URBAN PARTNERSHIP AGREEMENT AND CONGESTION REDUCTION DEMONSTRATION: NATIONAL EVALUATION FRAMEWORK

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URBAN PARTNERSHIP AGREEMENT AND CONGESTION REDUCTION DEMONSTRATION: NATIONAL EVALUATION FRAMEWORK

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16. Abstract

This report provides an analytical framework for evaluating six deployments under the United States Department of Transportation (U.S. DOT) Urban Partnership Agreement (UPA) and Congestion Reduction Demonstration (CRD) Programs. The six UPA/CRD sites are Chicago, Los Angeles, Miami, Minnesota, San Francisco, and Seattle. Those sites are seeking to reduce congestion by employing strategies consisting of combinations of tolling, transit, telecommuting/TDM, and technology, also known as the 4 Ts. The national evaluation framework identifies the major questions to be answered through the evaluation; the approach to be used to address those questions; and risks to the evaluation and how they will be mitigated. Four objective questions posed by U.S. DOT serve as a starting point for the evaluation framework: how much congestion was reduced; what contributed to the reduction and what were the associated impacts; what lessons were learned about non-technical factors for success; and what were the overall cost and benefit of the congestion reduction strategies. The four objective questions were translated into twelve evaluation analyses, which in turn consist of hypotheses and questions, measures of effectiveness (MOEs), and data required for the MOEs. This document explains each of the twelve analyses and discusses the major data requirements and data collection methods that will be needed. Next steps include development of site-specific evaluation plans and test plans.

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LIST OF ABBREVIATIONS

4Ts	Tolling, Transit, Telecommuting, and Technology
APC	Automatic passenger counter
ATM	Active traffic management
AVL	Automatic vehicle location
BRT	Bus rapid transit
CALTRANS	California Department of Transportation
CBA	Cost and benefit analysis
CRD	Congestion Reduction Demonstration
CTA	Chicago Transit Authority
CVO	Commercial vehicle operator
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
HC	Hydrocarbon(s)
HOT	High-occupancy tolling
HOV	High-occupancy vehicle
ITS	Intelligent transportation systems
ITS-OTMC	Intelligent Transportation Systems-Operational Testing to Mitigate Congestion
LA	Los Angeles
LWC	Lake Washington Corridor
Mn/DOT	Minnesota Department of Transportation
MOE	Measure of effectiveness
MVTA	Minnesota Valley Transit Authority
NEF	National Evaluation Framework
NEPA	National Environmental Policy Act
NTOC	National Transportation Operations Coalition
O&M	Operation and maintenance
OTMC	Operational Testing to Mitigate Congestion
PDSL	Priced dynamic shoulder lane
RITA	Research and Innovative Technology Administration
ROG	Reactive organic gas(es)
ROWE	Results Only Work Environment
SOV	Single-occupant vehicle
SR	State route
TDM	Travel demand management
TMO	Traffic management operations
UPA	Urban Partnership Agreement
U.S. DOT	U.S. Department of Transportation
VII	Vehicle Infrastructure Integration
VMT	Vehicle miles traveled
VOC	Vehicle operating cost or Volatile organic compound
VT	Vehicle trips
WSDOT	Washington State Department of Transportation

EXECUTIVE SUMMARY

This report provides an analytical framework for evaluating six deployments under the United States Department of Transportation (U.S. DOT) Urban Partnership Agreement and Congestion Reduction Demonstration Programs. The framework identifies:

- The major questions to be answered through the evaluation
- The approach to be used to address those questions
- Risks to the evaluation and how they will be mitigated.

Background

Transportation system congestion is one of the greatest threats to our nation's economic prosperity and way of life. Whether it takes the form of cars stuck in traffic, cargo backed up at overwhelmed seaports, or airplanes waiting on the tarmac, congestion costs the nation an estimated $200 billion a year. The problem of traffic congestion in major metropolitan areas in particular is severe and worsening. In 2003, traffic jams in the nation's largest 85 urban areas cost Americans 3.7 billion hours and 2.3 billion gallons of fuel.

In 2006, the U.S. DOT announced the National Strategy to Reduce Congestion on America's Transportation Network, also known as the "Congestion Initiative." The intent of the initiative was to demonstrate a variety of innovative but proven strategies that could provide relief to traffic gridlock if more widely practiced. Two of the programs within the Congestion Initiative are Urban Partnership Agreements (UPAs) and Congestion Reduction Demonstrations (CRDs). In each program, multiple sites around the United States have been awarded funding for implementation of congestion reduction strategies. In April 2008, U.S. DOT selected a national evaluation team, led by Battelle, to evaluate the effectiveness of the UPA and CRD deployments.

The UPA/CRD Sites

In December 2006, the U.S. DOT issued a Federal Register Notice soliciting cities to apply for Urban Partnership status by April 30, 2007. For the cities that were selected, this Urban Partnership status would confer priority for available Federal discretionary funds (about $1 billion) across about a dozen programs. The applicants' proposals for congestion reduction were to be based on four complementary strategies known as the 4Ts: Tolling, Transit, Telecommuting (which includes other travel demand management (TDM) strategies besides telecommuting), and Technology. On November 13, 2007, U.S. DOT issued a Federal Register Notice soliciting applications for the CRD Program, a follow-on to the UPA program. Across both programs, a total of $853 million in Federal discretionary grants was awarded. Four awards went to UPA sites--Miami, Minnesota, San Francisco, and Seattle--and two awards went to CRD sites--Los Angeles and Chicago. Table ES-1 summarizes the strategies within each of the 4Ts being deployed at each site along with the projected operational date.

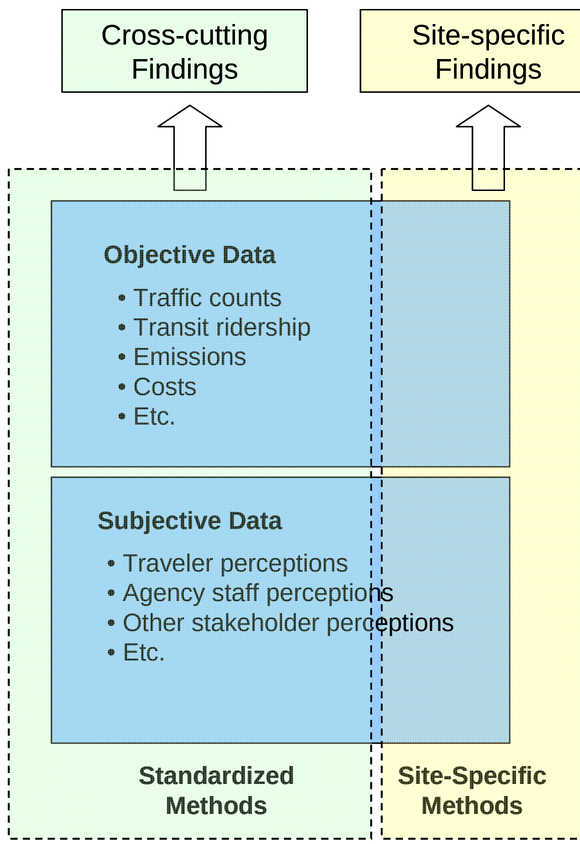
Table ES-1. Summary of the UPA/CRD Strategies by Site

UPA/CRD Strategies Planned Operational Date	Deployment Sites					
	MN	SF	Sea	Mia	Chi	LA
	9/30/09	TBD	9/30/09	TBD	4/30/10	12/31/10
Tolling						
Convert HOV lanes to dynamically priced HOT lanes and/or new HOT lanes	X			X		X
Priced dynamic shoulder lanes	X					
Variably priced parking and/or loading zones		X			X	X
Variably priced roadways or bridges (partial cordon)			X			
Transit						
Increase park-and-ride capacity (expand existing or add new)	X		X	X		X
Expand or enhance bus service	X		X	X		X
Implement new, or expand existing, Bus Rapid Transit	X			X	X	
Transit on special runningways (e.g., contraflow lanes, shoulders)	X			X		
New and/or enhanced transit stops/stations	X		X	X		X
Transit traveler information systems (bus arrival times, parking availability)	X		X			
Transit lane keeping/lane guidance	X					
Transit traffic signal priority	X			X		X
Transit fare subsidies	X					
Arterial street traffic signal improvements to improve transit travel times	X					
Ferry service improvements		X	X			
Improved transit travel forecasting techniques		X				
Pedestrian improvements				X		X
Telecommuting/TDM						
"Results Only Work Environment" employer-based techniques	X					
Work to increase use of telecommuting		X	X	X		
Work to increase flexible scheduling			X	X		
Work to increase alternative commute programs, including car and van pools		X	X	X		X
Technology						
Vehicle infrastructure integration test bed		X				
Active Traffic Management			X			
Regional multi-modal traveler information (e.g., 511)	X	X	X			
Freeway management (ramp meters, travel time signs, enhanced monitoring)	X			X		
Enhanced traffic signal operations	X					
Parking management system		X			X	X

Objectives of the UPA/CRD National Evaluation and the Evaluation Framework

U.S. DOT has posed four objective questions to be addressed by the evaluation. The national evaluation team has identified 12 analyses that will provide the results necessary to address those questions. Table ES-2 identifies the 12 analyses and their relationship to the four questions. The analyses associated with Objective Question #2 (associated impacts) are of two types. The first four analyses responding to Question #2 focus on the performance of the deployed strategies across the 4Ts. Those analyses will provide the results necessary to draw conclusions about the relative contribution of the various strategies. The other five analyses responding to Question #2 examine a number of additional potential impacts of the strategies above and beyond their impact on traffic congestion.

The twelve evaluation analyses have been further elaborated into one or more hypotheses or questions. Then, measures of effectiveness (MOEs) are specified for each hypothesis and question and required data are identified for each MOE.



The national evaluation seeks to collect at least one year of baseline ("before") data and one year of post-deployment "after" data. The national evaluation data includes both objective data such as traffic counts, travel times, transit ridership, and costs, as well as subjective data such as traveler and stakeholder perceptions gathered through surveys, focus groups, and interviews. There are many strategies and intended impacts that are very similar across the UPA/CRD sites. The national evaluation, starting with this framework and further developing the similarities in subsequent planning products, will define data needed, methods of data collection, and analysis methods that will be standardized across the six evaluation sites. These comparable strategies and standardized evaluation approaches will generate cross-cutting findings, including conclusions about the effectiveness of various types of congestion reduction strategies. There are also a number of strategies being deployed that are specific to individual UPA/CRD sites and, of course, the sites themselves are all unique. Therefore, some aspects of the evaluation approach will be customized by site and will contribute to site-specific national evaluation findings.

Table ES-2. U.S. DOT National Evaluation "Objective Questions"

U.S. DOT 4 Objective Questions	Evaluation Analyses
#1 – How much was congestion reduced?	
How much was congestion reduced in the area impacted by the implementation of the tolling, transit, technology and telework strategies? It is anticipated that congestion reduction could be measured by one of the following measures, and will vary by site and implementation strategy: • Reductions in vehicle trips made during peak/congested periods • Reductions in travel times during peak/congested periods • Reductions in congestion delay during peak/congested periods • Reductions in the duration of congested periods.	#1 – Congestion
#2 – What are the associated impacts of the congestion reduction strategies?	
What are the associated impacts of implementing the congestion reduction strategies? It is anticipated that impacts will vary by site and that the following measures may be used: • Increases in facility throughput during peak/congested periods • Increases in transit ridership during peak/congested periods • Modal shifts to transit and carpools/vanpools • Traveler behavior change (e.g., shifts in time of travel, mode, route, destination, or forgoing trips) • Operational impacts on parallel systems/routes • Equity impacts • Environmental impacts • Impacts on goods movement • Effects on businesses.	**Strategy Performance** #2 – Strategy Performance: Tolling #3 – Strategy Performance: Transit #4 – Strategy Performance: Telecommuting/TDM #5 – Strategy Performance: Technology **Associated Impacts** #6 – Associated Impacts: Safety #7 – Associated Impacts: Equity #8 – Associated Impacts: Environmental #9 – Associated Impacts: Goods Movement #10 – Associated Impacts: Business Impacts
#3 – What are the non-technical success factors?	
What are the non-technical success factors with respect to the impacts of outreach, political and community support, and institutional arrangements implemented to manage and guide the implementation?	#11 – Non-Technical Success Factors
#4 – What are the overall cost and benefit of the strategies?	
	#12 – Cost and Benefit Analysis

Next Steps

The next step in the national evaluation planning process is to develop site-specific evaluation plans that will finalize the hypotheses, MOEs, and data from this national framework that are relevant to each UPA/CRD site. Evaluation planning activities will conclude with the development of test plans for each site. Those test plans, organized around types of data such as "survey" and "traffic," will provide detailed direction on data formats, data collection procedures, and analysis methods.

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1.0 OVERVIEW

The U.S. Department of Transportation (U.S. DOT) awarded grants in 2007 and 2008 to six metropolitan areas for implementation of congestion reduction strategies under the Urban Partnership Agreement (UPA) and Congestion Reduction Demonstration (CRD) programs. For evaluating the effectiveness of those strategies, U.S. DOT selected a national evaluation team, led by Battelle, in April 2008. This document presents the National Evaluation Framework (NEF) developed by the Battelle team. The overview section describes U.S. DOT's Congestion Initiative and the strategies being implemented at the six sites, discusses the purpose of the NEF, and describes the organization of the document.

1.1 The Urban Partnership Agreement and Congestion Reduction Demonstration Programs

Transportation system congestion is one of the greatest threats to our nation's economic prosperity and way of life. Whether it takes the form of trucks stalled in traffic, cargo stuck at overwhelmed seaports, or airplanes stuck on the tarmac, congestion costs the nation an estimated $200 billion a year. The problem of traffic congestion in major metropolitan areas in particular is severe and worsening. In 2003, traffic jams in the nation's largest 85 urban areas cost Americans 3.7 billion hours and 2.3 billion gallons of fuel. Congestion is affecting the quality of life in America by robbing time that could be spent with families and friends and in participation in civic life. As indicated in Figure 1-1, average annual hours lost to traffic delay per traveler in the nation's largest metropolitan areas has more than doubled between 1982 and 2005 and now amounts to more than 50 hours per year per traveler.

In 2006, the U.S. DOT announced the National Strategy to Reduce Congestion on America's Transportation Network, also known as the "Congestion Initiative."[1] The intent of the initiative is to demonstrate a variety of innovative but proven strategies that could provide relief to traffic gridlock if more widely practiced. The Congestion Initiative contains several major components: (1) Congestion Relief Programs; (2) Public Private Partnerships; (3) Corridors of the Future; (4) Implementing Technological and Operational Improvements; (5) Border Congestion Relief; and (6) Increasing Aviation Capacity.

The congestion relief component of the Congestion Initiative includes two programs: Urban Partnership Agreements (UPAs) and Congestion Reduction Demonstrations (CRDs). Within each program, multiple sites around the United States have been awarded funding for implementation of congestion reduction strategies. Background information on the UPA and CRD programs is presented below, followed by a summary of strategies being deployed at each of the UPA and CRD sites.

[1] http://www.fightgridlocknow.gov/initiatives.htm.

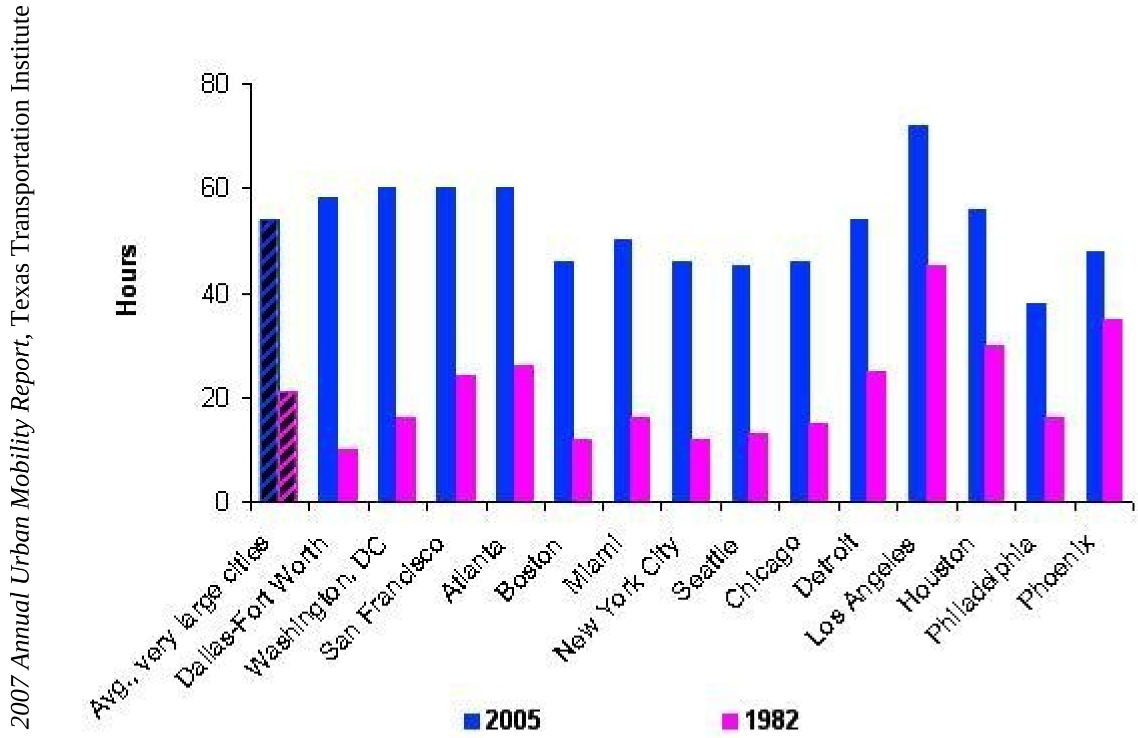

Figure 1-1. Annual Hours Lost to Traffic Delay per Peak Traveler in Very Large U.S. Metropolitan Areas, 2005 vs. 1982

1.1.1 Urban Partnership Agreements Background Information

The U.S. DOT's Congestion Initiative called on the U.S. DOT to enter into UPAs with model cities, pursuant to their commitment to, among other things, implement "broad congestion pricing." In December 2006, the U.S. DOT issued a Federal Register Notice[2] soliciting cities to apply for Urban Partnership status by April 30, 2007. For the cities that were selected, this Urban Partnership status would confer priority for available Federal discretionary funds (about $1 billion) across about a dozen programs. The applicants' proposals for congestion reduction were to be based on four complementary strategies known as the 4Ts: Tolling, Transit, Telecommuting, which includes other travel demand management (TDM) strategies besides telecommuting, and Technology.

In August 2007, the selection of five urban partners was announced—Miami, Minneapolis/St. Paul, New York City, San Francisco, and Seattle—along with a total of $853 million in Federal discretionary grants for these partners. On April 7, 2008, the New York State Assembly declined to take a formal vote to provide needed legislative authority to implement the proposed New York City congestion pricing project, effectively killing it. The U.S. DOT announced that the UPA funds previously targeted for New York would be made available to other areas for implementing congestion pricing and supporting strategies.

[2] http://www.fightgridlocknow.gov/docs/upafrfinal20061204.htm.

1.1.2 Congestion Reduction Demonstration Background Information

In 2007, the U.S. DOT announced a follow-on to the UPA Program, called the Congestion Reduction Demonstration Initiative. The November 13, 2007, Federal Register notice[3] set a December 31, 2007, deadline for applications. Subsequently, the U.S. DOT announced a $210.6 million CRD award to the City of Los Angeles and a $153 million award to the City of Chicago.

1.1.3 Overview of the UPA and CRD Sites

The sections below summarize the deployments for the six UPA/CRD sites. Section 1.1.4 presents a table summarizing the types of strategies that will be deployed at each site. Further details are available at the website http://www.fightgridlocknow.gov/.

Chicago

The Chicago CRD is being pursued in partnership by the City of Chicago and the Chicago Transit Authority (CTA). Figures 1-2 and 1-3 illustrate the traffic congestion on city streets in downtown Chicago. Five projects will be implemented:

1. Dedicated Bus Rapid Transit (BRT) service along four downtown corridors (serving as the first phase of a proposed city-wide arterial BRT network);
2. Pay-for-use charges in the City of Chicago's on-street loading zones, with prices varying by time of day or level of demand in a manner that both reduces traffic congestion and ensures reasonable availability of commercial loading zone space;
3. A peak period surcharge on off-street non-residential parking;
4. A system for variably pricing downtown on-street metered parking; and
5. A long-term concession agreement with the City of Chicago for the operation, improvement, and maintenance of its metered parking system.

City of Chicago

Figure 1-2. Traffic Congestion in Downtown Chicago

City of Chicago

Figure 1-3. Downtown Chicago Traffic

[3] http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=2007_register&docid=fr13no07-110

Under the terms of the CRD agreement, the Chicago partner agencies must enter into the parking concession agreement by December 31, 2008, and must implement all of the agreed-upon projects (BRT projects, loading zone fees, and variable parking pricing) by April 30, 2010. Also, all legal authority necessary to implement all project elements must be adopted and take effect no later than December 31, 2008. The Chicago CRD partner agencies have committed to providing any funding necessary to implement the loading zone fees and the variable parking pricing. The U.S. DOT will support the BRT projects with a total of $153.1 million in Federal funding drawn from two different Federal Transit Administration (FTA) capital funding programs and the Research and Innovative Technology Administration (RITA) Operational Testing to Mitigate Congestion (ITS-OTMC) Program.

Los Angeles

The Los Angeles CRD is being pursued in partnership by the California Department of Transportation (CALTRANS) and the Los Angeles County Metropolitan Transportation Authority (Metro). The Los Angeles (LA) CRD has the following major project elements:

1. High-occupancy vehicle (HOV) to dynamically priced high-occupancy tolling (HOT) lane conversions on 61 miles of freeway (I-10 and I-110);
2. A variety of transit investments along the priced corridors, such as transit signal priority, bus fleet acquisitions, improvements to transit stations, and park-and-ride facility improvements; and
3. A parking management system in the City of Los Angeles that will provide real-time information on parking availability. The HOV to HOT lane conversions constitute the first phase in what the partners envision as a broad network of congestion-priced lanes. If financing is available and appropriate legal authority is enacted, the LA CRD partner agencies also have committed to converting 24 miles of HOV lanes on I-210 to dynamically priced HOT lanes as well. Figure 1-4 maps the I-10 and I-110 corridors where the LA projects known as FastLanes will be deployed.

Under the terms of the LA CRD agreement, the HOT lanes will be in revenue operation no later than December 31, 2010. The U.S. DOT will provide the LA CRD partner agencies with $210.6 million in funding appropriated under the FTA's Section 5309 Bus and Bus-Related Facilities Discretionary Grant Program. The transit funds are targeted to transit service enhancements along the priced corridors. The U.S. DOT also reserves the right to extend loan financing or to facilitate procurement of additional project financing, in either case to aid in the implementation of the I-210 HOV-to-HOT conversion.

Los Angeles Metropolitan Transportation Authority

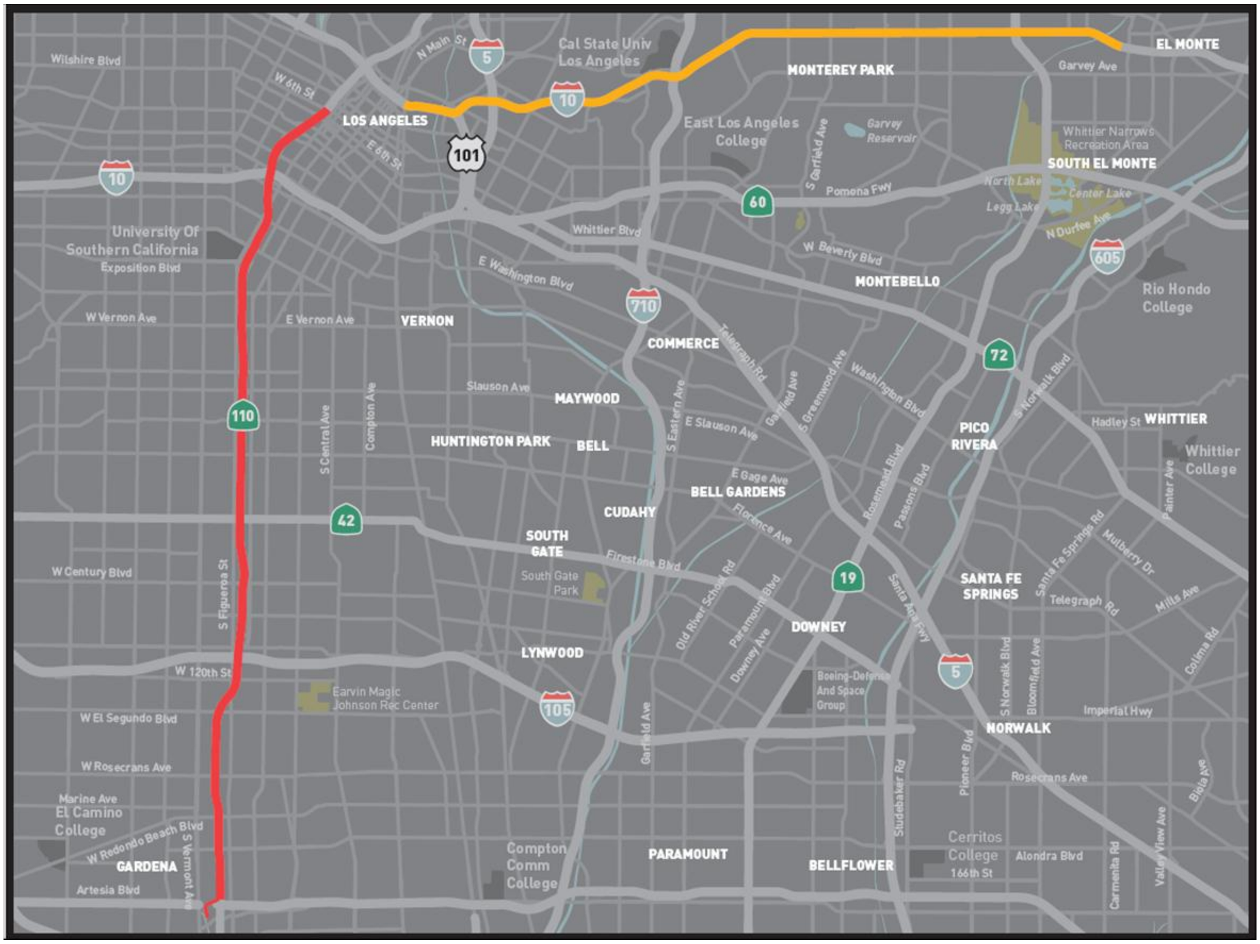

Figure 1-4. Los Angeles FastLanes Project Map

Miami

The Miami-Area UPA partners are the Florida Department of Transportation (FDOT), the Miami-Dade Metropolitan Planning Organization, the Broward Metropolitan Planning Organization, Miami-Dade Transit, Broward County Transit, the Miami-Dade Expressway Authority, and the Florida Turnpike Enterprise. The Miami-Area UPA partners have agreed to implement three main projects:

1. Convert not less than 21 miles of four (two in each direction) HOV lanes along I-95 from I-395 in Miami to I-595 in Fort Lauderdale into variably priced HOT lanes (and raise HOT occupancy requirements from HOV 2+ to HOV 3+);
2. Expand transit capacity to enhance current express bus services and implement new BRT service within the HOT lanes, east-west on Hollywood/Pines Boulevard in Broward County, and between Broward and Miami-Dade Counties on US 441/SR 7 and SR 817 (University Drive); and
3. Improve the Golden Glades multi-modal park-and-ride transit facility in Miami-Dade County.

In addition to pricing the managed lanes to reflect demand, the FDOT will install ramp meters on I-95. Additional transit-related improvements will be to allow transit vehicle priority at 50 signalized intersections, uniquely brand two new express/BRT stations in Broward County, and construct pedestrian access accommodations at one of the two new stations. Figure 1-5 illustrates the HOT lane portion of the Miami UPA.

Florida Department of Transportation

Figure 1-5. Computer Rendering of I-95 Express Lanes in the Miami UPA

The Miami-Area UPA projects will be deployed in phases, with all projects operational by September 30, 2009. The first phase of the project, the southern half of northbound lanes, was planned to be operational by May 2008 (a new operational date had not been determined by the time of this writing). The Miami-Area UPA projects will receive a total of $62.9 million in Federal funding drawn from FHWA's Interstate Maintenance Discretionary Program and FTA's Bus and Bus-Related Facilities Discretionary Grant Program (Section 5309).

Minnesota

The Minnesota UPA partners include the Minnesota Department of Transportation (Mn/DOT), the Twin Cities Metropolitan Council, Metro Transit, the City of Minneapolis, Minnesota Valley Transit Authority (MVTA), and Anoka, Dakota, Ramsey, and Hennepin Counties. The Minnesota UPA includes the following projects:

1. Expand the existing HOV lanes on I-35W from Burnsville Parkway to 66th Street into dynamically priced HOT lanes;
2. Add new dynamically priced HOT lanes on I-35W from 66th Street to 42nd Street as part of the reconstruction of the Crosstown Commons Section;
3. Implement a priced dynamic shoulder lane (PDSL) on I-35W in the northbound direction from 42nd Street to downtown Minneapolis (as shown in Figures 1-6 and 1-7);
4. Construct six new or expanded park-and-ride lots;
5. Purchase 26 new buses and operate new and expanded express bus service;
6. Construct two BRT stops/stations on Cedar Avenue;

7. Construct double contraflow bus lanes in downtown Minneapolis on Marquette and 2nd Avenues and improve sidewalks, lighting, landscaping, and passenger waiting areas;
8. Construct "Transit Advantage" bus bypass ramp – northbound Hwy 77 to Westbound Hwy 66;
9. Implement intelligent transportation systems (ITS) for transit, including bus arrival times, congestion conditions, parking availability, and transit signal priority;
10. Develop and implement lane guidance system for shoulder-running buses;
11. Install ITS technology to facilitate transit and arterial traffic management; and
12. Increase the use of Results Only Work Environment (ROWE)[4] and telecommuting throughout the region, including increasing the number of teleworkers and/or workers on flexible schedules in the I-35W corridor by 500 individuals.

Minnesota Department of Transportation

Figure 1-6. I-35 West Corridor in Downtown Minneapolis

[4] Results Only Work Environment, or ROWE, provides employees flexibility in the work location and hours by focusing on performance and results rather than presence at the office during standard work hours. ROWE is used extensively at Best Buy Corporation, headquartered in Minnesota, and the UPA program will seek to increase its use by other businesses in the region.

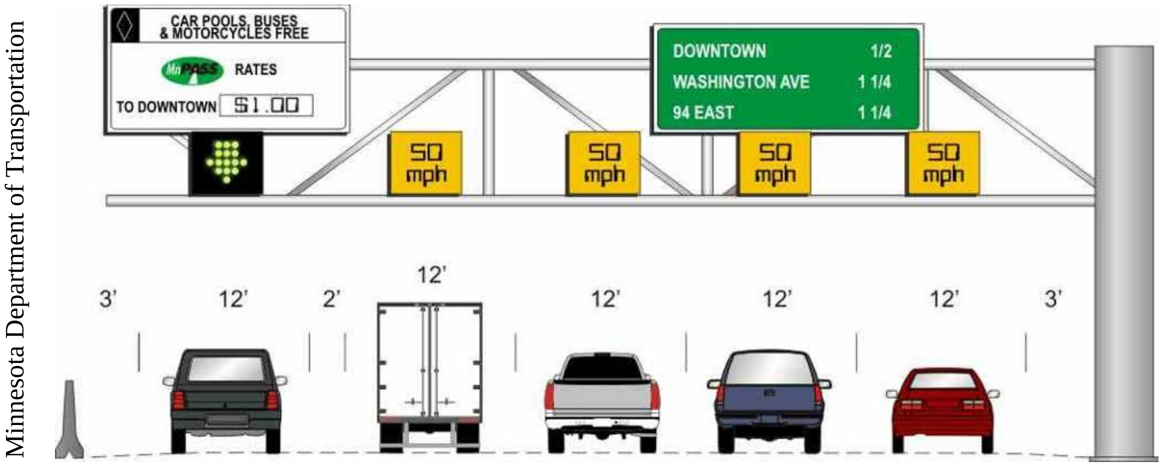

Figure 1-7. Drawing of Priced Dynamic Should Lane in Minnesota

The Minnesota UPA projects are scheduled to be completed by September 30, 2009, with a few exceptions. The downtown bus lanes are scheduled to be operational by December 2009. Construction of the Crosstown Commons Section and the new HOT lanes are scheduled to be completed in 2010. The ROWE and telecommuting activities, which are funded by the state, will continue beyond 2010. The U.S. DOT is allocating $133.3 million in Federal grant funding, drawn from three different FHWA funding programs, FTA's Section 5309 Bus Program, and RITA's ITS-OTMC Program for the Minnesota UPA projects.

San Francisco

The San Francisco Bay Area Urban Partners are the Alameda-Contra Costa Transit District, the California Department of Transportation (CALTRANS), the Metropolitan Transportation Commission, the San Francisco Municipal Transportation Agency, the San Francisco County Transportation Authority, the Bay Area Toll Authority, and the Golden Gate Bridge Highway and Transit District. Under the UPA agreement, the Urban Partners agree to:

1. Variably price on-street and off-street parking in downtown San Francisco;
2. Improve regional ferry boat service;
3. Develop a simplified travel forecasting approach for a Very Small Starts project in the Grand/MacArthur BRT corridor;
4. Upgrade the regional 511 system to provide real-time parking and transit information;
5. Create an open architecture Vehicle Infrastructure Integration (VII) test bed focused on parking pricing/management and traveler information; and
6. Expand the technical and promotional aspects of San Francisco's telecommuting and related alternative commute programs.

San Francisco Municipal Transportation Agency

Figure 1-8. Variable Message Signs Will Guide Drivers to Available Parking in San Francisco

Figures 1-8 and 1-9 illustrate a couple of ways in which the San Francisco partners intend to disseminate information about parking.

The proposed implementation had originally included congestion pricing on Doyle Drive or the Golden Gate Bridge, but this was later dropped by mutual agreement between the U.S. DOT and the San Francisco Bay Area Urban Partners. These same two parties were in the process of finalizing the agreement on funding and operational dates for all the projects at the time of this writing.

San Francisco Municipal Transportation Agency

Figure 1-9. Parking Information to be Available on Cell Phones in San Francisco

Seattle

The Seattle Area-Lake Washington Corridor (LWC) Urban Partners are the Washington State Department of Transportation (WSDOT), the Puget Sound Regional Council, and King County. Under this agreement, the Urban Partners agree to:

1. Implement variable pricing on all through-lanes of SR 520 between I-5 and I-405 and, to the extent necessary to maintain free flow traffic in the through-lanes, on all collectors and distributors for SR 520 between I-5 and I-405;
2. Use advanced technologies to employ “active traffic management” along SR 520 and the LWC;
3. Increase transit capacity along SR 520 by enhancing express bus service and constructing transit improvements, including bus facilities (stops/station/terminals) and expansions to existing park-and-ride lots;
4. Improve regional ferry boat service;
5. Provide travelers with real-time multi-modal transportation information; and
6. Work to increase the use of telecommuting, flexible scheduling, and employer-based alternative commute programs within the region.

Washington State Department of Transportation

Figure 1-10. A Common Rush Hour Traffic Jam on SR 520

Washington State Department of Transportation

Figure 1-11. Looking Southeast Across Lake Washington and the SR 520 Bridge

The Seattle Area-LWC Urban Partners have agreed that all projects will be in operation by no later than September 30, 2009. The urban partners have been awarded $154.5 million in Federal funds drawn from four different FHWA funding programs, FTA's Section 5309 Bus Program, and RITA's ITS-OTMC Program. Figures 1-10 and 1-11 illustrate the SR 520 corridor.

1.1.4 Summary of Strategies by Site

Table 1-1 summarizes the strategies being deployed at all six UPA/CRD sites. Most of the sites feature similar employer-based TDM strategies. Transit approaches among the sites include many common strategies, including bus service improvements (such as BRT) and ferry service improvements. The Minnesota UPA site is unique in that it includes transit lane keeping. Several of the "Technology" strategies are unique to single sites, including VII in San Francisco and active traffic management in Seattle. The most aggressive roadway congestion pricing strategy will be implemented in Seattle. The Seattle pricing strategy is notable because they will be introducing a new toll, tolling all lanes on the SR 520 bridge, and utilizing variable tolling.

Table 1-1. Summary of UPA/CRD Strategies by Site

UPA/CRD Strategies Planned Operational Date	Deployment Sites					
	MN	SF	Sea	Mia	Chi	LA
	9/30/09	TBD	9/30/09	TBD	4/30/10	12/31/10
Tolling						
Convert HOV lanes to dynamically priced HOT lanes and/or new HOT lanes	X			X		X
Priced dynamic shoulder lanes	X					
Variably priced parking and/or loading zones		X			X	X
Variably priced roadways or bridges (partial cordon)			X			
Transit						
Increase park-and-ride capacity (expand existing or add new)	X		X	X		X
Expand or enhance bus service	X		X	X		X
Implement new, or expand existing, Bus Rapid Transit	X			X	X	
Transit on special runningways (e.g., contraflow lanes, shoulders)	X			X		
New and/or enhanced transit stops/stations	X		X	X		X
Transit traveler information systems (bus arrival times, parking availability)	X		X			
Transit lane keeping/lane guidance	X					
Transit traffic signal priority	X			X		X
Transit fare subsidies	X					
Arterial street traffic signal improvements to improve transit travel times	X					
Ferry service improvements		X	X			
Improved transit travel forecasting techniques		X				
Pedestrian improvements				X		X
Telecommuting/TDM						
"Results Only Work Environment" employer-based techniques	X					
Work to increase use of telecommuting		X	X	X		
Work to increase flexible scheduling			X	X		
Work to increase alternative commute programs, including car and van pools		X	X	X		X
Technology						
Vehicle infrastructure Integration test bed		X				
Active traffic management			X			
Regional multi-modal traveler information (e.g., 511)	X	X	X			
Freeway management (ramp meters, travel time signs, enhanced monitoring)	X			X		
Enhanced traffic signal operations	X					
Parking management system		X			X	X

1.2 Purpose of the Evaluation Framework

This NEF provides the foundation for evaluation of the six UPA/CRD sites. It is based on the 4Ts congestion reduction strategies and the questions that the U.S. DOT seeks to answer through the evaluation. These "Objective Questions" are discussed in Section 2.0. The NEF is essential because it defines the questions, analyses, measures of effectiveness, and associated data collection for the entire UPA/CRD evaluation. As illustrated in Figure 1-12, the framework will be the key driver of the site-specific evaluation plans and test plans and will serve as a touchstone throughout the project to ensure that national evaluation objectives are being supported through the site-specific activities.

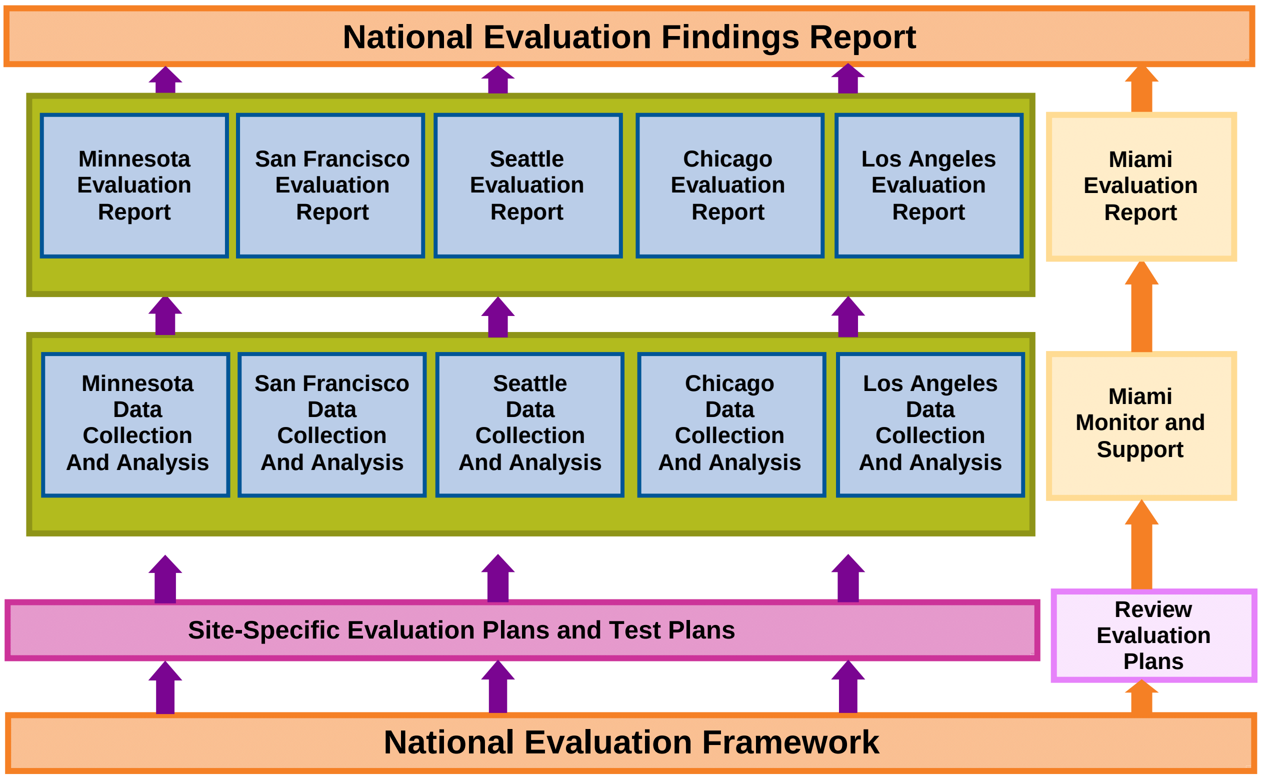

Figure 1-12. The National Evaluation Framework in Relation to Other Evaluation Activities

The evaluation of each UPA/CRD site will involve several steps. With the exception of Miami, where the national evaluation team is serving in a limited role of review and support to the local partners, the national evaluation team will work closely with the local partners to perform the following activities and provide the following products:

- A site-specific strategy guided by the NEF
- A site-specific evaluation plan that describes the strategy and provides a high-level view of all the test plans needed, the roles and responsibilities, and the schedule

- Multiple site-specific test plans that provide complete details on how the data collection and analysis activity will be implemented and that identify the resources needed
- Collection of one year of pre-deployment and one year of post-deployment data
- Analysis of the collected data
- Site-specific evaluation reports and a National Evaluation Findings Report.

Establishing the framework up front will influence how sites design and implement their strategies, such as by identifying the need to build in data collection mechanisms if such infrastructure does not already exist. To measure the impact of the congestion strategies, it is essential to collect both the "before" and "after" data for many of the measures of effectiveness identified in the NEF. Also important is establishing as many common measures as possible that can be used at all the sites to enable comparison of findings across the sites. For example, a core set of standardized questions and response categories for traveler surveys will be prepared. Questions may need to be tailored or added to reflect the specific congestion strategies and local context for each site, such as road names or transit lines, but striving for comparability among sites will be a goal of the evaluation.

A traditional "before and after" study is the recommended analysis approach for quantifying the extent to which the strategies affect congestion in the UPA/CRD sites. In the "before" condition, measures of effectiveness will be collected before the deployments became operational. For the "after" period, the same measures will be collected to examine the effects of the strategies. The analysis approach will track how the performance measures changed over time (trend analysis) and examine the degree to which they changed between the "before" and "after" periods. Whenever possible, field-measured data will be used to generate the measures of effectiveness.

The NEF is built on a foundation of prior research in the transportation and evaluation fields. While it draws heavily on a history of evaluation work at the U.S. DOT, the NEF also has been informed by a wealth of research conducted in the U.S. and abroad, including the comprehensive evaluation of the Stockholm pricing experiment.

1.3 Organization of the Document

In the following sections, the details of the NEF are presented. First, in Section 2.0, Evaluation Analyses, the U.S. DOT's four "Objective Questions" are presented and mapped to twelve evaluation analyses that are the heart of the evaluation. Each evaluation analysis shows the hypotheses or questions to be addressed, the measures of effectiveness, and the data that will be used. Section 3.0, Risks and Other Considerations, raises issues that can affect the evaluation and approaches for dealing with them, such as extraneous factors and risks to the schedule for the evaluation. The data collection framework, the subject of Section 4.0, maps the data to be collected to the twelve evaluation analyses. This section also provides detailed discussions in key data collection areas: surveys, interviews, and focus groups; traffic data; transit data; and environmental data. Section 5.0 discusses next steps.

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2.0 Evaluation Analyses

This section presents the core of the UPA/CRD NEF: twelve evaluation analyses that will be conducted for each of the UPA/CRD sites.

The twelve recommended analyses have been developed to address the four "Objective Questions" identified by the U.S. DOT[5] and shown in Table 2-1. The analyses lay out what must be studied in order to answer the four objective questions. Table 2-2 shows the relationship between the four objective questions and the twelve analyses.

Table 2-1. U.S. DOT National Evaluation "Objective Questions"

Objective Question #1	How much was congestion reduced in the area impacted by the implementation of the tolling, transit, technology and telecommuting strategies? It is anticipated that congestion reduction could be measured by one of the following measures, and will vary by site and implementation strategy: • Reductions in vehicle trips made during peak/congested periods • Reductions in travel times during peak/congested periods • Reductions in congestion delay during peak/congested periods • Reductions in the duration of congested periods.
Objective Question #2	What are the associated impacts of implementing the congestion reduction strategies? It is anticipated that impacts will vary by site and that the following measures may be used: • Increases in facility throughput during peak/congested periods • Increases in transit ridership during peak/congested periods • Modal shifts to transit and carpools/vanpools • Traveler behavior change (e.g., shifts in time of travel, mode, route, destination, or forgoing trips) • Operational impacts on parallel systems/routes • Equity impacts • Environmental impacts • Impacts on goods movement • Effects on businesses.
Objective Question #3	What are the non-technical success factors with respect to the impacts of outreach, political and community support, and institutional arrangements implemented to manage and guide the implementation?
Objective Question #4	What are the overall cost and benefit of the deployed set of strategies?

[5] "Urban Partnership Agreement Demonstration Evaluation – Statement of Work," United States Department of Transportation, Federal Highway Administration; November 29, 2007.

Table 2-2. U.S. DOT Objective Questions vs. Evaluation Analyses

U.S. DOT 4 Objective Questions	Evaluation Analyses
#1 – How much was congestion reduced?	#1 – Congestion
#2 – What are the associated impacts of the congestion reduction strategies?	**Strategy Performance**
	#2 – Strategy Performance: Tolling #3 – Strategy Performance: Transit #4 – Strategy Performance: Telecommuting/TDM #5 – Strategy Performance: Technology
	Associated Impacts
	#6 – Associated Impacts: Safety #7 – Associated Impacts: Equity #8 – Associated Impacts: Environmental #9 – Associated Impacts: Goods Movement #10 – Associated Impacts: Business Impacts
#3 – What are the non-technical success factors?	#11 – Non-Technical Success Factors
#4 – What is the overall cost and benefit of the strategies?	#12 – Cost-Benefit Analysis

The analyses associated with Objective Question #2 are of two types. The first four analyses focus on the performance of the deployed strategies across the 4Ts. These analyses will examine the specific impacts of each deployed project/strategy, and, to the extent possible, associate the performance of specific strategies with any changes in congestion. The second type of analysis associated with Objective Question #2 focuses on specific types of impacts, e.g., "equity" and "environmental."

The twelve evaluation analyses were further elaborated into one or more hypotheses for testing. In some cases, where the analysis is not guided by a hypothesis, per se, such as the analysis of the non-technical success factors, specific questions are stated rather than hypotheses. Next, measures of effectiveness (MOEs) are identified for each hypothesis, and required data are specified for each MOE.

2.1 Congestion

The primary purpose of the UPA/CRD is to demonstrate the effectiveness of deploying a combination of 4T strategies for reducing congestion in an urban corridor or area. Therefore, the first questions to be addressed in the national evaluation are the following:

1. Did the deployment of a set of 4T strategies in a key travel and/or commuting corridor reduce congestion in that corridor in each of the deployment sites?
2. If so, how much was congestion reduced?

The performance measures that will be used to assess the collective impacts of the strategies on congestion in the national evaluation are shown in Table 2-3.

Table 2-3. Congestion Evaluation Approach

Hypotheses/Questions	Measures of Effectiveness	Data
• The UPA/CRD deployment will reduce traffic congestion on targeted roadways. • Traffic congestion on alternate routes (roads) and feeder routes will not change	• Percent change in route/corridor travel time by time of day	• Travel time
	• Percent change in the travel time index for comparisons across sites (having corridors of differing lengths)	• Travel time • Free-flow travel time
	• Percent change in number of hours of the day with congested conditions and the number of congested travel links per day	• Link speeds
	• Percent change in average travel speeds by hour of the day	• Link speeds
	• Percent change in travel time reliability and planning time index	• Travel time
	• Percent change in vehicle and person trips by time of day and person and vehicle throughput	• Average number of occupants per vehicle by type of vehicle • Volume
• Travelers will perceive that congestion has been reduced.	• Change in traveler perceptions about congestion after deployment of strategies	• Data from traveler surveys

According the NCHRP's *Guide to Effective Freeway Performance Measurement*,[6] the first basic principle for measuring mobility is to use performance measures that are based on the measurement or estimation of travel time. Travel time is relatively easy for travelers to understand and reflects a fundamental principle related to quality of service for travel – a trip under congested traffic conditions takes more time than the same trip during uncongested conditions. Therefore, the majority of performance measures used in the congestion analysis are travel-time based. Many of these performance measures have been used as part of FHWA's *Urban Congestion Report*.[7]

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[6] *Guide to Effective Freeway Performance Measurement: Final Report and Guidebook.* NCHRP Web-Only Report 97. National Academies, Transportation Research Board. Washington, D.C. 2006. Available at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w97.pdf.

[7] *The Urban Congestion Report (UCR): Documentation and Definitions*. Available at http://ops.fhwa.dot.gov/perf_measurement/ucr/documentation.htm

The first measure to be used in the national evaluation is average travel time. This is the average time consumed by vehicles traversing a fixed distance of roadway. Travel time is strongly influenced by the speed that the vehicle is able to travel, as well as any delays experienced due to stops or slow downs caused by congestion. Generally, travel times are measured for specific points on a section of roadway and can be collected separately for different types of facilities (e.g., general purpose lanes versus HOV/HOT lanes, freeway versus arterial). For the national evaluation, the changes in travel times before and after the strategies have been deployed will be used to measure collective effectiveness of all the strategies at reducing congestion.

Because travel time is highly dependent on the length of the roadway section, comparing changes in travel time between deployment sites may not produce a fair assessment of the impacts. Because of different corridor lengths, the national evaluation also will use the travel time index as a means of assessing the collective effectiveness of the strategies at reducing congestion between deployment sites. The travel time index is the ratio of the average peak period travel time as compared to a free-flow travel time. The free-flow travel time for each road section is the 15th percentile travel time during traditional off-peak times (i.e., weekdays between 9 am and 4 pm, between 7 pm and 10 pm; and weekends between 6 am and 10 pm). For example, a value of 1.20 means that average peak period travel times are 20% longer than free-flow travel times.

The UPA/CRD national evaluation will determine if the deployed strategies collectively are able to improve travel time reliability in a corridor. To assess improvement in travel time reliability, the national evaluation will use the planning time index. The planning time index is the ratio of the total time needed to ensure 95% on-time arrival at a downstream destination compared to a free-flow travel time. A value of 40% means that a traveler would have to allocate 40% more than the average free-flow travel time to guarantee that he or she will arrive on time 95% of the time (e.g., 8 minutes for a 20-minute average trip during peak periods). Higher planning time index values imply that there is more variability in the travel time; therefore, travelers need to plan to include more travel time to ensure that they arrive at their destination on time in the corridor.

The UPA/CRD national evaluation also will examine how the deployment strategies influence the spatial and temporal extent of congestion in the corridor. The temporal extent of congestion refers to how many hours in the day the corridor is operating under congested conditions. For the purposes of this evaluation, this measure will be the time duration in which more than 20% of the roadway sections in a predefined area are "congested" or "severely congested." The spatial extent of congestion will be assessed by determining the percentage of freeway vehicle miles traveled (VMT) occurring during periods when the roadways are "congested" or "severely congested." For the purposes of this study, freeway sections will be defined as "congested" when the average link speed is less than 50 mph and "severely congested" when the average link speed is less than 30 mph. For arterial streets, "congested" conditions will be assumed to exist when the travel speeds drop 10 mph below the posted speed limit and "severely congested" when the travel speeds drop 15 mph below the posted speed limit.

The UPA/CRD national evaluation also recognizes throughput (both person and vehicle) as another important measure of congestion reduction. Throughput is being used as a measure of performance because it is assumed that if more vehicles and/or persons are serviced in the corridor, congestion has been reduced, even though changes in the measures related to travel time may or may not have been observed. Vehicle throughput refers to the number of vehicles traversing the corridor, while person throughput refers to the number of persons traversing the corridor on both transit and in private vehicles. Increases in these values would imply that the deployment strategies were effective in serving more vehicles and/or persons who previously could not have been serviced in the corridor because of the congestion that existed prior to the improvements being made.

In addition to the quantitative measures of congestion reduction, the UPA/CRD national evaluation also recognizes the importance that improvements may have on customer satisfaction measures related to capacity reduction. In order to maintain political and institutional support, it is essential that the traveling public also perceive that the deployment strategies have produced changes in the duration and/or amount of congestion that exist in the corridor. The national evaluation will include a survey of travelers in the corridor to gauge how traveler perceptions of congestion in the corridor have changed as a result of the deployment of the collective 4T strategies.

2.2 Strategy Performance: Tolling

The focus of this analysis is to understand whether and how the UPA/CRD congestion pricing ("tolling") strategies succeed in producing the intended improvements in vehicular throughput and parking utilization. This understanding also will reveal how pricing strategies contributed to changes in overall congestion levels that may be observed (see Section 2.1).

As indicated in Table 2-4, the evaluation framework examines the extent to which specific tolling elements contribute to changes in travel behavior and utilization of priced and non-priced facilities, as described below.

- Effects of tolling and price signals upon the efficiency of the priced facilities – This performance evaluation examines the ability of tolling to maximize vehicular throughput by allowing tolled facilities to operate at optimum efficiency. (The shift of travel demand to non-single-occupant vehicle (SOV), non-toll-bearing modes of travel such as transit, vanpools, etc.), albeit an outcome of pricing on facilities, is evaluated in transit and telecommuting/TDM in Sections 2.3 and 2.4, respectively.) The measurements of efficiency will rely on longitudinal analysis using continuous data on traffic volumes and toll transaction and data on commute trip behavior from traveler surveys.
- Ability to maintain gains over time – Congestion pricing, in particular, has the promise to maintain gains in throughput by regulating vehicular access by price. The extent to which travelers respond to the price signals over time will be evaluated in traffic and toll transaction data and traveler survey-based data.
- Reduction in parking-search time – Parking pricing, in San Francisco, Chicago, and Los Angeles, postulates that variable pricing for parking spaces will provide system management benefits similar to that of pricing highway facilities. The ability to determine the effects of variable prices for parking upon utilization rates will depend upon statistical isolation and adequate control for affected areas.

Table 2-4. Tolling Analysis Approach

Hypotheses/Questions	Measures of Effectiveness	Data
• Pricing will regulate vehicular access to increase vehicular throughput on the priced lanes • General purpose lane travelers will shift to HOT lane, while HOV lane travelers will remain in HOT lane	• Level of service in tolled lanes • Travel-time reliability in tolled lanes • Average occupants per vehicle of tolled lanes vs. general purpose lanes • Use of tolling options • Traffic density in tolled lanes	• Traffic volumes by time of day, location/segment, and lane type (continuous) • Transactions by time of day (continuous) • Traveler survey data
• After ramp-up, pricing maintains vehicular throughput gains on the priced facility	• Travel-time reliability (seasonally controlled) • Days exceeding reliability and performance thresholds	• Time-series comparison of traffic data • Data from surveys of traveler behavior
• Parking pricing will reduce inefficiencies in parking space utilization • Parking pricing will improve reliability of finding parking on demand	• Turnover rates for on-street and off-street parking based on pricing rate by time of day • Vacancies for off-street parking by distance from destinations	• Off-street parking garage/lots occupancy data by time of day • On-street parking utilization by time of day • Employment density maps for priced zones

2.3 Strategy Performance: Transit

Transit has been included as one of the 4T strategies designed to mitigate traffic congestion and effect more efficient use of highway capacity. In order to be successful as a congestion mitigation tool, enhanced public transportation services must retain existing riders while also attracting new riders who previously traveled the corridor by private vehicle. These "potential riders," along with the "choice riders" that choose to use transit even though they have a private vehicle available to them, make up the transit market toward which the transit elements of the UPA/CRD proposal are primarily directed. Figure 2-1 depicts the current and potential transit market.

A core objective of the UPA/CRD program is to increase transit's utility relative to the private auto, leading to a mode shift to transit. Mode shift may result from potential users being attracted to transit, or from increased transit use among choice users. Thus, the central transit evaluation issue is the identification and measurement of mode shift. In theory, a mode shift to transit should then facilitate higher transit ridership, reduced levels of traffic congestion, more efficient use of existing road capacity, and potentially higher levels of person throughput.

Krizek & El-Geneidy (2007)[8]

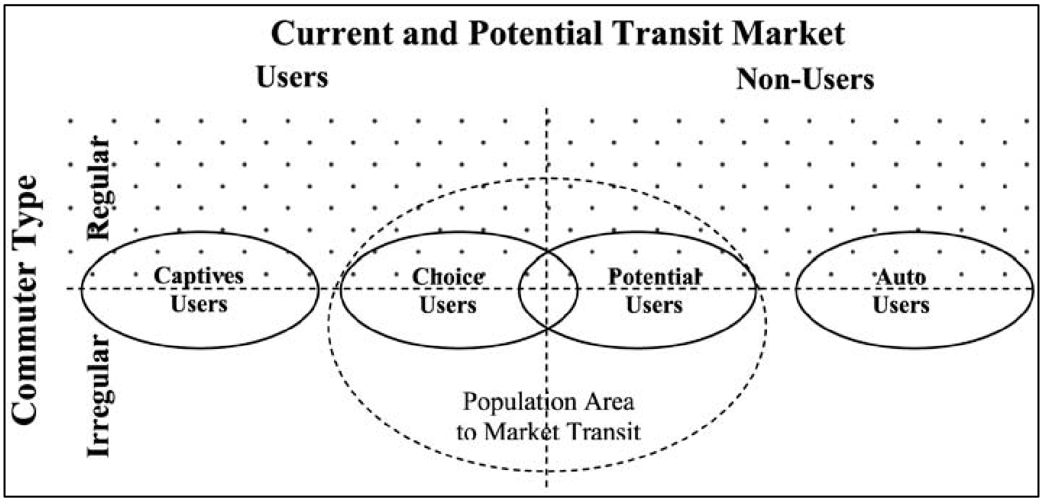

Figure 2-1. Current and Potential Transit Market

Table 2-5 summarizes the four core hypotheses and questions that have been defined as the focus of the transit component of the evaluation. These hypotheses and questions, and the associated MOEs and data used to evaluate them, are based on the standard evaluation framework defined by the FTA for the evaluation of BRT projects.[9] The first hypothesis relates to supply-side aspects of the transit service, measuring the extent to which the UPA/CRD projects improve transit service performance, expressed in terms of reduced travel times, increased reliability, schedule adherence, service capacity, and user perceptions.

The second and third hypotheses then relate to demand-side impacts on transit usage. The second hypothesis focuses on the core issue of mode shift, the measurement of which requires a combination of ridership data, survey data, vehicle occupancy data, and park-and-ride utilization data. The third hypothesis relates to the identification and measurement of any secondary impacts resulting from a mode shift to transit. The most important of these is the impact of mode shift on traffic congestion within the UPA/CRD corridors. Negative impacts, such as vehicle overcrowding and bus-bunching, are also possible and will be evaluated within this section.

[8] Krizek, K., & El-Geneidy, A. (2007). Segmenting Preferences and Habits of Transit Users and Non-Users. *Journal of Public Transportation*, Vol. 10, No. 3, 2007, pp. 71-94.

[9] Diaz, R.B., M. Chang, G. Darido. (2004). *Characteristics of Bus Rapid Transit for Decision Making.* Federal Transit Administration, United States Department of Transportation.

Table 2-5. Transit Analysis Approach

Hypotheses/Questions	Measures of Effectiveness	Data
UPA/CRD projects will enhance transit performance in the UPA/CRD corridors (reduced travel times, increased reliability, increased capacity, etc.)	• End-to-end travel time • Service reliability • Maximum/unconstrained travel-time ratio • Schedule adherence • User ratings of service performance	• Transit travel-time data • Transit-reliability and schedule-adherence data • Park-and-ride lot capacity data • Transit service characteristics data • On-board survey data
UPA/CRD projects will facilitate a mode shift to transit.	• Corridor ridership • Boardings/deboardings • Service load factors • Corridor mode split (%) • Park-and-ride utilization factors	• Transit ridership data • Farebox data • Park-and-ride lot utilization data • Vehicle occupancy data • On-board survey data
Mode shift to transit will contribute to congestion mitigation in the UPA/CRD corridors.	• Corridor ridership • Boardings/deboardings • Service load factors • Corridor mode split (%) • Park-and-ride utilization factors	• Transit ridership data • Farebox data • Park-and-ride lot utilization data • Vehicle occupancy data • On-board survey data
What was the relative contribution of each UPA/CRD project element to mode shift to transit?	• All of the above, supplemented by effectiveness measures from other aspects of the evaluation	• All of the above, supplemented by data from other aspects of the evaluation

The last hypothesis is concerned with the determination of the causal linkages between the supply-side, performance-related aspects of the UPA/CRD projects and the demand-side impacts on transit usage. There are a number of factors contributing to possible mode shift, including increased auto travel cost, decreased transit travel time, increased transit reliability, changes in minimum HOV-lane usage requirements, improved transit infrastructure, increased service quantity (headway and/or span), and increased parking capacity, in addition to extraneous factors like high gasoline prices. If mode shift to transit does occur, it is important to be able to understand why, and to relate the resultant mode shift to specific UPA/CRD project elements. This will require consideration of all of the transit data sources previously identified, supplemented by data from other aspects of the evaluation, such as observed changes in private auto travel time and travel cost.

2.4 Strategy Performance: Telecommuting/TDM

For the purposes of this evaluation the telecommuting strategy is broadly defined as including travel demand management (TDM) measures, such as supportive employer trip reduction programs, vanpooling, carpool promotion, walking and bicycling initiatives, as well as measures to increase the number of employers and employees adopting telecommuting programs. In most UPA/CRD cities, the telecommuting/TDM strategy is supportive of the other strategies that involve the introduction of new services and mechanisms to reduce congestion.[10] Telecommuting, broadly defined, will help promote the availability of traveler choices in corridors with new options, such as HOT lanes, BRT, and active traffic management (ATM).

As summarized in Table 2-6, the principal intended outcome of telecommuting/TDM activities will be mode shift. In other words, did travelers choose to switch to another mode (or to telework) as a result of the new or enhanced TDM programs that are implemented to support other UPA/CRD activities? This issue of tying mode shift to UPA/CRD activities is critical, as the evaluation should not count impacts that result from other planned TDM program enhancements or that result from exogenous factors such as gas prices or employment trends.

Table 2-6. Telecommuting/TDM Analysis Approach

Hypotheses/Questions	Measures of Effectiveness	Data
• Promotion of telecommuting and other alternatives (mode, time) removes trips and VMT from targeted corridors.	• New teleworkers and ridesharers • Commuters who shift their travel times to off-peak hours • VT and VMT reduction in targeted corridors	• Data from before and after surveys of travelers to document new ridesharers and time shifters (and any unintended shifts to lower occupancy modes) • Average trip lengths (for VMT calculations)
• Integration of Telecommuting/TDM into project(s) enhances congestion mitigation.	• Mode shift related to overall UPA activities in corridor	• Traveler survey data • Interviews with employers and stakeholders (both those directly involved in implementing strategies and overall project administrators)
• Employees who use telecommuting as an alternative to commuting (and their employers) will perceive no reduction in the employees' productivity.	• Perceptions about telecommuting experience	• Data from surveys of teleworkers and interviews with employers
• What was the relative contribution of the various TDM strategies to overall travel behavior changes (mode shift, eliminated and rescheduled trips)?	• Travel behavior changes of users and non-users of priced facilities in terms of ridesharing and trip elimination/ rescheduling	• Data from before and after surveys of alternative mode users • Data from survey of all travelers • Interviews with employers and stakeholders (same as above)

[10] The primary exception is the Minnesota, where the Results Only Work Environment (ROWE) concept will be formally introduced to new employers and their employees.

As is common in TDM evaluation, changes in mode shares, or the number of new alternative-mode users, can be easily translated into vehicle trips (VTs) reduced and VMT reduced.[11] Some understanding of the temporal and spatial distribution of these reduced trips also can help to explain the impact of specific areas of congestion, but this can be difficult to assess. Finally, beyond mode shifting, traveler behavioral changes such as time shifting, route shifting, or trip elimination (e.g., 4 day/40 hour work schedule and telecommuting) will be assessed.

Determining the number of new telecommuters involved at participating employers should be fairly straightforward, and gathering the information to assess the travel behavior changes of new teleworkers will be integrated into the programs. Assigning those impacts to targeted corridors will require some careful analysis of trip origins. Additionally, changes in employee productivity, or at least perceptions thereof, should be part of the evaluation of telecommuting.

Perhaps more challenging will be the ability to measure the unique impact of telecommuting and enhanced TDM programs on the effectiveness of the other UPA/CRD strategies. This may require asking those who shifted mode, time, or route why they changed their travel behavior in order to link impacts to specific initiatives.

Changes in carpool behavior will be of interest to this evaluation, as several outcomes are possible:

- Supportive TDM programs can induce new carpools
- HOT lane initiatives can form new carpools (2+ and 3+)
- New telecommuting programs can break up existing carpools.

However, some unintended consequences also might occur:

- HOT lane initiatives can break up existing carpools as travel time saving can be guaranteed with a fee
- Occupancy requirements increasing from 2+ to 3+ can break up existing carpools or form new shared ride arrangements.

2.5 Strategy Performance: Technology

Technology is an integral part of all of the strategies being deployed in the UPA. For example, in the toll/congestion pricing strategy, automatic toll collection and traveler information systems are being deployed. Likewise, several sites are deploying technology-related improvements (e.g., transit signal priority systems, next-bus arrival systems) as part of their transit improvements for on-time performance and ridership. The intent of this evaluation of the technology is not to determine how well the technology performed per se, but instead to focus on the role of technology in supporting congestion-reduction objectives. For example, the evaluation is more interested in knowing whether traffic signal improvements led to less congestion on arterial streets where the improvements were implemented than in knowing other types of signal performance measures.

[11] *SUMO, Standardized Evaluation Process for Sustainable Transport*, Swedish Road Administration, 2006.

The types of the technology-related improvements that are being proposed throughout the sites fall into four categories:

- Active traffic management
- Regional multi-modal traveler information systems
- Traditional freeway/incident management improvements
- Regional traffic signal system upgrades.

Those technology-related strategies classified as active traffic management include those that are using technology to dynamically optimize the use of the exiting infrastructure to reduce the potential for both recurring and non-recurring congestion in the first place and to manage it better when it does occur. Examples of the types of strategies within this category include speed harmonization, temporary shoulder use, and dynamic-lane-utilization signing and rerouting. The focus of these strategies is to improve trip reliability, safety, and throughput.

The regional multi-modal traveler information systems category includes those deployments that focus on the dissemination of real-time traffic, transit, and parking information designed to help travelers improve decision making about their route, mode, and departure time. Examples of the types of strategies that fall into this category include expansion/enhancement to regional 511 traveler information systems and on-route dynamic message signing.

Traditional freeway/incident management improvements include technology strategies that are designed to expand or enhance traditional freeway and incident management programs and systems. This category includes deployment of ramp traffic signal control/metering systems, and expansions to freeway incident service patrols. Through these improvements, agencies will expand their ability to manage traffic demand on these facilities and to improve detection, clearance, and response to non-recurring congestion events.

Deployment related to improving traffic congestion and performance on arterial streets is included in the final category, regional traffic signal systems. These strategies are focused on expanding and enhancing signal coordination and operations from a regional perspective to reduce travel time and total intersection delay. Examples of the types of deployments that fall within this category include upgrades to traffic control and communication equipment as well as installation of adaptive signal control.

Table 2-7 shows the hypotheses and MOEs that will be used to evaluate the performance of the technology deployments for reducing congestion as part of the national evaluation. The selected performance measures focus on quantifying how the technology deployments impacted travel time, trip reliability, and throughput, and are consistent with the recommendations of the National Transportation Operations Coalition (NTOC) *Performance Measurement Initiative*[12] and NCHRP's *Guide to Effective Freeway Performance Measurement.*[13]

[12] National Transportation Operations Coalition (NTOC). *Performance Measurement Initiative.* Final Report. July 2005. Available at http://www.ntoctalks.com/action_teams/ntoc_final_report.pdf.

[13] *Guide to Effective Freeway Performance Measurement*. National Cooperative Highway Research Web-Only Document 97. National Academy of Science, Transportation Research Board, Washington D.C. 2007. Available at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w97.pdf.

Table 2-7. Technology Analysis Approach

Hypotheses	Measures of Effectiveness	Data
• Active transportation management strategies will promote better utilization and distribution of traffic to available capacity in the UPA/CRD corridors. • Active transportation management strategies will reduce the number and duration of incidents that result in congestion in the UPA/CRD corridors.	• Percent change in route/corridor travel time by time of day • Percent change in buffer index, planning index, and/or travel time Index • Percent change in vehicle throughput (vehicle volumes) • Percent change in the number of hours per day and duration of congested flow • Change in distribution of traffic between facilities • Percent change in incident duration, incident frequency, and time to normal flow	• Link travel times • Time-of-day volume counts • Link speeds • Incident duration • Incident response times • Incident frequencies
• Regional multi-modal traveler information systems will promote better utilization and distribution of traffic between alternate modes and facilities in the UPA/CRD corridors.	• Change in the distribution of traffic between routes • Change in the average number of occupants per vehicle • Change in the frequency of use of traveler information systems • Travelers' reported use of traveler information (type and frequency) related to the congestion-reduction strategies and impact on travel behavior	• Traffic volumes by vehicle class by time of day • Occupant counts by vehicle class by time of day • Frequency of use of traveler information system (web hits, call volume, etc.) • Data from traveler survey on use of traveler information systems
• Implementing traditional freeway management strategies (ramp meters and incident assistance patrols) will reduce congestion in the UPA/CRD corridors by reducing incident clearance times and controlling demand during congested flow conditions.	• Percent change in route/corridor travel time by time of day • Percent change in buffer index, planning index and/or travel time index • Percent change in vehicle throughput (vehicle volumes) • Percent change in the number of hours per day and duration of congested flow • Change in distribution of traffic between facility • Percent change in incident duration, incident frequency, and time to normal flow	• Link travel times • Time-of-day volume counts • Link speeds • Incident duration • Incident response times • Incident frequencies

Table 2-7. Technology Analysis Approach (Continued)

Hypotheses	Measures of Effectiveness	Data
• Upgrades to regional traffic signal system will reduce travel time and total intersection delay in the UPA/CRD region.	• Percent change in travel time (floating car) on selected routes • Percent change in buffer index, planning index and/or travel Time index • Percent change in the number of congested lane miles of arterials • Percent change in the total delay at intersections	• Link travel times • Time-of-day volume counts • Link speeds • Intersection delay
• What was the relative contribution of each technology enhancement on congestion reduction in the UPA/CRD corridors?	• Combination of above performance measures	• Combination of above data

Many of the MOEs that will be used to evaluate the technology deployments are the same as those being used to evaluate overall congestion reduction impacts of the collection of tolling, transit, and telecommuting/travel demand management in a region or corridor. The intent of this evaluation is to isolate the extent to which the technology deployments contributed to the overall amount of congestion reduction in a corridor. To do this, the technology evaluation will focus specifically on (1) those sections of corridors or facilities where technology was deployed and (2) how the technology was used in the different situations and circumstance that existed within the corridor. Therefore, the evaluation will generate the MOEs shown in Table 2-7 during incident and non-incident conditions, inclement weather, etc. Furthermore, information related to the operating rules and procedures for the technology deployment also will be correlated to the MOEs to provide context to the results. For example, information will be needed on the thresholds for traffic conditions under which traffic will be allowed to use a dynamic shoulder lane, or the traffic and travel conditions under which alternate routes will be recommended to travelers via dynamic message signs.

For the technology deployments in the active traffic management and traditional freeway/incident management categories, the MOEs will be derived for traditional traffic measures, such as travel time, speed, and volume. In this category, MOEs also will be generated examining how the existing capacity of the roadway and adjacent facilities is managed and utilized during incidents and other situations. MOEs will be generated that examine how utilizing the active traffic management strategies permit agencies to respond better to those situations than before the deployments.

For the deployments in the regional multi-modal traveler information systems, both quantitative and qualitative measures will be used to assess the impacts and effectiveness of the technology-related deployments. The quantitative measures will focus on measuring the extent to which travelers' route and mode choice decisions change under different operating situations in the corridor. Quantitative measures also will be used to examine if the frequency of use of different traveler information systems (such as 511 and others) change as a result of the deployment of the different UPA/CRD strategies in the region. Traveler surveys will be used to examine how the quality, timeliness, accuracy, and usefulness of the information and the different information dissemination techniques used in the corridor and/or deployed as part of a UPA/CRD strategy influence travelers' trip behaviors in the corridor and/or region.

Quantitative measures also will be used to assess the degree to which the regional traffic signal deployments effect reductions in congestion. Field-measured travel time and traffic condition information will help to determine the amount of congestion reduction benefits generated from these improvements.

One issue to consider in establishment of the MOEs is their sensitivity to the changes being anticipated. Some of the technology-related strategies have never been attempted before in the United States (e.g., dynamic shoulder usage in Minnesota and speed harmonization in Seattle), while others are being deployed over a wide geographic area (over an entire region as opposed to a specific corridor). Thus, it is uncertain how well the MOEs will capture changes in congestion. For insight into the issue sensitivity analysis will be performed to ascertain the kind of errors we can expect in travel times and other MOEs given the resolution of the data being collected and the length of the segments over which the data are aggregated.

Another issue is that operating rules and procedures may change during the evaluation period. Because these are real operational systems operating in real traffic situations, it is not possible or practical to "fix" operating procedures and rules throughout the duration of the evaluation period. Agencies need to have the ability to change operating procedures and associated rules as they gain more experience and a better understanding of how travelers will respond in different situations. The evaluation needs to be aware of when and how standard operating rules and procedures change over time at each of the deployment sites.

2.6 Associated Impacts: Safety

There are two general types of safety implications of the congestion reduction strategies being deployed. First, for some strategies, such as the Seattle Area-LWC ATM, some of the congestion reduction is expected to be realized through the prevention of primary and secondary crashes. In other cases, some aspects of the deployed UPA/CRD hold the potential to reduce safety. For example, drivers may be confused by new lane markings and signage in the entrances to tolled facilities, or, as in the case of Minnesota, the narrowing of some travel lanes, the use of shoulders for priced dynamic shoulder lanes (PDSLs), and guided bus technology for shoulder running buses, may create safety concerns. This analysis will examine both types of safety impacts, the first testing for intended safety improvements and the second testing for the absence of undesirable degradation in safety.

Table 2-8 presents the safety hypotheses, MOEs, and data. MOEs focus on the percent change in crash rate by type and severity, the percent change in the time to clear incidents, and the change in the perception of safety by enforcement, service patrol, and first response personnel. Data needed to assess these MOEs include the number of crashes by type and severity and the number of incidents, the response time, and the clearing time. Information on changes in the perception of safety will be obtained through surveys and interviews with service patrol operators, state patrol officers, medical first responders, and bus operators.

Table 2-8. Safety Analysis Approach

Hypotheses/Questions	Measures of Effectiveness	Data
• Active traffic management will reduce the number of primary and/or secondary crashes.	• Percent change in crash rate by type and severity • Percent change in time to clear incidents	• Number, type, and severity of crashes • Number of incidents, response times, and clearing times • Safety records maintained by transit agencies • Data from surveys/interviews with freeway service patrol operators, state patrol officers, medical first responders, and bus operators
• Congestion reduction strategies will not adversely affect highway safety, including strategies that: - Reduce width of travel lanes and/or shoulders - Introduce unfamiliar signage - Lane guidance for shoulder running buses.	• Percent change in crash rate by type and severity • Percent change in time to clear incidents • Change in the perception of safety by service patrol operators, state patrol officers, medical first responders, and bus operators • Changes in the perception of safety by travelers	• Number, type, and severity of crashes • Number of incidents, response times, and clearing times • Data from surveys/interviews with freeway service patrol operators, state patrol officers, medical first responders, and bus operators • Data from survey of travelers

A number of issues may need to be considered in assessing the safety impacts of the UPA/CRD projects. First, crash data may not be available for all the locations. Second, the possible influence of other factors will need to be considered. Examples of other factors include the introduction of new non-UPA/CRD projects, construction, and major weather events. Third, it may be difficult to detect significant changes in safety impacts in the one-year post-deployment period. Finally, it may not be possible to link the cause of the crash to a specific UPA/CRD project element. To the extent that these challenges compromise the ability to draw conclusions based strictly on quantitative data, the qualitative input from transportation agency operations personnel and from travelers themselves may be useful in understanding safety impacts.

2.7 Associated Impacts: Equity

National experience has shown that perceptions of fairness, or equity, can become a factor in the acceptance of proposed toll and pricing projects. Even in areas with existing toll facilities, new pricing concepts are not immune from fairness criticisms. Equity additionally becomes a concern in the spatial distribution of services and infrastructure, extending beyond tolling and pricing. Although there is no definitive description of equity, there are five general types of equity, of which three specifically apply to the UPA/CRD National Evaluation: geographic, income, and modal equity.[14] For projects similar to those envisioned in the UPA/CRD, equity is typically one of the most important to evaluate, because the impacts (both positive and negative) can contribute significantly to public opinion and the effects upon various population groups.

As indicated in Table 2-9, the evaluation framework examines the extent to which the 4T strategies of the UPA/CRD program contribute to net equity in the following ways:

- Direct transportation user effects of the UPA/CRD strategies for various transportation system users – The social benefit and cost impacts of the 4T strategies will be examined through a study of users and non-users of the transportation investments. Taken into consideration will be the situational values of time, whereby an individual places different values for a minute of travel time savings depending upon the situation – such as a trip to the airport versus a trip to the park. This analysis, pertaining to income equity, determines the overall net effect of the strategies upon users. The primary data points include account data for customers of priced facilities and traveler surveys.
- Spatial distribution of costs and benefits – The net effect of the UPA/CRD strategies will inevitably yield a differential geographic distribution of benefits and costs (geographic equity) that may differ from one subarea to another within the affected metropolitan area. However, the national evaluation endeavors to determine whether that differential distribution between subareas is logical and rational, based upon objective and measurable criteria. For example, if subarea costs increase as a result of paying for more tolls on a facility in close proximity, but the benefits also increase with realized travel time savings from this subarea, this would be perceived as a logical and rational change. If, however, toll costs increases were not accompanied by mobility benefits (such as restrictions in access as a result of the toll policy that caused additional diversion to access the facility), then this would yield a negative finding for spatial equity. For this analysis, the income equity data points are used to reflect geographic distribution.
- The income and spatial analyses above comprise two components of environmental justice analysis. The two are combined in a specific analysis of disadvantaged communities, with focus upon the economic and environmental impacts of congestion relief projects on disadvantaged people as measured by socio-economic status in neighborhoods in the metropolitan region and among users and non-users of project

[14] The remaining two types of equity are: opportunity and participation equity. Opportunity and participation equity pertain to the process for planning and deciding upon the strategies to be developed. As these plans and decisions occurred prior to the UPA application for each member community, these types of equity are outside the scope of the national evaluation. Ungemah, D. "This Land is Your Land, This Land is My Land: Addressing Equity and Fairness in Tolling and Pricing," *Transportation Research Record 2013*, Transportation Research Board, 2007.

improvements. Although the direct impacts of construction in their neighborhoods will not be included, other neighborhood impacts such as increased congestion on arterials and local streets due to trip diversion from the projects will be considered.

- Reinvestment of pricing revenues – How and where pricing and tolling revenues are distributed can affect the distribution of benefits and costs. Modal equity impacts, such as the perceived use of revenue that goes towards rewarding higher occupancies of travel, will be examined relative to other qualified uses of revenue. Recognizing revenue distribution occurs over the long-term, and that conclusions regarding fairness of that distribution must likewise be examined over the long-term, the national evaluation will interview partner agencies to determine the policy and institutional arrangements for the future distribution of revenues, organized around income and spatial impacts of the above analysis.

Table 2-9. Equity Analysis Approach

Hypotheses/Questions	Measures of Effectiveness	Data
• What are the direct social effects (tolls paid, travel times, adaptation costs) for various transportation system user groups? • What is the spatial distribution of aggregate out-of-pocket and inconvenience costs, and travel-time and mobility benefits? • Are there any differential impacts on certain socio-economic groups?	• Socio-economic and geographic distribution of benefits and impacts including: o Tolls paid and adaptation costs o Change in travel time and distance by group o Total transportation cost o Environmental impacts • Public perception of the individualized equity impacts of pricing	• Data from household and/or traveler surveys • Focus groups with special populations (e.g., current HOV lane users) • Customer account data • Traffic and transit data • Transportation model outputs • Air quality and noise modeling outputs • Regional socio-economic data
• How does reinvestment of congestion pricing revenues impact various transportation system users?	• Spatial distribution of revenue reinvestment	• Spending data and data from interviews with UPA/CRD partner agencies • Transportation model outputs

2.8 Associated Impacts: Environmental

One key aspect of the overall evaluation will be the impact of congestion reduction and efficiency improvements on the environment; in other words, will the projects have a positive impact on the environment through mode shift, increased speeds, reductions in idling, etc.? The environmental analysis addresses three elements: air quality, noise, and energy. Environmental justice is examined under the equity analysis. Data need to be collected in the UPA/CRD corridor and in a control corridor or area to help ensure that changes in environmental indicators are due to the UPA/CRD strategies and not exogenous factors.

Air quality is the primary environmental impact to be investigated. Air quality benefits are often cited as a positive impact from pricing, transit, telecommuting, and some technology projects. The air pollutants to be analyzed will include the following: ozone precursors (hydrocarbons, reactive organic gases, and volatile organic compounds, or HC, ROG, and VOC), NO_x, $PM_{2.5}$, and CO_2.

Actual noise impacts will be modeled if noise monitoring data are available and will use the FHWA Traffic Noise Model[15] as appropriate. Energy impacts will be calculated using average fuel consumption factors applied to changes in VMT as assessed in the main evaluation effort. Changes in fuel efficiency from changes in average speeds for HOT lane users might also be assessed.

The hypotheses and questions that the evaluation will address are listed in Table 2-10. The first set refers to issues related to standard environmental assessment such as air and noise impacts. As stated earlier, the focus will primarily be on air quality as it relates to changes in travel behavior. The next hypothesis refers to perceptions of the public and stakeholders as to the overall environmental impacts of the projects. It will be interesting to gauge whether the public perceives benefits that are different from actual or measured benefits. Finally, the last hypothesis involves the potential for energy savings from mode shifts or even changes in highway operating conditions or the use of alternative fuels.

Table 2-10. Environmental Analysis Approach

Hypotheses/Questions	Measures of Effectiveness	Data Sources
• Air quality will improve as a result of the congestion reduction strategies. • Noise levels will diminish as a result of the congestion reduction strategies. • Are the impacts of a nature to be evaluated within the NEPA process?	• Reduction in criteria pollutants • Reductions in noise • Reductions in VMT	• Air quality monitoring data • Noise monitoring data • Mode shift data from traveler surveys for • Traveler survey data for access mode to new transit • Operational data for changes in speed, fleet composition, etc.
• The public and stakeholders will perceive environmental benefits resulting from the congestion reduction strategies.	• Qualitative assessment of perceived benefits on the environment	• Survey data from users and non-users • Data from interviews with stakeholders
• Energy consumption for transportation will decrease as a result of the congestion reduction strategies.	• Reductions in VMT • Reductions in estimated fuel use • Use and impact of alternative fuel vehicles for transit improvements	• Traveler survey data • Alternative fuel utilization in transit vehicles

[15]The website http://www.fhwa.dot.gov/environment/noise/tnm/index.htm contains documentation about the FHWA Traffic Noise Model.

For evaluation of air quality impacts the major issue is the method used for the impact analysis: direct measurement versus modeling VMT changes. Consideration was given to both methods for the National Evaluation Framework. Direct measurement involves assessing the change in pollution concentrations using sensing equipment near the corridor. This method was rejected because the amount of change in ambient pollution concentrations due to the projects is likely to be within the variability of the monitored data based on findings from previous studies.[16] Direct measurement has also been rejected for the UPA/CRD evaluations due to prohibitively high procurement and management costs for localized sensors, which neither the national nor local evaluators have budget to cover. Thus, as has been done in most pricing evaluations conducted to date, the evaluation of air quality impacts in the UPA/CRD sites will be based on VMT changes. Monitoring data where it already exists will be examined for each site, but VMT modeling will be used as the primary comparative methodology across sites.

The method used to assess air quality changes in previous HOT lane evaluations has been to model the impacts of the project on air quality.[17] This involves calculating total VMT in the corridor (total vehicles x length of the corridor) and then applying emission factors for each pollutant (based on vehicle type and speed expressed as grams per mile). The VMT data for the UPA/CRD evaluation will be derived as part of the main evaluation effort to assess the impact of tolling. Emission factors are available from state or regional planning or air quality agencies. A comparison of "before" and "after" emissions models for the project and control corridors will be used to estimate the impact of the project on air quality. VMT changes due to mode shift can also be modeled. In this case, the VMT reduced due to new transit riders, carpoolers, or telecommuters can be calculated and emission factors (grams/mile) can be applied.

The major issue relating to noise impacts will be the selection of models and the input data needed by the models that will enable discrimination between existing noise levels and current traffic patterns and noise impacts resulting from the UPA/CRD projects. The national evaluation will strive to use the FHWA Traffic Noise Model by recommending collection of necessary input data from the local evaluators. Another input will be consideration of local or community noise ordinances and their specific provisions.

2.9 Associated Impacts: Goods Movement

The congestion reduction strategies, in particular tolling, could affect the flow of goods within the metropolitan region. Given the economic importance of goods movement to both the local and national economy, understanding the impact of the 4Ts on this sector of the economy is warranted. On one hand, the reduction of congestion could reduce travel time for commercial

[16] In the Stockholm trials, air quality improvements were based on traffic analyses rather than monitored data. (Stockholmsforsoket, 2006. *Facts and Results from the Stockholm Trails, Final Version – December 2006,* pp. 80 - 91.) London,'s congestion charging program relies on modeling for estimating vehicle emissions, because data from monitoring stations, although available and reported, are subject to externalities such as weather and emission sources other than vehicles. (Transport for London, 2007. *Central London Congestion Charging: Impacts Monitoring, Fifth Annual Report, July, 2007*.) In the Minnesota I-394 MnPASS program, analysis was based only on air quality monitoring data, which showed no impact on the monitored emissions. (Cambridge Systematics, November 2006. *I-394 MnPASS Technical Evaluation Final Report*, pp. 5-15 – 5-16.)

[17] For example, San Diego State University, Phase II, Year 3 Air Quality Study, prepared for SANDAG, Report No 39, 2001.

vehicle operators (CVOs), thereby allowing faster movement of both long-haul trucks and short-haul trucks carrying goods in or through the metropolitan area. On the other hand, tolling on highways and pricing for loading zone parking represents an added cost of doing business to CVOs, and they will weigh those costs against the potential gains made in travel or loading time. Since the impact of UPA/CRD projects on goods movement are likely to vary among the sites, the importance of assessing goods movement will be determined on a site-by-site basis. As a result, this section presents potential analyses that may be performed if needed. Table 2-11 presents the goods movement analysis approach.

Table 2-11. Goods Movement Analysis Approach

Hypotheses/Questions	Measures of Effectiveness	Data
• Commercial vehicle operators (CVOs) will experience reduced travel time by using tolled lanes (where CVOs are permitted). • More commercial vehicle drivers will choose to use the priced lanes than the unpriced lanes.	• Percent change in travel time in priced and unpriced lanes • Percent of vehicles using tolled facilities	• System data reflecting CVO participation in pricing components (e.g., vehicle detector or tolling data) • Travel time
• CVOs hauling or delivering goods will perceive the net benefit of tolling strategies (e.g., benefits such as faster service and greater customer satisfaction outweigh higher operating costs due to tolls).	• Perceived advantages and disadvantages of tolling	• Data from surveys or interviews with a sample of impacted CVOs
• Loading zone pricing will enable deliveries to be made more efficiently.	• Average length of stay of trucks in loading zones	• Data on number and length of stay of trucks in loading zones collected manually or with automated system (post-deployment)

If trucks are permitted on the priced lanes, their travel time will be assessed before and after the implementation of tolling. Truck travel time in the priced lanes will also be compared to truck travel time in the unpriced lanes. It also will be useful to know what proportion of commercial vehicles choose to use the tolled lanes. In Chicago, loading zone pricing is planned and the impact of pricing will be assessed to determine whether loading is faster as a result of the pricing. To more fully understand the impact of the congestion reduction strategies on commercial vehicle operations, beyond the analysis of traffic data alone, a survey of operators can yield insight into the perceived costs and benefits of congestion reduction strategies relative to their business. Such surveys will be conducted only for those UPA/CRD sites where goods movement analysis is particularly important.

2.10 Associated Impacts: Business Impacts

This element of the overall evaluation will examine the associated impacts of the UPA/CRD projects on employers and businesses. The various UPA/CRD projects may have both positive and negative impacts on employers and businesses. For example, implementation of the telework strategies may result in improved employee productivity, retention, and hiring. New and expanded bus services may result in improved employee satisfaction with commuting options. The ability to use an HOT lane may improve the efficiency of goods and service delivery. On the other hand, implementation of the dual bus lanes in downtown Minneapolis will remove some on-street parking, and service delivery vehicles and taxis will not be allowed to use the lanes during the morning and afternoon peak hours.

Table 2-12 highlights the approach for analyzing the impacts from the UPA/CRD projects on businesses and employers. As noted in the table, the questions focus on the impacts of the UPA/CRD projects on public and private sector employers, business operations, and businesses that are especially sensitive to transportation costs. The MOEs and data focus primarily on qualitative information. The MOEs address changes in perceptions among employers related to employee commute trips and the ability to telecommute, changes in perceptions related to the impact of congestion on retail and other similar businesses, and changes in perceptions of the costs and benefits for businesses.

Table 2-12. Business Impacts Analysis Approach

Hypotheses/Questions	Measures of Effectiveness	Data
• What is the impact of the strategies on employers? e.g., – employee satisfaction with commute – perceived productivity impacts – employee retention/hiring impacts – negative impacts (increased cost of doing business)	• Change in employers' perceptions about impacts of congestion strategies on employee satisfaction with commute • Change in employers' perceptions about impacts on business operations	• Data from interviews with various classes of employers in areas targeted for congestion reduction (including private and public sectors and nonprofits) • Business investments in strategies, such as telework or transit subsidies
• What is the impact of the strategies on businesses that rely on customers accessing their stores, such as retail and similar establishments?	• Change in perceived impact of congestion strategies on business volume, day/week patterns of business	• Data from interviews or focus groups with retail businesses in shopping districts where congestion reduction is sought • Data from traveler survey about changes in consumer shopping patterns and in other trip purposes (medical, educational, recreational)
• How are businesses that are particularly impacted by transportation costs affected (e.g., taxis, couriers, distributors, tradesmen)?	• Change in perception of transportation costs and benefits for businesses	• Data from interviews or focus groups with businesses

The information needed for the MOEs will be obtained through interviews, focus groups, or surveys. The ability to draw conclusions from the qualitative information alone is limited; however, this qualitative information is important in documenting perceptions, insights, and anecdotal evidence. Capturing information on the perceptions of employers and businesses on the impacts of UPA/CRD projects will be beneficial for the overall National Evaluation, because those measures can help gauge the acceptability of the congestion reduction strategies among the business community and identify negative perceptions that need to be addressed.

2.11 Non-Technical Success Factors

This analysis will collect lessons learned about non-technical success factors from the UPA/CRD deployments, including outreach, political and community support, and the institutional arrangements used to manage and guide the UPA/CRD implementation. Data on non-technical success factors will be gathered in recognition of the multiple audiences and purposes for the lessons, such as:

- U.S. DOT, for whom information about non-technical success factors will inform future congestion pricing and related policy and programming decisions
- State and local government, especially transportation planning and operating agencies, for whom lessons on non-technical success factors will inform their decisions about whether and how to implement strategies such as those included in the UPA/CRD deployments
- The international community of transportation researchers, who will be particularly interested in non-technical success factors that expand on the base of existing knowledge related to similar strategies deployed in the United States (e.g., prior HOT lane projects) and abroad (e.g., the London and Stockholm congestion pricing projects).

Table 2-13 presents the questions, MOEs and data sources associated with the lessons-learned analysis. The first question is an overarching one, and focuses on understanding how a wide range of variables impact the success of the deployment. Those variables have been grouped in Table 2-13 into five major categories: (1) people, (2) process, (3) structures, (4) media, and (5) competencies. That categorization scheme emerged through the University of Minnesota Hubert H. Humphrey Institute of Public Affairs' recent study of the Minnesota UPA Process (i.e., the process culminating with the successful award of the U.S. DOT UPA grant).[18]

[18] "Summary of Preliminary Conclusions from a Study of the Minnesota UPA Process," a presentation at the TRB Summer Conference, Baltimore, MD; June 17, 2008; Professor John M. Bryson, Hubert H. Humphrey Institute of Public Affairs, University of Minnesota.

Table 2-13. Non-Technical Success Factors Analysis Approach

Hypotheses/Questions	Measures of Effectiveness	Data
• What role did factors related to these five areas play in the success of the deployment? 1. People (sponsors, champions, policy entrepreneurs, neutral conveners) 2. Process (forums including stakeholder outreach, meetings, alignment of policy ideas with favorable politics, and agreement on nature of the problem) 3. Structures (networks, connections and partnerships, concentration of power and decision-making authority, conflict-management mechanisms, communications strategies, supportive rules and procedures) 4. Media (media coverage, public education) 5. Competencies (cutting across the preceding areas: persuasion, getting grants, doing research, technical/technological competencies; ability to be policy entrepreneurs; knowing how to use markets)	• Observations from UPA/CRD participants	• Data from one-on-one interviews followed by group workshops : – End of planning phase – End of implementation phase – End of UPA/CRD one-year operational evaluation period
	• Partnership documents (e.g., Memoranda of Understanding)	• UPA/CRD partners' documents
	• Outreach materials (press releases, brochures, websites, etc.)	• UPA/CRD partners' outreach materials
	• Radio, TV and newspaper coverage	• Internet-based tracking • UPA/CRD partners' files
• Does the public support the UPA/CRD strategies as effective and appropriate ways to reduce congestion?	• Public opinion	• Data from surveys of the general public

The second question guiding this analysis focuses on understanding whether the public supports the UPA/CRD strategies as effective and appropriate ways to reduce congestion and why or why not. One aspect of that question relates to how the public views transit and other "carrot" strategies intended to complement the "stick" strategy of congestion pricing. The evaluation of the Stockholm congestion pricing trial indicated that residents' attitude toward the trial is influenced by how it takes place. The expansion of public transport has had the biggest influence.[19] A study of the Edinburg road pricing proposal also found that the public views road

[19] "Stockholmsforsoket, 2006. *Facts and results from the Stockholm Trails, Final Version – December 2006.*

pricing more favorably when closely linked with public transportation improvements.[20] Presumably, the availability of good alternatives to priced roadways will play a key role in public acceptance of the congestion pricing in the United States, and this analysis will assess the extent to which the UPA/CRD partners were able to couple congestion pricing and various supporting strategies from an operational and public perception standpoint.

As indicated in Table 2-13, this analysis relies heavily on information provided by the UPA/CRD partners. Input from the partners will be collected using the formal mechanisms shown in Table 2-13, including rounds of interviews followed by large-group workshops focused on non-technical success factors. Additionally, information will be gleaned informally through observation and interaction with the UPA/CRD partners over the course of the demonstration.

2.12 Cost and Benefit Analysis

The purpose of the cost and benefit analysis (CBA) is to quantify and monetize the potential costs and benefits that may be incurred as a result of implementing the UPA/CRD project at each of the selected cities. Specific parties to be affected within each city include public agencies, facility users, and communities. While encompassing both roles of building and managing the facilities affected by the UPA/CRD project, public agencies will be responsible for updating and maintaining the facilities. At the same time, public agencies will collect tolls and fees from new services provided to the facility users.

The facility users include individual drivers, transit users, telecommuters, parking-lot users, and businesses. Once the UPA/CRD project is implemented, it is expected that congestion on the selected corridors will be reduced. As a result, facility users will experience less travel time, increasing travel time reliability, and other benefits. However, newly added tolls may increase some users' travel costs while they use the tolled facilities. For communities in each evaluation city, the potential benefits include reduction in emission, noise, and fuel consumption. Based on the benefits and costs evaluated for each party, the net benefit,[21] which is the difference between the total benefit and the total cost at each site, will be calculated to report potential returns for the UPA/CRD project investment.

The time frame that the CBA will cover includes: (1) the first year after implementing the UPA/CRD project and (2) a 10-year period after implementing the UPA/CRD project. Within this evaluation time frame, the CBA will compare and analyze traffic conditions under two scenarios—before and after implementing the UPA/CRD project.

The CBA for the UPA/CRD project depends on several types of data. The first data source is a variety of surveys designed in the UPA/CRD project for gathering data from facility users. The second data source relates to forecasts for 10 years that model conditions both with and without

[20] Cain, A. (2006). "Achieving Majority Support for Urban Road Pricing – Preserving the Driver's Right to Choose." *Transportation Research Record 1932*, pp. 119-128. Transportation Research Board, National Academies Press. Washington, D.C.

[21] During the calculation of the net benefit, the toll revenue collected by public agencies and the tolls paid by facility users will cancel out each other.

implementing the UPA/CRD project. The third data source covers the monetary value of UPA/CRD project investment, including expenditures from the U.S. DOT's funding and the local financial resources. Both kinds of funding will be recorded in detailed categories. The fourth data source includes statistics released by government agencies, such as wage rates in metropolitan areas.

To examine the impacts of certain parameters on the net benefits calculated in the CBA, a sensitivity analysis will be conducted. Vehicle operating cost (VOC) savings, for instance, are one of the major benefits that will be experienced by personal drivers and freight transportation. The calculation of the VOC savings depends on fuel price, which has been volatile and has remained at a relatively high level in recent years. Because forecasting the future movement of fuel price is out of scope of the UPA/CRD project, a sensitivity analysis will be utilized to examine the impacts of fuel price on VOC savings and the net benefit generated from the CBA.

Table 2-14 summarizes and highlights the key hypotheses/questions that will be addressed by the CBA and the main data that will be used in the analysis. Some of the important benefits realized from the project, such as improved comfort, reliability, simplicity, and other attributes related to improvements to transit services, will not be included in the CBA because it will be impossible to monetize those benefits. However, those benefits will be summarized and reported as non-monetized benefits in the final evaluation report.

Table 2-14. Hypotheses/Questions and Data for the Cost and Benefit Analysis

Hypotheses/Questions	Data
• What is the net benefit (benefits minus costs) of the UPA/CRD strategies?	• Much data will come from other analyses (Congestion, Impacts on Businesses, Equity, etc.) • Costs-related data include: – Capital and operation and maintenance (O&M) costs – User costs for tolls and fees – Businesses' costs for TDM/telecommuting – Loss of parking revenues • Benefits-related data include: – Travel time savings – Fuel, emissions, accident reductions – Reduced vehicle operating costs – Toll and fare revenues – Increased productivity • Costs and benefits for: public agencies, users, and communities

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3.0 Risks and Other Considerations

This chapter discusses a number of risks that pose challenges to the UPA/CRD national evaluation and discusses the ways that those risks and challenges will be addressed. Issues considered in this chapter include extraneous factors, schedule challenges, and the possible need for several types of data that may prove challenging for the UPA/CRD partners to collect.

Table 3-1 summarizes risks and mitigation strategies. The risks associated with the UPA/CRD national evaluation are those that are common to most evaluations of large, complex, real-world technology field deployments. The national evaluation team is using a variety of strategies to minimize any potential impact of these risks. No significant compromises to the national evaluation objectives are currently identified. Continuing to track these risks and proactively utilizing the strategies shown in Table 3-1, as well as other strategies that may become necessary, will be a critical on-going focus of the evaluation team.

Table 3-1. Risks and Mitigation Strategies

Risk	Examples	Mitigation Strategies
Extraneous Factors	• Fuel prices • Non-UPA/CRD-related transportation system changes • Roadway construction • Major, non-typical traffic and/or weather events • Major changes in regional economy	• Utilize control corridors where possible • Examine historic relationship between extraneous factors and travel data of interest • Utilize models
Details of Deployment Plans Uncertain	• Seattle tolling strategy not finalized until early 2009	• Track status of local partners' deployment plans closely • Identify local partners' uncertainties and their impact to the national evaluation
Deployment Schedule Slippage and Variability	• Some sites are no longer certain that all projects will be deployed on schedule • Specific projects come on line in a phased manner at several sites • Different sites have different deployment schedules	• Continue evaluation planning assuming on-time deployment • Track status of local partners' deployment plans closely • For resource-intensive, special data collection (i.e., non-system data that is not automatically collected) wait until all significant projects are implemented • Later in the evaluation process, consider options for reporting all results for all sites at one time vs. phasing of results
Taking Advantage of Current Local Data Collection Opportunities	• Household travel surveying planned for fall 2008 in Seattle	• Special focus on these issues in development of site-specific Evaluation Strategies and Evaluation Plans • Frequent discussions with local partners to identify and assess opportunities
Local Partner Data Collection Challenges	• Seattle and Minnesota sites are anxious to see the full extent of national evaluation team's survey data needs and approaches	• Develop evaluation plans in sufficient detail to allow local partners to understand and prepare for data collection

4.0 Framework for Data Collection

The broad scope of the evaluation analyses described in Section 2 rests on a wide range of data from a variety of sources. Table 4-1 summarizes the data and provides a cross-reference to the 12 analyses. While some data items are unique to certain evaluation analyses, many of the data items in Table 4-1 feed multiple analyses.

The objective of this section is not to discuss every data item in the table; rather it is to focus on certain key categories of data that have special features and issues that warrant further discussion in this NEF. These categories, presented in Sections 4.1 through 4.4, are data from surveys, interviews, and focus groups; traffic data; transit data; and environmental data.

4.1 Data from Surveys, Interviews, and Focus Groups

All of the evaluation analyses presented in Section 2 include the use of data from surveys, one-on-one interviews, or focus groups. Indeed, some aspects of the UPA/CRD evaluation can be assessed only by collecting information from individuals, for example, the drivers on priced facilities, transit riders, teleworkers, employers, enforcement officials, and the UPA/CRD stakeholders. Individuals can provide valuable, unique information such as how they have responded to the congestion reduction strategies and why, the perceived advantages and disadvantages of the strategies for them or others, and, in the case of stakeholders, the lessons they've learned about non-technical success factors in the course of implementing the strategies. This type of qualitative data will provide valuable insight into factors affecting the acceptability of the strategies to reduce congestion that comprise the UPA/CRD deployments.

Quantitative information also will be gathered from individuals, especially through surveys of large and representative samples of targeted populations. Surveys can gather data on trip information, such as frequency, purpose, mode, time, destination, and cost, that can be analyzed according to socio-economic characteristics, vehicle availability, location, or other descriptors.

One-on-one interviews and focus groups will be used when surveys are not practical (e.g., the size of the target population is small, such as the UPA/CRD partners) and/or where more in-depth probing and discussion are desired than can be achieved in a traditional survey format.

Table 4-1. Data for the Evaluation Analyses

Evaluation Data	Congestion	Tolling	Transit	Telecommuting / TDM	Technology	Safety	Equity	Environment	Goods Movement	Business Impacts	Lessons Learned	Cost Benefit
Traffic Data – Freeway												
Travel time	X	X			X		X	X	X			X
Travel speeds	X				X			X				
Volume	X	X			X							X
Occupants per vehicle		X	X		X							
Types of vehicles/fleet composition								X				X
Traffic Data – Arterial												
Delay at intersections					X							
Volume		X			X							
Travel times					X							
Incident Data												
Number of incidents/crashes					X	X						X
Types of incidents/crashes					X	X						
Severity of crashes						X						
Incident duration					X							
Incident response times					X	X						
Clearance times					X	X						
Transit Data												
Ridership		X	X									
Travel time		X	X				X					
Reliability and schedule adherence		X	X									
Farebox data			X									X
Service characteristics data			X									
Park and ride lot use			X									
Safety data			X			X						
Parking Data												
Garage and lot occupancy		X										
On-street parking and loading zone occupancy		X							X			
Parking and loading zone revenues		X							X			X
Traveler Information Data												
Website page views					X							
Call volumes					X							

Table 4-1. Data for the Evaluation Analyses (Continued)

Evaluation Data	Congestion	Tolling	Transit	Telecommuting / TDM	Technology	Safety	Equity	Environment	Goods Movement	Business Impacts	Lessons Learned	Cost Benefit
Toll Data												
Revenues and transactions		X		X			X					X
Customer account data				X			X					
Surveys/Interviews/Focus Groups: Transportation Experience and Opinion Data												
Travel modal behavior		X	X	X			X		X	X		X
Traveler costs							X					X
Public/travelers	X		X	X	X	X	X	X			X	
Teleworkers				X								X
Employers				X						X		X
Special populations (e.g. 511, HOV, CVO)				X	X		X		X			
Stakeholders				X			X	X			X	
Enforcement officers, first responders, bus operators						X						
Transportation-sensitive businesses										X		
Retail businesses										X		
Agency Data												
Cost data												X
Transportation model outputs							X					
Regional socio-economic data							X	X				
Air quality monitoring data								X				
Noise quality monitoring data								X				
Air quality modeling data								X				X
Alternative vehicle fuel use								X				
Stakeholder documents											X	
Stakeholder outreach materials											X	
Media Coverage Information											X	

Tables 4-2 and 4-3 list the potential surveys, interviews, and focus groups that comprise the NEF. The tables contain the following information for each study:

- The population to which the study is directed: the group of individuals that share common characteristics and from which a sample will be drawn for the particular study. For example, a survey might be directed at just transit riders or just teleworkers.
- The objectives for each study: how the data will help address evaluation questions.
- The timing of the study: before and/or after the UPA/CRD strategies are operational.
- Sampling and other methodological considerations: indications of how the study might be carried out or decisions that need to be made.
- Evaluation areas: using the data from the study.
- Comments: observations pertinent to planning the study.

The surveys, interviews, and focus groups identified in Tables 4-2 and 4-3 will be mapped to the strategy components at each site and the appropriate subset of data collection activities will be selected for the UPA/CRD strategies and conditions at each site. To maximize comparability of the data among the UPA/CRD sites, a core set of questions to be asked and data collection designs (e.g., sampling methods) will be established to serve as templates for the site-specific evaluations. Included among the core set of questions will be descriptive data on the respondent, such as socio-demographic characteristics, vehicle availability, location, and other characteristics that will help in analyzing the impact of the congestion reduction strategies on different groups of the population.

Table 4-2. UPA/CRD Evaluation Surveys

Population	Survey Objectives	Timing	Sampling and Other Methodology Considerations	Analysis Areas Using the Data	Comments
Travelers (users and non-users of the strategy-affected congestion priced road facilities)	• Measure travel behavior changes resulting from UPA/CRD strategies (e.g., mode, travel time, trips deferred, timing or destination of trip) • Measure cost of travel (e.g., tolls, SOV operating costs, transit, parking) • Assess opinions and perceptions about the congestion reduction strategies (e.g., advantages or disadvantages to them and others) • Assess access to information about travel choices	Before and after	- Panel or independent before and after samples - Telephone survey	Congestion, Tolling, Transit, Equity, Environmental, Non-Technical Success Factors	Need sufficient users in corridor and outside of corridor for control group.
Transit riders	• Measure transit usage changes resulting from UPA/CRD strategies (e.g., frequency of transit usage, fare paid, park-and-ride usage), • Assess perceptions about transit service quality (e.g., travel time, comfort, reliability) • Assess motivation for using transit (e.g., cost saving, time saving, environmental)	Before and after	On-board transit survey	Transit, Telecommuting/ TDM, Technology, Equity	Possibly piggy back to transit agency's own survey or use their survey capabilities
Car pool and van pool riders	• Measure change in car and van pool usage resulting from UPA/CRD strategies (e.g., trips per week, travel time, cost) • Assess motivation for using car or van pool (e.g., cost saving, time savings, environmental)	Before and after	May need to use special databases to identify sample if oversampling of general traveler survey not sufficient	Telecommuting/ TDM, Environmental, Non-Technical Success Factors	
511 and other real-time traveler information users	• Measure usage of real-time information systems for parking, tolls, and transit information • Assess how information affected users travel choices	After	- Phone intercept survey of 511 phone - Online survey of web users	Technology	
Teleworkers	• Measure usage of telework (e.g., number of days and hours of telework as alternative to travel to office) • Assess motivation for telework as it relates to UPA/CRD strategies (e.g., cost saving, time saving, environmental)	After	- Identify sample through employers - Telephone, mail, or on-line survey	Telecommuting/ TDM	Consider on-line survey if employee e-mail addresses are available.
Commercial Vehicle Operators	• Measure travel behavior changes resulting from UPA/CRD strategies (e.g., travel time, trips deferred, timing or destination of trip) • Measure cost of travel (e.g., tolls, operating costs) • Assess opinions about the congestion reduction strategies (e.g., advantages or disadvantages to themselves and others)	Before and after	Some of these drivers may be captured in the user/non-user survey	Goods Movement	

Table 4-3. UPA/CRD Evaluation Interviews and Focus Groups

Population	Objectives	Timing	Sampling and Other Methodology Considerations	Analyses Areas Using the Data	Comments
Employers	• Identify and describe the types of employer-based programs (e.g., eligibility, cost, productivity impacts) • Obtain data on use of programs by employees (e.g., number and percent of employees using and modal commute patterns of their employees)	After	Interviews	Telecommuting/TDM	Possibly work with Traffic Management Operations (TMOs) to help gather data
Commercial Vehicle Operators	• Assess impact of tolling and/or loading zone parking on business operations (e.g., travel times, tolls and fees paid, customer satisfaction) • Assess opinions about the congestion reduction strategies (e.g., advantages or disadvantages to them and others)	After	Interviews	Good Movement	
Bus operators	• Assess perceptions of new operating environment for BRT, PDSL or other new UPA/CRD transit deployments (e.g., for safety and other impacts)	After	Interviews	Transit	
Law Enforcement, Service Patrols, and Medical First Responders	• Assess perceptions of HOT and PDSL enforcement and safety environment (e.g., number of violators, enforcement issues, safety issues)	After	Interviews	Tolling, Transit	
Stakeholders (i.e., UPA/CRD partners and others)	• Assess expected and achieved success of the UPA/CRD strategies • Assess factors contributing to level of success of the UPA/CRD strategies (i.e., people, process, structures, media, competencies)	Before and after	Interviews	Telecommuting/TDM, Non-Technical Success Factors, Environmental	
Businesses in Impacted Area	• Measure the impact of the UPA/CRD strategies on business (e.g., number of customers and sales) • Assess opinions about the congestion reduction strategies (e.g., advantages or disadvantages to them and others)	After	Interviews	Business Impacts	
Transportation-sensitive business (e.g., taxis, distributors, tradesmen)	• Measure the impact of the tolling and parking strategies on business (e.g., travel time, tolls/fees paid, customers and sales) • Assess opinions about the congestion reduction strategies (e.g., advantages or disadvantages to them and others)	After	Interviews	Business Impacts	
Viewers/users of new signing in association with some UPA/CRD strategies	• Assess human factors aspects of new types of signage for UPA/CRD such as tolling, PDSL, and parking pricing	After	Interviews or focus groups	Safety	

4.2 Traffic Data

Many of the evaluations, particularly the strategy performance evaluations, depend upon traffic data. Table 4-4 lists the types and characteristics of the anticipated traffic data needed to complete the evaluations.

Table 4-4. Traffic Data in the National Evaluation

Data Need	Data Characteristics	Anticipated Data Source
• Section- or link-level travel time	• Before and after deployment of strategies • Freeway and arterial links • By route and time of day	• Freeway surveillance system • Floating car sampling on arterial streets
• Section- or link-level traffic counts	• Before and after deployment of strategies • Freeway and arterial links • By route and time of day • Continuous data stream aggregated to 5-minute intervals	• Freeway surveillance systems • Arterial traffic signal system detectors
• Section- or link-level travel speeds	• Before and after deployment of strategies • Freeway and arterial links • By route and time of day • Continuous data stream aggregated to 5-minute intervals	• Freeway surveillance systems • Arterial traffic signal system detectors
• Number of vehicle occupants	• Before and after deployment of strategies • Freeway and arterial links • By route and time of day	• Field studies • Sampling of selected links and time of day
• Incident characteristics – Duration – Response time – Time to normal flow	• Before and after deployment of strategies • Per incident records	• Freeway surveillance systems • Operator logs • Police accident/incident records
• Intersection delay	• Before and after deployment of strategies	• Field studies • Sampling of selected arterial intersections

Most of the traffic data from the freeway links are readily available for traditional data sources, such as state surveillance and control systems. The majority of sites routinely collects and retains travel time and/or traffic sensor data from the freeway networks. However, travel time and sensor information from the adjacent arterial network currently is unknown at many of the locations. It is anticipated that data may not currently exist on the travel conditions of the arterial street network, and it is unclear at the time of this writing whether systems are available and capable of automatically collecting this travel time, travel-time reliability, and throughput information from the arterial street system. It may be necessary for some of the sites to install traffic sensor stations on the arterial street network to collect some of the traffic data.

In addition to the traffic data, each site also will need to collect and retain ancillary data that can be used to interpret and provide context to the evaluation. Examples of the types of ancillary data to be collected include the following:

- Time and duration of special events that impact traffic operations in the evaluation network
- Time and duration of inclement weather events
- Changes to standard operating rules and traffic management procedures that occur throughout the duration of the study.

4.3 Transit Data

The general approach used for the evaluation of the transit elements of the UPA/CRD project is a before-after comparison. The transit evaluation must be inclusive of all transit agencies providing service within the UPA/CRD corridors, not just the agencies receiving UPA/CRD funding. Obtaining the cooperation of transit agencies operating within study corridors that are not involved in the UPA/CRD project will need to be considered.

The national evaluation team will work with the transit agencies at each UPA/CRD site to ascertain whether the quality and quantity of the transit data available will be sufficient for evaluation purposes or whether any supplementary special studies and data collection efforts will be required. The national evaluation team will work with each UPA/CRD partner, requesting samples of each of the transit data sources described in more detail in this section.

The deployments are composed of a series of different elements scheduled for implementation at discrete points in time. The incremental nature of this phased implementation makes it difficult to accurately measure the impact of individual project elements using temporally discrete special studies. In contrast, continuous data streams make it possible to track the impact of incremental service improvements. Any available continuous data sources, such as automatic vehicle location (AVL) and automatic passenger counter (APC) data, are of particular interest.

4.3.1 Travel Time / Reliability Data

Average end-to-end transit travel times for revenue service are required for each route within UPA/CRD study corridors. Other required performance measures related to travel time are service reliability and schedule adherence.

If AVL units are fitted to the bus fleet (or a portion of the bus fleet), obtaining the above information should be relatively straightforward. AVL units allow continuous travel time information to be collected. Information on the level of data disaggregation will be needed, i.e., proportion of bus fleet fitted with AVL, data availability by route, data availability by run, data availability by time of day, etc. Details of the data archiving and data mining process also will be required.

If AVL data are not available, manual data collection will be required in order to obtain a minimum of one sample of before data and one sample of after data. Manual data collection will involve positioning surveyors on corridor buses to obtain a sufficient sample of bus runs, using stop watches to log travel-time information, reliability, and schedule adherence information, as well as other components of travel time

4.3.2 Ridership Data

Ridership information is required for all routes serving UPA/CRD study corridors. If APCs are fitted to the bus fleet (or a portion of the bus fleet), obtaining the required ridership information should be relatively straightforward. APCs allow continuous ridership data to be collected, and to be disaggregated to the level of individual route segments, by logging the number of boardings and deboardings at each stop. Thus, average ridership and peak load factors can be calculated for each route segment and aggregated to provide average daily ridership by route and for the corridor as a whole. It also would be useful to be able to disaggregate average ridership by time of day and day of week, in order to determine if any temporal ridership impacts are induced by the UPA/CRD project. A detailed data archiving and data mining process also will be developed and documented.

If APC data are not available, other sources of ridership data will need to be considered. These could include ridechecks and/or farebox information (discussed in more detail below). The preliminary data assessment will determine whether any special studies are required to supplement existing sources of ridership data.

4.3.3 Transit Survey Data

Obtaining high-quality survey data is crucial to assessing mode shift, user perceptions of changes in service performance, and any changes in user profiles. Transit service providers typically conduct their own on-board surveys at varying intervals, and opportunities may exist for "piggybacking" on any survey efforts scheduled during the before and/or after evaluation periods. Details of past and future survey efforts, copies of survey instruments, and any completed survey reports will be examined. However, due to the specific nature of the UPA/CRD projects, and the need to ensure data comparability across the different UPA/CRD sites, some on-board surveys that are specific to the UPA/CRD project are required: at a minimum, this will entail one on-board survey during the before period and one on-board survey during the after period. National evaluation team members intend to work with local partners to develop survey methodologies and design survey instruments, which will consist of a set of core questions to be used at all UPA/CRD sites, supplemented by a series of site-specific questions.

User surveys may be supplemented by other market research activities like focus groups and interviews (of bus operators, for example). The need for such supplementary activities will depend on the type of transit improvements being implemented at each site.

4.3.4 Park-and-Ride Lot Utilization Data

Given the focus of the UPA/CRD project on the attraction of "potential riders" and retention of "choice riders," both of which are likely to have car access, it is important to understand how the UPA/CRD projects will affect park-and-ride lot capacity and lot utilization. Information on park-and-ride lot usage is required in terms of average lot utilization for each site by time of day and day of week. Some agencies may collect more detailed information on their park-and-ride lot users, such as origin and destination data, that can assist the national evaluation.

If park-and-ride lot utilization data are not routinely collected, it will be necessary to conduct special studies to obtain, at a minimum, one set of before data and one set of after data. The preliminary data assessment will determine whether any special studies are required to supplement existing sources of data.

4.3.5 Safety Data

It is standard practice for transit agencies to record and archive incident records pertaining to the services they provide. At the customer level, safety is expressed in terms of safety at waiting locations and safety while on board the bus, which can be obtained from on-board surveys. At the operations level, safety is measured in terms of total collisions, injuries, fatalities, breakdowns/road calls, and other incidents that disrupt the safe operation of the bus. Both pre- and post-implementation safety records, with data reported at the summary level, will be sought.

4.3.6 Farebox Data

Farebox information is a useful supplement to ridership data, and also is necessary for the assessment of operating cost efficiency. Farebox data can be highly variable, depending on the type of hardware and software employed. Information typically extracted from farebox data includes the following:

- Type of fare paid
- Development of new fare media
- Changes in pricing of fare media
- Farebox recovery ratio
- Comparison mechanism with APC data
- Transfers to/from routes.

4.3.7 Transit Service Characteristics

Basic service information is required for all existing and new services implemented as part of the UPA/CRD initiative. For evaluation purposes, it will be necessary to examine network characteristics for existing versus new services. Pre- and post-implementation data included in this part of the evaluation will be as follows:

- Route/network configuration
- Revenue miles/hours
- Service frequency/headway
- Service span/days of operation
- Capital costs of transit improvements
- O&M costs.

4.4 Environmental Data

As detailed in Section 2.8, there are two fundamental approaches for measuring air quality: monitoring and modeling. Monitoring refers to direct measurement of pollutant concentrations in a before-and-after comparison. Modeling (either total traffic volumes or just mode shift) calculates pollution reductions as a function of reductions in VMT and other operating characteristics. It also will be important to consider local evaluation plans as well as the need for consistency across UPA sites when selecting the most appropriate data sources for air quality evaluation. Differences in data sources could lead to differences in measured impacts across sites. Thus, the national evaluation will utilize the modeling approach for the reasons explained in Section 2.8, although the monitoring data will also be examined where available at the UPA/CRD sites.

Data on the fleet characteristics of light duty and transit vehicles in the study corridors also might be needed to select the most appropriate emission factors to use in the VMT-based modeling approach. This will include vehicle classification studies, which are accomplished either by physically observing traffic on site or by analysis of video. The analysis also should include consideration of alternative fuel vehicles (especially in the delivery of new transit services).

Data collection needs for noise impacts will need to come from existing local sources. Data collected will be compatible with the FHWA Traffic Noise Model,[22] in terms of traffic volumes, fleet composition, speeds, and changes in operating characteristics. Data for energy consumption impacts will come from changes in travel behavior and calculated reductions in VMT, consistent with the second approach for air quality analysis discussed in Section 2.8. Reductions in VMT will be derived from mode shift survey data from traveler surveys. Survey questions need to include both current and former modes, vehicle occupancy, distance to access transit and ridesharing, etc. Changes in carpool and vanpool rates also can be observed (via vehicle occupancy counts), but changes in modal behavior then would require a before study to assess overall changes in carpool and vanpool rates. Individual mode shifts due to the project are better assessed using travel survey data.

Finally, qualitative data on perceived environmental benefits will come from traveler surveys, as well as interviews with key UPA/CRD stakeholders.

[22] The website http://www.fhwa.dot.gov/environment/noise/tnm/index.htm contains documentation about the FHWA Traffic Noise Model.

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5.0 Next Steps

As stated at the beginning of this document, the objective of the NEF is to communicate the approach to be used for the evaluation of the performance of the congestion strategies implemented at the six UPA/CRD sites. The evaluation will extend over approximately four years, from its initiation in April of 2008, assuming there are no significant delays in the deployments to be evaluated. Having the NEF available will help keep the process on track over such a long period to ensure the consistency of approach and comparability of findings as much as possible.

The general tasks of the evaluation are to

- Develop site-specific strategies guided by the NEF
- Develop site-specific evaluation plans that provide a high-level view of all the test plans needed, the roles and responsibilities, and the schedule
- Prepare multiple site-specific test plans that provide complete details on how the data collection and analysis activities will be implemented and that identify the resources needed
- Collect one year of pre-deployment data and a second year of post-deployment data
- Analyze the data
- Report the results in the form of site-specific evaluation reports and a National Evaluation Findings Report.

The immediate next steps are to develop site-specific evaluation strategies reflecting the congestion reduction measures for each site so each site's evaluation fits within the overall NEF. A workshop will be held with each site so that the UPA/CRD partners, U.S. DOT, and the national evaluation team can confer on the evaluation priorities, tailor hypotheses/questions as appropriate to their particular deployments, and determine data requirements. Once developed, the site-specific strategies must meet the approval of the U.S. DOT and the UPA/CRD partners before the site-specific evaluation plans can be developed. It is anticipated that an evaluation strategy for each site will be finalized in the fall of 2008 for two UPA sites--Minnesota and Seattle. The evaluation strategies for the San Francisco UPA and the two CRD sites, Chicago and Los Angeles, should follow shortly thereafter. (The Miami UPA site is developing its own evaluation planning materials and the National Evaluation Team is reviewing and providing technical assistance where appropriate.)

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