bikeways Plan

Re: Existing Conditions Network Assessment

Overview

This memo describes the five analyses that together make up the network assessment completed as part of the MARC Greater Kansas City Regional Bikeways Plan. The network assessment quantifies the current connectivity of on and off-street facilities available to bicyclists and the relative importance of potential improvements. Overall, the goal of the network assessment is to allow for a better understanding of how the existing street network in the Kansas City region serves trips by bicycle and to provide a foundation for planning improvements that will better allow people to travel throughout the region by bicycle.

The key input to the network assessment is the Level of Traffic Stress (LTS) Analysis[1] that was completed for all non-restricted access streets and off-street facilities in the nine-county MARC region. The LTS analysis grades the stress of a street to bicyclists based largely on exposure to fast moving motor vehicle traffic. This network assessment takes the perspective of an "Interested but Concerned"[2] adult bicyclist, who is assumed to be willing to bicycle on LTS 1 and 2 streets. Research shows that Interest but Concerned bicyclists constitute slightly more than half the adult population. LTS 2 streets may pose a level of traffic stress that is not appropriate for children and other less confident bicyclists but can make up an important part of the bike network for many people that use or want to use bicycles in their daily lives, particularly Interested but Concerned bicyclists.

The following analyses are included in the network assessment:

[1] For additional detail and explanation of Level of Traffic Stress (LTS) please see the separate Level of Traffic Stress Memo.
[2] *See* FHWA *Bikeway Selection Guide*, pp.12-13, available at: https://highways.dot.gov/sites/fhwa.dot.gov/files/2022-07/fhwasa18077.pdf

- **Trip Potential** is a quantitative answer to the question, "*Where do we expect the most bicycle trips to occur if we ignore the quality and connectivity of the current street network*?" This analysis is useful for understanding differences in land use both between and within communities across the region and how conducive that land use is to trips by bicycle.
- **Connected Components** considers "*islands of connectivity*" and shows which areas are completely disconnected from each other for a bicyclist unwilling to ride on or across stressful streets (defined as those rated LTS 3 or 4).
- **Centrality** quantifies which streets make up the most important connections for people traveling in the region. Some streets allow for more direct travel between places and the centrality calculations estimate which streets people are most likely to use to efficiently travel where they need to go regardless of the stress level of a particular street.
- **Directness and Connectivity** answers the questions "*How many nearby locations can be safely reached by bicycle?*" and "*How much of a detour is required to avoid bicycling on stressful roads?*"
- **Access** identifies specific destination types and illustrates the area around those destinations that can safely access the destination by bicycle, as well as the areas where, by lowering the stress level of a roadway, more access is possible.

The remainder of this memorandum examines each component of the network assessment and its results in more detail. Together, these analyses will be used to understand where future investments in regional bicycling routes are likely to have the highest return on investment—providing a quantitative foundation as the MARC Greater Kansas City Bikeway Plan project team begins developing a revised regional bike network for the Kansas City region.

Trip Potential

The Trip Potential analysis yields a heatmap of the region's Census Blocks that shows where land uses indicate the most potential for trips by bicycle. Inputs to the calculation include residential and employment densities, proximity to schools, transit/streetcar stops, and grocery stores. While many other types of destinations can attract and generate trips, the selected locations are representative of typical trips within our street network. As shown in **Table 1**, 2020 Census data was used for residential and employment data while the rest of the data was sourced from MARC. While decennial Census data are slightly older than data from the American Community Survey (ACS), Census data is available at the more detailed block level, rather than the larger block groups that the ACS uses.

The project team also incorporated the density of short vehicle trips as an indicator for potential bike trips. The short-trip density is based on the short-length vehicle trip analysis results[3], which analyzed the number of private motor vehicle trips, from Replica, with trip distances shorter than 3-miles. These six factors were combined with equal weighting to produce a composite trip potential score.

[3] For additional explanation, please see MARC Bikeway Data Summary Memo.

Table 1: Trip Potential Factors

Factor	Measure	Data Source	Description
Population	Total population in Census Block	2020 Census	Population min/max scaled between 0 and 1
Employment	Total jobs in Census Block	2020 Census	Total Jobs min/max scaled between 0 and 1
Transit / Streetcar Stops	Presence of a stop within ¼ of a mile	MARC	Scaled to 0-1 based on proximity
Schools	Presence of a school within one mile	MARC	Scaled to 0-1 based on proximity
Grocery Stores	Presence of a grocery store within a mile	MARC	Scaled to 0-1 based on proximity
Short Vehicle Trips	Number of private vehicle trips with trip distance < 3 miles in the Census Block	Replica/Kimley-Horn	Number of trips min/max scaled between 0 and 1.

The result shown in **Figure 1** depicts the trip potential score of each Census Block normalized between 0 and 100, with darker shaded Census Blocks representing areas of higher trip potential. The highest trip potential scores are clustered in the region's principal cities, such as Kansas City, MO, Independence, MO, Kansas City, KS, and Overland Park, KS. Outside of the regional core, trip potential scores are relatively low, with moderately higher scores in some smaller outlying cities and towns forming isolated areas of higher trip potential.

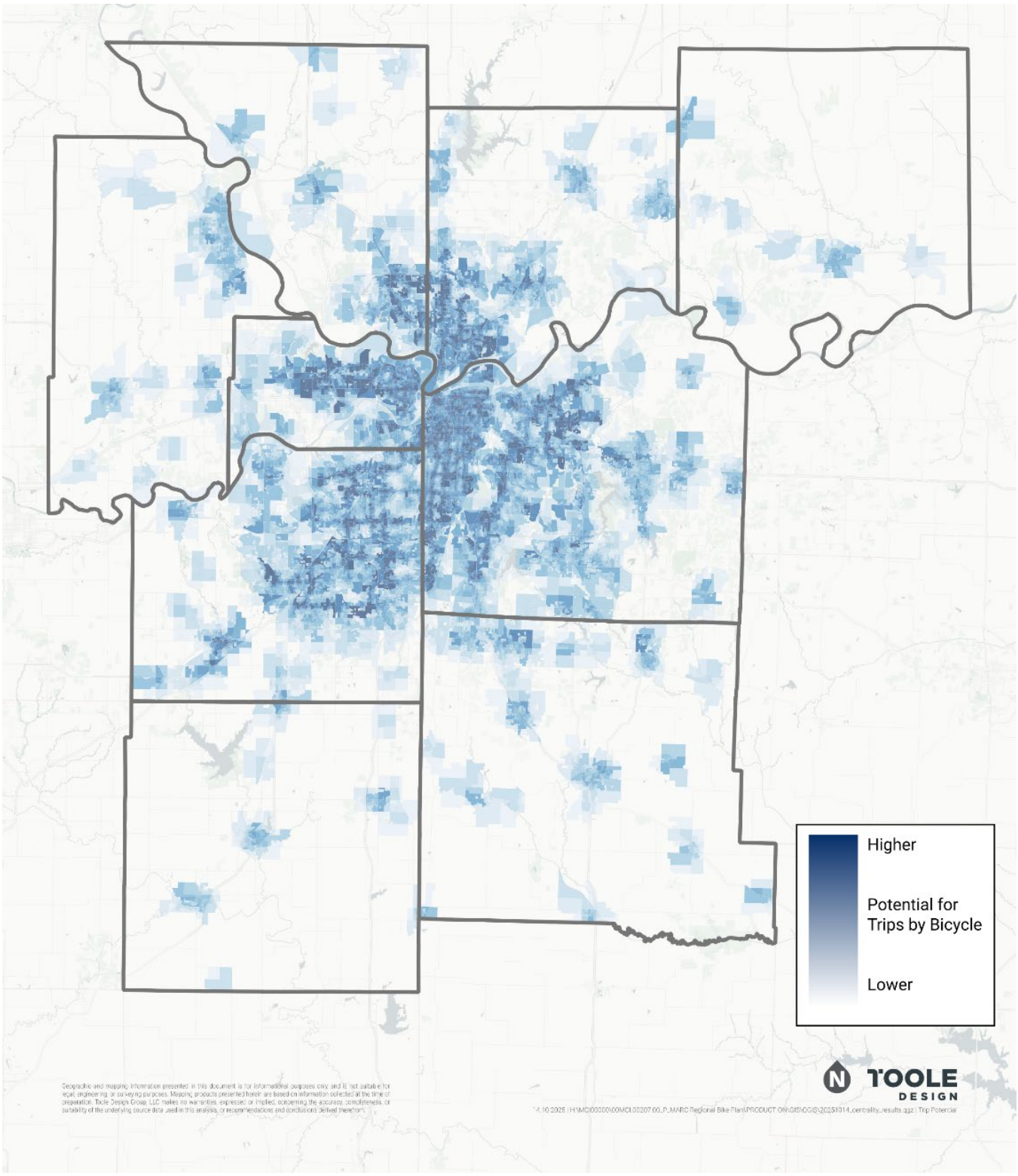


Figure 1: Trip Potential Analysis Result

Low-Stress Connectivity

The Low-Stress Connectivity analysis builds on the Level of Traffic Stress (LTS) analysis to identify “islands” of low-stress connectivity in the region. These islands are a helpful illustration of how challenging it can be to travel even short distances by bicycle. Each island, shown in **Figure 3**, is depicted in a distinct color. An island is a collection of streets which all connect safely to each other but do not connect safely to other areas (i.e., islands) using an LTS 1 or 2 street.

Low-stress connectivity in this analysis was assessed in two ways. The first method, shown in **Figure 3**, uses only segment stress, which assumes that a bicyclist will travel on any series of low stress streets regardless of the stress rating of streets they cross. The second method, shown in **Figure 4**, assumes that a bicyclist will not cross a high stress street even if the street they are traveling down is low stress itself.

Reality is likely in between these approaches as some bicyclists are comfortable crossing with traffic or in a pedestrian crossing while other bicyclists are unwilling to bike across a high-stress street. Another consideration is that a signalized crossing of a high-stress street may be comfortable enough for most bicyclists. However, the true stress level of a signalized intersection depends on the various turning movements and intersection configurations such as lane count, pedestrian facilities, and the allowance or restriction on “right on red” turns, all of which have significant effects on the safety and perceived stress of a given intersection.

A key limitation of the Low-Stress Connectivity analysis is that any low-stress street connecting to a particular island becomes part of that island, even if a significant detour is required to stay within the low-stress island. Research has shown that bicyclists are not consistently willing to ride far out of their way during a trip and are likely to choose another mode for their travel if a large detour is required.

One final consideration in the connected components assessment is how large networks of dedicated bike facilities shown in **Figure 2** connect to one another. Overland Park has approximately 60 miles of connected facilities as seen in purple in the southwest. Kansas City has about 8 miles of connected facilities in its urban core. These calculations are very sensitive to the assumptions made about connections between facilities: what constitutes a bridgeable gap compared to a true disconnection. For these calculations, crossing stress was not considered as many bike facilities are constructed with improvements to crossings along them as well as the facilities themselves, but this is rarely reflected in the data.

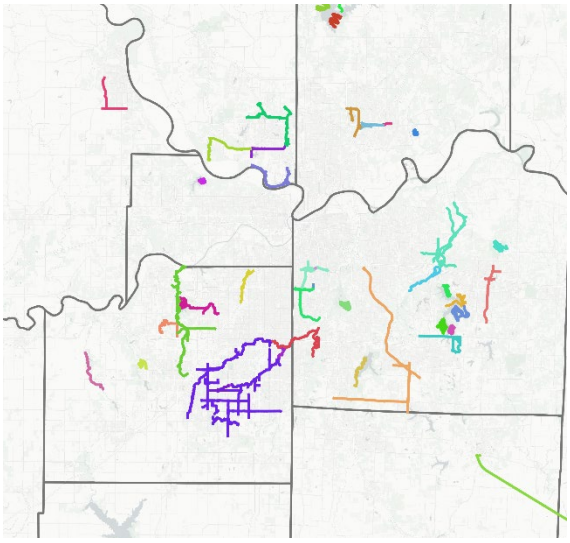


Figure 2: Connected Bike Facilities

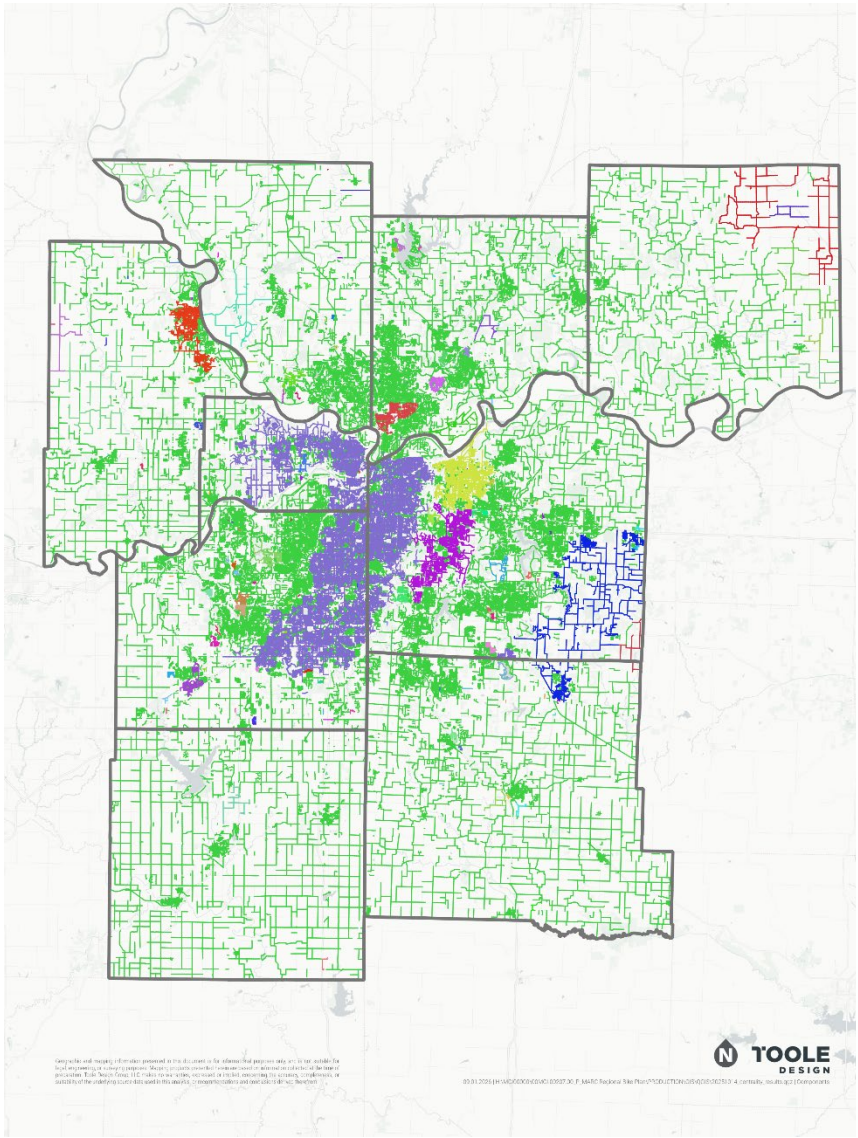


Figure 3: Low Stress Islands by Segment Stress

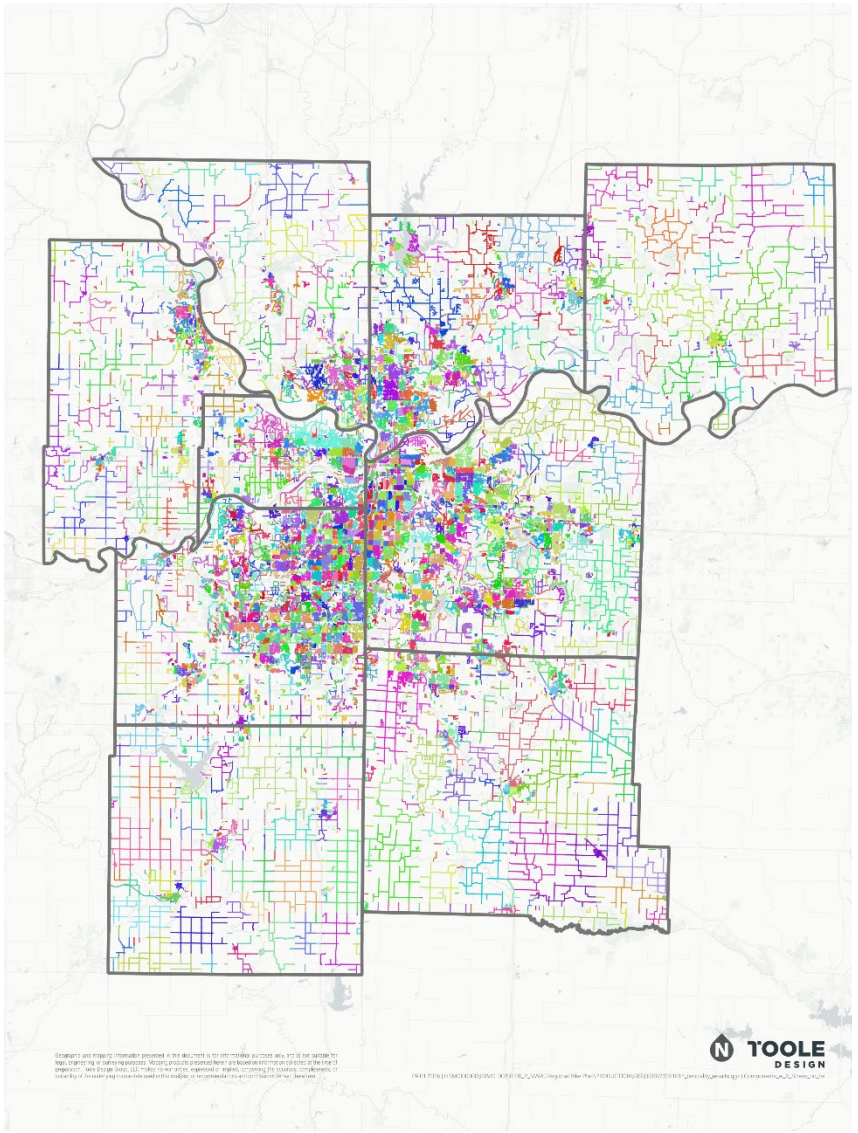


Figure 4: Low Stress Islands Including Crossing Stress

Centrality

Centrality assesses the relative importance of network links for efficient travel by calculating millions of trip-routes that are the shortest paths between origin and destination locations using the entire roadway and off-street network, regardless of stress level. **Figure 5** illustrates the idea that some streets are more important than others when traveling between locations.

Centrality can be calculated in multiple ways. The first is by looking at trips between any pair of intersections within reasonable bicycling proximity to each other. For this analysis the distance used was three miles. While bicycle trips are often longer than this, most are shorter. Ultimately, any long trip can be treated as a series of short trips, meaning the centrality results for longer trip distances tend to be very close to the results for shorter distances.

Centrality quantifies the idea that streets with more trip-routes passing through them are more important. However, this analysis does not tell us whether there is a similar alternate route available that runs parallel to the shortest route, which may be slightly longer but less stressful and therefore more acceptable to most bicyclists.

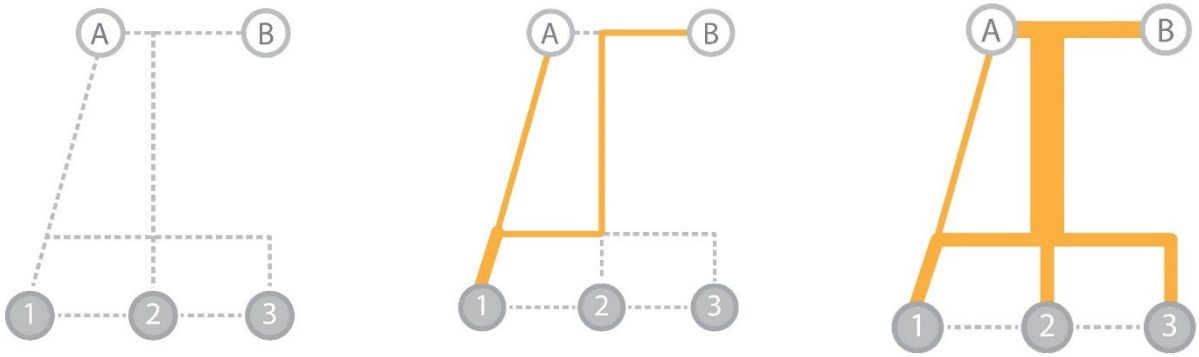


Figure 5: Centrality Diagrams

Centrality Results

Looking at the simple count of trips through a street segment, shown in **Figure 6**, it becomes clear that streets in areas of higher intersection density are scored as being more important. This is a correct conclusion as intersection density is a key indicator of activity levels but also can cloud our understanding of how streets compare to each other. To address this, we adjusted the centrality results to also look at a normalized centrality score which is the raw score divided by the intersection density around the street segment.

The adjusted centrality results in **Figure 7** show more results distributed across the suburbs around Kansas City. These results can help identify locations where bike facilities serving longer trips would be useful as population and destination density falls substantially outside of downtown while also serving local populations. These results also begin to highlight connections between more rural town centers where intersection density is low, but some roads are substantially more important for serving trips than others because they travel more directly between places.

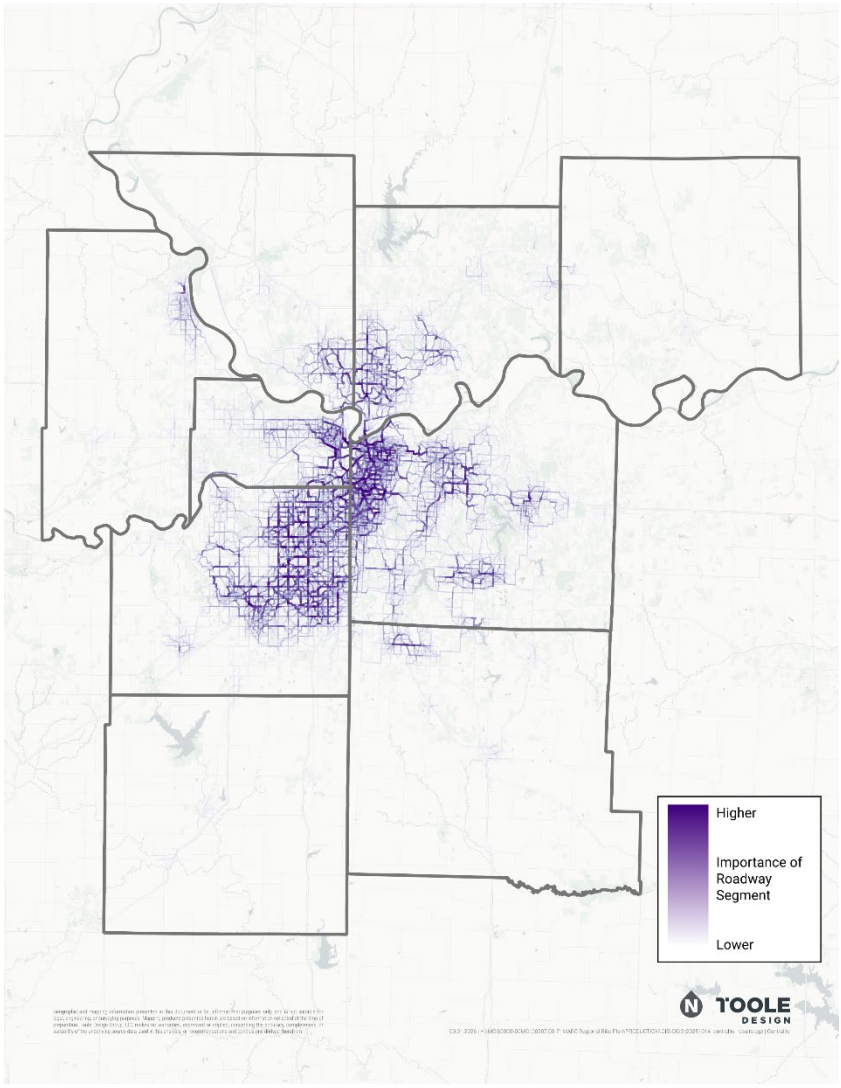


Figure 6: Centrality of Road Network Segments

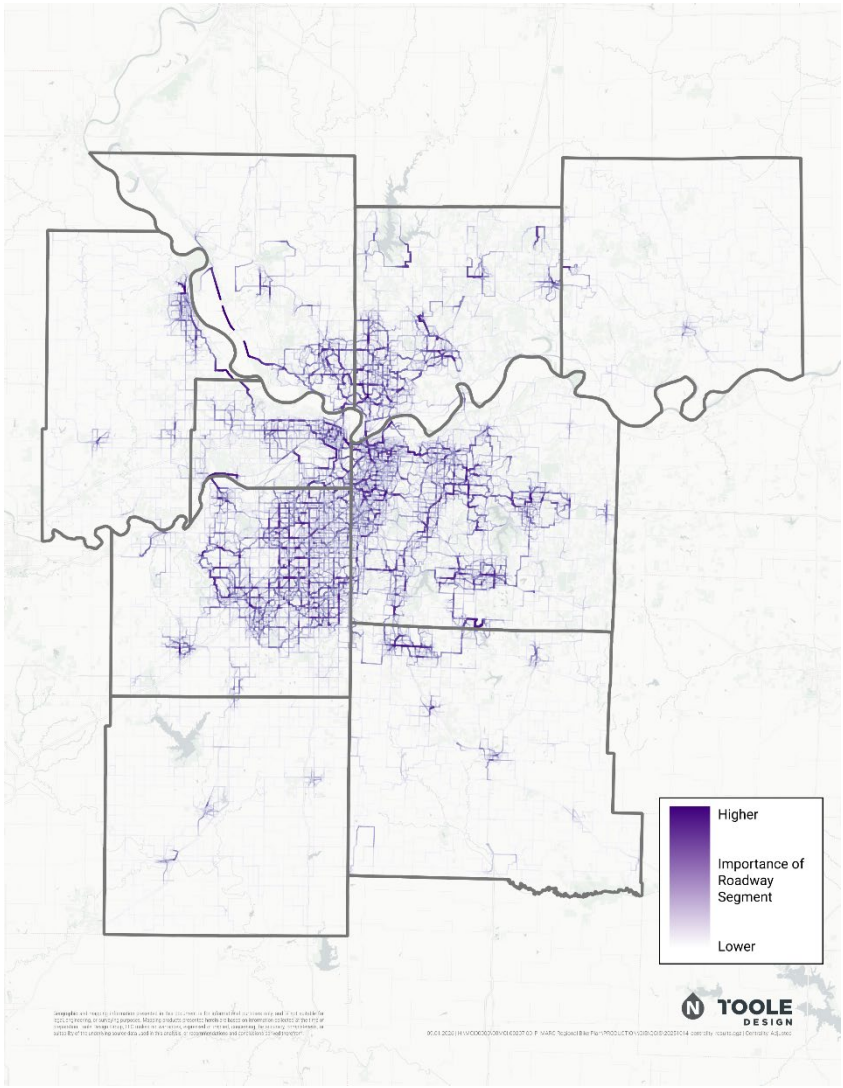


Figure 7: Centrality of Road Network Segments Adjusted for Intersection Density

Weighted Centrality

In addition to looking at the basic centrality values discussed above, the activity level at the origin and destination of each trip can be incorporated. Because the centrality analysis uses intersections as origin and destination points, not all trips are equal. Some trips originate and terminate in areas with much more activity than others. For example, a trip between a place with high density housing and a place with a high employment density will occur much more often than a trip between a place with only a few housing units and a street with only a few stores. To better understand this reality, we also examined weighted centralities. Four separate weighted centrality calculations were run: 1) by population totals at the origin and destinations of a trip, 2) by employment totals at the origin and destination of a trip, 3) by the population at the origin and employment at the destination of trips, and 4) by the total population and employment at the origin and destination. Ultimately, the versions using population only and total population plus total employment resulted in the greatest differentiation across the region, shown in **Figure 8** and **Figure 9**. This results in a potentially more nuanced understanding of travel across the region.

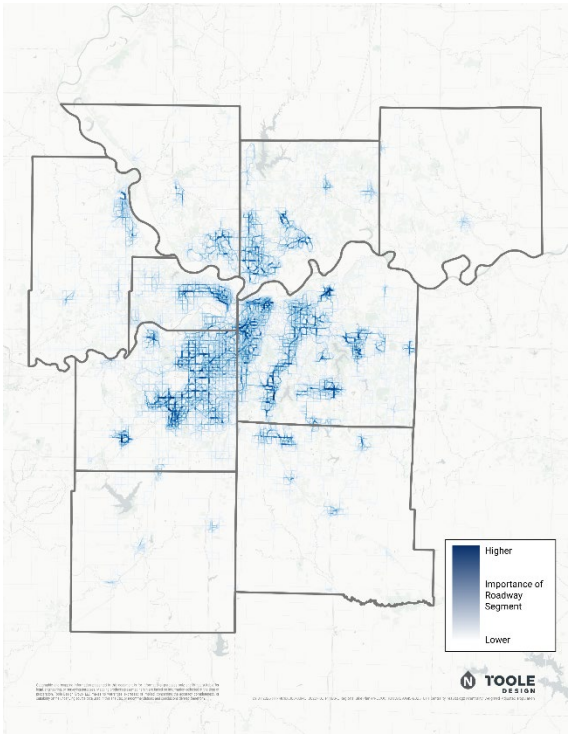


Figure 8: Population Weighted Centrality Adjusted for Intersection Density

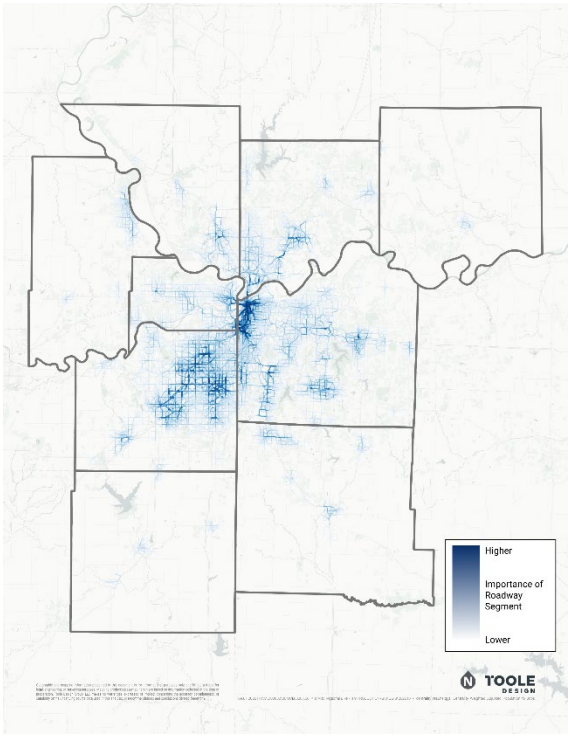


Figure 9: Centrality Weighted by Total Population and Employment Adjusted for Intersection Density

Trips to and Between Important Places

In addition to calculating trips between nearby places, the Centrality analysis also looks at longer trips between “important places”. It is computationally infeasible to calculate trips between all intersections within a large radius because the number of trips increases exponentially with distance. Instead, we look at a sample of trips across longer distances. Important places are locations that we estimate to serve relatively more trips than other places, based on the activity in those locations. The Census Block with the highest job count in each regional municipality within the study area was identified, as shown in **Figure 10**. For each Block, the intersection with the highest average AADT volume across the streets that pass through it was used as the start location for trips, shown in

Figure 11. This serves as a location that represents a high level of activity based both on job counts and vehicle traffic. Trips were calculated starting and ending at each of these intersections.

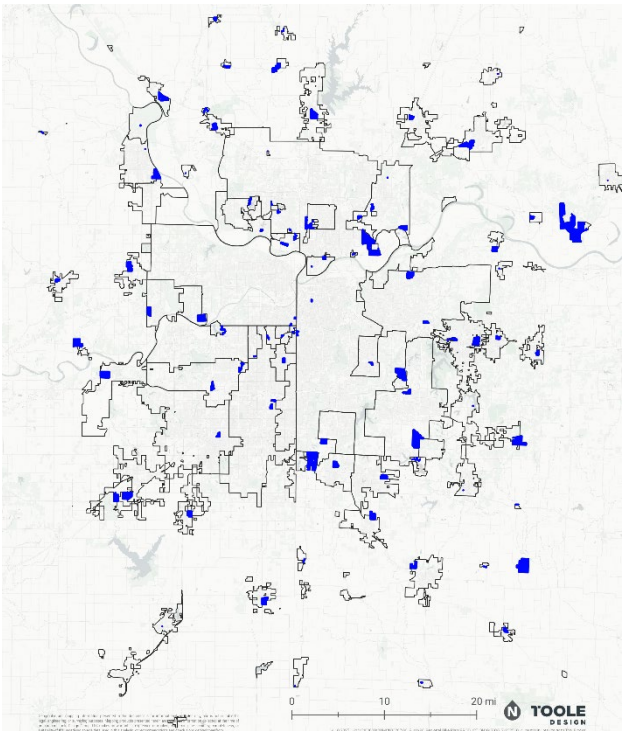


Figure 10: Top Census Blocks in Each Municipality by Job Totals

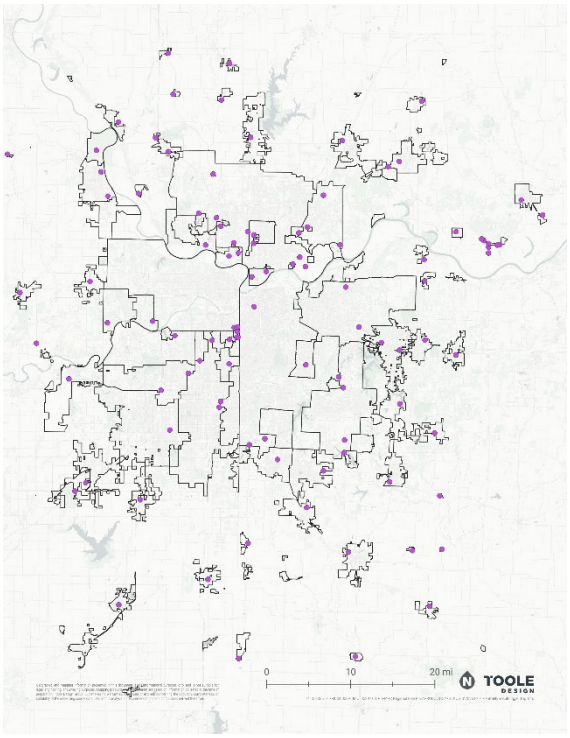


Figure 11: Top Intersections By AADT, Near Top Census Blocks

More than 5,000 routes were calculated between the locations in **Figure 10** and **Figure 11**, with results shown in **Figure 12**: Centrality for Trips Between Major Intersections. In addition to trips between important places, trips from the area surrounding an important place were calculated to understand trips from tributary locations within the "catchment area" of a key location. These results are shown in **Figure 13**. The results for these trips are much more distributed than the results for trips between important places and may serve particularly well for identifying improvements in more rural areas around town centers to which people are likely to bike.

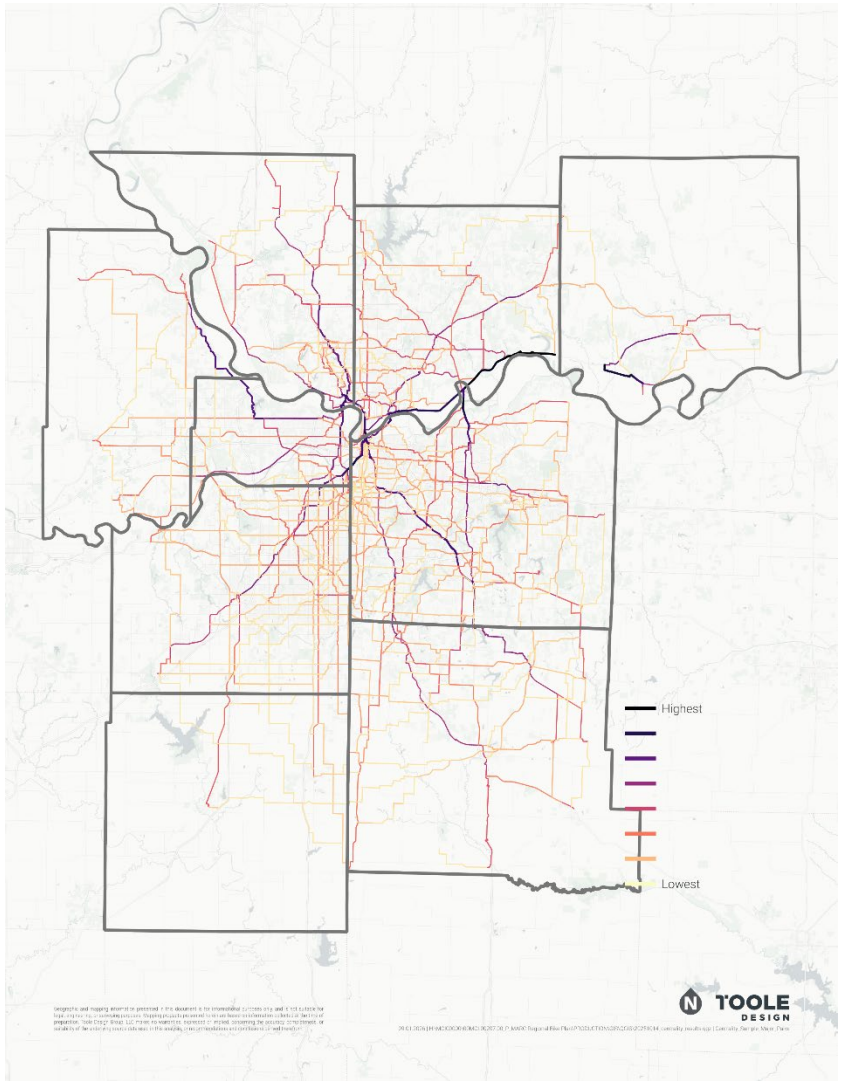


Figure 12: Centrality for Trips Between Major Intersections

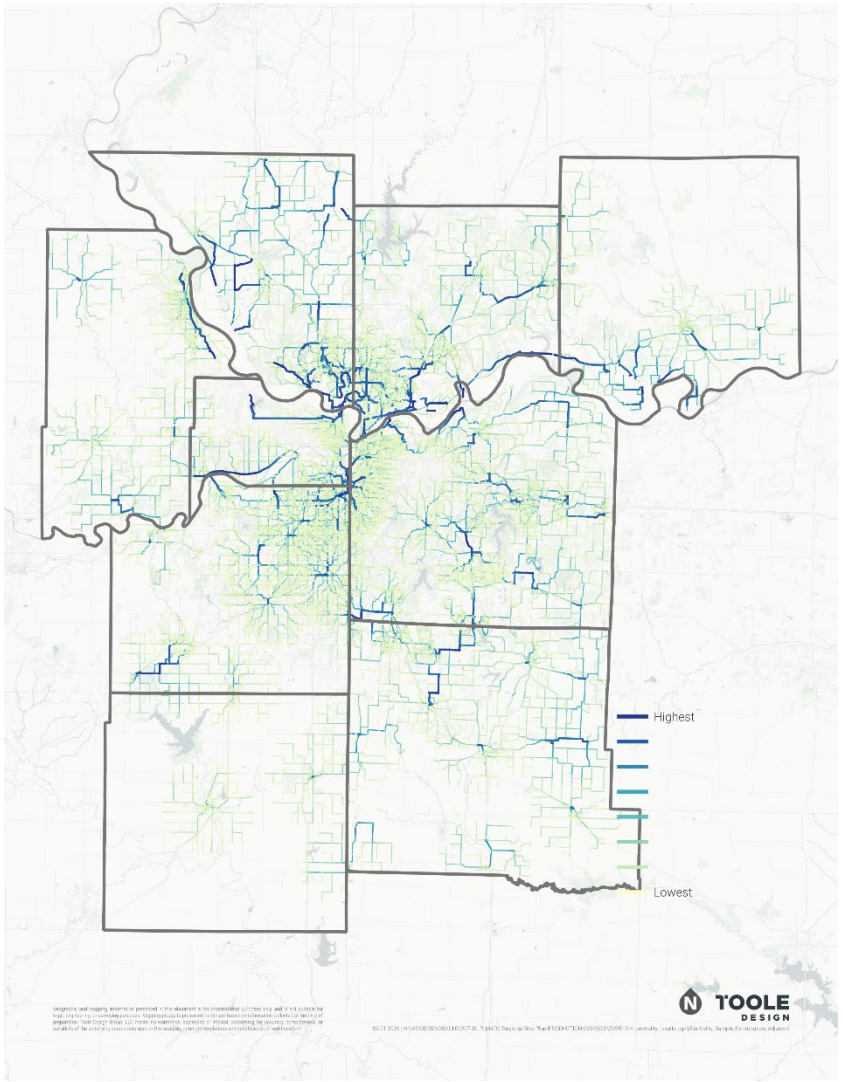


Figure 13: Centrality for Trips to Important Places from Surrounding Areas Adjusted for Surrounding Intersection Density

In addition to the mapped results above, it is informative to look at the functional classes of the roads making up routes between the identified important places, shown in **Table 2.** Higher functional class roads are much more likely than lower functional class roads to be included in these routes. Principal and Minor Arterials are more than twice as likely to be used on one of these routes than they would if picked at random. **This is strong evidence that bike facilities are needed on higher functional class roads as these roads are overwhelmingly higher stress and very important to efficiently traveling throughout the region**. While some parallel routes may be available, these key roads tend to be much more direct than lower functional class roads. For example, local roads are significantly underrepresented as they are more often interrupted, forcing a detour, and are more likely to take a non-direct route through a neighborhood.

Table 2, Summary of Routes Between Major Intersections by Functional Class

Functional Class	% of Major Pair Routes	% of Total Street Network	Ratio
Freeway/Expressway	8.0%	3.4%	2.36
Principal Arterial	6.2%	2.4%	2.62
Minor Arterial	22.0%	7.8%	2.81
Major Collector	24.2%	11.6%	2.09
Minor Collector	2.6%	2.3%	1.09
Local Street	36.9%	72.4%	0.51
Service	0.0%	0.1%	0.20

Directness

Directness considers the same routes calculated for the Centrality analysis but adds level of traffic stress as an additional factor. In addition to calculating the shortest route between origins and destinations, we also calculate routes using only low stress links. For each trip this results in one of three outcomes: Possibility 1 (**Figure 14**) is that the route is the same because the most efficient route between the origin and destination is low stress; Possibility 2 (**Figure 15**) is that the route is longer because a bicyclist must make a detour to avoid a high-stress street that someone driving a car would use to travel more directly; Possibility 3 (**Figure 16**) is that the route is impossible because there is no viable low stress way to travel between the origin and destination. **Figure 17** shows the average percentage of trips that are impossible on the low stress network for places within each Census Block. **Figure 18** shows the average increase in distance (detour) for the trips that are possible. Areas with more trips that are impossible and larger average detours are less connected for bicycling than areas with fewer impossible trips and smaller average detours.

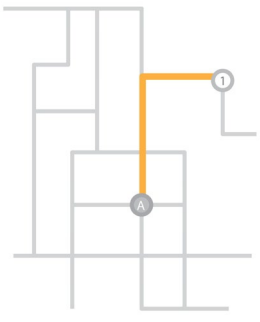


Figure 14: Direct Route

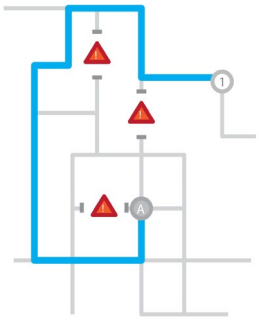


Figure 15: Indirect/Detour Route

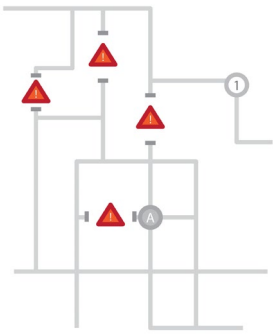


Figure 16: Disconnected Route

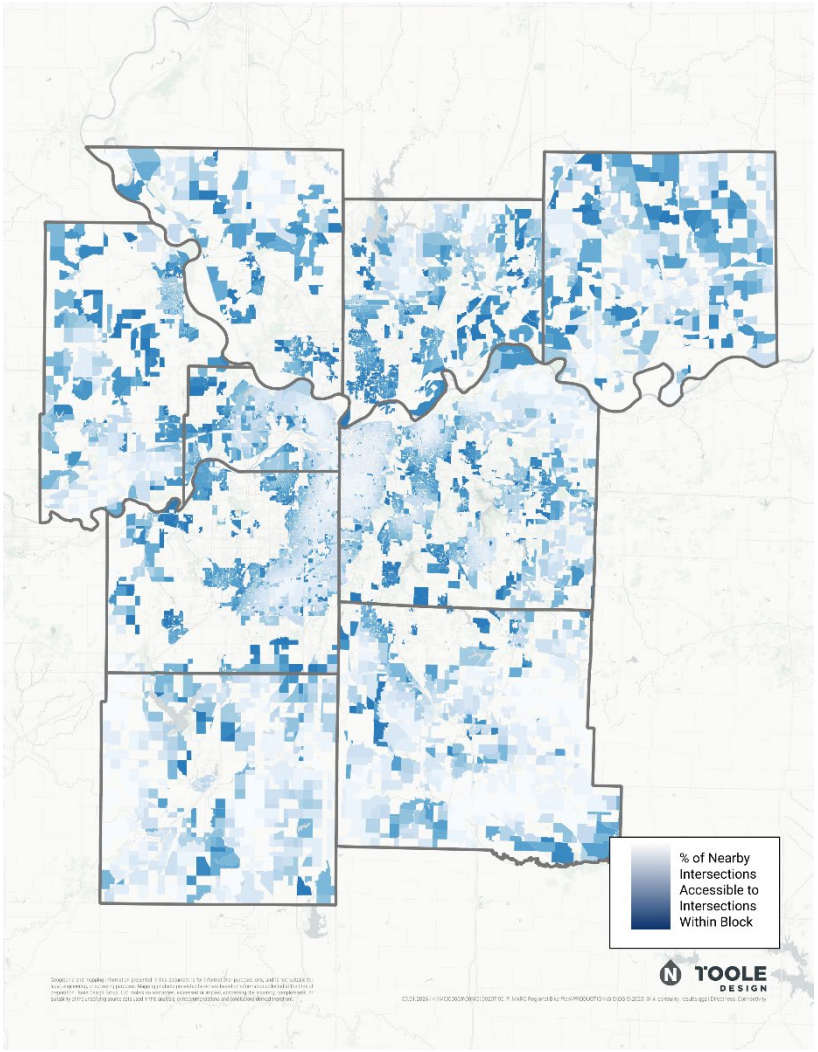


Figure 17: Directness – Connectivity (Darker areas are less connected)

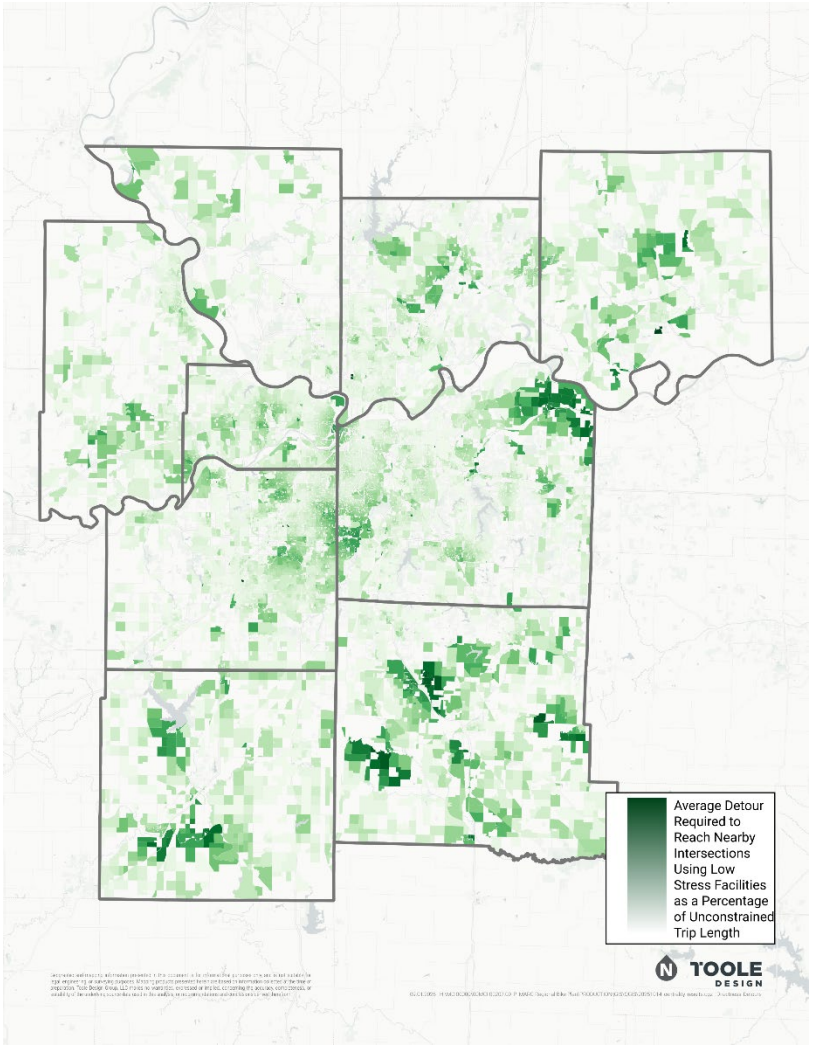


Figure 18: Directness – Detours (Darker areas require larger detours)

Access

The Access analysis looks at what areas can reach a given amenity within a reasonable trip distance on the low-stress network. It considers a collection of factors including the location of amenities (a person can't reasonably access a grocery store by bicycle if the nearest grocery store is 20 miles away), barriers to access (if the only route to an amenity includes high stress roads, that amenity is not reachable for most people by bike), and required detours. The analysis limits trips to 3 miles, therefore large detours may limit the low-stress access area and may help identify locations for improvements to provide more direct low stress routes.

Access to the streetcar, seen in **Figure 19**, is relatively widespread. In contrast, bus stops (**Figure 20**), particularly in the more peripheral areas of bus service, have substantial room for improvement. In the suburban areas, bus stops are likely on high stress arterial streets which are both stressful to bike on and may contain many important amenities beyond just the bus stops the analysis considers. This is the case for grocery stores as well (**Figure 21**), where substantial opportunity exists to increase access by bike to these locations. Finally, **Figure 22** and **Figure 23** show access to all schools and access to public high schools. Focused route improvements to schools may make substantial improvements to safety and bike-ability in the areas around these schools where the analysis shows that there is significant room for access improvements to the school area by bicycle.



Figure 19: Access to Streetcar

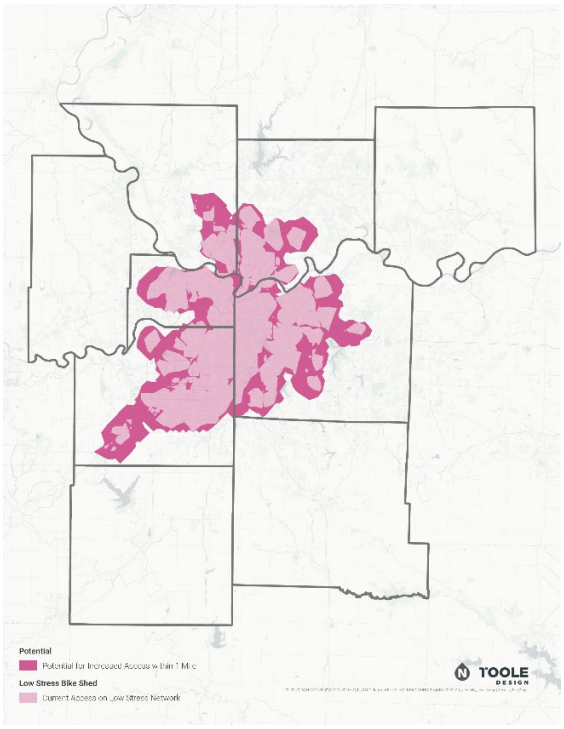


Figure 20: Access to Bus Stops

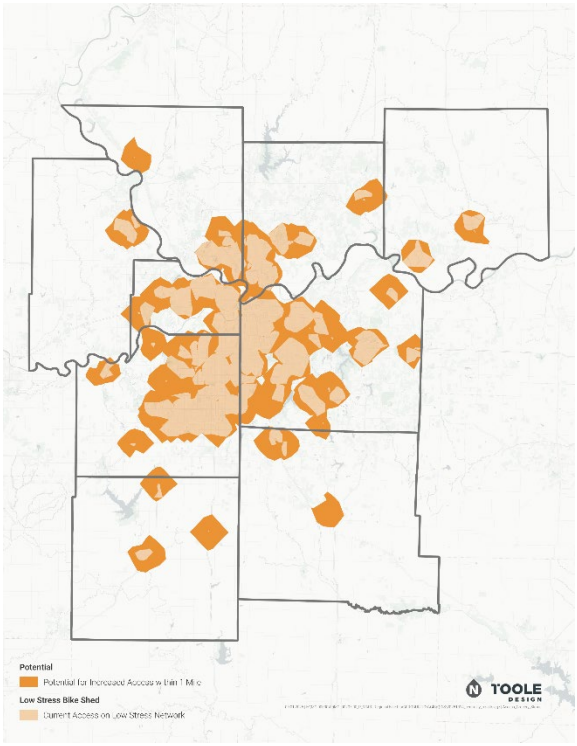


Figure 21: Access to Grocery Stores

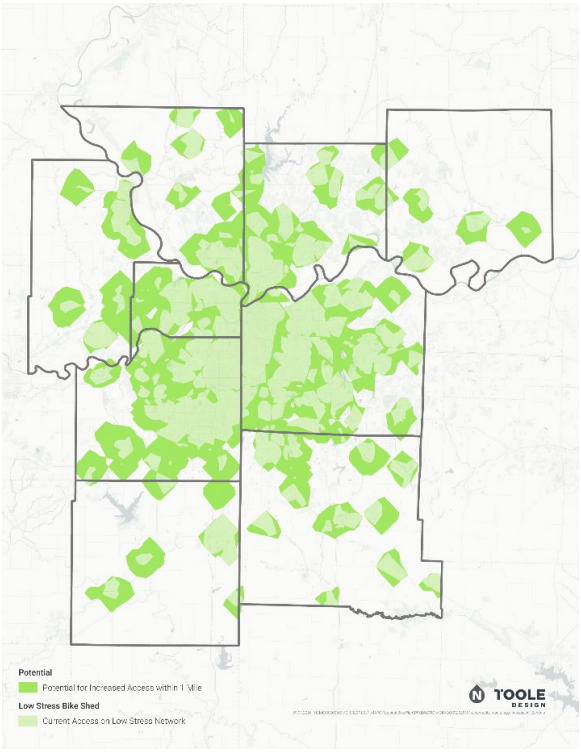


Figure 22: Access to Schools

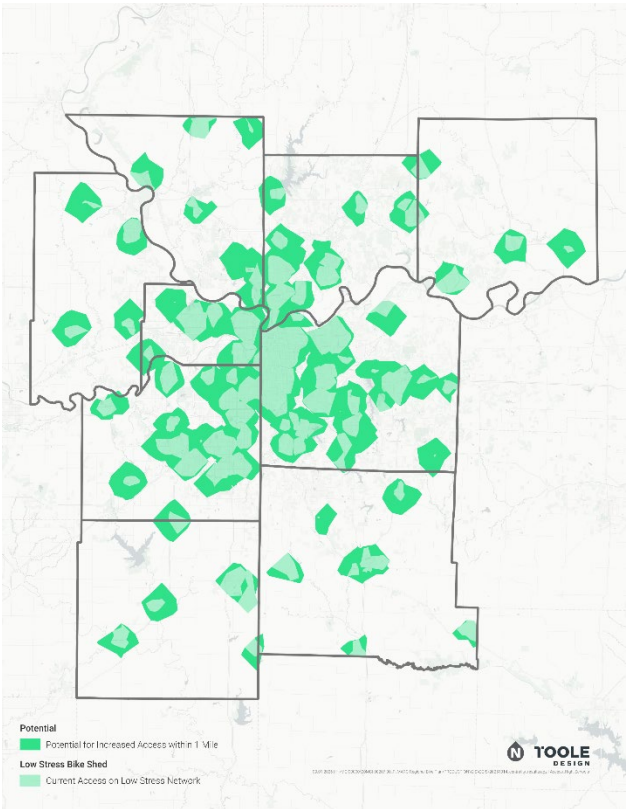


Figure 23: Access to Public High Schools

Next Steps

The analyses in this network assessment quantify the existing connectivity of the Kansas City region's street network for bicyclists considering both network structure and the current Level of Traffic Stress of streets. It allows for some initial observations about the current quality of the network and the potential areas where improvements to support more low-stress biking may be most utilized, and which streets are most central to connectivity in the region. Each of these analyses will next carry into the bicycle network development task supporting identification of high impact, useful, and implementable corridors for the regional bike network. Subsequently, these analyses will be relevant to local jurisdictions in planning their own local bicycle networks.