



# Recommended Network Report

July 2023



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# 1. Introduction & Executive Summary

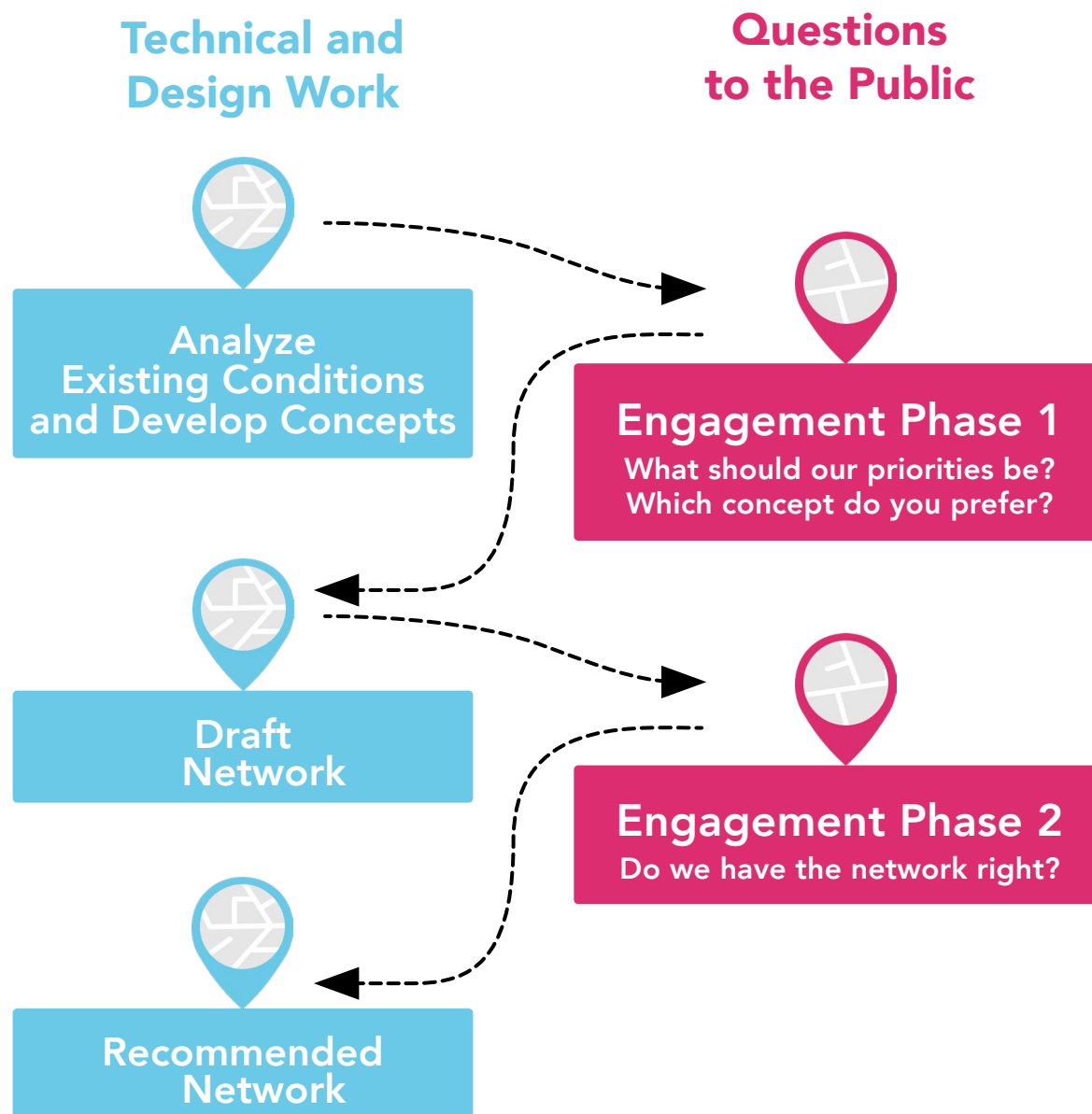
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# What is KAT Reimagined?

**KAT Reimagined** is a chance for Knoxville to rethink and reconsider its entire bus network and consider how its transit system is meeting the City of Knoxville's mobility needs. This project is a collaboration between Knoxville Area Transit (KAT) & Knoxville Regional Transportation Planning Organization (TPO) and involves riders, the general public, and key stakeholders in conversations about how Knoxville's bus network should serve its residents, businesses, and visitors.

Today, KAT's network is the result of decades of cumulative small changes and adjustments. The resulting network may not be meeting the goals and priorities of today's residents, employers, and institutions. Redesigning KAT's bus network is an opportunity to review existing and potential transit demand and need, and to design a network that meets those demands and needs most effectively.

Redesign does not mean changing every bus route and stop. The key point is that thinking is not constrained by the existing network. Where the analysis suggests that existing service patterns make sense, those elements would be retained. Ultimately, the goal is a network designed for the Knoxville of today and tomorrow.



# The Product of Transit: Access

A common goal for transit is to help people access opportunities: work, shopping, medical needs, education, and all the economic, social, cultural, and natural riches that a community has. Maximizing the places that people can reach in a limited amount of time is something we can calculate in assessing how well transit is meeting this goal.

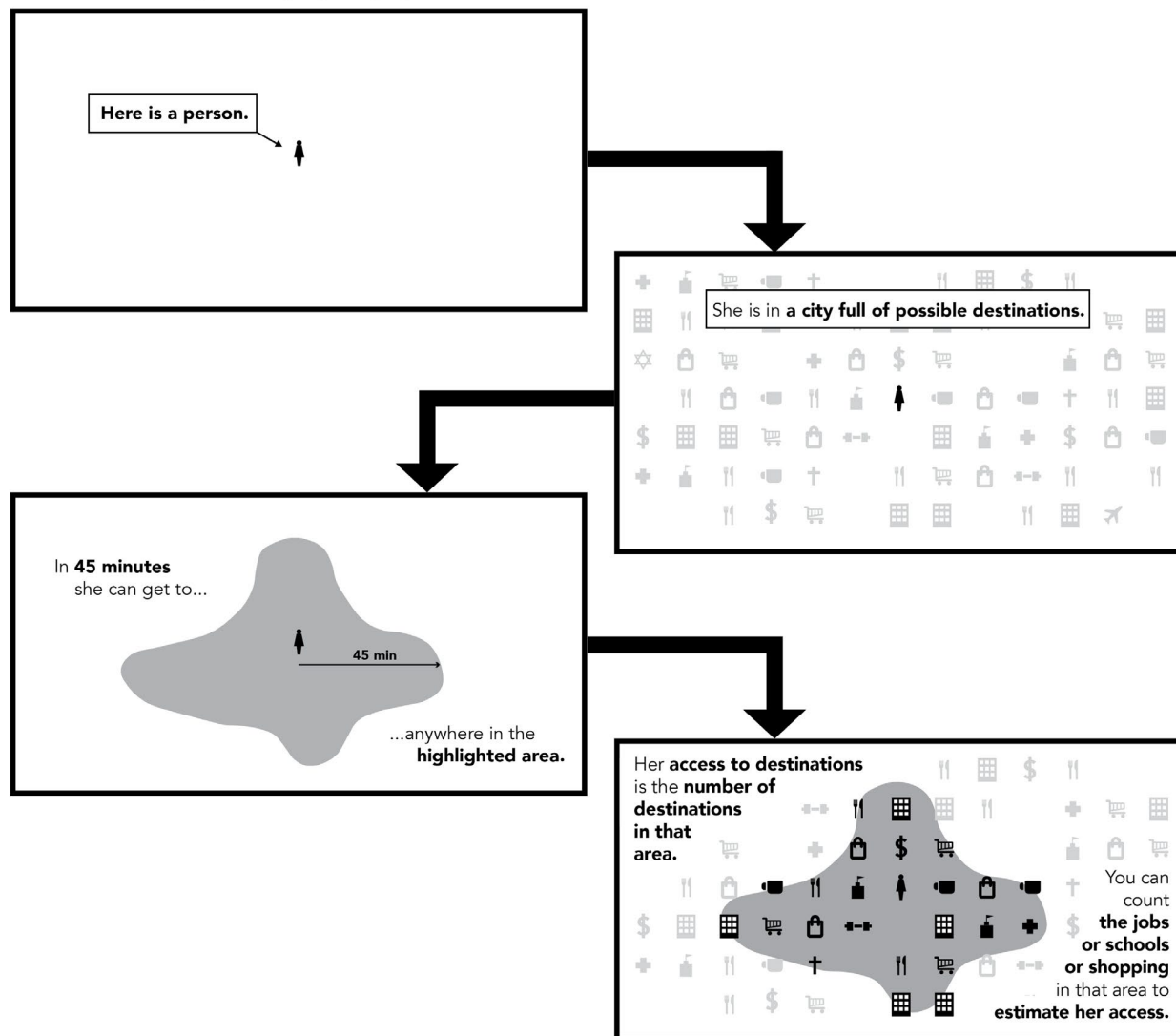
When we expand access, we achieve many important things:

- We **make service more useful** for many different trips. When transit is more useful, more people use it.
- We **increase ridership potential**, as a result of service being more useful.
- We increase transit's potential to help with **pollution and congestion**.
- We **expand access to opportunity** (jobs, education, shopping, services).
- We **increase the economic attractiveness** of the urban area.

That's why the Recommended Network looks as it does.

**The Recommended Network increases access to jobs and opportunities for most people and places in Knoxville. The average Knoxville resident could reach 19% more jobs.**

## WHAT IS ACCESS?



# How the Plan Expands Access

## Frequency is Freedom

Transit travel time has three elements: **walking**, **waiting**, and **riding**. If a trip requires changing buses, the steps may be repeated. Waiting is often the most onerous part of a transit trip. Some people can wait for an infrequent bus at home or in a cafe, but for everyone, waiting is time spent not where you want to be.

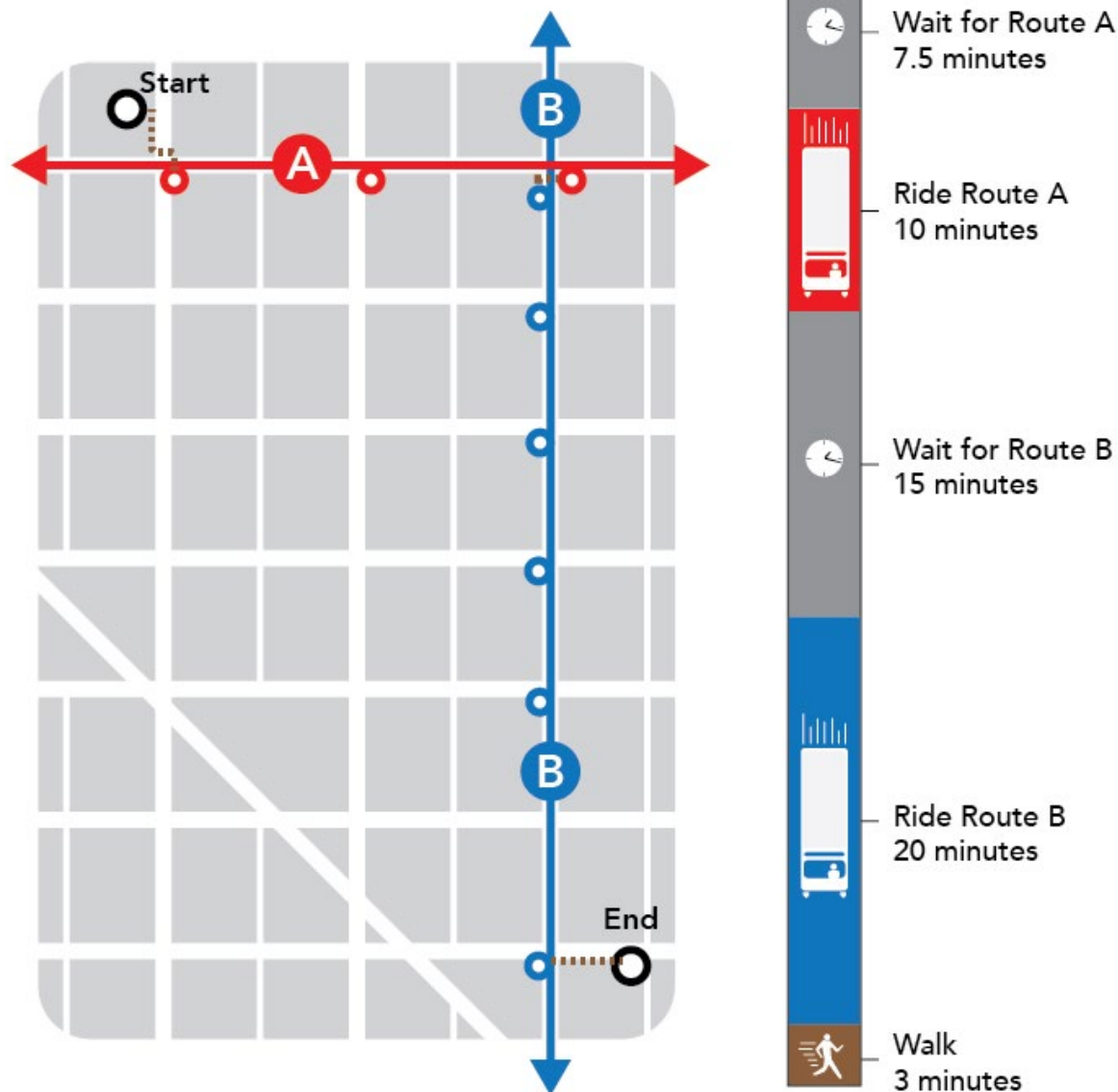
The solution to the problem of waiting is frequency. Frequency—the amount of time between one bus and the next on a route—is a dominant factor in determining travel time, so it's a core focus of any plan that tries to expand where people can go in a reasonable time.

Frequency does three good things:

- **It reduces waiting**, the most onerous part of a transit trip.
- **It makes it easy to transfer**, from one route to another, so that you can go all over the network instead of just along one.
- **It improves reliability**. (If a bus breaks down, the next will be along soon.)

## What's taking so long?

*Elements of Transit Travel Time*



# Recommended Network

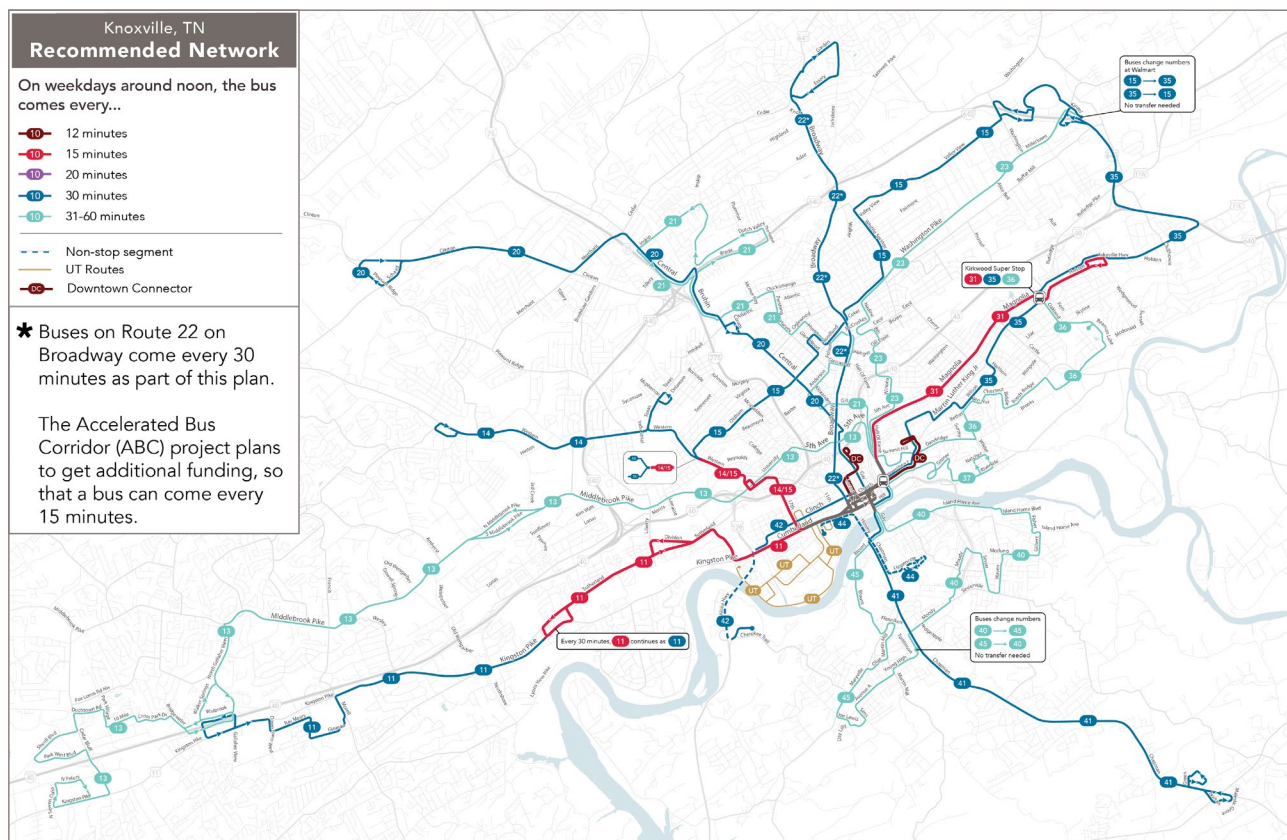
This map shows the **Recommended Network**. Every route is color-coded based on its frequency.

- **Dark red** lines every 12 minutes
- **Light red** lines every 15 minutes
- **Dark blue** lines every 30 minutes
- **Light blue** lines every 60 minutes

Based on the KTA Board's resolution, the Recommended Network has been designed to assign 70% of resources to goals that can achieve high ridership and 30% to provide coverage. This is done by consolidating duplicative resources and moving some resources from coverage service to ridership (or higher frequency) service.

For most people and places, the Recommended Network improves access to jobs, people, and opportunities by transit. It does this by providing more frequent service along the busiest and densest corridors. Specifically, there would be frequent service on Cumberland/Sutherland, Western, and Magnolia.

The Recommended Network is explained in more detail in Chapter 3.





# Outcomes

## Change in Access to Jobs

The Recommended Network allows the average person to reach 18,300 jobs within 45 minutes by walking and taking transit, **19% more jobs than are reachable within the existing network.**

Likewise, the average person in poverty, would be able to reach 24% more jobs. For the average resident of color, jobs accessible would increase by 26%.

This analysis measures jobs, but it reflects a wide range of opportunities that a person can reach. This means a person can get to more shopping, education, recreational areas, social events, places of worship, and any other opportunities that the region can offer.

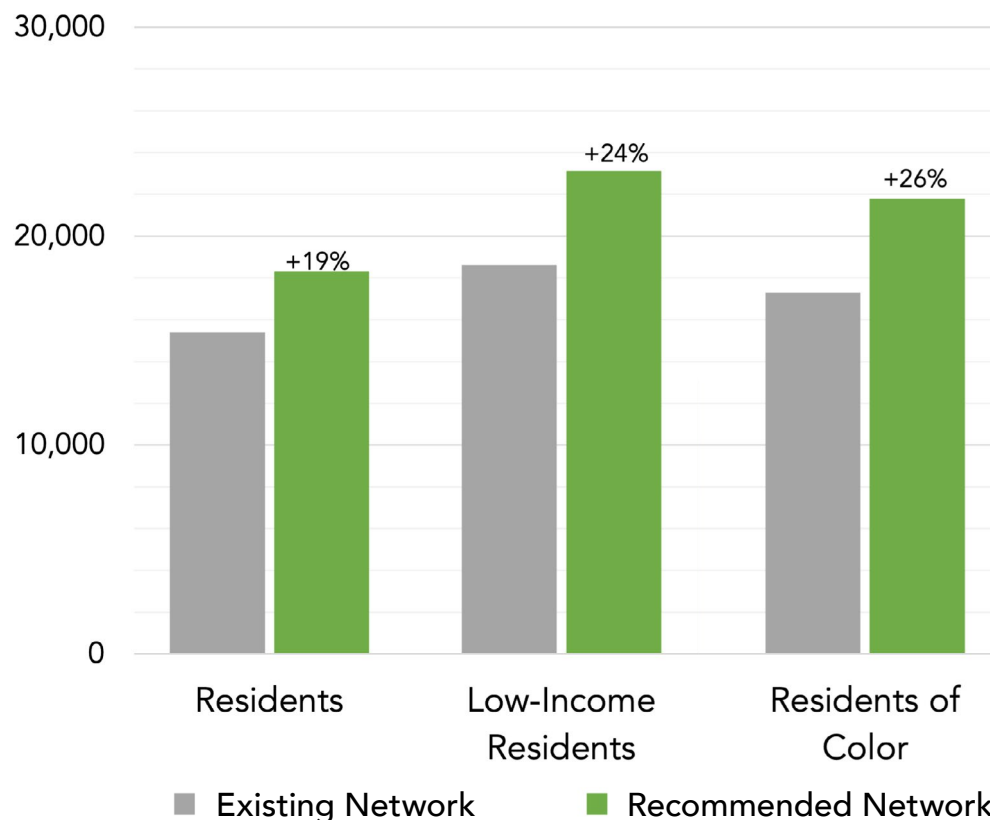
## Proximity to 15-Minute Service

The Recommended Network provides 15-minute service near (within 1/2 mile of) 12,000 more residents and 8,200 more jobs—that's 79% more residents and 23% more jobs than in the Existing Network.

The outcomes of the Recommended Network are explained in more detail in Chapter 4.

## Change in Average 45-Minute Job Access

At midday on weekdays, the average number of jobs accessible by transit within 45 minutes by different groups





## 2. How did we get here?

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# Steps to Design the Recommended Network

Designing the Recommended Network has been a collaborative effort between KAT, TPO, the City of Knoxville, riders, the general public, and key stakeholders. These are the steps we have taken to reach this design.



## Step 1. Analyze Existing Network

We assessed the performance of existing routes and the network as a whole. By looking at ridership and land use patterns in Knoxville, we learned about how the network is used today and where there is potential for improvement.



## Step 2. Consider Key Goals

There are different ways to design a transit network based on the community's goals. We can put service along dense corridors to provide frequent service and achieve high **ridership** or we can provide **coverage** to large areas to with low frequency service.



## Step 3. Develop Concepts

To illustrate the tradeoff between ridership and coverage, we developed two contrasting conceptual networks. These are the opposite ends of a spectrum for what the network could be.



## Step 4. Engagement on Concepts

We had an extensive phase of engagement with riders, the general public, and key stakeholders about the key goals of transit. We asked their preference between the conceptual networks.



## Step 5. Design Draft Network

We used the input from the public and the direction from the KTA Board to develop the Draft Network. The new network shifts the budget from coverage to ridership.



## Step 6. Engagement on Draft Network

We went to the public again and asked if we have the network right. We heard both praises and concerns about the Draft Network.



## Step 7. Design Recommended Network

We took the input we heard from the public and adjusted the network. The Recommended network is the result from the collaborative effort with the public.

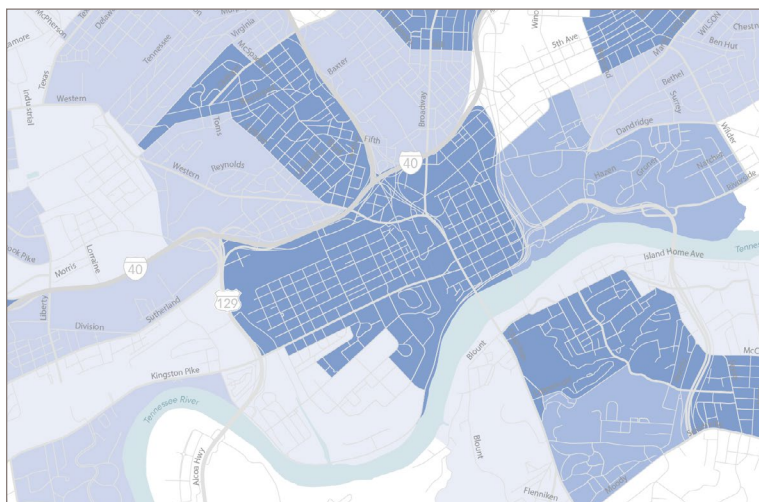
# Step 1. Analyze the Existing Network

To understand how the network functions, our first step was to analyze the existing network. We looked at every route individually as well as the network as a whole. Ridership patterns told us when and where the network is being used today. Yet, we didn't just look at ridership numbers, we also compared them to the level of service provided to understand how productive each route is. We generally saw that higher frequency routes are more productive.

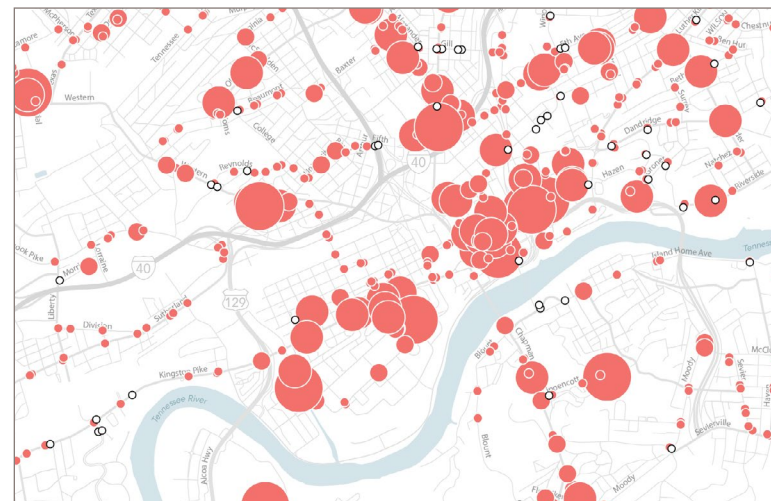
Because existing ridership patterns only reflect how people can travel with the current layout of the network, we took a deep look at the land use patterns in Knoxville. We analyzed demographic data including residential density, job density, low-income resident density, and density of minorities. This gave us a better understanding of where activity is concentrated in the region. We learned where there is a strong market for transit and where there is a significant need for transit.

For more information about the analysis of the Existing Network, see the Transit Choices & Concepts Report. You can download it from [katreimagined.com/library](https://katreimagined.com/library).

## Residential Density



## Ridership



## Step 2. Consider Key Choices

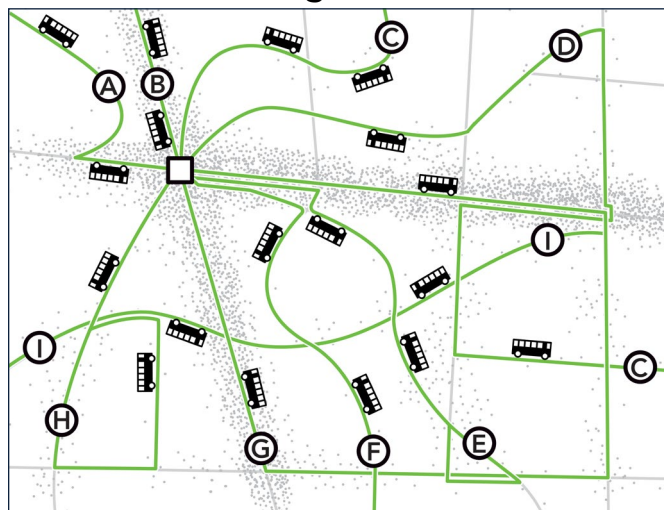
One of the most important, but difficult, decisions that has to be made is whether KAT wants to have a system designed for high ridership, high coverage, or something in between.

A simpler way to answer this question is: how much of the transit budget should be allocated to pursue high ridership? The remaining budget would be used to provide coverage in places where few people will ride, but those who do ride need the service badly.

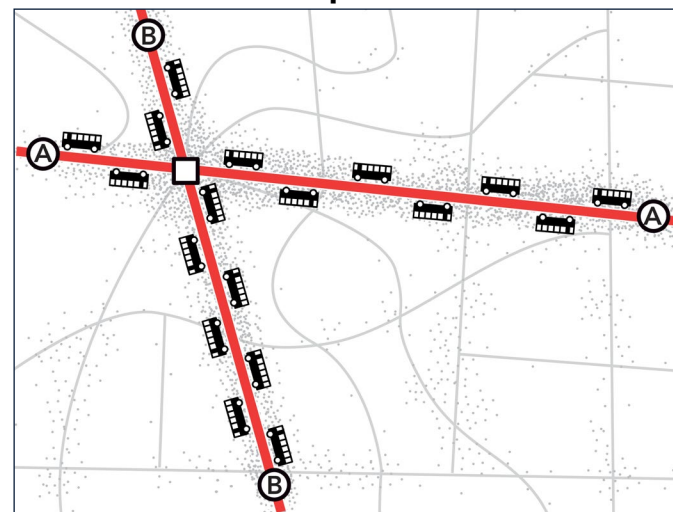
The fictional neighborhood to the right shows what a transit network could look like if it were focused on maximizing ridership or maximizing coverage. These two networks are on opposite ends of a spectrum.

KAT's current network spends about 50% of its resources on ridership, 40% is spent on coverage goals, and about 10% of the network provides duplicative service. Should the City maintain the current balance between investing in high-ridership services and providing wide coverage?

**Coverage Network**



**Ridership Network**



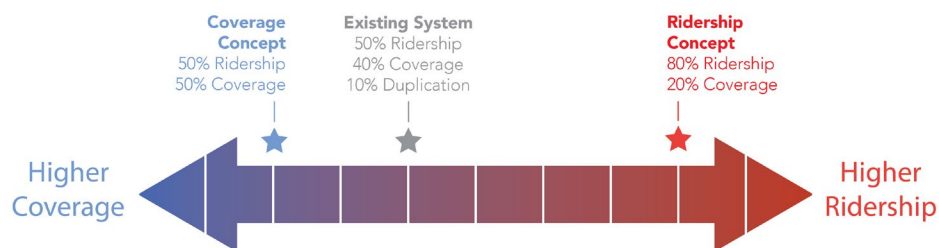


## The Coverage Concept

- slightly expanded the number of people that are close to transit service overall.
- only had routes with a frequency of 30 or 60 minutes.

- provided much higher frequency along the City's most active corridors, but some people in lower density areas would lose bus service.
- had five high frequency 15-minute routes that many people would find useful.

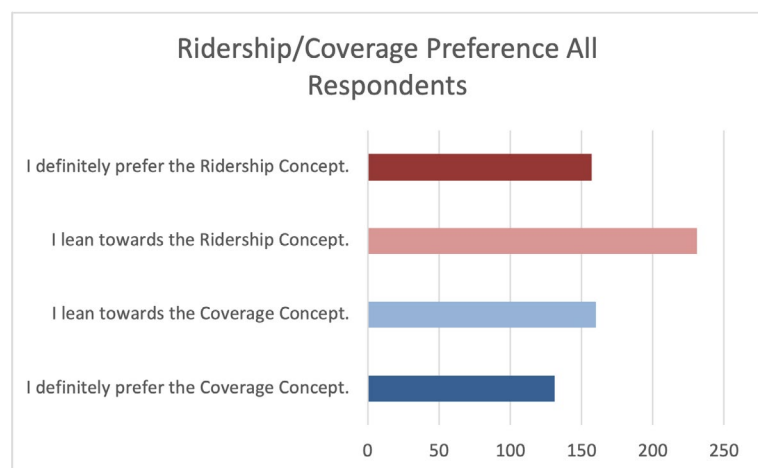
For more information about the Concepts, see the Transit Choices & Concepts Report. You can download it from [katreimagined.com/library](https://katreimagined.com/library).



## Step 4. Engagement on Concepts

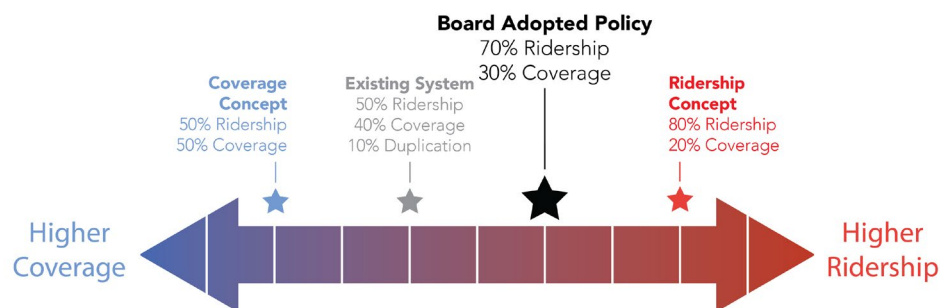
By showing the public, stakeholders, and decision-makers the range of possibilities, we asked: **"Now that you see the outcomes of emphasizing one goal over another, how do you balance the Ridership and Coverage goals? In other words, if you want better service, what is your definition of better?"**

These conceptual networks developed were used to explain the trade-offs between ridership and coverage goals and ask the public which one they prefer. We asked respondents which of the two network concepts they preferred. Of all who provided a response, 57% preferred or definitely-preferred the high-ridership scenario, while 43% preferred or strongly-preferred the high-coverage scenario. Between the two scenarios, most respondents tended to express more of a slight preference than a strong preference. Only 23% strongly preferred the Ridership Concept and only 19% strongly preferred the Coverage Concept. So, most respondents had a weak preference.



## Policy Direction

The public survey responses were presented to the Knoxville Transportation Authority Board (KTA) to help them make a decision on how resource should be allocated between ridership and coverage. **On May 26, 2022 the KTA Board voted on a resolution to assign 70% of the transit operating budget to maximize ridership and 30% of the transit operating budget to maximize geographic coverage. This is a change that would mean shifting the budget from coverage to ridership.**



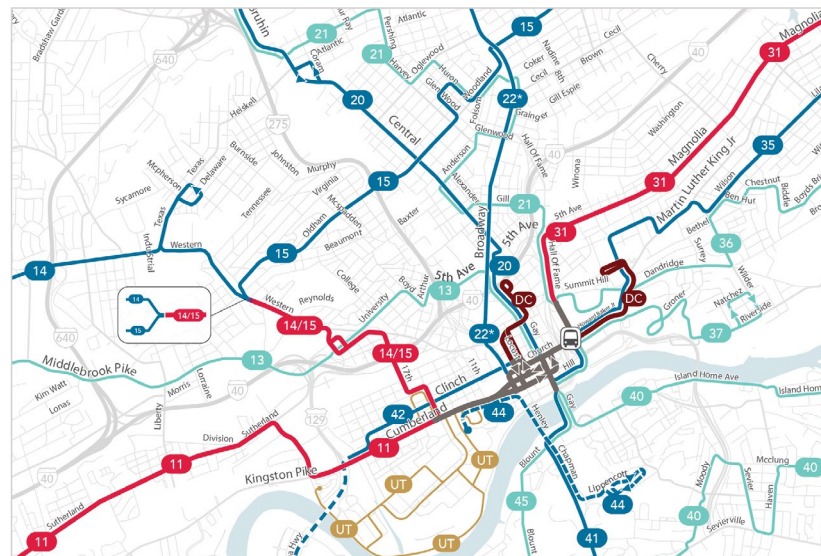
## Step 5. Design Draft Network

Using the input that we got from the public and the direction from the KTA Board, we developed a Draft Network. This network assigned 70% of the transit operating budget to maximize ridership and 30% of the transit operating budget to maximize geographic coverage. This is a change that means shifting the budget from coverage to ridership.

The Draft Network concentrates frequent 15-minute service on the most dense and active corridors, with frequent service on Cumberland/Sutherland, Western, and Magnolia. The cost of these investments in frequency is that some areas lose service.

In other places, routes are consolidated so people will have to walk farther to reach a bus stop, but, in general, buses are coming more frequently. This results in great access meaning that, on average, most people can get to where they are going in less time.

**Draft Network**





## Step 6. Engagement on Draft Network

We went back to the public with the Draft Network to ask them if we have the network right. To understand if the public thinks the network is appropriate for Knoxville, we asked if they agree with this statement—"Compared to the Pre-Covid Network, the Draft Network will be better for the city overall." This is how the public responded:

- 52% agree that Draft Network will be better
- 22% neutral
- 26% disagree that Draft Network will be better

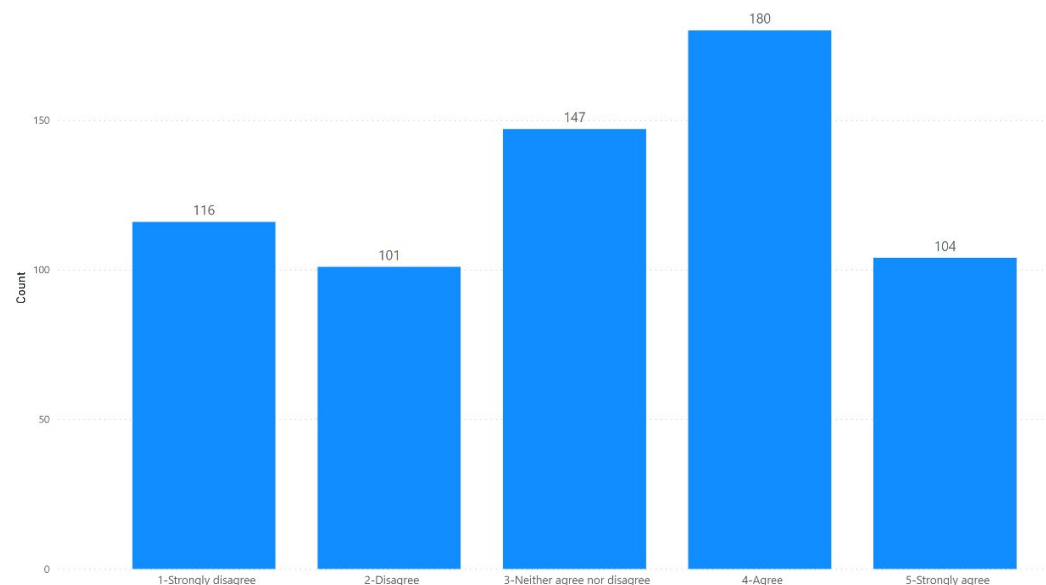
The majority of people agree that the Draft Network will be better, and the network received many praises, particularly about the increased frequencies and the increase in weekend service.

However, 26% of respondents disagree. To understand why they disagree, we looked at the top comments. These included the removal of Route 23 and the removal of service on Broadway Towers and O'Connor Senior Center.

### Policy Direction

These comments were taken into consideration as the Draft Network was revised and turned into the Recommended Network. The next chapter describes the Recommended Network in detail.

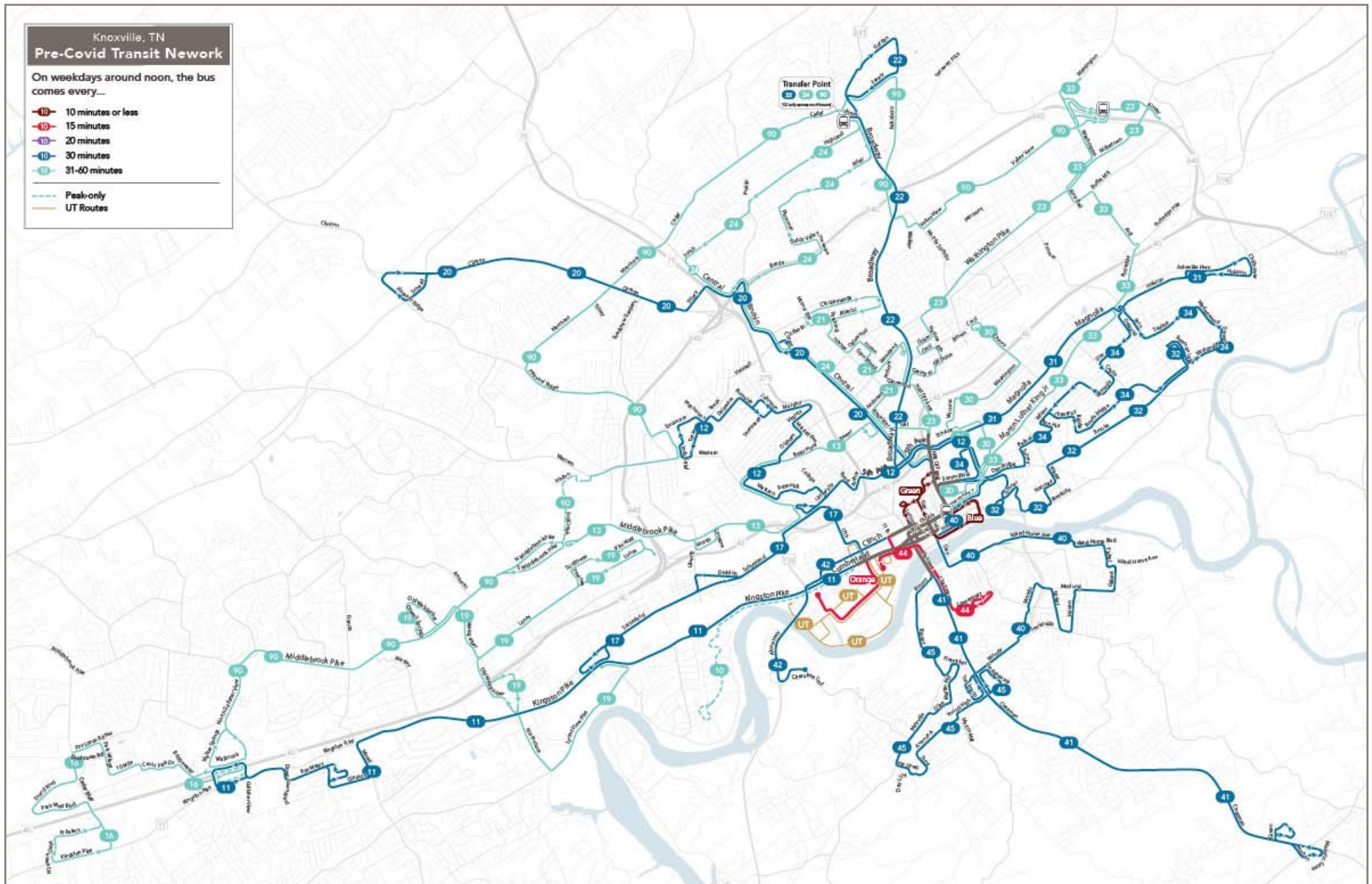
**Compared to the Pre-Covid Network, the Draft Network will be better for the city overall.**



## 3. Recommended Network

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# Existing Network



# Existing Network

This map shows KAT's existing bus network and the map on the following page shows the Recommended Network.

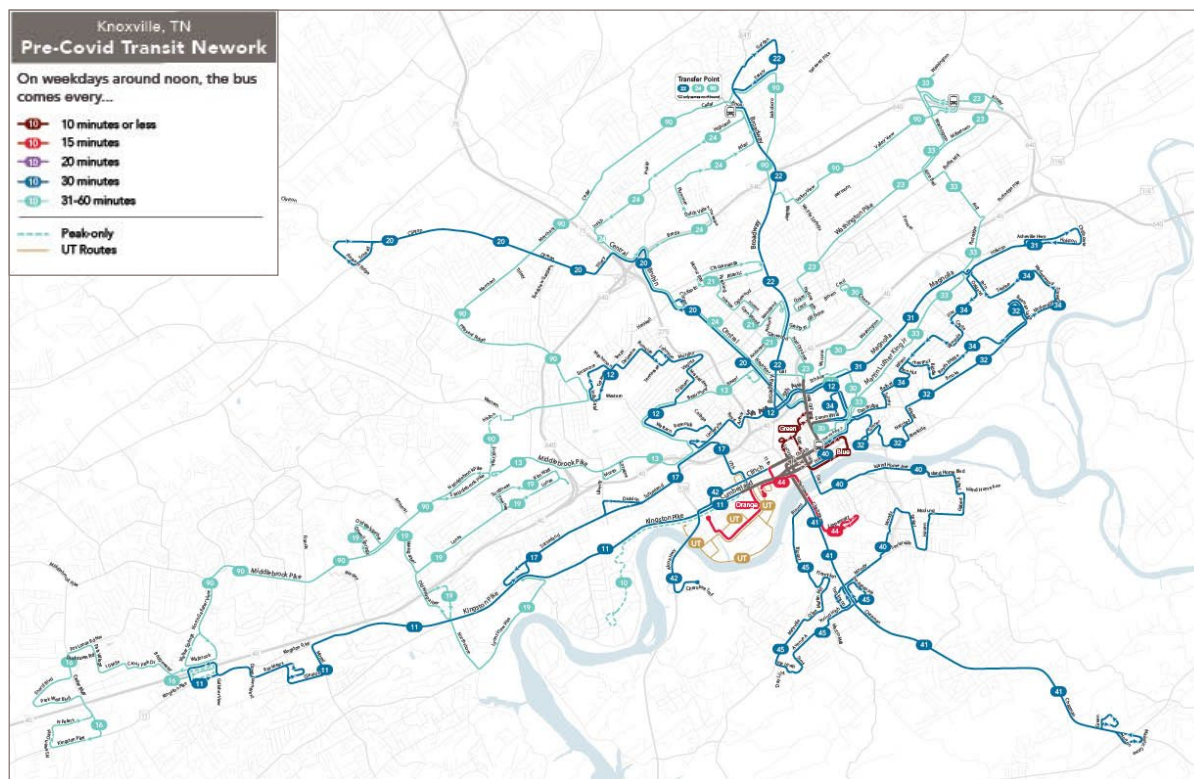
In both maps, every route is color-coded based on its frequency during the midday on a weekday. In the network maps, colors make all the difference.

- **Dark red** lines every 12 minutes
- **Light red** lines every 15 minutes
- **Dark blue** lines every 30 minutes
- **Light blue** lines every 60 minutes

**Except for the trolleys, every bus route in KAT's network operates every 30 minutes or worse at midday.**

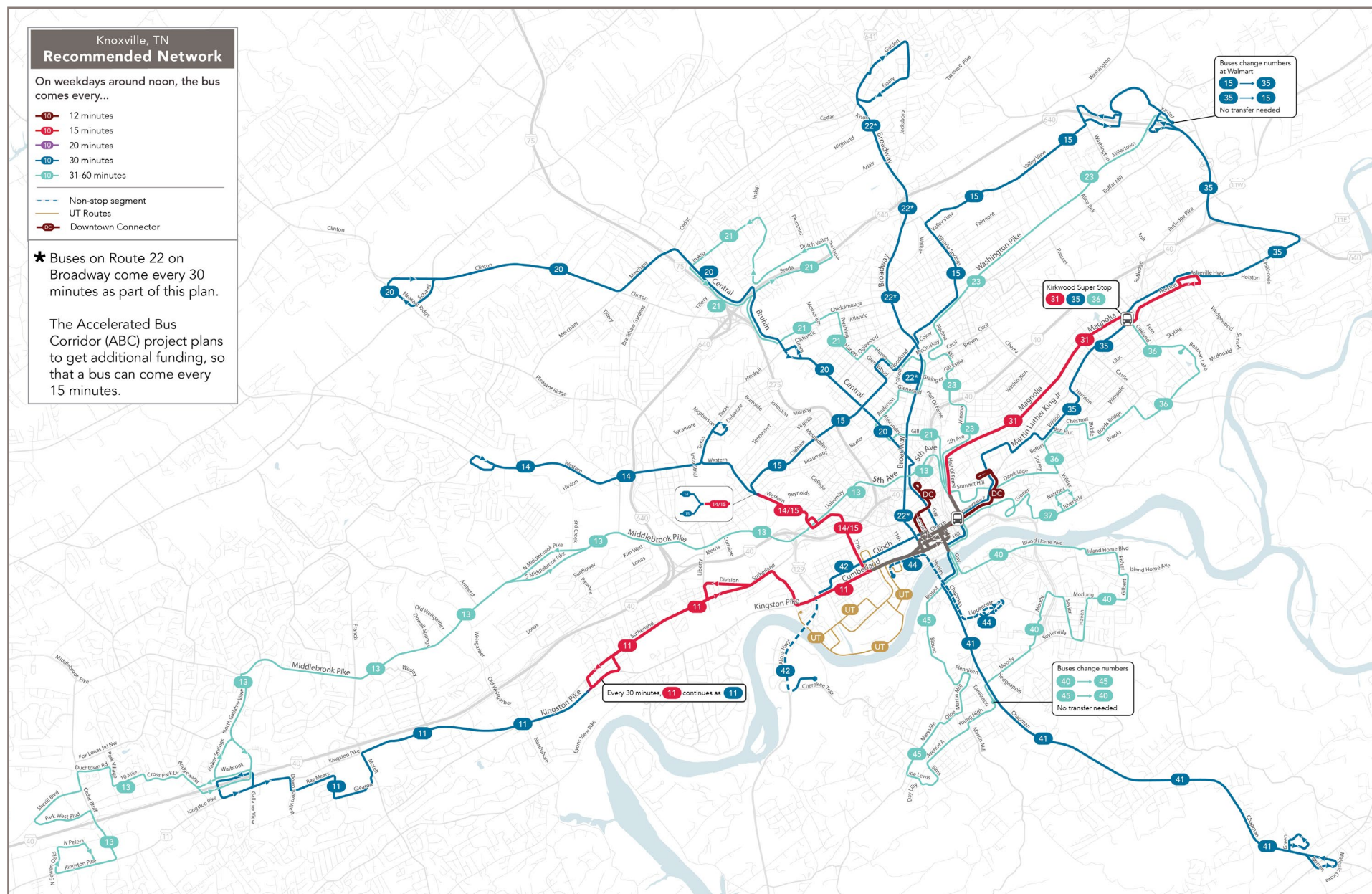
The Existing Network uses 50% of resources towards service that can achieve high ridership, 40% is spent on coverage goals, and about 10% of the network provides duplicative service.

Route 44 is a specialized service with a separate funding source and any change to its service level is separate from this study.





# Recommended Network



# Recommended Network

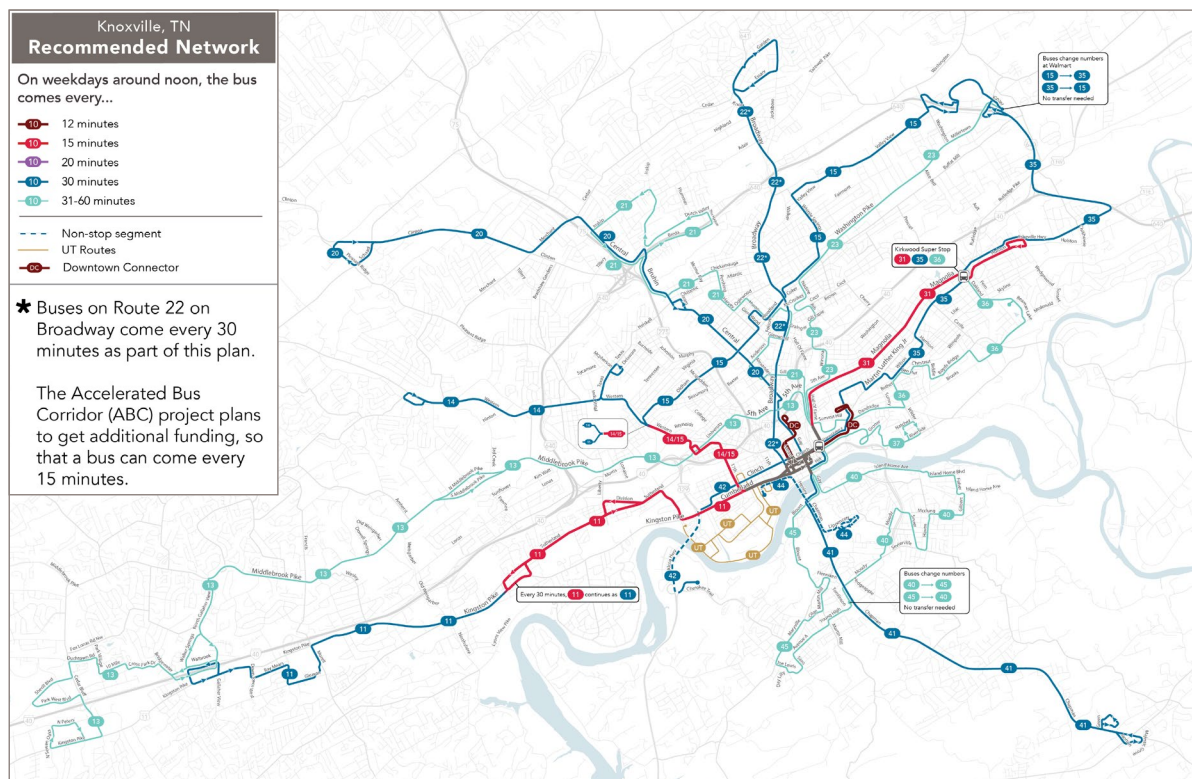
The Recommended Network, shown on the right, concentrates more frequent service where there are more people, jobs, and opportunities. Based on the KTA Board's direction, this network was designed to allocate 70% of resources towards service that can achieve high ridership and 30% to provide coverage.

The Recommended Network concentrates frequent 15-minute service on the most dense and active corridors, with frequent service on Cumberland/Sutherland, Western, and Magnolia.

The cost of these investments in frequency is that some areas lose service. No service is provided to areas along parts of Merchant Drive and Cedar Lane where today's Route 90 is or along Lonas Drive where Route 19 runs today.

In other places, routes are consolidated so people will have to walk farther to reach a bus stop, but, in general, buses are coming more frequently. This results in great access meaning that, on average, most people can get to where they are going in less time.

Route 22, on Broadway, has buses coming every 30 minutes despite being a very dense corridor. However, The Accelerated Bus Corridor Project (ABC), includes additional service that will increase service on Route 22 with buses coming every 15 minutes.



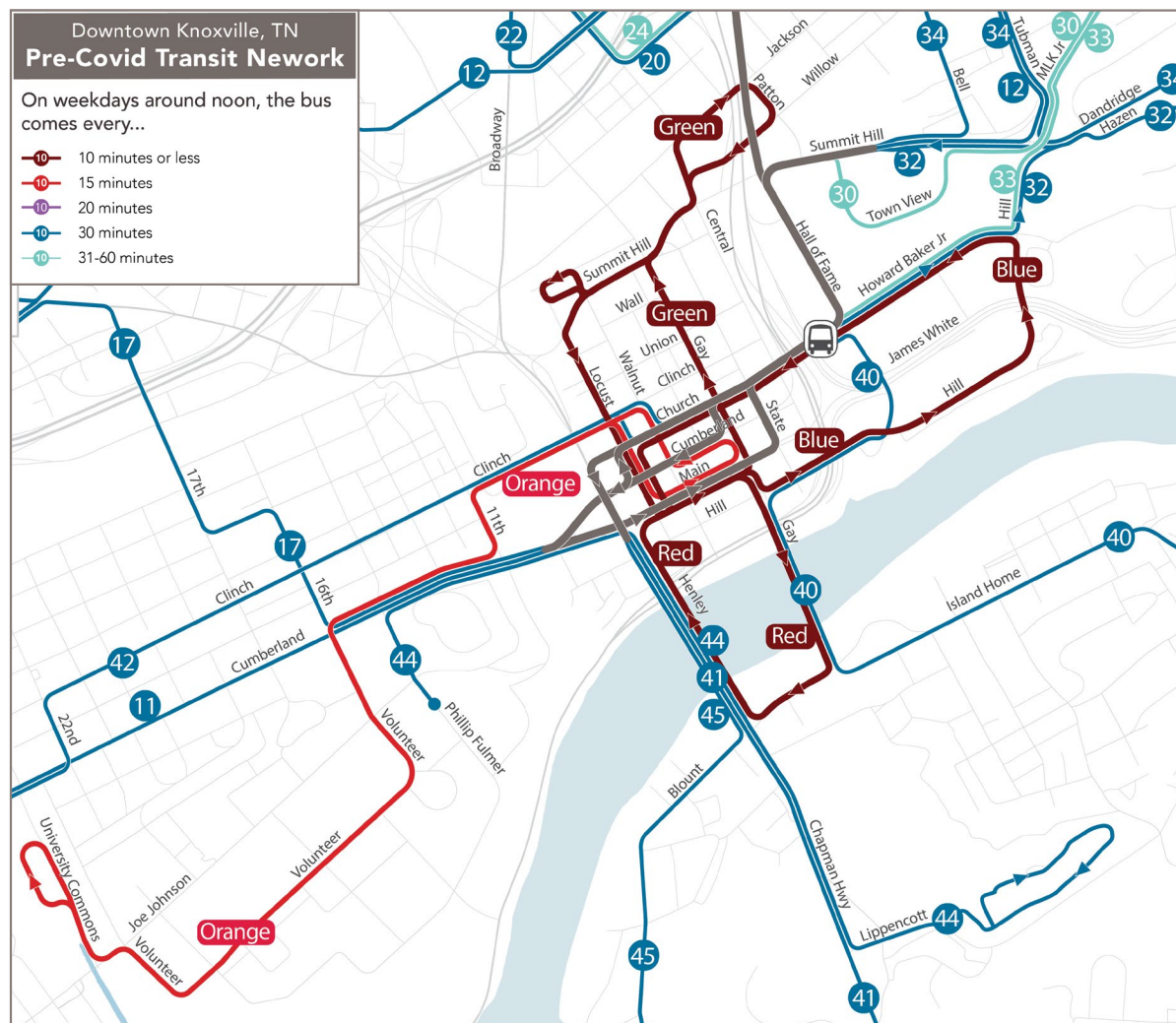


## Downtown: Existing Network

Downtown Knoxville has the strongest offering of transit service in city. This is due in part to the radial design of the system. Most routes come into Knoxville Station to provide an opportunity for customers to transfer from one route to another. KAT's three trolley routes also operate within the city's core. The Trolleys are short, relatively frequent routes which circulate passengers in and near Downtown Knoxville.

Although the trolley routes do not directly overlap for their entire lengths with other routes in the KAT network, there is a good deal of overall duplication happening in the downtown area between regular KAT routes and the trolley routes. This creates competition between routes in the KAT system.

The trolleys are designed and marketed primarily toward moving people just within the downtown areas. By separating out this service from the rest of the system, the market for transit downtown is being divided into smaller, potentially less productive segments. In transit, specialized services tend to dilute the market whereas generalized services tend to get the highest ridership across the entire system.

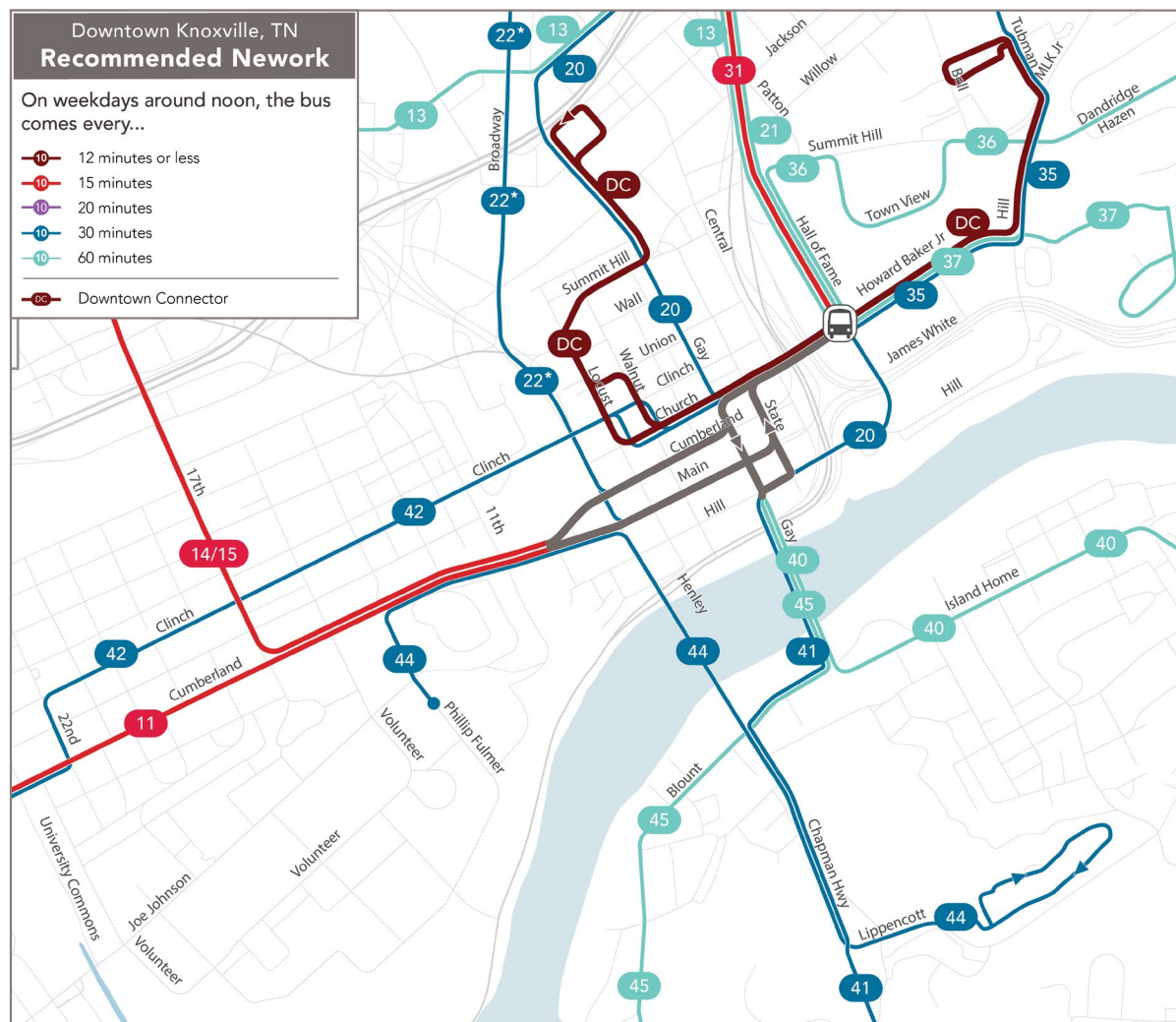




# Downtown: Recommended Network

Downtown in the Recommended Network would be served by four high-frequency routes and a much simpler network, making it easier for a rider to figure out how to get around Downtown. The existing trolley routes have been replaced with a new 12-minute Downtown Connector route that does something similar to what the Green and Blue are doing today. This Downtown Connector would run all day, every day.

Having so many corridors in Downtown with 15-minute routes means that many of the densest parts of Knoxville will have high frequency service and there would be multiple options for connecting across Downtown and nearby destinations with relatively frequent service. For example, in this network, the combination of Routes 11, 14, and 15 would provide 8 buses per hour from downtown to the University of Tennessee. Therefore, many more people will find the transit service useful.



# When is service available in the Existing Network?

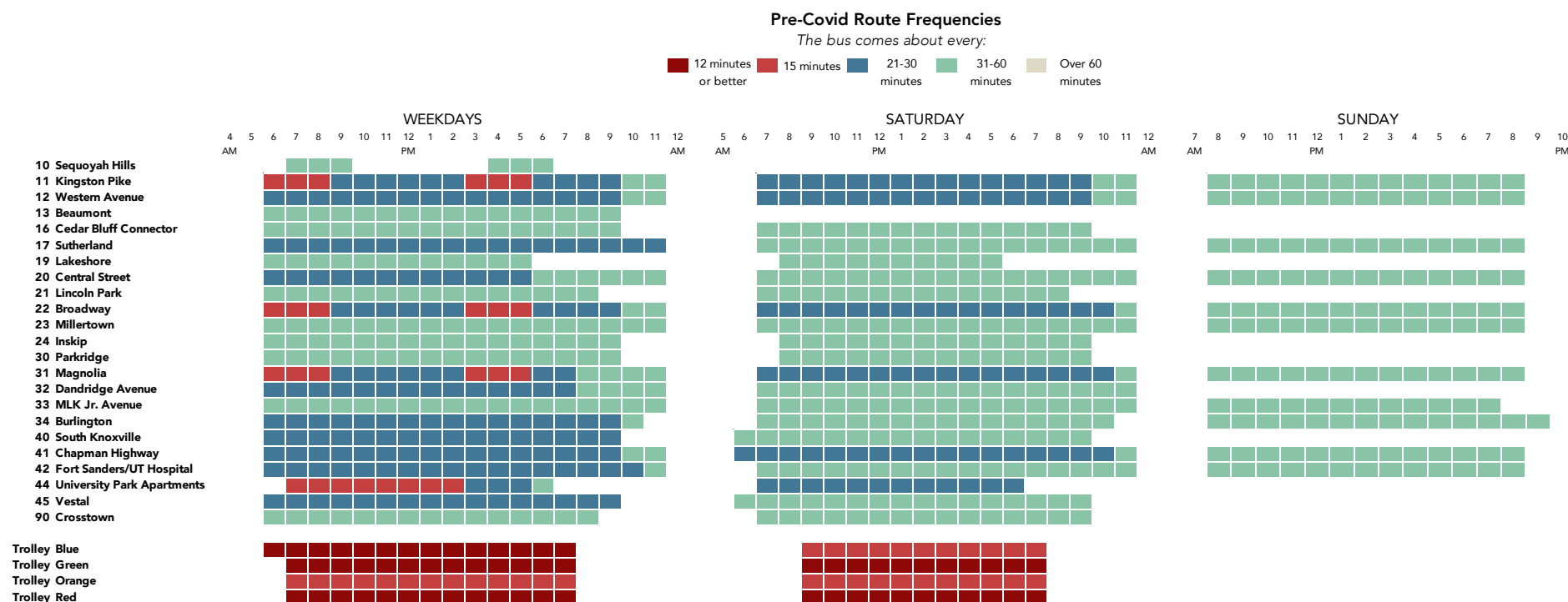
The table below summarizes each route's **frequency** (how often a bus on the route comes) and **span** of service (what days and what durations the route operates). Each hour a route operates is shown by a single block, colored roughly according to the frequency offered in that period. From left to right, the columns of blocks show service for each route during weekdays, Saturdays, and Sundays.

Similar to the network maps earlier, the span-frequency chart shows how KAT service consists of four frequent trolley routes, twelve 30-minute routes and the rest are 60-minute routes.

For most routes, the frequency is consistent throughout the day. Route 10 is the only peak-only service provided, and Routes 11, 22, and 31 have more service during the peaks.

## Less Service on Weekends, Especially Sunday

On Saturdays, the frequency of several routes declines to 60 minutes, and Route 13 does not run at all. On Sundays, only eleven routes run, all with a frequency of 60 minutes. The trolleys run on Saturdays but not Sundays.



# When is service available in the Recommended Network?

The chart below shows the frequency by time of day for the routes in the Recommended Network. It generally has greater spans than the Existing Network. It also consolidates service into fewer routes and proposes higher frequencies on many routes.

The Recommended Network would include 15-minute service or better throughout most of the day on Routes 11, 14/15, 31, and the Downtown Connector. Routes 11 and 31 run every

30 minutes on weekends, but **all other routes would keep their weekday frequency on weekends (including Sundays), a significant improvement over weekend frequencies in the Existing Network.**

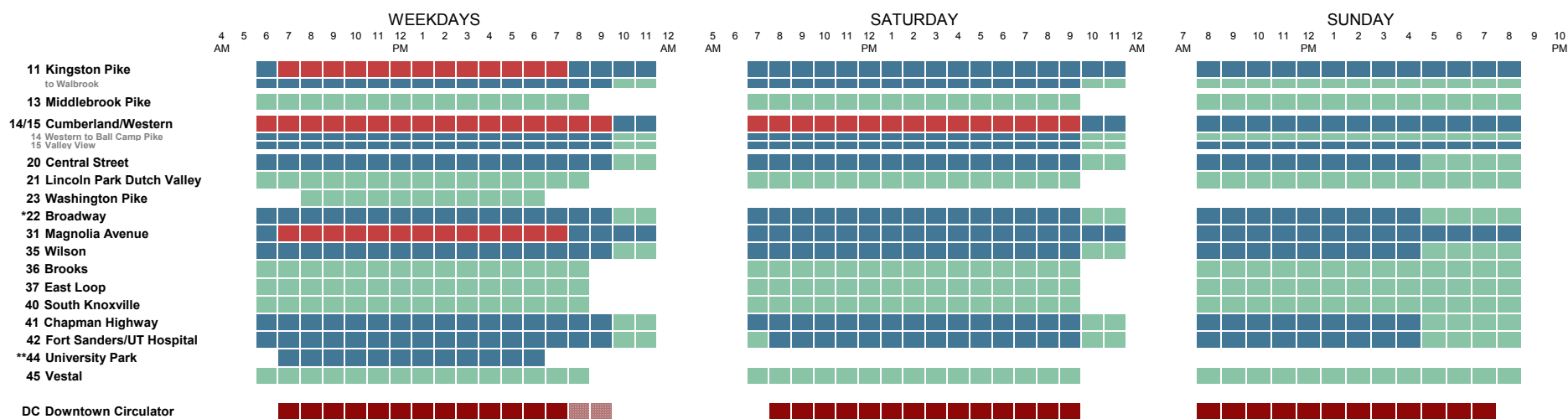
This increase in all-day and weekend frequencies reflects the fact that more and more jobs are on nontraditional schedules requiring shifts on weekends or that start in the midday and end later than 6pm. This trend is especially

pronounced for lower-wage jobs in retail, healthcare, restaurants and personal services, so **improving weekend and evening service helps improve the lives of people with lower incomes.**

Many people may be reluctant to use transit because of its inconsistent availability. If someone buys a car to get home after evening or weekend work shifts when transit is unavailable, they may feel that they might as well drive on weekdays too.

## Recommended Network Route Frequencies

The bus comes about every:



\* Route 22 has a frequency of 30 minutes under this plan. However, the Accelerated Bus Corridor (ABC) Project will include additional funding so that buses come every 15 minutes

\*\* Route 44 has a frequency of 30 minutes, which is less than today (15 minutes). This is because Route 44 has a separate funding source and is not part of this study.

\*\*\* DC Downtown Circulator runs from 7am to 8pm Sunday-Thursday and 8am to 10pm on Fridays and Saturdays.

# Weekend Service

The maps on the right show the network available during the weekends for the Existing and the Recommended Networks. The lines are color-coded by frequency like in the previous maps.

The Existing Network has several routes that run every 30 minutes during weekdays, but on Saturdays, most routes run every 60 minutes. Routes 10 and 13 do not run at all. This is shown on the map on the top-left.

Most 15-minute routes in the Recommended Network drop to 30 minutes on Saturdays, but everything else runs with the same frequency as weekdays. This is an improvement of the Existing Network. This is shown on the map on the bottom-left.

The Existing Network runs very little service on Sundays. Only eleven routes run, and they all run every 60 minutes. The trolleys don't run on Sundays. This is shown in the map on the top-right.

The Recommended Network provides much more service on Sundays. Routes 11L and 14 run every 60 minutes but everything else is the same as Saturday. This is a huge improvement of the Existing Network. This is shown on the map on the bottom-right.



## 4. Comparing Outcomes

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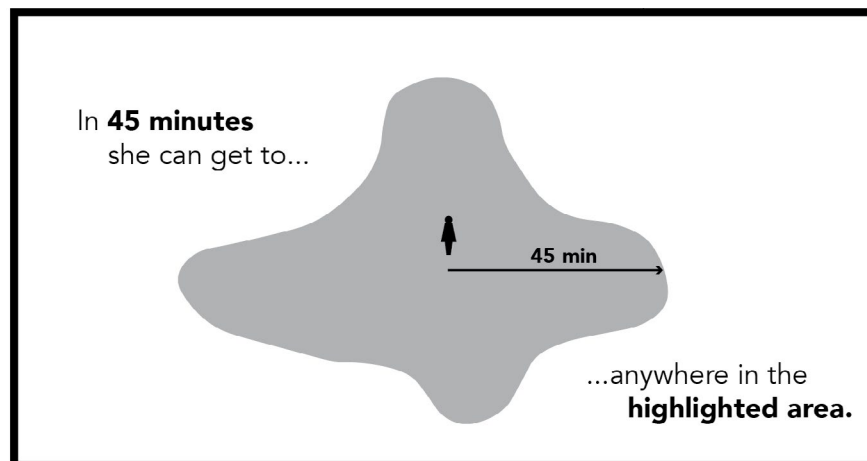
# Freedom, Access, Usefulness

Wherever you are, there is a limited number of places you could reach in a given amount of time. The figure on the right shows an example of this type of visualization of transit access. This blob determines what your options are in life: for employment, school, shopping, or whatever places you want to reach. If you have a bigger blob, you have more choices, so in an important sense you are more free.

## Access is a Matter of Geometry

Freedom is about what you could do, not what we predict you will do. Access is how network design generates ridership, because it measures how likely it is that any particular trip will be viable on transit.

- **Access to jobs** is a key concern for keeping people employed.
- **Access from a particular place** gives a location value. In dense cities, transit access can be an important factor in land value.
- Access describes an outcome in terms that many people will care about. **If you are deciding where to live based on whether you'll be able to get to your job, school, or relatives, you are asking a question about access.**
- The reason people live in urban areas is to have access to opportunities. **So, access is a measure of whether a city is functional.**





# Measuring Access to Opportunities

The real measure of usefulness is not just how much geographic area we can reach, but how many useful destinations are in that area. Ridership arises from service being useful, for more people, to get to more busy places.

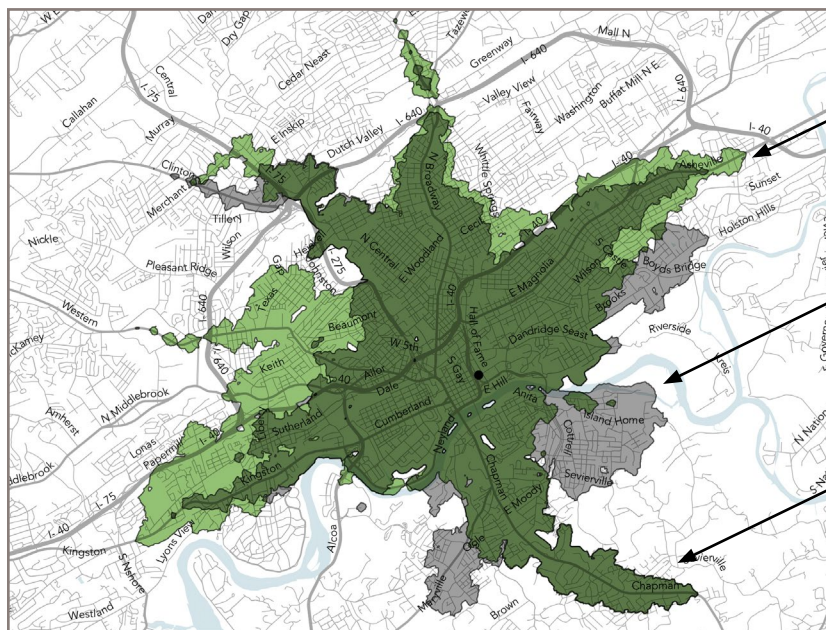
The example on the right shows how access changes for Knoxville Station with the Recommended Network compared to Existing. Areas reachable with both networks in **dark green**, newly reachable areas in **light green**, and places no longer reachable within 45 minutes are shown as **grey areas**. The change in jobs and people reachable is shown above the map. The technical term for this map is an isochrone. The maps on the next two pages show the same comparison of isochrones for four other example locations.

When reviewing these maps remember that **waiting time counts, and in most cases, a longer walk to a high-frequency route can get people farther and faster**, than a shorter walk to an infrequent route. Also remember that some of the access shown in these maps isn't reached on a single route, but requires a transfer.

From  
**Knoxville Station**  
in the  
**Recommended Network**  
on weekdays at noon,  
using transit, you can reach

<b>+8,100</b>	<b>+7,700</b>
<b>Jobs</b>	<b>Residents</b>

in 45 minutes



**Light green areas** are newly reachable in 45 minutes in the Recommended Network.

**Grey areas** are reachable in 45 minutes in the Existing Network, but not in the Recommended Network.

**Dark green areas** are reachable in 45 minutes in both the Existing Network and Recommended Network.

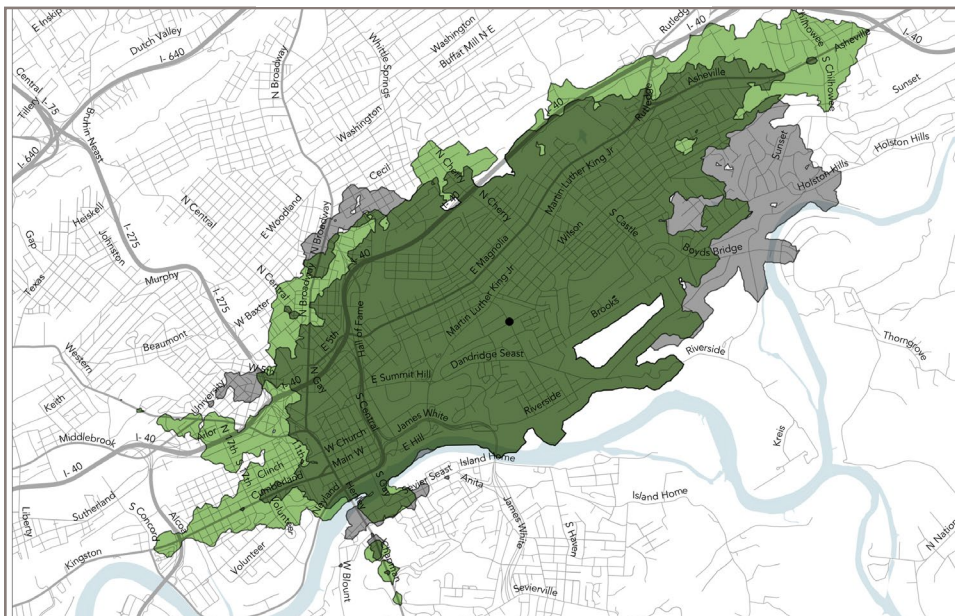


# Isochrone Examples (1)

Residents near Five Points  
could reach 6,800 more jobs  
in 45 minutes with the  
Recommended Network.

From  
**Five Points**  
in the  
**Recommended Network**  
on weekdays at noon,  
using transit, you can reach

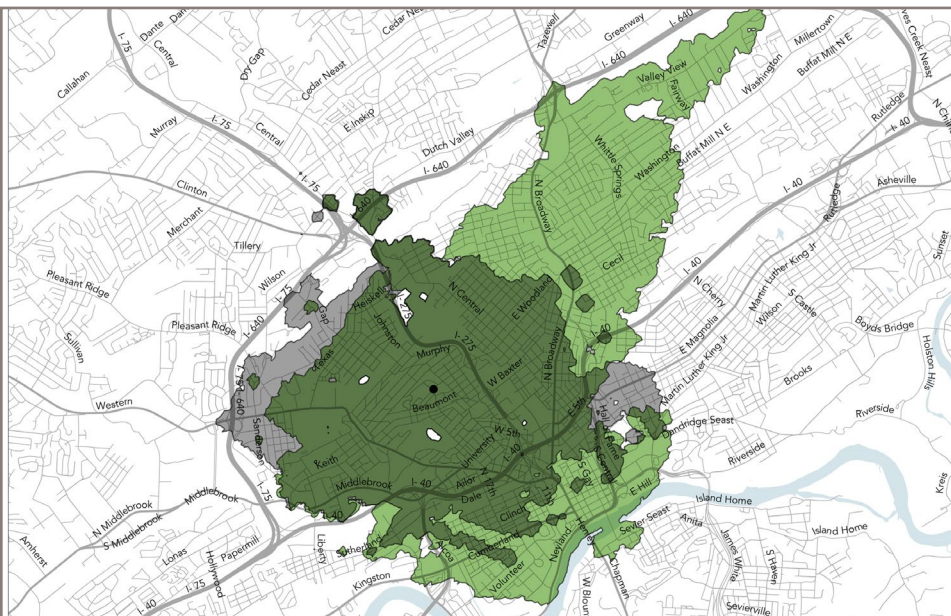
<b>+6,800</b>	<b>+7,600</b>
<b>Jobs</b>	<b>Residents</b>
<b>in 45 minutes</b>	



Residents near Western Heights  
could reach 26,000 more jobs  
in 45 minutes with the  
Recommended Network.

From  
**Western Heights**  
in the  
**Recommended Network**  
on weekdays at noon,  
using transit, you can reach

<b>+26,000</b>	<b>+18,200</b>
<b>Jobs</b>	<b>Residents</b>
<b>in 45 minutes</b>	



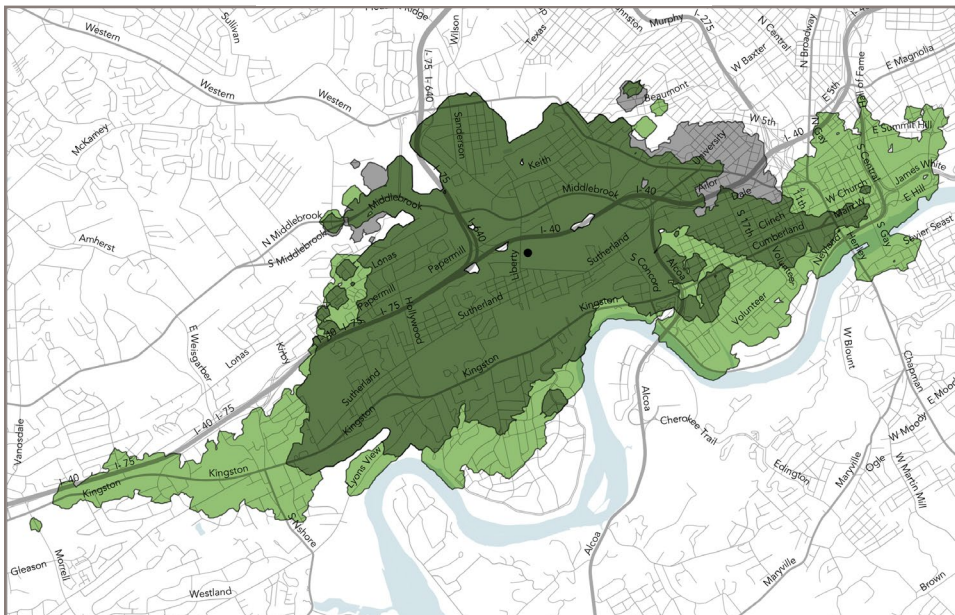
## Isochrone Examples (2)

Residents near TN College of Applied Tech could reach 32,600 more jobs in 45 minutes with the Recommended Network.

From  
TN College of Applied Tech  
in the  
Recommended Network  
on weekdays at noon,  
using transit, you can reach

<b>+32,600</b>	<b>+8,900</b>
<b>Jobs</b>	<b>Residents</b>

in 45 minutes

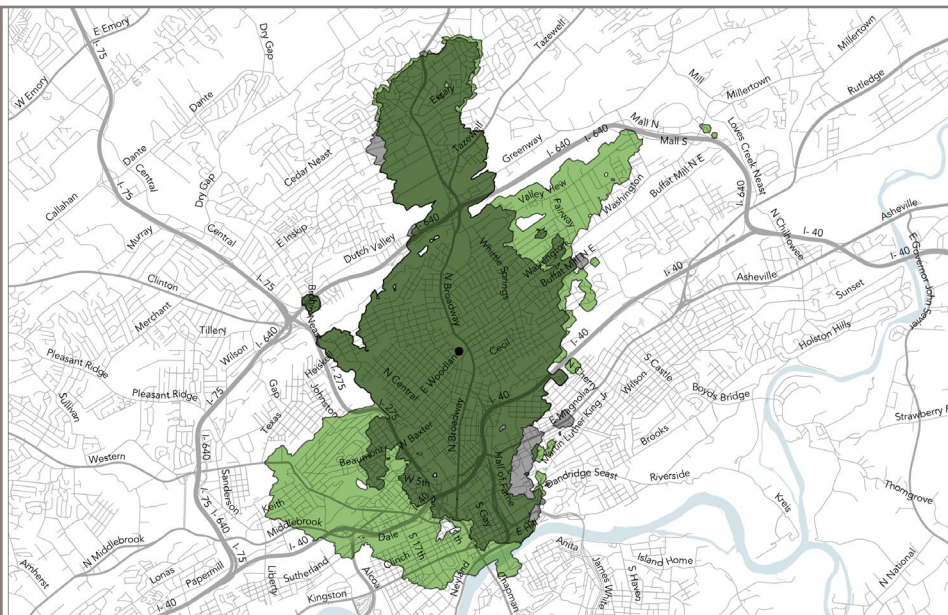


Residents near Fulton High School could reach 12,600 more jobs in 45 minutes with the Recommended Network.

From  
Fulton High School  
in the  
Recommended Network  
on weekdays at noon,  
using transit, you can reach

<b>+12,600</b>	<b>+15,900</b>
<b>Jobs</b>	<b>Residents</b>

in 45 minutes





# Change in Access to Opportunities

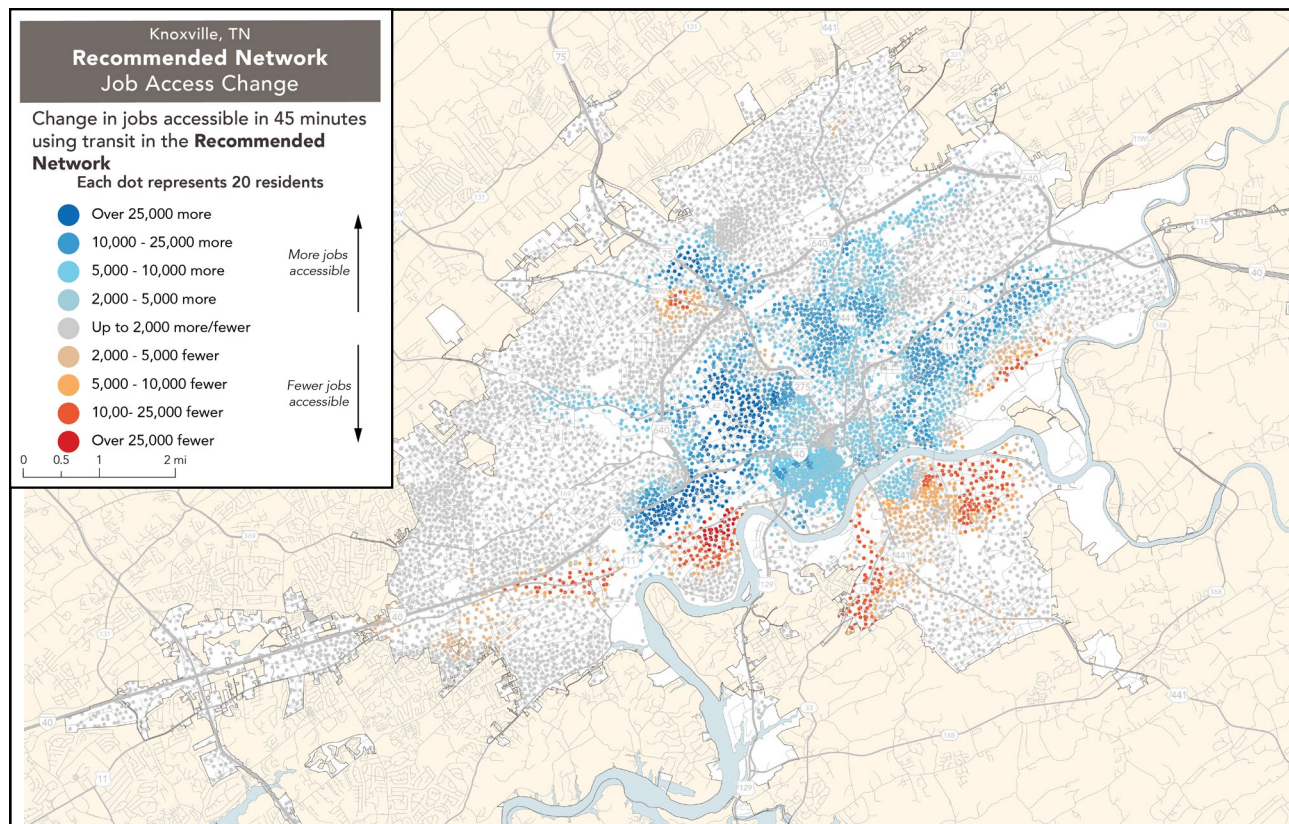
The previous maps show how the Recommended Network changes where people could go in a given time, from certain places. We can run the same analysis on a grid of locations throughout the city to estimate the access impacts of the Recommended Network on jobs access for different areas of the city.

The map on this page summarizes the change in jobs reachable for every part in the city. In this map, every dot represents 20 residents and the color indicates the jobs that can be reached in 45 minutes as compared to the Existing Network.

**Blue dots** represent more jobs accessible and **red dots** represent fewer jobs available. The darker the color, the greater the change in jobs accessible.

In general, the Recommended Network significantly increases access to jobs for the most dense parts of the city, which is clear because places with many dots close together tend to be darker shades of blue. Also, more areas of the city are blue, indicating that more areas are benefiting from the increased frequency of service.

Corridors like Cumberland/Sutherland, Western, and Magnolia would see large access benefits due to increases in frequency. Even residents in other neighborhoods and corridors see job access benefits because of improved connections to other routes.



Not all parts of the city benefit; some areas see a decrease in frequency or a loss of service. The most substantial decrease in access would be experienced along parts of Brooks Avenue, Clinton Highway, Sequoyah Hills, and South Knoxville. The area along Kingston Pike, near Northshore Drive, also sees a decrease in access due to the changes to Route 11. These losses are the trade-off of shifting service toward a higher ridership emphasis.

# Change in Access Summarized

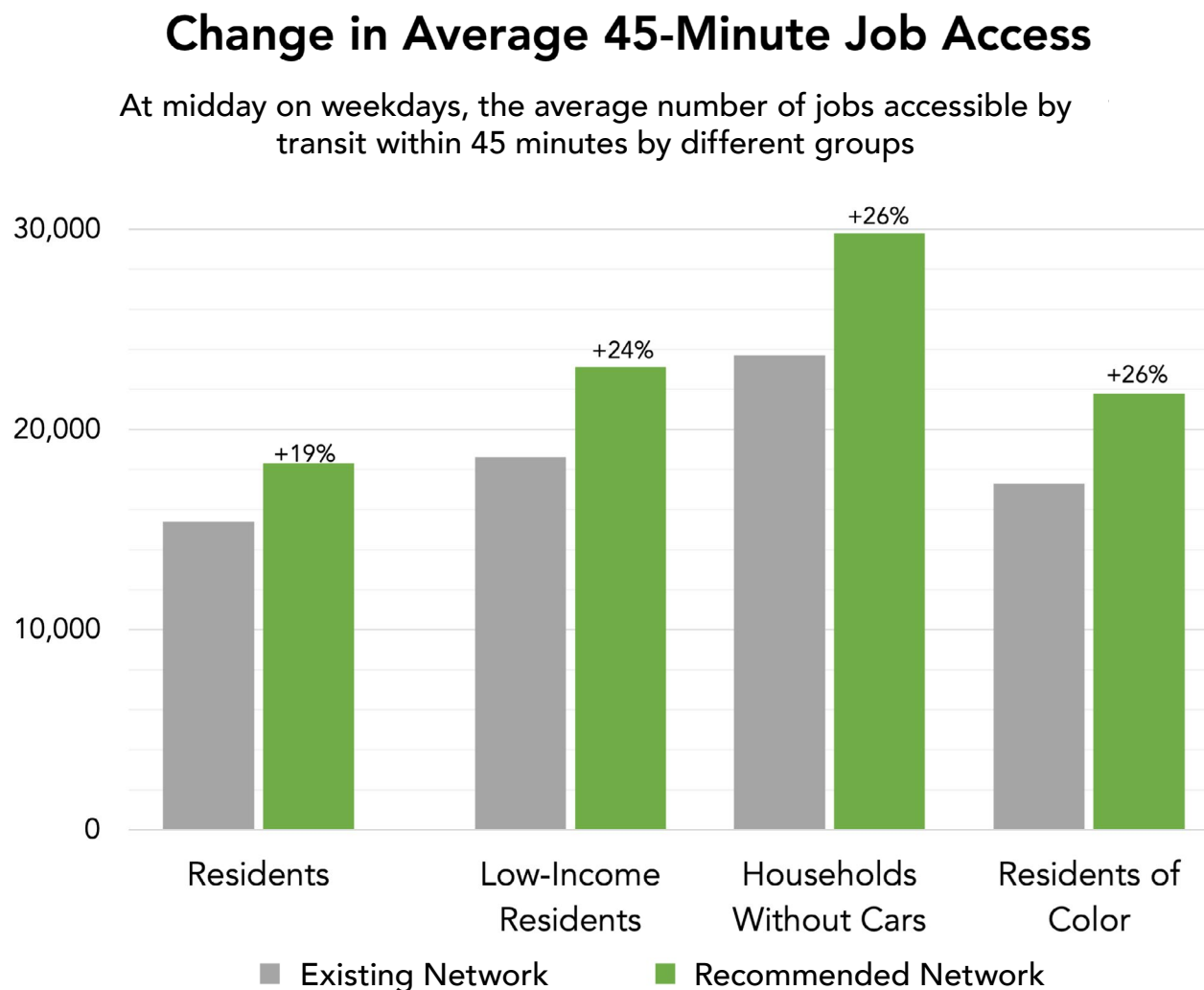
Using the data in the map on the previous page, we can estimate the change in access for the average person and for different subgroups as shown on the right.

By multiplying the change in access in each dot by the population and then dividing by the total population, we can calculate that the Recommended Network allows the average person to reach 18,300 jobs within 45 minutes by walking and taking transit—**19% more jobs than are reachable with the existing network.**

We can apply the same calculations to different population groups.

- The average low-income resident can reach 24% more jobs in 45 minutes.
- The average household without a car can reach 26% more jobs in 45 minutes.
- The average resident of color can reach 26% more jobs in 45 minutes.

This analysis measures jobs, but it reflects a wide range of opportunities that a person can reach. This means a person can get to more shopping, education, recreational areas, social events, places of worship, and any other opportunities that Knoxville can offer.



# Proximity to Transit

The number of people and jobs within a certain distance from transit is the simplest measure of transit outcomes. In this report, we call this measure “proximity to transit.”

The Existing Network reaches 109,800 people within 1/2 mile of a transit stop. Yet because service is spread so thinly, only 15,200 are near 15-minute service. The Recommended Network would increase the number of people and jobs near 15-minute service.

Compared to Existing, the Recommended Network would

- increase the number of residents near 15-minute service from 15,200 to 27,400, **a 80% increase.**
- increase the number of jobs near 15-minute service from 35,000 to 43,400, **a 24% increase.**
- reduce the number of residents who are within 1/2 mile of any transit service from 109,800 to 93,600, a 15% decrease in residents who are within 1/2 mile of service.
- reduce the number of jobs that are within a 1/2 mile of any transit from 100,800 to 87,800, a 13% decrease in jobs that are within 1/2 mile of service.

The figure to the right also shows how proximity to transit changes for different subgroups.

## Proximity to Transit at Midday - Weekday

Residents within 1/2 mile of transit service

