Travel Modeling in Shasta County

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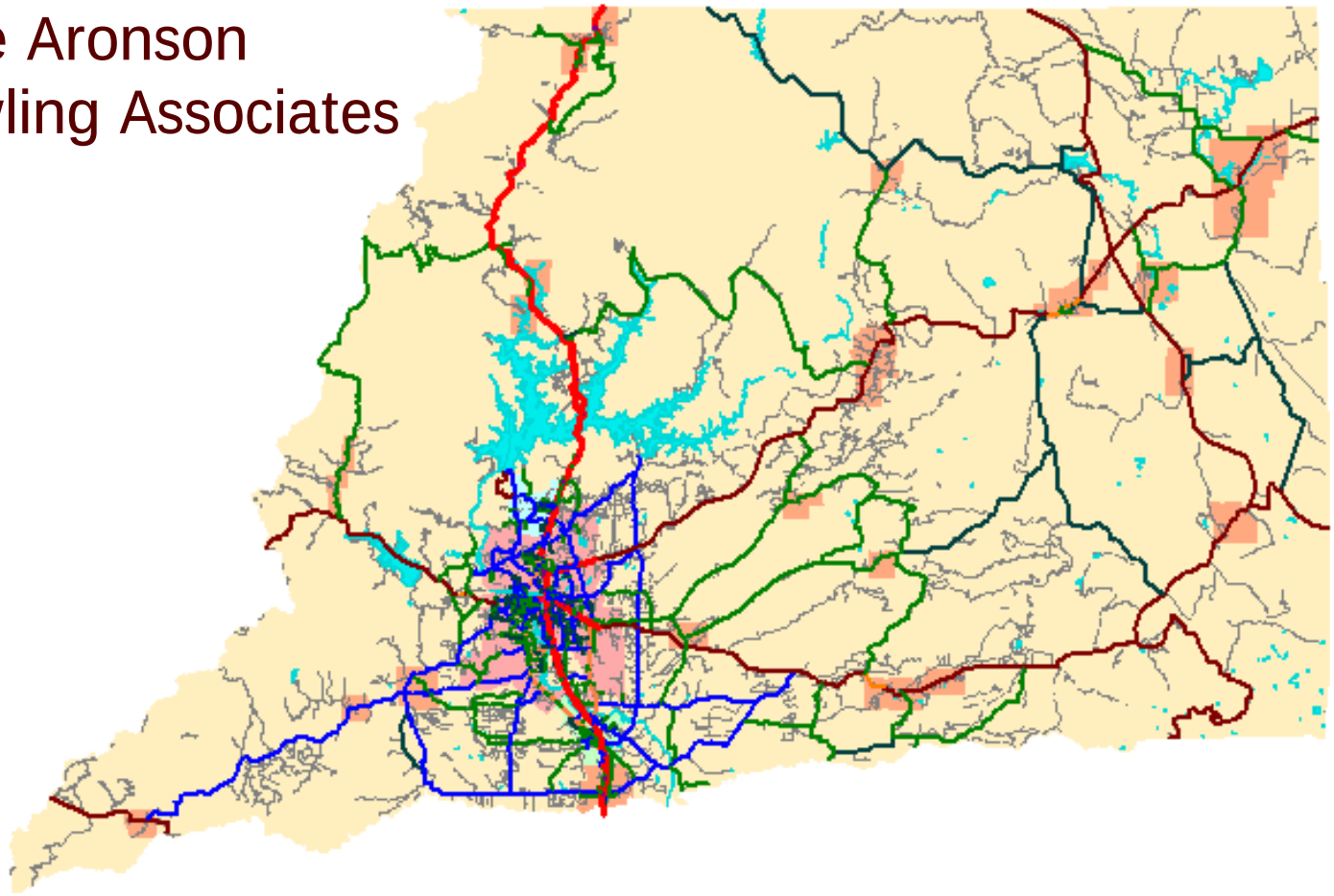
Dowling Associates



Travel Modeling 101

- What is a travel demand forecasting model?
- When are models useful?
- Model components
- Steps in process

What is a Travel Demand Model?

- A systematic process for translating land use and transportation supply into projections of future travel demand
- Computers and software are NOT models
- Models ***use*** computers and software to manipulate large amounts of data
- Specific land use assumptions also do not equal “the model”

Types of Travel Models

- Growth Factor
  - Example: 2.5% annual growth on a road
- Impact "Model" (Bookkeeper?) - Traffix
  - Add increments to observed counts
  - Manual assumptions for traffic amounts, directions, routes
- Travel Demand Model
  - Formulas that relate travel demand to people's activities

Travel Demand Forecast Models

- "Travel" vs. "Traffic"
  - Can consider other modes such as transit
- "Demand"
  - The model is estimating how many people ***want*** to make the trips, not necessarily how many ***can*** make the trips when they want to
- "Forecast"
  - **OPINION:** Reasonable predictions more important than accurate replication of existing conditions

Why Bother with Travel Models?

- Can evaluate changes in travel by people who are already on the road
  - Diversion to new road connection or transit service
  - Diversions due to increased congestion
  - New land use that will divert existing travel
    - WalMart diverts from existing stores
- Evaluate several new developments that will interact with each other
  - New housing plus new jobs
- Agencies use as database for consistency

Limitations of Travel Models

- Need to group people and land uses
- Cannot predict changes in land use
- Cannot predict changes in attitudes
- With congestion, models predict demand, not throughput volumes
- Cannot directly predict intersection turns
- Only as good as inputs

Model Components

- Inputs that vary by scenario
- Inputs that are “fixed”
- Outputs
- Process
  - Equations
- Software to execute process

Model Inputs that Vary

- Road and Transit Networks
- Land Use & Socioeconomic
- Internal & External Trip Assumptions
- **SOMETIMES** Transportation Analysis Zones (TAZs)

Fixed Model Inputs

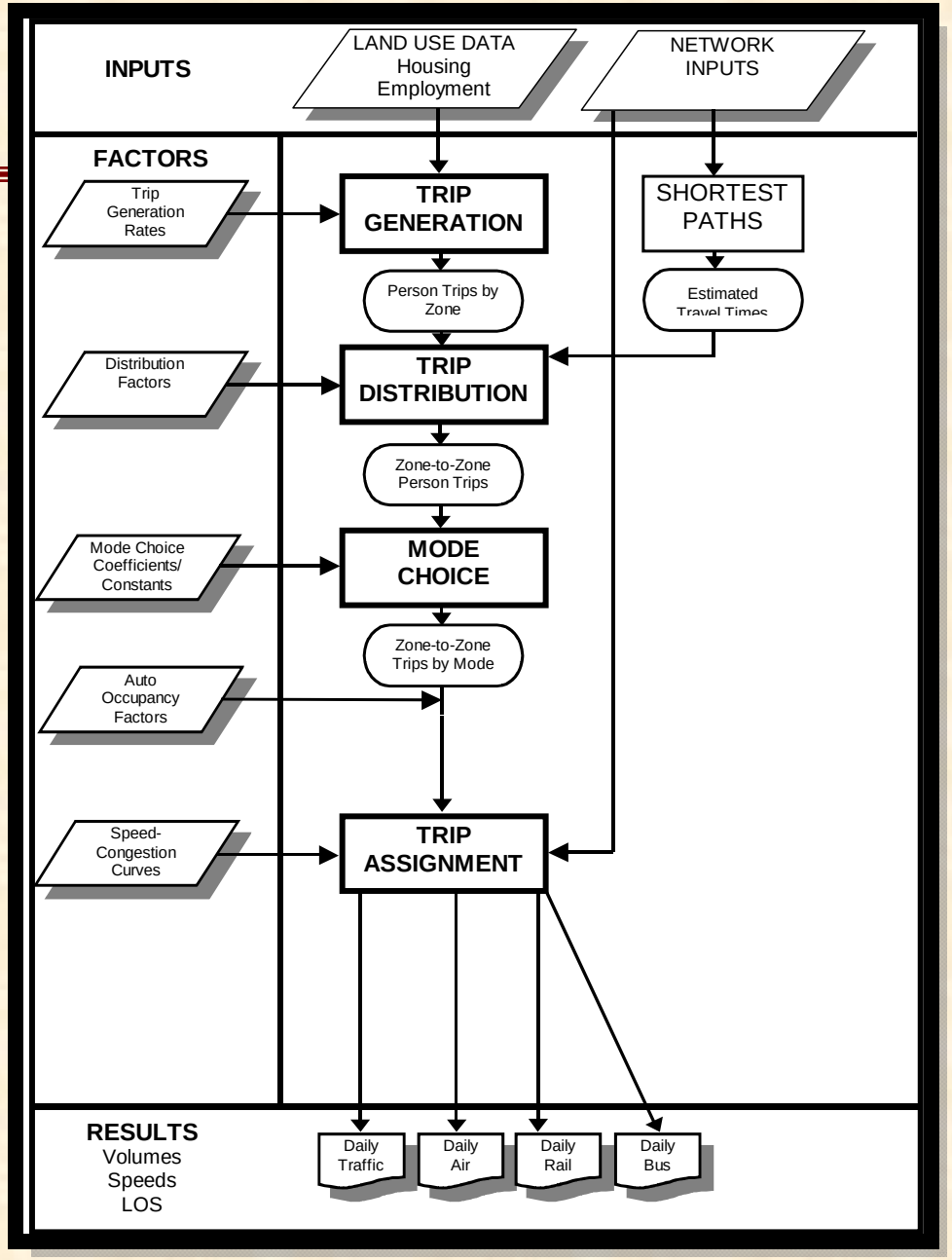
- Trip Generation Rates
- Distribution Factors (Friction Factors)
- Adjustment ("K") Factors
- Volume/Delay Equations
- Mode Choice Parameters
- **OFTEN** Peak Hour / Peak Period Factors

Model Outputs

- "Loaded" network(s)
  - Copy of input networks plus volumes
- Trip matrices
- "Skim" matrices (time, distance)
- Printed reports
- Select intersection, link, zone volumes

Model Process

The Black Box



Traditional Four Step Process

- Trip Generation
  - How many trips travel to and from each land use?
- Trip Distribution
  - How many trips travel from each area to each other area?
- Mode Choice
  - What travel modes do they use?
- Trip Assignment
  - What routes do the drivers and transit riders use?

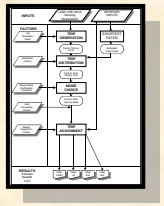
Activity or Tour-Based Model

- Population Synthesizer
  - Simulate each person in model area
- Activity Estimates
  - What activities do each person need to do on a given day?
- Random Simulation of Choices
  - Destinations, mode, time of day
- Trip Assignment
  - What routes do the drivers and transit riders use?
  - Aggregate person tours to TAZs

The Real Process

- Define Model Area – What happens at gateways?
- Code Transportation Networks
- Define Zone System – Aggregate land uses
- Inventory Land Uses

Hardest Step



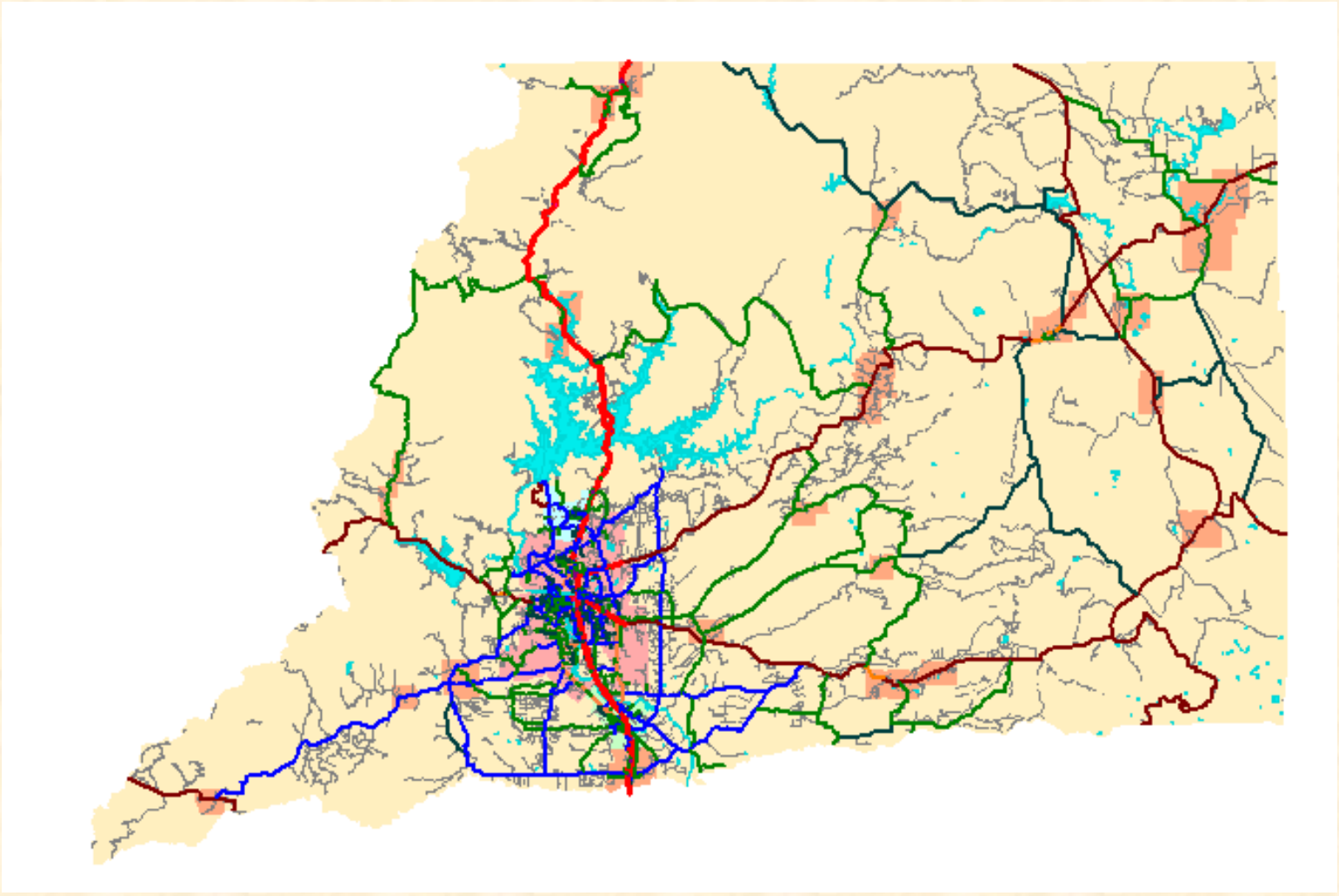
- Calibration – Formulas based on survey data
- Validation – Compare model results to counts
- Forecast Inputs – Land uses, networks
- Policy Framework – Which assumptions should remain constant?
- Adjust Model Results

Rarely Considered

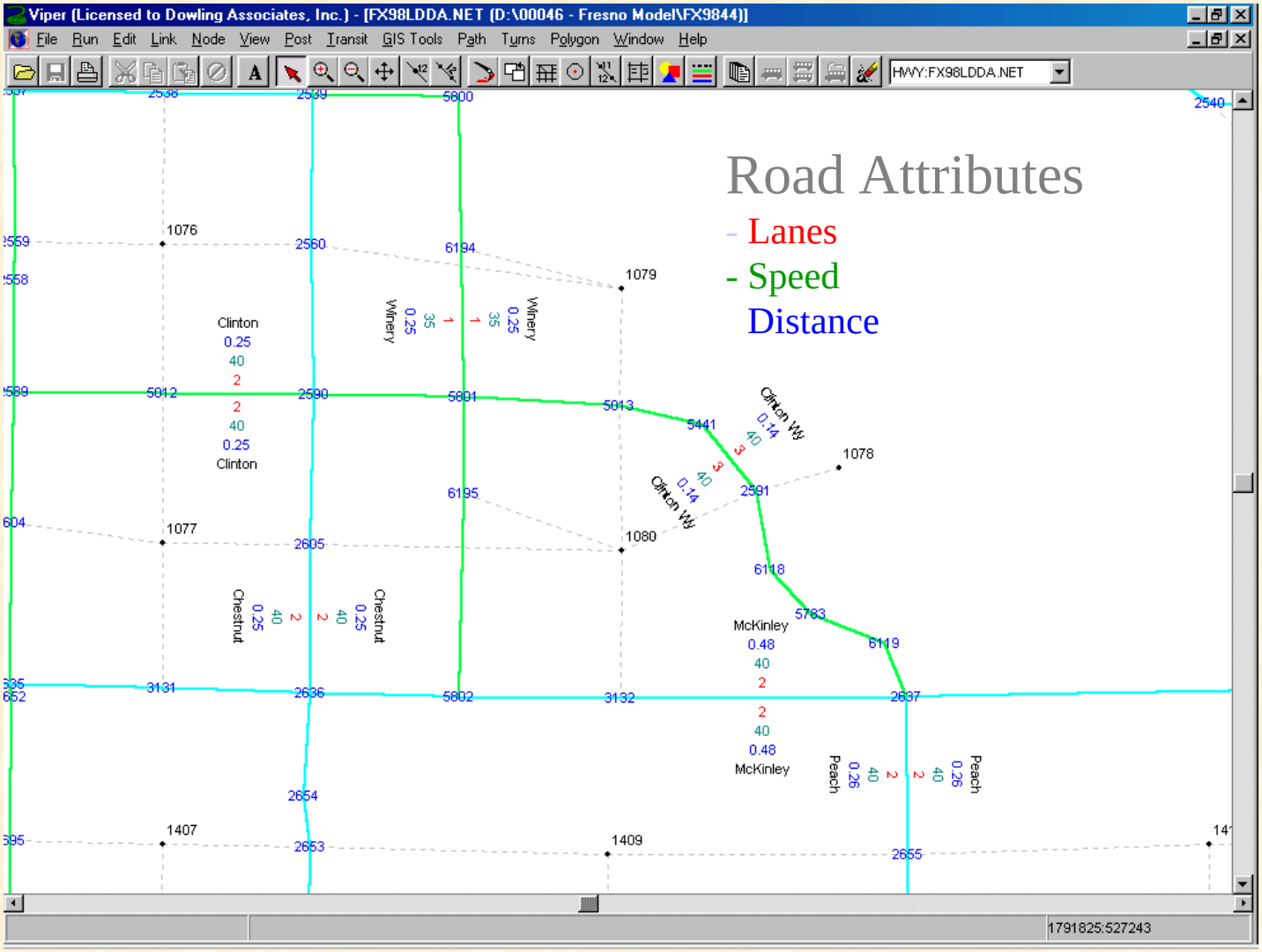
Don't Say "We're using THE MODEL"

- Which version/generation of the model?
  - Example: May, 2009 update of the Vineyards version of the Shasta County 0802T model, 2025 forecast
- Which version of the software?
  - Can give different results
- The LAND USE is not THE MODEL
  - Pick best modeling tool, then update inputs
  - Example: Add Oasis Specific Plan buildout to official RTPA 2030 growth forecast
- How should results be reported?
  - Did other consultants use adjustments?

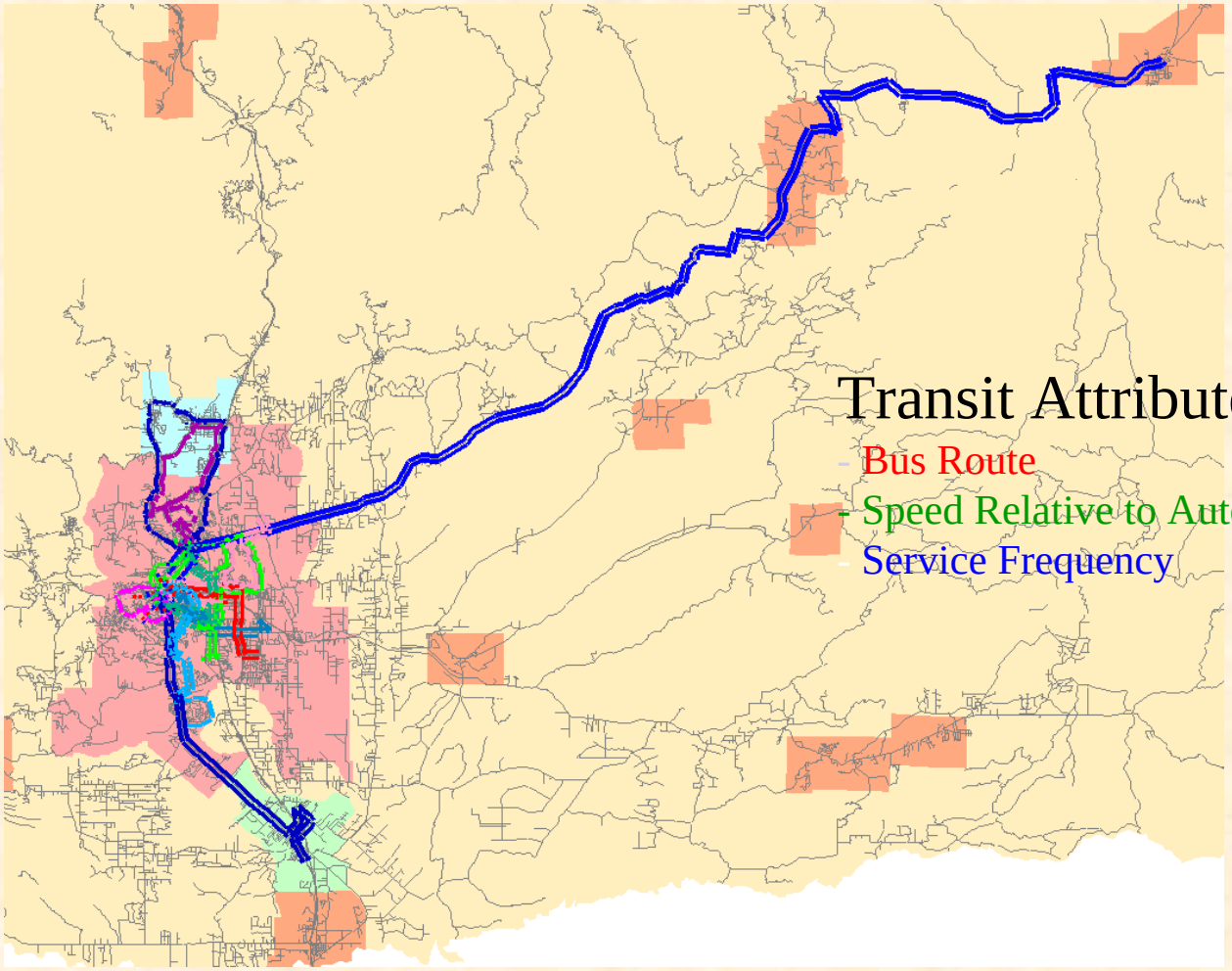
Model Inputs



Road Network Inputs



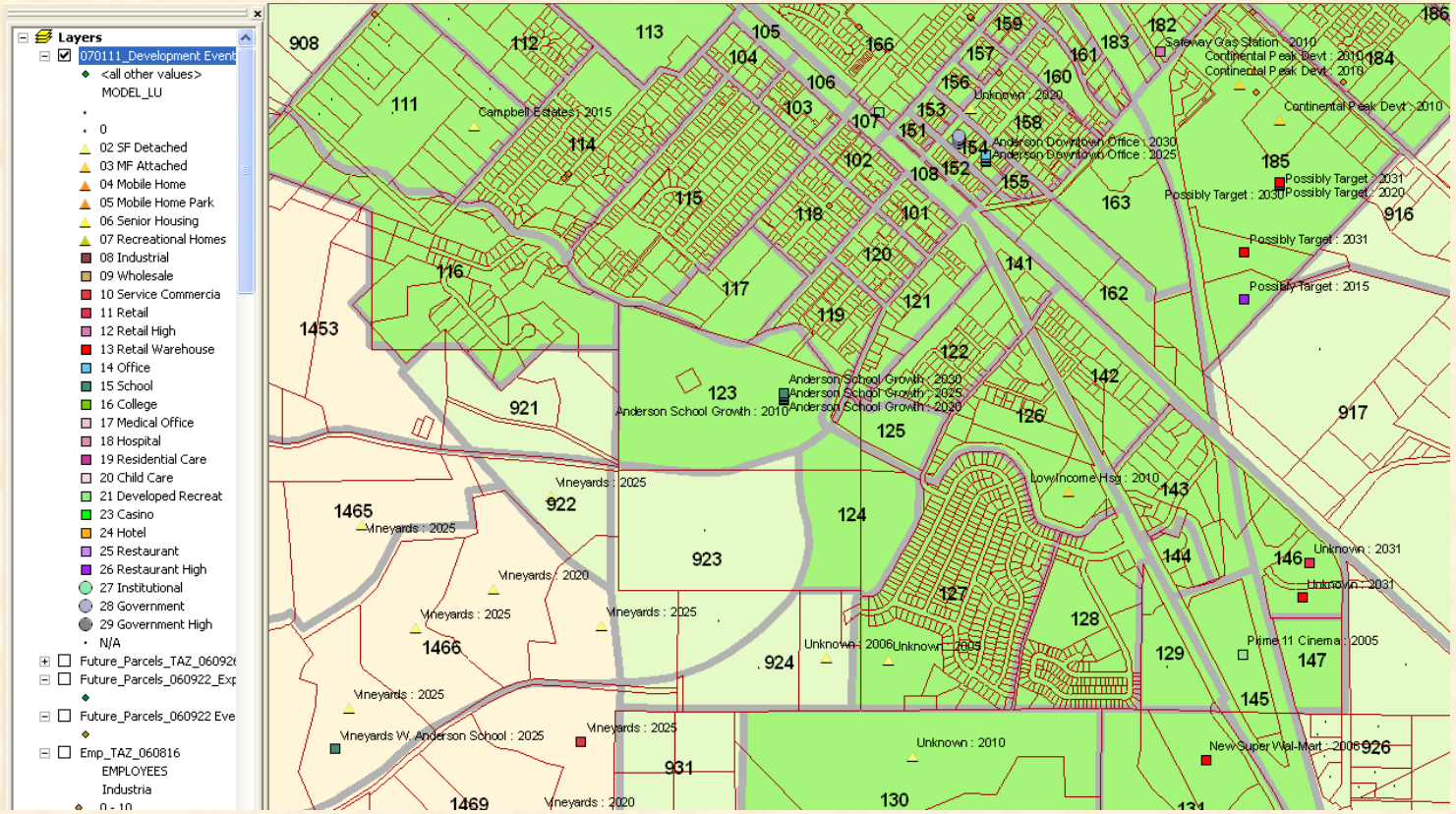
Transit Network Inputs



Land Use Inputs

- Housing
  - 6 categories including recreational housing
- Employment
  - 22 categories including casino
- Socioeconomic
  - Median income by TAZ
  - Percent 0, 1 or 2+ auto households by TAZ

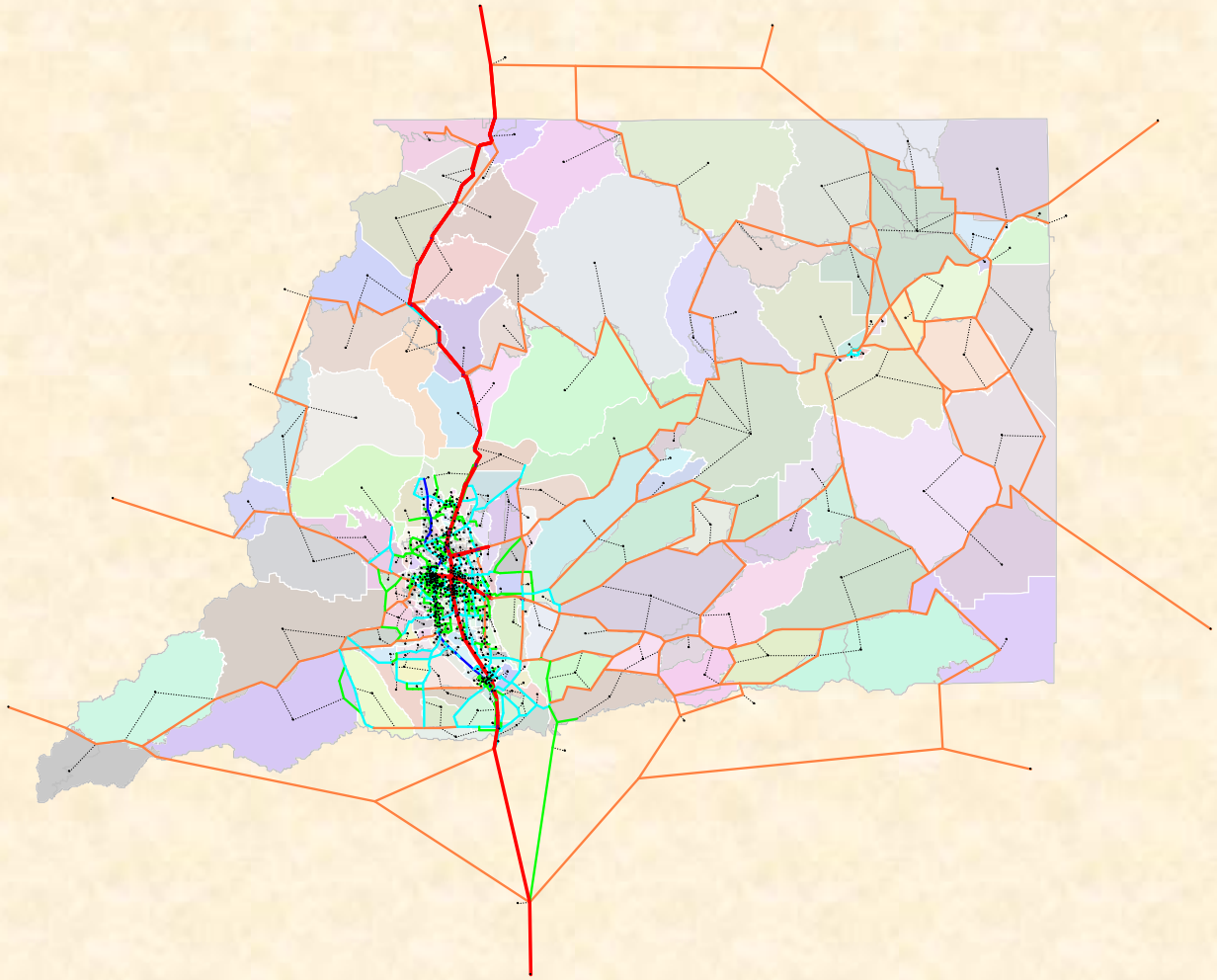
Future Development Using GIS



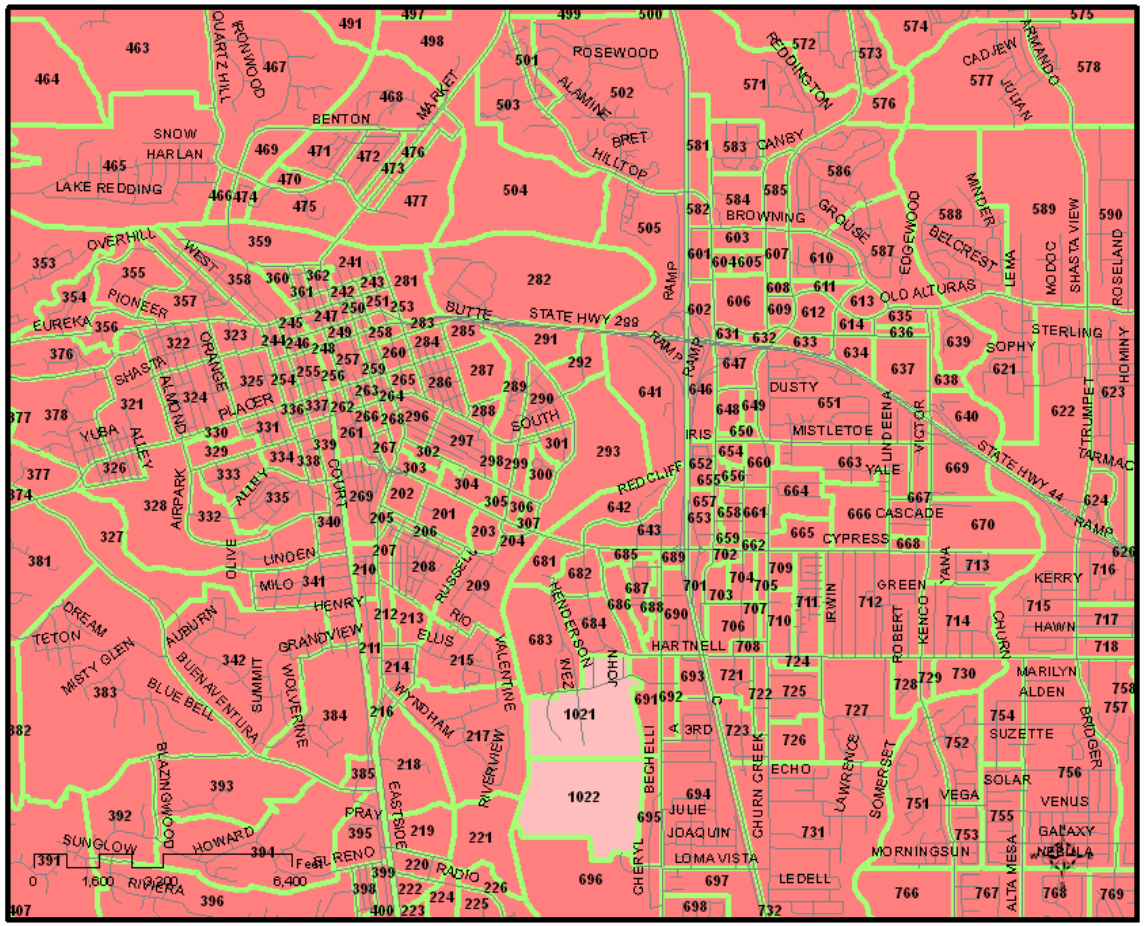
Transportation Analysis Zones

- Or:
  - *"Traffic* Analysis Zones"
  - "TAZs"
  - "Zones"
- Grouping of land uses into TAZs can be biggest source of model error
- High number of TAZs increases model processing times
- Activity-based models still use TAZs for trip assignment

Shasta County TAZs

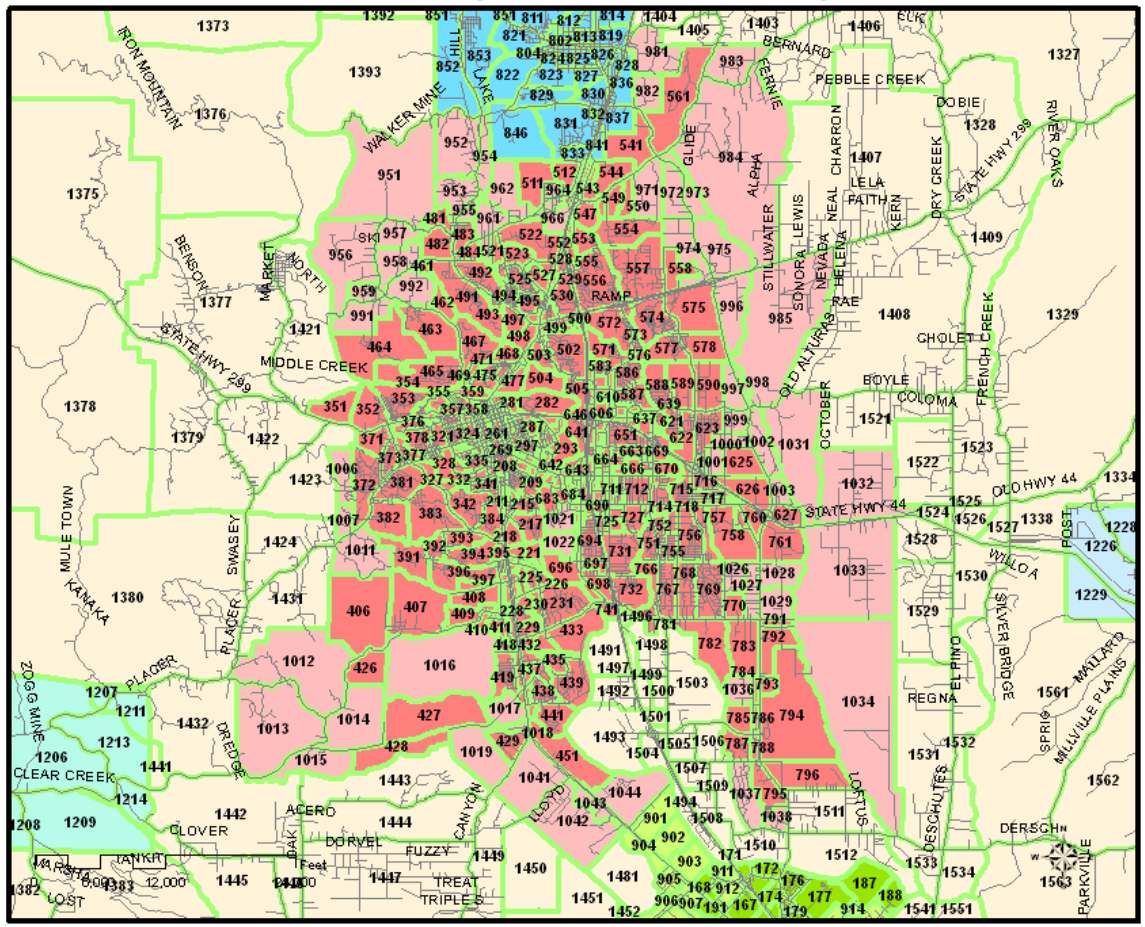


Central Redding TAZs



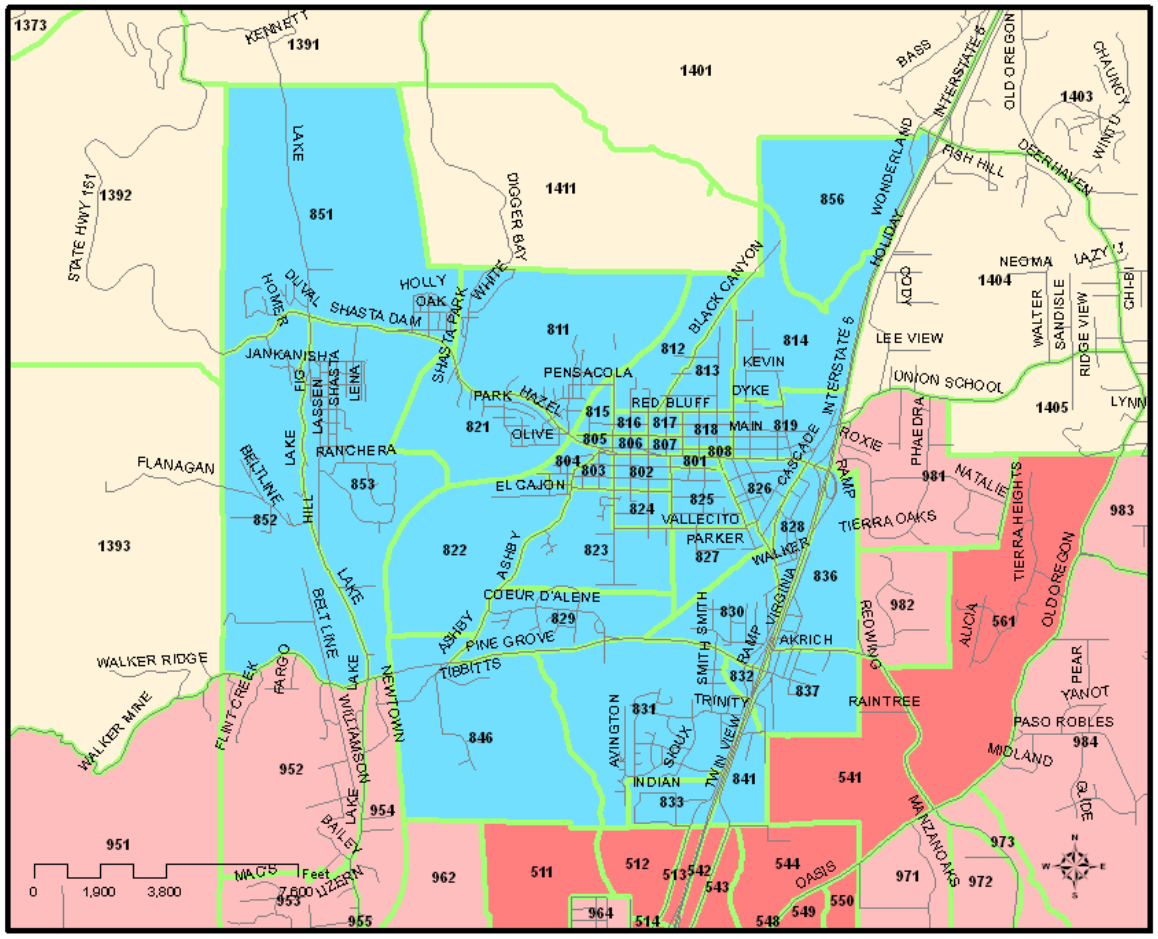
Redding TAZs

Shasta County Model TAZ Updates



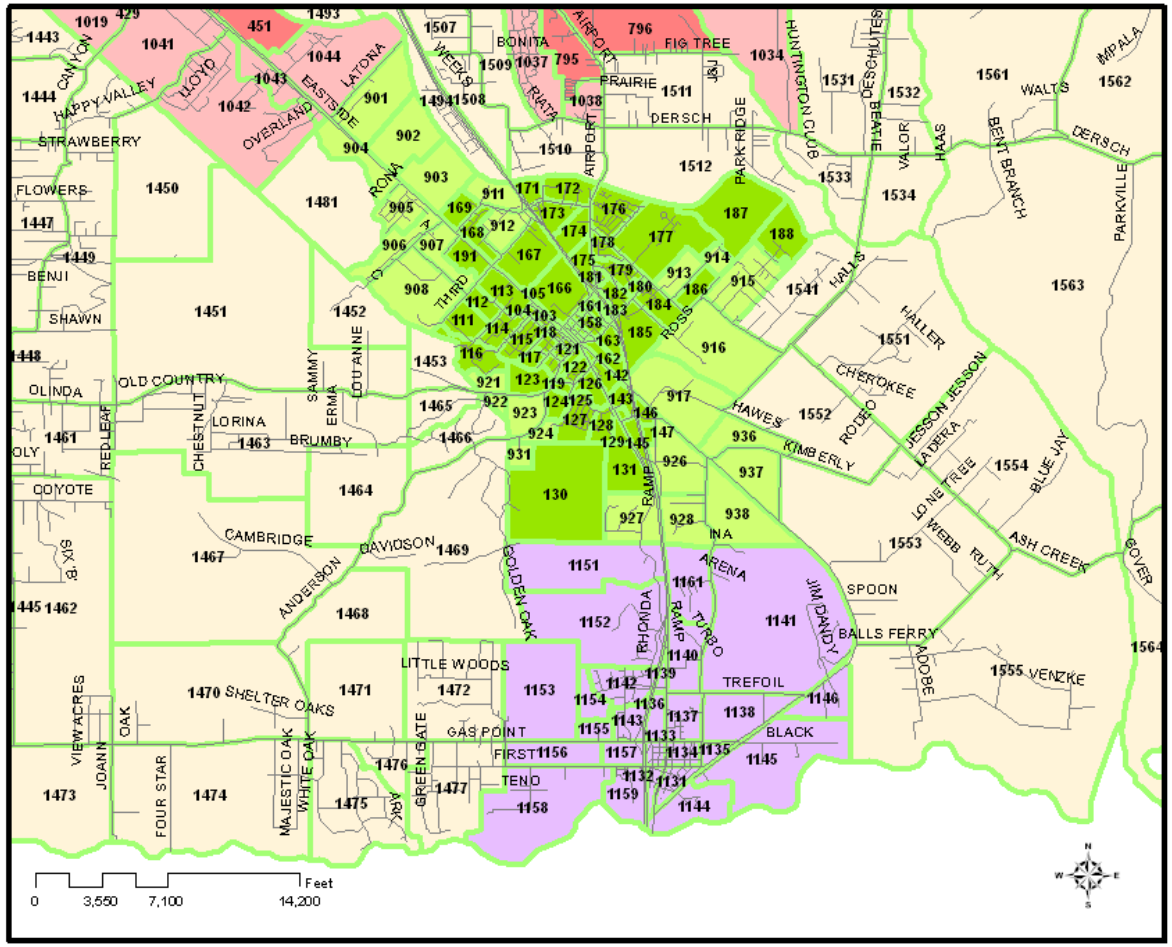
Shasta Lake TAZs

Shasta County Model TAZ Updates



Anderson / South County TAZs

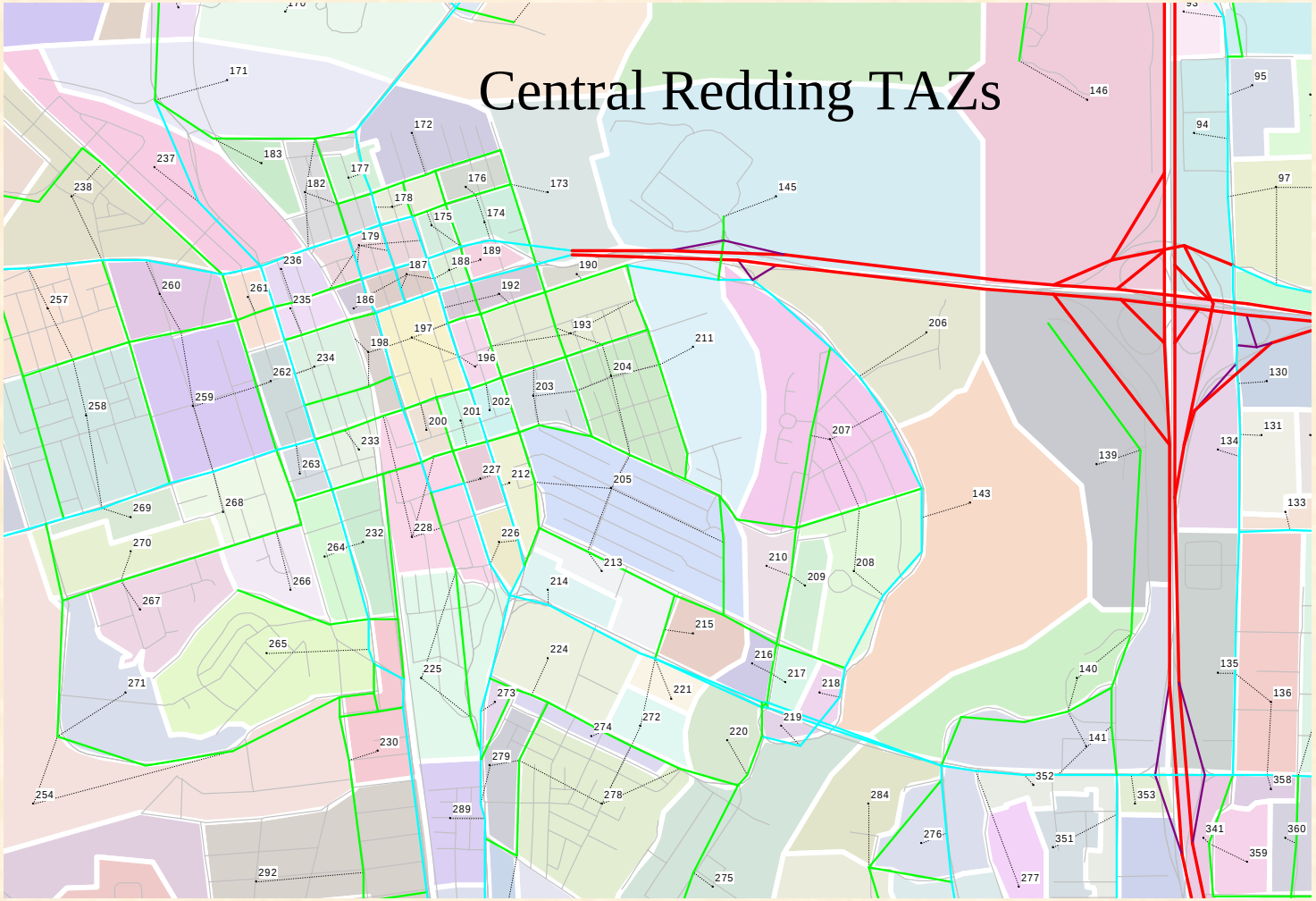
Shasta County Model TAZ Updates



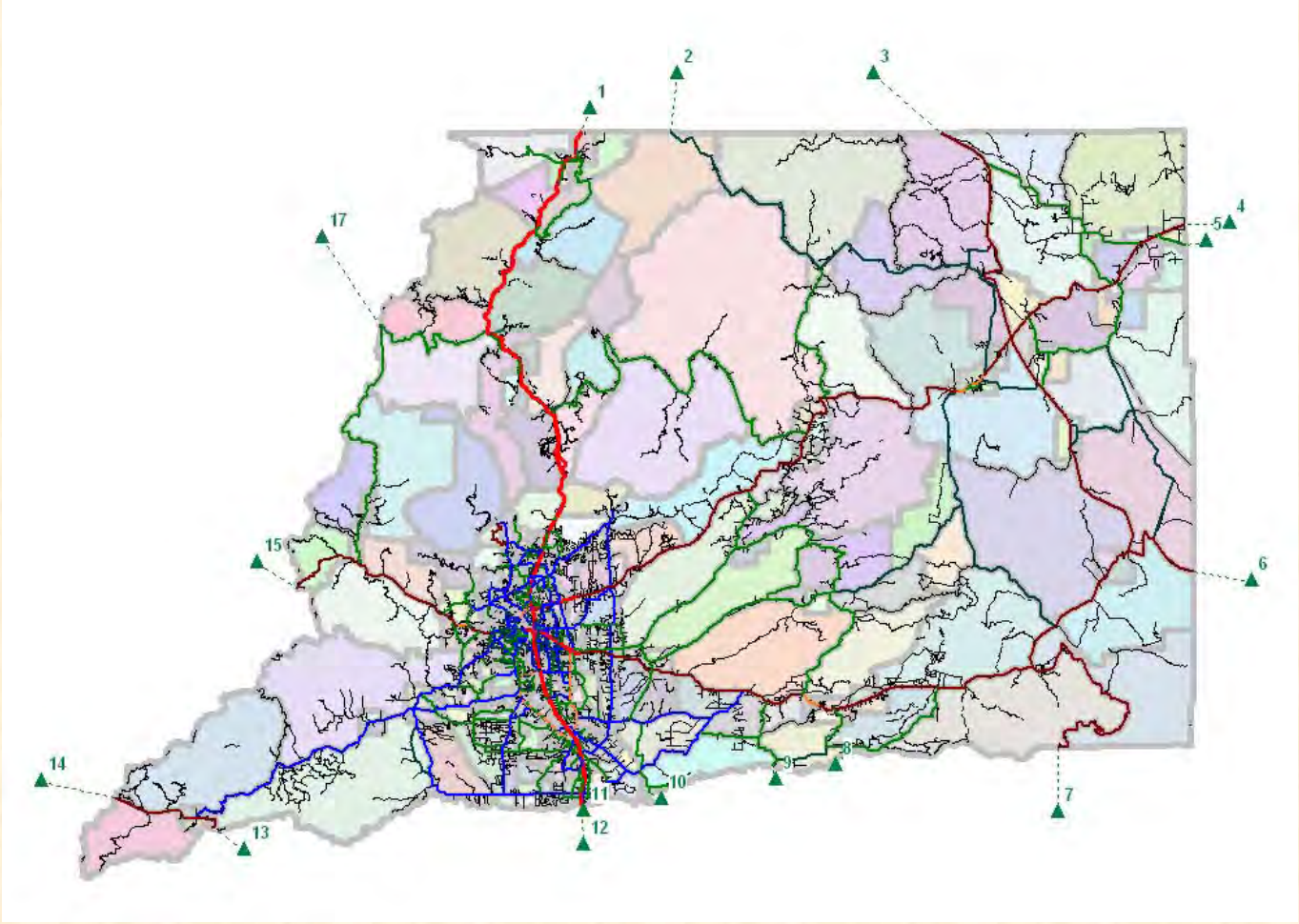
TAZ Features

- Group land uses that have same access to transportation network
- Need to be smaller for transit modeling to isolate areas with walk access
- "Centroid" represents center of trip activity, not geographic center
- "Centroid connectors" represent access for *majority* of trips, not *all* trips in TAZ

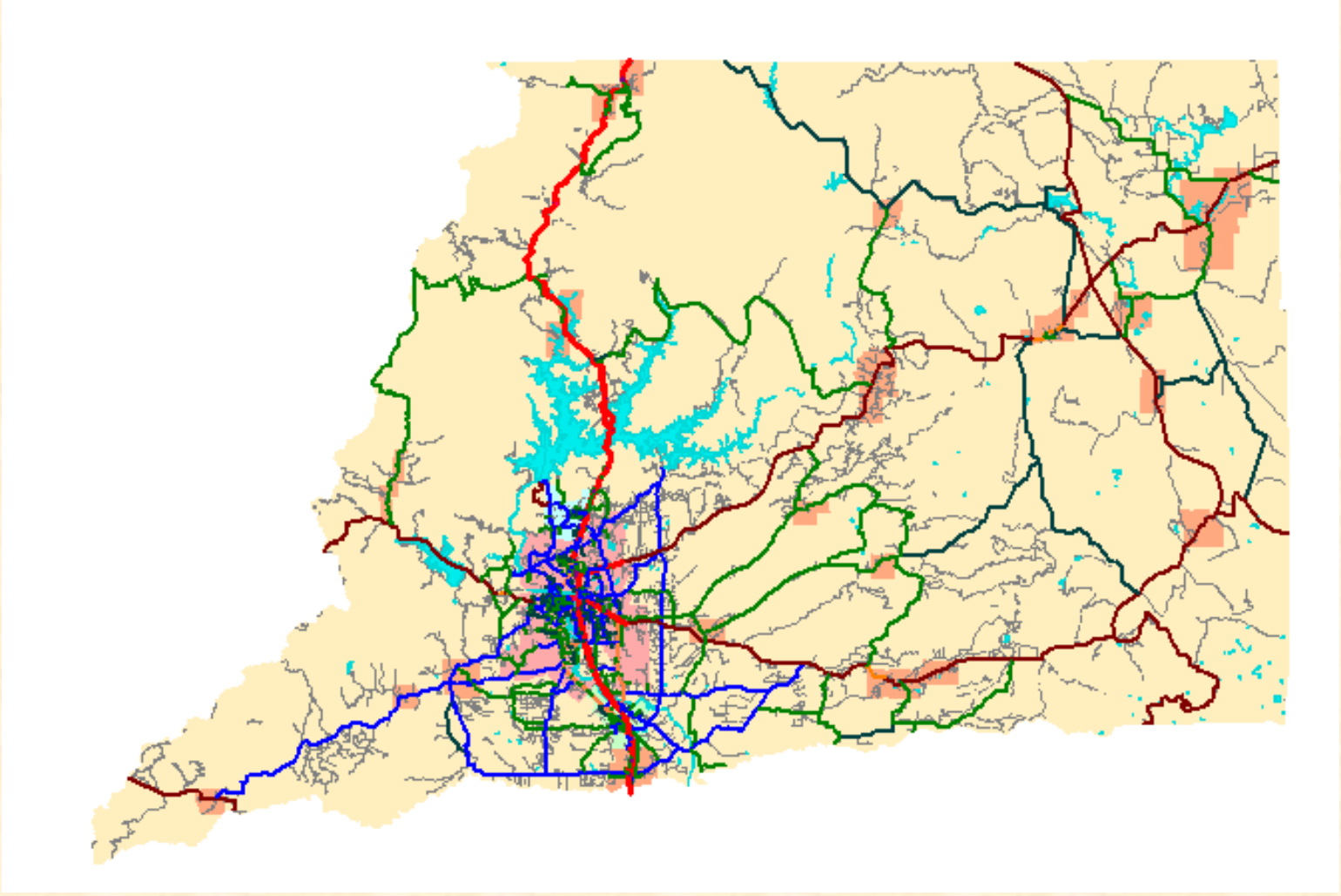
TAZs with Connectors



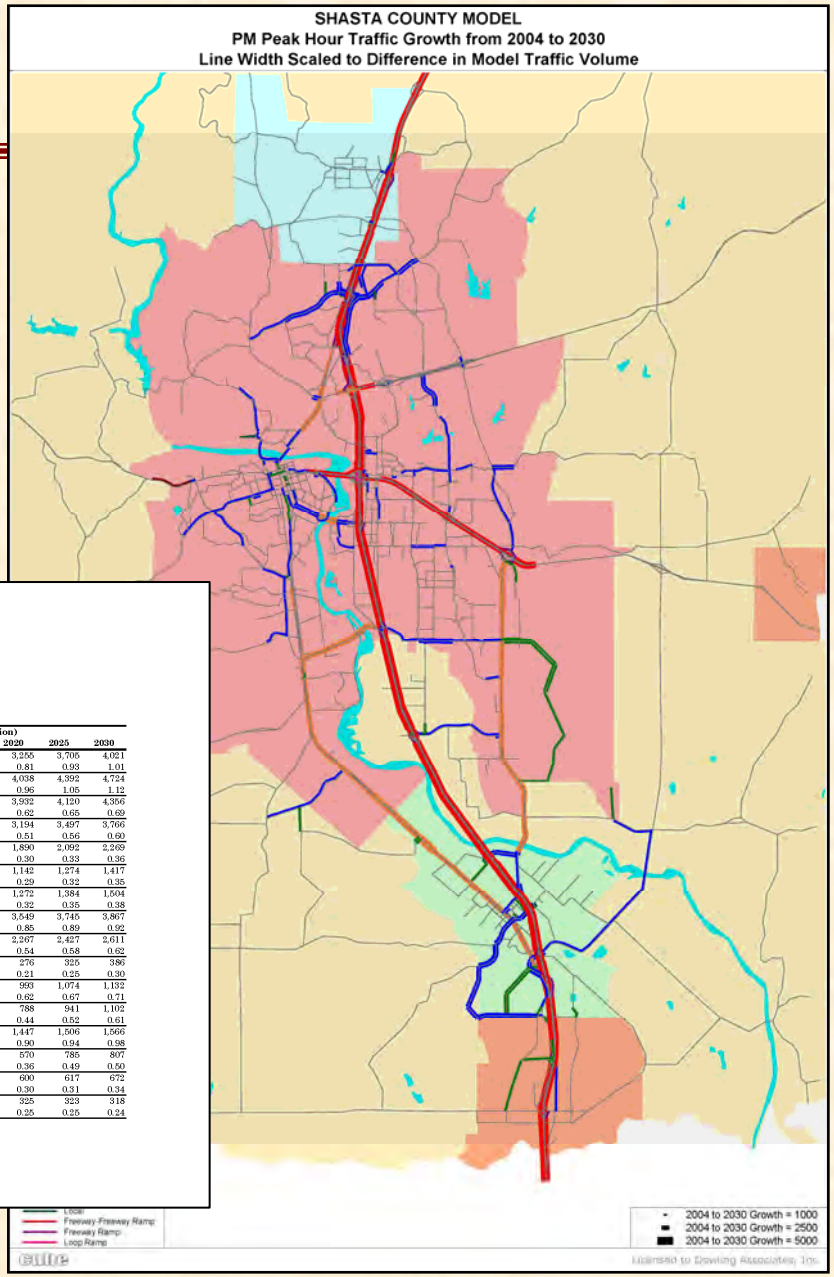
External Gateways



Model Outputs



Traffic Volumes



SHASTA COUNTY TRAVEL MODEL
Travel Forecasts on Selected Road Segments

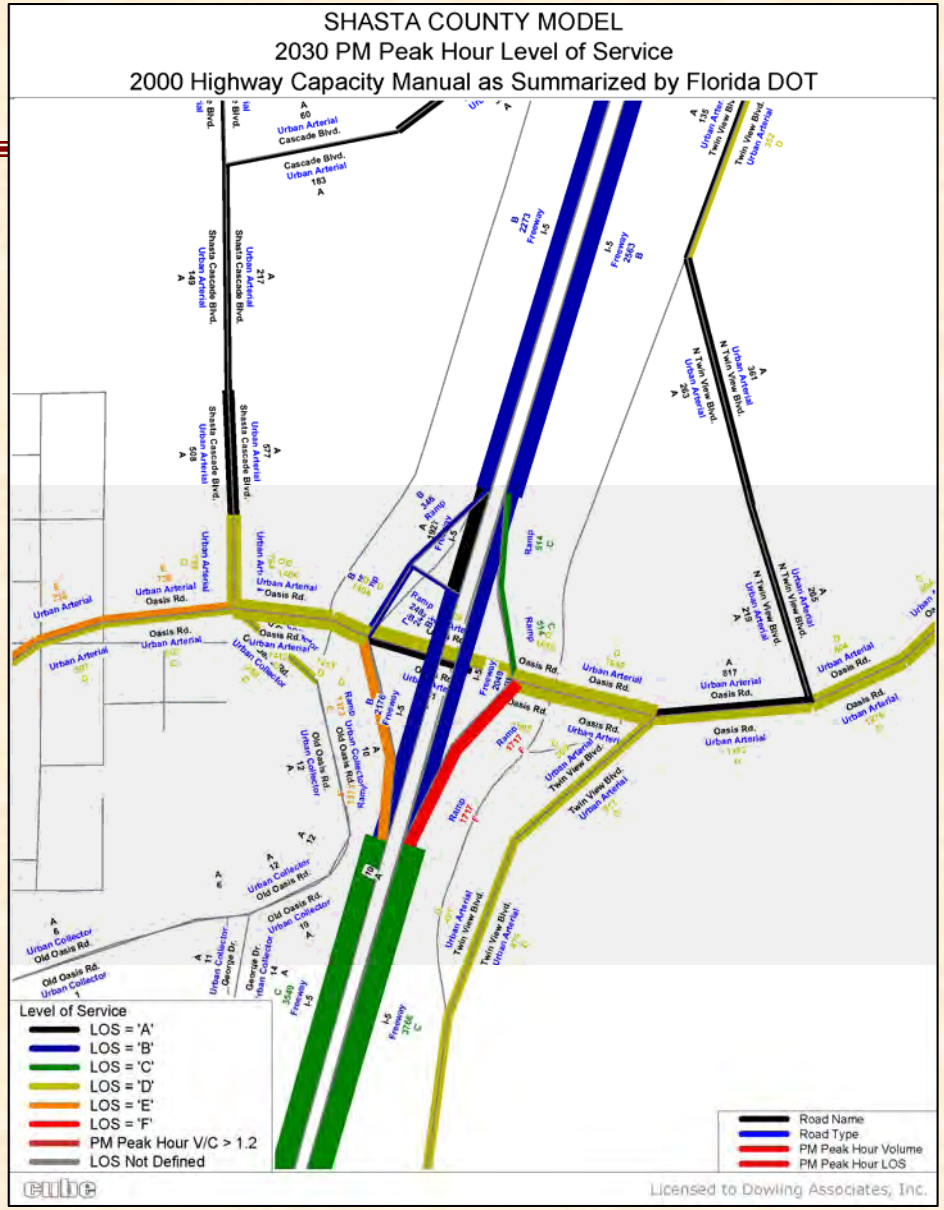
Road	Location		Daily (Two-Way Total) 2004	2010	2015	2020	2025	2030	2004-2030 Growth	PM Peak Hour (Highest Direction) 2004	2010	2015	2020	2025	2030
I-5	Tehama County Line	Volume	41,500	51,959	59,973	67,928	76,217	84,177	103%	2,358	2,485	2,855	3,255	3,705	4,021
		V/C Ratio								0.59	0.62	0.71	0.81	0.93	1.01
I-5	N. of Riverside	Volume	50,000	60,053	68,331	80,897	88,962	93,432	87%	0	3,022	3,558	4,038	4,392	4,724
		V/C Ratio								0.00	0.72	0.85	0.96	1.05	1.12
I-5	S. of SR 44	Volume	67,000	77,136	87,006	93,907	99,988	102,742	53%	3,120	3,459	3,705	3,932	4,120	4,356
		V/C Ratio								0.50	0.55	0.59	0.62	0.65	0.69
I-5	N. of SR 273	Volume	46,000	57,973	67,686	79,676	86,598	93,560	103%	0	2,328	2,836	3,194	3,497	3,766
		V/C Ratio								0.00	0.37	0.45	0.51	0.56	0.60
I-5	S. of SR 151 Shasta Dam	Volume	34,000	37,707	42,517	48,561	53,459	58,255	71%	0	1,363	1,611	1,890	2,092	2,269
		V/C Ratio								0.00	0.22	0.26	0.30	0.33	0.36
I-5	Fawndale	Volume	14,511	24,204	27,334	30,534	33,349	36,399	151%	575	822	983	1,142	1,274	1,417
		V/C Ratio								0.14	0.21	0.25	0.29	0.32	0.35
I-5	Siskiyou County Line	Volume	18,800	22,228	24,931	27,723	30,241	32,959	75%	0	1,010	1,141	1,272	1,384	1,504
		V/C Ratio								0.00	0.25	0.29	0.32	0.35	0.38
SR 44	W. of I-5	Volume	52,000	52,947	59,012	62,340	64,566	67,559	30%	3,197	2,922	3,371	3,549	3,745	3,867
		V/C Ratio								0.76	0.70	0.80	0.85	0.89	0.92
SR 44	E. of Victor	Volume	37,086	37,129	38,517	41,019	43,099	46,520	25%	1,888	2,118	2,170	2,267	2,427	2,611
		V/C Ratio								0.45	0.50	0.52	0.54	0.58	0.62
SR 44	E. of Wilson Hill	Volume	4,123	4,568	5,097	5,717	6,470	7,286	77%	193	209	237	276	325	386
		V/C Ratio								0.15	0.16	0.18	0.21	0.25	0.30
SR 151	E. of Cascade	Volume	13,100	15,370	16,827	19,611	21,789	23,882	82%	705	834	881	993	1,074	1,132
		V/C Ratio								0.44	0.52	0.55	0.62	0.67	0.71
SR 273	N. of Deschutes	Volume	9,100	12,045	12,470	12,732	15,376	20,750	128%	434	529	562	788	941	1,102
		V/C Ratio								0.24	0.29	0.31	0.44	0.52	0.61
SR 273	S. of Quartz Hill	Volume	20,500	22,884	24,813	26,989	29,192	30,833	50%	1,165	1,331	1,406	1,447	1,506	1,566
		V/C Ratio								0.73	0.83	0.88	0.90	0.94	0.98
SR 299	W. of Ridge	Volume	10,963	11,372	11,791	12,289	15,588	16,058	46%	512	540	552	570	785	807
		V/C Ratio								0.32	0.34	0.35	0.36	0.49	0.50
SR 299	E. of Old Oregon	Volume	10,000	9,723	9,863	10,200	10,694	10,972	10%	592	564	570	600	617	672
		V/C Ratio								0.30	0.28	0.29	0.30	0.31	0.34
SR 299	E. of Black Ranch	Volume	6,500	6,831	7,197	7,508	7,657	7,801	20%	0	285	310	325	323	318
		V/C Ratio								0.00	0.22	0.24	0.25	0.25	0.24

Regional Performance Measures

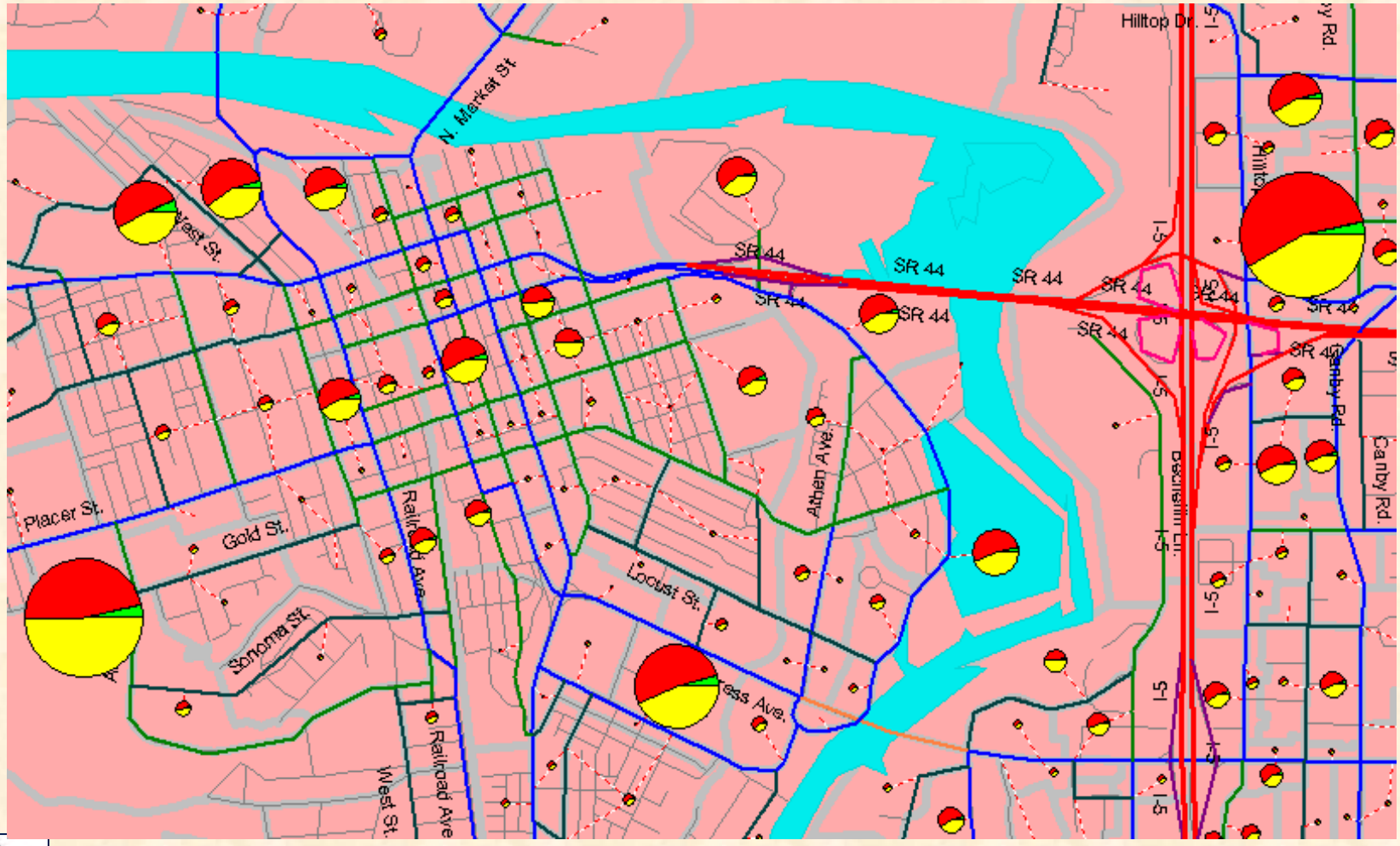
	Vehicle Miles of Travel (VMT)	Vehicle Hours of Travel (VHT)	Vehicle Hours of Delay (VHD)	Average Speed (miles per hour)		
Year	Daily	Daily	Daily	A.M. Peak Period	P.M. Peak Period	Off-Peak
2004	5,315,000	127,600	4,000	39.3	38.7	42.3
2005	5,395,000	129,700	4,400	39.3	37.8	42.3
2010	5,995,000	140,900	3,700	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

Level of Service

- Based on average segment capacities
- Not intersection analysis

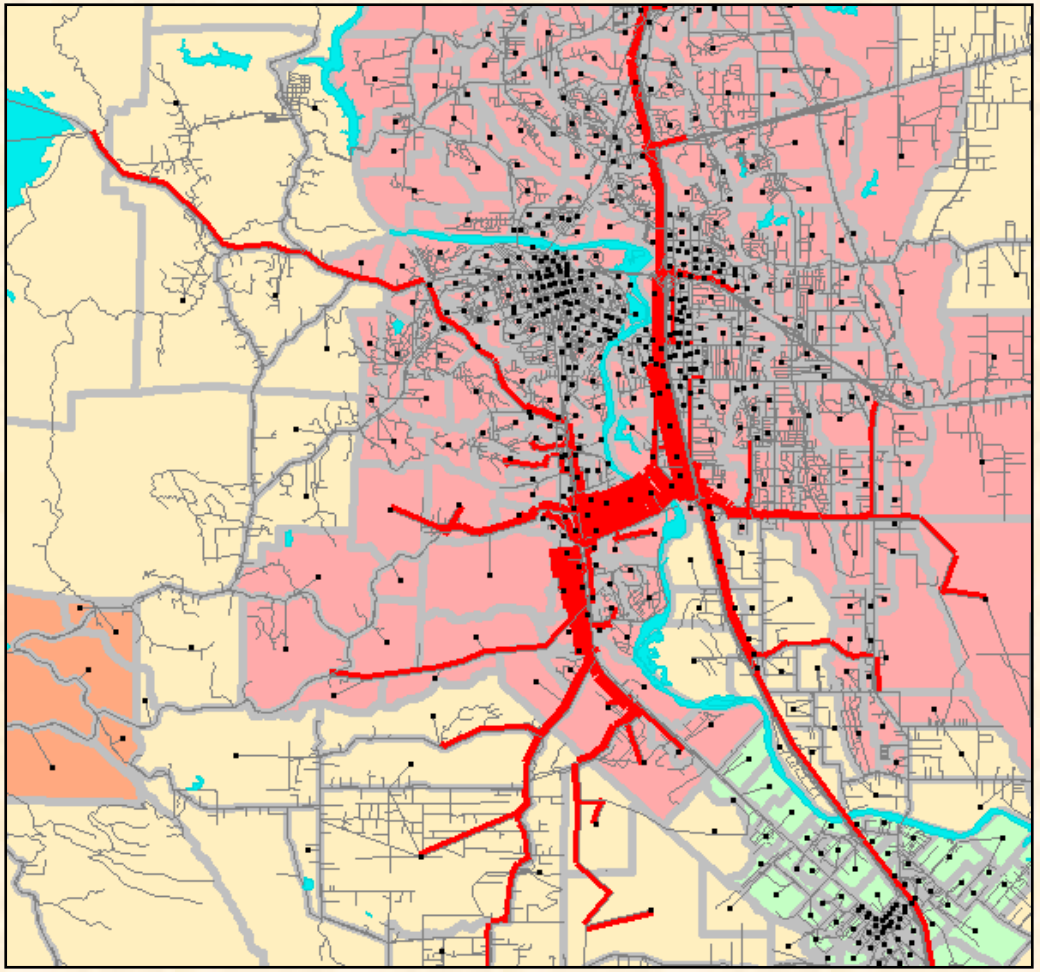


TAZ Data – Example: Mode Shares



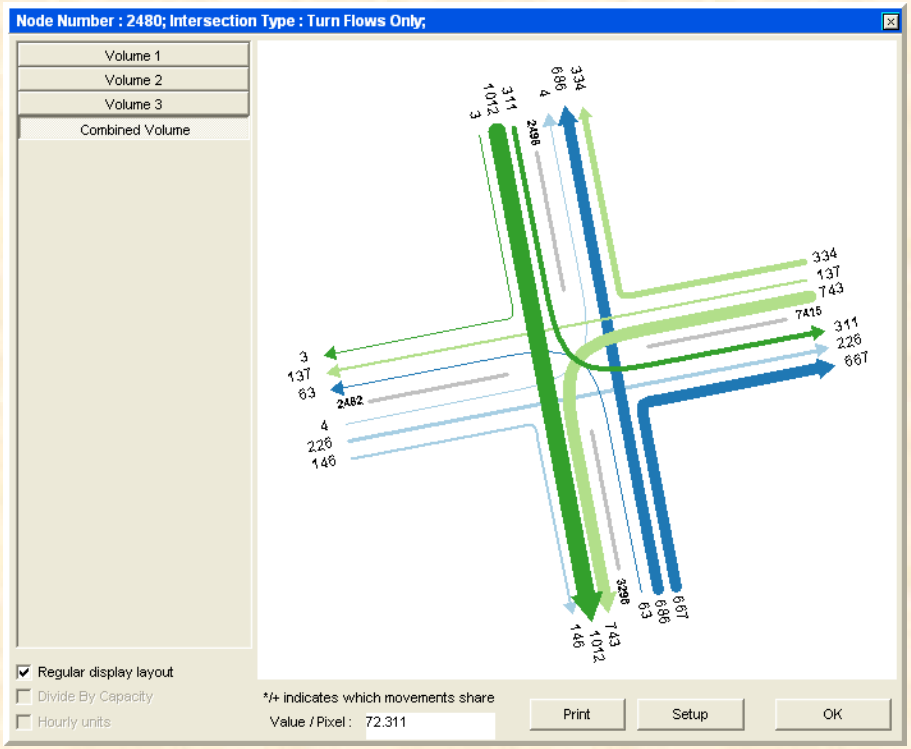
Select Link Trips

- Trace origins and destinations for trips on South Bonnyview



Intersection Turns

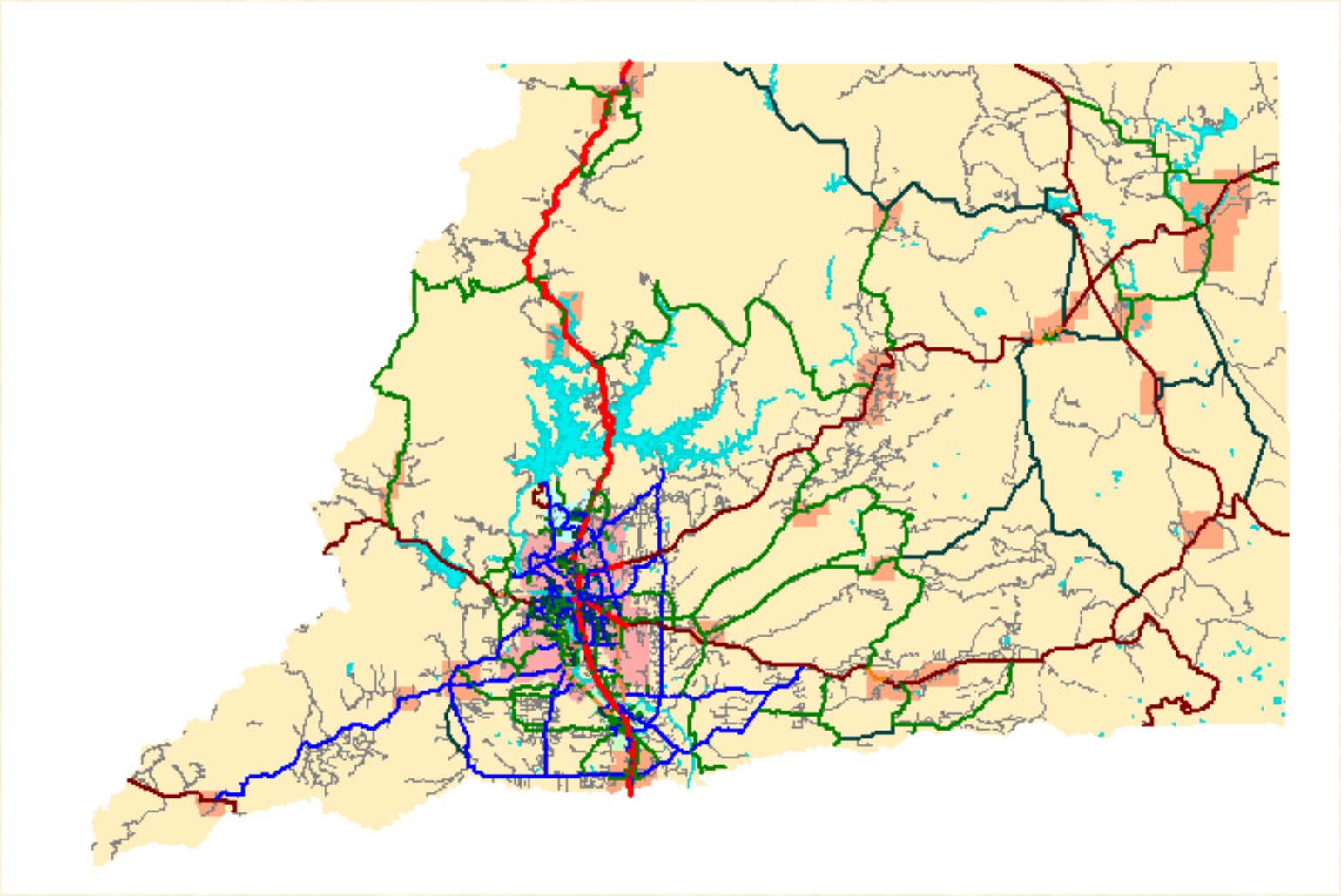
- Generally do not use directly from model
- Main problem is aggregation to TAZs



Adjustment Processes

- Built-in ODME (Origin Destination Matrix Estimation)
  - Adjustments applied to 2004 base year only
  - Base year (2004) trip origins and destinations were adjusted to better match traffic counts
- Forecasts use increments from UNADJUSTED 2004 to UNADJUSTED forecast year
  - Added to ODME adjusted 2004 trips
  - Maintains model sensitivity to land use and networks

Additional Slides



Trip Generation

- Divide into trip purposes:
  - Why? Different lengths in trip distribution
  - Example: Home-Work, Home-Shop, Non-Home
- Rates often based on household diaries
  - Probably okay for daily commute trips
  - People may leave out many short trips

P's and A's – Yikes!

- Every trip at the home end (Production) should match up with a trip at the non-home end (Attraction)
- Every model handles imbalances differently
  - Many keep P's constant, factor A's to match
  - Can make jobs disappear by factoring down A's
  - Dowling alternative – don't factor within study area, make up difference from outside study area

Comparison with ITE

- Regional travel rates are often much lower, particularly for retail
- ITE Trip Generation uses vehicles, not persons
- **OPINION:** ITE driveway counts pick up many short trips which are not recorded well in surveys or left out of regional models
- Amazingly, the number of trips assigned to major streets can be identical using either set of rates

Trip Distribution

- "Gravity Model" is most common
  - Trips proportional to trip ends in TAZs
  - Inversely proportional to travel time
- Friction Factors
  - Old-style lookup tables
  - Newer models generally use formulas
- K-Factors
  - Adjustments for specific pairs of TAZs
  - Supposed to represent factors other than travel time – bridges, language barriers, etc...
  - Commonly abused, but far from the worst thing we can do

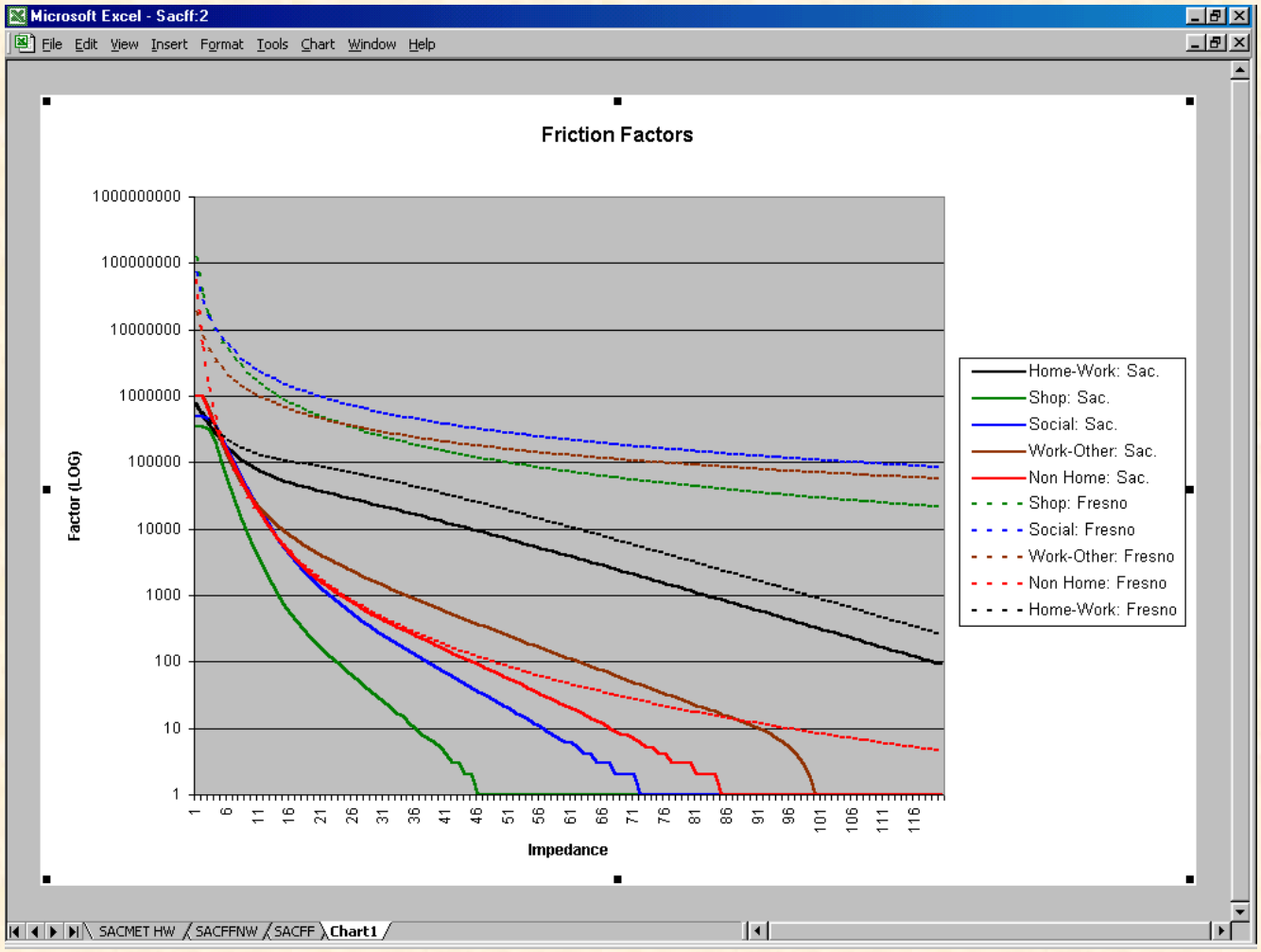
Gravity Model Formula

- Proportion of Zone A productions going to Zone B attractions =

$$\frac{\text{Zone B Attractions} * \text{(Friction Factor for A to B)}}{\text{Sum of all [Zone x Attractions} * \text{Friction Factor for A to x]}}$$

- Iterate until Attraction ends add up to correct totals

Distribution Factors



Mode Choice

- "Mode Split" implies trips can be split based on travel times, costs
- "Mode Choice" implies that characteristics of traveler are important
- Significantly increases model complexity
- Need to consider personal characteristics – income, etc...

Logit Model Formula

$$P(a) = \frac{\exp(U_a)}{\sum_j \exp(U_j)}$$

where:

P(a) = Probability of choosing mode "a".

exp = The exponential function "e" (2.71).

Ua = The utility of mode "a".

Trip Assignment

- Network attributes
  - "Free-flow" (11 P.M.) speeds
  - Capacities
    - LOS E or C? Older models use C
  - Volume-delay functions
    - Relate speed to V/C
    - Older models based on LOS C capacities!
    - What happens when V/Cs are >1.2 or so?
- Iterative process
  - Equilibrium – no drivers can switch routes and find a faster route
  - How many iterations to remove "lumps"?

Validation Tools

- Check specific land uses
- Adjust assumed “free-flow” speeds within reasonable limits
- Adjust zone connectors
- Adopt adjustment process so that model is used for growth increments rather than absolute volumes

Validation Tools (2)

- ODME (Origin-Destination Matrix Estimation)
- Factor initial trip table from standard process to match counts on links
- Makes validation look better
- How do you apply it to the future?
  - Factors? Increments?