Bike Trip Type
Understanding where and why people ride bikes within Georgetown is key to understanding and addressing the needs of the community. The survey asked questions related to the location and purpose of bike trips, and opportunities to convert non-cycling trips to cycling. Insights gathered helped make decisions regarding infrastructure types and locations, as well as what types of encouragement campaigns may work in the city within the Plan.

An overwhelming majority – 89% – of respondents indicated that they ride for exercise or fun most frequently. Biking to the park is the second most popular reason for biking, with 37% of respondents indicating that they do so. Utilitarian bike trips are less popular than those taken for recreational purposes. Only 22% of survey respondents said they run errands on their bike, and nearly 60% of survey respondents never bike to school or work.

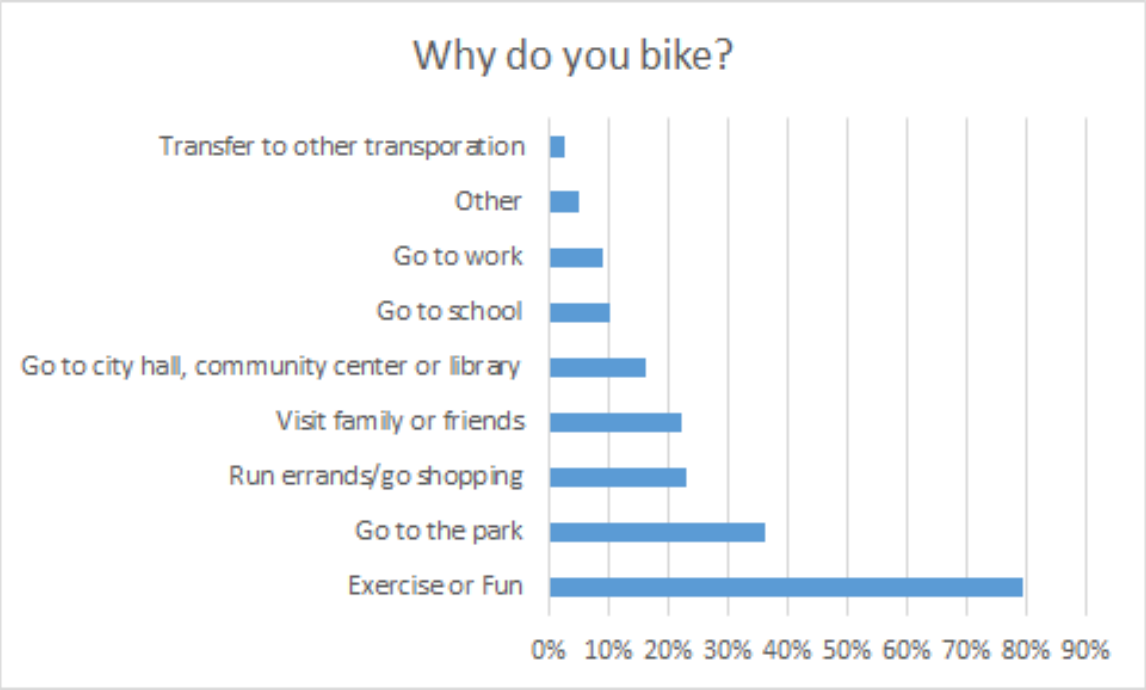


Figure 3. Do You Bike? Results

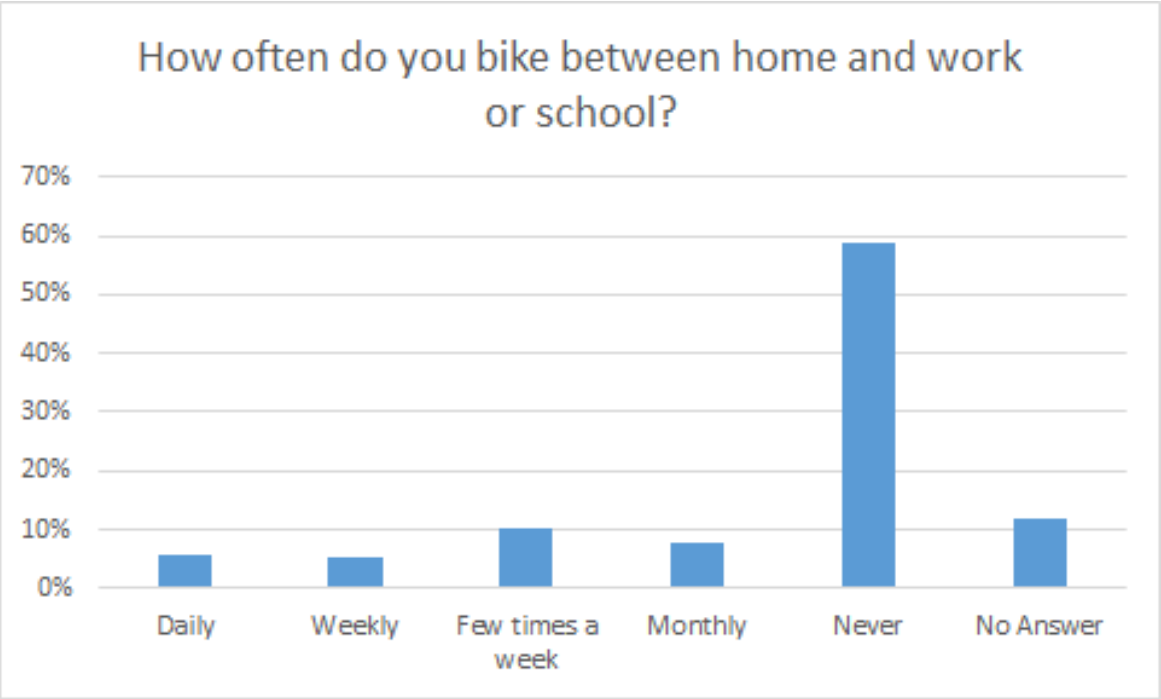


Figure 4. How Often Do You Bike Between Home and Work or School? Results

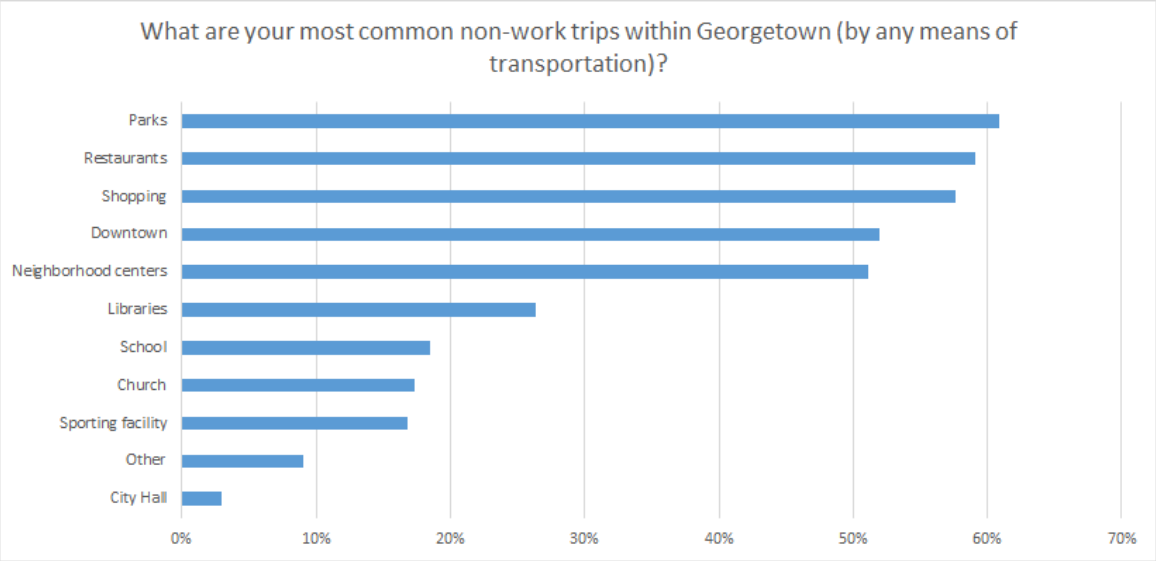


Figure 5. Most Common Non-Work Trips? Results

Bike Demand in Georgetown
The question "What type of rider are you?" showed that 29% of respondents consider themselves "interested but concerned" riders. This group is interested in cycling, but has concerns regarding safety and connectivity of the bike network. If barriers and points of concern are addressed, there is potential convert those "interested but concerned," and potentially "not bikers" into cyclists.

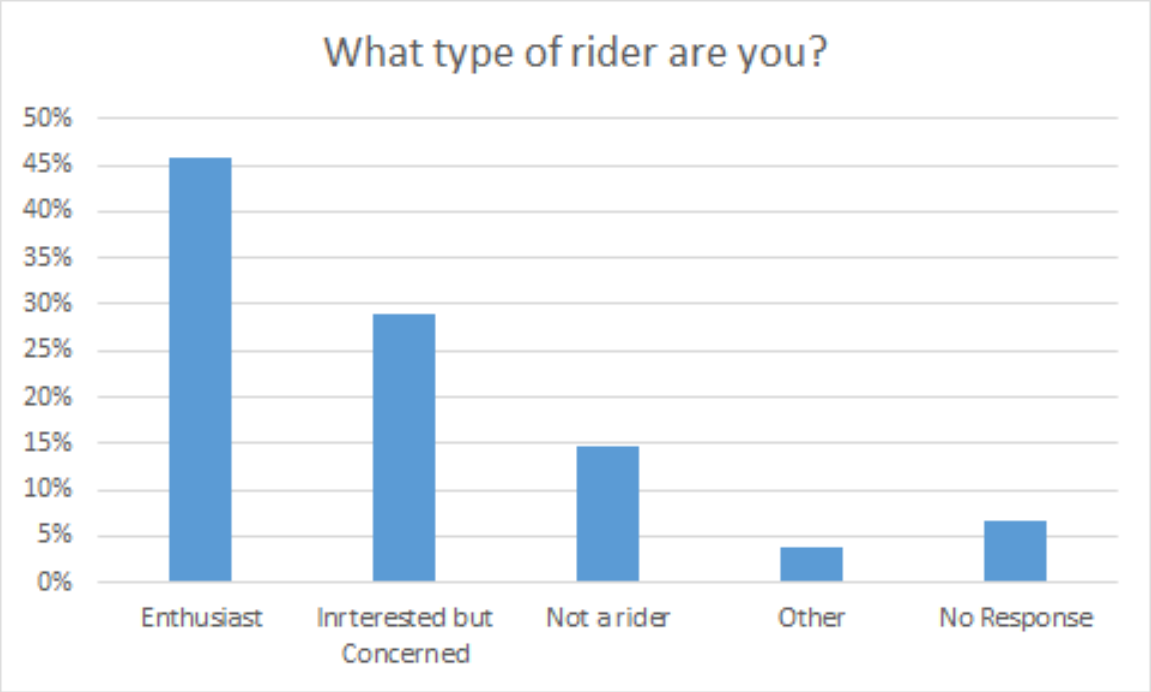


Figure 6. What type of Rider are You? Results

Bicycling Barriers in Georgetown
Lack of bicycle lanes and personal safety were the top concerns for both cyclists and non-cyclists. Barriers that prevent current residents from cycling are due to a lack of dedicated bicycle infrastructure, including bicycle lanes and off-street bicycle trails. Barriers are graphed in Figure 7.

Despite the barriers indicated, many residents are enthusiastic about the potential of bicycling in Georgetown. Many expressed interest in the bicycle master plan, investing in bicycling infrastructure, and promoting bicycling in the city. Non-cyclists and infrequent cyclists indicated that the most impactful method for increasing their biking habits would be installing dedicated bike lanes, off-street bicycle trails, and paved shoulders, as indicated in Figure 8.

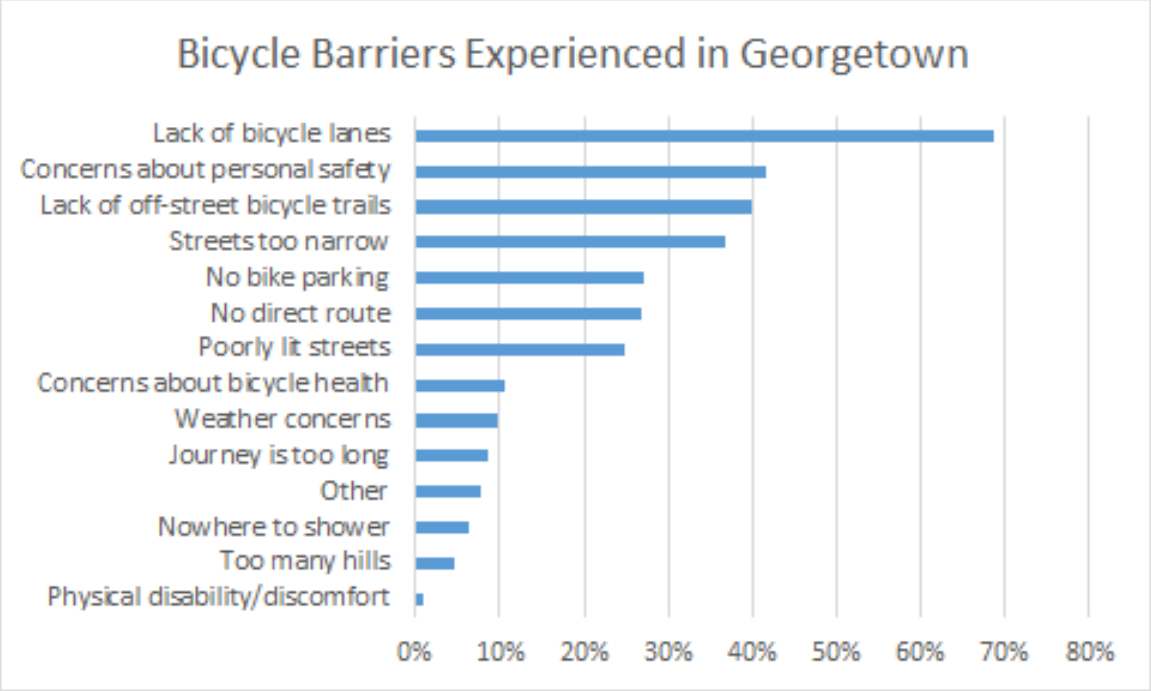


Figure 7. Bicycle Barriers Results

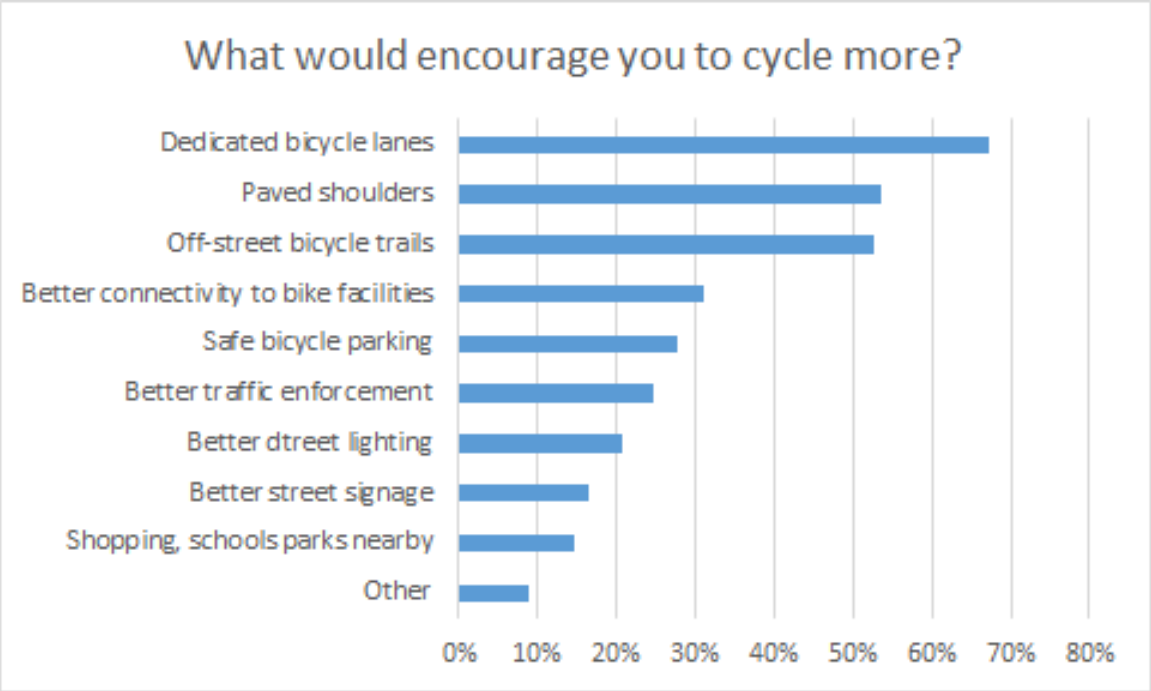


Figure 8. What Would Encourage You to Cycle More? Results

Appendix 4:
Current Conditions Analysis Supporting Maps

To inform the recommendations within the Georgetown Bike Plan, the project team conducted a substantial existing conditions analysis. A series of maps and geospatial analyses were produced to help choose the most appropriate location for each segment of the proposed network.

A4.1 ENVIRONMENTAL CONDITIONS

An environmental conditions assessment was completed to identify natural landmarks and visualize flood risk in Georgetown. Figure 9 shows a map of Georgetown's city limits in conjunction with the Federal Emergency Management Agency (FEMA) flood plain. Figure 10 shows an elevation map of the city, and Figure 11 shows the slopes and topography of Georgetown.

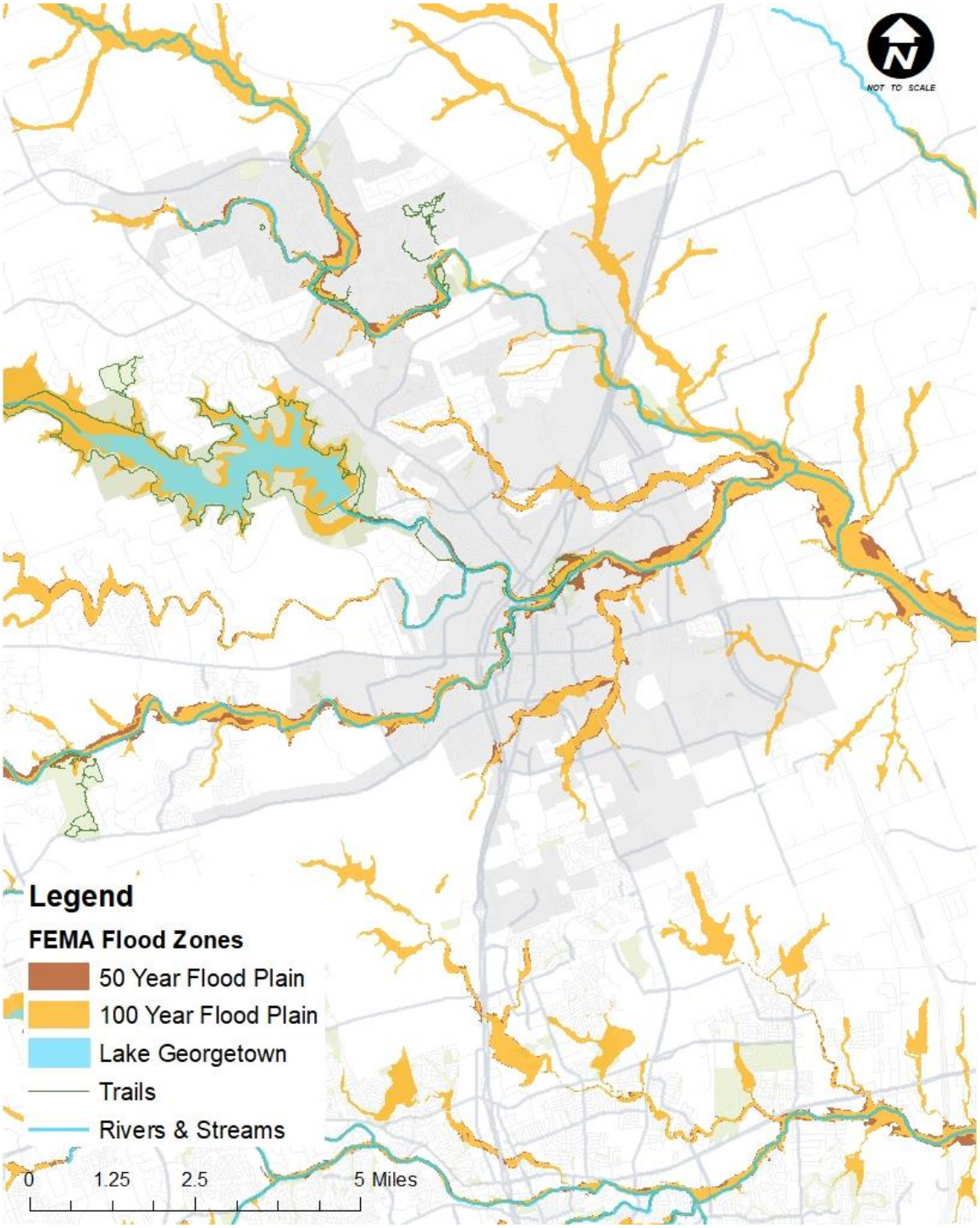


Figure 9. FEMA-designated Flood Plains[3]

3 - Williamson County (2013)

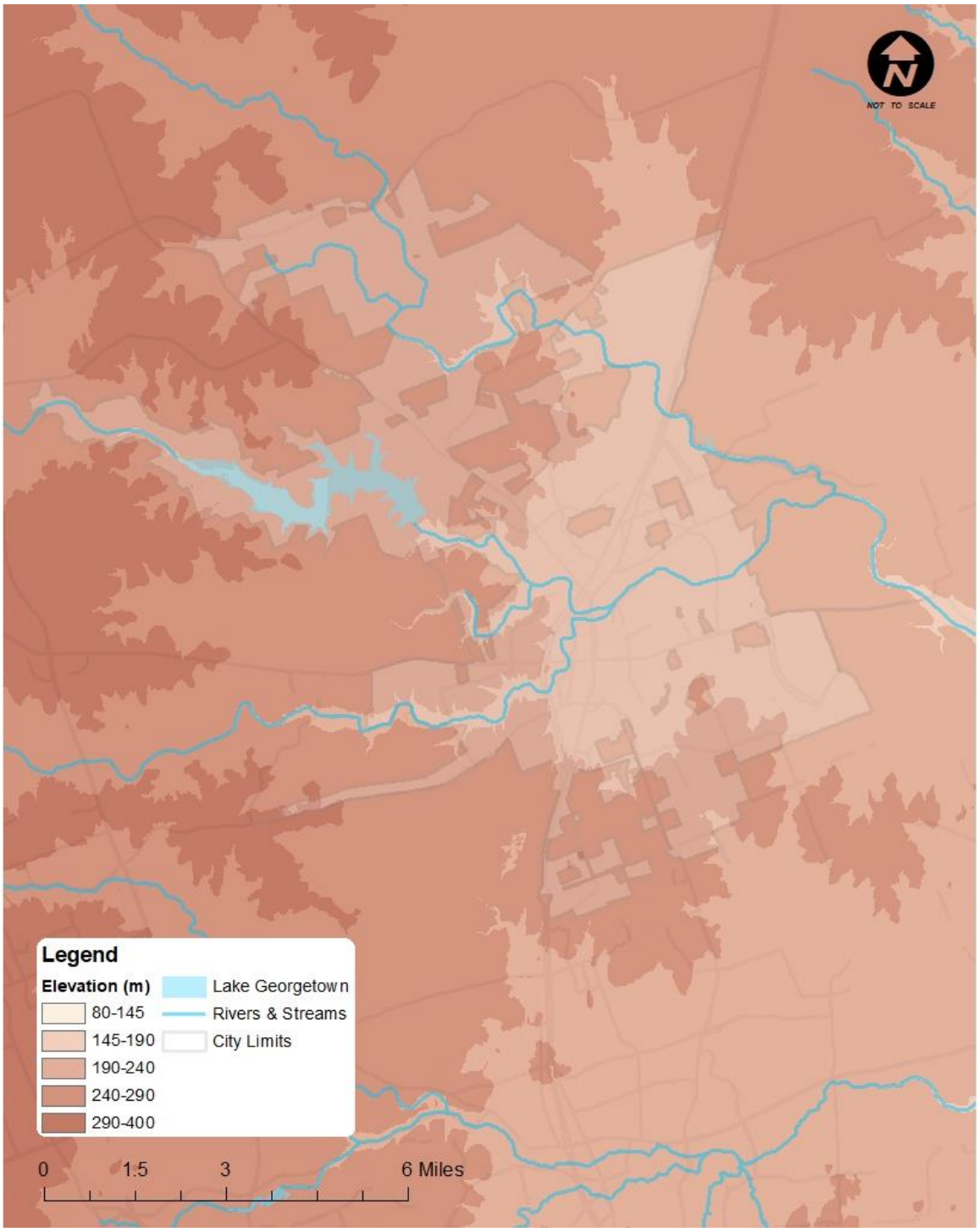


Figure 10. Elevation Map[4]

4 - USGS.com (2018)

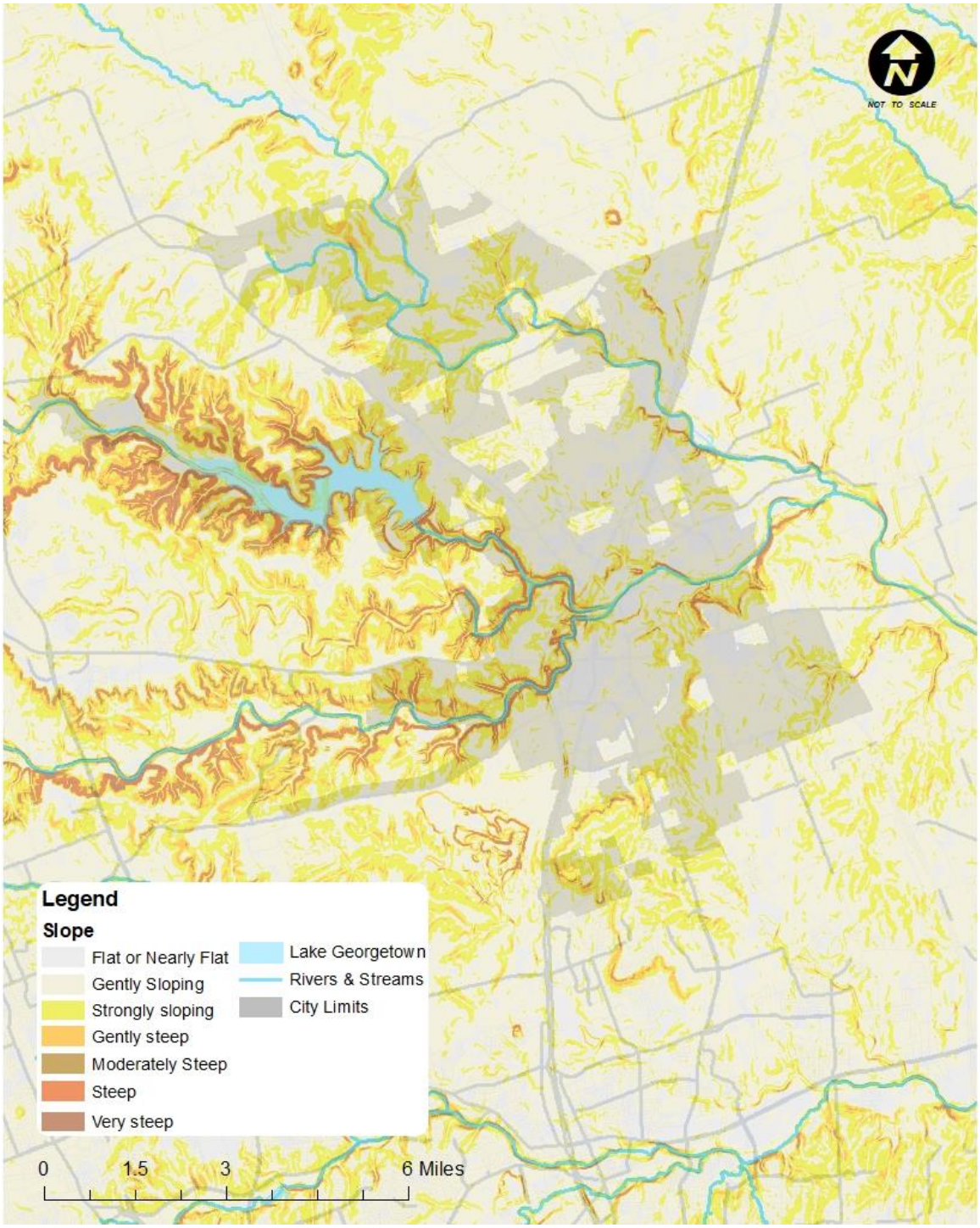


Figure 11. Slope Map[5]

5 - USGS.com (2018)

A4.2 DEMOGRAPHIC FACTORS

Demographic factors were taken into consideration when creating the bike plan in order to better understand the community that was being planned for. Certain density and demographic characteristics impact individual decisions to bike, as well as which potential bike routes will serve the most people. Figure 12, Figure 13, and Figure 14 show basic demographic information, while Figure 15 show basic shows bike commuter density.

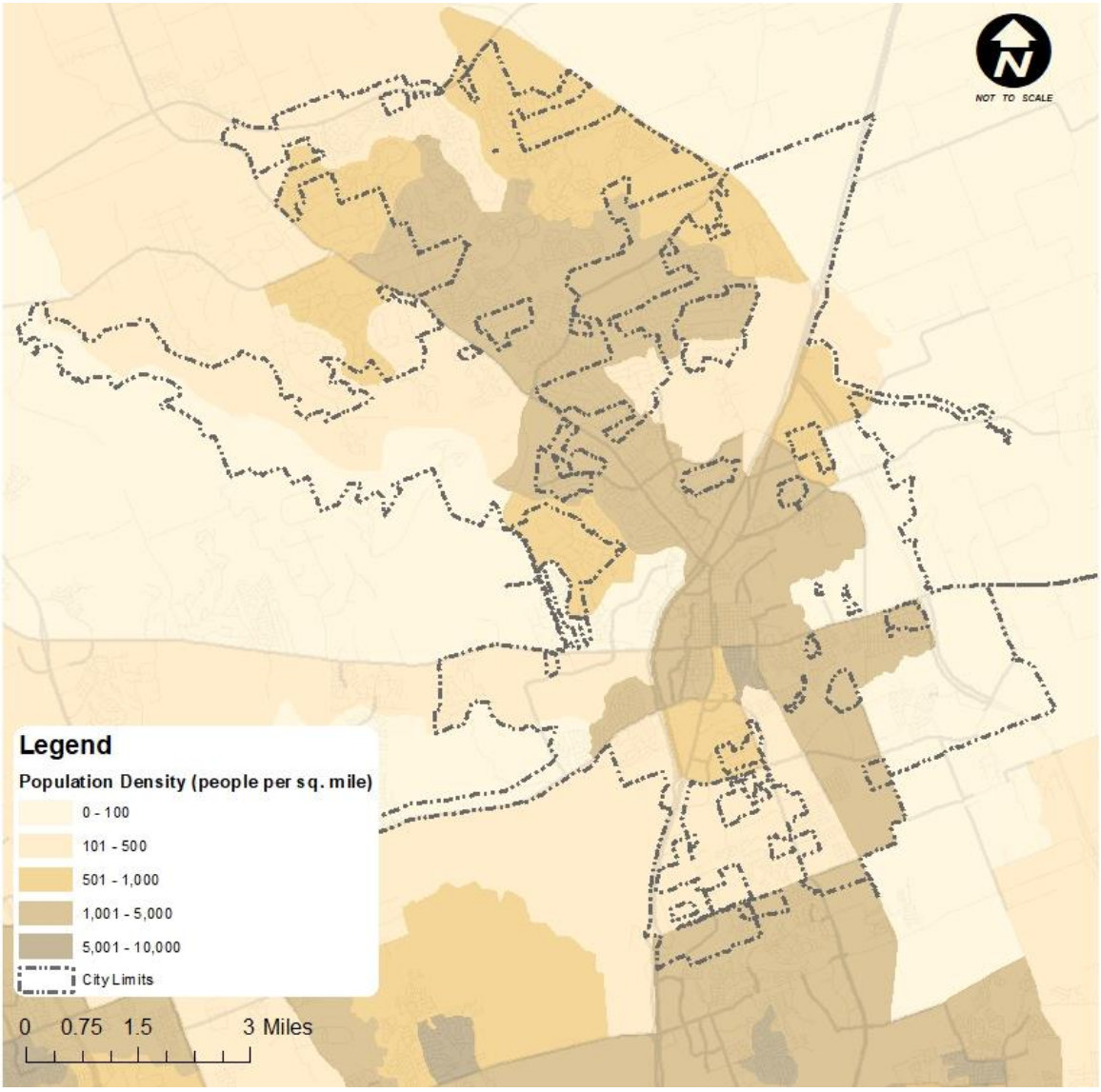


Figure 12. Georgetown Population Density[6]

6 - 2016 American Communities Survey (ACS), 5-Year

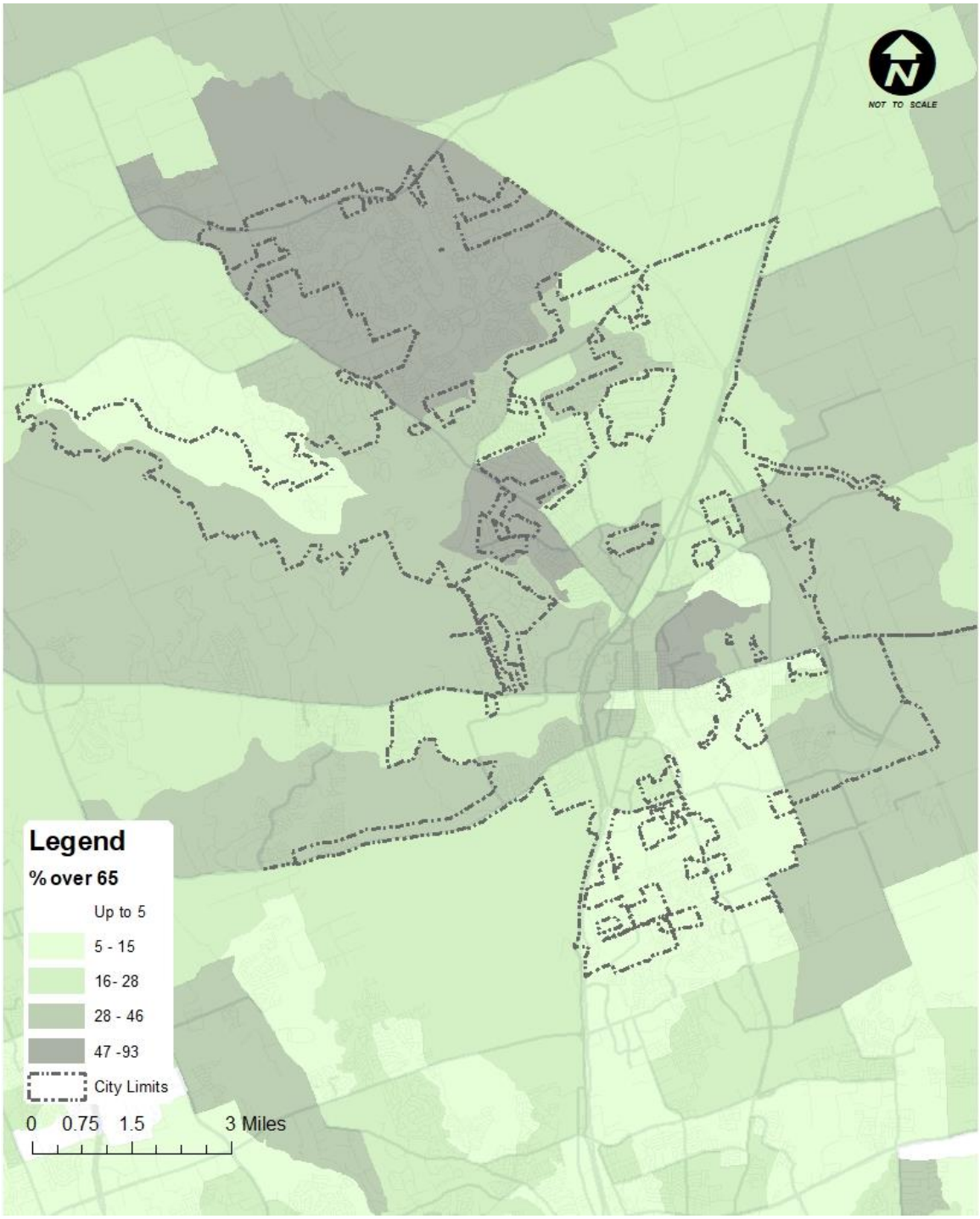


Figure 13. Percent of Population Age 65+[7]

7 - 2016 American Communities Survey (ACS), 5-Year

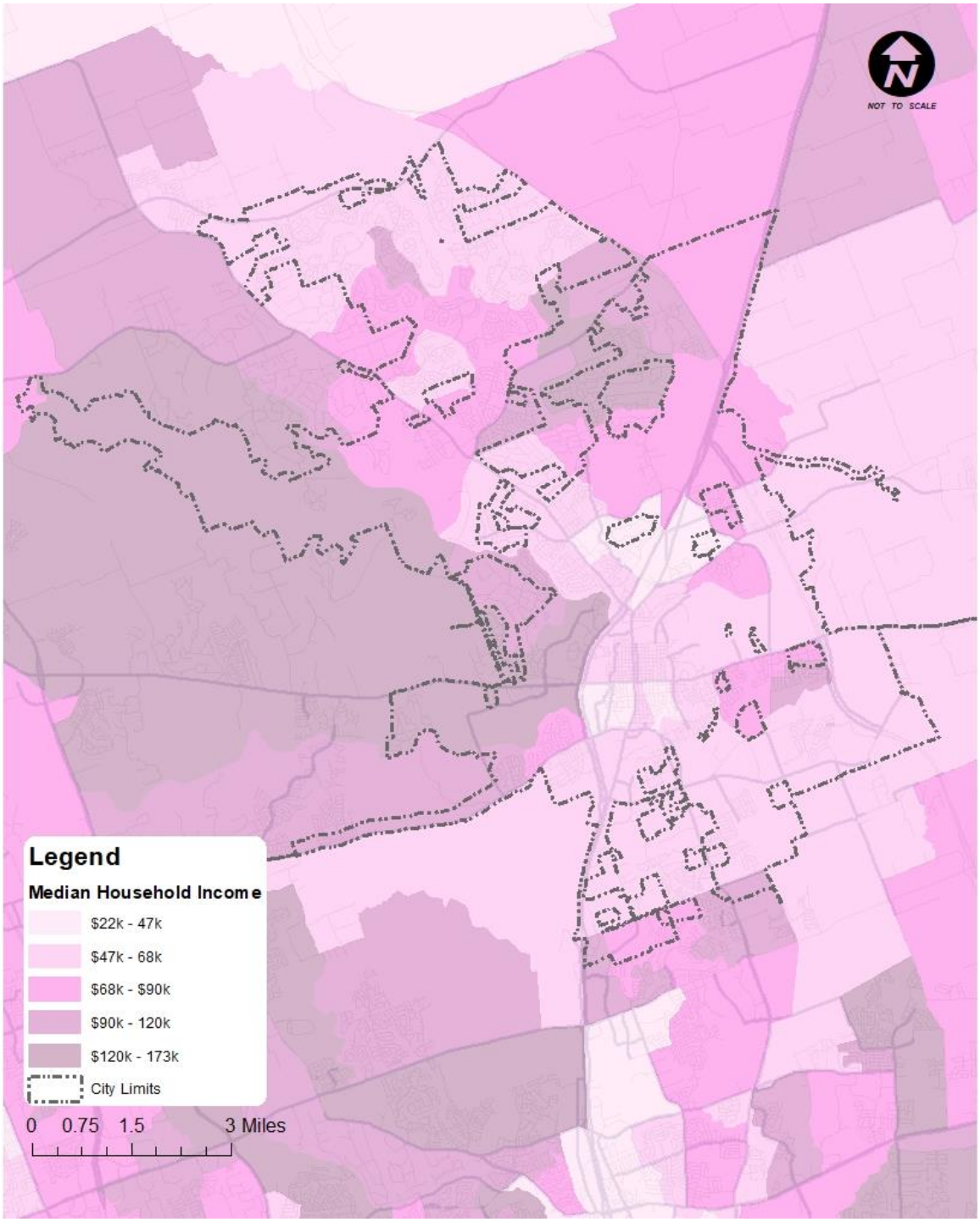


Figure 14. Median Income[8]

8 - 2016 American Communities Survey (ACS), 5-Year

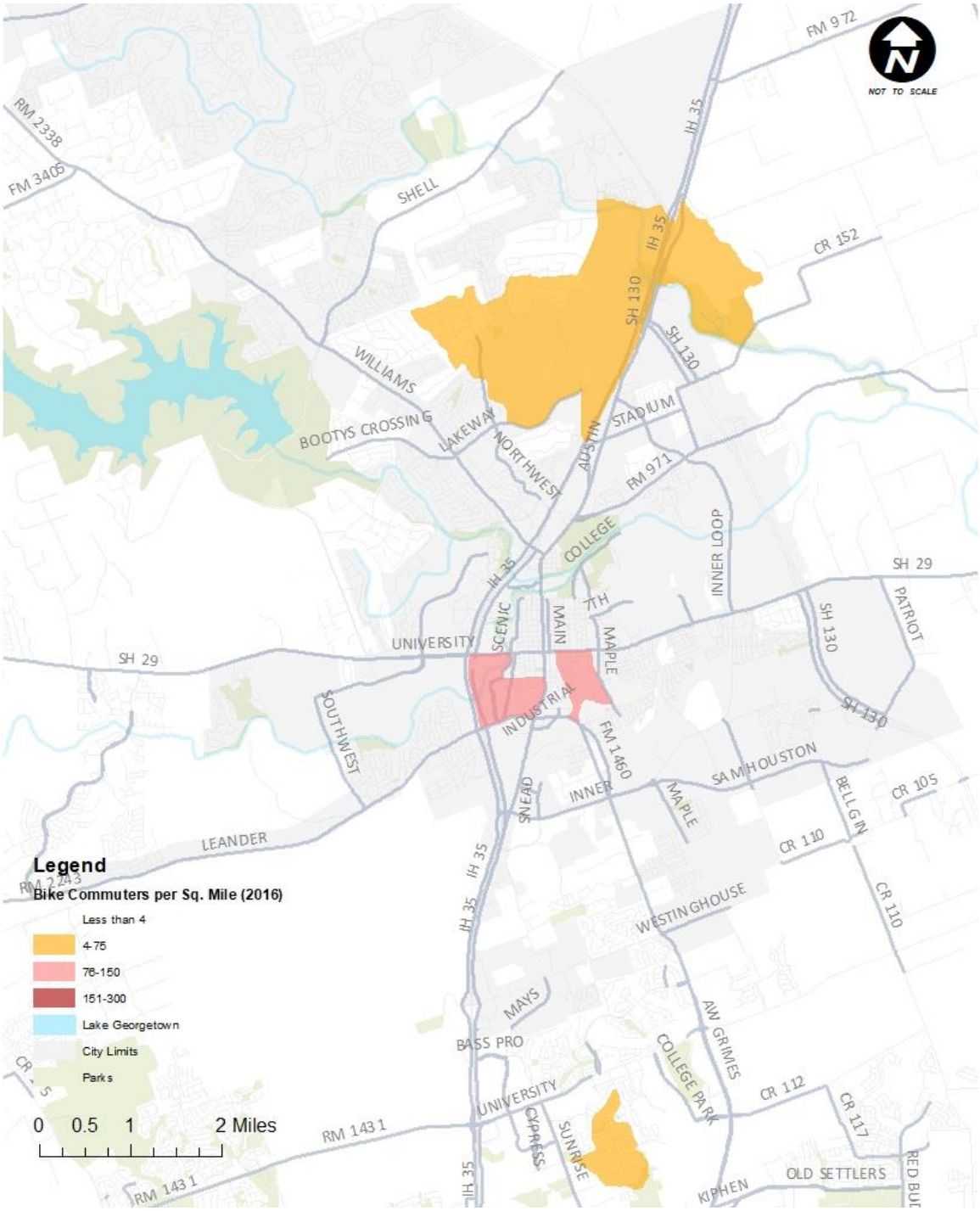


Figure 15. Bike Commuter Density[9]

9 - 2016 American Communities Survey (ACS), 5-Year

A4.3 CURRENT TRANSPORTATION CONDITIONS IN GEORGETOWN

Figure 16 maps the concentration of people traveling to particular geographical destinations in Georgetown. Many trips occur to Downtown Georgetown, as well as Southwestern University, Sun City, and other key shopping centers and neighborhoods. Figure 17 shows completed and on-going transportation projects in Georgetown. Figure 18 maps schools, sidewalks, and existing trails.

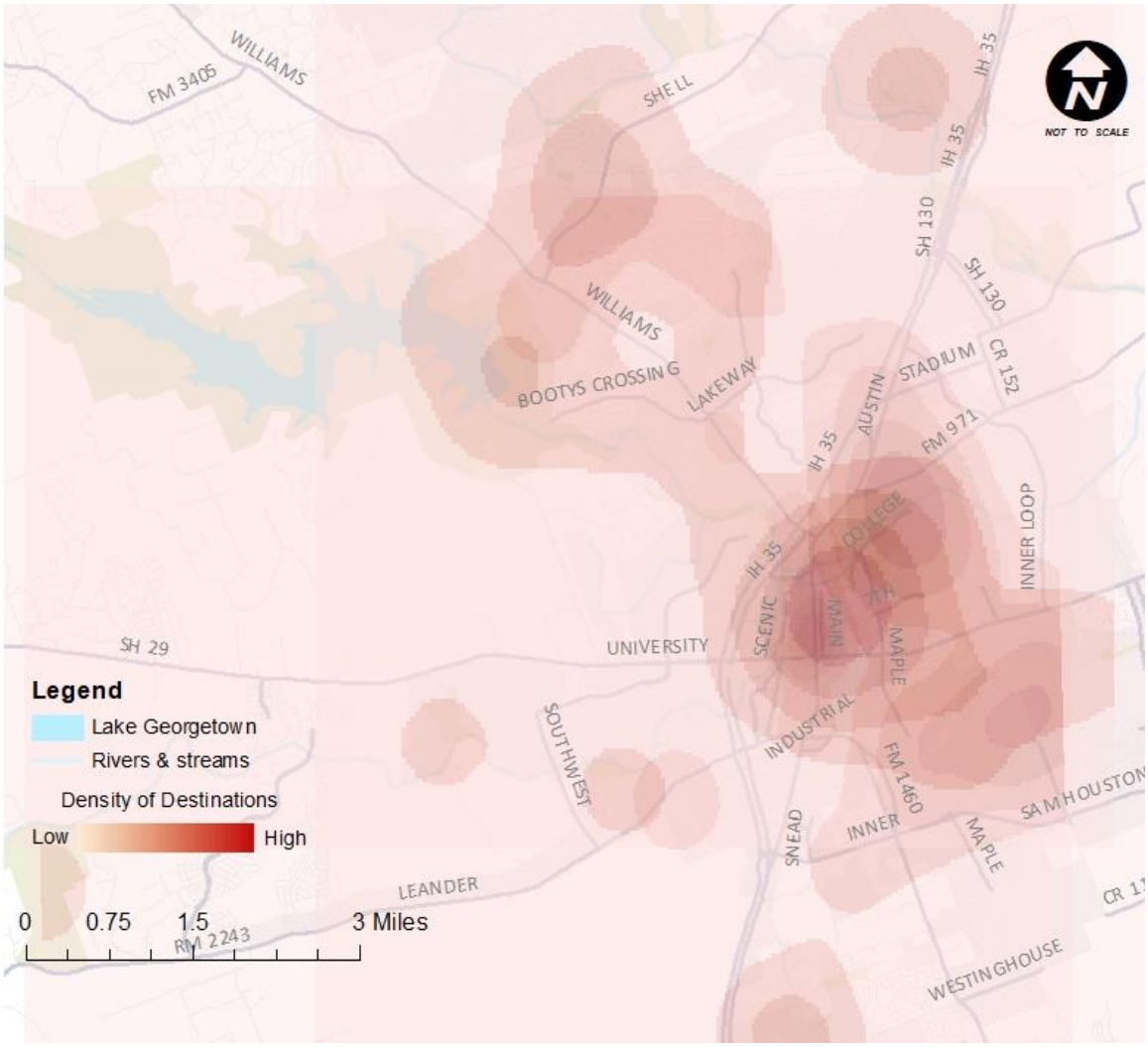


Figure 16. Destination Heat Map[10]

10 – Online Surveys

Ongoing projects such as 2 and 5 produce construction debris and eliminate wide shoulders, limiting suitable routes for cyclists. Projects 3B and 7 could be opportunities for creating shadow network in the future.

Figure 17. Recent and Future Roadwork in the City of Georgetown[11]

11 – Community Impact Newspaper, 10/10/2018

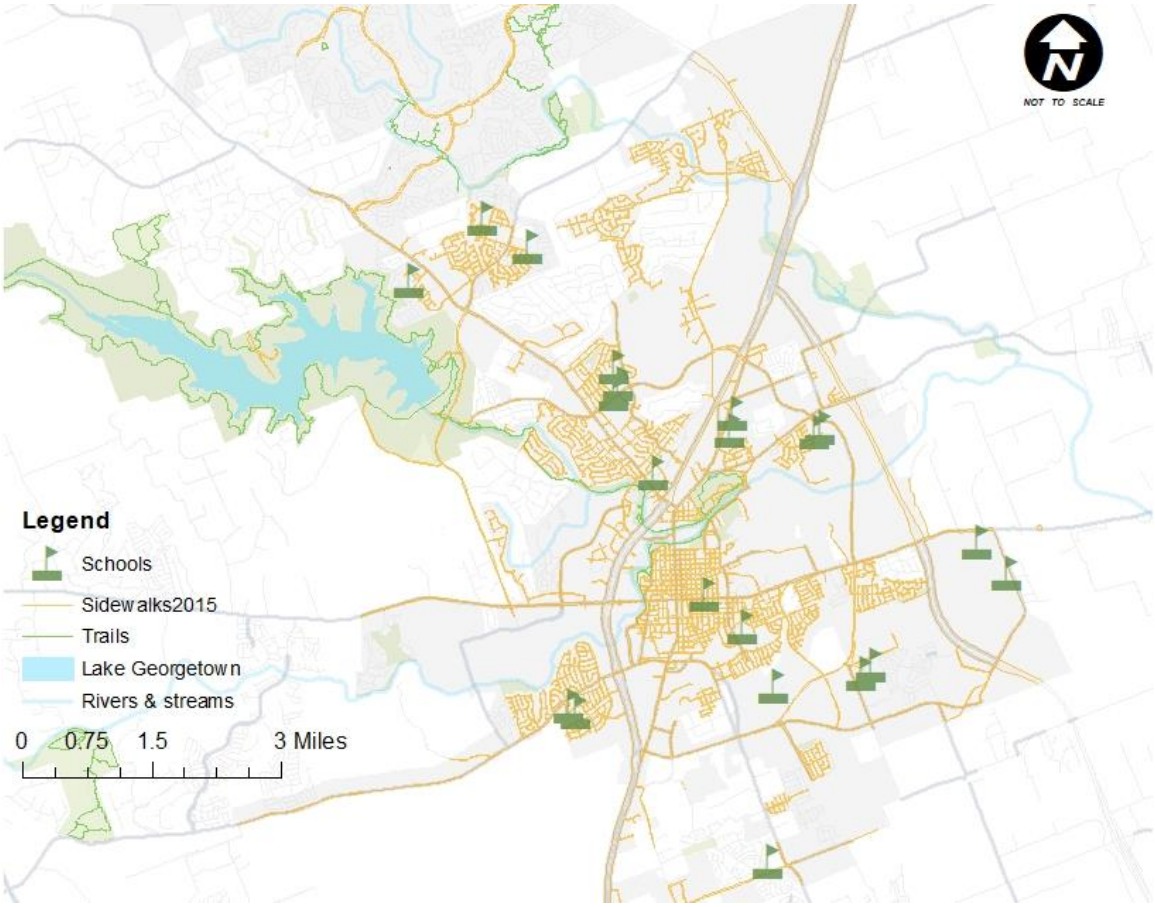


Figure 18. Schools, Sidewalks, and Trails[12]

Figure 19 and Figure 20 show portions of the Williamson County Bike Master Plan. The County's proposed network stretches more than 350 miles, and includes new trails along most of the major arterials in Georgetown. It should be noted that these proposals are not in line with the recommendations of this Plan.

The planned Williamson County network includes connections to Liberty Hills, Florence and Jarrell by extending the existing off-street trails on the San Gabriel River and in Sun City. On the east side of Georgetown, a proposed trail will connect Berry Creek Trail and further extend to Taylor. FM 1460 would serve as a regional corridor to connect Round Rock in the south. On the south-west side of the city, the proposed trail along south fork of San Gabriel River will connect to Leander.

12 - City of Georgetown (2018)

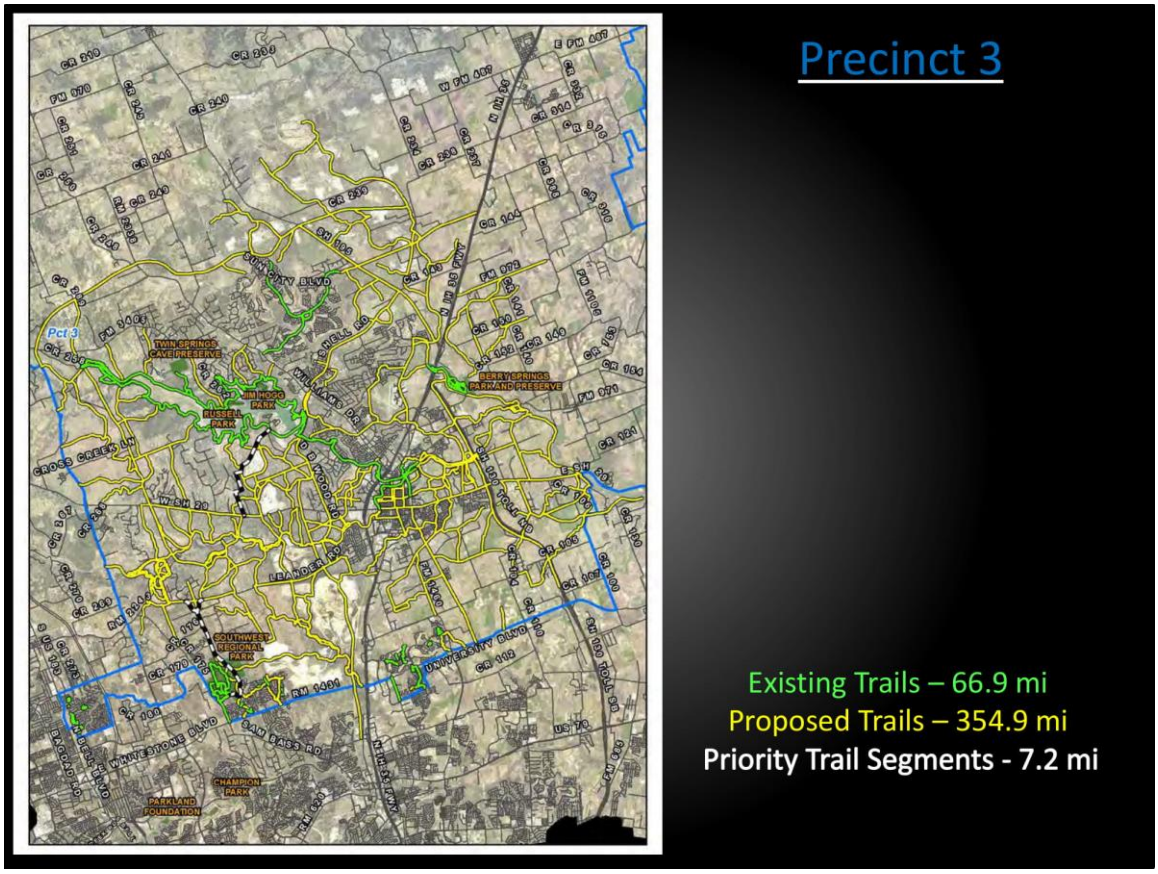


Figure 19. Existing, Proposed and Priority Trail Segments[13]

13 - Williamson County Comprehensive Parks Master Plan (2018)

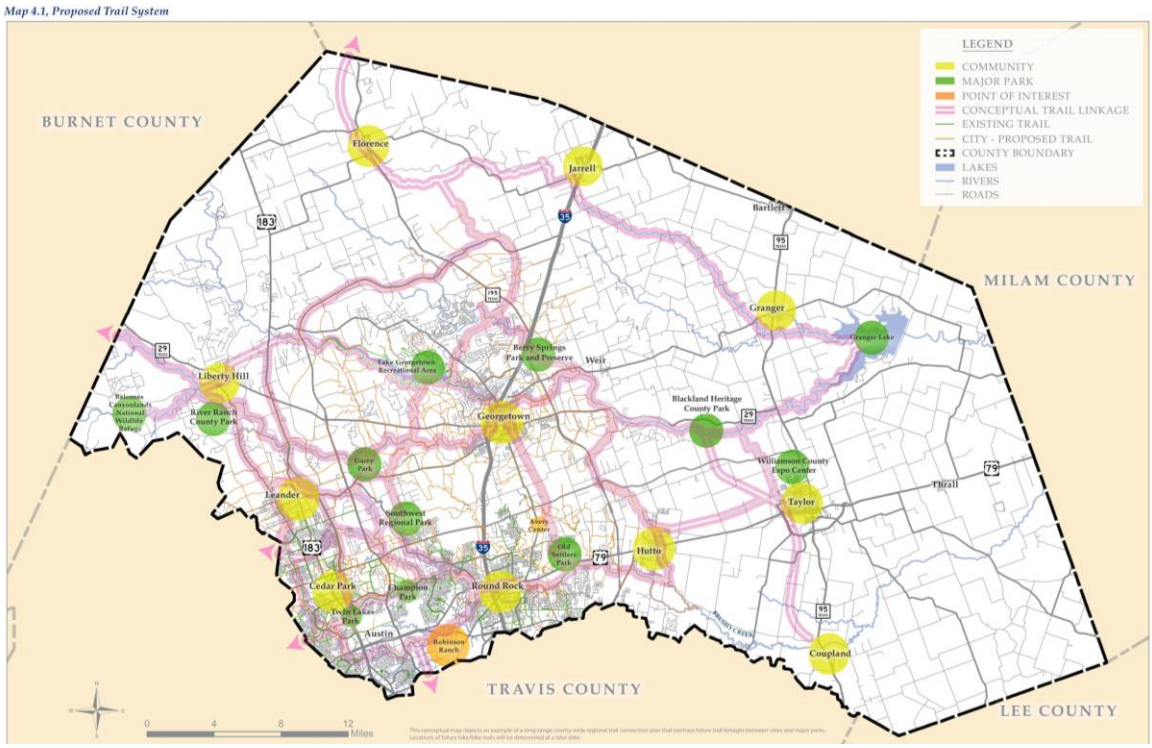


Figure 20. Proposed Regional Trail Network[14]

14 - Williamson County Comprehensive Parks Master Plan (2018)

Figure 21 and Figure 22 show current railroads, airports, and transit stops.

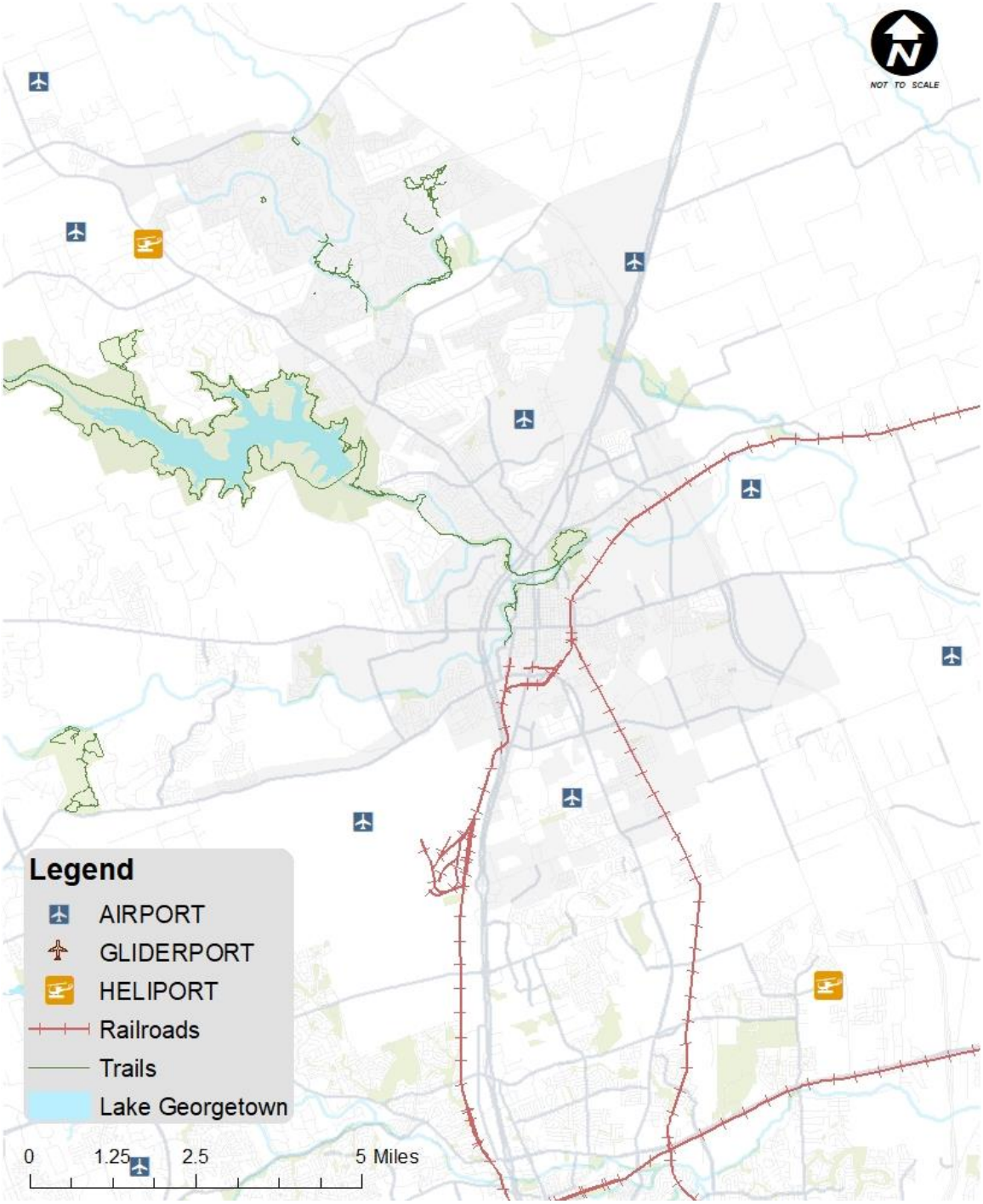


Figure 21. Railroads and Airports[15]

15 - Williamson County (2018)

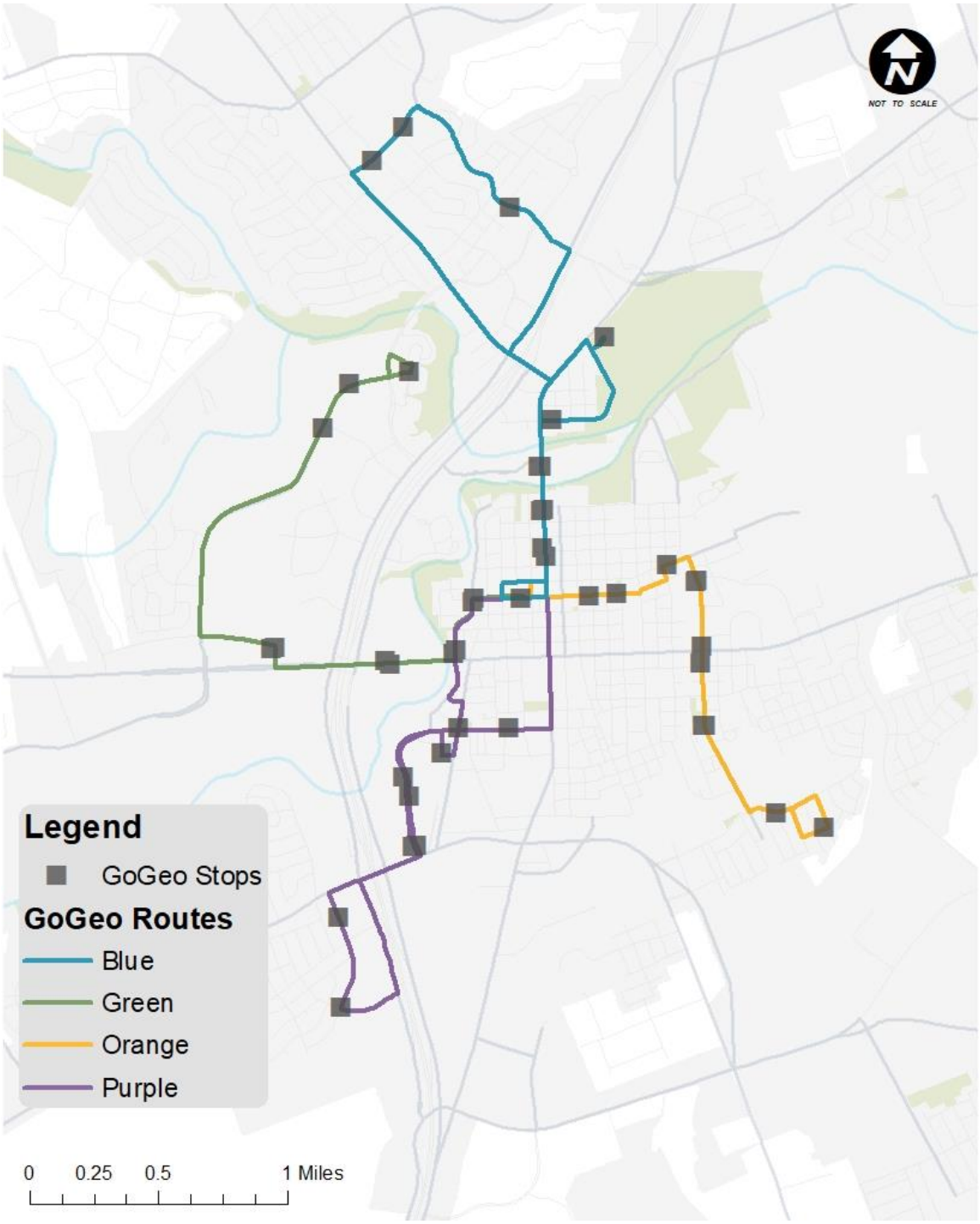


Figure 22. GoGeo Georgetown Transit Routes[16]

16 – City of Georgetown(2018)

A4.4 CONNECTIVITY ANALYSIS

Current bike infrastructure connectivity was primarily analyzed using a function called the Service Area spatial statistic function in ArcMap, a mapping software. The project team first identified routes that are currently comfortable to bike on (streets with BLTS ≤ 2, see Section 2.5 in the Bike Plan) using both existing trails and roads.

Popular points of interest such as schools, parks, and transit stops were mapped, and then service or catchment areas were generated for each. These catchment areas are shown through a series of maps below, and can be defined as the geographical area in which a person could reach one of these points of interest, traveling on presently comfortable routes within 5, 10, and 20 minutes on a bike. The average cyclist can travel 0.8, 1.6, and 3 miles, respectively in these times.

Catchment areas were regenerated using the proposed network from this Plan in addition to current comfortable bike routes, to visualize the degree to which access would be improved through implementation of the proposed Plan.

Schools
As shown in Figure 23 schools in Georgetown are not fully connected to neighborhoods and many residences don't have safe biking access to school for children.

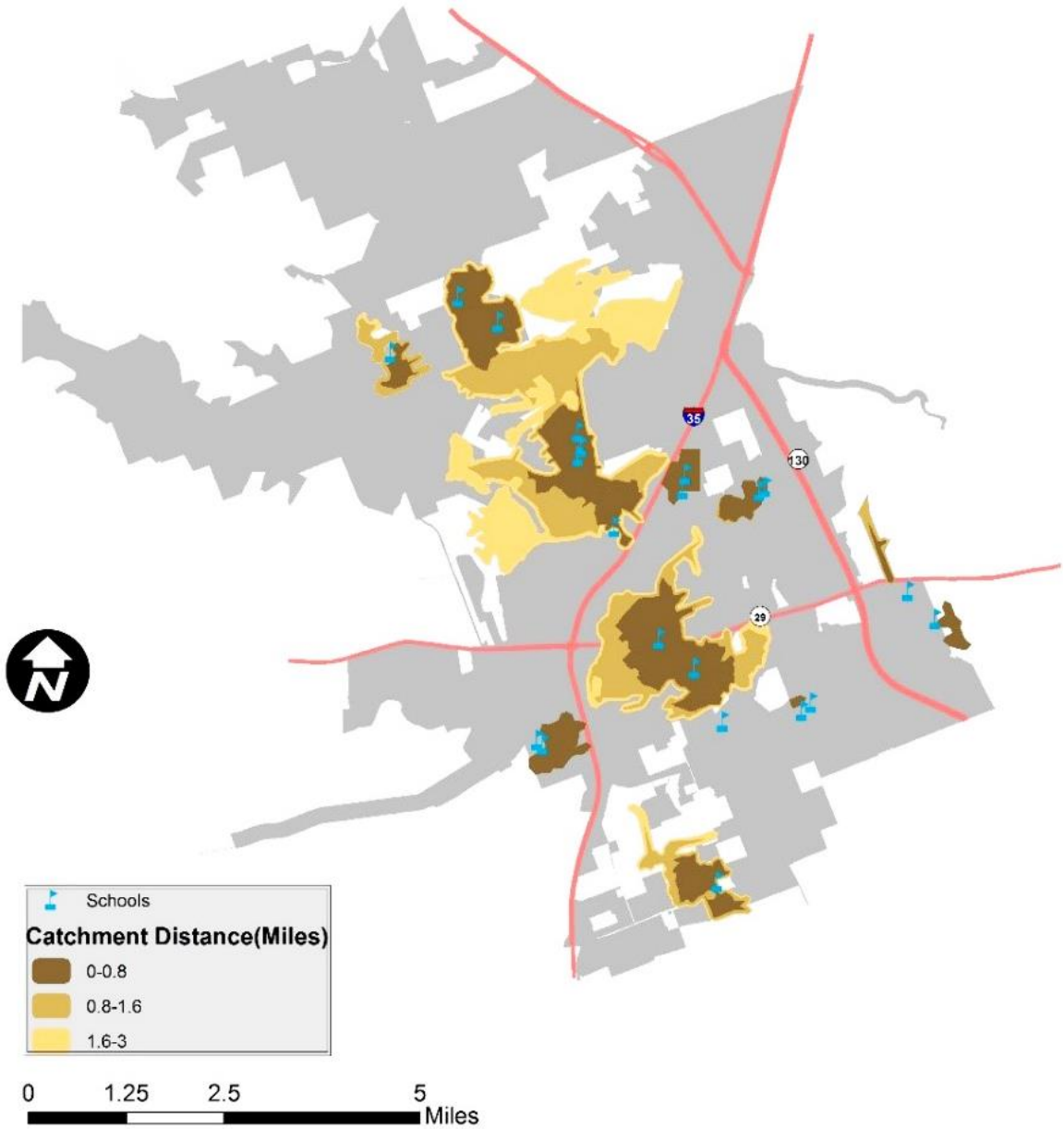


Figure 23. Current School Connectivity

Figure 24 shows the potential for expanding school accessibility through the proposed network. More direct routes would be available for kids to ride their bikes, including safe crossings at major intersections that currently separate residential neighborhoods from schools.

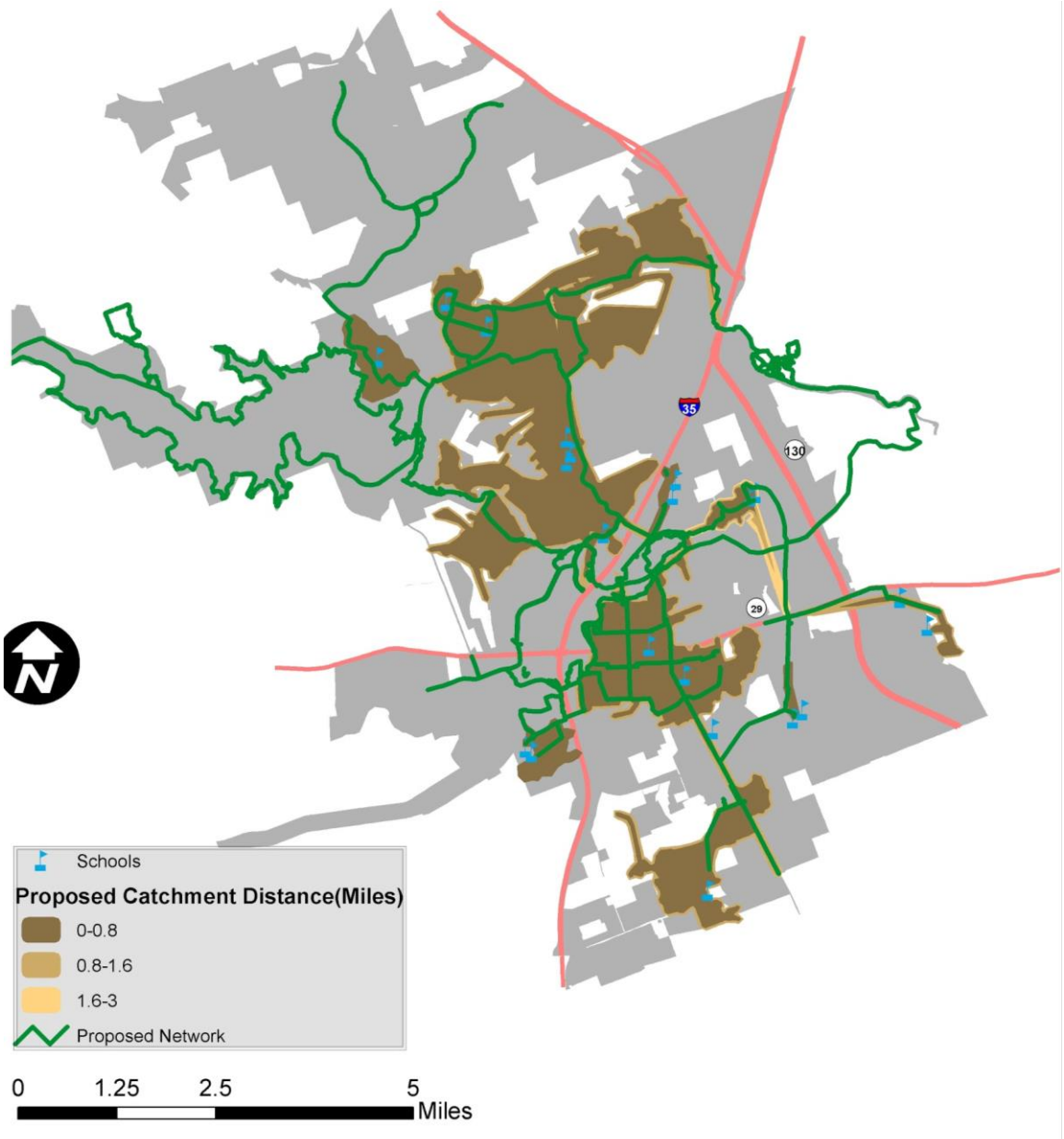


Figure 24. Future School Connectivity

Table 1. School Proximity to Low-Stress Bike Network

School	Current Distance from Bike-safe Network (Feet)	Future Distance from Bike-safe Network (Feet)
James E Mitchell Elementary	725	131
East View High School	1,399	532
James Tippit Middle School	474	265
George Wagner Middle School	702	597

Transit Stops
Figure 25 below shows how present bike infrastructure connects to transit. The map highlights that connectivity is low west of IH-35.

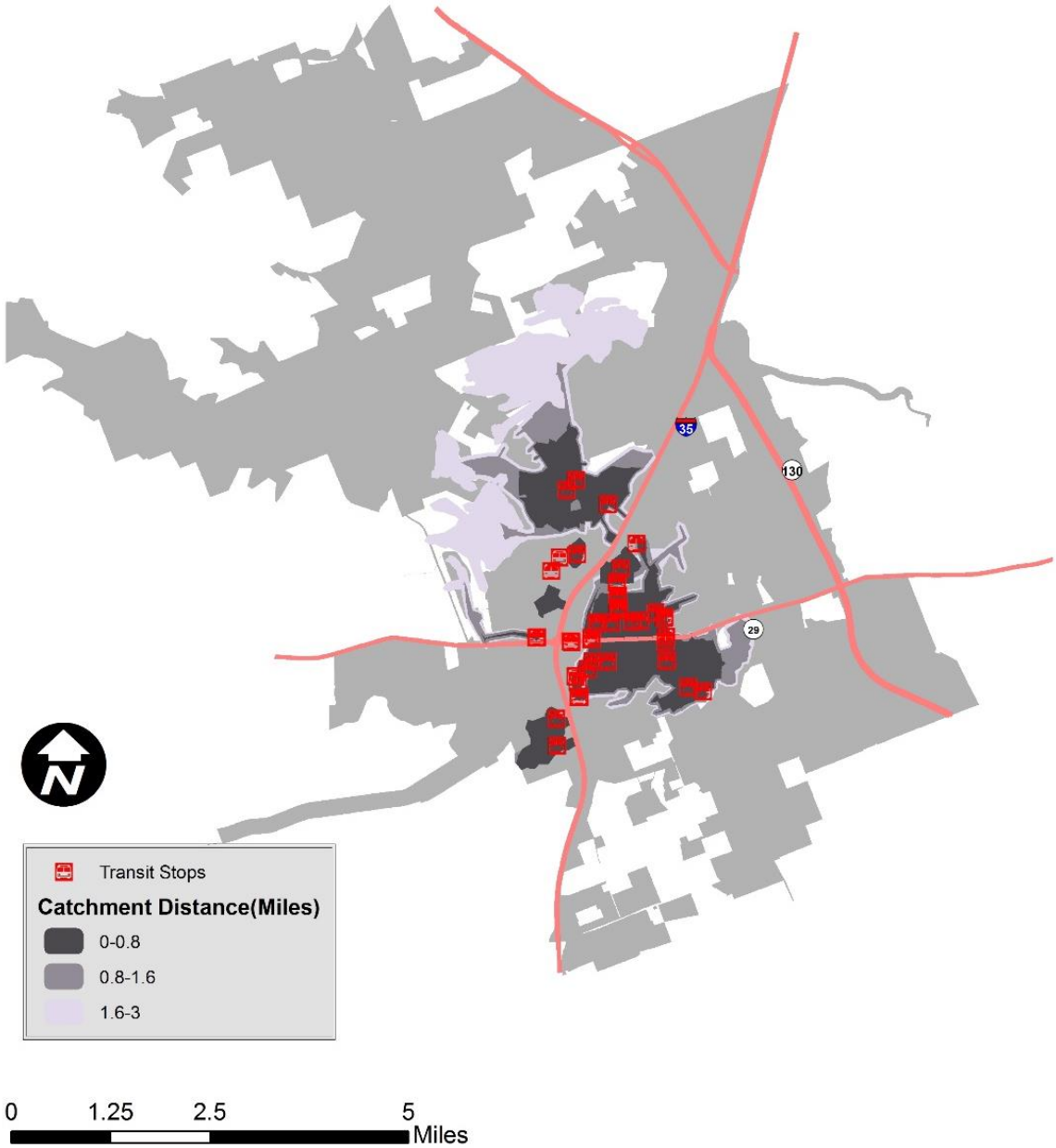


Figure 25. Current Transit Stop Connectivity

By implementing the proposed bike network, bus stops to the west of I-35 are more accessible to Sun City and other communities in the northern portion of Georgetown. Access is also expanded further into southeast Georgetown communities, as depicted in Figure 26.

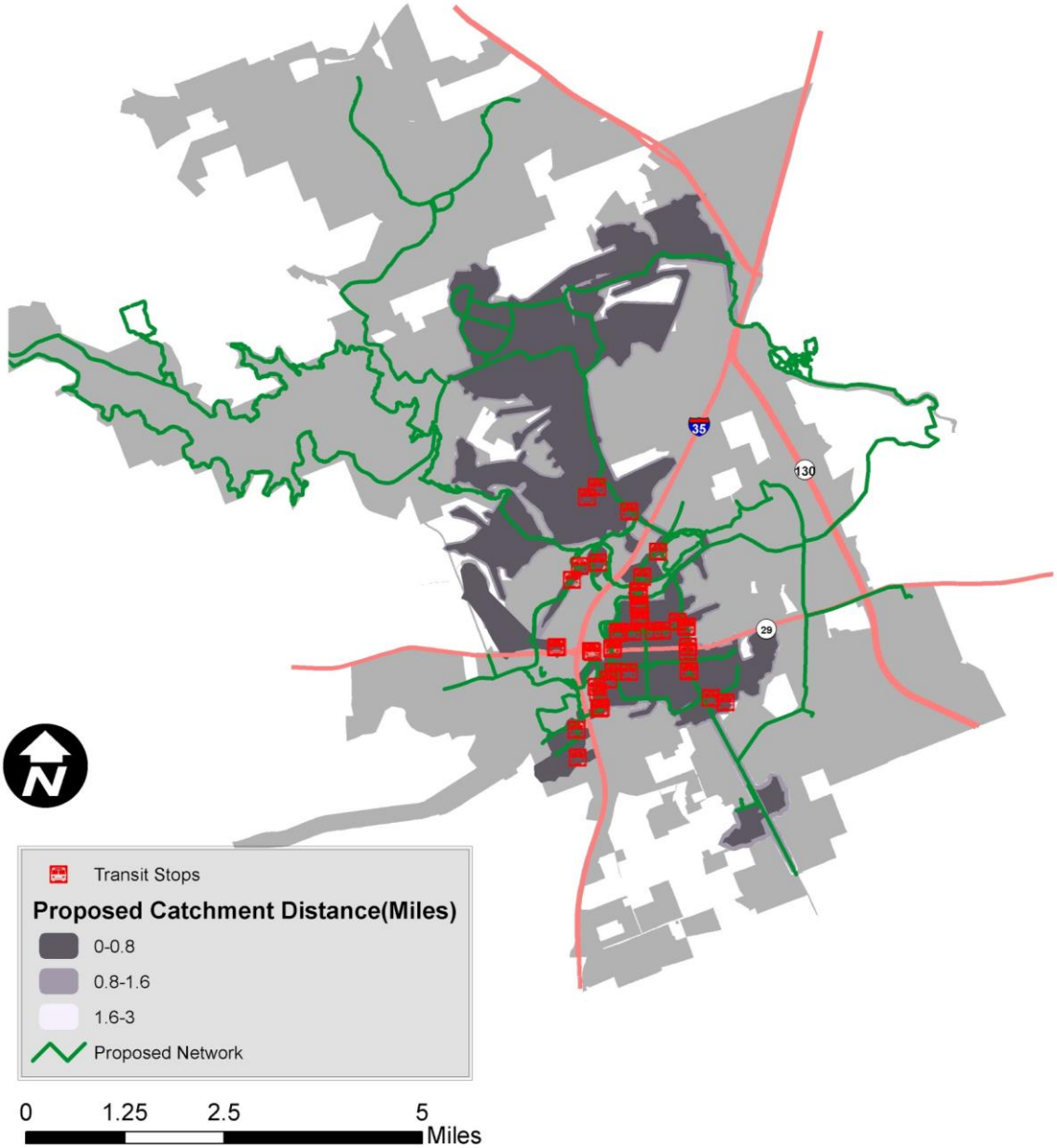


Figure 26. Future Transit Stop Connectivity

The two bus stops on Wolf Ranch Pkwy. have poor current accessibility because the road itself serves as a major barrier. Figure 27 shows that the proposed off-street trails along Wolf Ranch Pkwy. would provide improved access to both stops.

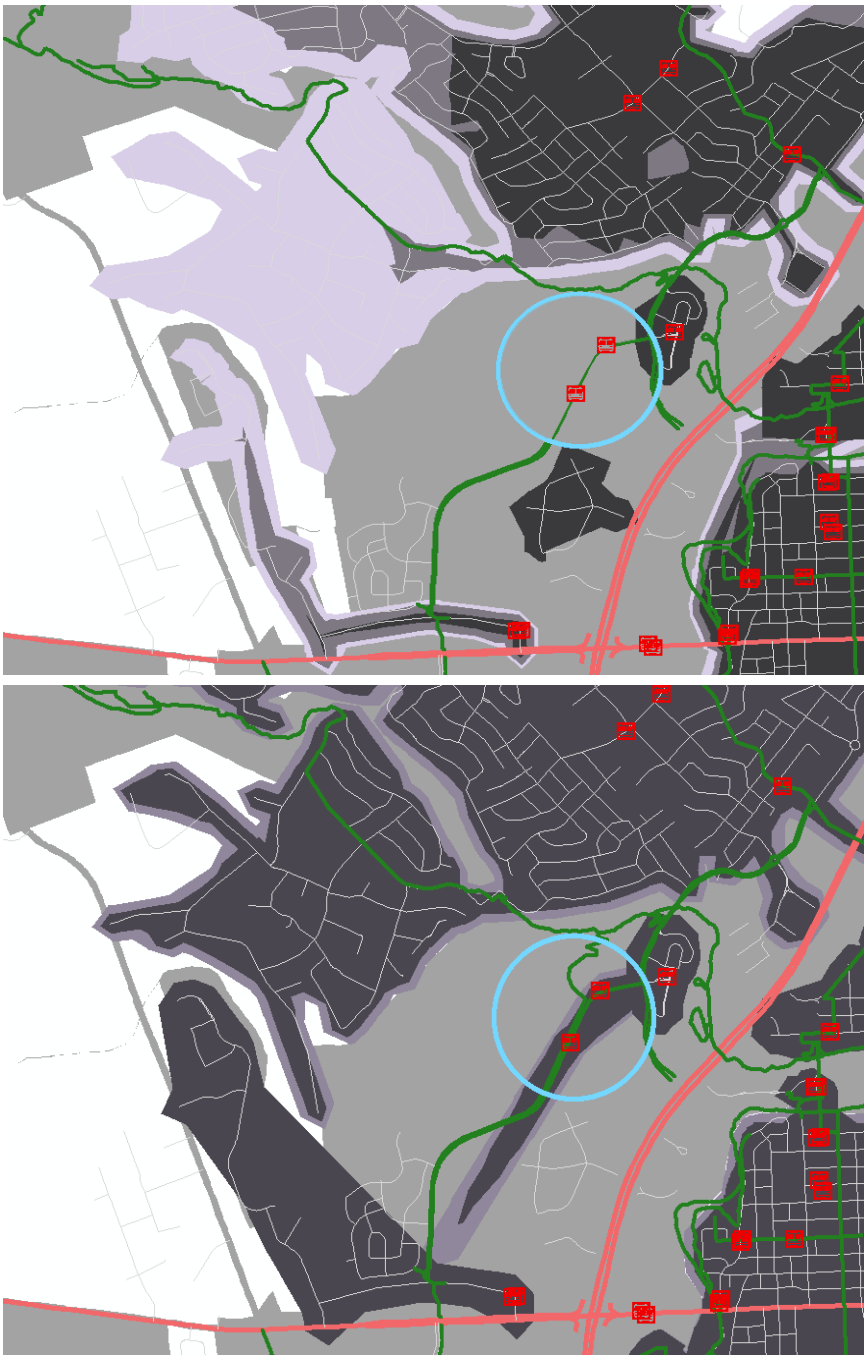


Figure 27. Wolf Ranch Pkwy. / Rivery Dr. & City Lights Stations

Commercial Locations
Connectivity to major commercial properties was analyzed, including: Wolf Ranch Town Center, HEB on SR 29, the HEB in Sun City, and a commercial strip at Williams Dr. and Austin Ave. Figure 28 shows current commercial connectivity.

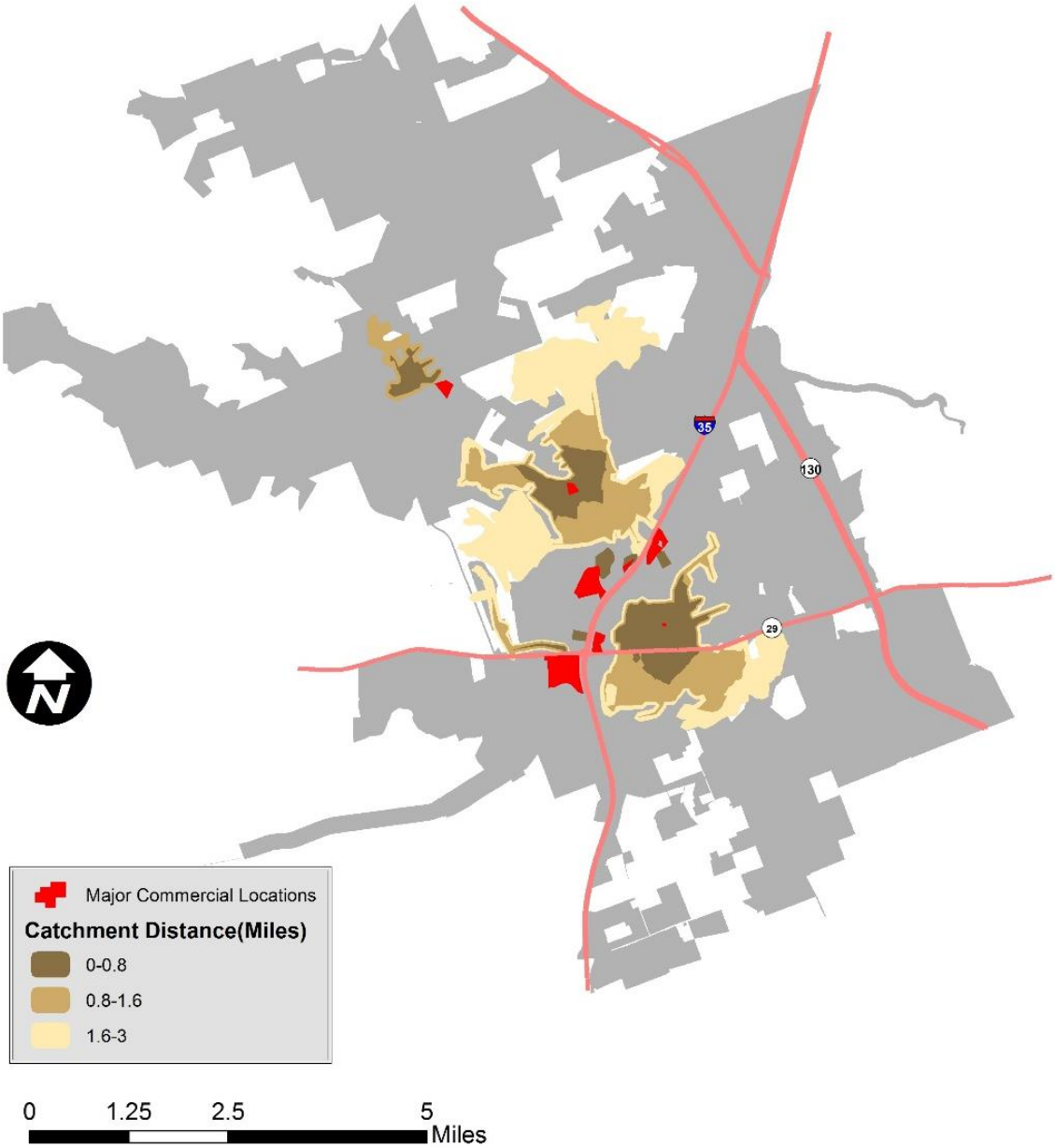


Figure 28. Current Commercial Lot Connectivity

Because major commercial destinations along I-35 are not currently accessible to bikes, dedicated paths connecting Wolf Ranch and HEB on University Ave to nearby bike routes are proposed in this Plan. People living in neighborhoods west of IH-35, have easier and faster bike access to the Sun City HEB, as well.

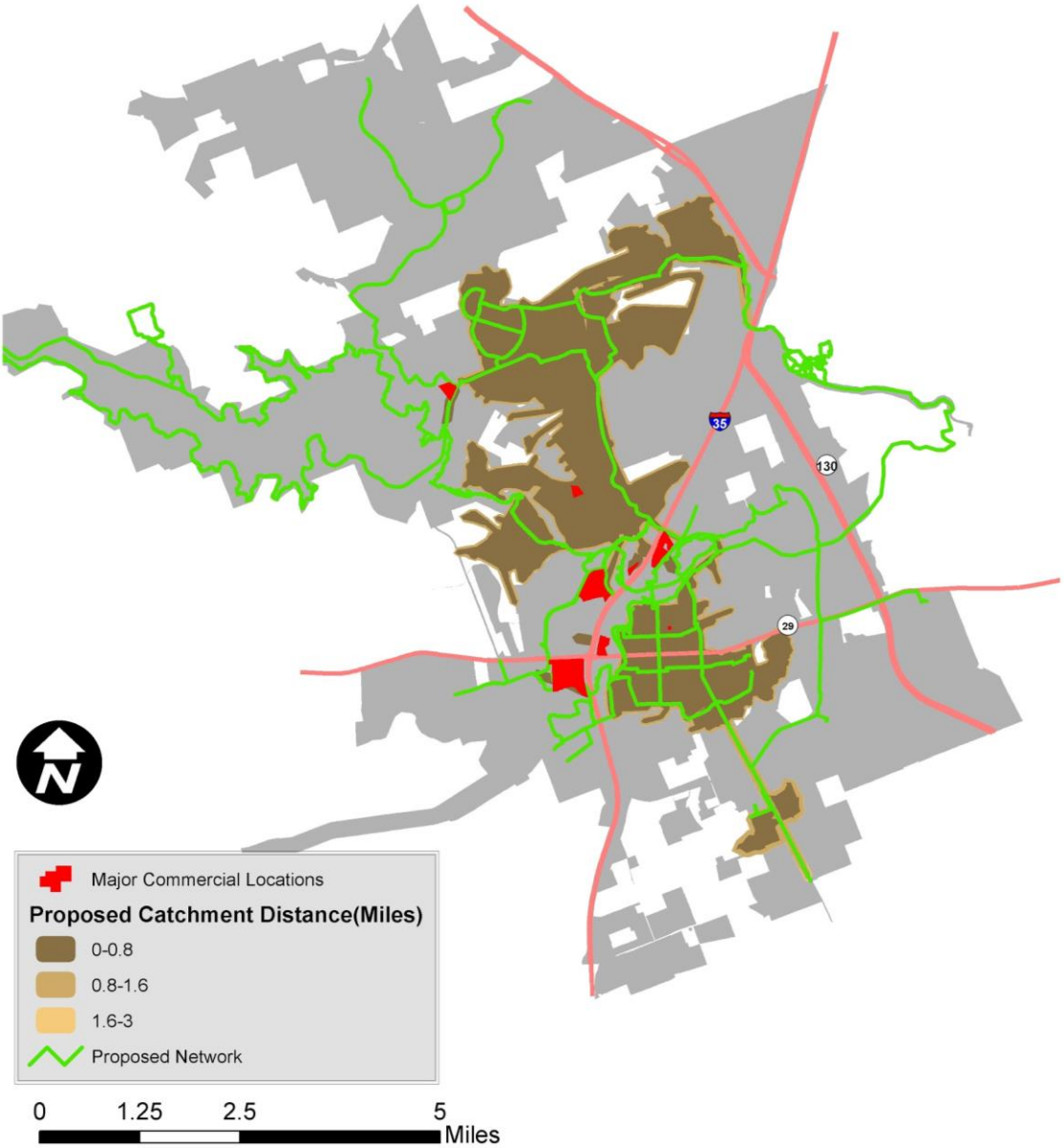


Figure 29. Future Commercial Connectivity

Public Facilities and Parks
Bike access to parks and public facilities is shown in the figures below. Figure 30 and Figure 32 show existing conditions of public facilities and parks, respectively. Figure 31 and Figure 33 show future connectivity, post bike plan implementation.

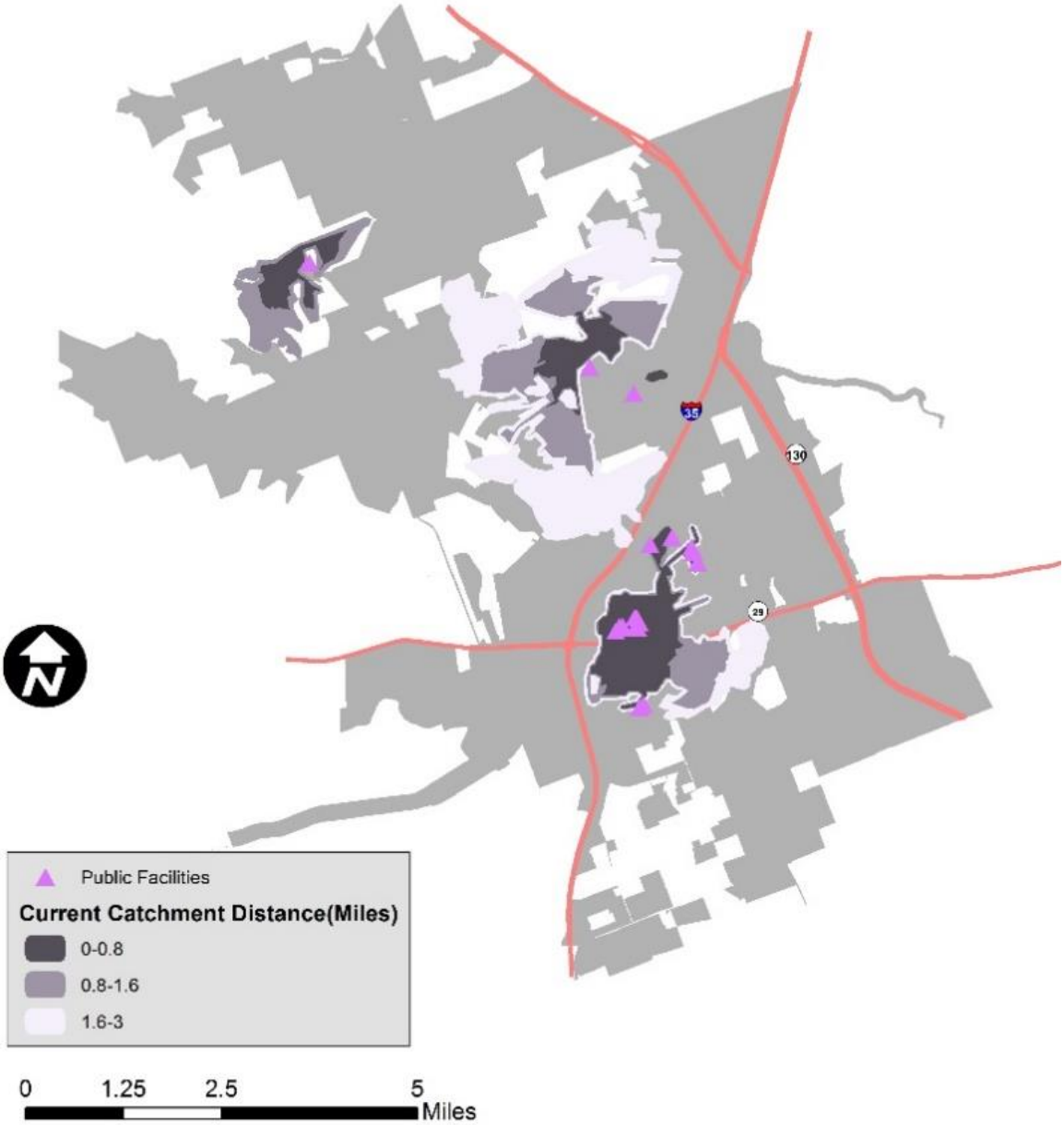


Figure 30. Current Public Facility Connectivity

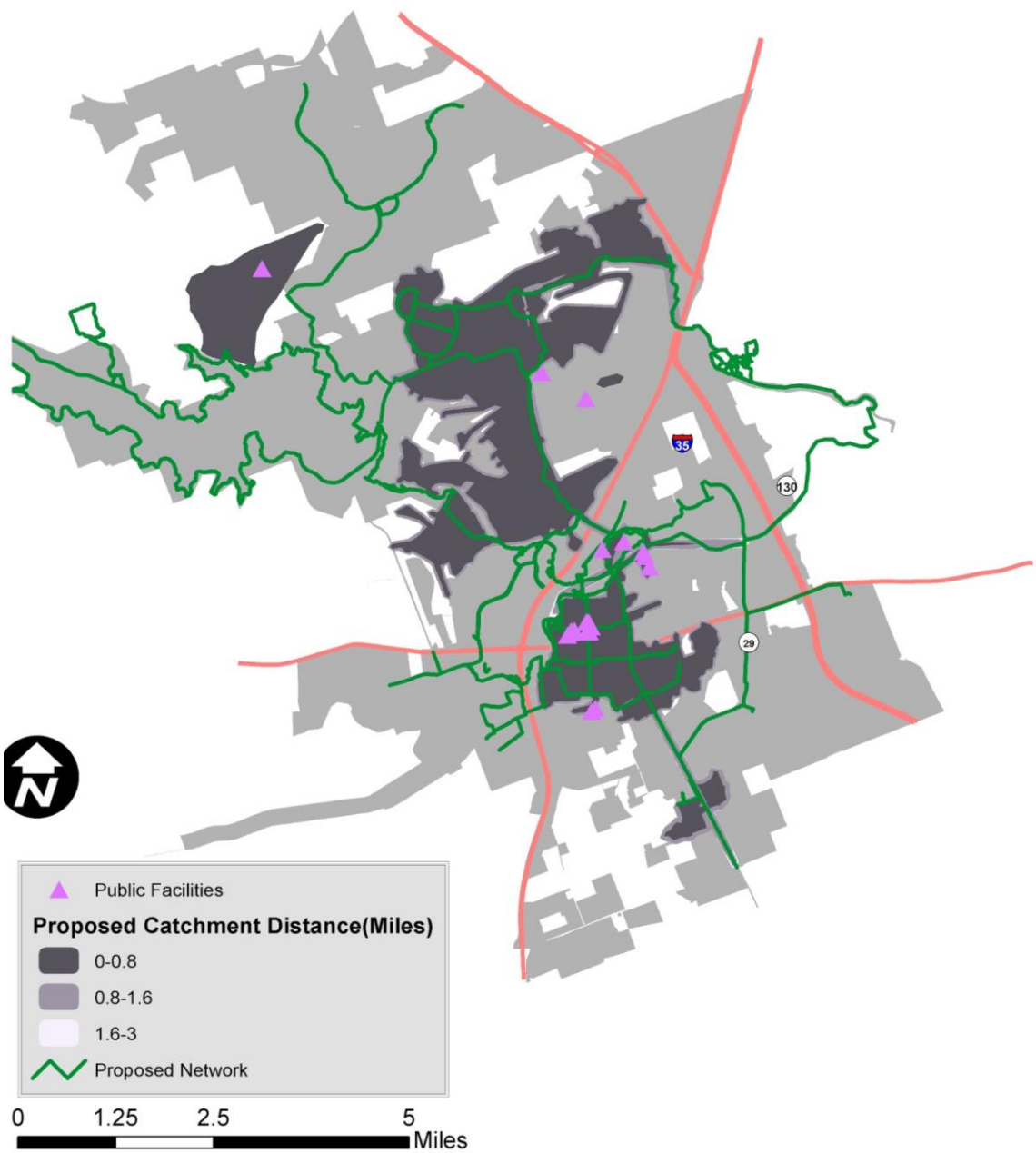


Figure 31. Future Public Facility Connectivity

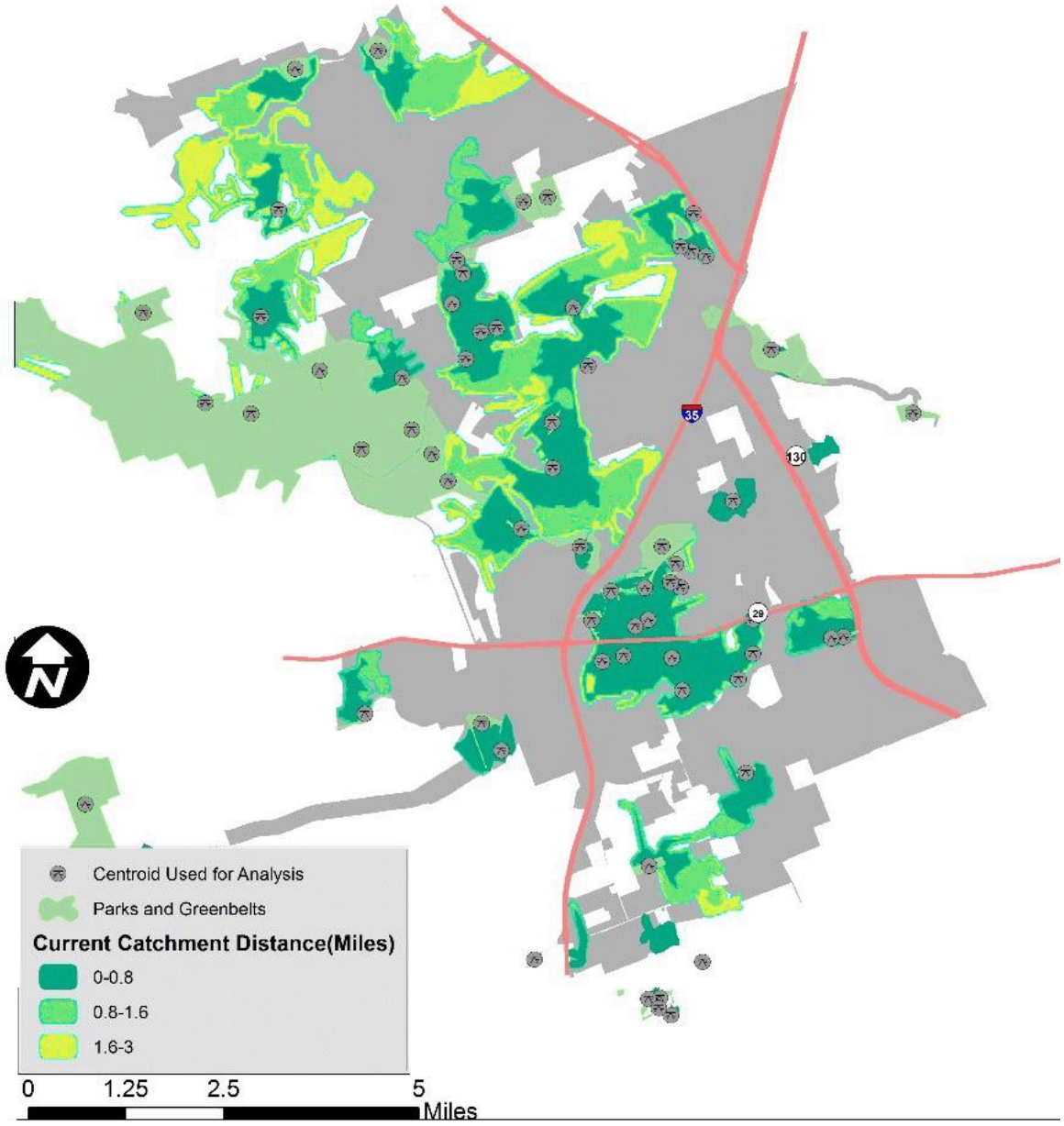


Figure 32. Current Parks Connectivity

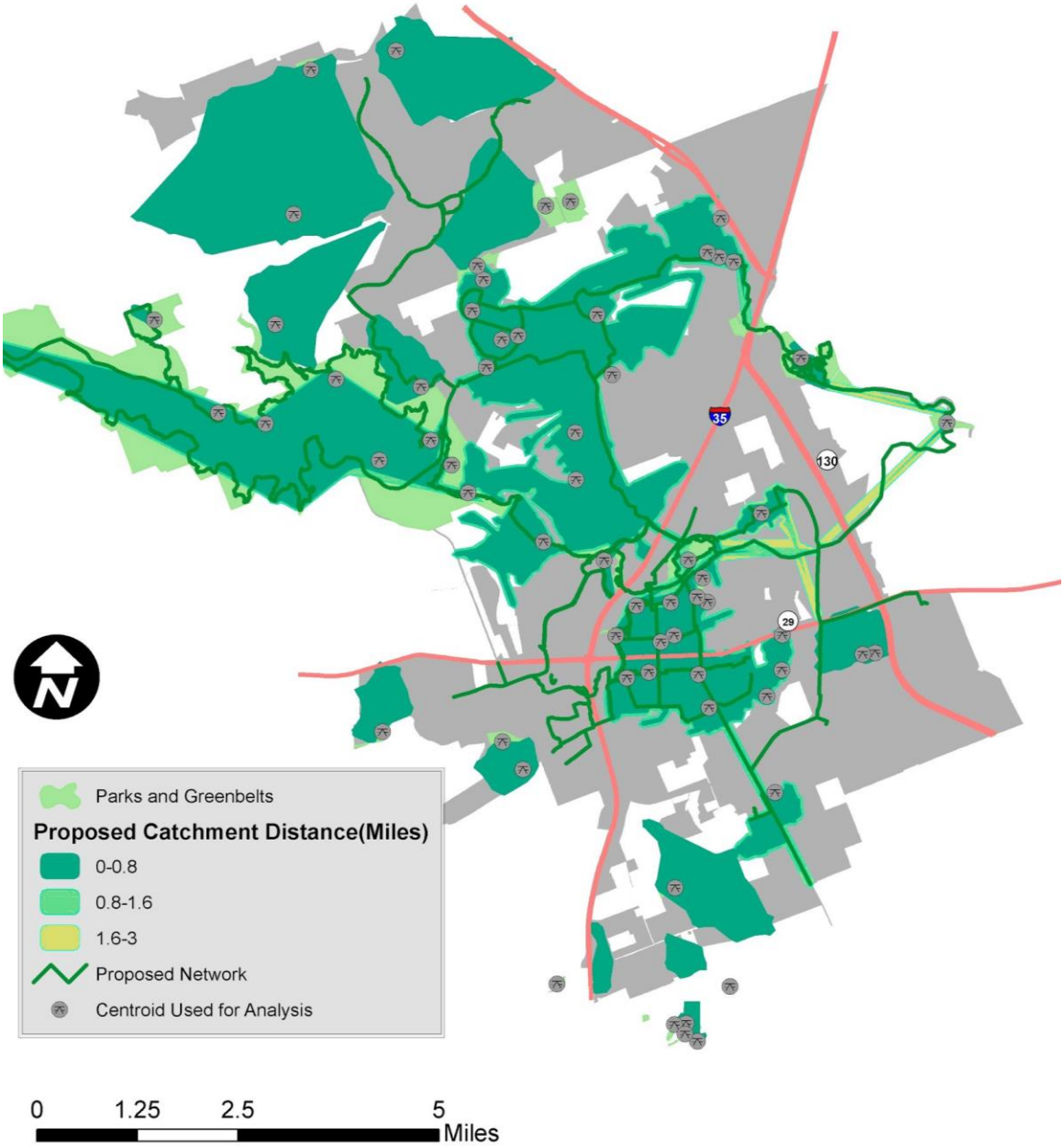


Figure 33. Future Parks Connectivity

A4.5 BICYCLE LEVEL OF TRAVEL STRESS ANALYSIS

Bicycle Level of Traffic Stress (BLTS) is an objective, data-driven way to evaluate the traffic stress imposed on cyclists. It was originally developed by researchers at the Mineta Transportation Institute and later adopted by governments and nonprofits.

Based on the criteria of Dr. Peter G. Furth from the College of Engineering at Northeastern University, level of traffic stress ranges from a comfortable 1 to a very high-stress 4. The higher stress the bike lane is, the fewer people are willing to use it[17]. Most BLTS measures involve the incorporation of traffic volume data; Annual Average Daily Traffic (AADT) volume measures were available on approximately 40 roadway segments of the thousands present in the Georgetown network. We have sourced roadway design volume ranges based on functional classification from the 2030 Comprehensive Plan (see Table 2 below). These vehicles per day (VPD) values by roadway segment are mapped in Figure 35.

To avoid speculative approximations of traffic volume on the many other roads in Georgetown, a BLTS matrix was developed based on best practices from other US studies which did not require traffic volume data in their methodologies.

17 - Furth, P. (2012). Level of Traffic Stress. Retrieved from http://www.northeastern.edu/peter.furth/criteria-for-level-of-traffic-stress/.

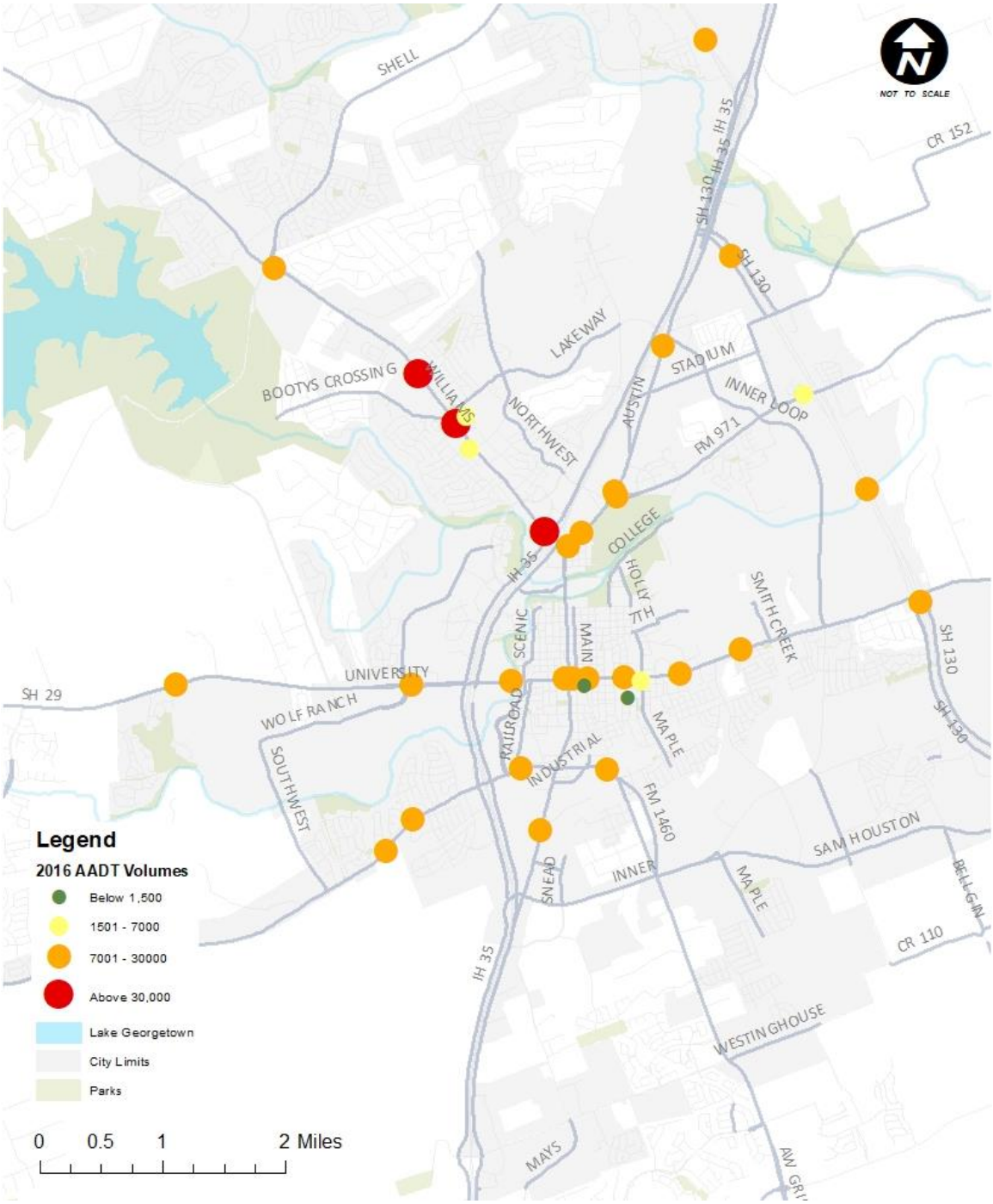


Figure 34. AADT Volumes[18]

18 - TxDOT (2016) and City of Georgetown (2018)

Table 2. Design Volume Ranges by Functional Classification[19]

Functional Classification	Volume Ranges
Local Streets	< 2,500 vpd
Collector Streets (2 lane with Parking)	2,500 to 5,000 vpd
Collector Streets (3 lane)	5,000 to 8,500 vpd
Collector Streets (4 lane)	8,500 to 12,500 vpd
Minor Arterials	12,500 to 24,000 vpd
Major Arterials	24,000 to 36,000 vpd
Freeways/Expressways	> 36,000 vpd

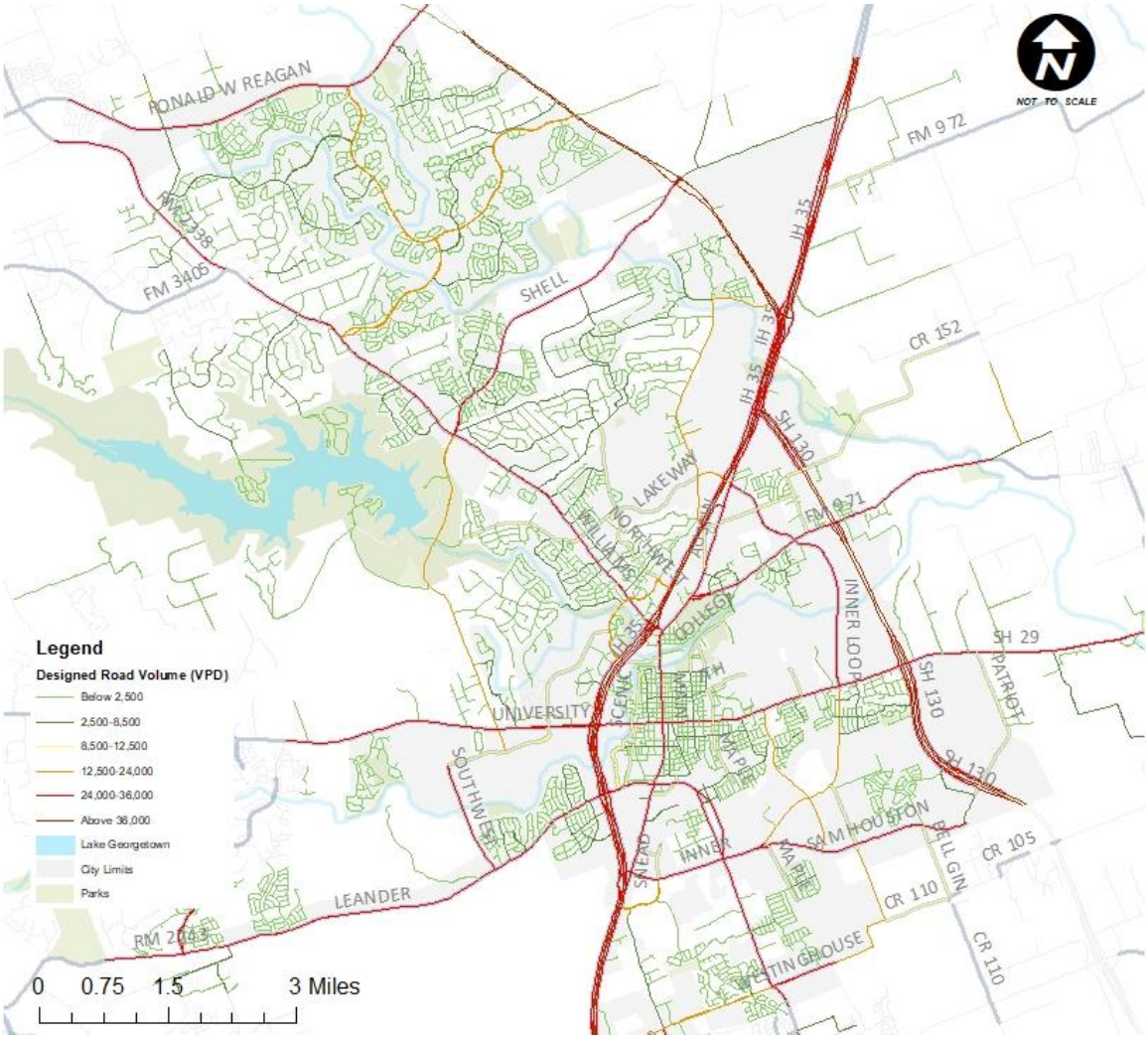


Figure 36. Designed Road Volume (VPD) by Street Segment

19 - Georgetown Overall Transportation Plan (2015)

Furth (2012) indicates that stand-alone, off-street paths achieve the lowest level of BLTS with a rating of '1'. This is logical since most of travel stress occurs as a result of interactions and sharing space with motorized vehicles. Georgetown features a number of off-street trails, both paved and unpaved, that connect areas along the San Gabriel River basin, along the Berry Springs Canyon, around Lake Georgetown, and in some select locations within Sun City. Furth (2012) classifies streets with dedicated bicycle facilities using a separate matrix from streets with bicycles traveling in mixed traffic. Each matrix uses the following information to delineate four levels of stress: street width, bike-lane width, speed limit, and regularity of bike lane blockage.

Montgomery County revised the Mineta Transportation Institute's original BLTS method by considering the effects of the street center lines, on-street parking, shoulder width, and number of lanes. Due to the unavailability of a robust AADT dataset, traffic volume was not used as a major attribute in their analysis. According to Table 4, the Montgomery County Planning Department used AADT to distinguish two-lane arterials from two-lane residential streets. Because the City of Georgetown has a similar population to Rockville, the county seat of Montgomery County, this method sets a suitable precedent for conducting a BLTS analysis without using traffic volume data as a major attribute.

Table 3. BLTS for Bike Lanes Not Alongside a Parking Lane[20]

	LTS ≥ 1	LTS ≥ 2	LTS ≥ 3	LTS ≥ 4
Street width (thru lanes per direction)	1	2, if directions are separated by a raised median	more than 2, or 2 without a separating median	(n.a.)
Bike lane width	6 ft or more	5.5 ft or less	(n.a.)	(n.a.)
Speed limit or prevailing speed	30 mph or less	(n.a.)	35 mph	40 mph or more
Bike lane blockage	rare	(n.a.)	frequent	(n.a.)

20 - Furth, P. (2012). Level of Traffic Stress. Retrieved from http://www.northeastern.edu/peter.furth/criteria-for-level-of-traffic-stress/.

Table 4. BLTS Criteria for Mixed Traffic Roadway Segments[21]

	Street Width		
Speed Limit or Prevailing Speed	2-3 lanes	4-5 lanes	6+ lanes
Up to 25 mph	LTS 1 [a] or 2 [a]	LTS 3	LTS 4
30 mph	LTS 2 [a] or 3 [a]	LTS 4	LTS 4
35+ mph	LTS 4	LTS 4	LTS 4

[a] Use lower value for streets without marked centerlines and with ADT ≤ 3000; use higher value otherwise.

KEY	Low Stress	Medium Stress	High Stress

21 - Furth, P. (2012). Level of Traffic Stress. Retrieved from http://www.northeastern.edu/peter.furth/criteria-for-level-of-traffic-stress/.

Table 5. Mixed Traffic Street Segment: Level of Stress[22 + 23]

Posted Speed Limit (mph)	# of Through Lanes	Mixed Traffic					
		No Parking		Parking			
		Center Line	No Center Line	Center Line & High Parking Turnover	Center Line & Low Parking Turnover	No Center Line & Non-Residential	No Center Line & Residential
≤25	2-3	3 (2c)	2 (1d)	2.5	2	2.5	2 (1d)
	4-5	3	n/a	3	3	n/a	n/a
	≥6	4	n/a	4	4	n/a	n/a
30	2-3	3	2	3	3	2.5	2
	4-5	4	n/a	4	4	n/a	n/a
	≥6	4	n/a	4	4	n/a	n/a
35	2-3	4	4	4	4	n/a	n/a
	4-5						
	≥6						
40	2-3	4	4	4	4	n/a	n/a
	4-5						
	≥6						
≥45	2-3	5	5	5	5	n/a	n/a
	4-5						
	≥6						

22 - Montgomery County (2018)

23 - c. if Average Daily Traffic is less than 6,000 ADT; d. If Average Daily Traffic is less than 3,000 ADT

There are currently very few applications of on-street bicycle facilities in the City of Georgetown. The facilities that are used for on-street cycling (e.g. shoulders, emergency lanes) are not signed as dedicated cycling lanes. However, shoulders that are greater than 5 feet wide are prevalent in Georgetown, and are considered comfortable cycling facilities. In an effort to reconcile the original classifications developed by Fruth with the data available for Georgetown, the following matrix was developed to rate BLTS by street segment (see Table 6).

Table 6. BLTS Ratings Utilized to Grade Georgetown, TX

BLTS Ratings	**Undivided**		**2-3 lanes**		**4-5 lanes**		**6+ lanes**	
Bikeable Shoulder?	Yes	No	Yes	No	Yes	No	Yes	No
Up to 25mph	1	1	1	2	3	3	3	4
30 mph	1	2	2	3	3	4	4	4
35 mph	3	4	3	4	3	4	4	4
40+ mph	n/a	n/a	4	4	4	4	4	4

Key:	*Lowest Stress*	*Low Stress*	*Medium Stress*	*High Stress*

The data available to the project team to generate BLTS measure includes: street width by number of lanes, presence of a bikeable shoulder (greater than 5 ft.), and posted speed limit. Each of these data categories are mapped in Figure 36, Figure 37, and Figure 38. The final BLTS map is shown in Figure 39.

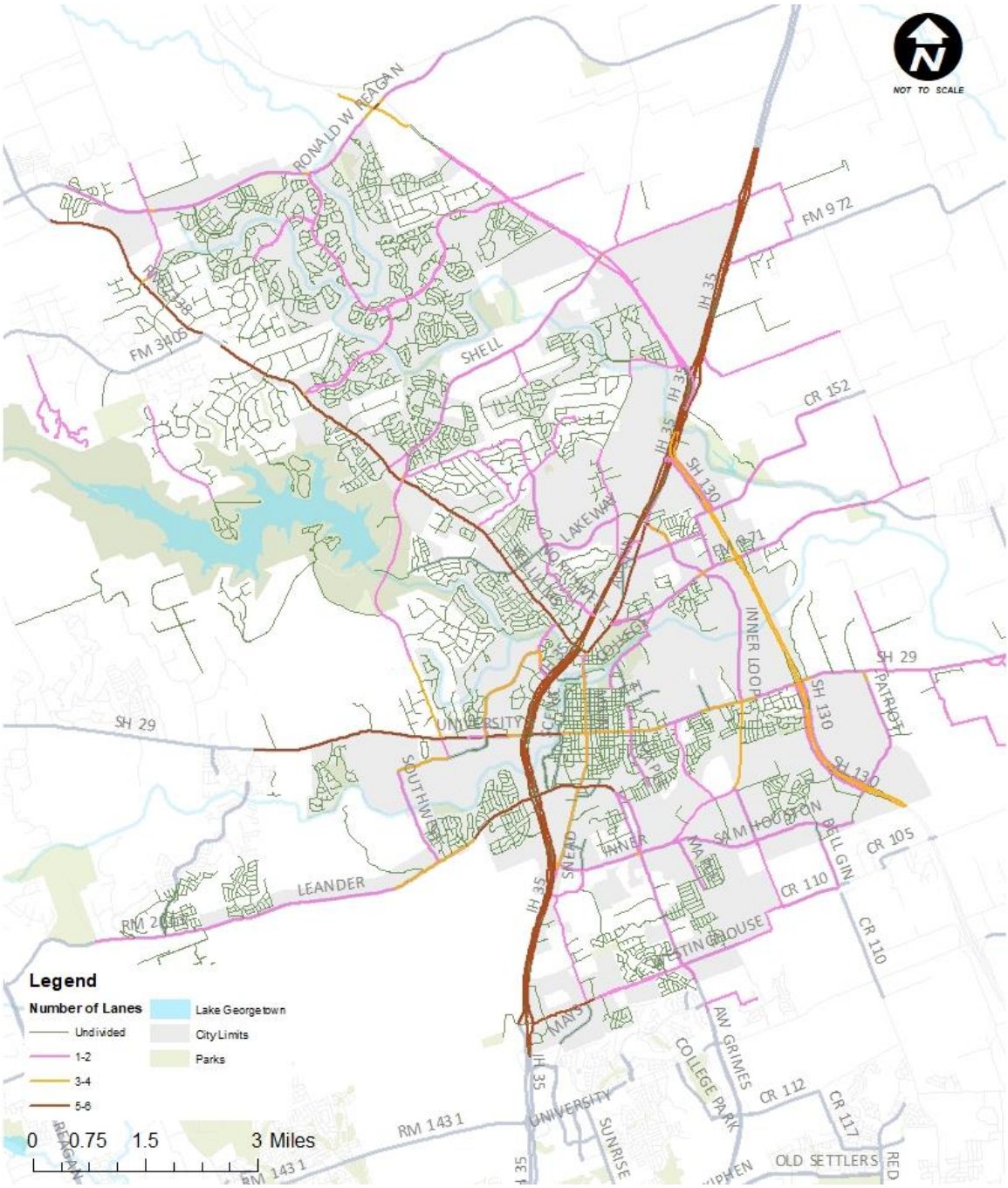


Figure 37. Street Segment by # of Vehicle Travel Lanes

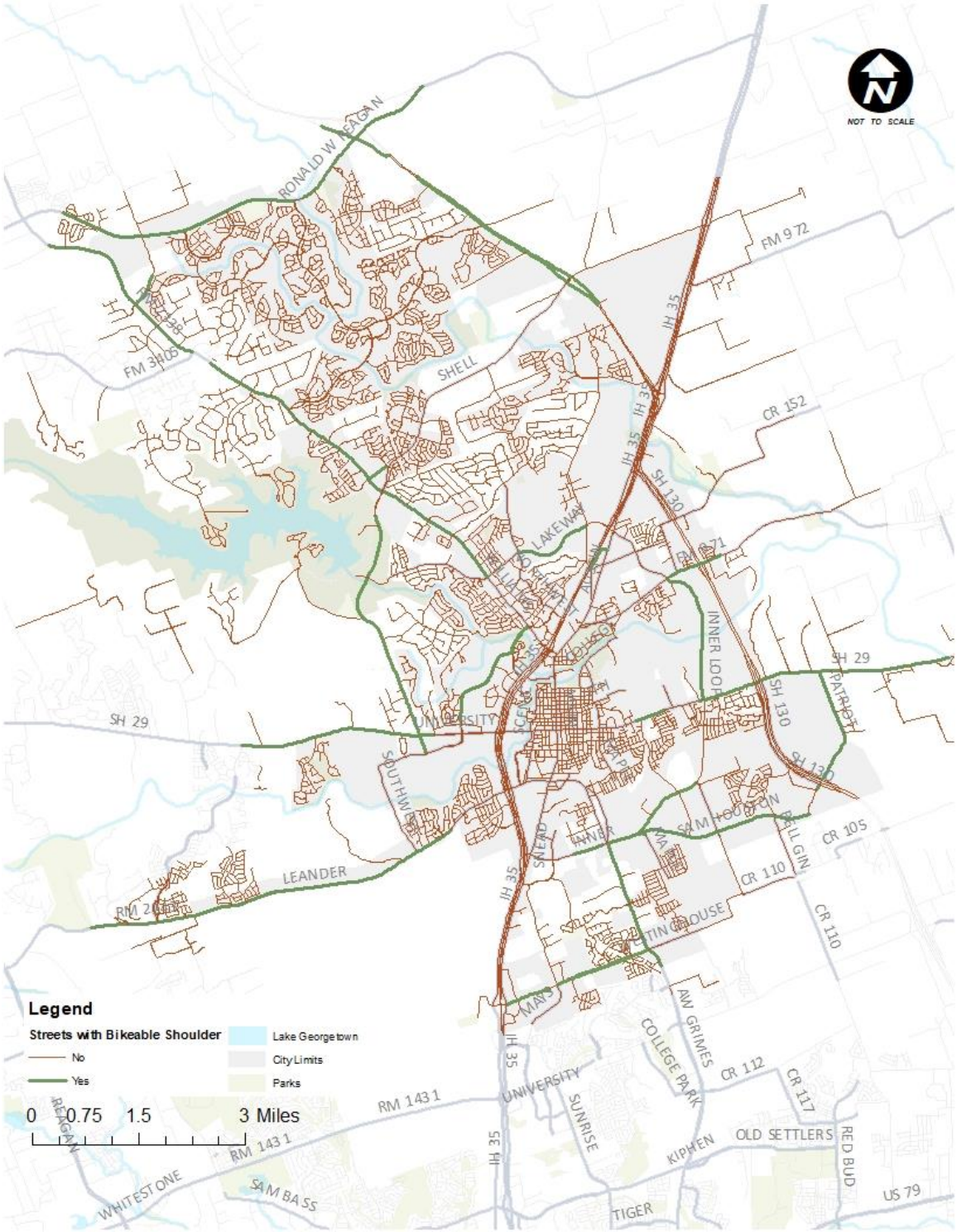


Figure 38. Street Segment by Provision of 5′ or More Bikeable Shoulder

Figure 39. Street Segment by Posted Speed Limit

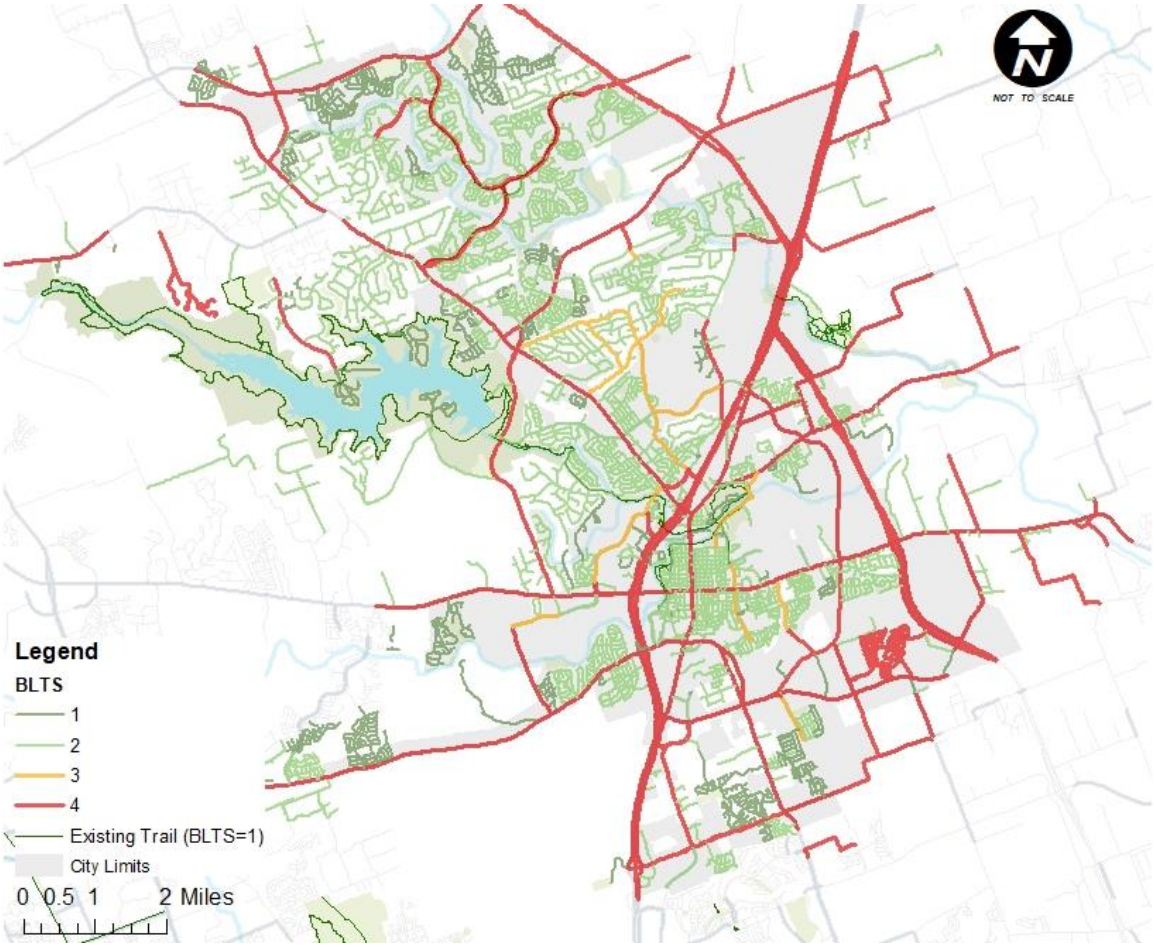


Figure 40. Final BLTS Rating Map by Street Segment

In reviewing the final BLTS map above, a number of islands of 'green' (BLTS 1 & 2) are visible, which are suitable for all ages and abilities. However, most of these areas face connectivity issues to other parts of town and remain walled off either geographically (e.g. river), by property (e.g. private property, fencing), or by roadway barriers. IH-35 is the most visible and prominent of these dividers, but crossing barriers are also prevalent along Austin Ave. or University Ave. which can dissuade cyclists falling into the 'interested but concerned' from cycling to the otherwise highly comfortable Downtown area.

A4.6 PEDESTRIAN SUITABILITY INDEX

Pedestrian suitability can be determined based on many factors, such as the environment surrounding a road segment and the types of development that the road or sidewalk connects. A foundational factor in determining the suitability of an area or street segment for pedestrians is the roadway speed limit. High-volume and speed roadways are the least compatible with pedestrian activity.

Figure 40 below highlights the dangers relative to speed limits in increments of ten. The difference between a car travelling at 20 and 40 mph is dramatic, and the City of Georgetown's roadway speeds reach up to 80 mph.

Figure 41. Fatality Risk by Speed Limit Increase[24]

The Pedestrian Suitability Index in Table 7 incorporates Georgetown's speed limits and data gathered from the Georgetown Sidewalk Master Plan, which was adopted by Georgetown City Council in 2015. A map of existing conditions (Figure 41) displays the distribution of sidewalk conditions as of 2015.

Sidewalks are classified by Excellent, Good, Passable, Limited Failure, Failing, and N/A. 'N/A' indicates that no sidewalk facilities are present along the segment. Based on the statistics of fatality risks related to speed limits, 5 indices were developed for pedestrian suitability. The geographic distribution of the index is shown in Figure 42.

24 - Seattle Department of Transportation (2017)

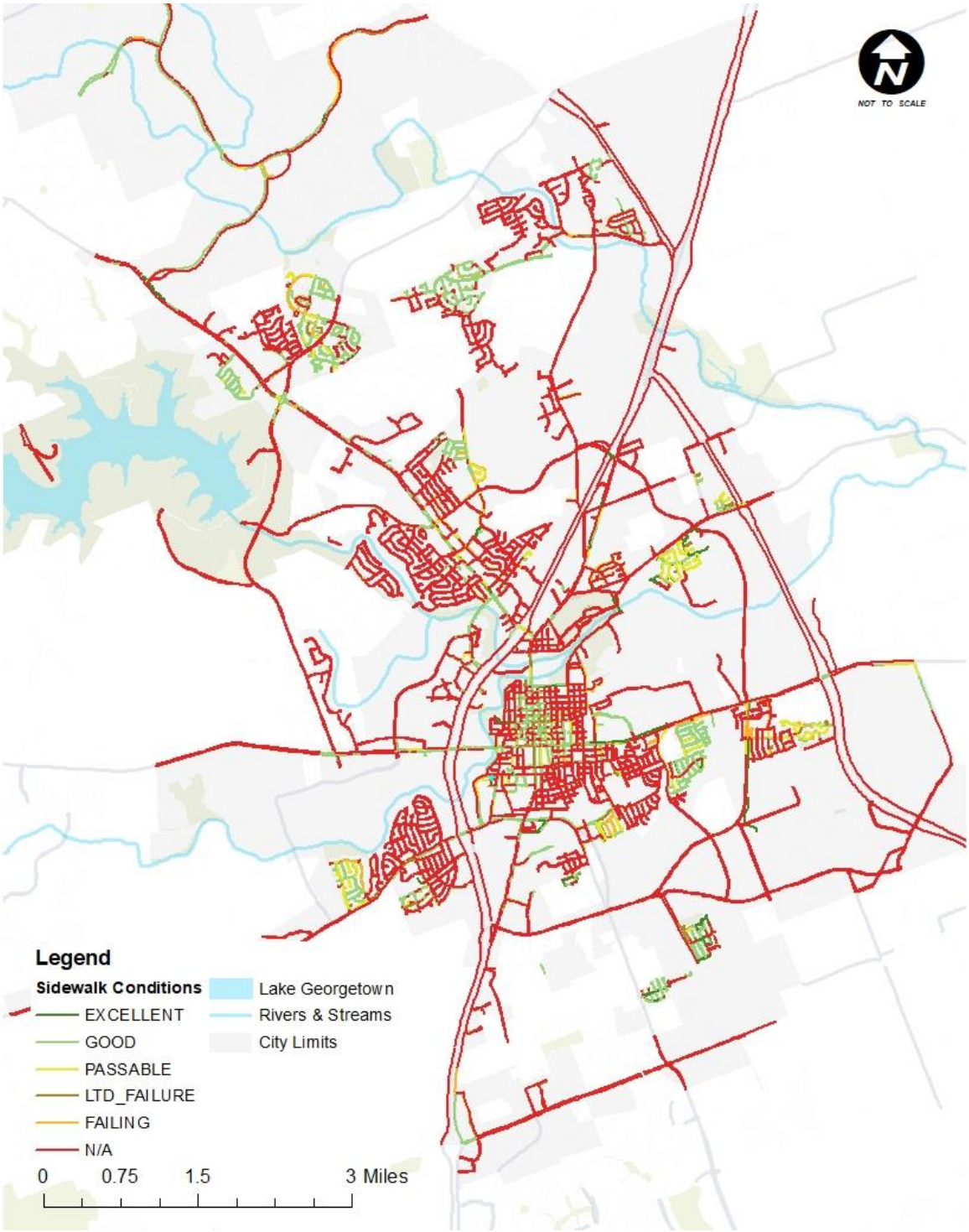


Figure 42. Sidewalk Conditions Map by Sidewalk Segment

Table 7. Pedestrian Suitability Index Category Definitions

Index	Sidewalk Condition	Speeds
1	Excellent, Good, Passable	Under 20 mph
2	Excellent, Good, Passable	20-29 mph
3	Limited Failure	Under 20mph
4	Excellent, Good, Passable	30-39 mph
5	Limited Failure	20-39
6	All sidewalk condition types	40+ mph

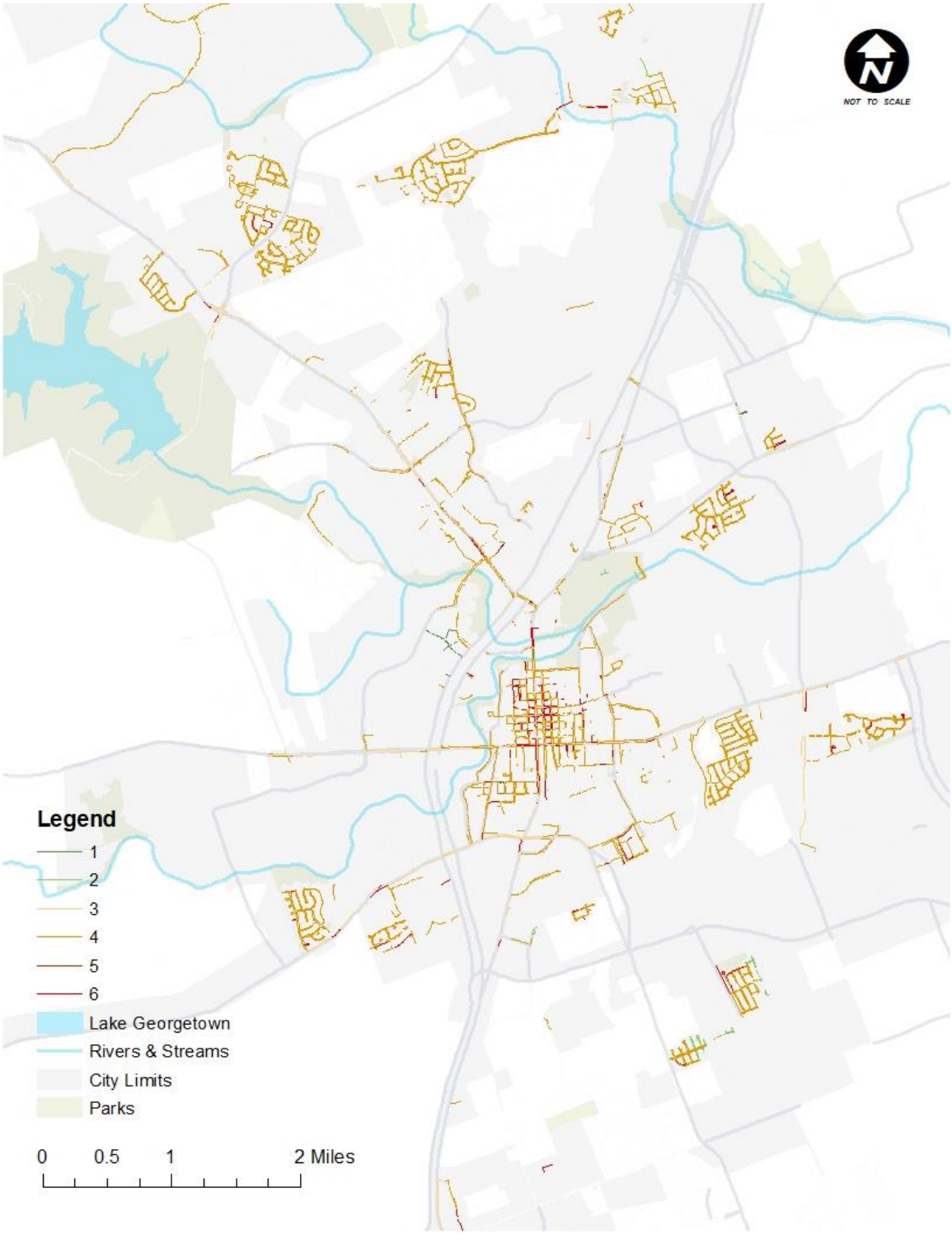


Figure 43. Sidewalk Ratings Map by Sidewalk Segment

A4.7 CRASH ANALYSIS SUPPLEMENT MAPS

A description of the crash analysis can be found in Section 2.7 in the bike plan. Below are additional figures and close-ups of the crash analysis.

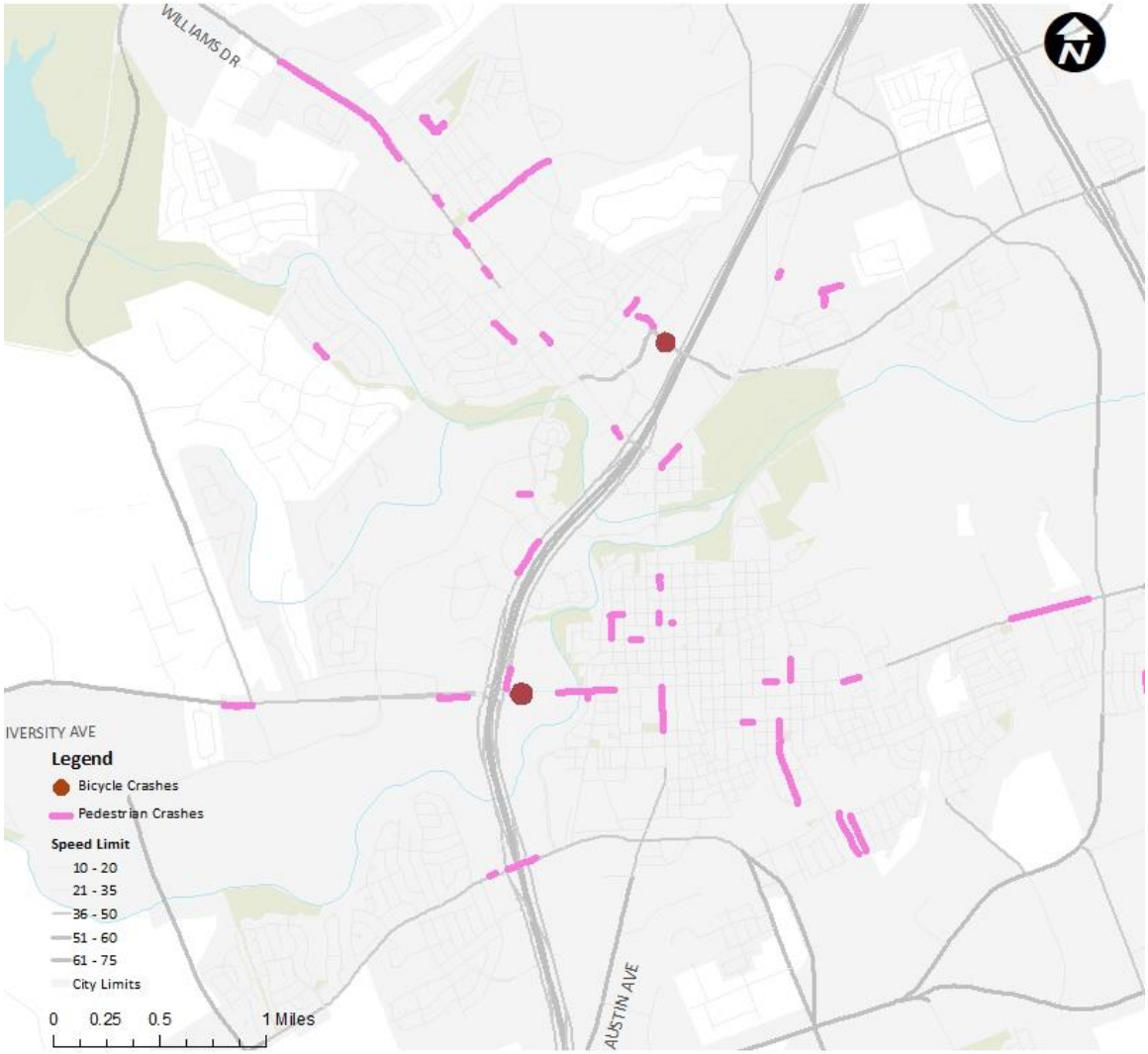


Figure 44. Pedestrian and Bicycle Crash Locations[25]

25 - Georgetown Sidewalk Master Plan (2015) & Georgetown Bicycle Master Plan Community Workshop

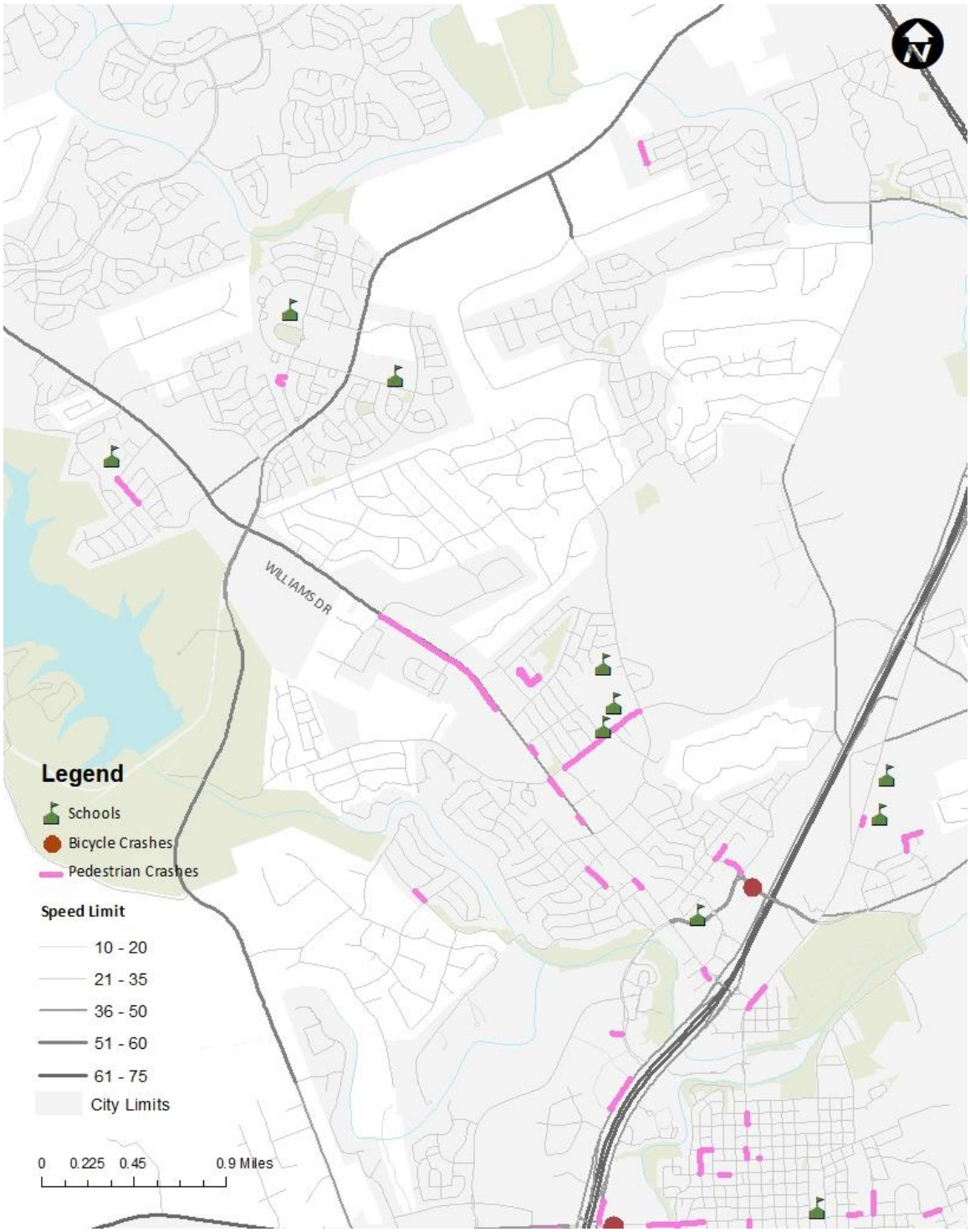


Figure 45. Bicycle and Pedestrian Crashes with Roadway Speed Limits – Northwest Georgetown

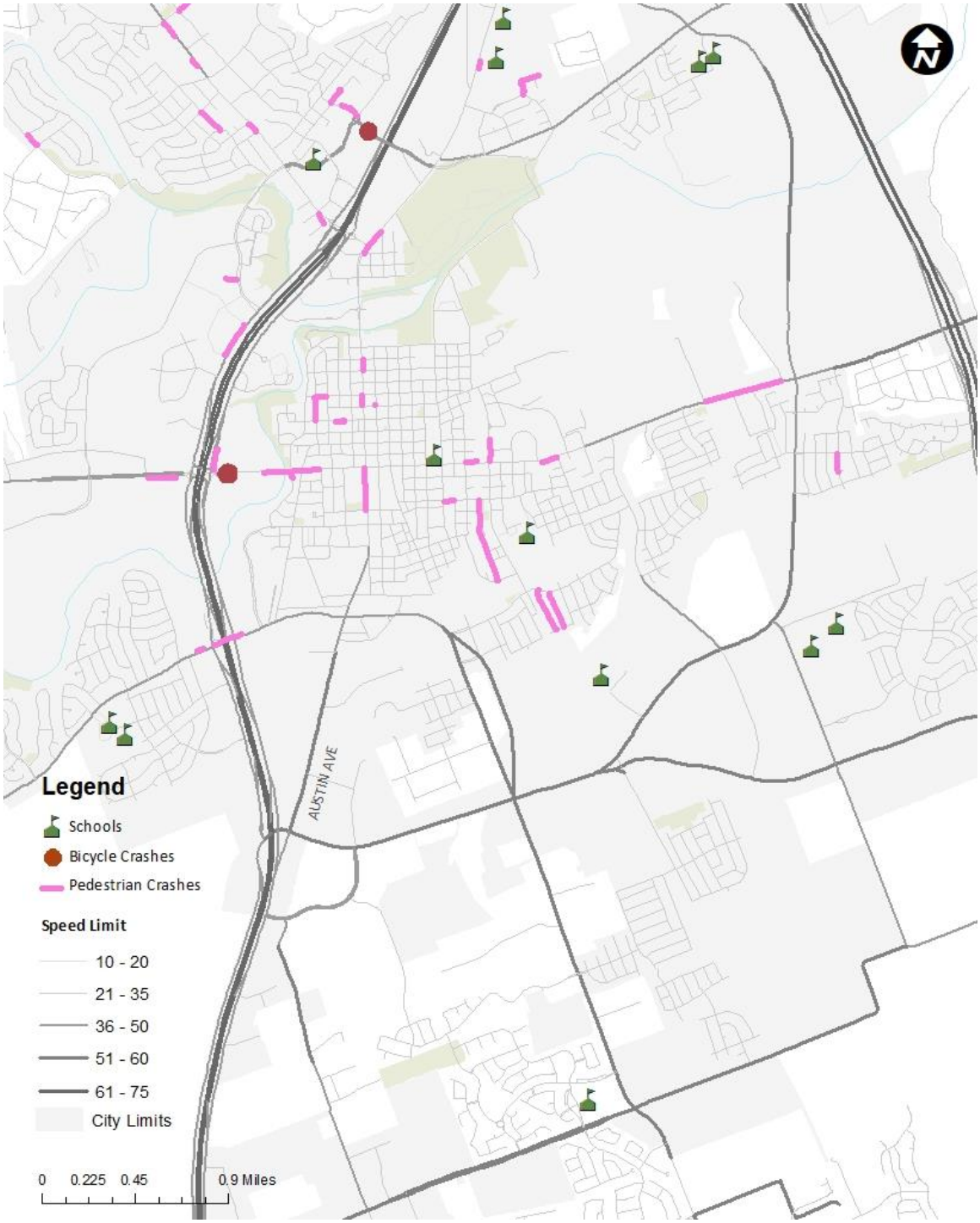


Figure 46. Bicycle and Pedestrian Crashes with Roadway Speed Limits – Central Georgetown

Appendix 5:
Bikeway Design Guidelines and Standards

A5.1 BICYCLE FACILITIES

There are multiple types of bicycle facilities that are recommended by the Urban Bikeway Design Guide, authored by the National Association of Transportation Officials (NACTO) within the context of Georgetown. Bike lanes are defined as dedicated space for non-motorized vehicles to travel without interacting with automobiles. Various types of bicycle lanes exist, ranging from a simple painted white line, to a cycle track that physically separates bikes from vehicles using bollards, poles, concrete curbs, or planters.

The following recommendations only address on-street infrastructure types, as facility design differs greatly on hike and bike trails, off-street trails, and other types of recreational facilities. Choosing the correct treatment for each street segment will allow cyclists throughout the city to reach their destinations safely and efficiently. On-street facilities can encourage residents to swap their short vehicle trips for biking trips, and can connect Georgetown's extensive off-street trails to popular destinations in a way that helps more cyclists feel comfortable.

The following types of bicycle treatments are recommended:

- Sharrows
- Conventional Bike Lane
- Buffered Bike Lane
- One-or-Two-Way Protected Cycle Tracks
- Off-Street Cycle Lanes

Sharrows

Sharrows legitimize cyclists' presence through markings on the street. Often referred to as a shared-lane marking, a sharrow is not considered an actual bicycle lane since cyclists must share space with motorists. Sharrows are the most inexpensive type of bike infrastructure because they do not require road redesign. While they are effective in discouraging wrong-way biking, the lack of dedicated space may discourage inexperienced cyclists. Texas law classifies bicycles as vehicles when traveling on streets, but sharrows offer no physical protection. This makes sharrows the least safe treatment, compared to the types that follow.

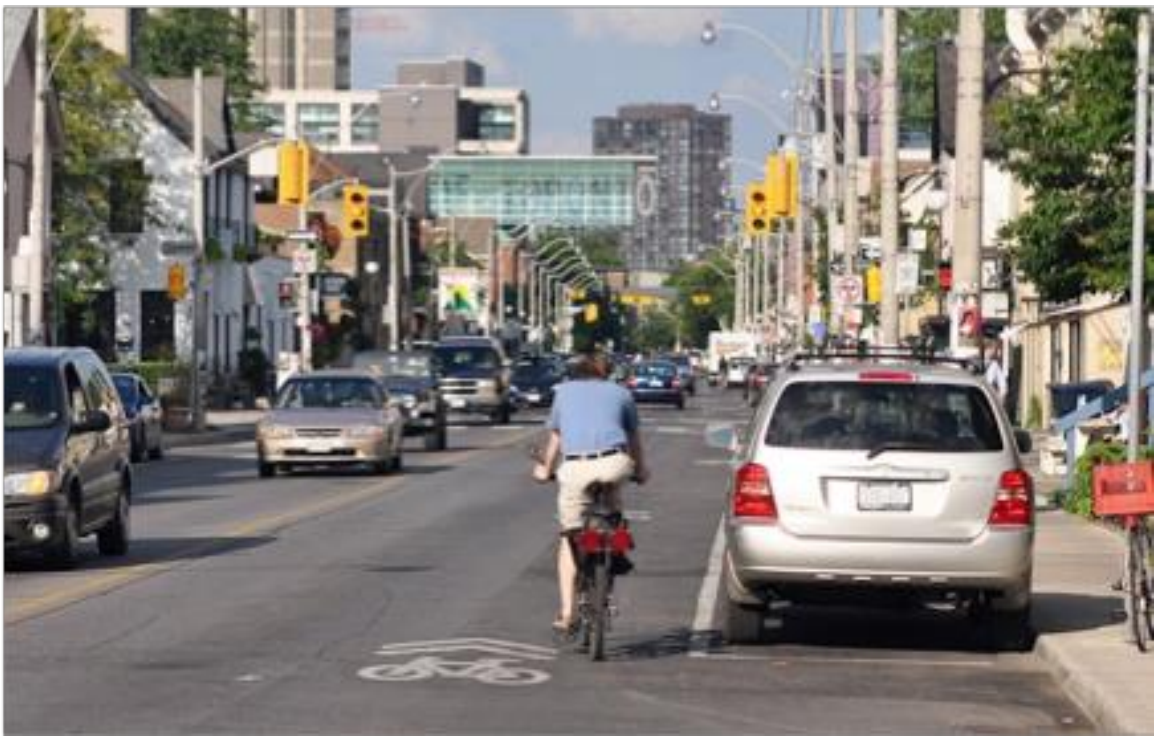


Figure 47. Sharrow Example

Conventional Bike Lane

Conventional bike lanes are the most common bicycle infrastructure in America. These lanes are usually located on the right side of regular traffic lanes, and are separated by a solid white line indicating that the space is off limits for automobile users. This type of infrastructure allows cyclists to travel at their own speed without competing for space with cars.

Although separate bike lanes are safer than sharrows, they still do not rate highly on the safety spectrum. The implementation of additional infrastructure will improve cyclist safety.

Bicycle lanes are typically placed between the curb and vehicular travel lane. When a street contains on-street parking, the bike lane may be placed either between the vehicle travel lane and the parking lane, or between the curb and the parking lane to enhance safety.

Conventional bike lanes offer a multitude of benefits. First, a dedicated space allows cyclists to travel at their own speed without worrying about competition for road space with automobile users. Second, installation typically doesn't involve acquiring additional right of way as many roads already have shoulders that can be repurposed, which saves on cost and time. Conventional bike lanes are a low-cost option for municipal governments and provide an increased level of safety and comfort when compared to shared-use roads.

Required features of conventional bike lanes:

- The minimum desirable width of a conventional bike lane next to a curbside is 6 feet; it must not be less than 4 feet if adjacent to parking.
- A solid white line indicates separation between cyclists and motorists and must be 6 to 8 inches wide.
- If the lane is next to a guardrail, an additional 2 feet must be provided to the cyclist.

Figure 48. Conventional Bike Lane Example

Buffered Bike Lanes

Buffered bike lanes are conventional bike lanes with a buffer space to provide additional separation between cyclists and motorists. Research has consistently shown that buffered bike lanes have higher usage and higher perceived safety than conventional lanes, and they are recommended as a minimum treatment for high speed or volume roads. For specific standards and legal guidance, refer to the MUTCD section 3D-01[26].

Buffered bike lanes have advantages beyond further separation from vehicles -- it is easier to maneuver around parked vehicles without veering into general traffic lanes, cyclists are able to pass other cyclists, and they encourage less confident cyclists to bike due to increased security.

Figure 49. Buffered Bike Lane Example

Required features for buffered bike lanes:

- MUTCD markings must be painted on the designated bike area.
- The buffer must be marked with two solid white lines, six to eight inches apart.
- Hatching must be included between the two white lines if the area is three or more feet apart.
- Hatched lines should be painted at 30 to 45-degree angles at intervals of 10 to 40 feet.
- The minimum width of buffered bike lanes is seven feet.

26 - https://mutcd.fhwa.dot.gov/htm/2009r1r2/part3/part3d.htm

Cycle Tracks

Cycle tracks provide another level of protection for cyclists. The buffered space between the bike lane and vehicle lane, contains additional physical barriers that generate greater comfort and a sense of confidence for the cyclist. These barriers can include bollards, traffic poles, planters, concrete curbs, and more.

Required features for cycle tracks:

- MUTCD requires that bicycle lane words, symbols, and/or arrow markings be placed at the beginning of a cycle track and at periodic intervals along the facility based on engineering judgment.
- Solid white lane line markings must be painted.
- Diagonal hatched markings must be placed in the neutral area to further emphasize the buffer.
- Raised medians or other barriers must provide physical separation to the cycle track.

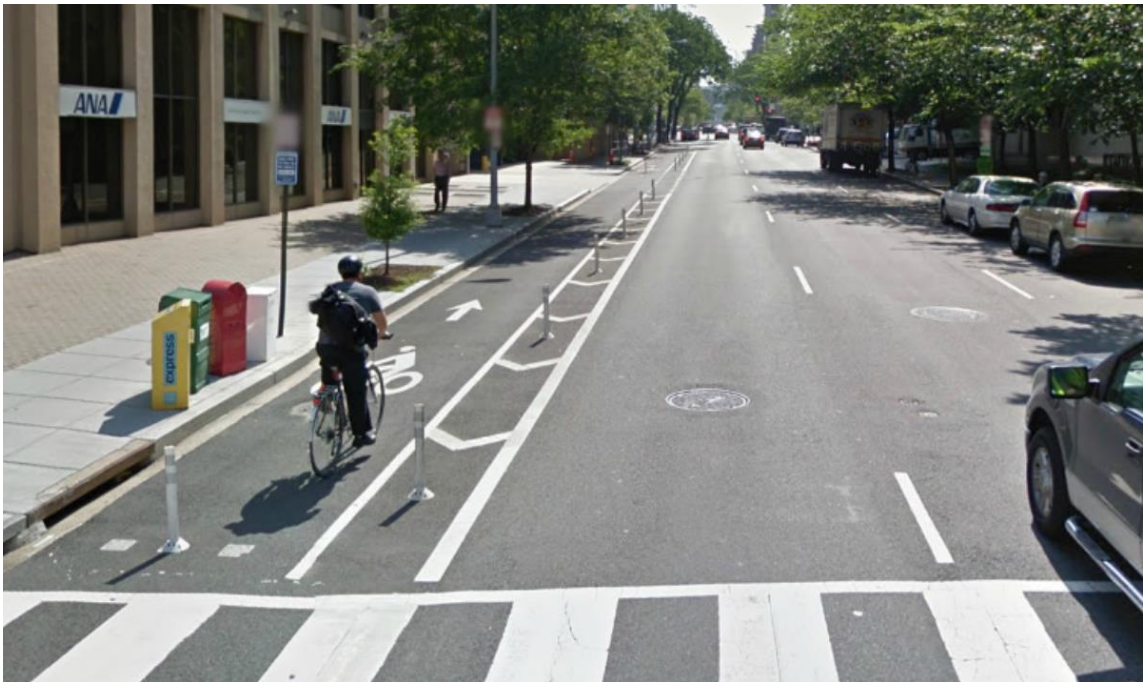


Figure 50. Cycle Track Example

Off-Street Cycle Lanes

The highest level of protection that can be given to cyclists is through an off-street cycle lane. These bike facilities are fully separated from vehicle traffic by a strip of greenway or are built completely on their own. Off-street cycle lanes are usually for the exclusive use of bicycles, but can be shared between bikes and pedestrians.

Required features of off-street cycle lanes:

- The lane must be fully separated from vehicular traffic by a strip of greenway.
- Lanes must be a minimum of eight feet wide, and a 10-foot width is recommended.

Figure 51. Off Street Cycle Lane Example

A5.2 INTERSECTION DESIGN

Intersections are integral to street design as they are where motorists, pedestrians, and cyclists converge. Based on NACTO guidelines, the intersection design standards recommended here will benefit motorists and cyclists through enhanced visibility, predictability, and safety.

Bike Boxes

The bike box intersection design standard consists of a dedicated space at the head of traffic and prior to the pedestrian crosswalk. It is essential that this space be painted to indicate bicycle priority and avoid conflicts. In this space, cyclists are able to wait for signal changes at the head of the intersection, helping them cross more comfortably. The positioning of the cyclist results in a greater sense of predictability and visibility from a motorist's perspective.

Required features for bike boxes:

- Stop lines must be used to indicate the point behind which vehicles are required to stop in compliance with a traffic control signal; stop lines must be 12 to 24 inches wide[27].
- Stop lines must be placed 4 feet in advance of the nearest crosswalk line.
- A "No Turn on Red" sign must be present to prevent vehicles from entering the bike boxes.
- Specific pavement markings should be painted in the bike box[28]

Figure 52. Bike Box Example

27 - MUTCD 3B.16, https://mutcd.fhwa.dot.gov/htm/2009/part3/part3b.htm#section3B16
28 - MUTCD 9C-3A or 9C-3B, https://mutcd.fhwa.dot.gov/htm/2009/part9/fig9c_03_longdesc.htm

Crossing Markings

Intersection crossing markings indicate a clear cycling path through an intersection. Crossing markings consist of dashed lines that can range in width and length, and can be supplemented with bicycle markings, arrows, or paint.

Crossing markings increase visibility and predictability of cyclists for motorists, and are particularly helpful at wide or complex intersections where the bicycle path may be less clear.

Georgetown bicyclists repeatedly made clear that right-turns are one of the most unsettling aspects of intersections. Unless directed by existing signs, vehicles in Georgetown are able to turn right at a red light, which can induce a greater sense of discomfort in cyclists. The following two intersection designs are a method for managing right turns at intersections.

Required features for crossing markings are:

- Dotted lines must bind the crossing space[29].
- Striped lines must be a minimum of six inches wide.
- Crossings should match the width and lateral positioning of leading bike lane striping, except for elephants' feet markings.

Figure 53. Crossing Markings Examples

29 - MUTCD 3B.08, https://mutcd.fhwa.dot.gov/htm/2009/part3/part3b.htm#section3B08

Through Bike Lanes

If a road is expanded to accommodate a right turn lane, through bike lanes guide cyclists from the bike lane to the intersection, across right-turning traffic. Through lanes help alert motorists to bike traffic that may interrupt normal vehicle flows into the turn lane.

Required features of through bike lanes:

- Lanes must be a minimum of four feet wide; it is recommended that they are six feet wide
- Symbols or markings must be painted per MUTCH regulations[30].
- Through bike lane must be placed to the left of right-turn-only lanes.
- Through bike lanes should not be used where there are double right turn lanes.
- Dotted lines signifying the merge must begin a minimum of 50 feet before the intersection, or a minimum of 100 feet for high speed or high-volume roadways.

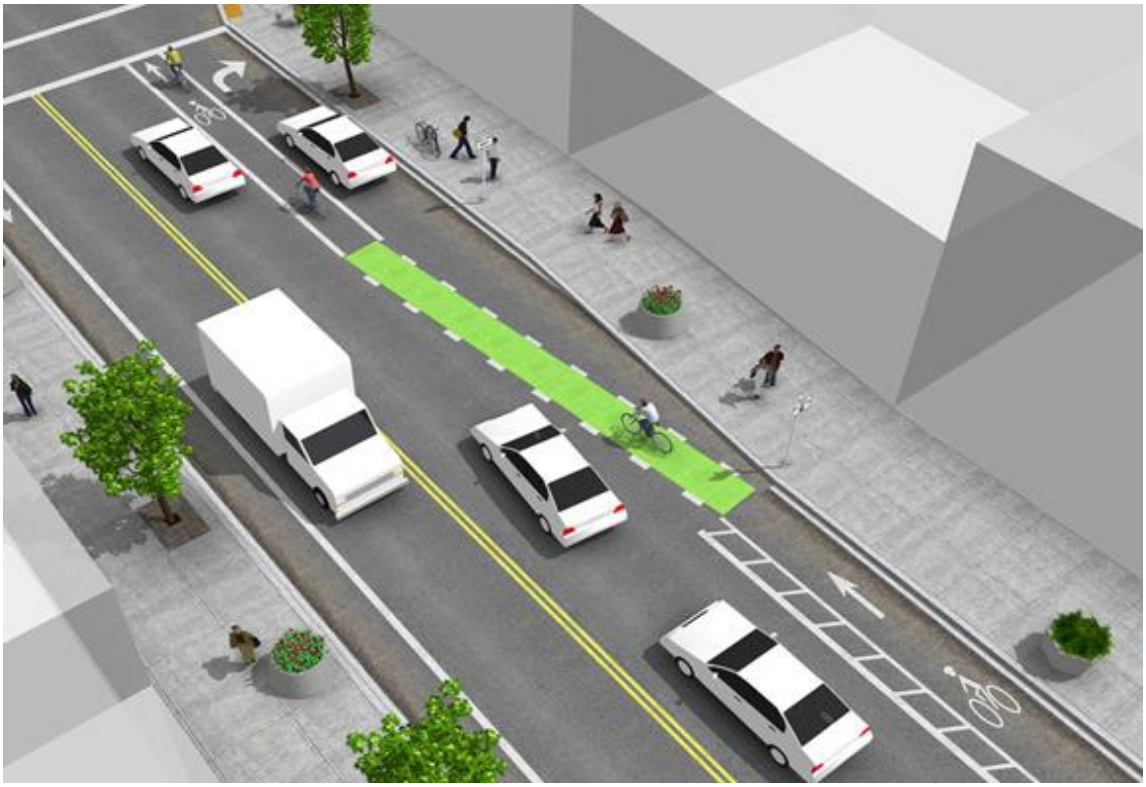


Figure 54. Through Bike Lanes

30 - MUTCD Figure 9C-3, https://mutcd.fhwa.dot.gov/htm/2009/part9/fig9c_03_longdesc.htm

Combined Bike Lane/Turn Lane

Similar to through bike lanes, combined bike lane/turn lanes help cyclists navigate street segments where dedicated bike lanes end and vehicle turn lanes begin. Shared lane markings or conventional bicycle stencils with a dashed line can delineate the space for bicyclists and motorists within the shared turn lane or indicate the intended path for through bicyclists[31]. This treatment is less expensive than through bike lanes, but provides less separation and awareness as bike space is combined with vehicle space.

Required features of combined bike lane/turn lanes[32]:

- Some form of bicycle marking should be painted to delineate which portion of the turn lane is dedicated to the cyclist.
- The bicycle lane portion of the lane must be a minimum of four feet wide.
- The width of the combined lane should be a minimum of nine feet and a maximum of 13 feet.
- A four-inch-wide dotted line should be painted to separate the bicycle portion of the lane.

Figure 55. Combined Bike/Turn Lane Example

31 - https://nacto.org/publication/urban-bikeway-design-guide/intersection-treatments/combined-bike-laneturn-lane/
32 - https://nacto.org/publication/urban-bikeway-design-guide/intersection-treatments/combined-bike-laneturn-lane/

A5.3 BICYCLE PARKING FACILITIES

Public Bicycle Parking

Public bike racks are a common type of bicycle parking facility. Standard public bicycle racks are inexpensive and take up little space, which allows for frequent and convenient placement near common destinations. These types of racks required cyclists to provide their own bike locks, and are not very secure in some cities. Additional public parking facilities include bike cages, which typically require a membership, are costly to install, and take up a generous amount of space.

Bicycle Repair Facilities

Cities can choose to install public bicycle repair stations. They provide tools to help cyclists solve common bike problems, such as air pumps to re-inflate tires and stands to conduct chain adjustments. Stations like this, when placed throughout common cycling areas, can give residents peace of mind that if they choose to travel by bike and have unexpected issues, they will still be able to reach their destination.

Figure 56. Bike Box Example

Appendix 6:
Bicycle Friendly Community Designation Action Plan

The League of American Bicyclists recognizes states, communities, universities, and businesses that have achieved a certain level of bicycle friendliness. The League's Bicycle Friendly Program is a tool for entities to encourage bicycling as a viable transportation option for everyone. Since the creation of the Bicycle Friendly Communities (BFC) program in 1995, 450 communities have been recognized as BFCs[33]. The League provides hands-on assistance to these communities, giving them the necessary building blocks to realize their vision of a bikeable community.

In order for Georgetown to become a Bicycle Friendly Community the following 10 criteria must be addressed. These building blocks are subcategories of the 5 E's, which are the primary components of a Bicycle Friendly Community[34].

1. High-speed roads with bicycle facilities
2. Total bicycle network mileage to total road network mileage ratio
3. Bicycle education in schools
4. Percentage of total transportation budget allocated to bicycling projects and maintenance
5. An active bicycle advocacy group
6. An official active bicycle advocacy committee
7. Bike Month and Bike to Work events
8. Bicycle friendly laws and ordinances
9. A current and effective bike plan
10. Bike program staff to population ratio

The infographic below provides a visual representation of the building blocks, and color-coded steps to help get communities get started, make progress, and set standards.

33 - "Bicycle Friendly America℠." League of American Bicyclists, League of American Bicyclists, 26 Aug. 2016
34 - League of American Bicyclists, https://bikeleague.org/content/building-blocks-bicycle-friendly-communities

The BFC program has five award levels -- diamond, platinum, gold, silver, and bronze -- that rate the bicycle friendliness of a community. Although the BFC program makes suggestions for entry-level efforts, there is no single way for a community to achieve any of the five rankings. This makes it easy for a community to customize its action plan. Georgetown staff will need to work with community members and stakeholders to choose the best route for the City to achieve a BFC designation.

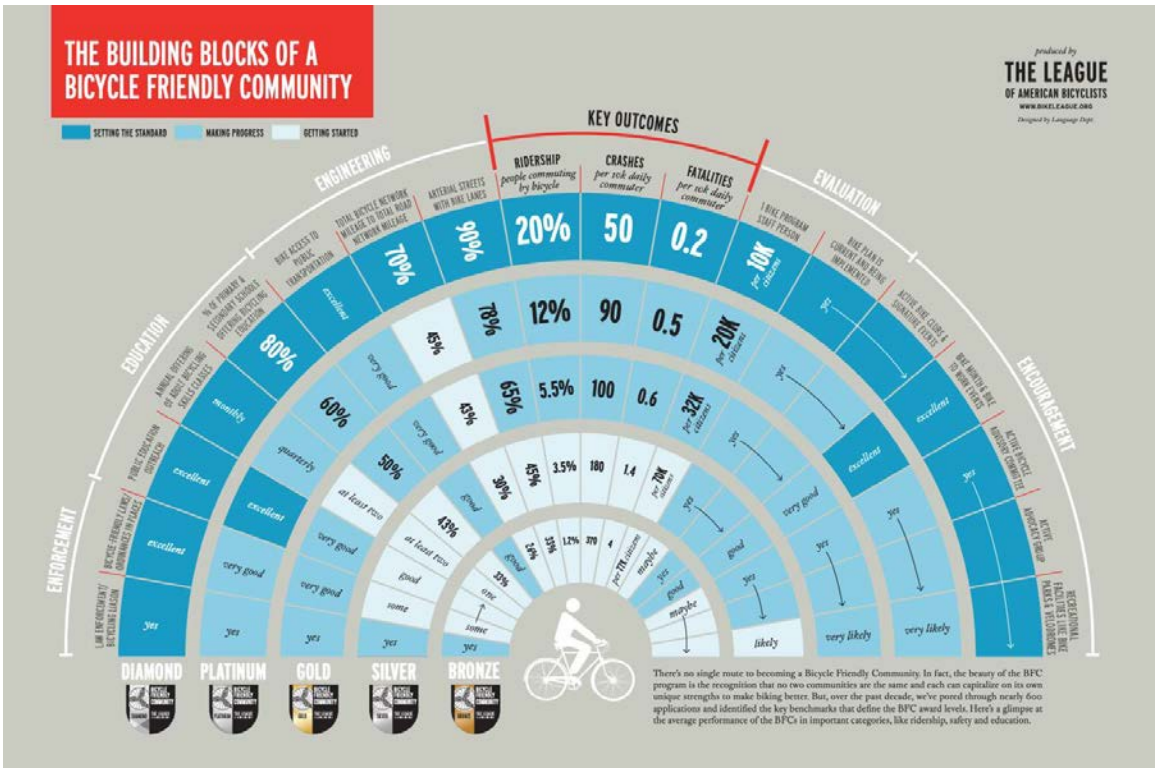


Figure 57. BFC Building Blocks

Much of the BFC application process focuses on how evolved a community is in terms of the 5 E's framework. The application requires performance measures from each of the E's, which are outlined in Chapter 4 of the Bike Plan. Georgetown will be awarded a BFC designation equivalent to the City's progress on these measures at the time of application.

Applications are accepted in the spring and fall of each year. The most current round opened in February 2019 and will close in August 2019. The League of American Bicyclists provides applications and instructions about how to apply on their website[35].

35 - www.apply.bikeleague.org

Appendix 7:
In Depth Methodology for Determining Cost Estimates

Details on the parameters used to develop the cost estimates for the Georgetown bicycle network can be found below. Forecasted costs are broken down into the following categories: off-street path, protected bike lane, buffered bike lane, bike lane, and sharrows. First, the number of linear miles or markings was determined for each project, shown in Table 8 below for the Top 10 recommended projects in the Plan.

Table 8. Facility Miles Recommended in Top 10 Projects

Project Rank	Project Name	Facility Type	Miles
1	**Austin Ave. Bridge**	Off-street path	0.49
2	**8th St.**	Protected bike lane & off-street path	1.04
3	**Main St.**	Protected bike lane	1.20
4	**Holly St. Bridge**	Off-street path	0.14
5	**Maple St. Phase 1**	Protected bike lane & off-street path	1.14
6	**Northwest Blvd./ IH-35 Crossing Phase 1**	Bike lane & protected bike lane	1.08
7	**San Gabriel River Crossing at St. David's Hospital**	Off-street path	0.91
8	**Williams Dr.**	Off-street path	0.45
9	**DB Wood Rd. and Williams Dr.**	Off-street path	0.74
10	**SR-29 East View HS connection across SR 130**	Off-street path	1.26

Unit costs were then assigned to each of the different types of treatments recommended as part of the network. The unit costs are based on the cost of bicycle infrastructure in the City of Portland, as well as different cost structures used by cities that have already implemented bicycle facilities. The following high and low estimate unit costs per foot were assigned to estimate a cost range for each project: $0.83 to $3.00 per ft. for traditional bike lanes, $2.00 to $5.00 per ft. for buffered bike lanes, and $24.79 to $68.16 per ft. for at-grade cycle tracks.

These costs were multiplied by 5,280 ft. to obtain the cost per mile that is reflected in Table 9 below.

Additional costs for sharrow stencils ($339 for materials and installation) and crossing markings and bike boxes ($5,000 each) were also based on the Portland bicycle cost report. The cost of a shared use path is detailed by the Pedestrian and Bicycle Information Center, and the median cost of $261,000 per mile was used for a low estimate, and the average cost of $481,140 was used for the high estimate . When implementing an on-street facility, the street resurfacing that may be required to remove previously existing striping is a significant cost associated with implementation. These cost estimates have not been considered due to their fluctuating nature.

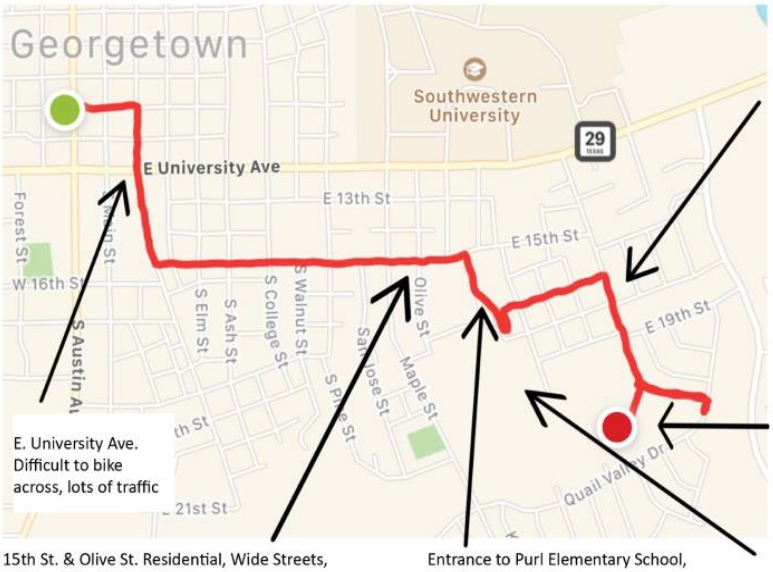
36 - Weigand, L. et al. (2013). Cost Analysis of Bicycle Facilities. Retrieved from https://activelivingresearch.org/sites/activelivingresearch.sdsc.edu/files/Dill_Bicycle_Facility_Cost_June2013.pdf
37 - Bike and Pedestrian Information Center. (2013). Costs for Bicycle and Pedestrian Improvements. http://www.pedbikeinfo.org/cms/downloads/countermeasure%20costs_report_nov2013.pdf

Table 9. Network Cost Estimates

Network Element	Quantity	Cost per Unit (Low)	Cost per Unit (High)	Total Cost Range
On-Street				
Bike Lane	9.84 miles	$4,382	$15,840	$43,000 - 156,000
Bike Lane - Buffered	3.95 miles	$10,560	$26,400	$42,000 – 105,000
Protected Bike Lane	10.83 miles	$130,891	$359,885	$1,418,000 – 3,900,000
Pavement Markings	159 markings	$339	$339	$53,750
Subtotal:				*$1,557,000 – 4,212,000*
Off-Street				
Shared use path	19.97 miles	$261,000	$481,140	$5,211,000 – 9,607,000
Subtotal:				*$5,211,000 – 9,607,000*
Intersections				
Crossing Markings and Bike Boxes	1 marking	$5,000	$5,000	$5,000
Subtotal:				*$5,000*
Total:				**$7,056,000 – 14,350,000**

Appendix 8:
Compilation of Field Investigation Reports

During field investigations, the project team rented bikes from the Georgetown Public Library and rode city streets to see what it is like to bike in Georgetown. Environmental conditions were documented from on-the-ground experience. Below is a collection of all bike routes taken by the cyclists documented using the Map My Ride app to geo-locate the specific paths traveled



Hutto Road, Residential Neighborhood, Wide Streets, easy to bike

Mickler Park Entrance/Heritage Community Garden

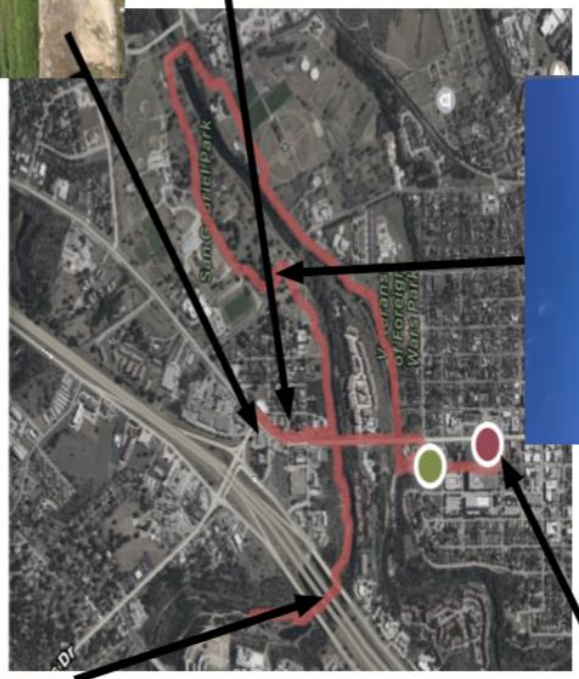
15th St. & Olive St. Residential, Wide Streets, quiet residential neighborhood

Entrance to Purl Elementary School, Residential neighborhood, sidewalks obstructed by trees & bushes

Purl Elementary School

Austin Ave. and Williams Dr. Intersection has a heavy volume of cars. There is no crosswalk for pedestrians.

There is no bike path on Austin Ave. The sidewalks are relatively narrow for people to be pushing their bikes.

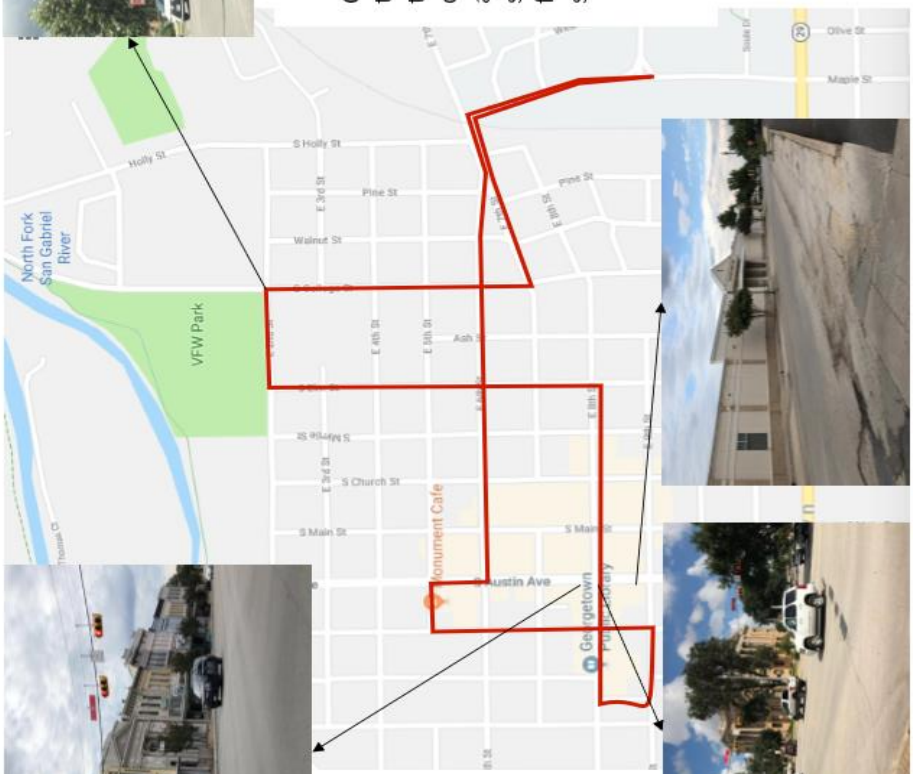


A nicely built restroom on the trail is equipped with water fountains. The facility is new and well-maintained. The surrounding park had children and senior citizens present during this workday visit.

The overpass of I-35 where the trail travels north to Spring Valley Rd. Under the overpass, the trail zig zags and is hard to ride on.

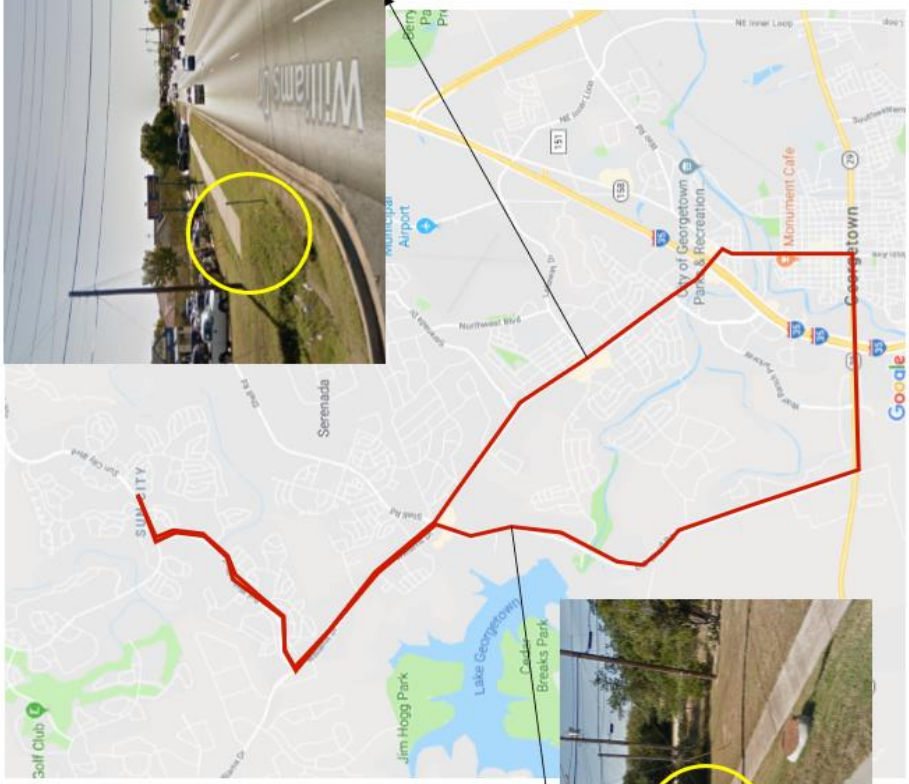
This trip started from the Library on 8th St. 8th St. is a 2-lane s with angled street parking. Given the low traffic volume, biking is comfortable.

College St. is another main road that crosses the river. It has less traffic than Austin Ave. and has continuous sidewalks. However, at the north end, where the sidewalk ends there is not a place for cyclists to cross the river safely.



Austin Ave. is the main road in Downtown for external and through traffic. It lacks road signage which makes it difficult to distinguish lanes. There is a bike rack at the intersection of Austin Ave. and 8th St.

The heavy traffic on Williams Dr. is a threat to cyclists. There is potential to install a separated bike lane to help connect Sun City to Downtown in a more comfortable manner.



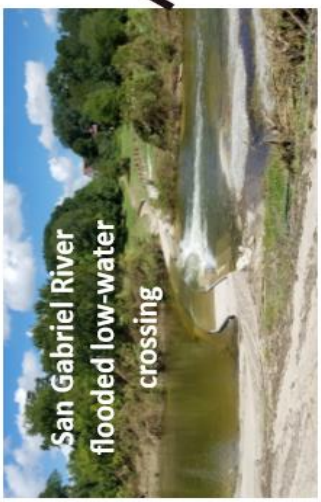
Multiple residents mentioned a discontinous sidewalk on DB Wood Rd. From conversations DB Wood seems to be an important connection between Downtown and Sun City, as well as a main access point to the trails in the Cedar Breaks park.

Sidewalks are prone to ending and require cyclists to merge with vehicle traffic.

The Austin Ave. bridge is intimidating to cross, and requires cyclists to dismount bikes and walk alongside them.

There are a number of high-quality, off street trails in Georgetown, particularly within the park system.

River crossings are flooded quite often and create a connectivity problem for cyclists.



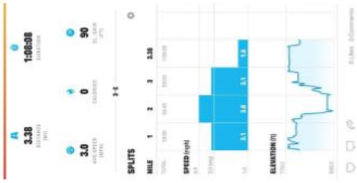
There are multiple places in Georgetown where cars, buses, and bikes must cross railroads.

On many neighborhood streets, speeds are low enough for cars to manuever around bikes, however some cyclists may not be comfortable in mixed traffic.

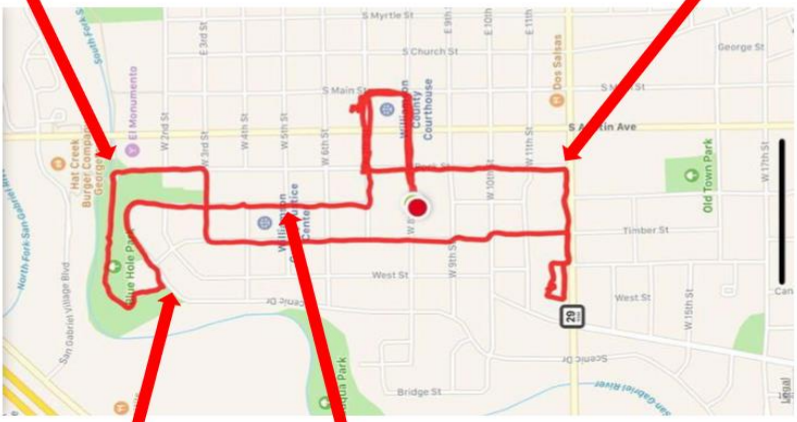
Cyclists have to get creative when securing their bikes due to a lack of proper bike racks.

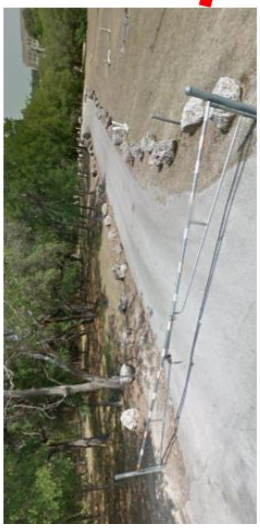
There are numerous yellow Pirate Bikes throughout the Southwestern Campus. Though the bikes are not meant to leave campus, some can be found in other spots around town.

The opening to the bike trail.

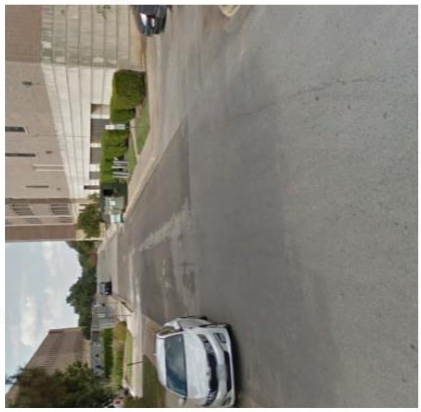


Cycling on University Ave. was very dangerous. We stayed on the sidewalk, but the terrain was so rough that we were in danger of falling. Trash cans littered the sidewalk as well, so it was hard to cycle on stretches of this road.



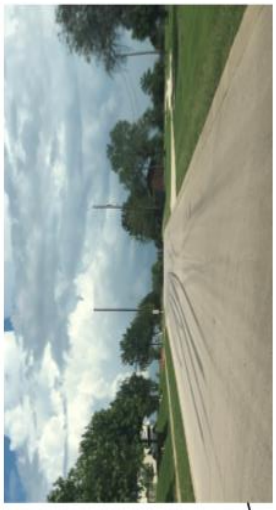


The bike trail was well-paved, smooth, and had a great view. However, this part of the trail was so extremely steep that we had to get off of our bikes and walk.



The long ride back to the library was interesting. The roads were fairly steep, and there were stretches where we were either riding dangerously fast due to the slope, or putting in a strong effort to reach the peak. However, lanes were very wide and could easily accomodate cycling infrastructure.

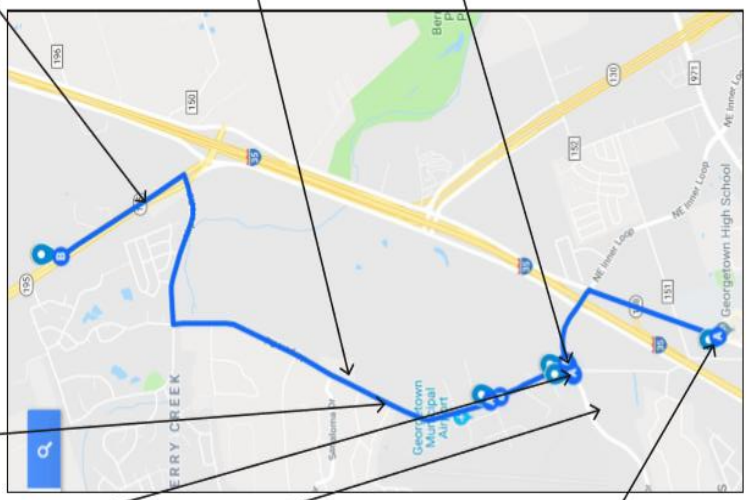
Wide shoulder on roadway could serve as cycling infrastructure for confident riders. High speeds are not safe for unprotected cycling and could produce bicycling high stress levels.



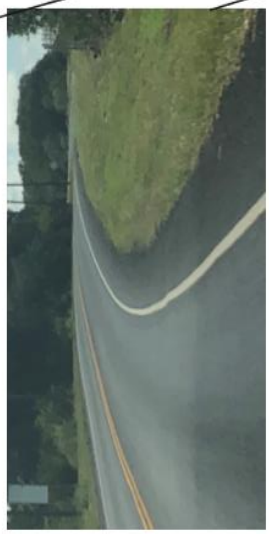
Example of industrial roads off of Airport Rd. not conducive to cycling.

Lakeway Dr., east of Airport Rd., right before the road narrows from four to two lanes. Unsafe conditions for cyclists on either side of the road.

Airport Rd. is very narrow and could serve as a connection to northwest Georgetown. There is limited ROW which provides an unsafe environment and no space to add bike lanes.

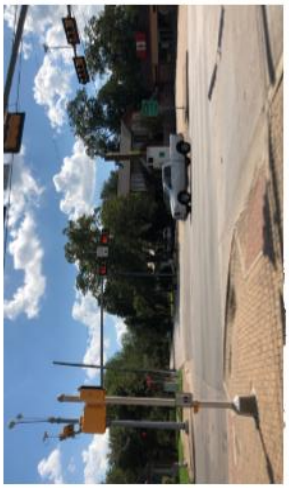


Lakeway Dr., west of Airport Rd. has small shoulders which could be utilized by cyclists, but do not present a safe riding environment.

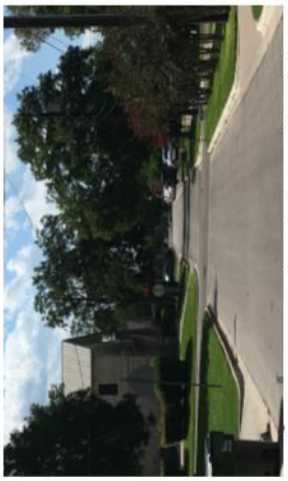


Sharp turns on Lakeway Dr. and lack of lighting provide unsafe conditions for cyclits.

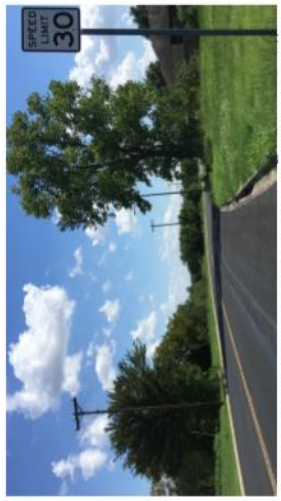
Roadway conditions in front of Georgetown High School; small, potential bike lane on high speed roadway is not safe.



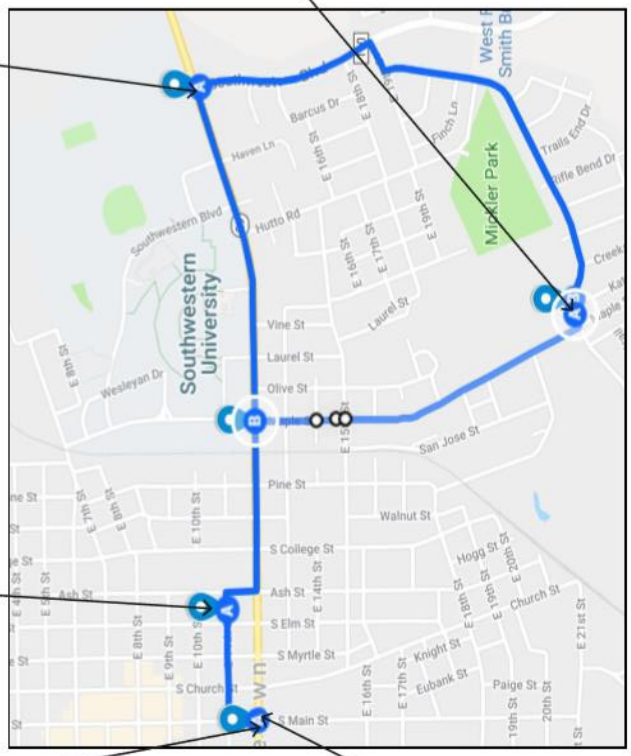
Major intersection of University Ave. and Main St. This is a good example of conditions for cyclists to cross at signalized intersections.



11th St. between Ash and Elm; residential neighborhoods between the Square and Southwestern University. The area has wide roads and some sidewalks.



Southwestern Blvd. connects to Southwestern and thr trail on campus. Posted speed limits are 30mph but roadway conditions may yield faster speeds.



Parking conditions in Downtown

Bus stop on Quail Valley; cars are parked on one side of the residential street.

Appendix 9:
Case Study Reviews

The following are other cities' and jurisdictions' bicycle plans that were reviewed by the project team as part of the development process of the Georgetown Bicycle Master Plan. Takeaways from each plan and how they were incorporated in the Bike Georgetown planning process are listed below.

A9.1 MADISON, WI METROPOLITAN AREA AND DANE COUNTY BICYCLE TRANSPORTATION PLAN[38]

This Bicycle Master Plan was created by the Madison Area Transportation Planning Board, and MPO and the regional transportation planning body for Madison, WI and its surrounding cities. This plan was chosen for review because several of the cities within this planning jurisdiction have received Bicycle Friendly Community designations . The following attributes were noted as useful for the Georgetown bike planning process and Plan document:

Framework:
The Madison Area Plan's goals are safety (increase safety and decrease crashes), usage (increase mode share of biking), connectivity (connect people to the places they want to go), equity (ensure equal access), livability (enhance quality of life), and longevity (maintain the bike network). Then, the plan translates these goals into seven "E's" to implement them. These Es are: Education, Encouragement, Enforcement, Engineering, Envisioning, Evaluation, and End of Trip Facilities. This framework translated well into the Georgetown context, and many similarities can be seen between the two plan's goals and implementation sections.

Prioritization and Cost Estimates:
The Madison Plan has a clear list of first-priority projects and their cost estimates. This methodology was used for the Georgetown plan as well, since it was successful in kickstarting this area's bike infrastructure implementation. Bike Georgetown also recommends a number of federal, state, and local funding sources similarly to the Madison Area Plan.

38 & 39 - Madison Area Transportation Planning Board. (2015). Bicycle Transportation Plan. Retrieved from: http://www.madisonareampo.org/planning/BikePlan.cfm

A9.2 CITY OF DENTON, TX PEDESTRIAN AND BICYCLE LINKAGE COMPONENT OF THE DENTON MOBILITY PLAN[40]

Denton's plan was reviewed because it is similarly situated to Dallas as Georgetown is to Austin. Both cities are suburbs of major Texas urban centers, and grapple with similar transportation issues as much of the population commutes into a major city each day. The following aspects of the Denton Plan inspired portions of the Georgetown Bike Plan:

Design Standards:
The Denton Plan details design standards carefully, providing the guidance needed to implement all recommended treatment types. The same approach was taken in the Georgetown Plan following this review.

Implementation Strategies:
Denton's bicycle plan included a strong implementation section which outlines five action areas: organize a bicycle program, plan and construct needed facilities, promote bicycling and walking, educate bicyclists and the public, and law enforcement and regulations. Each action area has action items, and specific tasks. The Georgetown Bike Plan uses a very similar framework in Chapter 4: 5 E's Recommendations in order to communicate general implementation strategies, and those specific to Georgetown along with clear directions for reaching targets.

40 - City of Denton. (2012). Update to the Pedestrian and Bicycle Linkage Component of the Denton Mobility Plan. Retrieved from: https://www.cityofdenton.com/CoD/media/City-of-Denton/Residents/Getting%20Around%20Denton/Pedestrian_and_Bicycle_Linkage_Component_Plan.pdf

A9.3 CITY OF BERKELEY, CA BICYCLE PLAN[41]

Berkeley, California's plan was chosen because it is a medium-sized city well known for cycling infrastructure, and is home to a University that generates cycling demand as Southwestern University does in Georgetown. According to the plan, Berkeley holds the fourth highest bicycle commute share of any city in the United States with 8.5% of people choosing bicycling as their primary commute mode. The following portions of the Berkeley Plan were applied in Georgetown:

Incorporate other Planning Efforts:
The Berkeley Plan aligns itself with the seven goals of Berkeley's most recent general plan, particularly those pertaining to preserving Berkeley's unique character and quality of life, and those regarding sustainability, and high-quality public infrastructure. The Plan is also built upon past city and regional transportation planning efforts, namely the Berkeley Strategic Transportation Plan and the Alameda County Transportation Commission's Countywide Transportation Plan and Countywide Multimodal Arterial Plan. As a result, Georgetown's bike planning process included reviewing current planning documents in order to intentionally align with previously established City goals and objectives.

Shadow Networks:
Berkeley is famous for its deployment of 'bicycle boulevards' as a cost-efficient means to achieving a wide-reaching low-stress cycling network taking advantage of quieter neighborhood streets of the city's grid. Using simple tactics like distinct visual identity with signage and pavement markings, bicycle prioritization through traffic calming, and safe intersection crossing facilities, the city is able to develop a number of high comfort cycling facilities without constructing expensive segregated cycling infrastructure or acquiring right-of-way to construct off-street paths. Similarly, Georgetown's Plan has placed shadow networks at the heart of its bicycle planning methodology to enhance connectivity at a lower cost and on more compatible roads.

40 - City of Berkeley. (2017). City of Berkeley Bicycle Plan. Retrieved from: https://www.cityofberkeley.info/berkeleybikeplan/

A9.4 CITY OF GREENVILLE, SC BICYCLE MASTER PLAN[42]

Greenville, SC is of a similar size and population to the City of Georgetown. Greenville's first bike lane was installed in 2005 and incremental steps have been made since toward increasing the bicycling network and becoming a more bicycle friendly community. The City also has a very similar staffing structure to Georgetown, as existing greenways or bikeways are managed by the Parks and Recreation Department, and the Public Works Department where the City's Traffic Engineer works. The following are important ideas generated by Greenville's Plan used as guidance for the Georgetown Plan:

Focus on Bicycle Friendly Community:
Community-led groups were cited as a major cause of the rising popularity of bicycling in Greenville as they are hosting educational programs and events. After conducting a sample count of bicyclists around the city, the masterplan includes key observations regarding cycling behaviors: most bicycles counted were male, bicycling seemed to be more common on the weekend than weekdays, and existing parks and trail pathways were the most popular destinations for bicycling. One of the goals pervasive in the plan is the desire to grow bicycling in the community and become a bicycle-friendly community. The focus on listening to the community regarding key destinations and routes was carried forth into the Georgetown Bicycle Plan, as well as leveraging community groups to enhance education and awareness.

Low Cost First:
Greenville identified low-cost and potentially high-impact improvements such as striping bicycle lanes on roadways that already have a large enough right of way to carry out first. As a City with similar budget constraints and the desire to increase community participation in biking quickly, similar projects were identified as first priority in the Georgetown Plan.

Rider Typologies:
The Greenville Plan identifies four types of bicyclists: strong and fearless; enthused and confident; interested but concerned; and no way no how. Defining the types of bicyclists that exist within Greenville naturally helps best serve community members by understanding their comfort levels and goals. Georgetown surveys all required respondents to classify themselves by rider type and responses were used in planning for facility types similarly to Greenville.

40 - City of Greenville. (2011). Bikeville: City of Greenville Bicycle Master Plan. Retrieved from: www.greenvillesc.gov/544/Bikeville.

A9.5 CITY OF FORT COLLINS, CO BICYCLE MASTER PLAN[43]

Fort Collins is a medium sized city, well known for its biking infrastructure and is a Platinum level Bicycle Friendly Community since 2013. It is also home to Colorado State University, and is an example of a rapidly growing smaller city that has successfully implemented a connected bicycle network. The city also has extensive hike and bike trails that now connect to on street bicycling infrastructure – a major goal for Georgetown.

All Ages and Abilities:
The overall vision for the Fort Collins Plan is as follows:

"It is a city where people of all ages and abilities have access to a comfortable, safe, and connected network of bicycle facilities, and where bicycling is an integral part of daily life and the local cultural experience". It is made clear throughout the Plan that facilities in Fort Collins should seek low-speed and low-volume streets to attract a wider range of bicyclists. Specifically, those that would cycle if they felt comfortable and safe. This idea was integrated heavily into the Georgetown Plan through the use of shadow networks, careful treatment choice based on road type, and an emphasis on connections to schools.

40 - City of Fort Collins. (2014). Bicycle Master Plan. Retrieved from: https://www.fcgov.com/bicycling/bike-plan.php

A9.6 CITY OF SACRAMENTO, CA BICYCLE MASTER PLAN[44]

While Sacramento is a much larger city than the City of Georgetown (both in size and population), the cities are similar in geography and climate. They both have flat topography and a temperate year-round climate which is attractive to bicyclists. Both cities face similar barriers to bicycling, since the City of Sacramento is divided by 2 rivers (The Sacramento and the American) and by 5 major highways (I-5, I-80, Highway 50, State Route 160, and State Route 99), which form barriers to travel between adjacent neighborhoods. Like in Georgetown, there are only a limited number of bridges over the rivers, which hinder bicycle connections. Considering the similar challenges both the cities face, Sacramento is an excellent model to follow since the city is designated as a "Silver Level" Bicycle Friendly Community by the League of American Bicyclists. Key takeaways are as follows:

Underrepresented Populations:
The sampling strategy, as well as the implementation strategy outlined in the Sacramento Plan focuses on engaging underrepresented communities in the city. The Plan includes a GIS Equity analysis of historically disadvantaged and underserved areas, and outlines a robust and targeted Community Outreach strategy that incorporated these areas. In Georgetown, minority communities and in particular the Hispanic community, were underrepresented in the 2016 round of surveys, and the City had a primary concern to ensure that all voices were heard in the planning process. The project team conducted a geospatial analysis to identify areas where feedback had not been received, targeted those areas through on-the-ground interviews, and made materials translated into Spanish and Spanish-speaking interviewers accessible.

Connections to Other Modes:
There is a focus in the Sacramento Plan on using cycling to fully connect all modes of transportation and increase total connectivity in the city. In the case of Sacramento, it is planned that the downtown area will be reorganized through a grid system that considers motor vehicles, transit, bicycles, and pedestrians, as well as how easily they all integrate with one another. The Georgetown Plan explores options for connecting bike to the GoGeo bus system, the primary form of transit in the city. It also recommends an expansion of bike sharing as a method for connecting pedestrian travel to bike travel.

44 - City of Sacramento. (2016). City of Sacramento Bicycle Master Plan. Retrieved from: http://www.cityofsacramento.org/-/media/corporate/files/public-works/transportation/bicycle-master-plan/sacramento-2016-bicycle-master-plan.pdf

A9.7 SAN ANTONIO, TX BIKE PLAN + IMPLEMENTATION STRATEGY[45]

San Antonio's location within the State of Texas made this a relevant plan to review, as many of the same policies and regulations govern Georgetown's ability to plan a bike network. It also has a well-known recreational trail network which has faced challenges connecting to on-street facilities in the past, similar to Georgetown. The following are key portions of the San Antonio Plan that were referenced in the drafting of Georgetown's Bike Plan:

Monitoring and Evaluation:
The San Antonio Plan has a strong implementation chapter that also explains the importance of monitoring and evaluating infrastructure performance as it is installed. It is stated that this helps the Plan get updated accordingly as goals are or are not being met. The Georgetown Plan recommends installing bicycle counters as infrastructure is implemented, as well as collecting baseline biking information now, so that decision makers will have the data they need to make changes and recommendations in the future.

City Department Collaboration:
The San Antonio Bike Master Plan emphasizes the many departments that are necessary to successfully plan and implement a connected bicycle network. It is stated that departments must be in contact with one another to not only support the bike plan but also to help achieve the many other City initiatives. Georgetown's planning process included members of the Parks and Recreation Department, Police Department, Public Works Department, Communications Department, and Fire Department to help ensure that the Bike Plan is in harmony with other department's current goals and initiatives. Feedback was also gathered to ensure that the Plan will be implementable from many different perspectives.

44 - City of San Antonio. (2013). City of San Antonio Bike Plan + Implementation Strategy. Retrieved from: https://www.sanantonio.gov/SABikes/BicycleMasterPlan

A9.8 THE WOODLANDS TOWNSHIP, TX PEDESTRIAN AND BICYCLE MASTER[46]

The Woodlands began is similar to Georgetown due to its location in Texas and position as a suburb of a major city, Houston. It adopted its first bike master plan recently, in 2016, making it new to formal bicycle planning as well. The following are notable portions of the Woodlands Plan that were considered during the creation of the Georgetown Plan:

Intersections for All:
The Woodlands Plan identifies that intersections are a key point in a bicycle network and should be designed so that pedestrians, cyclists, and drivers should all be aware of one other, and have a clear path for crossing. The Georgetown Plan recommends design standards specifically for intersections such as bike boxes, and various types of cycling paths to raise awareness of and for cyclists. Intersections are also identified through public input and a crash analysis which should be treated for safety and ease of use.

Project Phasing:
The Woodlands identified projects as either short-term, mid-term, and long-term, providing a phasing approach to building out the complete bike network. This gives a clear road map for those working on these projects in the future that may not have worked directly in the planning process. Georgetown's Plan identifies Tier 1 and Tier 2 projects which should be implemented in phases.

44 - The Woodlands Township. (2016). The Woodlands Township Pedestrian and Bicycle Master Plan. Retrieved from: https://www.thewoodlandstownship-tx.gov/1212/PedestrianBicycle-Master-Plan

Appendix 10:
Bicycle Network and Complete List of Improvement Projects

This appendix provides larger versions of proposed sections of the bicycle network. A complete list of all 47 bicycle improvement projects are listed with a brief description and rough cost estimate.

Figure 58. Downtown Georgetown Area Map - Proposed Bike Network

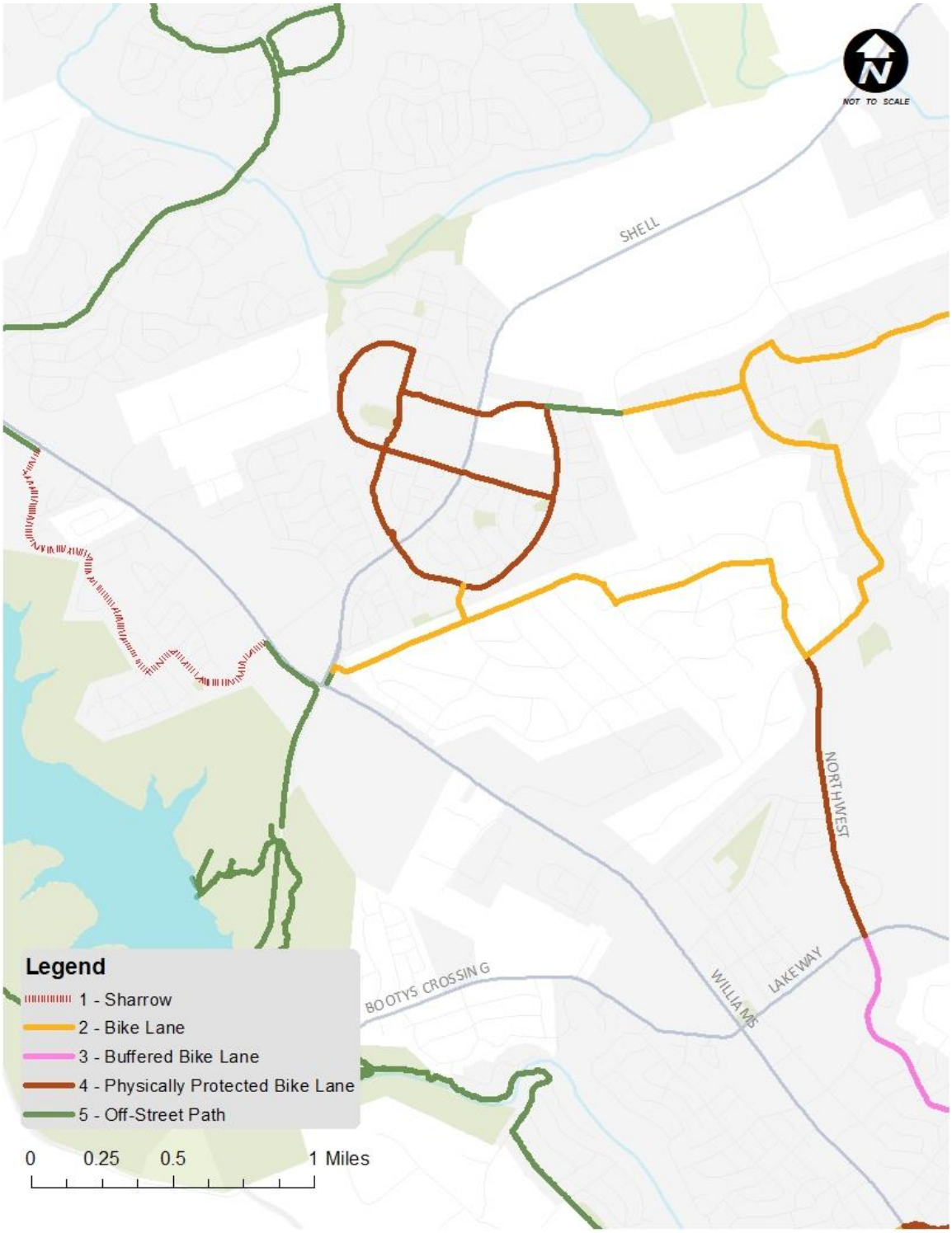


Figure 59. Northwest Georgetown Area Map - Proposed Bike Network

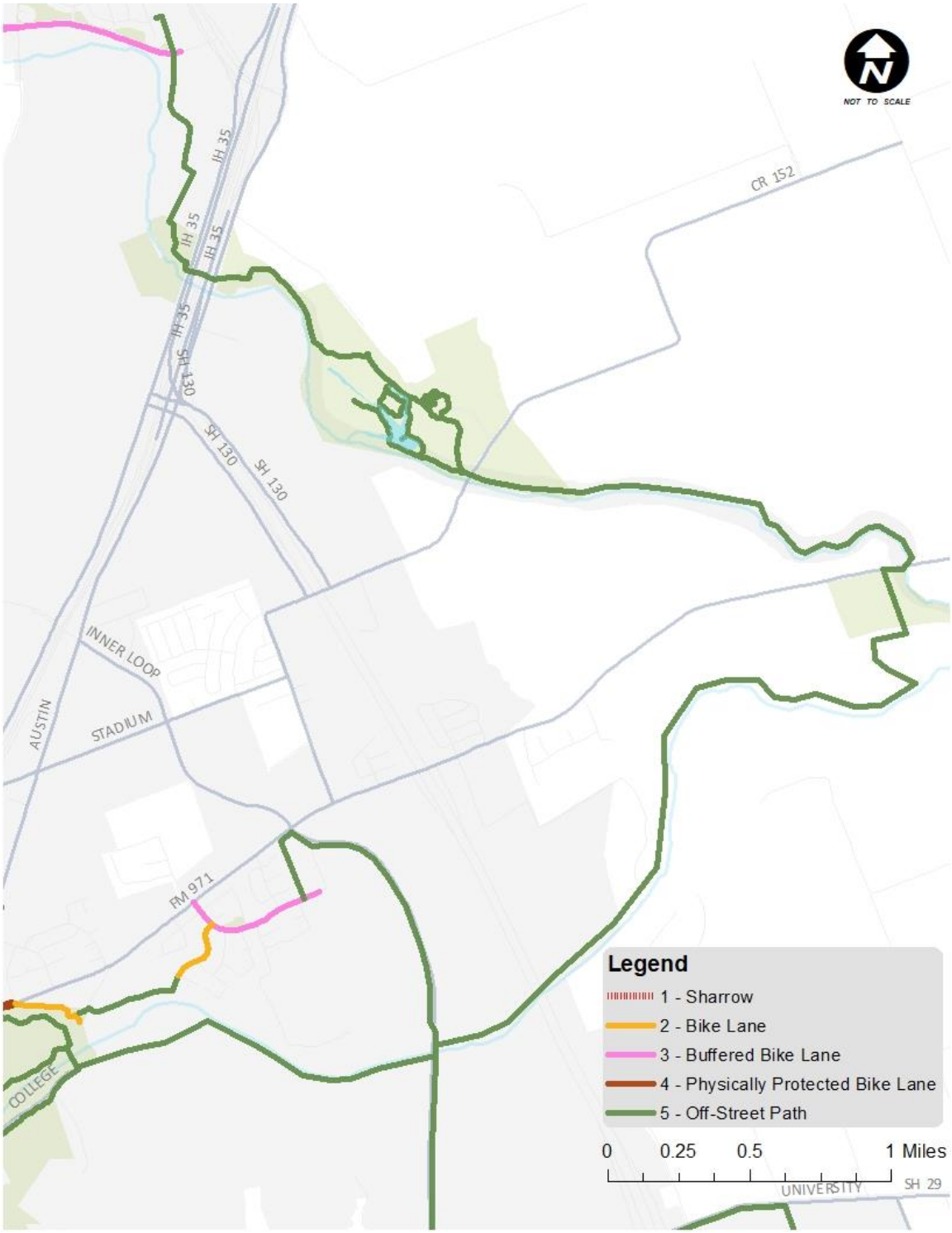


Figure 60. Northeast Area Map - Proposed Bike Network

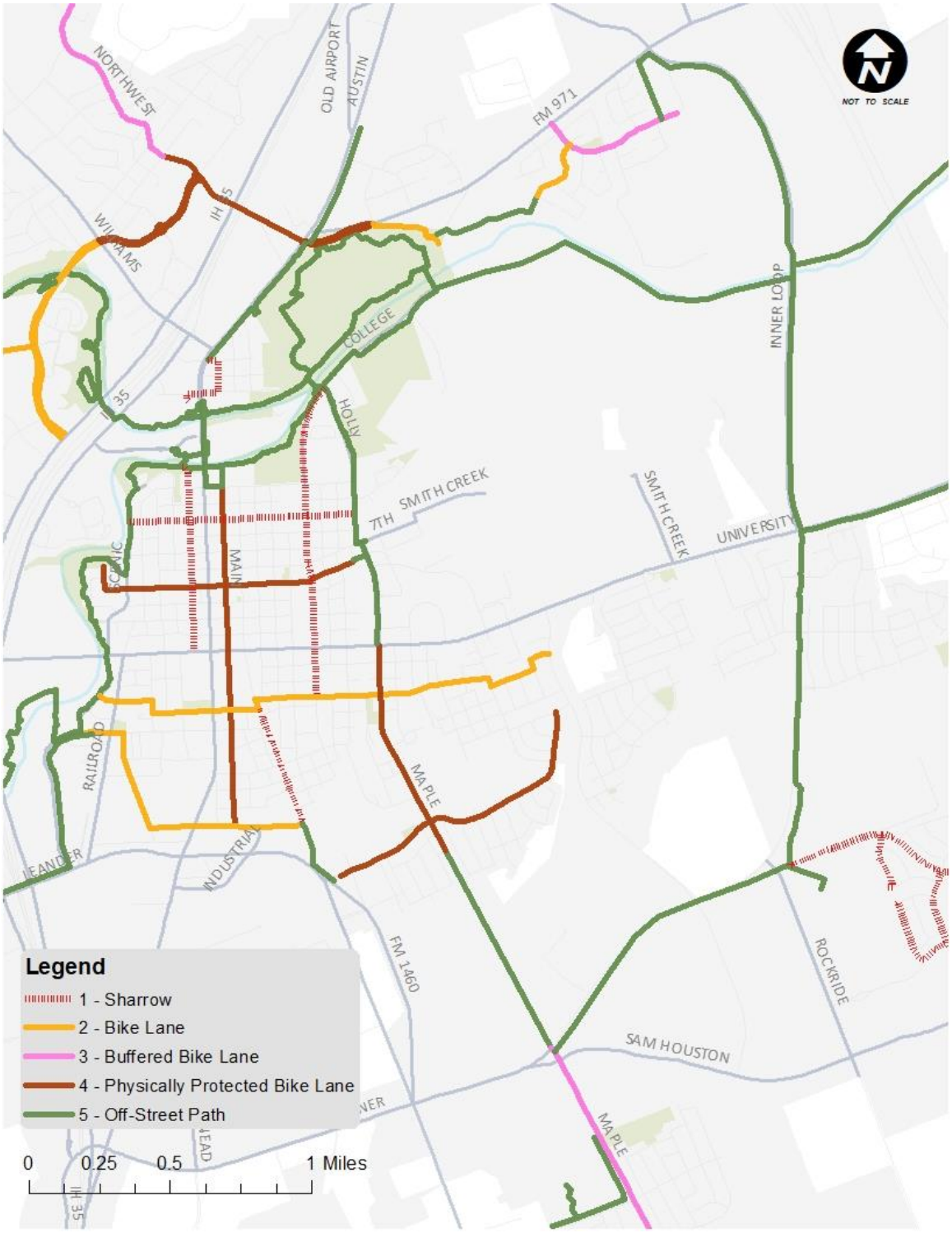


Figure 61. East Georgetown Area Map - Proposed Bike Network

Figure 62. Southeast Georgetown Area Map - Proposed Bike Network

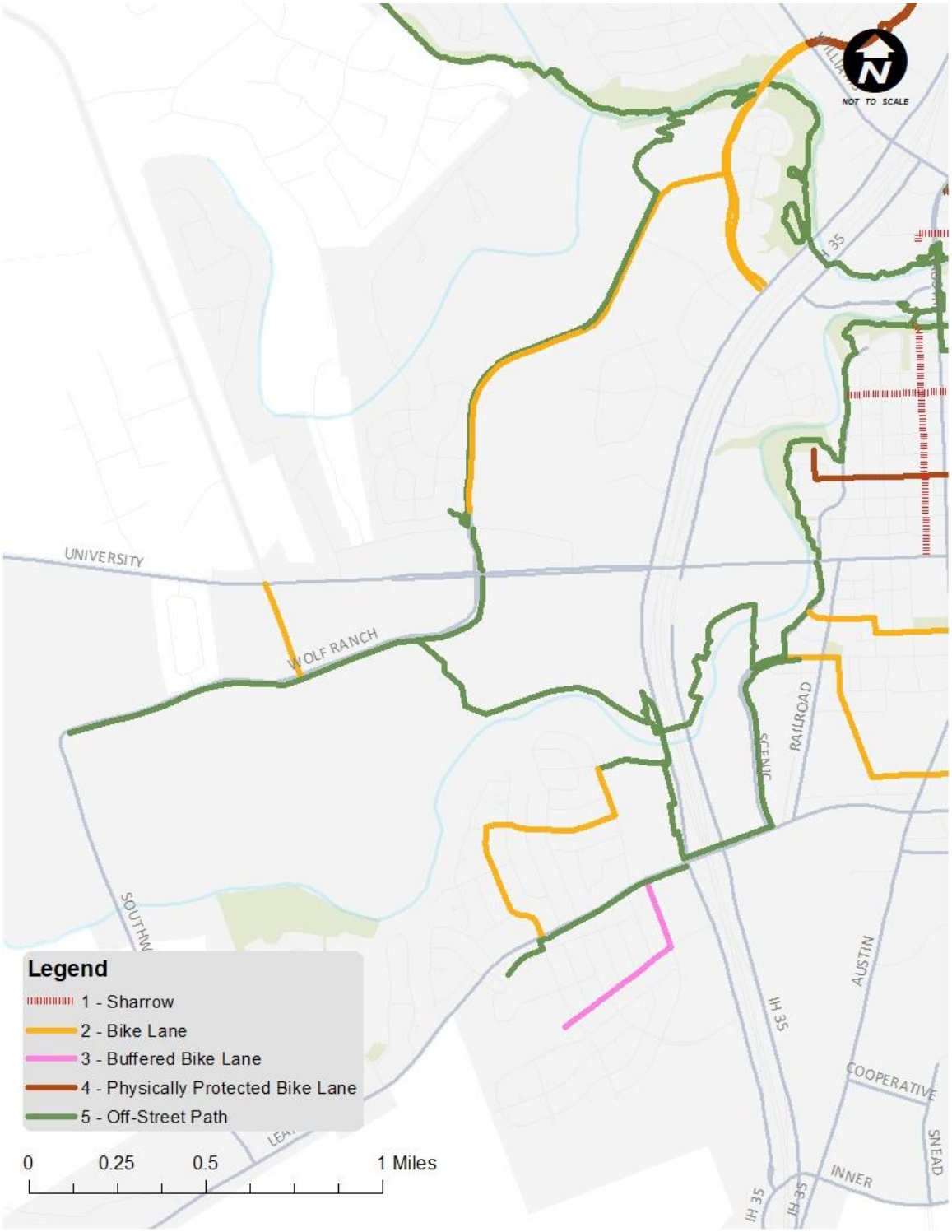


Figure 63. Southeast Georgetown Area Map - Proposed Bike Network

Table 10. Complete List of Bicycle Improvement Projects

Project Rank	Name and Extent	Cost (in thousands)	Phase
1	**Austin Ave. Bridge:** Off street path connecting across San Gabriel River to the Northwest Blvd. Bridge project	$129 - 238	Planned (approved by Council)
2	**8th St:** Scenic Dr. trail connection to Maple St. bicycle corridor	$142 - 379	Proposed
3	**Main St:** Buffered bike lane from 2nd St. to 21st St.	$157 - 431	Proposed
4	**Holly St. Bridge:** San Gabriel River crossing from Holly St. to the North San Gabriel River Trail	$37 - 67	Planned (unfunded)
5	**Maple St. Phase 1:** Combination of off-street paths and protected bicycle lanes from 7th St. to Britannia St., including a safe connection across University Blvd.	$197 - 456	Proposed
6	**Northwest Blvd./ IH-35 Crossing Phase 1:** Regular and buffered bike lanes across IH-35 from Rivery Dr. to FM-971	$108 - 297	Planned and funded
7	**San Gabriel River Crossing at St. David's Hospital:** Connection from Scenic Dr. to Wolf Ranch Town Center across IH-35	$238 - 438	Proposed

8	**Williams Dr:** Off-street path from Del Webb Blvd. to Gatlin Creek	$119 – 219	Proposed
9	**DB Wood Rd. and Williams Dr:** Bike lanes from Wildwood Dr. to Overlook Park	$194 - 357	Proposed
10	**SR-29 East View HS connection across SR 130:** Bike lanes from East View High School across SR-29 between Reinhardt Blvd. and Eastview Dr.	$328 - 605	Proposed
11	**Wolf Ranch Town Center**: Off-street path between Wolf Ranch Pkwy. & Proposed St. David's I-35 trail crossing	$209 - 385	Proposed
12	**Rivery Blvd**: Buffered Bike Lane from Northwest Blvd. to Williams Dr., and off-street path connecting the Randy Morrow Trail to Wolf Ranch Pkwy.	$349 - 757	Planned
13	**15th/16th St:** Bike Lanes: Scenic Dr. to Southwestern Blvd.	$8 - 29	Proposed
14	**San Gabriel River Trail**: Extension from College St. to Katy Crossing Trail Park	$397 - 731	Construction
15	**North Austin Ave:** Off-Street path from Williams Dr. to Chamber Way	$67 - 124	Planned
16	**Saddle Creek Development**: Access Sharrows to Wagner Middle School and Mitchell Elementary School	$18 - 19	Proposed

17	**Leander St. & 21st St:** Bike Lane from Kelley Park to Church St. & East 21st St.	$5 - 17	Proposed
18	**Quail Valley Dr:** Physically Protected Bike Lane from 1460 to 19th St.	$141 - 386	Proposed
19	**Northwest Blvd. Phase 2:** Buffered & physically protected bike lanes from Rivery Dr. to Seranada Dr.	$185 - 507	Proposed
20	**SR-2S:** Protected bike lanes between Westbury Ln. and Bellaire Dr. and Rosedale Blvd. and Village Commons Blvd. connecting McCoy and Village Elementary Schools	$482 – 1,325	Proposed
21	**Wolf Ranch Pkwy:** Off-Street path from CR-265 to SR-29	$31 - 57	Proposed
22	**Leander Rd:** Off-Street path from Scenic Dr. to I-35 S Frontage Rd.	$70 - 129	Proposed
23	**Wolf Ranch Pkwy:** Off-Street Path to San Gabriel River Trail	$13 - 23	Proposed
24	**Berry Creek**: Neighborhood connections along Champions Dr., Shinnecock Hills Dr., Luna Trail, & Seranada Dr.	$26 - 78	Proposed
25	**North Austin Ave:** Access sharrows between E. Spring Street, Main St. & W. Morrow St.	$2 - 3	Proposed

26	**Wolf Ranch Pkwy**: Off-Street path from SR-29 to future Wolf Ranch Elementary School	$87 - 160	Planned
27	**Leander Dr:** Off-Street Path from I-35 SB Frontage Rd. to Rockcrest Dr.	$18 - 33	Proposed
28	**Scenic Dr:** Off-Street path extension from 17th St. to Leander Rd.	$153 - 281	Proposed
29	**Gatlin Creek**: Sharrows and signage on Limestone Lake Dr., Lakeside Ranch Rd., Cedar Lake Blvd., and Wildwood Dr.	$11 - 12	Proposed
30	**Seranada Dr:** Connection to McCoy Elementary School, combining bike lanes on Lovie Ln. and an off-street path	$70 - 132	Proposed
31	**College St:** Sharrows from VFW Park to East 15th St.	$8 - 9	Proposed
32	**Berry Creek Trail**: Off-Street path from Berry Springs Park to Airport Rd. along Berry Creek	$259 - 477	Proposed
33	**Thousand Oaks Blvd./Luther Dr:** Buffered bike lane from Pickett Elementary School to Leander Dr.	$7 - 16	Proposed
34	**Church St:** Sharrows from 15th St. to 21st St.	$3 - 4	Proposed

35	**Trail segment:** Off-street trail Connection from 21st St. and Church St. to Quail Valley Dr.	$65 - 119	Proposed
36	**SE Inner Loop**: Off-street path from Rockride Ln. to Maple St.	$289 - 532	Proposed
37	**Sunshine Dr:** Off-street path between I-35 S Frontage Rd. and San Gabriel Overlook Blvd.	$54 - 99	Proposed
38	**Woodview Dr. and Rockcrest Dr:** Off-street path extension to create access to Tippit Middle School	$39 - 72	Proposed
39	**Ridge Oak Dr./Tallwood Dr:** Bike lane from Sunshine Dr. to Leander Rd.	$4 - 15	Proposed
40	**San Gabriel River Trail**: Extension from College St. to Berry Springs Park	$1,308 – 2,410	Planned
41	**4th St:** Sharrows from Scenic Dr. Trail to Holly St.	$5 - 6	Proposed
42	**NE Inner Loop**: Off-Street path from SR-29 to Forbes Middle School and to Cooper Elementary School	$568 – 1,046	Proposed

43	**Katy Crossing**: Buffered bike lane from Katy Crossing Trail Park to Cooper Elementary School	$6 - 14	Proposed
44	**Sequoia Spur and Shell Dr**: Bike lane from Seranada Dr. to Shell Rd., and off-street trail on Shell Dr. creating a connection to Williams Dr. crossing	$27 - 67	Proposed
45	**River Park Ln:** Bike lane from Katy Crossing Trail Park to Katy Crossing Rd.	$2 - 4	Proposed
46	**Rock St**: Sharrows from San Gabriel River Trail to University Ave.	$4 - 5	Proposed
47	**Maple St. Phase 2:** Combination of off-street paths and protected bicycle lanes from Britannia St. To Westinghouse Rd.	$434 - 804	Proposed

Appendix 11:
Crash Analysis Study Recommendations

The following types of improvements will enhance traffic and road safety for all road users by prioritizing major arterials and intersections with high crash rates.

Create a bicycle crash database
It is recommended that a database that records bicycle crash data in Georgetown be created. Having this data easily available will help identify major safety issues, and track impacts of roadway improvements over time. Data will stay up-to-date through reports from the City of Georgetown Police Department taken at the time of each crash. Engagement with the Capital Area Metropolitan Planning Organization (CAMPO) and Texas Department of Transportation could help develop a wider-reaching, more robust crash database for central Texas.

Create a shadow network for bicycling
As recommended throughout this Plan, a shadow network should be created for bicyclists, to promote active transportation off of high-speed arterial roadways. Primary elements of this type of network include safe crossings at major safety barriers, such as IH-35, Williams Dr, and University Avenue, and clear signage directing cyclists toward nearby low-speed streets or bicycle infrastructure.

Maintain an ongoing commitment to prioritize safer streets
Incorporating bicycles into Georgetown's current commitment to prioritize safer streets may help influence decisions regarding types of infrastructure for pedestrians and cyclists. Safer bicycle facilities tend to be more expensive, however, the cost of a protected bicycle facility capital improvement is marginal to the cost of a life due to unsafe street conditions. This type of policy can enable The City of Georgetown to evaluate its most dangerous streets and intersections based on national safety guidelines and evaluate potential engineering and design improvements over time.

Adjust speeds to be context-appropriate[47]
Speed limits on Georgetown roadways vary widely, and small changes to the City's speed methodology could help improve the safety of cyclists. The FHWA Safety Program developed a speed management toolkit for all cities to use a guide for various road improvements and enhancements to manage speeds on various road-way types[48.] Some speed management tactics are determined by development area type, which the City of Georgetown could apply to its own multiple development type areas.

Implement slow traffic zones around schools and high crash volume areas
Slow Zone pilot projects can be used to test low-cost and high-impact safety improvements, such as introducing new signage and roadway markings that indicate a change in speed limit.

Crosswalks can also be painted to indicate a space for pedestrians and bicyclists, particularly near schools and locations identified in crash analysis in Section 2.6., or other traffic safety measures like roundabouts can be used in the case of demonstrated need for additional levels of improvements.

Increase education of all road users on sharing the road
Texas Share the Road is an educational initiative to improve bicycling safety in Texas. The organization has created multiple videos sharing safety tips for both cyclists and motorists to understand the safest ways to move through specific roadway scenarios alongside other modes[49]. Launching a safety campaign that incorporates educational videos and safety brochures into City offices with TV paneling or screens, or inclusion in local news stations can help improve education in Georgetown[50].

49 - Share the Road. (2016). "Campaign Materials." Retrieved from: www.sharetheroadtexas.org/campaign-materials/.
50 - Share the Road. (2017). "Safety Tips." Retrieved from: www.sharetheroadtexas.org/safety-tips/.

Appendix 12:
Bicycle Parking Suitability Analysis

A12.1 INTRODUCTION

Georgetown currently features a handful of secure bike parking areas, including artistic bike racks at the Courthouse and Library decorated with the city's iconic red poppy flower. Southwestern University, some school campuses, and select public parks are the only locations outside of Downtown where bicycle racks are available.

Figure 64. Existing Bicycle Rack on San Gabriel Trail

Based on the analysis below, Georgetown does not presently have enough secure bicycle parking to accommodate a growing base of cyclists. Though Georgetown reports extremely low crime rates, many people are still generally uncomfortable leaving their bicycle unattended. As a result, lack of parking creates a barrier for those who want to use bikes to reach public transit, or to complete any type of trip that requires getting off of the bicycle.

The purpose of this study is to identify areas that will have high demand for bicycle parking after significant progress has been made in expanding the city's bike network per this Bicycle Master Plan. Based on key destinations and points of interest indicated by the public through online surveys, in-person surveys, and community workshops, and major connections within the proposed network itself, a geographic information system (GIS)-based spatial analysis was employed to generate a map of priority focus areas for bike parking additions.

Currently, the Georgetown Unified Development Code (UDC) does not offer any requirements or guidance on off-street bicycle parking and can be amended to do so. Furthermore, the City can proactively pursue opportunities to build bicycle racks in priority areas on sidewalks in a way that does not impede ADA walking access, or consider converting on-street parking spaces into bicycle corrals which can accommodate eight to 10 bicycles per car parking space.

A12.2 RELATED STUDIES

Bicycle parking and support facilities can often be overlooked in the build out of a bicycle network. However, according to Alta Planning + Design consultants, "End-of-trip facilities are just as important as on-and-off-street bikeways in encouraging bicycle use for transportation"[51]. A lack of available bicycle parking can diminish the positive potential economic effects of the bicycle network by limiting shopping trips that require a person to leave their bike unattended for any portion of time. Studies conducted in San Francisco and Toronto indicate positive economic effects of replacing on-street car parking with wider sidewalks, bike lanes, and bike parking as in these contexts, "patrons arriving by foot and bicycle visit the most often and spend the most money"[52].

51 - Durrant, S. (2014). Bike Parking. Retrieved from https://altaplanning.com/services/complete-streets/bike-parking/
52 - Clean Air Partnership. (2009). Bike Lanes, On-Street Parking and Business: A Study of Bloor Street in Toronto's Annex Neighbourhood. Retrieved from: http://www.bikeleague.org/sites/default/files/bikeleague/bikeleague.org/programs/bicyclefriendlyamerica/bicyclefriendlybusiness/pdfs/toronto_study_bike_lanes_parking.pdf

As cycling increases in popularity in Georgetown, there is potential that dockless bike and scooter providers will enter the market, providing new challenges to parking infrastructure. This issue has manifested itself in many cities around the world, but is particularly apparent in Sydney, Australia where companies deployed over 5,500 bikes to a city with only 2,500 public bike parking spots[53]. One study concludes that when limited parking is available in an area with high demand, a "conformity effect" occurs between bicyclists that can result in undesirable results like "chronic illegal bicycle parking"[54] .

Various methodologies exist for determining bicycle parking demand, many of which pertain to individual projects, rather than an entire network. The Metropolitan Washington Council of Governments bicycle parking demand analysis for the Purple Line Light Rail project, bases demand on transit ridership projections, and set percentages of forecast bicycle access rates[55]. The City of Eugene-Springfield, Oregon uses a school-based bicycle parking assessment involving environmental audits and policy analysis[56]. Lane Transit District in Eugene, Oregon, in its regional bike parking study, considers input from a variety of key stakeholder groups, an inventory of existing conditions, and mapped bicycle demand points in downtown and at transit stations[57]. The Georgetown parking methodology builds upon these studies, along with a version of suitability analysis which finds points of overlap between different weighted attributes[58], sourced from public input and public online data portals, to determine a geospatially defined prioritization of bicycle parking space demand throughout the city of Georgetown.

53 - Fuller, G., Waitt, G., Buchanan, I., & Ozolins, N. (2018). "The problem isn't dockless share bikes. It's the lack of bike parking." The Conversation. Retrieved from: http://theconversation.com/the-problem-isnt-dockless-share-bikes-its-the-lack-of-bike-parking-102985

54 - Fukuda, D., & Morichi, S. (2007). "Incorporating aggregate behavior in an individual's discrete choice: An application to analyzing illegal bicycle parking behavior." Transportation Research Part A: Policy and Practice, 41(4), 313–325. https://doi.org/10.1016/j.tra.2006.09.001

55 - Metropolitan Washington Council of Governments. (n.d.). Purple Line Bicycle Parking Demand Analysis. Retrieved from http://www1.mwcog.org/transportation/activities/tlc/pdf/PurpleLine3-5.pdf

56 - MacRhodes, S., & Newman, E. (2015). "School Bicycle Parking Assessment." Retrieved from: https://www.oregonsaferoutes.org/wp-content/uploads/2017/08/SchoolBikePkingAssessment.2015.pdf

57 - Lane Transit District, & Alta Planning + Design. (2013). Regional Bike Parking Study. Eugene, Oregon.

58 - McHarg, I. (1969). Design with Nature (1st ed.). Garden City, New York: Natural History Press.

A12.3 STUDY METHOD AND PROCESS

In order to quantify bicycle parking priority areas spatial data was aggregated based on descriptions of the proposed bicycle network with destinations, intermodal connection points, and special points of interest. Employing the same basic principles of multidisciplinary-based suitability analysis described in Section 2 above, polygon-based representations of these elements were overlaid with various weighting properties. The sum of these weights in a given location translates to a nominal value between zero and eight describing the relative need or priority for bicycle parking.

Proposed Bicycle Network
The lines on the map representing the connected bicycle network have been generated through an intensive process of weighing various community and network priorities.

Because the amount of parking needed will be proportional to the amount of ridership on a given route, different weights have been assigned to different bicycle route types. Due to the high level of comfort associated with off-street paths, these network facilities will receive a higher bicycle parking weight when compared to routes where simple bike lanes or sharrows are proposed. Using an access shed of ¼ mile, a buffer was generated along the proposed bicycle network facilities, and a weight value was assessed for each polygon buffer according to the following framework:

- Off-Street Path = 4 points
- Physically Protected Bike Lane = 3 points
- Buffered Bike Lane = 2 points
- Conventional Bike Lane/Sharrow = 1 point
- No bicycle facilities = 0 points

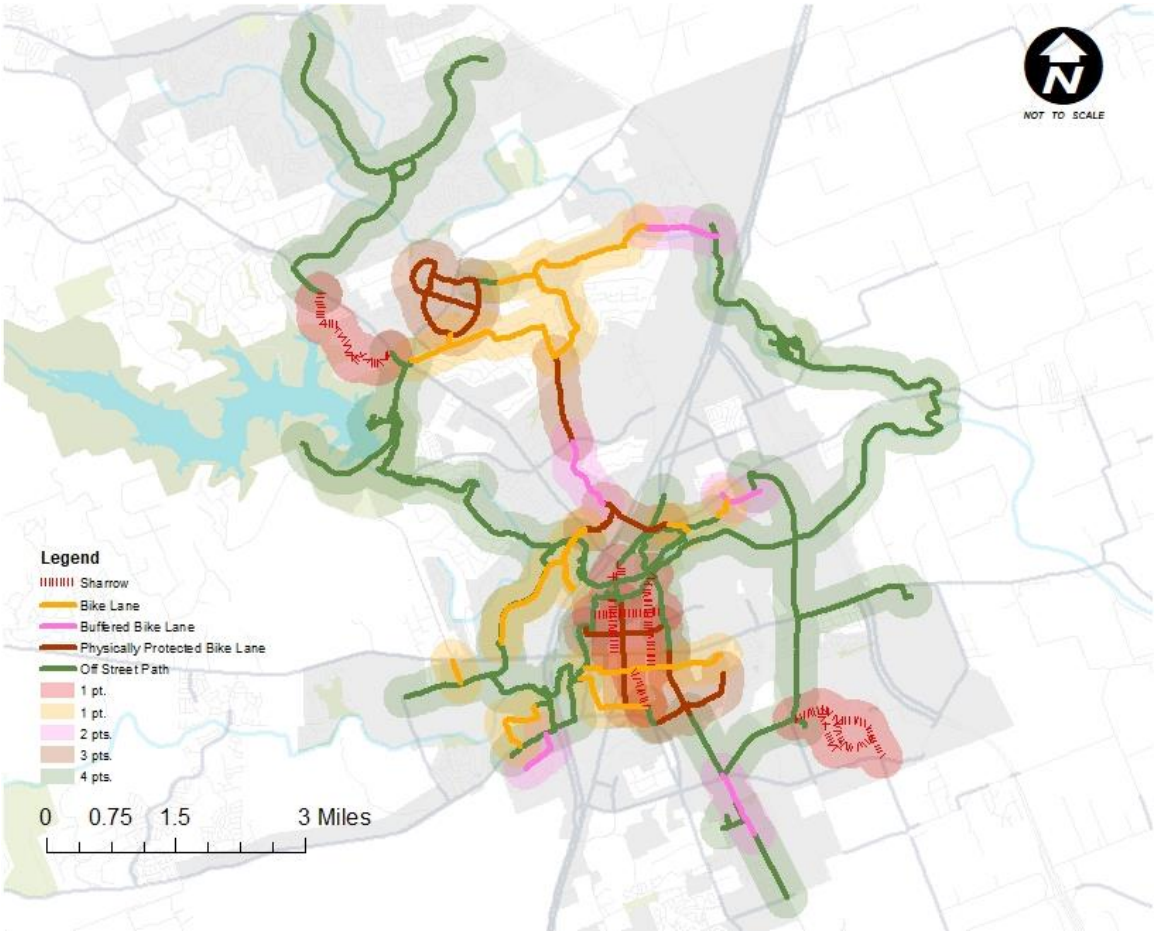


Figure 65. Proposed Bicycle Network Buffer Weights

Key Destinations
Based on community feedback received through surveys and in-person public engagement efforts, three primary destinations types were identified: 1 - Parks, 2 - Shopping destinations, 3 - public facilities such as schools, colleges, and athletic complexes.

Parks are the most popular bicycling destination because of the high level of recreational biking in Georgetown using the city's trail network.

San Gabriel Park, Lake Georgetown (Overlook Park), and Rivery Park are the top three destinations, respectively, and all are connected via the San Gabriel River Trail. Some bicycle parking facilities already exist in these locations. Polygons representing parks are given a value of one on the weighting scale, but since many parks overlap with off-street trails (four points), they rise to the upper end of bicycle parking priority areas.

Shopping areas represent the second most popular bicycling destinations. In order to quantify this broad term spatially, all zoning parcels which include shopping uses (General Commercial, Local Commercial, Neighborhood Commercial, and Downtown Mixed-Use) were combined, and resulting polygons were assigned a value of one point.

The third most popular areas, and arguably the most important from a safety perspective, are public facilities like schools and athletic fields. The primary users of these facilities are youths who for age or financial reasons are restricted to walking and bicycling for everyday mobility. As such, these vulnerable road users should be prioritized in this framework to allow them to safely access Georgetown via bike. Elementary, Middle, and High School polygons are given a value of two points. Southwestern University's campus and adjacent athletic facilities are given a value of three points due to the density of students and bike-friendly culture.

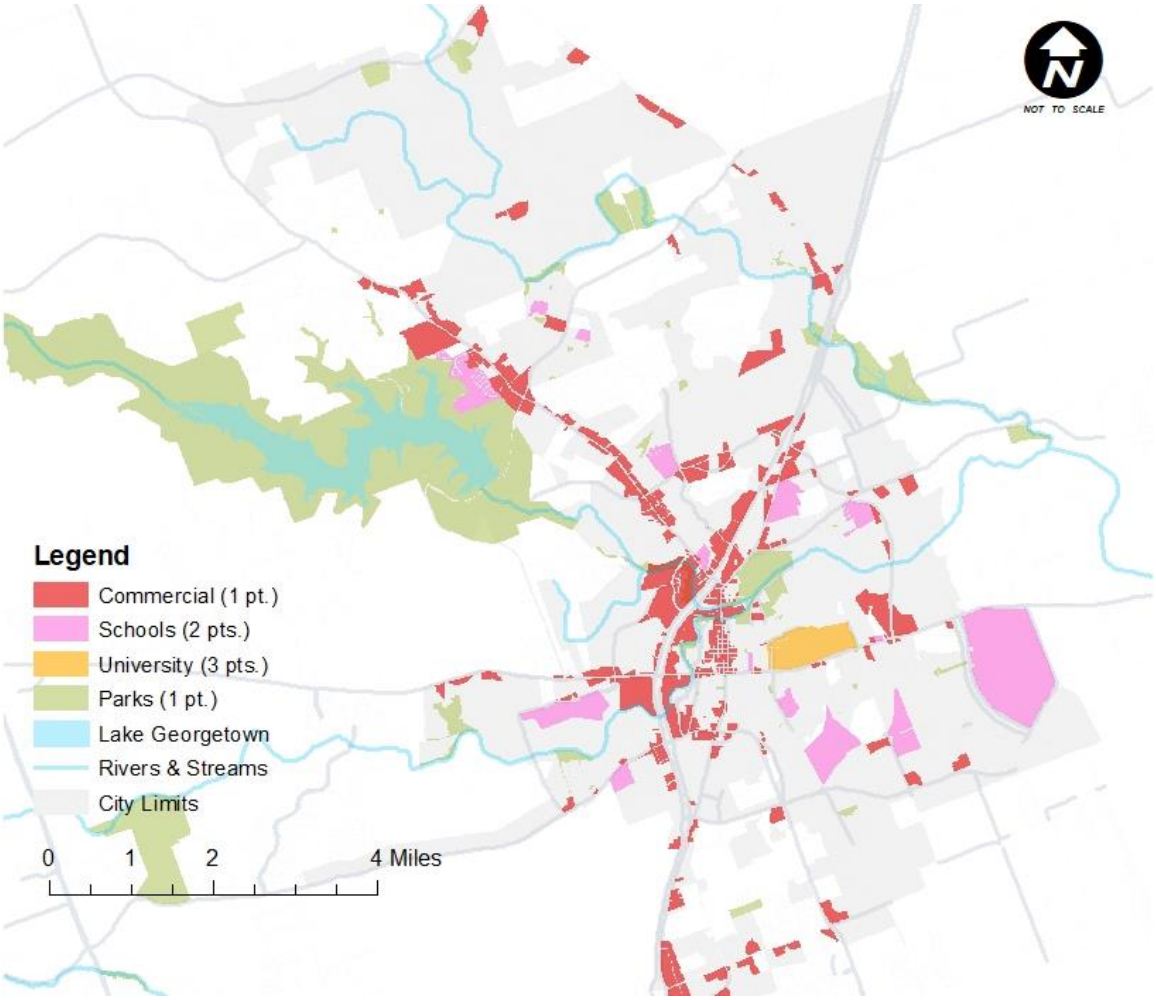


Figure 66. Destination Polygon Weights

Intermodal Connection Points
Bus trips between Georgetown and Round Rock are offered three times a day by the Capital Area Regional Transit System (CARTS). From Round Rock, connections can be made to express bus services into Downtown Austin. Additionally, with the introduction of the four GoGeo public transit routes in Georgetown, intermodal connectivity is an important factor to take into consideration locally. Currently the routes only operate once hourly, but future growth in Georgetown will likely warrant additional bus frequency. Bicycles extend the potential radius of transit access beyond the standard ¼ mile walking threshold. The public transit system should complement the proposed bicycle network to provide a safe, interconnected, and accessible multimodal transport network. A ¼ mile access buffer is generated around each bus stop and is assigned a value of one point on the map below.

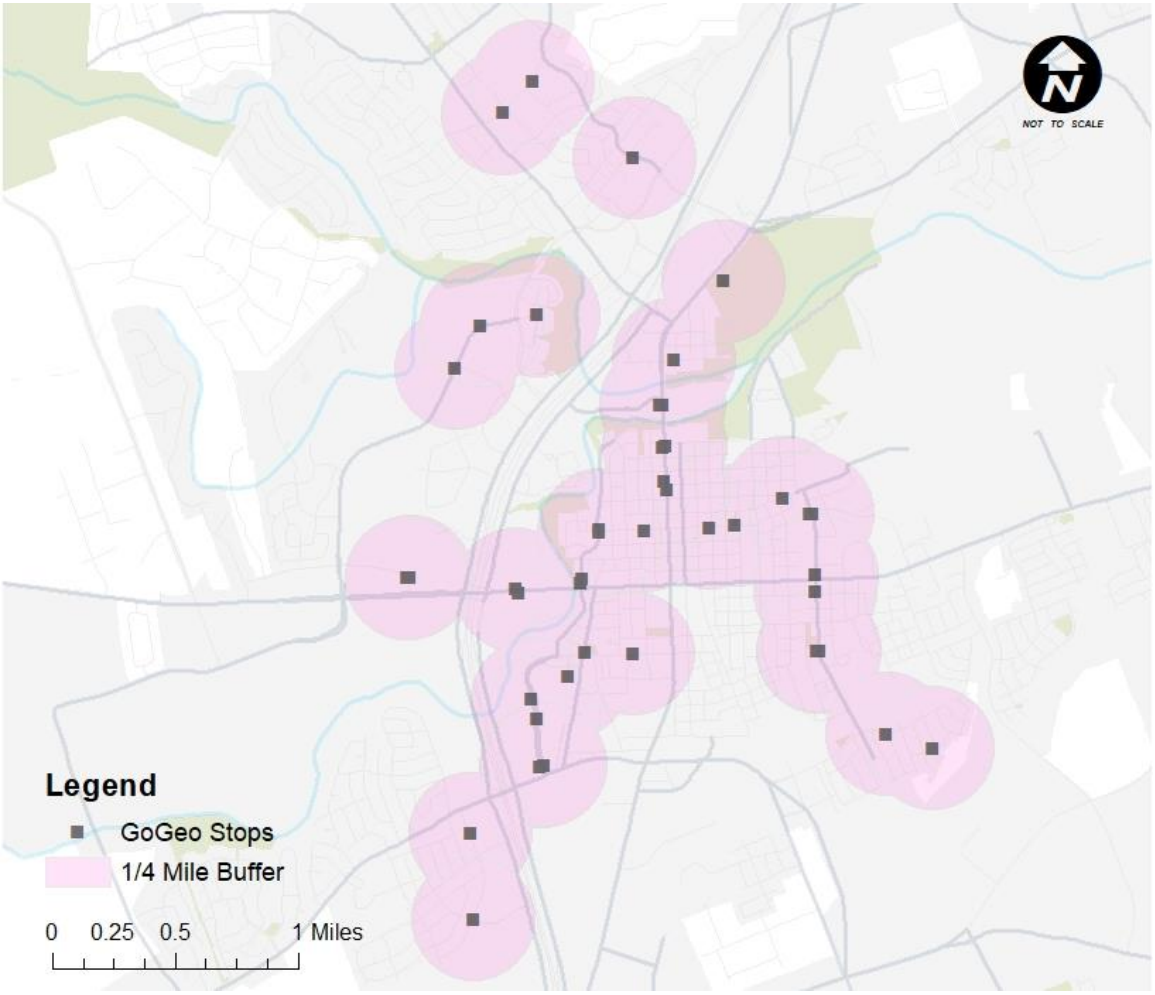


Figure 67. Transit Stop ¼ Mile Buffer Weights

Special Generators/Points of Interest
A few points of interest within Georgetown that are likely to generate large volumes of attraction for all travel modes did not necessarily fall into any of the wider buckets quantified above. As such, another attraction category for special generators was added. These points represent a standard block length, or 300-foot buffer around the following sites:

- Williamson County Courthouse Square = 3 points
- Georgetown Public Library = 2 points
- Sun City Texas Community Association = 2 points

Aggregating All Inputs
Each of the aforementioned polygon sets and corresponding weights were overlaid in ArcMap. A new field representing the sum of weighted points from each category returns the final prioritization score.

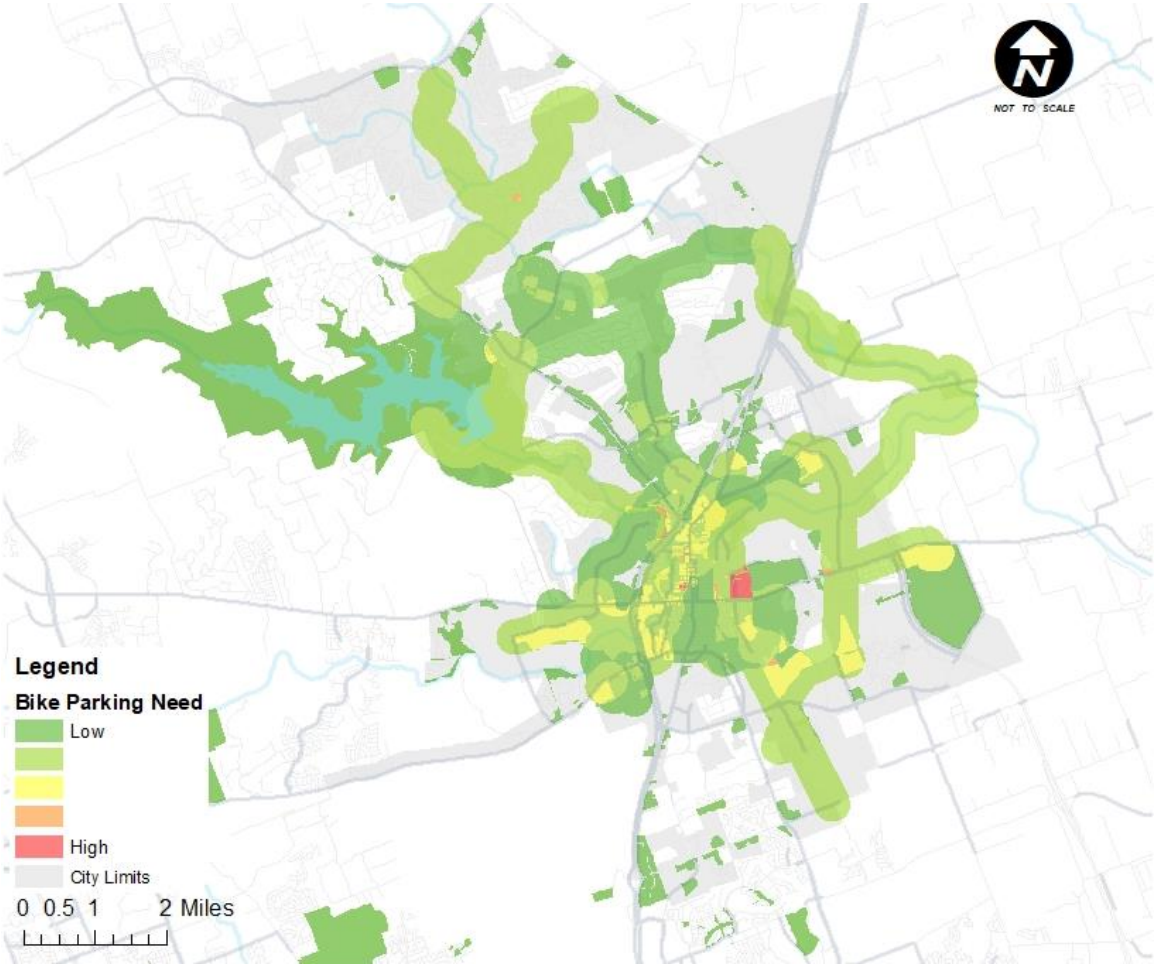


Figure 68. Weighted Suitability Analysis for Bicycle Parking Priority Areas

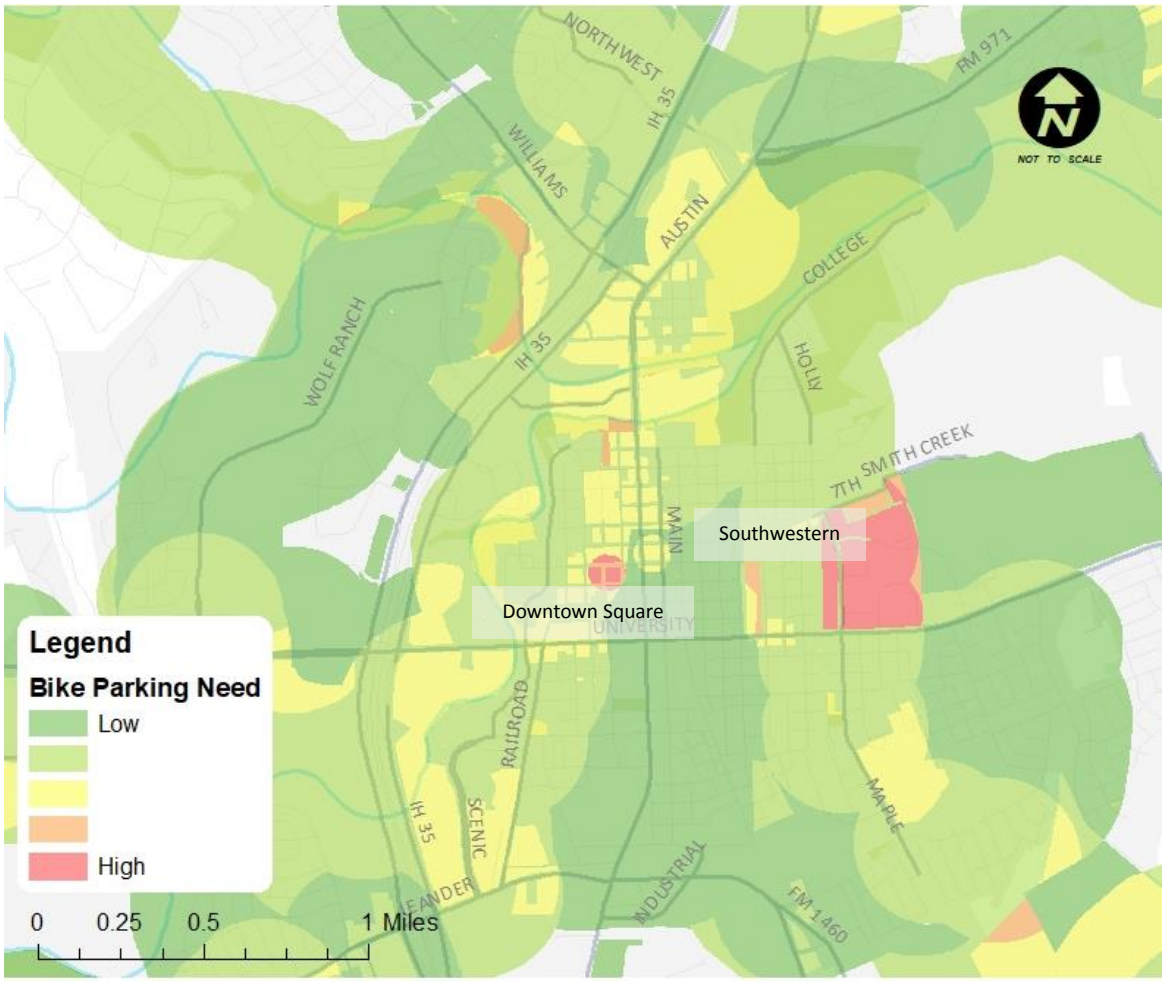


Figure 69. Weighted Suitability Analysis for Bicycle Parking Priority Areas (Zoom to Downtown)

A12.4 FINDINGS AND CONCLUSIONS

The suitability analysis returned the map shown in Figure 67 and Figure 68 with defined areas of high and low values of bicycle parking demand, based on the given input datasets. Table 11 below displays the top demand locations identified through this process.

Table 11. Top 10 Bicycle Parking Demand Locations

RANK	NAME	SCORE
1	Southwestern University Campus & Athletic Fields	8
2	Georgetown Public Library & surrounding block	8
3	Blue Hole Park & Rock St.	7
4	Rivery Park, Sheraton Hotel and surrounding mixed-use development	7
5	Sun City Texas Community Association	7
6	College St. & University Ave. School Complex	7
7	Georgetown Soccer Association at Purl Elementary School	7
8	Williamson County Courthouse and nine block Downtown	6
9	East Side HS, Georgetown HS, Wagner MS, Tippit MS, Forbes MS, Cooper ES, Mitchell ES, Ford ES, Dell-Pickett ES, and Wolf Ranch ES	6
10	Wolf Ranch Town Center	6

With limited vehicle parking spaces, the cost of a parking permit, an existing campus bike-sharing program, and a youthful population with positive attitudes towards cycling, Southwestern University is the leader for bicycle parking needs.

Public facilities like the Georgetown Public Library and the Williamson County Courthouse Square are key nodes in the network and already hubs of a bike-share system afforded to residents for free through library membership. The high demand scores for these destinations also align with community feedback, as these central locations were among the most mentioned by residents.

Blue Hole Park and Rivery Park sit at the confluence of multiple network nodes and adjacent to major commercial attractors. In the case of Blue Hole Park, there are restaurants on both sides of the low-water crossing including El Monumento and Hat Creek Burger Company. Rivery Park abuts the Rivery Blvd. mixed-use development surrounding the Sheraton Hotel, known for its popular bike rental services. Rivery Park is also located near one of the only paved trail crossings of 1-35, providing connections to other activities available along Rivery Blvd.

The Sun City Texas Community Association offers athletic services like a community gym, tennis courts, and social meeting spaces for residents. The facility sits at the crossroads of the Sun City trail system and also serves as the home for the weekly Sun City Farmer's Market. This age - restricted retirement community has constructed its own off-street trail network, many of which are currently off-limits for bicyclists. There is a large demand for bicycling infrastructure and amenities in the community, which is home to one of the region's most popular bicycling clubs.

City of Georgetown has already constructed a Safe Routes to School off-street path connecting Wagner Middle School and Mitchell Elementary School to nearby neighborhoods along SE Inner Loop. The planned network seeks to expand this network and provide easy bicycle access from the adjacent Saddle Creek community, which is currently under construction. All schools in Georgetown have been connected to the core low-stress bicycle network and proper, secure parking facilities should be included on these schools' campuses to accommodate the demand of these young cyclists.

The Wolf Ranch Town Center is a key shopping and employment destination within the City of Georgetown. The Bicycle Master Plan network proposes connecting this complex to the eastern side of I-35 through a trail underneath the highway behind St. David's Medical Center. The complex is now connected on its southern side via a recently constructed ADA-accessible pedestrian bridge along the I-35 frontage road. Furthermore, in the future, the complex will be connected along the entirety of Wolf Ranch Parkway to the west to the future Wolf Ranch Elementary School and housing development, and to the north to Rivery Blvd. by an off-street bicycle path.

Implementation Strategies and Best Practices

Currently, the Georgetown Unified Development Code does not offer any requirements or guidance for the addition of off-street bicycle parking and should be amended to do so. For example, the City of Austin's Bicycle Advisory Council recently passed a recommendation that the City amend its land development code's bicycle parking minimums to align with the goals set forth in the Imagine Austin Comprehensive Plan and the Austin Bicycle Master Plan. This requires all new developments to provide 5-15% of the building's maximum fire code person capacity in bicycle parking spaces[59].

The City should pursue partnerships with existing business owners, Southwestern University and transit providers to expand bicycle parking facilities around Georgetown. Business owners would benefit from attraction of more regular, frequent customers and tourists, as well as from discouraging illegal parking practices such as chaining bikes to trees, street furniture or utility poles that can detract from the atmosphere of the business district. The University has a limited supply of car parking facilities, and could benefit by converting some car trips to campus to bike trips, reducing the need to expand vehicle parking. It is also a notable benefit that bike parking spaces cost much less than vehicle parking spots, and could provide a cost savings benefit. Bicycle parking facilities should be provided adjacent to bus stops to help accommodate first and last mile connections to transit, especially since each bus has space to carry only two bicycles. Together, bicycling and transit can offer users more mobility options than either are able to individually, and according to the American Public Transit Association's Bicycle/Transit Integration Best Practices Guide, lack of secure parking at transit stops "will discourage and preclude potential riders."[60]

In order to determine how many bicycle parking spaces to provide at each stop, the City should set a quantitative threshold based on peak transit ridership.

The City should proactively pursue opportunities to build bicycle racks in priority areas on sidewalks without impeding ADA access. One example of this practice includes converting on-street parking spaces into bicycle corrals; 8-10 bicycles can be accommodated by one on-street car parking space.

59 - 5% represents the citywide mode choice goal and 15% represents the central city area mode choice goal for bicycling according to the Austin Bicycle Master Plan & Imagine Austin Comprehensive Plan.
60 - American Public Transit Association. (2018). Bicycle and Transit Integration: A Practical Transit Agency Guide to Bicycle Integration and Equitable Mobility (Recommended Practice No. SUDS-UD-RP-009-18). Washington, DC. Retrieved from https://www.apta.com/resources/standards/Documents/APTA%20SUDS-UD-RP-009-18.pdf

Limitations of Analysis and Future Studies

The survey mechanism administered in online form only asked for popular destinations in a categorical format to ease response coding (e.g. Shopping, School, Work). Specific locations like the Georgetown Public Library and the mixed-use development around Rivery Blvd., among others, could only be gleaned from in-person intercept surveys and at the community workshops. If more time were available, it would be better to obtain a statistically significant sample of specific locations to prioritize bicycle parking, not simply zoned parcels.

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The buffering conducted for the network and transit stop overlays is conducted as the crow flies rather than constrained by the existing street/sidewalk network. A more accurate way of representing accessibility would be to create a network and measure access sheds with respect to this available network

Appendix 13:
"5E's" Literature Review

A13.1 STUDY METHOD AND PROCESS

Many online resources were reviewed and assessed to develop the recommendations for this study. The 5 E's framework itself was researched to understand the benefits of its use when implementing traffic safety improvements for vulnerable road users.

Surprisingly, not much literature is provided on why this framework is so popular. Many bike plans, bike programs, and other cycling and pedestrian efforts use this approach; however, not much theoretical background is provided in terms of the origin of the framework outside of a brief overview from the Federal Highway Administration. Additionally, the framework has changed over the years, beginning at the 3E's, and is sometimes now seen as the 6E's.

Multiple variations of this framework have been produced across various fields, including those outside of transportation safety such as railroad safety[61], fire prevention[62–63], and workplace safety[64]. According to the FHWA, the original application of this framework took place in the 1970's within progressive cities such as Boulder, CO, and Madison, WI. The framework originally obtained only 3E's: Engineering, Enforcement, and Education. This framework is still seen in some cities today, such as the City of Chilliwack[65], the State of New York[66], and the Los Angeles County Metropolitan Transportation Authority[67].

61 - Sheehan-McCulloch, N. (2014). The Three E's: Education, Engineering and the third E is… Enforcement. California Operation Lifesaver. Retrieved from https://caoperationlifesaver.wordpress.com/2015/03/04/the-three-es-education-engineering-and-the-third-e-is-enforcement/.
62 - Cotton, J. (2016). Education, Engineering, and Enforcement. Buildings Insider Issue. Retrieved from https://www.buildings.com/buzz/buildings-buzz/entryid/139/education-engineering-and-enforcement.
63 - Marculus, S. (2013). Fire Safety Education: The "Three E's" of Fire Prevention. Firehouse. Retrieved from https://www.firehouse.com/prevention-investigation/community-risk-reduction/article/11201116/fire-safety-education-the-three-es-of-fire-prevention.
64 - EHS Insight Resources. (2015). The 5 E's of Workplace Safety. EHS Insight. Retrieved from https://www.ehsinsight.com/blog/the-5-es-of-workplace-safety.
65 - The 3'E's – Engineering, Enforcement, and Education. The City of Chilliwack. Retrieved from https://www.chilliwack.com/main/page.cfm?id=1361.

Since then, the framework has added more E's, including Evaluation[68], Encouragement, and sometimes entities also include Equity[69], Emergency Management Systems (EMS)[70], and/or Engagement[71]. The current five listed in this report: Engineering, Education, Encouragement, Evaluation, and Enforcement are the most common factors used to assess transportation safety.

In this report, close attention was paid to the Bicycle Friendly Community application, as one effort of Georgetown's Bicycle Master Plan is to create a plan for achieving BFC recognition. This program was founded in 1995 by the League of American Bicyclists. According to the League's website, the Bicycle Friendly Community Program "provides a roadmap to improving conditions for bicycling and guidance to help make your community's vision for a better, bikeable community a reality"[72]. The application relies heavily on the status of the 5 E's within a community.

The 5 E's are evaluated individually in the next section, with supporting material from over 35 references. Each E is assessed and examples from other bicycle plans or programs are discussed. The next section will act as a basis for recommending action steps for Georgetown's Bicycle Master Plan. Examples frequently referenced are the Safe Routes to School Program, FHWA's Course on Bicycle and Pedestrian Safety and the League of American Bicyclists.[73]

66 - The Three Es. New York State. Retrieved from https://www.ny.gov/pedestrian-safety/three-es.
67 - Washington, P. (2015). Spelling Safety Through the Three Es: Engineering, Education, Enforcement. Mass Transit. Retrieved from https://www.masstransitmag.com/article/12130845/spelling-safety-through-the-three-es-engineering-education-enforcement.
68 - The 5 E's – Education, Encouragement, Enforcement, Evaluation, and Engineering. State of Vermont – Safe Routes to School. Retrieved from https://saferoutes.vermont.gov/your-school/5es.
69 - City of Austin. (2016). Beyond the 5Es: Adding Equity to Traffic Safety. Vision Zero Conference. Retrieved from https://austintexas.gov/sites/default/files/files/Imagine_Austin/VisionZero/equity_V0confforweb.pdf.
70 - DOAADI. (2018). The Four E's of Road Safety. Diary of an ADI. Retrieved from https://www.diaryofanadi.co.uk/?p=7227.
71 - The 7 E's of Safe Routes. Lawrence-Douglas County Health Department. Retrieved from https://ldchealth.org/271/The-7-Es-of-Safe-Routes.
72 - League of American Bicyclists. (2018). Bicycle Friendly Communities. Retrieved from https://bikeleague.org/community.
73 - League of American Bicyclists. (2018). The 5E's. Retrieved from https://www.bikeleague.org/content/5-es.

A13.2 RELATED APPLICATIONS

This section assesses the implementation strategies of various cities or programs. It includes a brief literature review, and a comprehensive approach for improving conditions for cyclists on roadways.

Engineering
Engineering is the most tangible of the 5E's. Engineering efforts are physical improvements to roadway systems, including painting bicycle lanes, creating shared-use paths, and adding striping and signage to intersections. Various types of facilities can be implemented, including sharrows, bike lanes, buffered bike lanes, and cycle tracks. The types chosen are dependent on the local context and the amount of money available to be spent on these efforts.

One visible effort that a city can make is to adopt a Complete Streets program.

In 2015, the Fixing America's Surface Transportation (FAST) Act was the first federal transportation act that included a conversation about Complete Streets[74]. According to Smart Growth America's website, Complete Streets are "streets for everyone. They are designed and operated to enable safe access for all users, including pedestrians, bicyclists, motorists, and transit riders of all ages and abilities"[75]. Adopting a Complete Streets policy falls under the engineering section because, even though it is a policy action, it is a policy that requires by law all street improvements be made for the betterment of all road users, not just motorized vehicles.

Figure 69 shows the overall idea of what a complete street would look like before and after improvements. This is an example from New York City's First Avenue[76].

74 - Smart Growth America. (2018). Federal Policy. Complete Streets. Retrieved from https://smartgrowthamerica.org/program/locus/advocacy/federal-policy/.
75 - Smart Growth America. (2018). What are Complete Streets? Complete Streets. Retrieved from https://smartgrowthamerica.org/program/national-complete-streets-coalition/publications/what-are-complete-streets/.
76 - NYSDOT. (2014). Complete Streets at NYSDOT. Retrieved from https://www.dot.ny.gov/programs/completestreets/nysdot.

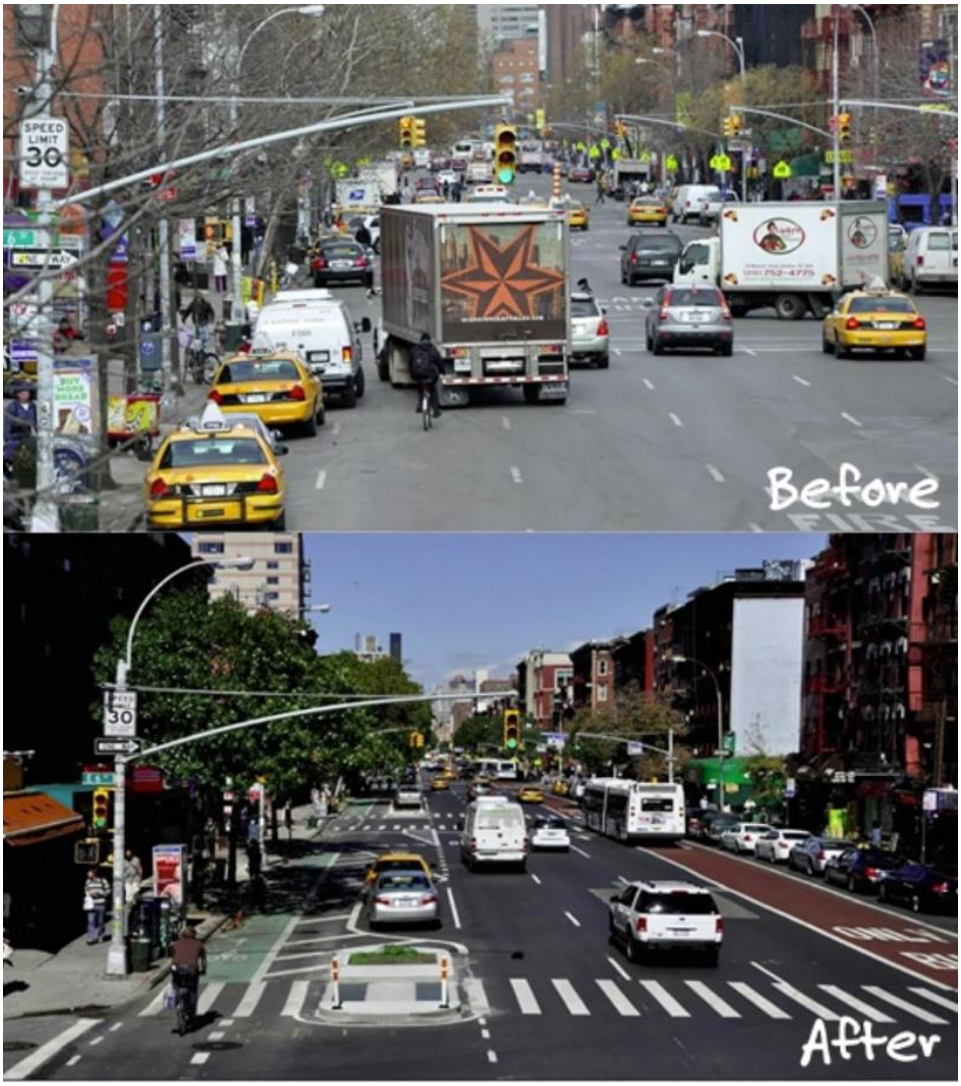

Figure 70. Complete Streets Before and After – New York City's First Avenue Example

Figure 70 depicts a Complete Streets effort in Orlando, FL. The depicted roadway segment underwent significant engineering changes that made it easier for cyclists and pedestrians to share the road facilities with vehicles. There is room for creativity in these engineering efforts so they can become local attractors and statement pieces that can trigger increased usage. Complete Streets efforts not only make an area safer for non-motorized roadway users, but also activate economic development in surrounding areas due to increased usage.

Figure 71. Complete Streets Example – Orlando, FL

The Safe Routes to School (SRTS) program focuses engineering efforts to create a safer environment for school-aged children to walk and bike to school through concentrated efforts to slow traffic, make drivers aware of their surroundings, and create safe crossing areas[77]. According to the SRTS website, "the physical environment often determines whether many children walk or bike to school. To safely walk or bike to school along a street or a separate path… children need well-designed, well-built, well-maintained, and accessible facilities."[78] The website recommends specific engineering improvements, such as including standard school zone signs and pavement markings, in accordance to the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)[79].

77 - Safe Routes to School. (2017). Engineering. SRTS Guide. Retrieved from http://guide.saferoutesinfo.org/engineering/index.cfm.
78 - Safe Routes to School. (2017). Guiding Principles for Applying Safe Routes to School Engineering Solutions. SRTS Guide. Retrieved from http://guide.saferoutesinfo.org/engineering/guiding_principles_for_applying_srts_engineering_solutions.cfm.
79 - Federal Highway Administration. (2003). Manual on Uniform Traffic Control Devices for Streets and Highways. Part 7. U.S. Department of Transportation. Retrieved from https://mutcd.fhwa.dot.gov/pdfs/2003/Ch7.pdf.

The City of Greeley's Bicycle Master Plan, implemented in 2015, has a section dedicated to "lay out a plan focused on the next ten to twenty years for enhancing the network and support facility components of the bikeway system in Greeley."[80]

Their improvements consist of intersections, mid-block crossings, shoulder widening, railroad crossing safety improvements, and bicycle parking. Figure 71 is the recommended bicycle parking requirements table created for the Greeley Plan.

Table 4-2: Recommended Bicycle Parking Requirements

Type of Activity	Long-Term Bicycle Parking Requirement	Short-Term Bicycle Parking Requirement
Residential Land Uses		
Single-family dwelling	No spaces required	No spaces required
Multi-family dwelling		
a) with private garage for each unit	No spaces required	0.5 for each bedroom
b) without private garage for each unit*	0.5 spaces for each bedroom, minimum 2 spaces	0.5 spaces for each bedroom, min 2 spaces
c) Senior housing	Minimum 2 spaces	Minimum 2 spaces
Civic/Cultural Land Uses		
Non-assembly cultural (library, government buildings, etc.)	1 space for each 10 employees, min. 2 spaces	1 space for each 10,000 s.f. of floor area, minimum 2 spaces
Assembly (church, theater, stadium park, beach)	1 space for each 20 employees, min. 2 spaces	Spaces for 2% of minimum expected daily attendance
Health care/hospital	1 space for each 20 employees, or 1 space for each 70,000 s.f. of floor area, whichever is greater, min. 2 spaces	1 space for each 20,000 s.f. of floor area, minimum 2 spaces
Education		
a) Public, parochial, and private day-care centers for 15 or more children	1 space for each 20 employees, min. 2 spaces	1 space for each 20 students of planned capacity, minimum 2 spaces
b) Public, parochial and private nursery schools, kindergartens, and elementary schools (1-3)	1 space for each 10 employees, min. 2 spaces	1 space for each 20 students of planned capacity, minimum 2 spaces
c) Public, parochial and elementary (4-6) public and high schools	1 space for each 10 employees, plus 1 space for each 20 students or planned capacity, min. 2 spaces	1 space for each 20 students of planned capacity, minimum 2 spaces
d) Colleges and universities	1 space for each 10 employees, plus 1 space for each 10 students planned capacity; or 1 space for each 20,000 s.f. of floor area, whichever is greater	1 space for each 20 students of planned capacity, minimum 2 spaces
Rail/bus terminals and stations/airports	Spaces for 5% of projected am peak period daily ridership	Spaces for 1.5% am peak period daily ridership
Commercial Land Uses		
Retail		
General food sales or grocery	1 space for each 12,000 s.f. of floor area, min. 2 spaces	1 space for each 2,000 s.f. of floor area, minimum 2 spaces
General retail	1 space for each 12,000 s.f. of floor area, min. 2 spaces	1 space for each 5,000 s.f. of floor area minimum 2 spaces
Office	1 space for each 1,000 s.f. of floor area, min. 2 spaces	1 space for each 20,000 s.f. of floor area, minimum 2 spaces
Auto related		
Automotive sales, rental & delivery, automotive servicing/repair, cleaning	1 space for each 12,000 s.f. of floor area, min. 2 spaces	1 space for each 20,000 s.f. of floor area, minimum 2 spaces
Off-street public parking lots/garages without charge on a fee basis	1 space for each 20 automobile spaces, min. 2 spaces - unattended surface parking lots excepted	Min 6 spaces or 1 per 20 auto spaces - unattended surface parking lots excepted
Industrial Land Uses		
Manufacturing and production	1 space for each 15,000 s.f. of floor area, min. 2 spaces	Number of spaces to be prescribed by Planning Director or Coordinator. Consider min. 2 spaces at each public building entrance
* A private locked storage unit may be considered as a private garage if a bicycle can fit into it.		

Figure 72. Greeley's Bicycle Master Plan Recommended Bicycle Parking Requirements

80 - Alta Planning + Design. (2015). Bicycle Master Plan. City of Greeley. Retrieved from https://greeleybikes.com/wp-content/uploads/2017/11/bicycle-master-plan.pdf.

The assessed literature concludes that it is always ideal to execute "low-hanging fruit" projects. These projects are simple, low-cost efforts and produce immediate results.[80] SRTS says: "smaller, more cost-effective projects… are likely to have lasting impacts on the built environment and garner interest and support from the community."[78] The easy, low-cost projects on the list of engineering efforts should be executed first.

Education

Public education is a key component to communicate the dangers, as well as opportunities, that come with bicycling. Bicycling education campaigns should reach the whole community: children, parents, adults, drivers, and neighbors [81]. Safe Routes to School is a key provider of educational materials for school-aged children[82], with various types of content available. Content is also available for parents, as it is key to keep parents involved in this process because they can serve as role models for safe cycling behaviors, and provide guidance when cycling with their children.

The Los Angeles County Bicycle Master Plan has a list of cycling education programs that the county sponsors, including Community Bicycle Education Courses, youth bicycle safety education, bicycle rodeos, Share the Path campaigns, and public awareness campaigns[83]. A specific program that is recommended, both in this Plan, and in the Bicycle Friendly Community application, is the Smart Cycling course[84]. This course covers topics like signaling, finding a properly sized helmet, riding at night, riding on sidewalks, and understanding traffic laws.

The City of Austin has made extensive efforts to educate all road users on the safety of cyclists. According to the City of Austin's 2014 Bike Plan, the City "educates school-aged children on bicycling and walking to school through the Public Works Department's Child Safety Program and the Health and Human Services Department's Safe Routes to School Program." Because providing education programs requires budget that may not always be available, Austin's Bike Plan recommends that the City "provide low-cost or free educational classes to the public through City programming or partnerships with organizations."[85] Figure 72 is a brochure handed out to the citizens of Austin detailing the challenges of sharing the road with motorists.

81 - Safe Routes to School. (2017). Education. SRTS Guide. Retrieved from http://guide.saferoutesinfo.org/education/index.cfm.
82 - Safe Routes to School. (2017). Key Messages for Children. SRTS Guide. Retrieved from http://guide.saferoutesinfo.org/education/key_messages_for_children.cfm.
83 - Alta Planning + Design. (2012). County of Los Angeles Bicycle Master Plan. County of Lost Angeles. Retrieved from https://dpw.lacounty.gov/pdd/bike/docs/bmp/FINAL%20Bicycle%20Master%20Plan.pdf.
84 - The League of American Bicyclists. Smart Cycling. Retrieved from https://bikeleague.org/ridesmart.
85 - City of Austin. (2014). 2014 Austin Bicycle Plan. Retrieved from https://austintexas.gov/sites/default/files/files/2014_Austin_Bicycle_Master_Plan__Reduced_Size_.pdf.

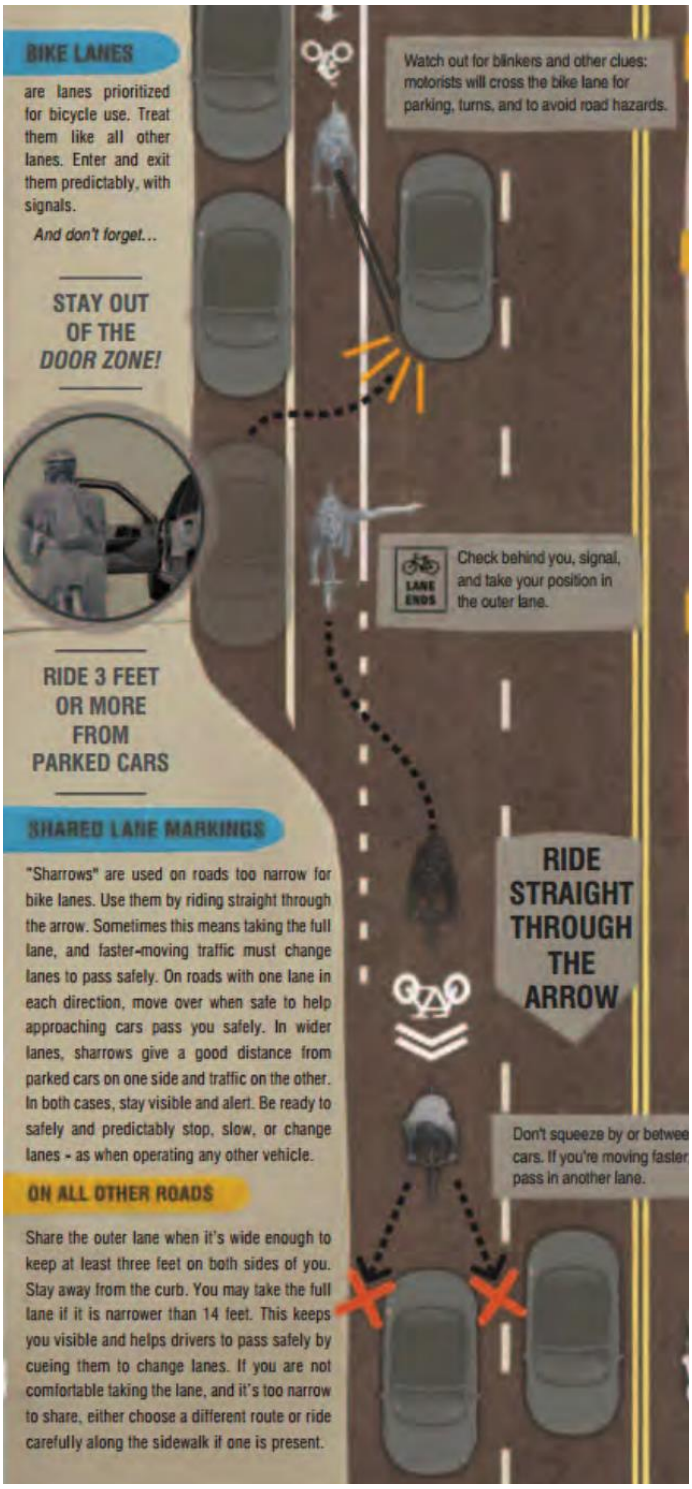

Figure 73. City of Austin's Bicycle Education Example Material

Encouragement
Encouragement covers a wide variety of outreach efforts. Encouragement efforts seek to find creative ways to incentivize individuals to get out of their cars, and use a bicycle as a regular form of transportation. Austin's Bike Plan reports that 17% of Austinites are interested in riding a bike; however, only 2% of people bike to work.[85] Implementing programs to encourage cycling is a proven way to convert short automobile trips to other modes. According to Portland's 2030 Bicycle Plan, encouragement programs "are designed to motivate 'interested but concerned' residents to ride a bicycle confidently and securely."[86] One of Portland's most progressive encouragement efforts is to measure behavior changes, though programs such as the SmartTrips Program, which helps residents plan a biking route between destinations and can track use based on the number of requests received. These continuous outreach programs seek to change behavior over time to reduce the number of motorized vehicles on the road, and have been successful in Portland.[86]

The Federal Highway Administration promotes many activities for encouraging cycling. Key activities include reducing barriers for walking and cycling, creating barriers for single-occupancy-vehicles, providing non-cyclists a casual and friendly introduction to cycling, and use various outreach methods such as brochures, flyers, and social media. Other community encouragement methods can include promoting programs like Take Your Bike to Work Week and National Bike Month. These types of activities will allow the City to engage in conversations with citizens about cycling. The City of San Diego has created a local bicycle committee that is present at local meetings and local government sessions, in addition to monitoring bicycle counts, and organizing cycling events.[87] Forming a local bicycling committee can encourage active community participation in cycling-oriented programs. A cycling committee can benefit all five areas of outreach efforts, not just encouragement. San Diego also engages in a local program called "CicloSDias." This event temporarily closes streets to create temporary parks that are open to the public for biking, walking, dancing, and scootering. This event raises awareness and enthusiasm for alternative forms of transportation.[87]

86 - Portland Transportation. (2012). Portland Bicycle Plan for 2030. City of Portland, OR. Retrieved from https://nacto.org/wp-content/uploads/2012/06/City-of-Portland-2010-2030-Plan.pdf.
87 - Alta Planning + Design. (2013). San Diego Bicycle Master Plan. City of San Diego. Retrieved from https://www.sandiego.gov/sites/default/files/legacy/planning/programs/transportation/mobility/pdf/bicycle_master_plan_final_dec_2013.pdf.

Ultimately, there are many ways that local communities can engage with the public through encouragement activities. There are plenty of resources available to aid local entities in setting up encouragement programs or campaigns. For example, Alta Planning+Design offers marketing services for education and. encouragement programs, such as creating banners, brochures, social media posts, and events[88]. Figure 73 shows an example of some of the products this company offers. Partnering with a planning firm for encouragement activities can be a useful way to boost event attendance

Figure 74. Cycling Encouragement Activities - Marketing Services Example (Retrieved from Alta Planning + Design)

88 - Alta Planning + Design. Campaigns and Marketing. Retrieved from https://altaplanning.com/services/education-and-encouragement-programs/campaign-and-marketing/.

Enforcement
Research has shown that enforcement, when coupled with physical improvements and public engagement, reduces pedestrian and bicycle crashes. One study found an increase in vehicle yielding rates to bicycles and pedestrians between 4-7% in areas that introduced targeted police operations[89]. Another study found that after a targeted policing effort was implemented, helmet usage in observed middle schools increased across the board[90]. By working with local law enforcement, agencies can ensure that motorists and cyclists are both following the law. The City of Pasadena's Bike Plan points out the importance of combining enforcement with educational campaigns because, "it is vitally important that bicyclists, motorists, and pedestrians all take responsibility for their own safety as well as the safety of other on the roadways because targeted enforcement programs are temporary."[91]

Enforcement is primarily concerned with reducing pedestrian and cycling related crashes with motor vehicles. Police officers should be refreshed on safe passing laws, requirements to yield to cyclists when turning right, and other traffic violations which could put cyclists in danger. The Pedestrian and Bicycle Information Center has created a guidebook on involving law enforcement in improving safety for cyclists and pedestrians. This book emphasizes the importance of establishing partnerships with local advocacy groups, law enforcement, and other municipal or regional departments; a balanced approach in enforcing both motorized and non-motorized travelers; and maintaining enforcement investments long-term.[92]

Enforcement activities are often coupled with education campaigns. The City of Austin frequently partners with the Austin Police Department to implement their Vision Zero program which pledges to "1) target enforcement on high injury and fatal roadways, and on the most dangerous driving behaviors, 2) enforce improper driver behavior around traffic calming devices, crossing devices, and bicycle facilities, 3) coordinate enforcement across all law enforcement agencies and coordinate to increase prosecution of repeat offenders, and 4) work with the APD to continue enforcement of transit priority lanes."[93]

89 - Sandt, L., Marshall, S., Rodriguez, D., Evenson, K., Ennet, S., Roinson, W. (2013). Effect of a community-based pedestrian injury prevention program on driver yielding behavior at marked crosswalks. TRB Annual Conference 2017. Retrieved from http://amonline.trb.org/16-5125-1.2980849?qr=1.
90 - Van Houten, R. (2013). Impact of a Comprehensive Safety Program on Bicycle Helmet Use Among Middle-School Children. Journal of Applied Behavior Analysis. Vol. 40, No. 2. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1901/jaba.2007.62-06.
91 - KOA Corporation. (2015). Bicycle Transportation Action Plan. City of Pasadena. Retrieved from https://ww5.cityofpasadena.net/transportation/wp-content/uploads/sites/6/2016/05/Pasadena-Bike-Action-Plan-08-17-2015.pdf.

Evaluation
A data-driven approach to monitoring pedestrian and cyclist activity is critical to proving that public dollars are being invested properly. Data gathered from engineering, education, enforcement, and encouragement programs can provide policymakers with information about how infrastructure improvements are encouraging and protecting cyclists. Data points can include:

- Decreases in the number of cyclist and pedestrian related crashes after infrastructure improvements
- The amount of people reached at tabling events
- Behavioral change surveys to monitor increased use of helmets, choice to travel by bicycle instead of car, and many other behaviors
- The number of cyclists and pedestrians using the new facilities

The FHWA has a standardized toolkit for monitoring traffic. The "Traffic Monitoring Guide," provides local DOTs and public entities with the resources to collect traffic data.[94] Special equipment such as inductive loops, radar sensors, video imaging, or even manual observations can be used. Figure 74 shows the strengths and weaknesses of each monitoring device, and how to choose the ones best for individual communities.

92 - Pedestrian and Bicycle Information Center. (2017). The Role of Law Enforcement in Supporting Pedestrian and Bicycle Safety: An Idea Book. Retrieved from http://www.pedbikeinfo.org/pdf/Lifesavers_CaseStudies_FINAL.pdf.
93 - City of Austin. Vision Zero 2016-2018 Action Plan. Retrieved from https://austintexas.gov/sites/default/files/files/Imagine_Austin/VisionZero/ActionPlan_5.19.16adoption.pdf.
Federal Highway Administration. (2016). Traffic Monitoring Guide. U.S. Department of Transportation. Retrieved from https://www.fhwa.dot.gov/policyinformation/tmguide/tmg_fhwa_pl_17_003.pdf.
94 - Federal Highway Administration. (2016). Traffic Monitoring Guide. U.S. Department of Transportation. Retrieved from https://www.fhwa.dot.gov/policyinformation/tmguide/tmg_fhwa_pl_17_003.pdf.

1. What Are You Counting?	Technology	Bicyclists Only	Pedestrians Only	Pedestrians & Bicyclist Combined	Pedestrians & Bicyclist Separately	Cost
Permanent	Inductance Loops[1]	●			◐	$$
↑	Magnetometer[2]	○				$-$$
	Pressure Sensor[2]	○	○	○	○	$$
	Radar Sensor	○	○	○		$-$$
2. How Long?	Seismic Sensor	○	○	○		$$
	Video Imaging: Automated	○	○	○	○	$-$$
	Infrared Sensor (Active or Passive)	○[3]	●	●	◐	$-$$
	Pneumatic Tubes	●			◐	$-$$
↓	Video Imaging: Manual	○	○	○	●	$-$$$
Temporary/ Short Term	Manual Observers	●	●	●	●	$$-$$$

○ Indicates what is technologically possible.
● Indicates a common practice.
◐ Indicates a common practice, but must be combined with another technology to classify pedestrians and bicyclists separately.
$, $$, $$$: Indicates relative cost per data point.
[1] Typically requires a unique loop configuration separate from motor vehicle loops, especially in a traffic lane shared by bicyclists and motor vehicles.
[2] Permanent installation is typical for asphalt or concrete pavements; temporary installation is possible for unpaved, natural surface trails.
[3] Requires specific mounting configuration to avoid counting cars in main traffic lanes or counting pedestrians on the sidewalk.

Figure 75. Bicycle and Pedestrian Monitoring Devices (Retrieved from FHWA's Traffic Monitoring Guide)

The Texas A&M Transportation Institute recently completed a study that establishes a standard methodology for bicycle and pedestrian data collection.[95] The report provides tools for annualizing bicycle and pedestrian counts to calculate annual average daily traffic for non-motorized vehicles.

Efficient system performance management practices should also be implemented. The City of College Station's Bicycle, Pedestrian, and Greenways Master Plan outlines seven key areas in its performance management system[96]:

- system development
- safety
- usage
- education, encouragement, and enforcement
- environment
- maintenance
- cost

95 - Turner S., Benz, R., Dadashaova, B., Das, S., Graham, M., Griffin, G., Hudson, J., Jha, K., Lasley, P. (2018). Evaluation of Bicycle and Pedestrian Monitoring Equipment to Establish Collection Database and Methodologies for Estimating Non-motorized Transportation. Texas Department of Transportation. https://static.tti.tamu.edu/tti.tamu.edu/documents/0-6927-PSR.pdf

These performance measures were established along with target goals, and data was collected and presented to College Station's Parks and Recreation Advisory Board, the Planning and Zoning Commission, and the City Council. The FHWA developed the Guidebook for Developing Pedestrian and Bicycle Performance Measures, which provides agencies a framework for monitoring the efficacy of a bicycle network. This report provides the metric, the data sources needed to complete the measurement, the goals achieved from the metric, and related measures. It includes metrics such as access to jobs, miles of facilities, throughput, route directness, user perceptions, and vehicle miles traveled (VMT) impacts[97].

Many bicycle plans use performance measures to track progress and to stay accountable to set goals. Performance measures should be chosen carefully by working with local stakeholders and governing bodies to choose those that will be most helpful to policymakers.

96 - City of College Station. Bicycle, Pedestrian, and Greenways Master Plan. Retrieved from http://cstx.gov/modules/ShowDocument.aspx?documentid=10289.
97 - Semler, C., Vest, A., Kingsley, K., Mah, S., Kittelson, W., Sunderstrom, C., Brookshire, K. (2016). Guidebook for Developing Pedestrian and Bicycle Performance Measures. Federal Highway Administration. Retrieved from https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/performance_measures_guidebook/pm_guidebook.pdf.

Appendix 14:
Bike Infrastructure Financing Options

A14.1 GUIDE TO FUNDING OPTIONS

The following guide gives a high level view of how each proposed funding option performs in terms of three categories: 1) effort required, 2) potential payoff, and 3) competitiveness of a suburban bike project relative to the other options. It should be noted that this scoring rubric loses some of the nuance required in making funding decisions, but is intended as a starting point in deciding which sources may be appropriate for a particular project.

Scoring was tallied using the guidelines in the rubrics below, with individual point allocations within each for specific criteria in each category. Lower total scores in a particular category indicate more positive outcomes within those scoring criteria. Factors were chosen after review of many types of applications and processes for the funding mechanisms previously outlined.

To calculate level of effort required for particular funding options, three factors were taken into account: number of steps, whether specialized knowledge is required, and whether dedicated staff would be needed. Steps were identified by reviewing the full application process for each funding option. Specialized knowledge requirements were decided based on the depth of the information requested. For example, some applications only require the applicant to include an amount and the purpose the bike infrastructure will serve in the community. Others require very time consuming and difficult analyses such as a cost-benefit analysis or a detailed construction phasing breakdown. Dedicated staff requirements were determined similarly – using the level of depth required for the application or development of the funding opportunity. If extra analyses such as cost benefit analysis were required outside of the application itself, funding was scored to require staff.

Payoff was calculated based on the amount of funding that could potentially be received, whether the money needs to be paid back (a loan), and if matching is required. Amounts were all pulled from the application criteria, as all grants and loans set requirements for maximum dollar awards. Loans were given extra points because the funds would need to be paid back, which is less cost-beneficial when compared to a grant. Matching requirements were stated in all application materials.

The final category, competitiveness, was calculated using a number of factors including: how commonly the mechanism is used to bicycle infrastructure specifically, and whether that particular type of grant or funding mechanism has been used for suburban bicycle infrastructure. For those that are not grants or do not require an application there is a category for non-competitive methods.

Table 12. Effort Scoring Rubric

EFFORT	***Points***				
Criteria	**3**	**2**	**1**	**0**	**TOTAL**
Number of steps	**4+ steps**	**2-3 steps**	**1 step**	**--**	High 4-5 points
Specialized knowledge required	**--**	**--**	**Yes**	**No**	Medium 3 points
Dedicated staff required	**--**	**--**	**Yes**	**No**	Low 1-2 points

Table 13. Payoff Scoring Rubric

PAYOFF	*Points*				
Criteria	**3**	**2**	**1**	**0**	**TOTAL**
Funding amount	**$1k-$100k**	**$100k-$2M**	**$2M+**	**--**	High 4 points
Loan	**Yes**	**--**	**--**	**No**	Medium 3 points
Matching required	**--**	**--**	**Yes**	**No**	Low 2 points

Table 14. Competitiveness Scoring Rubric

COMPETITIVENESS	*Points*					
Criteria	**3**	**2**	**1**	**0**	**-1**	**TOTAL**
Frequency awarded to bike projects alone	**Never**	**Sometimes**	**Often**	**--**	**--**	High 3 points
Suburban bike projects (bonus point)	**--**	**--**	**--**	**--**	**Yes**	Medium 2 points
Non-competitive/ not applicable	**--**	**--**	**--**	**Yes**	**--**	Low 0-1 points

This scoring table reflects that, as predicted, local funding options require the lowest levels of effort relative to other options. Local options also benefit from lack of competition, and since the amount is chosen rather than requested, generally cover the cost of the project. These attributes serve to make local funds the primary method through which bicycle infrastructure is funded. There are also very suitable options stemming from TxDOT, MPOs, and private and nonprofit options. The following coded guide is ranked roughly from most suitable for suburban bike infrastructure to least.

Table 15. Funding Source Ratings

POINT OF ACCESS	FUNDING SOURCE	EFFORT	PAYOFF	COMPETITIVENESS
Local	TIRZ Funds	LOW	HIGH	HIGH
Local	Capital Improvement Program	LOW	HIGH	HIGH
Local	Development Impact Fees	MEDIUM	HIGH	HIGH
TxDOT	Bike Lanes on TxDOT Roads	MEDIUM	HIGH	HIGH
TxDOT	SRTS Grant	MEDIUM	HIGH	HIGH
Local	Bonds	LOW	LOW	HIGH
Local	Parking Benefits Districts	HIGH	HIGH	HIGH

Private/ Nonprofit	Walmart Foundation Community Grant	LOW	MEDIUM	MEDIUM
Private/ Nonprofit	State Farm Good Neighbor Citizenship Company Grant	LOW	MEDIUM	MEDIUM
CAMPO	TA Set Aside	HIGH	MEDIUM	HIGH
Private/ Nonprofit	PeopleForBikes Community Grant	MEDIUM	LOW	HIGH
Federal	BUILD Grant	HIGH	HIGH	LOW
Federal	INFRA Grant	HIGH	HIGH	LOW
Federal	TIFIA Loan	HIGH	LOW	LOW

Based on reviewing the application procedures, requirements, and past awards, federal discretionary funds require very high levels of effort, and often bike projects are not competitive for these funding sources. However, high payoff can sometimes result if the odds are overcome and a bike project is funded in this manner through inclusion in a larger project.

State and MPO funding options show promise as the primary place that local governments should be looking when funding bicycle infrastructure outside of their own pockets. These grants often do require a moderate amount of up-front effort, but payoff meets needs, suburban bicycle projects are very well suited to these grants' scoring criteria, and there is an established track record for these pots funding exactly the types of projects in question.

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Private and nonprofit grants do not seem to typically require as rigorous processes as federal, state, and MPOs and may not require the staffing or technical knowledge that some other grants do. However, they often have small payouts and are difficult to win due to the large volume of competitors and wide breadth of eligible projects outside of bike and pedestrian infrastructure. These could make sense in particular circumstances for smaller projects, but not as a regularly tapped resource in a bicycle funding plan.

A14.2 GEORGETOWN PRIORITY NETWORK FUNDING OPTIONS

It is possible that in choosing appropriate sources for funding individual bicycle projects various stakeholders within City government may have differing opinions regarding which method is most appropriate. For this reason, it is recommended here that initial funding plans include two to three streams that could be tapped for each project to leave room for discussion in final decision-making conversations. This provides a starting point for making these decisions quickly and efficiently. Not all projects may have more than one, if any, appropriate funding streams outside of the City's budget, and local funding can be the best path in a number of cases. While the City's general fund is not directly listed as an option considered through this scoring rubric — although CIP funding can come from many places including the general fund — it is always a silent final choice for any project.

The build-out of the recommended Georgetown priority bicycle network (the Top 10), without considering maintenance costs, staffing, striping removal and other operations, is currently estimated between $1.7 and $3.5 million.

Because these are the first projects to be implemented as part of the new bike plan, it is recommended that they are built quickly in order to begin garnering public support for the remaining projects. Due to this time sensitivity, primarily targeted funding

sources that ranked green in the competitiveness category should be considered. This eliminates the three federal discretionary options, as well as all but one of the private or nonprofit options, suggesting that a combination of state, MPO, and local funding may be most appropriate.

It is next important to note the level of funding required for each project to ensure that if effort is exerted to apply for funding that it will be worthwhile and able to push the project through to completion. All of the Top 10 projects, other than the Holly St. Bridge, happen to classify within the medium cost category on this scoring rubric, falling between $100,000 and $2 million. Therefore, the funding options will likely need to return an orange or green result in the payoff category to meet needs. This deduction calls into question the appropriateness of a local bond option. However, bonds should be considered slightly differently than grants as the money must be repaid, but is often still a prudent way to implement public projects. In this case, unless a transportation bond is already under consideration and could wrap in bicycle funding, this option may not be timely for quick implementation.

Because these projects are medium sized in terms of investment, it would likely also be prudent to choose funding sources that require lower levels of effort to ensure that costs do not outweigh benefits.

After combining each specific need from each of the three categories, it appears that funds from existing TIRZ districts and CIP inclusion may be the most suitable financing methods, with the options of TxDOT SRTS funding, inclusion of bike infrastructure on TxDOT roads, and development impact fees requiring slightly more effort, but showing as strong contenders. These are not the only sources recommended, as the scoring rubric alone did not inform the choices presented below. Rather, a combination of the scoring rubric, local knowledge, and further research produced the following potential funding sources for each priority segment of the Georgetown Bicycle Master Plan.

Table 16. Potential Funding Options

Project Rank	Project Name	Top Funding Options
1	Austin Ave. Bridge	• Inclusion on TxDOT Roads • Downtown TIRZ • Development Impact Fees (Riverplace Georgetown)
2	8th St: Scenic Dr. trail Connection to Maple St.	• Downtown TIRZ • Capital Improvement Program • Development Impact Fees (mixed use development at the corner of 8th and Church)
3	Main St: Buffered bike lane from 2nd St. to 21st St.	• Downtown TIRZ (northern half) • TxDOT SRTS (Purl Elementary)
4	Holly Street Bridge	• Capital Improvement Program
5	Maple St. Phase 1: 7th St. to Britannia St.	• TxDOT SRTS (Purl Elementary)
6	Northwest Blvd./ IH-35 Crossing Phase 1: Rivery Dr. to FM-971	• TxDOT Roads (I-35, in progress)[98] • 2015 Transportation Bond (in progress)

7	San Gabriel River Crossing at St. David's Hospital: Scenic Dr. to Wolf Ranch Town Center	●TxDOT Roads (I-35) ●Wolf Lakes TIRZ ●Development Impact Fees (Wolf Lakes Village)
8	Williams Dr: Del Webb Blvd. to Gatlin Creek	• CAMPO Transportation Alternatives Set-Aside (due to recommendations in the Williams Drive study and ongoing partnership) • TxDOT SRTS (Benold Middle School and Frost Elementary)
9	DB Wood Rd: Wildwood Dr. to Overlook Park along Williams Dr. & DB Wood Rd.	• CAMPO TA Funding (due to recommendations in the Williams Drive study and ongoing partnership) • TxDOT SRTS (McCoy Elementary and Village Elementary)
10	SR-29 East View HS connection across SR 130: Reinhardt Blvd. to Eastview Dr.	• TxDOT SRTS (East View High School)

98 - Williamson County. (2018). http://ftp.dot.state.tx.us/pub/txdot/my35/capital/implementationplan/williamson/williamson.pdf

Based on this exercise, it seems that leveraging several tools in addition to the general fund would be beneficial in more efficiently building out Georgetown's bicycle network. Partnerships with TxDOT could prove very beneficial due to the strong presence of state-owned I-35 in Georgetown, one of the most commonly cited barriers to cycling. Although Georgetown would still need to contribute financially to these projects, TxDOT dollars could be leveraged as well (TxDOT, 2015).

The established and future TIRZs in the city are also important resources to consider in allocating funding to bicycle infrastructure, as multiple proposed segments coincide with their boundaries, and bike lanes are already authorized as approved uses of funds in each.

With recent strong development interest in the area, development impact fees should be strengthened and utilized where appropriate to garner private dollars to build bike infrastructure where it is planned and larger-scale developments are being proposed (City of Georgetown, 2019). Georgetown currently has water and wastewater impact fees in its Code of Ordinances (City of Georgetown, 2019), and has commissioned traffic impact fee studies in the past for potential incorporation into City policy (City of Georgetown, 2009). With the present car-dependent state of Georgetown, it may be difficult to make a case for a development causing a proportional impact requiring a bike lane. However, in certain highly developing areas they could be implemented now.

A number of the projects in the Top 10 are within the two-mile radius of a public school, as required to receive Safe Routes to School funding. An application for TxDOT SRTS funding that combines all of these projects into one proposal could provide a very logical and fruitful return on effort and allow simultaneous construction of lanes in various parts of the City if obtained. This application in particular might be an ideal opportunity to leverage other resources such as a consultant to help draft the application, or to partner with the Georgetown Independent School District to share the burden.

Lastly, in many cases it does make sense to use more general local funds through the CIP in order to build out smaller projects that do not fit well into the criteria for outside grants. Georgetown's CIP is divided into three categories: Georgetown Utility Systems, Transportation, and General Capital Projects. Bicycle infrastructure would likely fall into the transportation category, but in some cases may be classified in the General Capital Projects category where sidewalks, parks, and the Downtown Master Plan reside. A key source within the CIP could be Georgetown's street maintenance sales tax, which

is a quarter cent tax consistently approved by voters that goes toward transportation projects and road maintenance. This tax set-aside can be used only for curb-to-curb street maintenance, and is prohibited from funding new roads or off street trails, as reiterated in its most recent renewal, Prop A in 2018. Sidewalks in the 2016 CIP were funded by transportation bonds, nearly $1M were allocated in that year and nearly $5.5M over a five year period (City of Georgetown, 2016). The 2018 CIP incorporates multiple road projects that correspond with the locations of proposed bicycle improvements in Bike Georgetown. Funds for most of these road redesign or resurfacing projected are set be expended in 2020-2022, creating an opportunity to work the proposed bike lanes or treatments into the design of the project (City of Georgetown, 2018).

Some projects on the list already have a funding source in mind, or have had outside agencies involved in the planning process that may also be able to assist with funding. This include the Northwest Blvd. project which is already included in the Transportation Bond passed in 2015 (City of Georgetown, 2015), and the Williams Dr. project which heavily engaged CAMPO in the planning and design process (City of Georgetown & CAMPO, 2018). Although the Williams Dr. project itself may not have originally qualified based on the rubric to apply for CAMPO TA set aside funds, the familiarity of the MPO with the project could make this application a good fit for this project.

As a note, bonds may be a an excellent options for future projects. Georgetown approved a Transportation Bond in 2015 which authorized $105M to fund transportation projects over a 10 year period. Projects from the City's 2014 Master Sidewalk Plan were incorporated into that bond and proposed sidewalk segments have been built out as planned. Road projects funded in the planning and design phases by this 2015 bond could still potentially incorporate bicycle infrastructure, including streets proposed for bike improvements in the Georgetown Bicycle Master Plan such as DB Wood Rd., Shell Rd., Williams Dr., East University Ave., and SE Inner Loop (City of Georgetown, 2015).

Should another transportation bond be brought to Georgetown voters in the future, incorporating bike infrastructure specifically, as sidewalks were incorporated into the 2015 bond, could be a very impactful and efficient way to fund some of the most critical routes.