Contemporary Approaches in Congestion Pricing:

Lessons Learned from the National Evaluation of Congestion Pricing Strategies at Six Sites

August 2015

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16. Abstract

This document represents the final report of the national evaluation of congestion reduction strategies at six sites that received federal funding under the Urban Partnership Agreement (UPA) and Congestion Reduction Demonstration (CRD) programs. The six sites, or "urban partners," were Atlanta, Georgia; Los Angeles, California; Miami, Florida; Minneapolis, Minnesota; San Francisco, California; and Seattle, Washington. Each site implemented a comprehensive policy response to urban congestion that included four essential components known as the "4 Ts": 1) tolling (or congestion pricing), 2) enhanced transit services, 3) telecommuting and other transportation demand management (TDM) strategies, and 4) advanced technology. The U.S. Department of Transportation sponsored an independent national evaluation of the multi-year, multi-site demonstration of congestion pricing and other supporting strategies. The contents of this "lessons learned" report are derived from the national evaluation and represent a cross-cutting review and assessment of the impacts of the six projects. The findings will be useful to state and regional agencies interested in advancing new congestion pricing programs or expanding programs already in place. The report notes the strategies that worked well across sites and those that did not. The findings are presented in the following sections: Growth and Change in Usage, Congestion Performance, Transit Performance, Telecommuting and TDM Performance, Environmental Impacts, Benefit-Cost Analysis, Equity and Congestion Pricing, Technology Performance, The Deployment Experience, Operational Impacts, and the Long-Term Effects of the UPA/CRD Projects at the Six Sites.

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PREFACE AND LIST OF KEY FINDINGS

In 2007, the U.S. Department of Transportation (U.S. DOT) announced the designation of four metropolitan areas (Miami, Florida; Minneapolis, Minnesota; San Francisco, California; and Seattle, Washington) as "urban partners," based on the results of a thorough review and competitive selection process. Each urban partner agreed to implement a comprehensive policy response to urban congestion that included four essential components known as the "4 Ts": (1) demonstration of tolling (congestion pricing), (2) enhanced transit services, (3) increased emphasis on telecommuting and other transportation demand management (TDM) strategies that include flexible scheduling, alternate commute programs, vanpooling, or carpooling, and (4) deployment of advanced technology. Termed as the Urban Partnership Agreements (UPA), the approaches taken vary between partner jurisdictions (e.g., HOV-to-HOT lane conversion in Miami vs. full facility pricing in Seattle), but in each case the projects represented innovative solutions, involving variable pricing, that had the potential to lead to substantial reductions in urban congestion in the long-run.

In 2008, the Department again solicited applications for a sister program identified as the Congestion Reduction Demonstration (CRD) Program. Under this similar initiative, the Department announced the designation of two additional metropolitan areas (Los Angeles, California and Atlanta, Georgia) as "urban partners," again based on the results of a thorough review and competitive selection process. As with the earlier initiative, each urban partner agreed to implement a comprehensive policy response to urban congestion that included the "4 Ts".

Because they were innovative, had the ability to significantly influence travel behavior, and involved the application of a high degree of advanced technologies, the Department undertook a national evaluation of these six UPA/CRD projects. The national evaluation was funded by the Intelligent Transportation Systems Joint Program Office (ITS JPO) in the Office of the Assistant Secretary for Research and Technology (formerly in the Research and Innovative Technology Administration (RITA)) and jointly managed with the Federal Highway Administration (FHWA).

The contents of this "lessons learned" report are derived from the national evaluation and represent a cross-cutting review and assessment of the impacts of the UPA/CRD projects. This document summarizes the findings from the evaluation of the multi-year, multi-site demonstration of congestion pricing and other supporting strategies sponsored by U.S. DOT. It provides a high-level snapshot of a variety of impacts and lessons learned that will be useful to state and regional agencies interested in advancing new congestion pricing programs or expanding programs already in place. The report notes the strategies that worked well across sites and those that did not. At the end of the document, sources for more information about the evaluation and its findings are available to the reader. For example, in addition to this report, the national evaluation effort produced specific reports and analyses for each of the six sites, which are available online at http://www.ops.fhwa.dot.gov/congestionpricing/urb_partner_agree.htm and http://www.ops.fhwa.dot.gov/congestionpricing/cong_reduc_demo.htm.

Below is a listing of some of the key findings and lessons learned from the national evaluation of the six sites. Details of each of the topics are presented in the report sections that follow.

Growth and Change in Usage

- HOT lanes grew in terms of new accounts/transponders, tolled trips, and gross revenues at all four sites, indicative of a growing acceptance of tolling.
- On the SR 520 Bridge tolling succeeded in reducing traffic volumes by 34% in the first year, while transit ridership grew by 38%. Monthly toll transactions remained steady.
- As part of the SF*park* pilot, pricing was effective in gradually reducing the prevalence of blocks with high occupancy and increasing occupancies on under-utilized blocks. A similar trend in occupancy as a result of price changes was seen for LA Express Park™.

Congestion

- Congestion impacts were assessed with several measures – travel time, speed, and reliability. HOV-to-HOT conversion, along with transit and other improvements, led to reductions in some congestion metrics and increased throughput in some, but not all, sites. Particular combinations of added capacity, HOV restrictions, and registration and toll tag requirements appear to affect the differences observed among the sites.
- Tolling on SR 520 resulted in improved congestion on the bridge but led to slightly more traffic on the alternate I-90 route.
- SF*park* variable pricing significantly reduced cruising for parking in the pilot areas, as compared to the control areas. Less cruising for parking would have reduced congestion, but congestion reduction was difficult to detect with available data. Higher traffic volumes associated with an improving economy may have obscured the congestion impact as well.

Transit

- In five of the six sites, express buses using tolled lanes had faster speeds and shorter travel times. Bus ridership on the UPA/CRD corridors increased by a greater percentage than ridership on other parts of the respective local systems.

Telecommuting/TDM

- Typically only a modest amount of funding, if any, was allocated for the telecommuting and TDM component of the 4T strategies at the six sites. This was most notably reflected in the results of ridesharing impacts where there was a noticeable decline in HOV 2+ and 3+ carpools. Minneapolis successfully demonstrated telecommuting as a congestion management tool, and Los Angeles and Seattle dramatically increased vanpool operations related to their projects.

Environmental Impacts

- Emissions changed as a direct, but not exclusive, effect of VMT – declined at three of the five evaluated sites and increased at two sites. Lower emissions associated with congestion pricing could not offset higher emissions when VMT increased at the two sites where this occurred.

Benefit-Cost Analysis

- The results were modest, or in some cases negative, perhaps reflecting the experimental nature of some of the investments. In addition, limitations in data available to measure some benefits at certain sites may have impacted the findings.

Equity

- The UPA/CRD projects did not generally have any negative equity impact and succeeded in expanding travel options through transit improvements and by expanding the range of parking price and convenience options available to drivers. Nevertheless, surveys at several sites indicate a persistent perception of unfairness in the tolling efforts.

Technology

- Intelligent transportation technology permeated the congestion pricing and many of the other 4 T strategies. Interviews with agency personnel indicated that, by and large, the technologies added operational value and provided benefits to travelers. At the same time, technology sometimes presented technical challenges that had to be surmounted by the local partners.

The Deployment Experience

- Stakeholders concluded that several key factors contributed to the success of the UPA/CRD projects, including staff competencies, working "outside" of their usual domains, building upon existing partnerships, working with new partners, and having shared goals and a common vision.
- Through purposeful and extensive marketing and outreach conducted by the UPA/CRD partners, they were generally quite successful in communicating plans about their projects over time and effectively managing customer relations.

Public Acceptance

- Based on surveys and media coverage, the projects were seen as doing something beneficial for the transportation system in the region and users of the new projects perceived direct benefits to themselves. One HOT lane site was the exception in sustaining considerable negative reactions for many months, perhaps an indication of the numerous simultaneous changes – more than at other sites – that the public was being asked to absorb.

Operational Impacts

- New technologies imposed new responsibilities on agency staff that required additional training, staff members, and new ways of thinking about operations.
- The fairness and sustainability of congestion pricing strategies requires successful enforcement, and the UPA/CRD sites used various combinations of technology and manual enforcement processes to detect and process violations. Owing to differences in metrics among the sites, no general conclusions about enforcement trends were drawn.

Long-Term Effects of the UPA/CRD Projects

Since the demonstration period each of the six sites has continued to build on its UPA/CRD experience in various ways:

- Regional expansion of tolling is underway or planned in Atlanta, Miami, Minnesota, and Seattle, and further expansion is being studied in Los Angeles and other sites. The public appears to have accepted tolling based on the growth in toll accounts, transponders, and tolled trips at the sites.
- Transit continues to make significant gains in ridership on routes initiated with UPA/CRD funds.
- San Francisco has deployed smart meters throughout the city, which will be the platform for expanding demand-responsive SF*park* pricing citywide. LA Express Park™ is expanding, as well.
- These and many more developments at the six sites are directly attributable to the lessons learned from UPA/CRD projects.

CONGESTION REDUCTION STRATEGIES AT SIX SITES

The U.S. DOT awarded approximately $800 million in grants from discretionary sources in 2007 and 2008 to six metropolitan areas to reduce congestion under the Urban Partnership Agreement (UPA) and Congestion Reduction Demonstration (CRD) programs. The major infusion of federal funding enabled the sites to implement a suite of integrated multi-modal projects aimed at congestion reduction that would not otherwise have been possible. For example, large transit investments made by many of the sites would not have occurred without the significant discretionary resources made available through the UPA/CRD programs. By focusing substantial investments on congestion problems specific to their regions, UPA/CRD partners at each site were able to demonstrate the effectiveness of the elements of the 4-T strategies they implemented. The investments in the UPA/CRD projects at each site, including the state and local funds contributed, are shown in Table 1.

Table 1. Federal and State/Local Investments in UPA/CRD Projects at Six Sites*

4-T Category	Site					
	Atlanta	Los Angeles	Miami	Minnesota	San Francisco	Seattle
Tolling	$52,786,428	$106,762,152	$43,400,000	$267,616,038	$ 40,653,000	$ 33,347,358
Transit	$14,818,829	$102,771,629	$19,500,000	$ 69,496,718		$ 54,532,026
Telecommuting/ TDM	$ 230,522	$ 400,000		$ 462,610		$ 113,000
Technology				$ 41,988,434	$ 1,079,316	$ 39,934,788
Other**	$ 2,625,000					
Total	$70,460,779	$209,933,781	$62,900,000	$379,563,800	$ 41,732,316	$127,927,172

*Costs are for planning, design and construction and do not include operations and maintenance. Federal UPA/CRD funds awarded to individual sites may have included some projects that were not included in the evaluation in this report. Funds for such projects are excluded from this table.

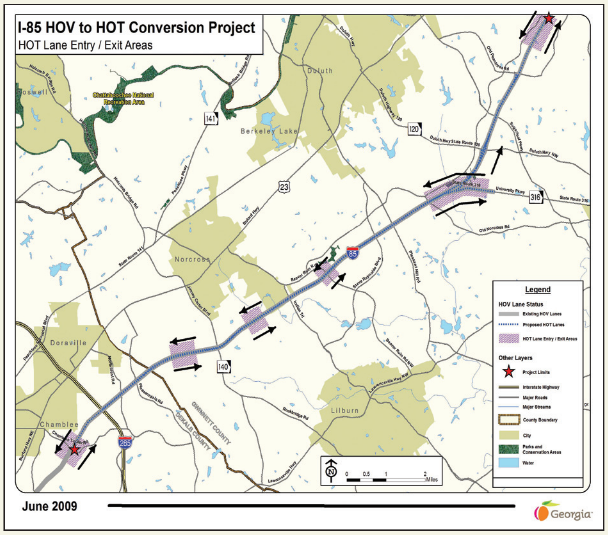
**E.g., performance monitoring, evaluation, etc.

Strategies Used at Each Site

The six UPA/CRD sites deployed innovative congestion management strategies that demonstrated the effectiveness of an integrated approach to addressing problems associated with congestion, such as slow travel times and reduced throughput. Table 2 shows the variety of strategies deployed by the six sites, and the accompanying maps (Figure 1 through Figure 6) illustrate the project locations within each metropolitan area. Four of the sites converted high-occupancy-vehicle (HOV) lanes to high-occupancy-toll (HOT) lanes with demand-based pricing, one site deployed full-facility tolling with demand-based pricing, and two sites deployed demand-based parking pricing. Two of the HOT sites raised the occupancy requirement for carpools to ride for free from HOV 2+ to HOV 3+. The six sites employed a variety of integrated strategies that included major transit enhancements, the promotion of ridesharing, an innovative telework project, and technology innovations.

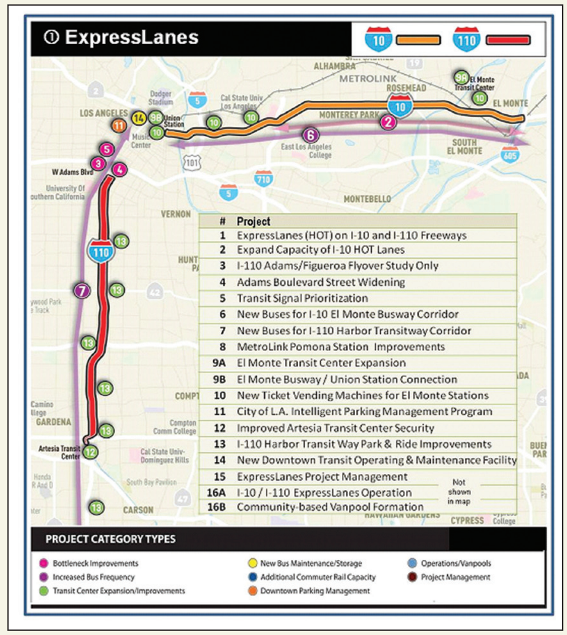
Table 2. 4-T Congestion Reduction Strategies Deployed at Six Sites and Start Date for Congestion Pricing

Atlanta	Los Angeles	Miami	Minneapolis	San Francisco	Seattle
Oct. 2011	I-110 in Nov. 2012; I-10 in Feb. 2013; Express Park in May 2012.	Dec. 2008 northbound; Jan. 2010 southbound.	Phase 1 in Sept. 2009; Phase 2 in Nov. 2010.	Sept. 2011	Dec. 2011
Tolling					
HOV to HOT lane conversion on I-85 (Express Lanes).	HOV to HOT lane conversion on I-10 and I-110 (ExpressLanes). A second HOT lane was added on I-10. Also, demand-based parking pricing (LA Express Park™).	HOV to HOT lane conversion on I-95 (95 Express). Also added a second HOT lane in each direction.	HOV to HOT lane conversion and addition of new HOT lanes on I-35 W (MnPass). Also added priced dynamic shoulder lane.	Demand-based pricing of city-owned on-street and off-street parking spaces in 7 pilot areas (SF*park*).	Variable tolling on SR 520 Bridge.
Increased HOV requirement from 2+ to 3+.	Maintained existing HOV requirements, 2+ on I-110 and 3+ during peak periods on I-10.	Increased vehicle occupancy requirement from 2+ to 3+.	Maintained 2+ carpool occupancy requirement.		Registered vanpools and buses ride for free.
Carpools required to register and use toll tag.	Carpools required to register and use switchable transponder.	3+ carpools required to register and display special decal but no transponder.	Carpools do not need to register or use transponder.		Registered vanpools and buses required to use transponder.
Transit					
12 new commuter buses in the corridor.	59 new clean-fuel buses to 4 service providers.	23 new buses	27 new buses.		44 new buses.
3 new Xpress bus routes in the corridor.	More frequent bus rapid transit service and municipal feeder service.	3 new transit routes.			Addition of 90 one-way peak period bus trips.
4 new or expanded park-and-ride lots.	Expanded parking capacity at transit stations.	500 park-and-ride spaces added.	6 new or expanded park-and-ride lots.		Enhancements to two park-and-ride lots.
	Transit signal priority on two streets in downtown LA.	Bus rapid transit in HOT lanes.	Bus bypass lane at Highway 77/Highway 62 interchange.		
	Other enhancements, e.g., new transit operating and maintenance facility.		Double contraflow lanes in downtown Minneapolis (MARQ2).		
Telecommuting /TDM					
Outreach to encourage formation of 3-person carpools.	Promotion to increase registered vanpools and employer-based ridesharing.	Outreach to encourage 3-person carpool formation as well as other existing employer-based programs for ridesharing, telecommuting and flex-time.	eWorkPlace telework program.	Use of existing alternate commute outreach to distribute brochures on SF*park* and 511 parking information.	Continued programs already in use by agencies and other employers that aim to reduce trips in the region.
Technology					
Automated toll enforcement systems.	Dissemination of parking information on-line and on variable message signs.	Introduction of ramp metering at 22 locations.	Active traffic management.	Real-time information on parking price and availability disseminated by websites, telephone, and mobile apps.	Active traffic management system on SR 520 and I-90 corridors.
	Transit signal priority on selected streets in downtown Los Angeles.	Transit signal priority on selected routes leading to I-95.	Real-time transit and traffic signs.		New travel time signs near key interchanges for SR 520.
			Driver assist system for shoulder running buses.		



Source: Georgia Department of Transportation

Figure 1. Atlanta CRD Location

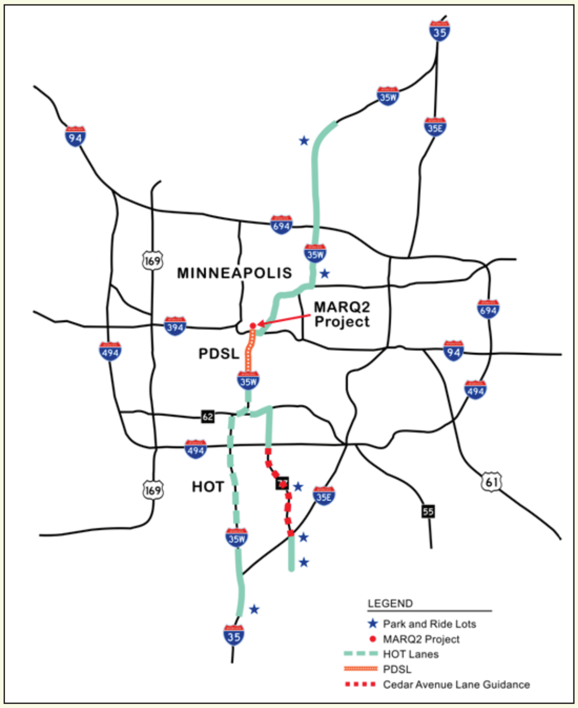


Source: LA Metro

Figure 2. Los Angeles CRD Location

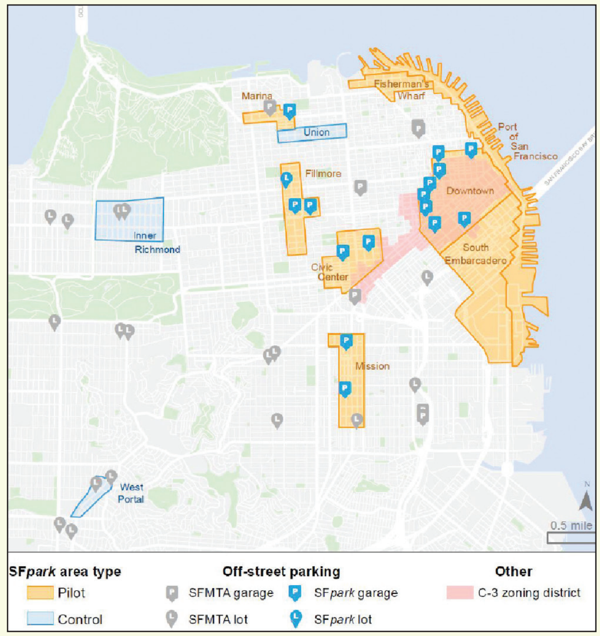
Source: Florida Department of Transportation

Figure 3. Miami UPA Location



Source: Minnesota Department of Transportation

Figure 4. Minneapolis UPA Location



Source: San Francisco Municipal Transportation Agency

Figure 5. San Francisco UPA Location

Source: Washington Department of Transportation

Figure 6. Seattle UPA Location

National Evaluation of the Sites' Strategies

The U.S. DOT commissioned an independent evaluation of the sites[1] to measure the performance of the congestion reduction strategies and lessons learned during the course of their implementation. The objective was to obtain findings that would be useful to other agencies seeking solutions to their congestion problems. The evaluation addressed four basic questions (text box) and applied a consistent approach across the sites to facilitate comparison of the findings. Local agencies were responsible for collecting the data for the national evaluation, which employed a comparison of conditions prior to the start of each site's congestion pricing project with conditions a year later. In general, a year of "before" data was compared against a year of "after" data at each site, although in some cases data for longer or shorter periods of time were used.

The evaluation encountered a number of challenges in measuring before/after changes owing to the amount and quality of data available and comparison of data with different collection methodologies. For example, roadway sensors needed for measuring traffic volumes and speeds were sometimes absent or not working properly. Another challenge was separating the effect of the strategy from exogenous factors, such as local construction projects or economic conditions including the nationwide recession that began in 2008. Deployment schedules varied among the six sites between 2008 and 2013, and thus the impact of the recession could have been felt differently among the sites and be reflected in the data.

Four U.S. DOT Evaluation Questions:

- How much was congestion reduced?
- What are the associated impacts of the congestion reduction strategies?
- What are the non-technical success factors?
- What are the overall costs and benefits of the strategies?

[1] Miami began deploying its projects prior to the start of the independent evaluation, and thus it performed a self-evaluation. The other five sites were evaluated by a multi-disciplinary team led by Battelle under contract to U.S. DOT. For this reason, some findings presented in this report were not available for Miami.

GROWTH AND CHANGE IN USAGE

This section looks at overall growth and change in facility usage at the UPA/CRD sites before and after the advent of congestion pricing. The results are presented first for the four sites where HOV-to-HOT conversions took place – Atlanta, Los Angeles, Miami, and Minneapolis – followed by growth after tolling began on the SR 520 Bridge in Seattle. The section concludes with a look at change in parking occupancy in San Francisco and Los Angeles.

HOT Lanes Growth in Usage

Once HOV lanes were converted to HOT lanes, use of the HOT lanes in Miami, Minneapolis, Atlanta, and Los Angeles increased during the post-deployment period. The number of new toll accounts and transponders, tolled trips, and toll revenues all increased.

Table 3 presents the number of new toll accounts and transponders issued during the evaluation period at each site. As noted in the table, all vehicles using the HOT lanes in Atlanta and Los Angeles must have toll tags, while toll tags are not required for HOVs and other exempt vehicles in Miami and Minneapolis (although in Miami there is a registration requirement and special decal for non-tolled vehicles).

Table 3. New Toll Accounts and Transponders Issued for HOT Lanes

Site (Time Period Covered in the National Evaluation)	New Toll Accounts	Number of Transponders
Atlanta – I-85 Express Lanes* (June 2011 – September 2012)	69,143	197,044
Los Angeles – I-110 and I-10 ExpressLanes* (July 2012 – February 2014)	210,367	261,230
Miami – 95 Express Lanes**	NA	NA
Minneapolis – I-35W MnPASS Express Lanes ** (October 2009 – December 2011	7,397	8,425

NA – Not available as the SunPass is used, which can be purchased and used on toll facilities throughout the state.
*All vehicles must have toll tags.
**Only tolled vehicles must have toll tags and HOVs and other exempt vehicles do not have to open a toll account or obtain a transponder.
In Miami, non-tolled vehicles must register and display a special decal.

Table 4 presents the growth in monthly tolled trips for the HOT lane projects at the different sites (except for Miami which includes both tolled and non-tolled HOT users). The number of tolled trips increased at all sites, with the largest percentage of growth occurring in Atlanta, Minneapolis, and on the I-10 ExpressLanes in Los Angeles.

Table 4. Growth in Monthly HOT Tolled Trips

Site (First Month/Last Month and Time of Day for Tolled Trips)	First Full Month of Deployment	Last Month of Evaluation	Percentage Growth
Atlanta (October 2011/September 2012, peak and off-peak)	123,045	333,624	171%
Los Angeles I-110 (December 2012/February 2014, a.m. peak period)	251,130	296,370	18%
Los Angeles I-10 (March 2013/February 2014, a.m. peak period)	153,540	297,270	94%
Miami (January 2009/January 2011 NB peak tolled and non-tolled HOT users)	134,220	165,100	23%
Miami (February 2010/January 2011 SB peak tolled and non-tolled HOT users)	150,200	174,160	16%
Minneapolis (October 2009/December 2012, a.m. and p.m. peak periods)	25,024	55,177	120%

Table 5 presents the growth in monthly gross revenue for the HOT lane projects. The growth in revenue follows the growth in toll use highlighted in Table 4, with the largest percentage of growth occurring in Atlanta, Minneapolis, and Miami. The I-110 ExpressLanes in Los Angeles had the largest amount of total revenue collected by the end of the evaluation period.

Table 5. Growth in Total Monthly HOT Gross Revenue

Site (Dates of First/Last Month)	First Full Month of Evaluation	Last Month of Evaluation	Percentage Growth
Atlanta – I-85 Express Lanes (October 2011/September 2012)	$105,807	$400,760	278%
Los Angeles I-110 ExpressLanes (December 2012/February 2014)	$885,316	$1,269,639	43%
Los Angeles I-10 ExpressLanes (March 2013/February 2014)	$535,166	$841,594	57%
Miami – 95 Express Lanes (January 2009 NB and February 2010 SB/January 2011 both)	$999,217	$1,273,700	27%
Minneapolis – I-35W MnPASS Express Lanes (October 2009/ December 2011)*	$19,609	$76,270	289%

*HOT lanes were deployed in two phases in Minneapolis and revenues are shown for the beginning of the first phase through the end of both phases.

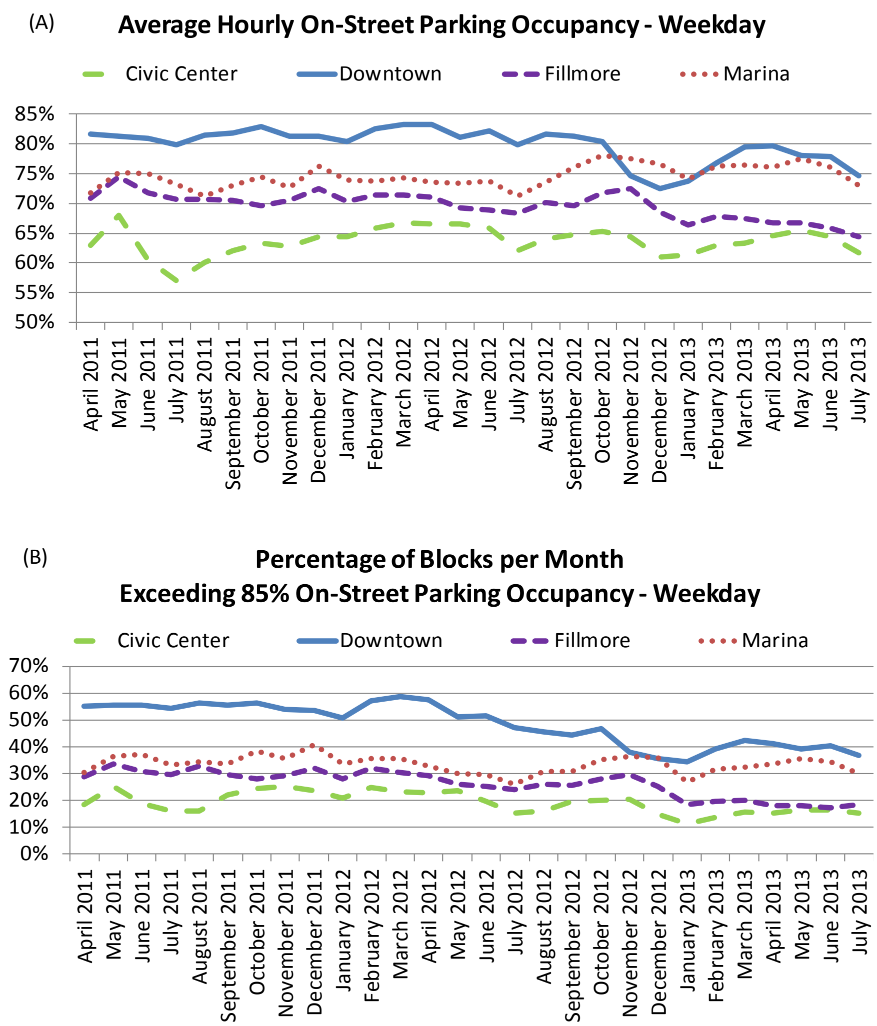
Changes in Traffic on Seattle's SR 520 Bridge

The SR 520 Bridge over Lake Washington was the first conversion of an existing free facility in the U.S. to a tolled facility with no infrastructure changes or improvements made. Moreover, because a new toll bridge was going to be built as a replacement, the local partners were able to advance the use of the toll application for a few years on the old bridge to manage congestion and begin the revenue stream for funding the new bridge. Tolling was successful in reducing congestion on the SR 520 Bridge, although some traffic shifted to alternate routes. Traffic volumes declined by about 34 percent in the year after tolling began, and monthly tolled trips remained steady averaging between 1 and 1.5 million during that period. However, transit ridership on the SR 520 Bridge increased 38 percent during the same time, attributable in part to an increase in transit service made possible with UPA funding. King County Metro and Sound Transit added 90 more one-way peak period trips in preparation for SR 520 tolling, which increased service on 19 routes serving SR 520. By comparison, King County Metro saw an estimated 8 percent increase in regionwide transit ridership during the same period. Moreover, during the evaluation period the number of people riding in vanpools on the SR 520 Bridge increased by 107 percent.

Change in Occupancy with SF*park* and LA Express Park™

The prime objective of both SF*park* and LA Express Park™ was to raise parking rates to make parking spaces more available in high-demand areas and to lower rates to encourage more parking in low-demand areas, and the evaluation found such pricing to be an effective management tool. The national evaluation of SF*park* was more extensive than for LA ExpressPark™ owing to different levels of local resources to support the evaluation, resulting in less data available for analysis of the parking project in Los Angeles. Thus, more details are presented here for San Francisco than Los Angeles.

For SF*park* parking availability was measured by trends in on-street parking occupancy, which was the percent of total time the parking sensors on a block indicated a car was in a space during a given hour between 9 a.m. and 6 p.m. when parking rates were in effect in the seven pilot areas. Analysis of occupancy by individual parking areas showed that pricing was effective in gradually reducing the prevalence of blocks with high occupancy. Figure 7 shows the trends in four pilot areas where average occupancy and/or the proportion of blocks exceeding 85 percent occupancy declined over time. The trends extended from April 2011, before price changes, to July 2013 after a series of price adjustments that started in the summer of 2011. In other pilot areas with lower occupancies to start with (not shown), price reductions on under-utilized blocks led to gradually higher occupancies.



Source: Elliot Martin

Figure 7. Weekday Parking Occupancy Trends in Four SF*park* Pilot Areas with Declines in Parking Occupancy between 9 A.M. and 6 P.M.

In Los Angeles, analysis of changes in parking use over the first seven months of Express Park™ indicated that occupancy moved in the desired direction according to price. Generally, rate reductions resulted in increases in use and rate increases resulted in slightly lower use levels. More spaces were occupied between 70 and 90 percent of the time, fewer spaces were occupied over 90 percent of the time, and fewer were occupied less than 70 percent of the time.

CONGESTION PERFORMANCE

Reducing congestion was the primary focus of the UPA and CRD programs. This section presents measures of changes in congestion that illustrate the impact of each site's combination of 4-T strategies. The four sites with HOV-to-HOT conversions (Atlanta, and Los Angeles, Miami, Minneapolis) are shown first, followed by Seattle which tolled all lanes of the SR 520 Bridge, and finally San Francisco, which deployed congestion-based parking pricing. (The parking pricing project in Los Angeles is not discussed in this section owing to the unavailability of data on congestion performance.) The summary is not intended to draw negative comparisons among the sites, as differences in the projects and strategies deployed and local conditions could influence possible outcomes. Rather, the summary highlights the experience with the different approaches at the various sites to provide insight on what worked, what didn't, and why.

The congestion analysis used four main measures – mean travel time, mean travel speed, the travel-time index, and the buffer index.[2] The national evaluation relied on data from the local partners to assess these measures. Data limitations were encountered at all sites, influencing the ability to analyze the measures and to identify changes in congestion. In some cases, traffic sensors were not working due to construction activities. In other cases, additional capacity was added via another lane, making it difficult to analyze with no "before" data available.

Other factors may have influenced possible changes in traffic congestion, including construction in the corridors or adjacent freeways not related to the UPA/CRD projects, improved geometrics as part of the projects or other improvements, and growth in the local economy. In addition, differences were noted in data collected through the tolling system and the traditional loop detectors and visual occupancy counts at some sites. In regards to the LA project, clean fuel vehicles, which were required to pay a toll if they did not meet the occupancy requirement during the demonstration period, were allowed to use the ExpressLanes free in 2014.

Express Lanes

Table 6 presents examples of pre- deployment and one-year post-deployment congestion measures at the four sites, and Table 7 presents examples of changes in vehicle and person throughput. The conversion of HOV lanes to HOT lanes in Los Angeles, Miami, and Minneapolis all resulted in increases in vehicle throughput. The HOT projects in these areas also resulted in increases in person throughput, with the exception of I-110 in Los Angeles, which experienced a slight decline of 328 people in the morning peak hour and 24 people in the afternoon peak hour (2.6 percent and 0.2 percent respectively). In Atlanta, I-85 experienced a decline in both vehicle and person throughput. However, this change is to be expected as the Atlanta project involved the most changes to any previous HOV lane operation, including not only the introduction of tolling without capacity expansion, but also increasing the carpool vehicle occupancy requirement from 2+ to 3+ and requiring carpools to register and obtain transponders.

Thus, most of the HOT projects opened up capacity in the HOT lanes enabling more vehicles and more people to access the already congested freeways. At the same time, as presented in Table 6, at least some congestion measures improved at every site as a result of the HOT lanes and other UPA/CRD projects. Miami, which re-striped to add a second lane, and Minneapolis, which included corridor capacity and geometric improvements not related to UPA projects, realized some of the largest improvements. Improvements were also seen in the I-10 HOT lanes in Los Angeles, in which restriping added a second HOT lane for 9 out of 15 total miles. While travel times increased slightly in the I-85 general purpose freeway lanes in Atlanta, trip-time reliability improved. Other examples of changes at the various sites are highlighted in Figure 8.

[2]The travel time index and buffer index are measures of travel time reliability. The travel time index is a comparison between the travel conditions in the peak period to free-flow conditions. The buffer index represents the amount of extra time to allow for on-time arrival at a destination.

Table 6. Congestion Measures Pre- and Post-Deployment[3]

Site, Time Period, Direction	Pre-Deployment	Post-Deployment	Change
Atlanta – I-85, A.M. Peak Period, Southbound			
General Purpose Freeway Lanes			
Mean Travel Time	16.1 min	16.9 min	+0.80 min
Mean Travel Speed	46.1 mph	43.9 mph	-2.20 mph
Travel-Time Index	1.39	1.46	+0.07
Buffer Index	77%	66%	-11%
HOV/HOT Lanes			
Mean Travel Time	14.1 min	13.8 min	-0.30 min
Mean Travel Speed	50.1 mph	51.5 mph	+1.4 mph
Travel-Time Index	1.28	1.25	-0.30
Buffer Index	44%	57%	+13%
Los Angeles – I-110, A.M. Peak Period, Northbound			
General Purpose Freeway Lanes			
Mean Travel Time	27.09 min	27.07 min	-0.02 min
Buffer Index	51%	48%	-3%
HOV/HOT Lanes			
Mean Travel Time	12.40 min	14.29 min	+1.90 min
Buffer Index	43%	85%	+42%
Los Angeles – I-10, A.M. Peak Period, Westbound			
General Purpose Freeway Lanes			
Mean Travel Time	30.88 min	33.90 min	+3.02 min
Buffer Index	57%	34%	-23%
HOV/HOT Lanes			
Mean Travel Time	15.96 min	15.08 min	-0.85 min
Buffer Index	40%	26%	-14%
Miami – I-95, A.M. Peak Period, Southbound			
General Purpose Freeway Lanes			
Mean Travel Speed	15 mph	51 mph	+36 mph
HOV/HOT Lanes			
Mean Travel Speed	20 mph	64 mph	+44 mph
Minneapolis – I-35W, A.M. Peak Period, Northbound			
General Purpose Freeway Lanes			
Mean Travel Time	18.9 min	16.8 min	-2.10 min
Mean Travel Speed	50.7 mph	55.3 mph	+4.6 mph
Buffer Index	100%	70%	-30%
HOV/HOT Lanes (Section south of I-494 only)			
Mean Travel Time	6.4 min	6.0 min	-0.4 min
Mean Travel Speed	67.2 mph	65.7 mph	-1.5 mph
Buffer Index	40%	20%	-20%

[3]Not all measures were available at each site.

Table 7. Total Vehicle and Person Throughput Pre- and Post-Deployment

Site	Pre-Deployment	Post-Deployment	Change
Atlanta – I-85			
A.M. Peak Period, Southbound			
Vehicle Throughput	38,289	37,024	-1,265
Person Throughput	45,780	43,091	-2,689
P. M. Peak Period, Northbound			
Vehicle Throughput	42,673	40,381	-2,291
Person Throughput	52,370	48,209	-4,161
Los Angeles – I-110			
A.M. Peak Hour, Northbound			
Vehicle Throughput	8,522	9,209	+687
Person Throughput	12,410	12,082	-328
P. M. Peak Hour, Southbound			
Vehicle Throughput	8,639	9,262	+623
Person Throughput	13,135	13,111	-24
Los Angeles – I-10			
A.M. Peak Hour, Westbound			
Vehicle Throughput	5,817	7,659	+1,842
Person Throughput	11,192	12,713	+1,521
P. M. Peak Hour, Eastbound			
Vehicle Throughput	7,752	8,822	+1,070
Person Throughput	10,467	13,112	+2,645
Miami – I-95			
A.M. Peak Period, Southbound			
Vehicle Throughput	6,040	9,557	+3,517
Person Throughput	7,805	11,742	+3,937
P. M. Peak Period, Northbound			
Vehicle Throughput	9,185	9,626	+441
Person Throughput	12,768	13,109	+341
Minneapolis – I-35W (Section South of I-494 Only)			
A.M. Peak Period, Northbound			
Vehicle Throughput	14,452	16,937	+2,484
P. M. Peak Period, Southbound			
Vehicle Throughput	16,274	20,221	+3,947

- **Atlanta:** Morning peak period, peak direction travel time in the Atlanta I-85 general purpose freeway lanes remained the same or increased slightly in the post-deployment period, while travel times in the Express Lanes declined slightly. Trip-time reliability for the general purpose freeway lanes improved, but declined slightly for the Express Lanes. The relative travel-time advantage for using the Express Lanes increased.

- **Los Angeles:** Implementation of the I-10 and I-110 ExpressLanes in Los Angeles resulted in increased vehicle throughput on both facilities. The increase in vehicles had mixed impacts on travel times and travel time reliability. Peak period, peak direction travel times on I-10 increased slightly in the general purpose freeway lanes in the morning and declined slightly in the afternoon. Travel times on the I-10 ExpressLanes declined during both time periods. Travel times in the I-110 general purpose freeway lanes remained approximately the same in both time periods, while travel times in the ExpressLanes increased in the morning and remained the same in the afternoon. Travel time reliability improved on the I-10 ExpressLanes and general purpose freeway lanes, improved on the I-110 general purpose freeway lanes, but declined on the I-110 ExpressLanes.

- **Miami:** Travel speeds in the Miami I-95 Express Lanes during the morning peak period, peak direction increased from approximately 20 mph during the pre-deployment period to 64 mph in the post-deployment period, while travel speeds in the general purpose freeway lanes increased from approximately 15 mph to 51 mph. Travel time reliability also increased, with Express Lane travel speeds of over 45 mph 100 percent of the time in the morning peak period. Total person throughput for the Express Lanes and the general purpose freeway lanes increased by approximately 21 percent.

- **Minneapolis:** Motorists traveling the length of the I-35W South corridor using the general purpose freeway lanes during the morning peak period in the northbound direction realized approximately three minutes in travel-time savings in the post-deployment period. Buses, carpools, and HOT vehicles in the MnPASS lane saved approximately three minutes compared to motorists in the general purpose freeway lanes. Travel time reliability also improved in the post-deployment period and vehicle throughput increased.

Figure 8. Examples of Changes in Congestion at HOV-to-HOT Conversion Sites

Travelers in the HOT lane corridors generally perceived a reduction in traffic congestion as a result of the HOT lanes and other UPA/CRD improvements. For example, in Minneapolis a majority of I-35W MnPASS customers responded to a survey that travel on I-35W South was easier and less congested than the previous year, while travelers using I-35W South responding to another survey indicated a general perception that traffic congestion had been reduced and traffic flow had improved compared to two years earlier. Agency operations personnel at the four sites – including incident response teams, bus operators, and state patrol officers – reported lower levels of congestion after implementation of the HOT lanes and other UPA/CRD projects in the corridors.

SR 520 Bridge

Implementing tolling on the SR 520 Bridge reduced traffic congestion on the bridge, but slightly increased traffic on parallel and adjacent freeways, including I-90, I-405, and SR 522. Table 8 presents congestion measures for the SR 520 Bridge and parallel Route I-90. In general, the measures exhibited improvements in congestion on SR 520, but I-90 experienced slightly higher congestion levels. For example, speed in the a.m. eastbound peak period on I-90 dropped from 60 to 57 mph, and speed in the p.m. westbound peak fell from 50 to 41 mph. I-405 and SR 522 also experienced no change or slight increases in travel times, decreases in travel speeds, and reduction in the travel time index and the buffer index in the peak hours, peak direction of travel.

Surveys and interviews conducted by local partners and the John A. Volpe National Transportation Systems Center (The Volpe Center) provided information on the perspectives of travelers on SR 520, I-90, and other freeways, as well as bus riders, Washington State Patrol (WSP) Troopers, King County Metro Transit bus operators, and Washington State Department of Transportation (WSDOT) Incident Response Team (ITR) operators. The survey and interview results indicated a general perception that tolling the SR 520 Bridge reduced congestion on the bridge and the SR 520 corridor between I-5 and I-405, but increased traffic on I-90, and to a lesser extent, on SR 522.

Table 8. SR 520 and I-90 Congestion Measures Pre- and Post-Deployment

Facility	Pre-Deployment	Post-Deployment	Change
SR 520 Bridge			
A.M. Peak Period			
Mean Travel Time Eastbound	9.68 min	7.31 min	-2.37 min
Mean Travel Time Westbound	9.28 min	7.00 min	-2.28 min
Mean Travel Speed Eastbound	45.4 mph	56.1 mph	+10.7 mph
Mean Travel Speed Westbound	47.4 mph	58.1 mph	+10.7 mph
Travel Time Index, Eastbound	1.53	1.16	-0.37
Travel Time Index, Westbound	1.47	1.11	-0.36
Buffer Index, Eastbound	37%	41%	+4%
Buffer Index, Westbound	68%	24%	-44%
P.M. Peak Period			
Mean Travel Time Eastbound	8.97 min	6.75 min	-2.22 min
Mean Travel Time Westbound	18.08 min	10.71 min	-7.37 min
Mean Travel Speed Eastbound	47.3 mph	61.0 mph	+13.7 mph
Mean Travel Speed Westbound	27.1 mph	44.8 mph	+17.7 mph
Travel-Time Index, Eastbound	1.42	1.07	-0.35
Travel-Time Index, Westbound	2.86	1.70	-1.16
Buffer Index, Eastbound	57%	18%	-39%
Buffer Index, Westbound	101%	1.08%	+7%
I-90			
A.M. Peak Period			
Mean Travel Time Eastbound	7.96 min	8.40 min	+0.44 min
Mean Travel Time Westbound	7.81 min	8.89 min	+1.08 min
Mean Travel Speed Eastbound	60.3 mph	57.3 mph	-3.00 mph
Mean Travel Speed Westbound	57.1 mph	56.3 mph	-0.80 mph
Travel-Time Index, Eastbound	1.11	1.17	+0.06
Travel-Time Index, Westbound	1.22	1.22	No Change
Buffer Index, Eastbound	69%	46%	-23%
Buffer Index, Westbound	98%	100%	+2%
P.M. Peak Period			
Mean Travel Time Eastbound	8.78 min	8.73 min	-0.05 min
Mean Travel Time Westbound	10.64 min	13.57 min	+2.93 min
Mean Travel Speed Eastbound	57.1 mph	56.3 mph	-0.80 mph
Mean Travel Speed Westbound	49.7 mph	40.7 mph	-9.00 mph
Travel-Time Index, Eastbound	1.22	1.22	No Change
Travel-Time Index, Westbound	1.48	1.89	+0.41
Buffer Index, Eastbound	98%	100%	+2%
Buffer Index, Westbound	145%	119%	-26%

SF*park*

The traditional measures of linked travel speeds and travel times did not change substantially with the introduction of variable parking pricing in the pilot areas, despite the study clearly showing a reduction in cruising for parking. While limitations with the pavement sensor and transit travel-time data used in the analysis may have contributed to the inability to detect changes in congestion, the analysis also pointed out the need for localized congestion measures focusing on the impact of changes in parking maneuvers.

Surveyed visitors and shoppers reported finding parking spaces faster and closer to their destination after the implementation of variable pricing. The reduction in parking search time was greater in the pilot areas than in the control areas. These results suggest that SF*park* was effective in making it faster to find a place to park. Visitors and shoppers in the pilot areas did not perceive a reduction in congestion, however.

In conclusion, the congestion-reducing impacts of the different UPA/CRD projects varied. The largest impacts on congestion resulted from the conversion of HOV lanes to HOT lanes and the implementation of tolling on the SR 520 Bridge in Seattle, along with transit and other transit improvements at those sites. Among the HOT sites, some congestion measures improved at every site and users of the HOT lanes realized travel-time savings over travelers in the general purpose freeway lanes. Tolling on the SR 520 Bridge in Seattle resulted in decreased congestion on the bridge, but slightly increased congestion on I-90. In San Francisco, shoppers and visitors reported finding spaces faster and closer to their destinations after SF*park* was implemented, although conclusions about the impact on traffic congestion in general could not be drawn due to limitations in available data.

TRANSIT PERFORMANCE

U.S. DOT's congestion initiative invested a considerable amount of funding into transit. As a result, five of the six UPA/CRD sites were able to implement significant transit enhancements that were designed to support the introduction of congestion pricing on roadways. Over $261 million in federal and local funds were spent on transit improvements for enhanced express bus services that provided new buses, park-and-ride lot improvements (redesigned stations, additional parking spaces, safety enhancements), variable message signs, transit signal priority (TSP)[4], and more. The goal was to offer commuters an attractive alternative to driving alone with the benefit of riding toll-free in the priced lanes. The MARQ2 project in Minneapolis (Figure 9) is one of many examples of the innovative transit enhancements implemented by the local partners.

The MARQ2 dual contraflow bus lanes in Minneapolis improved bus speeds up to 72 percent and increased bus throughput up to 52 percent.

Source: Metro Transit

The Minneapolis UPA included a unique transit improvement known as the MARQ2, a set of contraflow bus lanes in downtown Minneapolis on Marquette Avenue and 2nd Avenue. Originally there was one contraflow bus lane on Marquette and another on 2nd. These were expanded to two lanes so that buses could pass one another. A new bus operating strategy was also implemented with the MARQ2 lanes, shown in the photograph. Bus stops were designated for different express routes every two blocks, further enhancing the flow of buses through the downtown area. The target speed of buses on the MARQ2 lanes was 8 mph. The largest increase in bus operating speeds was realized on 2nd Avenue in the morning peak period, when speeds improved from 4.3 to 7.4 mph, a 72 percent increase. In the afternoon peak period speeds improved from 4.0 to 6.4 mph, a 60 percent increase. These faster speeds resulted in increased bus throughput in downtown. The number of buses operating on the MARQ2 lanes increased 23 percent, from 475 buses to 586 buses in the morning peak period and increased 52 percent in the afternoon peak period from 387 to 587 buses.

Figure 9. MARQ2 Lanes in Downtown Minneapolis

[4]In Los Angeles the term Transit Priority System, or TPS, is used.

One of the most positive findings of the UPA/CRD evaluation has been the increase in transit ridership on commuter buses in the five cities that initiated major transit enhancements. (The San Francisco site did not include a transit element and, based on the before-and-after evaluation, demand-based parking pricing had no discernable effect on existing transit service.)

As shown in Figure 10, the ridership increases varied from a high of 57 percent in Miami to a low of 8 percent in Minneapolis. The 33 percent increase in Seattle amounted to 1,555 additional daily riders in the morning peak period. In contrast, system-wide bus ridership did not experience the growth of the UPA/CRD corridors, as it decreased in Miami (-15%) and Atlanta (-1%), stayed the same in Los Angeles, and increased slightly in Seattle (1%) and Minneapolis (5%).

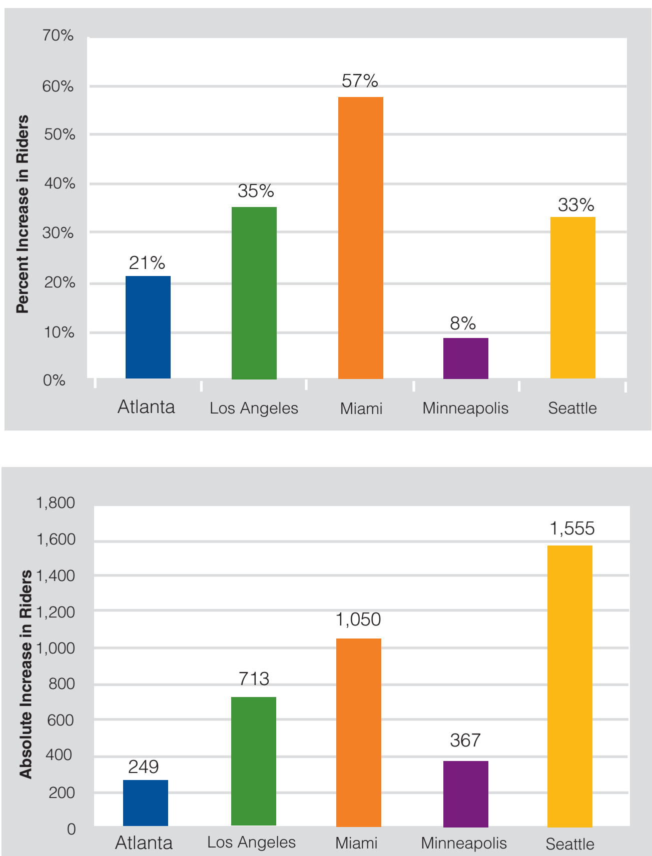


Figure 10. Average Daily Ridership in the A.M. Peak: Percentage and Absolute Increase

Los Angeles, Seattle, Atlanta, and Minneapolis were able to implement their transit enhancements several months prior to tolling. As shown in Figure 11 the enhancements alone attracted ridership even before tolling occurred. Once tolling began in the UPA/CRD corridors, transit experienced additional growth, most notably in Seattle with a 16 percent boost in ridership.

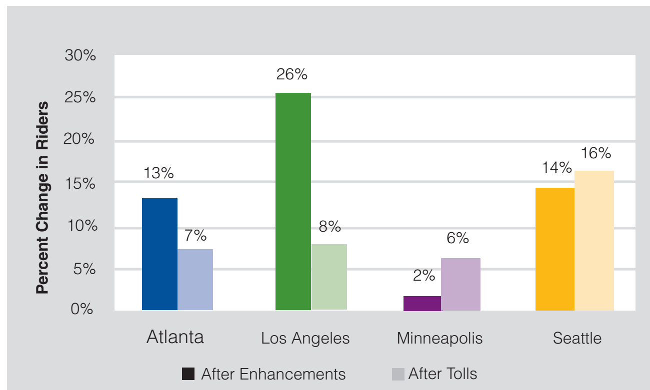


Figure 11. Increase in Bus Ridership after Enhancements and after Tolls

Commuter bus service benefited from faster travel times and speeds after tolling went into effect.

- On Miami's 95 Express lanes bus travel times improved by 17 minutes, and speeds improved from 18 to 57 miles per hour.
- In Minneapolis in the congested section of the I-35W corridor near Highway 62, travel time improved by 4 ½ minutes, and speeds increased from 28 to 57 mph.
- On Atlanta's I-85 Express Lanes 5 minutes were cut from the travel time.
- In Seattle, bus travel times across the SR 520 Bridge improved between 1.0 and 1.5 minutes depending on the direction, and speeds increased by 14 and 18 mph. (Average post-toll speed was 54 mph.)
- In Los Angeles, bus travel times on the I-110 ExpressLanes remained relatively flat, but on the I-10 ExpressLanes, there was almost a 5 minute improvement.

Surveys of bus passengers in the UPA/CRD corridors further substantiated the positive effect on transit. Tolling had influenced some passengers to switch to transit, ranging from a low of 23 percent in Minneapolis to a high of 55 percent in Seattle (Figure 12). About a third of "new" transit riders said they used to drive alone to work: 38 percent in Miami, 33 percent in Los Angeles, and 20 percent in Minneapolis. In Atlanta, 65% of I-85 Xpress bus riders said they would drive alone were it not for the express bus.

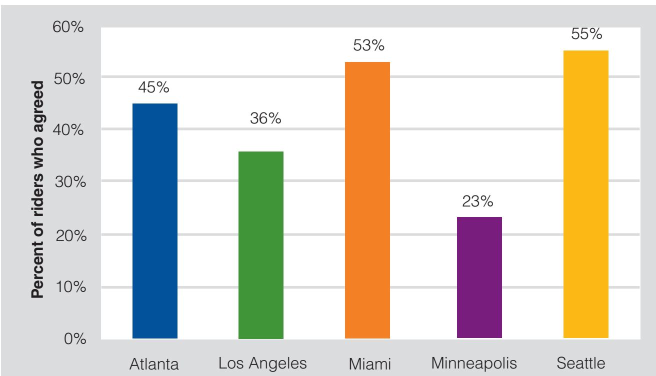


Figure 12. Percent of New Riders Who Agreed That Tolling Influenced Them to Take Transit

When asked whether their travel had improved after tolling went into effect, bus riders generally responded positively (Figure 13). In Los Angeles, close to half of the riders agreed, and in Minneapolis and Seattle it was more than half. The exception was Atlanta where there was some public disgruntlement over the I-85 Express Lanes in the first year. The question was not asked in the survey of Miami riders.

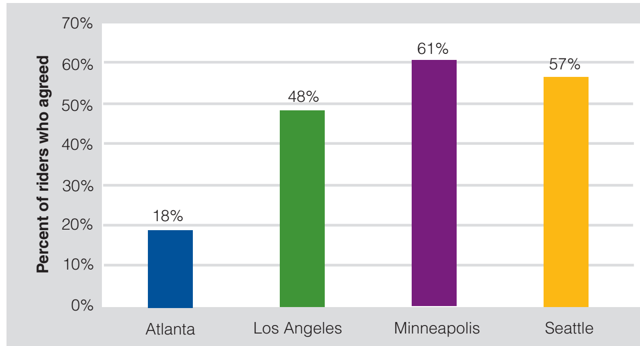


Figure 13. Percent of Riders Who Agreed That Tolling Had Improved Their Travel

Based on the evidence, several conclusions can be drawn from the national evaluation. The first is that the HOT lane conversions in four cities and the implementation of tolls on the bridge in Seattle had no negative impact on bus performance. On the contrary, express buses using the tolled lanes benefitted from the improved traffic flow with faster speeds and shorter travel times. A second conclusion is that tolled lanes did not negatively impact bus ridership. In fact, ridership on the UPA/CRD corridors increased by a greater percentage when compared to the rest of respective local systems. Finally, the inclusion of transit enhancements as a complementary strategy with tolling provides a benefit to bus riders.

TELECOMMUTING AND TDM PERFORMANCE

Telecommuting and Transportation Demand Management (TDM) comprised one of the 4-T strategies and were to be supportive of and complementary to the primary pricing elements. With the exception of the telework project in Minneapolis, the TDM element used by the local partners to promote ridesharing generally involved leveraging existing and/or modest enhancements to ridesharing services on the tolled corridor and not the implementation of wholly new programs, technologies or services. For example, in Los Angeles the existing Metro Vanpool Program was used to conduct an intensive marketing and outreach campaign to form new vanpools in the two HOT lane corridors. When such existing programs were used during the demonstration period, separation of the unique effects of the TDM efforts on travel in the corridors was difficult.

At the four sites that involved HOV-to-HOT lane conversion, before and after occupancy counts measured changes in carpooling and user surveys provided insights on reasons for observed changes. At the other two sites, Seattle promoted TDM via targeted information on commute alternatives for the SR 520 corridor while tolling was being implemented, whereas San Francisco did not attempt a strong linkage between TDM and parking pricing.

Table 9 summarizes the main findings, with respect to changes in carpooling from before and after implementation of tolling, for five of the sites. In very general terms, it appears that TDM efforts had a very limited effect on preventing the break-up of ridesharing arrangements as an uninteded impact of tolling.[5] In Seattle carpooling was virtually unchanged in the first year of tolling. Based on occupancy counts, carpooling was observed to decline in many of the

Table 9. Observed Changes in Carpooling after Tolling

Location	Change in Carpooling	Comments
Atlanta	Total carpooling decreased by 34% in the a.m. peak and 16% in p.m. peak. Peak-period carpools declined by over 85% in the HOT lanes and doubled in the general purpose lanes.*	Overall levels of traffic declined in the I-85 corridor during the evaluation period.
Los Angeles	Data sources related to carpooling show varied and even contradictory results, and, thus, no conclusion could be drawn about the impact of tolling.	Carpool occupancy counts revealed a drop in carpooling after the advent of tolling, whereas tolling system data revealed an increase in carpooling and a customer service survey showed little or no change in carpooling.
Miami	2-person carpools (now tolled) declined in HOT lanes by 16% a.m. and 53% p.m. and increased in general purpose lanes by 16% a.m. and 96% p.m. 3-person carpools (free) declined by 35% a.m. and 83% p.m. in HOT lanes.	The decline in carpools was greater in the first year after tolling (2009) and rebounded some in the second year (2010) in the p.m.
Minneapolis	Carpools in the HOV lane declined by 8% after opening of the 1st HOT /PDSL lane, remained stable after opening of 2nd HOT facility, and then increased by 34% one year later.	The initial decline in carpools was likely influenced by construction in 2009 - 2010; the later increase was in 2010 - 2011.
Seattle	Carpooling experienced a very small decline (<1%).* (On the other hand, ridership on vanpools, which use SR 520 for free, doubled from 2010 to 2012.)	Carpool data were from a mandated survey for employers and thousands of commuters in the corridor. Vanpool data from King County Metro Transit. Overall traffic levels and person throughput declined on SR 520 after tolling.

*A survey of households in Atlanta and Seattle by the Volpe Center revealed a slight increase in carpooling for all trip purposes by all household members in both cities.

[5]FHWA has a study underway to examine in more detail the potential impact of HOV-to-HOT lane conversion on carpooling.

sites, followed by increases after the first year or two of tolling at a couple of the sites as longer term behavior responses settled in. The greatest reduction in carpooling was reported at the two sites (Miami and Atlanta) where the occupancy requirement for free passage was raised to 3+ and these carpools were required to register and obtain a transponder. A before-and-after survey of 2-person carpoolers in Atlanta revealed that, while 25 percent started driving alone and 4 percent shifted to transit or telework, 30 percent remained in the Express Lanes and paid the toll and 41 percent retained their carpool but shifted to the general purpose lanes.

In many cases traveler surveys revealed that among those who changed carpooling (less or more) tended to do so for personal reasons (e.g., change of job or home location). In at least two cases (Minneapolis and Miami) short-term drops in carpooling (as some began driving alone and paying) were replaced with growth in carpooling in the longer-term. Thus, the evidence suggests that, if tolling led to an unintended drop in carpooling, it was short-lived, and the drop was perhaps due to circumstances unrelated to tolling itself. The evaluation confirmed that carpooling is a very dynamic mode and that future HOT lane projects would benefit from carefully nurturing carpoolers and vanpoolers in the form of outreach, information, and incentives to minimize any unintended impacts. LA Metro implemented a Carpool Loyalty Program that awarded $50 gift cards to 10 carpoolers in various categories. To enter a monthly drawing a transponder user indicated each day they had carpooled that month.

Two sites set specific, pre-determined targets for their Telecommuting/TDM efforts. Table 10 summarizes the assessment of achievement of program targets at these two sites. In Minneapolis, the eWorkPlace program (Figure 14) worked with 48 area employers to promote telecommuting. In Los Angeles, a specific push was made to form new vanpools in the two ExpressLane corridors of I-10 and I-110.

Table 10. Achievement of TDM Targets

Location	TDM Target	Actual Result	Mode Impact
Minneapolis eWorkPlace Program in the I-35W Corridor	500 telecommuters.	570 new telecommuters; reduced 1% of peak period work trips.	74% would have driven alone on telework day.
Minneapolis eWorkPlace Program Region-wide	2,700 telecommuters.	4,212 new telecommuters.	
Los Angeles Metro Vanpool Program	100 new vanpools in two corridors.	119 new vanpools; 79 on I-10, 34 on I-110 and 6 using both.	51% previously drove alone; 12% carpooled.

An innovative component of the Minneapolis UPA project was the implementation of the eWorkPlace program, which combined telecommuting and alternative work schedules within a Results-Only Work Environment framework, as pioneered by Best Buy, headquartered in the Twin Cities. The goal of the program was to reduce peak period commuting by eliminating trips or shifting them to off-peak times. The program offered both on-line tools and in-person consulting for employers. The original target of 500 new telecommuters in the I-35W corridor was expanded to 2,700 region-wide. The program ran from March 2009 to June 2011, when almost 50 employers were participating. Survey data from participating employees was used to estimate impacts: 4,212 new telework participants, 570 of whom commuted in the I-35W corridor (with three-quarters of these formerly driving alone) resulting in 1,260 vehicle trips being removed from the corridor weekly. The program benefitted employers as well, with 75% reporting an increase in productivity and 93% planning to continue or expand their in-house programs after the state-supported effort ended.

Source: H.H. Humphrey School of Public Affairs

Figure 14. Minneapolis eWorkPlace Program

In summary, while the telecommuting and TDM component was the most modest of the 4-T strategies at the UPA/CRD sites, it succeeded in demonstrating the potential for telecommuting as a congestion-management tool in the case of eWorkPlace. It also confirmed the belief that there is a need for vigorous efforts to retain if not increase carpooling when congestion pricing goes into effect.

ENVIRONMENTAL IMPACTS

The effects of congestion pricing on air quality was assessed for five sites, excluding Miami which performed a self-evaluation that did not include environmental analysis. Comparison of vehicle miles traveled (VMT) and travel speeds before and after congestion pricing at each site was used to evaluate changes in nitrogen oxides, (NOx), volatile organic compounds (VOC), carbon monoxide, (CO), fine particulate matter less than 2.5 microns ($PM_{2.5}$), and carbon dioxide (CO_2). Table 11 shows VMT and air pollution changes for five sites.

Table 11. Percent Change in VMT and Emissions at Five UPA/CRD Sites on Weekdays during Morning and Evening Peak Periods

Variable	Atlanta I-85	Los Angeles		Minneapolis I-35W	Seattle		San Francisco
		I-110	I-10		SR 520	SR 520 Plus I-90 and Feeder Routes	
VMT	-5.2%	6.6%	26.8%	18.6%	-28.9%	-2.7%	-26.7%
VOC	-0.8%	7.8%	32.9%	17.8%	-37.9%	-4.1%	-26.7%
NOx	-4.6%	13.8%	54.4%	21.8%	-30.0%	-2.5%	-26.7%
CO	-6.0%	6.1%	26.1%	19.9%	-30.6%	-5.8%	-26.7%
PM 2.5	+1.0%	21.4%	82.1%	18.8%	36.9%	-3.4%	-26.7%
CO2	-3.6%	7.5%	33.9%	18.6%	32.3%	-3.0%	-26.7%

For the sites where VMT increased (Los Angeles and Minneapolis), emissions also increased, although not necessarily in a linear fashion. Emissions vary with speed, and, for sites in which the locally used emissions model accommodated speed data, the emission changes represent the combined effects of speed and volume changes. For example, in Atlanta the 5.2 percent VMT decrease led to only a 0.8 percent decrease in VOC and a small increase in $PM_{2.5}$, because of the differing ways in which speeds affect different emission rates. Regarding the large VMT changes in Los Angeles, it should be noted that the local partners provided rather limited data for the analysis, and, thus, the emissions findings may be less reliable than at other sites. In addition, the California Department of Transportation's measurement of similar VMT increases on other freeways in the region and state, suggests that some of the increase may have been due to economic factors.

The emission changes for Seattle are shown in two ways. Tolling was instituted on all lanes of the SR 520 Bridge, resulting in a 28.9 percent decrease in travel on that facility. However, many of the vehicles that had used SR 520 may have switched to other routes. When all four interconnected freeway facilities connecting the two Lake Washington crossings (SR 520 and I-90) were considered there was a net 2.7 percent decrease in VMT.

The reasons for the decrease or increase in emissions are based on the overall traffic impacts: increases in effective or actual capacity leading to increases in traffic volumes; decreases in volumes due to exogenous factors, such as economic conditions or construction; or the effects of tolling an entire facility. For example, in Los Angeles and Minneapolis new lanes due to restriping and other projects not part of the UPA/CRD contributed to additional capacity.

The effect of parking pricing on VMT was evaluated for San Francisco (but not Los Angeles due to the lack of data in the area of parking price changes). Cruising for parking spots can represent a lot of VMT, and there was a 26.7 percent decrease in VMT in the SF*park* pilot areas after demand-based pricing was implemented. Speed changes, however, were very minor and related data were insufficient to use in the emissions calculations, resulting in estimates of percent change in emissions to be the same as VMT. In Los Angeles, the lack of VMT and speed data needed for estimating emissions changes attributable to parking pricing meant that the effects could not be included in the emissions changes for that site in Table 11.

Variation in the regional impact of the UPA/CRD projects on emissions among the sites is noteworthy, owing to the relative scope of the projects. For example, as a proportion of all VMT in the study areas, the UPA/CRD facilities in Los Angeles and Atlanta represented 0.3 and 0.5 percent of regional daily CO_2 emissions respectively, whereas in Minneapolis and Seattle (the SR 520 Bridge only) the facilities represented 4.5 and 5.5 percent of the regional daily emissions totals respectively.

In conclusion, in the period following the implementation of congestion pricing at the UPA/CRD sites, emissions changed as a direct, but not necessarily exclusive, effect of VMT. VMT declined at three of the five evaluated sites and increased at two sites. The environmental effects were generally in the same direction as the VMT, showing that the effects of decreased congestion due to pricing were not enough to offset all of the VMT when it increased.

BENEFIT-COST ANALYSIS

The national evaluation performed a benefit cost analysis (BCA) for each site. The purpose was to quantify and monetize the societal benefits and costs of implementing each site's suite of projects. The net benefit from the projects, i.e., the difference between the total benefits and the total costs, indicates the net societal benefit of this public investment.

Costs were based on federal UPA/CRD grants and local agency funding and included planning and implementation of the projects and 10 years of management and operation. The ten-year horizon was considered most appropriate for technology-oriented projects, such as the pricing components of the UPA/CRD projects. Some sites included investments that had a salvage value after ten years (buses for example), and the salvage amount was deducted from the initial investments to achieve a net cost for the BCA analysis.

Benefits were based on a 10-year projection of the benefits observed in the one-year post-deployment evaluation period. Use of regional metropolitan transportation models assisted in the projections at some sites. The monetized benefits included savings in travel time from auto, truck and transit usage, in emissions and fuel usage, and, where data were available, in other vehicle operating costs. Local values of time were used in the calculation of travel time savings. A negative benefit could result when the post-deployment impact caused increases in travel times, fuel use, or emissions. Moreover, in some cases shortcomings in data available for measuring benefits could have affected the results of the BCA.

Table 12 shows the BCA results for five sites (excluding Miami where a BCA was not performed). The BCA results vary widely among the sites owing to the scope of projects described in the introduction section of this report. One commonality with respect to benefits was that travel time savings projected over 10 years had the largest effect at four sites (i.e., Atlanta 54 percent, Seattle 97 percent, Minnesota 98 percent, and San Francisco 87 percent), but not in Los Angeles where changes in vehicle fuel consumption predominated resulting in a large negative net benefit. Those fuel impacts were the direct outcome of increased vehicle throughput in the I-10 and I-110 corridors in the post-deployment period. Although some individual site evaluation reports included findings about changes in crashes, safety benefits were not included in the BCA, as one year of post-deployment data was not sufficient to reliably project long-term safety benefits.

Table 12. Benefit-Cost Analysis for the UPA/CRD Sites

Site	Benefits ($)	Costs ($)	Net Benefits ($)	Benefit to Cost Ratio
Atlanta	9,549,980	106,296,834	-96,746,854	0.09
Los Angeles	-99,306,603	208,187,629	-307,494,232	-0.48
Minneapolis*	216,169,606	83,953,942	132,215,664	2.57
San Francisco	36,564,178	43,529,299	-6,965,121	0.84
Seattle	203,240,696	115,250,100	87,990,596	1.76

*Expansion of Crosstown Commons was not funded by the UPA, but its cost was included because its benefits could not be separated from those of the UPA.

In summary, the BCA showed total benefits to be positive at all but one site, while net benefits were positive at only two sites. However, the analysis is not without its limitations, but it was the best that could be obtained with available information and assumptions made for the analysis. Moreover, the future benefits of the projects could be different than those that were projected. It should also be noted that these were demonstration projects that were intended to test new approaches to managing congestion and provide useful feedback on what works and doesn't work well. Relatedly, in at least one site, San Francisco, the technology deployed was very new. With the anticipated expansion of SF*park* citywide, and deployment of similar systems in other cities, less expensive technologies are expected to be used, having learned from the SF*park* pilot.

EQUITY AND CONGESTION PRICING

Equity impacts, or the perceptions of fairness, especially for low-income travelers, could be a key factor in the acceptance of transportation projects involving the introduction of pricing. Equity impacts of pricing were examined at all UPA/CRD sites except Miami and include specific impacts to user groups, environmental equity across geographic area and demographic groups, and the reinvestment of revenue. In addition, perceptions of fairness were available from surveys at some sites.

User Groups

Most users benefited as a result of the pricing improvements. Increased costs to tolled users were offset by faster, more reliable travel, and transit users typically experienced a faster, higher quality trip on the tolled facility. In Atlanta, Seattle, and Los Angeles, travel conditions in the free facility (alternate route or general purpose lane) either did not change or speeds decreased slightly, while travel improved in Minneapolis' general purpose lanes. In Seattle, where tolling was deployed for all lanes on the SR 520 Bridge, lower income groups eliminated a greater proportion of trips across Lake Washington than other income groups. Parking pricing in San Francisco did not reveal any differences in impacts by income or age groups.

Environmental Equity

No apparent adverse air quality impacts to minority or low-income households were found at most UPA/CRD sites. However, given the prevalence of minority and low-income households adjacent to the Los Angeles ExpressLanes corridors, these populations were, therefore, disproportionately affected by adverse air quality impacts. Based on limited data provided by local partners, the calculation of net emissions on the ExpressLanes corridors showed an increase of 6.1 – 82.1 percent, depending on the pollutant. It is not known if increased traffic was utilizing alternate routes before, or if it was due to latent demand for use of the I-110 and I-10, or an improving economy that led to more traffic after tolling.

Reinvesting Revenues

One measure of equity is how revenues collected by the tolling and pricing systems are to be used. In San Francisco the city charter requires parking revenues to be used on city-owned transit services. Los Angeles expects to use parking revenue to expand LA Express Park into other neighborhoods.

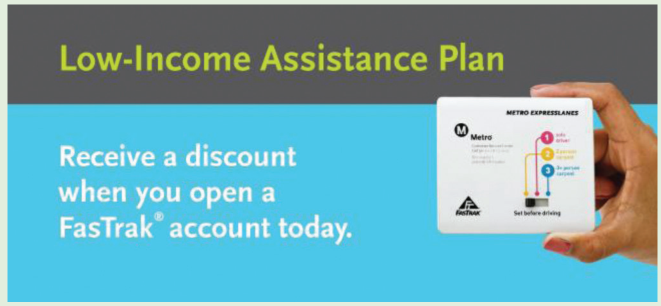
At sites with tolling deployments, revenues are generally applied first to paying for operations, maintenance, administration, and/or enforcement costs of the tolled facility. Some sites developed explicit plans for reinvesting potential net revenues from their tolling operations. In Seattle, net toll revenues from the SR 520 Bridge are being used to pay for a replacement bridge that will benefit all transportation users of SR 520, including drivers and transit users, as well as pedestrians and bicyclists who will be able to use the new bridge.

In Minneapolis net revenues from the I-35W South MnPASS HOT lanes are to be divided equally between public transit services and other roadway improvements on I-35W South. Similarly, in Los Angeles, net revenue from the ExpressLanes must be used in the respective corridor from which it was collected. This revenue will support transit service that was implemented to complement the ExpressLanes, with all remaining net revenue to be devoted to a combination of transit, system connectivity/active transportation, and highway improvements. In addition, Los Angeles implemented a Low-Income Assistance Plan (Figure 15) that addresses equity concerns.

Overall, these policies for allocating pricing revenues for multimodal projects promotes a positive, equitable impact that benefits all users. Geographic equity is promoted when revenues are reinvested within the corridor from which the revenue was collected. Highway improvements support drivers that utilize the tolled facility. Environmental equity is promoted by investments that reduce adverse air quality impacts in the corridor, such as transit, bicycling, and pedestrian travel.

Los Angeles ExpressLanes Low-Income Assistance Plan

The ExpressLanes were the first HOT lane operation in the U.S. to offer a plan to assist low-income commuters, originally called the Equity Plan. The plan was developed in response to concerns about low-income households' ability to afford the toll and monthly transponder fee. To be eligible, the applicant must be a Los Angeles County resident with an annual household income at or below two times the Federal poverty level based on household size. Once enrolled they obtain access to toll credits and a waived monthly transponder fee, as illustrated above. As of the end of February 2014, a total of 4,415 Los Angeles County households were enrolled in the plan, accounting for $110,375 in toll/transponder credits. This program helped lower-income single-occupant vehicle users to take advantage of the travel time savings offered by the ExpressLanes



Source: LA Metro

Figure 15. Low-Income Assistance Plan Advertisement

Survey Findings

The Volpe Center conducted a two-stage panel survey in Atlanta and Seattle to examine the impacts of tolling on corridor users. In Atlanta 74 percent of respondents in the survey before tolling started agreed that highway tolls were unfair to people with limited incomes, but after tolling was implemented that percent dropped to 57. In Seattle, 56 percent of respondents in the after-tolling survey agreed that tolling on SR 520 was unfair to people with limited incomes, with the lowest income group the most concerned about equity. In Seattle, lower-income households reported paying less in tolls, but reduced their travel across Lake Washington more significantly than other groups. Although this may raise concerns, equity impacts are difficult to interpret since household income levels of SR 520 Bridge users were high even prior to tolling (averaging $132,000).

In on-board transit surveys that were conducted in Seattle, Atlanta, and Los Angeles, slightly more than half the riders agreed that tolls were unfair to people with limited incomes. In customer satisfaction surveys in Los Angeles, the percentage of HOV, ExpressLanes, and general purpose lane motorists who agreed that the ExpressLanes only benefit the rich increased from 51 percent in the pre-deployment period to 60 percent in the post-deployment period. Moreover, the percent who agreed that the "ExpressLanes were accessible to everyone regardless of income because qualifying low-income households will receive a discount on their responder" fell from 47 percent in the pre-deployment period to 33 percent in the post-deployment period.

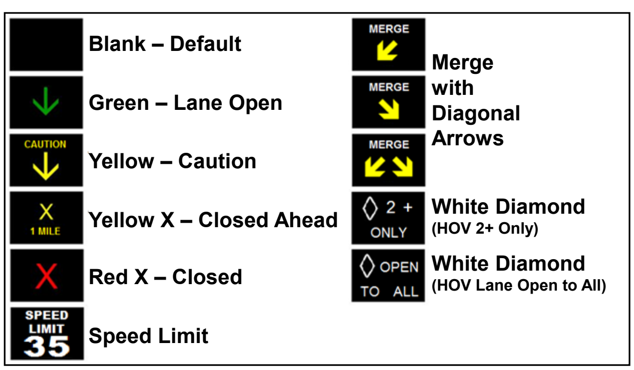
In summary, the evaluation findings indicate that the UPA/CRD projects did not generally have a negative equity impact and succeeded in expanding travel options through transit improvements. One site – Los Angeles – was notable for offering a program to assist low income travelers in using the ExpressLanes. Nevertheless, surveys at several sites indicate that perceptions of unfairness of tolling persist.

TECHNOLOGY PERFORMANCE

Intelligent transportation systems (ITS) technologies were incorporated into projects at all the sites. The national evaluation focused on a subset of technology projects, and highlighted in this section are findings about active traffic management (ATM) strategies, advanced parking technology, and automated enforcement technology. Technologies for ATM were deployed in Minneapolis and Seattle. Advanced parking meters and parking sensors were used in San Francisco and Los Angeles. Automated enforcement tools were used on the I-85 Express Lanes in Atlanta and for parking management in San Francisco and Los Angeles.

Active Traffic Management

The ATM strategies in Minneapolis and Seattle used similar technologies, but slightly different sign options and approaches. Minneapolis displayed variable advisory speeds that were not enforceable, while Seattle displayed variable speed limits (VSLs) that were enforceable, but were typically used in an advisory capacity during periods of congestion. Figure 16 shows the lane control option used in Seattle.



Source: Washington State Department of Transportation

Figure 16. Advanced Traffic Management System Sign Options Used in Seattle

Minneapolis deployed intelligent lane control signals (ILCS) and real-time transit and traffic dynamic message signs (DMS). The 174 ILCS on gantries about 0.5 miles apart on I-35W South were used primarily for incident management and speed harmonization, as well as designating when the MnPASS Express Lanes were in operation. Loop detectors measured traffic speeds downstream of the ILCS signs. The advisory speeds were posted up to 1.5 miles upstream. The system automatically activated advisory speeds in advance of congested areas. As illustrated in Figure 17, the advisory speeds were always the same for all signs on a single gantry, with a white diamond over the MnPASS lanes. Comparative real-time traffic and transit information was displayed on DMS along I-35W.

Source: Minnesota Department of Transportation

Figure 17. I-35W MnPASS Express Lane Diamond and General Purpose Freeway Lane Advisory Speeds

The evaluation found that operational, enforcement, emergency and transit staff viewed the ILCS as effective in managing, slowing down, and moving traffic to other lanes in the case of a crash or other situation, and no major technical problems were reported. Approximately 90 percent of surveyed travelers had seen messages on the electronic signs and the vast majority agreed that the strategies and signing would keep them informed of upcoming traffic conditions, would increase safety on the highway, and would ease traffic congestion.

The Seattle ATM and DMS systems included 70 new signs at 19 locations along eight miles of SR 520 and 129 new signs at 25 locations along nine miles of I-90. Figure 18 illustrates the signs on the SR 520 Bridge. The VSL signs were automated and activated by the system in advance of congested freeway segments. Three DMS displaying real-time comparative travel times to downtown Seattle via SR 520 and I-90 were deployed along SR 520, I-405, and SR 522.

Source: Washington State Department of Transportation

Figure 18. Signs on SR 520 Bridge in Seattle

Enforcement personnel, emergency responders, and bus operators who were interviewed generally reacted positively to the ATM and DMS components. The VSL signs helped in proactively managing traffic in congested freeway sections and informed drivers of incidents, although some staff questioned if drivers paid attention to the VSL signs.

As is noted in the last section of this report describing the long-term effects of the UPA/CRD projects at each site, Seattle and Minneapolis have had slightly different experiences with ATM since the evaluation. Citing the lack of measurable benefits along with substantial implementation costs and maintenance and operations costs, MnDOT will not be expanding the use of intelligent lane control signals and will gradually phase them out as replacement is needed. WSDOT, on the other hand, is looking at expanding its use of ATM, including lane control signage.

Advanced Parking Technology

Two projects, SF*park* in San Francisco and LA Express Park in Los Angeles, used advanced parking meters, state-of-the-art parking occupancy sensors, real-time parking information systems, and other technologies to implement and operate demand-based parking management systems. Figure 19 through Figure 21 illustrate these technologies. Although similar, the two cities differed slightly in approach, technologies, and issues encountered.

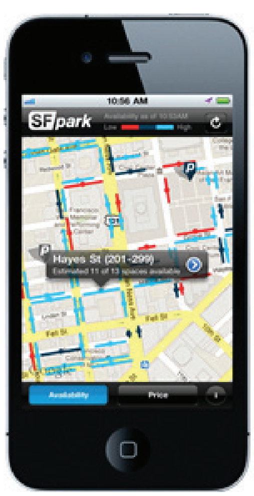
Source: San Francisco Municipal Transportation Agency

Figure 19. In-ground Parking Sensor in San Francisco

Source: Los Angeles Department of Transportation and San Francisco Municipal Transportation Agency

Figure 20. Examples of Advanced Parking Meters in LA ExpressPark™ and SF*park*

Technology used in SF*park* enabled the San Francisco Municipal Transportation Agency (SFMTA) to use variable pricing to manage availability of parking spaces and, thereby, reduce the number of drivers circling to find parking or double parking. New parking meters and parking space occupancy sensors were installed at approximately 7,000 on-street parking spaces in the seven pilot areas where variable pricing was implemented. The new parking meters expanded payment options to include cash, credit card, debit card, SFMTA issued parking/debit cards, and cellphone. Real-time information on parking price and availability was disseminated by websites, smart phone apps, and the 511 phone system. Figure 20 illustrates the SF*park* smart phone app.



Source: San Francisco Municipal Transportation Agency

Figure 21. Example of SFMTA Real-time Parking Information Mobile App

According to SFMTA personnel who were interviewed, the new parking meters worked well, the advanced parking technology improved the agency's ability to manage parking in the pilot areas, and the expanded payment options were well received by the public because they made paying easier and reduced the risk of receiving a citation. The state-of-the-art technology was not without problems, however. Initial parking sensors did not meet the SFMTA performance standard and had to be removed. Although the second sensor technology met the performance specifications and functioned well, the battery life was shorter than expected.

Information on real-time parking price and availability on the SF*park* webpage received an average of 21,417 real-time parking availability requests per day. The webpage served as a datafeed for serving various data users, including viewers of the webpage, requests from mobile apps, and numerous app developers and third party providers including the MTC for the 511 system. The cumulative number of iPhone SF*park* app downloads was 59,512 during the evaluation period and the total number of Android app downloads was 10,875. Requests for parking information from the regional 511 system averaged 979 calls a month by phone and 3,045 visits to the 511 website during the evaluation period. At the end of 2013 SFMTA discontinued use of the in-ground parking sensors, which meant that real-time information on parking availability was no longer offered for on-street parking.

Despite the high number of requests to the datafeed and the variety of platforms that travelers could have used for real-time parking information, awareness and usage tended to be low among surveyed respondents. The roll-out of the 511 parking information late in the deployment period and limited marketing of parking information may have been factors. Only 15 percent of respondents were aware of the information – the most frequently cited sources of parking information were the 511.org website and the SF*park* mobile app – and still fewer reported using any source.

The Los Angeles Department of Transportation (LADOT) implemented the LA Express Park™ demand-based parking project in a 4.5 square mile area in downtown Los Angeles. Technologies included approximately 6,000 parking space vehicle sensors, new parking meters, a real-time parking guidance system, a website, an integrated parking management system, and smart phone parking apps with real-time parking information. The advanced parking meters accommodated different parking rates for different times of the day and expanded payment options to include not only cash, but also debit and credit cards and payment by cell phones. The meters provide real-time communication, allowing motorists to receive a notification when the time on a meter was about to expire. Individuals could pay for additional time using their cell phones.

LADOT personnel believed that the parking sensors, parking meters, and parking management system – along with the policy changes – facilitated the department's ability to implement demand-based parking pricing and the parking guidance system, and the same technology components improved the department's ability to enforce parking regulations. Expanded payment options were seen as making it easier for motorists to pay for parking, thereby increasing payment compliance. No major technology issues with the parking sensors were experienced in Los Angeles during the evaluation period, although they were the same sensors that had been installed in San Francisco initially but later replaced with those from a different vendor.

In Los Angeles, real-time parking information was distributed by website, smart phone parking apps, and by dynamic message signs. Requests for parking information on the LA Express ParkTM website averaged 2,500 monthly hits initially, but increased to almost 4,000 hits a month by the end of the second year. Only 25 percent of respondents surveyed in the LA Express Park™ area were aware of the smart phone parking apps.

Automated Enforcement Technology

Atlanta developed and operated an automated enforcement system on the I-85 Express Lanes. The system included two major components – the gantry controlled access (GCA) technology and the vehicle-based enforcement technology. Transponder readers located on overhead gantries spaced approximately every half mile detected vehicles moving into and out of the Express Lanes between toll collection stations. When a vehicle making an illegal movement was identified, the system recorded the identity of the vehicle for enforcement purposes via license plate readers and a video enforcement system. Toll violation notices were mailed to the vehicle owner, based on the number of toll gantries missed by the vehicle.

The vehicle-based enforcement technology included a mobile automated license plate reader, which allowed Department of Public Safety (DPS) officers to verify the declared occupancy status of vehicles in the Express Lanes. The devices were linked to the State Road and Tollway Authority (SRTA) back office via a wireless communication system. Officers could immediately determine "toll exempt" vehicles in the Express Lanes and check for the required three people. Enforcement personnel were also able to compare license plate images to the registration database to ensure that only authorized vehicles were using the lanes. Citations were issued to the owners of unregistered vehicles. SRTA personnel who were interviewed noted that the technologies operated as envisioned, were reliable, and enhanced enforcement.

The enforcement tools developed to manage advanced parking management systems in San Francisco and Los Angeles helped to make enforcement more efficient and provide effective use of enforcement personnel. SFMTA conducted a small-scale test of a prototype handheld enforcement device during the demonstration period and found that it enhanced the efficiency of parking enforcement. In Los Angeles, occupancy data from the parking sensors and payment data from the parking meters were used to help identify potential violators as part of a guided parking enforcement effort. This effort built on activities initiated prior to the LA Express Park™ project, including a smart phone enforcement app that helped identify potential violations (showing occupied parking spaces that were unpaid) and tracked enforcement activities in real-time. However, because California law allows drivers with a valid disabled parking permit to park for free at an on-street meter, the technology's effectiveness for enforcement purposes is reduced.

In summary, the UPA/CRD program offered the opportunity to develop and test a diverse range of technologies in real-world settings that might not have been feasible otherwise. Evaluation of the performance of the technologies relied primarily on interviews with agency personnel and, where available, surveys of travelers. Agency personnel generally viewed the technologies as adding operational value and providing benefits to end-users. An exception was the problem with in-ground parking sensors in San Francisco, although they performed satisfactorily in Los Angeles. Nevertheless, the information gained from experience with performance standards and battery failures in San Francisco should help advance specifications for this type of product for other cities. The evaluation also demonstrated that development of a technology, e.g. a parking information app, is only the first step, and robust marketing is needed to encourage widespread usage.

THE DEPLOYMENT EXPERIENCE

This section highlights findings about the experience of the UPA/CRD deployers by examining non-technical factors that affected the success of the projects. First is a discussion of institutional issues, followed by marketing efforts undertaken by the sites, and finally the reaction of the public to the projects.

Institutional Issues

An important aspect of the overall evaluation entailed an understanding of "non-technical success factors" that influenced the projects and may be a significant variable in explaining project results. Interviews with key stakeholders were held during the planning and implementation stages to identify success factors in areas such as staff, collaborative processes, and institutional structures.

Key Success Factors

- Multi-agency collaboration
- Shared goals
- Good communication
- Competent staff
- Early, broad outreach

The interviews revealed that the complexity of innovation attempted by the UPA/CRD projects required levels of collaboration and communication that went beyond the norm. Project success (defined as both successful implementation and positive intended results) was linked to multi-department and multi-agency collaboration. For example, to plan, implement, and operate the new HOT lanes on I-85 in Atlanta, the state DOT built the physical infrastructure, worked closely with two other principal partners – the state toll authority which operates the tolling system and the regional transportation authority which implemented enhanced bus service – and many others. Regular communication among collaborating parties was vital as was a desire to strive toward common goals, such as offering more and better choices, increasing travel reliability, expanding effective capacity, and improving efficiency.

Each site undertook extensive marketing and outreach to inform potential users about the requirements and benefits of the systems (e.g., tolling/pricing) and services (e.g., bus service). Outreach served to address early concerns by policy-makers who might oppose tolling (Seattle), HOT lanes (Los Angeles), or parking pricing (San Francisco). In Los Angeles, this resulted in an alternative corridor being selected. However, in Seattle early tolling on the SR 520, and the link to bridge replacement, was accepted publicly and politically through the deliberate outreach and communications of top agency leadership. Existing marketing and outreach channels, such as those available from ridesharing programs, were utilized as well. More details on marketing and outreach appear in the next section.

Technical, administrative, financial, and other staff competencies played a key role in assuring success. Since advanced technology was used extensively in all the projects, having appropriate expertise involved in the projects was vital. In several cities technology was a source of delay, but staff worked diligently to overcome these hurdles. San Francisco, for example, deployed a state-of-the-art parking pricing system which pushed the San Francisco Municipal Transportation Agency into uncharted territory with new equipment and back office information systems.

In summary, project stakeholders concluded that several key factors contributed to the success of the UPA/CRD projects. They recognized that staff competencies were essential, but working "outside" of their usual domains to understand other viewpoints created a better overall end-product (in the form of a tolling option, parking program, express bus service, etc.). This also meant building upon existing partnership as in Minneapolis, or allowing somewhat new partners to join, such as Georgia DOT collaborating with the State Road and Tollway Authority on the HOV-to-HOT conversion. Finally, shared goals and a common vision were cited as necessary ingredients at all the sites, as for example the need to replace the 520 floating bridge in Seattle and the role of tolling in providing needed revenue.

Marketing and Outreach

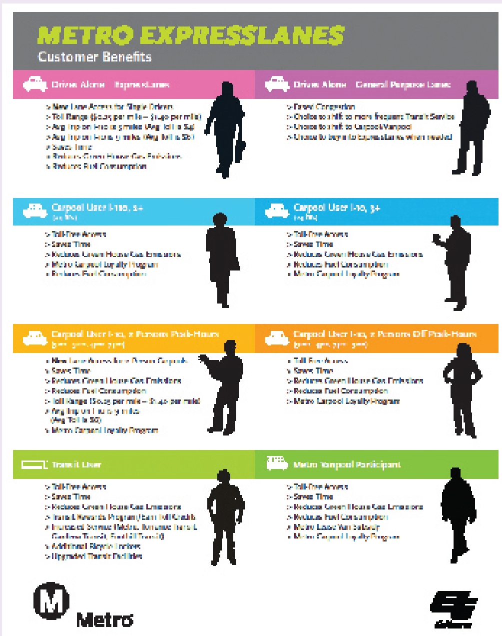
By their very nature the UPA/CRD projects were meant to demonstrate significant changes to the transportation landscape in the communities where they were deployed and to do it in a short period of time, thereby presenting formidable marketing challenges for the local partners. Not only did they need to reach the public who would experience these changes, but often outreach was needed to elected officials and institutional stakeholders to garner their support for the projects. All six sites used a variety of methods to reach their targeted audiences (sidebar). Figure 22 presents a small sample of the material produced. Highlights and examples of the marketing efforts are presented in this section.

Among the greatest marketing challenges was communicating the unfamiliar concept of congestion pricing in transportation. Agency personnel spoke about needing to change the culture – how travelers think about their transportation system, be it highways or parking. Indeed, Florida DOT found that many Miami express lane users did not understand that a higher price meant that the lanes were congested, and education of the public would be a continuing need as there would always be new express lane customers to inform.

Delivering high quality customer experience was another challenge local deployers had to address now that transportation facility users were customers paying a premium for service. To differentiate the new from the old, the sites employed distinctive brand names and brand graphics, such as SF*park*, Good-to-Go, 95 Express, Peach Pass, LA Express Park™, MnPass, and ExpressLanes. Agencies used combinations of outreach events with employers, retail outlets, online accounts, customer service centers, and call centers to promote tolling and to register and maintain relationships with tolling customers. In this transition in agency culture to regard the public as customers, customer satisfaction with the service they received became critically important. For example, in Atlanta, a region not previously familiar with HOT lanes, surveys showed that 70 percent of Peach Pass holders were satisfied with their experience of opening and setting up accounts and 72 percent were satisfied with managing their accounts.

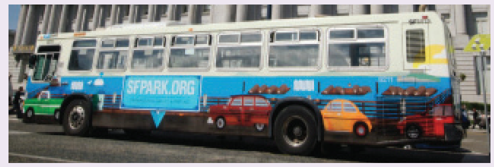
Many Audiences, Many Methods

- Public meetings
- Booths at special events and shopping malls
- Press briefings
- Meetings with employers
- Press releases
- Fact sheets
- Websites
- Social media
- E-newsletters
- E-mail updates
- On-line videos to explain how the system works
- Brochures and posters
- Live web chats
- Purchased advertising
- One-on-one meetings with elected officials and other stakeholders



Source: LA Metro

Identification of Customer Benefits of Los Angeles ExpressLanes



Source: SFMTA

Advertising Bus Wrap in San Francisco

Source: State Road and Tollway Authority

Peach Pass Website

Source: Minnesota Department of Transportation

MnPASS Logo in Minneapolis

Source: Washington State Department of Transportation

SR 520 Bridge Tolling Advertisement

Figure 22. Examples of Local Partners' Marketing Materials

Despite the extensive marketing that was conducted by the UPA/CRD sites, more promotion of some parts of their projects might have made a difference. For example, more marketing and incentives for alternate mode choices may have mitigated carpool break-up or led to greater transit usage. A case in point was Atlanta, where marketing and media coverage of the transit alternative to the Express Lanes were minimal, despite the addition of new routes, new buses, new park-and-ride lots and the travel time advantage enjoyed by buses using the Express Lanes. Another example was in San Francisco, where on-street interviews conducted at the end of the evaluation period revealed that few people knew about real-time parking information sources. Low awareness was not surprising considering that SFMTA's promotional event that highlighted their smart phone parking app had occurred two years before post-deployment surveying and MTC had not conducted any marketing of parking information on their 511 system prior to the end of the evaluation period.

Typically, state and local governments are reluctant to invest in marketng and outreach. However, based on the results from efforts at the six sites, the importance of dedicating funding in this area was demonstrated. Through purposeful and extensive marketing and outreach conducted by the UPA/CRD partners (for example, Figure 23 and Figure 24), they were generally quite successful in communicating plans about their projects over time and in effectively managing customer relations. The local media served as an important partner in the outreach process by keeping the projects in the public eye and helping to disseminate operational details to make the transition to new transportation services easier. More about the media's role is presented in the next section.

LA Metro is a good example of a local partner's commitment to outreach. Their outreach campaign targeted specific stakeholders using a variety of methods and venues. By the end of the demonstration period, Metro had conducted a total of 640 briefings and events on the LA CRD, including 303 stakeholder briefings and 95 legislative briefings. In addition, Metro developed Corridor Advisory Groups (CAG), which served as citizen advisors to the CRD and provided insight and recommendations on messaging and helped to shape some of the elements and features of the LA CRD projects. The CAG met 20 times over the course of the LA CRD planning, implementation, and post-deployment periods.

Figure 23. LA Metro's Commitment to Outreach and Citizen Involvment

"If Apple were to design parking management, what would it look like?" Jay Primus, SFpark Manager, Jan. 26, 2012.

SFMTA was striving for a uniform, simple, smart customer experience when it set out to change the way people thought about paying for parking. Education about demand-based prices and the benefits to the individual and the city, as well as where the pilot was in effect, needed to be efficiently communicated to a skeptical public bombarded with information from every direction. Thus, creating a strong SF*park* brand was as essential to the success of the SF*park* pilot as the technology behind it. To do this SFMTA brought in innovative design firms to develop a communications strategy and to design and execute a coordinated suite of products, including meter decals, garage signs, mobile apps, website, and more along with a tagline that captured the intended customer experience to "circle less, live more."

Source: San Francisco Municipal Transportation Agency

Figure 24. SF*park* Branding

Public Acceptance of Innovative Projects

In addition to observed patterns of usage of the UPA/CRD projects described earlier, understanding public opinion about the projects and whether they were perceived as beneficial to those who used them was an important line of inquiry in the national evaluation. Moreover, since the media can influence public opinion based on its coverage of transportation, the evaluation also sought to understand the media's potential role in shaping public opinion.

Public acceptance of the UPA/CRD projects was assessed using customer satisfaction surveys. Although the survey questions and sampling methodologies varied among the sites, the results tended to show that the majority of users of facilities with demand-based pricing perceived benefits to their travel compared to the period before such pricing was in effect.

- Miami 95 Express users had faster travel times (79 percent) and more reliable trips (80 percent) after tolling.
- Minneapolis MnPASS lane users said travel was easier and less congested (56 percent) than before, and they saved time and traveled faster (69 percent).
- San Francisco drivers who parked in pilot areas took less time to find parking (4 minutes) after demand-based pricing and were able to park within a block or less to their destination (31 percent before vs. 46 percent after).
- Seattle users of the tolled SR 520 Bridge reported faster trips, were more satisfied with their travel speeds, and found their trips more predictable compared to before tolling. (Details are in Table 13.)
- Los Angeles motorists thought having the ExpressLanes as an option was a good idea even if they didn't use it on a regular basis (58 percent), and time savings was seen as the greatest benefit (71 percent) for FastTrack® transponder owners who used the ExpressLanes.
- Atlanta Express Lane users were the exception: dissatisfaction outweighed satisfaction for travel time (48 percent vs. 43 percent), speed (46 percent vs. 43 percent) and predictability (45 percent vs. 36 percent) a full eight months after tolling began.

Not surprisingly, the surveys sometimes revealed that not all travelers perceived the same benefits from the UPA/CRD projects. A case in point are the drivers who took alternative bridges across Lake Washington in Seattle. The Volpe Center conducted a pre- and post-tolling panel survey of households in the SR 520 corridor. Table 13 presents the change in satisfaction scores for trips by those who used the SR 520 Bridge and those who used the I-90 Bridge. Satisfaction on SR 520 increased after tolling in terms of time, speed, and predictability of travel. In contrast, satisfaction with trips on I-90 declined slightly. These patterns are consistent with the change in average a.m. and p.m. peak-hour speeds measured by WSDOT: a 10-26 mph improvement on SR 520 and 2–7 mph decrease on I-90.

Table 13. Mean Satisfaction Scores for Peak-Period Driving Trips across Lake Washington Before and After SR 520 Tolling

(Based on 7-point scale, with 1 = highly dissatisfied, 4=neutral, 7=highly satisfied)

	Pre-Tolling on SR 520	Post-Tolling on SR 520	Change
On SR 520 (N=1,840 trips pre-tolling, N=1,032 trips post-tolling)			
Travel Time	3.41	5.17	+1.76*
Travel Speed	3.35	5.16	+1.81*
Travel Predictability	3.47	5.13	+1.66*
On I-90 N=1,306 trips pre-tolling, N=1,199 trips post-tolling			
Travel Time	3.98	3.87	-0.11*
Travel Speed	3.93	3.81	-0.12*
Travel Predictability	4.03	3.68	-0.35*

* Statistically significant change.

Source: The Volpe Center.

Media coverage of the UPA/CRD projects was collected at each site and included items from mainstream sources such as local and national newspapers, blogs, targeted educational pieces from organizations not part of the UPA/CRD projects, op-ed pieces, and industry publications. The total items varied considerably among the UPA/CRD sites: 257 for Atlanta, 709 for Los Angeles, 42 for Minneapolis, 596 for San Francisco, and 832 for Seattle. (The total amount of coverage was not available for Miami.) The low number for Minneapolis was most likely a reflection of the lack of controversy about its projects.

Results of an analysis of the content of the coverage (based on a sample at most sites) ranged from dispassionate reporter to helpful partner to sharp critic. The focus was overwhelmingly on tolling or pricing projects with little attention to transit or other supporting strategies at most sites. For example:

- **Atlanta:** In the wake of limited media coverage prior to the HOT lane opening, extensive coverage in the immediate post-launch period was predominantly negative and emphasized the public's dissatisfaction with paying a toll and loss of free use of the lane by two-person carpools.
- **Los Angeles:** Balanced coverage of all points of view were observed. The media played a helpful informational role by explaining how the new system would work and what to expect.
- **Miami:** Florida DOT found the media to be key partners in informing the public about how pricing worked and in correcting misperceptions in the immediate post-launch period. Miami was one of the few sites with news coverage about the advantages of express bus service, which in turn helped to promote the transit option.
- **Minnesota:** The media informed the public about the projects but did not try to influence public opinion, since the projects were not viewed as controversial.
- **San Francisco:** Coverage was extensive and primarily positive, emphasizing the benefits that the deploying agency expected to achieve and the national attention focused on the innovative technology project.
- **Seattle:** The media helped the partners frame tolling as an unavoidable means for paying for needed infrastructure, that is the SR 520 Bridge, but delays in the start of tolling and other technical problems turned coverage negative at times.

In conclusion, surveys and media coverage of the UPA/CRD projects showed public opinion to be generally positive at most sites. The projects were seen as doing something beneficial for the transportation system in the region, and the users of the new projects perceived direct benefits to themselves. Atlanta was the exception in sustaining considerable negative reactions for many months after the opening of its express lanes, perhaps an indication of the considerable change the public was being asked to absorb. No other site instituted tolling without added capacity and simultaneously changed occupancy to HOV3+ requiring registration and a transponder. However, the LA ExpressLanes were required to allow clean fuel vehicles to use the lanes at the end of the one year pilot which contributed to the lanes once again reaching capacity.

OPERATIONAL IMPACTS

Agency operations were impacted by the UPA/CRD projects that they became responsible for managing. This section discusses findings on two aspects of operations, the impact on agency staffing and the changes in how agencies performed enforcement for violations related to pricing.

Staffing

The UPA/CRD projects, in offering new technologies imposed new responsibilities on agency staff that required additional training, staff members, and new ways of thinking about operations. A few examples are discussed below.

The ATM lane control signage deployed in Minneapolis and Seattle required a more involved approach to operations than had previously been necessary. In both locations, the ATM signage is actively managed 24 hours every day, placing an increased responsibility on operators to ensure accuracy and retain motorist confidence in the signage. For example, during an incident as conditions change with the arrival and departure of emergency responders, it is very apparent to motorists when ATM signs (spaced every ½ mile) are wrong (for example, if the wrong lane is listed as closed, marked closed at the wrong place, or still marked closed after an incident is cleared). As a result, additional staff were hired at the transportation management center (TMC) in Seattle, whereas the TMC in Minneapolis cross-trained additional staff to ensure 24/7 coverage. Even though the systems automatically posted variable speeds, TMC operator oversight was still valuable for ensuring the messages were appropriate.

Deploying agencies in Los Angeles noted that implementing innovative traffic management solutions disrupted typical processes and challenged established practices. Traditionally the regional transit operator, Metro was in charge of implementing and operating the tolling system on the ExpressLanes, including procuring a first-ever Design-Build-Operate-Maintain (DBOM) contract for tolling, but it had to do this on a Caltrans-owned facility. Once the ExpressLanes were deployed, Metro staff recognized that they were running a business and that control over the customer experience must remain in-house.

HOT lanes necessitated new levels of interagency cooperation. In Atlanta, coordination between emergency response personnel and tolling operations staff was noted to be critical during incident events. The tolling and enforcement agencies needed to know when incident responders were forcing traffic into or out of the Express Lane so that Express Lane users were not issued citations when they were directed to leave or enter the Express Lane.

The UPA/CRD projects also impacted enforcement with new or more targeted enforcement efforts as a result of the new approaches to pricing. The State Road and Tollway Authority in Atlanta funded additional personnel from the Department of Public Safety for enforcement in the Express Lanes, and technology (see technology discussion below) enhanced their ability to spot occupancy violations. In Los Angeles, the California Highway Patrol (CHP) dedicated a specific ExpressLanes patrol after the deployment of the ExpressLanes where previously only officers on routine patrol in the corridors had issued citations. In Miami, off-duty Florida Highway Patrol officers were contracted by FDOT to provide extra enforcement on 95 Express. In Minneapolis, MnDOT funded extra State Patrol coverage on the I-35W MnPASS lanes during the morning and afternoon operating periods.

For SFMTA in San Francisco the staffing challenge was one brought on by the technical nature of SF*park*. On the surface, SF*park* was seen primarily as a parking policy project that transformed how parking rates were set, moving away from elected policymakers (after they set overarching policies) and instead toward market demand principles. However, once the project began, it became evident to all involved that it was a deeply technical project, which in turn required types of technical expertise not normally associated with municipal parking operations.

Violations and Enforcement

Assessing trends in violations before and after the deployment of the UPA/CRD projects proved difficult due to a number of confounding factors at the sites, such as how violations are measured. The following is a summary of the findings from the data available for each site.

In Atlanta, 49,229 violation notices based on the gantry-controlled access system were issued from February through September 2012. During the first three months of operation (November 2011 through January 2012), violators were offered a grace period, and during that time 1,207 warning letters were issued. Insufficient data prevented a comparison of the rate of occupancy violations in the previous HOV lane with the rate after tolling began. Also, analysis of the data was complicated by the fact that the violations did not differentiate between I-85 Express Lanes and the Georgia 400 Toll Road, which was also managed by SRTA. SRTA contracted with the DPS for spot enforcement of the Express Lanes. DPS reported an average of 47 citations per month for failing to correctly self-report the number of occupants in the vehicle and 21 citations per month for unlawfully entering the Express Lanes by crossing the double white lines. In the post-deployment period, occupancy violations comprised about 19 percent of the total number of citations issued by DPS while unauthorized entry into the Express Lanes represented about 8 percent. Data were not sufficient to determine actual number of violations, but only those that were detected manually or with the enforcement technology. The analysis indicated that recorded violations and manual citations remained fairly constant throughout the evaluation period.

In Los Angeles, a grace period for violators was in effect for the first 60 days of operation, after which both electronic and manual visual enforcement were used on the I-110 and I-10 ExpressLanes. Both types of enforcement were used to address violations of the self-declared occupancy requirements. The electronic toll collection system only addressed vehicles without a transponder or a non-active account, and from March through December 2013, the number of violation toll trips recorded during the morning peak hour, peak direction on the I-110 and I-10 ExpressLanes represented approximately 6 to 7 percent of the total toll trips during that time period. A dedicated California Highway Patrol was added after the ExpressLanes were deployed. The total number of manual vehicle code violations issued by CHP increased in both corridors from the pre-deployment period to the post-deployment period. Although the number of occupancy violations decreased significantly in the post-deployment period, the overall number of toll and transponder violations issued in the post-deployment period more than made up for this decrease. Toll and transponder violations can include citations issued for refusal to pay the toll and failure to possess or display a transponder at the toll gantry, for example. The type of citation issued is at the discretion of the CHP officer, and more than one violation may apply to a given scenario even though only one citation is typically issued.

In Miami FDOT contracts with Florida Highway Patrol (FHP) to provide visual enforcement within the express lanes. Toll/HOV violations are the most frequent type of violations and occur when a registered HOV3+ vehicle is observed by FHP to have less than three people and using the express lanes. Toll/HOV violations decreased in FY2012 from 35% to 29% of the citations issued.

In Minnesota the majority of citations and warnings were issued to individuals driving alone in the MnPASS HOT lanes without a MnPASS account and active transponder. A total of 1,515 citations and 231 warnings were issued to drivers in this category over an eight-month period in 2011. Discounting July, when the MnPASS lanes were not in operation for 21 days due to the Minnesota state government shutdown, there were an average of 249 citations and warnings per month to non-MnPASS drivers. MnPASS customers with an inactive, malfunctioning, or not engaged transponder represent the second largest number of citations and warnings. Finally, individuals illegally crossing the double white lines separating the MnPASS lanes from the adjacent general-purpose freeway lanes accounted for 32 citations and 134 warnings during the eight-month period. While it appears the number of occupancy violators has decreased to 5 percent from the previous HOV operations, when violation rates were approximately 15 percent, the number of citations and warnings issued to drivers without an active MnPASS account remained relatively constant over the eight-month period. This suggests that some drivers may feel they can violate both the MnPASS toll and the carpool requirements and not get caught.

In Seattle, when a vehicle does not have a transponder or the transponder account does not have sufficient funds a toll bill is mailed. If a toll remains unpaid after 80 days, a $40 notice of civil penalty is issued for each unpaid toll transaction, plus all accumulated tolls and fees, as required by state law. From December 29, 2011 through April 30, 2013, approximately 1.5 percent of all tolls went unpaid long enough to trigger the $40 notice of civil penalty.

In San Francisco, many pilot parking areas experienced declines in the number of citations, but no specific trends were evident and there were no statistically significant differences from the control parking areas for changes in average monthly citations. Although Los Angeles officials asserted that enforcement for LA Express Park™ areas provided for a more efficient and effective use of parking enforcement personnel, citation data were unavailable.

There are a number of reasons that violations occur, and steps that an agency can take to reduce those violations. In Atlanta the media was a valuable resource in terms of disseminating operational changes to the public. SRTA found that when the media were involved in announced changes in operations or tolling policies, violation rates dropped after the change. Additionally, SRTA noted the importance of treating violators as potential customers, as many violators were unclear or misinformed about the way the tolling operations in the Express Lanes worked. SRTA encouraged their customer service representatives to work with violators to help them establish new accounts or clarify rules so as to turn them into customers of the system. Similarly in Los Angeles, Metro quickly realized that they must meet the needs of the public with a customer service orientation, which became particularly evident when managing the tolling call center. Additionally, both Atlanta and Los Angeles included a grace period to violators following the deployment of tolling on the HOT lanes based on the assumption that some drivers would be unaware of the operational changes. Finally, the relatively constant number of citations and warnings issued to drivers without an active MnPASS account in the post-deployment evaluation period suggests that some drivers felt free to violate both the MnPASS toll and the carpool requirements and not get caught, implying that additional outreach and public education on use of the MnPASS lanes was needed.

LONG-TERM EFFECTS OF THE UPA/CRD PROJECTS AT THE SIX SITES

This final section looks at the impact that participation in the UPA/CRD program has had on the six cities. Local partners at each site provided information on how their projects have fared since the end of the demonstration period and the long-term effects that the projects may have had.

Atlanta

The Atlanta I-85 Express Lanes were intended as the first segment of a regional HOT lane network, and additional Express Lanes are in the works, as shown in Figure 25. As the state gathered feedback on the I-85 Express Lanes, they shifted their policy to focus on prioritizing new priced managed lanes that were new capacity rather than conversion projects.

Source: Georgia Department of Transportation

Figure 25. Managed Lane Corridors in Atlanta

The goal is to address congestion by providing an additional choice for motorists, without reducing or converting any of the existing options. Unlike the HOV-to-HOT conversion on I-85, new tolled lanes will be added in the expanded system. The first to open will be twelve miles of two dynamically priced reversible tolled lanes in the median along I-75 south of Atlanta at McDonough Road and ending at Stockbridge Highway. Construction started in 2014 and the reversible lanes will open to traffic in 2017. Construction also began in 2014 on another Express Lane project known as the Northwest Corridor that will consist of 29.7 miles of new dynamically-priced reversible tolled lanes added along I-75 from Akers Mill Road to Hickory Grove Road and along I-575 from I-75 to Sixes Road. It is set to open in 2018. In the fall of 2015 construction is set to begin on yet another Express Lanes project which will be a 10-mile extension of the existing I-85 Express Lanes. Scheduled to open in 2018 the extension will stretch north from Old Peachtree Road to Hamilton Mill Road and will add new toll HOT3+ lanes and new auxiliary lanes between on- and off-ramps intended to improve merging and prevent bottlenecks. With the exception of the I-85 Express Lanes extension, all of the other contemplated projects are designed as express toll lanes, where all vehicles will be tolled with the exception of public transit vehicles, registered vanpools, and emergency vehicles.

Usage of the I-85 Express Lanes has continued to increase.[7] Average weekday trips in January 2015 reached 21,998, 28 percent higher than at the end of the demonstration period in September 2012. The average peak toll in January 2015 was $2.45 compared to $1.47 in September 2012. At 301,554 the total number of assigned Peach Pass transponders has increased by over one-third during that time. Non-tolled trips have remained steady around 14 percent.

[5] Georgia Department of Transportation,http://www.dot.ga.gov/DS/GEL.

[6] State Road and Tollway Authority,http://www.peachpass.com/peach-pass-toll-facilities/i-85-travel-data.

The upward growth in GRTA's Xpress bus ridership on routes operating from the three CRD-funded lots (Mall of Georgia, Hamilton Mill, and Hebron Baptist) has continued, collectively increasing by 24 percent between 2012 and 2014. During that same time the Xpress bus route operated by Gwinnett County Transit (GCT) from the CRD-expanded I-985 lot declined by 25 percent. Fares on GRTA's routes are lower than those of GCT, which might explain the difference in growth. Ridership on buses that use the Express Lanes from other lots in the corridor has declined, resulting in an overall drop of 6 percent when combined with the CRD-funded routes.

Signaling the potential for more integration of tolling and ridesharing to address congestion, Georgia's governor appointed one person to lead both SRTA and GRTA in 2014.[8] Since then, three new pilot programs have been developed for launch in 2015. The Shift Commute Pilot seeks to reduce morning congestion by awarding toll credits to selected Peach Pass drivers, who are invited to participate, to make fewer southbound trips between 7 to 8 a.m. The Carpool Pilot aims to attract 2+ person carpools by awarding toll credits in addition to the standard commute options cash payment. The Ride Transit Pilot plans to entice Peach Pass drivers who drive alone by awarding toll credits based on the number of trips they take on Xpress and GCT buses using I-85 Express Lanes. The pilots will be assessed in December 2015 and January 2016.

Los Angeles

Los Angeles implemented two distinct pricing projects: ExpressLanes and LA Express Park™. Since the end of the evaluation in February 2014, both projects have continued to garner support of decision-makers that has, in turn, led to plans for further improvements and expansion.

The I-110 and I-10 ExpressLanes were initially approved for deployment as a pilot, but are now being used as a model for deploying HOT lanes in other parts of the region. In a show of support for the program, the Metro Board voted in April 2014 to make the I-110 and I-10 ExpressLanes permanent, and in September 2014 the state legislature passed and the governor signed a bill (Senate Bill 1298 (Hernandez)) approving their permanent status. Currently, LA Metro is working with California Department of Transportation (Caltrans) to study the possibility of deploying ExpressLanes on the entire 16-mile I-105 corridor from Los Angeles International Airport to the I-605, as well as an extension of the I-110 ExpressLanes south to the I-405. Metro is also developing a strategic plan for expanding the ExpressLanes network regionally.

Usage of the I-110 and I-10 ExpressLanes continues to increase, with 357,583 transponders in distribution by March 2015 (up from 261,230 at the end of the evaluation period in February 2014). There was also an 18 percent increase in the number of ExpressLanes trips taken during FY15-Q1 (July to September 2014) compared to FY14-Q1. Since the evaluation period ended, the number of self-declared carpool trips has continued to outnumber self-declared SOV trips on both the I-10 and the I-110. Transit ridership on the ExpressLanes has also increased by 2.8 percent since September 2013, with over 34,000 riders as of September 2014.

Average travel speeds during the peak morning commute have remained above the 45 mph threshold on both ExpressLanes corridors. However, the continued increase in vehicle trips on the ExpressLanes has caused speed to occasionally drop below the threshold during the 7–9 a.m. peak period. When that happens, the ExpressLanes have been restricted to HOV only to help alleviate some congestion thereby not allowing SOV drivers into the lanes. The restriction has occurred more frequently on I-110 than I-10 due to the higher concentration of vehicle trips on I-110.

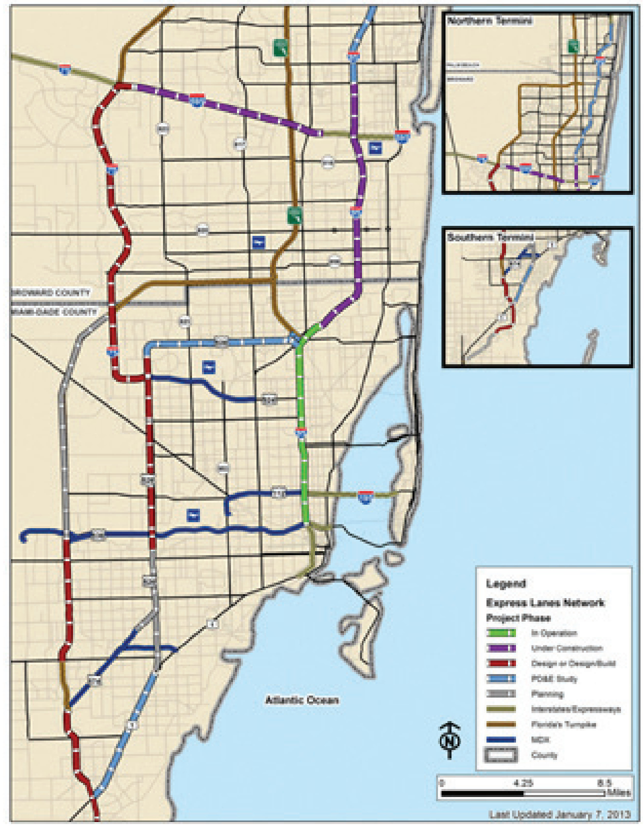
The I-110 and I-10 ExpressLanes generated sufficient revenue in the first year of operations to pay for continued funding of the incremental, additional transit services that support the ExpressLanes, and Metro is currently releasing $20 million of Net Toll Revenue Reinvestment Grants for adjacent communities. Local jurisdictions applied to fund projects that increase mobility and person throughput in the ExpressLanes

[8]Atlanta Regional Council news release, Dec. 10, 2014, http://arcnewsmanager.atlantaregional.com/templates/?a=53865.

corridors through transit improvements, highway improvements, and projects that promote active transportation and system connectivity. The local jurisdictions were very welcoming of this opportunity. In addition, Metro's transit rewards program had provided over $26,000 in toll credits to 6,896 accounts as of September 2014. Finally, the program to assist low-income household (formerly known as the Equity Plan) had enrolled 5,740 households by December 2014, which is up from 4,400 at the end of the evaluation period.

LA Express Park™ is expanding to include Westwood Village and Hollywood with planned go-live dates in 2015. LA Express Park™ may also expand to Exposition Park near the University of Southern California and Venice Beach, but this would be dependent upon receiving grants and would not take place before 2020. The new Metro 511 system that was introduced in May 2014 includes interactive voice response with an option for parking availability in LA Express Park™ areas.

LA Express Park™ has seen a small increase in revenue of 2.5 percent, but that may be the result of an improving economy. Average occupancy in LA Express Park™ areas has increased from 57 percent to 62 percent. After the evaluation period, parking sensors began to fail due to battery life, but maintenance or replacement of sensors has succeeded in keeping them on-line over 96 percent of the time. On the other hand, LA Express Park™ has not been as effective as possible at increasing parking availability in areas with high demand, because increased prices cause paying customers to leave and those vacant spaces are often filled by vehicles with disabled placards, which are not subject to payment requirements or time restrictions. Disabled placards comprise 25 percent of parking occupancy, i.e., unpaid hours, in LA Express Park™ areas. However, LA Express Park™ technology has provided a wealth of quantifiable data that has enabled a state-level dialogue to begin with the Department of Disability and legislators who now recognize that parking congestion results mostly from a policy choice instead of inadequate enforcement.



Source: Florida Department of Transportation

Figure 26. Florida Express Lane Network Phases

Miami

Florida DOT has continued to expand its regional network of express lanes throughout South Florida, including the original 95 Express project, as illustrated in Figure 26. The UPA demonstration focused on Phases 1A and 1B of the 95 Express and provided valuable lessons that have been applied to the next phases. Lessons learned from Phase 1 included the need to develop a concept of operations prior to design phases and to maximize shoulder width for emergency response vehicles. FDOT also decided to remove the electronic message sign above the tolling gantry that caused confusion for some drivers in Phase 1 who saw one toll amount before entering the facility and, at times, a different toll amount at the point where their transponder was read.

Phase 2, under construction since November 2011, will begin operation in 2015, extending northward 13 miles from the Golden Glades Interchange in Miami-Dade County to Broward Boulevard in Broward

County. Existing HOV lanes will be converted into two express lanes in each direction. Phase 3 will add 29 more miles of express lanes north from Stirling Road in Broward County to Linton Boulevard in Palm Beach County. Phase 3 will be implemented in phases due to funding limitations, with construction on Phase 3A-1 and 3A-2 scheduled to begin in 2016.

Usage of the Phase 1 express lanes has continued to increase although at a slower rate, reaching 1.8 million trips in February 2015 compared to 1.6 million in February 2011. The speed advantage of the express lanes over the general purpose lanes, especially during the peak period, has been maintained. To maintain express lane performance, tolls have increased reaching an average $4.50 in the afternoon peak and a maximum of $10.50.

Ridership of express buses using 95 Express has continued to grow. On the routes operated by Broward County Transit and Miami-Dade Transit that were part of the UPA, 95 Express buses carried an average of 3,430 riders per day in fiscal year 2013-2014 (July through June) compared to 2,430 in FY2012-2013 and 1,860 in FY 2010-2011, the last year of the demonstration period. In addition, the Golden Glades route operated by Miami-Dade Transit that was not part of the UPA carried another 2200 persons daily on 95 Express, bringing the total daily ridership to 5600 in FY 2013-2014. The growth in buses has a significant impact on person throughput in the express lanes, with express bus service estimated to account for 20 and 25 percent of total person throughput during a.m. and p.m. peak periods respectively.[9]

In FY2011-2012 FDOT began tracking trips made by registered vehicles exempt from paying tolls, which accounted for about 2 percent of all trips on 95 Express and 6 percent in the peak periods in FY2013-2014. Trips by exempt vehicles in all categories grew by 42 percent during the last three fiscal years, with the greatest peak period percentage growth among van pools (>100) and hybrids (60) followed by buses (30), HOV3+ (10) and motorcycles (4).

Minneapolis

The robust suite of tolling, transit, technology and telecommuting projects enabled by the Minneapolis UPA has continued to benefit travelers since the completion of the demonstration period in December 2011. Moreover, the UPA expanded the dialog for considering similar applications in other parts of the metropolitan area and provided synergy for ongoing collaboration and cooperation among agencies. Highlights of the progress are presented here.

The I-35W MnPASS Express Lanes were extended two miles to the south from Burnsville Parkway to the I-35W/I-35E split in 2012, bringing the total length of the I-35W MnPASS Express Lanes to 18 miles in the northbound direction, including the priced dynamic shoulder lane, and 16 miles in the southbound direction. In addition, MnDOT plans to rebuild the I-35W/Lake Street interchange in 2017-2020. The project will include replacing the priced dynamic shoulder lane with a MnPASS lane in the northbound direction and adding a new MnPASS lane in the southbound direction. The intelligent lane control signals in the section will also be replaced with two dynamic message signs in each direction to reduce replacement and ongoing maintenance costs.

Use of the I-35W MnPASS Express Lanes continues to increase. The number of active I-35W MnPASS accounts increased from 7,397 in November 2011 to 11,346 in January 2015. The number of transponders associated with these accounts increased from 8,425 to 13,480 over the same time period. Almost 61,000 trips were made by I-35W MnPASS customers in November 2011, accounting for $94,619 in revenue. In January 2015, 74,542 trips were made in the I-35W MnPASS Express Lanes, accounting for $151,244 in revenue.

The UPA facilitated consideration of MnPASS Express Lanes in other corridors by MnDOT and the Metropolitan Council, with a managed lanes system included in MnDOT's Regional 2030 Transportation Policy Plan. The next addition to the MnPASS Express Lanes system is already under construction on I-35E between St. Paul and Little Canada, with completion anticipated by 2016. The I-35E MnPASS Express Lanes represent the first MnPASS investment in the eastern metropolitan area, enhancing travel between downtown St. Paul and the northern suburbs.

[9]For buses operating between the Golden Glades Interchange and Downtown Miami. Cambridge Systematics (March 31, 2015), "2014 I-95 Managed Lanes Monitoring Report" at http://www.dot.state.fl.us/transit/Pages/2014I-95MLsMonitoringReport-Final.pdf.

The MARQ2 lanes in downtown Minneapolis continue to provide faster bus travel speeds, reduced travel times, and improved trip-time reliability for transit riders on express routes from throughout the metropolitan area, including the I-35W corridor. Five separate express buses operators all use the MARQ2 lanes, which accommodate 80 percent of the downtown express buses from 75 park-and-ride lots throughout the metropolitan area. Ridership on routes using the MARQ2 Lanes continues to increase.

The eWorkPlace telework program has continued operation as a project at the Hubert H. Humphrey School of Public Affairs at the University of Minnesota. The Minnesota state legislature provided $75,000 during the 2013 session to maintain the website. The Humphrey School was successful in leveraging the state funding into a $300,000 Congestion Mitigation and Air Quality Improvement (CMAQ) program grant from the Metropolitan Council for eWorkPlace2. Activities being undertaken with this funding include updating the website, developing new tools to assist employers in developing and implementing telework programs, reconnecting to eWorkPlace employers, and recruiting new employers to participate in eWorkPlace2. The funding represents the first use of the CMAQ program by the Metropolitan Council to support telecommuting projects. In addition to the Humphrey School, funding was provided to the Transportation Management Organizations (TMOs) in the metropolitan area, all of which now include telework in their service portfolios.

Bus rapid transit (BRT) in the Twin Cities area received a major boost from the UPA, serving as a key catalyst in the implementation of the METRO Red Line, the first BRT line in the metropolitan area. Opened in June 2013, the METRO Red Line operates along Highway 77 and Cedar Avenue between the Mall of America and the Apple Valley Transit Station. The Cedar Grove park-and-ride lot, the Apple Valley Transit Station, and the Lakeville Cedar park-and-ride lot, all funded by the UPA, are key elements of the METRO Red Line. Additional BRT lines in the metropolitan area are in various stages of planning and implementation, including the METRO Orange Line, which will operate on I-35W South between downtown Minneapolis and Burnsville and use the UPA-funded MARQ2 lanes and the I-35W MnPASS Express Lanes.

The Driver Assist System (DAS) for shoulder-running buses continues to be used on the 10 Minnesota Valley Transit Authority (MVTA) buses equipped with the technology, which provides feedback to bus operators through a “heads up” windshield display, a vibrating seat, and an active steering wheel. The MVTA is seeking to expand the number of DAS-equipped buses. In addition, the DAS driver simulator developed by the MVTA as part of the UPA continues to be used to train bus operators on how to use the system.

San Francisco

SF*park* gained national and international attention for its use of cutting-edge technology and demand-based pricing to manage parking spaces in the congested heart of a major urban area. The UPA enabled the SFMTA to demonstrate the effectiveness of the approach in seven pilot areas and provided valuable experience for decisions about what form SF*park* would take in the future. Likewise, the MTC, which used SF*park* data to develop a parking information component for the regional 511 traveler information system, has built on its UPA experience in continued enhancements to 511. This section highlights some of the developments by the two agencies.

Several months before the end of the demonstration period SFMTA discontinued use of in-ground parking sensors due to battery failures and limitations of parking sensor technologies. The SFMTA now employs sensor-independent rate adjustments (SIRA) which utilize meter payment data to estimate parking occupancy. The first SIRA rate adjustment occurred in SF*park* pilot areas in 2014, utilizing the rigorously developed SIRA model.[10] The SFMTA plans to continue use of SIRA for quarterly rate adjustments in SF*park* pilot areas and, eventually, citywide.

As SIRA rate adjustments depend on meter payment data alone (after having been calibrated using historical sensor data), SFMTA can continue to implement rate adjustments on any block that once had sensors so long as they now have smart meters.

[10]Documentation for the SIRA model can be found at http://sfpark.org/wp-content/uploads/2014/05/SIRA-methodology-and-implementation-plan_2014_05-14.pdf

From October 2014 through April 2015, SFMTA replaced all legacy meters in the City of San Francisco with smart meters. This sets the stage for demand-responsive rate adjustments citywide after the city develops a methodology to calibrate payment data to estimate occupancy on blocks where sensors had never been deployed.

With the discontinuation of the parking sensors, SFMTA modified its data feed and associated smartphone app and web app. Currently, the data feed provides real-time parking availability for SF*park* garages and pricing information for both on and off- street parking. However, it may be possible to bring back some form of real-time parking availability for on-street parking. According to SFMTA "meter payment data from smart meters may provide limited options to model real-time occupancy, and we have historic sensor data that can help us or others create occupancy models."[11] Low payment compliance continues to be a significant obstacle for deriving parking availability from meter payment data.

The parking information component of MTC's 511 system (phone, website, and mobile website) offers parking information by city throughout the nine-county region. Currently, the SF*park* data feed is the only source for real-time (vs. static) information on parking price and availability, and that is only for SFMTA garages, but MTC is working to obtain some real-time parking data from a private vendor as well as other municipalities. Nevertheless, usage of parking information on 511 has remained relatively flat, which MTC attributes to the absence of any significant expansion of the data (real-time or static) since the demonstration period. MTC is working on the 511 NextGen system, one element of which will be a new responsive 511 website that will detect a user's device and automatically resize and reorganize information based on the device (e.g. desktop, laptop, tablet, or smart phone). MTC expects to continue disseminating parking information on 511 NextGen.

SF*park* has had significant impact on the pricing of parking in urban areas. Through numerous publications and outreach events, including participation in parking pricing workshops with FHWA, SFMTA has shared its experience and helped to change how cities view management of their parking assets. Seattle and New York City, for example, have implemented demand-based parking pricing in some areas, and other cities are seriously contemplating some form of demand-based pricing.

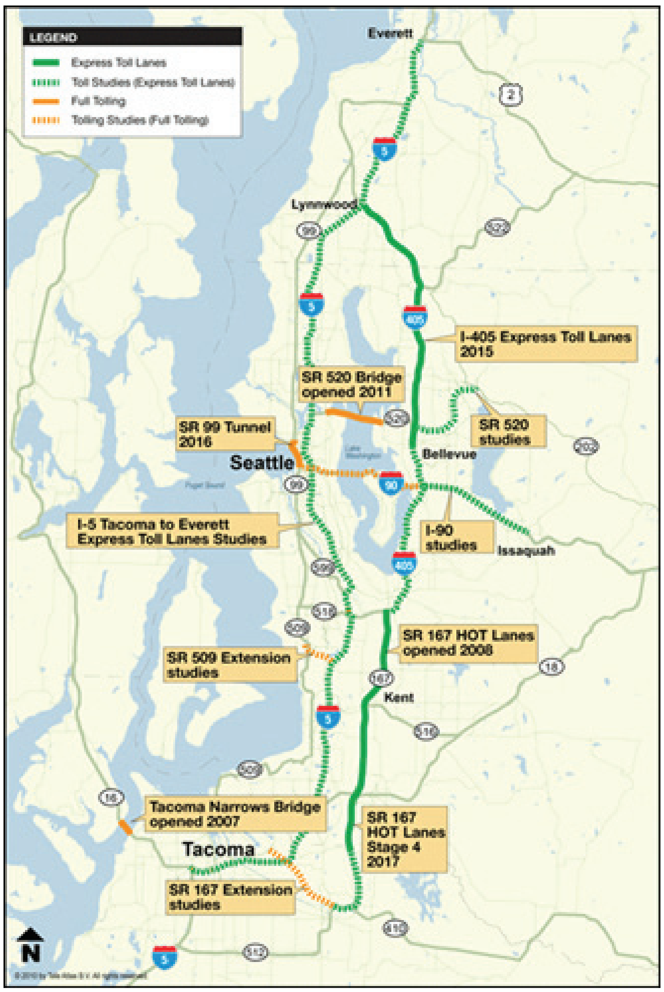
Seattle

Tolling on the SR 520 Bridge continues to meet its two central goals: to reduce congestion on SR 520 and generate revenue to help finance the replacement bridge. Tolling is projected to generate $1.2 billion towards the funded portion of the SR 520 Bridge Replacement and HOV Program. A new SR 520 bridge across Lake Washington, expected to open in 2016, will include an additional HOV/transit lane in each direction and a pedestrian and bike path. Although an average of 72,000 vehicles crossing the SR 520 on weekdays during FY 2014 was 2,000 more than during FY 2013, traffic volumes on the bridge were still down almost one-third from pre-tolling levels of 103,000 in 2011. SR 520 corridor weekday transit ridership was more than 22,000 in spring 2014, an increase of 4 percent since 2012. Additionally, 200 vanpools now cross the lake on SR 520, an increase of 20 percent since December 2012.

Travel time advantages on SR 520, relative to two alternate routes, realized with the start of tolling have persisted. Travel times for drivers using the SR 520 Bridge continue to remain faster than pre-tolling travel times. All three cross-lake routes experienced a small increase in peak hour travel time between 2013 and 2014, which suggests that adaptation to tolling has stabilized in terms of traffic volumes and their effect on travel times.

[11]Personal communication with SFMTA representative, March 2015.

Given the success of the tolling on the SR 520 Bridge, other toll facilities are being constructed or planned in the state as shown in Figure 27. According to WSDOT "Washington State is integrating tolling as a strategic tool to help manage congestion, enhance mobility and generate revenue for future improvements." However, a tolling study for a full-tolling application on the I-90 Bridge similar to tolling on the SR 520 Bridge was put on hold, and in November 2014 the state Legislature directed WSDOT to delay any further expenditures on the I-90 Tolling Project environmental review document.



Source: Washington State Department of Transportation

Figure 27. Toll Facilities in the Seattle Area, Including Existing, Under Construction and In-Study

As part of the UPA program, ATM signage was deployed on SR 520 and I-90, in a consistent manner with the ATM signage already in place on I-5 northbound. Operating full ATM signage on a total of three corridors allowed WSDOT to see what works well, as they consider deploying similar systems in additional areas. For example, ATM signage may be deployed through Seattle on I-5 to allow the addition of a third lane despite geometric constraints that limit expansion. A second project north of Seattle on I-5 would use a simplified ATM approach that includes lane control signage only for a dynamic shoulder lane, in addition to variable speed limits and DMS along the corridor.

FOR MORE INFORMATION

Information on the UPA/CRD programs is available at FHWA's Congestion Pricing website. For the four UPA sites the link is http://ops.fhwa.dot.gov/congestionpricing/urb_partner_agree.htm. For the two CRP sites the link is http://ops.fhwa.dot.gov/congestionpricing/cong_reduc_demo.htm.

The National Evaluation produced numerous documents detailing the planning of the evaluation, including the following:

- An overarching evaluation framework that provided consistent methodology for collection and analysis of data at six sites. Titled "Urban Partnership Agreement and Congestion Reduction Demonstration: National Evaluation Framework," it is available at http://ntl.bts.gov/lib/30000/30700/30764/14446.pdf.
- Individual national evaluation plans and data collection plans for each site (except Miami which performed a self-evaluation). These are available on the FHWA Congestion Pricing website at the links above.
- Individual national evaluation reports that document the findings and lessons learned for each site (except Miami). These are available on the FHWA Congestion Pricing website at the links above.

The Volpe National Transportation Systems Center conducted household surveys in Atlanta and Seattle to support the national evaluation. The report titled "Lessons Learned on Congestion Pricing from the Seattle and Atlanta Household Travel Behavior Surveys" can be found at http://ntl.bts.gov/lib/54000/54000/54065/UPA-CRD_Panel_Survey_Lessons_Learned_Final_Report_Volpe.pdf.

The six urban partners have produced information about their projects as shown below.

Atlanta

The State Road and Tollway Authority's website includes information about the I-85 Express Lanes along with monthly reports on usage and on-line registration and management of Peach Pass accounts for toll customers. Their site is http://www.georgiatolls.com/.

Georgia Department of Transportation maintains a website on all Express Lanes in operation, under construction, or being planned. Information can be found at http://www.dot.ga.gov/DriveSmart/GEL.

Los Angeles

Los Angeles Metro maintains a website that provides a variety of information about the ExpressLanes, ranging from information about the CRD project to how to register for a toll account: https://www.metroexpresslanes.net/en/about/about.shtml.

The City of Los Angeles Department of Transportation has a website for LA Express Park™: http://www.laexpresspark.org/.

Miami

Miami 95 Express monthly, mid-year, annual and special evaluation reports are available from FDOT's website: http://sunguide.info/sunguide/index.php/tmc_reports.

Additional information is contained in a special study titled "2014 I-95 Managed Lanes Monitoring Report" available at http://www.dot.state.fl.us/transit/Pages/2014I-95MLsMonitoringReport-Final.pdf.

Minneapolis

Minnesota DOT maintains a website for I-35W and I-394 MnPASS toll customers: http://www.mnpass.org/index.html. While they no longer have a website exclusively for the I-35W UPA project, MnDOT provides information about the expansion of MnPASS lanes to I-35E on the following website: http://www.dot.state.mn.us/metro/projects/35estpaul/index.html.

San Francisco

SFMTA continues to maintain a comprehensive website on SF*park* at http://sfpark.org/. The site includes their own evaluation of the pilot along with extensive archives of data that can be downloaded by others wishing to perform their own analyses.

Seattle

Washington State DOT maintains a website on SR 520 Bridge tolling at http://www.wsdot.wa.gov/Tolling/520/. The site contains information for the toll customer as well as project background, including the UPA, and a library of reports and other resources.

LIST OF ACRONYMS

4 T	Tolling, Transit, Telecommuning and Technology Strategies
ATM	Active Traffic Management
BCA	Benefit-Cost Analysis
BRT	Bus Rapid Transit
CAG	Corridor Advisory Group
Caltrans	California Department of Transportation
CHP	California Highway Patrol
CMAQ	Congestion Mitigation and Air Quality
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CRD	Congestion Reduction Demonstration
DAS	Driver Assist System
DBOM	Design-Build-Operate-Maintain
DMS	Dynamic Message Sign
DPS	Department of Public Safety
FHP	Florida Highway Patrol
GCA	Gantry-Controlled Access
GCT	Gwinnett County Transit
GRTA	Georgia Regional Transportation Authority
HOT	High-Occupancy Tolling
HOV	High-Occupancy Vehicle
ILCS	Intelligent Lane Control Signals
ITR	Incident Response Team
ITS	Intelligent Transportation Systems
LADOT	Los Angeles Department of Transportation
MARQ2	Marquette Avenue and 2nd Avenue Contraflow Lanes
MnDOT	Minnesota Department of Transportation
MPH	Miles Per Hour
MVTA	Minnesota Valley Transit Authority
NOx	Nitrous Oxide
$PM_{2.5}$	Particulate Matter Less Than 2.5 Microns
SFMTA	San Francisco Municipal Transportation Agency
SIRA	Sensor-Independent Rate Adustment
SR	State Route
SRTA	State Road and Tollway Authority
TDM	Travel Demand Management
TSP	Transit Signal Priority
U.S. DOT	United States Department of Transportation
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compounds
VSL	Variable Speed Limit
WSDOT	Washington State Department of Transportation
WSP	Washington State Police

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