



# City of Lawrence Transit Redesign Study



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## **Introduction**

Over the past decade, the Lawrence community has discussed, debated, and studied a permanent location for a primary bus transfer facility. The City conducted two site selection studies in 2014 and 2018, in addition to a TIGER grant application in 2016 that was not awarded.

In July 2020, the City and the University of Kansas signed a legal agreement to move forward with further study and development of a multimodal transfer facility on university property located at Bob Billings & Crestline Drive. This location takes into account community feedback from prior studies that sought a relatively central location and one that did not encroach on established neighborhoods.

As the City and KU continue moving forward on the legal and technical requirements for this site, it is critical to begin community discussions early about redesigning routes to serve this new primary transfer facility.

University of Kansas Urban Planning 758 students are assisting in this effort by conducting a Route Redesign Study. In this study current travel behavior and socio-demographic data is analyzed in order to identify areas within Lawrence which demand transit service. Various transit network designs are reviewed in order to provide an overview of possible alternatives which could be incorporated in the city's redesigned network. Given the findings of previously detailed tasks, three varying transit system networks are then presented which deliver adequate service within the City of Lawrence. These tasks compose the sections of this report.

## Section 1: Community Overview

The purpose of this section is to briefly review the data collected, our sources for the data, and our observations from mapping the data.

We collected sociodemographic, boarding, and jobs data from the following sources:

- U.S. Census Bureau. 2018: ACS 5-Year Estimates Data Profiles
- U.S. Census Bureau. 2019: ACS 5-Year Estimates Data Profiles
- 2017 LEHD Origin-Destination Employment Statistics
- City of Lawrence and Lawrence Transit

After we collected the data, we used it to create maps in ArcGIS to provide a visual, spatial display of the data.

### Boardings (Maps 1-4)

Average daily boardings during the 2019 academic year are presented by census block groups and stations in Maps 1 and 2 respectively. The same data is presented for the summer term in Maps 3 and 4. Usage of the transit system varies considerably between KU's summer and Fall/Spring sessions as a result of variations in student enrollment. For this reason, boarding data is presented separately between these two terms.

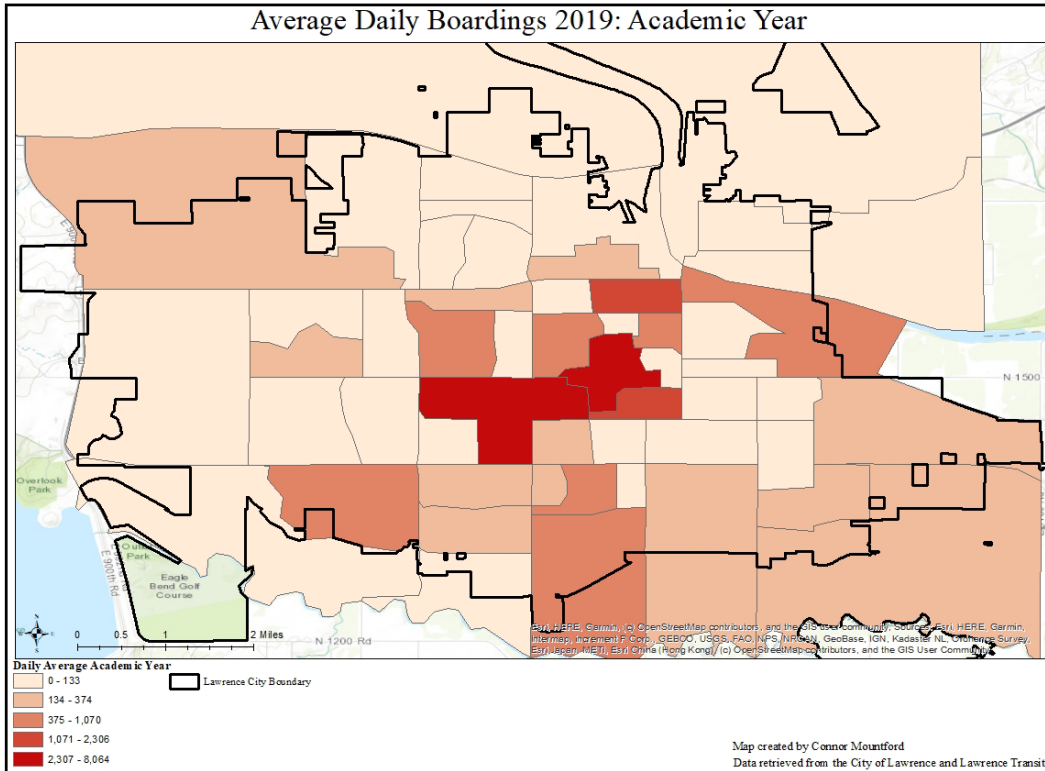
Boarding data was compiled to better comprehend how passengers utilize the existing transit system. Frequencies of boarding activity also can signal towards the presence of prominent destinations nearby. Ultimately, this data is very influential in informing the placement of transit infrastructure in forthcoming transit system alternatives.

During the academic year, it is evident that heightened boarding activity is occurring in central Lawrence (Maps 1-2). Most is concentrated within, or adjacent to, the KU campus. There is also heightened boarding activity, although to a lesser degree, in Downtown, south Iowa Street, SW Lawrence, and E Lawrence. Reviewing station specific data, it is made clear that much of this activity is originating within KU Lot 301/302 and along 15<sup>th</sup> Street. Prominent travel paths are also visible both in the East/West (6<sup>th</sup> Street, Bob Billings Pkwy, Clinton Pkwy/W 23<sup>rd</sup> St) and North/South (Massachusetts Street) designations. Given the heightened use of transit in these areas, they will be prioritized for service accordingly in forthcoming transit system proposals.

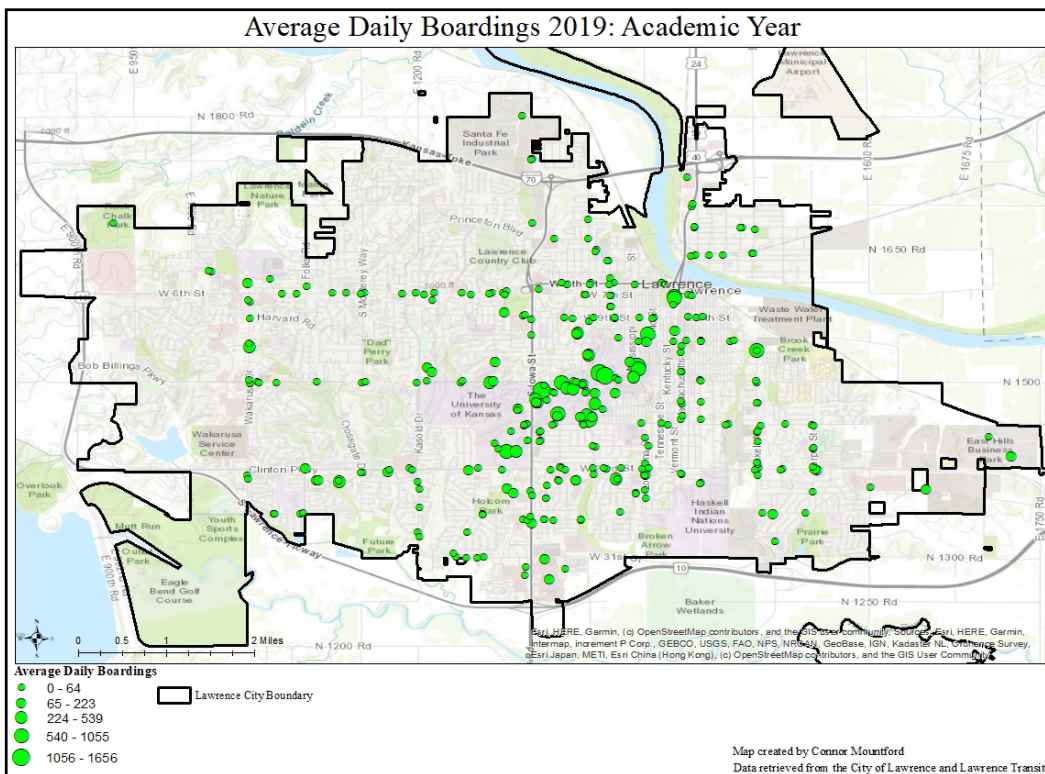
During the summer term (Maps 3-4), heightened boarding activity is observed in Downtown Lawrence and, although to a lesser degree, on the KU campus, south Iowa Street, NW Lawrence, SW Lawrence, and SE Lawrence. A review of station specific boarding activity helps identify downtown, Target and Walmart on south Iowa street, and the 25th street & Franklin station near the Douglas County Jail as major activity generators. Detailed boarding data is presented in Appendix A.



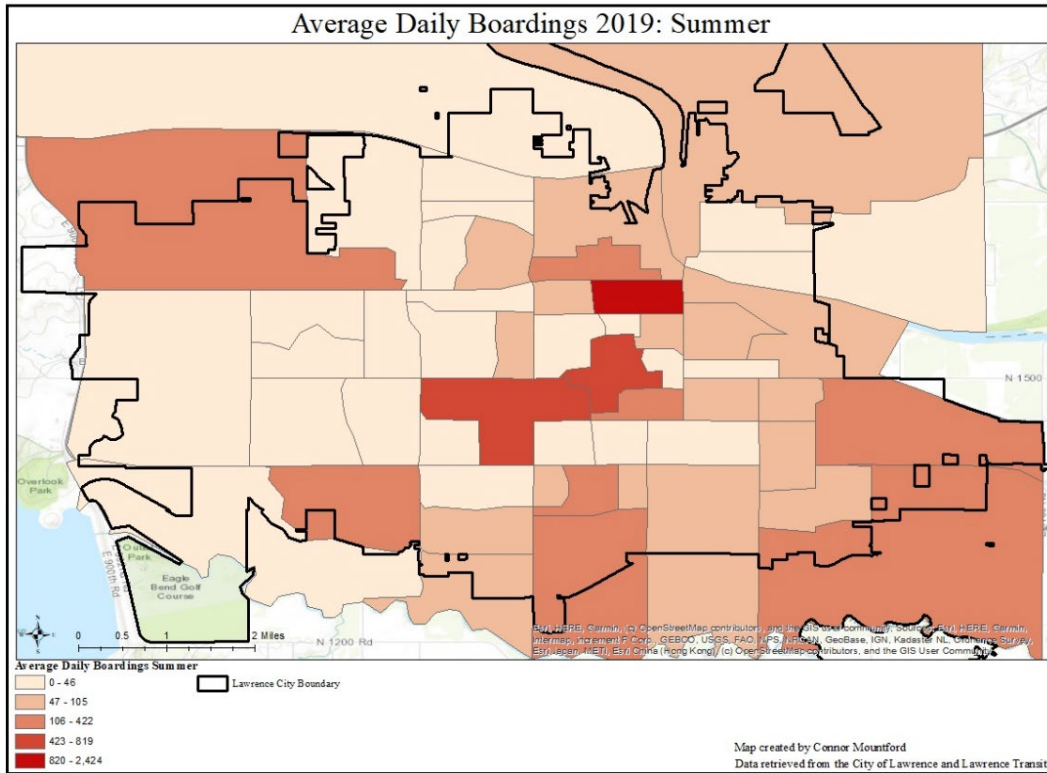
Map 1



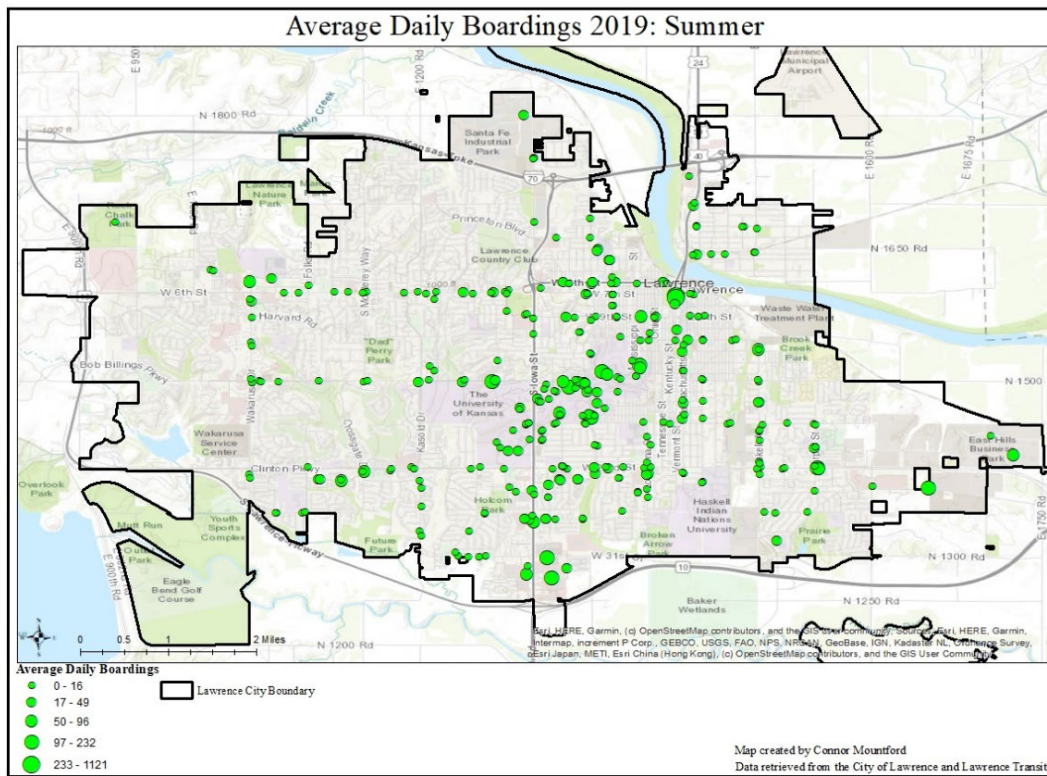
Map 2



Map 3



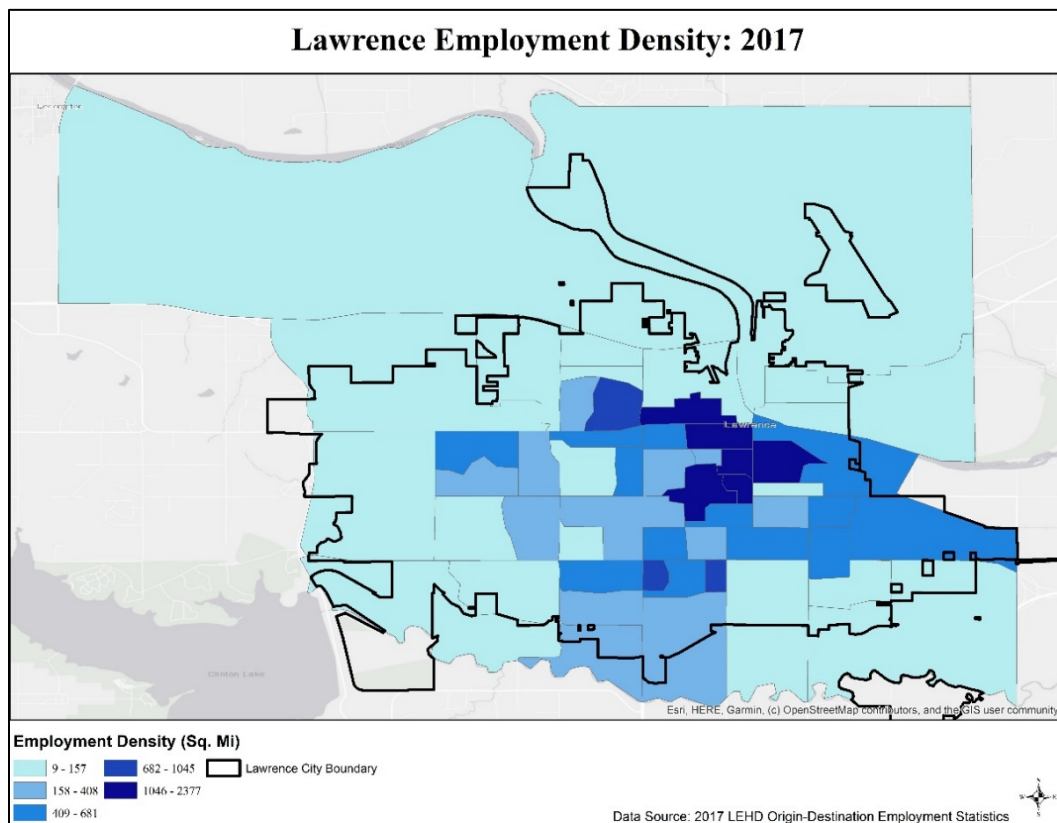
Map 4



### Employment Density (Map 5)

Employment density is presented via census block groups. The highest employment density is found on the KU campus and to the north and east of campus, concentrated around Downtown and along 6<sup>th</sup> Street between Downtown and Iowa. The high employment density on this section of 6<sup>th</sup> Street is explained by the presence of the Lawrence Memorial Hospital and other medical facilities, as well as retail in the area. There are also pockets of higher employment density on south Iowa Street, which is a function of considerable commercial activity in the area. It is a priority of the proposed transit alternatives to connect to major employment centers as identified in this map.

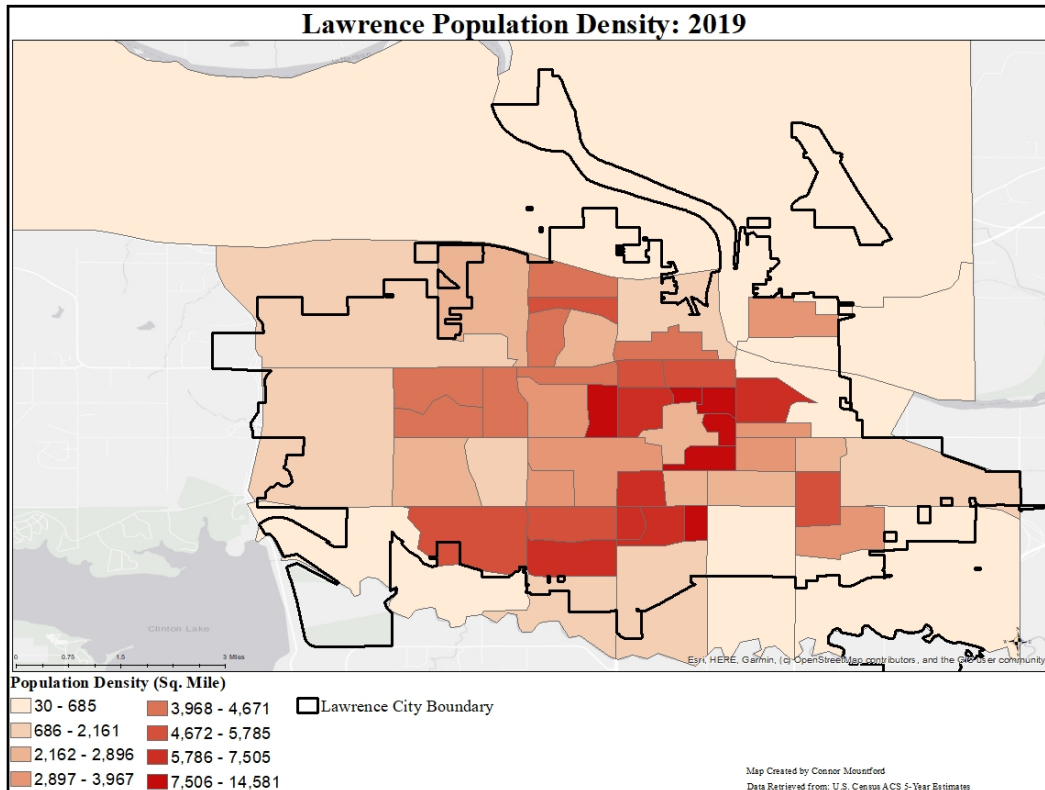
Map 5



### Lawrence Population Density (Map 6)

Population density is presented via census block groups. The densest population areas are adjacent, or in proximity, to the KU campus. Another area of higher population density can also be found along Clinton Parkway/W 23<sup>rd</sup> Street in areas where there are a significant number of apartments and other multi-unit dwellings. Proposed transit alternatives will prioritize serving areas with heightened population densities, such as those identified in this map.

Map 6





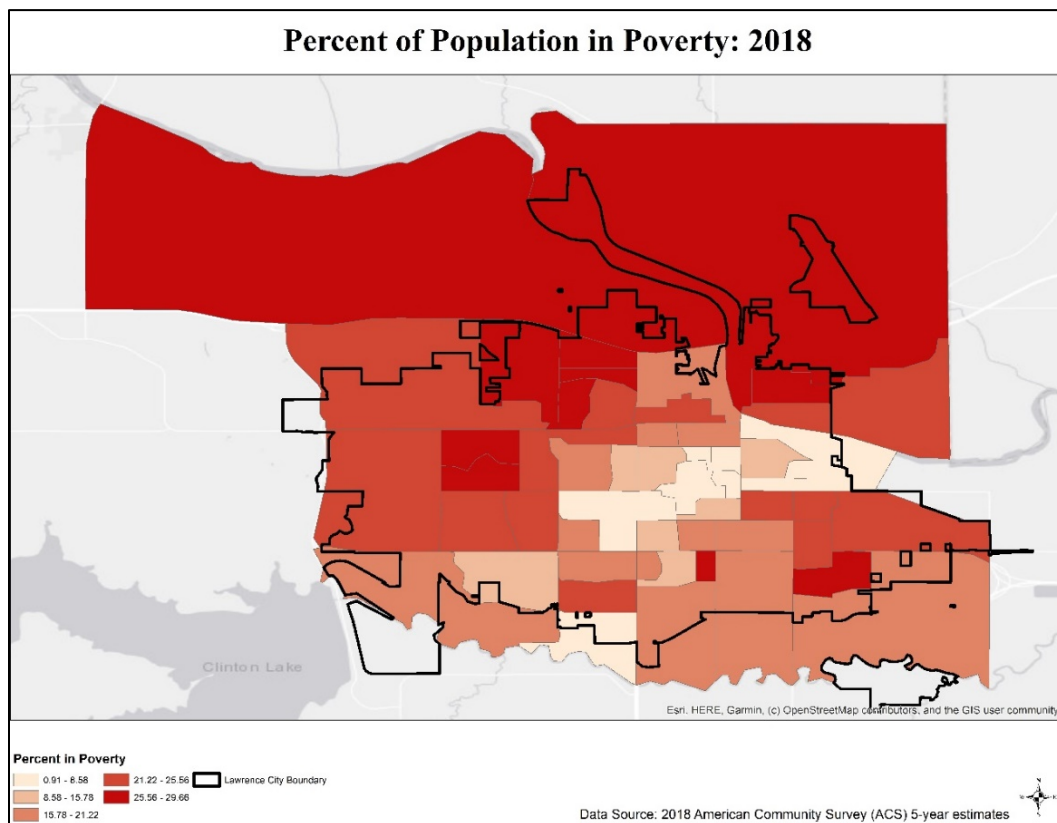
## Equity Oriented Sociodemographic Information

The following maps depict concentrations of segments of the population which may be more likely to be transit dependent. Identifying heightened concentration of such populations better allow for the development of an equitable transit system as service can be modified to better serve in need areas. Forthcoming transit alternatives will prioritize the provision of service in areas deemed to be of high need.

### Percent Population in Poverty (Map 7)

Households classified as being impoverished are likely to have limited resources which makes it difficult to afford the costs of auto ownership. Their mobility may be compromised as a result. It is necessary to connect such households with affordable transportation alternatives in an effort to mitigate this negative impact on their mobility. Northern Lawrence is home to heightened concentrations of households which are impoverished.<sup>1</sup> Additional pockets can also be found in West and SE Lawrence.

Map 7



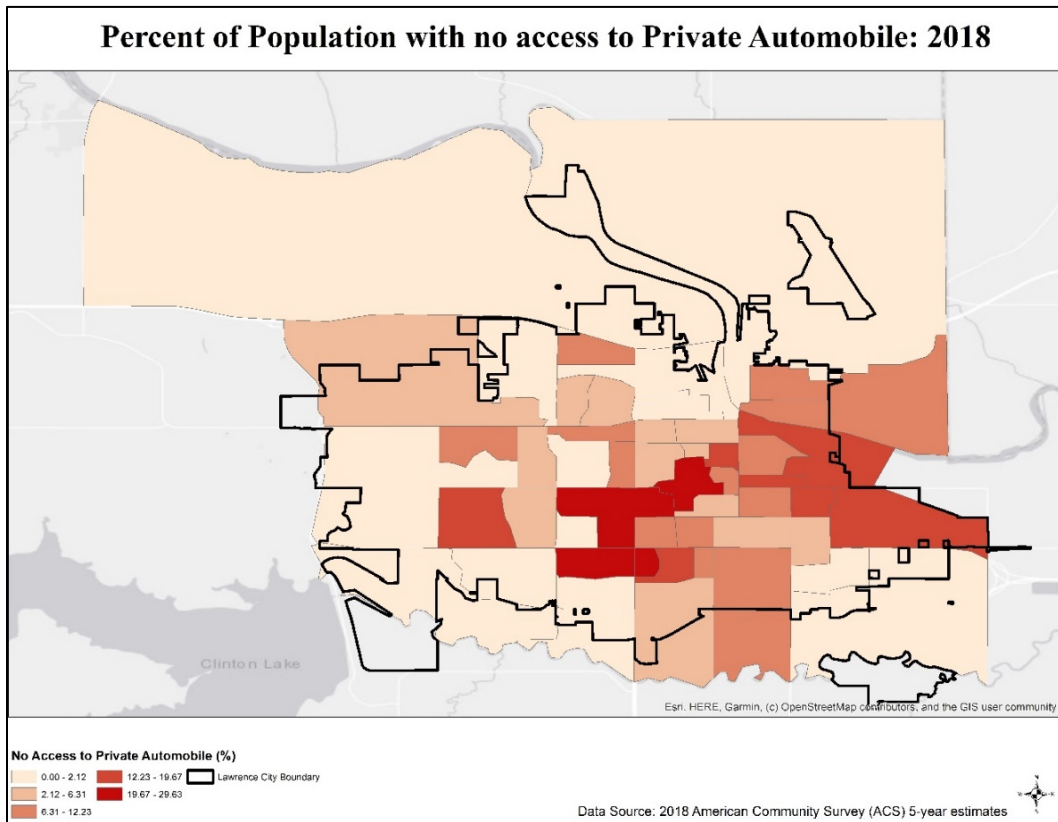
<sup>1</sup> It should be noted that the large areas outside the city limits of Lawrence to the north are rural areas that are one continuous census block that includes North Lawrence.



### Percent Population with no Access to an Automobile (Map 8)

People with no access to a private automobile are more heavily concentrated in central Lawrence and around the KU campus. It can be inferred that some of those numbers include college students that do not have cars and rely on other forms of transportation. There are additional pockets of populations with no auto access in East Lawrence.

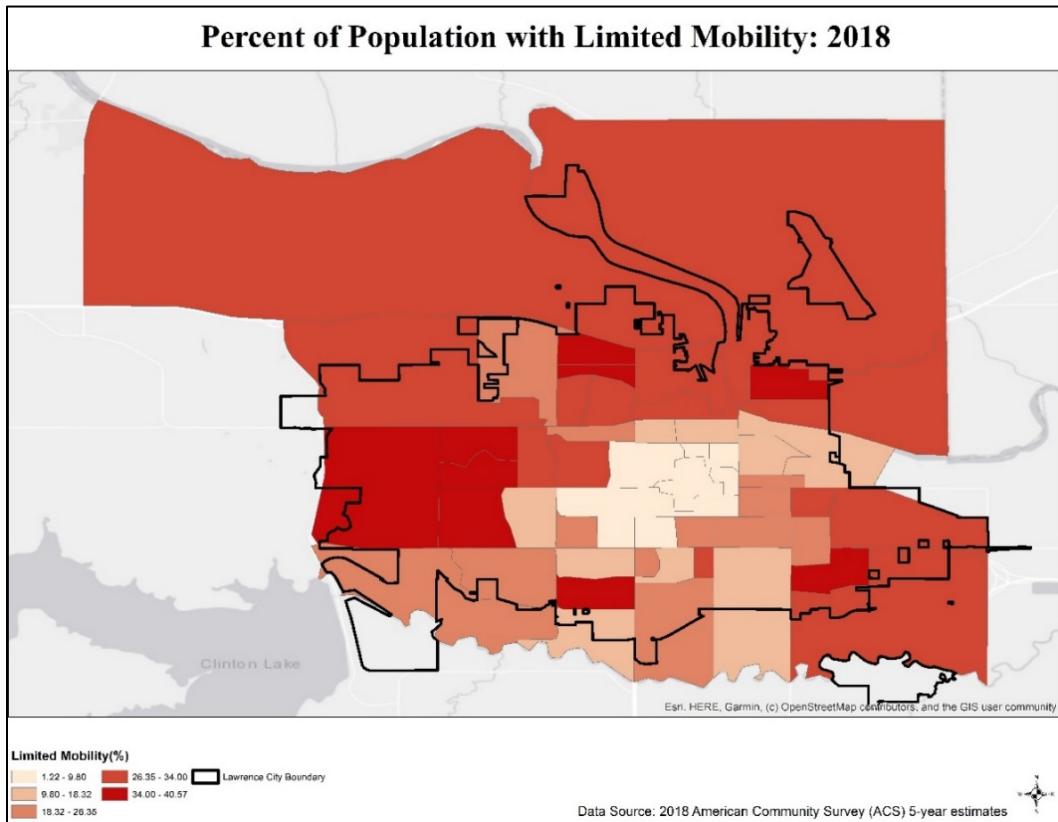
Map 8



### Percent of Population with Limited Mobility (Map 9)

The concentration of people under the age of 18 and over the age of 70 was determined within census block groups which compose the city of Lawrence. People within these age ranges are likely to have difficulties driving due to limitations associated with their age. It is then essential to provide them access to alternate modes of transportation in an effort to enhance their limited mobility. There are heightened concentrations of people within this designated age range in West Lawrence. Additional pockets of heightened concentrations can also be found in North, NE, South, and SE Lawrence.

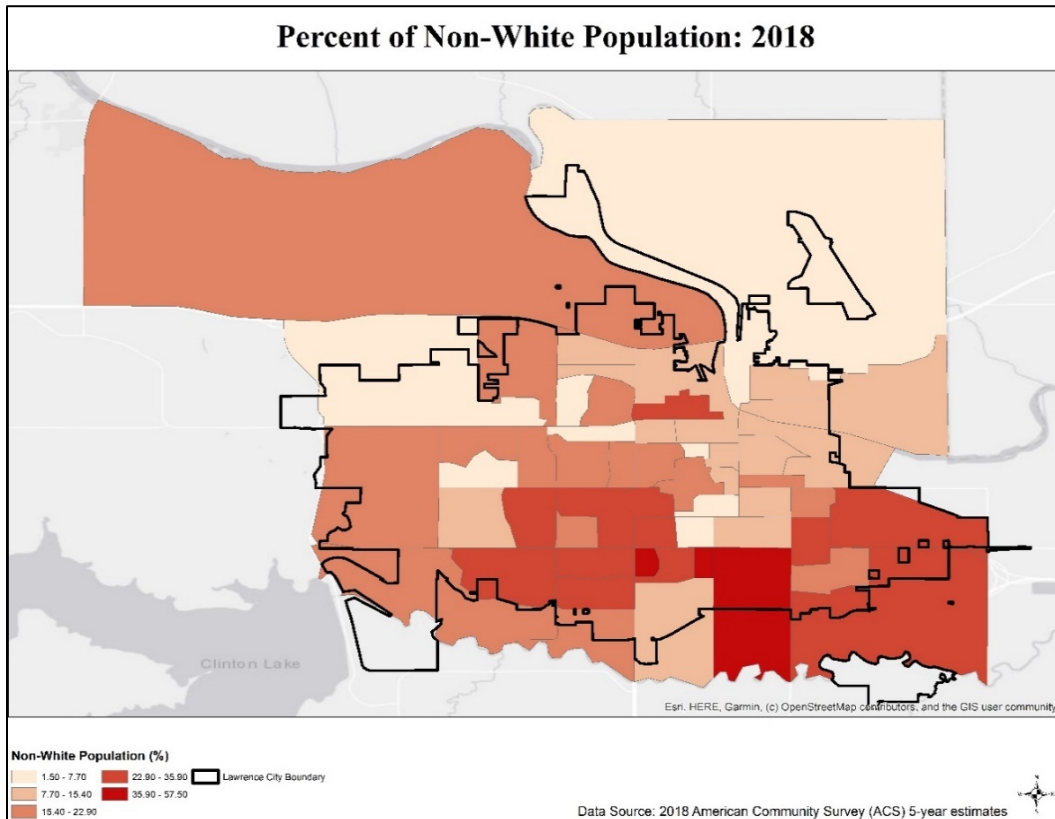
Map 9



### Percent of Non-White Populations (Map 10)

Non-white populations have historically been underserved when it comes to the distribution of community services and resources. From an equity standpoint, it is necessary to identify areas with heightened concentrations of non-white populations to assure that they are being served by the transit system. Heightened concentrations of non-white populations are most commonly found in South Lawrence along Clinton Pkwy/W 23<sup>rd</sup> Street.

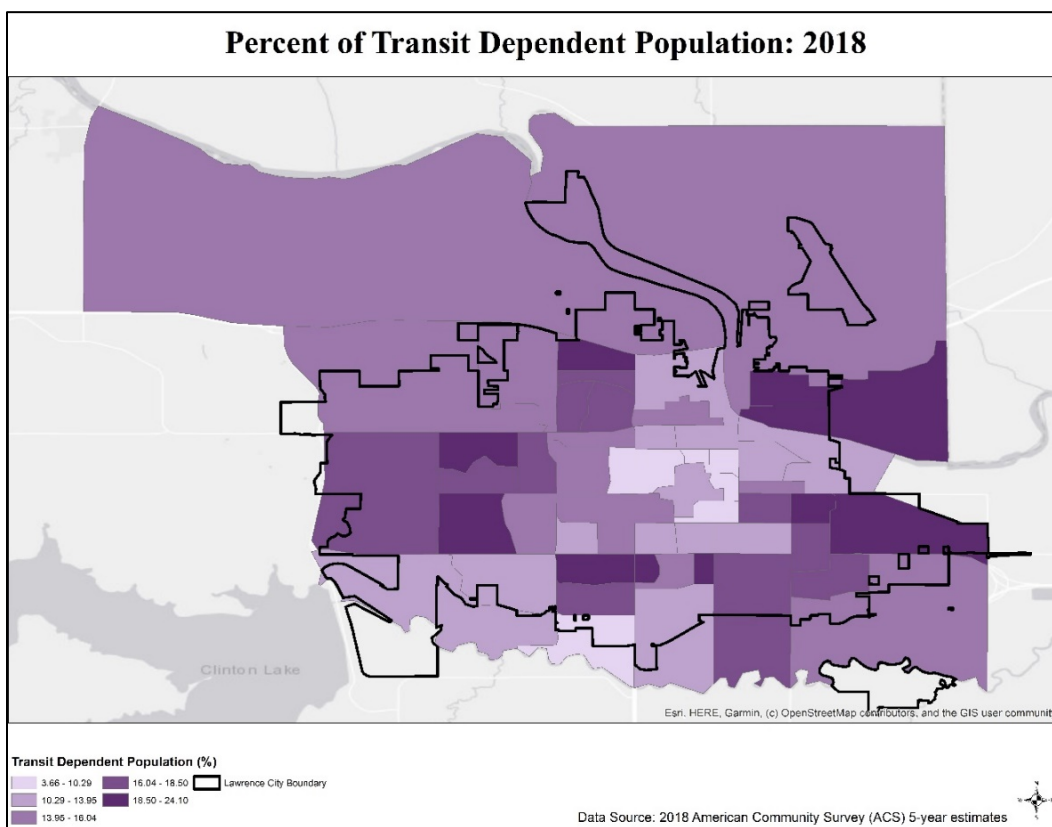
Map 10



### Transit Dependent Populations (Map 11)

Transit dependent populations are those who are statistically most vulnerable to transportation barriers and more likely to depend and use public transit. The demographic factors associated with being transit dependent are those represented in this section: no access to a private automobile, poverty status, minority, and limited mobility. This data was compiled for census block groups and each factor was assigned a weight and combined in order to present the percentage of a population which is transit dependent. As presented in the corresponding map, heightened concentrations of transit dependent populations are found scattered throughout the City of Lawrence. It will be the objective of forthcoming transit alternatives to deliver service to these areas.

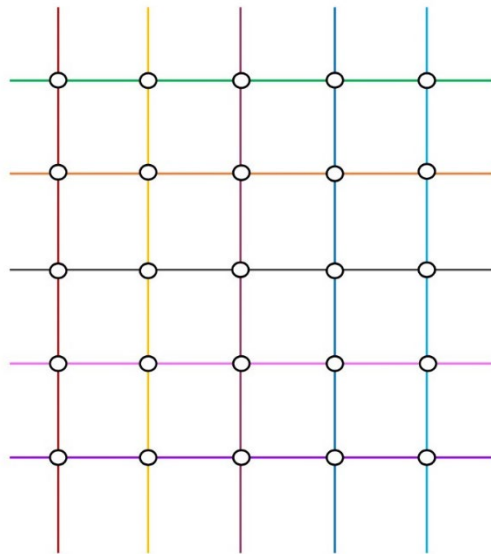
Map 11



## Section 2: Network Design Review

The purpose this section is to provide a review of commonly implemented transit network designs. This review can provide a broader and deeper understanding of potential solutions which the City of Lawrence and Lawrence Transit may consider when reimagining their transit system. An overview, strengths, and weaknesses are presented for grid, radial, and ubiquitous transit network designs. Real-world examples of each design concept are also detailed within this section.

### Grid Network Design



Grid networks place transit routes along continuous vertical and horizontal corridors, providing a uniform coverage area with many transfer points. Due to the uniform distribution of routes implemented by this network type, they are more commonly found in areas with relatively consistent development densities. Grid networks are also appropriate in cities with geographically dispersed employment centers or high employment corridors.<sup>2</sup> This design relies on the presence of a grid like road network, which is more commonly found in populous historic cities. In the United States, these include New York, Chicago, Philadelphia, Phoenix, and Portland.

The main benefit of grid networks is their large area coverage. If routes are placed strategically, universal coverage within a ¼ mile (5-10-minute walk) can be achieved. This creates the opportunity to attract new passengers, especially those whose destinations are outside of downtown. Additionally, the simplicity of route paths in a grid network (straight line, L, and U shaped) make the network easier to understand and have the potential to improve operating efficiency.

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<sup>2</sup> Nocera, Silvio, Fabio Alberto, and Cavallaro Federico. 2019. "The adoption of grid transit networks in non-metropolitan contexts." *Transportation Research Part A* .



The trade-off for greater area coverage and simple routes is the increased reliance on transfers.<sup>3</sup> A transfer is when a passenger must exit one bus and board another to reach their destination. In most cases, reaching one's destination can be achieved within a single transfer from a horizontal to a vertical line or vice versa. However, if there are breaks in the street grid multiple transfers are likely for longer trips.

#### *Grid Network in Action: Phoenix, Arizona*

The Valley Metro transit agency operates an expansive grid network that connects downtown Phoenix, Arizona with surrounding suburbs including Tempe, Glendale, and Scottsdale. To create this grid, several north/south and east/west routes were created along many of the city's arterial roads. Most routes are structured in a manner which allows them to operate on a single street rather than be based out of a downtown terminal (see Figure 1).

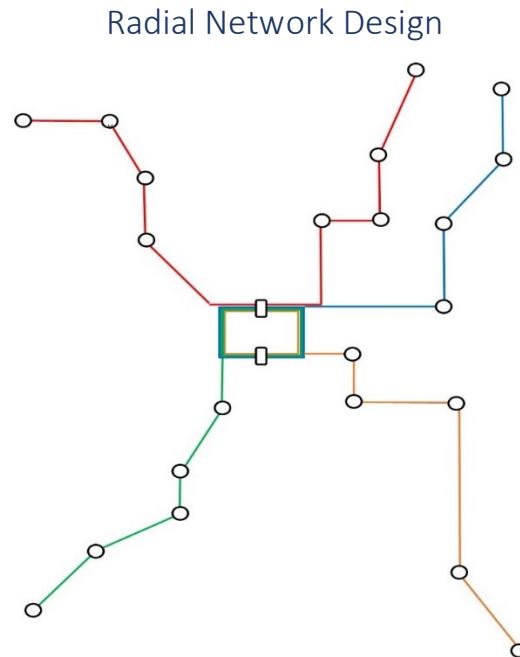
A total of 102 routes, 7,712 stations, and 893 vehicles are used to deliver bus service within this area<sup>4</sup>. The expansive grid design maximizes system coverage and makes the system very accessible, especially to the roughly 2.1 million people who reside within ¼ mile of a bus route. This amounts to 51% of the population within the county where service is delivered. The coverage of the grid bus network allows for the connection of major destinations scattered throughout the region, which include several major universities.

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<sup>3</sup> Vuchic, Vukan. 2005. *Urban Transit: Operations, Planning, and Economics*. John Wiley & Sons .

<sup>4</sup> Valley Metro Fact Sheet. <https://www.valleymetro.org/about/agency/fact-sheets-brochures/fact-sheets>





A radial network design, also called a hub and spoke design, is composed of a central station which most routes connect to. Terminals are built at that central station and connect to areas in the urban periphery. Since radial networks converge at one point, they are ideal in cities which have a concentration of destinations in a particular area, such as downtown.

Historically, dominant travel patterns have seen people commute from residential communities in the urban periphery to employment opportunities in the city center. A major benefit of a radial network design is that it efficiently supports such activity as transit routes are designed to follow major travel corridors and converge at a central station.<sup>5</sup> An additional benefit of this design is that most trips won't require a transfer, given that destinations are concentrated near the central station. Given that most lines converge at the central station, a radial network transit system has the ability to transfer a vast amount of people to and from the central city while limiting congestion across transit routes.

There are various limitations associated with the implementation of a radial network design. The most glaring of limitations is that this network design may not attract trips which are not oriented towards the central station. This is due to the necessity to travel to the central station in order to transfer to another line. This can elongate the travel time experienced by passengers undertaking such trips and influence their mode selection decision. Another limitation of this network design is its ability to produce congested road environments near the central station. Given that most routes will converge at this location, buses can accumulate on adjacent streets. This can create a multitude of issues, one of which is the deterioration of on-time performance.

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<sup>5</sup> Vuchic, Vukan. 2005. *Urban Transit: Operations, Planning, and Economics* . John Wiley & Sons .

### *Radial Network in Action: Tallahassee, Florida*

StarMetro operates local bus service within Tallahassee, Florida. Tallahassee is home to the state capitol and two major universities, all of which are connected via a radial like bus network.

At the city center lies C.K. Steele Plaza. This plaza serves as the major transfer facility, and central focal point, of this radial like network. Fourteen of the fifteen transit routes which deliver local bus service connect at this facility<sup>6</sup>. These routes extend outward from the central city to the urban periphery and follow major travel demand corridors. C.K. Steele Plaza was established as the central transfer station due to its proximity to downtown, state government offices, Florida State University, and Florida A&M University.

In addition to the fifteen routes which operate throughout the city, there are eight routes which specifically serve the Florida State University campus. A total of 68 vehicles are utilized to deliver bus service and over 162,000 people are considered to reside within the system's service area.<sup>7</sup>

Figure 2: Tallahassee System Map

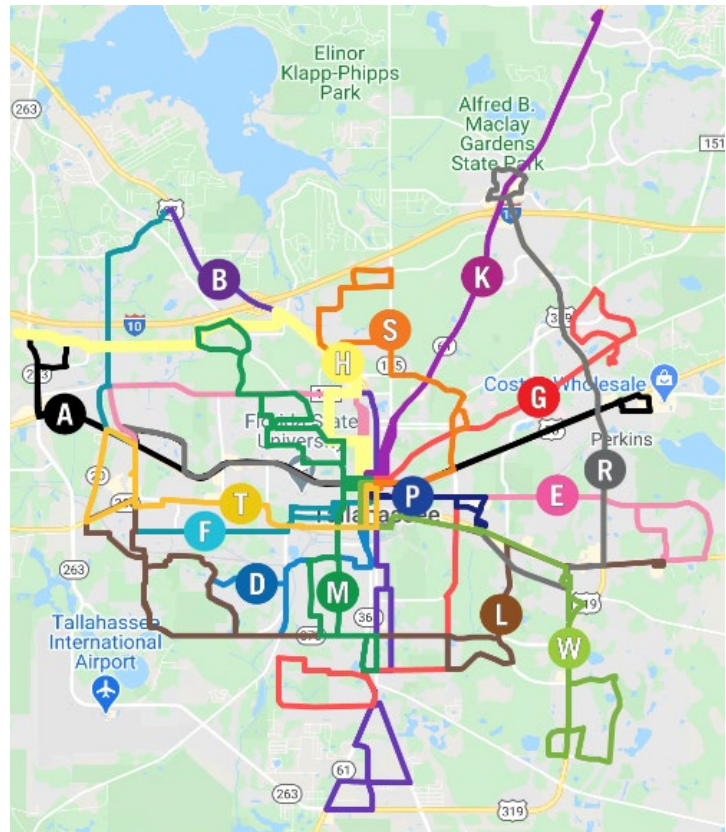


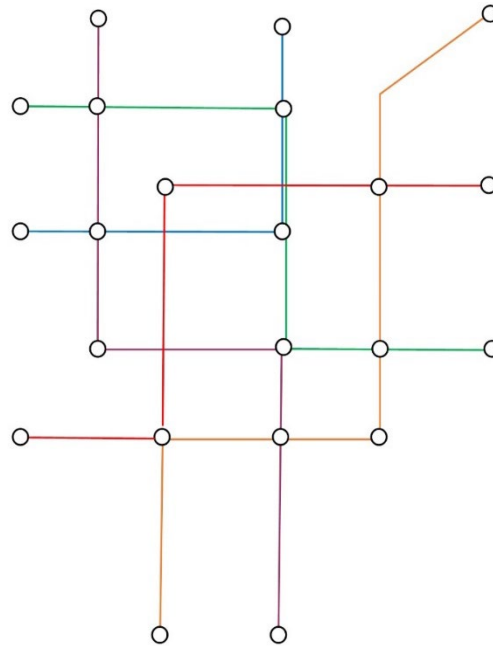
Figure 3: C.K. Steele Plaza



<sup>6</sup> StarMetro. <https://www.talgov.com/starmetro/sm-weekday.aspx>

<sup>7</sup> Federal Transit Authority, National Transit Database. <https://www.transit.dot.gov/ntd/transit-agency-profiles>

### Ubiquitous Network Design



Ubiquitous transit networks provide extensive coverage that connect all areas of the city using routes that pass through the center and connect at multiple transfer stations. These networks usually require well balanced passenger volumes across routes to be feasible. So, routes are typically placed along major travel corridors with transfer stations being located at major activity centers.<sup>8</sup> As a result, there is no focal point within this design concept as major transfer stations are located throughout.

The main benefit of ubiquitous networks is the high level of connectivity they provide. Intersecting routes produce a vast number of transfer opportunities which grant passengers ultimate flexibility in the delimitation of their trip. Passengers are able to pursue the most direct route to their final destination and, in a well-designed system, most trips can be made with a single transfer – including suburb to suburb trips. A ubiquitous transit system can thus experience many of the major advantages commonly experienced in grid and radial network designs.

An objective of a ubiquitous transit network is for it to be accessible to the vast majority of the population while connecting all major destinations. This can lead to the creation of an extensive system with a plethora of routes traversing an already chaotic urban environment. The complexity of the resulting system can make it difficult to navigate from a passenger perspective due to route complexity and the number of transfer stations present. Such a system would also be costly to implement due to the expansive nature of the network created.

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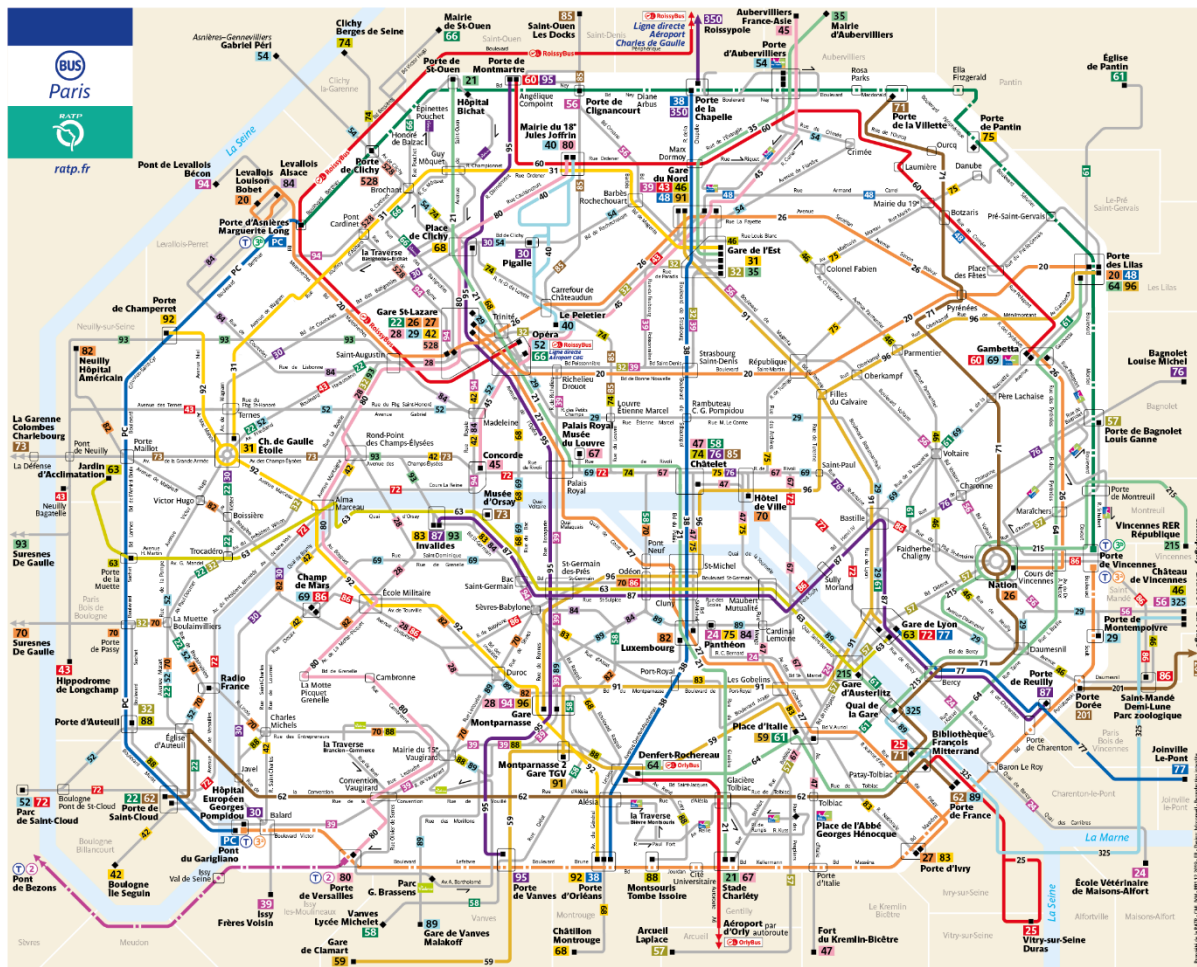
<sup>8</sup> Vuchic, Vukan. 2005. *Urban Transit: Operations, Planning, and Economics*. John Wiley & Sons .



### Ubiquitous Network in Action: Paris Metro

The Paris bus network is one of the most complete transit systems in the world with no point within the city being more than 1,500 feet from a station.<sup>9</sup> Each line operates independently starting in the periphery of the city and passing through the city center to a terminal station. The lines are irregularly shaped to serve major activity centers and connect with multiple other lines. A total of 64 bus routes operate within the city. Viewing the system as a whole, the number of crossing lines may appear chaotic and intimidating. Using this system may not be intuitive for some and require a great deal of planning.

Figure 4: Paris Metro System Map



<sup>9</sup> Vuchic, Vukan. 2005. *Urban Transit: Operations, Planning, and Economics*. John Wiley & Sons.

### **Section 3: Transit Redesign Alternatives**

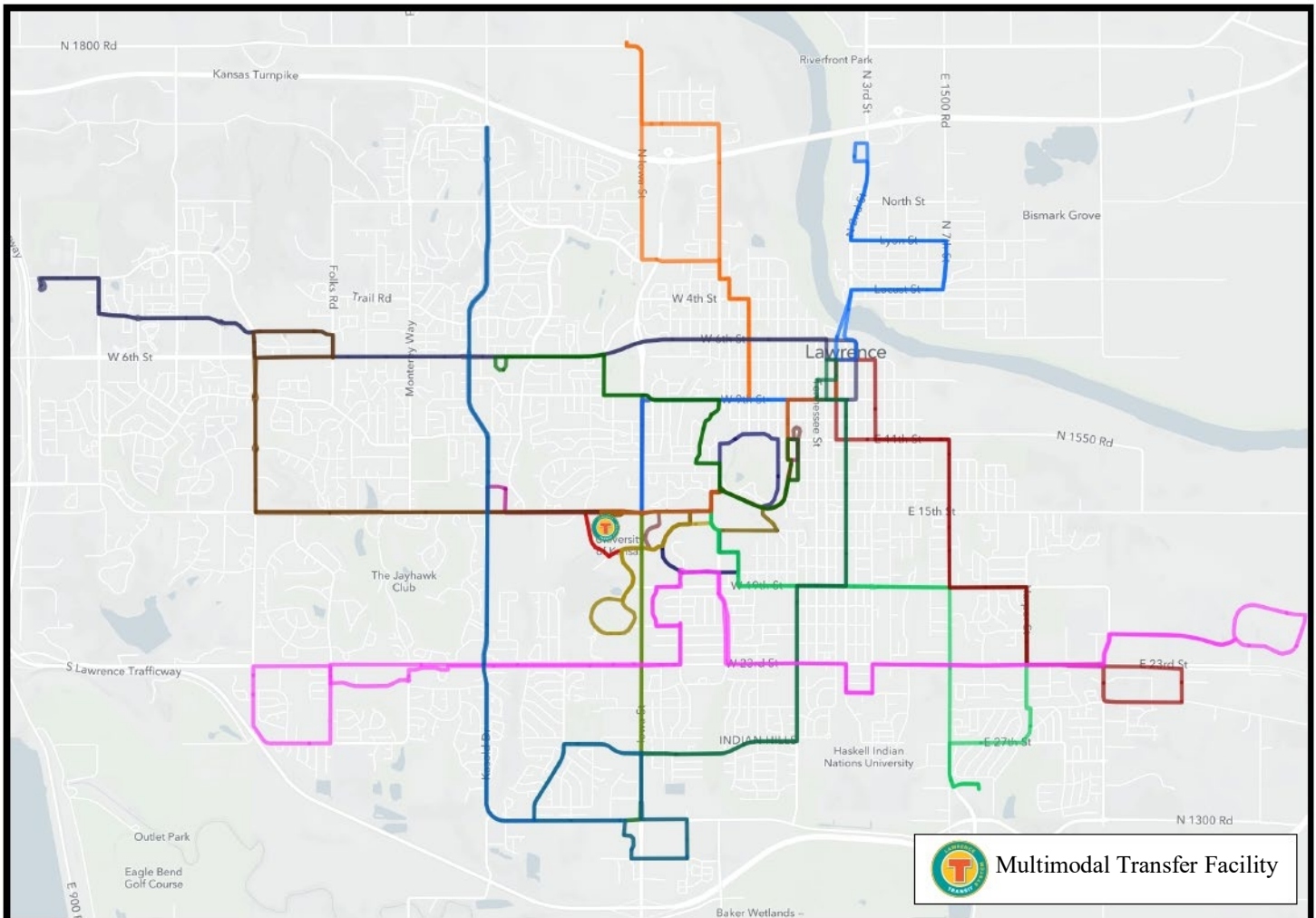
This section presents three transit redesign alternatives which could effectively serve the City of Lawrence based on each of the network design theories presented in section 2, and developed using the data analyzed in section 1 of this report. These conceptual scenarios have been capped by existing service hours and vehicle availability in order to ensure fiscal responsibility.

There are two variations presented for each alternative: the first shows the level of service when KU classes are in session for the fall and spring semesters, referred to here as “Academic Year”, and the second shows the base service for class breaks and summer semester, referred to here as “Summer”, when demand is considerably lower.

For each alternative, a system map is presented along with individual maps of every route which composes the system, and a table which describes the nature and purpose of each transit route.

## Alternative A: Grid System

Academic Year



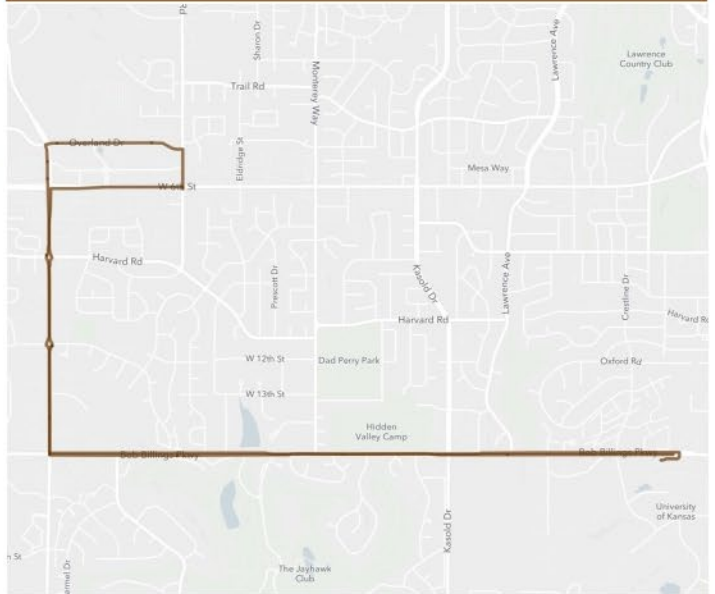
Alternative A implements a grid like design composed of 17 routes. Eight of these routes originate in the planned multimodal transfer facility located at Bob Billings & Crestline Drive and connect to major activity generators. Four circulator routes are retained to serve the KU Campus. Most routes are major north/south or east/west through routes which operate within major thoroughfares. It is these routes which help create the grid-like design presented within this alternative. The grid design, created via multiple intersecting routes throughout the service area, maximizes transfer opportunities for passengers. Transfer opportunities provide passengers the flexibility to adjust their trip as necessary to find the most direct path to their destination. Given the draw of Downtown Lawrence, five routes remain which provide direct access to this area.

### Routes

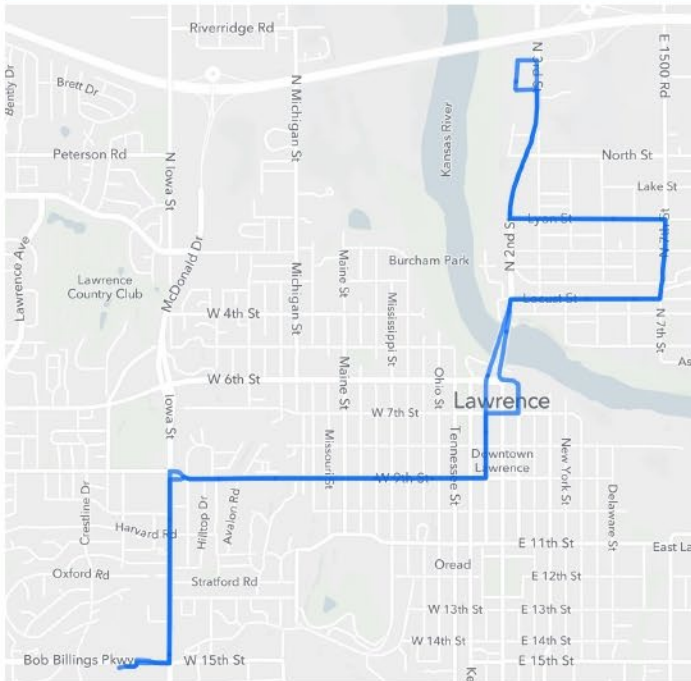
#### 1: E. Lawrence/Downtown



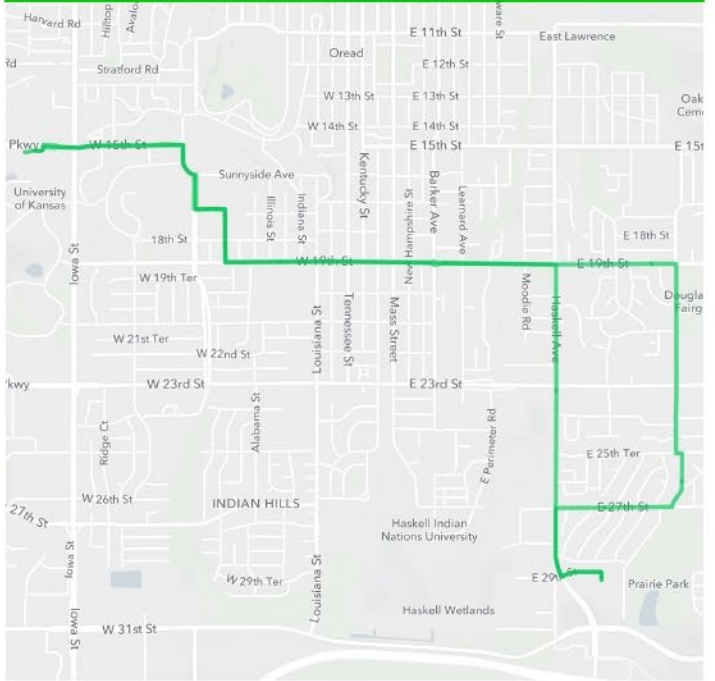
#### 10: Wakarusa/Bob Billings



#### 4: N. Lawrence/Bob Billings



#### 15: SE Lawrence/KU

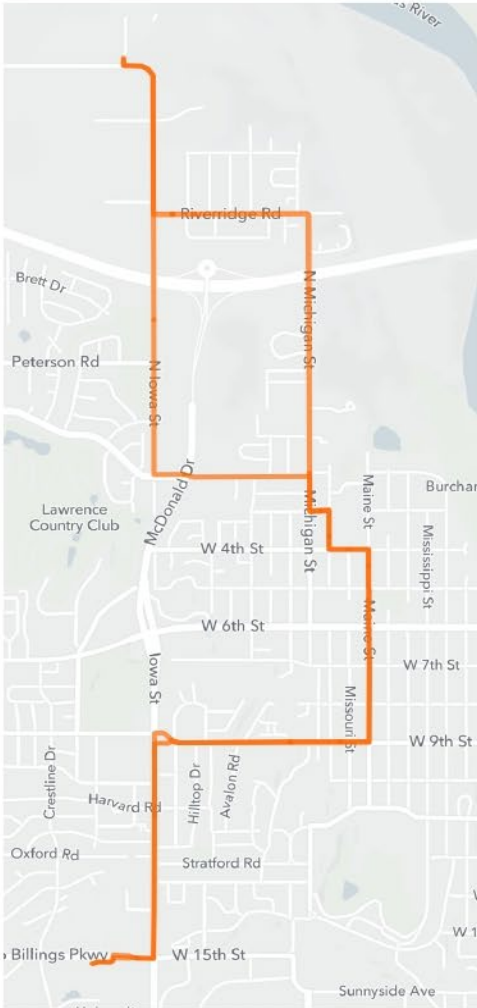




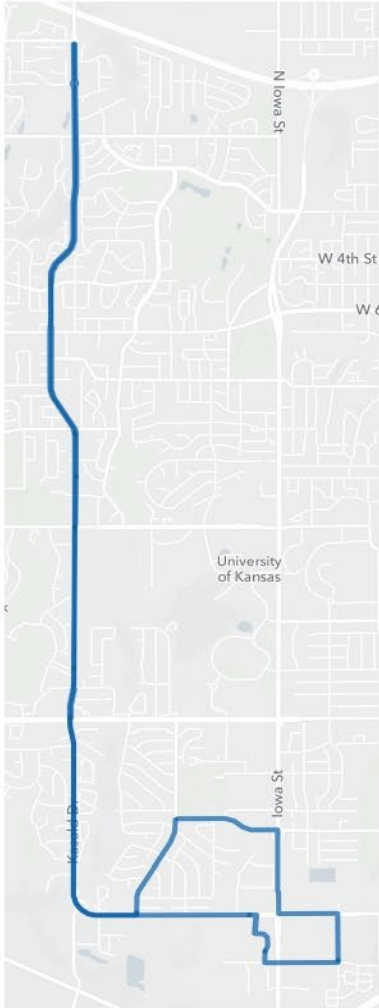
### 20: S. Iowa/Bob Billings



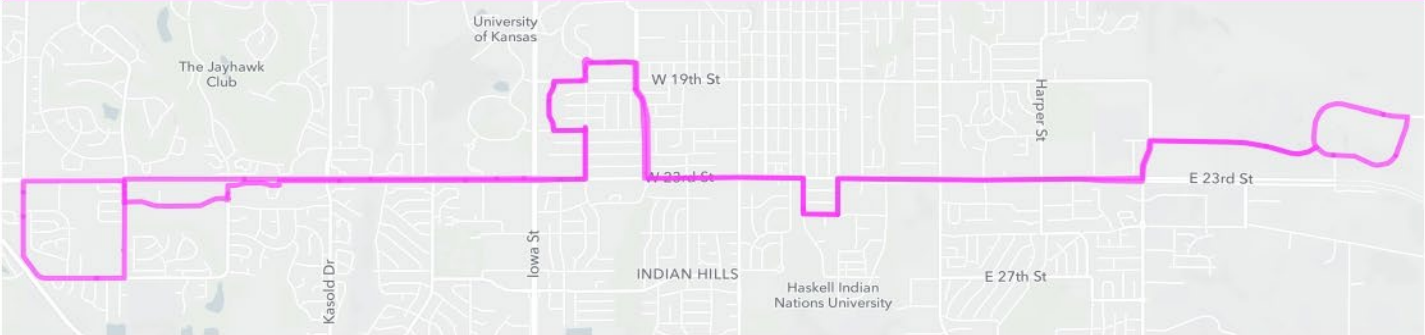
### 3: Riverridge/Bob Billings



### 17: Kasold/S Iowa

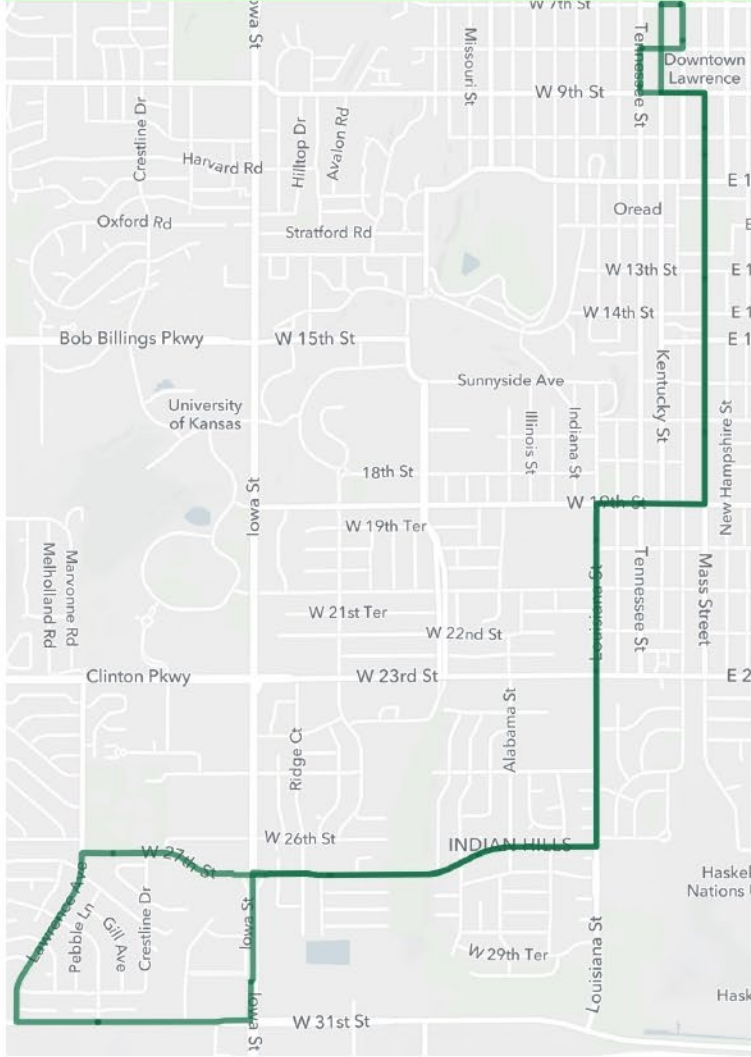


### 29: Clinton Parkway/Venture Park

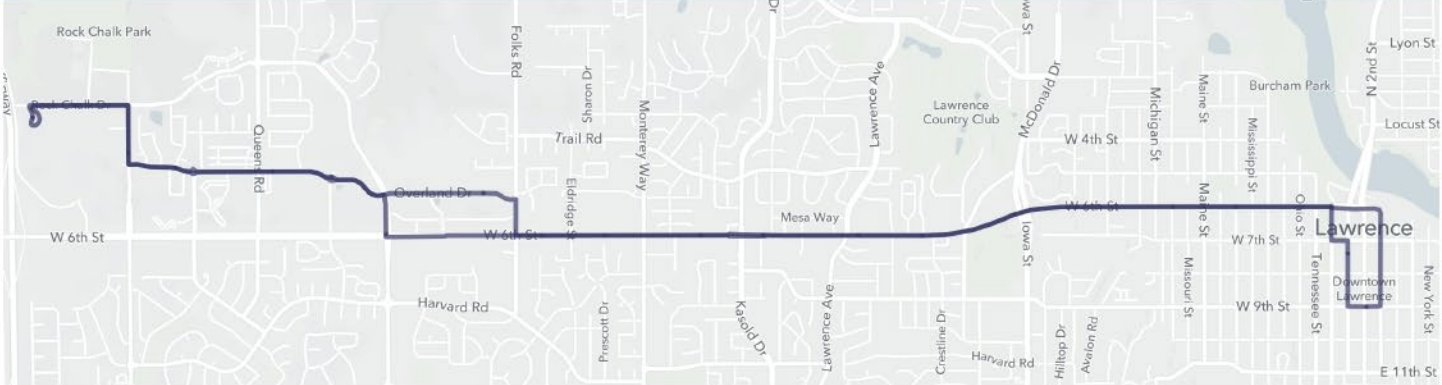




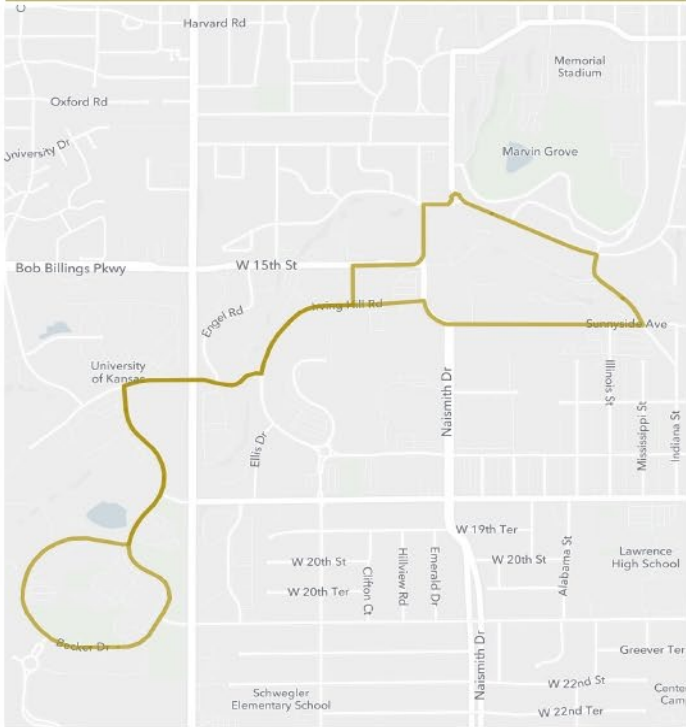
## 12: Indian Hills/Downtown



## 6: Downtown / LMH West



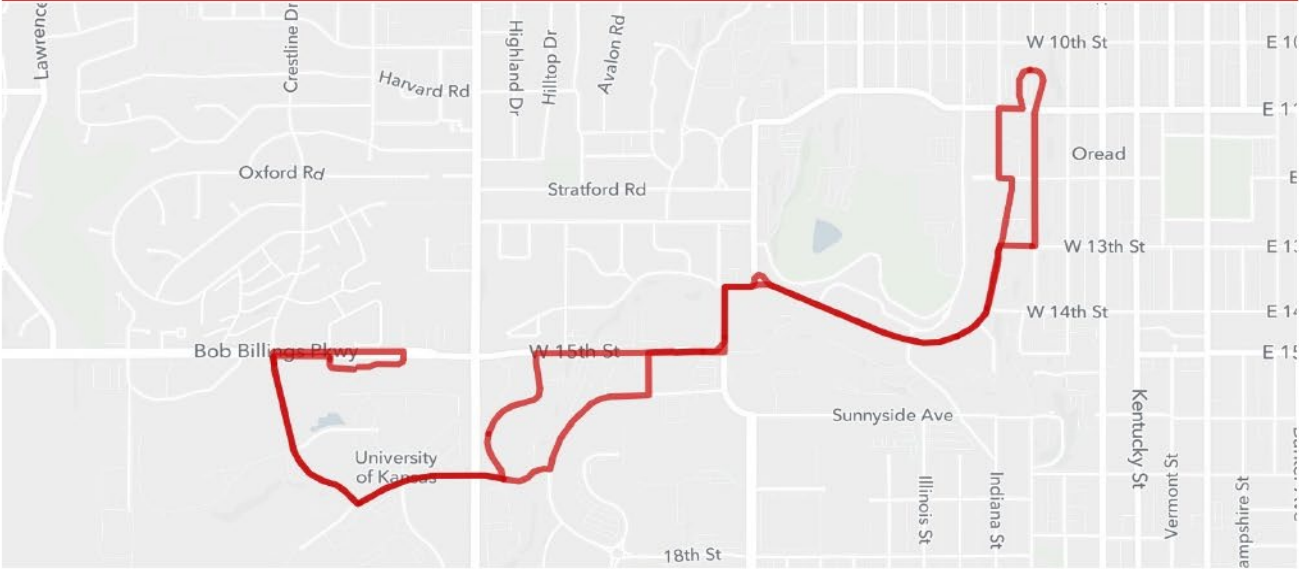
### 41: Yellow Campus Circulator



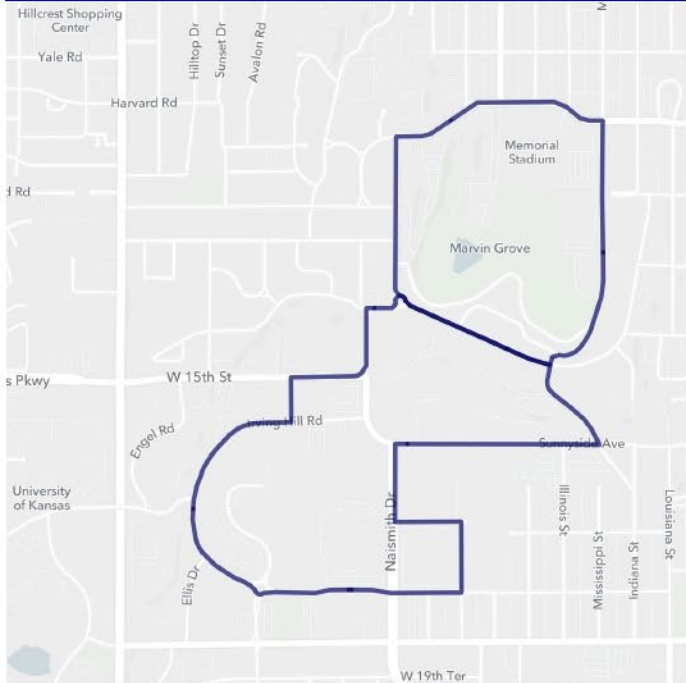
### 44: Evening Campus Circulator



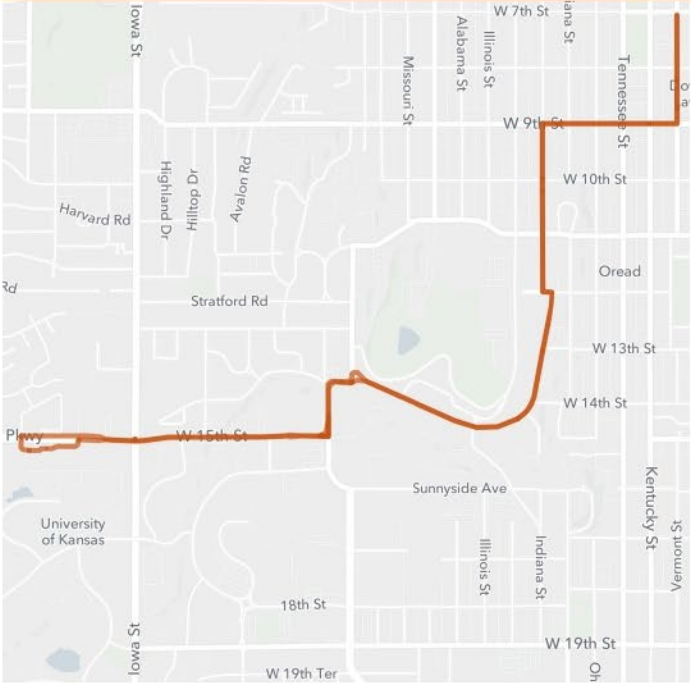
### 43: Red Campus Circulator



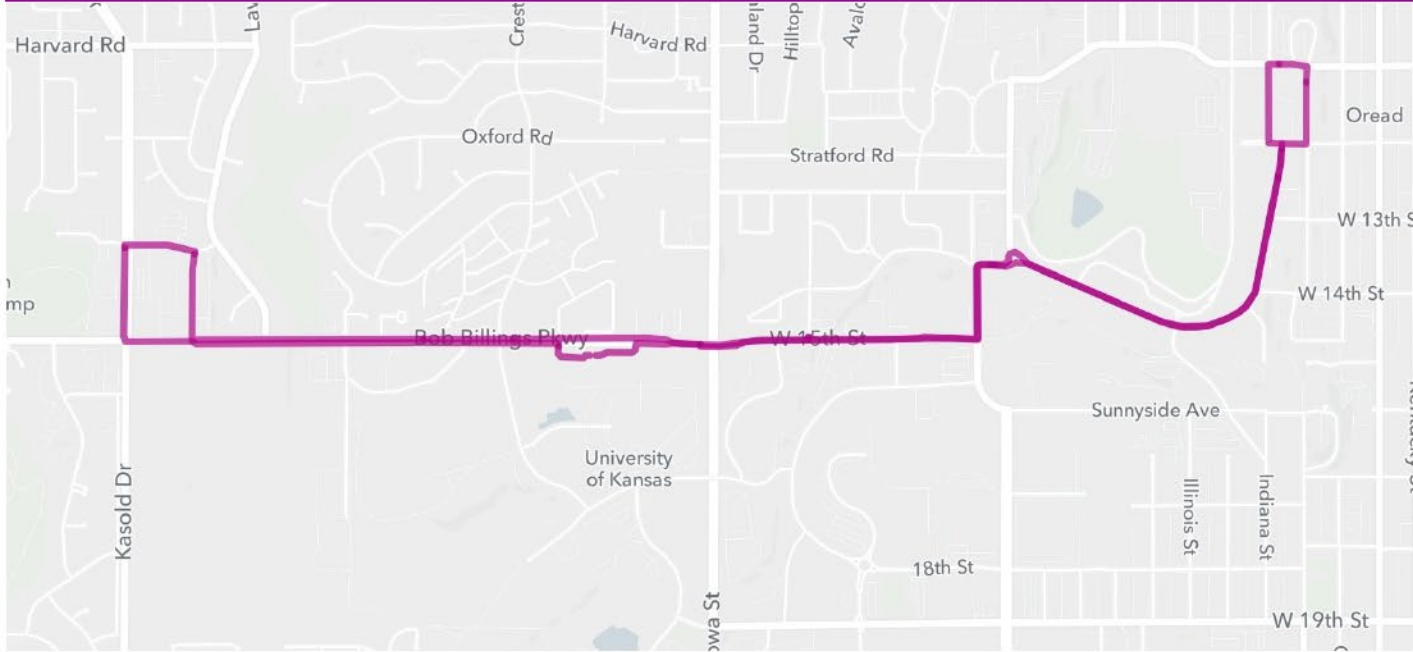
## 42: Blue Campus Circulator



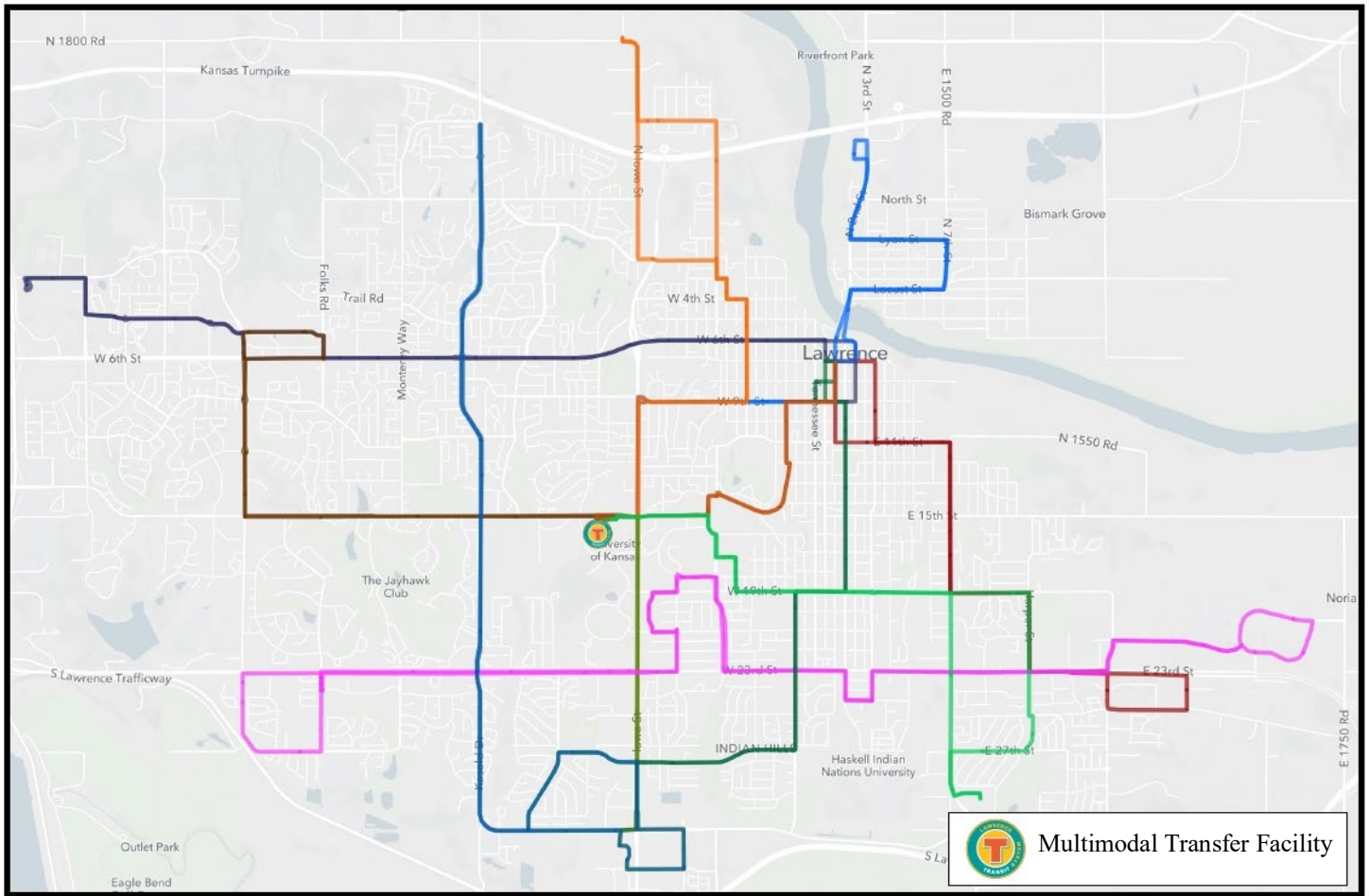
## 19: Bob Billings/Downtown



## 30: Bob Billings & Kasold/KU



Summer



The summer version of alternative A is composed of 11 routes. This alternative maintains a similar level of coverage as the academic year but reduces the number of routes that circulate on the University of Kansas campus. Frequency across all routes is also reduced. Summer service includes these routes:

Route	Name	Route	Name
1	E. Lawrence / Downtown	15	SE Lawrence / KU
3	Riverridge / Bob Billings	17	Kasold / Iowa
4	N. Lawrence / Bob Billings	19	Bob Billings / Downtown
6	Downtown / LMH West	20	S Iowa / Bob Billings
10	Wakarusa / Bob Billings	29	Clinton Parkway / Venture Park
12	Indian Hills / Downtown		

## Alternative A Route Descriptions

Route	Description
1	Route 1 delivers service to SW Lawrence and provides a direct connection to downtown. Its orientation allows it to intersect with six other routes, producing numerous transfer opportunities for passengers.
3	Route 3 delivers service to northern Lawrence via the multimodal facility located at the intersection of Crestline & Bob Billings. Major destinations serviced by this route include Lawrence Memorial Hospital and a diverse array of major industrial employers.
4	Route 4 delivers service to NE Lawrence via the multimodal facility located at the intersection of Crestline & Bob Billings. This route serves downtown Lawrence and areas in NE Lawrence which were found to have a high proportion of transit dependent residents.
6	Route 6 runs across a major travel corridor as it delivers service along W 6 <sup>th</sup> Street from Downtown to the LMH Health West Campus. This route serves a number of residential and commercial destinations. Its orientation allows it to intersect with eight other routes, producing numerous transfer opportunities for passengers.
10	Route 10 provides a direct connection from the multimodal transfer facility to key destinations such as Walmart, Dillons, Theatre Lawrence, Free State High School, and numerous residential complexes.
12	Route 12 delivers service to south Lawrence and provides a direct connection to Downtown. This route connects numerous residential communities to Broken Arrow Elementary School, Cordley Elementary School, Billy Mills Middle School, Lawrence High School, and the Lawrence Public Library. This route also traverses areas in Lawrence with concentrated student and transit dependent populations. Its orientation allows it to intersect with eight other routes, producing numerous transfer opportunities for passengers.
15	Route 15 delivers service to SW Lawrence via the multimodal transfer facility located at the intersection of Crestline & Bob Billings. This route traverses the KU campus and provides connections to other educational facilities such as Lawrence High School and the Dwayne Peaslee Technical Training Center.
17	Route 17 provides North/South service and runs the length on Kasold Drive. This route connects numerous residential communities with commercial development concentrated in south Lawrence. This route also connects to various areas within Lawrence which have high proportions of transit dependent populations. Its orientation allows it to intersect with six other routes.

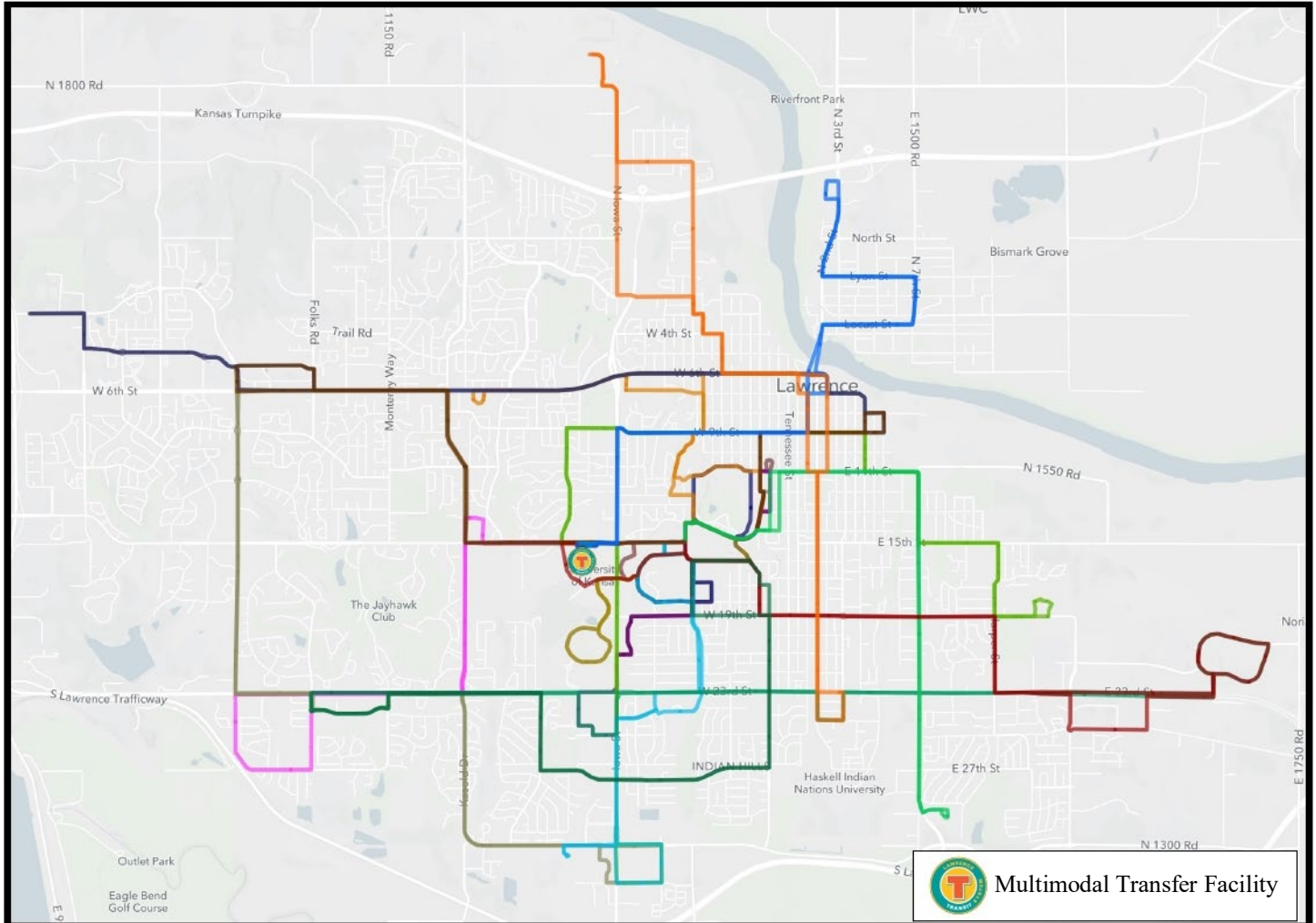


19	Route 19 delivers service from the multimodal transfer facility to Downtown Lawrence while traveling through the KU campus along Jayhawk Blvd.
20	Route 20 delivers service to south Lawrence along Iowa Street via the multimodal transfer facility. It provides access to the considerable commercial activity located along Iowa Street which includes major destinations such as Walmart and Target.
29	Route 29 runs across a major travel corridor as it delivers service along Clinton Pkwy/ W 23 <sup>rd</sup> Street. This route connects numerous residential complexes, commercial destinations, Venture Park, the KU Campus, and the Haskell Campus. This route also connects to various areas within Lawrence which have high proportions of transit dependent populations. Its orientation allows it to intersect with seven other routes, producing numerous transfer opportunities.
30	Route 30 provides a direct connection to the KU campus along Bob Billings Pkwy. This route travels through the multimodal transfer facility and serves numerous student-oriented housing complexes.
36	Route 36 provides a direct connection to the KU campus along 6 <sup>th</sup> and 9 <sup>th</sup> street. This route connects to numerous student-oriented housing complexes including many affiliated with university Greek life.
41	Route 41 serves as a campus circulator connecting KU's West District with the central core of campus.
42	Route 42 serves as a campus circulator connecting residence halls and apartments in the Central District and parking lots at the Rec Center and Stadium with the central core of campus.
43	Route 43 serves as a campus circulator which travels from the multimodal transfer facility to the main KU campus. This route partially runs through Jayhawk Blvd and connects to numerous university residence halls, Greek life houses, and other residential complexes.
44	Route 44 combines most of the destinations served by routes 41-43 for a more limited evening service.



## Alternative B: Ubiquitous Network

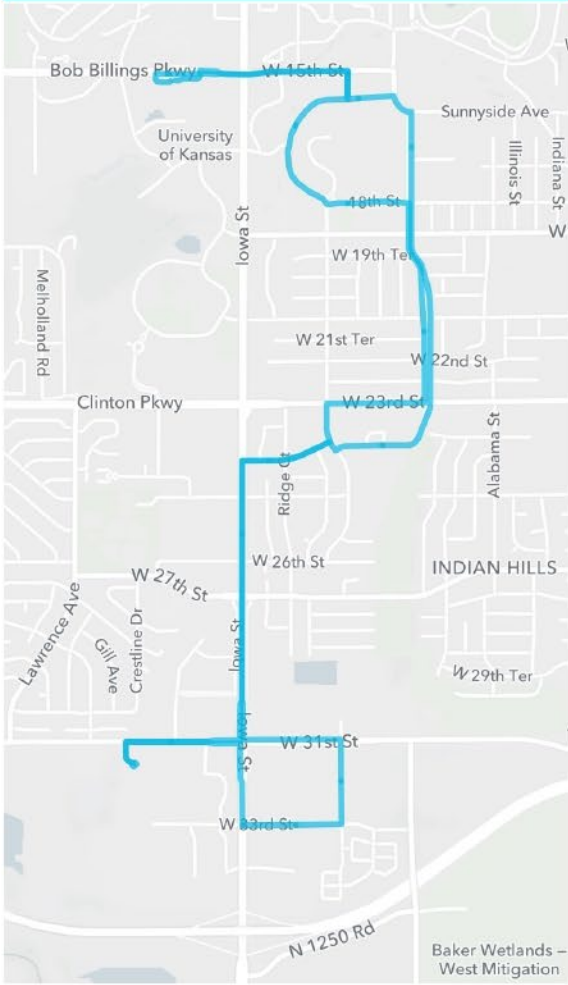
Academic Year



Alternative B implements a ubiquitous network design that utilizes a combination of longer through-routes and shorter student circulators to connect the city at multiple transfer stations, increase the number of routes served by each station, and provide extensive coverage to two of Lawrence's major activity centers - the University of Kansas and Downtown. The primary transfer station has been relocated from downtown to the new planned station along Bob Billings Parkway and the downtown transfer station has been eliminated. The routes serving the downtown station have been converted to through-routes to increase area coverage. Additional transfer stations are located at activity generators along 6th Street, Clinton Parkway & 23rd Street, and South Iowa. As the largest activity generators, most routes connect to, or pass through, the University of Kansas campus. Several routes were converted to quasi-campus shuttles; connecting areas of with large student populations to campus. This alternative implements a total of 18 routes to deliver service.



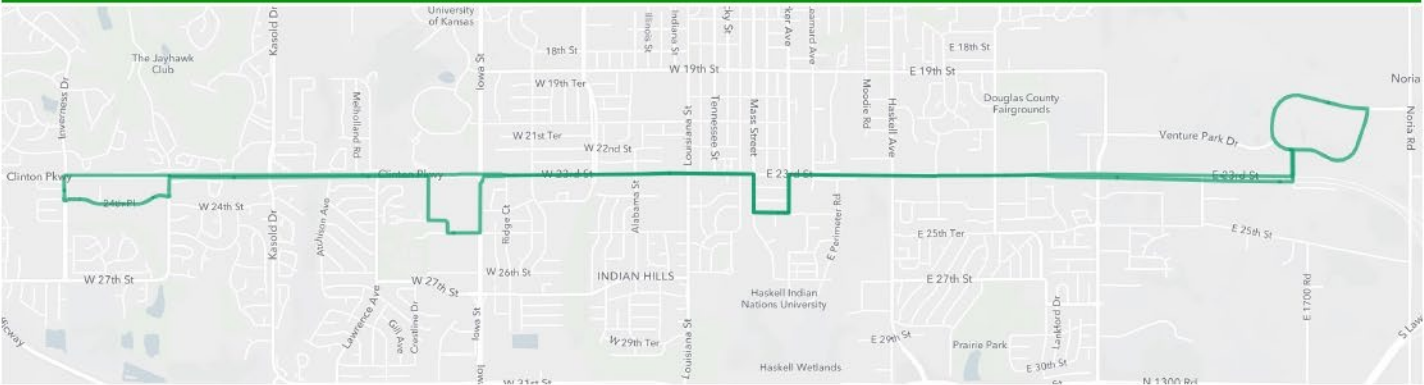
### 11: S. Iowa/KU



### 38: 25th & Melrose/KU

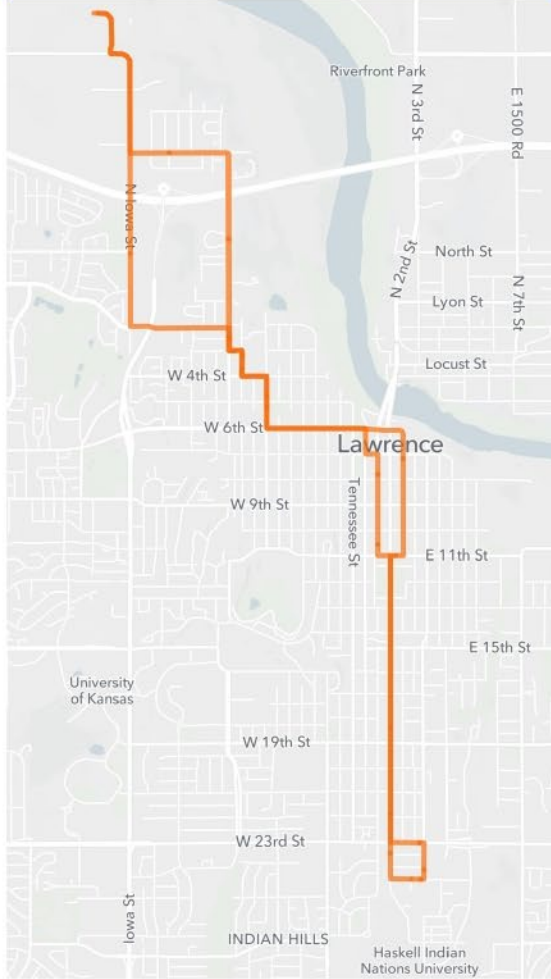


### 5: Clinton East/West Connector

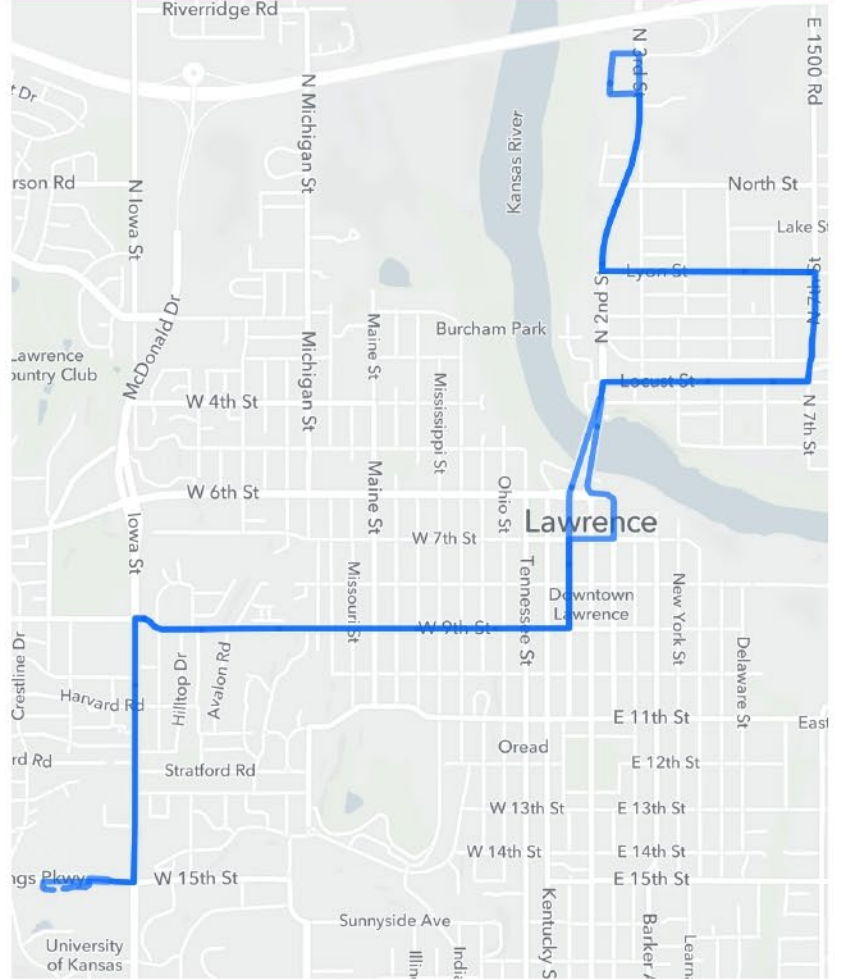




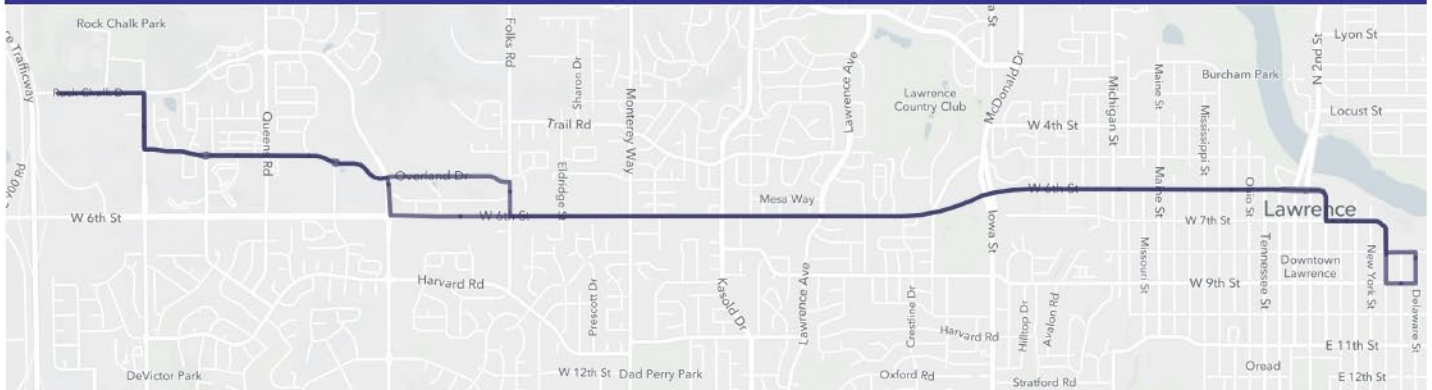
### 3: Lakeview/23rd St.



### 4: N. Lawrence/Bob Billings



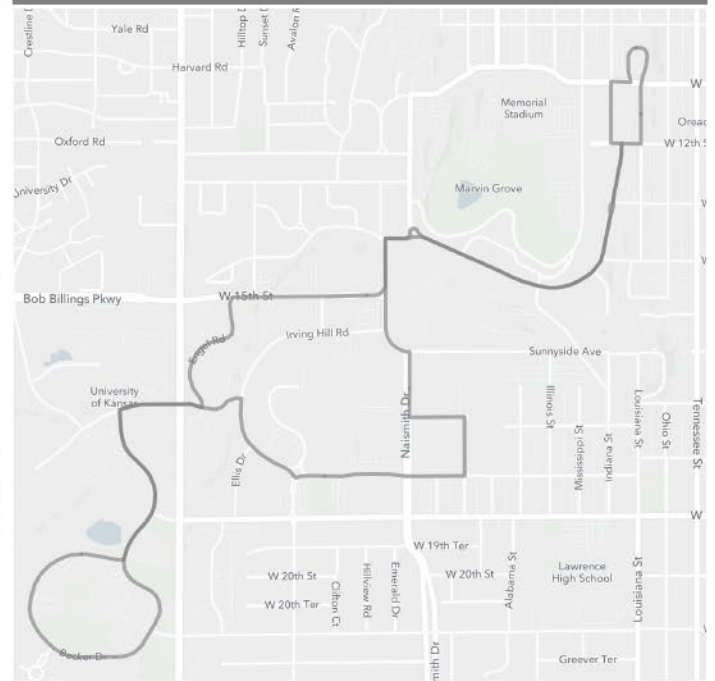
### 6: LMH West / Downtown



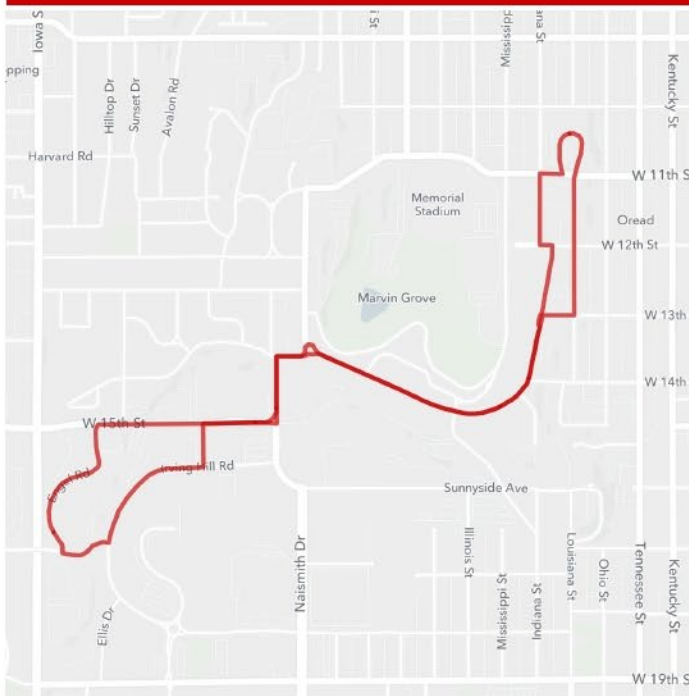
### 42: Blue Campus Circulator



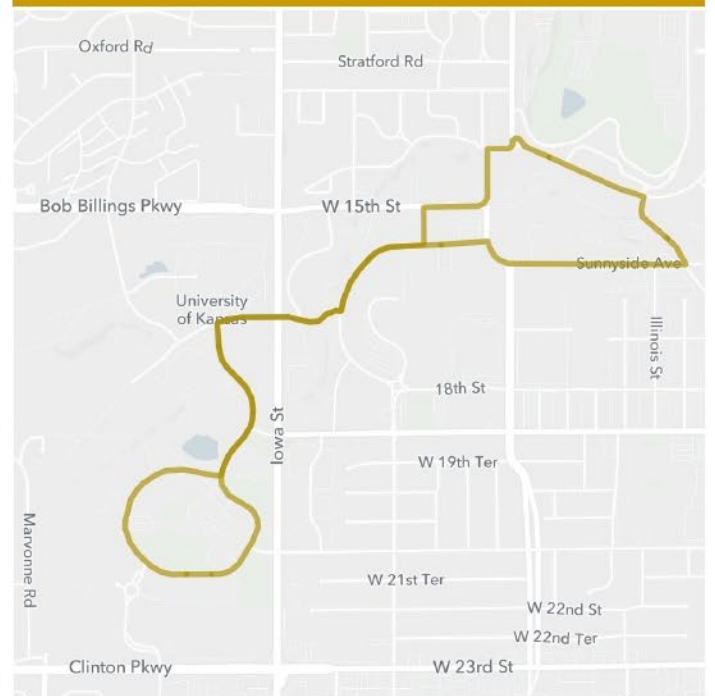
### 44: Evening Campus Circulator



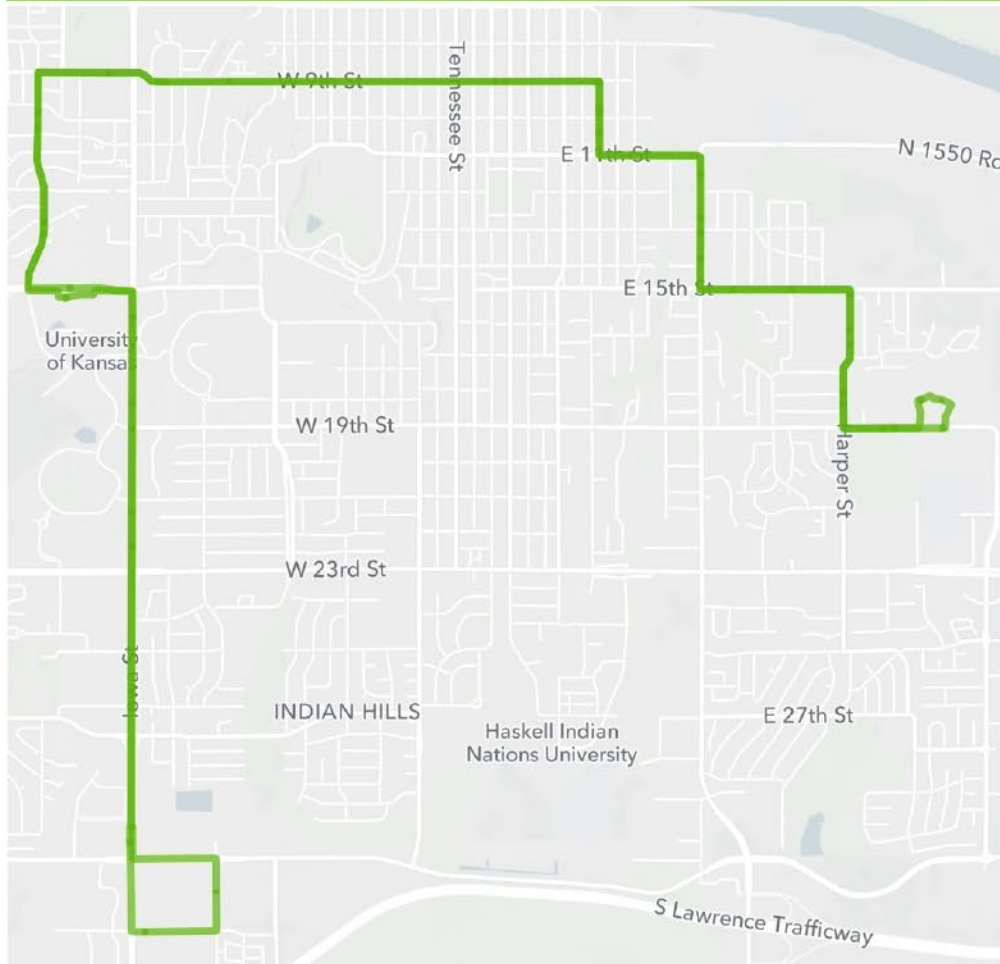
### 43: Red Campus Circulator



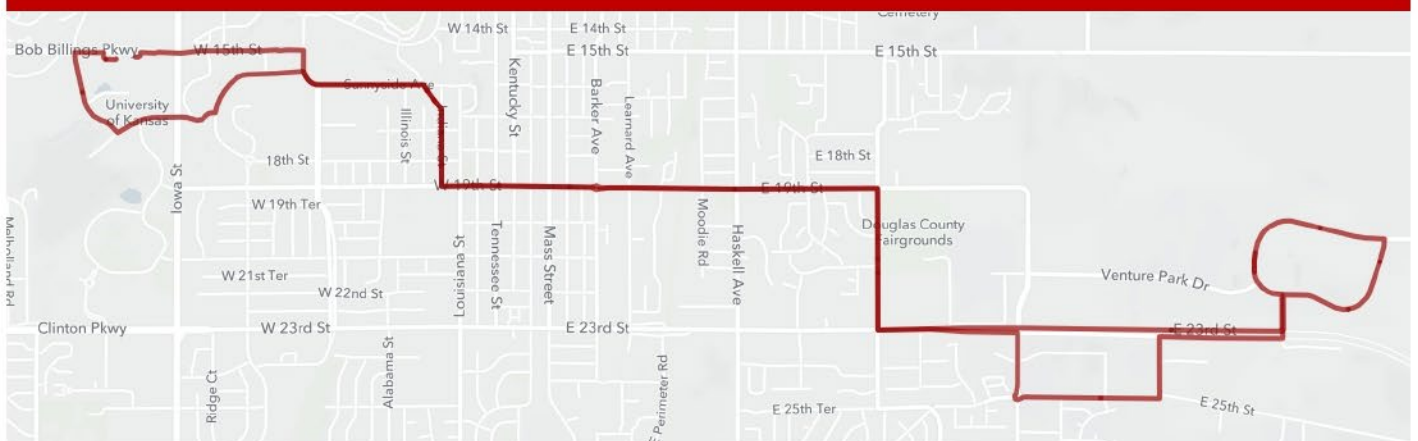
### 41: Yellow Campus Circulator



## 7: Fairgrounds/Downtown/S. Iowa

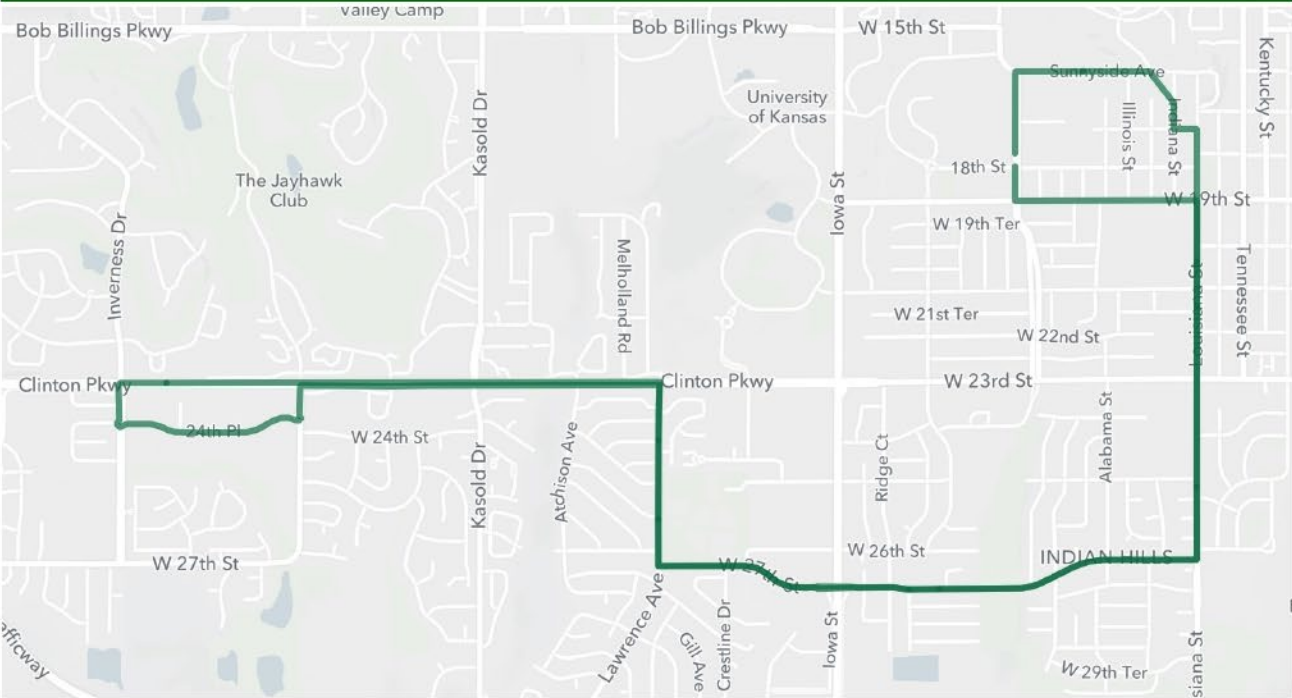


## 1: Bob Billings / Lawrence Business Park - via 19th

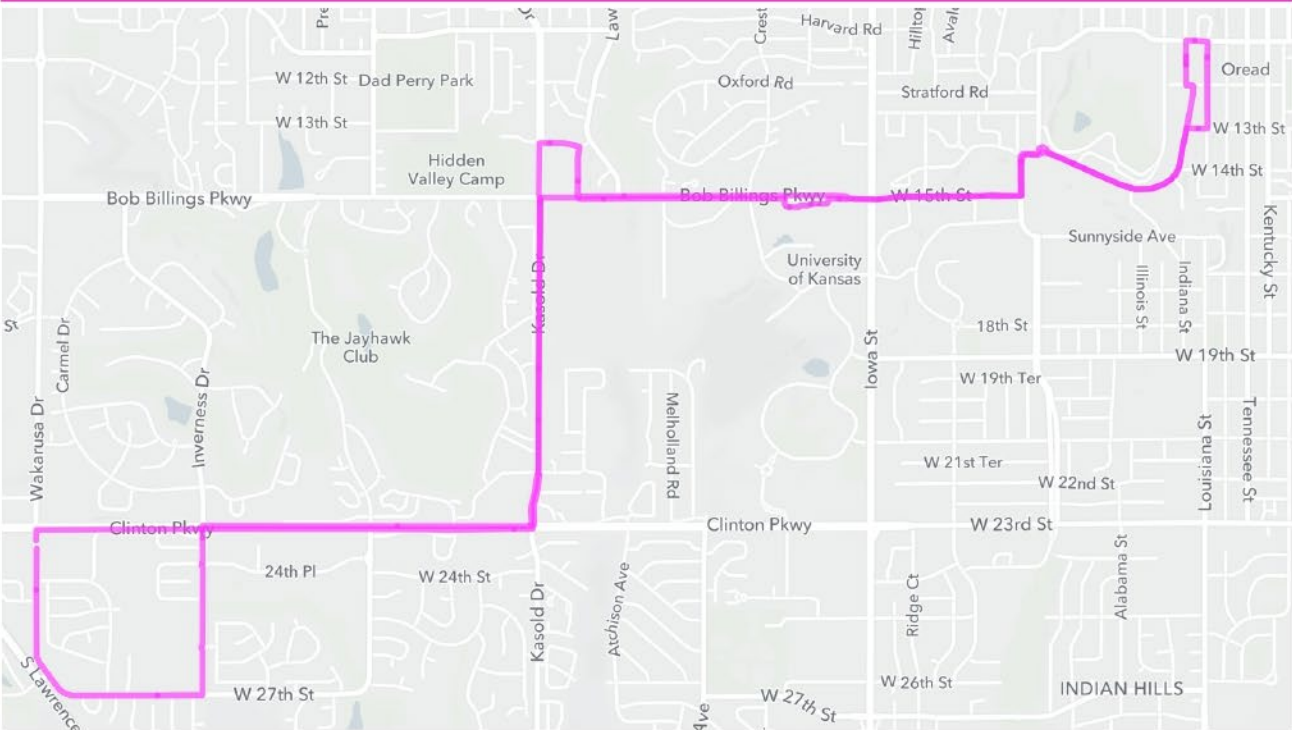




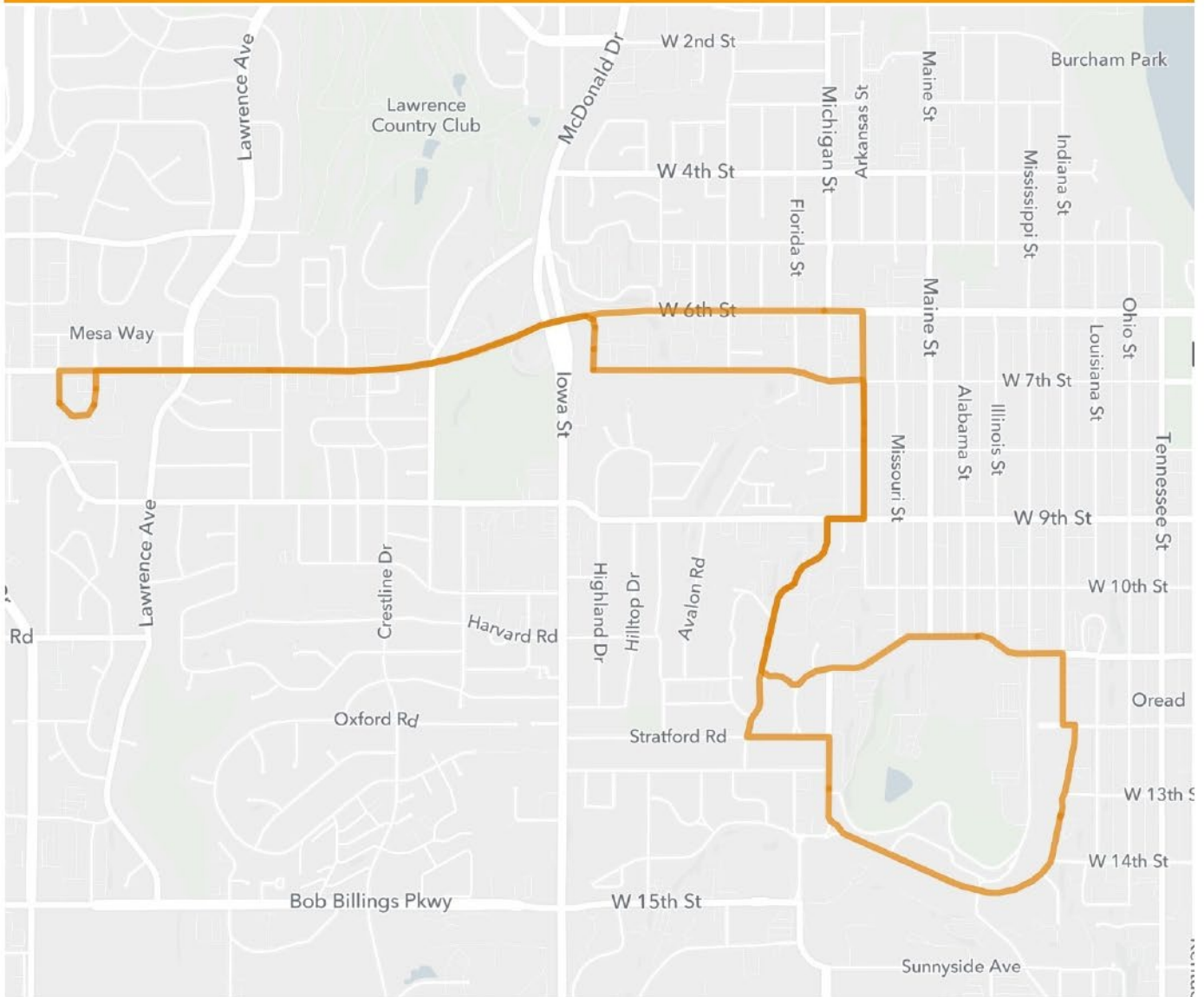
### 30: Clinton/KU/Louisiana



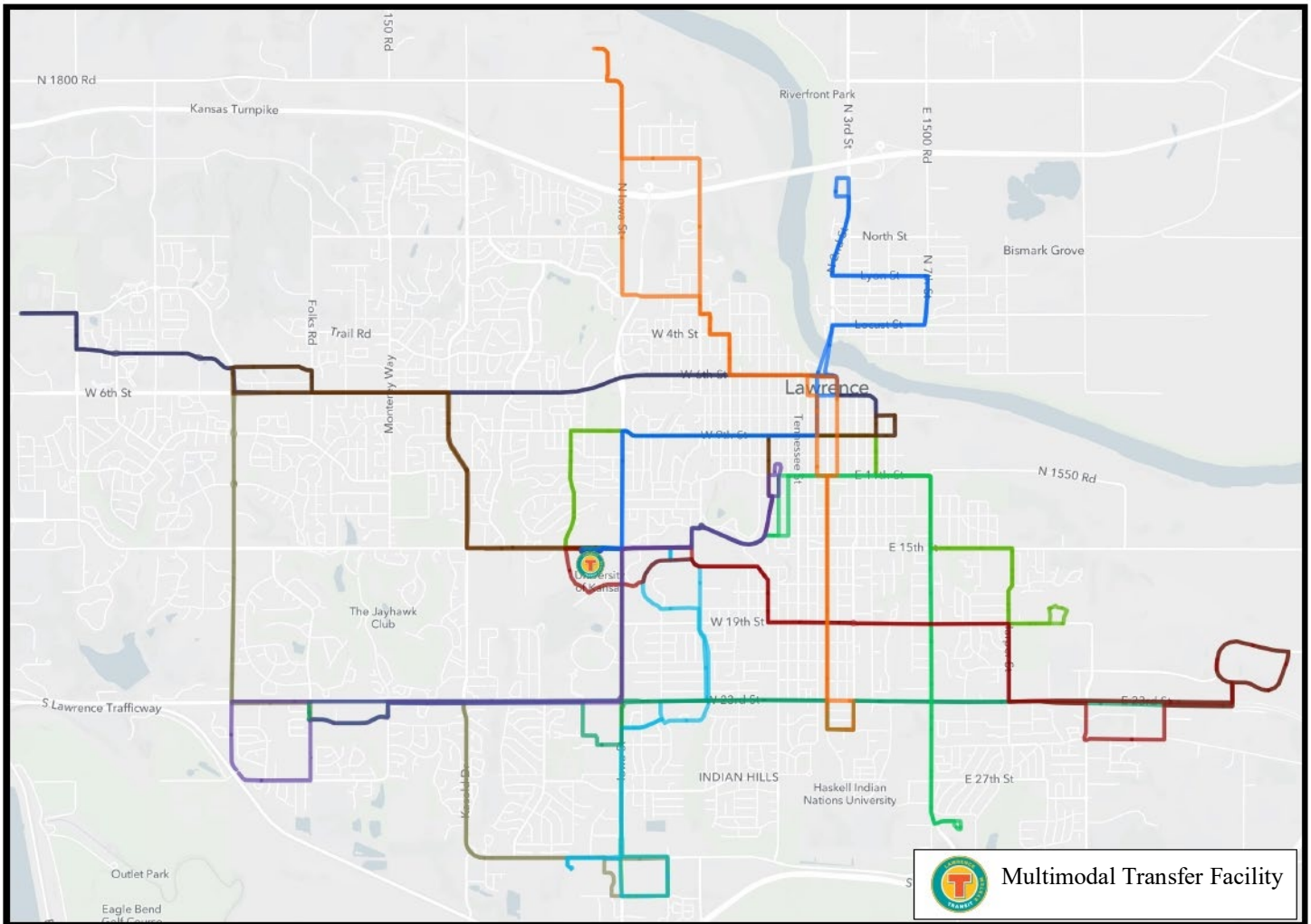
### 29: 27th & Wakarusa/KU



### 34: 6th St./KU



Summer



The summer version of alternative B is composed of 11 routes. This alternative maintains a similar level of coverage as the academic year but reduces the number of routes that circulate on the University of Kansas campus. Frequency across all routes is also reduced. Summer service includes these routes:

Route	Name	Route	Name
1	Bob Billings / Lawrence Business Park	9	S. Iowa / 6th & Wakarusa
3	Lakeview / 23rd Street	10	E. Lawrence / 6th & Wakarusa
4	N. Lawrence / Bob Billings	11	S. Iowa / KU
5	Clinton East / West Connector	15	S. Haskell / Bob Billings
6	Downtown / LMH West	29	Clinton / KU
7	Fairgrounds / Downtown / S. Iowa		

## Alternative B Route Descriptions

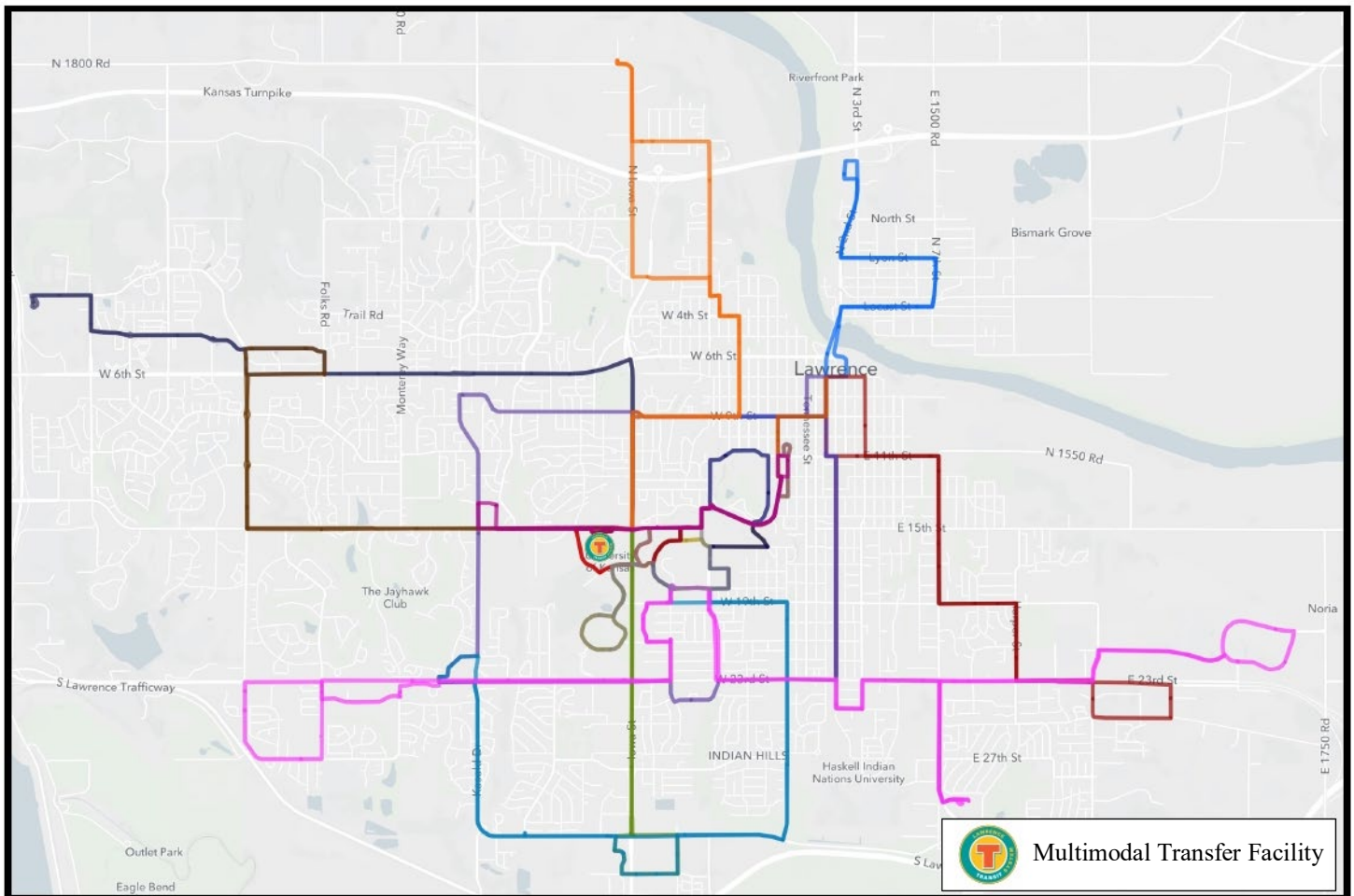
Route	Description
1	Route 1 connects two major employment centers - the University of Kansas and the East Lawrence Business Park - to the new transfer station.
3	Route 3 provides a north-south connection between Haskell Indian Nations University and major industrial development north of the interstate. Additionally, the route provides service to Lawrence Memorial Hospital and downtown.
4	Route 4 is extended to terminate at the new transfer station instead of downtown. This provides greater connectivity to the system for people living in north Lawrence.
5	Route 5 provides service along the Clinton/23rd Street corridor and provides transfer opportunities with 9 other routes.
6	Route 6 connects heavily populated areas in north western and eastern Lawrence to downtown along the 6th Street Corridor.
7	Route 7 directly connects areas with large transit dependent populations to major commercial and employment destinations. This line was intentionally routed to pass through major transfer location downtown, at new transfer location, and at the Iowa & Clinton Parkway intersection to provide greater connectivity.
9	Route 9 has been adjusted to remove underperforming stops. Major commercial, employment, and population centers remain connected and provides transfer opportunities to 5 other routes.
10	Route 10 connects areas with high student populations to University of Kansas and commercial centers along 6th Street and downtown.
11	Route 11 connects commercial centers along Iowa Street and 23rd Street to University of Kansas and the new transfer station.
15	Route 15 provides both north-south and east-west service to eastern Lawrence; connecting with the University of Kansas and the new transfer station.
29	Route 29 connects the eastern Clinton Parkway to the University of Kansas via Bob Billings Parkway. This route utilizes existing stations along southern Wakarusa Drive and 27th Street and removes the duplication of service with Route 9. Additionally, the routing along Bob Billings allows for transfer opportunities at the new transfer station.

<b>30</b>	Route 30 utilizes existing stops along 27th Street and Louisiana Street to provide service to Lawrence High School, Billy Mills Middle School, and Holcom Park.
<b>34</b>	Route 34 connects areas with large student populations to the University of Kansas.
<b>38</b>	Route 38 connects areas with large student populations to the University of Kansas. Opportunities to transfer are provided with 3 routes.
<b>41</b>	Route 41 serves as a campus circulator connecting KU's West District with the central core of campus.
<b>42</b>	Route 42 serves as a campus circulator connecting residence halls and apartments in the Central District and parking lots at the Rec Center and Stadium with the central core of campus.
<b>43</b>	Route 43 serves as a campus circulator. This route partially runs through Jayhawk Blvd and connects to numerous university residence halls, Greek life houses, and other residential complexes.
<b>44</b>	Route 44 combines most of the destinations served by routes 41-43 for a more limited evening service.



## Alternative C: Radial Design

Academic Year



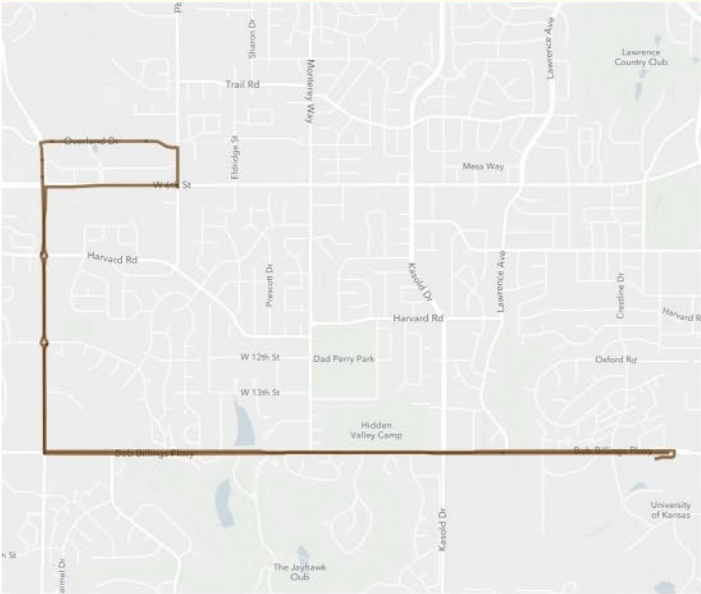
Alternative C implements a radial design composed of 15 routes which would maximize the use of the planned multimodal transfer facility located at Bob Billings & Crestline Drive. This facility will serve as the dominant hub within this network as it will accommodate most transfers. Eight routes will originate from this facility and extend into major activity generators located throughout Lawrence. A circle route is integrated into this network design in order to provide passengers greater flexibility. This route allows passengers to transfer to their desired route without having to travel to the multimodal transfer facility located in central Lawrence. This can result in travel time savings in instances where a passenger's final destination is not near the transfer facility. Given the draw of Downtown Lawrence, four routes remain which provide direct access to this area.

Routes

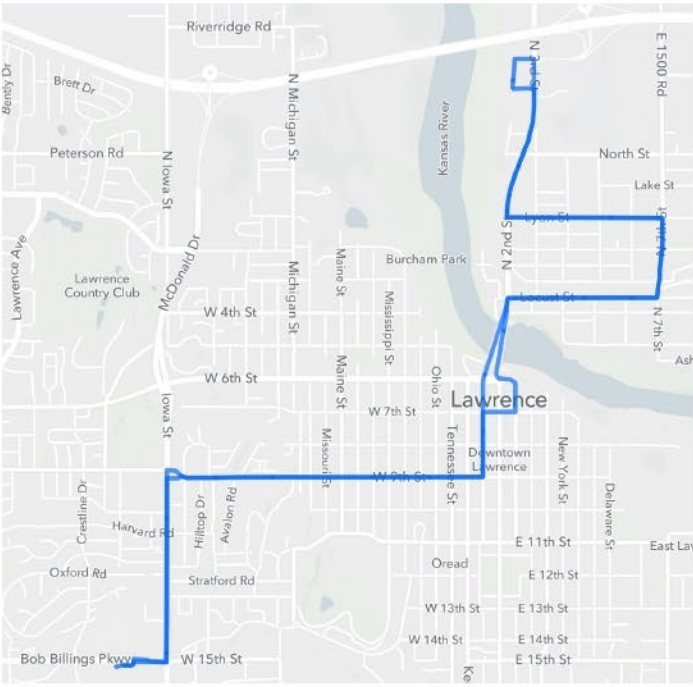
1: E. Lawrence/Downtown



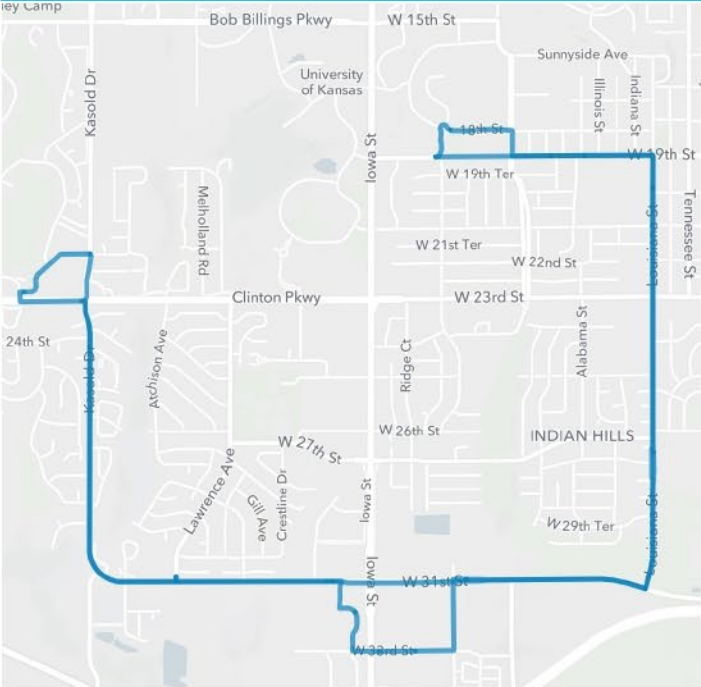
10: Wakarusa/Bob Billings



4: N. Lawrence/Bob Billings



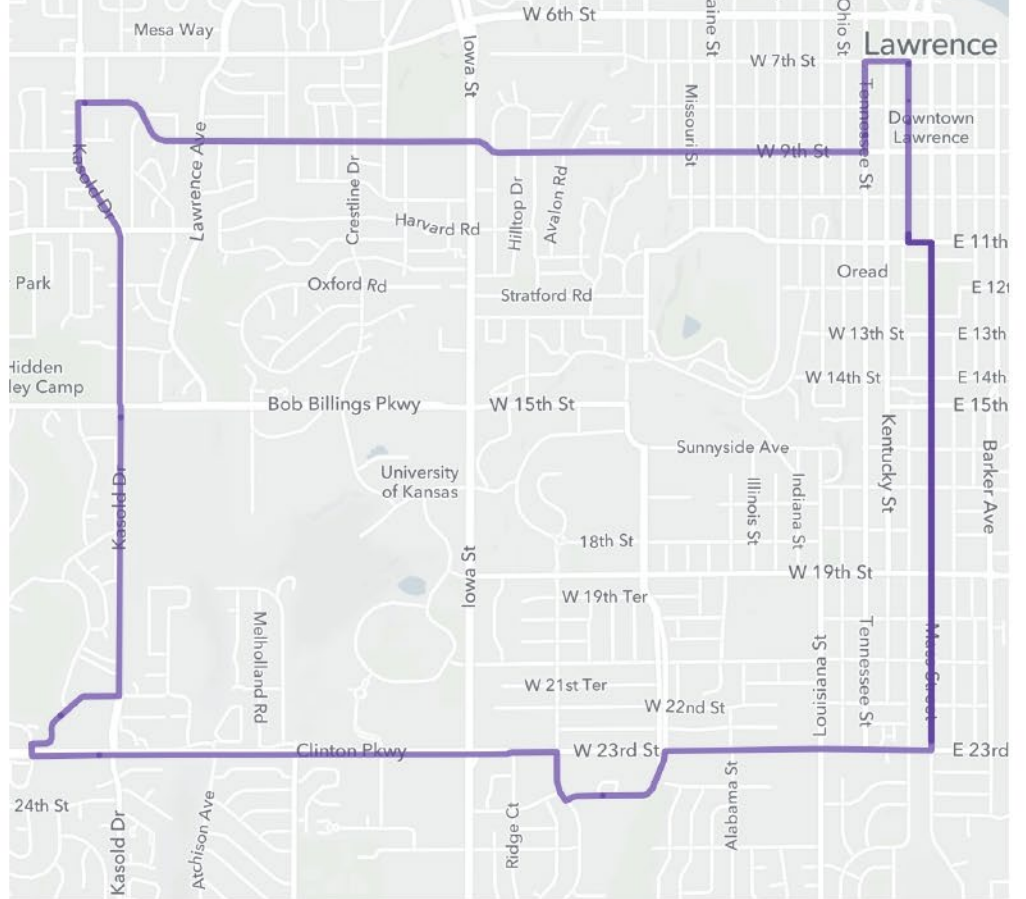
14: Kasold/Indian Hills



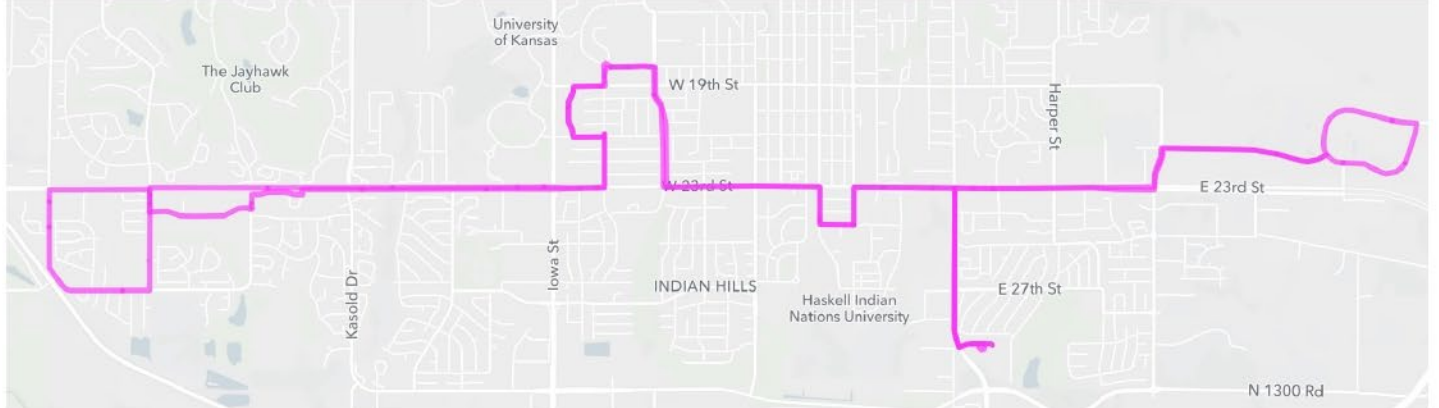
### 20: S. Iowa/Bob Billings



### 21: Lawrence Circle

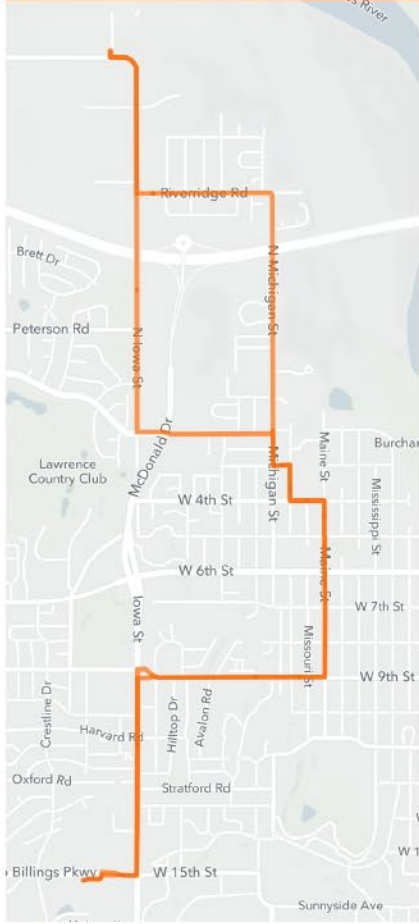


### 29: Clinton Pkwy/KU

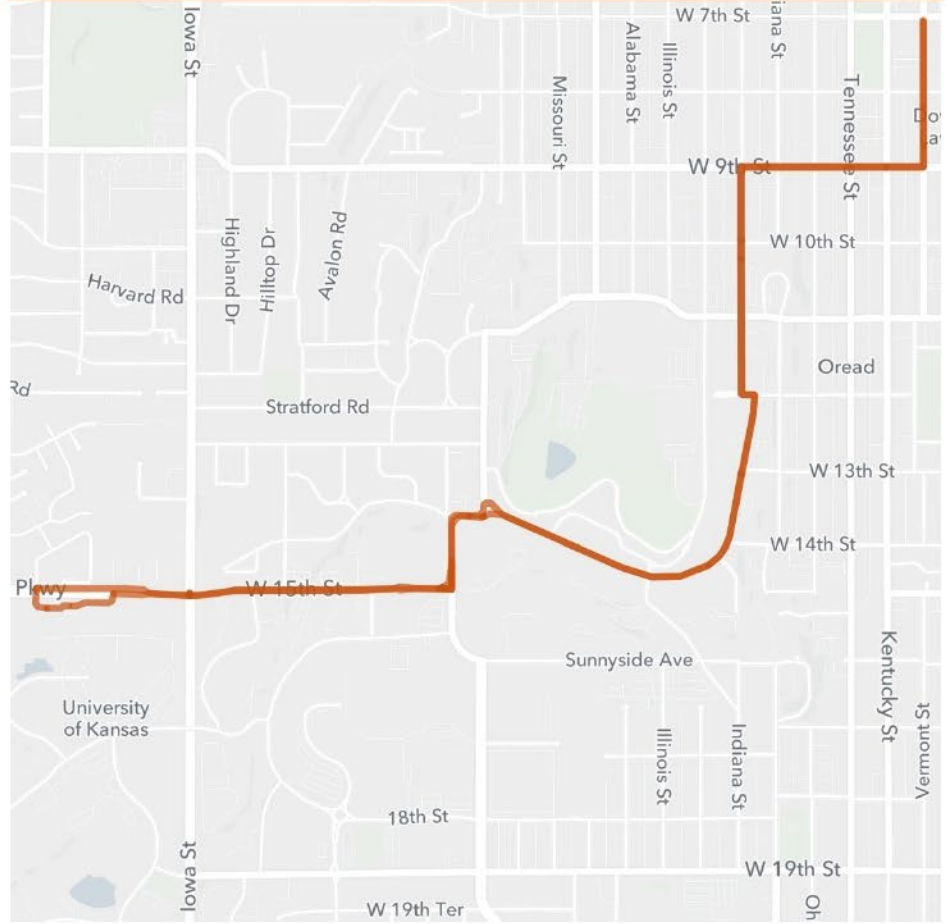




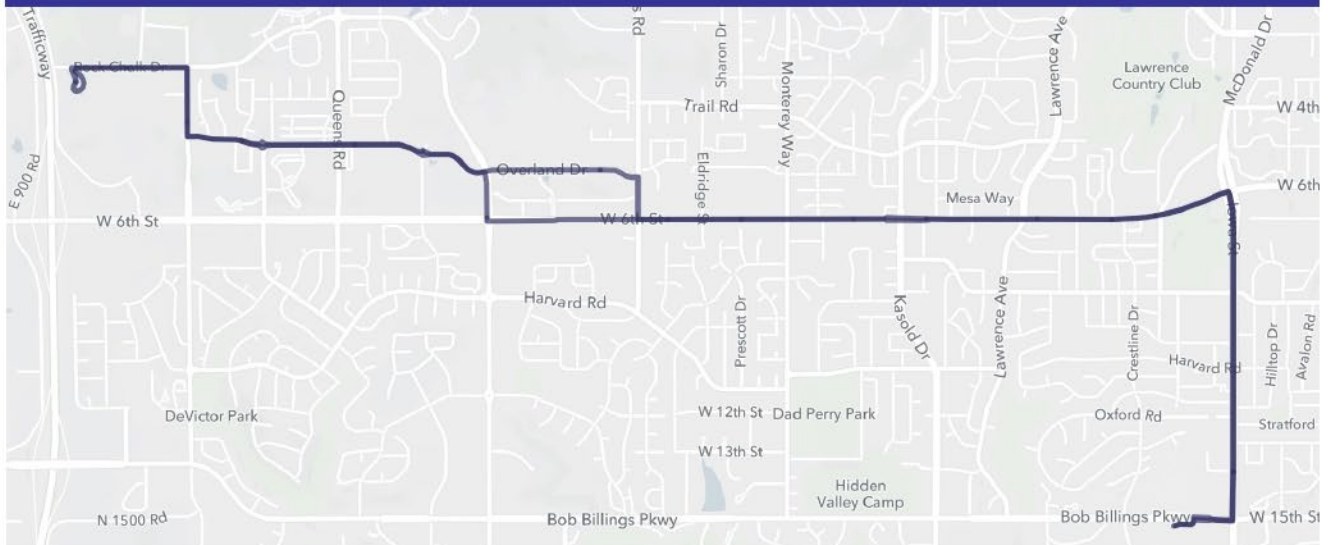
### 3: Lakeview / Bob Billings



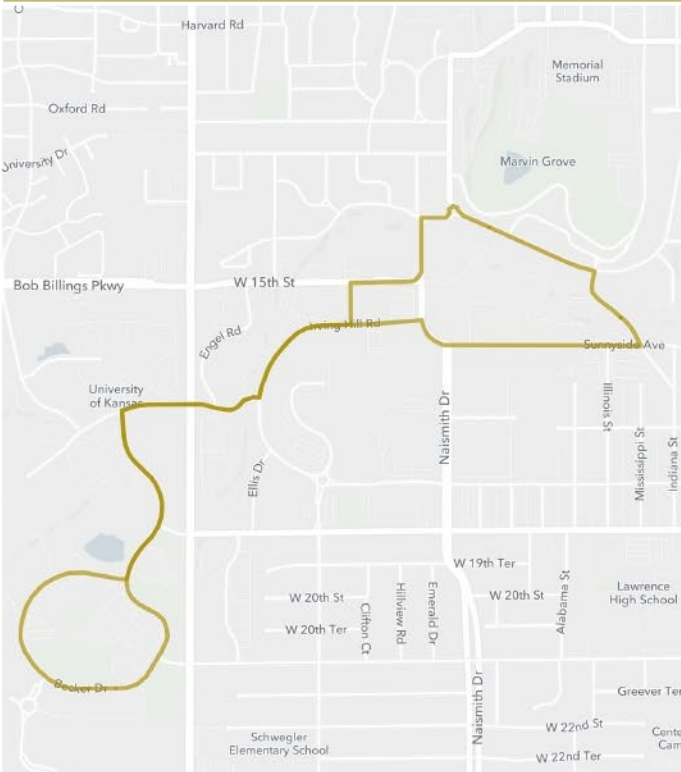
### 19: Bob Billings/Downtown



### 6: LMH West / Bob Billings



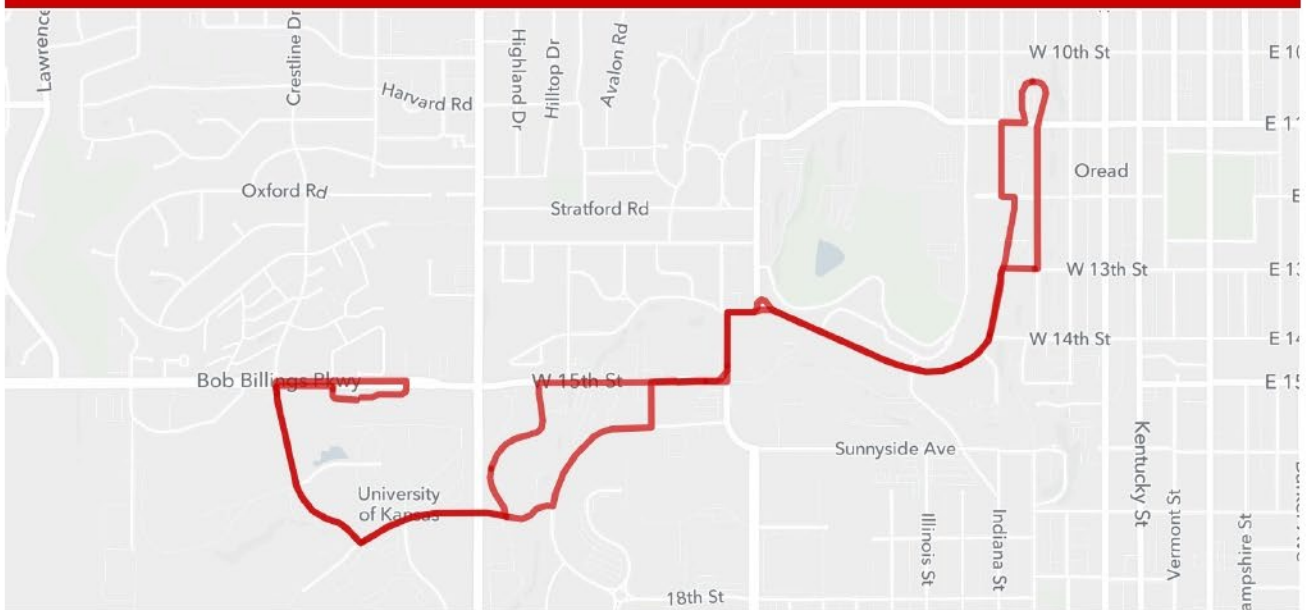
### 41: Yellow Campus Circulator



### 44: Evening Campus Circulator



### 43: Red Campus Circulator

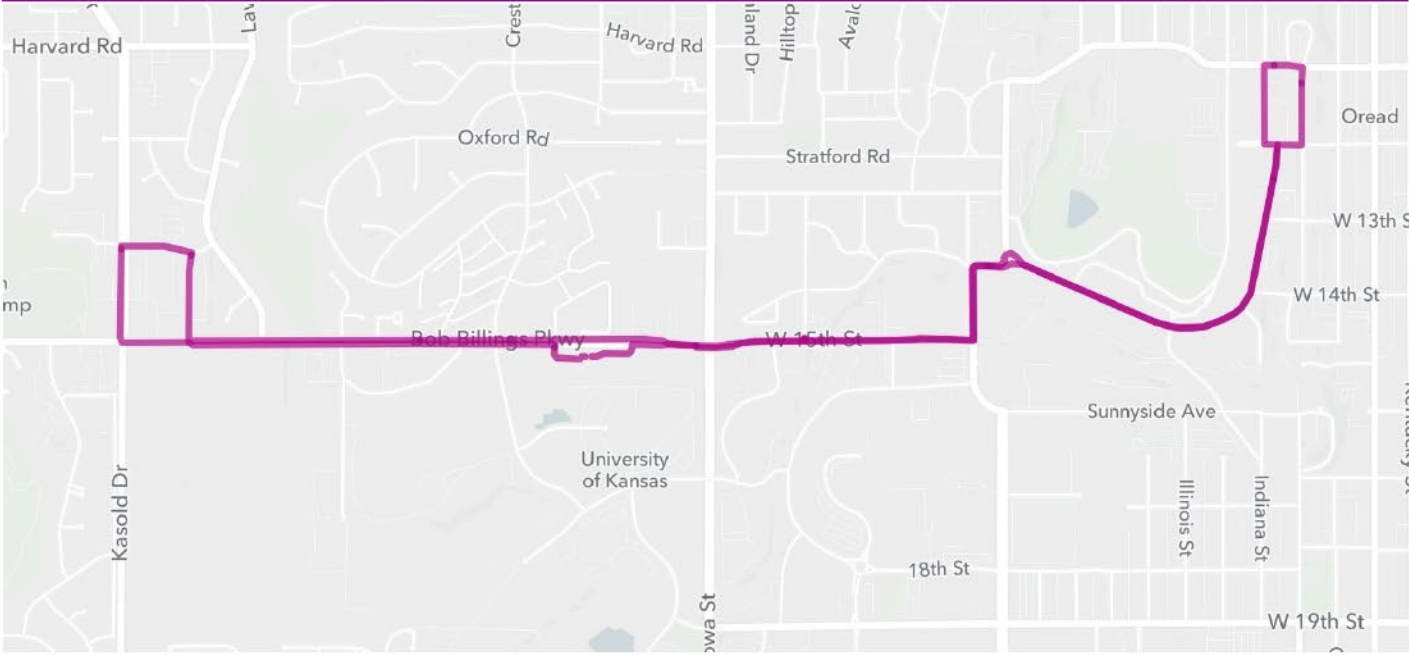




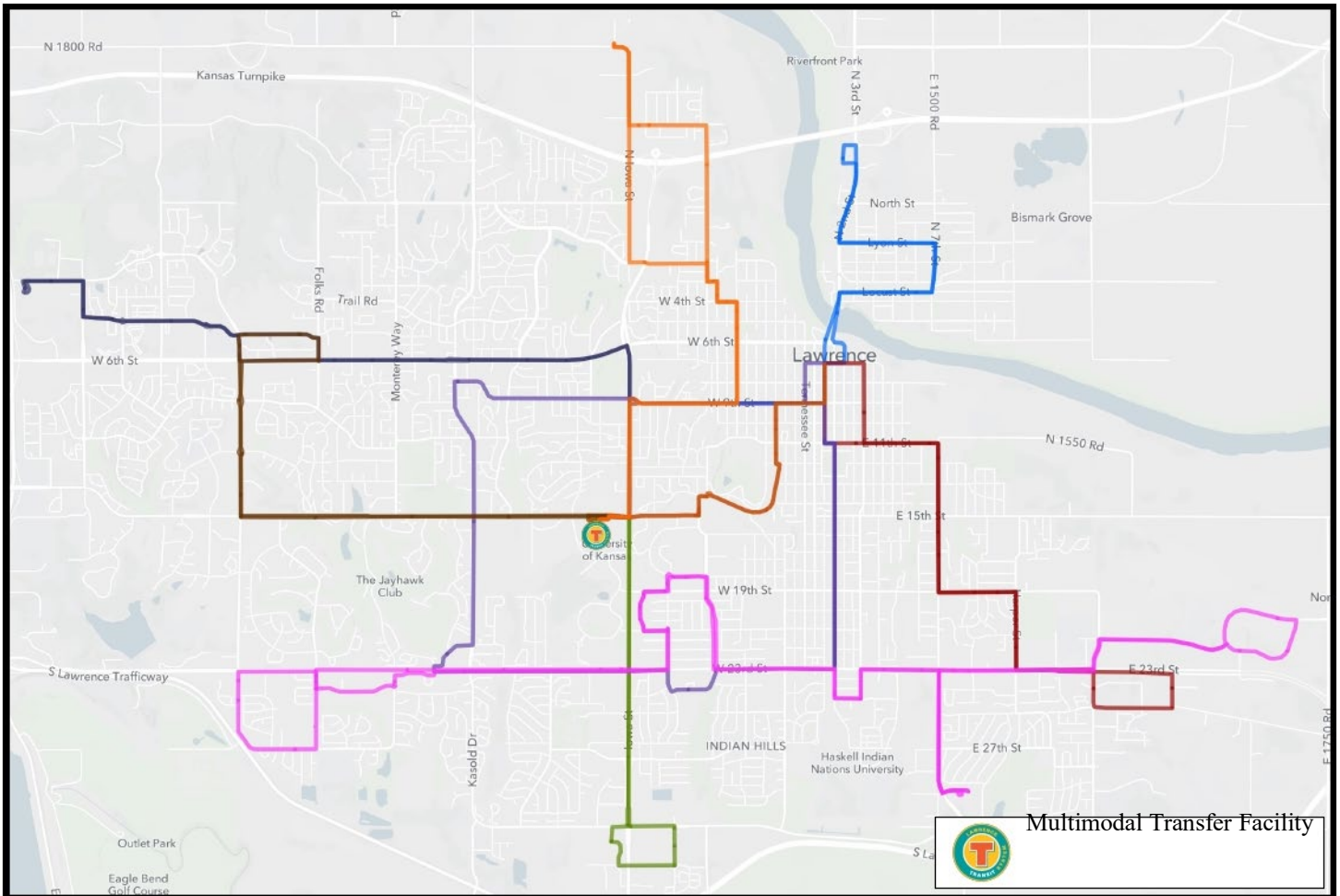
## 42: Blue Campus Circulator



## 30: Bob Billings & Kasold/KU



Summer



The summer version of alternative C is composed of 9 routes. This alternative maintains a similar level of coverage as the academic year but reduces the number of routes that circulate on the University of Kansas campus. Frequency across all routes is also reduced. The routes which compose this version are noted in the table below.

Route	Name		
1	E. Lawrence/Downtown	19	Wakarusa/Bob Billings Bob Billings/Downtown
3	Lakeview / Bob Billings	20	S. Iowa / Bob Billings
4	N. Lawrence / Bob Billings	21	Lawrence Circle
6	LMH West / 6 <sup>th</sup> / Bob Billings	29	Clinton Pkwy/KU
10	6th & Wakarusa/Bob Billings		

## Alternative C Route Descriptions

Route	Description
<b>1</b>	Route 1 delivers service to SW Lawrence and provides a direct connection to downtown. Its orientation allows it to intersect with six other routes, producing numerous transfer opportunities for passengers.
<b>3</b>	Route 3 delivers service to northern Lawrence via the multimodal facility located at the intersection of Crestline & Bob Billings. Major destinations serviced by this route include Lawrence Memorial Hospital and a diverse array of major industrial employers.
<b>4</b>	Route 4 delivers service to NW Lawrence via the multimodal facility located at the intersection of Crestline & Bob Billings. This route serves downtown Lawrence and areas in NW Lawrence which were found to have a high proportion of transit dependent residents.
<b>6</b>	Route 6 runs across a major travel corridor as it delivers service along W 6 <sup>th</sup> Street from the multimodal transfer facility to the LMH Health West Campus. This route serves a number of residential and commercial destinations. Its orientation allows it to intersect with eight other routes, producing numerous transfer opportunities for passengers.
<b>10</b>	Route 10 provides a direct connection from the multimodal transfer facility to key destinations such as Walmart, Dillons, Theatre Lawrence, Free State High School, and numerous residential complexes.
<b>14</b>	Route 14 delivers service to south Lawrence. It is a U-shaped route which connects numerous residential communities to Broken Arrow Elementary School, Billy Mills Middle School, Lawrence High School, and commercial development on south Iowa Street. This route also traverses areas in Lawrence with concentrated transit dependent populations.
<b>19</b>	Route 19 delivers service from the multimodal transfer facility to Downtown Lawrence while traveling through the KU campus along Jayhawk Blvd.
<b>20</b>	Route 20 delivers service to south Lawrence along Iowa Street via the multimodal transfer facility. It provides access to the considerable commercial activity located along Iowa Street which includes major destinations such as Walmart and Target.
<b>21</b>	Route 21 runs across four major travel corridors as it delivers service along Clinton Pkwy/ W 23 <sup>rd</sup> Street, 9 <sup>th</sup> Street, Massachusetts Street, and Kasold Drive. This route is meant to enhance connections and produce shorter travel times for passengers. It does this by granting passengers the opportunity to transfer without having to reach the multimodal transfer facility. This is significant in instances where someone's final destination is not near this central transfer facility. The orientation of this line is meant to maximize transfer

	possibilities. Route 21 intersects with 10 other lines, producing numerous transfer opportunities for passengers.
<b>29</b>	Route 29 runs across a major travel corridor as it delivers service along Clinton Pkwy/ W 23 <sup>rd</sup> Street. This route connects numerous residential complexes, commercial destinations, Venture Park, the Dwayne Peaslee Technical Training Center, the KU Campus, and the Haskell Campus. This route also connects to various areas within Lawrence which have high proportions of transit dependent populations. Its orientation allows it to intersect with six other routes, producing numerous transfer opportunities for passengers.
<b>30</b>	Route 30 provides a direct connection to the KU campus along Bob Billings Pkwy. This route travels through the multimodal transfer facility and serves numerous student-oriented housing complexes.
<b>41</b>	Route 41 serves as a campus circulator connecting the west KU campus to the main KU campus.
<b>42</b>	Route 42 serves as a campus circulator which provides comprehensive service on the KU main campus.
<b>43</b>	Route 43 serves as a campus circulator which travels from the multimodal transfer facility to the main KU campus. This route partially runs through Jayhawk Blvd and connects to numerous university residence halls, Greek life houses, and other residential complexes.
<b>44</b>	Route 44 serves as a campus circulator and has an evening service window. It serves the main KU campus while also providing a connection to west campus.

## Appendix A: Station Boarding Data

Stop ID	Stop Name	Average Daily Boardings	
		Academic Year	Summer
1	7th & Vermont	1,037	1,121
2	Ousdahl & 31st	60	40
3	31st & Iowa	191	150
5	Nieder & 31st (Petco)	19	14
6	Nieder & 33rd	64	68
7	33rd & Kohl's	142	115
10	31st & Harrison	39	8
11	31st & Lawrence (First Step)	3	2
12	31st & Harrison (Cottonwood)	12	15
13	31st & Lawrence	6	4
14	Lawrence & 28th	4	6
15	27th & Holcom	14	10
16	27th & Holcom	11	12
17	27th & Iowa (eastbound)	27	24
18	27th & Redbud (eastbound)	54	39
19	27th & Redbud (westbound)	49	28
20	27th & Alabama	6	6
21	27th & Naismith Valley Park (eastbound)	7	8
22	27th & Naismith Valley Park	6	6
23	27th & Alabama	6	5
24	27th & Iowa (westbound)	31	19
25	Lawrence & 31st	4	3
26	Kasold & Meadow	3	2
27	Kasold & 26th	2	1
28	Kasold & 24th Place	3	5
29	Clinton & Kasold (LMH South)	8	8
30	Clinton & Kasold	37	12
31	Crossgate & Clinton	58	70
32	27th & Inverness	11	5
33	27th & Inverness	3	2
34	27th & Scottsdale (westbound)	7	8
35	Clinton Frontage Rd & Hawthorne	76	13
36	23rd & Ridge	20	7
37	24th & Ousdahl (westbound)	38	29
38	24th & Ousdahl (eastbound)	29	22
39	24th & Eddingham (eastbound)	122	49
40	24th & Eddingham (westbound)	70	32



41	Naismith & 23rd	53	27
42	23rd & Naismith (Dillons)	32	30
43	23rd & Naismith (westbound)	21	16
44	23rd & Ousdahl (eastbound)	10	14
45	23rd & Ousdahl (westbound)	13	13
46	Ousdahl & 23rd (northbound)	35	-
47	Ousdahl & 23rd (southbound)	26	-
48	Ridge & 25th (United Way)	6	3
49	Ridge & 25th (southbound)	10	5
50	Louisiana & 23rd (Petworld)	40	35
51	Louisiana & 23rd (Checker's)	83	75
52	Louisiana & 23rd	13	6
53	23rd & Alabama	6	7
54	23rd & Louisiana	17	12
55	Louisiana & 25th	16	6
56	-	3	-
57	East Hills Business Park	99	79
58	23rd & Harper (eastbound)	84	109
59	Harper & 23rd	3	-
60	23rd & Harper (westbound)	93	80
61	23rd & Louisiana (westbound)	12	8
62	HINU (southbound)	14	6
63	HINU (northbound)	60	7
64	Mass & Winona (northbound)	4	7
65	Mass & Winona (southbound)	4	3
66	Iowa & 25th	20	17
67	Iowa & 27th	10	8
68	Iowa & 27th	72	64
69	Iowa & 25th	5	5
70	23rd & Haskell	6	7
71	23rd & Haskell	9	9
72	Haskell & 23rd (northbound)	5	6
73	Bob Billings & Kasold	24	10
74	Bob Billings & Monterey Way	5	2
75	Bob Billings & Monterey Way	10	7
76	Wakarusa & Bob Billings	5	9
77	Wakarusa & Bob Billings	4	4
78	Wakarusa & Clinton	20	10
79	-	2	3
80	Wakarusa & Harvard	2	6
81	Wakarusa & 6th	25	23

82	6th & Westgate Entrance	36	14
83	6th & Folks	4	1
84	Rock Chalk Park	28	1
85	Overland & Free State HS	58	41
86	Wakarusa & 6th	137	81
87	Wakarusa & Harvard	9	6
88	Bob Billings & Wakarusa	10	10
89	Bob Billings & Inverness (Brandon Woods)	6	8
90	Bob Billings & St. Andrews	13	20
91	Bob Billings & Crestline (eastbound)	265	108
92	23rd & Ponderosa	3	6
93	23rd & Silicon	4	3
94	Haskell & Pinecone	8	10
95	Haskell & 19th	2	-
96	19th & Delaware (eastbound)	5	6
97	19th & Delaware (westbound)	5	5
98	Barker & Johnson	3	3
99	Connecticut & 15th (northbound)	4	5
100	Haskell & 15th (southbound)	10	11
101	Haskell & LaSalle	16	17
102	19th & Haskell (eastbound)	15	15
103	19th & Harper (eastbound)	6	6
104	Harper & 21st Terrace	13	18
105	Douglas County Fairgrounds	9	8
106	19th & Ousdahl (Applecroft)	29	-
107	19th & Ellis	11	-
108	Naismith & 21st (southbound)	16	6
109	Naismith & 21st (northbound)	29	9
110	Naismith & 23rd	33	22
111	19th & Tennessee	5	2
112	Louisiana & 20th	27	-
113	Harper & 19th	5	4
114	21st & Louisiana	27	3
115	19th @ Tennessee	10	2
116	Mass & 19th	19	29
117	Mass & 17th	13	10
118	Mass & 17th (Babcock)	24	23
119	Mass & 14th (Central Middle School)	20	14
120	Mass & 14th (southbound)	18	14
121	Mass & South Park	18	19
122	Mass & South Park	20	11

123	9th & Rhode Island	24	4
124	9th & New Hampshire	40	14
125	11th & Connecticut	6	2
126	Haskell & 23rd (southbound)	5	7
127	-	3	3
128	Greenway Circle	17	16
129	Connecticut & 15th (southbound)	5	3
130	Haskell & 15th (northbound)	12	12
131	Haskell & 16th	38	31
132	19th & Maple (westbound)	14	15
138	-	27	24
139	11th & New Hampshire	18	19
140	6th & Kentucky	4	3
141	6th & Constant Park	12	18
142	New Hampshire & 7th	8	3
143	11th & Vermont (Community Building)	17	3
144	7th & New Hampshire	4	4
145	Vermont and 10th	132	46
147	11th & Connecticut	7	8
148	Lawrence Memorial Hospital (northbound)	35	24
149	Lawrence Memorial Hospital (southbound)	17	20
150	4th & Maine	26	20
151	4th & Maine	21	26
152	Maine & 6th	7	7
153	6th & Maine	23	26
154	Connecticut & 9th	6	9
157	N Iowa & Packer (southbound)	2	3
158	N Iowa & Packer (northbound)	4	4
159	Timberedge & N Iowa	27	24
160	N Iowa & Riverridge	9	12
162	Overland & Wakarusa	17	27
163	2nd & MacDonald Drive	12	10
164	Overland & Eisenhower	13	-
165	Overland & Eisenhower	4	13
166	Lippincott Hall	400	-
167	N Iowa & Kingston	15	15
168	Fraser Hall	376	-
169	6th & Maine	16	3
170	6th & Michigan	25	24
171	Kansas Union	880	85
172	Bob Billings & Stone Meadows	5	5

173	Kansas Union (southbound)	1,656	156
177	Spencer Museum of Art	214	-
179	6th & Colorado	22	19
180	6th & Wisconsin	34	4
181	6th & Rockledge	8	7
182	6th & Rockledge	23	1
183	6th & Lawrence	54	33
184	6th & Crestline	23	5
185	6th & Schwarz	52	5
186	6th & Crestline	23	19
187	-	-	-
188	6th & Frontier	12	10
189	6th & Kasold	19	3
190	6th & Gateway	10	3
191	6th & HyVee	7	11
192	6th & Eldridge	9	3
193	6th & Monterey Way	21	2
194	6th & Mississippi	29	8
195	Locust & 2nd	3	2
196	Visitor's Center	29	36
197	Locust & 4th	9	6
198	Locust & 5th	4	3
199	7th & Locust	6	8
200	7th & Locust	10	12
201	7th & Lyon	3	5
203	Lyon & 6th	4	4
204	Lyon & 3rd	3	4
205	2nd & North	33	38
206	2nd & North	6	5
207	I 70 Business Center	10	3
208	9th & Ohio	39	25
209	9th & Mississippi (westbound)	8	84
210	9th & Maine	4	2
211	9th & Michigan	5	6
212	Iowa & 9th @ The Merc	13	11
213	Iowa & Harvard	6	5
214	9th & University Terrace	49	12
216	Allen Fieldhouse Garage	238	-
219	DeBruce Center	8	25
226	Capital Federal Hall	269	32
228	18th & Naismith	223	3

233	Murphy Hall	58	14
238	Naismith & 15th (Crafton Preyer)	188	27
251	Templin Hall	17	9
252	Irving Hill & Engel	94	6
253	19th & Constant (eastbound)	10	-
254	Kansas Geological Survey (northbound)	35	4
255	School of Pharmacy	27	4
256	Kansas Geological Survey (southbound)	5	4
273	Constant & Irving Hill (Pioneer Cemetary)	82	35
274	Nicholls Hall	45	9
277	GSP & Corbin	668	-
278	11th & Delaware	3	4
279	11th & Delaware	9	7
281	27th & Rawhide	6	6
282	27th & Haskell	3	4
283	Lyon & 6th	2	1
284	27th & Scottsdale	13	5
285	Bob Billings & Westbrooke (eastbound)	37	23
286	11th & Louisiana	99	-
287	-	69	30
288	Bob Billings & Westbrooke (westbound)	36	10
289	Bob Billings & Wakarusa	40	13
290	-	40	20
291	University & Crestline	170	-
292	Apple & 14th	136	-
294	N Michigan & 2nd	15	9
295	7th & Maine	21	-
297	7th & Michigan	60	26
298	25th & Belle Haven	7	-
299	25th & Belle Haven	14	-
300	Alabama & 24th	16	-
301	7th & Maine	23	-
302	-	-	-
303	Maine & 9th	20	-
306	Gateway Ct	54	5
307	9th & Maine	19	-
309	Emery & Sigma Nu	71	-
312	9th & Iowa	13	-
313	Stewart & 19th	25	-
314	Stewart & 21st	24	-
315	Melrose & 25th	94	-



316	Stewart & 21st	56	-
317	Stewart & 21st	5	-
318	Clinton & Lawrence	15	4
319	N Michigan & George	18	5
320	Inverness @ Adam	72	5
321	24th & Inverness	109	20
322	24th & Crossgate	323	67
323	Clinton & Hawthorn	3	3
324	Harper & 25th	2	2
325	Haskell & 23rd	6	3
326	Barker & 17th	3	2
327	9th & Iowa	17	6
328	29th @ Peaslee	13	17
329	9th & Maine	8	3
330	25th Ter & O'Connell	22	11
331	9th & Ohio (eastbound)	7	8
332	25th & Franklin	124	129
333	Lyon & 3rd	4	3
334	14th & Apple	138	-
337	Crossgate & Clinton	10	4
338	24th & Inverness	4	7
339	Clinton & Crestline	75	17
340	Clinton & Lawrence (eastbound)	9	3
341	7th & Highpointe	72	-
342	24th & Kasold	5	4
345	19th & Naismith (Oliver)	12	-
348	19th & Naismith	51	-
349	Rockledge & 6th	8	-
350	Rockledge & 9th (northbound)	7	-
354	Emery & 9th (northbound)	92	-
355	Emery & Sigma Nu	33	-
356	Indiana & 11th	450	-
357	Stratford & West Campus	50	-
358	Carruth O'Leary Hall	95	-
359	Fambrough & Alabama	245	-
360	Haskell & 12th (southbound)	12	9
361	6th & Monterey Way (westbound)	7	8
362	Folks & Bauer Farm	29	16
363	9th & Avalon	17	5
364	Mass & 19th (Dillons)	27	27
365	Louisiana & 21st	1	-

366	19th & Constant (westbound)	122	-
367	Haskell & 12th (northbound)	27	16
368	Learned Hall (Engineering)	1,051	75
369	Jayhawker Towers	61	10
370	Green Hall	1,055	64
371	Naismith Hall	18	43
372	Bailey Hall	1,248	120
373	Daisy Hill	58	10
374	Becker Drive Stop #1 (formerly Park & Ride)	69	6
375	Becker Drive Stop #2 (formerly Park & Ride)	23	5
376	Becker Drive Stop #3 (formerly Park & Ride)	14	6
377	Becker Drive Stop #4 (formerly Park & Ride)	729	38
378	Oliver Hall	334	26
379	Lewis & Self Halls	539	36
380	Oswald Hall	1,360	8
381	Stauffer Flint Hall	315	47
382	19th & Louisiana	35	-
383	27th & Ponderosa	24	3
384	24th Terr @ Crestline	128	-
385	Burdick & Irving Hill	176	-
386	Robinson Center	439	122
387	Price Computer Center	92	48
388	Ambler Student Recreation & Fitness Center	195	2
389	Kasold & Winterbrook	4	5
390	Wakarusa & Legends	31	11
391	Wakarusa & Inverness	15	3
392	Stouffer Place Apartments (eastbound)	303	1
393	Stouffer Place Apartments (westbound)	122	-
394	Oliver/Downs Halls	768	54
395	Irving Hill & 18th	147	2
396	-	61	-
397	Burge Union	8	-
398	31st & Atchison	3	1
400	Alabama & 24th	271	-
455	Snow Hall	1,574	232
456	Wescoc Hall	1,491	96
457	Naismith & 15th	12	59
458	Simons Labs	14	2
<b>Total Average Daily Boardings:</b>		<b>27,344</b>	<b>6,303</b>