I'LL TAKE YOU THERE

USING CENSUS LONGITUDINAL EMPLOYER-HOUSEHOLD DYNAMICS DATA FOR ASSESSING TRANSIT SERVICE COVERAGE

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EXECUTIVE SUMMARY

Transport for NOLA, a non-profit transit education and outreach organization based in New Orleans, wants to increase access to the growing mass of data that describes cities. We believe that increasing access to data and information about transportation systems will lead to wise investment decisions that will give our region a world-class, multi-modal transportation system.

Transit service coverage, or the share of a region's served by transit, is an important dimension for understanding a transit-system and its service quality. The Transportation Cooperative Research Board's *Transit Capacity and Quality of Service Manual, 2nd Edition* provides a relatively simple "Planning Methodology" that allows an analyst to see how well a transit system covers its service area or region as a whole and find specific areas where gaps are present. However, this method only evaluates coverage of housing and job locations without knowledge of actual travel demand between home and work.

Given that the Census Bureau now offers (nearly) nationwide, uniform datasets that contain information on the origin and destination of work trips through the Longitudinal Employer-Household Dynamics (LEHD) program, we set about exploring how data from this program might be used to support transit service-coverage analysis based not only on where people live and work but also on the actual travel demand between the two.

We used the "Planning Methodology" to assess the service coverage level of service (LOS) provided by the New Orleans Regional Transit Authority (RTA) in Orleans Parish, Louisiana. We found that the RTA provides coverage to nearly 90% of the land in Orleans Parish that the *Manual* deems "transit-supportive" based on job and housing density; this gives the RTA a high "B" service-coverage LOS on the *Manual's* A-to-F scale.

We also described two new methodologies based on the "Planning Methodology" that incorporate LEHD data about commute patterns between Census Block Groups in Orleans Parish. In our first methodology, we measured the share of commutes covered by RTA service as described in the 2010 LEHD Origin Destination file. We found that RTA service covers 89.7% of the trips within Orleans Parish that have their start and end in transit-supportive Block Groups. Overall, RTA service covers 81.2% of all commutes within the parish.

Our second methodology sought to assess service coverage by comparing RTA routes to the shortest paths between home and work Block Groups as mapped through network analysis. We tested this method on the commutes mapped in and out of three Block Groups within the parish. Our analysis revealed that, as currently constructed, this second method is highly sensitive to the parameters of our network analysis, and that further refinement of the method is necessary before it can be used as a robust measure of service coverage.

Future research would also need to assess the reliability of network analysis in generating realistic descriptions of travel demand, the relationship between the results of our alternative methods and the *Manual*'s method, and the utility of our alternative methods over the *Manual's* method, given the extra time required to carry out our methods.

INTRODUCTION

Over the past several years, the rapid increase in the data available to describe our world has given us many more ways to examine, describe, and make predictions about cities. Rapid advances in internet technology have made much of this information available not only to those who call themselves urban planners by profession but also to anyone else with a computer and internet connection.

This "democratization" of data is important because it means that larger segments of the population have access to the same observations upon which to make evidence-based arguments with quantitative information, maps, and other tools once available only to professionals and scholars.

Our organization, Transport for NOLA, is strongly in favor of increased access to data. We seek to inform and engage leaders and the general public on transportation issues. Equipping more of our leaders and neighbors with data about existing and potential transportation systems will, we believe, lead to wise transportation-investment decisions that will give our region a world-class, multi-modal transportation system that promotes a vibrant, healthy, and sustainable region.

Of course, data is not helpful until it is turned into information through analysis, interpretation, and presentation in an easy-to-understand format. Transport for NOLA understands that in order to give everyday residents information about transportation it needs to distill the mass of tables, censuses, spatial data, and survey results for those who not have the time or expertise to do so themselves.

Impressive examples of this kind of work include the Center for Neighborhood Technology's Housing + Transportation Affordability Index, Walkscore, the Center for Urban Pedagogy, and (locally) the Greater New Orleans Community Data Center.[1] These projects are exciting not only because they present their own interpretation of data, but also provide general audiences with easy-to-use interfaces with which to manipulate data for themselves and draw their own conclusions.

As an organization, we want to help develop tools like these that explain and present to everyday residents the many dimensions of transit-service provision and performance. The Transportation Cooperative Research Board's *Transit Capacity and Quality of Service Manual (*the *Manual*) presents, among other things, metrics for evaluating aspects of transit "level of service" (LOS), or the quality of a transit system. One of the dimensions presented is "service coverage," or the extent to which transit service is present across space to provide travelers with transportation from point A to point B.

The *Manual* presents a back-of-the-envelope way to evaluate a region's service-coverage level of service, or what it calls a "Planning Methodology." This method fits with our vision for a tool that provides transportation information to the public; while not technically sophisticated, it allows an analyst—with a relatively small amount of data and relatively little time—to see how well a transit system covers its service area as a whole and specific areas where gaps are present.

[1] To learn more about each of these projects and organizations, see (respectively): http://htaindex.cnt.org, http://www.walkscore.com, http://www.anothercupdevelopment.org, and http://www.gnocdc.org .

THE SERVICE-COVERAGE "PLANNING METHODOLOGY"

According to this method, first an analyst defines the service area and finds the parts of that service area where land use is "transit-supportive" in terms of housing and job density. While the definition of transit-supportive is not universally defined, the *Manual* uses the benchmarks of three residential dwelling units per gross acre and four jobs (not workplaces) per gross acre (Transportation Cooperative Research Board, pp. 3-33). Then the analyst maps all of the areas that are easily accessible to transit in the region. The *Manual* uses a ¼-mile Euclidean buffer around transit service as a quick rule-of-thumb distance for how far people will walk to reach a transit stop (Transportation Cooperative Research Board, pp. 3-34). Finally, the analyst finds the intersection of the transit supportive and transit-accessible areas, and finds the share of transit-supportive land that is accessible to transit. This share is then compared against a table that converts the percentage into an A-F scale.

The *Manual* provides an example analysis based on TriMet service in Portland, Oregon. The blue line in the figure below marks the TriMet Service area, and the green areas are those areas within a ¼-mile of a transit stop. The pink areas inside that boundary on the next figure are the areas that are transit-supportive based on job and/or housing density.

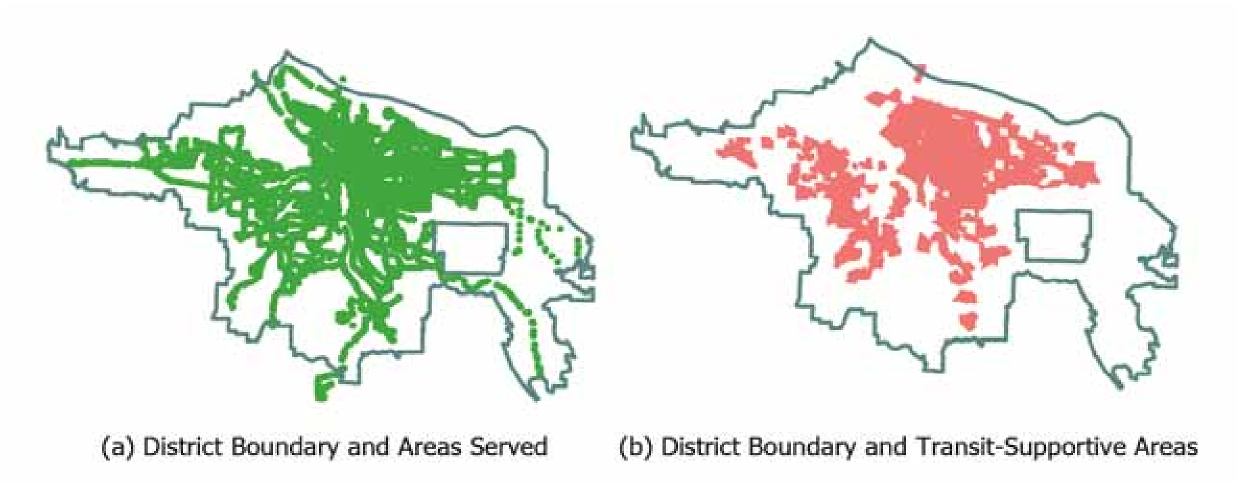
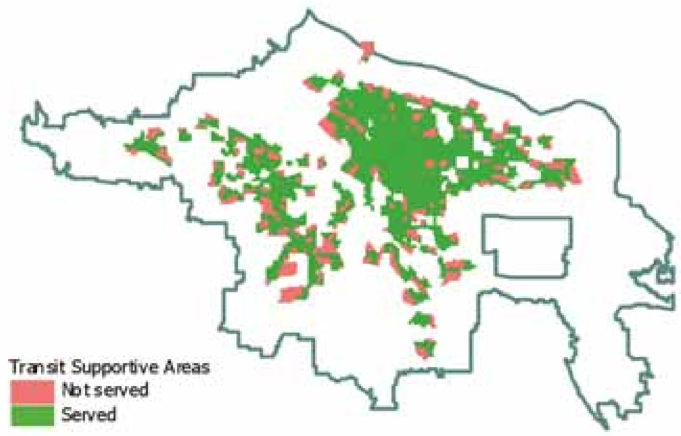


Figure 1: Example of the "Planning Methodology" for Evaluating Transit Service Coverage Level of Service (Transportation Cooperative Research Board, pp. 3-35)

Overlaying these regions reveals that transit service is easily accessible from 86% of the land that is dense enough to support transit. Thus, TriMet gets a "B" rating for its transit service coverage.



Analysis Area	Area (mi^2)	Households	Jobs	% Area Served	LOS
TriMet District	563.8	458,076	786,713		
Coverage Area	243.1	345,260	664,684		
Transit-Supportive Area	132.9	273,341	639,375		
TSA Served	114.4	244,587	588,072	86.1%	B

Figure 2 Results of the Example "Planning Methodology" (Transportation Cooperative Research Board, pp. 3-35)

Fundamentally, this method is based on land use or the location of things without knowledge of actual travel demand; it takes for granted that covering transit-supportive areas actually covers trips. It is not surprising that the method makes this simplifying assumption given that data on trip demand has often not been readily available or at least not in a format that allows for quick, preliminary analysis. However, the Census Bureau now offers datasets that contain information on the origin and destination of work trips that allows us to analyze actual travel demand in a standardized format free of charge.

THE LONGITUDINAL EMPLOYER-HOUSEHOLD DYNAMICS DATASET

Over the past few years, Transport for NOLA has become interested in the Census Bureau's Longitudinal Employer-Household Dynamics (LEHD) program data as a potential base for giving the general public a new tool for understanding the demand side of transportation planning. This program is a partnership between the Census Bureau and various state labor departments around the country.

Among other datasets, it prepares the Local Employer-Household Dynamics Origin Destination Employment Statistics (LODES). The LODES data is an annual synthesis (with an approximate 18-month lag) of federal and state employment administrative data and other Census Bureau surveys and censuses that provides information about the connections between where people live and where they work. The Census Bureau also offers a relatively user-friendly, map-based interface for displaying and downloading the LEHD data called OnTheMap, which is in the mold of the kind of web-based, visual tools that can help those outside the land-use and transportation planning communities obtain data about travel patterns.[2]

Available for download free of charge, the LODES data offers a high degree of geographic detail, with figures available at the Census Block level. It also provides information about origin and destination pairs, not only where people live and where people work. These last two points are what we find most interesting about this dataset and what make it a possible input for an enhanced version of the *Manual's* planning methodology for evaluating transit service coverage. Other publicly available datasets also offer information about work flows; the Census Transportation Planning Products (CTPP) program provides information about travel for work at the Census Tract and transportation analysis zone (TAZ) level; however, it is updated less frequently.[3]

Of course, like all datasets, the LODES data have disadvantages that we must take into account.

As discussed before, even though we are interested in using this data to learn about the flows between work and home, we do not have the actual routes that everyone takes; it knows where workers start at home and where they end up, but not in between. Unlike the CTPP program, the LODES data also does not offer information about commute times, mode of travel, or time of travel during the day (Spear, 2011, pp. ES-5). Furthermore, there are inaccuracies in the way that the Census Bureau records places of work that stem from improper reporting by employers with multiple work sites; firms with fewer than 10 employees do not need to report the exact worksite for all employees and some simply assign all employees to the primary worksite (Spear, 2011, p. 7).

Also, the LEHD program does not yet have data for Massachusetts, Puerto Rico, and the US Virgin Islands, though the program's web site lists them as "States Pending Production" (Longitudinal Employer-Household Dynamics Program). Because the LODES data is based on unemployment-insurance programs, certain classes of workers are not counted in the program. These include the self-employed, uniformed military personnel, railroad workers, domestic workers, and some state and municipal employees (Spear, 2011, pp. 29-30)[4].

Finally, LEHD users need to keep in mind that the data available to the public is "synthetic"; in order to preserve confidentiality, the Census Bureau introduces "noise" at the Census Block level in order to prevent the identification of an individual or firm when the number of persons or firms living or located in those Blocks is small. These alterations are made in such a way that, once aggregated to the Census Tract or county level, the synthetic data and observed data match. Also, this "noise" does not change

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[2] See: http://onthemap.ces.census.gov/

[3] (Spear, 2011, p. 43). Census-tract and TAZ-level data will be available based on the five-year American Community Survey (ACS) data; counties with populations over 20,000 people are the smallest geography available for the three-year data. According to the US Department of Transportation, the first CTPP dataset based on the five-year ACS for 2006 through 2010 will be available to the American Association of State Highway and Transportation Officials in May 2013 (Federal Highway Administration).

[4] The LEHD program first incorporated federal civilian employment with the release of its Version 6.1 2010 dataset on May 31st, 2012 (see: http://lehd.did.census.gov/led/whatsnew.html#053112). Our analysis relies on an earlier release of 2010 data and does not include these federal workers.

the origin-destination flow datasets, which are presented with fewer descriptive variables than the datasets that describe the home and worksite locations of workers (Spear, 2011, pp. 23, 44, 82).

WHAT WE OFFER HERE

We have envisioned two methods for using LODES data in evaluating transit service coverage that build upon the *Manual's* "Planning Methodology."

The first is a method that presents the OD matrices in the LODES dataset at a given level of geography (Census Block; TAZ, etc.) and which then, through a GIS, overlays the quarter-mile area around transit stops with the analysis geography to determine which of the OD pairs are connected by the transit service. The following diagram illustrates this method graphically.

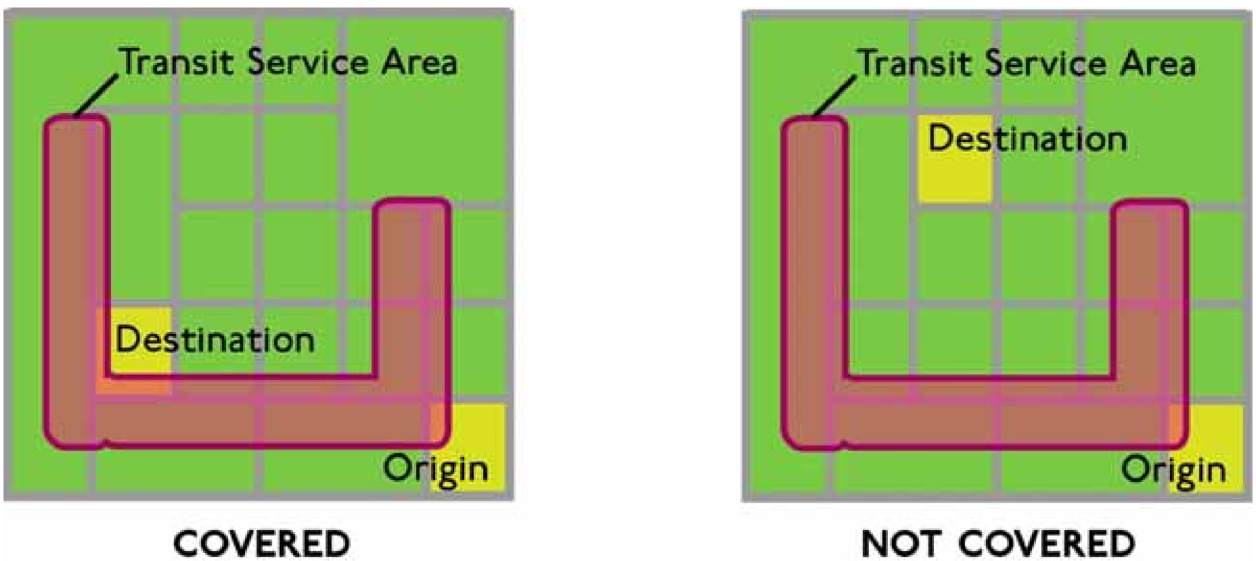

Figure 3 Transit-Coverage Analysis of OD Pairs

Our second method is more complex, and seeks to compare transit service areas to the actual routes taken by commuters between trip origins and destinations. Given that the LODES dataset does not contain information about the routes taken to travel between home and work, this method would rely on an estimation or model of routes taken between origins and destinations. Specifically, it would rely on paths generated through GIS network analysis that searches for the shortest (in terms of travel time) route between points based on a range of parameters about the road network. Such a method would add a new dimension to the service-coverage planning methodology by adding information about the efficiency with which transit service is able to carry travelers from point A to point B.

The TCRB's planning methodology and the first method that we imagine both indicate whether or not it is possible to travel on the transit network between two points, but it tells nothing about how circuitously (and thus, how long) it might take you there. This second new method would add information about the efficiency with which a transit system covers trip demand, and could be a basic tool to inform route planning.

TESTING THE THEORETICAL METHODS

The Planning Methodology from the Transit Capacity and Quality of Service Manual

The first part of our analysis was to carry out the methodology described in the TRB *Manual* for Orleans Parish at the Census Block-group level. Our inputs for this analysis were the 2010 (Version 6.0) Work-Area Characteristics data for Orleans Parish as downloaded through the LEHD OnTheMap interface, the Census 2010 Block-group geography made available by the New Orleans Regional Planning Commission (NORPC),[5] the ESRI StreetMap USA network dataset provided with ArcGIS Desktop 10, and the New Orleans Regional Transit Authority's (NORTA) general transit feed specification files.[6] We used ArcGIS Desktop 10 (with an ArcEditor license), Microsoft Access 2010, and Microsoft Excel 2010 to process the data.

While our technical appendix describes our method in full detail, here is a brief description of our work flow:

1. Using SQL queries, we aggregated the Work-Area Characteristics Census-Block-level data to the Block-Group level.
2. We then joined the resulting table to the NORPC Census Block Group file for Orleans Parish in ArcGIS. The NORPC Census files contain an attribute for the number of housing units counted as part of Census 2010, and with the LODES data joined, we were then able to calculate the residential and job density of each Block Group. Values for land area came from the ALAND10 attribute in the NORPC Census data files, which describes each Block Group's land area in square meters; we converted the square-meter measurement to acres in a new field called "ALANDACRE". We then coded each Block Group according to the following schema:
    a. -1 = Not transit supportive, or with residential density below three dwelling units per acre and job density below four jobs per acre.
    b. 1 = Transit supportive with a residential density at or above three dwelling units per acre but with job density below four jobs per acre.
    c. 2 = Transit supportive with a job density at or above four jobs per acre but with residential density below three dwelling units per acre.
    d. 3 = Transit supportive with residential density at or above three dwelling units per acre and job density at or above four jobs per acre.
3. Using the RTA General Transit Feed Specification (GTFS) files, we geolocated the transit system's bus and streetcar stops, and then created two service areas: one based on quarter-mile buffers and another based on quarter-mile distances along the New Orleans street network.
4. We then found the intersection of the quarter-mile buffers and the census Block Groups and clipped these intersections to land (some buffer areas extended into bodies of water such as the

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[5] The NORPC provides, through its web site, http://www.norpc.org, processed Census geometry that joins basic demographic data from the Census SF1 tables with the corresponding TIGER geography for the five-parish region that the RPC cover. This eliminates the need for others to download, process, and join the two files for themselves.
[6] See: http://www.norta.com. Though data download is free, users must sign up for a "myRTA" account in order to access the files.

Mississippi River) using a state-wide major water bodies file from the Louisiana State University's ATLAS database.[7]

5. We computed the area of the intersection layers in acres in order to calculate the share of transit-supportive land covered by the quarter-mile RTA transit sheds.
6. Consulting the Fixed-Route Service Coverage LOS table in the *Manual* , we found the level-of-service that corresponds with the share of transit-supportive area covered by the transit shed.

A large segment of Orleans Parish fits the definition of transit supportive as laid out in the *Manual*. Of the 497 Block Groups of the parish, 401 meet the *Manual's* criteria based on either residential and/or job density. While these 401 Block Groups only represent approximately 25% of the parish's land area, they are home to 83% of the population (286,382) and 87% (136,886) of jobs (New Orleans Regional Planning Commission, 2011) (Longitudinal Employer-Household Dynamics, 2012). Figure 4 reveals that while the historic areas of the city are transit supportive, as one may expect, many parts of the newer neighborhoods (including Lakeview and Gentilly) also meet the minimum criteria for transit-supportive status.[8]

[7] See: http://atlas.lsu.edu/

[8] We should note that we calculated residential density on the total number of housing units in each Block Group, not occupied housing units. Therefore, blighted, unoccupied properties left over from Hurricane Katrina are included.

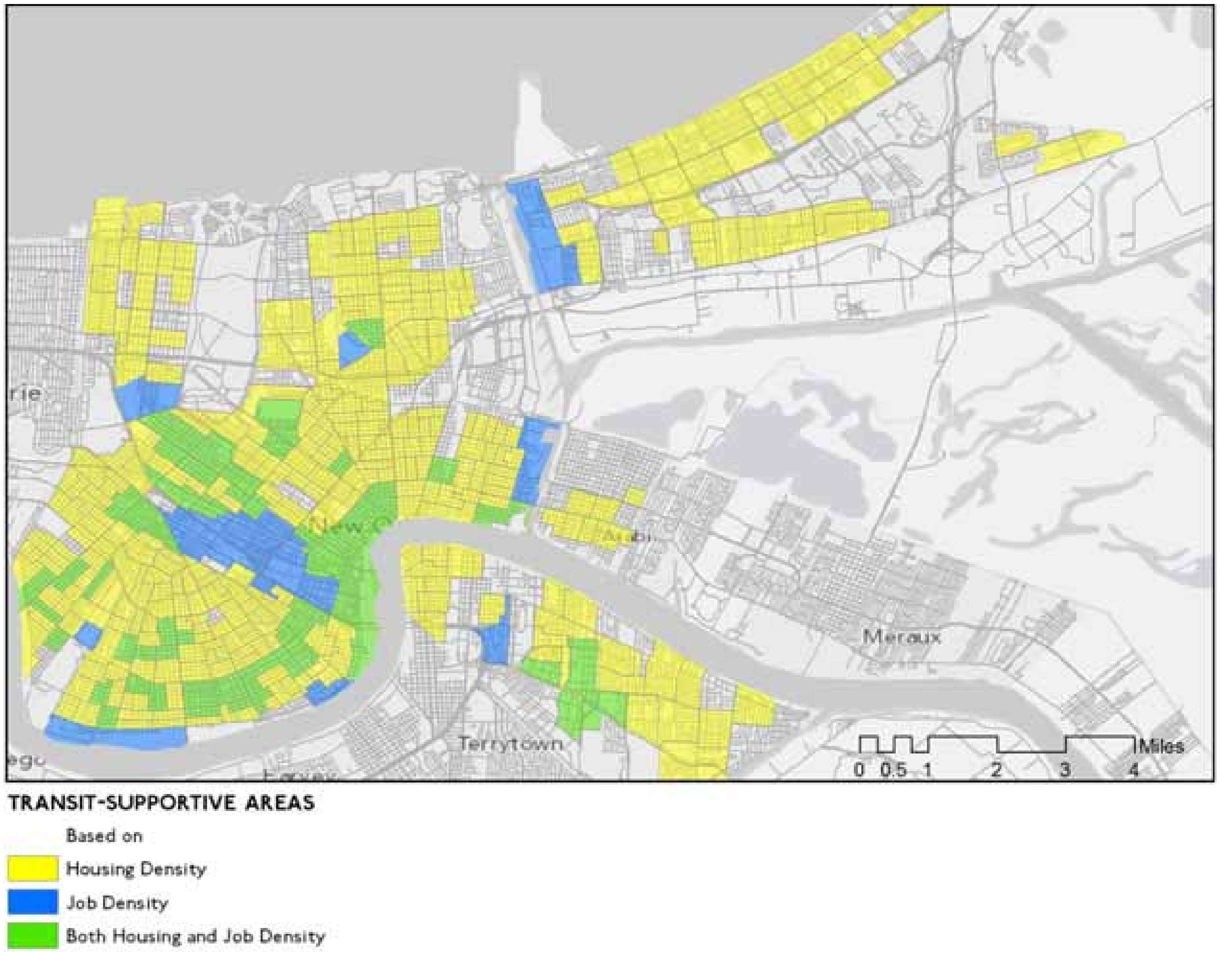


Figure 4: Transit-Supportive Areas of Orleans Parish. Sources: NORPC; LEHD OnTheMap Program 2010 (Version 6.0) Data; ESRI.

The quarter-mile service areas (both buffer and network-based) around RTA streetcar and bus stops also cover large swathes of the parish (see Figure 5 and Figure 6). The buffer-based area covers 37,700 acres of the parish's land (or 35%)while the network-based quarter-mile area covers nearly 30,000 acres (or 27%).

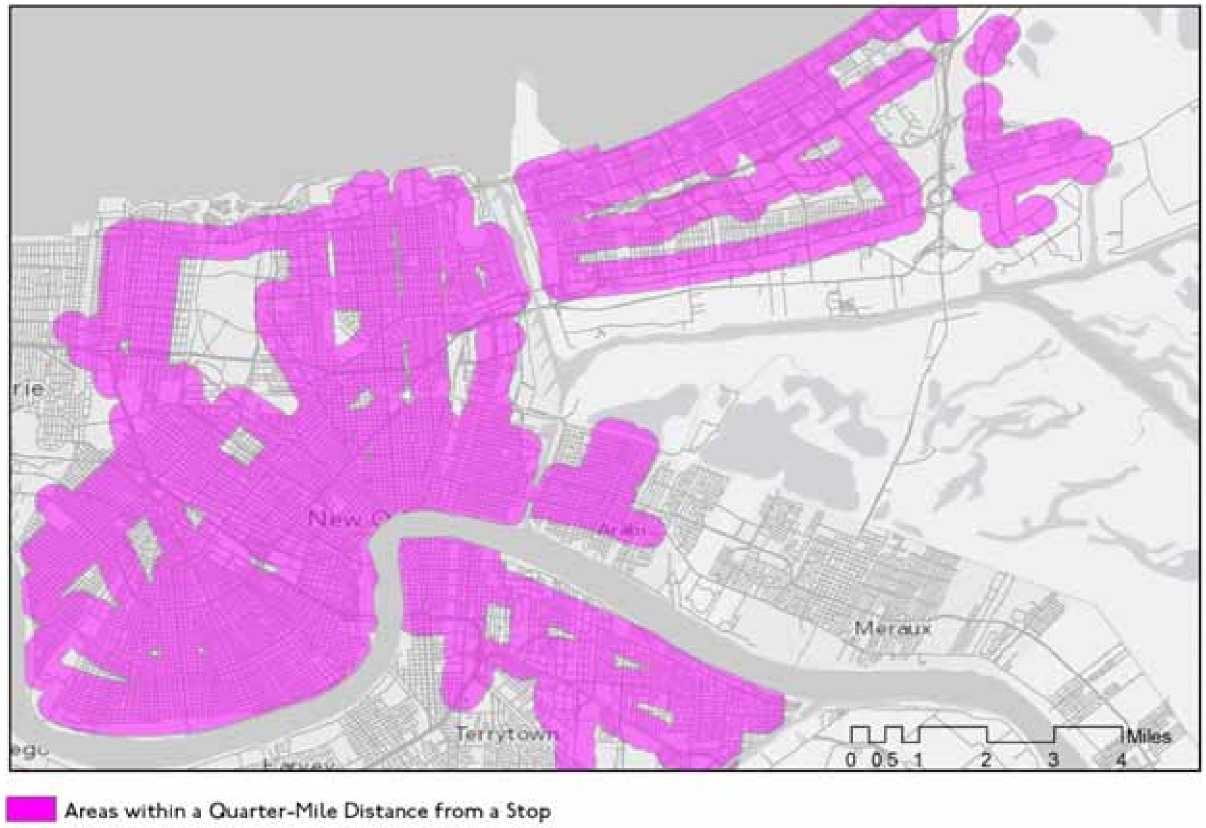


Figure 5: RTA Bus and Streetcar Stop Coverage: Orleans Parish. Sources: RTA, ESRI.

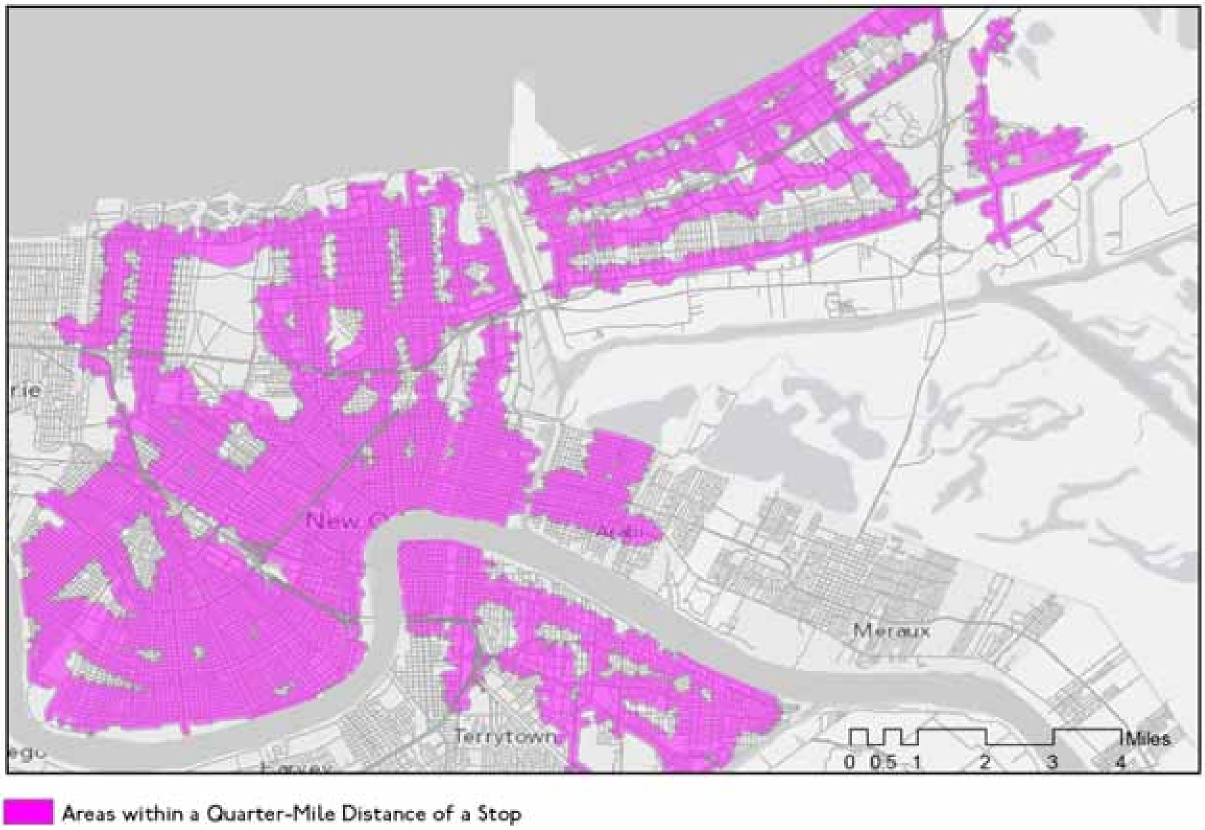


Figure 6: RTA Bus and Streetcar Stop Coverage Using the Street Network: Orleans Parish. Sources: RTA; ESRI.

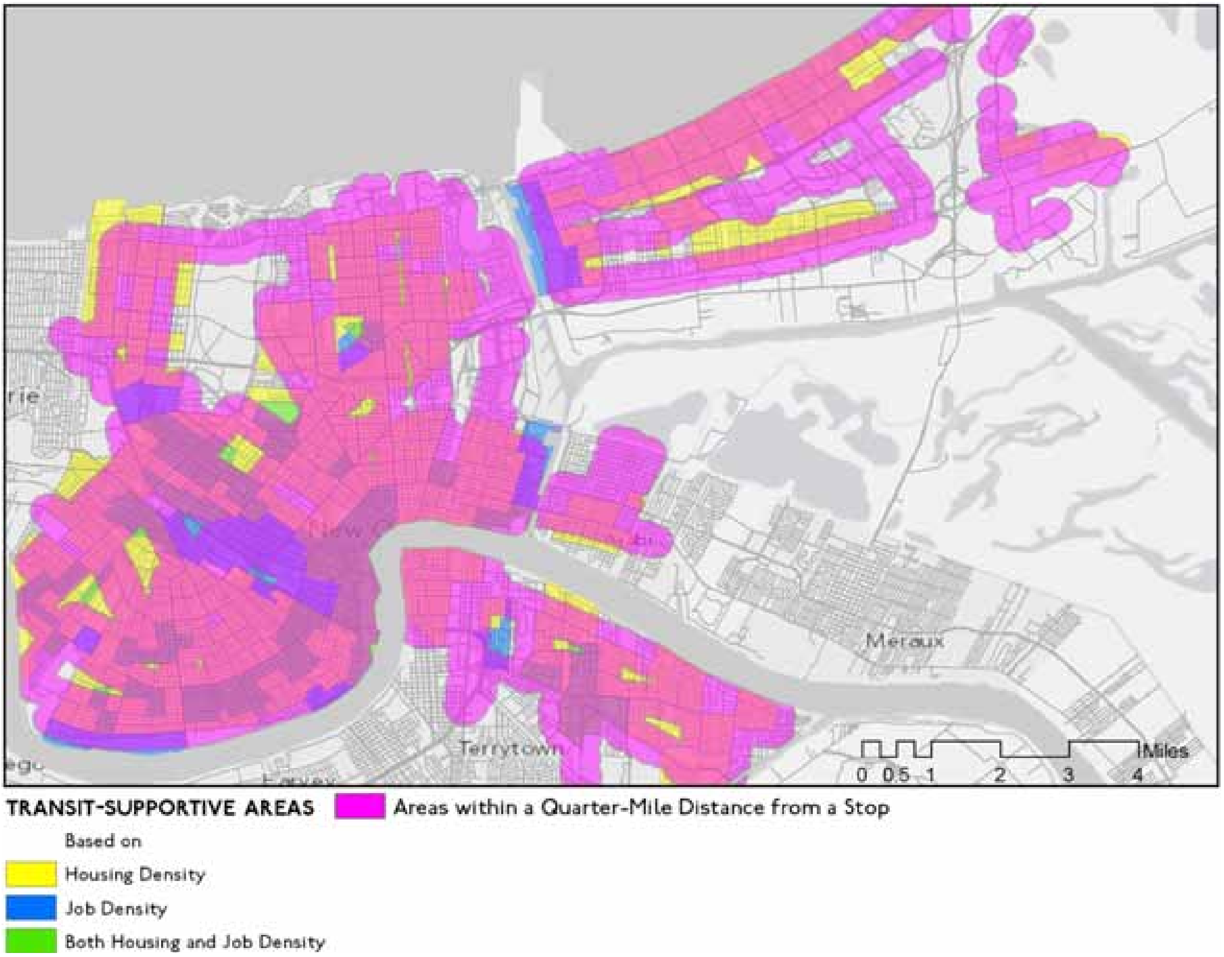


Figure 7: RTA Bus and Streetcar Stop Coverage over Transit-Supportive Areas of Orleans Parish. Sources: RTA; ESRI; NORPC; LEHD OnTheMap Program 2010 (Version 6.0) Data

When we calculate the transit-supportive areas of the Parish that are within the quarter-mile service area, we find that nearly 90% of the transit-supportive land-area in the parish is within a quarter-mile of a transit stop based on the buffer method, while 78% is covered with the network method. According to the *Manual*, the nearly 90% coverage gives the RTA a service-coverage LOS rating on the line between "B" and "A". A 78% coverage share would normally equal a LOS rating of "C"; however, given that the *Manual's* rating system is based on a simple buffer, the 78% share does not translate to the rating system. An alternative, network-based scale is needed.

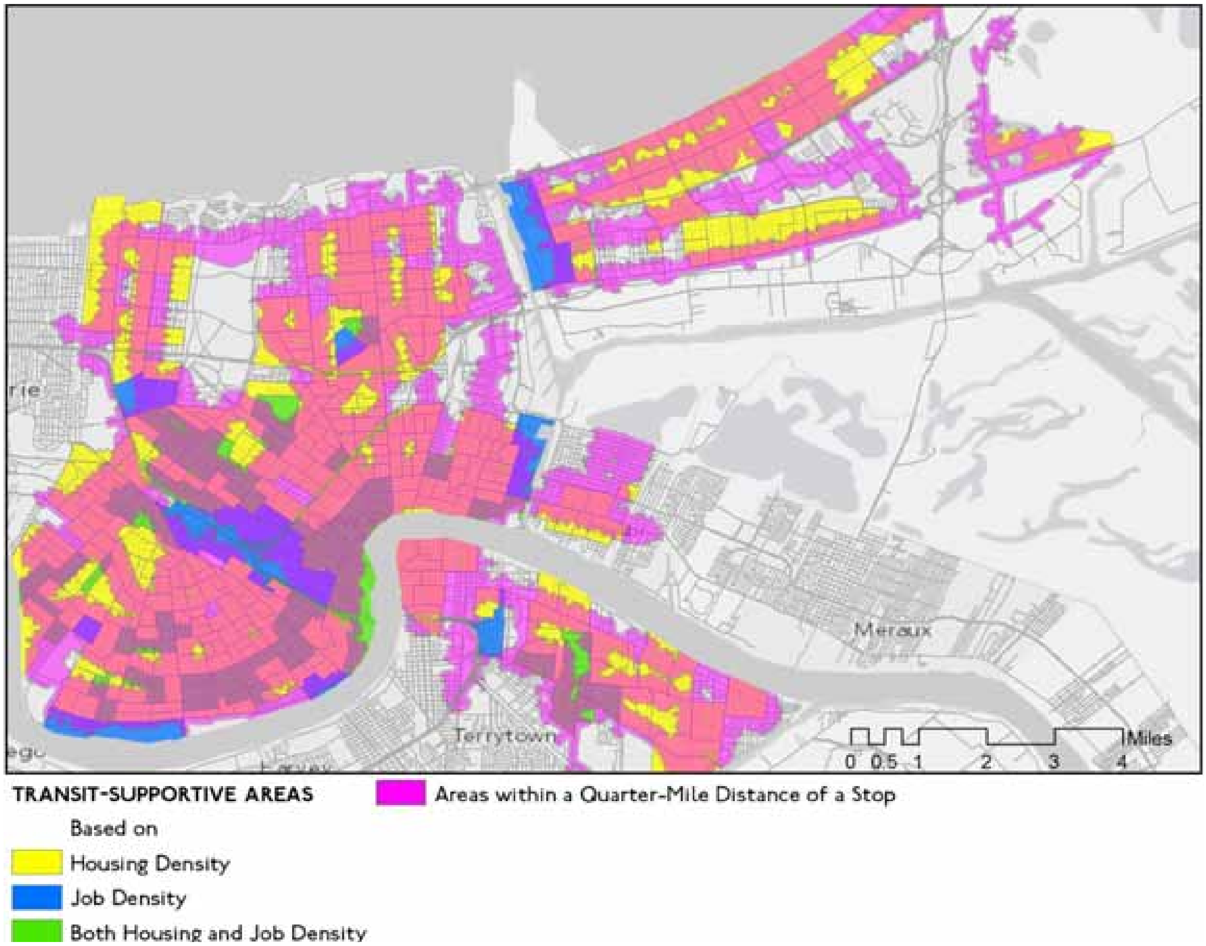


Figure 8: RTA Bus and Streetcar Stop Coverage over Transit-Supportive Areas of Orleans Parish. Sources: RTA; ESRI; NORPC; LEHD OnTheMap Program 2010 (Version 6.0) Data

Both the buffer-based and network-based service areas provide levels of coverage that differ by type of transit-supportive Block Group; nearly all of the land in Block Groups that are transit supportive based on jobs and housing is covered by the RTA service area (97%). Meanwhile, the RTA service area covers only 16.3% of the land that does not meet the minimum thresholds for the transit-supportive designation. The same pattern appears for the network-based service area.

Table 1: Orleans Parish Service-Coverage Level of Service Calculations: Quarter-Mile Buffer Method

Land Area in Gross Acres

Transit Supportive by	Number of Block Groups*	Land Area	Transit-Covered Land Area	Share of Land Covered
Not Transit Supportive	95	81,190	13,241	16.3%
Residential Density	320	20,078	17,877	89.0%
Job Density	15	2,747	2,288	83.3%
Both Residential and Job Density	66	4,415	4,296	97.3%
Sum of Transit-Supportive Land	**401**	**27,241**	**24,462**	**89.8%**

Sources: NORPC; NORTA; Transport for NOLA.

*Does not include Census Tract 9900, Block Group 0, which covers Lake Pontchartrain and which has no land area.

Table 2: Orleans Parish Service-Coverage Level of Service Calculations: Quarter-Mile Network Buffer Method

Land Area in Gross Acres

Transit Supportive by	Number of Block Groups*	Land Area	Transit-Covered Land Area	Share of Land Covered
Not Transit Supportive	95	81,190	8,719	10.7%
Residential Density	320	20,078	15,603	77.7%
Job Density	15	2,747	1,650	60.0%
Both Residential and Job Density	66	4,415	3,949	89.4%
Sum of Transit-Supportive Land	**401**	**27,241**	**21,202**	**77.8%**

Sources: NORPC; NORTA; Transport for NOLA.

*Does not include Census Tract 9900, Block Group 0, which covers Lake Pontchartrain and which has no land area.

Based on the *Manual's* methodology and these calculations, it appears that the RTA provides Orleans Parish with a high level of service coverage.

Alternative Method One: A Commute-Based Method

Our first alternative methodology for evaluating service-coverage LOS with the LODES data was relatively straightforward. We used the same quarter-mile service areas and Census Block Group geometry from the *Manual's* method, as well as the LODES Origin-Destination data file for Orleans Parish, as inputs. Here is a brief description of our work flow:

1. Using SQL queries, we coded the origin and destination Block Groups in each of Orleans Parish's 24,278 OD pairs dataset according to their supportiveness of transit based on the same -1 to 3 coding system used before.[9]

[9] Recall that we are only considering OD pairs where both the origin and destination are within Orleans Parish; we are not capturing in- or out-commuting.

2. We then used ArcGIS Desktop to find which of the Block Groups have their centroid within the RTA service-area buffer. By using this centroid-based approach, we capture the Block Groups that have at least the majority of their land area within the service-area buffer. A more conservative approach would have been to capture only those Block Groups that are within or completely covered by the buffer area.
3. Using cross-tabulations in Access and Excel, we were able to determine how many jobs are associated with each OD-pair type (transit-supportive to transit-supportive, transit-supportive to not-transit supportive, etc.),[10] and which of these OD pairs are served by transit.

As seen in Table 3, our methodology finds that RTA service covers OD pairs that represent 54,948 commutes or 81.2% of the 67,683 commutes within Orleans Parish. A further 11,907, or 17.6% of commutes take place between OD pairs in which one of the Block Groups is covered by RTA service. Of course, as the *Transit Capacity and Quality of Service Manual* states, "either service is available for a particular trip or it is not" (pp. 3-34), meaning that when we consider service coverage, we can only count the OD pairs that cover *both* the origin and destination.

Table 3: RTA Coverage of Orleans Parish Job Flows

Total Number of Jobs (2010)	**Work Location**		
Home Location	Not Covered	Covered	**Grand Total**
Not Covered	828	8,099	8,927
Covered	3,808	54,948	58,756
Grand Total	**4,636**	**63,047**	**67,683**

Sources: NORTA; NORPC; LEHD Program; Transport for NOLA.

Drilling down further gives us a more refined picture of how RTA service covers these commutes vis-à-vis the transit supportiveness of the origin and destination Block Groups.

[10] Note that this method covers jobs in which individuals live and work in the same Block Group, though, at least in the smaller Block Groups, it is likely that these people are walking or biking to work.

Table 4: RTA Coverage of Orleans Parish Job Flows by Transit Supportiveness of Origins and Destinations

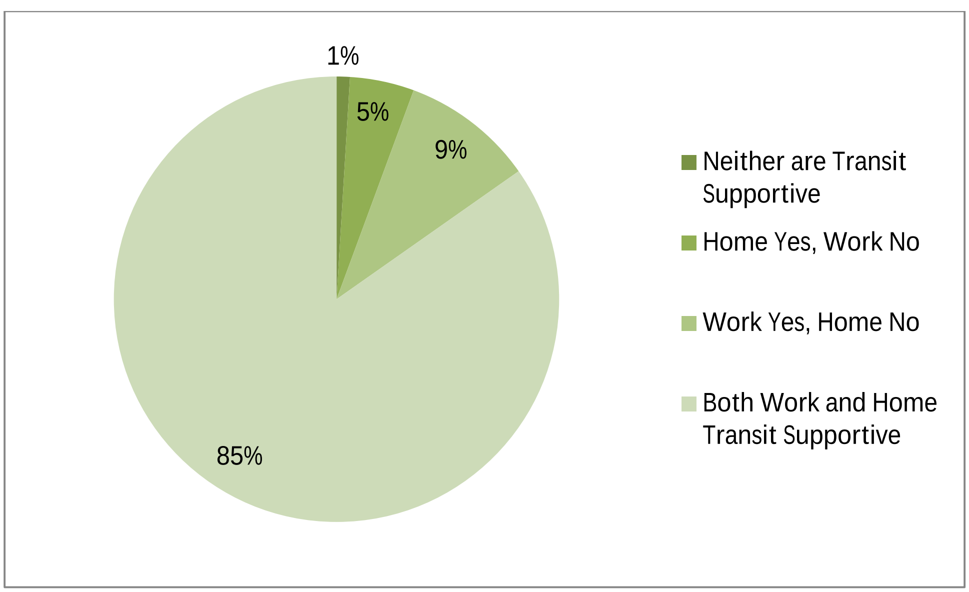
Total Number of Jobs (2010)	Work Location				Grand Total
	Not-Transit Supportive		Transit-Supportive		
Home Location	Not Covered	Covered	Not Covered	Covered	
Not Transit Supportive	841	803	207	8,580	10,431
Not Covered	365	272	91	3,291	4,019
Covered	476	531	116	5,289	6,412
Transit-Supportive	2,452	2,909	1,136	50,755	57,252
Not Covered	247	346	125	4,190	4,908
Covered	2,205	2,563	1,011	46,565	52,344
Grand Total	**3,293**	**3,712**	**1,343**	**59,335**	**67,683**

Sources: NORTA; NORPC; LEHD Program; Transport for NOLA.

In sum, commutes between transit-supportive Block Groups represent 51,891 (76.7%) of the 67,683 commutes within Orleans Parish. RTA service covers 46,565 (89.7%) of these 51,891 commutes. The RTA system covers a further 8,383 commutes where one or both of the origin and destination Block Groups are not transit supportive. We also found that the RTA covers a greater percentage of trips in which a person lives in a Block Group that is not transit supportive but where work is located in a transit-supportive Block Group (5,289 out of 8,767 or 60.2%) than vice-versa (2,563 out of 5,361 or 47.8%).

As seen in Figure 9, 85% of covered trips take place between origins and destinations that are both transit-supportive.

Figure 9: RTA-Covered Commutes by Transit Supportiveness of Origin and Destination Block Groups



Sources: NORTA; NORPC; LEHD Program; Transport for NOLA.

These results indicate that the RTA provides a high level of coverage for commutes within Orleans parish. It is interesting that the share of commutes between transit-supportive Block Groups covered by RTA service (89.7%) is numerically similar to the share of transit-supportive land covered by RTA service (89.8%). However, this is not enough to conclude that the land-coverage method is more-or-less equivalent to a method based on commutes.

Given that the land-based method in the *Manual* measures coverage of all transit-supportive land, not only the land that is transit-supportive in terms of both residential *and* job density, it might be more comparable to calculate the share of commutes from OD pairs in which *either* the home or work location is transit supportive. In other words, what is the share of commutes that the RTA covers between residential areas that do not have a housing density of over three dwelling units per acre and commercial areas with more than four jobs per acre, or vice versa? RTA service covers 54,417 commutes where at least one of the OD-pair Block Groups is transit supportive out of a total of 66,039 commutes (or 82.4%; see Table 5).

Table 5 RTA Coverage of Orleans Parish Job Flows by Transit Supportiveness of Origins and Destinations (Covered Trips from OD Pairs in which at Least One Block Group is Transit Supportive in Orange; Other Trips, Not Covered by RTA Service, in Purple)

Total Number of Jobs (2010)	**Work Location**				**Grand Total**
	Not-Transit Supportive		Transit-Supportive		
Home Location	Not Covered	Covered	Not Covered	Covered	
Not Transit Supportive	841	803	207	8,580	10,431
Not Covered	365	272	91	3,291	4,019
Covered	476	531	116	5,289	6,412
Transit-Supportive	2,452	2,909	1,136	50,755	57,252
Not Covered	247	346	125	4,190	4,908
Covered	2,205	2,563	1,011	46,565	52,344
Grand Total	**3,293**	**3,712**	**1,343**	**59,335**	**67,683**

Sources: NORTA; NORPC; LEHD Program; Transport for NOLA

We would need to make further comparisons between the land-use-based, *Manual* method and the commute-based method presented here in order to make any conclusions about their relationship. We would want to know if there is a statistically significant correlation between the two measures, and what the nature of that relationship is (e.g. linear, exponential, negative, positive). These comparisons could be across geography (applying the two methods to many transit systems and cities around the country) or across time.

Alternative Method Two: A Network-Based Method

Our second alternative methodology for evaluating service-coverage LOS with the LODES data relied on network analysis to generate implied routes for commuting over the Orleans Parish street system. For this analysis we, once again, relied on the NORPC Census Block Group geometry, the 2010 (Version 6) LODES Origin-Destination data file for Orleans Parish, and the ESRI StreetMap USA network dataset provided with ArcGIS Desktop 10. We also used a quarter-mile buffer of the RTA routes (as opposed to stops). Here is a brief description of our work flow:

1. To generate the commuting routes between Block Groups, we used the ArcGIS Desktop 10 Network Analyst extension. Loading the centroids of the 496 Orleans Parish Block Groups (all Block Groups with the exception of the one covering Lake Pontchartrain) as both "Facilities" and "Incidents," we ran a Closest Facility analysis to generate the shortest routes between all combinations of Block-group centroids. Our analysis settings respected one-way streets, non-traversable segments (such as the Exchange Place alley in the French Quarter), included limited-access highways, and restricted the Mississippi River ferries included in the dataset.[11]
2. With this set of 243,049 routes (which included trips within the same Block Group, but which did not generate routes), we made an inner join with the OD pairs in the LODES Origin-Destination file, which left 24,728 routes with job information.[12]
3. From these 24,278 routes, we selected all routes originating and terminating in three different Block Groups based on their job and housing-density characteristics.
    a. Census Tract 134, Block Group 3, which is located in the CBD, and has its downriver boundary at Iberville Street, its riverside boundaries at Magazine/Decatur Streets, its upriver boundary at Lafayette Street, and its lakeside boundary at Loyola Avenue, then South Liberty Street, and finally at Claiborne Avenue/Interstate 10. According to our analysis, this Block Group has the highest job density in the city at 156.8 jobs per gross acre.
    b. Census Tract 128, Block Group 1, located in the Marlyville/Fountainbleu neighborhood, bounded upriver by South Carrollton Avenue, Colapissa Street lakeside, Pine Street and Lowerline Street downriver, and Fountainbleau Drive riverside. This Block Group has a residential density of 5.7 dwelling units per acre, which is the city-wide median.
    c. Census Tract 17.2, Block Group 4, bounded by the Industrial Canal upriver, Hayne Boulevard on the lake side, Downman Road and Stemway Drive downriver, and Chef Menteur Highway riverside. This Block Group has a density of close to 4.2 jobs per gross acre, which is near the minimum for qualification as "transit-supportive" according to the *Manual*.

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11 Because we are evaluating service-coverage of RTA service, we made this last assumption in order to force all trips onto the street network, and off of the ferries, which are not operated by the RTA. An alternative analysis would allow for travel on the ferry routes and include them in our service-coverage areas.

12 Because of one-way streets, the way in which the city's neutral-ground-separated avenues are drawn with two centerlines, and the position of highway on- and off-ramps, the "to-from" and "from-to" routes between the same pair of Block Groups were not necessarily coincident.

4. We summed the number of commutes originating and terminating for each of the three Block Groups.
5. We then selected all routes originating and terminating in each Block Group that were contained by the quarter-mile buffer around the RTA system's routes. We used a route-based buffer instead of a stop-based buffer as before because the stop-based buffer would not include any portions of a route where no stops are present; this would prevent too many routes from being selected. For example, the stop-based buffer of RTA service would have no coverage over the Crescent City Connection and, thus, not contain routes over the bridge. However, a person traveling between the East and West Bank does not need to be able to stop on the bridge, only traverse it. Therefore, a route-based buffer is more accurate than a stop-based buffer for evaluating the transit service coverage of the generated commuting routes.
6. Finally, we summed the number of commutes contained by the RTA route buffer. To this sum, we added the number of commutes taking place within the Block Groups if the centroid of the Block Group fell within the route buffer. Since these trips did not generate any route lines in the Closest Facility calculations, they cannot be selected using the same select-by-location function with the route buffer. This final sum was then compared to the total.

With its many jobs, the commute routes generated from our network analysis for Census Tract 134, Block Group 3 extend out across Orleans Parish (see Figure 10). In total, 11,439 commutes (approximately 17% of all commutes within Orleans Parish from the 2010 dataset), had their origin and/or destination in this Block Group.

Figure 10: Commute Flows for Census Tract 134, Block Group 3. Sources: NORPC; LODES 2010 (Version 6.0) OD File; ESRI.

When the quarter-mile RTA service buffer was laid over the network-analyst-generated routes, it appeared that the majority would have been covered by RTA service (see Figure 11).

Figure 11: RTA Route Buffers and Commute Flows for Census Tract 134, Block Group 3. Sources: RTA; NORPC; LODES 2010 (Version 6.0) OD File; ESRI.

However, as Figure 12 illustrates, of the 543 unique routes carrying these 11,439 commutes, 353 were contained by the quarter-mile RTA-route service buffer. These 353 routes carried 7,054 commutes. When added to the 208 commutes made within the Block Group, the total number of commutes covered reaches 7,262 or 63.5% of the total.

Figure 12: Covered Commute Flows for Census Tract 134, Block Group 3. Sources: RTA; NORPC; LODES 2010 (Version 6.0) OD File; ESRI.

Many routes were mostly within the service-coverage area but had a segment that was not contained within the service area and were not selected. A similar pattern appeared in the routes associated with Tract 128, Block Group 1.

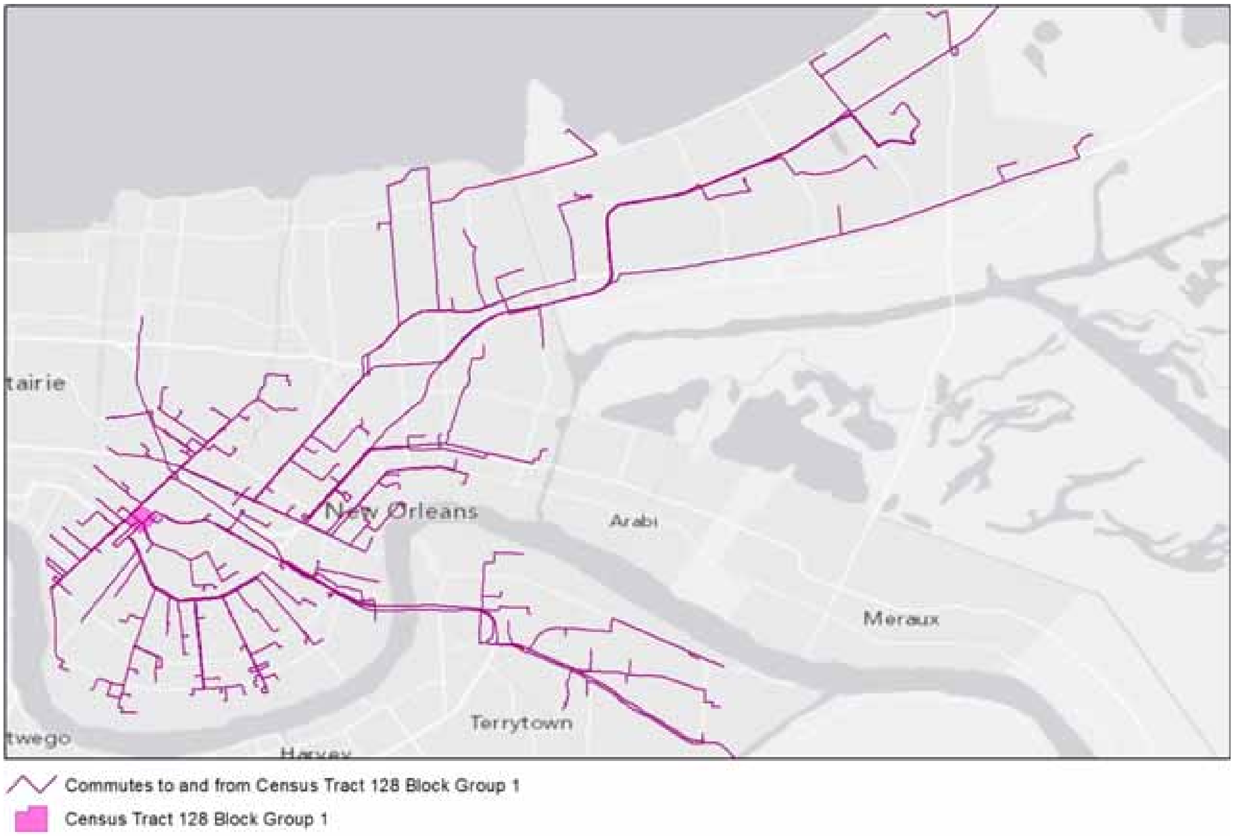

Figure 13: Commute Flows for Census Tract 128, Block Group 1. Sources: NORPC; LODES 2010 (Version 6.0) OD File; ESRI.

In total, 357 commutes begin and/or end in the Block Group over 157 unique routes (see Figure 13). As Figure 14 shows, when the RTA quarter-mile service area was superimposed, it covered most of the linear distance of the routes. However, only 87 of the routes were completely contained within the buffer. Along with the three commutes that begin and end within the Block Group, these routes represented a total of 212 trips to or from work, or 59.4% (see Figure 14, Figure 15).

Figure 14: RTA Route Buffers and Commute Flows for Census Tract 128, Block Group 1. Sources: RTA; NORPC; LODES 2010 (Version 6.0) OD File; ESRI.

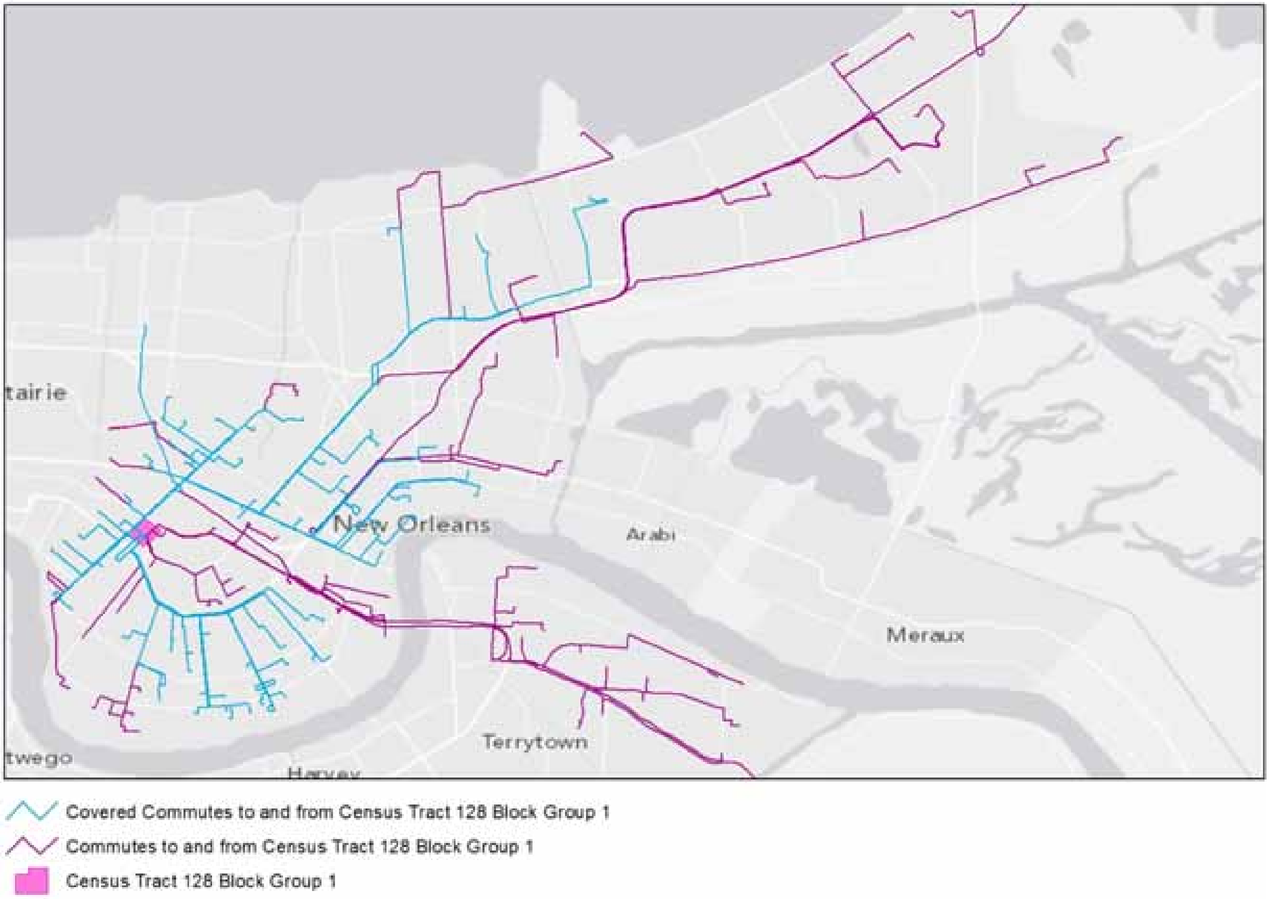

Figure 15: Covered Commute Flows for Census Tract 128, Block Group 1. Sources: RTA; NORPC; LODES 2010 (Version 6.0) OD File; ESRI.

Finally, Census Tract 17.2, Block Group 4 is the origin and/or destination of 847 commutes over 337 OD pairs that extend across Orleans Parish.

Figure 16: Commute Flows for Census Tract 17.2, Block Group 4. Sources: NORPC; LODES 2010 (Version 6.0) OD File; ESRI.

Figure 17: RTA Route Buffers and Commute Flows for Census Tract 17.2, Block Group 4. Sources: RTA; NORPC; LODES 2010 (Version 6.0) OD File; ESRI.

As Figure 17 illustrates, though most of the Block Group itself is not within the quarter-mile RTA buffer, most of the routes appear to be. However, when we applied the selection method to these routes, none were found to be completely within the RTA service area.

To understand why, recall that we used the centroids of each Block Group as the start and end point for our network analysis, not the Block Group polygons. It is also important to know how the ArcGIS Desktop Network Analyst extension processes objects for routing on a street network. Since most objects of interest for network analysis are not located directly on the street grid (we may refer to a person's house as located "on" a certain street but it is not on the roadway, literally), Network Analyst must first assign the object to a position on the network. The user sets parameters that dictate how objects are to be located on the network; the simplest method is for the software to simply locate the object at the point along the street network that is closest to the object. This is the method that we used.

Figure 18: Position of Census Tract 17.2, Block Group 4 Geographic Centroid in Relation to the Street Network and RTA Route Buffers. Sources: RTA; NORPC; ESRI.

As Figure 18 describes, our analysis of Census Tract 17.2, Block Group 4 revealed a fundamental weakness in our method. Given the instruction to locate each centroid at the closest point on the Orleans Parish street network, ArcGIS Desktop located this Block Group on a section of Jourdan Road that is outside of the RTA service-area buffer. As such, it was impossible for Network Analyst to generate any routes that would have been within the service buffer. However, had the software located the centroid on Downman or Dwyer Roads, then at least some of the commutes originating or terminating in the Block Group would have been covered entirely by RTA service.

In theory, if all of the jobs in the Census Block were located along Jourdan Road, then it could be reasonable to say that none of the commutes in and out of this Block Group should be counted as transit supportive. Yet a quick look at satellite imagery of the area indicates that the jobs in this Block Group are not located at the centroid or on Jourdan Road (see Figure 19).

Figure 19: Satellite Imagery of Land near Centroid of Census Tract 17.4, Block Group 4 with the RTA Route Buffer and Street Network. Sources: RTA; NORPC; ESRI.

Regardless, the fact that the location of a centroid along a street network can drive coverage for one Block Group down to 0% indicates that our network-based method, as currently formulated, is unacceptably sensitive for providing a meaningful picture of how well local transit serves its community.

There are a few technical solutions to this problem that immediately come to mind and which we can explore in order to develop this method further:

- Input smaller geographies. The LODES data is available at the Census Block level, and we could base our analysis on OD pairs between Blocks. By reducing the extent of each geographic unit, we could maximize the chance that a given area's centroid would be close to the actual location of the housing or jobs located within the Block. The disadvantage to this solution would be the steep increase in computer processing required to create routes for Block-level OD pairs.
- Run multiple iterations of the method based on random points created within each Block Group. Without knowing more about the location of jobs or housing within each Block Group, any point within the Block Group is equally valid for describing the Block Group's location on the street network. Therefore, we could generate, say, ten random points within each Block Group and then conduct our method on the resulting 100 combinations for each OD pair; we could then

select the mean values of routes and commutes covered from all combinations of points for each pair. Again, the major drawback to this method is the processing time required.

- Use Block-level geography to define more accurate centroids. As a compromise solution, we could use Block-level data to find where the concentration of housing and jobs are within a Block Group and then assign the "centroid" to the point where housing and jobs are most concentrated.

CONCLUSION AND QUESTIONS FOR FURTHER RESEARCH

What we have presented here is an exploration of data produced by the Census Bureau's Longitudinal Employer-Household Dynamics (LEHD) dataset and ways in which it might be used to support analysis of the coverage that existing transit systems provide. The LEHD program's products offer distinct advantages when compared with other free, publicly available transportation planning data products: it describes the flows of commutes between home and work locations, and it provides information about work and home locations at the Census Block level, which allows for fine-grained geographic analysis.

We used Orleans Parish, Louisiana, as the geography for our exploration, and the New Orleans Regional Transit Authority (RTA) system as the transit system for study. First, we evaluated RTA level of service (LOS) using the Planning Methodology for service-coverage LOS as outlined in Part 3 of the *Transit Capacity and Quality of Service Manual* (2nd Edition). We found that the RTA system provides Orleans Parish with a "B" LOS and is quite close to an "A" LOS. This indicates that the RTA system provides a high level of service coverage in the parish; in other words, according to the *Manual's* methodology, the RTA provides service to almost all of the parts of the city that we might expect would generate transit trips. To be clear, however, this method says nothing about service frequency, the speed of travel, or other dimensions of transit-service quality, only whether or not service is present.

We then presented two alternative methodologies based on the *Manual's* method, but which incorporate the commute-pattern data found in the LODES data products. As opposed to the *Manual's* method, which evaluates service coverage based on the share of transit-supportive land area covered by transit service, our first method evaluated service coverage based on the number of commutes covered by transit service. Our analysis found that RTA service covers the vast majority (89.7%) of commutes within Orleans Parish that take place between two transit-supportive Block Groups as well as those that take place in an pair where at least one of the Block Groups is transit-supportive (82.4%). These results indicate that the RTA provides a high degree of service coverage for commutes within Orleans Parish. That said, we do not have enough information to relate these results with the results found in the *Manual*'s method; we do not know if one measure provides a more accurate picture of actual service coverage than the other.

Our second method attempted to measure service coverage not on the location of home and work locations, but on the shortest routes taken to travel between the two. Using network analysis, we plotted the shortest routes between every pair of Block Groups in Orleans Parish. The idea was to test service coverage for each Block Group based on the share of routes and commutes beginning or ending in that Block Group that are completely covered by RTA service. To test this methodology, we selected three Block Groups for study. For a Block Group in the CBD that has the highest job density in the city and a Block Group in the Fountainbleu area with a residential density at the parish-wide median, we found that RTA service covered approximately 60% of commutes. However, we found that RTA service covered 0% of commutes to and from a Block Group along the Industrial Canal. This result led us to discover that our method is highly sensitive to the parameters with which our GIS software located the Block Groups along the street network.

In this case, we instructed the software to locate the centroid of the Block Group on the closest segment of the street network. Following this parameter, the software located the centroid on a section of road outside of the RTA service buffer, meaning that no trips to or from the Block Group could be counted as completely covered by RTA service. However, if the software had located the centroid on other nearby street segments that were only slightly farther away from the Block Group's centroid, then it would have likely generated routes that would have been completely covered by the RTA's bus and streetcar lines. This situation led us to believe that our second method, as currently constructed, provides a weak method for describing service-coverage LOS. We have identified a few techniques to minimize this problem, and we plan to explore them in later work.

Our work also yielded other questions and issues that need answering before we can reach our ultimate goal of putting the LEHD data and our methods to public use through easy-to-use transportation planning tools.

1. How accurately does the network analysis method for finding shortest paths between Block Groups model real, observed travel patterns? Given that we are only considering work trips, there will always be differences between field-collected traffic counts and the volume of trips contained in the LODES data. However, the values must positively correlate if we are to assume that this method provides an accurate picture of travel patterns.
2. If it turns out that network analysis for finding shortest routes does not produce travel patterns that correlate with observed traffic volumes, the shortest routes might still be useful for comparing the circuity of travel on transit with the most direct paths of travel by automobile, bicycle, or walking. However, that kind of analysis would move away from service-coverage LOS and move towards the "transit-auto travel time" measure.[13]
3. What are the advantages of these alternative methods? If the Planning Methodology contained in the *Manual* is meant only to provide a quick, initial assessment of existing transit service, do we gain significant information by evaluating service coverage on the basis of commutes?
4. Answering the third question may depend, in part, on exploring another question: what is the relationship between the results of our methods and the *Manual's* method? In this case, there seemed to be a strong positive relationship between the *Manual* method and our first alternative method. However, we would need to look at other cities and other years of data in order to arrive at a clear sense of how the results of these two methods correlate; if they

[13] Briefly, this is the difference between travel time between two points on transit and travel time by automobile. See (Transportation Cooperative Research Board, pp. 3-49)

produce nearly identical results, then the first alternative method may be of little additional use, but if there is variance, then there may be value in it.

5. How would the network-based method apply to other geographies? The RTA system's routes (with the exception of the Riverfront Streetcar line) all run in or parallel to the street network, which allows for easy comparison of transit routes with driving routes. The city's geology precludes the introduction of subway service, and, looking ahead, the RTA is likely to continue providing rail service in the street right-of-way, whether in mixed traffic or neutral grounds (medians). However, in cities where transit service is provided below ground or in completely separated rights of way, would it be possible to compare transit service with shortest-distance paths on the surface street network?

Clearly, we are only in the initial stages of our work with the LODES data. However, we hope that with further work, these first steps will yield tools that advance the general understanding of our transportation systems, help residents and professionals make informed decisions about transit investment, and eventually create a world-class transportation system for New Orleans or any other community that uses these tools.

TECHNICAL APPENDIX

As stated in the Introduction, Transport for NOLA is committed to make data and information available to others. In order to help readers understand how we conducted our analysis and recreate that analysis for themselves, we present a step-by-step description of our work.

The Planning Methodology from the Transit Capacity and Quality of Service Manual

In order to conduct the analysis outlined in the *Transit Capacity and Quality of Service Manual (2nd Edition)*, we took the following steps.

1. Downloaded the New Orleans Regional Planning Commission's (NORPC) Census 2010 Block Group shapefile for Orleans Parish, through its web site, http://www.norpc.org. The NORPC describes the methodology that it used to produce its Census 2010 shapefiles in a methodology document available at the same web site.[14]
2. Downloaded the 2010, Version 6.0 Work Area Characteristics (WAC) file for Louisiana from the LEHD web site. Because the raw, tabular form of the 2010 data was not available at the time (4/26/2012), we used the LEHD OnTheMap data explorer to extract the data.[15] Here are the steps we took to download the data:
    a. We selected "Orleans Parish" as our "Selection Area". In the "Analysis Settings" window, we selected the following parameters:
        i. "Work" for "Home/Work Area"
        ii. "Area Profile" under "Analysis Type" and "All Workers" for "Labor Market Segment:".
        iii. "2010" for "Year"
        iv. "All Jobs" for "Job Type"
    b. On the "Results" tab, we clicked "Export Geography," chose the "ShapeFile" format, and saved the provided ZIP file.
3. In ArcMap, opened the downloaded shapefile and exported the attribute table to a .txt file for import into a Microsoft Access database. We then used a SQL "Group By" query to aggregate the jobs (contained in the c000 field) from the Census Block level to the Census Block Group level. To do this, we summed the count of jobs in each Census Block on LEFT(GEOID,12), where 12 equals the number of characters in the "GEOID" string (the unique identifier for all Census 2010 geography) that corresponds to each unique Block Group.
4. Exported the Block-Group level file back into ArcGIS and joined it to the NORPC Census Block Group file for Orleans Parish. The NORPC Census files contain an attribute for the number of housing units counted as part of Census 2010 (TOTALHU), and the land area for each Block

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[14] See: http://www.norpc.org/assets/pdf-documents/zip/MethodologyOutline_Census2010_shapefiles.pdf.
[15] See the "OnTheMap" link at the site http://lehd.did.census.gov/led/; tutorials and documentation for the OnTheMap interface are available at http://lehd.did.census.gov/led/datatools/onthemap.html. As of writing, the LEHD program has updated OnTheMap and its "Data Download" features so that the 2010 data is the Version 6.1 data, which includes data for federal employees and the District of Columbia (see: http://lehd.did.census.gov/led/whatsnew.html#061612). It is no longer possible to download the 2010 Version 6.0 data used here.

Group (ALAND10) in square meters, which, with the LODES data joined, allowed us to calculate the residential and job density of each Block Group.

5. Added a field to the joined NORPC file called "ALANDACRE." Using the Field Calculator, we set the value for ALANDACRE in each record equal to $ALAND10 \times 0.000247105381$, the constant for converting area in square meters to area in acres.
6. Created a field, SUPPORT10 in which we could code each Block Group's "transit supportiveness."
7. Used a series of Select by Attribute functions to find Block Groups and then used the Update Column tool on SUPPORT10 to code records.
    a. Records where $TOTALHU/ALANDACRE \geq 3$ and $c000/ALANDACRE < 4$ were coded as "1," or transit supportive based on residential density.
    b. Records where $TOTALHU/ALANDACRE \leq 3$ and $c000/ALANDACRE \geq 4$ were coded as "2," or transit supportive based on job density.
    c. Records where $TOTALHU/ALANDACRE \geq 3$ and $c000/ALANDACRE \geq 4$ were coded as "3," or transit supportive based on both job and housing density.
    d. All other records were coded as "-1" or transit supportive.
8. Downloaded the GTFS files from the New Orleans Regional Transit Authority's (RTA) web site, http://www.norta.com.[16]
9. Using the Create Points command in ArcGIS Desktop, created a layer with points for all bus and streetcar stops in the RTA system based on the oci_stops.csv file. The Latitude and Longitude fields in this file were incorrectly entered. For example, the Latitude for the stop with StopCode = 1 had was set to 29938923 when it should have been set to 29.938923. To correct for this, we created new fields LAT2 and LONG2 in which we divided the Latitude and Longitude values by 1,000,000.
10. Created a quarter-mile service area for each of the system's bus stops by using the Buffer command set to dissolve all overlapping buffers into one buffer.
11. Using the StreetMap USA Network Dataset provided with ArcGIS Desktop 2010, created quarter-mile service areas for each stop using the Network Analyst Service Area command. In order to appropriately model pedestrian travel on the street network, in the Service Area Analysis Settings, we removed restrictions for one-way streets, but added the restriction "Avoid Limited Access Roads."
12. Downloaded a file from http://atlas.lsu.edu/ that contains major water bodies in Louisiana and used it to remove sections of the two RTA service-area shapefiles that extended into the Mississippi River and Industrial Canal. In order to do this, used the Union command on the water-body shapefile and each of the service-area shapefiles. Deleted all records that had both the attributes of the quarter-mile service areas and the water-bodies file.[17]
13. Calculated the total land area of the Block Groups in the parish by its transit-supportiveness code using the Summarize command on the attribute field that stored the transit-supportiveness codes for each Block Group.

[16] Though data download is free, users must sign up for a "myRTA" account in order to access the files. The files we used in this study were released on 3/12/12. Since then, these files have been superseded by updated files.
[17] Since we had land area for the Census Block Groups as an attribute, we did not remove sections of the Block Groups that extended over water.

14. Using the Intersect command on the RTA service-coverage layers and the Block Groups, we created a new shapefile that had polygons for each section of the Census Block Groups covered by the service-coverage layers.
15. Using the Calculate Geometry tool, we measured the area of each intersection polygon in acres.
16. Using the Summarize command on the polygon-area field in the attribute table, we found the total area of the Census Block Groups covered by the quarter-mile service area files grouped by the Block Group's transit-supportiveness code.
17. In MS Excel, we compared the total land area of the Block Groups calculated in step 13 with the land area calculated in step 16. Calculated the share of transit-supportive land covered by the RTA service-area shapefiles.
18. Consulted the "Fixed-Route Service Coverage LOS" table in the *Manual* to find the level-of-service that corresponds with the share of transit-supportive area covered by the transit service areas.

First Alternative Method

Our first alternative methodology for evaluating service-coverage LOS with the LODES data used the same quarter-mile service areas and Census Block Group geometry, coded for transit supportiveness, from the *Manual's* method. Refer to the steps described above for the method we used to create those files. The following steps describe how we incorporated those files with other data to carry out our first alternative methodology.

1. Downloaded the 2010, Version 6.0 Origin-Destination (OD) file for Louisiana from the LEHD web site.[18] The specific file downloaded was la_od_main_JT00_2010.csv.gz, which included all OD pairs within the state of Louisiana (in other words, the file excluded any commutes in from another state) and all jobs, including primary and secondary jobs.[19]
2. Imported the OD file into MS Access and used an SQL query to find only those OD pairs where both the home and work Census Blocks were within Orleans Parish and to aggregate the number of jobs at the Census Block level to the Census Block Group level. To find the OD pairs within Orleans Parish, we selected records where the fields for the place of residence ("h_geocode") and the place of work ("w_geocode") had the code for Orleans Parish (071) beginning at the third position in the field. We used a "Group By" query to aggregate the jobs (contained in the "s000" field) from the Census Block level to the Census Block Group level, summing the count of jobs in each Census Block on LEFT(h_geocode,12) and LEFT(w_geocode,12) where 12 equals the number of characters in the two fields that correspond to each Block Group.
3. Created a new table from the query in Step 2 and joined it with the table that had every Block Group in Orleans Parish coded on the "-1"-to-"3" scale for transit supportiveness on both

[18] This file was available as of 4/27/12. See the "Data Download, OnTheMap Data"link at the site http://lehd.did.census.gov/led/. Since that time, the 2010 Version 6.0 data has been superseded by the Version 6.1 data, and it is no longer possible to download the data set used here.
[19] For more on the LODES OD file structure, see the LODES technical documentation at http://lehd.did.census.gov/led/onthemap/LODES6/.

the“w_geocode” and “h_geocode” fields. This provided a table that described the transit supportiveness of both the location of residence and location of work for each OD pair.

4. Used the ArcGIS Desktop Select by Location tool to find all Orleans Parish Block Groups with its centroid within the quarter-mile RTA service-area buffer. Created a new field, “CENTWITHIN,” and coded this field as “-1” if the Block Group’s centroid was not within the service area and “1” if the Block Group’s centroid was in the service area. We exported this table to MS Access and joined it on both the “w_geocode” and “h_geocode” fields in the table generated in Steps 1 through 3. After this join, we then had a table where each OD pair had fields that showed the transit supportiveness and transit accessibility of each home and work Block Group.
5. Exported this table to MS Excel and used the PivotTable features to cross-tabulate the number of commutes by the transit supportiveness of the home and work Block Groups as well as the coverage of the home and work Block Groups by the RTA system.

Alternative Method Two

Our second alternative methodology for evaluating service-coverage LOS with the LODES data relied on network analysis to generate implied routes for commuting over the Orleans Parish street system. For this analysis we, once again, relied on the NORPC Census Block Group geometry, and the 2010 (Version 6) LODES Origin-Destination data file for Orleans Parish. We combined these files in order to reach our findings by the following process:

7. Loaded, in ArcGIS Desktop 10, the StreetMap North America network dataset provided with the ArcGIS Desktop 10 software.[20] This dataset includes information about restricted turns (such as the restriction of left-hand turns between avenues at major intersections), street hierarchies, and legal speed limits.
8. Loaded the centroids of 496 Orleans Parish Block Groups (all parish Block Groups with the exception of Census Tract 9900, Block Group 0, which covers Lake Pontchartrain) as both “Facilities” and “Incidents” in the Network Analyst extension.
9. Set up a “Closest Facility” analysis to generate the shortest routes between all combinations of block-group centroids. Our analysis settings:
    a. Respected built-in restrictions on one-way streets, non-traversable street segments (such as the Exchange Place alley in the French Quarter), and avoided both passenger and vehicular ferries (such as the Algiers-Canal ferry).[21]
    b. Set “Facilities to Find” at 496 so as to allow all Network Analyst to route all OD combinations.
    c. Snapped “Facility” and “Incident” locations to the closest point on the network when finding network locations (i.e., we did not snap the centroids to the street network when loading the points).

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[20] StreetMap North America is a read-only network dataset based on 2005 data from the Tele Atlas company and ESRI. For more information, see the article “About StreetMap North America” at http://help.arcgis.com.

[21] Because we are evaluating service-coverage of RTA service, we made this last assumption in order to force all trips onto the street network, and off of the ferries, which are not operated by the RTA. An alternative analysis would allow for travel on the ferry routes and include them in our service-coverage areas.

10. Made an inner join of the 243,049 routes (which included trips within the same Block Group, but which did not generate geometry) created by the Closest Facility analysis with the OD pairs in the LODES Origin-Destination file, which left 24,728 routes with job information.[22]
11. Merged routes by Block Group so that all routes ending or beginning in that Block Group were copied into separate shapefiles.
12. Plotted, in MS Excel, the distribution of job density and housing density across the 496 Orleans Parish Block Groups.
13. Selected, based on this plot, three Block Groups that appeared to represent diverse housing and job density characteristics:
    a. Census Tract 134, Block Group 3, located in the CBD, and which had the highest job density in the city: 156.8 jobs per gross acre.
    b. Census Tract 128, Block Group 1, located in the Marlyville/Fountainbleu neighborhood. This Block Group had a residential density of 5.7 dwelling units per acre, which is the city-wide median.
    c. Census Tract 17.2, Block Group 4 along the eastern bank of the Industrial Canal. This Block Group had a job density near the minimum required for qualification as "transit-supportive" according to the *Manual*.
14. Summed the number of commutes originating and terminating in each of the three Block Groups.
15. Generated a polyline shapefile from the RTA General Transit Specification (GTFS) dataset based on the oci_routes.csv file.[23]
16. Created a dissolved, quarter-mile buffer around the RTA system's routes.
17. Selected all routes originating and terminating in each Block Group that were contained by the quarter-mile buffer around the RTA system's routes.
18. Summed, for each of the three Block Group files, the number of commutes in the "s000" field of the selected routes. To this sum, we added the number of commutes taking place within the Block Groups if the centroid of the Block Group fell within the route buffer.
19. Compared this final sum to the sum found in Step 14.

[22] Because of one-way streets, the way in which the cities neutral-ground separated avenues are drawn with two centerlines, and the position of highway on- and off-ramps, the "to-from" and "from-to" routes between the same pair of Block Groups were not necessarily coincident.
[23] For more detailed information on the GTFS file format, see: https://developers.google.com/transit/gtfs/reference. Multiple sets of instructions on converting GTFS files to shapefiles are available online. For example: http://www.stevencanplan.com/2010/how-to-convert-gtfs-to-shapefiles-and-kml/.

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