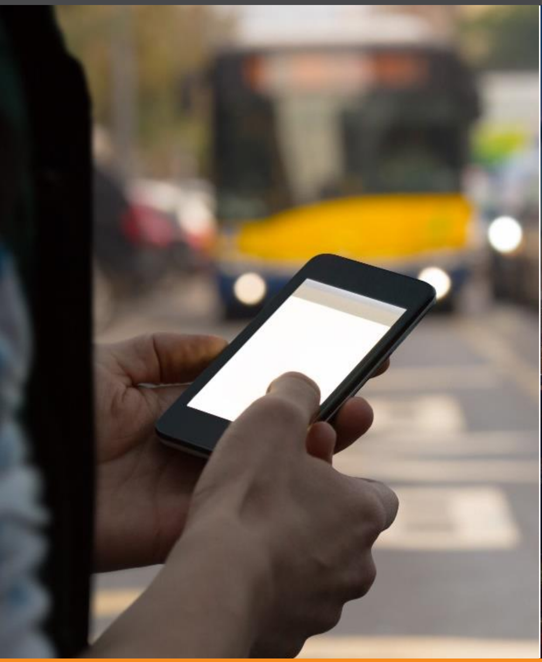
CITY OF SEATAC AND SEATAC AIRPORT

# SEATAC MODEL VALIDATION REPORT

**September 11, 2024**



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# 1.0 INTRODUCTION

The RSG team developed a new SeaTac focused regional model ("SeaCast") to enhance the city of Seattle and Airport specific projects and planning efforts. This model supports a variety of initiatives, including transportation plans, road and intersection design, and other critical endeavors. By providing a comprehensive framework, it aims to improve overall planning efficiency.

## 1.1 PURPOSE

RSG has successfully developed two versions of the SoundCast model, tailored specifically for Bellevue, Kirkland, and Redmond (BKRCast) and Pierce County (PierceCast). These models have demonstrated significant benefits in streamlining planning efforts, which have been recognized by the respective agencies. The positive impact of these tools has highlighted the value of having a robust and adaptable transportation model.

Building on this success, RSG has proposed the development of a new version for city of Seattle and Seattle Airport (SeaCast), of the SoundCast model. This version is designed to support local planning efforts more comprehensively. SeaCast will incorporate the unique requirements and challenges faced by local planners, providing them with a powerful tool to enhance their decision-making processes. By leveraging the insights gained from the previous versions, SeaCast aims to deliver even greater efficiency and effectiveness in planning activities.

## 1.2 MODEL DEVELOPMENT

The SeaCast is a county-specific adaptation of the PSRC's SoundCast travel model. To tailor it for SeaTac, we incorporated a new zone system and updated the roadway network for detailed representation of the local region. The new zone system disaggregates SoundCast zones within SeaTac and aggregates them outside, while the new network provides more detail within SeaTac, maintaining the same level of detail as SoundCast outside. The SeaCast model base year is 2018, the same as the current SoundCast model.

The development of SeaCast involved two main updates to the SoundCast travel model:

- **Model Inputs.**
    - Introduced a new zone system and roadway network.
    - Updated model input files to reflect the new zone system, including land use data and synthetic population.

  - Updated observed datasets for calibration and validation, including re-weighted 2017/19 household travel survey data and local traffic counts within SeaTac.
- **Model Scripts.**
  - Revised scripts to align settings and parameters with the SeaCast zone system.
  - Updated summary scripts to include SeaTac-specific summaries.
  - Added a new and improved Airport model.
  - Added enhancements to reduce model variance (household sampling).

RSG has compiled a set of scripts designed to convert SoundCast model inputs into SeaCast model inputs. Detailed information about these scripts can be found at https://github.com/RSGInc/SeaCast/wiki/Scripts. These scripts should be utilized for any future revisions to the zone system.

## 1.3 MODEL CALIBRATION AND VALIDATION

Model calibration involves adjusting constants and other parameters in travel models to ensure they reflect travel behavior similar to observed data for a base year or produce more reasonable results. Once calibrated to predict observed travel behavior in the region accurately, the model undergoes validation to confirm its network-level demand usage. This validation process includes comparing estimated traffic volumes from the model with observed traffic counts for highways and comparing estimated transit boardings with observed ridership for transit. Validating the model is crucial to demonstrate its usefulness. Well-validated models give decision-makers the confidence to use them for making informed transportation investment decisions.

Table 1-1 presents the datasets used in the SeaCast model calibration and validation.

**TABLE 1-1:MODEL CALIBRATION AND VALIDATION DATASETS**

| DATASET | YEAR | SOURCE | PURPOSE |
|---|---|---|---|
| **Calibration** | | | |
| Household Travel Survey (HTS) | 2017/2019 | PSRC | Resident travel generation |
| Census Auto Ownership | 2014-2018 and 2018 | Public Use Microdata Sample (PUMS) and American Community Survey (Census) | Auto ownership |

| DATASET | YEAR | SOURCE | PURPOSE |
|---|---|---|---|
| **Validation** | | | |
| Traffic counts (daily, hourly, and screenline) | 2018/2022 | PSRC (2018) and SeaTac (2022) | Highway validation |
| Transit boardings | 2018 | PSRC | Transit validation |

The SeaCast calibration utilized the re-weighted 2017/2019 household travel survey as the primary dataset for observed travel behavior. Due to the small household samples in the city of SeaTac, calibration was only conducted at the regionwide level. Overall, the calibrated SeaCast aligns well with the HTS dataset. The regional-level calibration summaries are either comparable to or better than the SoundCast's performance. The city of SeaTac level summaries also improved during the regional-level calibration.

The SeaCast validation adhered to guidelines from the National Cooperative Highway Research Program (NCHRP) 765 and the Federal Highway Administration's Travel Model Validation and Reasonability Checking Manual (Second Edition), Cambridge Systematics, Inc. 2010. The final model flows align well with observed traffic counts and transit boardings. Validation was performed at both the regional and the city of SeaTac levels. As anticipated, the SeaCast shows enhanced validation at the SeaTac level compared to the SoundCast.

## 1.4 MODEL STRENGTHS AND WEAKNESSES

The SeaCast is a disaggregated travel demand model that offers several key benefits:

- **Spatial resolution**. SeaCast uses parcels as the spatial input unit for households and employment, which is crucial for estimating nonmotorized travel (bike, walk, and transit access).
- **Multimodal analysis.** SeaCast responds to changes in multimodal accessibility for all travel modes and land uses. SeaCast is sensitive to variations in density, land use diversity, time-of-day congestion, and relevant costs by mode (parking, tolls, fares, etc.).
- **Active transportation**. Active travel modes are primarily used for short-distance trips and are important for understanding public health. SeaCast represents space (and short trips) at a more detailed scale.
- **Continuous improvements**. SeaCast is a local implementation of PSRC's SoundCast travel model. Due to similar structure, the model would benefit from the improvements to SoundCast model as those could be transferred with relatively small efforts.

The SeaCast is reasonably calibrated and validated to reflect conditions in observed datasets. However, there are a few areas that need improvement and should be addressed in future model development tasks:

- **Travel Survey**: The 2017/2019 HTS had negligible samples in the city of SeaTac, limiting the consultant's ability to adjust the model for local conditions (in the city of SeaTac). A new travel survey with a larger sample size in the city of SeaTac could be used to estimate and calibrate the AB model for SeaTac conditions and therefore, improve the model's performance to forecast traffic in the region.
- **Observed traffic Counts**: The highway validation involved significant effort in reviewing and cleaning up observed traffic counts. Due to time constraints, only some count locations were reviewed. A more comprehensive review of traffic counts would help examine the model's reasonableness more accurately.
- **Screenlines**: Generally, the screenlines in the SeaTac region show comparable flows with the observed traffic counts. However, a few low volume screenlines (*N of S 160th St* and *W of Des Moines Mem'l N of 176th*) see bigger differences (>20%). The future work should look at these screenlines in more detail and adjust the model as necessary.
- **External stations**: Overall, the external stations of the model region are overestimated by 14%. This work did not make any adjustments to improve these validations. The future work should examine the flows at external stations and make as needed adjustments to improve the validations.
- **Transit ridership by route**: At the SeaTac level, the transit ridership compares well with observed transit ridership. However, individual routes do not perform well, except the highest ridership route (SeaTac LINK). We recommend that the future work obtain a transit on-board survey dataset and use in model development to improve transit ridership estimates.

## 1.5 MODEL APPLICATION

Beyond typical highway and transit scenarios, the SeaCast model supports several key applications:

- **Equity**. SeaCast simulates each individual in a population without grouping them together. This disaggregated structure allows the model to assess the impact of policy changes on specific populations, including historically marginalized or environmental justice groups such as low-income communities.
- **Pricing**. By simulating individual members of a population, SeaCast enables practitioners to test how people will respond to tolls and congestion pricing.

- **New mobility services**. SeaCast includes transportation network companies (e.g., Uber, Lyft) as a mode in its mode choice, aiding practitioners in planning for the introduction and expansion of these services.
- **Autonomous vehicles**. SeaCast leverages DaySim capabilities to represent autonomous vehicle (AV) scenarios.
- **Transportation demand management**. SeaCast is sensitive to transportation demand management (TDM) strategies, such as employer-sponsored transit passes, teleworking, flexible work schedules, and central business district (CBD) parking constraints.

# 2.0 MODEL CALIBRATION

A calibration process fine-tunes the model to ensure that it accurately reflects the demand patterns observed in real-world data. The demand is defined as frequency of trips by origin and destination (OD) pair and can have different segmentation (e.g., mode, purpose). The demand are then assigned to a network to determine frequency of trips using each link in the network. For highway, the assignment provides vehicle flows on every link (road) in the highway network and for transit, the assignment generates number of people (boardings) using each transit service.

After the model is calibrated to produce demand that reasonably predicts observed travel behavior in the region, it is validated to ensure network-level usage of the demand. The model validation includes, on the highway side, comparing estimated traffic volume from the model with observed traffic counts, and on the transit side, comparing estimated transit boardings from the model with observed transit ridership.

In model calibration, alternative-specific constants (ASCs) and other model parameters are iteratively adjusted until the model generates demand that reasonably matches travel patterns in observed data. Typically, models are calibrated according to the following procedure: first, create comparisons between observed data and estimated model results. Next, calculate ASC adjustments by calculating the natural log of the ratio between the observed value and the estimated value for each alternative. Then, add the adjustments to the ASCs from the previous iteration. Next, run the model with the updated constants. These steps are followed until estimated model results provide desired match with the observed data.

## 2.1 DATA

Model calibration requires observed targets to calculate adjustments and confirm model's performance. The targets are generated from the data sources collected in the real world to gather information related to actual travel. **Table 2-1** presents a list of observed datasets utilized in calibrating the SeaCast model.

**Table 2-1:Model Calibration Datasets**

| DATASET | YEAR | SOURCE | PURPOSE |
|---|---|---|---|
| Household Travel Survey (HTS) | 2017/2019 | PSRC | Resident (DaySim) travel generation |
| Census Auto Ownership | 2014-2018 and 2018 | Public Use Microdata Sample (PUMS) and | Resident auto ownership |

| | |
|---|---|
| | American Community Survey (Census) |

The calibration effort used multiple observed datasets to adjust the SeaCast model to represent base year (2018) travel patterns. The 2017/2019 PSRC household travel survey (HTS) dataset was the primary dataset used during the calibration. The survey was used to inform residents' travel pattern in terms of rates, average distances, and distribution of travel in various market segments. The other datasets included Census (2015-2018 5-year PUMS and 2018 1-year ACS) for Auto Ownership.

The calibration focused on improving travel patterns within SeaTac model region while maintaining reasonable patterns regionwide.

## Household Travel Survey (HTS)

PSRC provided the 2017/2019 household travel survey for the development of the SeaCast model. The survey was re-weighted to get it ready for model calibration. The re-weighting effort included the following key highlights:

- Used the new weights for 2017 and 2019 combined.
- Factored the person-weights by county and person type (PPTYP) to match the counts in the synthetic population.
- Added in person-day records for valid days with 0 trips. There were a lot of person-days that had weights but were not in the person-day file. Some of those were because of 0 trips and some for other reasons (missing trip data). These were sorted out as much as possible. Would have needed to start the whole DaySim file preparation over from scratch to get it totally right.
- Expanded the household ID (HHNO) on the records to be HHNO = HHNO * 10 + DAY (where DAY=1 to 4 for Mon-Thu), and then set DAY=1 on all the files. This is because DaySim doesn't handle multiple days, so now there is exactly 1 household-day record for each household and 1 person-day record for each person. For households and persons with multiple day records, the weights were divided by the number of days so the total weight for the household and person didn't change.  The weight person expansion factor (PSEXPFAC) is the same as the person-day expansion factor (PDEXPFAC).
- For consistency after adjusting the person weights to match the synthetic population, the household and household-day weights (HHEXPFAC and HDEXPFAC) were re-calculated as the average of the person weights (PSEXPFAC) for persons in the HH.

- The new weighting includes a trip rate adjustment factor based on non-response bias for the dairy-based data compared to the smartphone-based data. The weight (TREXPFAC) on the trip file is equal to person day weight (PDEXPFAC) times the trip factor. (Both of those are also on the trip file.) Using the trip weight (TREXPFAC) instead of person day weight (PDEXPFAC) brings the weighted trips per day up from 3.14 to 3.86.
- The tour weight (TOEXPFAC) was re-calculated as the average of trip weight (TREXPFAC) for the trips on the tour.
- There were some trips on person days that weren't in the person-day day file, those were removed.
- There were some completely duplicate trip records, those were removed.
- There were some trips on incomplete tours that only had 1 trip. Those were removed from both files.
- There were cases where the TRIPSH1 and TRIPSH2 fields on the tour file did not match the number of trips in the trip file for the tour. Those were fixed.
- The variable student type (PSTYP) on the original survey file had the wrong coding. It had 2 for full time students and 1 for part time students, so switched it to be the other way around.
- The variable person type (PPTYP) on the original PSRC file also had the wrong coding. It had 3 for non-workers age <65 and 4 for non-workers age 65+, so switched that to be the other way around.
- The original PSRC survey file had about 5% with missing (-1) for person type (PPTYP). We fixed those cases and also some other ones that had been assigned to the wrong person type. This gave some more university students and workers.

The re-weighted survey data was geocoded for origin (home, tour, and trip) and destination locations (work, school, tour, and trip) to assign corresponding zone (TAZ) in the SeaCast model.

## Census Auto Ownership

The team downloaded the 2014-2018 5-year PUMS and 2018 1-year American Community Survey Data. The 5-year PUMS was summarized for number of households regionally. The summarized data was then scaled to match number of households by number of vehicles owned from the 2018 1-year ACS and used in calibrating the auto ownership model.

## 2.2 DAYSIM CALIBRATION SUMMARIES

An R language utility tool summarizes DaySim outputs into statistics that are meaningful and easy to understand. The summaries are prepared by key model components and include work and school location, auto ownership, day pattern, tour/trip destination choice, mode choice, and time of day. The summaries from the final calibrated model are presented below.

Note that the combined survey included 9,818 households and 17,704 persons sampled regionwide. However, out of those, only 32 households and 65 persons were from the SeaTac region. Due to the negligible sample size in the city of SeaTac, except the work location choice model, we did not perform any other adjustments specific to the SeaTac region. The home to work distances for the SeaTac residents were adjusted using survey records from King County. We evaluated the model's performance at the SeaTac level by comparing model outputs with the survey records in from King County. Consequently, the ensuing tables and figures will present comparisons for the SeaTac region which will utilize survey data from the King County and model data from the city of SeaTac. This approach is necessary to ensure the reliability and validity of the comparisons, as the larger sample size from the county region provides a more robust dataset for analysis.

### Synthetic Population

Table 2-2 and Table 2-3 compare synthetic population in the ABM with the observed survey data (2017/19 HTS). The population only includes households population and does not include group quarters (GQs)[1]. The travel for non-institutional GQs population is generated by the supplemental model. As institutional GQs do not generate any travel, they are not modeled.

The synthetic population matches the distribution in the survey data at the regional level. This is expected given that the survey was scaled to match the distribution by county and person type in the synthetic population (see Data). Due to lack of HTS sample data within the SeaTac region, the SeaTac region data is not used. Instead, the comparisons utilize survey data at the King County level to evaluate model's performance at the SeaTac region.  The tables and figures henceforth will show comparison of survey statistics for King County and model statistics from SeaTac model region.

[1] The Census Bureau classifies all people not living in housing units (house, apartment, mobile home, rented rooms) as living in group quarters. People living in group quarters are typically not related to each other. There are two types of group quarters – institutional and non-institutional. Institutional GQs are not modeled as they usually do not generate travel. They include correctional facilities, nursing homes, or mental hospitals. Non-institutional GQs are modeled and include college dormitories, military barracks, group homes, missions, or shelters. (source: https://www.census.gov/topics/income-poverty/poverty/guidance/group-quarters.html)

**TABLE 2-2: POPULATION BY PERSON TYPE**

| PERSON TYPE | SEATAC REGION | | MODEL REGION | |
|---|---|---|---|---|
| | HTS (KING COUNTY) | ABM | HTS | ABM |
| Full Time Worker | 900,611 | 33,235 | 1,610,659 | 1,610,659 |
| Part Time Worker | 161,273 | 6,676 | 296,080 | 296,080 |
| Retired | 237,786 | 9,277 | 473,685 | 473,685 |
| Non-Worker | 302,111 | 13,471 | 613,336 | 613,336 |
| University Student | 94,922 | 2,952 | 160,485 | 160,485 |
| Student Age 16+ | 83,374 | 2,568 | 160,696 | 160,696 |
| Student Age 5-15 | 259,218 | 11,223 | 519,085 | 519,085 |
| Kid under 5 | 109,939 | 6,136 | 219,128 | 219,128 |
| **Total** | **2,149,234** | **85,538** | **4,053,154** | **4,053,154** |

**TABLE 2-3: POPULATION BY PERSON TYPE (SHARE)**

| PERSON TYPE | SEATAC REGION | | MODEL REGION | |
|---|---|---|---|---|
| | HTS (KING COUNTY) | ABM | HTS | ABM |
| Full Time Worker | 42% | 39% | 40% | 40% |
| Part Time Worker | 8% | 8% | 7% | 7% |
| Retired | 11% | 11% | 12% | 12% |
| Non-Worker | 14% | 16% | 15% | 15% |
| University Student | 4% | 3% | 4% | 4% |

| PERSON TYPE | SEATAC REGION | | MODEL REGION | |
|---|---|---|---|---|
| | HTS (KING COUNTY) | ABM | HTS | ABM |
| Student Age 16+ | 4% | 3% | 4% | 4% |
| Student Age 5-15 | 12% | 13% | 13% | 13% |
| Kid under 5 | 5% | 7% | 5% | 5% |
| **Total** | **100%** | **100%** | **100%** | **100%** |

## Home to Work Distance

As presented in Table 2-4, the HTS data indicates an average home to work distance of 10.1 miles for King County and 11.5 miles regionwide. The model was calibrated at both geographies (regional and SeaTac region). The calibration added and adjusted SeaTac specific constants by distance bins to match distances for the SeaTac region. The calibration tried to balance distances at both geographies.

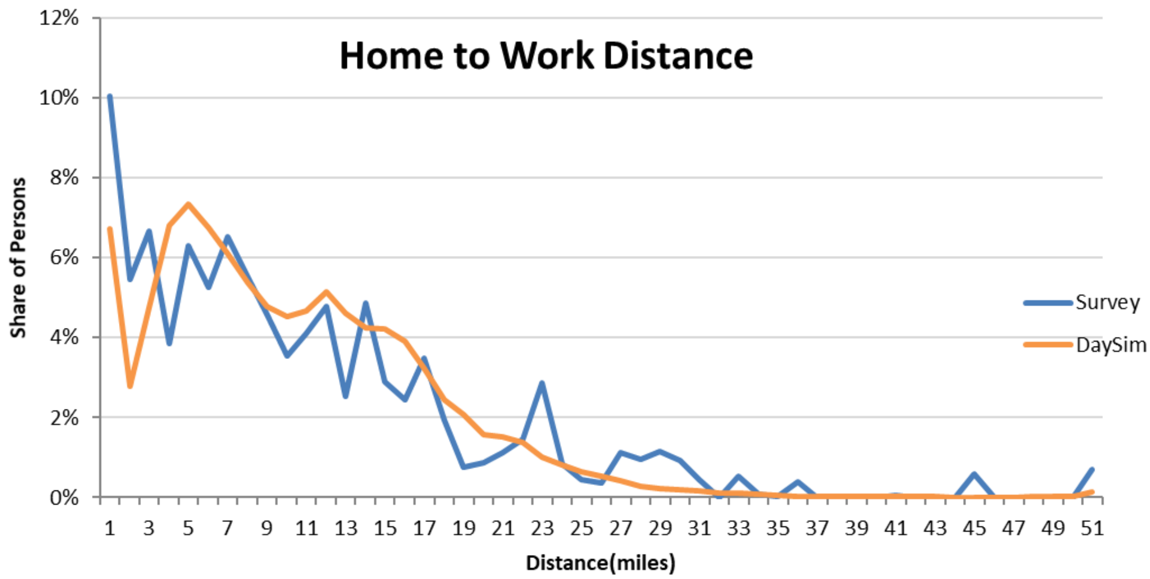
**TABLE 2-4: AVERAGE HOME TO WORK DISTANCE (MILES)**

| WORKER TYPE | SEATAC REGION | | MODEL REGION | |
|---|---|---|---|---|
| | HTS[2] | ABM | HTS | ABM |
| Full Time | 11.0 | 10.4 | 12.3 | 13.0 |
| Part Time | 7.2 | 7.7 | 8.4 | 8.2 |
| Other | 3.1 | 6.6 | 6.0 | 6.7 |
| **Total** | **10.1** | **9.8** | **11.5** | **12.1** |

Figure 2-1 shows a distribution of home to work distances of workers at the SeaTac region and the regional level. Note that the survey data in the SeaTac region plot is for King County. The X-axis is distance in miles and the Y-axis is share (%) of the total workers. Due to relatively lower samples, observed datasets in both geographies show lumpy distributions. The model

[2] KING COUNTY

distributions are comparatively smoother and generally follow the observed distributions from the HTS.



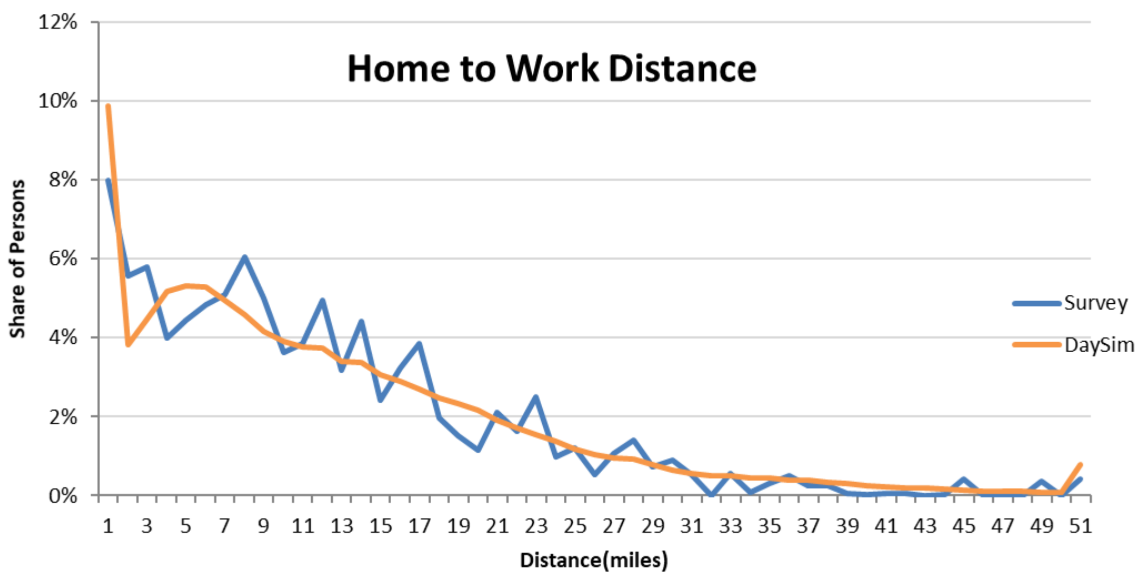



**FIGURE 2-1: DISTRIBUTION OF HOME TO WORK DISTANCES IN SEATAC REGION[3] (TOP) AND MODEL REGION (BOTTOM)**

## Home to School Distance

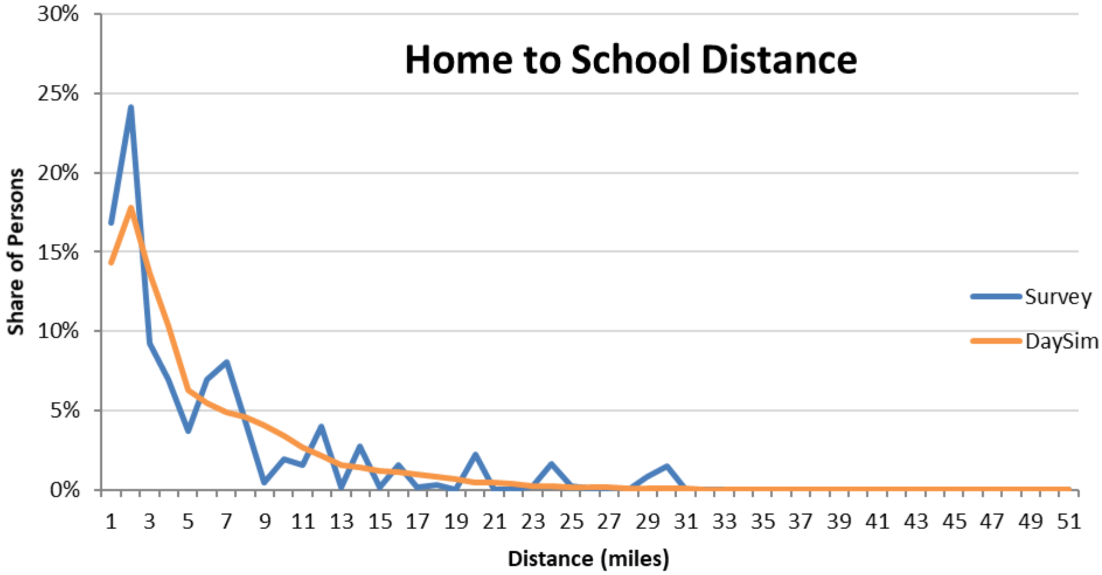
According to the survey, Table 2-5, the average distance traveled by students from home to school is 5.55 miles for King County and 5.87 miles regionwide. The calibrated model produces similar distances (5.26 miles) for SeaTac and slightly lower regionwide (4.66 miles). Due to the survey containing almost no student records (1 student in the city of SeaTac out of 1237 students regionwide), the calibration did not perform SeaTac specific adjustments for the school location choice model. The calibration adjusted regional constants for Kids 5 to 15 to match distances reasonably at both geographies.

**TABLE 2-5: AVERAGE HOME TO SCHOOL DISTANCE (MILES)**

| STUDENT TYPE | SEATAC REGION | | MODEL REGION | |
|---|---|---|---|---|
| | HTS[4] | ABM | HTS | ABM |
| Kids 5 to 15 | 4.48 | 4.44 | 3.95 | 3.86 |
| Student 16+ | 5.84 | 5.70 | 6.51 | 5.34 |
| University Student | 7.65 | 7.90 | 9.62 | 6.48 |
| **Total** | **5.55** | **5.26** | **5.87** | **4.66** |

**FIGURE 2-2** presents a comparison of observed and estimated frequency distribution of trip lengths between home and school. The X-axis is distance in miles and the Y-axis is share (%) of the students. The observed dataset shows lumpy distributions in both geographies due to relatively smaller samples. The model distributions are comparatively smoother and generally follow the observed distributions from the HTS.

[3] Survey data from KING COUNTY
[4] KING COUNTY



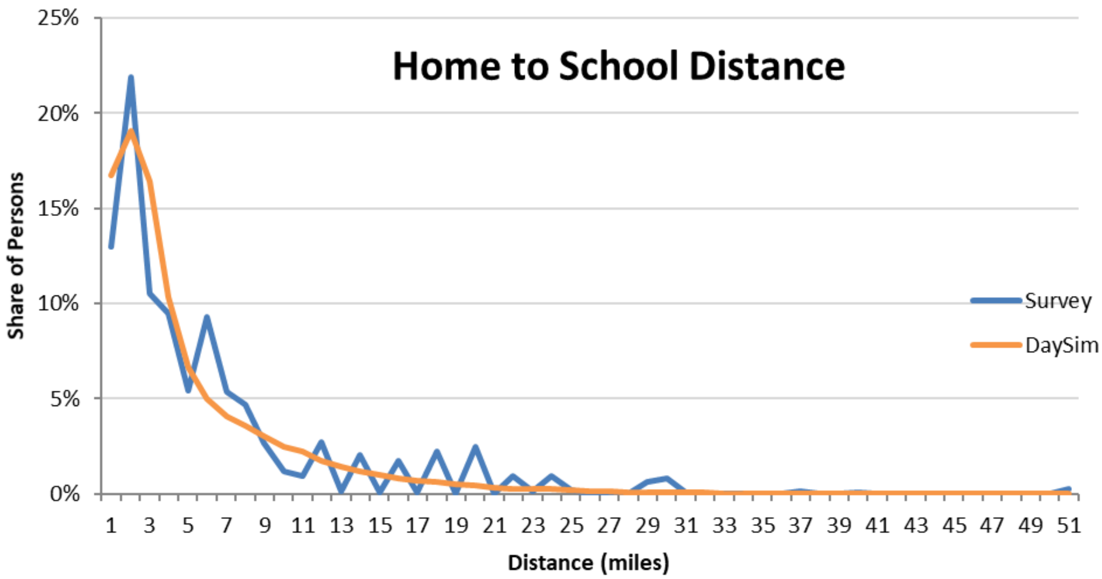




**FIGURE 2-2: DISTRIBUTION OF HOME TO SCHOOL DISTANCE IN SEATAC REGION[5] (TOP) AND MODEL REGION (BOTTOM)**

## Auto Ownership

The auto ownership model predicts the number of vehicles owned by a household. The auto ownership model is structured as a multinomial logit (MNL) with five available alternatives: 0, 1,

[5] Survey data from KING COUNTY

2, 3, and 4+. The key variables are the numbers of working adults, non-working adults, students of driving age, children below driving age and income. Table 2-6 and Table 2-7 present share of households by number of vehicles and drivers in the household from Census and the model respectively. Difference of household shares between the two datasets are presented in Table 2-8. The calibration adjusted regional constants by number of vehicles and number of drivers to match the Census distribution at the regional level. No SeaTac specific adjustments were made.

**TABLE 2-6: SHARE OF HOUSEHOLDS BY VEHICLES AND DRIVERS (CENSUS)**

| | NUMBER OF VEHICLES | | | | | |
|---|---|---|---|---|---|---|
| No. of Drivers | 0 | 1 | 2 | 3 | 4+ | **Total** |
| 1 | 6% | 20% | 4% | 1% | 0% | **31%** |
| 2 | 2% | 9% | 26% | 6% | 2% | **44%** |
| 3 | 0% | 2% | 6% | 7% | 3% | **17%** |
| 4+ | 0% | 1% | 2% | 2% | 4% | **8%** |
| **Total** | **8.2%** | **30.4%** | **37.6%** | **15.8%** | **8.0%** | **100%** |

**TABLE 2-7: SHARE OF HOUSEHOLDS BY VEHICLES AND DRIVERS (ABM)**

| | NUMBER OF VEHICLES | | | | | |
|---|---|---|---|---|---|---|
| No. of Drivers | 0 | 1 | 2 | 3 | 4+ | **Total** |
| 1 | 6% | 20% | 4% | 1% | 0% | **31%** |
| 2 | 2% | 9% | 26% | 6% | 2% | **44%** |
| 3 | 0% | 2% | 6% | 7% | 2% | **17%** |
| 4+ | 0% | 1% | 2% | 2% | 3% | **8%** |
| **Total** | **8%** | **30%** | **38%** | **16%** | **8%** | **100%** |

**TABLE 2-8: DIFF IN SHARE OF HOUSEHOLDS BY VEHICLES AND DRIVERS (ABM-CENSUS)**

| | NUMBER OF VEHICLES | | | | | |
|---|---|---|---|---|---|---|
| No. of drivers | 0 | 1 | 2 | 3 | 4+ | Total |
| 1 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | **0.0%** |
| 2 | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% | **0.0%** |
| 3 | 0.0% | 0.0% | 0.1% | -0.1% | 0.0% | **0.0%** |
| 4+ | 0.0% | 0.0% | 0.0% | 0.0% | -0.1% | **0.0%** |
| **Total** | **-0.1%** | **0.0%** | **0.2%** | **0.0%** | **-0.1%** | **0.0%** |

## Day Pattern

Day pattern summaries compare observed and estimated resident travel (tours and trips) by purpose and person type. Due to thin sample size by purpose/person type segmentation in SeaTac region, no SeaTac specific adjustments were made. Instead, the individual day pattern model was calibrated to match the observed survey data at the regional level.

Table 2-9 compares tours by tour purpose. As per the HTS data, of the total tours regionwide, 28% are work tours and 9% are school tours. Social and recreation tours are about 18% and personal business and shopping are about 14% each. The calibrated model distributions generally look similar to the observed for both the SeaTac and the model regions.

**TABLE 2-9: TOURS BY PURPOSE**

| TOUR PURPOSE | SEATAC REGION | | | MODEL REGION | | |
|---|---|---|---|---|---|---|
| | HTS[6] | ABM | DIFF | HTS | ABM | DIFF |
| Work | 27% | 26% | **-1.6%** | 28% | 25% | **-3.3%** |
| School | 9% | 9% | **-0.4%** | 9% | 9% | **-0.1%** |
| Escort | 7% | 9% | **2.7%** | 8% | 9% | **1.2%** |
| Personal Business | 16% | 17% | **0.7%** | 14% | 17% | **2.6%** |
| Shop | 13% | 13% | **-0.5%** | 14% | 13% | **-0.2%** |

[6] KING COUNTY

| | | | | | | |
|---|---|---|---|---|---|---|
| Meal | 4% | 5% | **0.9%** | 5% | 5% | **0.0%** |
| Social/Recreation | 18% | 18% | **-0.6%** | 18% | 18% | **0.4%** |
| Work-based | 6% | 4% | **-1.3%** | 4% | 4% | **-0.5%** |
| **Total** | **100%** | **100%** | **0.0%** | **100%** | **100%** | **0.0%** |

A tour rate is calculated as number of tours divided by number of persons (total population). Table 2-10 compares tour rates by tour purpose. The HTS indicates on average of 1.48 tours per person for King County and 1.40 tours per person regionwide. The model is calibrated to a slightly higher tour rate (1.65 regionwide and 1.67 in SeaTac region) to resolve underestimation of model flows with the observed traffic count in the assignment stage.

**TABLE 2-10: TOUR RATE BY PURPOSE**

| TOUR PURPOSE | SEATAC REGION | | | MODEL REGION | | |
|---|---|---|---|---|---|---|
| | HTS[7] | ABM | DIFF | HTS | ABM | DIFF |
| Work | 0.40 | 0.43 | **0.03** | 0.40 | 0.42 | **0.02** |
| School | 0.14 | 0.15 | **0.01** | 0.13 | 0.15 | **0.02** |
| Escort | 0.10 | 0.16 | **0.06** | 0.11 | 0.15 | **0.04** |
| Personal Business | 0.23 | 0.28 | **0.04** | 0.20 | 0.28 | **0.08** |
| Shop | 0.20 | 0.22 | **0.02** | 0.19 | 0.22 | **0.03** |
| Meal | 0.06 | 0.08 | **0.02** | 0.06 | 0.08 | **0.01** |
| Social/Recreation | 0.27 | 0.29 | **0.03** | 0.25 | 0.30 | **0.05** |
| Work-based | 0.08 | 0.07 | **-0.01** | 0.06 | 0.07 | **0.00** |
| **Total** | **1.48** | **1.67** | **0.20** | **1.40** | **1.65** | **0.26** |

Table 2-11 compares observed and estimated tours by person type. Generally, the tours in the model match with the HTS distribution regionwide well. For SeaTac, some of the differences are due to differences in population distribution.

[7] KING COUNTY

**TABLE 2-11: TOURS BY PERSON TYPE**

| PERSON TYPE | SEATAC REGION | | | MODEL REGION | | |
|---|---|---|---|---|---|---|
| | HTS[8] | ABM | % DIFF | HTS | ABM | % DIFF |
| Full-Time Worker | 44% | 40% | **-4.3%** | 42% | 40% | **-1.5%** |
| Part-Time Worker | 8% | 8% | **0.5%** | 7% | 7% | **0.4%** |
| Retired | 11% | 12% | **0.8%** | 12% | 12% | **0.3%** |
| Non-Worker | 18% | 21% | **3.0%** | 19% | 20% | **0.3%** |
| University Student | 4% | 3% | **-0.8%** | 4% | 4% | **0.1%** |
| Student 16+ | 3% | 2% | **-0.9%** | 3% | 3% | **0.0%** |
| Student 5-15 | 9% | 10% | **0.5%** | 9% | 10% | **0.3%** |
| Kid Under 5 | 3% | 5% | **1.3%** | 3% | 3% | **0.1%** |
| **Total** | **100%** | **100%** | 0.0% | **100%** | **100%** | 0.0% |

As presented in Table 2-12, a comparison of tour rate by person type categories also exhibits similar closeness of the model tour rates with the HTS data.

**TABLE 2-12: TOUR RATE BY PERSON TYPE**

| PERSON TYPE | SEATAC REGION | | | MODEL REGION | | |
|---|---|---|---|---|---|---|
| | HTS[9] | ABM | DIFF | HTS | ABM | DIFF |
| Full-Time Worker | 1.56 | 1.73 | **0.16** | 1.47 | 1.68 | **0.21** |
| Part-Time Worker | 1.48 | 1.72 | **0.24** | 1.36 | 1.69 | **0.33** |
| Retired | 1.45 | 1.80 | **0.35** | 1.45 | 1.77 | **0.31** |
| Non-Worker | 1.84 | 2.18 | **0.34** | 1.80 | 2.16 | **0.36** |
| University Student | 1.37 | 1.59 | **0.22** | 1.28 | 1.57 | **0.29** |

[8] KING COUNTY
[9] KING COUNTY

| PERSON TYPE | SEATAC REGION | | | MODEL REGION | | |
|---|---|---|---|---|---|---|
| | HTS[9] | ABM | DIFF | HTS | ABM | DIFF |
| Student 16+ | 1.20 | 1.27 | **0.07** | 1.05 | 1.25 | **0.20** |
| Student 5-15 | 1.12 | 1.23 | **0.11** | 1.03 | 1.25 | **0.22** |
| Kid Under 5 | 0.92 | 1.06 | **0.13** | 0.86 | 1.05 | **0.20** |
| **Total** | **1.48** | **1.67** | **0.20** | **1.40** | **1.65** | **0.26** |

The distribution of model trips by destination purpose matches well with the HTS data regionwide, see Table 2-13. The trip shares in the model are generally within 1% of the observed shares except return home (3.1%) trips. In SeaTac region, the distribution is slightly different, but not surprising given that the model was calibrated to match distribution at the regional level and not at the SeaTac level.

**TABLE 2-13: TRIPS BY PURPOSE**

| DESTINATION PURPOSE | SEATAC REGION | | | MODEL REGION | | |
|---|---|---|---|---|---|---|
| | HTS[10] | ABM | DIFF | HTS | ABM | DIFF |
| Work | 17% | 15% | **-1.9%** | 16% | 14% | **-1.6%** |
| School | 4% | 3% | **-0.5%** | 4% | 3% | **-0.2%** |
| Escort | 7% | 7% | **0.6%** | 7% | 7% | **-0.2%** |
| Personal Business | 10% | 11% | **0.3%** | 11% | 11% | **0.2%** |
| Shop | 12% | 13% | **0.5%** | 14% | 13% | **-0.7%** |
| Meal | 6% | 6% | **0.2%** | 6% | 6% | **-0.2%** |
| Social/Recreation | 10% | 9% | **-1.0%** | 10% | 9% | **-0.3%** |
| Home | 35% | 36% | **1.7%** | 34% | 37% | **3.1%** |
| **Total** | **100%** | **100%** | **0.0%** | **100%** | **100%** | **0.0%** |

[10] KING COUNTY

As shown in Table 2-14, according to the HTS data, a resident of the model region makes 3.85 trips per day. Residents of King County exhibit even higher trip rate of 3.92 trips per day. The model was calibrated to produce slightly higher estimates in order to improve highway assignment validations.

**TABLE 2-14: TRIP RATE BY PURPOSE**

| DESTINATION PURPOSE | SEATAC REGION | | | MODEL REGION | | |
|---|---|---|---|---|---|---|
| | HTS[11] | ABM | DIFF | HTS | ABM | DIFF |
| Work | 0.65 | 0.65 | **0.00** | 0.61 | 0.62 | **0.01** |
| School | 0.15 | 0.15 | **0.00** | 0.14 | 0.15 | **0.01** |
| Escort | 0.27 | 0.32 | **0.06** | 0.28 | 0.30 | **0.02** |
| Personal Business | 0.41 | 0.47 | **0.06** | 0.41 | 0.47 | **0.06** |
| Shop | 0.49 | 0.57 | **0.09** | 0.53 | 0.57 | **0.04** |
| Meal | 0.22 | 0.26 | **0.04** | 0.22 | 0.24 | **0.02** |
| Social/Recreation | 0.39 | 0.40 | **0.01** | 0.37 | 0.40 | **0.03** |
| Home | 1.36 | 1.60 | **0.25** | 1.29 | 1.59 | **0.29** |
| **Total** | **3.92** | **4.42** | **0.49** | **3.85** | **4.33** | **0.48** |

As indicated in Table 2-15, The HTS data suggests, on average, residents of the King County make 2.66 trips on a tour. The ABM produces a comparable rate of 2.64 trips per tour for the residents of SeaTac region. The estimated trips per tour regionwide are also generally similar to the HTS data.

**TABLE 2-15: TRIPS PER TOUR BY PURPOSE**

| DESTINATION PURPOSE | SEATAC REGION | | | MODEL REGION | | |
|---|---|---|---|---|---|---|
| | HTS[12] | ABM | DIFF | HTS | ABM | DIFF |
| Work | 1.61 | 1.50 | **-0.11** | 1.53 | 1.48 | **-0.05** |
| School | 1.11 | 1.01 | **-0.10** | 1.12 | 1.01 | **-0.11** |

[11] KING COUNTY
[12] KING COUNTY

| DESTINATION PURPOSE | SEATAC REGION | | | MODEL REGION | | |
|---|---|---|---|---|---|---|
| | HTS[12] | ABM | DIFF | HTS | ABM | DIFF |
| Escort | 2.72 | 2.07 | **-0.65** | 2.60 | 2.07 | **-0.53** |
| Personal Business | 1.75 | 1.71 | **-0.04** | 2.04 | 1.67 | **-0.36** |
| Shop | 2.47 | 2.65 | **0.18** | 2.83 | 2.58 | **-0.24** |
| Meal | 3.94 | 3.26 | **-0.67** | 3.39 | 3.12 | **-0.27** |
| Social/Recreation | 1.45 | 1.34 | **-0.10** | 1.49 | 1.33 | **-0.16** |
| **Total** | **2.66** | **2.64** | **-0.02** | **2.76** | **2.62** | **-0.14** |

The distribution of model trips by person type categories is similar to the HTS data regionwide, see Table 2-16. The trip shares in the model are within 1% of the HTS data. The SeaTac distributions are also comparable.

**TABLE 2-16: TRIPS BY PERSON TYPE**

| PERSON TYPE | SEATAC REGION | | | MODEL REGION | | |
|---|---|---|---|---|---|---|
| | HTS[13] | ABM | DIFF | HTS | ABM | DIFF |
| Full-Time Worker | 46% | 42% | **-3.9%** | 42% | 42% | **-0.4%** |
| Part-Time Worker | 8% | 8% | **0.0%** | 7% | 8% | **0.1%** |
| Retired | 11% | 12% | **0.9%** | 13% | 13% | **-0.2%** |
| Non-Worker | 17% | 20% | **3.0%** | 20% | 20% | **0.0%** |
| University Student | 4% | 3% | **-0.5%** | 4% | 4% | **0.3%** |
| Student 16+ | 3% | 2% | **-0.9%** | 3% | 3% | **0.0%** |
| Student 5-15 | 8% | 9% | **0.2%** | 9% | 9% | **0.2%** |
| Kid Under 5 | 3% | 4% | **1.4%** | 3% | 3% | **0.0%** |
| **Total** | **100%** | **100%** | **0.0%** | **100%** | **100%** | **0.0%** |

[13] KING COUNTY

As presented in Table 2-17, similar to the tour rate by person type (see Table 2-12), the average number of trips per person in the model is slightly higher than the average number of trips per person in HTS.

**TABLE 2-17: TRIP RATE BY PERSON TYPE**

| PERSON TYPE | SEATAC REGION | | | MODEL REGION | | |
|---|---|---|---|---|---|---|
| | HTS[14] | ABM | DIFF | HTS | ABM | DIFF |
| Full-Time Worker | 4.27 | 4.74 | **0.47** | 4.08 | 4.55 | **0.47** |
| Part-Time Worker | 4.22 | 4.57 | **0.35** | 3.95 | 4.47 | **0.52** |
| Retired | 3.83 | 4.76 | **0.92** | 4.20 | 4.66 | **0.46** |
| Non-Worker | 4.83 | 5.69 | **0.86** | 4.99 | 5.62 | **0.63** |
| University Student | 3.46 | 4.37 | **0.90** | 3.51 | 4.23 | **0.73** |
| Student 16+ | 2.93 | 2.88 | **-0.06** | 2.56 | 2.85 | **0.28** |
| Student 5-15 | 2.76 | 2.91 | **0.15** | 2.59 | 2.98 | **0.38** |
| Kid Under 5 | 2.20 | 2.61 | **0.41** | 2.29 | 2.59 | **0.30** |
| **Total** | **3.92** | **4.42** | **0.49** | **3.85** | **4.33** | **0.48** |

## Other Tour Destination

A comparison of average half tour lengths by purpose between the observed (HTS) and the model data is presented in Table 2-18. A half tour length is calculated as distance between tour origin and primary destination. The comparison includes only non-mandatory tour purposes as the mandatory tour purposes (work and school) have already been discussed before (see Table 2-9 and Table 2-10).

For each non-mandatory purpose, the average model half tour length is calibrated to the HTS data regionwide. The regional tour lengths compare well. The SeaTac Region shows some differences, however, it is not surprising given that the calibration adjusted regional constants only and did not make any SeaTac specific adjustments. Due to smaller HTS sample size in the King County region, the tour length frequency distributions of individuals non-mandatory purpose tours are lumpy, Figure 2-3, Figure 2-4, in Figure 2-5, Figure 2-6, Figure 2-7, and

[14] KING COUNTY

Figure 2-8. This makes it difficult to know the real travel behavior for these destination purposes. The ABM distributions are generally smooth and follow distributions from the observed dataset.

**TABLE 2-18: AVERAGE TOUR LENGTHS FOR OTHER TOUR PURPOSE**

| TOUR PURPOSE | SEATAC REGION | | | MODEL REGION | | |
|---|---|---|---|---|---|---|
| | HTS | ABM | DIFF | HTS | ABM | DIFF |
| Escort | 3.81 | 3.82 | 0.00 | 3.84 | 4.34 | 0.50 |
| Personal Business | 4.49 | 6.98 | 2.49 | 6.06 | 6.87 | 0.81 |
| Shop | 4.82 | 5.21 | 0.38 | 4.68 | 5.27 | 0.59 |
| Meal | 3.28 | 7.10 | 3.82 | 6.06 | 6.61 | 0.54 |
| Social/Recreation | 4.09 | 5.11 | 1.02 | 5.07 | 4.79 | -0.27 |
| Work-based | 3.32 | 2.72 | -0.60 | 3.24 | 2.63 | -0.61 |


**FIGURE 2-3: TOUR LENGTH FREQUENCY DISTRIBUTION FOR ESCORT TRAVEL (SEATAC REGION[15])**

[15] Survey data from KING COUNTY

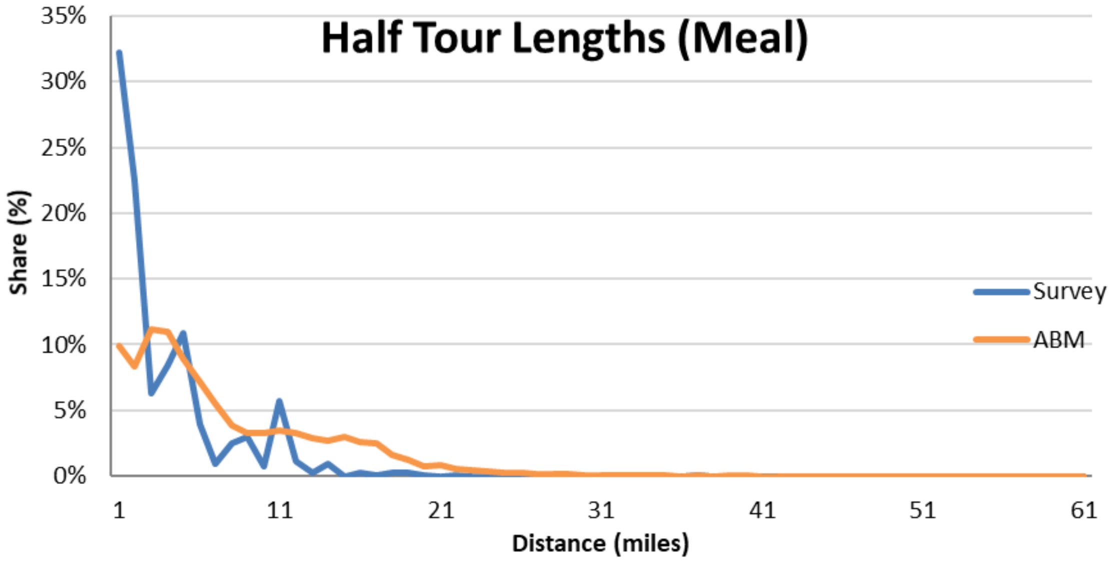



**FIGURE 2-4: TOUR LENGTH FREQUENCY DISTRIBUTION FOR MEAL TRAVEL (SEATAC REGION[16])**

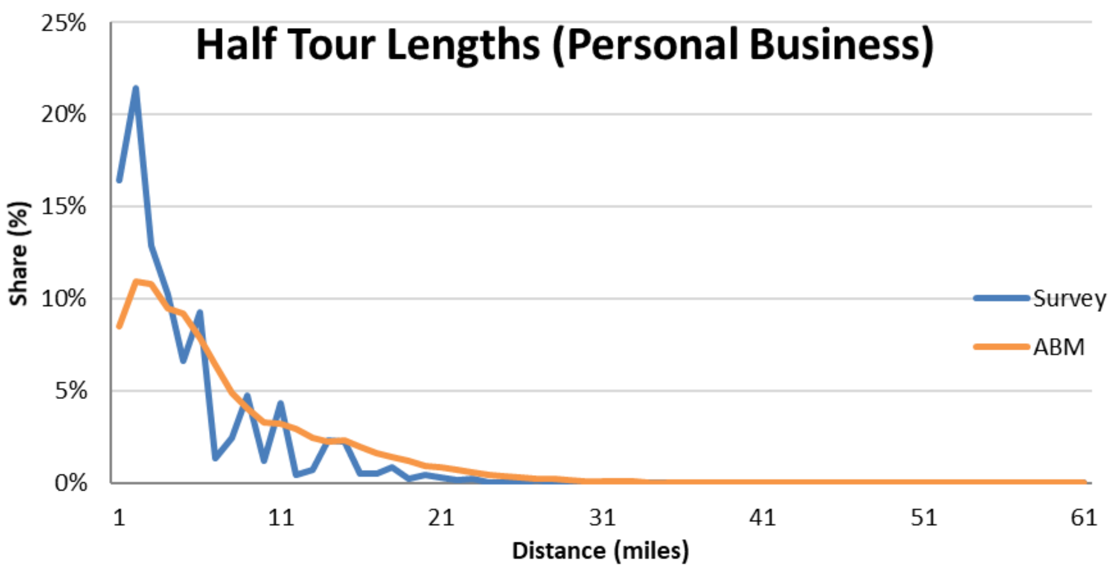



**FIGURE 2-5: TOUR LENGTH FREQUENCY DISTRIBUTION FOR PERSONAL BUSINESS TRAVEL (SEATAC REGION[17])**

[16] Survey data from KING COUNTY
[17] Survey data from KING COUNTY

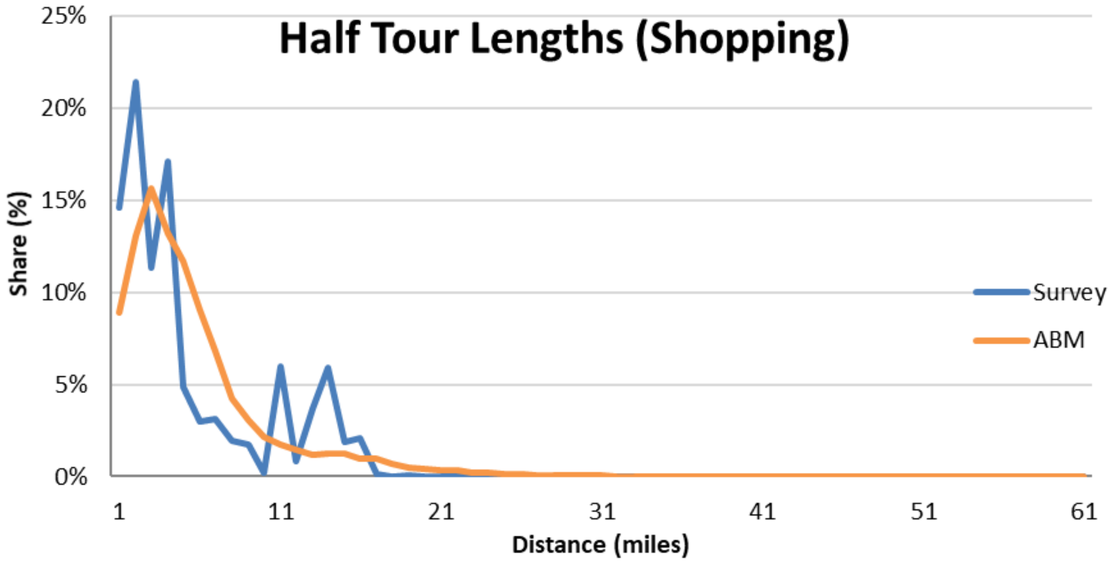



**FIGURE 2-6: TOUR LENGTH FREQUENCY DISTRIBUTION FOR SHOPPING TRAVEL (SEATAC REGION[18])**

[18] Survey data from KING COUNTY

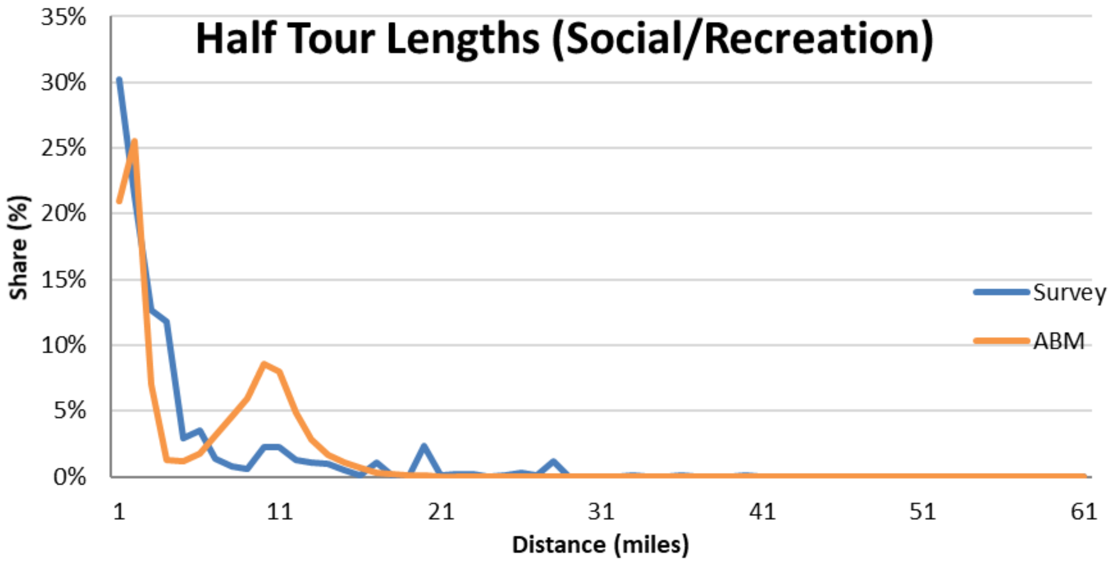



**FIGURE 2-7: TOUR LENGTH FREQUENCY DISTRIBUTION FOR SOCIAL/RECREATION TRAVEL (SEATAC REGION[19])**

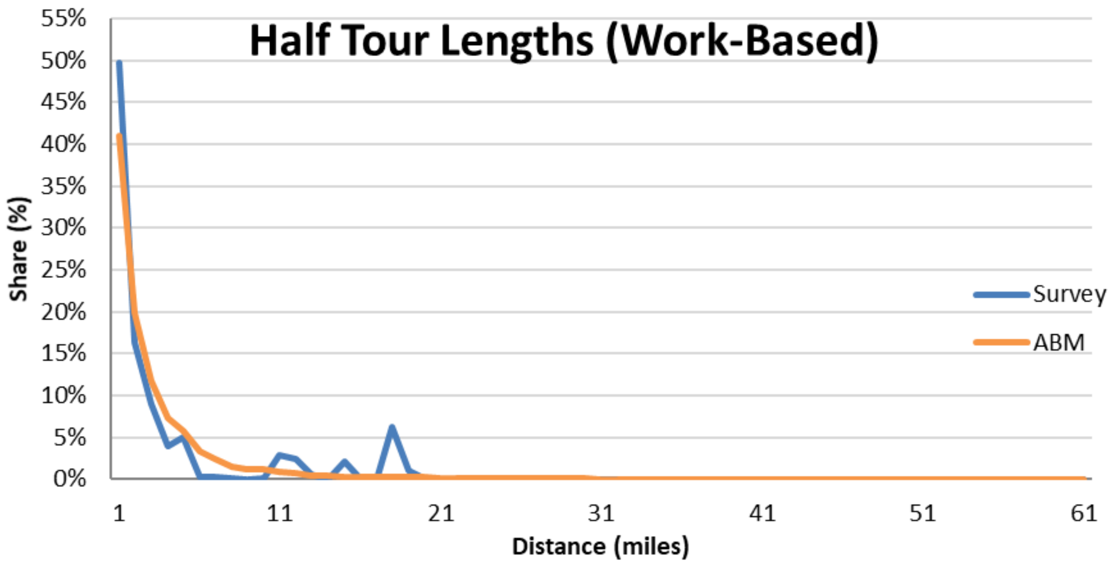



**FIGURE 2-8: TOUR LENGTH FREQUENCY DISTRIBUTION FOR WORK-BASED TRAVEL (SEATAC REGION[20])**

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[19] Survey data from KING COUNTY

[20] Survey data from KING COUNTY

## Tour Mode Choice

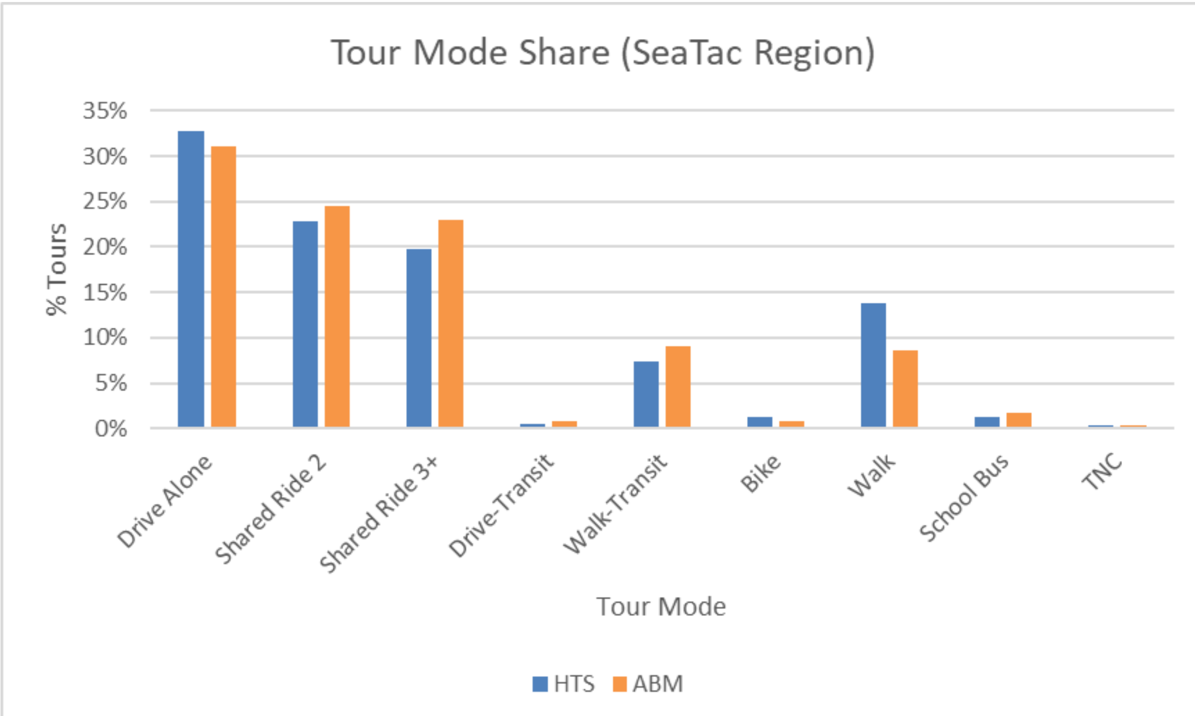
Tour mode is an abstract concept, defined as the main mode of travel used to get from the origin to the primary destination and back. The following 8 tour modes are available in the model: drive alone, shared-ride 2, shared-ride 3+, bike, walk, drive-transit, walk-transit, and school bus. The tour mode is coded in the survey based on a set of rules that are dependent on the combination of trip modes used on the tour. The rules can be summarized as follows:

- Any tour with a transit trip is defined as a transit tour
    - Any transit tour with a PNR-transit trip is defined as a PNR-transit tour
    - Any transit tour with neither a PNR-transit trip or a KNR-transit trip is defined as a walk-transit tour
- Any tour with a bicycle trip is defined as a bicycle tour
- Any tour with an auto trip is defined as an auto tour
    - The highest occupancy mode of all auto trips on the tour is used to set the occupancy of the tour
- Remaining tours are walk tours

A similar set of rules is used in tour mode choice to constrain the availability of trip modes based on tour mode. These rules also influence the accessibilities used to choose the locations of intermediate stops on tours; for example, transit and walk accessibilities are used to choose stop locations on transit tours, rather than auto accessibilities.

Generally, a tour mode choice calibration aims to adjust the mode choice model so that the distribution of tours by mode is similar to observed share. Therefore, tour mode choice adjustments are made to alternative-specific constants to match observed mode shares. The calibration work from similar Pierce County model was used here, where the work and other-home based tour mode choice models were adjusted to match the HTS data in Pierce County. Other purposes (school, escort, and work-based) were not adjusted due to their small sample size in Pierce County.

Figure 2-9 displays comparison of model tour mode shares with the HTS regionwide as well in the SeaTac region (survey data from King County). Regionwide, the tour mode shares in the ABM match the HTS shares reasonably well. In SeaTac region, modes show some differences. These differences are expected as individual tour purposes (Table 2-19, Table 2-20, and Table 2-21) are not calibrated for the SeaTac region. Transit travel in the model is calibrated lower than the HTS to match transit ridership with the observed boardings data.


Tour Mode Share (SeaTac Region)
% Tours
35%
30%
25%
20%
15%
10%
5%
0%
Drive Alone
Shared Ride 2
Shared Ride 3+
Drive-Transit
Walk-Transit
Bike
Walk
School Bus
TNC
Tour Mode
HTS
ABM

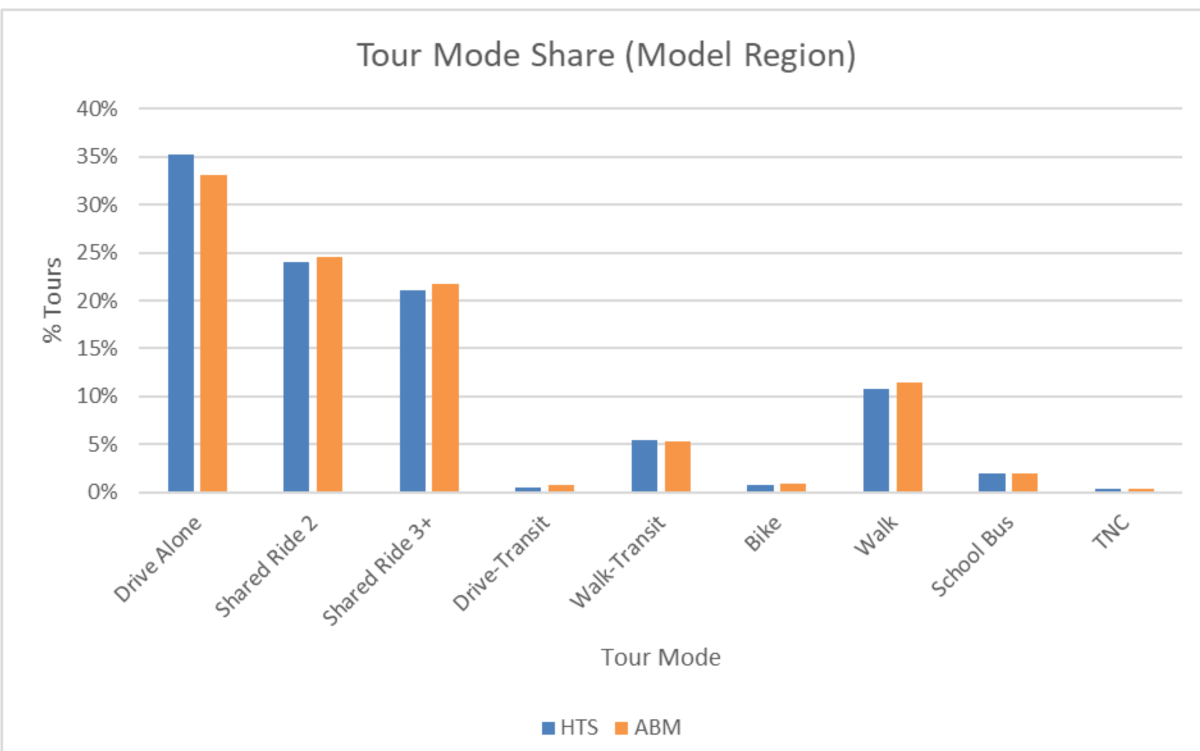

Tour Mode Share (Model Region)
% Tours
40%
35%
30%
25%
20%
15%
10%
5%
0%
Drive Alone
Shared Ride 2
Shared Ride 3+
Drive-Transit
Walk-Transit
Bike
Walk
School Bus
TNC
Tour Mode
HTS
ABM

**FIGURE 2-9: TOUR MODE SHARES (TOTAL) IN SEATAC REGION[21] (TOP) AND MODEL REGION (BOTTOM)**

**TABLE 2-19: TOUR MODE SHARES (HTS, KING COUNTY)**

| MODE | WORK | SCHOOL | ESCORT | OTHER | WORK-BASED | TOTAL |
|---|---|---|---|---|---|---|
| Drive Alone | 53% | 9% | 2% | 30% | 39% | **32.8%** |
| SR2 | 15% | 18% | 47% | 27% | 4% | **22.8%** |
| SR3+ | 11% | 38% | 40% | 20% | 9% | **19.8%** |
| Drive Transit | 2% | 0% | 0% | 0% | 0% | **0.5%** |
| Walk Transit | 13% | 10% | 1% | 5% | 1% | **7.3%** |
| Bike | 2.1% | 0.9% | 0.6% | 1.1% | 0% | **1.3%** |
| Walk | 4% | 9% | 11% | 17% | 46% | **13.8%** |
| School Bus | 0% | 15% | 0% | 0% | 0% | **1.3%** |
| TNC | 1% | 0% | 0% | 0% | 0% | **0.4%** |
| Total | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |

**TABLE 2-20: TOUR MODE SHARES (ABM, SEATAC REGION)**

| MODE | WORK | SCHOOL | ESCORT | OTHER | WORK-BASED | TOTAL |
|---|---|---|---|---|---|---|
| Drive Alone | 53% | 8% | 3% | 29% | 35% | **31.1%** |
| SR2 | 15% | 15% | 45% | 28% | 14% | **24.6%** |
| SR3+ | 10% | 39% | 47% | 23% | 9% | **23.0%** |
| Drive Transit | 3% | 0% | 0% | 0% | 0% | **0.8%** |
| Walk Transit | 16% | 10% | 0% | 8% | 3% | **9.1%** |

[21] Survey data from KING COUNTY

| | | | | | | |
|---|---|---|---|---|---|---|
| Bike | 1.3% | 0.5% | 0.4% | 0.8% | 0% | **0.8%** |
| Walk | 1% | 7% | 5% | 11% | 39% | **8.5%** |
| School Bus | 0% | 20% | 0% | 0% | 0% | **1.8%** |
| TNC | 0% | 0% | 0% | 0% | 0% | **0.3%** |
| Total | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |

**TABLE 2-21: TOUR MODE SHARES (ABM- HTS, SEATAC REGION[22])**

| MODE | WORK | SCHOOL | ESCORT | OTHER | WORK-BASED | TOTAL |
|---|---|---|---|---|---|---|
| Drive Alone | 0.5% | -1.3% | 1.4% | -0.7% | -4.6% | **-1.7%** |
| SR2 | 0.7% | -3.1% | -2.4% | 1.0% | 10.1% | **1.8%** |
| SR3+ | -0.8% | 1.8% | 7.1% | 3.4% | -0.1% | **3.3%** |
| Drive Transit | 1.2% | 0.0% | 0.0% | 0.0% | 0.0% | **0.3%** |
| Walk Transit | 2.6% | -0.2% | -0.6% | 2.4% | 2.4% | **1.8%** |
| Bike | -0.8% | -0.5% | -0.3% | -0.4% | -0.1% | **-0.5%** |
| Walk | -3.3% | -2.1% | -5.2% | -5.6% | -7.7% | **-5.3%** |
| School Bus | 0.0% | 5.2% | 0.0% | 0.0% | 0.0% | **0.4%** |
| TNC | -0.1% | 0.0% | 0.0% | -0.1% | 0.0% | **-0.1%** |
| **Total** | **0.0%** | **0.0%** | **0.0%** | **0.0%** | **0.0%** | **0.0%** |

## Trip Destination

As presented in Table 2-22, the HTS data suggest an average trip length of 5.89 miles regionwide and 5.25 miles for King County. The calibrated model produces similar trip lengths (5.63 miles regionwide and 5.30 miles in SeaTac region). The lengths by trip destination

[22] Survey data from KING COUNTY

purpose match reasonably well too. The calibration did not adjust trip lengths, instead they were guided by adjustments to half tour lengths (Table 2-19, Table 2-20, and Table 2-21).

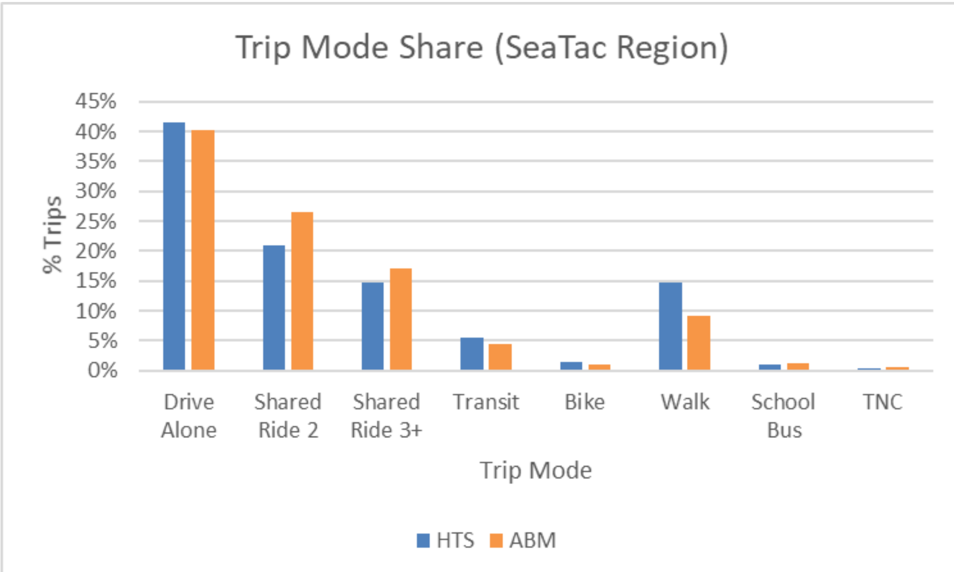
**TABLE 2-22: TRIP LENGTHS (MILES) BY DESTINATION PURPOSE**

| DESTINATION PURPOSE | SEATAC REGION | | | MODEL REGION | | |
|---|---|---|---|---|---|---|
| | HTS | ABM | DIFF | HTS | ABM | DIFF |
| Home | 5.37 | 5.60 | **0.22** | 6.10 | 5.89 | **-0.21** |
| Work | 8.49 | 7.41 | **-1.08** | 9.14 | 8.87 | **-0.27** |
| School | 4.54 | 4.92 | **0.38** | 4.73 | 4.50 | **-0.23** |
| Escort | 4.67 | 3.62 | **-1.05** | 4.84 | 4.09 | **-0.76** |
| Personal Business | 4.28 | 5.15 | **0.87** | 5.39 | 5.19 | **-0.21** |
| Shop | 4.01 | 4.06 | **0.05** | 4.32 | 4.17 | **-0.16** |
| Meal | 3.06 | 4.51 | **1.45** | 4.11 | 4.52 | **0.41** |
| Social/Recreation | 3.90 | 4.63 | **0.73** | 4.94 | 4.51 | **-0.43** |
| **Total** | **5.25** | **5.30** | **0.05** | **5.89** | **5.63** | **-0.26** |

## Trip Mode Choice

Trip mode targets are usually prepared from the HTS data for the model region. The calibration process involves adjustment of alternative-specific constants to match observed trips by trip mode and tour mode within each tour purpose. The trip mode choice model can be thought of as a ‘mode switching’ model, in which the tour mode constrains which modes are available for trips on tours. The trip mode choice was informed by tour mode choice calibration regionwide and no further trip mode choice calibration was performed.

Overall, the trip mode choice model generates a trip mode distribution similar to the HTS (Figure 2-10, Table 2-23, Table 2-24, and Table 2-25) at both regionwide and the SeaTac region. The HTS data indicate that on an average weekday, 41.5% trips of the King County residents are drive alone and 35.6% are shared-ride (SR2 and SR3), approximately 5.5% trips are made by transit, and 16.0% are made by a non-motorized mode (walk or bike). Again, the transit travel was calibrated lower than the HTS to match transit boardings with the observed boarding data.


Trip Mode Share (SeaTac Region)
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
% Trips
Drive Alone
Shared Ride 2
Shared Ride 3+
Transit
Bike
Walk
School Bus
TNC
Trip Mode
HTS
ABM

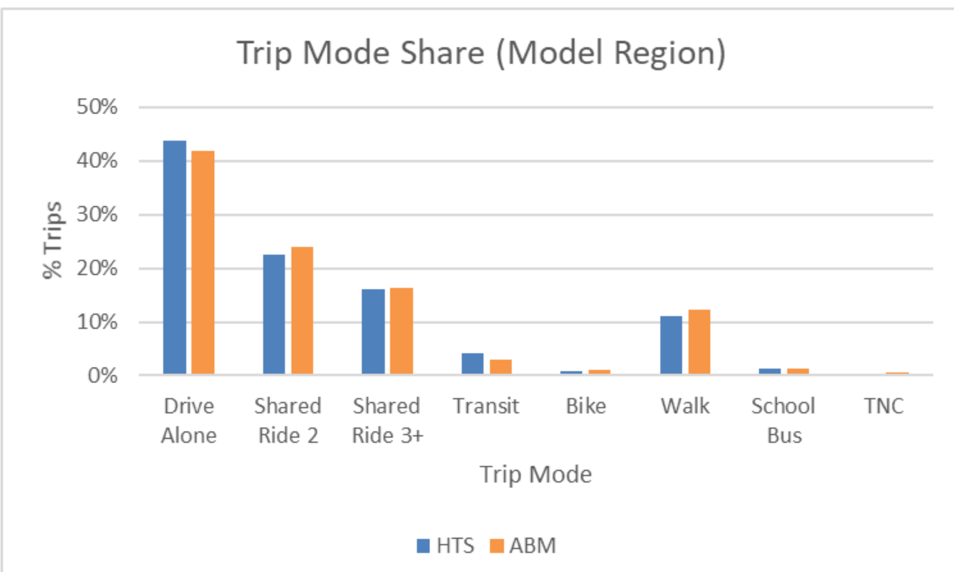

Trip Mode Share (Model Region)
50%
40%
30%
20%
10%
0%
% Trips
Drive Alone
Shared Ride 2
Shared Ride 3+
Transit
Bike
Walk
School Bus
TNC
Trip Mode
HTS
ABM

**FIGURE 2-10: TRIP MODE SHARES (TOTAL) IN SEATAC REGION[23] (TOP) AND MODEL REGION (BOTTOM)**

**TABLE 2-23: TRIP MODE SHARES (HTS, KING COUNTY)**

| MODE | WORK | SCHOOL | ESCORT | OTHER | WORK-BASED | TOTAL |
|---|---|---|---|---|---|---|
| Drive Alone | 63% | 13% | 23% | 35% | 43% | **41.5%** |
| SR2 | 13% | 24% | 36% | 25% | 4% | **20.9%** |
| SR3+ | 5% | 30% | 27% | 17% | 9% | **14.7%** |
| Transit | 9% | 8% | 0% | 4% | 1% | **5.5%** |
| Bike | 2% | 1% | 1% | 1% | 0% | **1.3%** |
| Walk | 7% | 13% | 13% | 17% | 44% | **14.7%** |
| School Bus | 0% | 10% | 0% | 0% | 0% | **0.9%** |
| TNC | 0% | 0% | 0% | 1% | 0% | **0.4%** |
| **Total** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |

**TABLE 2-24: TRIP MODE SHARES (ABM, SEATAC REGION)**

| MODE | WORK | SCHOOL | ESCORT | OTHER | WORK-BASED | TOTAL |
|---|---|---|---|---|---|---|
| Drive Alone | 63% | 10% | 32% | 33% | 32% | **40.2%** |
| SR2 | 18% | 25% | 30% | 32% | 14% | **26.4%** |
| SR3+ | 6% | 36% | 28% | 19% | 8% | **17.2%** |
| Transit | 8% | 5% | 0% | 3% | 2% | **4.4%** |
| Bike | 1% | 1% | 1% | 1% | 0% | **0.9%** |
| Walk | 3% | 10% | 9% | 11% | 34% | **9.2%** |
| School Bus | 0% | 14% | 0% | 0% | 0% | **1.1%** |

[23] Survey data from KING COUNTY

| MODE | WORK | SCHOOL | ESCORT | OTHER | WORK-BASED | TOTAL |
|---|---|---|---|---|---|---|
| TNC | 0% | 0% | 0% | 0% | 10% | **0.5%** |
| **Total** | **100%** | **100%** | **100%** | **100%** | **100%** | **100%** |

**TABLE 2-25: TRIP MODE SHARES (ABM- HTS, SEATAC REGION[24])**

| MODE | WORK | SCHOOL | ESCORT | OTHER | WORK-BASED | TOTAL |
|---|---|---|---|---|---|---|
| Drive Alone | 0.0% | -3.5% | 8.8% | -1.9% | -10.5% | **-1.3%** |
| SR2 | 5.0% | 0.7% | -6.1% | 7.4% | 10.1% | **5.6%** |
| SR3+ | 1.3% | 6.2% | 1.0% | 2.0% | -0.3% | **2.4%** |
| Transit | -1.3% | -3.9% | -0.4% | -0.6% | 1.5% | **-1.1%** |
| Bike | -0.7% | 0.0% | 0.5% | -0.5% | 0.0% | **-0.4%** |
| Walk | -4.0% | -2.7% | -3.9% | -6.1% | -10.1% | **-5.5%** |
| School Bus | 0.0% | 3.2% | 0.0% | 0.0% | 0.0% | **0.2%** |
| TNC | -0.2% | -0.1% | 0.0% | -0.4% | 9.4% | **0.1%** |
| **Total** | **0.0%** | **0.0%** | **0.0%** | **0.0%** | **0.0%** | **0.0%** |

## 2.3 SUMMARY

The SeaCast model is a city of SeaTac specific implementation of PSRC’s SoundCast model. The model calibration used the re-weighted 2017/2019 household travel survey as the primary datasets for observed travel behavior. Due to small HTS samples in the SeaTac region, the calibration was largely performed at the regionwide level. However, due to its importance the work location choice model was calibrated for the SeaTac region using HTS data for King County. This was done by adding and adjusting SeaTac specific constants to the model. In addition, the calibration utilized the work performed in the development of the PierceCast[25]

[24] Survey data from KING COUNTY
[25] Activity-based travel model of Pierce County

model by using Pierce County specific adjustments work location, work tour mode, and other tour mode models.

Generally, the calibrated SeaCast model compares well with the HTS data. The calibration summaries at the regional level are either similar to the SoundCast model performance or better. The summaries at the SeaTac level are also better, especially for work location and tour mode choice.

There are a few areas that still need improvement and shall be addressed in future model development tasks:

- **Travel Survey**: The 2017/2019 HTS did not have enough samples for SeaTac region and therefore, limited consultant's ability to use the data in adjusting the model for local conditions (in city of SeaTac). A new travel survey with a bigger sample size in SeaTac region could be used to estimate and calibrate the AB model for city of SeaTac conditions and therefore, improve the model's performance to forecast traffic in the region.

# 3.0 MODEL VALIDATION

A model validation tests the model's predictive capabilities before it is used to produce forecasts. There are two types of model validation; static validation, which compares model outputs against independent data that was not used to build the travel model, and dynamic validation, in which model inputs are systematically varied to assess the reasonableness of model responses. The static validation process compares outputs from model assignment with observed data. Model parameters are adjusted until the model outputs fall within an acceptable range of error.

In the assignment step, model demand (e.g., trips by time period, mode, and vehicle class\value-of-time) are loaded on to network. In highway assignment, the output includes vehicle flows on every link (road) in the highway network and for transit assignment, the output includes the number of boardings on each route. These are compared to observed traffic counts and observed transit ridership respectively. The next section describes the guidelines used in the model validation. The two observed datasets (traffic counts and transit boardings) used in the present model validation are described in the next section, followed by highway and transit validation summaries. Finally, a summary presents key takeaways from the analysis.

## 3.1 VALIDATION MEASURES

The SeaCast model is validated using the statistics measures described in the following two reports: National Cooperative Highway Research Program (NCHRP) 765 and Federal Highway Administration Travel Model Validation and Reasonability Checking Manual (Second Edition), Cambridge Systematics, Inc. 2010. Note that these reports generally do not recommend minimum or acceptable thresholds for the validation measures. The following measures are used in comparing SeaCast model flows with observed counts.

**Volume-to-Count Ratio and Percent Error (% diff):** The volume-to-count ratio is computed by dividing the volume assigned by the model (Flow [y]) by the actual traffic count (Observed [x]) for individual road segments across the model. This value provides a general context for the relationship (i.e., high or low) between the model estimated volumes and actual (observed) traffic counts. The percentage error (% diff) is calculated as the ratio of (modeled – observed) and observed.

**Correlation Coefficient or Coefficient of Determination ($R^2$):** The correlation coefficient (Pearson's product-moment correlation coefficient [R])—measured -1.0 to 1.0—estimates the correlation, or the strength and direction of the linear relationship, between the actual/observed counts and the estimated/predicted traffic volumes from the model. The coefficient of determination ($R^2$) is simply the square of R and is assumed to be a measure of the amount of variation in traffic counts explained by the model. Achieving a regional $R^2$ of 0.88 is typically suggested as a “standard” for determining model’s validity.

**Percent Root Mean Square Error (% RMSE):** Percent Root Mean Square Error (% RMSE) is the square root of the squared actual observed count minus the model’s estimated (predicted) volume, divided by the number of counts. It is measured in a manner like Standard Deviation in that it assesses the assignment accuracy of the entire model. Lower percentages indicate better goodness-of-fit. The % RMSE is one of the most frequent methods of comparing different models to each other. Figure 3-1 outlines % RMSE calculations.

$$\text{RMSE} = \sqrt{\frac{\sum_{i=1}^{N}\left[(\text{Count}_i - \text{Model}_i)^2\right]}{N}}$$

and

$$\%\text{RMSE} = \frac{\text{RMSE}}{\left(\frac{\sum_{i=1}^{N}\text{Count}_i}{N}\right)} \times 100$$

Where:

$\text{Count}_i$ = The observed traffic count for link *i*;

$\text{Model}_i$ = The modeled traffic volume for link *i*; and

N = The number of links[33] in the group of links including link *i*.

**FIGURE 3-1: % RMSE FORMULAE**

## 3.2 VALIDATION DATA

The validation data for the SeaCast model is stored in a SQLite database, easily accessible to the model. The model, after reaching convergence, summarizes observed validation data and model data, and generates a validation report. The model was updated to report summaries for regionwide as well as for the SeaTac region – see **Error! Reference source not found.** in 4.2Appendix A. The SeaTac summaries from the validation report are primarily used to assess the performance of the model in predicting travel behavior within the city of SeaTac. Table 3-1 presents a list of datasets utilized in the validation of the SeaCast model.

**TABLE 3-1: MODEL VALIDATION DATASETS**

| DATASET | DATABASE NAME | YEAR | SOURCE | PURPOSE |
|---|---|---|---|---|
| Daily Traffic Counts | daily_counts | 2018 | PSRC and SeaTac | Highway Validation |
| Hourly Traffic Counts | hourly_counts | 2018 | PSRC and SeaTac | Highway Validation |

| DATASET | DATABASE NAME | YEAR | SOURCE | PURPOSE |
|---|---|---|---|---|
| Screenline Traffic Counts | observed_screenline_volumes | 2018 | PSRC and SeaTac | Highway Validation |
| External Traffic Counts | observed_external_volumes | 2018 | PSRC | Highway Validation |
| Transit Ridership | observed_transit_boardings | 2018 | PSRC | Transit Validation |

## Highway

Observed traffic counts are used to validate link-level estimated daily traffic flow generated by the model. A crow's-foot diagram detailing the daily and hourly count datasets and their relation to network link data is shown in Figure 3-2, and the development of these two datasets is briefly described in the next subsections.

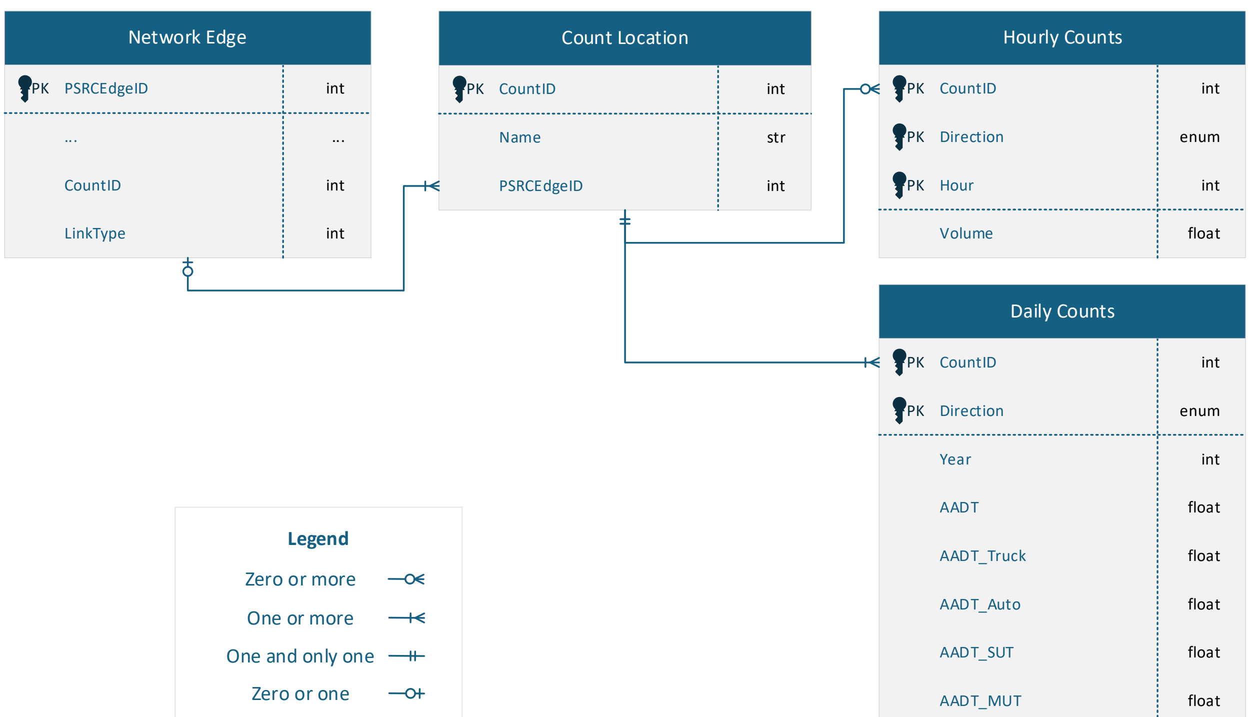



**FIGURE 3-2: COUNT DATA MODEL**

### *Daily Traffic Counts*

The observed traffic counts are assembled from three sources: PSRC, the SEA Airport, and the city of SeaTac. PSRC provided a database that included daily traffic counts on highways (interstates and state routes) in the model region outside the city of SeaTac. SeaTac provided link level traffic counts for highway links[26] (arterial, freeway, collector, and ramp) as well as intersection turning movement counts within the city of SeaTac.

As the count data formats varied not only across the three sources but also within individual sources' datasets, the count data was reformatted to a flat table indicating counts stratified by vehicle class. The dataset was filtered to remove records that met any of these conditions:

- Less than 24 hours of count records are available,
- Four or more hours of count records have zero volume, or
- Bidirectional count pairs have a percent difference ≥ 50%

As needed, the filtered counts were averaged over each study period, aggregated by day, and factored according to the facility type, month, and weekday-vs.-weekend in which the counts were collected to establish AADT counts. The resulting validation dataset contains, for each count location, AADT values for all vehicles and, optionally, auto-vs.-truck AADTs and truck AADTs stratified by size (SUT vs. MUT). The dataset was then compacted by selecting the AADT record for the year closest to the model year. Finally, a smaller validation dataset was created which includes only those count records collected within the SeaTac subarea.

### *Hourly Traffic Counts*

Similar to daily traffic counts, the hourly observed traffic counts were developed using data provided by PSRC, the city, and the airport for the model region. The links for which the hourly traffic counts are available is a subset of links for which daily counts are also available, as some count locations provided AADT values directly. For each dataset with hourly (or better) precision, 24-hour density distributions were generated from all-vehicle counts (i.e., not stratified by vehicle class).

These hourly proportions were then multiplied by the count locations' (unstratified) daily AADT values to provide hourly count distributions for each location, where the hourly counts sum to the AADT value in the daily dataset. These distributions then are used as ground truth in evaluating model departure time validation.

### *Screenline Volumes*

SeaTac provided traffic volumes on screenlines which are combined with the screenline volume dataset provided by PSRC. Links with daily counts which cross the screenlines are tagged with an identifying LinkType field which corresponds to the screenline ID. The AADTs of the tagged links are aggregated by LinkType to use as a control in assignment model validation.

[26] Some locations were collected during the project and were processed and factored to represent 2018 conditions.

### *External Volumes*

PSRC provided traffic counts on 17 external locations. These are external locations to the model region and not the SeaTac region. The modeled volumes are aggregated and compared with the traffic counts at these locations for validating the model.

## Transit

Transit ridership (boardings) by route compare the estimated boardings in the model by transit line.

### *Transit Boardings*

The observed transit boardings are provided by PSRC and were included in the sqlite database. The seven transit agencies provided daily ridership in year 2018 for their transit routes.

# 3.3 HIGHWAY VALIDATION

The estimated traffic flows from the model and the observed traffic counts are compared in various dimensions, including:

- Region
- Facility Type
- Volume Group
- Time Period
- Screenline
- External

## Region

The observed daily traffic count database used in this model validation effort encompasses 6,820 links on the highway network in the model region and 410 links in the city of SeaTac. The total traffic across the links in the SeaTac regionsums up to 3.53 million vehicles, Table 3-2. On the same links, the model produces a comparable estimate of traffic volume (3.48 million vehicles) and is only 1.46% lower than the total observed vehicle count. The model produces slightly lower estimate of traffic volume (-1.99%) regionwide.

**TABLE 3-2: HIGHWAY VALIDATION**

| REGION | OBSERVED | MODELED | DIFF | % DIFF |
|---|---|---|---|---|
| SeaTac | 3,527,678 | 3,476,035 | -51,643 | -1.46% |

| | | | | |
|---|---|---|---|---|
| Regionwide | 61,568,019 | 60,345,199 | -1,222,820 | -1.99% |

Regionally, the estimated traffic flows are compared with the observed traffic counts by creating a scatter plot, Figure 3-3 for the SeaTac region and Figure 3-4 for the model region. Points in the scatter plot are locations where traffic counts are available. A point represents observed traffic count on the X-axis and the corresponding estimated flow on the Y-axis.

The plot includes a 45-degree line representing a virtual scenario of perfect match between traffic counts and estimated flows. The 45-degree line is useful in quickly identifying overestimation (flow>count) or underestimation (flow<count) of a flow. Highway validation aims to make most points as close to this line as possible. An ideal validation would have all count locations on the 45-degree line. However, a perfect match for all count locations is almost impossible to achieve due to various reasons such as errors in traffic counts, simulation errors in the model etc. The plot also displays an R-squared value representing goodness of fit of all data points.

```
City of SeaTac r^2: 0.9697063664957206
```

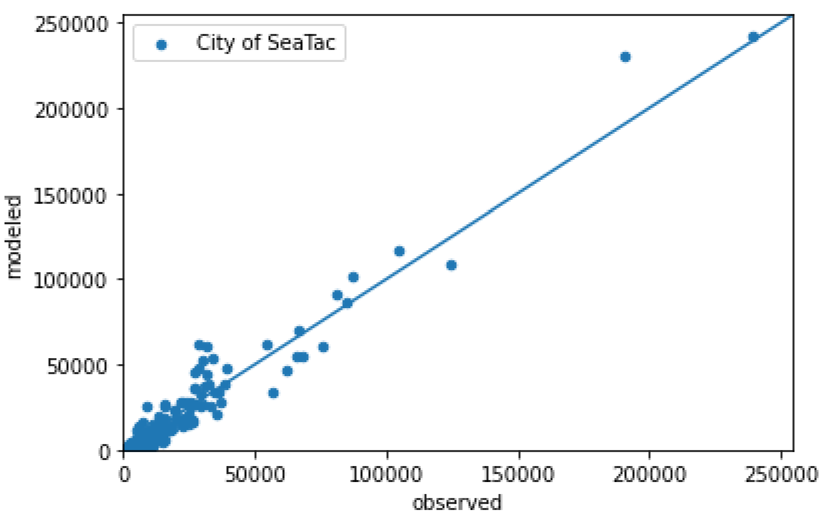
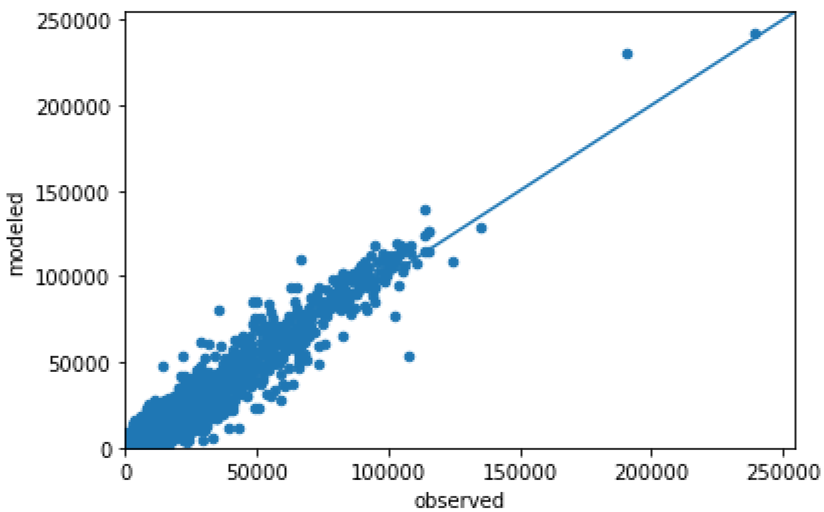


**FIGURE 3-3: DAILY ESTIMATED FLOWS VS OBSERVED TRAFFIC COUNTS (SEATAC REGION)**




```
r^2: 0.9636270205021839
```

**FIGURE 3-4: DAILY ESTIMATED FLOWS VS OBSERVED TRAFFIC COUNTS (REGIONWIDE)**

As displayed in the scatter plots, the R-squared value of 0.970 for the traffic count locations in City of SeaTac and 0.964 for the locations in the entire model region indicates excellent fit. A value of 1 for R-squared is considered a perfect fit.

## Facility Type

Table 3-3 (SeaTac) and Table 3-4 (model region) present a summary of links by facility type. The facilities in the model network are grouped into four types – Freeway, Arterial, Collector, and Ramp. Overall, the estimated traffic volume from the model matches closely (-1.46% for SeaTac and -1.99% for model region) with the total counts on the compared links. The comparison within the freeway and arterial facility type exhibits a good match as well. The lower volume facilities, including collector, and ramps, show underestimation. This is usually due to a lower quality of traffic counts compared to the higher volume facilities.

**TABLE 3-3: HIGHWAY VALIDATION – FACILITY TYPE (SEATAC)**

| FACILITY TYPE | OBSERVED | MODELED | DIFF | % DIFF |
|---|---|---|---|---|
| Freeway | 1,588,271 | 1,639,327 | 51,056 | 3.21% |
| Arterial | 1,526,685 | 1,525,353 | -1,332 | -0.09% |
| Collector | 310,457 | 247,486 | -62,971 | -20.28% |

| | | | | |
|---|---|---|---|---|
| Ramp | 102,265 | 63,869 | -38,396 | -37.55% |
| Total | **3,527,678** | **3,476,035** | **-51,643** | **-1.46%** |

**TABLE 3-4: HIGHWAY VALIDATION - FACILITY TYPE (REGIONWIDE)**

| FACILITY TYPE | OBSERVED | MODELED | DIFF | % DIFF |
|---|---|---|---|---|
| Freeway | 28,691,420 | 30,445,374 | 1,753,954 | 6.11% |
| Arterial | 27,316,992 | 25,299,322 | -2,017,670 | -7.39% |
| Collector | 4,700,740 | 3,881,976 | -818,764 | -17.42% |
| Ramp | 858,867 | 718,527 | -140,340 | -16.34% |
| **Total** | **61,568,019** | **60,345,199** | **-1,222,820** | **-1.99%** |

Figure 3-5 and Figure 3-6 show scatter plots of observed traffic counts against model estimated flow by facility type (freeway and arterial) for the locations in the SeaTac region and the model region respectively.

As displayed in the scatter plot, the R-squared value of 0.98 (freeway) and 0.821 (arterial) for traffic count locations within SeaTac and 0.944 (freeway) and 0.842 (arterial) for traffic count locations over the entire model region indicates good fit.

```
r^2 Freeway: 0.9803002573933143
r^2 Arterial: 0.8209681542976124
```

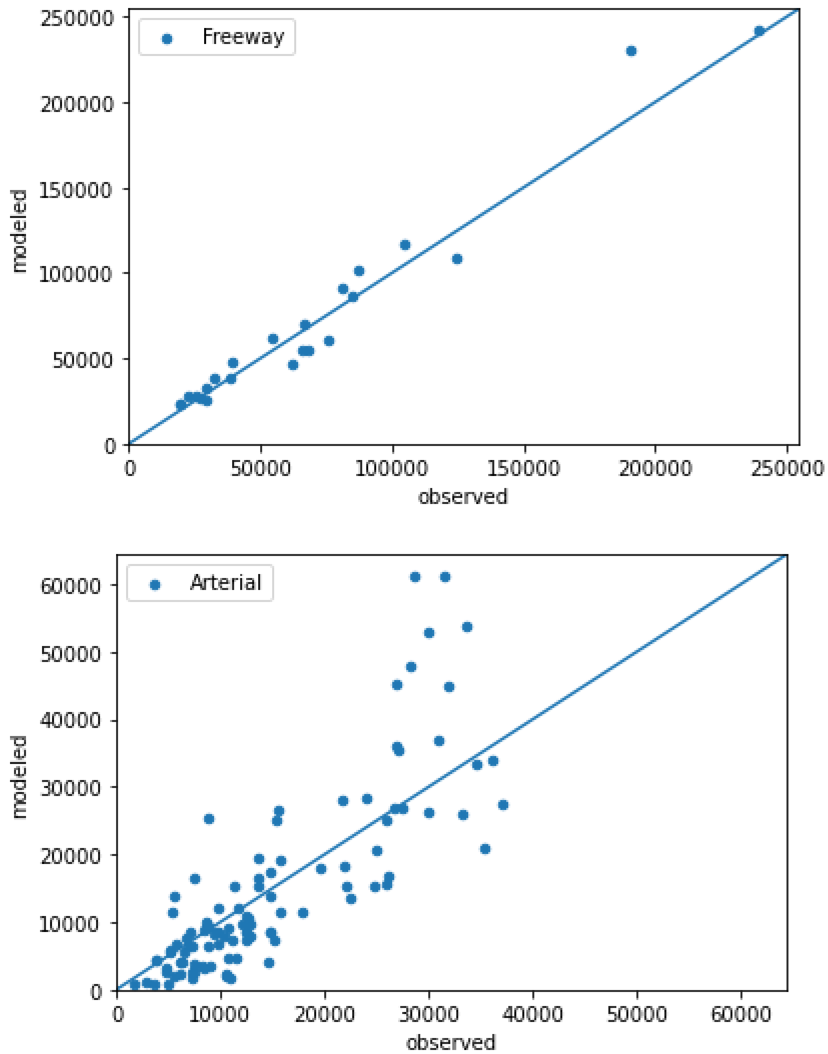



**FIGURE 3-5: DAILY ESTIMATED FLOWS VS OBSERVED TRAFFIC COUNTS BY FACILITY TYPE (SEATAC)**

```
r^2 Freeway: 0.9438234279389318
r^2 Arterial: 0.841832792393569
```

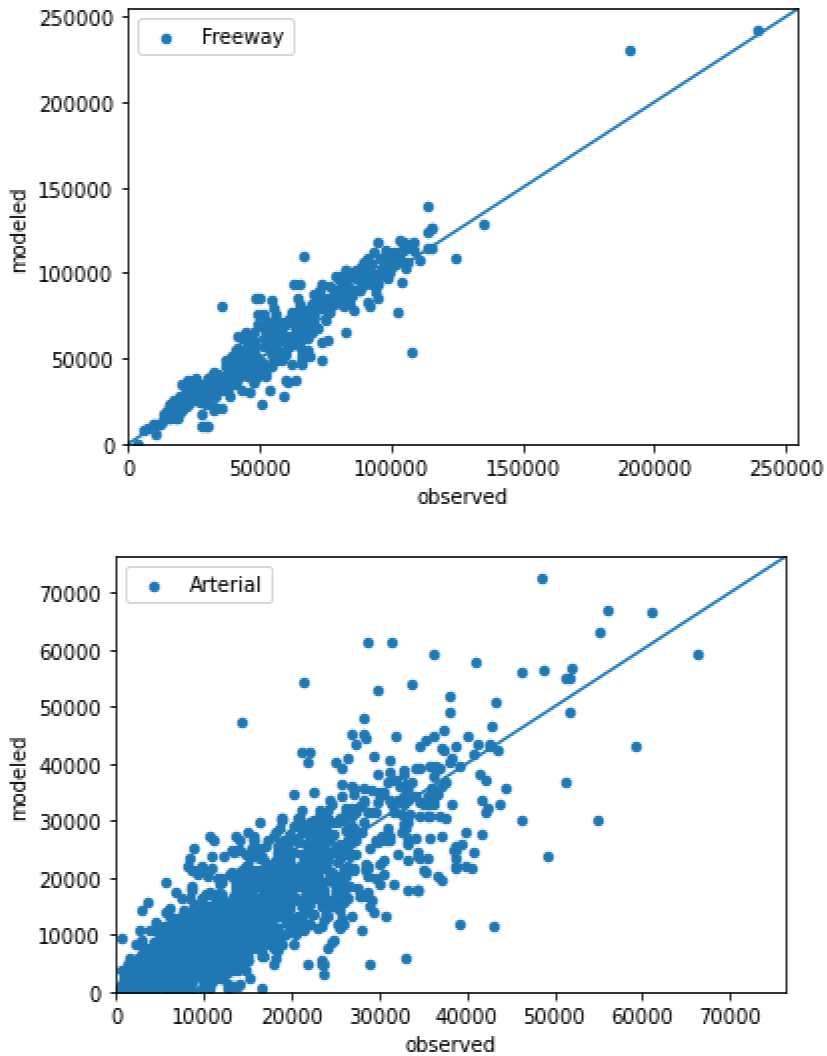



**FIGURE 3-6: DAILY ESTIMATED FLOWS VS OBSERVED TRAFFIC COUNTS BY FACILITY TYPE (REGIONWIDE)**

## Volume Group

Table 3-5 presents a comparison of model flows with observed traffic counts by volume groups in the SeaTac region. The comparison summarizes percent gap (% Diff) and percent root mean squared error[27] (% RMSE) for each volume group. Since the primary focus is SeaTac, the regional summaries are not included.

Largely, the volume groups show good match with observed counts with %RMSE at SeaTac level at about 41%. As expected, the %RMSE value is generally higher for lower volume groups.

**TABLE 3-5: HIGHWAY VALIDATION – VOLUME GROUP (SEATAC)**

| VOLUME | GROUP | # | OBSERVED | MODELED | DIFF | % DIFF | % RMSE |
|---|---|---|---|---|---|---|---|
| >=0 | <10000 | 109 | 697,130 | 472,599 | -224,531 | -32.21% | 53.45% |
| >=10000 | <25000 | 36 | 591,893 | 541,653 | -50,240 | -8.49% | 34.59% |
| >=25000 | <50000 | 29 | 871,781 | 950,797 | 79,017 | 9.06% | 32.92% |
| >=50000 | <100000 | 11 | 621,086 | 708,976 | 87,890 | 14.15% | 33.62% |
| >=100000 | | 5 | 745,789 | 802,011 | 56,221 | 7.54% | 16.02% |
| **Total** | | **190** | **3,527,678** | **3,476,035** | **-51,643** | **-1.46%** | **41.14%** |

## Time Period

Diurnal performance of the model is compared in the 12 model time periods: 4 AM periods (5am-6am, 6am-7am, 7am-8am, 8am-9am), 3 MD periods (9am-10am, 10am-2pm, 2pm-3pm), 3 PM periods (3pm-4pm, 4pm-5pm, 5pm-6pm), 1 EV period (6pm-8pm), and 1 NI period (8pm-5am). The period traffic counts are prepared from hourly traffic counts by aggregating across these 12 time periods before using it for validation.

The estimated traffic flows are compared with the observed traffic counts by creating a scatter plot, Figure 3-7 for SeaTac and Figure 3-8 for the model region. A point represents observed traffic counts for one of the 12 time periods on the X-axis and the corresponding estimated flow on the Y-axis.

An R-squared value of 0.921 for the traffic count on location within SeaTac limits suggests a reasonable fit. The regionwide R-squared value (0.940) is slightly better.

[27] Source: FHWA Travel Model Validation and Reasonability Checking Manual Second Edition, Cambridge Systematics 2010 (Page 9-8)

r^2: 0.9205145072886957

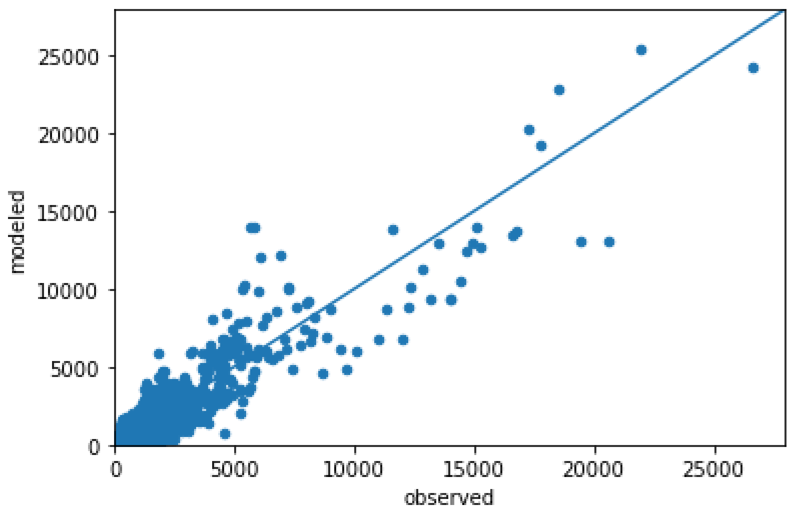



**FIGURE 3-7: TIME PERIOD ESTIMATED FLOWS VS OBSERVED TRAFFIC COUNTS (SEATAC)**

r^2: 0.9393275029216216

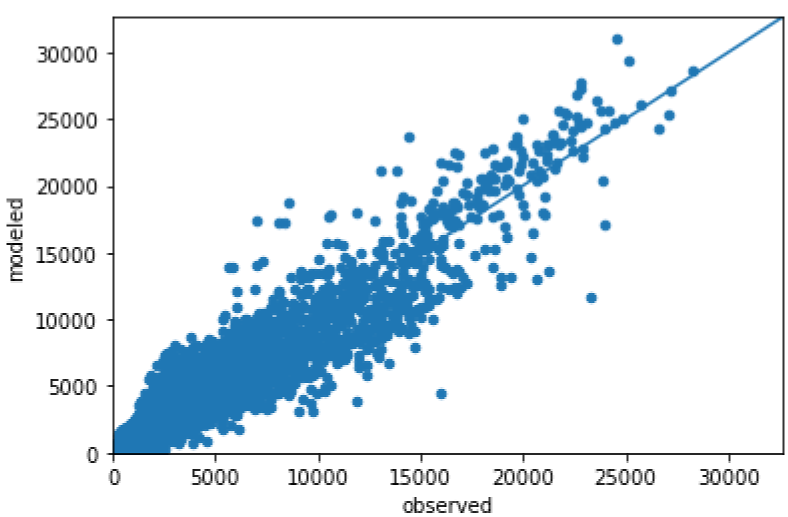



**FIGURE 3-8: TIME PERIOD ESTIMATED FLOWS VS OBSERVED TRAFFIC COUNTS (REGIONWIDE)**

## Screenlines

A total of 13 screenlines in SeaTac are compared for validating estimated traffic flows with the observed traffic counts, Figure 3-9. The estimated model flows (1.34 million vehicles) across these screenlines is only 3.28% lower than the total observed traffic count (1.39 million vehicles), Table 3-6. The model flows on eight screenlines are within 10% and 3 screenlines within 20% of the respective observed counts. The validation investigated the remaining two screenlines N of S 160th St (-22.06%), and W of Des Moines Mem'l N of 176th (-44.06%) for traffic counts and network attributes but did not find any obvious issues. The future work should look at these screenlines in more detail.

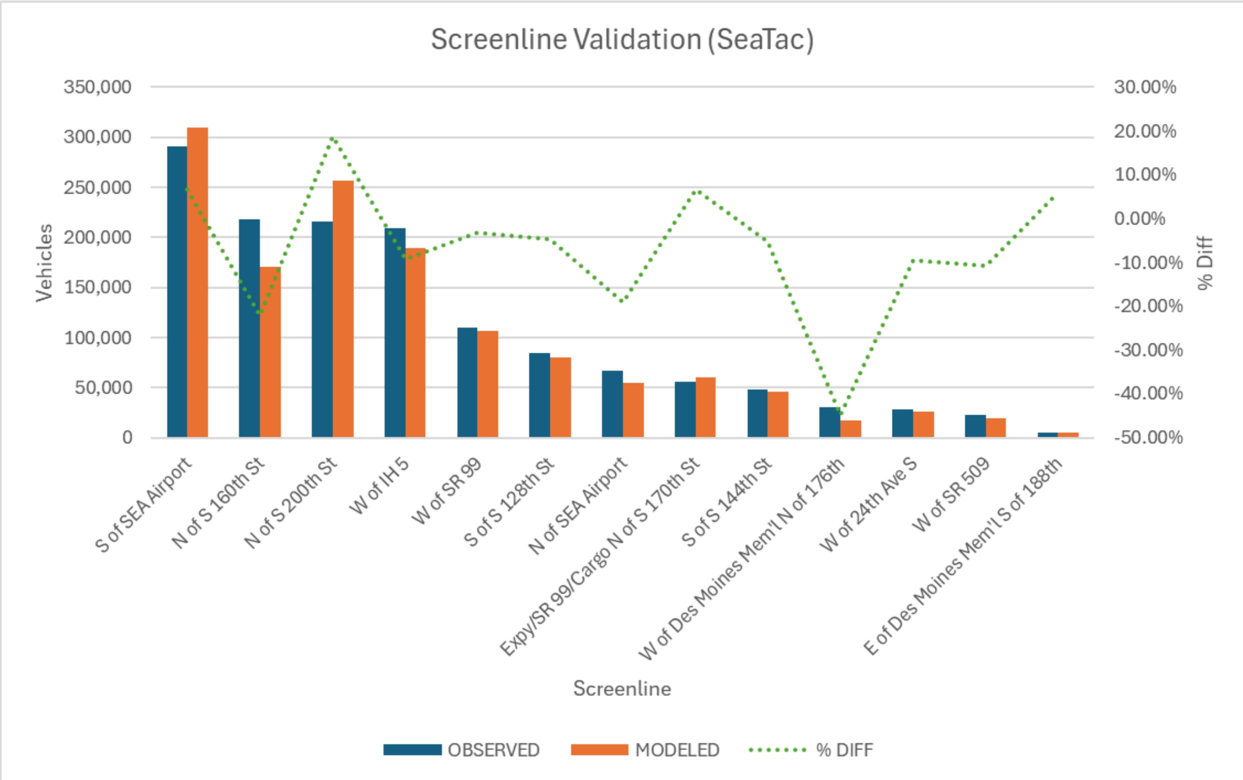



**FIGURE 3-9: SCREENLINE VALIDATION (SEATAC)**

**TABLE 3-6: OBSERVED SCREENLINE VOLUMES AND ESTIMATE FLOWS (SEATAC)**

| SCREENLINE | OBSERVED | MODELED | DIFF | % DIFF |
|---|---|---|---|---|
| S of SEA Airport | 290,943 | 309,935 | 18,992 | **6.53%** |
| N of S 160th St | 218,251 | 170,094 | -48,157 | **-22.06%** |
| N of S 200th St | 216,377 | 257,054 | 40,677 | **18.80%** |
| W of IH 5 | 208,727 | 189,339 | -19,388 | **-9.29%** |
| W of SR 99 | 109,861 | 106,310 | -3,551 | **-3.23%** |
| S of S 128th St | 84,474 | 80,553 | -3,921 | **-4.64%** |

| SCREENLINE | OBSERVED | MODELED | DIFF | % DIFF |
|---|---|---|---|---|
| N of SEA Airport | 66,919 | 54,216 | -12,703 | **-18.98%** |
| Expy/SR 99/Cargo N of S 170th St | 56,245 | 59,933 | 3,688 | **6.56%** |
| S of S 144th St | 48,532 | 45,946 | -2,586 | **-5.33%** |
| W of Des Moines Mem'l N of 176th | 30,790 | 17,008 | -13,782 | **-44.76%** |
| W of 24th Ave S | 28,231 | 25,515 | -2,716 | **-9.62%** |
| W of SR 509 | 22,232 | 19,862 | -2,370 | **-10.66%** |
| E of Des Moines Mem'l S of 188th | 5,136 | 5,441 | 305 | **5.94%** |
| **Total** | **1,386,718** | **1,341,207** | **-45,511** | **-3.28%** |

## External

There are a total of 17 external locations in the model where the model flows are compared with observed external volumes for validating the model. Overall, the model underestimates the observed external volumes by 11.04%, Table 3-7. The issue of underestimation at external locations has been observed in the SoundCast model as well. The model validation did not take any action to improve external validations as it would have required updating the external flow component. The future work should look at external flows in more detail to improve these validations.

**TABLE 3-7: OBSERVED EXTERNAL VOLUMES AND MODELED EXTERNAL FLOWS**

| EXTERNAL LOCATION | COUNTY | OBSERVED | MODELED | DIFF | % DIFF |
|---|---|---|---|---|---|
| I-5 to Olympia | Pierce | 130,000 | 124,301 | -5,699 | **-4.38%** |
| SR-507 to Yelm | Pierce | 23,000 | 24,104 | 1,104 | **4.80%** |
| SR-7 to Morton | Pierce | 2,700 | 1,992 | -708 | **-26.24%** |
| SR-706 to Longmire | Pierce | 1,800 | 1,790 | -10 | **-0.54%** |

| EXTERNAL LOCATION | COUNTY | OBSERVED | MODELED | DIFF | % DIFF |
|---|---|---|---|---|---|
| SR-123 S/O Cayuse Pass | Pierce | 1,100 | 524 | -576 | **-52.38%** |
| SR 410 E/O Cayuse Pass | Pierce | 960 | 525 | -435 | **-45.32%** |
| SR-302 to Shelton | Pierce | 4,100 | 3,954 | -146 | **-3.55%** |
| I-90 @ Snoqualmie Pass | King | 33,000 | 27,398 | -5,602 | **-16.98%** |
| SR-2 @ Stevens Pass | King | 5,600 | 2,908 | -2,692 | **-48.07%** |
| Hood Canal Bridge | Kitsap | 18,000 | 15,737 | -2,263 | **-12.57%** |
| SR-3 to Belfair | Kitsap | 18,000 | 15,103 | -2,897 | **-16.09%** |
| SR-530 N/O Darrington | Snohomish | 1,600 | 1,086 | -514 | **-32.12%** |
| SR-9 N/O Arlington | Snohomish | 1,400 | 1,788 | 388 | **27.70%** |
| I-5 to Mount Vernon | Snohomish | 67,000 | 54,401 | -12,599 | **-18.80%** |
| SR-530 N/O Stanwood | Snohomish | 9,100 | 7,967 | -1,133 | **-12.45%** |
| SR-532 to Camano Island | Snohomish | 23,000 | 19,163 | -3,837 | **-16.68%** |
| Mukilteo-Clinton Ferry | Snohomish | 6,300 | 5,644 | -656 | **-10.42%** |
| **Total** | | **346,660** | **308,384** | **-38,276** | **-11.04%** |

## 3.4 TRANSIT VALIDATION

Transit ridership produced by the model is compared against the observed ridership. The ridership (boarding) is compared regionally as well by transit agency and transit line.

### Region

Regionally, Table 3-8, the model generates only 3% more transit boardings than the observed data. The slight regional overestimation is to improve transit validation in SeaTac, especially the Sound Transit and King County Metro system, see comparison by Transit Agency in the next subsection.

**TABLE 3-8: TRANSIT BOARDINGS – REGIONAL**

| REGION | OBSERVED | MODELED | DIFF | % DIFF |
|---|---|---|---|---|
| REGION | 628,185 | 649,635 | 21,451 | 3.41% |

## Transit Agency

A comparison of ridership by transit agency examines the model's ability of producing transit boardings by transit agencies. As presented in Table 3-9, the transit ridership estimated for the transit agencies operating within city of SeaTac i.e. Sound Transit and King County Metro, is within 1% of the observed transit boarding.

**TABLE 3-9: OBSERVED TRANSIT BOARDINGS AND MODELED TRANSIT BOARDINGS BY TRANSIT AGENCY**

| TRANSIT AGENCY | OBSERVED | MODELED | DIFF | %DIFF |
|---|---|---|---|---|
| King County Metro | 392,694 | 370,301 | -22,393 | -5.70% |
| Sound Transit | 148,468 | 170,877 | 22,409 | 15.09% |
| ***Sub Total*** | ***541,162*** | ***541,178*** | ***16*** | ***0.00%*** |
| Community Transit | 30,918 | 39,994 | 9,075 | 29.35% |
| Pierce Transit | 27,233 | 34,493 | 7,260 | 26.66% |
| Washington Ferries | 16,912 | 12,650 | -4,262 | -25.20% |
| Kitsap Transit | 8,669 | 18,835 | 10,166 | 117.26% |
| Everett Transit | 3,290 | 2,486 | -804 | -24.44% |
| **TOTAL** | **628,185** | **649,635** | **21,451** | **3.41%** |

## Transit Route

The boardings on transit system serving the city of SeaTac and the Seattle Airport were further validated at the route level, Table 3-10. The Link light rail to/from Airport, which has the largest observed transit boardings (69,383), is within 8% of the observed boardings. The other routes show bigger differences, which is difficult to improve due to comparatively small ridership and absence of a detailed transit onboard survey.

**TABLE 3-10: OBSERVED AND MODELED TRANSIT BOARDINGS BY TRANSIT ROUTE BY ROUTES SERVING SEATTLE AND SEATTLE AIRPORT**

| TRANSIT AGENCY | TRANSIT ROUTE *(ROUTE NO. DESCRIPTION)* | OBSERVED | MODELED | DIFF | % DIFF |
|---|---|---|---|---|---|
| Sound Transit | LINK: SeaTac - Downt | 69,383 | 74,822 | 5,439 | 7.84% |

| TRANSIT AGENCY | TRANSIT ROUTE *(ROUTE NO. DESCRIPTION)* | OBSERVED | MODELED | DIFF | % DIFF |
|---|---|---|---|---|---|
| Sound Transit | 574 Lakewood - Seattle | 1,768 | 2,279 | 512 | 28.96% |
| Sound Transit | 560 Bellevue - Sea-T | 1,681 | 3,303 | 1,622 | 96.48% |
| King County Metro | 180 Auburn Station - | 3,911 | 6,485 | 2,574 | 65.82% |
| King County Metro | 156 Southcenter - Se | 1,027 | 1,254 | 227 | 22.09% |
| ***Seattle Airport*** | ***Subtotal*** | ***77,770*** | ***88,144*** | ***10,374*** | ***13.34%*** |
| Sound Transit | 590 Tacoma - Seattle | 2,656 | 3,997 | 1,341 | 50.49% |
| Sound Transit | 577 Federal Way - Se | 1,916 | 1,602 | -314 | -16.37% |
| Sound Transit | 594 Lakewood - Seattle | 1,828 | 4,008 | 2,180 | 119.30% |
| Sound Transit | 578 Puyallup - Seattle | 1,686 | 4,172 | 2,486 | 147.38% |
| Sound Transit | 592 Olympia/DuPont - | 702 | 1,220 | 519 | 73.88% |
| Sound Transit | 586 Tacoma - U. Dist. | 472 | 58 | -414 | -87.76% |
| King County Metro | Federal Way TC - Sea | 8,522 | 8,637 | 115 | 1.35% |
| King County Metro | Burien TC - Tukwila | 5,267 | 6,831 | 1,564 | 29.70% |
| King County Metro | 124 Tukwila International | 3,727 | 4,099 | 372 | 9.98% |
| King County Metro | 128 Southcenter - Al | 3,071 | 2,165 | -906 | -29.50% |
| King County Metro | 132 Burien TC - Sout | 2,651 | 2,908 | 257 | 9.70% |
| King County Metro | 121 Highline Coll-Ma | 897 | 1,390 | 493 | 54.94% |

| TRANSIT AGENCY | TRANSIT ROUTE *(ROUTE NO. DESCRIPTION)* | OBSERVED | MODELED | DIFF | % DIFF |
|---|---|---|---|---|---|
| King County Metro | 179 Twin Lakes P&R | 779 | 728 | -51 | -6.53% |
| King County Metro | 158 Kent East Hill - | 495 | 1,279 | 784 | 158.43% |
| King County Metro | 177 Federal Way S 32 | 492 | 1,002 | 510 | 103.69% |
| King County Metro | 122 Highline College | 488 | 824 | 336 | 68.83% |
| King County Metro | 193 Federal Way S 32 | 447 | 266 | -181 | -40.40% |
| King County Metro | 178 S Federal Way P& | 446 | 1,056 | 610 | 136.74% |
| King County Metro | 197 Twin Lakes P&R - | 445 | 381 | -64 | -14.43% |
| King County Metro | 190 Redondo Heights | 392 | 864 | 472 | 120.44% |
| King County Metro | 159 Timberlane - Ken | 349 | 1,042 | 693 | 198.55% |
| King County Metro | 123 Gregory Heights | 339 | 448 | 109 | 32.14% |
| King County Metro | 157 Lake Meridian P& | 211 | 372 | 161 | 76.20% |
| King County Metro | 192 Star Lake - Down | 136 | 157 | 21 | 15.65% |
| King County Metro | 913 Kent Station - R | 118 | 136 | 18 | 15.56% |

| TRANSIT AGENCY | TRANSIT ROUTE *(ROUTE NO. DESCRIPTION)* | OBSERVED | MODELED | DIFF | % DIFF |
|---|---|---|---|---|---|
| King County Metro | 635 Des Moines Marin | 0 | 300 | 300 | - |
| **TOTAL** | | **116,301** | **138,087** | **21,786** | **18.73%** |

## 3.5 SUMMARY

The SeaCast model validation followed guidelines provided in National Cooperative Highway Research Program (NCHRP) 765 and Federal Highway Administration Travel Model Validation and Reasonability Checking Manual (Second Edition), Cambridge Systematics, Inc. 2010. The final model flows compare well with the observed traffic counts and transit boardings. The model flows were validated both at the regional level as well as at the SeaTac region level. As expected, the SeaCast model shows improved validations at the SeaTac level compared to the SoundCast model.

However, there are a few areas that still need improvement and shall be addressed in future model development tasks:

- **Observed traffic Counts**: The highway validation directed a lot of effort in reviewing and cleaning up observed traffic counts. Due to limited time, only some count locations were reviewed. A more comprehensive review of traffic counts would help examine model's reasonable check more accurately.
- **Screenlines**: Generally, the screenlines in the SeaTac region show comparable flows with the observed traffic counts. However, a few low volume screenlines (N of S 160th St and W of Des Moines Mem'l N of 176th) see bigger differences (>20%). The future work should examine these screenlines in more detail.
- **External stations**: Overall, the external stations of the model region are overestimated by 11%. This work did not make any adjustments to improve these validations. The future work should look at flows at external stations and make as needed adjustments to improve the validations.

**Transit ridership by route**: At the SeaTac region level, the transit ridership compares well with observed transit ridership. However, individual routes do not perform well, except the highest ridership route (SeaTac LINK). We recommend that the future work obtain a transit on-board survey dataset and use in model development to improve transit ridership estimates.

# 4.0 CONCLUSIONS AND NEXT STEPS

RSG developed the SeaCast activity-based model based on a well-established activity-based model SoundCast, maintained by the regional agency PSRC. The new travel model is developed with primary focus on improved forecasting of travel related to the city of SeaTac and the SEA airport in the PSRC region. This will serve as a valuable tool for various local planning efforts in the SeaTac region. The SeaCast model base year is 2018, the same as the current version of the SoundCast model.

The development process included revisions of the zone system and network as outlined in Appendix A.1 and Appendix A.2 respectively. Additionally, the model inputs that either contained spatial information or required in model calibration/validation were also updated. The work made the following key changes and enhancements to the SoundCast model to develop the SeaCast model:

- Updated the model inputs to a new zone system.
- Updated the network with additional details in the city of SeaTac.
- Added household resampling feature that will better represent and amplify the characteristics of the population in the city of SeaTac.
- Replaced the existing Airport model with a new Airport activity-based model.

## 4.1 CONCLUSIONS

The project calibrated the DaySim activity-based model in the SeaCast model system using the PSRC household travel survey data which was re-weighted by including additional data for improved observed travel patterns. The model system was added with a new airport model in ActivitySim framework for improved representation of airport travel and enhanced sensitivities for planning purposes. The airport model was calibrated to 2018 observed conditions. The base year network assignment results were validated using observed traffic counts (2013-2023 traffic counts) and 2018 transit ridership. The calibration and validation summaries from the SeaTac model show improved performance in the SeaTac region compared to the SoundCast model.

## 4.2 NEXT STEPS

The work identified a few model improvements for future as outlined below:

- Household travel survey – The project used the HTS data from the PSRC region which contained a very small sample from the SeaTac region. A new household travel survey for the region and designed specifically for an AB model calibration needs will improve the process and the model performance greatly.

- Transit on-board survey – The work used the existing boarding and transfer data in the SoundCast model to validate the transit patterns within the region. A region focused transit on-board survey would help the calibration of transit ridership and better represent the transit flows.
- Traffic counts – The project spent a significant amount of time cleaning and conglomerating the traffic counts with acceptable quality to use in highway validation. Further QA/QC of traffic counts will improve highway validation.
- DaySim enhancements – DaySim offers many features like Transportation Network Companies (TNC), currently active in the model but not calibrated, and Autonomous Vehicles (AV) representation which can be utilized by SeaCast to its full potential to represent present and future year travel behavior. Calibrating these available features would be useful for SeaTac and the Airport.
- ActivitySim conversion – PSRC is working on converting their DaySim based SoundCast model system to an ActivitySim framework. When converted, the new SeaCast model should be transitioned to the ActivitySim framework to align with PSRC's modeling efforts and bring in benefits of the state-of-the-art AB travel model framework.

# APPENDIX A ZONES AND NETWORK DEVELOPMENT

The team developed a new zone system with an aim to add detailed zones within the SeaTac region for better representation of travel in the local region. This appendix describes the procedure undertaken to develop and incorporate the new zone system into the SeaCast model inputs, including the changes made to the SeaCast model network.

## A.1 ZONES

The City of SeaTac and SEA airport presently maintain a Visum based four-step model representing the SeaTac region with a more detailed zone system (let's call "local zone system") than the SoundCast zone system. While combining the two zone systems (four-step model and SoundCast model), the zones categorized as 'Inner' or 'Outer' zones in the local zone system were retained and the corresponding zones in the SoundCast zone system were removed. The local zones with zone ID of 400 or greater (park-and-ride locations) were either removed or merged into adjacent zones based on centroid proximity. After this, the new zone system included 210 zones in the SeaTac region. Outside the SeaTac region, we aggregated zones[28] in Snohomish and Kitsap counties to reduce number of zones from 3620 in the SoundCast zone system to 2759 in the new zone system for the SeaCast model. The zones representing park-and-rides and external stations were retained from the SoundCast zone system. The aggregation outside the SeaTac region was necessary to keep model runtime reasonable and meet the limit on number of zones (3700) in the model system. A comparison of the original SoundCast zone system and the new SeaCast zone system is shown in Table A-1.

**TABLE A-1: ZONE SYSTEM COMPARISON**

| | SoundCast model | SeaCast model |
|---|---|---|
| SeaTac local zones | 80 | 210 |
| Regional (outside SeaTac) zones | 3620 | 2759 |
| Park-n-Rides | 178 | 178 |
| External stations | 18 | 18 |

[28] The aggregation is based on the work performed by Pierce County to develop a Zone system to their new PierceCast travel model.

| | | |
|---|---|---|
| **Total internal zones** | **3700** | **2969** |
| **Total zones** | **3896** | **3165** |

## A.2 NETWORK

A new SeaCast model roadway network was developed by updating the SoundCast model roadway network to accommodate the modified zone system described in the previous section. The updates included addition/modification of centroids and centroid connectors. In addition, more network details were added to the SeaTac region.

The zones identified to be retained from the SoundCast model which are not involved in the merging process were left unmodified, and the centroids of the merged zones from the local zone system (from the Visum trip-based model) were imported. Additionally, centroids were imported from the PierceCast zone system (aggregated zones outside the SeaCast region), and the three groups of centroids were reindexed as a collective. A mapping was developed which links all zone IDs from their respective source zone systems to the new ID value assigned in this reindexing procedure. These newly reindexed centroids were updated with default metadata then merged with the existing non-centroid nodes in the SoundCast network.

Next, the centroid connectors from the SoundCast and the existing trip-based models were duplicated, and their head and tail nodes were updated to match the new zone ID indexing. The connectors were then imported, and a procedure was undertaken to ensure the connectors attached to roadways retained by the PSRC network builder tool. This involved in some cases relocating the connectors' network-side junctions to different locations and rebuilding their component geometry. The connectors were then merged in with the existing non-centroid-connector links in the roadway network and their metadata was populated.

The resulting nodes and links were then combined with the existing SoundCast transit network, mode attribute, and turning movement data in a geodatabase file which was then input into the PSRC network builder tool. This tool validated the connectivity of the network, thinned unnecessary geometries to reduce network size, and converted the geodatabase into appropriate EMME project files.