Getting There

A Travel Market Analysis of the Triangle's Passenger Rail Corridor

GoTriangle ◈ Triangle J Council of Governments

November 29, 2021

Rail Corridor Analysis

This is one in a series of reports examining travel, land use, affordable housing and economic development opportunities associated with new passenger rail service within the North Carolina Railroad Corridor (NCRR Corridor) between West Durham and Clayton in Johnston County. The project's overall rail planning has two main parts:

1. A set of activities that focus on what happens ***within*** the corridor – a rail service analysis: the types and numbers and schedules for trains; the locations of station platforms, park-and-ride lots and train maintenance facilities; the ridership that is expected; the infrastructure investments – and their costs – that would be needed to support the service; and a host of operational and environmental considerations required for successful implementation. Called the Greater Triangle Commuter Rail (GTCR) Study, the current phase is the third part of a careful, deliberate step-by-step process to inform the decisions about whether to invest in passenger rail:
    a. CRT Major Investment Study (MIS). Completed in May 2019, the CRT MIS examined existing conditions in the rail corridor between West Durham and Garner, looked at peer commuter rail systems, developed systems level guidelines, and evaluated service scenarios based on the guidelines. The conclusion was that there were no fatal flaws in pursuing a passenger rail investment and that a more detailed analysis was warranted. Documents and files from the MIS can be accessed at [web site]
    b. Greater Triangle Commuter Rail – Phase I. Completed in May 2020, Phase I looked at different corridor lengths (including extending into Orange and Johnston Counties) and operating scenarios to determine general costs and benefits and which, if any, scenarios would be competitive for federal funding. It concluded that scenarios involving 20 daily round-trip trains between West Durham and either eastern Garner or Clayton could be competitive investments.
    c. Greater Triangle Commuter Rail – Phase II. Currently underway, Phase II is identifying additional infrastructure that is needed; analyzing different train technologies, examining station, park-and-ride and maintenance facility locations; developing cost and ridership estimates; and analyzing operational issues associated with adding regional passenger rail service to the freight and intercity trains in the corridor.
2. A set of activities that focus on what happens ***along*** the corridor – a corridor opportunity analysis: the travel markets that passenger rail could serve, the land use and development close to the corridor – both today and in the future, the affordable housing that exists and is planned near the rail line and how land use, affordable housing and travel patterns combine to define opportunities.

This rail opportunity analysis about what happens along the corridor recognizes that the key to a successful rail investment is not just about the trains, but what happens outside the windows of the trains – the jobs and households and economic development that trains could serve. It has five parts:

- A *Real Estate Market Analysis* and *Regional Economic Impact Analysis* prepared by HR&A Advisors, Incorporated;
- A *Travel Market Analysis* that looks at travel markets in the region, the rail corridor, and station study areas;
- A *Land Use Analysis* that focuses on station study areas and "first-mile-last-mile" locations, along with how community land use plans and standards align with the *Real Estate Market Analysis;*
- An *Affordable Housing Analysis* that addresses both publicly-supported and market-provided affordable housing; and
- An *Opportunity Analysis* that combines information from the other reports.

All of the corridor opportunity analysis reports and related technical information is located at www.readyforrailnc.com.

Contents

Introduction

The idiom "getting there" means "reaching or attaining one's goal(s); being successful in some endeavor." To have a successful transit endeavor, it must take people where they want to go, when they want to go – it must allow them to "get there" in a way that is better than their other choices. In technical lingo, it must successfully serve a *travel market.*

This report looks at the travel market that can be served by a passenger rail investment in the existing railroad corridor between West Durham near Duke University and Clayton in Johnston County and the role of this travel market in the wider region. It shines an especially bright light on certain components of the travel market:

- The key job hubs in the region and along the corridor
- The key neighborhoods where providing access to jobs, services and opportunities may be especially meaningful
- Current travel that both begins and ends along the rail corridor – the heart of the travel market
- Commuter travel, since the transit service being explored is geared primarily to connecting workers to jobs.

The report is analytical: it looks at the evidence that can help us better understand travel in the corridor, so that decision-makers can weigh this evidence in making informed decisions about whether to invest in a particular transit project to serve the corridor.

And what makes a "good" transit corridor? That depends as much on one's values as it does on data, but the writer of *Trains, Buses, People* defines it this way:

> "A good transit corridor is one with high density where multiple centers line up, perhaps resulting in a bottleneck….A good corridor must be reasonably straight: people do not want to move in "U"s or circles or zig-zags. It is critical when identifying corridors to think about land use, not existing transportation infrastructure. A congested freeway might be a sign that transit is needed, but that doesn't mean that freeway is a strong transit corridor. We need to think about where people are going, not what path they are currently taking."

The author of *Better Buses, Better Cities* also emphasizes that good transit corridor planning doesn't start with the type of vehicle, but with the type of service that best aligns with a corridor's travel markets:

> "I don't think that buses are superior to trains. We need a lot of investment in trains. We need new subway extensions, commuter rail improvements and more light rail. We also need a lot more bus service to complement that. ***We need a strong spine of high-capacity transit***, and then we have great arteries and bus lines running to many more neighborhoods that have good service today. It's all connected."

Travel Markets Defined

A travel market is just like any other market: it is where an exchange can take place - where supply and demand can meet. It can be thought of like a grocery market, where a store provides a supply of items that can be bought, and customers choose whether or not to buy those items, at the prices offered. Items that are bought are where supply meets demand.

For this rail market, the *supply* is the train trips: how many, where they begin and end and stop in between, how much time there is between each train and when they start and stop operating each day (and if they run every day or just on weekdays).

The *demand* is the trips that people can make on the trains at the price offered, given where people live and work, and whether the trains can also serve shopping, school or other trips riders want to make. Ridership is where supply meets demand.

For the analysis of rail travel markets, understanding three different kinds of places may be helpful:

- The Region. For this analysis, the region is four counties that lie along the NC Railroad Company's (NCRR) rail line: Orange, Durham, Wake and Johnston. The region contains 1.5 million acres (or 2,350 square miles). Although the initial phase of rail service is not expected to include Orange County, it is an important part of overall regional mobility.
- The Corridor. Within the region, the corridor is the area within one mile of the tracks between two end-points, or "terminal stations:" West Durham – where the train track crosses Fulton street – and Clayton – near where the rail line crosses NC42. A one-mile distance from the track was selected for commuter rail, which often involves a large number of riders who drive or take short bus rides to stations. The corridor contains 59,300 acres (or 90 square miles), which is 4% of the 4-county region.
- Station Study Areas. Within the corridor, station study areas are the initial locations where stations are being considered, based on the Greater Triangle Commuter Rail Phase I Analysis. There are 15 station areas being studied, including the West Durham and Clayton termini. Station Study Areas are one-mile diameter circles centered on the points where the station platforms seem most likely at the start of this analysis. The final number of stations, and their locations, may shift during the analysis, as more is learned. The half-mile distance is a transit "rule-of-thumb" for the area around a station that is a reasonable walking distance for riders, and therefore where land use decisions are most meaningful. Each station area is about 500 acres, therefore the 15 stations (none of which have a study area that overlaps with an adjacent station) total 7,540 acres (or just under 12 square miles), which is 13% of the corridor and about 1/2 of 1% of the region.

The corridor and station study areas, and an image symbolizing their role in the region, are shown in the map on the next page.

Keys to Successful Transit Travel Markets

Several reports stress the importance of a combination of factors that make up the "user experience" as the key to successful transit.

Human Transit – How Clearer Thinking About Public Transit Can Enrich Our Communities and Our Lives (2012)

"expectations that potential riders have…

1. It takes me *where* I want to go
2. It takes me *when* I want to go
3. It is a good use of my *time*
4. It is a good use of my *money*
5. It *respects* me in the level of safety, comfort, and amenity it provides
6. I can *trust* it [it is reliable]
7. It gives me *freedom* to change my plans"

Trains, Buses, People – An Opiniated Atlas of US and Canadian Transit (2nd edition, 2021)

"To build good public transit, which is transit that is useful to lots of people…we need to talk about what matters—to focus on the quality of service, not the technology that delivers it; to talk about all kinds of transit riders, not just about a narrow target market; to understand that the transit experience depends on buildings and streets and sidewalks as much as it does on stations and trains; and, above all, to talk about getting transit in the right places….It is remarkable how much of the public transit we build in the United States and Canada doesn't go where people want to go or when they want to go there."

Better Buses, Better Cities (2019)

"Bus and rail lines across the country attract riders under the same circumstances: when they are fast, frequent, and connect many destinations that can be walked to."

Figure 1. The Passenger Rail Corridor and Initial Station Study Areas

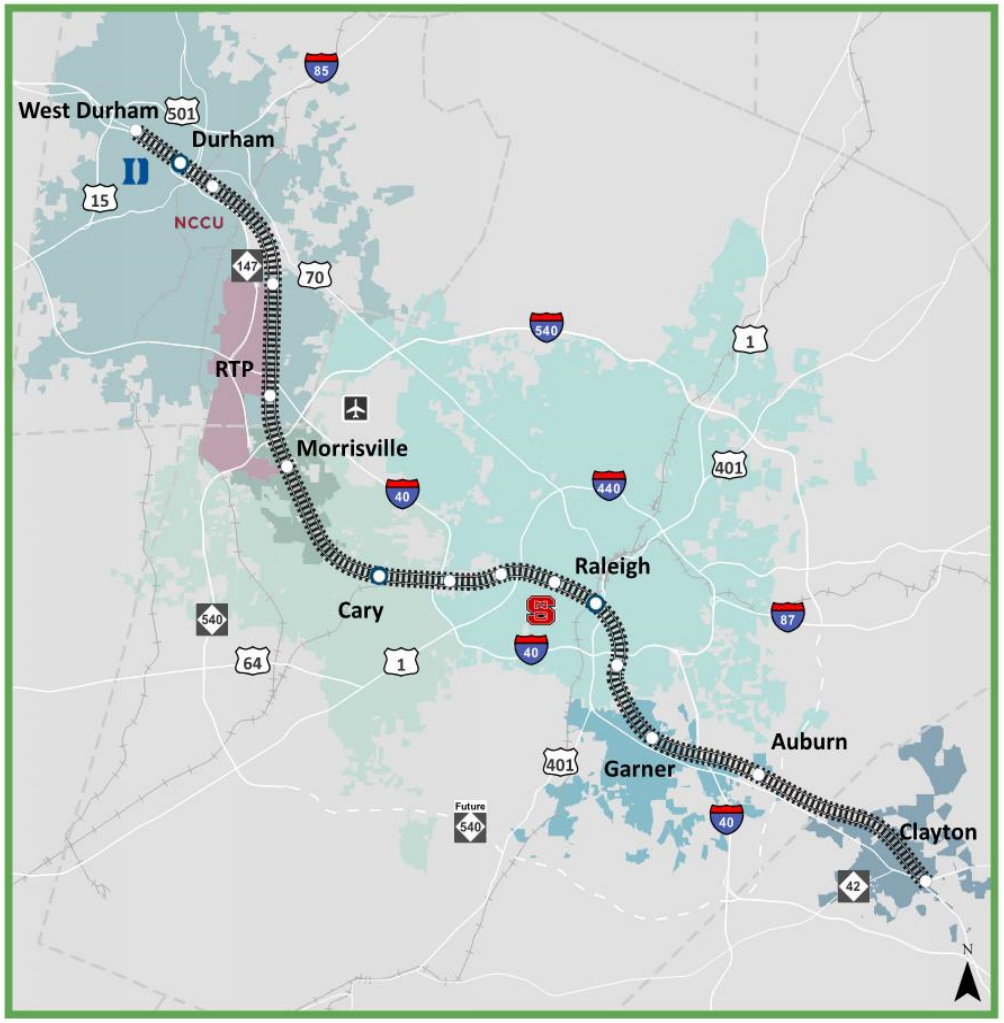
In addition to the region, the corridor and station study areas, this report looks closely at two other types of places, which are defined and mapped later in this report:

1. *Key Hubs:* activity centers with dense development or relatively dense development compared to their surroundings,

2. *REINVEST Neighborhoods:* places with residents most likely to be considered low income, not own a car, or be Black, Indigenous and People Of Color (BIPOC).

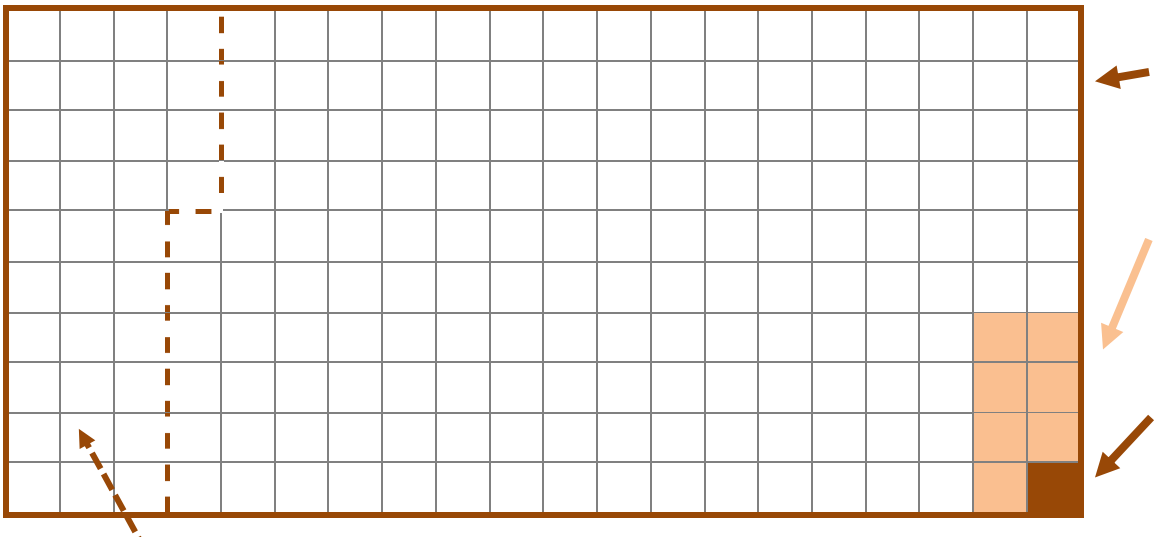
This "Hubs and Neighborhoods" focus is important for understanding how investment in passenger rail could both serve the Triangle region's largest concentrations of jobs, and also provide meaningful connections to jobs, education and services for traditionally underserved places.

The rail corridor is a small portion of the region's area, but it serves an outsized role in the region's job market. Thoughtful, deliberate land use, affordable housing and economic development decisions in this area can make a big difference.



The final number and locations of stations is being decided through the Greater Triangle Commuter Rail Study. This map shows the initial station study areas as white dots.

Figure 2. Relative Size of The 4-County Region, The 2-Mile Wide Rail Corridor, and the 15 Initial Station Study Areas



The large grid represents the combined size of Wake, Durham, Johnston and Orange Counties.

These 8 boxes represent the size of the rail corridor – 2 miles wide centered on the tracks.

This box represents the combined size of the 15 station study areas: one-mile wide circles centered on a station platform.

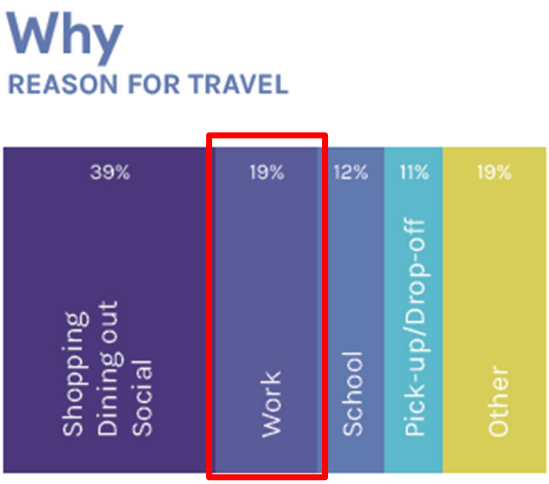
Portion of region in Orange County, which is not part of the initial investment phase

What Do We Need to Know and Where Do We Get Our Information?

Travel markets boil down to "trips:" both the train *vehicle trips* that can carry passengers (the supply side) and the individual *person trips* that could be carried on the train trips (the demand side). The rail service analysis is examining the characteristics of the train trips – how many at what times, where they stop and how fast they go. This corridor opportunity analysis is examining the potential for person trips – who might ride the train trips.

Four characteristics of person trips are central to understanding the travel market:

1. Trip origins (where trips begin, like at someone's home)
2. Trip destinations (where trips end, like at someone's workplace)
3. Trip purposes or types (e.g., for work, or shopping, or school, or social activities)
4. Household income and vehicle-ownership



There are other important factors in how people decide to travel and what routes they will take, but the four characteristics above are the basis for understanding travel markets and are the focus of this report.

When looking at transit investment travel markets, it is especially important to understand the types of trips (also called "trip purposes") that the investment is designed to serve. Frequent, all day transit services like light rail or bus rapid transit are designed to serve all types of trips – commuting, shopping, attending meetings or medical appointments or social events or entertainment venues. Commuter rail -- with less frequent vehicle trips, more widely spaced stations and service primarily during week-day rush hours – mainly serves, as its name implies, work trips. In planner parlance, these are known as "home-based work trips" and as the figure on this page shows, they are typically about 1 out of every 5 total trips.

This section of the report summarizes where we turn to for information on where people want to go ("trip destinations") and where their trips start ("trip origins"), focusing on work trips, since the planned commuter rail investment is designed to primarily serve work trips. Measuring the details of existing travel is hard; trying to forecast how travel may change, especially over long periods of time is even harder, made doubly so by the uncertainty over how work travel may change in a post-pandemic economy. The travel market analysis considered three sources of information to look at trip origins, destinations and types, each of which has its own strengths, but also its own shortcomings:

1. Worker Flows from the US Census Bureau. The Census Bureau connects data from residents through the American Community Survey and data from businesses through each state's employment commission, and links workers' homes to job locations through administrative records. This composite data set is referred to as the LEHD/LODES data.

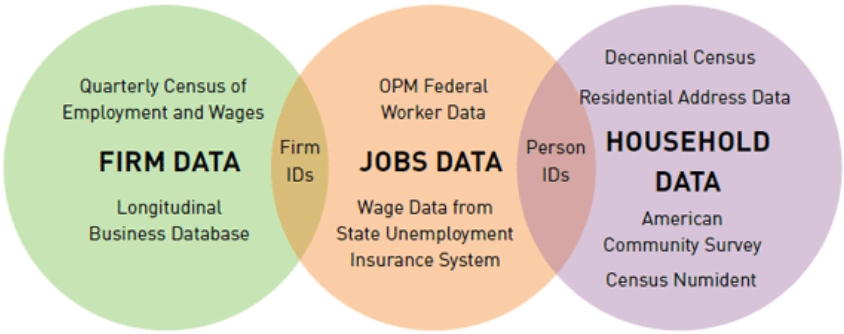
2. Work Trips from the Triangle Regional Transportation Demand Model. Estimated from periodic household travel behavior surveys, the travel model both estimates "base year" trips and forecasts future trips.

3. Commute Trips from the Streetlight Data Set. A private data source to which both of the region's MPOs have subscribed, Streetlight tracks cell phones. Commuter data is then estimated based on phones that tend to go to the same place each workday and "sleep" at the same place each night.

In the end, this report focused on the first of these three sources – the Census Bureau Worker Flow data. All of these sources, and how they can be used, are briefly described in this section.

The Census Bureau: LEHD LODES

The U.S. Census Bureau produces two complementary data products, the American Community Survey (ACS) commuting and data and the Longitudinal Employer-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES), which can be used to answer questions about spatial, economic, and demographic questions about home-to-work flows. The two datasets are based on different inputs, cover different populations and time periods, are subject to different assumptions, have different confidentiality methods, and are tabulated at different geographic and characteristic levels. As a rule, the two products cannot be expected to match and may differ substantially in some respects. The LEHD Origin-Destination Employment Statistics (LODES) program is the primary source of local-area employment data in this analysis.



The LODES are produced by the LEHD program at the U.S. Census Bureau and are an extract of the LEHD data composed of administrative records, census and survey data focused on labor market, worker, and firm statistics. State unemployment insurance data and federal worker earnings records provide information on employment location for covered jobs and residential information for workers, which form the basis of the LODES data. The graphic above illustrates how these data sources are linked to develop the LODES data. The LODES data cover all civilian wage-and-salary employment covered by unemployment insurance in every industry sector; LODES reports data for sectors defined at the two-digit NAICS level. LODES excludes self-employment and some types of contract, informal, and "gig" employment. Altogether, this means LODES covers 96% of all U.S. employment.

Generally, LODES block group-level data are more accurate than block-level data and more geographically precise than tract-level data; this analysis uses block-group-level data. The block-group level data are continuous, complete, and comprehensive for most areas, including the Triangle, but in some cases the Census Bureau has incomplete data or lacks the locations of jobs for multi-site organizations. This issue is prevalent in the government, public administration, and administrative services sectors and the accompanying technical memo addresses specific situations in the Triangle.

The Triangle Regional Model

The Triangle Regional Transportation Model ("TRM") is the tool used to estimate many characteristics of travel, and then forecast these characteristics in the future. Like the LODES data, it examines where commuters live and where they work, but it also estimates the sources and destinations of many other kinds of trips, and then goes further to estimate and forecast what types of "modes" are used for the trips (e.g., drive-alone auto, carpool, transit, walking or biking), and the routes that people follow to make trips. It also estimates the movement of freight. The TRM is the best tool we have to forecast how travel might be in the future, so we use it to see how land use changes, population and job growth, and changes to road and transit networks may affect travel markets, for example after a commuter rail investment is put in place. A new model will be completed by the end of 2021 and will be important to compare to LEHD/LODES data.

Streetlight

Streetlight is a computer application that estimates where different kinds of trips begin and end based on cellphone data. Both the Capital Area Metropolitan Planning Organization (CAMPO) and the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHC MPO) have subscribed to the Streetlight service. Because it measures actual, recent travel based on the movement of cell phones), Streetlight can be a good tool for understanding travel, especially work travel to key hubs and from priority neighborhoods (based on where cell phones stay at night and during the day).

Where the Jobs Are: The Region and the Rail Corridor

Understanding the job piece of a travel market can be tricky: people may have more than one job, some people, even pre-COVID, could live very far away from the location of their employer and rarely travel there, employment rises and falls with economic cycles, and people may work from home or have jobs with no fixed location. Different data sources define jobs differently.

For example, the table at right shows three reputable sources for job data used in the region and how they compare.

Table 1. Job Data Sources

County	NC QCEW 2018	LODES 2018 *(revised-used in this report)*	Employment Analyst 2020
Durham	205,029	217,610	235,002
Johnston	49,245	50,725	54,923
Orange	73,837	72,977	74,721
Wake	562,470	589,157	614,734
Total	**890,581**	**930,469**	**979,380**

When looking at jobs, then, it is important to both be clear about how jobs are defined and be comfortable with a bit of uncertainty and nuance. For this report, here are some important clarifying points (see the technical appendix for detail):

1. We started with the Census Bureau's LEHD-LODES data from 2018 (the most recent available, and a data set that reflects conditions pre-COVID).
2. We removed jobs from the raw data in a few selected locations based on a careful analysis that strongly indicated these jobs had what is called a "headquartering" problem – although the employer may have a location there, the actual workplaces for many of the jobs were outside of the Triangle region.
3. We shifted some jobs from one location to others within the same county where "headquartering" issues also seemed likely – so these jobs were moved but not removed.
4. When we got to the step of looking at data that paired residence locations with employer locations, we ignored home-work pairs of more than 100 miles straight line distance, judging that either these jobs were reflective of "headquartering," or it was unlikely that the employee actually commuted to that location on a frequent basis.
5. The Census Bureau data that is used is available at the block and block group level – since this is a regional scale analysis, we mostly use block group level data (there are 767 block groups in the four counties). When the report refers to "hubs" or "neighborhoods," it is referencing these block groups, which often would not align with local perceptions of neighborhood or activity center boundaries.

In the analysis that follows, here are what terms used in the LEHD LODES dataset mean:

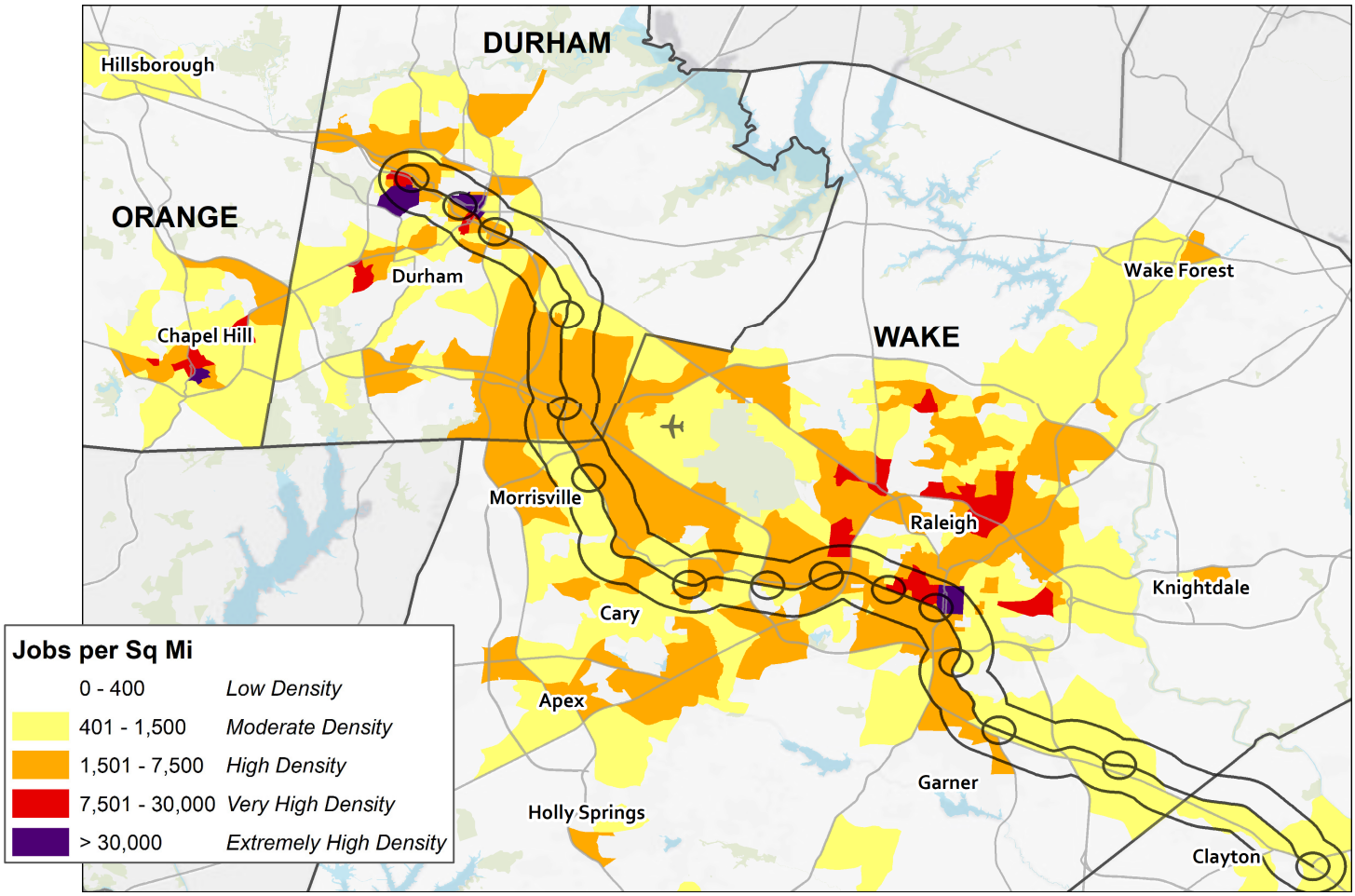
- "jobs" or "total jobs" mean all jobs, whether full time or part-time and including multiple jobs held by one worker
- "primary job" means the job with the highest earnings for people who hold more than one job
- "low earnings job" means a job with an equivalent annual pay up to $14,999 per year
- "moderate earnings job" means a job with an equivalent annual pay from $15,000 to $39,999
- "high earnings job" means a job with an equivalent annual pay of $40,000 and up

The report first summarizes total and primary jobs within the four-county region and the rail corridor, and places regional work-oriented travel – defined as travel between two counties -- in the context of overall work travel. The report then defines and summarizes two important types of places within the region: Key Hubs and REINVEST Neighborhoods. Next, the report looks at how jobs in Key Hubs and workers who live in REINVEST Neighborhoods relate to the rail corridor.

Rail Corridor Jobs

The four counties in the study region – Johnston, Wake, Durham and Orange were home to 930,000 total jobs, pre-COVID. **The rail corridor is 4% of the region's area, but contains 280,000 total jobs: 30% of the total**. Importantly, about 56,000 workers both live and have their primary job in block groups completely or partly in the corridor, the main travel market for rail service. Looking only at primary jobs with low and moderate earnings - less than $40,000 per year – 23% of these jobs in the 4-county region are located in the rail corridor. With major education and training, medical, and entertainment facilities, corridor travel markets are more than just commute trips.

Figure 3. Job Density



Block groups along the rail corridor contain almost 90% of the jobs in block groups considered extremely high density – typically the most transit-oriented pattern and where there are usually parking costs for commuters who choose to drive. Thirty-five percent (35%) of those jobs are also within an initial station study area, shown as black circles in the map above – a rule of thumb for being within a walking distance of a train station. The reminder would be within a "first-mile, last-mile" distance that would need to be served by shuttles, connecting transit routes and/or micro-mobility options like scooters or bike-shares in order to be most effectively served.

Regional transit connections, including along the rail corridor, may be especially important in the Triangle: 45% of the workers who live in Wake, Durham, Orange and Johnston Counties are employed by firms outside of the county where they live. The Wake-Durham County flow is especially prominent, with over 96,000 workers living in one county and employed by firms, agencies or institutions in the other, by far the largest inter-county flow in North Carolina.

There is adequate or better job density all along the rail corridor; of the 59,300 acres within the rail corridor, 48,900 acres (82%) are in block groups with moderate or better job density, and 24,200 acres (41%) are in block groups with high, very high or extremely high job density.

Key Hubs & REINVEST Neighborhoods: A Focus on Important Travel Markets

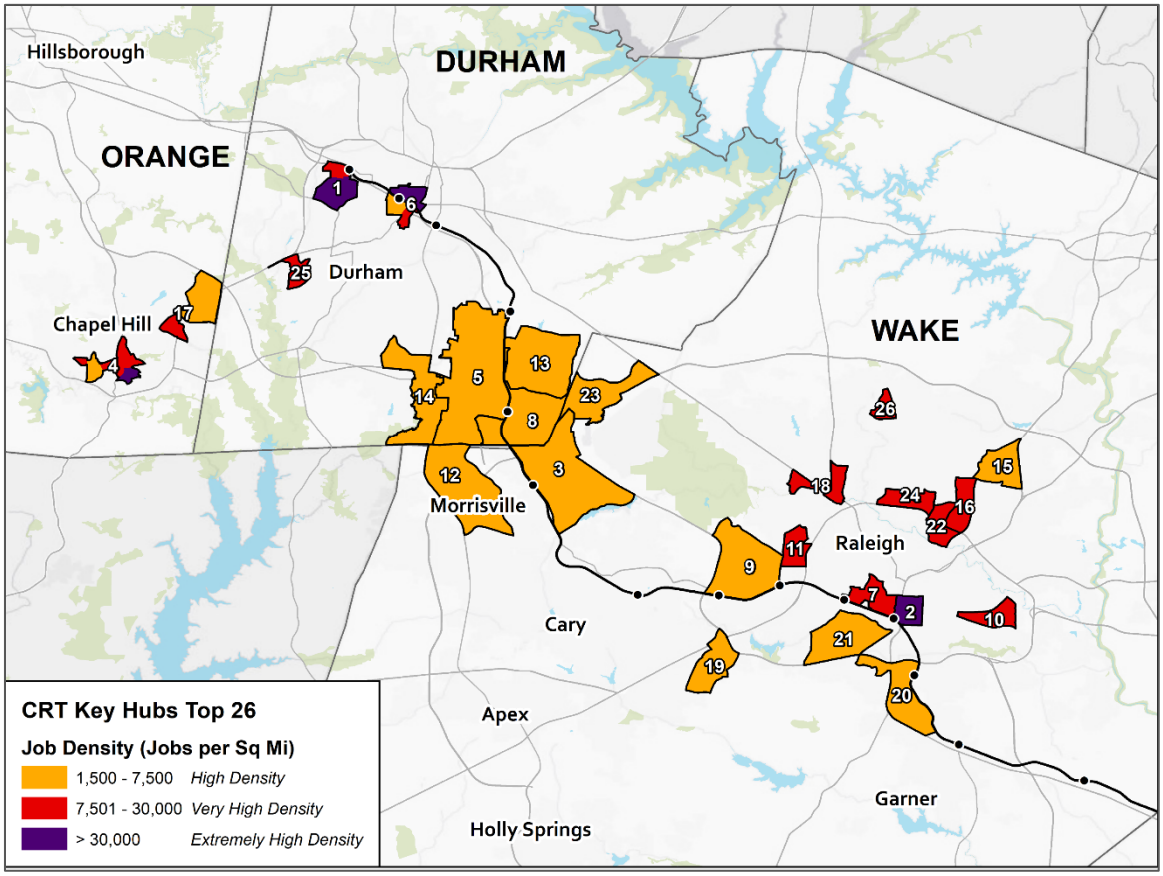
Travel is complex, and especially so in the Triangle Region, where there are multiple job hubs of different sizes and intensities, and many neighborhoods where an equity lens indicates transit connections to job hubs would be especially important. Later sections of this report dive into that complexity; this section simplifies and synthesizes that work to better understand travel markets of most significance.

We start with the top regional job hubs, based on a combination of their importance – the number of jobs located there today – and their intensity – the concentration of jobs – since transit works best where jobs are clustered together.

The map below shows the places with the greatest number of jobs that also meet "high," "very high," or "extremely high" job density thresholds. Together, these 26 places contain nearly 40% of the jobs in the four counties, but on less than 3% of the land in the four counties. The rail line runs through eight of the top 10 job hubs, these eight hubs account for just over 200,000 jobs. The corridor contains 88% of the jobs in the region's extremely high-density block groups.

Figure 4. Top Regional Job Hubs (2018 data)

Hub #	Jobs
1	48,000
2	38,000
3	28,000
4	26,000
5	25,000
6	24,000
7	14,000
8	13,000
9	13,000
10	12,000
11	12,000
12	11,000
13	11,000
14	10,000
15	10,000
16	9,000
17	9,000
18	8,000
19	8,000
20	8,000
21	7,000
22	7,000
23	7,000
24	7,000
25	5,000
26	5,000



Place	# of total jobs	% of 4-county jobs	# of acres	% of 4-county acres
Top 10 Hubs	241,000	26%	19,000	1.3%
Top 26 Hubs	376,000	40%	39,000	2.6%
Four Counties	930,000		1,505,000	

The map on this page looks at total jobs, but a similar conclusion applies to primary jobs (the main job for workers with more than one job) that have low or moderate earnings. Seven of the top 10 job hubs for all jobs are also in the top 10 for primary jobs with low and moderate earnings; only two of the job hubs around the RTP (#5 and #8) and the one with Wake Med (#10) fall out of the top ten when the focus is exclusively on low and moderate earnings levels.

REINVEST Neighborhoods: Understanding Where Transit Matters Most for Workers

Just as it is important to understand key job hubs in making transit investment decisions, it is important to understand how transit investments can link important residential neighborhoods to these job hubs. This section of the report creates a framework for key neighborhoods, starting with a foundation in federal civil rights law and building on recent local and regional efforts to identify communities of concern. It concludes with a straightforward set of places based on race and ethnicity, income, vehicle ownership and the presence of existing and planned legally-binding affordable housing.

This analysis summarizes an extensive set of data that is available to examine equity-centered mobility issues in a variety of ways and from different perspectives. The technical appendix contains more detail and the Triangle J Council of Governments project team is available to guide interested users through a more fine-grained analysis.

The neighborhood analysis is based on two main concepts: i) Communities of Concern and ii) Transit Propensity. Communities of Concern are groups that are identified through an equity lens, groups that have been traditionally under-represented in transportation decision-making based on such characteristics as race, ethnicity and income. Transit propensity is the likelihood that someone will use transit compared to the overall population; data show that characteristics of traditionally under-represented groups and transit propensity go hand-in-hand. What this means is that emphasizing transit service for households that have been traditionally under-represented – such as low-income households or BIPOC (Black, Indigenous, People of Color) households – is a "win-win:" it promotes equitable investment and also is likely to result in more effective transit service with more ridership.

For example, in Table 2, which shows transit propensity from the Wake Transit Plan, the group most likely to use transit are households without vehicles, who use transit more than 15 times as much as the overall population. Even households with one car use transit 3.4 times as often as the overall population. Poverty is also highly related to transit use; people below the poverty line use transit more than four times as much as the overall population, and those between 100% and 150% of the poverty line use transit 3.4 times as much. The third most influential characteristic is race; Black people use transit twice as much as the overall population, and Hispanic or Latino people 1.4 times as much.

Table 2. Propensity to Use Transit by Group

Demographic Group	Transit Propensity
Race/Ethnicity	
White, non-Hispanic	0.5
Hispanic or Latino (any race)	1.4
Black	2.1
Native American	3.0
Asian	1.4
Native/Foreign Born	
Native-Born	0.9
Foreign-Born	1.5
Poverty Level	
< 100% of Poverty Line	4.2
100-149% of Poverty Line	3.4
> 150% of Poverty Line	0.7
Household Vehicle Availability	
No Vehicles	15.8
1 Vehicle	3.4
2 or More Vehicles	0.7

Federal Legal Framework

Equity concerns are not just of local or regional interest. Federal law and programs have long required special attention to how investments that use federal funding, as the proposed commuter rail line would, might affect communities with legally protected status. *Title VI of the Civil Rights Act in 1964* and *Executive Order 12898* require opportunities for all to participate in the planning process, and federal interest is encapsulated in three key environmental justice principles:

- Avoid, minimize or mitigate disproportionately high **adverse impacts** to minority and low-income populations,
- Prevent the denial of, reduction in, or significant delay in the **receipt of benefits** by minority and low-income people,
- Ensure the **full and fair participation** by all affected communities in the decision-making process.

Title VI protects individuals and groups from discrimination on the basis of race, color, and national origin in programs, services, and activities of a Federal-aid recipient: "No person in the United States shall, on the ground of race, color or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance." Other laws have expanded protections against discrimination based on age, sex, limited English proficiency (LEP), income-level, and disability; (and creed/religion, where applicable). The intent is to remove barriers and conditions that prevent minority, low-income, LEP, and other disadvantaged persons from accessing, participating in, and benefiting from programs and activities that receive federal resources.

Local and Regional Communities of Concern

A collaborative approach to defining and mapping communities of concern based on federal law and guidance was developed by the region's two federally constituted transportation planning organizations: the Capital Area Metropolitan Planning Organization (CAMPO) and the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHC MPO). This approach has been used for the development of the 2050 Metropolitan Transportation Plan, and was used as the basis for identifying communities of concern for this analysis.

This environmental justice approach recognizes that transportation investments are "location specific" – a road is widened here, but not there; a transit line is funded along a specific alignment; a bicycle facility is added along a particular route, etc. In other words, some neighborhoods are affected more than other neighborhoods, either positively or negatively, not only by individual investments, like the rapid rail service, but by a set of many investments, as in an overall plan.

Defining neighborhoods through an equity lens, mapping them, and then illustrating how investments affect these neighborhoods compared to other neighborhoods is at the heart of an environmental justice analysis. Neighborhoods that can be shown to have the highest concentrations of equity-based demographic groups are identified as Communities of Concern.

Table 3. Communities of Concern

Demographic Group	Included in MPO Regional-Scale Geographic Analysis
Non-white Race	√
Hispanic or Latino Origin	√
Age 70 and over	√
Linguistic Isolation	√
Sex	
Disability	
Foreign-Born	
< 150% of Poverty Line	√
Zero-Car Households	√

Since an environmental justice analysis is always comparative – noting how communities of concern fare in relation to others, the first step is to define the area to be analyzed. For the regional Metropolitan Transportation Plan, the area of the combined MPOs was used. But regardless of the overall area, the same information can be used to examine a smaller area, such as a single MPO or county. For the rail corridor analysis, a four-county region was used, covering Orange, Durham, Wake and Johnston Counties.

The approach then focused on what to measure, how to measure it, what data source(s) to use, and what thresholds to apply. In the Metro Transportation Plan process, the "what" started with nine characteristics: race, ethnicity, age, linguistic isolation, sex, disability, poverty, nativity and vehicle ownership, the last of these not designated as a protected class, but important for transportation planning purposes.

The MPO analysis found that two of the characteristics, sex and disability, did not vary significantly by location, and so were not helpful in determining different effects in different places. They remain important for decision-making participation, ensuring that engagement is equitable by sex and disability status. Zero-car households were also recognized as a surrogate for any disability that might preclude driving. Similarly, Foreign-Born population was found to be better represented for transportation purposes by the combination of the linguistic isolation and Hispanic or Latino Origin variables, and so was not separately analyzed in detail. MPO Communities of Concern for regional-scale geographic analysis was therefore defined as the six characteristics shown in the table on this page.

The latest (2019) 5-year American Community Survey (ACS) was used as the data source, since it contained consistent data down to the Census Block Group level. The threshold chosen to emphasize the locations of each community of concern was the 75th percentile, meaning the top quarter of all block groups for each community of concern was mapped in the analysis. Block groups could then be displayed for how many of the thresholds were achieved in each block group.

Finally, the MPOs selected Age 70 as an appropriate metric for the age characteristic, and 150% of the poverty line as an appropriate income measure, which is borne out by the transit propensity table on the previous page.

The Communities of Concern data and methods were finalized after a December 2016 meeting involving the two MPOs, the Triangle J Council of Governments, the NCDOT Community Studies staff, the NCDOT Office of Civil Rights and the Federal Highway Administration.

Defining REINVEST Neighborhoods

Combining equity for Communities of Concern and the propensity of many of these same demographic groups to use transit more than the overall population, this report defines and identifies a set of places called REINVEST Neighborhoods. REINVEST neighborhoods are identified based on four characteristics, each represented by two letters in RE-IN-VE-ST:

RE	Race/Ethnicity – the degree to which a neighborhood is home to people who are Black, Indigenous or People of Color (BIPOC).
IN	Income – the degree to which households in the neighborhood have annual incomes below designated thresholds.
VE	Vehicles – the degree to which households in the neighborhood report having no vehicles available.
ST	Status – whether or not a neighborhood has a specific designation that makes it of particular interest for transportation investment. In this analysis, two neighborhood status characteristics are included, although either fewer or more criteria could be used: i) # of legally-binding, affordability-restricted (LBAR) housing units, and ii) designation as a federal Opportunity Zone.

REINVEST Neighborhoods, therefore, are places with the most significant presence of BIPOC residents, lower income households, households without vehicles and legally-binding, affordability restricted (LBAR) housing. About 100 of the region's 767 block groups score high on multiple REINVEST metrics. Taken together, all of the REINVEST neighborhoods have about twice the percentage of BIPOC residents, twice the proportion of people living below the poverty line, three times the percentage of households without vehicles and four times the percentage of LBAR housing units as the region as a whole. This report focuses on the location and characteristics of the most populous REINVEST neighborhoods – about one-third of all REINVEST neighborhoods; many of them are located within or adjacent to the rail corridor, especially near central and southeast Durham, central and southeast Raleigh, and Garner. Almost 70,000 people live in REINVEST Neighborhoods that are completely or partly in the rail corridor.

The technical appendix and back-up data sets depict block groups that meet one, two, three or all four of selected REINVEST thresholds. Different environmental justice and equity studies in the Triangle have defined thresholds in different ways, and the technique that is selected will affect the amount and distribution of REINVEST neighborhoods. As examples, the following three types of thresholds result in sequentially more focused identification of REINVEST neighborhoods, since each builds on the preceding threshold:

1. Greater Than Average Values (used in the 2020 DCHC MPO Environmental Justice Report)
2. Top Quartile Values (used in the 2045 and 2050 Metropolitan Transportation Plans and this analysis)
3. Top 25 Values (analogous to what is used in many general ranking systems and comparable to the "top job hubs" of the previous section)

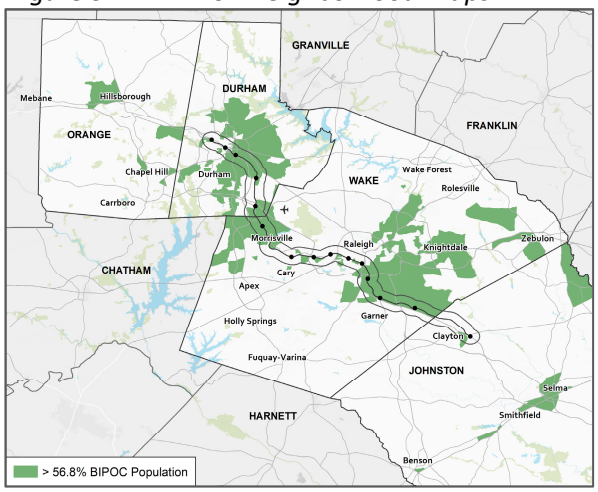
There is no single right way to define key neighborhoods, and the data allow a range of definitions and emphases to be applied. Because the passenger rail project is a regional-scale investment that transcends both MPOs and four counties, the method used here follows the technique used to identify Environmental Justice Communities of Concern in the MPO's 2045 and 2050 Metropolitan Transportation Plans. Note that thresholds can be set for the region as a whole (which is done for this analysis) or for each component MPO or County.

The first three maps on the next page are threshold maps for race & ethnicity, income and vehicle availability in the four-county region – the three measures with the highest impact on transit use. Each shows the top quartile of block groups in the region for the threshold. A fourth map is a special status map: it shows all block groups that have 100 or more legally binding, affordability-restricted (LBAR) housing units and/or are designated as Federal Opportunity Zones. The final map combines these maps to depict block groups that meet one, two, three or all four of the REINVEST thresholds.

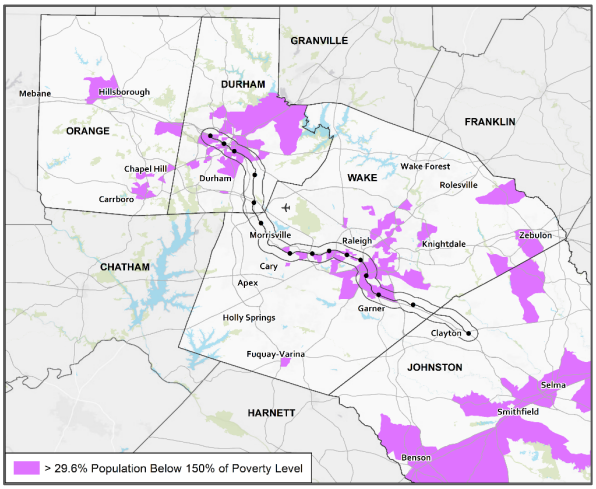
Table 4. REINVEST Neighborhoods Summary of Regional Percentages

Characteristic:	BIPOC population	People <150% poverty line	0-car households	LBAR housing units
% of land area:	12%	18%	12%	11%
% of characteristic:	48%	46%	66%	74%

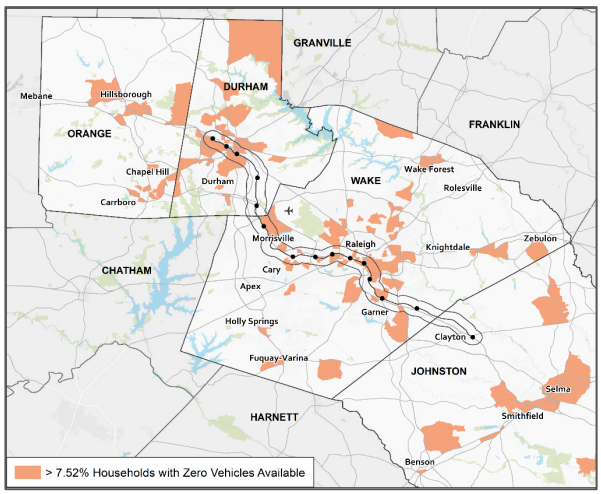
Figure 5. REINVEST Neighborhood Maps



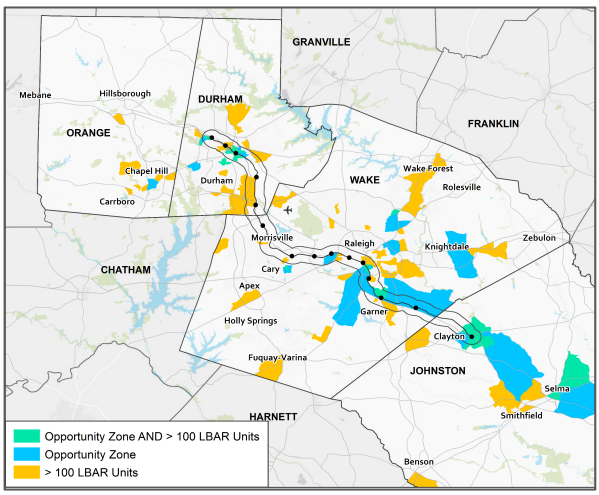
RACE & ETHNICITY



INCOME



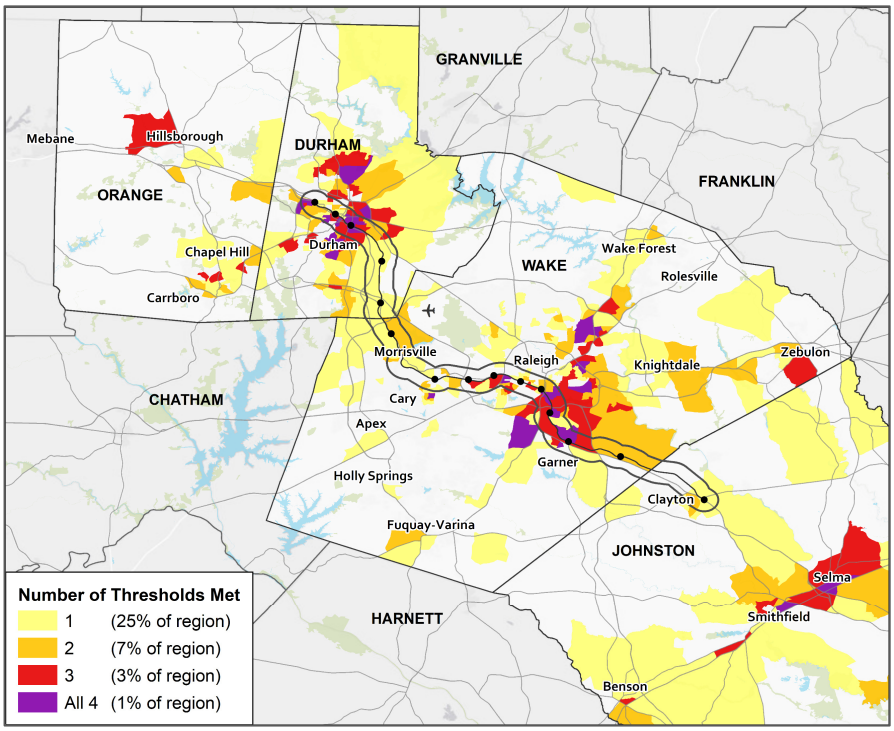
VEHICLE AVAILABILITY



STATUS: LBAR HOUSING & OPPORTUNITY ZONES

REINVEST NEIGHBORHOOD COMPOSITE THRESHOLD MAP

All REINVEST threshold maps can be explored in an interactive ArcGIS Online map, available at: https://arcg.is/104mSq0



The final step in the REINVEST Neighborhood analysis involved looking more closely at the Census Block Groups that met one or more of the thresholds, then focusing on the top places that met multiple thresholds.

Of the 767 block groups in the four-county region, 177 (23%) met one of the thresholds and another 156 (20%) met two or more thresholds. Using a point-based ranking system that is illustrated below, 103 block groups were selected for further analysis, including all 80 that met thresholds for race/ethnicity, income and vehicle availability, plus 23 that met two of the thresholds and also scored highest in the point system. Because some of the block groups were small and adjacent to other block groups that also scored high, the 103 block groups were consolidated into 81 key REINVEST Neighborhoods for mapping and analysis.

For RE, IN, and VE, **points** are assigned to each Census block group (CBG) based on quartile ranges.

Points	RE % Range	IN % Range	VE % Range	ST # LBAR Units
0	0	0	0	0
1	0.01 - 20.71	0.01 - 6.89	--	1 - 99
2	20.72 - 35.0	6.90 - 15.22	0.01 - 2.62	100 - 249
3	35.01 - 56.78	15.23 - 29.63	2.63 - 7.51	250 - 964
4	**56.79** - 100	**29.64** - 100	**7.52** - 50	

75th percentile Threshold

For ST: Status, CBGs designated as Federal Opportunity Zones get 1 additional point.

REINVE Thresholds Met	Total REINVEST Points 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total CBGs
0	2	9	55	42	60	64	59	53	46	25	12	5	2					**434**
1						4	11	24	27	36	32	18	20	5				**177**
2									3	4	9	17	20	18	5			**76**
3													12	38	15	10	5	**80**
Total CBGs	2	9	55	42	60	68	70	77	76	65	53	40	54	61	20	10	5	**767**

103 BGs that meet 3 thresholds *OR* 2 thresholds and 13-16 Points

These 81 neighborhoods were divided into three groups, or tiers, ranked by total population, and their characteristics compared. The results are shown in the map at right and table below.

All three tiers scored similarly across all four measures, with about 70-80% of the population of each group being BIPOC, 40-45% living below 150% of the poverty line, 15-20% of the households without cars, and about 15% of the housing stock consisting of legally-binding, affordability restricted (LBAR) units.

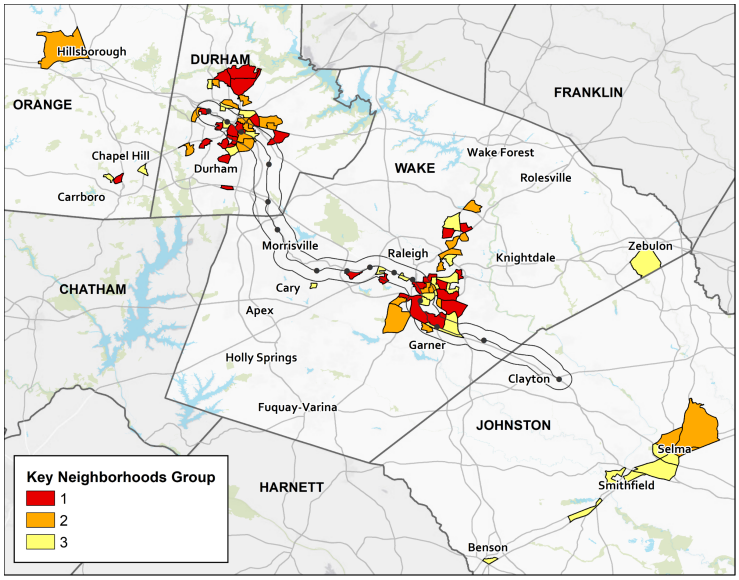


Figure 6. Determining and Analyzing Key REINVEST Neighborhoods

Tier	Population: Total Pop	BIPOC Pop	% BIPOC	Poverty Pop	% Poverty	Households: Total HHs	Zero Car HHs	% Zero Car HHs	LBAR Units	% LBAR Units
1	98,490	79,372	81%	42,441	43%	35,036	6,014	17%	5,992	17%
2	56,633	44,419	78%	23,242	41%	21,393	3,249	15%	2,558	12%
3	32,473	23,518	72%	14,798	46%	12,966	2,435	19%	1,937	15%
Tiers 1-3 Total	**187,596**	**147,309**	79%	**80,481**	43%	**69,395**	**11,698**	17%	**10,487**	15%
Four Counties Total	**1,722,633**	**714,493**	41%	**302,021**	18%	**648,469**	**31,501**	5%	**25,546**	4%
Tiers 1-3 % of Four Counties	**11%**	**21%**		**27%**		**11%**	**37%**		**41%**	

Key Hubs and REINVEST Neighborhood Conclusions

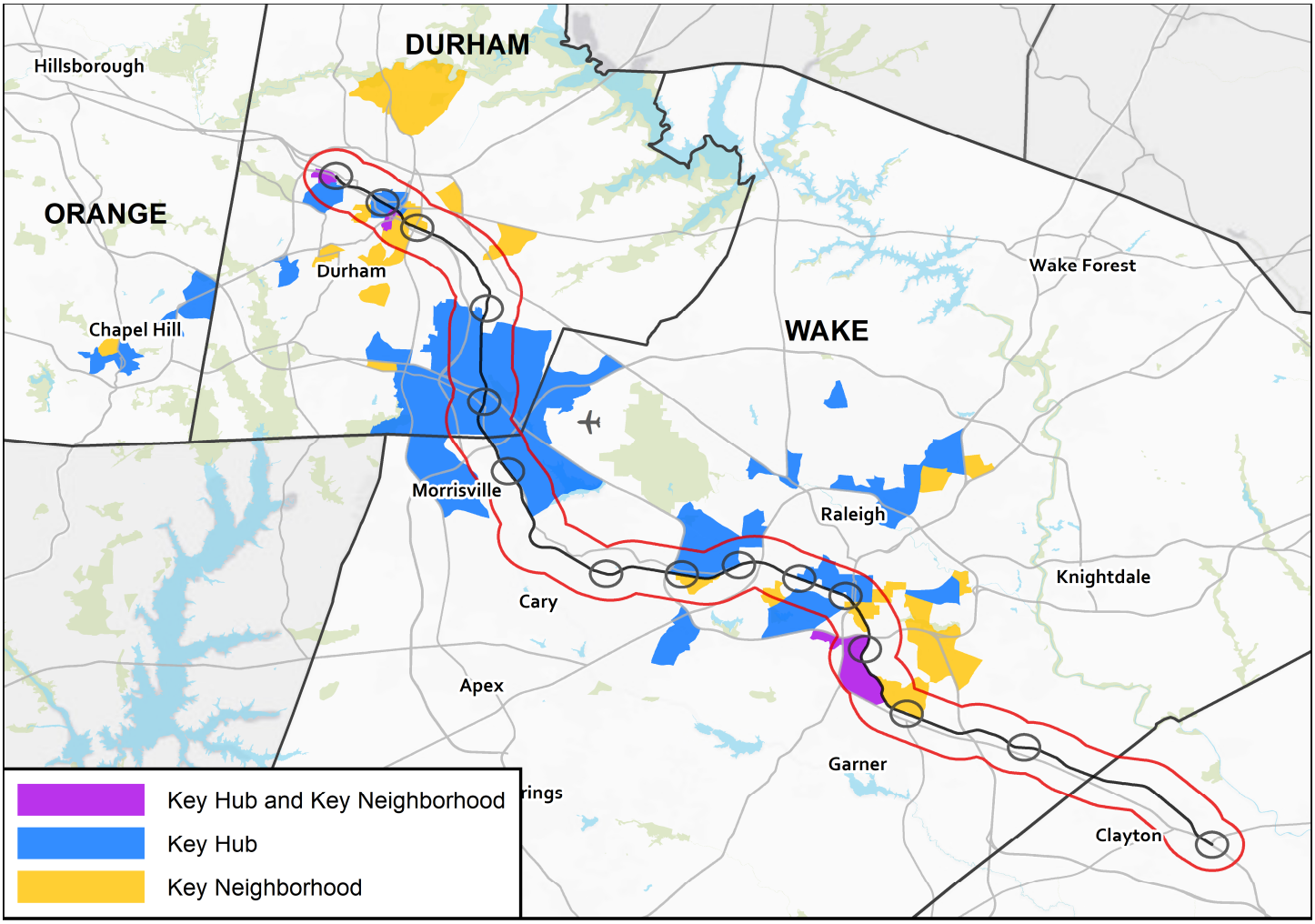
The preceding sections described:

i) how job hubs were determined and where the most prominent hubs are located, and

ii) how Communities of Concern were determined and were used to identify and map the most significant ("top tier") REINVEST Neighborhoods in the region from a combined equity and transit propensity perspective.

The map below shows key job hubs and top-tier REINVEST Neighborhoods together, and their relationship to the rail line.

Figure 7. Key Hubs and Key Neighborhoods



- Of the 59,300 acres in the rail corridor, 22,800 acres (38%) are in a key hub, a top-tier REINVEST neighborhood, or both.
- 12 of the 15 initial station study areas overlap a key hub, a top-tier REINVEST neighborhood, or both.
- The rail corridor is 4% of the region but contains 30% of the region's jobs: 280,000 jobs.
- 8 of the top 10 job hubs in the region lie along the rail line.
- REINVEST Neighborhoods that are partly or wholly within the rail corridor house 70,000 people.
- Only 11% of the region's area met 2 or more REINVEST Neighborhood thresholds, but 37% of the rail corridor's area meet 2 or more thresholds.

Travel Markets – Connecting Neighborhoods to Job Hubs

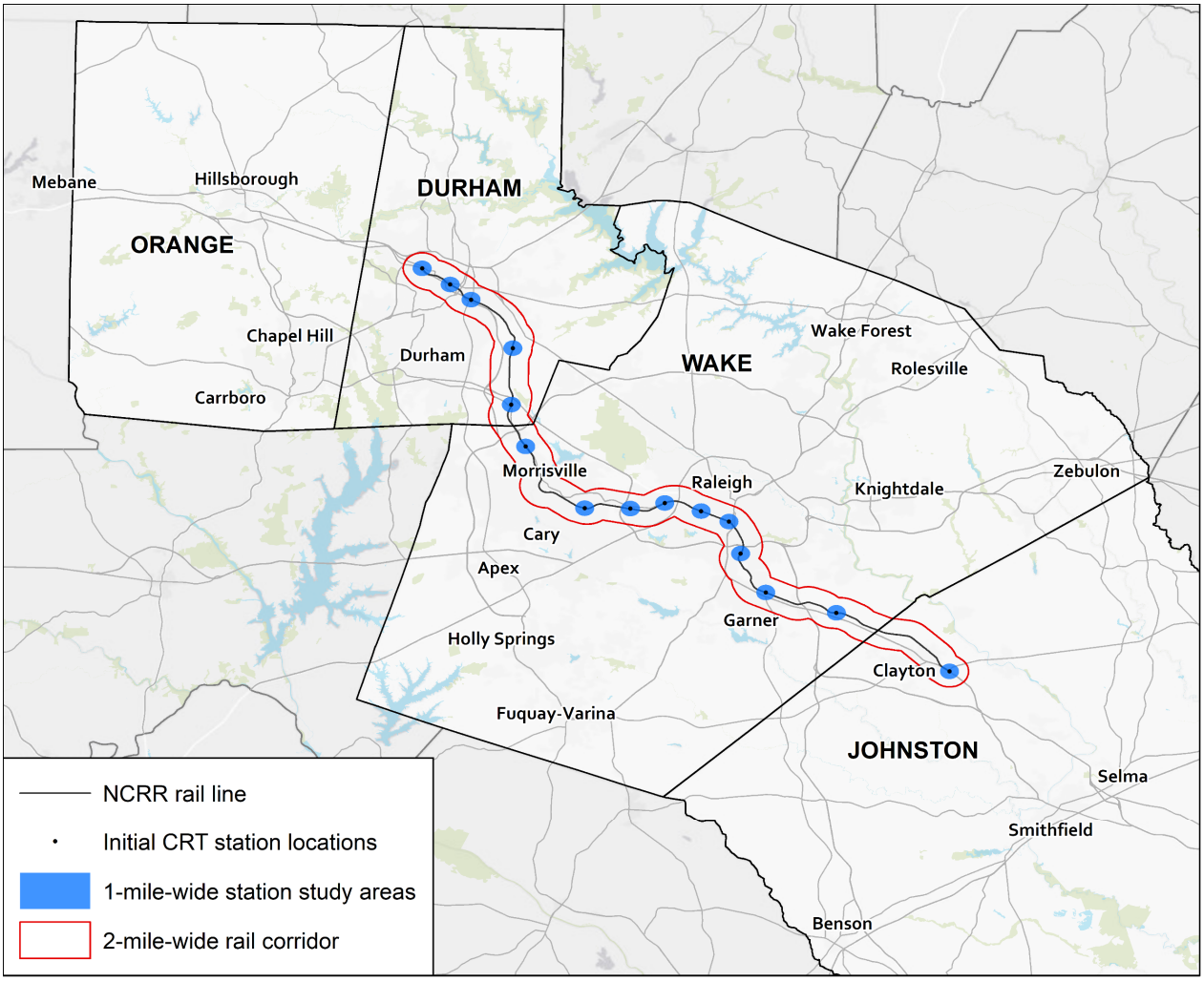
The previous sections focused individually on the two important ends of a work trip: the places where people live and the places where people work. This section brings those two pieces together: travel markets link origins and destinations; they define the nature of a trip. This analysis starts with a broad regional view of travel markets, then increasingly focuses in on travel to, from and within the passenger rail corridor, and travel to and from the station study areas. For each of these areas – region, corridor, station study areas – the analysis places emphasis on travel related to the key hubs and REINVEST neighborhoods that were analyzed earlier in this report.

The analysis focuses on the work trip, since the proposed investment is a Commuter Rail Transit project, but it is important to remember that work trips are only a part of total travel, typically 20-30% depending on how work trips are defined.

The primary data source is the Census Bureau's LEHD/LODES 2018 Origin-Destination (O-D) data set, which was described earlier. The results from LEHD/LODES can be compared to analogous Home-Based Work trips from version 6 of the Triangle Regional Model, which is based on different sources and calculates different metrics. The TRM is especially important because it is the only tool able to forecast what travel might be like in the future, not just estimate travel in the recent past. All of the LEHD/LODES data reflects time prior to the COVID epidemic.

The map below illustrates the region, corridor and station study areas. The region for this analysis is the four counties in the two MPOs and GoTriangle service area through which the passenger rail corridor passes: Orange, Durham, Wake and Johnston. The four-county region contains 1,505,400 acres, the corridor is 59,300 acres (4% of the region) and the station study areas are 7,500 acres, about one-half of one percent of the region.

Figure 8. Region, Rail Corridor, Station Study Areas



Regional Travel Markets

People who live in one county and are employed by establishments in another county make up a significant portion of the work force. The Durham-Wake interchange is especially prominent – 96,000 people live in one county and have their primary job in the other, the largest inter-county flow in North Carolina. The tables in this section summarize LEHD/LODES work-related "flows" for the region.

The following table summarizes the regional employment-based travel market – the number of employee destinations in each of the four counties and the home locations of these employees. It shows *primary* jobs within the region – meaning only the main job for workers, including those who have more than one job.

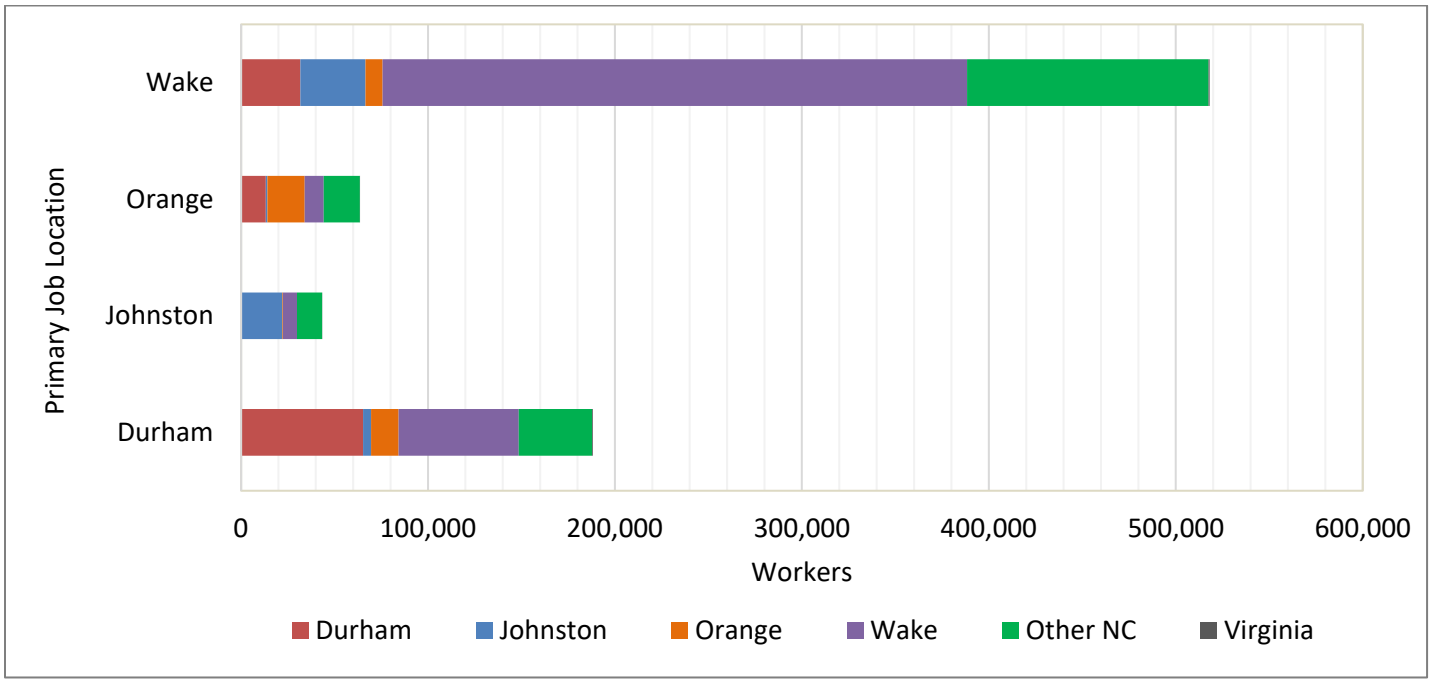
*Table 5. County Work Flows for Primary Jobs**

	Home Location						
Work Location	**Durham**	**Johnston**	**Orange**	**Wake**	**Other NC**	**Virginia**	**Primary Jobs**
Durham	65,272	4,315	14,734	64,233	39,214	446	188,214
Johnston	499	21,613	279	7,534	13,496	32	43,453
Orange	13,231	891	19,965	10,177	19,330	101	63,695
Wake	31,762	34,832	9,133	312,649	129,098	592	518,066
Workers	110,764	61,651	44,111	394,593	201,138	1,171	**813,428**

**the original LEHD/LODES O-D data include people who live great distances from their employer location. These people are unlikely to actually travel to work on a regular basis; therefore this table excludes those long trips (>100 miles).*

An additional 147,000 workers who live in the four counties (not shown in the above table) work for establishments outside of the four-county region, with the result that 45% of the region's workers have jobs located outside of their home county. The chart below illustrates the home location for primary jobs in each county.

Figure 9. Home Location of Workers by Primary Job Location



Corridor Travel Markets

Of the 813,000 primary jobs located in the four-county region, 227,000 (28%) are located in the rail corridor. The table and charts below show the home location of workers who hold these jobs. Four out of five corridor jobs are held by workers who live in the four-county region.

Table 6. Home Location of Rail Corridor Job-Holders

	Home Location						
Work Location	**Durham**	**Johnston**	**Orange**	**Wake**	**Other NC**	**Virginia**	**Primary Jobs**
Durham*	42,575	2,326	9,578	39,793	19,798	162	114,232
Johnston*	81	2,171	57	1,394	1,680	5	5,388
Wake*	6,903	8,517	2,077	67,763	22,264	91	107,615
Workers	**49,559**	**13,015**	**11,712**	**108,950**	**43,742**	**257**	**227,235**

*Portion in rail corridor

Figure 10. Number of Rail Corridor Jobs by Home Location of Worker

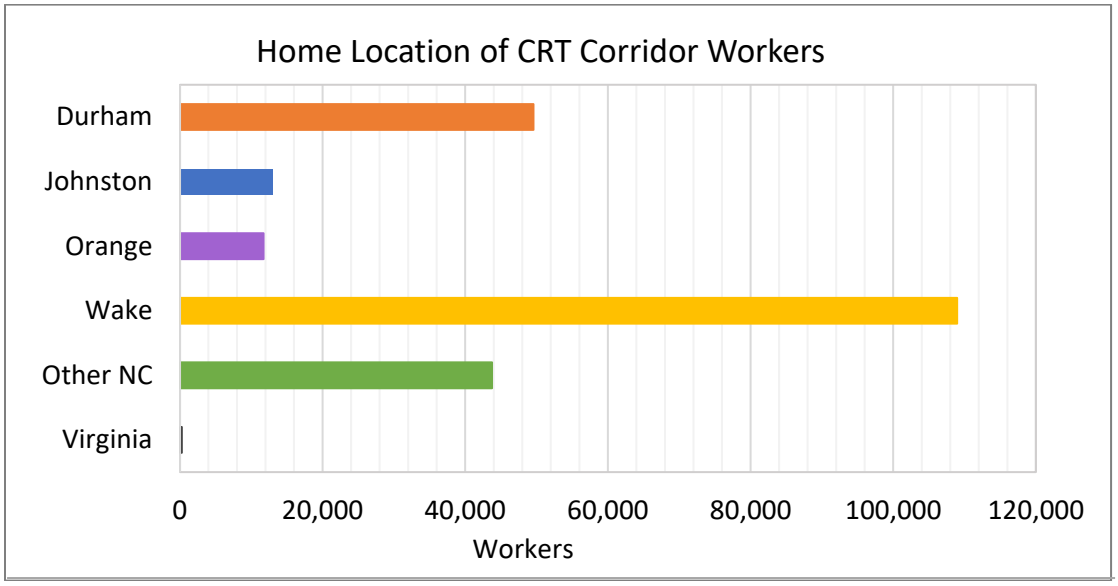
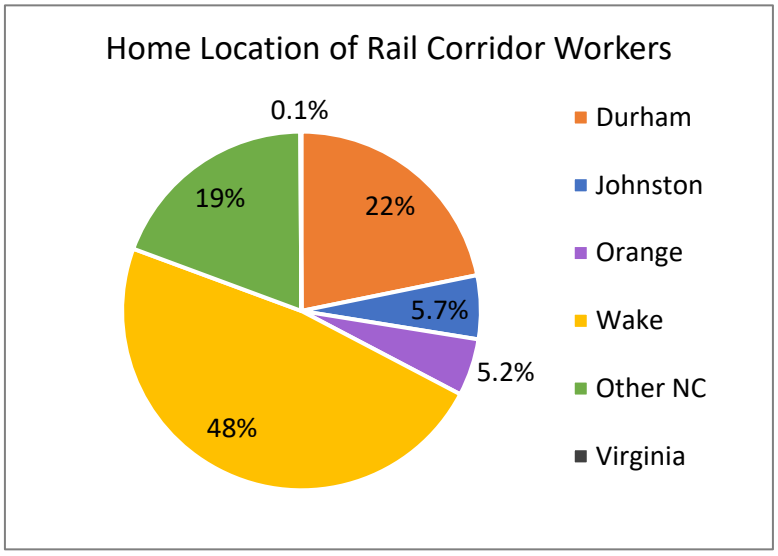


Figure 11. Percentage of Rail Corridor Jobs by Home Location of Worker



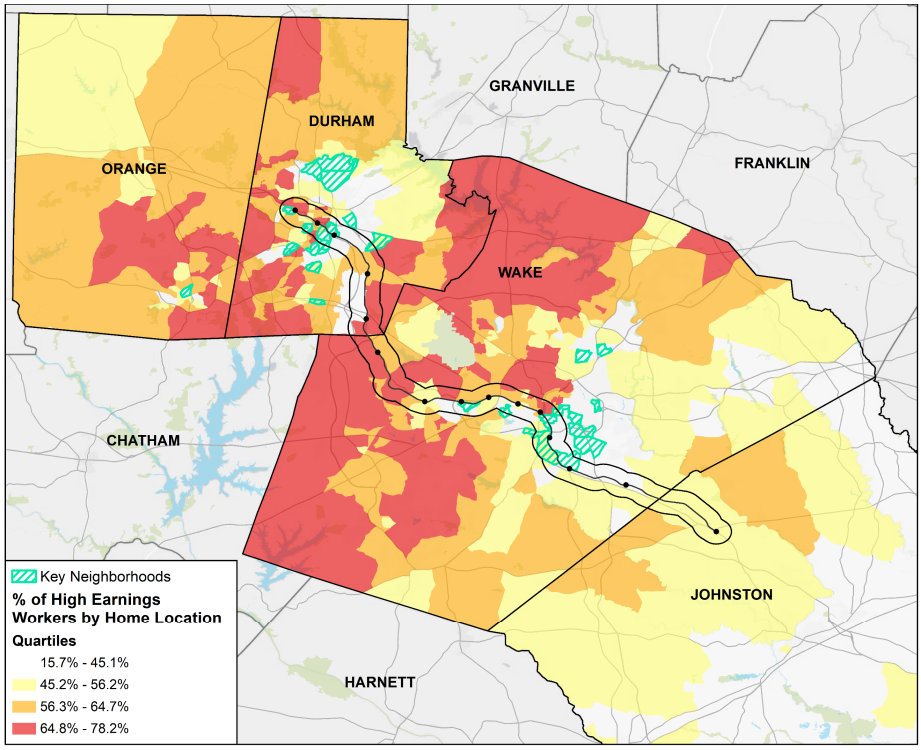
Although workers can travel from outside of the rail corridor to use a rail investment, through park-and-ride lots or feeder bus service, the heart of a commute-oriented travel market are people who both live and work within the corridor where an investment is made. About 56,000 people both live and have their primary job in a census block group that is partly or completely in the rail corridor, suggesting a healthy commute-oriented travel market, especially if the areas along the rail corridor continue their recent robust growth in both residential and commercial development.

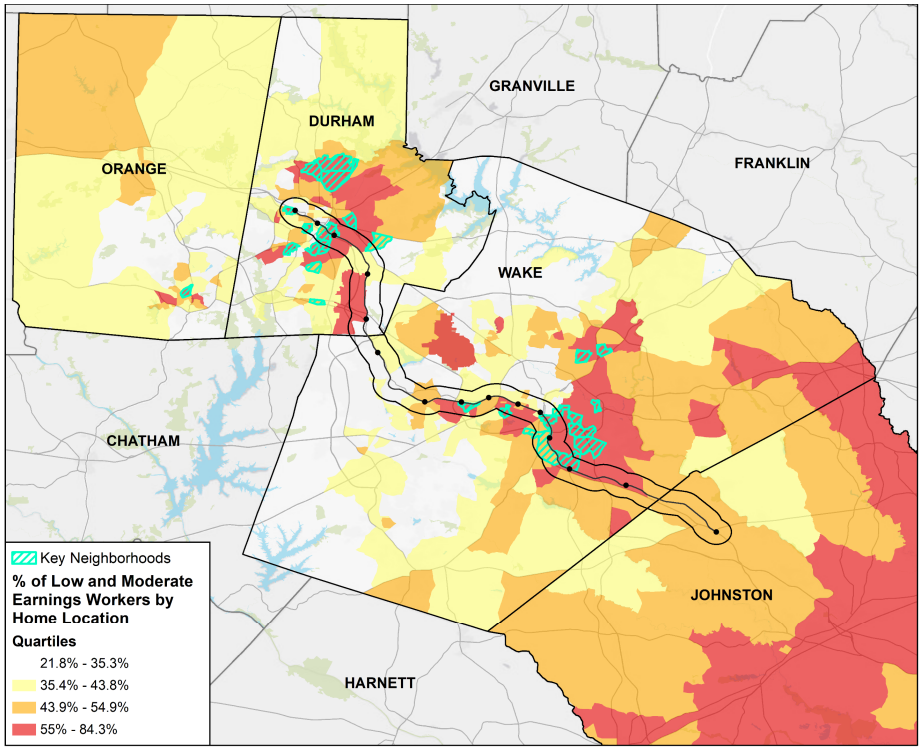
The LEHD/LODES data allows a look at the home location for workers in three earnings ranges:

- Low earnings – jobs earning less than $15,000 per year
- Moderate earnings – jobs earning between $15,000 and $40,000 per year
- High earnings – jobs earning more than $40,000 per year

This analysis combined the low and moderate earnings jobs, then divided the census block groups into quartiles based on the earnings for primary jobs for low/moderate earning jobs and for high earnings jobs. The results are mapped below.

Figure 12. Home Locations of High Earnings and Low/Moderate Earnings Workers





The homes of low and moderate earnings workers tend to cluster near the rail corridor in central and southeastern Durham County and central and southeastern Wake County. A look at the homes of low and moderate earnings workers also indicates that eventual extension of the rail service farther into Johnston County could be beneficial.

Unsurprisingly, the home locations of low and moderate earnings workers are closely aligned with the top tier REINVEST Neighborhoods analyzed previously.

Conversely, the block groups with the greatest prevalence of high earning workers living in them are generally farther away from the rail corridor in northwest and southwest Wake County, southwest and northern Durham County and southeastern Orange County.

Combined with the previous key hubs analysis that concluded that many of the key hubs along the corridor were in the top 10 for low and moderate earnings jobs, this analysis suggests that rail service that can serve the work hours of low/moderate jobs can both enable workers to reach those jobs and to pursue higher earning jobs also served by a rail investment.

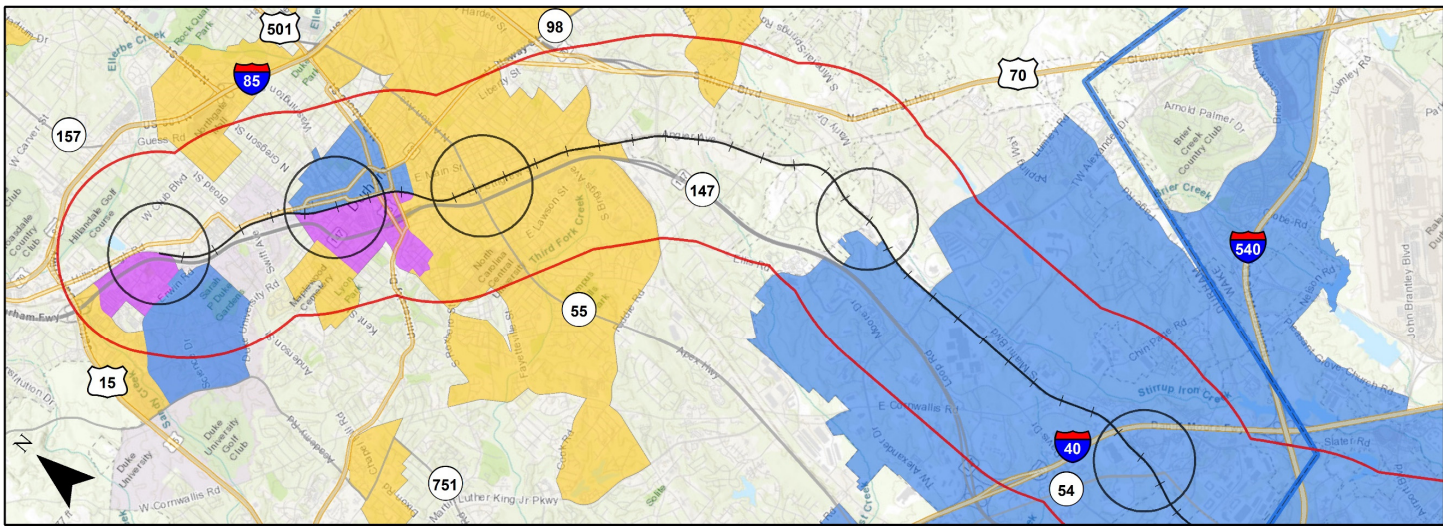
Station Study Area Travel Markets

This section of the report makes an initial assessment of the 15 station study areas, each of which is about 500 acres. As smaller areas are examined, data margins of error and suppression of data to address privacy concerns introduce increased uncertainty into the analysis, as does data manipulation necessary to address the mismatch between the boundaries of the station study areas and the boundaries of census block groups. Nevertheless, some general patterns emerge:

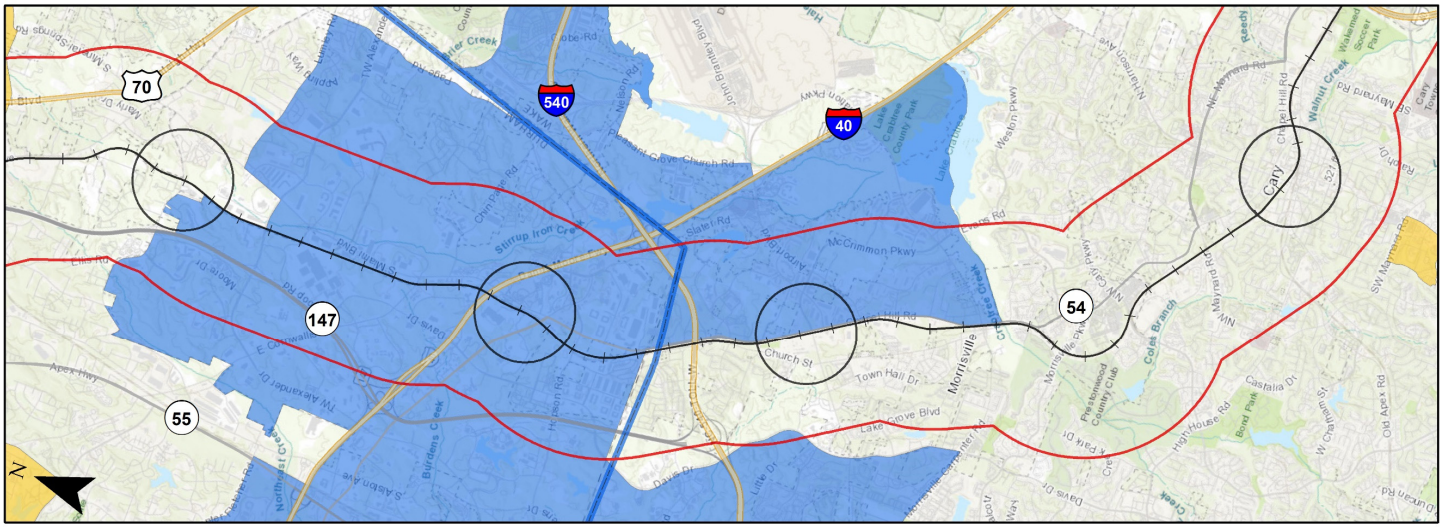
- 12 of the 15 initial station study areas overlap a key hub, a REINVEST Neighborhood, or both.
- Census Block Groups that are wholly or partly within a station study area—and therefore more likely to be within walking distance of a station -- hold 216,000 primary jobs. 38,000 workers who hold these station-area primary jobs live within the rail corridor, and another 137,000 live within the 4-county region.

The maps below and on the next page show how the corridor and the initial station study areas relate to areas that meet thresholds for REINVEST neighborhoods, key job hubs, or both.

Stations (left-to-right): W. Durham, Downtown Durham, E. Durham, Ellis Rd, RTP



Stations (left-to-right): Ellis Rd, RTP, Morrisville, Cary CBD



The railroad corridor – 1 mile on each side of the tracks where service is planned

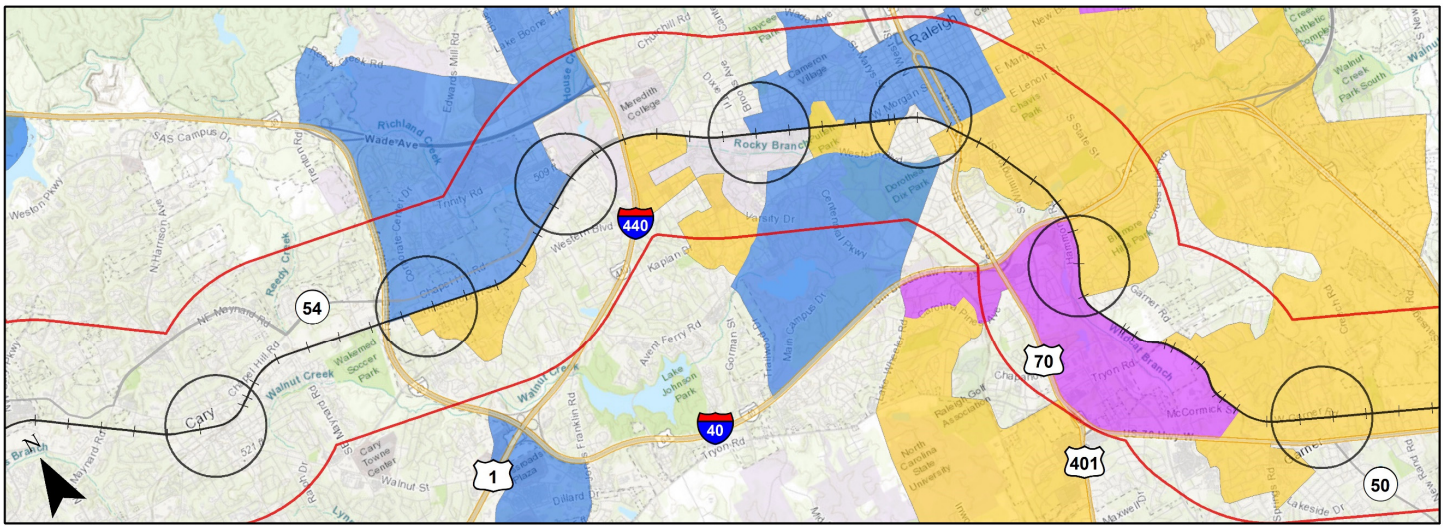
Initial Station Study Areas: ½ mile radius circles around stops being analyzed

Places that measure as key job hubs

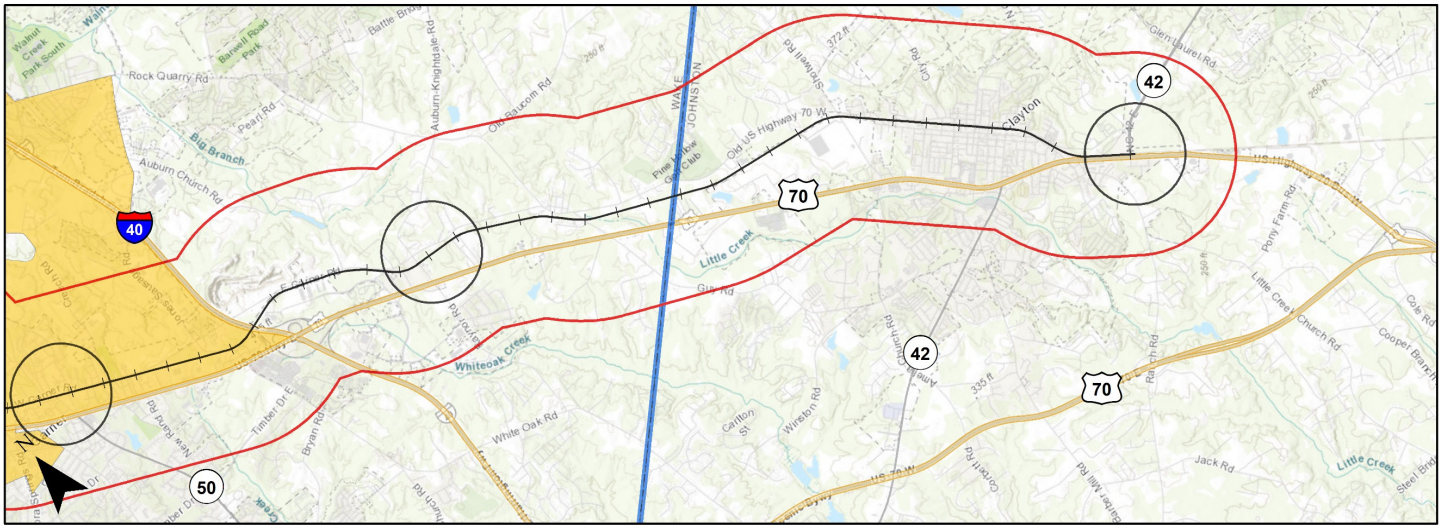
Places that measure as REINVEST Neighborhoods

Places that measure as both key job hubs and REINVEST Neighborhoods

Stations (left-to-right): Cary CBD, Corp Center Dr, Blue Ridge Rd, NCSU, DT Raleigh, Hammond, Garner



Stations (left-to-right): Garner, Auburn, Clayton



The railroad corridor – 1 mile on each side of the tracks where service is planned

Initial Station Study Areas: ½ mile radius circles around stops being analyzed

Places that measure as key job hubs

Places that measure as REINVEST Neighborhoods

Places that measure as both key job hubs and REINVEST Neighborhoods

Appendix 4 contains additional information on individual station study areas, including potential infill and alternative location stations that have been identified during the affordable housing, travel market and land use analyses.

Key Hub and REINVEST Neighborhood Travel Markets

Table 7 shows the relationship of the work trips associated with REINVEST neighborhoods (Tiers 1-3) and key hubs to the corridor and four-county region. In total, about 54,000 workers in the four-county region live in REINVEST neighborhoods, and over 23,000 of these (43%) have their primary jobs within the corridor.

Looking at the other end of the work trip, there are over 260,000 primary jobs located within key hubs in the four-county region, and 172,000 of these (66%) are located in the corridor.

Table 7. Travel Market Summary for Block Groups Partly or Completely within the Corridor

Primary Jobs/Workers	**Primary Job Location In:**				
Worker Lives In:	Four Counties	CRT Corridor	Key Hub	Key Hub in CRT Corridor	CRT Corridor Not Key Hub
NC or VA[1]	813,428	**316,425**	340,182	**210,095**	**106,330**
Four Counties	611,119	**255,711**	263,097	**172,443**	**83,268**
CRT Corridor	111,197	**56,332**	52,216	**36,264**	**20,068**
REINVEST Neighborhood	54,341	**23,401**	23,209	**15,492**	**7,909**
REINVEST Neighborhood in CRT Corridor	18,865	**9,131**	8,463	**5,939**	**3,192**
CRT Corridor Not REINVEST Neighborhood	92,332	**47,201**	43,753	**30,325**	**16,876**

In Table 7, the cells highlighted in **bold red text** are the cells that represent work travel that both begins and ends in the corridor. These "in-corridor" trips can be an important focus since they can be served if there are safe and seamless connections to get people between stations and their homes and workplaces, whether through walking, cycling, or short bus rides.

The cells highlighted in **bold black text** are the cells that have the work end of their trips within the corridor, with the home end of the trip either inside or outside of the corridor – these are "to-corridor" trips, since the corridor is their destination for a work trip. Where the home end is outside of the corridor, some of these locations might be along a connecting bus line, but in order for many of these trips to be served, the travelers would rely on park-and-ride access.

[1] Includes primary jobs for workers whose home location block group was less than 100 miles from their work location block group (about 90% of all primary jobs located in the four-county region, according to the 2018 LEHD-LODES data).

Critical Considerations & Next Steps

There can be a tension between service that is best for the travel markets and service that is easiest for railroad operations, especially where tracks are shared among freight, inter-city passenger and intra-regional passenger rail, like the proposed rail connection for Wake, Durham and Johnston Counties. Mutually beneficial investments may require systematic, sustained partnerships involving people of good will dedicated to creatively solving problems as they arise. A critical part of collaboration will be ensuring seamless "first mile-last mile" bus and micromobility connections that link neighborhoods and business districts to rail stops – every rail trip begins and ends with someone walking from and to a building.

The analysis focused on work-oriented travel during pre-COVID conditions. Although the future is always uncertain, two things seem likely: i) traditional office work may become more of a "hybrid" model – with people working part of the time in a traditional work environment and part of the time from home or other remote locations; and ii) the region will continue to be fast-growing, with the spine of the region along the rail corridor a magnet for growth. Remote work is less of an option for many lower earning jobs, including many deemed "essential workers" during COVID. Health care, hospitality, retail and other "customer-facing" work is not as amenable to remote work as office work, and many of these jobs are located along the rail corridor. These kinds of jobs may also have work schedules that are not as aligned to a "9-to-5" transit service that is typical of many legacy commuter rail operations.

To both better understand the full range of travel markets and how they may be changing, and to optimize travel market opportunities for the rail corridor, the region may benefit from pursuing three "next step" activities:

Updating Travel Market Data and Integrating it with Ridership Modeling

The Census Bureau updates its LEHD/LODES data each year, providing an opportunity to refresh the analysis of existing work trip travel markets over time. In 2022, the region will institute a completely rebuilt travel demand model, the best tool for understanding future travel markets. By aligning this re-vamped tool with continually updated LEHD/LODES data, the region can have a better handle on how travel markets may grow and change in the future, not just for work trips, but for other trips that could be served by the rail corridor.

Strengthening the Land Use-Housing-Transit Connection and Envisioning Future Growth

Because travel markets connect people to their activities: workers to jobs, patients to health care, students to education, etc., planning for more compact, walkable land uses along transit investments can be the most effective way to grow and guide travel markets, especially in a rapidly growing region like the Research Triangle. Maintaining a focus on the integration of land use, transit services and affordable housing along key regional corridors can yield long-term dividends.

Continuing to Build Partnerships and Open Dialogue – and the Leadership to Sustain Them

The NCRR corridor can be the transit backbone of the region, connecting the centers of the region's three largest cities, major universities and health facilities, the seat of state government and the Research Triangle Park. The mirror of this widespread value is diverse authority and responsibility – no single organization or small group of organizations holds the keys to success. Rail investments take many years to plan, design and implement, and during this span, executive and staff technical leadership will typically change in many organizations with authority and influence. Regular convenings of all the executive leadership with their key technical staff can lessen risks to the project and enable leaders to hear directly from one another about their interests and concerns.

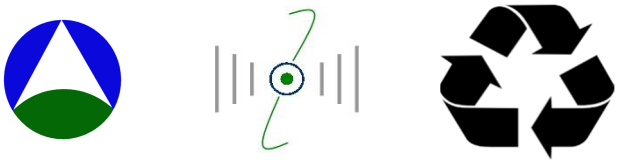
Additional Resources

- LEHD/LODES – https://lehd.ces.census.gov/
- GoTriangle Transit Planning Projects – https://goforwardnc.org/project/commuter-rail/
- US Census Bureau American Community Survey – https://www.census.gov/programs-surveys/acs
- Walker, J. (2012). Human transit - how clearer thinking about public transit can enrich our communities and our lives. *Island Press*.
- Spieler, C. (2021). Trains, buses, people: An opinionated Atlas of Us Transit. *Island Press*.
- Higashide. (2019). Better buses, better cities. *Island Press*.
- Shearer, C., Vey, J. S., & Kim, J. (2019). Where jobs are concentrating and why it matters to cities and regions. Washington, D.C.: *Bass Center for Transformative Placemaking at Brookings*.
- Park, K., Ewing, R., Sabouri, S., Choi, D.-ah, Hamidi, & Tian, G. (2020). Guidelines for a polycentric region to reduce vehicle use and increase walking and transit use. *Journal of the American Planning Association*, 86(2), 236–249. https://doi.org/10.1080/01944363.2019.1692690.
- Connect2050: The Research Triangle Region's Metropolitan Transportation Plan – dchcmpo.org; campo-nc.us
- Center for Transit Oriented Development – www.ctod.org
- Reconnecting America – www.reconnectingamerica.org

This report was prepared by Jenna Kolling, Kaley Huston and John Hodges-Copple of the Triangle J Council of Governments. Special thanks to Katharine Eggleston, Jay Heikes and Margaret Scully of GoTriangle for their review. Jenna Kolling was the principal analyst for the project; for questions or comments, please contact her at jkolling@tjcog.org, or John Hodges-Copple at johnhc@tjcog.org. Copies of this report, along with supplementary material and additional mapping, are available for download from the GoTriangle website at:

https://www.readyforrailnc.com/reports/

Funding support for this report came from county transit tax revenues from Wake and Durham Counties.



Appendices

Appendix 1: Glossary of Terms and Acronyms

Term	Definition
Anchor Institution	Hospitals, universities, and other institutions that have decision-making ability to affect the success of a strategy or investment.
Communities of Concern	Groups that are identified through an equity lens, groups that have been traditionally under-represented in transportation decision-making based on such characteristics as race, ethnicity, disability, age and income.
Corridor (rail)	As used in this report, the corridor is 2 miles wide, one mile on each side of the existing tracks within the North Carolina Railroad Company right of way
CRT (Commuter Rail Transit)	Defined by the Federal Transit Administration as an electric or diesel propelled railway for urban passenger train service consisting of local travel which operates between a central city and outlying areas. In this report, CRT is used interchangeably with "regional rail" or "rapid rail," terms that do not imply a limitation to one type of traveler (a commuter going between home and work).
Earnings (Low, Moderate, High)	Jobs and workers are classified into three earnings categories in the LEHD Origin-Destination Employment Statistics (LODES) data: Low: earnings of $1,250 per month or less Moderate: earnings between $1,251 and $3,333 per month High: earnings of $3,334 per month or more
Federal Transit Administration (FTA)	The agency within the US Department of Transportation that oversees transit programs and investments that use federal funds
In-Corridor Trips	Trips that both begin and end within the rail corridor
Job Hubs/Key Hubs	Places in the region with the highest concentrations or number of jobs, including: 1) Block groups with very high (7,500-30,000 jobs per square mile) or extremely high (>30,000 jobs per square mile) job density. 2) Block groups with high (1,500-7,500 jobs per square mile) job density + more than 7,000 jobs. The top 26 Key Hubs, ranked from 1 to 26 by the total number of jobs in each hub, are made up of 44 block groups. In some cases, two or more block groups were clustered together into a single hub when they shared a border with other qualifying block groups, or when census boundaries divided areas with a large number of jobs into two or more block groups that didn't meet either of the above thresholds alone.
Jobs (total and primary)	Total jobs are from the LEHD Origin-Destination Employment Statistics (LODES) work area characteristics dataset (all jobs for all workers), which includes all beginning-of-quarter (Q2) jobs from unemployment insurance covered employment (private and state- and local-government), and some Federal civilian employment. Primary jobs are a subset of total jobs, including only the highest paying job for workers holding two or more jobs in a given year. The count of primary jobs is the same as the count of workers.
Joint Development	Local transit agencies can utilize the FTA's joint development program to support affordable housing projects near transit, including funds for property acquisition, demolition of existing structures, site preparation, relocation or construction of utilities, building foundations, walkways, and providing bike and pedestrian access between public transit and related development.
Legally Binding Affordability Restricted (LBAR) housing units	Housing that includes legally-binding agreements to keep it affordable, either permanently or for a set period of time. LBAR units can include both single family houses and apartments, or multi-family housing units that are made affordable by funding sources for households that meet specified income limits.
Opportunity Zones	The Opportunity Zones Program was signed into legislation in December 2017 through the Tax Cuts and Jobs Act (H.R.1) that provides tax incentives for qualified investors to re-invest unrealized capital gains into low-income communities through a qualified Opportunity Fund.
Region	In this analysis, the region is the 4 counties in the Greater Triangle containing the NCRR right-of-way: Orange, Durham, Wake and Johnston.

REINVEST Neighborhood	Neighborhoods, measured at the census block group level, with individual or household characteristics related to race, ethnicity, income, vehicle availability or affordable housing status that place them in the top 25% of all such block groups.
Station Study Area	A one-half mile radius area around a point that represents a potential rail station platform. A half-mile distance is a transit industry rule of thumb for a walking distance to transit.
To-Corridor Trips	Trips with the home end of a trip outside of the corridor, but the destination end – such as an employer location for at work trip – inside the corridor.
Transit Propensity	The likelihood of a person with a particular characteristic to use transit as their commuting mode relative to the total population. A transit propensity greater than 1.0 means a person with the characteristic is more likely to use transit than the population as a whole.
Travel Market	Travel to particular places for specific purposes. This analysis focuses on employment trips to locations along the rail corridor.

Appendix 2. Travel Market Analysis Framework for Transit Corridor Investments

To better understand the most important destinations for commuters, this part of the technical appendix examines methods and data sources developed in recent studies that emphasized transit investment. Each study is briefly described, then its methods and updated data examined for applicability to the region, CRT corridor and CRT station study areas.

Guidelines for a Polycentric Region to Reduce Vehicle Use and Increase Walking and Transit Use

Keunhyun Park, Reid Ewing, Sadegh Sabouri, Dong-ah Choi, Shima Hamidi & Guang Tian (2020). Guidelines for a Polycentric Region to Reduce Vehicle Use and Increase Walking and Transit Use, *Journal of the American Planning Association*, 86:2, 236-249, DOI: 10.1080/01944363.2019.1692690

Summary

This study reviewed 126 regional transportation plans and found that polycentric development (a pattern consisting of multiple compact centers) was the dominant vison for most. However, while 90% of the regional transportation plans examined mentioned the term *centers* (the densest parts of a region, characterized by compact and mixed-use development, well-connected by a multimodal transportation network, and with more job opportunities than the areas around them), only 20% gave quantitative criteria for designating these centers, and none of those quantitative criteria were empirically based on transportation benefits. Thus, this study sought to provide: 1) empirically driven guidelines for identifying existing or emerging centers that could be shared across MPOs, transit agencies, and municipalities, and 2) findings that can help planners establish polycentric development goals, quantify the progress being made in the region to concentrate growth in centers, and describe in detail how the designated centers achieved the goals over time.

The authors of this study did subsequent work that both categorized different types of centers and developed case studies in four regions (Denver, Seattle, Minneapolis-St. Paul and Portland, OR), which the authors identify as the strongest case.

Approach

The location of 35 central business districts (CBDs) and 589 potential employment subcenters (clusters of activities outside of the traditional CBD large enough to influence real estate and thus the spatial form of nearby areas) were identified for 28 U.S. study regions using two steps.

First, CBDs were identified among census block groups in each region using the spatial statistic local Moran's *I*—an indicator of the extent of significant spatial clustering related to the variable of interest (in this case, employment density). The Moran's *I* analysis was run using ArcGIS Desktop 10.6 at the block group level for the 28 regions using Longitudinal Employer-Household Dynamics (LEHD) employment data for 2015.

Second, a geographically weighted regression (GWR) was used to identify potential employment subcenters. The GWR method estimated an employment density surface using only neighboring observations for any block group while giving more weight to the closer observations. For the GWR, the dependent variable was the employment density of a block group; the independent variable was the distance of the block group centroid from the CBD.

Findings & Conclusion

The research defined 5 broad categories of centers, with the following characteristics:

- Regional Center -- primary commercial, civic and cultural centers which serve the county and region with an intense mix of land uses including homes, workplaces, universities, stores, public facilities, entertainment venues, and medical centers. These centers are characterized by dense population, typically clustered in multistory buildings and economic

vitality. They generally sit along other heavily traveled corridors, connecting them to other centers throughout the region. Regional centers typically cover more than 100 acres, with floor-area ratios ranging from 3 to 5.

- Urban Center -- mid- to high-density and mixed-use. Urban centers are characterized by two- to four-story buildings, floor-area ratios between .75 and 4, roughly 20-120 dwelling units per acre, and around 300 jobs per acre.
- Town Center -- contain multiple land uses, some density, and transit options, but cater especially to pedestrians by providing walkable connections to surrounding neighborhoods. These centers are roughly one-third the density of urban centers. They function as the center of economic and civic activity, effectively the focal point of a community. Buildings typically stand two or more stories. Town centers cover between 100-640 acres, serve around 30,000-40,000 people, contain 10-50 housing units and 30-120 jobs per acre, and are between .5 and 1 mile across.
- Employment Center -- industrial and business parks that, due to their location and associated infrastructure, are developed to support the attraction and retention of large-scale employment opportunities. Scale varies from the regional employment center down to the suburban employment center. Typically, employment centers have a job density of at least 1,000 workers per square mile and also have a greater job density than population density.
- Activity Center -- varies by scale and activity mix depending on location. They contain a concentration of business, civic and cultural activities, facilitating interaction. Each activity center is unique with contextual and distinctive identities, derived from environmental features, a mix of uses, well-designed public spaces, parks, plazas, and high-quality urban design. Since the quantitative criteria vary by the scale of an activity center (e.g., regional, community, and rural levels of activity centers), the report found that is was not practical to provide unique characteristics for this type of center.

For the four case studies, the main conclusions were:

- Portland. Highlights include the region's Centers Functional Plan to help communities promote and grow their centers, a periodic "State of the Centers" report to track progress, and funding that is only eligible for use in centers.
- Denver. The region set targets for growth within centers, created design criteria, and has dedicated funding for station area and urban center planning by localities. Transportation project prioritization rewards projects that serve centers.
- Seattle. A regional centers framework is the hallmark of the regional growth strategy. Both transportation and economic development funding priority are given to projects serving centers.
- Minneapolis-St. Paul. Emphasis is placed on the alignment of transit investments and activity centers. Programs are focused on station areas along existing and planned transit ways and at job centers with at least 7,000 jobs and a density of 10 jobs per acre. A regional inventory of locally-identified priority development and redevelopment sites is maintained; market readiness and customized strategies are analyzed for these sites. As with other best-practice regions, dedicated funding is available for use only in centers, promoting Transit-Oriented Development.

Application to Travel Markets Report

- Compare key hubs to the 5 types of activity centers defined by the research
- Indicate how travel characteristics related to centers may differ from non-center travel characteristics
- Analyze data related to centers in this report ("key hubs") relative to the rail corridor and station study areas

Where Jobs are Concentrating and Why It Matters to Cities and Regions

Shearer, C., Vey, J. S., & Kim, J. (2019). Where jobs are concentrating and why it matters to cities and regions. Washington, D.C.: Bass Center for Transformative Placemaking at Brookings. Retrieved July 10, 2020, from https://www.brookings.edu/wp-content/uploads/2019/06/2019.06_Bass-Center_Geography-of-jobs-report.pdf

Summary

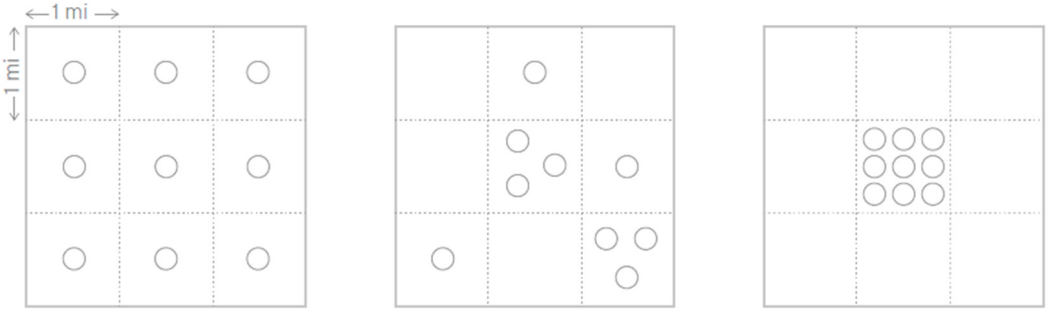
This new research analyzes job density—the degree to which jobs are concentrating or dispersing—in the nation's largest metro areas. In analyzing job density within and across 94 of the nation's largest metro areas, which together contained 66% of the nation's private sector jobs as of 2015, this report found that job density increased from 2004 to 2015 by nearly 6,000 jobs per square mile on average in these 94 large metro areas, or nearly 30%. Not only did most metro areas have more jobs in 2015 than 2004, jobs became more concentrated in denser parts of metro areas. This analysis provides greater insight into how the relationship between place and economy continues to evolve, and what this might mean for cities and regions seeking to harness these trends to drive more equitable and sustainable economic growth.

Approach

To better understand the changing role of density during the first wave of the digital revolution, the report tracked trends in large metropolitan areas from 2004 to 2015, with an emphasis on job density rather than proximity. The report describes recent trends in the density of most private-sector wage-and-salary jobs in metro areas, as well as the local and sectoral dynamics behind these trends. The Census Bureau's Longitudinal Employer-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES) program was the primary source of local-area employment data in the analysis.

Measuring Job Density

All the findings on job density in the report refer to the weighted or "perceived" density of jobs in metro areas. Perceived density is different from the "standard" measure of density. *Standard job density* is calculated by dividing the total number of jobs by the total land area of a metro area, revealing the average amount of land around each job. *Perceived job density* instead measures the job density of the place in which the average job is located, revealing the average number of jobs in the vicinity of each job. Therefore, perceived job density provides a better approximation of how dense a metro area feels and how compactly its jobs are concentrated. To see how these two measures can lead to different indications of job density in a metro area, consider the examples at right.

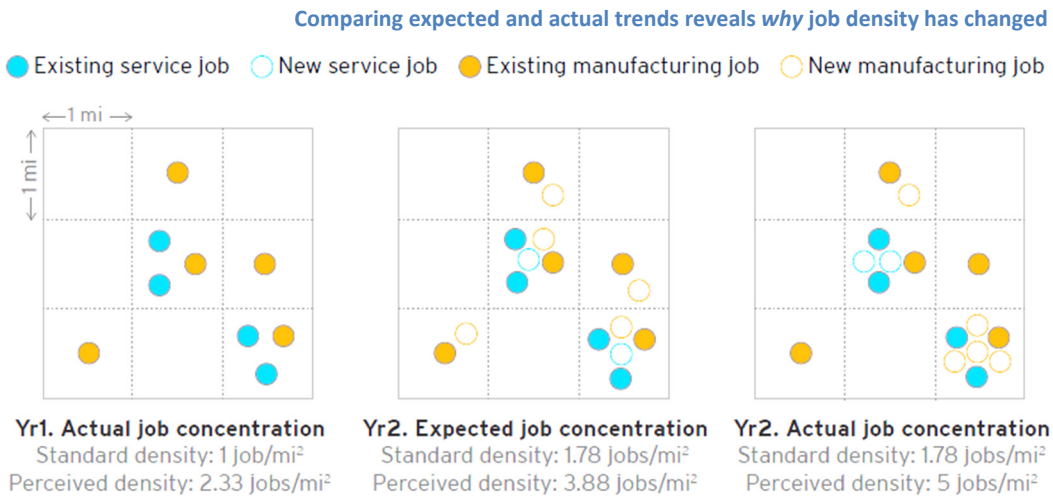


Perceived job density indicates the number of jobs around a typical job

Calculating Expected Trends

The report explored whether metro areas' job density is increasing or decreasing, by how much, and why. A metro area's job density can change because of job growth, changes in the distribution of its jobs across sectors, and because of shifts in the distribution of sectors' jobs across space. The authors measured spatial shifts in the distribution of jobs across a metro area and analyzed their effects on its job density by comparing the "actual" trend in job density to a counterfactual or "expected" trend. The *actual trend* in job density refers to observed changes in a metro area's perceived job density. The *expected trend* refers to how a metro area's job density would have changed if job growth in each industry sector had been distributed according to each block group's starting share of the metro area's jobs in that sector. In other words, the

expected change reveals how a metro area's job density would have changed due to job growth alone, independent of shifts in the distribution of jobs across space. To see how a comparison of expected and actual job density trends can reveal the effects of spatial shifts in the distribution of jobs, consider the example at right.



Findings & Conclusions

The report found that job density has increased at a faster pace than job growth, driven in large part by the densification of core urban areas and advanced business service sectors, while job growth has also continued to spread out, or sprawl, to less-dense parts of metropolitan areas, such as suburban and exurban counties. The report also shed light on shifts in the density of jobs – one measure of economic activity – within and among America's large metro areas. By analyzing job density rather than jobs' proximity to the core, the authors were able to provide a nuanced look at not just where jobs are locating but also how they are concentrating – not only in downtown or other central city communities, but also in suburban and exurban areas.

This report provided evidence that, overall, jobs in metropolitan America are densifying. But it also showed that individual metro areas could be doing far more to prioritize and support such trends by investing in existing areas of concentrated development. This represents a missed opportunity: Density offers a means to increase productivity and economic growth, improve social and environmental outcomes, increase civic engagement, and reduce fiscal liabilities. When coupled with investments in people and the public realm, dense places can become inclusive communities where firms and workers flourish. Moving forward, researchers and policymakers need to be more attentive to the strategies and policies that shape communities, the ways in which they align with changing economic needs, and how they can be reformed and reimagined to work better and harder for more people and places.

Application to Travel Markets Report

- Use as part of input to defining and refining job hubs
- Use of block group instead of block level data in LEHD LODES.
- Available for "deeper dive" analyses for sections of the corridor and for specific activity centers.

Trains, Buses, People: An Opinionated Atlas of US Transit

Spieler, Christof (2021). Trains, Buses, People: An Opinionated Atlas of US Transit. Washington, D.C.: Island Press.

Summary

The publication examined all 57 Combined Statistical Areas or Metropolitan Statistical Areas in the US and Canada that have rail transit and/or Bus Rapid Transit (BRT) lines. Each area has a 2- to 14-page section and for each, two maps are shown at the same scale that is used throughout the publication:

1. The physical form of the transit system, with transit lines color-coded by mode: heavy rail, light rail, bus rapid transit, street car, commuter rail and "frequent bus" (defined as a bus every 15 minutes or more frequently).
2. The frequent transit network (all lines, regardless of mode, where a vehicle arrives every 15 minutes or more frequently) overlaid on population and job densities within one half mile of frequent-rail stations and frequent-bus lines. These maps also show the locations of large college campuses and callouts for large job centers.

The report identifies high-performing and low-performing rail systems -- based on riders per mile -- by mode (heavy rail, light rail, commuter rail, people-mover and streetcar); where metro areas have more than one system for a mode, each system is rated separately. The report includes a "best and worst" section that gives the author's judgement of:

- Best transit cities
- Best heavy-rail networks
- Best commuter rail
- Best streetcars
- Most useless rail-transit lines
- Best light-rail networks
- Best BRT lines
- Best frequent bus networks
- Best bus-rail integration
- Missed opportunities

The report stresses nine basics of successful transit (density, activity, walkability, connectivity, frequency, travel time, reliability, capacity and legibility), notes good ideas from abroad, and concludes with a transit agenda for agencies and elected officials who want to improve transit service.

Approach

The report relies on data gathered mostly in 2016-17 and focuses on three types of information:

- The supply of transit service (routes by mode, focusing on frequent services where a vehicle arrives at a stop every 15 minutes or more frequently)
- The use of the transit service (ridership)
- Areas served by the transit service (population & job densities, activity center locations like big college campuses).

The supply information comes mainly from a review of system maps and schedules and the National Transit Database (NTD; on line at https://www.transit.dot.gov/ntd). Detailed route mapping is from OpenStreetMap (openstreetmap.org). Transit use comes from American Public Transportation Association (APTA) quarterly ridership reports and 2018 NTD data.

Population and employment data are sourced as from the US Census Bureau; population data are from the 2010 Census and shown at the Census Tract level. The population density ranges that are mapped (in people per square mile) are:

- 2,500 to 5,000
- 5,000 to 7,500
- 7,500 to 10,000
- 10,000 to 12,500
- 12,500 to 15,000
- 15,000 to 17,500
- Over 17,500

Employment data are not sourced, but are likely from LEHD/LODES and also appear to be at the census tract level. Employment density (jobs per square mile) ranges that are mapped are:

- 15,000 to 30,000
- 30,000 to 45,000
- 45,000 to 60,000
- Over 60,000

The author does not indicate if the population and employment density ranges have specific meaning for particular types or levels of transit service, but does assert that at around 3,000 people per square mile, some level of infrequent service is worthwhile and around 10,000 people per square mile frequent service is justified. Downtown employment center job amounts and national rankings are displayed; they are from a 2013 report of the International Downtown Association.

Findings & Conclusions

The report's findings are in the form of nine basics of successful transit:

- Density – "nothing matters as much to making transit useful and successful as population density"
- Activity – "building transit where people live is not enough; transit needs to go where they go"
- Walkability – "nearly every transit trip begins or ends on foot or on a bike….pedestrian connections are cheap, but they're often forgotten"
- Connectivity –"connections can be where a trip goes wrong: they are often sources of delay, confusion, and hassle. Good connections offer freedom; bad ones offer frustration."
- Frequency – "frequency…is freedom. How frequently a transit route operates makes the difference between a rider being able to depend on transit to be there when needed, and a rider needing to plan their life around transit."
- travel time – "optimize trip time, not speed. A transit trip is not from station to station; it is from door to door…making trains faster doesn't necessarily make trips faster."
- Reliability – "reliability is nearly as important to transit users as travel time….by far the biggest source of unreliability is sharing space with cars"
- Capacity – "all modes of transit have high capacity….often, then, capacity is not the driver; the drivers are speed, reliability and quality of service"
- legibility – "a transit trip is a series of decisions…every one of those decisions requires information, and a good transit system provides that information when it is needed, in an easy to understand form"

In the concluding section, the author stresses the centrality of focusing on areas where the demand is greatest -- that more homes, jobs, and services near transit makes that transit useful to more people. He urges that "government agencies, educational institutions, health care and social services need to locate on transit. The social security office, the community college, and the clinic are essential parts of life – they should be convenient for transit riders, not in a car-oriented neighborhood on a hourly bus route, or at the end of a shuttle bus." He also highlights some inexpensive but important user experience steps that transit agencies can take.

Specific to commuter rail, the author concludes:

> "The United States has invested billions in commuter rail. But rather than being operated as all-purpose transit, that infrastructure is focused on 9-to-5 commuters, even when the surrounding areas have the density to justify all-day, two-way, frequent service. Changing this will require a change in attitude, coupled with new ticketing systems and work rules that allow trains to be operated at lower cost with fewer crew members."

Application to Travel Markets Report

- Calculate similar job and population densities to supplement other sources, especially in high density areas.
- Identify any of the largest 100 universities in the region.
- Apply IDA definitions of downtowns to Raleigh and Durham.

Appendix 3: Detailed Technical Appendix

This technical appendix is published as a separate document and contains detail on the choice of data sources, the revision of data sources, the framing of the travel market analysis based on recent research, and the analysis of the revised data based on the research framework. It consists of summary powerpoint slides and underlying datasets and can be accessed by contacting Jenna Kolling of Triangle J Council of Governments at: jkolling@tjcog.org

Appendix 4: Station Study Areas

Stations	Job Density	REINVEST Neighbor-hood	# of Thresh-olds	# of LBAR units	BIPOC rank	Zero car rank	Income rank	Primary Jobs		Worker Home	
								Total	Low/Mod Earnings	Corridor	Region[2]
Station Analysis Areas[3]											
West Durham	Extremely High	Y	4	134	8	4	4	49,003	15,138	8,396	32,390
Downtown Durham	Extremely High	Y	3	715	7	3	7	21,560	8,558	4,101	13,719
East Durham	High	Y	4	1,338	2	1	1	2,369	1,371	528	1,415
Ellis Rd - North RTP	High	N		92	12	14	13	2,704	1,180	433	1,555
RTP	High	N		204	14	17	18	34,338	4,796	5,828	22,695
McCrimmon Parkway	High	N		4	1	8	12	24,322	8,221	4,313	14,800
Morrisville Parkway*	High	N		0	5	9	15	8,112	4,501	1,912	4,612
Cary CBD	High	N		283	10	6	9	4,336	2,097	856	2,646
Corporate Center	High	Y	3	96	6	11	3	11,878	5,535	2,025	7,242
Blue Ridge	High	N		48	15	10	11	5,356	2,567	787	3,029
NCSU	Very High	Y	3	76	16	7	8	6,002	2,716	1,144	3,795
Downtown Raleigh	Extremely High	Y	4	841	9	2	6	37,119	14,695	6,661	24,028
South Raleigh-Hammond	High	Y	4	302	3	12	5	7,216	3,144	1,013	4,088
Garner Town Center	High	Y	4	569	4	5	2	4,469	2,688	873	2,706
Garner Auburn	Moderate	N		4	11	15	14	4,656	2,035	649	2,494
Clayton Town Center**	Moderate	N		99	13	13	10	4,340	2,526	696	2,330
Clayton NC-42	Moderate	N		54	17	16	16	663	310	90	356
Clayton Powhattan**	Moderate	N		2	18	18	17	2,314	907	281	1,354

* not part of initial station study areas, but identified as potential infill station based on affordable housing analysis and 2050 Metropolitan Transportation Plan preferred scenario.
** reflects ongoing discussion about alternate to single Clayton stop at NC42.

NOTE: job density designation is for the most dense block group overlapping the station study area. Similarly, the # of REINVEST Neighborhood thresholds that were met is for the highest scoring block group in the station study area.

"Rank" is from 1 to 18 with 1 reflecting the highest prevalence of the indicated characteristic (e.g., the greatest BIPOC population, the most zero-car households or the largest lower-income population).

[2] Four-county region (Orange, Durham, Wake, and Johnston) outside of the 2-mile Corridor.

[3] Station analysis areas include data for entire block groups that are mostly or partly within a ½ mile radius of the stations. As smaller areas are examined, data margins of error and suppression of data to address privacy concerns introduce increased uncertainty into the analysis, as does data manipulation necessary to address the mismatch between the boundaries of the station study areas and the boundaries of census block groups.