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## Metropolitan Washington Council of Governments

# GEN3/VER. 1.0.4 MODEL CALIBRATION AND VALIDATION REPORT

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# 1.0 INTRODUCTION

The National Capital Region Transportation Planning Board (TPB) Generation 3 (Gen3) Travel Demand Forecasting Model (TDFM) is a disaggregate, tour-based/activity-based travel demand model designed to simulate the transportation demand and supply for an average weekday in the metropolitan Washington region.

This model utilizes some components and techniques from the Gen2 Travel Demand Model, an aggregate, trip-based ("four-step") travel model. These components include highway and transit network processing, path building, path skimming, and trip assignment. The major difference from the Gen2 Model is the way transportation demand is simulated. Transportation demand in the Gen2 Model utilizes aggregated household data to simulate trips between zone pairs, but without the ability to represent tours (i.e., trip chains, which are an ordered sequence of trips, starting and ending at an anchor point, such as a person's home). By contrast, the Gen3 Model uses ActivitySim to simulate travel for each individual person and household in the modeled area. The Gen3 Model approach allows for significantly more decision-making fidelity, including maintaining continuity of information across trips in a tour, to ensure that travel modes are consistent with those actually available to the person and allowing interactions among households regarding whether to travel.

The purpose of this calibration and validation report is to report the calibration adjustments in the Gen3 Travel Demand Model, specifically Version 1.0.4 of that model, that were made to reflect observed surface transportation patterns in the metropolitan Washington region and to document the model's goodness-of-fit compared to the 2017/2018 Regional Travel Survey, Census, traffic, and transit data. There is a Gen3 Model User's Guide[1] that fully documents the model's development, as well as documentation of model estimation.[2] [3] The next section of this document discusses the calibration checks and adjustments for those component models (also referred to as model steps) of ActivitySim where calibration adjustments were made. Following that section, highway validation and transit validation performance of the Gen3 Model are reported in separate sections.

In some cases, specific constants were created and used for the calibration of a model step, and the final adjusted values of these constants are listed in the report. In other instances, additional constants were not created for calibration; Instead, existing constants that were

[1] RSG, Baseline Mobility Group, and Metropolitan Washington Council of Governments. *Gen3 Model User Guide.* August 22, 2023.
[2] RSG. *Gen3 Tour Mode and Destination Choice Model Estimation.* January 19, 2022.
[3] RSG and Metropolitan Washington Council of Governments. *Gen3 Model Phase 2 Model Estimation.* March 2, 2023.

estimated as part of a model estimation process were adjusted and their adjusted values are also reported in this document.

# 2.0 MODEL CALIBRATION ADJUSTMENTS IN ACTIVITYSIM

The ActivitySim portion of the Gen3 Model, which is the demand-side model representing resident travel, started with a model transferred from the Southeast Michigan Council of Governments (SEMCOG). This provided a starting point for most of the model steps in ActivitySim. Model steps that have the most impact on transportation in the metropolitan Washington region were estimated using the 2017/2018 Regional Travel Survey (RTS) data, which includes the workplace location, auto ownership, telecommute frequency, coordinated daily activity pattern, mandatory tour frequency, tour mode choice, and trip mode choice. Additionally, the transit pass subsidy model was estimated for and used an asserted transit pass subsidy distribution from the Metropolitan Transportation Commission (MTC, nine-county San Francisco Bay Area).

More than a dozen of the component models were then calibrated to the base-year (2018) conditions. Table 1 lists each component model in ActivitySim, the source of the estimated model, the source of the calibration data, and the level of calibration. In this table, "Local Surveys" refers to the survey data listed in the data development documentation.[4] This includes the 2017/2018 Regional Travel Survey (RTS) and transit on-board surveys (where applicable). Census data is from the 2019 American Community Survey (ACS). The calibration level refers to the lowest geographic resolution of calibration. Regional calibration means that the model is calibrated to the modeled area (which is shown in Figure 1). "Region + DC" indicates that the model was calibrated for the region and also underwent additional adjustments specifically for the District of Columbia to improve screenline validation performance. "Jurisdiction" indicates that the model was calibrated and validated to counties and cities when the data was available (such as when RTS data was used for calibration).

**TABLE 1: ACTIVITYSIM MODEL CALIBRATION SUMMARY**

| MODEL STEP | SOURCE MODEL | CALIBRATION DATA | CALIBRATION LEVEL |
|---|---|---|---|
| School Location | Estimated in Gen3 Phase 1 | Local Surveys | Region |
| Work From Home | Transfer from SEMCOG | 2019 Census ACS | Jurisdiction |
| Workplace Location | Estimated in Gen3 Phase 1 | 2019 Census ACS | Jurisdiction |

[4] RSG and Baseline Mobility Group. *Gen3 Data Development*. December 29, 2021. https://www.mwcog.org/assets/1/6/Gen3_Phase_1_Data_Development_Report_Final.pdf

| MODEL STEP | SOURCE MODEL | CALIBRATION DATA | CALIBRATION LEVEL |
|---|---|---|---|
| Transit Pass Subsidy | Estimated in Gen3 Phase 2 + MTC Data | | |
| AV Ownership | DaySim | NA | NA |
| Auto Ownership | Estimated in Gen3 Phase 2 | 2019 Census ACS | Jurisdiction |
| Vehicle Type Choice | ActivitySim Consortium | NA | NA |
| Free Parking | Transfer from MTC | NA | NA |
| Telecommute Frequency | Estimated in Gen3 Phase 1 | Local Surveys | Region |
| CDAP Simulate | Estimated in Gen3 Phase 2 | Local Surveys | Region + DC |
| Mandatory Tour Frequency | Estimated in Gen3 Phase 2 | Local Surveys | Region |
| Mandatory Tour Scheduling | Transfer from SEMCOG | Local Surveys | Region |
| Joint Tour Frequency | Transfer from SEMCOG | Local Surveys | Region |
| Joint Tour Composition | Transfer from SEMCOG | Local Surveys | Region |
| Joint Tour Participation | Transfer from SEMCOG | Local Surveys | Region |
| Joint Tour Destination | Estimated in Gen3 Phase 1 | Local Surveys | Region |
| Joint Tour Scheduling | Transfer from SEMCOG | Local Surveys | Region |
| Non-Mandatory Tour Frequency | Transfer from SEMCOG | Local Surveys | Region |
| Non-Mandatory Tour Destination | Estimated in Gen3 Phase 1 | Local Surveys | Jurisdiction |
| Non-Mandatory Tour Scheduling | Transfer from SEMCOG | Local Surveys | Region |
| Vehicle Allocation | ActivitySim Consortium | NA | NA |
| Tour Mode Choice | Estimated in Gen3 Phase 1 | Local Surveys | Region + DC, transit boardings, traffic counts. |
| At-Work Subtour Frequency | Transfer from SEMCOG | Local Surveys | Region |
| At-Work Subtour Destination | Estimated in Gen3 Phase 1 | Local Surveys | Region |
| At-Work Subtour Scheduling | Transfer from SEMCOG | Local Surveys | Region |
| At-Work Subtour Mode Choice | Estimated in Gen3 Phase 1 | Local Surveys | Region |
| Stop Frequency | Transfer from SEMCOG | Local Surveys | Region |
| Trip Purpose | Transfer from SEMCOG | Local Surveys | Region |

| MODEL STEP | SOURCE MODEL | CALIBRATION DATA | CALIBRATION LEVEL |
|---|---|---|---|
| Trip Destination | Transfer from SEMCOG | Local Surveys | Region |
| Trip Purpose and Destination | Transfer from SEMCOG | Local Surveys | Region |
| Trip Scheduling | Transfer from SEMCOG | Local Surveys | Region |
| Trip Mode Choice | Estimated in Gen3 Phase 2 | Local Surveys | Region + DC, transit boardings, traffic counts. |

After the initial model calibration conducted in the Gen3/Version 1.0.0 Model,[5] another, more focused calibration was performed in 2025 after fixing a few bugs, in order to improve the goodness-of-fit to household survey trip rates, time of day distributions, and mode shares. This effort resulted in a new model version (Gen3/Ver. 1.0.4) and a greatly improved comparison across all these dimensions. Figure 1 shows the overall resulting comparison of estimated to observed tour rates, trip rates, and vehicle miles of travel at a regional level.

[5] Initial calibration/validation results with the Gen3/Version 1.0.0 Model are documented in the following report: RSG and Baseline Mobility Group. "Gen3 Model Calibration and Validation Report." Final Report. Washington, D.C.: Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board, February 7, 2024. https://www.mwcog.org/assets/1/6/Gen3_Model_Calibration_and_Validation_Report.pdf


**FIGURE 1: MODEL CALIBRATION SUMMARY**

The next sub-sections discuss, in turn, those model steps where some form of calibration and validation was performed.

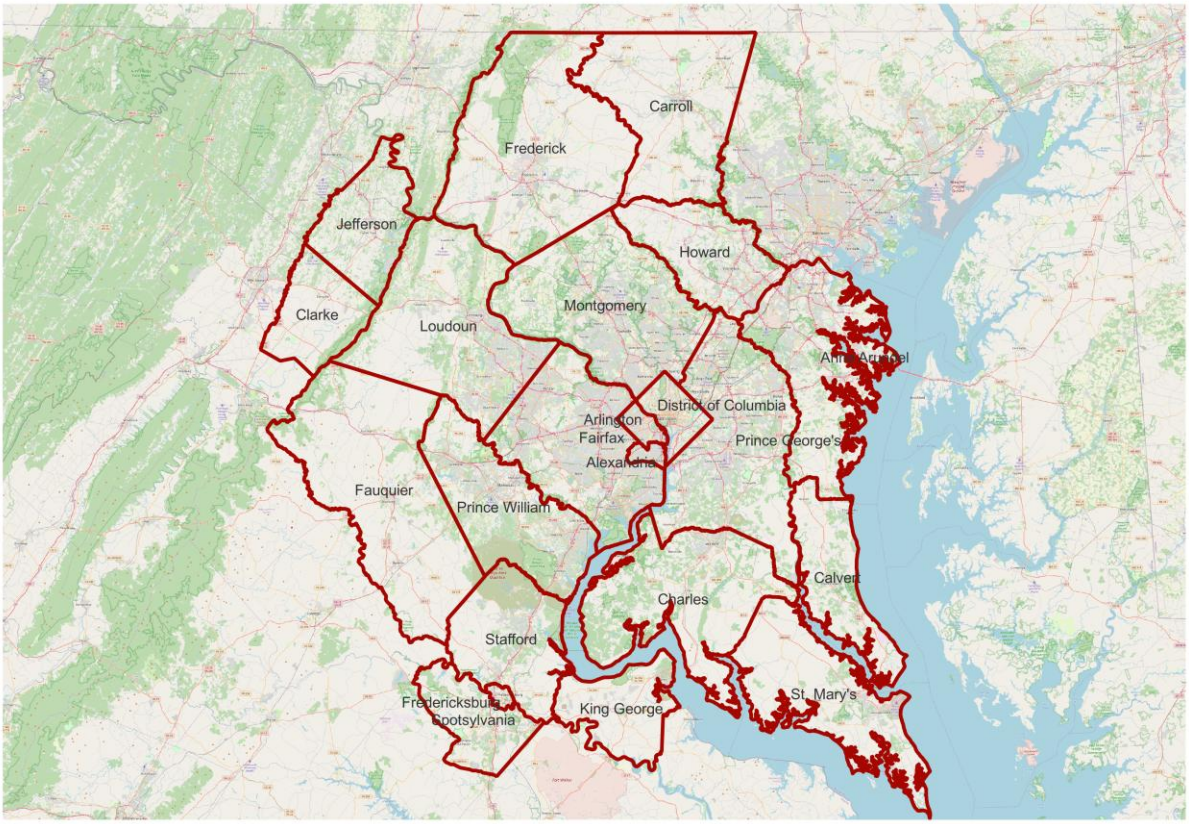


**FIGURE 2: MWCOG GEN3 MODEL JURISDICTIONS**

## 2.1 SCHOOL LOCATION MODEL

The school location model step assigns a school location to every student simulated in the model. This model step was estimated in Phase 1 of the Gen3 ActivitySim Model Implementation Project[6] and calibrated for regional trip-length frequency in Phase 2. The adjustment constant is -0.035, which was added to the model as "coef_dist_calib" and applies only to high school and grade school (Kindergarten through 8th grade). The resulting distance-to-university distribution is shown in Figure 3 and the resulting distance-to-school distribution is shown in Figure 4. The average estimated/modeled distance to university is 11.48 miles, compared to 11.08 miles from the survey. The Gen3 Model shows a significantly higher number of short distances to university due to intrazonal trips made by individuals living in group quarters. Group quarters are not typically surveyed in household travel surveys. The

[6] RSG. *Tour Mode and Destination Choice Model Estimation*. January 19, 2022.

estimated/modeled average distance to school (K-12) is 5.04 miles, compared to 4.04 miles from the survey. The distance used for comparison is the midday network skim distance.

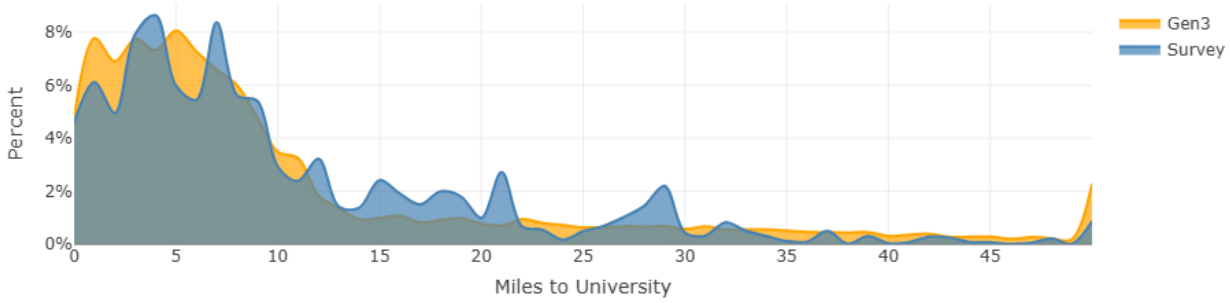


**FIGURE 3: DISTANCE-TO-UNIVERSITY DISTRIBUTION**

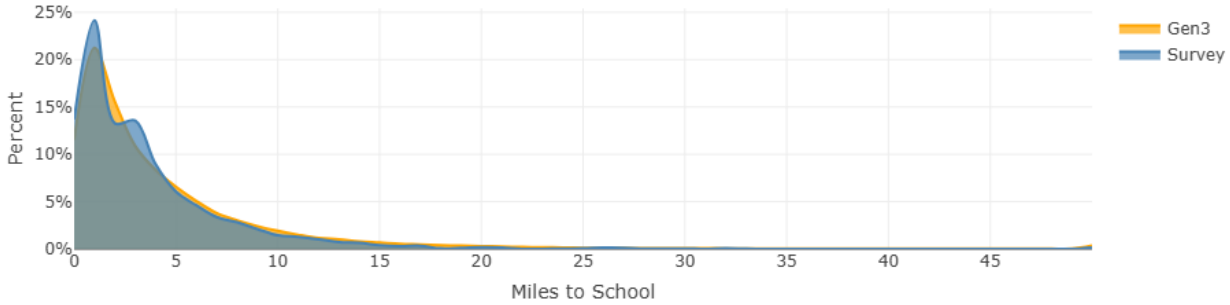


**FIGURE 4: DISTANCE-TO-SCHOOL DISTRIBUTION**

## 2.2 WORK FROM HOME MODEL

The work from home model step is used to represent workers who do not have a regular out-of-home workplace location. The model assigns a flag to each person in the simulation indicating whether they are a worker who works from home or who has a regular out-of-home workplace. The work from home model was transferred from SEMCOG and calibrated to Census ACS data at jurisdiction-level geography. The resulting constants are listed in Table 2. The resulting percent of workers working from home is shown in Figure 5. Overall, the observed percentage of workers working from home is 5.1% and the model estimates that 5.3% of workers work from home.

**TABLE 2: WORK FROM HOME JURISDICTION-SPECIFIC CONSTANTS**

| Jurisdiction | Constant |
|---|---|
| DC | -0.27 |
| Alexandria | -0.42 |
| Anne Arundel | -0.78 |
| Arlington | -0.08 |
| Calvert | -1.03 |
| Carroll | -1.07 |
| Charles | -1.31 |
| Clarke | -0.76 |
| Fairfax | -0.38 |
| Fauquier | -0.47 |
| Frederick | -0.53 |
| Fredericksburg | -0.31 |
| Howard | -0.63 |
| Jefferson | -1.03 |
| King George | -1.27 |
| Loudoun | -0.30 |
| Montgomery | -0.50 |
| Prince George's | -1.25 |
| PrinceWilliam | -0.97 |
| Spotsylvania | -1.01 |
| Stafford | -0.65 |
| St. Mary's | -1.70 |

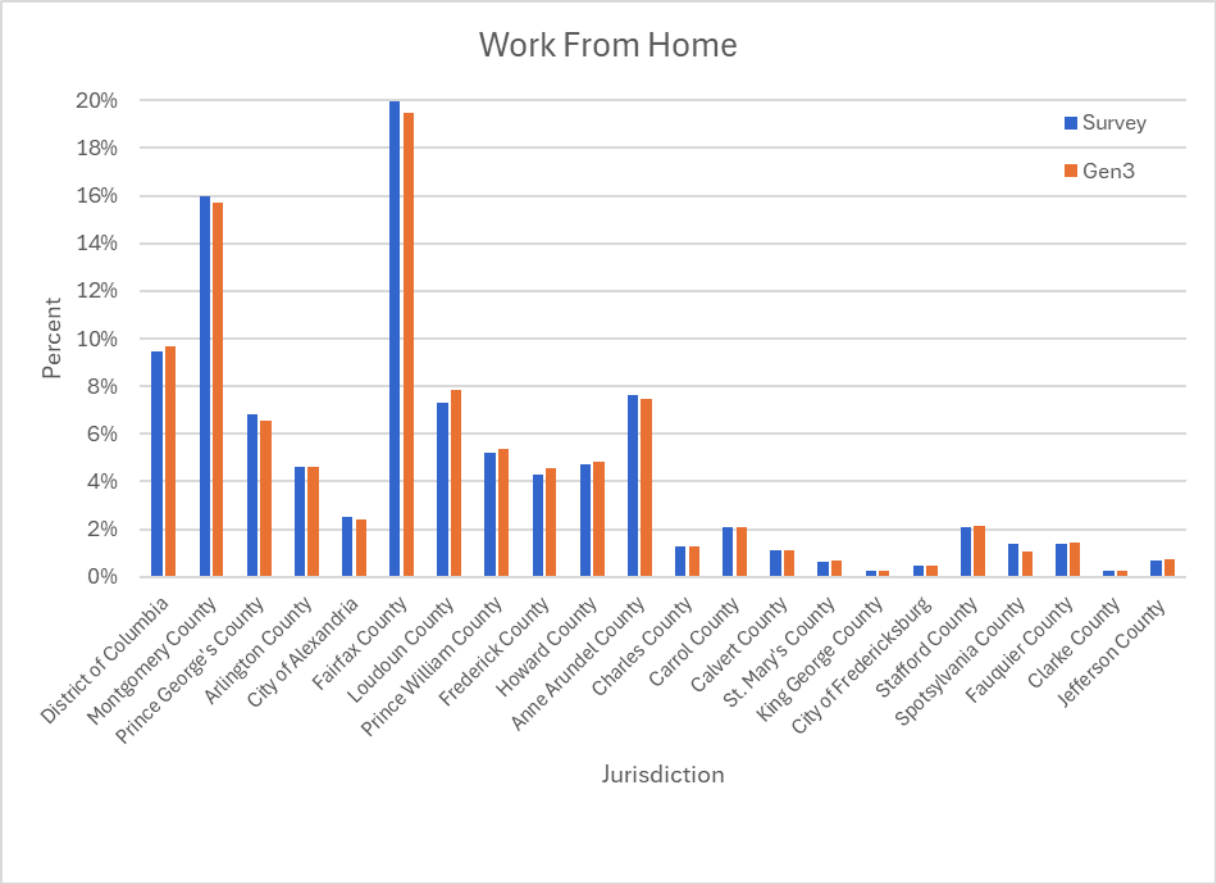


**FIGURE 5: WORK FROM HOME MODEL VALIDATION**

## 2.3 WORKPLACE LOCATION MODEL

The work location choice model step assigns a workplace transportation analysis zone (TAZ) to all workers in the model who do not work from home. This model was estimated in Phase 1 of the Gen3 ActivitySim Model Implementation Project. This model was calibrated in Phase 2 of the project using Census ACS Journey-To-Work (JTW) data at the origin-destination geography for local jurisdictions. Calibration constants were added between jurisdictions only where the difference between the model and the observed data was greater than 10%. The final constants are listed in Table 3. The midday network distance frequency comparison is shown in Figure 6. The regional average trip length to work is 12.88 miles observed and 13.22 modeled. The

coincidence ratio, which is a percentage of the area of the two curves that coincide,[7] of the observed compared to the modeled distances is 0.96. A perfect coincidence ratio is 1.0, and an abysmal coincidence ratio would likely be less than 0.1 (and possibly down to 0.0).

Jurisdiction-to-jurisdiction worker journey-to-work (JTW) flow comparisons for work location choice are included in the appendix as Table 63 (observed ACS), Table 64 (Gen3 Model), Table 65 (difference), and Table 66 (estimated/observed).

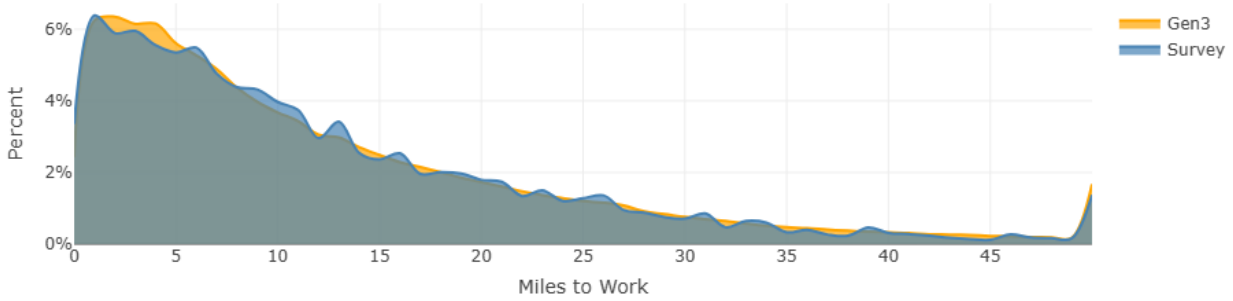


**FIGURE 6: WORK LOCATION DISTANCE FREQUENCY COMPARISON**

**TABLE 3: WORK LOCATION CALIBRATION CONSTANTS**

| From | To | COEFFICIENT |
|---|---|---|
| DC | DC | 0.032 |
| DC | Arlington | -0.229 |
| Montgomery | Montgomery | 0.65 |
| Montgomery | Fairfax | -0.361 |
| Montgomery | Howard | -0.492 |
| Montgomery | DC | -0.112 |
| Prince George's | DC | -0.245 |
| Prince George's | Prince George's | 0.287 |
| Prince George's | Arlington | -0.288 |
| Prince George's | Anne Arundel | -0.3 |
| Arlington | DC | -0.216 |
| Arlington | Fairfax | 0.433 |
| Alexandria | DC | -0.205 |

[7] Cambridge Systematics. Travel Model Validation and Reasonableness Checking Manual, Second Edition, prepared for Travel Model Improvement Program, Federal Highway Administration, Washington, D.C. https://www.fhwa.dot.gov/planning/tmip/publications/other_reports/validation_and_reasonableness_2010/fhwahep10042.pdf. Chapter 6 (HTML) / page 6-10 (PDF).

| From | To | COEFFICIENT |
|---|---|---|
| Fairfax | DC | -0.25 |
| Fairfax | Montgomery | -0.774 |
| Fairfax | Arlington | 0.102 |
| Fairfax | Fairfax | 0.094 |
| Loudoun | Montgomery | -1.078 |
| Loudoun | Fairfax | 0.154 |
| Loudoun | Loudoun | 0.389 |
| Prince William | DC | -0.304 |
| Prince William | Fairfax | -0.071 |
| Prince William | Prince William | 0.14 |
| Frederick | Montgomery | 0.319 |
| Howard | DC | -0.342 |
| Howard | Prince George's | 0.283 |
| Howard | Howard | 0.128 |
| Anne Arundel | DC | -0.526 |
| Anne Arundel | Howard | -0.206 |
| Anne Arundel | Anne Arundel | 0.14 |
| Charles | DC | -0.385 |
| Charles | Charles | 0.369 |
| Calvert | Calvert | 0.322 |
| Fauquier | Fauquier | 0.802 |
| Carroll | Carroll | 0.078 |
| Jefferson | Jefferson | 0.084 |
| Clarke | Clarke | 0.384 |
| St Mary's | St Mary's | 0.028 |
| Stafford | Stafford | 0.07 |

## 2.4 AUTO OWNERSHIP

The auto ownership model step assigns the number of motor vehicles owned by a household to each household in the model. This model was estimated by MWCOG staff and validated by RSG using Census ACS Data. The calibration constants are shown in Table 4. This model was initially calibrated to regional auto ownership, which is the "Regional" line in Table 4. Additionally, a constant was added to increase the number of 0-auto households with one, two, or three plus workers. In many places, auto ownership and number of workers in a household are highly correlated, but both Census ACS data and local survey data showed that the correlation is weaker in the DC region. These constants are the "1/2/3 Worker HH" lines in Table

4. Finally, the constants for five jurisdictions – DC, City of Alexandria, Arlington County, Montgomery County, and Prince George's County – were adjusted to increase 0-auto and 1-auto households to match Census data.

The observed and modeled regional auto ownership is shown in the chart included as Figure 7 and a comparison of 0-auto households by jurisdiction is included as Figure 8. For the modeled region, 8.9% of the households were 0-auto households according to the Census, and 10.6% were estimated by the Gen3 Model. The auto ownership for the regional core jurisdictions – particularly DC – were allowed to be a little higher than the calibration data due to the model underestimating Highway Performance Monitoring System (HPMS) VMT during calibration.

The auto ownership model includes constants for autonomous vehicle (AV) modeling based on prior research.[8] [9] To ensure that these factors do not affect the calibration of the model, a constant of -999 was used in the AV ownership model to prohibit AVs from being owned in the base year.

**TABLE 4: AUTO OWNERSHIP CALIBRATION CONSTANTS**

| Constant Description | 0 Autos | 1 Auto | 2 Autos | 3 Autos | 4+ Autos |
|---|---|---|---|---|---|
| Regional | | 1.25 | -1.03 | -3.45 | -4.97 |
| 1 Worker HHs | 0.64 | | | | |
| 2 Worker HHs | 0.91 | | | | |
| 3 Worker HHs | 2.27 | | | | |
| DC | 4.77 | 2.03 | | | |
| Alexandria | 2.34 | 1.01 | | | |
| Arlington | 2.87 | 1.09 | | | |
| Montgomery | 1.45 | | | | |
| Prince George's | 1.46 | | | | |

[8] Bradley, Mark. AVs and TNCs in Daysim. Presentation to SACOG. 1/17/2009. https://www.sacog.org/sites/main/files/file-attachments/avs_and_tnc_in_daysim-sacsim-rsg_0.pdf?1548293104

[9] Ou, Yanmei and Griesenbeck, Bruce. Estimating the Potential Impacts of AVs and TNCs using Activity-Based Travel Demand Model in MTP/SCS Scenario Development. Presentation at 2018 Innovations in Travel Modeling Conference, Atlanta, GA. 2018. https://onlinepubs.trb.org/onlinepubs/Conferences/2018/ITM/YOu.pdf

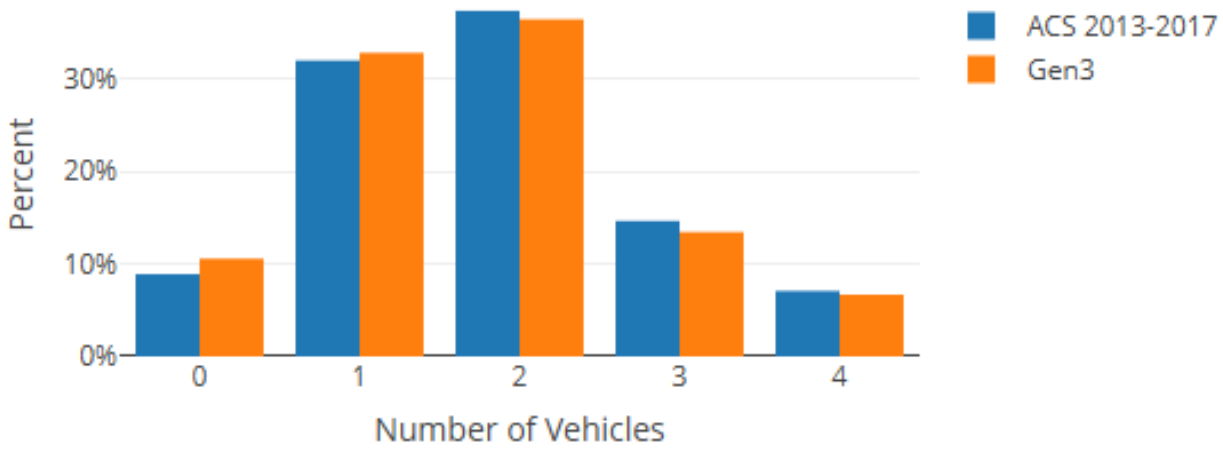


**FIGURE 7: HOUSEHOLD AUTO OWNERSHIP SUMMARIZED AT THE REGIONAL LEVEL**

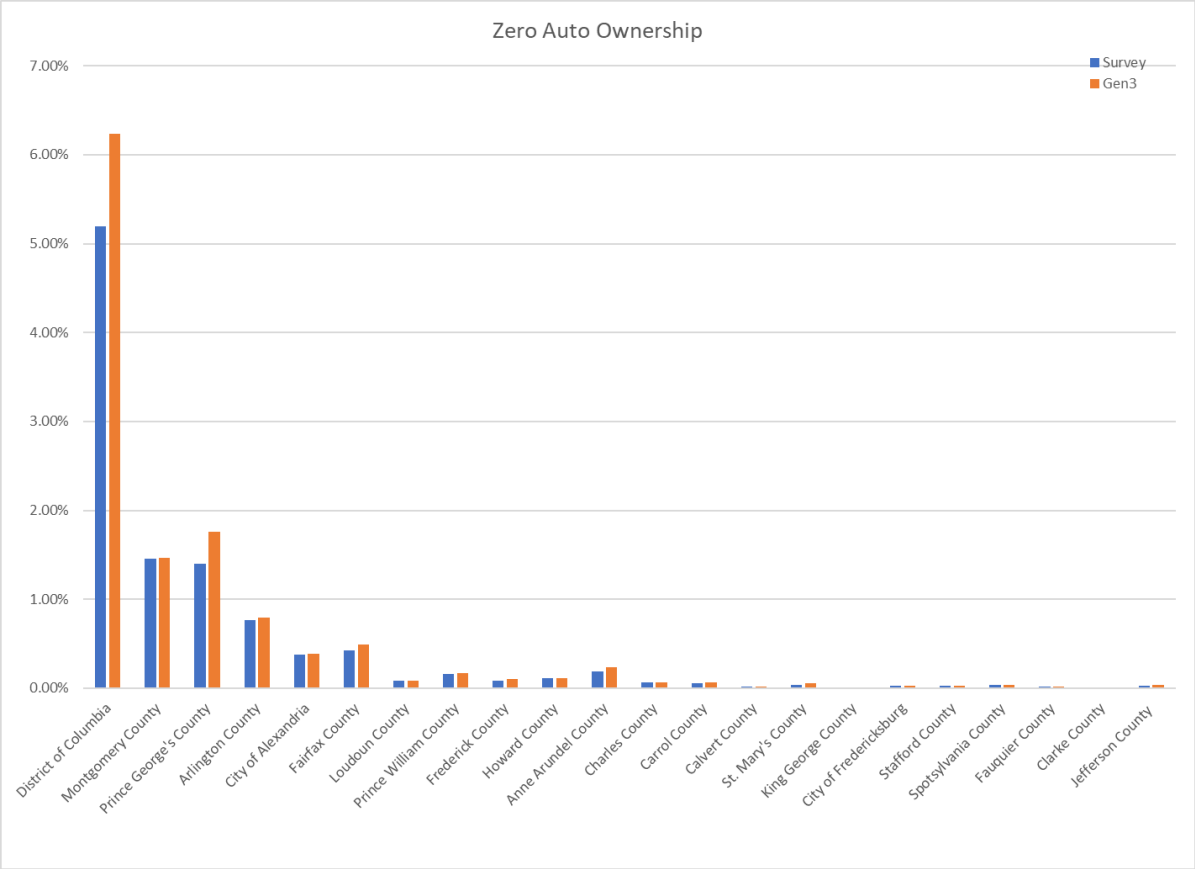


**FIGURE 8: ZERO-AUTO HOUSEHOLDS BY JURISDICTION**

## 2.5 TELECOMMUTE FREQUENCY

The telecommute frequency model step assigns a telecommute frequency value to a worker *with a regular out-of-home workplace*. This model was estimated as part of the Gen3 Phase 2 Model Development by RSG. The model's output includes simulated telecommute frequencies of no telecommute, 1 day per week, 2-3 days per week, or 4 days per week for individual workers.[10] The constants for this model are listed in Table 5. The resulting region-level model results are shown in Figure 9, which shows that the Gen3 vs. Survey comparisons are reasonably close: slightly higher for telecommute 1 day per week (9.1 vs. 7.7%), slightly higher for telecommute 2-3 days per week (6.3 vs. 5.9%), slightly higher for telecommute 4 days per week (3.1 vs. 2.4%), and slightly lower for no telecommute (81.5 vs. 84%).

[10] In the case that a person telecommutes more than five days per week, they are assumed to work from home.

**TABLE 5: TELECOMMUTE FREQUENCY CALIBRATION CONSTANTS**

| CONSTANT DESCRIPTION | VALUE |
|---|---|
| 1 Day/week Calibration Constant | -3.80 |
| 2-3 Days/week Calibration Constant | -4.58 |
| 4 Days/week Calibration Constant | -3.36 |

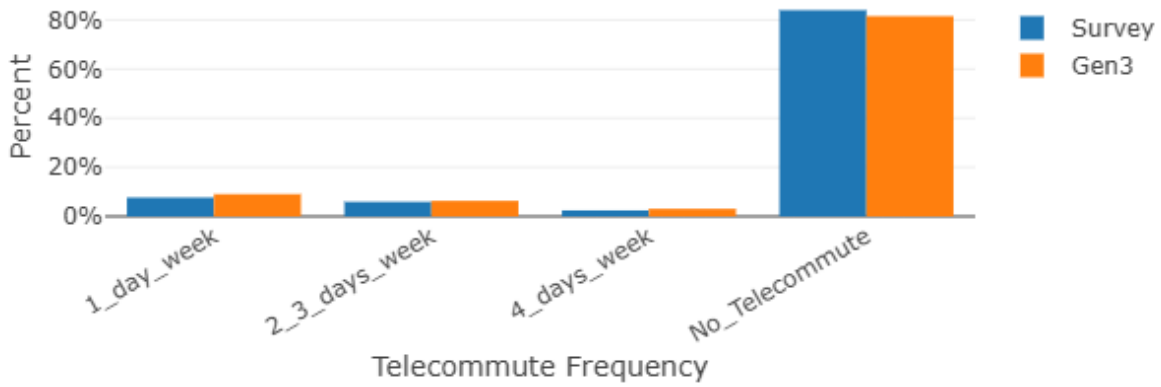


**FIGURE 9: REGIONAL TELECOMMUTE FREQUENCY VALIDATION**

## 2.6 COORDINATED DAILY ACTIVITY PATTERN

The coordinated daily activity pattern (CDAP) model step assigns to each person a day pattern value that indicates if they will travel for mandatory purposes (work or school), non-mandatory purposes, or not travel (or be out of the area). This model was estimated by MWCOG. The final model was calibrated by RSG. The calibration constants are listed in Table 6. The first eight rows of this table are a regional calibration for each person type, and the last five rows are a sub-regional calibration for some person types. Note that the model forbids mandatory tours for non-working adults and retired persons, since, according to the current rules of ActivitySim, persons of these types do not work or go to school. The resulting calibrated model output is shown in Figure 10 (full-time workers), Figure 11 (part-time workers), Figure 12 (university students), Figure 13 (non-working adults), Figure 14 (retired persons), Figure 15 (driving-aged students), Figure 16 (school pre-driving aged students), and Figure 17 (preschool-aged students).

In the calibration process, RSG found that traffic counts and HPMS VMT estimates implied significantly more traffic than the household travel survey. To better match the traffic counts and

HPMS-based VMT data, the non-working adults and retired adults were calibrated to decrease at-home day patterns for area types 3-6. The decision to do this was largely driven by the effort to improve the highway validation performance of the model, which will be discussed in the next chapter.

During the 2025 calibration updates, the CDAP models for part-time workers, non-working adults, and retired people were updated.

**TABLE 6: CDAP MODEL CALIBRATION CONSTANTS**

| Segment | Mandatory | Non-Mandatory | Home or Out of Area |
|---|---|---|---|
| Full-Time Worker | 2.51 | 0.25 | |
| Part-Time Worker | 1.12 | 0.87 | |
| University Student | 1.93 | 0.30 | |
| Non-Working Adult | | -1.52 | |
| Retired | | -0.29 | |
| Driving Age Child | 3.11 | 0.63 | |
| School Pre-Driving Age Child | 2.76 | 0.06 | |
| Preschool Child | 3.02 | -0.78 | |
| Full-Time Worker, Area Type 3-6 | | | -0.55 |
| Part-Time Worker, Area Type 3-6 | | | -0.55 |
| University Student, Area Type 3-6 | | | -0.55 |
| Non-Working Adult, Area Type 3-6 | | | -0.95 |
| Retired, Area Type 3-6 | | | -0.95 |

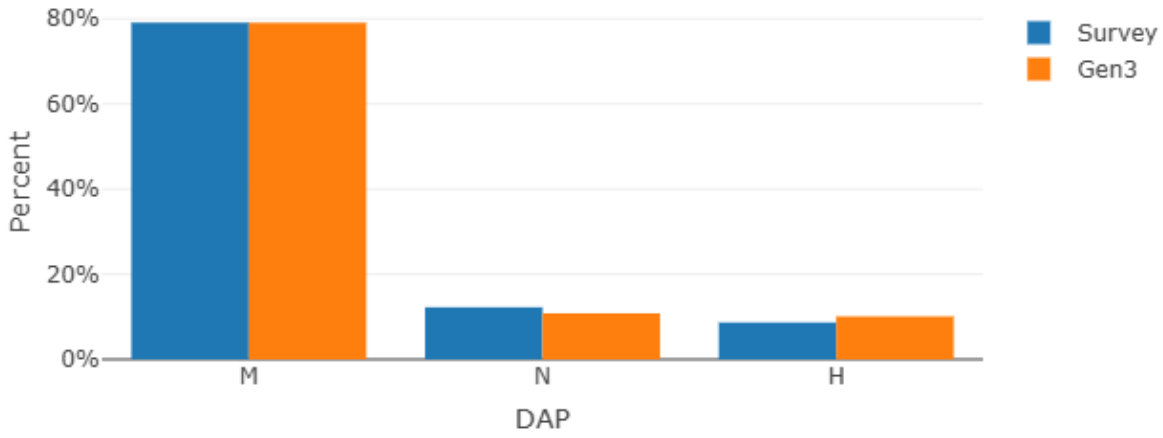


**FIGURE 10: FULL-TIME WORKER DAILY ACTIVITY PATTERN VALIDATION**

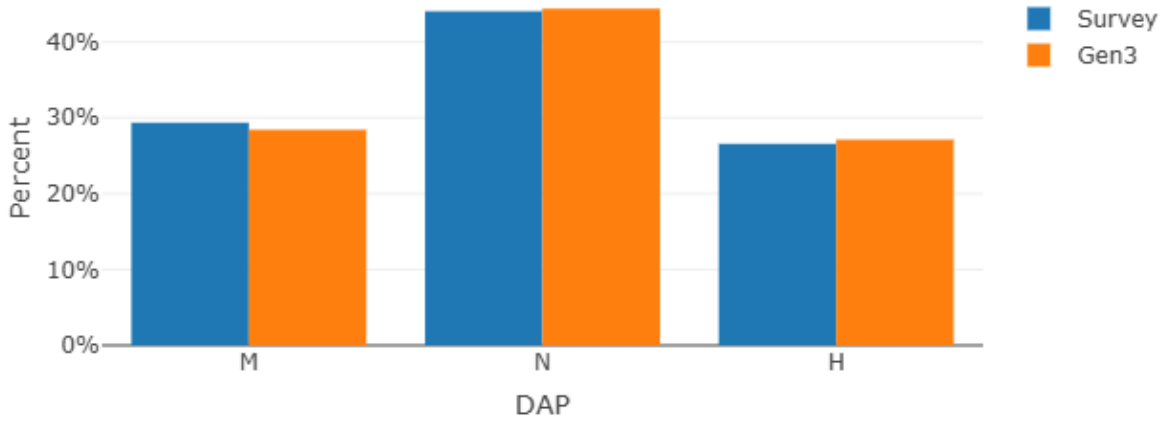


**FIGURE 11: PART-TIME WORKER DAILY ACTIVITY PATTERN VALIDATION**

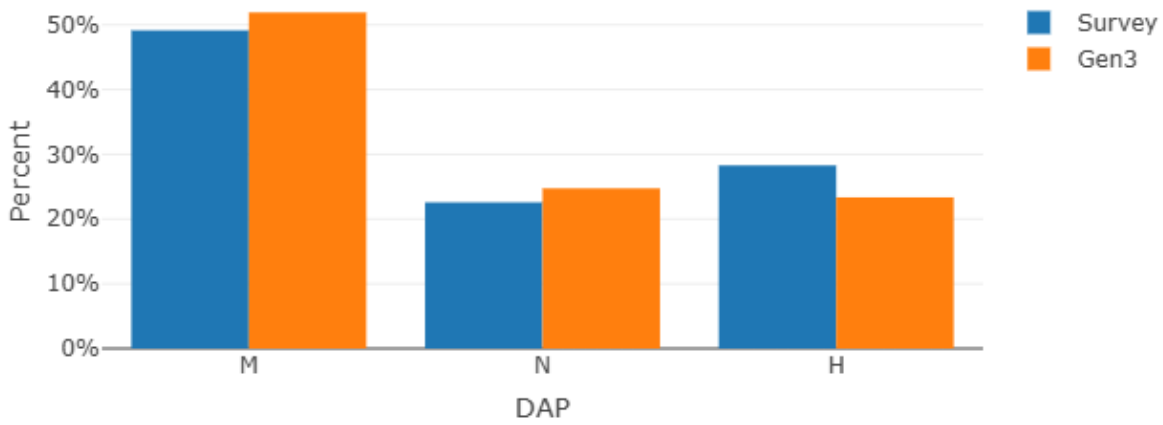


**FIGURE 12: UNIVERSITY STUDENT DAILY ACTIVITY PATTERN VALIDATION**

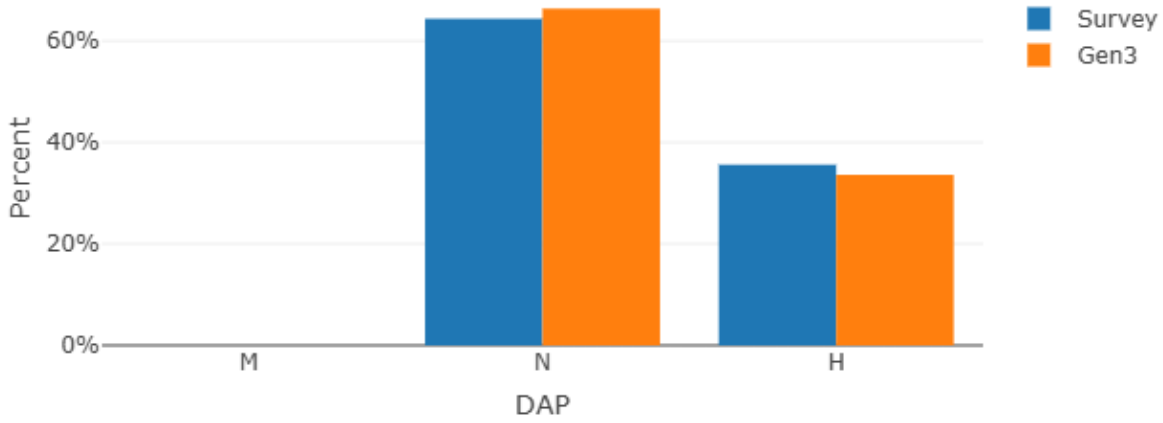


**FIGURE 13: NONWORKER DAILY ACTIVITY PATTERN VALIDATION**

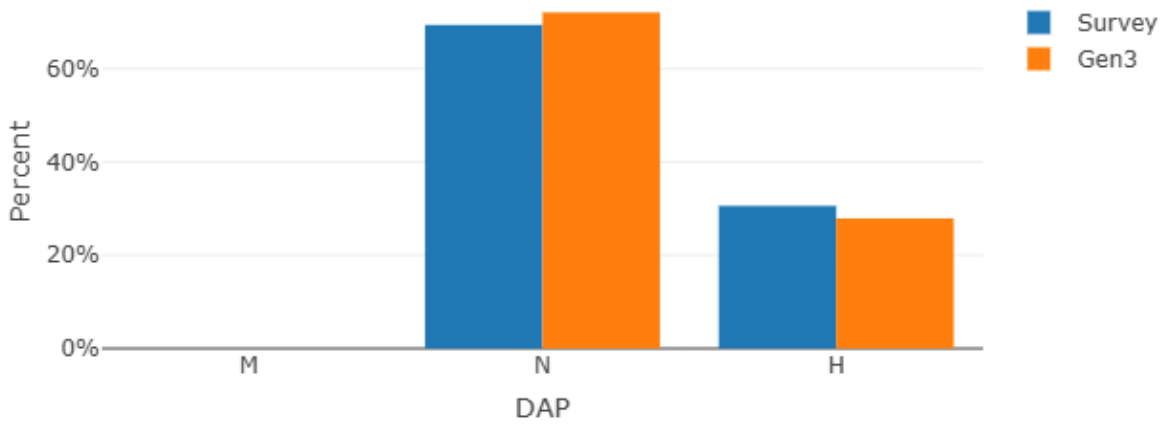


**FIGURE 14: RETIRED PERSON DAILY ACTIVITY PATTERN VALIDATION**

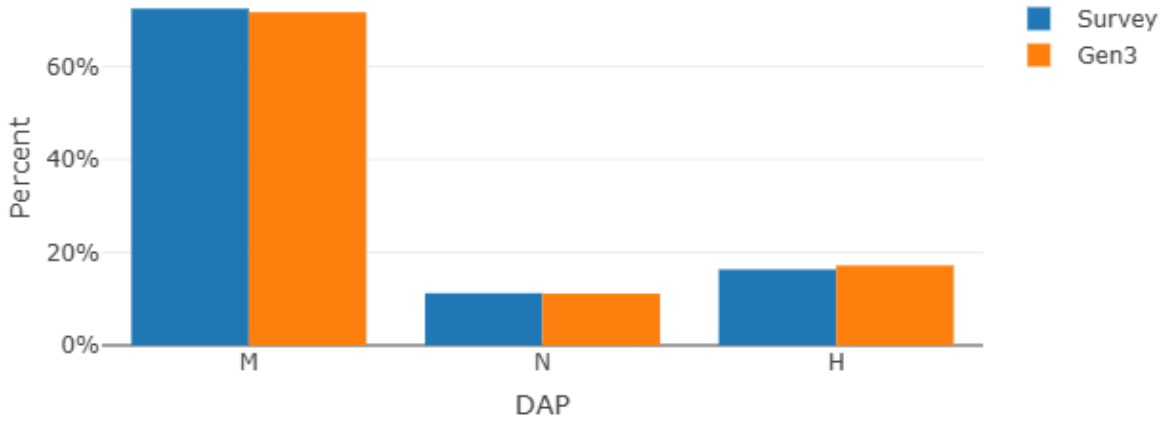


**FIGURE 15: DRIVING-AGE STUDENT DAILY ACTIVITY PATTERN VALIDATION**

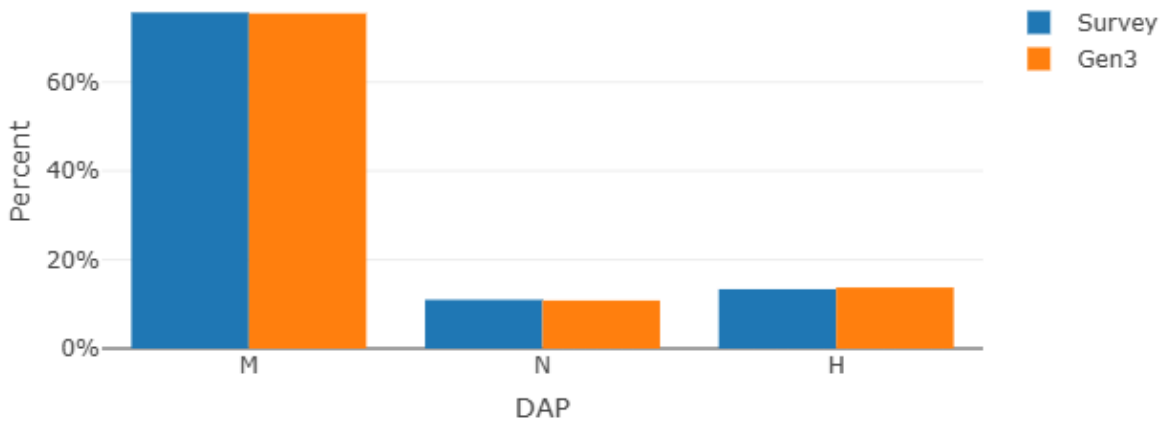


**FIGURE 16: SCHOOL PRE-DRIVING AGE STUDENT DAILY ACTIVITY PATTERN VALIDATION**

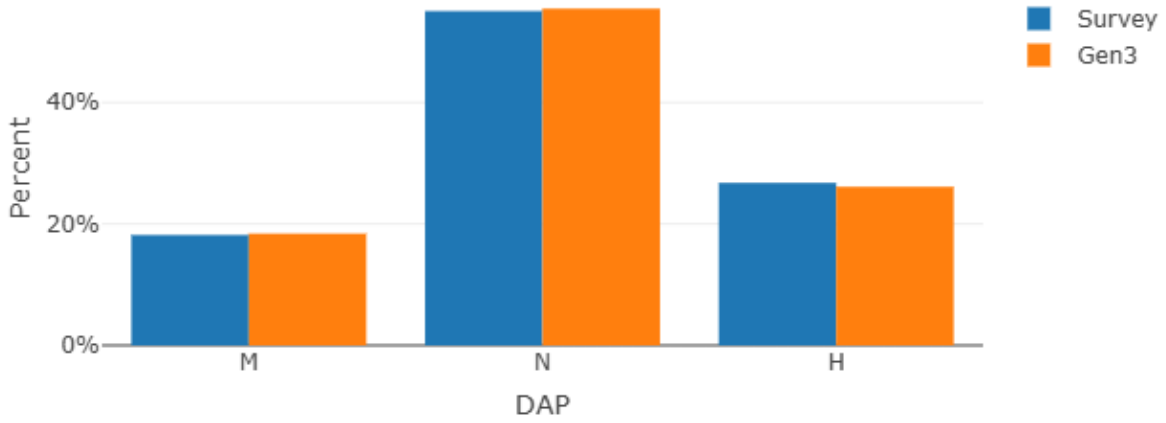


**FIGURE 17: PRESCHOOL-AGE CHILD DAILY ACTIVITY PATTERN VALIDATION**

## 2.7 MANDATORY TOUR FREQUENCY

The mandatory tour frequency model step assigns the number of mandatory tours for each person with a mandatory daily activity pattern. This model was estimated by MWCOG and calibrated by RSG. The calibrated constants are listed in Table 7. Note that non-working adults and retired persons are not included in this table since those person types are restricted, according to current rules in ActivitySim, from making mandatory tours. Additionally, full-time workers are not allowed to be students[11]. The resulting calibrated model output is shown in Figure 18 (full-time workers), Figure 19 (part-time workers), Figure 20 (university students), Figure 21 (school driving-aged students), Figure 22 (school pre-driving aged students), and Figure 23 (preschool-aged students).

**TABLE 7: MANDATORY TOUR FREQUENCY CALIBRATION CONSTANTS**

| Person Type | 1 Work | 2 Work | 1 School | 2 School | Work & School |
|---|---|---|---|---|---|
| Full-Time Worker | | -2.23 | | | |
| Part-Time Worker | | -2.20 | | | |
| University Student | 0.55 | -1.79 | | -2.83 | -1.03 |
| Driving Age Child | | | | -2.98 | 0.61 |
| School Pre-Driving Age Child | | | | -3.18 | |

[11] In a review of RTS data, it was found that very few full-time workers made trips as a student (email Andrew Rohne to Feng Xie 9/6/2022). Note that full-time workers are still able to make trips to a school to drop off a student, but these are coded in ActivitySim as escort tours and trips.

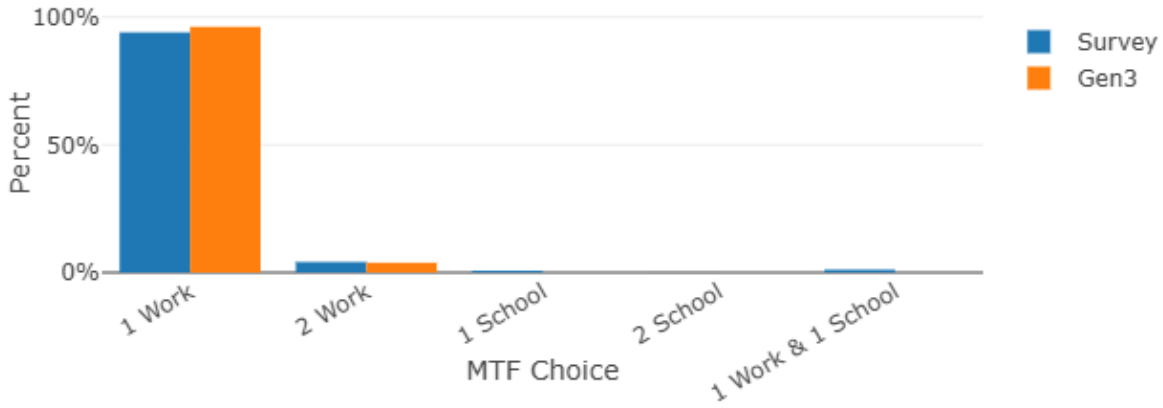


**FIGURE 18: MANDATORY TOUR FREQUENCY VALIDATION FOR FULL-TIME WORKERS**

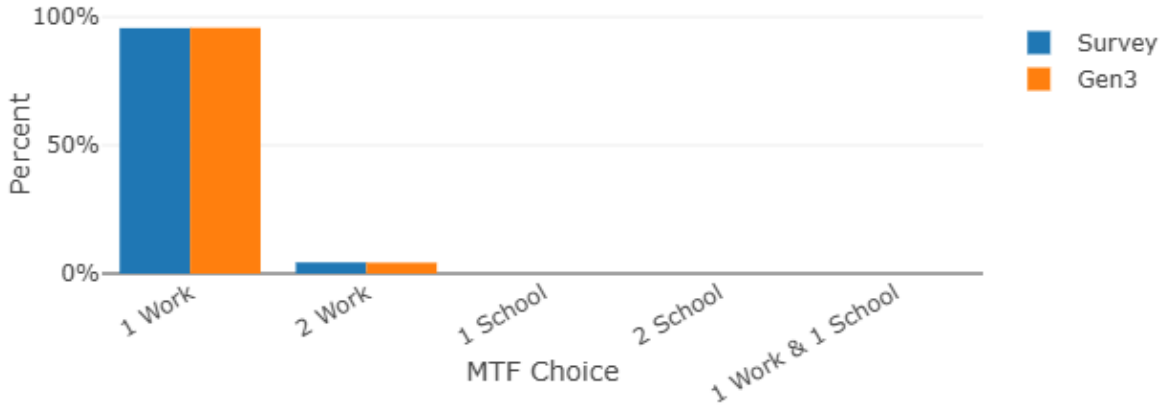


**FIGURE 19: MANDATORY TOUR FREQUENCY VALIDATION FOR PART-TIME WORKERS**

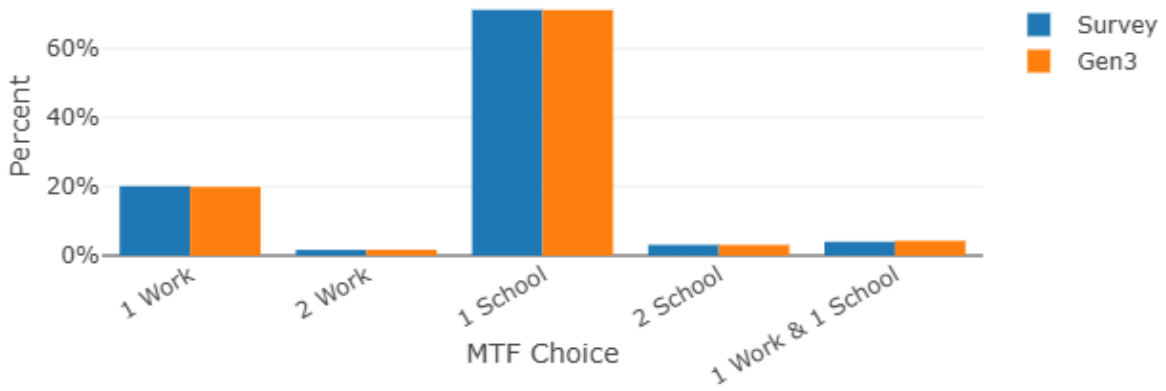


**FIGURE 20: MANDATORY TOUR FREQUENCY VALIDATION FOR UNIVERSITY STUDENTS**

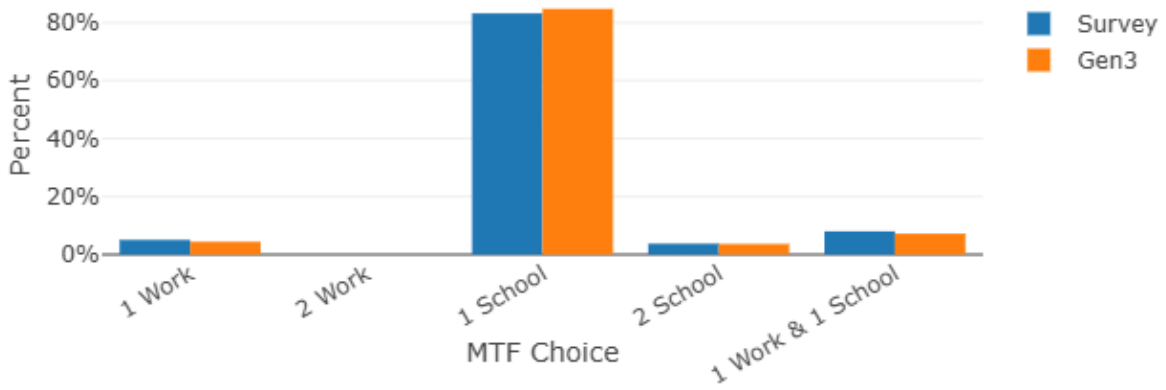


**FIGURE 21: MANDATORY TOUR FREQUENCY VALIDATION FOR DRIVING-AGE STUDENTS**

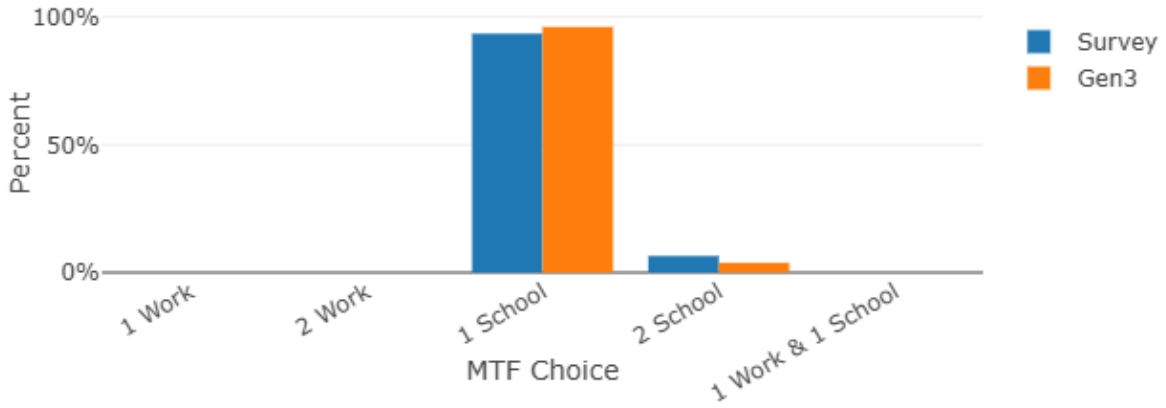


**FIGURE 22: MANDATORY TOUR FREQUENCY VALIDATION FOR PRE-DRIVING-AGED STUDENTS**

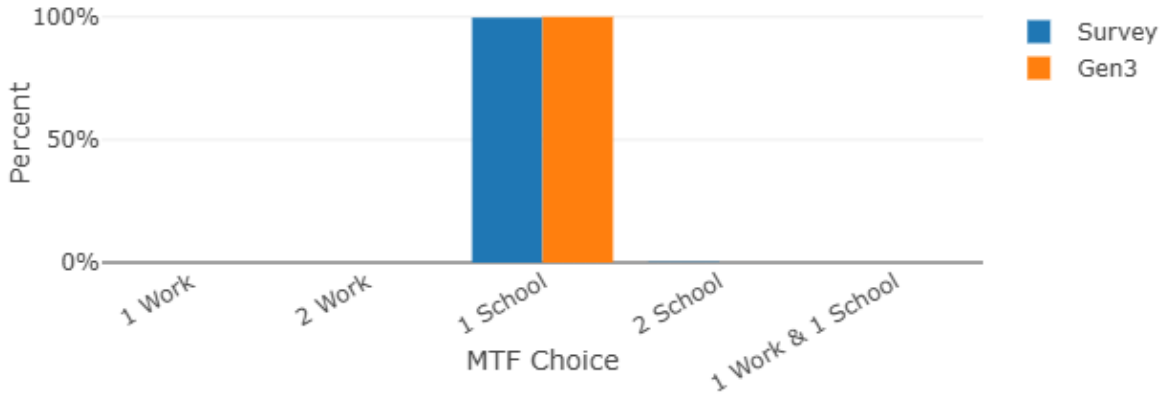


**FIGURE 23: MANDATORY TOUR FORMATION FOR PRE-SCHOOL AGED STUDENTS**

## 2.8 JOINT TOUR FREQUENCY

The joint tour frequency model step estimates the number of fully joint tours that will be made at the household level. Fully joint tours are tours where two or more household members are together for the entire tour. The alternatives include none, one discretionary, eating out, maintenance, shopping, or visiting tour, or two tours with a combination of those types. The calibration constants are listed in Table 8 for single tours and Table 9 for two tours (using the rows as one tour-type and the columns as the second tour-type; the tours are not ordered at this point in ActivitySim). The validated model output is shown in Figure 24.

**TABLE 8: JOINT TOUR FREQUENCY SINGLE-TOUR CALIBRATION CONSTANTS**

| Tour Frequency and Type | Constant |
|---|---|
| 1 Discretionary Tour | -4.84 |
| 1 Eat-out Tour | -5.29 |
| 1 Maintenance Tour | -5.13 |
| 1 Shopping Tour | -4.39 |
| 1 Visiting Tour | -5.44 |

**TABLE 9: JOINT TOUR FREQUENCY TWO-TOUR CALIBRATION CONSTANTS**

| Tour Type | Discretionary | Eat-out | Maintenance | Visiting | Shopping |
|---|---|---|---|---|---|
| Discretionary | -12.51 | -10.60 | -10.68 | -10.43 | -10.71 |
| Eat-out | | -12.02 | -10.51 | -99.00 | -11.98 |
| Maintenance | | | -10.99 | -12.05 | -12.48 |
| Visiting | | | | -12.71 | -12.71 |
| Shopping | | | | | -11.42 |

**TABLE 10: JOINT TOUR 4+ PERSON HOUSEHOLD ADJUSTMENTS**

| Tour Frequency and Type | Constant |
|---|---|
| 0 Joint Tours | 0.15 |
| 1 Joint Tour | -0.54 |
| 2 Joint Tours | -1.02 |

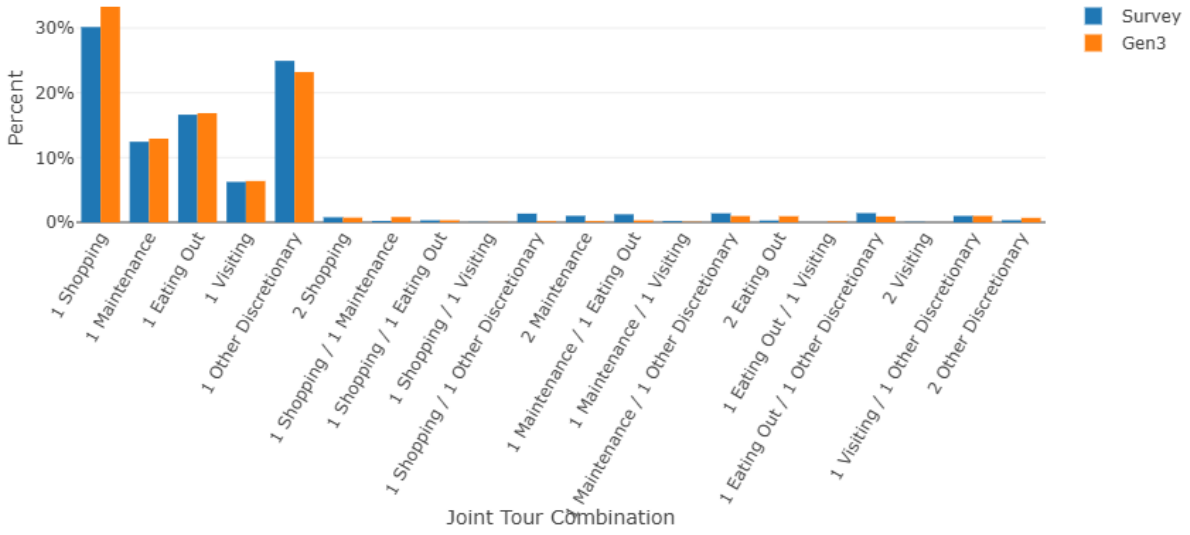


**FIGURE 24: JOINT TOUR FREQUENCY VALIDATION**

## 2.9 JOINT TOUR COMPOSITION

The joint tour composition model step assigns a tour composition to each joint tour. Composition refers to if the participants are adults-only, children-only, or mixed. The final calibration constants are listed in Table 11 and the calibrated model output is shown in Figure 25. The model summaries show some differences with the survey summaries, with the model overpredicting the “All Adult” tours by 7.8%. Future calibration efforts should lower this share to better match the survey target shares.

**TABLE 11: JOINT TOUR COMPOSITION MODEL CALIBRATION CONSTANTS**

| Tour Composition | Coefficient |
|---|---|
| Children Only | 5.35 |
| Mixed (adults and children) | 5.63 |

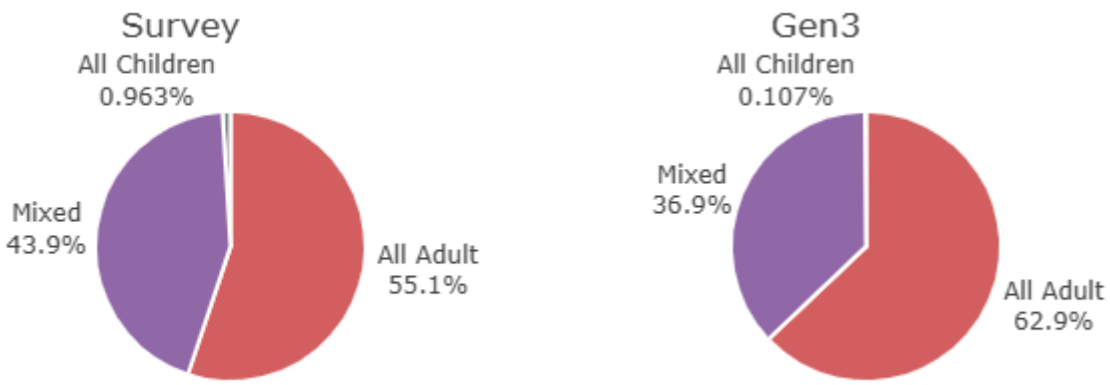


**FIGURE 25: JOINT TOUR COMPOSITION VALIDATION**

## 2.10 JOINT TOUR PARTICIPATION

The joint tour participation model is run for each person in a household and for each joint tour to assign if the person will or will not participate in the tour. The calibration constants for this model are listed in Table 12, and the resulting model calibration output is shown in Figure 26.

In the 2025 calibration update, a constant was added to this model to improve joint tours with greater than 2 people, with the broader goal of improving the joint tour mode choice model. The additional constant is **-1.04** and is applied only if the participation alternative has more than two people in the travel party.

**TABLE 12: JOINT TOUR PARTICIPATION CALIBRATION CONSTANTS**

| Constant | Participate | Not Participate |
|---|---|---|
| Full-Time Worker, mixed party | -3.57 | 0.50 |
| Part-Time Worker, adults-only party | -3.57 | 0.50 |
| Part-Time Worker, mixed party | -0.37 | |
| University Student, mixed party | -3.04 | |
| Non-Worker, adults-only party | -3.16 | |
| Non-Worker, mixed party | 0.72 | |
| Child too Young for School, children-only party | -2.79 | |
| Child too Young for School, mixed party | -1.89 | |
| Pre-driving age Student, children-only party | -0.72 | |
| Pre-driving age Student, mixed party | -1.75 | |
| Driving-age Student, children-only party | -1.82 | |
| Driving-age Student, mixed party | -1.35 | |
| Full-Time Worker, specific to eating out joint tours | 0.72 | 0.50 |
| Full-Time Worker, specific to discretionary joint tours | 0.44 | 0.50 |
| Part-Time Worker, specific to eating out joint tours | 2.19 | |
| Part-Time Worker, specific to discretionary joint tours | 0.29 | |
| University Student, specific to eating out joint tours | -0.82 | |
| University Student, specific to discretionary joint tours | 0.00 | |
| Non-worker, specific to eating out joint tours | 0.16 | |
| Non-worker, specific to discretionary joint tours | -0.18 | |
| Child too Young for School, specific to eating out joint tours | 0.66 | |
| Child too Young for School, specific to discretionary joint tours | 0.13 | |
| Pre-driving Age Student, specific to eating out joint tours | 1.39 | |
| Pre-driving age Student, specific to discretionary joint tours | 0.66 | |
| Driving-age Student, specific to eating out joint tours | 2.34 | |
| Driving-age Student, specific to discretionary joint tours | -0.67 | |

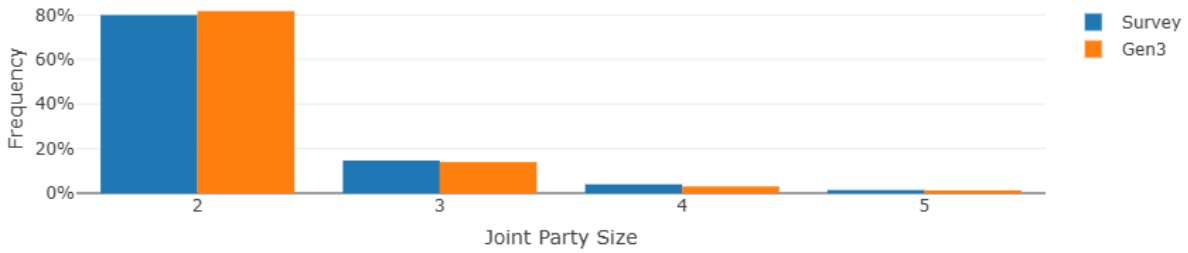


**FIGURE 26: JOINT TOUR PARTY SIZE VALIDATION**

## 2.11 JOINT TOUR DESTINATION

The joint tour destination model assigns the primary destination TAZ to each joint tour. The constants for this model are included in the non-mandatory tour destination model. The model output for joint discretionary tours is shown in Figure 27 and the model output for joint maintenance tours is shown in Figure 28. The average tour lengths and coincidence ratios are listed in Table 13.

**TABLE 13: JOINT TOUR DESTINATION SUMMARY**

| TOUR PURPOSE | OBSERVED AVERAGE TOUR LENGTH | GEN3 MODEL AVERAGE TOUR LENGTH | COINCIDENCE RATIO |
|---|---|---|---|
| Joint Maintenance | 6.81 | 6.10 | 0.78 |
| Joint Discretionary | 7.02 | 6.95 | 0.75 |

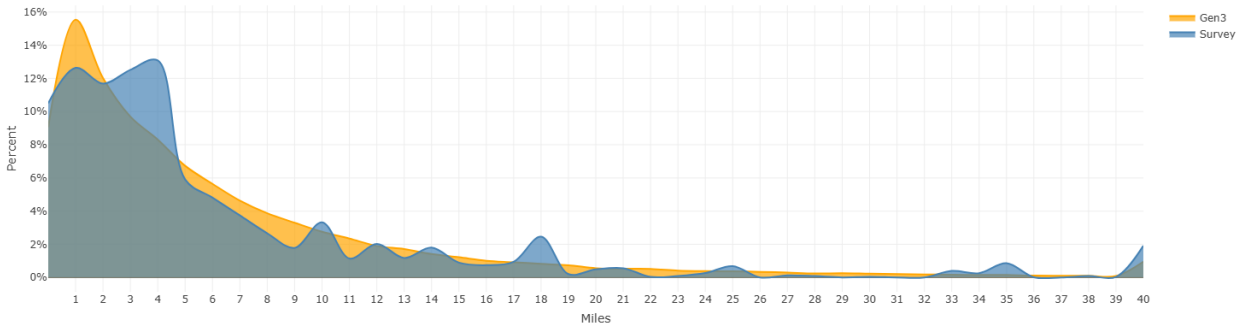


**FIGURE 27: JOINT DISCRETIONARY TOUR DESTINATION DISTANCE DISTRIBUTION**

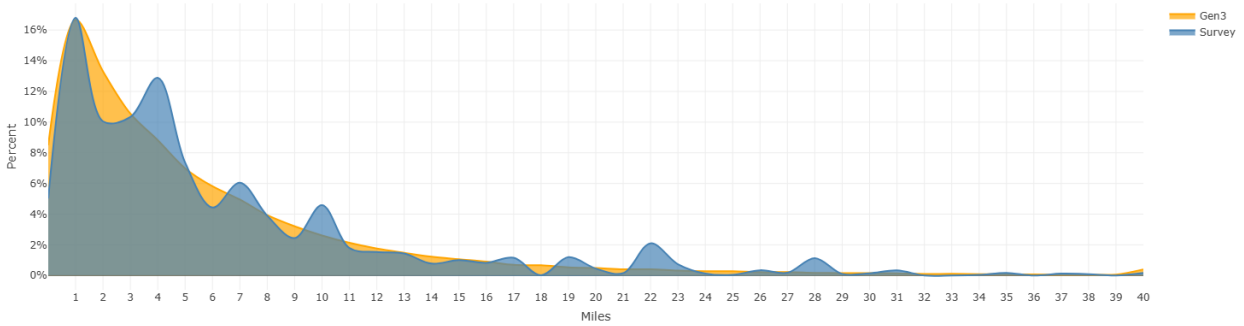


**FIGURE 28: JOINT MAINTENANCE TOUR DESTINATION DISTANCE DISTRIBUTION**

## 2.12 NON-MANDATORY TOUR DESTINATION

The non-mandatory tour destination choice model step assigns a primary destination TAZ to each non-mandatory tour. This model was calibrated using both survey data and traffic counts to match the traffic counts on the Potomac River bridges and HPMS VMT estimates. The calibration of this model primarily used calibration constants, but it also used a multiplier against the distance for tours that go in and out of DC. Determining the value of these multipliers utilized survey data. The calibration constants and coefficients are listed in Table 15. The output of the joint discretionary and maintenance tours is shown in Figure 27 and Figure 28 respectively in the previous section. The output of the individual discretionary and maintenance tour destination choice models is shown in Figure 29 and Figure 30, respectively.

Jurisdiction-to-jurisdiction flow comparisons for non-mandatory tours are included in the appendix as Table 67 (observed ACS), Table 68, Table 64 (Gen3 Model), Table 69 (difference), and Table 70 (estimated/observed).

**TABLE 14: NON-MANDATORY TOUR SUMMARY STATISTICS**

| TOUR PURPOSE | OBSERVED AVERAGE TOUR LENGTH | GEN3 MODEL AVERAGE TOUR LENGTH | COINCIDENCE RATIO |
|---|---|---|---|
| Individual Maintenance | 5.64 | 5.83 | 0.88 |
| Individual Discretionary | 6.44 | 7.20 | 0.88 |
| Escort | 4.20 | 5.16 | 0.81 |

**TABLE 15: NON-MANDATORY TOUR DESTINATION CALIBRATION CONSTANTS AND COEFFICIENTS**

| CONSTANT OR COEFFICIENT DESCRIPTION | CONSTANT OR COEFFICIENT VALUE |
|---|---|
| Carrol County Intra-county Discretionary Tour Constant | 0.14 |
| Jefferson County Intra-county Discretionary Tour Constant | 0.13 |
| Clarke County Intra-county Discretionary Tour Constant | 0.48 |
| Loudon County Intra-county Discretionary Tour Constant | 0.10 |
| Howard County Intra-county Discretionary Tour Constant | 0.14 |
| Anne Arundel County Intra-county Discretionary Tour Constant | 0.16 |
| Calvert County Intra-county Discretionary Tour Constant | 0.29 |
| St. Mary's County Intra-county Discretionary Tour Constant | 0.63 |
| Fauquier County Intra-county Discretionary Tour Constant | 0.32 |
| Stafford County Intra-county Discretionary Tour Constant | -0.28 |
| Maintenance Tours - out of DC to DC Constant | -3.42 |
| Discretionary Tours - out of DC to DC Constant | -1.68 |
| Montgomery to Fairfax County Constant | -3.00 |
| Fairfax to Montgomery County Constant | -3.00 |
| Montgomery to Prince Georges County Constant | -1.11 |
| Prince Georges County to Montgomery Constant | -0.59 |
| Outside of DC Distance Multiplier for Maintenance Tours | 0.02 |
| Outside of DC Distance Multiplier for Discretionary Tours | 0.02 |
| DC Distance Multiplier | -0.12 |

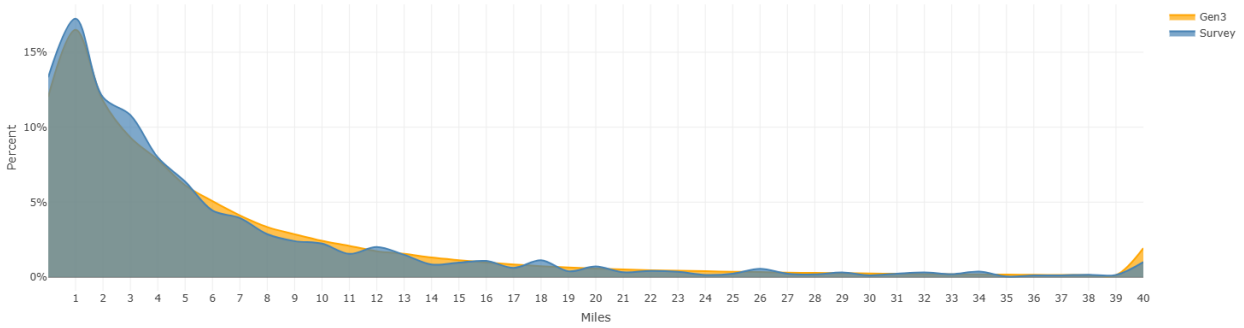


**FIGURE 29: INDIVIDUAL DISCRETIONARY TOUR DESTINATION DISTANCE DISTRIBUTION**

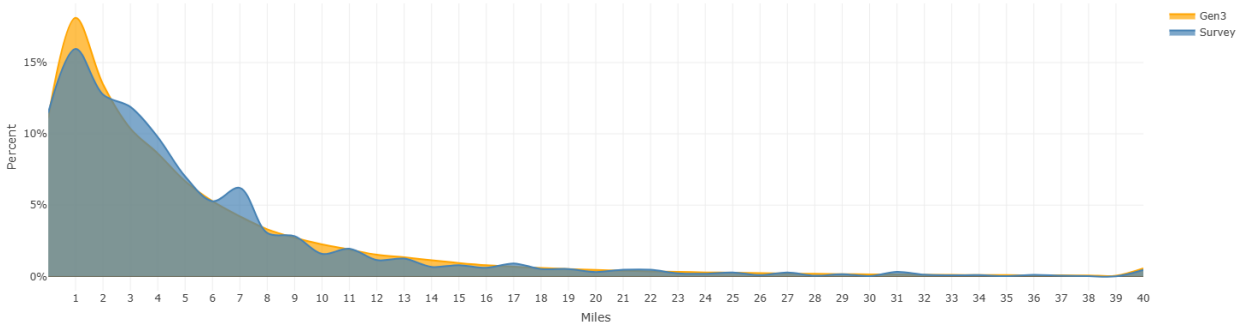


**FIGURE 30: INDIVIDUAL MAINTENANCE TOUR DESTINATION DISTANCE DISTRIBUTION**

## 2.13 TOUR SCHEDULING

The tour scheduling model step determines the departure and duration of tours by time period in the model. Time periods in the model are half-hour increments beginning at 3:00 AM as period 1. There are 48 periods in the travel day, and ActivitySim will not schedule travel beyond the current travel day. The tour scheduling model is a multinomial choice model that includes the alternatives of each departure period and available duration periods as alternatives. For example, a departure during the first period of the model has 48 alternatives, a duration of 0-47 periods (ending in periods 1-48). A departure during the 46th period includes three alternatives, a duration of 0, 1, or 2 periods. This is because the travel day must end by the final period of the day, so the alternatives end during periods 46, 47, or 48.

The calibration of these models started with an update of the model specification for all non-mandatory tour scheduling models. Like many models, these models are calibrated via alternative-specific constants. In these models, alternatives are calibrated along three

dimensions – departure period, arrival period, and duration. Because there are so many alternatives for each dimension (there are 48 half-hour periods in a day), the constants are determined via a function. An example of this is shown below, where the constants for before 8:30 AM are determined via a function using the start time as a linear parameter and the square root of the start time as another parameter and finally using a constant for all times before 9:00 AM.

```
util_shopping_departure_constant_shift_for_every_30_minutes_before_8_30_am_linear,SHOPPING -
Departure Constant: Shift for every 30 minutes before 08:30 am -
Linear,"@np.where(((df.start<12)), ((12-df.start)*(df.start<=12) + (df.start-
12)*(df.start>12)),
0)",coef_shopping_departure_constant_shift_for_every_30_minutes_before_8_30_am_linear


util_shopping_departure_constant_shift_for_every_30_minutes_before_8_30_am_square_root,SHOPPIN
G - Departure Constant: Shift for every 30 minutes before 08:30 am - Square
root,"@np.where(((df.start<12)), ((12-df.start)*(df.start<=12) + (df.start-
12)*(df.start>12))**0.5,
0)",coef_shopping_departure_constant_shift_for_every_30_minutes_before_8_30_am_square_root

 util_shopping_departure_constant_before_9_am,SHOPPING - Departure Constant: Before 09:00
AM,@((df.start<13)),coef_shopping_departure_constant_before_9_am
```

All non-mandatory models were updated to use a linear curve (y = mx + b) for early morning and late evening departure and arrival alternatives, and for very long duration alternatives. The remaining alternatives (for departure, arrival, and duration dimensions) use alternative-specific constants.

## Work Tour Scheduling Model Calibration

The work tour time of day calibration constants are listed in Table 16. The resulting model calibration by day period is shown in Figure 31.

**TABLE 16: WORK TOUR TIME OF DAY CALIBRATION CONSTANTS**

| CONSTANT DESCRIPTION | CONSTANT |
|---|---|
| Departure Linear: shift for every 30 minutes before 6:00 AM | -0.72 |
| Departure Constant: departure before 6:00 AM | -0.19 |
| Departure 6:00 AM - 6:30 AM | -0.54 |
| Departure 6:30 AM - 7:00 AM | -0.08 |

| CONSTANT DESCRIPTION | CONSTANT |
|---|---|
| Departure 7:00 AM - 7:30 AM | 0.00 |
| Departure 7:30 AM - 8:00 AM | -0.12 |
| Departure 8:00 AM - 8:30 AM | -0.45 |
| Departure 8:30 AM - 9:00 AM | -0.98 |
| Constant: departure after 9:00 AM | -1.56 |
| Departure Sublinear: shift by square root of every 30 minutes after 9:00 AM | -0.58 |
| Arrival Linear: shift for every 30 minutes before 3:00 PM | -0.20 |
| Arrival Constant: arrival before 3:00 PM | -0.86 |
| Arrival 3:30 PM - 4:00 PM | -0.64 |
| Arrival 4:00 PM - 4:30 PM | -0.30 |
| Arrival 4:30 PM - 5:00 PM | -0.19 |
| Arrival 5:00 PM - 5:30 PM | 0.00 |
| Arrival 5:30 PM - 6:00 PM | 0.25 |
| Arrival 6:00 PM - 6:30 PM | 0.24 |
| Arrival 6:30 PM - 7:00 PM | 0.16 |
| Arrival 7:00 PM - 7:30 PM | 0.00 |
| Arrival 7:30 PM - 8:00 PM | -0.18 |
| Arrival Constant: arrival after 8:00 PM | 0.00 |
| Arrival Sublinear: shift by square root of every 30 minutes after 8:30 PM | 0.00 |
| Duration Quadratic: shift for square of every 30 minutes less than 8.5 hours | -0.04 |
| Duration Linear: shift for every 30 minutes less than 8.5 hours | 0.43 |
| Duration Constant: duration less than 8.5 hours | -1.03 |
| Duration 8.5 hours | -0.66 |
| Duration 9 hours | -0.32 |
| Duration 9.5 hours | -0.15 |
| Duration 10 hours | -0.09 |
| Duration 10.5 hours | -0.14 |
| Duration 11 hours | -0.34 |
| Duration 11.5 hours | -0.64 |
| Duration 12 hours | -0.93 |
| Duration Constant: duration longer than 12 hours | -1.10 |
| Duration Linear: shift for every 30 minutes longer than 12 hours | -0.49 |
| Duration constant for 0 hours (same departure and arrival period) | -1.21 |

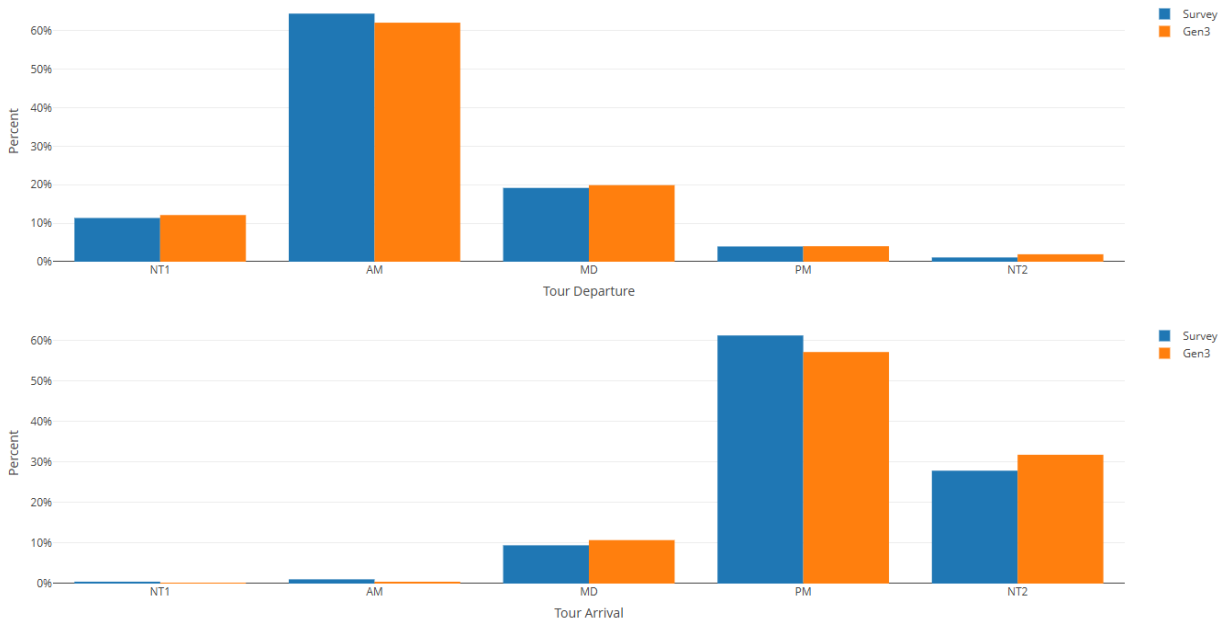


**FIGURE 31: WORK TOUR TIME OF DAY CALIBRATION**

## University Tour Scheduling Model Calibration

University tour time of day calibration constants are listed in Table 17. The university tour time of day calibration is shown in Figure 32.

**TABLE 17: UNIVERSITY TOUR TIME OF DAY CALIBRATION CONSTANTS**

| CONSTANT DESCRIPTION | CONSTANT |
|---|---|
| Departure before 5:00 AM (constant) | -4.75 |
| Departure 5:00 AM - 5:30 AM | -0.67 |
| Departure 5:30 AM - 6:00 AM | 0.55 |
| Departure 6:00 AM - 6:30 AM | -0.22 |
| Departure 6:30 AM - 7:00 AM | 1.51 |
| Departure 7:00 AM - 7:30 AM | 2.18 |
| Departure 7:30 AM - 8:00 AM | 2.71 |
| Departure 8:00 AM - 8:30 AM | 3.25 |
| Departure 8:30 AM - 9:00 AM | 2.87 |
| Departure 9:00 AM - 9:30 AM | 2.92 |
| Departure 9:30 AM - 10:00 AM | 2.54 |
| Departure 10:00 AM - 11:00 AM | 2.43 |

| CONSTANT DESCRIPTION | CONSTANT |
|---|---|
| Departure 11:00 AM - 12:00 PM | 2.55 |
| Departure 12:00 PM - 1:00 PM | 2.47 |
| Departure 1:00 PM - 2:00 PM | 2.56 |
| Departure 2:00 PM - 3:00 PM | 2.49 |
| Departure 3:00 PM - 4:00 PM | 2.24 |
| Departure 4:00 PM - 5:00 PM | 3.72 |
| Departure 5:00 PM - 5:30 PM | 4.54 |
| Departure 5:30 PM - 6:00 PM | 4.74 |
| Departure 6:00 PM - 6:30 PM | 5.78 |
| Departure 6:30 PM - 7:00 PM | 5.57 |
| Departure 7:00 PM - 10:30 PM | 2.72 |
| Departure after 10:30 PM | -2.12 |
| Arrival linear every 30 minutes before 6:30 AM | -0.01 |
| Arrival before 6:30 AM | -0.15 |
| Arrival 6:30 AM - 7:00 AM | 3.57 |
| Arrival 7:00 AM - 7:30 AM | 1.65 |
| Arrival 7:30 AM - 8:00 AM | 3.68 |
| Arrival 8:00 AM - 8:30 AM | -1.38 |
| Arrival 8:30 AM - 9:00 AM | 1.13 |
| Arrival 9:00 AM - 9:30 AM | 0.71 |
| Arrival 9:30 AM - 10:00 AM | 1.17 |
| Arrival 10:00 AM - 10:30 AM | -0.90 |
| Arrival 10:30 AM - 11:00 AM | -1.42 |
| Arrival 11:00 AM - 11:30 AM | 0.11 |
| Arrival 11:30 AM - 12:00 PM | 1.09 |
| Arrival 12:00 PM - 12:30 PM | 0.33 |
| Arrival 12:30 PM - 1:00 PM | 0.26 |
| Arrival 1:00 PM - 1:30 PM | 0.12 |
| Arrival 1:30 PM - 2:00 PM | 0.37 |
| Arrival 2:00 PM - 2:30 PM | 0.14 |
| Arrival 2:30 PM - 3:00 PM | 0.25 |
| Arrival 3:00 PM - 3:30 PM | 0.46 |
| Arrival 3:30 PM - 4:00 PM | 0.22 |
| Arrival 4:00 PM - 4:30 PM | 0.52 |
| Arrival 4:30 PM - 5:00 PM | 0.62 |
| Arrival 5:00 PM - 5:30 PM | 0.08 |
| Arrival 5:30 PM - 6:00 PM | 0.04 |
| Arrival 6:00 PM - 6:30 PM | -0.01 |

| CONSTANT DESCRIPTION | CONSTANT |
|---|---|
| Arrival 6:30 PM - 7:00 PM | -1.24 |
| Arrival 7:00 PM - 7:30 PM | -0.99 |
| Arrival 7:30 PM - 8:00 PM | -1.07 |
| Arrival 8:00 PM - 8:30 PM | -0.89 |
| Arrival 8:30 PM - 9:00 PM | -0.57 |
| Arrival 9:00 PM - 9:30 PM | -0.95 |
| Arrival 9:30 PM - 10:00 PM | -1.93 |
| Arrival after 10:00 PM | -2.06 |
| Arrival linear every 30 minutes after 10:00 PM | -0.58 |
| Arrival sublinear: square root of every 30 minutes past 10:00 PM | -1.35 |
| Duration less than a half hour | -7.52 |
| Duration of 0.5 hour | -5.62 |
| Duration of 1 hour | -1.98 |
| Duration of 1.5 hours | -0.69 |
| Duration of 2 hours | -0.79 |
| Duration of 2.5 hours | -0.23 |
| Duration of 3 hours | 0.27 |
| Duration of 3.5 hours | 0.15 |
| Duration of 4 hours | -0.26 |
| Duration of 4.5 hours | -0.15 |
| Duration of 5 hours | 0.52 |
| Duration of 5.5 hours | 0.19 |
| Duration of 6 hours | 0.01 |
| Duration of 6.5 hours | 0.10 |
| Duration of 7 hours | 0.07 |
| Duration of 7.5 hours | 0.07 |
| Duration of 8 hours | 0.49 |
| Duration of 8.5 hours | -0.18 |
| Duration of 9 hours | 0.34 |
| Duration greater than 9 hours | 0.31 |
| Duration linear every 30 minutes past 9.5 hours | -0.07 |

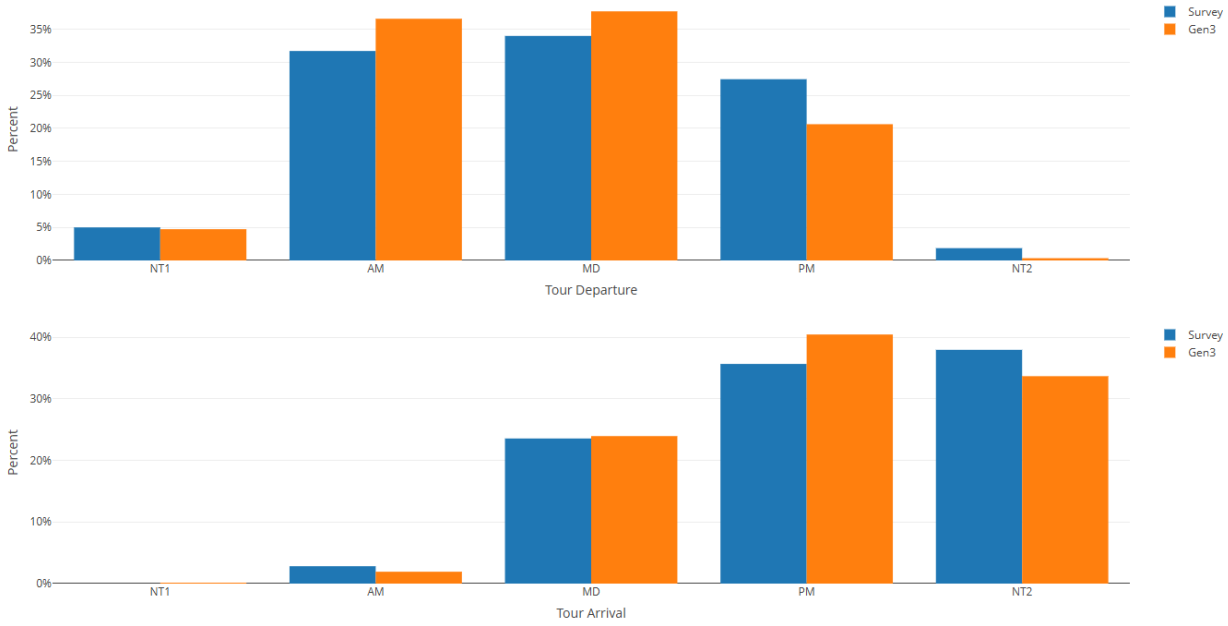


**FIGURE 32: UNIVERSITY TOUR TIME OF DAY CALIBRATION**

## School Tour Scheduling Model Calibration

School tours time of day factors were not adjusted. These matched well from the donor model. The calibration constants are listed in Table 18. The calibration of the model is shown in Figure 33

**TABLE 18: SCHOOL TOUR TIME OF DAY CALIBRATION CONSTANTS**

| CONSTANT DESCRIPTION | CONSTANT |
|---|---|
| Departure constant: Before 6:00 AM | -8.76 |
| Departure 6:00 AM - 6:30 AM | -2.71 |
| Departure 6:30 AM - 7:00 AM | -0.65 |
| Departure 7:00 AM - 7:30 AM | 0.00 |

| CONSTANT DESCRIPTION | CONSTANT |
|---|---|
| Departure 7:30 AM - 8:00 AM | -0.48 |
| Departure constant: After 8:00 AM | 1.03 |
| Depature linear: shift for every 30 minutes after 8:30 AM | 0.00 |
| Depature sublinear: shift by square root of every 30 minutes after 8:30 AM | -0.50 |
| Arrival constant: before 2:30 PM | 0.00 |
| Arrival 2:30 PM - 3:00 PM | 0.00 |
| Arrival 3:00 PM - 3:30 PM | 0.23 |
| Arrival 3:30 PM - 4:00 PM | 0.00 |
| Arrival 4:00 PM - 4:30 PM | 0.00 |
| Arrival 4:30 PM - 5:00 PM | -1.02 |
| Arrival 5:00 PM - 5:30 PM | -1.44 |
| Arrival 5:30 PM - 6:00 PM | -1.85 |
| Arrival constant: after 6:00 PM | -2.33 |
| Arrival linear: shift for every 30 minutes after 6:30 PM | -0.69 |
| Duration linear: shift for every 30 minutes under 6.5 hours | -0.20 |
| Duration constant: less than 7 hours | -3.03 |
| Duration 7 hours | -1.87 |
| Duration 7.5 hours | -0.38 |
| Duration 8 hours | 0.00 |
| Duration 8.5 hours | -0.27 |
| Duration 9 hours | -0.82 |
| Duration constant: longer than 9 hours | -0.54 |
| Duration linear: shift for every 30 minutes longer than 9.5 hours | 0.22 |

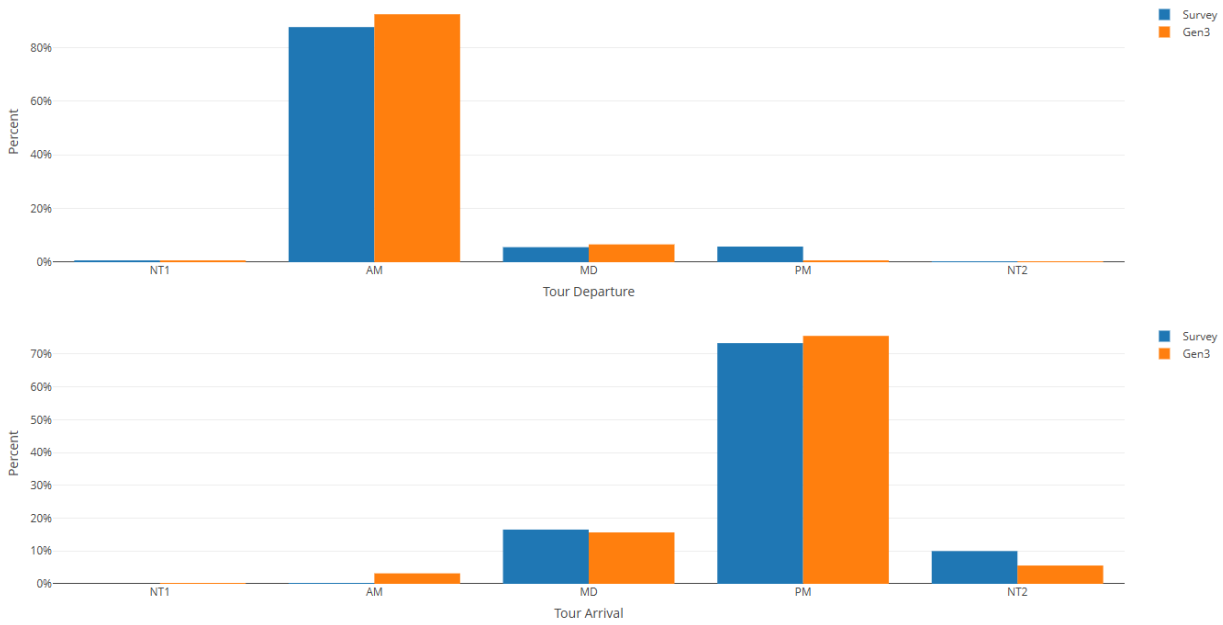


**FIGURE 33: SCHOOL TOUR TIME OF DAY CALIBRATION**

## Joint Tour Scheduling Model Calibration

The calibration of the model is shown in Figure 34 which shows a close match with the survey results.

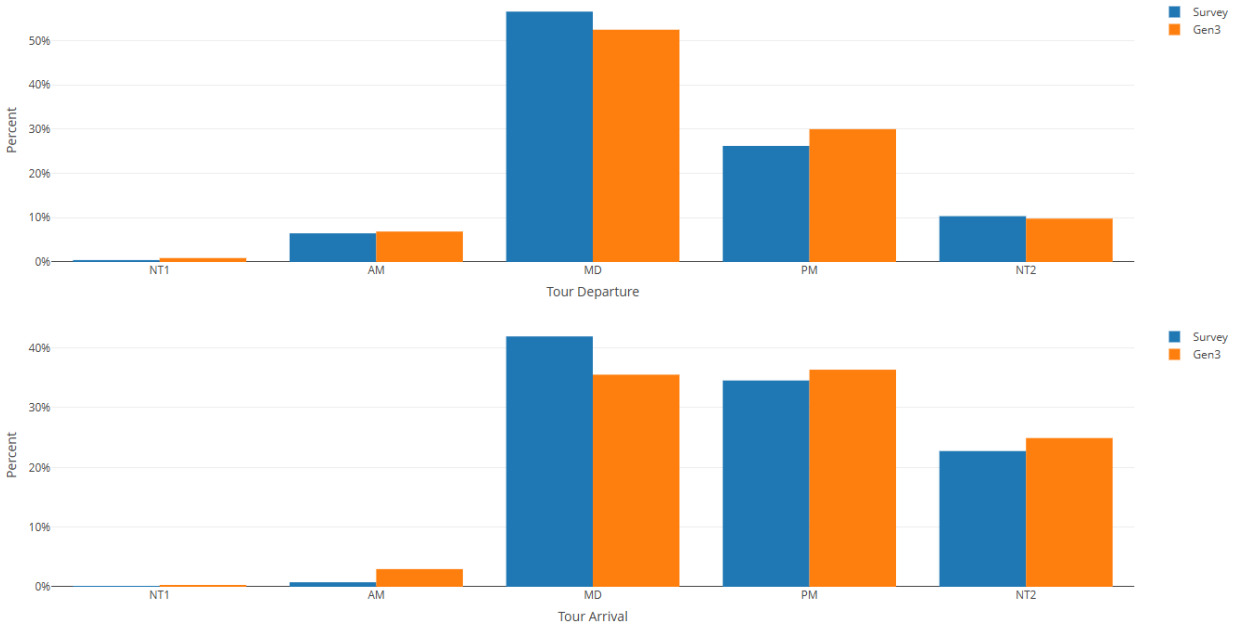


**FIGURE 34: JOINT MAINTENANCE TOUR TIME OF DAY CALIBRATION**

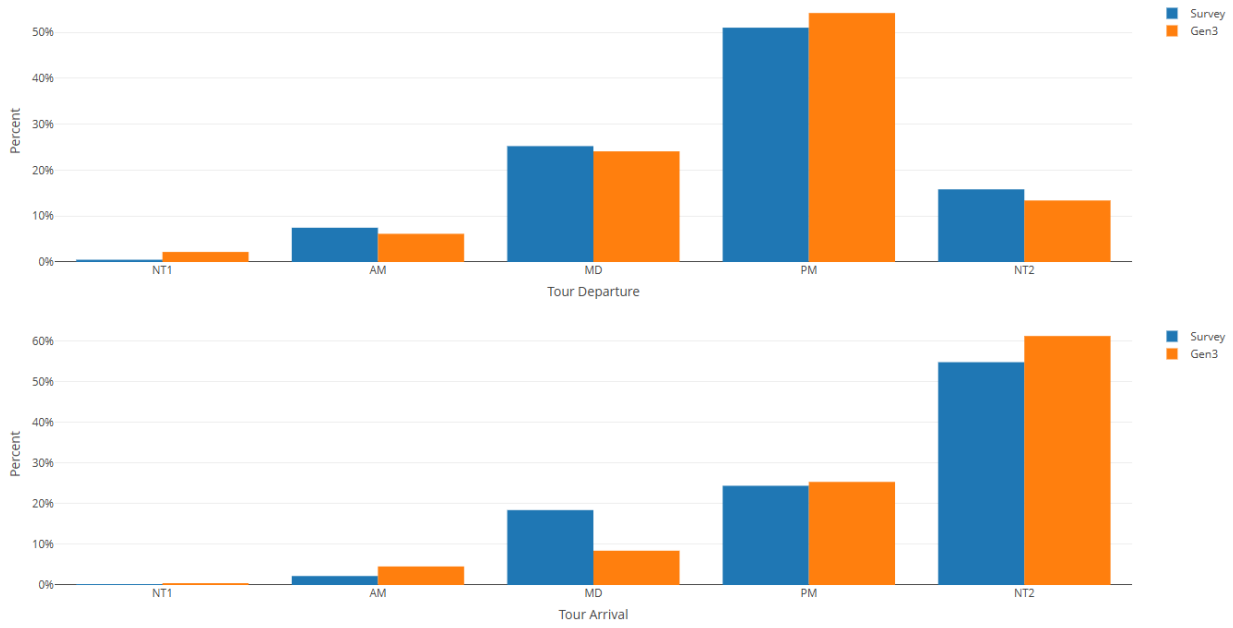


**FIGURE 35: JOINT DISCRETIONARY TOUR TIME OF DAY CALIBRATION**

## Individual Non-mandatory Tour Scheduling Model Calibration

Individual non-mandatory tour scheduling model specifications were largely unified prior to attempting to calibrate the five purposes shown. The configuration of these models includes five purpose groups:

- Escort tours
- Individual and Joint Maintenance Tours
    - Shopping
    - Other Maintenance
- Individual and Joint Discretionary Tours
    - Eating out
    - Social-Recreational
    - Other Discretionary

**TABLE 19: INDIVIDUAL NON-MANDATORY TOUR DEPARTURE CALIBRATION CONSTANTS**

| CONSTANT DESCRIPTION | ESCORT | SHOPPING | OTHER MAINT | EAT-OUT | SOCIAL-REC | OTHER DISC |
|---|---|---|---|---|---|---|
| Departure linear every half hour before 7:30 AM | 0.50 | 0.51 | 0.93 | 0.82 | 1.95 | 1.85 |
| Departure before 7:30 AM | 0.00 | -0.55 | 0.22 | 0.15 | -0.32 | -0.15 |
| Departure 5:00 AM - 5:30 AM | -2.31 | | | | | |
| Departure 5:30 AM - 6:00 AM | -2.97 | -1.77 | -2.53 | -0.04 | -0.18 | 1.66 |
| Departure 6:00 AM - 6:30 AM | -4.15 | -0.24 | -1.24 | -0.43 | -1.48 | 0.41 |
| Departure 6:30 AM - 7:00 AM | -3.38 | 0.05 | -1.12 | -0.68 | -2.56 | -0.81 |
| Departure 7:00 AM - 7:30 AM | -0.88 | 0.31 | -1.17 | -0.56 | -1.78 | -1.71 |
| Departure 7:30 AM - 8:00 AM | 1.75 | 0.07 | -0.88 | -0.62 | -4.94 | -3.06 |
| Departure 8:00 AM - 8:30 AM | 4.78 | 0.49 | -0.27 | -0.15 | -4.37 | -2.63 |
| Departure 8:30 AM - 9:00 AM | 7.45 | 0.77 | 0.18 | 0.31 | -3.75 | -2.22 |
| Departure 9:00 AM - 9:30 AM | 6.40 | 0.70 | 0.28 | 0.10 | -3.80 | -2.48 |
| Departure 9:30 AM - 10:00 AM | 4.35 | 0.80 | 0.56 | 0.37 | -3.34 | -2.19 |
| Departure 10:00 AM - 10:30 AM | 3.52 | 1.28 | 1.21 | 0.86 | -2.71 | -1.71 |
| Departure 10:30 AM - 11:00 AM | 2.45 | 1.27 | 1.34 | 0.71 | -2.68 | -1.89 |
| Departure 11:00 AM - 11:30 AM | 3.26 | 1.64 | 1.85 | 1.13 | -2.10 | -1.48 |
| Departure 11:30 AM - 12:00 PM | 2.42 | 1.61 | 1.91 | 1.30 | -1.74 | -1.31 |
| Departure 12:00 PM - 12:30 PM | 1.14 | 1.94 | 2.38 | 1.57 | -1.32 | -1.06 |
| Departure 12:30 PM - 1:00 PM | 0.38 | 1.93 | 2.48 | 1.64 | -1.06 | -0.93 |
| Departure 1:00 PM - 1:30 PM | -1.49 | 2.31 | 2.95 | 1.89 | -0.69 | -0.72 |
| Departure 1:30 PM - 2:00 PM | -1.18 | 2.23 | 2.97 | 1.93 | -0.51 | -0.69 |
| Departure 2:00 PM - 2:30 PM | -0.17 | 2.62 | 3.49 | 2.42 | 0.11 | -0.26 |
| Departure 2:30 PM - 3:00 PM | 0.41 | 2.94 | 3.98 | 2.54 | 0.36 | -0.09 |
| Departure 3:00 PM - 3:30 PM | 2.10 | 2.59 | 3.83 | 2.60 | 0.57 | -0.07 |
| Departure 3:30 PM - 4:00 PM | 4.01 | 2.72 | 4.08 | 3.05 | 1.08 | 0.30 |
| Departure 4:00 PM - 4:30 PM | 5.08 | 3.00 | 4.49 | 3.78 | 1.84 | 0.84 |
| Departure 4:30 PM - 5:00 PM | 5.09 | 3.04 | 4.67 | 4.42 | 2.52 | 1.30 |
| Departure 5:00 PM - 5:30 PM | 5.90 | 2.99 | 4.68 | 5.35 | 3.41 | 1.97 |
| Departure 5:30 PM - 6:00 PM | 6.77 | 3.12 | 4.95 | 5.84 | 3.86 | 2.22 |

| CONSTANT DESCRIPTION | ESCORT | SHOPPING | OTHER MAINT | EAT-OUT | SOCIAL-REC | OTHER DISC |
|---|---|---|---|---|---|---|
| Departure 6:00 PM - 6:30 PM | 6.38 | 3.70 | 5.75 | 6.62 | 4.63 | 2.71 |
| Departure 6:30 PM - 7:00 PM | 5.92 | 3.44 | 5.71 | 6.91 | 5.25 | 2.99 |
| Departure 7:00 PM - 7:30 PM | 4.71 | 2.89 | 5.45 | 6.93 | 5.64 | 2.94 |
| Departure 7:30 PM - 8:00 PM | 4.78 | 3.28 | 6.21 | 6.41 | 5.65 | 2.55 |
| Departure 8:00 PM - 8:30 PM | 5.02 | 3.43 | 6.77 | 7.11 | 6.92 | 3.29 |
| Departure 8:30 PM - 9:00 PM | 5.02 | 3.44 | 7.03 | 6.19 | 6.60 | 2.88 |
| Departure 9:00 PM - 9:30 PM | 4.98 | 4.29 | 7.41 | 8.47 | 6.90 | 3.42 |
| Departure 9:30 PM - 10:00 PM | 5.50 | 4.36 | 9.46 | 7.93 | 6.56 | 3.26 |
| Departure 10:00 PM - 10:30 PM | 5.55 | 3.12 | 6.82 | 8.56 | 8.52 | 4.23 |
| Departure 10:30 PM - 11:00 PM | 4.51 | -0.45 | 0.24 | 9.31 | 11.35 | 5.62 |
| Departure 11:00 PM - 11:30 PM | 3.93 | 3.65 | 9.43 | 8.92 | 11.94 | 5.28 |
| Departure after 9:00 PM | -1.20 | -0.53 | -0.38 | -2.00 | 0.66 | 0.07 |
| Departure linear every half hour after 9:00 PM | -0.18 | -0.18 | -0.47 | -0.46 | -0.43 | -0.27 |

**TABLE 20: INDIVIDUAL NON-MANDATORY TOUR ARRIVAL CALIBRATION CONSTANTS**

| CONSTANT DESCRIPTION | ESCORT | SHOPPING | OTHER MAINT | EAT-OUT | SOCIAL-REC | OTHER DISC |
|---|---|---|---|---|---|---|
| Arrival linear every half hour before 7:30 AM | -0.01 | 0.00 | -0.07 | 0.08 | -0.23 | -0.06 |
| Arrival before 7:30 AM | 0.93 | 0.00 | -3.09 | -3.81 | -1.19 | -1.29 |
| Arrival 5:00 AM - 5:30 AM | 4.97 | | | | | |
| Arrival 5:30 AM - 6:00 AM | 4.80 | | | | | |
| Arrival 6:00 AM - 6:30 AM | 4.78 | | | | | |
| Arrival 6:30 AM - 7:00 AM | 6.03 | | | | | |
| Arrival 7:00 AM - 7:30 AM | 8.05 | | | | | |
| Arrival 7:30 AM - 8:00 AM | 9.98 | 4.03 | 4.63 | -1.30 | 5.47 | 4.92 |
| Arrival 8:00 AM - 8:30 AM | 7.93 | 4.38 | 5.34 | -1.18 | 5.83 | 4.62 |
| Arrival 8:30 AM - 9:00 AM | 4.89 | 5.46 | 6.58 | -1.29 | 5.64 | 4.15 |
| Arrival 9:00 AM - 9:30 AM | 2.30 | 5.63 | 6.61 | -0.89 | 5.77 | 4.26 |

| CONSTANT DESCRIPTION | ESCORT | SHOPPING | OTHER MAINT | EAT-OUT | SOCIAL-REC | OTHER DISC |
|---|---|---|---|---|---|---|
| Arrival 9:30 AM - 10:00 AM | -0.69 | 5.20 | 6.02 | -0.33 | 5.94 | 4.51 |
| Arrival 10:00 AM - 10:30 AM | -2.03 | 5.44 | 6.20 | -0.05 | 5.78 | 4.54 |
| Arrival 10:30 AM - 11:00 AM | -2.29 | 5.84 | 6.49 | -0.33 | 5.18 | 4.03 |
| Arrival 11:00 AM - 11:30 AM | -0.08 | 5.64 | 6.17 | -0.09 | 4.86 | 3.89 |
| Arrival 11:30 AM - 12:00 PM | 1.57 | 5.38 | 5.80 | 0.23 | 4.69 | 3.91 |
| Arrival 12:00 PM - 12:30 PM | 2.44 | 5.43 | 5.73 | 0.09 | 4.10 | 3.41 |
| Arrival 12:30 PM - 1:00 PM | 2.16 | 5.07 | 5.21 | 0.49 | 3.94 | 3.46 |
| Arrival 1:00 PM - 1:30 PM | 3.07 | 4.52 | 4.55 | 0.56 | 3.52 | 3.19 |
| Arrival 1:30 PM - 2:00 PM | 3.40 | 4.45 | 4.33 | 0.91 | 3.31 | 3.19 |
| Arrival 2:00 PM - 2:30 PM | 4.44 | 4.36 | 4.10 | 0.86 | 2.80 | 2.83 |
| Arrival 2:30 PM - 3:00 PM | 6.54 | 3.90 | 3.50 | 0.88 | 2.22 | 2.43 |
| Arrival 3:00 PM - 3:30 PM | 6.32 | 3.91 | 3.34 | 1.37 | 2.24 | 2.60 |
| Arrival 3:30 PM - 4:00 PM | 6.32 | 3.84 | 3.15 | 1.61 | 1.92 | 2.47 |
| Arrival 4:00 PM - 4:30 PM | 5.06 | 3.76 | 2.90 | 1.55 | 1.30 | 2.02 |
| Arrival 4:30 PM - 5:00 PM | 2.92 | 3.41 | 2.43 | 1.47 | 0.67 | 1.50 |
| Arrival 5:00 PM - 5:30 PM | 1.59 | 3.33 | 2.17 | 1.79 | 0.47 | 1.47 |
| Arrival 5:30 PM - 6:00 PM | 0.81 | 2.81 | 1.47 | 1.91 | 0.11 | 1.24 |
| Arrival 6:00 PM - 6:30 PM | 0.15 | 2.59 | 1.08 | 1.58 | -0.60 | 0.62 |
| Arrival 6:30 PM - 7:00 PM | -0.81 | 1.81 | 0.09 | 1.22 | -1.35 | 0.08 |
| Arrival 7:00 PM - 7:30 PM | -2.24 | 1.21 | -0.73 | 0.70 | -2.22 | -0.55 |
| Arrival 7:30 PM - 8:00 PM | -1.86 | 0.40 | -1.84 | 0.37 | -2.79 | -0.91 |
| Arrival 8:00 PM - 8:30 PM | -1.48 | 0.04 | -2.42 | 0.01 | -3.45 | -1.28 |
| Arrival 8:30 PM - 9:00 PM | -1.24 | 0.01 | -2.72 | 0.01 | -3.79 | -1.30 |
| Arrival 9:00 PM - 9:30 PM | | | -2.16 | | -2.77 | -1.12 |
| Arrival 9:30 PM - 10:00 PM | | | -1.19 | | -1.23 | -0.78 |
| Arrival 10:00 PM - 10:30 PM | | | | | 0.19 | -0.45 |
| Arrival 10:30 PM - 11:00 PM | | | | | | |
| Arrival 11:00 PM - 11:30 PM | | | | | | |
| Arrival after 9:00 PM | -2.52 | 0.38 | 0.20 | -1.00 | 0.50 | 0.16 |
| Arrival linear every half hour after 9:00 PM | 0.04 | -0.64 | -1.82 | -0.32 | -2.60 | -0.99 |

**TABLE 21: INDIVIDUAL NON-MANDATORY TOUR DURATION CALIBRATION CONSTANTS**

| CONSTANT DESCRIPTION | ESCORT | SHOPPING | OTHER MAINT | EAT-OUT | SOCIAL-REC | OTHER DISC |
|---|---|---|---|---|---|---|
| Duration < 30 minutes | -8.47 | -10.07 | -11.98 | -10.21 | -17.18 | -13.49 |
| Duration 0.5 hour | 4.85 | 5.48 | 5.58 | 2.24 | 0.05 | -2.02 |
| Duration 1 hour | 8.24 | 6.40 | 6.49 | 0.66 | 2.47 | 1.82 |
| Duration 1.5 hour | 8.46 | 6.14 | 6.39 | 0.91 | 3.09 | 4.01 |
| Duration 2 hour | 7.32 | 5.60 | 6.01 | 1.44 | 3.91 | 6.41 |
| Duration 2.5 hour | 6.20 | 5.22 | 5.74 | 1.48 | 4.21 | 5.95 |
| Duration 3 hour | 4.34 | 4.42 | 5.10 | 1.44 | 4.40 | 5.45 |
| Duration 3.5 hour | 2.98 | 3.71 | 4.52 | 1.09 | 3.85 | 4.69 |
| Duration 4 hour | 2.94 | 3.08 | 4.00 | 0.82 | 3.37 | 4.03 |
| Duration longer than 4 hours | 0.00 | 2.58 | 3.06 | 0.00 | 2.36 | 2.26 |
| Duration linear for every half hour > 4 hours | -0.31 | -0.42 | -0.24 | -0.19 | -0.41 | -0.49 |

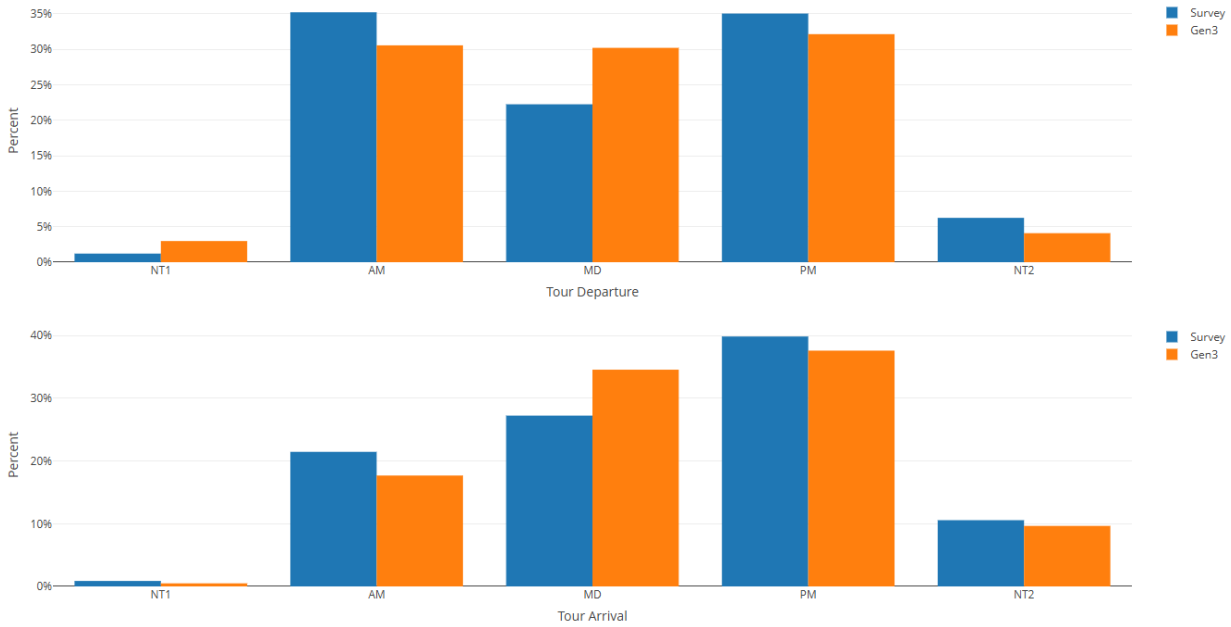


**FIGURE 36: ESCORT TOUR TIME OF DAY CALIBRATION**

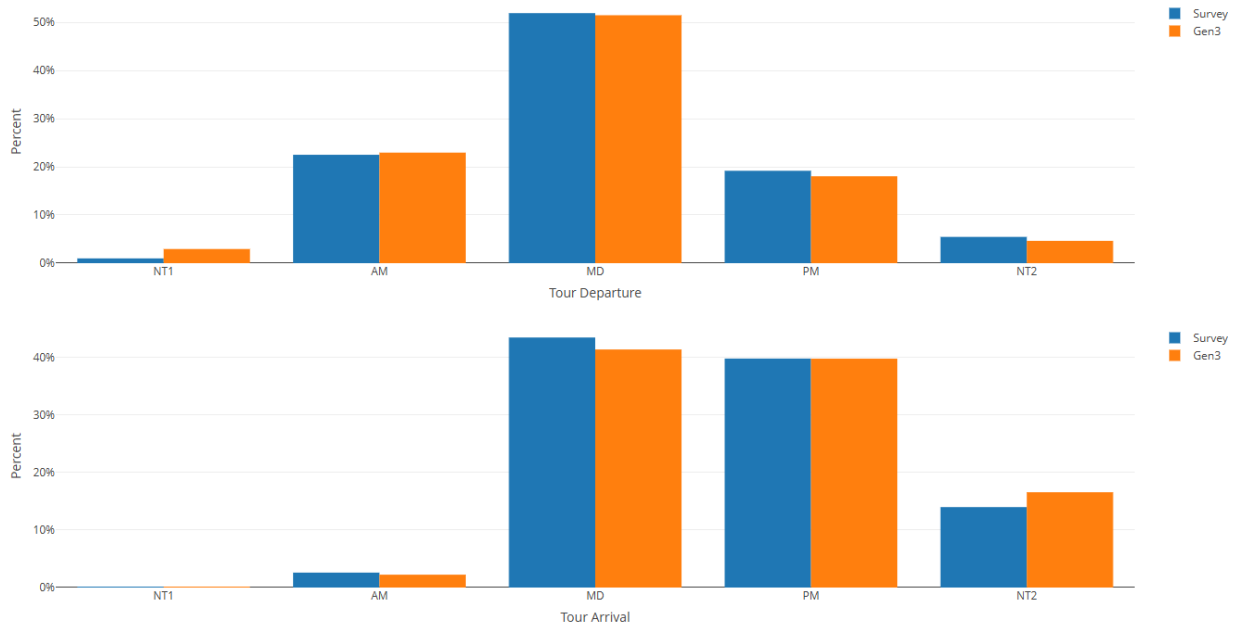


**FIGURE 37: INDIVIDUAL MAINTENANCE TOUR TIME OF DAY CALIBRATION**

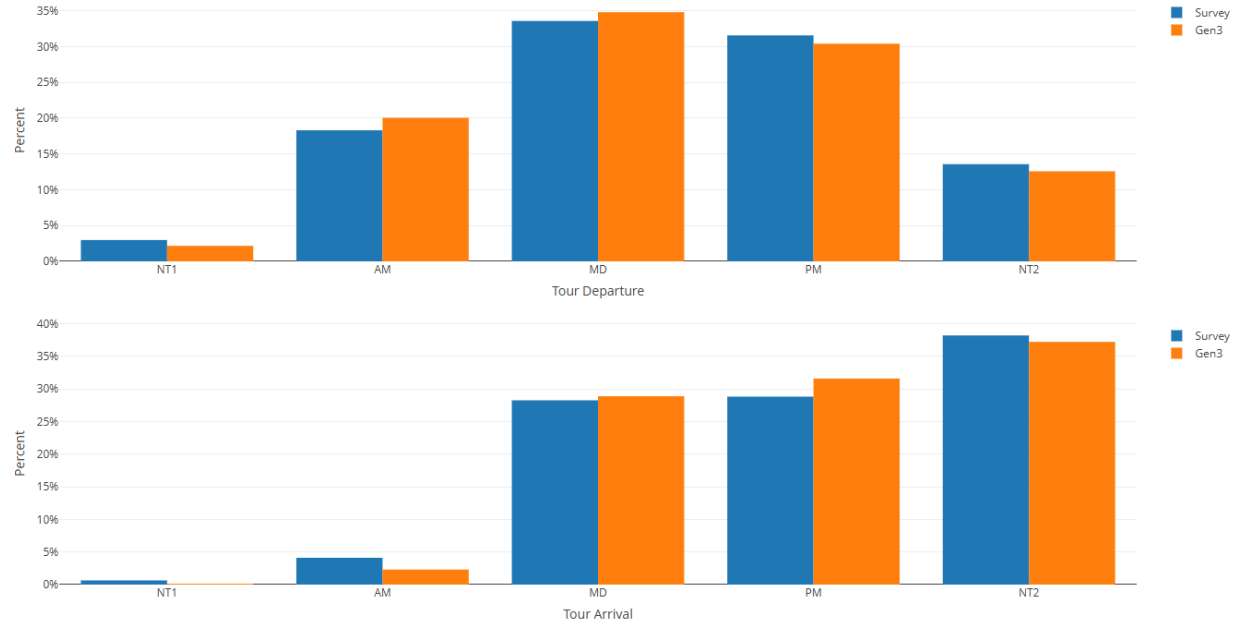


**FIGURE 38: INDIVIDUAL DISCRETIONARY TOUR TIME OF DAY CALIBRATION**

## At-Work Subtour Scheduling Model Calibration

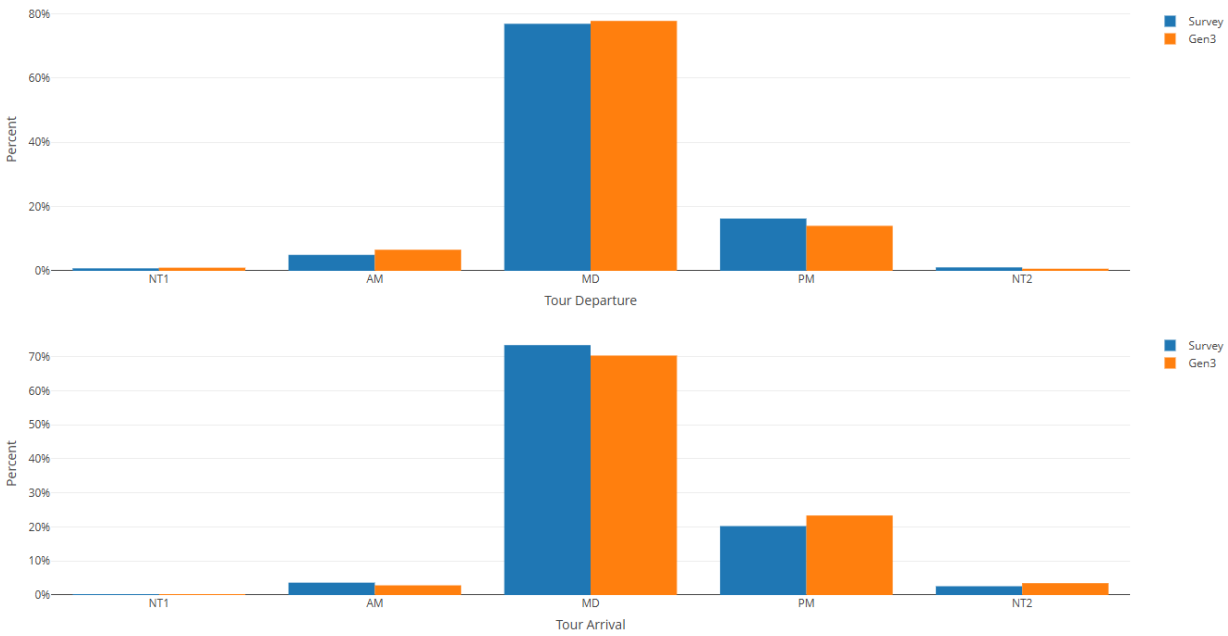


**FIGURE 39: AT-WORK SUBTOUR TIME OF DAY CALIBRATION**

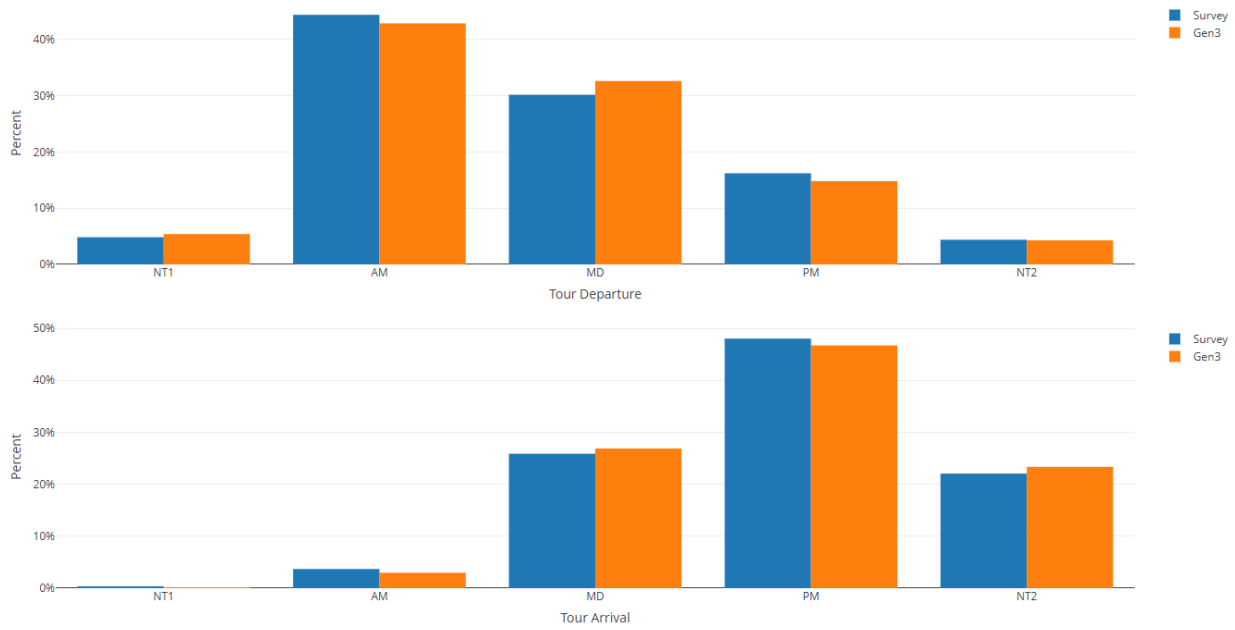


**FIGURE 40: OVERALL TOUR TIME OF DAY CALIBRATION**

## 2.14 TOUR MODE CHOICE

The tour mode choice model step assigns a tour mode to all the simulated tours in the model. It uses a nested logit model that is shown in Figure 41. This model was estimated in the first phase of the Gen3 Model development. Auto modes include single-occupant vehicle (SOV), two-person shared ride (SR2), and three or more person shared ride (SR3). Non-motorized modes include walk or bike. Ride hail modes include taxi, single-pay transportation network company (TNC),[12] or a shared TNC service such as UberPool or LyftLine. Transit tours are differentiated by access/egress mode, and transit path type. Access/egress modes include walk, Park-and-Ride (PNR), or Kiss-and-Ride (KNR). Path type includes Bus Only, Metrorail Only, Bus and Metrorail combined, or Commuter Rail (MARC and VRE trains).

During Phase 2, the mode share targets by tour purpose were revised based on comparisons of the household survey, the transit surveys, and the transit ridership data. During calibration, adjustments were made to the model constants to improve boardings by transit mode. Additionally, the calibration of this model uncovered an issue in the auto ownership model

[12] Transportation Network Companies at the time of writing are primarily Uber and Lyft.

where too few 0-auto working households were represented in the model. This was fixed with a constant in the auto ownership model.

Calibration of this model utilized a significant number of constants, since the model includes ten modes and eight purposes as well as some general factors that apply to all purposes. Additionally, many of the constants utilize auto sufficiency groups, defined as zero auto households, auto deficient households (fewer autos than drivers in the household), and auto sufficient households (at least as many autos as drivers in the household). In addition to these groups, some constants were added at the end based on traffic counts and transit ridership. These additional constants are listed in Table 22. The overall calibration results are shown in Figure 42. The calibration constants and results for individual tour purposes are discussed in each sub-section below.

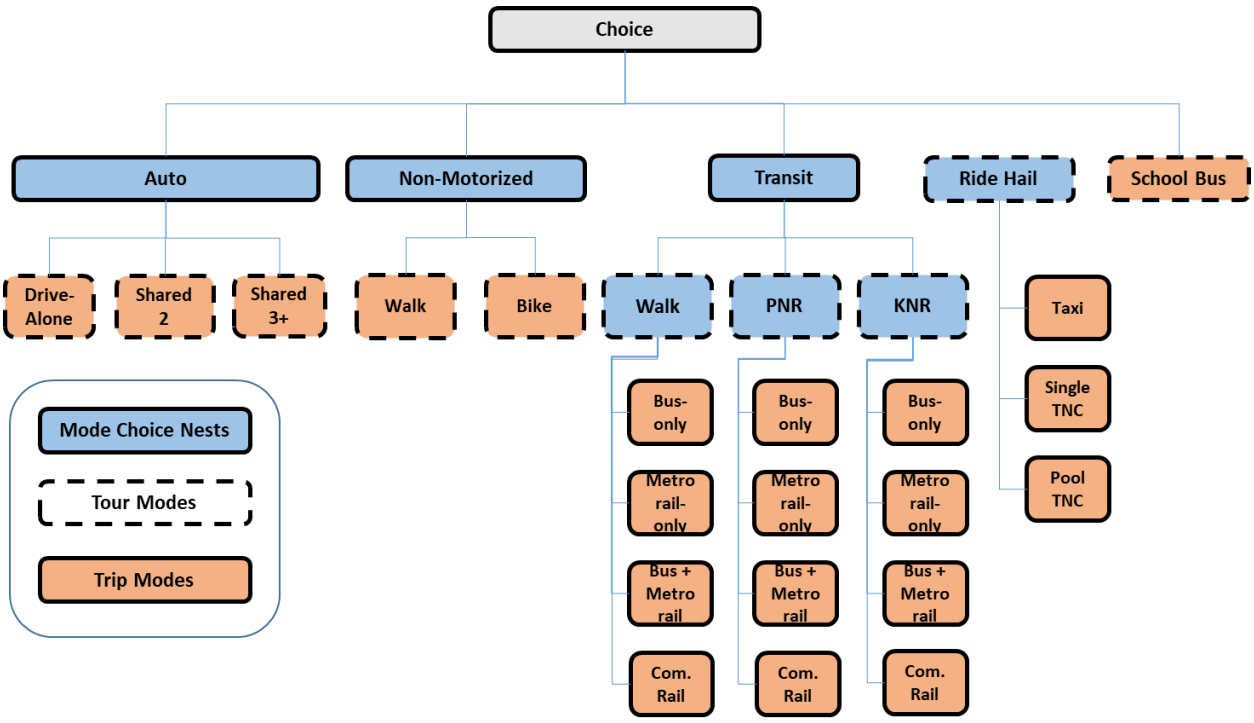


**FIGURE 41: TOUR MODE CHOICE NESTING STRUCTURE**

**TABLE 22: ADDITIONAL TOUR MODE CHOICE CALIBRATION CONSTANTS**

| Description | Constant |
|---|---|
| Auto Sufficient SOV Tours to DC Destination | -0.18 |
| Auto Sufficient SR2 Tours to DC Destination | -0.64 |
| Auto Sufficient Walk-Access Transit Tours to DC Destination | 0.80 |
| Auto Sufficient SOV School Tours | -0.34 |
| Metrorail Tours to DC Destination | 0.48 |
| Bus-only Tours to DC Destination | -0.40 |
| Bus+Metrorail Tours to DC Destination | -0.10 |
| Commuter Rail tours to DC Destination | 0.30 |
| SOV Tours to DC Destination (all auto sufficiency groups) | -1.10 |
| Bus modes within DC | 0.55 |
| SOV modes within DC | 0.20 |
| Shared-Ride 2 tours to DC Destination | 0.75 |
| Shared-Ride 3+ tours to DC Destination | 0.55 |
| SOV tours to non-DC Destinations | 0.50 |
| Transit technology ASC* | Differing by purpose |

* This set of constants were mainly used in the last phase of calibration to better match observed ridership.

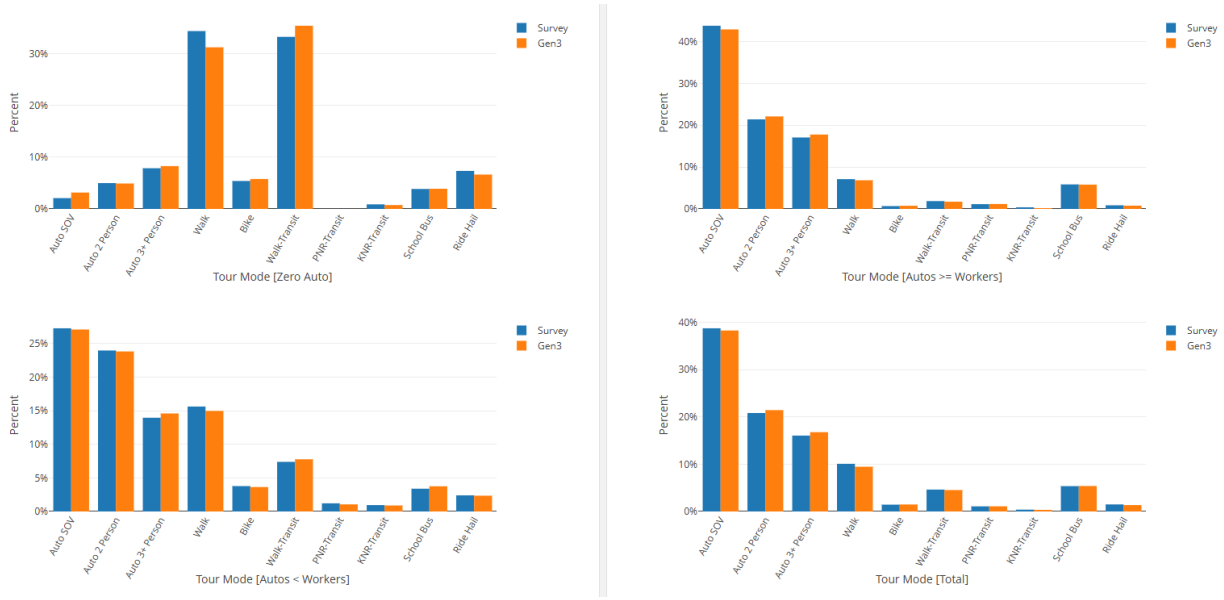


**FIGURE 42: TOUR MODE CHOICE CALIBRATION - ALL TOUR PURPOSES**

## Work Tours

The main work tour mode choice calibration constants by auto sufficiency group are listed in Table 23, and the transit access and path type calibration constants are listed in Table 24. For work tours and households with no autos, PNR transit is disabled via constants (the -999 constant effectively disables a choice). This is because the survey data does not have any zero-auto households that used PNR access to transit. The tour mode choice results for work tours are shown in Figure 43. While overall estimated tours by tour mode is very close to observed, the zero-auto household group does overestimate transit over walking, and the autos < workers group overestimates auto while underestimating walk-access transit.

**TABLE 23: WORK TOUR CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)**

| Tour Mode | No Auto | Auto Deficient | Auto Sufficient |
|---|---|---|---|
| Drive Alone | 0.00 | 0.00 | 0.22 |
| Shared-Ride 2 | 14.33 | -3.41 | 0.05 |
| Shared-Ride 3+ | 14.80 | -4.01 | -0.77 |
| Walk | 19.97 | -0.16 | 0.73 |
| Bike | 17.09 | -3.30 | -2.46 |
| Walk Transit | 19.71 | -0.82 | 0.38 |
| PNR Transit | -999 | -3.03 | -0.05 |
| KNR Transit | 15.60 | -3.96 | -2.47 |
| Taxi | 16.03 | -3.94 | -2.12 |
| TNC Single | 16.73 | -3.58 | -2.70 |
| TNC Shared | 15.03 | -5.16 | -3.81 |

**TABLE 24: WORK TRANSIT ACCESS AND LINE HAUL CALIBRATION CONSTANTS**

| Transit Mode | Walk Access | PNR Access | KNR Access |
|---|---|---|---|
| Bus Only | -0.53 | -1.35 | -0.42 |
| Metrorail Only | 0.20 | -0.60 | -0.02 |
| Bus + Metrorail | -0.89 | -0.26 | -0.26 |
| Commuter Rail | -1.31 | 1.05 | 0.76 |

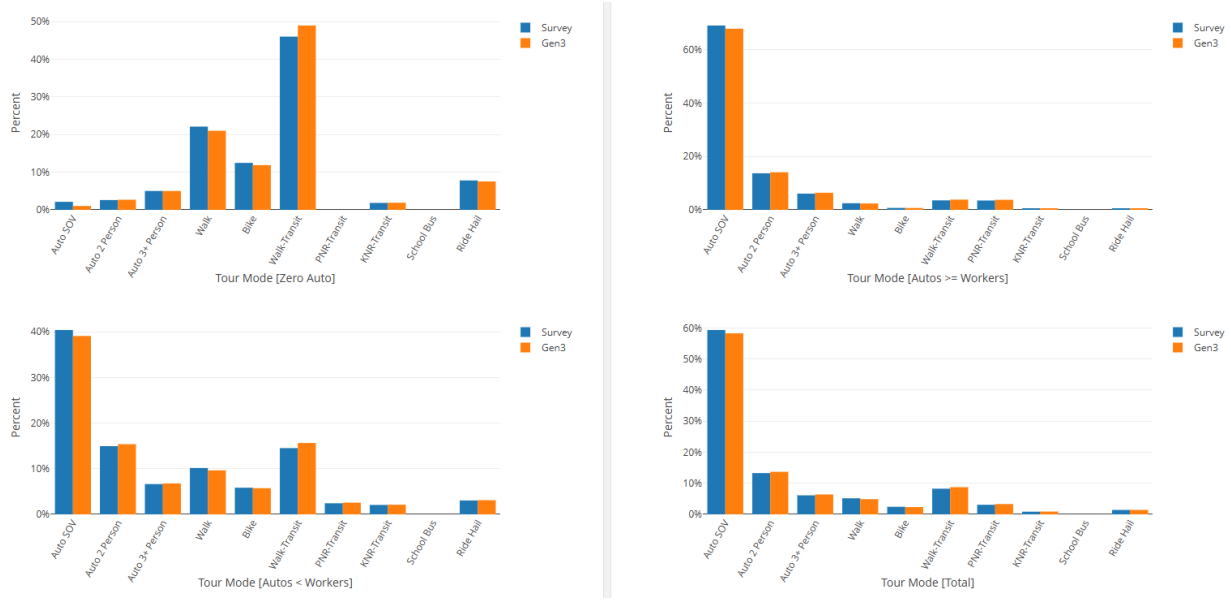


**FIGURE 43: TOUR MODE CHOICE VALIDATION - WORK TOURS**

## University and School Tours

The main university and school tour mode choice calibration constants by auto sufficiency group are listed in Table 25 and Table 26, respectively. A value of -999 effectively disables the choice. For university tours, the surveys did not observe any persons living in zero-auto households using PNR or KNR transit, so those alternatives were disallowed. Additionally, no bicycle tours were observed for auto sufficient households, so that alternative was also disallowed. For school tours, no PNR or KNR transit or rideshare tours from households owning autos were observed in the survey data, so those alternatives were disallowed. The transit access and line-haul constants are shown in Table 27. Similar to the tour mode by auto sufficiency groups, all of the PNR and most of the KNR alternatives were disallowed. The calibration results for university tours are shown in Figure 44. The model's zero-auto households segment overestimates rideshare tours and underestimates walk and walk-access transit. The other segments overestimate drive-alone tours. The validation results for school tours are shown in Figure 45. The results of this group are very close except for underestimating walk and overestimating walk-access transit for zero-auto households.

**TABLE 25: UNIVERSITY TOUR CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)**

| Tour Mode | No Auto | Auto Deficient | Auto Sufficient |
|---|---|---|---|
| Drive Alone | 0.00 | 0.00 | 0.00 |
| Shared-Ride 2 | -15.24 | -1.99 | 3.87 |
| Shared-Ride 3+ | -14.35 | -2.44 | 3.76 |
| Walk | -10.8 | -3.1 | 3.56 |
| Bike | -15.25 | -5.11 | -999 |
| Walk Transit | -12.67 | -1.66 | 4.23 |
| PNR Transit | -999 | 7.18 | 10.24 |
| KNR Transit | -999 | -2.79 | 1.42 |
| Taxi | -12.34 | -4.38 | 1.74 |
| TNC Single | -15.22 | -4.38 | 1.74 |
| TNC Shared | -15.22 | -4.38 | 1.74 |

**TABLE 26: SCHOOL TOUR CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)**

| Tour Mode | No Auto | Auto Deficient | Auto Sufficient |
|---|---|---|---|
| Drive Alone | 0.00 | 0.00 | 0.00 |
| Shared-Ride 2 | -999 | 0.59 | 0.69 |
| Shared-Ride 3+ | 2.84 | 0.8 | 1.14 |
| Walk | 7.31 | 1.29 | 1.08 |
| Bike | -6.61 | -0.83 | -2.04 |
| Walk Transit | 8 | -0.41 | -0.42 |
| PNR Transit | 0.00 | -999 | -999 |
| KNR Transit | 6.93 | -999 | -999 |
| Taxi | -0.3 | -999 | -999 |
| TNC Single | 0.00 | -999 | -999 |
| TNC Shared | 3.65 | -999 | -999 |

**TABLE 27: SCHOOL AND UNIVERSITY TRANSIT ACCESS AND LINE HAUL CALIBRATION CONSTANTS**

| Transit Mode | Walk Access | PNR Access | KNR Access |
|---|---|---|---|
| Bus Only | -0.30 | -999 | -0.77 |
| Metrorail Only | 0.00 | -999 | -999 |
| Bus + Metrorail | -0.01 | -999 | -999 |
| Commuter Rail | -0.85 | -999 | -999 |

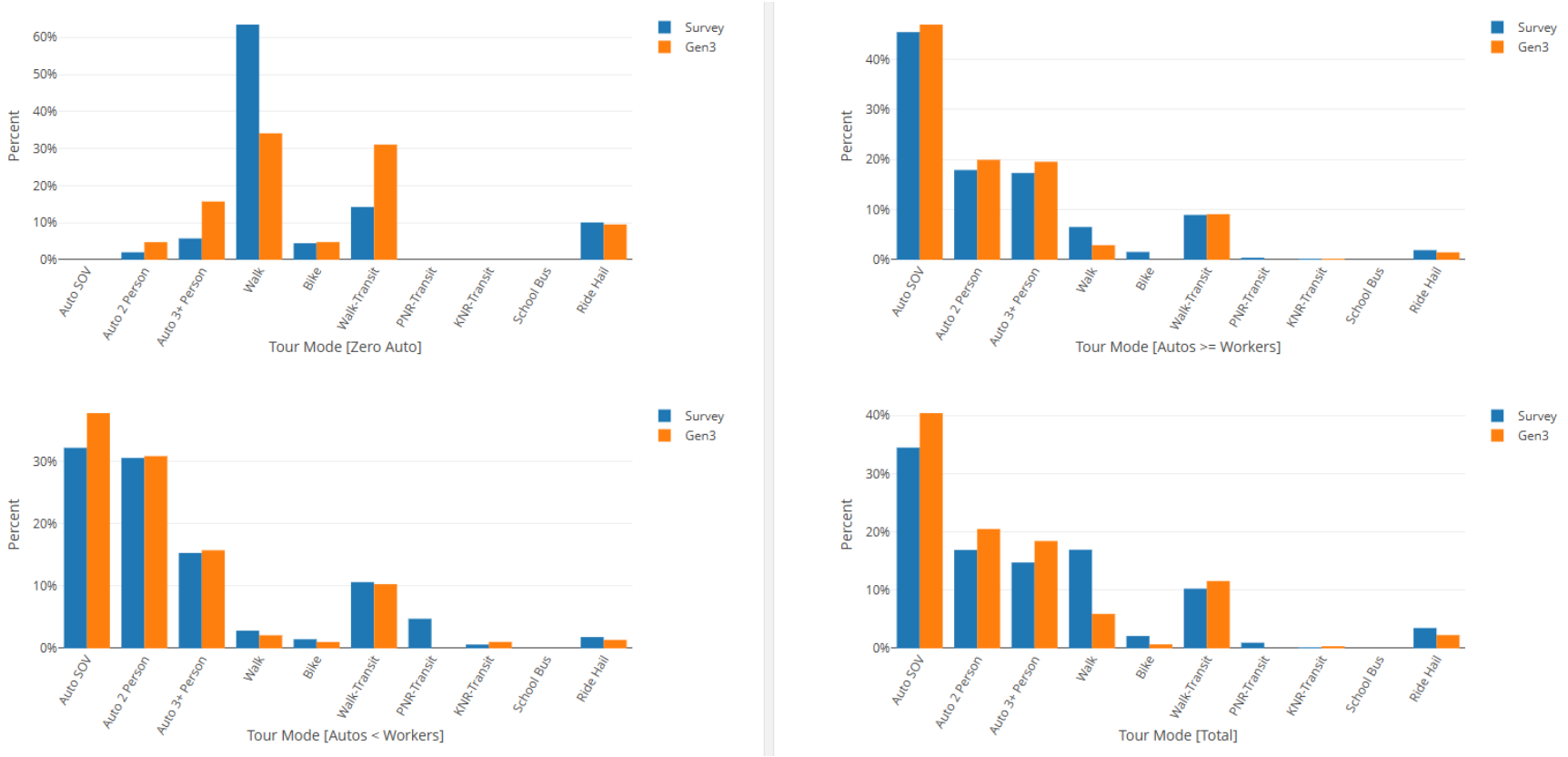


**FIGURE 44: TOUR MODE CHOICE VALIDATION - UNIVERSITY TOURS**

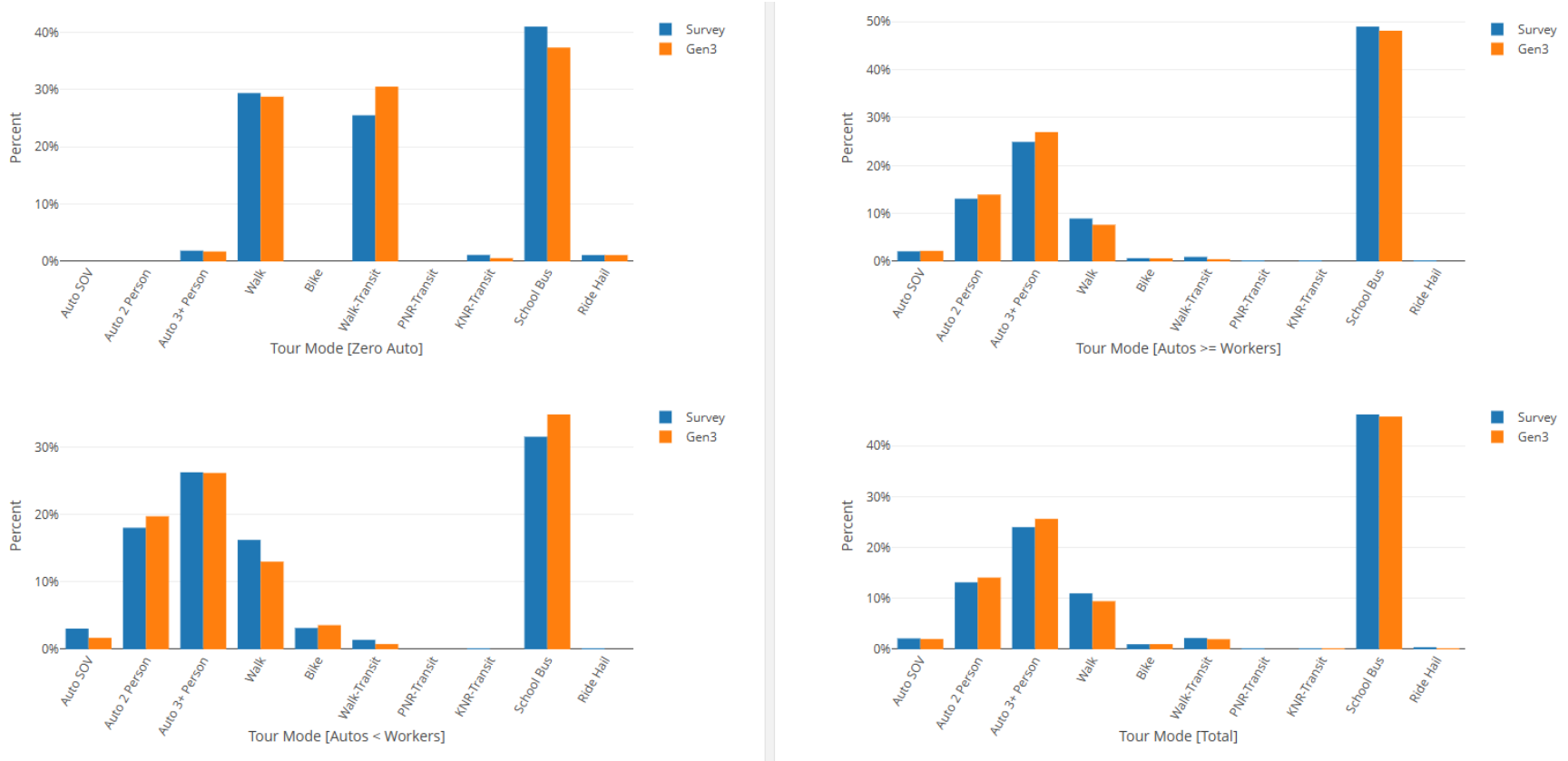


**FIGURE 45: TOUR MODE CHOICE VALIDATION - SCHOOL TOURS**

## Non-Mandatory Tours

In the data used to estimate many of the non-mandatory tour mode choice models, there were very few observed PNR- or KNR-access transit trips, so those choices are prohibited in the model via constants. The tour mode choice calibration by market segment is listed in Table 28, Table 29, Table 30, and Table 31 for individual maintenance, individual discretionary, joint maintenance, and joint discretionary, respectively. Table 32 lists the transit line-haul calibration constants for all non-mandatory tour purposes. The results of the individual maintenance mode choice model are shown in Figure 46. This model overestimates drive-alone auto travel but is otherwise close. The results of the individual discretionary mode choice model are shown in Figure 47. Similar to the individual maintenance model, this model overestimates drive-alone auto. The results of the joint maintenance model are shown in Figure 48. Note that the drive-alone auto choice is not allowed for this model, since by definition there has to be more than one person on the tour. This model has some tradeoffs between 2-person auto and 3-person auto but is close with non-auto mode choice. Finally, the results of the joint discretionary model are shown in Figure 49. Similar to the joint maintenance model, the drive-alone auto choice is not allowed.

**TABLE 28: INDIVIDUAL MAINTENANCE TOUR CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)**

| Tour Mode | No Auto | Auto Deficient | Auto Sufficient |
|---|---|---|---|
| Drive Alone | 0.00 | 0.00 | 0.00 |
| Shared-Ride 2 | 1.87 | 3.54 | 4.04 |
| Shared-Ride 3+ | 2.3 | 3.3 | 3.91 |
| Walk | 6.55 | 5.52 | 5.76 |
| Bike | 2.01 | 0.8 | 2.15 |
| Walk Transit | 6.23 | 3.5 | 3.56 |
| PNR Transit | -999 | -999 | -999 |
| KNR Transit | 0.00 | -999 | -999 |
| Taxi | 4.02 | 1.15 | 2.01 |
| TNC Single | 3.03 | 0.6 | 0.25 |
| TNC Shared | 0.55 | 0.24 | -999 |

**TABLE 29: INDIVIDUAL DISCRETIONARY TOUR CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)**

| Tour Mode | No Auto | Auto Deficient | Auto Sufficient |
|---|---|---|---|
| Drive Alone | 0.00 | 0.00 | 0.00 |
| Shared-Ride 2 | 1.12 | 3.26 | 6.54 |
| Shared-Ride 3+ | 1.04 | 2.78 | 6.44 |
| Walk | 5.39 | 5.73 | 8.34 |
| Bike | 2.01 | 0.8 | 2.15 |
| Walk Transit | 5.1 | 4.59 | 6.25 |
| PNR Transit | -6 | -999 | 5.09 |
| KNR Transit | 1.47 | -1.18 | -2.12 |
| Taxi | 2.71 | 2.16 | 5.56 |
| TNC Single | 3.04 | 3.08 | 5.64 |
| TNC Shared | 1.12 | 1.9 | 3.99 |

**TABLE 30: JOINT MAINTENANCE TOUR CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)**

| Tour Mode | No Auto | Auto Deficient | Auto Sufficient |
|---|---|---|---|
| Drive Alone | 0.00 | 0.00 | 0.00 |
| Shared-Ride 2 | -7.38 | 17.33 | 5.29 |
| Shared-Ride 3+ | -5.98 | -34.07 | 3.9 |
| Walk | -0.38 | -28.87 | 5.01 |
| Bike | -999 | -999 | -4.14 |
| Walk Transit | -4.27 | -999 | 4.22 |
| PNR Transit | -999 | -999 | -999 |
| KNR Transit | -999 | -999 | -999 |
| Taxi | -6.42 | -999 | -999 |
| TNC Single | -6.42 | -999 | -999 |
| TNC Shared | -6.42 | -999 | -999 |

**TABLE 31: JOINT DISCRETIONARY TOUR CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)**

| Tour Mode | No Auto | Auto Deficient | Auto Sufficient |
|---|---|---|---|
| Drive Alone | 0.00 | 0.00 | 0.00 |
| Shared-Ride 2 | -999 | 4.8 | 7.63 |
| Shared-Ride 3+ | 1.76 | -6.91 | 6.5 |
| Walk | 5.88 | 0.17 | 8.7 |
| Bike | -999 | -5.27 | 4.5 |
| Walk Transit | 7.47 | -5.24 | 4.73 |
| PNR Transit | -999 | -999 | -999 |
| KNR Transit | -999 | -999 | -999 |
| Taxi | -999 | -4.59 | 4.61 |
| TNC Single | -999 | -6.57 | 4.61 |
| TNC Shared | -999 | -5.17 | 4.61 |

**TABLE 32: NON-MANDATORY TOUR TRANSIT ACCESS AND LINE HAUL CALIBRATION CONSTANTS**

| Transit Mode | Walk Access | PNR Access | KNR Access |
|---|---|---|---|
| Bus Only | -0.23 | 0.03 | -0.18 |
| Metrorail Only | -0.52 | -999 | -0.68 |
| Bus + Metrorail | -1.54 | -999 | -999 |
| Commuter Rail | 0.72 | -999 | -999 |

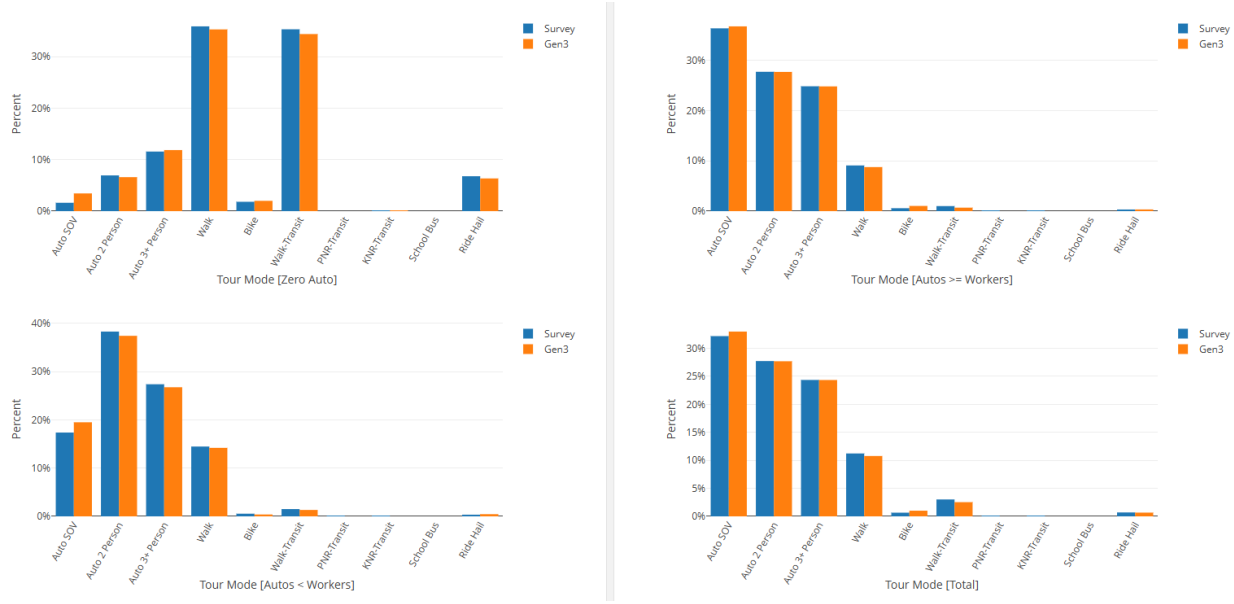


**FIGURE 46: TOUR MODE CHOICE CALIBRATION RESULTS- INDIVIDUAL MAINTENANCE TOURS**

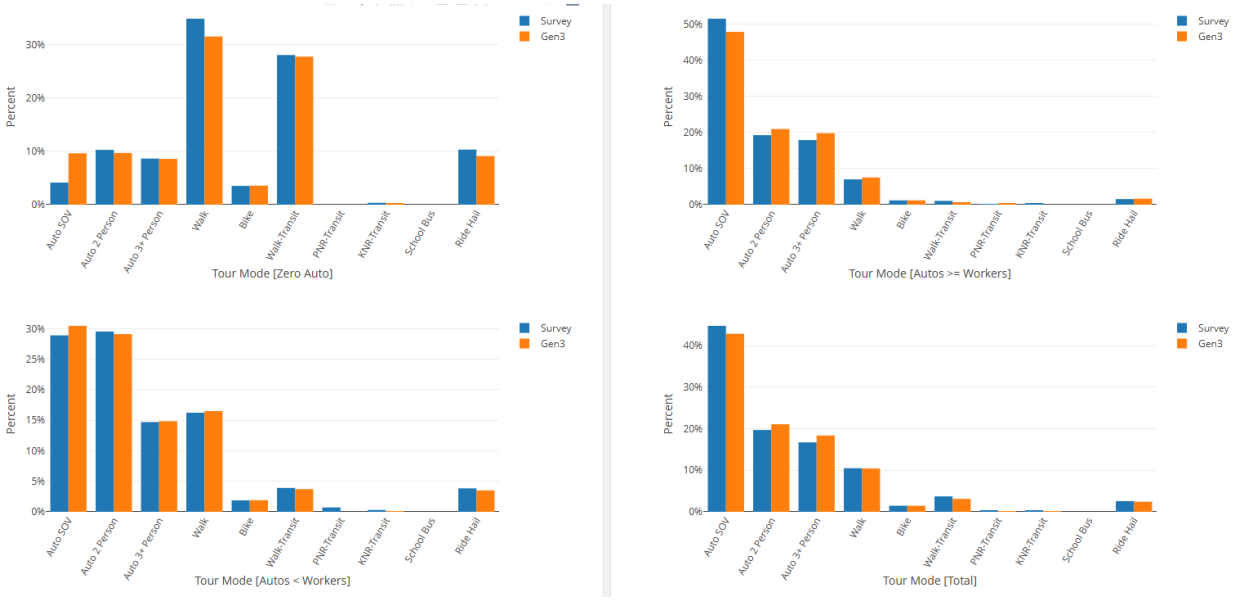


**FIGURE 47: TOUR MODE CHOICE CALIBRATION RESULTS - INDIVIDUAL DISCRETIONARY TOURS**

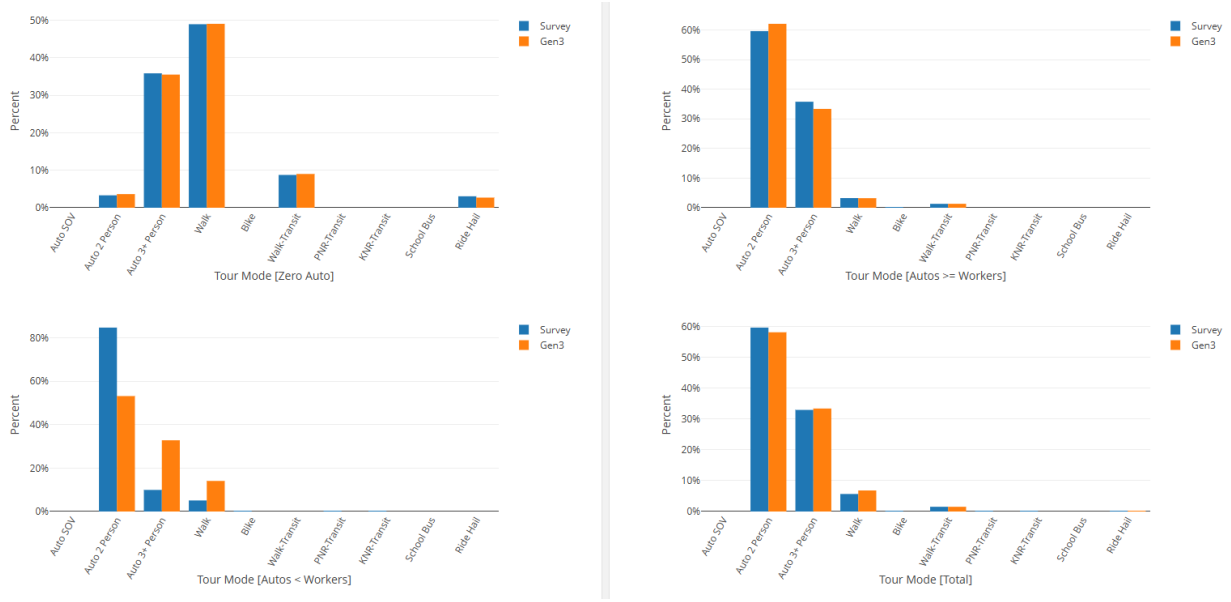


**FIGURE 48: TOUR MODE CHOICE CALIBRATION RESULTS - JOINT MAINTENANCE TOURS**

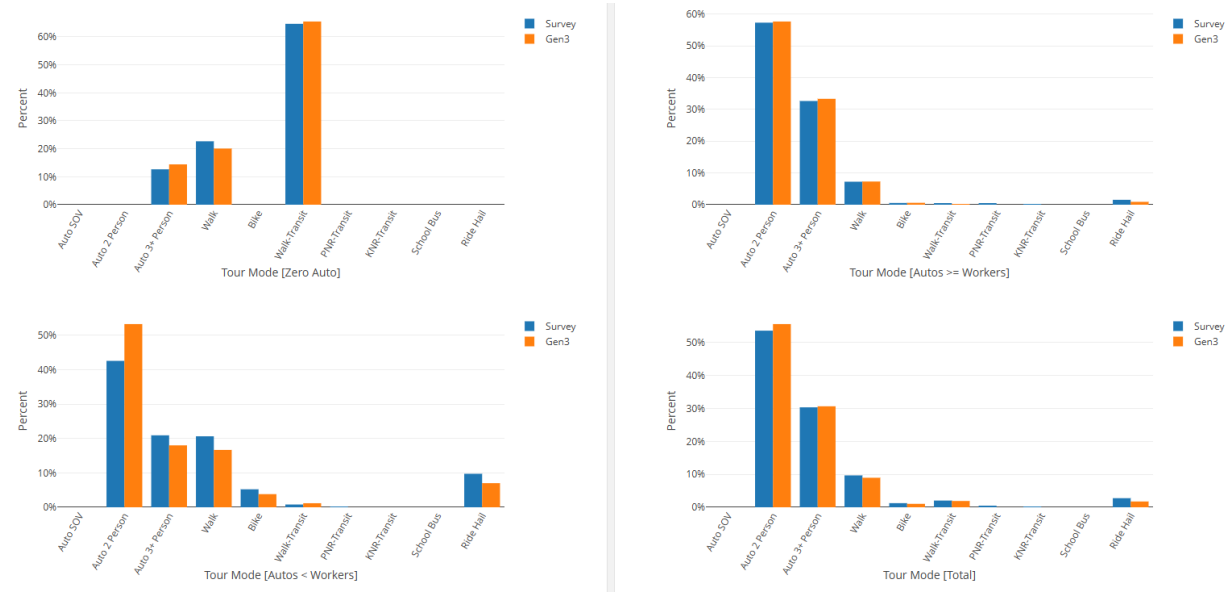


**FIGURE 49: TOUR MODE CHOICE CALIBRATION RESULTS - JOINT DISCRETIONARY TOURS**

## 2.15 AT-WORK SUBTOUR FREQUENCY

The at-work subtour frequency model step assigns the number of and types of subtours for work tours. This model step is applied to only work tours and uses a choice set of no-subtours, 1 business subtour, 2 business subtours, 1 eat subtour, 1 eat and 1 business subtour, or 1 maintenance subtour. The calibration constants for this model step are listed in Table 33. The results of this model are shown in Figure 50. This model underestimates maintenance and eat-out subtours, and overestimates no subtours.

**TABLE 33: AT-WORK SUBTOUR FREQUENCY CALIBRATION CONSTANTS**

| CONSTANT DESCRIPTION | CONSTANT |
|---|---|
| 1 Business Subtour | -0.54 |
| 2 Business Subtour | -2.13 |
| Eat Subtour | 0.86 |
| Eat & Business Subtour | -0.97 |
| 1 Maintenance Subtour | -0.62 |
| No Subtours | 0.00 |

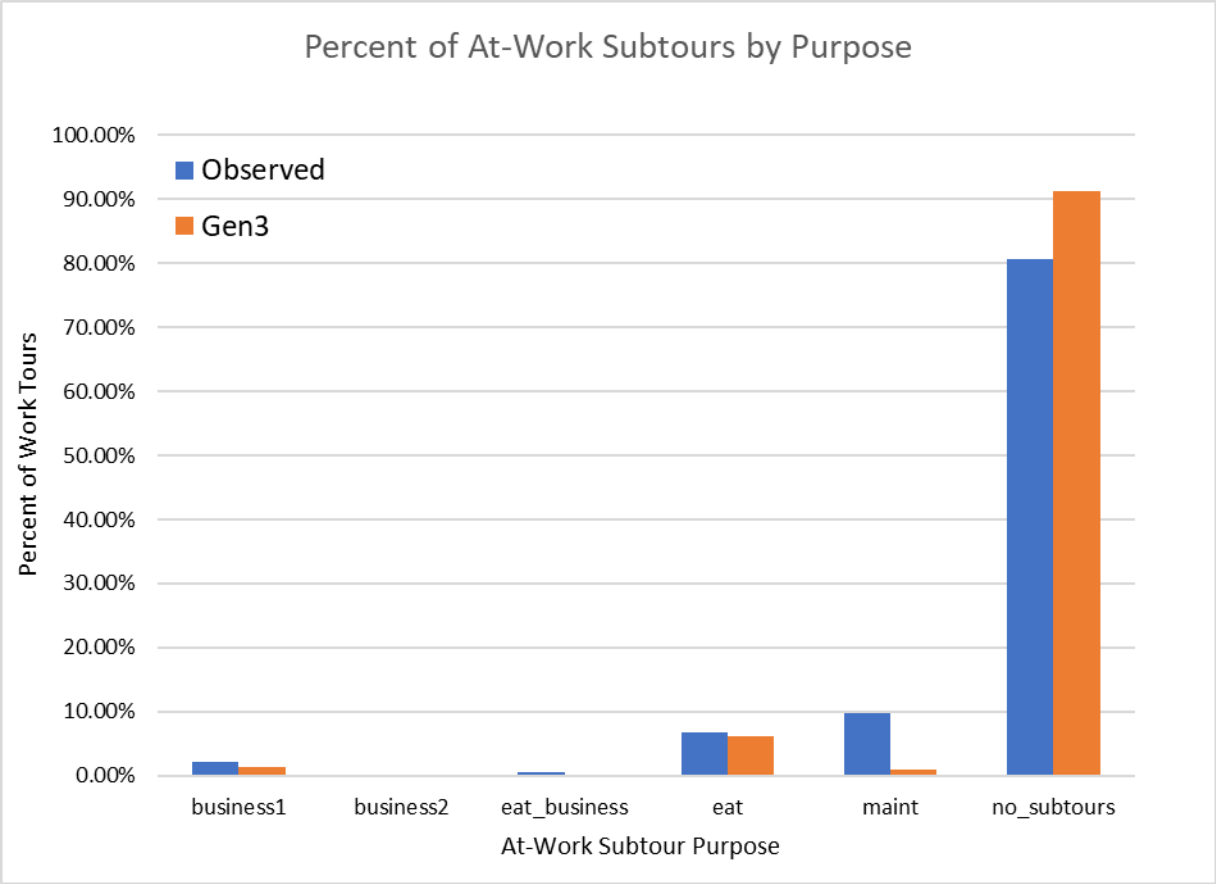


**FIGURE 50: AT-WORK SUBTOUR FREQUENCY CALIBRATION RESULTS**

## 2.16 AT-WORK SUBTOUR DESTINATION

The at-work subtour destination location model step assigns the destination TAZ to at-work subtours. Table 34 lists a summary of the at-work subtour tour lengths and coincidence ratio. There was only one constant used in this model, which is listed in Table 35. The resulting tour distance frequency diagram is shown in Figure 51, which shows a very close match to the survey. Table 34

**TABLE 34: AT-WORK SUBTOUR SUMMARY STATISTICS**

| ESTIMATED TOUR LENGTH | OBSERVED TOUR LENGTH | COINCIDENCE RATIO |
|---|---|---|
| 4.80 | 5.38 | 0.79 |

**TABLE 35: AT-WORK SUBTOUR DESTINATION CALIBRATION CONSTANTS**

| Constant Description | Constant Value |
|---|---|
| DC Destination | -0.50 |

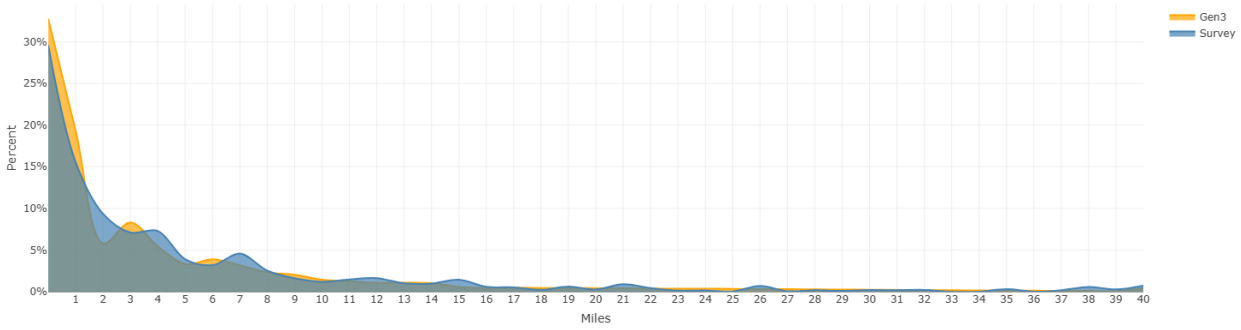


**FIGURE 51: AT-WORK SUBTOUR DESTINATION DISTANCE DISTRIBUTION**

## 2.17 AT-WORK SUBTOUR MODE CHOICE

The at-work subtour mode choice model step assigns a mode to at-work subtours. The calibration constants for at-work subtours by mode and auto sufficiency are listed in Table 36. The survey data did not have any persons making an at-work subtour using PNR or KNR transit, so those modes are prohibited via constants. The calibration constants by transit line-haul and access mode are listed in Table 37. The resulting model output is shown in Figure 52. This model has a slight overestimation for drive-alone trips that is offset by an underestimate for walk trips. Note that the overall tour mode choice constants listed in Table 22 are applied to this model.

**TABLE 36: AT-WORK SUBTOUR MODE CHOICE CALIBRATION CONSTANTS (MODE + AUTO SUFFICIENCY)**

| At-Work | No Auto | Auto Deficient | Auto Sufficient |
|---|---|---|---|
| Drive Alone | 0.00 | 0.00 | 0.00 |
| Shared-Ride 2 | 26.82 | -6.43 | -2.02 |
| Shared-Ride 3+ | 26.38 | -6.82 | -2.70 |
| Walk | 33.11 | -2.46 | 0.55 |
| Bike | 33.50 | 2.15 | -2.00 |
| Walk Transit | 30.48 | -5.27 | -2.94 |
| PNR Transit | -999 | -999 | -999 |
| KNR Transit | -999 | -999 | -999 |
| Taxi | 28.03 | -6.08 | -1.99 |
| TNC Single | 28.53 | -36.82 | -3.10 |
| TNC Shared | -2.47 | -24.92 | -3.01 |

**TABLE 37: AT-WORK SUBTOUR MODE CHOICE CALIBRATION CONSTANTS (TRANSIT LINE HAUL AND ACCESS MODE)**

| At-Work | Walk Access | PNR Access | KNR Access |
|---|---|---|---|
| Bus Only | 0.14 | -999 | -999 |
| Metrorail Only | 0.78 | -999 | -999 |
| Bus + Metrorail | -999 | -999 | -999 |
| Commuter Rail | -2.25 | -999 | -999 |

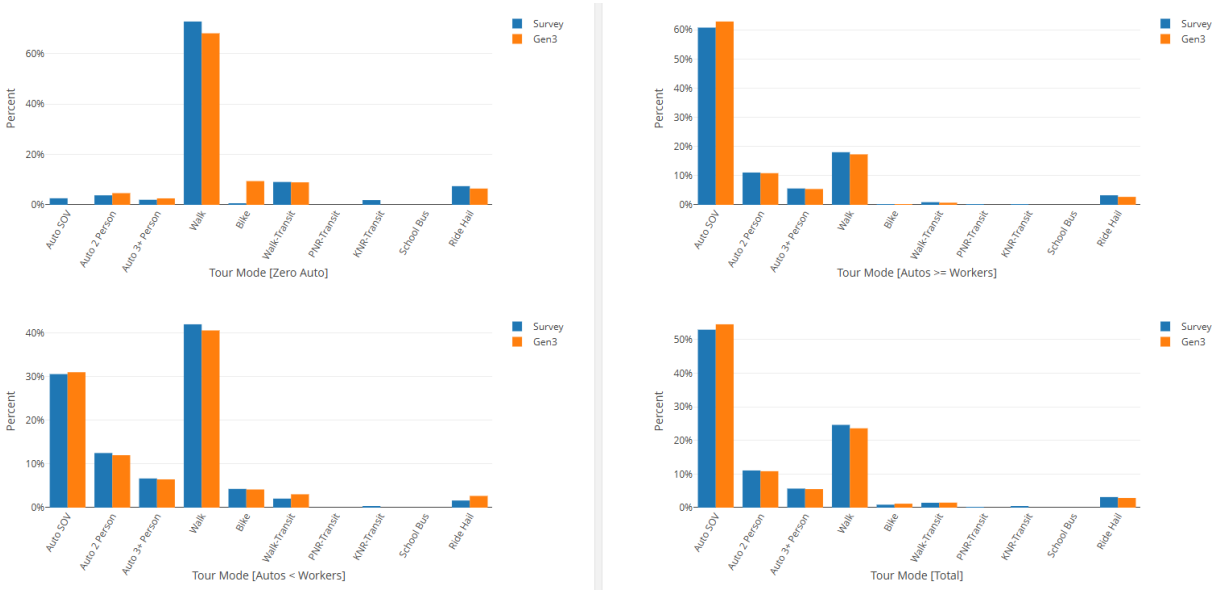


**FIGURE 52: AT-WORK SUBTOUR MODE CHOICE CALIBRATION RESULTS**

During the trip mode choice model step, at-work trip modes are assigned. The constants and results are included in this section. The trip mode choice calibration constants for at-work subtour trips are listed in Table 38. The results of the model are shown in Figure 53. Similar to the at-work tour mode choice model, there is an overestimate of drive-alone auto that is offset by an underestimate of walk trips.

**TABLE 38: AT-WORK SUBTOUR TRIP MODE CHOICE CALIBRATION CONSTANTS**

| Tour Mode | Trip Mode | Constant |
|---|---|---|
| Shared-Ride 2 | Drive Alone | -0.60 |
| Shared-Ride 3+ | Drive Alone | -1.56 |
| Shared-Ride 3+ | Shared-Ride 2 | -2.90 |
| Walk | Drive Alone | -4.65 |
| Walk | Shared-Ride 2 | -7.06 |
| Walk | Shared-Ride 3+ | -7.14 |
| Bicycle | Walk | -1.85 |
| Walk Transit | Shared-Ride 2 | -12.00 |
| Walk Transit | Shared-Ride 3+ | -6.82 |
| Walk Transit | Walk | -1.37 |
| Walk Transit | Bicycle | 0.00 |
| Walk Transit | Taxi | -7.79 |
| Walk Transit | TNC Single | -6.15 |
| Walk Transit | TNC Shared | -6.79 |
| Walk Transit | Metrorail | 0.01 |
| Walk Transit | Bus+Metrorail | 26.72 |
| Walk Transit | Commuter Rail | -4.00 |
| Ridehail | Shared-Ride 2 | -3.51 |
| Ridehail | Shared-Ride 3+ | -12.00 |
| Ridehail | Walk | -0.42 |

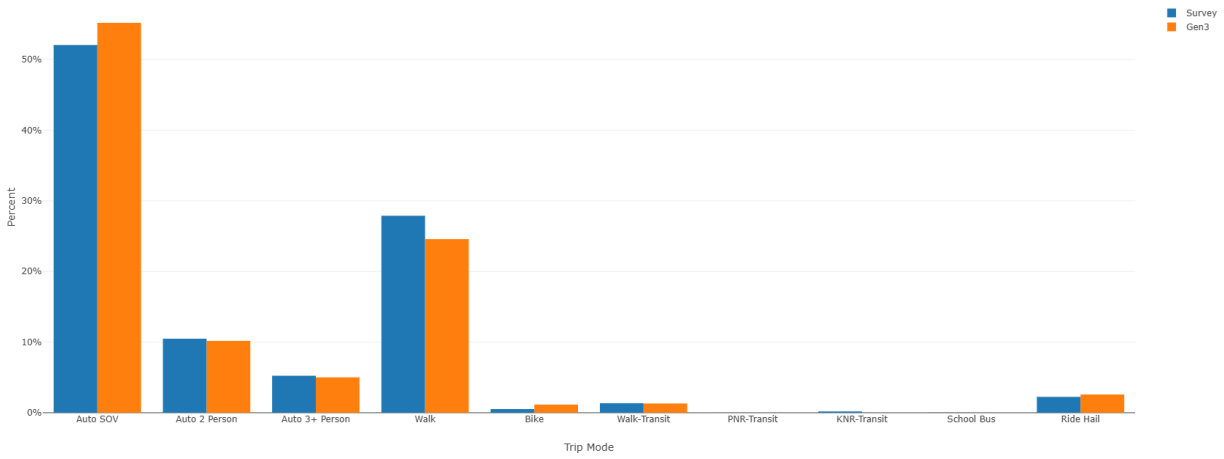


**FIGURE 53: TRIP MODE CHOICE CALIBRATION RESULTS FOR AT-WORK SUBTOURS**

## 2.18 STOP FREQUENCY

The stop frequency model step assigns to tours the number of stops and the directionality, which is outbound – from home to the tour destination, or inbound – from the tour destination to home. This step of ActivitySim generates trips that are ultimately output for use with traffic and transit assignment. The model was initially transferred from SEMCOG. Subsequent comparisons of trips by trip departure and arrival time indicated that intermediate stop timing needed to be adjusted to better match observed data. The current ActivitySim trip departure and arrival time model is a simulation from observed distributions and is heavily constrained by the tour time-of-day choice model. After calibrating this model, the team discovered that the estimated distribution of stops by tour departure and arrival period did not match household survey data. Therefore, parameters were added to the stop frequency model to better match that distribution. These parameters, along with the overall tour frequency constants, are listed in Table 39 for mandatory (work, university, and school) tours, in Table 40 for escort, eat-out, and shopping tours, in Table 41 for social, other maintenance, and other discretionary tours, and Table 42 for at-work subtours.

Total stop frequency, shown in Figure 54, is very well calibrated with the observed data. Work stop frequency, shown in Figure 55, also matches observed data nearly perfectly. University and school stop frequency are shown in Figure 56 and Figure 57, respectively, The university stop frequency matches very well but the school stop frequency show small overestimation in tours with no stops and a slight underestimation in tours with stops.

Escort tours, shown in Figure 58, also match nearly perfectly. Individual maintenance (shopping and other maintenance) and discretionary (eat-out, social, and other discretionary) tour stop frequencies, shown in Figure 46 and Figure 47 respectively, show a very small underestimation in tours with no stops and a slight overestimation in tours with one, two, and three stops. Joint maintenance and discretionary tour stop frequencies, shown in Figure 48 and Figure 49, respectively, show a very small overestimation in tours with no stops and a slight underestimation in tours with stops. At-work tours, shown in Figure 50, match nearly perfectly with the observed data.

**TABLE 39 MANDATORY TOUR STOP FREQUENCY TIME-OF-DAY SPECIFIC CALIBRATION CONSTANTS**

| PURPOSE | CONSTANT | NT1 | AM | MD | PM | NT2 |
|---|---|---|---|---|---|---|
| Work | 0 Outbound Stops and 1 Inbound Stop | -1.63 | 0.01 | -1.17 | -1.80 | -2.27 |
| | 0 Outbound Stops and 2 Inbound Stop | -2.81 | -1.26 | -2.46 | -3.74 | -12.00 |
| | 0 Outbound Stops and 3 Inbound Stop | -3.33 | -2.22 | -3.23 | -3.99 | -12.00 |
| | 1 Outbound Stop and 0 Inbound Stops | -2.79 | -0.80 | -2.30 | -1.88 | -1.60 |
| | 1 Outbound Stop and 1 Inbound Stops | -3.18 | -1.07 | -2.53 | -3.84 | -12.00 |
| | 1 Outbound Stop and 2 Inbound Stops | -5.21 | -2.21 | -3.65 | -6.17 | -12.00 |
| | 1 Outbound Stop and 3 Inbound Stops | -4.84 | -3.22 | -4.55 | -14.00 | -14.00 |
| | 2 Outbound Stop and 0 Inbound Stops | -4.91 | -2.83 | -3.25 | -3.31 | -2.87 |
| | 2 Outbound Stop and 1 Inbound Stops | -14.30 | -2.97 | -4.17 | -12.00 | -10.00 |
| | 2 Outbound Stop and 2 Inbound Stops | -6.00 | -3.03 | -5.12 | -7.87 | -12.00 |
| | 2 Outbound Stop and 3 Inbound Stops | -22.00 | -3.62 | -5.81 | -14.00 | -12.00 |
| | 3 Outbound Stop and 0 Inbound Stops | -6.52 | -3.64 | -4.08 | -4.14 | -12.00 |
| | 3 Outbound Stop and 1 Inbound Stops | -7.42 | -4.98 | -5.90 | -12.00 | -10.00 |
| | 3 Outbound Stop and 2 Inbound Stops | -5.91 | -6.70 | -9.96 | -12.00 | -10.00 |
| | 3 Outbound Stop and 3 Inbound Stops | -22.00 | -5.15 | -7.23 | -12.00 | -10.00 |
| University | 0 Outbound Stops and 1 Inbound Stop | -3.50 | -2.44 | -1.80 | -3.11 | -2.95 |
| | 0 Outbound Stops and 2 Inbound Stop | -22.00 | -2.16 | -3.11 | -3.56 | -8.00 |
| | 0 Outbound Stops and 3 Inbound Stop | -22.00 | -3.94 | -4.07 | -16.00 | -8.00 |
| | 1 Outbound Stop and 0 Inbound Stops | -3.14 | -2.54 | -3.20 | -2.97 | -0.39 |
| | 1 Outbound Stop and 1 Inbound Stops | -3.26 | -3.45 | -3.86 | -3.82 | -6.00 |
| | 1 Outbound Stop and 2 Inbound Stops | -22.00 | -3.00 | -4.74 | -5.03 | -6.00 |
| | 1 Outbound Stop and 3 Inbound Stops | -5.39 | -5.06 | -6.32 | -20.00 | -6.00 |
| | 2 Outbound Stop and 0 Inbound Stops | -11.97 | -2.65 | -4.76 | -5.62 | -6.00 |
| | 2 Outbound Stop and 1 Inbound Stops | -12.00 | -6.84 | -5.04 | -18.00 | -8.00 |
| | 2 Outbound Stop and 2 Inbound Stops | -22.00 | -5.19 | -14.00 | -22.00 | -8.00 |
| | 2 Outbound Stop and 3 Inbound Stops | -14.00 | -12.00 | -12.00 | -22.00 | -10.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 3 Outbound Stop and 0 Inbound Stops | -5.05 | -5.30 | -5.90 | -6.68 | -12.00 |
| | 3 Outbound Stop and 1 Inbound Stops | -22.00 | -5.87 | -5.61 | -10.00 | -10.00 |
| | 3 Outbound Stop and 2 Inbound Stops | -14.00 | -22.00 | -6.18 | -12.00 | -10.00 |
| | 3 Outbound Stop and 3 Inbound Stops | -10.00 | -7.80 | -12.00 | -22.00 | -6.00 |
| School | 0 Outbound Stops and 1 Inbound Stop | -22.00 | -1.83 | -1.44 | -0.98 | -8.00 |
| | 0 Outbound Stops and 2 Inbound Stop | -5.88 | -3.06 | -2.88 | -2.14 | -8.00 |
| | 0 Outbound Stops and 3 Inbound Stop | -2.57 | -3.86 | -4.67 | -1.53 | -6.00 |
| | 1 Outbound Stop and 0 Inbound Stops | -1.71 | -3.18 | -2.33 | -1.60 | -8.00 |
| | 1 Outbound Stop and 1 Inbound Stops | -2.55 | -3.57 | -4.76 | -7.18 | -8.00 |
| | 1 Outbound Stop and 2 Inbound Stops | -10.00 | -4.87 | -4.85 | -14.00 | -6.00 |
| | 1 Outbound Stop and 3 Inbound Stops | -3.98 | -5.16 | -14.00 | -20.00 | -4.00 |
| | 2 Outbound Stop and 0 Inbound Stops | -10.00 | -5.28 | -5.06 | -3.13 | -6.00 |
| | 2 Outbound Stop and 1 Inbound Stops | -2.79 | -7.01 | -5.92 | -12.00 | -10.00 |
| | 2 Outbound Stop and 2 Inbound Stops | -10.00 | -7.37 | -14.00 | -12.00 | -10.00 |
| | 2 Outbound Stop and 3 Inbound Stops | -10.00 | -16.00 | -14.00 | -10.00 | -10.00 |
| | 3 Outbound Stop and 0 Inbound Stops | -10.00 | -10.68 | -6.70 | -8.00 | -10.00 |
| | 3 Outbound Stop and 1 Inbound Stops | -12.00 | -9.55 | -12.00 | -8.00 | -8.00 |
| | 3 Outbound Stop and 2 Inbound Stops | -10.00 | -8.85 | -12.00 | -14.00 | -8.00 |
| | 3 Outbound Stop and 3 Inbound Stops | -8.00 | -14.00 | -10.00 | -16.00 | -4.00 |

**TABLE 40 ESCORT, EAT-OUT, AND SHOPPING TOUR STOP FREQUENCY TIME-OF-DAY SPECIFIC CALIBRATION CONSTANTS**

| PURPOSE | CONSTANT | NT1 | AM | MD | PM | NT2 |
|---|---|---|---|---|---|---|
| Shopping | 0 Outbound Stops and 1 Inbound Stop | -6.00 | -3.09 | -0.86 | -0.39 | -1.90 |
| | 0 Outbound Stops and 2 Inbound Stop | -4.00 | -1.59 | -1.65 | -2.21 | -6.33 |
| | 0 Outbound Stops and 3 Inbound Stop | -8.00 | -10.00 | -3.60 | -2.13 | -10.00 |
| | 1 Outbound Stop and 0 Inbound Stops | 2.74 | -0.32 | -1.28 | -2.45 | -1.86 |
| | 1 Outbound Stop and 1 Inbound Stops | -6.00 | -2.96 | -2.59 | -3.52 | -12.00 |
| | 1 Outbound Stop and 2 Inbound Stops | -6.00 | -3.20 | -3.07 | -2.52 | -14.00 |
| | 1 Outbound Stop and 3 Inbound Stops | -6.00 | -10.00 | -4.07 | -12.00 | -12.00 |
| | 2 Outbound Stop and 0 Inbound Stops | -8.00 | -2.24 | -2.67 | -2.89 | -12.00 |
| | 2 Outbound Stop and 1 Inbound Stops | -6.00 | -3.24 | -2.41 | -5.70 | -12.00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 2 Outbound Stop and 2 Inbound Stops | -6.00 | -5.28 | -6.57 | -12.00 | -12.00 |
| | 2 Outbound Stop and 3 Inbound Stops | -6.00 | -12.00 | -7.85 | -12.00 | -10.00 |
| | 3 Outbound Stop and 0 Inbound Stops | -4.00 | -12.00 | -2.45 | -12.00 | -12.00 |
| | 3 Outbound Stop and 1 Inbound Stops | -4.00 | -10.00 | -4.57 | -3.31 | -10.00 |
| | 3 Outbound Stop and 2 Inbound Stops | -4.00 | -10.00 | -5.03 | -10.00 | -10.00 |
| | 3 Outbound Stop and 3 Inbound Stops | -4.00 | -10.00 | -10.00 | -8.00 | -10.00 |
| Escort | 0 Outbound Stops and 1 Inbound Stop | -2.90 | -1.69 | -0.89 | -1.30 | -2.29 |
| | 0 Outbound Stops and 2 Inbound Stop | -22.00 | -2.79 | -2.98 | -2.45 | -2.94 |
| | 0 Outbound Stops and 3 Inbound Stop | -22.00 | -4.02 | -3.05 | -3.87 | -4.61 |
| | 1 Outbound Stop and 0 Inbound Stops | -4.34 | -2.06 | -1.88 | -2.10 | -1.88 |
| | 1 Outbound Stop and 1 Inbound Stops | -1.92 | -3.06 | -3.56 | -2.95 | -12.00 |
| | 1 Outbound Stop and 2 Inbound Stops | -8.00 | -26.07 | -4.57 | -3.61 | -10.00 |
| | 1 Outbound Stop and 3 Inbound Stops | -22.00 | -5.47 | -5.34 | -14.00 | -14.00 |
| | 2 Outbound Stop and 0 Inbound Stops | -22.00 | -4.08 | -3.47 | -4.18 | -5.29 |
| | 2 Outbound Stop and 1 Inbound Stops | -22.00 | -4.29 | -5.61 | -4.10 | -14.00 |
| | 2 Outbound Stop and 2 Inbound Stops | -8.00 | -22.00 | -6.68 | -16.00 | -12.00 |
| | 2 Outbound Stop and 3 Inbound Stops | -22.00 | -5.65 | -6.30 | -14.00 | -12.00 |
| | 3 Outbound Stop and 0 Inbound Stops | -10.00 | -4.38 | -2.89 | -4.56 | -12.00 |
| | 3 Outbound Stop and 1 Inbound Stops | -22.00 | -4.59 | -4.95 | -4.54 | -12.00 |
| | 3 Outbound Stop and 2 Inbound Stops | -8.00 | -16.97 | -5.33 | -14.00 | -12.00 |
| | 3 Outbound Stop and 3 Inbound Stops | -8.00 | -22.00 | -6.33 | -10.00 | -12.00 |
| Eatout | 0 Outbound Stops and 1 Inbound Stop | -1.34 | -1.93 | -1.93 | -0.94 | -2.57 |
| | 0 Outbound Stops and 2 Inbound Stop | -10.00 | -0.91 | -3.22 | -3.12 | -12.00 |
| | 0 Outbound Stops and 3 Inbound Stop | -10.00 | -4.98 | -3.81 | -4.08 | -11.50 |
| | 1 Outbound Stop and 0 Inbound Stops | -2.62 | -0.20 | -1.83 | -1.55 | -1.69 |
| | 1 Outbound Stop and 1 Inbound Stops | -12.00 | -2.58 | -3.00 | -3.27 | -3.29 |
| | 1 Outbound Stop and 2 Inbound Stops | -10.00 | -13.50 | -4.58 | -3.62 | -7.22 |
| | 1 Outbound Stop and 3 Inbound Stops | -13.50 | -5.00 | -5.33 | -6.39 | -14.00 |
| | 2 Outbound Stop and 0 Inbound Stops | -2.23 | -1.29 | -4.30 | -2.55 | -4.06 |
| | 2 Outbound Stop and 1 Inbound Stops | -10.00 | -5.22 | -4.40 | -3.85 | -6.67 |
| | 2 Outbound Stop and 2 Inbound Stops | -10.00 | -12.00 | -5.41 | -5.55 | -14.00 |
| | 2 Outbound Stop and 3 Inbound Stops | -14.00 | -10.00 | -14.00 | -5.65 | -12.00 |
| | 3 Outbound Stop and 0 Inbound Stops | -3.24 | -1.17 | -3.54 | -4.61 | -12.00 |
| | 3 Outbound Stop and 1 Inbound Stops | -15.00 | -3.26 | -5.86 | -4.10 | -10.00 |
| | 3 Outbound Stop and 2 Inbound Stops | -14.00 | -12.00 | -14.00 | -10.00 | -10.00 |
| | 3 Outbound Stop and 3 Inbound Stops | -12.00 | -3.83 | -7.33 | -10.00 | -10.00 |

**TABLE 41 SOCIAL, OTHER MAINTENANCE, AND OTHER DISCRETIONARY TOUR STOP FREQUENCY TIME-OF-DAY SPECIFIC CALIBRATION CONSTANTS**

| PURPOSE | CONSTANT | NT1 | AM | MD | PM | NT2 |
|---|---|---|---|---|---|---|
| Social | 0 Outbound Stops and 1 Inbound Stop | 0.56 | -0.89 | -1.52 | -0.91 | -0.68 |
| | 0 Outbound Stops and 2 Inbound Stop | -8.00 | -2.32 | -1.74 | -3.74 | -8.00 |
| | 0 Outbound Stops and 3 Inbound Stop | -8.00 | -1.17 | -4.47 | -6.04 | -10.00 |
| | 1 Outbound Stop and 0 Inbound Stops | 0.22 | 0.41 | -1.05 | -1.14 | -1.27 |
| | 1 Outbound Stop and 1 Inbound Stops | -8.00 | -5.11 | -2.72 | -2.50 | -1.16 |
| | 1 Outbound Stop and 2 Inbound Stops | -8.00 | -1.47 | -3.19 | -4.31 | -12.00 |
| | 1 Outbound Stop and 3 Inbound Stops | -8.00 | -12.00 | -5.20 | -11.50 | -10.00 |
| | 2 Outbound Stop and 0 Inbound Stops | -0.59 | -1.06 | -1.60 | -1.37 | -1.08 |
| | 2 Outbound Stop and 1 Inbound Stops | -7.50 | -4.91 | -4.51 | -12.00 | -10.00 |
| | 2 Outbound Stop and 2 Inbound Stops | -7.50 | -12.00 | -4.77 | -4.21 | -10.00 |
| | 2 Outbound Stop and 3 Inbound Stops | -8.00 | -4.44 | -4.49 | -11.50 | -11.50 |
| | 3 Outbound Stop and 0 Inbound Stops | 1.38 | -1.09 | -1.35 | -2.14 | -2.26 |
| | 3 Outbound Stop and 1 Inbound Stops | -6.00 | -3.04 | -4.84 | -4.98 | -10.00 |
| | 3 Outbound Stop and 2 Inbound Stops | -6.00 | -3.10 | -2.38 | -10.00 | -10.00 |
| | 3 Outbound Stop and 3 Inbound Stops | -4.00 | -8.00 | -12.00 | -10.00 | -10.00 |
| Other maintenance | 0 Outbound Stops and 1 Inbound Stop | -1.07 | -0.98 | -0.29 | -0.62 | -0.01 |
| | 0 Outbound Stops and 2 Inbound Stop | -13.50 | -2.06 | -1.00 | -2.10 | -3.86 |
| | 0 Outbound Stops and 3 Inbound Stop | -10.00 | -2.81 | -1.66 | -2.23 | -10.00 |
| | 1 Outbound Stop and 0 Inbound Stops | -2.35 | -1.45 | -0.99 | -1.13 | -1.54 |
| | 1 Outbound Stop and 1 Inbound Stops | -1.23 | -1.56 | -2.23 | -2.26 | -10.00 |
| | 1 Outbound Stop and 2 Inbound Stops | -10.00 | -3.77 | -2.20 | -6.77 | -4.17 |
| | 1 Outbound Stop and 3 Inbound Stops | -11.50 | -4.03 | -2.59 | -10.00 | -11.50 |
| | 2 Outbound Stop and 0 Inbound Stops | -11.50 | -3.26 | -2.08 | -2.69 | -1.70 |
| | 2 Outbound Stop and 1 Inbound Stops | -12.00 | -5.13 | -3.37 | -7.39 | -11.50 |
| | 2 Outbound Stop and 2 Inbound Stops | -12.00 | -3.86 | -4.70 | -14.00 | -12.00 |
| | 2 Outbound Stop and 3 Inbound Stops | -12.00 | -3.76 | -3.92 | -4.85 | -12.00 |
| | 3 Outbound Stop and 0 Inbound Stops | -12.00 | -4.78 | -3.62 | -4.48 | -12.00 |
| | 3 Outbound Stop and 1 Inbound Stops | -12.00 | -5.07 | -2.74 | -6.17 | -10.00 |
| | 3 Outbound Stop and 2 Inbound Stops | -3.85 | -5.83 | -5.32 | -12.00 | -10.00 |
| | 3 Outbound Stop and 3 Inbound Stops | -8.00 | -5.90 | -7.65 | -12.00 | -8.00 |
| Other Discretionary | 0 Outbound Stops and 1 Inbound Stop | -2.21 | -1.58 | -0.65 | -0.73 | -0.75 |
| | 0 Outbound Stops and 2 Inbound Stop | -2.64 | -2.6 | -1.6 | -2.46 | -2.81 |
| | 0 Outbound Stops and 3 Inbound Stop | -4.23 | -2.31 | -2.42 | -3.9 | -4.5 |
| | 1 Outbound Stop and 0 Inbound Stops | -0.91 | -0.73 | -0.99 | -0.63 | -1.76 |
| | 1 Outbound Stop and 1 Inbound Stops | -3.27 | -2.06 | -1.93 | -1.94 | -1.92 |

| | | | | | |
|---|---|---|---|---|---|
| 1 Outbound Stop and 2 Inbound Stops | -4.5 | -2.88 | -3.75 | -3.16 | -2.92 |
| 1 Outbound Stop and 3 Inbound Stops | -6.43 | -3.4 | -3.04 | -4.75 | -4.5 |
| 2 Outbound Stop and 0 Inbound Stops | -2.67 | -1.9 | -1.78 | -2.69 | -2.27 |
| 2 Outbound Stop and 1 Inbound Stops | -4.5 | -3.79 | -2.85 | -3.27 | -4.5 |
| 2 Outbound Stop and 2 Inbound Stops | -5.85 | -4.88 | -4.52 | -5.71 | -4.5 |
| 2 Outbound Stop and 3 Inbound Stops | -4.5 | -4.99 | -6.02 | -4.5 | -4.5 |
| 3 Outbound Stop and 0 Inbound Stops | -2.9 | -1.84 | -1.5 | -3.34 | -4.37 |
| 3 Outbound Stop and 1 Inbound Stops | -4.5 | -4.44 | -5.16 | -4.5 | -4.5 |
| 3 Outbound Stop and 2 Inbound Stops | -5.9 | -4.99 | -3.96 | -4.5 | -4.5 |
| 3 Outbound Stop and 3 Inbound Stops | -4.5 | -4.5 | -4.5 | -4.5 | -4.5 |

**TABLE 42: AT-WORK SUBTOUR STOP FREQUENCY CALIBRATION CONSTANTS**

| CONSTANT | NT1 | AM | MD | PM | NT2 |
|---|---|---|---|---|---|
| 0 Outbound Stops and 1 Inbound Stop | -22.00 | -6.43 | -4.96 | -6.81 | -6.61 |
| 0 Outbound Stops and 2 Inbound Stop | -22.00 | -8.19 | -6.83 | -8.61 | -12.00 |
| 0 Outbound Stops and 3 Inbound Stop | -14.00 | -18.00 | -18.00 | -18.00 | -12.00 |
| 1 Outbound Stop and 0 Inbound Stops | -12.00 | -8.97 | -6.11 | -6.60 | -14.00 |
| 1 Outbound Stop and 1 Inbound Stops | -16.00 | -9.98 | -7.29 | -6.92 | -6.18 |
| 1 Outbound Stop and 2 Inbound Stops | -16.00 | -20.00 | -10.50 | -16.00 | -16.00 |
| 1 Outbound Stop and 3 Inbound Stops | -14.00 | -16.00 | -11.64 | -16.00 | -16.00 |
| 2 Outbound Stop and 0 Inbound Stops | -14.00 | -22.00 | -8.11 | -9.82 | -16.00 |
| 2 Outbound Stop and 1 Inbound Stops | -12.00 | -16.00 | -18.00 | -16.00 | -16.00 |
| 2 Outbound Stop and 2 Inbound Stops | -12.00 | -16.00 | -18.00 | -16.00 | -14.00 |
| 2 Outbound Stop and 3 Inbound Stops | -12.00 | -16.00 | -18.00 | -18.00 | -12.00 |
| 3 Outbound Stop and 0 Inbound Stops | -12.00 | -14.00 | -18.00 | -20.00 | -12.00 |
| 3 Outbound Stop and 1 Inbound Stops | -12.00 | -14.00 | -18.00 | -20.00 | -12.00 |
| 3 Outbound Stop and 2 Inbound Stops | -12.00 | -14.00 | -16.00 | -18.00 | -12.00 |
| 3 Outbound Stop and 3 Inbound Stops | -10.00 | -12.00 | -14.00 | -18.00 | -12.00 |

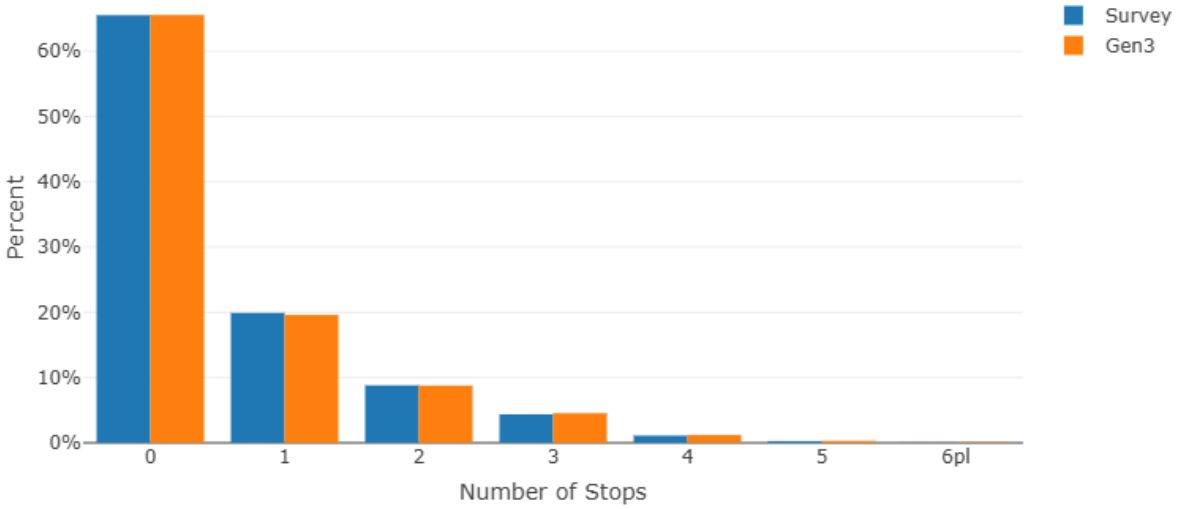


**FIGURE 54: TOTAL STOP FREQUENCY**

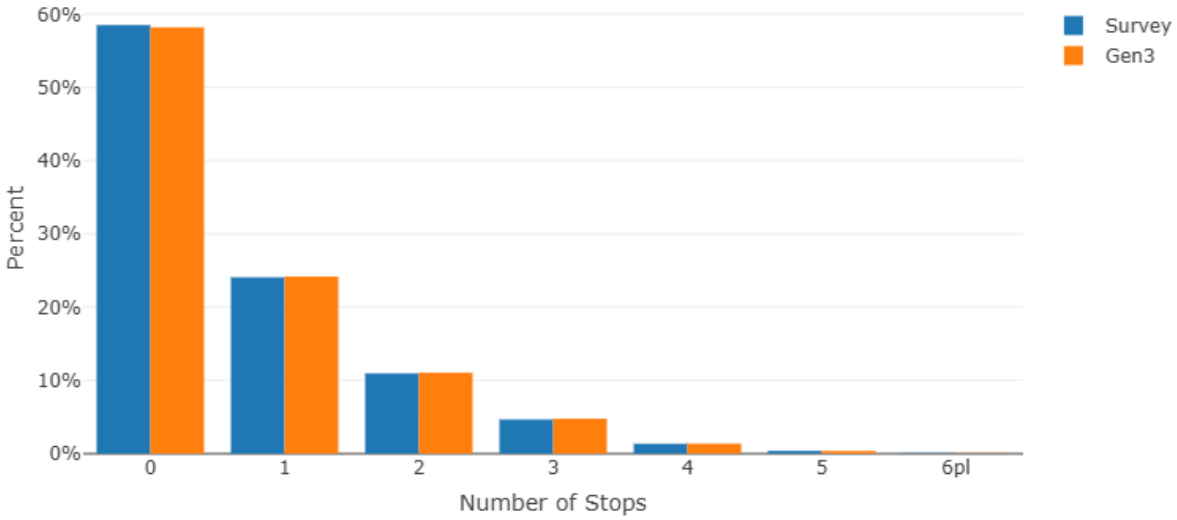


**FIGURE 55: WORK TOUR STOP FREQUENCY**

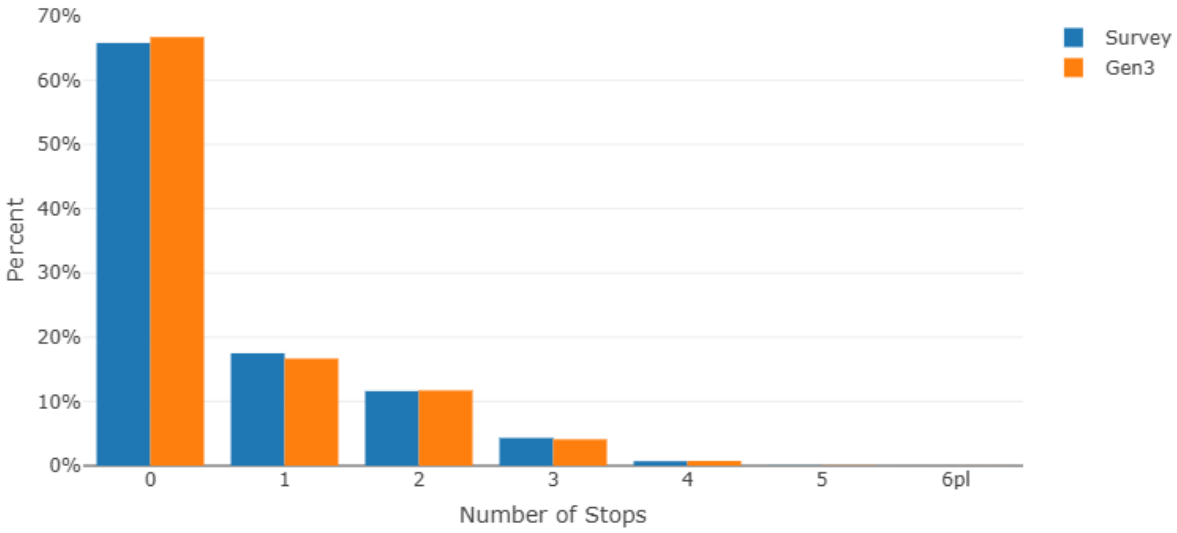


**FIGURE 56: UNIVERSITY TOUR STOP FREQUENCY**

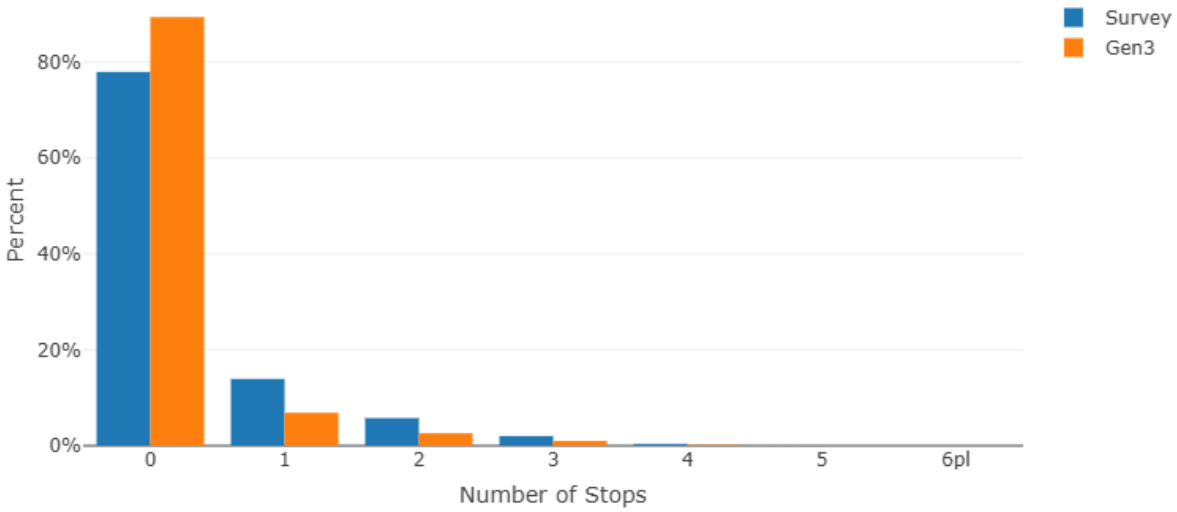


**FIGURE 57: SCHOOL TOUR STOP FREQUENCY**

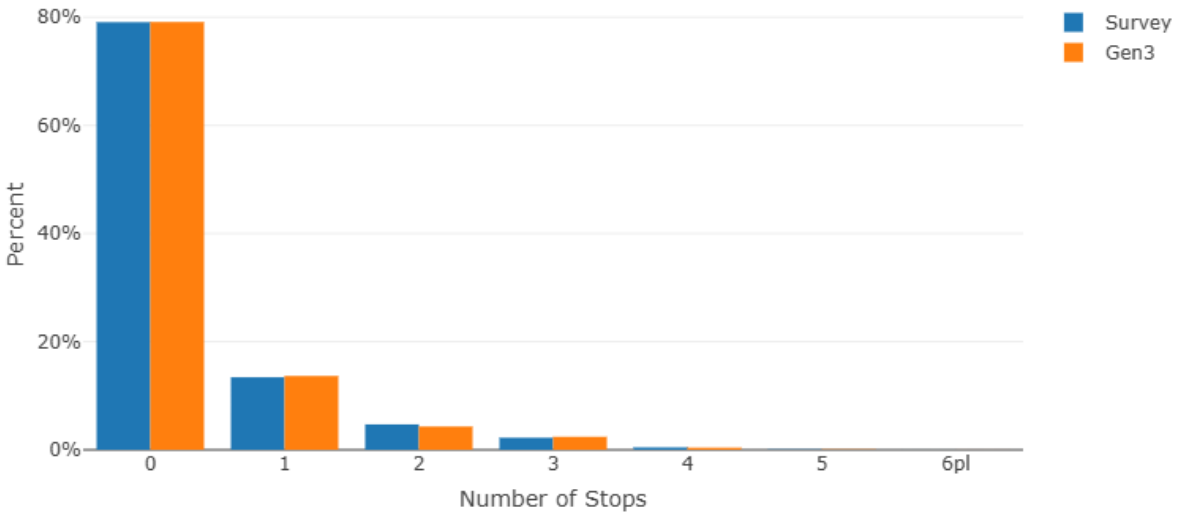


**FIGURE 58: ESCORTING TOUR STOP FREQUENCY**

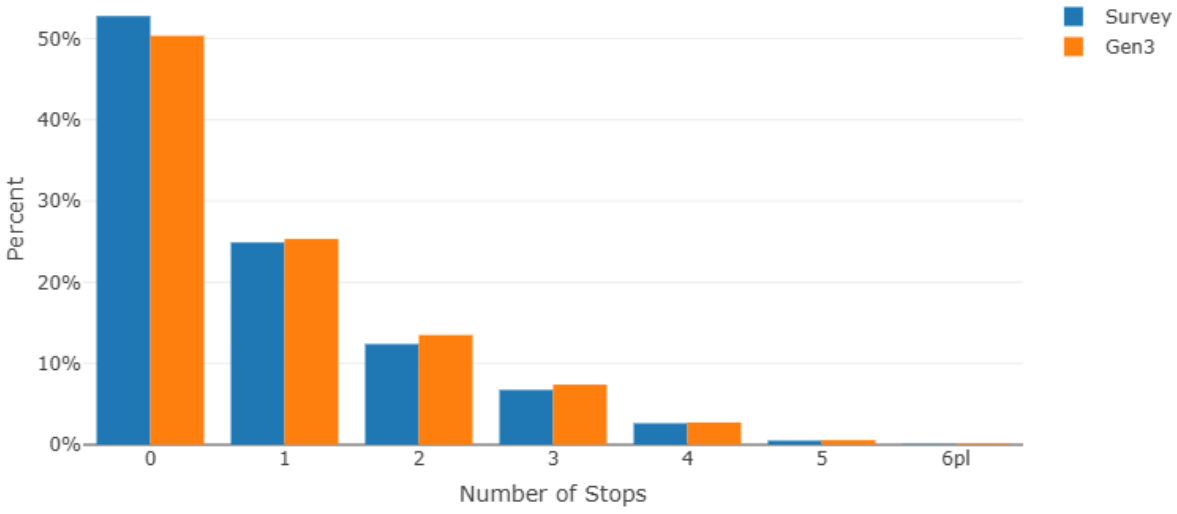


**FIGURE 59: INDIVIDUAL MAINTENANCE TOUR STOP FREQUENCY**

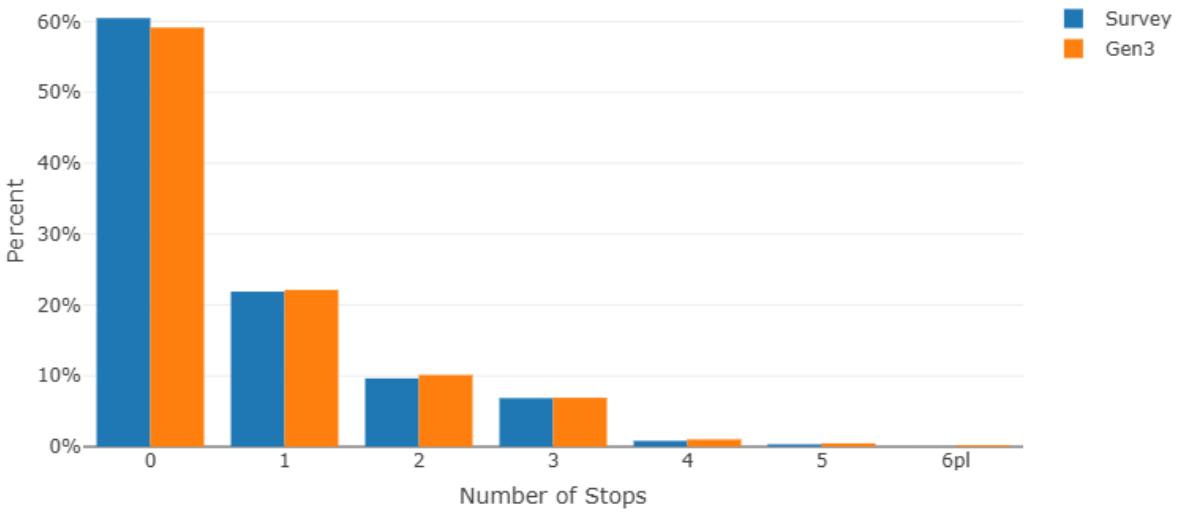


**FIGURE 60: INDIVIDUAL DISCRETIONARY TOUR STOP FREQUENCY**

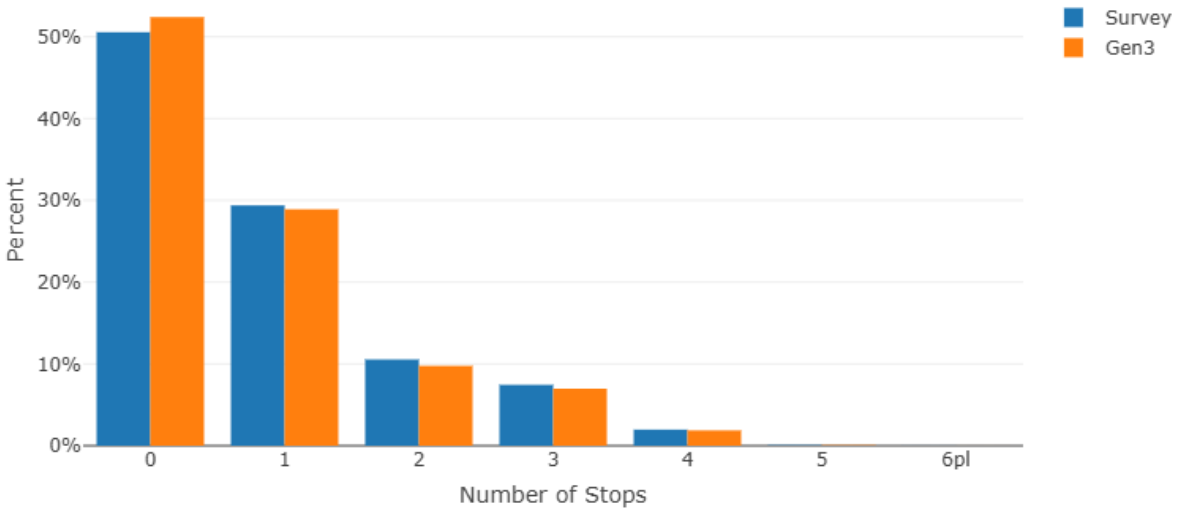


**FIGURE 61: JOINT MAINTENANCE TOUR STOP FREQUENCY**

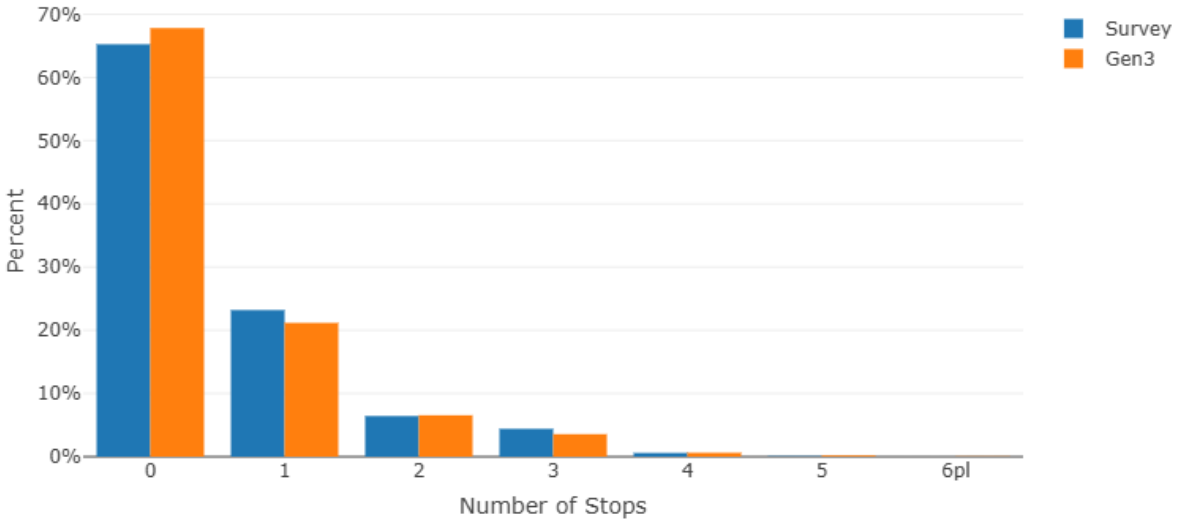


**FIGURE 62: JOINT DISCRETIONARY TOUR STOP FREQUENCY**

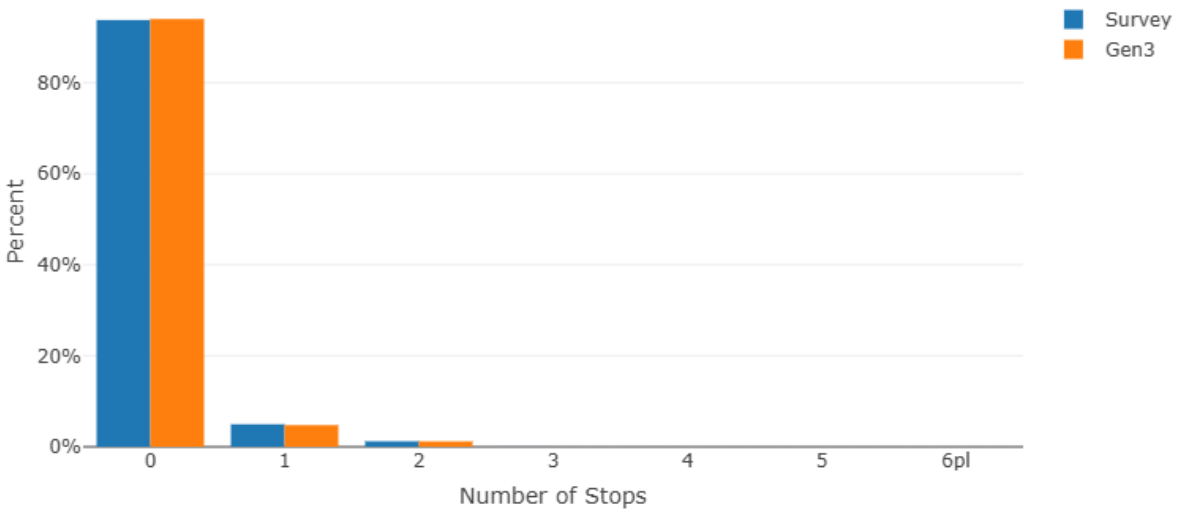


**FIGURE 63: AT-WORK TOUR STOP FREQUENCY**

## 2.19 STOP AND TRIP DEPARTURE

This section documents the aggregate stop and trip departure distribution for the Gen3 Model's five time-of-day (TOD) periods (i.e., Early morning or Night1, AM, Midday, PM, and late night or Night2 time periods). These results were taken from the post-processed plots from the ActivitySim visualizer. It should be noted that the supply models (e.g., highway/transit skimming and assignment) use four time-of-day (TOD) periods (i.e., AM, Midday, PM, and Night-Time), while stop and trip departure models use half-hour resolutions and aggregate results in five time-of-day periods for calibration purposes only.

It should be noted that no constants or calibration coefficients are necessary or relevant for these trip-level models, as the distributions presented in this section are the result of previously discussed tour time of day choice calibration, stop frequency model calibration, and intermediate stop departure and arrival time distribution calibration that were achieved based on the survey data. This section simply presents the Survey vs. Gen3 comparisons of stop and trip distributions by the five TOD time periods defined in the model.

The stop and trip departure distributions by TOD are shown for different tour purposes as defined in the Gen3 Model. Figure 64 shows the stop and trip-level departures for all tour purposes combined, which shows that the Gen3 Model slightly overestimates stop departures in the AM time period and underestimates in the PM time period. However, trip-level departures compare well with the survey for NT1, AM, and MD time periods,

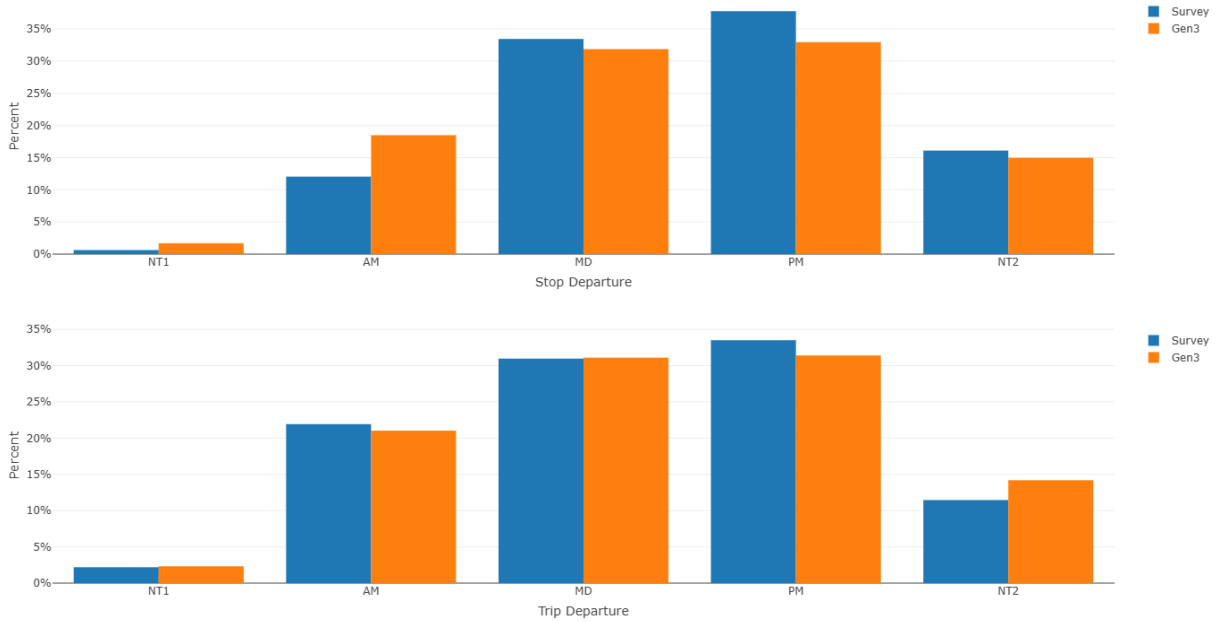

**FIGURE 64: TOTAL STOP AND TRIP DEPARTURE**

The next series of charts show the Gen3 vs Survey comparisons of stop and trip departures for specific tour purpose: Figure 65 for work tours; Figure 66 for university tours; Figure 67 for school tours; Figure 68 joint maintenance tours; Figure 69 for joint discretionary tours; Figure 70 for individual maintenance tours; Figure 71 for individual discretionary tours; Figure 72 for escort tours; Figure 73 and for at-work tours. These charts show a similar trend of small underestimation or overestimation for a specific period. In general, the trip departure matches more closely with the survey data.

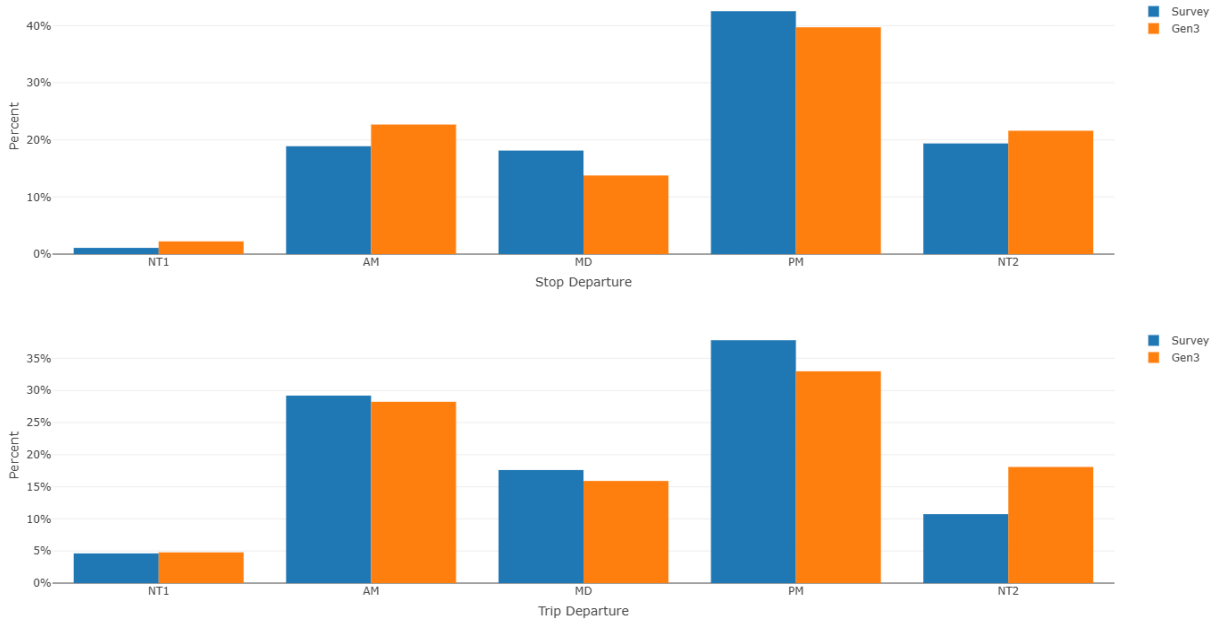


**FIGURE 65: WORK TOUR STOP AND TRIP DEPARTURE**

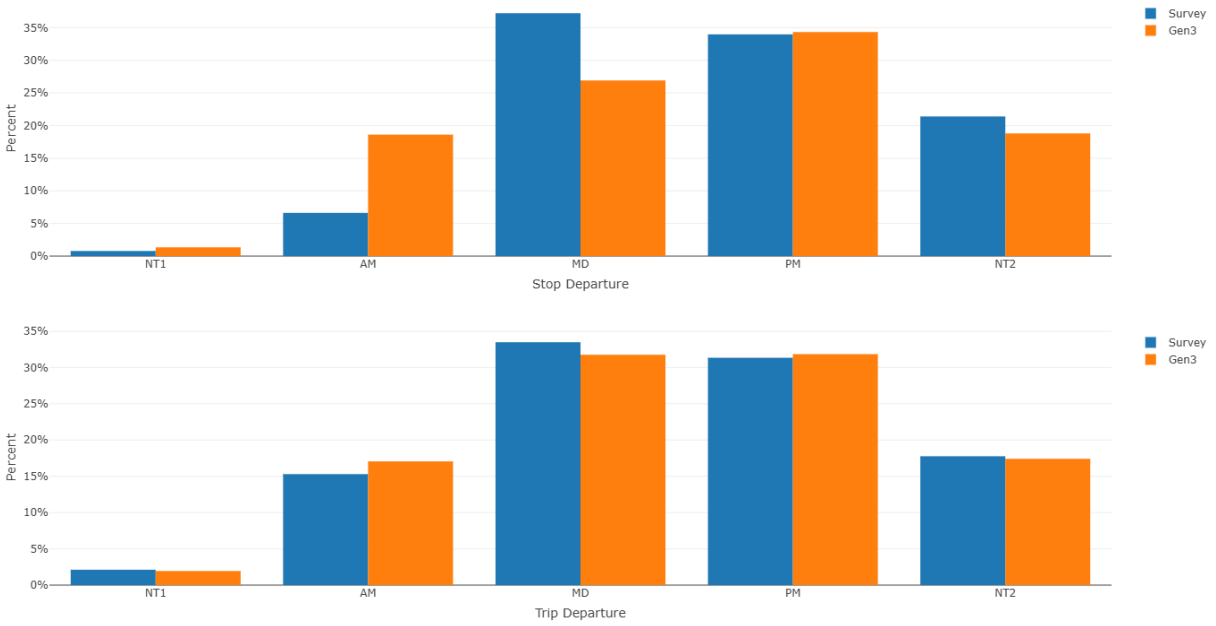


**FIGURE 66: UNIVERSITY TOUR STOP AND TRIP DEPARTURE**

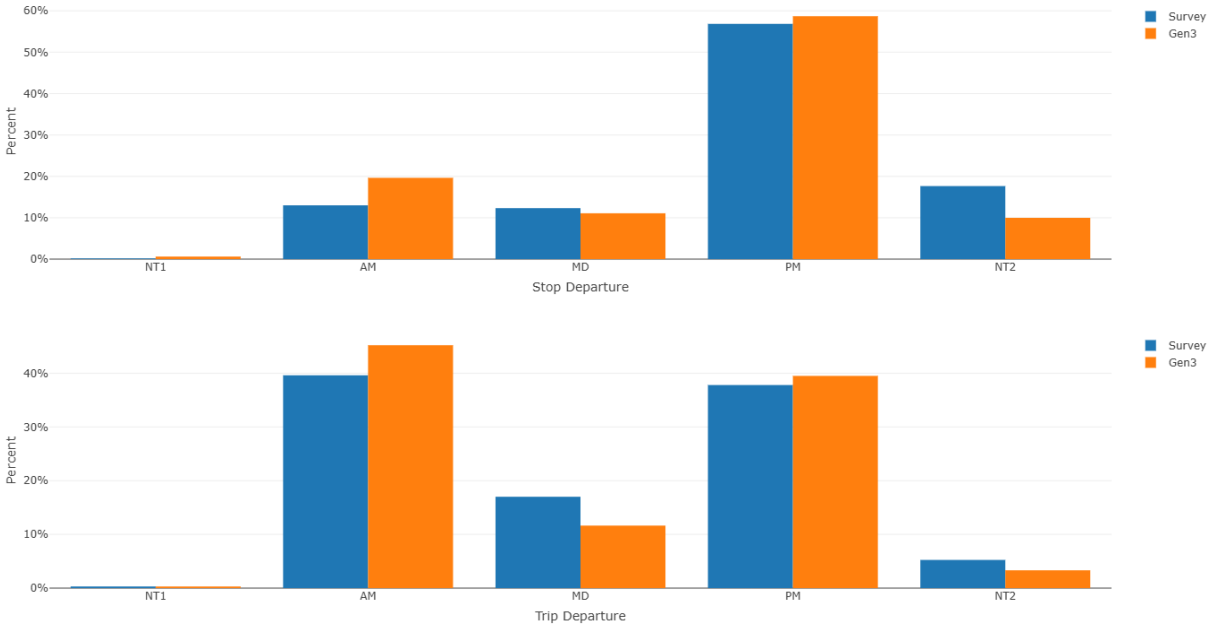


**FIGURE 67: SCHOOL TOUR STOP AND TRIP DEPARTURE**

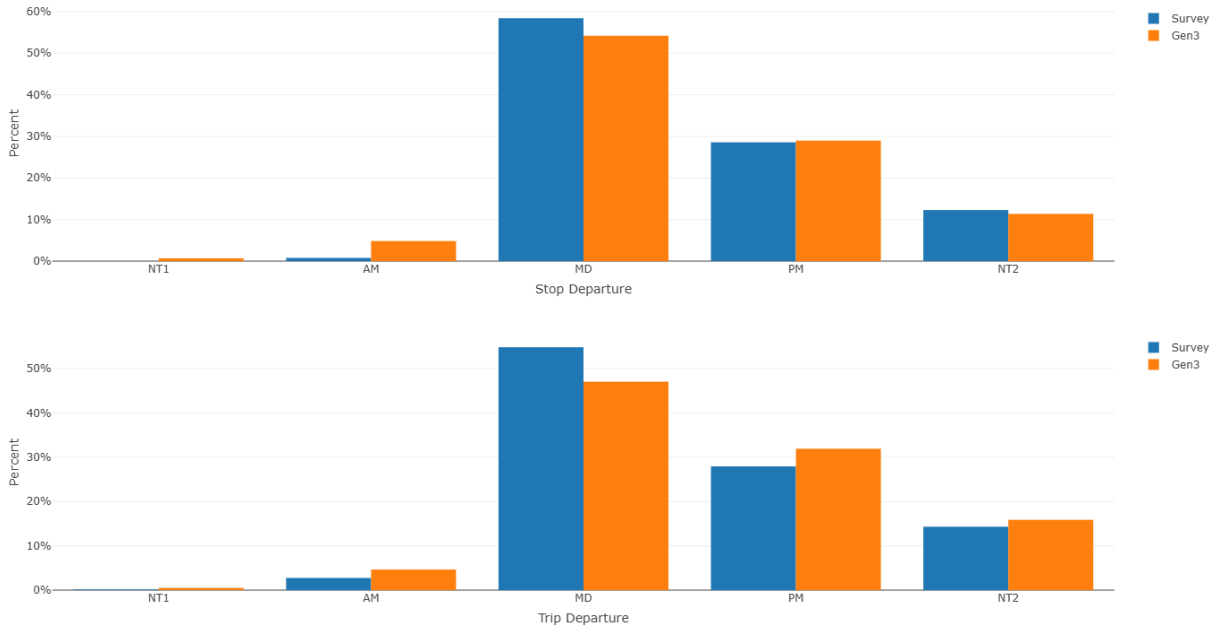


**FIGURE 68: JOINT MAINTENANCE TOUR STOP AND TRIP DEPARTURE**

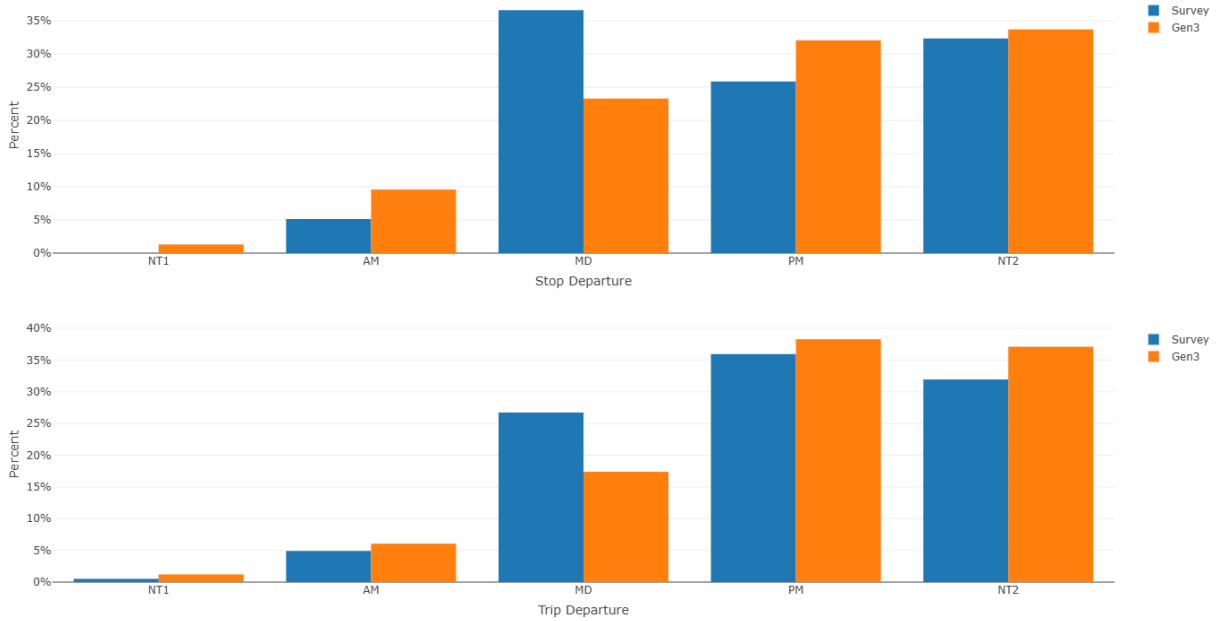


**FIGURE 69: JOINT DISCRETIONARY TOUR STOP AND TRIP DEPARTURE**

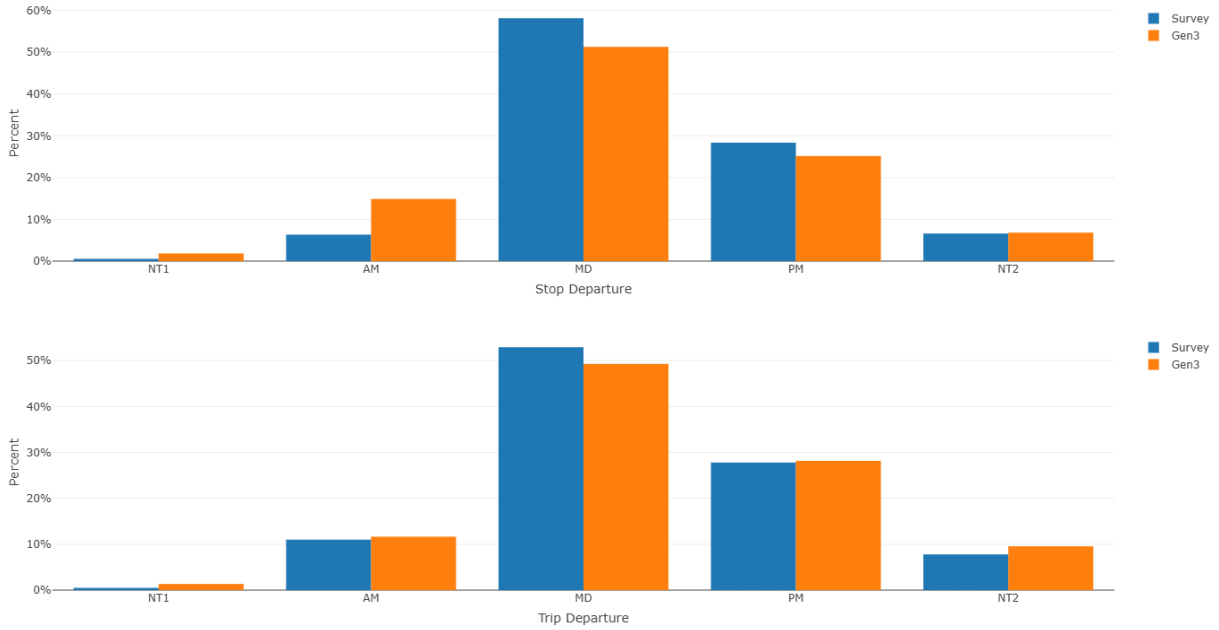


**FIGURE 70: INDIVIDUAL MAINTENANCE TOUR STOP AND TRIP DEPARTURE**

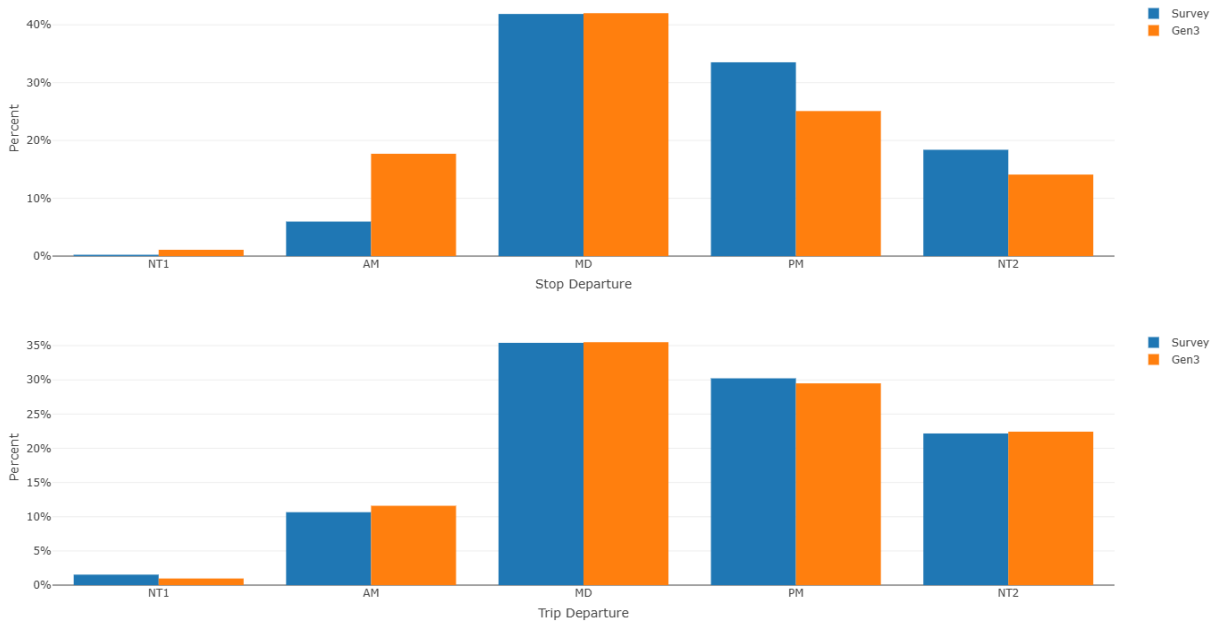


**FIGURE 71: INDIVIDUAL DISCRETIONARY TOUR STOP AND TRIP DEPARTURE**

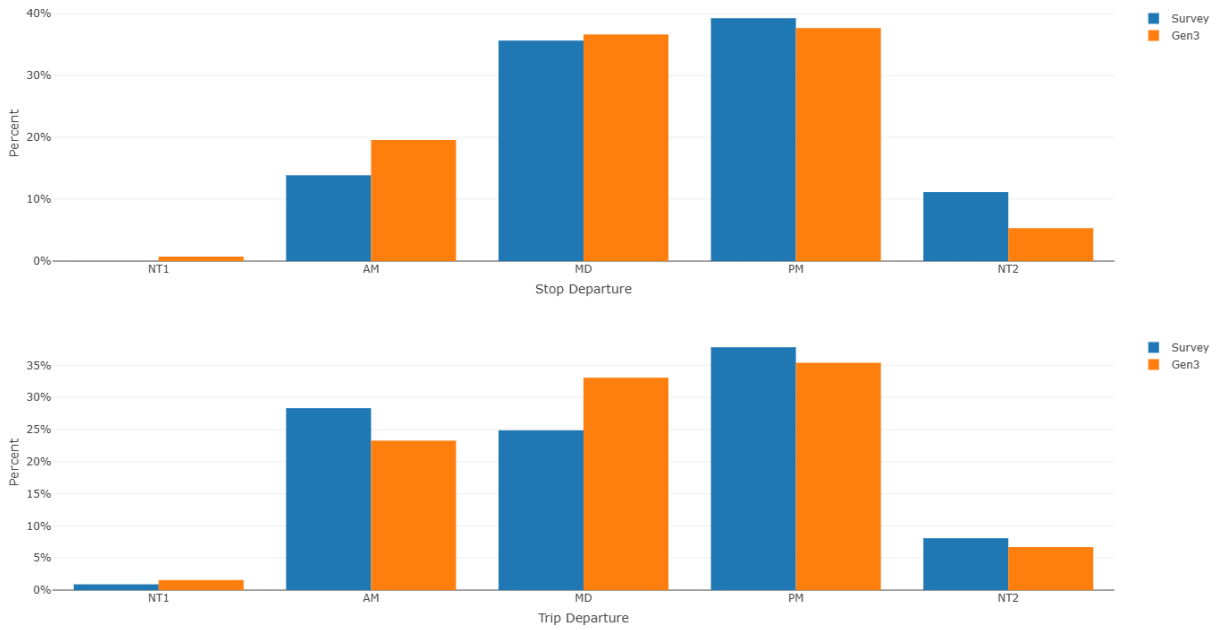


**FIGURE 72: ESCORT TOUR STOP AND TRIP DEPARTURE**

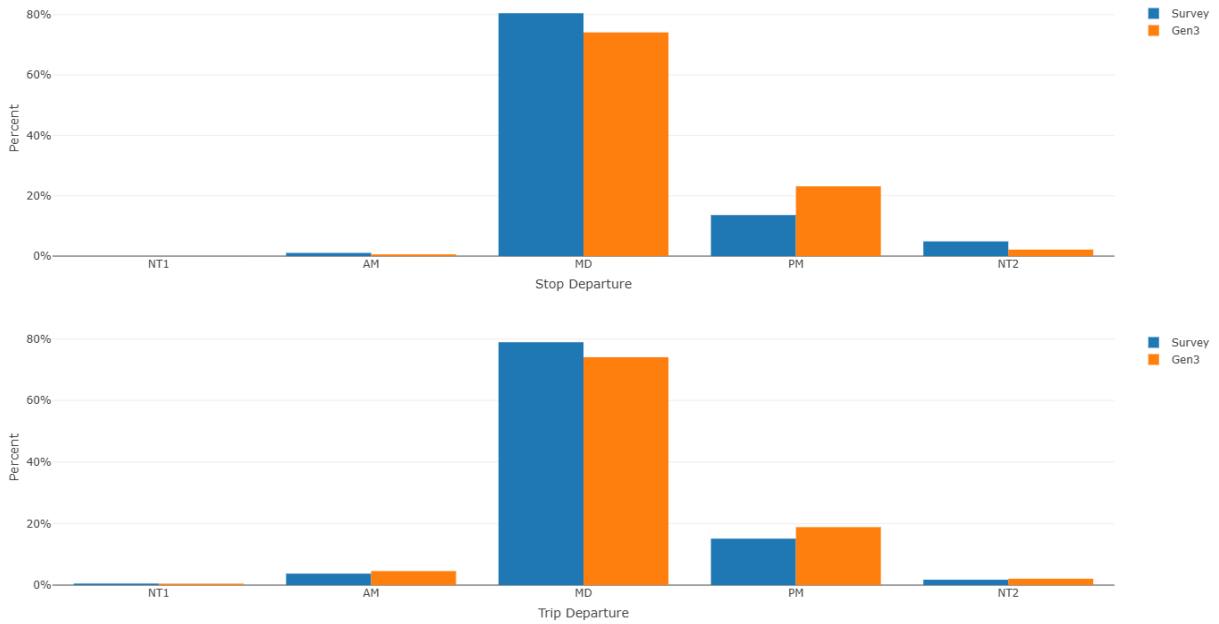


**FIGURE 73: AT-WORK TOUR STOP AND TRIP DEPARTURE**

## 2.20 TRIP MODE CHOICE

The trip mode choice model step is a multinomial logit model that assigns the travel mode used to each trip. It is set up the same way as the tour mode choice model (shown in Figure 41), but the nesting coefficients are set to 1.0, which effectively collapses the nested logit structure into a multinomial logit structure.[13] The model is heavily constrained by the tour mode selected by the tour, so in effect the cross-elasticities between modes are determined by the tour mode choice. Table 43 presents the trip mode availability conditions under each tour mode.

**TABLE 43 TRIP MODE AVAILABILITY UNDER TOUR MODE**

| TRIP MODE | TOUR MODE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Drive alone | SR2 | SR3 | Walk | Bike | Walk transit | PNR transit | KNR transit | School bus | Taxi | TNC single | TNC shared |
| Drive alone | ✓ | ✓ | ✓ | ✓ | × | × | × | × | ✓ | × | × | × |
| SR2 | × | ✓ | ✓ | ✓ | × | ✓ | × | × | ✓ | ✓ | ✓ | ✓ |
| SR3 | × | × | ✓ | ✓ | × | ✓ | × | × | ✓ | ✓ | ✓ | ✓ |
| WALK | × | × | × | ✓ | ✓ | ✓ | × | × | ✓ | ✓ | ✓ | ✓ |
| BIKE | × | × | × | × | ✓ | ✓ | × | × | × | × | × | × |
| Walk transit | × | × | × | × | × | ✓ | ✓ | ✓ | × | × | × | × |
| PNR transit | × | × | × | × | × | × | ✓ | ✓ | × | × | × | × |
| KNR transit | × | × | × | × | × | × | × | ✓ | × | × | × | × |
| School bus | × | × | × | × | × | × | × | × | ✓ | × | × | × |
| Taxi | × | × | × | × | × | ✓ | × | × | × | ✓ | ✓ | ✓ |
| TNC single | × | × | × | × | × | ✓ | × | × | × | ✓ | ✓ | ✓ |
| TNC shared | × | × | × | × | × | ✓ | × | × | × | ✓ | ✓ | ✓ |

The mode share targets by trip purpose were revised based on comparisons of the household survey, the transit surveys, and the transit ridership data. During calibration, adjustments were made to the model constants to improve boardings by transit mode. Additionally, the transit surveys were used to estimate the observed number of transfers, which was calibrated in this model step.

The model includes some overall constants that are used in all trip purposes, and those are listed in Table 44. These were added after survey-based calibration to adjust trips based on traffic volumes and transit ridership comparisons. The overall calibration output for the model is

[13] See Koppelman and Bhat, *A Self-Instructing Guide to Mode Choice Modeling*. U.S. Department of Transportation, Federal Transit Administration, June 30, 2006. Page 163.

shown in Figure 74. The model overestimates 2-person shared-ride trips and single-occupant vehicle trips, but underestimates walk and school bus trips.

**TABLE 44: MISCELLANEOUS TRIP CALIBRATION CONSTANTS**

| Description | Constant |
|---|---|
| Adjustment for Drive Alone trips to DC | -0.16 |
| Adjustment for bus trips within DC | 0.60 |
| Transfer constant for walk access to all-bus transit[14] | -0.10 |

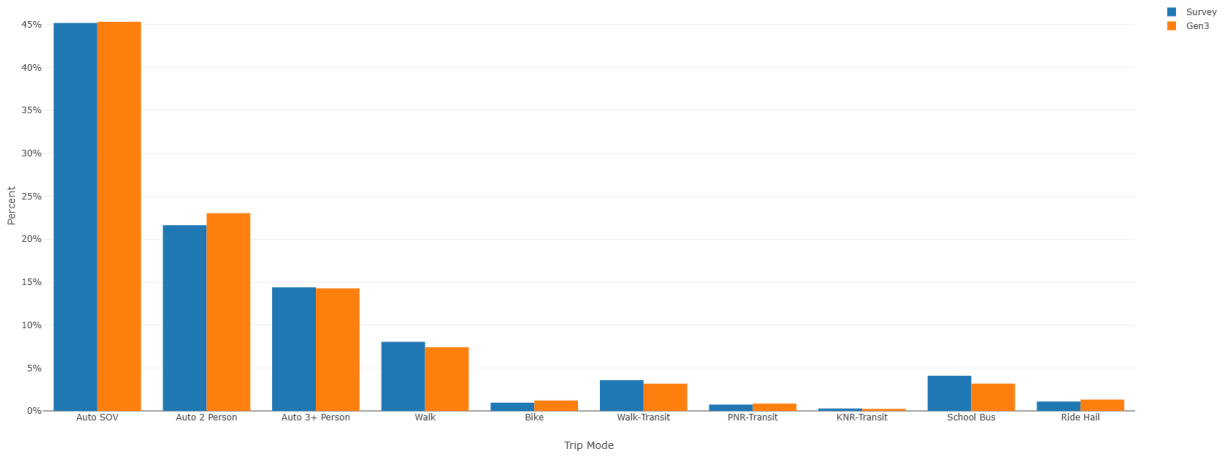


**FIGURE 74: TRIP MODE CHOICE CALIBRATION RESULTS FOR ALL TOUR PURPOSES**

The calibration constants and results for individual trip purposes are discussed, in turn, in the sub-sections below.

## Work Trips

The work trip mode choice calibration constants by tour mode and trip mode are listed in Table 45. These constants link the tour mode with trips that may be different from the tour mode (e.g., a drive-alone trip on a shared-ride 2-person tour). Additionally, there are some adjustments used for tour composition – such as when a tour has no stops or for the first or last trip on a

[14] In the model setup, this constant is split into trip purposes (work, university, school, maintenance, discretionary, and at-work), but the constant is the same for all trip purposes.

tour. Those are listed in Table 46. The calibration results for trips on work tours are shown in Figure 75. The model shows a very close comparison between estimated and observed trips by mode.

Table 45: Work Trip Purpose Calibration Constants

| Tour Mode | Trip Mode | Constant |
|---|---|---|
| Shared-Ride 2 | Drive Alone | -0.31 |
| Shared-Ride 3+ | Drive Alone | 0.15 |
| Shared-Ride 3+ | Shared-Ride 2 | 0.21 |
| Walk | Drive Alone | -2.15 |
| Walk | Shared-Ride 2 | -3.24 |
| Walk | Shared-Ride 3+ | -3.86 |
| Bicycle | Walk | 0.47 |
| Walk Transit | Shared-Ride 2 | -9.13 |
| Walk Transit | Shared-Ride 3+ | -10.63 |
| Walk Transit | Walk | -0.84 |
| Walk Transit | Bicycle | 30 |
| Walk Transit | Taxi | -8.29 |
| Walk Transit | TNC Single | -8.14 |
| Walk Transit | TNC Shared | -8.33 |
| Walk Transit | Metrorail | 0.35 |
| Walk Transit | Bus+Metrorail | -1.12 |
| Walk Transit | Commuter Rail | -6.13 |
| Ridehail | Shared-Ride 2 | -2.23 |
| Ridehail | Shared-Ride 3+ | -2.33 |
| Ridehail | Walk | 1.27 |
| Any | PNR Metrorail-Only | 3.31 |
| Any | PNR Bus+Metrorail | 0.63 |
| Any | PNR Commuter Rail | 1.73 |
| Any | KNR Metrorail-Only | 0.59 |
| Any | KNR Bus+Metrorail | -0.24 |
| Any | KNR Commuter Rail | 12.78 |
| Any | Taxi | -0.14 |
| Any | TNC Single | -1.23 |
| Any | TNC Shared | 0.84 |

**TABLE 46: WORK TRIP PURPOSE STOP ARRANGEMENT CALIBRATION CONSTANTS**

| Tour Mode | Trip Mode | Condition | Constant |
|---|---|---|---|
| Shared-Ride 2 | Drive Alone | No Stops | -2.08 |
| Shared-Ride 3+ | Drive Alone | No Stops | -2.82 |
| Shared-Ride 3+ | Shared-Ride 2 | No Stops | -2.59 |
| Shared-Ride 2 | Drive Alone | First Outbound Trip in Tour | -0.36 |
| Shared-Ride 3+ | Drive Alone | First Outbound Trip in Tour | -0.51 |
| Shared-Ride 3+ | Shared-Ride 2 | First Outbound Trip in Tour | -1.06 |
| Shared-Ride 2 | Drive Alone | Last Inbound Trip in Tour | -0.28 |
| Shared-Ride 3+ | Drive Alone | Last Inbound Trip in Tour | -0.31 |
| Shared-Ride 3+ | Shared-Ride 2 | Last Inbound Trip in Tour | -0.84 |

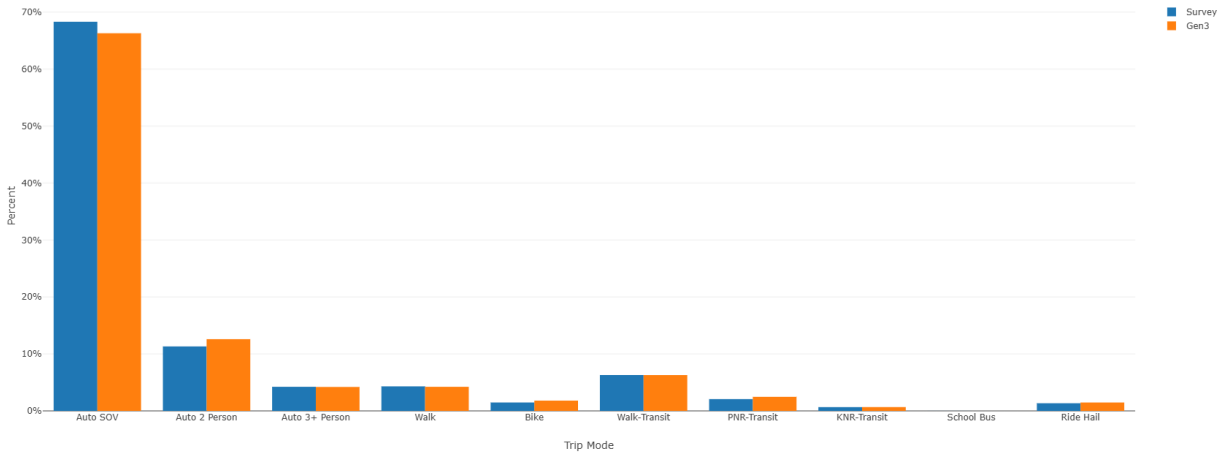


**FIGURE 75: TRIP MODE CHOICE CALIBRATION RESULTS FOR TRIPS ON WORK TOURS**

## University and School Trips

The calibration constants for university trips are listed in Table 47 and the calibration constants for school trips are listed in Table 48. These trip purposes do not use any additional tour composition constants (unlike the work trip mode choice model). The calibration results for trips on university tours are shown in Figure 76. University trip mode choice slightly overestimates single-occupant vehicle, walk, and ride hailing (taxi, TNC); the model slightly underestimates shared-ride and walk access transit.

The calibration results for trips on school tours are shown in Figure 77. The school mode choice model slightly overestimates shared-ride trips and slightly underestimates school bus trips.

**TABLE 47: UNIVERSITY TRIP PURPOSE CALIBRATION CONSTANTS**

| Tour Mode | Trip Mode | Constant |
|---|---|---|
| Shared-Ride 2 | Drive Alone | -2.00 |
| Shared-Ride 3+ | Drive Alone | -2.00 |
| Shared-Ride 3+ | Shared-Ride 2 | -1.48 |
| Walk | Drive Alone | -1.95 |
| Walk | Shared-Ride 2 | -3.49 |
| Walk | Shared-Ride 3+ | -5.04 |
| Bicycle | Walk | -2.32 |
| Walk Transit | Shared-Ride 2 | -11.54 |
| Walk Transit | Shared-Ride 3+ | -12.08 |
| Walk Transit | Walk | -1.63 |
| Walk Transit | Bicycle | 26.00 |
| Walk Transit | Taxi | -12.06 |
| Walk Transit | TNC Single | -14.22 |
| Walk Transit | TNC Shared | -19.00 |
| Walk Transit | Metrorail | 5.61 |
| Walk Transit | Bus+Metrorail | -7.09 |
| Walk Transit | Commuter Rail | -5.69 |
| Ridehail | Shared-Ride 2 | -2.05 |
| Ridehail | Shared-Ride 3+ | -4.12 |
| Ridehail | Walk | 1.10 |
| Any | PNR Metrorail-Only | 10.75 |
| Any | PNR Bus+Metrorail | -11.90 |
| Any | PNR Commuter Rail | -0.90 |
| Any | KNR Metrorail-Only | 5.34 |
| Any | KNR Bus+Metrorail | -16.00 |
| Any | KNR Commuter Rail | -16.00 |

**TABLE 48: SCHOOL TRIP PURPOSE CALIBRATION CONSTANTS**

| Tour Mode | Trip Mode | Constant |
|---|---|---|
| Shared-Ride 2 | Drive Alone | -0.41 |
| Shared-Ride 3+ | Drive Alone | -3.00 |
| Shared-Ride 3+ | Shared-Ride 2 | -1.41 |
| Walk | Drive Alone | -4.40 |
| Walk | Shared-Ride 2 | -2.62 |
| Walk | Shared-Ride 3+ | -2.93 |
| Bicycle | Walk | -1.12 |
| Walk Transit | Shared-Ride 2 | -5.77 |
| Walk Transit | Shared-Ride 3+ | -5.94 |
| Walk Transit | Walk | -2.00 |
| Walk Transit | Bicycle | 0.00 |
| Walk Transit | Taxi | -14.00 |
| Walk Transit | TNC Single | -14.00 |
| Walk Transit | TNC Shared | -9.17 |
| Walk Transit | Metrorail | -5.54 |
| Walk Transit | Bus+Metrorail | -0.45 |
| Walk Transit | Commuter Rail | -8.00 |
| Ridehail | Shared-Ride 2 | -0.70 |
| Ridehail | Shared-Ride 3+ | -0.66 |
| Ridehail | Walk | -8.00 |
| School Bus | Shared-Ride 2 | -1.15 |
| School Bus | Shared-Ride 3+ | -1.05 |
| School Bus | Walk | -0.93 |
| Any | PNR Metrorail-Only | 2.71 |
| Any | PNR Bus+Metrorail | 0.00 |
| Any | PNR Commuter Rail | 0.00 |
| Any | KNR Metrorail-Only | 22.00 |
| Any | KNR Bus+Metrorail | 27.65 |
| Any | KNR Commuter Rail | -4.00 |

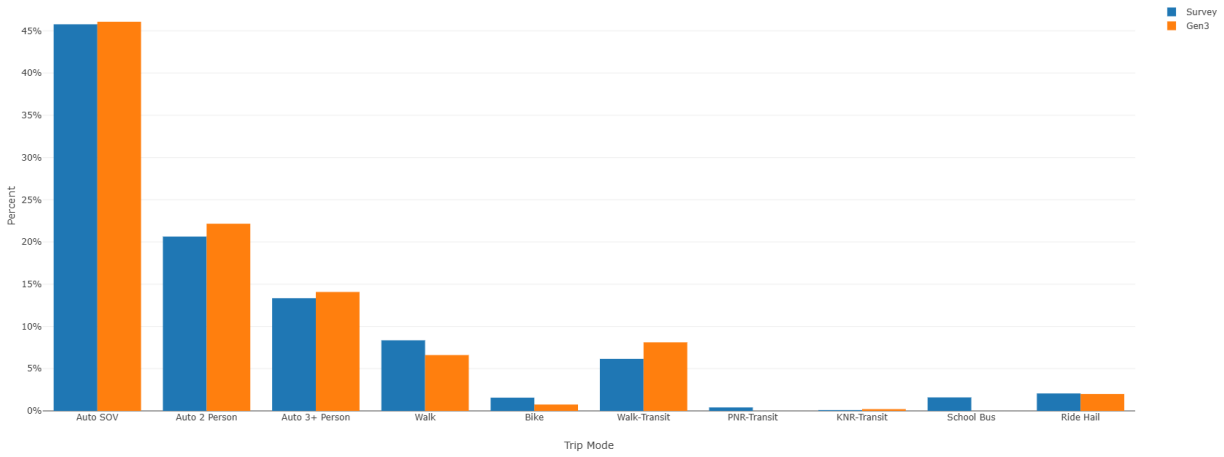


**FIGURE 76: TRIP MODE CHOICE CALIBRATION RESULTS FOR UNIVERSITY TOURS**

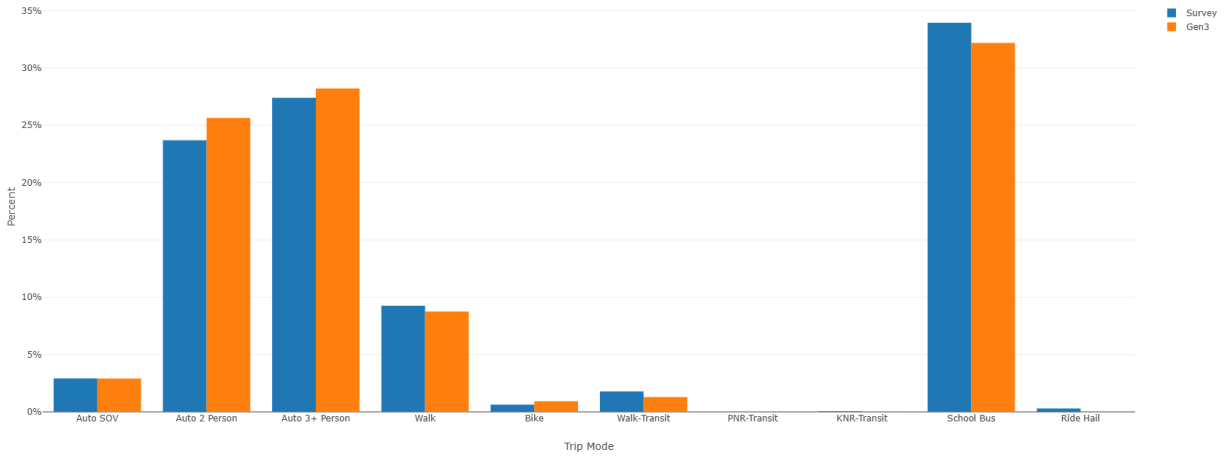


**FIGURE 77: TRIP MODE CHOICE CALIBRATION RESULTS FOR SCHOOL TOURS**

## Non-Mandatory Trips

Non-mandatory trips include maintenance (shopping, escort, other maintenance) and discretionary trips (eat out, social-recreation, and other discretionary) trips. The calibration constants for maintenance trips are listed in Table 49 and the calibration constants for discretionary trips are listed in Table 50.

The calibration results for trips on individual maintenance tours is shown in Figure 78 and the calibration of trips on joint maintenance tours is shown in Figure 79. The individual trip model overestimates single-occupant vehicle trips and slightly underestimates shared-ride and walk trips. The joint tours model underestimates 2-person shared-ride trips and overestimates 3-person shared-ride trips.

The calibration of trips on individual discretionary tours is shown in Figure 80, and the calibration of trips on joint discretionary tours is shown in Figure 81. The individual trip mode choice model overestimates single-occupant vehicles and slightly underestimates shared-ride and walk trips. The joint trip mode choice model underestimates 2-person shared-ride trips and overestimates 3-person shared-ride trips.

**TABLE 49: MAINTENANCE TRIP PURPOSE CALIBRATION CONSTANTS**

| Tour Mode | Trip Mode | Constant |
|---|---|---|
| Shared-Ride 2 | Drive Alone | -1.08 |
| Shared-Ride 3+ | Drive Alone | -2.10 |
| Shared-Ride 3+ | Shared-Ride 2 | -1.35 |
| Walk | Drive Alone | -3.46 |
| Walk | Shared-Ride 2 | -4.53 |
| Walk | Shared-Ride 3+ | -5.18 |
| Bicycle | Walk | -2.65 |
| Walk Transit | Shared-Ride 2 | -8.94 |
| Walk Transit | Shared-Ride 3+ | -10.17 |
| Walk Transit | Walk | -1.55 |
| Walk Transit | Bicycle | 30.00 |
| Walk Transit | Taxi | -7.86 |
| Walk Transit | TNC Single | -8.20 |
| Walk Transit | TNC Shared | -11.27 |
| Walk Transit | Metrorail | -5.98 |
| Walk Transit | Bus+Metrorail | -2.11 |
| Walk Transit | Commuter Rail | -14.00 |
| Ridehail | Shared-Ride 2 | -6.21 |
| Ridehail | Shared-Ride 3+ | -4.64 |
| Ridehail | Walk | 0.69 |
| Any | PNR Metrorail-Only | 0.00 |
| Any | PNR Bus+Metrorail | 0.00 |
| Any | PNR Commuter Rail | 0.00 |
| Any | KNR Metrorail-Only | -4.59 |
| Any | KNR Bus+Metrorail | 0.00 |
| Any | KNR Commuter Rail | 0.00 |

**TABLE 50: DISCRETIONARY TRIP PURPOSE CALIBRATION CONSTANTS**

| Tour Mode | Trip Mode | Constant |
|---|---|---|
| Shared-Ride 2 | Drive Alone | -1.00 |
| Shared-Ride 3+ | Drive Alone | -2.25 |
| Shared-Ride 3+ | Shared-Ride 2 | -1.75 |
| Walk | Drive Alone | -2.66 |
| Walk | Shared-Ride 2 | -4.13 |
| Walk | Shared-Ride 3+ | -3.83 |
| Bicycle | Walk | -0.70 |
| Walk Transit | Shared-Ride 2 | -14.34 |
| Walk Transit | Shared-Ride 3+ | -14.92 |
| Walk Transit | Walk | -0.72 |
| Walk Transit | Bicycle | 30.00 |
| Walk Transit | Taxi | -8.43 |
| Walk Transit | TNC Single | -6.97 |
| Walk Transit | TNC Shared | -12.17 |
| Walk Transit | Metrorail | -1.96 |
| Walk Transit | Bus+Metrorail | -4.45 |
| Walk Transit | Commuter Rail | -9.55 |
| Ridehail | Shared-Ride 2 | -2.88 |
| Ridehail | Shared-Ride 3+ | -4.02 |
| Ridehail | Walk | 0.47 |
| Any | PNR Metrorail-Only | 31.29 |
| Any | PNR Bus+Metrorail | 27.17 |
| Any | PNR Commuter Rail | 32.65 |
| Any | KNR Metrorail-Only | -2.30 |
| Any | KNR Bus+Metrorail | 23.76 |
| Any | KNR Commuter Rail | 31.88 |

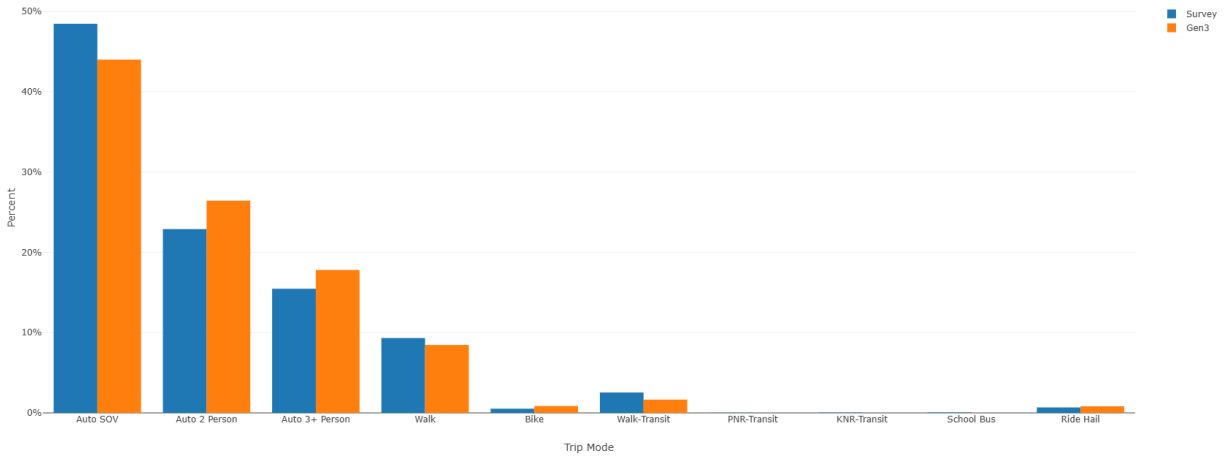


**FIGURE 78: TRIP MODE CHOICE CALIBRATION RESULTS FOR INDIVIDUAL MAINTENANCE TOURS**

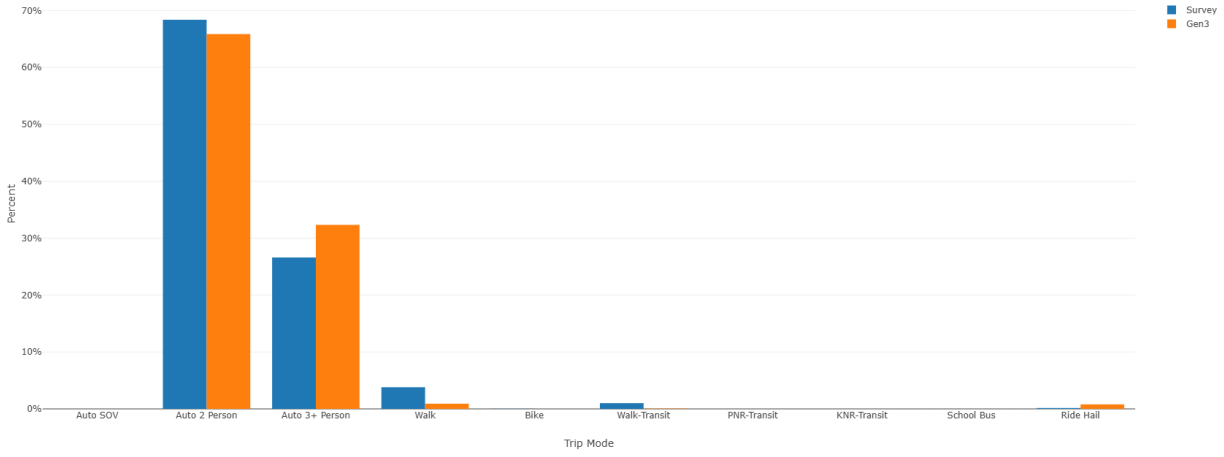


**FIGURE 79: TRIP MODE CHOICE CALIBRATION RESULTS FOR JOINT MAINTENANCE TOURS**

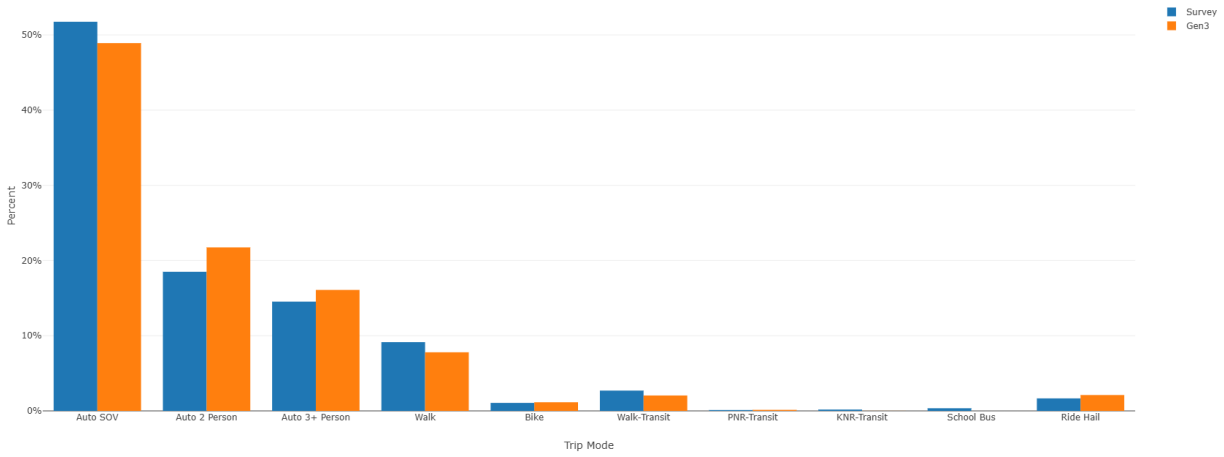


**FIGURE 80: TRIP MODE CHOICE CALIBRATION RESULTS FOR INDIVIDUAL DISCRETIONARY TOURS**

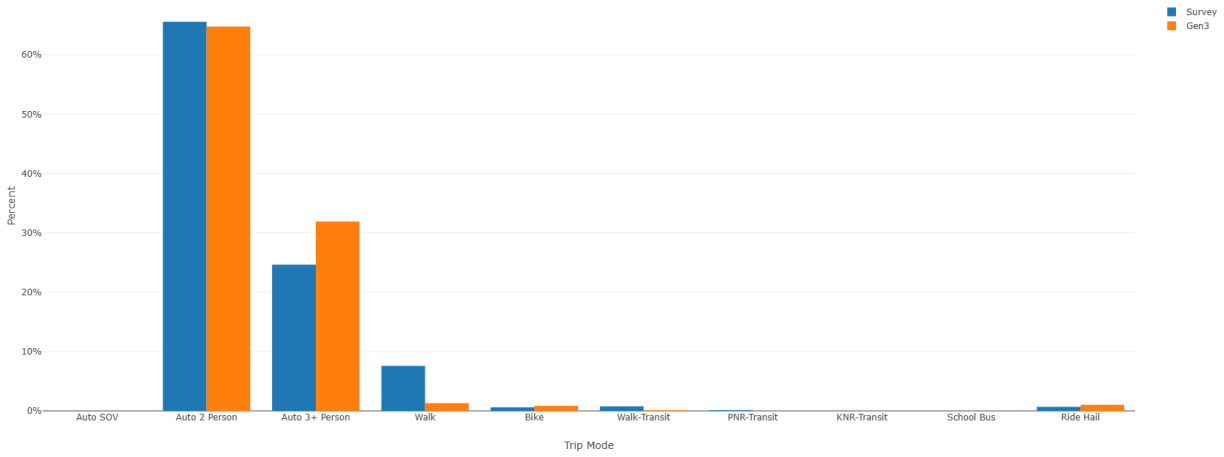


**FIGURE 81: TRIP MODE CHOICE CALIBRATION RESULTS FOR JOINT DISCRETIONARY TOURS**

# 3.0 HIGHWAY VALIDATION

The highway assignment validation is based on a comparison of model highway assignment output to observed data, which includes traffic count data collected by local jurisdictions and the Highway Performance Monitoring System (HPMS) vehicle miles of travel (VMT) data, which is developed based on data collected by the state departments of transportation (DOTs). Note that the HPMS data does not necessarily match traffic counts collected by local jurisdictions. This is evident in some of the following summaries and comparisons.

Table 51 lists the comparison of highway assignment volumes to traffic counts by jurisdiction and facility type, as well as the ratio of estimated volume to observed count. This table shows that the model estimates are 2% higher than observed traffic counts. However, as indicated in Table 55, model VMT estimates are slightly lower than HPMS VMT estimates.

The density and variation in land activity is measured in terms of the “area type,” an index that can range from 1 to 6, where 1 is extremely densely developed, and area type 6 is very sparsely developed.  (shown in Table 53). All facility types except collectors are within 8% of counts; collector model assignment is 14% lower than counts (shown in Table 54).

Table 51 lists the comparison of estimated average weekday traffic volumes to observed AAWDT traffic counts by jurisdiction. Most of the TPB planning area jurisdictions have overall estimated-to-observed ratios for traffic volumes that are within 10%.

**TABLE 51: HIGHWAY ASSIGNMENT VOLUME TO OBSERVED COUNT COMPARISON BY JURISDICTION AND FACILITY TYPE (ON LINKS WITH COUNTS)**

| JURISDICTION | FREEWAY | MAJOR ARTERIAL | MINOR ARTERIAL | COLLECTOR | EXPRESSWAY | TOTAL* |
|---|---|---|---|---|---|---|
| District of Columbia | 0.79 | 1.10 | 1.03 | 0.91 | 0.68 | 0.91 |
| Montgomery County | 0.95 | 1.11 | 1.13 | 0.75 | 1.58 | 1.03 |
| Prince George's County | 0.93 | 0.97 | 0.91 | 0.62 | 0.84 | 0.91 |
| Arlington County | 0.88 | 0.83 | 0.89 | 0.76 | 1.02 | 0.88 |
| City of Alexandria | 1.02 | 0.98 | 1.03 | 1.51 | - | 1.02 |
| Fairfax County | 0.96 | 0.84 | 0.95 | 0.89 | 0.91 | 0.93 |
| Loudoun County | 0.75 | 1.02 | 1.49 | 0.99 | 0.67 | 1.16 |
| Prince William County | 1.12 | 1.06 | 0.96 | 0.86 | 1.08 | 1.04 |
| Frederick County | 1.11 | 1.32 | 1.28 | 0.84 | 1.00 | 1.14 |
| Howard County | 1.09 | 1.35 | 1.24 | 0.80 | 0.92 | 1.09 |
| Anne Arundel County | 1.05 | 1.03 | 1.04 | 0.88 | 1.05 | 1.04 |
| Charles County | - | 1.16 | 1.08 | 0.39 | - | 1.09 |
| Carrol County | 1.15 | 1.38 | 2.13 | 1.07 | - | 1.59 |
| Calvert County | - | 0.85 | 1.06 | 0.73 | - | 0.87 |
| St. Mary's County | - | 0.92 | 0.87 | 0.97 | - | 0.90 |
| King George County | - | 0.92 | 0.90 | 0.87 | - | 0.91 |
| City of Fredericksburg | 0.94 | 0.94 | 1.87 | 0.48 | - | 1.00 |
| Stafford County | 1.13 | 1.11 | 1.13 | 0.63 | - | 1.06 |
| Spotsylvania County | 0.99 | 0.91 | 0.65 | 0.55 | - | 0.87 |
| Fauquier County | 1.20 | 0.96 | 1.44 | 1.45 | - | 1.14 |
| Clarke County | - | 1.43 | 1.67 | - | - | 1.52 |
| Jefferson County | 1.26 | 1.77 | 2.37 | 1.22 | - | 1.70 |
| TOTAL | 1.01 | 1.06 | 1.12 | 0.80 | 0.91 | 1.02 |

* The Florida DOT (FDOT) standard for estimated/observed VMT areawide is +/- 5% (acceptable) and +/- 2% (preferable).

Table 52 lists the comparison of estimated volume to observed count on screenlines, which is also shown in Figure 82. The column “STD” presents the general acceptable standard for deviation from ideal “1” ratio (adopted from FDOT’s standard). This deviation is +-0.1 for screenlines within MWCOG planning region and +-0.2 for those outside. Over half of the

screenlines are within 15% of the observed volume, and two thirds of them are within 20% of the observed volume.

It is worth noting that, in an iterative process to improve the highway validation performance, incremental model adjustments were made both on the demand side and on the supply (network) side. On the demand side, the calibration adjustments in ActivitySim have were discussed in the previous chapter. On the network side, RSG kept the 11-minute Potomac River crossing time penalty that is implemented in the Gen2 Regional Travel Demand Model and introduced a 5-minute time penalty on all the Anacostia River bridge crossings. RSG also changed the facility type coding on some of the Anacostia River bridges and their upstream/downstream links based on aerial photography. In addition, COG reviewed the coding of screenline links in DC (specifically, Screenline 2 and Screenline 4) and their upstream and downstream links and revised the number of lanes coded on those links in consideration of the time-of-day, on-street parking in DC. The final highway validation results presented in this report reflect all these model adjustments.

**TABLE 52: ESTIMATE/OBSERVED TRAFFIC VOLUMES ON REGIONAL SCREENLINES**

| SCREEN-LINE | FREEWAY | MAJOR ARTERIAL | MINOR ARTERIAL | COLLECTOR | EXPRESS-WAY | TOTAL | STD |
|---|---|---|---|---|---|---|---|
| 1 | 1.13 | 0.63 | 1.01 | 1.02 | - | 0.95 | +/- 0.1 |
| 2 | - | 1.19 | 1.31 | 1.11 | 0.70 | 1.12 | +/- 0.1 |
| 3 | 1.01 | 0.96 | 0.85 | 0.68 | - | 0.95 | +/- 0.1 |
| 4 | 0.00 | 1.33 | 1.14 | 1.08 | 0.70 | 1.10 | +/- 0.1 |
| 5 | 0.86 | 1.00 | 1.13 | 0.99 | - | 0.98 | +/- 0.1 |
| 6 | 0.96 | 1.03 | 0.90 | 0.49 | 0.78 | 0.92 | +/- 0.1 |
| 7 | 0.90 | 0.97 | 0.96 | 0.62 | 0.87 | 0.92 | +/- 0.1 |
| 8 | 0.96 | 1.18 | 0.93 | 0.64 | 1.17 | 1.02 | +/- 0.1 |
| 9 | 1.01 | 1.52 | 1.01 | 1.01 | - | 1.12 | +/- 0.1 |
| 10 | 0.94 | 1.14 | 0.96 | 1.49 | - | 1.12 | +/- 0.1 |
| 11 | 1.03 | 0.87 | 1.16 | 0.87 | - | 0.97 | +/- 0.1 |
| 12 | 0.95 | 1.28 | 1.44 | 0.79 | - | 1.10 | +/- 0.1 |
| 13 | 0.95 | 1.26 | 1.61 | - | - | 1.11 | +/- 0.1 |
| 14 | 0.89 | 1.09 | 0.63 | 0.40 | - | 0.85 | +/- 0.1 |
| 15 | 0.78 | 0.94 | 0.95 | 0.85 | - | 0.84 | +/- 0.1 |
| 16 | 0.83 | 1.12 | 0.83 | 0.32 | - | 0.80 | +/- 0.1 |
| 17 | 0.99 | 0.92 | 0.96 | 0.91 | - | 0.96 | +/- 0.1 |
| 18 | 0.92 | 0.71 | 1.10 | 1.27 | 0.75 | 0.90 | +/- 0.1 |
| 19 | 0.86 | 1.08 | 0.99 | 0.75 | 0.73 | 0.86 | +/- 0.1 |
| 20 | 1.19 | 1.08 | - | - | 0.75 | 1.02 | +/- 0.1 |
| 22 | 0.91 | 1.08 | 0.95 | 0.57 | 0.99 | 0.94 | +/- 0.1 |

| SCREEN-LINE | FREEWAY | MAJOR ARTERIAL | MINOR ARTERIAL | COLLECTOR | EXPRESS-WAY | TOTAL | STD |
|---|---|---|---|---|---|---|---|
| 23 | 1.24 | 1.47 | 0.86 | 0.27 | - | 1.04 | +/- 0.2 |
| 24 | 0.87 | 0.89 | 0.79 | 0.86 | - | 0.86 | +/- 0.1 |
| 25 | 1.34 | - | 1.60 | 2.07 | - | 1.42 | +/- 0.1 |
| 26 | 1.23 | - | 1.59 | 3.17 | 1.34 | 1.38 | +/- 0.2 |
| 27 | 1.37 | 1.19 | 0.97 | 1.25 | - | 1.28 | +/- 0.1 |
| 28 | - | 0.87 | 0.94 | 0.90 | - | 0.90 | +/- 0.1 |
| 31 | - | 2.11 | 2.48 | 2.45 | - | 2.37 | +/- 0.1 |
| 32 | - | 1.80 | 1.72 | - | - | 1.77 | +/- 0.2 |
| 33 | 1.30 | 0.99 | 1.40 | - | - | 1.23 | +/- 0.2 |
| 34 | - | 1.08 | 1.49 | - | - | 1.17 | +/- 0.1 |
| 35 | 1.08 | 0.83 | 0.80 | 0.42 | 0.79 | 0.92 | +/- 0.1 |
| 36 | - | 1.72 | 3.08 | - | - | 1.87 | +/- 0.2 |
| 37 | - | - | 1.89 | 2.54 | - | 1.91 | +/- 0.2 |
| 38 | - | 1.06 | 0.49 | 0.69 | - | 0.78 | +/- 0.1 |

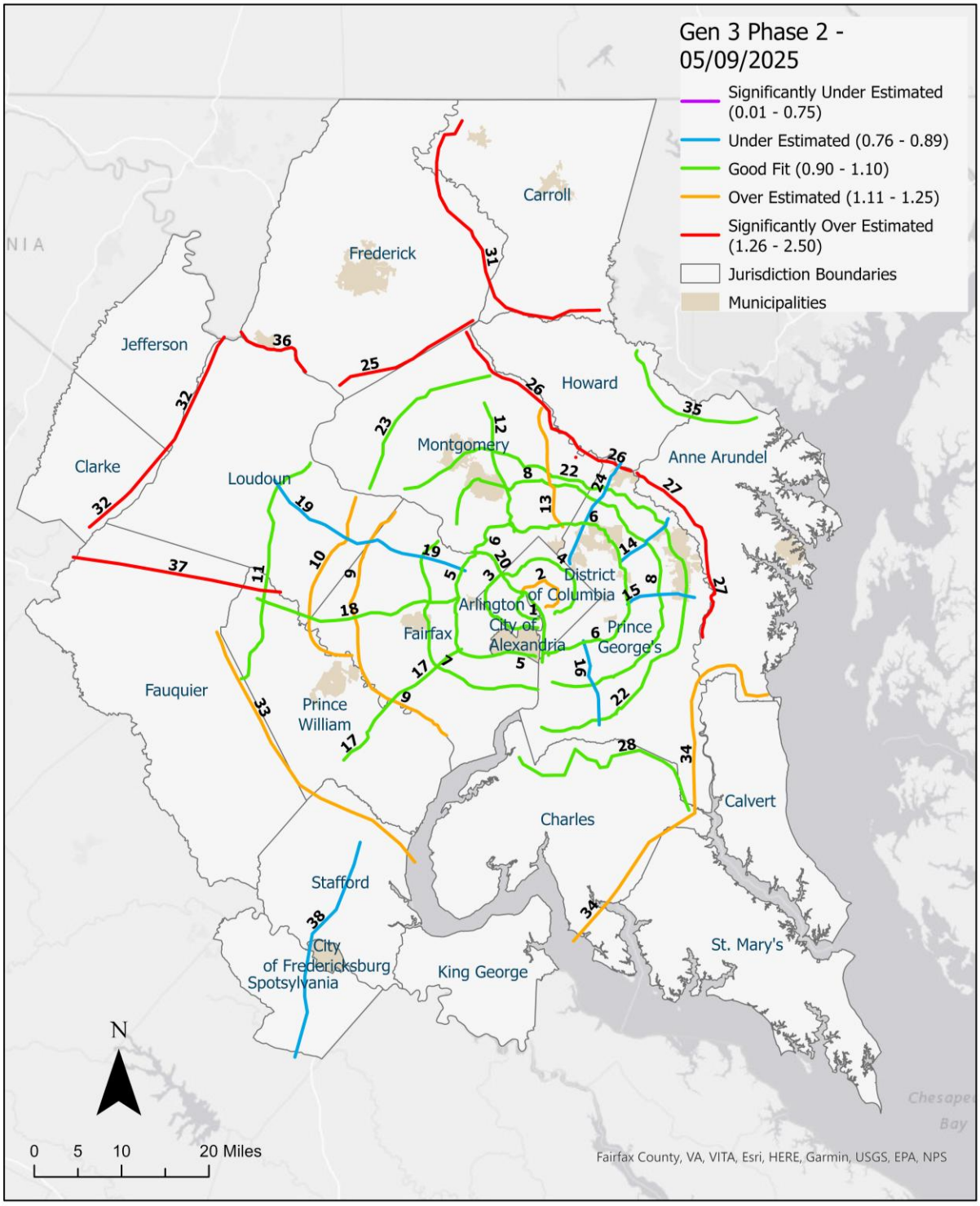


**FIGURE 82: ESTIMATED-TO-OBSERVED TRAFFIC VOLUMES ON SCREENLINES**

Table 53 shows the estimated VMT compared to the observed VMT by jurisdiction. This table includes the comparison for links with counts available. Table 55, on the other hand, shows the estimated VMT compared to the HPMS-based VMT data for all network links. As shown in the two tables, most of the jurisdictions are within 10% of both count-based VMT and HPMS VMT estimates. Almost all the jurisdictions are within 20% of count-based VMT and only a few of them fall outside the +/- 20% range when compared to the HPMS VMT data.

**TABLE 53: ESTIMATED VOLUME COMPARED TO OBSERVED VOLUME BY AREA TYPE BASED ON LINKS WITH COUNTS**

| AREA TYPE | OBSERVED 2018 | GEN3 2018 | GEN2 2018 | GEN 3 E/O | GEN2 E/O | STANDARD (ACCEPTABLE/ PREFERABLE) |
|---|---|---|---|---|---|---|
| 1: High mixed employment and population density | 9,843,948 | 9,939,139 | 10,328,977 | 1.01 | 1.04 | ± 25% / ± 15% |
| 2: Medium/high mixed density | 31,266,106 | 29,548,749 | 31,049,705 | 0.95 | 0.98 | ± 25% / ± 15% |
| 3: Medium employment density | 27,384,672 | 25,959,222 | 26,166,926 | 0.95 | 0.96 | ± 25% / ± 15% |
| 4: Medium population density | 17,129,636 | 17,086,056 | 17,739,028 | 1.00 | 1.03 | ± 25% / ± 15% |
| 5: Low density | 19,077,729 | 19,969,996 | 19,874,883 | 1.05 | 1.04 | ± 25% / ± 15% |
| 6: Rural | 10,562,619 | 13,198,407 | 12,944,715 | 1.25 | 1.23 | ± 25% / ± 15% |
| TOTAL | 115,264,710 | 115,701,569 | 118,104,234 | 1.00 | 1.02 | |

* Based on 7,889 directional links with daily traffic counts in 2018

**TABLE 54: ESTIMATED VOLUME COMPARED TO OBSERVED VOLUME BY FACILITY TYPE BASED ON LINKS WITH COUNTS**

| FACILITY TYPE | OBSERVED 2018 | GEN3 2018 | GEN2 2018 | GEN 3 E/O | GEN2 E/O | STANDARD (ACCEPTABLE/ PREFERABLE) |
|---|---|---|---|---|---|---|
| Freeway | 39,264,889 | 38,789,089 | 41,149,106 | 0.99 | 1.04 | ± 7% / ± 6% |
| Major Arterial | 35,108,530 | 37,038,053 | 37,418,680 | 1.05 | 1.06 | ± 15% / ± 10% |
| Minor Arterial | 25,577,725 | 26,354,750 | 26,101,599 | 1.03 | 1.02 | ± 15% / ± 10% |
| Collector | 6,046,370 | 5,120,653 | 4,865,434 | 0.85 | 0.80 | ± 25% / ± 20% |
| Expressway | 9,233,286 | 8,373,237 | 8,536,418 | 0.91 | 0.92 | ± 15% / ± 10% |
| TOTAL | 115,264,710 | 115,701,569 | 118,104,234 | 1.00 | 1.02 | ± 5% / ± 2% |

* Based on 7,889 directional links with daily traffic counts in 2018

A comparison of the VMT by jurisdiction to HPMS is listed in Table 54. Compared to the Gen2 Model, the Gen3 Model is closer to the observed HPMS VMT for the TPB planning area, the air quality nonattainment area, and the non-TPB member area. The City of Alexandria, Loudon County, St. Mary's County, and Stafford County have the largest differences between the Gen2 and Gen3 models.

Compared to the Gen2 Model, the Gen3 Model performs better for most TPB Member jurisdictions (Montgomery County, Prince George's County, City of Alexandria, Loudoun County, Prince William County, Frederick County, and Charles County). In the cases where the Gen2 Model performed better than the Gen3 Model, no model-related problems have been identified. The underestimation for DC can be attributed to screenline counts that indicate less traffic should be going to DC while VMT suggests more traffic in DC. In DC and in other TPB member jurisdictions, the traffic assignment underestimation can be attributed to one or more factors of land use problems, potential traffic count problems, or network coding errors. Outside of the TPB member area, Spotsylvania County's observed VMT includes the entire county while the VMT for the Gen2 and Gen3 models includes only the northern portion of the county. The remaining non-TPB member counties may have similar potential issues as the member counties but may also have travel patterns that differ significantly from the rest of the region, thus leading to model volumes that are over- or under-assigned.

**TABLE 55: MODELED VS. HPMS-BASED OBSERVED VMT BY JURISDICTION (FOR ALL LINKS)**

| JURISDICTION NAME | OBSERVED (HPMS) VMT | GEN3 ESTIMATED VMT | GEN2 ESTIMATED VMT | GEN3 ESTIMATED / OBSERVED | GEN2 ESTIMATED/ OBSERVED |
|---|---|---|---|---|---|
| District of Columbia | 8,410,547 | 7,480,741 | 8,160,131 | 0.89 | 0.97 |
| Montgomery County | 20,844,658 | 21,056,805 | 20,794,264 | 1.01 | 1.00 |
| Prince George's County | 25,320,822 | 23,625,486 | 22,659,440 | 0.93 | 0.89 |
| Arlington County | 4,115,600 | 3,842,674 | 4,109,213 | 0.93 | 1.00 |
| City of Alexandria | 1,851,663 | 2,280,807 | 2,140,651 | 1.23 | 1.16 |
| Fairfax County | 28,284,350 | 27,420,859 | 28,111,767 | 0.97 | 0.99 |
| Loudoun County | 7,342,782 | 8,208,072 | 7,449,609 | 1.12 | 1.01 |
| Prince William County | 10,300,396 | 10,410,601 | 10,162,646 | 1.01 | 0.99 |
| Frederick County | 8,391,370 | 9,188,821 | 9,066,690 | 1.10 | 1.08 |
| Howard County | 11,526,986 | 12,078,250 | 11,426,554 | 1.05 | 0.99 |
| Anne Arundel County | 16,518,082 | 16,043,434 | 16,058,595 | 0.97 | 0.97 |
| Charles County | 3,426,164 | 3,304,173 | 3,237,059 | 0.96 | 0.94 |
| Carrol County | 3,408,904 | 4,532,172 | 4,381,657 | 1.33 | 1.29 |
| Calvert County | 2,019,452 | 1,506,812 | 1,652,935 | 0.75 | 0.82 |
| St. Mary's County | 2,367,534 | 1,950,242 | 2,134,629 | 0.82 | 0.90 |
| King George County | 932,207 | 824,228 | 835,845 | 0.88 | 0.90 |
| City of Fredericksburg | 990,749 | 896,476 | 894,269 | 0.90 | 0.90 |
| Stafford County | 4,358,421 | 4,316,349 | 4,716,562 | 0.99 | 1.08 |
| Spotsylvania County** | 3,774,287 | 2,422,378 | 2,376,420 | 0.64 | 0.63 |
| Fauquier County*** | 3,686,566 | 3,639,789 | 3,802,460 | 0.99 | 1.03 |
| Clarke County | 827,733 | 1,122,960 | 1,082,114 | 1.36 | 1.31 |
| Jefferson County | 1,069,310 | 1,520,613 | 1,505,290 | 1.42 | 1.41 |
| **Total** | **169,768,582** | **167,672,741** | **166,758,800** | **0.99** | **0.98** |
| | | | | | |
| **TPB Planning Area** | **118,288,351** | **116,819,038** | **115,891,470** | **0.99** | **0.98** |
| **Non-TPB Member Area** | **51,480,231** | **50,853,703** | **50,867,330** | **0.99** | **0.99** |
| **Air Quality Nonattainment Area (8-Hour Ozone)** | **120,307,803** | **118,325,850** | **117,544,405** | **0.98** | **0.98** |

* The observed VMT data is from HPMS.

** Observed VMT is for the entire Spotsylvania County while Estimated is for northern portion of county only.

*** Fauquier County urbanized area was part of TPB Planning Area as of 2023. Fauquier County, however, is not included as a TPB member in this summary as the HPMS VMT data is only available for the whole county.

§ Florida DOT standard for estimated-over-observed VMT Areawide is ±5% (acceptable) and ±2% (preferable).

§§ MWCOG standard for estimated-over-observed VMT for DC is between 1.0 and 1.03.[15]

[15] MWCOG. Gen3 Model Development Task Order 5 Scope of Work. 7/5/2023.

The percent root mean square error (RMSE) by facility type is listed in Table 56. Since smaller values of RMSE are better, the RMSE for freeways is excellent, and the RMSE for expressways and major arterials is good.

**TABLE 56: HIGHWAY ASSIGNMENT RMSE BY FACILITY TYPE**

| FACILITY TYPE | NUMBER OF OBSERVED COUNTS | SUM OF SQUARED DIFFERENCE | SUM OF OBSERVED COUNTS | GEN3 PERCENT RMSE | GEN2 PERCENT RMSE* |
|---|---|---|---|---|---|
| Freeway | 663 | 107,429,020,710 | 39,209,493 | 21.5% | 24.4% |
| Major Arterial | 2,069 | 84,620,540,299 | 35,160,052 | 37.6% | 38.9% |
| Minor Arterial | 3,375 | 50,370,233,052 | 25,794,076 | 50.5% | 48.5% |
| Collector | 1,711 | 14,614,260,279 | 6,445,884 | 77.6% | 76.7% |
| Expressway | 251 | 51,131,560,087 | 9,255,438 | 38.7% | 36.1% |
| Ramp | 2 | 32,997,077 | 33,910 | 23.96 | 4.1% |
| **Total** | **8,069** | **308,165,614,428** | **115,864,943** | **43.0%** | **44.2%** |

* Year 2018 Validation of TPB Version 2.4 Travel Model

The RMSE by area type is listed in Table 57. The RMSE for area types 1-5 is good. The RMSE by jurisdiction is listed in Table 58. Many jurisdictions have good RMSE scores (below 40% RMSE).

**TABLE 57: HIGHWAY ASSIGNMENT RMSE BY AREA TYPE**

| AREA TYPE | NUMBER OF OBSERVED COUNTS | SUM OF SQUARED DIFFERENCE | SUM OF OBSERVED COUNTS | GEN3 PERCENT RMSE |
|---|---|---|---|---|
| 1 | 807 | 41,570,215,996 | 10,038,017 | 57.7% |
| 2 | 1,982 | 85,063,172,869 | 31,530,660 | 41.2% |
| 3 | 1,271 | 74,933,794,255 | 27,407,090 | 35.6% |
| 4 | 1,137 | 37,405,342,764 | 17,191,331 | 37.9% |
| 5 | 1,275 | 39,823,280,700 | 19,109,588 | 37.3% |
| 6 | 1,597 | 29,369,807,843 | 10,588,257 | 64.7% |
| **Total** | **8,069** | **308,165,614,428** | **115,864,943** | **43.0%** |

**TABLE 58: HIGHWAY ASSIGNMENT RMSE BY JURISDICTION**

| JURISDICTION | NUMBER OF OBSERVED COUNTS | SUM OF OBSERVED COUNTS | GEN3 PERCENT RMSE | GEN2 PERCENT RMSE |
|---|---|---|---|---|
| District of Columbia | 1,363 | 13,689,128 | 66.8% | 64.6% |
| Montgomery County | 857 | 15,104,533 | 30.0% | 29.5% |
| Prince George's County | 830 | 17,192,570 | 36.5% | 37.9% |
| Arlington County | 348 | 4,912,374 | 50.6% | 51.3% |
| City of Alexandria | 132 | 2,391,200 | 29.9% | 33.9% |
| Fairfax County | 1,540 | 23,864,008 | 40.0% | 43.9% |
| Loudoun County | 338 | 3,070,888 | 57.3% | 54.6% |
| Prince William County | 445 | 6,265,650 | 38.6% | 43.6% |
| Frederick County | 374 | 3,827,168 | 46.8% | 48.6% |
| Howard County | 222 | 5,584,580 | 31.9% | 31.8% |
| Anne Arundel County | 456 | 9,991,954 | 33.7% | 32.5% |
| Charles County | 176 | 1,356,056 | 58.2% | 60.5% |
| Carrol County | 174 | 1,241,916 | 84.6% | 80.9% |
| Calvert County | 98 | 806,624 | 34.2% | 22.6% |
| St. Mary's County | 120 | 815,868 | 32.2% | 30.7% |
| King George County | 50 | 271,000 | 36.2% | 31.6% |
| City of Fredericksburg | 44 | 777,134 | 38.0% | 38.5% |
| Stafford County | 148 | 1,852,468 | 43.5% | 62.1% |
| Spotsylvania County | 96 | 986,600 | 41.1% | 41.7% |
| Fauquier County | 134 | 1,117,082 | 36.6% | 34.7% |
| Clarke County | 38 | 321,500 | 63.8% | 58.4% |
| Jefferson County | 86 | 424,642 | 116.8% | 119.4% |
| **Total** | **8,069** | **115,864,943** | **43.0%** | **44.2%** |

The Root Mean Square Error comparison by volume group is shown in Table 59. The RMSE for the Gen2 and Gen3 models are very similar.

**TABLE 59: VOLUME GROUP RMSE COMPARISON**

| VOLUME GROUP | NUMBER OF OBSERVED COUNTS | GEN3 PERCENT RMSE | GEN2 PERCENT RMSE | STANDARD |
|---|---|---|---|---|
| < 5,000 | 2,635 | 114.2% | 112.7% | 100% |
| 5,000 – 9,999 | 1,969 | 54.7% | 58.3% | 45% |
| 10,000 – 14,999 | 1,169 | 41.3% | 42.3% | 35% |
| 15,000 – 19,999 | 727 | 33.5% | 33.5% | 30% |
| 20,000 – 29,999 | 731 | 29.5% | 31.1% | 27% |
| 30,000 – 49,999 | 392 | 27.3% | 27.9% | 25% |
| 50,000 – 59,999 | 116 | 24.6% | 22.7% | 20% |
| 60,000 + | 330 | 19.7% | 21.3% | 19% |
| **Total** | **8,069** | **43.0%** | **44.2%** | |

# 4.0 TRANSIT VALIDATION

The transit validation is based on observed transit data from the transit providers (WMATA, MARC, VRE, and the Federal Transit Administration's National Transit Data). A summary of the transit validation is listed in Table 60. All of the major modes – Metrorail, commuter rail, and bus (All Bus in the table) are within 5% and overall transit is 2% overestimated.

**TABLE 60: TRANSIT LOADING SUMMARY**

| TRANSIT MODE | MODEL ESTIMATE | OBSERVED RIDERSHIP | EST / OBS | STANDARD (ACCEPTABLE) [16] | STANDARD (PREFERABLE) |
|---|---|---|---|---|---|
| **Metrorail*** | **624,717** | **641,227** | **0.97** | **+/- 9%** | **+/- 3%** |
| **Commuter Rail** | **55,776** | **57,989** | **0.96** | **+/- 9%** | **+/- 3%** |
| *MARC* | *40,724* | *39,498* | *1.03* | +/- 9% | +/- 3% |
| *VRE* | *15,053* | *18,491* | *0.81* | +/- 9% | +/- 3% |
| **All Bus**** | **608,083** | **575,642** | **1.06** | **+/- 9%** | **+/- 3%** |
| *Metrobus Total* | *336,969* | *360,000* | *0.94* | +/- 9% | +/- 3% |
| *Other Bus in WMATA Area* | *173,702* | *141,390* | *1.23* | +/- 9% | +/- 3% |
| *Other Bus not in WMATA Area* | *97,412* | *74,252* | *1.31* | +/- 9% | +/- 3% |
| **Total Transit**[17] | **1,288,577** | **1,273,449** | **1.01** | +/- 9% | +/- 3% |

** Source: RSG. Gen3 Data Development. Washington, D.C.: Metropolitan Washington Council of Governments, National Capital Region Transportation Planning Board, December 29, 2021, Table 3-11, https://www.mwcog.org/assets/1/6/Gen3_Phase_1_Data_Development_Report_Final.pdf*

** * Source: Meseret Seifu and Sanghyeon Ko, "Year-2018 Validation of TPB Version 2.4 Travel Model", COG/TPB Memorandum, August 17, 2021. Note that the observed bus ridership data includes I-X and X-I bus trips made by residents/non-residents of the TPB modeled area while the Ver. 2.4 Model simulates only resident I-I trips. However, the I-X and X-I bus trips which likely use commuter buses, accounted for only a very small fraction of total bus ridership (0.63 %). The Gen3 Model similarly models only resident I-I trips but does include visitor and I-X and X-I transit trips. Again, this is a small fraction of bus ridership, but a slightly larger fraction of commuter rail ridership (about 1%).*

[16] Cambridge Systematics. FSUTMS-Cube Framework Phase II Model Calibration and Validation Standards. 10/2/2008.

[17] Metrorail + Commuter Rail + All Bus; note that Metrobus Total + Other Bus in WMATA Area + Other Bus not in WMATA Area = All Bus

Table 61 lists the station group ridership for Metrorail. Most station groups are within 20% of the observed data. See Figure 83 for a map of station groups.

**TABLE 61: METRORAIL STATION GROUP BOARDING COMPARISON**

| STATION GROUP | STATION GROUP NAME | MODEL ESTIMATE | OBSERVED RIDERSHIP | EST / OBS | STANDARD (ACCEPTABLE/ PREFERABLE) |
|---|---|---|---|---|---|
| 1 | Red Line - "A" route MD outside Beltway | 20,123 | 28,038 | 0.72 | ± 20% / ± 15% |
| 2 | Red Line - "A" route MD inside Beltway | 21,814 | 22,663 | 0.96 | ± 20% / ± 15% |
| 3 | Red Line - "A" route DC non-core | 24,968 | 22,157 | 1.13 | ± 20% / ± 15% |
| 4 | Red Line - DC core | 132,265 | 134,602 | 0.98 | ± 20% / ± 15% |
| 5 | Red Line - "B" route DC non-core | 27,568 | 24,075 | 1.15 | ± 20% / ± 15% |
| 6 | Red Line - "B" route MD | 21,124 | 22,873 | 0.92 | ± 20% / ± 15% |
| 7 | Green Line - "E" route MD | 11,517 | 17,003 | 0.68 | ± 25% / ± 20% |
| 8 | Green Line - "E" route DC non-core | 16,840 | 22,469 | 0.75 | ± 20% / ± 15% |
| 9 | Green Line - DC core | 40,201 | 38,192 | 1.05 | ± 20% / ± 15% |
| 10 | Green Line - "F" route DC non-core | 25,789 | 21,253 | 1.21 | ± 20% / ± 15% |
| 11 | Green Line - "F" route MD | 13,872 | 17,359 | 0.8 | ± 25% / ± 20% |
| 12 | Blue/Yellow Line - VA Fairfax | 15,851 | 16,027 | 0.99 | ± 25% / ± 20% |
| 13 | Blue/Yellow Line - VA Alexandria | 11,330 | 13,536 | 0.84 | ± 25% / ± 20% |
| 14 | Blue/Yellow Line - VA Core | 28,557 | 45,438 | 0.63 | ± 20% / ± 15% |
| 15 | Orange Line - VA Fairfax | 9,596 | 15,724 | 0.61 | ± 25% / ± 20% |
| 16 | Orange Line - VA Arlington non-core | 34,059 | 28,802 | 1.18 | ± 20% / ± 15% |
| 17 | Orange/Blue Line - VA/DC core | 103,835 | 95,840 | 1.08 | ± 20% / ± 15% |
| 18 | Orange/Blue Line - DC non-core | 14,811 | 11,628 | 1.27 | ± 25% / ± 20% |
| 19 | Orange Line - DC/MD | 13,841 | 13,401 | 1.03 | ± 25% / ± 20% |
| 20 | Blue Line - DC/MD | 19,411 | 13,680 | 1.42 | ± 25% / ± 20% |

| STATION GROUP | STATION GROUP NAME | MODEL ESTIMATE | OBSERVED RIDERSHIP | EST / OBS | STANDARD (ACCEPTABLE/ PREFERABLE) |
|---|---|---|---|---|---|
| 21 | Silver Line - Phase I & Phase 2 | 17,343 | 16,466 | 1.05 | ± 25% / ± 20% |
| | **Total for Red Line Station Groups** | **247,862** | **254,408** | **0.97** | **± 20% / ± 15%** |
| | **Total for Green Line Station Groups** | **108,221** | **116,276** | **0.93** | **± 20% / ± 15%** |
| | **Total for Blue/Yellow Line Station Groups** | **55,738** | **75,001** | **0.74** | **± 20% / ± 15%** |
| | **Total for Orange/Blue Line Station Groups** | **195,553** | **179,075** | **1.09** | **± 20% / ± 15%** |
| | **Total for Silver Line Station Groups** | **17,343** | **16,466** | **1.05** | **± 20% / ± 15%** |
| | **Grand Total** | **624,717** | **641,226** | **0.97** | **± 9% / ± 3%** |

Note: * FDOT standard for transit ridership >20,000 passengers per day is ±20% (acceptable) and ±15% (preferable) and is ±25% (acceptable) and ±20% (preferable) for 10k-20k passengers per day.

Table 62 lists the station boardings for commuter rail stations. There is a lot of variability from station to station, which may be due to reasons that the model does not understand, for example the number of parking spaces at each station.

**TABLE 62: COMMUTER RAIL STATION BOARDING COMPARISON**

| CR SERVICE | CR LINE | STATION NAME | MODEL ESTIMATE | OBSERVED BOARDINGS* | EST / OBS | STANDARD (ACCEPTABLE/ PREFERABLE) |
|---|---|---|---|---|---|---|
| MARC | Penn | ***External*** | 6,951 | 6,421 | 1.08 | ± 35% / ± 25% |
| MARC | Penn | BWI Airport | 386 | 2,339 | 0.17 | ± 65% / ± 35% |
| MARC | Penn | Odenton | 4,288 | 3,334 | 1.29 | ± 65% / ± 35% |
| MARC | Penn | Bowie State | 884 | 265 | 3.34 | ± 150% / ± 100% |
| MARC | Penn | Seabrook | 1,672 | 517 | 3.23 | ± 150% / ± 100% |
| MARC | Penn | New Carrollton | 1,482 | 1,763 | 0.84 | ± 100% / ± 65% |

| CR SERVICE | CR LINE | STATION NAME | MODEL ESTIMATE | OBSERVED BOARDINGS* | EST / OBS | STANDARD (ACCEPTABLE/ PREFERABLE) |
|---|---|---|---|---|---|---|
| MARC | Camden | ***External*** | 457 | 440 | 1.04 | ± 150% / ± 100% |
| MARC | Camden | Dorsey | 420 | 554 | 0.76 | ± 150% / ± 100% |
| MARC | Camden | Jessup | 24 | 10 | 2.53 | ± 150% / ± 100% |
| MARC | Camden | Savage | 172 | 461 | 0.37 | ± 150% / ± 100% |
| MARC | Camden | Laurel | 2,084 | 658 | 3.17 | ± 150% / ± 100% |
| MARC | Camden | Muirkirk | 563 | 444 | 1.27 | ± 150% / ± 100% |
| MARC | Camden | Greenbelt | 38 | 71 | 0.54 | ± 150% / ± 100% |
| MARC | Camden | College Park | 570 | 213 | 2.68 | ± 150% / ± 100% |
| MARC | Camden | Riverdale | 203 | 109 | 1.86 | ± 150% / ± 100% |
| MARC | Brunswick | ***External*** | 195 | 77 | 2.53 | ± 150% / ± 100% |
| MARC | Brunswick | Duffields | 183 | 98 | 1.88 | ± 150% / ± 100% |
| MARC | Brunswick | Harpers Ferry | 310 | 66 | 4.68 | ± 150% / ± 100% |
| MARC | Brunswick | Brunswick | 321 | 367 | 0.87 | ± 150% / ± 100% |
| MARC | Brunswick | Point of Rocks | 353 | 334 | 1.06 | ± 150% / ± 100% |
| MARC | Brunswick | Dickerson | 9 | 29 | 0.3 | ± 150% / ± 100% |
| MARC | Brunswick | Barnesville | 2 | 90 | 0.02 | ± 150% / ± 100% |
| MARC | Brunswick | Boyds | 27 | 22 | 1.21 | ± 150% / ± 100% |
| MARC | Brunswick | Germantown | 726 | 756 | 0.96 | ± 150% / ± 100% |
| MARC | Brunswick | Metropolitan Grove | 176 | 357 | 0.49 | ± 150% / ± 100% |
| MARC | Brunswick | Gaithersburg | 596 | 549 | 1.09 | ± 150% / ± 100% |
| MARC | Brunswick | Washington Grove | 19 | 88 | 0.22 | ± 150% / ± 100% |
| MARC | Brunswick | Rockville | 952 | 336 | 2.83 | ± 150% / ± 100% |

| CR SERVICE | CR LINE | STATION NAME | MODEL ESTIMATE | OBSERVED BOARDINGS* | EST / OBS | STANDARD (ACCEPTABLE/ PREFERABLE) |
|---|---|---|---|---|---|---|
| MARC | Brunswick | Garrett Park | 46 | 224 | 0.2 | ± 150% / ± 100% |
| MARC | Brunswick | Kensington | 86 | 192 | 0.45 | ± 150% / ± 100% |
| MARC | Brunswick | Silver Spring | 1,197 | 452 | 2.65 | ± 150% / ± 100% |
| MARC | Brunswick | Monocacy/I-270 | 217 | 195 | 1.12 | ± 150% / ± 100% |
| MARC | Brunswick | Frederick | 56 | 114 | 0.49 | ± 150% / ± 100% |
| VRE | Fredericksburg | Spotsylvania | 352 | 661 | 0.71 | ± 150% / ± 100% |
| VRE | Fredericksburg | Fredericksburg | 2,243 | 817 | 2.74 | ± 150% / ± 100% |
| VRE | Fredericksburg | Leeland Road | 174 | 832 | 0.21 | ± 150% / ± 100% |
| VRE | Fredericksburg | Brooke | 441 | 479 | 0.92 | ± 150% / ± 100% |
| VRE | Fredericksburg | Quantico | 866 | 457 | 1.89 | ± 150% / ± 100% |
| VRE | Fredericksburg | Rippon | 422 | 572 | 0.74 | ± 150% / ± 100% |
| VRE | Fredericksburg | Woodbridge | 774 | 619 | 1.25 | ± 150% / ± 100% |
| VRE | Fredericksburg | Lorton | 180 | 749 | 0.24 | ± 150% / ± 100% |
| VRE | Fredericksburg | Franconia-Spgfld | 238 | 327 | 0.73 | ± 150% / ± 100% |
| VRE | Manassas | Broad Run/Airport | 117 | 1,005 | 0.12 | ± 100% / ± 65% |
| VRE | Manassas | Manassas City | 1,244 | 809 | 1.54 | ± 150% / ± 100% |
| VRE | Manassas | Manassas Park | 419 | 687 | 0.61 | ± 150% / ± 100% |
| VRE | Manassas | Burke Center | 497 | 977 | 0.51 | ± 150% / ± 100% |
| VRE | Manassas | Rolling Road | 123 | 453 | 0.27 | ± 150% / ± 100% |
| VRE | Manassas | Backlick Road | 158 | 284 | 0.56 | ± 150% / ± 100% |
| VRE | Fredericksburg + Manassas | Alexandria | 1,597 | 759 | 2.1 | ± 150% / ± 100% |
| VRE | Fredericksburg + Manassas | Crystal City | 223 | 1,644 | 0.14 | ± 100% / ± 65% |

| CR SERVICE | CR LINE | STATION NAME | MODEL ESTIMATE | OBSERVED BOARDINGS* | EST / OBS | STANDARD (ACCEPTABLE/ PREFERABLE) |
|---|---|---|---|---|---|---|
| VRE | Fredericksburg + Manassas | L'Enfant Plaza | 2,439 | 3,813 | 0.64 | ± 65% / ± 35% |
| | All Lines | Union Station | 17,213 | 19,240 | 0.89 | ± 25% / ± 20% |
| | | | | | | |
| MARC | MARC Lines | MARC Stations | 40,384 | 38,795 | 1.04 | ± 20% / ± 15% |
| VRE | VRE Lines | VRE Stations | 15,005 | 18,332 | 0.82 | ± 25% / ± 20% |
| | | | | | | |
| **TOTAL** | | | **55,389** | **57,128** | **0.97** | |

* Station boardings only, does not include transfers

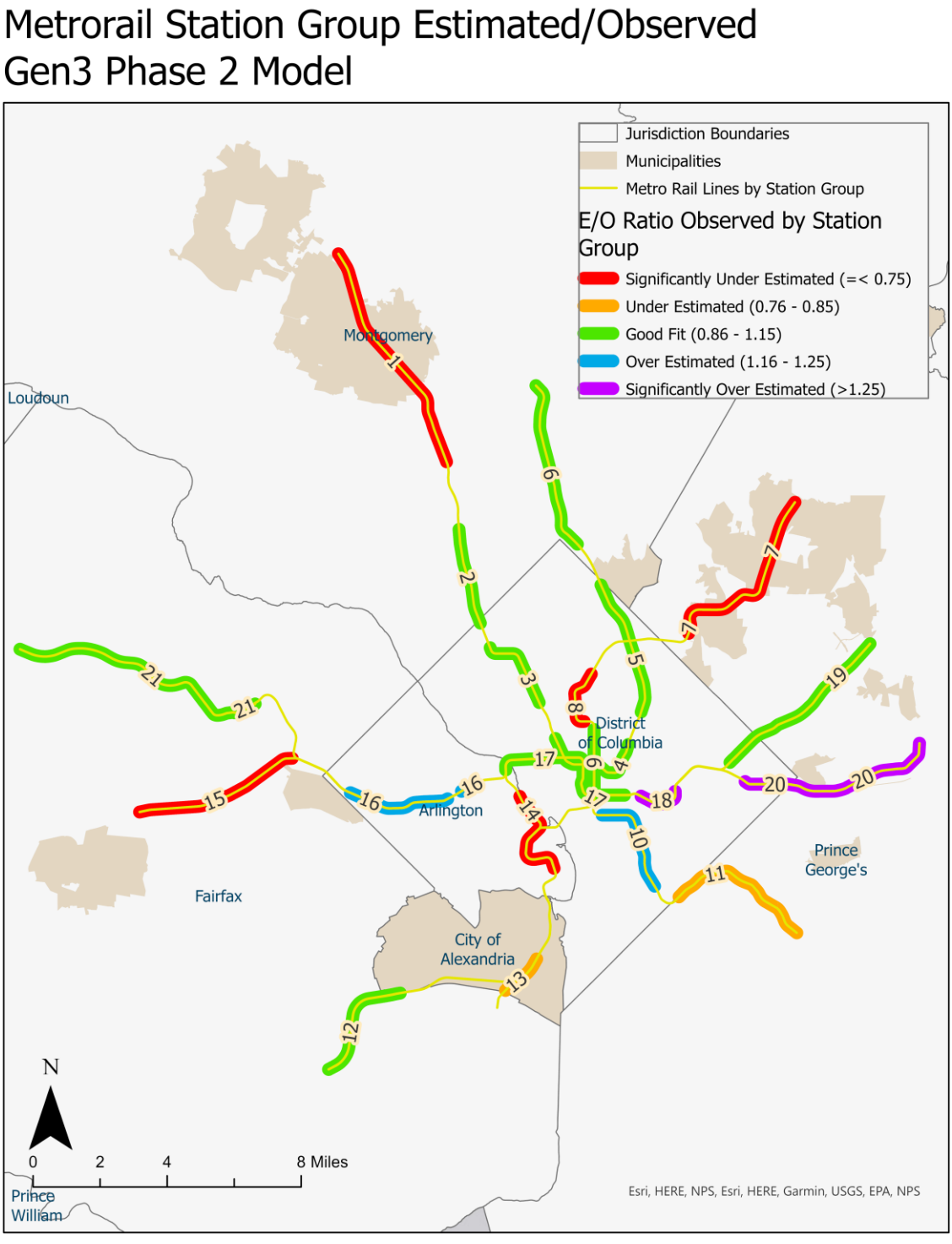


**FIGURE 83: METRORAIL STATION GROUP GEN3 ESTIMATED/OBSERVED**

# 5.0 CONCLUSION

The highway and transit validation results for the Gen3, Version 1.0.4, Model are reasonable for regional model scenarios testing highway and transit capacity projects. The validation metrics of the model generally conform to the federal and state benchmarking standards. The highway validation performance is comparable to that of the current production-use, trip-based Gen2 Travel Demand Model. The transit validation performance remains strong for Metrorail and has largely improved for commuter rail and bus as compared to the Gen2 Model (for both validation years of 2014 and 2018). The model validation results presented in this report suggest that the Gen3 Model is ready for use with COG/TPB's production work activities, although COG staff are further evaluating the usability of the model for production work by running it for the upcoming air quality conformity analysis for the Visualize 2050 Long-Range Transportation Plan (LRTP) update.

In addition to the highway and transit validation discussed in this documentation, the Gen3 Model has undergone five sensitivity tests during the Phase 2 development that included:

- Auto Operating Cost Increase
- Bridge Closure
- Doubling the Frequency of High-Capacity Transit
- Increased Telecommuting to DC
- Hypothetical AV Ownership in the Horizon Year

The results of the sensitivity testing are documented in a separate report.[18] As part of the Gen3 Model usability testing in the ongoing Phase 3 development, COG staff conducted additional sensitivity tests. In general, the Gen3 Model showed sensible responses to various model input changes in those tests, and the project team (MWCOG, RSG, and BMG) have found the outcomes of these tests to be satisfactory.

[18] RSG, Baseline Mobility Group, and Metropolitan Washington Council of Governments. Gen3 Model Phase 2 Sensitivity Testing Results, February 12, 2024.

# 6.0 APPENDIX

### TABLE 63: CENSUS ACS JOURNEY-TO-WORK FLOWS

| | DC | Alexandria city | Anne Arundel County | Arlington County | Calvert County | Carroll County | Charles County | Clarke County | Fairfax County | Fauquier County | Frederick County | Fredericksburg city | Howard County | Jefferson County | King George County | Loudoun County | Montgomery County | Prince George's County | Prince William County | Spotsylvania County | St. Mary's County | Stafford County | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 252,256 | 6,054 | 1,290 | 16,190 | 0 | 32 | 262 | 0 | 12,673 | 0 | 162 | 56 | 960 | 19 | 0 | 898 | 22,447 | 16,214 | 410 | 0 | 14 | 49 | 329,986 |
| Alexandria city | 27,707 | 25,007 | 350 | 14,036 | 51 | 45 | 207 | 0 | 18,653 | 43 | 23 | 42 | 220 | 0 | 6 | 791 | 1,889 | 2,279 | 1,112 | 0 | 22 | 42 | 92,525 |
| Anne Arundel County | 18,474 | 846 | 168,876 | 2,103 | 1,323 | 272 | 440 | 0 | 2,571 | 0 | 331 | 0 | 18,565 | 0 | 0 | 346 | 8,142 | 27,927 | 223 | 0 | 255 | 22 | 250,716 |
| Arlington County | 49,463 | 5,614 | 483 | 46,632 | 16 | 99 | 78 | 0 | 28,382 | 18 | 60 | 9 | 189 | 18 | 5 | 1,067 | 4,644 | 2,492 | 1,127 | 8 | 0 | 83 | 140,487 |
| Calvert County | 4,951 | 520 | 2,992 | 471 | 17,276 | 7 | 1,384 | 0 | 761 | 0 | 18 | 0 | 371 | 0 | 10 | 110 | 931 | 9,316 | 122 | 0 | 4,949 | 43 | 44,232 |
| Carroll County | 934 | 26 | 5,049 | 62 | 10 | 39,419 | 0 | 0 | 474 | 0 | 3,102 | 19 | 8,617 | 40 | 0 | 143 | 3,998 | 1,354 | 47 | 0 | 0 | 0 | 63,294 |
| Charles County | 15,719 | 1,813 | 1,356 | 3,083 | 1,132 | 15 | 28,979 | 0 | 3,624 | 0 | 9 | 0 | 358 | 0 | 457 | 421 | 1,527 | 14,062 | 203 | 13 | 2,610 | 28 | 75,409 |
| Clarke County | 105 | 9 | 15 | 55 | 0 | 0 | 0 | 1,640 | 792 | 65 | 35 | 0 | 0 | 202 | 0 | 2,018 | 71 | 0 | 70 | 0 | 11 | 0 | 5,088 |
| Fairfax County | 100,085 | 31,778 | 1,954 | 50,516 | 183 | 0 | 499 | 0 | 358,096 | 666 | 443 | 238 | 983 | 44 | 11 | 25,309 | 16,191 | 11,265 | 13,872 | 270 | 159 | 923 | 613,485 |
| Fauquier County | 983 | 239 | 79 | 519 | 0 | 12 | 0 | 33 | 6,484 | 13,958 | 0 | 262 | 11 | 0 | 10 | 1,868 | 159 | 50 | 6,897 | 124 | 0 | 413 | 32,101 |
| Frederick County | 4,549 | 262 | 1,718 | 921 | 0 | 2,654 | 37 | 27 | 2,362 | 2 | 71,718 | 0 | 3,215 | 428 | 0 | 1,765 | 25,783 | 1,897 | 53 | 0 | 16 | 3 | 117,410 |
| Fredericksburg city | 472 | 95 | 0 | 120 | 0 | 0 | 232 | 35 | 575 | 15 | 5 | 5,229 | 0 | 0 | 672 | 35 | 0 | 0 | 895 | 2,437 | 0 | 1,905 | 12,722 |
| Howard County | 9,226 | 412 | 17,598 | 1,003 | 29 | 1,465 | 96 | 0 | 1,926 | 0 | 799 | 0 | 65,811 | 0 | 0 | 259 | 16,240 | 14,783 | 108 | 0 | 35 | 0 | 129,790 |
| Jefferson County | 777 | 85 | 31 | 316 | 0 | 42 | 0 | 226 | 1,463 | 33 | 1,829 | 0 | 87 | 11,227 | 0 | 4,282 | 1,455 | 102 | 122 | 0 | 0 | 21 | 22,098 |
| King George County | 307 | 138 | 33 | 123 | 0 | 0 | 783 | 0 | 433 | 0 | 0 | 1,221 | 0 | 0 | 5,624 | 0 | 59 | 266 | 405 | 837 | 148 | 1,281 | 11,658 |
| Loudoun County | 10,600 | 1,327 | 421 | 4,704 | 0 | 17 | 5 | 173 | 65,915 | 450 | 540 | 29 | 292 | 230 | 12 | 88,958 | 3,609 | 667 | 3,036 | 33 | 63 | 181 | 181,262 |
| Montgomery County | 111,756 | 3,306 | 5,249 | 10,151 | 88 | 484 | 175 | 0 | 21,166 | 15 | 5,972 | 0 | 8,339 | 66 | 84 | 1,853 | 318,806 | 30,835 | 826 | 21 | 135 | 138 | 519,465 |
| Prince George's County | 139,856 | 8,324 | 16,075 | 15,687 | 805 | 181 | 4,431 | 0 | 21,002 | 52 | 678 | 15 | 9,546 | 52 | 94 | 1,709 | 46,799 | 177,993 | 1,280 | 55 | 461 | 153 | 445,248 |
| Prince William County | 24,699 | 8,132 | 828 | 13,283 | 39 | 16 | 218 | 28 | 75,653 | 2,240 | 193 | 635 | 206 | 29 | 60 | 9,848 | 2,860 | 3,130 | 105,996 | 763 | 22 | 3,003 | 251,881 |
| Spotsylvania County | 2,939 | 499 | 13 | 1,156 | 0 | 0 | 40 | 30 | 3,910 | 211 | 10 | 9,750 | 70 | 0 | 1,699 | 302 | 313 | 224 | 4,906 | 23,460 | 15 | 7,689 | 57,236 |
| St. Mary's County | 2,234 | 132 | 312 | 311 | 2,507 | 0 | 4,065 | 0 | 341 | 0 | 20 | 11 | 133 | 0 | 151 | 21 | 363 | 2,325 | 20 | 0 | 41,526 | 0 | 54,472 |
| Stafford County | 6,119 | 1,415 | 207 | 2,768 | 15 | 0 | 28 | 0 | 8,780 | 457 | 10 | 5,849 | 15 | 0 | 856 | 547 | 321 | 448 | 11,970 | 3,136 | 29 | 23,234 | 66,204 |
| Total | 784,211 | 96,033 | 224,929 | 184,210 | 23,474 | 44,760 | 41,959 | 2,192 | 636,036 | 18,225 | 85,957 | 23,365 | 117,988 | 12,355 | 9,751 | 142,550 | 476,607 | 317,629 | 153,700 | 31,157 | 50,470 | 39,211 | 3,516,769 |

**TABLE 64: GEN3 WORK COUNTY FLOWS**

| | DC | Alexandria city | Anne Arundel County | Arlington County | Calvert County | Carroll County | Charles County | Clarke County | Fairfax County | Fauquier County | Frederick County | Fredericksburg city | Howard County | Jefferson County | King George County | Loudoun County | Montgomery County | Prince George's County | Prince William County | Spotsylvania County | St. Mary's County | Stafford County | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 252,254 | 6,000 | 1,643 | 19,862 | 149 | 25 | 441 | 0 | 15,397 | 21 | 92 | 6 | 1,358 | 1 | 67 | 1,137 | 23,614 | 19,527 | 780 | 5 | 79 | 36 | 342,494 |
| Alexandria city | 24,982 | 19,164 | 294 | 15,610 | 50 | 5 | 258 | 1 | 20,451 | 30 | 32 | 11 | 220 | 0 | 20 | 730 | 3,579 | 4,015 | 1,077 | 10 | 40 | 60 | 90,639 |
| Anne Arundel County | 19,784 | 1,531 | 175,224 | 4,503 | 1,592 | 245 | 737 | 0 | 4,661 | 15 | 253 | 1 | 22,422 | 3 | 71 | 394 | 11,678 | 31,225 | 290 | 3 | 279 | 14 | 274,925 |
| Arlington County | 45,887 | 7,586 | 357 | 37,091 | 38 | 7 | 157 | 1 | 33,275 | 20 | 46 | 4 | 289 | 0 | 14 | 1,195 | 6,494 | 3,955 | 941 | 11 | 28 | 37 | 137,433 |
| Calvert County | 6,917 | 626 | 2,831 | 1,040 | 17,091 | 5 | 1,200 | 0 | 1,376 | 2 | 13 | 13 | 243 | 0 | 63 | 51 | 1,012 | 5,451 | 104 | 4 | 5,468 | 11 | 43,521 |
| Carroll County | 3,727 | 189 | 3,023 | 533 | 40 | 42,291 | 21 | 10 | 1,602 | 44 | 7,676 | 1 | 10,435 | 51 | 13 | 1,129 | 9,029 | 1,729 | 297 | 2 | 24 | 3 | 81,869 |
| Charles County | 13,965 | 3,057 | 1,308 | 3,596 | 1,487 | 8 | 29,377 | 0 | 5,749 | 4 | 15 | 88 | 317 | 0 | 826 | 244 | 1,867 | 12,541 | 352 | 73 | 2,575 | 144 | 77,593 |
| Clarke County | 311 | 40 | 8 | 109 | 1 | 14 | 3 | 1,025 | 1,385 | 135 | 226 | 5 | 19 | 547 | 0 | 1,954 | 169 | 31 | 403 | 4 | 1 | 14 | 6,404 |
| Fairfax County | 85,243 | 31,170 | 1,298 | 51,165 | 155 | 42 | 865 | 8 | 334,512 | 567 | 340 | 133 | 1,076 | 29 | 46 | 26,534 | 13,444 | 14,192 | 20,475 | 118 | 120 | 654 | 582,186 |
| Fauquier County | 1,707 | 245 | 28 | 613 | 3 | 1 | 12 | 12 | 6,631 | 11,005 | 61 | 436 | 32 | 18 | 38 | 1,931 | 580 | 188 | 7,024 | 356 | 11 | 1,266 | 32,198 |
| Frederick County | 6,500 | 354 | 1,454 | 1,284 | 23 | 4,490 | 27 | 47 | 4,857 | 118 | 64,832 | 4 | 4,409 | 537 | 2 | 7,931 | 25,160 | 1,465 | 757 | 1 | 8 | 13 | 124,273 |
| Fredericksburg city | 469 | 134 | 5 | 156 | 8 | 1 | 49 | 0 | 691 | 72 | 1 | 4,782 | 6 | 0 | 378 | 54 | 68 | 51 | 697 | 2,590 | 18 | 2,463 | 12,693 |
| Howard County | 14,032 | 648 | 21,924 | 2,582 | 83 | 1,543 | 90 | 1 | 3,414 | 15 | 1,321 | 2 | 74,837 | 14 | 15 | 578 | 22,153 | 17,686 | 276 | 4 | 37 | 11 | 161,266 |
| Jefferson County | 977 | 123 | 86 | 399 | 2 | 165 | 5 | 674 | 3,234 | 107 | 3,835 | 1 | 256 | 9,238 | 2 | 5,690 | 1,623 | 149 | 519 | 0 | 0 | 8 | 27,093 |
| King George County | 853 | 106 | 63 | 150 | 79 | 1 | 832 | 0 | 582 | 37 | 2 | 1,139 | 18 | 0 | 3,991 | 38 | 120 | 453 | 492 | 984 | 367 | 1,321 | 11,628 |
| Loudoun County | 12,920 | 1,573 | 272 | 4,845 | 18 | 82 | 62 | 77 | 72,066 | 481 | 2,249 | 16 | 319 | 392 | 5 | 86,791 | 2,647 | 1,417 | 6,459 | 18 | 8 | 82 | 192,799 |
| Montgomery County | 97,874 | 4,822 | 7,332 | 16,547 | 231 | 819 | 274 | 2 | 23,868 | 109 | 4,205 | 8 | 7,946 | 23 | 41 | 5,908 | 312,311 | 27,012 | 1,838 | 13 | 106 | 39 | 511,328 |
| Prince George's County | 150,331 | 12,949 | 14,884 | 19,569 | 1,618 | 107 | 5,119 | 0 | 26,544 | 37 | 231 | 20 | 11,095 | 2 | 241 | 1,487 | 39,580 | 168,095 | 1,494 | 15 | 770 | 80 | 454,268 |
| Prince William County | 22,551 | 7,936 | 394 | 10,454 | 42 | 10 | 257 | 11 | 79,342 | 2,031 | 148 | 653 | 263 | 22 | 82 | 10,195 | 5,385 | 3,561 | 105,652 | 482 | 42 | 3,475 | 252,988 |
| Spotsylvania County | 2,103 | 467 | 36 | 667 | 30 | 0 | 157 | 0 | 3,009 | 342 | 5 | 9,477 | 26 | 1 | 1,237 | 205 | 318 | 294 | 2,783 | 18,218 | 103 | 7,272 | 46,750 |
| St. Mary's County | 3,832 | 381 | 398 | 585 | 2,946 | 1 | 3,209 | 0 | 910 | 1 | 8 | 53 | 89 | 0 | 423 | 44 | 416 | 2,380 | 71 | 44 | 39,617 | 92 | 55,500 |
| Stafford County | 6,219 | 1,456 | 102 | 1,975 | 34 | 2 | 180 | 2 | 9,706 | 760 | 16 | 6,489 | 51 | 4 | 1,235 | 632 | 858 | 749 | 10,900 | 4,850 | 114 | 20,907 | 67,241 |
| Total | 773,438 | 100,557 | 232,964 | 193,335 | 25,720 | 49,864 | 43,332 | 1,871 | 653,262 | 15,953 | 85,607 | 23,342 | 135,726 | 10,882 | 8,810 | 154,852 | 482,105 | 316,166 | 163,681 | 27,805 | 49,815 | 38,002 | 3,587,089 |

### TABLE 65: DIFFERENCE BETWEEN CENSUS JTW AND MODEL WORK LOCATION CHOICE

| | DC | Alexandria city | Anne Arundel County | Arlington County | Calvert County | Carroll County | Charles County | Clarke County | Fairfax County | Fauquier County | Frederick County | Fredericksburg city | Howard County | Jefferson County | King George County | Loudoun County | Montgomery County | Prince George's County | Prince William County | Spotsylvania County | St. Mary's County | Stafford County | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | -2 | -54 | 353 | 3,672 | 149 | -7 | 179 | 0 | 2,724 | 21 | -70 | -50 | 398 | -18 | 67 | 239 | 1,167 | 3,313 | 370 | 5 | 65 | -13 | 12,508 |
| Alexandria city | -2,725 | -5,843 | -56 | 1,574 | -1 | -40 | 51 | 1 | 1,798 | -13 | 9 | -31 | 0 | 0 | 14 | -61 | 1,690 | 1,736 | -35 | 10 | 18 | 18 | -1,886 |
| Anne Arundel County | 1,310 | 685 | 6,348 | 2,400 | 269 | -27 | 297 | 0 | 2,090 | 15 | -78 | 1 | 3,857 | 3 | 71 | 48 | 3,536 | 3,298 | 67 | 3 | 24 | -8 | 24,209 |
| Arlington County | -3,576 | 1,972 | -126 | -9,541 | 22 | -92 | 79 | 1 | 4,893 | 2 | -14 | -5 | 100 | -18 | 9 | 128 | 1,850 | 1,463 | -186 | 3 | 28 | -46 | -3,054 |
| Calvert County | 1,966 | 106 | -161 | 569 | -185 | -2 | -184 | 0 | 615 | 2 | -5 | 13 | -128 | 0 | 53 | -59 | 81 | -3,865 | -18 | 4 | 519 | -32 | -711 |
| Carroll County | 2,793 | 163 | -2,026 | 471 | 30 | 2,872 | 21 | 10 | 1,128 | 44 | 4,574 | -18 | 1,818 | 11 | 13 | 986 | 5,031 | 375 | 250 | 2 | 24 | 3 | 18,575 |
| Charles County | -1,754 | 1,244 | -48 | 513 | 355 | -7 | 398 | 0 | 2,125 | 4 | 6 | 88 | -41 | 0 | 369 | -177 | 340 | -1,521 | 149 | 60 | -35 | 116 | 2,184 |
| Clarke County | 206 | 31 | -7 | 54 | 1 | 14 | 3 | -615 | 593 | 70 | 191 | 5 | 19 | 345 | 0 | -64 | 98 | 31 | 333 | 4 | -10 | 14 | 1,316 |
| Fairfax County | -14,842 | -608 | -656 | 649 | -28 | 42 | 366 | 8 | -23,584 | -99 | -103 | -105 | 93 | -15 | 35 | 1,225 | -2,747 | 2,927 | 6,603 | -152 | -39 | -269 | -31,299 |
| Fauquier County | 724 | 6 | -51 | 94 | 3 | -11 | 12 | -21 | 147 | -2,953 | 61 | 174 | 21 | 18 | 28 | 63 | 421 | 138 | 127 | 232 | 11 | 853 | 97 |
| Frederick County | 1,951 | 92 | -264 | 363 | 23 | 1,836 | -10 | 20 | 2,495 | 116 | -6,886 | 4 | 1,194 | 109 | 2 | 6,166 | -623 | -432 | 704 | 1 | -8 | 10 | 6,863 |
| Fredericksburg city | -3 | 39 | 5 | 36 | 8 | 1 | -183 | -35 | 116 | 57 | -4 | -447 | 6 | 0 | -294 | 19 | 68 | 51 | -198 | 153 | 18 | 558 | -29 |
| Howard County | 4,806 | 236 | 4,326 | 1,579 | 54 | 78 | -6 | 1 | 1,488 | 15 | 522 | 2 | 9,026 | 14 | 15 | 319 | 5,913 | 2,903 | 168 | 4 | 2 | 11 | 31,476 |
| Jefferson County | 200 | 38 | 55 | 83 | 2 | 123 | 5 | 448 | 1,771 | 74 | 2,006 | 1 | 169 | -1,989 | 2 | 1,408 | 168 | 47 | 397 | 0 | 0 | -13 | 4,995 |
| King George County | 546 | -32 | 30 | 27 | 79 | 1 | 49 | 0 | 149 | 37 | 2 | -82 | 18 | 0 | -1,633 | 38 | 61 | 187 | 87 | 147 | 219 | 40 | -30 |
| Loudoun County | 2,320 | 246 | -149 | 141 | 18 | 65 | 57 | -96 | 6,151 | 31 | 1,709 | -13 | 27 | 162 | -7 | -2,167 | -962 | 750 | 3,423 | -15 | -55 | -99 | 11,537 |
| Montgomery County | -13,882 | 1,516 | 2,083 | 6,396 | 143 | 335 | 99 | 2 | 2,702 | 94 | -1,767 | 8 | -393 | -43 | -43 | 4,055 | -6,495 | -3,823 | 1,012 | -8 | -29 | -99 | -8,137 |
| Prince George's County | 10,475 | 4,625 | -1,191 | 3,882 | 813 | -74 | 688 | 0 | 5,542 | -15 | -447 | 5 | 1,549 | -50 | 147 | -222 | -7,219 | -9,898 | 214 | -40 | 309 | -73 | 9,020 |
| Prince William County | -2,148 | -196 | -434 | -2,829 | 3 | -6 | 39 | -17 | 3,689 | -209 | -45 | 18 | 57 | -7 | 22 | 347 | 2,525 | 431 | -344 | -281 | 20 | 472 | 1,107 |
| Spotsylvania County | -836 | -32 | 23 | -489 | 30 | 0 | 117 | -30 | -901 | 131 | -5 | -273 | -44 | 1 | -462 | -97 | 5 | 70 | -2,123 | -5,242 | 88 | -417 | -10,486 |
| St. Mary's County | 1,598 | 249 | 86 | 274 | 439 | 1 | -856 | 0 | 569 | 1 | -12 | 42 | -44 | 0 | 272 | 23 | 53 | 55 | 51 | 44 | -1,909 | 92 | 1,028 |
| Stafford County | 100 | 41 | -105 | -793 | 19 | 2 | 152 | 2 | 926 | 303 | 6 | 640 | 36 | 4 | 379 | 85 | 537 | 301 | -1,070 | 1,714 | 85 | -2,327 | 1,037 |
| Total | -10,773 | 4,524 | 8,035 | 9,125 | 2,246 | 5,104 | 1,373 | -321 | 17,226 | -2,272 | -350 | -23 | 17,738 | -1,473 | -941 | 12,302 | 5,498 | -1,463 | 9,981 | -3,352 | -655 | -1,209 | 70,320 |

### TABLE 66: WORK LOCATION CHOICE GEN3 / ACS JTW

| | DC | Alexandria city | Anne Arundel County | Arlington County | Calvert County | Carroll County | Charles County | Clarke County | Fairfax County | Fauquier County | Frederick County | Fredericksburg city | Howard County | Jefferson County | King George County | Loudoun County | Montgomery County | Prince George's County | Prince William County | Spotsylvania County | St. Mary's County | Stafford County | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 1.00 | 0.99 | 1.27 | 1.23 | | 0.78 | 1.68 | | 1.21 | | 0.57 | 0.11 | 1.41 | 0.05 | | 1.27 | 1.05 | 1.20 | 1.90 | | 5.64 | 0.73 | 1.04 |
| Alexandria city | 0.90 | 0.77 | 0.84 | 1.11 | 0.98 | 0.11 | 1.25 | | 1.10 | 0.70 | 1.39 | 0.26 | 1.00 | | 3.33 | 0.92 | 1.89 | 1.76 | 0.97 | | 1.82 | 1.43 | 0.98 |
| Anne Arundel County | 1.07 | 1.81 | 1.04 | 2.14 | 1.20 | 0.90 | 1.68 | | 1.81 | | 0.76 | | 1.21 | | | 1.14 | 1.43 | 1.12 | 1.30 | | 1.09 | 0.64 | 1.10 |
| Arlington County | 0.93 | 1.35 | 0.74 | 0.80 | 2.38 | 0.07 | 2.01 | | 1.17 | 1.11 | 0.77 | 0.44 | 1.53 | 0.00 | 2.80 | 1.12 | 1.40 | 1.59 | 0.83 | 1.38 | | 0.45 | 0.98 |
| Calvert County | 1.40 | 1.20 | 0.95 | 2.21 | 0.99 | 0.71 | 0.87 | | 1.81 | | 0.72 | | 0.65 | | 6.30 | 0.46 | 1.09 | 0.59 | 0.85 | | 1.10 | 0.26 | 0.98 |
| Carroll County | 3.99 | 7.27 | 0.60 | 8.60 | 4.00 | 1.07 | | | 3.38 | | 2.47 | 0.05 | 1.21 | 1.28 | | 7.90 | 2.26 | 1.28 | 6.32 | | | | 1.29 |
| Charles County | 0.89 | 1.69 | 0.96 | 1.17 | 1.31 | 0.53 | 1.01 | | 1.59 | | 1.67 | | 0.89 | | 1.81 | 0.58 | 1.22 | 0.89 | 1.73 | 5.62 | 0.99 | 5.14 | 1.03 |
| Clarke County | 2.96 | 4.44 | 0.53 | 1.98 | | | | 0.63 | 1.75 | 2.08 | 6.46 | | | 2.71 | | 0.97 | 2.38 | | 5.76 | | 0.09 | | 1.26 |
| Fairfax County | 0.85 | 0.98 | 0.66 | 1.01 | 0.85 | | 1.73 | | 0.93 | 0.85 | 0.77 | 0.56 | 1.09 | 0.66 | 4.18 | 1.05 | 0.83 | 1.26 | 1.48 | 0.44 | 0.75 | 0.71 | 0.95 |
| Fauquier County | 1.74 | 1.03 | 0.35 | 1.18 | | 0.08 | | 0.36 | 1.02 | 0.79 | | 1.66 | 2.91 | | 3.80 | 1.03 | 3.65 | 3.76 | 1.02 | 2.87 | | 3.07 | 1.00 |
| Frederick County | 1.43 | 1.35 | 0.85 | 1.39 | | 1.69 | 0.73 | 1.74 | 2.06 | 59.00 | 0.90 | | 1.37 | 1.25 | | 4.49 | 0.98 | 0.77 | 14.28 | | 0.50 | 4.33 | 1.06 |
| Fredericksburg city | 0.99 | 1.41 | | 1.30 | | | 0.21 | 0.00 | 1.20 | 4.80 | 0.20 | 0.91 | | | 0.56 | 1.54 | | | 0.78 | 1.06 | | 1.29 | 1.00 |
| Howard County | 1.52 | 1.57 | 1.25 | 2.57 | 2.86 | 1.05 | 0.94 | | 1.77 | | 1.65 | | 1.14 | | | 2.23 | 1.36 | 1.20 | 2.56 | | 1.06 | | 1.24 |
| Jefferson County | 1.26 | 1.45 | 2.77 | 1.26 | | 3.93 | | 2.98 | 2.21 | 3.24 | 2.10 | | 2.94 | 0.82 | | 1.33 | 1.12 | 1.46 | 4.25 | | | 0.38 | 1.23 |
| King George County | 2.78 | 0.77 | 1.91 | 1.22 | | | 1.06 | | 1.34 | | | 0.93 | | | 0.71 | | 2.03 | 1.70 | 1.21 | 1.18 | 2.48 | 1.03 | 1.00 |
| Loudoun County | 1.22 | 1.19 | 0.65 | 1.03 | | 4.82 | 12.40 | 0.45 | 1.09 | 1.07 | 4.16 | 0.55 | 1.09 | 1.70 | 0.42 | 0.98 | 0.73 | 2.12 | 2.13 | 0.55 | 0.13 | 0.45 | 1.06 |
| Montgomery County | 0.88 | 1.46 | 1.40 | 1.63 | 2.63 | 1.69 | 1.57 | | 1.13 | 7.27 | 0.70 | | 0.95 | 0.35 | 0.49 | 3.19 | 0.98 | 0.88 | 2.23 | 0.62 | 0.79 | 0.28 | 0.98 |
| Prince George's County | 1.07 | 1.56 | 0.93 | 1.25 | 2.01 | 0.59 | 1.16 | | 1.26 | 0.71 | 0.34 | 1.33 | 1.16 | 0.04 | 2.56 | 0.87 | 0.85 | 0.94 | 1.17 | 0.27 | 1.67 | 0.52 | 1.02 |
| Prince William County | 0.91 | 0.98 | 0.48 | 0.79 | 1.08 | 0.63 | 1.18 | 0.39 | 1.05 | 0.91 | 0.77 | 1.03 | 1.28 | 0.76 | 1.37 | 1.04 | 1.88 | 1.14 | 1.00 | 0.63 | 1.91 | 1.16 | 1.00 |
| Spotsylvania County | 0.72 | 0.94 | 2.77 | 0.58 | | | 3.93 | 0.00 | 0.77 | 1.62 | 0.50 | 0.97 | 0.37 | | 0.73 | 0.68 | 1.02 | 1.31 | 0.57 | 0.78 | 6.87 | 0.95 | 0.82 |
| St. Mary's County | 1.72 | 2.89 | 1.28 | 1.88 | 1.18 | | 0.79 | | 2.67 | | 0.40 | 4.82 | 0.67 | | 2.80 | 2.10 | 1.15 | 1.02 | 3.55 | | 0.95 | | 1.02 |
| Stafford County | 1.02 | 1.03 | 0.49 | 0.71 | 2.27 | | 6.43 | | 1.11 | 1.66 | 1.60 | 1.11 | 3.40 | | 1.44 | 1.16 | 2.67 | 1.67 | 0.91 | 1.55 | 3.93 | 0.90 | 1.02 |
| Total | 0.99 | 1.05 | 1.04 | 1.05 | 1.10 | 1.11 | 1.03 | 0.85 | 1.03 | 0.88 | 1.00 | 1.00 | 1.15 | 0.88 | 0.90 | 1.09 | 1.01 | 1.00 | 1.06 | 0.89 | 0.99 | 0.97 | 1.02 |

### TABLE 67: OBSERVED (SURVEY) NON-MANDATORY TOURS BY COUNTY

| | DC | MONTGOMERY | PRINCE GEORGE'S | ARLINGTON | ALEXANDRIA | FAIRFAX | LOUDOUN | PRINCE WILLIAM | FREDERICK | HOWARD | ANNE ARUNDEL | CHARLES | CARROLL | CALVERT | ST. MARY'S | KING GEORGE | FREDERICKSBURG | STAFFORD | SPOTSYLVANIA | FAUQUIER | CLARKE | JEFFERSON | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 225,880 | 0 | 0 | 6,154 | 18,956 | 161 | 0 | 0 | 398 | 0 | 19,444 | 803 | 3,484 | 3,052 | 0 | 265 | 11 | 69 | 0 | 68 | 0 | 145 | 278,891 |
| Montgomery | 0 | 8,526 | 945 | 0 | 0 | 0 | 0 | 1,330 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 361 | 0 | 11,162 |
| Prince George's | 528 | 4,001 | 41,867 | 0 | 88 | 0 | 61 | 5,423 | 0 | 0 | 0 | 0 | 456 | 815 | 0 | 0 | 0 | 0 | 0 | 0 | 1,455 | 0 | 54,692 |
| Arlington | 7,343 | 0 | 72 | 86,353 | 547 | 0 | 0 | 0 | 26 | 0 | 814 | 112 | 21,098 | 4,568 | 0 | 123 | 0 | 0 | 0 | 0 | 253 | 0 | 121,309 |
| Alexandria | 24,313 | 0 | 0 | 1,526 | 413,033 | 2,152 | 0 | 0 | 2,619 | 1,421 | 6,054 | 1,072 | 3,536 | 101 | 0 | 0 | 59 | 0 | 0 | 1,417 | 20 | 0 | 457,323 |
| Fairfax | 634 | 0 | 0 | 0 | 6,172 | 90,500 | 0 | 0 | 1,149 | 6,096 | 49 | 680 | 0 | 0 | 0 | 0 | 0 | 85 | 0 | 151 | 0 | 0 | 105,516 |
| Loudoun | 0 | 1,643 | 117 | 0 | 0 | 0 | 8,850 | 191 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10,800 |
| Prince William | 37 | 4,062 | 2,284 | 183 | 0 | 0 | 0 | 22,675 | 0 | 0 | 0 | 584 | 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 29,861 |
| Frederick | 3,075 | 0 | 92 | 294 | 908 | 232 | 0 | 0 | 207,662 | 38 | 7,754 | 0 | 581 | 0 | 0 | 36 | 0 | 0 | 0 | 4,430 | 0 | 584 | 225,687 |
| Howard | 0 | 0 | 0 | 0 | 1,010 | 666 | 0 | 0 | 182 | 55,945 | 0 | 82 | 0 | 0 | 0 | 0 | 534 | 0 | 0 | 996 | 0 | 22 | 59,437 |
| Anne Arundel | 25,666 | 0 | 0 | 956 | 14,959 | 84 | 0 | 0 | 12,807 | 0 | 239,049 | 14 | 3,212 | 2,198 | 0 | 438 | 4,744 | 43 | 355 | 5,618 | 231 | 2,441 | 312,816 |

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Charles | 1,474 | 0 | 0 | 0 | 574 | 325 | 0 | 0 | 40 | 164 | 1,803 | 123,077 | 23,902 | 1,990 | 77 | 0 | 0 | 0 | 368 | 0 | 3,070 | 0 | 156,863 |
| Carroll | 5,146 | 0 | 100 | 17,126 | 3,889 | 45 | 118 | 0 | 809 | 32 | 2,861 | 10,503 | 429,436 | 11,141 | 0 | 0 | 0 | 0 | 783 | 0 | 6,099 | 0 | 488,089 |
| Calvert | 905 | 40 | 0 | 11,036 | 227 | 0 | 0 | 0 | 0 | 0 | 323 | 0 | 11,400 | 50,050 | 0 | 0 | 0 | 0 | 0 | 0 | 51 | 0 | 74,032 |
| St. Mary's | 0 | 0 | 0 | 0 | 0 | 343 | 0 | 0 | 0 | 0 | 0 | 391 | 283 | 0 | 4,046 | 0 | 0 | 47 | 201 | 0 | 0 | 0 | 5,311 |
| King George | 0 | 0 | 0 | 0 | 166 | 0 | 0 | 0 | 555 | 0 | 240 | 0 | 0 | 0 | 0 | 41,609 | 1,521 | 0 | 0 | 0 | 0 | 741 | 44,832 |
| Fredericksburg | 1,736 | 0 | 0 | 105 | 753 | 0 | 0 | 0 | 137 | 0 | 6,397 | 0 | 68 | 0 | 0 | 2,248 | 53,692 | 0 | 0 | 47 | 0 | 575 | 65,758 |
| Stafford | 52 | 0 | 0 | 0 | 0 | 579 | 0 | 0 | 0 | 0 | 0 | 825 | 0 | 0 | 0 | 0 | 0 | 19,529 | 0 | 0 | 0 | 0 | 20,985 |
| Spotsylvania | 0 | 0 | 30 | 53 | 57 | 0 | 0 | 0 | 0 | 0 | 0 | 66 | 586 | 26 | 0 | 0 | 0 | 0 | 17,393 | 0 | 1,810 | 0 | 20,021 |
| Fauquier | 554 | 0 | 0 | 0 | 1,821 | 0 | 0 | 0 | 2,884 | 1,224 | 3,926 | 0 | 211 | 0 | 0 | 0 | 0 | 0 | 0 | 105,495 | 0 | 0 | 116,115 |
| Clarke | 3,056 | 0 | 1,046 | 1,107 | 1,685 | 0 | 0 | 542 | 42 | 0 | 583 | 6,192 | 12,243 | 1,257 | 0 | 0 | 0 | 0 | 440 | 0 | 157,023 | 0 | 185,217 |
| Jefferson | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1,191 | 0 | 1,206 | 0 | 71 | 0 | 0 | 1,833 | 377 | 0 | 0 | 0 | 0 | 22,883 | 27,561 |
| Total | 300,400 | 18,272 | 46,552 | 124,894 | 464,845 | 95,089 | 9,029 | 30,160 | 230,501 | 64,921 | 290,503 | 144,400 | 510,601 | 75,199 | 4,122 | 46,552 | 60,938 | 19,773 | 19,541 | 118,222 | 170,372 | 27,391 | 2,872,279 |

**TABLE 68: GEN3 NON-MANDATORY TOURS BY COUNTY**

| | DC | MONTGOMERY | PRINCE GEORGE'S | ARLINGTON | ALEXANDRIA | FAIRFAX | LOUDOUN | PRINCE WILLIAM | FREDERICK | HOWARD | ANNE ARUNDEL | CHARLES | CARROLL | CALVERT | ST. MARY'S | KING GEORGE | FREDERICKSBURG | STAFFORD | SPOTSYLVANIA | FAUQUIER | CLARKE | JEFFERSON | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 246,206 | 14,528 | 22,171 | 8,216 | 1,435 | 1,953 | 32 | 56 | 8 | 109 | 152 | 48 | 1 | 5 | 0 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 294,924 |
| Montgomery | 10,347 | 429,951 | 10,868 | 6,309 | 1,542 | 540 | 1,017 | 765 | 3,580 | 8,311 | 3,450 | 195 | 621 | 70 | 109 | 10 | 24 | 79 | 49 | 46 | 10 | 62 | 477,955 |
| Prince George's | 18,721 | 19,426 | 328,084 | 9,350 | 7,430 | 9,892 | 492 | 1,193 | 418 | 7,295 | 13,937 | 7,056 | 87 | 550 | 274 | 42 | 61 | 172 | 95 | 46 | 3 | 50 | 424,674 |
| Arlington | 2,825 | 1,871 | 1,461 | 67,538 | 8,181 | 15,910 | 178 | 334 | 26 | 77 | 109 | 45 | 4 | 13 | 9 | 3 | 12 | 24 | 19 | 6 | 1 | 2 | 98,648 |
| Alexandria | 1,012 | 635 | 1,312 | 11,606 | 39,190 | 12,111 | 93 | 412 | 12 | 52 | 81 | 39 | 0 | 5 | 6 | 3 | 2 | 26 | 9 | 7 | 0 | 2 | 66,615 |
| Fairfax | 3,832 | 457 | 6,595 | 31,433 | 30,715 | 445,147 | 18,206 | 18,478 | 177 | 369 | 495 | 288 | 28 | 41 | 35 | 19 | 86 | 402 | 118 | 295 | 15 | 32 | 557,263 |
| Loudoun | 215 | 1,688 | 443 | 960 | 377 | 27,372 | 142,524 | 3,561 | 1,619 | 151 | 125 | 23 | 48 | 13 | 4 | 4 | 19 | 44 | 20 | 343 | 310 | 602 | 180,465 |
| Prince William | 465 | 1,164 | 1,001 | 1,813 | 1,560 | 24,938 | 3,463 | 200,538 | 68 | 91 | 172 | 93 | 22 | 14 | 18 | 29 | 214 | 2,055 | 319 | 2,087 | 21 | 14 | 240,159 |
| Frederick | 219 | 7,085 | 745 | 269 | 101 | 967 | 1,650 | 187 | 100,351 | 1,567 | 530 | 24 | 4,046 | 13 | 25 | 2 | 4 | 29 | 28 | 32 | 37 | 403 | 118,314 |
| Howard | 398 | 8,911 | 7,265 | 244 | 108 | 461 | 99 | 69 | 930 | 120,325 | 10,309 | 30 | 1,642 | 17 | 11 | 0 | 5 | 12 | 2 | 1 | 4 | 15 | 150,858 |
| Anne Arundel | 715 | 2,758 | 14,969 | 588 | 277 | 880 | 90 | 185 | 166 | 9,583 | 233,739 | 328 | 111 | 1,091 | 75 | 0 | 17 | 29 | 20 | 8 | 2 | 11 | 265,642 |
| Charles | 729 | 867 | 9,674 | 873 | 906 | 1,997 | 110 | 222 | 33 | 202 | 697 | 52,001 | 6 | 727 | 1,765 | 515 | 42 | 78 | 59 | 16 | 0 | 6 | 71,525 |
| Carroll | 120 | 2,640 | 528 | 107 | 52 | 380 | 200 | 68 | 4,036 | 3,225 | 631 | 16 | 63,790 | 7 | 13 | 1 | 6 | 15 | 4 | 16 | 5 | 44 | 75,904 |
| Calvert | 297 | 557 | 3,672 | 265 | 202 | 501 | 40 | 84 | 20 | 161 | 2,100 | 782 | 3 | 29,556 | 2,381 | 13 | 6 | 23 | 14 | 6 | 1 | 0 | 40,684 |
| St. Mary's | 245 | 442 | 1,593 | 166 | 127 | 495 | 59 | 121 | 41 | 117 | 362 | 2,016 | 17 | 1,198 | 43,693 | 144 | 22 | 62 | 49 | 16 | 1 | 13 | 50,999 |
| King George | 51 | 82 | 298 | 63 | 30 | 257 | 18 | 302 | 3 | 18 | 67 | 354 | 1 | 39 | 95 | 6,682 | 695 | 982 | 724 | 38 | 1 | 2 | 10,802 |
| Fredericksburg | 12 | 27 | 33 | 13 | 10 | 88 | 15 | 104 | 9 | 7 | 20 | 8 | 2 | 5 | 5 | 21 | 8,588 | 1,607 | 2,355 | 16 | 0 | 5 | 12,950 |
| Stafford | 115 | 291 | 313 | 339 | 314 | 2,097 | 163 | 5,536 | 17 | 24 | 69 | 54 | 2 | 7 | 13 | 258 | 8,662 | 44,706 | 5,037 | 554 | 5 | 9 | 68,585 |
| Spotsylvania | 51 | 128 | 146 | 116 | 79 | 493 | 68 | 651 | 14 | 19 | 55 | 39 | 6 | 7 | 17 | 108 | 7,996 | 3,264 | 34,535 | 84 | 0 | 7 | 47,883 |
| Fauquier | 66 | 294 | 181 | 239 | 129 | 2,452 | 1,196 | 5,200 | 52 | 24 | 34 | 14 | 3 | 4 | 11 | 20 | 281 | 1,200 | 333 | 20,540 | 68 | 36 | 32,377 |
| Clarke | 8 | 107 | 41 | 26 | 15 | 374 | 921 | 190 | 115 | 31 | 21 | 1 | 13 | 0 | 1 | 0 | 4 | 9 | 9 | 138 | 3,885 | 474 | 6,383 |
| Jefferson | 70 | 666 | 162 | 76 | 24 | 600 | 1,626 | 192 | 1,441 | 192 | 120 | 11 | 110 | 1 | 14 | 2 | 5 | 28 | 10 | 68 | 778 | 20,652 | 26,848 |
| Total | 286,719 | 494,575 | 411,555 | 140,609 | 92,804 | 549,905 | 172,260 | 238,448 | 113,136 | 151,950 | 267,275 | 63,465 | 70,563 | 33,383 | 48,574 | 7,876 | 26,752 | 54,848 | 43,808 | 24,364 | 5,147 | 22,441 | 3,320,457 |

### TABLE 69: DIFFERENCE BETWEEN GEN3 AND SURVEY NON-MANDATORY TOURS BY COUNTY

| | DC | MONTGOMERY | PRINCE GEORGE'S | ARLINGTON | ALEXANDRIA | FAIRFAX | LOUDOUN | PRINCE WILLIAM | FREDERICK | HOWARD | ANNE ARUNDEL | CHARLES | CARROLL | CALVERT | ST. MARY'S | KING GEORGE | FREDERICKSBURG | STAFFORD | SPOTSYLVANIA | FAUQUIER | CLARKE | JEFFERSON | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 20,326 | 14,528 | 22,171 | 2,062 | -17,521 | 1,792 | 32 | 56 | -390 | 109 | -19,292 | -755 | -3,483 | -3,047 | 0 | -265 | -10 | -67 | 0 | -67 | 0 | -145 | 16,034 |
| Montgomery | 10,347 | 421,425 | 9,923 | 6,309 | 1,542 | 540 | 1,017 | -565 | 3,580 | 8,311 | 3,450 | 195 | 621 | 70 | 109 | 10 | 24 | 79 | 49 | 46 | -351 | 62 | 466,793 |
| Prince George's | 18,193 | 15,425 | 286,217 | 9,350 | 7,342 | 9,892 | 431 | -4,230 | 418 | 7,295 | 13,937 | 7,056 | -369 | -265 | 274 | 42 | 61 | 172 | 95 | 46 | -1,452 | 50 | 369,980 |
| Arlington | -4,518 | 1,871 | 1,389 | -18,815 | 7,634 | 15,910 | 178 | 334 | 0 | 77 | -705 | -67 | -21,094 | -4,555 | 9 | -120 | 12 | 24 | 19 | 6 | -252 | 2 | -22,661 |
| Alexandria | -23,301 | 635 | 1,312 | 10,080 | -373,843 | 9,959 | 93 | 412 | -2,607 | -1,369 | -5,973 | -1,033 | -3,536 | -96 | 6 | 3 | -57 | 26 | 9 | -1,410 | -20 | 2 | -390,708 |
| Fairfax | 3,198 | 457 | 6,595 | 31,433 | 24,543 | 354,647 | 18,206 | 18,478 | -972 | -5,727 | 446 | -392 | 28 | 41 | 35 | 19 | 86 | 317 | 118 | 144 | 15 | 32 | 451,747 |
| Loudoun | 215 | 45 | 326 | 960 | 377 | 27,372 | 133,674 | 3,370 | 1,619 | 151 | 125 | 23 | 48 | 13 | 4 | 4 | 19 | 44 | 20 | 343 | 310 | 602 | 169,664 |
| Prince William | 428 | -2,898 | -1,283 | 1,630 | 1,560 | 24,938 | 3,463 | 177,863 | 68 | 91 | 172 | -491 | -15 | 14 | 18 | 29 | 214 | 2,055 | 319 | 2,087 | 21 | 14 | 210,297 |
| Frederick | -2,856 | 7,085 | 653 | -25 | -807 | 735 | 1,650 | 187 | -107,311 | 1,529 | -7,224 | 24 | 3,465 | 13 | 25 | -34 | 4 | 29 | 28 | -4,398 | 37 | -181 | -107,372 |
| Howard | 398 | 8,911 | 7,265 | 244 | -902 | -205 | 99 | 69 | 748 | 64,380 | 10,309 | -52 | 1,642 | 17 | 11 | 0 | -529 | 12 | 2 | -995 | 4 | -7 | 91,421 |
| Anne Arundel | -24,951 | 2,758 | 14,969 | -368 | -14,682 | 796 | 90 | 185 | -12,641 | 9,583 | -5,310 | 314 | -3,101 | -1,107 | 75 | -438 | -4,727 | -14 | -335 | -5,610 | -229 | -2,430 | -47,173 |
| Charles | -745 | 867 | 9,674 | 873 | 332 | 1,672 | 110 | 222 | -7 | 38 | -1,106 | -71,076 | -23,896 | -1,263 | 1,688 | 515 | 42 | 78 | -309 | 16 | -3,070 | 6 | -85,339 |
| Carroll | -5,026 | 2,640 | 428 | -17,019 | -3,837 | 335 | 82 | 68 | 3,227 | 3,193 | -2,230 | -10,487 | -365,646 | -11,134 | 13 | 1 | 6 | 15 | -779 | 16 | -6,094 | 44 | -412,184 |
| Calvert | -608 | 517 | 3,672 | -10,771 | -25 | 501 | 40 | 84 | 20 | 161 | 1,777 | 782 | -11,397 | -20,494 | 2,381 | 13 | 6 | 23 | 14 | 6 | -50 | 0 | -33,348 |
| St. Mary's | 245 | 442 | 1,593 | 166 | 127 | 152 | 59 | 121 | 41 | 117 | 362 | 1,625 | -266 | 1,198 | 39,647 | 144 | 22 | 15 | -152 | 16 | 1 | 13 | 45,688 |
| King George | 51 | 82 | 298 | 63 | -136 | 257 | 18 | 302 | -552 | 18 | -173 | 354 | 1 | 39 | 95 | -34,927 | -826 | 982 | 724 | 38 | 1 | -739 | -34,030 |
| Fredericksburg | -1,724 | 27 | 33 | -92 | -743 | 88 | 15 | 104 | -128 | 7 | -6,377 | 8 | -66 | 5 | 5 | -2,227 | -45,104 | 1,607 | 2,355 | -31 | 0 | -570 | -52,808 |
| Stafford | 63 | 291 | 313 | 339 | 314 | 1,518 | 163 | 5,536 | 17 | 24 | 69 | -771 | 2 | 7 | 13 | 258 | 8,662 | 25,177 | 5,037 | 554 | 5 | 9 | 47,600 |
| Spotsylvania | 51 | 128 | 116 | 63 | 22 | 493 | 68 | 651 | 14 | 19 | 55 | -27 | -580 | -19 | 17 | 108 | 7,996 | 3,264 | 17,142 | 84 | -1,810 | 7 | 27,862 |
| Fauquier | -488 | 294 | 181 | 239 | -1,692 | 2,452 | 1,196 | 5,200 | -2,832 | -1,200 | -3,892 | 14 | -208 | 4 | 11 | 20 | 281 | 1,200 | 333 | -84,955 | 68 | 36 | -83,738 |
| Clarke | -3,048 | 107 | -1,005 | -1,081 | -1,670 | 374 | 921 | -352 | 73 | 31 | -562 | -6,191 | -12,230 | -1,257 | 1 | 0 | 4 | 9 | -431 | 138 | -153,138 | 474 | -178,833 |
| Jefferson | 70 | 666 | 162 | 76 | 24 | 600 | 1,626 | 192 | 250 | 192 | -1,086 | 11 | 39 | 1 | 14 | -1,831 | -372 | 28 | 10 | 68 | 778 | -2,231 | -713 |
| Total | -13,680 | 476,303 | 365,002 | 15,716 | -372,041 | 454,818 | 163,231 | 208,287 | -117,365 | 87,030 | -23,228 | -80,936 | -440,041 | -41,815 | 44,451 | -38,676 | -34,186 | 35,075 | 24,268 | -93,858 | -165,226 | -4,950 | 448,179 |

### TABLE 70: GEN3 / SURVEY NON-MANDATORY TOURS BY COUNTY

| | DC | MONTGOMERY | PRINCE GEORGE'S | ARLINGTON | ALEXANDRIA | FAIRFAX | LOUDOUN | PRINCE WILLIAM | FREDERICK | HOWARD | ANNE ARUNDEL | CHARLES | CARROLL | CALVERT | ST. MARY'S | KING GEORGE | FREDERICKSBURG | STAFFORD | SPOTSYLVANIA | FAUQUIER | CLARKE | JEFFERSON | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DC | 1.09 | | | 1.34 | 0.08 | 12.13 | | | 0.02 | | 0.01 | 0.06 | 0.00 | 0.00 | | 0.00 | 0.09 | 0.03 | | 0.01 | | 0.00 | 1.06 |
| Montgomery | | 50.43 | 11.50 | | | | | 0.58 | | | | | | | | | | | | | 0.03 | | 42.82 |
| Prince George's | 35.46 | 4.86 | 7.84 | | 84.43 | | 8.07 | 0.22 | | | | | 0.19 | 0.67 | | | | | | | 0.00 | | 7.76 |
| Arlington | 0.38 | | 20.29 | 0.78 | 14.96 | | | | 1.00 | | 0.13 | 0.40 | 0.00 | 0.00 | | 0.02 | | | | | 0.00 | | 0.81 |
| Alexandria | 0.04 | | | 7.61 | 0.09 | 5.63 | | | 0.00 | 0.04 | 0.01 | 0.04 | 0.00 | 0.05 | | | 0.03 | | | 0.00 | 0.00 | | 0.15 |
| Fairfax | 6.04 | | | | 4.98 | 4.92 | | | 0.15 | 0.06 | 10.10 | 0.42 | | | | | | 4.73 | | 1.95 | | | 5.28 |
| Loudoun | | 1.03 | 3.79 | | | | 16.10 | 18.64 | | | | | | | | | | | | | | | 16.71 |
| Prince William | 12.57 | 0.29 | 0.44 | 9.91 | | | | 8.84 | | | | 0.16 | 0.59 | | | | | | | | | | 8.04 |
| Frederick | 0.07 | | 8.10 | 0.91 | 0.11 | 4.17 | | | 0.48 | 41.24 | 0.07 | | 6.96 | | | 0.06 | | | | 0.01 | | 0.69 | 0.52 |
| Howard | | | | | 0.11 | 0.69 | | | 5.11 | 2.15 | | 0.37 | | | | | 0.01 | | | 0.00 | | 0.68 | 2.54 |
| Anne Arundel | 0.03 | | | 0.62 | 0.02 | 10.48 | | | 0.01 | | 0.98 | 23.43 | 0.03 | 0.50 | | 0.00 | 0.00 | 0.67 | 0.06 | 0.00 | 0.01 | 0.00 | 0.85 |
| Charles | 0.49 | | | | 1.58 | 6.14 | | | 0.83 | 1.23 | 0.39 | 0.42 | 0.00 | 0.37 | 22.92 | | | | 0.16 | | 0.00 | | 0.46 |
| Carroll | 0.02 | | 5.28 | 0.01 | 0.01 | 8.44 | 1.69 | | 4.99 | 100.78 | 0.22 | 0.00 | 0.15 | 0.00 | | | | | 0.01 | | 0.00 | | 0.16 |
| Calvert | 0.33 | 13.93 | | 0.02 | 0.89 | | | | | | 6.50 | | 0.00 | 0.59 | | | | | | | 0.02 | | 0.55 |
| St. Mary's | | | | | | 1.44 | | | | | | 5.16 | 0.06 | | 10.80 | | | 1.32 | 0.24 | | | | 9.60 |
| King George | | | | | 0.18 | | | | 0.01 | | 0.28 | | | | | 0.16 | 0.46 | | | | | 0.00 | 0.24 |
| Fredericksburg | 0.01 | | | 0.12 | 0.01 | | | | 0.07 | | 0.00 | | 0.03 | | | 0.01 | 0.16 | | | 0.34 | | 0.01 | 0.20 |
| Stafford | 2.21 | | | | | 3.62 | | | | | | 0.07 | | | | | | 2.29 | | | | | 3.27 |
| Spotsylvania | | | 4.87 | 2.19 | 1.39 | | | | | | | 0.59 | 0.01 | 0.27 | | | | | 1.99 | | 0.00 | | 2.39 |
| Fauquier | 0.12 | | | | 0.07 | | | | 0.02 | 0.02 | 0.01 | | 0.01 | | | | | | | 0.19 | | | 0.28 |
| Clarke | 0.00 | | 0.04 | 0.02 | 0.01 | | | 0.35 | 2.74 | | 0.04 | 0.00 | 0.00 | 0.00 | | | | | 0.02 | | 0.02 | | 0.03 |
| Jefferson | | | | | | | | | 1.21 | | 0.10 | | 1.55 | | | 0.00 | 0.01 | | | | | 0.90 | 0.97 |
| Total | 0.95 | 27.07 | 8.84 | 1.13 | 0.20 | 5.78 | 19.08 | 7.91 | 0.49 | 2.34 | 0.92 | 0.44 | 0.14 | 0.44 | 11.78 | 0.17 | 0.44 | 2.77 | 2.24 | 0.21 | 0.03 | 0.82 | 1.16 |

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