



Alexandria Transit Choices Report Appendix 1

ORIGIN-DESTINATION DATA TECHNICAL MEMORANDUM

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FROM: Alexandria Transit Vision Project Team

DATE: September 28, 2018

SUBJECT: Alexandria Transit Vision Study
StreetLight Data Analysis

Introduction

This memorandum is written to serve as a supplemental and supportive analysis for the “Trip Patterns” section of the Choices Report for the Alexandria Transit Vision Study, conducted by the City of Alexandria (City) and DASH. Included in this memorandum is a description of StreetLight Data metrics, a discussion of the analysis conducted for the Choices Report, and an analysis of high-level demographic comparisons in relationship to the Alexandria Transit Vision.

StreetLight Data is a big data source, based on location-based services (LBS) from mobile devices such as smart phones, connected vehicles, wearable devices, navigation-GPS records, and trucks with commercial fleet management systems. The data used in this study is LBS data. This data is informed and supported by other contextual data such as the US Census, American Community Surveys, road network maps, and parcel data (streetlightdata.com). The data is reported in terms of flows between two or more identified zones. This is known as an origin-destination (O-D) analysis.

This memorandum serves to summarize and present findings of the analyses performed for the Alexandria Transit Vision study. Included is a description of the data set basis, the four primary analysis sets and discussion of results, and conclusions regarding the outcomes/results of the analysis.

Basis of Data

The StreetLight origin-destination data analysis consisted of four sets of analysis zones. These included:

- Zones located within and immediately adjacent to the City of Alexandria border
- Primary regional activity centers, as identified by the project team
- Primary roadway gateways, identifying major vehicular/bus routes into the city
- The counties surrounding the City of Alexandria, **excluding** the major activity centers



The set of gateway analysis zones and the internal and immediately adjacent zones to the City of Alexandria are shown in **Figure 1**. The set of remaining analysis zones (excluding gateways) are shown in **Figure 2**. Regional activity centers and surrounding counties are labeled.

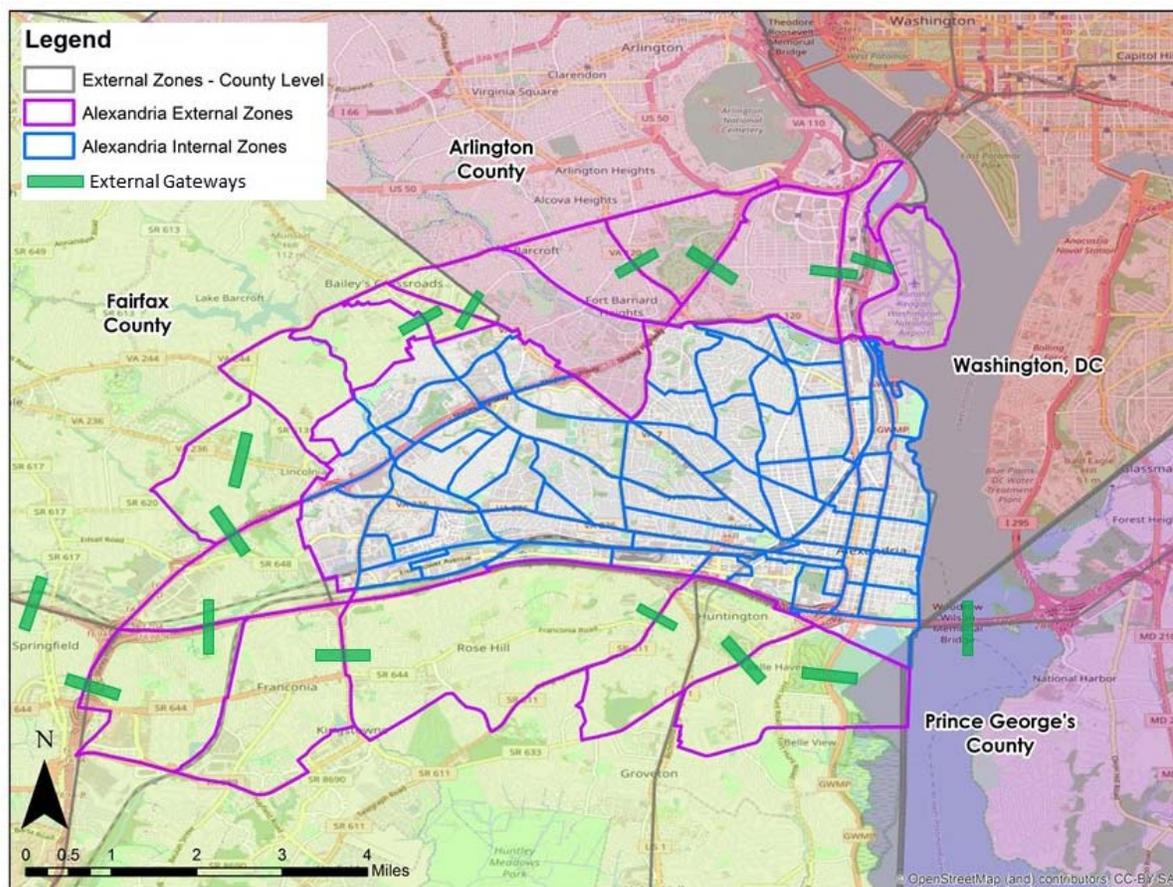


Figure 1: Internal, Adjacent, and Gateway Analysis Zones

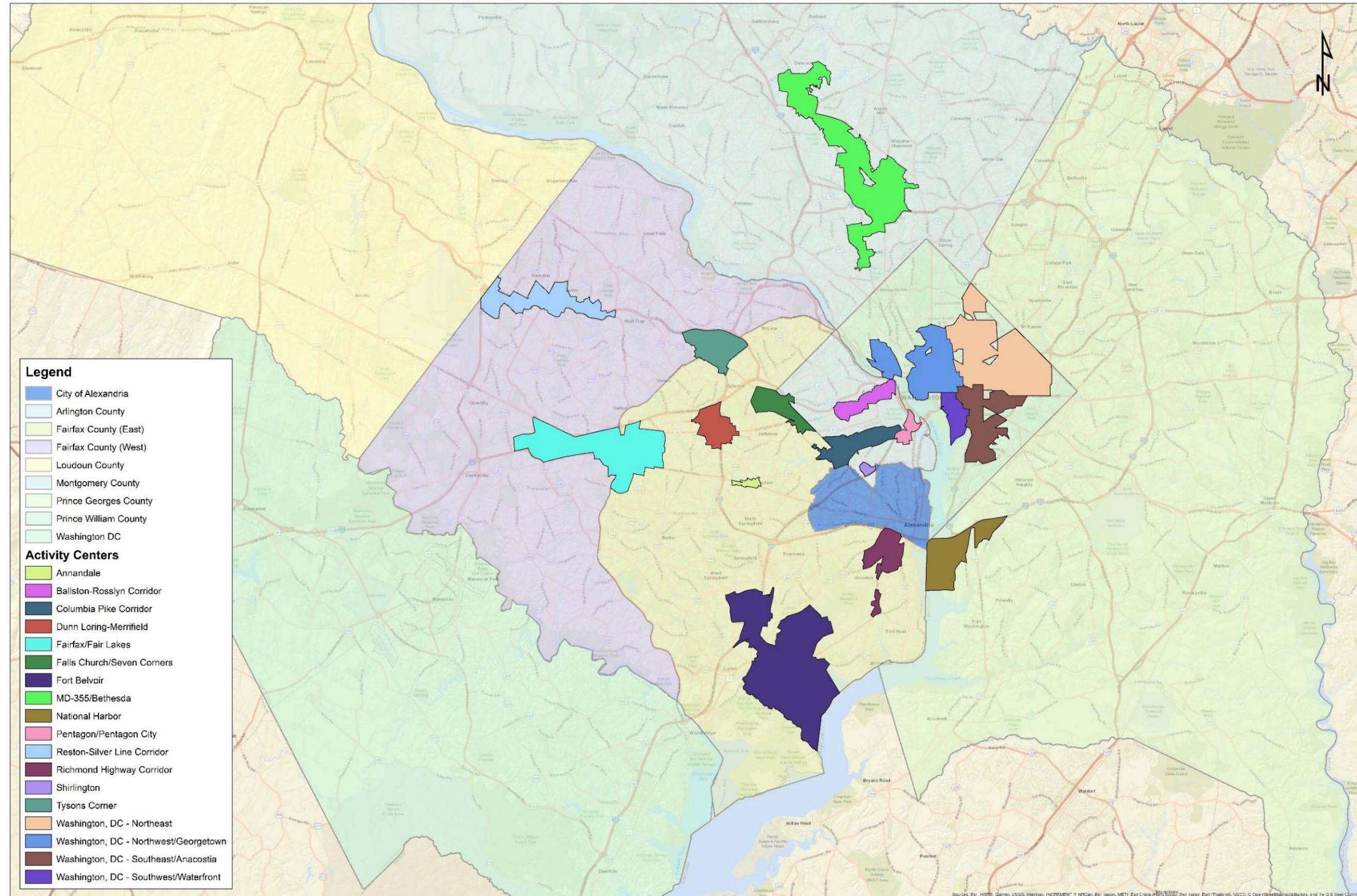


Figure 2: Analysis Zones, Excluding Gateways



The above sets of data were selected to compare and identify routes which may be well-served by transit, experience high demand as a result of employment or residential density, or represent logical pairings for regional transportation connections. The county zones were specifically chosen to capture the vast majority of the remaining trips not included in the activity center set. Note that the gateway zone set consists of a single cross-section through which to measure flows from an origin to a destination. This is known as a middle filter for O-D analysis, or O-M-D for short. The middle filter zones (gateway zones) capture trip flow that traverse the roadway cross-section while the origin and destination zones (e.g. activity centers, counties, internal and adjacent zones) measure trips that start and end in the zones.

StreetLight data was accessed for a one-year period, using information ranging from April 2017 through March 2018. Data was parsed over the following day types:

- Average day from Monday through Sunday
- Average weekday from Monday through Thursday
- Average weekend day from Saturday through Sunday

Data was also analyzed using the following day parts:

- All day, from 12:00 AM to 12:00 AM
- Early AM from 12:00 AM to 6:00 AM
- Peak AM from 6:00 AM to 10:00 AM
- Mid-day from 10:00 AM to 3:00 PM
- Peak PM from 3:00 PM to 6:00 PM
- Late PM from 6:00 PM to 12:00 AM

Note that the above periods apply for all analyses described in this memorandum.

Several limitations apply to the StreetLight data metrics. The trips which comprise an O-D pair must belong to a one of the above specified zone sets. As such, the greatest extent of the analyzed data only covers trip beginning and ending within the City of Alexandria, the counties of Arlington, Fairfax, Prince William, Loudoun, Prince Georges, Montgomery, and the District of Columbia. Trips outside these counties were not captured (e.g. trips from Richmond, VA or West Virginia). Additionally, StreetLight data is correlated directly to the national roadway network. As such, trips completed by modes other than vehicular are not considered within the analysis. More specifically, the origin-destination data sets **do not** include Metrorail trips, but do include trips completed by bus, carpool, or rideshare. Lastly, as a result of the way StreetLight data is collected, bicycle trips may also be included in the data set, if the trip used roadway exclusively and remained moving at a speed comparable to vehicular traffic for a duration greater than 5 minutes consistently throughout the trip.

The raw trip data for these modes over the aforementioned period are aggregated to metrics, which is described later in this memorandum, and reported by StreetLight Data analytics online portal.

The following analyses were performed for the Alexandria Transit Vision Study:

- **Activity Center Analysis:** O-D flow between regional activity centers and all City of Alexandria internal zones
- **Gateway Analysis:** O-M-D flow between all zones outside the City of Alexandria, through the middle gateway zones, to zones within the City of Alexandria



- **Internal (and Adjacent) Zones Analysis:** O-D flow between zones within the City of Alexandria to other zones within the City of Alexandria and zones adjacent to the City of Alexandria (grouping of zones which are within one to two miles of the border of Alexandria)
- **Internal (only) Zones Analysis:** O-D flow between zones within the City of Alexandria to other zones within the City of Alexandria

The data provided from the StreetLight analysis comes primarily in the form of a sample-based index number, which is normalized across the United States (or country of study) based on population of the analysis zones. The StreetLight Index is not directly correlated to trip or vehicle counts, but may be calibrated to a specific existing data set. An effort was made as part of this study to normalize the data sets using VDOT Average Daily Traffic (ADT) data from 2016¹. The VDOT ADT data was aligned with each of the gateway zones, then input to StreetLight's calibration tool for O-D datasets. This tool enables the user to relate the StreetLight Index number to a 'real-world' number, such as traffic volume. For the purpose of this study, analysis results are presented in terms of 'estimated vehicle trips' as opposed to the StreetLight normalized index number, given that ADT was used as the calibration dataset. Note that as a result of the way StreetLight data is collected and compiled, the vehicle trips presented are non-inclusive of commercial truck volumes on the analyzed roadway facilities. To account for this, VDOT-collected truck percentages were factored into the ADT calibration.

Note that there are limitations with the traffic volume calibration due to the data available and the process for such calibration. These limitations are:

- The calibration data sets are not all encompassing in a way that traffic counts for roadways internal to the City of Alexandria were not used
- The calibration process does not generate scaling factors for each O-D pair but a composite scale factor for the entire O-D sets
- The calibration data used is daily volumes while some analysis pertains to a period of the day

As such, the estimated vehicle trips should be interpreted with cautions to the degree that the magnitude of trips between zone pairs are more relevant than the absolute numbers. It is still an improved approximation of the trip numbers than StreetLight Index.

Analysis and Discussion

This section is organized by the analysis performed with StreetLight data as described in the previous section. It covers the Activity Center, Gateway, and Internal Zones analyses, and provides results from the analyses. Results are generally discussed in terms of proportions and the relationship between trips within the same data set. Some approximation of trip count is provided, as described previously.

¹ VDOT 2016 ADT, <https://www.arcgis.com/home/item.html?id=bff29e1bc0fd4908b2c035fe67695088>



ACTIVITY CENTERS

This analysis focuses on trips between the City of Alexandria and the designated Activity Centers. **Figure 3** and **Figure 4** show the top origins and top destinations for activity centers outside the City of Alexandria, respectively. For reference, the areas with moderate trip activities in the figure represent an estimated 450 vehicular trips per day and the areas with high trip activities represent and estimated 1,450 vehicle trips per day.

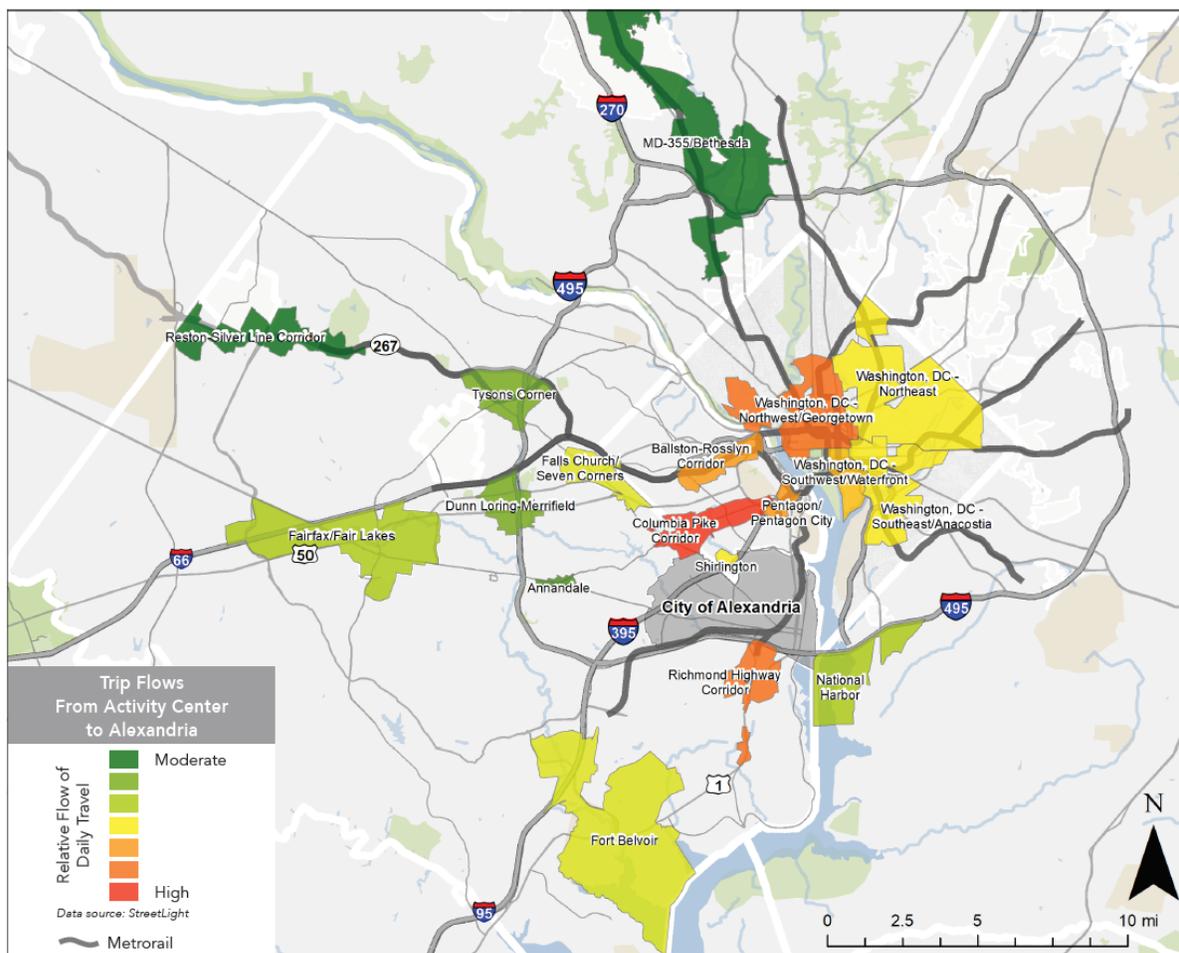


Figure 3: Regional Activity Center Origins

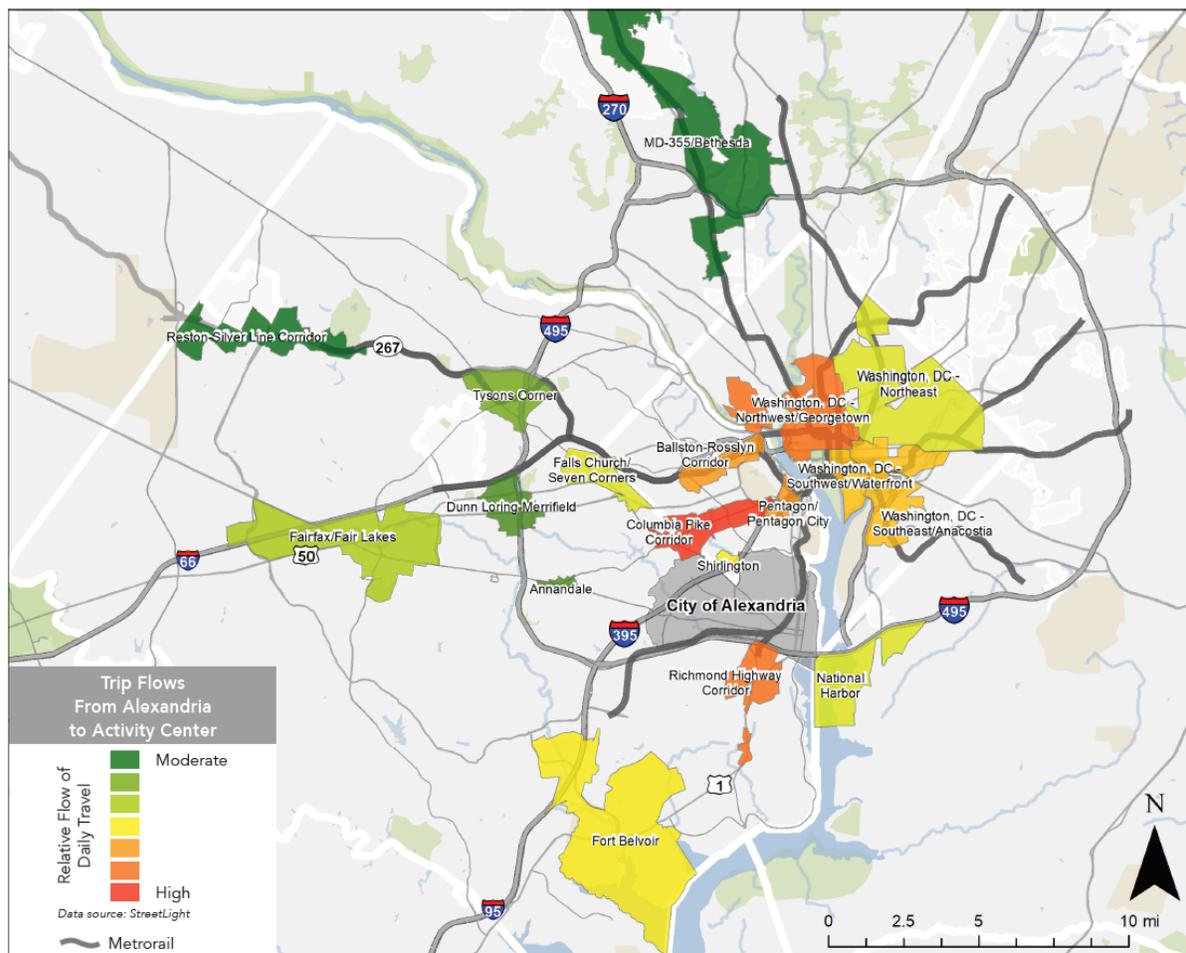


Figure 4: Regional Activity Center Destinations

This analysis indicates that, of the major regional activity centers, the greatest number of trips to and from the City of Alexandria are with the Columbia Pike Corridor, the Arlington Wilson Boulevard/Fairfax Drive Corridor, the Richmond Highway Corridor, and northwest Washington, D.C. Furthermore, the analysis reveals that flows are similar in magnitude for both inbound and outbound trips to the City of Alexandria, as well as independent of which period they take place during. In other words, the number of trips occurring between the City and a regional activity center is consistent throughout the day, and is consistent in terms of magnitude between the City and each of the activity centers.

These results indicate that a higher percentage of vehicular trips are kept relatively short in distance, relative to the total number of trips to and from each activity center to the City of Alexandria. This is reflective of a preference for shorter commutes to the City of Alexandria, compared to longer trip (e.g. from Reston or Bethesda). The three corridor activity centers reflect areas with substantial population densities that have a strong relationship to the City of Alexandria, from a vehicular trip perspective.



GATEWAYS

The gateway analysis focused on 15 of the primary vehicular entries/exits into and out of the City of Alexandria. This includes interstate and primary arterial connections through which a majority of traffic flows. Note that the gateways included in the analysis account for an estimated 305,000 (73%) of trips crossing the border of the City of Alexandria to or from the City on an average day, with the remaining 27% of vehicular trips using routes other than the 15 identified ones.

The analysis of the I-95, I-395, and I-495 interchange was calculated using StreetLight data proportions. Data zones pulled included trips along I-395 immediately north of the interchange, trips along I-95 immediately south of the interchange, and trips along I-495 immediately west of the interchange. Using the trips along I-395 and considering the proportions of trips coming from I-495 and from I-95, the analysis approximated the relative share of trips to and from each leg of the interchange to and from the City of Alexandria (e.g. what portion of traffic from I-495 in the west entered the City along I-495 east of the interchange, and which portion entered the City from I-395).

The percentage share of the primary 15 gateways in and out of the city for an all-day period is shown in **Figure 5**. Note that the percentages into and out of the city add up to 100% (and therefore does not include shares of vehicles entering the City through other routes).

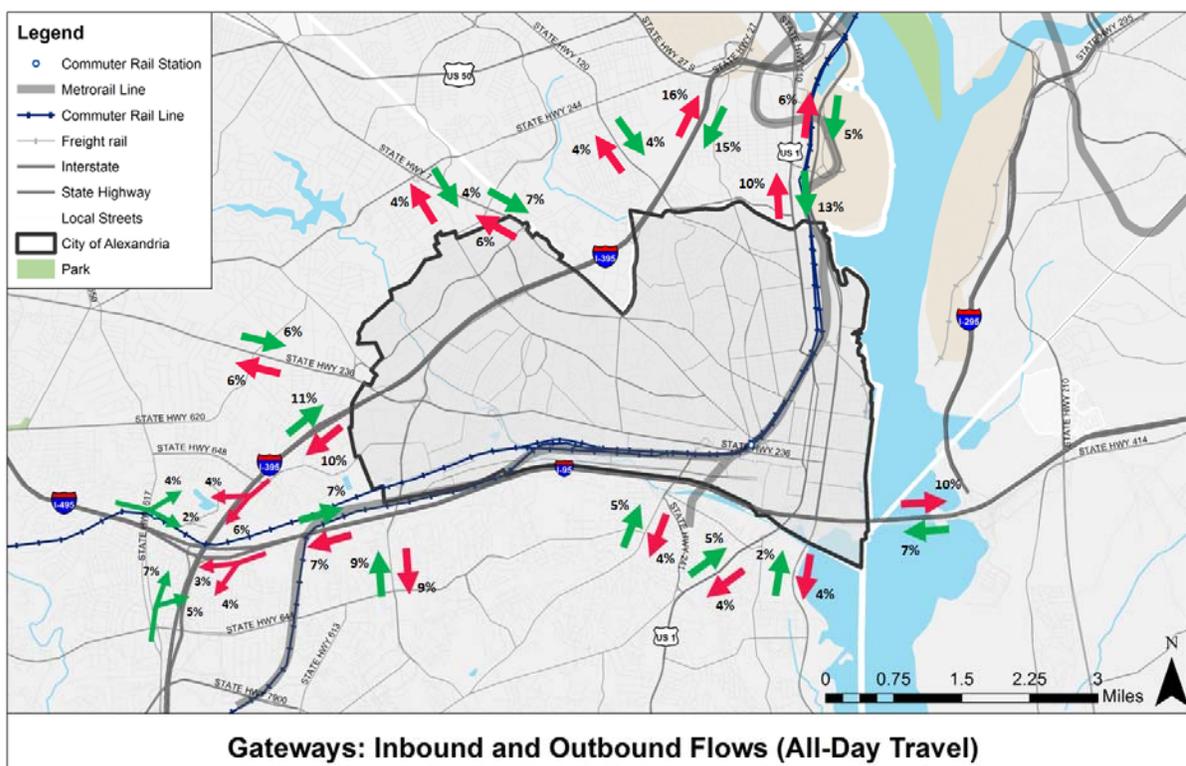


Figure 5: Gateway Analysis

This analysis shows a relatively well-distributed proportion of trips entering the city through the 15 gateways, with slightly higher shares along the interstate freeways. I-395 to and from the north of the City accommodates the highest portion of freeway demand, followed by I-395 southwest of the City



and I-495 east of the City, respectively. US Route 1 accommodates the highest portion of arterial traffic, followed by South Van Dorn Street and Leesburg Pike (Route 7), respectively.

The following table provides an approximation on vehicular trips through each of the gateways identified in this analysis. Note that the percentage is the gateway portion of the total gateway traffic, not of all City traffic.

Table 1: Gateway Analysis for All-Day Vehicular Trips (Estimated Calibrated Daily Vehicle Trips, (Percent))

Primary Vehicular Gateway	Inbound to the City	Outbound from the City
George Washington Parkway, North of Alexandria	9,400 (5%)	9,600 (6%)
US Route 1	20,500 (13%)	14,600 (10%)
I-395, North of Alexandria	23,200 (15%)	25,000 (16%)
South Glebe Road	4,900 (4%)	5,600 (4%)
Leesburg Pike	6,500 (7%)	8,800 (6%)
Seminary Road	5,100 (4%)	6,500 (4%)
Little River Turnpike	5,400 (6%)	9,600 (6%)
From West I-495 via I-395, South of Alexandria	6,800 (4%)	5,900 (4%)
From West I-495 via I-495, South of Alexandria	3,300 (2%)	3,900 (3%)
From South I-95 via I-395, South of Alexandria	17,000 (7%)	9,800 (6%)
From South I-95 via I-495, South of Alexandria	8,200 (5%)	6,500 (4%)
S Van Dorn Street	9,700 (9%)	13,200 (9%)
Telegraph Road	5,200 (5%)	6,100 (4%)
US Route 1, South of Alexandria	8,400 (5%)	6,300 (4%)
George Washington Parkway, South of Alexandria	1,400 (2%)	6,100 (4%)
Woodrow Wilson Memorial Bridge	17,700 (7%)	15,300 (10%)
GATEWAYS TOTAL	152,700 (100%)	152,800 (100%)

INTERNAL ZONES

The internal zones analysis includes areas which are wholly within the borders of the City of Alexandria, as well as consider the areas immediately adjacent to the City. For simplicity, this analysis is broken into two sections: the first considers the internal and adjacent zones, and the second considers only internal zones.

Internal and Adjacent Zone Analysis

The zones adjacent to the City of Alexandria were included to measure the relative activity impacting the city (trips to and from) in relationship to these immediately adjacent zones. It is likely that DASH may be able to provide service to these areas, given their proximity (generally within one to two miles) and relationship to the City of Alexandria. Note that the areas immediately adjacent to the City are larger than the zones contained within the City.



In order to simplify the internal and adjacent zone analysis and add value to the results, trips which were completed within one mile were excluded from consideration. This was done following preliminary results (which shows high neighboring zone travel) to factor out trips which do not necessitate the use of transit, and represent an appropriate walking trip distance or the distances for which bus transit is non-competitive. This also helps eliminate the potential trips that would be part of a longer trip chain due to short stops (less than 5 minutes) given that how StreetLight Data defines a trip.

Figure 6 and **Figure 7** show the top 50 vehicular trip origin-destination pairings completed partially (at least the origin or destination) within the City of Alexandria and adjacent zones for a typical weekday and weekend day, respectively.

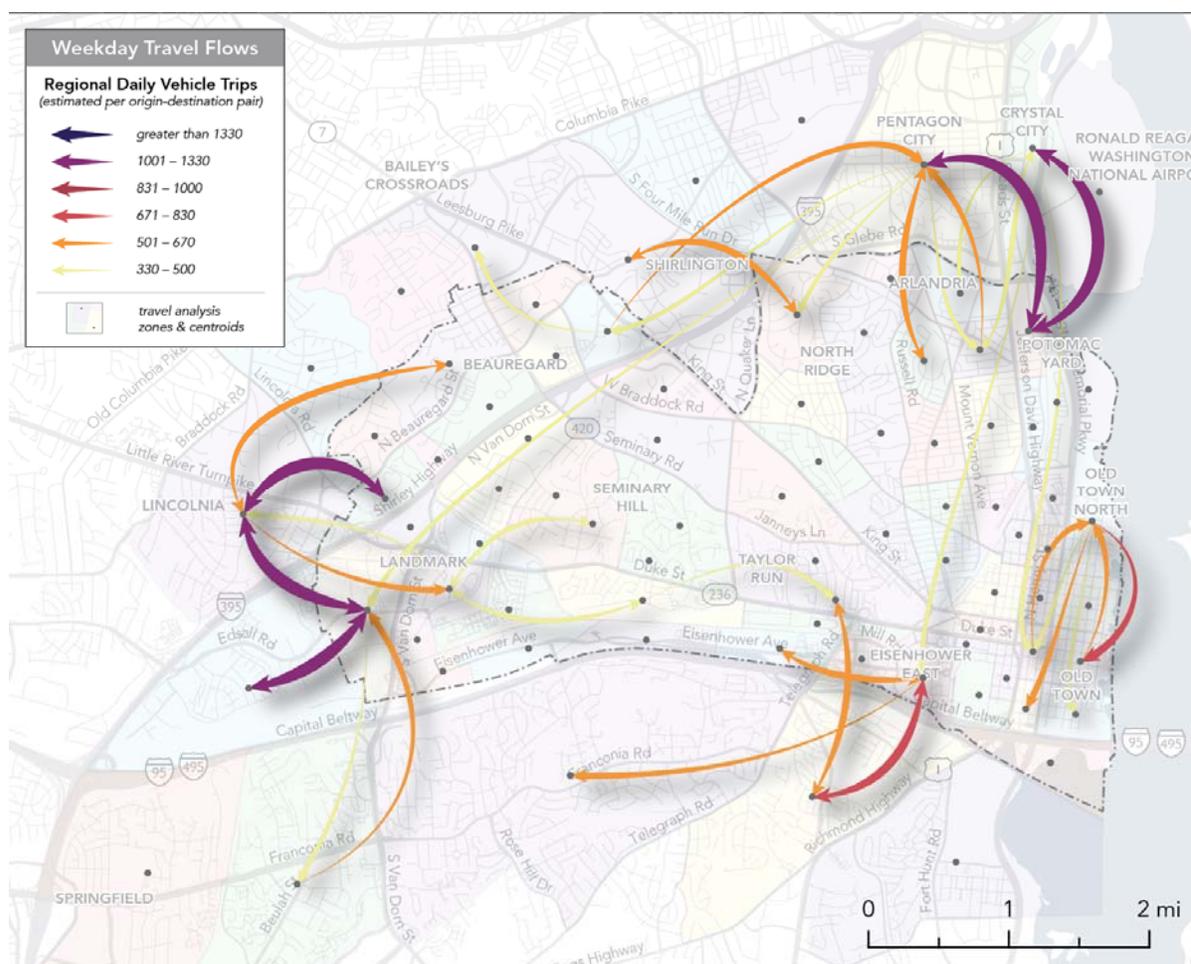


Figure 6: Weekday Internal and Adjacent Zone O-D Pairs

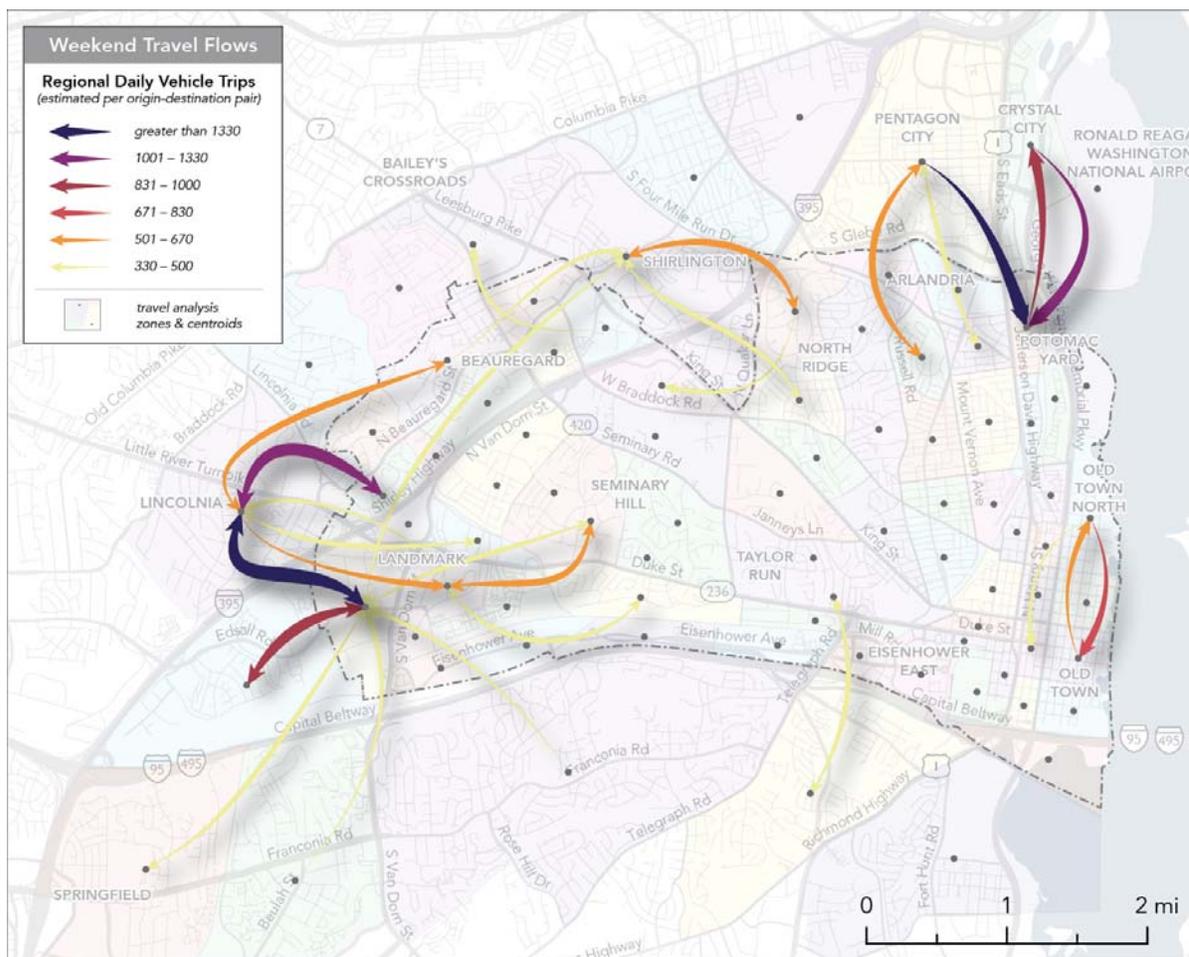


Figure 7: Weekend Internal and Adjacent Zone O-D Pairs

Results from this analysis show strong relationships to zones within the Old Town/Old Town North, Landmark, Alexandria West, Arlandria, and Crystal City/Pentagon areas.

Internal Zone Only Analysis

In order to get a more detailed picture of trips within the City of Alexandria, an O-D analysis was performed with only zones contained wholly within the border of the City. Note that no distance cutoff was applied to this analysis. **Figure 8** and **Figure 9** show the major trip origin-destination pairings completed wholly within the City of Alexandria for a typical weekday and weekend day, respectively.

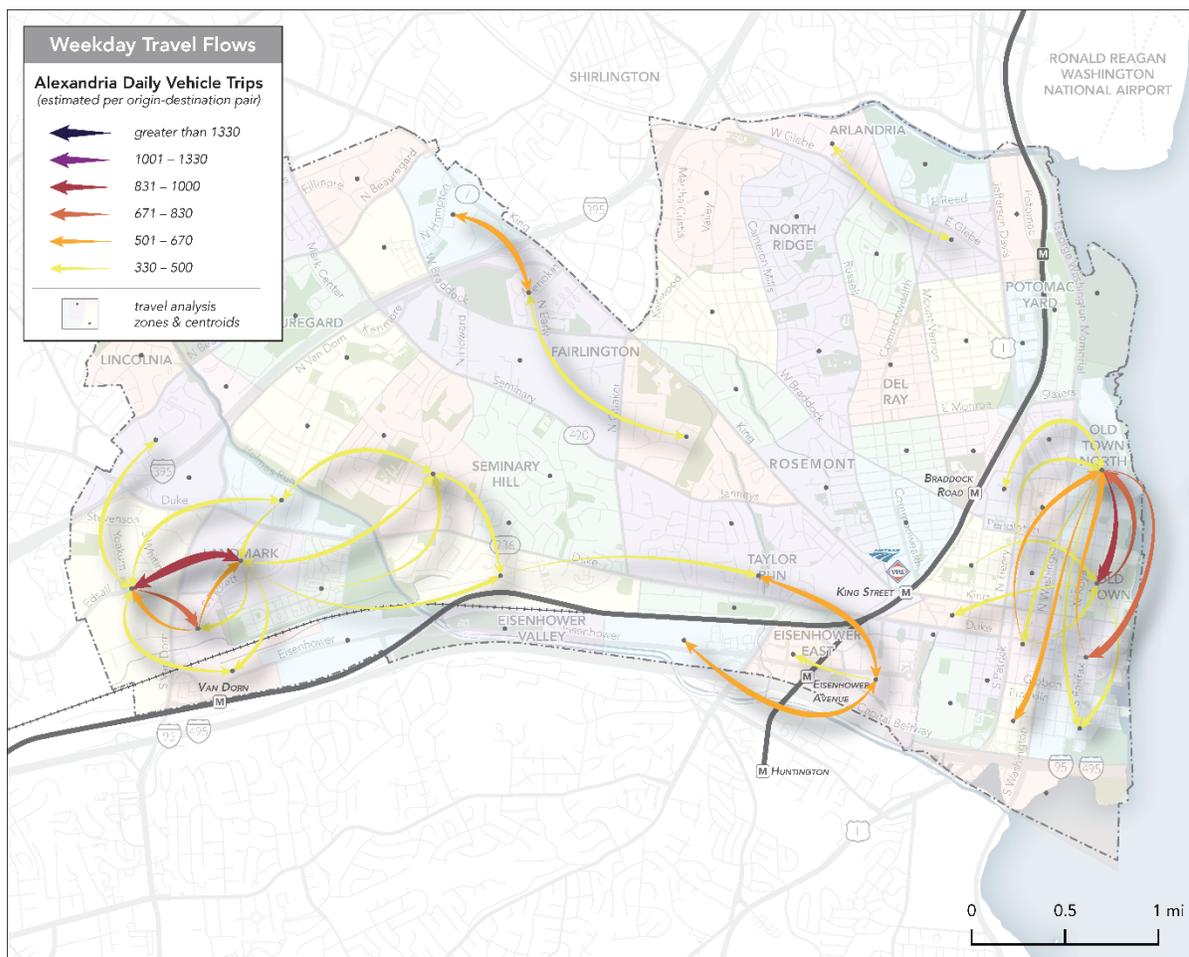


Figure 8: Weekday Internal-Only Zone O-D Pairs

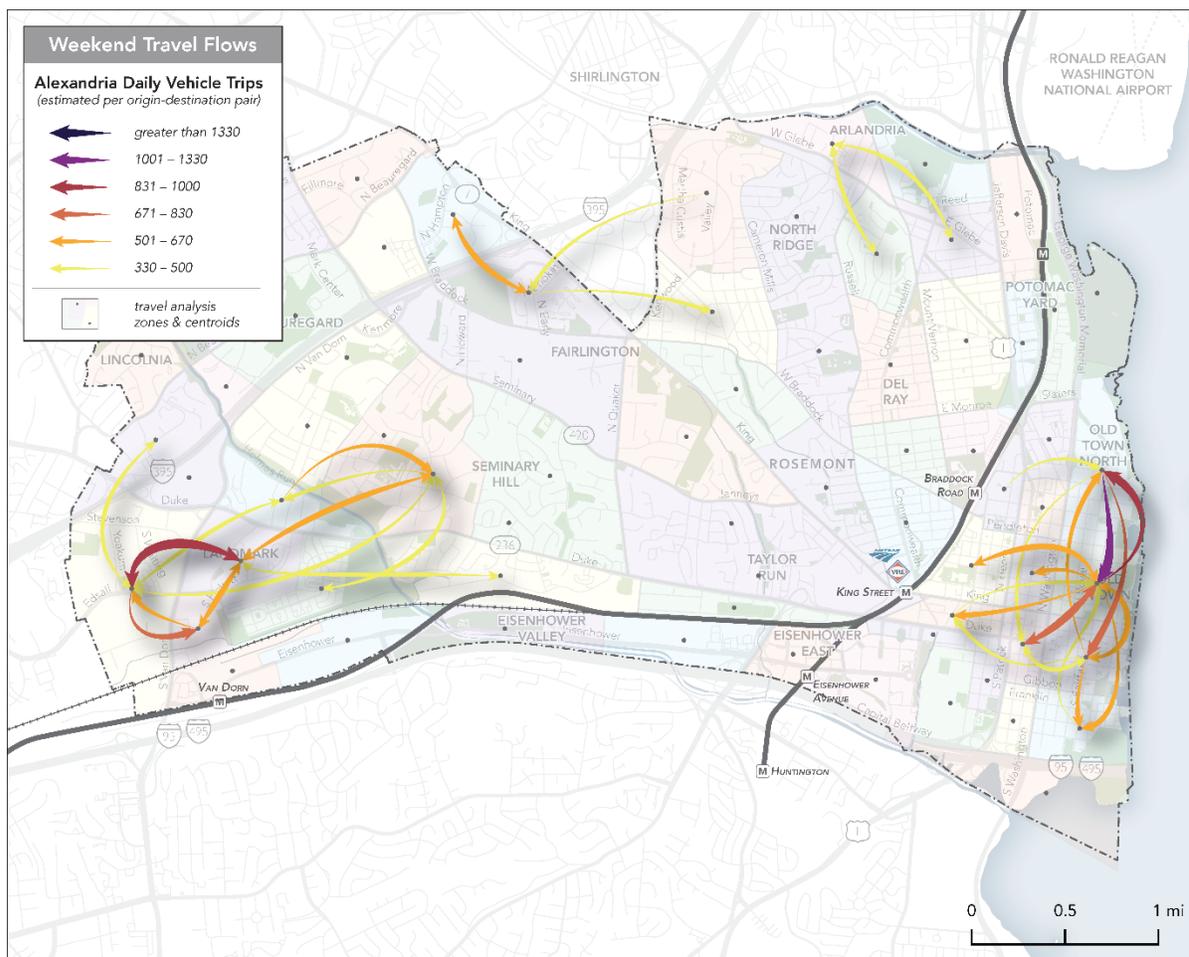


Figure 9: Weekend Internal-Only Zone O-D Pairs

The following table describes the relative share of trips wholly within, and either one origin or destination point within the City of Alexandria.

Table 2: Trips To, From, and Within the City of Alexandria

Alexandria Trip Proportions	Percentage of all Trips:	Average Day on a:	
		Weekday	Weekend
Of Trips Started in the City:	Completed in City	48%	49%
	Completed Outside City	52%	51%
Of Trips Ending in the City:	Start in the City	48%	50%
	Start Outside the City	52%	50%



Analysis Results

Some key observations from the analysis are described below:

- There are many trips that originate and end within the Landmark area
- There is a strong relationship between Crystal City/Pentagon and Potomac Yard
- There is a substantial relationship between Crystal City/Pentagon and the Landmark area; note this is the approximate route for the West End Transitway
- There is a substantial amount of activity near the interchange of I-395 and Route 7; as there is little land use activity in this area, there may be some bias in the data as to origin and destination points, or points in which the StreetLight data analysis breaks trips into multiple parts based on speed and time stopped.
- Weekend patterns are similar to weekday patterns, though there are fewer trips, trips tend to be shorter, and activity is more concentrated to key areas such as Old Town, Landmark, Alexandria West, and Arlandria/Potomac Yard

Based on the above observations, existing DASH transit is able to serve some of the primary O-D pairings. Old Town and Old Town north are relatively well-connected north to south with several DASH lines. Connections between Crystal City/Pentagon and Arlandria/Potomac Yard are fewer, with only a couple Metrobus routes providing service for these pairings. The pairings in landmark and West Alexandria have some service provided, although transit routes in these areas are circuitous in nature, with significant diversions as a result of roadway geometry and the radial design of the network.

DEMOGRAPHIC COMPARISONS

The calibrated StreetLight dataset allows some more general analysis of travel patterns, compared to transit system metrics and other transportation. The following is a list of publicly-available statistics about DASH and the City of Alexandria:

- DASH Average Daily Ridership in 2017 was approximately 10,700 boardings per day (*NVTC FY2017 Annual Ridership Report*)
- The 2015 population for the City of Alexandria was an estimated 148,000 people (*Metropolitan Washington Council of Governments, 9th Round*)
- The 2015 employment for the City of Alexandria was an estimated 106,000 jobs (*Metropolitan Washington Council of Governments, 9th Round*)
- Americans make about 1,200 trips per person per year, or an average of 3.4 trips per person per day, regardless of mode. Americans make about 700 vehicle-trips per year, or an average of 2 vehicle-trips per person per day (*US DOT, Bureau of Transportation Statistics National Household Travel Survey, 2017*)

With the above numbers in mind, the following numbers are a result of the calibrated, vehicular volumes developed for the analyses previously listed. Note that these numbers are reflective of only vehicular-based trips, including personal vehicle, bus, truck, rideshare, and taxi cab, to name a few. These numbers are also estimates, based on 2016 ADT data and only include trips starting or ending within the aforementioned boundaries of this analysis; as such, they should not be taken to replace other data collection methods or represent the actual values for the respective analysis description.

- On any average weekday, nearly 450,000 vehicular trips begin in the City of Alexandria. Of these trips:



- 104,000 (23%) begin during the AM peak commuter period
- 137,000 (30%) begin during the PM peak commuter period
- On any average weekday, nearly 452,000 vehicular trips end in the City of Alexandria. Of these trips:
 - 95,000 (21%) end during the AM peak commuter period
 - 142,000 (32%) end during the PM peak commuter period
- On any average weekday, approximately 218,000 vehicular trips begin and end wholly within the City of Alexandria
- On any average weekend day, approximately 396,000 vehicular trips begin and 395,000 vehicular trips end in the City of Alexandria, respectively
- On any average weekend day, approximately 189,000 vehicular trips begin and end wholly within the City of Alexandria

The above information reveals some underlying information regarding the City of Alexandria and how Alexandrians move. For example, based on average daily ridership and vehicular trip estimates, approximately 5% of on-surface street trips completed within Alexandria use DASH, with the remaining 95% of trips are completed using personal vehicle, rideshare, Metrobus, or bicycle on roadway (to name a few options). Additionally, analysis reveals that just under half of the vehicular trips that began or ended within the City of Alexandria were completed wholly within the City of Alexandria. Given these types of comparisons, and appropriate consideration of the above O-D analyses, StreetLight data analysis will aid in the development of transit service for DASH and the City of Alexandria. Further discussions on the use and relevance of this data are presented in the main body of the Choices Report.