# SRTC Travel Forecasting Documentation

Federal transportation planning regulations require documentation of the input assumptions and methods used for developing forecasts [23 CFR 450.316]. This documentation will include an (1) inventory of the current state of transportation in the planning area, (2) key planning assumptions used in developing forecasts, and (3) descriptions of the methods used to develop forecasts of future travel demand.

*This technical documentation should be readily available to all interested parties, consistent with public involvement provisions in the planning regulations [23 CFR 450.316 (b)(1)]. Documentation shall be updated as changes are made to models or the assumptions used to develop the transportation plan.*

# 1. Inventory of Key Conditions

The foundation for any travel forecast is a comprehensive inventory of current conditions of transportation supply and demand. These conditions are documented below.

## Highway System

In Spokane County there are 4,397 centerline miles and 9,248 lane miles of roadways (**Table 1**). Federal Functional Classification data is collected on an annual basis and imported into each new model update.

The roadway network in the travel demand model includes all roadways classified as collector or higher. In addition, a number of local roads are also activated for travel to better reflect local travel patterns.

**Table 1.** 2008 Roadway Miles by FFC

| Rural | | | Urban | | |
|---|---|---|---|---|---|
| FFC No/Type | Centerline Miles | Lane Miles | FFC No/Type | Centerline Miles | Lane Miles |
| 1 Interstate | 17 | 66 | 11 Interstate | 28 | 153 |
| 2 Principal Arterial | 64 | 177 | 12 Other Freeways | 13 | 52 |
| 6 Minor Arterial | 20 | 40 | 14 Principal Arterial | 174 | 540 |
| 7 Major Collector | 419 | 837 | 16 Minor Arterial | 230 | 514 |
| 8 Minor Collector | 306 | 611 | 17 Urban Collector | 175 | 353 |
| 9 Local Access | 1,555 | 3,111 | 19 Local Access | 1,396 | 2,793 |
| **TOTAL** | **2,380** | **4,231** | **TOTAL** | **2,017** | **4,406** |

Source: WSDOT 2009; Note: classification changes in 2009 are backed out to reflect the 2008 FFC System.

### Vehicle Miles Traveled (VMT)

Daily VMT from the travel demand model is approximately 11.13 million for all of Spokane County. This includes VMT on all roadways classified collector or higher and a handful of local access roads.

According to Texas Transportation Institute's 2008 Urban Mobility Report, daily VMT on freeways and arterials in the Spokane Urban Area was 6.51 million. It is important to note that these values are only for the Federal-Aid Urban Area and that it measures VMT only on roadways classified as urban interstate/freeway or urban arterial.

## Transit System

Spokane Transit Authority (STA) provides mass transit services in Spokane County Public Transportation Benefit Area (PTBA). In the 371 square mile PTBA, STA operates approximately 350 miles of fixed-route bus service (**Table 2**). These routes are included in the travel demand model, and are revised to reflect current conditions and assumptions with each model update.

**Table 2.** 2008 Transit Miles

| Route | Length (undirected miles) | Route | Length (undirected miles) |
|---|---|---|---|
| 1 Plaza/Arena | 1.4 | 43 Lincoln/37th | 6.7 |
| 2 South Side Medical Shuttle | 3.3 | 44 29th Ave | 6.5 |
| 20 SFCC | 4.3 | 45 Southeast Blvd | 7.1 |
| 21 West Broadway | 3.0 | 46 Altamont | 5.0 |
| 22 Northwest Blvd | 5.2 | 47 Glenrose | 3.1 |
| 23 Maple/Ash | 10.3 | 61 Highway 2 | 17.6 |
| 24 Monroe | 5.1 | 62 Medical Lake | 20.3 |
| 25 Division | 9.1 | 64 Airport | 9.0 |
| 26 Addison | 9.4 | 65 Cheney/EWU | 20.3 |
| 27 Crestline | 7.3 | 66 EWU Express | 17.1 |
| 28 Nevada | 9.0 | 72 Liberty Lake Express | 22.9 |
| 29 SCC | 7.3 | 73 VTC Express | 10.4 |
| 30 Francis | 5.9 | 74 Valley Limited | 18.5 |
| 31 Garland | 7.8 | 90 Sprague | 14.2 |
| 32 Trent/Indiana | 9.5 | 91 Mission | 4.1 |
| 33 Wellesley | 13.9 | 94 East Fifth | 6.8 |
| 35 Five Mile P&R | 6.1 | 95 Millwood | 5.1 |
| 40 Browne's Addition | 1.4 | 96 Pines | 10.0 |
| 41 Latah | 5.1 | 97 South Valley | 9.1 |
| 42 South Maple | 1.4 | 124 North Express | 9.3 |
| | | **TOTAL** | **348.9** |

Sources: Spokane Transit Authority (2008)

### Transit Use

In 2008, there were 11,132,771 unlinked transit trips on STA's fixed-route system (STA). Transit accounts for 2.96% of the commuter mode split in Spokane County (U.S. Census American Community Survey, 2005-2009 5 Year Estimate).

## Non-Motorized System

Biking and walking trips account for 3.61% of commute trips in Spokane County (U.S. Census American Community Survey, 2005-2009 5 Year Estimate); 2.97% are walking trips and .64% are bike trips.

Pedestrian and bicycle facilities are not incorporated into the current regional travel demand model, as these modes are not represented in the mode choice model.

## Population/Dwelling Units

For base year modeling purposes, SRTC uses dwelling units rather than population. Dwelling unit data is derived in part from the US Census Bureau; it is adjusted annually based on permit information supplied by the local jurisdictions in Spokane County. In the 2008 base model, there are a total of 204,141 dwelling units (**Table 3**). Of that total, 160,132 are single-family dwelling units (1 or 2 unit) and 44,009 are multi-family households (3+ units).

**Table 3.** 2008 Dwelling Units by Jurisdiction*

| Jurisdiction | Dwelling Units |
|---|---|
| City of Spokane | 95,163 |
| Spokane Valley | 39,861 |
| Liberty Lake | 3,699 |
| Cheney | 2,830 |
| Airway Heights | 1,357 |
| Millwood | 827 |
| Unincorporated Spokane County + Small Towns | 60,404 |
| **TOTAL** | **204,141** |

*Employees are separated into jurisdictions by approximation; employee numbers are input into the model by Transportation Analysis Zones (TAZs), which may span more than one jurisdiction. Employee count includes University Students and does not include Hotels/Campgrounds, which are input into the model in numbers of rooms/spaces rather than employees.

## Employment

Employment data is collected on an annual basis from 2$^{nd}$ quarter Employment Security Department (ESD) information. Local knowledge and ESD control totals are used to fill in any gaps. In the 2008 model, there are approximately 221,000 employees in Spokane County (**Tables 4 & 5**). This total includes all employment types (except hotel/campground employment; which are represented in the model as a number of rooms or camp spaces rather than employees), university and education employees, and off-campus university students. For more information on how land use is categorized for modeling purposes, please see **Appendix A** Land Use Definitions by two-digit Standard Industrial Code.

**Table 4.** 2008 Employees by Employment Type

| Employment Type | Employees |
|---|---|
| Industrial | 54,695 |
| Retail (non CBD) | 56,189 |
| Services and Office | 28,399 |
| Medical | 28,074 |
| Finance, Insurance, and Real Estate Services | 13,565 |
| University Students | 15,054 |
| Education Employees | 12,996 |
| Retail (CBD) | 7,223 |
| University Employees | 5,258 |
| **TOTAL** | **221,453** |

**Table 5.** 2008 Employees by Jurisdiction

| Jurisdiction | Employees* |
|---|---|
| City of Spokane | 118,256 |
| Spokane Valley | 48,538 |
| Liberty Lake | 5,768 |
| Cheney | 6,699 |
| Airway Heights | 3,735 |
| Millwood | 1,009 |
| Unincorporated Spokane County + Small Towns | 37,448 |
| **TOTAL** | **221,453** |

*Employees are separated into jurisdictions by approximation; employee numbers are input into the model by Transportation Analysis Zones (TAZs), which may span more than one jurisdiction.

For the education land uses (university employees and off-campus students, and education employees), SRTC contacts and verifies the employment and student numbers at each higher education institution and the number of employees at each school within school districts. This additional verification step is taken because many education-based employers reporting all of their employees at one centralized location to WA ESD, rather than the numbers of employees at each location.

# 2. Planning Assumptions

The principal determinants of any long-range travel demand forecast are the planning assumptions about the growth and distribution of population, developed land, and individual travel preferences.

## Population and Dwelling Unit Change

For the 2035 model, SRTC first derived 2030 dwelling units from the Spokane Board of County Commissioners (BoCC) Population Allocation Resolution (09-0531). The resolution forecasts a countywide population of 612,226, which is an additional 17,025 over the Office of Financial Management (OFM's) Medium Forecast of 595,201) and 93,774 lower than OFM's High Forecast of 706,000. In addition to setting the countywide population forecast, the Population Allocation Resolution identifies population growth targets by jurisdiction, Urban Growth Areas (UGAs), Joint Planning Areas (JPAs), and rural areas.

The BoCC's Population Allocation Resolution forecasts population numbers, while SRTC's model operates in dwelling units. Population growth by municipality, UGA, JPA, etc. is set by the resolution. SRTC provided each jurisdiction with their 2008 dwelling unit values. Using the allocation set by the BoCC, jurisdictions were then asked to supply the number of dwelling units by transportation analysis zone (TAZ) for 2030 and 2015. This required individual jurisdictions to come up with persons per household (PPH) ratios in order to convert their 2030 population allocation into a number of dwelling units. The future dwelling unit estimation process is described in detail in **Appendix B**, Future Land Use Documentation.

For the 2035 model, 2030 dwelling units were extrapolated to 2035 by SRTC staff using an annual growth rate of 1.0109%, resulting in 274,270 dwelling units. This growth rate was established by interpolating between the 2008 and 2030 dwelling unit values, and represents a growth of 70,129 (or 34%) over 2008 dwelling units.

### Interim Year Forecasts

For interim year forecasts, dwelling units are interpolated using 2008 and 2030 values. For the 2015 interim year model, there are 220,051 dwelling units; in the 2025 interim year model there are 246,600 dwelling units.

## Employment Change

Employment growth is derived using a flat growth rate of 1.365% compounded annually. This rate was arrived at by referencing a variety of employment sources (US Bureau of Labor Statistics, US Census Bureau Longitudinal Employer-Household Dynamics, Quarterly Workforce Indicators, ESD, IMD). Estimated 2035 employees by employment type are listed in **Table 6**.

**Table 6.** 2035 Employees by Employment Type

| Employment Type | 2008 Employees | 2035 Employees | % Change |
|---|---|---|---|
| Industrial | 54,695 | 79,423 | 45% |
| Retail, non CBD | 56,189 | 84,086 | 50% |
| Services and Office | 28,399 | 45,614 | 61% |
| Medical | 28,074 | 39,376 | 40% |
| Finance, Insurance, and Real Estate Services | 13,565 | 19,460 | 44% |
| University Students | 15,054 | 21,708 | 44% |
| Education Employees | 12,996 | 18,942 | 46% |
| Retail, CBD | 7,223 | 11,043 | 53% |
| University Employees | 5,258 | 7,467 | 42% |
| **TOTAL** | **221,453** | **327,120** | **48%** |

## Regional Distribution of Future Population and Employment

For the allocation of future year population, the Board of County Commissioners Population Allocation Resolution included growth targets for each jurisdiction, urban growth area (UGA), joint planning area (JPA), and rural areas. Each jurisdiction converted these population targets into dwelling units using ratios of persons per household (PPH). Based upon Land Quantity Analysis, comprehensive plan, zoning regulations, and local knowledge; each jurisdiction placed their 2015 and 2030 dwelling unit allocation by transportation analysis zone (TAZ). For the 2035 model, SRTC staff extrapolated the 2030 dwelling unit allocations at an annual growth rate of 1.0997178%.

**Table 7.** 2035 Dwelling Units by Jurisdiction*

| Jurisdiction | 2008 Dwelling Units | 2035 Dwelling Units | % Growth |
|---|---|---|---|
| City of Spokane | 95,163 | 120,652 | 27% |
| Spokane Valley | 39,861 | 52,160 | 31% |
| Liberty Lake | 3,699 | 5,767 | 56% |
| Cheney | 2,830 | 3,546 | 25% |
| Airway Heights | 1,357 | 2,680 | 97% |
| Millwood | 827 | 939 | 14% |
| Unincorporated Spokane County + Small Towns | 60,404 | 88,527 | 47% |
| **TOTAL** | **204,141** | **274,270** | **34%** |

*Dwelling units are separated into jurisdictions by approximation; dwelling unit values are input into the model by Transportation Analysis Zones (TAZs), which may span more than one jurisdiction.

As described in the previous section (Employment Change), an annual rate of 1.365% was used to arrive at 2015 and 2030 overall employment values. SRTC then offered jurisdictions the option apply the growth rate uniformly among their TAZs or to hand place 30% of their employment growth in areas they expect to see higher than normal growth. If the agency chose to have the uniform rate applied, SRTC staff simply used the growth rate to arrive at their 2015 and 2030 values. Jurisdictions that chose to hand place growth were provided an Excel worksheet to complete. This worksheet allowed jurisdictions to place 30% of their growth by TAZ in the aforementioned areas. The future employee estimation process is described in detail in **Appendix B**, Future Land Use Documentation.

For the 2035 model, SRTC extrapolated 2030 employment values for five years.

**Table 8.** 2035 Employees by Jurisdiction*

| Jurisdiction | 2008 Employees | 2035 Employees | % Change |
|---|---|---|---|
| City of Spokane | 118,256 | 170,326 | 44% |
| Spokane Valley | 48,538 | 75,460 | 55% |
| Liberty Lake | 5,768 | 11,843 | 105% |
| Cheney | 6,699 | 9,568 | 43% |
| Airway Heights | 3,735 | 5,574 | 49% |
| Millwood | 1,009 | 1,455 | 44% |
| Unincorporated Spokane County + Small Towns | 37,448 | 52,893 | 41% |
| **TOTAL** | **221,453** | **327,120** | **48%** |

*Employees are separated into jurisdictions by approximation; employee numbers are input into the model by Transportation Analysis Zones (TAZs), which may span more than one jurisdiction. Employee count includes University Students and does not include Hotels/Campgrounds, which are input into the model in numbers of rooms/spaces rather than employees.

### Interim Year Forecasts

For interim year forecasts, employment values are interpolated using 2008 and 2030 values. For the 2015 interim year model, there are 247,883 employees; in the 2025 interim year model there are 286,397 employees.

## Demographic and Travel Behavior Changes

The 2008/2030 models are based on the demographic characteristics and travel behaviors identified by the 2005 Spokane and Kootenai County Regional Travel Survey (**Appendix C**). Demographics currently utilized in the model include household income, household size, and multi-worker households. For modeling purposes, these demographic characteristics are presumed to remain stable through the planning horizon. With the completion of future household travel surveys, it may be possible to analyze historical trends in demography and make reasonable assumptions about demographic changes for future horizon year models.

Travel behaviors are also discerned from the travel survey. Behaviors such as the change in telecommuting, internet shopping, and mode preference shifts may be revealed with additional travel surveys over time. However, the current model sets do not presume any fundamental changes in travel behaviors between the 2008 and 2030 models.

# 3. Forecasting Methods

The complexity of an MPO's forecasting methods can vary considerably, depending on current transportation conditions, and on the future transportation investments and policies being evaluated. Current forecasting methods and model details are described below.

## Latest Model Revision

The model set (2008/2035) was built off of a model revised and recalibrated in 2006. The current model set differs from the previous only in the updates to land use and transportation network (based on 2008 and 2035 conditions).

## Network Characteristics

The model includes 500 transportation analysis zones (TAZ). Of the total, 12 are park and ride locations, 34 are external zones, and the remaining 454 are standard TAZs.

There are 17,767 active links in the model (69,772 total). Active links include all roadways classified as collector or higher. In addition, a number of local roads are also activated for travel to better reflect local travel patterns.

There are 8,596 active nodes in the model (26,008 total).

The model uses zone connectors to emulate traffic generated on local roads. There are 5,248 connectors in the model; 1,066 of these are connectors to park and rides zones.

## Model Specification

SRTC utilizes a standard four-step gravity model for travel forecasting. The four steps of the modeling process are trip generation, trip distribution, mode choice and network assignment.

### Trip Generation

Production and attraction rates by trip purpose, demand stratum (household characteristics), and land use category are provided in **Appendix D**. The model results of the trip generation step were compared against the 2005 Spokane County Household Travel Survey. The difference between the model and survey are negligible in terms of the total-region wide daily trips, trip percentage distribution, and the number of trips per household (**Table 9**).

**Table 9.** 2006 Model Run Trip Generation Rates vs. Survey

| Trip Purpose | Daily Trips | | % of Total Trips | | Trips per Household | |
|---|---|---|---|---|---|---|
| | Survey | Model | Survey | Model | Survey | Model |
| Work/College | 231,976 | 250,553 | 11.3% | 11.4% | 1.27 | 1.30 |
| School | 106,532 | 109,091 | 5.2% | 5.0% | 0.58 | 0.57 |
| Retail | 316,289 | 335,009 | 15.3% | 15.3% | 1.73 | 1.74 |
| Other | 681,748 | 723,332 | 33.1% | 33.0% | 3.73 | 3.76 |
| NonHome | 725,086 | 773,324 | 35.2% | 35.3% | 3.97 | 4.02 |
| Total HH Trips | 2,061,631 | 2,191,309 | 100.0% | 100.0% | 10.71 | 11.39 |

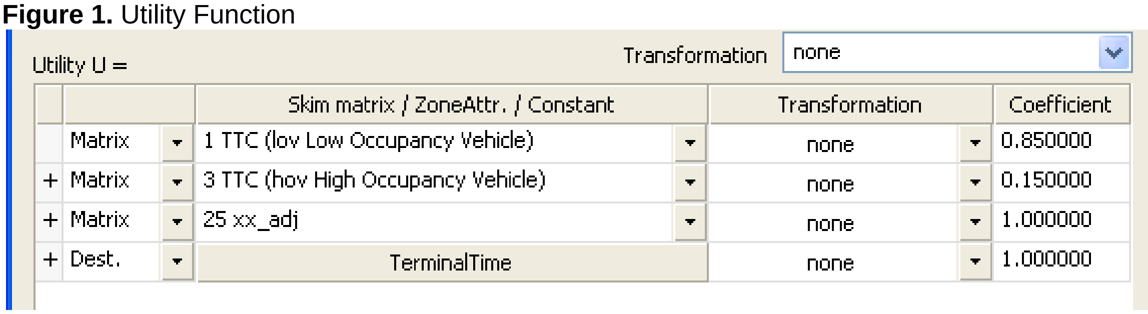
## Trip Distribution

Trips are distributed geographically based on gravity model functions for the following trip purposes: home-based work (HBW), home-based college (HBC), home-based retail (HBR), home-based other (HBO), non-home based (NHB), and commercial (COM). The trip distribution model is a modified gravity formulation. The basic equation is:

F(U) = 1 /((U)^b + c*(U)^a)

where U is the utility function defined by:

**Figure 1.** Utility Function



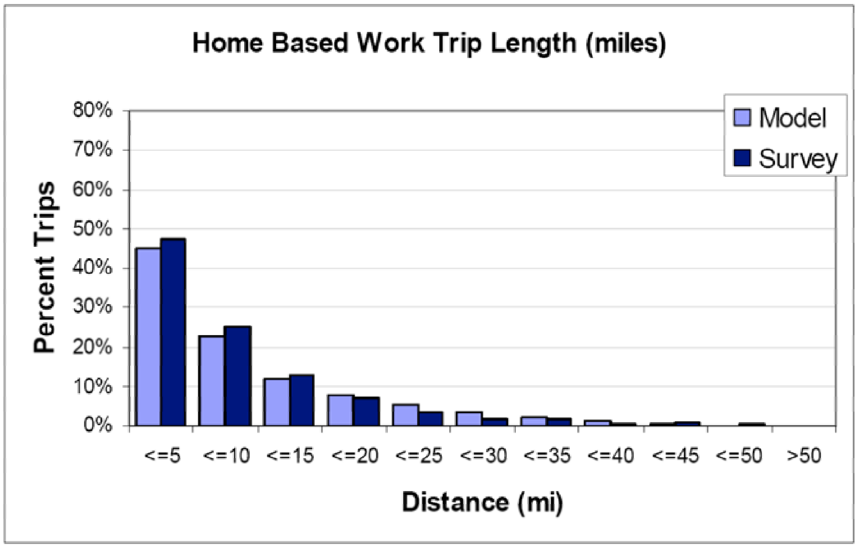

The utility function includes composite impedance for LOV and SOV along with terminal time and an adjustment to ensure that there are no external to external trips distributed. The value of the co-efficient for each trip purpose is shown below (**Table 10**).

**Table 10.** Trip Distribution Utility Parameters

| Trip Purpose | Distribution Parameters | | |
|---|---|---|---|
| | a | b | c |
| Work | 0.00 | 1.80 | 0.00 |
| School | 0.00 | 9.00 | 0.00 |
| Retail | 0.00 | 3.10 | 0.00 |
| Other | 0.00 | 2.75 | 0.00 |
| NonHome | 0.00 | 2.50 | 0.00 |
| Commercial | 0.00 | 2.40 | 0.00 |

Trip distribution by trip purpose was calibrated against the 2005 Spokane County Household Travel Survey (an example calibration result of HBW trip distribution is illustrated in **Figure 2**). The complete trip distribution calibration results can be found in the **Appendix D**.

**Figure 2.** Trip Distribution Calibration Results (HBW)




## Mode Choice

The mode choice model formulation uses a nested Logit structure. This structure takes into account that mode choice requires more than one decision point. Trip makers must first choose between auto and transit, and then they choose between drive alone or carpool (auto) or to walk or drive to transit (transit). The utility of a mode varies by household characteristics and trip purpose, and includes variables such as travel time, distance, and parking costs (auto); in-vehicle time, wait time, number of transfers, and fares (transit).

Modal constants used in the mode choice models are shown in **Table 11**. These constants are all expressed in terms of the bottom nest level of the nested mode choice structure.

**Table 11.** Modal Constants by Trip Purpose

| Modal Constants | Trip Purpose | | | |
|---|---|---|---|---|
| | HBW | HBR | HBO | NHB |
| Walk to Bus | 0.00 | 0.00 | 0.00 | 0.00 |
| Walk to Rail | 0.00 | 0.00 | 0.00 | 0.00 |
| Drive to Bus | 0.00 | 0.00 | 0.00 | 0.00 |
| Drive to Rail | 0.00 | 0.00 | 0.00 | 0.00 |
| Drive Alone | 0.00 | 0.00 | 0.00 | 0.00 |
| Shared Ride | -2.360 | -0.170 | -0.750 | -1.170 |
| Drive to Transit | -1.048 | -14.502 | -14.502 | -7.725 |
| Walk to Transit | 0.00 | 0.00 | 0.00 | 0.00 |
| Transit | -2.650 | -2.464 | -2.464 | -1.720 |
| Auto | 0.00 | 0.00 | 0.00 | 0.00 |

The basic utility functions are identical for all trip purposes. The only differences in the utility functions are the constants. The basic utility functions from the mode choice model are shown below.

**Uda = -0.03571 * Auto Time + -0.00357 * Operating Cost * Distance + -0.00357 * Parking Cost + Cda**

**Usr = -0.03571 * Auto Time + -0.00357 * Operating Cost * Distance + -0.001785 * Parking Cost + Cda**

**Uwlktrn = -0.11905 * InVehTime + -0.29762* (Walk + Transfer + Wait)**
**+-0.0119 * Fare + -0.47619 * Transfers + Ccbd + Cinc + Cwlkbus**

**Uwlkrail = -0.11905 * InVehTime + -0.29762* (Walk + Transfer + Wait)**
**+-0.0119 * Fare + -0.47619 * Transfers + Ccbd + Cinc + Cwlkrail**

**Udrvbus = -0.11905 * InVehTime + -0.29762* (Drive + Walk + Transfer + Wait)**
**+-0.0119 * Fare + -0.47619 * Transfers + Ccbd + Cinc + Cdrvbus**

**Udrvrail = -0.11905 * InVehTime + -0.29762* (Drive + Walk + Transfer + Wait)**
**+-0.0119 * Fare + -0.47619 * Transfers + Ccbd + Cinc + Cdrvrail**

The CBD and Income constants only exist for the transit utility functions. These constants are shown in **Table 12**.

**Table 12.** Modal Constants by Trip Purpose

| CBD Constant – Bottom Nest Level | Trip Purpose | | | |
|---|---|---|---|---|
| | HBW | HBR | HBO | NHB |
| | 0.350 | -2.119 | -2.119 | -1.952 |
| | | | | |
| Purpose | Income Group | | | |
| | 1 (Low) | 2 | 3 | 4 (High) |
| *Walk Access Transit* | | | | |
| HBW | 0.410 | 0.227 | 0.185 | 0.000 |
| HBR | 0.377 | 0.247 | 0.222 | 0.000 |
| HBO | 0.377 | 0.247 | 0.222 | 0.000 |
| NHB | 0.000 | 0.000 | 0.000 | 0.000 |
| *Auto Access Transit* | | | | |
| HBW | 0.839 | 0.350 | 0.277 | 0.092 |
| HBR | 0.377 | 0.247 | 0.228 | 0.000 |
| HBO | 0.377 | 0.247 | 0.228 | 0.000 |
| NHB | 0.000 | 0.000 | 0.000 | 0.000 |

At the time of model development (2006), the transit fare structure in STA's service area was $1 for a 2 hour pass, regardless of trip length or time of day. The mode choice models are set up to allow varying transit fares by time period as well as by geographic area.

The mode choice results from the model were calibrated in 2006 model development against the 2005 Spokane County Household Travel Survey (**Table 13**).

**Table 13.** 2006 Mode Choice Model vs. Survey by Trip Purpose

| | **Work Trips** | | **Retail Trips** | | **Other Trips** | | **Non Home Trips** | |
|---|---|---|---|---|---|---|---|---|
| Mode | Survey | Model | Survey | Model | Survey | Model | Survey | Model |
| SOV | 89.6% | 89.3% | 53.7% | 54.0% | 67.4% | 67.2% | 74.5% | 74.0% |
| HOV | 8.5% | 8.6% | 45.4% | 46.0% | 32.0% | 32.0% | 23.2% | 23.5% |
| Transit | 1.9% | 2.0% | 0.8% | 0.0% | 0.6% | 0.8% | 2.3% | 2.4% |
| School Bus | - | - | - | - | - | - | - | - |
| Total | 100% | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

## Highway Assignment

The current model is run for all time periods, however the main calibration and validation has occurred for the PM Peak Hour.

### *Volume Delay Functions*

The model utilizes a BPR function to calculate volume delay on links. There are currently six variations of the TModel Link Volume Delay function used in the SRTC model. The basic structure is identical for all link types; however the parameters vary by link type. The basic formula for the TModel Link volume delay function is shown in **Figure 3Error! Reference source not found.** and the variations on the parameters within the function are shown in **Table 14Error! Reference source not found.**.

**Figure 3.** TModel Link Volume Delay Function

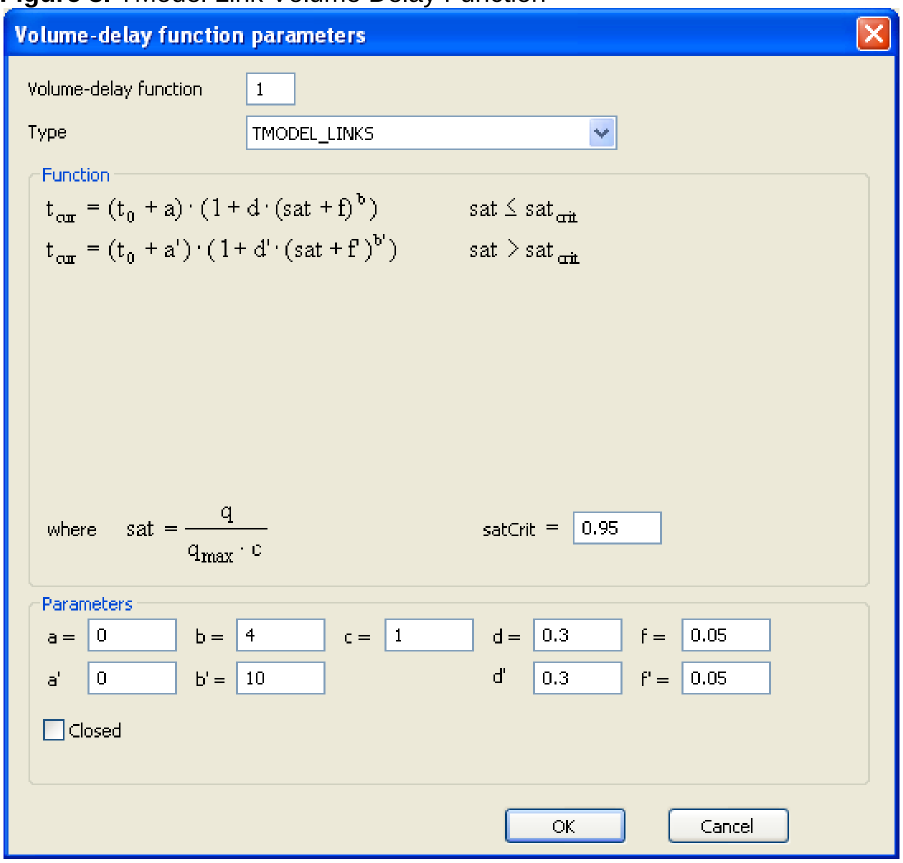
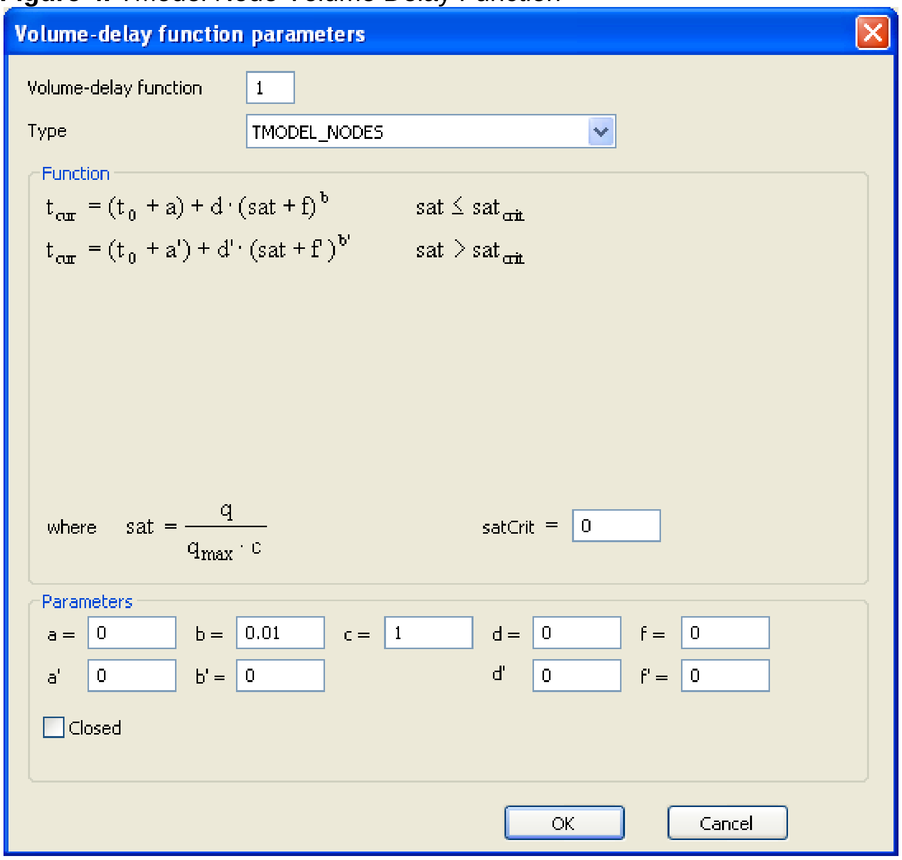



**Table 14.** Link Volume Delay Function Parameters

| VDF | Sat Crit | *Below* Critical Saturation Flow Rate | | | | | VDF | Sat Crit | *Above* Critical Saturation Flow Rate | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | a | b | c | d | f | | | a | b | c | d | f |
| 1 | 0.95 | 0 | 4 | 1 | 0.30 | 0.05 | 1 | 0.95 | 0 | 10 | 1 | 0.30 | 0.05 |
| 2 | 0.90 | 0 | 4 | 1 | 0.30 | 0.10 | 2 | 0.90 | 0 | 10 | 1 | 0.30 | 0.10 |
| 3 | 0.85 | 0 | 4 | 1 | 0.30 | 0.15 | 3 | 0.85 | 0 | 10 | 1 | 0.30 | 0.15 |
| 4 | 0.80 | 0 | 4 | 1 | 0.30 | 0.20 | 4 | 0.80 | 0 | 10 | 1 | 0.30 | 0.20 |
| 5 | 0.75 | 0 | 4 | 1 | 0.30 | 0.25 | 5 | 0.75 | 0 | 10 | 1 | 0.30 | 0.25 |
| 6 | 0.70 | 0 | 4 | 1 | 0.30 | 0.30 | 6 | 0.70 | 0 | 10 | 1 | 0.30 | 0.30 |

There are also nine node delay functions (five are active) in the model. All of the node volume delay functions are of the TModel type. The basic formulation of the TModel node volume delay function is illustrated below (**Figure 4**).

**Figure 4.** TModel Node Volume Delay Function




The TModel Node function is designed to simulate travel delay that occurs at intersections. The incoming capacity of all links is factored to simulate the capacity of the intersection. The parameters used to calculate node delay is detailed in **Table 15**.

**Table 15.** TModel Node Volume Delay Function Parameters

| VDF | Sat Crit | *Below* Critical Saturation Flow Rate | | | | | | VDF | Sat Crit | *Above* Critical Saturation Flow Rate | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | a | b | c | d | f | | | | a | b | c | d | f |
| 1 | 0.00 | 0.00 | 0.01 | 1 | 0.00 | 0.00 | | 1 | 0.00 | 0.00 | 0.00 | 1 | 0.00 | 0.00 |
| 3 | 0.90 | 2.00 | 3.80 | 1 | 30.00 | 0.10 | | 3 | 0.90 | 4.00 | 6.00 | 1 | 30.00 | 0.10 |
| 6 | 0.90 | 2.00 | 3.60 | 1 | 30.00 | 0.10 | | 6 | 0.90 | 4.00 | 4.60 | 1 | 30.00 | 0.10 |
| 8 | 0.85 | 0.00 | 4.00 | 1 | 30.00 | 0.15 | | 8 | 0.85 | 0.60 | 6.00 | 1 | 30.00 | 0.15 |
| 9 | 0.95 | 0.00 | 4.00 | 1 | 25.00 | 0.05 | | 9 | 0.95 | 0.00 | 4.00 | 1 | 25.00 | 0.05 |

Node types and corresponding volume delay functions are listed in **Table 16**.

**Table 16.** Volume Delay Functions by Node Type

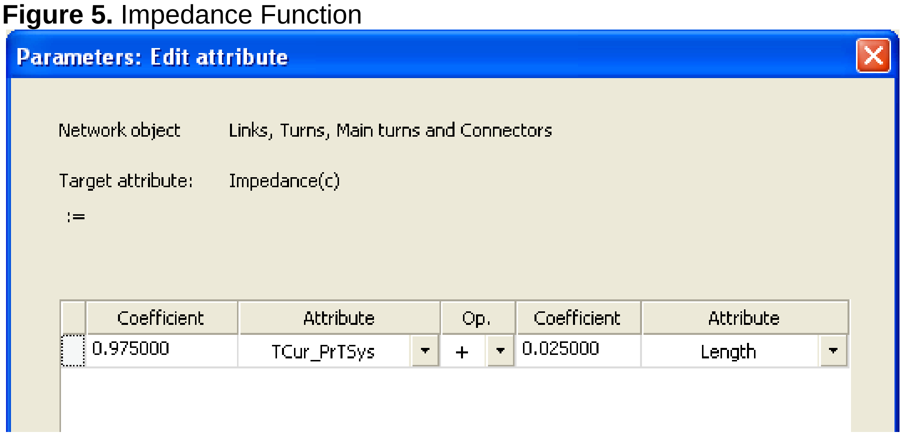
| Number | VDF | Intersection Control |
|---|---|---|
| 1 | 1 | Uncontrolled |
| 2 | 6 | Two-Way Stop |
| 3 | 3 | Signalized |
| 4 | 6 | All-Way Stop |
| 5 | 1 | Diverge |
| 6 | 6 | Emergency Signal |
| 7 | 9 | Merge Point |
| 8 | 8 | Flashing Signal |
| 10 | 9 | Roundabout |
| 11 | 9 | Railroad Crossing Low Use |

The resulting delay at the intersection was compared with delay values for base year Synchro models to determine if the proper amount of delay was being estimated with the volume delay function parameters. This comparison led to minor adjustments in the final calibration of the model.

### *Impedance Calculation*

The impedance function for the base model combines both the link distance as well as travel time. The same impedance function is used for lov, hov and trucks in the model. The weights applied to the travel time and length can be seen in **Figure 5**.

**Figure 5.** Impedance Function




### *Assignment Validation*

In 2006 the PM peak model assignment was validated against traffic counts from 2006-2008. Validation results are provided in **Appendix D**.

## Transit Assignment

The model currently runs transit assignment; however, the results under-estimate ridership significantly.

## Model Calibration

The current model set was calibrated in 2005 and 2006 using the 2005 Spokane and Kootenai County Travel Survey. The survey included 1,221 valid household records in Spokane County (1,828 in both counties).

With the inclusion of home-based college trips (HBC) in 2006, SRTC used several regional sources to calibrate trip generation, distribution and mode choice for HBC trips (off-campus students and university employees). The 1998/1999 Thurston County Travel Survey provided HBC daily trip productions and attractions by persons per household; coefficients from the Bellevue-Kirkland-Redmond Travel Demand Model were used to estimate daily attractions for university students (HBC), university employees (HBW, HBO, and NHB); a friction factor equation for distribution of HBC trips in a gravity model was borrowed from PSRC; and mode choice assumptions for HBC trips were borrowed from the 1998/1999 Thurston County Travel Survey.

## Model Validation

The 2006 model set was validated against traffic counts using a screenline analysis. The screenline analysis includes count data from approximately 180 locations across the Spokane Region, and was completed in accordance to TMIP protocol and acceptable deviations. Traffic counts for the 2006 model validation were from 2006-2008. Validation results are provided in **Appendix D**.

Traffic count data for screenline count locations are collected by SRTC on an annual basis.