Analysis Tools for Demonstrating ITS/Operations Benefits

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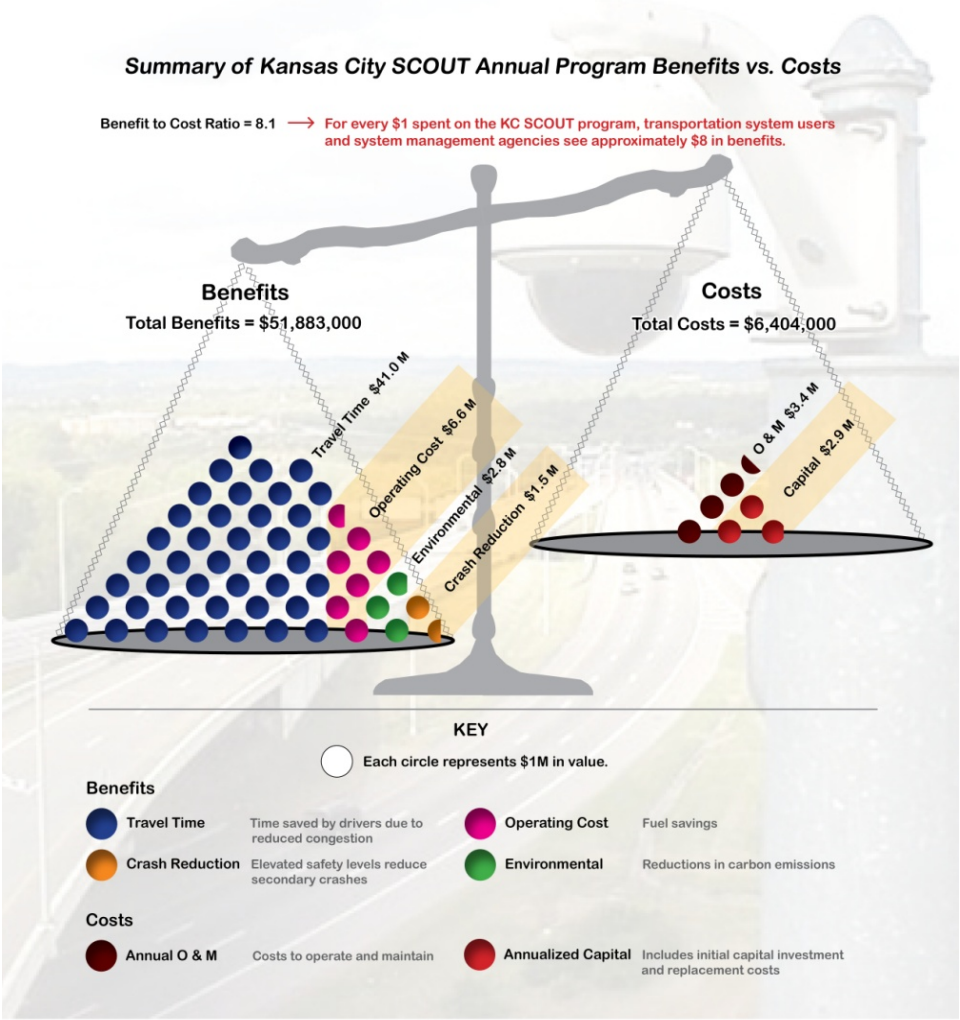
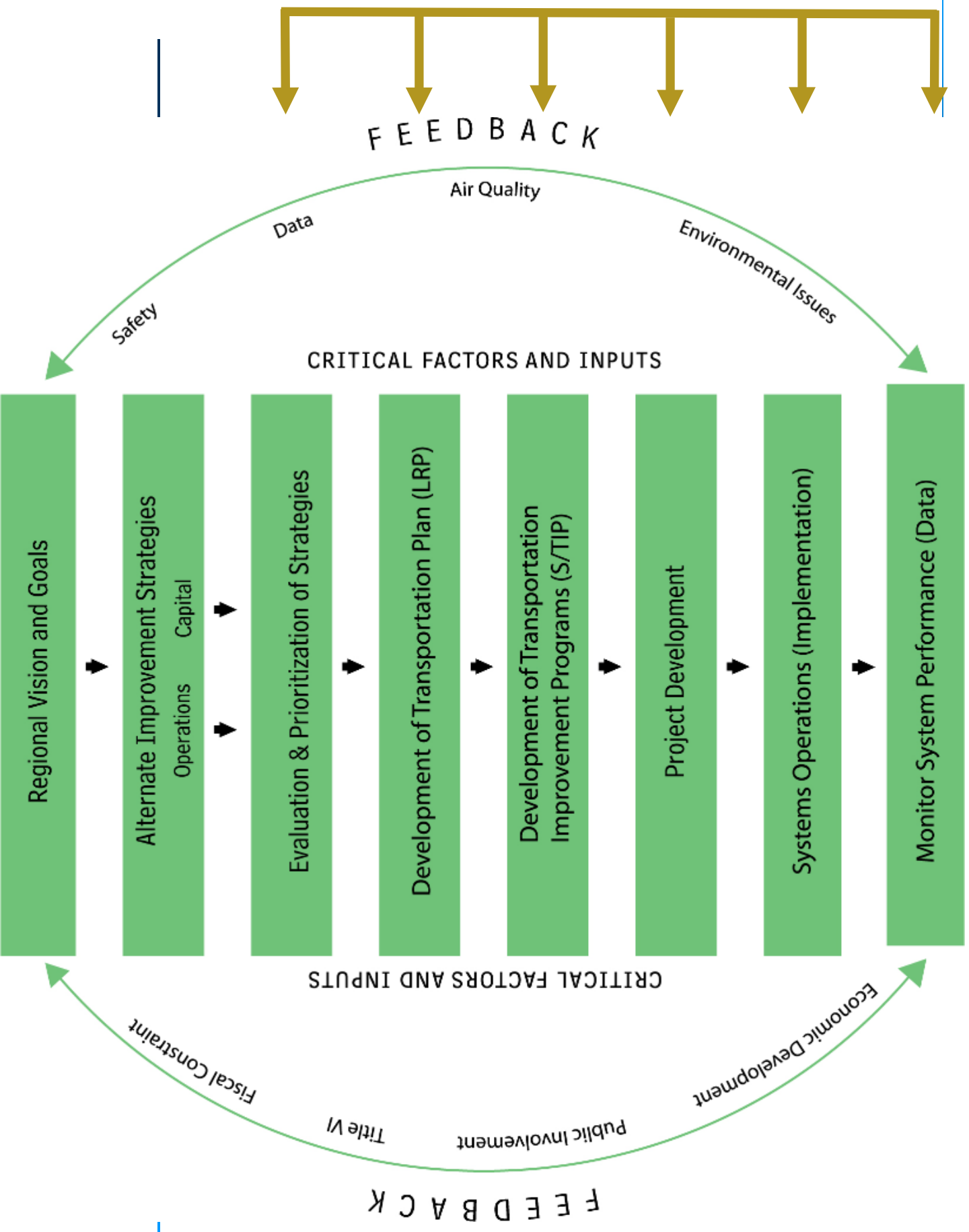
Benefits of Using Analysis Tools

- Improved decision making
- Evaluate multiple alternatives
- Intuitive presentation to stakeholders
- Analyze alternatives to optimize transportation system performance



Analysis Tools



Categories of Analysis Methods and Tools

A. **Sketch-planning tools**

B. **Travel demand models**

C. **Analytical/deterministic tools (HCM-based)**

D. **Traffic signal optimization tools**

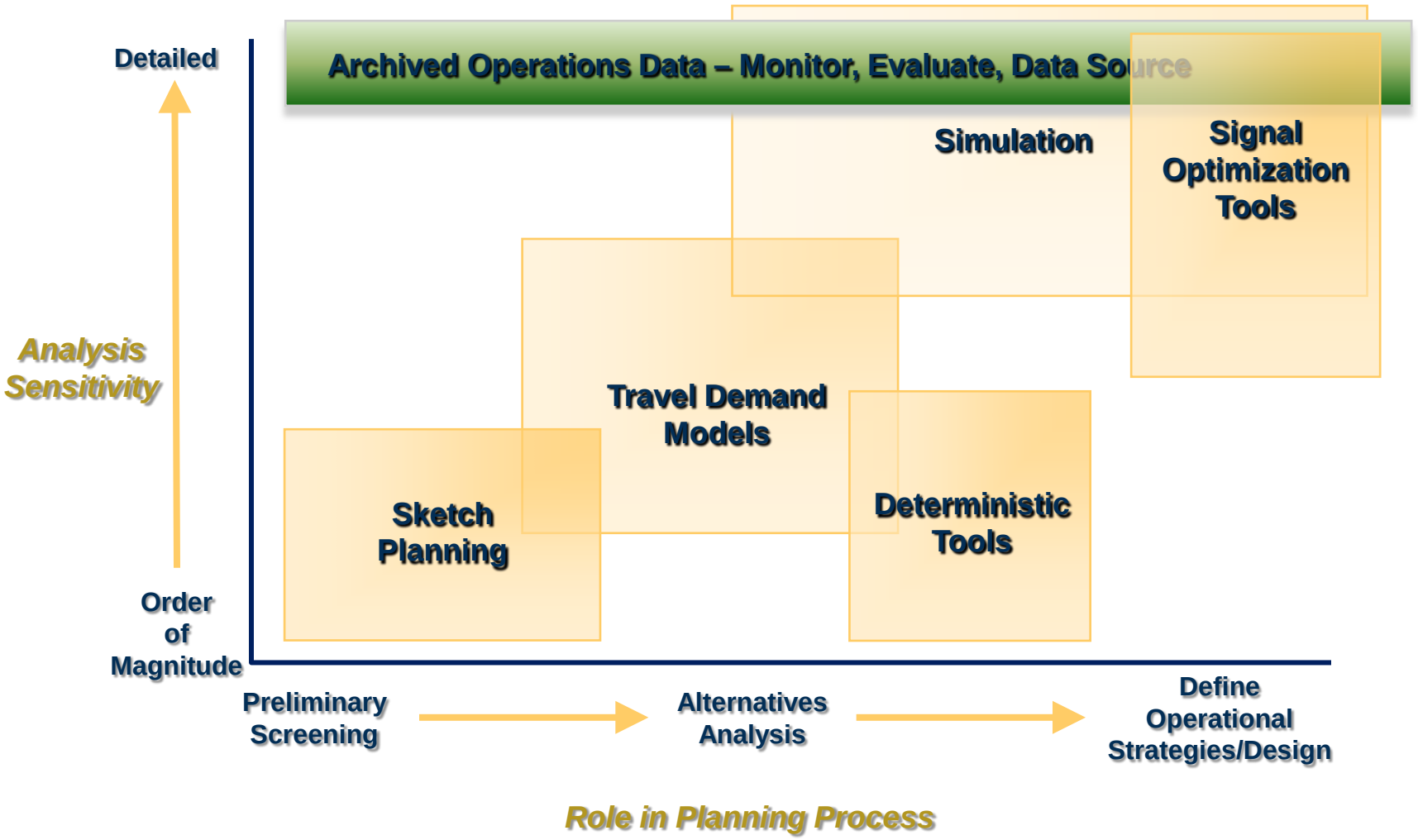
E. **Simulation models**
   - Macroscopic
   - Mesoscopic
   - Microscopic

F. **Archived operations data**

G. ***…Plus many hybrid approaches***

Source: FHWA Traffic Analysis Toolbox Volume II, 2004

Comparison of Tool Capabilities



No One Tool Can Solve Every Problem

- There is no one analytical tool that can do everything or solve every problem
- Method or tool should be consistent with planning objectives and matched with budget and resource requirements
  - Using a too-sophisticated tool results in poor use of resources
    - » Use of a complex and time-consuming microsimulation for a preliminary screening of scenarios
  - Using a too basic tool results in inaccurate or unreliable results
    - » Use of a travel demand model for determining ramp metering rate

General Characteristics of Each Tool Category

Transportation Planning Needs	Operational Analysis Tools/Methods					
	Sketch Planning Tools	Deterministic Models	Travel Demand Forecasting Models	Simulation	Archived Operations Data	Traffic Signal Optimization Tools
Needs Assessments/ Deficiency Analysis		◆	◆	◆	◆	◆
Preliminary Screening Assessments	◆					
Alternatives Analysis	◆		◆	◆		
Strategic ITS Planning	◆		◆			
Project Scoring/ Ranking/ Prioritizing	◆	◆	◆			
Corridor and Environmental Analysis		◆	◆	◆		◆
Planning for Nonrecurring Congestion	◆		◆	◆	◆	
Performance Monitoring		◆			◆	◆
Evaluations of Deployed Projects	◆		◆		◆	

Summary of Tools Benefits and Challenges

Tool/Methods	Advantages	Challenges
Sketch Planning Tools	• Low cost • Fast analysis times • Limited data requirements • View of the “big picture”	• Limited in scope, robustness, and presentation capabilities
Travel Demand Forecasting Models	• Validated models available for most metro areas • Evaluation of the regional impacts • Consistent with current planning practices	• Limited ability to analyze operational strategies • Typically does not capture non-recurring delay
Deterministic Models	• Quickly predict impacts for an isolated area • Widely accepted	• Limited ability to analyze broader network impacts • Limited performance measures
Traffic Signal Optimization Tools	• Effective tool for testing plans prior to field implementation • Proven operational benefits	• Calibration process can be time consuming

Summary of Benefits and Challenges (continued)

Tool/Methods	Advantages	Challenges
Simulation	• Detailed results, particularly microsimulation • Dynamic analysis of incidents and real-time diversion patterns • Visual presentation opportunities	• Demanding data and computing requirements, particularly microsimulation • Resource requirements may limit network size and number of analysis scenarios
Archived Operations Data	• Quick data collection • Current/up-to-date data • Provides detailed response to public officials based on real-world data	• Limited availability of quality data • Requires access to data, creates privacy concerns

Analysis Tool Selection Process

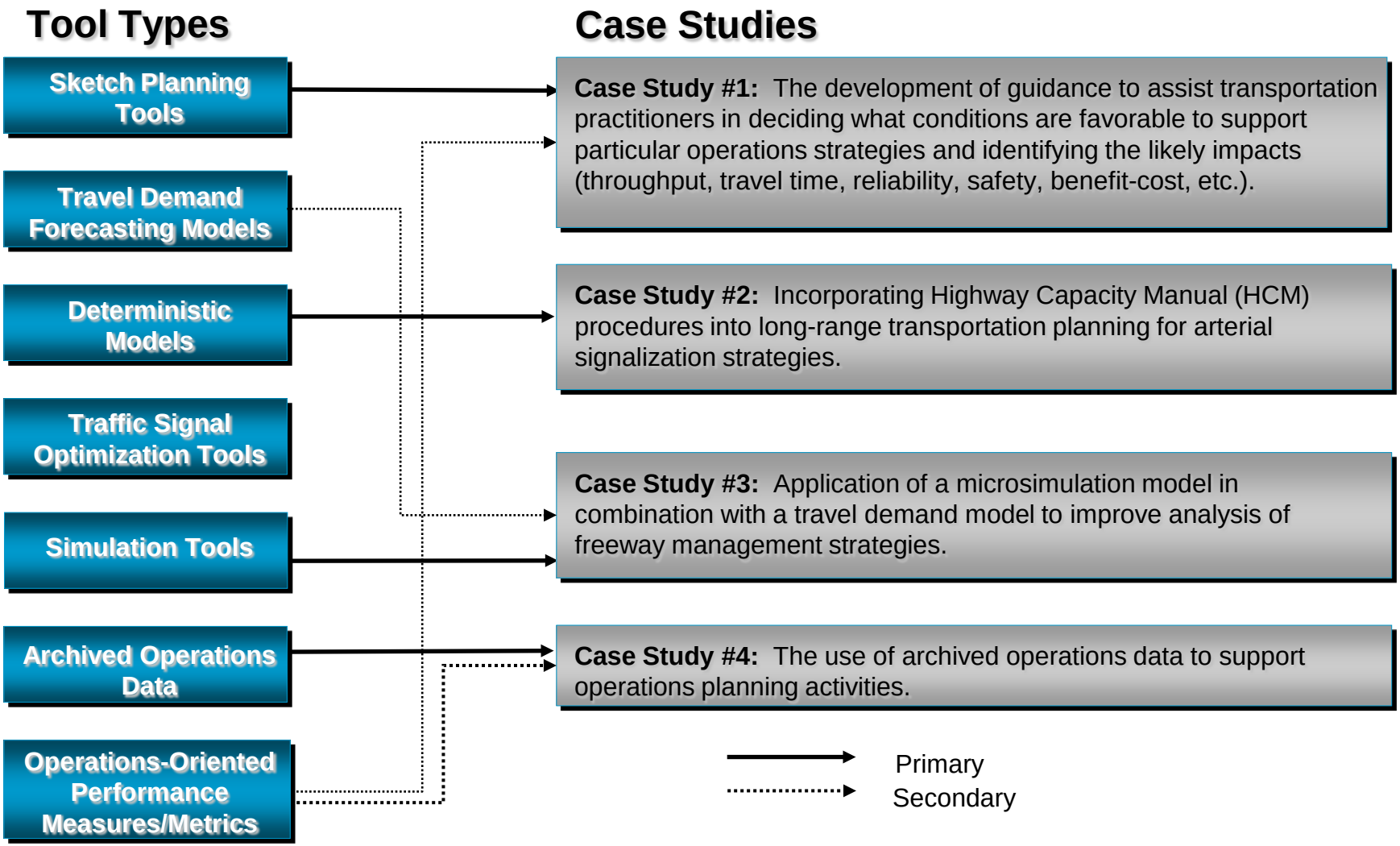
Analysis Context:
Planning, Design, or Operations/Construction

1	2	3	4	5	6	7
Geographic Scope	Facility Type	Travel Mode	Management Strategy	Traveler Response	Performance Measures	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?	At what analysis cost?

Source: FHWA Traffic Analysis Toolbox Volume II, 2004

Analysis Tools in Planning for Operations

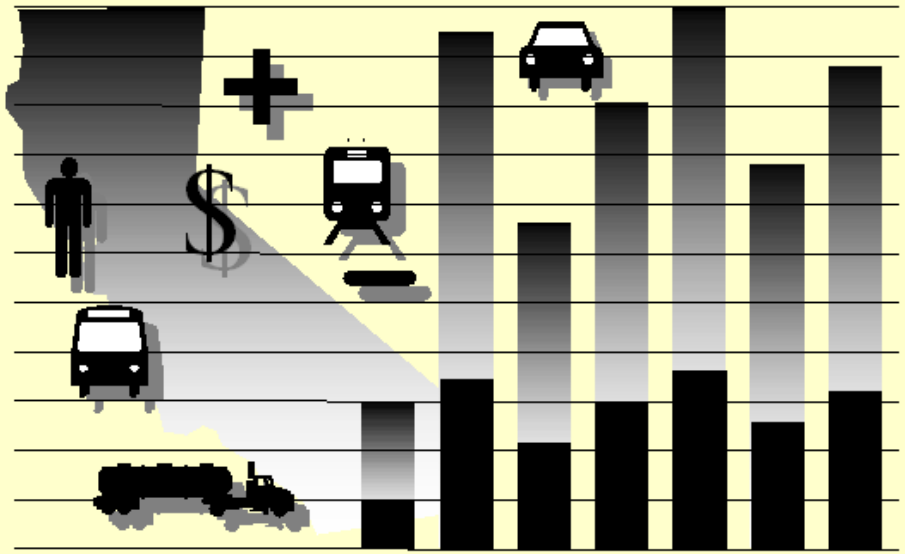
Case Studies Overview



Cal-B/C

Caltrans
California Department Of Transportation

California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C) Version 4.0



Office of Transportation Economics
Division of Transportation Planning
February 2009

Cal-B/C Example Tool

- Sketch-planning tool developed for Caltrans in 1999
- Used to conduct investment analyses of State Transportation Improvement Program (STIP) projects
- Updated in 2004 to include transportation management system (TMS)/intelligent transportation system (ITS) investments as well as operational improvements
- Updated in 2009 to include corridor and network analyses methods, HOT lanes, rail grade crossings, and queues
- Software and information available at:
  - http://www.dot.ca.gov/hq/tpp/offices/ote/benefit.html

Cal-B/C
Input Data

District: 4 | **Project #** 16

PROJECT: US 101 HOV Lanes - Narrows Phase A (SR 37 to Atherton Ave) | **EA:** | **PPNO:**

1A PROJECT DATA

Type of Project	Enter HOV restriction in section 1B	
Select project type from list	HOV Lane	
Project Location (enter 1 for So. Cal., 2 for No. Cal., or 3 for rural)		2
Length of Construction Period	3	years
	Existing	
Length of Peak Period(s) (up to 8 hrs)	2	hours

1B HIGHWAY DESIGN AND TRAFFIC DATA

Highway Design		Existing	New
Number of General Traffic Lanes		6	6
Number of HOV Lanes		0	2
HOV Restriction (2 or 3)		2	
Exclusive ROW for Buses (y/n)		N	
Highway Free-Flow Speed		55	65
Ramp Design Speed (if aux. lane/off-ramp proj.)		35	35
Length (in miles)	Highway Segment	4.7	4.7
	Affected Area	4.7	4.7

Average Daily Traffic			
	Current	128,000	
		w/o Project	w/ Project
	Base (Year 1)	129,716	129,716
	Forecast (Year 20)	140,586	140,586
Average Hourly HOV Traffic (if HOV lanes)		2,400	2,400
Percent Traffic in Weave (if oper. improvement)			
Percent Trucks (include RVs, if applicable)		7.0%	7.0%
Truck Speed (if passing lane project)			

On-Ramp Volume	Peak	Non-Peak
Hourly Ramp Volume (if aux. lane/on-ramp proj.)	0	0
Metering Strategy (1, 2, 3, or D, if on-ramp proj.)		

Pavement Condition (if pavement project)		w/o Project	w/ Project
IRI (inches/mile)	Base (Year 1)		
	Forecast (Year 20)		

Average Vehicle Occupancy		Existing	New
General Traffic	Non-Peak	1.48	1.48
	Peak	1.00	1.00
High Occupancy Vehicle (if HOV lanes)		2.05	2.05

1C HIGHWAY ACCIDENT DATA

Actual 3-Year Accident Data for Facility	Count (No.)	Rate
Fatal Accidents	1	0.002
Injury Accidents	57	0.09
Property Damage Only (PDO) Accidents	83	0.13

Statewide Average for Highway Classification	Existing	New
Accident Rate (per million vehicle-miles)	0.39	0.39
Percent Fatal Accidents	1.5%	1.5%
Percent Injury Accidents	33.8%	33.8%

1D TRANSIT DATA

Annual Person-Trips		w/o Project	w/ Project
	Base (Year 1)		
	Forecast (Year 20)		
Percent Trips during Peak Period		16%	
Percent New Trips from Parallel Highway			100%

Annual Vehicle-Miles		w/o Project	w/ Project
	Base (Year 1)		
	Forecast (Year 20)		
Average Vehicles/Train (if rail project)			

Reduction in Transit Accidents	
Percent Reduction (if safety project)	

Average Transit Travel Time		Existing	New
In-Vehicle	Non-Peak (in minutes)		0.0
	Peak (in minutes)		0.0
Out-of-Vehicle	Non-Peak (in minutes)	0.0	0.0
	Peak (in minutes)	0.0	0.0

Transit Agency Costs (if TMS project)	Existing	New
Annual Capital Expenditure		$0
Annual Ops. and Maintenance Expenditure		$0

Model should be run for both roads for intersection or bypass highway proj
may be run twice for connectors. Press button below to prepare model to e
data for second road. After data are entered, results reflect total project be

Prepare Model for Second Road

Cal-B/C Results

District: 4

PROJECT: US 101 HOV Lanes - Narrows Phase A (SR 37 to Atherton Ave)

Project #: 16
EA:
PPNO:

3

INVESTMENT ANALYSIS

SUMMARY RESULTS

Life-Cycle Costs (mil. $)	$76.2
Life-Cycle Benefits (mil. $)	$236.1
Net Present Value (mil. $)	$159.9
Benefit / Cost Ratio:	3.1
Rate of Return on Investment:	18.8%
Payback Period:	5 years

ITEMIZED BENEFITS (mil. $)	Average Annual	Total Over 20 Years
Travel Time Savings	$13.2	$264.4
Veh. Op. Cost Savings	-$1.4	-$28.3
Accident Cost Savings	$0.0	$0.0
Emission Cost Savings	$0.0	$0.0
TOTAL BENEFITS	$11.8	$236.1
Person Hours of Delay Saved	2,104,087	42,081,737

Should results include:

1) Induced Travel? (y/n): Y (Default = Y)

2) Vehicle Emissions? (y/n): N (Default = N)

MTC PRIORITIZATION RESULTS (first year only)

DVHD Reduction*	3,778
DVHD/Escalated Cost (in $M)	48
DPHD Reduction	5,003.2
Peak Period V/C – Before	0.84
Peak Period V/C – After	0.63

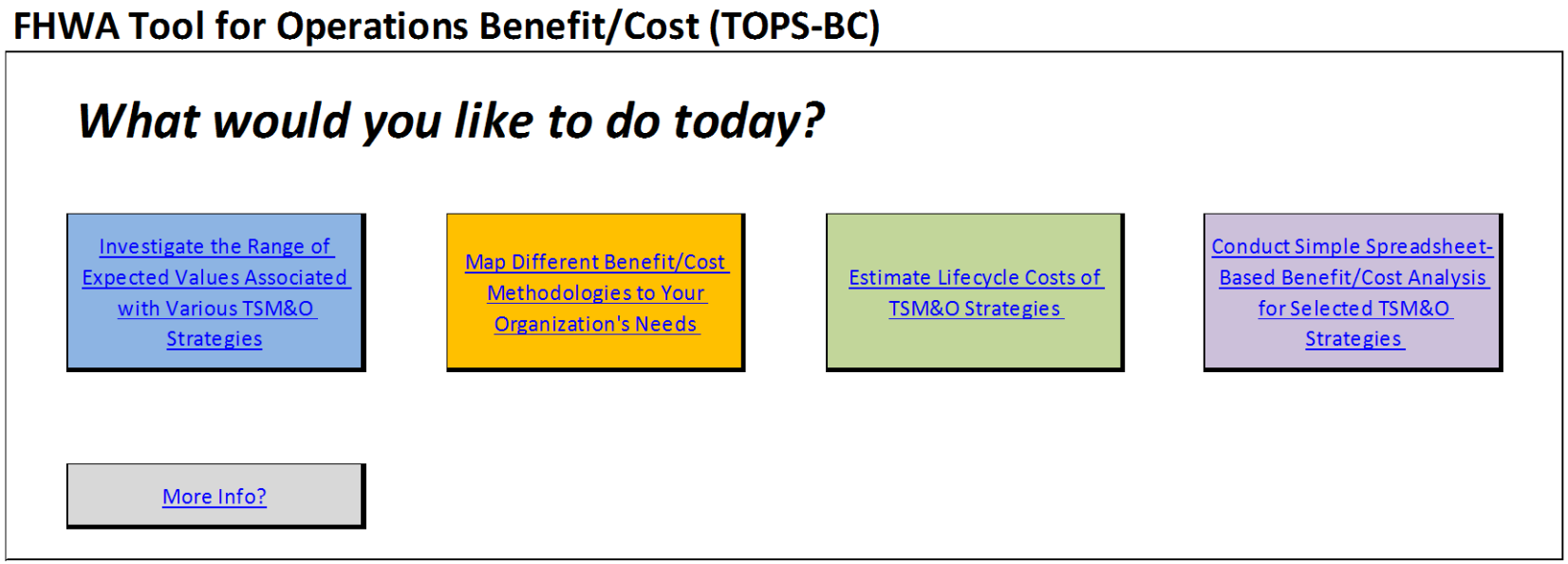
FREEWAY TRAVEL TIME (min.)

	Peak	Non-Peak
Before	11.3	5.1
After	4.3	4.3
Savings	6.9	0.8

Notes: 1) DVHD is difference in travel time for existing vehicles, 2) need to calculate twice for bypass and intersection projects

Tool for Operations Benefit/Cost (TOPS-BC)

- **Provides sketch planning benefit/cost analysis for TSM&O strategies - available Fall/Winter 2011**
- **Desk Reference Document - B/C information related to TSM&O and primer for those unfamiliar with B/C analysis**



TOPS-BC: Guidance on Methods

FHWA Tool for Operations Benefit/Cost (TOPS-BC)

Guidance on Appropriate Benefit/Cost Methods

Return to OPENING SCREEN

Instructions: Please indicate the needs of your analysis associated with the following criteria then press "GO".
A list of appropriate methodologies will be displayed to the right and will change in response to your answers to the input analysis criteria.

INPUT CRITERIA

Go

1 What is the geographic scope of the analysis? (Select 1)

- ● Do not care
- ● Statewide
- ● Regional
- ● Corridor
- ● Isolated Location
- ● Other

2 What is the desired level of confidence of the analysis results? (Select 1)

- ● Do not care
- ● High (extremely accurate)
- ● Medium
- ● Low (order of magnitude)

3 What TSM&O strategy(ies) do you want to analyze? (Choose Multiple)

- ☑ Do not care
- ☐ Arterial Corridor Traffic Signal Coordination Strategies
- ☐ Traffic Signal Priority Strategies
- ☐ Ramp Metering Strategies
- ☐ Traffic Incident Management Systems
- ☐ Transit AVL and Automated Scheduling
- ☐ Pre-Trip Traveler Information
- ☐ En-Route Traveler Information
- ☐ Active Traffic Demand and Management
- ☐ Work Zone Management
- ☐ Travel Demand Management - Employer Based
- ☐ Supporting Systems (Surveillance, TMC, Communications)

4 What are the key measures of effectiveness you are interested in generating? (Choose mulitple)

Suggested Methodologies:

Recommended:	Also Consider:
Tools meeting ALL criteria	Tools meeting ALL BUT 1 criteria
TOPS-BC	
BCA.net	
CAL-BC	
EMFITS	
FITSEval	
HERS-ST	
IDAS	
MicroBENCOST	
Redbook Wizard	
SCRITS	
SPASM	
STEAM	
Travel Demand Model Methods	
Simulation Methods	

TOPS-BC: Estimate Lifecycle Costs

- **Estimates lifecycle costs: capital, replacement, and O&M**
- **Generates average annual costs and stream of expected costs**

FHWA Operations B/C Decision Support Tool (TEST CONCEPT)

PURPOSE: Estimate Lifecycle Costs of TSM&O Strategies

WORK AREA 1 - ESTIMATE AVERAGE ANNUAL COST

Strategy: Traveler Information - DMS

Equipment	Useful Life	Capital / Replacement Costs (Total)	O&M Costs (Annual)	Annualized Costs
Basic Infrastructure Equipment				
TMC Hardware for Information Dissemination	5	$ 7,500	$ 375	$ 1,875
TMC Software for Information Dissemination	5	$ 20,000	$ 1,000	$ 5,000
TMC System Integration	20	$ 100,000	$ 5,000	$ 10,000
Labor			$ 100,000	$ 100,000
TOTAL Infrastructure Cost		***$ 127,500***	***$ 106,375***	***$ 116,875***
Incremental Deployment Equipment (Per Sign Location)				
Communication Line	25	$ 750	$ 900	$ 930
Variable Message Sign	25	$ 92,500	$ 4,400	$ 8,100
Variable Message Sign Tower	25	$ 125,000	$ 275	$ 5,275
TOTAL Incremental Cost		***$ 218,250***	***$ 5,575***	***$ 14,305***

INPUT	Enter Number of Infrastructure Deployments	1	$ 116,875
INPUT	Enter Number of Incremental Deployments (# of Signs)	5	$ 71,525
INPUT	Enter Year of Deployment	2011	
	Average Annual Cost		**$188,400**

TOPS-BC: Estimate Benefits of TSM&O Strategies

FHWA Tool for Operations Benefit/Cost (TOPS-BC)

Estimate Benefits of TSM&O Strategies

Strategy: Dynamic Message Signs

Notes: For additional information on this analysis method, please see Section X.X.X of the *Desk Reference*
For information on alternative methods for performing analysis of this strategy, please see Section X.X.X of the *Desk Reference*

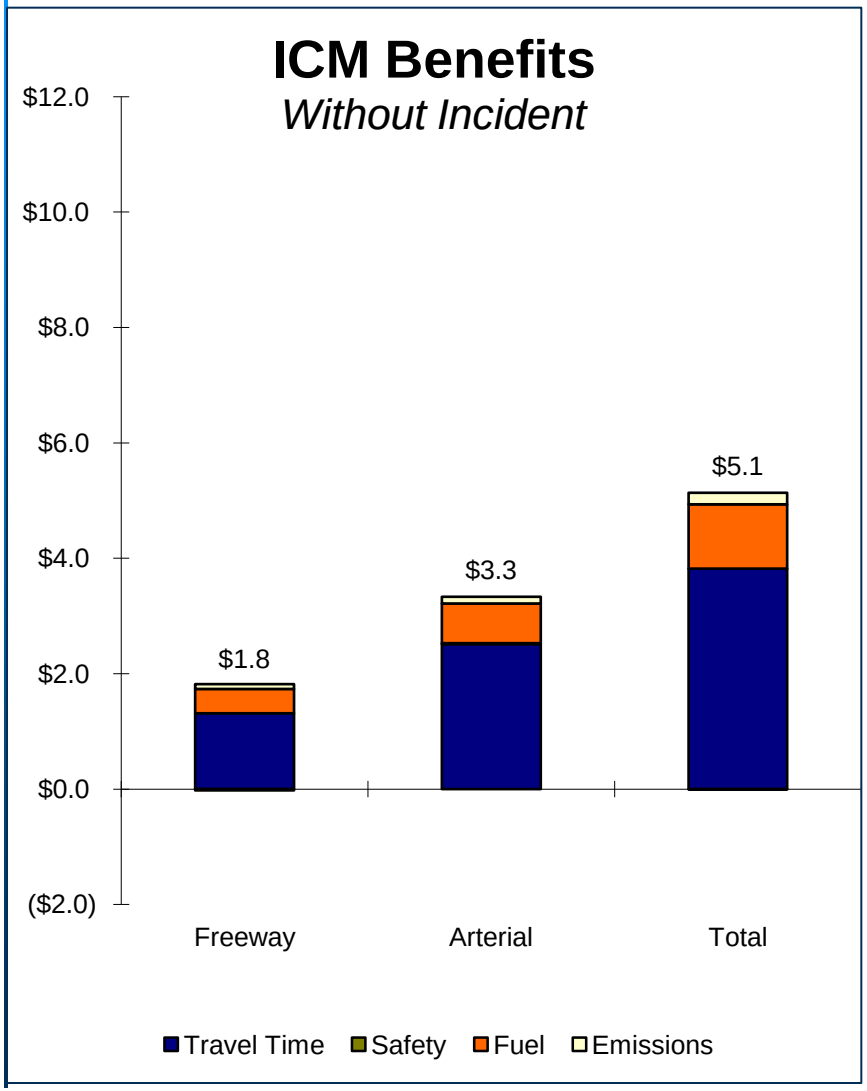
Primary Benefits Estimated by this Method:	Travel Time Reliability
Other Benefits that may be Considered:	Safety, Customer Satisfaction, Agency Efficiency, Emissions, Fuel Use

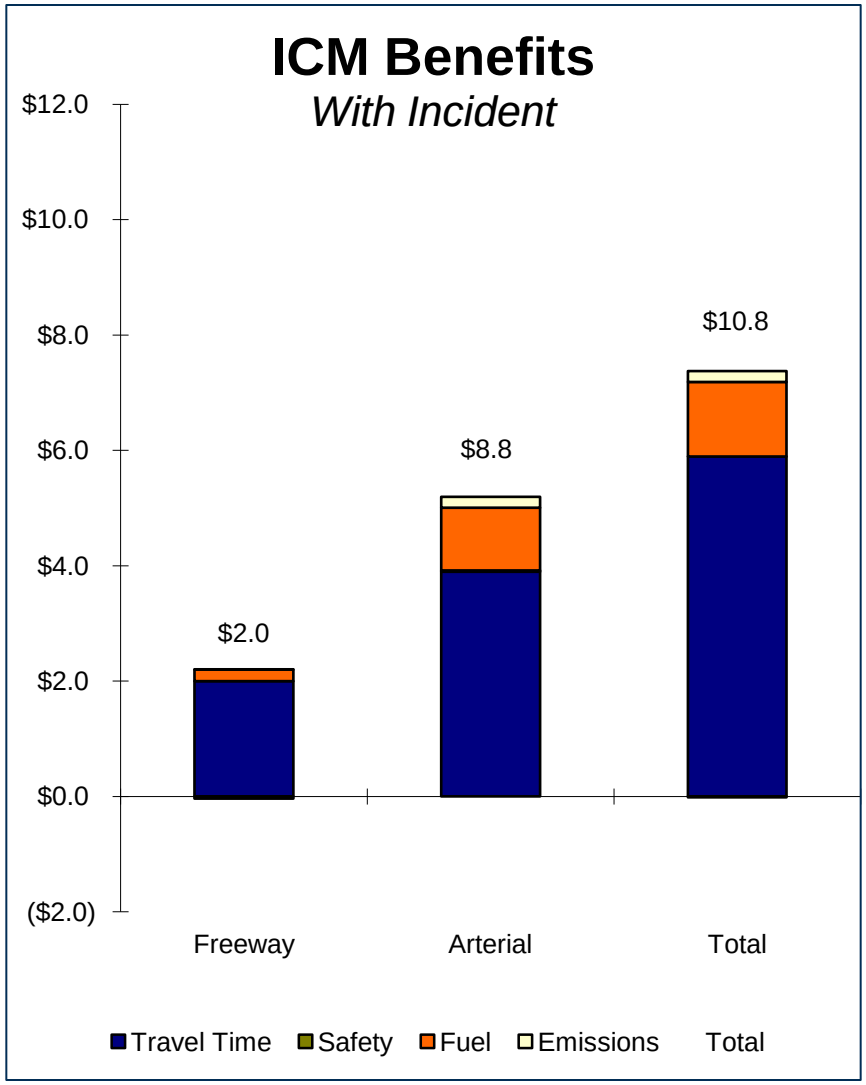
	Impact	User Input	Default	Modeled	
INPUT	Average Number of Vehicles Passing Sign Location(s) (per period)	60,000			
INPUT	Average Vehicle Occupancy	1.2			
INPUT	% of Time Sign is Displaying Information	5%			
INPUT	Type of Information Being Displayed 1 = Comparitive Travel Times 2 = Congestion Warning 3 = Alternative Route Recommendations	3			
	% of Drivers Passing the Sign that Act on the Information	10%	10%		Typical Range = 5% to 60%
	Average Time (Minutes) Saved by Drivers Acting on the Information		5.5		Typical Range = 2 minutes to 15 minutes
	Average Time (Minutes) Saved by Drivers Not Acting on the Information		0		No Typical Range Available
	Average Hours of Vehicle Delay Saved Per Period			28	
	Number of Periods Per Year		260		Assumes non-holiday weekdays
	Average Hours of Vehicle Delay Saved per Year			7,150	
	Average Hours of Person Delay Saved per Year			8,580	
	$ Value of Person Hour (per hour)		$ 14.00		Uses Value of *Travel Time Reliability*
	Total Average Annual Modeled Travel Time Benefit			**$ 120,120**	
	User Entered Benefit (Annual $'s)				
	TOTAL AVERAGE ANNUAL BENEFIT			**$ 120,120**	
	Average Annual Equipment Deployment and Replacement Costs			$ 60,000	From Lifecycle Cost Estimation Module
	Average Annual Equipment Operations and Maintenance Costs	$ 25,000		$ 20,000	From Lifecycle Cost Estimation Module
	TOTAL AVERAGE ANNUAL COST			**$ 85,000**	

Benefit Cost Ratio (Average Annual Benefits / Average Annual Costs)	**1.41**
Annual Net Benefit (Average Annual Benefits - Average Annual Costs)	**$ 35,120**

Use of Dynamic Traffic Assignment

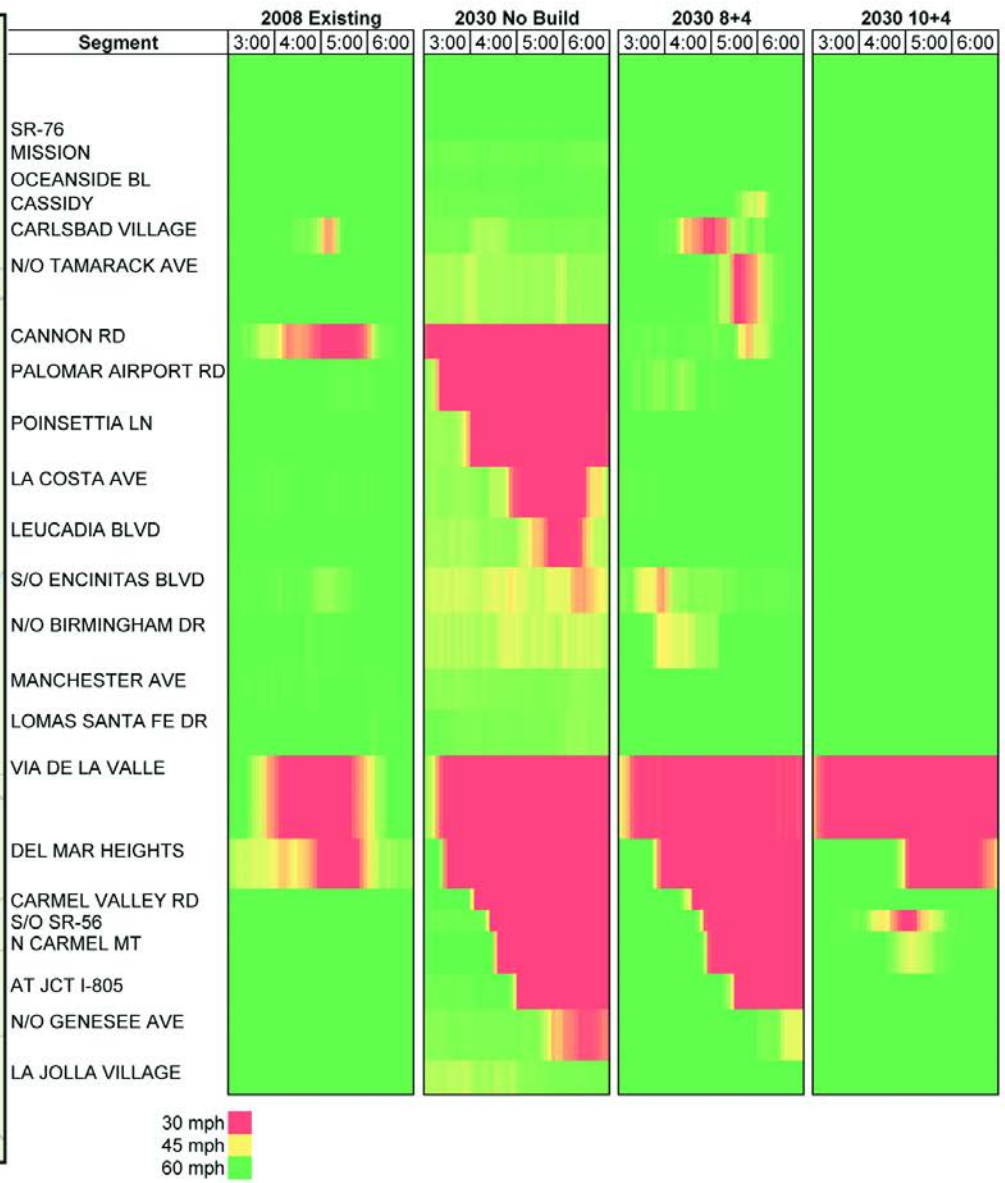
San Diego Integrated Corridor Management



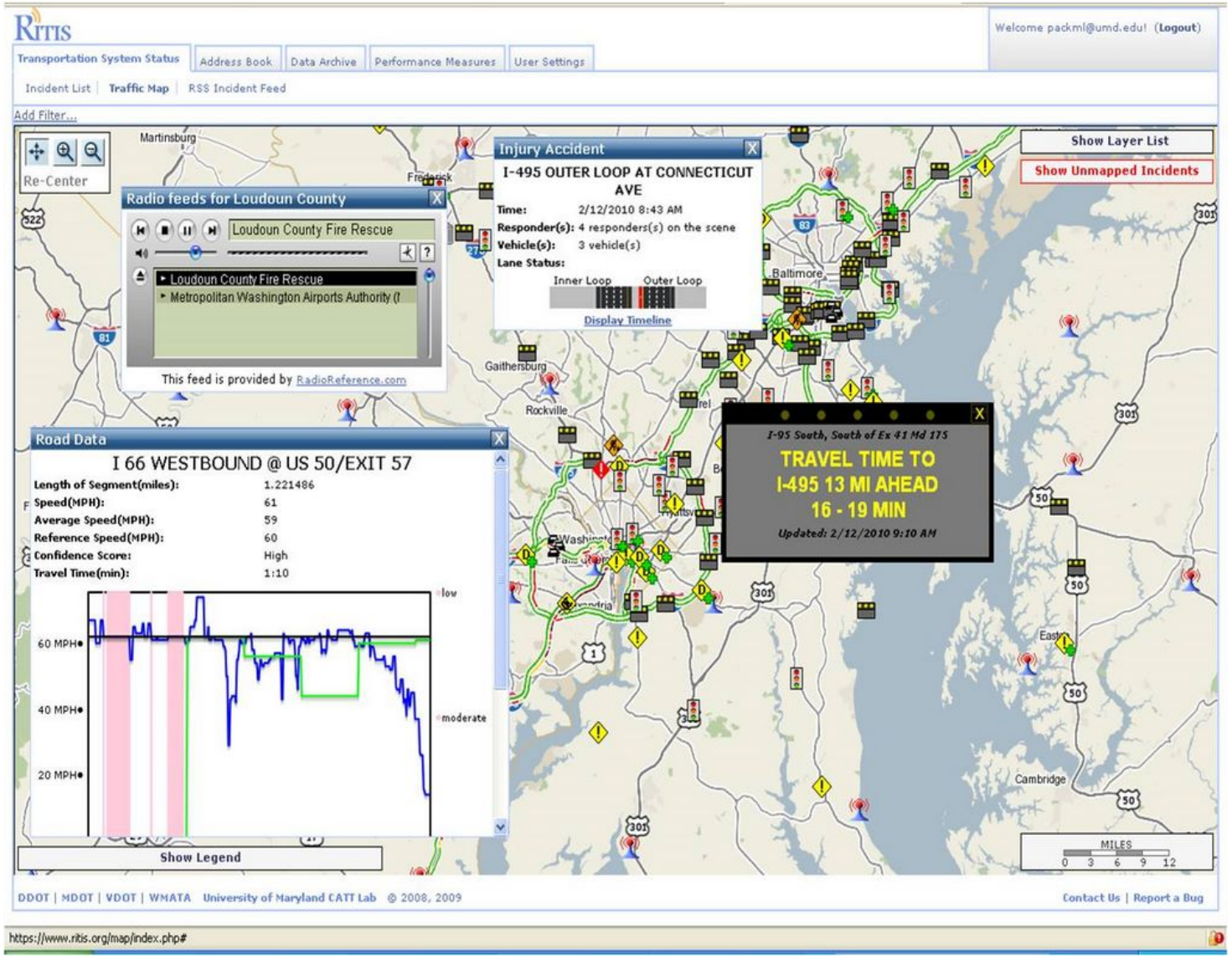


Use of Simulation and Archived Data

San Diego – I-5 Corridor



Regional Integrated Transportation Information System

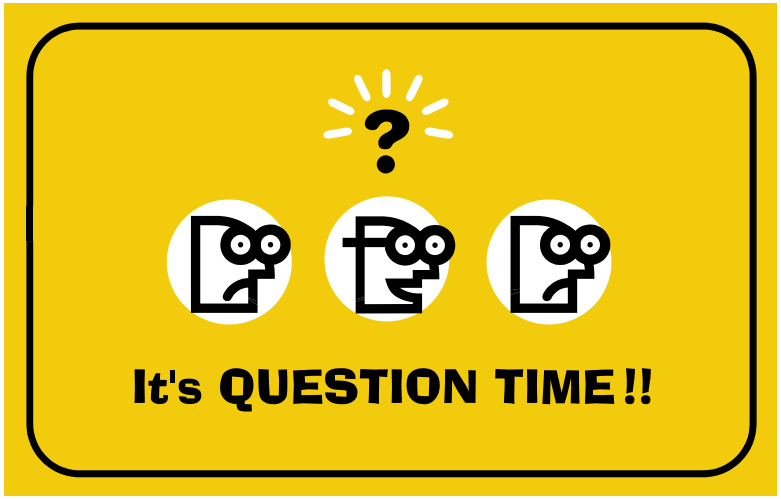


Common Challenges and Issues

- **Need to better understand benefits of using operations data and using them as part of planning**
- **Few established procedures on regional-scale analyses**
- **Important analysis gaps still remain (i.e., incidents, construction, weather, special events, etc.)**
- **No tool can account for all *travel modes* and *programs* (i.e., HOT lanes, ramp metering, BRT, etc.)**
- **Need to better understand how operational strategies impact travel decisions**
- **Analyses often require use of multiple tools or post-processing of results or data**

Key Resources

- **FHWA Planning for Operations Website**
  http://www.plan4operations.dot.gov
- **Applying Analysis Tools in Planning for Operations**
  http://www.plan4operations.dot.gov/casestudies/analysis.htm
- **FHWA Traffic Analysis Toolbox (TAT)**
  http://www.ops.fhwa.dot.gov/trafficanalysistools/index.htm
- **Research and Innovative Technology Administration (RITA) - ITS Benefits, Costs, and Lessons Learned Databases**
  http://www.its.dot.gov



Questions?