OFFICE BUILDING STUDY
2015-2016

Analysis of 16 Transportation Performance Monitoring Studies in Arlington’s Rosslyn-Ballston Corridor

June 30, 2016
Thanks to:

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I. Background

Introduction

More than 30 years ago, Arlington County leaders envisioned a development approach characterized by coordinated urban planning and transportation design. Since then, the County has invested in mixed-use “urban village” land development combined with an interconnected, multi-modal transportation system. Arlington planners have concentrated high-density commercial and residential development around Metrorail stations in the Rosslyn-Ballston and Jefferson Davis Metrorail corridors, while maintaining lower density residential neighborhoods in the rest of the County. The County has also supported a high level of public transit, non-motorized facilities, and transportation amenities to maximize non-driving travel options. The result is a network of walkable, mixed-use neighborhoods well-served by public transportation and pedestrian facilities. This visionary approach has created an environment that fosters mobility and accessibility, but visionary development alone does not ensure success, when placed in the middle of a vehicle-dependent region. Travelers must learn of the variety of travel options available, understand how they work, and consider how to incorporate them into their personal trip decision-making process.

Arlington County Commuter Services

In Arlington County, Virginia, transportation demand management (TDM) support, sales, and outreach is provided by Arlington County Commuter Services (ACCS), a bureau of the Transportation Division of the Department of Environmental Services. The mission is to make it easy for residents, employees, and visitors to use all available transportation options, other than driving alone, to meet their travel needs. ACCS programs and services support the Arlington County land use vision of mixed-use high-density urban villages served by multiple modes of transportation and surrounded by lower-density, primarily residential neighborhoods.

TDM for Site Plan Development

Arlington first adopted a TDM policy for site plan development in 1990. Some important policy objectives were to:

- Maintain peak hour level of service at major intersections at or preferably above Level of Service D.
- Limit single occupancy vehicle trips generated by development.
- Reduce vehicle-generated air pollution.
- Maximize transportation alternatives while minimizing single occupancy travel.
- Encourage efficient, cost-effective modes of transportation that focus on moving people, not vehicles.
- Improve transit information and its dissemination so people will be able to make the most efficient and friendly use of the system.
- Encourage group riding and shared parking arrangements through parking management plans.
TDM-related development conditions have evolved over the years to include new and improved TDM strategies, and to better align with updated County goals and policies, all of which help to achieve the enduring vision of providing a sustainable, multimodal transportation system to the County.

Today, one of the key features of standard TDM site plan conditions is a performance monitoring requirement, which commits building owners to report on building transportation performance during operation. This requirement is designed to help the County get a sense of how transportation impacts play out at specific buildings, and to allow staff to aggregate data to better generalize to the neighborhood, corridor, and community levels. Follow-through on this condition language has facilitated the collection of transportation data at dozens of buildings since 2010.

**Previous Studies**

Several related local and regional transportation studies precede and inform this present analysis.

The 2005 Development-Related Ridership Survey sponsored by the Washington Metropolitan Area Transit Authority (WMATA) surveyed the travel behavior of persons traveling to and from office, residential, hotel and retail sites near Metrorail stations in the Washington metropolitan area. The study confirmed previous findings that the walking distance between a site and the Metrorail station affects transit ridership. At the overall site level, survey results showed that high-density, mixed-use environments with good transit access generated higher shares of transit and walk trips.¹

In 2008, ACCS conducted the first Commercial Building Study to explore the relative roles of site features, public transit, parking, and other transportation services on commercial location decisions in Arlington County and on the choices employees make in how they travel to work. This study was designed to assess the value of TDM services to employers and employees and to define the role of TDM services relative to site location and transportation infrastructure factors that also might influence employees’ travel choices.² Key findings of this study included:

- Transportation factors influenced employers’ choice of a business neighborhood
- Commute factors were important considerations for employees when deciding where to work
- Nearly all of the buildings in the study limited the amount of employee parking allocated to each tenant; but even with the restrictions, employees who wanted to park on-site generally were able to do so.
- Most of the building owners/managers in the study offered only limited commute assistance to tenants or employees.
- About half (51 percent) of the weekly commute trips made by employees who responded to the employee survey were made by train, bus, carpool, bicycle, or walking.
- Parking fees had an influence on employees’ travel choice, but only when the fee reached $100 per month.

Another preceding study of interest is the 2012 Arlington Business Leaders Study.³ The study assessed the importance of the County’s transportation network as a component of the overall business environment, how well that system is serving the business community, and identified areas for

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³ [http://mobilitylab.org/2013/04/30/2012-arlington-business-leaders-study/](http://mobilitylab.org/2013/04/30/2012-arlington-business-leaders-study/)
improvement. Most respondents rated the county’s quality of life as “very good” or “excellent.” Without prompting, 22 percent of respondents gave accessibility and transportation as a reason for rating the business climate the way they did. Only responses related to the county’s great amenities came up more frequently (27 percent). Whether it was flexible work schedules, teleworking arrangements, SmarTrip cards, or pre-tax transportation accounts, a greater share of business leaders reported that transportation benefits were available to employees than in 2007.

The most recent study informing this effort is Arlington’s Residential Building Transportation Performance Monitoring Study of 2013, the first of the aggregate analyses to be based on site plan transportation performance monitoring requirements specifically. At the building level, these transportation performance monitoring studies were conducted to learn about the travel and parking behavior of Arlington residents in high-density residential buildings. These studies explored several building and neighborhood characteristics, as well as awareness and attitudes of residents that could potentially cause or correlate to the identified travel behavior. The data from these individual building studies was aggregated to increase the generalizability of the findings as well as to protect the privacy of residents in the studied buildings. Findings from the aggregate study were designed to be used for public dissemination and discourse about the transportation performance of Arlington’s residential buildings, and the factors that have a significant correlation with travel behavior. Key findings included:

- Vehicle trip generation was lower than predicted by ITE
- Respondents reported driving alone less and using transit more than the County and region as a whole
- Work parking cost was related to commute mode choice
- Awareness and use of TDM services was related to drive-alone commute rate
- Few garages were full, and many vehicles were rarely used

In sum, this analysis builds upon lessons from the last decade about the relationship between built environment, awareness and use of TDM services, and transportation behavior in Arlington and the DC metro region, and gives Arlington a current look at the transportation performance of office buildings on the Rosslyn-Ballston Corridor in particular.

The Scoping Process

A comprehensive scoping process was undertaken prior to initiating data collection for this sample, in order to ensure that the survey and methods were closely tuned not only to the performance monitoring requirements of each site plan building, but to the needs of staff and stakeholders who will use the results to inform their projects and policy recommendations. Participants in the scoping process included staff from several departments, divisions, and bureaus (from the Department of Environmental Services staff represented the Arlington Initiative to Rethink Energy, Commuter Services Bureau, Division of Transportation, Development Services, Parking, Transportation Planning, and Transportation Engineering and Operations; other departments represented included Community Planning, Housing and Development and Arlington Economic Development). Other participating stakeholders included representatives from the Transportation and Planning commissions and NAIOP.

The scoping meeting informed participants of the history, purposes, and timeline of the office building study, and gathered input on the importance of possible study objectives and supporting research questions. The research team took notes during facilitated conversations and participants were asked to
select the objectives that were most important to them. Based on the collected comments and voting, the research team distilled participants’ input into research purpose statements and four priority areas for examination.

**Research Purpose and Objectives**

**Purposes:**

- Learn about travel and parking behaviors of office employees in commercial buildings. (answer staff questions)
- Provide staff and decision-makers with useful local data about influences on travel and parking behaviors. (collect local data)
- Support a better understanding among the wider public about transportation influences and outcomes, and their relationship to county-wide objectives and national standards. (communications plan)

In preparing for the study, five priority areas were identified:

- Contribute to building and neighborhood travel profiles
- Describe influences of TDM on mode split
- Describe influences of TDM on parking behavior
- Describe the adequacy of parking supply
- Explore influence of ACCS on economic competitiveness

This study design is reasonably able to speak to the first four priority areas above.
II. Methods

In studying the impacts of parking pricing, supply, TDM, and other variables, the researchers used a cross-sectional approach that compared buildings at roughly the same point in time. This cross-sectional method was also used in the 2013 Residential Building Study aggregate analysis (Simple Solutions Planning & Design, LLC and LDA Consulting, 2013). This is one of three general methods used for studying the effects of parking pricing and parking supply as described in the chapters on “Parking Pricing and Fees,” as well as “Parking Management and Supply” in TCRP Report 95, Traveler Response to Transportation System Changes (Kuzmyak, Weinberger, Pratt, & Levinson, 2003). Other relevant building level transportation studies that use a cross-sectional design include the District of Columbia Department of Transportation’s “Trip Generation Data Collection in Urban Areas” (2014); TCRP Report 128 by Arrington and Cervero, (2008); and “Ridership Impacts of Transit-Focused Development in California” (Cervero, 1994).

The other methods are longitudinal case studies, in which observers record and study travel behavior at one place over time, usually before or after a change in parking policy at that site; and “modeling studies” that use travel demand models to simulate changes in trip behavior given a proposed change in policy (Kuzmyak, Weinberger, Pratt, & Levinson, 2003, pp. 18-4) (Vaca & Kuzmyak, 2005, pp. 13-3)

Lund and Cervero (2004) provide a mix of cross-sectional and longitudinal case study methods in their analysis of travel patterns at residential, office, retail, and hotel TOD uses around California. By revisiting sites that Cervero (1994) first studied in the early 1990s, the authors are able to provide longitudinal results while also providing cross-sectional results across a wider set of building sites. Arlington County’s performance-monitoring requirements call for multiple studies over time at a set interval; once future studies are completed, similar longitudinal studies will be possible for most of the buildings included in this analysis.

Data collection for this sample occurred at 16 commercial office building sites between 2014 and 2015. Figure 1 indicates the general locations of these sites. All sites included in the final sample of 16 were located within the Rosslyn-Ballston Metrorail corridor, which the Orange line serves (the Silver line opened after this data collection was complete). Earlier sampling attempted to collect data at locations in Crystal City as well, but low office building occupancy rates, coupled with complex garage-building relationships, made data available from these sites unreliable, and they were ultimately dropped from the sample.

Study Variables

This study used existing literature and especially previous studies out of Arlington County to shape the selection of key study variables for analysis. “A vast body of research informs us that the built environment is significantly related to travel behavior. The D’s of development – measures of density, diversity, design, and distance to transit – were related to reduced automobile travel.” (Currans, 2013, p. 32). The literature suggests vehicle ownership is lower in TOD zones than in non-TOD zones, and personal vehicle use is likewise lower (Faghri & Venigalla, 2013).

“The TOD literature identifies residential and employment densities, pedestrian amenities and connectivity, accessibility to transit, high-quality transit, and trip purpose as having influence on vehicle mode shares.” (Currans, 2013, p. 28) The ACCS 2008 Commercial Building Study looked at distance from...
Metrorail, the “urban village” in which the building was located, and level of “urban-ness”. TDM availability was also a key independent variable considered in the 2008 Commercial Building Study. Table 1 lists the independent variables collected in both the 2008 and 2014-2015 Commercial Building Study and used in analysis with mode-split, parking and trip-generation data.

### Table 1: Variables Collected for Analysis with Mode-Split, Parking, and Trip-Generation Data

<table>
<thead>
<tr>
<th>Measure</th>
<th>Commercial Building Study 2008</th>
<th>Commercial Building Study 2014-2015</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Connectivity</strong></td>
<td>• Distance to transit at work and home&lt;br&gt;• Commute distance</td>
<td>• Distance to&lt;br&gt;  ○ Transit&lt;br&gt;  ○ Carshare&lt;br&gt;  ○ Capital Bikeshare&lt;br&gt;  ○ Bike trails&lt;br&gt;  ○ Walk Score™&lt;br&gt;  ○ Transit Score™&lt;br&gt;  ○ Bike Score™&lt;br&gt;  ○ Commute distance</td>
</tr>
<tr>
<td><strong>Density</strong></td>
<td>“Urban-ness”&lt;br&gt;Neighborhood Intensity</td>
<td></td>
</tr>
<tr>
<td><strong>Parking Provision and Price</strong></td>
<td>• Parking Price&lt;br&gt;• Parking Supply</td>
<td>• Parking Price&lt;br&gt;• Parking Supply</td>
</tr>
<tr>
<td><strong>TDM Benefits and Services</strong></td>
<td>• Availability at the worksite (from building or employer)&lt;br&gt;• Employee Use</td>
<td>• Availability at the worksite (from building or employer)&lt;br&gt;• Employee Use</td>
</tr>
<tr>
<td><strong>ACCS Programs</strong></td>
<td>• Employer awareness&lt;br&gt;• Employer use&lt;br&gt;• Employee awareness&lt;br&gt;• Employee use</td>
<td>• Employer awareness&lt;br&gt;• Employer use&lt;br&gt;• Employee awareness&lt;br&gt;• Employee use</td>
</tr>
</tbody>
</table>

A complete list of study variables is attached as Appendix A. The variables were grouped into the following categories:

**Building and Neighborhood Data**

These data were collected through an interview with property managers as well as through secondary research of Arlington County data (including Planning, Research and Analysis Team data, Capital Bikeshare, and Department of Real Estate Assessments) and public websites (including Walk Score™ and Google Maps). The key variables included:

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4 “Urban-ness” was defined roughly by the density of development and availability of shopping/retail services in the immediate area of the site and the walkability of the site area. Classifications for this variable were Low, Medium, High, and Very High.
- Neighborhood characteristics
- Access to transportation infrastructure
- Access to transportation information/assistance
- Demographics of employees
- Home location of employees

**Parking and Trip Generation**

Vehicle trips were counted by tube (or hose) counts for 24 hours/day for seven consecutive days for each entrance/exit of parking facilities, i.e. garages or surface lots. Tube counts are a widely used method for automatic trip data collection. Counts are conducted by placing a rubber tube or hose across the travel lanes, and recording the pressure changes caused by wheels of vehicles crossing the tubes as axle movements. Trips were aggregated into 15-minute intervals. Parking occupancy was calculated for the seven-day survey period based on calibration of the tube count data against manual counts during the week. The parking and trip generation data were used to identify key variables:

- Peak hour time of day (AM and PM) for vehicle trip generation
- Peak hour trips generated
- Total daily trips generated
- Parking occupancy by time of day

The counts were compared with ITE code 710 (general office building).

**Employer Interview**

Employers were interviewed in order to collect firmographic information, the transportation services offered, employer awareness of local travel services, and outside assistance that the employer received to develop its TDM program.

**Employee Survey**

Employee surveys were used to assess the following key variables:

- Weekly commute mode split, commute distance, and other commute characteristics
- Vehicle ownership
- Awareness and use of TDM services

Employee participation in the survey was voluntary, and surveys were conducted both online and on paper forms disseminated by the survey team at on-site events or through the property manager. The property manager was also asked to send notifications and reminders over e-mail for a period of two to four weeks or until a response rate of at least 20 percent was reached.

In order to examine the influence that TOD and TDM have on travel behavior, other researchers have used surveys of residents, workers, or guests that ask about commute and non-commute behavior to describe travel patterns in terms of mode split, a technique that allows comparison to publicly available Census data about commute patterns in the surrounding area (Lund, Cervero, & Wilson, 2004) (De Gruyter, Rose, & Currie, 2015).
Other Methodologies

Recent building-level research by the District Department of Transportation (District of Columbia Department of Transportation, 2014) begins with similar premises – that the researchers need to better understand travel demands of new development sites, and that ITE’s trip generation factors overestimate vehicle trips generated by the sites in urban, mixed-use areas. The study considers methods for trip-generation in dense, transit-accessible areas that are alternatives to ITE. However, with additional diverging priorities, their data collection methodology is somewhat different from that used in Arlington’s 2013 Residential Building Study (Simple Solutions Planning & Design, LLC and LDA Consulting) and this Office Building Study.

Instead of capturing a week of vehicle movement in and out of the site, DDOT counted all persons entering or leaving the building, no matter what mode, during only the morning and evening peak hours of one day. Instead of conducting a building-wide survey over a period of weeks to ask questions about mode choice, and awareness and use of transportation services, DDOT intercepted travelers during the counting period and asked them one or two questions in order to determine which mode was being used for the specific trips being counted.

DDOT’s methodology offers a more complete count of non-vehicle trips during the peak hours which in their study revealed not only an over-prediction of vehicle trips using ITE, which the researchers will also demonstrate here, but also an under-prediction of person-trips overall. DDOT’s methodology, however, doesn’t capture a full day worth of trips, making it difficult to apply to highly mixed-use sites with several peaks in daily activity. Their methodology also does not capture awareness, use of, or satisfaction with transportation services, which has historically been of interest to Arlington staff and decision-makers. DDOT’s methodology is better suited to development with little or no on-site parking – something the researchers are seeing more of in DC today, but which doesn’t yet apply to new development in Arlington County.

Analysis and Interpretations

This study sample is made up of both employees and buildings. In most cases, building-level attributes are attached to employee responses in order to analyze and depict relationships between variables at the employee level. However, there are also cases in this analysis where the researchers look at the relationship between two different building-level attributes, and still other cases where the researchers want to know what exactly is going on at each building when it comes to employee-level attributes. These latter two cases typically result in scatter plot charts of the building sample accompanied by a trend line through that data.

However, since the scatter plots contain 16 or fewer building-level data points, the trend lines are illustrative; it is currently not possible to prove (or disprove) significance for those relationships. This type of building-level analysis will become more robust as Arlington gathers a larger sample of buildings with these complete performance data profiles.
III. Summary Statistics

Building Level

Off the 16 sites studied, 12 were primarily office buildings, all but one of which had at least some retail space. Four sites also had residential units, and one had a hotel on site.

The 16 buildings represented about 3.7 million square feet of office space, with individual buildings ranging between approximately 41,400 and 625,000 square feet. Based on property manager interviews, office-space occupancy exceeded 90 percent in 12 buildings, with the additional four buildings ranging between 60 percent and 76 percent occupied, for a sample-wide office occupancy rate of 86 percent.

The buildings included 8,415 total parking spaces, with 4,688 unreserved spaces available for office employees; when normalized for building size, the provided parking ratios of unreserved spaces for office employees (i.e., with visitor, retail, handicap, and other reserved spaces excluded) ranged from 0.72 spaces per 1,000 gross square feet to 2.68 spaces per 1,000 gross square feet of office.

**FIGURE 1: LOCATIONS OF BUILDINGS STUDIED**

Sources: District of Columbia GIS, ESRI, HERE, DeLorme, MapmyIndia, OpenStreetMap contributors.
All building sites had similar, excellent transit access; all were within 0.4 miles of a Metrorail station, and all were within 0.2 miles of ART bus and/or Metrobus service. Additionally, all sites were within 0.3 miles of a Capital Bikeshare station. Figure 1 describes the location of the buildings in the context of North Arlington County.

**Employer Level**

Based on tenant lists provided by building property managers, the sixteen buildings were home to 135 office tenants. The number of tenants in each building ranged from four to 35. Not all employer tenants were responsive to requests for interviews; only 63 agreed to participate. However, employees with some of the employers that did not participate in the employer interviews did participate in the employee survey. Thus, the employee surveys captured responses from the employees of 86 different companies.

The number of employees that each employer had on site varied between 1 and over 500.

Of the 135 employers, the team was able to identify whether the employer was a for-profit company, a non-profit organization, or a government organization for 66 employers. Of these, 43 employers or 67 percent of the total were for-profit companies, 21 employers or 33 percent were non-profit organizations.

Though the team could only identify the employer industry for 64 of the employers, these 64 were part of a variety of industries; the following table describes the number of employers in each industry.

**Table 2: Industries of the Employer Tenants for Whom Industry Could Be Identified**

<table>
<thead>
<tr>
<th>Employer Industry</th>
<th>Number of Employers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banking, Finance, Insurance</td>
<td>3</td>
</tr>
<tr>
<td>Business or Personnel Services</td>
<td>1</td>
</tr>
<tr>
<td>Construction, Building Trades</td>
<td>1</td>
</tr>
<tr>
<td>Development, Real Estate</td>
<td>4</td>
</tr>
<tr>
<td>Education, Training</td>
<td>2</td>
</tr>
<tr>
<td>Government Support (e.g., Contractor)</td>
<td>5</td>
</tr>
<tr>
<td>Government, Public Administration</td>
<td>1</td>
</tr>
<tr>
<td>Hospital, Medical Services</td>
<td>1</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>1</td>
</tr>
<tr>
<td>Non-Profit Organization, Trade Association</td>
<td>16</td>
</tr>
<tr>
<td>Other</td>
<td>10</td>
</tr>
<tr>
<td>Professional / Consulting Services</td>
<td>19</td>
</tr>
</tbody>
</table>

Number of employers n = 64

**Person Level**

The surveys achieved 2,644 completes, for an overall response rate of 20 percent of the approximately 13,400 employees at worksites in the buildings.
Gender
Of those who gave their gender in this survey, 56 percent were female and 44 percent were male; the female share of this sample is higher than that reported among Arlington workers in the 2013 State of the Commute survey (51 percent).

Age
Survey respondents were younger than the Arlington workforce as reported in the 2013 State of the Commute Survey (LDA Consulting, 2014); among respondents who gave age information, nearly 45 percent said that they were under the age of 35, which is nearly three times more than of the proportion of all Arlington employees who gave their age as under 35 (14 percent). A full 67 percent, or two-thirds, gave their age as under 45.

**Figure 2: Age Distribution of Surveyed Employees**

Race and Ethnicity
The racial and ethnic composition of the employees surveyed differed from that of all Arlington workers, as measured in the MWCOG 2013 State of the Commute survey; while only 54 percent of the workers in that survey identified as white, nearly 77 percent of those who gave their race when asked in this survey identified as “white, non-Hispanic.” Only 9 percent of those respondents who answered gave African American as their race, compared to 25 percent in the State of the Commute survey, and only 4 percent of respondents who gave their race in this survey identified as “Hispanic or Latino,” as opposed to 12 percent in the State of the Commute.

Household Income
Though reported annual household incomes were high in this sample (about 68 percent lived in households with annual income over $80,000, roughly the regional median at the time of writing), this
group is actually less affluent than the Arlington workforce as a whole, which is likely related to the age composition of respondents; 77 percent of Arlington workers reported annual household income above $80,000 in the 2013 State of the Commute survey.

**Figure 3: Surveyed Employees’ Annual Household Income**

![Surveyed Employees' Annual Household Income](image)

Survey respondents n = 923

**Location of Residence**

About 39 percent of the employees who gave their home ZIP code as part of the building studies reported living in Alexandria, Arlington, or the District of Columbia, the three core jurisdictions as defined by MWCOG and the three core cities in the region’s Metropolitan Statistical Area. The 2013 State of the Commute survey found that a similar percentage of all Arlington workers (37 percent) lived in these central jurisdictions. Of the respondents reached in the office-building surveys, 20 percent lived in Arlington, which is lower than the 24 percent found in the 2013 State of the Commute; 14 percent lived in the District of Columbia, compared with 9 percent as reported by Arlington workers in the State of the Commute; the share of respondents that live in Alexandria was approximately the same in both studies, at about 5 percent. Outside of the core, Fairfax was the home to the largest share of respondents at 22 percent (lower than the 31 percent reported in the 2013 State of the Commute).

**Home Access to Transit**

Respondents in this sample had better access to transit at home (as measured by distance to stations or stops), then Arlington employees as a whole. In the building surveys, 84 percent of respondents said that their home was within one mile of a bus stop (compared with 67 percent of employees reached in the State of the Commute). Only 22 percent lived less than ¼-mile from a Metrorail or commuter rail station, though nearly 40 percent reported living less than one mile from such a station, which is much higher than the 21 percent reported by all Arlington workers in the 2013 State of the Commute survey.
Motor Vehicles in Household

About 9 percent of the employees surveyed at the 16 buildings reported living in a household without a vehicle available; an additional 36 percent lived in a household with only one car available. A slightly smaller share (6 percent) of all Arlington employees, as reported in the 2013 State of the Commute survey, did not have access to a vehicle at home.
IV. Overall Sample Results

Mode Choice

One objective of the study was to examine commute mode splits for employees who worked in the study buildings as a function of various factors that might influence employees’ commute mode choice. The mode split for Arlington residents and workers is of special interest to Arlington County planners and decision makers as a metric for understanding the impact of the county’s Smart Growth development strategy.

The mode split data were obtained through the employee survey described in the methodology section. Employees were asked to report how they travel to work each day for a “typical week.”

Comparisons were made between the study residents’ typical commute mode split and mode splits for worker populations in several geographic areas:

- All regional commuters in the Washington metropolitan region, based on data from the 2013 State of Commute Survey conducted by the Metropolitan Washington Council of Governments
- All Arlington workers, and employees who worked in neighboring jurisdictions based on data from the 2013 State of Commute Survey
- Employees who worked in the transportation analysis zones (TAZs) in which each of the 16 buildings was located, based on Census Transportation Planning Package data derived from the 2006-2010 American Community Survey

Mode split comparisons were also made for sub-groups of study residents, based on the following location and travel-related variables for employees’ workplace buildings and on employees’ demographics:

- Neighborhood intensity (defined here as the number of jobs and residents per acre within a half-mile radius)
- Transit accessibility, including distance from the worksite to bus and rail (in this case, Metrorail only) transit services and Transit Score™ of the building address
- Walk access, defined by the Walk Score™ of the building address
- Bike accessibility, including Bike Score™ of the building address and distance to bike paths
- Availability of parking at work and the monthly cost for parking
- Availability of commute assistance services at the workplace
- Employee demographics and home location

Two other infrastructure access options, distance to the closest carshare and Capital Bikeshare pick-up locations, also were analyzed, but they did not show any significant influence. Note that all of the study

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6 AASHTO. “CTPP – 5-Year Info.” AASHTO web site. (2013). Retrieved from http://ctpp.transportation.org/Pages/5-Year-Info.aspx. This comparison method is similar to that used in a TCRP report on TDM cost/benefit analysis from the mid-1990s (Comsis 1994 in TCRP report 95, p. 18-21).
buildings were located within 0.3 miles of both of these options and all but two of the buildings were within 0.2 miles, so the ranges were very limited.

All commute mode share comparisons exclude telework and compressed schedule days off unless specified otherwise.

Commuter Mode Split by Geographic Areas

All Arlington Workers and All Regional Workers

Respondents were asked what types of transportation they used to travel to work each weekday (Monday-Friday) in a typical week. Figure 4 presents shares of types of transportation as a percentage of weekly “work days,” that is, days that employees are assigned to work. The figure shows four commute mode for travel to a work location outside the home: drive alone, train (Metrorail), carpool/vanpool, bus, and bike/walk. The figure also includes the mode share for telework and compressed work schedules (TW/CWS). These are not actual travel modes, but rather show work trips avoided through use of these options.

Study respondents drove alone to work less than all Arlington individuals who work in Arlington (47 percent versus 54 percent) and considerably less than the regional average of 66 percent. Study respondents used transit more than Arlington workers overall (32 percent vs. 26 percent). The transit difference was even more striking when compared with the regional average (only 18 percent). Study residents walked/biked at twice the rate for all Arlington workers and four times the rates of commuters region-wide. Study respondents carpooled/vanpooled at about the regional rate. Study respondents teleworked less than did respondents in the other two groups.

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7 In this case, “region” refers to the area within the MWCOG participating jurisdictions, which is not co-terminus with the Washington-Arlington-Alexandria, DC-VA-MD-WV Metropolitan Statistical Area. For a map of the MWCOG participating jurisdictions, see: http://www.mwcog.org/about/jurisdiction/.
By comparison, in the 2008 ACCS Commercial Building Study, 49 percent of individuals reported driving alone as their primary commute mode, while 29 percent took a train, 8 percent took a bus, 7 percent biked or walked, and 8 percent carpooled or vanpooled.

As a national point of comparison, in a 2004 study, Lund and Cervero found that office workers in nine TOD office buildings studied around California were 3.5 times more likely than the population of the surrounding region to give transit as their primary commute mode (p. 89). The drive-alone rate ranged from a low of 45.2 percent at an office building near the BART station in Berkeley, California, to a high of 85.1 percent at a site near the Anaheim station on the Metrolink commuter rail system (p. 89). Transit use ranged from a high of 38.5 at the Berkeley building to 2.9 percent at a building near the Mission Valley station on the San Diego light-rail system (pp. v, 89).

Commuters Who Worked in Neighboring Jurisdictions
Table 3 below displays the mode shares for study respondents and for commuters who worked in several neighboring jurisdictions: the District of Columbia, four Northern Virginia jurisdictions (City of Alexandria and Fairfax, Prince William, and Loudoun counties) and for the suburban Maryland counties that border the District of Columbia to the north and east (Montgomery and Prince George’s counties combined).
Study respondents drove alone less than respondents in nearly all neighboring jurisdictions. The drive alone rate was lower only for commuters who worked in the District of Columbia (41 percent). Drive alone rates for commuters who worked in other Northern Virginia jurisdictions were much higher than for study respondents. The primary difference was in the use of transit for commuting, but study respondents also had a higher bike/walk rate than did workers in all neighboring jurisdictions, including the District of Columbia. The carpool/vanpool share for study respondents was higher than for all jurisdictions except the District.

**TABLE 3: PERCENTAGE OF WEEKLY COMMUTE TRIPS BY MODE – STUDY RESPONDENTS VS RESPONDENTS WHO WORK IN NEIGHBORING JURISDICTIONS**

<table>
<thead>
<tr>
<th>Commute Mode by Work Location</th>
<th>Drive alone</th>
<th>Bus or train</th>
<th>Bike/Walk</th>
<th>Telework/ CWS</th>
<th>Carpool/ Vanpool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study respondents (n = 2,644)</td>
<td>47%</td>
<td>32%</td>
<td>9%</td>
<td>5%</td>
<td>7%</td>
</tr>
<tr>
<td>All Arlington Residents</td>
<td>53%</td>
<td>26%</td>
<td>7%</td>
<td>8%</td>
<td>6%</td>
</tr>
<tr>
<td>All Arlington Workers</td>
<td>54%</td>
<td>26%</td>
<td>4%</td>
<td>9%</td>
<td>7%</td>
</tr>
<tr>
<td>District of Columbia (n = 1,743)</td>
<td>41%</td>
<td>38%</td>
<td>4%</td>
<td>6%</td>
<td>11%</td>
</tr>
<tr>
<td>Other Virginia Jurisdictions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alexandria (n = 311)</td>
<td>79%</td>
<td>9%</td>
<td>3%</td>
<td>5%</td>
<td>4%</td>
</tr>
<tr>
<td>Fairfax (n = 882)</td>
<td>78%</td>
<td>7%</td>
<td>1%</td>
<td>9%</td>
<td>5%</td>
</tr>
<tr>
<td>Prince William (n = 195)</td>
<td>84%</td>
<td>1%</td>
<td>1%</td>
<td>10%</td>
<td>4%</td>
</tr>
<tr>
<td>Loudoun (n = 279)</td>
<td>86%</td>
<td>1%</td>
<td>1%</td>
<td>11%</td>
<td>2%</td>
</tr>
<tr>
<td>Suburban Maryland (n = 1,049)</td>
<td>79%</td>
<td>6%</td>
<td>1%</td>
<td>9%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Sources: Modes for all Arlington workers and workers in other jurisdictions, 2013 MWCOG State of the Commute Survey.

**Commuters Who Work in the Immediate Neighborhood**

The commute mode split of study respondents also was compared to that for commuters who worked in the vicinity of the commercial study buildings, as estimated from Census Journey-to-Work data for the TAZ’s in which the study buildings were located. Figure 5 presents the drive alone mode split for each of the 16 study buildings, compared with the average drive alone rate for commercial buildings in the immediate neighborhood. In nearly all cases the study buildings had lower than average drive alone rates; in many cases it was much lower. In general, this good performance relative to neighbors held across the three Arlington areas – Ballston, Clarendon, and Rosslyn – although three Ballston buildings and one Rosslyn building had drive-alone rates that were close to or above the average for their respective TAZs.

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8 It is worth noting that while all study respondents were in office buildings close to Metrorail in areas considered “urban”, the DC data covers a sample of workers from all parts of DC, not necessarily just the urban parts. For more about how DC includes suburban places, see a recent article in Greater Greater Washington: [http://greatergreaterwashington.org/post/27502/this-map-shows-which-parts-of-the-dc-area-are-really-urban-and-suburban/](http://greatergreaterwashington.org/post/27502/this-map-shows-which-parts-of-the-dc-area-are-really-urban-and-suburban/)
FIGURE 5: PERCENTAGE OF WORKERS USING DRIVE-ALONE AS PRIMARY MODE – STUDY BUILDINGS VS NEIGHBORING AREA

Commute Mode Split by Neighborhood Intensity

Figure 6 shows drive alone, transit, carpool/vanpool, and bike/walk mode splits for each of the 16 buildings as a function of their “neighborhood intensity,” with neighborhood intensity defined as the total number of employees and residents per acre, within a one-half mile radius of the building. As illustrated by the dotted trend lines for drive alone and transit mode shares, there was a slight downward trend in drive alone use and a corresponding increase in transit use as neighborhood intensity increased. Carpool/vanpool and bike/walk rates showed no particular patterns.
16 study buildings, Individual building mode survey samples ranged from 64 to 329.

**Commute Mode Split by Transit Access**

**Distance from Work to Metrorail**

The transit mode split was higher and the drive alone rate was lower for study respondents who worked in buildings that were closer to Metrorail. But as all sites were within 0.4 miles of Metrorail, all were “close” to Metrorail and these results cannot be generalized beyond these distances. Similar results were found in the 2008 Commercial Building Study: there was little difference in drive-alone or transit mode share for 0–2 blocks and 3–5 blocks from Metrorail. In the current study, 15 of the 16 buildings were within 0.1 mile of a bus stop, so it was not possible to analyze mode split as a function of bus distance.
FIGURE 7: PERCENTAGE OF STUDY RESPONDENTS USING MODE AS PRIMARY COMMUTE MODE BY DISTANCE FROM WORK TO METRORAIL

Transit Score™
A second and more expansive view of transit accessibility is provided by Transit Score™, which assigns addresses a rating of 0 to 100 to indicate how well they are served by public transportation overall, considering geographic coverage as well as service frequency. The highest ratings of 90 to 100 ("Rider's Paradise") are given for locations with multiple and frequent transit options available within a quarter of a mile. Lower ratings indicate progressively more limited service, with lower operating frequency and greater walking distance. Transit Score™ was used as a proxy for the quality and availability of transit service to the building.9 Mode split was compared for study buildings by their Transit Score™ (Figure 8).

The commute drive-alone mode share trend line decreased steadily and the transit trend line increased as the Transit Score™ of the building went up. Note, however, that the transit shares for some buildings deviated substantially from the trend line, with one substantially higher and another much lower than anticipated, indicating that other factors also influenced transit mode use.

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9 For more on the Transit Score methodology, see: http://www.walkscore.com/transit-score-methodology.shtml
Figure 9 presents another comparison of mode split by Transit Score™, with all employee survey respondents grouped into Transit Score™ categories. As noted for the previous figure, the range of Transit Scores™ was relatively compact, with only 15 score points separating the lowest score (63) from the highest (78). When grouped in the score categories, all respondents fell into either the “Good Transit” (score of 52 to 69) or “Excellent Transit” (score of 70 to 89) categories. Employees who worked in buildings with “Excellent” transit drove alone less and used transit and walked/biked more than those who worked in buildings with “Good” transit.
Transit Scores range from 63 to 78; Some Transit 25 – 51 n = 0, Good Transit 52 – 69 n = 806, Excellent Transit 70 – 89 n = 1,838, Rider’s paradise 90 – 100 n = 0.

**Commute Mode Split by Bike Access and Walk Access**

**Walk Score™**

Walk Score™, another transportation access index with ratings from 0 to 100, indicates the relative number of public and personal amenities, such as businesses, parks, theaters, schools and other common destinations, within one mile of an address. The score is not a true measure of walkability since it does not take into account factors such as safety, topography or street design.10

As shown in Figure 10, drive-alone and transit mode shares showed very little change as the Walk Score™ of the building increased. Unexpectedly, a slight decline in walk mode share was observed as Walk Score™ rose, although one building seemed to slightly over-perform the trend line expectation. But even the lowest Walk Score™ building had a score of 82, which fell into the higher end of the “Very Walkable” category (score of 70-89). The absence of a distinct trend in walk mode share could suggest that the walkability of all the buildings had crossed a threshold for an acceptable walking environment.

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10 For more on the Walk Score methodology, see: [http://www.walkscore.com/methodology.shtml](http://www.walkscore.com/methodology.shtml)
16 study buildings; individual building mode samples ranged from 64 to 329; Walk Score™ ranged from 82 to 97.

**Bike Score™**

The Bike Score™ index, also ranging from 0 to 100, measures the bikeability of a location, taking into account the availability of bike infrastructure, terrain around the location, destinations that can be reached easily by bike, and road connectivity.\(^\text{11}\) Mode split patterns for the 16 buildings seemed unrelated to the building’s Bike Score™. However, as noted for Transit Score™ and Walk Score™, the Bike Score™ range for the 16 study buildings was extremely close, ranging only from 76 to 85. With these scores, all of the buildings would be classified as “Very Bikeable” (score of 70 to 89).

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\(^{11}\) For more on the Bike Score methodology, see: [https://www.walkscore.com/bike-score-methodology.shtml](https://www.walkscore.com/bike-score-methodology.shtml)
Distance from Work to Bike Trails

A second measure of bike access was the distance from the work location to the nearest bike trail, such as the Custis Trail or Mount Vernon Trail. As illustrated by Figure 12, the drive alone mode share rose slightly and the transit mode share fell as the distance to bike trails increased. But the bike mode share was essentially the same across all buildings, regardless of their bike trail proximity. Building distances ranged from 0.1 miles to 1.0 miles, so this result likely is not as affected by the limited building sample as was noted for other transportation access features.
**FIGURE 12: PERCENTAGE OF WEEKLY COMMUTE TRIPS BY MODE — STUDY RESIDENTS BY DISTANCE FROM WORK TO BIKE TRAIL**

16 study buildings, individual building mode samples ranged from 64 to 329.

**Commute Mode Split by Worksite Parking Availability and Cost**

Many research studies have documented the role parking plays in influencing travel behavior. This study examined several questions related to parking, including how much is provided with respect to building occupancy, and the price of parking experienced by the worker. However, this study acknowledges that “supply and pricing factors are obviously highly interrelated.” (TCRP Report 95, 18-5) “Many parking supply management strategies involve or abet parking pricing, and their effects are heavily intertwined...Statistical analyses will typically show a stronger direct relationship between travel behavior and price than between travel behavior and supply.” (18-38, 18-39) Parking supply and price were key independent variables examined in the ACCS 2008 Commercial Building Study (Slide 12) as well here in this new analysis.

In this study, property managers were asked how many spaces were available in all lots/garages associated with the building and how those spaces were allocated to tenants and visitors. Employers were asked how many employees worked at the site and what fees, if any, did they charge employees for parking. Finally, employees were asked; on days that you drive to work, where do you park, and how much do you, or would you, pay to park at this location?

Property manager interviews and employee surveys were used to define two parking variables:

- **Parking ratio** – This was defined as the number of spaces available per employee. It was calculated by dividing the total employee parking spaces reported by the property manager, including both reserved and spaces that were unreserved but open to employees, by the estimated number of employees working in the building. A value of 1.0 would mean that the employer had a space for
each employee. A value of 0.5 meant that the employer had one parking space for every two employees; in other words, the employer had parking for only half the employees.12

- Parking fee – This was defined as the fee per month that was paid or would be paid if the employee drove to work. Both employers and employees were asked about parking charges. But because most employers did not offer parking to all employees and assessed a fee for some, but not all, employees, the parking fee was defined as the fee reported by the employee. All employees were asked to report their parking charge. Employees who said they did not usually drive to work were asked how much they “would pay” if they drove, even on an occasional basis. Some employees were not able to answer the question, presumably because they had never driven. Other employees reported the charge as a daily charge. These rates were converted to a monthly charge by multiplying by an 18-workday month.

Employee Parking Availability
Employee parking availability in the study buildings ranged from a low of 0.11 spaces per employee to a high of 1.04 spaces per employee.13 The distribution of employees by building parking ratio is described in Table 4.

Table 4: On-Site Parking Supplied to Surveyed Employees:

<table>
<thead>
<tr>
<th>Parking Ratio Range</th>
<th>Percentage of Employees</th>
<th>Number of Buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 – 0.25 spaces per employees</td>
<td>13%</td>
<td>1</td>
</tr>
<tr>
<td>0.26 – 0.50 spaces per employees</td>
<td>28%</td>
<td>4</td>
</tr>
<tr>
<td>0.51 – 0.75 spaces per employees</td>
<td>48%</td>
<td>6</td>
</tr>
<tr>
<td>0.76 – 0.90 spaces per employees</td>
<td>4%</td>
<td>1</td>
</tr>
<tr>
<td>More than 0.90 spaces per employees</td>
<td>7%</td>
<td>3</td>
</tr>
</tbody>
</table>

Parking spaces per employee: 0.01 – 0.25 n = 318, 0.26 – 0.50 n = 733, 0.51 – 0.75 n = 1,262; 0.76 – 0.90 n = 93, 0.91 or more.

About four in ten employees worked in buildings with less than one space for every two employees. The remaining 59 percent worked in buildings with parking for at least half of the employees, but only 7 percent worked in a building with more than 0.90 spaces per employee, essentially a space for each employee, given some daily absenteeism. Over all the employees in the survey, the average parking ratio was 0.52 spaces per employee.

Figure 13 shows the drive-alone commute mode split for respondents by the number of parking spaces available per employee in their worksite building.14 As shown, the drive-alone rate was lowest when

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12 “In primarily suburban office and business park situations... [minimum parking requirements] has resulted in parking ratios typically in the range of three to four spaces per 1,000 square feet, often equivalent to one space for every employee.” (TCRP Report 95, p 18-5)

13 The employee parking ratio could not be clearly determined for one mixed-used building because the number of parking spaces included several significant retail uses and a substantial number of spaces for retail use; these spaces could not be separated from employee spaces.

14 Parking studies have concluded that parking is a powerful factor in commute decision-making, particularly when commuters have access to non-driving travel options and the analysis compared commute mode for study respondents who worked in
Parking was very constrained and the drive alone rate increased as parking availability increased, but the growth in the drive alone rate was modest once the parking ratio reached 0.50 spaces per employee. It is also important to note that only one building had a parking ratio below 0.26 spaces per employee, so the 39 percent drive alone rate for this category reflects a limited range of location characteristics other than parking ratio.

It is also important to note that the parking ratios shown reflect only parking that is available directly in the building. The survey data indicated that only 85 percent of employees who drove alone parked in in their work building; the remaining 15 percent parked in a near-by building. This suggest that even when very few employees were provided parking by their employers, employees who wanted to drive to work could find parking, either onsite or in a nearby lot or garage.

The relationship between parking availability at the worksite and drive-alone mode share was similarly evident for individual buildings. The chart in Figure 13 presents the share of weekly commute trips made by driving alone for each of the study buildings, plotted against the number of parking spaces per employee in the building. The drive-alone mode shares were higher for buildings with higher parking ratios. The relationship was not steeply increasing, but the data points were clustered fairly closely around the trend line.

**Figure 13: Percentage of Weekly Commute Trips by Driving Alone – Study Buildings by Parking Spaces per Employee**

![Graph showing the relationship between parking spaces per employee and percentage of weekly commute trips by driving alone.](image)

n = 15 study buildings

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Buildings with limited parking versus buildings with greater parking availability. Lund and Cervero (2004) found a negative relationship between parking supply and transit use: when parking was provided at 0.5 spaces per employee, about 30 percent of workers commuted by transit, but when parking supply was greater than 0.5 spaces per employee, the share of workers giving transit as their primary commute mode dropped to less than 10 percent of workers (pp. 97-98). These data do not show primary commute mode, but rather percent of total weekly commute trips by mode, so the two studies are not directly comparable, but they share a similar direction of influence.
**Employee Parking Cost**

Based on a study of mode split and parking characteristics for 17 US CBDs (1997), “[o]verall, the most important factor influencing modal choice appears to be parking price.” (TCRP Report 95, p. 18-43). The data showed that 75 percent of employees who primarily drove alone paid or would pay a charge to park. Among employees who primarily used a non-drive-alone mode for commuting, 78 percent said they would have to pay to park if they drove alone to work.

The employees in these buildings are more likely to pay for parking than the Arlington workforce as a whole. According to the 2013 State of the Commute, 44 percent of Arlington employees said that they would have to pay all or some of the cost to park at their work site. A summary analysis of State of the Commute surveys from 2007, 2010, and 2013 found that on 62 percent of employees in the Metrorail corridors reported paying for parking. Possible explanations for discrepancy between the findings from the building surveys and the State of the Commute surveys may simply be due to differences between the employers at the sample buildings and the entire set of employers in Arlington’s Metrorail corridors or because the respondents to the building surveys were younger than the Arlington work force reached in the State of the Commute surveys. Younger employees might be less likely than their senior colleagues to receive the “perk” of free parking from their employers.

In comparison, in the 2008 ACCS Commercial Building Study, 56 percent of employers surveyed said that they offer free parking, but only 23 percent of employees surveyed said that parking was free at work because large employers were less likely to offer free parking than small employers. However, an equivalent share said that the monthly cost of parking was over $126 (slide 158). Lund and Cervero (2004) also found that employers subsidized parking at a high rate in the California TODs that they studied: workers at a site in Sacramento had the lowest access to subsidized parking (24.6 percent of respondents reported having it), while 82.9 percent of employees at the building near San Diego’s Mission Valley station had access to free parking (p. v).

Workplace parking cost did not appear to influence commute mode until the monthly cost exceeded $150, at which point the drive alone rate dropped dramatically and the transit rate rose substantially. Bike/walk and carpool/vanpool mode shares were not affected, even when parking cost was quite high.
FIGURE 14: PERCENTAGE OF WEEKLY COMMUTE TRIPS BY MODE – STUDY RESPONDENTS BY MONTHLY PARKING COST AT WORK

Parking cost per month: $0 n = 558, $1 - $100 n = 313, $101 - $150 n = 704, $151 or more n = 444

The share of employees who drove alone to work also was lower at individual buildings where employees reported a higher average cost to park (Figure 15). The slope of the trend line for drive-alone mode share against average parking cost is distinctly downward trending.  

15 A similar relationship was seen in the 2008 Commercial Building Study, where drive-alone rate peaked at 73 percent of employees in the lower $76-$100/month range, and dropped steadily to 30 percent of employees when workplace parking cost was $125 or more per month.
In Arlington’s 2013 Residential Building Study, parking costs at work had a stronger correlation with commute mode choice than had home parking cost, with the biggest jump in transit use observed where work parking cost over $150 a month. In that sample however, most homes were transit-accessible, leaving the work-end transit accessibility the larger varying factor, a factor that likely co-varied with work parking cost. In this study of commercial office buildings the researchers see a similar but flipped pattern; workplace parking cost was less related to commute mode than home parking cost (which appears later in this report) because across the sample (of workplaces) there was high transit access. In this case, the home-end transit access is the larger varying factor, a factor that likely co-varies with home parking cost (i.e., homes with the highest transit access likely charge the highest parking costs).

**Commute Mode Split by Access to Commute Assistance Services**

Employees who responded to the survey were shown a list of 17 commute assistance services and asked which, if any, of the services were available to them at their workplace. The services included both financial incentives as well as non-financial “support” services. This analysis is based on the following grouping of services:
TABLE 5: TDM SERVICES AND BENEFITS BY CATEGORY

<table>
<thead>
<tr>
<th>Financial Services</th>
<th>Non-Financial “Support” Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash or other financial benefit for carpooling</td>
<td>Help finding carpool/vanpool partners, “match list”</td>
</tr>
<tr>
<td>Cash or other financial benefit for vanpooling</td>
<td>Reserved or preferential parking for carpools/vanpools</td>
</tr>
<tr>
<td>SmartBenefits or other financial benefit for riding public transportation</td>
<td>Secure parking for bicycles in the building</td>
</tr>
<tr>
<td>Free or discounted membership for Capital Bikeshare</td>
<td>Personal lockers or showers for employees who bicycle</td>
</tr>
<tr>
<td>Other cash or financial benefit for bicycling</td>
<td>Transit schedule or route information</td>
</tr>
<tr>
<td>Free or discounted carshare membership (e.g., Zipcar, Car2Go)</td>
<td>Shuttle to Metrorail</td>
</tr>
<tr>
<td></td>
<td>Bicycle/walking information</td>
</tr>
<tr>
<td></td>
<td>Guaranteed Ride Home in case of emergencies</td>
</tr>
<tr>
<td></td>
<td>Company fleet vehicles available for personal trips during the workday</td>
</tr>
<tr>
<td></td>
<td>Transportation information display/kiosk in building lobby</td>
</tr>
<tr>
<td></td>
<td>Transportation information on company intranet</td>
</tr>
</tbody>
</table>

Data from this question were used to define an overall level of commute assistance or “transportation demand management” (TDM) program into three levels by the type and number of services offered:

- **No / Low TDM** – No financial incentive and zero to four non-financial support services (e.g., Guaranteed Ride Home, preferential carpool/vanpool parking, transit information, etc.)
- **Moderate TDM** – No financial incentives and five or more support services
- **High TDM** – At least one financial incentive, plus zero to four non-financial support services
- **Very High TDM** – At least one financial incentive, plus five or more non-financial support services

**Overall Level of TDM Services**

Employees who reported access to a High or Very High level of TDM services at their workplace drove alone less and used transit much more than did employees who had lower TDM access (Figure 16). The mode shares were not substantially different, however, for employees who reported having access to a Moderate level TDM program versus no TDM/Low TDM.\(^\text{16}\)

In Arlington’s 2013 Residential Building Study, respondents who knew of TDM services were less likely to drive to work, and those who used TDM services were even less likely to drive to work.

This reinforces the conclusion, drawn from other TDM research, that a financial incentive offers a higher mode-shift motivating value than do most non-financial services. It also supports the large increase in transit mode share for High-Very High TDM programs, compared with Moderate TDM programs.

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\(^\text{16}\) Across the entire set of buildings in the 2008 ACCS Commercial Building Study, the drive alone rate declined from 56 percent in the presence of “low” TDM to 41 percent and 42 percent at “moderate/high” levels as reported by employees (slide 165). However, the grouping of programs into low, medium, and high is not the same between the two studies.
Nearly all (93 percent) employees who reported having a financial incentive said a transit subsidy was offered, while only 39 percent of employees reported having that their employer offered a subsidy for carpools/vanpools or bicycling to work.

Notably, the rate of carpooling and vanpooling in this sample drops as worksite level of TDM service increases, which seems counterintuitive. These worksites all have good transit proximity, so it is possible that with better transit incentives and these nearby services, people who might otherwise carpool or vanpool are choosing to take transit instead.

**Figure 16: Percentage of Weekly Commute Trips by Mode — Study Respondents by Worksite TDM Program Level**

No/Low TDM n = 432, Moderate TDM n = 187, High- Very High TDM n = 1,436

**Mode-Specific Services**

The analysis also tested whether transit and bike use was influenced by availability of workplace services that particularly targeted these modes. As presented in Figure 17, transit mode share was about twice as high when transit-focused services, such as transit route and schedule information, transit financial incentive, shuttle to Metrorail, and Guaranteed Ride Home, were offered as when no services were offered. Bike mode share similarly was higher when bike-focused services such as bike/walk information, secure bike parking, showers/personal lockers, Capital Bikeshare membership, and bike financial incentive, were offered.
Bike services – No services $n = 477$, 1 to 3 services $n = 1,344$, 4 or more services $n = 278$; Transit services – No services $n = 309$, 1 to 3 services $n = 1,530$, 4 or more services $n = 260$

**Bike-Focused Services**

Bike/walk information and secure bike parking appeared to influence use of bike for commuting, but the bike commute mode shares were low overall.
FIGURE 18: PERCENTAGE OF WEEKLY COMMUTE TRIPS BY BIKE – STUDY RESPONDENTS BY AVAILABILITY OF BIKE SERVICES

Bike/walk info: Not available n = 355, Available n = 1,148; Secure bike parking: Not available n = 179, Available n = 1,305; Capital Bikeshare membership: Not available n = 529, Available n = 425; Other bike financial service: Not available n = 483, Available n = 122; Lockers/showers: Not available n = 305, Available n = 1,221

Transit-Focused Services

As shown in Figure 19 availability of a discounted transit pass appeared particularly influential for transit use; the transit mode split was 39 percent when a pass was offered, compared with 23 percent when it was not offered. No significant differences were noted in transit mode split for availability of transit information or a shuttle to Metrorail. But, as noted earlier, all of the worksites were within 0.4 miles of a Metrorail station, so walking distances were well within the range of what most commuters would consider acceptable. Also, many respondents who reported having access to a shuttle also worked for employers who said that such a service was not actually provided.17

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17 See the section “Employee Perception of TDM Services Versus Employer-Reported Services” below.
FIGURE 19: PERCENTAGE OF WEEKLY COMMUTE TRIPS BY TRANSIT – STUDY RESPONDENTS BY AVAILABILITY OF TRANSIT SERVICES

Transit information services: Not available n = 275, Available n = 1,344; Discounted transit pass: Not available n = 346, Available n = 1,370; Shuttle to Metrorail: Not available n = 739, Available n = 391

Lund, Cervero, and Wilson found that “[i]f an employer does not help pay the cost of transit, the likelihood that the office worker will commute by transit is just 4.7 percent; if the employer does help with the cost of transit, the share increases to 25.4 percent” (2004, p. 96). “Disaggregate modeling of office worker mode choice indicates that parking policies and employer assistance with transit costs significantly influence whether those working in offices near California rail stations commute by transit” (Lund, Cervero, & Wilson, 2004, p. v)

Transit Subsidy Combined with Parking Cost

According to Lund, Cervero, and Wilson “transit ridership is highest when transit and carpool incentives are matched with driving disincentives” as was the case at a particular work site in Sacramento; 39 percent of the Sacramento station-area workers used transit; 61 percent of respondents received transit fare subsidies, while only 25 percent had free parking (2004, p. 88).

What the researchers see here is that a discounted transit pass or other transit subsidy had an even stronger relationship with transit mode share when it was paired with a parking charge. As indicated in Figure 20, the transit mode share was considerably higher when a transit subsidy was offered than when it was not offered, and the boost in transit mode share was evident at all parking cost levels. When the transit subsidy was coupled with a parking cost of $151 or more, the transit share was three times as high as when the subsidy was not offered.
Figure 20: Percentage of Weekly Commute Trips by Transit – Study Respondents by Parking Cost at Work and Availability of Transit Subsidy

Future Mode-Influencing Potential for Worksite TDM Services

Employees who drove alone to work were asked how likely they would be to try carpooling, vanpooling, public transit, bicycling, or walking for their trip to work if TDM services that were not currently available were offered. Four of every ten (41 percent) employees who drove alone said at least one of the TDM services would encourage them to try other transportation options for commuting.

Several services were particularly noteworthy, with at least one in ten drive alone employees saying the service would encourage them: information kiosk in the building lobby (20 percent), information on company intranet (18 percent), transit financial incentives (17 percent), carpool financial incentive (15 percent), and transit schedule information (12 percent).
Transit information services: Not available n = 275, Available n = 1,344; Discounted transit pass: Not available n = 346, Available n = 1,370; Shuttle to Metrorail: Not available n = 739, Available n = 391

Commuter Mode Split by Employee Demographics and Home Location Characteristics

The analysis discussed previously in this section explored the role that location, transportation infrastructure, parking, and commute services might have on employees’ mode choice. Various TDM research studies have shown that characteristics of employees themselves and characteristics of where they live also can influence their commute mode choice decisions, and the employee survey included several questions related to these topics.

Employee Household Income and Age

Analysis of the employee survey data showed no significant differences in mode use by gender or race: men and women were approximately equally likely to drive alone as were respondents from the four largest ethnic groups (African-American, Asian, Hispanic, and Non-Hispanic White). But differences were
observed for both income and age. Less affluent respondents drove alone to work much less and used transit much more than did respondents with higher annual incomes (Figure 22).

**FIGURE 22: PERCENTAGE OF WEEKLY COMMUTE TRIPS BY MODE – STUDY RESPONDENTS BY ANNUAL HOUSEHOLD INCOME**

A similar pattern was noted for age: respondents who were younger than 35 drove alone at a much lower rate and used transit much more than did older respondents (Figure 23). But age and income are typically correlated, so the similarity of the income and age mode distributions is not surprising.
Employees’ Home Locations

The survey data also indicated that where employees lived strongly influenced how they got to work (Figure 24). The drive-alone commute mode shares for respondents who lived in Arlington and the District of Columbia were 37 percent and 30 percent, respectively, well below the 59 percent share for employees who lived outside these two jurisdictions. Among employees who lived in the District, the primary mode, by a wide margin, was transit, which they reported using for 63 percent of commute trips.

This is reinforced by other research: personal vehicle use exceeds transit use even in TOD areas because many trip-ends are still outside a TOD zone, suggesting a strong association between transit network coverage and transit ridership (Faghri & Venigalla, 2013).

Study employees who lived in Arlington also used transit (26 percent of trips), but more than one-third biked/walked (6 percent of trips by bike, 28 percent of trips walking) to work. The high bike/walk mode share is not surprising considering that most of the study buildings were located in walkable areas with significant residential space. Among respondents who lived outside Arlington and the District, a notable finding was the 10 percent share of trips made by carpool or vanpool; only 2 percent of employees who lived in Arlington and 1 percent who lived in the District carpooled or vanpooled to work. This makes sense, because carpooling and vanpooling are inferior options if you live close enough to work to walk or bike easily, or if the transit options get you easily from home to work.
The mode splits by home location also were related to the age distributions of employees. As shown below, a much higher share of survey respondents who lived in the District of Columbia, Arlington, and Alexandria were young than was the case for respondents who lived in other jurisdictions.

**Table 6: Percentage of Study Respondents Under 35, by Home Location**

<table>
<thead>
<tr>
<th>Home Location</th>
<th>Respondents Younger than 35 Years (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>District of Columbia (n = 300)</td>
<td>65%</td>
</tr>
<tr>
<td>Arlington County (n = 416)</td>
<td>60%</td>
</tr>
<tr>
<td>City of Alexandria (n = 90)</td>
<td>46%</td>
</tr>
<tr>
<td>Fairfax County (n = 410)</td>
<td>32%</td>
</tr>
<tr>
<td>Loudoun/Prince William counties (n = 121)</td>
<td>28%</td>
</tr>
<tr>
<td>Montgomery/Prince George’s counties (n = 176)</td>
<td>27%</td>
</tr>
</tbody>
</table>

The large shares of young respondents in the District of Columbia and Arlington particularly influenced the low drive-alone rates for these two home areas (Figure 25). Among respondents who lived in the District of Columbia, only 15 percent of respondents under 35 drove alone to work. In Arlington, the drive-alone rate for young respondents was double that, at 30 percent. When coupled with the large proportions of young respondents in these jurisdictions, this resulted in overall low drive-alone rates for these two home areas. Young respondents who lived in both Fairfax and Montgomery/Prince George’s also drove alone at much lower rates than did their older neighbors, but far fewer young employees lived in these counties, so their mode choices had less impact on the overall mode splits for the jurisdictions.
FIGURE 25: PERCENTAGE OF RESPONDENTS WHO PRIMARILY DROVE ALONE – STUDY RESPONDENTS BY HOME LOCATION AND AGE

Distance from Employees’ Homes to Metrorail Station

Earlier analysis showed the transit commute mode share was slightly higher among employees who worked closer to Metrorail, but the relationship was weak, likely due to the narrow range for distance; all of the study buildings were located within 0.4 miles of Metrorail. Employees’ access to Metrorail was less homogenous at the home end, however; only 22 percent of employees lived within one-half mile of a Metrorail station and only 40 percent lived within one mile. With this wider range of home area transit access, a much more definitive relationship was found between transit use and home transit access (Figure 26).

As the distance from home to Metrorail increased, the drive alone rate increased dramatically and the transit mode split dropped. Among respondents who lived less than one-half mile of Metrorail, only 24 percent drove alone to work and 50 percent rode transit. Transit use was still relatively high, at 47 percent, for respondents who lived between one-half and one mile. Transit use fell to 27 percent for distances between 1.1 and 1.9 miles, and to just 20 percent for distances of two miles or more.

The bike/walk mode share also was very high (25 percent) for respondents who lived within one-half mile of Metrorail and declined steeply as home to Metrorail distance increased. This reflects the excellent transit access of respondents who lived in Arlington. As noted in Figure 26, which presented mode splits by home jurisdiction, respondents who lived in Arlington walked to work for 25 percent of their weekly commute trips.

District of Columbia: Under 35 n = 195, 35 or older n = 105; Arlington: Under 35 n = 248, 35 or older n = 168; Alexandria: Under 35 n = 41, 35 or older n = 49; Fairfax: Under 35 n = 130, 35 or older n = 280; Loudoun / Prince William: Under 35 n = 34, 35 or older n = 87; Montgomery / Prince George’s: Under 35 n = 48, 35 or older n = 128
Drive-alone rates were lower among younger respondents than older respondents. Figure 27 presents the drive-alone mode shares by distance from home to Metrorail with the additional dimension of respondent age. At each Metrorail distance grouping, respondents who were under 35 years old drove alone less than did older respondents. The gap in drive alone mode share ranges from 10 to 20 percentage points lower for young respondents, depending on proximity to Metrorail.
FIGURE 27: PERCENTAGE OF RESPONDENTS WHO PRIMARILY DROVE ALONE – STUDY RESPONDENTS BY DISTANCE FROM HOME TO METRORAIL AND AGE

Less than 0.5 miles: Under 35 n = 258, 35 or older n = 135; 0.5 – 1.0 miles: Under 35 n = 169, 35 or older n = 126; 1.1 – 1.9 miles: Under 35 n = 105, 35 or older n = 138; 2.0 miles or more: Under 35 n = 199, 35 or older n = 495

Vehicle Ownership

Lastly, the mode analysis examined mode use by vehicle ownership. According to Lund and Cervero, “the full transportation benefits of TOD occur when a combination of non-automobile access modes and mixed land uses are sufficient to allow households to reduce automobile ownership” (2004, p. vi).

The survey asked employees how many motor vehicles were owned or leased by member of their household for personal travel use. About 10 percent of respondents said they did not have any household vehicles; they were “car-free.” About 36 percent had one household vehicle, 37 percent reported two vehicles, and 18 percent said they had three or more vehicles in the household.

Not surprisingly, only a tiny share (3 percent) of respondents who lived in a car-free household drove alone to work; note that this category included taxi, so this likely was the mode they used, though some may have also used a vehicle owned by a friend or neighbor. Car-free respondents overwhelmingly commuted by transit (79 percent), but almost two in ten (17 percent) biked or walked (Figure 28). Transit (37 percent) and bike/walk (15 percent) also were common modes for respondents who had one household vehicle, but 43 percent of these respondents drove alone to work. As the number of household vehicles increased, the drive alone rate increased and the bike/walk share decreased. Carpool/vanpool use also increased with a higher number of household vehicles.
The number of household vehicles is not a true measure of vehicle availability, because it does not take into account the number of adults in the household. A one-vehicle household that has only one adult member has full vehicle availability, while a one-vehicle household with two or more adult members would leave some of the members without a vehicle.

The survey did not include a question about household size, so mode split by vehicle availability could not be tested. But car-free households were more common among young respondents, who would be more likely to be living alone or with unrelated adults who would be less likely to share vehicles. Four in ten (39 percent) respondents who were younger than 25 years and 15 percent of respondents who were between 25 and 34 lived in a car-free household, compared with just 4 percent of respondents who were 35 years or older.

Car-free households also were much more common among respondents with lower household incomes; 34 percent of respondents with annual household incomes of less than $50,000 and 16 percent of those with incomes between $50,000 and $99,999 were car-free, compared with 4 percent of respondents with annual household incomes of $100,000 or more. And car-free households were concentrated in the District of Columbia and Arlington. Almost one-third (32 percent) of respondents who lived in the District of Columbia and 12 percent of Arlington resident respondents said they were car-free, compared with 2 percent of respondents who lived in another area.

It is very likely that the low vehicle ownership rates for younger, lower-income respondents and those who lived in Arlington and the District of Columbia were related to the lower drive-alone rates described earlier for respondents in these demographic sub-groups.
However, the source and order of the relationship cannot be defined. Did the high cost of vehicle ownership and use lead to a decision not to own a vehicle and, thus, a need to find another transportation option for commuting? Or did a combination of residential and work location opportunities that allowed an easy commute by means other than driving alone lead to a decision not to purchase a vehicle, even for respondents who could afford to do so? The most likely conclusion is that all of these factors had some role in respondents’ mode choice, with different degrees of influences for different respondents.

**Employer-Based TDM**

**Commute (TDM) Services Available and Perceived by Employees**

To determine the role TDM services play in influencing commute travel behavior at study buildings, the employee survey explored employees’ awareness and use of TDM information and assistance services offered at work. Employers who completed the employer survey also were presented with a list of services and were asked to indicate any that they offer to employees and any that were provided by the building management to employees.

But other research has indicated that employees are not always aware of all the services available to them. So the employee survey presented a list of 17 services and asked employees to indicate for each service if it was “available and you have used it”, “available but you have not used it”, or “not available.” This question defined the services that employees perceived were available.

Earlier in this report the authors defined four levels of commute service packages, defined by the type and number of services offered/perceived. Those definitions are repeated here for reference:

- **No / Low TDM level** – No financial incentive and 0 to 4 non-financial support services
- **Moderate TDM level** – No financial incentive, but 5 or more support services
- **High TDM level** – Financial incentive for one or more modes, plus 0 to 4 support services
- **Very High TDM level** – Financial incentive for one or more modes, plus 5 or more support services

**TDM Services Perceived by Employees**

Figure 29 displays the individual services that were shown to employees, grouped into categories for the modes they support or target. The sum of the two percentages listed for each service represents the percentage of employees who were aware of the service. The light bar shows the percentage of employees who had used the service. Nearly all (95 percent) of respondents said at least one of the 17 services was offered and 61 percent said they had access to at least five services.

Transit and bicycle services were the most commonly offered services. Two-thirds (65 percent) of respondents said a financial benefit was available for transit users and 64 percent noted access to transit route and schedule information. About six in ten respondents said secure bicycle parking (62 percent) and shower facilities/personal lockers (58 percent) were available in the building and 55 percent mentioned that bicycle/walking information was available at work. About half of respondents indicated that at least one carpool/vanpool service was offered, such as help finding carpool/vanpool partners (45 percent) or reserved/preferential parking for carpools/vanpool (23 percent). Three in ten (29 percent) respondents said transportation information was available from a display or kiosk located in the building.
lobby and about two in ten reported that their employer offered free or discounted carshare membership (25 percent) and Capital Bikeshare membership (20 percent).

**FIGURE 29: WORKSITE TDM SERVICES – INDIVIDUAL SERVICES REPORTED BY EMPLOYEES AS AWARE/NOT USED AND AWARE/USED**

When these services were classified into the four TDM level categories defined above, 68 percent of respondents had reported services that constituted either a High or Very High TDM level; 36 percent...
reported a Very High level of services and 32 percent reported a High TDM level (Figure 30). About one in ten (9 percent) reported access to a Moderate level of services and 23 percent reported a No/Low TDM program, with a small number of non-financial support services.

**FIGURE 30: WORKSITE TDM LEVEL – AS PERCEIVED BY EMPLOYEES**

Employee survey n = 2,099

**TDM Services Reported by Employer**

But while only 68 percent of employees reported having a High or Very High level of services at work, 95 percent worked for an employer that said either the employer or the building management offered a package of services that would constitute either a High or Very High level of TDM services (Figure 31). This suggests that employees were not aware of all the services that were offered at the worksite.
Employee perception \( n = 2,099 \), Employer reported \( n = 1,455 \); note that not all employers completed the employer survey, so employer-reported data were not available for some employee respondents.

Figure 32 presents the same list of services that was presented earlier, with the percentages of employees whose employers said each service was available. The percentages shown by the dark bar represent services offered by the employer and the light bar shows services offered by the building management.
**Figure 32: Worksite TDM Services – Individual Services Reported by Employers as Offered by Either the Employer or the Building Management**

- **Help finding carpool / vanpool partner**: Employer offers 5%, Building offers 35%
- **Reserved/preferential carpool/vanpool parking**: Employer offers 4%, Building offers 16%
- **Cash / financial benefits for carpools**: Employer offers 4%, Building offers 5%
- **Cash / financial benefits for vanpools**: Employer offers 1%, Building offers 2%
- **SmarBenefits / financial benefits for transit**: Employer offers 1%, Building offers 92%
- **Transit schedule / route information**: Employer offers 38%, Building offers 35%
- **Shuttle to Metrorail**: Employer offers 0%
- **Secure parking for bicycles in the building**: Employer offers 1%, Building offers 93%
- **Personal lockers/showers for bicyclists**: Employer offers 2%, Building offers 90%
- **Bicycle / walking information**: Employer offers 55%, Building offers 23%
- **Free/discounted Capital Bikeshare membership**: Employer offers 27%
- **Other cash/financial benefit for bicycling**: Employer offers 1%
- **Transportation info display/kiosk in building lobby**: Employer offers 31%, Building offers 35%
- **Free/discounted carshare membership**: Employer offers 11%, Building offers 2%
- **Guaranteed Ride Home**: Employer offers 2%
- **Transportation info on company intranet**: Employer offers 27%, Building offers 2%
- **Company vehicles for personal trips during workday**: Employer offers 0%

Employees whose employers reported TDM services n = 1,455
Nearly all (92 percent) employees worked for employers that said they offered a transit benefit to employees and about the same percentage worked in buildings where secure bicycle parking and personal lockers and showers were offered, in nearly all cases by the building management. Several other widely-available services, including transit information, bike/walk information, and transportation information display/kiosks were available to about seven in ten employees; in about half of the cases, the employer offered the service, with building management offering it in the remaining cases. Reserved/preferential parking and Capital Bikeshare both were provided to about one-third of employees, with building management primarily responsible for the first service and employers primarily responsible for the second.18

Employee Perception of TDM Services Versus Employer-Reported Services
As indicated by the green bars in Figure 33, employees were generally aware of most services that employers said were offered. Employees were least likely to know of information kiosks in the lobby (20 percent unaware) and information on company intranet (18 percent), but nearly two in ten employees were unaware of transit financial incentives (17 percent unaware), Capital Bikeshare membership (17 percent), and carpool financial incentive (15 percent), services that could have significant motivating value.

Another notable finding was employees’ perception that some services were available when employers said the services were not offered. For example, 44 percent of employees said carpool matching was offered at their workplace, but only 2 percent of employers said this service was offered by either the employer or the building management, so 42 percent of employees incorrectly believed the service was available. Similarly high shares of employees mistakenly said Guaranteed Ride Home (34 percent), shuttle to Metrorail (32 percent), and carshare membership (27 percent) were offered by their employer. It is possible some employees interpreted the “is it available” question too broadly, checking “available” when they believed it was offered by some organization. It also is possible, although less likely, that some employers were unaware of services that were available from the building management.

18 The 2008 Commercial Building Study surveys of employers also asked about availability for various, specific TDM benefits and services. While the sample of buildings was different than the sample in this study, there are some differences worth noting, such as: 92 percent of employers surveyed in this study report offering a transit benefit program to employees, while only 58 percent of employers surveyed in 2008 reported offering such a benefit; 93 percent of employers surveyed in this study report that the building offers secure bike parking, while only 52 percent of employers surveyed in 2008 reported such a benefit being available (either through the employer or through another organization). (Slide 52)
FIGURE 33: WORKSITE TDM SERVICES – INDIVIDUAL SERVICES REPORTED BY EMPLOYEES AS AWARE/NOT USED AND AWARE/USED

<table>
<thead>
<tr>
<th>Service</th>
<th>Offered-employees aware</th>
<th>Offered-empl not aware</th>
<th>NOT offered-employees report it not available</th>
<th>NOT offered - employees believe it is available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secure bicycle parking</td>
<td>86%</td>
<td>10%</td>
<td>4%</td>
<td></td>
</tr>
<tr>
<td>Showers / personal lockers</td>
<td>80%</td>
<td>14%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Transit financial incentive</td>
<td>76%</td>
<td>17%</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>Bicycle/walking info</td>
<td>70%</td>
<td>12%</td>
<td>6%</td>
<td>12%</td>
</tr>
<tr>
<td>Transit schedule info</td>
<td>63%</td>
<td>12%</td>
<td>7%</td>
<td>16%</td>
</tr>
<tr>
<td>Info kiosk in lobby</td>
<td>47%</td>
<td>20%</td>
<td>28%</td>
<td>5%</td>
</tr>
<tr>
<td>Capital Bikeshare membership</td>
<td>19%</td>
<td>17%</td>
<td>52%</td>
<td>12%</td>
</tr>
<tr>
<td>Preferential carpool/vanpool parking</td>
<td>25%</td>
<td>12%</td>
<td>45%</td>
<td>10%</td>
</tr>
<tr>
<td>Info on company intranet</td>
<td>11%</td>
<td>18%</td>
<td>47%</td>
<td>23%</td>
</tr>
<tr>
<td>Carpool financial incentive</td>
<td>5%</td>
<td>15%</td>
<td>68%</td>
<td>14%</td>
</tr>
<tr>
<td>Carshare membership</td>
<td>9%</td>
<td>61%</td>
<td>27%</td>
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</tr>
<tr>
<td>Carpool matching</td>
<td>5%</td>
<td>51%</td>
<td>42%</td>
<td></td>
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<tr>
<td>Guaranteed Ride Home</td>
<td>1%</td>
<td>64%</td>
<td>34%</td>
<td></td>
</tr>
<tr>
<td>Shuttle to Metrorail</td>
<td>1%</td>
<td>68%</td>
<td>32%</td>
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<tr>
<td>Bicycle financial incentive</td>
<td>1%</td>
<td>83%</td>
<td>17%</td>
<td></td>
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<tr>
<td>Vanpool financial incentive</td>
<td>1%</td>
<td>80%</td>
<td>12%</td>
<td></td>
</tr>
<tr>
<td>Fleet vehicles for personal trips</td>
<td>1%</td>
<td>95%</td>
<td>5%</td>
<td></td>
</tr>
</tbody>
</table>

Employees Whose Employers Reported TDM Services n = 1,455.

TDM Services Perceived Available by Employer Size and Type

Employer Size

About one-third of the employees surveyed worked for a small organization, with 50 or fewer employees at the surveyed worksite. About one-quarter (27 percent) worked for mid-sized firms with between 51 and 250 employees. The remaining 40 percent of employees surveyed worked for large firms, with more than 250 employees at the surveyed worksite.

The level of TDM services generally increased as employer size increased (Figure 34). About 57 percent of employees who worked for small employers (1 to 50 employees) reported to a High or Very High level of TDM services. This was compared with 70 percent of employees who worked for mid-sized companies (51 to 250 employees) and 67 percent of employees who worked for companies with more than 250 employees.
FIGURE 34: WORKSITE TDM SERVICE LEVEL (EMPLOYEE PERCEIVED) – BY EMPLOYER SIZE

However, employees who worked for mid-sized companies, while more likely to have access to a transit financial incentive than employees who worked for either smaller or larger employers, were less likely than other employees to report having most other services. By contrast, employees at firms with more than 250 employees had access to the widest range of services.
FIGURE 35: WORKSITE TDM SERVICES (EMPLOYEE-PERCEIVED) – INDIVIDUAL SERVICES EMPLOYER SIZE

Employer Type

The employees who participated in the survey were predominantly for-profit; 63 percent worked for a for-profit company and 33 percent worked for a non-profit organization or trade association. The remaining 4 percent worked for a government agency.

Employees were somewhat more likely to report access to a robust TDM program when they were employed by a non-profit organization or trade associations; 69 percent of non-profit employees reported access to a High or Very High level of TDM services at work compared with 64 percent of for-profit workers (Figure 36). The employer/employee survey sample did not include enough Federal or state/local employers to draw any comparisons about the level of TDM programs perceived as available at those kinds of organizations.

Non-profit employees had better access to most TDM services than did for-profit employees. They particularly had the advantage in transit and carshare financial incentives, transit and bike/walk information services, and facilities that would make it easier or more convenient to bicycle to work.
They were less likely to report having reserved carpool/vanpool parking and incentives for modes other than transit.

**Figure 36: Worksite TDM Services Available (Employee Perceived) – By Employer Type**

High and Very High levels of TDM services also were most common for certain types of industries (Figure 37). Business/Personnel services topped the list; 88 percent of employees who worked for firms in this industry reported a High or Very High level of TDM services. Banking/Financial (78 percent), Education/training (72 percent), and associations/non-governmental organizations (67 percent) also had significant share of employees reporting High and Very High levels of services.
FIGURE 37: WORKSITE TDM SERVICE LEVEL (EMPLOYEE PERCEIVED) – BY EMPLOYER INDUSTRY

TDM Services Perceived Available by Worksite Parking and Transportation Access
Worksite Parking Availability

There was no clear pattern of TDM program level by worksite parking availability, until the parking ratio reached 0.91 spaces per employee. At that point, the share of employees with access to High/Very High TDM programs dropped significantly and the share of employees who had little to no TDM access jumped.
Distance to Metrorail and Transit Score™ – The TDM level also seemed independent of the distance from the worksites to Metrorail (Figure 39). But, as mentioned before, all sites were quite close to a Metrorail station.
FIGURE 39: WORKSITE TDM SERVICE LEVEL (EMPLOYEE PERCEIVED) – BY DISTANCE FROM WORKSITE TO METRORAIL (MILES)

Also, TDM program levels were essentially the same for employees who worked in buildings with “Good” Transit Score™ ratings as for buildings with “Excellent” ratings (Figure 40).

FIGURE 40: WORKSITE TDM SERVICE LEVEL (EMPLOYEE PERCEIVED) – BY TRANSIT SCORE™

Transit Scores ranged from 63 to 78; Good Transit 52 – 69 n = 645, Excellent Transit 70 – 89 n = 1,410
Walk Score™ – Figure 41 presents TDM level perceived by employees against Walk Score™ groupings. Again, there was no significant difference in the availability of TDM services by Walk Score™ ratings, but all of the study buildings were located in areas that were at least “Very Walkable.” All of the study buildings were located in a single Bike Score™ category (Very Bikeable), so a TDM level comparison is not shown for this index.

**FIGURE 41: WORKSITE TDM SERVICE LEVEL (EMPLOYEE PERCEIVED) – BY WALK SCORE™**

Walk Scores ranged from 82 to 97; Very walkable (70 – 89) n = 1,564, Walker’s paradise (90-100) n = 491
V. Building-Level Results

The following section of results is based on an analysis of variables either collected at the building level, or aggregated to the building level. This means the analysis plots the data of up to 16 buildings as discrete points. Some of the analysis uses as few as 13 buildings, due to exclusions for outlier behaviors or problems with collection of specific variables. This level of analysis is important for looking at factors like trip generation and parking occupancy which really only attributable to a building, as they are the sum of all activities going on there. However, with this small sample size there is a greater possibility that within-building variables, such unknown characteristics of a large employer, may have a stronger influence on building-level averages than the variables actually collected and studies here. Due to the small sample size, the relationships between buildings cannot be evaluated for their significance at this point.

Rather, as the sample of office buildings grows, tests such as the ones demonstrated here may be conducted with the ability to capture significant relationships at the building level. For now, this report provides an extensive look at the available dataset, and gives some examples of how outlier behavior can influence an apparent trend. Where the analysis depicts trend lines, they are illustrative only.

Vehicle Trip Generation

One element of the building level analysis was an examination of the number of vehicle trips generated by the study buildings. In this section, “trips” refer to the total vehicle trips entering or leaving the site. Daily trips are defined as the total vehicle trips observed in a 24-hour period. A “peak hour” refers to the 60-minute window of the day during which the highest number of trips was observed. Trip data were aggregated into 15-minute intervals, and the peak hour was calculated to the closest 15 minutes. A morning (AM) and an evening (PM) peak hour were calculated for weekdays, defined as Monday through Friday, and separately for both Saturday and Sunday.

To determine if travel patterns on Fridays were distinct from patterns on other weekdays, trip generation was studied in four intervals: Monday through Thursday, Friday, Saturday, and Sunday. Trip generation rates per employee were calculated by taking the total number of observed trips and dividing that figure by the reported estimate of employees working in the building as estimated by the property manager; trip rates were also compared for buildings or groups of buildings by different characteristics. The general trend for the four intervals and the two types of rates were often similar, and a select number of figures are depicted in this report.

The majority of trips analyzed in this study related to office land uses, particularly those generated during peak morning and evening commuting periods. However, since nearly all of the buildings included at least some retail uses, a small percentage of trips might have been generated by retail or restaurant employee parking and/or retail customer parking, where the configuration of the parking facility did not allow for exclusion of such spaces.

One additional note is particularly relevant to this section: three of the study buildings were broadly mixed-use, with substantial retail, housing, and/or hotel uses. One of the buildings housed a grocery store, which would generate a large number of PM peak trips for after-work shopping. A gym was located in another of the buildings; this use could generate a substantial number of visitor trips at both AM and PM peak periods. Because these buildings represented quite different travel patterns and the
commute travel could not always be segmented from the non-work travel, these buildings were excluded from some of the trip-generation analysis.

**Observed Trip Generation Rates by Building and Time Period**

**Weekday and Weekend Peak Hour**

Figure 42 presents the number of vehicle trips generated per employee for each of the 13 primarily office buildings for four time periods: weekday AM peak hour, weekday PM peak hour, Saturday peak hour, and Sunday peak hour. Each color represents an individual study building, with the same color used for a particular building through the four time periods to facilitate comparisons. The buildings are ordered from smallest to largest trip rate for the weekday AM peak hour period. The same building order is maintained for the other three time periods in order to highlight any buildings that do not follow the weekday AM peak hour trip pattern.

Weekday AM peak hour rates ranged from a low of 0.09 vehicle trips per employee to a high of 0.29 vehicle trips per employee, with an average rate of 0.20 (or one trip for every five employees) across the 13 buildings. Weekday PM peak hour trip rates are essentially the same as for the AM peak hour, ranging from 0.08 vehicle trips per employee to 0.28 trips, with an average of 0.19 vehicle trips per employee.
Weekend peak hour trip generation rates were considerably different from weekday rates, with trip rates generally much lower on weekends than on weekdays. This is not surprising, as the buildings primarily house office-type employers whose offices would be closed on weekends. Saturday peak hour rates ranged from a low of 0.01 vehicle trips per employee to a high of 0.17 vehicle trips per employee, with an average of 0.05 trips. Sunday peak hour rates ranged from 0.00 to 0.12 vehicle trips per employee, with an average of 0.03 trips. A small number of buildings had weekend trip rates that were much closer to their weekday rates, however.

Weekday and Weekend Daily Trips
Figure 43 presents a similar chart of daily vehicle trips generated per employee for each of the 13 primarily commercial buildings. The buildings are again ordered from smallest to largest weekday AM peak hour trip rate.
Weekday daily trip rates ranged from a 0.71 to a high of 2.61 vehicle trips per employee, with an average rate of 1.46 across the 13 buildings. Buildings that had low peak hour trip rates also generally had low daily trips rates. And Saturday and Sunday daily trip generation rates were again generally much lower than the weekday daily rates.

**FIGURE 43: DAILY VEHICLE TRIPS PER EMPLOYEE – STUDY BUILDINGS BY DAILY TRIPS**

(n = 13 study buildings; 3 mixed-use buildings not shown)

**Observed Trip Generation vs Rates Predicted by Others**

ITE’s *Trip Generation Manual* 9th Edition provides trip generation rates per employee for a number of office building categories (listed in Table 2).
Table 2: Office land use categories in the ITE Trip Generation Manual (codes used for study comparison in bold)

<table>
<thead>
<tr>
<th>Code</th>
<th>Land Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>710</td>
<td>General Office Building</td>
</tr>
<tr>
<td>714</td>
<td>Corporate Headquarters Building</td>
</tr>
<tr>
<td>715</td>
<td>Single Tenant Office Building</td>
</tr>
<tr>
<td>720</td>
<td>Medical-Dental Office Building</td>
</tr>
<tr>
<td>730</td>
<td>Government Office Building</td>
</tr>
<tr>
<td>732</td>
<td>United States Post Office</td>
</tr>
<tr>
<td>733</td>
<td>Government Office Complex</td>
</tr>
<tr>
<td>750</td>
<td>Office Park</td>
</tr>
<tr>
<td>760</td>
<td>Research and Development Center</td>
</tr>
<tr>
<td>770</td>
<td>Business Park</td>
</tr>
</tbody>
</table>

Weekday Daily Vehicle Trips
Observed trips at each building were compared to predicted trips based on published rates for ITE General Office Building land use code 710. Figure 44 presents the weekday daily vehicle trip per employee rate (red line) for each of the 13 primary-commercial study buildings, with the buildings ordered from lowest to highest trip rate.

Figure 44: Weekday Daily Vehicle Trips per Employee – by Study Building Compared with ITE Standards

n = 13 study buildings; 3 mixed-use buildings omitted
The horizontal black line, at 3.32 vehicle trips per employee, shows the predicted ITE value for the study buildings. As is clearly evident, the 13 buildings generated vehicle trips at a much lower rate than predicted by ITE, between 39 percent and 79 percent of the ITE value.

The average daily trips generated by the 13 study buildings was 1.46 trips per employee or 44 percent of the ITE predicted value. The vehicle trips rates for the study buildings for daily Saturday were similarly under the ITE predicted values. The study buildings’ average of 0.22 trips per employee for daily Sunday matched the ITE value.

These findings are similar to those from Arlington’s 2013 study of 16 residential site plan buildings, which found that vehicle trip generation at these locations was much lower than predicted by ITE for residential high-rise development.

Figure 44 also presents a second comparison, with the “Currans Adjusted ITE” method, which accounts for land use density in predicting vehicle trip generation. These values come from work completed by Kristina Currans, a graduate student at Portland State University.

Her work involved compiling household travel survey data, collecting data on variables that describe the built environment in the areas covered by the survey data, and then developing equations that relate the household travel survey data to the variables about the built environment. She then used the results of these equations to develop a method to adjust ITE trip-generation rates for multiple land uses, including offices (Currans, 2013).19

This method predicts values of 0.46 for six of the buildings and 0.56 for seven buildings. Eight of the buildings generated fewer trips than predicted by this method. The remaining five buildings had higher trip rates than predicted.

Another alternative method for calculating trip rates comes from Fahgri and Venigalla (2013) who created a TOD Trip Generation Model. The authors created the model using data from the 2007-2008 MWCOG Household Travel Survey for trips that started or ended at 38 sites within a quarter-mile distance of Metrorail stations in Arlington’s Rosslyn-Ballston corridor. By combining the trip data with measures of the gross floor area of the buildings where the trips began and terminated, the authors were able to generate a simple prediction of daily trip rates (measured in trips per 1,000 square feet of gross floor area) based solely on the gross floor area of the building.20

Figure 45 presents the weekday daily vehicle trip per 1,000 gross square feet of office space (red line) for each of the 13 primary-commercial study buildings, with the buildings ordered from lowest to highest trip rate. Note that buildings greater than 0.25 miles away from a Metrorail station do not have calculations using the Fahgri and Venigalla model; their data set only included trips to and from buildings within 0.25 miles.

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20 The equation for this predictive model is $\ln(T) = 1.05+1.096 \ln(X)$, where $T$ is trip ends and $X$ is TOD GFA in thousand SF.
FIGURE 45: WEEKDAY DAILY VEHICLE TRIPS PER 1,000 GSF – BY STUDY BUILDING COMPARED WITH ITE STANDARDS

n = 13 study buildings; 3 mixed-use buildings omitted

Though the Fahgri and Venigalla model over-predicts the number of daily trips at almost all buildings, it does predict values closer to those observed during the study than those predicted by ITE.

Weekday AM Peak Hour Vehicle Trips

The study buildings also generated many fewer trips in comparison with ITE-published rates for peak hour trips. Figure 46 shows the weekday AM peak hour vehicle trips per employee for the 13 primary commercial study. In this case, the ITE prediction is for 0.48 vehicle trips per employee while the highest rate of the buildings studied was 0.29, only 66 percent of the ITE prediction.

The average study building trip rate was 0.20 vehicle trips per employee, or 42 percent of the ITE value. Vehicle trips rates for the study buildings during the weekday PM peak hour and the Saturday peak hour were similarly under the ITE predicted values. The study buildings’ average of 0.03 trips per employee for the Sunday peak hour matched the ITE value.

In a summary of thirteen trip generation studies, Currans found that trip generation rates in the AM peak were anywhere from 80 percent to 22 percent lower than the ITE-predicted rate for offices in the Central Business District/Urban Core/Downtown; automobile mode shares varied from 56 percent to 95 percent. In TOD settings, no trip-generation comparisons were available from the studies considered, but automobile mode share varied from 50 percent to 96 percent. (2013, p. 12).
Observed Trip Generation Rates Compared with Drive-Alone Mode Split

Weekday Daily Vehicle Trips

It is reasonable to assume that a building’s vehicle trip generation rate would increase as the drive alone mode split for the building increases. But as illustrated in the trend line in the chart in Figure 47, such a relationship was not observed. The trend line was essentially flat across a wide range of drive alone mode splits, with wide variation above and below the trend line. The other chart in Figure 47 shows observed trips per employee for the weekday AM peak hour period. Although the range of the data points appeared less varied around the trend line, the slope of the trend line again was essentially flat.

Several possible hypotheses for this unexpected situation were examined, including the possibility that buildings with low employee survey response rates or high shares of drive alone employees parking outside the study building could be skewing the results. Six of the 16 buildings did have employee survey response rates of less than 20 percent, but these buildings were not significantly outliers from the trend line. And the percentages of employees who parked outside the buildings also were not systematically higher for the outlier buildings.

A more likely situation is that the sample of 16 study buildings is too small to enable relationships with some factors to be measurable. Given the possibility that multiple location and employee-characteristic factors could affect trip generation results, a relationship with any single factor would need to be quite strong for a trend line to be conclusive. With a small sample modest relationships could be masked by the impacts of other factors.
**Figure 47: Vehicle Trips per Employee for Weekday Daily and Weekday AM Peak Period – Study Buildings by Drive Alone Mode Split (Percentage of Weekly Commute Trips)**

**Weekday daily vehicle trips per employee**

![Graph showing vehicle trips per employee for weekday daily commute, with percentage drive alone on the x-axis and vehicle trips per employee on the y-axis.](image)

**Weekday AM peak hour vehicle trips per employee**

![Graph showing vehicle trips per employee for weekday AM peak hour commute, with percentage drive alone on the x-axis and vehicle trips per employee on the y-axis.](image)

n = 13 study buildings; 3 mixed-use buildings not shown, individual building mode samples ranged from 64 to 329
Figure 48 presents the Weekday AM peak hour trip generation results shown in the right-side chart in Figure 47 above, but with two buildings removed from the trend line. These two buildings, shown on Figure 48 in blue had trip rate/drive-alone mode split combinations that were extremely counterintuitive. One had the lowest reported commute drive-alone mode split of all the buildings, and yet the third highest rate of vehicle trips per employee. The other had the lowest overall trip generation rate, and yet the third highest drive-alone mode split.

This suggests other factors could be influencing the vehicle trip generation rates for these buildings in ways that were not immediately evident. When these two buildings were removed from the dataset, the peak hour trip generation-drive alone mode split trend line tracked much more closely for the remaining buildings, and in an intuitive direction.

**FIGURE 48: WEEKDAY AM PEAK PERIOD VEHICLE TRIPS PER EMPLOYEE – STUDY BUILDINGS BY DRIVE ALONE MODE SPLIT (PERCENTAGE OF WEEKLY COMMUTE TRIPS)**

*Observed Trip Generation by Neighborhood Intensity*

Figure 49 presents scatter plots for trip generation rates against half-mile Neighborhood Intensity. Daily vehicle trips per employees appeared independent of Neighborhood Intensity. Weekday AM peak hour trips per employee had a slight downward trend as Neighborhood Intensity increased, but it was a very weak relationship.
FIGURE 49: VEHICLE TRIPS PER EMPLOYEE FOR DAILY WEEKEND AND WEEKDAY AM PEAK PERIOD – STUDY BUILDINGS BY NEIGHBORHOOD INTENSITY (HALF MILE)

Daily Weekday vehicle trips per employee

Weekday AM peak hour vehicle trips per employee

n = 13 study buildings; mixed-use buildings not shown
Observed Trip Generation by Transportation Access

Metrorail Distance

The ITE *Trip Generation Handbook* suggests a reduction in trip-generation rates between 5 percent and 20 percent for buildings within one-quarter mile of light rail or “near transit centers;” for sites within one-quarter mile of a bus corridor, the reductions recommended are 2.5 percent to 10 percent (in (Currans, 2013, p. 26)).

Figure 50 presents Daily Weekday, Saturday, and Sunday vehicle trip rates per employee for the 13 individual buildings, grouped by their distance to Metrorail. The building location in relation to Metrorail appears to be a significant factor affecting vehicle trip generation. Trip rates vary within the distance categories, but there remains an upward trend in average trip rates as Metrorail distance increases.

**FIGURE 50: DAILY VEHICLE TRIPS PER EMPLOYEE BY DISTANCE TO METRORAIL – WEEKDAY, SATURDAY, AND SUNDAY**

A similar upward trend is evident for Weekday AM peak hour and Weekday PM peak hour trip generation as a function of Metrorail distance.
**FIGURE 51: WEEKDAY PEAK HOUR VEHICLE TRIPS PER EMPLOYEE BY DISTANCE TO METRORAIL – AM AND PM**

When the weekday, Saturday, and Sunday trip generation rates are averaged within the distance groupings, the following average rates result. As has been found with other Metrorail distance comparisons, the results for 0.1 miles and 0.2 miles do not show a clear positive trend, but the comparison of 0.1 miles to 0.4 miles distance shows a clearer pattern.

**TABLE 7: VEHICLE TRIPS PER EMPLOYEE BY DISTANCE FROM BUILDING TO METRORAIL**

<table>
<thead>
<tr>
<th></th>
<th>0.1 miles</th>
<th>0.2 miles</th>
<th>0.3-0.4 miles</th>
<th>0.44 - 0.1 miles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Daily rates</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday</td>
<td>1.09</td>
<td>1.52</td>
<td>1.72</td>
<td>+0.63</td>
</tr>
<tr>
<td>Saturday</td>
<td>0.28</td>
<td>0.15</td>
<td>0.58</td>
<td>+0.30</td>
</tr>
<tr>
<td>Sunday</td>
<td>0.17</td>
<td>0.09</td>
<td>0.37</td>
<td>+0.20</td>
</tr>
<tr>
<td><strong>Peak Hour rates</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weekday AM</td>
<td>0.17</td>
<td>0.18</td>
<td>0.21</td>
<td>+0.04</td>
</tr>
<tr>
<td>Weekday PM</td>
<td>0.16</td>
<td>0.16</td>
<td>0.20</td>
<td>+0.04</td>
</tr>
<tr>
<td>Saturday</td>
<td>0.05</td>
<td>0.02</td>
<td>0.08</td>
<td>+0.03</td>
</tr>
<tr>
<td>Sunday</td>
<td>0.03</td>
<td>0.01</td>
<td>0.04</td>
<td>+0.01</td>
</tr>
</tbody>
</table>

**Transit Score™**
Both daily weekday vehicle trips per employees and weekday AM peak hour trips per employee showed a slight increasing trend with increasing Transit Score™ (Figure 52). This is a counter-intuitive result. As previously noted, the Transit Score™ range was fairly narrow (63 to 78), with all of the study buildings being classified in either the Good or Excellent transit category. So this finding likely is due to other factors rather than variability in access to transit service.
**FIGURE 52: WEEKDAY DAILY VEHICLE TRIPS PER EMPLOYEE AND WEEKDAY AM PEAK PERIOD – STUDY BUILDINGS BY TRANSIT SCORE™**

**Daily Weekday vehicle trips per employee**

![Graph showing the relationship between Transit Score™ and daily vehicle trips per employee. The R² value is 0.0648.]

**Weekday AM peak hour vehicle trips per employee**

![Graph showing the relationship between Transit Score™ and weekday AM peak hour vehicle trips per employee. The R² value is 0.0471.]

n = 13 study buildings; mixed-use buildings not shown
Walk Score™ and Bike Score™

Figure 53 presents Daily Weekday vehicle trips per employee and weekday AM peak hour trips per employee graphed against Walk Score™. Figure 53 shows trip rates against Bike Score™. Daily and peak hour trips exhibited a slight decline with both increasing Bike Score™ and Bike Score™. But it is difficult estimate the impact of walkability or bikeability on the trip rate results, due to the narrow range of scores. Even the lowest Walk Score™ building had a score of 82, which fell into the higher end of the “Very Walkable” category (score of 70-89), and three of the buildings had scores in the “Walker’s Paradise” category. And the Bike Score™ range was extremely close, ranging only from 76 to 85. With these scores, all of the buildings would be classified as “Very Bikeable” (score of 70 to 89).

FIGURE 53: DAILY AND WEEKDAY AM PEAK VEHICLE TRIPS PER EMPLOYEE – STUDY BUILDINGS BY WALK SCORE™

Daily Weekday vehicle trips per employee

Weekday AM peak hour vehicle trips per employee

n = 13 study buildings; mixed-use buildings not shown
**FIGURE 54: DAILY WEEKDAY VEHICLE TRIPS PER EMPLOYEE AND WEEKDAY AM PEAK PERIOD – STUDY BUILDINGS BY BIKE SCORE™**

Daily Weekday vehicle trips per employee

![Daily Weekday vehicle trips per employee graph](image)

Weekday AM peak hour vehicle trips per employee

![Weekday AM peak hour vehicle trips per employee graph](image)

n = 13 study buildings; mixed-use buildings not shown

**Observed Trip Generation by Worksite Parking**

**Building Employee Parking Ratio**

Both daily vehicle trips per employee and Weekday AM peak hour trips per employee showed a strong increasing relationship as the number of parking spaces per employee in the building increased (Figure 55). In this case, the range of parking ratios is quite broad, from a low of 0.11 spaces per employee to a
high of 1.09 spaces per employee, so this finding is more suggestive than was noted for measures of transit, bike, and walk access.

**FIGURE 55: DAILY WEEKDAY VEHICLE TRIPS PER EMPLOYEE AND WEEKDAY AM PEAK PERIOD – STUDY BUILDINGS BY PARKING SPACES PER EMPLOYEE**

**Daily Weekday vehicle trips per employee**

![Graph showing daily vehicle trips per employee vs. parking spaces per employee. R² = 0.4584.]

**Weekday AM peak hour vehicle trips per employee**

![Graph showing weekday AM peak hour vehicle trips per employee vs. parking spaces per employee. R² = 0.4001.]

n = 13 study buildings; mixed-use buildings not shown

**Employee Permit Parking Cost**

The analysis also examined the relationship between vehicle trip rates and the cost employees incurred
to park if they drove to work. Figure 56 compares weekday daily vehicle trips per employee to the monthly permit parking cost for unreserved parking. The permit costs for the 13 buildings ranged from a low of $90 per month to a high of $170 per month. Buildings with higher permit parking costs generated more daily weekday vehicle trips per employee. Given other research that has definitively shown that parking charges can influence commuters to shift away from driving alone, this also is an unexpected result. Results for weekday AM peak period vehicle trip generation showed essentially the same relationship as was found for weekday daily trips.

**Figure 56: Weekday Daily Vehicle Trips per Employee – Study Buildings by Monthly Permit Cost for Unreserved Parking Space**

![Graph showing the relationship between monthly permit cost and weekday daily vehicle trips per employee.](image)

\( n = 12 \) study buildings; 3 mixed-use buildings not shown; 1 outlier building excluded from trend line

**Employee-Paid, Non-Reimbursed Parking Cost**

The permit parking cost is not necessarily the cost an employee actually pays or would pay to park. Some employers provided free parking to at least some employees and/or reimbursed employees for part or all of their parking cost. Additionally, some employees indicated that they parked off-site, because it was less expensive than the on-site cost or because monthly permit parking was unavailable in the study building.

To examine this situation, Figure 57 compares weekday daily vehicle trips per employee to the average cost that employees in the study buildings reported as the cost they paid or would pay if they drove alone. This cost is net of any employer parking reimbursement or subsidy reported by the employee.

The slope of the trip rate by parking cost trend line was essentially the same as for the monthly permit parking cost chart in Figure 56. Buildings in which employees reported a higher average parking cost generated more daily weekday vehicle trips per employee. The Weekday AM peak period vehicle trip generation rates exhibited the same relationship as did the Weekday daily trip rates.
Over the 13 buildings, the employee-reported parking costs were approximately 10 percent higher than the monthly permit costs for the buildings, due to some employees paying a higher monthly cost to park in a public or private garage off-site or paying a higher per-day cost, rather than buying a monthly permit. Again, this finding is counterintuitive due to the abundance of evidence that increases in parking costs lead to decreases in drive-alone commuting.

**FIGURE 57: WEEKDAY DAILY VEHICLE TRIPS PER EMPLOYEE – STUDY BUILDINGS BY MONTHLY UNREIMBURSED, OUT-OF-POCKET PARKING COST REPORTED BY EMPLOYEES**

![Graph showing the relationship between average monthly unreimbursed parking cost and vehicle trips per employee.](image)

n = 12 study buildings; 3 mixed-use buildings not shown; 1 outlier building excluded from trend line

**Observed Trip Generation by TDM Service Access**

**Overall Level of TDM Services**

Buildings in which larger shares of employees reported having access to a High or Very High level of TDM services at their workplace generated fewer daily vehicle trips than did buildings where TDM services were less available (Figure 58). The trend line for this relationship was strongly downward.
FIGURE 58: WEEKDAY DAILY VEHICLE TRIPS PER EMPLOYEE – STUDY BUILDINGS BY AVAILABILITY OF HIGH-VERY HIGH TDM SERVICES (AS REPORTED BY EMPLOYEES)

\[ R^2 = 0.5116 \]

n = 13 study buildings; 3 mixed-use buildings not shown

Transit Financial Incentive

A similar trend was noted for access to a transit financial benefit; buildings in which larger shares of employees reported having access to this benefit generated fewer daily vehicle trips than did buildings where fewer employees had access to a transit subsidy ( \( R^2 = 0.5116 \).
Figure 59). The result also was similar for access to transit information, but buildings with high access to transit information typically also had high access to transit subsidies, so the subsidy could be driving this result.
**Figure 59: Weekday Daily Vehicle Trips per Employee – Study Buildings by Availability of Transit Subsidy (As Reported by Employees)**

\[ R^2 = 0.5078 \]

\[ 0\% ~ 20\% ~ 40\% ~ 60\% ~ 80\% ~ 100\% \]

\[ 0.0 ~ 1.0 ~ 2.0 ~ 3.0 \]

- **n = 13 study buildings; 3 mixed-use buildings not shown**

**Bike/Walk Information and Bike Racks**

The Weekday daily vehicle trips per employee appeared to decline with greater availability of bike/walk information (Figure 60). As shown by the chart on the right side of Figure 60, the relationship of vehicle trips per employee to bike rack access was less strong.
**FIGURE 60: WEEKDAY DAILY VEHICLE TRIPS PER EMPLOYEE – STUDY BUILDINGS BY AVAILABILITY OF BIKE/WALK INFORMATION AND BIKE RACKS (AS REPORTED BY EMPLOYEES)**

Weekday daily vehicle trips per employee

![Graph showing the relationship between vehicle trips per employee and percentage of respondents reporting access to bike/walk information. The R² value is 0.0097.]

Weekday daily vehicle trips per employee

![Graph showing the relationship between vehicle trips per employee and percentage of respondents reporting access to bike racks. The R² value is 0.0993.]

n = 13 study buildings; mixed-use buildings not shown
Parking Occupancy
Employees’ Parking Location and Overall Parking Occupancy

On-Site Parking

The employee survey found that 74 percent of all employees who worked in the study buildings parked or would park on-site on days they drove to work (Figure 61). This share was similar to that found in the 2008 commercial building study; 77 percent of the employees surveyed in that study said that they park at the work site, or would park at the work site if they drove to work.

On-site parking was most common among employees who drove alone regularly (e.g., most of their commute day); 85 percent of primary drive alone employees said they parked on-site. But some on-site parking was evidently available for occasional parking, because 60 percent of employees who primarily used a non-drive alone mode to get to work said they would park on-site on a day they needed to drive to work. About 15 percent of all employees said they parked or would park in a public or private garage or lot nearby.

**Figure 61: Parking Location – Percentage of Respondents Who Park at Various Locations by Primary Commute Mode**

- **On-site**: 74% for all employees, 85% for drive alone, 60% for alternative mode.
- **Public facility nearby**: 15% for all employees, 9% for drive alone, 25% for alternative mode.
- **Street**: 7% for all employees, 3% for drive alone, 10% for alternative mode.
- **Other**: 2% for all employees, 2% for drive alone, 3% for alternative mode.

n = 16 study buildings. Note that parking location for employees who do not drive alone reflects the location they “would use” on a day they drove to work.

Overall Parking Occupancy

Other studies of office parking (and especially free parking) in the United States exceed demand. A nationwide study of parking supply and demand at eight suburban business parks found that peak utilization ratios ranged from 28.0 percent to 60.6 percent; peak utilization per 1,000 gross sq. ft. was 0.6 to 4.5 (TCRP Report 95, Table 18-1, p. 18-9).
Of course, the office buildings in Arlington’s Rosslyn-Ballston Corridor are not like suburban office parks in their parking supply. Some employees surveyed who parked off-site said they did so because parking was not available to them in the building where they worked, suggesting parking was constrained in some way. As illustrated by data presented earlier in the report, most of the study buildings had less than one parking space per employee in the building. About four in ten employees worked in buildings with less than one space for every two employees and only 7 percent worked in a building that had a space for each employee. Other possible constraints are ones not measured physically: parking may be designated to specific employers, and employers may make parking available to some employees and not others, by pay grade, for example.

Constrained parking did not translate to full (or even nearly full) garages, however. Maximum parking occupancy across the 16 buildings ranged from 54 percent to 100 percent, but only four of the 16 study buildings had a maximum parking occupancy of more than 80 percent for any day of the week and eight of the buildings had a maximum occupancy under 70 percent.

In Arlington’s 2013 Residential Building Study, all the parking garages hovered at an average maximum or peak occupancy of around 80 percent (in this case at night). Those on the Metrorail corridors differed from those off the corridors in their minimum occupancy, with corridor garages staying almost 40 percent full, and those off the corridors dropping to 20 percent, suggesting higher daytime vehicle use. Parking availability ranged between .63 spaces per resident to 1.22 spaces per resident (1.04-1.55 spaces per unit).

**Maximum Occupancy by Day of the Week**

The weekday occupancy patterns were generally fairly consistent across the days of the week for any particular building as illustrated by the blue and green Monday through Friday maximum occupancy lines in Figure 62. Buildings that had high occupancy on one weekday typically had a similarly high occupancy across the other weekdays and the same was true for buildings with low parking occupancy.

The patterns were different for weekends. Most buildings had very low occupancy on weekends, as would be expected for an office building whose tenants are not open for business on weekends. The exception to the pattern was the three mixed-use buildings, shown as Buildings #8, #10, and #11. These three buildings had parking occupancy rates as high on weekends as on weekdays, due to the weekend patronage at the gym, grocery store and other retail, and residential and hotel traffic. Building #16 also had high parking occupancy on weekends. Building #16 is part of a mixed-use complex of buildings that includes office and residential uses, and data collection at the garage recorded trips both for the office and residential uses.

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21 Note that parking operators do not necessarily define “full” occupancy as 100 percent occupancy, even at the time of day with the highest occupancy. Nor is 100 percent occupancy necessarily desirable, because it leads to drivers searching for open spaces and, over time, can be a deterrent to drivers attempting to park in the lot or garage.
One important consideration in examination of parking occupancy is that it is not a “pure” variable; it is always a derived variable that combines demand for and supply of parking. Low parking occupancy can be related either to low demand for parking or high supply of parking. So is it possible that some developers simply built a greater excess of parking than did others?

Figure 63 charts maximum weekday parking occupancy against the parking supply of the building, defined by the spaces per employee. Buildings with lower parking ratios tended to have higher parking occupancy, while buildings with higher parking ratios were more likely to have lower parking occupancy, suggesting that buildings that provided parking for most employees had more parking than was needed.
Share of Drive-alone Employees Who Parked Outside the Building

In areas where competitively-priced public parking is available in a building nearby, parking occupancy in the study building could be lower than anticipated if some parking demand is satisfied by space in neighboring buildings. Data on the amount of neighborhood parking were not available for this study, but as previously noted, 26 percent of employees said they parked or would park outside the study building on days they drove to work.

This phenomenon does not seem to explain low parking occupancy, however. Figure 64 shows that parking occupancy increased slightly as the share of drive alone employees who parked outside the building increased. Stated another way, buildings with high parking occupancy tended to have higher shares of employees parking outside the building, suggesting the choice to park outside the building might be related at least in part to a constraint on study building parking. But in the employee survey, some employees said they parked outside the building because it was less expensive, so space availability was not the only constraint for these employees.
FIGURE 64: MAXIMUM PARKING OCCUPANCY OF STUDY BUILDINGS BY PERCENTAGE OF DRIVE ALONE EMPLOYEES WHO PARK OUTSIDE THE STUDY BUILDINGS

n = 15 study buildings; 1 outlier building excluded from trend line

Parking Occupancy by Parking Demand Factors
Parking Occupancy by Weekday Peak Hour Building Trip Generation
Buildings that generated the greatest number of vehicle trips per employee tended to have lower parking occupancy, but buildings with low vehicle trip rates also had low occupancies (Figure 65).
Maximum Parking Occupancy by Employee Drive-alone Mode Split

Similarly, parking occupancies had a non-linear relationship with the share of employees who drove alone to work (Figure 66). The result was essentially the same when carpool and vanpool mode shares also were included.
A very weak, negative relationship existed between the drive-alone mode split and the maximum number of cars parked per employee (a measure which, unlike occupancy, does not include parking supply as a factor).

**FIGURE 67: MAXIMUM NUMBER OF CARS PARKED PER OFFICE EMPLOYEE BY DRIVE ALONE MODE SHARE**
However, removing the three mixed-use buildings identified earlier yields a stronger, though still weak, positive relationship between the drive-alone mode split and the maximum number of cars parked per employee.

**Figure 68: Maximum Number of Cars Parked per Office Employee by Drive Alone Mode Share**

A similar, positive relationship existed between the maximum number of cars parked per office employee and the total share of drive-alone, carpools, and vanpools reported by employees (recall that carpools and vanpools still count as vehicle trips).
Maximum Parking Occupancy by Building Office Occupancy

Low parking occupancies did not seem to be correlated with the level of office occupancy in the buildings. Examination of the building office occupancies showed that 12 of the 16 buildings had a building occupancy of greater than 90 percent and seven buildings were fully occupied. And as presented in Figure 70, four buildings that had office occupancies of 95 percent or higher had parking occupancies of 65 percent or less.
**FIGURE 70: MAXIMUM PARKING OCCUPANCY – STUDY BUILDINGS BY BUILDING OFFICE OCCUPANCY**

\[ n = 16 \text{ study buildings} \]
Parking Occupancy by Building Location and Transportation Access

Neighborhood Intensity

Figure 71 presents a scatter plot for maximum parking occupancy in the 16 study buildings against half-mile Neighborhood Intensity. The parking occupancy seems to have very little relationship with Neighborhood Intensity.

**FIGURE 71: MAXIMUM WEEKDAY PARKING OCCUPANCY – STUDY BUILDINGS BY NEIGHBORHOOD INTENSITY (HALF MILE)**

A comparison of neighborhood intensity and the maximum number of cars parked per office employee revealed a similar pattern.

**Metrorail Distance and Transit Score™**

Figure 72 presents the 16 study buildings grouped by their distance to Metrorail. The building location in relation to Metrorail appeared to affect parking occupancy. Occupancy rates varied within the distance categories, but there was a moderate downward trend in occupancy as Metrorail distance increased. For the five buildings located within 0.1 mile of Metrorail, the average maximum weekday occupancy was 80 percent, at 0.2 miles, the average occupancy was 69 percent, and for the five buildings located up to 0.44 miles from Metrorail, the average occupancy was 64 percent.

But mode split and vehicle trip generation findings both indicated no difference in drive alone rates for buildings at 0.1 miles or 0.2 miles from Metrorail, and only a slight increase in driving alone at 0.4 miles. What seems the most likely explanation for the drop in parking occupancy, therefore, is that buildings located farther from Metrorail built a greater excess of spaces than did buildings that were closer. The
average parking ratio for the five buildings that were located within 0.1 mile of Metrorail was 0.57 spaces per employee, while buildings located at 0.2 miles and 0.4 miles had parking ratios of 0.62 spaces per employee and 0.65 spaces per employee, respectively.

**FIGURE 72: MAXIMUM WEEKDAY PARKING OCCUPANCY – STUDY BUILDINGS BY DISTANCE TO METRORAIL**

![Bar chart showing maximum weekday parking occupancy by distance to Metrorail]

n = 16 study buildings

Parking occupancy exhibited a very slight downward trend against increasing Transit Score™ (Figure 73). But the correlation was very weak and, with the narrow range of score ratings (63 to 78), this finding is likely unsupportable.
A similarly weak relationship appeared between the building’s Transit Score™ and the maximum number of cars parked per 1,000 gross square feet of office space when the three mixed-use buildings were excluded from analysis.
n = 16 study buildings

**Walk Score™ and Bike Score™**

Figure 75 presents parking occupancy against Walk Score™ and Bike Score™. Parking occupancy exhibited an apparent decline with increasing Walk Score™ and an increase with increasing Bike Score™. The relationship with Walk Score™ is in the direction that would be logical to expect, but the Bike Score™ result is in the opposite direction. Given the narrow ranges of scores for both indexes, it is likely neither of these results is conclusive or reliable.
FIGURE 75: MAXIMUM WEEKDAY PARKING OCCUPANCY – STUDY BUILDINGS BY WALK SCORE™ AND BIKE SCORE™

Walk Score™

Bike Score™

R² = 0.0576

R² = 0.1075

n = 16 study buildings; mixed-use buildings not shown
Parking Occupancy by Parking Cost
Employee Permit Parking Cost
The analysis also examined the relationship between parking occupancy and employees’ parking cost. Figure 76 displays two cost scenarios, 1) the monthly permit parking cost for unreserved parking, and 2) the average unreimbursed cost, net of any employer parking reimbursement, that employees reported they paid or would pay if they drove alone. Parking occupancy appeared to be entirely unrelated to the cost of parking, based on either the parking permit cost or the average monthly cost that employees reported paying out-of-pocket.
**FIGURE 76: MAXIMUM WEEKDAY PARKING OCCUPANCY – STUDY BUILDINGS BY MONTHLY PERMIT COST FOR UNRESERVED PARKING SPACE AND MONTHLY UNREIMBURSED PARKING COST REPORTED BY EMPLOYEES**

**Monthly Permit Parking Cost for Study Building**

![Graph showing the relationship between monthly permit parking cost and maximum parking occupancy. The graph includes a scatter plot and a regression line with R² = 0.0013.]

**Employees’ Monthly Unreimbursed Parking Cost**

![Graph showing the relationship between employees’ monthly unreimbursed parking cost and maximum parking occupancy. The graph includes a scatter plot and a regression line with R² = 0.001.]

n = 16 study buildings
Employees’ Satisfaction with Commute and Parking

This section of the analysis has examined various considerations that might affect parking occupancy rates. Parking occupancy and the availability of parking at the worksite also affect employees; if parking is unavailable in a study building, employees who work there must either park elsewhere or find a non-driving mode to get to work. Both of these options could negatively impact employees’ satisfaction with their commute overall and/or specifically with parking options.

The employee survey asked employees to rate their overall satisfaction with their commute, using a five-point scale in which 1 meant “not at all satisfied” and 5 meant “very satisfied.” Overall slightly more than half of all employees were satisfied with their commute; 29 percent gave a rating of 4 and 23 percent gave a rating of 5 (very satisfied); the average satisfaction rating was 3.53 on the five-point scale.

Next, using the same scale, employees rated their commute on each of eight travel characteristics that they might have considered in choosing how they got to work. Finally, they rated how important each characteristic was to the commute mode decision. The eight factors, ordered by highest to lowest satisfaction rating, included:

**Table 8: Commute Characteristics by Employee-Perceived Satisfaction and Importance**

<table>
<thead>
<tr>
<th>Commute Characteristic</th>
<th>Satisfaction Rating</th>
<th>Importance Rating</th>
<th>Rating Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of parking at work location</td>
<td>3.74</td>
<td>3.84</td>
<td>-0.10</td>
</tr>
<tr>
<td>Comfort</td>
<td>3.55</td>
<td>3.78</td>
<td>-0.23</td>
</tr>
<tr>
<td>Consistency/reliability of travel time</td>
<td>3.30</td>
<td>4.36</td>
<td>-1.06</td>
</tr>
<tr>
<td>Variety of transportation options</td>
<td>3.24</td>
<td>3.40</td>
<td>-0.16</td>
</tr>
<tr>
<td>Total travel time</td>
<td>3.15</td>
<td>4.45</td>
<td>-1.30</td>
</tr>
<tr>
<td>Ability to relax on the trip</td>
<td>3.15</td>
<td>3.62</td>
<td>-0.47</td>
</tr>
<tr>
<td>Total cost</td>
<td>3.03</td>
<td>4.23</td>
<td>-1.20</td>
</tr>
<tr>
<td>Parking expense</td>
<td>2.99</td>
<td>3.84</td>
<td>-0.85</td>
</tr>
</tbody>
</table>

Of the eight factors, employees were most satisfied with the availability of parking at their work location. Six in ten were satisfied, with 23 percent giving a rating of 4 and 38 percent giving a rating of 5 (very satisfied), with an average rating across all employees of 3.74. By contrast, employees were least satisfied with the expense they incurred to park at work. Only one-third of employees were satisfied with their parking expense; 11 percent gave a rating of 4 and 22 percent gave a rating of 5, with an average score of 2.99 overall.

The bullets presented above also show employees’ average ratings for the importance of each characteristic to their decision on how they travel to work. Parking availability and parking expense ranked 4th and 5th in importance (3.84 rating for both), with total travel time (4.45), consistency/reliability of travel time (4.36), and total travel cost (4.23) higher in importance.

Employee Satisfaction with Commute and Parking Availability by Parking Occupancy

As illustrated in the chart of the left side of Figure 77, employees’ satisfaction with parking availability declined slightly as parking occupancy increased. But as shown in Figure 77, high maximum parking
occupancy did not appear to negatively affect employees’ overall commute satisfaction rating at all; commute satisfaction actually increased as parking occupancy increased. Note that this analysis did not consider the relationship between parking availability and satisfaction among those employees who do not drive to work separate from those who do drive to work. This is a logical result, considering the 3.74 average rating employees gave for satisfaction with parking availability nearly matched their 3.84 rating for the importance of this characteristic in their mode decision. This also might suggest that employees who parked outside the buildings did not discount their commute satisfaction rating for a full study building garage if they could find parking nearby.

Employees’ Satisfaction with Parking Availability and Commute by Parking Ratio

Employees’ satisfaction with parking availability at work was more strongly related to the number of spaces available per employees (Figure 78). Employees who worked in buildings with parking for a larger share of employees gave higher ratings for satisfaction with the availability of parking at work. Only 40 percent of employees who worked in buildings with parking ratios of 0.25 or less (parking for one in four employees) were satisfied with the parking available at work, compared to the six in ten who worked in buildings with between 0.26 and 0.75 spaces per employee, and the more than seven in ten who worked in buildings with parking for all or nearly all employees (0.76 or more spaces per employee). Note that this analysis did not consider the relationship between parking availability and satisfaction among those employees who do not drive to work separate from those who do drive to work.

**Figure 77: Employees’ Satisfaction with Parking Availability and with Commute (Scale of 1 to 5, where 1 means “not at all satisfied” and 5 means “very satisfied”) – Study Buildings by Maximum Weekday Parking Occupancy**

Employees’ Satisfaction with Parking Availability

![Graph showing the relationship between parking occupancy and employees' satisfaction rating. The graph has a title, axis labels, and a legend. R² value is labeled at the bottom of the graph.](image)
Employees’ Satisfaction with Commute Overall

![Graph showing the relationship between employees' satisfaction with commute and parking availability.]

R² = 0.0144

n = 16 study buildings

**FIGURE 78:** Employees’ Satisfaction with Parking Availability (Scale of 1 to 5, where 1 means “not at all satisfied” and 5 means “very satisfied”) – by Worksite Parking Ratio (parking spaces per employee)

Additionally, employees who were more satisfied with the availability of parking at work, as signified by a satisfaction rating of 4 or 5, were more likely to say they were satisfied with their commute overall.
Fifty-six percent of employees who were satisfied with parking availability said they were satisfied with the commute, compared with 45 percent of employees who were not satisfied with parking at work.

**Figure 79: Employees’ Satisfaction with Commute (Scale of 1 to 5, where 1 means “not at all satisfied” and 5 means “very satisfied”) – by Employees’ Satisfaction with Parking Available at Work**

Employee Satisfaction with Commute and Parking Cost

The average ratings presented earlier for employees’ satisfaction with commute characteristics included satisfaction with parking expense. As shown in Figure 80, employees’ satisfaction was clearly inversely related to the average cost they paid to park; buildings with higher parking cost had lower satisfaction ratings for parking expense among all employees. And as shown by the chart on the right side of Figure 80, higher parking cost also translated into lower overall commute satisfaction; commute satisfaction decreased as parking expense increased.

Again this result is a logical result, considering that the gap between employees’ satisfaction with parking expense (2.99) and their average importance rating (3.84) produced a much greater, 0.85 “gap” for this commute characteristic. In short, employees’ experience with parking expense fell much farther short of their expectation for this feature (0.85 gap) than did parking availability (0.10 gap). Note that this analysis did not consider the relationship between parking price and satisfaction among those employees who do not drive to work separate from those who do drive to work.
FIGURE 80: EMPLOYEES’ SATISFACTION WITH PARKING EXPENSE AND WITH COMMUTE (SCALE OF 1 TO 5, WHERE 1 MEANS “NOT AT ALL SATISFIED” AND 5 MEANS “VERY SATISFIED”) – STUDY BUILDINGS BY MONTHLY UNREIMBursed PARKING COST REPORTED BY EMPLOYEES

Employees’ Satisfaction with Parking Expense

Employees’ Satisfaction with Commute Overall

n = 16 study buildings
Employees’ Satisfaction with Parking Expense and Commute by Monthly Parking Cost

Employees who paid or would pay high monthly parking costs gave substantially lower ratings for their satisfaction with parking expense (Figure 81). Fewer than two in ten employees who reported paying $101 or more to park said they were satisfied with their parking expense, compared with 35 percent who paid $100 or less and 68 percent who reported having free parking.

**FIGURE 81: EMPLOYEES’ SATISFACTION WITH PARKING EXPENSE (SCALE OF 1 TO 5, WHERE 1 MEANS “NOT AT ALL SATISFIED” AND 5 MEANS “VERY SATISFIED”) – BY MONTHLY UNREIMBURSED, OUT-OF-POCKET PARKING COST REPORTED BY EMPLOYEES**

As was noted with regard to parking availability, employees who were more satisfied with the parking expense they incurred at work, as indicated by a satisfaction rating of 4 or 5, were much more likely to say they were satisfied with their commute overall. Sixty-seven percent of employees who were satisfied with parking expense said they were satisfied with their commute, compared with 39 percent of employees who were not satisfied with parking expense. Note that this analysis did not consider the relationship between parking price and satisfaction among those employees who do not drive to work separate from those who do drive to work.
TDM and Mode Choice: Building-Level Analysis

This section comprises the building-level analysis of person-level TDM and mode choice data the researchers have reported on earlier in this paper. When these data are grouped in smaller geographic populations by building, instead of across the entire sample, they reflect the difficulty of getting transportation options awareness and use into place across geographic populations, in this case, building populations.

The significant relationship reported earlier between TDM service level and mode split did not appear to hold when summary variables were created for buildings. The two charts in Figure 83 present the share of weekly commute trips made by driving alone and by transit for each of the study buildings, plotted against the share of employees in those buildings who said they had access to High or Very High TDM services. The drive-alone mode shares for buildings in which larger shares of employees reported having access to High or Very High TDM services actually were slightly higher than for buildings with lower access to TDM services. And as presented by the chart of the right side of the figure, the transit mode share was essentially flat across a wide range of TDM access percentages.
Similarly, the strong positive relationship between availability of a transit subsidy and transit mode share was also not evident on a building-by-building level. The charts in Figure 84 present the share of weekly commute trips made by transit for each of the study buildings, plotted against the share of employees in those buildings who said they had access to a transit financial benefit/subsidy (left-side chart) and transit route and schedule information. The trend line for transit mode share was nearly flat across a wide range of service availability percentages for both transit financial benefit and for transit information.
A modest positive relationship between availability of a bike/walk information and bike mode share was noted at the building level. The two charts in Figure 85 present the share of weekly commute trips made by bike for each of the study buildings, plotted against the share of employees in those buildings who said they had access to bike/walk information (left-side chart) and secure bike storage/bike racks (right-side chart).

**FIGURE 85: PERCENTAGE OF WEEKLY COMMUTE TRIPS BY BIKE – STUDY BUILDINGS BY AVAILABILITY OF BIKE/WALK INFORMATION AND BIKE RACKS (AS REPORTED BY EMPLOYEES) – NOTE Y-AXIS SCALE EXTENDS ONLY TO 10 PERCENT TO HIGHLIGHT RESULTS**

n = 16 study buildings
The share of weekly commute trips made by bicycle at individual study buildings appeared to increase slightly with greater availability of bike/walk information. The relationship between bike mode share and availability of bike parking appeared modest, as illustrated in Figure 85. Note also that nine of the 16 buildings had bike mode shares of between 2 percent and 4 percent, so the variability was limited.

**Outlier Buildings**

The purpose of the study was to examine travel and parking behavior of office employees who worked in commercial buildings and identify factors that influence travel and parking behavior. The previous sections of this report have presented data, at both the building level and the employee level, comparing mode split, vehicle trip generation, parking utilization, and other behavioral variables against a wide range of location and building characteristics that might be expected to influence travel patterns.

The scatterplot charts that presented building-by-building data for travel behavior variables against independent characteristic variables provided illustrative trends of the modeled relationship between variables. As expected, none of the “trend lines” showed a perfect correlation; in all cases, there was variation above and below the trend line, with some buildings performing better than average for that relationship and others performing less well.

But in some of the analyses, a building or small number of buildings appeared to perform extremely differently than did other buildings. In a small sample of 16 buildings, even one outlier can substantially alter the modeled trend line and mask relationships between variables. This raises several questions:

- What features or characteristics about the outliers make them perform the way they do?
- Are these buildings outliers on all or most travel behavior results or only in an isolated situation?
- Within the 16-building sample, are there buildings that perform similarly enough to serve as an analysis set for planning decision-making?
- Can the outliers be used as anecdotal “case studies” to enhance planners understanding of the range of travel behaviors observed?

This section presents building data identifying possible location and/or employee characteristics that could help to explain performance variation and outlier results.

**Building Size, Land Uses, and Transportation Access**

**Transit Access**

Seven buildings were in Ballston, five in Clarendon, and four in Rosslyn. These locations placed all of the buildings in the Rosslyn – Ballston corridor, along the Metrorail Orange line. All the buildings had good or excellent transit access; all were located within 0.4 miles of Metrorail, all were located with 0.1 miles of a bus stop, and all had Transit Score™ ratings that fell into either the “Good Transit” (score of 52 to 69) or “Excellent Transit” (score of 70 to 89) categories.

**Bike and Walk Access**

Bike access, as defined by the Bike Score™ index, also was quite good; scores for the 16 study buildings ranged only from 76 to 85. With these scores, all of the buildings would be classified as “Very Bikeable” (score of 70 to 89). And all of the building locations were quite walkable. The lowest Walk Score™ was 82, which fell into the higher end of the “Very Walkable” category (score of 70-89). Five buildings had scores over 90, scores which fell into the “Walker’s Paradise” category.
## Table 9: Study Buildings – Building Size, Use, Location, and TDM Data

<table>
<thead>
<tr>
<th>Building Number</th>
<th>Primary Building Land Uses</th>
<th>Office GSF</th>
<th>Office Occupancy (%)</th>
<th>Office GSF as % of Total GSF</th>
<th>Neighborhood Intensity (half-mile)</th>
<th>Miles to Metrorail</th>
<th>Transit Score™</th>
<th>Walk Score™</th>
<th>Bike Score™</th>
<th>% Employees with High/ VHigh TDM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Range</strong></td>
<td>NA</td>
<td>NA</td>
<td>60% - 100%</td>
<td>52% - 100%</td>
<td>55 - 125</td>
<td>0.1 – 0.3</td>
<td>63 - 78</td>
<td>82 - 97</td>
<td>76 - 85</td>
<td>41% - 86%</td>
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<tr>
<td><strong>Average</strong></td>
<td>NA</td>
<td>NA</td>
<td>91</td>
<td>0.20</td>
<td>71</td>
<td>89</td>
<td>81</td>
<td>68%</td>
<td></td>
<td></td>
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<tr>
<td><strong>Ballston</strong></td>
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<tr>
<td>Building #1</td>
<td>Office</td>
<td>275,630</td>
<td>60%</td>
<td>92%</td>
<td>100</td>
<td>0.3</td>
<td>74</td>
<td>88</td>
<td>80</td>
<td>52%</td>
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<td>Office</td>
<td>126,045</td>
<td>100%</td>
<td>91%</td>
<td>93</td>
<td>0.3</td>
<td>70</td>
<td>85</td>
<td>80</td>
<td>57%</td>
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<td>98%</td>
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<td>88</td>
<td>81</td>
<td>66%</td>
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<td>Office</td>
<td>306,000</td>
<td>91%</td>
<td>95%</td>
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<td>Building #6</td>
<td>Office</td>
<td>475,000</td>
<td>100%</td>
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<td>Office</td>
<td>236,623</td>
<td>100%</td>
<td>96%</td>
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<td>0.3</td>
<td>69</td>
<td>89</td>
<td>81</td>
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<td><strong>Clarendon</strong></td>
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<td>Building #8</td>
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<td>65,022</td>
<td>100%</td>
<td>77%</td>
<td>56</td>
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<td>65</td>
<td>92</td>
<td>84</td>
<td>82%</td>
</tr>
<tr>
<td>Building #9</td>
<td>Office</td>
<td>95,501</td>
<td>95%</td>
<td>88%</td>
<td>55</td>
<td>0.1</td>
<td>70</td>
<td>86</td>
<td>85</td>
<td>80%</td>
</tr>
<tr>
<td>Building #10</td>
<td>Mixed</td>
<td>76,055</td>
<td>100%</td>
<td>64%</td>
<td>56</td>
<td>0.1</td>
<td>70</td>
<td>86</td>
<td>85</td>
<td>59%</td>
</tr>
<tr>
<td>Building #11</td>
<td>Mixed</td>
<td>41,435</td>
<td>100%</td>
<td>52%</td>
<td>67</td>
<td>0.2</td>
<td>64</td>
<td>97</td>
<td>85</td>
<td>76%</td>
</tr>
<tr>
<td>Building #12</td>
<td>Office</td>
<td>209,351</td>
<td>91%</td>
<td>90%</td>
<td>80</td>
<td>0.1</td>
<td>63</td>
<td>89</td>
<td>84</td>
<td>86%</td>
</tr>
<tr>
<td><strong>Rosslyn</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building #13</td>
<td>Mixed</td>
<td>625,062</td>
<td>70%</td>
<td>74%</td>
<td>125</td>
<td>0.2</td>
<td>78</td>
<td>86</td>
<td>80</td>
<td>74%</td>
</tr>
<tr>
<td>Building #14</td>
<td>Office</td>
<td>226,020</td>
<td>94%</td>
<td>90%</td>
<td>115</td>
<td>0.2</td>
<td>78</td>
<td>92</td>
<td>78</td>
<td>44%</td>
</tr>
<tr>
<td>Building #15</td>
<td>Office</td>
<td>171,750</td>
<td>62%</td>
<td>100%</td>
<td>96</td>
<td>0.2</td>
<td>75</td>
<td>92</td>
<td>76</td>
<td>41%</td>
</tr>
<tr>
<td>Building #16</td>
<td>Office</td>
<td>157,871</td>
<td>76%</td>
<td>94%</td>
<td>115</td>
<td>0.3</td>
<td>74</td>
<td>85</td>
<td>82</td>
<td>47%</td>
</tr>
</tbody>
</table>
Neighborhood Intensity and Land Use
Two areas of difference among the buildings were in the half-mile Neighborhood Intensity (NI) values and in the land uses included in the building or complex. The half-mile NI values ranged from 55 to 125, with an average of 91 across all the buildings. As a measure of comparison, a white paper prepared by Arlington Economic Development set the NI in downtown Washington, DC at about 168 and the NI for the Dulles corridor at about 15.

The other clear difference with the buildings is the share of the development used for purpose other than office. All of the buildings were primarily office use, with at least a small amount of non-office use (e.g., small retail). But several included some significant non-office uses as well. As shown in Table 9, two buildings had about 25 percent of their total space used for retail, residential, hotel, or other non-office purposes, one building had 36 percent non-office, and one building had 48 percent of the space devoted to non-office use. By comparison, the other buildings had at most 12 percent non-office use.

Parking Conditions
Two other building characteristics that could influence travel behavior and certainly could influence parking behavior are the amount of parking and the cost of parking in the building. Table 10 shows these parking conditions for each building as well as several other parking-related characteristics.

Parking Supply
The office parking ratio, as defined by the number of spaces per employee, ranged from 0.11 to 1.04 spaces per employee. The parking ratio for Building #11 is not shown because the office parking for that building could not be separated from the parking for non-office uses, due to the design of the garage. This building had substantial non-office uses and a substantial number of parking spaces, so the employee parking ratio could not even be estimated. Four of the buildings had at least 0.85 spaces per employee. Considering some level of employee absenteeism on any particular day, this could be considered full-availability. By contrast, five buildings had parking ratios of under 0.5, or space for fewer than half of the employees.

On-site Parking and Parking Occupancy
The share of employees who said they parked or would park on-site ranged from 49 percent to 91 percent, with an average overall of 74 percent. In general, buildings with high parking ratios also were buildings with high shares of reported on-site parking.

Table 10 also shows maximum parking occupancy percentages for both weekdays and weekends. Weekday occupancy ranged from 54 percent to 95 percent, with an average of 71 percent. The average weekend occupancy was much lower, 24 percent, but the range was very broad, from 0 percent to 72 percent and 12 of the 16 buildings had weekend parking ratios of 20 percent or less, while the other four buildings ranged between 40 percent and 72 percent.

Parking Cost
The last three columns of Table 10 present data on three parking cost items: 1) the percentage of employees who said they had free parking, 2) the monthly permit cost for an unreserved parking space in the building, and 3) the average monthly parking cost reported by employees, accounting for any parking reimbursement by their employers and costs (higher or lower) that they paid to park in off-site
locations. The free parking percentage ranged from 6 percent to 67 percent, but across all buildings/all employees, only about one-quarter had free parking.

The monthly unreserved permit cost averaged $110 per month, with a range from $90 to $170 per month. The range of unreimbursed parking costs reported by employees was slightly broader: $85 to $187 per month, with an average of $134 per month, or about $24 per month more than the permit cost. Most buildings had a similar differential between the employee-reported and permit costs, but five buildings had differentials of $5 or less.
### Table 10: Study Buildings – Parking Conditions

<table>
<thead>
<tr>
<th>Building Number</th>
<th>Primary Building Land Uses</th>
<th>Office Parking shared with Other Uses?</th>
<th>Parking Ratio (spaces per employee)</th>
<th>Percentage of Employees who Park On-site</th>
<th>Maximum Weekday Occupancy</th>
<th>Maximum Weekend Occupancy</th>
<th>Percentage of Employees with Free Parking</th>
<th>Monthly Cost – Unreserved parking</th>
<th>Monthly Parking Cost Reported by Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Range</strong></td>
<td></td>
<td>0.11 – 1.04</td>
<td>49% - 91%</td>
<td>54% - 95%</td>
<td>0% - 72%</td>
<td>6% - 67%</td>
<td>$90 - $170</td>
<td>$85 - $187</td>
<td></td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td>0.52</td>
<td>74%</td>
<td>71%</td>
<td>24%</td>
<td>24%</td>
<td>$110</td>
<td>$134</td>
<td></td>
</tr>
<tr>
<td><strong>Ballston</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building #1</td>
<td>Office</td>
<td>No</td>
<td>0.42</td>
<td>79%</td>
<td>76%</td>
<td>11%</td>
<td>6%</td>
<td>$110</td>
<td>$144</td>
</tr>
<tr>
<td>Building #2</td>
<td>Office</td>
<td>No</td>
<td>1.04</td>
<td>83%</td>
<td>54%</td>
<td>19%</td>
<td>10%</td>
<td>$110</td>
<td>$130</td>
</tr>
<tr>
<td>Building #3</td>
<td>Office</td>
<td>No</td>
<td>0.26</td>
<td>49%</td>
<td>88%</td>
<td>14%</td>
<td>9%</td>
<td>$90</td>
<td>$110</td>
</tr>
<tr>
<td>Building #4</td>
<td>Office</td>
<td>No</td>
<td>0.53</td>
<td>75%</td>
<td>95%</td>
<td>16%</td>
<td>7%</td>
<td>$113</td>
<td>$128</td>
</tr>
<tr>
<td>Building #5</td>
<td>Office</td>
<td>No</td>
<td>0.53</td>
<td>89%</td>
<td>80%</td>
<td>7%</td>
<td>43%</td>
<td>$105</td>
<td>$124</td>
</tr>
<tr>
<td>Building #6</td>
<td>Office</td>
<td>No</td>
<td>0.40</td>
<td>80%</td>
<td>64%</td>
<td>0%</td>
<td>19%</td>
<td>$100</td>
<td>$104</td>
</tr>
<tr>
<td>Building #7</td>
<td>Office</td>
<td>No</td>
<td>0.71</td>
<td>86%</td>
<td>64%</td>
<td>23%</td>
<td>26%</td>
<td>$110</td>
<td>$124</td>
</tr>
<tr>
<td><strong>Clarendon</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building #8</td>
<td>Mixed</td>
<td>Yes</td>
<td>0.85</td>
<td>80%</td>
<td>56%</td>
<td>51%</td>
<td>66%</td>
<td>NA</td>
<td>$85</td>
</tr>
<tr>
<td>Building #9</td>
<td>Office</td>
<td>No</td>
<td>0.41</td>
<td>62%</td>
<td>83%</td>
<td>16%</td>
<td>14%</td>
<td>$125</td>
<td>$129</td>
</tr>
<tr>
<td>Building #10</td>
<td>Mixed</td>
<td>Yes</td>
<td>0.93</td>
<td>88%</td>
<td>75%</td>
<td>55%</td>
<td>35%</td>
<td>$125</td>
<td>$144</td>
</tr>
<tr>
<td>Building #11</td>
<td>Mixed</td>
<td>Yes</td>
<td>NA</td>
<td>73%</td>
<td>77%</td>
<td>72%</td>
<td>30%</td>
<td>NA</td>
<td>$130</td>
</tr>
<tr>
<td>Building #12</td>
<td>Office</td>
<td>No</td>
<td>0.72</td>
<td>79%</td>
<td>72%</td>
<td>20%</td>
<td>22%</td>
<td>$120</td>
<td>$123</td>
</tr>
<tr>
<td><strong>Rosslyn</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building #13</td>
<td>Mixed</td>
<td>Yes</td>
<td>0.11</td>
<td>68%</td>
<td>69%</td>
<td>20%</td>
<td>9%</td>
<td>$170</td>
<td>$187</td>
</tr>
<tr>
<td>Building #14</td>
<td>Office</td>
<td>No</td>
<td>0.56</td>
<td>57%</td>
<td>54%</td>
<td>15%</td>
<td>31%</td>
<td>$150</td>
<td>$153</td>
</tr>
<tr>
<td>Building #15</td>
<td>Office</td>
<td>No</td>
<td>1.04</td>
<td>91%</td>
<td>63%</td>
<td>6%</td>
<td>67%</td>
<td>$145</td>
<td>$139</td>
</tr>
<tr>
<td>Building #16</td>
<td>Office</td>
<td>Yes</td>
<td>0.67</td>
<td>79%</td>
<td>61%</td>
<td>40%</td>
<td>47%</td>
<td>$125</td>
<td>$144</td>
</tr>
</tbody>
</table>
Mode Split Performance by Building

Several of the figures presented in earlier sections of this report noted buildings that performed above or below the mode split trend lines for the buildings overall, where high performance was defined:

- Lower than average drive-alone mode share
- Higher than average transit share
- Higher than average bike/walk mode share

Outliers for mode split were particularly noted for relationships with neighborhood intensity, distance to Metrorail, parking ratio, and parking cost. Building-level data are shown for these variables in Table 11. Buildings that performed better than expected along the trend line for that variable are noted with blue shading. Buildings that performed less well than expected are noted with green shading.

Blue and green shading in the independent variable columns denoted values that were substantially different from the average values for the variables. Values noted with (++), represent values that theory suggests should be associated with lower drive alone rates and higher transit and/or bike/walk mode use. Conversely, values noted with (--) represent values that would be expected with higher drive alone use and lower use of transportation options.

High Performers (Blue Shading)

Five buildings, numbers #3, #10, #11, #13, and #14, seemed to perform better than expected on drive alone and transit and/or bike/walk mode shares. Each Arlington area included at least one high performing building, but Clarendon and Rosslyn each had two buildings, while only one was located in Ballston, notable since about half of the buildings were located in Ballston.

Three high performing buildings were mixed-use and two were primarily office. This is notable because only four of the 16 buildings were mixed-use, so mixed-use buildings were a disproportionate share of high performers. Three high performers had high Neighborhood Intensity, but the other two had quite low NI values, well below the average for the 16 buildings. High performers were generally closer to Metrorail; two were within 0.1 mile and three were located 0.2 miles away.

Two high performers had lower than average parking ratios, but two had very high ratios. Two had low shares of employees with free parking and three had high average parking cost. One building had high TDM availability, but three high performers had TDM availability that was well below average.

Observations about individual high performing buildings include the following:

- **Building #3** (39% DA, 12% B/W) – Primary office with four high performance features: higher NI (++), closer to Metrorail (++), very low parking supply (++), and very low free parking percentage (++); and one low performance feature: low parking cost (--).

- **Building #10** (40%, 21% B/W) – Mixed-use with two high performance features: close to Metrorail (++ and high parking cost (++; and four low performance features: very low NI (--) high parking ratio (--), high free parking percentage (--), and low TDM availability (--).

- **Building #11** (41% DA, 36% TR) – Mixed-use with one high performance feature: high TDM availability (++); and one low performance feature: low NI (--).
- **Building #13** (36% DA, 47% TR) – Mixed-use with **four high performance features**: very high NI (++), very low parking supply (++), very high parking cost (++), and very low free parking percentage (++).

- **Building #14** (32% DA, 47% TR, 13% B/W) – Primary office with **two high performance features**: high NI (++), high parking cost (++); and **one low performance feature**: very low TDM availability (--).
<table>
<thead>
<tr>
<th>Building Number and Land Use</th>
<th>Drive Alone Mode Share</th>
<th>Transit Mode Share</th>
<th>Bike/ Walk Mode Share</th>
<th>Neighborhood Intensity (half-mile)</th>
<th>Miles to Metrorail</th>
<th>Parking Ratio (spaces per employee)</th>
<th>% Employees with Free Parking</th>
<th>Monthly Parking Cost Reported by Employees</th>
<th>% Employees with High/ VHigh TDM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Range</strong></td>
<td>32% - 18% - 3% -</td>
<td></td>
<td></td>
<td>55 - 125</td>
<td>0.1 – 0.3</td>
<td>0.11 – 1.04</td>
<td>6% - 67%</td>
<td>$85 - $187</td>
<td>41% - 86%</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>47%</td>
<td>32%</td>
<td>9%</td>
<td>91</td>
<td>0.20</td>
<td>0.52</td>
<td>24%</td>
<td>$134</td>
<td>68%</td>
</tr>
<tr>
<td><strong>Ballston</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building #1 - office</td>
<td>42%</td>
<td>34%</td>
<td>9%</td>
<td>100</td>
<td>0.3</td>
<td>0.42</td>
<td>6%</td>
<td>$144</td>
<td>52%</td>
</tr>
<tr>
<td>Building #2 – office</td>
<td>43%</td>
<td>33%</td>
<td>9%</td>
<td>93</td>
<td>0.3</td>
<td>1.04</td>
<td>10%</td>
<td>$130</td>
<td>57%</td>
</tr>
<tr>
<td>Building #3 – office</td>
<td>39%</td>
<td>33%</td>
<td>12%</td>
<td>99 (++)</td>
<td>0.1 (++)</td>
<td>0.26 (++)</td>
<td>9% (++)</td>
<td>$110 (--)</td>
<td>66%</td>
</tr>
<tr>
<td>Building #4 – office</td>
<td>56%</td>
<td>22%</td>
<td>9%</td>
<td>96</td>
<td>0.2</td>
<td>0.53</td>
<td>7% (++)</td>
<td>$128</td>
<td>57% (--)</td>
</tr>
<tr>
<td>Building #5 – office</td>
<td>43%</td>
<td>40%</td>
<td>9%</td>
<td>106</td>
<td>0.1</td>
<td>0.53</td>
<td>43%</td>
<td>$124</td>
<td>80%</td>
</tr>
<tr>
<td>Building #6 – office</td>
<td>59%</td>
<td>20%</td>
<td>8%</td>
<td>110 (++)</td>
<td>0.3 (--)</td>
<td>0.40 (++)</td>
<td>19%</td>
<td>$104 (--)</td>
<td>82% (++)</td>
</tr>
<tr>
<td>Building #7 – office</td>
<td>63%</td>
<td>21%</td>
<td>7%</td>
<td>86</td>
<td>0.3 (--)</td>
<td>0.71 (--)</td>
<td>26%</td>
<td>$124</td>
<td>77% (++)</td>
</tr>
<tr>
<td><strong>Clarendon</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building #8 – mixed</td>
<td>52%</td>
<td>30%</td>
<td>7%</td>
<td>56</td>
<td>0.2</td>
<td>0.85</td>
<td>66%</td>
<td>$85</td>
<td>82%</td>
</tr>
<tr>
<td>Building #9 – office</td>
<td>55%</td>
<td>22%</td>
<td>6%</td>
<td>55 (--)</td>
<td>0.1 (++)</td>
<td>0.41 (++)</td>
<td>14% (++)</td>
<td>$129</td>
<td>80% (++)</td>
</tr>
<tr>
<td>Building #10 – mixed</td>
<td>40%</td>
<td>31%</td>
<td>21%</td>
<td>56 (--)</td>
<td>0.1 (++)</td>
<td>0.93 (--)</td>
<td>35% (--)</td>
<td>$144 (++)</td>
<td>59% (--)</td>
</tr>
<tr>
<td>Building #11 – mixed</td>
<td>41%</td>
<td>36%</td>
<td>3%</td>
<td>67 (--)</td>
<td>0.2</td>
<td>NA</td>
<td>30%</td>
<td>$130</td>
<td>76% (++)</td>
</tr>
<tr>
<td>Building #12 – office</td>
<td>52%</td>
<td>32%</td>
<td>7%</td>
<td>80</td>
<td>0.1</td>
<td>0.72</td>
<td>22%</td>
<td>$123</td>
<td>86%</td>
</tr>
<tr>
<td><strong>Rosslyn</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building #13 – mixed</td>
<td>36%</td>
<td>47%</td>
<td>10%</td>
<td>125 (++)</td>
<td>0.2</td>
<td>0.11 (++)</td>
<td>9% (++)</td>
<td>$187 (++)</td>
<td>74%</td>
</tr>
<tr>
<td>Building #14 – office</td>
<td>32%</td>
<td>47%</td>
<td>13%</td>
<td>115 (++)</td>
<td>0.2</td>
<td>0.56</td>
<td>31%</td>
<td>$153 (++)</td>
<td>44% (--)</td>
</tr>
<tr>
<td>Building #15 – office</td>
<td>65%</td>
<td>18%</td>
<td>3%</td>
<td>96</td>
<td>0.2</td>
<td>1.04 (--)</td>
<td>67% (--)</td>
<td>$139</td>
<td>41% (--)</td>
</tr>
<tr>
<td>Building #16 - mixed</td>
<td>48%</td>
<td>33%</td>
<td>12%</td>
<td>115</td>
<td>0.3</td>
<td>0.67</td>
<td>47%</td>
<td>$144</td>
<td>47%</td>
</tr>
</tbody>
</table>

Orange shading – Lower performer; Blue shading – Higher performer
Low Performers (Green Shading)

Five buildings, numbers #4, #6, #7, #9, and #15, seemed to perform less well than expected on drive-alone (high mode share) and transit and/or bike/walk (low mode shares). Again, the buildings were distributed by Arlington area, but three were located in Ballston and one in each of Clarendon and Rosslyn. All of the buildings were primarily office. There was no obvious trend with Neighborhood Intensity; one building had a quite low NI, but one had a quite high NI. Low performers were generally farther from Metrorail; three were located 0.3 miles away and the other two were located 0.2 miles.

Two low performers had higher than average parking ratios. Two had lower than average ratios, but they were not extremely low. One had a very high share of employees with free parking, but two had lower than average free parking rates. One building had a quite low average parking cost, but costs for the remaining four buildings were at about the average rate. Two low performing buildings had low TDM availability, but the other three had TDM availability that was well above average. Observations about individual buildings include the following:

- **Building #4** (56% DA, 22% TR) – Primary office with one low performance feature: low TDM availability (--); and one high performance feature: very low free parking percentage (++).

- **Building #6** (59%, 20% TR) – Primary office with two low performance features: farther from Metrorail (--) and low parking cost (--); and three high performance features: high NI (++), low parking supply (++), and high TDM availability (++).

- **Building #7** (63% DA, 21% TR) – Primary office with two low performance features: farther from Metrorail (--) and high parking supply (--); and one high performance feature: high TDM availability (++).

- **Building #9** (55% DA, 22% TR, 6% B/W) – Primary office with one low performance feature: lower NI (--); and four high performance features: close to Metrorail (++), low parking supply (++), low free parking percentage (++), and high TDM availability (++).

- **Building #15** (65% DA, 18% TR, 3% B/W) – Primary office with three low performance features: very high parking supply (--), very high free parking percentage (--), and very low TDM availability (--).

Overall, high performers seemed more consistent as a group than did low performers. Four of the high performers had at least two features that were associated with high performance. They also were unlikely to have features associated with low performance; one building had four low performance features but the others had zero or one low performance features. By contrast, the low performance buildings were more varied. Four of the buildings had just one or two low performance features and two of the buildings had at least three high performance features.

Vehicle Trip Generation Performance by Building

Various buildings also seemed to perform above or below the trend lines for daily Weekday trip generation and Weekday AM peak hour trip generation, where high performance was defined as lower than average vehicle trips per employee. Table 12 presents building-level data for weekday vehicle trips generated along with the same location, transportation access, and parking variables presented for mode split. Buildings that performed better than expected along the trend for that variable are noted with blue shading. Buildings that performed less well than expected are noted with green shading.
### Table 12: Study Buildings – Weekday Trip Generation by Location / Transportation Access / Parking Conditions

<table>
<thead>
<tr>
<th>Building Number and Land Use</th>
<th>Weekday Daily Vehicle Trips per Employee</th>
<th>Weekday AM Peak Hour Vehicle Trips per Employee</th>
<th>Neighborhood Intensity (half-mile)</th>
<th>Miles to Metrorail</th>
<th>Parking Ratio (spaces per employee)</th>
<th>% Employees with Free Parking</th>
<th>Monthly Parking Cost Reported by Employees</th>
<th>% Empl with High/VH TDM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Range</strong></td>
<td>0.85 – 2.61</td>
<td>0.09 – 0.29</td>
<td>55 – 125</td>
<td>0.1 – 0.3</td>
<td>0.11 – 1.04</td>
<td>6% - 67%</td>
<td>$85 - $187</td>
<td>41% - 86%</td>
</tr>
<tr>
<td><strong>Average</strong>*</td>
<td>1.46</td>
<td>0.20</td>
<td>91</td>
<td>0.20</td>
<td>0.52</td>
<td>24%</td>
<td>$134</td>
<td>68%</td>
</tr>
</tbody>
</table>

#### Ballston

| Building #1 - office        | 1.64                                  | 0.25                                          | 100                             | 0.3               | 0.42                             | 6%                             | $144                                   | 52%                    |
| Building #2 – office        | 1.98                                  | 0.23                                          | 93                              | 0.3 (-)           | 1.04 (-)                        | 10% (+)                        | $130                                   | 57% (-)                |
| Building #3 – office        | 0.71                                  | 0.12                                          | 99 (+)                          | 0.1 (+)           | 0.26 (+)                        | 9% (+)                         | $110 (-)                               | 66%                    |
| Building #4 – office        | 1.28                                  | 0.23                                          | 96                              | 0.2               | 0.53                             | 7%                             | $128                                   | 57% (-)                |
| Building #5 – office        | 1.15                                  | 0.18                                          | 106                             | 0.1               | 0.53                             | 43%                            | $124                                   | 80%                    |
| Building #6 – office        | 0.76                                  | 0.09                                          | 110 (+)                          | 0.3 (-)           | 0.40 (+)                        | 19%                            | $104 (-)                               | 82% (+)                |
| Building #7 – office        | 1.60                                  | 0.18                                          | 86                              | 0.3               | 0.71                             | 26%                            | $124                                   | 77%                    |

#### Clarendon

| Building #8 – mixed         | 4.17*                                 | 0.49*                                         | 56                              | 0.2               | 0.85                             | 66%                            | $85                                    | 82%                    |
| Building #9 – office        | 1.17                                  | 0.18                                          | 55                              | 0.1               | 0.41                             | 14%                            | $129                                   | 80%                    |
| Building #10 – mixed        | 8.90*                                 | 0.53*                                         | 56                              | 0.1               | 0.93                             | 35%                            | $144                                   | 59%                    |
| Building #11 – mixed        | 11.44*                                | 1.07*                                         | 67                              | 0.2               | NA                               | 30%                            | $130                                   | 76%                    |
| Building #12 – office       | 1.33                                  | 0.18                                          | 80                              | 0.1               | 0.72                             | 22%                            | $123                                   | 86%                    |

#### Rosslyn

| Building #13 – mixed        | 0.85                                  | 0.12                                          | 125 (+)                          | 0.2               | 0.11 (+)                        | 9% (+)                         | $187 (+)                               | 74%                    |
| Building #14 – office       | 2.03                                  | 0.26                                          | 115 (+)                          | 0.2               | 0.56                             | 31%                            | $153 (+)                               | 44% (-)                |
| Building #15 – office       | 1.94                                  | 0.29                                          | 96                              | 0.2               | 1.04 (-)                        | 67% (-)                        | $139                                   | 41% (-)                |
| Building #16 - mixed        | 2.61                                  | 0.29                                          | 115 (+)                          | 0.3 (-)           | 0.67                             | 47% (-)                        | $144                                   | 47% (-)                |

Orange shading – Lower performer; Blue shading – Higher performer; *Average trips per employee exclude buildings #8, #10, and #11
Blue and green shading in the independent variable columns denoted values that were substantially different from the average values for the variables. Values noted with (++) represent values that theory suggests should be associated with lower drive alone rates and higher transit and/or bike/walk mode use. Conversely, values noted with (--) represent values that would be expected with higher drive alone use and lower use of transportation options.

Note that three buildings, #8, #10, and #11, had trip generation rates that were dramatically higher than for the other 13 buildings: 4.17, 8.90, and 11.44 daily vehicle trips per employee, respectively, compared with a range of 0.71 to 2.61 for the other buildings. These three buildings were broadly mixed-use, with substantial retail, housing, and/or hotel uses. One of the buildings housed a grocery store, which would generate a large number of PM peak trips for after-work shopping. And a gym was located in another of the buildings; this use could generate a substantial number of trips at both AM and PM peak periods. Because these buildings represented quite different travel patterns, and as the commute travel could not reliably be segmented from the non-work travel, these buildings were excluded from the trip generation analysis and they are excluded from both the ranges and average vehicle trips per employee values shown in the top two rows.

High Performers (Blue Shading)
Three buildings, numbers #3, #6, and #13, performed better than expected on trip generation rates. Two of the buildings were located in Ballston and one was located in Rosslyn. Two of the buildings were primarily office and one was mixed-use. All three high performers had high Neighborhood Intensity values. Metrorail distance did not show any pattern; one high performer was located at each of the three Metrorail distances: 0.1 miles, 0.2 miles, and 0.3 miles.

All three high performers had lower than average parking ratios. Two had low shares of employees with free parking. One had a high average parking cost, but two had costs well under the average. One high performing building had high TDM availability; the other two had TDM availability that was about at the average level.

Observations about individual buildings include the following:

- Building #3 (0.71 daily VT per employee, 0.12 AM Peak Hour VT per employee) – Primary office with **four high performance features**: higher NI (++), close to Metrorail (++), very low parking supply (++), and very low free parking percentage (++); and **one low performance feature**: low parking cost (--).

- Building #6 (0.76 daily VT per employee, 0.09 AM peak hour VT per employee) – Primary office with **three high performance features**: high NI (++), low parking ratio, and very high TDM availability; and **two low performance features**: farther from Metrorail (--) and lower parking cost (--).

- Building #13 (0.85 daily VT per employee, 0.12 AM peak hour VT per employee) – Mixed-use with **four high performance features**: very high NI (++), very low parking supply (++), very low free parking percentage (++), and very high parking cost (++)

Low Performers (Green Shading)
Four buildings, numbers #2, #14, #15, and #16 seemed to perform less well than expected on vehicle trip generation rates. One of the buildings was in Ballston, but three of the four were located in Rosslyn. All of the buildings were primarily office.
There was no obvious trend with Neighborhood Intensity; two buildings had a quite high NI, but the other two were just slightly above average. Low performers were generally farther from Metrorail; one was located 0.4 miles away, one was located 0.3 miles away and the other two were located 0.2 miles.

Parking ratio appeared to be a common thread for low performers; two had parking ratios much higher than average and one had a parking ratios moderately above the average. The availability of free parking might be related; two of the buildings had very high rates of free parking. But average parking cost did not seem related to low performance. All four of the low performers had parking costs approximately at or above the average for all buildings. TDM availability did show a possible connection; all four of the low performing buildings had low TDM availability – in three buildings, it was well below average.

Observations about individual buildings include the following:

- **Building #2** (1.98 daily VT per employee, 0.23 AM peak hour VT per employee) – Primary office with **three low performance features**: farther from Metrorail (--), very high parking ratio (++), and low TDM availability (--); and **one high performance feature**: low free parking percentage (++)

- **Building #14** (2.03 daily VT per employee, 0.26 AM peak hour VT per employee) – Primary office with **one low performance feature**: very low TDM availability (--); and **two high performance features**: high NI (++) and high parking cost (++).

- **Building #15** (1.94 daily VT per employee, 0.29 AM peak hour VT per employee) – Primary office with **three low performance features**: very high parking supply (--), very high free parking percentage (--), and very low TDM availability (--).

- **Building #16** (2.61 daily VT per employee, 0.29 AM peak hour VT per employee) – Mixed-use with **three low performance feature**: farther from Metrorail (--), very high free parking percentage (--), and very low TDM availability (--); and **one high performance feature**: high NI (++)

As was observed for mode split high performers, high performers on vehicle trip generation seemed more consistent as a group than did low performers. All of the high performers had at least three features that were associated with high performance. They also were unlikely to have features associated with low performance; one building had two low performance features and the others had zero or one low performance features.

Among low performance buildings, three had at least three low performance features. Three had high performance features, but only one or two per building.

**Building Analysis Challenges**

A particular challenge working with this data set was in the comparison of individual-level data (obtained through responses to the mode split survey) with building-level data (things only measured building by building, such as trip generation). This comparison generated some seemingly counter-intuitive results. In a specific example, it did not always follow that low reported drive-alone mode share at a building was correlated with low observed vehicle trip generation at that same building, though that would be a reasonable hypothesis based on the observed correlation at the level of the individual across the entire sample. Some possible sources of mismatch between building-level variables and individual-level variables may include:
• Respondent universe: The surveys were distributed to only a subset of the regular building occupants (office workers), while other building occupants may also have been using the garage. Visitors, for instance, were not invited to take the survey. People who do not usually work at the worksite may also have traveled to the building during the counting period, but not taken the survey. Furthermore, only some employers participated and promoted the survey. The researchers do not know if there is a difference in garage use between the employees of those employers that participated and those that did not.

• Respondent self-selection: There may have been a difference between the garage use of those employees who were offered and chose to respond to the survey, and those who were offered but chose not to respond to the survey.

• Reference time period: The trip-generation data collected from a garage may not align precisely with the time period in which the surveys were conducted. Also, the mode split surveys only ask about commute trips across a “typical” work week, while the vehicle trip-generation data capture all trips (regardless of purpose) across a specific week that may or may not reflect what employees say is a “typical” week.

• Building level variable uniformity: In some instances, the variables the researchers were collecting at the building level may have been too uniform to suggest influence in one direction or another. In the case of distance from Metrorail, this uniformity was identified from the outset and was not the focus of analysis. In a different example, the data indicated that as Transit Score™ increased (better transit access), vehicle trip generation at the building also increased, a counter-intuitive result. However, the range of values of Transit Score™ across the 16-building sample was fairly narrow, making it difficult to demonstrate influence on variation in vehicle trip generation at each building. It may be reasonable to seek to set thresholds, much as the researchers did for distance from Metrorail, below which variability is largely irrelevant to behavior.

These data and this analysis cannot explain the cause of these unexpected relationships between building-level and individual-level variables. This issue also appears when examining the survey results for each building individually. In several instances, the relationship between an independent and dependent variable is present when all survey responses are included, but it disappears when the responses were pooled for each of the 16 buildings and then compared with one another. Factors that may contribute to the difficulty of observing relationships at the building level include:

• Sample size: The sample of people in the survey was a robust 2,644; however, the sample of buildings is only 16. It is difficult to observe correlation between two variables within a sample that is this small.

• Within-building variability: Since the study is looking at individual behaviors and individual awareness, there is likely to be within-building variability on any given survey variable, for instance availability of a transit subsidy, which has to be averaged in order to assign that variable at the building level. This step of creating average variables at the building level is likely to diminish or wash out some of the effects that can be seen at the individual level through the aggregate analysis. For instance, if the researchers are looking for a relationship between availability of a transit benefit and mode choice, the relationship would be most apparent when grouping the sample according to the individual perception of availability (yes or no) and the individual mode choice behavior (walk, bike, transit, drive, etc.).
- Differential employer influence: Given the potential influence of employers on the availability of transportation benefits and services, this employer influence too would be less visible when looking at an average value across a whole building.
VI. Neighborhood Travel Profiles

All of the study buildings were located in the Rosslyn-Ballston Metrorail Orange line corridor of Arlington County. The buildings were concentrated in three urban villages within that corridor:

- Ballston, at the western end of the corridor
- Clarendon, in the center of the corridor
- Rosslyn, at the eastern end of the corridor, bordering the Potomac River and District of Columbia, to the east

This concentration of buildings, with seven Ballston buildings, five Clarendon buildings, and four Rosslyn buildings, allows some comparison of results for these three areas. Note that these results are not necessarily representative of all buildings or workers in these areas, because the buildings were not randomly selected. However, they illustrate some differences across the three areas for newer buildings and buildings with site plan conditions.

Commute Mode Split and Trip Generation Rates

Drive Alone Commute Mode Split by Building by Area

Figure 86 presents a building-by-building comparison of the drive-alone mode splits for employees who worked in each building, with buildings grouped into the three areas. Drive alone mode shares varied widely for buildings across each area. Ballston building drive alone rates ranged from 39 percent to 63 percent, Clarendon buildings ranged from 40 percent to 55 percent, and Rosslyn buildings ranged from 32 percent to 65 percent drive alone.

**FIGURE 86: PRIMARY DRIVE ALONE MODE SHARE – STUDY BUILDINGS BY AREA**

<table>
<thead>
<tr>
<th>Ballston</th>
<th>Clarendon</th>
<th>Rosslyn</th>
</tr>
</thead>
<tbody>
<tr>
<td>42%</td>
<td>56%</td>
<td>65%</td>
</tr>
<tr>
<td>43%</td>
<td>59%</td>
<td>48%</td>
</tr>
<tr>
<td>39%</td>
<td>63%</td>
<td>32%</td>
</tr>
<tr>
<td>43%</td>
<td>52%</td>
<td></td>
</tr>
<tr>
<td>41%</td>
<td>55%</td>
<td></td>
</tr>
<tr>
<td>36%</td>
<td>52%</td>
<td></td>
</tr>
</tbody>
</table>

16 study buildings, Individual building mode samples ranged from 64 to 329
Average Commute Mode Split for all Employees in the Study Buildings

In aggregate, only 43 percent of study respondents who worked in Rosslyn drove alone, compared with more than half of respondents who worked in Ballston (54 percent) and Clarendon (53 percent) (Figure 87). The difference was entirely made up by an increase in the transit rate; 41 percent of Rosslyn workers rode transit, compared with 30 percent in each of Ballston and Clarendon.

This higher transit mode share for Rosslyn likely is due to its proximity to the District of Columbia and its location at the junction of two Metrorail lines. (Note that the Silver Line had not yet opened at the time most study data were collected). The Orange line travels east from Rosslyn to the District of Columbia and west through Arlington. The Blue line travels east into the District of Columbia and south through Arlington into Alexandria. This offers easy transit access to a wide range of home origins.

**FIGURE 87: PRIMARY COMMUTE MODE – STUDY RESPONDENTS BY WORKSITE LOCATION**

Employee survey data: Ballston n = 1,494, Clarendon n = 512, Rosslyn n = 638

Vehicle Trip Generation Rates

Figure 88 shows a building-by-building comparison of the daily vehicle trips per employee generated for each study building, with buildings grouped into the three areas. The figure also shows the predicted ITE value, 3.32 vehicle trips per employee, for all study buildings.
The 13 buildings generated vehicle trips at a much lower rate than predicted by ITE. Ballston and Clarendon buildings performed particularly below the ITE prediction. The seven Ballston buildings had an average of 1.30 daily weekday vehicle trips per employee, just 39 percent of the ITE value. The two Clarendon buildings had an average trip rate of 1.25 trips per employee, 37 percent of the ITE value. The four Rosslyn buildings generated an average of 1.86 vehicle trips per employee, equating to 56 percent of the value predicted by ITE.

Although the average commute drive alone mode split was lower for employees who worked in Rosslyn than for employees who worked in other areas, the Rosslyn buildings generated the highest numbers of daily vehicle trips (Figure 88). The Rosslyn trip rates were higher for all daily periods, but the Sunday daily rate was particularly notable. However, one Rosslyn building included some residential units. If this building is excluded from the weekend calculation the average Saturday and Sunday trip rates for Rosslyn fall to 0.12 and 0.07, respectively, well below the rates for the other two areas. Peak hour rates were more consistent across the three areas.
TABLE 13: VEHICLE TRIP GENERATION RATES – THREE STUDY AREAS BY TIME PERIODS

<table>
<thead>
<tr>
<th>Trip Generation Time Period</th>
<th>Ballston (7 buildings)</th>
<th>Clarendon (2 buildings)*</th>
<th>Rosslyn (4 buildings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Weekday</td>
<td>1.30</td>
<td>1.25</td>
<td>1.86</td>
</tr>
<tr>
<td>- Saturday</td>
<td>0.30</td>
<td>0.38</td>
<td>0.43</td>
</tr>
<tr>
<td>- Sunday</td>
<td>0.14</td>
<td>0.23</td>
<td>0.36</td>
</tr>
<tr>
<td>Peak Hour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Weekday AM</td>
<td>0.18</td>
<td>0.18</td>
<td>0.24</td>
</tr>
<tr>
<td>- Weekday PM</td>
<td>0.17</td>
<td>0.16</td>
<td>0.22</td>
</tr>
<tr>
<td>- Saturday</td>
<td>0.05</td>
<td>0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>- Sunday</td>
<td>0.02</td>
<td>0.04</td>
<td>0.04</td>
</tr>
</tbody>
</table>

* Three mixed-use Clarendon buildings were excluded from this calculation, due to the difficulty in separating non-work trips from work trips generated.

Parking Characteristics

Parking Location

Across all employees surveyed, about three-quarters parked on-site in the study building garage on days they drove to work. Among employees who drove alone to work, the percentage of on-site parking was about 85 percent. Employees parked on-site at about the same rate in the three study areas (Figure 89). Rosslyn employees who did not park on-site were more likely to park in a public or private garage nearby; 13 percent of Rosslyn employees reported this parking location, compared with 9 percent of Ballston employees and 7 percent of Clarendon employees. Street parking was noted by no more than 5 percent in any of the three areas.
FIGURE 89: PARKING LOCATION – BY AREA, REPORTED BY EMPLOYEES WHO DROVE ALONE TO WORK

Parking Supply and Occupancy
Parking ratios for individual buildings showed a wide range in all three areas: Ballston – 0.26 – 1.04 spaces per employee; Clarendon – 0.41 – 0.93 spaces per employee; and Rosslyn – 0.11 – 1.04 spaces per employee (Table 14). Clarendon had the overall highest average parking availability of the three areas, with an average of 0.73 spaces per employee. The ratios for Ballston and Rosslyn were 0.56 and 0.59, respectively. But weekday parking occupancies were not substantially different in the three areas: Ballston – 74 percent, Clarendon – 73 percent, and Rosslyn – 62 percent.

As also shown in Table 14, half of the Rosslyn and Ballston survey respondents worked at locations with constrained on-site parking, defined as parking in the building for no more than half of the employees who worked there. Parking was more readily available in Clarendon; 72 percent of employees in this area worked in a building with between 0.51 and 0.75 spaces per employee and 28 percent worked in a building with at least 0.76 spaces per employee.
TABLE 14: PARKING RATIO (SPACES PER EMPLOYEE) AND AVERAGE PARKING OCCUPANCY – BY AREA

<table>
<thead>
<tr>
<th>Parking Ratio</th>
<th>Ballston (n = 1,494)</th>
<th>Clarendon (n = 512)</th>
<th>Rosslyn (n = 638)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 – 0.25</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
</tr>
<tr>
<td>0.26 – 0.50</td>
<td>49%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>0.51 – 0.75</td>
<td>46%</td>
<td>72%</td>
<td>34%</td>
</tr>
<tr>
<td>0.76 – 0.90</td>
<td>0%</td>
<td>18%</td>
<td>0%</td>
</tr>
<tr>
<td>0.91 or more</td>
<td>5%</td>
<td>10%</td>
<td>16%</td>
</tr>
</tbody>
</table>

Parking ratio range (space per employee)  0.26 – 1.04  0.41 – 0.93  0.11 – 1.04
Average ratio (spaces per employee)      0.56         0.73                 0.59
Average parking occupancy (weekday)      74%          73%                  62%

Parking Cost
Across all employees surveyed, about three-quarters (76 percent) paid or would pay to park on days they drove to work. Ballston employees were least likely to have free parking at work; only 18 percent of Ballston employees had free parking, compared with about three in ten employees who worked in Clarendon and Rosslyn. But the average parking cost was highest in Rosslyn, $174 per month, compared with $122 per month in Clarendon and $126 per month in Ballston.

FIGURE 90: UNREIMBURSED MONTHLY PARKING COST – BY AREA, REPORTED BY EMPLOYEES

Ballston n = 1,317, Clarendon n = 478, Rosslyn n = 553
In the 2008 Commercial building study parking fees varied by the employees’ work locations as well. Only 11 percent of the commuters to buildings in the Ballston/Courthouse areas had free parking, while 30 percent of Rosslyn employees reported having free parking.” (LDA Consulting and the Southeastern Institute of Research, 2009, p. 159)

Neighborhood Intensity and Transportation Infrastructure Access

Neighborhood Intensity

The Rosslyn area buildings had the highest value for half-mile Neighborhood Intensity. Buildings in this area had values ranging from 95 to 125, with an average value of 113. Clarendon buildings had the lowest Neighborhood Intensity values; the five buildings in this area ranged from 55 to 80, with an average of 63.

**Table 15: Neighborhood Intensity (Residents plus Employees within a Half-mile) – Study Buildings by Area**

<table>
<thead>
<tr>
<th>Neighborhood Intensity</th>
<th>Ballston (n = 7 buildings)</th>
<th>Clarendon (n = 5 buildings)</th>
<th>Rosslyn (n = 4 buildings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>86 - 110</td>
<td>55 - 80</td>
<td>95 – 125</td>
</tr>
<tr>
<td>Average</td>
<td>99</td>
<td>63</td>
<td>113</td>
</tr>
</tbody>
</table>

Distance to Metrorail

As shown in Table 16, the study buildings located in Ballston and Rosslyn were slightly farther away from Metrorail (average distance of 0.23 miles) than were the Clarendon buildings (average distance of 0.14 miles). But given the relatively proximity of all study buildings to Metrorail, the difference was only about one block.

**Table 16: Distance to Metrorail Station – By Area**

<table>
<thead>
<tr>
<th>Metrorail Distance</th>
<th>Ballston (n = 7 buildings)</th>
<th>Clarendon (n = 5 buildings)</th>
<th>Rosslyn (n = 4 buildings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 miles</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>0.2 miles</td>
<td>1</td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td>0.3 miles</td>
<td>4</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0.4 miles</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Average distance (miles)</td>
<td>0.23</td>
<td>0.14</td>
<td>0.828</td>
</tr>
</tbody>
</table>

Transit Score™

In all three areas, the Transit Score™ had very narrow ranges. The scores ranged from a low of 69 to a high of 76 in Ballston. In Clarendon, the lowest score was 65 and the highest was 70. And only four points separated the highest score (78) from the lowest (74) in Rosslyn.
FIGURE 91: TRANSIT SCORE™ RANGE – BY AREA

Study Buildings: Ballston n = 7, Clarendon n = 5, Rosslyn n = 4

Walk Score™ and Bike Score™
Ranges were similarly narrow for Bike Scores™. The set of scores for the seven Ballston buildings ranged from 80 to 84 and from 76 to 82 in Rosslyn. The five Clarendon buildings had essentially the same score. Walk Score™ was somewhat more varied. Scores for Ballston buildings ranged from 82 to 97, Clarendon buildings had scores ranging from 86 to 97, and Rosslyn scores ranged from 86 to 92.

FIGURE 92: BIKE SCORE™ AND WALK SCORE™ RANGE– BY AREA

Study Buildings: Ballston n = 7, Clarendon n = 5, Rosslyn n = 4
**TDM Service Access**

**TDM Level**

Employees located in Clarendon reported having the greatest access to TDM services; 79 percent of Clarendon employees reported access to High or Very High TDM services, compared with 60 percent of Rosslyn employees and 68 percent of Ballston employees. Among respondents who worked in Rosslyn, one-third (34 percent) reported No/Low TDM services availability.

**FIGURE 93: TDM PROGRAM LEVEL (EMPLOYEE-PERCEIVED) – BY AREA**

![Bar chart showing TDM program level by area.](chart)

Ballston n = 1,177, Clarendon n = 446, Rosslyn n = 476

As shown by Figure 94, the percentage of employees who reported having access to each service varied by their work location. But employees who worked in Clarendon were generally more likely to report access to individual services than were either Ballston or Rosslyn employees. Rosslyn employees were least likely to report access to any of the services. Ballston employees mentioned two services, showers/personal lockers, and information displays in the building lobby, at notably higher rates than did workers in other areas. Services that are not shown were perceived as available at about the same rate in all areas.
Figure 94: Worksite TDM Services (Employee-Perceived) – Individual Services by Area

Ballston n = 1,177, Clarendon n = 446, Rosslyn n = 476
VII. Conclusion

This study brings together data collected between 2013 and 2015 through the enforcement of Arlington County’s transportation demand management (TDM) site plan requirements in order to answer general questions about transportation behavior in the county. Vehicle-trip counts, parking-occupancy calculations, and a series of surveys with property managers, employers, and employees at 16 office buildings in Arlington County’s Rosslyn-Ballston Corridor provide a data set that the researchers were able analyze in order to:

1. Learn about travel and parking behaviors of office employees who work in one of the densest, most urban sections of Arlington.
2. Provide useful local data about which factors are most likely to influence travel and parking behaviors.
3. Support better understanding about what influences transportation choices and outcomes so as to help the County reach its long-term objectives and to influence national planning standards.

Similar to other studies made by transportation researchers in recent decades, this study used a “cross-sectional” method. Although the building data was collected between 2013 and 2015, each building’s data collection occurred at one time over only a few weeks; therefore, the researchers treated the 16-building data “set” as a point-in-time snapshot of travel at these buildings.

Transportation Performance Key Findings

Trip Generation

The researchers compared the vehicle trip generation observed at these buildings with the rates predicted by the Institute for Transportation Engineers (ITE) Trip-Generation Manual in order to make a general statement about how accurately the ITE standards predict vehicle travel in the Arlington Metrorail corridors. The researchers found that ITE trip-generation standards generally over-estimate vehicle trips when the researchers compare them to observations at these buildings. Other researchers are finding similar results when studying transit-oriented developments or traditional urban neighborhoods around the region, around the United States, and elsewhere. Other researchers have created methods for predicting vehicle trips that “adjust” ITE values for dense, transit-rich environments. This study compared the adjustment methods created by two sets of researchers and found that they provided vehicle trip-generation estimates that were more accurate than ITE for the buildings studied here.

Parking Occupancy

This study’s results reinforced the existing literature when it came to parking-garage occupancy. Average weekday (Monday through Thursday) parking occupancy was no higher than 85 percent across all the buildings studied and was as low as 50 percent in one case. Though parking garages are not intended to operate at 100 percent occupancy, the parking occupancies seen here indicate that many Arlington office buildings provide more parking than necessary, even controlling for current office occupancy rates. As expected, weekend parking occupancy in office building garages was lower than on week days, with the exception of three buildings where garages served a more diverse mix of uses (offices coupled with large scale retail, hotels, and residences). In these buildings, overall demand for parking in the building was relatively stable across all seven days of the week, just as proponents of shared parking
would predict. Unfortunately, the true benefits of this shared parking opportunity are not really achieved because in these buildings the parking is separated by land use type, not shared across land use types.

Mode Split
Given the parking and trip-generation data that were collected, it comes as no surprise that workers at the 16 buildings are much more likely to take transit, bike, or walk to work than the average worker in Arlington, and around the Washington region. However, workers in the District of Columbia (and especially in the District’s downtown employment core) are even less likely to drive to work and are more likely to carpool or vanpool.

When the researchers look at Arlington residents who work in the 16 office buildings, the mode split is more environmentally sustainable than that of all workers who come to work from around the region; 37 percent of Arlington residents drive alone to work at these locations, but fully 28 percent walk to work, 26 percent take public transportation, and 6 percent bike to work (only two percent carpool or vanpool). District of Columbia residents who reverse commute to these Arlington locations are even less likely to drive to work (only 30 percent), probably due to DC’s much lower household vehicle ownership rates and the relative greater difficulty in driving across the Potomac River, compared to driving across the neighborhoods of Arlington.

Parking Location
When asked, workers at these sixteen buildings reported that they are most likely to park in the garages at the office building where they work or at other parking garages nearby; only three percent said that they park on the street. This finding is important because (as in other communities) those who oppose high-density development in Arlington frequently cite concerns about “spillover” parking, a situation in which individuals who drive to high-rise office buildings take up on-street parking spaces in nearby residential neighborhoods.

TDM-Related Key Findings: Influence of Pricing on Mode Choice
Unlike many other studies of travel behavior in transit-oriented developments, this research focuses attention on the relationship between pricing for parking and transit, as well as other TDM measures that office building owners and employers might offer, including secure bike parking and subsidies for carpooling and vanpooling. Though TDM influences travel behavior in concert with density, land-use mix, and transportation infrastructure, the 16 buildings studied had very similar surrounding densities and very similar access to transit infrastructure. Therefore, when the researchers analyze the impact of pricing and other forms of TDM, they make the simplifying assumption that these impacts are independent of variation in density, land-use mix, and transportation infrastructure.

In general, transportation pricing appears to be a powerful factor influencing travel behavior, which is consistent with findings from others. Employees with access to generous parking subsidies that brought their out-of-pocket cost down to $0 were much more likely to drive to work than those who paid market prices for parking. When employees had access to transit subsidies, they were about twice as likely to take transit for their commutes. Though direct subsidies for carpooling and direct or tax-advantaged subsidies or set-asides for vanpooling may also have a strong relationship to actual rates of carpooling
and vanpooling respectively, these benefits were perceived available so infrequently that the researchers could not analyze their correlation with behavior.

Magnitude of Parking Subsidies in the R-B Corridor
In order to gauge the magnitude of the parking subsidies that employers provide to their employees in the corridor, the researchers considered data from the employee surveys, and the rates for parking collected in the field. Based on the share of employees who said that they pay or would pay nothing to park at the buildings studied (which ranged from six to 67 percent, depending on the building), and the listed price for unreserved monthly parking permits at these buildings (which ranged from $90 to $170), the researchers estimate that employers in 14 of the studied buildings offer about $3.8 million worth of free parking to their employees each year.22

If one extrapolates the figures from the 14 buildings and their estimated 13,100 employees to the 89,900 employees across the Rosslyn-Ballston Corridor, free-parking subsidies in the corridor may be as much as $25 million each year.23

This estimate is believed to be conservative for three reasons:

1. The regional State of the Commute surveys indicate that free parking is more prevalent in the Metrorail Corridors than it was in this sample.
2. These calculations do not include people who get a partial subsidy for parking costs. Due to the way this survey question was worded, it was difficult to quantify the value of the partial parking subsidies, so they were omitted from the estimates.
3. The estimate is based on the cost of an unreserved space monthly parking permit. Reserved space parking permits are more expensive, and it is possible that many employers subsidize reserved parking permits in addition to, or instead of, unreserved permits.

Interaction between Parking and Transit Subsidies
The degree to which parking pricing and transit subsidies can either work together or at cross purposes to influence travel behavior was another important finding. It may be obvious that employees are more likely to drive when employers subsidize parking but not transit. However, these data are also consistent with other research that has found that when parking and transit subsidies are available together, the potential behavior impacts of the transit subsidy offer are diminished. When employers simultaneously make available free parking and subsidized transit, employees are half as likely to commute by transit as when they have access to transit subsidies but no parking subsidies.

Influence of Carpooling and Vanpooling Incentives
Services and subsidies for carpooling and vanpooling (such as ride-matching, preferential carpool/vanpool parking, and financial incentives) were made available at frequencies much lower than services or subsidies that support transit and bicycling commutes. From a TDM perspective, transit may

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22 Complete data on the price of parking at two buildings were not available.
23 In order to reach this Corridor-wide estimate, the researchers calculated an average subsidy per employee value by dividing the estimate of total monthly subsidy at the 14 buildings ($317,919) by the number of employees estimated to work at those buildings (13,118). They then multiplied this number ($23.72) by the total employment in the Corridor (89,900) and then multiplied that product by 12 to get an annual estimate. Estimate of Corridor employment is from the Arlington Center for Urban Design and Research for January 1, 2015 (personal communication, September 2nd, 2015).
be preferable to ridesharing in that transporting an individual on transit is more space efficient than transporting him or her in a carpool or vanpool; however, carpooling and vanpooling are still more efficient than driving alone, and may be the only reasonable option, other than driving alone, for those who do not live near fixed-route transit.

When employees do report carpool and vanpool benefits as available, they report using them at rates similar to use of other available benefits. For example, 17 percent of employees who report access to carpool financial incentives take advantage of them, which is close to the 19 percent of employees who report using secure bicycle parking when they know it is available. These data suggest that employers and building owners may shift more individuals from driving alone to shared rides if ridesharing services and subsidies were more readily available and promoted.

To close out this brief summary of key findings, it’s worth reminding the reader that this analysis has not explored this dataset exhaustively, and there are perhaps more detailed insights to be gleaned. In just one example, these data indicate there was a set of respondents (393) who primarily drove alone to their workplace (on the Rosslyn-Ballston Corridor), and yet they lived less than half a mile (or a ten-minute walk) from Metrorail at the home end of their trip. This suggests a group whose barriers to mode shift may be low, and who may benefit from targeted incentives, education, and promotion of travel options. There may be similar detailed findings within the dataset which could inform specific promotional campaigns, or specific development review processes for the Ballston, Clarendon, and Rosslyn neighborhoods featured in this study.

Program and Policy Recommendations

The following are key program or policy recommendations by the researchers in response to the key findings described above. These recommendations are not agency-specific; rather, they may be implemented at several levels, from the employer, to the building owner or manager, to the County government, all the way up to the region. Importantly, virtually all of these recommendations require funding to implement and evaluate.

Recommendations with Regard to Mode-Split Data

The research team has two recommendations based on the mode-split data collected from employees at the 16 buildings studied.

First, Arlington County should communicate frequently and broadly the findings that one-third of the Arlingtonians working in the buildings we studied R-B corridor walk or bike to work, which is only a few percentage points less than the 37 percent of Arlingtonians working in these buildings who drive alone to work. Decisions about how to spend transportation funds and prioritize projects often rely on evidence about the number of individuals who will benefit; members of the public often judge government spending as wasteful or worthwhile based on perceptions of how many people or what share of the population will benefit from that spending. The mode split described in this article can help frame debates on how to spend money on transportation and how to allocate space for different modes of transportation with information about what share of the Arlington public uses each mode for commuting already.

Second, officials should use the number of zero-car households as a key performance metric for transportation investment; investments in transit frequency and coverage, as well as carsharing services
and bicycle infrastructure will help households feel comfortable with moving from a “car-light” to a “car-free” lifestyle. There are great marginal reductions in vehicle trips to be had by creating a transportation environment in which households feel empowered to go “car-free.” The results of this survey demonstrated that automobile ownership is a key determinant of whether or not an individual drives to work by him- or herself. The finding that individuals living in households with zero vehicles available make only 3 percent of their commute trips by driving alone is not at all surprising. However, individuals from one-car households still make 40 percent of commute trips by driving alone as compared to the 63 percent and 67 percent of commute trips made by driving alone among employees in households with two-or-more vehicles.

Recommendations with Regard to Trip-Generation Results
The assumptions planners use about how many vehicle trips a particular land use will generate have ramifications for street design, the mitigation or impact fees that private land owners have to produce in exchange for the right to develop property, and in TDM planning (given that performance-based TDM plans often mandate future trip levels at some level below a general benchmark rate). This study’s findings indicate that planners and developers should rely on locally collected trip-rate data instead of the values contained in the Trip-Generation Handbook produced by the Institute of Transportation Engineers, or they should utilize one of the growing number of “adjustment” methods created by other researchers to derive trip-generation rates that will forecast future trip-generation rates with more accuracy. In particular, it is recommended that local planners use the adjustment models developed by Currans (2013) for quick forecasts of trip generation, while continuing to validate results from these models by comparing model results to observed data.24 Arlington County development review, and the traffic impact analyses of local consultants, are already well underway using these available data to adjust baseline assumptions.

Recommendations with Regard to Parking Results
Arlington County has already enacted a policy measure that addresses the finding that the 16 buildings discussed here routinely have excess parking supply. The system adopted by the Arlington County Board in 2013 that allows for off-street parking reductions at commercial buildings with a sliding scale of mitigation fees should allow developers to deliver new buildings without extraneous, costly parking.

However, this policy does not address the existing office parking supply. Jurisdictions should strive to ease the regulatory process for converting automobile parking to other uses. In Arlington, special exception projects could be offered a special administrative process under which County staff could allow building owners to convert consistently underutilized parking to other uses without going through a full site-plan amendment process. There may only be a limited set of productive (and rentable) uses to which building owners could convert below-ground parking, but structured parking above ground in Arlington and elsewhere has a wider range of possible conversions.

Property owners could explore “temporary” replacement uses for excess parking. For example, a building might place pod-style storage units in unused parking spaces and then rent that space to tenants, or install trailer units with shower and bathroom facilities for the use of bicycle commuters.

24 Faghri & Venigalla (2013) created a useful model, but their work is based on a data set from a limited geographic area. Therefore, their model is less appropriate than Currans’ for generating estimates across Arlington, the Washington region, or the United States.
Jurisdictions should strive to allow these conversions of parking space based on an understanding that the owners would remove these amenities if demand from building tenants for the underlying spaces were to require that the spaces be opened to vehicles again.

Jurisdictions should also continue to encourage shared parking, especially through the creation of horizontally and vertically mixed-use buildings that directly share garages. The “highly mixed-use” buildings profiled in this report had the efficiency of consistent parking occupancy across weekdays and weekends, and while studying their travel behavior is more difficult than studying travel behavior at single-use buildings, these mixed-use structures make the most of expensive, space-consuming, off-street, structured parking. Furthermore, to the extent that regulations obstruct the ability to share parking across user types, jurisdictions should look for ways to remove those regulatory barriers so garage operators can make the most of the asset at their disposal.

Recommendations with Regard to Parking Pricing and Transit Subsidies
In order to get the maximum return on the investment from TDM-support policies and programs, jurisdictions need strategies to discourage building owners, garage operators, or employers from subsidizing employee driving with free or discounted parking. The underlying challenge is that garage operators and parking garage owners have a financial incentive for the garage to be full. Parking “deals” (in the form of reduced rates for carpoolers or vanpoolers) with commercial tenants seem to contradict the objective to get as much money per space as possible. Arlington County has very limited experience regulating the rates building owners charge employer tenants for parking (specifically, through carpool and vanpool parking subsidy programs), but it does not compel buildings, garage operators, or employers to pass unbundled, market-rate parking prices on to individual employee driving commuters. Arlington County and other jurisdictions should explore ways to do this more directly, appeal to these interest groups to constrain or eliminate the free and reduced price parking opportunities for single occupant vehicles. In fact, the building and employer role in regulating parking pricing is one of the key opportunities Arlington has to influence the transportation behavior of workers who work here, but live outside Arlington County.

Arlington County could also extend the reach of TDM by looking for new ways to provide information to employees directly. ATP representatives attend employer-organized benefit fairs at which representatives share information directly with employees, but ATP’s primary strategy is to promote TDM by persuading employers to provide information as well as tangible support measures, such as transit subsidies and bicycle facilities. In 2010, ATP experimented with a direct-outreach model through its “Redefine Your Commute” campaign. This campaign focused on events at employer work sites where ATP staff interacted with employees and provided personalized commute planning services.

Program staff consider that effort to have been a success, but increased funding would be needed to make it a permanent service, in addition to ATP’s work with employer, developer, and residential-property contacts. Some states offer a transit tax credit for corporations that offer direct transit benefits to their employees. In 2001 and 2009, ACCS ran campaigns in which it provided a cash match (up to 50 percent) for new employer transit subsidies on a limited-time basis. ACCS staff report that the 2001 campaign was popular with employers and had high retention after ACCS removed the limited-time subsidies; the 2009 campaign proved much less popular. ACCS staff attribute the lack of participation in 2009 to employer and business cost cutting that was common during the depths of the financial and economic crisis that began in 2008. With the recent increase in available federal tax benefit for transit
commutes, both employers and employees can receive more tax relief by applying the benefit to longer commutes. The time may be ripe for a new subsidy campaign or program. Jurisdictions could partner with transit service providers, community associations, social service agencies, building owners, and others to develop creative ways to reduce the individual’s cost for their transit commute.

**Recommendations with Regard to Carpooling and Vanpooling Incentives**

Based on the finding that employers at the study buildings are offering transit subsidies more frequently than they are offering support for carpooling and vanpooling, transit is likely relatively more attractive to the office employee than ridesharing. This difference in perceived availability of support may lead employees to take transit instead of sharing rides, when they have a choice between the two. When an employee doesn’t have a transit option, without better information about carpool and vanpooling the personal vehicle will seem like the only realistic option.

Indeed, the wide availability of transit subsidies and information in this sample is a positive phenomenon. However, transit is not a practical option for many of the people that commute to the buildings that were studied, or who commute to Arlington in general. Data from the American Community Survey show that three-quarters of the Arlington workforce commute in from outside the county (US Census Bureau, 2015). Unfortunately, there is no federal tax benefit to support carpooling, leaving employers with less incentive to pursue the program on their own. Local or regional agencies could implement several measures or programs in order to increase the frequency with which office buildings and employers support carpooling and vanpooling, and therefore increase actual use of carpooling or vanpooling as a commute option. For example:

- **Building-level program carpool-vanpool training and promotion:** Many if not all of the buildings studied have a carpool vanpool program requirement tied to their development approval. This requirement typically consists of reserving convenient parking spaces for registered carpools and vanpools, and providing them with discounted parking rates. Unfortunately, these programs are among the worst promoted at the building level, not least because property owners and garage managers have a financial disincentive to encouraging people to use the discounted parking rates. On-site garage management staff often plead ignorance to these program requirements.

- **Employer-level carpool-vanpool program training and promotion:** At the property manager or employer level, it may be beneficial to boost education on the federal tax benefits of vanpooling, and the worker satisfaction and productivity benefits of both carpooling and vanpooling. There may also be opportunities to support employers with employer and building-based ride-matching services. For example, in an effort to get more people interested and educated about vanpooling, Arlington Transportation Partners has teamed up with Enterprise Rideshare on a program called Vanpool Connect, to help people take their next step in securing an easy and affordable commute to work both into and out of Arlington County.

- **Expand opportunities for shared parking:** Building owners and garage managers could aim for better implementation of shared parking policy, bringing day and monthly permit holders to a garage even if they don’t work in the building would help to defray the “costs” of pushing tenant monthly permit holders into the discounted carpool and vanpool program.

- **Use of new technology services:** For-profit companies at the intersection of technology and travel services are offering new options that close the gap between fixed-route transit and
driving alone. Local and regional agencies could explore opportunities to partner with these organizations – for instance Karma, UberPool, LyftLine, Brij, or Split for variations on real-time ridesharing.

- Dedicated staff: TDM outreach programs that interact with employers and real estate developers would be in a better position to support ridesharing with a dedicated carpooling and vanpooling representative.

- Direct subsidies: In part because employers cannot shield carpool subsidies from payroll taxes in the way that they can with transit, bicycle, and vanpooling subsidies, local or regional agencies could increase carpooling by providing direct subsidies to employers who decide to offer carpool benefits. An existing example in this region is the Commuter Connections “Pool Rewards” program which offers $1/way or $2/day for enrolled users who carpool to work.

- Transit-sponsored vanpool program: Arlington County could support Arlington Transit in the creation of a program wherein the transit agency purchases vans, promotes vanpool formation, and services the vehicles with federal funding support. In the Northern Virginia market, where vanpool formation programs market based on home location, an ART program could focus on the work location. MetroTransit (Minneapolis/St. Paul, Minn.), King County Transit (Seattle, Wash.), and Metro (Los Angeles) all administer vanpool programs that could be models for Arlington.

Other Property Manager/Building-Wide Opportunities

Site plan TDM conditions in Arlington County rely on the influence that a property developer or owner can have on the built environment and on the behaviors of the building’s occupants. Simultaneously, Arlington’s voluntary support services available through various Commuter Services Bureau programs include a long-standing emphasis on employer outreach. In commercial buildings in particular, the building owner/manager’s influence on individuals is heavily mediated by employers. In this context, how can local governments such as Arlington County empower building owners to support individual travelers? There are some directions worth consideration:

- Increase property manager buy-in: In anecdotal experience with monitoring site plan condition compliance over time, buildings with managers (also known as property transportation coordinators) who genuinely care about promoting transportation options are more likely to be implementing the TDM program and maintaining on-site facilities and information streams. One approach would be to capitalize on this role of PTC and develop a training curriculum and certification that both equips and rewards PTCs for their TDM efforts. A certification could be good for their professional development and their sense of appreciation in their current position.

- Train and engage regional managers: Due to the high rate of on-site property management turnover, building level TDM programs may benefit from engagement with the regional managers that oversee multiple properties. This engagement may help ensure that new on-site managers are familiarized with the programs, as well as support the implementation of employer-level programs or services across multiple sites under the same management company.

- Incorporate trip generation or mode shift goals into development conditions: Another potential new building level approach would be to establish performance metrics appropriate at the
building level, and allow managers to tailor and invest in their TDM program in order to achieve the required level of performance. This would not necessarily preclude proscriptive program elements, but it would put more responsibility on the building owner, while allowing flexibility to meet intended targets. One challenge of this approach is in the establishment of appropriate thresholds of performance, and appropriate incentives to achieve (or disincentives to miss) the target. Another challenge is ensuring that goals can be adjusted over time as the County overall aims for higher levels of achievement in these areas.

Other Uses of Findings
As with the residential aggregate study from 2013, this aggregate study and the individual building studies provide data that can be used to improve transportation policy and programs in Arlington and beyond. It can help improve new/existing education and outreach campaigns, contribute to discussions on appropriate commercial parking ratios for development approval, and inform updates and implementation to parking and TDM policies adopted by jurisdictions. Here are a few specific examples of how readers might use the study results:

- Mode split and trip generation data can provide a baseline for future evaluations of the buildings studied.
- Parking demand data can help decision-makers set minimum-parking and mitigation policy as well as approvals for projects.
- Private consultants and County staff can and do use the observed vehicle trip generation rates and comparisons with ITE standards as reference points when assessing the reasonableness of traffic impact analyses (TIAs) conducted for future development proposals and approvals. This study can also support sketch estimates or predictions of mode share at existing or proposed buildings.
- Other researchers can incorporate this trip-generation and survey data into larger datasets in order to develop and calibrate predictive vehicle trip generation and parking-demand models.
- When building level trip generation results are submitted to ITE, the researchers hope that the organization will use the observations to update its Trip Generation Handbook.

Caveats
As with any research project, there are aspects of this study that one should keep in mind when considering its findings and especially when comparing its findings to those of other studies.

As is common with cross-sectional studies, this study is not able to describe definitively the causality between variables. Instead, the results offer correlations of a limited number of variables, correlations that can only suggest but not prove causality. Furthermore, while data collection yielded a set of 2,644 unique survey responses, sample sizes for sub-sets of respondents were sometimes small enough to limit comparisons between groups, which made it difficult to test for interactions among some variables and the relative influences of variables.

The travel patterns, TDM offerings, and parking observed at the buildings in this sample may not be reflective of all buildings, employers, and employees across the Rosslyn-Ballston Corridor, and may not be reflective of all transit-oriented development in Arlington County, especially because the study did
not include any buildings from the Jefferson-Davis Corridor. Also, of the 16 buildings that were studied, 15 had site plan conditions related to TDM incorporated into their development approvals. Buildings without these conditions may be less likely to have facilities (such as secure bike parking) that influence travel behavior. Given these issues, the researchers recommend that readers treat these results as reflective of the 16 buildings studied, not the entire Rosslyn-Ballston Corridor.

There are two central issues that impacted the data-collection methods once the researchers identified buildings for study: 1) cost and 2) the willingness of buildings and employers to participate. Cost constraints impact all research projects, while willingness to participate is a particular challenge for research studies like ours.

Even if research funds were limitless, some office building property managers would not want to allow the team into their property or dedicate staff time to facilitate the studies; though buildings with transportation-performance monitoring requirements are legally obligated to submit reports, Arlington County has not yet had to resort to established penalties when buildings fail to comply with reporting requirements which are a part of their site plan conditions. Meanwhile, Arlington County employers are not required to participate in transportation-performance monitoring studies and many within the sample buildings were unwilling to promote the survey to their employees. The research team attempted to reach employees through lobby events, but could only host a few of these events at each building.

Survey participants were recruited through a “convenience sample” method in which anyone who received notice of the survey was welcomed to take it. The survey team used a variety of methods to make all individuals who worked at each of the buildings aware of the survey. It is possible that some employees were never made aware of the survey and that others received multiple reminders to participate. This is different from the random sample method in which participants would have been selected at random from a complete list, and in which only those who were selected at random would be able to participate. Random sampling would have been preferable for ensuring that the respondents reflected the personal characteristics and travel behaviors of all building occupants, but cost and the unwillingness of employers to share information about their employees make this approach impractical, both for this study sample and similar studies in the foreseeable future. The researchers made no attempt to measure “non-response bias,” that is, any difference in personal characteristics or travel patterns between those who answered the survey and the rest of the population of employees at the 16 buildings who were aware of it but chose to not answer the survey.

Incentives are a common way to encourage survey participation and the team offered them (usually through a raffle of gift cards for which all participants who gave contact information would be eligible) as part of the data collection that supported this study. However, because some employers have guidelines that prohibit the giving of gifts or incentives to employees and because the team made modifications to incentive structure based on feedback from property managers, incentives were not offered in the same way to the population of employees at the 16 buildings. The researchers do not know what bias (if any) this introduced to the survey results.

As mentioned before, the team collected data over approximately two years. Though the researchers treat these data as one “point-in-time,” it is possible (though improbable) that the travel behavior of workers in the Rosslyn-Ballston Corridor changed substantially such that travel behavior observed at a
particular building at the start of the data-collection period would have been different if data collection were repeated at the end of the data-collection period.

Individual buildings may have had unusual events during the week when vehicle-trip counts were taken, which would have yielded results that differ from usual patterns. Data collection was not conducted around major holidays and during parts of the summer when many workers were likely to be on vacation. The team also avoided data collection when buildings were undergoing major renovation. However, there may have been situations affecting tenants in a way that was unapparent to the property manager or the research team.

Our analysis attempted to remove residential, retail, and other uses from garage counts. In some buildings with highly mixed uses sharing a single garage, the team collected trip data but then removed results from certain analysis, as described throughout the report. However, it is possible that there were shared parking situations in other buildings of which the researchers were not aware.

Much of the analysis depended on estimates of the total number of employees who regularly worked at the buildings studied. Estimates were necessary because many employers chose not to participate in the studies. The analysis assumes that the property managers were accurate in their estimates of the total employees who regularly work at each building.

This analysis was not designed to evaluate the effectiveness of specific Arlington County programs. These surveys are focused on individual awareness and use of services and transportation options. These surveys do not capture information about the development of long term relationships between employers and Arlington County programs, and so they offer no way to distinguish between employers who are active participants in these programs and employers that have never worked with Arlington County TDM programs before.

**Future Research Needs**

The findings are useful for informing action, though like any research project, the analysis of office building travel patterns leads to new questions and ideas for further investigation. The following section describes several of the potential future directions of research to help answer outstanding questions or tackle challenges experienced in this study associated with the data collection or methodology.

Here in Arlington, researchers will continue to collect data using similar methods at buildings with and without transportation-performance monitoring requirements and incorporate those data into future analyses. Collecting more data is particularly important in this case because while 2,644 people responded to these employee surveys, these surveys and the trip-generation data that the researchers collected came from only 16 buildings. As mentioned before, the researchers suspect that some of the unexpected and inconsistent relationships between independent and dependent variables (such as parking cost and drive-alone mode split) appeared because there were only 16 buildings in the sample. Other studies of travel behavior at TOD have included similar-or-smaller sample sizes, but those studies had narrower sets of analytical questions.

Though this study did examine the relationship between parking price and other TDM measures (such as transit subsidies), the data collected could not support analysis of certain measures, and because the team needed to keep survey questionnaires to a minimum length, questions about less common measures were not even covered. Arlington County will explore other ways of evaluating the
effectiveness of individual measures. Finding new ways to assess effects is particularly important for the kinds of TDM benefits that Arlington employers do not commonly offer to their employees, such as carpooling subsidies. Of course, other research has clearly documented both the relative and absolute impact of TDM measures around the country and the world,25 but if there is a need for more Arlington-specific studies, options for new methods include: 1) before-and-after studies at employers around the time that they introduce a new benefit or remove parking subsidies and 2) twinning studies that compare the travel patterns of employees at similar companies in similar locations but with differences in TDM measures.

This project also suggests some research needs that the entire transportation-research field could take up in Arlington and elsewhere. One need is for data collection and analysis on the relationship between the results of mode-split surveys and trip-generation rates. For a variety of reasons, results from these two kinds of measurement will never exactly match at a given building. However, because TDM and other transportation researchers commonly use both techniques to address similar questions, it would be helpful to have knowledge of the degree to which researchers might expect results from the two methods to differ and the factors that reduce or increase that difference.

A related data-collection question is how do individuals’ responses differ when asked to describe their travel patterns “last week” and when asked to describe their travel patterns in a “typical week.” The single most important question in the employee surveys is the one in which the researchers ask “[i]n a typical week, what type of transportation do you use each day for your travel TO work...”? This question format is, for these purposes, superior to a question that simply asks “how do you usually get to work?” because it allows the participant to describe day-to-day variations in their travel. However, the researchers are concerned that asking for a typical week may cause the participant to overstate their use of certain modes, and that asking for a typical week might be challenging to a person who frequently switches between modes. Also, the researchers have concerns about the accuracy of describing mode split based on this question given that there is not likely to be one week which is “typical” for all survey participants. On the other hand, asking respondents about “last week” would require follow-up questions for anyone that did have an unusual “last week.” A common assumption in travel surveys is that with a large, randomly selected sample, the individuals who did not follow their typical travel patterns during the reference period are part of a distribution with enough other participants such that an accurate picture of usual travel patterns emerges. However, the sample is not randomly selected and since surveying occurs at each building across multiple weeks (or multiple years for an entire set of building data), the total sample may not actually yield an accurate picture of overall travel.

Given these concerns, the researchers hope to introduce an experiment into future surveys such that participants will answer the “last week” question first, and then they will be asked if the last week was typical. If the participant says that the week was not typical, then they will be asked the same question for a “typical week.” Asking both questions in one survey will allow us to construct and compare two travel profiles and assess the magnitude of the difference between the two question types.

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A research priority that various Arlington County staff and others initially identified for these studies was to measure the impact of TDM on “economic competitiveness.” More specifically, stakeholders were interested in the degree to which Arlington County TDM helps attract office tenants to Arlington real estate, and the degree to which it helps employers to attract and retain employees. At the time the researchers scoped this aggregate analysis and prepared the data-collection instruments, Arlington County was experiencing a high rate of office vacancy, which multiple stakeholders saw as a threat to the real estate community and the County’s tax base. That high rate of office vacancy remains at the time of writing, a result of many factors including continued federal agency repositioning, mobile workforce/hoteling, and competing new markets of office space in the region. However, in order to keep the scope of the survey instrument manageable, the revised instrument did not include any questions that would help us address either of these specific questions.

There is a third way, not touched on in the scoping, through which TDM contributes to economic development. Economists have found that dense environments are more economically productive than their low-density counterparts because these dense areas allow for large concentrations of labor and jobs, which helps firms and individuals match up with each other (a phenomenon known as “economies of agglomeration”). These concentrations also allow individuals to change jobs without the hassle of moving. Economists are coming to see that the enhanced productivity of cities comes from the social and professional relationships that cities foster, relationships that are especially important for generating new products and knowledge. These relationships cannot be formed through remote communication alone, and so they require repeated face-to-face contact.

However, the marginal advantages of density begin to decline with traffic congestion and poor transportation options, because it becomes harder and harder for individuals to move around the region and make or sustain connections. Congestion can even begin to drive firms and individuals away as everyone gets fed up with the difficulty of movement around the region. Because TDM relieves congestion, it allows communities to keep benefiting from the positive effects of density at levels that wouldn’t be possible otherwise. To the extent that TDM helps make dense urban development successful through managing transportation demand, TDM supports the overall economic productivity of the region.

Studies related to all three concepts (tenant attraction, employee retention and recruitment, and facilitating economies of agglomeration) would be useful for justifying TDM programs as well as justifying employer investment in TDM services.
VIII. Bibliography


