On-Call Simulation Modeling Training

Webinar 1: Transportation Analysis Overview

presented to

Caltrans

presented by

Cambridge Systematics, Inc.

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Think Forward

January 22, 2018

Webinar Overview

- Project background and objectives
- **Simulation Overview (Part 1)**
  - How to select corridors to be modeled with simulation
  - Regional transportation plans and their relationship to corridor selection
  - Legislative requirements related to simulation modeling
  - Sample animations
- **Simulation analysis details (Part 2)**
  - Available simulation tools
  - Strengths and limitations of the simulation tools
  - Output produced by simulation models
  - Using simulation model results in project prioritization

Project Background and Objectives

- **Senate Bill (SB) 375 (Sustainable Community), SB 743 (CEQA Reform), and SB 391 (California Transportation Plan)** require a more robust quantitative and analytic evaluation to describe the relative performance of transportation policies, strategies, and programs.

- **SB 1, now in force;** Caltrans will be collaborating with regional partners to identify and develop fixes for key corridors, which cannot be analyzed using static methods alone.

- **On-call traffic simulation training** will enable Caltrans to meet the mandate of these bills by educating Caltrans staff about how to perform complex analyses of our facilities for critical planning, operations, and capital improvement projects using the latest generation of traffic analysis tools.

Webinar Four-part Series

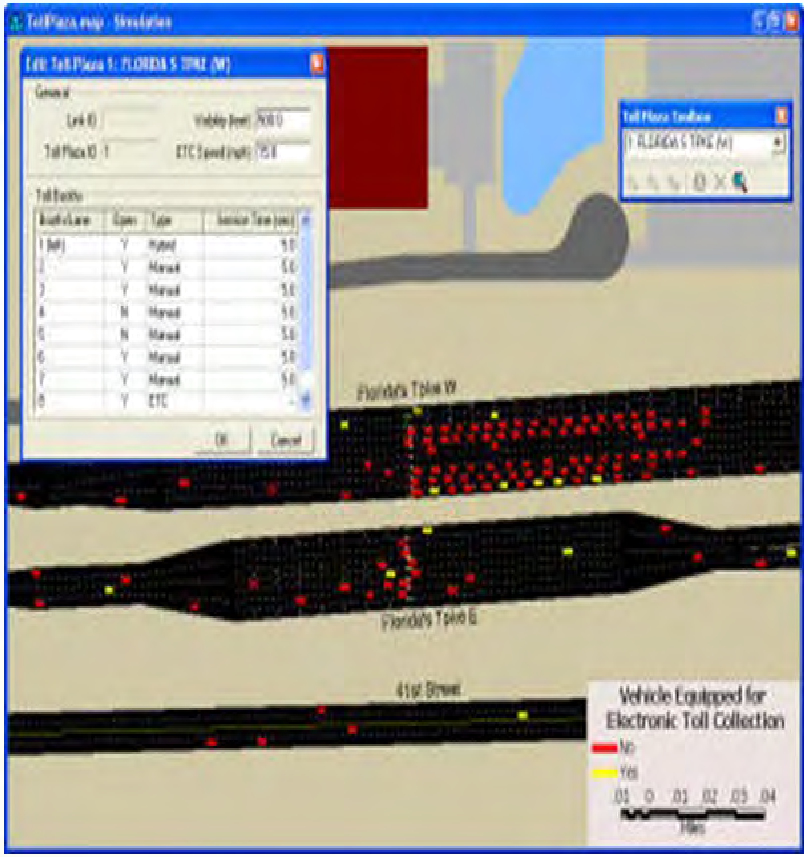
- **Webinar 1 - Transportation Analysis and Simulation Overview** - **Today**
- **Webinar 2 – How to Develop & Review Models** – How to develop a simulation model including network and trip table development, what inputs and data are required, how to conduct the required data collection, model calibration and model calibration parameters
- **Webinar 3 - How to Communicate Model Results** – Documentation of calibration assumptions and results; documentation of overall analysis results; with and without project; tables, charts, graphics and maps summaries of performance measures
- **Webinar 4 - How to produce output for environmental studies from simulation models** – Key output from simulation models, key needs for environmental studies (volumes, delay, speeds, queueing, travel time, VMT, etc.), how to use and interpret simulation model output for environmental studies
- **Webinars to be presented in 2018**

PART ONE

OVERVIEW OF SIMULATION ANALYSIS

Simulation Analysis Overview

- What is Microsimulation?
- How does simulation differ from travel demand modeling and static methods?
- What does Caltrans use Simulation for?
- What output is produced by simulation models?



What is Microsimulation?

"Microsimulation is the modeling of individual vehicle movements on a second or sub second basis for assessing the traffic performance of highways and street systems, transit and pedestrians"

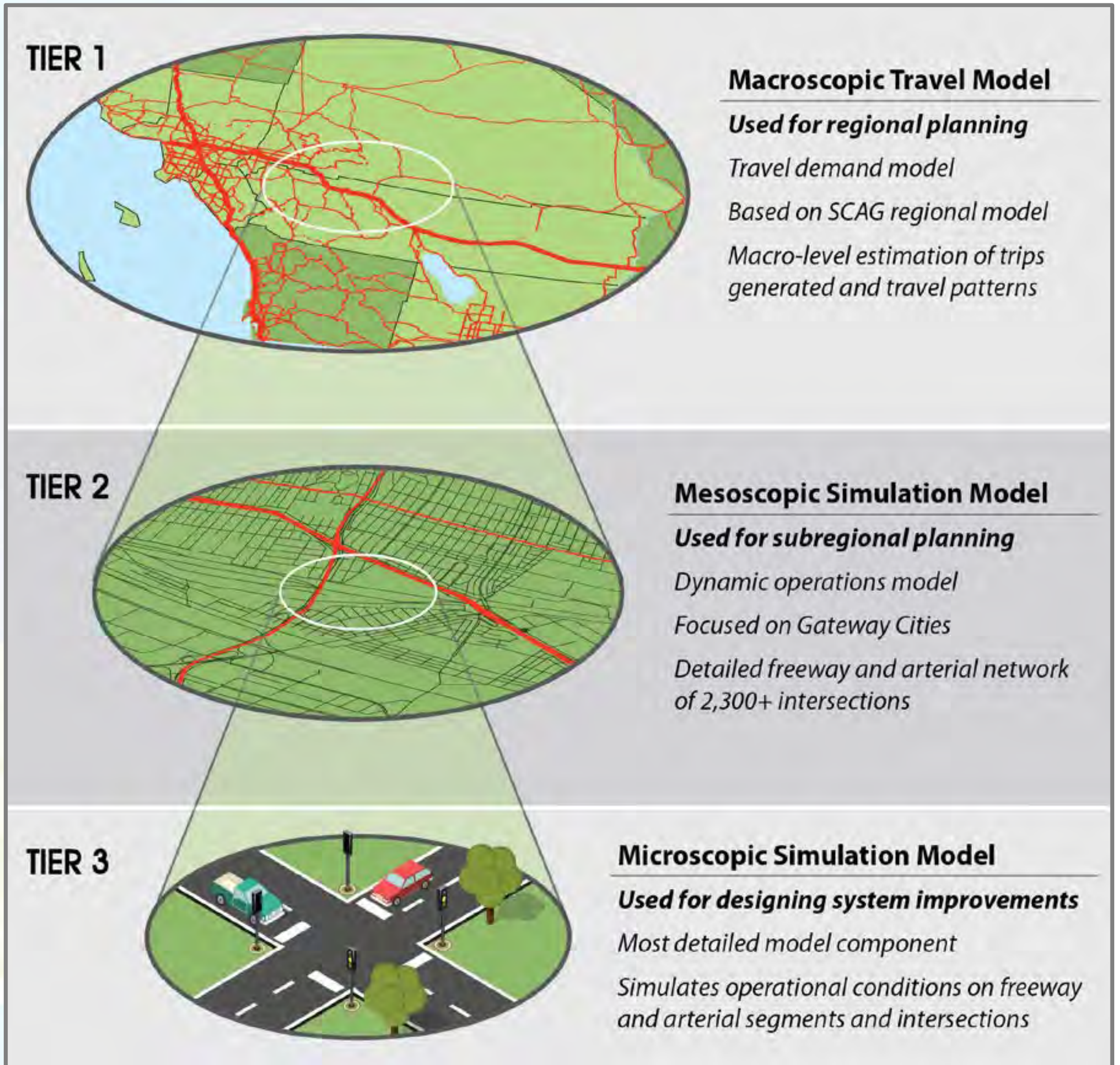
Source: FHWA Traffic Analysis Toolbox

Macro, Meso and Micro Modeling

- ***Macro travel models***- Long range traffic forecasts, regional patterns and mode shift

- ***Mesoscopic models –*** Assessing traveler information, HOT lanes, congestion pricing, traffic diversion

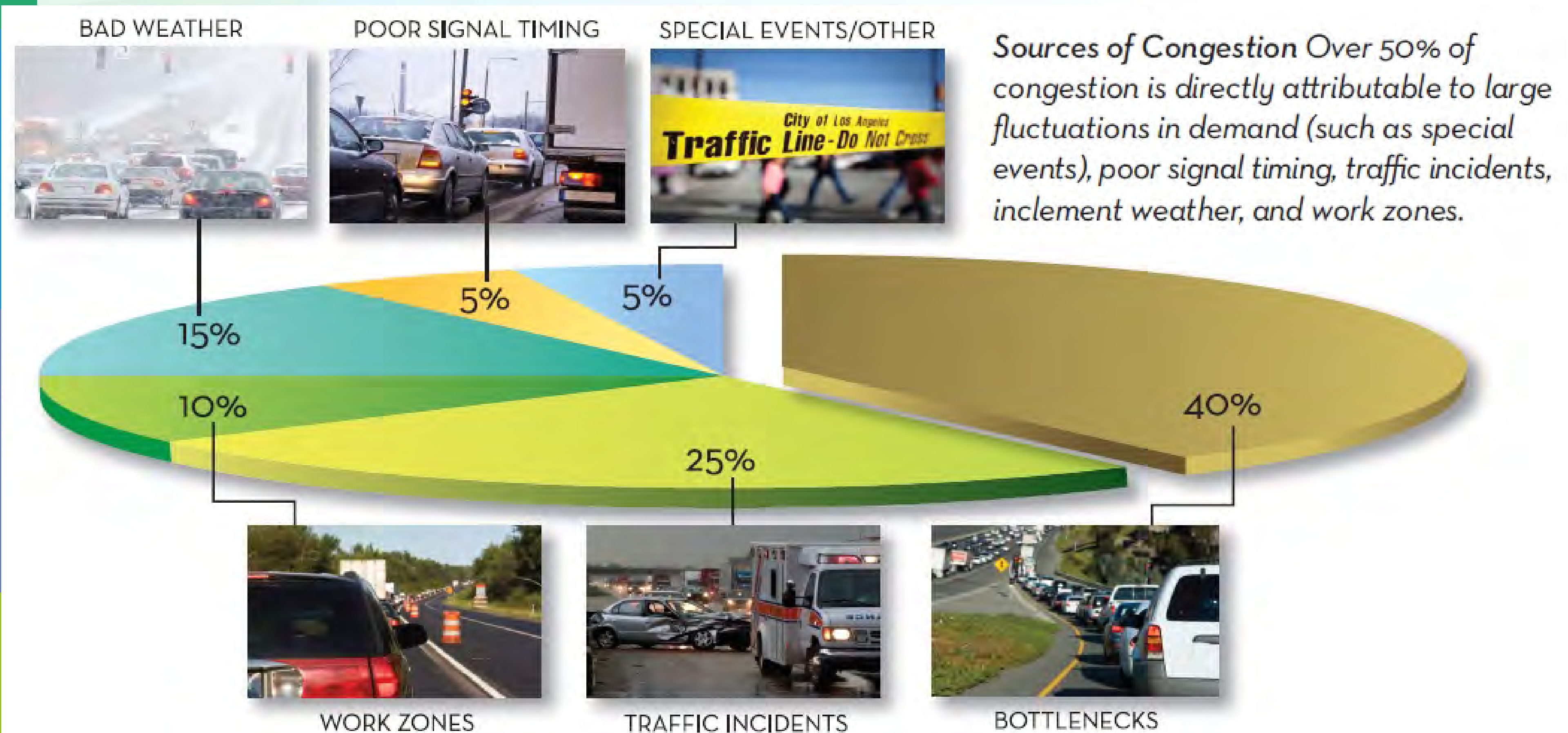
- ***Microsimulation*** - Detailed analysis of improvements and traffic control strategies, congested conditions



Typical Model Applications

Study Area	Travel Demand Modeling	Mesoscopic Modeling	Microscopic Modeling
Regional	**Yes**	Possible	No
Large Corridor	**Yes**	**Yes**	Possible
Small/Med. Corridor	**Yes**	**Yes**	**Yes**
Subarea	**Yes**	**Yes**	**Yes**
Interchange/ Intersection	No	**Yes**	**Yes**

Simulation is Preferred for the Analysis of Heavy Congestion



Source: Federal Highway Administration.

Simulation is Preferred for the Analysis of Heavy Congestion

- **Conditions suited for Microsimulation Modeling:**
  - Heavy congestion & low speeds
  - Congestion longer than one peak hour
  - Queues spillback from one freeway segment to another
  - Queues from city streets back up onto freeway
  - Queues from freeway ramps back up onto streets
  - Queues spillback from one intersection to another
  - Queues overflow turn pockets

Typical Microsimulation Applications

- **Corridor Improvement Projects**
- **HOT/Express Lanes**
- **Active Traffic Management Strategies (ATMS)**
- **Real-time Simulation for Integrated Corridor Management and Connected Corridors**
- **Multi-modal applications** – (BRT, queue jump, etc.)
- **Connected and Autonomous Vehicles**

Desired Input Data

- **Network geometric conditions** (lanes by type, ramps, ramp meter locations, gore points)
- **Control data** (signal timing, signage)
- **Counts** (daily and hourly)
- **Counts by classification** (trucks, buses, auto)
- **Locations of queues, slowing & bottlenecks**
- **Corridor travel times**
- **Demand information** (trip origins and destinations)

Typical Model Output

- **Speeds and travel times**
  - » Average speed in network
  - » Average speed on specific segments
- **Vehicle delay**
- **Traffic Flow/Vehicle Miles Travelled (VMT)**
- **Density**
- **Queues**
- **Animations/Visualizations**

SAMPLE MICROSIMULATION VISUALIZATIONS/ANIMATIONS

Intersection Example

Imperial Hwy & Studebaker Rd

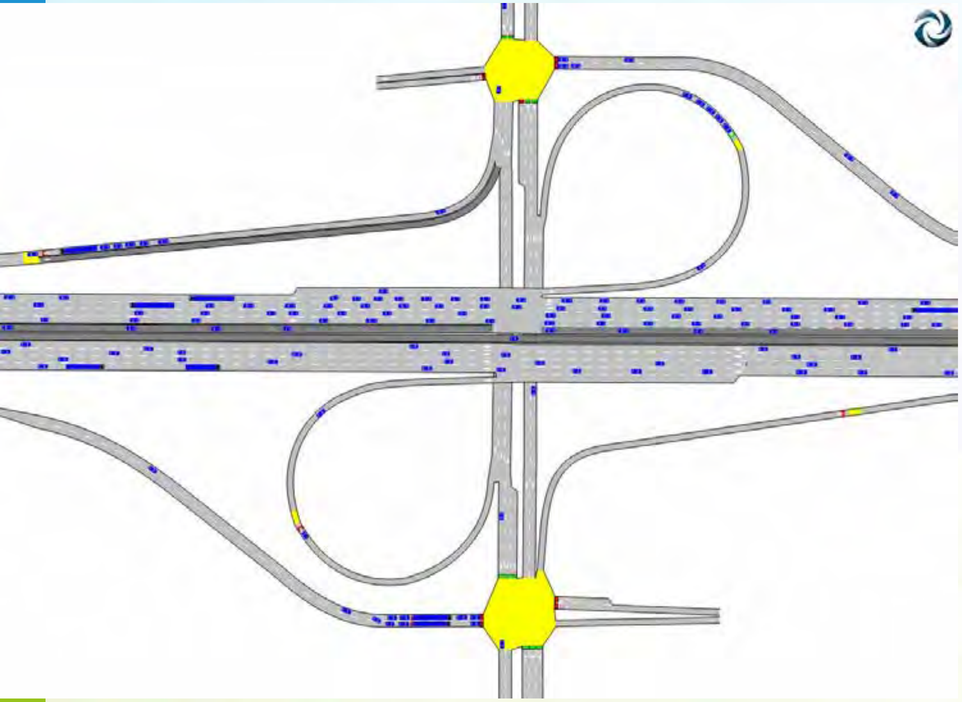
Ramp Meter Simulation

I-105 West at Crenshaw Bl

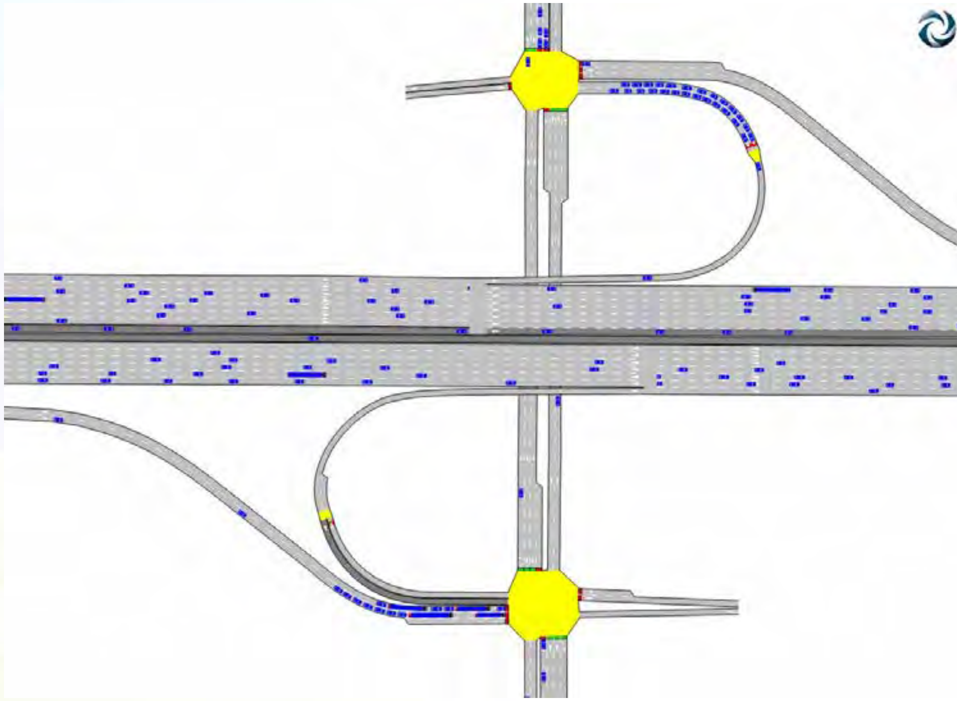
Simulation of Ramp Modification

SR-91 & Pioneer

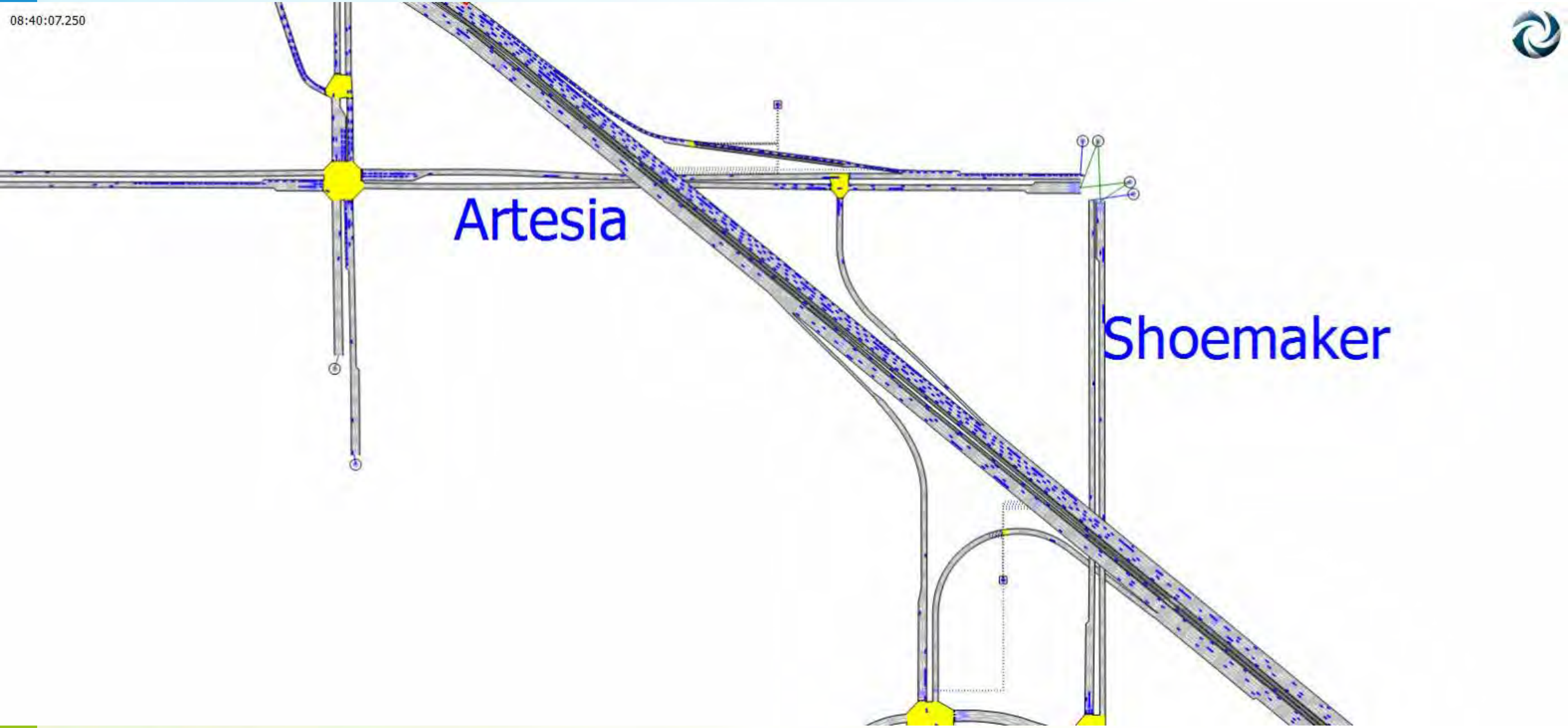
Base Year Model



2035 'Build' Scenario



SR-91 Westbound No-build



SR-91 Westbound Build Alt. 1

Hard Shoulder Running Example

I-105, East of Central Ave

Freeway Queue Warning Example

I-105 Westbound before Prairie/Hawthorne Bl

Value of Analysis, Modeling and Simulation

- Appropriate for congested urban corridors
- More detailed and accurate than static models
- Good for testing ITS, ATM and Express Lane Strategies
- Understandable by public and decision makers (visualization)
- Helps Caltrans invest in the right strategies

Caltrans Simulation Needs - 1

- **Caltrans Staff should be trained to review:**
  - Proposed simulation methodology
  - Calibration process and results
  - Network coding and model development
  - Model output and performance measures
  - Consultant Traffic Studies, ICE, Intergovernmental Review (IGR) submissions, Environmental Reports and related studies
  - ✓ **Conclusions based on model results**

Other Caltrans Simulation Needs - 2

- Perform simulation studies prior to development and construction of HOV/Corridor projects and projects that impact major arterials.
- Apply microsimulation during the planning stage (i.e. Value Analysis) for freeway interchange projects.
- Analyze and investigate access management options involving intersection control evaluations (ICE).
- Perform evaluations of local interchanges and develop various alternatives for existing, build-out and future conditions.
- Determine ideal geometric layouts (i.e. lane configuration/ designation) and appropriate phasing of improvements for short and long term.

Caltrans Simulation Needs - 3

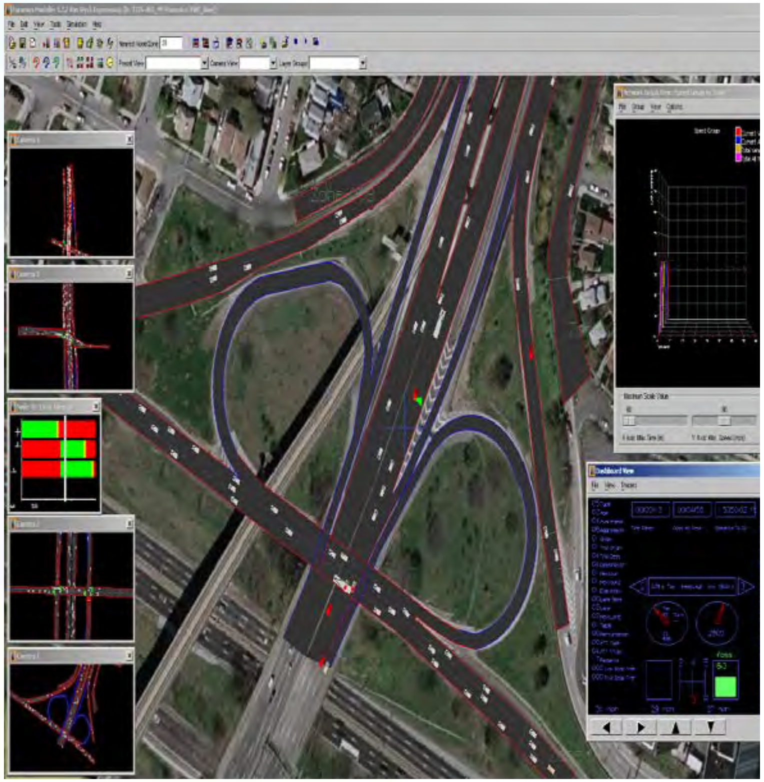
- **Caltrans Traffic Operations can use simulation to examine;**
  - functioning of interchanges,
  - to determine if ramps have sufficient storage capacity,
  - to observe weaving and merging behavior,
  - optimize signal timing.

- **Caltrans Transportation Planning can use simulation to;**
  - Extract and analyze subareas from regional MPO models;
  - Develop Corridor System Management Plans and other documents

HOW TO CHOOSE WHERE TO APPLY MICROSIMULATION

Analysis Requirements

- How to select project locations and corridors to be modeled with simulation
- Regional and local transportation plans and their relationship to corridor selection
- Example from Gateway Cities subregion
- Value of analysis, modeling and simulation



Corridor Selection - 1

- **State, Regional and Local Planning**
  - California Transportation Plan (travel demand forecasting focus)
  - Regional Transportation Plans (travel demand forecasting focus)
  - Subregional Plans (may include microsimulation)
  - County Level Plans (may include microsimulation)
  - Corridor Level Plans (should include microsimulation for accuracy)
- ***Simulation can be used to prioritize and refine regional project lists***

Corridor Selection - 2

- ***So where to apply simulation***?
- **Project Readiness**
  - Is a Project Study Report (PSR) completed?
  - Environmental Clearance (PA&ED often includes simulation)
  - Highway Capacity Manual is used for PSRs and EIRs but often not accurate where congestion levels are high
  - ***Simulation provides information on impacts, design refinement and public outreach***

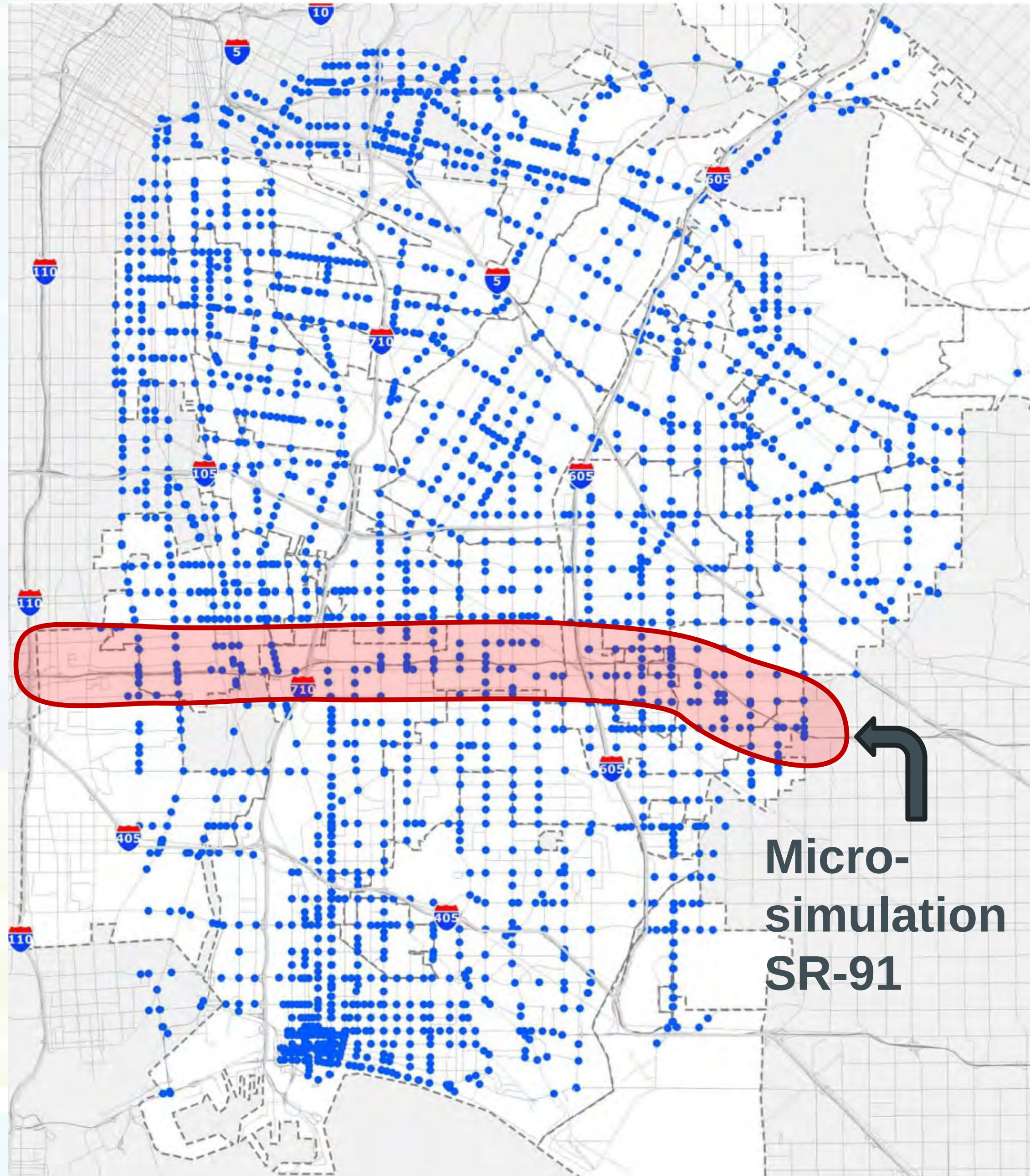
EXAMPLE SIMULATION APPLICATION IN DISTRICT 7

Subregional Example – Gateway Cities

- **LA Metro** – Historically no detailed county level highway plan with prioritization
- **Gateway Cities subarea** did their own highway planning using Measure R funds
- **Gateway Cities** used simulation to develop their own subregional highway plan

Mesoscopic Model (Aimsun):

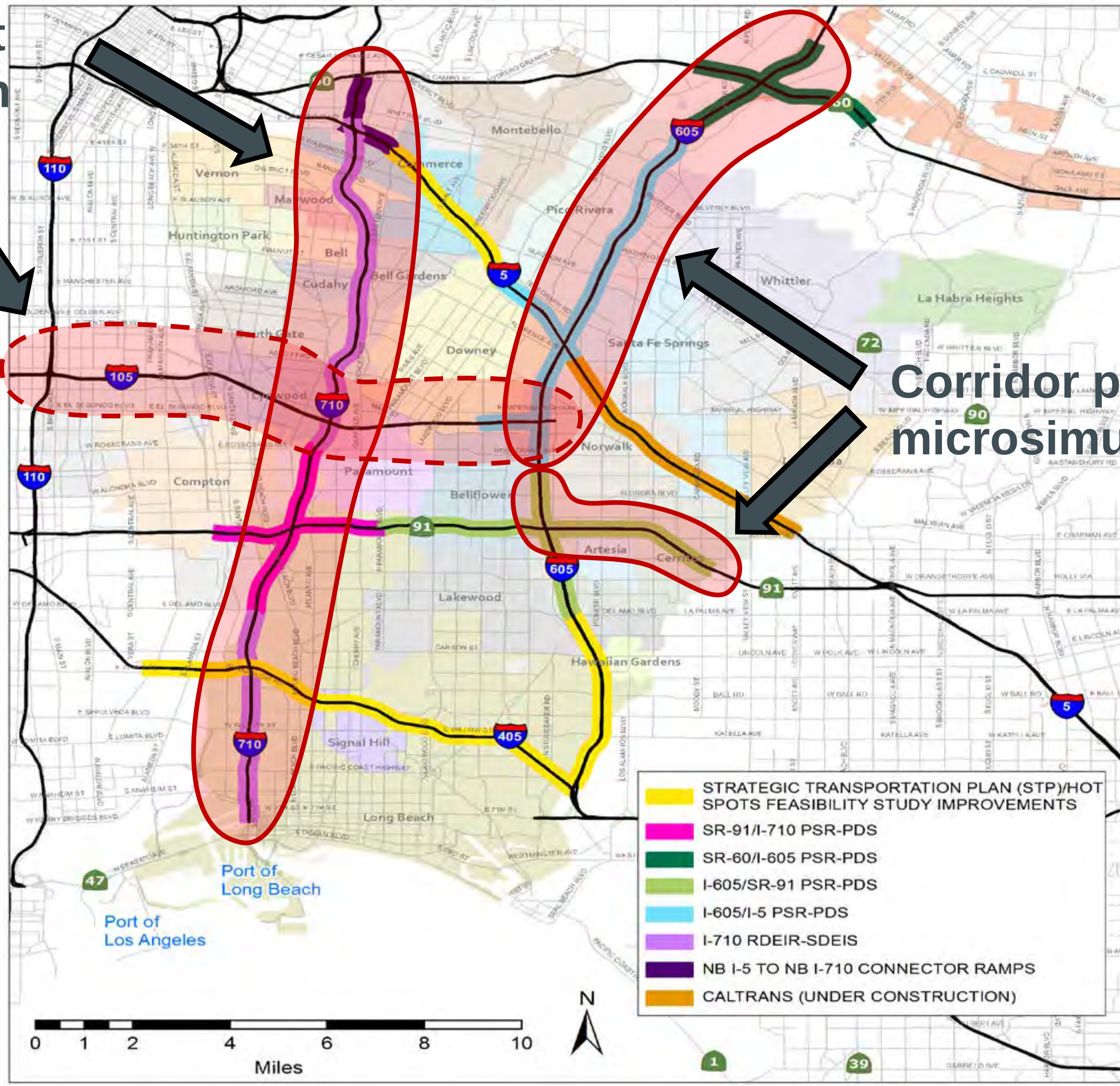
- 27 city area
- 2 million population
- All arterial highways
- All freeways (5, 91, 405, 605, 710)
- All ramps and ramp meters
- Over 2,300 signals



Subregional Freeway Improvement Program

Corridor project microsimulation

Figure 4.5 - Freeway Improvement Concepts and Studies



Corridor project microsimulation

Gateway Cites Simulation Program

- **Mesoscopic model** completed and used to test 16 scenarios
- **Corridor level simulation then conducted**
  - I-710 Major Corridor Project – VISSIM model for EIR
  - SR-91 Westbound from Artesia to I-605 – Aimsun model for PA&ED
  - I-605 Corridor Improvement Program – 2 VISSIM models in progress
    - From I-105 to north of I-10
    - Includes HOV direct connectors
    - Includes Express Lanes simulation
  - I-105 – Simulation modeling to study Express Lanes (early 2018)

SB-1 IMPLICATIONS

SB-1 Implications - 1

- **Additional Funds for Highway Projects**
  - $26 B for State Highway System / $26 B for cities and counties
  - $1.5 B annually for State Highway System
  - $300 M annually for Trade Corridor Enhancements
  - $250 M annually for Congested Corridors
  - $200 M annually matching for local agencies
- ***Some of these could result in specific projects that require detailed analysis***

SB-1 Implications - 2

- **Trade Corridor Enhancement Program (examples):**
  - High-priority grade separation projects statewide that improve safety where vehicles and trains intersect
  - 7th border crossing at the Mexico/ California border — Otay Mesa East
  - I-710 improvements from the Southern California Ports
  - Highway 99 improvements in the Central Valley
  - Phase 2 of the 680/80/12 intersection in the Bay Area
- ***Many of these would likely benefit from simulation analysis***

SB-1 Implications - 3

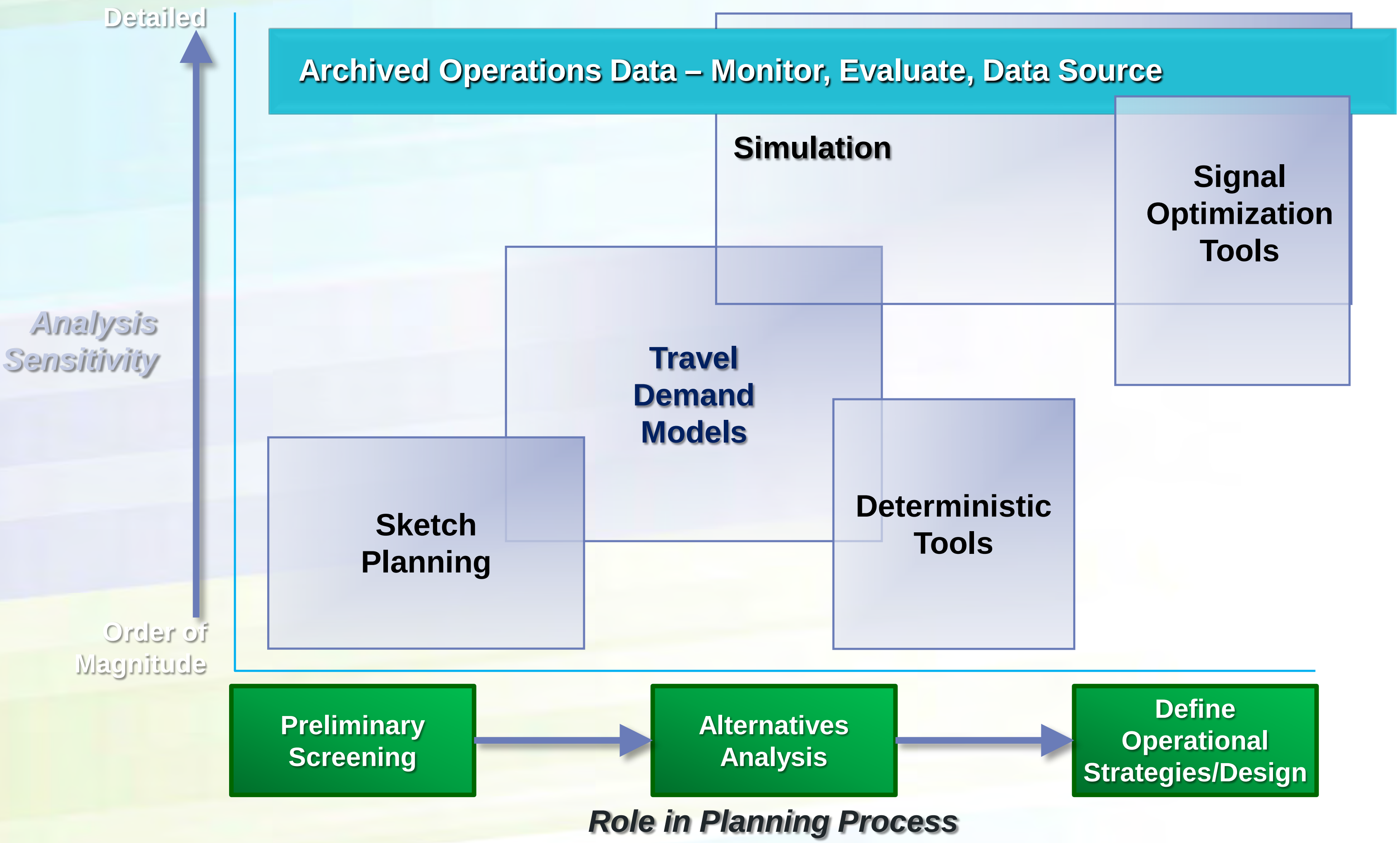
- **Congested Corridors Program** - projects that will improve traffic flow and mobility along the state’s most congested routes while also seeking to improve air quality and health.
  - Improve traffic flow while improving air quality and taking on environmental/health challenges
- ***Simulation analysis can help assess these key Congested Corridors projects***

PART TWO – MORE IN DEPTH REVIEW OF SIMULATION

Part Two

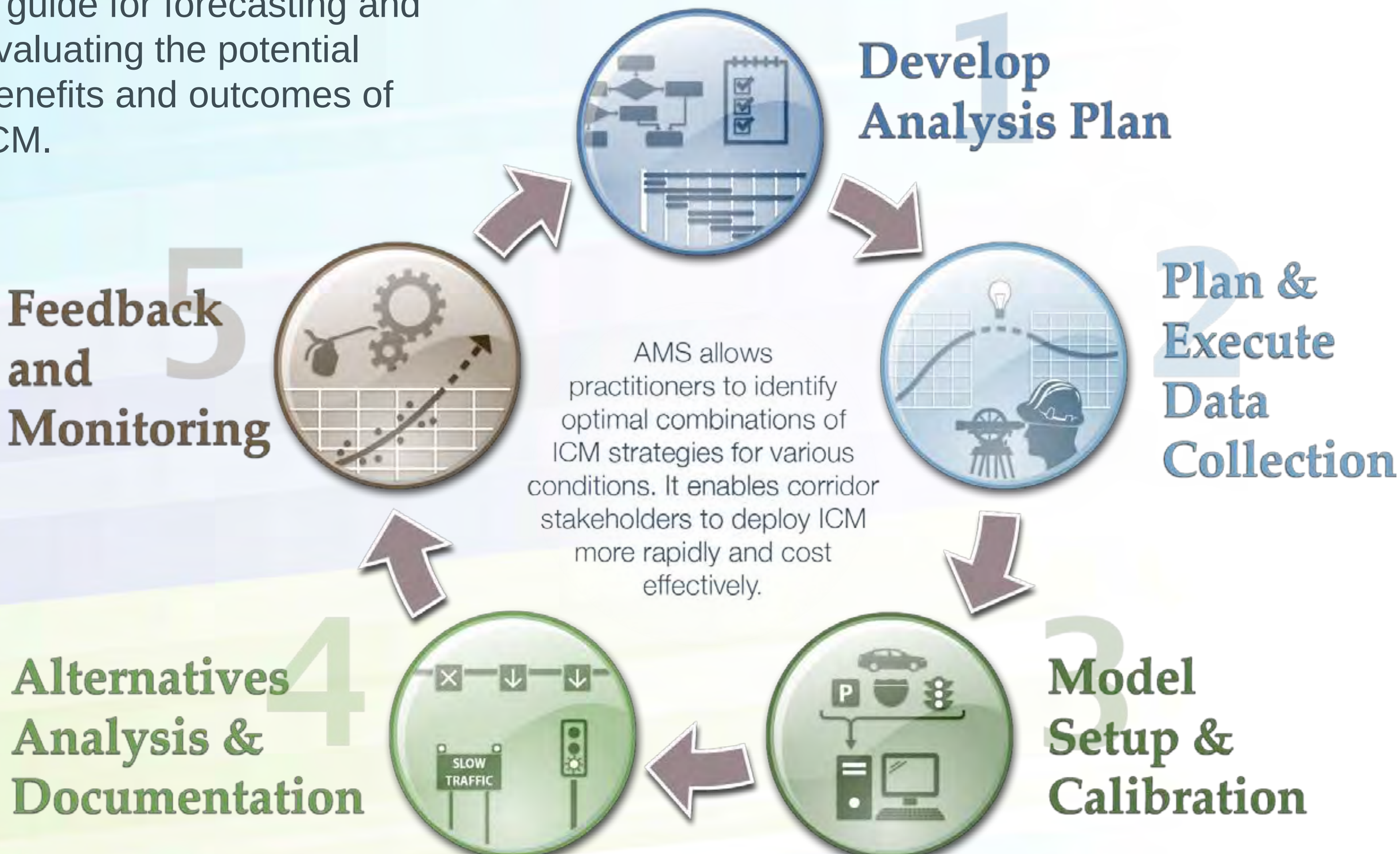
- Emerging trends in simulation
- Analysis tool selection
- Scoping for simulation analysis projects
- Simulation output examples

Analysis Tool Capabilities



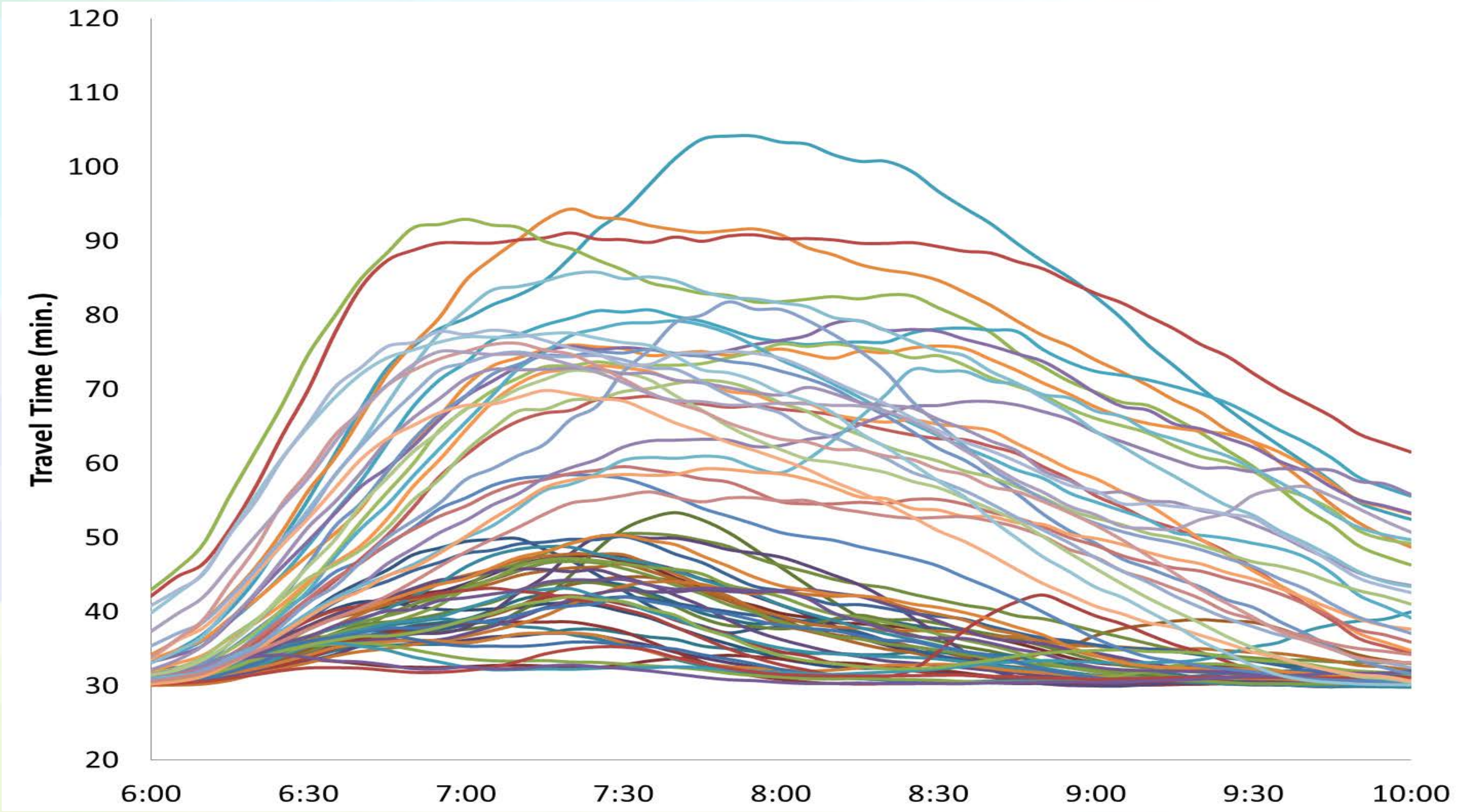
ICM Analysis, Modeling, and Simulation (AMS) Framework

A guide for forecasting and evaluating the potential benefits and outcomes of ICM.



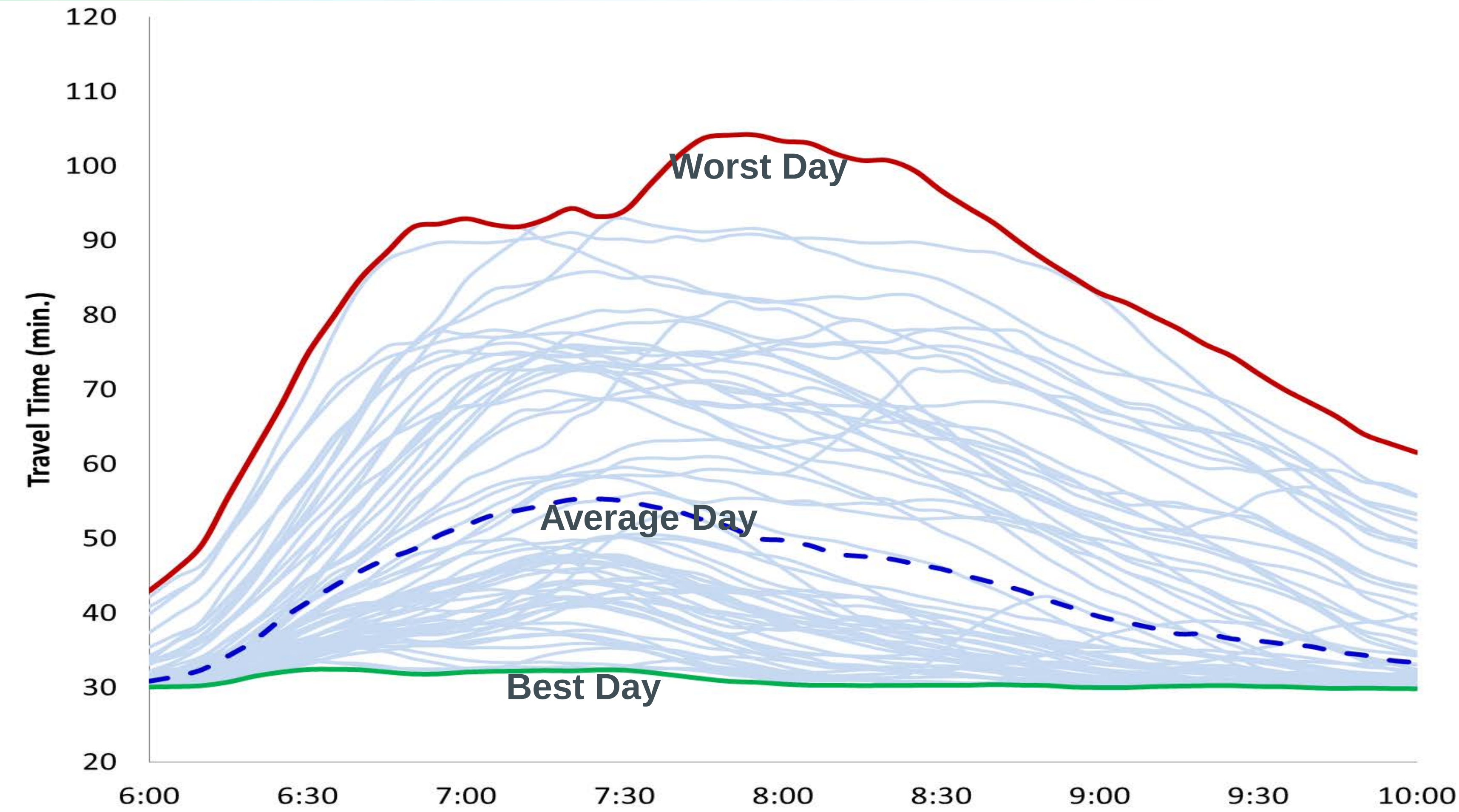
Real Systems Have Good Days and Bad Days

2012 South Bound AM Peak Travel Times, I-405 Corridor



Source: FHWA & Noblis "TAT Volume III Guidelines for Microsimulation" presentation

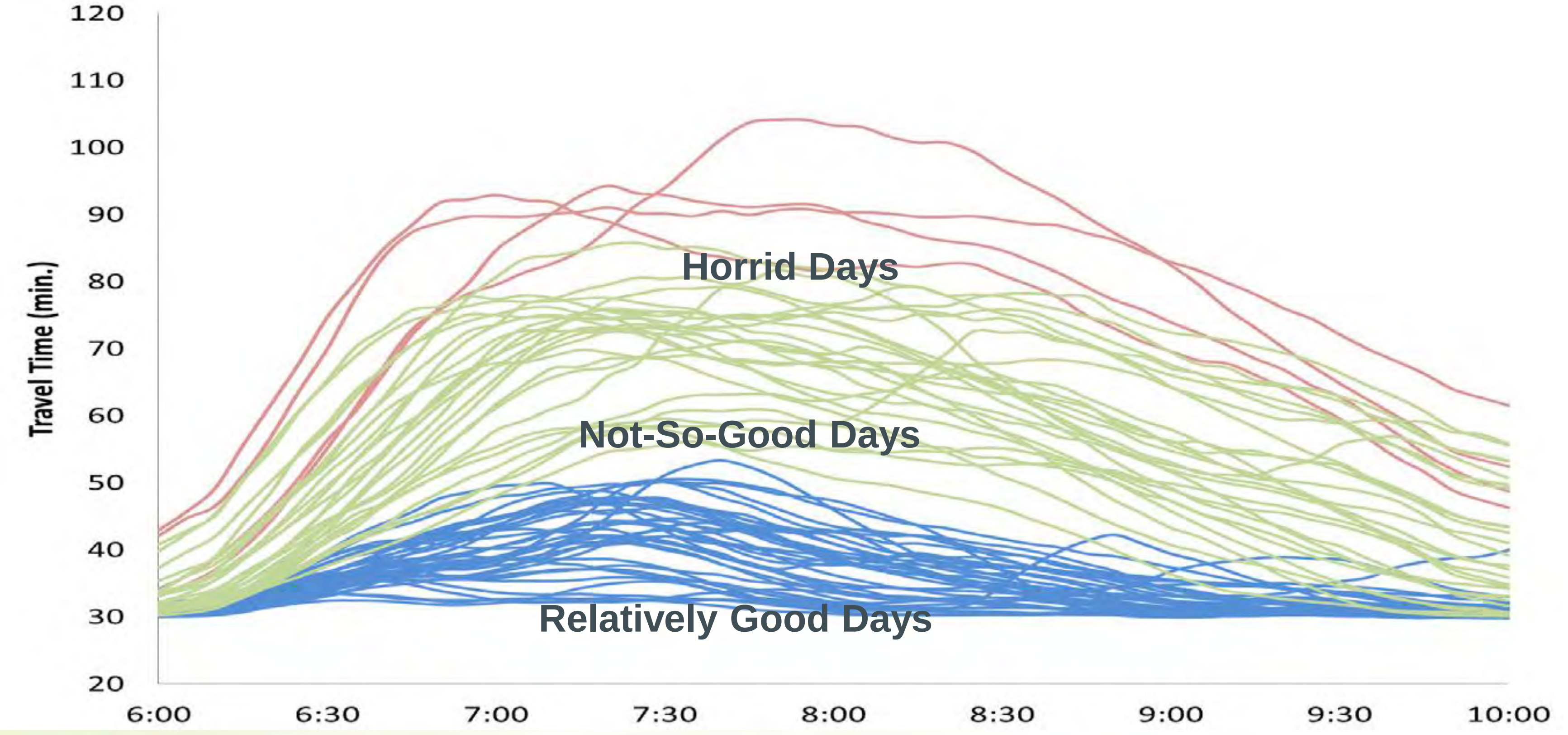
Even An Average Day Captures Only a Fraction of System Dynamics



Source: FHWA & Noblis "TAT Volume III Guidelines for Microsimulation" presentation

Use Cluster Analysis to Identify Distinct, Dissimilar Operational Conditions

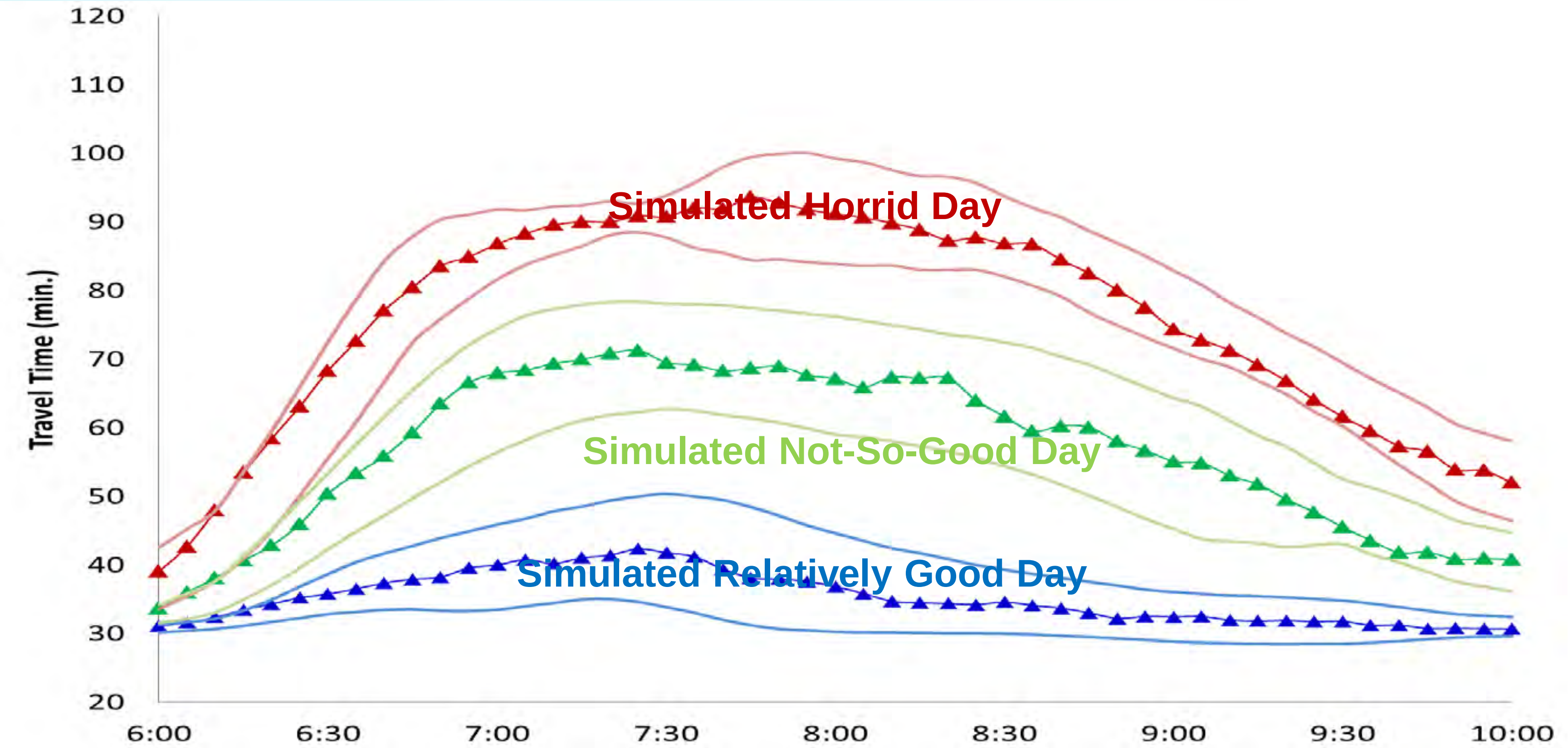
Cluster Analysis Done for Many Attributes, Not Just One Measure… (But We Can Only Show So Much In 2-Dimensions)



Source: FHWA & Noblis "TAT Volume III Guidelines for Microsimulation" presentation

Simulations Are Calibrated to Lie Within the Statistical Envelope

We Perform Statistical Testing to Determine if the Simulated Day Falls in the Envelope Under Many Trials



Source: FHWA & Noblis "TAT Volume III Guidelines for Microsimulation" presentation

San Diego ICM - AMS Scenarios

Summary of Best Matching Incident Results

#	Baseline Cluster by Direction and Time Period	Information from Baseline Cluster Analysis			Baseline Period	Post-Deployment Period			
		Days in Cluster	Total Cluster Day Impact (min.)	% of Total Analysis Time Period	Date	Date	DSS Event ID	DSS Plan Type Implemented	DSS Response ID
1	NB PM 4	25	63.25	24.0	10/12/12	7/7/14	639956	Ramps, Signals, ATIS	19536
2	SB AM 2	39	108.03	37.5	10/2/12	2/9/15	754666	Signals, ATIS	27929
3	NB PM 5	3	18.75	2.9	11/21/12	2/19/15	760369	Signals, ATIS	28292
4	SB AM 3	8	34.64	7.7	10/1/12	5/7/15	804238	Ramps, Signals, ATIS	30028
5	n/a, hypothetical	-	-	-	-	5/26/15		None. Managed lanes opened.	
6	SB AM 1	29	49.88	27.9	1/30/13	5/27/15	817649	Signals	30332
7	NB PM 2	8	23.36	7.7	1/15/13	6/9/15	842085	Ramps, Signals	30451
8	NB PM 1	17	41.82	16.3	1/28/13	6/16/15	845922	Ramps, Signals, ATIS	30617
9	NB PM 3b	36	99.72	34.6	1/30/13	5/5/14	853963	Ramps, Signals, ATIS	31039

ATM, ICM and HOT Lanes Simulation Examples

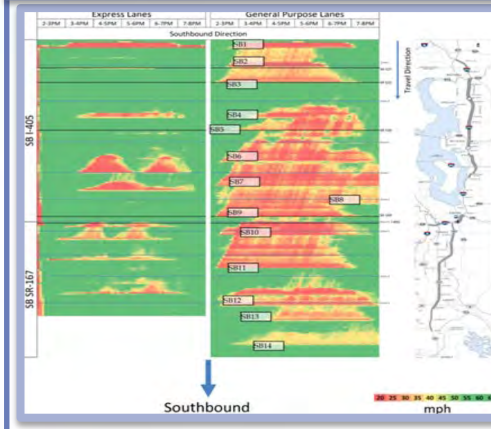
Caltrans District 7 Active Traffic Management Study

Simulation analysis of active traffic management strategies on a 17-mile freeway corridor in Los Angeles that included dynamic speed limits, dynamic shoulder use, adaptive ramp metering, signal coordination, and other relevant strategies.

Caltrans I-15 ICM Analysis, Modeling, and Simulation

Analysis, modeling, and simulation of the ICM Pioneer Sites on I-15 and U.S. 75, including development of suitable methods and tools, in-depth research regarding modeling of ICM operations, and overall evaluation of these sites postdeployment.

Washington State DOT I-405 Traffic and Revenue Review



Operational simulation-based dynamic toll revenue estimation of proposed HOT lanes. Probabilistic revenue estimates were based on combinations of potential pricing policies, growth scenarios forecasts, pricing sensitivities of the public, and traveler's value of time.

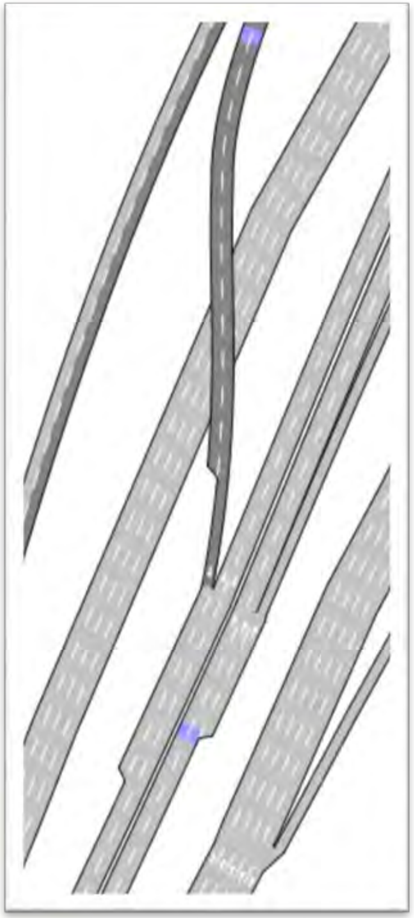
San Diego I-15 ICM –
Real-Time Multimodal Decision Support System

Predict
- Next 60 minutes
- Every 5 minutes

Decide
- Capacity
- Availability
- Posture

Evaluate
- Response Strategies
- 15 min. interval

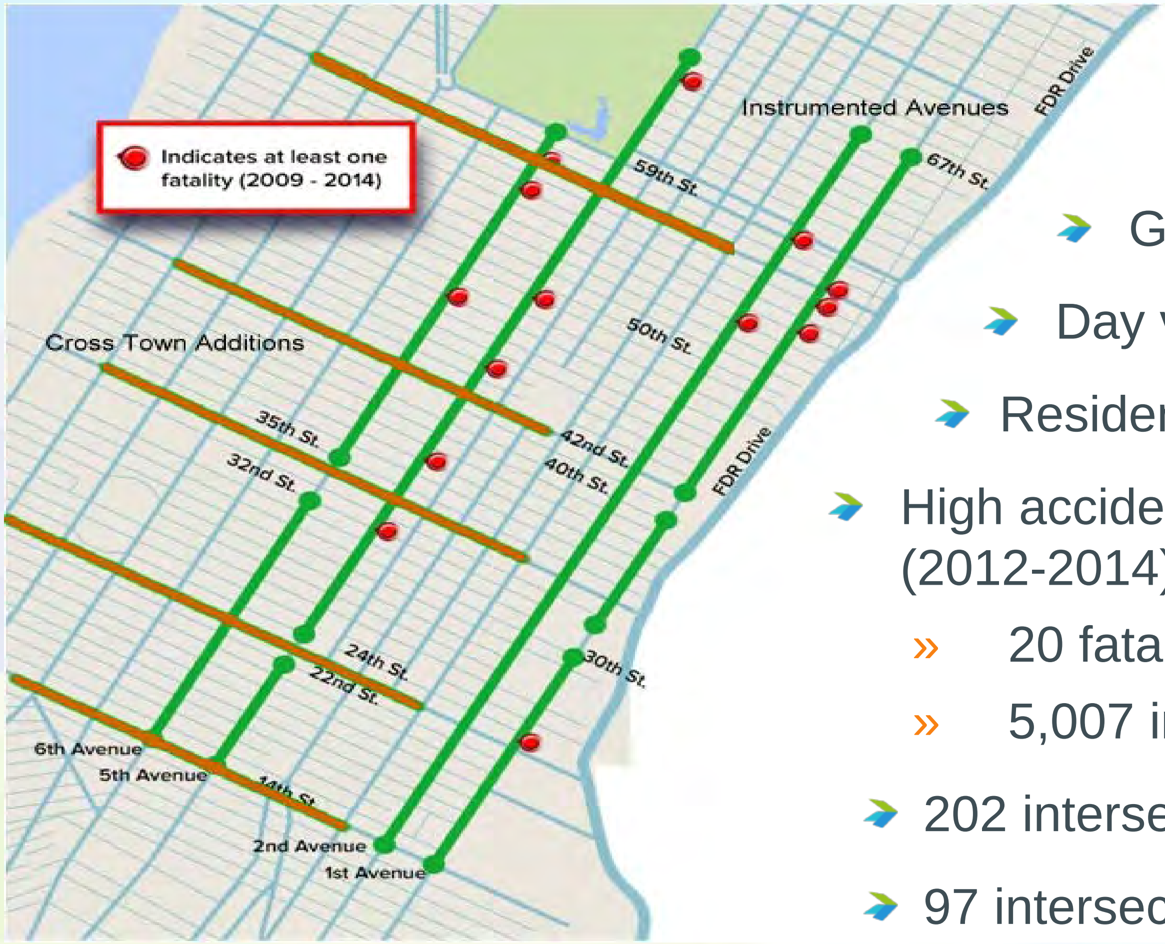
Control
- Send to the field
- Monitor



Source: Cambridge Systematics and San Diego Association of Governments.

NYC Connected Vehicle Pilot Site: Manhattan – Arterial Grid

Source: NYCDOT



- Grid (600’ x 250’)
- Day vs. Night conditions
- Residential/commercial mix
- High accident rate arterials (2012-2014)
  - 20 fatalities
  - 5,007 injuries
- 202 intersections – avenues
- 97 intersections – cross town

Analysis Tool Selection

Which Tool Type to Use – Leveraging Caltrans Selection Tool

Microsoft Excel - Caltrans Automated Traffic Analysis Tools v2

Criteria Weights

5		6	7							8						
Context/Criteria (0 = not relevant, 5 = most relevant)		Criteria Relevance	Weighted Subtotals							Column 6 x Column 7						
			Sketch Plan	TDM	Analytical (HCM)	Traffic Opt	Macro Sim	Meso Sim	Micro Sim	Sketch Plan	TDM	Analytical (HCM)	Traffic Opt	Macro Sim	Meso Sim	Micro Sim
0	Analysis Context	1	50	50	25	0	25	25	0	50	50	25	0	25	25	0
1	Geographic Scope	5	38	25	25	0	25	25	25	188	125	125	0	125	125	125
2	Facility Type	5	19	42	36	31	44	44	50	97	208	181	153	222	222	250
3	Travel Mode	1	22	30	22	22	22	29	29	22	30	22	22	22	29	29
4	Management Strategy/Applications	5	14	4	13	10	20	20	25	72	20	65	50	98	98	123
5	Traveler Response	5	-5	15	-248	-33	-16	0	18	-24	75	-1238	-165	-82	1	88
6	Performance Measures	5	13	16	19	18	20	25	26	63	80	93	89	100	126	132
7	Tool/Cost Effectiveness	1	28	16	32	26	26	20	21	28	16	32	26	26	20	21
									VEIGHTED TOTALS	495	604	-695	175	537	646	768

Most Appropriate Tool Categories:
1. Micro Sim
2. Meso Sim

Tool Categories:

- Sketch Plan = Sketch-planning methodologies and tools
- TDM = Travel demand models
- Analytical (HCM) = Analytical/deterministic tools (HCM-based)
- Traffic Opt = Traffic optimization tools
- Macro Sim = Macroscopic simulation models
- Meso Sim = Mesoscopic simulation models
- Micro Sim = Microscopic simulation models

Please see the 'Tool Definitions' worksheet for more details

Recalculate

Microscopic simulation models were selected as the most appropriate traffic analysis category because of the project's requirements in terms of facility type, performance measures, geographic scope, and management strategy/applications.

Mesoscopic simulation models were selected as the second most appropriate traffic analysis category because of the project's requirements in terms of facility type, performance measures, geographic scope, and management strategy/applications.

Tool Category / Help / Criteria Definitions / Tool Category Definitions / Sheet1

Analysis Context: Planning, Design, or Operations/Construction

1 Geographic Scope	2 Facility Type	3 Travel Mode	4 Management Strategy	5 Traveler Response	6 Performance Measures	7 Traveler Response
What is your study area?	Which facility types do you want to include?	Which travel modes do you want to include?	Which mgmt strategies should be analyzed?	Which traveler responses should be analyzed?	What performance measures are needed?	What operational characteristics are important?
• Isolated Location • Segment • Corridor/ small network • Region	• Isolated intersection • Roundabout • Arterial • Highway • Freeway • HOV lane • HOV bypass lane • Ramp • Auxiliary lane • Reversible lane • Truck lane • Bus lane • Toll plaza • Light rail	• SOV • HOV (2, 3, 3+) • Bus • Rail • Truck • Motorcycle • Bicycle • Pedestrian	• Freeway mgmt • Arterial intersections • Arterial mgmt • Incident mgmt • Emergency mgmt • Work zone • Special event • APTS • ATIS • Electronic payment • RRX • CVO • AVCSS • Weather mgmt • TDM	• Route diversion (pre-trip and en-route) • Mode shift • Departure time choice • Destination change • Included/ foregone demand	• LOS • Speed • Travel time • Volume • Travel distance • Ridership • AVO • v/c ratio • Density • VMT/PMT • VJJT/PHT • Delay • Queue length • # stops • Crashes/durati on • TT reliability • Emissions/fuel • Noise • Mode shift • Benefit/cost	• Tool capital cost • Effort (cost/training) • Ease of use • Popular/well-trusted • Hardware requirements • Data requirements • Run time • Post-processing • Documentation • User support • Key parameters user definable • Default values • Integration • Animation

Data and Resources - Leveraging Caltrans Non-IT Microsimulation TAC

CAMBRIDGE SYSTEMATICS

Microsimulation Scoping Template

technical

report

prepared for

California Department of Transportation

prepared by

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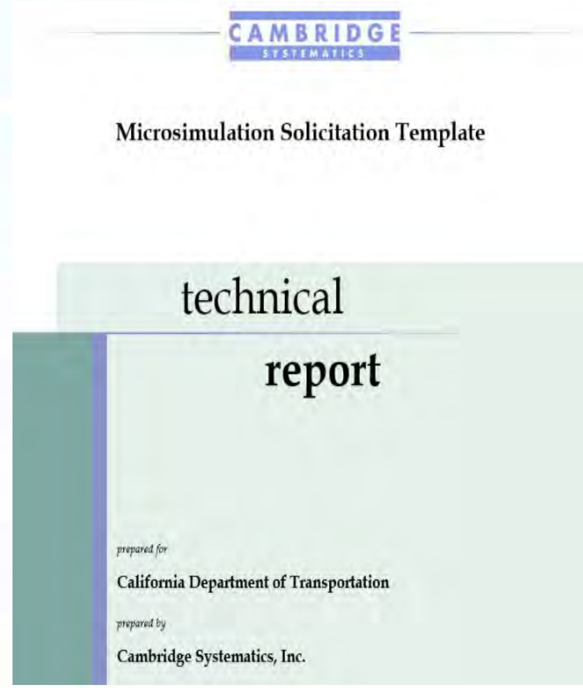

CAMBRIDGE SYSTEMATICS

Microsimulation Solicitation Template

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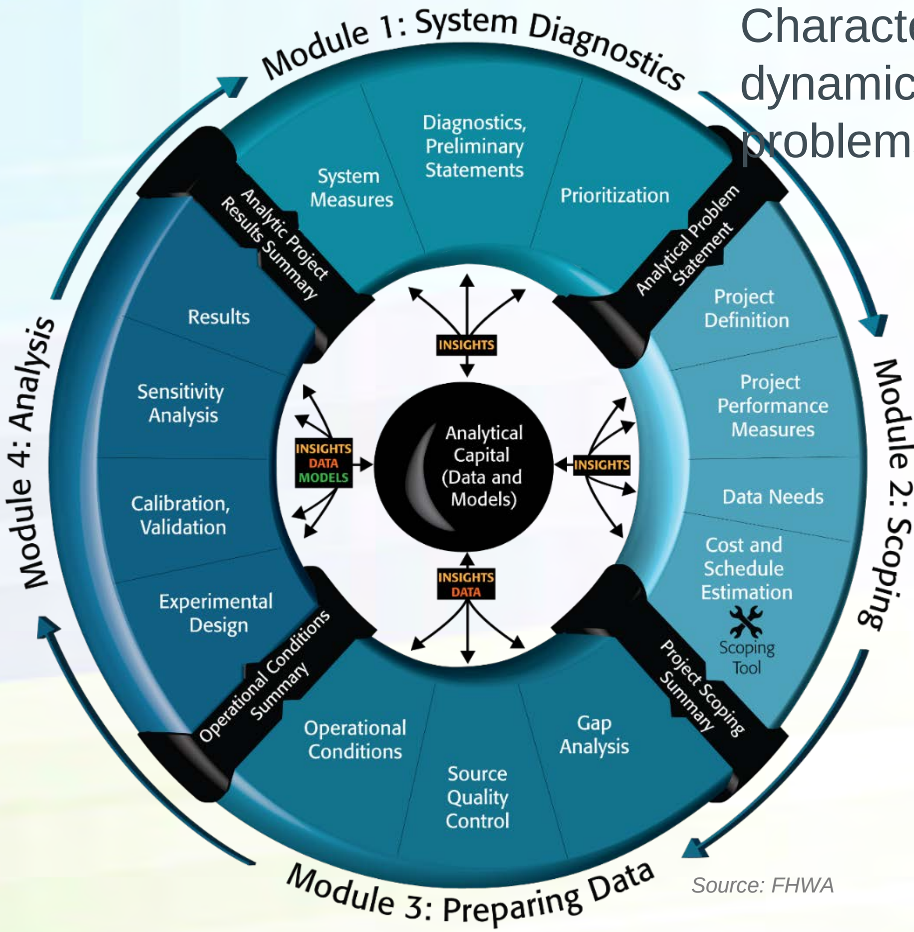
ANALYSIS SCOPING

The 21st Century Analytical Project Scoping Process



Source: FHWA

Characterize system dynamics and diagnose problems.

Perform data-driven transportation analysis project scoping.

Collect and organize the data needed to conduct a transportation analysis.

Conduct and document transportation analyses.

Components of a Scoping Plan

- Project definition
- Geographic and temporal scope
- Selection of the appropriate analysis tool type
- Performance measures to be used in the analysis
- Analysis data requirements
- Preliminary list of alternatives to be studied, including analysis scenarios and transportation mitigation strategies
- Expected cost, schedule, and responsibilities for the analysis

Module 2 Output

Project Scoping Summary Elements

Project Definition	A concise statement of the overall system problem includes cross-validation and other insights from stakeholders on the nature of the issue and potential solutions.
Geographic Scope	The geographic area to be covered by the analytical project includes a statement of the required detail of representation within this geographical area.
Temporal Scope	The times of day, days of week, seasonality, and years of operation are assessed in the analytical effort. This includes an assessment of the simulation horizon.
Candidate Hypothesis	The candidate hypothesis represents the leading underlying cause of the system performance issue.
Analytical Approach	This element describes of the proposed method for evaluating the effectiveness of the mitigating strategies in resolving the system performance issue.
Selected Tool Type(s)	The one or more tool types will be used in the analytical approach. This section should identify if existing models are to be employed, or if new models must be developed.
Data Requirements	A summary of data will be used to characterize operational conditions, represent alternatives, and model the geographic and temporal aspects of the system.

Module 2 Output (continued)
Project Scoping Summary Elements

Preliminary List of Alternatives	High-level description of the alternative solutions and/or operational practices will be assessed within the analytical project.
Key Operational Conditions	The set of travel demand, incident, and weather conditions under which a meaningful examination of alternative impacts must be conducted.
Selected Performance Measures	The measures of system performance selected for the effort. These measures should be most suited to differentiate alternatives, be meaningful to stakeholders, and can be well-represented/estimated within the proposed analytical approach.
Expected Costs	The projected cost of the analytical project, including data collection.
Expected Schedule	The projected time to conduct the analysis, including data collection.
Expected Assignment of Responsibilities	An assessment of responsibilities related to the project and how those responsibilities are allocated among departments, contractors, and other organizations engaged in the effort.
Risks	A summary of risks comprising risks in data collection, technical risks, and non-technical risks.

Analysis Scoping Tool

Summary of Example User Inputs

Transportation Analysis Project Costing Tool

Press This Button to Start

Summary of User Inputs:

1	Name of Study Area:	Standard TIS
2	Number of Intersections:	5
3	Number of Freeway Ramps:	10
4	Base Model Availability:	Yes
5	Is the Base Model Calibrated:	Yes
6	Number of Analysis Horizons:	2
7	Number of Alternatives:	2
8	Number of Representative Days:	2
9	Number of Peak Periods	2
10	Data Processing Requirements:	Low
11	Complexity of Analysis Scenarios:	Simple
12	Complexity of Methodology:	Deterministic
13	Complexity of Outputs:	Comprehensive
14	Analyst Experience:	Considerable

Note: This Transportation Analysis Costing Tool is provided "as is" without warranty of any kind, and without any documentation, user's guide, or mai

(Source: Federal Highway Administration.)

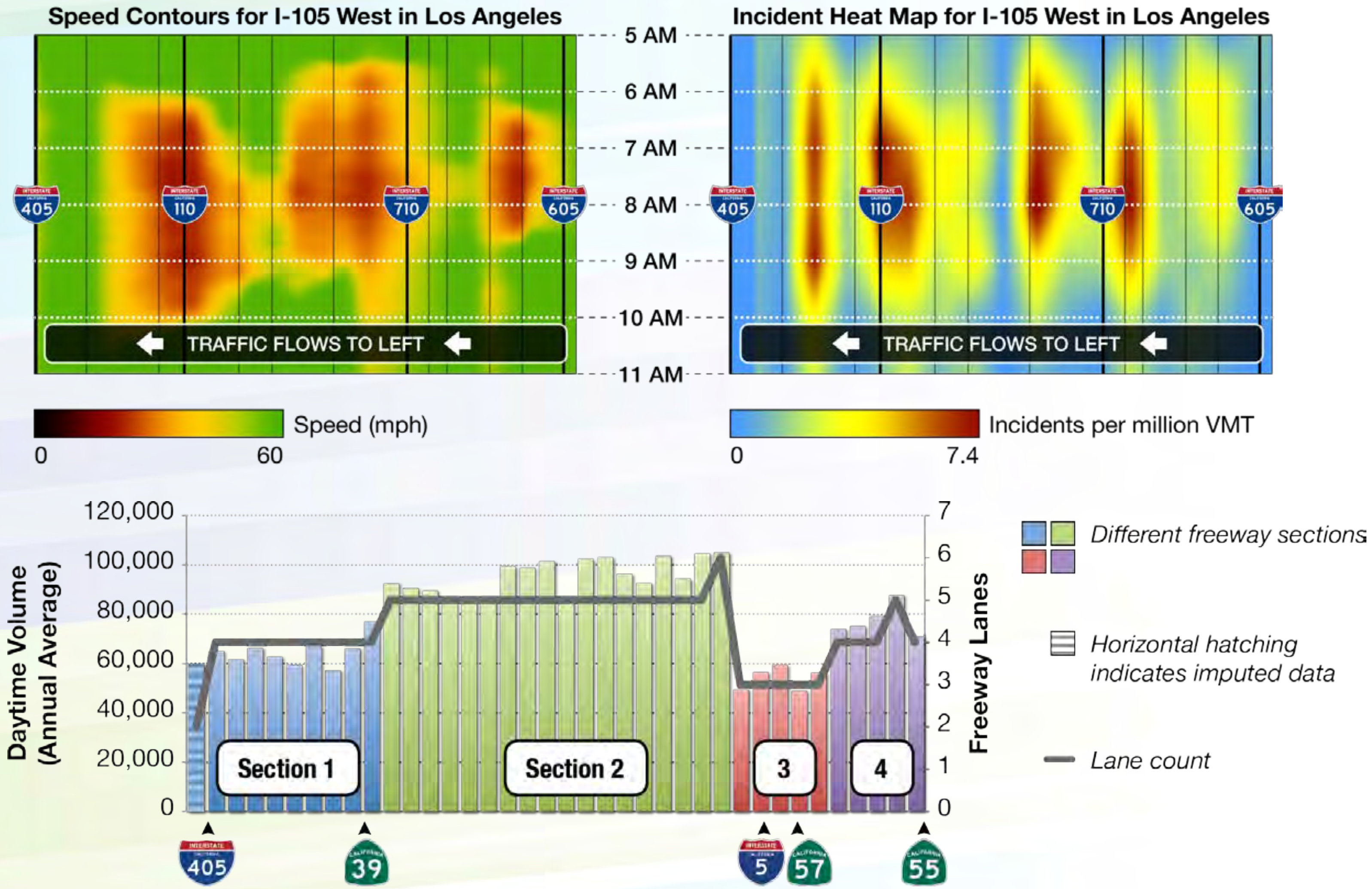
Analysis Costing Tool

Example Output

	Transportation Analysis Project Costing Tool						
OUTPUT REPORT							
Estimate of Labor Hours Required to Complete the Analysis of:							
	Standard TIS						
	Project Task	Manager Hours	Engineer/ Planner Hours	Technician Hours	Total Hours	Lower Bound	Upper Bound
1	Develop workplan, analysis plan, and project management	30	30	10	**70**	**60**	**80**
2	Select analysis tool	10	10	-	**20**	**20**	**20**
3	Develop data plan and process data	-	-	40	**40**	**40**	**40**
4	Define clusters and representative days	30	50	-	**80**	**70**	**90**
5	Develop and calibrate baseline model(s)	20	40	70	**130**	**120**	**170**
6	Develop future baseline model(s)	30	30	30	**90**	**80**	**100**
7	Analyze alternatives	90	180	90	**360**	**320**	**400**
8	Reports and presentations	30	30	10	**70**	**60**	**80**
	Total Labor Hours	**240**	**370**	**250**	**860**	**770**	**980**

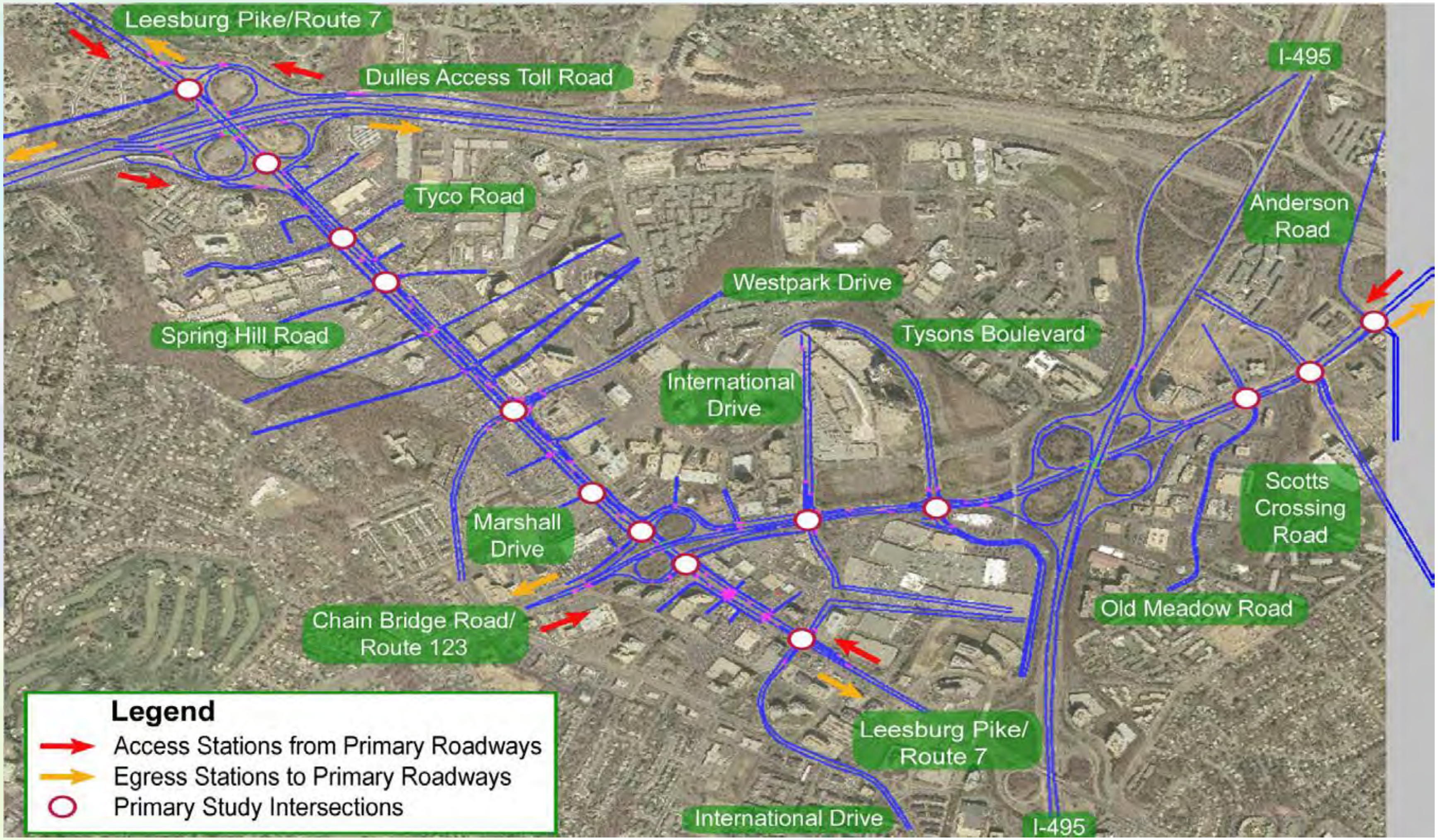
(Source: Federal Highway Administration.)

LA I-105 Active Traffic Management



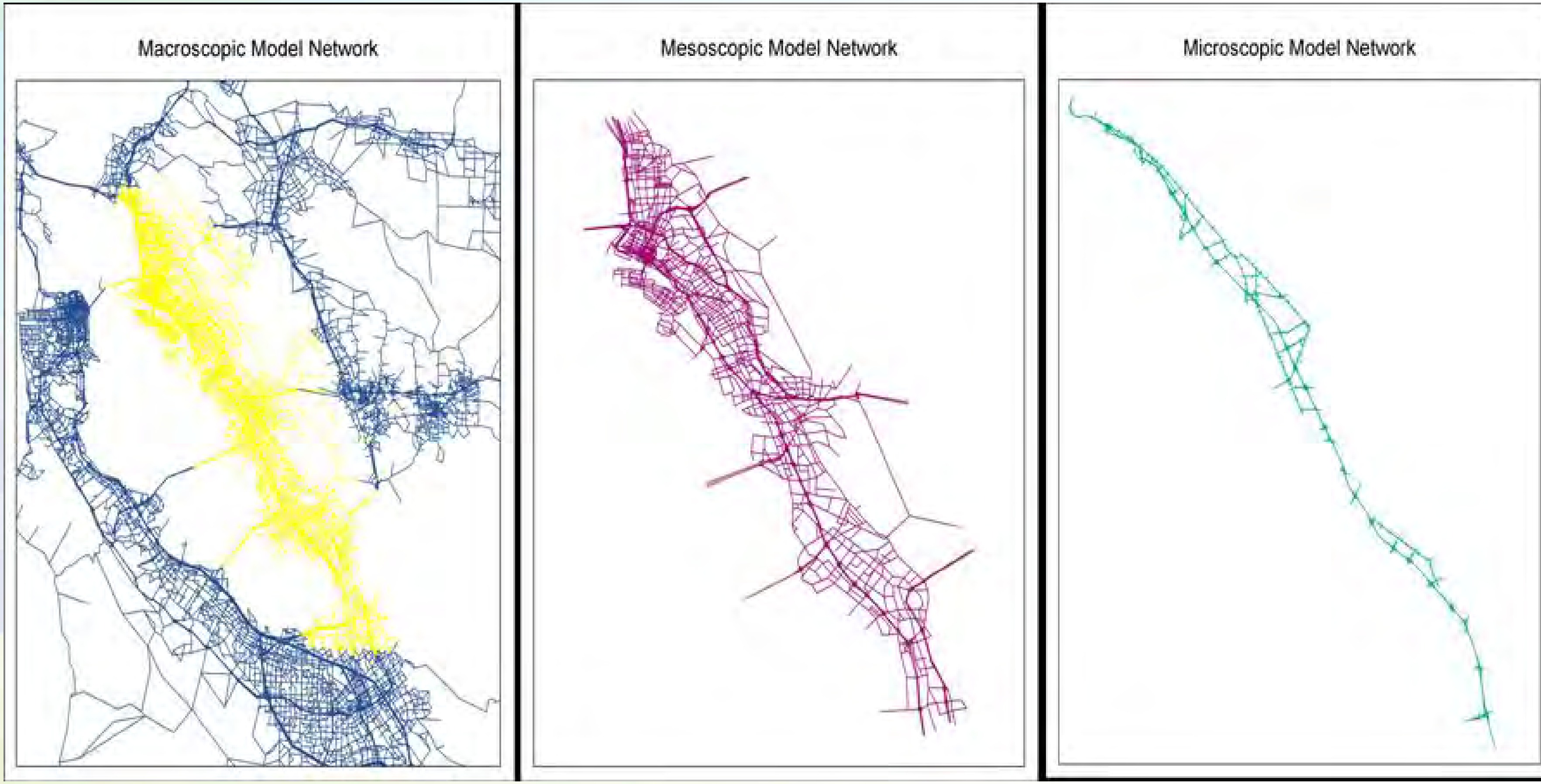
SIMULATION OUTPUT

Study Area

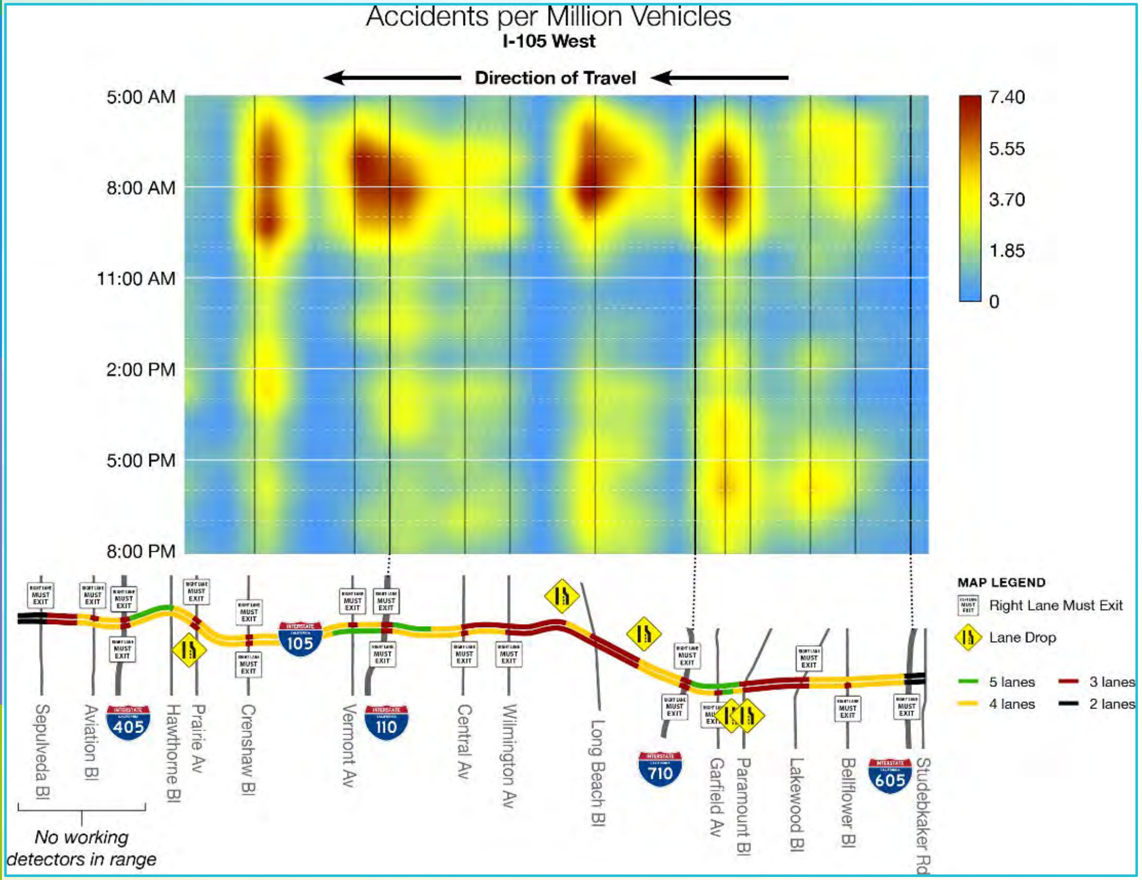


Leesburg Pike/Route 7
Dulles Access Toll Road
I-495
Tyco Road
Anderson Road
Westpark Drive
Spring Hill Road
Tysons Boulevard
International Drive
Scotts Crossing Road
Marshall Drive
Old Meadow Road
Chain Bridge Road/ Route 123
Leesburg Pike/ Route 7
International Drive
I-495
Legend
Access Stations from Primary Roadways
Egress Stations to Primary Roadways
Primary Study Intersections

Analysis Resolutions



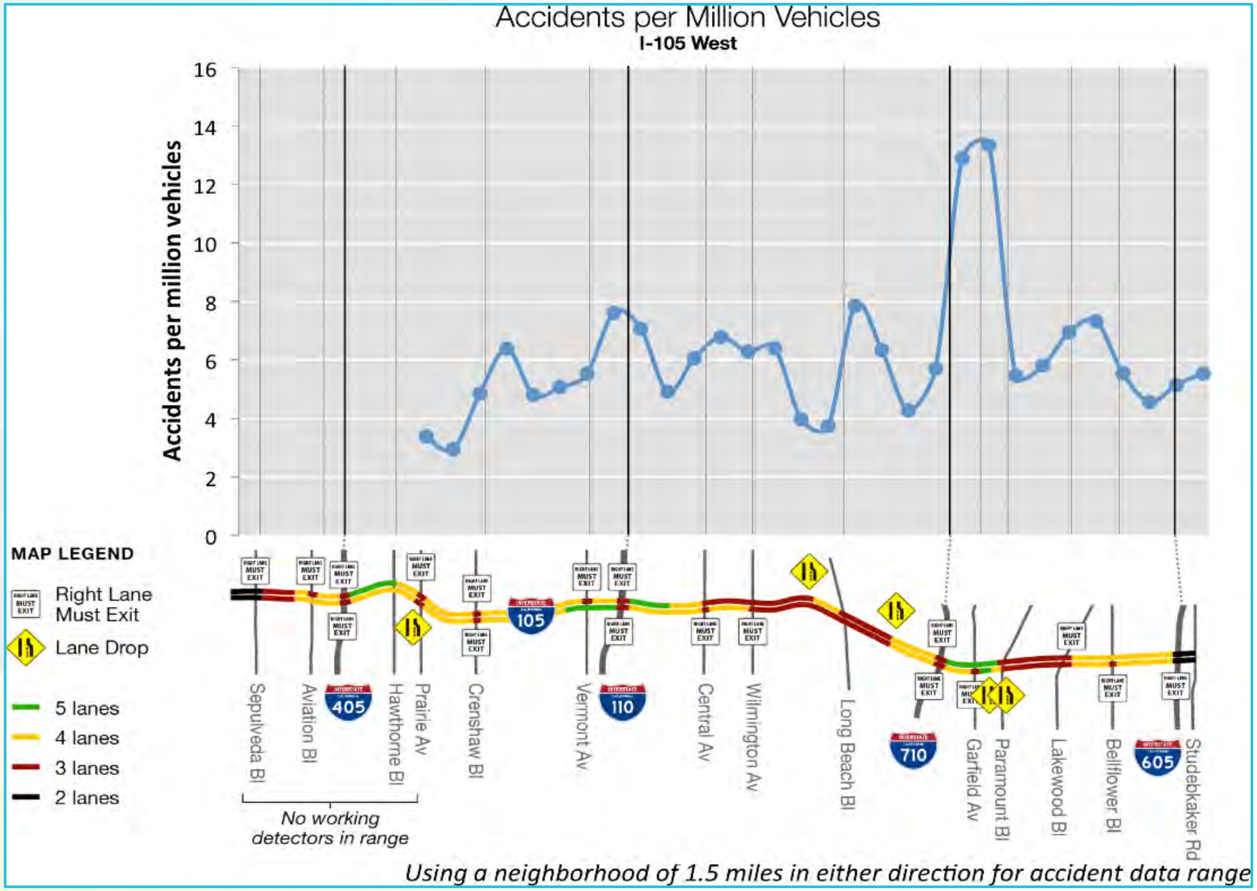
Accident Rates in Space and in Time



(Source: Federal Highway Administration.)

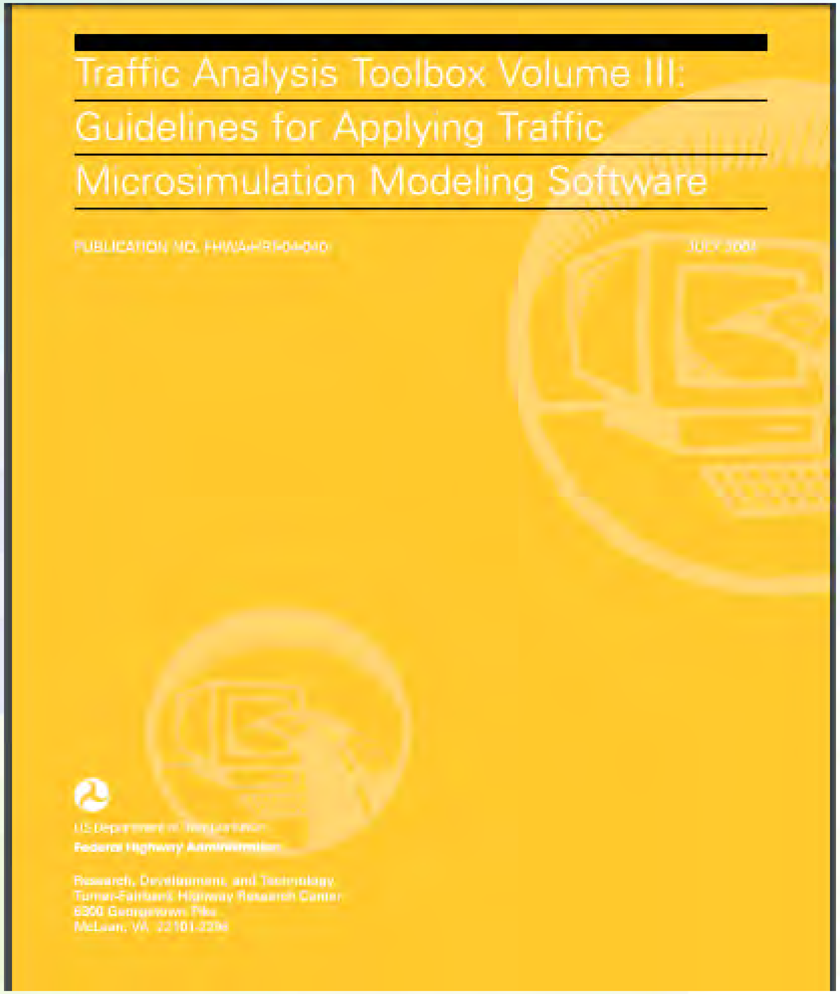
This figure shows how existing accident rates can be presented in space and in time and how this depiction can help analysts determine problematic locations and time spans when accident rates are greater than average.

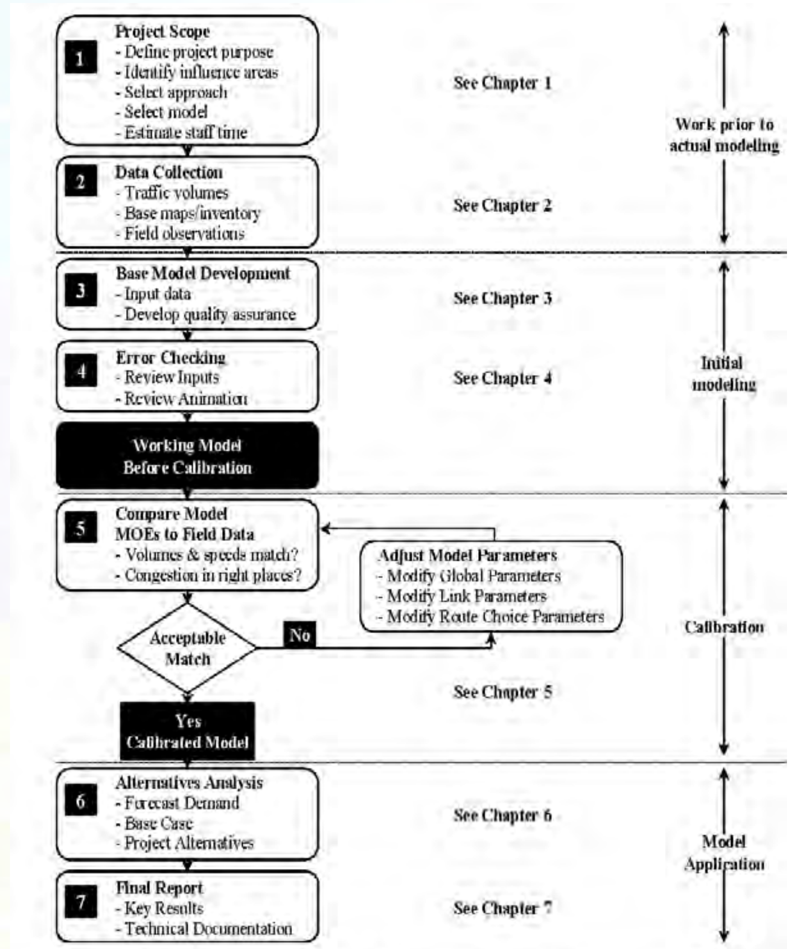
Accident Rates by Location



(Source: Federal Highway Administration.)

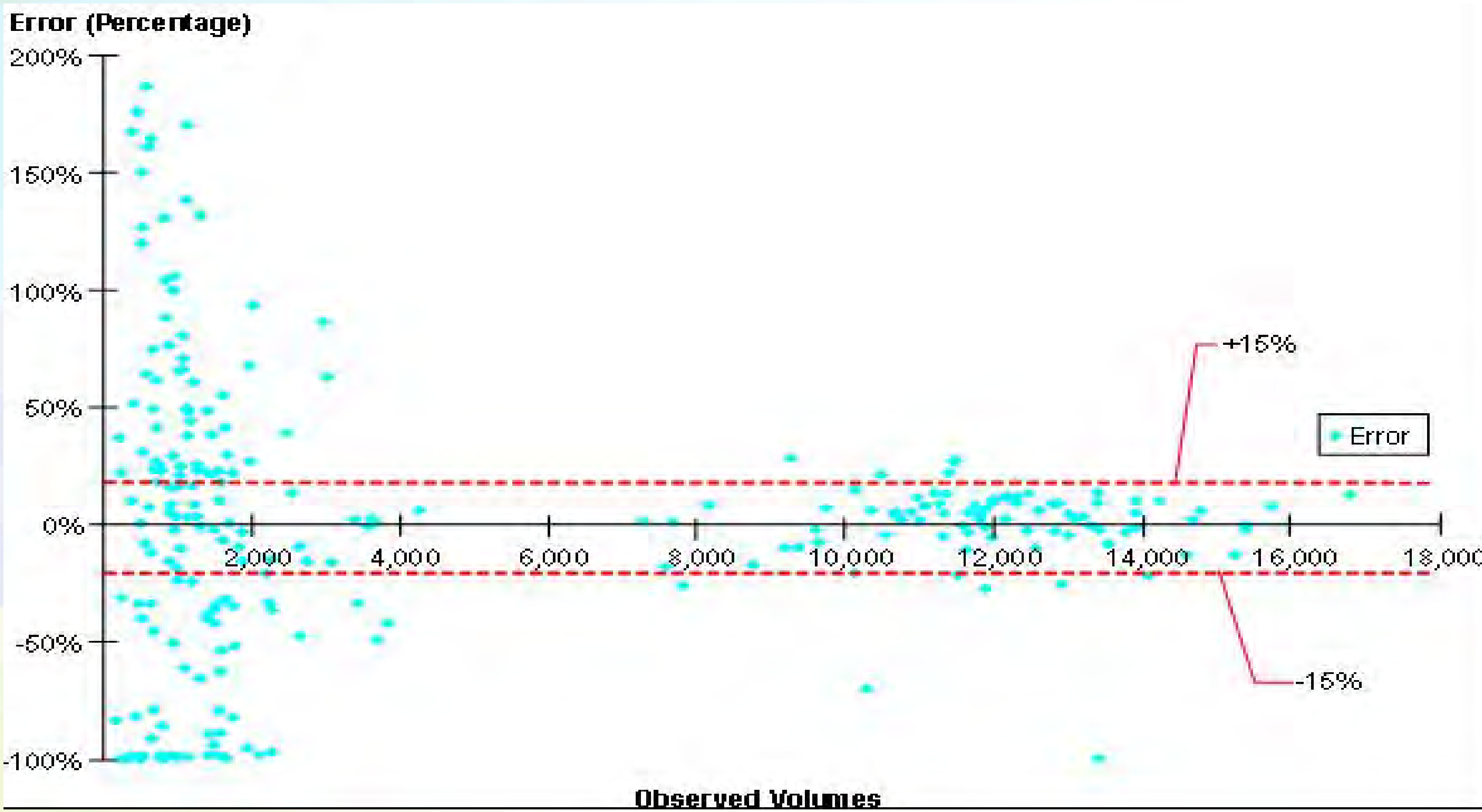
Model Calibration Requirements Leveraging FHWA Microsimulation Guidance



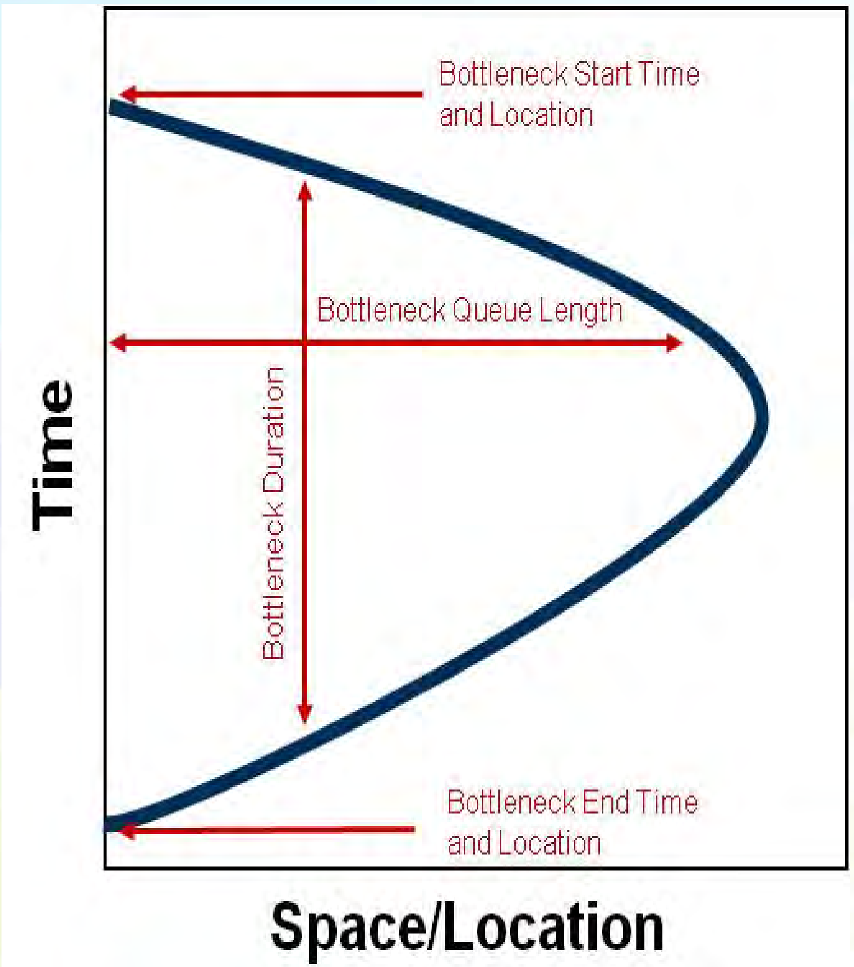


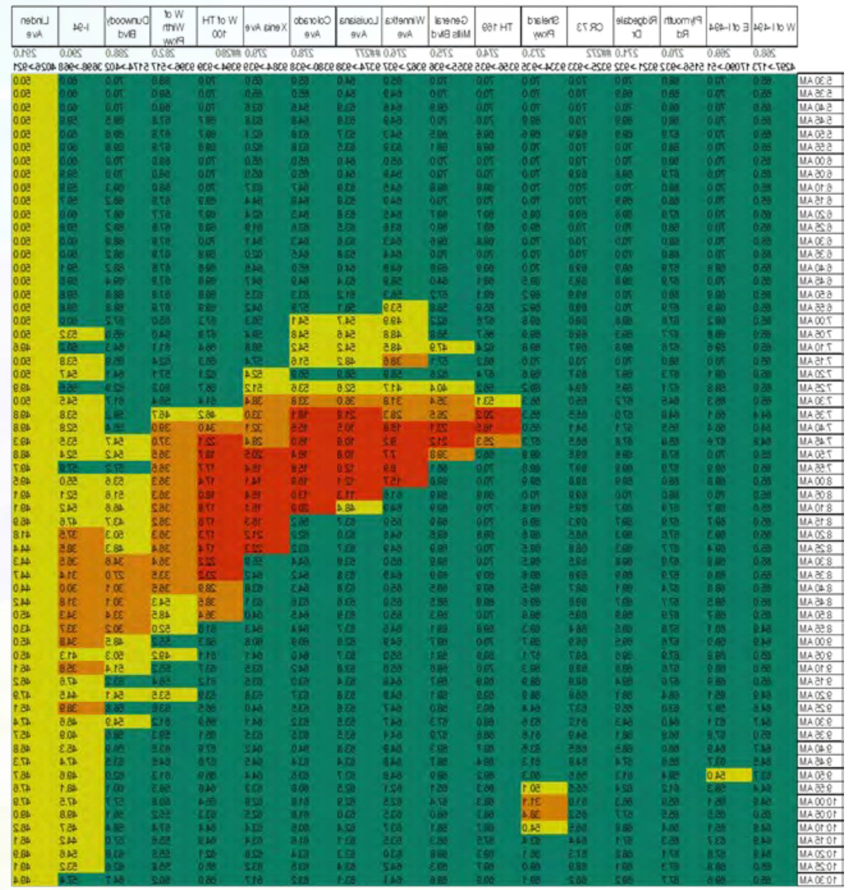
Developed by the FHWA Traffic Analysis Tools Team and later adapted from *Advanced Corsim Training Manual*, Short, Elliott, Hendrickson, Inc., Minnesota Department of Transportation, September 2003.

Substep 3.4: Example Observed vs Modeled Volumes

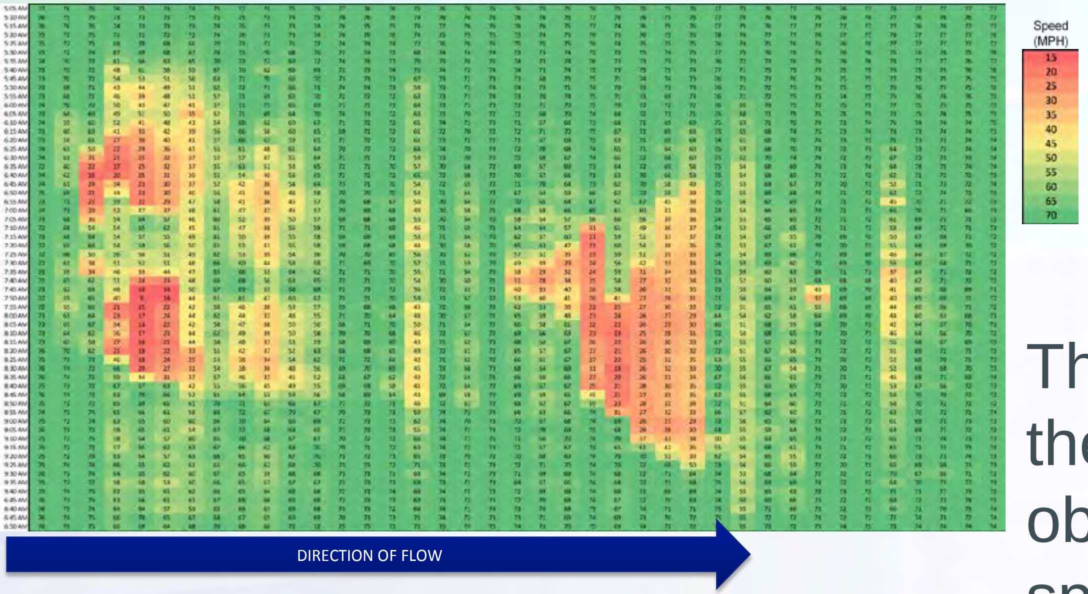


Substep 3.4: Example Speed Contour Diagram





Speed Diagram for an Analysis Scenario

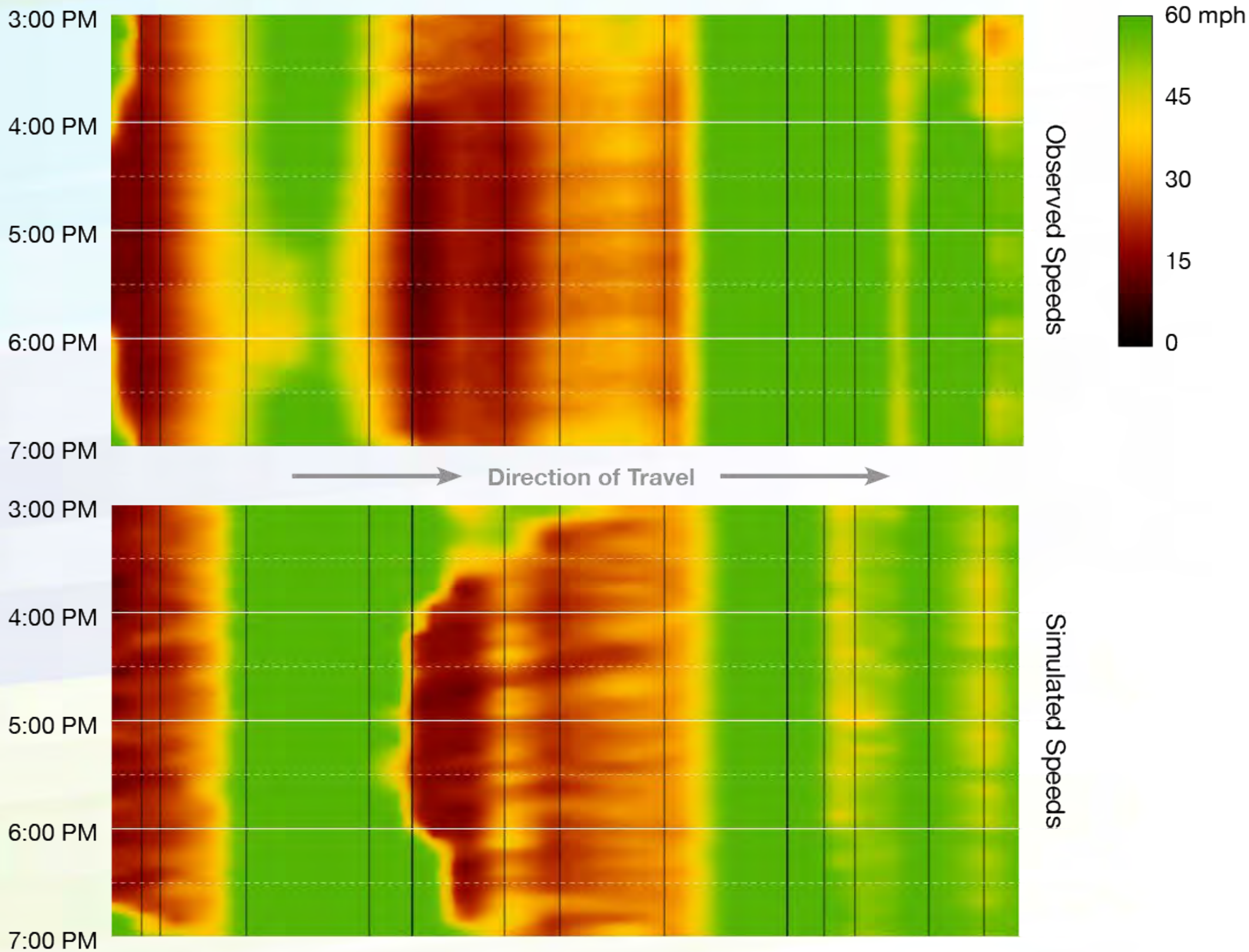


(Source: Federal Highway Administration.)

This type of diagram helps the analyst compare observed and modeled speeds in space and in time, so an assessment can be made about whether the model can adequately replicate existing conditions.

Example Bottleneck Model Calibration

PM Eastbound



Experimental Design for Analysis of Different Operational Conditions

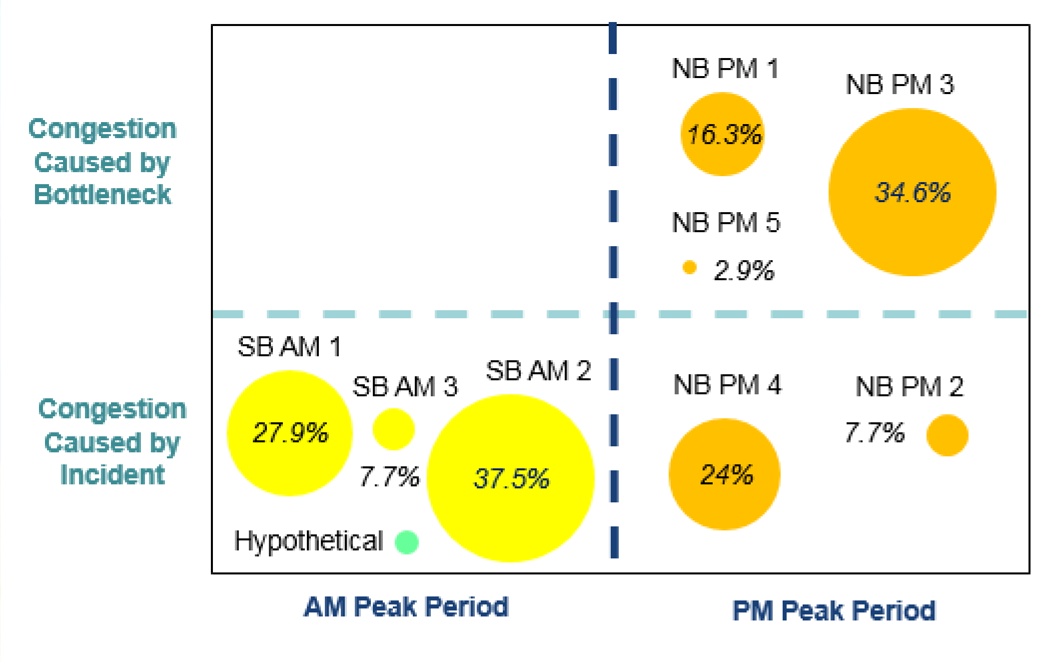
Highest Priority
- Scenarios with greatest frequency and impact

Lower Priority
- Scenarios with low likelihood but major impact
- Scenarios with frequent occurrence but limited impact

Lowest Priority
- Scenarios with low frequency and low impacts

Operational Condition Dartboard

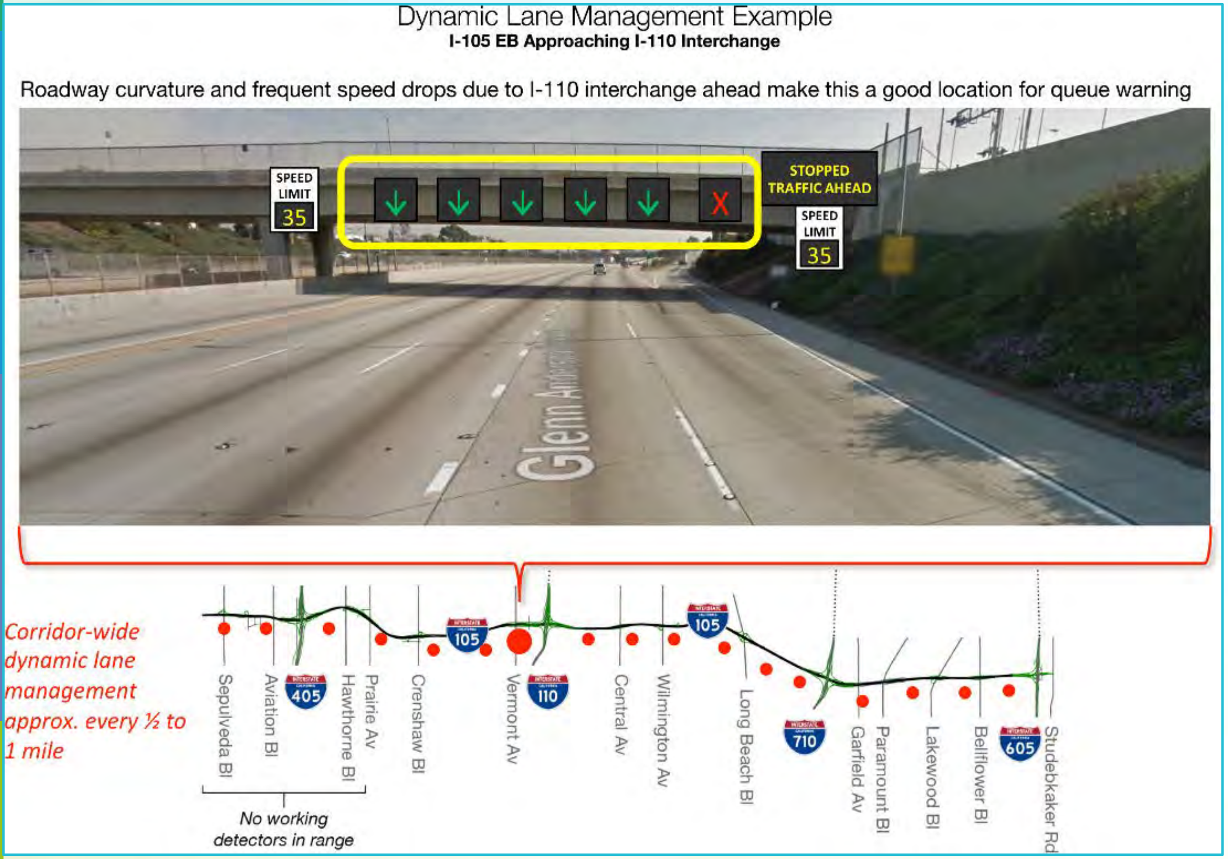
Scenario Frequency



Note: The size of each circle represents the percent of total analysis time period.

(Source: Federal Highway Administration.)

Illustration of an Alternative



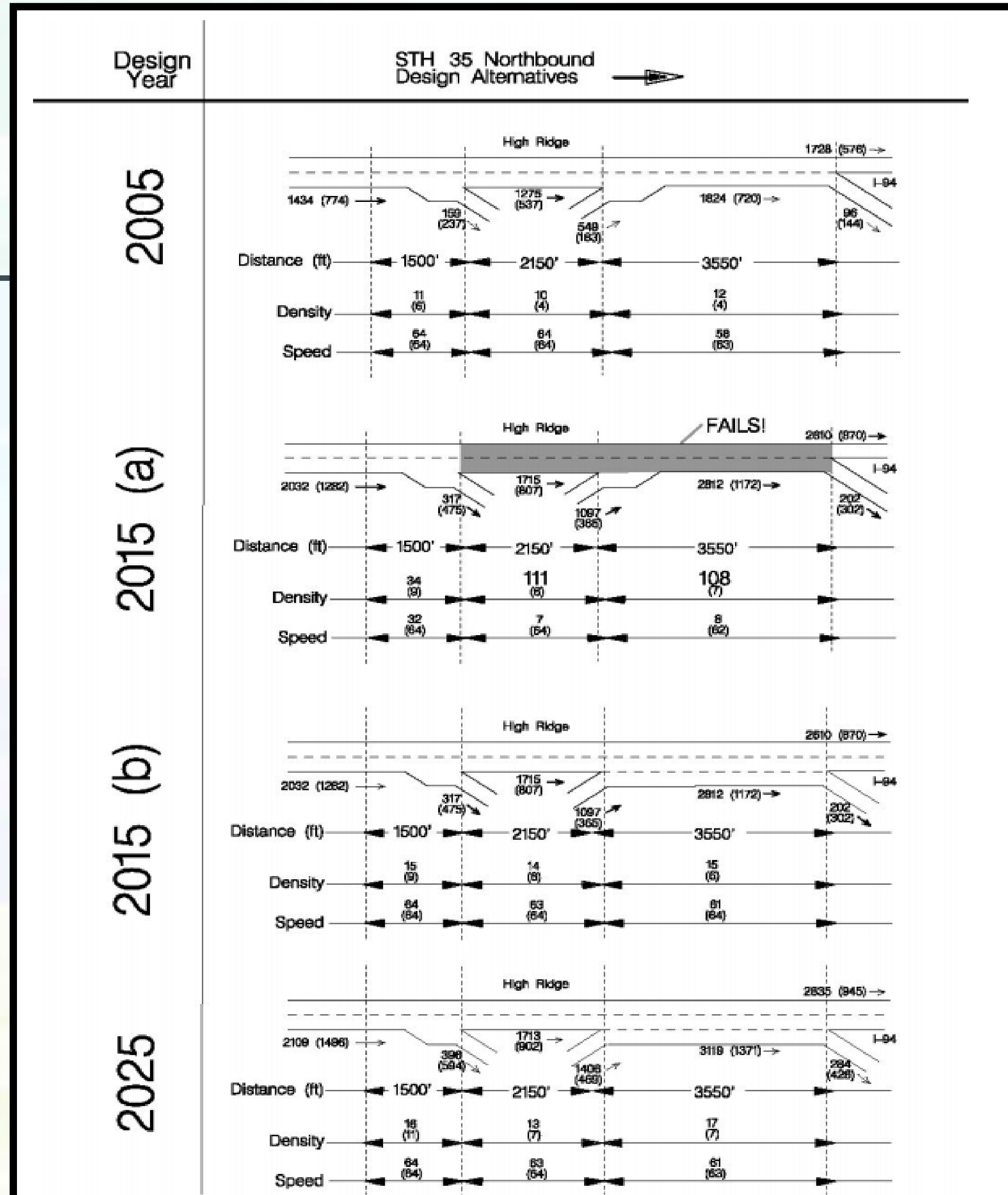
(Source: Federal Highway Administration.)

Illustrations such as this help stakeholders visualize the implementation of the strategy, enabling them to make better-educated decisions about how this strategy should be implemented.

Alternatives Analysis Objectives

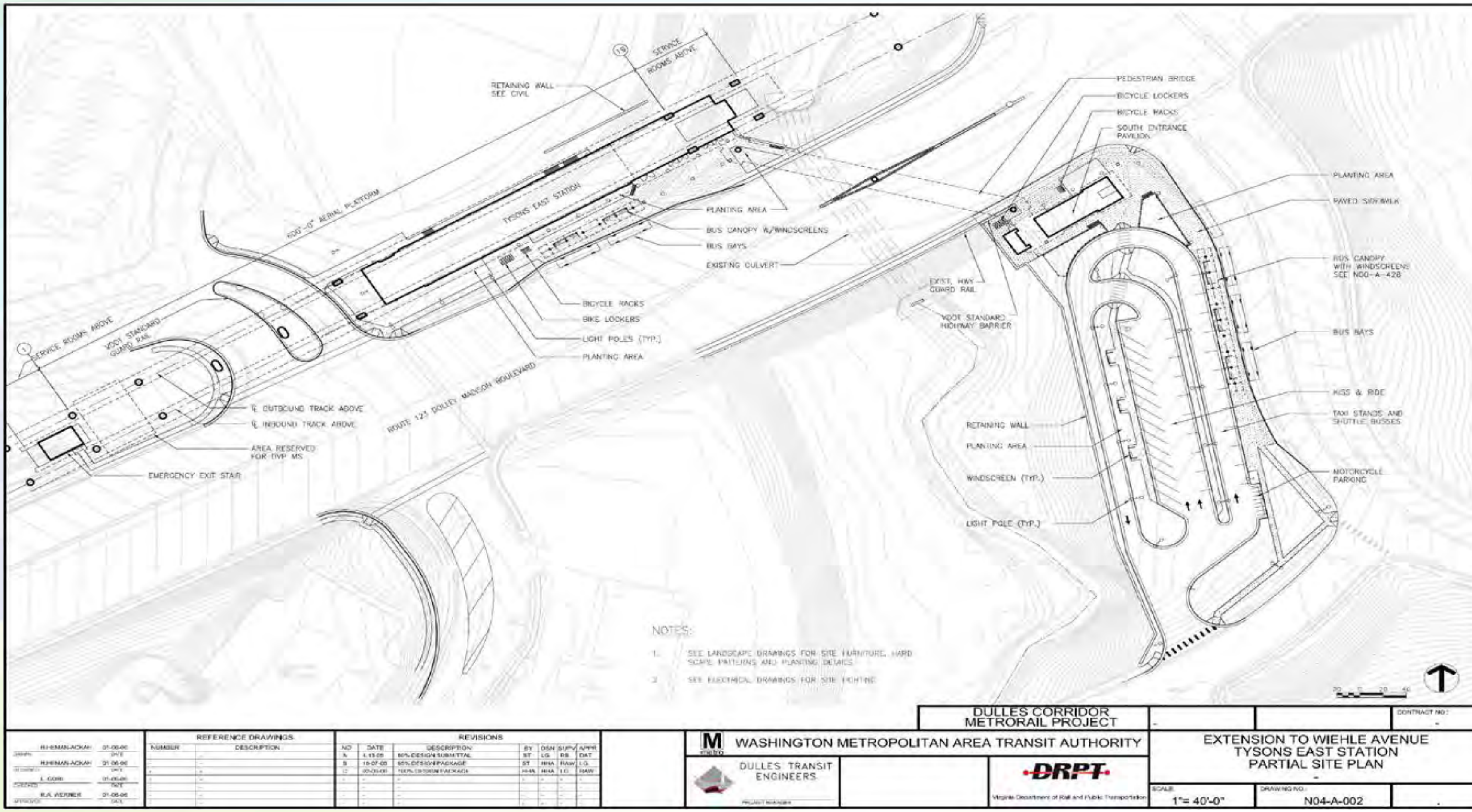
- Provide critical feedback to system designers and operators.
- Clearly demonstrate potential project benefits.
- Enable prioritization and selection of the right mix of strategies to deploy.
- Assist planners and operators in devising appropriate operating parameters and concepts of operation to optimize the impacts of the selected strategies.
- Shape investment decisions and to secure deeper and broader support for the project among stakeholder organizations.

Sample comparison of project alternatives using schematic drawing



(Source: Minnesota Department of Transportation/ Federal Highway Administration Traffic Analysis Toolbox Volume IV.)

Metro Station Analysis



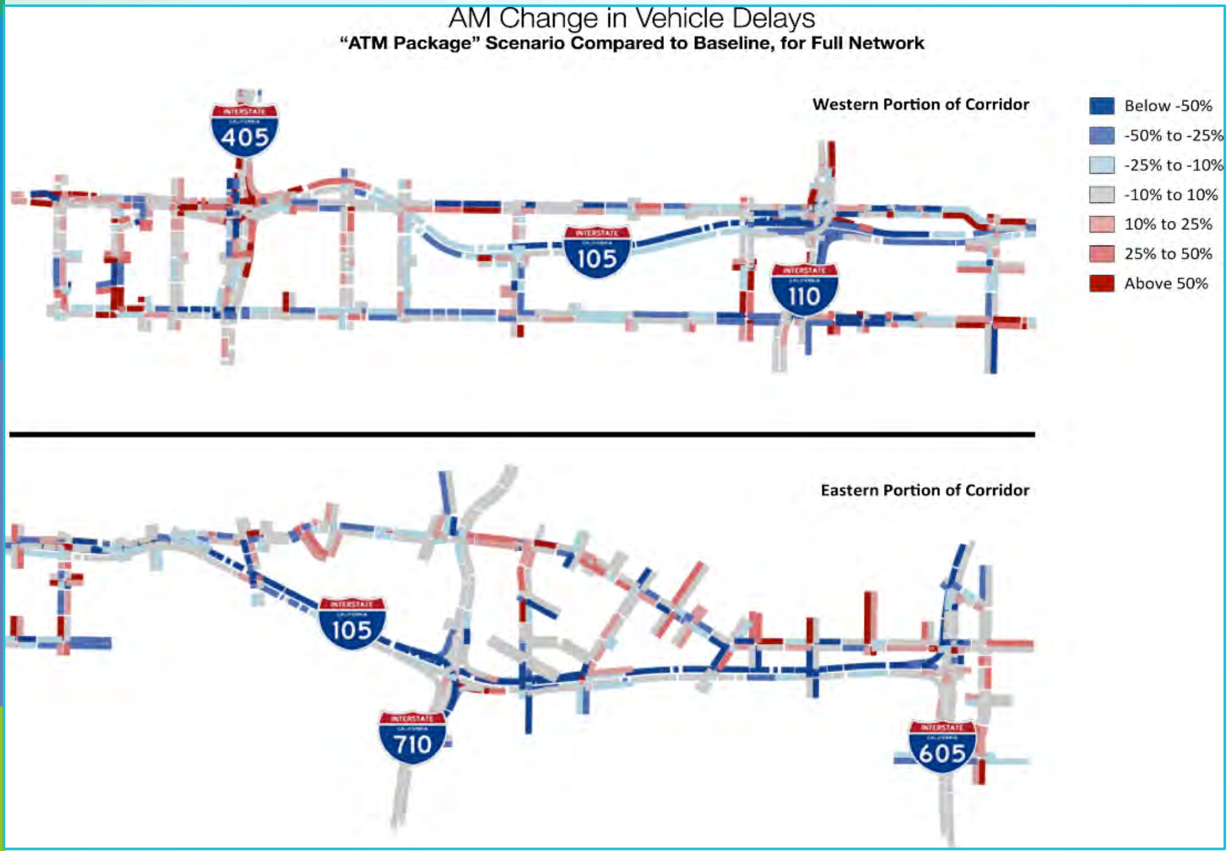
Conduct Analysis of Improvement Strategies for All Operational Conditions

- Evaluate the initial operational analysis assumptions, scrutinizing the results for any underperforming or counterintuitive metrics.
- Brainstorm a number of causes for the underperformance and a potential set of “what if” adjustments that might be made to alleviate the deficiencies.
- Formulate a set of scenarios that may be evaluated in the analysis structure to assess the impacts and benefits of adjustments to the operational assumptions.
- Analyze, compare, and refine—and re-run through the analysis procedures as necessary—to identify the optimal operating parameters.
- Document the tested scenarios and results for potential future use.
- Re-conduct the refinement process in a continual feedback loop as future conditions change or encountered deficiencies are warranted.

Assess Performance Measures

Performance Measure	Useful Metrics
Mobility	Travel time, delay, throughput
Reliability and Variability of Travel Time	Changes in Planning Index, changes in the standard deviation of travel time
Emissions and Fuel Consumption	Emissions and fuel consumption rates based on factors such as facility type, vehicle mix
Safety	Accidents or crashes in the study area (fatalities, injuries, property-damage-only accidents). *This is an area deserving of new research.*
Cost Estimation	Capital, operating, and maintenance costs

Comparison of Change in Delays



(Source: Federal Highway Administration.)

Such comparisons help stakeholders visually assess expected improvements and reductions in service in different parts of the network.

Comparison of Alternatives Across Various Performance Measures

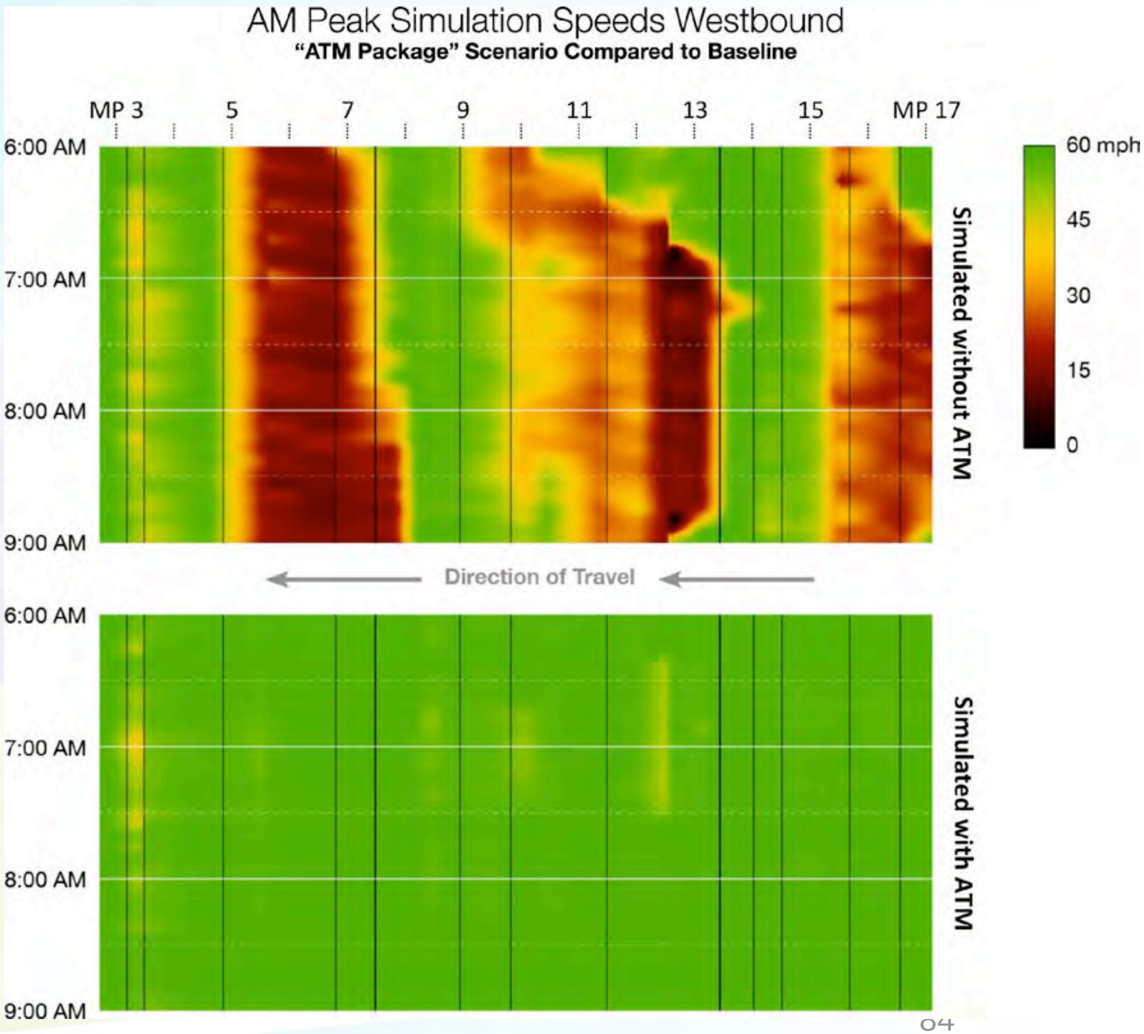
AM Performance Measures

System-wide, for a typical day

		Percent Change from Baseline	
Metric	**Without ATM**	*ATM Package*	*HSR Only*
VMT (vehicle miles)	1,400,468	1.51%	0.70%
VHT (vehicle hours)	44,832	-26.74%	-22.13%
Vehicle Hours of Delay (vehicle hours)	20,451	-59.59%	-48.64%
Person-Miles Traveled (passenger miles)	1,953,167	1.35%	0.50%
Person-Hours Traveled (passenger hours)	60,453	-25.06%	-20.87%
Person-Hours of Delay (passenger hours)	26,677	-57.68%	-47.30%
Average Travel Time (seconds per mile)	115.24	-27.83%	-22.67%
Average Trip Time (minutes per trip)	6.34	-27.31%	-22.47%

(Source: Federal Highway Administration.)

Heat Map Comparison of Freeway Speeds between Alternatives



(Source: Federal Highway Administration.)

Conduct Benefit-Cost Evaluation for all Performance Measures

- Benefits should be estimated for the improvements by monetizing the incremental change in performance measures associated with the strategies and scenarios analyzed.
- The incremental change in the performance measure should reflect the weighted sum of changes for all analysis scenarios.
- The results of this analysis enables the identification of the optimal combinations of mitigation strategies that can deliver the greatest impact on the corridor’s transportation objectives for the cost.

Monetary Benefits Across Various Performance Measures

AM Monetized Benefits Per Year

"ATM Package" Scenario

Benefit Category	**Freeways Only**	**Arterials Only**	**System-Wide**
Person-Hours of Delay Saved (recurrent congestion)	$37,997,253	$9,707,588	$47,704,841
Emissions Reductions	$801,901	$220,067	$1,021,968
Fuel Savings	$2,241,780	$845,969	$3,087,749
Collision Reductions	$5,350,762		$5,350,762
Improved Travel Time Reliability	$8,123,244		$8,123,244
Total Monetary Benefits	$54,514,940	$10,773,624	$65,288,564

(Source: Federal Highway Administration.)

Pioneer Sites ICM AMS Results

	San Diego	Dallas	Minneapolis
Annual Travel Time Savings (Person-Hours)	246,000	740,000	132,000
Improvement in Travel Time Reliability (Reduction in Travel Time Variance)	10.6%	3%	4.4%
Gallons of Fuel Saved Annually	323,000	981,000	17,600
Tons of Mobile Emissions Saved Annually	3,100	9,400	175
10-Year Net Benefit	$104M	$264M	$82M
10-Year Cost	$12M	$14M	$4M
Benefit-Cost Ratio	10:1	20:1	22:1

Document Analysis Results

- The Analysis Report functions as a stand-alone document containing:
  - Modifications to the analysis input
  - Analysis process
  - Results of alternatives analysis
  - Performance measures for all alternatives
  - Benefit/cost analysis for each alternative
  - A prioritized list of improvement strategies for each scenario
  - Lessons learned through alternatives analysis

Module 4 Output

Project Results Summary Elements

Project Definition	A concise statement of the overall system problem including cross-validation and other insights from stakeholders on the nature of the issue and potential solutions.
Geographic Scope	The geographic area covered by the analytical project, including a statement of the required detail of representation within this geographical area.
Temporal Scope	The times of day, days of week, seasonality, and years of operation assessed in the analytical effort. This includes an assessment of the simulation horizon.
Hypotheses	The hypotheses represents the leading underlying cause of the system performance issue.
Results Summary	A text description summarizing the analytical results of the effort. This section should reference the final report that details project findings.
Analytical Approach	A description of the method used for evaluating the effectiveness of the mitigating strategies in resolving the system performance issue.
Developed Models	The one or more tool types used in the analytical approach, and the models developed to represent the system. This section should identify where these data are archived and documented.
Data Resources	A summary of data used to characterize operational conditions, represent alternatives, and model the geographic and temporal aspects of the system. This section should identify where these data are archived and documented.

Module 4 Output (continued)

Project Results Summary Elements

Alternatives Modeled	Detailed description of the alternative solutions and/or operational practices assessed within the analytical project.
Key Operational Conditions	The set of travel demand, incident, and weather conditions under which a meaningful examination of alternative impacts were conducted.
Selected Performance Measures	The measures of system performance used in the effort.
Actual and Expected Costs	The actual and projected cost of the analytical project, including data collection.
Actual and Expected Schedule	The actual and projected time to conduct the analysis, including data collection.
Lessons Learned	An assessment of lessons learned regarding technical and non-technical issues.
Risks	A summary of risks comprising risks in data collection, technical risks, and non-technical risks—and how they were overcome or mitigated in the effort.