



CAMBRIDGE
SYSTEMATICS

Think  Forward

District Modeling Support

Kick-Off Meeting

presented to

District 12 Staff


presented by

Cambridge Systematics, Inc.

Ron West & Sean McAtee

February 1, 2016

Morning Agenda

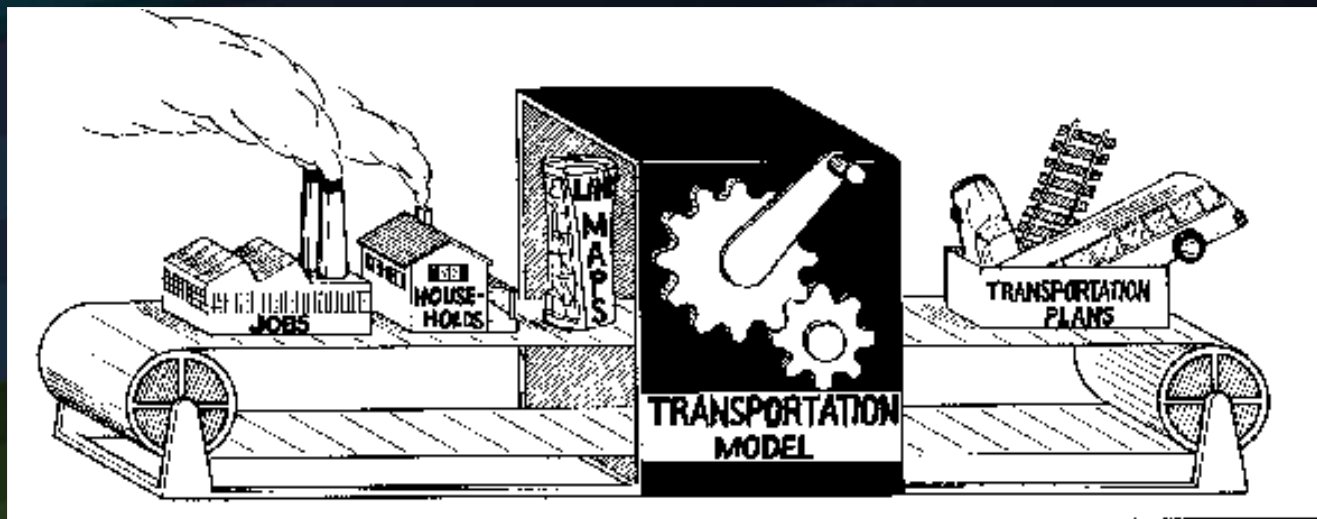
- About our team
- Modeling basics
 - » Opening the black box
 - » Example applications
- Travel model The graphic consists of two circular icons with a peeling effect at the bottom. The left icon is green and contains the word "Do" in yellow. The right icon is orange and contains the word "Don't" in red. A large black ampersand "&" is positioned between the two icons. Below each icon is a small white letter "s".
 - » Modeling at District 12
 - » Discussion with managers and modelers

Task Order Team

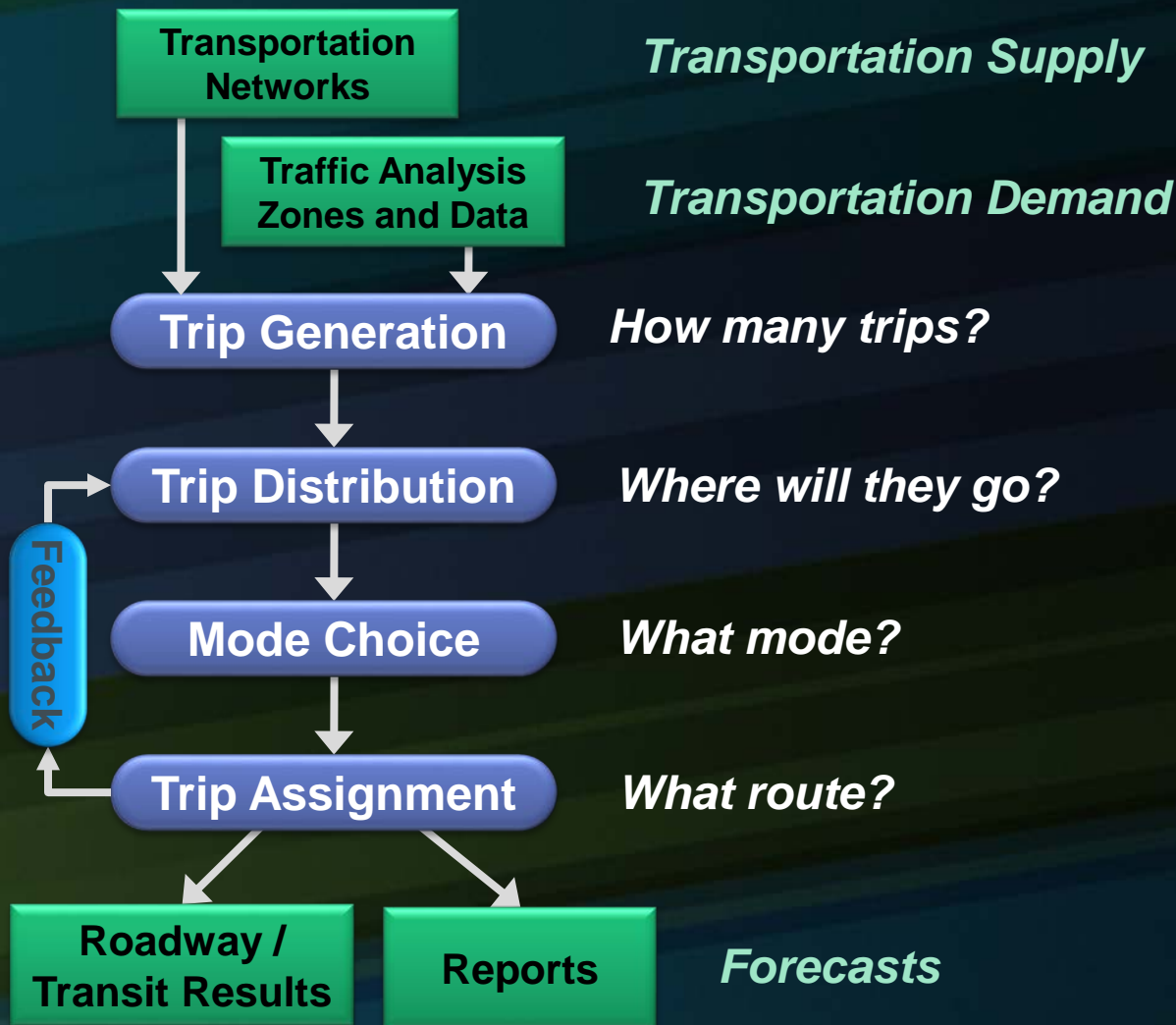


Travel Modeling Basics

Opening the Black Box



The Four Steps



Model Inputs and Outputs

Inputs

Transportation
Networks

Socioeconomic
Data

External
Data

Special
Generators

Model
Parameters



Outputs

Trips by
Mode

Traffic
Volumes

Congested
Speeds

Transit
Volumes

Summary
Information

Model Inputs and Outputs

Inputs

Transportation
Networks

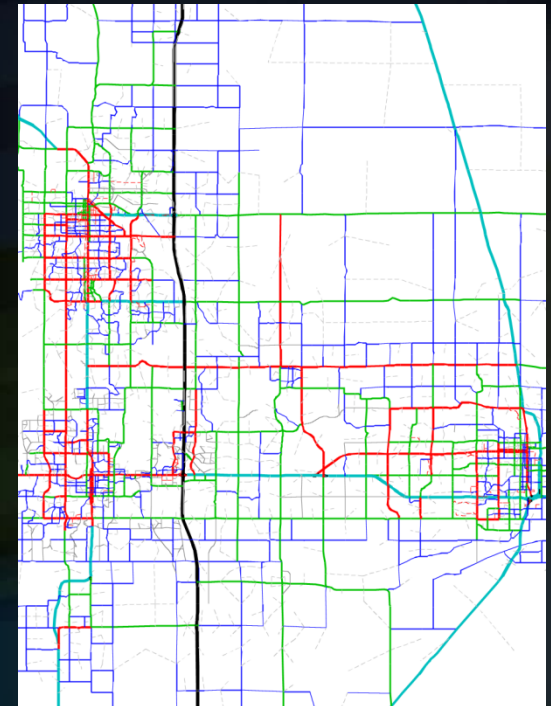
Socioeconomic
Data

External
Data

Special
Generators

Model
Parameters

- Roadway Networks
 - » Contains roadway characteristics
 - Number of Lanes
 - Roadway Type (Freeway, arterial, etc.)
 - Area Type (CBD, Urban, Suburban, Rural)
- Transit Networks
 - » All fixed route transit service
 - » The model is sensitive to transit level of service (frequency, speed, coverage)
 - » Local/Express Bus, BRT, Rail



Model Inputs and Outputs

Inputs

Transportation
Networks

Socioeconomic
Data

External
Data

Special
Generators

Model
Parameters

- Identifies **demand** for travel
- Household data
 - » Average household **size**
 - » Median household **income**
 - » Number of resident **workers**
 - » **Age** of household residents
 - » And more...
- Employment data
 - » By 13 industries
 - » By Wage level

Model Inputs and Outputs

Inputs

Transportation
Networks

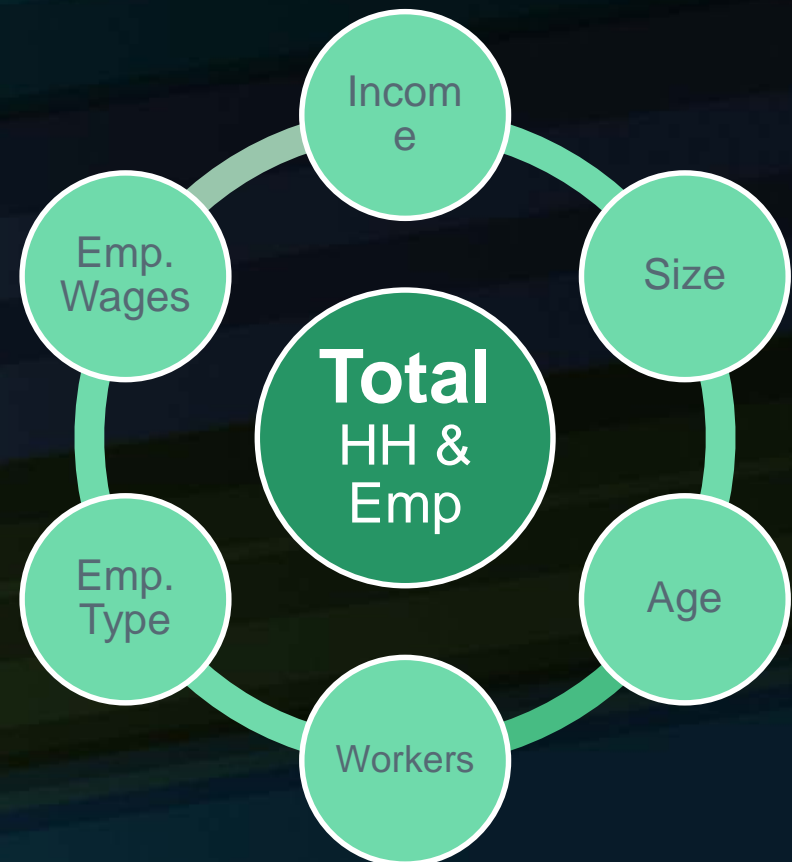
Socioeconomic
Data

External
Data

Special
Generators

Model
Parameters

- How Much Detail is Needed for scenario testing?
 - » Only totals are required



Model Inputs and Outputs

Inputs

Transportation
Networks

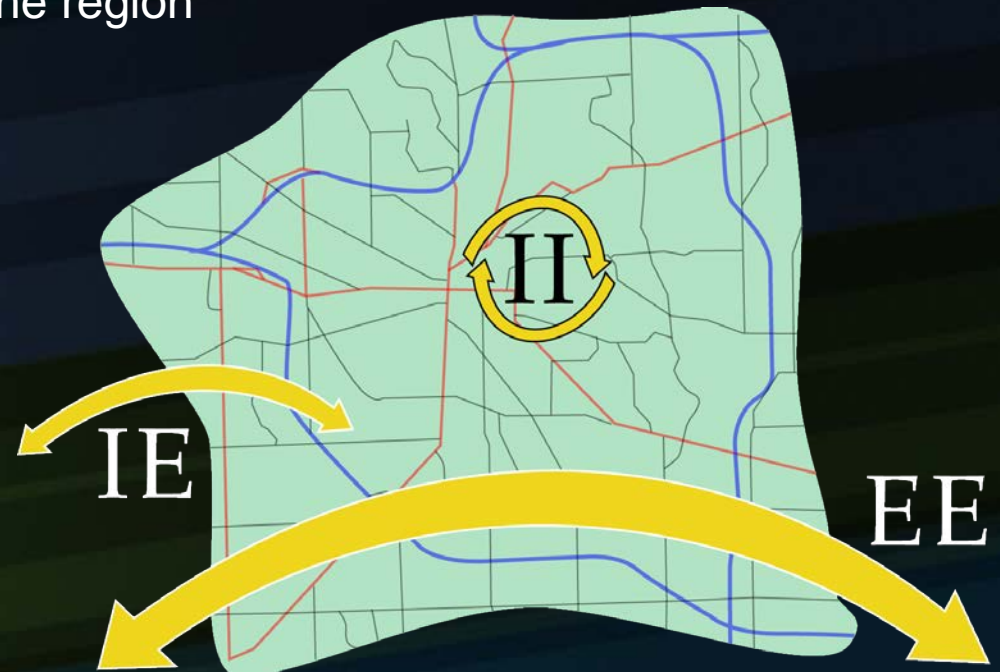
Socioeconomic
Data

External
Data

Special
Generators

Model
Parameters

- Model travel:
 - » To/from the region
 - » Through the region



Model Inputs and Outputs

Inputs

Transportation
Networks

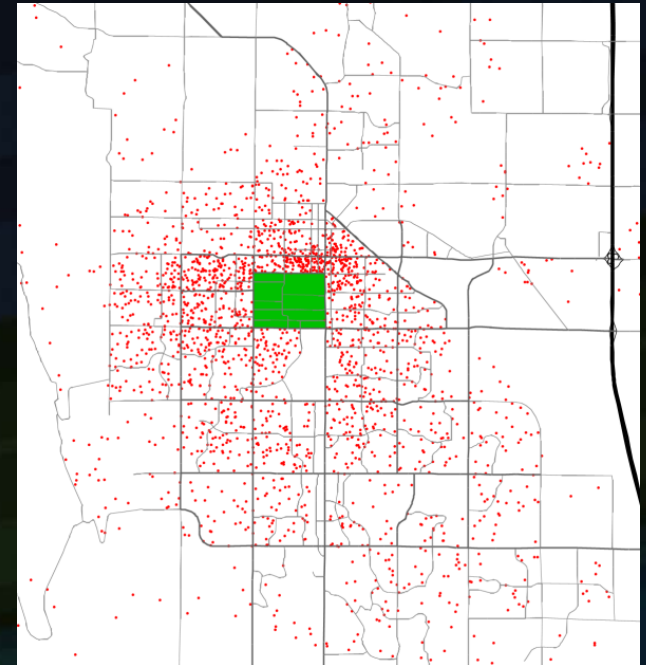
Socioeconomic
Data

External
Data

Special
Generators

Model
Parameters

- Unique locations not well represented by employment data
 - » SCAG's Special Generators:
 - Ports
 - Airports
 - » Potential Additional:
 - Large Warehouses
 - Specific study areas



Model Inputs and Outputs

Inputs

Transportation
Networks

Socioeconomic
Data

External
Data

Special
Generators

Model
Parameters

- Represent the way people behave
 - » How many trips are made?
 - » How far will people travel?
 - » What impacts decisions about travel mode?
 - » How does congestion impact travel?
- Source Data
 - » SCAG / Caltrans Household Travel Survey
 - » On-Board Transit Surveys
 - » Speed Surveys
 - » Big Data
 - » Validated to traffic counts



Model Inputs and Outputs

- Information about each trip
 - » Start/end
 - » Time of day
 - » Mode of travel
 - » Purpose of trip
 - » Trip time and distance

Outputs

**Trips by
Mode**

**Traffic
Volumes**

**Congested
Speeds**

**Transit
Volumes**

**Summary
Information**



Model Inputs and Outputs

- By Time of Day
 - » Daily
 - » AM, PM, Mid-Day, Evening, Night
 - » AM and PM Peak Hours
- Turn Movements
 - » Better estimated with assistance of base-year counts
- Congested speed based on volume

Outputs

Trips by
Mode

Traffic
Volumes

Congested
Speeds

Transit
Volumes

Summary
Information



Model Inputs and Outputs

- By Time of Day
 - » Peak and Off-Peak
 - » Daily sum
- By route or route group
 - » Also by stop, but with less accuracy
- Useful for Big-Picture transit analysis
 - » Detailed analysis requires localized model refinement
- Transit trips are removed from the highway network

Outputs

Trips by
Mode

Traffic
Volumes

Congested
Speeds

Transit
Volumes

Summary
Information



Model Inputs and Outputs

➤ Performance Report

- » Summaries of model results
- » Useful for planners and engineers

➤ Planning Tools

- » Maps and charts
- » Results presented for general understanding
 - VMT, VHT, Delay
 - Level of Service
 - Trip Lengths
 - Trip Patterns

Outputs

Trips by
Mode

Traffic
Volumes

Congested
Speeds

Transit
Volumes

Summary
Information



Example Applications

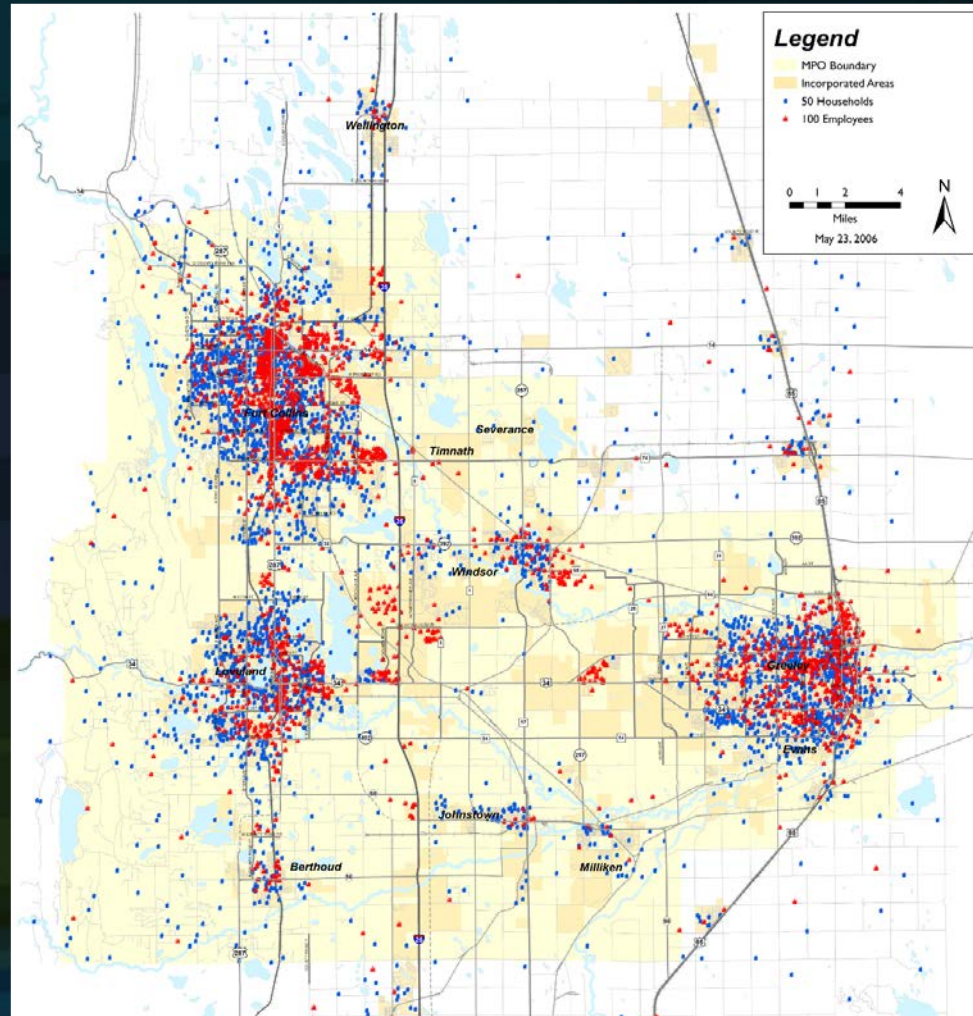
Model Inputs and Outputs

- The model can estimate level of service to help identify problem areas.

	Uncongested			Congesting	Congested	
	A	B	C	D	E	F
Driver Comfort	High	High	Some Tension	Growing Tension	Uncomfortable	Distressed
Average Travel Speed	Speed Limit	Close to Speed Limit	Close to Speed Limit	Some Slowing	Significantly Slower than Speed Limit	Significantly Slower than Speed Limit
Maneuverability	Almost Completely Unimpeded	Only Slightly Restricted	Somewhat Restricted	Noticeably Limited	Extremely Unstable	Almost None

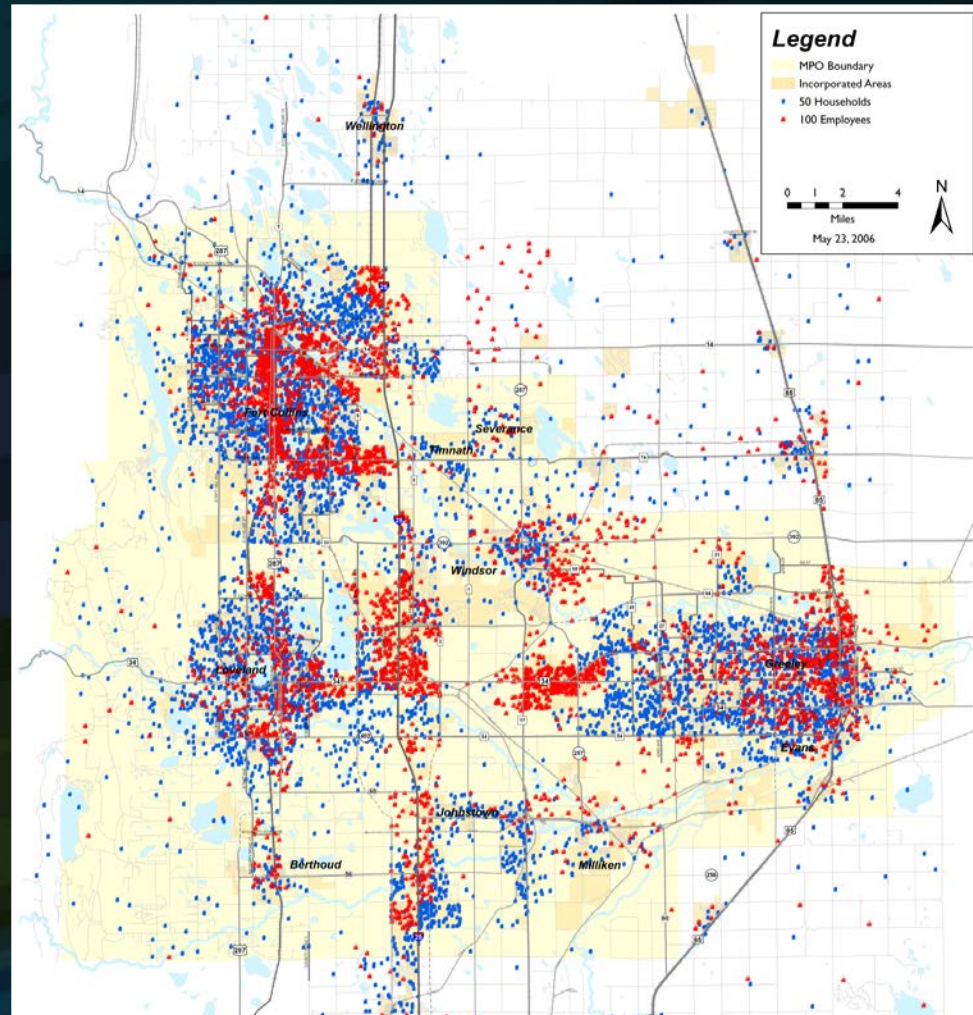
Household And Employment Growth

Today



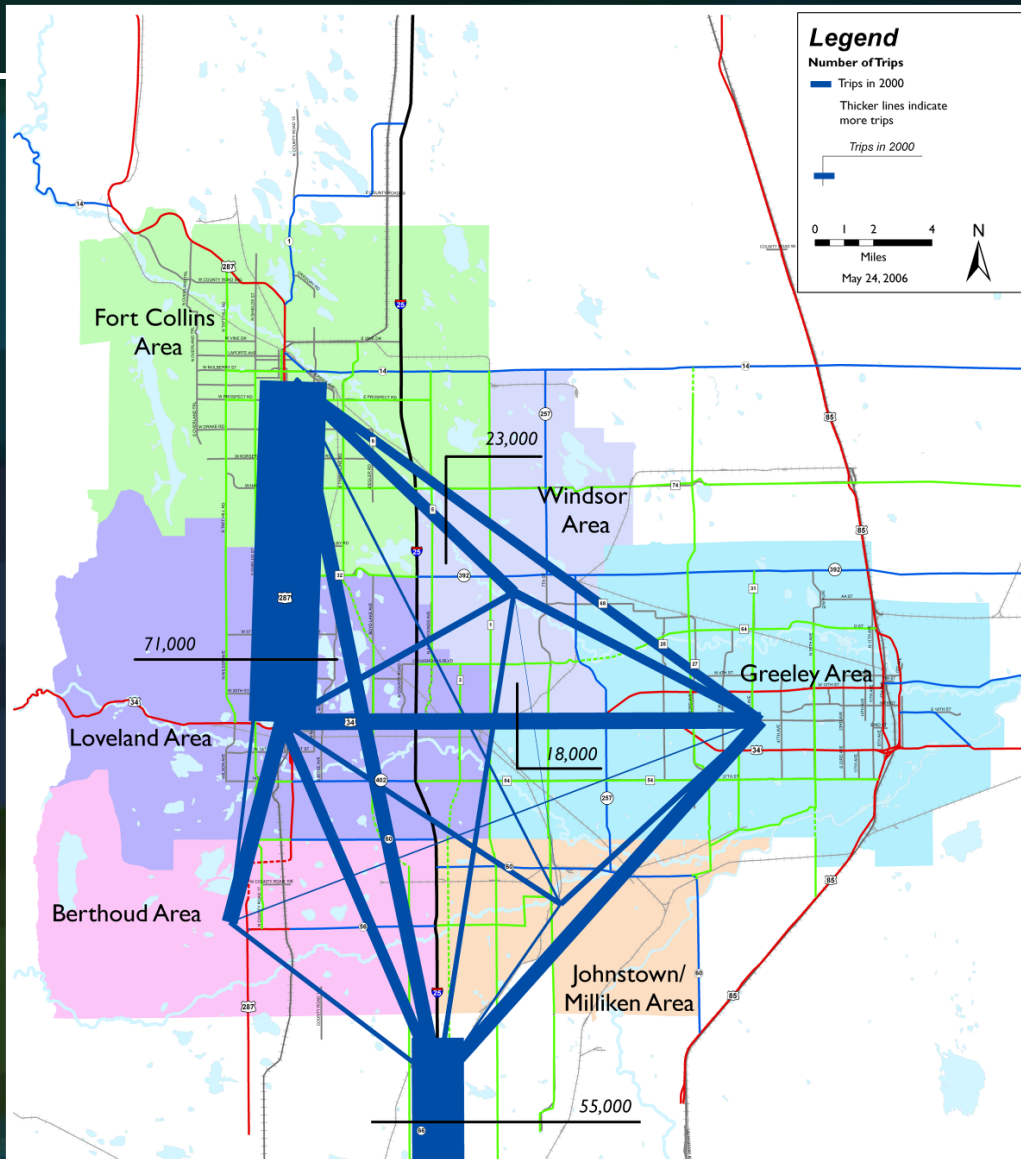
Household And Employment Growth

Future



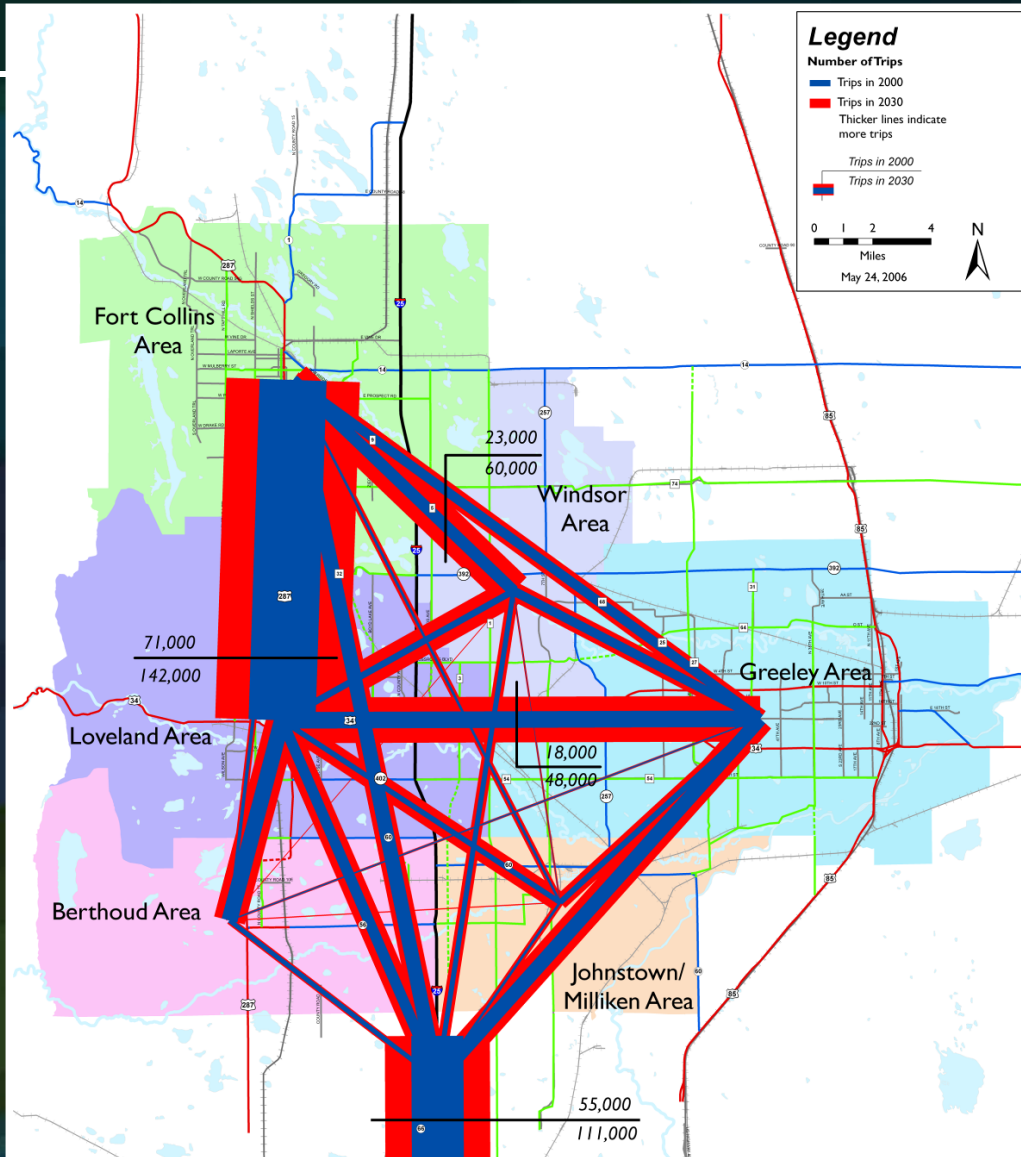
Travel Patterns

Today

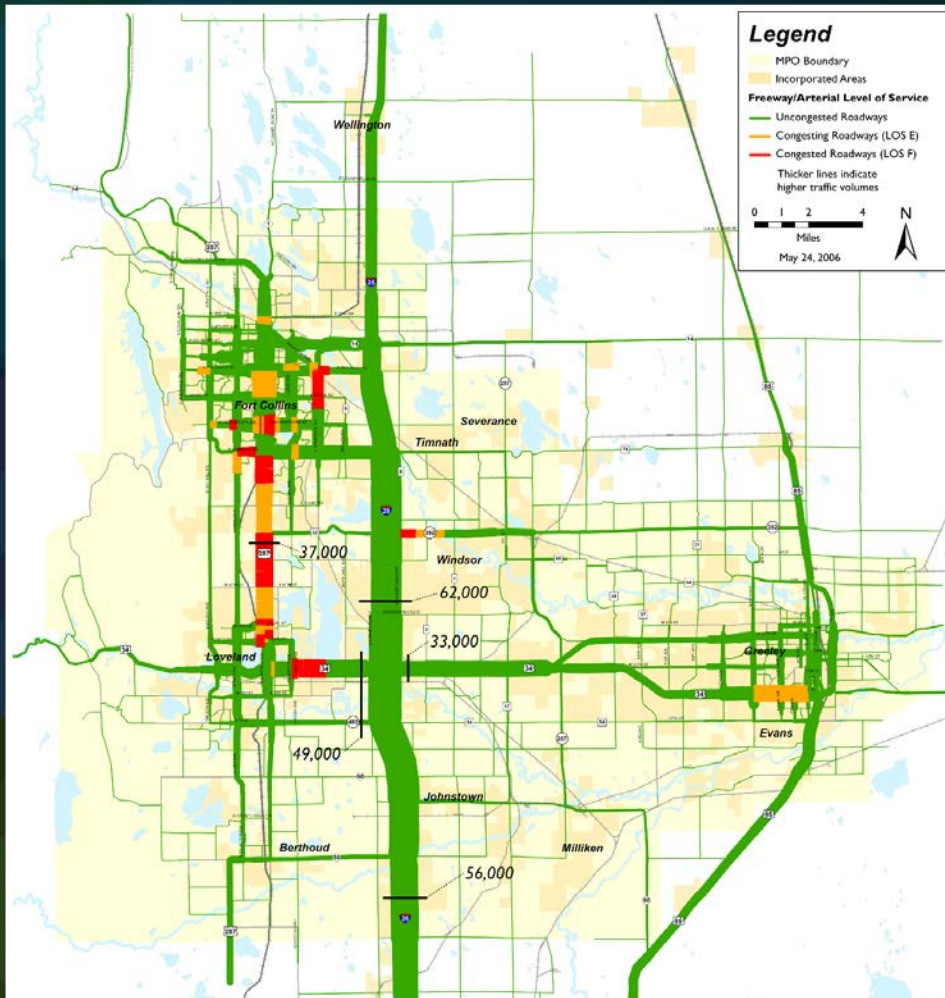


Travel Patterns

Future



Traffic Volumes And Congestion

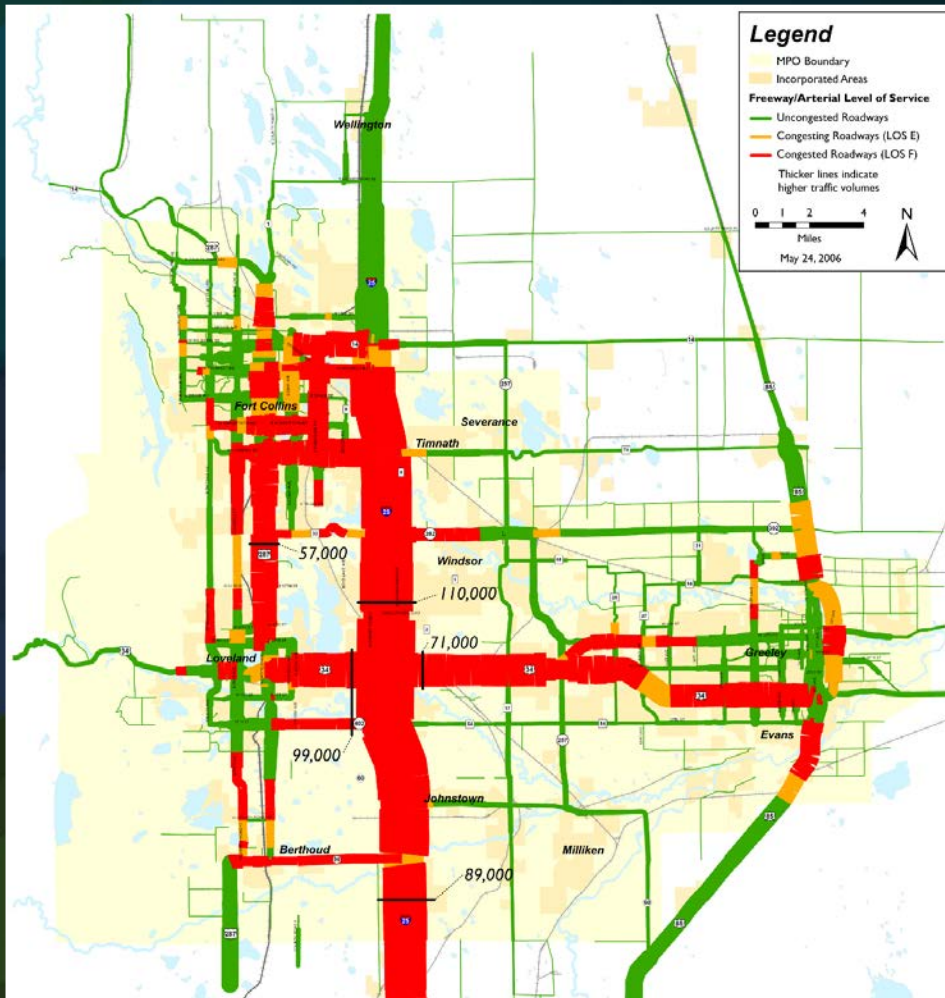


Today

Travel Times			
From/To	Today	2030	Increase
Fort Collins to Denver	73 Minutes	119 Minutes	46 Minutes (63%)
Fort Collins to Greeley	37 Minutes	49 Minutes	12 Minutes (32%)
Greeley to Loveland	29 Minutes	39 Minutes	10 Minutes (34%)
Berthoud to Windsor	24 Minutes	37 Minutes	13 Minutes (54%)



Traffic Volumes And Congestion



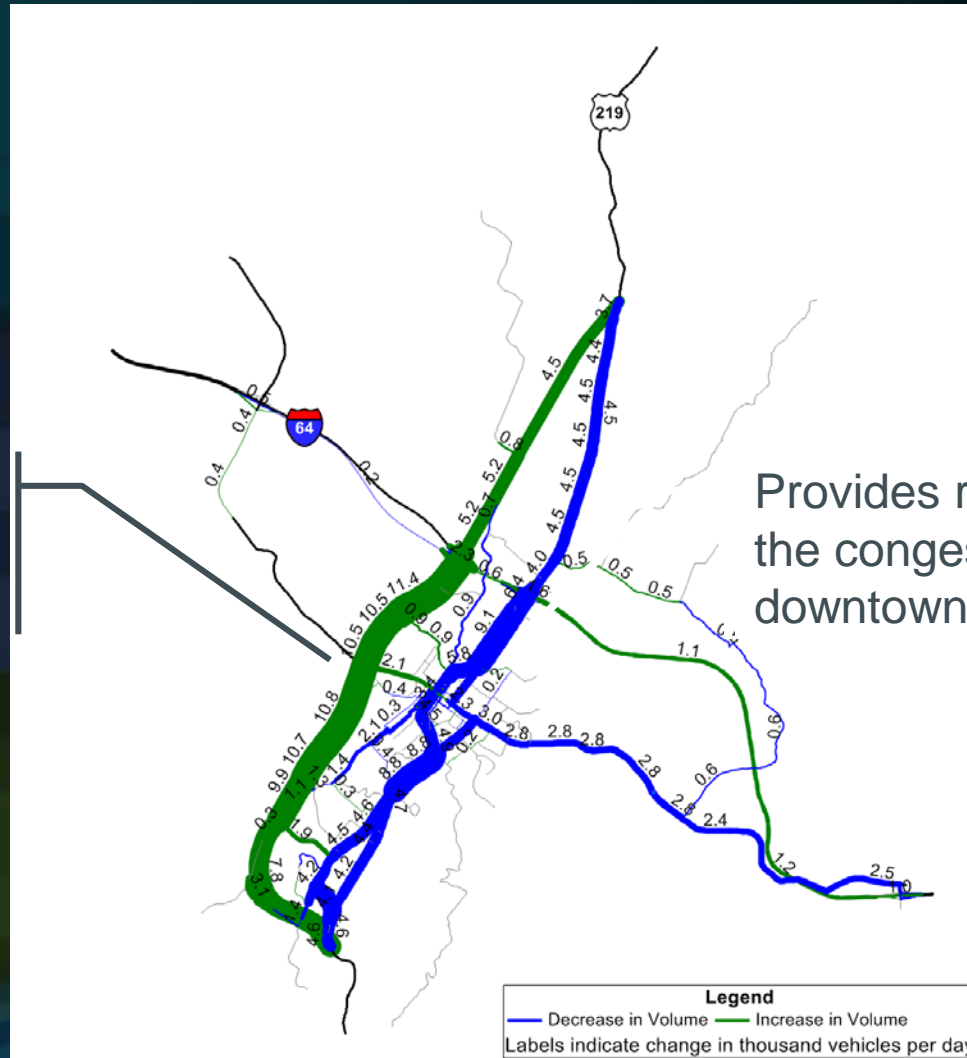
Future

Travel Times			
From/To	Today	2030	Increase
Fort Collins to Denver	73 Minutes	119 Minutes	46 Minutes (63%)
Fort Collins to Greeley	37 Minutes	49 Minutes	12 Minutes (32%)
Greeley to Loveland	29 Minutes	39 Minutes	10 Minutes (34%)
Berthoud to Windsor	24 Minutes	37 Minutes	13 Minutes (54%)



Where Does The Traffic Go?

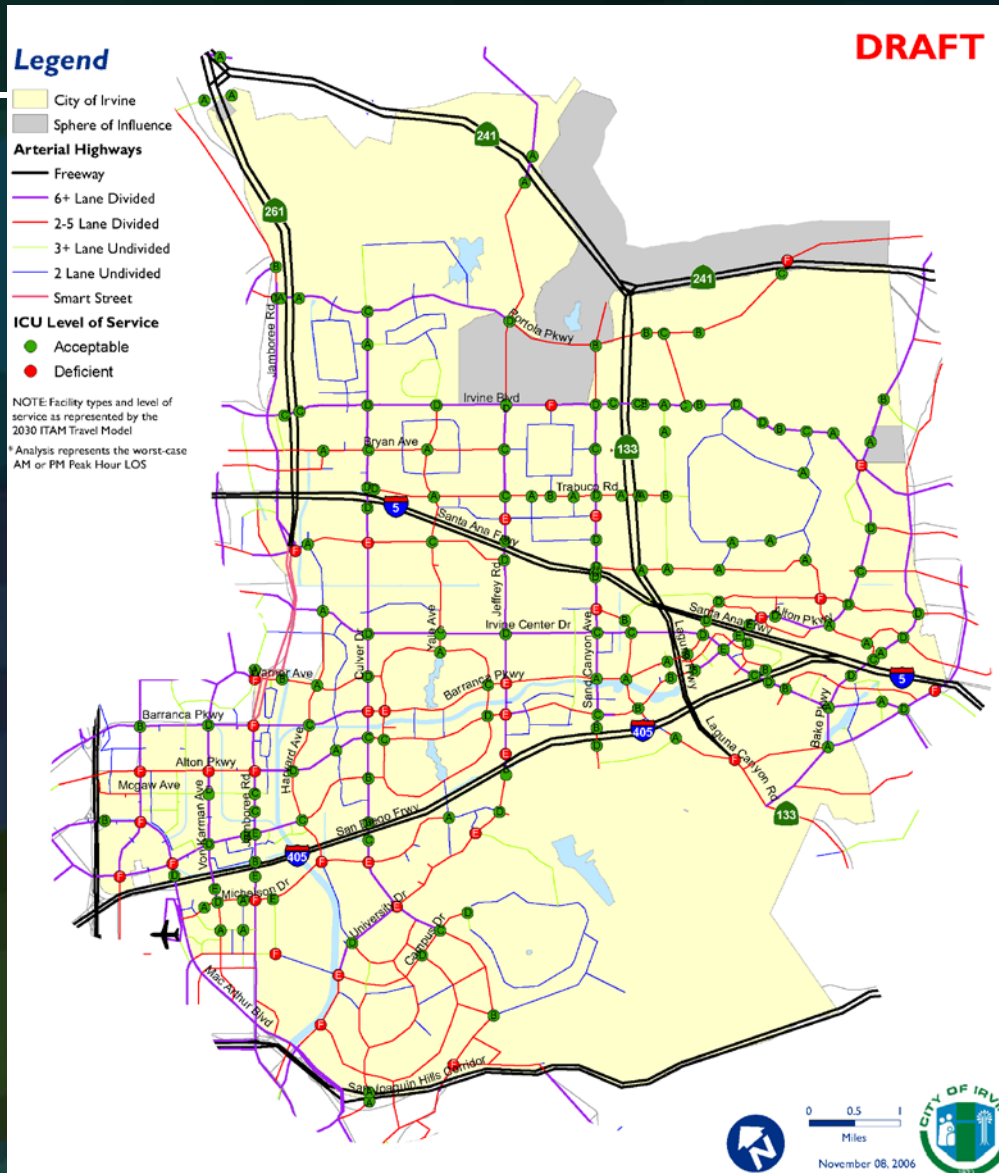
A new parkway serves through traffic



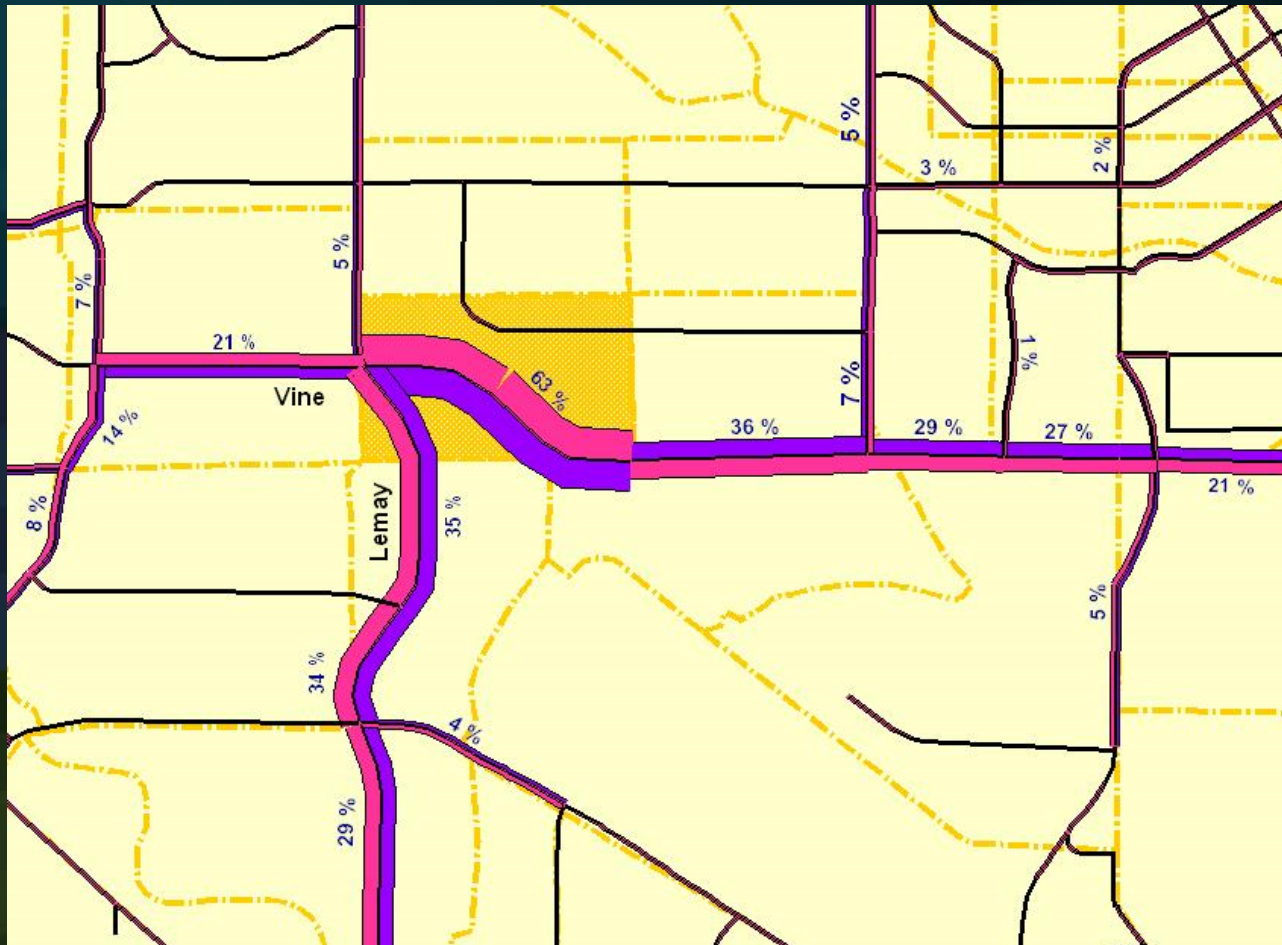
Provides relief in the congested downtown area



Intersection Los Reporting



Traffic Impact Analysis



Travel Model



Testing Demand Changes



- » Evaluate base, interim, and forecast year datasets
- » Consider testing large development proposals (e.g., over 200 households or employees)
 - Use the model's trip distribution to compare to traffic study assumptions
 - Cross-check development model runs with ITE-based traffic studies



- » Use the model to test very small developments
- » Test unreasonable changes to the jobs/housing balance



Testing Roadway Changes



- » Test large and medium-scale capacity changes
- » Test different roadway alternatives
- » Test a comprehensive roadway plan
- » Test various corridor configurations



- » Test scenarios that do not impact system capacity
- » Try to model very small capacity or speed changes
- » Rely on the demand model to test interchange configurations

Non-motorized Results



- » Focus on potential non-motorized demand
 - E.g., 1, 2, and 5 mile trip bandwidths
 - Identify good places for infrastructure improvements
- » Consider non-motorized model results to be a rough estimate
 - The model is only one tool to aid in analysis



- » Expect detailed numbers
 - YES: “There is a high demand for a new bike lane in this corridor”
 - NO: “This new bike lane will result in X new bike trips”



Transit Results



- » Evaluate major system adjustments
- » Test large route changes
- » Focus on a system-wide results



- » Test fine tuning of route alignments
- » Expect detailed forecasts by transit route or transit stop
 - This information is available, but must be interpreted carefully by a transit professional



Traffic Results



- » Post process traffic volumes based on counts
- » Focus on forecast **growth** rather than values
- » Consider corridors as a whole
- » Use the model to plan freeways, expressways, and arterials

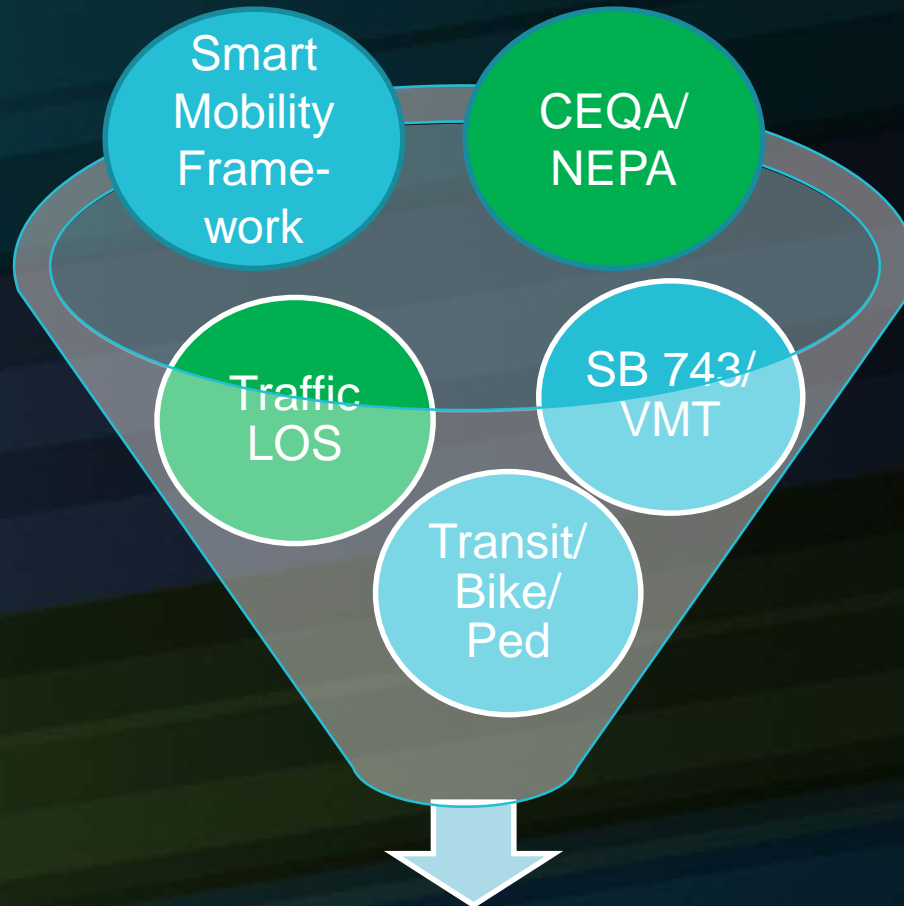


- » Rely on raw model volumes
- » Expect detailed collector and intersection forecasts
 - This information is available, but must be interpreted and may require additional post processing



***District 12 Modeling
Activities***

A Changing Planning Framework

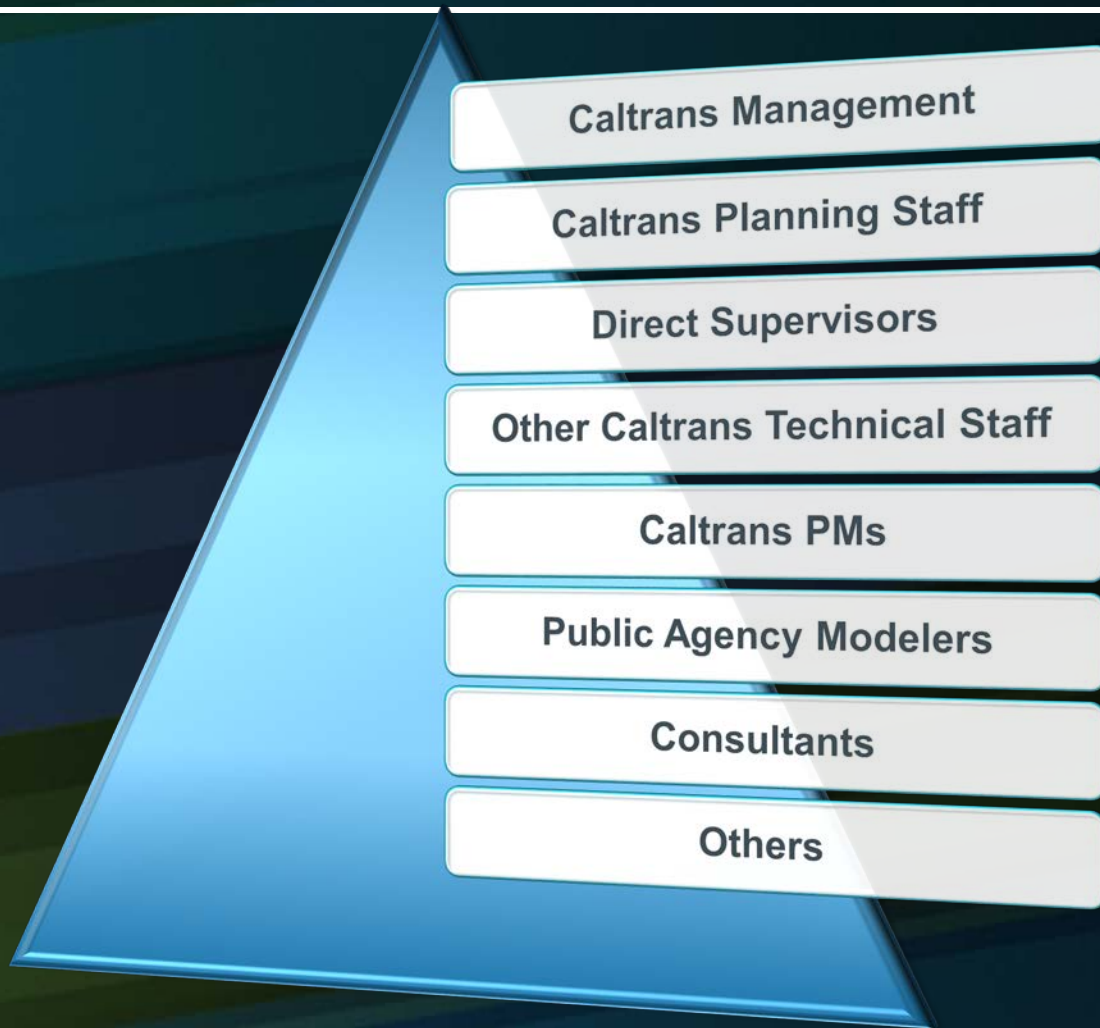


Caltrans Planning/Project Delivery

District 12 Modeling Context

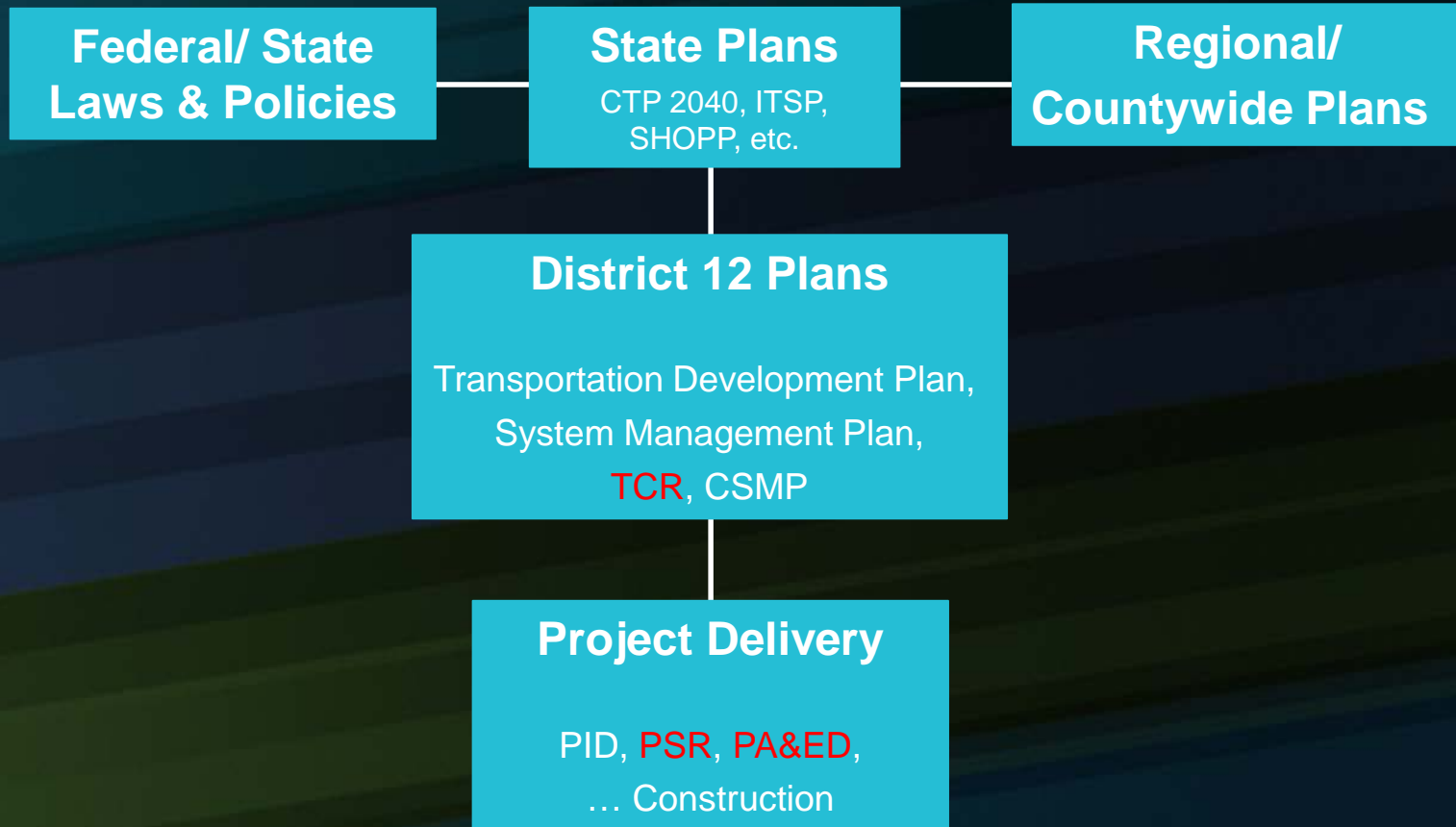
- Staff resources/ staff retention
- District modelers generally *apply* models (forecasting)
- MPO/County models increasingly complex
 - » SB 743, AB 32, SB 375
 - » OCTA Model (OCTAM)
 - SCAG Model
 - » Model updates – SCAG 2016 RTP/SCS is coming soon

Modeling Group as Service Bureau



Time sensitive
Critical path
Credible

District Planning Process



Project Delivery



Modeling activities are generally front-loaded:
This applies for both project delivery and for planning activities

Transportation Concept Reports

- All State Highways
 - » Updated periodically
- Generally straightforward data requirements – Except when they are not
 - » CSMP
- Base year / Horizon year
- Auto / Truck splits
 - » AADT
 - » Peak hour splits
 - » VMT
 - » LOS, V/C
- Alternative modes
 - » Including express lanes

TCR Example

Segment 1 ~ PM 10.00 - 11.76



NON-MOTORIZED	REGIONAL RAIL
No designated facility	Amtrak and Metro link operates inland with the nearest stations 3-6 miles away in San Juan Capistrano and Laguna Niguel.
PARK and RIDE	BUS ROUTES
Nearest facilities are the Laguna Hills Transportation Center and I-5 at Junipero Serra.	OCTA – Routes 85, 91 and 490 cross the SR 73.

SYSTEM DESIGNATIONS	
State Scenic Highway	No
MPAH Designation	N/A
Federal Designation	Freeway
Local Coastal Program	Yes

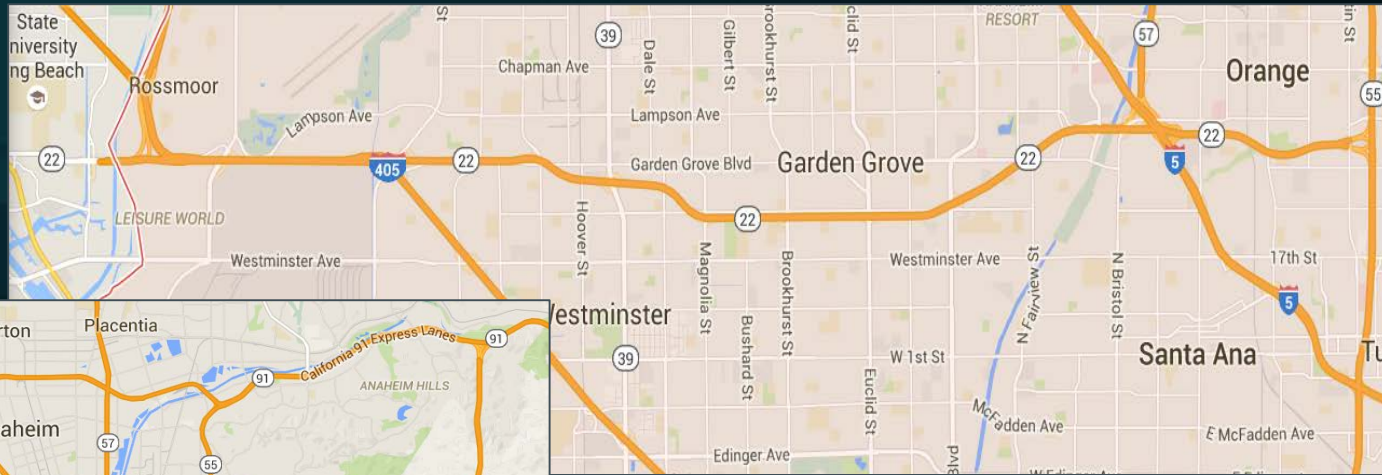
PHYSICAL CHARACTERISTICS		
Direction	SB	NB
Number of Lanes	3	3
Lane Widths	12'	12'
Inside Shoulder Type	Paved	Paved
Inside Shoulder Width	10'	10'
Outside Shoulder Type	Paved	Paved
Outside Shoulder Width	10'	10'
Sidewalks	No	No
On-Street Parking	No	No
Median Type	Barrier	
Median Width	88-99'	
Terrain	Flat	
Divided / Undivided	Divided	
Posted Speed Limit	65	
Number of Signalized Intersections	0	
Pavement Condition	No Distress Observed	

ANNUAL AVERAGE DAILY TRAFFIC	
Current	39,200
2035	70,000
PEAK HOUR VOLUMES	
Current	4,450
2035	7,966
TRAFFIC PROFILE	
Peak Hour Direction Distribution	55%NB
Traffic Growth/Year	3.16%
TRUCKS	
Truck Percentage of ADT	2%
Truck Percentage of Peak Hour	2%
LEVEL OF SERVICE	
2010 (Existing)	B*
2035 (No Build)	C*
2035 (Improved)	N/A
VOLUME/CAPACITY	
2010 (Existing)	0.36*
2035 (No Build)	0.65*
2035 (Improved)	N/A

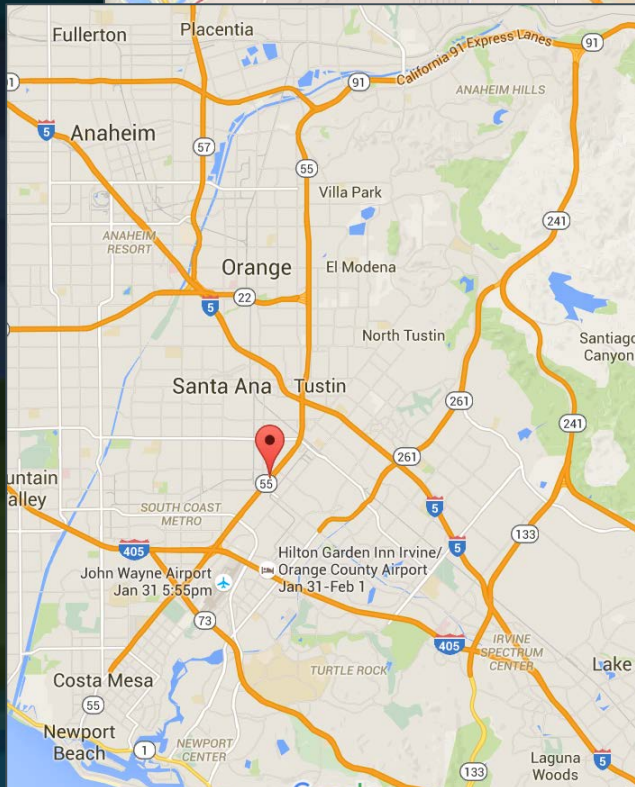
District 12 SR 73 TCR

Upcoming/In-Progress District 12 TCRs

➤ SR 22

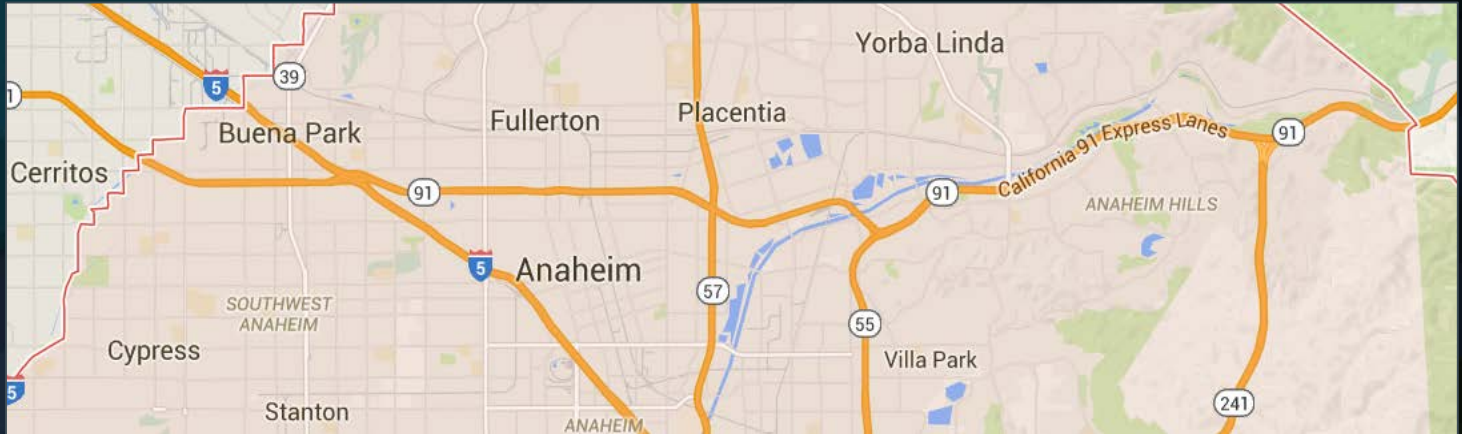


➤ SR 55

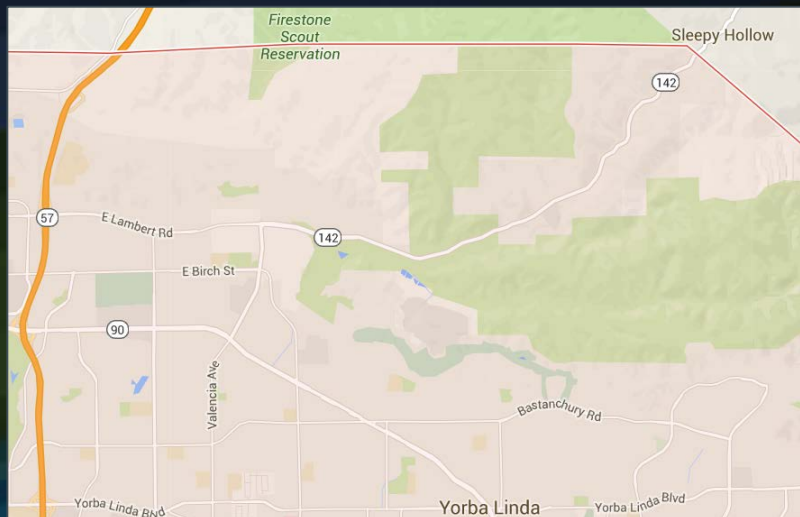


Upcoming/In-Progress District 12 TCRs

➤ SR 91



➤ SR 142



TCRs – Model Data

- Select roadway segments
- Observed Base Year Data
 - » Traffic Counts, PeMS, Caltrans Count Book
- Travel Model
 - » Base horizon + Horizon year
 - » Horizon year: With and without projects
- Adjust future forecasts
 - » Observed + model growth
- HCM
 - » For LOS – may involve Traffic Ops

Project Study Report

- Early Project Delivery Document
 - » Inform Purpose and Need
- Travel Model Forecasts Required
 - » Traffic counts collected specifically for project (plus off the shelf data - HPMS)
 - » Big Data (Origin-Destination)
- Base Year / Opening Year / Horizon Year
 - » Mainline, ramps, intersections
 - » Detailed, link level analyses
- Auto, truck, multimodal
- Traffic assignment to inform HCM
 - » Changes in VMT/GHG?

PSR Example

Segment		Type	Balanced 2040 No-Project	
From	To		AM Peak Hour (vph)	PM Peak Hour (vph)
Santa Anita Ave On-Ramp	Peck Rd SB Off-Ramp	Mainline	0	0
		Express	214	1,885
Peck Rd SB Off-Ramp		Off-Ramp	0	0
Peck Rd SB Off-Ramp	Peck Rd NB Off-Ramp	Mainline	6,114	4,933
		Express	214	1,885
Peck Rd NB Off-Ramp		Off-Ramp	521	704
Peck Rd NB Off-Ramp	Valley Blvd On-Ramp	Mainline	5,593	4,229
		Express	214	1,885
Valley Blvd On-Ramp		On-Ramp	234	167
Valley Blvd On-Ramp	Stewart St On-Ramp	Mainline	5,827	4,396
		Express	214	1,885

SR 60/I-605/I-10 PSR

Project Approval and Environmental Document

- Purpose & Need
- Environmental document
 - » CEQA, NEPA
 - Public review
- Travel model forecasts required – support traffic microsimulation
 - » Traffic counts collected specifically for project
 - » Big Data (Origin-Destination)
- Base year / Opening year / Horizon year
 - » Primarily trip tables to inform traffic analysis
 - Traffic assignment may be conducted
- Auto, truck, multimodal
- SB 743 – VMT analysis

Other Areas Where Model Data Is/Can Be Used

- Local government review/ IGR
- District System Management Plan
- Other elements

Morning Wrap-Up



PM Agenda

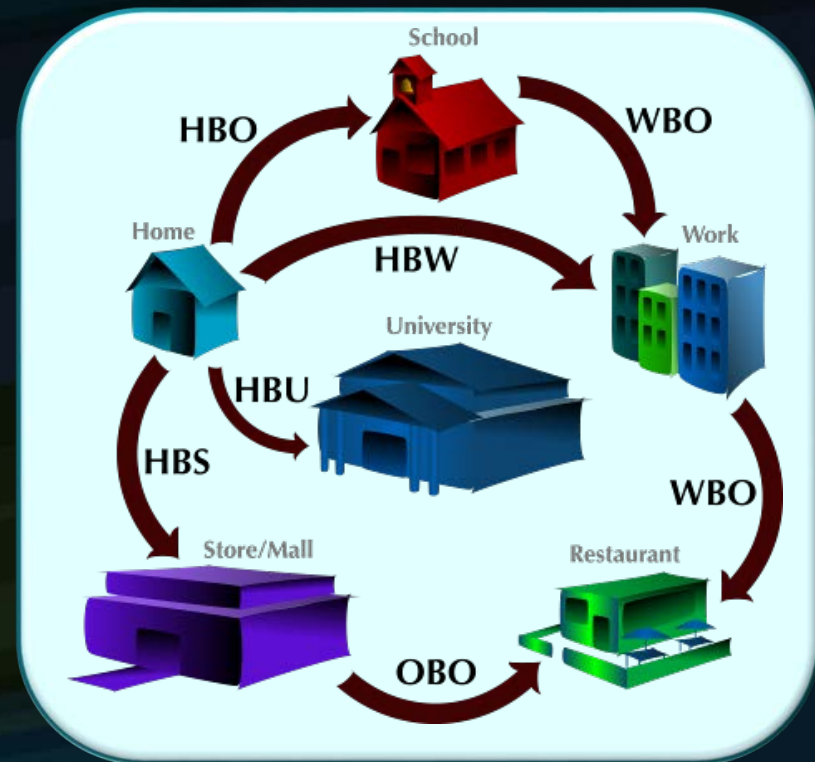
- Model steps
 - » Basic model components
 - » Recap of validation and post-processing
- Review of homework
 - » Separate presentation
- Next steps

Model Steps

Trip Generation: *How Many Trips?*

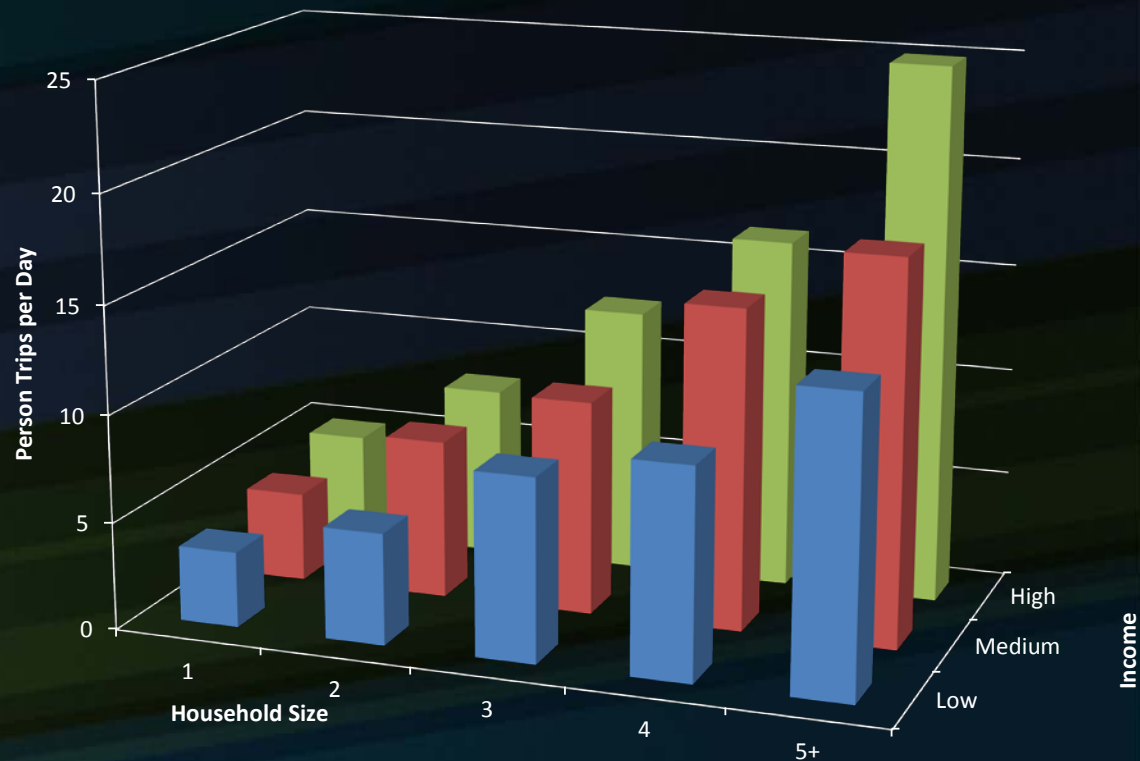
- Based on household survey
- Different trip purposes
- Generate all trips*
 - Walk
 - Bike
 - Transit
 - Auto

* *This is different than ITE Trip Generation, which only considers vehicle trips*



Trip Generation: *How Many Trips?*

- Cross-classified production rates
 - » Household size & income
 - » Household Workers & Income



Trip Distribution: *Where will they go?*

➤ Match

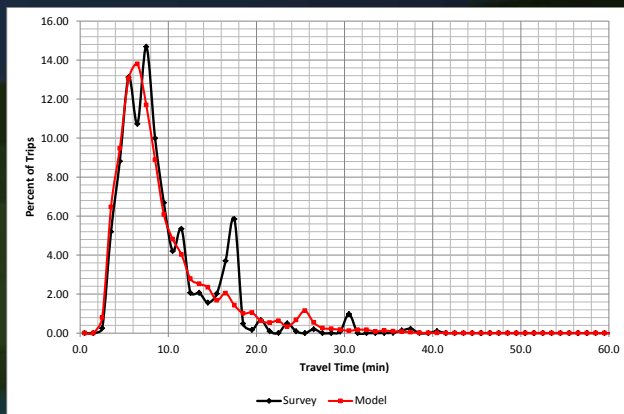
- » Productions & attractions



➤ Survey Data

- » Trip length distributions
- » Subregion to subregion patterns

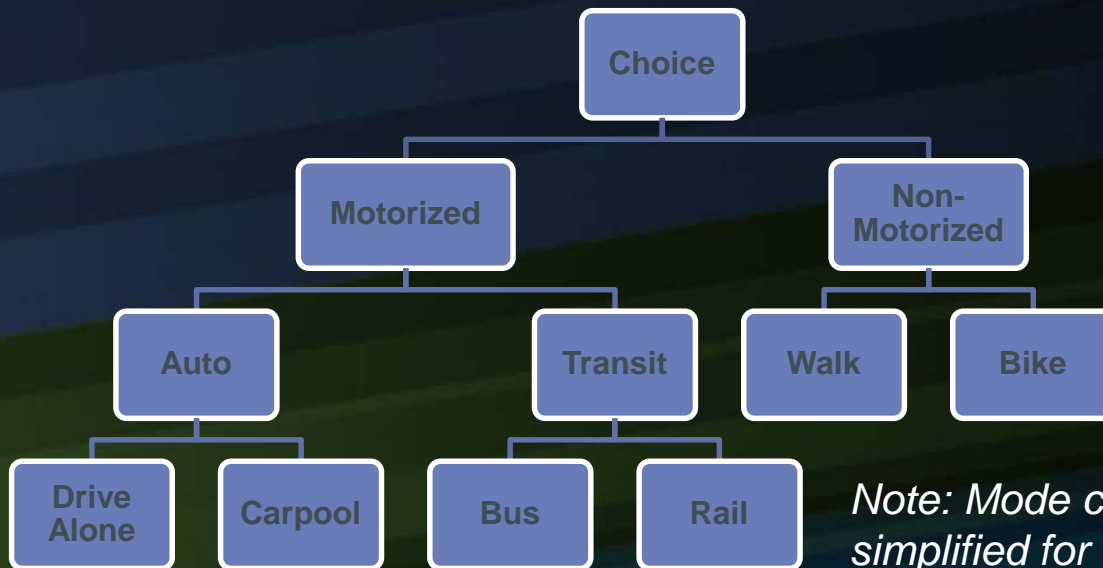
The *Gravity* concept can be used to model travel!



Mode Choice: *What Mode?*

- Nested Logit Model
 - » Consider all modes for each zone pair

Can I get a ride?
Is it close enough to bike?
How much \$ is parking?
How about the bus?

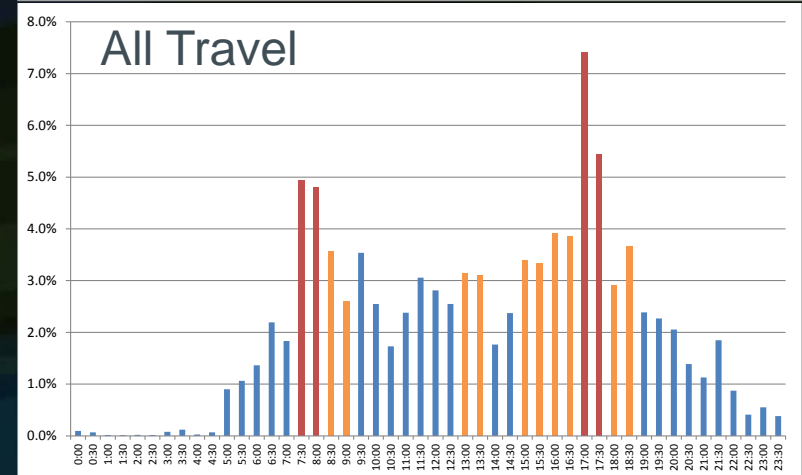
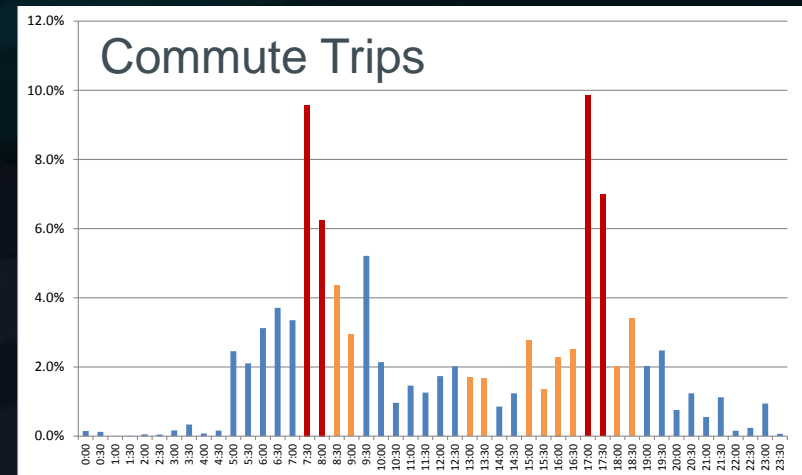


Note: Mode choice diagram is simplified for explanatory purposes



Traffic Assignment: *What Route?*

- 4 to 5 time periods (depending on model version)
- Account for localized and peak period congestion



***Model Validation /
Post-Processing***

Matching Counts

➤ How does the model work for today

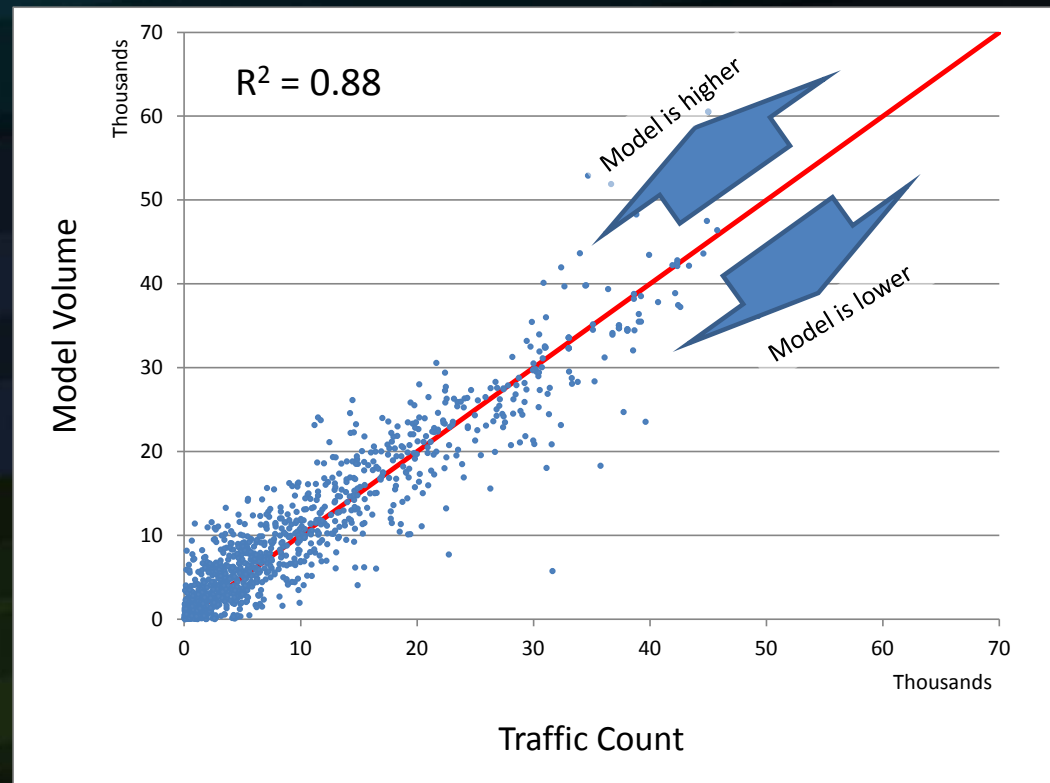
» Statistics

- R-Squared
- % RMSE
- Volume / Count Ratio
- Etc...

» Screenlines

» Corridor Review

» Highest Errors



Example Only

Testing Sensitivity

- Dynamic validation
 - » Observe how the model reacts changes
 - Test big and small changes
 - Test the base and forecast year
 - » Do results make sense?



Post Processing: Reconciling to Counts

- Is the model too low in the base year?
 - » Then the forecast is increased by the same amount
- Is the model too high in the base year?
 - » Then the forecast is decreased by the same amount
- Both ***Post Processed*** and ***Raw*** volumes are available for analysis

Post Processing: *Reconciling to Counts*

Use % Growth (e.g., traffic increases by 30%)

$$Forecast_{ratio} = Raw\ Volume \cdot \frac{Count\ Volume}{Raw\ Base\ Year\ Volume}$$

Use Volume Growth (e.g., traffic increases by 5,000 vehicles)

$$Forecast_{diff} = Raw\ Volume \\ +\ Count\ Volume \\ -\ Raw\ Base\ Year\ Volume$$

Use the Average

$$Forecast_{avg} = \frac{Forecast_{ratio} + Forecast_{diff}}{2}$$

Next Steps

- Refine/finalize work plan
- Master schedule
 - » In-person meeting dates
- Immediate next steps

Morning Wrap-Up

