Shasta Regional Transportation Agency (SRTA)
Activity-Based Travel Demand (ShastaSIM)
Model Development Report

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Mr. Sean Tiedgen
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Subject: Shasta County AB Travel Model (ShastaSIM)
FINAL DRAFT Model Development Report

Dear Sean Tiedgen:

DKS is transmitting the **FINAL DRAFT** Model Users Guide for the new Shasta County Activity-based Travel Model (ShastaSIM). This model supersedes the previous version of the AB model developed by DKS Associates in 2012 and includes many improvements and enhancements to the model. The inventory of available MOE's has been expanded to better serve SRTA in applying the requirements of SB375.

Please contact me if you have any questions or need additional material for this report.

Sincerely,

David Tokarski
DKS

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

The Shasta Regional Transportation Agency (SRTA), as the designated Metropolitan Planning Organization (MPO) for the Shasta County, has the primary responsibility for the development and maintenance of travel demand forecasting methods and models for the region. To comply with Senate Bill (SB) 375 goals and to conduct regional performance measures analysis, SRTA teamed with DKS Associates, John Bowman, Mark Bradley, and Resource Systems Group Inc. (RSG) to develop a new activity-based (AB) travel model for the Shasta County region. SB 375 is an effort by California to connect and integrate land use, transportation, housing and greenhouse gas (GHG) reduction planning efforts. This report describes the new Shasta AB travel demand model, henceforth referred to as ShastaSIM. The user guide, which provides step-by-step instructions for application of the model, is a separate document.

Model Purpose

ShastaSIM is intended to provide reliable travel forecasts to support regional planning and programming projects, transportation and land use studies, corridor studies, performance measure development and other similar tasks conducted by SRTA and local agencies. Specifically, the region's travel model needs to address: (1) relationships between land-use density/mix and vehicle miles traveled (VMT), and (2) the localized benefits in travel due to sustainable development and pedestrian/transit enhancements. Understanding how the built environment or potential policies may affect travel decisions, VMT, and mode choice goes well beyond the capabilities of a four-step model with traffic-analysis-zones (TAZ). This new model will help to bridge the missing gaps long known in 4-step models and better represent how individuals in Shasta County make transportation choices.

Organization of the Report

The report is organized into nine chapters, as follows:

- Chapter 1 is an introduction and overview of ShastaSIM.
- Chapters 2 through 5 cover key model inputs: (2) parcel land use, (3) population, (4) transportation networks, and (5) all other key inputs.
- Chapters 6 and 7 provide a detailed description of each sub-model which makes up ShastaSIM, as well as the overall structure and flow of the model in its operation. **Figure 1** provides a simplified flow chart for the model, and identifies each major sub-model.
  - Chapter 6 describes *DaySim*, the person-day activity and travel simulator.
  - Chapter 7 describes all other sub-models scripted in Citilabs® CUBE Base/Voyager software.
- Chapter 8 covers key model outputs and validation results.
- Chapter 9 includes Measures of Effectiveness (MOE's) that have been calculated for households, roadways and transit.

Shasta County Four-Step Travel Model

For the past two decades the travel model for the Shasta County region has been a conventional four-step travel demand model similar in structure to many regional models used for traffic forecasting across the country. It uses land use, socioeconomic, and road network data to estimate travel patterns, roadway traffic volumes and transit volumes. Over the years the travel model has undergone several updates and enhancements. Most recently being the November 2011 "update-light" version.

The Shasta County four-step travel model was replaced by the new activity-based model on June 24, 2014, which was adopted by SRTA's Board of Directors. However, the four-step model will be retained by SRTA and lead agencies until all past projects that used the four-step model for analysis are complete. SRTA archives past travel models for reference as needed.

New Shasta County Activity-Based (AB) Travel Model - ShastaSIM

The new Shasta AB travel demand model (ShastaSIM) is an advanced forecasting tool that simulates individuals' travel patterns as a series of "trip-legs" connecting activities during the course of a 24-hour day. Travel behavior is no longer analyzed at a TAZ level; but simulated at the parcel level. The parcel-level land use data, combined with the population synthesis approach, provides an unprecedented level of model sensitivity and detail regarding representation of land use and its effects on travel behavior.

DaySim is the person-day activity and travel simulator, which is the activity-based, tour component of the new model. *DaySim* accounts for all travel by "residents" of Shasta County, where their travel remains within the region. The simulation is at a person level, so the major outputs of *DaySim* relate to personal travel for work, school, social/recreational, and other non-work purposes. *DaySim* includes a set of long-term choice models at the highest level, and a larger set of short-term choice models at lower levels. The term *simulation* is used in various ways related to transportation modeling and analysis. For the purposes of this model, simulation refers to two characteristics of transportation simulations which apply to activity-based models, and distinguish them from four-step travel demand models: (1) disaggregate application; and (2) explicit treatment of time.

DaySim is disaggregating in its application—its units of analysis, or "agents", are people. The units of analysis for conventional four-step models are TAZ's. *DaySim* applies models estimated on a household travel survey of individual people to a representative population file with one record per person. All person-level variables in the estimation are accounted for explicitly in the model and can be grouped by household. This data can be summed by TAZ, Census tract, city boundary or by any other acceptable boundary file available in the model. For conventional four-step models, many of the key variables included in the estimated model are aggregated and simplified at the TAZ level, with true distributions of behavior represented by the averages for groups of individuals.

DaySim also explicitly treats time. Durations of activities and travel times are constrained by the length of a 24-hour day and travel choices, as modeled, account for time explicitly in minute blocks. Most conventional four-step models actually model a complete day's travel as a number of trips, with those trips assigned to time "blocks" using fixed time factors.

Although ShastaSIM is very different in structure to the four-step travel model; it shares and uses many similar parts and most of the data of the "update light" version. This includes networks, skims, external travel, and assignment. Like the four-step model, ShastaSIM runs within an application shell, scripted in Citilabs® CUBE Voyager software. *DaySim* itself is a stand-alone program written in Pascal, and compiled to run within the model application. All trip aggregation, plus the non- *DaySim* components, are Voyager scripts. Many input data files were prepared using GIS shapefiles (ArcView GIS) or tables (Microsoft Excel 2010).

The current model version is: ShastaSIM 1.0.

Travel Model Software and Technical Requirements

ShastaSIM uses the Citilabs® Cube Base and Voyager software (currently version 6.1) to run the model. Users of the model must have their own licensed copy of the software to run the model. All other components, including DaySim will be included on a copy of the 2014 ShastaSIM Travel Demand Model CD.

Technical Requirements

Because ShastaSIM is a more complex model the following additional components beyond Cube software are required to run the model:

- **Microsoft Office 2010 (specifically Excel)**

The following are the minimum computer system requirements to run the model:

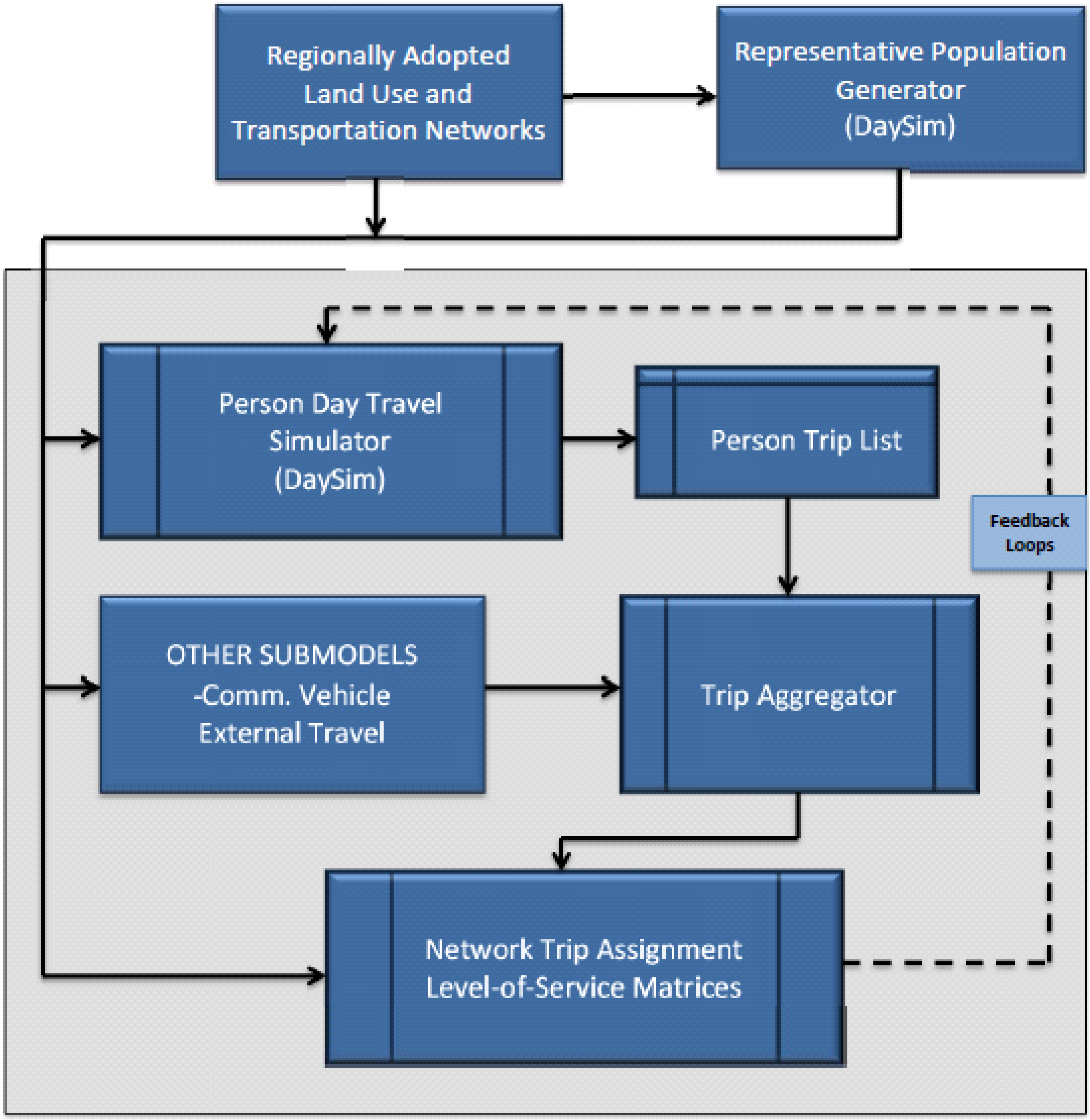
- Intel Core 2 Duo
- 4GB of RAM
- 15GB of hard drive space
- 32-bit Operating system
- **Windows Vista/7/8***
  **Because the Windows XP operating system is no longer supported by Microsoft, it is not recommended.*

SRTA currently runs the model using the following computer system†:

- Dell Precison T5600
- Intel® Xeon® CPU E5-2643 0 @ 3.30 GHz (2 processors)
- 32GB of RAM
- 64-bit Operating System
- Windows 7

†Note: Model run times average 5.5 hours per model year with SRTA's current setup.

Figure 1: Travel Model Process



2. PARCEL-POINT LAND USE DATA

The extent of ShastaSIM covers all of Shasta County. One of the distinguishing features of the model is that it utilizes the county's Geographic Information System (GIS) parcel database (2012). Parcels are the basic spatial unit for referencing socioeconomic data such as households and population. This chapter presents the details and process for assembling the model parcel-point data file.

Parcel File

The county GIS database consists of approximately 95,000 parcels. *Parcels* are pieces of land with area, shape, and location defined by assessor's maps and records. In general, this definition applies to the county GIS database, with a couple of caveats:

- Parcelization is based on the best assessor's records available in electronic form in the year 2010. Subdivisions of parcels since 2010 are not included in the parcelization.
- Large parcels were manually gridded down to "false" or "pseudo" parcels, which have no bearing to assessor's records. Meaning that they were broken down to smaller parcels for model analysis purposes only.

A *parcel-point* is a dimensionless point located roughly at the geographic center of a parcel, and used to represent the location of that parcel by an x-and y-coordinate system. The projection system used for the GIS and model files is the NAD 83 State Plane California Zone 1 coordinate system, applied in linear feet.

All land use is allocated to a parcel point in the model parcel-point data file. Use of parcels allows for a more detailed, spatially disaggregate description of the land use in a region than TAZ-based models (which may have anywhere from 1 to 100+ parcels within one TAZ). As a result this provides greater sensitivity to fine-grained urban form and accessibility attributes, particularly with respect to transportation and land use. However, use of these detailed measures results in the need to develop and manage larger quantities of data.

The parcel data input file is a comma-delimited ASCII text format file (.csv) with one row of data per parcel. **Table 1** shows the fields contained in the parcel data input file. The file contains fields that identify the parcel, describe the physical location and size of the parcel, describe the quantity and/or type of housing, school enrollment, and employment possible to exist on the parcel, and identifies those same characteristics within a quarter- and half mile of the parcel. In addition, the parcel file contains information about urban form and how close the transportation system is to the parcel, including the proximity to transit stops, and the price and supply of parking.

TABLE 1: PARCEL DATA INPUT (PARCEL_*UPDATE_ALLOCHH.CSV)* FILE FORMAT

FIELD	DESCRIPTION
parcelid	parcel ID number
xcoord_p	X coordinate – state plane feet
ycoord_p	Y coordinate – state plane feet
sqft_p	Area – square feet
taz_p	TAZ number
block_p	census block
SFDU	single family dwelling units on parcel
MF2_4DU	multi-family (2-4 units) dwelling units on parcel
MF5+DU	multi-family (5+ units) dwelling units on parcel
MHDU	mobile home dwelling units on parcel
TOT_DU	total dwelling units on parcel
SFHH	single family occupied households on parcel
MF2_4HH	multi-family (2-4 units) occupied households on parcel
MF5+HH	multi-family (5+ units) occupied households on parcel
MHHH	mobile home occupied households on parcel
TOT_HH	total occupied households on parcel
stugrd_p	grade school enrollment on parcel
stuhgh_p	high school enrollment on parcel
stuuni_p	university enrollment on parcel
empedu_p	educational employment on parcel
empfoo_p	food employment on parcel
empgov_p	government employment on parcel
empind_p	industrial employment on parcel
empmed_p	medical employment on parcel
empofc_p	office employment on parcel
empret_p	retail employment on parcel
empsvc_p	service employment on parcel
empoth_p	other employment on parcel
emptot_p	total employment on parcel
parkdy_p	off-street daily parking on parcel
parkhr_p	off-street hourly parking on parcel
ppricdyp	off-street daily parking price
pprichrp	off-street hourly parking price
track	census tract
group	census block group

Parcel Buffering

To create the detailed parcel file, including all buffer, urban form, and transit access measures, an automated software tool has been developed called ParcelBuffer. ParcelBuffer is a standalone executable program that is called through a Voyager script named "create_buffers.s". This tool requires a set of established inputs, including:

- Parcel_Base file
- Intersection file
- Transit stop file
- Open space file

Once the four required inputs are created and updated ParcelBuffer is ready to run. Descriptions of each required input are provided below.

Parcel_Base

The parcel_base file is the primary file used to maintain socioeconomic information. This file contains information on the geographic location of the file, corresponding aggregate geographies, households, school enrollment by grade level, employment by sector and parking. The parcel_base file is currently a comma-separated-value format file (.csv). The Voyager script reads in the comma-separated-value format file (.csv) and outputs a dBase file (.dbf) then calls ParcelBuffer.

Parcel ID / Coordinates / Area

The parcelid field stores a unique alphanumeric value that is useful for relating the records of the *DaySim* table back to the original source files. Currently, the original source files are from the County's GIS parcel-level database.

The x_coord and y_coord fields store the X and Y NAD 83 State Plane coordinates of each parcel's location. The location is a point within the parcel area and closest to the centroid as possible. The precision of the coordinates is to the nearest foot and therefore these fields store the data as Long Integers.

The sqft_p field stores the area of the parcel in square feet. This is calculated from the geometric area of the parcel polygon feature. Some parcels may have a geometry that is corrupt, which would result in zero square feet. For these anomalies, the area can be manually calculated to a reasonable value (i.e. 1000 sq-ft).

Households

Parcel-level information on households is used to allocate the synthetic population down to individual parcels and to influence destination choices. This data, compiled from the county's GIS parcel data, may potentially be refined or enhanced with additional data sources such as the United States Census. A more detailed description of household characteristics is discussed in Chapter 3: Population.

Employment

Parcel-level information on the total number of jobs, by employment type, for each parcel is a critical model input. In *DaySim*, the number of workers attracted to each employment site is calibrated to the number of jobs available at that site. Employment numbers for the model were based on a detailed inventory of employers in year 2004, starting with a commercial database from InfoUSA and supplemented by manual review and checks of government employment locations and major missing employers. Employment information was re-estimated to 2010 conditions as a part of SRTA's 2011 "Update Light" model improvement project; which included adjustments to account for the economic recession and estimated a 20-year timeframe before returning to a "normal" economic climate. The detailed employment database includes point/location level data on the number of employees at that location by employment sector. It should be noted that the business location database was reviewed and updated as best as possible by members of the Shasta Model Users Group during the 2011 "Update Light" project for the region's four-step model.

The employment sectors used in the *DaySim* activity-based model system are more aggregate than those developed to support the previous trip-based model. The previous twenty-two detailed trip-based model employment sectors were collapsed into nine employment categories. The nine employment categories for ShastaSIM are:

- Education (EMPEDU),
- Food (EMPFOO),
- Government (EMPOV),
- Industrial (EMPIND),
- Medical (EMPMED),
- Office (EMPOFC),
- Retail (EMPRET),
- Service (EMPSVC)
- Other (EMPOTH

Table 2 summarizes the correspondence between the original employment sectors and the more aggregate employment sectors used in the activity-based model system.

Enrollment

Like workers, the number of students that are attracted to each school location is calibrated to the enrollment available, by grade-level, at that school location. As a result, parcel-level information on school enrollment is necessary. *DaySim* distinguishes school grade levels by three enrollment sectors:

- Grade school enrollment (K-8)
- High school enrollment (9-12)
- University enrollment (post-secondary)

In Shasta County, the enrollment by sector was initially derived from 2010 school enrollment data provided by the California Department of Education. This data included information on enrollment by grade for all schools in the county. The school locations were geocoded and associated with parcels.

TABLE 2: ORIGINAL 4-STEP MODEL TO DAYSIM EMPLOYMENT CONVERSION

ORIGINAL	DESCRIPTION	*DAYSIM*
Industrial	Manufacturing and light industrial	EMPIND
Wholesale	Wholesale, trucking	EMPIND
Service Commercial	Construction supplies and services	EMPSVC
Retail	Stores and shopping centers	EMPRET
Retail High	Convenience stores, gas stations	EMPRET
Retail Warehouse	Big box stores	EMPRET
Office	Non-government office	EMPOFC
School	Public schools, private schools, administration	EMPEDU
College	Large and small colleges and universities	EMPEDU
Medical Office	Medical, dental, veterinary offices	EMPMED
Hospital		EMPMED
Residential Care	Assisted living, skilled nursing facilities	EMPMED
Child Care		EMPMED
Developed Recreation	Marinas, camps, movie theaters, golf courses, museums	EMPSVC
UNUSED	Reserved for additional category	EMPSVC
Casino		EMPSVC
Hotel	Hotel, motel	EMPSVC
Restaurant	Stand-alone, not including fast food	EMPFOO
Restaurant High	Fast-food	EMPFOO
Institutional	Religious, clubs	EMPSVC
Government	Government offices	EMPGOV
Government High	Post office branches, DMV, libraries	EMPGOV

Parking

Off-street parking location and pricing information is used in the model system to influence transportation mode and other choices. However, this parking information is focused on publically accessible off-street locations and does not consider private off-street parking locations (such as those available only to workers in an office building); nor does it consider location of on-street parking**.** The parking feature is currently not used in the Shasta model, but a place holder exists for potential enhancements. For all parcels, the parking attributes should be set to '0.'

Process to Create

The parcel base file is created in a macro-enabled spreadsheet process. The "CREATE_PARCELSNEW.XLSM" file is a macro enabled Excel2010+ spreadsheet that updates the parcel land use database to the year of analysis desired. The spreadsheet tool is similar to the tools used by the previous 4-step model – in that it adds future development phases to a base year (2010) land use database and updates the household occupancy for the year of analysis. Occupancy rates are based on 2010 census block group data and applied at a parcel level. The output is the parcel base coma-separated-value format file (.csv) required for buffering, called PARCEL_UPDATE_ALLOCHH.CSV, as described in **Table 1**.

QA/QC

Given the number and diversity of data items in the parcel_base file, it is important to ensure that when edits, changes or updates are made to this file that the values are coded correctly. A preliminary, but not exhaustive list of QA/QC checks might include:

- Ensuring that there are no negative values in any of the fields
- Ensuring the sum of employment sectors equals total employment
- Checks against land use type
- Checks of households and employment against trip-based model inputs

Intersections

A unique, parcel-level measure of urban form that *DaySim* uses is nodes. *DaySim* identifies the number of intersections or nodes of different types and calculates ¼- and ½-mile buffers to characterize the pattern (or accessibility) of urban development. These intersection types include: dead-ends (1 link), T-intersections (3-links), and traditional intersections (4+ links). The intersection file, which is used as input for the ParcelBuffer, is currently a DBF format file. **Table 3** summarizes the contents of this file.

TABLE 3: INTERSECTION FILE (INTERSECTIONS.DBF) FORMAT

FIELD	DESCRIPTION
id	Intersection ID number
links	Number of links associated with node
xcoord_p	X coordinate – state plane feet
ycoord_p	Y coordinate – state plane feet

A largely automated process has been developed to calculate these urban form measures for the Shasta County region based on detailed, GIS-based street centerline files. The GIS files are more detailed than the modeled network – which does not include all streets in the region. This process first analyzes the GIS street centerline file to locate nodes and assign an "intersection type" code to them based on the number of links joined to the node. The process then creates quarter mile and half mile buffer areas around each parcel and then counts the number of intersections of each type that fall within the buffers.

Transit Stops

In addition to using zone-level information on access times to transit, *DaySim* also incorporates detailed parcel-level information on the distance to transit by transit sub-mode. For ShastaSIM, all bus stops are coded as sub-mode one. The transit stop file used as input to the ParcelBuffer is currently a DBF format file. **Table 4** summarizes the contents of this file.

TABLE 4: TRANSIT STOP FILE (TRANSIT_STOPS.DBF) FORMAT

FIELD	DESCRIPTION
id	Intersection ID number
mode	Transit sub-mode code
xcoord_p	X coordinate – state plane feet
ycoord_p	Y coordinate – state plane feet

The primary source for bus stop data was a shapefile of transit stop locations from the Redding Area Bus Authority (RABA), last updated December 2013. The GIS information includes specific locations of all bus stops located in the county. In addition to the bus stops located in urban areas of the county, it is also necessary to incorporate bus stop locations for rural transit routes into the model, such as Burney Express. Currently only RABA's fixed-route system is included in the model. Demand response services are not included due to the difficulty in accurately modeling them.

Open Space

Although not currently used in the ShastaSIM model, a unique feature of *DaySim* is that it can incorporate measures of access to publicly accessible open space. The open space measures incorporated into *DaySim* capture the proximity of each parcel to the nearest open space, and the amount of open space within different access bands from the parcel. The open space file used as input to the ParcelBuffer is currently a DBF format file. **Table 5** summarizes the contents of this file.

TABLE 5: OPEN SPACE FILE (OPEN_SPACE.DBF) FORMAT

FIELD	DESCRIPTION
id	Intersection ID number
xcoord_p	X coordinate – state plane feet
ycoord_p	Y coordinate – state plane feet
sqft	Open space grid cell size in sq ft

The resultant buffered parcel file is detailed in **Table 6**.

TABLE 6: BUFFERED PARCEL DATA (SHASTA_PARCEL_QANDH.CSV) FILE FORMAT

FIELD	DESCRIPTION
parcelid	parcel ID number
xcoord_p	X coordinate – state plane feet
ycoord_p	Y coordinate – state plane feet
sqft_p	Area – square feet
taz_p	TAZ number
lutype_p	land use type
hh_p	households on parcel
stugrd_p	grade school enrollment on parcel
stuhgh_p	high school enrollment on parcel
stuuni_p	university enrollment on parcel
empedu_p	educational employment on parcel
empfoo_p	food employment on parcel
empgov_p	government employment on parcel
empind_p	industrial employment on parcel
empmed_p	medical employment on parcel
empofc_p	office employment on parcel
empret_p	retail employment on parcel
empsvc_p	service employment on parcel
empoth_p	other employment on parcel
emptot_p	total employment on parcel
parkdy_p	off-street daily parking on parcel
parkhr_p	off-street hourly parking on parcel
ppricdyp	off-street daily parking price
pprichrp	off-street hourly parking price
hh_1	households within buffer 1 (quarter mile)
stugrd_1	grade school enrollment within buffer 1 (quarter mile)
stuhgh_1	high school enrollment within buffer 1 (quarter mile)
stuuni_1	university enrollment within buffer 1 (quarter mile)
empedu_1	educational employment within buffer 1 (quarter mile)
empfoo_1	food employment within buffer 1 (quarter mile)
empgov_1	government employment within buffer 1 (quarter mile)
empind_1	industrial employment within buffer 1 (quarter mile)
empmed_1	medical employment within buffer 1 (quarter mile)
empofc_1	office employment within buffer 1 (quarter mile)
empret_1	retail employment within buffer 1 (quarter mile)
empsvc_1	service employment within buffer 1 (quarter mile)
empoth_1	other employment within buffer 1 (quarter mile)
emptot_1	total employment within buffer 1 (quarter mile)
parkdy_1	off-street daily parking within buffer 1 (quarter mile)

TABLE 6: BUFFERED PARCEL DATA (SHASTA_PARCEL_QANDH.CSV) FILE FORMAT

parkhr_1	off-street hourly parking within buffer 1 (quarter mile)
ppricdy1	average off-street daily parking price within buffer 1 (quarter mile)
pprichr1	average off-street hourly parking price within buffer 1 (quarter mile)
nodes1_1	number of single link street nodes (dead ends) within buffer 1 (quarter mile)
nodes3_1	number of three-link street nodes (T-intersections) within buffer 1 (quarter mile)
nodes4_1	number of 4+ link street nodes (traditional 4-way +) within buffer 1 (quarter mile)
tstops_1	number of transit stops within buffer 1 (quarter mile)
nparks_1	number of open space parks within buffer 1 (quarter mile)
aparks_1	open space area in square feet within buffer 1 (quarter mile)
hh_2	households within buffer 2 (half mile)
stugrd_2	grade school enrollment within buffer 2 (half mile)
stuhgh_2	high school enrollment within buffer 2 (half mile)
stuuni_2	university enrollment within buffer 2 (half mile)
empedu_2	educational employment within buffer 2 (half mile)
empfoo_2	food employment within buffer 2 (half mile)
empgov_2	government employment within buffer 2 (half mile)
empind_2	industrial employment within buffer 2 (half mile)
empmed_2	medical employment within buffer 2 (half mile)
empofc_2	office employment within buffer 2 (half mile)
empret_2	retail employment within buffer 2 (half mile)
empsvc_2	service employment within buffer 2 (half mile)
empoth_2	other employment within buffer 2 (half mile)
emptot_2	total employment within buffer 2 (half mile)
parkdy_2	off-street daily parking within buffer 2 (half mile)
parkhr_2	off-street hourly parking within buffer 2 (half mile)
ppricdy2	average off-street daily parking price within buffer 2 (half mile)
pprichr2	average off-street hourly parking price within buffer 2 (half mile)
nodes1_2	number of single link street nodes (dead ends) within buffer 2 (half mile)
nodes3_2	number of three-link street nodes (T-intersections) within buffer 2 (half mile)
nodes4_2	number of 4+ link street nodes (traditional 4-way +) within buffer 2 (half mile)
tstops_2	number of transit stops within buffer 2 (half mile)
nparks_2	number of open space parks within buffer 2 (half mile)
aparks_2	open space area in square feet within buffer 2 (half mile)
dist_lbus	distance to nearest local bus stop from parcel
dist_ebus	distance to nearest express bus stop from parcel
dist_crt	distance to nearest commuter rail stop from parcel
dist_fry	distance to nearest ferry stop from parcel
dist_lrt	distance to nearest light rail stop from parcel
dist_park	distance to nearest park from parcel

3. POPULATION AND EMPLOYMENT

DaySim is the person-day activity and travel simulator, which is the true activity-based tour component of the new ShastaSIM model. *DaySim* accounts for all travel by residents of Shasta County where their travel remains within the region. The simulation is at a "person level", so the major outputs of *DaySim* relate to personal travel for work, school, social/recreational, and other non-work purposes. Hence, prior to applying the *DaySim* model, it is necessary to first develop a "synthetic population" of regional residents. This chapter presents the details and process for assembling the ShastaSIM population data file.

Synthetic Population

The population data input file is a comma-separated-value format file (.csv) with one row of data per person. **Table 7** shows the fields contained in the population data input file.

TABLE 7: POPULATION FILE *(20XX_POPULATION.DBF)* FORMAT

FIELD	DESCRIPTION
serialno	Household id
pnum	Person # within household
hhtaz	Household TAZ
hhcel	Household parcelid
persons	Total persons in household
tenure	Own (1), rent(2)
bldgsz	Residence building size/type
p65	# of persons age 65+ in household
p18	# of persons age under 18 in household
npf	# of persons part of family in household
noc	# of children in household
hinc	Household income
vehicl	# of vehicles in household
relate	Relationship to householder
sex	Gender: male (1), female (2)
age	Age
grade	Current education school type
hours	Hours worked per week
worker	Worker: yes (1), no(0)
student	Enrolled student: yes (1), no(0)
nworkers	# of employed workers in household
nstudent	# of enrolled students in household
exfac	Expansion factor (assigned later)

The file begins with the "serialno," field which is a unique alphanumeric value that is useful for relating people to a household. The population file then contains several fields that describe the household that the person lives in (hhtaz, hhcel, persons, tenure, bldgsz, p65, p18, npf, noc, hinc, vehicl, relate, nworkers, and nstudent). Of the household fields, all fields except tenure and bldgsz are numeric quantities (i.e. if persons = 5, then the household has 5 people living there).

The tenure field describes home ownership and has a range from one to two where: (1) the house is owned and (2) the house is rented.

The bldgsz field describes the type of home and has a range from one to ten where: (1) mobile home, (2) detached single-family house, (3) attached single-family house, (4) 2 unit apartment, (5) 3-4 unit apartment, (6) 5-9 unit apartment, (7) 10-19 unit apartment, (8) 20-49 unit apartment, (9) 50+ unit apartment, and (10) boat, RV, van, etc.

The remaining fields in the population file describe the individual person (pnum, relate, sex, age, grade, hours, worker, and student). All the person fields are numeric values.

The relate field describes the relationship of the persons within a household and has twenty-one categories: 1 = householder, 2 = spouse, 3 = child, 4 = adopted child, 5 = stepchild, 6 = sibling, 7 = parent, 8 = grandchild, 9 = parent in-law, 10 = child in-law, 11 = other relative, 12 = sibling in-law, 13 = nephew/niece, 14 = grandparent, 15 = aunt/uncle, 16 = cousin, 17 = boarder, 18 = housemate, 19 = unmarried partner, 20 = foster child, and 21 = other non-relative.

The sex field describes gender and has a range from one to two where: (1) the person is male, and (2) the person is female.

The grade field describes the school grade level of each person and has a range from zero to seven where: (0) not enrolled, (1) preschool, (2) kindergarten, (3) grade 1-4, (4) grade 5-8, (5) grade 9-12, (6) college undergrad, and (7) college grad school.

The population file is created using DaySIM. The main input files required for population generation include:

- Parcel.dbf (parcel file)
- TAZ.dbf (TAZ data file)
- Marg_4.dbf (household marginal file)
- Pums_shas_acs08_12.dbf (PUMS sample file)

As discussed above, the parcel file includes data for every parcel countywide, including number of households and employees by category (per parcel and within ¼ and ½ mile buffer), distance to transit stops, and parking price data. The TAZ file includes data generalized by TAZ. The household marginal file is calculated from the parcel file and includes the TAZ number and the numbers of single family, multi-family (2-4 units), multi-family (5+ units), and number of households in mobile homes, RVs, boats, etc.

The PUMS (Public Use Microdata Sample) file includes sample data from the US Census and American Community Survey (ACS). PUMS has been updated to the 2008-2012 five-year sample, which includes scaled household sample data, e.g. household income, number of persons, workers, non-workers, students, and vehicles per sample household. Data also includes number of persons by gender and by age group (under 18, 18 to 65, and over 65).

Sample data are based on the 2008-2012 Public Use Microdata Area (PUMA) for Shasta County (represented by the number 8900). The PUMA number in the table is a single "filler" number valid for the Shasta region.

The model uses DaySIM's built-in population synthesizer in order to generate the population for each model year. The 2010 US Census and most recent ACS provide the background data. The process attempts to replicate the population data included in Shasta County's 2010 Regional Housing Need Allocation (RHNA) as closely as possible. **Table 8** shows a comparison between the model-generated 2010 population numbers and the County's 2010 RHNA numbers (derived from the 2010 Census).

TABLE 8: 2010 POPULATION ESTIMATES

JURISDICTION	Model	Census/ RHNA	Error	Error %
REDDING	90,794	89,861	+933	+1.1%
ANDERSON	9,795	9,932	-137	-1.4%
SHASTA LAKE	9,827	10,164	-337	-3.3%
UNINCORPORATED COUNTY	66,049	67,266	-1,217	-1.8%
TOTAL SHASTA COUNTY	**176,465**	**177,223**	**-758**	**-0.4%**

Table 9 and **Table 10** show the five year incremental population and household growth for the County and each local jurisdiction. DKS has worked closely with SRTA staff to develop household forecasts consistent with previous modeling efforts and RHNA estimates. It should be noted however that population is an output of the model and it is not possible to force and exact population to match the forecast assumptions exactly. More detail into the development of the households and population forecasts is available on SRTA's website at: http://www.srta.ca.gov/pastel/RT_TDM.htm and from agenda item #10 of the June 24, 2014, SRTA Board of Directors meeting.

TABLE 9: POPULATION AND HOUSEHOLD PROJECTIONS

Population	2005	2010	2015	2020	2025	2030	2035
Shasta County Total	174,495	176,465	182,261	191,855	199,968	207,383	214,723
Redding	89,936	91,148	95,570	102,858	106,232	108,455	113,057
Anderson	9,767	9,796	10,523	11,085	13,030	13,183	13,414
Shasta Lake	10,040	9,888	9,936	10,172	10,806	11,229	11,336
Unincorporated County	64,752	65,633	66,232	67,740	69,900	74,516	76,916
Households	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Shasta County Total	70,343	71,136	73,471	77,277	80,597	83,644	86,546
Redding	36,170	36,795	38,613	41,431	42,873	43,831	45,482
Anderson	3,926	3,991	4,204	4,528	5,260	5,260	5,335
Shasta Lake	3,993	4,008	4,034	4,073	4,298	4,528	4,583
Unincorporated County	26,254	26,342	26,620	27,245	28,166	30,025	31,146

TABLE 10: POPULATION AND HOUSEHOLD GROWTH

Population Growth	2005-2010	2010-2015	2015-2020	2020-2025	2025-2030	2030-2035
Shasta County Total	1,970	5,796	9,594	8,113	7,415	7,340
Redding	1,212	4,422	7,288	3,374	2,223	4,602
Anderson	29	727	562	1,945	153	231
Shasta Lake	-152	48	236	634	423	107
Unincorporated County	881	599	1,508	2,160	4,616	2,400
Households Growth	**2005-2010**	**2010-2015**	**2015-2020**	**2020-2025**	**2025-2030**	**2030-2035**
Shasta County Total	793	2,335	3,806	3,320	3,047	2,902
Redding	625	1,818	2,818	1,442	958	1,651
Anderson	65	213	324	732	0	75
Shasta Lake	15	26	39	225	230	55
Unincorporated County	88	278	625	921	1,859	1,121

Employment Projections

Employment projections are based on revised employment projections contained within the November 2011 4-step model update, and the updated phased development assumptions table; with data provided by the local jurisdictions and SRTA. **Table 11** shows employment projections by 5-year increments and by models employment sectors.

TABLE 11: EMPLOYMENT PROJECTIONS BY JURISDICTION AND REGIONWIDE TOTAL

Total County	2005	2010	2015	2020	2025	2030	2035
Education	3,612	3,686	4,749	4,939	5,129	5,384	5,639
Food	4,265	4,323	4,429	4,586	4,666	4,749	4,774
Government	7,240	7,089	7,182	7,312	7,442	7,572	7,702
Office	10,111	10,487	11,796	12,556	13,212	13,715	14,185
Other	-	553	1,428	2,434	3,275	3,923	4,128
Retail	10,788	10,788	10,788	10,788	10,788	10,788	10,788
Service	8,989	9,081	10,816	11,723	12,143	12,385	13,493
Medical	9,223	9,214	9,244	9,414	9,584	9,754	9,924
Industrial	7,985	8,443	9,092	9,728	10,301	11,092	11,442
Total	**62,213**	**63,664**	**69,524**	**73,480**	**76,540**	**79,362**	**82,075**

Redding	2005	2010	2015	2020	2025	2030	2035
Education	1,548	1,548	1,638	1,703	1,768	1,898	1,978
Food	3,350	3,359	3,431	3,536	3,608	3,659	3,659
Government	5,483	5,492	5,542	5,622	5,702	5,782	5,862
Office	8,392	8,699	9,502	10,083	10,628	11,027	11,344
Other	-	393	936	1,475	1,956	2,349	2,494
Retail	7,606	7,649	7,649	7,649	7,649	7,649	7,649
Service	5,475	5,635	7,230	7,987	8,296	8,488	9,194
Medical	7,639	7,623	7,633	7,758	7,883	8,008	8,133
Industrial	4,032	4,364	4,636	4,916	5,232	5,743	6,043
Total	**43,525**	**44,762**	**48,197**	**50,729**	**52,722**	**54,603**	**56,356**

Anderson	2005	2010	2015	2020	2025	2030	2035
Education	247	247	257	267	277	287	297
Food	273	299	302	316	318	322	322
Government	145	145	148	158	168	178	188
Office	384	398	443	484	518	541	541
Other	-	34	105	162	201	235	235
Retail	885	1,065	1,065	1,065	1,065	1,065	1,065
Service	588	594	600	634	680	686	988
Medical	254	254	254	254	254	254	254
Industrial	513	551	613	660	697	735	735
Total	**3,289**	**3,587**	**3,787**	**4,000**	**4,178**	**4,303**	**4,625**

TABLE 11: EMPLOYMENT PROJECTIONS BY JURISDICTION AND REGIONWIDE TOTAL

Shasta Lake	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Education	146	146	196	206	216	226	236
Food	136	169	171	177	179	180	180
Government	359	359	369	379	389	399	409
Office	177	181	198	211	218	223	223
Other	-	22	50	164	302	384	444
Retail	426	410	410	410	410	410	410
Service	273	280	292	312	314	315	315
Medical	137	137	137	137	137	137	137
Industrial	284	207	235	267	305	379	429
Total	**1,938**	**1,911**	**2,058**	**2,263**	**2,470**	**2,653**	**2,783**

Unincorporated Shasta County	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**
Education	1,671	1,745	2,658	2,763	2,868	2,973	3,128
Food	506	496	525	557	561	588	613
Government	1,253	1,093	1,123	1,153	1,183	1,213	1,243
Office	1,158	1,209	1,653	1,778	1,848	1,924	2,077
Other	-	104	337	633	816	955	955
Retail	1,871	1,664	1,664	1,664	1,664	1,664	1,664
Service	2,653	2,572	2,694	2,790	2,853	2,896	2,996
Medical	1,193	1,200	1,220	1,265	1,310	1,355	1,400
Industrial	3,156	3,321	3,608	3,885	4,067	4,235	4,235
Total	**13,461**	**13,404**	**15,482**	**16,488**	**17,170**	**17,803**	**18,311**

Phased Development Projects

The development years for major projects, provided by local jurisdictions, were adjusted in order to fit within the overall Shasta County growth projections (**Table 12**). In particular, several development areas are not projected to be fully built out until after 2040.

TABLE 12: UPDATED PHASED DEVELOPMENT TABLE

ANDERSON

Development	Land Use	Units	2010	2015	2020	2025	2030	2035	2040	After 2040	TOTAL	% by 2040
Anderson Commercial	Retail	SF	0	0	10,000	0	0	0	58,500	58,500	127,000	54%
Anderson Condos	MF Attached	DU	0	70	0	0	0	0	0	0	70	100%
Anderson Conference Facility	Restaurant	SF	0	2,500	0	0	0	0	0	0	2,500	100%
Anderson Potential	Retail	SF	0	0	0	0	0	130,000	66,000	130,000	326,000	60%
Target Site	Fast Food	SF	0	2,500	0	0	2,500	2,500	0	0	7,500	100%
Church Property	SF Detached	DU	0	0	0	0	0	69	0	0	69	100%
Silvergate Subdivision	MF Attached	DU	16	16	0	0	0	0	0	0	32	100%
River Pointe	SF Detached	DU	0	0	0	111	74	0	0	0	185	100%
Homewood	SF Detached	DU	43	60	0	0	0	0	0	0	103	100%
Vineyards	SF Detached	DU	15	85	157	722	848	981	839	648	4,295	85%
	MF Attached	DU	0	640	0	287	287	0	0	0	1,214	100%
	Retail	SF	0	0	0	0	0	70,000	20,000	50,000	140,000	64%
	Office	SF	0	0	0	0	0	50,000	0	50,000	100,000	50%
	School	Emp	0	0	0	0	0	50	50	0	100	100%
Willow Glen	SF Detached	DU	28	28	0	0	0	0	0	0	56	100%

REDDING

Development	Land Use	Units	2010	2015	2020	2025	2030	2035	2040	After 2040	TOTAL	% by 2040
Airpark Manor	SF Detached	DU	10	10	0	0	0	0	0	0	20	100%
Airport Rd. Auto Dealer Site	Service Comm	SF	0	0	0	0	0	44,000	135,000	0	179,000	100%
Alize Subdivision	SF Detached	DU	0	93	87	0	0	0	0	0	180	100%
Avalon Park	SF Detached	DU	0	55	0	0	0	0	0	0	55	100%
Bel Air	SF Detached	DU	13	12	0	0	0	0	0	0	25	100%
Bel Air Estates	SF Detached	DU	149	0	0	0	0	0	0	0	149	100%
Buenaventura Senior Hsg	Senior Housing	DU	0	0	120	0	0	0	0	0	120	100%
Chapel of the Ferns	SF Detached	DU	0	0	80	0	0	0	0	0	80	100%

TABLE 12: UPDATED PHASED DEVELOPMENT TABLE

City of Redding	Industrial	SF	0	0	0	0	0	198,000	298,000	496,000	992,000	50%
Clover Creek	Office	SF	0	0	0	36,400	0	36,400	0	0	72,800	100%
Cottages at Bel Air	SF Detached	DU	14	41	0	0	0	0	0	0	55	100%
Del Monte PSL	Retail	SF	0	0	0	0	0	0	61,500	67,000	128,500	48%
East Oaks Estates	SF Detached	DU	37	37	0	0	0	0	0	0	74	100%
Emily Estates	SF Detached	DU	58	0	0	0	0	0	0	0	58	100%
Fleur de Lac	SF Detached	DU	39	39	0	0	0	0	0	0	78	100%
Forootan	SF Detached	DU	0	0	23	41	41	41	41	0	187	100%
Gironda	SF Detached	DU	0	0	102	102	103	0	0	0	307	100%
Gold Hills Park	SF Detached	DU	0	175	0	0	0	0	0	0	175	100%
Green	Retail	SF	0	0	0	0	0	4,000	0	0	4,000	100%
Highland Park	SF Detached	DU	0	100	200	120	0	0	0	0	420	100%
Hilltop Center	Retail	SF	0	46,500	46,500	0	0	0	0	0	93,000	100%
Hilltop Estates	SF Detached	DU	27	0	0	0	0	0	0	0	27	100%
Hinds Feet LLC	SF Detached	DU	0	0	11	37	0	0	0	0	48	100%
Hope Lane	SF Detached	DU	44	0	0	0	0	0	0	0	44	100%
Kohn	SF Detached	DU	0	202	0	0	0	0	0	0	202	100%
Lakeside Avenues	SF Detached	DU	40	0	0	0	0	0	0	0	40	100%
Lanzing	SF Detached	DU	0	0	30	0	0	0	0	0	30	100%
Lemm	SF Detached	DU	0	0	0	0	0	0	38	0	38	100%
McConnell Land	SF Detached	DU	0	0	0	0	0	605	447	337	1,389	76%
MD Development	SF Detached	DU	0	50	50	0	0	0	0	0	100	100%
Mercy Hospital	Retail	SF	0	0	0	0	0	0	11,000	0	11,000	100%
	Office	SF	0	0	0	0	0	0	11,000	0	11,000	100%
Metz Road Development	Industrial	SF	0	0	0	0	200,000	200,000	200,000	392,000	992,000	60%
Michiels	SF Detached	DU	0	0	0	0	0	0	260	0	260	100%
Mid State Apartments	MF Attached	DU	12	36	0	0	0	0	0	0	48	100%
Money Vest	SF Detached	DU	7	22	0	0	0	0	0	0	29	100%
	Retail	SF	0	41,000	0	0	0	0	0	0	41,000	100%
Morgan	SF Detached	DU	0	20	0	0	0	0	0	0	20	100%
Niemann	MF Attached	DU	12	34	0	0	0	0	0	0	46	100%
Oasis Point Village	SF Detached	DU	40	121	0	0	0	0	0	0	161	100%

TABLE 12: UPDATED PHASED DEVELOPMENT TABLE

Oasis Road Specific Plan	SF 1-5 DU/Acre	DU	0	0	5	4	3	0	0	0	12	100%
	SF 2-3.5 DU/Acre	DU	0	0	30	30	30	0	0	0	90	100%
	SF 6-10 DU/Acre	DU	0	0	30	30	0	0	0	0	60	100%
	MF 15 DU/Acre	DU	0	0	100	100	100	100	100	435	935	53%
	Regional Comm	SF	0	160,000	180,000	45,000	50,000	185,000	50,000	1,614,722	2,284,722	29%
	General Comm	SF	0	0	40,000	0	0	40,000	40,000	454,000	574,000	21%
	Shopping Ctr	SF	0	0	0	37,500	0	37,500	75,000	77,000	227,000	66%
	General Office	SF	0	0	0	0	10,000	9,800	0	0	19,800	100%
	Limited Office	SF	0	0	0	0	7,000	6,100	0	0	13,100	100%
Park Marina Drive Specific Plan	Retail	SF	0	8,000	0	12,500	0	27,500	50,000	89,200	187,200	52%
	Office	SF	0	0	22,000	20,500	0	0	0	0	42,500	100%
	Hotel	SF	0	0	0	0	0	50,500	0	0	50,500	100%
Parkview/Orange	SF Detached	DU	54	0	0	0	0	0	0	0	54	100%
Quartz Hill PSL	SF Detached	DU	0	0	120	0	0	0	0	0	120	100%
Redding PD-03-02	MF Attached	DU	0	232	0	0	0	0	0	0	232	100%
Redding S.51.90	SF Detached	DU	0	0	160	0	149	0	0	0	309	100%
Redding SDP.18.04	MF Attached	DU	0	15	15	0	0	0	0	0	30	100%
Redding SDP.24.04	MF Attached	DU	0	140	140	0	0	0	0	0	280	100%
Roesner	SF Detached	DU	0	0	0	0	0	23	0	0	23	100%
Roman Catholic Bishop	SF Detached	DU	0	0	0	0	0	0	79	0	79	100%
Salt Creek	SF Detached	DU	0	0	120	250	70	0	0	0	440	100%
Scarborough	MF Attached	DU	0	67	0	0	0	0	0	0	67	100%
Shascade	SF Detached	DU	0	0	0	0	0	38	0	0	38	100%
Shasta Bible College	MF Attached	DU	0	100	0	0	0	0	0	0	100	100%
Shastina Ranch	SF Detached	DU	0	0	150	200	125	0	0	0	475	100%
	School	Emp	0	0	0	0	50	0	0	0	50	100%
Sierra Pacific	SF Detached	DU	5	64	113	0	0	0	0	0	182	100%
Signature Northwest	SF Detached	DU	0	78	0	0	0	0	0	0	78	100%
Stillwater Business Park	Industrial	SF	0	224,000	0	0	0	0	224,000	3,573,000	4,201,000	11%
	Office	SF	0	105,500	0	0	0	132,700	132,700	1,726,600	2,097,500	18%
Stone Creek Subdivision	SF Detached	DU	0	0	155	0	0	0	0	0	155	100%
Stonesfair Subdivision	SF Detached	DU	0	0	215	0	0	0	0	0	215	100%
Summer Field Meadows	SF Detached	DU	18	18	0	0	0	0	0	0	36	100%

TABLE 12: UPDATED PHASED DEVELOPMENT TABLE

Tarmac Ridge Villas	SF Detached	DU	43	43	0	0	0	0	0	0	86	100%
Thomason	Retail	SF	0	0	0	0	0	72,500	0	0	72,500	100%
Tip Top Partners	Retail	SF	0	0	0	0	0	0	0	6,500	6,500	0%
	Office	SF	0	6,500	0	0	0	0	0	0	6,500	100%
Turtle Bay Hotel	Hotel	SF	0	70,000	0	0	0	0	0	0	70,000	100%
	Restaurant	SF	0	8,000	0	0	0	0	0	0	8,000	100%
Tuscany Villas	SF Detached	DU	0	79	0	0	0	0	0	0	79	100%
Van Eperen	SF Detached	DU	43	43	0	0	0	0	0	0	86	100%
Veterans Home	Residential Care	SF	0	145,000	0	0	0	0	0	0	145,000	100%
Villages at Shasta View Gardens	SF Detached	DU	31	93	0	0	0	0	0	0	124	100%
Viale	SF Detached	DU	0	0	0	0	112	0	0	0	112	100%
Vistas	SF Detached	DU	0	210	0	0	0	0	0	0	210	100%
Western Acres	SF Detached	DU	0	0	0	0	0	80	0	0	80	100%
Westridge Subdivision	SF Detached	DU	0	0	132	0	0	0	0	0	132	100%
Westward Estates	SF Detached	DU	0	0	150	0	0	0	0	0	150	100%
Williams	SF Detached	DU	0	0	18	0	0	0	0	0	18	100%

SHASTA LAKE

Development	Land Use	Units	2010	2015	2020	2025	2030	2035	2040	After 2040	TOTAL	% by 2040
Deer Creek Manor	SF Detached	DU	0	5	5	10	10	10	10	35	85	59%
Mountain Gate at Shasta	SF Detached	DU	0	0	0	30	25	25	25	1,095	1,200	9%
	MF Attached	DU	0	0	0	150	100	0	150	0	400	100%
	Service Comm	SF	0	0	0	50,000	50,000	50,000	50,000	0	200,000	100%
Mountain Properties	SF Detached	DU	0	0	10	10	10	10	10	114	164	30%
Oak Ridge	SF Detached	DU	0	0	5	5	5	5	5	3	28	89%
Shasta Gateway Industrial Park	Light Industrial	SF	0	0	0	10,000	50,000	50,000	0	90,000	200,000	55%
	Industrial	SF	0	0	0	0	0	0	0	1,970,000	1,970,000	0%
Shasta Lake Commercial Center	Service Commercial	SF	0	0	20,000	60,000	10,000	10,000	0	0	100,000	74%
Windsor Estates	SF Detached	DU	0	3	5	5	5	5	5	10	38	74%

TABLE 12: UPDATED PHASED DEVELOPMENT TABLE

SHASTA COUNTY

Development	Land Use	Units	2010	2015	2020	2025	2030	2035	2040	After 2040	TOTAL	% by 2040
Alman	SF Detached	DU	5	2	1	1	1	1	1	1	13	92%
Anderson	SF Detached	DU	0	2	3	3	2	1	0	0	11	100%
Aventino	SF Detached	DU	0	0	2	3	10	10	6	14	45	69%
Cabb LLC	SF Detached	DU	4	5	9	0	0	0	0	0	18	100%
Canto De Las Lupine	SF Detached	DU	2	3	2	2	3	2	1	0	15	100%
Canto De Las Lupine Unit 2	SF Detached	DU	0	4	4	8	8	9	0	0	33	100%
Cassel Ridge	SF Detached	DU	0	0	4	13	12	8	2	3	42	93%
Chuck	SF Detached	DU	0	0	5	5	5	5	0	0	20	100%
Crowley Creek Ranchettes	SF Detached	DU	0	2	2	0	0	0	0	0	4	100%
Diamond Ridge Unit 2 (Jewell)	SF Detached	DU	0	0	2	2	2	4	0	0	10	100%
Foxwood Estates Unit 1	SF Detached	DU	9	3	3	3	0	0	0	0	18	100%
Foxwood Estates Unit 2	SF Detached	DU	0	2	2	2	1	0	0	0	7	100%
Keller	SF Detached	DU	0	0	3	3	3	2	0	0	11	100%
Keswick Dam	SF Detached	DU	17	0	0	0	0	0	0	0	17	100%
Knighten	SF Detached	DU	0	2	2	6	6	5	1	1	23	100%
Manzanillo	SF Detached	DU	2	2	5	3	1	1	1	0	15	100%
Mountain Gate Meadows	SF Detached	DU	3	1	3	3	1	0	0	0	11	100%
Nelson	SF Detached	DU	0	1	4	5	5	7	0	0	22	100%
Nichols	SF Detached	DU	0	5	5	5	5	5	5	0	30	100%
Nunes	SF Detached	DU	0	0	2	2	2	4	3	3	16	81%
Oak Ranch Estates	SF Detached	DU	0	0	10	10	10	26	15	69	140	51%
Platina Road Subdivision	SF Detached	DU	0	1	1	1	1	1	1	2	8	75%
Ricks	SF Detached	DU	0	0	3	3	3	2	0	0	11	100%
Rock Ledge Estates	SF Detached	DU	1	2	3	3	3	3	3	3	24	75%
Rossi	SF Detached	DU	0	1	2	3	3	6	0	0	15	100%

TABLE 12: UPDATED PHASED DEVELOPMENT TABLE

Scott	SF Detached	DU	0	1	2	3	3	2	0	0	11	100%
SHASTA RED East	SF Detached	DU	0	0	5	10	10	10	15	116	166	30%
SHASTA RED West	SF Detached	DU	0	0	10	10	10	10	15	139	194	28%
Shingle Glen	SF Detached	DU	0	1	4	5	5	8	0	0	23	100%
Shingletown Sierra Pacific	SF Detached	DU	0	4	6	6	6	5	4	4	35	89%
Silver Saddles Estate	SF Detached	DU	0	4	2	3	2	1	1	0	13	100%
Stahl	SF Detached	DU	0	0	3	3	4	0	0	0	10	100%
Stillwater Ranch Unit 1	SF Detached	DU	1	3	3	3	0	0	0	0	10	100%
Stillwater Ranch~~es~~ Unit 2	SF Detached	DU	0	0	7	7	7	8	0	0	29	100%
Stone Creek	SF Detached	DU	0	0	3	3	3	5	0	0	14	100%
Whiteoak Subdivision	SF Detached	DU	0	3	3	2	0	0	0	0	8	100%
Wine Village	Retail Restaurant	SQ FT SQ FT	0	7,500 2,500	4,500	10,000						

4. TRANSPORTATION NETWORKS

The ShastaSIM model uses coded representations of the region's existing and future roadway and transit networks. The roadway and transit networks have been updated to incorporate comprehensive project lists provided by local jurisdictions, as of May 2014.

Road Networks

The road network is a computerized representation of the major local streets and highway system. Only the most regionally important roads (generally freeways, highways, expressways, arterials and collectors) are included in the network. The model includes some collector streets and excludes most local streets. Most local streets and driveways are instead represented by simplified network links, called "zone centroid connectors," that represent local connections to the coded road network.

Master Network

Road network information for all base year and forecast scenarios are contained in a single "master network" file. The master network contains information on the scenarios that correspond to various road improvement projects. The master network is currently set up for the following scenarios:

- 2010 Base Year
- Improvement 1
- Improvement 2

Other network scenarios can be added as necessary.

The purpose of creating a master network is to make the task of network maintenance more efficient. In the past, if a roadway network improvement was to be included in several alternatives (e.g., add a new widening to the current network and all other future networks), the same network editing had to be performed individually for each of the scenarios. With a master network, the user need only input the improvement in one place with the appropriate scenarios designated and then all scenarios built from the master network will be consistent. See **Table 14**for a list of network link variables that are coded for each master network scenario.

At the beginning of the model process, the master network is processed to create the individual road network for the desired scenario.

Road Network Elements

The coded road network is comprised of three basic types of data: nodes, links and turn penalties:

- **Nodes.** Nodes are established at each and every intersection between two or more links. Nodes are assigned numbers to make identification easier. *[Note: The first 1,600 node numbers in the ShastaSIM model represent the centroids of the model TAZs.]* The road network nodes are coded with geographical "X" and "Y" coordinates to permit plotting and graphic displays. See **Table 13** below regarding road network node attributes.

TABLE 13: MASTER NETWORK NODE ATTRIBUTES

NETWORK VARIABLE	DESCRIPTION
N*	Node number
X*	X-coordinate in feet (NAD 83 State Plane California Zone 1)
Y*	Y-coordinate in feet (NAD 83 State Plane California Zone 1)
TAZ Nodes Only	
JURISDCTN	TAZ Jurisdiction (i.e. city of Anderson or Shasta County)
COMMUNITY	TAZ Community (example: Cottonwood)
AREATYPE	U=Urban, S=Small Urban, R=Rural
*Network variables that are not edited by model users	

- **Links.** Links represent road segments, and are uniquely identified by the node numbers at each end of the segment (for example, a link may be identified as "1232-1234"). Information is coded for each road link, such as distance, speed and facility type (**Table 14**).
  - **New attribute – BIKE**

    A new component added in this version of the model is the 'BIKE' attribute. This was added to identify where Class I and Class II bike facilities exist on the master network. The Shasta County model highway network now includes links accessible for non-motorized travel - walk and bike. The measurement of the shortest zone-to-zone non-motorized travel distance skims includes these links. DaySim uses the distances thus measured in determining the attractiveness and frequency of travel by walk and bike modes. Automobile travel is inaccessible to walk-bike links for both its skim measurements and its traffic assignment. *(Neither walk nor bike travel is assigned to network traffic volumes since the practice of doing so is rare, it has been attempted mainly in a few major cities such as San Francisco, the traveler path-choice behavior is only slightly understood, and validation counts are unavailable.)*

    Exclusive non-motorized facilities are identified in the network with a new "FACTYP" link class of 21.

    To prepare to take advantage of capabilities of newer versions of DaySim in the future, bike lanes on roadways are coded with a "BIKE" identifier of 2 or 3, for Class 2 or Class 3 respectively. Exclusive facilities are coded as class 1. Presently, however, the shortest distance path applies to both walk and bike travel.

Freeway links are inaccessible to bikes or walking unless the BIKE identifier is nonzero. The reverse direction of one-way streets is also available to walk and bike. *(In reality, bikes on roads must normally travel in the direction of traffic, but the error from modeling them in either direction should be negligible.)*

- **Turn Penalties.** Turn penalties can be used to identify node-to-node movements that are prohibited (such as certain left turns) or which have additional delays. Turn penalties are primarily used to represent prohibited left turns to and from ramps at freeway interchanges, in particular if an interchange has two on-ramps or for one-way streets.

TABLE 14: MASTER NETWORK LINK ATTRIBUTES

NETWORK VARIABLE	DESCRIPTION
A*	A node number
B*	B node number
NAME	Road Name *(Text)*
ROUTE	Caltrans Route Number *(Number Only)*
JURIS	Jurisdiction *(currently unused)*
DISTANCE*	Distance in miles *(calculated from coordinates)*
AREATYPE	U *(Urban)*, S *(Small Urban)*, or R *(Rural)*
TERRAIN	F *(Flat)*, R *(Rolling)*, or M *(Mountainous)*
SPEEDLIMIT	Posted speed limit in miles per hour
HPMS	Indicates link included in HPMS tabulations
SCREENLN	Screenline number for model validation *(currently unused)*
2010 Base Year Attributes	
BASE_FACTY	Facility Type code representing the road type for 2004 Base Year
BASE_LANES	Number of through lanes in each direction for 2004 Base Year
BASE_SPEED	Uncongested speed in miles per hour for 2004 Base Year
BASE_HOV**	Segment used by HOVs only for 2004 Base Year
BIKE	Existing Bicycle Lane Variable (Class I, II)
Attributes for Road Improvement 1	
IMPROVE_1	Description of road improvement 1
IMP1_YEAR	Year that link will be modified
IMP1_DELYR	Year that link will be deleted or replaced
IMP1_FACTY	Facility Type code representing the road type for Improvement 1
IMP1_LANES	Number of through lanes in each direction for Improvement 1
IMP1_SPEED	Uncongested speed in miles per hour for Improvement 1
IMP1_HOV**	Segment used by HOVs only for Improvement 1
Attributes for Road Improvement 2	
IMPROVE_2	Description of road improvement 2
IMP2_YEAR	Year that link will be modified
IMP2_DELYR	Year that link will be deleted or replaced
IMP2_FACTY	Facility Type code representing the road type for Improvement 2
IMP2_LANES	Number of through lanes in each direction for Improvement 2
IMP2_SPEED	Uncongested speed in miles per hour for Improvement 2
IMP2_HOV**	Segment used by HOVs only for Improvement 2

*Network variables that are not edited by model users
**HOV = High Occupancy Vehicle

Network Conflation

In order for the model road network to be consistent with other available geographic information the network was "conflated" by adjusting the orientation and scale to match with the Shasta County road layer and other GIS files – which are in the NAD 83 State Plane California Zone 1 coordinate system (with units in feet). The model network now can be overlaid with all other mapping or graphics prepared using the NAD 83 State Plane California Zone 1 coordinate system.

The initial conflation was done by calculating a coordinate conversion based on a sample of points. This was followed by a significant amount of manual conflation to fit specific roads in the model network over the corresponding roads in the county and city GIS layers.

Capacity

The basic information coded in the road network is used to derive additional link characteristics such as capacities and speed/congestion relationships. The capacity of each link is determined based on the road type (FACTYP), the area type and the terrain type (**Table 17**). The capacities are based on the capacity formulas for each road type in the 2000 Highway Capacity Manual (HCM). Input assumptions are based on HCM defaults wherever possible.

Model Output Networks

The model outputs six “loaded” networks:

- AM 1 Hour (20xxA1VO.NET)
- Am 3 Hour (20xxA2VO.NET)
- Midday (20xxMDVO.NET)
- PM 1 Hour (20xxP1VO.NET)
- PM 3 Hour (20xxP3VO.NET)
- Evening/Overnight (20xxEVVO.NET)

These six loaded networks are then merged and combined with count data into two networks:

- Peak Hour network (20xxA1P1.NET)
- Daily Network (20xxDAYSUM.NET)

TABLE 15: PEAK HOUR LOADED NETWORK (20XXA1P1.NET) LINK ATTRIBUTES

NETWORK VARIABLE	DESCRIPTION
A*	A node number
B*	B node number
NAME	Road Name *(Text)*
ROUTE	Caltrans Route Number *(Number Only)*
JURIS	Jurisdiction *(currently unused)*
DISTANCE*	Distance in miles *(calculated from coordinates)*
FACTYPE	Facility Type (Numeric, 1-21)
Lanes	Number of Lanes per Direction (Numeric)
SPEED	Roadway Design Speed
ID	Roadway ID Number
AM2010	2010 AM 1 Hour Directional Count
PM2010	2010 PM 1 Hour Directional Count
AMV	AM 1 Hour Directional Model Volume
PMV	PM 1 Hour Directional Model Volume
VALID	Model-to-Count Ratio (AM 1 Hour plus PM 1 Hour)

TABLE 16: DAILY LOADED NETWORK (20XXDAYSUM.NET) LINK ATTRIBUTES

NETWORK VARIABLE	DESCRIPTION
A*	A node number
B*	B node number
NAME	Road Name *(Text)*
ROUTE	Caltrans Route Number *(Number Only)*
JURIS	Jurisdiction *(currently unused)*
DISTANCE*	Distance in miles *(calculated from coordinates)*
FACTYPE	Facility Type (Numeric, 1-21)
Lanes	Number of Lanes per Direction (Numeric)
SPEED	Roadway Design Speed
ID	Roadway ID Number
DA2005	2005 Daily Directional Count
DA2010	2010 Daily Directional Count
DAYV	Daily Directional Model Volume
VALID	Model-to-Count Ratio
XVOL	Daily Volume to/from Outside Shasta County
XXVOL	Daily Through Volume (does not begin or end in Shasta County)
RVOL	Daily Volume (begins or ends in Redding)

TABLE 17: CAPACITIES BY ROAD AND AREA/TERRAIN TYPE

ROAD TYPE	FACILITY TYPE (FACTYP)	AREA/TERAIN TYPE	CAPACITY (VEHICLES PER LANE PER HOUR)	TYPICAL UNCONGESTED SPEEDS
Freeway	1	Urban	2100	55-65
		Small Urban	2100	65-70
		Rural Flat	2000	70
		Rural Rolling	1800	65-70
		Rural Mountain	1500	65
Highway/ Expressway	2 3	Urban	900	40-45
		Small Urban	900	45-55
		Rural Flat 2L	1600	55
		Rural Flat ML	2000	55-65
		Rural Rolling 2L	1300	55
		Rural Rolling ML	1800	50-65
		Rural Mountain 2L	700	55
		Rural Mountain ML	1400	40-55
Arterial	4	Urban	800	25-45
		Small Urban	800	30-45
		Rural Flat 2L	1600	40-45
		Rural Flat ML	1800	35-50
		Rural Rolling 2L	1300	55
		Rural Rolling ML	1700	35-40
		Rural Mountain 2L	700	45
		Rural Mountain ML	1400	35-40
Collector	5	Urban	700	35-40
		Small Urban	700	35-50
		Rural Flat 2L	1600	50
		Rural Flat ML	1800	50
		Rural Rolling 2L	1300	50
		Rural Rolling ML	1700	50
		Rural Mountain 2L	700	25-40
		Rural Mountain ML	1400	25-40
Local	6	Urban	600	35-40
		Small Urban	600	35-50
		Rural Flat 2L	1100	50
		Rural Flat ML	1700	50
		Rural Rolling 2L	1000	50
		Rural Rolling ML	1600	50
		Rural Mountain 2L	600	25-40
		Rural Mountain ML	1300	25-40
Ramp: Freeway-Freeway	7	All	1800	45
Ramp: Slip	8	All	1500	40
Ramp: Loop	9	All	1250	35
Zone Connector	10 11	Dist. ≤ 0.25 miles	0	15
		Dist. 0.22-0.5 miles	0	20
		Dist. > 0.5 miles	0	25
2L = Two-Lane; ML=Multi-Lane				

Transit Networks

The 2010 base year transit network consists of the lines operated by the Redding Area Bus Authority (RABA). Bus routes are coded directly on the road network (**Figure 2**). The routes are specified as a series of nodes on the road network. Nodes can be designated as stops *(where a transit stop is located)* or non-stops *(for example, a road intersection the bus passes through, but no transit stop is located)*. Due to a requirement of the software, loop routes *(routes where a bus goes in both directions on a road)* are coded as two separate routes – with one route for the outbound direction and one for the inbound direction. The attributes coded for each bus route include the name of the route and the frequency, in terms of average time between buses at stops (described as headway), during commute peak and off-peak periods. The average wait time for a bus is assumed to be one-half the headway. For example, a bus that operates every 30 minutes is assumed to have an average wait time of 15 minutes.

Access to and from each bus stop is generated automatically based on the road network and an assumed "walk" speed of three miles per hour.

Bus Speeds

Bus travel times are derived from the road network, with a delay factor to account for stops and slower operating speeds. A factor of 1.9 times the travel time for vehicles traveling at the prevailing road speed was found to closely match scheduled bus operating speeds. For example, if a passenger car travels one mile in 60 seconds it will take a bus approximately 114 seconds to travel the same distance.

Transfer Points

Timed transfer points are designated at the following locations:

- Downtown Transit Center
- Masonic Transit Center
- Canby Road Transit Center

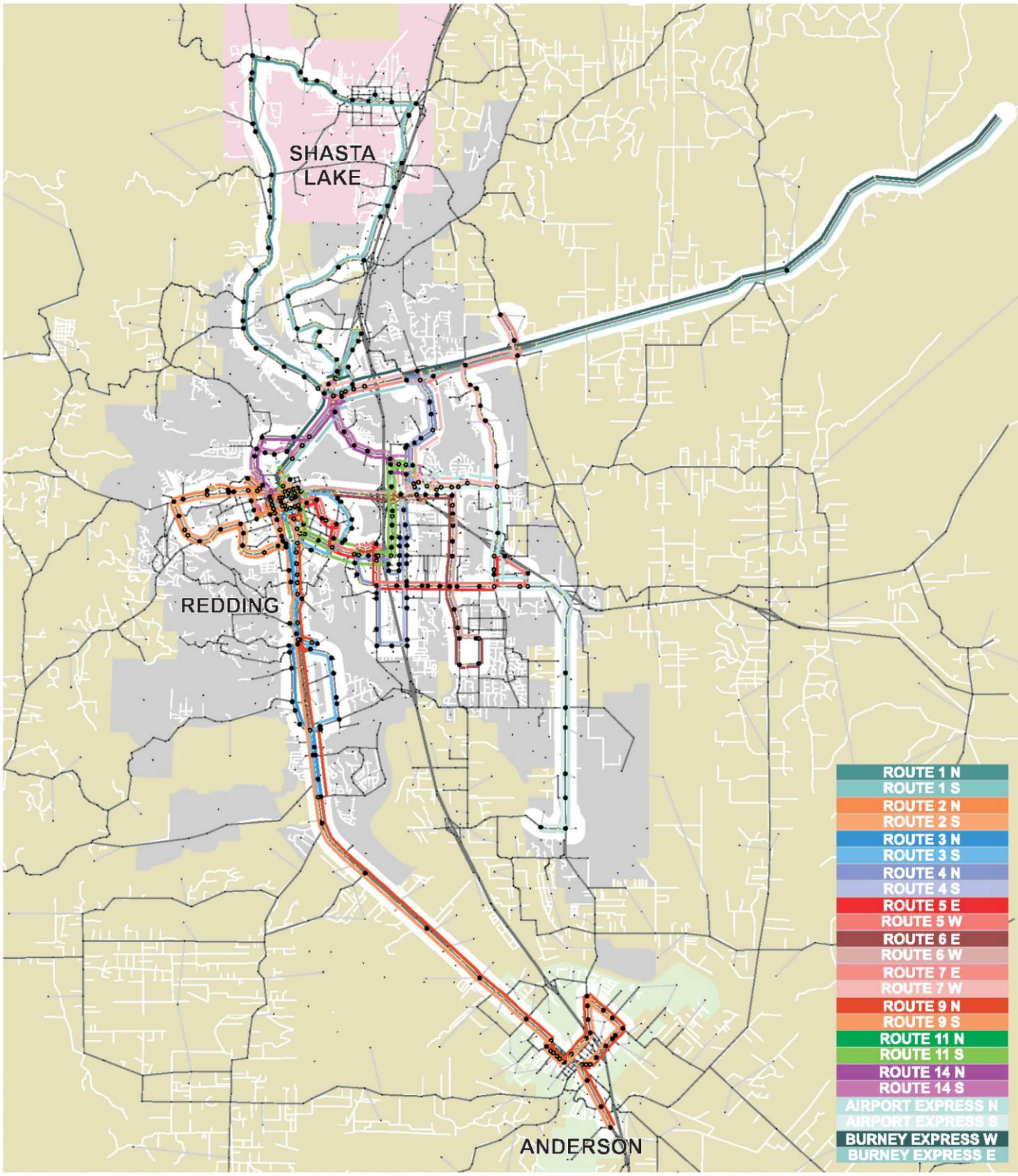
At these timed transfer locations, the maximum wait time between buses is set to be 5 minutes, rather than one-half the headway.

For loop routes represented by two separate routes (outbound and inbound), the “turnaround” node is designated as a timed transfer with one minute of delay. This represents the fact that passengers can actually stay on the same bus at the end of the loop, rather than having to transfer to another bus.

Drive Access or “Park and Rides”

Separate "park and ride" (PNR) nodes are designated to indicate locations where people could use automobiles (generally drop-off or pick-up in Shasta County) to access transit. These locations have been designated at each of the transfer centers, as well as four stops along the Burney transit service. Other park and ride locations could be designated in the future.

Figure 2: Existing Transit Lines in Shasta County



5. OTHER KEY INPUTS

While much of the model information for Shasta County is located at the parcel level for analysis, the region is also divided into Transportation Analysis Zones (TAZs). Parcel-level geographic information is used for maintaining socioeconomic and related data, while TAZ-level geography is used for developing estimates of network-based travel times and costs (i.e. “skims”). External travel to and from Shasta County is represented by external gateway zones. This chapter includes a brief discussion on the model’s TAZ system and external travel inputs. The model’s TAZ system is the same system previously used in the 4-step travel demand model. The external trips use the same process developed during the 2005-07 model update, with re-adjustments based on new 2010 count data.

Internal Zones (Traffic Analysis Zones)

Zone numbers 101 to 1600 are used for Traffic Analysis Zones (TAZs) within Shasta County. Not all zone numbers in this range have been used, allowing for future detailing or expansion of the model. The TAZs are generally smaller in size where land use density is higher, such as in downtown areas, while larger zones are used for the more rural portions of the county. The TAZs are generally consistent with aggregations of United States Census Block Groups.

The TAZ map is maintained as a Geographic Information System (GIS) file, using an ArcView polygon shapefile. The GIS file can be displayed with the travel model road network.

Boundaries

There are several parameters that are used to develop TAZ boundaries. Below is a list of those parameters used for TAZs in this model:

<u>Street Centerlines:</u> Wherever appropriate, TAZ boundaries have been moved to coincide with street centerline boundaries. Street centerline files from Redding and Anderson are followed within those coverages, otherwise the county street centerline file is used.

<u>Census Tracts:</u> All census tract boundaries are followed, with minor variations when a natural feature (creek) or street closely parallels the census tract boundary and provides a better boundary.

<u>Jurisdictions:</u> TAZs are split along jurisdiction boundaries wherever possible, including city limits, city sphere of influence areas, and county planning areas.

<u>Parcel Lines:</u> If a street does not provide a good TAZ boundary, then they generally follow parcel lines. Parcel maps from Redding and Anderson are followed within those coverages, otherwise the county parcel line file is used.

Numbering

There are 880 TAZs within the model. The numbering covers the range from 1 to 1600.

The TAZ numbering follows jurisdictional boundaries (**Table 18**). Within each jurisdiction, the TAZ numbers are grouped by Census tracts. Gaps in the numbering system are left for future TAZ additions whenever the numbering moves to a new jurisdiction, Census tract or different area of the same Census tract. The numbering for each jurisdiction and/or Census tract generally starts with a number ending in the digit 1 or 6.

TABLE 18: SHASTA COUNTY MODEL TAZS

Jurisdiction	Community	TAZ Range	Unused
Gateways		1-100	18-100
Anderson	Anderson	101-200	109-110, 132-140 148-150, 164-165 170, 189-190 192-200
Redding	Redding	201-800	232-240, 270-280 294-295, 308-320 343-350, 363-370 379-380, 386-390 401-405, 423-425 430, 442-450 452-460, 478-480 485-490, 506-510 516-520, 533-540 545, 559-560 562-570, 579-580 591-600, 615-620 628-630, 644-645 700, 719-720 734-740, 742-750 762-765, 771-780 789-790, 797-800
Shasta Lake	Shasta Lake	801-900	809-810, 820 834-835, 836-840 842-845, 847-850 854-855, 857-900
Shasta County	Anderson Sphere	901-950	909-910, 918-920 925, 929-930 932-935, 939-950
Shasta County	Redding Sphere	951-1100	960, 967-970 976-980, 986-990 993-995, 1004-1005 1008-1010, 1020 1023-1025, 1030 1035, 1039-1040 1045-1100
Shasta County	Big Bend	1101-1105	1104-1105
Shasta County	Burney	1106-1120	1115-1120
Shasta County	Cassel	1121-1125	1124-1125
Shasta County	Castella	1126-1130	1127-1130
Shasta County	Cottonwood	1131-1170	1147-1150, 1160 1162-1170
Shasta County	East Shingletown	1171-1175	1174-1175

TABLE 18: SHASTA COUNTY MODEL TAZS

Shasta County	Fall River Mills/ McArthur	1176-1190	1185-1190
Shasta County	French Gulch North	1191-1195	1193-1195
Shasta County	French Gulch South	1196-1200	1199-1200
Shasta County	Hat Creek	1201-1205	1204-1205
Shasta County	Igo	1206-1215	1210, 1212, 1215
Shasta County	Lakehead	1216-1220	1218-1220
Shasta County	Lakeshore	1221-1225	1223-1225
Shasta County	Millville	1226-1235	1231-1235
Shasta County	Montgomery Creek	1236-1240	1239-1240
Shasta County	Oak Run	1241-1245	1244-1245
Shasta County	Old Station	1246-1250	1248-1250
Shasta County	Ono	1251-1255	1253-1255
Shasta County	Platina	1256-1260	1259-1260
Shasta County	Round Mountain	1261-1265	1263-1265
Shasta County	South Dunsmuir	1266-1270	1269-1270
Shasta County	West Shingletown	1271-1275	1275
Shasta County	Whitmore	1276-1280	1278-1280
Shasta County	TBD	1281-1300	1281-1300
Shasta County	Unincorporated	1301-1600	1317-1320, 1339-1340 1347-1350, 1363-1370 1386-1390, 1394-1400 1410, 1412-1420 1425-1430, 1432-1440 1454-1460, 1478-1480 1482-1490, 1495 1513-1520, 1535-1540 1542-1550, 1556-1560 1570, 1578-1600

Figure 3: West Shasta County TAZs

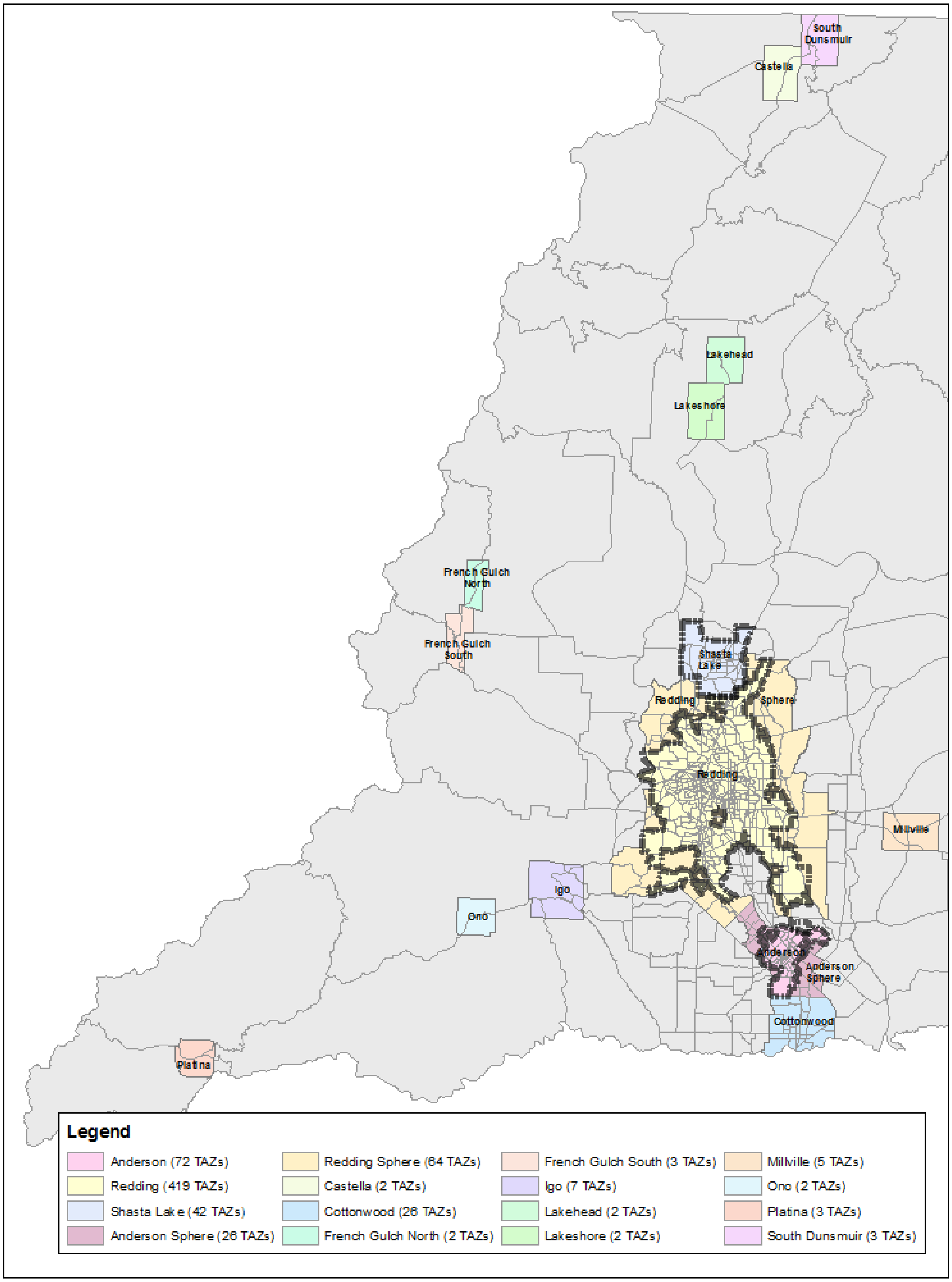


Figure 4: East Shasta County TAZs

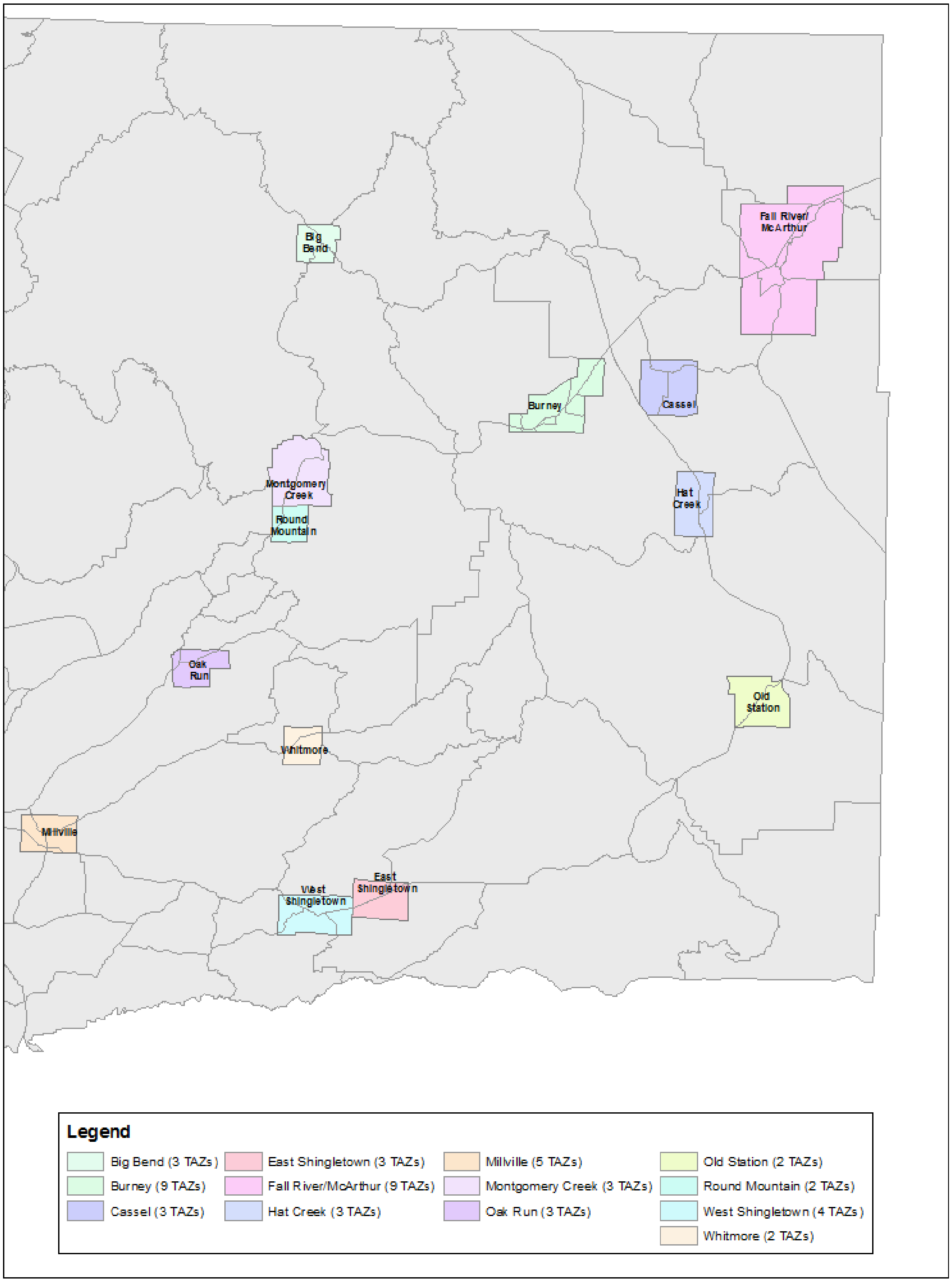
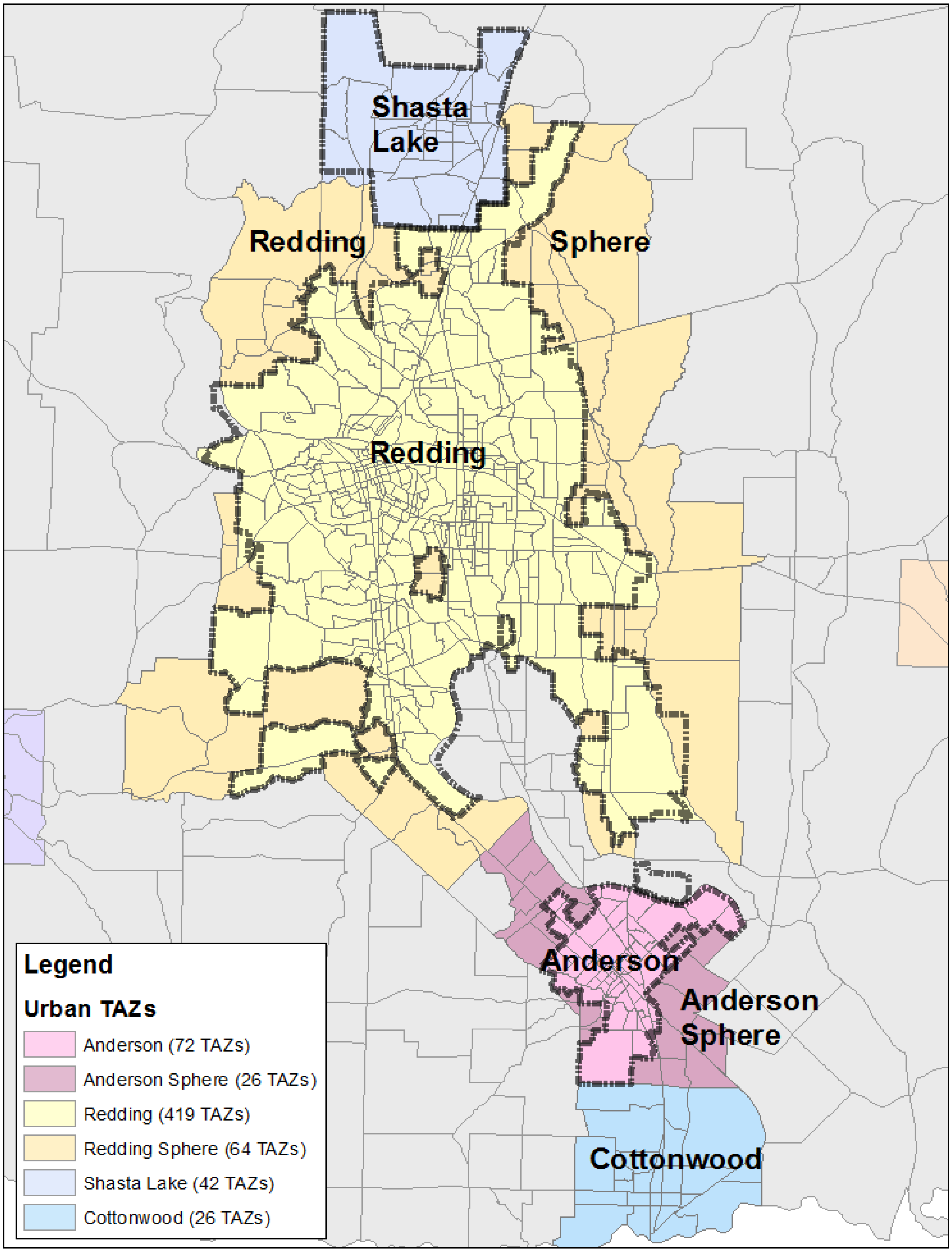


Figure 5: Shasta County Urban Area TAZs



External Zones

The Shasta County travel model has 16 external gateways for representing travel into, out of, and through the county (**Figure 6** and **Table 19**). Zone numbers 1 to 100 are reserved for external cordons.

Figure 6: Shasta Model External Gateways

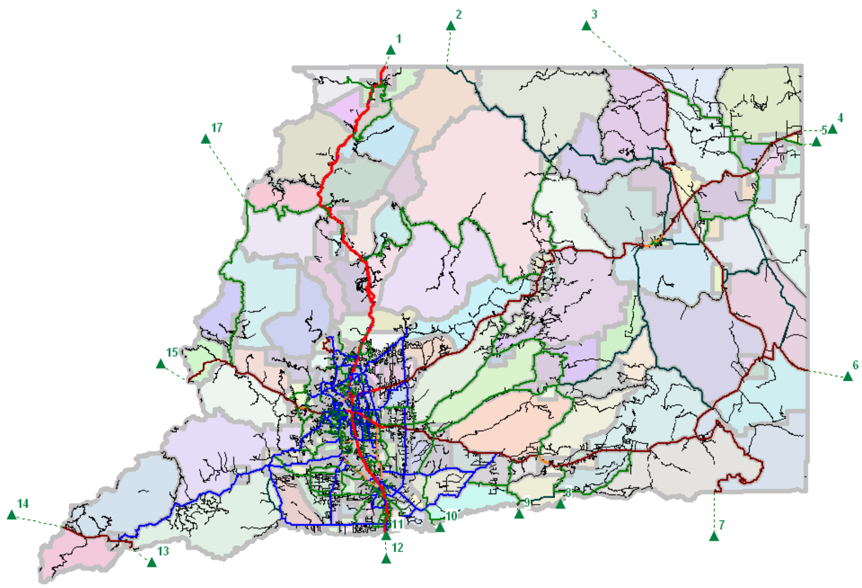


TABLE 19: **SHASTA MODEL GATEWAY VOLUMES**

Zone Number	Gateway	Location	2010 Volume	2030 Projection	Annual Growth Rate
1	I-5	Siskiyou Co Line	18,000	26,320	2.3%
2	Squaw Valley	Siskiyou Co Line	1,000	1,370	1.9%
3	SR 89	Siskiyou Co Line	1,850	2,260	1.1%
4	SR 299	Lassen Co Line	2,900	3,250	0.6%
5	Pittville Rd	Lassen Co Line	1,000	1,120	0.6%
6	SR 44	Lassen Co Line	1,700	2,300	1.8%
7	SR 89	Tehama Co Line	1,450	1,450	0.0%
8	Rock Creek Rd	Tehama Co Line	1,000	1,260	1.3%
9	Wildcat Rd	Tehama Co Line	1,000	1,260	1.3%
10	Gover Rd	Tehama Co Line	1,000	1,260	1.3%
11	Main St	Tehama Co Line	5,400	6,800	1.3%
12	I-5	Tehama Co Line	43,000	86,000	5.0%
13	SR 36	Tehama Co Line	570	750	1.6%
14	SR 36	Trinity Co Line	300	810	8.5%
15	SR 299	Trinity Co Line	3,800	4,700	1.2%
17	East Side Rd	Trinity Co Line	1,000	1,180	0.9%

Cordon or "Gateway" Trips

There are two types of trips at the cordons or "gateways" of the model: "through trips" (external-external or X-X) and "external trips" (external-internal (X-I) or internal-external (I-X)). Through trips are trips that pass through the model area without stopping. External trips are trips that either start or end somewhere within Shasta County.

Through Trips

Through trips were estimated from the Caltrans Statewide Model and factored to correlate to 2010 traffic counts.

External Trips

Base year external trips to and from Shasta County were estimated from 2010 traffic counts at the cordon points. The external trips (I-X and X-I) at each of the gateways are split into the seven trip purposes and further divided into gateway productions (trips produced outside of and attracted to Shasta County) and attractions. The external vehicle trips for each trip purpose are multiplied by the appropriate average auto occupancy rate to convert them to person trips. The initial estimates of productions and attractions at each gateway are added to the internally generated trips. These gateway trips are then distributed to the model zones along with the internal model area trips.

Future External Trips

Future total gateway volumes are factored from the 2010 base year gateway traffic counts using annual growth factors derived from historical traffic growth rates.

Gateway Trips Input File

Both the through trips and external trips input files are dBase files (.dbf) calculated in an Excel file called "ixxi_xx_trips.xlsx." The gateway trips input files follow the same process as previously done in the 4-step travel demand model.

6. *DAYSIM*

DAYSIM is a regional activity-based, tour (ABT) simulator for the intra-regional travel of the region's residents only. Around the country, ABT models are increasingly used as replacements for more conventional, four-step trip models. ABT models seek to represent a person's travel as it actually occurs: in a series of trips connecting activities, which a traveler needs or wants to participate in during the course of a day.

ShastaSim was developed to use the 2008 version of DaySim as originally applied for SACOG. This was an update of the 2005 version for SACOG, which was developed from its authors' research projects (John Bowman and Mark Bradley). Detailed working papers are available on the author's website, http://jbowman.net/.

A 2011 version was prepared for use by SACOG, which offers an enhanced representation of bicycle level of service. Distinct bicycle skims are prepared, separate from walk distances, which give different weights to the disutility of traveling on Class 1, Class 2, ordinary and high-traffic on-street travel, accounting for assigned daily volumes. SACOG developed special bicycle network skimming to provide these inputs in their SacSim model application. This version of SacSim was first released in mid 2012, after much of the adaptation and calibration of the 2008 version was done for the original ShastaSim.

Beginning in 2011, the authors of DaySim have been working with a software development group in RSG Inc. to develop a new version of DaySim in a modern programming platform. Presently (June 2014), SACOG and Puget Sound Regional Council (PSRC) have been testing and calibrating activity-based models with this version, but have not yet published their model applications, or applied them in planning work. (DKS has assisted both SACOG and PSRC develop their application contexts, SACOG directly with Cube scripts and application tests, and PSRC indirectly.)

Terminology and Concepts

The specific definitions of activities and tours should be clearly established before detailing the model:

- ***Activities*** are the things that people do during the course of the day, either to meet basic needs or for pleasure. The range of activities which people engage in is nearly infinite. For purposes of *DAYSIM*, activities are simplified into a set of seven generic categories, as follows:
  - Work (full-time or part-time)
  - School (K-12, college, university, or other education)
  - Personal Business (e.g. medical appointment)
  - Shopping
  - Meal (i.e. having a meal outside of the home)
  - Social/Recreational (e.g. going to health club, visiting a friend or family member)
  - Escort (i.e. accompanying another person to an activity they are engaging in, e.g. a parent driving a child to school)

- Home (any activity which takes place within the home)

- ***Tours*** are a series of trips which a person does from their home in order to engage in one or more of the above activities. A single tour consists of the activities and travel one person does between leaving home and returning home. Each person in a household may engage in one or more activities in the course of a single tour. Also, each person may make no tours (i.e. stay at home all day), or they make many tours. A tour may be very simple, consisting of as few as two trips (i.e. one trip away from home to work, for example, and a return trip home), or it may consist of many trips, with lots of intermediate stops along the way.

Figure 7 illustrates a typical set of activities and travel for a sample family of four. **Table 20** provides a tally of the trips and tours for that sample family. The sample family makes a total of 19 person trips, which are grouped into eight tours. The most complicated tour is that by Person 2, who escorted two children to school, proceeded to work, and returned to pick up children on the way home. This tour included one work-based sub-tour, with two trips going from work to an off-site meeting, and a return trip to work. Including the sub-tour, Person 2 made a total of six trips in the course of the work tour. The simplest tours include four with only two trips each, by Person 1 (escort tour for Person 3 to/from soccer), two school tours made by Persons 3 and 4, and a social/recreational tour (to/from soccer) for Person 3.

Figure 7: Travel Activity for a Four-Person Household

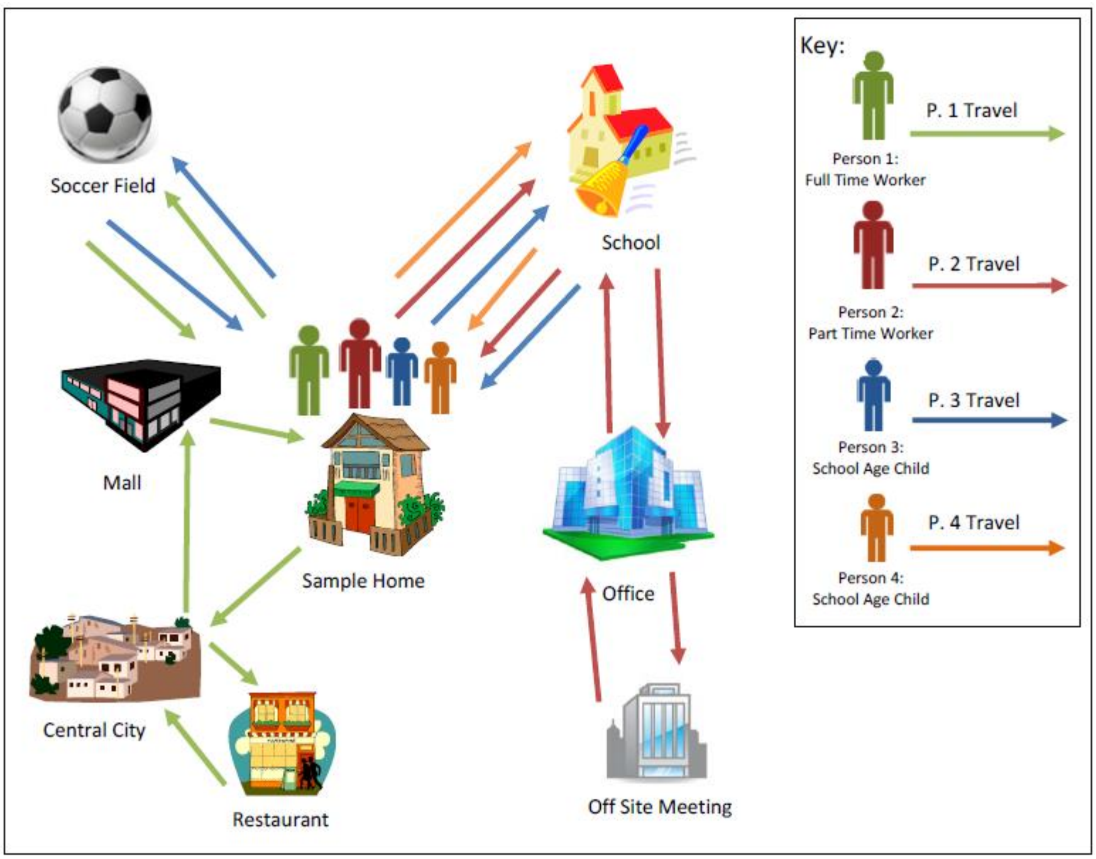


TABLE 20: TRIPS AND TOURS FOR A SAMPLE FOUR-PERSON HOUSEHOLD

Trip Origin/Destination	Person Trips				Description
	Person 1	Person 2	Person 3	Person 4	
Home to Work Work to Shopping Center Shopping Center to Home	X X X				Pers. 1: Work Tour with 3 trips
Work to Restaurant Restaurant to Work	X X				Pers. 1: Work Based Sub-tour with 2 trips
Home to School School to Office Office to School School to Home		X X X X	X X	X X	Pers. 2: Work Tour with 4 trips Pers. 3, 4: School Tours with 2 trips each
Office to Off Site Meeting Off Site Meeting to Office		X X			Pers. 2: Work Based Sub-tour with 2 trips each
Home to Soccer Field Soccer Field to Home	X X		X X		Pers. 1: Escort Tour with 2 trips Pers. 3: Soc/Rec Tour with 2 trips
Person Trips	7	6	4	2	Household Trips: 19
Person Tours	3	2	2	1	Household Tours: 8

DAYSIM also distinguishes long-term and short-term choices in representing activities and travel. Long-term choices are those which are taken regularly, such as a daily work trip, and are unlikely to change in the course of a few months or even a year. Short-term choices are those which are made quite frequently, and may vary day-to-day for most people. Again, in reality the number and range of choices which might be long-term or short-term in nature, for any individual or household, is nearly infinite. Additionally, each household makes choices on many different timeframes, not just long or short-term. *DAYSIM* simplifies these choices to a relatively limited number:

- Long-term choices:
  - Household automobile availability (i.e. the number of vehicle(s) owned and available for use by a household)
  - Usual work location for each worker (i.e. the location where a worker normally reports for work, for each worker)
  - Usual school location (i.e. the location where a student normally goes to school, for each student)
- Short-term choices:
  - The number and type of tours made by each person
  - The main destination of each tour
  - The main mode of travel for each tour
  - The arrival and departure times for each activity on each tour
  - The number and purpose of intermediate stops made on each tour
  - The location of each intermediate stop
  - The mode of travel for each trip segment on each tour

- The arrival and departure time for each intermediate activity on each tour

DAYSIM places these choices in a hierarchy, with the highest level choices being the long-term choices, and the lowest level being the short-term choices. Other *DAYSIM* terms are:

- ***Locations vs. destinations*** — In *DAYSIM*, the terms location and destination both refer to parcels. Typically, in *DAYSIM* documentation, the term "location" is associated with long-term choices, like usual workplace, or to intermediate stops on tours. "Destination" typically refers to the main place that a traveler chooses on any given tour. For example, the usual workplace location is the place a worker usually reports for work. However, on any given day, that worker may report to another place for their work tour destination. For the vast majority of workers, the usual work location and the work tour destination on any given day are one-in-the-same.
- ***Tour purpose*** — Tours are "branded" by the main activity which is engaged in during the tour. Given that multiple activities may occur during some tours, this branding requires that a hierarchy of activity purposes be established – with the tour branded by the highest level activity engaged in on the tour. Tour purposes are keyed to seven of the eight categories of activities defined above, with the following hierarchy (1 being of highest importance and 7 being of lowest importance):
    1) Work
    2) School
    3) Escort
    4) Personal Business
    5) Shop
    6) Meal
    7) Social/Recreational
- ***Tour destination*** — The parcel selected as the destination for the main activity of the tour. If there are two or more activities along the tour with the same, highest priority tour purpose, then the location of the activity with that purpose of the longest duration is designated as the tour destination. This is often referred to as the "primary" destination.
- ***Half-tour*** — The trips from home to the primary destination of the tour, or the trips from the primary destination of the tour to home.
- ***Person type*** — In reality, the variety of activities that any person engages in, and the degree to which any single activity typifies an individual, is highly complex and variable, with practically infinite possible classifications. *DAYSIM* uses many person and household characteristics to capture differences in activity and travel preferences. One useful composite variable used extensively to classify persons for purposes of estimating and applying the *DAYSIM* models is the person type:
    - Full-time worker *(more than 32 hours worked)*
    - Part-time worker *(less than 32 hours worked)*
    - Non-worker, aged 65 years or older

- Other non-worker, non-student adult
- College/university student *(full time student)*
- Grade school student aged 16 years or older *(i.e. driving age)*
- Grade school student aged 5-15 years
- Child aged 0-4 years

- ***Intermediate stop*** — Places (parcels) on a half-tour where a person stops to engage in an activity other than the activity at the main destination. A Example of an intermediate stop in the sample household (**Figure** 7) is the stop at the shopping center on the way from work to home by Person 1.

- ***Day pattern*** — The overall number of tours made by a person, the combination of purposes of those tours, and the purposes of intermediate stops on those tours, constitutes the day pattern for that person. Participation in tours and intermediate stops of the seven purposes is predicted for each person. This set of predictions is referred to as the day pattern. The exact numbers of stops on tours is predicted by lower level choice models.

- ***Random seed and Monte Carlo selection process*** — Choice models predict probabilities of selecting each of several options, based on the characteristics of the person choosing and the relative attractiveness of the options available to that person. Aggregate models (not *DAYSIM*) utilize those probabilities by splitting the choices to all members of the applicable segment of the population according to the probabilities. e.g. if a mode choice model predicted a probability of 0.20 of using transit and 0.80 of using automobile for a particular segment with 100 persons, 20 of the persons would be assigned to transit and 80 to automobile. Person level simulations (including *DAYSIM*) require another process to allocate individuals to particular choices at the person level.

  In *DAYSIM* this is accomplished by assigning a random seed to each possible outcome for each person. Monte Carlo selections are made based on the predicted probabilities and the random seed. For example, if a person's choice probability is 0.20 for the first of two possible outcomes in a choice situation, and their random seed for that choice is 0.20 or less, then the simulator assigns the first outcome to that choice for that person. <u>This is the source of a unique characteristic of simulation models</u>: random variation in results for exactly the same input files and processing, arising from differences in the random seeds from one run to the next.

DaySim Structure and Flow

DAYSIM is structured as a series of hierarchical or nested choices models. The general hierarchy places the long-term models at the top of the choice hierarchy, and the short-term models at successively lower levels in the hierarchy. The detailed hierarchy and flow through the model is illustrated in **Figure 8**. Note that the general flow is downward from the long-term models to the short-term models. Moving down from top to bottom, the choices from the long-term models influence or constrain choices in lower level models. For example:

- Choices of usual locations for work and school affect the choices of work and tour destinations, since the usual locations are the most likely destinations.
- Auto ownership affects both day pattern and tour (and trip) mode choice, by generating auto ownership market segments used in the model.

In addition to these direct influences, utilities from lower level models flow upward to higher level models, too. Logsums of tour destination and tour mode affect other short-term models, as well as the upper level, long-term models. Some of the logsums from lower level models are aggregated for use in the long-term models, in order to reduce the computational load of using true logsums in such a complex nesting structure. The details of the process of utilizing logsums both "upward" and "downward" in the overall model structure are described in more detail in the *DAYSIM* technical memoranda produced by the Sacramento Area Council of Governments (SACOG), available on SRTA's website at: http://www.srta.ca.gov/pastel/RT_TDM.htm. **Table** 115 provides more detail on the upward and downward flow of logsums and other variables in the location and destination models.

Figure 8: DaySim Hierarchy and Flow

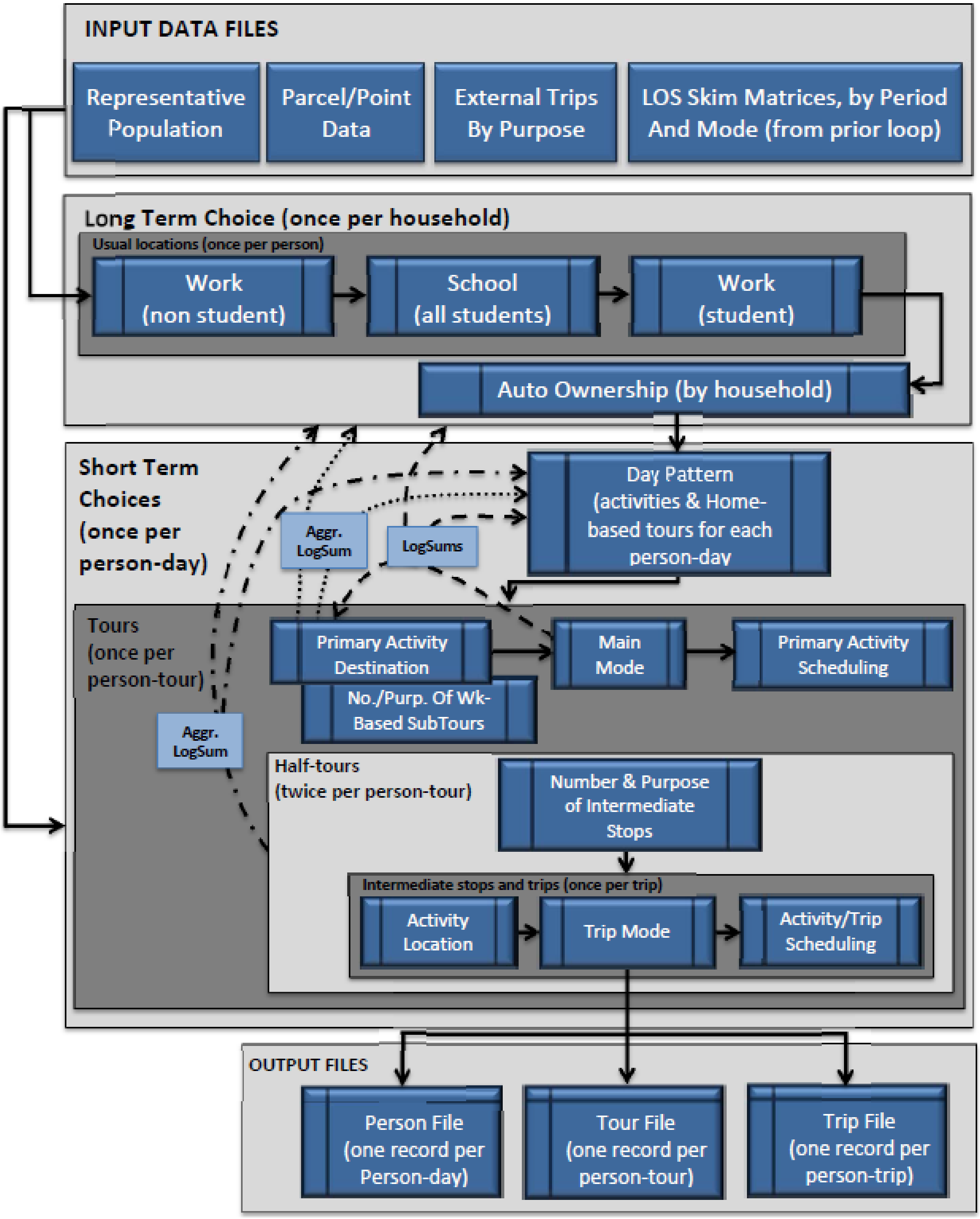


TABLE 21: UTILITY FUNCTION VARIABLES IN THE LOCATION CHOICE MODELS

ATTRIBUTES	MODELS			
	Usual Work Location	Work Tour Destination	Usual School Location	Non-Work Tour Destination
Binary Choice				
Choice between…	home vs. other	usual vs. other	home vs. other	n/a
Constants	by person type	by person type & tour type	by person type & HH size	
Dissagg. logsum for usual locations	yes	yes	yes	
Conditional MNL choice among regular locations				
Disaggregate mode choice logsum to destination	yes	yes	yes	yes
Piecewise linear driving distance	for full-time workers		for children under age 16	by purpose, priority, pattern type
Natural log of driving distance	for other than fulltime workers by person type & income	by person type & tour type	for persons age 16+ by person type	by tour type, person type, income, & time
Distance from usual work location		yes	for not-student-aged	
Distance from usual school location	for student-aged	for student-aged		yes
Aggregate mode+dest logsum at destination	by person type	by person type	by person type	by purpose
Parking and employment mix	for daily parking in parcel and in TAZ	for daily parking in parcel and in TAZ		for hourly parking in parcel and in TAZ by car availability
Ratio of "good" intersections	yes	by car availability		by car availability
Employment, enrollment and households by category	by person type & income	by person type & income	by person type	by purpose (and by 'kids-in-HH' for escort tours)
Zonal density	yes	yes	yes	yes
Parcel size	yes	yes	yes	yes
Person type categories in the model	full-time worker, part-time worker, not full/part-time worker	full-time worker, part-time worker, not full/part-time worker	child under 5, child 5 to 15, child +16, university student, not-student aged	full-time worker, part-time worker, retired adult, other adult, child under 5, child 5 to 15, child +16, university student
Source: SACOG, 2008				

Long-term Choice Models

As mentioned above, three choices are treated as long-term choice models, and are at the top level of the choice hierarchy:

- Usual work location *(for workers)*
- Usual school location *(for students)*
- Household auto availability

For persons who are both worker and student, a usual work location and a usual school location are modeled.

An additional long-term choice model is included in *DAYSIM*:

- Usual workplace *(for students)*

This section details the structure, estimation results, calibration and validation of these models.

Usual Work Location Sub-Model

Usual work location is the top-level model in the *DAYSIM* hierarchy. Except for auto ownership, logsums from lower level models influence choice; auto ownership logsum flows down to lower level models. Auto ownership is assumed to be conditioned by usual work and school locations, not the other way around. Choice sets are constrained by ratios of maximum travel times reported in the survey; alternatives which meet the time constraints are sampled for the final choice sets. In application, each choice is simulated from a sample of the available alternatives. Work-at-home utilities are determined by constants and person type.

In addition to the constraints applied to choice sets, total work location choices are constrained to TAZ-level total jobs at the work location. In application, this is accomplished by tallying the usual workplace locations to TAZ through the course of the simulation. As TAZs become "filled" they become unavailable in subsequent choices sets. This process effectively fills the equivalent of doubly constraining matrices in a gravity distribution. This accounting process is currently being replaced by a shadow price process.

Level-of-service variables are primarily home-to-work location distance, and three logsums: destination choice, mode-destination choice, and mode choice. Several parking supply and street pattern variables are included: paid, off-street parking supply (+ effect), and the "good" intersection ratio within ¼ mile (+ effect). Density variables split into two primary effects: density of service and education employment, and households (- effect); and other employment density (+ effect). Size variables enter the model at parcel level, and have similar effects by variable as density.

Usual School Location Sub-Model

Structurally, the usual school location sub-model is similar to the work location model, but with person types focused on students (K-12 and college/university). Because of the strong relationship between usual school location and enrollment at the school site, and the generally shorter trip length associated with school trips, the array of land use variables is simpler compared to the work location sub-model. Like work locations, alternative sampling is used in the model application.

For purposes of this model, “college/university” students are students enrolled at one of the public community colleges, or one of the private colleges or graduate schools within Shasta County and the surrounding area.

Automobile Ownership / Availability Sub-Model

Auto ownership here implies outright ownership, leasing, or availability of an automobile to a household for general use by other means. The sub-model includes constants for ownership “choices” of no cars, one car, two cars, three cars, or four-or-more cars. Separate constants for households with one through four-plus driving age persons in the household are included. Other demographic variables relate to life cycle (e.g. presence of retired persons, school age children, or college/university students) or to household income level.

An array of accessibility and land use variables are included in the mode choice logsums to work (for workers) or to school (for students). One logsum formulation compares the mode choice logsum assuming every driver had a car, with that assuming the household owned no cars; as that difference expands (i.e. the difference between having full access to autos and no access to autos expands), the likelihood of the household owning no cars decreases. Proximity of residence to the nearest transit station or stop is included (+ effect for owning no cars, or for owning less than one auto per driver). The amount of accessible residential service land uses (defined as food, retail, medical, and service employment within ½ mile of the place of residence) is included (also + effect for owning no cars or for owning less than one car per driver).

Short-term Choice Models

Short-term sub-models include choices which are presumed to be more transitory in nature than usual place of work, usual school location, and auto ownership. These short-term choices are:

- The day pattern for each person;
- The primary destination for each tour made;
- The main (but not only) mode of travel for each tour;
- The scheduling and timing of each activity; and
- Subsequent choices related to the number of intermediate stops on tours, the mode of travel for each trip segment on a tour, and the timing of the trip segments.

As described above, logsums from these lower level models (e.g. tour mode/destination choice, tour mode choice, etc.) are included in the upper level, long-term models.

Day Pattern and Exact Number of Tours Sub-Models

The day pattern sub-model consists of the number of tours of different purposes a person makes during the course of a day, plus the numbers of stops made on each tour.

The parts of the model are:

- A set of binary choices for each of the seven tour purposes (making 0 or 1+ tours, and 0 or 1+ stops on tours). Constants were estimated for each of seven person types, along with additional coefficients for household composition, income, auto ownership, and land use at place of residence, and accessibility variables.
- A set of constants for predicting multiple "tour+stop" purpose combinations (i.e. 1 tour purpose + 1 stop purpose, 1 tour purpose + 2 stop purposes, etc).
- A set of demographic variables and accessibility variables, which affect predictions of the exact number of tour purposes and stop purposes.
- A set of constants for various combinations of multiple tour purposes and stop purposes

The sub-model shows that personal and demographic characteristics strongly influence the number and purpose of tours.

- Work tours are most likely by full time workers, less likely by part-time workers, least likely by retired adults, etc.
- Adults aged 18 to 25 are the most likely of all adults to make a school tour.
- Adults with children of school age are most likely to make escort tours and females are more likely than males to make escort tours.
- Persons in higher income households are more likely to make tours than those in lower income households.
- Adults who are the only adult in the household are more likely to make more non-work tours.
- Accessibility variables (logsums from lower-level models like tour mode choice, and home-work intermediate stops) generally increase the likelihood of making tours.
- Mixed use density at or near place of residence increases the likelihood of making shop tours.

Another sub-model predicts the exact number of tours by purpose. The person type, demographic, and family composition variables are less influential in predicting exact number of tours, while the accessibility variables (logsums for 2 or 3 tours) are more influential in the higher level pattern models. In general, the higher numbers of tours per person (2 or 3+) are much more likely in areas with higher accessibility, as measured by the logsums.

Tour Primary Destination Sub-Model

Tour destination choice occurs below the usual location choices for work and school. So for workers and students (and student-workers), the usual locations of those work and school activities are already modeled. In fact, the tour destination for the majority of these persons for work and school is the usual work or school location. The work tour destination model is structured as a nested choice, with the highest level choice being the usual work location vs. other locations; with all the other locations nested below the usual work location choice.

For non-work/non-school tour destinations, no "usual" location has been chosen, so tour destination choice is more complicated. The tour destination sub-model includes a set of coefficients applied to logsum variables (mode choice to destination, purpose-specific aggregate mode/destination choice at destination), as well as other coefficients by purpose for various drive distance ranges.

An array of parking supply, street pattern, and land use variables impact choices and are included in the non-work/non-school sub-model, including:

- Combinations of parking and commercial employment increase the attractiveness of parcels within a TAZ.
- Street pattern (the so-called "good intersection ratio") within one-quarter mile of a destination increases its attractiveness. The street pattern variable is computed as a proportion of the 3 or 4 leg intersections, compared to all intersections within one quarter mile.
- A large array of density and parcel size variables by different tour purposes and density is included in the sub-model. The following general patterns emerge:
    - Some more obvious matches between land use variables and tour purposes are captured in the sub-model (e.g. higher numbers of food service employees make parcels more attractive for meal tour destinations; higher numbers of K-12 enrollments make parcels more attractive for escort tour destinations; etc.).
    - Higher household density and higher numbers of households on parcels reduce the attractiveness of a parcel as a destination for most purposes.

Tour Main Mode Sub-Model

Tour main mode is the predominant mode chosen for making a given tour. The actual mode chosen for each segment of the tour is modeled as "trip mode" at a lower level. The relationship between tour main mode and trip mode for trips within a single tour for a given person has an analogous relationship, as that between usual work and school location, and work and tour destination—the higher level choice is highly determinative of the lower level choice. That is, the predominant mode chosen for a tour is the most likely mode for each segment within that tour. The exceptions to this general pattern will be discussed below, in the trip mode choice section.

The tour main mode sub-model is structured as a multinomial logit with the following eight mode options:

- Drive-to-transit *(work tours only)*
- Walk-to-transit
- School bus *(school tours only)*
- Shared Ride *(3-or-more persons)*
- Shared Ride *(2 persons)*
- Drive Alone
- Bicycle
- Walk

Non-mandatory trip purposes (personal business, shop, meal, social/recreational) were combined for the mode choice estimations. Sub-models were estimated for the following trip purposes:

- Work tour
- School tour
- Non-mandatory tour
- Work-based sub-tours

Two unique land use and street pattern variables are included in the sub-models. One variable combines residential-oriented land use mix and density, and is defined as:

(0.001 * RS * HH) / (RS + HH)

Where:

- RS = sum of retail and service employment within ½ mile
- HH = sum of households within ½ mile

The variable equals zero in homogenous areas, and increases in areas where density and mix of housing and employment increase.

Work Tour Mode Choice

Estimation results for work tour mode choice includes a set of four generic level-of-service variables: 1) cost, 2) in-vehicle time, 3) wait time, and 4) walk and bike time. Walk or bike time for drive-to-transit, walk-to-transit, walk and bike were split out from wait time, with coefficients estimated rather than fixed.

In addition to a mode constant, drive-to-transit variables included two auto-availability variables (-effect for no autos, -effect for autos less than workers), and a ratio of drive time to total in-vehicle time (the coefficient for which is useful for weighting drive access time in transit path building). Walk-to-transit had only a constant and a dummy variable, if the closest transit stop is an LRT station (+effect for walk-to-transit).

Shared ride modes included variables on numbers of persons in the household, with likelihood of choosing shared ride declining steeply if the number of persons in the household is one (for 2 person shared ride), or less than three (for 3+ person shared ride). Shared ride is also more likely for households with school age children, with fewer cars than drivers, or households with a higher share of escort stops during the course of the day.

Drive alone included variables on auto availability (- effect for autos less than workers), income (- effect for household income less than $25,000), and share of escort stops during the course of the day (for higher share).

Bike mode is more likely for males, younger travelers (-effect for people greater than 50 years of age), and for areas with good land use mix (+effect for mixed use density at place of residence). Bike mode also includes a “Davis constant,” which provides for a preference for cycling in communities such as Davis. The SACOG versions of DaySim include a geographic indicator variable for whether a location is in the city or vicinity of Davis. This university town on the western edge of the SACOG model region is particularly noted for bicycle travel. Since their first survey-based model developments in the 1990s, SACOG has identified strong and statistically significant distinctions of estimated behavior parameters for travel in Davis, including bicycle-related. DaySim has continued providing this distinction with special Davis travel parameters.

In the Shasta County application, the Davis indicator is used for certain areas in Redding (in the Civic Center area south of Cypress Ave., plus parts of the northern portion of the city of Anderson. This adds propensity to the bicycle mode for travel by males under age 50.

Walk is less likely to happen for males, but more likely in areas with good land use mix and density at place of residence.

School Tour Mode Choice

Estimation results for school tour mode choice includes: cost and in-vehicle time (both constrained); and combined out-of-vehicle time.

School bus mode is less likely for very young students (- effect for age under 5 years), and for older students (- effect for age 18 years and older).

Walk-to-transit mode choice includes auto availability (+ effect for no cars, + effect for fewer cars than drivers). A constrained constant is included for children under 5 years. Walk-to-transit is more likely for older students (+ effect for age 16 or 17 years, + effect for age 18 or older). Walk-to-transit is also more likely in areas with good land use mix and density.

Auto modes (shared ride and drive alone) include the same constellation of variables used in the work sub-model.

Bike mode is more likely for male students and students 18 years of age or older. A "Davis constant" is also included.

Walk mode is more likely in areas with good street pattern (+ effect for higher proportions of "good" intersections).

Escort Tour Mode Choice

The escort tour mode choice model is relatively simple. It relies primarily on personal and family composition constants and variables. Walk mode is more likely in areas with a good street pattern.

Work-Based Sub-Tour Mode Choice

Work-based sub-tours are the only non-home-based (NHB) tours in *DAYSIM*. Work-based sub-tours begin and end at the place of work, while all other tours begin and end (albeit with other destinations and stops) at home. The mode of travel used to get to work is influential in determining the mode used for work-based sub-tours.

Non-Mandatory Tour Mode Choice

This sub-model predicts tour mode choice for home-based (HB) personal business, shop, meal, and social/recreational tours. The sub-model includes many of the same variables as seen in the other purposes. However, the street pattern and land use density and land use mix variables are more prevalent and significant in this model. The street pattern variable or mixed use density variable is included in walk-to-transit, bike, and walk modes.

Tour Primary Activity Scheduling Sub-Model

Each alternative in the models is characterized by three separate dimensions: 1) arrival time, 2) departure time, and 3) duration of stay. Constants are included for ten arrival time blocks, departure time blocks, and activity durations per purpose. The arrival and departure blocks differ by tour purpose. For example: work arrival blocks are the shortest for the normal, morning work start times, while the time blocks for the late morning and afternoon time blocks are longer.

Activity and travel scheduling models were estimated for four (4) trip purposes (or aggregated purposes):

- Work activities and tours;
- School activities and tours;
- Non-mandatory activities and tours (i.e. personal business, shop, meal and social/recreational); and
- Work-based sub-tours.

An additional scheduling sub-model was estimated for intermediate stops. For intermediate stops, the departure time is fixed for stops on the outbound half tour, so those observations only contribute to the constants for arrival time and duration. Additionally, the arrival time is fixed for stops on the return half tour, so those observations only contribute to the constants for departure time and duration.

In addition to the time block constants, the sub-models include other variables, described below:

- "**Shift" variables by person type**--These variables effectively adjust the time block constants for arrival or duration by person type. For example, part time workers and student workers tend to start work activities later than full time workers—the shift constant for the arrival time for part time workers is positive, indicating later arrivals. Negative-sign (-) shift coefficients arrive earlier or participate in the activity for a shorter duration, compared to other person types. Positive-sign (+) shift coefficients arrive later or participate longer.

- **"Shift" variables by tour complexity**--Some shift variables account for complexity of tours, either by quantifying the numbers of stops for tours of different types, or the number of tours.

- **Income variables**--Lower income workers tend to work for shorter durations, and higher income workers for longer durations.

- **Purpose specific variables**--Especially for the non-mandatory purpose sub-model, arrival and duration shift variables are included to differentiate the differences in each purpose.

- **Time pressure/constraint variables**--Several variables were used to represent the constraints imposed on scheduling by inclusion of longer activities in a daily pattern, or by overall schedule complexity (e.g. number of tours, number of stops on tours). This includes:
    - Duration of the adjacent empty "window" before a period starts
    - Duration of the maximum consecutive empty "window" before the period starts
    - Total duration of all empty "windows" in the day before the period starts
    - Duration of the adjacent empty "window" after the period ends
    - Duration of the maximum consecutive empty "window" after the period ends
    - Total duration of all empty "windows" in the day after the period ends
- **Level of Service and Congestion Variables**--Auto and transit travel time is accounted for in the model, along with the time spent in severe congestion. Note that for purposes of the estimation, the marginal skims for the 'i-j' TAZ interchange was used – not any actual surveyed information about the path actually taken for the trip.

Major effects captured in the models are as follows:

- <u>Work activities and tours</u>
    - Lower income workers tend to have shorter duration activities while higher income workers have longer activities.
    - The more work-based sub-tours that are part of the tour, the longer the total duration of the work activity (including the sub-tour).
    - Making more intermediate stops to/from primary destination reduces time spent at primary activity.
    - Workers with 2+ tours to schedule will tend to try to leave a large consecutive block of time rather than two or more smaller blocks.
    - For both AM and PM peak period, the tendency is to move the work activity earlier as the time in very congested conditions increases.
- <u>School activities and tours</u>
    - Many time pressure/constraint effects are similar to work activities and tours.
- <u>Non-mandatory activities and tours</u>
    - Relative to personal-business activities, people tend to arrive earlier in the day for escort activities and later in the day for shopping, meal and social/recreation activities.
    - Escort and shopping activities also tend to be much shorter in duration, while social/recreation activities are much longer.
    - Escort and shopping activities are likely to last less than an hour, and shopping and meal activities are likely to last 1-2 hours.
    - Shopping activities are unlikely to begin before 7 AM or end after 9 PM. Meal activities are also unlikely to end after 9 PM.
    - Escort activities are relatively likely to end after 9 PM.

- Time pressure/constraint effects are similar to those found for work and school tours. The main difference is that the overall time pressure effect is stronger, but the other effects are weaker, and there is evidence that people will try to space tours more evenly in the day.
  - The PM peak was found to shift both earlier and later with high congestion.
- Work-based activities and tours
  - Relative to work-related activities on sub-tours, escort, meal and shopping activities tend to start later and be of shorter duration.
  - Social/recreation activities also tend to start later, while personal business activities are also of shorter duration.
  - People try to leave consecutive windows both before and after the tour, meaning a tendency to "center" the sub-tour during the duration of the work activity.
- Intermediate stop activities and tours
  - Compared to work-related activities, stops for escort, shopping, meal, and personal business activities all tend to be of shorter duration.
  - Escort, shopping, social/recreation and personal business stops also tend to be somewhat later in the day. These results are very similar to those in the work-based sub-tour model.
  - Stops will tend to be shorter when there are more tours to be scheduled in day, and also when there are more stops to be scheduled on the half tour.

DaySim Input

DaySim itself is a stand-alone program written in Pascal, and compiled to run within the model application. ShastaSIM runs within an application shell, scripted in Citilabs® CUBE Voyager software, which calls up the *DaySim* executable. DaySim requires a set of established inputs, including:

- Parcel file;
- Population file;
- Zonal file;
- IXXI file;
- Level of service files;
- Control file; and
- DBF templates.

The parcel and population files are described in detail in chapters 2 and 3 respectively. The zonal file and ixxi file are described in detail in chapter 5. The level of service files are TAZ-based, time and distance origin-destination skims. All level of service files are created within the ShastaSIM Voyager script as space delimited ASCII files, with no header record. All values are integer values, with no decimal. The level of service files include:

- Walk skims (skwalk.txt);
- AM auto skims (skauam.txt);

- Midday auto skims (skaumd.txt);
- PM auto skims (skaupm.txt);
- Evening auto skims (skauev.txt);
- AM walk to transit skims (sktwam.txt);
- Midday walk to transit skims (sktwmd.txt);
- Evening walk to transit skims (sktwmd.txt);
- Peak drive to transit skims (sktdam.txt); and
- Off-peak drive to transit skims (sktdmd.txt).

Table 22 through **Table 31** summarize the content of each level of service file.

TABLE 22: WALK SKIM FILE FORMAT

FIELD	DESCRIPTION
ORIG	Origin zone
DEST	Destination zone
WALKDIST	Walk distance (miles x 100)

TABLE 23: AM AUTO HIGHWAY SKIM FILE FORMAT

FIELD	DESCRIPTION
ORIG	Origin zone
DEST	Destination zone
D1TIME	SOV time (minutes x 100)
D1DIST	SOV distance (miles x 100)
D2TIME	HOV 2+ time (minutes x 100)
D2DIST	HOV 2+ distance (miles x 100)

TABLE 24: MIDDAY AUTO HIGHWAY SKIM FILE FORMAT

FIELD	DESCRIPTION
ORIG	Origin zone
DEST	Destination zone
D1TIME	SOV time (minutes x 100)
D1DIST	SOV distance (miles x 100)

TABLE 25: PM AUTO HIGHWAY SKIM FILE FORMAT

FIELD	DESCRIPTION
ORIG	Origin zone
DEST	Destination zone
D1TIME	SOV time (minutes x 100)
D1DIST	SOV distance (miles x 100)
D2TIME	HOV 2+ time (minutes x 100)

TABLE 25: PM AUTO HIGHWAY SKIM FILE FORMAT

D2DIST	HOV 2+ distance (miles x 100)

TABLE 26: EVENING AUTO HIGHWAY SKIM FILE FORMAT

FIELD	DESCRIPTION
ORIG	Origin zone
DEST	Destination zone
D1TIME	SOV time (minutes x 100)
D1DIST	SOV distance (miles x 100)

TABLE 27: AM WALK TO TRANSIT SKIM FILE FORMAT

FIELD	DESCRIPTION
ORIG	Origin zone
DEST	Destination zone
XFNUMW	Number of transfers
XFTIMW	Transfer time (min. x 100)
FWTIMW	First wait time (min. x 100)
FAREW	Fare (cents)
TRDISW	In-vehicle distance (miles x 100)
WATIMW	Walk time (min x 100)
TRTIMW	In-vehicle time (min x 100)
*The reverse directions of the AM peak paths are used for the PM peak	

TABLE 28: MIDDAY WALK TO TRANSIT SKIM FILE FORMAT

FIELD	DESCRIPTION
ORIG	Origin zone
DEST	Destination zone
XFNUMW	Number of transfers
XFTIMW	Transfer time (min. x 100)
FWTIMW	First wait time (min. x 100)
FAREW	Fare (cents)
TRDISW	In-vehicle distance (miles x 100)
WATIMW	Walk time (min x 100)
TRTIMW	In-vehicle time (min x 100)

TABLE 29: EVENING WALK TO TRANSIT SKIM FILE FORMAT

FIELD	DESCRIPTION
ORIG	Origin zone
DEST	Destination zone
XFNUMW	Number of transfers
XFTIMW	Transfer time (min. x 100)
FWTIMW	First wait time (min. x 100)
FAREW	Fare (cents)
TRDISW	In-vehicle distance (miles x 100)
WATIMW	Walk time (min x 100)
TRTIMW	In-vehicle time (min x 100)

TABLE 30: PEAK DRIVE TO TRANSIT SKIM FILE FORMAT

FIELD	DESCRIPTION
ORIG	Origin zone (Drive end)
DEST	Destination zone (Walk end)
PKTAZD	Park and ride lot zone number
XFTIMD	Transfer time (min x 100)
FWTIMD	First wait time (min x 100)
DRTIMD	Drive access time (min x 100)
FARED	Fare (cents)
DRDISD	Drive access distance (miles x 100)
TRDISD	In-vehicle distance (miles x 100)
WATIMD	Walk egress time (min x 100)
XFNUMD	Number of transfers
TRTIMD	In-vehicle time (min x 100)

TABLE 31: OFF-PEAK DRIVE TO TRANSIT SKIM FILE FORMAT

FIELD	DESCRIPTION
ORIG	Origin zone (Drive end)
DEST	Destination zone (Walk end)
PKTAZD	Park and ride lot zone number
XFTIMD	Transfer time (min x 100)
FWTIMD	First wait time (min x 100)
DRTIMD	Drive access time (min x 100)
FARED	Fare (cents)
DRDISD	Drive access distance (miles x 100)
TRDISD	In-vehicle distance (miles x 100)
WATIMD	Walk egress time (min x 100)

TABLE 31: OFF-PEAK DRIVE TO TRANSIT SKIM FILE FORMAT

XFNUMD	Number of transfers
TRTIMD	In-vehicle time (min x 100)

For the transit skims, walk time is not used in the models because parcel-specific walk distances to transit are included in the parcel file.

The control file name is the name of a text file containing various switch and file name settings. The option parameters are the same control codes that are in the control file, and must be in the format CODE=argument, with no spaces, where CODE is the 6-letter control code as listed below, and argument is the text (filename or directory name) or integer value that is expected according to the code.

The table below shows example lines from a control file with all of the codes recognized by DaySim08. The default values for all of the controls are also shown.

All of the lines except for the italicized ones would be valid lines in a control file. The formatting rules for a control line are:

- A valid six letter code (can be any combination of upper and lower case)
- One or more spaces and/or equals signs
- The code argument – an integer or a file name or a directory name
- One or more spaces
- Any comment or blank (this is ignored by the program)

Only the RUNLAB argument with the run name can include spaces.

CODE	***Value***	***Comment***
Run label (can include spaces)		
PRFDIR	.\	/ Directory supplying string substitute for ? in control file filenames
PREFFN	tppl.prj	/ name of text file supplying string substitute in its first line of text
PREFPO	1	/ position in first line of PREFFN on which string substitute starts
PREFLE	4	/ Length of string substitute on first line of PREFFN
Directory and file name controls		
RUNDIR	.\	/ main directory holds executable
COEFFI	coeffs13.txt	/ model coefficient file
LOSDIR	.\	/ level of service data file directory
LOSFTY	1	/ level of service file type 1 = text, 2 = TP+ (not currently supported)
WALKFN	skwalk.txt	/ walk skim matrix file
AMHWFN	skauam.txt	/ am peak highway skim matrix file
MDHWFN	skaumd.txt	/ midday highway skim matrix file

CODE	Value	Comment
PMHWFN	skaupm.txt	/ pm peak highway skim matrix file
EVHWFN	skauev.txt	/ evening highway skim matrix file
PKWTFN	sktwam.txt	/ AM peak walk to transit skim matrix file (PM peak is transpose)
OPWTFN	sktwmd.txt	/ midday walk to transit skim matrix file
EVWTFN	sktwmd.txt	/ evening walk to transit skim matrix file
PKDTFN	sktdam.txt	/ AM peak drive to transit skim matrix file
OPDTFN	sktdmd.txt	/ off peak drive to transit skim matrix file
IXXIFN	ixximat.txt	/ ix-xi text file
HWFLFN	hwflows.txt	/ Validation input file with CTPP commuter flows
PCLDIR	..\input\	/ parcel and zonal data file directory
PCLFTY	2	/ parcel file type 1 = text, 2 = dBF
PARCFN	?_parcel.dbf	/ parcel file name
ZONEFN	?_taz.dbf	/ zonal fle name (always a dbf file)
SHADFN	?_shadowprice.dbf	/ shadow price file name (always a dbf file)
SAMDIR	..\input\	/ population sample file directory
SAMFTY	2	/ sample file type 0 = none, 1 = HH survey sample, 2 = synthetic sample
SAMPFN	?_population.dbf	/ sample file name (if file type=2. If type=1 then file names are fixed)
CENDIR	..\input\	/ census data directory for pop.syn.
CTPPFN	?_marg_1.dbf	/ CTPP table 1-75 data file
PUMSFN	pums.dbf	/ PUMS records file for sampling
INPDIR	.\	/ census data directory for pop.syn.
PINPFN	pin	/CTPP table 1-75 data file
TINPFN	tin	/ PUMS records file for sampling
SINPFN	sin	/ trip file (dbf file, name automat. extended by THISND, and by '.dbf')
OUTDIR	.\	/ output file directory
PRNTFN	?_daysim	/ print file (name automat. extended by THISND for Clusternode mode, and by .prn)
POUTFN	pout	/ person-day file (dbf file, name automat. extended by THISND, and by '.dbf')
TOUTFN	tout	/ tour file (dbf file, name automat. extended by THISND, and by '.dbf')
SOUTFN	sout	/ trip file (dbf file, name automat. extended by THISND, and by '.dbf')
POUVFN	?_pout1	/ person outp. to be validated (implicit '.dbf'; add '1' to POUTFN for local run)
ZOUTFN	zout.dbf	/ zonal validation file
EOUVFN	celpred	/ pred usu. work,K-12 & Uni choices (parcel level) (name automat. extended by '.dbf')
EOUTFN	eout.dbf	/ employment validation file (parcel level)

CODE	Value	Comment
V1OUFN	?_hwflowrad.dbf	/ Validation output file with Rad commuter flows
V2OUFN	?_hwflowdist.dbf	/ Validation output file with District commuter flows
Model control switches		
RNMODE	1	/ run mode (1=local; 2=ClusterNode; 3=ClusterMerge)
CMMODE	2	/ cluster merge mode (2=keep merged p,s,t output; 3=keep merged & node p,s,t output)
NCLNDS	1	/ Number of nodes in cluster
THISND	1	/ ID of this node (must satisfy 1<=THISND<=NCLNDS)
FIRSTM	2	/ 1st & last models to run: 1-syn sampl; 2-usuWork&Schl; 3-autOwn; 4-dayPatt;
FINALM	12	/ 5-TDest; 6-WBTGen; 7-TMode; 8-TTOD; 9-SFreq; 10-SLoc; 11-TripMode; 12-TripTime
PINPSW	0	/ person-level file read switch (0=off, 1=on) required on for FIRSTM>2
TINPSW	0	/ tour level file read switch (0=off, 1=on) required on for FIRSTM>5
SINPSW	0	/ trip segment level file read switch (0=off, 1=on) required on for FIRSTM>9
PRINTS	1	/ print log detail switch (0=almost none; 1=standard; 2-7=extra details)
POUTSW	1	/ person-level file write switch (0=off, 1=on)
TOUTSW	1	/ tour level file write switch (0=off, 1=on)
SOUTSW	1	/ trip segment level file write switch (0=off, 1=on)
EOUTSW	0	/ employment validation file write switch (0=off, 1=on)
SHADSW	1	/ shadow pricing switch (1=adjust shadow prices with local run or merge)
THLDUW	5	/ if parcel tot empl.t>=THLDUW then UW shad price based on parcel, else based on zone
THLDUS	5	/ if parcel k-12 enrol.>=THLDUS then US shad price based on parcel, else based on zone
THLDUU	5	/ if parcel uni enrol.>=THLDUU then UU shad price based on parcel, else based on zone
TOLPUW	10	/ Targeted Percent tolerance for usual work loc prediction vs target (integer >=0)
TOLAUW	10	/ Targeted Absolute tolerance for usual work loc prediction vs target (integer >=0)
TOLPUS	10	/ Targeted Percent tolerance for usual k-12 loc prediction vs target (integer >=0)
TOLAUS	10	/ Targeted Absolute tolerance for usual k-12 loc prediction vs target (integer >=0)
TOLPUU	10	/ Targeted Percent tolerance for usual univ loc prediction vs target (integer >=0)
TOLAUU	10	/ Targeted Absolute tolerance for usual univ loc prediction vs target (integer >=0)
NRPDIF	10	/ Num parcels included in print file rpts of large pct and abs diffs (integer >=0)

CODE	***Value***	***Comment***
VALIDS	0	/ switch to run long-term model validation output (0=off, 1=on)
PSSEED	55555	/ random seed for pop sampling to generate synthetic population
NSBINS	9	/ number of bins to use in pop.sampling to gerate synthetic population
SEXFAC	1	/ pop.sampling expansion factor in synthetic population (currently fixed at 1)
RNSEED	23456	/ seed for random number generator
HHSRAT	1	/ hh sample sampling ratio (e.g 10 = simulate every 10th household)
HHSBEG	1	/ hh sampling - postion first hh to use (e.g. 5 = start with 5th household)
WKLSSZ	100	/ work location model dest. sample size
SCLSSZ	100	/ school location model dest. sample size
WTDSSZ	50	/ work tour destination model dest. sample size
OTDSSZ	50	/ other tour destination model dest. sample size
ISLSSZ	50	/ int. stop location model dest. sample size
DEBUGS	0	/ debug switch (0=no debug, 1=debug mode)
SHOWID	0	/ show current household number on screen (0=don't show, 1=show)
WAITEX	0	/ wait at end of program (0=don't wait, 1=wait)
AGGLGS	1	/ aggregate logsum switch (1=calculate w/out writing, 2-calculate & write, 3=read)
AOCOST	15	/ auto ownersip costs/mi(cts) '00:12; '05:15=25% real incr.; '35:20=66% real incr.
SOVAMT	0	/ SOV am cordon toll
HOVAMT	0	/ HOV am cordon toll
ND1PCT	0	/ pct change in number of 1-link intersection nodes
ND3PCT	0	/ pct change in number of 3-link intersection nodes
ND4PCT	0	/ pct change in number of 4-link intersection nodes

The DBF template files should be in scenario directory. The names of these files cannot be changed by the user:

- pfiletemplate.dbf: Template for person level output file
- tfiletemplate.dbf: Template for tour level output file
- sfiletemplate.dbf: Template for trip level output file
- zouttemplate.dbf: Template for zone level employment output file
- eouttemplate.dbf: Template for parcel level employment output file
- hwflowradtemplate.dbf: Template for rad level commute output file
- hwflowdisttemplate.dbf: Template for district level commute output file

- celpredfiletemplate.dbf: Template for usual choice output file
- shadfiletemplate.dbf: Template for shadow-pricing output file

DaySim Output

The person, tour and trip level output files contain all of the variables predicted by DaySim, plus enough ID variables to cross-reference each other and the input data files in order to append more information if necessary.

The person day-level output file is a dBase format file (pout1.dbf) with one row of data per person. Table 32 shows the fields contained in the person day-level output file.

TABLE 32: PERSON DAY-LEVEL OUTPUT FILE (POUT1.DBF) FORMAT

FIELD	DESCRIPTION
sampn	Household ID (same as input sampno)
persn	Person sequence number within HH (same as input pnum)
hhtaz	Residence zone (same as input hzone)
hhcel	Residence parcel ID (same as input hparcel)
hhsize	# persons in the household (same as input persons)
hhcars	# vehicles in the household – predicted
uwtaz	Usual work zone – predicted
uwcel	Usual work parcel – predicted
ustaz	Usual school zone – predicted
uscel	Usual school parcel – predicted
ntours1	Number of work tours – predicted
ntours2	Number of school tours – predicted
ntours3	Number of escort tours – predicted
ntours4	Number of personal business tours – predicted
ntours5	Number of shopping tours – predicted
ntours6	Number of meal tours – predicted
ntours7	Number of social/recreation tours – predicted
nstops1	Number of work stops – predicted
nstops2	Number of school stops – predicted
nstops3	Number of escort stops – predicted
nstops4	Number of personal business stops – predicted
nstops5	Number of shopping stops – predicted
nstops6	Number of meal stops – predicted
nstops7	Number of social/recreation stops – predicted
wbtours	Number of work
expfac	Expansion factor
worker	Worker dummy variable
perstype	Person type code
hhincome	Household income ($)

TABLE 32: PERSON DAY-LEVEL OUTPUT FILE (POUT1.DBF) FORMAT

hhworkers	Household # workers

The perstype codes are: (1) full time worker, (2) part time worker, (3) non-worker age 65+, (4) other non-worker/non-student, (5) university student, (6) grade school student age 16+, (7) child age 5-15, and (8) child age 0-4.

The tour day-level output file is a dBase format file (tout1.dbf) with one row of data per person. **Table 33** shows the fields contained in the tour day-level output file. The trip day-level output file is a dBase format file (sout1.dbf) with one row of data per person. **Table 34** shows the fields contained in the trip day-level output file.

TABLE 33: TOUR DAY-LEVEL OUTPUT FILE (TOUT1.DBF) FORMAT

FIELD	DESCRIPTION
sampn	Household ID (same as input sampno)
persn	Person sequence number within HH (same as input pnum)
tourno	Tour sequence number within person day
tourpurp	Tour purpose (1 to 7)
prntour	Work-based sub-tour “parent” work tour ID (0 for home-based)
pdtaz	Tour primary destination zone – predicted
pdcel	Tour primary destination parcel – predicted
timarrpd	Tour primary destination arrival time (HHMM) – predicted
timdeppd	Tour primary destination departure time (HHMM) – predicted
mainmode	Tour main mode – predicted
tripsh1	Tour # of trips in first half tour – predicted
tripsh2	Tour # of trips in second half tour – predicted
sub-tours	Tour # of sub-tours – predicted
expfac	Expansion factor

TABLE 34: TRIP DAY-LEVEL OUTPUT FILE (SOUT1.DBF) FORMAT

FIELD	DESCRIPTION
sampn	Household ID (same as input sampno)
persn	Person sequence number within HH (same as input pnum)
tourno	Tour sequence number within person day
tourhalf	Tour half (1=outbound, 2=return)
tripno	Trip sequence number within half-tour
otaz	Trip origin zone – predicted
ocel	Trip origin parcel – predicted
dtaz	Trip destination zone – predicted
dcel	Trip destination parcel – predicted
mode	Trip mode – predicted
opurp	Trip origin activity purpose (1-7 as above, or 8=home)
dpurp	Trip destination activity purpose (1-7 as above, or 8=home)
deptime	Trip departure time – predicted (HHMM)
arrtime	Trip arrival time – predicted (HHMM)
travtime	Trip door-to-door travel time (min)
travdist	Trip travel distance (miles)
expfac	Expansion factor

The tourpurp, opurp, and dpurp codes are: (1) work, (2) school, (3) escort, (4) personal business, (5) shopping, (6) meal, (7) social/recreation, and (8) home.

The mainmode and mode codes are: (1) drive-transit-walk, (2) walk-transit-drive, (3) walk-transit-walk, (4) school bus, (5) shared ride 3+, (6) shared ride 2, (7) drive alone, (8) bike, and (9) walk.

7. TRIP ASSIGNMENT

In this step, zone-to-zone trips from the trip distribution step are assigned to the network.

Traffic Assignment

ShastaSIM uses a standard equilibrium assignment to assign vehicles. Vehicle trips are initially assigned to the road network using the "all-or-nothing" method, which assumes that all drivers will use the fastest route without regard to congestion caused by other vehicles. Travel times on the road network are recalculated based on the estimated level of congestion, and new shortest paths identified. The process is repeated for several iterations, in which some traffic is shifted to alternative routes with shorter travel times. In a perfect equilibrium assignment, no driver can shift to an alternative route with a faster travel time; in application, each iteration provides a closer approximation of equilibrium.

ShastaSIM is currently set to iterate final assignment to achieve a relative gap of 0.0002 (the fractional difference between assigned paths and shortest paths), or stop at a maximum of 80 iterations for each traffic assignment. To reduce runtimes, feedback assignments (used to update skim travel times, not for link volumes) tolerate moderately larger gaps, the tolerance progressively tightened for each feedback iteration before the final assignments.

Congested Travel Speeds

The relationship of speed to congestion on a particular roadway is based on a set of speed-flow curves that are included in the traffic assignment model. For example, the curves may indicate that an arterial street with no congestion will operate at 35 miles per hour, while an arterial link with a traffic volume equal to 90 percent of the capacity of the link will operate at about 28 miles per hour. The curves are based on the 2000 Highway Capacity Manual.

There are separate curves for the following types of roads:

1) Freeways;
2) Expressways/Highways;
3) Major Arterials; and
4) Minor Arterials.

Each link facility type is associated with a curve. The "minor arterial" curve is applied to collector and local streets. The "expressway" curve is applied to freeway ramps. Zone connectors are not actual streets and are not assumed to slow down during the assignment process.

Transit Assignment

Daily transit trips are assigned to the transit network. Transit trips are assigned to the best path based on shortest in-vehicle time plus weighted out-of-vehicle times.

Road Segment Level of Service

The forecast results include estimates of road segment link level of service (LOS) for the A.M. and P.M. peak hours. The LOS is based on the 2000 *Highway Capacity Manual* (HCM) using average default values as tabulated by the Florida Department of Transportation (FDOT). The maximum per-lane capacities were adjusted to more closely correlate to the lane capacities used in the Shasta Model traffic assignments (**Table 35** and **Table 36**).

TABLE 35: LEVEL OF SERVICE LOOKUP TABLES (FREEWAY, HIGHWAY, ARTERIAL)

Lanes	Terrain	Maximum Volume for Level of Service					Capacity
		A	B	C	D	E	per Lane
Urban Freeway							
2	All	1,270	2,110	2,940	3,580	3,980	1,990
3	All	1,970	3,260	4,550	5,530	6,150	2,050
4	All	2,660	4,410	6,150	7,480	8,320	2,080
5	All	3,360	5,560	7,760	9,440	10,480	2,096
6	All	4,050	6,710	9,360	11,390	12,650	2,108
Rural Freeway							
2	Flat	1,220	2,020	2,740	3,240	3,600	1,800
3	Flat	1,890	3,110	4,230	5,000	5,560	1,853
4	Flat	2,560	4,210	5,720	6,770	7,520	1,880
2	Rolling	1,098	1,818	2,466	2,916	3,240	1,620
3	Rolling	1,701	2,799	3,807	4,500	5,004	1,668
4	Rolling	2,304	3,789	5,148	6,093	6,768	1,692
2	Mountain	915	1,515	2,055	2,430	2,700	1,350
3	Mountain	1,418	2,333	3,173	3,750	4,170	1,390
4	Mountain	1,920	3,158	4,290	5,078	5,640	1,410
Expressway (Urban Area)							
1	All	n/a	100	590	810	850	850
2	All	n/a	220	1,360	1,710	1,800	900
3	All	n/a	340	2,110	2,570	2,710	903
4	All	n/a	440	2,790	3,330	3,500	875
Highway/Expressway (Small Urban Area)							
1	All	120	350	600	820	1,120	1,120
2	All	950	1,540	2,230	2,890	3,280	1,640
3	All	1,430	2,310	3,350	4,330	4,920	1,640
Rural Highway							
1	Flat	181	377	619	981	1,600	1,600
2	Flat	1,197	1,962	2,803	3,605	4,000	2,000
3	Flat	1,796	2,943	4,242	5,401	6,000	2,000
1	Rolling	147	307	503	797	1,300	1,300
2	Rolling	1,078	1,766	2,522	3,245	3,600	1,800
3	Rolling	1,617	2,648	3,818	4,861	5,400	1,800
1	Mountain	79	165	271	429	700	700
2	Mountain	838	1,373	1,962	2,524	2,800	1,400
3	Mountain	1,257	2,060	2,969	3,781	4,200	1,400

TABLE 36: LEVEL OF SERVICE LOOKUP TABLES (COLLECTOR, URBAN, LOCAL, FREEWAY)

Lanes	Terrain	Maximum Volume for Level of Service A	B	C	D	E	Capacity per Lane
Urban Collector							
1	All	n/a	n/a	250	530	660	660
2	All	n/a	n/a	580	1,140	1,320	660
Small Urban Collector							
1	All	n/a	100	492	617	667	667
2	All	n/a	232	1,088	1,256	1,328	664
Rural Collector							
1	Flat	181	377	619	981	1,600	1,600
2	Flat	1,078	1,766	2,522	3,245	3,600	1,800
3	Flat	1,617	2,648	3,818	4,861	5,400	1,800
1	Rolling	147	307	503	797	1,300	1,300
2	Rolling	1,018	1,668	2,382	3,064	3,400	1,700
3	Rolling	1,527	2,501	3,606	4,591	5,100	1,700
1	Mountain	79	165	271	429	700	700
2	Mountain	838	1,373	1,962	2,524	2,800	1,400
3	Mountain	1,257	2,060	2,969	3,781	4,200	1,400
Urban Local							
1	All	n/a	n/a	208	442	550	550
2	All	n/a	n/a	464	912	1,056	528
Small Urban Local							
1	All	n/a	n/a	83	342	450	450
2	All	n/a	n/a	160	656	864	432
Rural Local							
1	Flat	120	250	410	650	1,060	1,060
2	Flat	940	1,540	2,200	2,830	3,140	1,570
3	Flat	1,410	2,310	3,330	4,240	4,710	1,570
1	Rolling	109	227	373	591	964	964
2	Rolling	885	1,449	2,071	2,664	2,955	1,478
3	Rolling	1,327	2,174	3,134	3,991	4,433	1,478
1	Mountain	65	136	224	355	578	578
2	Mountain	719	1,178	1,682	2,164	2,401	1,201
3	Mountain	1,078	1,766	2,546	3,242	3,602	1,201
Freeway-Freeway Ramp							
1	All	138	471	928	1,315	1,800	1,800
2	All	1,468	2,382	3,462	4,472	5,082	2,541
Freeway Slip Ramp							
1	All	115	392	773	1,096	1,500	1,500
2	All	1,223	1,985	2,885	3,727	4,235	2,117
Freeway Loop Ramp							
1	All	96	327	644	913	1,250	1,250

8. MODEL VALIDATION

Model validation refers to comparing the model outputs (traffic volumes) to observed conditions (traffic counts). During validation, adjustments are made to model inputs, such as the road network and base year land uses; and calibration parameters such as model coefficients or peak factors. Once validated, the model can be used to predict future travel patterns with a high degree of confidence.

Traffic Validation Overview

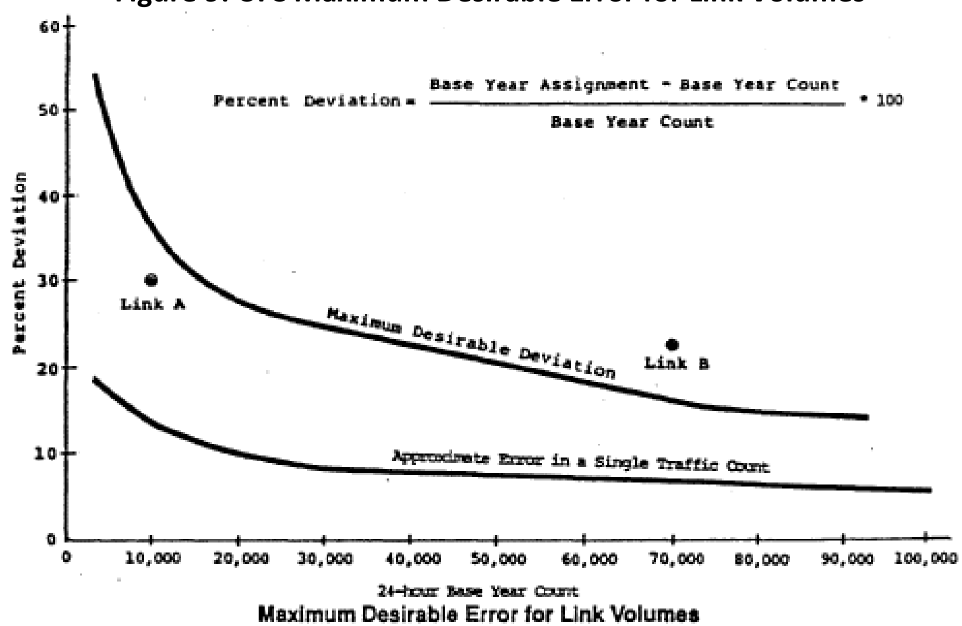
ShastaSIM 2010 validation meets the standard criteria for model validation as indicated in **Table 37** below and based on the CTC maximum desireable error for link volumes as shown in Figure 9.

TABLE 37: SUMMARY STATIC ASSIGNMENT GUIDELINES AND SHASTASIM PERFORMANCE

Guideline†	Threshold	ShastaSIM
% of Locations w/ Model Below Max Desired Error	>75%	**80%**
Correlation Coefficient	>0.88	**0.95**
RMSE for Daily Traffic Assignment	<0.40	**0.38**

†California Transportation Commission, *2010 Regional Transportation Plan Guidelines*, p. 53.

Figure 9: CTC Maximum Desirable Error for Link Volumes



Traffic Data

Traffic data for validation were obtained from a variety of sources, including the Caltrans traffic count databases, local traffic counts provided by Shasta County and the cities of Redding, Anderson and Shasta Lake, and counts derived from recent traffic impact studies provided by several jurisdictions. Where necessary, the raw traffic counts were processed to derive average mid-week (Tuesday to Thursday) volumes. Additional daily traffic counts were added based on the 2010 Caltrans Traffic Volumes; which are estimated daily traffic volumes, as opposed to direct traffic counts.

The traffic counts were reviewed to ensure that they were reasonable, and to identify the best count to use in locations where multiple counts were provided. There are over 700 unique daily traffic count locations and over 500 unique AM and PM peak hour traffic count locations in the database.

Traffic Validation

The ShastaSIM model traffic validation is based on total volume by road type.

Functional Classification

The Federal Highway Administration (FHWA) and Caltrans recommend error limits for total error by functional classification (type of road):

- Freeways Less than 7 percent
- Principal Arterials Less than 10 percent
- Minor Arterials Less than 15 percent
- Collectors Less than 25 percent
- Frontage Roads Less than 25 percent

The 2010 model validation was compared to both sets of criteria for all time periods.

Daily

The ShastaSIM model validation meets the FHWA targets for total volume by road type (**Table 38**) for all road types. The total model estimates are within 2.9 percent of the sample of links that have available traffic counts.

TABLE 38: **DAILY VALIDATION BY ROAD TYPE**

	Class	Links	Count	Model	Percent	FHWA Standard	Meets
1	Freeway	86	1,274,370	1,364,860	7.1%	+/- 7%	YES
2-3	Highway/Expwy	133	531,931	546,866	2.8%	+/- 10%	NO
4	Arterial	233	715,053	715,088	0.0%	+/- 15%	YES
5-6	Collector/Local	160	111,274	86,918	-21.9%	+/- 25%	YES
7-9	Ramps	114	304,573	312,738	2.7%		
11	Gateways	18	73,080	71,397	-2.3%		
	TOTAL	**744**	**3,010,281**	**3,097,867**	**2.9%**	**+/- 7%**	**YES**

Peak Hour

The ShastaSIM model AM peak hour validation meets the FHWA targets for total volume by road type (**Table 39**) for all road types combined and arterials. FHWA standards are not met for Freeway, Highway/Expressway and Collector/Local road types individually. The total model estimates are within 6.1 percent on the sample of links that have available traffic counts.

TABLE 39: **AM PEAK HOUR VALIDATION BY ROAD TYPE**

	Class	Links	Count	Model	Percent	FHWA Standard	Meets
1	Freeway	22	25,083	27,617	10.1%	+/- 7%	NO
2-3	Highway/Expwy	33	10,132	12,096	19.4%	+/- 10%	NO
4	Arterial	190	34,172	33,172	-2.9%	+/- 15%	YES
5-6	Collector/Local	147	7,745	5,211	-32.7%	+/- 25%	NO
7-9	Ramps	114	19,067	23,993	25.8%		
11	Gateways						
	TOTAL	**506**	**96,199**	**102,089**	**6.1%**	**+/- 7%**	**YES**

The ShastaSIM model PM peak hour validation meets the FHWA for total volume by road type (**Table 40**) for all road types. The total model estimates are within 2.6 percent on the sample of links that have available traffic counts.

TABLE 40: **PM PEAK HOUR VALIDATION BY ROAD TYPE**

	Class	Links	Count	Model	Percent	FHWA Standard	Meets
1	Freeway	22	30,105	30,114	0.0%	+/- 7%	YES
2-3	Highway/Expwy	33	12,181	12,945	6.3%	+/- 10%	YES
4	Arterial	190	37,032	37,150	0.3%	+/- 15%	YES
5-6	Collector/Local	147	7,722	6,027	-22.0%	+/- 25%	YES
7-9	Ramps	114	24,090	27,769	15.3%		
11	Gateways						
	TOTAL	**506**	**111,130**	**114,005**	**2.6%**	**+/- 7%**	**YES**

Root Mean Square Error

The root mean square error (RMSE) provides a measure of accuracy based on the statistical standard deviation. The RMSE puts a greater emphasis on larger errors that may cancel each other out in the total validation, by road type described previously. The overall Shasta target RMSE is 40 percent. The ShastaSIM model meets the RMSE validation criteria for daily traffic (**Table 41**).

TABLE 41: **VALIDATION BY ROOT MEAN SQUARE ERROR**

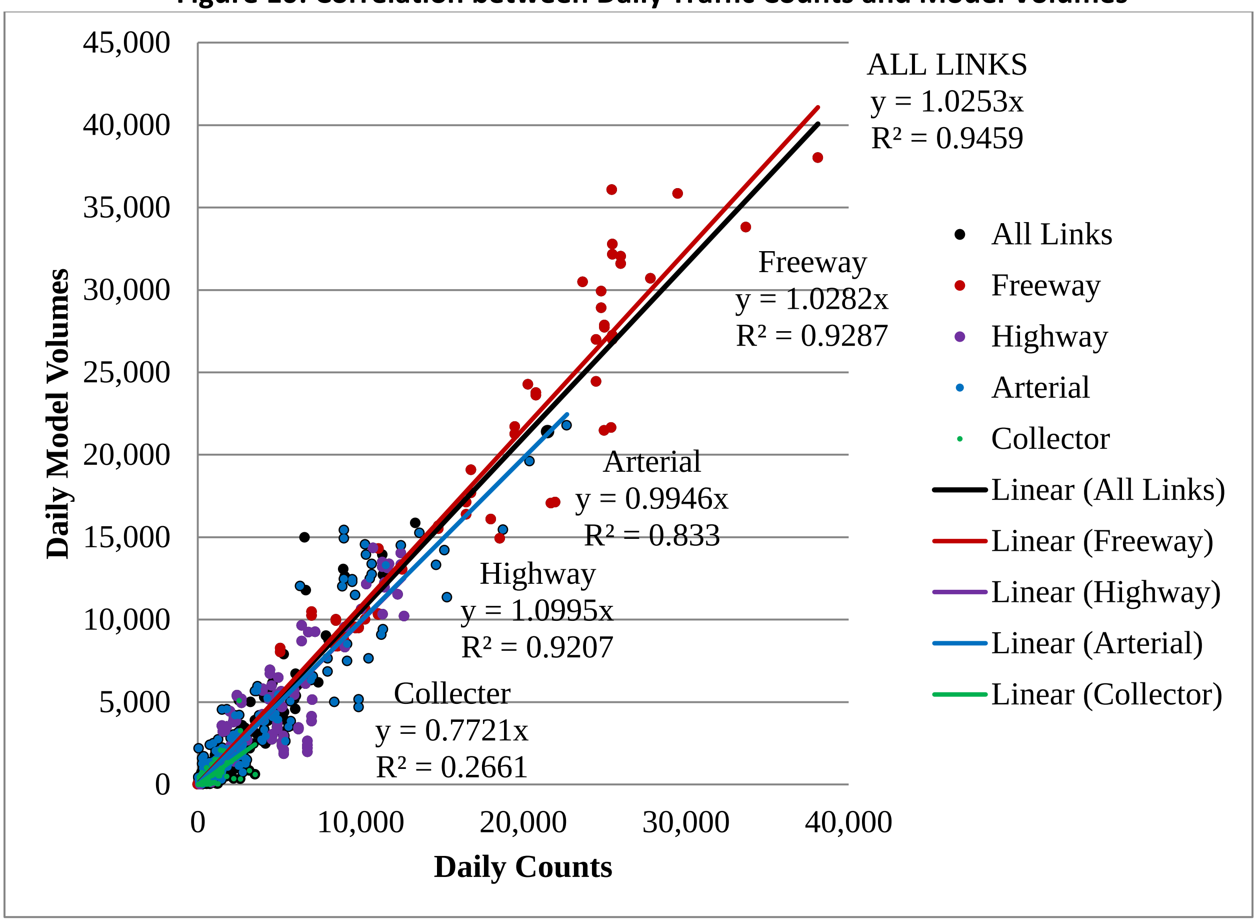
TABLE 41: VALIDATION BY ROOT MEAN SQUARE ERROR

Class		Daily			AM Peak Hour		PM Peak Hour	
		RMSE	FHWA Target	Meets	RMSE	Meets	RMSE	Meets
1	Freeway	18.7%			46.2%		33.1%	
2-3	Highway/Expwy	43.7%			55.5%		32.8%	
4	Arterial	45.7%			68.4%		55.6%	
5-6	Collector/Local	80.7%			89.7%		68.1%	
7-9	Ramps	49.8%			91.6%		68.3%	
11	Gateways	4.5%						
	TOTAL	**38.1%**	**40.0%**	**YES**	**83.1%**	**N/A**	**62.6%**	**N/A**

Correlation and R-Squared

Figure 10 shows the correlation between observed daily traffic counts and estimated model volumes and also displays the trendlines for each road type, along with the R-squared values. The calculated R-squared value for all links is 0.95.

Figure 10: Correlation between Daily Traffic Counts and Model Volumes



Screenlines

Screenlines are imaginary lines, often along natural or man-made physical barriers (e.g., rivers, railroad tracks) that have a limited number of crossings. The screenlines should “cut” the entire study area, intercepting all travel across them, thereby eliminating issues about individual route choice. Use of a system of screenlines allows systematic comparison of total model estimated versus observed travel in different parts of the model area. However, they do not ensure that traffic is being assigned to the correct routes across each screenline.

As this 2010 validation is more focused on specific assignments, screenline results have not been compiled for the 2010 validation.

Transit Validation

The ShastaSIM model transit validation is based on a comparison of the model’s estimated daily transit ridership against observed daily transit ridership (**Table 42**). The model is within three percent of overall daily ridership on fixed-route transit services in Shasta County.

TABLE 42: TRANSIT VALIDATION

Route	Ridership Counts		Model	
	Annual	Daily	Boardings	% Error
1	63,221	218	171	-21.6%
2	43,216	149	264	77.2%
3	84,762	292	137	-53.1%
4	46,514	160	179	11.9%
5	58,491	202	242	19.8%
6	60,390	208	308	48.1%
7	49,449	171	154	-9.9%
9	47,320	163	278	70.6%
11	99,8008	344	510	48.3%
14	127,380	439	386	-12.1%
Airport Express	n/a	239	65	-72.8%
Burney	n/a	32	2	-93.8%
Total	**691,038**	**2,617**	**2,789**	**+3.0%**

Note: RABA average daily ridership data from 4/2011-4/2012
N/A: less than 12 months of data available

The validation results indicate that the model can generally predict overall transit ridership. It may not be as appropriate for detailed route planning, particularly in areas with low transit demand.

Dynamic Validation

The *2010 Regional Transportation Guidelines* developed by the California Transportation Commission (CTC) suggest that additional sensitivity or “dynamic validation” testing be done to models in order to determine how well the model responds to changes in land uses and/or the transportation system. The extent and level of testing should be considered on a case-by-case basis, given the type of model used, available time/cost constraints and expectations of the model to assist in policy analysis or planning. Below is a list of CTC suggested tests[1] that are commonly conducted:

- Add lanes to a link
- Add a link
- Delete a link
- Change link speeds
- Change link capacities
- Add 100 households to a TAZ
- Add 1,000 households to a TAZ
- Add 5,000 households to a TAZ
- Add 10,000 households to a TAZ
- Increase/Decrease toll rates
- Increase/Decrease transit fares
- Increase transit speeds

As part of requirements under Senate Bill 375 (SB 375), the California Air Resources Board staff will work with SRTA to review sensitivity testing of the model in support of the 2015 Regional Transportation Plan (RTP). This work will be conducted during the summer and fall of 2014. Results of that work will be made available in an updated model documentation report after the 2015 RTP is adopted by the SRTA Board of Directors. At the time of this report SRTA had conducted some dynamic land use testing of the model. A discussion of that effort follows.

Land Use Testing

Because California Senate Bill 375 requires MPOs to evaluate the impacts of land use and transportation investments together, dynamic testing was done during development of ShastaSIM to test the sensitivity of the model to changes in land use. This was done accomplished by incrementally increasing residential density in specific areas within the city of Redding and evaluating results. These tests also helped inform the selection of preliminary Strategic Growth Areas (SGAs) developed by the city of Redding for SRTA's 2015 RTP. SGAs are focus areas where SRTA and the local agency will coordinate to develop plans and fund projects that address the five 'D' factors effectively known to reduce VMT, i.e. Density, Diversity, Design, Destination accessibility, and Distance to Transit.

SRTA, DKS Associates and city of Redding worked together to develop a methodology and process for incorporating SGAs into the model. New SGA boundary files were created using Geographic Information Systems (GIS) for four areas in Redding: Downtown Redding, Oasis Road, South Bonnyview, and Rancho/Shasta View. The methodology consisted of taking a

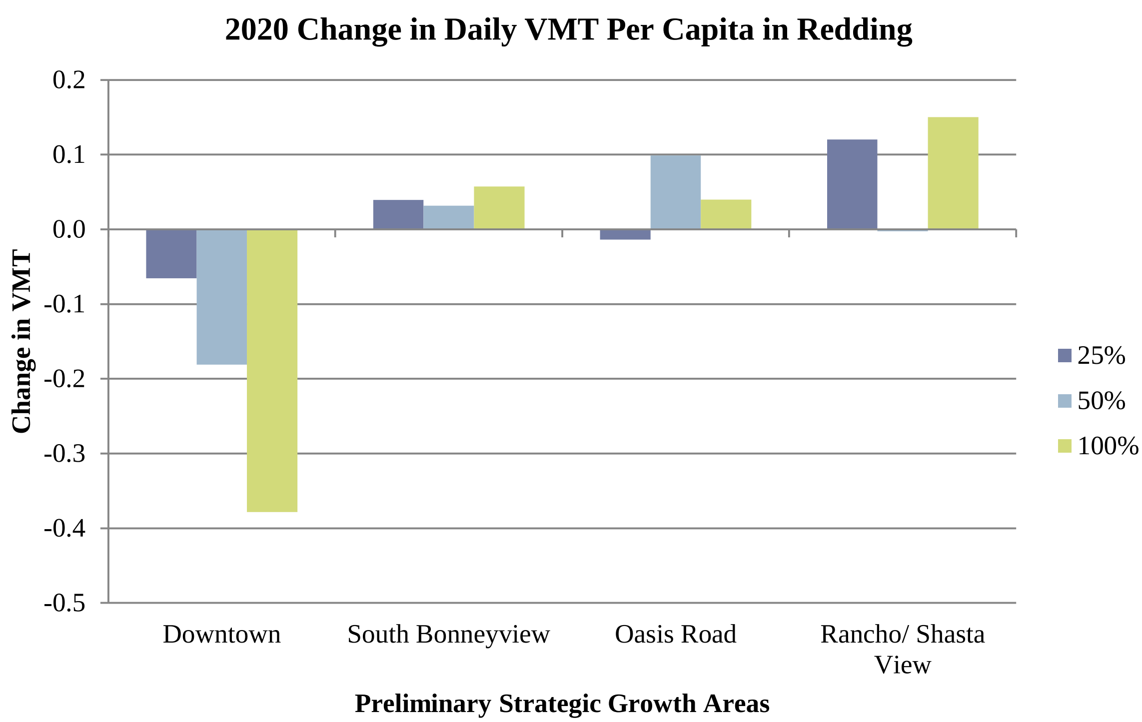
[1] California Transportation Commission, *2010 Regional Transportation Plan Guidelines*, p. 54.

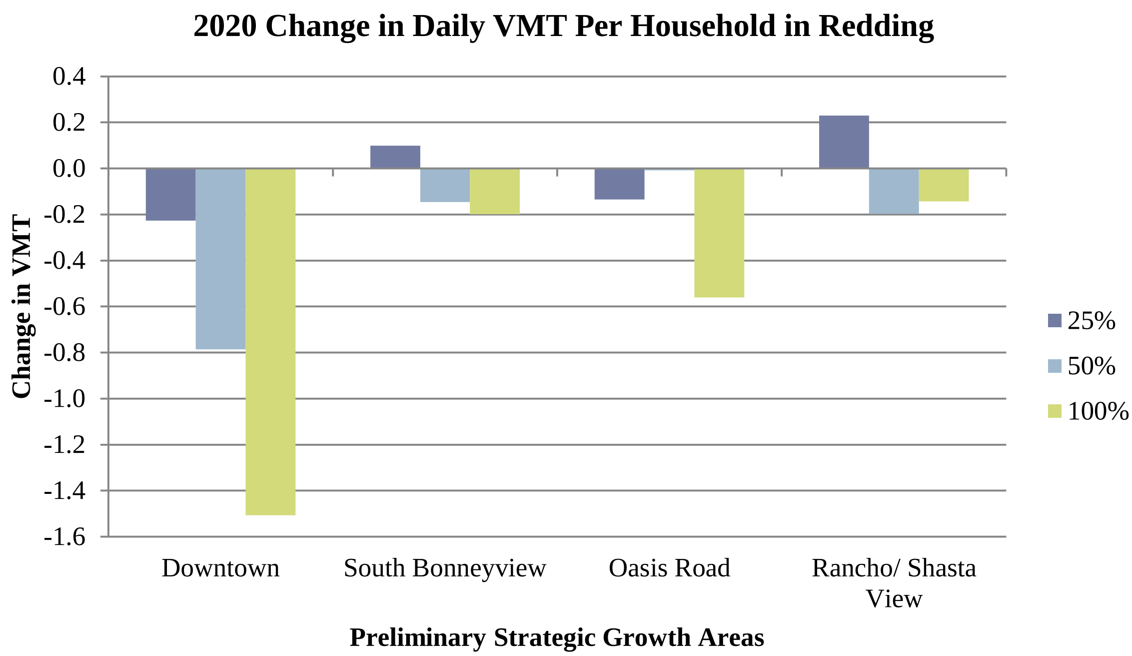
percentage of the anticipated future residential growth for Redding and then redirecting that growth to the specific SGA for years 2020 and 2035. Below are the three land use scenarios tested for each SGA:

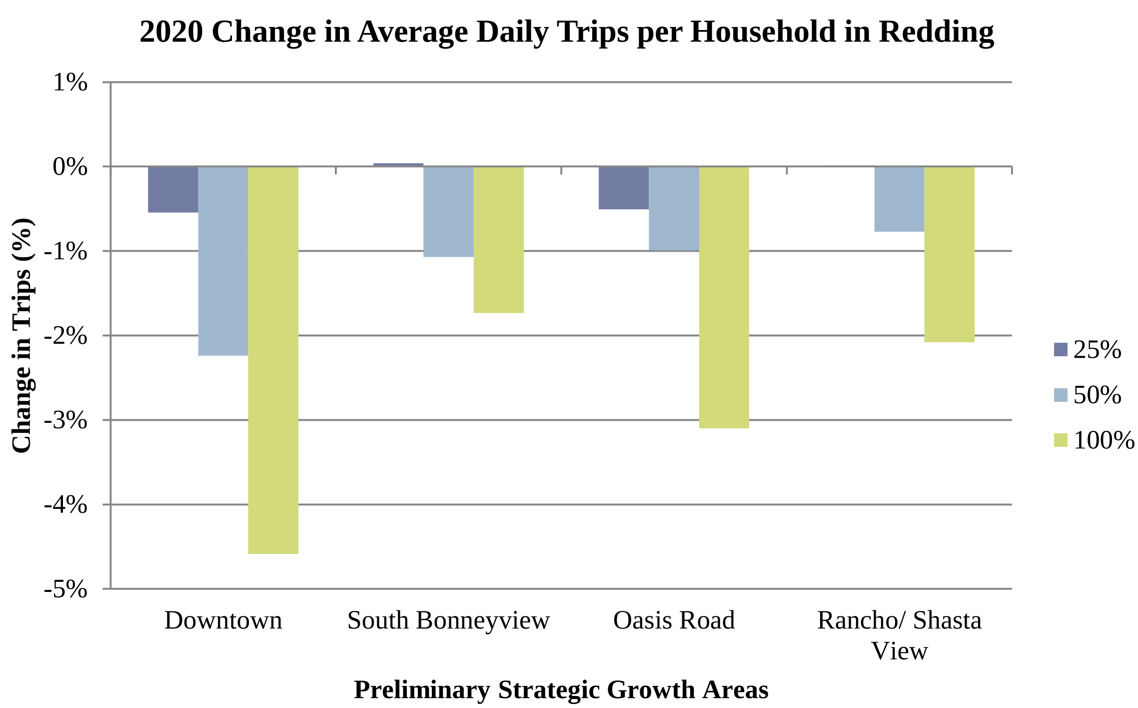
- **Moderately Reasonable** (Scenario A) – assumes that **25%** of the growth in total housing units citywide would be redirected to a single SGA for a given time frame.
- **Midpoint** (Scenario B) – assumes that **50%** of the growth in total housing units citywide would be redirected to a single SGA for a given time frame.
- **Maximum Potential** (Scenario C) – assumes that **100%** of the growth in total housing units citywide would be redirected to a single SGA for a given time frame.

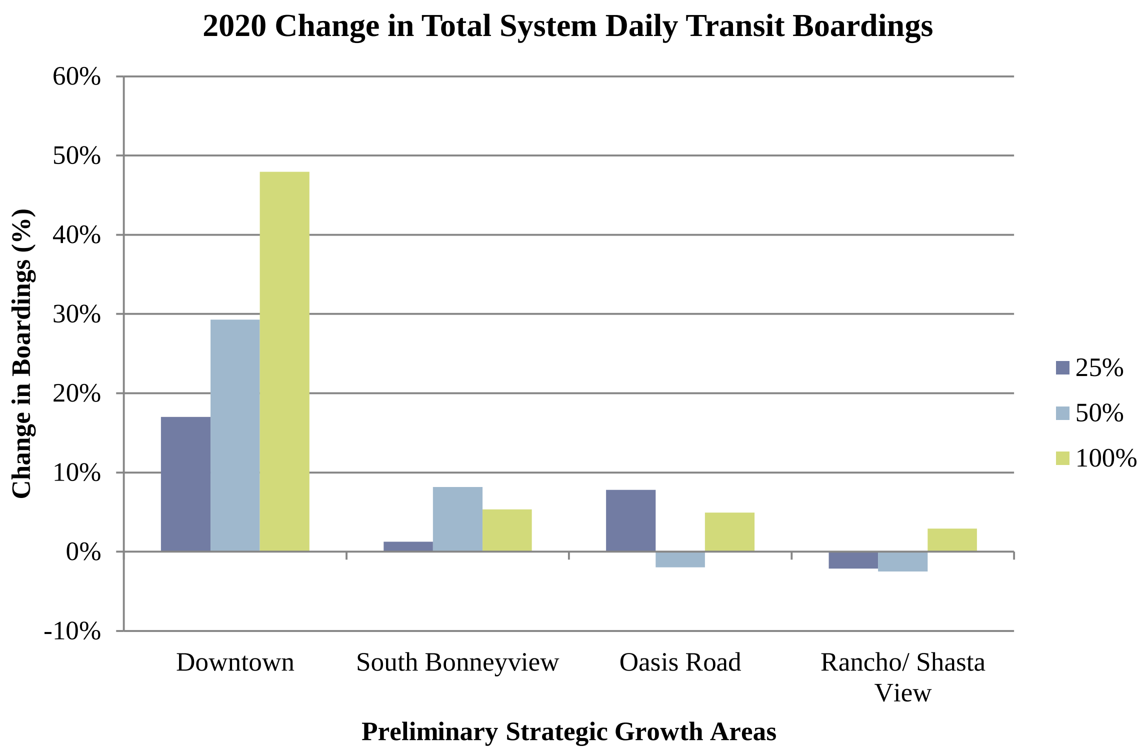
During testing of the scenarios it was found that the model was reasonably sensitive to land use changes for each SGA. It was also sensitive to the available transportation network infrastructure (e.g. grid streets vs suburban roads with limited access) and transit service within ¼ and ½ mile of the SGAs. Complete details regarding the SGA work and testing results are available in the *2015 Shasta Regional Transportation Plan and Sustainable Community Strategy: Redding Strategic Growth Areas Technical Memo*, available on SRTA's website at: http://www.srta.ca.gov/pastel/RT_TDM.htm

The following graphs highlight some of the modeling results for the SGAs for year 2020. Each graph shows the city of Redding's four initial SGAs being considered and results of the moderately reasonable (25% redirected growth), midpoint (50% redirected growth) and maximum potential scenarios (100% redirected growth).




2020 Change in Daily VMT Per Household in Redding
0.4
0.2
0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
Change in VMT
Downtown
South Bonneyview
Oasis Road
Rancho/ Shasta View
Preliminary Strategic Growth Areas
25%
50%
100%


2020 Change in Average Daily Trips per Household in Redding
1%
0%
-1%
-2%
-3%
-4%
-5%
Change in Trips (%)
Downtown
South Bonneyview
Oasis Road
Rancho/ Shasta View
Preliminary Strategic Growth Areas
25%
50%
100%


2020 Change in Total System Daily Transit Boardings
Change in Boardings (%)
60%
50%
40%
30%
20%
10%
0%
-10%
25%
50%
100%
Downtown
South Bonneyview
Oasis Road
Rancho/ Shasta View
Preliminary Strategic Growth Areas

9. MEASURES OF EFFECTIVENESS

ShastaSIM has been developed not only to provide model users with projections of future traffic volumes and transit ridership, but also to provide a wide range of measures of effectiveness (MOE's) of plans, projects or policies that may affect air quality, mobility, accessibility, mode share, travel time, trips and congestion. The detail inherent in the activity based model allows much more detailed MOE's to be calculated, documented, and compared between scenarios.

For example, whereas traditional four step models allow the user to determine overall vehicle miles traveled (VMT) on the roadway system or by roadway type, ShastaSIM can allow the model user to determine VMT by residents of a particular jurisdiction or area. It can also allow more detailed determination of VMT per household, encompassing a full day's worth of travel (a tour, as described previously in this document) for each person in the household.

MOEs Related to Households in Shasta County

In addition to population and households by geographic area or jurisdiction, the following MOE's can be determined using **ShastaSIM**. Many of these are new and unique due to the level of modeling now capable.

Average Population per Household

Because the population dataset includes every person in each household, it is possible to determine average population per household by simply dividing the population of a desired geographic area by the number of households in the same geographic area.

TABLE 43: FORECASTED AVERAGE POPULATION PER HOUSEHOLD

	2005	2010	2015	2020	2025	2030	2035
Shasta County Total	2.48	2.48	2.48	2.48	2.48	2.48	2.48
Redding	2.49	2.48	2.48	2.48	2.48	2.47	2.49
Anderson	2.49	2.45	2.50	2.45	2.48	2.51	2.51
Shasta Lake	2.51	2.47	2.46	2.50	2.51	2.48	2.47
Unincorporated County	2.47	2.49	2.49	2.49	2.48	2.48	2.47

VMT Attributed to Households

With the advent of the activity based (AB) model, it is now possible to determine the daily VMT attributed to each household within the County. This is based on the fact that ShastaSIM produces what is called a daily "tour" for each person. For example, a person's daily tour could consist of the following, starting at home:

1) Leave home
2) Drop off kids at school
3) Drive to work
4) Walk to lunch appointment
5) Walk back to work
6) Drive to gym
7) Drive home

The output trips file includes each trip segment (and its trip length) generated by each person in each household and these are aggregated by household. Therefore the total miles driven by all driving members of a household can be summed up to determine VMT per household. This ability to attribute VMT to each household in turn allows the analysis to more accurately document total VMT attributed to households within a jurisdiction or area of interest. It should be noted that this metric only considers VMT attributed to the households within Shasta County and does not include VMT related to through traffic (e.g. semi-trucks passing through on Interstate 5 with goods for Portland, Oregon).

TABLE 44: FORECASTED VMT ATTRIBUTED TO HOUSEHOLDS IN SHASTA COUNTY

	2005	2010	2015	2020	2025	2030	2035
Shasta County Total	3,507,836	3,552,184	3,780,747	4,013,188	4,146,141	4,229,355	4,495,895
Redding	1,278,222	1,325,504	1,442,805	1,600,368	1,637,151	1,618,833	1,853,442
Anderson	158,788	161,047	176,506	193,013	230,233	224,587	236,283
Shasta Lake	183,299	187,540	188,590	194,289	201,068	207,289	227,915
Unincorporated County	1,887,527	1,878,093	1,972,846	2,025,519	2,077,689	2,178,646	2,178,256

VMT per Capita

VMT per capita for a given area of interest is calculated by dividing the VMT attributed to households by the total population.

TABLE 45: FORECASTED VMT PER CAPITA IN SHASTA COUNTY

	2005	2010	2015	2020	2025	2030	2035
Shasta County Total	20.10	20.13	20.74	20.92	20.73	20.39	20.94
Redding	14.21	14.54	15.10	15.56	15.41	14.93	16.39
Anderson	16.26	16.44	16.77	17.41	17.67	17.04	17.61
Shasta Lake	18.26	18.97	18.98	19.10	18.61	18.46	20.11
Unincorporated County	29.15	28.62	29.79	29.90	29.72	29.24	28.32

VMT per Household

VMT per household for a given area of interest is calculated by dividing the VMT attributed to households by the total households.

TABLE 46: FORECASTED VMT PER CAPITA IN SHASTA COUNTY

	2005	2010	2015	2020	2025	2030	2035
Shasta County Total	20.10	20.13	20.74	20.92	20.73	20.39	20.94
Redding	14.21	14.54	15.10	15.56	15.41	14.93	16.39
Anderson	16.26	16.44	16.77	17.41	17.67	17.04	17.61
Shasta Lake	18.26	18.97	18.98	19.10	18.61	18.46	20.11
Unincorporated County	29.15	28.62	29.79	29.90	29.72	29.24	28.32

Vehicle Trips

The vehicle trips file includes every trip conducted by every person in Shasta County. By linking these trips to the household that generates them, it is possible to assign trips to the area of interest (e.g. traffic analysis zones). This includes trips originating at home or elsewhere, so long as the trip was completed by a resident of the particular home.

TABLE 47: FORECASTED TOTAL DAILY VEHICLE TRIPS

	2005	2010	2015	2020	2025	2030	2035
Shasta County Total	448,610	454,822	472,897	501,527	523,369	542,435	565,800
Redding	234,157	238,882	251,412	274,530	282,730	286,515	302,256
Anderson	24,953	24,970	26,738	28,586	33,837	33,794	35,262
Shasta Lake	24,483	24,733	25,071	25,546	26,729	28,113	28,771
Unincorporated County	165,016	166,238	169,676	172,865	180,073	194,014	199,512

Average Trip Length

The vehicle trips file includes the length of every trip conducted by every person in the Shasta County region. By linking these trip lengths to the household that generates them, it is possible to allocate trip lengths to the area of interest and divide this by the number of vehicle trips.

TABLE 48: FORECASTED AVERAGE TRIP LENGTH (MILES)

	2005	2010	2015	2020	2025	2030	2035
Shasta County Total	7.82	7.81	7.99	8.00	7.92	7.80	7.95
Redding	5.46	5.55	5.74	5.83	5.79	5.65	6.13
Anderson	6.36	6.45	6.60	6.75	6.80	6.65	6.70
Shasta Lake	7.49	7.58	7.52	7.61	7.52	7.37	7.92
Unincorporated County	11.44	11.30	11.63	11.72	11.54	11.23	10.92

Average Daily Trips per Household

Average daily trips per household for a given area of interest is calculated by dividing the total vehicle trips attributed to households by the total households.

TABLE 49: FORECASTED AVERAGE DAILY TRIPS PER HOUSEHOLD

	2005	2010	2015	2020	2025	2030	2035
Shasta County Total	6.38	6.39	6.44	6.49	6.49	6.49	6.54
Redding	6.47	6.49	6.51	6.63	6.59	6.54	6.65
Anderson	6.36	6.26	6.36	6.31	6.43	6.42	6.61
Shasta Lake	6.13	6.17	6.21	6.27	6.22	6.21	6.28
Unincorporated County	6.29	6.31	6.37	6.34	6.39	6.46	6.41

MOE's Related to Roadways

Roadway statistics measure the impact that land use and transportation projects may have on the regional network during peak travel times, off-peak travel times and the overall day. They look at the amount of vehicle miles traveled in and through the region, number of hours spent on congested roads, and average speeds on roadways. Categories of roadway statistics are similar to those developed in the past for SRTA for the original 4-step travel model and are continued with ShastaSIM. These statistics may be calculated for all roadways or for a desired area(s) of interest.

The model provides the following statistical reports by facility type:

- Daily Vehicle Miles Traveled (VMT)
- Vehicle hours of travel, free-flow speeds
- Average speeds, free-flow speeds
- Vehicle hours of travel, congested speeds
- Average speeds, congested speeds
- Daily Vehicle Hours of Delay
- Miles of Roadway at LOS D, E or F
- Total lane miles of road

All of the above MOEs include data for the following time periods:

- AM Peak
- PM Peak
- Off-peak
- Daily

Table 50 shows a summary of roadway statistics for 2005-2035

TABLE 50: ROADWAY MOE'S (SHASTA COUNTY)

Roadway Statistics	Year 2005	2010	2015	2020	2025	2030	2035
Total Lane Miles of Roads in Analysis Area	**3,826.7**	**3,837.9**	**3,870.8**	**3,898.0**	**3,911.8**	**3,921.0**	**3,965.1**
5 year increment		11.2	44.1	27.2	13.8	9.1	44.2
Daily Vehicle Miles of Travel on Roadways	**4,976,252**	**5,288,601**	**5,575,035**	**5,951,791**	**6,246,772**	**6,435,628**	**7,308,811**
Freeway	1,959,604	2,195,519	2,397,816	2,624,034	2,807,233	2,929,383	3,380,440
Highway	1,020,877	1,037,873	1,052,646	1,072,495	1,096,690	1,100,756	1,274,027
Expressway	209,845	222,884	229,151	241,042	250,526	261,169	284,274
Arterial	990,062	1,016,621	1,065,166	1,142,834	1,192,072	1,231,473	1,351,065
Collector	314,934	327,467	328,177	345,153	358,929	363,413	412,710
Local	86,305	84,821	83,239	86,302	86,324	86,016	102,379
Ramp	104,520	110,107	116,080	124,059	130,388	130,418	141,320
Zone Connector	290,106	293,309	302,761	315,871	324,611	333,001	362,597
Daily Vehicle Hours of Delay	**1,564**	**1,314**	**1,428**	**1,537**	**1,788**	**2,072**	**2,636**
Freeway	18.6	43.6	35.4	17.0	33.9	51.0	91.9
Highway	106.4	105.2	104.8	120.7	132.8	168.8	199.5
Expressway	445.7	200.9	238.8	267.6	307.9	374.0	489.1
Arterial	553.1	489.0	548.2	547.1	625.5	730.9	980.6
Collector	215.3	219.5	234.8	266.9	348.1	366.8	386.0
Local	133.7	142.4	138.7	158.6	150.2	161.3	189.3
Ramp	91.2	113.1	127.8	159.5	189.6	219.0	299.6
Zone Connector	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Miles of Roads at LOS E/F	**12.2**	**8.8**	**8.9**	**7.2**	**8.1**	**11.2**	**14.2**
Freeway	0.9	1.7	0.9	0.9	0.9	2.2	2.6
Highway	2.5	2.5	2.5	2.5	3.1	3.1	3.1
Expressway	3.0	0.0	0.0	0.0	0.0	0.1	0.1
Arterial	3.5	2.3	3.2	1.1	1.7	2.7	4.7
Collector	0.4	0.3	0.4	0.5	0.5	0.7	0.5
Local	0.2	0.2	0.2	0.2	0.0	0.4	0.7
Ramp	1.7	1.7	1.7	1.9	1.9	1.9	2.5
Zone Connector	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MOEs Related to Transit

Total System Daily Transit Boardings

As in previous analyses, model transit outputs include peak, off peak, and daily transit boardings by transit stop and transit line. Table 51 provides a daily transit boarding summary.

TABLE 51: FORECASTED RABA DAILY TRANSIT BOARDINGS

	2005	2010	2015	2020	2025	2030	2035
Total System	**2,482**	**2,696**	**2,928**	**2,968**	**3,197**	**2,917**	**2,975**
Route 1	73	171	213	218	230	231	202
Route 2	285	264	323	322	313	310	322
Route 3	126	137	158	158	166	179	186
Route 4	204	179	211	220	232	213	214
Route 5	341	242	247	237	291	252	281
Route 6	351	308	311	302	334	285	310
Route 7	234	154	165	177	177	140	166
Route 8*	48	n/a	n/a	n/a	n/a	n/a	n/a
Route 9	273	278	324	316	346	359	351
Route 11	244	510	513	523	567	508	497
Route 14	302	386	410	423	473	378	378
Airport Express	0	65	50	67	65	56	65
Burney Express	1	2	3	5	3	6	3

*Route 8 eliminated before 2010

Total Households and Employment within ¼ and ½ mile of transit stops

At the request of SRTA, DKS prepared scripts to compute and compare the total number of households and employees within ¼ and ½ mile of transit stops for each route and for the system as a whole. These scripts create a buffer around each stop and tabulate the number of households and employees within the buffer. The scripts have been written to avoid double counting households or employees that fall within the buffer or more than one stop or route. This is done by buffering all stop nodes instead of one at a time. When the buffering is done on all nodes, it does not double count – unlike if buffering was done on individual nodes and added afterwards.

TABLE 52: FORECASTED HOUSEHOLDS AND EMPLOYMENT WITHIN ½ AND ¼ MILE OF TRANSIT STOPS

	2005	2010	2015	2020	2025	2030	2035
Households Within 1/2 Mile of Transit Stops	43,329	44,265	45,241	46,578	47,757	48,647	50,060
Employment Within 1/2 Mile of Transit Stops	49,097	53,184	57,711	60,808	63,225	65,430	67,083
Households Within 1/4 Mile of Transit Stops	31,679	32,214	32,670	33,121	33,436	33,799	34,291
Employment Within 1/4 Mile of Transit Stops	44,847	47,023	50,499	52,749	54,541	55,977	56,304