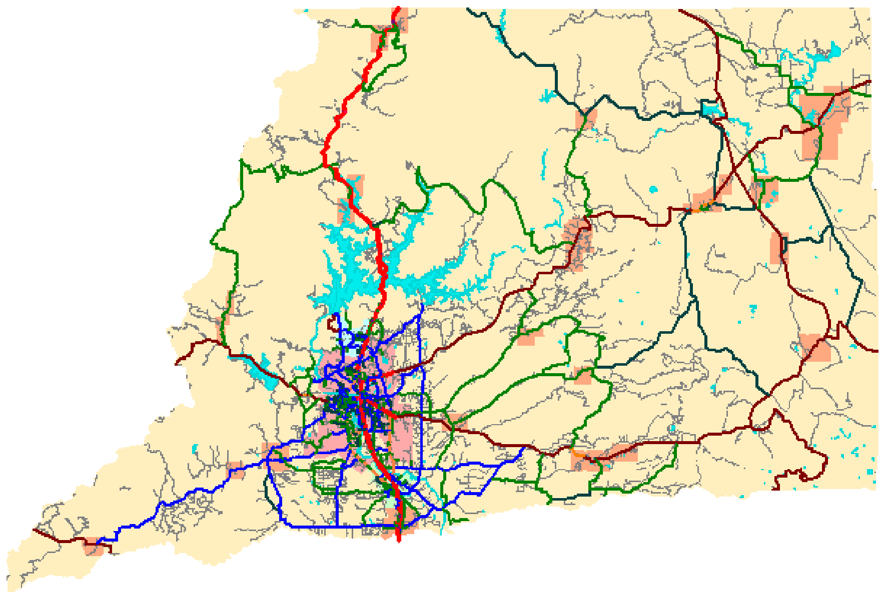
Model Users Guide

Shasta County Travel Demand Model



prepared for

Shasta County
Regional Transportation Planning Agency

Prepared by

Dowling Associates, Inc.
Transportation Engineering • Planning • Research • Education

April 24, 2008

April 24, 2008

Mr. Thomas Hays
Shasta County Regional Transportation Planning Agency
1855 Placer Street
Redding, CA 96001

Subject: Shasta County Travel Demand Model P04114
Model Users Guide

Dear Mr. Hays:

Dowling Associates is transmitting the Model Users Guide for the updated Shasta County Travel Demand Model. This version supercedes the Draft Model Users Guide dated September 25, 2006. It includes additional material on mode choice analysis and a significantly expanded user section for the Cube software.

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

Sincerely,

Dowling Associates, Inc.

Michael N. Aronson, P.E.

Principal

C:\Projects\2004\04114 Shasta Model\Documents\080424 Shasta Model Guide.doc

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (continued)

1. INTRODUCTION

This report describes the Shasta County travel demand forecast model. The report also includes a user guide for application of the model using the Cube software.

Model Purpose

The Shasta County travel model is intended to provide reliable traffic forecasts to support the participating agencies in transportation and land use studies.

Summary of Model

The Shasta County travel model is a conventional travel model demand forecasting model that is similar in structure to most other current area-wide models used for traffic forecasting. It uses land use, socioeconomic, and road network data to estimate travel patterns, roadway traffic volumes and transit volumes.

Model Coverage and Transportation Analysis Zones (TAZs)

The study area for the Shasta County travel model covers all of Shasta County. The county is divided into approximately 880 transportation analysis zones (TAZs). Travel to and from Shasta County is represented by 16 gateway zones at major road crossings of the county line.

Land Use Inputs

The travel demand model land use inputs (socioeconomic data) are aggregated by TAZ. Population-related inputs include population and numbers of housing units stratified by type. Employment-related inputs include numbers of employees by 21 employment categories. There are additional inputs for "special generators," primarily major recreational uses.

Land uses outside of Shasta County are represented by existing and projected traffic counts on the gateway roads at the county line.

Network Characteristics

The travel model roadway network includes over 5,000 active nodes and about 12,000 links. Link types include freeway, highway, expressway, arterial, collector, local and three types of freeway ramps. The model distinguishes between urban, small urban and rural areas. Important road network attributes include distances, uncongested speeds and terrain (flat, rolling or mountain).

Transit networks have been coded to represent Redding Area Bus Authority (RABA) bus lines and rural transit service.

The NAD 27 State Plane California Zone 1 coordinate projection is used for the model networks so that the model network can be viewed together with other geographic information (GIS) such as street maps, TAZ maps and census information.

Forecasting Process

Four sequential steps (actually sub-models) are involved in the travel demand forecasting process:

1. **Trip Generation.** This initial step translates household and employment data into person trip ends using trip generation rates established during model calibration.
2. **Trip Distribution.** The second general step estimates how many trips travel from one zone to any other zone. The distribution is based on the number of trip ends generated in each of the two zones, and on factors that relate the likelihood of travel between any two zones to the travel time between the two zones.
3. **Mode Choice.** This step estimates the proportions of the total person trips using drive-alone or shared-ride auto, transit or non-motorized modes for travel between each pair of zones.
4. **Trip Assignment.** In this final step, vehicle trips or transit trips from one zone to another are assigned to specific travel routes between the zones.

A flow chart of the travel model process is shown in Figure 1.

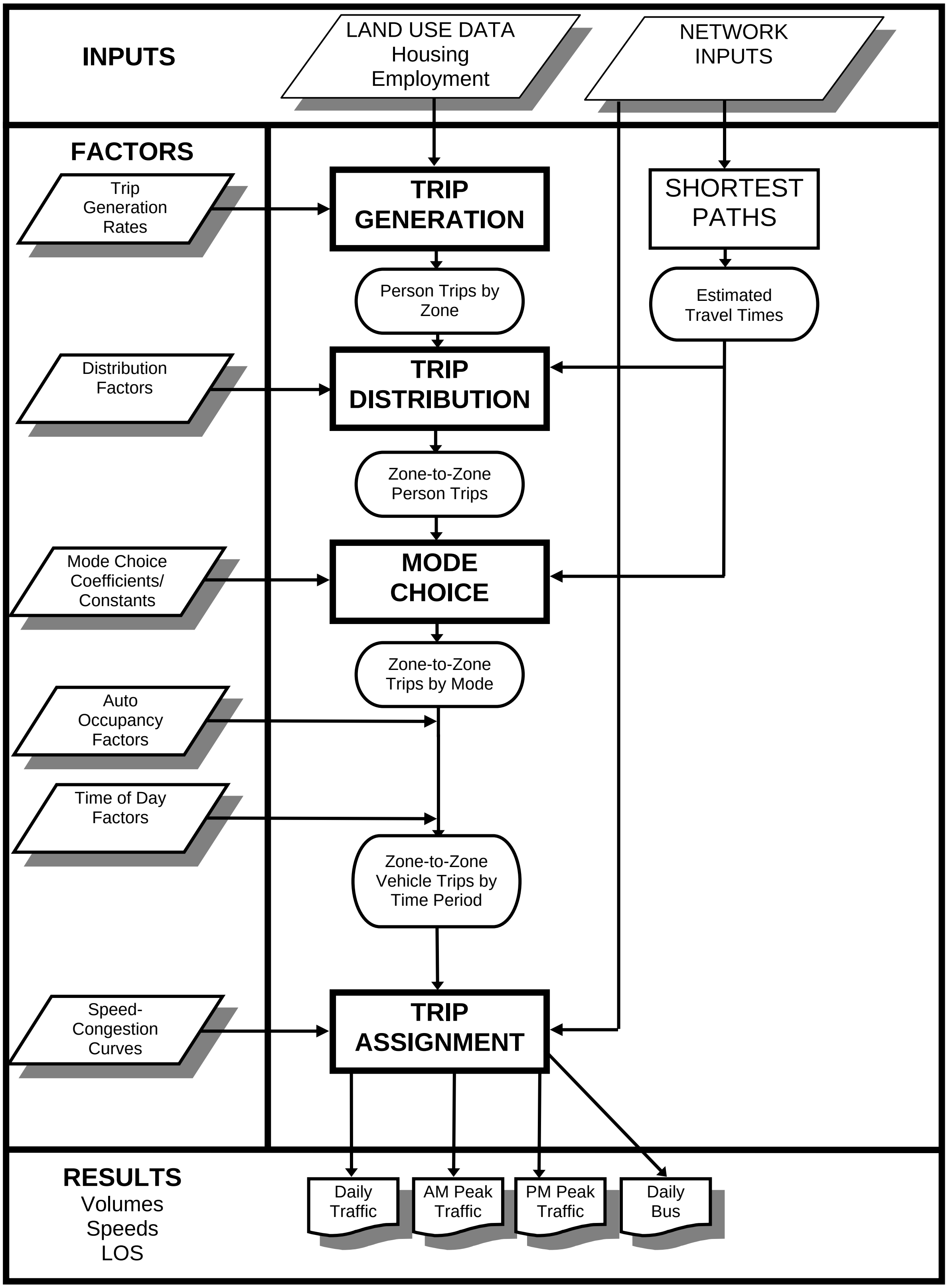
Forecast Time Periods

The Shasta County travel model estimates travel demand and traffic and transit volumes for the average weekday (Monday through Friday) daily time period, and traffic volumes for the A.M. and P.M. peak commute hours. Weekend peak traffic volumes could be estimated based on the weekday traffic volume forecasts and ratios of existing weekend-to-weekday traffic volumes.

Feedback Loops

The Shasta County travel model does not currently include feedback loops that use the congested speeds estimated from traffic assignment to recalculate the trip distribution.

Figure 1: Travel Model Process



Model Validation

The Shasta County travel model was validated by comparing its estimates of year 2004 traffic volumes with approximately 1,000 traffic counts from comparable years (2002-2005). The validation is compared to standard criteria for replicating total traffic volumes on various road types and for percent error on links.

Travel Model Software

The Shasta County travel model uses the Citilabs Cube Voyager software (Version 4.1) for all model components, although all components are compatible with the previous Citilabs TP+ software. Model networks may be viewed using the Cube Base component only or the previous Cube Viper software. Many input data files were prepared using ArcView GIS or Microsoft Excel.

2. MODEL STUDY AREA AND ZONE SYSTEM

The study area for the Shasta County travel model covers all of Shasta County. The county has been divided into Transportation Analysis Zones (TAZs) that are used to represent origins and destinations of travel. Travel to and from Shasta County is represented by external gateway zones.

Internal Zones

Zone numbers 101 to 1600 are used for internal Shasta County zones. 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. Figure 2 shows the overall TAZ system in the County. Figure 3, Figure 4, Figure 5 and Figure 6 show closer views of the urbanized areas.

Boundaries

Street Centerlines: 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.

Census Tracts: 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.

Jurisdictions: TAZs are split along jurisdiction boundaries wherever possible, including city limits, city sphere of influence areas, and County planning areas.

Parcel Lines: If a street does not provide a good TAZ boundary, boundaries generally follow parcel lines. Parcel maps from Redding and Anderson are followed within those coverages, otherwise the County parcel line file is used.

South County Studies: Wherever possible, the TAZs in the Anderson and Cottonwood areas have been revised to match the TAZ system proposed for local demand modeling by Omni-Means for their traffic studies in South County.

Figure 2: Transportation Analysis Zones, Shasta County

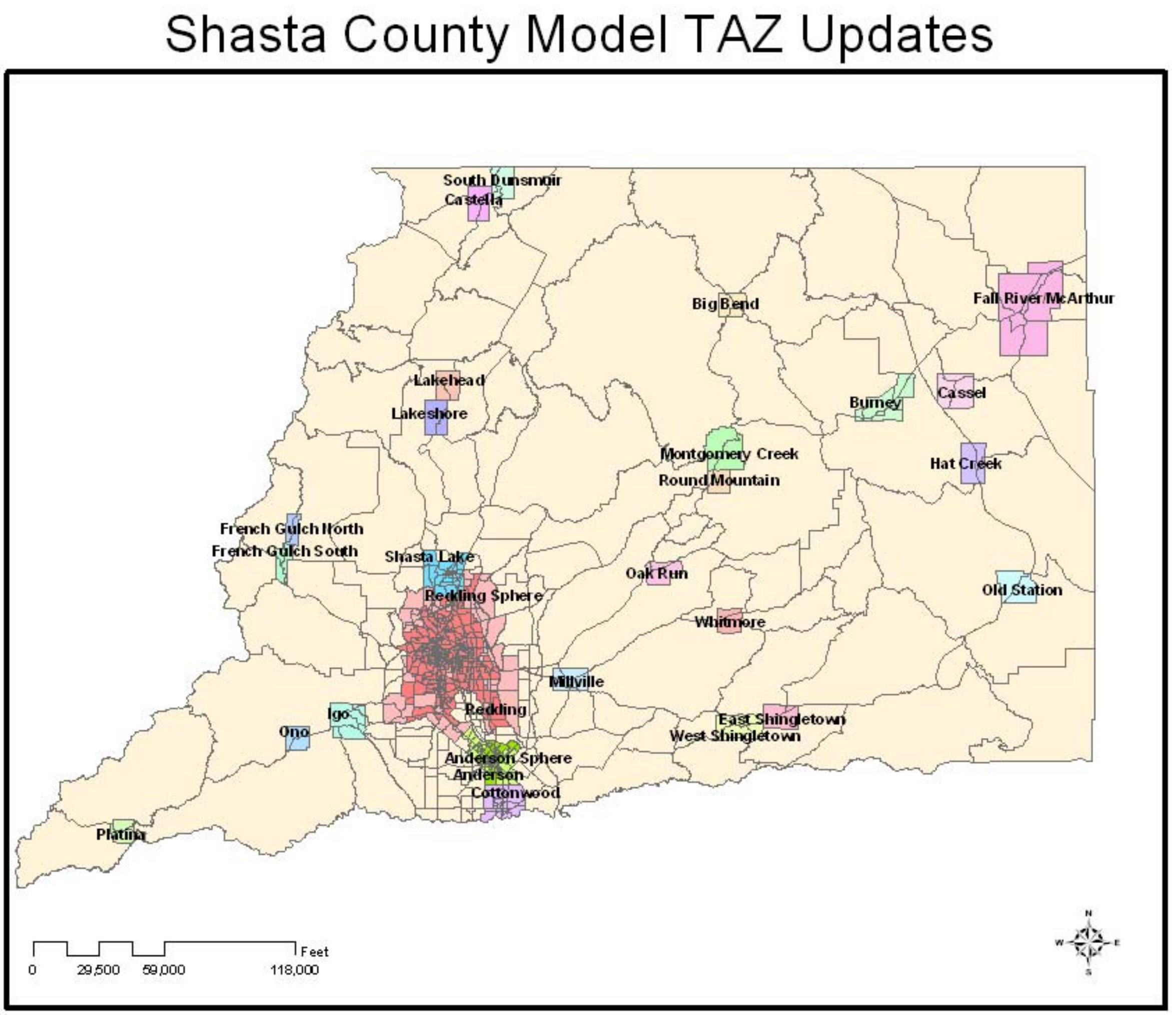


Figure 3: Transportation Analysis Zones, Anderson/Cottonwood Area

Shasta County Model TAZ Updates

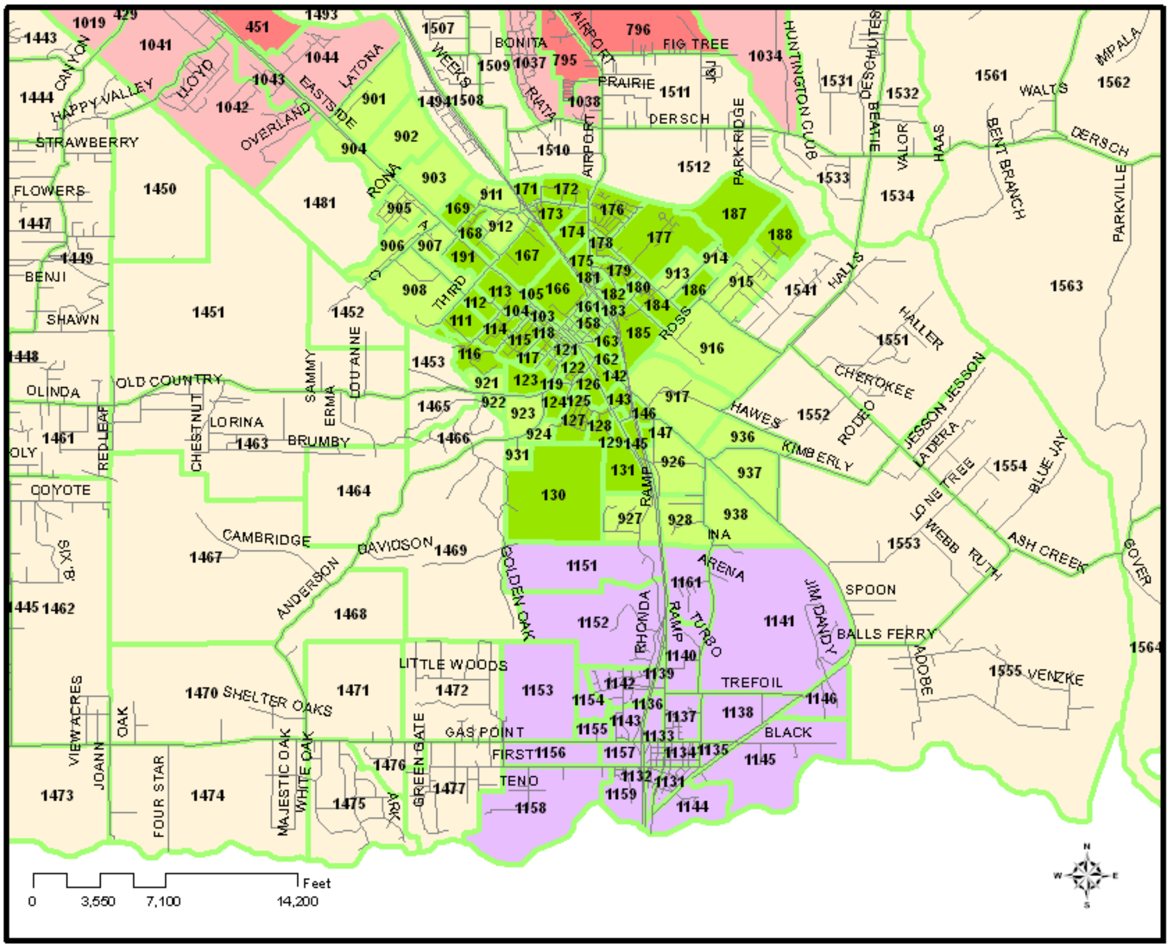


Figure 4: Transportation Analysis Zones, Redding Area

Shasta County Model TAZ Updates

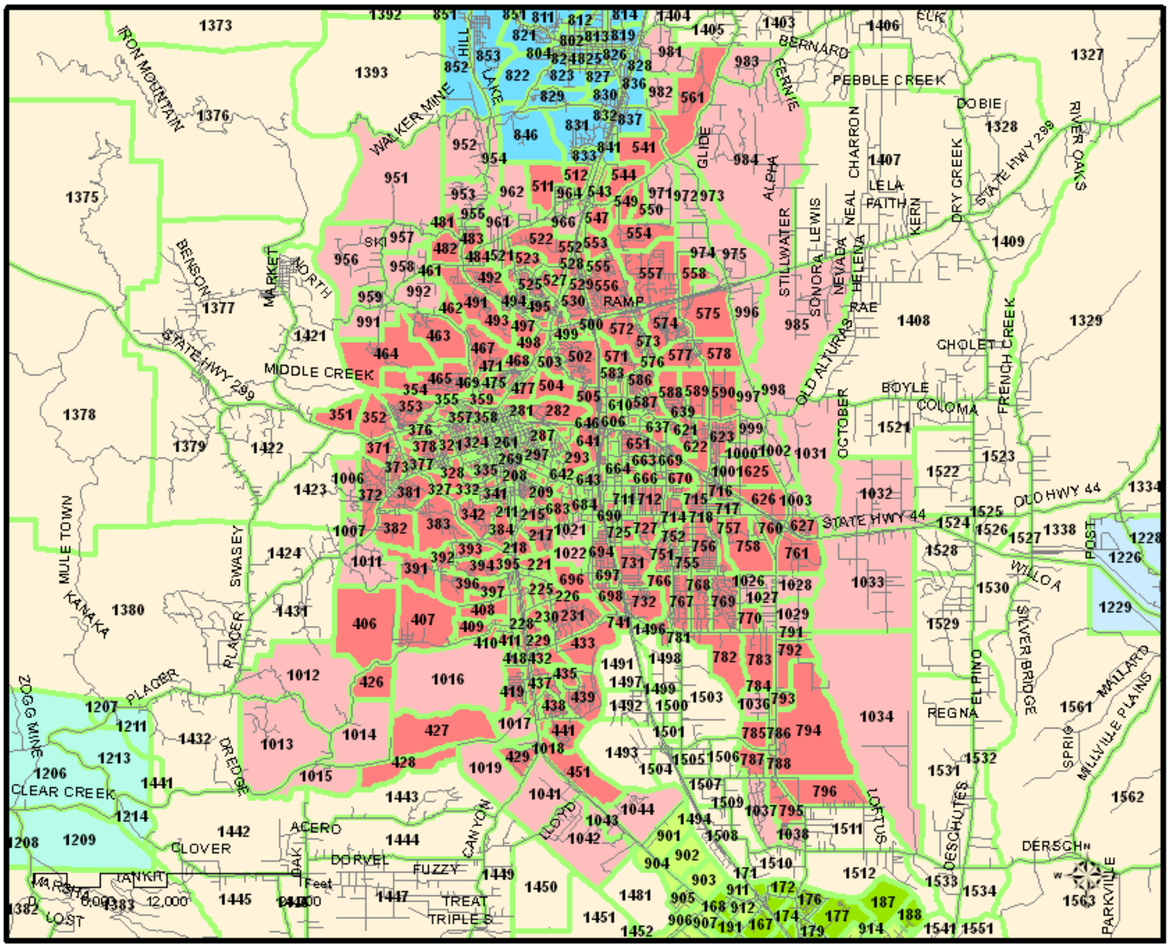


Figure 5: Transportation Analsyis Zones, Central Redding

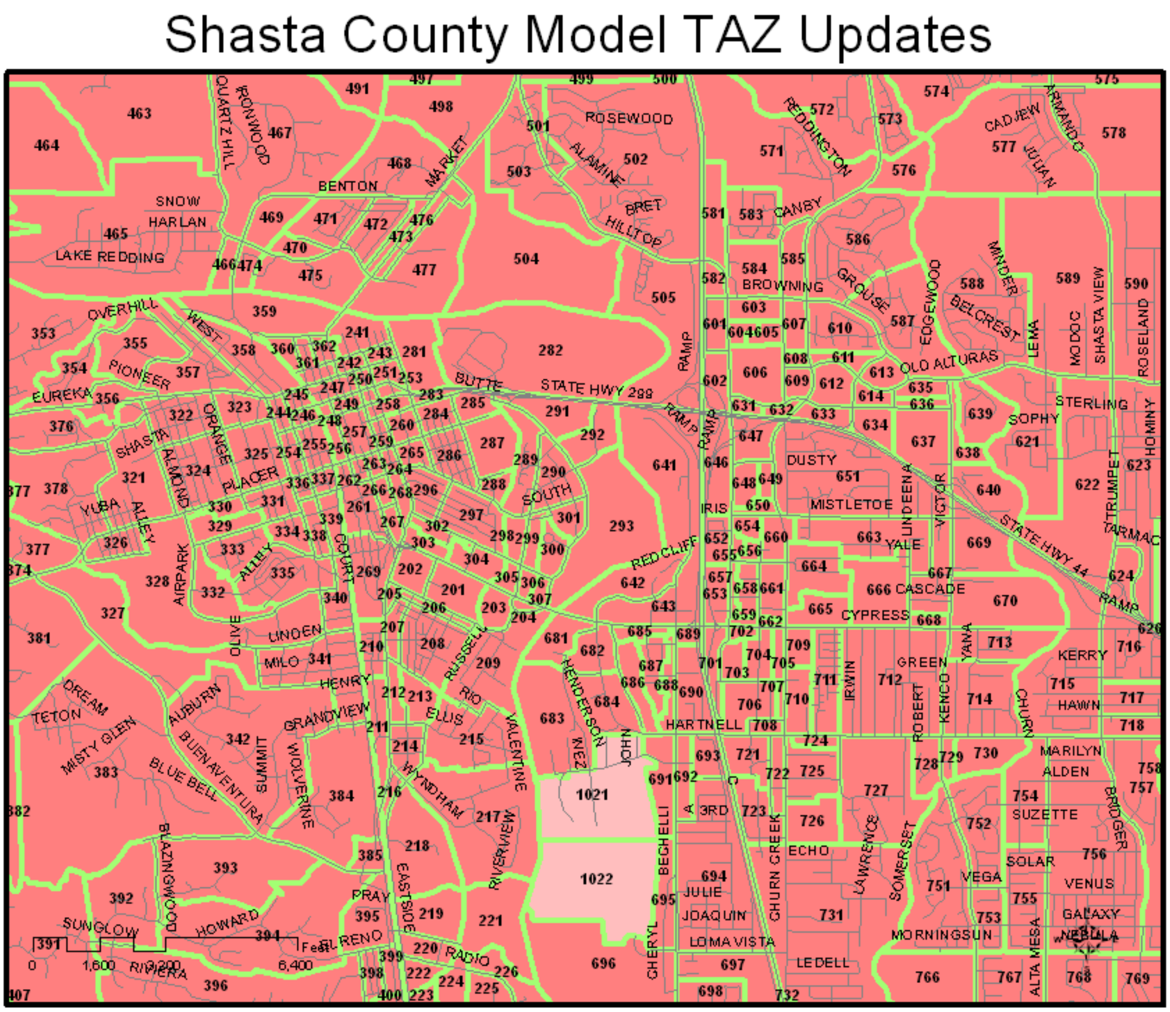
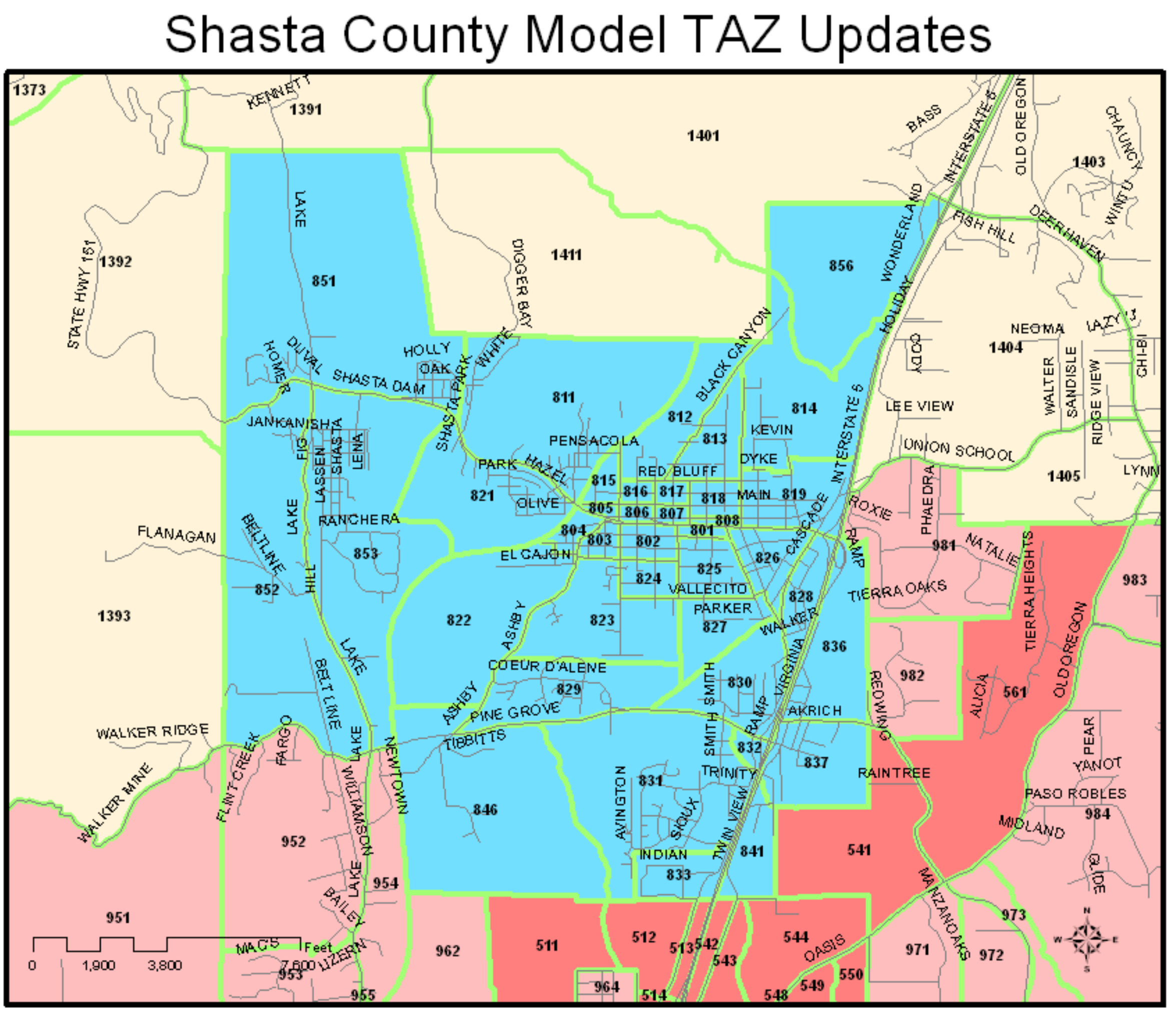


Figure 6: Transportation Analysis Zones, Shasta Lake



Numbering

There are 880 TAZs, an increase of 32 percent compared to the 666 TAZs in the 2000 version of the model. The numbering covers the range from 1 to 1600.

The TAZ numbering has been revised to follow jurisdiction boundaries (Table 1). 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 tracts generally starts with a number ending in the digit 1 or 6.

Table 1: Shasta County Model TAZs

Jurisdiction	Community	TAZ Range	Unused
Gateways		1-100	18-100
Anderson	Anderson	101-200	109-110
			1320140
			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

Table 1: Shasta County Model TAZs

Jurisdiction	Community	TAZ Range	Unused
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
Shasta County	Fall River/Macarthur	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

Table 1: Shasta County Model TAZs

Jurisdiction	Community	TAZ Range	Unused
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

External Zones

The Shasta County travel model has 16 external gateways for representing travel into, out of, and through the county (Figure 7 and Table 2). Zone numbers 1 to 100 are reserved for external cordons.

Figure 7: Shasta Model External Gateways

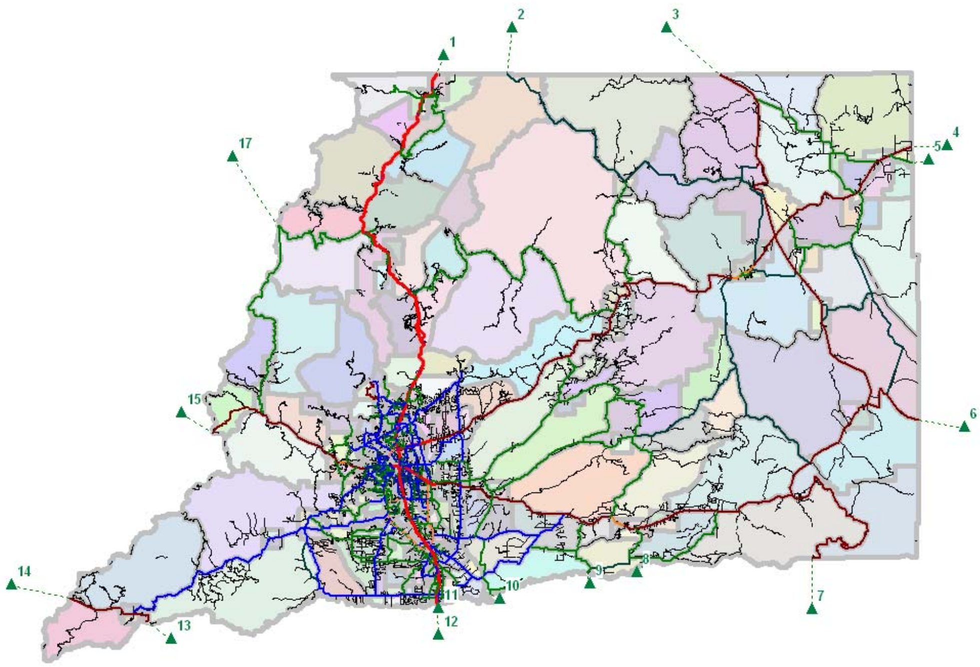


Table 2: Shasta Model Gateway Volumes

Zone Number	Gateway	Location	2004 Volume	2030 Projection	Annual Growth Rate
1	I-5	Siskiyou Co Line	18,800	26,320	1.5%
2	Squaw Valley	Siskiyou Co Line	1,000	1,370	1.4%
3	SR 89	Siskiyou Co Line	1,650	2,260	1.4%
4	SR 299	Lassen Co Line	2,900	3,250	0.5%
5	Pittville Rd	Lassen Co Line	1,000	1,120	0.5%
6	SR 44	Lassen Co Line	1,900	2,300	0.8%
7	SR 89	Tehama Co Line	390	400	0.1%
8	Rock Creek Rd	Tehama Co Line	1,000	1,260	1.0%
9	Wildcat Rd	Tehama Co Line	1,000	1,260	1.0%
10	Gover Rd	Tehama Co Line	1,000	1,260	1.0%
11	Main St	Tehama Co Line	5,400	6,800	1.0%
12	I-5	Tehama Co Line	41,500	86,000	4.1%
13	SR 36	Tehama Co Line	450	750	2.6%
14	SR 36	Trinity Co Line	350	810	5.0%
15	SR 299	Trinity Co Line	4,000	4,700	0.7%
17	East Side Rd	Trinity Co Line	1,000	1,180	0.7%

3. TRANSPORTATION NETWORKS

The Shasta County travel model uses coded representations of the county's existing and future roadway and transit networks.

3.1 Road Networks

The road network is a computerized representation of the major street and highway system. Only the more important streets (generally freeways, highways, expressways, arterials and collectors) are included in the network. The model does not explicitly include some collector streets or most local streets. Most local streets and driveways are instead represented by simplified network links ("zone centroid connectors") that represent local connections to the coded road network.

Master Network

All road network information for all base year and forecast scenarios is 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:

- 2004 Base Year
- Improvement 1
- Improvement 2

Other network scenarios can be added as necessary.

The purpose of creating a master network was 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 near term 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.

The following network link variables are coded for each master network scenario:

- Road type (FACTY)
- Lanes
- Speed
- HOV (2 or 3 if the facility is designated for HOVs)

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, with the first 1,600 node numbers in the Shasta County travel model representing the centroids of the TAZs. The road network nodes are coded with geographical "X" and "Y" coordinates to permit plotting and graphic displays. The nodes representing TAZs contain additional information on the TAZ's attractiveness to each gateway, the jurisdiction and community, and the area type (Table 3).

Table 3: Master Network Node Attributes

Network Variable	Description
N*	Node number
X*	X-coordinate in feet (NAD 27 California State Plane Zone 1)
Y*	Y-coordinate in feet (NAD 27 California State Plane Zone 1)
TAZ NODES ONLY	
G01 to G17	Attractiveness to gateways (see Table 2 for list)
	0 = No trips allowed between this TAZ and Gateway nn
	1 = Trips are allowed between this TAZ and Gateway nn
	2 = Partly Highway Commercial - increases trip attractiveness to Gateway nn
	3 = Mostly Highway Commercial - significantly increases trip attractiveness to Gateway nn
JURISDCTN	TAZ Jurisdiction (City 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 4).

Turn Penalties. Turn penalties can be used to identify node-to-node movements which 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.

Table 4: 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 (currently corrected for Redding only)
HPMS	Indicates link included in HPMS tabulations (currently unused)
SCREENLN	Screenline number for model validation (currently unused)
2004 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
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

Network Conflation

It is desirable for the model road network to be consistent with other available geographic information. The model road 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 27 California State Plane Zone 1 projection coordinate system with units in feet. The model network now can be overlaid with all other mapping or graphics prepared using the NAD 27 State Plane 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 5). 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.

Table 5: Capacities by Road Type

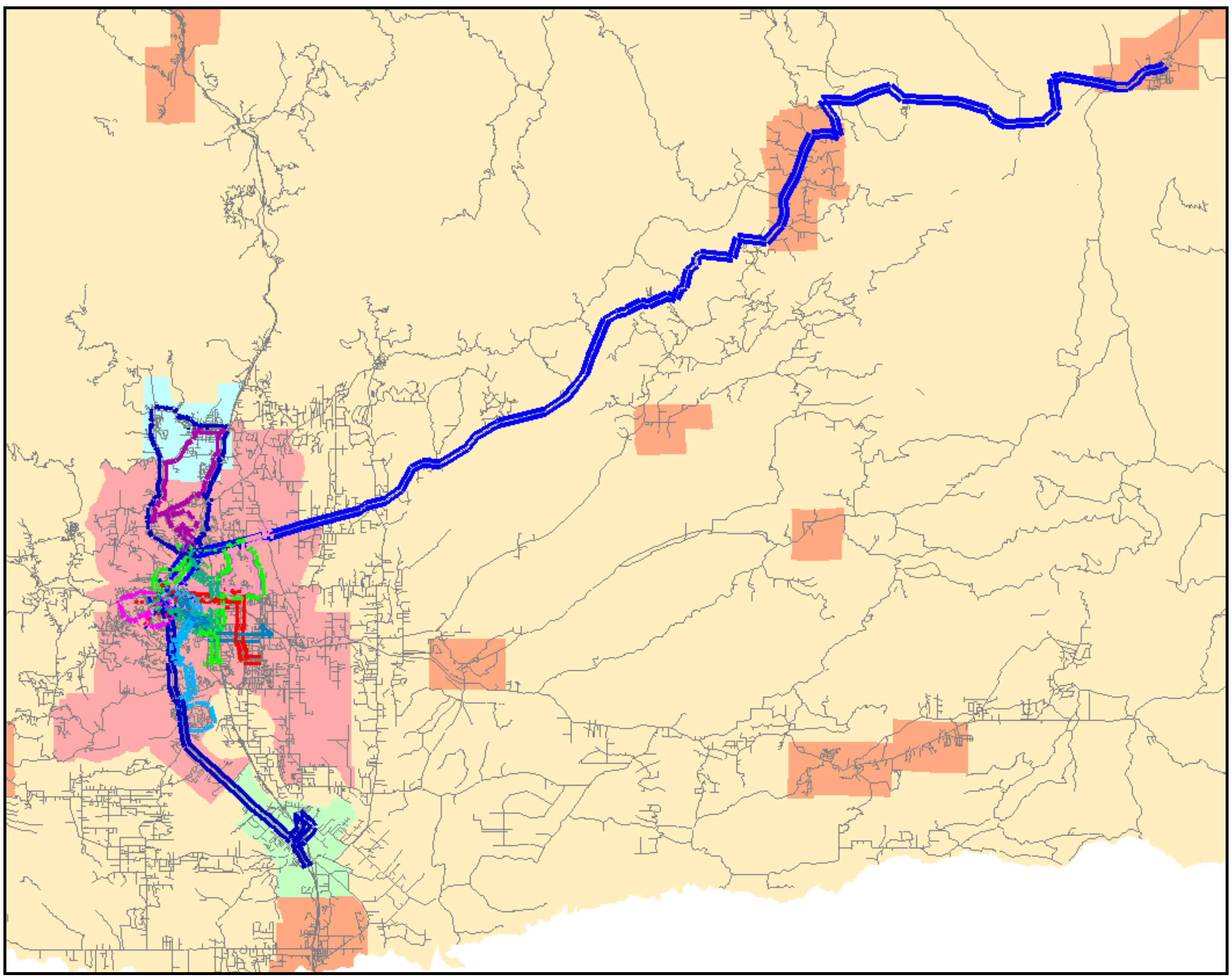
Road Type	Facility Type (FACTYP)	Type	Capacity (Vehicles per Lane per Hour)	Typical Uncongested Speeds
Freeway	1	Urban	2100	55-65
		Small Urban	2100	65-70
		Rural Flat	2000	70
		Rural Rolling	1800	65-70
		Rural Mountain	1500	65
Highway	2	Urban	900	40-45
Expressway	3	Small Urban	900	45-55
		Rural Flat 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-Freeeway	7	All	1800	50
Ramp: Slip	8	All	1500	45
Ramp: Loop	9	All	1250	35
Zone Connector	10	Dist. $\leq$ 0.25 miles	0	15
	11	Dist. 0.22-0.5 miles	0	20
		Dist. > 0.5 miles	0	25

2L = Two-Lane; ML=Multi-Lane

Transit Networks

The 2004 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 8). The routes are specified as a series of nodes on the road network. Nodes can be designated as stops or non-stops (for example, along freeways). Due to a requirement of the TP+ software, loop routes are coded as two separate routes, with one route for the outbound direction and one for the inbound direction.

Figure 8: Shasta County Transit Lines



The attributes coded for each bus route include the name of the route and the frequency in terms of average time between buses (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.

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

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.

4. DEMOGRAPHIC/LAND USE DATA

Land use and socioeconomic data at the zonal level are used for determining trip generation.

Land Use Categories

The land use inputs to the model were divided into six residential and 22 non-residential categories (Table 6). The categories represent different levels and types of trip generation per housing unit or employee.

2004 Base Year Land Use Data

A 2004 land use database was developed to provide inputs to the 2004 model validation. The 2004 land use inputs are used to set up model parameters such as trip generation rates and external gateway trip types and percentages. Once these model parameters are established, they are used in conjunction with future land use data alternatives for model application.

2004 Population and Housing Data

The 2004 population and household inputs were initially developed based on 2000 United States Census information by census block. The increment between the 2000 Census and the 2004 model base year was determined based on building permits. Households are stratified by housing type.

The Census data and building permits were coded to specific geographic locations. They were then summed into the corresponding TAZs.

2004 Employment Data

Employment numbers and locations were initially compiled from a commercial database from InfoUSA. The commercial database was expanded through a significant amount of additional research and phone calls to verify addresses and employment levels. The commercial database is particularly incomplete for public sector employment quantities and locations. Therefore, each local government and school district in Shasta County was contacted to get direct information on employee numbers and locations.

The totals from the expanded InfoUSA database were compared to the 2004 annual averages from the California Employment Development Department (EDD). The totals were also compared to an independent estimate of Shastra County employment compiled by Woods and Poole (Table 7). The Shasta County employment estimate is much higher than the EDD total for retail, as the EDD figures account primarily for full-time-equivalent employment while the model land use is based on part-time as well as full-time employees.

Table 6: Land Use Categories

Land Use Code	Major Category	Land Use Category	Units	Description
1	Population	Population	Persons	
2	Residential	SF Detached	Dwelling Units	Can include attached townhomes
3	Residential	MF Attached	Dwelling Units	Apartments, condominiums
4	Residential	Mobile Home	Dwelling Units	Stand-alone mobile homes
5	Residential	Mobile Home Park	Dwelling Units	Mobile homes used like SF Detached units
6	Residential	Senior Housing	Dwelling Units	Not care facilities
7	Residential	Recreational Homes	Dwelling Units	Homes used less than half the time as primary residence
8	Industrial	Industrial	Employees	Includes manufacturing and light industrial
9	Wholesale	Wholesale	Employees	Wholesale, trucking
10	Wholesale	Service Commercial	Employees	Construction supplies, home services (plumbing, etc..), business services (printers, etc…), repair shops
11	Retail	Retail	Employees	All stores and shopping centers except stand-alone convenience stores and big-box, bank branches
12	Retail	Retail High	Employees	Stand-alone convenience stores, gas stations
13	Retail	Retail Warehouse	Employees	Big box stores
14	Office	Office	Employees	All non-government office, non-customer bank functions
15	Education	School	Employees	Public schools, private schools (including private lessons such as driving), administration
16	Education	College	Employees	Large and small colleges and universities
17	Health	Medical Office	Employees	Medical, dental, veterinary offices
18	Health	Hospital	Employees	
19	Health	Residential Care	Employees	Assisted living, skilled nursing facilities
20	Health	Child Care	Employees	
21	Recreation	Developed Recreation	Employees	Marinas, camps, movie theaters, sports facilities, golf courses, museums

Table 6: Land Use Categories

Land Use Code	Major Category	Land Use Category	Units	Description
22	UNUSED	UNUSED		Reserved for additional category
23	Recreation	Casino	Employees	
24	Service	Hotel	Employees	Hotel, motel
25	Service	Restaurant	Employees	Stand-alone, not including fast food
26	Service	Restaurant High	Employees	Fast-food
27	Service	Institutional	Employees	Religious, clubs
28	Government	Government	Employees	Government offices excluding post office branches, DMV, libraries
29	Government	Government High	Employees	Post office branches, DMV, libraries
30	Other		Trips	Allows for direct input of trips for uses not defined in other categories (can also be input as special generators)

Table 7: 2004 Employment Comparison

Category	EDD CES	Woods & Poole	Shasta County Employment Database
Agriculture	900	1,481	833
Mining	500	162	-
Construction	4,500	5,912	4,017
Manufacturing	2,800	5,165	3,719
Wholesale	1,600	2,552	3,339
Retail	9,600	16,410	14,416
Trans/Com/Util	2,400	4,792	2,375
Fin/Ins/RE	3,300	5,783	4,176
Educ/Health	10,000	32,263	9,379
Service Other	16,300		15,772
Govt Educ	5,300	13,982	4,574
Govt Other	7,500		6,013
Govt Milit		316	
Unclassified			46
TOTAL	64,700	88,818	68,659

Special Generators

The special generators in the Shasta County travel model are intended to account for trips that are not primarily related to employment, and are mostly recreational sites. Annual attendance figures were compiled for national parks and state parks and recreation areas, as well as several local parks and attractions. Other trips were estimated based on typical values in the Institute of Transportation Engineers *Trip Generation* reference.

Table 8: Shasta County Special Generators

TAZ	Name	Year Opened	Average Daily Attendance	Total Daily Vehicle Trips
756	Alta Mesa Park	Before 2004		50
177	Anderson River Park	Before 2004		200
1144	Balls Ferry Boat Ramp	Before 2004		100
625	Big League Dreams	2002	900	
483	Buckeye Park	Before 2004		50
475	Caldwell Park	Before 2004	1000	
441	Cascade Park	Before 2004		50
1127	Castle Crags	Before 2004	90	
823	Central Valley Ball Park	Before 2004		100
577	Churn Creek Open Space	Before 2004		50
818	Clair Engel Park	Before 2004		50
716	Clover Creek Park	Before 2004		50
394	Country Heights Park	Before 2004		50
435	Creekside Park	Before 2004		50
766	Enterprise Park	Before 2004	1000	
321	Foothill Park	Before 2004		50
1197	French Gulch Park	Before 2004	100	
722	Graham Park	Before 2004		50
1344	Hat Creek Park	Before 2004	100	
1392	Interlakes Special Recreation Area	Before 2004	100	
1376	Keswick Boat Ramp	Before 2004		100
1576	Lassen Volcanic	Before 2004	520	
1577	Lassen Volcanic	Before 2004	520	
256	Library Park	Before 2004		100
340	Marin Luther King Jr.	Before 2004		100
853	Margaret Polf Regional Park	Before 2004		100
372	Mary Lake Park	Before 2004		50
1341	McArthur-Burney Falls	Before 2004	1100	
588	Minder Park	Before 2004		50
209	Parkview Riverfront Park	Before 2004		50
502	Peppertree Park	Before 2004		100
623	Ravenswood Park	Before 2004		50
794	Redding Airport	Before 2004		200

Table 8: Shasta County Special Generators

TAZ	Name	Year Opened	Average Daily Attendance	Total Daily Vehicle Trips
381	Ridgeview Park	Before 2004		50
1391	Shasta Dam	Before 2004	500	
1392	Shasta Dam	Before 2004	500	
1377	Shasta State Historic Park	Before 2004	120	
1312	Shasta-Trinity Recreation Area	Before 2004	768	
1314	Shasta-Trinity Recreation Area	Before 2004	768	
1316	Shasta-Trinity Recreation Area	Before 2004	768	
1401	Shasta-Trinity Recreation Area	Before 2004	1536	
202	South City Park	Before 2004		100
282	Sundial Bridge	2002	1200	
282	Turtle Bay Exploration Park	2002	410	
125	Volonte Park	Before 2004		50
768	Western Oaks Park	Before 2004		50
1375	Whiskeytown	Before 2004	1030	
1378	Whiskeytown	Before 2004	1030	

Future Housing and Employment

The land use forecasts for the Shasta County travel model were developed using a combination of:

- Detailed information on individual planned development in each jurisdiction
- Overall growth forecasts for Shasta County from several sources
- Growth forecasts prepared by economists for specific areas (Redding and South County)

The overall forecasts for all of Shasta County and for individual jurisdictions were compiled for each five-year increment between 2005 and 2030.

Summary of Land Use Forecasting Process

The actual inputs to the travel modeling process were developed on a parcel basis, starting with the known pipeline development and adding assumed development in other likely areas to match the control totals as closely as possible. In some cases, pipeline development alone would exceed the growth totals, and therefore a slower phasing of development and occupancy would be assumed for certain development areas.

Pipeline Development

The economic consulting firm of Strategic Economics met with planning staff from Shasta County and the cities of Anderson, Redding and Shasta Lake. They prepared comprehensive lists and maps of known "pipeline" development projects in each jurisdiction.

Population Forecasts

Population and housing forecasts to the year 2030 were compiled from the following sources:

- Overall County: California Department of Finance population projections
- Redding: Economic Science Corporation (ESC) projection for the Redding Electric Utility, adjusted for available residential land supply
- Anderson, Cottonwood and South County: Forecasts prepared by Pacific Municipal Consultants (PMC) for South County transportation studies
- Other areas: Historic growth rates from 1990 and 2000 Census, adjusted upwards for areas with known development proposals

The forecasts result in an increase of 48 percent in housing units between 2005 and 2030,

Employment Forecasts

There are no official State of California forecasts of employment by jurisdiction or county. Overall employment forecasts by economic sector were initially based on commercial forecasts prepared by Woods and Poole. These were adjusted upwards to be consistent with the assumed Shasta County population forecasts, which were higher than those assumed by Woods and Poole.

The forecasts result in an increase of 49 percent in total employment between 2005 and 2030.

Residential Projections

Projections for residential growth were documented by Strategic Economics in a memorandum dated November 10, 2005 (Figure 9 and Table 9). These projections were used as the control total targets for residential growth during the parcel-based allocation process. The individual assumptions by jurisdiction and subarea were also noted (Table 10).

Based on the information available regarding the historical accuracy of the various projection sources, the methodology with which these projections are calculated and information regarding the availability of land in the City of Redding, the following projection sources have been used in the residential projections.

Economic Sciences Corporation

While these projections were deemed to be overly aggressive in the long term, they are very accurate for the City of Redding in the short-term. Therefore, Redding's long-term projections were adjusted downward based on information regarding the availability of land.

Department of Finance

Given the historical accuracy and the DOF's position as a mid-range scenario among all available population projections, the Department of Finance projections for the County were used as the base for the population projections. However, the total county population was adjusted with input from the stakeholders.

Figure 9: Shasta County Subareas for Residential Projections

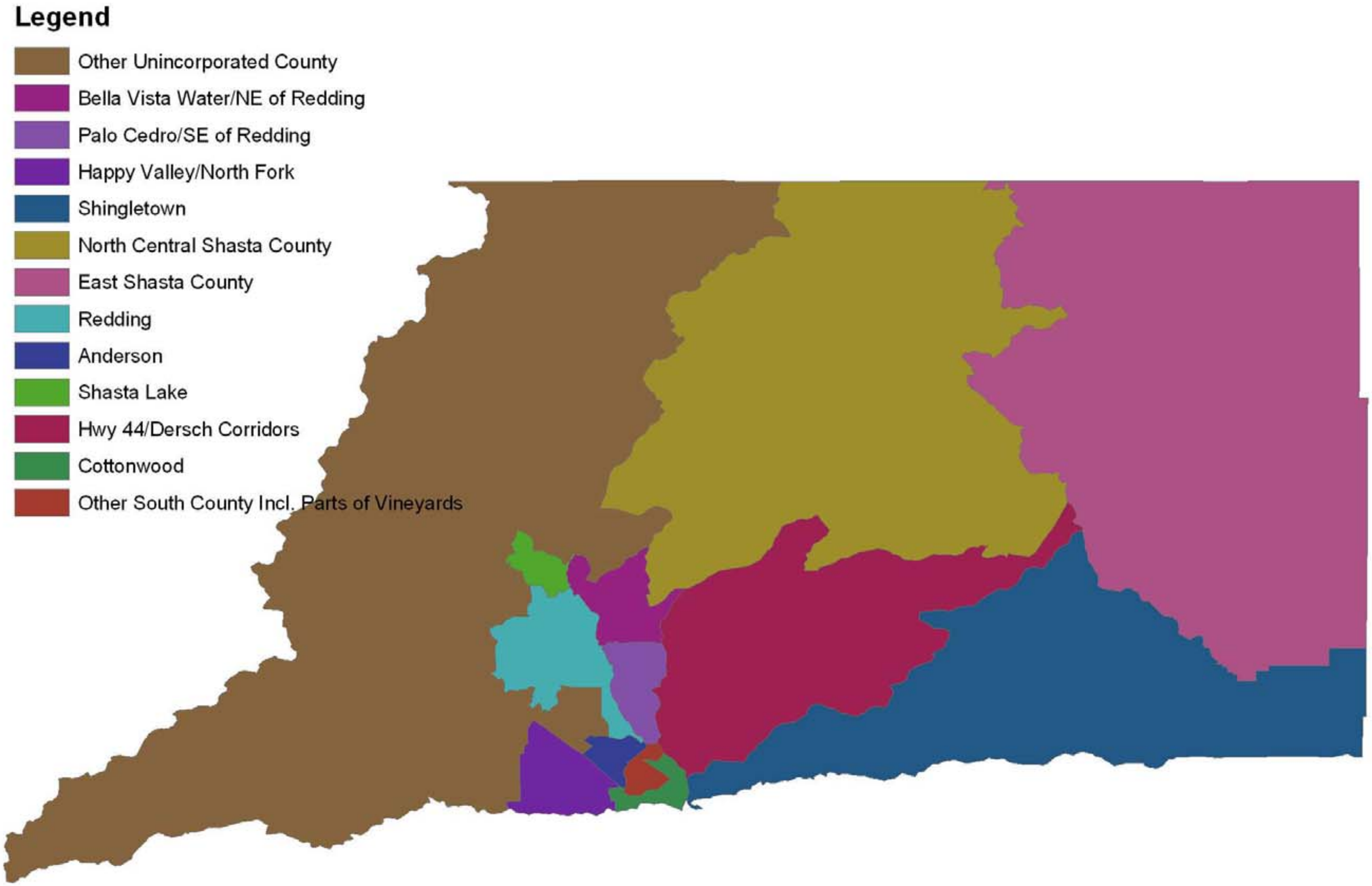


Table 9: Shasta County Residential Projection Targets

PROJECTION OF OCCUPIED RESIDENTIAL UNITS BY SUBAREA, SHASTA COUNTY 2005-2030

		2005 base year (DOF occupied housing units)	2010	2015	2020	2025	2030	Estimated Incremental Household Growth	Estimated Percent Household Growth	Net Remaining	Land Capacity (Est. Units)[1]
	Projected Units Countywide	68,220	75,158	81,656	88,154	94,652	101,150	32,930	48.3%	32,930	43,962
	Redding at Midpoint Densities, Assume 75% Buildout	34,612	39,109	43,115	46,603	49,587	52,044	17,432	50.4%	15,497	17,432
	Anderson (OmniMeans/PMC)	3,847	5,191	6,531	7,765	8,553	9,193	5,346	139.0%	10,151	5,346
	Shasta Lake	3,786	4,286	4,786	5,286	5,786	6,286	2,500	66.0%	7,651	3,917
	Total Unincorporated County	25,975	26,572	27,224	28,499	30,726	33,626	7,651	29.5%	7,651	17,503
Urban:	Cottonwood (OmniMeans/PMC)	1,160	1,368	1,614	1,904	2,247	2,651	1,491	128.5%	6,160	1,492
	Other South County (OmniMeans/PMC)	932	1,020	1,104	1,188	1,830	2,482	1,550	166.3%	4,610	444
	Palo Cedro and Southeast of Redding, 70% Buildout	1,562	1,592	1,624	1,715	1,839	2,024	462	29.6%	4,149	924
	Happy Valley (Incl. North Fork)	845	919	998	1,219	1,524	1,977	1,132	134.0%	3,017	2,724
Rural:	North Central Shasta County (Big Bend, Montgomery	1,240	1,253	1,268	1,308	1,363	1,444	204	16.5%	2,812	----
	East Shasta County (Burney, Fall River, McArthur, C	3,365	3,399	3,436	3,538	3,680	3,889	524	15.6%	2,288	
	Shingletown and Highway 44 Dersch Road Corridor	1,811	1,890	1,974	2,211	2,536	3,020	1,209	66.8%	1,079	5,770
	Other	10,856	10,881	10,908	10,984	11,088	11,242	386	3.6%	693	
	Bella Vista Water/Northeast of Redding	4,204	4,249	4,298	4,433	4,620	4,897	693	16.5%	0	1,095

PROJECTION OF OCCUPIED RESIDENTIAL UNITS BY SUBAREA, SHASTA COUNTY, 5-YEAR INCREMENTS

		2005 base year (DOF occupied housing units)	2005 to 2010	2010 to 2015	2015 to 2020	2020 to 2025	2025 to 2030
	Projected Units Countywide	68,220	6,938	6,498	6,498	6,498	6,498
	Redding at Midpoint Densities, Assume 75% Buildout	34,612	4,497	4,006	3,488	2,983	2,458
	Anderson (OmniMeans/PMC)	3,847	1,344	1,340	1,234	788	640
	Shasta Lake	3,786	500	500	500	500	500
	Total Unincorporated County	25,975	597	652	1,276	2,227	2,900
Urban:	Cottonwood (OmniMeans/PMC)	1,160	208	246	290	343	404
	Other South County (OmniMeans/PMC)	932	88	84	84	642	652
	Palo Cedro and Southeast of Redding, 70% Buildout	1,562	30	32	90	124	185
	Happy Valley (Incl. North Fork)	845	74	79	221	305	453
Rural:	North Central Shasta County (Big Bend, Montgomery	1,240	13	14	40	55	82
	East Shasta County (Burney, Fall River, McArthur, C	3,365	34	37	103	141	210
	Shingletown and Highway 44 Dersch Road Corridor	1,811	79	84	236	326	484
	Other	10,856	25	27	76	104	155
	Bella Vista Water/Northeast of Redding	4,204	45	48	135	187	277

Source: Strategic Economics, November, 2005

Table 10: Residential Projections Assumptions

			2005 Base Year Assumptions	Projection Assumptions
Projected Units Countywide			Occupied housing units as reported by the CA Department of Finance	From DoF population projections by age group, worked into households using household formation rates from 2000 U.S. Census
	Redding at Midpoint Densities, Assume 75% Buildout TOTAL HOUSEHOLDS		Occupied housing units as reported by the CA Department of Finance	Years 2005-2015 correspond to growth rates from ESC Projection. Growth rate gradually decreases over time from 2015 to 2030, and total estimated incremental growth reflects 75 percent of Redding's land capacity estimate. This number falls short of the E
	Anderson (OmniMeans/PMC)		Occupied housing units as reported by the CA Department of Finance	OmniMeans/PMC Memorandum
	Shasta Lake		Occupied housing units as reported by the CA Department of Finance	Assumed absorption rate of 100 units/year. This is higher than historic rate of 78 units/year in last 5 years but reflects strong showings in pipeline development, including estimated 1500 units Mountain Gate Meadows
	Total Unincorporated County		Occupied housing units as reported by the CA Department of Finance	County net of Cities
	Urban:	Cottonwood (OmniMeans/PMC)	From PMC/OmniMeans Projection for South County	From PMC/OmniMeans Projection for South County
		Other South County (OmniMeans/PMC)	From PMC/OmniMeans Projection for South County	From PMC/OmniMeans Projection for South County
		Palo Cedro and Southeast of Redding, 70% Buildout	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	From 2005-2030, change at double its historic 10 year average annual growth rate from 1990-2000 Census.
		Happy Valley (Incl. North Fork)	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	Control total for 2030 accommodates major pipeline development + 20 percent additional development
	Rural:	North Central Shasta County (Big Bend, Montgomery Creek, Round Mountain)	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	Assumed to develop at 25 year average annual growth rate for the total unincorporated county of 0.61%
		East Shasta County (Burney, Fall River, McArthur, Cassel)	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	Assumed to develop at tract 10 year average annual growth rate from 1990-2000, or 0.58%
		Shingletown and Highway 44 Dersch Road Corridor	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	Assumed to develop at tract10 year average annual growth rate from 1990-2000, or 2.07%
		Other	Total DOF for Uninc county minus all other unincorporated areas	Assumed to develop at tract's 10 year average annual growth rate for the total unincorporated county of 0.14%. Assume this rate because growth in these areas will be the slowest, and more likely to reflect unincorporated rate
		Bella Vista Water/Northeast of Redding	Applied constant growth rate from 1990 and 2000 Census for Households. Census Tracts:	Assumed to develop at 25 year average annual growth rate for the total unincorporated county of 0.61%

Source: Strategic Economics, November, 2005

Additional Adjustments

The basic residential projections were modified based on input from stakeholders in late 2005, particularly in the following ways:

- Growth rates for Anderson, Cottonwood and South County were made consistent with other land use forecasts prepared for transportation studies in those areas
- Pipeline activity was assumed to phase in over time;
- Historic growth rates were reflected in areas where constant growth is expected to occur;

Projections were adjusted to accommodate both large scale development projects, such as North Fork, the Vineyards, and Mountain Gate Meadows, as well as some increment of additional development where appropriate.

Employment Projections

The overall employment projection targets are based on growth rates by sector developed by Woods & Poole, adjusted to correspond to the higher rate of population growth assumed for Shasta County (Table 11).

Woods & Poole (W&P) 2004 is a national private projection of jobs by sector. The W&P projection is based on a modified "export base" model incorporating national trends in sectoral growth and decline, and accounting for the effect of employment trends of adjacent areas on each other. Woods & Poole is considered an excellent source of employment projections, in that it includes employment information for categories of workers not included in other projection series including the self-employed, proprietors, domestic workers, unpaid family workers, railroad workers, and members of the armed forces.

Table 11: Shasta County Employment Projection Targets

Total County	2005	2010	2015	2020	2025	2030
Retail	14,719	15,943	17,121	18,403	19,790	21,300
Service	29,669	33,229	36,798	40,706	44,950	49,531
Government	11,147	11,892	12,588	13,331	14,112	14,924
Other	14,094	14,947	15,673	16,442	17,249	18,087
Total Employment	**69,629**	**76,011**	**82,180**	**88,882**	**96,101**	**103,843**

Anderson + Anderson SOI	2005	2010	2015	2020	2025	2030
Retail	1,183	1,281	1,376	1,479	1,591	1,712
Service	1,403	1,571	1,740	1,925	2,126	2,342
Government	483	515	545	578	611	647
Other	1,713	1,817	1,905	1,998	2,096	2,198
Total Employment	**4,782**	**5,185**	**5,567**	**5,980**	**6,424**	**6,899**

Redding + Redding SOI	2005	2010	2015	2020	2025	2030
Retail	11,417	12,366	13,280	14,275	15,350	16,522
Service	23,748	26,598	29,454	32,582	35,979	39,647
Government	8,069	8,609	9,112	9,650	10,215	10,803
Other	9,156	9,710	10,182	10,681	11,205	11,750
Total Employment	**52,390**	**57,282**	**62,028**	**67,188**	**72,750**	**78,722**

Shasta Lake	2005	2010	2015	2020	2025	2030
Retail	493	534	573	616	663	713
Service	678	759	841	930	1,027	1,132
Government	576	615	651	689	729	771
Other	577	612	641	673	706	740
Total Employment	**2,324**	**2,520**	**2,706**	**2,909**	**3,125**	**3,357**

Cottonwood	2005	2010	2015	2020	2025	2030
Retail	278	301	323	347	373	402
Service	297	333	369	408	451	496
Government	341	364	386	408	432	457
Other	302	321	336	353	370	388
Total Employment	**1,219**	**1,319**	**1,414**	**1,516**	**1,626**	**1,744**

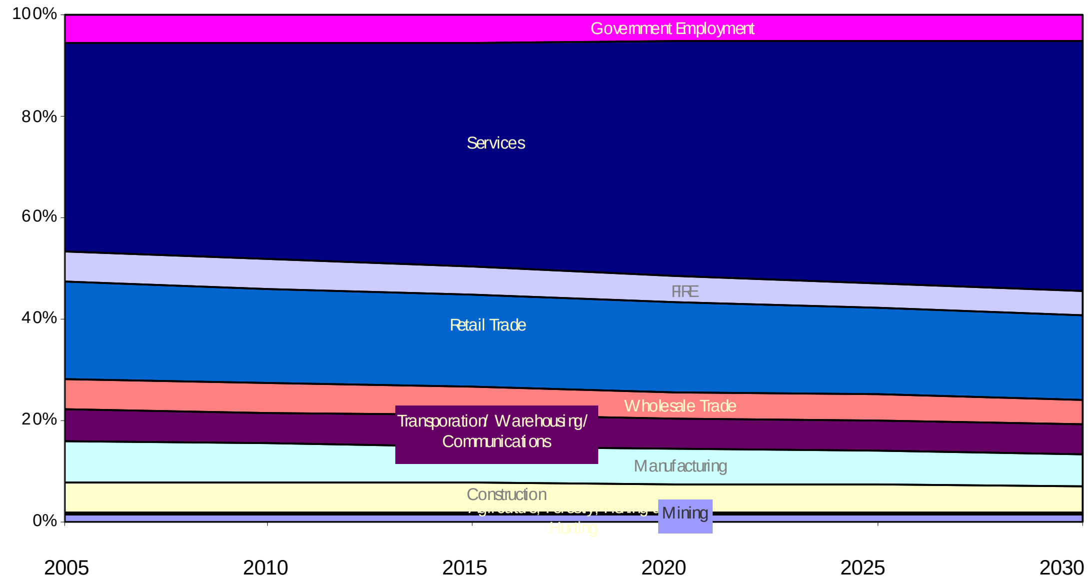
Rural East (Burney, Fall River, McArthur, Cassel)	2005	2010	2015	2020	2025	2030
Retail	484	524	563	605	650	700
Service	977	1,094	1,212	1,341	1,480	1,631
Government	387	413	437	462	490	518
Other	443	470	493	517	543	569
Total Employment	**2,291**	**2,501**	**2,704**	**2,925**	**3,163**	**3,418**

Shasta County Other	2005	2010	2015	2020	2025	2030
Retail	864	936	1,005	1,080	1,162	1,250
Service	2,567	2,875	3,184	3,522	3,889	4,286
Government	1,290	1,376	1,457	1,543	1,633	1,727
Other	1,902	2,017	2,115	2,219	2,328	2,441
Total Employment	**6,623**	**7,204**	**7,761**	**8,364**	**9,012**	**9,704**

Based on Woods & Poole, growth rates adjusted in proportion to population projections

Figure 10 shows how the employment sectors are projected to shift over time within Shasta County. The Services sector is anticipated to become a larger share of total jobs in the County, while Manufacturing and Wholesale Trade become a declining share of total jobs. All sectors are anticipated to increase their total absolute number of jobs.

Figure 10: Shift in Sectors as a Percent of Total Employment, Shasta County 2005-2030



The Woods & Poole projections had retail employment increasing by 21 percent between 2005 and 2030, while overall employment would grow by 37 percent. This compares to an assumed housing growth of 48 percent during the same period. For this forecast, retail employment was adjusted to increase by 45 percent, with an overall employment increase of 49 percent between 2005 and 2030.

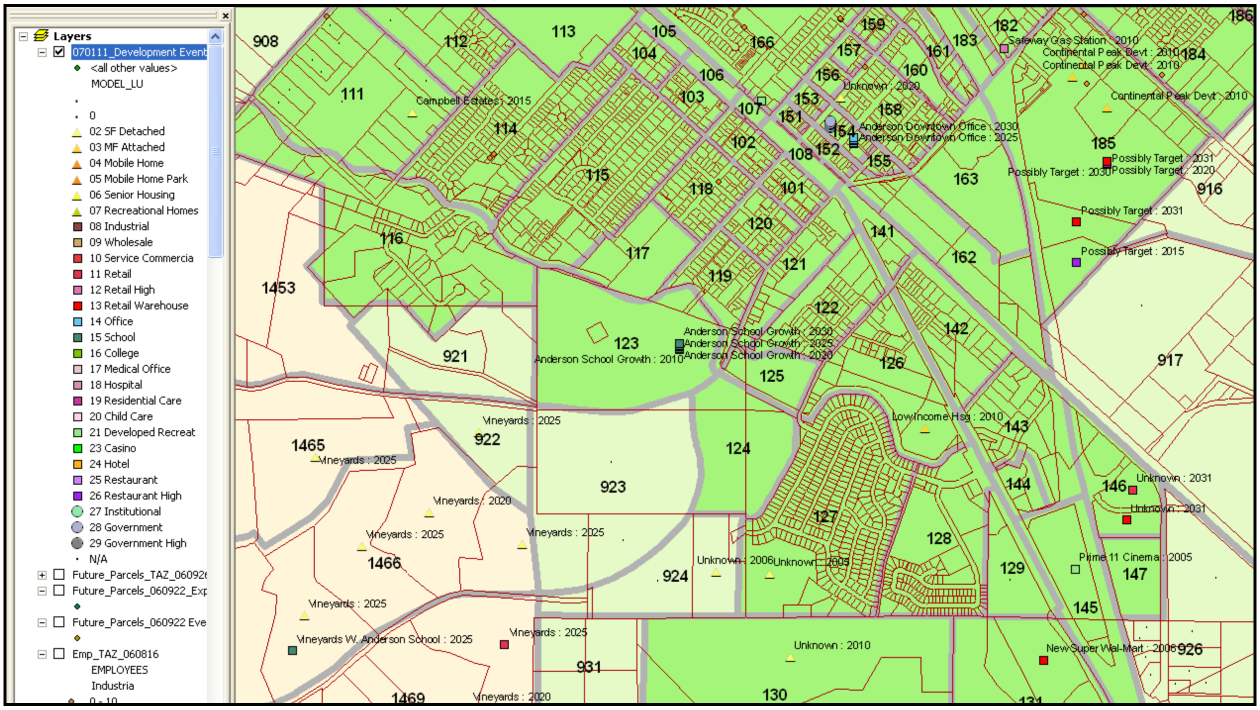
Subarea Allocation

Employment growth was allocated to the Cities and unincorporated county using a proportional formula. In this estimate, Cities maintain their current share of jobs in each of the given sectors. It is expected that land capacity limitations in Anderson and Cottonwood, as well as anticipated large scale development projects such as Oasis Road and Stillwater Business Park will shift a larger share of the projected job growth to Redding, and possibly to Shasta Lake, while Anderson's share of growth decreases. This shift would be most likely to occur in the Manufacturing, Warehousing, and Transportation/ Communications sectors.

Geographic Allocation

Future land uses were allocated to individual parcels and aggregated to the transportation analysis zones (TAZs) used in the Shasta County travel model. A geographic information systems (GIS) process was used to track the various development assumptions (Figure 11.).

Figure 11: Example GIS Land Use Allocation



The initial geographic allocations were based on the pipeline development projects and expected development years provided by each of the jurisdictions. Several major projects, such as Vineyards, provided detailed phasing expectations for residential and non-residential land uses.

Locations for additional development beyond pipeline development were assumed based primarily on proximity to other similar development. The City of Redding provided extensive information on zoning and expected likelihood of development for each vacant parcel. In other areas, residential development was assumed to occur near recent development activity (based on 2000 to 2004 building permit data), while non-residential development was assumed to occur near similar existing non-residential uses.

Employment in health services, education and government was projected to grow, but specific development areas were not identified for these uses (with the exception of several new school sites). Therefore, most of the growth in these sectors were assumed to occur in the vicinity of existing concentrations of employment, such as existing medical centers, government offices and school administration sites.

Phased Development Projects

The development years for major projects provided by jurisidictions 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 by 2030.

Table 12: Shasta County Development Phasing Assumptions

Development	Land Use	Units	2005	2010	2015	2020	2025	2030	After 2030	TOTAL	Percent by 2030
Anderson Potential Target Site	Retail	SF	0	0	0	130,000	0	130,000	66,000	326,000	80%
	Fast Food	SF	0	0	2,500	0	0	2,500	0	5,000	100%
City of Redding (7251 Eastside)	Industrial	SF	0	0	0	198,000	0	298,000	496,000	992,000	50%
Clover Creek (3901 Airport)	Office	SF	0	0	72,700	0	0	0	0	72,700	100%
	Retail	SF	0	0	0	72,700	0	0	0	72,700	100%
Cobblestone Business Park	Office	SF	0	187,000	0	0	0	0	0	187,000	100%
Lasata	MF Attached	DU	0	0	150	151	0	0	0	301	100%
Manor Crest (Cottonwood Hills)	SF Detached	DU	0	64	64	0	0	0	0	128	100%
McConnell Land (350 Old Oregon)	SF Detached	DU	0	0	223	1,165	0	0	0	1,388	100%
Mountain Gate Meadows	SF Detached	DU	0	0	0	0	250	500	250	1,000	75%
	MF Attached	DU	0	0	0	250	250	0	0	500	100%
	Service Commercial	SF	0	0	0	100,000	0	0	0	100,000	100%
North Fork	SF Detached	DU	0	47	47	460	314	532	0	1,400	100%
	Retail	SF	0	0	0	0	180,000	290,000	472,000	942,000	50%
	Office	SF	0	0	0	145,000	0	0	0	145,000	100%
	Equestrian Center	Emps	0	0	0	0	10	0	0	10	100%
Oak Ranch Estates	SF Detached	DU	0	66	66	0	0	0	0	132	100%
Oasis Road Specific Plan	SF 1-5 DU/Acre	DU	0	0	6	3	3	0	0	12	100%
	SF 2-3.5 DU/Acre	DU	0	0	16	0	16	0	0	32	100%
	SF 6-10 DU/Acre	DU	0	0	30	30	0	0	0	60	100%
	MF 15 DU/Acre	DU	0	0	593	296	296	0	0	1,185	100%
	MF 18 DU/Acre	DU	0	0	448	280	168	0	0	896	100%
	Regional Commercial	SF	0	188,500	188,500	188,500	377,000	0	1,342,222	2,284,722	41%
	General Commercial	SF	0	0	143,500	143,500	0	143,500	143,500	574,000	75%
	Shopping Center	SF	0	0	0	0	0	113,500	113,500	227,000	50%
	General Office	SF	0	0	0	0	19,800	0	0	19,800	100%
	Limited Office	SF	0	0	13,100	0	0	0	0	13,100	100%
Palo Cedro Silverbridge Oaks	SF Detached	DU	0	0	0	100	200	0	0	300	100%
Palomar Davis Ridge	SF Detached	DU	0	197	197	0	0	0	0	394	100%
	MF Attached	DU	0	56	0	0	0	0	0	56	100%
Park Marina Drive Specific Plan	SF Detached	DU	0	22	0	0	0	0	0	22	100%
	MF Attached	DU	0	0	99	14	10	0	0	123	100%
	Retail	SF	0	0	50,000	39,200	42,500	55,500	0	187,200	100%
	Office	SF	0	0	0	0	42,500	0	0	42,500	100%
	Hotel	SF	0	0	0	55,500	42,500	0	0	98,000	100%
Shasta Gateway Industrial Park	Industrial	SF	0	49,000	49,000	94,000	94,000	94,000	1,590,000	1,970,000	19%
	Office	SF	0	24,500	24,500	24,500	24,500	0	0	98,000	100%
Shastina Ranch	SF Detached	DU	0	328	0	94	0	0	0	422	100%
	School	Emps	0	0	50	0	0	0	0	50	100%
Shingletown Sierra Pacific	SF Detached	DU	0	66	66	0	0	0	0	132	100%

Table 10 (continued): Shasta County Development Phasing Assumptions

Development	Land Use	Units	2005	2010	2015	2020	2025	2030	After 2030	TOTAL	Percent by 2030
Stillwater Business Park	Industrial	SF	0	0	0	224,000	224,000	199,000	3,554,000	4,201,000	15%
	Office	SF	0	0	205,200	563,900	223,600	593,900	510,900	2,097,500	76%
VA Home Property (Knighton)	Industrial	SF	0	365,000	138,000	0	0	132,000	0	635,000	100%
	Office	SF	0	191,800	127,900	0	179,100	0	0	498,800	100%
Vineyards	SF Detached	DU	0	682	422	1,166	1,029	666	330	4,295	92%
	MF Attached	DU	0	0	640	0	287	287	0	1,214	100%
	Retail	SF	0	20,000	0	50,000	20,000	50,000	0	140,000	100%
	Office	SF	0	0	50,000	50,000	0	0	0	100,000	100%
	School	Emps	0	0	0	50	50	0	0	100	100%
Woodridge Lake	Retail	SF	0	0	30,000	30,000	0	0	0	60,000	100%

5. TRIP GENERATION

The trip generation step quantifies the total magnitude of travel (person trips) generated in each zone based upon land uses within the zone.

Trip Stratification

Trips are stratified by seven trip purposes. The trip ends generated within any area are further classified as either trip end productions or trip end attractions. The seven trip purposes are estimated separately and then later combined prior to assignment to the networks.

Trip Purposes

To derive more accurate projections of future travel behavior, the Shasta County travel model stratifies trip ends by seven trip purposes:

1 **Home-Work** trips are commute trips between residences and places of employment, including both trips from home to work and from work to home.

2 **Home-School** trips are trips between residences and grade schools, high schools, colleges or other types of educational sites (vocational schools, music schools, etc…)

3 **Home-Shop** trips are trips between residences and places of retail employment.

4 **Home-Other** trips account for all other trips that begin or end at home, and include social trips, recreational trips and medical appointments.

5 **Other-Work** trips are trips between places of employment and places other than home, such as driving to a restaurant during a lunch break, driving a delivery truck away from the main office, or stopping at the gas station on the way home from work.

6 **Other-Other** trips account for all other "non-home-based" trips, such as trips between two stores

7 **Commercial Vehicle** trips account for small and large trucks

Splitting the trips into purposes allows for a better understanding of the relationship between jobs and housing, by separating commute trips. It also provides more control over the trip distribution, since different types of trips involve different trip lengths. For a peak period model, it is important to identify the differences in travel characteristics over the day.

Productions and Attractions

Consistent with conventional modeling practice, each one-way trip is defined as having two trip ends in the trip generation process:

- **Trip Production.** This is defined as the home end of any home-based trip, regardless of whether the trip is directed to or from home. If neither end of the trip is a home (i.e., non-home based), it is defined as the origin end.
- **Trip Attraction.** This is the non-home end (e.g., place of work, school or shopping) of a home-based trip. If neither end of the trip is a home (i.e., it is a non-home based trip), the trip attraction is defined as the destination end.

In other words, trip productions are generally home related while trip attractions are generally related to place of work. For example, a typical commute from home to work in the morning and then back home in the evening represents two separate one-way trips, and there are two trip ends produced in the home zone and two trip ends attracted in the work zone.

Trip Generation Rates

Trip generation rates for the Shasta County Model were derived from the 2001 Caltrans Statewide Travel Survey wherever possible, supplemented by information from NCHRP Report 365, Travel Estimation Techniques for Urban Planning, previously developed models and knowledge about the accuracy of travel surveys. Separate trip generation rates were derived for each land use category and for each trip purpose. Daily vehicle trip generation rates are summarized in Table 13.

Household Trip Productions

The Caltrans Statewide Travel Survey was based on households. Therefore, it is most useful for determining travel characteristics at households as opposed to employment. A standard procedure for "cross-classification" trip generation was used which determined the average trip rate for each of the housing categories.

Work-Other Trip Productions

The Caltrans Statewide Travel Survey can also provide some information on trips made by surveyed workers. For each surveyed person, the work trip characteristics can be correlated to their reported type of employment. These survey records were used to determine Work-Other productions for each of the types of employment.

Trip Attractions

Home-Work attractions can be derived from the travel survey. Each person at the surveyed households was also asked about their type of employment. The average number of home-work commute trips for each type of employment can be calculated from these survey records.

Table 13: Daily Vehicle Trip Generation Rates

Land Use Code	Land Use Category	Description	Units	2004 Quantity	Total Daily Trip Rate
1	Population	Population	Persons	163,299	0.00
2	Residential	SF Detached	Dwelling Units	46,556	9.57
3	Residential	MF Attached	Dwelling Units	10,007	6.72
4	Residential	Mobile Home	Dwelling Units	9,608	4.99
5	Residential	Mobile Home Park	Dwelling Units	0	4.99
6	Residential	Senior Housing	Dwelling Units	0	4.00
7	Residential	Recreational Homes	Dwelling Units	1,580	5.00
8	Industrial	Industrial	Employees	6,794	2.50
9	Wholesale	Wholesale	Employees	3,565	6.00
10	Wholesale	Service Commercial	Employees	7,585	20.00
11	Retail	Retail	Employees	9,120	26.50
12	Retail	Retail High	Employees	410	62.00
13	Retail	Retail Warehouse	Employees	983	29.00
14	Office	Office	Employees	10,983	3.30
15	Education	School	Employees	3,884	18.00
16	Education	College	Employees	1,114	15.55
17	Health	Medical Office	Employees	4,845	8.00
18	Health	Hospital	Employees	2,102	5.20
19	Health	Residential Care	Employees	1,743	4.00
20	Health	Child Care	Employees	363	28.13
21	Recreation	Developed Recreation	Employees	1,440	35.00
22	UNUSED	UNUSED		0	0
23	Recreation	Casino	Employees	390	50.00
24	Service	Hotel	Employees	962	14.00
25	Service	Restaurant	Employees	3,736	15.00
26	Service	Restaurant High	Employees	962	38.00
27	Service	Institutional	Employees	1,222	20.00
28	Government	Government	Employees	6,873	12.00
29	Government	Government High	Employees	232	40.00
30	Other		Trips	0	1.00

Trip attractions for other purposes are difficult to derive directly from limited travel survey data. The Home-Non-Work (Home-School, Home-Shop, Home-Other) and Non-Home-Based (Other-Work, Other-Other) trip attraction rates for the STM model are based on the publication Travel Estimation Techniques for Urban Planning (National Cooperative Highway Research Report 365, 1998) which contains a summary of rates used in travel models for other metropolitan areas. The rates were split into the individual trip purposes in each category based on the survey totals.

Cordon or "Gateway" Trips

There are two types of trips at the cordons or "gateways" of a model, through trips (external-external or X-X) and external trips (external-internal, internal-external or I-X/X-I). Through trips are trips that pass through the model area without stopping.

Through Trips

Through trips were estimated from the Caltrans Statewide Model and factored to correlate to 2004 traffic counts.

External Trips

Base year external trips to and from Shasta County were estimated from 2004 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 Shasta County 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 2004 base year gateway traffic counts using annual growth factors derived from historical traffic growth rates.

Special Generators

Special generators are used to include trips from land uses that are not well represented by the standard trip rates. Trips to and from special generators are input directly and there are no trip generation rates.

6. TRIP DISTRIBUTION

The trip distribution process estimates how many trips travel from one zone to another. The model uses a method known as the gravity model to estimate trips between zones based on the trip productions and attractions in each zone and on factors that relate the likelihood of travel between zones to the separation between the zones.

Description of Gravity Model

The gravity model follows the concept of Isaac Newton's Universal Law of Gravitation, which states that the attractive force between two bodies is proportional to the product of their masses and inversely proportional to the square of the distance between them. Similarly, zone-to-zone trip interchanges in the gravity model are directly proportional to the relative attraction or opportunity provided by each of the zones (productions and attractions) and inversely proportional to the spatial separation between zones. Expressed mathematically, the gravity model formula of trip distribution is:

$$T_{ij} = P_I * \frac{A_j F(t_{ij}) K_{ij}}{\text{Sum}_{x=1,n} [A_x F(t_{ij}) K_{ij}]}$$

where:

T_{ij} = number of trips produced in zone i and attracted to zone j

P_i = total number of trips produced in zone I

A_j = attractions of zone j

t_{ij} = travel time in minutes between zone i and zone j

$F(t_{ij})$ = the friction factors between zone i and zone j

K_{ij} = zone-to-zone adjustment factor

n = number of zones

The inputs to the gravity model include the person trip productions and attractions for each zone (as defined earlier in the trip generation step), the zone-to-zone travel times, and friction factors that define the effects of travel time. The zone-to-zone distributions are calculated separately for each trip purpose.

Travel Times

The travel time between each pair of zones is calculated by determining the shortest time path along the coded network between the two zones, and accumulating the travel time along that path. The path building process produces a table (skim matrix) of travel times between each pair of zones in the model. The resulting table of zone-to-zone travel times is then used as an input to the trip distribution analysis.

Intrazonal Travel Times

Intrazonal travel times represent the average travel time for trips that stay within a particular zone. They are typically estimated as a percentage of the travel time to the nearest one or more adjacent zones.

Terminal Times

Terminal times are added to represent the average time to access one's vehicle at each end of the trip. The Shasta County model assumes one minute at each end of each trip.

Friction Factors

The effects of spatial separation in the gravity model are represented empirically by "friction factors" that express the effect that travel time exerts on the propensity for making a trip to a given zone. Typically, the probability for making a particular trip declines as the travel time increases. For the Shasta County model, seven sets of friction factors are used, with each set corresponding to one of the seven trip purposes. This accounts for the possibility that people may be willing to drive a long distance to go to work, but only short distances for most shopping or school trips.

The friction factors for the Shasta County travel model were initially based on the gamma function friction factors reported in NCHRP 365. The trip lengths estimated by the model using these factors were compared to trip lengths reported in the 2001 Caltrans travel survey. The friction factors were then adjusted using an iterative process to better replicate the survey trip distribution in each five minute trip length category.

Adjustment Factors

Adjustment Factors ("K factors") are used in gravity model trip distribution calculations where travel time does not fully explain the attractiveness or unattractiveness of certain trips. The adjustments are often used where bridges, other perceived travel barriers or special socioeconomic factors (such as housing prices or campus housing areas) may distort the distribution of trips between specific areas. The K-factors are not adjustments to the number of trips, but rather adjustments to the friction factors that represent the attractiveness of a certain trip relative to other trips.

The Shasta County model only uses "K Factors" to prohibit illogical trips between certain gateways and certain areas inside Shasta County, and to increase the attractiveness between TAZs identified as "highway oriented" and the external gateways.

7. MODE CHOICE

The mode choice step estimates how many of the trips between each pair of zones will use each travel mode.

The Shasta County travel model includes a mode choice step which divides trips into drive alone, shared ride, transit and non-motorized modes. The mode choice analysis is accomplished in two steps:

1. The first step ("Model Run Vehicle") estimates initial mode choice using average ratios of persons to vehicles to estimate vehicle trips without running through the mode choice calculations.
2. The second step ("Mode Choice") uses congested road times from the first step to assess the tradeoffs between autos and other modes.

The results of the first step model run with the initial mode choice can be used as a standalone quick run of the travel model, or as input to the second step with the full mode choice analysis.

Initial Mode Choice

As a first step, average ratios of persons to vehicles are applied to the person trips resulting from the trip generation and distribution steps (Table 14). These ratios were derived from the Caltrans Household Travel Survey and are the same factors used to convert between vehicle trip rates and person trip rates in the trip generation process.

Table 14: Average Person to Vehicle Ratios

Trip Purpose	Average Ratio of Person Trips to Vehicle Trips
Home-Work	1.05
Home-School	6.17*
Home-Shop	1.40
Home-Other	1.56
Work-Other	1.08
Other-Other	1.54
Commercial Vehicle	1.08
TOTAL	1.43

*Includes trips by school bus and auto passengers
Source: 2000/2001 California Statewide Household Travel Survey results for Shasta County

Full Mode Choice

The first mode choice model for Shasta County was developed in the 1995 model update by DKS Associates. The 2000 model update converted the software but kept the structure and assumptions from the 1995 model. This update uses elements of the 1995 mode choice model but updated the structure and assumptions and recalibrated to newer survey data.

Mode Choice Calibration Data

The calibration of mode choice models requires data on transit ridership characteristics and automobile occupancy rates. Data sources included:

- Caltrans 2000/2001 Statewide Household Travel Survey
- Redding Area Bus Authority (RABA) Short and Long Range Master Transit Plan Study (LSC Transportation Consultants, Inc., July, 2001)
- Redding Area Bus Authority annual ridership by route

Household Survey

The Statewide Travel Survey was used to estimate trips by vehicle ownership and also to estimate shared ride characteristics by trip purpose.

The household survey provided information on the proportion of trips made by households with 0 vehicles, 1 vehicle or 2+ vehicles (Table 15). Households with zero vehicles account for very low proportions of work trips, but higher percentages of school trips. It should be noted that "school" includes college trips and therefore includes college student households.

Table 15: Trips by Household Vehicle Ownership

Vehicles in Household	Work	Non-Work	School	Total Trips
0	0.4%	1.6%	2.8%	1.5%
1	11.7	18.2	12.6	16.5
2+	87.9	80.2	84.6	82.0
TOTAL	**100.0%**	**100.0%**	**100.0%**	**100.0%**

The household survey also asked respondents to list the number of persons in their vehicle during each trip made during the survey period. This allowed an estimate of vehicle occupancy by trip purpose (Table 16). The percentages shown for school trips only account for vehicles where the driver's trip purpose was "school." There are many other trips where the driver's trip purpose was "non-work" (serving passengers was considered non-work) while their passengers' trip purpose was "school."

Table 16: Trips by Vehicle Occupancy

Persons in Vehicle	Work	Non-Work	School	Total Trips
1	93.4%	41.7%	69.1%	51%
2	5.3	36.8	28.4	31
3+	1.3	21.5	2.5	18
TOTAL	**100.0%**	**100.0%**	**100%**	**100%**

Bus Ridership

The RABA ridership data reported 845,000 annual boardings on fixed-route service[1]. The average weekday boardings can be estimated by dividing the annual ridership by a factor of 300, representing full 13-hour operation on weekdays, 10-hour operation on Saturdays and no operation on Sundays. The estimated weekday boardings were approximately 2,800.

Since many RABA passengers transfer at transfer stations, one passenger trip may account for two boardings. It is estimated that over half of RABA trips involve a transfer, so that 1,700 weekday transit trips account for the 2,800 weekday boardings.

Bus Passenger Characteristics

The surveys conducted for the RABA Transit Plan provide additional information on the characteristics of bus passengers.

Trip Purpose. Excluding trips with a destination of "home," the survey indicated the following trip purpose percentages:

Work	21%
Non-Work	49%
School	31%

Vehicle Availability. The passenger survey indicated the following percentages of vehicle availability:

0 Vehicles Available	80%
1 Vehicle Available	16%
2+ Vehicles Available	4%

The majority of RABA passengers do not have a vehicle available. Of those with vehicles available in the household, some are not able to drive (68 percent of total passengers did not have a driver's license).

[1] 2000 ridership was used as it was the most recent year for which details by route were available

Access Mode. Most (96%) of RABA passengers walk to and from the bus. Only 4 percent reported using a vehicle (drop off/pick up or bicycle) to access the bus.

Mode Choice Targets

The observed "target" values for the mode choice calibration were estimated using a combination of all of the data sources. The starting point was the reported trips by mode by trip purpose from the Statewide Travel Survey. Since the travel survey reported very few transit trips in Shasta County, the RABA survey data were used to set control totals for transit, and the other mode percentages were adjusted to compensate. The percentages of drive alone, shared-ride 2 and shared-ride 3+ trips were also adjusted from the driver and passenger information reported in the household survey data

Mode Choice Model Description

The Shasta County mode choice models use a multinomial logit formulation which is by far the most commonly used model form for operating mode choice models in the United States. The logit model assigns the probability of using a particular travel mode based upon an attractiveness measure ("utility") for that mode in relation to the sum of the attractiveness measures for all modes. The attractiveness measure is expressed as an exponential function of level of service (mostly travel time and cost) and other variables. The mathematical expression for the logit model is as follows:

$$\text{Probability of using Mode 1} = \frac{e^{\text{Utility(Mode 1)}}}{\text{SUM}\ \left(e^{\text{Utility(Mode 1)}} + e^{\text{Utility(Mode 2)}} + e^{\text{Utility(Mode 3)}} + \ldots\right)}$$

Typically, the utility is calculated as a function of the attributes of each mode and each traveler group. For example, the utility of a transit trip may be expressed as follows:

Utility(Transit) = C1 + [C2 * In-Vehicle Time] + [C3 * Wait+Walk Time]
+ [C4 * Fare/Value of Time]

Where:

C1, C2, C3, C4 = Coefficients which are set during calibration

Value of Time = Dollars one would spend to save one minute of travel time (or the inverse of minutes to spend to save one dollar), generally based on the household income.

The coefficient "C1" is referred to as the constant and is used to represent factors other than travel time and cost, such as attitudes towards convenience, reliability and safety. The constant coefficient will be specific to each travel mode, while the coefficients for travel time and cost are generally held constant for all modes for a given trip purpose and population segment. In the Shasta County mode choice model calibration, most coefficients were set based on standard values, and the constants were the focus of the calibration.

Modes Represented in the Model

The mode choice model extends the definition of "mode" beyond the basic auto and transit options. In the Shasta County model, both 2-person and 3+-person autos are predicted separately so as to retain the capability of analyzing 2-person vs. 3-person minimum carpool occupancy policies for HOV lanes. The model also predicts "walk access" to transit separately from "drive access" to better represent the tradeoffs between access modes, and to provide a clearer analysis of passenger facility usage and requirements at transit stations for walk, feeder bus, park/ride and kiss/ride transit access options. In all, the mode choice model predicts the following six modes:

1. Drive Alone (DA)
2. 2-Person vehicle (S2)
3. 3+-Person vehicle (S3)
4. Walk to transit (TW)
5. Drive to transit (TD)
6. Walk/Bike (WK)

This set of alternative modes permits analysis of the trade-offs that will occur with a wide range of transportation projects or policies.

School Bus

School bus trips represent approximately 37 percent of school trips and 0.5 percent of non-work trips (some school bus trips are "other-other" if the students make a stop between school and home).

School bus trips are generally not estimated specifically in mode choice models, as they are not generally true "choice" trips and the routes cannot be easily represented in a travel model. Therefore, school bus trips are factored from total person trips prior to the mode choice step.

Mode Choice Stratifications

The COFCG model performs mode choice calculations separately for three trip purposes and three household categories:

Trip Purposes

1. Home-Work
2. Non-Work (sum of Home-Shop, Home-Other, Work-Other, Other-Other)
3. Home-School

Household Categories

1. Zero Auto Households
2. One Auto Households
3. Two-Plus Auto Households

Each of the household categories has a different likelihood of using transit and therefore model constants are estimated separately for each category.

Mode Choice Variables

The variables that are used for each travel mode are summarized in Table 17.

Table 17: Variables for Mode Choice Model

	Modes					
Variable	**Drive Alone (DA)**	**Shared Ride 2 (S2)**	**Shared Ride 3+ (S3)**	**Transit Walk (TW)**	**Transit Drive (TD)**	**Walk/ Bike (WK)**
IN-VEHICLE TIMES						
Auto Time	X	X	X		X	
Carpool Pick-Up Time		X	X			
Transit In-Vehicle Time				X	X	
OUT-OF-VEHICLE TIMES						
Production Terminal Time	X	X	X			
Attraction Terminal Time	X	X	X			
Walk Time				X	X	X
Wait & Transfer Time				X	X	
COSTS						
Auto Operating (per mile)	X	Divide by 2	Divide by 3.5		X	
Parking (half per trip)	X	Divide by 2	Divide by 3.5			
Transit Fare				X	X	

Mode Choice Standard Coefficients

Several basic coefficients and parameters were set based on standard assumptions used in other models. The amount of data and resources required to fully estimate specific coefficients were not available for this model update. However, many of these standard coefficients have been found to not vary significantly between areas.

Coefficient on in-vehicle time (minutes)	-0.025
Coefficient on out-of-vehicle time (minutes)	-0.050 (2x in-vehicle)
Perceived auto operating cost (2000 cents)	13.94 cents per mile
Time penalty for shared ride pick-up/drop-off	
Shared Ride 2, Work	5 minutes
Shared Ride 3+, Work	7 minutes
Shared Ride 2, Non-Work, School	0 minutes
Shared Ride 3+, Non-Work, School	2 minutes

Shared ride occupants for non-work and school trips are assumed to be primarily made up of members of the same family and would not generally require out-of-direction travel for carpooling.

Value of Time

Travel costs are converted to time units using a value of time. The perceived value of time in dollars per minute is estimated as 25 percent of the average income per minute. The average income per minute is calculated as the annual household income divided by the number of minutes in a typical work year (2,080 hours x 60 minutes/hour = 124,800 minutes).

The average household income is calculated separately for each zone as the median annual household income as reported in the 2000 US Census by Census Block Group. A zone with a higher median income will have a higher average value of time, and therefore will be more likely to make travel choices that are faster but cost more (such as drive alone).

The time values are further adjusted from the median for vehicle ownership as follows:

0 Vehicle Household Income = 0.33 * Median for TAZ

1 Vehicle Household Income = 0.63 * Median for TAZ

2+ Vehicle Household Income = 1.17 * Median for TAZ

Logit Model Calibration

The basic coefficients on time and cost were set to standard values. Therefore, calibration of the mode choice model for the 2004 Base Year update consisted of estimating the constants for each household category and mode. The goal of calibration is for the model-estimated number of trips for each mode and each category to closely replicate “observed” trips from the ridership counts and surveys. The mode choice model was applied iteratively to adjust the various constants until the model-estimated number of trips in each stratification closely approximated the observed number of trips.

The necessary adjustment to each constant was estimated with the equation:

New Constant = Old Constant + ln(observed trips / estimated trips)

This equation provides an approximate value for the next iteration. Several iterations were necessary because it is only an approximation, and because all of the adjustable constants change simultaneously during the process.

The target “observed” trips, estimated trips and final mode choice constants are listed in Table 18 for work trips, Table 19 for non-work trips and Table 20 for school trips.

Table 18: Mode Choice Calibration, Work Trips

	Target Trips	Percent by Mode	Estimated Trips	Percent Difference	Logit Constant
0 VEHICLE HOUSEHOLDS					
Drive Alone	0	0.0%	0	0	0.0000
Shared Ride 2	364	54.9%	399	10%	-0.2332
Shared Ride 3+	87	13.1%	95	9%	-1.8689
Transit Walk	193	29.1%	154	-20%	5.3584
Transit Drive	7	1.1%	8	13%	2.7057
Walk/Bike	12	1.8%	13	8%	-2.7576
TOTAL	**663**	**100.0%**	**669**		
1 VEHICLE HOUSEHOLDS					
Drive Alone	9,717	90.5%	9,835	1%	0.0000
Shared Ride 2	550	5.1%	555	1%	-3.0488
Shared Ride 3+	131	1.2%	133	1%	-4.6159
Transit Walk	141	1.3%	142	1%	-0.5587
Transit Drive	5	0.0%	5	-4%	-3.0899
Walk/Bike	194	1.8%	195	0%	-2.7431
TOTAL	**10,739**	**100.0%**	**10,865**		
2+ VEHICLE HOUSEHOLDS					
Drive Alone	74,411	91.7%	74,259	0%	0.0000
Shared Ride 2	4,209	5.2%	4,253	1%	-2.8909
Shared Ride 3+	1,005	1.2%	1,014	1%	-4.3402
Transit Walk	41	0.1%	41	0%	-3.8211
Transit Drive	2	0.0%	1	-34%	-7.1648
Walk/Bike	1,468	1.8%	1,474	0%	-2.4277
TOTAL	**81,136**	**100.0%**	**81,042**		

Note: Percent difference is based on fractional trip values in targets rather than rounded numbers shown in tables.

Table 19: Mode Choice Calibration, Non-Work Trips

	Target Trips	Percent by Mode	Estimated Trips	Percent Difference	Logit Constant
0 VEHICLE HOUSEHOLDS					
Drive Alone	0	0.0%	0	0%	0.0000
Shared Ride 2	9,226	58.2%	9,078	-2%	-0.0808
Shared Ride 3+	5,391	34.0%	5,304	-2%	-0.7310
Transit Walk	781	4.9%	1,014	30%	2.0000
Transit Drive	29	0.2%	28	-3%	1.0096
Walk/Bike	418	2.6%	411	-2%	-2.4462
TOTAL	**15,845**	**100.0%**	**15,835**		
1 VEHICLE HOUSEHOLDS					
Drive Alone	72,940	40.6%	68,711	-6%	0.0000
Shared Ride 2	64,281	35.8%	66,584	4%	-0.1871
Shared Ride 3+	37,561	20.9%	38,928	4%	-0.7667
Transit Walk	78	0.0%	81	4%	-3.4741
Transit Drive	3	0.0%	4	39%	-4.6574
Walk/Bike	4,740	2.6%	4,899	3%	-1.9061
TOTAL	**179,602**	**100.0%**	**179,207**		
2+ VEHICLE HOUSEHOLDS					
Drive Alone	322,284	40.6%	301,864	-6%	0.0000
Shared Ride 2	284,023	35.8%	297,352	5%	-0.1004
Shared Ride 3+	165,961	20.9%	173,772	5%	-0.6343
Transit Walk	20	0.0%	21	4%	-6.4779
Transit Drive	1	0.0%	2	169%	-6.4779
Walk/Bike	20,936	2.6%	21,866	4%	-1.7633
TOTAL	**793,224**	**100.0%**	**794,877**		

Note: Percent difference is based on fractional trip values in targets rather than rounded numbers shown in tables.

Table 20: Mode Choice Calibration, School Trips

	Target Trips	Percent by Mode[1]	Estimated Trips	Percent Difference	Logit Constant
0 VEHICLE HOUSEHOLDS					
Drive Alone	0	0.0%	0	0%	0.0000
Shared Ride 2	514	35.3%	612	19%	-0.5479
Shared Ride 3+	45	3.1%	53	19%	-3.2039
Transit Walk	470	32.3%	275	-41%	7.2742
Transit Drive	17	1.2%	20	16%	4.3843
Walk/Bike	410	28.2%	479	17%	0.5293
TOTAL	**1,456**	**100.0%**	**1,439**		
1 VEHICLE HOUSEHOLDS					
Drive Alone	958	46.9%	946	-1%	0.0000
Shared Ride 2	395	19.3%	400	1%	-1.0862
Shared Ride 3+	34	1.7%	35	2%	-3.6922
Transit Walk	78	3.8%	78	0%	2.1785
Transit Drive	3	0.1%	2	-30%	-0.1877
Walk/Bike	576	28.2%	580	1%	0.8557
TOTAL	**2,043**	**100.0%**	**2,041**		
2+ VEHICLE HOUSEHOLDS					
Drive Alone	6,751	49.5%	6,366	-6%	0.0000
Shared Ride 2	2,781	20.4%	2,915	5%	-0.8711
Shared Ride 3+	241	1.8%	255	6%	-3.4141
Transit Walk	10	0.1%	11	5%	-1.9340
Transit Drive	0	0.0%	7	1715%	-1.9340
Walk/Bike	3,841	28.2%	4,004	4%	1.1578
TOTAL	**13,626**	**100.0%**	**13,558**		

Note: Percent difference is based on fractional trip values in targets rather than rounded numbers shown in tables.

8. PEAKING FACTORS

The Shasta County model estimates vehicle trips for three time periods:

1 Daily

2 A.M. peak hour

3 P.M. peak hour

The A.M. peak hour and P.M. peak hour trips are calculated by factoring the daily vehicle trips after mode choice.

Peak Hour Factors

Daily trips are factored separately for each trip purpose using average areawide factors (Table 21). The factors for the Shasta County model were derived from the 2000/2001 California Statewide Travel Survey. The factors were adjusted for selected trip purposes based on comparisons to traffic counts during model validation.

Table 21: Peak Hour Percent of Daily Trips

Trip Purpose	Production to Attraction	Attraction to Production	Total Percent of Daily
AM PEAK HOUR			
Home-Work	17.0%	0.2%	17.2%
Home-School	37.5%	0.0%	37.5%
Home-Shop	1.7%	1.4%	3.1%
Home-Other	9.2%	2.7%	11.9%
Work-Other	1.8%	5.8%	7.6%
Other-Other	3.3%	2.8%	6.1%
Commercial Vehicle	3.3%	3.3%	6.6%
Through Trips	6.0%	0.0%	6.0%
PM PEAK HOUR			
Home-Work	1.1%	15.2%	16.3%
Home-School	0.0%	4.9%	4.9%
Home-Shop	2.8%	6.9%	9.7%
Home-Other	2.7%	5.9%	8.6%
Work-Other	7.8%	0.3%	8.1%
Other-Other	8.0%	0.4%	8.4%
Commercial Vehicle	4.0%	4.0%	8.0%
Through Trips	7.5%	0.0%	7.5%

Peak Hour Adjustments

During model validation, it appeared that the Shasta County model overestimated some peak hour trips, particularly on the I-5 freeway. Adjustments were applied to the peak hour factors on the I-5 gateways north and south of Shasta County, as the peaking characteristics of these longer distance trips would be expected to be different from the peaking characteristics of local trips (Table 22).

Table 22: Peak Hour Gateway Adjustment Factors

Peak Hour and Direction	I-5 at Siskiyou County Line	I-5 at Tehama County Line
AM PEAK HOUR		
Northbound	0.62	0.69
Southbound	0.85	0.58
PM PEAK HOUR		
Northbound	0.90	0.88
Southbound	0.91	0.78

9. TRIP ASSIGNMENT

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

Traffic Assignment

The Shasta County travel model uses a process known as "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 trips are reassigned to paths based on the congested speeds. The process is repeated for several iterations. After each iteration, some traffic is shifted to alternative routes with competitive travel times. The equilibrium assignment method is intended to ultimately assign traffic so that no driver can shift to an alternative route with a faster travel time. The overall road system is considered to be at equilibrium at this point.

The Shasta County model is currently set for a maximum of 20 iterations for each traffic assignment.

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
4. Minor Arterials

The curves are assigned based on the facility type of each link. 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. The effects of congestion are not included in the transit assignment.

10. FEEDBACK MECHANISMS

The Shasta County travel model does not currently include a feedback loop that uses congested travel times as an input to the trip distribution step. This step could be implemented if required for air quality analysis or other purposes.

Congested road travel times from the initial "vehicle only" run of the model are used in a feedback loop as input to the mode choice model.

11. MODEL VALIDATION

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

Traffic Data

Traffic data for validation were obtained from a variety of sources, including the Caltrans traffic count databases, traffic counts provided by Shasta County and the cities of Redding 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 2004 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 1,000 unique traffic count locations in the database.

The traffic counts provide good coverage for traffic validation in Shasta County, particularly in the urban areas (Figure 12, Figure 13, Figure 14 and Figure 15). The traffic counts on rural highways are primarily daily counts from the Caltrans Traffic Volumes.

Matrix Estimation

Model validation results can be significantly improved by using the traffic counts as one of the inputs to the model process. After estimation of trips using conventional procedures (trip generation, distribution and assignment), the matrix of trip origins and destinations can be factored to more closely replicate the traffic counts. This process is often referred to as origin-destination matrix estimation (ODME).

For example, if the conventional model process results in estimated traffic volumes that are 20 percent too high on a freeway segment, the matrix estimation process can adjust all of the origin-destination pairs using that segment by a factor of 0.8. This is a complex iterative process, as every adjustment affects many segments with traffic counts.

Figure 12: Traffic Count Locations, Shasta County

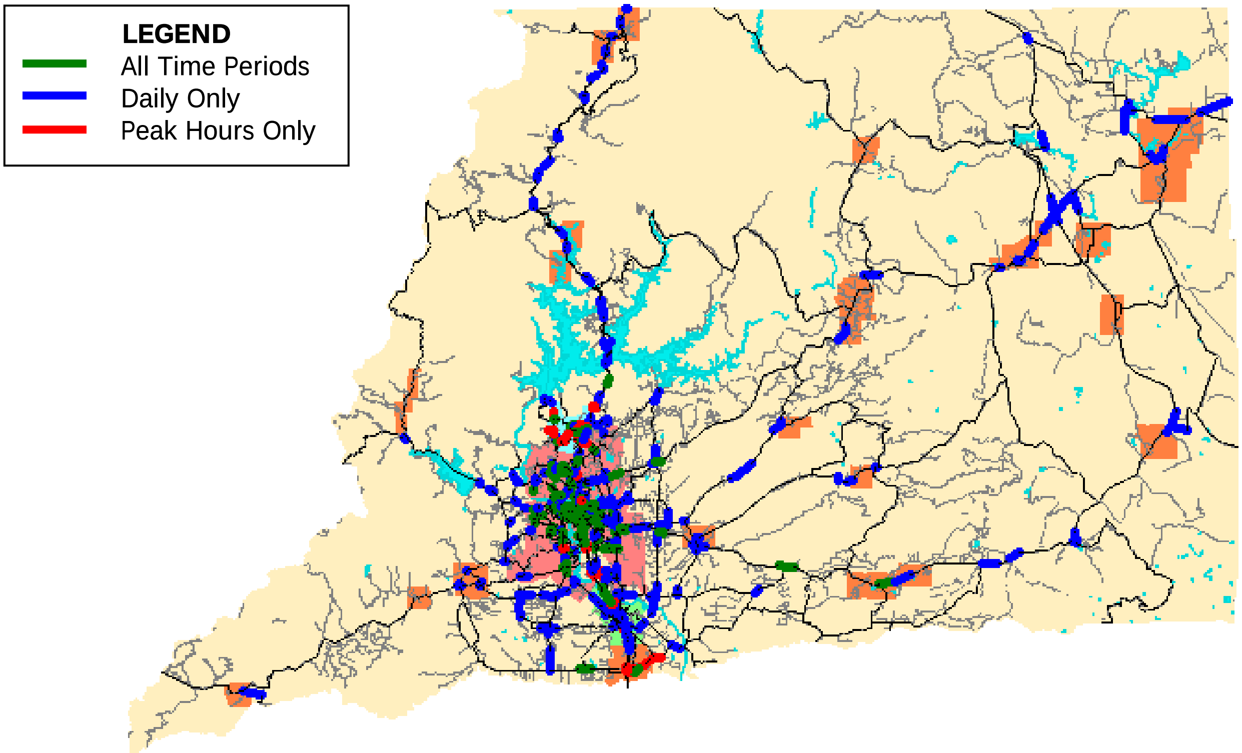


Figure 13: Traffic Count Locations, South County

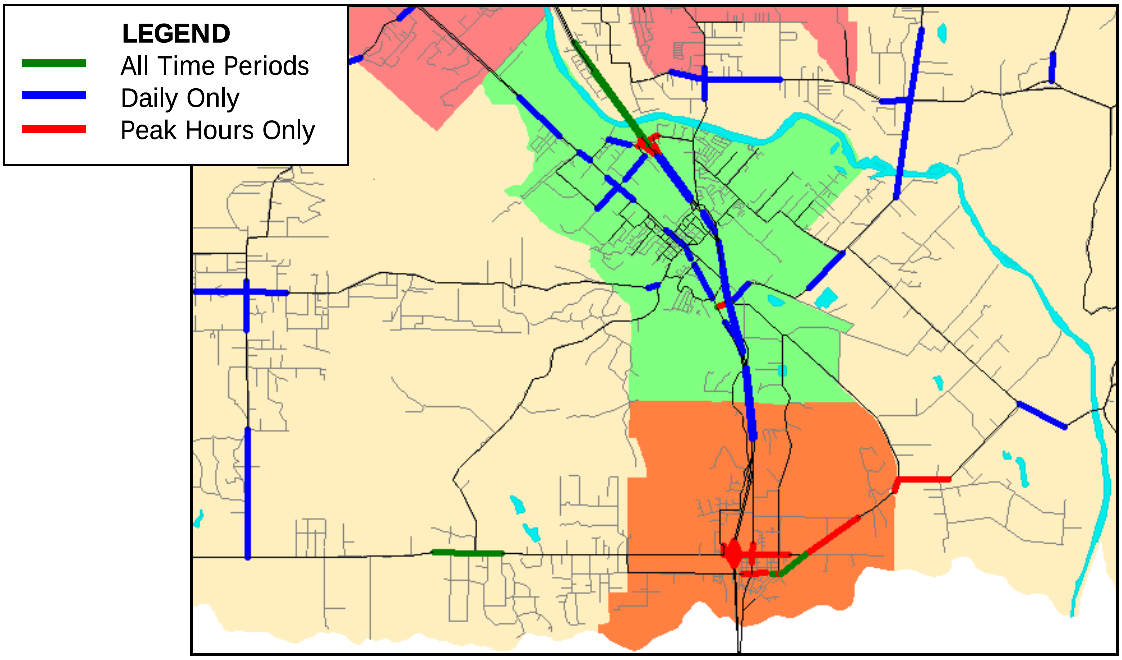


Figure 14: Traffic Count Locations, Redding

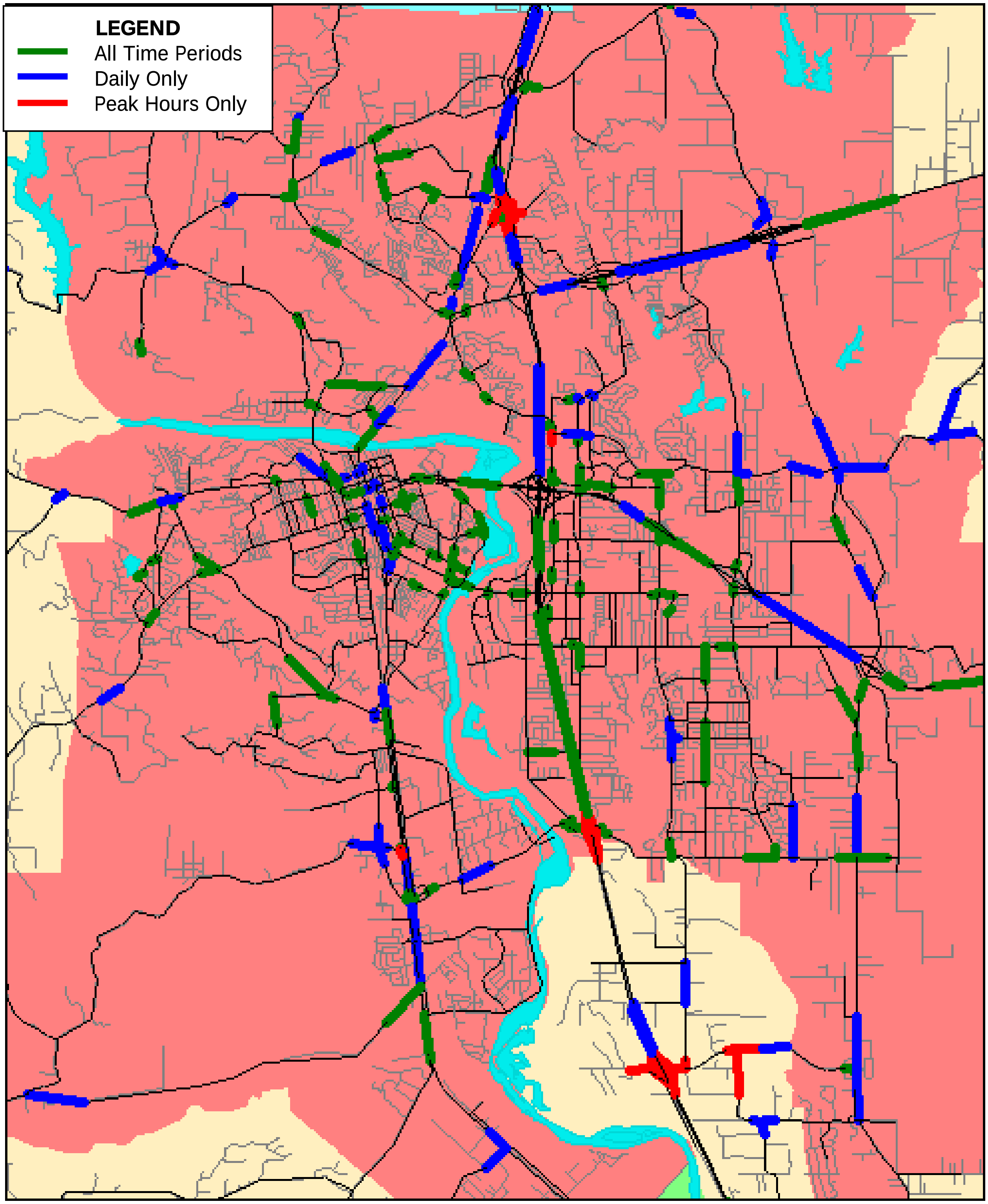
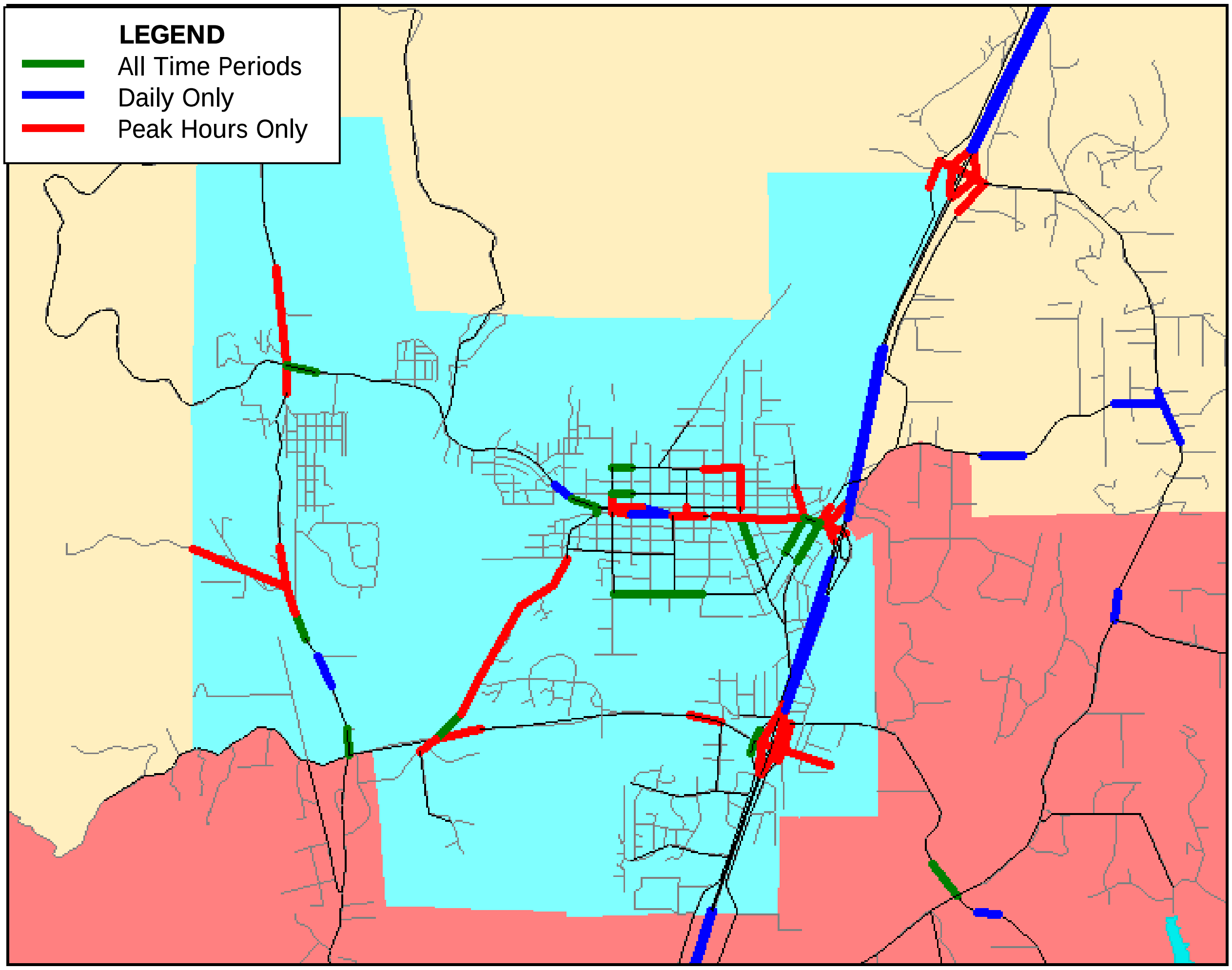


Figure 15: Traffic Count Locations, Shasta Lake



Matrix estimation can improve the validation statistics, but it adjusts the trip origins and destinations in ways that cannot be easily explained or replicated. The recommended application is to perform matrix estimation to provide a more accurate base year result, but use the conventional model procedures to forecast increments between the base year and future years.

Matrix estimation was applied to the Shasta Model 2004 daily and peak hour trip estimates. The result with matrix estimation meets all of the key validation criteria, including maximum desirable deviation for all volume ranges. To accomplish this result, the matrix estimation process may significantly adjust the trip distribution estimated using the conventional model process.

Traffic Validation

The Shasta County travel model traffic validation is based on several criteria, including vehicle miles of travel (VMT), total volume by road type, and percent of links within acceptable limits. The validation results are presented both without and with the origin-destination matrix estimation (ODME) adjustments.

Vehicle Miles of Travel

The Caltrans Highway Performance Monitoring System (HPMS) estimates vehicle miles of travel for each county based on a sample of traffic counts on various road types. Vehicle miles of travel (VMT) were estimated from the travel demand model by multiplying link volumes by link distances (Table 23).

Table 23: Daily Validation by Vehicle Miles of Travel (VMT)

Without ODME Matrix Estimation

Daily Validation by VMT

	Daily							
Class	Links	HPMS	Model	Percent	FHWA Standard	Meets	Shasta Standard	Meets
All	11,017	5,700,170	5,687,613	-0.2%	+/- 5%	YES	+/- 3%	YES

With ODME Matrix Estimation

Daily Validation by VMT

	Daily							
Class	Links	HPMS	Model	Percent	FHWA Standard	Meets	Shasta Standard	Meets
All	11,017	5,700,170	5,474,822	-4.0%	+/- 5%	YES	+/- 3%	NO

The Shasta Model VMT estimate without ODME is within 0.2 percent of the Caltrans HPMS target. With ODME, the validation is 4.0 percent lower than the HPMS target, which is within FHWA standards but does not meet the Shasta RTPA standard of +/- 3 percent. However, as shown in the following sections, the ODME version of the model more accurately replicates observed traffic counts. The HPMS target is based on a sample of traffic counts which may not be as comprehensive as the traffic count database used for model validation and matrix estimation. Therefore, it is recommended to use a model validation that more closely replicates the traffic count database than the HPMS target.

Functional Classification

The Federal Highway Administration 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 criterion for Principal Arterials is assumed to apply to highways and expressways. The criterion for Minor Arterials is assumed to apply to local arterial roads. The FHWA and Caltrans guidelines do not have a separate criteria for local roads, so the collector standard is assumed to apply to collector and local streets combined.

The Shasta RTPA also specified error limits by functional classification:

- Freeways Less than 10 percent
- Arterials Less than 20 percent
- Collectors Less than 25 percent
- Local Less than 25 percent

The 2004 model validation was compared to both sets of criteria for all time periods.

Daily

The Shasta Model validation meets the FHWA targets for total volume by road type (Table 24) for all road types without matrix estimation. The Shasta RTPA criteria include local roads as a separate category, and the model is 25.1 percent low compared to the criterion of +/- 25 percent. The total model estimates are within 1.5 percent on the sample of links that have available traffic counts.

With matrix estimation (ODME), the validation meets all FHWA and Shasta RTPA criteria

Table 24: Daily Validation by Road Type

Without ODME Matrix Estimation

Daily Validation by Functional Clasification

Class	Daily Volume Links	Count	Model	Percent	FHWA Standard	Meets	Shasta Standard	Meets
1 Freeway	91	1,417,602	1,511,151	6.6%	+/- 7%	YES	+/- 10%	YES
2 Highway	84	191,246	212,646	11.2%				
3 Expressway	66	553,624	518,447	-6.4%				
2-3 Highway/Expwy	150	744,870	731,093	-1.8%	+/- 10%	YES		
4 Arterial	362	1,547,979	1,435,292	-7.3%	+/- 15%	YES	+/- 20%	YES
5 Collector	196	223,931	184,100	-17.8%			+/- 25%	YES
6 Local	27	28,348	15,058	-46.9%			+/- 25%	NO
5-6 Collector/Local	223	252,279	199,158	-21.1%	+/- 25%	YES		
7-9 Ramps	162	421,659	442,773	5.0%				
TOTAL	**988**	**4,384,389**	**4,319,467**	**-1.5%**	**+/- 5%**	**YES**		

With ODME Matrix Estimation

Daily Validation by Functional Clasification

Class	Daily Volume Links	Count	Model	Percent	FHWA Standard	Meets	Shasta Standard	Meets
1 Freeway	91	1,417,602	1,425,269	0.5%	+/- 7%	YES	+/- 10%	YES
2 Highway	84	191,246	190,666	-0.3%				
3 Expressway	66	553,624	545,786	-1.4%				
2-3 Highway/Expwy	150	744,870	736,452	-1.1%	+/- 10%	YES		
4 Arterial	362	1,547,979	1,565,228	1.1%	+/- 15%	YES	+/- 20%	YES
5 Collector	196	223,931	205,958	-8.0%			+/- 25%	YES
6 Local	27	28,348	22,669	-20.0%			+/- 25%	YES
5-6 Collector/Local	223	252,279	228,627	-9.4%	+/- 25%	YES		
7-9 Ramps	162	421,659	427,064	1.3%				
TOTAL	**988**	**4,384,389**	**4,382,640**	**0.0%**	**+/- 5%**	**YES**		

Peak Hour

The Shasta Model A.M. peak hour validation meets the FHWA targets for total volume by road type (Table 25) for all road types without matrix estimation. The Shasta RTPA criteria include local roads as a separate category, and the model is 25.6 percent low compared to the criterion of +/- 25 percent. The total model estimates are within 0.4 percent on the sample of links that have available traffic counts.

With matrix estimation (ODME), the A.M. peak hour validation meets all FHWA and Shasta RTPA criteria.

Table 25: A.M. Peak Hour Validation by Road Type

Without ODME Matrix Estimation

AM Peak Hour Validation by Functional Clasification

	AM Peak Hour Volume							
Class	**Links**	**Count**	**Model**	**Percent**	**FHWA Standard**	**Meets**	**Shasta Standard**	**Meets**
1 Freeway	23	38,306	38,134	-0.4%	+/- 7%	YES	+/- 10%	YES
2 Highway	16	4,905	5,886	20.0%				
3 Expressway	22	17,798	18,932	6.4%				
2-3 Highway/Expwy	38	22,703	24,818	9.3%	+/- 10%	YES		
4 Arterial	290	105,119	103,429	-1.6%	+/- 15%	YES	+/- 20%	YES
5 Collector	144	15,452	13,441	-13.0%			+/- 25%	YES
6 Local	32	2,433	1,809	-25.6%			+/- 25%	NO
5-6 Collector/Local	176	17,885	15,250	-14.7%	+/- 25%	YES		
7-9 Ramps	35	8,768	10,287	17.3%				
TOTAL	**562**	**192,781**	**191,918**	**-0.4%**	**+/- 5%**	**YES**		

With ODME Matrix Estimation

AM Peak Hour Validation by Functional Clasification

	AM Peak Hour Volume							
Class	**Links**	**Count**	**Model**	**Percent**	**FHWA Standard**	**Meets**	**Shasta Standard**	**Meets**
1 Freeway	23	38,306	35,834	-6.5%	+/- 7%	YES	+/- 10%	YES
2 Highway	16	4,905	5,021	2.4%				
3 Expressway	22	17,798	16,847	-5.3%				
2-3 Highway/Expwy	38	22,703	21,868	-3.7%	+/- 10%	YES		
4 Arterial	290	105,119	105,434	0.3%	+/- 15%	YES	+/- 20%	YES
5 Collector	144	15,452	13,983	-9.5%			+/- 25%	YES
6 Local	32	2,433	2,052	-15.7%			+/- 25%	YES
5-6 Collector/Local	176	17,885	16,035	-10.3%	+/- 25%	YES		
7-9 Ramps	35	8,768	9,125	4.1%				
TOTAL	**562**	**192,781**	**188,296**	**-2.3%**	**+/- 5%**	**YES**		

The Shasta Model P.M. peak hour validation meets the FHWA and Shasta RTPA targets for total volume by road type (Table 26) for all road types without matrix estimation. The total model estimates are within 0.8 percent on the sample of links that have available traffic counts.

With matrix estimation (ODME), the P.M. peak hour validation also meets all FHWA and Shasta RTPA criteria. In particular, the matrix estimation improves the validation on rural highways.

Table 26: P.M. Peak Hour Validation by Road Type

Without ODME Matrix Estimation

PM Peak Hour Validation by Functional Clasification

	PM Peak Hour Volume							
Class	**Links**	**Count**	**Model**	**Percent**	**FHWA Standard**	**Meets**	**Shasta Standard**	**Meets**
1 Freeway	23	41,611	43,794	5.2%	+/- 7%	YES	+/- 10%	YES
2 Highway	16	5,309	6,371	20.0%				
3 Expressway	22	19,714	20,090	1.9%				
2-3 Highway/Expwy	38	25,023	26,461	5.7%	+/- 10%	YES		
4 Arterial	298	118,088	114,216	-3.3%	+/- 15%	YES	+/- 20%	YES
5 Collector	144	17,631	14,990	-15.0%			+/- 25%	YES
6 Local	32	2,358	1,968	-16.5%			+/- 25%	YES
5-6 Collector/Local	176	19,989	16,958	-15.2%	+/- 25%	YES		
7-9 Ramps	35	9,816	11,397	16.1%				
TOTAL	**570**	**214,527**	**212,826**	**-0.8%**	**+/- 5%**	**YES**		

With ODME Matrix Estimation

PM Peak Hour Validation by Functional Clasification

	PM Peak Hour Volume							
Class	**Links**	**Count**	**Model**	**Percent**	**FHWA Standard**	**Meets**	**Shasta Standard**	**Meets**
1 Freeway	23	41,611	40,699	-2.2%	+/- 7%	YES	+/- 10%	YES
2 Highway	16	5,309	5,520	4.0%				
3 Expressway	22	19,714	19,237	-2.4%				
2-3 Highway/Expwy	38	25,023	24,757	-1.1%	+/- 10%	YES		
4 Arterial	298	118,088	118,842	0.6%	+/- 15%	YES	+/- 20%	YES
5 Collector	144	17,631	15,901	-9.8%			+/- 25%	YES
6 Local	32	2,358	2,085	-11.6%			+/- 25%	YES
5-6 Collector/Local	176	19,989	17,986	-10.0%	+/- 25%	YES		
7-9 Ramps	35	9,816	10,250	4.4%				
TOTAL	**570**	**214,527**	**212,534**	**-0.9%**	**+/- 5%**	**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 target RMSE is 40 percent.

Without matrix estimation, the Shasta Model meets the RMSE validation criteria for daily traffic and is close for the P.M. peak hour (Table 27). With matrix estimation (ODME), the RMSE validation is very good for the daily and P.M. peak hour periods and meets the criteria for the A.M. peak hour.

Table 27: Validation by Root Mean Square Error

Without ODME Matrix Estimation

	Daily			AM Peak Hour			PM Peak Hour		
	RMSE			RMSE			RMSE		
Class	**Model**	**Shasta Standard**	**Meets**	**Model**	**Shasta Standard**	**Meets**	**Model**	**Shasta Standard**	**Meets**
1 Freeway	10.7%			28.9%			22.9%		
2 Highway	28.4%			32.2%			32.3%		
3 Expressway	27.1%			25.3%			21.7%		
2-3 Highway/Expwy									
4 Arterial	39.5%			61.6%			38.5%		
5 Collector	95.0%			95.8%			88.0%		
6 Local	681.8%			430.4%			469.9%		
5-6 Collector/Local									
7-9 Ramps	44.7%			38.5%			36.2%		
TOTAL	**33.1%**	**40.0%**	**YES**	**58.4%**	**40.0%**	**NO**	**41.5%**	**40.0%**	**NO**

With ODME Matrix Estimation

	Daily			AM Peak Hour			PM Peak Hour		
	RMSE			RMSE			RMSE		
Class	**Model**	**Shasta Standard**	**Meets**	**Model**	**Shasta Standard**	**Meets**	**Model**	**Shasta Standard**	**Meets**
1 Freeway	5.5%			17.3%			10.5%		
2 Highway	6.0%			8.2%			15.7%		
3 Expressway	10.4%			10.5%			9.1%		
2-3 Highway/Expwy									
4 Arterial	13.1%			43.7%			15.5%		
5 Collector	46.5%			49.0%			57.1%		
6 Local	317.5%			179.8%			141.7%		
5-6 Collector/Local									
7-9 Ramps	23.2%			14.0%			15.0%		
TOTAL	**13.4%**	**40.0%**	**YES**	**38.4%**	**40.0%**	**YES**	**18.9%**	**40.0%**	**YES**

Correlation and R-Squared

The correlation between observed daily traffic counts and estimated model volumes is shown in Figure 16 and Figure 17. Figure 16 also displays the trendlines for each road type, along with the R-squared values. The calculated R-squared value for all links is 0.92.

Figure 16: Correlation between Daily Traffic Counts and Model Volumes

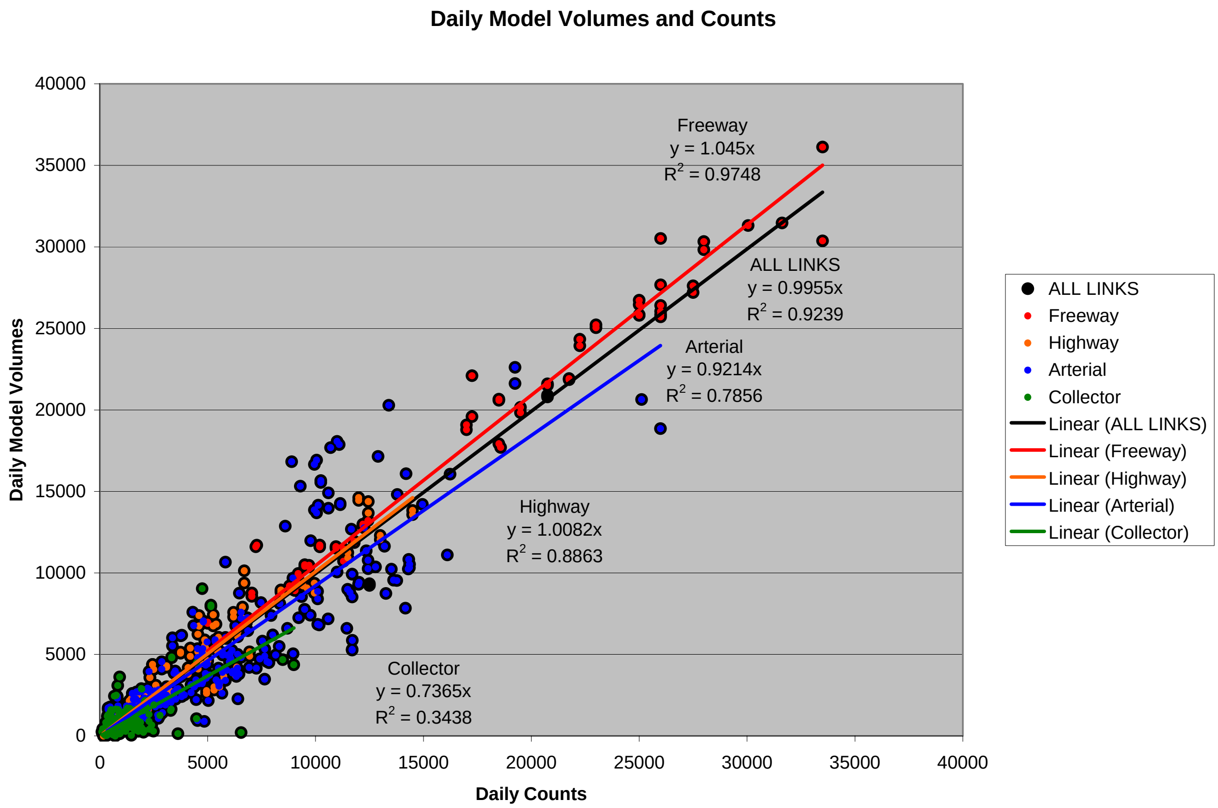
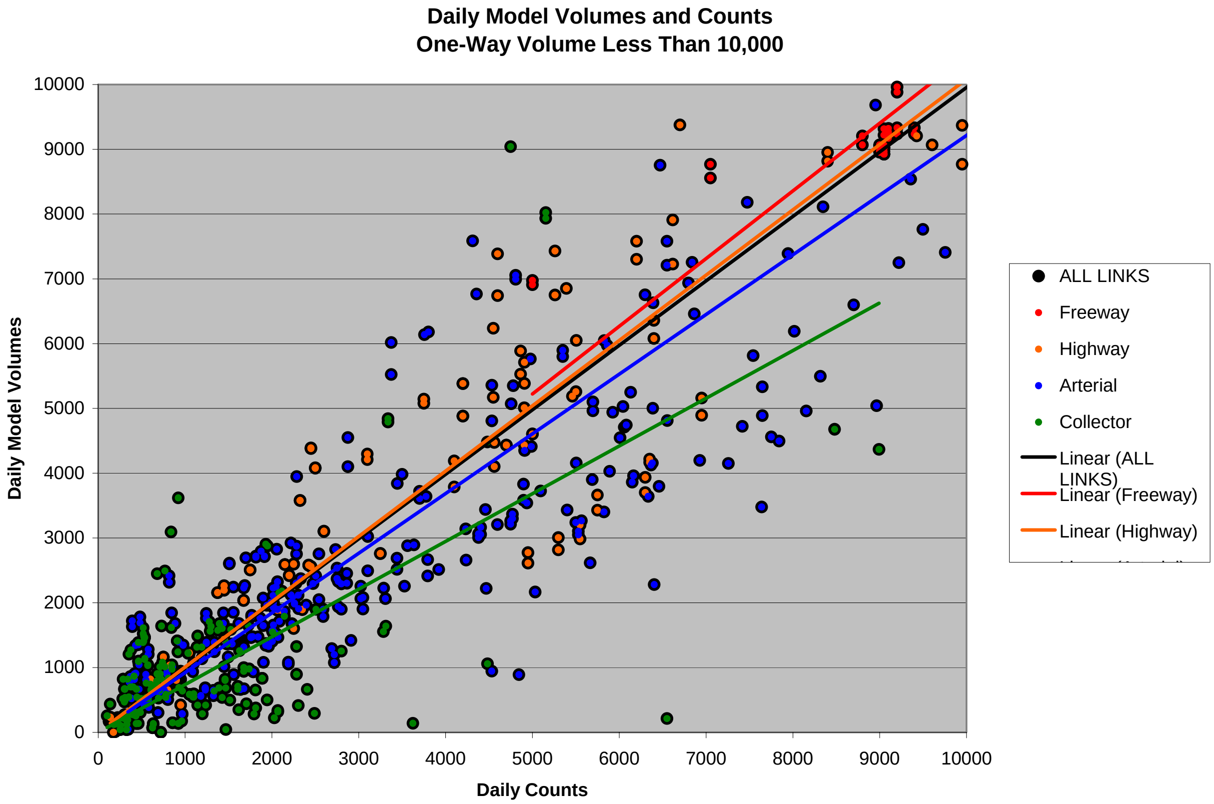


Figure 17: Correlation between Daily Traffic Counts and Model Volumes, Lower Volume Roads

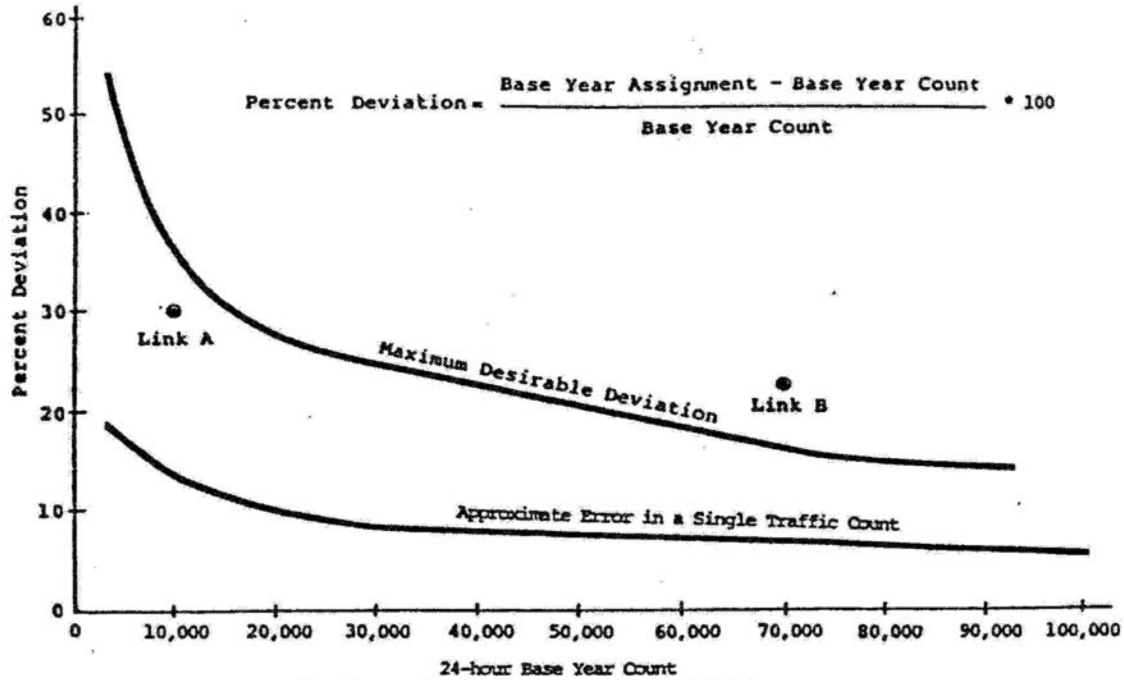


Maximum Desirable Deviation

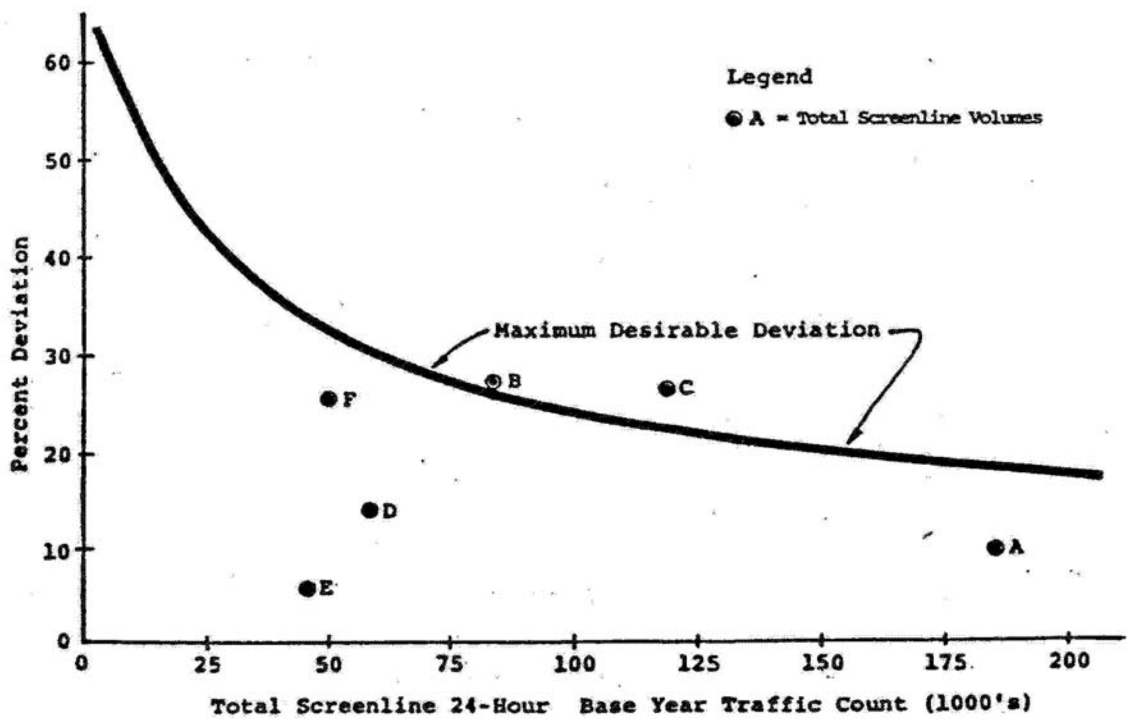
The Caltrans travel forecasting guidelines include a figure showing the maximum desirable deviation for individual link volumes between model volumes and traffic counts (Figure 18). The suggested link-specific validation criterion is that 75 percent of freeway and principal arterials meet the maximum desirable deviation.

The Shasta County travel model meets the Caltrans criteria for daily traffic volumes on 83.8 percent of all links without matrix estimation, including collector and local streets. With matrix estimation (ODME), the model meets the Caltrans criteria for daily traffic volumes on 98.6 percent of all links.

Figure 18: Maximum Desirable Error for Links and Screenlines



Maximum Desirable Error for Link Volumes



Maximum Desirable Deviation In Total Screenline Volumes

Shasta RTPA has specified closer limits for deviation for each range of traffic volumes. The Shasta RTPA criterion is that 90 percent of links must fall within the maximum deviation for each volume category.

Daily

The number of links in each volume range were tabulated according to traffic counts, and the number of links where the model estimated volumes within the maximum error were compared to the total number of links in that volume group (Table 28).

Table 28: Daily Validation by Volume Group

Without ODME Matrix Estimation

Daily Validation by Volume Group

Volume Group		Daily Links	Maximum Error	Model	Percent	Shasta Standard	Meets
1	<1000	307	50%	160	52.1%	90%	NO
2	1,000-2,999	269	50%	215	79.9%	90%	NO
3	3,000-4,999	131	40%	100	76.3%	90%	NO
4	5,000-7,499	104	33%	66	63.5%	90%	NO
5	7,500-9,999	69	28%	57	82.6%	90%	NO
6	10,000-19,999	92	25%	63	68.5%	90%	NO
7	20,000-29,999	30	20%	28	93.3%	90%	YES
8	30,000-39,999	4	15%	4	100.0%	90%	YES
9	40,000-49,999	0	13%	0		90%	
10	>=50,000	0	10%	0		90%	
TOTAL		**1006**		**693**	**68.9%**		

With ODME Matrix Estimation

Daily Validation by Volume Group

Volume Group		Daily Links	Maximum Error	Model	Percent	Shasta Standard	Meets
1	<1000	307	50%	265	86.3%	90%	NO
2	1,000-2,999	269	50%	267	99.3%	90%	YES
3	3,000-4,999	131	40%	126	96.2%	90%	YES
4	5,000-7,499	104	33%	101	97.1%	90%	YES
5	7,500-9,999	69	28%	68	98.6%	90%	YES
6	10,000-19,999	92	25%	91	98.9%	90%	YES
7	20,000-29,999	30	20%	30	100.0%	90%	YES
8	30,000-39,999	4	15%	4	100.0%	90%	YES
9	40,000-49,999	0	13%	0		90%	
10	>=50,000	0	10%	0		90%	
TOTAL		**1006**		**952**	**94.6%**		

For daily volumes, the Shasta Model meets the Shasta RTPA criteria for the two highest out of the eight applicable volume ranges without matrix estimation. These represent road segments with 40,000 or more ADT (20,000 each direction).

The Shasta Model validation meets the maximum desirable deviation for 693 out of 1006 links, or 69 percent of links when considering all road types.

With matrix estimation (ODME), the model validation is able to meet the criteria for all but the lowest volume links. For that volume range, the model meets the maximum error for 86 percent of links (265 out of 307) compared to the 90 percent standard.

Peak Hour

The Shasta RTPA criteria are specified for daily traffic only. However, the Shasta Model validation is compared to the same criteria for the A.M. (Table 29) and P.M. (Table 30) peak hour traffic estimates.

Table 29: A.M. Peak Hour Validation by Volume Group

Without ODME Matrix Estimation

AM Peak Hour Validation by Volume Group

Volume Group		AM Peak Hour Links	Maximum Error	Model	Percent	Shasta Standard	Meets
1	<1000	528	50%	350	66.3%	90%	NO
2	1,000-2,999	33	50%	33	100.0%	90%	YES
3	3,000-4,999	1	40%	0	0.0%	90%	NO
4	5,000-7,499	0	33%	0		90%	
5	7,500-9,999	0	28%	0		90%	
6	10,000-19,999	0	25%	0		90%	
7	20,000-29,999	0	20%	0		90%	
8	30,000-39,999	0	15%	0		90%	
9	40,000-49,999	0	13%	0		90%	
10	>=50,000	0	10%	0		90%	
TOTAL		**562**		**383**	**68.1%**		

With ODME Matrix Estimation

AM Peak Hour Validation by Volume Group

Volume Group		AM Peak Hour Links	Maximum Error	Model	Percent	Shasta Standard	Meets
1	<1000	528	50%	497	94.1%	90%	YES
2	1,000-2,999	33	50%	33	100.0%	90%	YES
3	3,000-4,999	1	40%	0	0.0%	90%	NO
4	5,000-7,499	0	33%	0		90%	
5	7,500-9,999	0	28%	0		90%	
6	10,000-19,999	0	25%	0		90%	
7	20,000-29,999	0	20%	0		90%	
8	30,000-39,999	0	15%	0		90%	
9	40,000-49,999	0	13%	0		90%	
10	>=50,000	0	10%	0		90%	
TOTAL		**562**		**530**	**94.3%**		

Table 30: P.M. Peak Hour Validation by Volume Group

Without ODME Matrix Estimation

PM Peak Hour Validation by Volume Group

Volume Group		PM Peak Hour Links	Maximum Error	Model	Percent	Shasta Standard	Meets
1	<1000	527	50%	365	69.3%	90%	NO
2	1,000-2,999	41	50%	40	97.6%	90%	YES
3	3,000-4,999	2	40%	2	100.0%	90%	YES
4	5,000-7,499	0	33%	0		90%	
5	7,500-9,999	0	28%	0		90%	
6	10,000-19,999	0	25%	0		90%	
7	20,000-29,999	0	20%	0		90%	
8	30,000-39,999	0	15%	0		90%	
9	40,000-49,999	0	13%	0		90%	
10	>=50,000	0	10%	0		90%	
TOTAL		**570**		**407**	**71.4%**		

With ODME Matrix Estimation

PM Peak Hour Validation by Volume Group

Volume Group		PM Peak Hour Links	Maximum Error	Model	Percent	Shasta Standard	Meets
1	<1000	527	50%	506	96.0%	90%	YES
2	1,000-2,999	41	50%	41	100.0%	90%	YES
3	3,000-4,999	2	40%	2	100.0%	90%	YES
4	5,000-7,499	0	33%	0		90%	
5	7,500-9,999	0	28%	0		90%	
6	10,000-19,999	0	25%	0		90%	
7	20,000-29,999	0	20%	0		90%	
8	30,000-39,999	0	15%	0		90%	
9	40,000-49,999	0	13%	0		90%	
10	>=50,000	0	10%	0		90%	
TOTAL		**570**		**549**	**96.3%**		

Without matrix estimation, the model meets the Shasta RTPA criteria for one group in the A.M. peak hour (representing six percent of all links) and two groups in the P.M. peak hour (representing eight percent of all links). For all road types combined, the Shasta Model meets the maximum desirable deviation criteria for 68 percent of links in the A.M. peak hour and 71 percent of links in the P.M. peak hour.

With matrix estimation (ODME), the model meets the Shasta RTPA criteria for all but one group with one link in the A.M. peak hour and all groups in the P.M. peak hour. For all road types combined, the Shasta Model meets the maximum desirable deviation criteria for 94 percent of links in the A.M. peak hour and 96 percent of links in the P.M. peak hour.

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.

Previous validations of the Shasta County model have used a set of screenlines. As this 2004 validation is more focused on specific assignments, screenline results have not been compiled for the 2004 validation.

Traffic Validation Issues

Without adjustment using matrix estimation, the Shasta Model 2004 validation meets the standard criteria for model validation. It does not meet the Shasta RTPA criteria for maximum desirable deviation unless matrix estimation is used to adjust the trips. The Shasta Model Users Group (SMUG) has determined that the base model used for traffic studies should be based on the matrix estimation results.

Many of the validation issues relate to the following:

- The model tends to estimate high volumes on freeways and highways, particularly near Redding. The assumed speeds on these roads could be further reviewed to determine if the assumed speeds truly represent average speeds on these roads.
- The model tends to be low on local streets. Further detailed review of housing allocations based on Census blocks, combined with further splitting of TAZs, could possibly improve estimates on some of these local street segments.

Although the model validation could always be improved, the model can still be applied to generate useful forecast results. There are standard procedures to adjust forecast model results based on observed data to minimize validation error.

Transit Validation

The Shasta County travel model transit validation is based on a comparison of model estimated daily transit ridership with observed daily transit ridership (Table 31). The model is within one percent of overall daily ridership on fixed-route transit services in Shasta County. The model is also relatively accurate (within 20 percent) on six of the seven RABA routes with the highest ridership.

Table 31: Transit Validation

	Ridership Counts		Model Estimated			
Route	Annual	Daily	Walk Access	Auto Access	Total	Percent
1	58,345	194	140	3	143	-26%
2	38,069	127	227	3	230	35%
3	49,195	164	150	1	151	-36%
4	66,999	223	317	10	327	46%
5	78,599	262	262	1	263	0%
6	71,297	238	240	6	246	4%
7	70,754	236	358	18	376	59%
8	68,293	228	215	4	219	-4%
9	111,330	371	317	2	319	-14%
10	13,217	44	Combined with Route 2			
11	86,813	289	267	6	273	-6%
12	21,940	73	Combined with Route 3			
14	110,128	367	296	8	304	-17%
Burney	n/a	n/a	1	0	1	0%
TOTAL	**844,979**	**2,817**	**2,790**	**62**	**2,852**	1%

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

12. FORECAST APPLICATIONS

Potential travel model forecast applications include:

- Identify traffic "hot spots"
- Forecast effectiveness of major road or transit improvements
- Impacts of land use changes
- Compare land use or transportation policy alternatives using regional measures of effectiveness

Origin-Destination Trip Table Adjustments

The matrix estimation (ODME) process provides origin-destination tables for the 2004 base year that more closely match the observed traffic counts. The Shasta County model is set up so that these ODME tables are used as a starting point for future forecasts.

For each model forecast, the following process is used:

1. Run the forecast model
2. For each trip matrix (daily, A.M., P.M.), calculate the increment between the unadjusted forecast and the unadjusted 2004 base year model estimate
3. Add the increment to the 2004 ODME trip matrix for the corresponding time period
4. Factor the increment results to ensure that the trips in and out of each TAZ match the intial forecast amounts
5. Assign the adjusted forecast trip matrices for each time period

The following example illustrates the adjustment process for one particular origin-destination pair:

2004 base model unadjusted daily trips:	300
2004 ODME adjusted daily trips:	420
2030 unadjusted forecast daily trips:	390
2030 increment from 2004 base:	90
2004 ODME plus increment:	510 (= 420+90)
Factor needed to match 2030 forecast trips at each end:	0.97
2030 adjusted daily trips:	495

In this example, the 2004 traffic counts indicated that more trips were needed between this particular origin-destination pair than those estimated by the basic

2004 model. The 2030 unadjusted forecast actually came out lower than the adjusted 2004 number of trips. If this unadjusted forecast were assigned to the road network, the resulting 2030 traffic forecast could be lower than the 2004 observed traffic count. The adjustment process minimizes these types of errors.

Adjustment of Traffic Assignment Results

If the matrix adjustment described in the previous section is not used, it is recommended that traffic forecasts on specific road segments use an adjustment process that accounts for validation errors. Where base year traffic counts are available, forecast traffic volumes are calculated based on the increment between the base year and future year model results:

Adjusted Forecast Volume = Base Year Count +
(Model Forecast Volume - Base Year Model Volume)

An incremental adjustment is recommended instead of an adjustment based on ratios. A ratio adjustment factor does not guarantee continuity of traffic volumes between adjacent road segments, and can result in very large adjustments on low-volume links. However, there are circumstances where a ratio or growth factor adjustment is appropriate. For example, a growth factor based on daily model volumes can be applied to peak hour traffic counts to generate approximate peak hour forecasts.

If a new road or ramp connection is tested in a forecast, there would not be an existing traffic count and the model forecast volume would be used directly.

Forecast Assumptions

An initial set of forecasts for the Shasta County travel model was completed for the 2005, 2010, 2015, 2020, 2025 and 2030 forecast years.

Future Road Network

The future road networks are based on a list of potential improvements provided by the participating agencies (Table 32). The list includes a year in which the improvement is scheduled to be completed. These years are included in the travel model master road network, and improvements are only included in model forecast years beyond the project completion year.

Future Transit Network

The 2004 base transit network was maintained for all forecast years. In reality, service changes may be implemented to serve new development areas. However, no service expansions are currently funded.

Table 32: Shasta County Road Improvements

Name	Location	Description	Year	Source	Comments
SR 151	Locust - Shasta	Narrow from 4 to 2 lanes	2007	Caltrans	SMUG meeting 8/06
Redding Downtown (RDI)	Liberty - Trinity/California	Add turn lanes, modify 1-way	2007	Caltrans	Sketch sent 9/7/06
I-5 NB Off-Ramp	Deschutes	Construct off-ramp	2008	City of Anderson	SMUG meeting 8/06
Pleasant Hills	SR 273 - Vineyards	Construct 2-lane road	2008	City of Anderson	Vineyards Plan 9/06
Rhonda Road	S. of Deschutes	Relocate intersection to Deschutes	2008	City of Anderson	SMUG meeting 8/06
Airport Road	Riverside - Dersch	Widen from 2 to 4 lanes	2010	City of Anderson	SMUG meeting 8/06
Anderson Hills Parkway	W. of Pleasant Hills	Construct 4-lane road	2010	City of Anderson	Vineyards Plan 9/06
Anderson Hills Parkway	Pleasant Hills - Anderson	Construct 4-lane road	2015	City of Anderson	Vineyards Plan 9/06
Anderson Hills Parkway	Pleasant Hills - Locust	Construct 4-lane road	2025	City of Anderson	Vineyards Plan 9/06
Gateway Drive	Deschutes - Balls Ferry	Construct 2-lane road	2025	City of Anderson	SMUG meeting 7/06
Eastside Road	N. of S. Bonnyview	Delete connection E. of RR	pre-2004	City of Redding	SMUG meeting 8/06
Shasta Street	E. of Manzanita Hills	Construct 2-lane road	2005	City of Redding	Comments on network 2005
Airstrip Road	Crossfire - Viking	Complete 2-lane road	2006	City of Redding	Comments on network 12/06
Crossfire Ave	Tarmac - Airstrip	Construct 2-lane road	2006	City of Redding	Comments on network 12/06
Foothill Blvd	Stoneridge - Lakeside	Construct 2-lane extension	2006	City of Redding	Comments on network 12/06
Lakeside Drive	Buenaventura - Foothill	Construct 2-lane extension	2006	City of Redding	Comments on network 12/06
South Bonnyview Road	SR 273 - Eastside	Widen to 2 EB lanes	2008	City of Redding	SMUG Meeting 9/06
South Bonnyview Road	Eastside - W. of Indianwood	Widen from 2 to 4 lanes	2008	City of Redding	SMUG Meeting 9/06
South Bonnyview Road	At Indianwood	Widen to 2 EB lanes	2008	City of Redding	SMUG Meeting 9/06
Browning Street	Churn Creek - Friendly	Widen from 2 to 4 lanes	2010	City of Redding	Comments on network 10/06
Hartnell Ave.	Victor - Shasta View	Widen from 2 to 4 lanes	2010	City of Redding	Comments on network 10/06
Hilltop Drive	SR 44 EB Ramps - Dana	Widen NB from 2 to 3 lanes	2010	City of Redding	Comments on network 10/06
Placer Street	Buenaventura - Airpark	Widen from 2 to 4 lanes	2010	City of Redding	Comments on network 10/06
Placer Street	Boston - Buenaventura	Widen from 2 to 4 lanes	2010	City of Redding	Comments on network 10/06
Shasta View Drive	Rancho - Airport	Construct 2-lane road	2010	City of Redding	Comments on network 12/06
Stillwater Bus. Park Rd.	North Portion	Construct 2-lane road	2010	City of Redding	SMUG meeting 7/06
Cypress Avenue	Athens - Hartnell	Widen from 4 to 6 lanes	2010	City of Redding	SMUG meeting 8/06
Market Street	Placer - Tehama	Construct 2-lane road	2012	City of Redding	
Airport Road	Rancho - SR 44	Widen from 2 to 4 lanes	2015	City of Redding	Comments on network 10/06
Oak Mesa Lane	Tarmac - Candlewood	Construct 2-lane road	2015	City of Redding	Comments on network 2005
Old Alturas Road	Victor - Oak Mesa	Widen from 2 to 4 lanes	2015	City of Redding	Comments on network 10/06
Shasta View Drive	Collyer - Oasis	Complete 4-lane road	2015	City of Redding	SMUG meeting 8/06
Tarmac Road	Oak Mesa - Shasta View	Construct 2-lane road	2015	City of Redding	Comments on network 2005
Cedars Road	El Reno - Westside	Construct 2-lane road	2025	City of Redding	Comments on network 2005
Stillwater Bus. Park Rd.	South Portion	Construct 2-lane road	2030	City of Redding	SMUG meeting 7/06
Shasta View Drive	College View - Collyer	4-lane overcrossing	2035	City of Redding	SMUG meeting 8/06
Shasta Gateway	Ashby - Cascade	Construct 2-lane road	2012	City of Shasta Lake	Comments on network 2005
Cascade Drive	N. of Union School	Construct 2-lane road	2012	City of Shasta Lake	Comments on network 2005
Pine Grove Avenue	Leona - Akrich	Construct 2-lane road	2012	City of Shasta Lake	Comments on network 2005
North Fork Ranch Road	Olinda - Happy Valley	Construct 2-lane road	2015	Shasta County	North Fork Ranch Plan 5/06
New E-W	N. Fork Ranch - SR 273	Construct 2-lane road	2015	Shasta County	North Fork Ranch Plan 5/06
Gas Point Road	New N-S - Rhonda	Widen from 2 to 4(5) lanes	2010	Shasta RTPA	South Region preferred
Rhonda Road	Gas Point - I-5/Main	New/realigned 2(3) lane road	2010	Shasta RTPA	South Region preferred
New N-S Road	First - New E-W	Construct 2(3) lane road	2010	Shasta RTPA	South Region preferred
New E-W Road	New N-S - Rhonda	Construct 2(3) lane road	2010	Shasta RTPA	South Region preferred
I-5 Interchange	Main Street	Connect to west, add roundabouts	2010	Shasta RTPA	South Region preferred
Dana Drive	Hilltop - SR 44	Construct connector to ramp	2012	Shasta RTPA	SMUG meeting 8/06
New N-S Road	New E-W - Rhonda	Construct 2(3) lane road	2015	Shasta RTPA	South Region preferred
Gas Point Road	Rhonda - Main over I-5	Widen from 2 to 4(5) lanes	2020	Shasta RTPA	South Region preferred

Forecast Results

The results of the travel forecasts can include the following:

- Traffic volumes on each link
- Congested speeds and travel times on each link
- Comparison of volume to capacity on each link
- Summary measures on TAZ nodes
- Transit ridership on bus routes
- Traffic volumes by vehicle occupancy (single, two-person, 3+ persons)
- Summary measures of effectiveness (MOE) for the entire county (or subareas) such as vehicle-miles of travel, person-hours of delay or average speed by road type

An example of a graphic display of traffic volumes is shown in Figure 19.

The attributes that are available on each link of the road network are listed in Table 33. There are also attributes that are calculated and added to the nodes representing TAZs (Table 34). These include land use inputs for the scenario and measures such as generated trips, mode shares and average trip lengths.

Figure 19: Example Forecast Volume Graphic

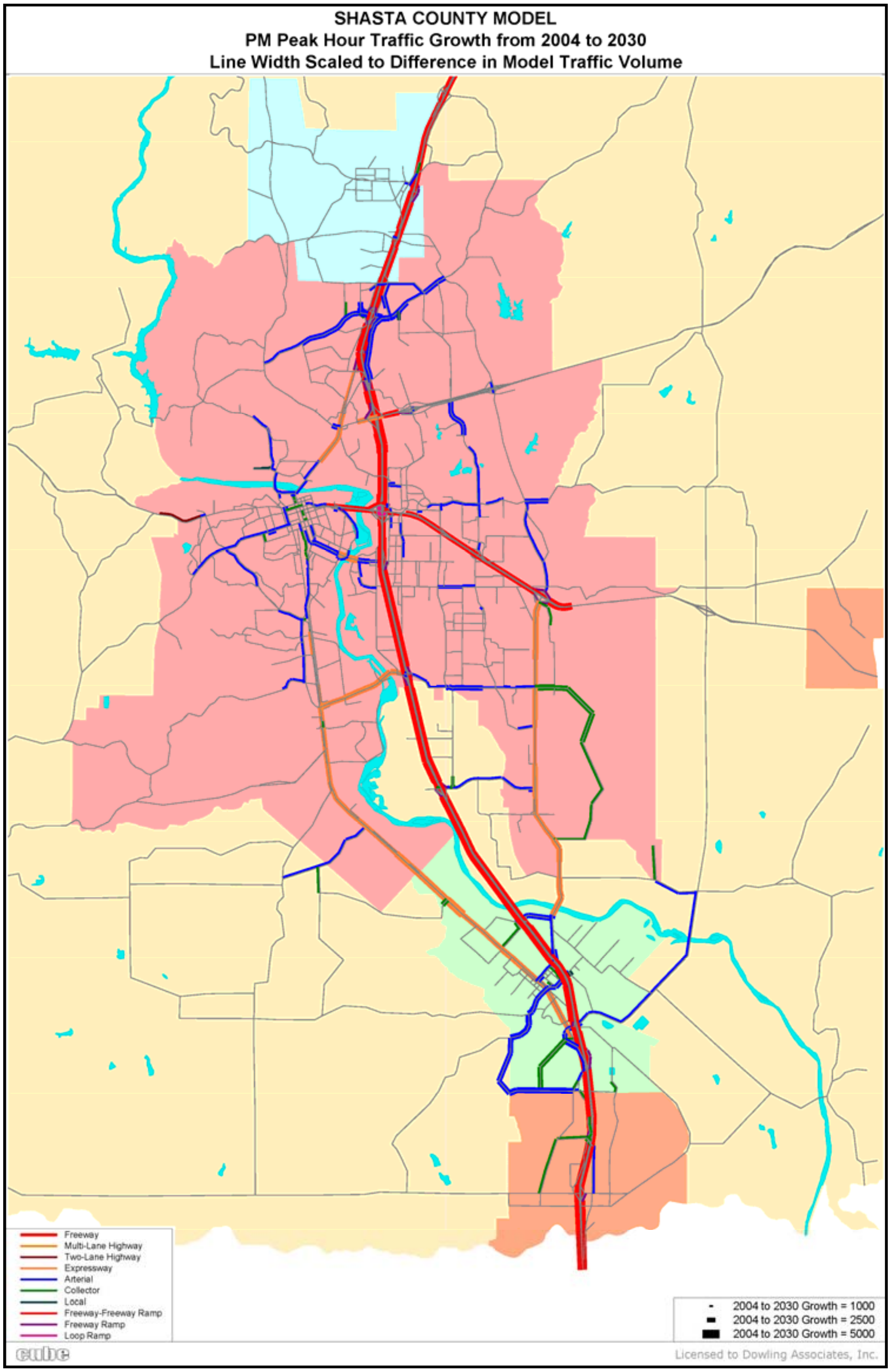


Table 33: Result Network Link Attributes

Link Variable	Description
MASTER NETWORK INPUTS	
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)
HPMS	Indicates link included in HPMS tabulations (currently unused)
SCREENLN	Screenline number for model validation (currently unused)
SCENARIO NETWORK INPUTS	
FACTYP	Facility Type code representing the road type
LANES	Number of through lanes in each direction
SPEED	Uncongested speed (miles per hour)
HOV	Segment used by HOVs only
CAPACITY	Capacity (vehicles per hour)
TIME_FF	Link travel time without congestion (minutes)
FROM TRAFFIC COUNT DATABASE	
CNT_ID	Traffic count database ID number
CNT_NAME	Traffic count road name
CNT_LOC	Traffic count location
CNT_PM	Caltrans Postmile (if state route)
CNT_DIR	Traffic count direction
CNT_DA	Daily traffic count
CNT_A1	A.M. peak hour traffic count
CNT_P1	P.M. peak hour traffic count
CNT_A3	A.M. peak 3-hour traffic count
CNT_P3	P.M. peak 3-hour traffic count
CNT_DATE	Traffic count date
CNT_SOURCE	Traffic count source
SCRNLN	Traffic count screenline (not used)
TRAFFIC ASSIGNMENT RESULTS	
DA_VOL	Daily assigned volume (this link direction)
DA_VOLTOT	Daily assigned volume (total both directions)
DA_VOL_D1	Daily drive-alone vehicles (MODE CHOICE RUN ONLY)
DA_VOL_S2	Daily shared-ride 2-person vehicles (MODE CHOICE RUN ONLY)
DA_VOL_S3	Daily shared-ride 3+-person vehicles (MODE CHOICE RUN ONLY)
DA_VC	Daily average volume/capacity ratio
DA_CTIME	Daily average congested link travel time (minutes)
DA_CSPD	Daily average congested link speed (miles per hour)
A1_VOL	A.M. peak hour assigned volume (this link direction)

Table 33: Result Network Link Attributes

Link Variable	Description
A1_VOLTOT	A.M. peak hour assigned volume (total both directions)
A1_VOL_D1	A.M. peak hour drive-alone vehicles (MODE CHOICE ONLY)
A1_VOL_S2	A.M. peak hour shared-ride 2-person vehicles (MODE CHOICE ONLY)
A1_VOL_S3	A.M. peak hour shared-ride 3+-person vehicles (MODE CHOICE ONLY)
A1_VC	A.M. peak hour volume/capacity ratio
A1_CTIME	A.M. peak hour congested link travel time (minutes)
A1_CSPD	A.M. peak hour congested link speed (miles per hour)
A1_VOL_LOS	A.M. peak hour adjusted volume used for LOS lookup
A1_LOS_NO	A.M. peak hour level of service (number, 1=A, 2=B, etc…)
A1_LOS	A.M. peak hour level of service (letter)
P1_VOL	P.M. peak hour assigned volume (this link direction)
P1_VOLTOT	P.M. peak hour assigned volume (total both directions)
P1_VOL_D1	P.M. peak hour drive-alone vehicles (MODE CHOICE ONLY)
P1_VOL_S2	P.M. peak hour shared-ride 2-person vehicles (MODE CHOICE ONLY)
P1_VOL_S3	P.M. peak hour shared-ride 3+-person vehicles(MODE CHOICE ONLY)
P1_VC	P.M. peak hour volume/capacity ratio
P1_CTIME	P.M. peak hour congested link travel time (minutes)
P1_CSPD	P.M. peak hour congested link speed (miles per hour)
P1_VOL_LOS	P.M. peak hour adjusted volume used for LOS lookup
P1_LOS_NO	P.M. peak hour level of service (number, 1=A, 2=B, etc…)
P1_LOS	P.M. peak hour level of service (letter)
EVALUATION MEASURES	
TYPE	Description of road type for summaries of measures
LOS_TYPE	Category number for Florida DOT lookup table
AMCONHRS	Hours at congested speeds during A.M. peak period (default is 1)
PMCONHRS	Hours at congested speeds during P.M. peak period (default is 1)
PKCONHRS	Total hours at congested speeds during peak periods (default is 2)
AMVPH	Vehicles per hour during A.M. peak period (A1_VOL or CAPACITY)
PMVPH	Vehicles per hour during P.M. peak period (P1_VOL or CAPACITY)
AMVOLCNG	Total vehicles during A.M. peak period (AMCONHRS * AMVPH)
PMVOLCNG	Total vehicles during P.M. peak period (PMCONHRS * PMVPH)
TOOCONG	1 if congested conditions estimated to exceed 4 hours during a peak period
OP_VOL	Off-peak volume (default is DA_VOL-AMVOLCNG-PMVOLCNG)
DA_VMT	Daily vehicle miles of travel (DA_VOL * DISTANCE)
AM_VMT	A.M. peak period vehicle miles of travel
PM_VMT	P.M. peak period vehicle miles of travel
OP_VMT	Off-peak period vehicle miles of travel
DA_VMT_SUM	Daily vehicle miles of travel (sum of AM, PM and OP VMT)
DA_VHF	Daily vehicle hours at free-flow speeds (DA_VOL * TIME_FF)
AM_VHF	A.M. peak period vehicle hours at free-flow speeds

Table 33: Result Network Link Attributes

Link Variable	Description
PM_VHF	P.M. peak period vehicle hours at free-flow speeds
OP_VHF	Off-peak vehicle hours at free-flow speeds
DA_VHF_SUM	Daily vehicle hours at free-flow speeds (sum of AM, PM and OP VMT)
AM_VHT	A.M. peak period vehicle hours at congested speeds
PM_VHT	P.M. peak period vehicle hours at congested speeds
OP_VHT	Off-peak vehicle hours at congested speeds
DA_VHT_SUM	Daily vehicle hours at congested speeds (sum of AM, PM and OP VMT)
AM_VHD	A.M. peak period vehicle hours of delay (AM_VHT – AM_VHF)
PM_VHD	P.M. peak period vehicle hours of delay
OP_VHD	Off-peak vehicle hours of delay
DA_VHD	Daily vehicle hours of delay(sum of AM, PM and OP VMT)
LANEMILES	Lane-miles (LANES * DISTANCE)
A1_LMVCGT1	A.M. peak hour lane-miles at volume/capacity ratios greater than 1.00
P1_LMVCGT1	P.M. peak hour lane-miles at volume/capacity ratios greater than 1.00

*Network variables that are not edited by model users

Table 34: Result Network TAZ Node Attributes

Node Variable	Description
MASTER NETWORK INPUTS	
N*	Node number
X*	X-coordinate in feet (NAD 27 California State Plane Zone 1)
Y*	Y-coordinate in feet (NAD 27 California State Plane Zone 1)
JURISDCTN	TAZ Jurisdiction (City or Shasta County)
COMMUNITY	TAZ Community (example: Cottonwood)
AREATYPE	U=Urban, S=Small Urban, R=Rural
LAND USE INPUTS	
POPULATION	Population, persons
DU_SF	SF Detached, units
DU_MF	MF Attached, units
DU_MH	Mobile Home, units
DU_MHP	Mobile Home Park, units
DU_SENIOR	Senior Housing, units
DU_REC	Recreational Homes, units
EMP_INDSTL	Industrial Employees
EMP_WHOLSL	Wholesale Employees
EMP_SRVCOM	Service Commercial Employees
EMP_RETAIL	Retail Employees
EMP_RETLHI	Retail High Employees
EMP_RETWAR	Retail Warehouse Employees
EMP_OFFICE	Office Employees
EMP_SCHOOL	School Employees
EMP_COLLGE	College Employees
EMP_MEDOFF	Medical Office Employees
EMP_HOSPTL	Hospital Employees
EMP_RESCAR	Residential Care Employees
EMP_CHLDCR	Child Care Employees
EMP_DEVREC	Developed Recreation Employees
EMP_BLANK1	UNUSED
EMP_CASINO	Casino Employees
EMP_HOTEL	Hotel Employees
EMP_RESTNT	Restaurant Employees
EMP_RESTHI	Restaurant High Employees
EMP_INST	Institutional Employees
RMP_GOVT	Government Employees
EMP_GOVTHI	Government High Employees
EMP_BLANK2	UNUSED
DU_TOTAL	Total Housing Units
EMP_TOTAL	Total Employees
DU_DIF04	Total Housing Units, difference between Scenario and 2004 Base Year
EMP_DIF04	Total Employees, difference between Scenario and 2004 Base Year

Table 34: Result Network TAZ Node Attributes

Node Variable	Description
TAZ MEASURES	
TRIPS_PERS	Total Person Trips
TRIPS_VEHS	Total Vehicle Trips
TRIP_DA	Person Trips, Drive Alone
TRIP_SR	Person Trips, Shared Ride (sum of 2 and 3+)
TRIP_TR	Person Trips, Transit (sum of walk and drive access)
TRIP_NM	Person Trips, Non-Motorized (walk/bike)
MODE_DA	Person Trips, Percent Drive Alone
MODE_SR	Person Trips, Percent Shared Ride (sum of 2 and 3+)
MODE_TR	Person Trips, Percent Transit (sum of walk and drive access)
MODE_NM	Person Trips, Percent Non-Motorized (walk/bike)
AVGTIME	Average Trip Length, Time (minutes)
AVGDIST	Average Trip Length, Distance (miles)
VMT	Vehicle Miles of Travel

*Network variables that are not edited by model users

Measures of Effectiveness

Measures of effectiveness for the 2004 base year and six forecast years are summarized in Table 35. These measures can also be stratified for particular road types.

Table 35: Measures of Effectiveness Summary

	Vehicle Miles of Travel (VMT)	Vehicle Hours of Travel (VHT)	Vehicle Hours of Delay (VHD)	Average Speed (miles per hour)		
Year	Daily	Daily	Daily	A.M. Peak Period	P.M. Peak Period	Off-Peak
2004	5,315,000	127,600	4,000	39.3	38.7	42.3
2005	5,395,000	129,700	4,400	39.3	37.8	42.3
2010	5,995,000	140,900	3,700	40.0	39.8	42.7
2015	6,487,000	153,700	4,700	39.6	39.5	42.8
2020	7,084,000	168,800	6,700	39.0	38.5	42.7
2025	7,655,000	183,700	8,900	38.7	38.4	42.4
2030	8,235,000	201,300	13,500	37.9	37.0	41.8

The results show a steady increase in vehicle-miles of travel (VMT) and vehicle-hours of travel (VHT) consistent with forecast growth in population and employment. Changes in vehicle-hours of delay (VHD) are not as linear. Delay is actually predicted to decrease between 2005 and 2010, most likely due to completion of road improvements in congested corridors such as South Bonnyview Road. Congestion in just a few important road segments can significantly affect the averages. Delay is then forecast to rise rapidly in 2025 and 2030 as traffic demands exceed capacities on more road segments.

Peak Periods

The MOEs are compiled for the A.M. peak period, P.M. peak period, off-peak period and total daily. The peak periods are not identical to the peak hours.

In order to capture additional delay beyond the peak one-hour, the Shasta County model estimates the duration of peak congestion on each link during the A.M. and P.M. peak periods. The duration of congestion is estimated based on the volume/capacity ratio and detailed analysis of congestion data that was originally collected in Santa Clara County. The congested "peak hour" speeds are then assumed to last for the entire duration of congestion for each peak period.

For example, a link with no congestion will be assumed to operate at A.M. peak hour congested speeds during one hour, P.M. peak hour congested speeds during one hour, and average daily speeds during the off-peak 22 hours. A link with high congestion may be assumed to operate at A.M. peak hour congested speeds for two hours during the A.M. peak period, P.M. peak hour congested speeds during a two-and-one-half hour P.M. peak period, and average daily speeds during the remaining off-peak 19 ½ hours.

The total daily MOEs are the sum of the A.M. peak period, P.M. peak period and off-peak period results.

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 36 and Table 37).

Table 36: Level of Service Lookup Tables (Freeway, Highway, Arterial)

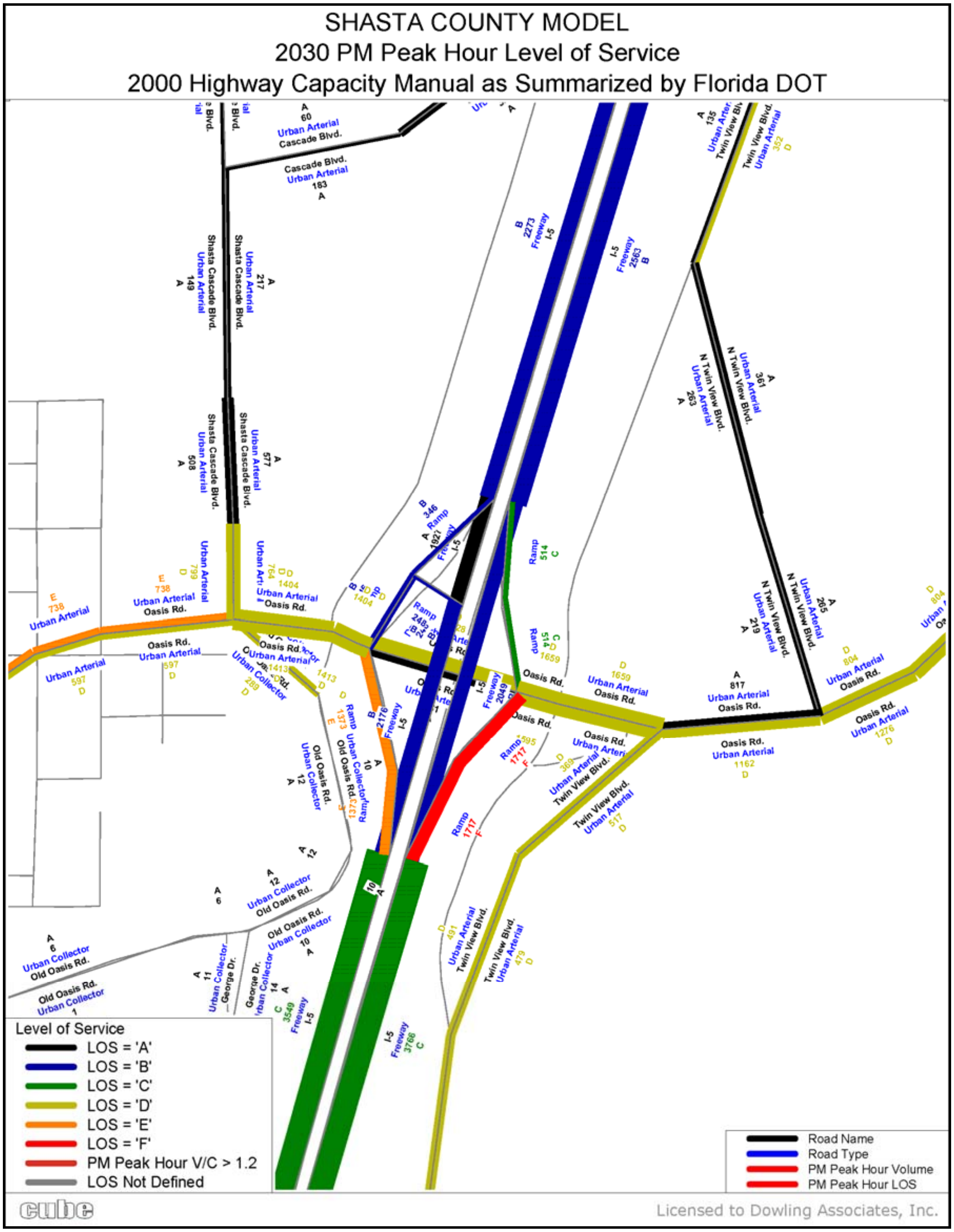
		Maximum Volume for Level of Service					Capacity
Lanes	**Terrain**	**A**	**B**	**C**	**D**	**E**	**per Lane**
Urban Freeway							
2	All	1,270	2,110	2,940	3,580	3,980	1,990
3	All	1,970	3,260	4,550	5,530	6,150	2,050
4	All	2,660	4,410	6,150	7,480	8,320	2,080
5	All	3,360	5,560	7,760	9,440	10,480	2,096
6	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	1360	1710	1800	900
3	All	n/a	340	2110	2570	2710	903
4	All	n/a	440	2790	3330	3500	875
Highway/Expressway (Small Urban Area)							
1	All	120	350	600	820	1120	1,120
2	All	950	1540	2230	2890	3280	1,640
3	All	1430	2310	3350	4330	4920	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 37: Level of Service Lookup Tables (Collector, Local, Ramps)

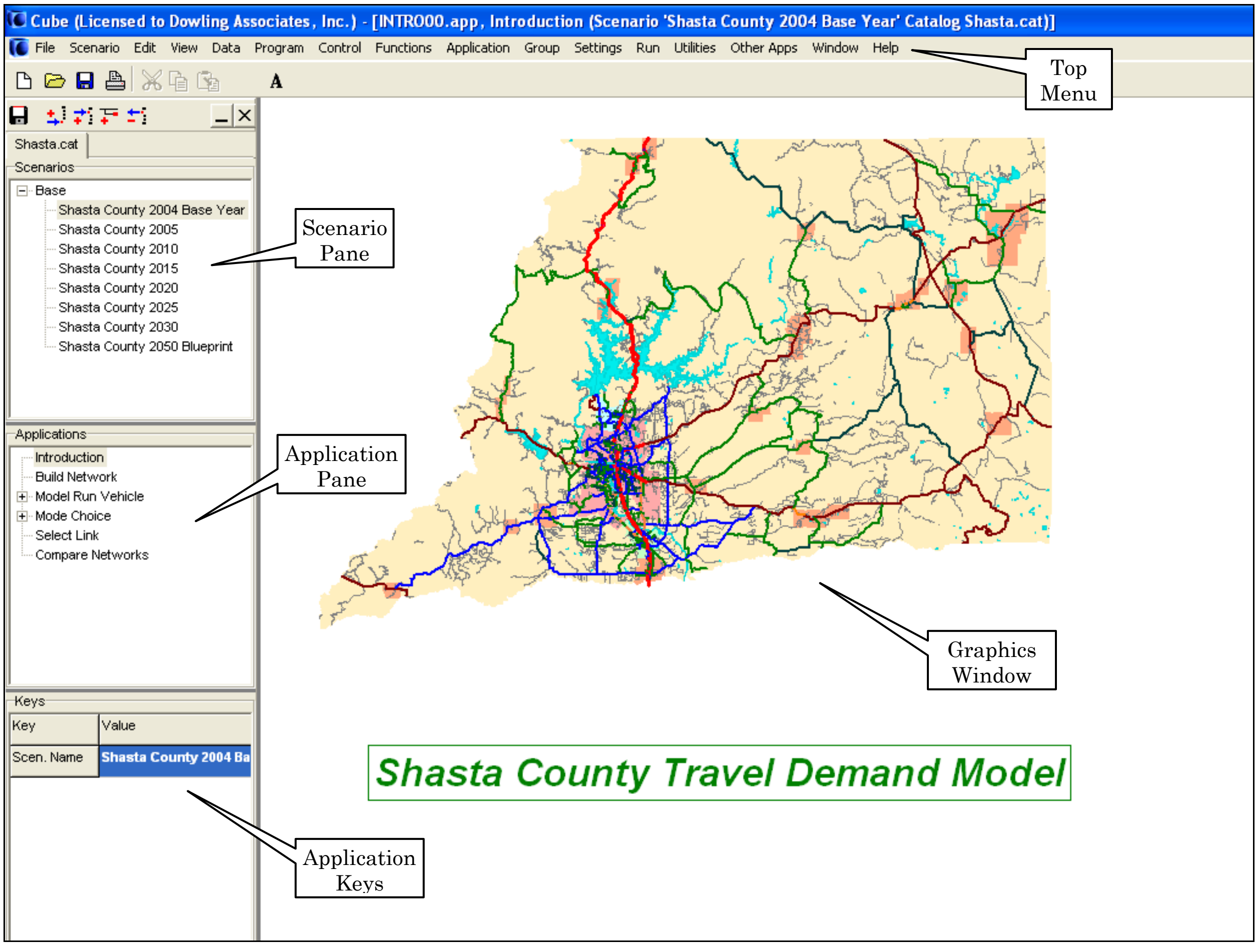
Lanes	Terrain	Maximum Volume for Level of Service					Capacity per Lane
		A	B	C	D	E	
Urban Collector							
1	All	n/a	n/a	250	530	660	660
2	All	n/a	n/a	580	1,140	1,320	660
Small Urban Collector							
1	All	n/a	100	492	617	667	667
2	All	n/a	232	1,088	1,256	1,328	664
Rural Collector							
1	Flat	181	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

An example of a graphic displaying level of service is shown in Figure 20.

Figure 20: Example Level of Service Graphic



13. USING CUBE



This section and the reminder of the User Guide provide general procedures to apply the Shasta County travel model using the Cube software by Citilabs. Users should refer to the Cube documentation provided by Citilabs for specific Cube and Voyager/TP+ related questions.

Summary of Model Application Steps

The general procedure to apply (or run) a travel model includes:

1. Document all changes and assumptions for this scenario
2. Copy the appropriate input files, or use "Save As" to save files to new names after editing
3. Modify roadway and transit networks, as necessary
4. Modify the land use and socioeconomic inputs, if necessary
5. Modify the job script, if necessary
6. "Run" the model alternative and post-process the model results (e.g., compare road volumes, select link analysis)
7. View and print the results

These steps are summarized here and discussed in more detail in this Users Guide.

1. Document all Alternative Changes and Assumptions

All assumptions for the alternative to be run should be adequately documented so that, after some time has gone by, a user can still identify the land use and network input sources.

- Network modifications should be noted on maps or network plots.
- Land use changes should be clearly marked in electronic files or printed out.

Ideally, all assumptions would be filed together so that they are easily accessible in the future.

2. Copy Appropriate Files

There are two file management steps which are important to maintain the integrity of the model files.

Maintain Original Files

A version of the original model files should always be kept in a separate place from the working copy of the model files. If files were received on a CD or DVD, the original CD or DVD should be kept for reference. If files were received electronically, the original version should be kept separate from the working version. This could include updated model files (such as a new land use workbook) as well as the original model release.

Work on Copies or Save With New Names

All work done on the model should use copies of the original model files. If you are modifying a network or land use input, you should either:

- Make a copy of the file first before editing; or
- Edit the input file and save with a new name (such as adding the current date to the file name)

These bookkeeping steps are very important for tracing model assumptions.

3. Update Roadway and Transit Networks

Use Cube (or Viper) to edit the master road and transit networks if necessary. This could include changing the number of lanes, adding new facilities, adding new rail lines, and/or adding new zones with centroid connectors.

4. Update Land Use / Trip Generation

Use Excel to update the land use workbook. Save the workbook with a new name. Use the macro buttons in the workbook to save the files that are input to the travel model.

5. Update the Job Script (Generally Not Necessary)

Use Cube (or Word or a text editor) to modify the Cube/TP+ job script, if necessary. The Shasta County model should not require any modifications to job scripts unless new functions are required.

6. Apply and Post Process the Model

Use Cube to "run" the model alternative. Select the "Model Run Vehicle" and "Mode Choice" applications and the required input files.

7. View and Report Model Results

- Use Cube to view road or transit volumes on specific segments, or to review detailed trip matrices.
- Use the Excel workbooks provided to compile systemwide measures of effectiveness or transit ridership summaries
- Use Cube for simple graphics of TAZ data or a GIS software such as ArcView for more complex graphics of TAZ data.

Cube Components

The Cube software includes the user interface (Cube Base) and the programs which run the model calculations (Voyager or TP+).

Cube Base

Cube Base includes the Graphics Window, the Application Manager and Scenario Manager.

Graphics Window

The Graphics Window is in the main part of the screen and displays various types of data. The Graphics Window can display model networks, GIS layers, text files, Excel workbooks or databases.

Application Manager

The Application Manager also appears in the main part of the screen and displays a flow chart for model applications. Input and output files are shown in the context of the model and can be immediately viewed or edited by double-clicking on the appropriate box in the flow chart.

Scenario Manager

The Scenario Manager is on the left side of the screen and highlights key model parameters and data for creation and testing of scenarios.

Voyager/TP+

The Cube Voyager or TP+ software runs the calculations that perform trip distribution, traffic assignment and trip calculations. The software is controlled by scripts which are essentially a programming language similar to Basic or FORTRAN.

Voyager is the current version of the Cube model software. It is mostly similar to the prior version, TP+. The Shasta County model uses Voyager scripts and will only run with a Cube/Voyager version of the Cube software. However, with minor changes the scripts are all compatible with the prior TP+ software.

Cube Catalog

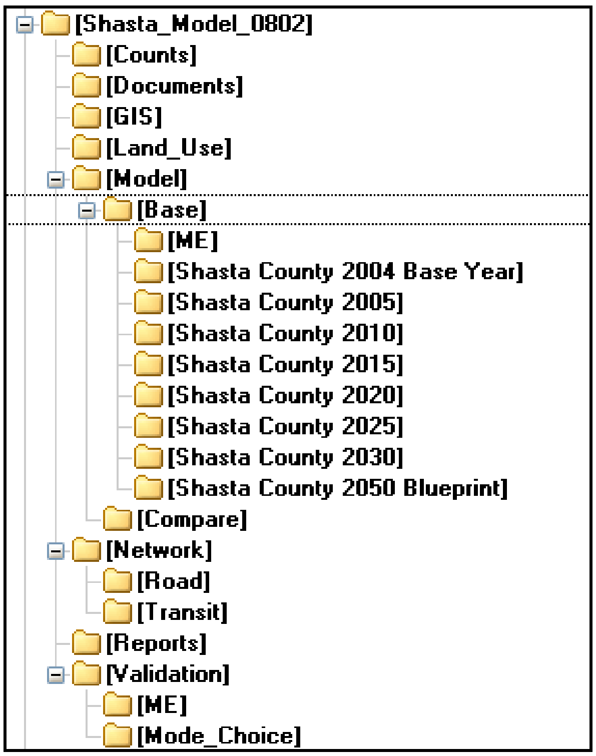
A catalog file stores links to and between the various model scenarios and applications. For this model the Cube catalog is “Shasta.CAT” and the applications contain TP+ modules. It is located in the “Model” directory.

Cube on Your Computer

The Cube software is typically installed in the C:\Program Files\Citilabs directory and subdirectories. These files do not need to be modified or accessed unless the user is updating the software from the web site or using a CD distributed by Citilabs.

The directory structure for the Shasta County travel model is shown in Figure 21. “Shasta_Model_0802” is the root directory and should be copied to a preferred location (i.e. if you want the model to reside on your C Drive, copy the folder “Shasta_Model_0802” from the CD to c:\).

Figure 21: Shasta Model Directory Structure



The output files produced by the Cube model are contained under “Model.” The “Model” directory contains the scripts and printed output from model runs. Input files which are the same for every scenario are stored under the “Model” directory in the “Base” directory. Files which are specific to each scenario are stored under “Model\Base” in subdirectories with the scenario name.

The Cube model uses input files from other directories when it runs, including GIS layers from the “GIS” directory, trip generation inputs from the “Land_Use” directory, base year matrix estimation (ODME) results in the “ME” directory and network input files from the “Network” directory.

Cube Model Application

Model application begins by opening a Cube Catalog.

Opening a Catalog

The following steps are used to open a Cube Catalog.

- Start Cube by either "double clicking" on its icon on your desktop

  OR

  Select Cube from the START bar under PROGRAMS.
- Select "Open your Last Catalog" if you are using the same version of the Shasta County model as your last time in Cube
- Select "Open an Existing Catalog" if the "Open your Last Catalog" option does not provide the correct file
  - In Cube, select "File Open"
  - Browse to the directory Shasta_Model_0802\Model
  - Select "Shasta.cat" and click "Open."

The Scenario Manager will be on the left side of the screen. The Graphics Window will initially be blank.

If you just want to look at a specific file, such as a network result, you can select Cancel and then use File Open to open the specific file without entering the Shasta Model Cube catalog. This option can be useful for examining files from other models.

Catalog Components

The catalog consists of four panes.

Scenarios Pane

The Scenarios Pane provides a way to manage, add and run alternatives. Each scenario has its own set of input files, listed below as "keys." A "Base" scenario represents the standard situation. From the Base, you can create scenarios that will appear as "children" of the Base. A child may be considered as a variation on its parent.

A "child" scenario will inherit key values from its parent. If a new scenario "AltA" was created as a child of the "SH25" scenario, the keys for the new Alt A scenario initially would have the same values as the "SH25" scenario. The keys should be modified to reflect the correct inputs for the new model run. These steps are described in a later section.

Applications Pane

The Application pane shows the applications that have been added to the catalog. Double clicking on any application will open it.

Data Pane

The Data Pane is hidden in the delivered version of the Shasta Model. It can be turned on using Scenario-View in the top Cube menu.

The Data Pane provides an alternative interface to edit and view data. To edit/view a data file, double click on the file name. The version of that file for the current scenario (as selected in the Scenario tree) will be displayed. Right clicking on the data file name and selecting Edit/Current Scenario produces the same result.

Keys

Catalog Keys define items that vary each time an Application in a Catalog is run. They are assigned values by Scenario.

Opening Applications

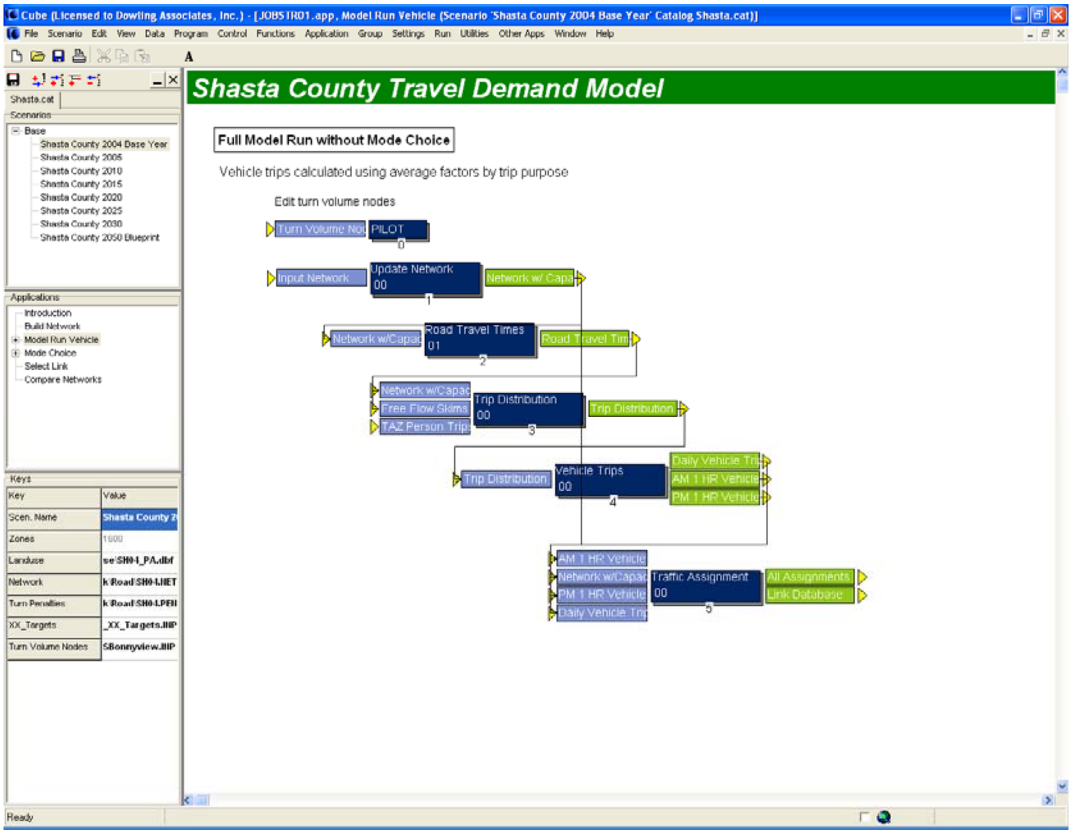
- Double Click on "Introduction", in the Applications Pane.

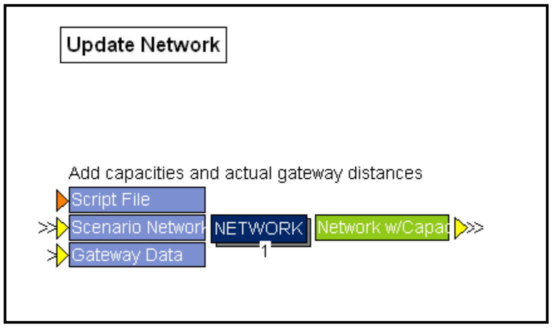
The introduction screen shows a graphic of the model network (see figure at the beginning of this section). The other applications are used to perform tasks.

- Build Network – Generates an input road network from the master network
- Model Run Vehicle – Runs the full model using default person-to-vehicle factors rather than mode choice
- Mode Choice – Reruns the full model (after Model Run Vehicle) using mode choice
- Select Link – Reruns traffic assignment tracking origins and destinations for a specific link(s) or zone(s)
- Compare Networks – Combines and compares attributes and results for two road networks

Double clicking on any application box will show the applications or programs under it.

Figure 22: Model Run Vehicle Application





Clicking on any of the individual component boxes, for example "Update Network" will take you to the next level of detail and display the files and processes for that individual step. The application now shows the Voyager program "NETWORK" which performs the network update task. The light blue boxes denote input files and green boxes denote output files. To go back to the previous screens, right click and select "Go to Parent".

Adding a Scenario

The Cube environment makes it easy to add and run a new scenario. As an example let us go step by step and create a street widening alternative along Oasis Road for 2030.

- Open Catalog "Shasta.Cat
- Click on the "SH30" alternative in the Scenarios Pane.
- Right Click and choose "Add Child"
- Give the Alternative an appropriate name. Let's call it "AltB".
- A Properties screen may appear.
    - If the Properties screen does not appear, right-click on the new scenario and select Properties
    - Type in a code for the scenario (such as "ALTB"). Keep the scenario code at 2 to 4 characters. The scenario code will be appended to the names of all of the files that are created during the run. Write a description for the alternative.
- A Run screen may appear. Click "OK" for now until you have set up the inputs for the model run.
- Find the network you wish to modify (for example, SH30.NET) in the Network\Road directory
- Use Cube to edit the network and create the new 2030 network file with the street widening. Save it in the Network\Road folder with a new name (for example, "ALTB.NET").
- In the Applications pane, select "Model Run Vehicle"
- In the Scenarios pane, double click on "ALTB." The run screen will appear.
- Use "Browse" to select the new input road network from the Network\Road folder.
- Click Run.

If a new scenario is completely independent of one of the existing scenarios, add the "Child" scenario to the Base scenario.

14. VIEWING AND PRINTING NETWORKS

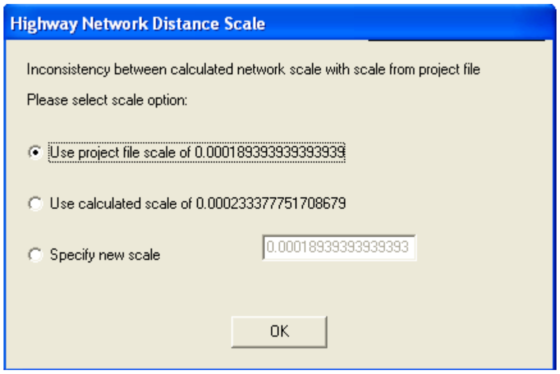
Cube is used to view networks, edit networks to represent changes in road or transit inputs, and to display results such as traffic volumes or level of service. The networks can also be displayed with GIS layers (generally created using other software).

Open a Network

A network can be opened for viewing in several ways.

- Double-click on a network box in the Application Pane, such as "Input Network" at the beginning of Model Run Vehicle or "All Assignments" at the end
- Use File/Open and browse to the network

Distance Scale



You may get a message box about the Distance Scale. Click "OK" to "Use project file scale of 0.00018939…" which equals 1/5280 and indicates that one foot in the model network coordinate system equals one mile.

If you do not get the message box, or if you are concerned about the accuracy of edits you are making, use File/Options to check the Distance Calculation. It should always state that 5280 layer coordinate units equals 1.0 distance units.

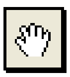
Cube can open multiple networks at once, so results from two or more scenarios can be opened and compared.

Changing the View

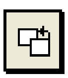
There are several tools to move around the network and get the view you want.

 **Zoom In:** Start in one corner of the desired view, hold down the left mouse button and drag a box around the desired view. When it looks right, release the mouse button.

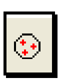
 **Zoom Out:** This command is not as intuitive. As with Zoom In, you draw a box with the mouse. The view will then shift to show more area, in proportion to the box you drew relative to the screen size. If you draw a box half as big as the screen, the new view will show twice as much network centered on the box you drew.

 **View Move:** Hold the left mouse button and drag the view to the place you want. You can use this command to "drive" down a particular road.

The scroll bars on the right side and bottom of the screen can also be used to pan the view.

 **Previous View:** Returns to the previous view screen. This command can be used repeatedly to go back several views.

 **Zoom All:** Display the entire extent of all layers. If you bring in a GIS layer for the entire state of California, this command will show the entire state rather than just the Shasta County road network.

 **View Center on Nodes:** This command is useful if you know you want to look at a specific TAZ or node. Type in a node number, and then a Zoom Level in feet. For example, if you want a quarter-mile square view, type in 1,320.

Saved Views

There are several saved views. These are most useful for printing the exact same view as a previous print. There are views that focus on each city, and there are also views for the four quadrants of the county.

Use a Saved View

1. Use View/Restore from the top menu.
2. Select a saved view.

Create a New View

1. Zoom to the view that you want to save.
2. Use View/Save from the top menu.
3. Select an unused number or letter
4. Enter a name for the view.

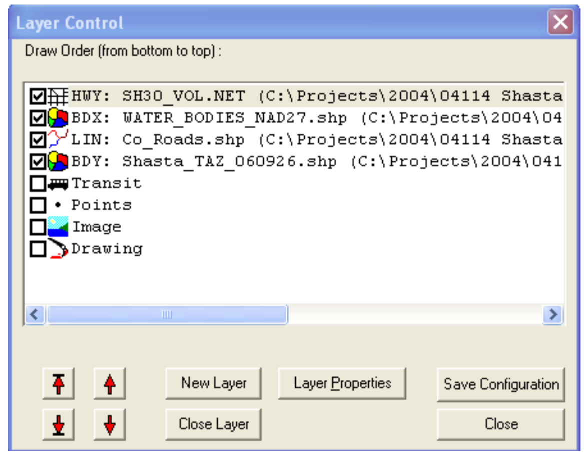
Use a Common View for Two or More Networks

Sometimes you may want to view a specific area in one network, and then look at the exact same area in another network.

1. Open the two (or more) networks for viewing.
2. Zoom to the desired view in the first network.
3. Use View/Save from the top menu and select Common View
4. Use Window from the top menu to switch to another network
5. Use View/Restore from the top menu and select Common View

Network Window Layers

Cube can show the model road network along with many other layers of information such as street maps or TAZ boundaries. Click on the layer control icon  or use View/Layer Control… from the menu.



The Layer Control lists the layers which are being displayed. It also allows you to browse to select different or additional layers.

The standard Shasta Model settings display the Highway Network on top, along with three GIS layers:

1. Water bodies
2. All roads
3. TAZ boundaries

To view characteristics of any of these layers, click on the file name and then click **Layer Properties** below. The **Layer Properties** is also used to find the correct location for a missing layer file, using the **Browse** button.

Use the check boxes to turn layers on and off.

If you want to add a new layer to the display, such as a City boundary, click on the correct layer type (in this example, click on one of the two BDY layers) and then click **New Layer** below. Browse to the directory with the file you would like to add to the display.

Available GIS Layers

Several GIS layers are provided with the Shasta Model data set (Table 38). Any of these layers can be added to a network display. Any other GIS layers or images (such as aerial photos) can also be added.

It is recommended that the GIS layers first be converted to be the same coordinate system as the Cube network (NAD 27 California State Plane Zone 1), particularly if you are working with a version of Cube prior to Cube 5. Later versions of Cube incorporate more features of ArcGIS by ESRI and may be able to convert coordinate systems automatically.

Table 38: Available GIS Layers

Description	Type	File Name
SHASTA COUNTY		
County Boundary	BDY: GIS polygon shape file	SHASTA_COUNTY_BOUNDARY_NAD27
Roads	LIN: GIS line shape file	Co_Roads
Parcels	BDY: GIS polygon shape file	PclBase_0205a
Railroads	LIN: GIS line shape file	County_Railroad_NAD27
TAZ Boundaries	BDY: GIS polygon shape file	Shasta_TAZ_060926
Water Bodies	BDY: GIS polygon shape file	WATER_BODIES_NAD27
ANDERSON		
City Limit	BDY: GIS polygon shape file	Anderson_City_Limit_NAD27
Sphere of Influence	BDY: GIS polygon shape file	Anderson_SOI_NAD27
Streets	LIN: GIS line shape file	Anderson_Street_NAD27
REDDING		
City Limit	BDY: GIS polygon shape file	REDDING_LIMITS_NAD27
SHASTA LAKE		
City Limit	BDY: GIS polygon shape file	SHASTA_LAKE_LIMITS_NAD27

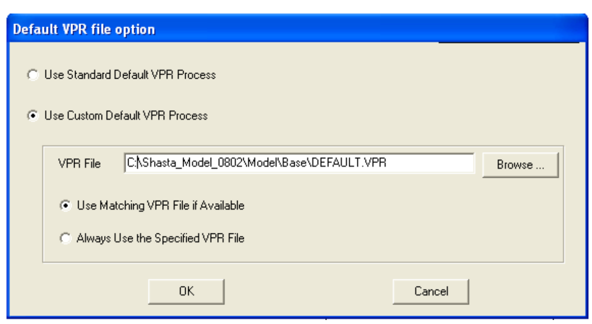
View Settings in Cube (Viper) Project Files

Cube "Project Files" store various settings, including:

- The status and drawing order of the layers
- Color settings for links and nodes
- Saved views
- Saved polygons
- Printer setups
- Highway network attribute calculation information

Recommended Settings: Custom Process

The settings for the Shasta County model are contained in the project file DEFAULT.VPR located in the \Model\Base directory. To use these standard settings, use File/Set Default Project. The setting should be Use Custom Default VPR Process.



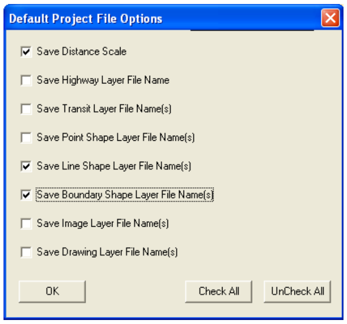
Other Option: Standard Process

With the Standard Default VPR Process, Cube will automatically search for a project file when a highway network file is opened. If a project file with the same name is found, the program will utilize the settings found in the project file. If such a file is not found, then Viper will try to search for a file named DEFAULT.VPR in the current (project) directory and then in the Cube program directory. If a DEFAULT.VPR file is located, Cube will utilize the settings in this file.

Saving New Settings

If you come up with a specific set of colors and/or print settings for a specific application, you can either add them to the DEFAULT.VPR settings or create a new Project File just for your network views.

Add to General Settings (DEFAULT.VPR)



1. File/Save Project As
2. Browse to the Model\Base directory
3. Select DEFAULT.VPR
4. Yes to Overwrite
5. Save Distance Scale, Line and Boundary files

Create New Settings for a Particular Network

Use this option if you have created very specific displays, for example graphics of trips to and from specific TAZs.

1. File/Save Project As
2. Browse to the directory where the network is (most likely under Model\Base\ in the scenario directory)
3. Cube will suggest a name which is the same as the network, with .VPR in place of .NET (for example, SH30.VPR for viewing SH30.NET). Use this name

The next time you open that particular network, Cube will use your specific settings rather than the general settings in DEFAULT.VPR.

Cube Project File Description

The project file is an ASCII text file which looks like a Windows INI (Initialization) file. Citilabs recommends that this file only be modified by changing the settings in Cube. However, it can be viewed in a text editor (or Word). If you choose to edit the file directly, make certain that there is a backup of the original file.

Color Settings

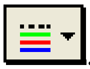
The settings for the Shasta Model include several color settings which are generally useful for viewing networks. Users can modify these settings or create their own. The settings are organized as follows:

- Settings 1-5 are most useful for Master and scenario networks
- Settings 6-10 are for final networks with traffic volumes
- Settings 11 and up are for viewing the 2004 base year validation

Users do not have to follow this numbering system. Link color settings can be assigned to any available numbers.

Link Colors

Current Link Color Settings

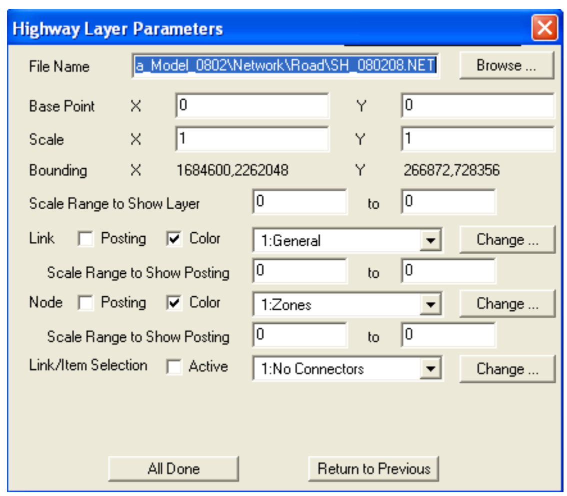
You can view the current link color settings by clicking on the icon with the horizontal bars . The color settings are based on various link attributes.

Select Link Color Settings

There are two ways to select different link color settings:

1. Click the arrow next to the horizontal bar icon. The available settings will drop down.

2. Click the Layer Control icon . Select the HWY layer and click the Layer Properties button at the bottom. The horizontal box to the right of "Link" has a drop-down arrow which will list the available settings (see example)

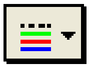


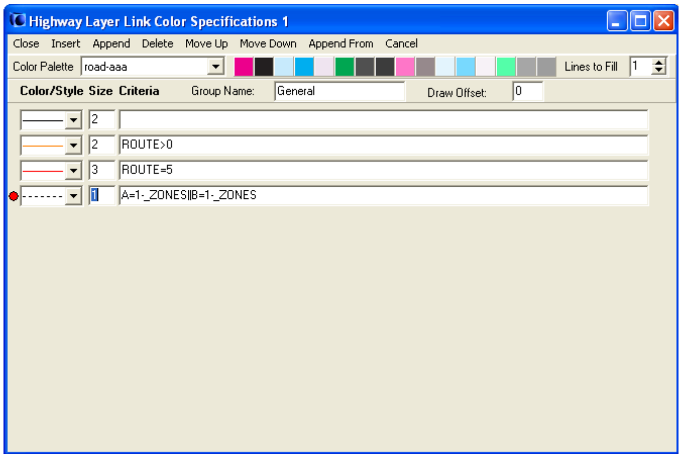
The provided settings are listed in Table 39.

Table 39: Link Color Settings

Link Setting Number	Link Setting Name	Used With	Display
1	General	Any network	I-5 in red, state routes in orange
2	Master Type	Master network	Color by facility type, road improvements highlighted
3	Master Speed	Master network	Speed range by color
6	Road Type	Scenario input network or output network	Color by facility type
7	LOS AM	Output network	A.M. peak hour level of service by color
8	VC AM	Output network	Highlights V/C ratios over 0.9, 1.0 and 1.1
9	LOS PM	Output network	P.M. peak hour level of service by color
10	VC PM	Output network	Highlights V/C ratios over 0.9, 1.0 and 1.1
11	Counts	Output network	Highlights locations of daily and peak hour counts
12	Validation Ratio	2004 validation network	Highlights ratio of unadjusted 2004 model to 2004 traffic counts

Change Link Color Settings

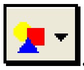
1. Choose a link color setting OR choose a blank setting number if you want to create a new setting.
2. View the current link color settings 
3. To change an assigned color, click on the horizontal line. Select the line type (usually the first one, a straight unbroken line), You will then get a color menu to choose from.



4. To change the line width, type a number in the Size column. Dashed lines only show up well with a Size of 1.
5. To add another setting, click in the last setting line. Then choose Append from the menu across the top. Click in the line box to choose a line type and color, then type in a Size. Now type a criterion based on a link attribute (for example, LANES=2 to highlight all roads with 2 lanes in each direction).
6. You can make the criteria more complex by using && (AND) to indicate a link has to meet both of two (or more) criteria, or | | (OR) to indicate that a link can meet either of two criteria.
7. A lower criterion supercedes all earlier criteria. In the example above , all links are first given a black color with a Size of 2. Then, all links with a ROUTE number are changed to orange. Then links with a ROUTE number of 5 are changed to red. Then zone connectors (the A number of the link is between 1 and the number of ZONES or the B number of the link is between 1 and the number of ZONES) are changed to dashed black lines.

Node Colors

Current Node Color Settings

You can view the current node color settings by clicking on the icon with the shapes . Set 1 is provided to highlight TAZ nodes, and Set 2 places a dot for every node in the network.

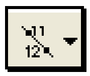
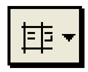
Change Node Color Settings

Node color settings are selected in the same ways as link color settings. The quickest way is generally to click the arrow next to the shape icon.

Node colors can also be modified using the same procedure as modifying link colors. For nodes, instead of line types, you will select shapes such as circles or squares to represent different node characteristics.

Posting Labels

There are three ways to post information alongside nodes or links:

1. Click the Post Node  or Post Link  icon

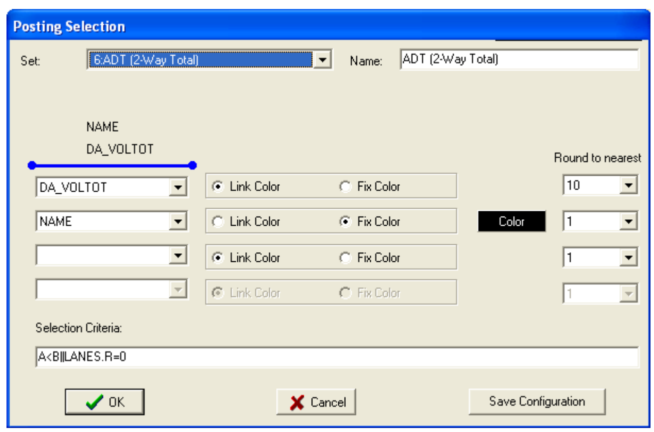
   OR

2. Select Post/All Nodes… or Post/All Links… from the top menu

   OR

3. Use the Layer Control  and click the appropriate check boxes

Any of these methods will bring up a Posting Selection box.



- You can post up to 4 attributes at once on a node or link.
- The color of the label defaults to be the same color as the node or link (black nodes will have black labels, blue links will have blue labels, etc…). You can also Fix Color to black or other colors.
- You can round numbers. Volume labels are sometimes easier to read rounded to the nearest 10 or 100. Volume/capacity ratios should be rounded to the nearest 0.01.
- You can set Selection Criteria so that not all nodes or links are labeled. For example, you may want to post information only on links with volumes greater than 100.
- To change the font size, select the font icon  from the command bar.

Current Node Posting Settings

Two basic node posting settings have been provided:

1. Setting 1 posts labels on TAZ nodes only
2. Setting 2 posts node numbers on all nodes, including TAZs

Current Link Posting Settings

Several link posting settings have been provided for common displays (Table 40).

Table 40: Link Posting Settings

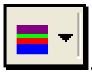
Link Posting Number	Link Posting Name	Used With	Display
1	Road Names	Any network	Road names
2	Master Lanes/Speed	Master network	Lanes and input speed in each direction
6	ADT (2-Way Total)	Output network	Daily two-way total volume and road name
7	AM Vol/VC	Output network	A.M. peak hour volume and V/C ratio
8	PM Vol/VC	Output network	P.M. peak hour volume and V/C ratio
11	Daily Count/Vol	2004 validation network	Daily traffic count and model estimate on links with counts
12	AM Count/Vol	2004 validation network	A.M. peak hour traffic count and model estimate on links with counts
13	PM Count/Vol	2004 validation network	P.M. peak hour traffic count and model estimate on links with counts

Bandwidths

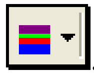
Bandwidths can be used to illustrate results by varying the line width in proportion to an attribute such as volume.

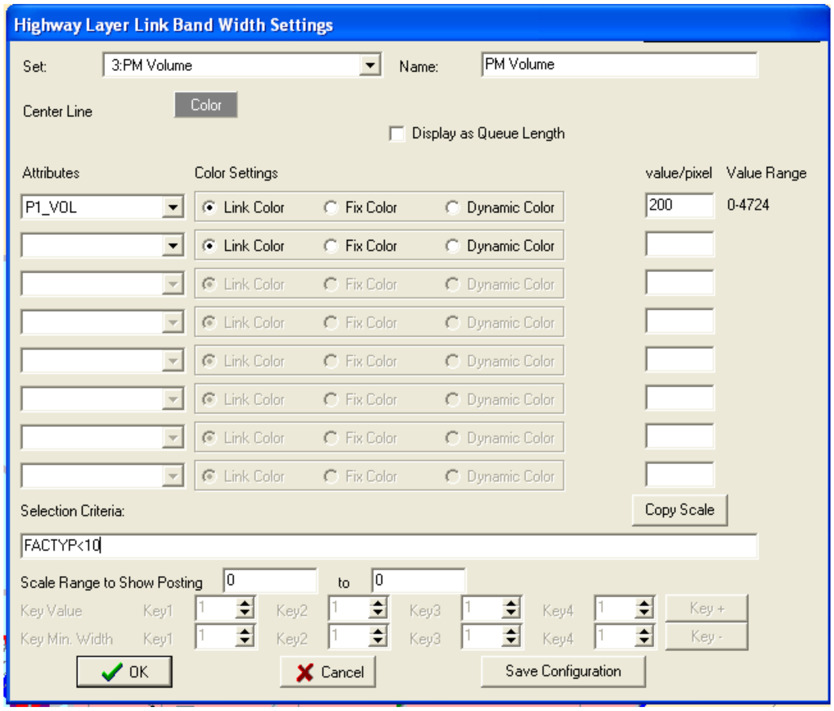
Select a Bandwidth Setting

Bandwidth settings are provided for daily volumes, A.M. peak hour volumes and P.m. peak hour volumes. These displays are particularly useful with color settings that highlight level of service.

1. Select the drop-down arrow next to the bandwidth icon .
2. Select a setting from the list.

Modify or Create a Bandwidth Setting

1. Select the bandwidth icon .
2. The Band Width Settings box will appear.

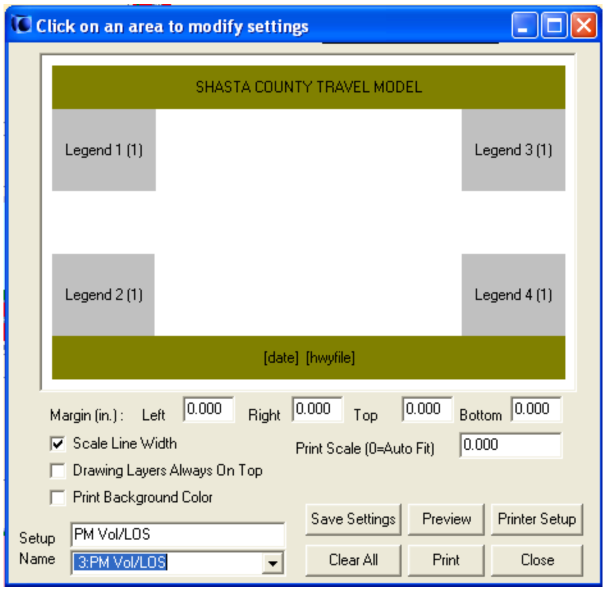


3. Select a Set you want to modify, or select an unused number to create a new set.
4. Under Attributes, select the network characteristic which will be used to set the line widths. Multiple attributes can be listed; for example, you may want to have three different colors of bands for drive alone, shared ride 2 and shared ride 3+ vehicles.
5. Set the band color to be either the Link Color set in the link color settings, or a specific fixed color.
6. In the value/pixel column, Cube will suggest a value. Try this value and see if you like the widths (after you click "OK"). If you want wider lines, go back and type in a smaller value/pixel. If you want narrower lines, type a larger number.
7. The selection criteria will only show widths for certain links. For example, FACTYP<10 will only show line widths for links which are not zone connectors.
8. Select **OK** when you like the settings. It generally takes several tries to get a good bandwidth display.

Printing Views

Printing a view of a model network is often called plotting. You can print to 8.5x11 paper in a standard printer, a large-scale plotter, or create Adobe PDF files (which in turn can be converted to JPG or PNG format for insertion in other documents).

1. Select File/Page Setup… to bring up the Page Setup box.



2. Select **Printer Setup** and select the printer (can be Adobe PDF), paper size and orientation (Portrait or Landscape).
3. Select **Close**
4. Select View/Resize to Plot Page to set your view window so WYSIWYG (what you see is what you get). The window should adjust to the orientation you selected (Portrait or Landscape).
5. Zoom to the view you wish to print or use View/Restore to retrieve a standard print view.
6. Select File/Page Setup… to bring up the Page Setup box again
7. Select one of the printer Setups provided:
   - ADT: Use with Link Color Setting 6, Link Post Setting 6 and Bandwidth Setting 1
   - AM Vol/LOS: Use with Link Color Setting 7, Link Post Setting 7 and Bandwidth Setting 2
   - PM Vol/LOS: Use with Link Color Setting 8, Link Post Setting 8 and Bandwidth Setting 3

   OR select an unused Setup number to create your own.

8. Select **Preview** to see how the print will look.
9. Click in any of the header, footer or Legend areas to change the text in those areas. The three printer Setups provided for the Shasta Model automatically include the Scenario Name in the header and the date and file name in the footer.
10. Make certain that Scale Line Width is checked if you want Bandwidths to show correctly.
11. It often takes several adjustments and Print Previews to get the print to look the way you want. When it does, select **Print**.

15. ROAD NETWORK CHANGES

The Shasta County travel model uses coded representations of the region's existing and future roadway networks. A "master network" was developed for the 2005 update of the model. The master network contains information on the years that various road improvement projects are programmed for implementation. The master network can be used to generate the model road network for any study year starting with 2004.

The elements of the road network are described on pages 17 to 20.

Which Network Should I Edit?

You can either base your changes on the Master Network or on a specific scenario network.

Master Network

Edit the Master Network (such as SH_080208.NET) if:

- You are revising a basic assumption, such as correcting the classification of a specific road
- You are making changes which apply to multiple years, such as adding a new TAZ
- You are making a permanent change to the initial assumptions for road improvements, such as updating the Regional Transportation Plan or moving a project completion date from 2015 to 2025

Scenario Network

Edit a specific scenario network (such as SH30.NET) if:

- You are doing a "what if" test for one specific year, such as testing a road widening for 2030

Editing the Network

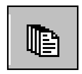
The purpose of creating a master network was to make the task of network maintenance more efficient. In the past, if a roadway network improvement was to be included in several alternatives (e.g., add a new freeway interchange to the 2010 and all future networks beyond 2010), the same network editing had to be performed individually for each of the network years. With a master network, the user need only input the improvement in one place with the appropriate year of construction and then all desired network years can be built and will be consistent.

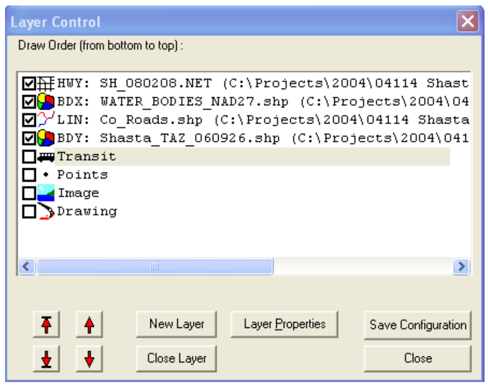
Transit Lines

It is strongly recommended to read in the transit line files whenever the master network is edited. This will ensure that the transit lines are modified along with the road network.

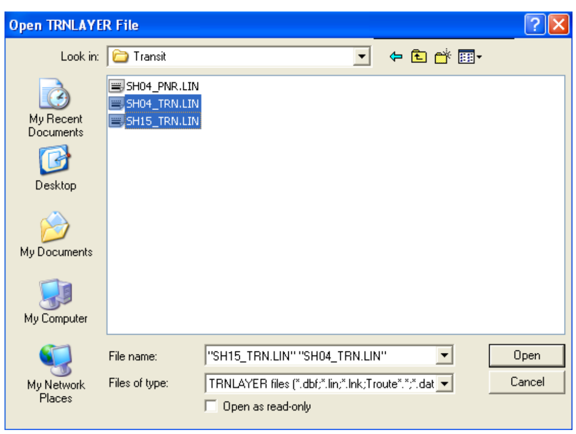
The transit line files are actually a series of nodes in the road network used by each bus or rail route. If a road link used by transit is split, a new node must be inserted in the transit line file for each transit line that uses the link. This process can be done automatically by Cube.

The following steps are used to read in the transit lines:

1. Click the Cube layer control: 
2. Select the Transit layer and click **Layer Properties**:



3. Use the **Browse** button to move to the Network\Transit directory and select the transit line files (all files ending with TRN.LIN). Click **Open**.



3. When you press "All Done", the transit lines should appear as bright thicker lines along the road network.

4. If the transit lines do not appear, use the Layer Control to move the Transit layer up above the GIS layers. You can either drag the layer names to the correct locations, or use the arrow keys below to move layers up or down.

Edits made to the road network will now modify the transit lines. However, you must be certain to save the transit lines separately when you are through editing (described below).

Types of Master Network Links

The master network must be edited differently from a single year road network. There are five basic types of links:

1. Same in Base and Future Years

A link that stays the same in the base and future years does not need any data in the IMP fields for facility type, lanes and speed.

2. Improved in Future Year

A link that is improved in the future year requires an improvement year in the IMP1_YEAR field (and the IMP2_YEAR files if there is a second round of improvements in a later year), and the improved attributes (such as additional lanes or lower speeds) should be entered in the IMP1 (and IMP2, if applicable) fields.

3. Exists in Base Year and Not in Future Year

A link may exist in 2004 but not in the future. An example would be the links that make up an at-grade intersection that will be replaced by a freeway interchange. These links require attributes in the BASE fields but not in the IMP1 fields. The IMP1_DELYR determines the year that the link is deleted.

4. Exists in Future Year and Not in Base Year

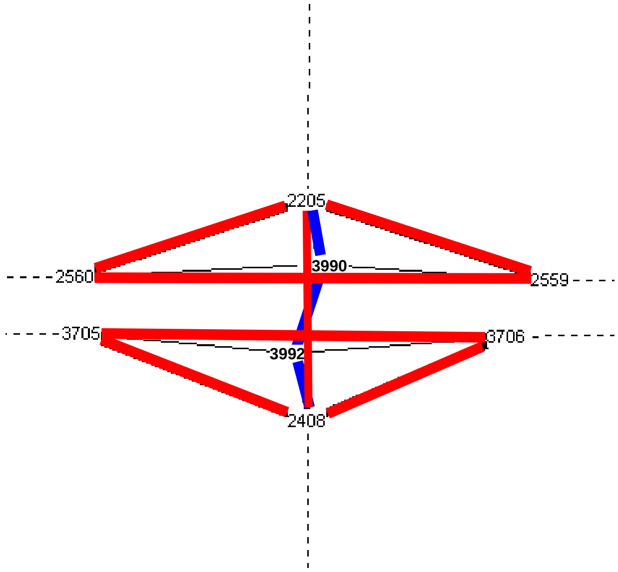
A link may be added in a future year. These links require attributes in the IMP fields but not in the BASE fields. The IMP1_YEAR determines the year that the link is added.

A link could be added in one future year and then improved in a later year. An example would be a two-lane road that is extended in 2005, and is further widened in 2015. This link would have no attributes in the BASE fields, but would have attributes in the IMP1 and IMP2 fields.

5. Exists Only in Years Between the Base and Future Years

Some links are associated with phased improvement projects, and exist only for a period of time between the base year and future year. An example would be a new connection to a highway in the year 2015 which is later replaced by an interchange in 2025 (Figure 23).

Figure 23: Example Phased Improvement Coding



Base Year Links
2559-3990
3990-2560
3705-3992
3992-3706

IMP1 Links (2015)
2205-3990*
3990-3992*
3992-2408*

IMP2 Links (2025)
2205-2408*
2559-2560
3705-3706
2559-2205
2205-2560
3705-2408
2408-3706

* = two-way link

The link representing the first improvement (in the example, the at-grade connection) would have no BASE attributes. The IMP1_YEAR determines the year that the link is added and the IMP1_DELYR determines the year that the link is replaced.

Separate links for the second improvement (in the example, any link which is part of the new interchange) would have no BASE attributes. The IMP1_YEAR would be the same as the IMP1_DELYR for the first improvement.

It may be necessary to code parallel links to represent phased projects. The ultimate link should be coded as a single link, but the interim phased link would need to be coded as two links to keep it separate from the ultimate link.

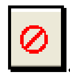
In the example, the highway is coded as two links in each direction. These links would have BASE attributes and would have an IMP1_DELYR for the year in which the interchange is constructed (2025). The initial new at-grade road connection (for example, 2205-2990) would be coded as three links with IMP1_LANES=1, IMP1_YEAR=2015 and IMP2_DELYR=2025. The interchange links would have no BASE attributes, IMP1_YEAR=2025 and the IMP1 attributes would represent the final interchange.

Network Edits

These instructions apply for editing either a Master Network or a Scenario Network.

Changes to a network might include adding links that are not already in the network, changing the number of lanes for links that are already present or deleting links that are already present.

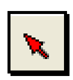
Undo

Perhaps the most important command, Cube will undo changes using the Undo on the top command bar . The Undo will not work once you have saved the revised network to disk.

Save Your Work

About every fifteen minutes, you should save the network to the disk to save the changes you have made so far. Use File/Save As…to save the network. It is recommended to use a series of temporary names (such as ALTB_Edit1.NET, ALTB_Edit2.NET, etc…) so that you can return to earlier versions of there is an error.

Move a Node

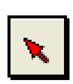
1. Click on the pointer icon 
2. Hold down the left mouse key and drag the node to the new location

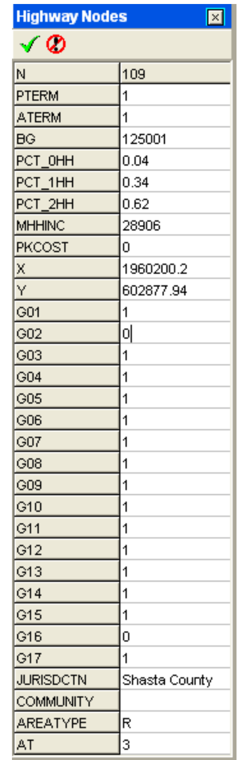
Cube will automatically change the distances of the links attached to the node when you move a node, based on the distance scale (shown under Edit/Options)

Add a Separate Node

1. Use Nodes/Add from the top menu
2. A node numbering box will appear. You can type in a node number or select from the list of unused nodes. Numbers 2,000 and below are reserved for TAZs. In general, it is best to choose a number close to the numbers of neighboring nodes.

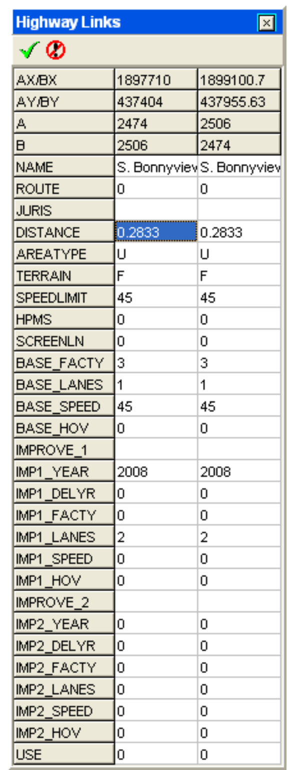
Add a Zone Node

1. Click on the pointer icon 
2. Select a zone node with similar characteristics. If you are dividing an existing TAZ, choose that TAZ.



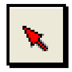
3. Use the Copy icon or Edit/Copy from the top menu.
4. Pasting in Cube is different than most Windows programs. You do not move to the location you want to paste first. Instead, you click the Paste icon or Edit/Paste from the top menu.
5. The cursor is now a cross shape. Click on the location of the new TAZ node.
6. Select a number of 2,000 or lower, preferably close to the numbers of the neighboring TAZs.
7. Click on the pointer icon and select the new node. Edit characteristics such as Jurisdiction and Community as needed (see Table 3 for reference).
8. The green check mark at the top saves edits. The red circle provides an Undo.

Change a Link



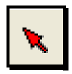
1. Click on the pointer icon
2. Select the link to change. The Highway Links window will appear. The window shows attributes for both directions of two-way links.
3. Click in any field and type in a new value. Be certain to make the changes in both directions if applicable.
4. The green check mark at the top saves edits. The red circle provides an Undo.
5. Notes on specific improvements can be input in the IMPROVE_1 and IMPROVE_2 fields.
6. You can copy text (such as street names) by double-clicking the text and then using the standard Windows <CTRL> C to copy and <CTRL> V to paste. *The Copy and Paste icons on the top menu will not work in this window.*

Move a Link

1. Click on the pointer icon 
2. Select the link to move. The Highway Links window will appear. Drag it out of the way if needed.
3. The selected link will flash and the end nodes will have red circles. Click on one of the end nodes, hold down the left mouse key, and drag the end node to the new end node.

Add a Link

Generally, the best way to add a link is to copy an existing link that is similar to the one you want to add.

12. Click on the pointer icon 
13. Select the link to copy. The Highway Links window will appear.
14. Use the Copy icon  OR Edit/Copy from the top menu OR click the right mouse button and select Copy.
15. Pasting in Cube is different than most Windows programs. You do not move to the location you want to paste first. Instead, you click the Paste icon  or Edit/Paste from the top menu.
16. Next, click and hold the left mouse button down when the cursor is on the A-node location, then drag the mouse cursor to the B-node location and release the mouse button. If the selected locations are near existing nodes, the end points of the new link will snap to these nodes.
17. If Cube does not find a node near your starting and/or end point, it will ask you to add a new node. If this is not what you wanted to do, select No or Cancel.
18. If you select Yes, a list of unused nodes will be displayed in the new node dialog box. Cube will generally suggest a new node number at the end of the current node numbering. The new node number can be selected from the list of unused nodes by double-clicking or entered manually. It is recommended to select a node number close to the nearby nodes.
19. Click on the new link and change the various link attributes to properly represent the link you are adding. Remember to change the street name in both directions!

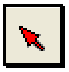
Delete a Link

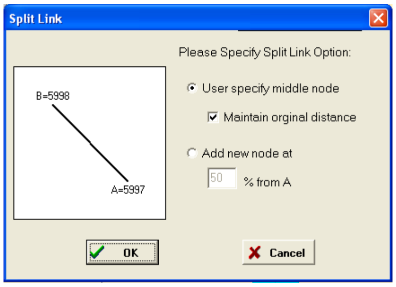
If the link is to be deleted from all study years, click on the link to select it, then press the **Delete** key.

If the link will exist and be deleted within the model time period, input the correct IMP1_DELYR.

Add a New Node on a Link (Split a Link)

If you want to add a new connection to an existing road segment, you cannot just add a new node and link in the desired location. You must split the existing segment into two segments with a new node.

1. Click on the pointer icon 
2. Select the link to split. The Highway Links window will appear. Drag it out of the way if needed.
3. Select Link/Split from the top menu, or click the right mouse button and select Split.
4. In most cases, accept the default option of User specify middle node.
5. The cursor will switch to a cross. Click on the location of the new middle node. It does not have to be directly on the link.
6. Answer "Yes" to Add New Middle Node.
7. Select a node number from the Unused Nodes.



8. There will be two links in place of the one original link. The distances will be automatically recalculated. You may wish to click on each link and make sure that the attributes are correct.

Check Your Work

Post labels such as lanes or speeds whenever you finish a short series of changes. Post in both directions. This will allow you to quickly check your work and ensure that link data has been edited in both directions if necessary.

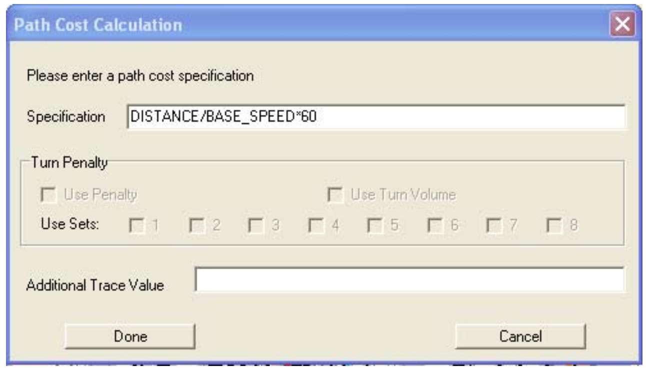
Another useful check is to add a link color setting with a very bright wide line for unrealistic values, such as speeds of 0 or greater than 70.

Paths

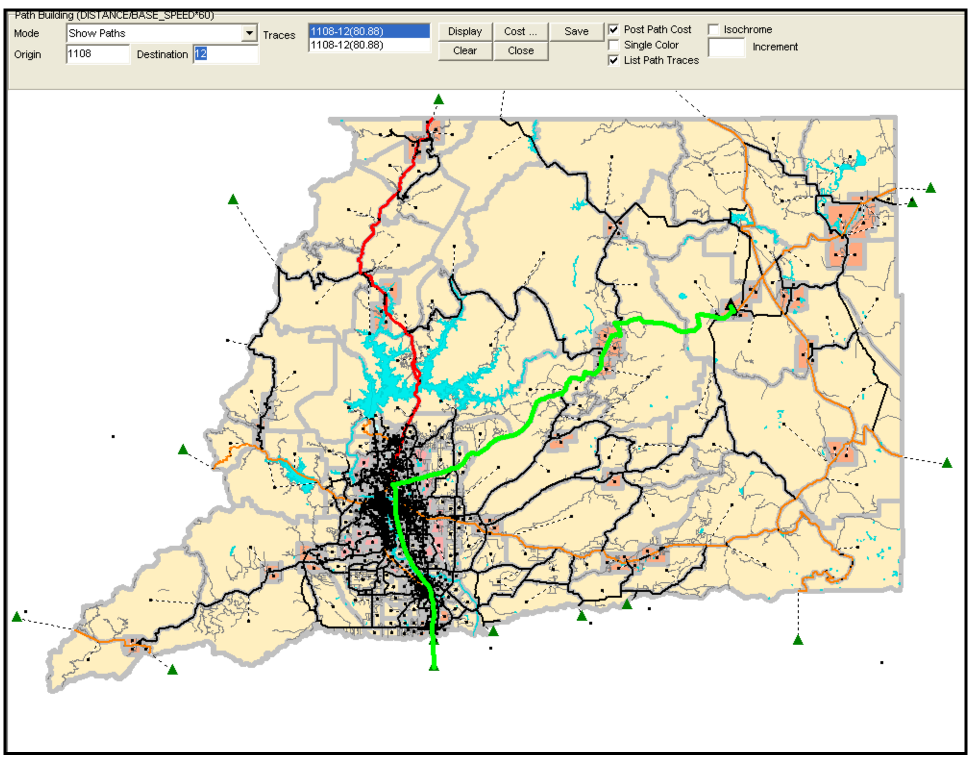
A useful way to check network revisions is to test zone-to-zone paths.

1. Select Path/Build from the top menu.

2. In the Specification window, click the right mouse button. A long list of network attributes will appear (including repeated attributes with a .R at the end which represent reverse direction attributes). Select DISTANCE.



3. Type " /" to indicate division
4. Select BASE_SPEED or SPEED.
5. Type "*60" to convert to minutes.
6. Click **Done** There may be compute errors which can be ignored (click "OK").
7. The Path Building menu will appear at the top of the Network Window. You can interactively enter Origin nodes and Destination nodes (either type numbers, or click in the window and then click a node). Click **Display** to see the selected path and determine if it is logical.

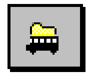


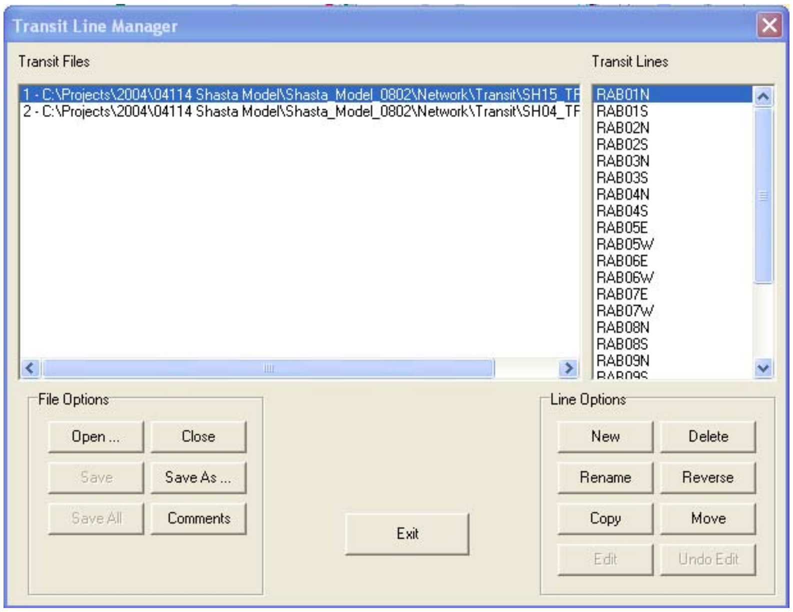
8. You can zoom in on the path and see the accumulated minutes. This information could help to spot an illogical speed or distance in the network.

Save Network and Transit Line Files

When editing is completed on the master road network, it is recommended that you save the master road network (File/Save As…) with a file name that includes the update date.

Transit line files must be saved separately using the following steps:

1. Click the Transit Line Manager Button: 
2. Select the first transit line file and click "Save As":

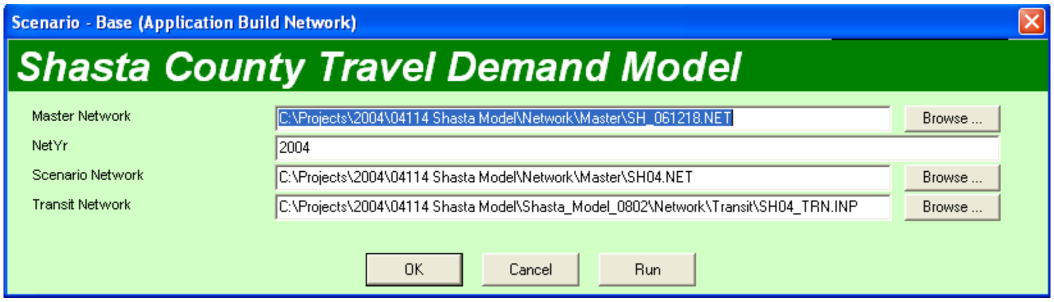


3. Select a new name (if changes are major) and save the file.
4. Repeat for each transit line file.

Create a Scenario Network

If you have edited the Master Network, you will need to create one or more scenario networks to use as input to the travel model. The scenario network will only include Master Network improvements up to a specified year.

1. Highlight the "Build Network" application in the Application Pane.
2. Double-click on any scenario in the Scenario Pane (Base will work also) and the run screen will appear.

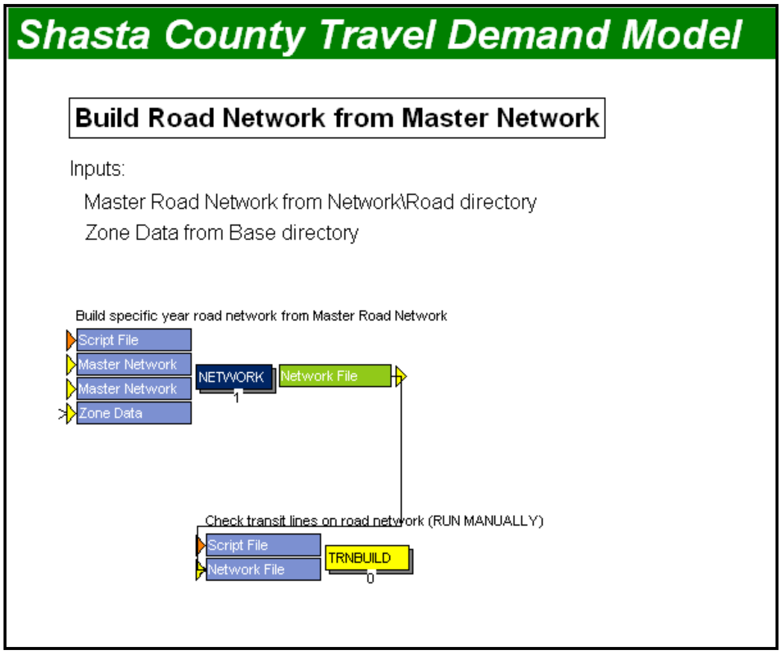


3. **Master Network:** The input Master Network will be your newly edited Master Network. **Browse** to the correct directory (usually Network\Road).
4. **NetYr:** Input the Year that your scenario network will represent.
5. **Scenario Network:** Browse to the directory for the output scenario network (usually Network\Road, the same directory as the Master Network) and type in a file name for the new scenario network. The file name does not have to match the Scenario Prefix; it could be a name such as "2015_ALTB_6-26-08.NET."
6. If you enter a new name for the Scenario Network, you will see a screen titled "Copy Scenario File." Check "Do Not Copy" and click **OK**.
7. **Transit Network:** This file is not always necessary, but can be used to ensure that the transit lines will work with your new network. **Browse** to the transit line file. In the files provided, SH04_TRN.INP is used for scenarios before 2015 and SH15_TRN.INP is used for 2015 and later. The different files are needed because some streets used by buses are scheduled to be rerouted by 2015.
8. Click **Run** to create the Scenario Network.

Check the Transit Lines

If you are going to run the Mode Choice application, it is a good idea to pretest the Scenario Network for compatibility with the transit lines.

1. Double-click Build Network in the Application Pane to ensure that the Build Network application flow chart is showing on the screen.

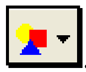


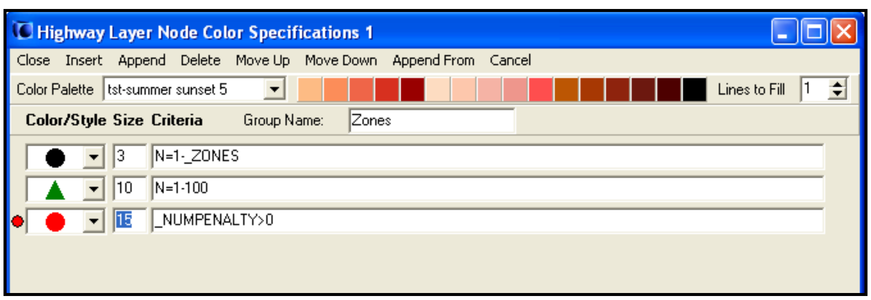
2. Double-click on the TRNBUILD box. This will run a step which attempts to build transit paths using the bus lines over the road network.
3. If there is an error in the run, it indicates that the transit lines may need to be edited for this particular scenario network. View the output printed report file and look for the errors among the listing of the transit line nodes.
4. To fix the errors, you will need to open the scenario network and the transit line layer, edit each transit line with an error listed in the output file, and save the edited transit lines with a new name. Then repeat the TRNBUILD check with the new transit line file. It may take several iterations to get rid of all errors.

Turn Penalties

Turn penalties are coded in a separate file, and can be used to identify node-to-node movements which 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.

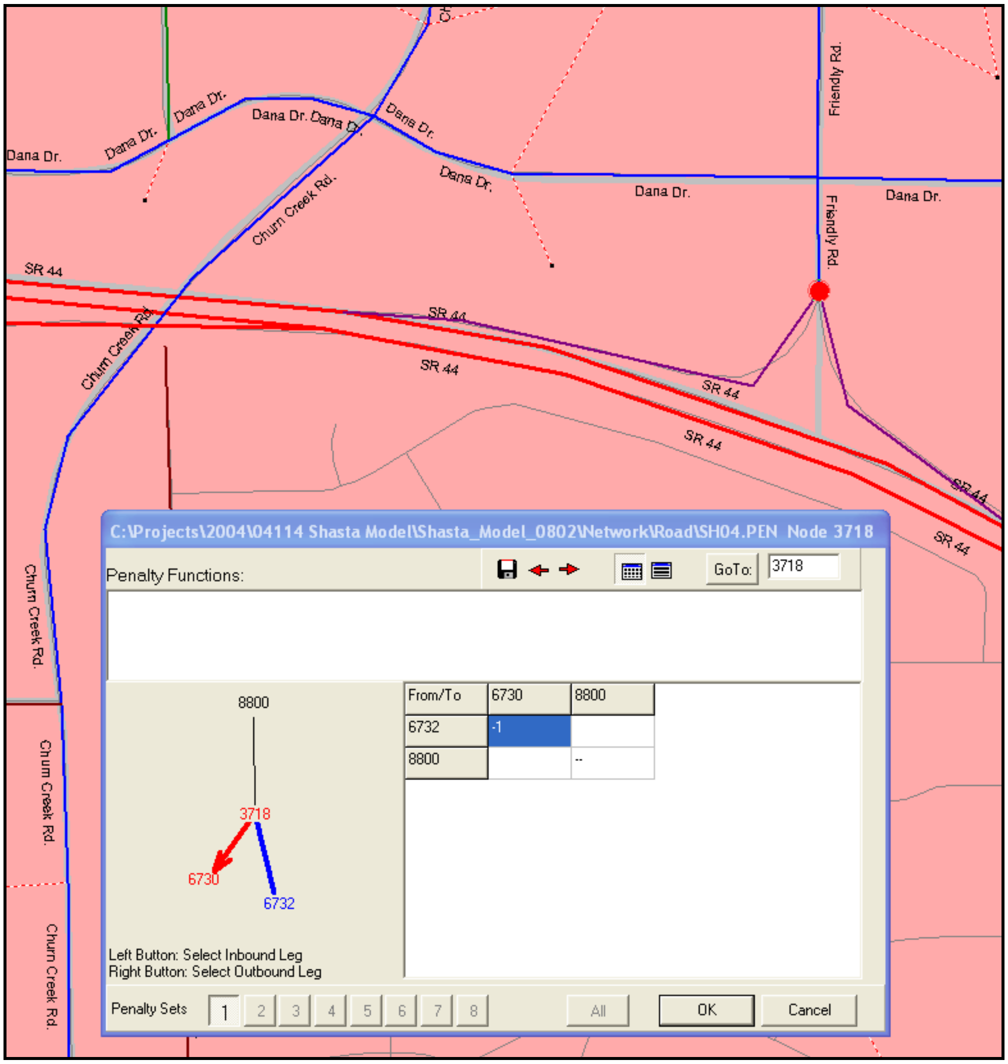
Cube or Viper can be used to view and edit turn penalty files using the following steps:

1. Use the Intersection/Open/Create Turn Penalty File menu command to read a penalty file from the Network\Road directory. The original penalty file is SH04.PEN and is used for all study years.
2. In order to see which nodes have turn penalties, you will have to modify the node color settings. View the current node color settings by clicking on the icon with the shapes . Select Append to add another setting. Choose a large bright shape, such as a red circle with a size of 15. For the criterion, select _NUMPENALTY>0 (type manually or use the right mouse button within the Criteria window) to identify nodes with penalties. Click "Close" on the top menu of the Node Color box. The nodes with turn penalties should show as large red circles.



3. Select a node from the network and press F2 (or select the Intersection/-Edit Penalty menu item) to display the penalty edit dialog box for that node (Figure 24).
4. The toolbar on top has buttons to save the penalty file, go to the previous intersection, go to the next intersection, switch grid style, and go to a particular intersection.
5. In the diagram, a blue line denotes the inbound leg, and a red line with an arrowhead denotes the outbound leg. The mouse can be used to select a particular movement on the intersection display. Use the left mouse button to select the inbound leg, and use the right button to select the outbound leg.
6. In the table, a -1 indicates a prohibited movement. You can also enter a time penalty in minutes in place of the prohibition.

Figure 24: Turn Penalty Example

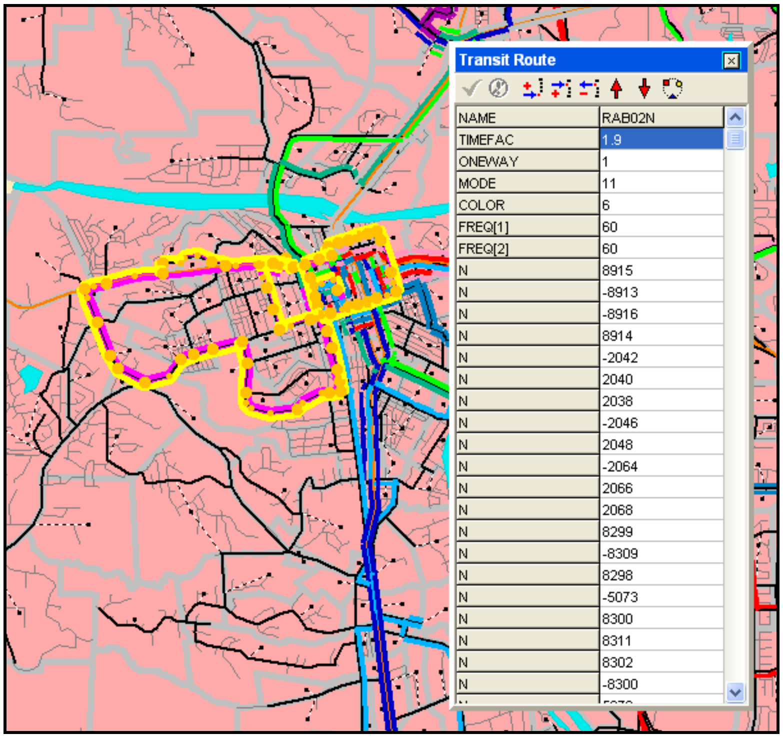


16. TRANSIT NETWORK CHANGES

The transit networks are saved as text files that list a series of nodes in the road network for each transit route. Changes to the transit network can be made in Cube or in a text editor.

Transit Line Attributes

Transit lines include the following attributes:



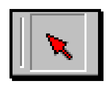
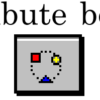
- **NAME:** The name of the transit service
- **TIMEFAC:** The factor that is multiplied by the auto time on each link to estimate the average bus speed. This can be modified for individual lines and/or for individual segments (for example, a freeway express can be assigned a time factor of 1.5 on city street links and 1.0 on freeway links).
- **ONEWAY:** 1 or 2 to indicate that the line is one-way or two-way. The Shasta County transit lines have all been coded as two one-way lines to represent the loops.
- **MODE:** The service provider. The mode is mostly used to differentiate between the type of fare. The Shasta model uses Mode 11 for RABA local bus and Mode 12 for rural transit service. Mode 13 is reserved for light rail and Mode 14 is reserved for commuter rail.

- **COLOR:** A number indicating the view color for the line in Cube. There is no guide to these colors, so they must be selected through trial and error.
- **FREQ(1)** and **FREQ(2)**: The peak period and off-peak average headways in minutes.
- **N:** The remaining lines are the series of nodes on the road network that the transit line follows. A number with no hyphen indicates a stop node, and a number preceded by a hyphen indicates a node with no stop.

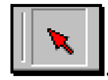
Modify a Transit Line

Transit lines can be modified using the Cube software, although some more involved changes may require manual editing of the text file.

1. Make the transit layer active using the layer control (drag the transit layer to the top line) or the window in the upper right corner:

2. Select a line for editing by using the pointer  or by selecting the line in the Transit Line Manager  and clicking "Edit." The selected line will turn yellow.
3. Attributes such as frequency can be edited in the attributes box, similar to road network editing. Be certain to edit the other direction of the line as well.
4. Changes in routing can be made by manually editing the node list in the attribute box, or by clicking the Route button at the top of the attribute box: 
5. After clicking the Route button, select a node where the edit will start. This will be indicated by a flashing circle. Click other nodes where stops will be located, and return to the original line where appropriate. The edited line will be colored purple behind the modification point and orange ahead of the modification point.
6. If you hold down the <Alt> key as you click a node, the node will be marked as a non-stop node (you should see a hyphen in front of the node number in the Transit Route box).

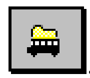
7. You may need to clean up the routing and stop nodes by manually editing the node list in the Transit Route box. There are buttons to insert, append and delete rows in the node list.

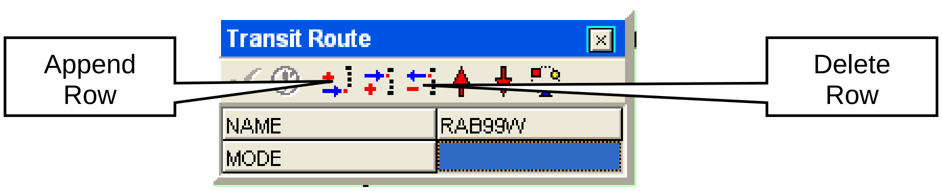
8. When editing is complete, press "Esc" or the pointer button .

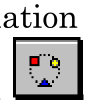
9. Use the check mark at the top of the Transit Route box to save changes, as in road network editing. However, the changes will not be saved to the file until you save the modified line files using the Transit Line Manager as described in the previous section on Road Network Editing.

Add a Transit Line

You can add a transit line by starting a new line or by copying an existing line.

1. Start with the Transit Line Manager .
2. Select **New** or **Copy.**
3. If you select Copy, first highlight a similar transit line. You will be asked which transit line file to save the new line into. This will most likely be the transit line file that you have already opened. It may be best to first make a backup copy of this file using Windows before you start.
4. Select a name for the new transit line. It will be added to the list of Transit Lines.
5. Select the new line and click **Edit**.
6. If you are starting new, you will need to use the Append Row button to add TIMEFAC, ONEWAY, COLOR, FREQ(1) and FREQ(2).



7. Once you have the basic information entered (or copied from another line), you can press the Route button  and click on nodes on the network to draw the new line.
8. Cube cannot list the same node as a stop node more than once on the same line. If you have a line that loops back on itself and has stops in both directions, you should split it into two lines, one for each direction.

17. CHANGING LAND USE

Land use assumptions are changed in the land use database, contained in an Excel workbook. The workbook also produces the trip generation inputs to the model.

Land Use Workbook Contents

The workbook contains information for any study year, but is used to generate land use and trip generation for one year at a time. When you open the file, it may be set to a particular year, such as 2030. However, by changing the year, the workbook will recalculate the information to correspond to the year you selected.

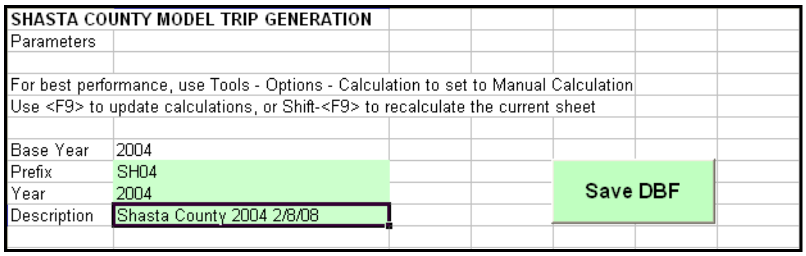
The workbook includes the following information on various sheets:

- Parameters, including the selected scenario year and the scenario description
- Land use summary for the 2004 base year and the selected scenario year
- 2004 base year land use
- Parcel-level listing of new development beyond 2004
- Growth increment by TAZ between the base year and the scenario year
- Total land use by TAZ for the scenario year
- Sources for trip generation rates
- Trip generation rates for vehicles and persons
- Special generator inputs
- External gateway inputs and adjustments
- Summary of internal and external trips
- Output files for travel model input

Create Land Use Inputs for a Scenario

These instructions assume that you are using the land use information as provided, and you need to create inputs to the travel model for a specific year.

1. Open the Excel file "SHxx_TripGen_{Date}.XLS" from the Land_Use directory.
2. Go the first sheet, "Parameters" and fill in the scenario Prefix (2-4 characters), scenario Year and scenario Description.



SHASTA COUNTY MODEL TRIP GENERATION		
Parameters		
For best performance, use Tools - Options - Calculation to set to Manual Calculation		
Use <F9> to update calculations, or Shift-<F9> to recalculate the current sheet		
Base Year	2004	
Prefix	SH04	Save DBF
Year	2004	
Description	Shasta County 2004 2/8/08	

3. Note the instructions on setting Manual Calculation. The workbook is very large and can take a long time to recalculate each time you change an entry. Manual Calculation keeps this form happening each time.
4. Save the Excel workbook. It is not necessary to use a different name if you are only specifying a scenario and year without changing other land uses. If you want a record of this specific scenario, Save As a different name. *Make certain that the Excel file is saved in the Land Use directory and NOT in My Documents.*
5. Press the **Save DBF** button which runs a "macro." The workbook automatically saves three files:
   - {Prefix}_PA.DBF: Trip generation results used as input to the model
   - {Prefix}_XX_Targets.INP: Total through trips at each gateway, used as input to the model for factoring through trips to correct values
   - {Prefix}_LU.DBF: Land use by TAZ in a form that can be viewed in GIS software (and newer versions of Cube)

   These files are saved in the Land_Use directory *as long as you have first saved the workbook in this directory*. Otherwise, Excel tends to put saved files in your My Documents directory, and you may have to find your files there using Windows Explorer.
6. The Save DBF macro also resaves the Excel workbook.

Change Land Use Inputs for a Scenario

There are several ways to change land use inputs. The preferred method is to update the Development list (LU_Development sheet in the trip generation workbook).

SHASTA COUNTY DEVELOPMENT						
ID	NAME	SOURCE	OWNER	PIN	ADDRESS	STNAME
20080	Mountain Properties	Shasta Lake	Unknown		0	N/A
20081	Mountain Properties	Shasta Lake	Unknown		0	N/A
20082	Oak Ridge	Shasta Lake	Unknown		0	N/A
20083	Lasata	Shasta Lake	Unknown		0	N/A
20084	Lasata	Shasta Lake	Unknown		0	N/A
20085	Lasata	Shasta Lake	Unknown		0	N/A
20086	Lasata	Shasta Lake	Unknown		0	N/A
20087	Winton Dr & Indian Ave	Shasta Lake	Unknown		0	N/A
20088	Shasta Gateway Industrial Park Phase I	Shasta Lake	Unknown		0	N/A
20089	Shasta Gateway Industrial Park Phase I	Shasta Lake	Unknown		0	N/A
20089	Shasta Gateway Industrial Park Phase I	Shasta Lake	Unknown		0	N/A
20089	Shasta Gateway Industrial Park Phase I	Shasta Lake	Unknown		0	N/A
20089	Shasta Gateway Industrial Park Phase I	Shasta Lake	Unknown		0	N/A
20089	Shasta Gateway Industrial Park Phase I	Shasta Lake	Unknown		0	N/A
20089	Shasta Gateway Industrial Park Phase I	Shasta Lake	Unknown		0	N/A
20090	Shasta Gateway Industrial Park Phase II	Shasta Lake	Unknown		0	N/A
20091	Shasta Gateway Industrial Park Phase II	Shasta Lake	Unknown		0	N/A
20092	Shasta Gateway Industrial Park Phase II	Shasta Lake	Unknown		0	N/A
20093	Shasta Gateway Industrial Park Phase II REMAINDI	Shasta Lake	Unknown		0	N/A
20094	Mobile Home Park Expansion	Shasta Lake	Unknown		0	N/A
20095	Poplar/Altus	Shasta Lake	Unknown	006080009000	0	N/A
20096	Shasta Way N. of Moon Shadow	Shasta Lake	Unknown	007052004000	0	N/A
20097	Pine Grove E. of Leona	Shasta Lake	Unknown	075018004000	0	N/A
20098	Pine Grove E. of Leona	Shasta Lake	Unknown	075020019000	0	N/A
20099	Pine Grove W. of Smith	Shasta Lake	Unknown	007014090000	0	N/A
20099	Pine Grove W. of Smith	Shasta Lake	Unknown	007014090000	0	N/A
20100	Black Canyon E. of Mussel Shoals	Shasta Lake	Unknown	005063001000	0	N/A
20101	Cascade/Riddle	Shasta Lake	Unknown	075006001000	0	N/A
20102	Rite Aid	Shasta Lake	Unknown		1715	Shasta St

The development list includes listings for all vacant or developable parcels provided by the cities of Anderson and Redding, specific development locations provided by Shasta Lake and Shasta County, and assumed locations of general growth in certain employment types such as health care, education and government.

Development List Fields

The development list includes a number of fields (Table 41). Only four of these are required to provide input to the model:

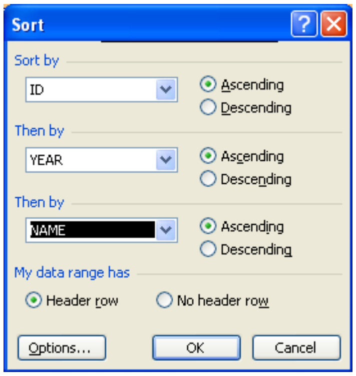
1. TAZ
2. Model Land Use Category
3. Quantity (housing units or employees)
4. Year of occupancy

Some developments may require more than one row. There should be a separate row for each land use type. If a development is going to be phased over several years, there should be a separate row for each land use type and occupancy year.

Table 41: Land Use Development Fields

Field	Description	User Input
ID	Sequential number used to resort list into original order	Optional
NAME	Development name	Optional
SOURCE	Source of development information (for, example City of Shasta Lake)	Optional
OWNER	Development owner	Optional
PIN	Assessors parcel number	Optional
ADDRESS	Address number	Optional
STNAME	Address street	Optional
X	X-Coordinate for GIS (you can use the cursor in Cube to point to the site; the coordinates are in the lower right corner of the screen)	Optional
Y	Y-Coordinate for GIS	Optional
ACRES	Parcel or site acres	Optional
AREA	Parcel or site area in square feet	Optional
TAZ	TAZ number	**REQUIRED**
RDNG_LUCLASS	City of Redding Land Use Class	Optional
RDNG_LUCODE	City of Redding Land Use Code	Optional
MODEL_LU	Model land use category (click on a cell to get a drop-down list)	**REQUIRED**
UNITS_Prop	Proposed number of residential units	Optional
SQFT_Prop	Proposed square feet	Optional
DU_ACRE	Residential dwelling units per acre (backup to Quantity calculation)	Optional
FAR	Floor Area Ratio: Ratio of building square feet to land square feet Typical Values: Retail: 0.25 Office: 0.35 Srvc Commcl: 0.15 Industrial: 0.40	Optional
EMP_KSF	Employees per Thousand Square Feet of Building Area Typical Values: Retail: 2.0 Office: 3.3 Restaurant: 6.0 Hotel: 2.0 Fast Food 12.0 Industrial: 1.0 Srvc Commcl: 1.0 Institutional: 1.0	Optional
QUANTITY	Number of residential units or employees for trip generation Can be a formula based on AREA, DU_ACRE, FAR and/or EMP_KSF	**REQUIRED**
DEV_PRIORITY	City of Redding likelihood of development (1=Most Likely)	Optional
YEAR	Year of occupancy (NOT approval or construction)	**REQUIRED**
INCLUDE	Include in current scenario	NO
COMMENTS	User comments	Optional
Pop/HH Default	Standard population per household rates	NO
Manual	USER-specified population per household rates	Optional
POP	Calculated population	NO
DU_SF, etc…	Values for each land use category to add to base year land use	NO

Sorting the List



The development list is set up so that you can use Excel functions to sort and view the information.

1. Select any cell within the list.
2. Use Data/Sort from the top menu. The Sort box will appear. The entire list should be highlighted.
3. Use the drop-down arrows to select the sorting attribute. Useful sorts include:
   - ID (to put list in original order)
   - NAME then YEAR
   - MODEL_LU then YEAR
   - TAZ then MODEL_LU then YEAR
4. The workbook will still calculate correctly no matter what order the development list is in.

Filter the List

The Excel Filter allows you to focus on specific rows without resorting the list.

1. Select any cell within the list.
2. Use Data/Filter/Auto Filter from the top menu.. The column headings should have small drop-down arrows.
3. Select a column to filter (for example, Name). A drop-down list of all Names will appear.
4. Select a value (for example, Vineyards). All rows will be hidden except for the ones containing the selected value.
5. You can filter several columns at once. For example, MODEL_LU=Office and YEAR=2030 will only show rows with office developments assumed to be occupied in 2030.

Add a Land Use

1. Open the Excel file “SHxx_TripGen_{Date}.XLS” from the Land_Use directory.
2. Select the “LU_Development” sheet.
3. Sort the development by ID number (as described above).
4. Scroll down to the UNUSED rows (starting around row 8,100).

5. Type the name of the development over the UNUSED text. *It is best not to insert new rows, and do not add to the end of the list.*
6. Type in the other required information: TAZ, MODEL_LU (drop-down list appears when you click the cell), QUANTITY and YEAR of occupancy.
7. Type in other optional fields if desired.
8. Type in information for more than one row if the development has more than one land use type, or if occupancy of a land use type will be split over several years.
9. Save the Excel workbook in the Land_Use directory with a new name.
10. Use the **<F9>** key to recalculate the workbook (may take a few minutes).
11. Follow the previous instructions under "Create Land Use Inputs for a Scenario."

Special Generators

The special generators provided with the release of the model are listed in Table 8, page 11. These can be updated or added to.

Special Generator Trip Generation

Enter average daily attendance (to be multiplied by 2 for daily person trips) or 2-way total daily vehicle trips

			Average	Total Daily	Annual	ESTIMATED TRIP PURPOSE PERCENTAGES														
		Year	Daily	Vehicle	Growth	Productions							Attractions							
Zone	Name	Opened	Attendance	Trips	Factor	HV	HSC	HS	HO	VO	OO	CV	HV	HSC	HS	HO	VO	OO	CV	TOTAL
756	Alta Mesa Park	1990		50	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
177	Anderson River Park	1990		200	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
1144	Balls Ferry Boat Ramp	1990		100	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
625	Big League Dreams	2002	900		2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
483	Buckeye Park	1990		50	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
475	Caldwell Park	1990	1000		2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
441	Cascade Park	1990		50	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
1127	Castle Crags	1990	90		2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
823	Central Valley Ball Park	1990		100	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
577	Churn Creek Open Space	1990		50	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
818	Clair Engel Park	1990		50	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
716	Clover Creek Park	1990		50	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
394	Country Heights Park	1990		50	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
435	Creekside Park	1990		50	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
766	Enterprise Park	1990	1000		2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
321	Foothill Park	1990		50	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
1197	French Gulch Park	1990	100		2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%
722	Graham Park	1990		50	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%	0%	0%	0%	100%

You can also use the Special Generator input as a way to add a specific development to the model and specify the exact number of vehicle trips it will generate.

Add a Special Generator

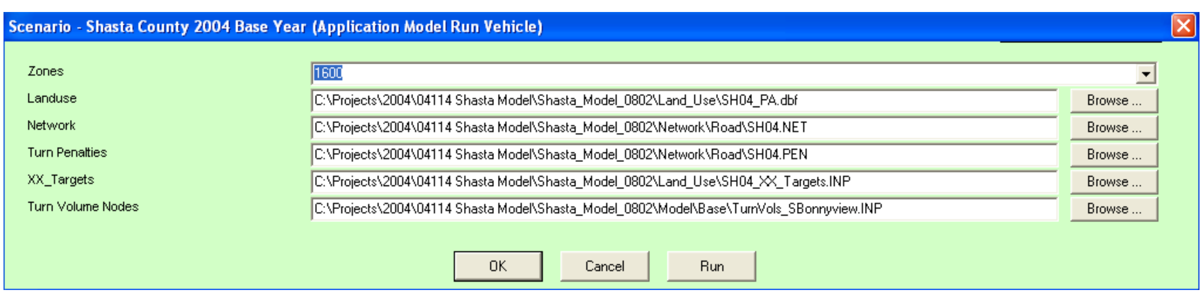
1. Open the Excel file "SHxx_TripGen_{Date}.XLS" from the Land_Use directory.
2. Select the "Spec_Gen" sheet.
3. Scroll to the first unused row.
4. Type in the Zone (TAZ), Name, and Year Opened (any year before 2004 will be included in all scenario years).
5. Enter either Average Daily Attendance (number of visitors) or Total Daily Vehicle Trips.
    - Average Daily Attendance is number of persons, NOT VEHICLES, and is multiplied by two to calculate the total trips in and out.
    - Total Daily Vehicle Trips is the two-way total, equivalent to the total number of vehicles one would observe in both directions at the driveway(s) to the site.
6. Specify trip purpose percentages adding up to 100 percent. If the Special Generator is primarily a recreational use, use the default setting of 100 percent Home-Other attractions.
7. If you are entering a non-recreational use, you will need to estimate the trip purpose percentages adding up to 100 percent. Use the rates on the "TripGen_Person" sheet as a guide.

18. RUNNING THE MODEL

When you make changes to the network and land use inputs, you do not instantly get the revised results. You must "run" the model using the new inputs. Depending on the speed of your computer, this can take about 5 to 10 minutes (for Model Run Vehicle) up to half an hour or an hour (for Mode Choice). Up to now, you have been using Cube Base only. The model run applies the Voyager/TP+ software.

Start a Model Run

1. In the Application Pane, double-click on an Application (such as Model Run vehicle). The application flow chart should appear in the Graphics Window.
2. Select a scenario by clicking its name in the Scenario Pane, and it will be highlighted.
3. **Specify Turn Movements:** For the "Model Run Vehicle" or "Mode Choice" applications, you may want to select a list of intersection nodes to save turn movements. *You must decide on the intersections before the model run.* Double click on the "Turn Volume Nodes" box at the top of the application and edit the list of nodes following the TURNS N= statement. You can use File/Save As to save a new set of intersections.
4. Double click on the Scenario and a Run Screen will appear as shown below.

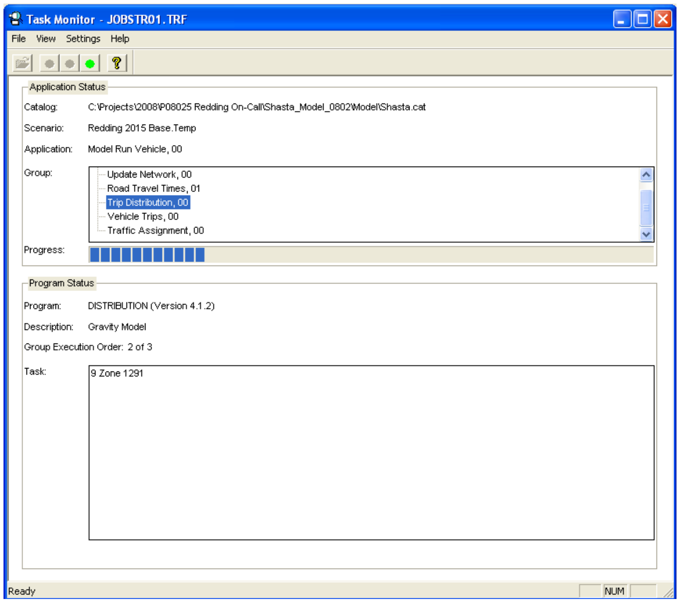


5. Choose the correct input files using the **Browse** buttons.
6. Click **Run**.

Task Monitor

When an application is running, the Task Monitor screen appears. It shows the progress of the steps in the application.

It will also show a warning if there is an error in the model run. Errors are documented in the print output file as described below.



Model Outputs

The primary model outputs are the "loaded networks" which are the network files with the assigned traffic volumes. These are shown at the ends of the Application flow charts and can be viewed by double-clicking the boxes:

- In the Model Run Vehicle application, the output network is labeled as "All Assignments" and has a file name of xxxx_VOL.NET where xxxx is the code for the scenario.
- In the Mode Choice application, the output network is labeled as "Road Network w/All Periods" and has a file name of xxxx_VOL_M.NET where xxxx is the code for the scenario.

Other outputs include:

- Interim trip matrix files from the trip distribution and mode choice steps.
- Transit line databases if Mode Choice is run.
- Printed output documenting the entire model run

Printed Output

A large text file is created by each model run. The file is placed in the \Model directory along with the catalog file (Shasta.CAT) and the script files (*.S). The print file has the name {Application}_xxxx.PRN, such as "Mode Choice_SH30.PRN."

You generally do not need to get information from the print file. It does document the date and time of all input files and model steps, and includes information on average trip lengths by trip purpose. If you know where to look (at the end of each Voyager function, using the comments in the script to locate specific matrix numbers), you can find various subtotals of person or vehicle trips by purpose and mode.

Errors

If there is an error, a screen will display a message such as "Program NETWORK failed." The only description of the error is contained in the .PRN file created by Cube.

Select "View Run Report File." Errors are identified by the symbol F(nnn). The most common errors involve selecting the incorrect directory for an input file, or forgetting to change the input file location for a new scenario.

The symbol W(nnn) indicates a warning. These may be something that should be fixed (such as turn penalties listed for nodes that do not exist in the network), but are not serious enough by themselves to stop a run. However, a long list of warnings may terminate a model run.

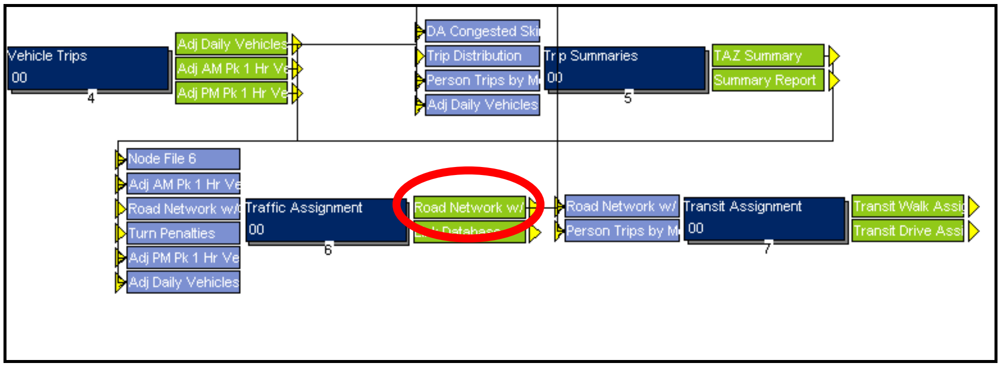
19. MODEL RESULTS

This section describes model results which can be obtained after the model is run. There are a variety of ways to review results, including Cube as well as Excel workbooks which have been customized for the Shasta County model.

Road Network Results

Many of the most useful model results can be viewed by bringing the road network into the Network Viewer.

1. If you have run the Mode Choice application, double click on the box in the lower right labeled "Road Network w/All Periods."

   OR

   Use File Open, browse to the scenario directory under Model\Base, and open the file xxxx_VOL_M.NET where xxxx is the Scenario Prefix.

2. If you have only run the Model Run Vehicle application, double click on the box in the lower right labeled "All Assignments"

   OR

   Use File Open, browse to the scenario directory under Model\Base, and open the file xxxx_VOL.NET where xxxx is the Scenario Prefix.

3. See Section 14, page 104 for instructions on viewing and printing road networks.

4. See **Table 33**, page 85 for a list of the attributes in the road network which can be used for link colors, bandwidths or labels.

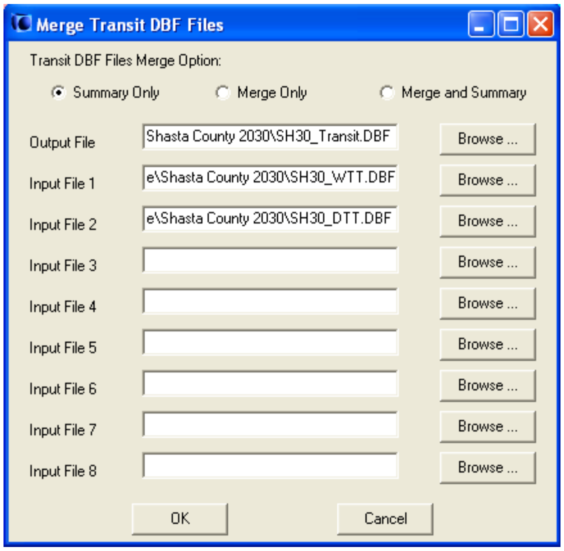
Transit Results

Viewing transit results requires a few extra steps compared to viewing road network results.

Create Summary Transit Results

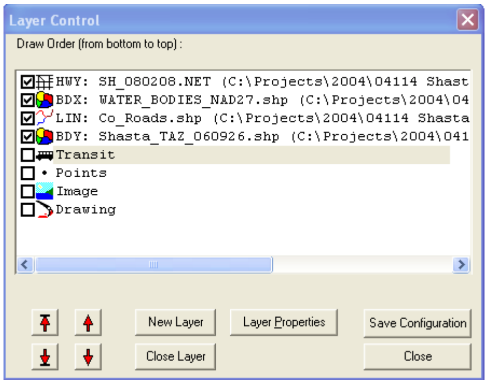
As a first step, the results for walk-access transit and drive-access transit should be summarized. The model run cannot do this step automatically.

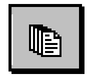
1. On the top menu, select Utilities/Merge Transit DBF…
2. On the lines labeled Input File 1 and Input File 2, use the **Browse** buttons to find the scenario directory under Model\Base and select xxxx_WTT.DBF and xxxx_DTT.DBF, where xxxx is the Scenario Prefix (such as SH30).
3. On the first line labeled Output File, **Browse** to the same scenario directory and enter a file name for the summary such as xxxx_Transit.DBF.
4. Select the "Summary Only" at the top of the screen. Click **OK**. This will create a combined transit results file.



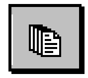
Read in the Summary Transit Results

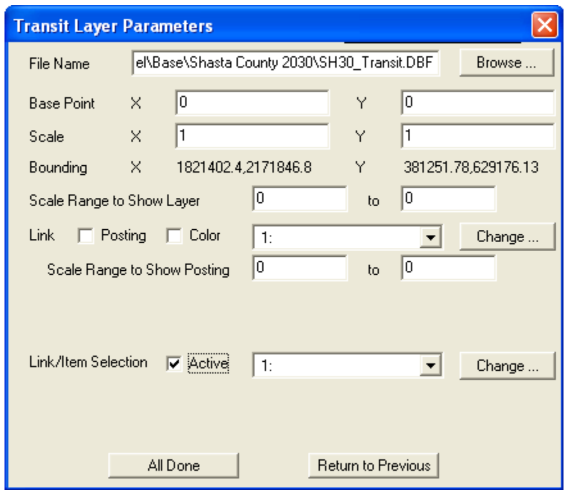
1. Click the Cube layer control: 
2. Select the Transit layer and click **Layer Properties**.
3. Use the **Browse** button to move to the scenario directory and select the combined transit results file.
4. Click **Open**.
5. When you click **All Done**, the transit lines should appear as bright thicker lines along the road network. There may also be a spider web of walk and drive connectors.



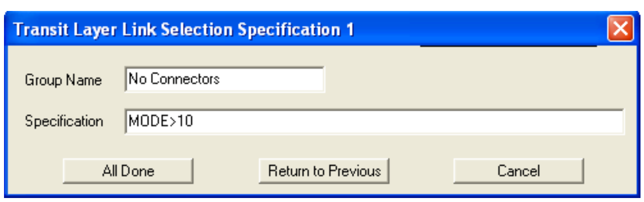
6. If the transit lines do not appear, use the Layer Control  to move the Transit layer up above the GIS layers. You can either drag the layer names to the correct locations, or use the arrow keys below to move layers up or down.

Hide the Transit Walk and Drive Connectors

1. To get rid of the "spider web," open the Layer Control  ,highlight the TRN transit layer and click **Layer Properties**. Check the box near the bottom titled Link/Item Selection and Active. Select **Change...**.

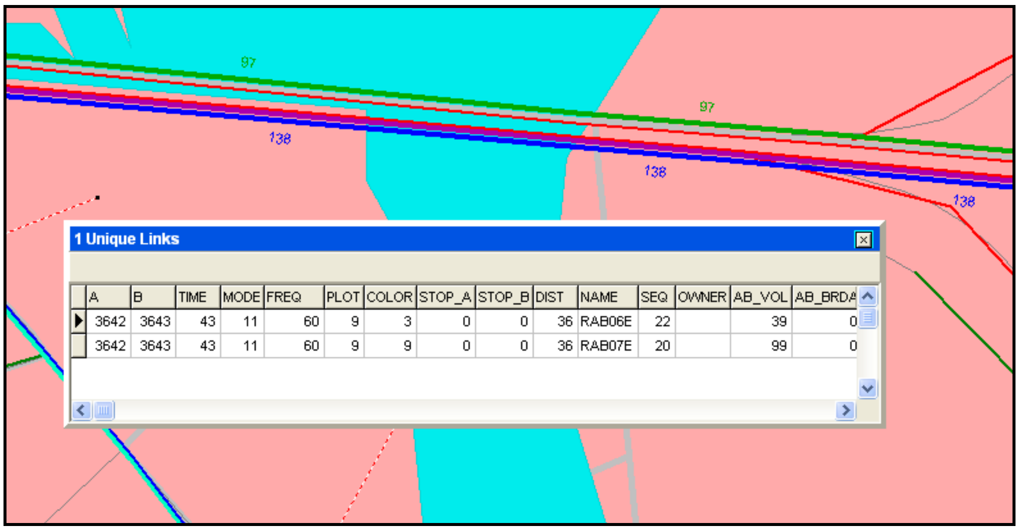


2. In the Transit Layer Link Selection Specification screen, type a Specification of MODE>10 and optionally type a Group Name such as "No Connectors." Click **All Done**. The spider web should disappear and you should see the transit lines next to the road links.



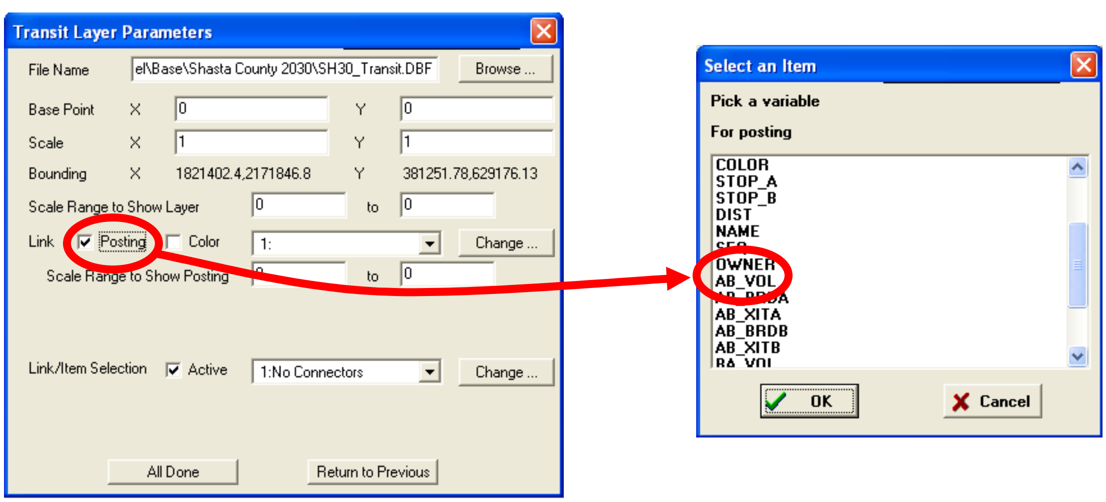
View Transit Results

1. To view information on a specific link, zoom in and use the pointer to select a *road* link (pointing right at the transit lines won't work). A box should appear listing information about each of the transit lines on that link. The most useful information is the NAME of the line and the AB_VOL (daily ridership) on the line.



2. You can also post ridership information on the lines. Click the Cube layer control , select the Transit layer and click **Layer Properties**.

3. On the line labeled Link, check Posting. A Select box will appear. Select AB_VOL.



4. The total ridership on each link will appear as labels on the links. In the example above, Route 6 eastbound (RAB06E) carries 39 and Route 7 eastbound (RAB07E) carries 99 for a total of 138.

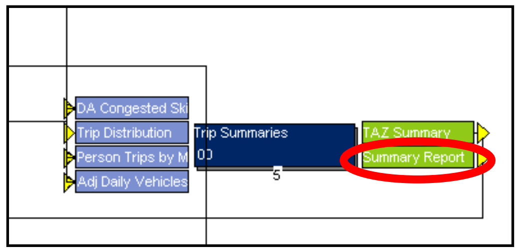
5. Labeling the NAME does not work in the version of Cube used for development of the Shasta Model (it labels with zeros). This may be corrected in later releases.

Measures of Effectiveness

There are two places where countywide measures of effectiveness (MOE) are reported. The Mode Choice application automatically produces a small report of trip-based MOEs such as trip lengths and mode shares. Network-based MOEs such as vehicle-miles and delay are compiled using an Excel workbook.

Trip Measures

A summary of trip-based MOEs is produced by the Mode Choice application (Figure 25). To see this summary, double-click on the box labeled Summary Report in the lower right portion of the Mode Choice application flow chart.



The summary is actually an Excel workbook titled xxxx_Summary.XLS (where xxxx is the Scenario Prefix such as SH30). It can be found in the scenario directory under \Model\Base. The information can be pasted into other documents.

Figure 25: Example Trip Measures Summary

```
-----------------------------------------------------
Summaries for Scenario Shasta County 2030
-----------------------------------------------------
Average Trip Length, Time, Minutes
---------------------------------------
     22.23  Home-Work
     23.64  Home-School
     16.45  Home-Shop
     18.39  Home-Other
     22.31  Work-Other
      8.32  Other-Other
     30.03  Commercial Vehicles
     15.74  All Trips
---------------------------------------
Average Trip Length, Distance, Miles
---------------------------------------
     16.17  Home-Work
     18.77  Home-School
     11.21  Home-Shop
     13.09  Home-Other
     16.94  Work-Other
      3.99  Other-Other
     24.45  Commercial Vehicles
     10.74  All Trips
---------------------------------------
Mode Shares
---------------------------------------
     44.34  Percent Drive Alone
     52.64  Percent Shared Ride
      0.13  Percent Transit
      2.90  Percent Walk/Bike
```

Network Measures

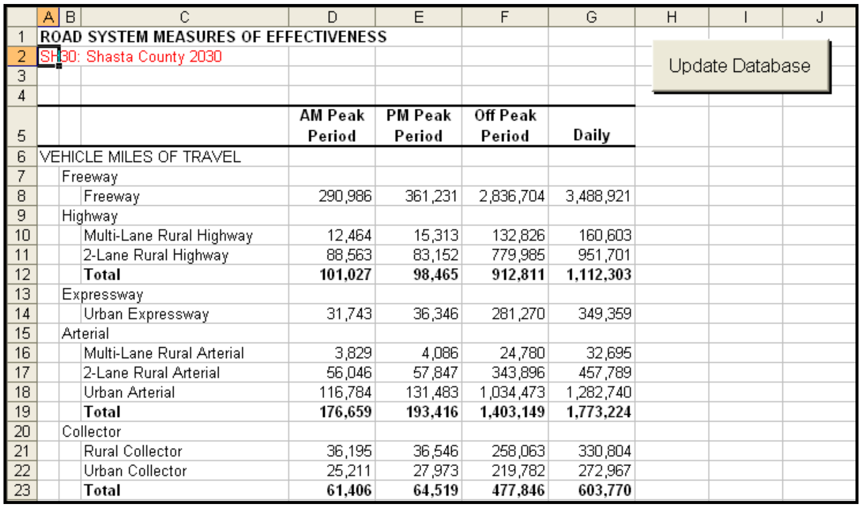
Network measures of effectiveness (MOE) are compiled using an Excel workbook. The workbook lists separate MOEs for each road type and a summary for all road types. The MOEs in the workbook include:

- Vehicle miles of travel
- Vehicle-hours of travel at free-flow speeds
- Average speeds at free-flow speeds
- Vehicle-hours of travel at congested speeds
- Average speeds at congested speeds
- Vehicle-hours of delay at congested speeds

Other measures could be calculated from the link data on the second sheet of the workbook using similar Excel tabulation formulas.

Using the MOE Workbook

1. Use Excel to open one of the workbooks in the Reports directory titled MOE_xxxx.XLS where xxxx is the Scenario Prefix such as SH30.
2. If you get a Security Warning, click **Enable Macros**.
3. Click on the sheet “Measures.”



	A B C	D	E	F	G	H
1	ROAD SYSTEM MEASURES OF EFFECTIVENESS					
2	SH30: Shasta County 2030					Update Database
3						
4						
5		AM Peak Period	PM Peak Period	Off Peak Period	Daily	
6	VEHICLE MILES OF TRAVEL					
7	Freeway					
8	Freeway	290,986	361,231	2,836,704	3,488,921	
9	Highway					
10	Multi-Lane Rural Highway	12,464	15,313	132,826	160,603	
11	2-Lane Rural Highway	88,563	83,152	779,985	951,701	
12	**Total**	**101,027**	**98,465**	**912,811**	**1,112,303**	
13	Expressway					
14	Urban Expressway	31,743	36,346	281,270	349,359	
15	Arterial					
16	Multi-Lane Rural Arterial	3,829	4,086	24,780	32,695	
17	2-Lane Rural Arterial	56,046	57,847	343,896	457,789	
18	Urban Arterial	116,784	131,483	1,034,473	1,282,740	
19	**Total**	**176,659**	**193,416**	**1,403,149**	**1,773,224**	
20	Collector					
21	Rural Collector	36,195	36,546	258,063	330,804	
22	Urban Collector	25,211	27,973	219,782	272,967	
23	**Total**	**61,406**	**64,519**	**477,846**	**603,770**	

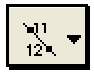
4. Click the **Update Database** button and click **Yes**.
5. A file box will appear asking you to select a data file. Browse to the scenario directory under Model\Base and select the file xxxx_VOL_M.DBF where xxxx is the Scenario Prefix such as SH30. Click **Yes** and **OK**.
6. The results can be printed or copied from the “Measures” sheet.

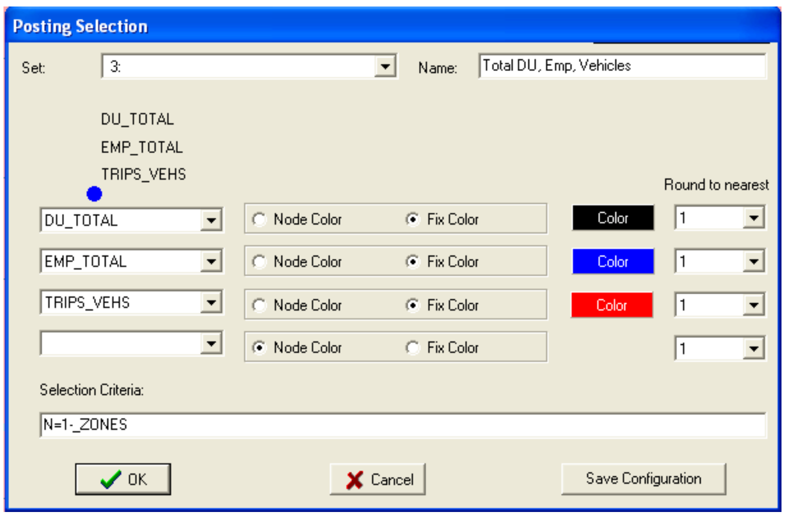
TAZ Reports

Results for TAZs can be viewed in several ways. The results can be posted on TAZ nodes, or Cube can create charts for TAZ nodes, or Cube has limited GIS display features (in the release used to create the Shasta County model) to create color TAZ maps.

TAZ Labels

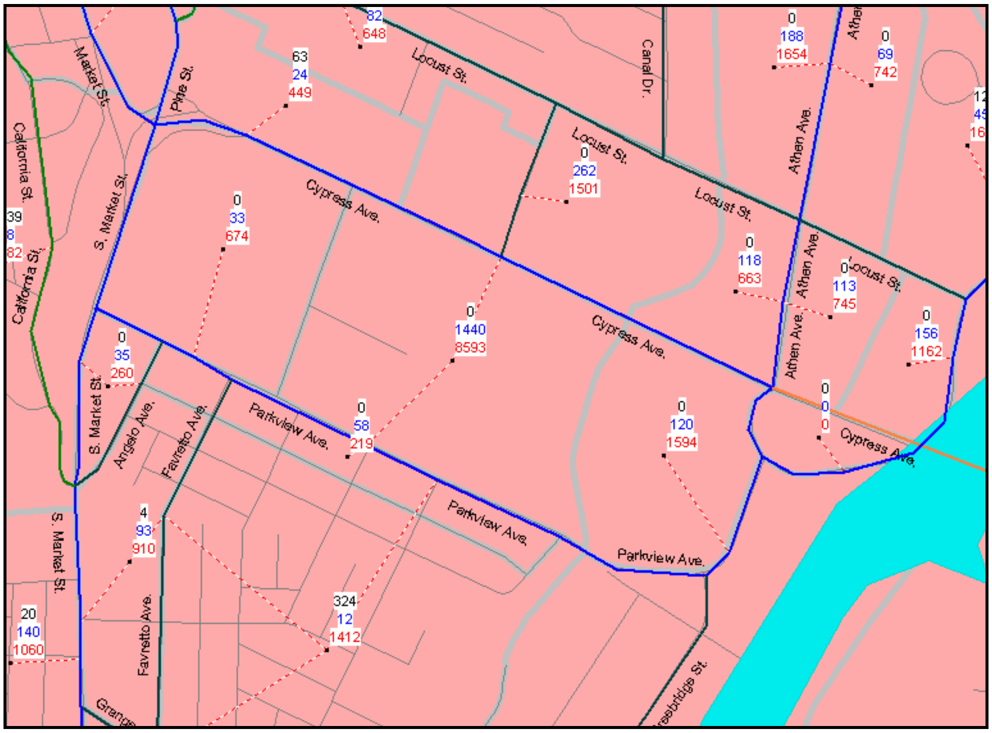
Labels on TAZs show specific values but do not by themselves provide graphical color displays of TAZ information. The list of all available TAZ attributes is in Table 34 on page 88.

1. Use the drop-down arrow next to the Post Node icon  and select an *unused* setting.
2. Click the Post Node icon.



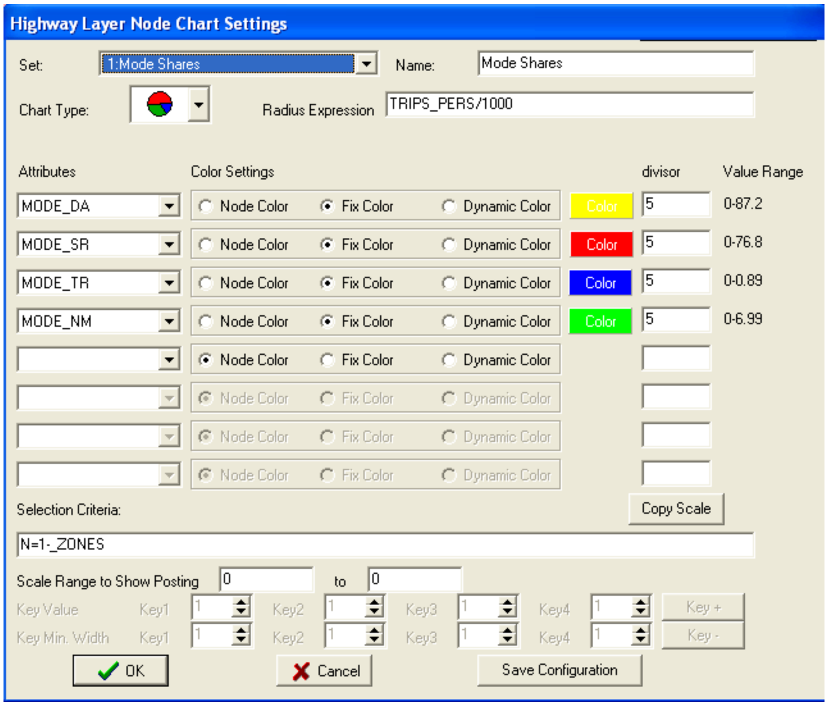
3. Fill in a Name for your setting, if desired.
4. Use the first drop down to select an attribute to post.
5. If you are posting multiple attributes, it is a good idea to set a Fix Color for each different attribute so you can tell them apart in the display.
6. Add the selection criteria N=1-_ZONES so that only TAZs will be labeled.
7. Click **OK**.

Figure 26: Example TAZ Labels



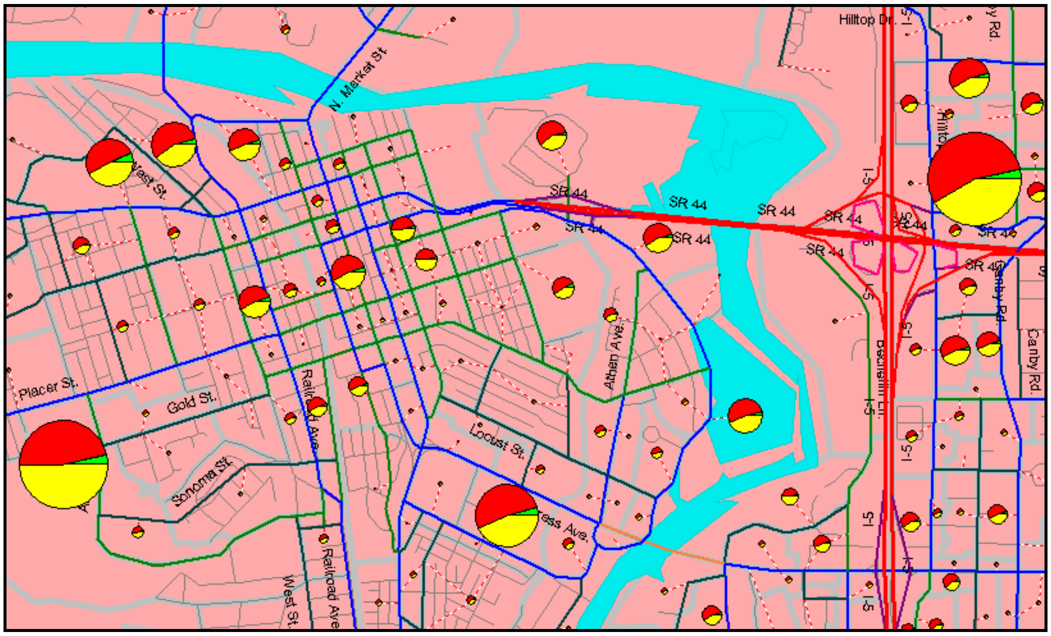
TAZ Charts

1. Select Post / Node/Point Chart… from the top menu



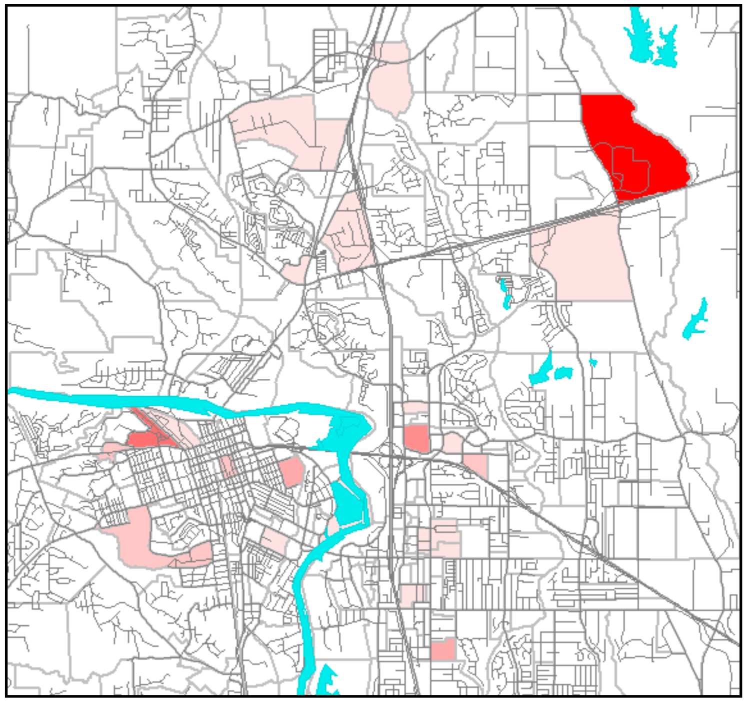
2. Fill in a Name for your setting, if desired.
3. Input a radius expression if you want the charts to be different sizes according to an attribute. The units are in pixels. This usually takes several trial-and-error attempts to get the symbols to be the right sizes. If you leave this blank, Cube will do the same standard size chart for each TAZ.
4. Use the first drop down on the left side to select an attribute to chart.
5. If you are posting multiple attributes, it is a good idea to set a Fix Color for each different attribute so you can tell them apart in the display.
6. If you want a comparative chart, change the "divisors' so that they are the same for each attribute. This is also a trial-and-error process.
7. Add the selection criteria N=1-_ZONES so that only TAZs will be labeled.
8. Click **OK**.

Figure 27: Example Node Chart



Cube offers bar chart options as well as pie charts. However, values cannot be labeled when the charts are turned on.

Thematic Maps

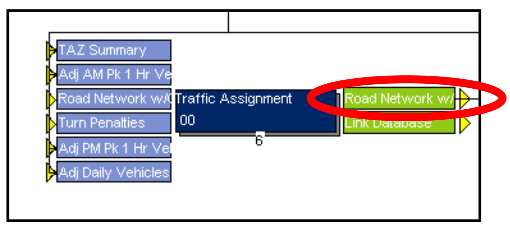


Cube can generate color maps using shapes from a GIS "polygon" or "boundary" file. For the Shasta County model, the most likely map for this purpose would be the TAZ map.

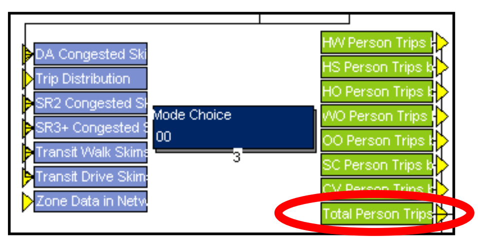
Thematic maps can only be based on attributes from the following (in the version of the Cube software used for the Shasta County model):

- Attributes that are already in the GIS file. The GIS files provided with the Shasta County model, such as the TAZ map, do not contain numerical data useful for mapping. However, additional GIS files can be created using GIS software by merging the TAZ file with other data files.
- Totals from a TAZ matrix, such as person or vehicle trips. However, the maps can only be based on one-way totals (such as Trips Out or Trips In) and not total two-way trips.

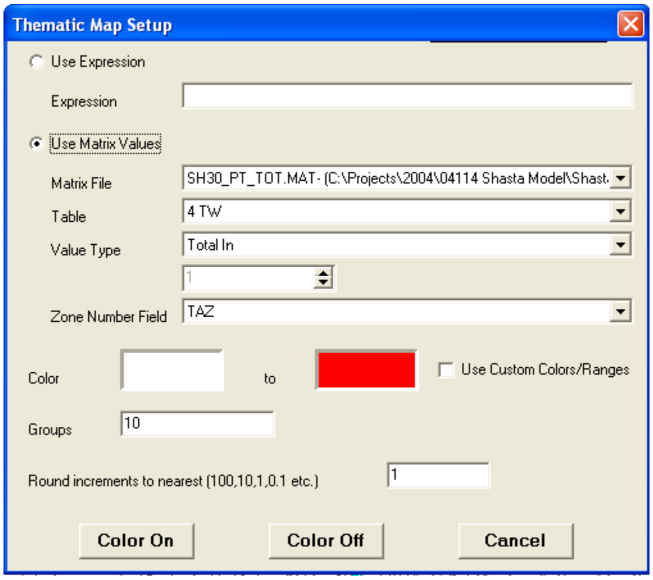
Later releases of Cube may provide more capabilities for mapping. The instructions below pertain to Version 4.



1. Open a result network by double-clicking on the appropriate box in the lower right portion of the Model Run Vehicle or Mode Choice applications.
2. Open a matrix with values which are of interest by double-clicking on the box in the flow chart. In the example, the total person trips by mode are selected. Answer "Yes" to the prompt.
3. Use the Window command on the top menu to go back to the network view.
4. Select Node/Link to Matrix… from the top menu.



5. Highlight the file name in the "Available Linkage" box and click **Add**, then **Close**.
6. Select Post/Thematic Map from the top menu.
7. Select the Shasta_TAZ… file and click **OK**. The Thematic Map Setup will appear.

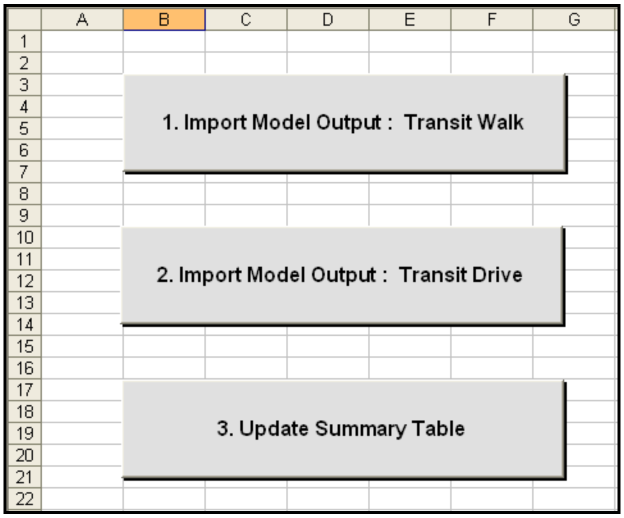


8. On the Thematic Map Setup, select Use Matrix Values.
9. For Table, select the values you want to use for your map. In the example, the selected values are Transit Walk Access trips (TW).
10. For Value Type, select Total Out or Total In.
11. For Color, it is recommended that the first color be changed to a light value or white. Double-click on the square to select a new color.
12. Click Color On. The example above produces the map shown at the beginning of this section, which highlights TAZs with high numbers of transit destinations.
13. You may want to use the Layer Control to change (or turn off, as in the example) the Highway Layer and to change the boundary settings for the TAZ layer.
14. On the Thematic Map Setup, you can click "Use Custom Colors/Ranges" and use trial and error to test various settings.

Transit Reports

An Excel workbook has been set up to summarize transit ridership by route.

1. Use Excel to open one of the workbooks in the Reports directory titled Transit_Sumary_xxxx.XLS where xxxx is the Scenario Prefix such as SH30.
2. If you get a Security Warning, click **Enable Macros**.
3. Click on the sheet "Control Panel."



4. Click the **1. Import Model Output: Transit Walk** button and click **Yes** to delete.
5. A file box will appear asking you to select a data file. Browse to the scenario directory under Model\Base and select the file xxxx_WTT.DBF where xxxx is the Scenario Prefix such as SH30. Click **OK** and **Yes** and **OK**.
6. Click the **2. Import Model Output: Transit Drive** button and click **Yes** to delete.
7. A file box will appear asking you to select a data file. Browse to the scenario directory under Model\Base and select the file xxxx_DTT.DBF. Click **OK** and **Yes** and **OK**.
8. Click the **3. Update Summary Table** button, answer **OK** twice.
9. On the Model Output Selection screen, select the only available choice for each drop-down and then **Confirm**. Click **Yes** and **OK** until the macro ends.
10. The results are on the LineReport sheet.

Select Link

Select link and select zone are special versions of traffic assignment. If you specify a select link, the origin and destination TAZs for traffic through that link will be stored as an output, as well as the paths to and from those TAZs. The typical outputs from select link analysis are:

- Map (plot) of traffic passing through the select link
- TAZ-to-TAZ matrix of origins and destinations for traffic through the select link.

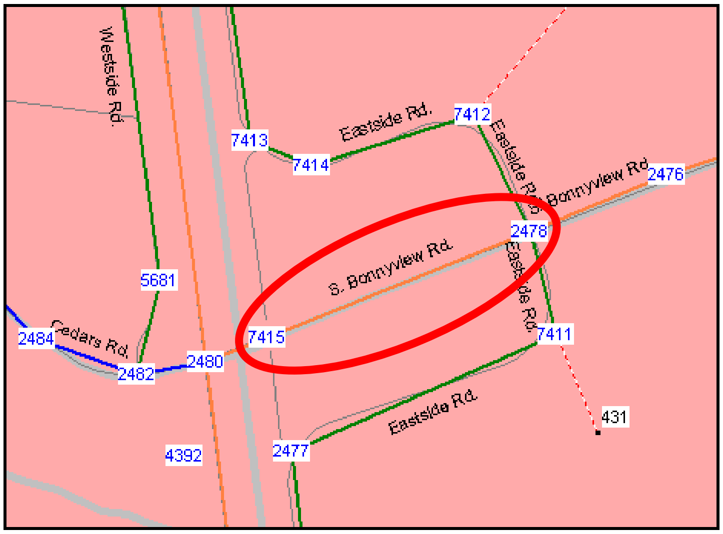
The select link matrix is often compressed to summary districts. For example, all TAZs outside Shasta County could be grouped in a district titled "External." Trips from the "External" district to the "External" district would be through trips.

Select zone is a version of select link where the select links are all of the zone connectors for a certain TAZ or group of TAZs. The select link assignment then reports on the origins and destinations of all trips to and/or from those TAZs. This is useful for identifying trip distribution or for tracing traffic for fee allocation studies.

Run Select Link in Cube

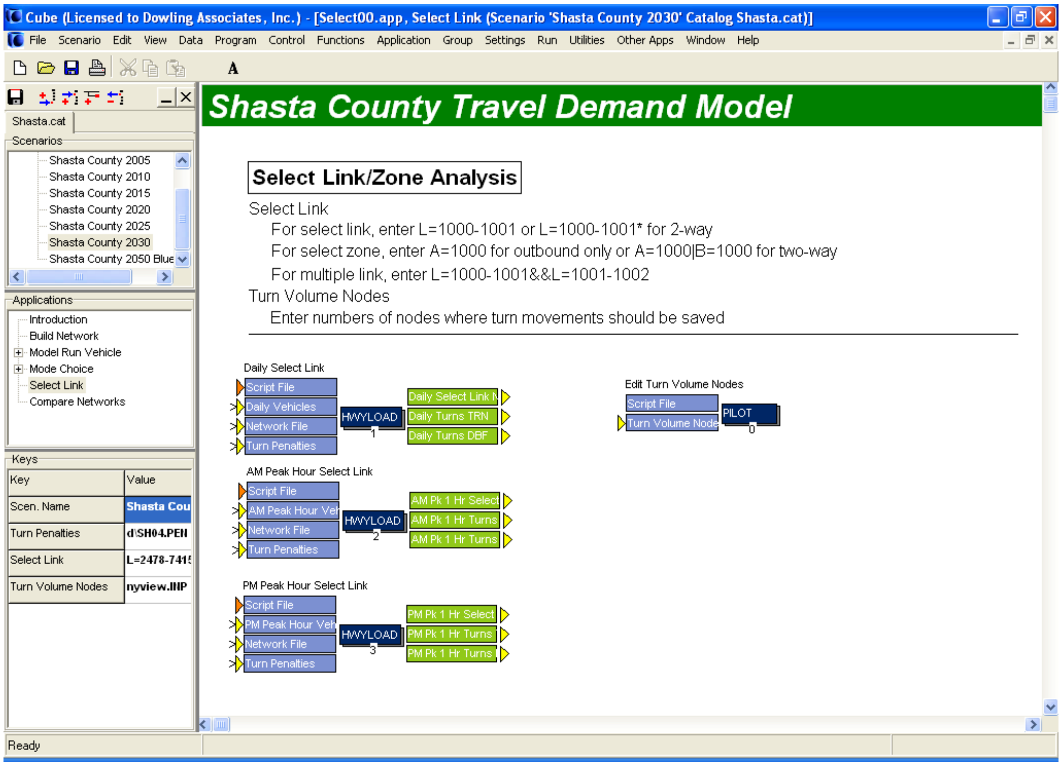
The Select Link application can only be run after the Model Run Vehicle application has been completed.

1. View a scenario or output network and zoom to the area of interest.
2. Select Post Node Setting 2 to show all node numbers.

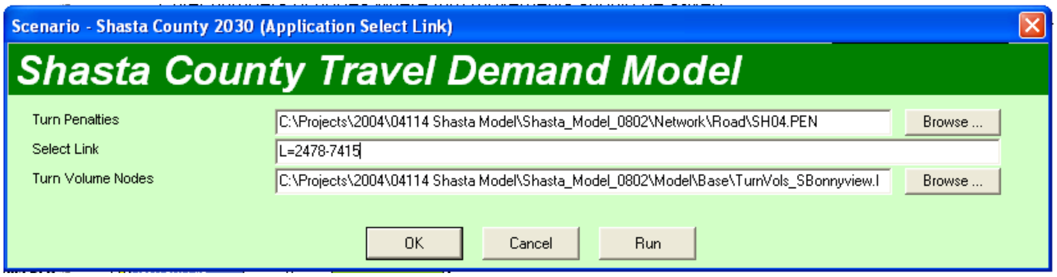


3. Write down the node numbers for the link you want to analyze. If you want to know about westbound South Bonnyview Road east of SR 273, the link would be 2478-7415 (not 7415-2478).

4. In the Cube Application Pane, double click on Select Link. The application flow chart should appear in the main window.



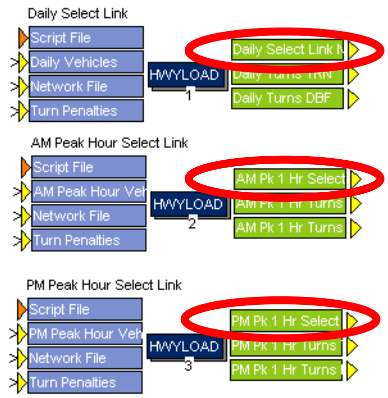
5. In the Cube Scenario Pane, double-click on the scenario you want to run. A run screen should appear



6. Browse to the Turn Penalties file (generally found in Network\Road). This will typically be the same file that was used for Model Run Vehicle.
7. Enter the Select Link information starting with “L=.”
8. Browse to the Turn Volume Nodes file, typically found in \Model\Base. Before starting the Run, you can double click on the box in the application flow chart if you want to change the intersection numbers.
9. Click **Run**. The model will rerun the traffic assignments for the three time periods.

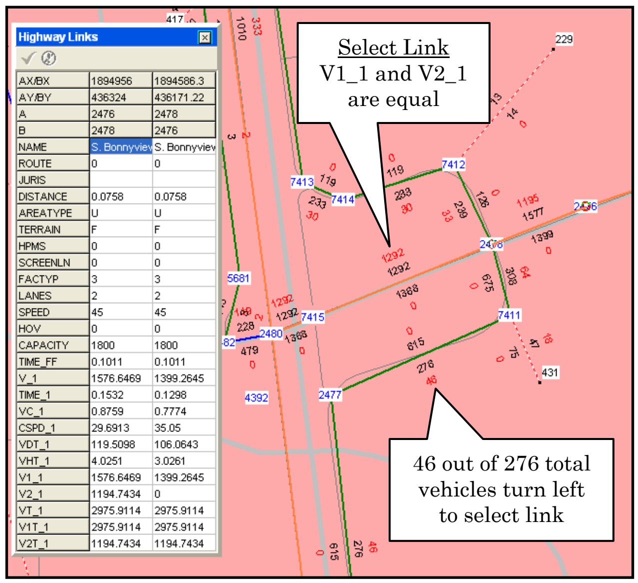
View Select Link Results

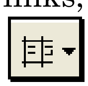
The most useful ways to view select link results are to label the links and also use bandwidths.

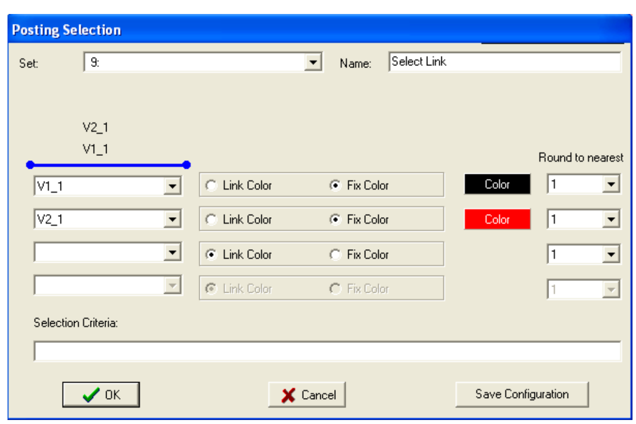


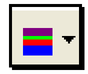
1. In the Select Link application flow chart, double click on the top output box for the time period you are interested in.
2. Zoom to the area you are interested in.
3. Use the pointer to click on a link. A link attribute box will appear.
4. The important new attributes are towards the bottom.
   - V1_1 is the total assigned traffic on the link, and should be identical to the original assignment from Model Run Vehicle.
   - V2_1 is only the traffic that uses the select link.

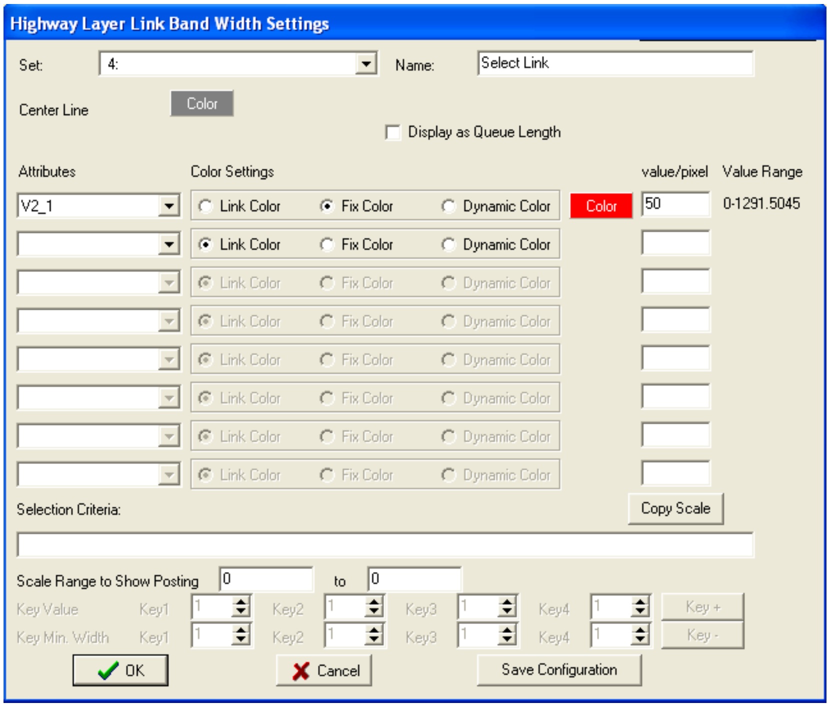
   On the select link itself, V2_1 should be identical to V1_1. On all other links, V2_1 should be less than or equal to V2_1.



5. **Labels:** To label the links, click the Post Link icon  to bring up the Posting Selection.
6. Scroll down to select an unused Set and optionally enter a new Name for the settings.
7. Use the drop-down boxes to select V1_1 and V2_1 as attributes.
8. Set Fix Color so you can tell the two volumes apart.
9. Click **OK**.



10. **Bandwidths:** Bandwidths help to visualize the origins and destinations through the select link. Click the Band Width Settings icon  to bring up the Posting Selection.



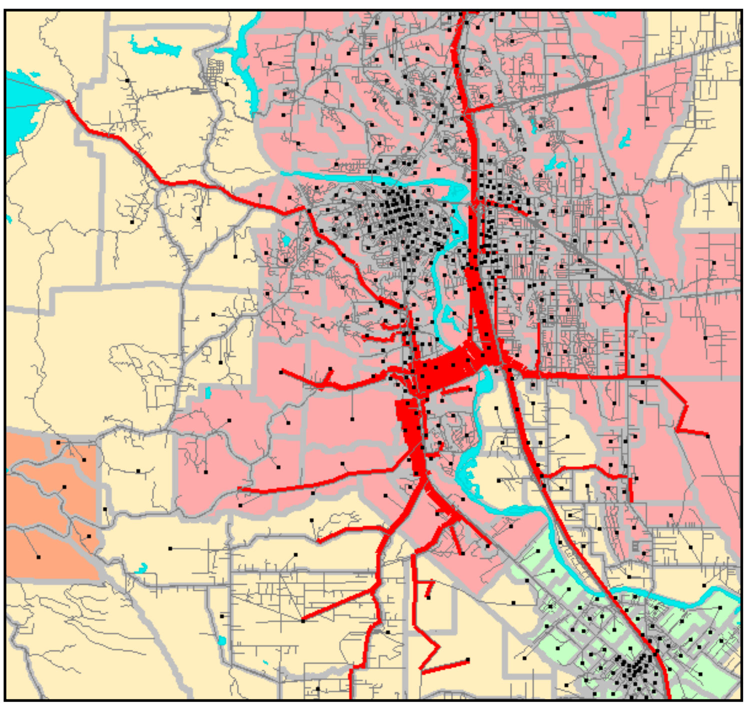
11. Scroll down to an unused Set and optionally enter a new Name for the settings.

12. Use the drop-down box to select V2_1 as attributes.

13. Set Fix Color if you decide to do bandwidths for more than one attribute so you can tell the two volumes apart.

14. Click **OK**.

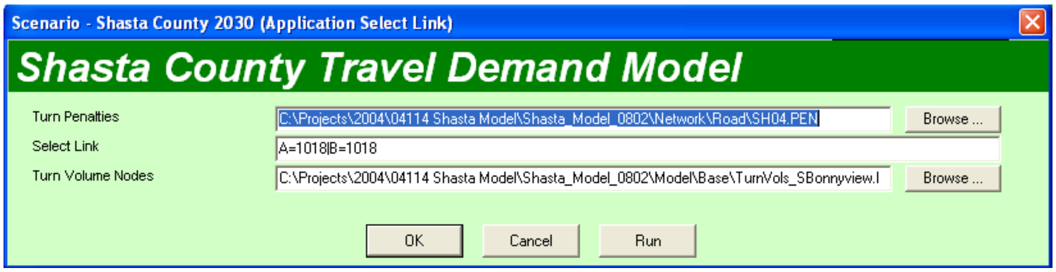
15. The bandwidths and labels can be used at the same time, but may only look good at closer zoom levels.



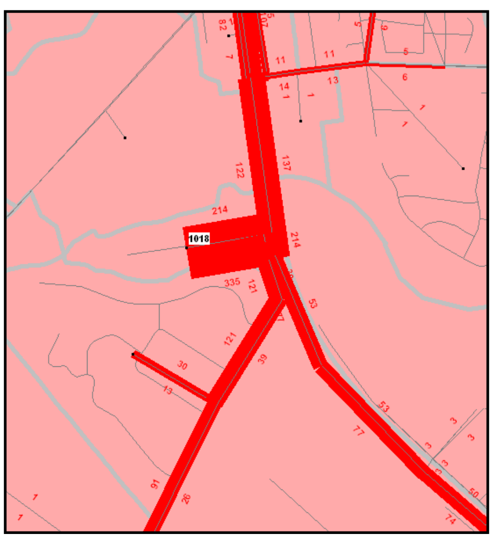
Select Zone

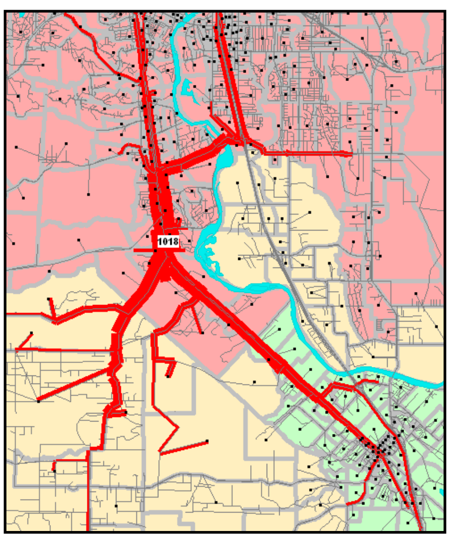
Select Zone identifies the trips to and from a specific TAZ (or TAZs). The process is identical to Select Link.

1. Write down the TAZ numbers.
2. In the Cube Application Pane, double click on Select Link. The application flow chart should appear in the main window.
3. In the Cube Scenario Pane, double-click on the scenario you want to run. A run screen should appear



4. Browse to the Turn Penalties file (generally found in Network\Road). This will typically be the same file that was used for Model Run Vehicle.
5. Enter the Select Link information. If you want to see trips from the TAZ only, enter A= (in the example, A=2018). If you want both directions combined, enter A= and B= separated by a vertical bar (in the example, A=2018|B=2018). The vertical bar indicates the "OR" condition.
6. Browse to the Turn Volume Nodes file, typically found in \Model\Base. Before starting the Run, you can double click on the box in the application flow chart if you want to change the intersection numbers.
7. Click **Run**. The model will rerun the traffic assignments for the three time periods. The V2_1 attribute will be trips to and from the TAZ.





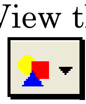
Intersection Turn Movements

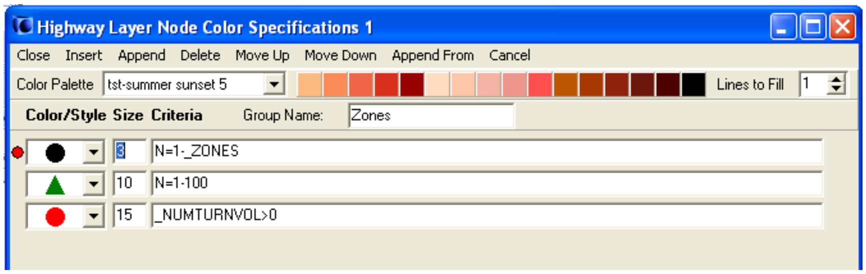
Each traffic assignment in the Shasta County model can report intersection turn movements at specified nodes.

Designate Intersections

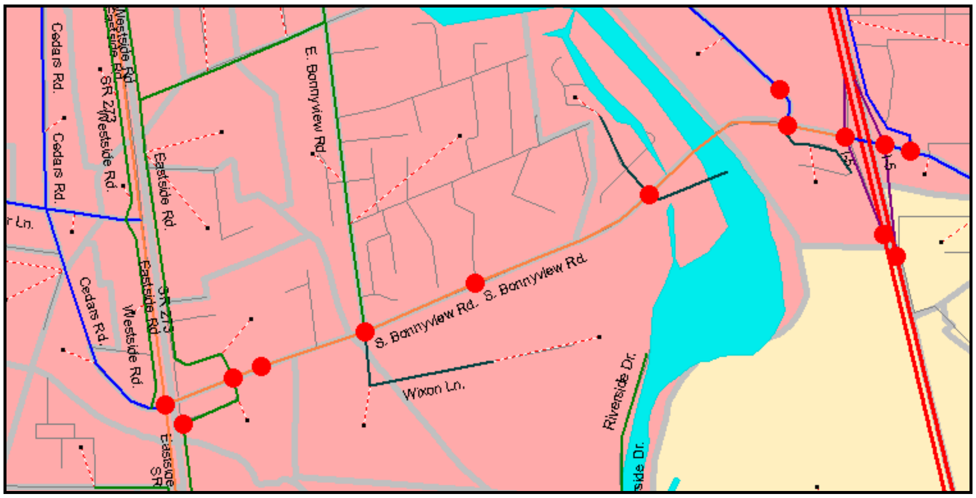
1. View a scenario or output network and zoom to the area of interest.
2. Select Post Node Setting 2 to show all node numbers.
3. Write down the node numbers for the intersections you want to analyze. The list does not have to be precise – you can specify a large range such as 2000-2200 even if you are only interested in eight of the nodes in that range.
4. Each of the Applications "Model Run Vehicle," "Mode Choice" and "Select Link" has a box near the top labeled "Edit Turn Volume Nodes." Double click on the box labeled "Turn Volume Nodes."
5. You are now in the Cube text editor. Make the changes to the list of nodes starting with the line TURNS N = . You can use multiple lines as long as each line ends with a comma. You can even put the nodes in a long vertical list with one node per line.
6. Use File/Save to keep the same Turn Volume file name, or File/Save As… to designate a new name. The file should generally be in the Model\Base directory. You can store as many Turn Volume lists as you like for different projects and study areas.
7. When you start one of the applications with the Run Screen, make sure you **Browse** to the updated Turn Volume file.

View Intersection Results

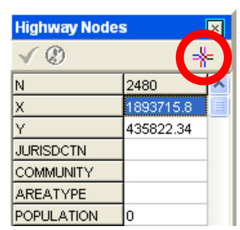
1. Open a result network with traffic volumes ("loaded" network).
2. Use the Intersection/Open Voyager/TP+ Turning Volume File menu command to read a TRN file from the scenario directory (for example, SH30_P1_TRN_M.TRN is the 2030 P.M. peak hour intersection output from the Mode Choice model).
3. In order to see which nodes have turns, you will have to modify the node color settings. View the current node color settings by clicking on the icon with the shapes .



4. Select Append to add another setting. Choose a large bright shape, such as a red circle with a size of 15. For the criterion, select _NUMTURNVOL>0 (type manually or use the right mouse button within the Criteria window) to identify nodes with penalties. Click “Close” on the top menu of the Node Color box. The nodes with turn movements should show as large red circles.



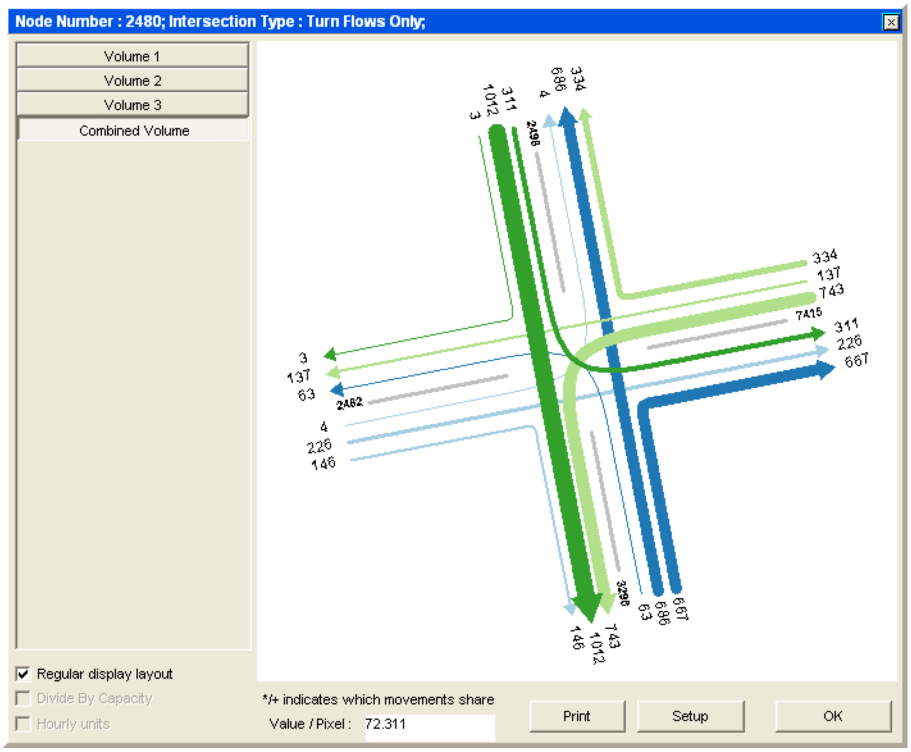
5. Use the pointer to select a node. To view the turn movements, you have three choices:



- Click the red and blue arrow icon at the top of the Highway Nodes box.
- From the top menu, select Intersection/View Output Intersection Data
- Click <CTRL><F3>

The <F3> key by itself will bring up an older TP+ style of turn movement diagram which resembles the turn penalty input screen.

6. A turn movement diagram will appear in the same orientation as the intersection on the network. A number of settings are available to change colors and other display features if you don't like the defaults.



7. The default display will show the "Combined Volume." If you are looking at turn movements from the Mode Choice application, there will be three volumes: 1=Drive Alone, 2=Shared Ride 2 and 3=Shared Ride 3+. In most cases you will just want to see the Combined. If you push the Combined Volume button together with any of the others, the volumes will be double counted in the display.

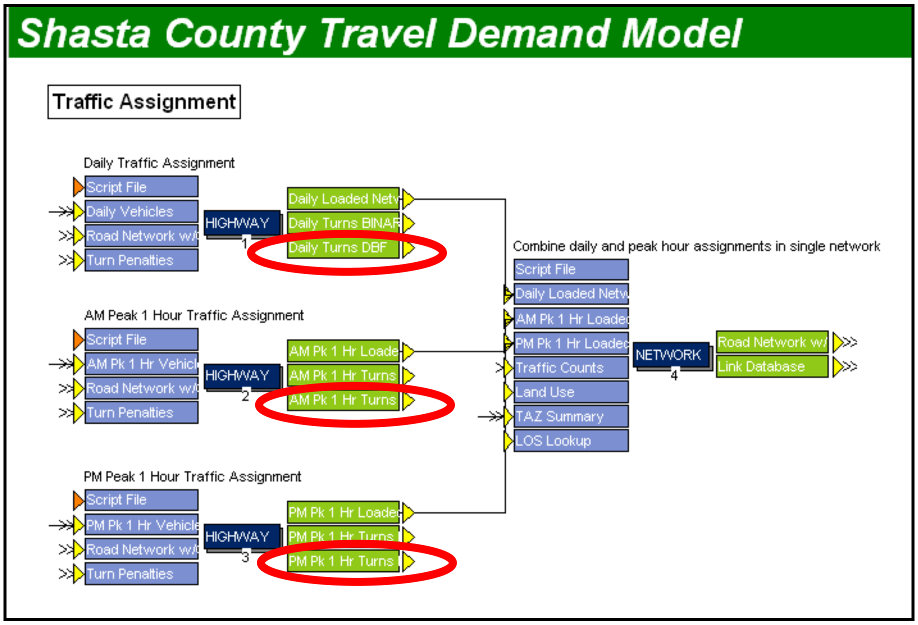
8. If you look at turn movements from a Select Link application, the results are different:

   - The Combined volume is an incorrect total of the total assigned volume and the select link volume.
   - Volume 1 is the correct total volume. Turn off Combined Volume and press Volume 1.
   - Volume 2 is the Select Link volume, representing the amount of traffic on a specific turn movement that also passes through the selected link.

Turn Movement Database

The intersection turn movements are also output as a database file. This file can be viewed in Cube, or it can be opened in Excel or any other program which can read DBF format.

1. If you are using the Model Run Vehicle or Mode Choice applications, double click on the flow chart box at the bottom labeled Traffic Assignment. Skip to Step 2 for Select Link.



2. Double click on the third output box for the time period you want to review. This is the turn movement output in DBF format.

A	B	C	T	T1	T2	T3
7415	2478	7411	130.15	99.61	23.43	7.11
7415	2478	7412	42.61	32.44	7.87	2.3
2482	2480	2498	4.16	3.15	0.77	0.24
2482	2480	3296	145.81	109.59	27.94	8.29
2482	2480	7415	225.79	170.99	42.71	12.09
2498	2480	2482	2.67	2.02	0.5	0.14
2498	2480	3296	1012.35	810.6	155.95	45.81
2498	2480	7415	310.63	244.11	52.11	14.41
3296	2480	2482	63.14	48.5	11.24	3.4
3296	2480	2498	685.95	537.41	114.9	33.64
3296	2480	7415	666.94	521.88	111.55	33.51
7415	2480	2482	136.81	105.31	24.24	7.26
7415	2480	2498	333.53	266.15	52.53	14.85
7415	2480	3296	742.53	569.37	131.9	41.26
2514	2520	3754	1328.56	1047.56	219.56	61.45
2514	2520	5019	173.63	126.73	35.95	10.95

3. The individual turn movements are listed in rows.
   - The B node is the intersection
   - The A node is the node where traffic is coming from
   - The C node is the node where traffic is going after the intersection
   - T is the total turn movement volume

4. T1, T2…etc…are the separate volume sets.
    - From the Mode Choice application (shown above), T1 is Drive Alone, T2 is Shared Ride 2 and T3 is Shared Ride 3+.
    - From the Model Run Vehicle application, there will only be T1 and it will equal the total volume listed under T.
    - With a select link application, the correct Total volume is actually under T1 (not T) and the select link volume is under T2.

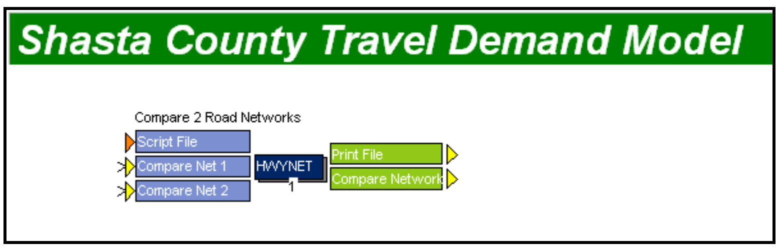
Compare Network Results

The Compare Network application will compare differences between two output networks from the Model Run Vehicle or Mode Choice applications. The Compare Network application produces two outputs:

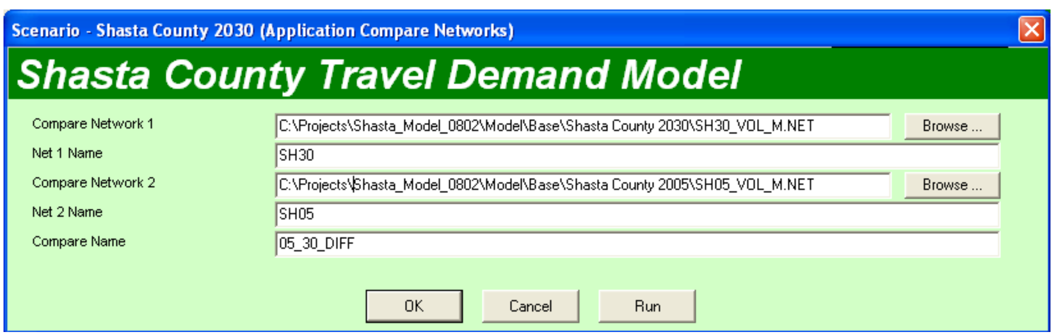
- A new result network with volumes from both input networks and total and percent differences on each link.
- A summary printout listing differences between each TAZ.

Run the Compare Network Application

1. In the Cube Application Pane, double-click the Compare Network application to show the application flow chart.



2. In the Cube Scenario Pane, double-click on an appropriate scenario. The Compare Networks application is not specific to any particular scenario, so it does not actually matter which scenario is selected. A Run screen will appear.

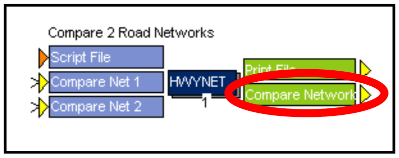


3. Browse to Compare Network 1, most likely in a scenario directory under Model\Base. The typical file names would be xxxx_VOL.NET from the Model Run Vehicle application or xxxx_VOL_M.NET from the Mode Choice application.

   Compare Network 1 will be the network that is being compared to a base case. If you are comparing future results with base year results, Compare Network 1 should be the future network.

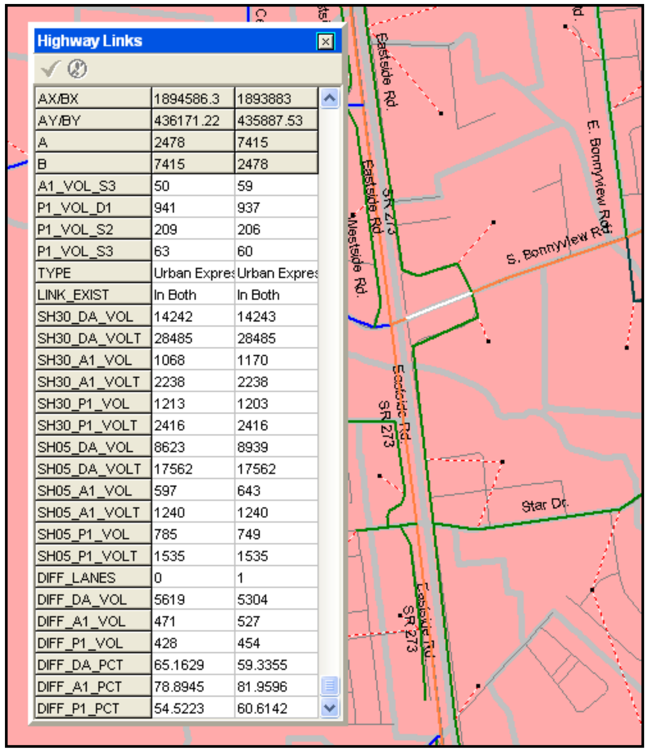
4. Enter a Net 1 Name that will be used to identify the attributes in the combined network. *The Name cannot start with a number*.
5. Browse to Compare Network 2. Compare Network 2 will be the network that is being compared to. If you are comparing future results with base year results, Compare Network 2 should be the base year network.
6. Enter a Net 2 Name that will be used to identify the attributes in the combined network. *The Name cannot start with a number*.
7. Enter a Compare Name that will be used to identify the combined output network. This output network is placed in a separate directory Model\Compare.
8. Click **Run**. The application should be very quick.
9. If there is an error, the Task Run Result will state "Program HWYNET failed." Click **OK** or **Cancel**. In the application flow chart, double click on the box "Print File" and look for the errors labeled with F(nnn). The most likely errors are browsing to an incorrect file name (such as an input scenario network rather than an output result network), or specifying Name starting with a number.

View Comparison Network



1. Double-click on the box on the right side of the application flow chart titled "Compare Network."
2. Zoom in on a area of interest.
3. Use the pointer arrow to click on a link. The link attribute box will appear.
4. The first link attributes will be the same as a result network. If you compare networks from a mode choice model, there will be volumes split by DA, S2 and S3. These are from Network 1.

5. Following "TYPE," there are attributes that are specific to the Compare Network. These include:
   - LINK_EXIST: Lists if the link is "In Both," "Net 1 Only" (new link) or "Net 2 Only" (deleted link).
   - Volumes from Network 1, labeled with the "Net 1 Name" that you selected.
   - Volumes from Network 2, labeled with the "Net 2 Name" that you selected.
   - DIFF_LANES, the change in number of lanes from Net 2 to Net 1. The example shows the addition of one lane in one direction.
   - DIFF_xx_VOL: Differences in daily and peak hour volumes from Net 2 to Net 1.
   - DIFF_xx_PCT: Percent differences in daily and peak hour volumes from Net 2 to Net 1.

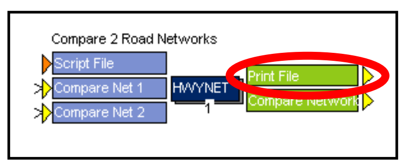


AX/BX	1894586.3	1893883
AY/BY	436171.22	435887.53
A	2478	7415
B	7415	2478
A1_VOL_S3	50	59
P1_VOL_D1	941	937
P1_VOL_S2	209	206
P1_VOL_S3	63	60
TYPE	Urban Expres	Urban Expres
LINK_EXIST	In Both	In Both
SH30_DA_VOL	14242	14243
SH30_DA_VOLT	28485	28485
SH30_A1_VOL	1068	1170
SH30_A1_VOLT	2238	2238
SH30_P1_VOL	1213	1203
SH30_P1_VOLT	2416	2416
SH05_DA_VOL	8623	8939
SH05_DA_VOLT	17562	17562
SH05_A1_VOL	597	643
SH05_A1_VOLT	1240	1240
SH05_P1_VOL	785	749
SH05_P1_VOLT	1535	1535
DIFF_LANES	0	1
DIFF_DA_VOL	5619	5304
DIFF_A1_VOL	471	527
DIFF_P1_VOL	428	454
DIFF_DA_PCT	65.1629	59.3355
DIFF_A1_PCT	78.8945	81.9596
DIFF_P1_PCT	54.5223	60.6142

Any of these difference attributes can be posted as labels or used for bandwidth displays.

View TAZ Comparison Report

1. Double-click on the box on the right side of the application flow chart titled "Print File."



2. A long listing of each TAZ will appear. It will show TAZ attributes for Network 1, Network 2 and the difference. Only attributes with differences will be listed.

   In the example, TAZ 131 has added 300 Retail Warehouse employees (WalMart) and trips and VMT increase from 2005 to 2030.

```
COMPARE 1-2: 131  EMP_RETWAR       300           0         300
                  EMP_TOTAL        320          20         300
                  EMP_DIF04        310          10         300
                  TRIPS_PERS     13368.99      803.12    12565.87
                  TRIPS_VEHS      4609.97      265.74     4344.23
                  TRIP_DA         5436.71      324        5112.71
                  TRIP_SR         7512.18      450.51     7061.67
                  TRIP_TR            4.75        0.5         4.25
                  TRIP_NM          358.11       21.42      336.69
                  MODE_DA           40.84       40.68        0.16
                  MODE_SR           56.43       56.57       -0.14
                  MODE_TR            0.04        0.06       -0.02
                  AVGTIME            9.91        9.06        0.85
                  AVGDIST            5.42        4.99        0.43
                  VMT            26092.16016  1361.3    24730.86016
COMPARE 1-2: 141  TRIPS_PERS       155.32      158.41       -3.09
                  TRIPS_VEHS        50.71       51.5        -0.79
```