FHWA's Traffic Analysis Toolbox:
Guidelines for Selecting and Applying Appropriate Analysis Methods

- **Introduction to FHWA's Traffic Analysis ToolBox**
  - Goals and Objectives
  - Transportation challenges and potential solutions
- **Review of Analysis Methods**
  - Macro, Meso, Micro, Optimization, Deterministic
- **Toolbox Support for Project Scoping**
  - Selection of appropriate methods
  - Expectations for analysis methods
  - Example application: HCM vs. Simulation
- **Project Management Plans: Implications for Tool Selection**
  - Scoping, Data, Calibration, Alternatives Analysis, Reporting
  - Relevance to specific analytical questions
- **Key Considerations for Developing an Analysis Plan**
  - Addressing analysis risks

Definition of Congestion

Naïve Definition: When Demand Exceeds Capacity

Dynamic Definition: Congestion is a function of the time-varying properties of transportation demand and supply

Sources of Traffic Congestion

Recurring:
- Insufficient capacity
- Unrestrained demand
- Ineffective management of capacity (e.g. poor signal timing)

Non-recurring:
- Incidents
- Work zones
- Weather events
- Special events
- Emergencies (e.g. hurricanes)

Congestion Management in the U.S.

- Travel demand is on the rise
- Traffic congestion is increasing
- Financial constraints are a reality
- Reduce traffic congestion by bringing supply and demand into alignment
- Active Traffic Management (ATM) is one of the operational strategies to manage congestion

Operational Strategies

Improving the efficiency of the transport system by:

- Providing real-time, multi-modal information
- Predicting travel times
- Active traffic management
- Traffic management centers
- Parking management
- Improved public transport
- Managing large-scale events and emergencies
- Highway reconstruction mitigation

Sources: ATAC, Schreffler, Hull, AVV

Active Traffic Management Strategy	Potential Benefits												
	Increased throughput	Increased capacity	Decrease in primary incidents	Decrease in secondary incidents	Decrease in incident severity	More uniform speeds	Decreased headways	More uniform driver behavior	Increased trip reliability	Delay onset of freeway breakdown	Reduction in traffic noise	Reduction in emissions	Reduction in fuel consumption
Speed harmonization	●		●		●	●	●	●	●	●	●	●	●
Temporary shoulder use	●	●							●	●			
Queue warning			●	●	●	●	●	●	●		●	●	●
Dynamic merge control	●	●	●			●		●	●	●	●	●	●
Construction site management	●	●							●		●	●	●
Dynamic truck restrictions	●	●				●		●	●			●	●
Dynamic rerouting and traveler information	●		●	●				●	●			●	●
Dynamic lane markings	●	●							●				
Automated speed enforcement			●		●	●		●	●			●	●

Role of Analysis Tools for Planning and Operations

Analytical Support for Improved decision making

- Set priorities among competing projects
- Consistent approach for comparing alternatives
  - "Balanced" comparison for programming projects
  - Impacts, benefits, and costs of construction & operations strategies considered
- Provides data to support planning needs
- Forecasts future operations resource needs
- Provides benefit information that can be communicated to agency management, politicians, and the traveling public

FHWA's Traffic Analysis Tools Program:
Goals and Objectives

Goal

"*The goal of the Traffic Analysis Tools Program is to make significant contributions to reducing congestion and improving traffic operations and safety by developing new and improved analytical tools and achieving wider use of these tools for __better decision-making__.*"

Objectives

- Help project sponsors develop an appropriate analytical process

- Promote analytical consistency and uniformity across method applications.

- Improve system efficiency

- Reduce implementation costs

- Support and advance the State of the Practice

TAT Resources

Volume 1 - Primer

Volume II – Decision Support Methodology for Selecting Traffic Analysis Tools

Volume III – Guidelines for Applying Traffic Microsimulation Modeling Software

Volume IV – Guidelines for Applying CORSIM Microsimulation

Volume V – Traffic Analysis Tools Case Studies: Benefits and Best Practices

Volume VI – Definition, Interpretation, and Calculation of Traffic Analysis Tools Measures of Effectiveness

Volume VII – Predicting Performance with Traffic Analysis Tools

Volume VIII – Work Zone Modeling and Simulation

Volume X - Localized Bottleneck Congestion Analysis

Volume XI - Weather and Traffic Analysis, Modeling and Simulation

http://ops.fhwa.dot.gov/trafficanalysistools/index.htm

Categories of Analytical Tools

Categories of Traffic Analysis Tools

Sketch-Planning tools
Analytical/deterministic tools (HCM-based)
Travel Demand Models
Traffic Signal Optimization tools
Macroscopic Simulation Models
Mesoscopic Simulation Models
Microscopic Simulation Models

DynaMIT-P

Sketch-Planning Tools

Provide quick order of magnitude estimates with minimal input data in support of preliminary screening assessments
- Typically depend on behavioral assumptions

Examples
- Sketch
  - SCRITS
  - Quickzone
  - Turbo Architecture
  - Cal B/C
  - Simple spreadsheets
- Hybrid
  - IDAS

Travel Demand/Forecasting Models

Estimates the regional traffic impact of changes in travel demand or system capacity

Examples

- Travel Demand Models
    - TRANPLAN
    - EMME/2
    - Cube
    - TransCAD
- Hybrid
    - IDAS (post-processor)

Source: IDAS

Limitations of Network Models

Regional network models limited in their ability to..

- Reflect oversaturated conditions
- Understand the time-dependent characteristics of congestion
- Represent impacts of bottlenecks on downstream links
- Understand how reliability impacts route choice (and other) decisions

Speed Delay Functions: Static Assignment Methods

Analytical

Noncongested Flow

A B C D

Speed

LOS F

LOS E: $\frac{V}{C} = 1$

Forced Flow

Volume

Deterministic Methods

Analyzes the performance for small segments of the transportation system

- Capacity, speed, delay, queuing
- Typically based on the HCM

Examples

- Highway Capacity Software (HCS)
- Traffix

HIGHWAY CAPACITY MANUAL

TRANSPORTATION RESEARCH BOARD
National Research Council

TRB   HCM2000

Deterministic Models and Queuing

- Uniform arrivals within the cycle
- Equal arrivals among cycles

RED   GREEN

Source: **NHI**

Travel Demand Model: Adoption of HCM relationships

Traffic signal timing data

Intersection data

Arterial segment data

Database (file conversion)

Regional Model

HCM-implementing software
(ARTPLAN)

Segment capacities

Adjust operations parameters

Deterministic Methods: Strengths, Limitations

Advantages
- Quickly predict impacts for an isolated area
- Widely accepted

Challenges
- Limited ability to analyze broader network impacts
- Limited performance measures

Traffic Signal Optimization Tools

- Develop optimal signal-phasing and timing plans
- Applied in isolated intersections and signalized networks
- Arterial corridors (e.g., SYNCHRO)
- Networks (e.g., TRANSYT-7F)
- Also used to optimize ramp metering rates

Traffic Signal Optimization: Strengths, Limitations

Advantages
- Effective tool for testing plans prior to field implementation
- Proven operational benefits

Challenges
- Limited ability to analyze broader network impacts

Simulation Methods

Macroscopic
- Simulation of flow, speed, and density made on a segment-by-segment basis

Mesoscopic
- Hybrid model where dynamic estimation of individual vehicles based on average segment speeds

Microscopic
- Simulates detailed movement of individual vehicles throughout the network

Simulation and Queuing

Queue at the start of a second
- + Arrivals
- - Departures
- = Queue at the end of the second

RED   GREEN

Source: **NHI**

Comparison: TDF vs. Meso vs. Micro

	STA	DTA	MICRO
Loading	Analytical	Meso Sim	Micro Sim
Shortest Path	Instantaneous	Time Dependent	Instantaneous
Route Choice	FW/OBA/TAPAS	GFV	Logit/MSA
Connectivity	Link	Link/Lane	Lane/Turn
Resolution	Hour	Minute	Second
Solution	UE	DUE	Non-UE
Convergence	Unique	Non-Unique	Non-Unique
Speed	Static Average	Time Varying	Time Varying
Flow Model	VDF	Speed-Density	Car Following
Arrival Time Profile	No	Yes	Yes

Simulation Methods: Strengths, Limitations

Advantages
- Network-based
- Detailed results, particularly microsimulation
- Dynamic analysis of incidents and real-time diversion patterns
- Visual presentation opportunities
- Reuse for future analyses

Challenges
- Demanding data and computing requirements, particularly microsimulation
- Calibration may be time consuming for larger, more complex, or congested networks

Selecting the Appropriate Analysis Tool

- Begin with the end in mind
- Identify analytical context
  - Planning
    - Short- or long-range studies
    - Master plans
    - Congestion management plans
    - ITS strategic plans
  - Design
    - Alternatives analysis
    - Preliminary design
    - Analysis of roadway features
  - Operations/construction
    - Optimizing or evaluating existing systems
- Determine Criteria Relevance

Analysis Tools and Project Life Cycle

Project Management Process For Traffic Analysis

Source:
TAT, Vol. III

Project Scoping

Identify Project Purpose and Need

- High Level Planning
- Detailed Design
- Operational Improvements

Project Scoping

Identify Limits of Project
- Physical Construction
- Operational Area of Influence
- Boundary Conditions

Estimate Data Collection
- Available Data Sources
- Additional Data Needs
- Analysis Year(s) and Time Period(s)

Estimate Level of Effort
- Beyond the Highway Capacity Manual
- Commensurate to Purpose and Need, Investment, and Safety or Failure Risk

Figure Courtesy of MNDOT

Insights for Decision Making

Expectations for Analytical Tools
- Compare to "No Build"
- Focus on more than LOS
- Understand upstream and downstream impacts

TAT Goal: To Better Inform the Decision Making Process
- Better planning/engineering decisions
- Estimate the impact of deployment
- Set priorities among competing projects
- Consistent approach for comparing alternatives

Other Considerations

Improve design/Evaluation time and costs
- Balancing Scope and Complexity
  - Determine 'optimal' method
- Assess multiple alternatives/deployments
- Assess complex scenarios
- Learn process once – use over and over

TAT Volume II: Decision Support Methodology for Selecting Traffic Analysis Tools

Assist with Selection of Most Appropriate Analytical Tool

- Identify appropriate criteria
- Systematic process
- Document tool selection
- TAT spreadsheet tool

Tool Selection

- What was considered in the selection of the proposed tool?
- Has the tool been validated and if so, how?
- Is there sufficient documentation to support the tool selection?

Resources: "Decision Support Methodology for Selecting Traffic Analysis Tools" → (Volume II of the Traffic Analysis Tools Toolbox)

Table 11. Example 3 worksheet (refer to sections 2.1 and 2.2 for criteria definitions).

1	2	3								4				
		Tool Category Relevance								Column 2 x Column				
Criteria	Context Relevance	Sketch Plan	TDM	Analytical (HCM)	Traffic Opt	Macro Sim	Meso Sim	Micro Sim	Sketch Plan	TDM	Analytical (HCM)	Traffic Opt	M s
0 Analysis Context (0 = not relevant, 5 = most relevant)													
Planning	0	10	10	5	0	5	5	0	0	0	0	0	
Design	0	-99	5	10	10	10	10	10	0	0	0	0	
Operations/Construction	5	5	0	10	10	10	10	10	25	0	50	50	
							Subtotal		25	0	50	50	
					Relevance Weights Above 0				1				
						WEIGHTED SUBTOTAL			25	0	50	50	

1	2	3								4				
		Tool Category Relevance								Column 2 x Column				
Criteria	Sub-Criteria Relevance	Sketch Plan	TDM	Analytical (HCM)	Traffic Opt	Macro Sim	Meso Sim	Micro Sim	Sketch Plan	TDM	Analytical (HCM)	Traffic Opt	M s

Selecting the Appropriate Tool

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 Tool/Cost-Effectiveness
What is your study area?	Which facility types do you want to include?	Which travel modes do you want to include?	Which management strategies should be analyzed?	Which traveler responses should be analyzed?	What performance measures are needed?	What operational characteristics are necessary?

• 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 Line
		• SOV
		• HOV (2, 3, 3+)
		• Bus
		• Rail
		• Truck
		• Motorcycle
		• Bicycle
		• Pedestrian
			• Freeway Mgmt
			• Arterial Intersections
			• Arterial Mgmt
			• Incident Mgmt
			• Emergency Mgmt
			• Work Zone
			• Spec Event
			• APTS
			• ATIS
			• Electronic Payment
			• RRX
			• CVO
			• AVCSS
			• Weather Mgmt
			• TDM
				• Route Diversion
				  – Pre-Trip
				  – En-Route
				• Mode Shift
				• Departure Time Choice
				• Destination Change
				• Induced/ Foregone Demand
					• LOS
					• Speed
					• Travel Time
					• Volume
					• Travel Distance
					• Ridership
					• AVO
					• v/c Ratio
					• Density
					• VMT/PMT
					• VHT/PHT
					• Delay
					• Queue Length
					• # Stops
					• Crashes/ Duration
					• TT Reliability
					• Emissions/ Fuel Consump
					• Noise
					• Mode Split
					• Benefit/Cost
						• Tool Capital Cost
						• Effort (Cost/ Training)
						• Ease of Use
						• Popular/Well-Trusted
						• Hardware Requirements
						• Data Requirements
						• Computer Run Time
						• Post-Processing
						• Documentation
						• User Support
						• Key Parameters User Definable
						• Default Values
						• Integration
						• Animation/ Presentation

Analysis Tools: Scope and Cost Tradeoffs

Exhibit 4: Geographic and Demand Focus of Analysis Tool Categories

Exhibit 5: Resource Requirements and Precision of Analysis Tool Categories

California's Microsimulation Scoping

3.0 Project Scope

Purpose. The spatial extent of the study area would include intersections, high ways, corridors, and other facilities to be analyzed with the microsimulation tool. The study area should cover the end of the full spatial and temporal extent of queues in the baseline and best estimate and bottlenecks in future years of the analysis. The facilities should be described in detail.

The following checklist should be used for specifying the components of the scope of work:

1. Intersections
   - ❑ Isolated signalized intersections;
   - ❑ Signalized corridor; and
   - ❑ Signalized city grid system.
2. Highway/Interstate Analysis
   - ❑ Mainline;
   - ❑ Mainline and frontage roads;
   - ❑ Mainline and ramp; and
   - ❑ Merge/diverge.
3. Modal Impacts
   - ❑ Auto Single Occupancy Vehicles (SOV);
   - ❑ Auto High Occupancy Vehicles (HOV);
   - ❑ Bus;
   - ❑ Light rail;
   - ❑ Truck;
   - ❑ Bicycle/bicycle detection;
   - ❑ High Occupancy Toll (HOT)/toll lanes; and
   - ❑ Pedestrian.
4. Specialized Operations Analysis

7.0 Alternatives Analysis

1. Development of Project Alternatives
   - ❑ Physical changes to roadway; and
   - ❑ Operational improvements.
2. Selection of Performance Measures
   - ❑ Travel time;
   - ❑ Reliability of travel time;
   - ❑ Volume;
   - ❑ Travel distance;
   - ❑ Vehicle miles traveled (VMT)/person miles traveled (PMT);
   - ❑ Vehicle hours traveled (VHT)/person hours traveled (PHT);
   - ❑ Delay;
   - ❑ Queue lengths;
   - ❑ Number of stops;
   - ❑ Emissions;
   - ❑ Fuel consumption; and
   - ❑ Benefit/cost (see Cal B/C requirements).
3. Model Application
   - ❑ Mean condition;
   - ❑ Minimum condition; and
   - ❑ Maximum condition.

Comment. When the model is applied to each alternative, multiple model runs need be conducted to provide for the variability of traffic encountered in real life. Typically nine model runs will be conducted with different "seeds" for each alternative. Typically, the analyst would use the median model run as the one being representative of a "typical day" in the particular alternative. VMT and VHT are used as control parameters for the analyst to identify the median model run.

Example of Costing Spreadsheet

Caltrans Microsimulation Costing Spreadsheet

[Press This Button to Start]

Summary of User Inputs:

Name of Study Area:		
# of Intersections:		
# of Freeway Ramps:		
Relevant Tasks:		
	Task 1:	Develop workplan and project management
	Task 2:	Select analysis tool
	Task 3:	Collect data
	Task 4:	Develop and calibrate baseline model(s)
	Task 5:	Develop future baseline model(s)
	Task 6:	Analyze alternatives
	Task 7:	Create report
	Task 8:	Develop and conduct presentation(s)
# of Alternatives:		
Complexity of Alts.		
Complexity of Model:		
# of Presentations:		

Caltrans Microsimulation Costing Spreadsheet

OUTPUT REPORT

Estimate of Labor Hours Required to Complete the Microsimulation of:

0

Project Task		Manager Hours	Engineer/ Planner Hours	Technician Hours	Total Hours
1	Develop workplan and project management	8	4	-	12
2	Select analysis tool	4	4	-	8
3	Collect data	-	-	-	-
4	Develop and calibrate baseline model(s)	16	80	160	256
5	Develop future baseline model(s)	3	16	32	51
6	Analyze alternatives	-	-	-	-
7	Create report	16	20	4	40
8	Develop and conduct presentation(s)	-	-	-	-
	Total Labor Hours	47	124	196	367

TAT and Interstate Access

- FHWA will continue to use HCM to review proposed access points
- Other traffic analysis methods may be used to aid in the decision making process

Handout

Performance Measures: Deterministic vs. Simulation

HCM

- Static approach to predicting traffic performance
- Estimates average density, speed or delay over 15 minutes
- Reports density in equivalent passenger vehicles
- Reports capacity in passenger car equivalents
- Not a system approach
- Limited capabilities for representing over-saturated conditions
  - Bottlenecks, queue spillback

Simulation

- Predict density, speed and delay for each time slice
- Reports flow and density in actual vehicles
- Reports delay and queues on the street segment where vehicles are slowed down
  - Congestion propagation to upstream links

HCM vs. Simulation (Cont'd)

Simulation strengths

- Effective in evaluating the dynamic evolution of traffic congestion
- Can evaluate buildup, dissipation and duration of traffic congestion
- Can model driver/vehicle characteristics

Simulation limitations

- Unable to model certain driver behaviors in urgent situations, particularly under congested conditions
- More demanding data requirements
- Complex calibration

2010 HCM: Uninterrupted Flows

Chapter 11: Basic Freeway Segments

27

- Revised speed-flow curves NEW!
- Improved free-flow speed prediction model Updated

Chapter 12: Freeway Weaving Segments

28

- Incorporates NCHRP 3-75 research NEW!
- New ways to consider length, width and configuration
- Lane-changing used as a measure of turbulence; methodology predicts total lane-changing activity
- New speed-prediction algorithms
- New approach to weaving capacity

2010 HCM: Interrupted Flows

Chapter 18: Signalized Intersections

36

- New method for calculating uniform delay term NEW!
- Actuated controller operation modeling procedure added NEW!
- Left-turn pocket overflow check added
- Ped & bike LOS incorporates NCHRP

Chapter 19: TWSC Intersections

37

- Gap acceptance parameters for six-lane streets added NEW!
- Interface with urban street segment methodology for upstream signal effects NEW!
- Pedestrian crossing LOS method NEW!
  - Considers various types of crossing treatments and associated driver yielding behavior

Important Simulation Properties

- Analysis of a System - Freeway and Arterial
- Analysis of over-saturated conditions
  - Spillback
  - Spillover
  - BottlenecksTime-varying
- Time-varying
- Stochastic (*random*)
- Human performance
- System-wide analysis

I-405 Corridor: Analytical Approach using Multiple Tools

Study Context

- 30 mile freeway corridor
- Purpose of modeling effort
  - Provide required information for environmental document process
  - Develop design solutions and improvement strategies
  - Solve specific traffic and congestion related problems
    - Existing
    - Future

Primary tool for freeway analysis
- VISSIM
  - Mainline segments
  - Ramps
  - Interchanges
  - Freeway connections

Other tools
- Synchro
  - Intersections
- EMME2
  - Travel demand forecasts

Handout

Microsimulation Data Needs

Flow, Queue, and Capacity Data
- **Mainline Volumes (Every X Feet)**
- **Mainline Speeds (Every X Feet)**
- **Travel Times (Link or Between Occupancy/Density Pairs)**
- **Bottleneck Capacity (Measured, Not Theoretical)**
- **Entrance Ramp Queues**
- **Intersection Queues and Queue Discharge Rates**

Sources
- **Instrumented Systems**
- **Permanent Count Stations**
- **Automatic Vehicle Locators (AVL)**
- **Crash Databases**
- **Manual Counts**
- **Speed Studies**
- **Queue Observations**
- **O-D Studies**

Workshop 3
Basic Freeway Section
Geometric Data
Freeway1.trf

Network Attribute Data
- Lane widths
- Speeds
- Length of accel/decel lanes
- Length of turn bays
- Exclusive turn movements

Source: Chapter 9 Model Calibration
John Hourdakis, Center for Transportation Studies
University of Minnesota

Alternatives Analysis
6
- Forecast Demand
- Base Case
- Project Alternatives

The Alternatives Analysis

• Screening of alternatives using:
  • Planning level tools
  • Design feasibility
  • Environmental constraints
  • Political Factors
  • R/W constraints
• Modeling 2-3 Alternatives
• Refine and re-analyze preferred alternative

Learned that we do not need to model every alternative!

Components of an Alternatives Analysis

• Reflect Upon the No-Build with Build Alternatives
• Consider Impacts of Geometric and Operational Strategies
• Baseline Demand Forecast
• Proper representation of capacity constraint(s)
• Sources of uncertainty
• Selection of MOE's
• Multiple Replications
• Comparison to HCM

Final Report: Key Components

- Address the Original Question / Problem
- Tie Back to the Purpose and Need
- Clarify the Geometric Modifications
- Clarify the Operational Strategy
- Identify the Operational Area of Influence

Characteristics of Successful Applications

- Accurate network portrayal

- Verifiable and reproducible

- Efficient design

- Relate back to problem statement

- Provide a level of insight to the decision maker which they would not have otherwise had access to

- Produces reasonable, defensible, and understandable results

Objectives of an Analysis Plan

- Ensure consistency in analysis
- Coordinate analytical team and stakeholders
- Focus resources on most important issues
- Identify and tackle key technical issues
- Set reasonable expectations for modeling results
- Document key analytical and management decisions

Consistency is Important

- Analysis cost and time are reduced because repeated effort is not needed
- Analysis results can be refined and reapplied based on results of prior studies
- Project analyses enjoy a longer shelf life
- The credibility of analysts, managers, and project development process improves
- Agency decision making is more effective and consistent

Challenges to Consistent Application of Tools

- The often lengthy elapsed time between project initiation and delivery
- No single tool will carry the analysis through the entire project development cycle
- The varying capabilities and limitations of each traffic analysis tools type
- The extensive training and experience necessary to apply each tool type
  - Different analysts and sections of the organization may be involved in different stages off the project development process

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The Analysis Plan Connect Models, Data, and Measures

Performance Measurement

Analysis Plan

Data

Modeling and Simulation

Exhibit 9: Relationship of Agency Goals, Project Objectives, Performance Measures, MOEs

	Safety	Mobility	Environment
Agency Goals	Ensure High Standards of Safety in the System	Provide Access to Jobs, Housing, Economic Activities	Improve Air Quality Reduce Global Warming
Project Objectives	Reduce Rate of Motor Vehicle Crashes	Decrease Travel Times Improve Reliability	Reduce Vehicular Emissions Encourage Alt. Modes
Performance Measures (MOEs)	• Fatalities per Year • Crashes per VMT • Crashes per Capita	• Hours of Delay • Average Travel Time • 80% Travel Time	• Tons Pollutant Emissions • Tons CO2 Equiv. Emissions • Alternative Mode Split

The Analysis Plan

Exhibit 6: Steps to Development of Project Delivery Analysis Plan

Flowchart:
1. Identify Goals & Objectives
2. Assess Agency Capabilities/Resources
3. Set Project Delivery Schedule
4. Draft Analysis Approach
5. Assess Risks
6. Identify Key Decision Points
7. Get Analyst Commitments
8. Project Delivery Analysis Plan

Task / Gantt chart:
1. Project Scope
2. Data Collection
3. Develop Base Model
4. Error Checking
5. Calibration
6. Alternatives Analysis
7. Final Report

-Determine Modeling Limits
-DiscussTime Periods
-Identify Scenarios
-Discuss Schedule

-Field Review
-Assemble Base Mapping
-Traffic Volumes
-Speed Runs
-Queue Observations

Intermediate review of link-node and lane schematic diagrams required if model is over 4 miles long.

-Develop Link-Node Diagram
-Develop Lane Schematic
-Balance Traffic Data Sets
-Create Model
-Develop O-D Matrix
-QA/QC Form

-Verify model results against observed field operational characteristics
-Calibration Tables and Graphics

-Measures of Effectiveness Tables and Graphics
-Write up of problem areas and proposal options

-Final Documentation See Section 7.3

◆ Review Milestone/Documentation

Reconciling Capabilities with Analysis Stages

Exhibit 11: Typical Measures of Effectiveness by Analysis Stage

Dimension	Project Initiation	Project Clearance	PS&E	Construction	Operations
Study Focus	System, 20 yrs	Facilities 5 to 25 yrs	Design, < 5 yrs	Construction, < 5 yrs	Facility, Day to Day
Utilization	VMT, PMT	VPH, D/C	V/C	V/C	VPH
Time	VHT, PHT	Mean, 80%	N/A	N/A	Mean, 80%
Delay	VHD, PHD	LOS	LOS	Delay/veh.	Delay/veh.
Speed	Mean	LOS, Mean	LOS	N/A	Mean
Stops	N/A	N/A	N/A	N/A	Stops/veh.
Queue	N/A	N/A	95% QSR	95% QSR	95% QSR
Density	N/A	LOS	LOS	N	
Collisions	Rate	Rate	N/A	N	
Emissions	Tons	Tons	N/A	N	

Exhibit 12: Measures of Effectiveness by Tool Category

Dimension	Sketch Planning Tools	Travel Demand Models	Deterministic HCM Based Tools	Optimization Tools	Simulation Models
Tool Focus	System	System	Facility, Bottlenecks	Facilities	Facilities
Utilization	VMT, PMT	VMT, PMT D/C	D/C	V/C	VMT, V/C
Time	VHT, PHT	VHT, PHT	Mean	Mean	VHT, Mean
Delay	VHD, PHD	VHD, PHD	Del/veh, LOS	Delay/veh.	VHD, Delay/veh.
Speed	Mean	Mean	Mean, LOS	Mean	Mean
Stops	N/A	N/A	Stops/veh.	Stops/veh.	Stops/veh.
Queue	N/A	N/A	95% QSR	95% QSR	95% QSR
Density	N/A	N/A	Mean, LOS	Mean	Mean
Collisions*	N/A	*	*	*	*
Emissions*	N/A	*	*	*	*

Some Analysis Plan Considerations

- Plan should address potential sources of uncertainty:
  - Changes in growth assumptions
  - Changes in funding
  - Changes in tools
  - Changes in road technology
  - Changes in personnel
  - Changes in project purpose
- Interim decision points may be needed based on degree of analytical risk
  - Plan to acknowledge that tools identified early on may not meet expectations
    - May need to initiate 'team B' on the *backup* tool while 'team A' resolves problem with *preferred* tool
- **The best analysis plan is useless unless the people implementing it are sufficiently committed to ensuring the outcomes are achieved**

Questions?

Thank you!

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Life-Cycle Simulation Models

Planning through Operations

Life Cycle Models

Definition – Simulation Tool for Decision Making in the Project Life Cycle

- Project Development
- Design
- Construction Staging and MOT
- Operations

Planning	PE/Design	Construction

decision evolution ————————————————➤

Modeling Opportunities

Data Requirements

Life Cycle Models Benefits

- Consistent model framework
- Reduced cost over project life cycle
- Time savings for traffic development and analysis
- Resource for understanding potential impacts of decisions
- Identify and evaluate low-cost/high-return improvement projects
- Real-time value engineering opportunites

Life Cycle Model Success Factors

- Project Planning
- Maintain Consistent Model Framework
  - Data and inputs
  - Software selection and tool integration
  - Calibration and Validation Targets
  - Agreement on MOE's
- Maximize use of analytical capital
- Requires agency commitment from all levels – Planning, Design, Operations
- Established policy guidelines for model application
- Project cost accounting

Case Study - Dulles Metrocorridor

- Development of a Life-Cycle Model that can be used throughout the entire project
  - Project Planning and Congestion Mitigation Planning
  - Alternatives Analysis for Roadway Configuration and Design
  - Final Design Operations
  - Maintenance of Traffic (MOT) Planning
  - Construction Staging and Construction Signal Timing Permits
  - Final Signal Timings
- Multimodel model incorporating interchanges, arterials, buses, park-n-ride lots, transit platform

Project Background

- Phase 1: Extension of the Washington Metro Orange Line
- Tysons Corner (Route 7) Virginia one of the most congested corridors in the State

- 3 New Metro Stations to be constructed in the Tysons Corner Route7/123 Corridor
- Orange line to be elevated structure in Route 7 Right-of-Way

Study Area

Model Development

Model Scope and Analysis Tool Selection

- Analyze development patterns in Tyson's Corner Area
- Analyze Congestion Mitigation Strategies
- Analyze various roadway configurations
- Analyze access/egress and internal operations of proposed Metro Stations
  - Bus Platform Operations
  - Kiss and Ride Operations
  - Park and Ride Operations
- Traffic Operations Analysis and Signal Timing Plans
- Build one model that can be continually updated throughout the entire project

Model Development

Tool Selection Process resulted in:

- Sub-area Extraction and Calibration of MWCOG Model
- Origin-Destination Matrix Estimation for Simulation Model Inputs
- Integration of Sub-Area Model with Microsimulation Model
- VISSIM Microsimulation Software
- VISSIM Conversion to Synchro for VDOT Signal Timing Plan Design

Model Development

Stages of Network Analysis

Regional Forecast   Subarea Forecast   Window Forecast

2006 Congestion Mitigation Plan Analysis

Sub-Area Model Extraction Performed and Validated for
AM and PM Peak Period;

Subzone and Highway Network Detail
Tysons Corner Transportation and Urban Design Study

— Highway Network Links
– – – Network Centroid Connectors
▭ Tysons Corner Subzones
▭ Dulles EIS Subzones

0 500 1,000   2,000   3,000
Feet

2006 Congestion Mitigation Plan Analysis

- Sub-Area Model Extraction Performed and Validated for AM and PM Peak Period
- Analysis of travel demand under updated socioeconomic forecasts
- Testing of Various Congestion Mitigation Plans
  - Additional Capacity on Route 7
  - One –Way Roadways
  - Alternative access from Dulles Toll Road
  - Demand Reduction Strategies

2008 Design Analysis

- Collect Data and Revalidate Models for 2008 Conditions
- Update Forecasts for 2011 and 2030
- Analyze Route 7 as an 8 lane facility with service roads closed
- Analyze detailed turning lane configurations
- Analyze 3 new Metro Stations within Route 7 Corridor

2008 Operation Model

Design Analysis – Service Road Evaluation

Analyze Route 7 as an 8 lane facility with service roads closed

No-Build

Build

Design Analysis – Service Road Evaluation

Year 2011 Scenario
Travel Times (in Seconds) – AM Peak Hour

Route	Eastbound		Westbound	
	No-Build	Build	No-Build	Build
Route 7	390	290	290	276
Route 123	177	186	192	181

Design Analysis - Metro Stations

Tysons East Station

Design Analysis – Metro Station

Metro Station Circulation Analysis Findings

- Visual verification - No significant impact by kiss-and-ride vehicles
- Capacity sufficient at both stations
  - Tysons East = 35 spaces serving 272 vph
  - Tysons West = 34 spaces serving 138 vph
- No significant friction between kiss-and-ride vehicles and regular traffic
- No significant friction between transit vehicles and regular traffic

2009 – 2013 MOT Analysis

- Traffic Data Updated to 2009
- Models re-calibrated and validated to 2009 conditions
- MOT Analysis
  - Stage 1
  - Stage 2
  - Stage 2A

MOT Analysis

Video

Final Signal Timings

- Update Traffic Data to 2013
- Revalidate Models to 2013
- Develop Final Signal Timing Plans

Lessons Learned

- Life cycle model credibility
- Plan for version changes and software updates
- Identify MOE's and outputs required for entire project by various agencies

Case Study – HEFT Corridor

- **HEFT – Homestead Extension of Florida's Turnpike**
- **Project limits extends from SR 874 (MP 17) to SR 836 (MP 26)**
- **Serves mostly residential areas in west Miami-Dade County**
- **6-lane roadway with auxiliary lanes near system-system interchanges**
- **AADT ranges from 90,300 to 146,200**

Corridor Timeline

2005	2006-2007	2008	2009-2010	2011-2013
•Project planning •Data collection •Model development	•Model calibration •Conduct PD&E Study •Corridor alternative selection	•Design refinement at interchanges •Work program reduction •AET evaluation	•AET construction and implementation	•Implement auxiliary lanes and interchange improvements

Traditional → ORT → AET

Model Features

Network

- **9 Miles of Mainline**
- **7 Existing Interchanges**
- **13 Toll Plazas**
- **24 Signalized Intersections**

Simulation Periods

- **AM and PM – 3 Hours Each**
- **Existing (2005)**
- **Future (2012, 2022)**

HEFT Morning Congestion

Legend
Severe Congestion
Moderate Congestion

Analysis Tool Selection

Why VISSIM?

Criteria	Software			
	Synchro/ SimTraffic	TSIS CORSIM	Paramics	VISSIM
Complex Geometry		✔	✔	✔
Pedestrian Operations	✔			✔
Freeway Operations		✔	✔	✔
Flexible Routing				✔
Accurate Toll Plaza Simulation			✔	✔
3D Animation	✔		✔	✔

Model Development

Roadway Geometry

Traffic Signal Timings

Balanced Volumes by Class and Payment Type

VISSIM Network Data

VISSIM Volume Data
Inputs
Composition
Routing

AM and PM VISSIM Models

Volume Development

Toll Counts by Vehicle Type

Toll Counts by Payment Type

Existing Link and Turn Counts

Data Collection

Integrated Process

Volumes by Classes

Traffic Compositions

Traffic Routing

Vehicle Inputs

VISSIM Volume Inputs

Future Link and Turn Volumes

Future Vehicle Classes

Future SunPass Particpation

Travel Demand Model

Calibration Challenges

- **Freeway and arterial congestion**
- **Extended periods of oversaturation**
- **Closely spaced intersection in proximity to ramp terminal intersection**
- **Mainline and ramp toll plaza influences**

Volume Development
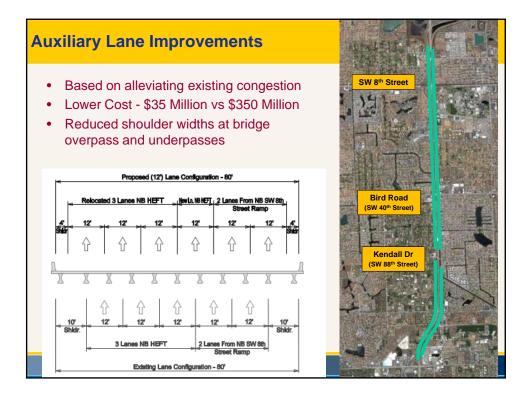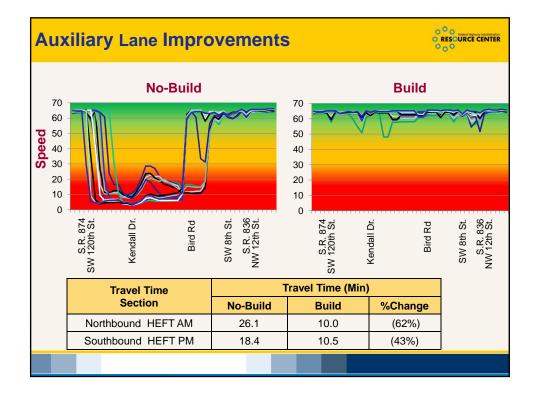
Volume Comparison

Location	AM peak period	PM peak period
Toll Plaza Volumes	<8%	<10%
Intersection Volumes	<8%	<9%

Travel Time Comparison

Overall Travel Time	AM Peak Period	PM Peak Period
Northbound HEFT	<15%	<3%
Southbound HEFT	<4%	<20%

PD&E Evaluation

Evaluated Three Corridor Alternatives

- **Widening to 10 lanes**
- **All considered interchange turn lane improvements**
- **One alternative considered cross street widening**
- **One alternative considered new interchange**

Key Evaluation Criteria

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Mainline Operations
- Travel Times

Arterial Operations
- Unmet Demand (Throughput)

Combined Operations
- Network Performance

Network Performance

Measure of Effectiveness	Peak Period	Alt 1	Alt 2	Alt 3
Average Travel Time (mins per vehicle)	AM	8.9	8.3	8.7
	PM	8.1	7.9	8.9
Average Delay Time (mins per vehicle)	AM	4.3	3.7	4.1
	PM	3.5	3.3	4.3
Average Speed (mph)	AM	28.3	30.0	29.2
	PM	30.4	31.2	28.1

Auxiliary Lane Improvements

- Based on alleviating existing congestion
- Lower Cost - $35 Million vs $350 Million
- Reduced shoulder widths at bridge overpass and underpasses

Auxiliary Lane Improvements

No-Build

Build

Travel Time Section	Travel Time (Min)		
	No-Build	Build	%Change
Northbound HEFT AM	26.1	10.0	(62%)
Southbound HEFT PM	18.4	10.5	(43%)

Design Refinements
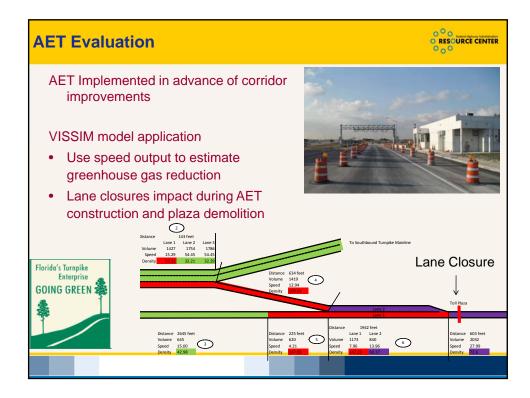
- Signal timing/phasing refinement
- Turn lane storage refinement
- Access management changes
- FDOT District 6 and Miami-Dade County coordination

Result:
- Multiple design sub-alternatives
- SW 8th Street – 10 sub-alternatives
- Bird Road – 5 sub-alternatives
- Kendall Drive – 4 sub-alternatives

AET Evaluation

RESOURCE CENTER
Federal Highway Administration

AET Implemented in advance of corridor improvements

VISSIM model application
- Use speed output to estimate greenhouse gas reduction
- Lane closures impact during AET construction and plaza demolition

Florida's Turnpike Enterprise
GOING GREEN

Lane Closure

One-Way Plan Evaluation

- Hurricane Evacuation One-Way Plan
- Scenario extending from US 1/Florida City (MP 0) to SW 8th St. (MP 25)
- Evaluation of one-way plan terminus at SW 8th St.
- VISSIM used to identify extent of queues

Lessons Learned

- Life cycle model credibility
- Plan for version changes and software updates
- Identify MOE's and outputs required for entire project by various agencies
- Allow sufficient lead time for model development and calibration
- Make use of other tools for alternatives screening and selection

Questions/Discussion