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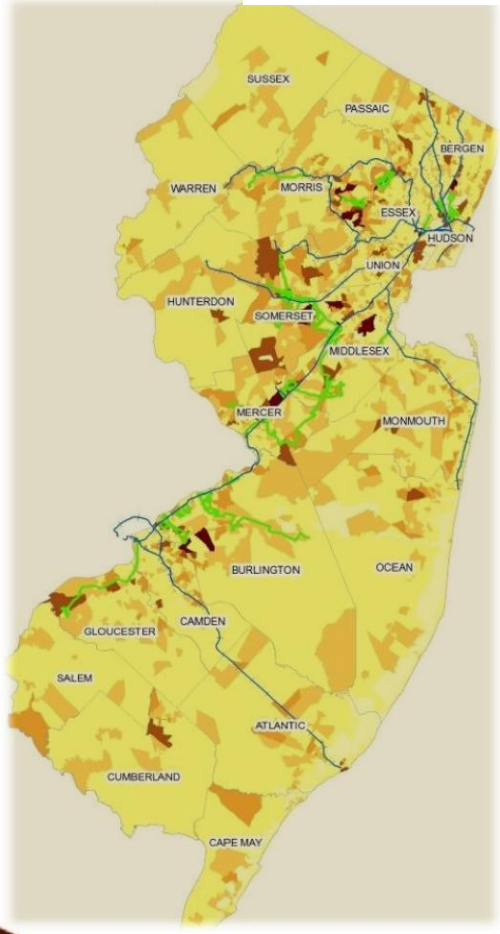

An Assessment of "Last Mile" Shuttles in New Jersey

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This research does not necessarily reflect the official views or policies of the Federal Transit Administration, NJ TRANSIT, the shuttle service providers, or anyone who provided information for this research. The author is solely responsible for the content of this report, including errors and omissions.

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EXECUTIVE SUMMARY

The primary objective of this research was to assess the "Last Mile" shuttles in New Jersey. "Last Mile" shuttles are the shuttles that provide passengers access from transit nodes such as rail stations to their destinations. In New Jersey, the term "Last Mile" shuttle is primarily used to describe shuttles that provide job access to workers from rail stations to work sites. Most, but not all, such shuttles in New Jersey are funded by the federal Job Access and Reverse Commute (JARC) program. Transportation management associations and counties are the primary providers of the services.

This research includes analysis of both primary and secondary data. At the outset of the research, 34 "Last Mile" Shuttle routes were identified for detailed analysis. All but one of these routes were mapped using Geographic Information System, and shuttle corridors were identified using ½ mile buffers around the routes. Secondary data on land uses, jobs, socioeconomic characteristics, housing characteristics, and commuting characteristics were used to distinguish the "Last Mile" corridors from "First Mile" shuttle corridors, control corridors, and areas not served by shuttles. The comparisons showed that the "Last Mile" shuttle corridors are substantially richer than other areas in terms of jobs, especially in "blue collar" jobs, including manufacturing and warehousing. Regarding socioeconomic, housing, and commuting characteristics, the "Last Mile" shuttle corridors are similar to typical middle-class suburban areas with low population density and a high dependence on automobile for commuting.

In addition to the analysis of secondary data for examining the characteristics of the shuttle corridors, an onboard survey was conducted on 18 shuttle routes, collecting data from 311 shuttle users. A vast majority of the respondents used shuttles for commuting purposes. The shuttle users were found to be of relatively young age, belonging to low-income and minority households. More than half of the shuttle users belonged to households without vehicles and 38% belonged to households with less than $25,000 household income. The characteristics of the passengers and the locations served by the shuttles clearly indicate that the shuttles are primarily serving population groups that are supposed to be served by JARC-funded projects.

The survey of the shuttle passengers also revealed important information about their labor force characteristics and the characteristics of their employers and work locations. Most workers using "Last Mile" shuttles work for large private employers, mostly in factories, warehouses, or offices. Although the household income of the shuttle users is substantially lower than the New Jersey population, their level of education is comparable to the state population.

It was evident from the study that the "Last Mile" shuttle users are highly dependent on shuttles and they are also highly appreciative of the service. However, including their travel by other modes before and after shuttle use, they spend a substantially longer time commuting than the general population of the state. Morning peak period and evening service frequency are the greatest concerns for the shuttle users. Implications of the research findings are discussed.

1. INTRODUCTION

During the past 15-20 years, shuttles have received an increasing attention in the United States as a tool for congestion reduction as well as a means of transportation for low-income and entry-level workers in the context of welfare reform. Dedicated funding from the federal government under the Congestion Mitigation and Air Quality Improvement (CMAQ) program and the Job Access and Reverse Commute (JARC) program has been one of the reasons for the increasing popularity of shuttles.

Shuttles can complement rail transit by collecting passengers from distant locations to rail stations and also distributing them from rail stations to distant locations. The terms "First Mile" shuttles and "Last Mile" shuttles, respectively, are often used to describe shuttles that provide access to stations and access from stations. Since shuttles are primarily used for work trips, "First Mile" shuttles are typically those that provide workers access between home and rail stations, whereas "Last Mile" shuttles are those that provide access to workers between rail station and work place.

Over the past 12 years, "First Mile" and "Last Mile" shuttles have been introduced in many parts of New Jersey. The "First Mile" shuttles have been mostly provided by communities and counties with funding from the CMAQ program. On the other hand, "Last Mile" shuttles have been provided primarily by transportation management associations (TMAs) and local governments with funding from the JARC program. The Alan M. Voorhees Center (VTC) of Rutgers University conducted a study on "First Mile" Shuttles in New Jersey. The results of the study were published in two articles in 2010 and 2011 (Deka, Carnegie, Bilton, 2010; Deka, Carnegie, Kabak, 2011). In contrast to the past study, the current research focuses on "Last Mile" shuttles in New Jersey. This study shows that the circumstances facing "Last Mile" shuttles are significantly different from the circumstances facing "First Mile" shuttles.

One of the primary objectives of this research is to comprehend the circumstances in which "Last Mile" shuttles operate in New Jersey. These circumstances relate to providers, funding sources, ridership, types of jobs served, land uses and socioeconomic characteristics of the service areas, characteristics of the users, characteristics of the trips made, users' satisfaction with service, and users' perceived needs.

This research includes analysis of both primary and secondary data pertaining to "Last Mile" shuttles in New Jersey. At the outset of this research, 34 "Last Mile" shuttle routes were identified throughout the state for detailed analysis on the basis of information provided by the providers and NJ TRANSIT staff. Thirty three of these shuttle routes were mapped using Geographic Information System (GIS) and the census Block Groups within ½ mile buffers of the routes were identified for the analysis of jobs and socioeconomic characteristics of the shuttle corridors. Data from the Longitudinal Employer-Household Dynamics (LEHD) and the American Community Survey (ACS) were used for the corridor-level analysis. The "Last Mile"

shuttle corridors were compared with "First Mile" shuttle corridors and control corridors to fully comprehend the nature of the areas served by "Last Mile" shuttles. In addition to the secondary data from the LEHD and ACS, characteristics of "Last Mile" and "First Mile" shuttle users were compared with shuttle non-users with NJ TRANSIT's commuter rail passenger survey data.

Little information is generally available about the "Last Mile" shuttle users or their trip patterns and travel needs. A significant contribution of this research is a survey of "Last Mile" shuttle users in New Jersey. This survey, conducted onboard 18 "Last Mile" shuttle routes provided information on the characteristics of the shuttle users, their travel characteristics, their satisfaction with the shuttle service they use, and their perceived needs. The survey revealed that the "Last Mile" shuttles are predominantly used by workers traveling to and from work, although a small proportion of the passengers use the service for non-work purposes. The survey also revealed that a large proportion of the shuttle users belong to carless, low-income, racial minority, and immigrant households. Since a large proportion of the shuttles surveyed are funded by the JARC program, the funds supporting the shuttle services appear to have been well spent. A comparison of the characteristics of the shuttle users and the socioeconomic characteristics of the areas where the shuttle routes are located shows a complete mismatch between the two. While most shuttle users belong to carless, low-income and minority households living in rented apartments, the shuttle corridors predominantly contain automobile-owning, middle-income families in low-density areas with a small proportion of apartment or multi-family units.

2. LITERATURE REVIEW

As a part of this research, a literature review was conducted on pertinent issues. The review is presented below in five separate sections. The review focuses on definition of shuttles, importance of shuttles, factors associated with the success of shuttles, and shuttles funded by the JARC program.

2.1. Definition of Shuttles

Shuttles provide pre-arranged service on regular routes configured as fixed route or loop (Cervero, 1997). Shuttle vehicles usually contain 15-30 seats. However, all vehicles that look like a shuttle may not be serving as shuttles. The technical definition of shuttles is evident from this comparison of shuttles with circulators by Urbitran Associates et al.(2006, p.9): "Circulators exhibit many of the same characteristics as shuttles, with the possible exception that shuttles connect to a particular destination, while circulators typically connect to multiple activity points." Yet, in reality, it is often difficult to clearly distinguish a shuttle from a circulator because (a) shuttle vehicles sometimes make one or two stops before heading to the destination, (b) shuttles sometimes serve more than one destination, and (c) shuttles sometimes serve as a circulator for a route segment and as a shuttle for another route segment. The "Last Mile" shuttles in New Jersey, although distinct from typical circulators that provide service within an urban area, often connect multiple nodes to one or more transit stations.

2.2. Importance of Shuttles

Shuttles usually constitute a small component of a region's public transportation system, but can complement fixed-route transit, especially rail transit, in a significant way. A serious limitation of rail transit is that beyond a short distance from stations, it loses attractiveness because people are usually willing to walk only a short distance (Dill, 2003). Because of the decentralization of jobs and homes in most metropolitan regions over the past few decades, only a small proportion of activities at a regional scale are currently located within walking distance of rail stations. Under the evolving circumstances, shuttles can play an increasingly important role in connecting people and jobs to rail transit.

Together with vanpools and carpools, shuttles are often conceived as an important component of transportation demand management (Meyer 1999). Deakin (2004) emphasized the importance of shuttles as a complement to fixed-route transit. In her words (p.1): "Shuttles are an innovation that clearly deserve more consideration, not only as a way to solve the first and last mile access problem but also to save money and reduce traffic." Because of their perceived benefits regarding congestion reduction, shuttle services have often been funded through grants from the federal CMAQ program since the 1990s. Since the inception of the JARC program in 1999, shuttles have gained additional popularity as a means of transportation to job sites by welfare recipients, low-income individuals, and entry-level workers. Thus, shuttles are perceived as a tool for congestion mitigation as a well as a means of transportation for those who cannot afford to own a personal vehicle. In the latter context, access to jobs is perceived to be the most important function of shuttles.

2.3. The Distinction between "Last Mile" and "First Mile" Shuttles

The term "Last Mile" is used in both passenger and freight transportation. In freight transportation, the term is commonly used to describe the last segment of a supply chain, such as the delivery of goods from a local depot to residences (Edwards, McKinnon, and Cullinane, 2010; Scott, 2009). In the context of passenger transportation, Deakin (2004) used the terms "First Mile" and "Last Mile" to describe feeder shuttles to and from transit stations. "First Mile" shuttles usually refer to shuttles that take passengers from trip origins to transit stations, whereas "Last Mile" shuttles refer to services that take passengers from stations to their destinations. In New Jersey, the term "Last Mile" shuttle is often used to describe services that provide access to workers from rail stations to employment sites. In this study, the term "First Mile" shuttle is used to describe shuttle services predominantly used by passengers to travel from home to transit nodes and the term "Last Mile" is used to indicate services that predominantly provide access from transit nodes to job sites. In this context, the term *predominantly* needs emphasis because in some instances, "First Mile" shuttles can be used by passengers to access jobs near transit stations and "Last Mile" shuttles can be used for accessing non-employment destinations, including homes.

2.4. Factors Associated with Shuttle's Success

Several studies have identified variables that make shuttles successful. A stated preference survey in a study for a suburban California community revealed that, like other transit modes, the most important considerations for potential shuttle users were travel time, cost of travel, and service reliability (Yim and Ceder, 2006). A study by Urbitran Associates, Multisystems, SG Associates, and Cervero (1999) that examined home-to-station shuttles in several suburban communities across the country concluded that shuttles were more successful in low- and moderate-income and moderate-density neighborhoods than high-income and low-density neighborhoods. A similar study on home-to-station shuttles by Shannon and Brower (2002) for the greater New York metropolitan area concluded that a variety of factors contributed to shuttle's success, including population density, travel time savings, parking costs, local government policies, shuttle stop characteristics, and vehicle size. Other studies on home-to-station shuttles have concluded that the willingness to use shuttles was influenced by proximity between home and shuttle stop as well as waiting time at shuttle stop (Anspacher, Khattak, Yim, 2004, 2005).

Urbitran Associates, et al. (2006) noted that employer participation was important for the success of employment-oriented shuttle services in suburban areas. The study concluded that shuttle services performed the best with sustained employer participation. It maintained that agencies were usually reluctant to establish shuttle service in suburban areas without subsidies from employers or transportation management associations. Because of shuttles' dependence on dedicated funding, little emphasis is placed on the actual performance of the services.

In the context of New Jersey, two studies provide important information about the factors potentially associated with the success of home-to-station shuttles. A study by Deka, Carnegie and Bilton (2010) concluded from the analysis of stated preference data that home-to-station shuttles are more likely to be successful in areas with a high concentration of immigrant populations, non-English speaking persons, and moderate income households, whereas they are less likely to be successful in areas with high incomes and predominantly white populations. Correlation analysis in the study showed that home ownership rate, housing mix, and job density of places, as well as race and ethnicity of individuals are also associated with the stated preference for shuttles. The study found that individuals living in close proximity of stations and individuals that have been using rail transit for a long time are less likely to use shuttles. The study also found evidence that lower parking fee and greater availability of parking at station lots may deter shuttle use.

Another New Jersey study on home-to-station shuttles by Deka, Carnegie, and Kabak (2011) that used panel data analysis concluded that local financial conditions as well as high ridership volume were important for shuttle services' longevity. The study also concluded that ease of access to stations by alternative modes, such as buses and cars, reduces the attractiveness of shuttles.

In sum, past studies have identified a variety of factors associated with shuttles' success. The factors that have been found to be associated with shuttle use are population and employment density, housing mix, home ownership rate, race and ethnicity, income, proximity to station, availability and cost of station parking, concentration of immigrant and non-English speaking populations, travel time and cost by shuttles relative to other modes, and local government policy. Furthermore, some studies have emphasized that the availability of dedicated funds is critical for establishing and continuing shuttle services. One study concluded that sustained employer participation and support were highly valuable for employment-oriented shuttles.

2.5. Studies Related to the Job Access and Reverse Commute Program

Although not all, a large proportion of the "Last Mile" shuttles in New Jersey are funded by the JARC program. The JARC program was established in 1999 under Section 3037 of the Transportation Equity Act for the 21st Century (TEA-21) to address the transportation needs of the welfare recipients and low-income individuals with an emphasis on access to jobs in suburban areas (Bregman, et al., 2009). The program can be conceived as an effort to develop and implement transportation solutions for those affected by the Personal Responsibility and Work Opportunity Reconciliation Act of 1996 (PRWORA). Although JARC project funding was originally allocated through directives, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETY-LU) of 2005 converted JARC to a formula-based program under Section 5316 of the Act. The formula is based on the number of eligible low-income riders and welfare recipients. The two primary performance measures for the program's evaluation are jobs accessed and number of one-way trips provided. While states and public bodies are designated recipients of the program, they may redistribute JARC grants to sub-recipients, including private non-profit organizations, public transportation agencies and local governments.

The JARC services are usually classified as trip-based services, information-based services, and capital investment programs (Bregman, et al., 2009). Of these three types, trip-based services constitute the largest share of the initiatives. Such trip-based services include fixed route service, flexible route service, shuttles, demand response service, and user-side subsidies such as vouchers. Shuttles constitute only a small proportion of the trip-based initiatives and an even smaller proportion of all initiatives. During the years 2007 and 2008, more than 80% of shuttle initiatives were located in urban areas, with large urban areas accounting for approximately 60% of the initiatives.

Since the program's inception in 1999, a few efforts have been made to evaluate the success of the JARC program. From a study involving a survey of JARC passengers in 23 project sites, Sööt, Sriraj, and Thakuriah (2002) concluded that the JARC-funded transit services were highly beneficial to the users. The study noted that such services were successful in reaching the target beneficiaries, received appreciation from the users, helped improving work opportunities for low-income individuals, fulfilled travel needs of persons without access to personal vehicles and

driver's licenses, and saved time and money for the users. The study further noted that JARC-funded transit services promoted socialization processes among users and thereby improved their long-term employment sustainability. In another study, Thakuriah, Sriraj, Sööt, and Persky (2008) held a similarly positive view about the impacts of JARC-funded transit services. They noted that the services have positive impacts on both economic and psychological wellbeing of the users. The study further noted that non-users also benefited from such services because of better utilization of tax dollars and a reduction in automobile travel.

Despite the positive evaluation of the JARC-funded transit services in the above studies, Sanchez and Schweitzer (2008) expressed a less optimistic view of the program. They pointed out that the JARC program evaluation processes are simplistic and the long-term effects of the program are yet to be known. However, the study acknowledges that low-income and minority populations as well as advocates of environmental justice are supportive of the JARC program. It further mentioned that by setting resources aside specifically to provide service for low-income individuals, the program prevents misuse of resources by other entities or services.

In a review of JARC initiatives in California, Blumenberg and Schweitzer (2006) maintained that despite some promising outcomes, the JARC program had not been able to fully achieve some of its professed goals. They argued that the 50% local matching requirement and other rigid requirements imposed constraints on the funding recipients. However, the study also mentioned certain benefits from initiatives under the program, including dissemination of transportation information to low-income populations, new transit services, and integration of transportation programs across organizations. The study identified situations where potential users could not substantially benefit from JARC-funded transit and recommended for the program to place greater emphasis on the travel needs of the individuals who might benefit instead of focusing on transit networks. Finally, the study recommended more rigorous evaluation of the JARC program.

In another Californian study on the JARC program, Cervero and Tsai (2003) noted that initiatives under the program often included modifications of existing public transit services instead of new services. However, the study noted that in addition to route and schedule extension of existing services, several new transit routes and new shuttle services were also established under the program in the study area. The study noted that the feeder shuttle services under the program were sponsored by transit agencies, churches and community-based organizations. It found that although some shuttle services were successful in providing access to entry-level workers to employment sites, other shuttle services failed because of the absence of qualities that make shuttles successful. They mentioned that dispersed work sites, varied work schedules (many schedules), minimal employer support, and short commute distance were some of the detriments to employment-oriented shuttles.

In sum, the literature on JARC-funded initiatives has generally been supportive of the program. Although some authors have expressed concerns about the simplistic criteria used for evaluating

program initiatives, most studies have concluded that the program has the potential to benefit low-income and entry-level workers. The review of literature showed that shuttle initiatives are not the most common JARC initiatives, but they serve a useful purpose.

3. IDENTIFICATION AND MAPPING OF NEW JERSEY SHUTTLE ROUTES

3.1. Identifying "First Mile" and "Last Mile" Shuttle Routes

The distinction between "First Mile" and "Last Mile" shuttles in this study was made on the basis of their basic characteristics and funding sources. In New Jersey, the "First Mile" shuttles, often referred to as community shuttles, came into being predominantly during the 2000-2004 period as a result of a new funding stream under the CMAQ program. During that period, approximately 40 "First Mile" shuttle services began in the state. Some of the services were terminated in the subsequent years because of lack of funding, but others have continued until the present. A total of 41 "First Mile" routes for 31 services were identified as a part of a previous study by the VTC (Deka, Carnegie, and Kabak, 2011).

The "Last Mile" shuttle routes for this study were identified on the basis of conversations with NJ TRANSIT staff, TMA staff, and county staff, as well as a review of funding source and the nature of service. A total of 34 "Last Mile" shuttle routes were identified for detailed analysis. These routes are listed in Table 1 along with the names of the service providers and the areas predominantly served. Their funding sources, average monthly ridership (trips), and route miles are shown in Table 2. It should be noted that the selected routes do not include all "Last Mile" shuttle routes in New Jersey, but they appear to be the most appropriate set of formal shuttle routes for the study area based on insights from the providers, ridership, geographic diversity, and data availability.

The "Last Mile" shuttles in New Jersey are provided predominantly by funding from the federal JARC program with local matching funds. In many instances, they are supported by local funds from counties, TMAs, employers, and farebox revenue. In a few instances, large corporations provide shuttles through TMAs to their own employees from rail stations to employment sites.

While the "First Mile" shuttles came into being primarily because of the CMAQ program and continue to provide service (after the initial three year period) with local funds, the "Last Mile" shuttles came into existence with funding from far more diverse sources. Because they did not come into existence due to a single program, unlike the "First Mile" shuttles, the "Last Mile" shuttles are constantly evolving. While some services have been discontinued over the years, and others have been replaced by conventional buses, new services are also emerging in a sporadic fashion.

3.2. Mapping Shuttle Routes, Creating Buffers and Selecting Block Groups

Among the 34 "Last Mile" shuttle routes identified for detailed analysis, 33 were mapped using GIS by collecting route information directly from the providers or their web sites. One shuttle route – the Medford Shuttle – was not mapped due to the lack of route information. The "Last Mile" shuttle routes included in this research are shown in Figure 1.

To examine the characteristics of the areas served by the "Last Mile" shuttles and to compare them with other areas, ½ mile buffers were created along all 33 shuttle routes and census Block Groups within and outside the buffers were identified. To be included in a shuttle buffer, or shuttle corridor, a Block Group had to have its centroid within a half mile of a shuttle route or its boundary had to be bisected by a shuttle route. Since shuttles on three routes operated partially on freeways, the Block Groups along the freeway segments were excluded from the buffers for analysis. A ½ mile buffer was used because typically walking distance is assumed to be a half mile. Although there are 6,510 Block Groups in the state of New Jersey, data from the 2008 LEHD and 2005-09 ACS are available for 6,464 Block Groups. Of these Block Groups, 576, or 8.9% Block Groups were uniquely within the ½ mile buffers of "Last-Mile" shuttle routes. Some of these Block Groups were within the buffers of more than one shuttle route, but for all analyses, they were counted only once to avoid duplication. Examples of buffers around "Last Mile" shuttle routes are shown in Figure 2.

As discussed previously, 41 routes for 31 "First Mile" shuttle services were identified and mapped by collecting route information from NJ TRANSIT as a part of a previous VTC study. These shuttle routes are shown in Figure 1 along with the "Last Mile" shuttle routes. By using the same methodology as "Last Mile" shuttles, Block Groups within and outside ½ mile buffers of these routes were identified for the comparison of "First Mile" shuttle corridors with "Last Mile" shuttle corridors.

In order to compare the characteristics of the "Last Mile" corridors with areas not served by shuttles, a set of control corridors were selected from the eleven counties where "Last Mile" shuttles are provided. These counties are Bergen, Burlington, Camden, Essex, Gloucester, Hudson, Mercer, Middlesex, Morris, Passaic, and Somerset. To identify these corridors, two road segments without shuttle operation were selected from each county that were of the same functional class (e.g., state road, county road, etc.) as the road segments where the "Last Mile" shuttles operated. In the second step, Block Groups within ½ mile buffers of these road segments were identified using the method used for the identification of Block Groups within "Last Mile" and "First Mile" shuttle corridors. Since the "Last Mile" shuttle corridors contained an average of 30 Block Groups, 30 Block Groups were selected from each of the 22 control corridors, amounting to a total of 660 Block Groups within all control corridors. These Block Groups were compared with the Block Groups within the "Last Mile" shuttle corridors for various purposes in the subsequent sections.

Table 1 – Last Mile Shuttles Identified By the Study

	Shuttle Service	Provider	Primary Service Area
1	Burlink1	Cross County Connection	Burlington County
2	Burlink2	Cross County Connection	Burlington County
3	Burlink5	Cross County Connection	Burlington County
4	Burlink8	Cross County Connection	Burlington County
5	Burlink9	Cross County Connection	Burlington County
6	Burlink10	Cross County Connection	Burlington County
7	CAT_1R	Somerset County Transportation	Somerset County
8	CAT_2R	Somerset County Transportation	Somerset County
9	Dash1	Somerset County Transportation	Somerset/Middlesex County
10	Dash2	Somerset County Transportation	Somerset County
11	Scoot-peak	Somerset County Transportation	Somerset County
12	Scoot_R1	Somerset County Transportation	Somerset County
13	Scoot_R2	Somerset County Transportation	Somerset County
14	MCAT - M1	Middlesex County Area Transit	Middlesex County
15	MCAT - M4	Middlesex County Area Transit	Middlesex County
16	MCAT - M5	Middlesex County Area Transit	Middlesex County
17	MCAT - M6	Middlesex County Area Transit	Middlesex County
18	MCAT - M7	Middlesex County Area Transit	Middlesex County
19	MOM - Dover Netcong	Morris County	Mercer County
20	Mercer TrainLink	Greater Mercer TMA	Mercer County
21	Hopewell Shuttle	Greater Mercer TMA	Mercer County
22	Route 130 Connection	Mercer County	Mercer County
23	Pureland Shuttle	South Jersey Transportation Authority	Camden/Gloucester County
24	TransIT Link	South Jersey Transportation Authority	Camden County
25	Medford Shuttle	South Jersey Transportation Authority	Camden County
26	Harmon Cove	Meadowlink TMA	Hudson County
27	Harmon Meadow	Meadowlink TMA	Hudson County
28	Secaucus-Carlstadt/Moonachie	Meadowlink TMA	Bergen County
29	Kearny	Meadowlink TMA	Hudson County
30	Lyndhurst	Meadowlink TMA	Bergen County
31	Fairfield & West Caldwell	Meadowlink TMA	Essex County
32	Wayne/Fairfield/W. Caldwell	Meadowlink TMA	Passaic County
33	Route10	Meadowlink TMA	Essex County
34	Meadowlands Shuttle	Meadowlink TMA	Bergen County

Table 2 – Funding Source, Ridership and Length of Shuttle Routes

	Shuttle Route	Funding source	Average monthly trips	Route length (mile)
1	Burlink1	JARC, Section 5311, farebox	1,792	33.1
2	Burlink2	JARC	358	13.58
3	Burlink5	County, farebox	1781	5.71
4	Burlink8	JARC, county, farebox	115	6.12
5	Burlink9	CMAQ, farebox	794	13.92
6	Burlink10	CMAQ, farebox	446	6.98
7	CAT_1R	Casino funds, TMA, county, farebox	95	19.84
8	CAT_2R	Casino funds, TMA, county, farebox	443	18.17
9	Dash1	Casino funds, TMA, county, farebox	1,547	24.37
10	Dash2	Casino funds, TMA, county, farebox	1,979	16.84
11	Scoot-peak	Casino funds, TMA, county, farebox	2,360	28.08
12	Scoot_R1	Casino funds, TMA, county, farebox	907	24.12
13	Scoot_R2	Casino funds, TMA, county, farebox	615	23.60
14	MCAT - M1	JARC, casino funds, passenger donation	9,579	29.40
15	MCAT - M4	County, city, passenger donations	9,410	5.94
16	MCAT - M5	County, city, passenger donations	4,413	4.32
17	MCAT - M6	New Freedom, passenger donations	906	16.98
18	MCAT - M7	CMAQ, passenger donations	NA	13.11
19	MOM - Dover Netcong	JARC, passenger donations	2,805	14.45
20	Mercer TrainLink	Private (discontinued)	1,281	8.89
21	Hopewell Shuttle	Private	6,541	11.46
22	Route 130 Connection	JARC, farebox	2,297	35.13
23	Pureland Shuttle	JARC, farebox	557	27.64
24	TransIT Link	JARC, farebox	NA	7.23
25	Medford Shuttle	NA	3,016	NA
26	Harmon Cove	JARC, private	3,269	4.88
27	Harmon Meadow	Private	4,803	5.20
28	Secaucus-Carlstadt/Moonachie	JARC, private	791	10.26
29	Kearny	JARC, TMA, county, farebox	418	3.48
30	Lyndhurst	New Freedom, Meadowlands Commission, private	1,787	6.47
31	Fairfield & West Caldwell	JARC, county	1,396	14.35
32	Wayne/Fairfield/W. Caldwell	JARC, county	1,832	21.54
33	Route10	JARC, county	1,189	13.70
34	Meadowlands Shuttle	JARC, private	1,322	1.21

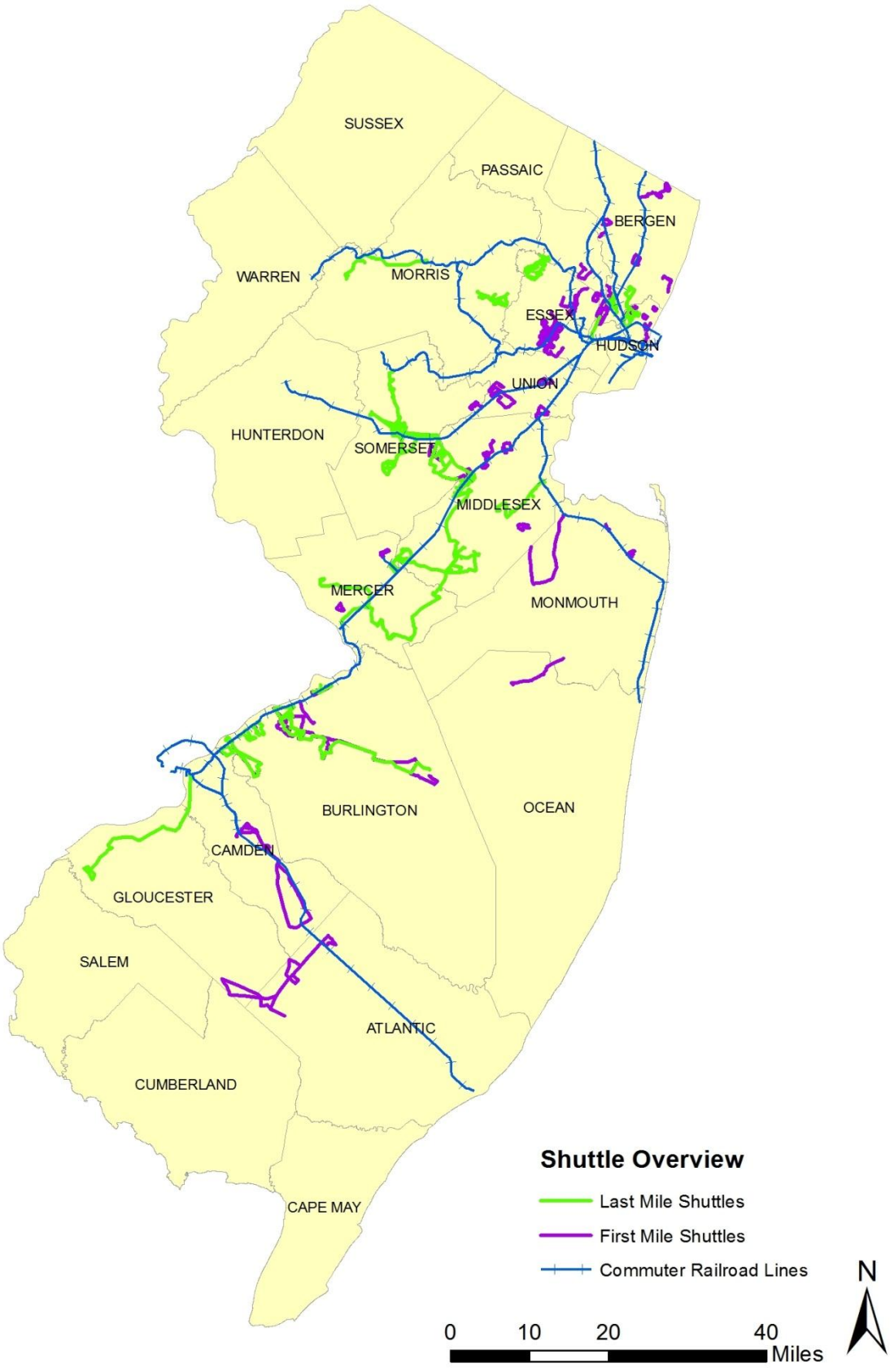

Figure 1 – "Last Mile" and "First Mile" Shuttle Routes in New Jersey

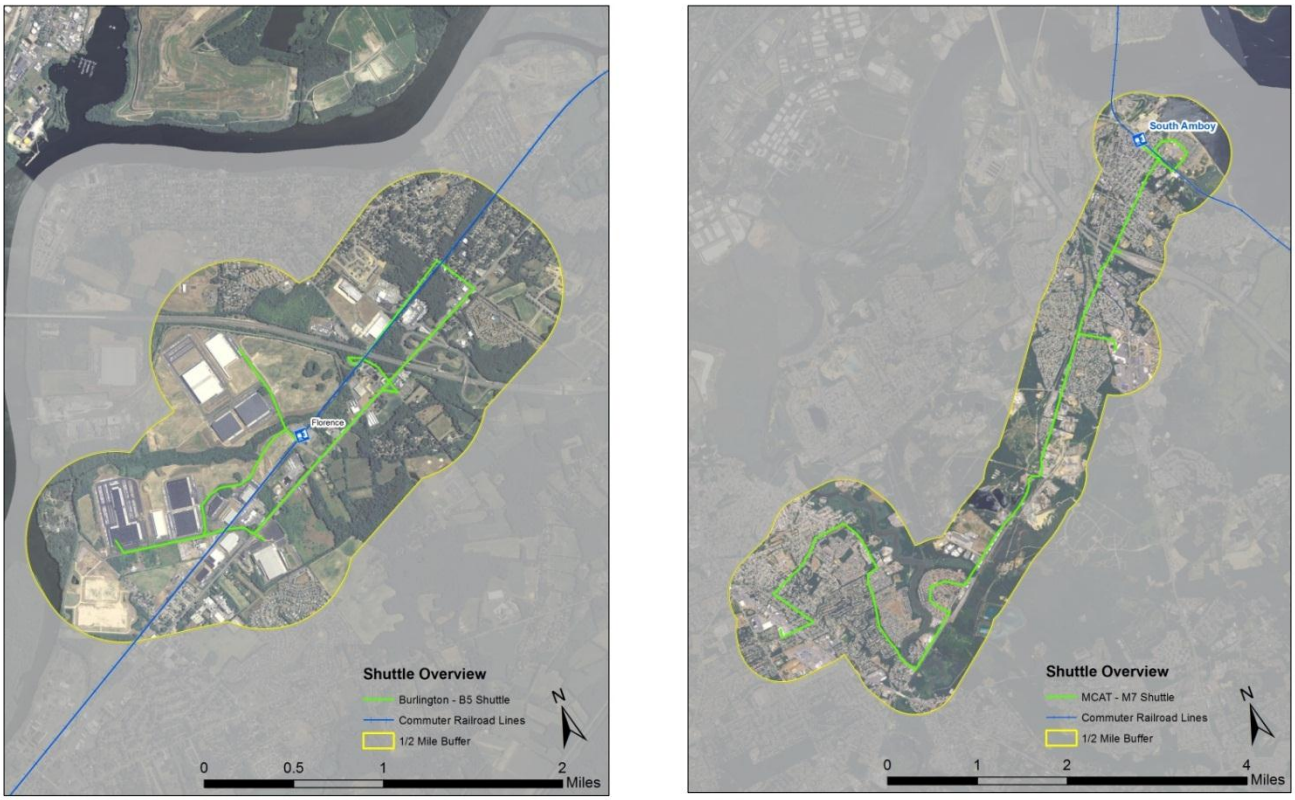

Figure 2 – Examples of Buffers around "Last Mile" Shuttle Routes

4. LAND USES IN THE "LAST MILE" SHUTTLE CORRIDORS

4.1. Comparison of Land Use/Land Cover

As a first step to comprehend the land uses in the "Last Mile" shuttle corridors, GIS files containing the 2007 Land Use/Land Cover data for New Jersey were obtained from the New Jersey Department of Environmental Protection (http://www.nj.gov/dep/gis/lulc07shp.html). The data were restricted to the urban classifications and the proportion of each urban land use was estimated for the "Last Mile" shuttle corridors, the control corridors, and the entire geographic area of the counties where the "Last Mile" shuttle service is available. These distributions are shown in Table 3. The "Last Mile" shuttle corridors are the most distinct from the control corridors and the counties in terms of industrial land. The proportional distribution of industrial land in the "Last Mile" shuttle corridors is twice the county aggregate and more than three times the control corridors. Compared to industrial land, the "Last Mile" shuttle corridors have only a slightly higher proportion of land in the commercial/services category. Similarly, the difference between the "Last Mile" shuttle corridors, the control corridors, and the county aggregate is small for all three residential categories. On the basis of the data, one can expect "Last Mile" shuttles to serve predominantly industrial land uses.

Table 3 – Land Uses in "Last Mile" Shuttle Corridors Compared with Control Corridors and County

Land Uses	Last Mile Shuttles	Control Corridors	County Aggregate
Industrial	10%	3%	5%
Commercial/services	11%	10%	10%
Recreational land	4%	5%	5%
Residential, high density or multiple dwelling	11%	8%	10%
Residential, single unit, low density	10%	11%	12%
Residential, single unit, medium density	27%	31%	28%
Other Urban	27%	33%	30%
Total	100%	100%	100%

4.2. Comparison of Jobs in the "Last Mile" Shuttle Corridors with Areas Not Served

Since the primary purpose of the "Last-Mile" shuttles is to provide access to jobs, the areas served by the shuttle routes are expected to be rich in jobs compared to other areas. However, little is known about the type of jobs that are served by the "Last Mile" shuttles in New Jersey.

In an effort to identify the types of jobs that are served by the "Last Mile" shuttles, 2008 LEHD data were analyzed. The LEHD provides data for 20 different industry types, each defined by a separate North American Industry Classification System (NAICS) code. Although the LEHD data are available at the Census Block level, they were analyzed at the Census Block Group level to conform to the ACS data.

The first set of analysis of jobs in the "Last Mile" shuttle corridors consisted of a comparison of Block Groups within and outside the corridors. For this comparison, Block Groups from only those counties were retained that had at least one "Last-Mile" shuttle route within its territory. These counties were Bergen, Burlington, Camden, Essex, Gloucester, Hudson, Mercer, Middlesex, Morris, Passaic and Somerset. The counties without "Last Mile" shuttles were excluded with the assumption that the non-existence of shuttles itself is a testimony to the fact that they are different from the areas served by "Last Mile" shuttles. Many of these counties contain large portions of rural and exurban areas where conventional transit is non-existent or rare.

The comparison of jobs within and outside "Last Mile" shuttle corridors is shown in Table 4. It shows the number of Block Groups within and outside shuttle corridors, the number of jobs per Block Group within the shuttle corridors and outside, as well as results from one-way analysis of variance (ANOVA) on the differences between jobs within and outside the shuttle corridors. Comparisons are shown in Table 4 for total jobs and the 14 industry types for which significant differences were found between the shuttle corridors and outer areas. For the other industry

types, namely, agriculture, mining, utilities, information, finance and insurance, and real estate, the differences were not significant.

Table 4 – ANOVA Results Comparing Block Group Jobs Within and Outside Half-Mile Buffer of "Last Mile" Shuttle Routes Estimated for Counties with Shuttles

	Block Group Location	Number of Block Groups	Mean jobs per Block Group	F	Sig.
Total jobs	Outside buffer	3855	561	63.90	.000
	Inside buffer	576	1085		
Construction jobs[a]	Outside buffer	3855	21	41.99	.000
	Inside buffer	576	37		
Manufacturing jobs[a]	Outside buffer	3855	40	70.07	.000
	Inside buffer	576	128		
Wholesale trade jobs	Outside buffer	3855	35	56.98	.000
	Inside buffer	576	92		
Retail trade jobs	Outside buffer	3855	65	21.90	.000
	Inside buffer	576	110		
Transportation and warehousing jobs	Outside buffer	3855	24	13.56	.000
	Inside buffer	576	60		
Professional, scientific, and technical services jobs	Outside buffer	3855	45	24.34	.000
	Inside buffer	576	98		
Management companies and enterprises jobs[a]	Outside buffer	3855	12	7.50	.006
	Inside buffer	576	27		
Administrative support & waste management jibs	Outside buffer	3855	38	33.70	.000
	Inside buffer	576	84		
Educational services jobs	Outside buffer	3855	59	4.50	.034
	Inside buffer	576	89		
Health care and social assistance services jobs	Outside buffer	3855	76	12.49	.000
	Inside buffer	576	130		
Arts, entertainment, and recreation jobs[a]	Outside buffer	3855	7	10.39	.001
	Inside buffer	576	13		
Accommodation and food services jobs	Outside buffer	3855	33	13.85	.000
	Inside buffer	576	51		
Other services jobs[a]	Outside buffer	3855	19	16.66	.000
	Inside buffer	576	27		
Public administration jobs	Outside buffer	3855	24	4.55	.033
	Inside buffer	576	47		

Note: ANOVA results on agriculture, mining, utilities, information, finance and insurance, and real estate jobs are not shown because significant differences were not found.

[a] Differences are also significant at 10% in terms of density of jobs per acre.

From the data presented in Table 4, it is evident that the "Last Mile" shuttle corridors are far more job rich than the areas outside. It is also evident from the table that the difference between number of jobs within and outside is the most substantial for the manufacturing, followed by wholesale trade, and construction – sectors that are typically considered "blue collar." This is consistent with the land use/land cover data compared in Table 3, where the shuttle corridors were found to have far more industrial land than the control corridors. Among the other industry types, the differences between the corridors and outer areas are also substantial for administrative, professional, scientific, and technical, and retail trade jobs compared to the other industry types. However, the F statistics for various industry types suggest that the difference between the shuttle corridors and outer areas is more distinct for typical "blue collar" jobs than "white collar" or office jobs.

When an additional analysis was carried out by considering jobs per acre instead of jobs per Block Group, significant differences were found between the "Last Mile" shuttle corridors and the outer areas for five industry types – manufacturing, construction, management services, arts and entertainment, and other services. Although number of jobs is a better measure than density of jobs to understand what types of industries are served by the "Last Mile" shuttles, the findings from the density analysis confirm that the shuttles serve "blue collar" jobs more significantly than other types of jobs.

The location pattern of jobs in typical "blue collar" and "white collar" industries in New Jersey are shown in Figures 3, and 4, respectively. Figure 5 shows how these jobs are located along the shuttle routes in central New Jersey.

4.3. Comparison of Jobs in the "Last Mile" Corridors with Control Corridors

Since counties contain diverse land uses, some more accessible by roads than others, the job distribution in "Last Mile" shuttle corridors was also compared with 22 control corridors. This comparison is expected to show how the "Last Mile" shuttle corridors differ from typical corridors regarding job location. As described in Section 3.2 of this report, the control corridors were selected from the same counties where the "Last Mile" shuttles operated and the road segments had the same characteristics as the roads where shuttles operated. The critical distinction between the "Last Mile" shuttle corridors and the control corridors is that no shuttles operate in the control corridors.

The comparison of jobs in the "Last Mile" shuttle corridors with the control corridors is shown in Table 5, where only those industry types are shown that had statistically significant differences between "Last Mile" shuttle corridors and the outer areas (shown in Table 4). Table 5 shows the comparison of Block Group jobs within corridors with jobs in outer areas for both "Last Mile" shuttle routes and the control routes. In addition to the mean number of jobs per Block Group within and outside the corridors, the table also shows the ANOVA results comparing the corridors with the outer areas.

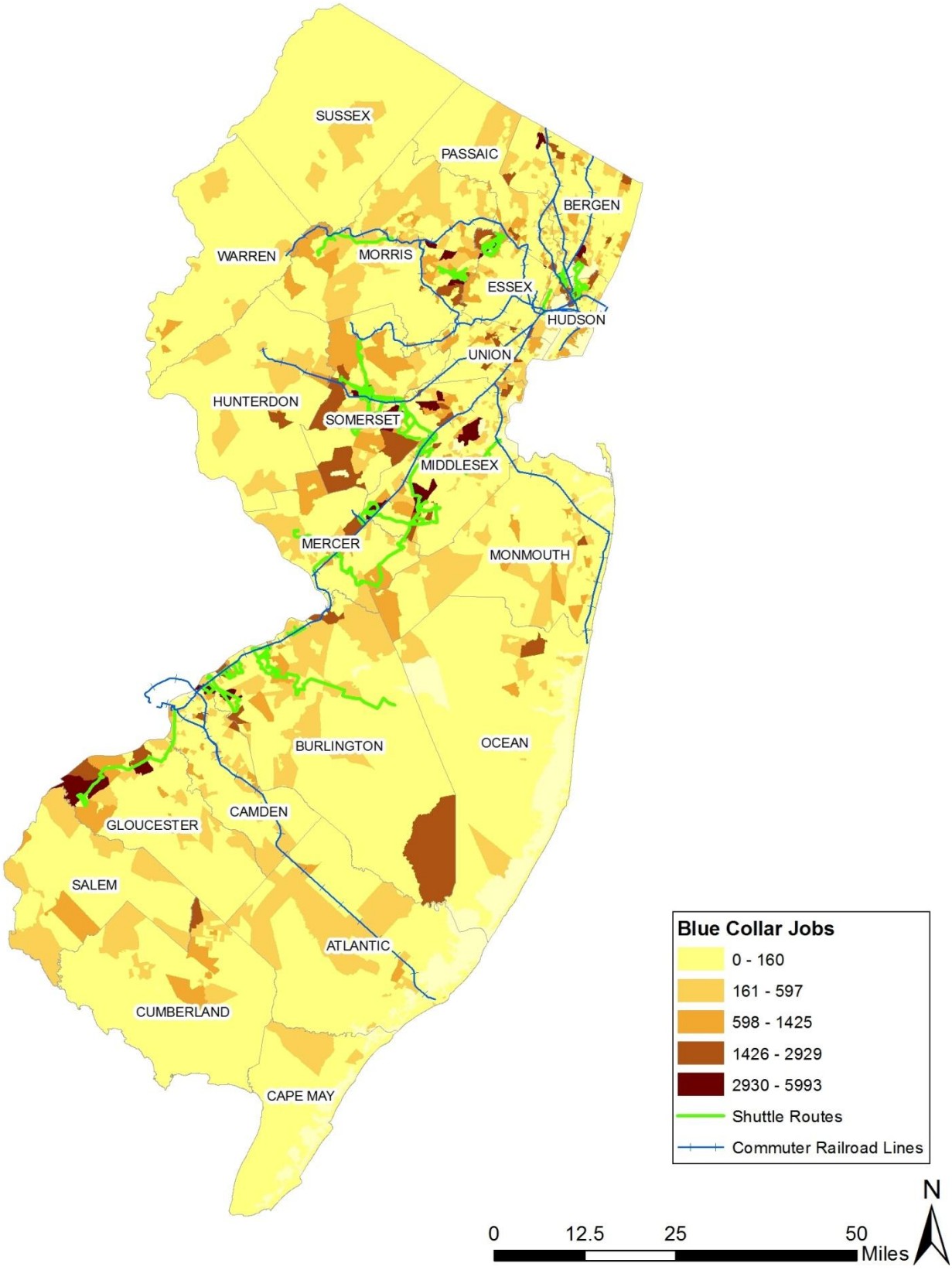

Figure 3 – "Blue collar" Jobs per Block Group in Relation to "Last Mile" Shuttles

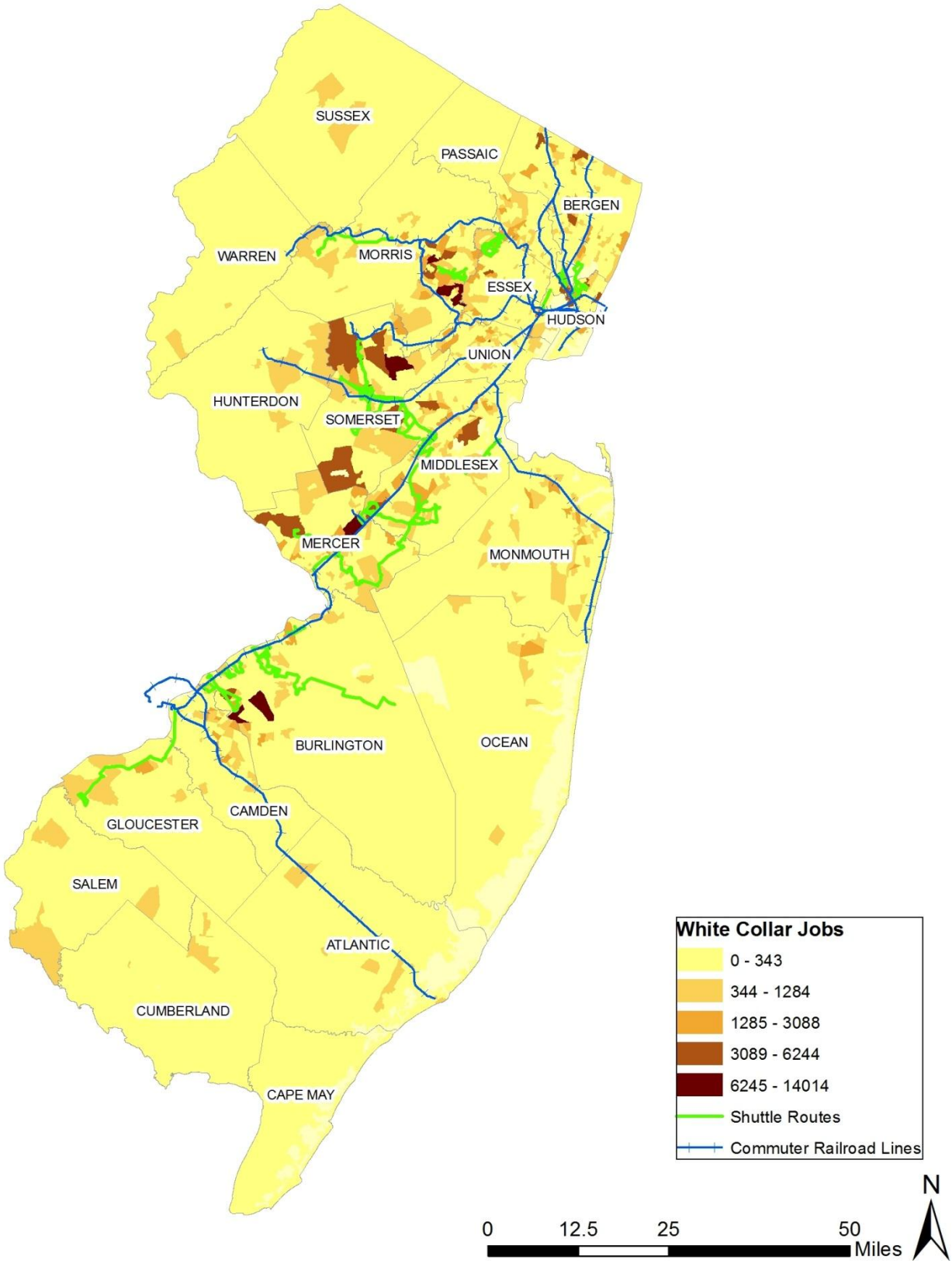

Figure 4 – "White Collar" Jobs per Block Group in Relation to "Last Mile" Shuttles

Figure 5 – "Last Mile" Shuttles in Relation to "Blue collar" and White Collar" Jobs in Central Jersey

Table 5 – Comparison of Block Group Jobs within "Last Mile" Shuttle Corridors and Control Corridors

		Last Mile Shuttle Corridor		Similar Corridor Without Shuttle	
	Block Group Location	**Mean Jobs per Block Group**	**F**	**Mean Jobs Per Block Group**	**F**
Total jobs	Outside buffer	561	63.90	595	13.80
	Inside buffer	1085		828	
Construction jobs	Outside buffer	21	41.99	21	11.77
	Inside buffer	37		30	
Manufacturing jobs	Outside buffer	40	70.07	48	5.47
	Inside buffer	128		71	
Wholesale trade jobs	Outside buffer	35	56.98	40	4.34
	Inside buffer	92		55	
Retail trade jobs	Outside buffer	65	21.90	65	18.06
	Inside buffer	110		104	
Transportation and warehousing jobs	Outside buffer	24	13.56	30	.956[a]
	Inside buffer	60		21	
Professional, scientific, and technical services jobs	Outside buffer	45	24.34	48	6.61
	Inside buffer	98		74	
Management companies and enterprises jobs	Outside buffer	12	7.50	14	.31[a]
	Inside buffer	27		17	
Administrative support & waste management jibs	Outside buffer	38	33.70	41	6.10
	Inside buffer	84		60	
Educational services jobs	Outside buffer	59	4.50	57	7.18
	Inside buffer	89		94	
Health care and social assistance services jobs	Outside buffer	76	12.49	80	1.43[a]
	Inside buffer	130		98	
Arts, entertainment, and recreation jobs	Outside buffer	7	10.39	7	1.76[a]
	Inside buffer	13		9	
Accommodation and food services jobs	Outside buffer	33	13.85	32	30.77
	Inside buffer	51		57	
Other services jobs	Outside buffer	19	16.66	18	33.51
	Inside buffer	27		30	
Public administration jobs	Outside buffer	24	4.55	27	.00[a]
	Inside buffer	47		28	

[a] Not statistically significant at 5%

Several important observations can be made from the data in Table 5. First, like the "Last Mile" shuttle corridors, there are more jobs in the control corridors than the outer areas, but the number of jobs within the control corridors is substantially smaller than the "Last Mile" shuttle corridors. This indicates that the "Last Mile" corridors are more job rich than similar corridors without

shuttles. Second, the control corridors also have more jobs in the typical "blue collar" industries such as manufacturing, construction, and wholesale trade, but the difference between inside and outside corridors is far more substantial for the "Last Mile" shuttle corridors than the control corridors. Third, the shuttle corridors are also richer than the control corridors in "white collar" jobs such as administrative, professional, scientific, and technical categories. Fourth, for several industry types such as transportation and warehousing, health and social assistance, and public administration, the difference between the control corridors and outer areas is not significant, even though the difference is significant for the "Last Mile" shuttle corridors. However, the control corridors are richer than the shuttle corridors regarding jobs in food and accommodation and other services. Overall, jobs are more abundant in the "Last Mile" shuttle corridors than the control corridors.

4.4. Comparison of Jobs in the "Last Mile" Corridors with "First Mile" Corridors

The predominantly CMAQ-funded "First Mile" shuttles provide individuals access to transit nodes, whereas "Last Mile" shuttles, predominantly funded by the JARC program, provide access from transit nodes to job sites. As discussed in Section 3.2 of this report, 41 "First Mile" shuttle routes throughout New Jersey were identified and mapped, and data were compiled for the Block Groups that were within a half mile of the shuttle routes. Jobs in the "Last Mile" shuttle corridors were compared with jobs in the "First Mile" shuttle corridors in Table 6.

Table 6 shows jobs per Block Group in the "Last Mile" shuttle corridors and the "First Mile" shuttle corridors along with the ANOVA results. It is evident from the table that the total number of jobs per Block Group is more than twice in the "Last Mile" corridors compared to the "First Mile" corridors. In fact, the difference between total jobs within "Last Mile" corridors and "First Mile" corridors is greater than the difference between the "Last Mile" corridors and the control corridors, indicating that the "First Mile" corridors are the least job rich among the three types of corridors. Moreover, with the exception of jobs in education, information, and health sectors, jobs per Block Group is significantly greater in the "Last Mile" corridors than the "First Mile" corridors at 5% level. The differences are significantly greater in the "Last Mile" shuttle corridors for both "blue collar" jobs, such as manufacturing, as well as "white collar" jobs, such as administrative services. However, the F statistics indicate that the differences are generally larger for the "blue collar" jobs than "white collar" jobs.

Table 6 – Comparison of Block Group Jobs within "Last Mile" Shuttle Corridors and "First Mile" Shuttle Corridors

	Block Group Location	BGs	Mean Jobs	F	Sig.
Total jobs in BG	First Mile shuttle buffer	758	467	49.83	.000
	Last mile shuttle buffer	416	1145		
Construction jobs	First Mile shuttle buffer	758	17	35.47	.000
	Last mile shuttle buffer	416	41		
Manufacturing jobs	First Mile shuttle buffer	758	33	30.18	.000
	Last mile shuttle buffer	416	142		
Wholesale trade jobs	First Mile shuttle buffer	758	19	54.58	.000
	Last mile shuttle buffer	416	100		
Retail trade jobs	First Mile shuttle buffer	758	52	24.33	.000
	Last mile shuttle buffer	416	118		
Transportation and warehousing jobs	First Mile shuttle buffer	758	12	29.90	.000
	Last mile shuttle buffer	416	54		
Information jobs	First Mile shuttle buffer	758	13	1.93	.165
	Last mile shuttle buffer	416	19		
Finance and insurance jobs	First Mile shuttle buffer	758	28	4.96	.026
	Last mile shuttle buffer	416	72		
Real estate and rental and leasing jobs	First Mile shuttle buffer	758	9	9.05	.003
	Last mile shuttle buffer	416	14		
Professional, scientific, and technical services jobs	First Mile shuttle buffer	758	33	16.69	.000
	Last mile shuttle buffer	416	112		
Management companies and enterprises jobs	First Mile shuttle buffer	758	3	14.36	.000
	Last mile shuttle buffer	416	24		
Administrative support, waste management, and remediation services jobs	First Mile shuttle buffer	758	26	31.75	.000
	Last mile shuttle buffer	416	84		
Educational services jobs	First Mile shuttle buffer	758	57	1.41	.236
	Last mile shuttle buffer	416	79		
Health care and social assistance services jobs	First Mile shuttle buffer	758	85	3.45	.063
	Last mile shuttle buffer	416	130		
Arts, entertainment, and recreation jobs	First Mile shuttle buffer	758	6	5.74	.017
	Last mile shuttle buffer	416	15		
Accommodation and food services jobs	First Mile shuttle buffer	758	30	19.62	.000
	Last mile shuttle buffer	416	54		
Other services jobs	First Mile shuttle buffer	758	18	19.06	.000
	Last mile shuttle buffer	416	31		
Public administration jobs	First Mile shuttle buffer	758	25	4.02	.045
	Last mile shuttle buffer	416	49		

Note: Agriculture, Mining, and utilities jobs not shown because of the small number of jobs.

4.5. Jobs-Workers Ratios in the "Last Mile" Shuttle Corridors

A comparison of jobs-workers ratios in the "Last Mile" shuttle corridors with the "First Mile" shuttle corridors and the control corridors provides additional insights. First, a high jobs-workers ratio in an area would indicate that the area is job rich, whereas a very low ratio would indicate that it is a predominantly residential area. Second, since shuttles often pick up and drop off passengers at short intervals, a balanced jobs-workers ratio (close to 1) in an area could potentially make it more conducive for shuttle operation. In contrast, a very high jobs-workers ratio in a shuttle corridor would indicate that the jobs in the area are filled by workers from other areas. When the jobs-workers ratio in a corridor is very high, the two nodes – the train station and the job location – are likely to have primacy over all other points along the shuttle route. In such instances, shuttles are likely to be used primarily between the train station and one or two job concentrations.

Table 7 – Average Jobs-Workers Ratios in "Last Mile" Shuttle, "First Mile" Shuttle and Control Corridors

	"Last Mile" Shuttle Corridors	"First Mile" Shuttle Corridors	Control Corridors
Mean	3.87	1.13	1.48
Highest	12.32	3.33	4.88
Lowest	0.42	0.18	0.28
Standard Deviation	3.48	0.80	0.97

The average jobs-workers ratio in the "Last Mile" shuttle corridors is compared with "First Mile" and control corridors in Table 7. Although the average ratio is greater than 1 for all three types of corridors (indicating that they have more jobs than workers), the ratio is the highest for the "Last Mile" shuttle corridors. On average, the "Last Mile" shuttle corridors have almost four jobs for one worker, once again showing that they have far more jobs compared to the other two corridor types.

The jobs-workers ratios for each of the "Last Mile" shuttle corridors are shown in Table 8. It is evident from the table that the jobs-workers ratio is the highest for the MCAT-M6 shuttle, followed by the Pureland shuttle. The MCAT-M6 Shuttle provides service between Jamesburg and Princeton Junction Rail Station in West Windsor Township and serves parts of Monroe, Cranbury and Plainsboro Townships. The high jobs-workers ratio in this corridor is because of the large regional employment center near Exit 8A of the New Jersey Turnpike in Jamesburg. On the other hand, the jobs-workers ratio in the Pureland corridor is high because of a large number of jobs in the 3,000 acre Pureland Industrial Complex in Gloucester County. Although the shuttle route is approximately 28 miles between Walter Rand Transportation Center in Camden City and the Pureland industrial complex, the Block Groups along the freeway segments of the route were eliminated in this analysis (because no one can board shuttles on freeways). The high jobs-workers ratio for the Pureland shuttle is partially because of the exclusion of these Block Groups, but the ratio is representative of the route because the shuttle's predominant purpose is to give

access to workers between the transit station and the industrial complex. The jobs-workers ratio is the lowest for the Kearny shuttle because it operates almost entirely on Kearny Avenue with residential developments on both sides. The ratios are also low for the routes in Burlington County, where many jobs sites are surrounded by residential developments.

Table 8 – Jobs-Workers Ratios in the "Last Mile" Shuttle Corridors

	Shuttle Route	Jobs-Workers Ratio
1	Burlink1	1.19
2	Burlink2	0.54
3	Burlink5	0.52
4	Burlink8	0.50
5	Burlink9	2.58
6	Burlink10	1.27
7	CAT_1R	2.44
8	CAT_2R	2.94
9	Dash1	2.36
10	Dash2	2.32
11	Scoot-peak	1.84
12	Scoot_R1	1.62
13	Scoot_R2	1.68
14	MCAT - M1	9.87
15	MCAT - M4	3.64
16	MCAT - M5	1.79
17	MCAT - M6	12.32
18	MCAT - M7	1.25
19	MOM - Dover Netcong	1.05
20	Mercer TrainLink	4.75
21	Hopewell Shuttle	3.39
22	Route 130 Connection	8.40
23	Pureland Shuttle	11.43
24	TransIT Link	7.63
25	Medford Shuttle	NA
26	Harmon Cove	8.89
27	Harmon Meadow	7.86
28	Secaucus-Carlstadt/Moonachie	2.46
29	Kearny	0.42
30	Lyndhurst	1.82
31	Fairfield & West Caldwell	7.51
32	Wayne/Fairfield/W. Caldwell	7.86
33	Route10	2.01
34	Meadowlands Shuttle	1.75

4.6. Job Mix in the "Last Mile" Shuttle Corridors

Shuttle corridors can have jobs in particular sectors or industries, such as manufacturing, or a mix of jobs in different sectors. To examine job mixes in the "Last Mile" shuttle corridors, a methodology is used that is commonly used for estimating land use mix of areas (Frank, Andersen, and Schmid, 2004). According to this method, job mix of shuttle corridor *x*, or J_x, is defined as:

$$J_x = \sum_{i=1}^{n} P_i \ln(P_i) / \ln(n)$$

where, P_i is the proportion of job in sector *i*, *n* is the number of sectors, and ln stands for natural log. The value of J_x lies between 0 and 1; it takes the value of 0 when there are jobs in only one sector in the corridor and 1 when jobs in different sectors are distributed perfectly evenly. A smaller value of the estimate for a corridor would indicate the dominance of one or two sectors, whereas a larger value would indicate a relatively uniform job mix.

The average job mix estimates for the "Last Mile" shuttle corridors are compared with the averages for the "First Mile" and the control corridors in Table 9. Three types of job mixes are presented in the table: (a) mix of "blue collar" jobs, consisting of manufacturing, construction, wholesale, transportation, and utilities sectors, (b) mix of "white collar" jobs, consisting of professional, management, finance, real estate, and administrative jobs, and (c) mix of all jobs, consisting of 18 sectors (excluding agriculture and mining because they have no relevance).

Table 9 – Comparison of Average Job Mix in "Last Mile" Shuttle Corridors with "First Mile" and Control Corridors

	"Blue collar" Jobs	"White Collar" Jobs	All Jobs
"Last Mile" Shuttle			
Mean	0.78	0.79	0.84
Highest	0.93	0.91	0.93
Lowest	0.52	0.39	0.62
Standard Deviation	0.09	0.12	0.07
"First Mile" Shuttle			
Mean	0.76	0.78	0.82
Highest	0.90	0.97	0.90
Lowest	0.35	0.51	0.64
Standard Deviation	0.11	0.11	0.06
Control Corridors			
Mean	0.78	0.82	0.84
Highest	0.90	0.92	0.91
Lowest	0.62	0.65	0.66
Standard Deviation	0.08	0.07	0.06

It is evident from Table 9 that the mean job mix estimates for the "Last Mile" shuttle corridors are fairly similar to the estimates for the "First Mile" shuttle and the control corridors. The similarity indicates that mix of jobs is not as important for the "Last Mile" shuttles as the number of jobs.

Table 10 – Job Mix Estimates in the "Last Mile" Shuttle Corridors

	Shuttle Route	All Jobs	Blue collar Jobs	White Collar Jobs
1	Burlink1	0.83	0.85	0.89
2	Burlink2	0.76	0.78	0.75
3	Burlink5	0.72	0.69	0.48
4	Burlink8	0.89	0.81	0.90
5	Burlink9	0.82	0.63	0.81
6	Burlink10	0.79	0.85	0.76
7	CAT_1R	0.89	0.78	0.86
8	CAT_2R	0.87	0.70	0.85
9	Dash1	0.88	0.80	0.89
10	Dash2	0.88	0.80	0.89
11	Scoot-peak	0.93	0.87	0.91
12	Scoot_R1	0.91	0.89	0.84
s13	Scoot_R2	0.90	0.87	0.84
14	MCAT - M1	0.88	0.72	0.86
15	MCAT - M4	0.80	0.69	0.80
16	MCAT - M5	0.74	0.73	0.89
17	MCAT - M6	0.87	0.74	0.76
18	MCAT - M7	0.83	0.85	0.81
19	MOM - Dover Netcong	0.87	0.89	0.67
20	Mercer TrainLink	0.76	0.63	0.68
21	Hopewell Shuttle	0.62	0.83	0.39
22	Route 130 Connection	0.89	0.86	0.81
23	Pureland Shuttle	0.84	0.84	0.90
24	TransIT Link	0.73	0.67	0.54
25	Medford Shuttle	NA	NA	NA
26	Harmon Cove	0.75	0.52	0.82
27	Harmon Meadow	0.86	0.75	0.80
28	Secaucus-Carlstadt/Moonachie	0.84	0.75	0.80
29	Kearny	0.89	0.93	0.64
30	Lyndhurst	0.90	0.82	0.81
31	Fairfield & West Caldwell	0.86	0.74	0.78
32	Wayne/Fairfield/W. Caldwell	0.86	0.75	0.80
33	Route10	0.92	0.78	0.89
34	Meadowlands Shuttle	0.88	0.81	0.79

Table 10 shows that the job mix estimates for all "Last Mile" shuttle corridors are closer to 1 than 0, indicating that the corridors generally have a reasonably high mix of different types of jobs. Job mix is high for the corridors irrespective of whether the mix is considered among "blue collar" jobs, "white collar" jobs, or all jobs. The small standard deviations relative to the means indicate that job mixes are consistently high across the shuttle corridors. In terms of all jobs, job mix is the lowest for the Hopewell Shuttle, a privately-funded service that connects Hamilton Rail Station to Merrill Lynch Hopewell campus. On the other hand, job mix is the highest in the SCOOT Peak shuttle corridor in Somerset County (operated by the County), a service that connects two train stations (Somerville and Far Hills) with several communities including Hillsborough, Manville, Somerville, and Bedminster. Regarding "white collar" job mix also, the SCOOT Peak shuttle ranks the highest and the Hopewell shuttle ranks the lowest. Regarding "blue collar" sector jobs, the mix is the lowest for the Harmon Cove shuttle corridor. This service, connecting Secaucus Junction Station to two large employers (Rose Brand and ARRI CSC), is also partially funded by private funds.

5. SOCIOECONOMIC, HOUSING, AND COMMUTING CHARACTERISTICS OF "LAST MILE" SHUTTLE CORRIDORS

Like other public transportation modes, shuttles' performance is expected to be associated with socioeconomic, housing, and commuting characteristics of the areas served. In general, public transportation is expected be successful in areas with high population and housing density and high proportions of zero-vehicle households, minority populations, and immigrant populations. Past studies have shown that "First Mile" shuttles are more likely to be successful in New Jersey in areas with moderate income, moderate housing density, and high proportion of immigrant and non-English populations (Deka, Carnegie and Bilton, 2010; Deka, Carnegie and Kabak, 2011). To examine the socioeconomic, housing, and commuting characteristics of the "Last Mile" shuttle corridors, these corridors are compared with areas not served by the shuttles, "First Mile" corridors, and control corridors.

5.1. Comparison of "Last Mile" Corridors with Areas Not Served by Shuttles

In order to examine how the "Last Mile" shuttle corridors compared with other parts of the region regarding socioeconomic, housing, and commuting characteristics, a methodology similar to the one used for comparing job distribution in Section 4.2 was used. In addition to population density, race, ethnicity, income, household size, and education, variables such as vehicle ownership rate, commuting mode, and dwelling characteristics were also compared. Similar to the comparison of jobs, the outer areas were restricted to only those counties that had at least one "Last Mile" shuttle route. The ANOVA results are presented in Table 10, where only those characteristics are shown that were found to be significantly different in the shuttle corridors compared to the outer areas.

Overall, the socioeconomic, dwelling, and commuting characteristics of the "Last Mile" shuttle corridors resemble what is typical of middle-class suburban areas. It is evident from Table 11 that population density is lower in the "Last Mile" shuttle corridors than the outer areas. The low population density in the "Last Mile" shuttle corridors is also evident in Figure 6. While population density is the highest in the northeastern part of the state, followed by the Camden area in the southwest corner, most shuttles serve in other areas. Even the shuttles that operate in the northeastern and southwestern parts of the state operate in low density areas within those parts. For example, several routes operate in the low density Meadowland area between the high density areas of Hudson County and Essex County. Similarly, the shuttle routes in the southwestern part serve low density areas of Gloucester and Burlington Counties. Although as a transit mode, shuttles are better suited for areas with high population density, the "Last Mile" shuttles certainly are not focused on taking advantage of population density. It is evident from Table 11 that, consistent with population density, the "Last Mile" shuttle corridors have a lower proportion of housing structures with 5 or more dwelling units, but a higher proportion of single family attached units.

Like housing, the commuting characteristics of the "Last Mile" shuttle corridors do not possess the characteristics that are usually perceived to be conducive to shuttles. For example, as shown in Table 11, the share of commuting trips by automobile is higher and the shares by bus and train are lower in the "Last Mile" shuttle corridors compared to the areas outside. In addition, the proportion of households without vehicles is lower in the shuttle corridors than the areas outside. These characteristics seem to suggest that the shuttles predominantly serve the purpose of transporting workers from transit stations to job sites and play a less important role in serving residents of the corridors.

The socioeconomic characteristics of the "Last Mile" shuttle corridors are similar to typical middle-class suburban areas, including a large proportion of white and moderate income households and a high dependence on the automobile for commuting. The characteristics that are usually perceived to be associated with urban areas and transit use, such as the proportions of minority households, foreign-born persons, and non-English speaking persons are lower in the shuttle corridors than the outer areas. The median income of households in the shuttle corridors is lower than the outer areas. They include a larger proportion of households in the middle-income range and a lower proportion of the wealthiest households. The population density as well as the scocioeconomic, housing, and commuting characteristics together provide a picture of the shuttle corridors that is not conducive to public transportation in general. Under the given circumstances, the "Last Mile" shuttles cannot possibly serve multiple purposes of providing mobility to a diverse set of passengers who travel for different purposes.

Table 11 – ANOVA Results Comparing Block Group Socioeconomic Characteristics Within and Outside Half-mile Buffer of "Last Mile" Shuttle Routes Estimated for Counties with Shuttles

	Block Group Location	Number of Block Groups	Mean	F	Sig.
Population density (per acre)	Outside buffer	3893	17	49.86	.000
	Inside buffer	576	11		
Percent zero-vehicle households	Outside buffer	3880	.13	7.62	.006
	Inside buffer	576	.11		
Percent Black persons	Outside buffer	3893	.16	4.46	.035
	Inside buffer	576	.14		
Percent bachelor degree or higher for 25 and over	Outside buffer	3891	.35	33.69	.000
	Inside buffer	576	.29		
Median household income ($)	Outside buffer	3866	77,257	14.06	.000
	Inside buffer	573	70,693		
Percent with income between $25-50k	Outside buffer	3880	.19	3.98	.046
	Inside buffer	576	.20		
Percent with income between $50-75k	Outside buffer	3880	.17	16.63	.000
	Inside buffer	576	.19		
Percent with income between $75-100k	Outside buffer	3880	.13	5.75	.017
	Inside buffer	576	.14		
Percent with income $150k and over	Outside buffer	3880	.16	28.86	.000
	Inside buffer	576	.12		
Percent non-English speaking households	Outside buffer	3880	.33	10.44	.001
	Inside buffer	576	.30		
Percent foreign born persons (2000)	Outside buffer	3821	.20	14.11	.000
	Inside buffer	562	.18		
Percent households with 1 or 2 persons in household	Outside buffer	3880	.54	4.97	.026
	Inside buffer	576	.55		
Percent single family attached	Outside buffer	3880	.08	64.02	.000
	Inside buffer	576	.13		
Percent with 5-9 units in dwelling structure	Outside buffer	3880	.05	4.43	.035
	Inside buffer	576	.04		
Percent with 10 or more units in dwelling structure	Outside buffer	3880	.14	6.31	.012
	Inside buffer	576	.12		
Percent workers who drove alone	Outside buffer	3877	.68	24.94	.000
	Inside buffer	575	.73		
Percent workers who took bus	Outside buffer	3877	.09	61.73	.000
	Inside buffer	575	.05		
Percent workers who took rail	Outside buffer	3877	.03	10.88	.001
	Inside buffer	575	.02		

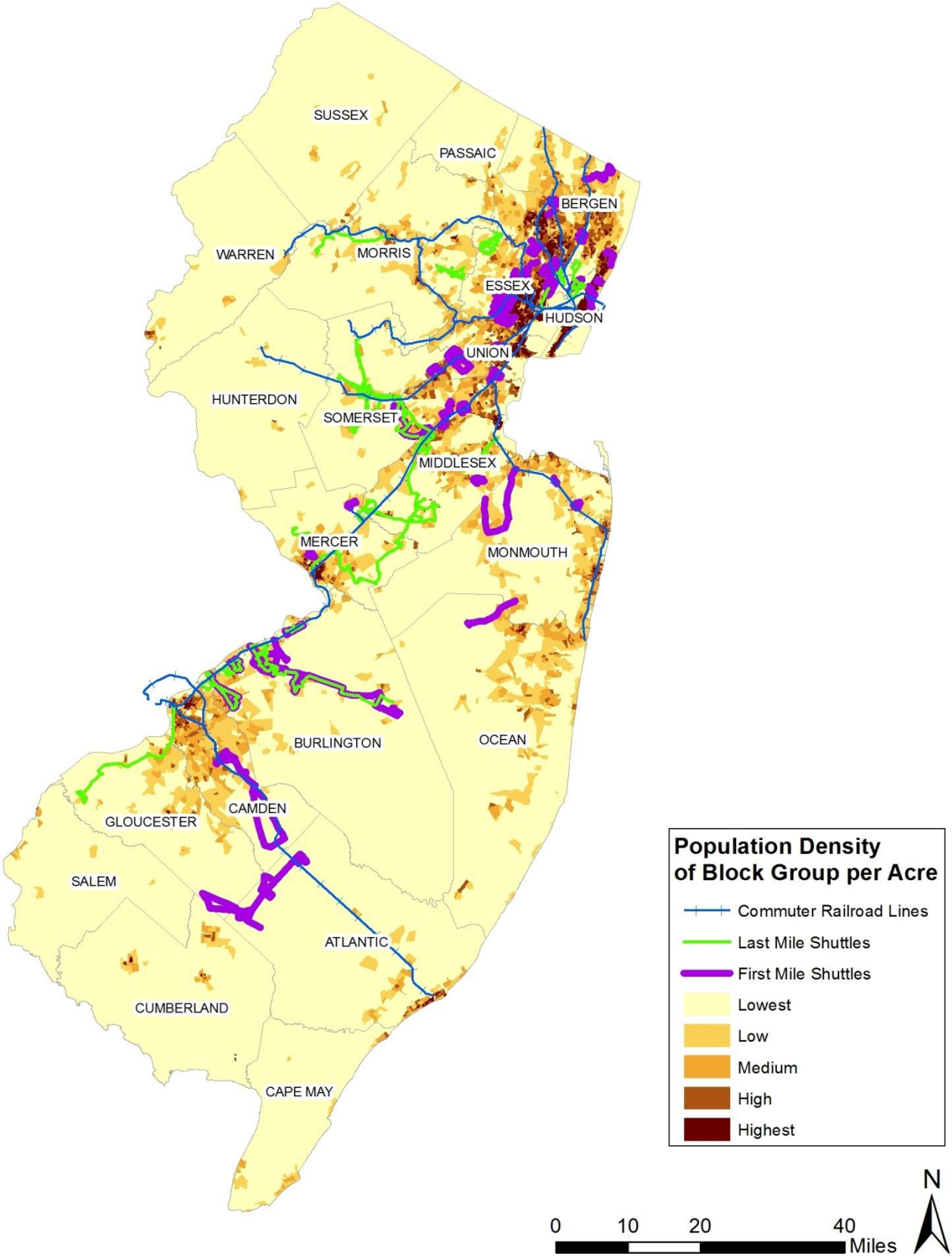

Figure 6 – Population Density in Relation to the "Last Mile" Shuttle Routes

5.2. Comparison of "Last Mile" Shuttle Corridors with Control Corridors

The socioeconomic, housing and commuting characteristics of the Block Groups in the "Last Mile" shuttle corridors are compared with the Block Groups within the control corridors in Table 12. Only those characteristics are presented in the table that showed significant differences between the "Last Mile" shuttle corridors and outer areas in Table 11. It is evident from the comparisons in Table 12 that some of the characteristics, such as proportion of minority populations and foreign-born persons, are identical in the "Last Mile" corridors as the control corridors. However, differences exist in many other regards, including population density, commuting mode, and housing type. The "Last Mile" corridors have lower population density, a higher proportion of automobile users and a lower proportion of bus and rail users, and a higher proportion of single family attached homes than the control corridors. These characteristics make the "Last Mile" shuttle corridors less conducive to transit than the control corridors.

5.3. Comparison of "Last Mile" Shuttle Corridors with Control Corridors

The socioeconomic characteristics of the "Last Mile" shuttle corridors are compared with the "First Mile" shuttle corridors in Table 13. For this analysis, the Block Groups that were within both "Last Mile" and "First Mile" shuttle corridors were excluded.

Table 13 shows that the differences between "Last Mile" and "First Mile" shuttle corridors are far more startling than the differences between "Last Mile" shuttle corridors and the control corridors shown in Table 12. First, the "Last Mile" shuttle corridors have significantly lower proportions of foreign-born, non-English speaking, and linguistically isolated persons. Since these populations are often considered typical shuttle users, the "Last Mile" shuttle routes are located in relatively disadvantageous areas. Some other characteristics typically associated with high transit use, such as population density, proportion of zero-vehicle households, proportion of multi-family housing units, and proportion of minority populations, are also significantly lower in the "Last Mile" corridors compared to the "First Mile" corridors. Not surprisingly, the proportion of commuters who drive to work is significantly higher in the "Last Mile" corridors, while the proportion of workers who take rail or bus is significantly lower.

The comparison of the socioeconomic, housing, and commuting characteristics of "Last Mile" shuttle corridors with areas not served by shuttles, control corridors, and "First Mile" shuttle corridors show that the "Last Mile" routes are not located in areas where the characteristics are conducive to shuttle use, or more generally, transit use. Because of the characteristics of the areas served, the "Last Mile" shuttles cannot be expected to provide access to diverse types of passengers traveling between many points along the route. The "Last Mile" shuttles can only be perceived as a mode that provides access to workers between transit nodes and selected job sites such as industrial parks. Since these shuttles primarily serve the workers who work in the areas where service is provided instead of the residents who live there, the role of employers in providing this type of service appears to be more significant than the role of municipalities.

Table 12 – ANOVA Results Comparing Block Group Socioeconomic, Housing, and Commuting Characteristics of "Last Mile" Shuttle Corridors with Control Corridors

		"Last Mile" Corridor		Control Corridor	
	Shuttle access to Block Group	**Mean**	**F**	**Mean**	**F**
Population density (per acre)	Outside buffer	17	49.86	17	14.01
	Inside buffer	11		13	
Percent zero-vehicle households	Outside buffer	.13	7.62	.14	15.91
	Inside buffer	.11		.11	
Percent Black persons	Outside buffer	.16	4.46	.16	3.34[a]
	Inside buffer	.14		.14	
Percent bachelor degree or higher for 25 and over	Outside buffer	.35	33.69	.34	5.78
	Inside buffer	.29		.36	
Median household income ($)	Outside buffer	77,257	14.06	76,321	.13[a]
	Inside buffer	70,693		76,928	
Percent with income between $25-50k	Outside buffer	.19	3.98	.18	9.21
	Inside buffer	.20		.16	
Percent with income between $50-75k	Outside buffer	.17	16.63	.19	.23[a]
	Inside buffer	.19		.19	
Percent with income between $75-100k	Outside buffer	.13	5.75	.17	2.43[a]
	Inside buffer	.14		.18	
Percent with income $150k and over	Outside buffer	.16	28.86	.15	.08[a]
	Inside buffer	.12		.16	
Percent non-English speaking households	Outside buffer	.33	10.44	.33	26.91
	Inside buffer	.30		.28	
Percent foreign born persons (2000)	Outside buffer	.20	14.11	.20	13.60
	Inside buffer	.18		.18	
Percent households with 1 or 2 persons in household	Outside buffer	.54	4.97	.54	3.04[a]
	Inside buffer	.55		.55	
Percent single family attached	Outside buffer	.08	64.02	.09	.03[a]
	Inside buffer	.13		.08	
Percent with 5-9 units in dwelling structure	Outside buffer	.05	4.43	.05	1.10
	Inside buffer	.04		.04	
Percent with 10 or more units in dwelling structure	Outside buffer	.14	6.31	.14	.91[a]
	Inside buffer	.12		.13	
Percent workers who drove alone	Outside buffer	.68	24.94	.69	12.52
	Inside buffer	.73		.71	
Percent workers who took bus	Outside buffer	.09	61.73	.08	9.97
	Inside buffer	.05		.07	
Percent workers who took rail	Outside buffer	.03	10.88	.03	.00[a]
	Inside buffer	.02		.03	

[a] Not significant at 5% level

Table 13 – ANOVA Results Comparing Block Group Socioeconomic, Housing, and Commuting Characteristics of "Last Mile" Corridors with "First Mile" Corridors

		BGs	Mean	F	Sig.
Population density per acre	First Mile shuttle buffer	769	23	84.68	.000
	Last Mile shuttle buffer	416	10		
Percent zero-vehicle households	First Mile shuttle buffer	766	.15	7.30	.007
	Last Mile shuttle buffer	416	.12		
Percent Black persons	First Mile shuttle buffer	769	.21	25.76	.000
	Last Mile shuttle buffer	416	.13		
Percent linguistically isolated households	First Mile shuttle buffer	766	.10	5.48	.019
	Last Mile shuttle buffer	416	.08		
Percent non-English speaking households	First Mile shuttle buffer	766	.36	7.28	.007
	Last Mile shuttle buffer	416	.32		
Percent foreign born persons (2000)	First Mile shuttle buffer	763	.25	33.96	.000
	Last Mile shuttle buffer	404	.19		
Percent bachelor degree or higher for age 25 and over	First Mile shuttle buffer	767	.37	43.21	.000
	Last Mile shuttle buffer	416	.29		
Median household income	First Mile shuttle buffer	766	77,728	8.51	.004
	Last Mile shuttle buffer	413	71,076		
Percent with income $150k and over	First Mile shuttle buffer	766	.16	13.90	.000
	Last Mile shuttle buffer	416	.12		
Percent renter occupied units	First Mile shuttle buffer	766	.39	11.61	.001
	Last Mile shuttle buffer	416	.33		
Percent single family detached homes	First Mile shuttle buffer	766	.49	6.22	.013
	Last Mile shuttle buffer	416	.54		
Percent single family attached homes	First Mile shuttle buffer	766	.05	123.44	.000
	Last Mile shuttle buffer	416	.15		
Percent dwellings with 2-4 units	First Mile shuttle buffer	766	.21	27.86	.000
	Last Mile shuttle buffer	416	.15		
Percent dwellings with 10 or more units	First Mile shuttle buffer	766	.19	29.44	.000
	Last Mile shuttle buffer	416	.12		
Percent workers who drove alone	First Mile shuttle buffer	768	.63	63.65	.000
	Last Mile shuttle buffer	415	.72		
Percent workers who took bus	First Mile shuttle buffer	768	.11	92.64	.000
	Last Mile shuttle buffer	415	.04		
Percent workers who took rail	First Mile shuttle buffer	768	.05	47.72	.000
	Last Mile shuttle buffer	415	.02		

Note: Other income categories are not different; Hispanic not different.

6. ANALYSIS OF 2005 NJ TRANSIT SURVEY DATA ON "FIRST MILE" AND "LAST MILE" SHUTTLE USERS

A 2005 NJ TRANSIT commuter rail passenger survey provides valuable information on the users of "Last Mile" and "First Mile" shuttles in New Jersey. The survey, conducted onboard all commuter rail lines except the Atlantic City line, collected data from 32,400 passengers. The survey was conducted predominantly in the AM peak period onboard inbound (New York bound) trains. The AM peak period trains accounted for 79% of the respondents, while the other 21% boarded trains at other times. Because of the time and direction of trains surveyed, most respondents (87%) were making trips to work. The survey included two questions on modes, one inquiring about the mode used to access boarding stations (access mode) and the other inquiring about mode used from station to the destination (egress mode). As indicated in Table 14, a small proportion of the passengers surveyed mentioned using shuttles as access and egress modes within New Jersey. As shown in the table, 588 passengers (525 workers) were using shuttles to the boarding station. These passengers can be termed the "First Mile" shuttle users. In contrast, 325 passengers (280 workers) were using shuttles from a station to the destination. These passengers can be considered "Last Mile" shuttle users.

Table 14 – "First Mile" and "Last Mile" Shuttle Users in New Jersey According to the 2005 NJ TRANSIT Commuter Rail Survey

	All Passengers		Commuters	
	Frequency	**Percent**	**Frequency**	**Percent**
Did not take any shuttle	31,479	97.2%	26,849	97.1%
Took shuttle to boarding station	588	1.8%	525	1.9%
Took shuttle from station to destination	325	1.0%	280	1.0%
Took shuttle to and from station	8	0.0%	6	0.0%
Total	**32,400**	**100.0%**	**27,660**	**100.0**

Using data from the NJ TRANSIT survey, the demographic and socioeconomic characteristics of the "First Mile" and "Last Mile" shuttle users are compared with passengers who did not use shuttles at either end. The comparison is presented in Table 15. The purpose of this comparison is to examine whether, and to what extent, each type of shuttle users is different from the shuttle non-users.

From the comparison of income, it is evident that the proportion of workers in moderate income level ($25,000-$74,999) is significantly higher for both "First Mile" and "Last Mile" shuttle users. In contrast, the proportion of workers in the highest income level ($150,000 and over) is lower for both "First Mile" and "Last Mile" shuttle users than shuttle non-users. The proportion is the lowest for the "Last Mile" shuttle users among the three groups, indicating overall that the "Last Mile" shuttle users include the least proportion of persons from the highest income households.

Table 15 –Characteristics of "First Mile" Shuttle Users, "Last Mile" Shuttle Users and Shuttle Non-Users According to NJ TRANSIT Commute Rail Survey

	Did not Use Shuttles	"First Mile" Users	"Last Mile" Users
Household Income[a]			
Under $25,000	4.9%	4.0%	5.8%
$25,000-49,999	10.5%	10.8%	12.0%
$50,000-74,999	14.2%	20.0%	18.2%
$75,000-99,999	15.9%	17.1%	21.0%
$100,000-149,999	23.7%	24.0%	23.7%
$150,000 or higher	30.8%	24.0%	19.2%
N	27,229	520	291
Race[a]			
White	71.5%	58.3%	68.6%
African American or Black	11.1%	14.6%	13.8%
Asian or Pacific Islander	13.2%	24.1%	13.8%
American Indian	0.7%	0.7%	1.0%
Other	3.6%	2.3%	2.9%
N	29,070	556	312
Language Spoken at Home[a]			
English	76.0%	70.4%	78.7%
Non-English	24.0%	29.6%	21.3%
N	29,658	564	314
Age[a]			
Under 18 years old	1.4%	0.7%	4.4%
18-24 years old	6.8%	5.8%	7.5%
25-34 years old	21.1%	32.3%	17.6%
35-44 years old	30.3%	28.8%	23.9%
45-54 years old	26.1%	18.1%	28.0%
55-64 years old	11.9%	12.5%	17.0%
65 years and over	2.4%	1.8%	1.6%
N	30,035	569	318
Gender[a]			
Male	58.7%	53.1%	46.7%
Female	41.3%	46.9%	53.3%
N	29,972	569	317
Home Ownership[a]			
Own	76.5%	60.2%	73.6%
Rent	23.5%	39.8%	26.4%
N	29,511	558	311
Current Residence[a]			
Less than 6 months	6.9%	10.6%	6.3%
Between 6-12 months	9.2%	10.8%	7.9%
Between 1-2 years	11.4%	16.4%	9.5%
Between 2-5 years	23.3%	26.3%	23.2%
Between 5-10 years	20.3%	16.6%	21.9%
More than 10 years	28.8%	19.3%	31.1%
N	29,836	566	315

Source: 2005 NJ TRANSIT commuter rail onboard survey

[a] Differences significant at 5% on a Chi-square test

It is evident from Table 15 that the proportion of persons with less than $25,000 household income is lower and the proportion of African Americans is higher among the "Last Mile" shuttle users compared to the shuttle non-users. Beyond these characteristics, however, the "Last Mile" shuttle users are more similar to the shuttle non-users than the "First Mile" shuttle users. The proportion of white persons using "First Mile" shuttles is noticeably lower than the "Last Mile" shuttle users and the shuttle non-users. On the other hand, the proportion of Asians or Pacific Islanders among the "First Mile" shuttle users is significantly higher than the other two groups. The proportion of non-English speakers among the "Last Mile" shuttle users is slightly lower than shuttle non-users, but substantially lower than "First Mile" shuttle users.

Regarding age and gender, the "Last Mile" shuttle users are distinct from the "First Mile" shuttle users and shuttle non-users. The greater proportion of persons in age 45-64 and lower proportion of persons in age 18-44 indicate that the "Last Mile" shuttle users on average are older than the "First Mile" shuttle users and shuttle non-users. The gender distribution shows that the proportion of women among both types of shuttle users is higher than shuttle non-users, but the proportion is the highest for the "Last Mile" shuttle users. Only among the "Last Mile" shuttle users the proportion of women is higher than men.

Regarding home ownership and length of stay in current residence, the "Last Mile" shuttle users are more similar to shuttle non-users than the "First Mile" shuttle users. The "First Mile" shuttle users are distinct from the other two groups in terms of home ownership as the proportion of renters among them is higher. The proportion of persons living in current residence for long durations is lower for this group. In contrast, the "Last Mile" shuttle users are similar to shuttle non-users regarding home ownership and length of stay at current residence.

The comparison of the "Last Mile" shuttle users with the "First Mile" shuttle users and shuttle non-users provides some evidence about their characteristics. According to the survey results, the "Last Mile" shuttle users are of more modest means, they are slightly older, and women constitute a larger share of them than the shuttle non-users. The "First Mile" shuttle users are also of more modest means than the shuttle non-users, but they differ from both non-users and "Last Mile" shuttle users in terms of race, language, and home ownership.

Although many of the respondents were traveling for work purposes during the survey, the "Last Mile" shuttle users in the NJ TRANSIT survey may not be representative of the typical JARC-funded, employment-oriented shuttle users. A review of the deboarding stations of the respondents showed that they were taking shuttles from stations where the typical JARC-funded shuttles did not operate. Furthermore, many respondents reported taking shuttles to Newark Airport, presumably confusing between regular shuttles and airport shuttles. A review of the deboarding stations suggests that many respondents might have confused between jitneys and shuttles. It will be evident from the following sections that the characteristics of employment-oriented "Last Mile" shuttle users are quite different from the characteristics of the passengers who reported using "Last Mile" shuttles in the NJ TRANSIT survey.

7. VTC SURVEY OF "LAST MILE" SHUTTLE PASSENGERS AND ANALYSIS

A survey of "Last Mile" passengers was conducted by researchers at the Alan M. Voorhees Transportation Center of Rutgers University during the months of September-December, 2011. The survey was conducted in the morning and afternoon peak periods onboard the shuttles by surveyors certified by the Rutgers University's Institutional Review Board (IRB). Passengers who were unable or unwilling to complete the survey onboard were given the opportunity to mail back the completed survey in postage-paid envelopes. The survey questionnaire contained a variety of questions, including reasons for using shuttles, origins and destinations, characteristics of work places, and socioeconomic and demographic characteristics of the respondents. The survey included a total of 45 questions and took between 10-15 minutes to complete. The survey questionnaire is attached as Appendix 1 of this report.

The sample frame for the survey was the 34 shuttle routes listed in Table 1 of this report. Eighteen of 34 routes were selected for the survey on the basis of ridership and geographic diversity. The selection was based on ridership to maintain a certain level of proportionality between riders and respondents. Geographic diversity was sought to obtain a greater mix of riders traveling to different types of locations. The 18 routes where passengers were surveyed are shown in Table 16 together with the number of completed surveys (i.e. respondents) for each route.

Table 16 – Completed Surveys by "Last Mile" Shuttle Route

Routes Surveyed	Provider	Respondents	Percent
Burlink1	Cross County Connection	22	7.1%
Meadowlands Shuttle	Meadowlink TMA	16	5.1%
Fairfield & West Caldwell	Meadowlink TMA	13	4.2%
Harmon Cove	Meadowlink TMA	42	13.5%
Route10	Meadowlink TMA	8	2.6%
Wayne/Fairfield/W. Caldwell	Meadowlink TMA	18	5.8%
Lyndhurst	Meadowlink TMA	16	5.1%
MCAT - M1	Middlesex County Area Transit	30	9.6%
MCAT - M4	Middlesex County Area Transit	45	14.5%
MCAT - M5	Middlesex County Area Transit	3	1.0%
MCAT - M6	Middlesex County Area Transit	3	1.0%
MOM - Dover Netcong	Morris County	13	4.2%
DASH1	Somerset County Transportation	30	9.6%
DASH2	Somerset County Transportation	23	7.4%
SCOOT Peak	Somerset County Transportation	8	2.6%
Pureland Shuttle	South Jersey Transportation Authority	12	3.9%
TransIT Link	South Jersey Transportation Authority	5	1.6%
Medford Shuttle	South Jersey Transportation Authority	4	1.3%
Total		**311**	**100.0%**

As shown in Table 16, a total of 311 respondents completed the survey. Number of respondents ranged from 3 to 45 for the surveyed routes. The reason for the variation is manifold. First, passengers on the longer routes had more time to complete the survey than passengers on shorter routes. In some of the shorter routes, it was virtually impossible for passengers to complete the survey before getting off. Almost all responses from such routes were mail-back responses. The second reason for the variation in number of respondents was a variation in ridership across the routes. Although the responses received from each route were not exactly proportional to ridership, more surveys were collected from the lines with the highest ridership. For example, a larger number of surveys were collected from MCAT-M1 and MCAT-M4 – the shuttle routes with the highest ridership. More surveys were also collected from the Harmon Cove shuttle because data could not be collected from the Harmon Meadow shuttle that operates in close proximity.

The number of survey respondents for many routes is not adequate for conducting route-specific analysis. However, the number of respondents from all routes is large enough for conducting statistical analysis for the whole sample and comparing respondents by service provider.

7.1. Demographic and Socioeconomic Characteristics of the Survey Respondents

The demographic and socioeconomic characteristics of the VTC survey respondents are presented in Table 17. The characteristics of the New Jersey population are also shown in the table as a reference. It is evident from the table that compared to the state's population, the "Last Mile" shuttle users are younger, less affluent, and include greater proportions of minority and immigrant populations.

A comparison between the "Last Mile" shuttle passengers in the 2005 NJ TRANSIT survey and the VTC survey respondents shows that the two groups are substantially different from each other. With the exception of language spoken at home, large differences can be observed regarding all characteristics. Among the NJ TRANSIT survey respondents, the proportion of women was 53%, whereas their proportion in the VTC survey was 42%. Among the "Last Mile" shuttle users in the NJ TRANSIT survey, the proportion of African Americans or Black was only 14%, whereas their proportion in the VTC survey was 38%. In the NJ TRANSIT survey, the proportion of persons in age 18-34 was approximately 25%, whereas their proportion in the VTC survey was approximately 46%. According to the VTC survey, the "Last Mile" shuttle users are far younger than found in the NJ TRANSIT survey. The starkest difference between the "Last Mile" shuttle users in the NJ TRANSIT survey and the VTC survey respondents can be observed in terms of household income. While less than 6% of the NJ TRANSIT survey respondents belonged to households with less than $25,000 annual income and 12% belonged to households with income $25,000-$49,999, the respective proportions among the VTC survey respondents were 38% and 30%. The differences between the two sets of survey respondents show that the NJ TRANSIT survey respondents used a much wider variety of shuttles than the shuttles used by the VTC survey respondents.

Table 17 – Socioeconomic and Demographic Characteristics of VTC Survey Respondents

	Respondents	Percent	NJ Population Percent[a]
Gender			
Female	111	41.6%	51.3%
Male	156	58.4%	48.7%
Total	267	100.0%	100.0%
Age			
18-24	34	13.2%	11.6%
25-34	85	32.9%	16.4%
35-44	62	24.0%	18.3%
45-54	48	18.6%	20.4%
55-64	24	9.3%	15.6%
65+	5	1.9%	17.6%
Total	258	100.0%	100.0%
Race and Ethnicity			
White	100	40.2%	68.6%
Black or African American	95	38.2%	14.4%
Asian	36	14.5%	8.8%
American Indian	1	0.4%	0.8%
Other or mixed	17	6.8%	7.4%
Total	249	100.0%	100.0%
Language Spoken at Home			
English only	206	77.7%	70.3%
Non-English	27	22.3%	29.7%
Total	265	100.0%	100.0%
Country of Birth			
In the USA	171	65.5%	79.7%
Outside USA	90	34.5%	20.3%
Total	261	100.0%	100.0%
Annual Household Income			
Less than $25,000	80	38.1%	17.2%
$25,000-$49,999	63	30.0%	19.1%
$50,000-$74,999	37	17.6%	16.9%
$75,000-$99,999	13	6.2%	13.5%
$100,000-$149,999	12	5.7%	17.3%
$150,000 or higher	5	2.4%	16.1%
Total	210	100.0%	100.0%
Highest Level of Education			
Less than high school	17	6.9%	12.7%
High school graduate or GED	62	25.1%	29.8%
Some college	64	25.9%	16.7%
Two-year college degree	23	9.3%	6.2%
Four-year college degree	51	20.6%	21.6%
Graduate degree	30	12.1%	13.0%
Total	247	100.0%	100.0%

[a] Source: American Community Survey, 2006-2010

Another reason for the difference between the "Last Mile" shuttle passengers in the NJ TRANSIT survey and the passengers in the VTC survey is that the NJ TRANSIT survey was conducted onboard commuter trains, while the VTC survey was conducted onboard shuttle vehicles. While it is a well-known fact that commuter rail users are economically better off than other mode users, many VTC survey respondents did not use this mode before boarding the shuttles. In addition, only a small proportion of the "Last Mile" shuttle users in the NJ TRANSIT survey used the "Last Mile" shuttles surveyed by VTC. Many of the "Last Mile" shuttle users in the NJ TRANSIT survey mentioned boarding shuttles at Hoboken Terminal, Newark Broad Street Station, Newark Airport Station, and several stations served by "First Mile" shuttles. Although most of the respondents in the NJ TRANSIT survey were using shuttles to access work places from stations, these shuttles appear to be far more diverse than the shuttles surveyed by VTC. A variety of services, including exclusive community shuttles, private shuttles, airport shuttles, and jitneys, were not included in the VTC survey.

7.2. Housing and Household Characteristics of the Survey Respondents

The housing and household characteristics of the respondents from the "Last Mile" shuttle survey conducted by VTC are shown in Table 18. Their dwelling type, home ownership, and vehicle ownership patterns are characteristic of low- to moderate-income households. While 64% of the state's residents live in single family homes, only 40% of the survey respondents did so. Around 28% of the survey respondents lived in structures with ten or more units compared to 15% of the state's population and 12% of the residents living in the shuttle corridors (see Table 11). An overwhelming 81% of the survey respondents reported living in rented dwellings compared to only 35% of the state's population. The high proportion of renters is consistent with lower incomes and a greater proportion of foreign-born persons among the shuttle users.

The characteristic that distinguishes the "Last Mile" Shuttle users the most from the state's population is vehicle ownership. More than half of the survey respondents belonged to a household without a single vehicle. In contrast, less than 12% of the households in the state did not own any vehicle. The proportion of households with two or more vehicles in the state is more than three times that of the survey respondents. The low vehicle ownership rate among the survey respondents is consistent with their low income and residence in rented units in apartment complexes. The greater proportion of foreign-born immigrants may also be a reason for their low vehicle ownership rate.

The average household size for the survey respondents is 3.33 persons per household compared to 2.69 persons for the state of New Jersey. As shown in Table 18, the proportion of households with five or more persons among the survey respondents is almost twice that of the state population. It was shown in Table 17 that the survey respondents have a substantially lower household income than the state population. The large household size of the survey respondents suggests that their incomes are even lower when income is considered on a per capita basis.

Table 18 – Housing and Household Characteristics of VTC Survey Respondents

	Respondents	Percent	NJ Population Percent[a]
Dwelling Type			
Single family home	103	39.9%	63.7%
Duplex	39	15.1%	9.5%
Building with 3-9 units	44	17.1%	11.6%
Building with 10 or more units	72	27.9%	15.1%
Total	258	100.0%	100.0%
Home Ownership			
Owns home	49	18.9%	65.4%
Rents home	210	81.1%	34.6%
Total	259	100.0%	100.0%
Number of Vehicles in Household			
None	128	51.0%	11.7%
One	79	31.5%	34.2%
Two	32	12.7%	36.9%
Three or more	12	4.8%	17.2%
Total	251	100.0%	100.0%
Number of Persons in Household			
One person	41	18.3%	26.0%
Two persons	55	24.6%	30.3%
Three persons	37	16.5%	17.3%
Four persons	42	18.8%	15.9%
Five or more persons	49	21.9%	10.5%
Total	224	100.0%	100.0%
Number of Children in Household			
No child	130	57.0%	NA
One child	41	18.0%	NA
Two children	32	14.0%	NA
Three or more children	25	11.0%	NA
Total	228	100.0%	NA

[a] Source: American Community Survey, 2006-2010

7.3. Duration of Shuttle Use and Fare Payment

Table 19 shows how long the survey respondents had been using shuttles. The distribution shows that approximately 44% of the respondents started using the specific shuttle service within the past year and almost half of them started using the service within the past three months. However, while the proportion of new riders is high among the respondents, the proportion of respondents who used the service more than two years is also high (38%). The distribution of duration seems to suggest that the shuttle users are of two types, one type uses the shuttles on a temporary basis, whereas the other type uses them on a permanent basis. It is evident from Table 19 that the distribution of duration remains similar when the respondents are restricted to only those who made the shuttle trips to work.

Table 19 – Duration of Shuttle Use by Survey Respondents

	All Respondents		Respondent's Origin or Destination is Work		Respondent's Destination is Work	
	Respondents	**Percent**	**Respondents**	**Percent**	**Respondents**	**Percent**
Less than 3 months	63	20.6%	44	19.1%	36	18.9%
3 to 6 months	38	12.4%	25	10.9%	21	11.1%
6 to 12 months	34	11.1%	27	11.7%	23	12.1%
1 to 2 years	54	17.6%	42	18.3%	37	19.5%
2 to 5 years	80	26.1%	65	28.3%	52	27.4%
More than 5 years	37	12.1%	27	11.7%	21	11.1%
Total	**306**	**100.0%**	**230**	**100.0%**	**190**	**100.0%**

Of the shuttle passengers surveyed, 126, or 40.5%, paid a fare for the trips they were making, whereas the others were either traveling free or their employers paid their fare. Out of the 126 passengers who paid fare, 105 (83.3%) paid per-trip fare, whereas the remaining paid per week or per month. Among the 105 passengers who paid per-trip fare, 74 (74.1%) paid $2, whereas 25 (23.8%) paid less than $2, and five (4.8%) paid more than $2. Of the 21 passengers who paid weekly fare, nine (43%) paid $20, whereas 4 (19%) paid $10. Only six passengers paid monthly fare, the amounts ranging from $20 to $100, and three paid annual fare, the amounts ranging between $960 and $996. Overall, less than half of the shuttle users paid for their trips, most paid on a per-trip basis, and the most common fare was $2 per trip.

7.4. Origin and Destination of Shuttle Trips

Although the survey was conducted in both morning and afternoon peak periods, 74% of the trips originated at home and 66% of trips were made to work (see Table 20). A reason for the greater proportion of trips originating from home than work is that 79% of the surveys were conducted in the morning peak period. Among the 283 respondents who mentioned both trip origins and destinations, 60% were making trips from home to work, whereas 11% were making trips from work to home. Besides work and home, transit stations/terminals were the most commonly cited origins and destinations, followed by personal business. However, the small proportion of trips originating at trains station/terminal is surprising, given that most surveyed shuttles originate at a commuter rail or light rail station.

The dominance of work as a trip destination confirms that the shuttles are primarily oriented towards providing job access to workers. The shuttles' orientation to work is also confirmed by the fact that even among those surveyed in the afternoon peak period, 36% were making trips to work. The high proportion of trips to work in the afternoon period is primarily due to shift workers, whose shifts often start in the afternoon or evening. This is particularly the case for workers at industrial parks and manufacturing plants.

Table 20 – Origin and Destination of Shuttle Trips by Survey Respondents

	Trip Origin		Trip Destination	
	Respondents	**Percent**	**Respondents**	**Percent**
Home	217	74.3%	43	14.8%
Work	49	16.8%	191	65.6%
School/University	2	0.7%	6	2.1%
Shopping	0	0.0%	3	1.0%
Personal business (doctor, bank, etc.)	4	1.4%	14	4.8%
Family, friend, social, recreational	3	1.0%	5	1.7%
Train station or terminal	11	3.8%	22	7.6%
Other	6	2.1%	7	2.4%
Total	**292**	**100.0%**	**291**	**100.0%**

7.5. Access Mode to Shuttle Boarding Stop

The distribution of modes used to access shuttle boarding stops by the survey respondents is presented in Table 21. Data are shown separately for all passengers as well as for passengers who were going to work. It is evident from the table that walking is the most common mode to shuttle stops, constituting more than half of all trips, followed by buses. The small proportion of trips by automobile is consistent with the low vehicle-ownership rate among the respondents. It is noteworthy that when the respondents are restricted to those who were making the trip to a work destination, the proportion of walking trips to stations decreases, whereas the proportion of trips by conventional transit modes (bus, commuter rail, and light rail) increases slightly.

A cautionary note is needed in interpreting the access modes to shuttle stops. Although the shares of commuter rail and light rail appear to be low in Table 21, many passengers who reported walking to the shuttle stop in fact used rail before their walk to the stop began. In response to another question, 135 passengers out of 235 (57%) reported using commuter or light rail at either end of their shuttle trip.

The distribution of access mode to stations for shuttles is substantially different from commuter rail users. A 2005 NJ TRANSIT survey of all of its commuter rail lines except the Atlantic City line showed that 53% of the passengers arrived at boarding stations by driving alone, more than 15% were dropped off at the station by someone else, 21% walked to station, and only 2% arrived at stations by buses. In contrast, the VTC survey of "Last Mile" shuttle passengers showed that the shuttle users are heavily dependent on buses to arrive at the shuttle stops. Although buses and shuttles are often considered competitors, in the case of "Last Mile" shuttles, it appears that buses complement shuttles.

Table 21 – Modes Used to Access Shuttle Stops by Survey Respondents

	All Destinations		Work Destinations	
	Respondents	**Percent**	**Respondents**	**Percent**
Walk	183	59.0%	100	52.4%
Drive alone and park	2	0.6%	0	0.0%
Car drop off	11	3.5%	7	3.7%
Bus	61	19.7%	50	26.2%
Commuter rail	24	7.7%	19	9.9%
Light rail	12	3.9%	9	4.7%
Shuttle pick up at origin	7	2.3%	2	1.0%
Another shuttle	3	1.0%	2	1.0%
Other mode	7	2.3%	2	1.0%
Total	**310**	**100.0%**	**191**	**100.0%**

7.6. Time Travelled to Shuttle Boarding Stop

The mean time travelled to the shuttle boarding stops by all respondents was 28 minutes. The distribution of time taken from trip origins to shuttle stops for the survey respondents is shown in Table 22. More than a quarter of the passengers travelled less than five minutes to the shuttle stop, which is consistent with the large proportion of respondents who walked to the stop. However, close to 20% of the respondents travelled more than 45 minutes to the shuttle stop. Among the respondents who travelled more than an hour to board shuttles, bus users constituted 43%, whereas commuter rail users constituted 38%. The mean travel time for bus users was 48 minutes, while commuter rail users travelled 59 minutes on average to arrive at the shuttle stop.

Table 22 –Access Duration to Shuttle Stops by Survey Respondents

	All Destinations		Work Destinations	
Duration	**Respondents**	**Percent**	**Respondents**	**Percent**
Up to 5 minutes	77	27.7%	44	24.3%
6-10 minutes	43	15.5%	24	13.3%
11-15 minutes	40	14.4%	25	13.8%
16-30 minutes	31	11.2%	24	13.3%
31-45 minutes	40	14.4%	29	16.0%
46-60 minutes	26	9.4%	18	9.9%
More than 60 minutes	21	7.6%	17	9.4%
Total	**278**	**100.0%**	**181**	**100.0%**

7.7. Duration of Shuttle Trip

The mean duration of shuttle trips for all respondents was approximately 20 minutes. Considering that the average route length for the surveyed shuttle was approximately 16 miles,

the average trip duration appears to be relatively short. The distribution of trip duration for all respondents and respondents who travelled to work is shown in Table 23. It is evident from the table that approximately 58% of the trips took 15 minutes or less, while only about 12% of the trips took more than 30 minutes. The average trip duration for those going to work was only slightly longer. From a comparison of access time to boarding stops (Table 22) and actual travel time (Table 23), it is clear that access time to boarding station for many shuttle users is longer than the actual travel time by shuttles.

Table 23 –Duration of Shuttle Trips for Survey Respondents

	All Destinations		Work Destinations	
	Respondents	**Percent**	**Respondents**	**Percent**
Up to 5 minutes	25	8.5%	15	8.2%
6-10 minutes	99	33.7%	52	28.3%
11-15 minutes	45	15.3%	34	18.5%
16-30 minutes	90	30.6%	63	34.2%
31-45 minutes	24	8.2%	14	7.6%
46-60 minutes	5	1.7%	5	2.7%
More than 60 minutes	6	2.0%	1	0.5%
Total	**294**	**100.0%**	**184**	**100.0%**

The mean travel time for shuttle users from trip origin to the destination shuttle stop was found to be 47 minutes. The distribution of total travel time is shown in Table 24. It is evident from the table that close to 24% of the shuttle users spend more than one hour traveling from their trip origins to the destination stop. Among respondents who were making trips to work destinations, close to 26% travelled longer than one hour.

Table 24 – Total One-Way Travel Time for Survey Respondents

	All Destinations		Work Destinations		New Jersey
	Respondents	**Percent**	**Respondents**	**Percent**	**Commuters**
Up to 15 minutes	38	14.0%	20	11.4%	24.2%
16-30 minutes	60	22.1%	39	22.2%	31.9%
31-45 minutes	62	22.9%	42	23.9%	20.8%
46-60 minutes	47	17.3%	30	17.0%	9.4%
61-90 minutes	43	15.9%	31	17.6%	9.2%
More than 90 minutes	21	7.7%	14	8.0%	4.5%
Total	**271**	**100.0%**	**176**	**100.0%**	**100.0%**

The distribution of commute time by all modes for New Jersey workers, obtained from ACS 2006-10 data, is provided in Table 24 for a comparison with the “Last Mile” shuttle users. While 56% of New Jersey workers commuted for less than half hour, less than 34% of the shuttle users

commuted less than half hour. On the other hand, while less than 15% of the New Jersey workers commuted more than one hour, more than 25% of the shuttle users did so. These figures show that the "Last Mile" shuttle users are clearly at a disadvantage compared to average New Jersey commuters in terms of travel time to work. The greatest difference between the "Last Mile" shuttle users and New Jersey commuters can be observed for trips less than 15 minutes.

7.8. Proximity to Rail Station and Bus Stop

To examine the proximity to bus and rail from shuttle stops, the survey included three questions. In response to a question on the availability of bus service at the shuttle stop, 48% of the respondents reported having a bus service, 40% reported not having a bus, and 12% did not know if there was a bus service. The survey respondents were also asked about the proximity to rail station at the boarding and deboarding stations. The responses are presented in Table 25. It is evident from the U-shaped distributions that rail stations are either at the shuttle stop or at a substantial distance from the shuttle stops. Given that most of the respondents were taking shuttles to work in the morning, it is not surprising that a larger number of respondents had a station at the boarding stop compared to their deboarding stations. Although it is encouraging to note that more than half of the respondents had rail service within ½ mile of their boarding stops, approximately 45% of the respondents either did not know where the nearest rail station was, or the station was more than a mile away. Somewhat surprisingly, among the respondents who arrived at the shuttle stop by rail, only 9% had a rail station at the boarding stop. In contrast, 22% of the respondents who arrived at the shuttle stop by a mode other than rail reported having a station at the shuttle stop. It appears from the results that although many shuttle vehicle trips originate from rail stations, a large number of shuttle users who boarded at those stops did not arrive at the stop by rail. On the other hand, a number of shuttle users who took rail prior to arriving at the shuttle stop had to walk some distance to arrive at the shuttle stop.

Table 25 – Proximity to Rail at Boarding and Deboarding Stations of Survey Respondents

	Boarding Stop		Deboarding Stop	
Distance	**Respondents**	**Percent**	**Respondents**	**Percent**
Station at the shuttle stop	95	34.8%	53	22.0%
Less than 1/4 mile	27	9.9%	21	8.7%
Between 1/4 and 1/2 mile	17	6.2%	11	4.6%
Between 1/2 and 1 mile	12	4.4%	15	6.2%
Between 1 and 3 miles	30	11.0%	35	14.5%
3 miles or more	39	14.3%	47	19.5%
Don't know	53	19.4%	59	24.5%
Total	**273**	**100.0%**	**241**	**100.0%**

7.9. Satisfaction with Shuttle Service

The shuttle passengers were asked how satisfied they were with the shuttle service they were using. The responses are shown by provider name in Table 26. Since the sample size for some of the providers is small, the results should be interpreted carefully. Overall, the data suggests that the shuttle users are highly satisfied with the service they use. Of the 282 respondents for all providers, 94% are either satisfied or very satisfied. For every provider, more than 80% of the respondents are either very satisfied or satisfied, indicating that the variation in satisfaction across providers is small. Table 27, where satisfaction of shuttle passengers is shown by the duration of the shuttle trips indicates that the respondents whose shuttle trips take five minutes or less are the most satisfied and the respondents whose trips take longer than 30 minutes are the least satisfied. The results could suggest that the duration of shuttle trips influences the passengers' satisfaction level.

Table 26 – Satisfaction with Shuttle Service Used By Provider

Service Provider	Very satisfied	Somewhat satisfied	Somewhat dissatisfied	Very dissatisfied	Total
Burlington County (N=19)	52.6%	31.6%	15.8%	0.0%	100%
Meadowlink (N=96)	60.4%	37.5%	2.1%	0.0%	100%
Middlesex County (N=74)	71.6%	21.6%	5.4%	1.4%	100%
Morris County (N=13)	76.9%	15.4%	7.7%	0.0%	100%
SJTA (N=21)	85.7%	9.5%	4.8%	0.0%	100%
Somerset County (N=59)	52.5%	40.7%	3.4%	3.4%	100%
Total (282)	**63.8%**	**30.5%**	**4.6%**	**1.1%**	**100%**

Table 27 – Satisfaction with Shuttle Service Used By Trip Duration

Duration of Shuttle Trip	Very satisfied	Somewhat satisfied	Somewhat dissatisfied	Very dissatisfied	Total
Up to 5 minutes (N=22)	77.3%	18.2%	4.5%	0.0%	100%
6-15 minutes (N=129)	62.8%	34.1%	3.1%	0.0%	100%
16-30 minutes (N=89)	62.9%	31.5%	4.5%	1.1%	100%
More than 30 minutes (N=33)	54.5%	27.3%	12.1%	6.1%	100%
Total (N=273)	**63.0%**	**31.1%**	**4.8%**	**1.1%**	**100%**

7.10. Passenger Recommendations for Shuttle Service Improvement

Although the shuttle passengers are highly satisfied with the service they use, they would like to see further improvements. A multiple choice question was included in the survey to inquire about the improvements sought by the shuttle users. The respondents were asked to identify their preferred improvements from a selected list of choices and also to rank the top three

recommended improvements by using an ordinal scale (with 1 representing the highest importance, 2 the next highest, etc.). The results are shown in Table 28. In addition to the number of respondents that identified an improvement as important in the first column, the table shows the number of respondents who ranked each improvement as first, second, and third. The ranks were converted to an aggregate score by first multiplying the first ranked responses by 3, the second ranked responses by 2, and the third ranked responses by 1, and subsequently aggregating the products for each improvement. In the last column, the aggregate scores are shown in relation to the least important improvement (more experienced operator).

It is evident from the results presented in Table 28 that the sequence of the improvements in terms of total number of respondents identifying each improvement (shown in the first column) is identical to the aggregate scores obtained from the ranks. Both the frequencies and rank aggregates show that greater frequency of service in the morning peak period is the most sought after improvement, followed by greater service frequency in the evening. The greater importance of morning service frequency is not surprising considering the fact that most surveys were conducted in the morning. However, the results show that afternoon peak period and evening service frequency are also important for the respondents. The greater emphasis of the respondents on evening service may be due to lower service frequency at that time compared to the afternoon peak period, and also due to the use of shuttles by shift workers who often return from work after the afternoon peak period.

Table 28 – Recommended Improvements and Ranks

	Frequency	Percent	Rank 1	Rank 2	Rank 3	Total score	Indexed to least
Greater AM peak frequency	134	21.6%	93	27	13	346	6.18
Greater frequency in the evening	91	14.7%	53	17	18	211	3.77
Greater PM peak frequency	90	14.5%	43	30	16	205	3.66
Greater midday frequency	58	9.4%	29	15	11	128	2.29
More route coverage	51	8.2%	25	11	14	111	1.98
Fewer stops	40	6.5%	16	10	14	82	1.46
Lower fare	36	5.8%	15	9	12	75	1.34
Better vehicle quality	33	5.3%	17	5	11	72	1.29
More stops	32	5.2%	11	8	13	62	1.11
More experienced operator	28	4.5%	13	4	9	56	1.00
Other improvements	26	4.2%	NA	NA	NA	NA	NA
Total	**619**	**100%**	**NA**	**NA**	**NA**	**NA**	**NA**

The responses in Table 28 show that service frequency at different times of the day is far more important than other improvements. Compared to service frequency, operator experience, fare, stops and vehicle quality appear to be less important. Greater route coverage is important to a modest number of respondents, but appears to be less important than service frequency. It is

worth noting that a few respondents who chose “other improvements” suggested larger vehicles and recommended better scheduling of shuttles to match train arrival and departure times.

7.11. Alternatives to Using Shuttles

To gauge the importance of shuttles and to examine what alternatives existed for the passengers, a question was included in the survey inquiring how the respondents would have travelled to their destination if the shuttle service they were using did not exist. The responses are shown in Table 29 for all respondents and respondents who were travelling to work. The most significant fact from the table is that close to 13% of the total shuttle users and 11% of the users commuting to work would not have made the trip if the shuttle service did not exist. A high proportion of respondents reported that they would walk to their destination presumably because of not having access to a vehicle and/or the destination being in close proximity. As shown in Table 18, more than half of the respondents belong to households without a vehicle, and, as shown in Table 23, the shuttle trip duration for approximately 42% of the shuttle users is ten minutes or less. Bus is the second most cited alternative, followed by taxi. The relevance of taxi for the shuttle users is important because this mode is often overlooked as an alternative. Automobile, rail, and bike appear to have relatively less significance for the shuttle users as an alternative mode.

Table 29 – Alternatives to Shuttles

	All Destinations		Work Destinations	
Alternative to Shuttle	**Respondents**	**Percent**	**Respondents**	**Percent**
Walk	67	24.1%	44	24.4%
Bus	65	23.4%	37	20.6%
Taxi	42	15.1%	34	18.9%
Would not make the trip	35	12.6%	19	10.6%
Drive	31	11.2%	22	12.2%
Car drop off/pick up	14	5.0%	8	4.4%
Rail	6	2.2%	5	2.8%
Carpool	6	2.2%	4	2.2%
Bike	1	0.4%	0	0.0%
Unspecified other	11	4.0%	7	3.9%
Total	**278**	**100.0%**	**180**	**100.0%**

7.12. Relevance of Rail to Shuttle Passengers

The information provided in Table 29 clearly shows that rail is not an alternative to the shuttle service for the respondents. However, commuter rail and light rail play a significant role for the shuttle passengers because many use rail to arrive at the shuttle boarding stop or getting to their destination after a shuttle trip. In response to a survey question, out of a total of 235 passengers, 135 (57%) mentioned using rail at either end of their shuttle trip. Out of these 135 passengers, 58

(42%) reported that they would not use rail if the shuttle service did not exist. This clearly shows a high degree of interdependence between rail and shuttle service.

7.13. Shuttles, Workers, and Work Places of Shuttle Users

Since the primary objective of "Last Mile" shuttles is to provide access to workers from transit nodes to work sites, learning about the characteristics of the workers who use them and the work places where they work is important. In order to examine the characteristics of the workers and their work places, a number of questions were included in the shuttle passenger survey. This series of questions were meant to be answered by only those respondents who were workers and travelling to or from work. The responses to specific questions are discussed in the sections below.

7.13.1. Importance of Shuttle Service in Decision to Work at the Current Location

The passengers who used shuttles to or from work were asked how important the shuttle service was when they decided to work in their current work location. An overwhelming 77% reported that the shuttle service was very important and another 11% reported that the service was important, while only 12% mentioned that the service was not important or not at all important. This clearly shows that the "Last Mile" shuttles are critical for accessing jobs for the shuttle users. The importance of shuttles was felt almost identically by full-time and part-time workers.

7.13.2. Industry Classification of the Workers Using Shuttles

Of the workers who used shuttles to travel to or from job locations, 83% were full-time workers and 17% were part-time workers. The industry classification of all workers using the "Last Mile" shuttles is presented in Table 30. It is evident from the table that the workers are engaged in diverse industries. Although surveys were conducted in only 18 of the 34 routes selected for corridor-level analysis, the results are consistent with the results from the land use and job location analyses of shuttle corridors in previous sections of the report. The previous analysis with secondary data showed that industrial land and jobs in the "blue collar" sectors such as manufacturing and warehousing were disproportionately located in the shuttle corridors (see Tables 3 and 4). Consistent with those findings, the survey results show that typical "blue collar" sectors, including production, construction, maintenance, warehousing, and transportation together account for approximately 22% of the workers who use "Last Mile" shuttles.

Although "blue collar" sectors account for most workers among the shuttle users, several other sectors also account for large proportions of the workers. For example, administrative/clerical, sales, information technology, and management/marketing/finance sectors each account for more than 10% of the workers who use shuttles. On the whole, the distribution of workers in Table 30 show that shuttles serve diverse industry types, although "blue collar" sectors account for most of the shuttle users.

Table 30 – Industry Classification of Workers Who Use Shuttles

Industry/Occupation	Respondents	Percent
Production/construction/maintenance	38	16.2%
Administrative/clerical	34	14.5%
Sales	30	12.8%
Information technology	27	11.5%
Management/marketing/finance	25	10.7%
Personal care or service	19	8.1%
Warehouse/transportation	13	5.6%
Science/engineering	12	5.1%
Healthcare occupation	11	4.7%
Food service	7	3.0%
Educational or training	6	2.6%
Protective service	3	1.3%
Legal occupation	2	0.9%
Unspecified other	7	3.0%
Total	**234**	**100.0%**

7.13.3. Duration of Work at Current Location for Shuttle Users

The survey respondents who were traveling to or from work were asked how long they had been working at their current location. The responses are summarized in Table 31. The U-shaped distribution is consistent with the distribution of duration of shuttle used shown in Table 19. The distribution shows that more than half of the shuttle users have been working at the current location for more than two years. However, close to 25% of them have been working for less than six months. The distribution suggests that most of the workers using shuttles are permanent workers, whereas a large proportion is also transitional.

Table 31 – Duration of Work at Current Location for Use Shuttles

Duration of work at current location	Respondents	Percent
Less than 3 months	33	14.0%
3-6 months	25	10.6%
6-12 months	18	7.6%
1-2 years	37	15.7%
2-5 years	63	26.7%
More than 5 years	60	25.4%
Total	**236**	**100.0%**

The cross tabulation of duration of work at the current location and duration of shuttle use is shown in Table 32. A total of 231 respondents responded to both questions. Some workers who

have worked at the current location for a specific time period reported using shuttles longer than that time period presumably because they worked for another employer on the shuttle route prior to their current job. However, for all workers except those who have worked at the current location for more than five years, a majority reported using the shuttle service around the same time they started working at the current location. This evidence confirms that shuttles were an important consideration when the workers decided to work at the current location. The workers who have worked at the current location for more than five years, only 39% reported starting to use shuttles around the same time presumably because the shuttles many of them use did not exist when they started working at the current location, but were added during the subsequent years.

Table 32 – Duration of Work at Current Location versus Duration of Shuttle Use

	Duration of Shuttle Use						
Duration of Work at Current Location	**Less than 3 months**	**3-6 months**	**6-12 months**	**1-2 years**	**2-5 years**	**More than 5 years**	**Total**
Less than 3 months	**78%**	6%	0%	3%	6%	6%	100%
3-6 months	21%	**58%**	8%	4%	8%	0%	100%
6-12 months	6%	17%	**61%**	11%	0%	6%	100%
1-2 years	11%	5%	22%	**54%**	8%	0%	100%
2-5 years	8%	7%	8%	16%	**56%**	5%	100%
More than 5 years	7%	5%	2%	14%	34%	**39%**	100%

7.13.4. The Nature of the Employers of Shuttle Users

The shuttle users were asked about the nature of their employers and the number of workers at the work place. While the analysis in Section 7.13.2 of this report pertained to the workers themselves, these questions were aimed at employer characteristics. The distribution of type of employers in Table 33 shows that an overwhelming proportion of workers work for private establishments, whether they be company offices, factories, warehouses, or commercial establishments. In contrast, public establishments and educational institutions account for a small proportion of the employers. The high proportions of private company offices and factories/warehouses are consistent with the industry classification of the shuttle users shown in Table 30, where it was shown that production/construction/maintenance and office/clerical workers constituted the largest proportions of workers. Approximately 92% of the workers who mentioned working as production/construction/maintenance workers reported working in factories or warehouses and 76% of workers working as administrative/clerical workers worked at private company's offices or factories. The dominance of the private sector is clearly evident among the employers of the shuttle users.

Table 33 – Type of Employers that Hire Shuttle Users

Type of Employer	Respondents	Percent
Private company's office	79	34.3%
Private company's factory or warehouse	73	31.7%
Commercial establishment or store/shop	37	16.1%
Public/government office	21	9.1%
Educational institution	9	3.9%
Healthcare facility	8	3.5%
Unspecified other	3	1.3%
Total	**230**	**100.0%**

As previously noted, sometimes very large employers in New Jersey provide exclusive shuttle service to their employees through transportation management associations. The Harmon Meadow shuttle service, provided by Meadowlink TMA and the Hopewell shuttle service, provided by the Greater Mercer TMA, are two examples of such privately funded services for employees of large corporations. Although those two routes could not be surveyed, the survey of passengers on other routes provides some insights about the size of the firms where the "Last Mile" shuttle users work.

Table 34 – Size of Employers that Hire Shuttle Users

Employee Size	Respondents	Percent
Less than 5 employees	15	6.6%
5-9 employees	40	17.5%
10-19 employees	25	11.0%
20-29 employees	19	8.3%
30-49 employees	27	11.8%
50-99 employees	29	12.7%
100-199 employees	23	10.1%
200 or more employees	50	21.9%
Total	**228**	**100.0%**

The distribution of survey respondents by the size of the firms where they work is shown in Table 34. The employee size shown in the table is location specific, meaning that the figures refer to the number of workers who work at the specific location of the firm where the shuttle user works, and not the total employees of the firm nationwide or statewide.

The most noticeable fact from Table 34 is that close to 22% of the workers using shuttles work for firms that have more than 200 employees. Moreover, almost 45% of the workers work for firms with more than 50 employees and almost 57% workers work for firms with more than 30 employees. In contrast, only 24% of the shuttle users work for employers with less than ten

employees at the work location. A cross tabulation of employee size and type of employers reveals that the 54% of the respondents working for employers with more than 200 employees work at private companies' offices, whereas 20% work for private companies' factories or warehouses. Overall, the survey data shows that the shuttle users primarily work for large private employers at locations that can be classified as company offices, factories or warehouses.

7.13.5. Characteristics of Work Sites of Shuttle Users

In the general context of public transportation, the characteristics of neighborhoods (e.g., dwelling type, population density) and workplaces (e.g., employment density, building height, etc.) are often considered important. For shuttles, however, very little information is usually available about these characteristics. To examine the characteristics of the locations where the "Last Mile" shuttle passengers in New Jersey work, a question was included in the shuttle passenger survey. The responses are presented in Table 35.

Consistent with the fact that the largest proportion of shuttle users work in private companies' offices (see Table 33), more than 30% of the respondents reported working in 2-4 story office buildings and more than 20% reported working in one story office building. More than a quarter of the respondents also reported working in factories or warehouses. In contrast, the proportion of shuttle users working in high-rise office buildings, shopping malls, strip malls, or downtown main streets is small. The responses of the shuttle passengers are consistent with the analysis of "Last Mile" shuttle corridors regarding land uses and job types, which showed that the corridors are generally located in low density areas with manufacturing/warehousing and office jobs.

Table 35 – Characteristics of Locations where Shuttle Users Work

Characteristic of Work Location	Respondents	Percent
2-4 story office building	69	30.3%
Factory or warehouse	59	25.9%
1 story office building	47	20.6%
10 or more story office building	19	8.3%
5-9 story office building	9	3.9%
Shopping mall	9	3.9%
Strip mall	6	2.6%
Downtown or main street store	2	0.9%
Other	8	3.5%
Total	**228**	**100.0%**

The survey respondents were also asked about the type of road where their work places were located. Slightly more than 75% reported that their work places were located on two-lane local roads, 10% reported state highways, and 7% reported four-lane roads, while the remaining reported other types of roads, including corporate roads and service roads.

7.13.6. Parking at the Work Sites of Shuttle Users

In the context of "First Mile" shuttles, it has often been stated that the availability of parking at rail station decreases the popularity of shuttles because parking encourages driving. Similarly, a large body of literature has concluded that parking at work places decreases the likelihood of transit use and increases the likelihood of driving. This is considered to be the case particularly when parking is provided free or subsidized by employers.

To assess the parking characteristics at their work places, shuttle passengers were asked whether free or paid parking was provided to them at their work locations. Ninety percent of the respondents reported that free parking was available for them at their work locations, whereas 8% reported that paid parking was available. From these responses, it is clear that parking availability or unavailability is not a concern for shuttle users. Their shuttle use is far more likely to be explained by their low vehicle ownership rate than parking constraint at the work location.

7.14. Summary of Shuttle Passenger Survey Results

The survey of "Last Mile" shuttle passengers provided some important information about their personal, household, and employment characteristics. The survey also provided useful insights about the importance of the shuttle services to the users, the perceived alternatives to shuttles, the connection between shuttles and other modes of public transportation, satisfaction with the shuttle services, and the types of shuttle improvements sought by the users.

Socioeconomically, the shuttle users belong to low to low-middle class. The proportion of persons from low income households is substantially higher and the shares of minority and foreign-born immigrant populations are significantly higher among the shuttle users than the state population. The shuttle users are younger than the state population and they include more men than women. The feature that distinguishes the shuttle users the most from others is household vehicle ownership. More than half of the shuttle users belong to households without any vehicles, whereas less than 12% of the state population belongs to such households. Although the average household size of the shuttle users is larger than the state population, they live in rented homes and apartments at a disproportionately higher rate.

A large proportion of shuttle users reported using shuttles to travel between home and work. On average, they spend a substantially longer time traveling between home and work than average workers in the state. One of the reasons for the long trips by the shuttle users is the time taken between home and the shuttle boarding stop. The average time taken from trip origins (mostly homes) to shuttle stops was found to be 28 minutes, whereas the average duration of the shuttle trips was found to be 20 minutes.

Most shuttle passengers reported arriving at the shuttle boarding stop by walking. However, a large proportion of shuttle user who reported walking to shuttle stop used rail before or after their shuttle trip. Buses also play a major role in providing access to shuttle stops for the passengers. It

is evident from the analysis that the "Last Mile' shuttles complement and are complemented by both rail and bus services. The analysis also shows that walking, buses, and taxis are perceived to be the primary alternatives to shuttles by the passengers.

The shuttle users appear to be highly satisfied with the service they use. Satisfaction is high for services provided by all providers. Despite their overall satisfaction with service, the shuttle users made suggestions for improvement. The suggestions reveal that service frequency in the morning peak period and evening are their greatest concerns, followed by afternoon peak period and midday service frequency. Fares, route coverage, number of stops, and operator experience were not the passengers' major concerns.

The survey generated useful information about the shuttle passengers' employment characteristics and the characteristics of their employers and employment sites. Eighty three percent of the workers who used shuttles to work were full-time workers. An overwhelming 88% of the workers who used shuttles reported that the availability of the shuttle service was important in their decision to work at the current location. A comparison of duration of work at current location with the duration of shuttle use indicates that most workers start using shuttles as soon as they begin to work at a specific location.

The workers who use shuttles to travel to their work places work predominantly in private companies' offices or factories. The office buildings where they work are mostly 1-4 story high, with only a small proportion working in high rise office buildings. A large proportion of shuttle users also work in factories and warehouses. The offices, factories and warehouses are mostly located on two-lane local roads.

Given the suburban environments where most of the employment sites are located, it is not surprising that free parking is available for more than 90% of the shuttle users at their work places. It is not parking constraint, but low vehicle ownership, that prompts most workers to use shuttles.

8. SUMMARY OF THE RESEARCH FINDINGS AND THEIR IMPLICATIONS

This research included analysis of secondary data on jobs, land uses, and socioeconomic characteristics of areas served by "Last Mile' shuttles in New Jersey as well as a survey of the shuttle passengers to comprehend their travel patterns and needs. In addition, data from a 2005 NJ TRANSIT commuter rail passenger survey was analyzed to compare the users of "Last Mile" and "First Mile" shuttles.

The analysis of land use, jobs, and socioeconomic data showed that the "Last Mile" shuttle corridors are similar to other suburban areas with the exception that they have more jobs than other suburban areas. It was also evident from the analysis that the jobs in typical "blue collar" sectors, such as manufacturing, construction, and warehousing are more abundant in the "Last Mile" shuttle corridors compared to other areas, including "First Mile" shuttle corridors and

control corridors. Consistent with these findings, the analysis of land use/land cover data from the NJDEP showed that the "Last Mile" shuttle corridors contained a substantial amount of industrial land compared to other areas. However, jobs in certain "white collar" sectors, especially administrative support jobs, are also available in greater amounts in the "Last Mile" shuttle corridors compared to other areas, including "First Mile" shuttle corridors and control corridors.

The socioeconomic characteristics of the "Last Mile" shuttle corridors are similar to other suburban areas of New Jersey. The shuttle corridors have lower population density than other parts of the counties where the "Last Mile" shuttles are provided. The population density in these corridors is significantly lower than the "First Mile" corridors also. The ANOVA results showed that the "Last Mile" corridors have a lower proportion of multi-family dwellings and apartments, a smaller proportion of minority and immigrant populations, and a smaller proportion of zero-vehicle households. These characteristics make the "Last Mile" corridors less conducive for conventional transit than other parts of the counties. It is not surprising that the proportion of resident workers in the "Last Mile" shuttle corridors use automobile at a higher rate and transit at a lower rate for commuting than other areas. Given the population and land use characteristics of the "Last Mile" shuttle corridors, shuttles appear to be the only viable alternative other than automobile for those who need to access locations within the corridors. Because of the relative unattractiveness of these areas to conventional transit, the "Last Mile" shuttles provide a useful service to these areas.

Although the "Last Mile" corridors have more jobs than other areas, the analysis of job mix showed that these corridors are no different from "First Mile" shuttle and control corridors in this regard. Since the job mix in the "Last Mile" shuttle corridors is not significantly higher and the characteristics of the corridors resemble typical suburban areas (e.g., low population and dwelling density, small proportion of zero-vehicle households, etc.), circulator services possibly cannot sustain in these corridors. Under these circumstances, shuttles that provide direct access between a rail station and a concentrated work site (e.g., an industrial park) appear to be more appropriate. However, shuttles that serve only one or two employment sites require large employers, and therefore employer participation in shuttle programs becomes important.

The analysis of the 2005 NJ TRANSIT survey data showed that "Last Mile" shuttle users have lower income and consist of a larger proportion of African Americans than shuttle non-users. However, regarding many other characteristics, including language, home ownership, and duration at current residence, the "Last Mile" shuttle users are more similar to shuttle non-users than "First Mile" shuttle users. The socioeconomic characteristics of the persons who reported using "Last Mile" shuttles from rail stations to their destinations in the NJ TRANSIT survey are very different from the characteristics of the "Last Mile" shuttle passengers surveyed by the VTC. Among the VTC survey respondents, the proportion of persons from low-income households, minority households, non-English speaking households, and households living in rental dwellings is significantly higher than the "Last Mile" shuttle users in the NJ TRANSIT

survey. The primary reason for the difference potentially lies in the fact that the NJ TRANSIT survey respondents used a far wider range of shuttles compared to the shuttles surveyed by the VTC. Many of the NJ TRANSIT survey respondents used shuttles that are not typical JARC-funded, employment-oriented shuttles. Another reason for the significant difference between the two groups is that all NJ TRANSIT survey respondents were using commuter rail, whereas many of the VTC survey respondents took buses or walked to the shuttle stops, even when the stops were located in a train station. Since commuter rail users are usually more affluent than other mode users, the "Last Mile" shuttle users in the NJ TRANSIT survey are not typical "Last Mile" shuttle users. Furthermore, a review of the stations where the NJ TRANSIT passengers reported taking shuttles to their destinations showed that many of those stations did not have formal "Last Mile" shuttle services.

The VTC survey of "Last Mile" shuttle passengers, conducted on 18 of the routes, provided information on 311 users. The shuttle users are economically far worse off than New Jersey's general population. More than 38% of the survey respondents belong to households with annual income less than $25,000 and 68% belong to households with income less than $50,000. More than half of the shuttle users belong to households without a vehicle. Thirty eight percent of the respondents belong to minority households, whereas approximately 35% were born outside the United States. More than 80% of the respondents live in rented housing and 60% live in multi-family units or apartments. The shuttle users are younger than the New Jersey population, as 46% of them are below age 35 and 70% are below age 45. They also appear to be mostly engaged in entry-level positions.

The survey revealed that the "Last Mile" shuttles play an important role in providing job access. An overwhelming 77% of the respondents who used shuttles for job access reported that the shuttle service was very important when they decided to work at the current location and another 11% reported that it was important. It also appears from the survey responses that most workers started using shuttles as soon as they started working at their current location.

The average commute time of the shuttle users is far longer than average commuters in New Jersey. The reason for the longer commuting time for the shuttle users is that the average time taken to arrive at the shuttle stops is longer than the actual shuttle trip. Yet the level of satisfaction of the survey respondents with the shuttle services appears to be extremely high as close to 64% reported being very satisfied and 31% reported being satisfied. The passengers who spent the longest time on shuttles appeared to have a lower level of satisfaction with shuttles than others. When asked how the shuttle service could be improved, most responses were about increasing service frequency. Increase in AM peak period service frequency was most commonly suggested, followed by evening service frequency. Other improvements, such as stops, fares, and operator experience were considered important by only a small proportion of the shuttle users.

The survey also provided useful information about the shuttle users' labor force characteristics and the characteristics of their employers and employment locations. The largest proportion of

the workers who used shuttles for job access worked in blue collar professions, such as production, construction, and maintenance, followed by administrative/clerical and sales. Most workers worked in private companies' offices, followed by factories and warehouses. The survey data shows that most workers worked for employers with a large number of employees at the work site. Close to 22% of the respondents worked for employers with 200 or more employees. This seems to suggest that shuttles typically serve large employers in the private sector.

The analysis in this study showed that the "Last Mile" shuttles in New Jersey have been highly beneficial in many regards. First, the characteristics of the shuttle users show that the shuttles provide much needed service to entry-level workers and workers from households with low incomes and without vehicles. The services are also socially equitable because they serve large proportions of minority and immigrant populations. To the extent that many of the shuttles are funded by the JARC program, the study provides evidence of federal dollars being spent appropriately to improve job access for individuals that need the service most. Second, the shuttle users are highly satisfied with the service they use. Third, the shuttles provide service to many private employers by collecting and distributing workers from distant locations. Fourth, by providing access to areas that are not conducive to conventional transit, the shuttles serve society at large in addition to serving the users and the employers. Fifth, shuttles serve many industrial areas and work sites such as manufacturing plants and warehouses that cannot be located with other land uses such as residential and commercial and therefore cannot be served efficiently by conventional transit. Finally, the shuttles complement rail and bus transit significantly, as many shuttle users use these modes at either end of their trip.

Despite the utility and appreciation of the "Last Mile" shuttles by the users, these shuttles face certain challenges. First, the survey showed that the shuttle users would like greater frequency of services, especially in the AM peak period and the evening. Given the funding constraints of the providers, increasing service frequency is certainly going to be a challenge. Second, including their travel before and after a shuttle trip, the shuttle users spend a substantially longer time commuting to and from work compared to other workers in New Jersey. Because of the need to travel by bus or rail before and after their shuttle trips, the total time spent on commuting by shuttle users becomes unduly long. Because of the long commutes by the shuttle users, increasing ridership by adding more stops does not appear to be a reasonable option on routes that have low ridership volumes. Third, currently "Last Mile" shuttles predominantly serve areas where offices and factories of large private employers are located. As a result, the shuttles primarily serve two nodes – a transit station and an employment site – instead of serving areas along the shuttle route. A case in point is the Pureland Shuttle, which picks up workers from the Walter Rand Transportation Center in Camden City to Pureland Industrial Park in Gloucester County with only one or two stops on a 28-mile route. This type of service reduces travel time by shuttles, but may increase total travel time for workers who have to take a train or bus to arrive at the shuttle stop. For reducing total commute time of shuttle users, "Last Mile" shuttles may perform better when service is provided from dense urban centers to employment sites so that a

large number of the shuttle users can access the shuttles by walking rather than having to take a bus or train to the boarding stop.

As noted in past studies, employers' participation in shuttle programs is important for their success. When providers depend on large employers, getting their support is potentially easier than getting support from a large number of small employers. For this reason, "Last Mile" shuttles are likely to continue their dependence on large employers. However, this practice does not benefit workers who work for small employers unless small employers locate their facilities in close proximity of large employers.

The focus of the existing "Last Mile" shuttles to primarily provide access to manufacturing/warehousing districts makes one wonder whether services to predominantly office employment sites such as office parks would be successful. The overall experience with office-oriented shuttles in New Jersey appears to have been less promising than services to industrial sites. The Hopewell Shuttle is an example of a successful office-oriented shuttle service between Hamilton Station and Merrill Lynch Hopewell campus, but it exclusively serves employees of one corporation. The office-oriented shuttles from the Convent Station were replaced by NJ TRANSIT bus service in 2010. A problem in serving office-oriented locations by shuttles is that office sites are geographically less isolated than manufacturing sites and average offices employ a smaller number of employees than manufacturing plants. Moreover, because of the contiguity of office complexes with other land uses such as strip malls and other commercial uses, office locations may be more serviceable by conventional transit such as buses. Finally, the characteristics of average office workers may not match the characteristics of the existing "Last Mile" shuttle users, who are predominantly of young age, and belong to carless households with low incomes.

Finally, an inherent issue facing shuttles resembling the "Last Mile" shuttles in New Jersey is that once the entry-level workers currently served by shuttles are well-established in the labor market, they may discontinue using the service in favor of driving to work (Thakuriah, Sriraj, Sööt, and Persky, 2008). In order to avoid loss of ridership, "Last Mile" shuttles will always have to maintain a high quality and level of service, which can be achieved only when adequate funding is available.

9. REFERENCES

Anspacher, D., A.J. Khattak., and Y. Yim. *Demand-responsive Transit Shuttles: Who Will Use Them?* UCB-ITS-PWP-2004-5. California Path Program, Institute of Transportation Studies, University of California, Berkeley, 2004.

Anspacher, D., A.J. Khattak., and Y. Yim. The demand for Rail Feeder Shuttles. *Journal of Public Transportation*, Vol. 8, No. 1, 2005, pp. 1-20.

Blumenberg, Evelyn, and Lisa Schweitzer. Devolution and Transport Policy for the Working Poor: The Case of the US Job Access and Reverse Commute Program. *Planning Theory and Practice*, Vol. 7, No. 1, 2006, pp. 7-25.

Bregman, Susan, Christoph Berendes, Rosemary Gerty, and Laura Miller. *Connecting People to Employment and Enhancing Mobility for People with Disabilities*. Final Report FTA-VA-26-5035. Federal Transit Administration, US Department of Transportation, Washington, DC, 2009.

Cervero, Robert. *Paratransit in America: Redefining Mass Transportation*. Praeger, Westport, CT, 1997.

Cervero, Robert, and Yu-Hsin Tsai. Job Access and Reverse Commuting Initiatives in California: Review and Assessment. *Transportation Research Record: Journal of the Transportation Research Board*, No. 1859, 2003, pp. 78-86.

Deakin, Elizabeth. "Shuttles for the First and Last Mile." *Access*, Vol. 25, 2004. p.1.

Deka, Devajyoti, Jon Carnegie, and Mathew Kabak. Panel Data Analysis to Identify the Covariates of Community Shuttle's Longevity and Patronage in New Jersey. *Transportation Research Record: Journal of the Transportation Research Board*, No. 2217, 2011, pp. 136-144.

Deka, Devajyoti, Jon Carnegie, and Peter Bilton. What does it take for shuttles to succeed? Comparison of stated preference and reality of shuttle's success in New Jersey? *Transportation Research Record: Journal of the Transportation Research Board*, No. 2144, 2010, pp. 102-110.

Dill, J. Transit Use and Proximity to Rail: Results from Large Employment Sites in the San Francisco, California, Bay Area. *Transportation Research Record: Journal of the Transportation Research Board*, No.1835, Transportation Research Board of the National Academies, Washington, D.C., 2003, pp. 19-24.

Edwards, Julia B., Alan C. McKinnon and Sharon L. Cullinane. "Comparative Analysis of the Carbon Footprints Of Conventional and Online Retailing: A 'Last Mile' Perspective." *International Journal of Physical Distribution & Logistics Management*, Vol. 40, No. 1/2, 2010, pp. 103-123.

Frank, Lawrence, Martin A. Andersen, and Thomas L. Schmid. Obesity Relationships with Community design, Physical Activity, and Time Spent in Car. *American Journal of Preventive Medicine*, Vol. 27, No. 2, 2004. pp. 1- 13.

Marcia Scott. *Improving Freight Movement in Delaware Central Business Districts*. Institute for Public Administration. College of Education & Public Policy, University of Delaware, Newark, DE, 2009.

Meyer, Michael D. "Demand Management as an Element of Transportation Policy: Using Carrots and Sticks to Influence Travel Behavior." *Transportation Research Part A*, Vol. 33, 1999, pp. 575-599.

Sanchez, Thomas W., and Lisa Schweitzer. *Assessing Federal Employment Accessibility Policy: An Analysis of the JARC Program*. Brookings, Washington, DC, 2008.

Shannon, E., and K. Brower. *You've Got Connections! Increasing Shuttle Bus Services to the MTA Railroads*. Permanent Citizens Advisory Committee to the MTA, Metropolitan Transit Authority, New York, NY, 2002.

Sööt, S., P. S. Sriraj, and P. Thakuriah. *A User Survey of Transportation Services Funded By the Job-Access-Reverse-Commute Program*. Urban Transportation Center, University of Illinois at Chicago, Chicago, 2002.

Thakuriah, Piyushimita, P. S. Sriraj, Siim Sööt, and Joseph Persky. *Economic Benefits of Employment Transportation Services*. Urban Transportation Center, University of Illinois at Chicago, Chicago, 2008.

Urbitran Associates, Inc. Multisystems, Inc., SG Associates, Inc., and R. Cervero. *Guidelines for Enhancing Suburban Mobility Using Public Transportation*. TCRP Report 55. Transportation Research Board of the National Academies, Washington, D.C., 1999.

Urbitran Associates, Inc., Cambridge Systematics, Kittelson & Associates, Pitman & Associates, and Center for Urban Transportation Research. *Guidebook for Evaluating, Selecting, and Implementing Suburban Transit Services*. TCRP Report 116. Transportation Research Board of the National Academies, Washington, D.C., 2006.

Yim, Y. B., and A. Ceder. Smart Feeder/Shuttle Bus Service: Consumer Research and Design. *Journal of Public Transportation*, Vol. 9, No. 1, 2006, pp. 19-43.

APPENDIX 1

SHUTTLE PASSENGER SURVEY INSTRUMENT