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Increasing Mobility in Southeast Florida:
A New Approach Based on Pricing and Bus Rapid Transit

by Robert W. Poole, Jr.
with Thomas A. Rubin, CPA and Chris Swenson, PE

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Needless to say, the findings and recommendations in this report are those of the authors and Reason Foundation, and do not necessarily reflect the views of any of the region's transportation agencies.

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Executive Summary

Mobility in Southeast Florida (the urbanized portions of Miami-Dade, Broward and Palm Beach Counties) has worsened dramatically over the past three decades. Today residents of this region waste 141 million hours per year delayed in congested traffic, at an estimated annual cost (in wasted time and fuel) of $3.3 billion. Unfortunately, by 2035, mobility will be even worse. According to figures from the region's 2035 long-range transportation plan, as Southeast Florida adds 36% more people during the next 25 years, congestion will increase to be greater than what is experienced today in Los Angeles—the most congested metro area in America. The already low rush-hour speeds will decline another 20% by 2035 if the long-range plan is implemented as written.

That plan puts a major emphasis on alternatives to driving—transit, bicycling and walking. In fact, of the $58 billion available for transportation between 2015 and 2035, the plan devotes 62% to improving and operating various forms of transit. Unfortunately, if the plan is implemented as written, by 2035 a smaller fraction of all trips (2.6%) will be made via transit than the 2.9% made via transit today. During peak commuting times, transit's share of trips *will* increase—but only from today's 3.7% to 4.7%. Driving alone will remain the overwhelming mode of commuting, says the plan, decreasing only slightly from today's 81.4% to 80% in 2035.

This report seeks to answer the question: *Can't Southeast Florida do better than that?* A key innovation that has been implemented in a small way in this region could hold the key. Variably priced express lanes have been added to I-95 in Miami-Dade County, and have been a big success. Generally referred to as "managed lanes," these lanes provide uncongested travel options for buses and motorists. In the I-95 corridor, they have produced dramatically better mobility, including much faster and more reliable express bus service between Miami and Fort Lauderdale.

Based on 18 months of study, with the cooperation of the region's transportation agencies, we are proposing a comprehensive approach to improving Southeast Florida's mobility. The plan includes four key components:

- A region-wide network of expressway managed lanes (MLs) like those on I-95, encompassing 302 route-miles and 1,117 lane-miles;
- Upgrades for 14 key arterials (107 route-miles) with underpasses at major signalized intersections, an innovation we call "managed arterials" (MAs);
- Premium bus rapid transit (BRT) as in the current long-range plan, but operating mostly on the "virtually exclusive busways" made possible by the network of MLs and MAs, rather than on politically dubious bus-only lanes;
- A series of system operational improvements, including extensive expressway ramp metering and further expansion of traffic signal coordination.

The proposed network of MLs and MAs was modeled by FDOT, using their regional transportation model (SERPM 6.5). The modeling compared the traffic situation in 2035 with (a) the infrastructure that would exist under the current long-range plan and (b) that network with the addition of our proposed MLs and MAs. The most important finding was that vehicle hours of delay (VHD) in 2035 would be *13% less* with the proposed ML/MA network in place, all other things equal. The value of time and fuel savings due to this reduced congestion would be $1.35 billion per year. And because better mobility directly increases a metro area's economic productivity, we estimate that the gross regional product of Southeast Florida would be $3.5 billion per year greater thanks to this increased mobility.

Fast and reliable premium BRT service would be another major benefit, both within each county and for new inter-county service in multiple corridors, with estimated daily ridership of 150,000. And because the three transit agencies would not have to spend scarce capital investment funds on acquiring right of way and building bus-only lanes, they could devote more of those funds to adding buses and building more-extensive transfer stations and park-and-ride lots.

We estimate the cost of the network of MAs and MLs at $20.2 billion—money that is mostly not in the current long-range plan. But the good news is we also estimate that nearly 80% of that cost can be financed based on the toll revenues the network would produce. The $4.4 billion balance could be reallocated from a portion of the $58 billion in the current long-range transportation plan's mix of federal, state and local transportation funding between 2015 and 2035. This would require shifting an average of $220 million per year from less cost-effective projects to the development of the highly cost-beneficial network.

Overall, then, we make five key recommendations for implementing this revised approach to Southeast Florida mobility:

1. In developing the next (2040) long-range transportation plan, include the proposed network of managed lanes and managed arterials.
2. Revamp bus rapid transit plans to make full use of the MA and ML network *rather than* seeking to develop bus-only lanes for BRT.
3. Ensure that all the region's transportation agencies work with Florida DOT on developing the managed lanes network Concept of Operations, in the study that began late in 2011.
4. Consider using a regional organization to contract for the management and operation of premium BRT services, both within each county and inter-county.
5. Consider further use of long-term public-private partnerships to finance, develop and maintain major elements of the managed lanes network.

None of this is rocket science. Every element of what is proposed here is being done or seriously considered in other metro areas around the country. We know that managed lanes provide for sustainable uncongested travel. We know that underpasses and overpasses can make major arterials flow better. We know that bus rapid transit is cost-effective and has far greater potential than most regions have taken advantage of. And there is tremendous synergy between managed lanes and BRT—adding managed lanes and making full use of their potential for BRT is both a transit solution and a motorist solution. Ramp meters and signal timing are highly cost-effective tools, as well.

The challenge for Southeast Florida is to use these tools in an integrated manner. Doing so can yield significant improvements in mobility by 2035.

Details of the Reason Foundation Mobility Plan for Southeast Florida

The major infrastructure components of the proposed mobility plan are two networks of priced capacity, overlaid on the existing expressway system as managed lanes and added as grade separations at major intersections on selected north-south and east-west arterials. Nearly all of the selected corridors are projected by Florida DOT to be significantly congested by 2035, which is the planning horizon year for this study. The expressway managed lanes corridors are those listed in Table ES 1.

Nearly all of these projects would be built within the existing right of way of the expressway corridor in question. Most corridors would have two managed lanes in each direction, as on the 95 Express facility in Miami-Dade County. And in most of those cases we have proposed developing the MLs in the same way as was done in that project: narrowing the general purpose (GP) lane widths from 12 feet to 11 feet by restriping, so as to retain the existing number of GP lanes while converting the existing HOV lane (if any) to priced-lane status and adding an additional lane. On existing toll roads, in some cases the two managed lanes would be created by converting one of the existing lanes to variable tolls and adding a second such lane alongside it.

Table ES 1: Proposed Expressway Managed Lanes			
	From-To	Route-miles	Number of MLs each way
North-South Routes			
I-95	I-395 to Indiantown Rd.	83.2	2*
I-75	I-595 to SR 826	17.4	2
Turnpike mainline	PGA Blvd. to Golden Glades	65.1	2
HEFT	Golden Glades to SR 874	29.8	2
SR 826 Palmetto	Golden Glades to US 1	23.8	2
US 1	Dadeland to I-95	7.0	3 (reversible)
Lejeune/N-S Connector	SR 836 to Opa-Locka Airport	8.45	2
Dolphin southern extension	NW 137th Ave. to SW 136th St.	12.0	2
East-West Routes			
SR 869 Sawgrass	Turnpike mainline to I-75	21.4	1
I-595	I-75 to I-95	12.5	3 (reversible)*
SR 924 Gratigny exts.	To HEFT on west; to I-95 on east	3.5	2
SR 836 Dolphin	HEFT to I-95	11.5	2
SR 874 Shula	HEFT to SR 826	6.6	1
TOTALS:		302.75	

*number of MLs for most of the listed route-miles

Three of the proposed 13 ML corridors would be all-new construction, filling in missing links in the current expressway system to greatly reduce congestion. One would add three reversible express lanes, elevated above US 1 from Dadeland to I-95. That corridor is one of the most chronically congested in the region. A second project is the Miami-Dade Expressway Authority's proposed southerly extension of the Dolphin Expressway to SW 136th Street. And the third project would be a new north-south link to provide better access to Miami International Airport. It would run from the Dolphin Expressway on the south to Opa-Locka Airport on the north (with a managed arterial connection from there north to the Palmetto Expressway).

Most of the expressways in Southeast Florida run chiefly north-south. The relative lack of east-west expressway capacity means that the few east-west expressways (e.g., the Dolphin, the east-west portion of the Palmetto, and I-595) are significantly congested. This lack of east-west expressway capacity also means that some of the major arterials in all three counties are projected to be extremely congested by 2035. On arterials, the largest constraint on vehicle throughput is signalized intersections. Thus, our concept of "managed arterials" aims to improve the performance of selected arterials by offering buses and toll-paying motorists a way to bypass major signalized intersections by adding grade separations at those locations. In most cases these would be underpasses, but in lower-density areas, overpasses might be used instead. A number of overpasses and underpasses are in service today in the region, including the underpasses on US 1 in Fort Lauderdale and on US 27 (Okeechobee Road) in Hialeah.

Our proposal calls for applying the managed arterial (MA) treatment to four north-south arterials and ten east-west arterials, as spelled out in Table ES 2.

Table ES 2: Proposed Managed Arterial Corridors			
Arterial	From-To	Route-miles	Number of Grade Separations
North-South			
US 441/SR 7	Southern Blvd. to Lantana Rd.	6.1	2
US 441/SR 7	Glades Rd. to Hollywood/Pines	24.8	17
Douglas Rd.	Opa-Locka Airport to SR 826	1.75	1
Busway	SW 344th St. to Dadeland	19.8	22
Subtotal N-S		52.45	42
East-West			
Southern Blvd.	SR 7 to I-95	8.3	1*
Boynton Beach Blvd.	Turnpike to I-95	6.3	4
Glades Road	SR 7 to US 1	7.6	5
SW 10th St.	Turnpike to I-95	3.1	4
Sample Rd.	SR 7 to I-95	4.8	3
Oakland Park Blvd.	SR 7 to I-95	2.7	2
Broward Blvd.	SR 7 to I-95	2.1	2
Pines/Hollywood Blvd.	SR 7 to I-75	8.3	7
Tamiami Trail	SR 826 to HEFT	4.0	3
Kendall Drive	SW 147th Ave. to US 1	7.6	6
Subtotal E-W		54.8	37
TOTAL		107.25	79

*plus three existing overpasses

Two long north-south corridors form the backbone of this network (US 441/SR 7 in Palm Beach and Broward Counties and the reconfigured Busway in Miami-Dade County), with east-west branches extending from SR 7 in Palm Beach and Broward Counties to provide much-needed congestion relief where there is very little east-west expressway capacity. One short link—SW 10th Street in Broward—substitutes for what was originally intended to be the eastward extension of the Sawgrass Expressway to I-95. The Southern Blvd. corridor in Palm Beach County takes advantage of the three existing overpasses on that route by adding one additional grade separation.

Premium Bus Rapid Transit (BRT) on Managed Lanes and Managed Arterials

The network of priced managed lanes and managed arterials provides a ready-made guideway for what this study terms "premium BRT service." On the managed arterials, this would be commuter express service from park-and-ride lots in residential areas traveling either non-stop or with very limited stops via the managed arterials to major employment centers. By allowing the buses to *always* bypass signalized intersections, those corridors would permit the buses to operate at higher speeds and with greater travel-time reliability. Prices would be charged only for vehicles choosing to use the underpasses rather than making their way via the signalized intersection. (Buses would not be charged.) All such tolls would be collected electronically via Sunpass.

The interconnected network of managed lanes spanning the region's entire expressway network would facilitate region-wide premium BRT service, especially for longer-distance commutes from one county to another. This approach has already been pioneered by Broward County Transit and Miami-Dade Transit on their highly successful 95 Express nonstop bus routes from various origins in Broward County to the Miami central business district. The managed lanes network would enable such services to be offered on any or all of the region's other expressways.

Based on inputs from the three transit agencies, we made very preliminary estimates of the daily ridership that might be generated for such premium BRT services once the entire network of managed lanes and managed arterials was in place, by 2035. Our estimate is for daily weekday ridership of 150,000—about 36% of the existing three-county total daily bus ridership. We very conservatively estimated the annual net new farebox revenue from these services at $31.3 million, in 2009 dollars.

The region's current long-range plan envisions the addition of bus-only lanes to a number of major arterials. Our analysis shows that dedicating a whole lane each way to buses—either by converting an existing arterial lane or widening the arterial to add one lane each way—would almost certainly make congestion even worse than it is already projected to be in 2035. That is because much of the capacity of a bus-only lane would go unused, under a wide range of assumptions of bus frequency and ridership. By contrast, our proposed managed arterial treatment (adding tolled grade separations at major intersections) would add significant throughput capacity to the arterial without widening it. Both managed lanes and managed arterials function as the *virtual equivalent* of exclusive busways, allowing a limited number of cars to co-exist with buses without congestion. Therefore, we recommend that the region plan for managed arterials for all corridors where bus-only lanes are now contemplated.

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Glossary

ACS: American Community Survey, annual data produced by the U.S. Census Bureau.

ADT: Average Daily Traffic, a traffic engineering measure of the total volume of traffic using a roadway during a 24-hour period.

BRT: Bus Rapid Transit, a form of bus service with limited stops, higher operating speed and some other features comparable to rail transit.

BRT Heavy: BRT service operating mostly on exclusive (bus-only) lanes, with widely spaced stations and other rail-like attributes.

BRT Lite: a form of limited-stop express bus service operating in mixed traffic.

FDOT: Florida Department of Transportation, which is organized into a number of districts, with District 6 responsible for Miami-Dade County and District 4 responsible for Broward and Palm Beach County.

FEC: Florida East Coast Railway, one of two north-south freight rail lines in the region.

FHWA: Federal Highway Administration, part of the U.S. Department of Transportation.

FTE: Florida's Turnpike Enterprise, the division of FDOT that finances and operates the Turnpike and manages the statewide Sunpass electronic toll collection system.

GP Lane: general purpose lane on a roadway, open to all vehicles, as distinguished from a lane that is restricted to certain types of vehicles.

HEFT: the Homestead Extension of Florida's Turnpike, located in Miami-Dade County.

HOV Lane: expressway lane that is open only to high-occupancy vehicles (HOVs) such as carpools, vanpools and buses.

HOT Lane: high occupancy toll lane, open to both toll-paying vehicles and high-occupancy vehicles at no charge.

LOS: level of service, a traffic engineering term that conveys the degree of congestion or its lack, ranging from LOS A (high-speed, uncongested flow) to LOS F (stop-and-go traffic, low speed and low flow rate).

Managed Arterial (MA): an arterial roadway of six or more lanes that is upgraded by adding grade separations (overpasses or underpasses) to enable through traffic to bypass signalized intersections in exchange for paying an electronic toll.

Managed Lane (ML): expressway lane with traffic flow managed by means of a variable toll, charged electronically (such as the I-95 Express Lanes).

MDX: Miami-Dade Expressway Authority, operator of toll roads in Miami-Dade County.

MPO: Metropolitan Planning Organization, the federally recognized transportation planning agency for an urban area.

Premium BRT: as used in this report, BRT service operating over relatively long distances using Managed Lanes and/or Managed Arterials.

Rapid Bus BRT: limited-stop express bus service operating in mixed traffic on arterials.

ROW: right of way, the land used for roadway or railway operations.

SERPM: South East Florida Regional Planning Model, a computerized regional planning model used by FDOT to estimate future travel patterns based on land use and transportation network assumptions developed for the Southeast Florida urbanized area. The current version of the model is SERPM 6.5.

Southeast Florida: the urbanized areas of Miami-Dade, Broward and Palm Beach Counties.

TSM+O: FDOT's term for transportation system management & operations, a number of techniques to make transportation systems operate more efficiently.

VHD: vehicle hours of delay, a measure of the amount of congestion in a day, week, month, year or other period of time.

VMT: vehicle miles of travel, a measure of the amount of travel taking place during a specific period of time, usually a day, a month or a year.

Part 1

Southeast Florida's Mobility Problem

Southeast Florida has a large and growing mobility problem. Traffic congestion in the tri-county urbanized area (Miami-Dade, Broward and Palm Beach Counties) exerts a huge burden on residents, visitors and businesses alike, especially during the morning and afternoon peak periods.

The *Urban Mobility Report 2010* from the Texas Transportation Institute tells us that for 2009, the most recent year for which data are available, tri-county residents wasted 141 million hours stuck in traffic, burning 109 million excess gallons of fuel in the process.[1] Counting only the cost of wasted time and fuel, the Institute estimates that congestion in Southeast Florida cost $3.27 billion in 2009.

Table 1 compares the Southeast Florida urban area with the nearest other "very large" urban area, metro Atlanta. The latter's overall congestion cost is somewhat lower, as might be expected from its smaller population (4.2 million vs. 5.35 million in Southeast Florida), but its congestion cost per commuter is slightly higher. As a result, the travel time index, defined as the ratio of the trip-time during peak (congested) conditions to the trip-time during uncongested conditions, is nearly identical for the two metro areas.

Table 1: 2009 Congestion Indicators, Southeast Florida and Other "Very Large" Metro Areas

Per-Commuter Data	Southeast Florida	Metro Atlanta	Average, 15 Largest
Annual hours delay	39	44	50
Rank	#15	#10	--
Travel Time Index	1.23	1.22	1.26
Rank	#13	#16	--
Excess fuel (gal.)	31	35	39
Rank	#18	#11	--
Congestion cost per year	$892	$1,046	$1,166
Rank	#18	#11	--
Metro Area Data	**Southeast Florida**	**Metro Atlanta**	**Average, 15 Largest**
Annual delay hours	140,972,000	112,262,000	185,503,000
Rank	#7	#11	--
Excess fuel (gal.)	109,281,000	90,645,000	145,959,000
Truck congestion cost	$883 million	$852 million	$1,273 million
Total congestion cost	$3,272 million	$2,727 million	$4,414 million
Rank	#8	#9	--
Population	5,350,000	4,200,000	6,036,000
Rank	#4	#9	--

Source: 2010 Urban Mobility Report, Texas Transportation Institute

The congestion costs tallied above include only the estimated cost of motorists' and truckers' wasted time and fuel. But that is only a portion of the full cost of congestion to urban-area economies. Ten years ago, the National Cooperative Highway Research Program (NCHRP) funded initial research into congestion's cost impact on businesses. Congestion interferes with just-in time delivery systems, thereby increasing inventory costs. It reduces the availability of skilled workers and raises the payroll cost of attracting such workers. It shrinks the market for local firms' products and services, and it reduces the range of job opportunities for workers. The NCHRP team used Chicago and Philadelphia data to model these impacts. On the logistics effects, they estimated that a 10% reduction in congestion would save businesses $1.15 billion per year in Chicago and $230 million per year in Philadelphia. The labor market effects were estimated at $410 million in Chicago and $230 million in Philadelphia.[2] Adjusting those numbers upwards from 2000 to 2010 dollars, the total cost for Chicago would be $1.9 billion per year and for Philadelphia would be $582 million per year. While no such study has been done for Southeast Florida, a comparable impact on business would be likely in this region.

Congestion restricts the labor market, making it harder for workers and jobs to link up in the most productive manner. Data show that most people are unwilling to commute for more than a particular amount of time per day, typically around 25 to 30 minutes each way. As congestion increases, the number of *miles* they can go within this time constraint gets smaller. A simplified way to visualize this is to consider the radius around one's home location which can be reached within, say, 30 minutes. The area within a 20-mile circle is four times that of a 10-mile circle. If job possibilities are randomly distributed within that circle, the 20-mile circle will have *four times as many* job possibilities as the 10-mile circle. And the same applies to employers seeking skilled workers. When Remy Prud'homme and Chang-Woon Lee studied this question using data on travel times and labor productivity for French and Korean cities, they found a robust relationship. When the effective labor market size (the size of the circle) increased by 10%, the economic productivity of the metro area increased by 1.3%.[3]

Finally, the economic competitiveness of the Southeast Florida metro area must be considered. This region is in competition with other major metro areas, especially in the southeastern part of the United States. While all Sunbelt cities suffer from traffic congestion, that situation is changing. Texas metro areas in 2004 signed onto a Texas Metropolitan Mobility Plan, under which each one has selected a target travel time index, lower than today's, to achieve by 2030.[4] Similarly, for metro Atlanta, the Governor's Congestion Mitigation Task Force in late 2005 presented a consensus recommendation to make reducing congestion the main goal of the region's transportation planning, with a goal of reducing the travel time index by 2030. In furtherance of that goal, the Georgia State Transportation Board adopted a $16.2 billion Managed Lanes Network plan in December 2009. A number of other very large urban areas are doing likewise (as discussed later in this report).

Current Long-Range Transportation Planning in Southeast Florida

Business leaders and transportation policymakers in all three Southeast Florida counties are rightly concerned about the impaired mobility of travelers in this region. The number one goal in the *Southeast Florida Regional Transportation Plan 2035* is mobility, albeit defined rather vaguely as "Provide an efficient and reliable transportation system for regional passenger and freight operations."[5] This tri-county overview plan, and the individual county long-range transportation plans on which it is based, estimates the available transportation funding from all sources and lays out a large array of transportation improvements for the period 2011–2035. In addition to operating and maintaining the current system, the plans call for adding limited amounts of capacity to expressways and arterial roadways, expanding transit (both bus and rail), adding bikeway capacity, improving sidewalks and making improvements for goods movement.

One way to assess the 2035 plan's impact on mobility is to review key outcome measures based on the modeling efforts embodied in the plan. The transportation system as it will exist in 2035 (with all the changes made via the various investments in each mode) is modeled based on assumed population growth, land-use changes and travel demand. The plan makes major investments in alternatives to driving (transit, bikeways, sidewalks, etc.) with the goal of *shifting significant numbers of people out of cars and into alternative modes*, thereby reducing congestion, especially during the AM and PM peak periods during which most commuting takes place (and when most congestion occurs).

Accordingly, one of the most important measures for achieving this goal is the fraction of commuters making use of each of the principal modes of travel during peak periods. Table 2 provides historical data from the U.S. Census and compares it with projected mode share data for the tri-county area in 2030, drawn from analysis produced for the *Southeast Florida Regional Transportation Plan 2035*. (Commute mode-share data were projected only for 2030; mode-share data for all trips were projected for 2035 and are shown in Table 3.)

Table 2A: Commute Mode Share Data, Historical and Projected Southeast Florida

Commute Mode	2005 (ACS)	2009 (ACS)	2030 (LRTP)
Drive alone	79.2%	77.7%	80.0%
Carpool	10.4%	10.4%	12.2%
Transit	3.6%	3.5%	4.7%
Bike/walk/other	3.5%	3.8%	3.2%
Telecommute	3.3%	4.5%	n.a.

Source: memo from Randy Whitfield to Robert Poole, April 26, 2011 Note: ACS is American Community Survey, U.S. Census Bureau; LRTP is the Southeast Florida Regional Transportation Plan 2035.

Table 2B: Adjusted Commute Mode-Share Data, Excluding Telecommute			
Commute Mode	2005 (ACS)	2009 (ACS)	2030 (LRTP)
Drive alone	81.9%	81.4%	80.0%
Carpool	10.8%	10.9%	12.2%
Transit	3.7%	3.7%	4.7%
Bike/walk/other	3.6%	4.0%	3.2%
Total	100.0%	100.0%	100.0%

Because telecommuting data were not included in the LRTP's projection, Table 2B adjusts the 2005 and 2009 percentages to exclude telecommuting, thereby enabling an apples vs. apples comparison with the historical numbers. As the adjusted table indicates, despite very large investments in transit and other non-highway modes, commuting via these alternative modes by 2030 will be only slightly more than it is today, and the fraction of drive-alone commuters will be only slightly less than it is today.

What accounts for this small impact despite the plan's major focus on changing how people travel? Further data on demographics and travel, drawn from documents supporting the 2035 plan, can provide some insights. Table 3 presents these key factors, comparing the 2005 base year with modeled results for 2035 for *all trips*, not just commute trips.

Table 3: Demographic and Travel Changes, 2035 vs. 2005			
	2005 Base Year	2035 Projected	Percent Change
Population (millions)	5.377	7.322	36.2%
Households (millions)	2.067	2.739	32.5%
Autos/Household	1.62	1.76	8.6%
Home-Based Work Trips (millions)	4.026	5.540	37.6%
Total Person Trips (millions)	17.747	24.985	40.8%
Total Transit Trips (millions)	0.518	0.660	27.4%
Percent Transit Trips	2.9%	2.6%	-10.3%
Vehicle Miles Traveled (millions)	111.538	153.832	37.9%
Congested Speed (mph)	32.76	26.06	-20.4%
Volume/Capacity Ratio	0.60	0.75	25.0%

Source: Tables 3.1 and 3.2, "Technical Memorandum No. 6: Travel Demand Modeling for Regional Needs Plan, Southeast Florida 2035 Regional Long-Range Transportation Plan," Cambridge Systematics, Feb. 19, 2010. (Note: the transportation figures are for the Revised RLRTP 2035 HOT/EC net (R35), as modeled by Cambridge Systematics.)

The demographic figures show that the region is expected to have 36% more people by 2035 and 32.5% more households. As affluence continues to increase, the average number of cars per household will increase by 8.6%. Commuting trips will increase slightly more than population (38%) and total person-trips by nearly 41%. The modeling shows that a large majority of people are still expected to find automobiles more convenient and practical than the other modes, despite the large-scale investment assumed to be in place by 2035 for those other modes. Thus, although the total *number* of transit trips will increase 27%, transit's *share* of total trips will decline by 10%.

Accordingly, vehicle miles traveled (VMT) on the region's roadways will grow essentially at pace with population, by 38%.

Unfortunately for overall mobility, that large growth in VMT means that speeds during congested peak periods will decrease from about 33 mph in 2005 to 26 mph in 2035, as the number of vehicles exceeds the capacity of the roadway system for more hours a day. This means that, despite the best intentions of elected officials and transportation planners in deciding what transportation investments to make over the next 25 years, the end result will be *worse congestion* than experienced today. And one of the 2035 plan's main goals—of improving mobility by providing more transit and other non-auto choices—will not be achieved, as indicated by transit's failure to increase its fraction of all trips and by the 20% reduction in speed during congested periods (which will also slow down most buses).

Thus, the challenge facing Southeast Florida is this: Can this region come up with a more effective set of transportation improvements than those embodied in the 2035 plan? By more effective, we mean an approach that would reduce congestion rather than allowing it to increase.

It is important to note that the figures in the 2035 plan are "fiscally constrained." That phrase, as required by federal regulations on producing long-range transportation plans, means that the plan must include only those transportation measures that can be paid for with known transportation funding sources, projected over the years encompassed by the plan. As this report is being written, Congress is grappling with what is likely to be an era of fiscal restraint, given the federal government's enormous deficits and growing national debt. That backdrop suggests little likelihood of any unanticipated windfall of transportation money from the federal government. Likewise, Florida's state and local governments are facing unfunded pension and retiree medical cost obligations, likewise making it unlikely that there will be significant new state or local transportation funding sources (although some local officials hope to build support for a dedicated transportation sales tax and/or transportation tax increment financing districts). Thus, we explore alternative transportation improvements within that frame of reference.

Part 2

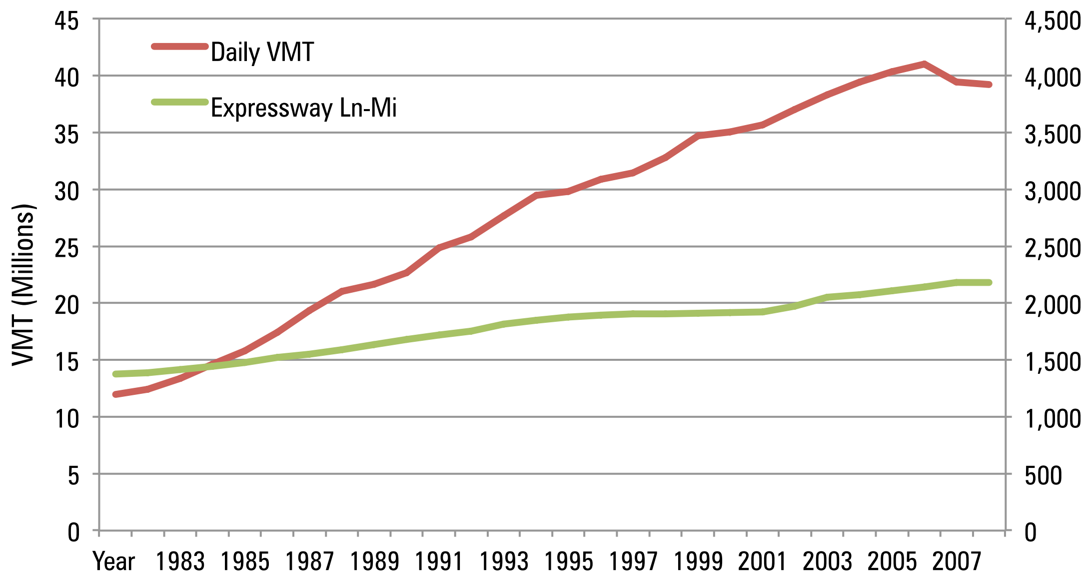
Thinking Smarter About Traffic Congestion

Why is traffic congestion in Southeast Florida so severe today, and projected to be even worse in 2035? Congestion was far less severe several decades ago, but has grown steadily over the last several decades. The Texas Transportation Institute (TTI) has maintained a detailed database on metro-area traffic and roadways since 1982, enabling us to gain a relatively long-term perspective on how things have changed.

Comparing 2009 with 1982, we find that daily vehicle miles of travel (VMT) on the region's expressways is more than three times the amount recorded in 1982, and daily VMT on the arterials is over twice what it was then. If the amount of roadway capacity had grown at the same rate, we would expect congestion to be no worse in 2009 than it was in 1982. The region's expressways have been expanded since 1982, but they have only 60% more capacity (measured in lane-miles) today than they did in 1982. And today's arterials have about 50% more lane-miles. The result is much greater "loading" of each lane-mile of roadway with traffic—twice as much (100% more) on each expressway lane-mile and 50% more on each arterial lane-mile.

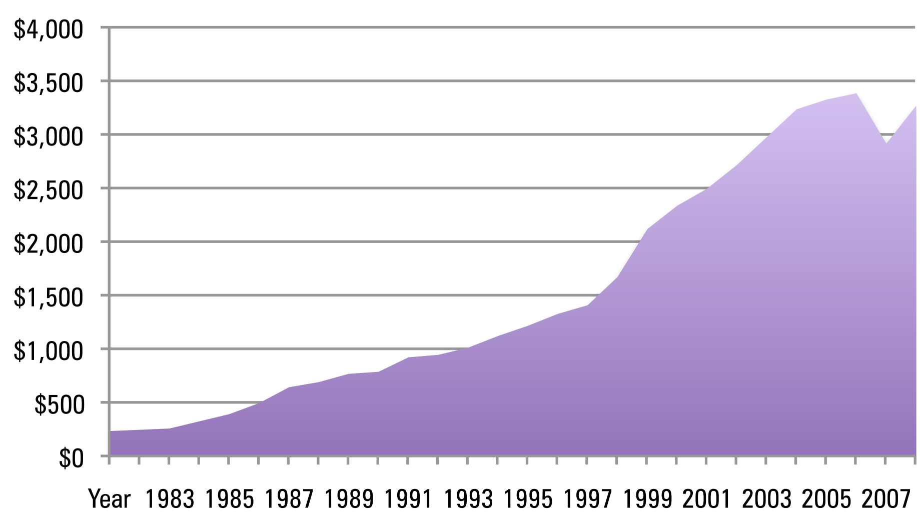
When roads approach the limits of their capacity to handle traffic, the flow of traffic breaks down into stop-and-go travel, in which the throughput of each lane may be cut in half. That is why a mere doubling of the loading on expressways between 1982 and 2009 has led to a *six-fold increase* in total delay hours and a nearly *14-fold increase* in congestion cost, as estimated by TTI. Figure 1 shows how roadway capacity has lagged behind the growth in travel. Figure 2 then shows how congestion cost has soared as a result.

Figure 1: Growth in Vehicle Miles of Travel vs. Growth in Roadway Capacity, 1982–2009



Source: Texas Transportation Institute

Figure 2: Growth in Annual Congestion Cost ($Millions), 1982–2009



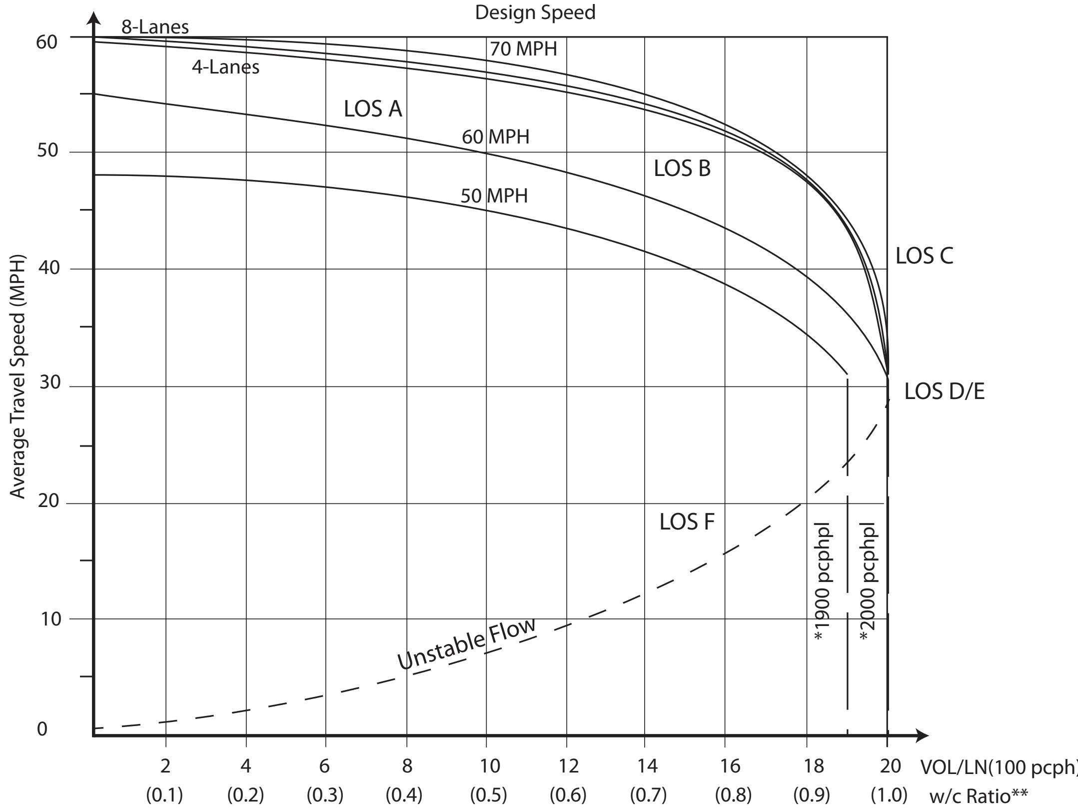
Source: Texas Transportation Institute

Do these results mean Southeast Florida should massively expand its roadway capacity? That is not a feasible alternative, for several reasons. First, there is no political consensus for large-scale roadway expansion in this region. Most such expansions would require the acquisition of significant right of way via eminent domain proceedings, displacing large numbers of businesses and residences. Second, the cost of such an undertaking would be very high, likely exceeding the funding sources available (even if funds were to be reallocated from currently planned uses). Third, large-scale roadway expansion would provide congestion relief in the short-term and medium-term (depending on how fast the region grows), but would not be sustainable long-term.

A smarter approach to dealing with roadway congestion is to make carefully targeted capacity increases and use “congestion pricing” to manage traffic flow on the new capacity, keeping traffic flow within the capacity of the amount of roadway that can be provided. Southeast Florida’s first experience with this smarter form of capacity expansion is the successful and popular 95 Express Lanes on I-95 in Miami-Dade County. Variable pricing on those lanes has been shown to keep them uncongested and free-flowing, even during the busiest peak periods. This benefits motorists by giving them an alternative to being stuck in congestion on those occasions when being somewhere on time is really important. Notably, the pricing also offers major benefits to transit, enabling express bus service to operate significantly faster and far more reliably than it used to do in congested HOV lanes.[6] This would make express bus service a more competitive alternative for drivers otherwise driving in congested lanes.

Traffic engineers explain why expressway lanes get congested and how pricing keeps them uncongested, using what is called a speed/flow curve. Figure 3 shows such a curve, with traffic speed on the vertical axis and traffic volume on the horizontal axis. At the top left, we can see that when traffic volume is low, speeds are high and steady. Engineers refer to this kind of flow as Level of Service (LOS) A. As volume gets higher and cars get somewhat closer together, speeds decline somewhat, and we have traffic at LOS B—still flowing pretty well, but not as fast. Further to the right, as volume continues to increase, speed drops further and we reach the maximum rate of flow that each lane can handle with minimal congestion, designated LOS C. At that point, if more vehicles enter the lane, speed decreases but throughput still increases (LOS D). If even more vehicles try to enter, speed declines further, and flow volume is only minimally increased (LOS E). Once LOS E is reached, if more vehicles enter, the flow degenerates into very unstable flow conditions, often called stop-and-go. This results in both low speed *and* low volume—called LOS F. Under LOS F conditions, the ability of the expressway to move traffic is hampered at precisely the time it is needed most. Once an expressway gets into severe LOS F, it can sometimes take an hour or more for it to recover.

Figure 3: Expressway Traffic Throughput vs. Speed



*capacity
** v/c ratio based on 2000 pcphpl valid for -60 and 70-MPH design speeds

Source: Adapted from the FHWA Highway Capacity Manual

What "congestion pricing" does is limit the number of vehicles entering the lane so as to keep traffic flowing at a specified level of service (perhaps C or D during peak periods). Some have described this as maintaining traffic at the "sweet spot" represented by the upper right-hand portion of the speed/flow curve. Such pricing was pioneered on the SR 91 Express Lanes in California, starting in 1995. Those lanes have remained free-flowing at all hours of the day thanks to congestion pricing for 15 years. Their success has inspired similar priced express lanes—now referred to as Managed Lanes—in Atlanta, Dallas, Denver, Houston, Los Angeles, Minneapolis, Salt Lake City, San Diego, the San Francisco Bay Area, Seattle and the Virginia suburbs of Washington, DC—and of course, in Miami.

This report suggests that Southeast Florida build on the success of the 95 Express Lanes to facilitate new transportation choices for the region's travelers, both motorists and transit riders.

Part 3

Bus Rapid Transit and Managed Lanes: A New Approach

Documents prepared for the "unconstrained" 2035 long-range transportation plan reflect transportation planners' desire to add significant rail transit in Southeast Florida: expanding the Metrorail system in Miami-Dade County, building considerable mileage of light rail in Broward County, and adding a second commuter rail system for all three counties using the Florida East Coast (FEC) Railway corridor. Little or no funding exists for these ambitious plans, which is why they are not included in the officially adopted, fiscally constrained 2035 plan. Thus, the region appears to be unable to achieve its goal of increasing transit's overall mode share, as indicated by the projections shown previously in Table 3.

The fiscally constrained plan does include what appears to be considered a second-best alternative: Bus Rapid Transit. A number of BRT projects are included, mostly on major arterials. In fact, a growing number of metro areas are giving high priority to BRT, not only because it is considerably less costly than rail, but also because it is considerably more flexible. Instead of being constrained to a fixed guideway, buses can use the entire network of local streets, arterials and expressways. They offer many possibilities for "one-seat-ride" trips from home to work—trips that would take two or three separate trips if made partly by rail, adding considerably to the door-to-door travel time.

The growing BRT literature frequently separates this concept into two major types:[7]

- "BRT-heavy" refers to projects that use mostly dedicated rights of way (such as a busway or bus-only lanes) and which may include features such as off-board ticketing, level boarding platforms, traffic signal priority, etc. The idea is to make the service features as much like light rail as possible.
- "BRT-lite" refers to projects that lack dedicated rights of way and use fewer other enhancements. They may be as basic as limited-stop arterial express service with traffic signal priority for buses at intersections.

Two recent projects from Los Angeles exemplify these two categories. The Metro Orange Line, representing BRT-heavy, operates on an exclusive busway built on the right of way of a former freight railroad line in the San Fernando Valley (comparable to the South Miami-Dade Busway).

The Metro Rapid service (BRT-lite) operates in mixed traffic on major arterials (such as Wilshire Blvd. and Ventura Blvd). It offers 10-minute or less headways during peak periods and has limited stops, generally between one-half and one mile apart. It has dedicated bus shelters and specific branding, and has limited traffic-signal preference. A 2007 study compared the Metro Rapid service on Ventura Blvd. with the Orange Line BRT, both operating east-west in the San Fernando Valley. While travel times were approximately the same (because the Orange Line is crossed by numerous perpendicular streets, despite having an exclusive corridor), the capital cost per boarding was only $1,300 for the BRT-lite versus $16,800 for the BRT-heavy line.[8] Since 2007, ridership on both lines has increased, reducing the capital cost per boarding for the Orange Line to $13,700.[9]

Much of the analytical work on the Southeast Florida 2035 plan was begun and carried out prior to detailed data being available on the operational phase of the managed lanes on I-95 in Miami-Dade County. Thus, the potential synergy between express bus services and congestion-priced managed lanes that are free-flowing (uncongested) during peak periods seems not to have been fully appreciated in developing the plan. The 2035 plan includes three types of BRT service:

- BRT-heavy, dubbed Express Bus, beginning on arterials and continuing on expressways, using HOV lanes where those exist.
- BRT-heavy service on semi-exclusive lanes on major arterials (dubbed Premium High Capacity).
- BRT-lite service, in the regular lanes on arterials (dubbed Premium Rapid Bus).

The first and third of these alternatives would have the BRT service operate mostly in mixed traffic, which is already significantly congested on expressways and many major arterials during peak periods, and will be far more congested by 2035. And the second alternative requires the politically difficult prospect of either taking away one of the three lanes in each direction on major arterials or condemning land to add lanes to such arterials.

An exclusive lane for BRT service is intended to allow those buses to operate reliably and at high speed by avoiding traffic congestion. But very few corridors in Southeast Florida, either on expressways or on arterials, have transit demand that can support more than 10 buses per hour (i.e., six-minute headways), even during peak periods. Even with one-minute headways (60 buses per hour), an exclusive expressway lane can handle 1,600 vehicles per hour at uncongested LOS C conditions. Restricting that lane only to buses would mean wasting over 1,500 spaces each hour that could be occupied by other vehicles without congestion.

And that is the premise under which today's 95 Express bus service is operating on the managed lanes on I-95 in Miami-Dade County, and will in 2013 be operating on the Phase 2 extension of those lanes as far north as Broward Blvd. in Broward County. Thanks to variable pricing on the managed lanes, buses and paying vehicles are, in effect, guaranteed uncongested passage, regardless of the time of day. That means the 95 Express bus services are much faster than when they operated in congested HOV lanes on I-95 and their trip-times are far more reliable. Data from 2010 express bus service on the I-95 MLs show that scheduled travel times for the portions of those trips that use the MLs (between Golden Glades Interchange and downtown Miami) have been reduced by 22% during the AM peak period (southbound) and 31% in the PM peak period (northbound).[10]

Additional managed lanes are, as of 2011, under study by various agencies in the Southeast Florida area, including:

- Extension of I-95 managed lanes into Palm Beach County as far north as PGA Boulevard or Indiantown Road;
- Managed lanes on SR 826 (Palmetto Expressway) in Miami-Dade County;
- Managed lanes on I-75 in Broward County;
- Managed lanes on SR 836 (Dolphin Expressway) in Miami-Dade County;
- Congestion pricing, which might include managed lanes, on portions of the Homestead Extension of Florida's Turnpike (HEFT);
- Conversion of South Miami-Dade Busway into a managed lanes facility.

In addition, the reconstruction of I-595 in Broward County, under way as of this publication, includes the addition of three reversible managed lanes in the center of the corridor.

All of these corridors could accommodate significant express bus (BRT-heavy) service, if the demand for such service exists and if transit agencies decide to provide it. From a transit agency's standpoint, expressway managed lanes offer them the *virtual equivalent* of an exclusive busway, but without the transit agency having to make the capital investment to provide that guideway. That guideway will, instead, be paid for in significant part by the toll revenues willingly paid by those motorists who choose to use the MLs to bypass congested regular lanes. Transit capital funds would be needed for the buses and potentially for additional park-and-ride facilities in suitable locations. But compared with the unaffordable rail transit plans, BRT service operating in MLs could be a way to provide region-wide express bus service with travel times and reliability comparable to what is now being offered by the new 95 Express service.

In recent years, a number of other major urban areas with chronic congestion problems have revised their long-range transportation plans to include a whole network of managed lanes as a platform for region-wide express bus/BRT service, in addition to providing congestion relief for motorists. Those with ML networks already in their long-range transportation plans include:

- Atlanta
- Dallas
- Houston
- Minneapolis
- San Diego
- San Francisco
- Seattle

Other metro areas where such networks are under serious study include Denver, Los Angeles, Phoenix and Washington, DC.

In 2008, District 6 of Florida FDOT commissioned a managed lanes “vision study” to sketch out what such a network might encompass in the Miami-Dade and Broward County region.[11] That study proposed and evaluated a network made up of three sub-networks: on expressways, on arterials, and a third network for heavy trucks linking the Port of Miami to the distribution centers and rail yard west of Miami International Airport. That two-county expressway and arterial network would total 799 lane-miles, and was estimated to cost $9.3 billion in 2008 dollars. Toll revenues were estimated to cover a large fraction of the capital costs.

The current project—the Southeast Florida Mobility Study—builds on that initial FDOT study. It expands the scope to include Palm Beach County in addition to Broward and Miami-Dade Counties, and it extends the time horizon from 2030 to 2035. While not commissioned by FDOT, the current study has received the cooperation of FDOT and other transportation agencies in the tri-county region, as well as in-kind modeling support from FDOT. The next two sections go into detail on, respectively, how BRT and managed lanes would work on the tri-county expressway system and then how to apply these concepts to major arterials in each of the three counties.

Part 4

Expressway Managed Lanes and Premium BRT

For clarity in this report, we will refer to relatively long-distance express buses operating on priced facilities as Premium BRT. And we will refer to express bus service that operates with limited stops on arterials as Rapid Bus BRT. In this section, we define a tri-county network of managed lanes on the expressway system, building on the previously mentioned 2009 FDOT ML vision study and various feasibility studies under way by FDOT, Miami-Dade Expressway Authority (MDX), and the Florida Turnpike Enterprise (FTE).

A. Defining an Expressway Managed Lanes Network

The ML network should encompass all expressway corridors where serious congestion is projected for the 2030–35 time-frame. In addition, it could include proposed missing links in the expressway system, if such links would provide significant congestion relief and alternate routes for buses and motorists. In addition, the network should, as much as possible, be "seamless": it should be possible for a BRT vehicle and other users to transition from the ML on one expressway to the ML on an intersecting expressway. (Otherwise, the vehicle would have to exit the ML on the first expressway, cross several lanes of congested traffic to reach the exit ramp to the intersecting expressway, and then cross several lanes of congested traffic to enter the ML on the second expressway.) That means flyover connectors for the MLs are needed at major expressway interchanges.

Another consideration is the number and type of MLs on particular expressways. A single priced lane can provide improved mobility, but its throughput capacity per lane is less than that of a two-lane (per direction) facility, since passing is not possible on the single-lane facility and therefore one slow (or disabled) vehicle can hold up everyone else. If projected levels of traffic and congestion are high enough on a particular expressway, then two lanes are preferable to one. And in corridors where the flow is highly directional (e.g., I-595, where traffic flows heavily eastbound in the morning and westbound in the afternoon), a multi-lane reversible ML facility is preferable.

Adding MLs to Non-Tolled Expressways

Where there is room in the median of an expressway (e.g., I-75), adding MLs is straightforward and involves no need to acquire additional right of way. If the expressway already includes HOV lanes (as on I-95), then a single-lane per direction ML can be achieved by converting the HOV lane. And if two MLs per direction are warranted by the projected traffic volume, the second ML can be created in many cases by restriping the existing general purpose lanes from 12 feet to 11 feet and narrowing the shoulders, as was done in the I-95 project in Miami-Dade County. (Such changes generally require design exceptions from the FHWA if the expressway is part of the federal-aid highway system.) The alternative to restriping is to widen the overall right of way to permit an additional lane in each direction, which in many cases would require the acquisition of additional land.

Managed Lanes on Tolled Expressways

Southeast Florida has a number of urban toll roads, including the mainline of Florida's Turnpike in all three counties, the Homestead Extension of Florida's Turnpike (HEFT) in Broward and Miami-Dade Counties, five Miami-Dade Expressway Authority (MDX) toll roads in Miami-Dade County, and the Sawgrass Expressway in Broward County. In principle, the ML concept could be implemented in three different ways on such toll roads:

- Shift the toll structure from fixed to variable, with higher toll rates during AM and PM peak periods for all lanes;
- Add a variably priced premium lane each way to the existing toll road, giving its users a choice of regular or premium lanes;
- Add one premium lane each direction and convert one of the existing lanes to premium, thereby offering users more premium capacity (possibly at a lower peak price than if there were only one premium lane per direction).

Both MDX and Florida's Turnpike Enterprise (FTE) did studies on adding premium lanes to selected facilities early in the last decade, with MDX focusing on the congested Dolphin Expressway (SR 836)[12] and FTE focusing on north-south portions of HEFT in Miami-Dade County.[13] Because the MLs on HEFT and the Dolphin would have had to be designed and implemented together, both agencies needed to agree on whether to go forward. By the middle of that decade, the agencies could not agree on going forward, so the idea was not included in their plans. As of 2011, however, both agencies are reconsidering two-tier pricing on some of their facilities.[14] FTE launched an "Integrated Congestion Pricing Plan" study in February 2011 to evaluate the potential for using congestion pricing (including two-tier pricing) on its facilities in large urban areas.[15]

We are aware of only one example of a toll road adding premium lanes. In Maryland, express toll lanes with variable pricing are being added to eight miles of I-95 near Baltimore. Known as the John F. Kennedy Expressway, it is operated by the state toll agency, Maryland Transportation

Authority. Some would argue that because most of the former toll points on this expressway have been removed over the last several decades (allowing most local users to be exempt from tolls, with tolls mostly collected from through-travelers near the Susquehanna River Bridge), the expressway should not be considered a true toll road.

Missing Links in the Expressway System

A network is defined in significant part by connectivity. Buses and other vehicles should be able to get from any one point on the ML network to any other point seamlessly and without encountering congestion. The benefits to users will be both time savings and reliability of trip-times. It is for this reason that those planning such a network must consider filling in missing links (in addition to the previously mentioned flyover connectors at expressway interchanges).

A review of the expressway system maps in all three counties identified possible missing links. In Miami-Dade County, the most obvious missing link is along the US 1 corridor in the southern part of the county, linking the southwestern suburbs to downtown Miami. Another possible missing link is an additional north-south route in Miami-Dade, linking central areas to Miami International Airport, thereby relieving pressure on the north-south Palmetto (SR 826) and I-95. Several minor east-west missing links could also be helpful. In Broward and Palm Beach Counties, the primary missing links are east-west routes that have greater current and projected traffic volume than the existing arterials can handle. We expect there would be little or no political support for upgrading these arterials to expressways, but alternate improvements for major arterials will be discussed in Part 5.

B. Selecting Expressway ML Corridors

The starting point for this process was data provided by FDOT on projected congestion levels for 2030. (We requested 2035 data, but at the time the analysis was taking place, only 2030 data were available.) FDOT provided spreadsheets and maps showing projected Level of Service (LOS) data for all roadways that are part of the State Highway System in Palm Beach, Broward and Miami-Dade Counties. Nearly all expressway corridors were projected to be at LOS F (severely congested) by 2030, with the exception of the Sawgrass (SR 869) in Broward, and SR 112 and a portion of HEFT in Miami-Dade County, the latter two of which were shown as LOS D.

The expressway ML network proposed in this study is summarized in Table 4. Most of these expressways would have two MLs in each direction, similar to the configuration in operation on I-95 in Miami-Dade County. That is the case for the two principal north-south corridors—I-95 and Florida's Turnpike—from PGA Blvd. in Palm Beach County to downtown Miami and Golden Glades Interchange, respectively. Two MLs each way are also proposed for I-75, the Palmetto Expressway (SR 826), the Dolphin Expressway (SR 836) and its proposed extension, and HEFT between I-75 and SR 836.

One ML per direction is proposed for several expressways with lower overall traffic, such as the Sawgrass (assuming congestion is severe enough by 2035 to warrant adding MLs), I-95 between PGA Blvd. and Indiantown Road, and the Don Shula Expressway (SR 874).

In several cases of highly directional traffic flow, the proposed network includes reversible MLs, including I-595 (currently under construction), US 1 from Dadeland to I-95 in downtown Miami (built elevated above the existing highway), and as the eastward extension of SR 924 to I-95.

Finally, the expressway ML network includes one new route, in two segments: the Lejeune Connector, elevated above Lejeune Road between SR 836 and SR 112 and, continuing northbound from there, a North-South Connector elevated alongside the South Florida Rail Corridor from SR 112 to Opa-Locka Airport, with connections to SR 826 just north of there.

Table 4 defines the corridors that comprise the proposed expressway ML network, including the connectors at interchanges. Intermediate access to MLs would be provided at some locations via slip ramps, but specifying those locations would require corridor-specific traffic analysis which is beyond the scope of this preliminary study. To avoid confusion, these corridors are being proposed by the authors of this study, not necessarily by FDOT, FTE or MDX. These agencies each have various ML studies under way, as noted previously, but they have not decided upon or endorsed the specific corridors and characteristics set forth in Table 4.

Table 4: Proposed Expressway ML Corridors						
Route Number	From/To	Rt-Mi	# Lanes	Description	Lane-miles	Fwy to Fwy ML connectors
SR 869 (Sawgrass)	I-75 to Turnpike mainline	21.4	2	MLs in tollway median	42.8	1 at I-595, 2 at Turnpike
I-95	Broward Blvd. to I-395	24.5	4	MLs in freeway median (existing)	98	
I-95	SR 810 (Hillsboro) to Broward Blvd.	14.4	4	MLs in freeway median	57.6	
I-95	PGA Blvd. to SR 810	37.1	4	MLs in freway median	148.4	
I-95	Indiantown Road to PGA Blvd.	7.2	2	MLs in freeway median	14.4	
I-595	SR 7 to I-95	2	2	Reversible elevated MLs in freeway median	4	2 at I-95
I-595	I-75 to SR 7	10.5	3	Reversible MLs in freeway median	31.5	1 at I-75, 2 at Turnpike
I-75	I-595 to HEFT	12.4	4	MLs in freeway median	49.6	1 at HEFT, 1 at I-595
Turnpike main line	PGA Blvd. to SR 810	36	4	MLs in tollway median	144	
Turnpike main line	SR 810 (Hillsboro) to Golden Glades	29.1	4	MLs in tollway median	116.4	1 at SR 826, 1 at I-95
SR 826 (Palmetto)	SR 924 to Golden Glades	8.5	4	MLs in freeway median	34	2 at I-95, 1 at SR 924
SR 924 west ext.	NW 87th Ave. to HEFT	1.5	4	Express toll lane facility	6	1 at HEFT
SR 836 (Dolphin)	HEFT to NW 37th Ave	8	4	MLs in tollway median	32	2 at HEFT, 4 at SR 826
SR 836 (Dolphin)	NW 37th Ave to I-95	3.5	4	Elevated MLs in tollway median	14	2 at I-95
SR 836 SW Ext.	NW 137 Ave. to SW 136 St.	12	4	New tollway	48	1 at HEFT
HEFT	Turnpike main to I-75	8	4	MLs in tollway median	32	1 at Turnpike Main
I-75	HEFT to SR 826	5	4	MLs in freeway median	20	2 at SR 924
HEFT	SR 836 to SR 874	9	4	MLs in tollway median	36	
HEFT	I-75 to SR 836	12.8	4	MLs in tollway median	51.2	
SR 826 (Palmetto)	SR 924 to US 1	15.3	4	MLs in freeway median	61.2	1 at SR 924, 1 at US 1
US 1	Dadeland to I-95	7	3	Elevated express lanes, reversible	21	
N-S Connector	SR 112 to Opa-Locka Airport	6.75	4	New tollway, elevated along South Florida Rail Corridor	27	1 at SR 924, 2 at SR 112
SR 874 (Shula)	HEFT to SR 826	6.6	2	MLs in tollway median	13.2	1 at SR 826
Lejeune Interconnector	SR 836 to SR 112	1.7	4	New elevated tollway	6.8	2 at SR 836, 1 at SR 112
SR 924 east ext.	NW 32nd Ave. to I-95	2	4	New elevated tollway	8	2 at I-95
	TOTALS	302.25			1117.1	

Part 5

Premium BRT on Arterials: The Managed Arterial

A. The Managed Arterial Concept

The current rethinking of the South Miami-Dade Busway helps to introduce the concept of a managed arterial. The only exclusive busway in Florida, this 19.8-mile corridor parallel to congested US 1 was constructed in stages using the former FEC Railroad right of way. The Busway is used for all or a part of 12 bus routes, but most of these are not express services. Route 34, the Busway Flyer, offers limited-stop service along the Busway, making just 12 stops. These various bus services make use of only a small portion of the Busway's vehicle capacity, even during peak periods. Since the parallel arterial, US 1, is severely congested, the Miami-Dade MPO commissioned a feasibility study of converting the Busway into some kind of a managed lanes facility, so as to use some of its excess capacity to relieve congestion on US 1. Under this approach, buses and paying vehicles would share an expanded, four-lane facility.[16] Variable pricing would limit the number of non-bus vehicles to an amount compatible with uncongested traffic flow. The initial study proposed several possible alternatives, and the Miami-Dade Expressway Authority has begun a study (in 2011) aimed at selecting the most feasible conversion alternative.

The potential Busway conversion stemmed from thinking about modifications that would enable it to provide faster and more reliable bus service while also making effective use of the Busway's otherwise-unused capacity in a corridor badly in need of congestion relief. One of the current Busway's major shortcomings is that it crosses numerous intersecting roadways along its nearly 20-mile length, most of them protected by traffic lights. Concerns about collisions between buses on the Busway and cars crossing the Busway has led to speed restrictions on the Busway, and the need for numerous intersection stops means that even so-called "express" services are still quite slow. (The same factors led to severe speed restrictions on the Orange Line BRT in Los Angeles.) Moreover, it is hard to imagine many motorists being willing to pay for trips on the Busway if it involved as many signalized intersections as the parallel US 1.

Consequently, several of the alternatives being considered for the revamped Busway involve providing grade separations at many or most of these intersections, via either overpasses or underpasses. If all 21 of the principal signalized intersections could be bypassed by vehicles using the Busway, safety would be significantly improved, trip-times for all such vehicles could be significantly reduced, and true express bus service would be possible. Under this approach, benefits to Busway users would be maximized if the minor intersections (in between the 21 principal ones) were closed off. A more costly way to accomplish the same goal would be to reconstruct the Busway elevated over most or all of its 20-mile length.

A somewhat similar concept was developed in Lee County, Florida early last decade. Under a federal Value Pricing Pilot Program grant, researchers examined the idea of reducing traffic congestion on principal arterials by adding tolled “queue jumps” at major intersections.[17] Survey data developed in that study suggested that large numbers of motorists would be willing to pay a modest (e.g., 25¢) Sunpass toll to bypass the typical three-minute traffic-light cycle time at congested intersections. The Lee County Department of Transportation did preliminary design studies of such tolled queue-jump overpasses for Colonial Blvd., but thus far none have been implemented. Lee County, has, however, gradually added non-tolled overpasses at six major arterial intersections in the county over the past decade, as it could assemble the funds to do so.

One of the principal researchers from the 2003 Lee County study expanded upon the idea in a 2009 study of mobility solutions for that county. Chris Swenson, PE, proposed retrofitting a congested arterial corridor with a series of tolled grade separations (overpasses or underpasses), to convert it into what is now termed a “managed arterial.”[18] In the MA configuration, at major signalized intersections four of an arterial’s six lanes would make use of a grade separation to bypass the intersection, but those who did not want to pay would use one or two surface through-lanes, in addition to the usual left- and right-turn lanes, at the signalized intersections. In between the grade separations, the center lane in each direction would be de-facto an express lane, though there would be no access restriction and no charge for using that lane. Sunpass tolls would be charged only to those using the grade separations, with a separate small charge for each grade separation a vehicle traversed. Hence, no one would be charged for using “existing” arterial capacity. The only charges would be for those choosing to use the new capacity (the grade separation). There would be no charge for buses.

In the 2009 study, Swenson compared (a) widening a six-lane arterial to eight lanes and (b) converting the arterial into the MA configuration with no widening. Standard FDOT highway capacity standards put the daily throughput of a six-lane arterial at 51,800 vehicles per day (vpd); widening it to eight lanes brings that to 67,000 vpd. Swenson’s calculations in the 2009 study show that the MA configuration would be able to handle 87,600 vpd. Thus, for arterial corridors where widening is either economically or politically infeasible, the MA approach would produce more vehicular capacity than widening. And by charging those vehicles choosing to use the grade separation, the MA produces a revenue stream that can pay for at least a portion of the cost.

B. The Problem with Exclusive Bus Lanes on Arterials

The long-range transportation plans of Broward and Miami-Dade Counties (and to a lesser extent, Palm Beach County) envision "Premium High Capacity" BRT service on arterials as operating in "semi-exclusive" lanes. This means that these BRT vehicles would operate on bus-only lanes for the majority of their arterial runs, and in regular (mixed-traffic) lanes only on sections of arterials with severe right-of-way constraints. For most six-lane (or greater) arterials, implementing bus-only lanes can be done in one of three ways:

1. Restripe existing lanes from 12 to 11 feet and convert the median to a single-lane reversible busway (as proposed for much of Kendall Drive in Miami-Dade);
2. Convert an existing lane each direction to bus-only use (one option being considered in Broward); or
3. Widen the arterial by one lane in each direction, with the new lanes operated as bus-only (also being considered in Broward).

We consider the first alternative to have serious safety shortcomings, since it would lead to buses in the peak direction traveling in the opposite direction to vehicles in the non-peak direction, without the protection of a median. That leaves the other two alternatives.

Very little widening of major arterials is contemplated in the 2035 plan. The corridors where widening (and the associated property takes) would provide the greatest benefits are the most congested ones, and in those cases it is not clear that using the new lane solely for buses would provide the greatest congestion reduction/mobility increase. Likewise, it is far from clear that converting an existing lane each way, on an already congested six-lane arterial, would improve mobility. We illustrate the trade-offs involved by means of a quantitative analysis.

The impact of converting one lane in each direction of a six-lane arterial to bus-only operations is fairly dramatic. Table 5 shows the operating results based on peak-hour/peak-direction analysis. Vehicular capacity used in this analysis is based on FDOT generalized service volumes.[19] In the generalized service volume tables, Table 7, *Generalized Peak Hour Directional Volumes for Florida's Urbanized Areas,* was used, and a Class II arterial was assumed.

As projected by FDOT for most major arterials, it was assumed that the six-lane arterial was operating at capacity at the time of the conversion to four general purpose lanes and two bus-only lanes. As shown, the capacity of four general purpose lanes is substantially less than six general purpose lanes.

For the capacity of the overall corridor (cars plus transit) simply to remain constant (not improved) and the level of service in the general purpose lanes to remain at LOS E, a large percentage of drivers would have to shift to transit to offset the capacity lost from the conversion of general purpose lanes to bus-only lanes. If this shift does not occur, demand will exceed capacity (right two columns in Table 5) by a substantial amount. Besides increasing congestion in the four GP lanes to LOS F, the excess demand will likely spill over onto parallel arterials, making them, too, more congested.

Table 5: Hourly Directional Throughput Comparison: 3 GP Lanes vs. 2 GP Lanes + 1 Bus-Only Lane									
Lanes	Demand (persons per hour)	Percent Transit	Vehicle Capacity of GP Lanes	Required Cars to Meet Demand in GP Lanes	LOS - GP Lanes	Transit Through-put (persons per hour)	Required Buses per Hour (40 person capacity)	Demand Beyond Capacity (vehicles per hour)	Demand Beyond Capacity (persons per hour)
3 GP	3,250	0%	2,830	2,826	E	0	0	0	0
2 GP + 1 Bus	3,250	0%	1,870	2,826	F	0	0	956	1,100
2 GP + 1 Bus	3,250	2%	1,870	2,770	F	65	2	901	1,036
2 GP + 1 Bus	3,250	4%	1,870	2,713	F	130	3	846	973
2 GP + 1 Bus	3,250	5%	1,870	2,685	F	163	4	819	942
2 GP + 1 Bus	3,250	10%	1,870	2,543	F	325	8	682	784
2 GP + 1 Bus	3,250	15%	1,870	2,402	F	488	12	544	626
2 GP + 1 Bus	3,250	20%	1,870	2,261	F	650	16	407	468
2 GP + 1 Bus	3,250	25%	1,870	2,120	F	813	20	270	310
2 GP + 1 Bus	3,250	30%	1,870	1,978	F	975	24	133	153
2 GP + 1 Bus	3,250	32%	1,870	1,922	F	1,040	26	78	89
2 GP + 1 Bus	3,250	33%	1,870	1,893	F	1,073	27	50	58
2 GP + 1 Bus	3,250	34%	1,870	1,865	E	1,105	28	0	0

Table 5 shows that almost 34% of those people using the corridor would have to shift to transit just to maintain the existing throughput and congested LOS E. At any lower percentage shift to transit, severe (LOS F) congestion would occur. Since 34% transit use is almost an order of magnitude greater than the commuter transit usage projected for this region in the long-range plan, this seems highly unlikely.

Another way to look at this is to hold the level of service constant and see what happens to total person throughput. In Table 6, we do this for LOS E. The maximum one-way vehicle capacity of the two general purpose lanes is 1,870 vehicles per hour. If drivers divert to transit, the cars that they were using would no longer be in the general purpose lanes. However, latent demand is likely to exist under the type of severe congestion projected in Southeast Florida. Hence, as some drivers shift to transit, the capacity their vehicles would have used will be consumed by latent demand. In this way, throughput in the general purpose lanes remains at 1,870 vehicles per hour. As Table 6 reveals, for every transit percentage less than 34%, total person throughput in the corridor remains below the level of demand (3,250 persons per hour).

Table 6: Hourly Directional Throughput Comparison for Constant LOS E							
Transit Percentage (person trips)	GP Lanes Vehicle Capacity (vph)	Cars per Hour	Auto Throughput (persons per hour @ 1.15 persons per vehicle)	Transit Throughput (persons per hour)	Required Buses per Hour (40 person capacity)	Total Vehicles per Hour	Total Throughput (persons per hour)
0%	1,870	1,870	2,151	0	0	1,870	2,151
2%	1,870	1,870	2,151	43	2	1,872	2,194
4%	1,870	1,870	2,151	89	3	1,873	2,240
5%	1,870	1,870	2,151	113	3	1,873	2,264
10%	1,870	1,870	2,151	238	6	1,876	2,389
15%	1,870	1,870	2,151	380	10	1,880	2,531
20%	1,870	1,870	2,151	536	14	1,884	2,687
25%	1,870	1,870	2,151	715	18	1,888	2,866
30%	1,870	1,870	2,151	920	23	1,893	3,071
32%	1,870	1,870	2,151	1,010	26	1,896	3,161
33%	1,870	1,870	2,151	1,059	27	1,897	3,210
34%	1,870	1,870	2,151	1,107	28	1,898	3,258

Comparing Tables 5 and 6, we can see that unless transit usage in the corridor rises to 34%—far higher than is likely—converting two general purpose lanes to bus-only results in either a degraded level of service (i.e., severe LOS F conditions) or a reduced throughput capacity (last column of Table 6). Neither of these conditions is a good outcome for reducing congestion and increasing mobility.

How does a managed arterial fare under similar circumstances? To answer this question, we first need to compute the throughput capacity of a managed arterial. We again assume a six-lane arterial, but with two grade-separated lanes in each direction at major intersections and one at-grade through lane in each direction (plus turn lanes) at major intersections. The hourly (peak-hour/peak-direction) capacity was calculated using standard FDOT figures based on a four-lane divided uninterrupted flow facility plus one-half of the capacity of a four-lane divided class II arterial. The same generalized capacity table referenced above was used in this analysis. One significant difference, however is that due to the nature of managed arterials serving to accommodate buses along with paying vehicles, the level service for all vehicles using the grade separations must be maintained at a higher level than is required for general purpose lanes. LOS C has been assumed for all vehicles on the managed arterial. The resulting throughput capacity is shown in Table 7.

Table 7: Hourly Directional Throughput Capacity of a Six-Lane Managed Arterial							
Transit Percentage (person trips)	Vehicle Capacity (vph)	Cars per Hour	Auto Throughput (persons per hour @ 1.15 persons per vehicle)	Transit Through-put (persons per hour)	Required Buses per Hour (40 person capacity)	Total Vehicles per Hour	Total Throughput (persons per hour)
0%	3,225	3,225	3,709	0	0	3,225	3,709
2%	3,225	3,223	3,706	75	2	3,225	3,781
4%	3,225	3,221	3,704	153	4	3,225	3,857
5%	3,225	3,220	3,704	195	5	3,225	3,899
10%	3,225	3,214	3,696	409	11	3,225	4,105
15%	3,225	3,208	3,689	649	17	3,225	4,338
20%	3,225	3,202	3,682	920	23	3,225	4,602
25%	3,225	3,194	3,673	1,224	31	3,225	4,897
30%	3,225	3,185	3,663	1,567	40	3,225	5,230
32%	3,225	3,181	3,659	1,721	44	3,225	5,380
33%	3,225	3,180	3,657	1,797	45	3,225	5,454
34%	3,225	3,177	3,654	1,882	48	3,225	5,536

Because managed arterials allow all the capacity of all the lanes on the facility to be fully utilized, with the total vehicular capacity of the facility increased by incorporating grade separations, it is able to provide greater capacity than its general purpose lane counterpart. Note especially that the full vehicular capacity is available on the managed arterial regardless of the extent of transit use. Because of this, there is no "lost" capacity while transit service builds, but the corridor benefits greatly from an increasing level of transit usage.[20]

Comparing Table 6 with Table 7, we can see that for all percentages of transit use, the managed arterial has a significantly higher person throughput than a six-lane arterial configured for four general purpose lanes and two bus-only lanes. At 4% transit use, the six-lane managed arterial is able to move 3,857 persons per hour compared to 2,240 persons on the 4 GP/2 bus-only arterial. In this case the managed arterial has a person capacity 72% greater than the 4 GP/2 bus-only arterial while maintaining a significantly higher LOS. At a transit usage of 34%, if that could actually be attained, the managed arterial would still provide almost 70% greater person throughput, again at a higher level of service.

The other way in which bus-only lanes could be implemented is by adding new lanes to the six-lane arterial (rather than converting two of the existing lanes). A managed arterial may, of course, require the addition of some right-of-way at intersections. While additional right-of-way will not be needed at all intersections, it will for some. Therefore we also compare this case with a managed arterial. Under any scenario where an eight-lane arterial can be accommodated within the existing right-of-way, a six-lane managed arterial would also require no added right-of-way. In fact, given that the seventh and eighth lanes would have to be maintained through the entire length of the facility, not just at the intersections, a six-lane managed arterial will require less right-of-way overall than an eight-lane arterial (six GP plus two bus-only lanes). The throughput capacity of an eight-lane arterial that includes two bus only-lanes is shown in Table 8.

Table 8: Hourly Directional Throughput Capacity of 8-Lane Arterial with 6 GP + 2 Bus-only Lanes							
Transit Percentage (person trips)	GP Lanes Vehicle Capacity (vph)	Cars per Hour	Auto Throughput (persons per hour @ 1.15 persons per vehicle)	Transit Throughput (persons per hour)	Required Buses per Hour (40 person capacity)	Total Vehicles per Hour	Total Throughput (persons per hour)
0%	2,830	2,830	3,255	0	0	2,830	3,255
2%	2,830	2,830	3,255	66	2	2,832	3,321
4%	2,830	2,830	3,255	134	4	2,834	3,389
5%	2,830	2,830	3,255	171	5	2,835	3,426
10%	2,830	2,830	3,255	363	10	2,840	3,618
15%	2,830	2,830	3,255	572	15	2,845	3,827
20%	2,830	2,830	3,255	819	21	2,851	4,074
25%	2,830	2,830	3,255	1,079	27	2,857	4,334
30%	2,830	2,830	3,255	1,378	35	2,865	4,633
32%	2,830	2,830	3,255	1,533	39	2,869	4,788
33%	2,830	2,830	3,255	1,604	41	2,871	4,859
34%	2,830	2,830	3,255	1,676	42	2,872	4,931

As with the six-lane arterial, the managed arterial alternative provides greater person throughput at all percentages of transit use, as can be seen by comparing Table 8 with Table 7. At 4% transit use, a *six-lane* managed arterial provides almost 14% more capacity than the *eight-lane* arterial with two bus-only lanes. Even at 34% transit use, the managed arterial alternative provides over 11% greater capacity. This again assumes that the managed arterial alternative is operating at a level of service C, while the six general purpose lanes on the eight-lane arterial are operating at level of service E.

We can summarize the trade-offs involved in the four alternatives for improving bus performance on congested arterials as shown in Table 9.

Table 9: Alternatives for Arterial Improvements				
	Restriping	Convert GP	Add Lanes	Managed Arterial
Right of way cost	None	None	High	Low
Construction cost	Low	Low	High	Very high
Reduced left turns	Yes	Yes	Yes	Yes
Impact on auto throughput	Minor, negative	Major, negative	Minor, positive	Major, positive
Under-utilized bus lane(s)	Yes	Yes	Yes	No
Impact on congestion	Minor, negative	Major, negative	Minor, positive	Major, positive
Safety impact	Significant, negative	Some, negative	Minor, positive	Minor, positive
Revenue generation	No	No	No	Yes, significant

Each of these alternatives involves trade-offs. All four would restrict left turns, to avoid holding up buses operating in the inner lane(s). All but the managed arterial would use only a small fraction of the bus lanes' capacity. And the restriping alternative would eliminate the median, with buses operating directly adjacent to traffic going in the opposite direction. All things considered, we conclude that the managed arterial provides greater mobility increases than any of the bus-lane alternatives.

Underpasses vs. Overpasses

Over the past decade, FDOT's Districts 4 and 6 have carried out a number of studies of overpasses to provide relief for traffic at major signalized intersections. In Miami Dade County, Parsons Brinckerhoff carried out a "superarterial" network study in 1998, whose candidate corridors included US 1 between SW 112th St. and I-95, major portions of Kendall Drive and major portions of Ludlum Rd.[21] Subsequent studies last decade included proposed grade separations on SW 8th St.,[22] Kendall Drive, SW 8th St., and Milam Dairy Road,[23] and the intersection of SW 8th St. and SW 87th Ave.[24] In the 1990s, FDOT District 4 carried out grade separation feasibility studies for both Broward[25] and Palm Beach Counties. Several overpasses were added to Southern Blvd. in Palm Beach County during the past decade. But when such overpasses were proposed in Broward County, there was strong negative reaction from a number of communities where overpasses had been proposed, on grounds of visual intrusiveness and incompatibility with their surroundings.

Underpasses can provide equivalent traffic flow improvements and congestion relief.
Many people assume that because of the water table in Southeast Florida, underpasses are not feasible. In fact, there are at least two functioning underpasses in this region as of 2011. The older of the two is the Kinney Tunnel, which conveys US 1 beneath the New River in downtown Fort Lauderdale. The other is the underpass completed in 2006 on Okeechobee Road (US 27) in Hialeah, adjacent to the Miami River Canal. The latter conveys six lanes of US 27 beneath the FEC Railroad tracks. It is equipped with a pump for use in rain or flooding. The roadway is sealed with an impermeable layer to prevent groundwater penetration into the concrete. Since it was opened to traffic in 2006, the underpass has operated without problems. FDOT District 6 reports that the only added maintenance cost is $15,496 per year to maintain the pump station.[26]

Underpasses are assumed to be more costly than overpasses of the same capacity, but research for the 2009 study estimated that an underpass would cost only slightly more than an equivalent overpass. Overpass grade separations exist in all three counties. Examples include Alton Road at the east end of the MacArthur Causeway in Miami Beach, Sunrise Blvd. crossing SR 7/US 441 in Broward County, and overpasses on Southern Blvd. at SR 7, the Turnpike, and Jog Road in Palm Beach County.

In denser, more-urbanized locations overpasses may be considered visually intrusive, compared with lower-density, suburban locations. By contrast, underpasses would be visually unobtrusive. Figures 4 and 5 provide dimensionally accurate renderings of the kind of arterial overpass and underpass designs we are proposing for managed arterials.

Figure 4: Typical Arterial Overpass

Figure 5: Typical Arterial Underpass

Given the past negative reaction to overpasses in Broward County, we understand that educational outreach efforts will be important in future efforts to bring about either underpasses or overpasses in selected arterial corridors. But the case for adding grade separations is robust. From a traffic flow standpoint, they would provide considerably more improvement than widening a highly congested arterial. By facilitating premium BRT service without requiring dedicated bus-only lanes, they offer a win-win approach to simultaneously improving bus service and relieving congestion for motorists in the corridor in question. And if implemented as we propose, with modest Sunpass tolls, they would generate revenue to cover a significant portion of their cost, as discussed in more detail in Part 7.

For the remainder of this report, we will use the term "underpass" to refer to proposed arterial grade separations, and we will use estimated underpass costs in Part 7. If managed arterials are actually implemented, the decision on whether to use an underpass or an overpass would be made on a case-by-case basis.

C. Proposed Managed Arterial Corridors

The process of selecting corridors for conversion to managed arterials was somewhat analogous to that used for selecting managed lanes corridors on the tri-county expressway system. We began with 2030 traffic projections from FDOT, focusing primarily on principal arterials that were projected to be significantly congested (LOS F) by 2030. Each corridor was visually observed by a two-person team (one driving, one making notes). In addition to serious peak-period congestion, candidate corridors needed to have at least six lanes and raised medians. We also reviewed maps of all three counties, seeking corridors that would supplement the expressway network with improved (faster, higher capacity) north-south and east-west links. Finally, we reviewed 2035 long-range transportation plans from each county to identify arterial corridors planned for BRT service, especially the "premium high capacity" form of BRT, which the plans envision as operating mostly on bus-only lanes.

This selection process led to an initial set of proposed MAs for each county, envisioned as being implemented between now and 2035:

- For Broward County, they encompass SR 7/US 441 from Glades Road in Palm Beach County to Hollywood/Pines Blvd. in southern Broward County as the principal north-south MA route. Five east-west MAs are also proposed. The first would link the Turnpike with I-95 along SW 10th Street, a route originally intended as part of the Sawgrass Expressway. Three others would extend from SR 7 on the west to I-95 on the east along Sample Road, Oakland Park Blvd., and Broward Blvd. The final east-west MA would be on Pines/Hollywood Blvd. from SR 7 to I-75. These routes are all planned for "premium high capacity" transit in the Broward County long-range transportation plan.
- For Palm Beach County, the only north-south MA would be on SR 7 between Southern Blvd. (SR 80) and Lantana Road and between Glades Road and the Broward County line. East-west MAs would include Southern Blvd. from SR 7 to I-95, Boynton Beach Blvd. from the Turnpike to I-95, and Glades Road from SR 7 to US 1.
- In Miami-Dade County, two east-west links would be Kendall Drive from SW 147th St. to US 1 and the Tamiami Trail (SW 8th St.) from the Palmetto Expressway to HEFT. A short north-south link would begin at the northern end of the new North-South Connector adjacent to Opa-Locka Airport and end by connecting to the Palmetto Expressway on the north. Finally, our MA system in Miami Dade would include the reconfigured Busway, from SW 344th St. to Dadeland.

All but two of these corridors (Broward Blvd. and Douglas Rd.) are listed in the 2035 regional plan as Regional Corridors of Significance. And eight of the 14 are included in the long-range plan as corridors for premium BRT service.

The details of these corridors are provided in Table 10.

Table 10: Proposed Managed Arterial Corridors

Name	Route No.	From/To	Rt-Miles	Grade Separations
SW 10th St.	SR 869	Turnpike to I-95	3.1	4: Powerline, Military Trail, Newport Ctr, SW 24th
Sample Road	SR 834	SR 7 to I-95	4.8	3: Lyons, Powerline, Military Trail
Oakland Park Blvd.	SR 816	SR 7 to I-95	2.7	2: NW 31st, NW 21st
Broward Blvd.	SR 842	SR 7 to I-95	2.1	2: NW 31st, NW 27th
Pines/Hollywood Blvd.	SR 820	SR-7 to I-75	8.3	7: SW 135th, Flamingo, Hiatus, Palm, Douglas, University, 72nd
US 441	SR 7	Glades Rd. to Hollywood/ Pines	24.8	17: Palmetto Park, Hillsboro, Wiles, Sample, Royal Palm, Coconut Creek, Atlantic, Kimberly, McNab, Commercial, Oakland Park, NW 19th, Broward, Davie, Griffin, Stirling, Taft
US 441	SR 7	SR 80 to Lantana Rd.	6.1	2: Forest Hill, Lake Worth
Southern Blvd.	SR 80	SR 7 to I-95	8.3	1: Military Trail (others already exist)
Boynton Beach Blvd.	SR 804	Turnpike to I-95	6.3	4: Jog, Military Trail, Lawrence, Congress
Glades Road	SR 808	SR 7 to US 1	7.6	5: Lyons, Jog, Andrews, Military Trail/I-95, Dixie
Kendall Drive	SR 94	SW 147th to US 1	7.6	6: SW 137th, SW 127th, SW 117th, SW 107th, SW 87th, SR 826
Busway		SW 344th St. to Dadeland	19.8	22: NW 6th, SW 320th, SW 312th, SW 296th, SW 286th, SW 272nd, SW 264th, SW 248th, SW 232nd, SW 224th, SW 216th, SW 211th, SW 200th, Marlin, SW 184th, Richmond, SW 152nd, SW 144th, SW 136th, SW 124th, SW 112th, SW 104th
Douglas Rd.		Opa-Locka Airport to SR 826	1.75	1: Oriental (NW 151st St)
Tamiami Trail/SW 8th St.	SR 90	SR 826 to HEFT	4	3: SW 87th Ave., SW 97th Ave., SW 107th Ave.

D. Arterial BRT Operations

By adding the MA corridors to the previously defined managed lanes network on the tri-county expressway system, we can see via Figures 6, 7 and 8 that they constitute an overall network providing improved mobility for both BRT services and motorists. This intent is furthered by the provision of numerous flyover connectors, as shown in these maps. The flyovers provide direct connections between MLs on intersecting expressways. Access from the managed arterials to the expressway MLs would be provided by slip ramps on the expressways.

Figure 6: ML and MA Network in Palm Beach County

Figure 7: ML and MA Network in Broward County

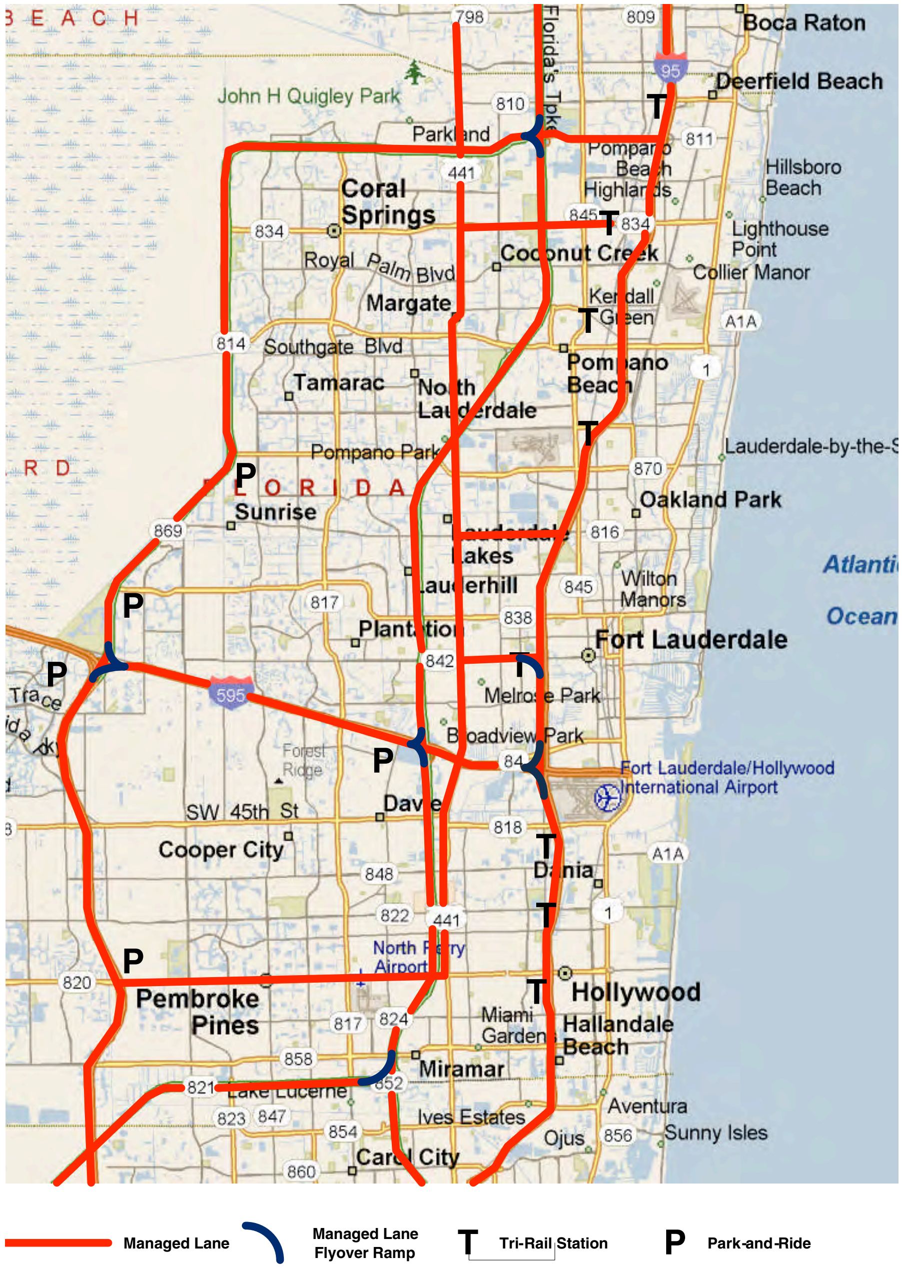
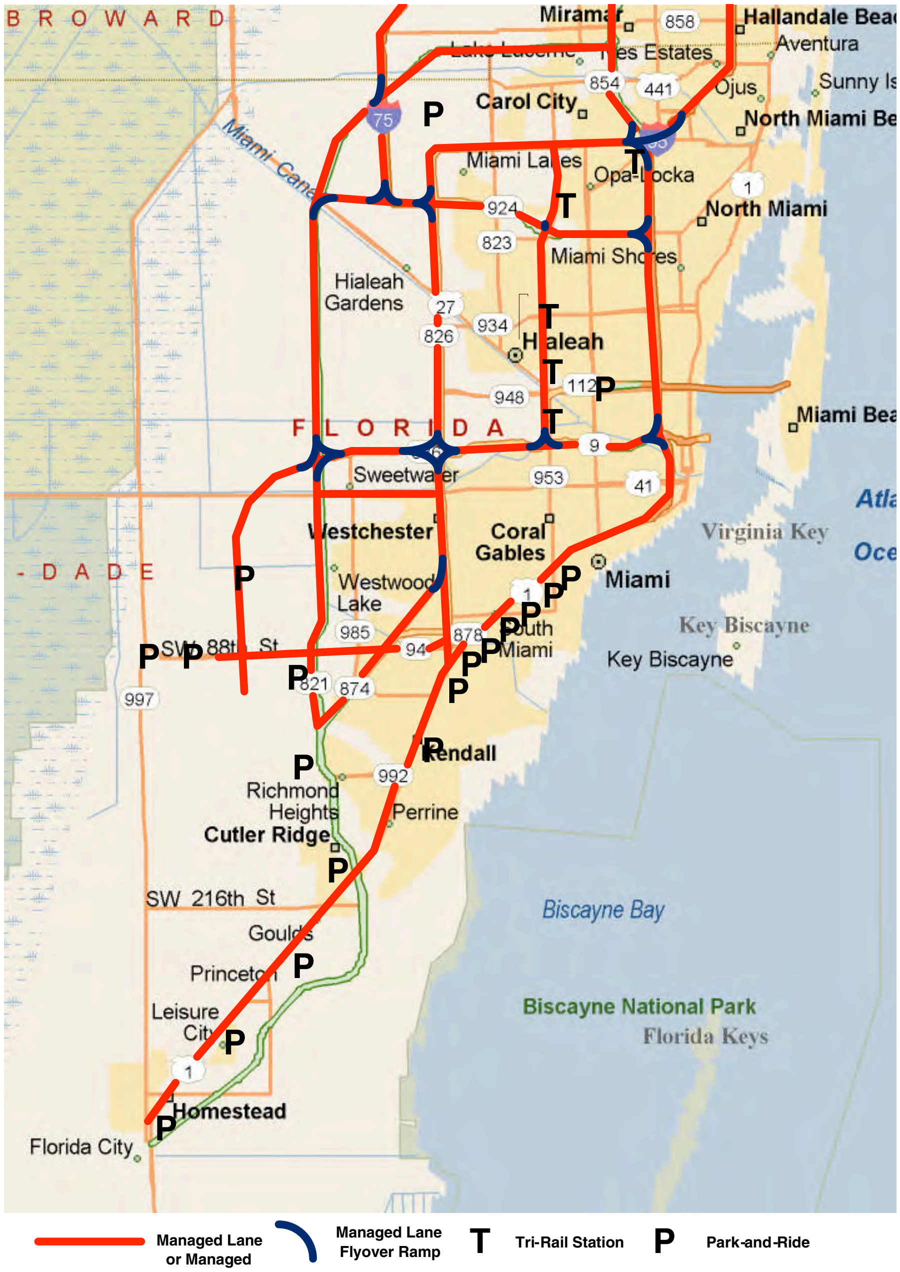


Figure 8: ML and MA Network in Miami-Dade County



Given the existence of this extensive tri-county network, how should BRT operations be configured? Instead of the three types of BRT service set forth in the 2035 fiscally constrained long-range transportation plan (Express Bus, Premium High Capacity and Premium Rapid Bus), we propose just two types: premium BRT (operating on MAs and MLs) and Rapid Bus BRT. The latter would operate as limited-stop service on arterials, and would not be a frequent user of the MA network, due to its relatively shorter-distance trip orientation. In this report, we assume the existence of this kind of Rapid Bus service on arterials, essentially as described in the tri-county long-range plan. Our focus in this report is on the premium BRT that would operate mostly on the MA/ML network.

The model for this service is the various 95 Express routes now operated by both Broward County Transit and Miami-Dade Transit using the region's first MLs—the I-95 Express Lanes. For example, the Pembroke Pines route begins at a park-and-ride lot at C.B. Smith Park near Flamingo Road and Pines Blvd. Currently it operates in mixed-traffic lanes along Pines/Hollywood Boulevards, making stops only at University Drive and SR 7. Upon reaching I-95, it transitions to the HOV lane (which by 2013 will be a managed lane) and operates nonstop to downtown Miami. There it makes four local stops. With the MA treatment applied to Hollywood/Pines, this premium BRT could operate nonstop to University, bypassing all the signalized intersections. It would operate again nonstop to SR 7. From there, one sub-route could continue on Hollywood Blvd. (mixed traffic) to the Tri-Rail station, and the other sub-route would head south toward Miami via the proposed MLs on the Turnpike.

The maps show the existing and currently planned location of park-and-ride lots and Tri-Rail stations. If the extensive ML and MA network shown in Figures 6 though 8 is implemented, additional park-and-ride lots would very likely be needed, but their locations would depend on a more detailed study of premium BRT routes.

Part 6

Supportive Mobility Enhancements

The transportation improvements set forth in Parts 4 and 5 would involve major capital investments, and would take place over several decades. Traffic engineers understand that in addition to such large-scale improvements, there are a number of less-dramatic ways to improve mobility by fine-tuning the way in which expressways and arterials operate. These measures are referred to as "operations strategies." It is often possible to achieve significant benefits for relatively low cost using such measures, and it is common for improvements of this sort to have very high benefit/cost ratios.

FDOT Districts 4 and 6 are developing transportation system management & operation (TSM+O) programs to focus more resources on achieving higher performance levels from existing facilities. The mobility objectives include reducing delay, increasing the reliability of travel times, increasing on-time transit performance, and clearing incidents most efficiently. Managed lanes, ramp metering and active operation of congested arterials are among the strategies to be used in the TSM+O program.

In this section of the report, we review several key operations strategies for expressways and arterials. After that, we review other additions to the transportation infrastructure aimed at improving the viability of BRT operations.

A. Improving Expressway Operations

Ramp Metering

One of the most important tools for reducing congestion on expressways—in addition to congestion pricing—is ramp metering. This technique, relatively new to Southeast Florida, works by limiting the rate at which vehicles attempt to enter an expressway all at once (which risks pushing the level of service for the lanes downstream of the entrance ramp from LOS D to LOS E or from LOS E to LOS F, creating upstream ripple effects from the resulting on-ramp bottleneck). Minneapolis/St. Paul makes extensive use of ramp metering, currently at on-ramps covering more than 90% of its freeway system's centerline miles. The Texas Transportation Institute reports that the Twin Cities save over 1.5 million hours of delay each year thanks to ramp metering.

As with most policies, ramp metering generally involves trade-offs. If the expressway is severely congested, the most effective ramp-metering (from an expressway congestion-reduction standpoint) would involve long intervals between green signals on the on-ramp. But those long intervals may create long queues that exceed the capacity of the on-ramp and overflow onto nearby arterials. In such situations, a balance must be sought between congestion mitigation on the expressway and congestion mitigation on the arterial.

Table 11 shows that the Southeast Florida urban area is a relative late-comer to ramp metering, with only 5% of the expressway system equipped as of 2009 (the latest year in the Texas Transportation Institute's national database). Consequently, ramp metering represents a kind of low-hanging fruit for this region. At relatively modest cost compared with lane additions, ramp metering could be expanded to all congested expressway corridors in the tri-county region.

Table 11: Southeast Florida Expressway Operations Strategies, 2000–2009

Strategy	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Ramp metering: % of centerline miles	0	0	0	0	0	0	0	5	5	5
Cameras: % of centerline miles	6	9	9	9	22	22	21	53	53	53
Service patrols: % of centerline miles	84	90	98	100	100	100	100	100	100	100

Sources: 2000 through 2006 data from Texas Transportation Institute *2008 Urban Mobility Report*; 2007 through 2009 data from TTI's *2010 Urban Mobility Report*

Video Surveillance

A second cost-effective strategy is equipping the expressway system with video-camera surveillance, to monitor traffic flow and especially to identify accidents and other incidents as they occur, so that appropriate service responders can be dispatched to the scene. Southeast Florida has made solid progress with this strategy, with more than half the expressway system camera-equipped as of 2009, compared with only 6% in 2000. Video monitoring equipage should continue until 100% of the system is included.

Service Patrols

Service patrols are the most commonly dispatched type of incident responder, assisting motorists who run out of gas, have a flat tire, or experience some other difficulty that does not involve an accident. Florida is a national leader in making use of this very cost-effective operational strategy, with 100% of Southeast Florida's expressways protected by this service. Quickly clearing such incidents reduces congestion caused by a vehicle stuck in traffic lanes and by reducing "gawkers' block" when passing vehicles slow down to observe the disabled vehicle even if it is stopped on a shoulder or breakdown lane.

Emergency Response

Another critically important operations strategy is emergency response, generally in response to crashes but also to single-vehicle emergencies such as a car fire. Clearing such incidents promptly not only saves lives (due to prompt medical attention) but also significantly reduces the congestion caused by accidents, especially during peak periods. The National Cooperative Highway Research Program's synthesis report on safe, quick clearance of traffic incidents recommends that each state have the following provisions:

- Quick-clearance legislation
- Hold-harmless law for incident responders
- Fatality certification law
- Interagency agreements (open roads policy).[27]

Florida was singled out in this report as one of only five states that make quick clearance a high priority (along with Connecticut, Maryland, Tennessee and Wisconsin).

B. Improving Arterial Operations

Two principal operations strategies for arterials are traffic signal timing/coordination and arterial access management. Table 12 shows that the Southeast Florida urbanized area has made extensive use of these strategies, though apparently their use has not quite kept up with the increase in arterial lane-miles. The TTI urban mobility database puts the regional total of arterial lane-miles at 6,105 in 2000, growing to 7,535 in 2009, a 23% increase. The rate of increase in traffic signal coordination did not keep pace, resulting in the fraction of total arterial lane-miles covered decreasing slightly.

Today's traffic management systems adjust the timing of traffic signals, and often other traffic control devices, to minimize delay on the arterial system. Systems that simply produced a "green wave" in the peak direction to minimize stops have been replaced with systems that analyze real-time information to minimize overall system delay. A recent example is Broward County's completion of signal synchronization on major east-west arterials such as Atlantic Blvd., Broward Blvd., Griffin Road and Oakland Park Blvd.[28] The next stage of Broward's synchronization effort will focus on major north-south arterials.

Table 12: Southeast Florida Arterial Operations Strategies, 2000–2009

Strategy	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Signal timing: % of centerline miles	82	80	78	83	79	74	74	78	79	79
Access management: % of centerline miles	82	82	81	80	83	78	78	80	78	78

Sources: 2000 through 2006 data from Texas Transportation Institute *2008 Urban Mobility Report*; 2007 through 2009 data from TTI's *2010 Urban Mobility Report*

Access management refers to a set of techniques to increase safety and improve traffic flow on major arterials. It generally includes measures such as consolidating commercial driveways to minimize disruptions to traffic flow, adding median turn lanes or turn restrictions, adding acceleration and deceleration lanes, and adding raised medians. Raised medians increase safety by reducing the number of conflict points (by restricting mid-block left turns). Under heavy traffic conditions, they can add to congestion if they limit the storage capacity of left-turn lanes. But the general consensus among traffic engineers is that raised medians, on balance, lead to decreased congestion. Because of limitations on data reported by state DOTs, the TTI urban mobility database uses data on the extent of raised medians as a proxy for the entire set of arterial access-management measures, so that is what is reported on this row of Table 12.

Transportation system management and operation (TSM+O) should always be considered prior to implementing managed arterials. At some point, however, no matter how well the traffic management system is operating, the requirement to reduce the amount of time available to a traffic movement (typically through-traffic movement) to allow other movements to occur will become a critical factor. A roadway that must shut itself down routinely to allow other movements to occur is physically incapable of carrying the same amount of traffic as one with uninterrupted flow. When this point is reached, the grade separations used in the managed arterial approach should be considered.

TSM+O can and should play an integral part in a MA system even after the grade separations are in place at some intersections. TSM+O strategies are needed to maximize the capacity of intersections that have not reached the critical point of needing a grade separation. In this way, the additional capacity provided by the grade separation is maximized, as TSM+O strategies maximize the flow to and from the grade-separated intersections. Further, the active use of TSM+O allows grade separations to be added only at those intersections carrying the highest volume of traffic.

C. BRT Enhancements

The discussion of premium BRT and managed arterials in Part 5 focused primarily on the infrastructure modifications to the arterials themselves that would create the largely uncongested "guideway" for high-end BRT in these corridors. A complete plan for BRT service will require additional kinds of infrastructure: park-and-ride lots and transfer stations. The 2035 long-range transportation plan includes both types of infrastructure, but premised on the premium BRT service operating mostly along the arterials, using mostly exclusive lanes, and thereby providing a kind of super-express service to supplement the Rapid Bus service operating in general purpose arterial lanes.

Our proposal in this report assumes Rapid Bus (BRT-lite) service as set forth in the 2035 plan, but redefines the BRT-heavy service to be more long-distance than envisioned in that plan. Given our proposed network of expressway managed lanes and managed arterial corridors, we are proposing a single type of BRT-heavy service (dubbed premium BRT) using the network for two types of AM trips:

1) Trips from suburban park-and-ride lots to same-county major activity centers, using mostly or entirely the managed arterials;
2) Trips from suburban park-and-ride lots to major activity centers in adjacent counties, generally using a combination of managed arterials and expressway managed lanes.

In this discussion, we use the AM peak period for simplicity, hence the focus on trip origins at suburban park-and-ride lots. Major activity centers include traditional downtowns (Miami, Ft. Lauderdale, West Palm Beach), other downtowns (Boca Raton, Doral), major shopping areas (Dadeland, Sawgrass Mills, Wellington) and transportation centers (transit, Tri-Rail). This revised conception of premium BRT will require rethinking the number and location of park-and-ride facilities and transfer stations.

Park-and-Ride Facilities

In Part 7 we present an initial estimate of likely principal premium BRT routes based on qualitative inputs from the MPOs and transit agencies of the three counties. The agencies were given the maps shown previously as Figures 6, 7 and 8 and asked to make some initial estimates of travel patterns on premium BRT routes that might be created to make use of the network of MAs and MLs. We did not ask them to suggest revisions to the plans of each county for expanding the size of some existing park-and-ride lots and adding new ones, thus, the locations shown in those figures are from the existing 2035 plan.

If the network of MAs and MLs that we are proposing is built, transit agencies would be able to offer a level and quality of express bus service never before available in Southeast Florida. Very likely this will require rethinking both the capacity and the locations of park-and ride-facilities, so as not to constrain the growth of premium BRT service due to lack of parking. It is premature to attempt to estimate those specifics in this report. We simply emphasize the need to do so as major elements of the network are implemented.

Managed Arterial Bus Transfer Stations

Our revised approach to BRT assumes Rapid Bus (BRT-lite) service on essentially all major arterials, providing limited-stop service and using the general purpose lanes, with traffic signal priority at intersections. On those major east-west and north-south arterials that receive managed arterial treatment, premium BRT services would operate as super-express services, from suburban park-and-ride lots to major activity centers, both within the county of origin and across county lines. Grade separations would occur at approximately one-mile (on average) intervals on the managed arterials, typically where, say, the east-west managed arterial intersects an important north-south arterial. Given that the premium BRT is envisioned as a super-express service (i.e., with far fewer stops than the express service offered on arterials by Rapid Bus), the question becomes how many of these intersecting arterials the premium BRT bus should stop at.

For the premium BRT service, there is an unavoidable trade-off between the number of intermediate stops and the trip-time from origin (park-and-ride) to destination (major activity center). Making no intermediate stops would produce the shortest trip-time, taking full advantage of every underpass along the way. But making no stops also would mean foregoing the added passengers who could transfer onto the premium BRT bus from a bus serving the intersecting arterial. Without resolving this trade-off, we assume for this discussion that it would be desirable for the premium BRT bus to stop and accept transfer passengers at a limited number of the underpasses along the managed arterial. For example, in Miami-Dade County, the proposed Kendall Drive managed arterial would have six grade separations along its 7.6 miles. And in Broward County, the Pines/Hollywood Blvd. managed arterial would have seven such grade separations in its 8.3 miles. The two long north-south managed arterials would have even more: 17 for SR 7/US 441 from Glades Road to Pines/Hollywood and 22 for the converted South Miami-Dade Busway.

Figure 9 depicts a conceptual design for a bus transfer station integrated into a managed arterial underpass. In addition to its usual two travel lanes each direction, the underpass that includes a bus transfer station would include a bus turn-out lane adjacent to the outer of the two through lanes on each side, plus a full acceleration lane by which the bus would exit the underpass and merge back into the regular lanes. Passengers seeking to board the premium BRT bus would descend from street level to the bus platform level via elevator, escalator or stairway. Transfer passengers would already have a transfer, but originating passengers would pay at a kiosk at street level. In order to accommodate all desired transfers from, say, north-south regular or Rapid Bus to east or west premium BRT bus, there would need to be access from street level to underpass platform level at two of the four corners of the intersection (assuming that some bus passengers would cross the street at the intersection above the underpass station). Ample lighting, video surveillance and audio speakers would be worthwhile security features at the platform level.

Figure 9: Underpass Bus Transfer Station Concept (Cutaway View)

Part 7

Estimated Costs and Revenues

A. Developing Unit Costs

In a preliminary study of this sort, time and resources do not permit a detailed cost analysis of each of the individual capital improvements proposed, to create the managed lanes and managed arterials. Instead, the method used was to develop generic cost estimates for the various components, and then add up the components needed to create the entire proposed 2035 network. Those components are as follows:

- New surface arterial lane
- New expressway lane
- New expressway ML obtained via restriping (as per 95 Express project)
- Right of way
- New elevated lane
- Flyover quadrant
- Ramps from arterial to elevated roadway
- Arterial overpass
- Arterial underpass

Unit costs for each of these components were developed for the January 2009 Managed Lanes Vision study for FDOT.[29] Those unit costs were in 2008 dollars. To adjust those numbers to 2010 dollars (the most recent year for which cost data are available), we used the construction cost index maintained by the American Road & Transportation Builders Association (ARTBA). There was considerable construction cost inflation during the first half of the last decade, but the index actually decreased in 2009 and then increased by approximately the same amount in 2010. Thus, 2010 construction cost estimates are essentially the same as those for 2008. Hence, the unit costs developed for the ML Vision study are used in the current report for 2010.

New Surface Arterial Lane

A table obtained from the Federal Highway Administration provided 2006 costs used in their Highway Economic Requirements System (HERS) model for nine types of highway construction activities in seven categories, with various subcategories. Some portions of the tri-county urbanized area would fit FHWA's category of *Large* Urbanized area, while others are more like a *Major* Urbanized area (such as Houston or Los Angeles). We used an average of the two figures. For the "add lane, normal" category, the average of $4.9 million/lane-mi (Large) and $9.9 million (Major) is $7.4 million in 2006; adjusting upwards by 4% annual inflation (the ARTBA average over 16 years) gives $8 million/lane-mile for adding arterial lanes in 2008, which we also use for 2010.

New Expressway Lane

The same procedure was followed for lane additions to expressways. For Large areas, the average in 2006 was $6.7 million, while for Major areas, it was $13.4 million. The average of those two is $10.05 million, which is $10.87 million/lane-mile, adjusted to 2010 dollars.

New Expressway Lane via Restriping

The generally stated cost of the modifications needed for Phase 1 of the 95 Express project (from I-395 to Golden Glades Interchange) is $122 million. At 7.3 route-miles and four resulting MLs, that is 29.2 lane-miles, which works out to $4.2 million/lane-mile obtained via this kind of restriping and related modifications. However, 95 Express may well be a special case. FDOT's SR 826 Managed Lanes Preliminary Design Analysis applied the lane-narrowing and restriping approach in several alternatives, with per-lane-mile costs ranging from a low of $1.2 million (Alternative 1) to $10.6 million (Alternative 1-A). The average of four such alternatives is $6.1 million/lane-mile. This higher number seems more prudent to use than the 95 Express figure of $4.2 million/lane-mile, given the wide range of conditions likely to be encountered on Southeast Florida expressway facilities where ML additions are contemplated.

Right of Way

Right-of-way costs will vary considerably, depending on location. But for this kind of generic cost estimate, a single figure was required. In Poole's 2007 study of truck toll lane feasibility,[30] figures from FDOT District 6 were obtained, on a per-mile basis, for a 50-foot wide right of way. Those numbers ranged from $19.8 million/mile to $28.4 million/mile, for the equivalent of slightly more than four 12-foot lanes. Thus, the average of $23 million/mi. equates to $5.75 million/lane-mile, or $5.98 million in 2008/2010 dollars. MDX's 2002 feasibility study for the Central Parkway estimated ROW cost at $6.16 million/lane-mile in 2001. Adjusting that at 4%/year to 2008 (equal to 2010) yields $8.11 million/lane-mile. To be conservative, however, we opted to use $10 million per lane-mile as the average right-of-way cost.

New Elevated Lanes

Precast, segmented construction has proved to be a cost-effective approach to bridge construction in recent years, with a recent Florida highway example being the elevated express lanes on Tampa's east-west Crosstown Expressway (and another notable example being the new I-35W bridge in Minneapolis). As part of Poole's 2007 Miami toll truck lanes study, construction cost estimates for such structures were obtained from Figg Bridge.[31] The per-mile cost was provided for two-lane, three-lane and four-lane bridges in 2006 dollars. These costs included design, construction, construction management and contingency. The widths of these bridges were 47 feet, 59 feet and 71 feet, respectively, and their per-mile costs were $35.9 million, $45.1 million and $58.7 million per mile. Adjusting these costs to 2010 dollars and dividing by the number of lanes in each case yields costs of $19.4 million/lane-mile for the two-lane structure, $16.3 million/lane-mile for the three-lane bridge, and $14.7 million/lane-mile for the four-lane bridge.

Flyover Quadrant

We define a quadrant as a pair of ramps (one per direction) between two adjacent compass points of an interchange—e.g., North and West. A full interchange provides such ramps for all four quadrants. The most recent available South Florida data come from FDOT District 4's SW 10th Street Connector Study. A full interchange between the Turnpike Mainline and SR 869's eastbound connector (rather than the existing half interchange) was the principal cost difference between alternatives 2a and 2b in that study, with the difference between those alternatives averaging $149.5 million. Since that represents the cost of adding two quadrants, we use $75 million as the cost of one flyover quadrant. In some cases, adding flyover quadrants will require the acquisition of right of way. We estimate this would occur in 25% of the cases. A parcel of up to one-quarter-mile square might be needed. Applying the same average right-of-way cost derived previously gives us $158 per square foot. For a parcel of 1.742 million sq. ft., the cost would be $275 million. If that were needed 25% of the time, the average right-of-way cost per quadrant would be $69 million. Adding this to the $75 million construction cost brings the total per quadrant to $144 million.

Ramps from Arterial to Elevated Roadway

Where an elevated ML facility (such as the proposed North-South Connector or the US 1 Managed Lanes) needs intermediate access at a major arterial, a set of four ramps must be provided. A 2008 communication from Figg Bridge estimated the cost of each such intersection access (four ramps) as $40 million in 2008 dollars, which would be the same in 2010 dollars.[32]

Arterial Overpass

To provide cost estimates for proposed overpasses, a prototype four-lane overpass planned in Lee County, Florida was selected. The county budgeted $32.25 million for this facility. In a subsequent Reason Foundation Lee County study, several different overpasses were evaluated, tailored to different intersections in a specific arterial corridor. They ranged from $32.5 million to $41.85 million, with the set of six averaging $39.5 million each, in 2008 dollars.[33] We use that average for the 2010 overpass cost.

Arterial Underpass

The only underpass constructed in Southeast Florida in recent years was on Okeechobee Road in Hialeah in 2006. That project permitted six lanes to pass beneath a railroad line, thereby approximating the configuration of an underpass with four main lanes plus two bus stopping and acceleration lanes. Its cost was $35 million. That total included the cost of a new railroad bridge, which might be comparable to the cost of adding the roadway structure over the underpass. Adjusting that for two years of inflation would bring the cost to $38 million in 2008 (and 2010). Adding an additional 10% contingency for underground utility relocation, we get $41.8 million for the average underpass cost.

B. Network Cost Estimate

Table 13 provides quantitative specifics on the set of MLs proposed for the 2035 expressway network. For each segment, the table gives the route-miles, number of MLs, number of MLs that represent new construction, and the number of lane-miles that will be provided as surface lanes and elevated lanes, or generated via restriping. Also included are estimated right-of-way costs (where needed), flyover quadrant costs and elevated interchange ramps for the two new elevated tollways.

Table 13: Expressway Managed Lanes Network Cost Estimate

Expressway	From/To	Route-Miles	Total MLs	New Lanes	New Lane-Miles Surf	New Lane Miles Elev.	Lane-Miles ROW	Lane-Miles Restriped	Flyover Quads	Elev. Intersect.
Sawgrass	I-75 to Turnpike Main	21.4	2	2	42.8	0	0	0	3	0
I-95	Hillsboro to Broward Bl.	14.4	4	0	0	0	0	57.6	0	0
I-95	PGA Blvd. to Hillsboro	37.1	4	0	0	0	0	148.4	0	0
I-95	Indiantown Rd. to PGA Blvd.	7.2	2	0	0	0	0	14.4	0	0
I-75	I-595 to HEFT	12.4	4	4	49.6	0	0	0	2	0
I-595	US 441 to I-95	2	2	2	0	4	0	0	2	0
1-595*	I-75 to US 441	10.5	3	3	31.5	0	31.5	0	3	0
I-95*	Broward Bl to I-395	24.5	4	0	0	0	0	98	0	0
Turnpike Main	PGA Blvd. to Hillsboro	36	4	2	72	0	0	72	0	0
Turnpike Main	Hillsboro to Golden Glades	29.1	4	2	58.2	0	0	58.2	2	0
HEFT	Turnpike Main to I-75	8	4	4	32	0	16	0	1	0
HEFT	I-75 to SR 836	12.8	4	4	51.2	0	0	0	0	0
HEFT	SR 836 to SR 874	9	4	2	18	0	0	18	0	0
SR 826	Golden Glades to SR 924	8.5	4	2	17	0	17	17	3	0
Lejeune Interconnect	SR 836 to SR 112	1.7	4	4	0	6.8	0.85	0	3	0
SR 924 ext. west	NW 87 Ave to HEFT	1.5	4	4	0	6	3	0	1	0
SR 836	HEFT to NW 37th Ave	8	4	2	16	0	16	16	6	0
SR 836	NW 37th Ave to I-95	3.5	4	4	0	14	0	0	2	0
SR 836 ext	NW 137 Ave to SW 136 St	12	4	4	48	0	48	0	1	0
I-75	HEFT to SR 826	5	4	4	20	0	0	0	2	0
SR 826	SR 924 to US 1	15.3	4	2	30.6	0	30.6	30.6	2	0
SR 874 (Shula)	HEFT to SR 826	6.6	2	2	0	13.2	0	0	1	0
US 1	Dadeland to I-95	7	3	3	0	21	3.5	0	0	3
NS Connector	SR 112 to Opa-Locka Airport	6.75	4	4	0	27	13.5	0	3	3
SR 924 ext east	NW 32nd Ave. to I-95	2	4	4	0	8	0	0	2	2
Subtotal, Exp. ML		302.3			486.9	92	179.95	530.2	39	8
Cost, Exp. ML, $M	$16,424				$4,950	$1,849	$1,485	$2,636	$5,184	$320

*excluded from cost estimate; already funded

As can be seen, the 2035 expressway network is estimated to cost $16.4 billion in 2010 dollars. It would extend over 302 route-miles, nearly all of which would have two MLs in each direction. Elevated lanes would constitute 92 lane-miles out of a total of 1,117 total lane-miles, about 8%.

Table 14 provides the same type of information on the managed arterials. The estimated cost of those MAs is $3.8 billion. Since the expressway and arterial lanes are intended to function as an integrated system, the total of the two would be a $20.2 billion system. This estimate is for capital costs only. There will, of course, be ongoing costs to operate and maintain the MA/ML network, but estimating those costs is beyond the scope of this preliminary mobility study.

Table 14: Managed Arterial Network Cost Estimate							
Managed Arterial	From/To	Rt-Mi	New lanes	# Grade Sep	New Ln-mi	ROW Ln-mi	Cost $M
SW 10th St.	Turnpike to I-95	3.1	4	4	12.4	0	$266
Sample Road	SR 7 to I-95	4.8	0	3	0	0	$125
Oakland Park Blvd.	SR 7 to I-95	2.7	0	2	0	0	$84
Broward Blvd.	SR 7 to I-95	2.1	0	2	0	0	$84
Pines/Hollywood Blvd.	SR 7 to I-75	8.3	0	7	0	0	$293
US 441	Glades Rd. to Hollywood Blvd.	24.8	0	17	0	0	$711
US 441	SR 80 to Lantana Rd.	6.1	0	2	0	0	$84
Southern Blvd.	SR 7 to I-95	8.3	0	1	0	0	$42
Boynton Beach Blvd.	Turnpike to I-95	6.3	0	4	0	0	$167
Glades Road	SR 7 to US 1	7.6	0	5	0	0	$209
Kendall Drive	SW 147th to US 1	7.6	0	6	0	0	$251
Busway	SW 344th to Dadeland	19.8	2	22	39.6	0	$1,236
Douglas Road	Opa-Locka Airport to SR 826	1.75	2	1	3.5	3.5	$105
Tamiami Trail	SR 826 to HEFT	4	0	3	0	0	$125
Totals		107.25		79			$3,781

C. Estimating Toll Revenues

As with the cost estimates, the budget for this kind of overview study did not permit a detailed traffic and revenue forecast. Such a forecast would model, year by year, the construction of the MLs and MAs in various corridors. As each corridor's tolled facility is implemented, traffic would be assumed to begin flowing in its first year and gradually increase until—at least in the peak direction during peak periods—all the throughput capacity consistent with the target level of uncongested service (probably LOS C) is reached, after which traffic flow would be maintained at that rate. The optimal toll rate for each corridor would also have to be estimated, and modeled as increasing over time so as to maintain uncongested traffic flow. The net present value (in 2010) of this 25-year revenue stream could then be compared with the total construction cost, again expressed in 2010 dollars, as a basic indicator of financial feasibility.

For this study, we must use a greatly simplified procedure. The basic idea is to estimate the annual revenue produced from the complete system of MLs and MAs. Since we cannot specify in advance the order in which the many different corridors would be implemented, our simplified method will assess the revenue that would be produced by the full 2035 system, but in 2010 dollars. This can be compared with our estimated construction cost in 2010 dollars, using a multiple of the annual toll revenue (as is done in very preliminary assessments of proposed toll roads).

Expressway Managed Lanes Toll Revenue Estimation

To estimate toll revenues for the expressway MLs, we must make a number of assumptions. Given the projections of 2035 conditions in the long-range transportation plan (summarized previously in Table 3), we know that congestion in 2035 will be much worse than today. The average speed during congested periods is projected to decrease by 20%, from just below 33 mph to 26 mph. And traffic engineers' measure of the volume/capacity ratio for major roadways will increase from an already high 0.60 to a very high 0.75, implying far more serious congestion. (Note: v/c is calculated on a 24-hour basis, not just for peak hours.)

What toll rate would be needed to ensure uncongested travel on the MLs under those circumstances? The rates currently charged on the initial I-95 Express Lanes are not a good indication, for several reasons. Those lanes are new, they extend for less than eight miles, and the project added an additional traffic lane in each direction, reducing congestion in the general purpose ("local") lanes. While certainly welcome, the congestion-relief in the local lanes will not be sustained as the region's vehicle miles of travel (VMT) increase by nearly 38% between now and 2035 and the general purpose lanes operate at LOS F during peak periods.

A better proxy for the likely traffic situation in Southeast Florida by 2035, when the *full ML network* will have passed its introductory "ramp-up" period, is the 91 Express Lanes that currently provide the only MLs in the Los Angeles urbanized area. This is a mature ML project, in operation since December 1995, in a corridor typical of the intense congestion that characterizes Los Angeles freeways. The current congestion situation in Los Angeles is what Southeast Florida is projected to experience by 2035, based on the modeling done for the 2035 fiscally constrained long-range transportation plan, as explained in the following paragraph.

The travel time index for Los Angeles is currently 1.38, compared with Southeast Florida's current 1.23. That index is the ratio of travel time in congested conditions to travel time in uncongested conditions. Thus, in Los Angeles it currently takes 38% more time to make a given trip during peak periods than at other times; in Southeast Florida, that congestion penalty is currently 23%. Since speed and travel time are inversely related, taking the inverse of the travel time index allows the current ratio of congested speed to uncongested speed to be determined. Those ratios are 0.813 for Southeast Florida today compared with 0.725 for Los Angeles today. The SERPM modeling for the 2035 plan showed that congested travel speeds in Southeast Florida are projected to decrease 20.4% by 2035. So the 2035 ratio of congested speed to uncongested speed will be 0.813 x (1 minus .204) = 0.647. Taking the inverse of this gives us the projected travel time index for Southeast Florida in 2035. That number is 1.54—significantly *worse* than Los Angeles's current index of 1.38. In other words, the congestion officially projected for Southeast Florida in 2035 based on implementing the adopted long-range plan will be significantly worse than *current* levels in Los Angeles (which are the worst in the nation).

Hence, we will use *current* toll rates on the 91 Express Lanes as a conservative estimate for the peak toll rate needed for the proposed ML network here by 2035. The 91 Express website (www.91expresslanes.com) provides the detailed toll-rate schedule, for each hour of each day of the week. That corridor operates with seven peak hours per weekday, 6 to 9 AM and 3 to 7 PM. The average weekday toll rate in the peak direction during the AM peak is $4.02 and during the PM peak is $6.21. Since the facility is 10 miles long, the rate per mile is the total toll divided by 10. Thus, the simple average peak-direction toll rate during the seven weekday peak hours is $.511 per mile.

Our basic model computes the toll revenue produced per lane-mile of ML during peak hours on a weekday. We make the following assumptions in doing this:

- The average toll charged on a ML in the *non-peak* direction is 41% of the peak-direction toll rate (again, based on data from the 91 Express Lanes).
- The volume of traffic in the peak direction during peak periods is 1,600 *paying* vehicles/lane/hour (which also allows for up to 100 *non-paying* vehicles, such as buses and vanpools, for a total of 1,700). Given the projected LOS F conditions as of 2035 in every corridor for which we have proposed MLs, our assumption is that the MLs would be filled to the maximum traffic level consistent with uncongested operation, *during peak periods in the peak direction*.
- The volume in MLs in the *non-peak* direction, paying 41% of the toll rate charged in the peak direction, is assumed to be *half* that of the peak direction, 800 vehicles/lane/hour.
- The number of peak hours in a weekday in 2035 is assumed to be seven (three in the AM and four in the PM period, as in Los Angeles today).

Using the above assumptions, we next compute the average weekday toll revenue generated during peak periods. The weighted average hourly traffic in a ML during the seven peak hours is 1,200, and the weighted average toll rate is $.411/mile. Hence, for the 1,117 lane-mile expressway ML system, the weekday peak-period revenue is $4,039,308. With 250 weekdays per year, the annual peak-period revenue is $1,009,827,000.

On the 91 Express Lanes in California, non-peak weekday revenue plus all weekend revenue equals 29% of peak-period revenue. Hence, the non-peak revenue for the expressway ML network can be estimated as $292,849,300. Thus, total annual revenue in 2035 for the expressway ML network is $1,302,676,300 or approximately $1.3 billion (in 2010 dollars).

This is a single-point estimate for a particular future year, assuming the full 1,117 lane-mile system is in operation in 2035 after various segments have been completed and put into operation over the previous 25 years. Obviously, annual revenues would be lower than that in the earlier years when only part of the network is in operation, and presumably annual revenues would increase each year after 2035 at least by the rate of inflation (unless economic growth in Southeast Florida stops or reverses after 2035). Without modeling a typical 30- or 40-year traffic and revenue projection, what can we say about the financing capability of a toll revenue stream that is potentially $1.3 billion per year early in the full network's life?

Various informal rules of thumb about bonding capacity exist among investment bankers and toll revenue forecasters. Most of these rules were developed in the context of traditional tolling, where toll rates remained flat for long periods of time, and the objective was only to cover the capital and operating costs of the toll facility (as opposed to also managing traffic flow). Revenue forecasting for MLs using market-clearing variable pricing is still at an early stage—but there are reasons to expect that the revenue growth for such MLs will be significantly greater over a typical 30-year financing period than for traditional toll roads.

One toll finance rule of thumb is that financing capability is a multiple of post-ramp-up annual toll revenues. A reasonable multiple might be ten times (10X), which for this project would suggest a possible financing capability of $13 billion, in 2010 dollars. That number is about 79% of our estimated network capital cost estimate of $16.4 billion, also in 2010 dollars.

That percentage may sound high, but it is comparable to recent projects that have involved adding new MLs to highly congested urban expressways. For the $1.9 billion project that is adding MLs to the I-495 Capital Beltway in northern Virginia, projected toll revenues have financed 79% of the project's capital cost. For the $2.1 billion North Tarrant Express ML project on I-820 and SH 183 in Ft. Worth, projected toll revenues have financed 73% of capital costs. And for the $2.8 billion project adding MLs to the LBJ Freeway (I-635) in Dallas, toll revenues have financed 82% of the project's cost.[34] These are individual ML projects on some of the most congested expressways in those metro areas. The percentage of costs covered by toll financing for an entire ML network, where some links may have less robust toll revenue than others, could well be lower. The ambitious $16.2 billion ML network approved by Georgia DOT in December 2009 is estimated to cover only 57% of its capital costs based on toll revenues.[35] Thus, the very preliminary estimate of 79% of the ML network cost being covered by toll revenue financing should be taken as a general indication of significant funding potential, rather than as a hard-and-fast number. Whatever the final percentage turns out to be, the balance of the cost of developing the network could come from re-allocating a modest portion of the $58 billion in federal, state and local transportation funding already in the long-range transportation plan.

Managed Arterials Revenue Estimation

The model assumed for pricing the managed arterials is to charge a flat rate toll, adjusted annually for inflation and traffic growth, for each grade separation (underpass or overpass) traversed. The 107.25 route-mile set of managed arterials defined in Part 5 has 78 newly constructed grade separations—underpasses or overpasses, as best suits each location. Both the toll rates and the usage rates assumed in our revenue calculations are based on previous studies that were undertaken for tolled, grade-separated interchanges in Lee County. The rates used below are actually slightly lower than the inflation-adjusted toll rates established in Lee County's Value Priced Queue Jump Study.[36] Those rates were developed based on stated preference surveys of drivers using congested at-grade intersections on arterials in Lee County. Usage rates are based on these same stated preference surveys.

As noted previously in Part 5, the throughput of a six-lane arterial reconfigured as a managed arterial is up to 87,600 average daily traffic (ADT). Given that these corridors were projected as operating at LOS F as of 2035, we assume that during peak and shoulder periods on weekdays, the arterials operate at capacity, with the MA grade separations operating at LOS C. We also make the following assumptions:

- Of the total ADT, traffic equal to half that amount (43,800) occurs during seven peak hours, and another quarter (21,900) during four shoulder hours, with the balance during the remaining 13 hours.
- 2010 toll rates per tolling point (each grade separation used) are assumed to be \$.35 peak, \$.25 shoulder and \$.15 other times.
- Based on the speed advantage of avoiding signaled interchanges, we assume that 60% of total arterial traffic (and 75% of through traffic) opts to use the underpasses rather than the signalized intersections lanes during peaks, 45% during shoulders and 30% at other times.

The assumption of 60% of total traffic approaching the intersection opting to use the grade separation during weekday peak periods may appear aggressive, but there are good reasons for making this assumption. First, the underpass or overpass will provide a lot of capacity, since two lanes in each direction is significantly less than twice as costly to build as one lane per direction, making it unlikely that a two-lane grade separation would be considered. The revenue stream needed to finance the project is set by the cost of constructing it; the greater the number of vehicles using it, the lower the per-vehicle charge can be. The number of vehicles using the facility at any given toll will be related to the level of congestion on the at-grade intersection's through lanes. The final number of vehicles using the grade separation and the at-grade lanes will be an equilibrium between the toll rate and the intersection's congestion level. While the toll rate is easily adjusted, the congestion at the intersection is affected by the signal timing. Besides its through traffic, the signalized intersection must also serve left, right and U-turns as well as cross-street through-movements and turns. The best public policy is that which minimizes total overall delay at the intersection, and total delay is minimized when use of the grade separation is maximized. Doing that allows the maximum amount of saved "green time" no longer needed by the through-movements shifted to the grade separation to be allocated to the other movements, thereby reducing overall delay.

Table 15 summarizes the calculation, based on the above assumptions.

Table 15: Managed Arterial Network Weekday & Weekend Revenue Estimation

	Traffic	Fraction Using	Rate per Grade Separation	Number Used	Daily Revenue
Peak	43,800	60%	\$.35	78	\$717,444
Shoulder	21,500	45%	\$.25	78	\$188,662
Off-peak	21,500	30%	\$.15	78	\$ 75,465
Total Weekday					\$981,571
Weekend & Holiday	52,560	40%	\$.20	78	\$327,974

With 250 weekdays per year, the annual revenue from weekday use is $245,392,750; and 115 weekend and holiday days at $327,974 yields another $37,717,010. This gives us total annual revenue of $283,109,760.

Using a 10X factor for financing capability (as done previously for the ML network) suggests that this revenue stream could support $2.8 billion in capital costs. Our cost estimate for the managed arterial system (Table 10) was $3.74 billion. Thus, if the assumptions made in the above revenue estimates are in the right ballpark, the MA system could cover approximately 75% of its construction cost from toll revenues.

D. Premium BRT Ridership and Revenue Estimates

To develop preliminary estimates of ridership on new premium BRT service that would make use of the managed arterials and expressway managed lanes, we sought input from this project's principal contact person in each of the three transit agencies and each of the three MPOs. These contact people were visited, in most cases on two separate occasions in 2010, during the early months of the Southeast Florida Mobility project; they have received monthly updates on the project's activities and progress since then. Each was provided with a map of the proposed network of MAs and MLs (Figures 6, 7 and 8) and asked to suggest the corridors best suited for premium BRT service. For each such corridor, they were also asked to provide an assessment of the relative strength of demand: low, medium or high. Fairly detailed responses were received from the Palm Beach County MPO, PalmTran and the Broward MPO. A less-detailed response was provided by the Miami-Dade MPO.

In order to move from qualitative to quantitative estimates, we turned to the 2035 long-range transportation plan for Broward County, which had the most detailed assessment of proposed BRT service.[37] That assessment focused only on premium BRT service on arterials, but provided sufficient information that it was possible to derive an average value of 842 for 2035 daily boardings per mile of dedicated guideway arterial BRT route. Daily in this case refers to non-holiday weekdays. Details of this assessment will be found in Appendix B, "Broward County Arterial Lane Bus Rapid Transit Ridership Projections" of the Broward long-range transportation plan.

An assessment of premium BRT service currently in operation in various U.S. metro areas identified six such operations making use either of an exclusive busway or a majority-exclusive busway, as shown in Table 16.

Table 16: U.S. Arterial Premium BRT Ridership, 2010					
Agency	Name of BRT	Length (mi.)	Stations	Weekday Ridership	Weekday Riders per Mile
Los Angeles County MTA	Orange Line	13.7	14	23,000	1,679
Miami-Dade Transit	South Miami-Dade Busway	20	28	20,000	1,000
Greater Cleveland RTA	HealthLine	6.8	40	14,000	2,059
Lane (OR) Transit District	Emerald Express	4.0	10	5,000	1,250
RTC of Southern Nevada	MAX	4.5	11	8,000	1,778
Port Authority Transit (Pittsburgh)	West Busway	5.1	6	9,000	1,765

The average value of weekday boardings per route mile is 1,460, and the range of these is from 1,000 (Miami-Dade) to 2,059 (Cleveland). These differences may reflect differences in urban land-use patterns, such as density. Unlike the South Miami-Dade Busway, most of these routes serve a central business district (CBD), which tends to be the major transit destination in most areas.

Because of the generally lower densities in Southeast Florida, and because many of the proposed MA BRT routes do not directly serve a major CBD, we would expect premium BRT ridership to be toward the lower end of the national experience, which would appear to be confirmed by the Broward long-range plan's projected average of 842 weekday boardings per route-mile for Broward premium BRT in 2035. Thus, for Southeast Florida arterial premium BRT services, we used 900 weekday boardings per route-mile for corridors judged by local transit/MPO experts as having "high" demand, 750 for those judged as "medium," and 500 for those judged to be "low" in ridership demand. The only exception was the South Miami-Dade Busway, where we estimated that population and economic growth plus the addition of numerous grade separations in that corridor would increase weekday boardings per route-mile from the current 1,000 to 1,500 by 2035.

Using those numbers to assess the MA corridors reviewed by our transit and MPO contacts produced the 2035 ridership estimates shown in Table 17.

As can be seen, the projected 2035 weekday ridership in the specified corridors is approximately 22,000 in Palm Beach County, 38,000 in Broward County and 40,000 in Miami-Dade County, for a total of 100,000.

Our transit agency and MPO contacts interpreted our request as focusing mainly on within-county BRT service and therefore, for the most part, did not provide as much information for inter-county routes that would make use of the proposed 2035 ML network on the expressway system. We therefore relied on general knowledge of commuting patterns in the region, gleaned from interviews with those and other agency staff members and from local news media.

Table 17: Projected 2035 Premium BRT Weekday Ridership on Managed Arterial Routes					
Arterial	From/To	Rt.-mi.	Rating	Ridership/Mile	Weekday Ridership
Palm Beach County					
SR 7	SR 80 to Lantana Rd.	6.1	Med.	750	4,575
Southern Blvd.	SR 7 to I-95	8.3	High	900	7,470
Boynton Beach Blvd.	Turnpike to I-95	6.3	Low	500	3,150
Glades Rd.	SR 7 to US 1	7.6	High	900	6,840
Subtotal		28.3		779	22,035
Broward County					
SW 10th St.	Turnpike to I-95	3.1	High	900	2,790
Sample Rd.	SR 7 to I-95	4.8	High	900	4,320
Oakland Park Blvd.	SR 7 to I-95	2.7	High	900	2,430
Broward Blvd.	SR 7 to I-95	2.1	High	900	1,890
Pines/Hollywood Blvd.	SR 7 to I-75	8.3	High	900	7,470
SR 7	Glades to Hollywood/Pines	24.8	Med.	793	19,666
Subtotal		45.8		842	38,566
Miami-Dade County					
SR 924	NW 32nd Ave. to I-95	2.0	Med.	750	1,500
Kendall Dr.	SW 147th to US 1	7.6	Med.	750	5,700
Busway	SW 344th St. to Dadeland	19.8	Actual	1,500	29,700
Douglas Rd.	Opa-Locka Airport to SR 826	1.8	Low	500	875
Tamiami Trail	SR 826 to HEFT	4.0	Low	500	2,000
Subtotal		35.2		1,132	39,775
Grand Total		**109.3**		**919**	**100,376**

For many years, the Federal Transit Administration had a rough rule of thumb for how ridership grows on new service: Year 1, 80% of initial ridership potential; Year 2, 90%; Year 3 100%. After that, ridership grows in proportion to population increase plus system additions. We began with that general approach, using the early ridership numbers from routes operating on the I-95 MLs.

For three of these routes there were 16 months of data. We fitted a regression line to those data and projected that three-route total to January 2013. For the Miramar line, with only five months of data showing rapid growth, we doubled the most recent month's figure as our January 2013 estimate. We added the 2013 numbers together and then "grew" that corridor total from 2013 to 2035 using projected annual population increases over that time period. This gave us a 2035 I-95 ML weekday ridership estimate of 5,236, which we rounded to 5,200. This number was used for 2035 daily ridership for all expressway ML corridors whose BRT ridership potential was rated "high." We used half this amount for those rated "medium." The results are shown in Table 18.

Table 18: Projected Daily 2035 Inter-County BRT Ridership on Expressway ML Routes									
	I-95		Turnpike		Glades/SR7		I-595		
From/To (AM)	Rating	Boardings	Rating	Boardings	Rating	Boardings	Rating	Boardings	Total
Palm Beach County									
Martin Co. to Jupiter, PBG, WPB	Med.	2,600							2,600
Martin Co. to Jupiter, Wellington			High	5,200					5,200
Delray to Broward coastal	Med.	2,600							2,600
Boca to NW Broward			Med.	2,600					2,600
Boca to NW Broward					High	5,200			5,200
Wellington, RPB to Ft. Lauderdale, Miami			High	5,200					5,200
Subtotals		5,200		13,000		5,200			23,400
Broward County									
Central Broward to Boca					High	5,200			5,200
Central Broward to PB	High	5,200							5,200
Central Broward to Miami	High	5,200							5,200
West Broward to Miami							High	5,200	5,200
Subtotals		10,400				5,200		5,200	20,800
Miami-Dade County									
Central Miami-Dade to Ft. Lauderdale	High	5,200							5,200
Grand Totals		20,800		13,000		10,400		5,200	49,400

These values (for both MA and ML BRT ridership) should be regarded as sketch-planning estimates based on peer comparisons and a high-level view of factors unique to Southeast Florida. While we believe they are sufficiently accurate to justify moving into the next phase of study, we do not recommend that any specific implementation actions be taken before further work is done, including the use of transportation demand model runs of various scenarios incorporating the proposed managed lanes and managed arterials. This will assist planners in identifying the best design and operating methods and the most promising corridors for initial demonstration projects, if justified.

Premium BRT Revenue Estimates

This preliminary estimate of the net new revenues that could be generated by the premium BRT service on MLs and MAs begins with figures for the current bus service provided by the three county transit agencies, gathered from the National Transit Database maintained by the Federal Transit Administration. The relevant figures are presented in Table 19. The average fare per boarding is obtained by dividing total fare revenue by total boardings.

Table 19: Current Bus Transit Revenue, 2009				
	Broward County Transit	Miami-Dade Transit	PalmTran	Totals
Bus fare revenue	$23,340,298	$78,850,396	$8,822,925	$111,013,619
Bus unlinked passenger trips	36,804,682	75,808,000	10,045,345	122,658,027
Average fare per boarding	$0.63	$1.04	$0.88	$0.91
Annual unlinked passenger trips	37,720,691	103,504,590	10,936,348	152,161,629
Weekday unlinked passenger trips	123,801	331,924	37,566	493,291
Annual/weekday ratio	305	312	291	308

Source: National Transit Database, 2009

We use data from Table 19, along with the premium BRT ridership projections discussed above, to estimate the net new revenue generated from this new service operating on MLs and MAs in the three counties, as shown in Table 20. In doing so, we use the average fare from Table 19 for the within-county service on MAs and we assume that fares on the longer-distance inter-county trips on expressway MLs average 1.67 times that amount.

Table 20: Estimated Premium BRT Net New Fare Revenue, 2035			
	MA Daily Ridership	ML Daily Ridership	Total
Projected daily riders	100,000	50,000	150,000
Times: annual/weekday ratio	308	255	291
Times: average fare	$0.91	$1.51	$1.08
Annual gross fare revenue	$27,917,868	$19,232,654	$47,150,522
Times: new rider percentage	50%	90%	66%
Estimated net new fare revenue	$13,958,934	$17,309,389	$31,268,322

Since our aim is to estimate the net *new* revenue from the premium BRT services that are facilitated by the MLs and MAs, we need to adjust the gross fare revenue figures. We estimate that 50% of those using the premium BRT on MAs are people who were already using bus service on those arterials, but who shift to the premium BRT because it is compatible with their trip needs. The other 50% are net new riders, who thereby produce net new farebox revenue. For the inter-county services using the expressway MLs, we assume that 90% of those riders have switched from some other mode, rather than having switched from some other bus service. Our estimate of the annual net new revenue from the premium BRT services is $31.3 million (in 2009 dollars) as of 2035.

While we used historical data down to the individual dollar to do the above calculations, there are obviously many factors that will affect the final results that cannot be foreseen at this time. So a figure of $30–31 million should be taken as an order of magnitude estimate, and no more than that. It is also worth noting that this kind of premium service could well command premium fares, which our estimate did not include. If such a fare structure proved to be viable, the farebox revenue could be considerably higher than $30–31 million.

Data from Tables 19 and 20 also help us to put the projected premium BRT ridership into perspective. From Table 20 we can compute the annual total (based on 291 days at 150,000/day) as being 43.65 million. Comparing that to the total current bus trips in Table 19 of 122.7 million, we see that the projected premium BRT ridership is 36% of the current total.

Part 8

Mobility Benefits

A. Transportation Modeling Results

The most widely accepted tool for quantitative analysis of regional transportation system improvements is a large-scale traffic and land-use simulation model. For Southeast Florida, the current version of this model is SERPM 6.5. FDOT District 4 made an in-kind contribution to this study by carrying out model runs to estimate changes in system performance due to the proposed network of managed lanes and managed arterials. This modeling work was carried out during the second half of 2010.

The basic objective of this exercise was to compare the roadway network that would exist in 2035 based on the adopted cost-feasible long-range transportation plan with that same network modified by the addition of MLs and MAs, as defined in previous sections of this report. The current version of SERPM 6.5 enables explicit modeling of general purpose lanes on expressways and arterials and toll roads, and managed lanes on expressways. It had no explicit way of modeling point charges at arterial intersections, since its toll modeling structure was based on tolls being charged for the use of entire lanes—which is not how our proposed managed arterials would be charged.

In the initial modeling runs, the modelers represented the MAs as if they were general purpose arterial lanes that had been converted to toll lanes. This produced absurd results, since restricting four out of the six lanes on a congested arterial to toll-paying traffic had the result of diverting large fractions of the traffic formerly using the arterial onto parallel routes. In the MAs proposed in this and previous reports, general purpose traffic can use all lanes in between the grade separations, and with low point-tolls charged for the grade separations, there are good reasons to expect a high fraction of the arterial's peak-period through-traffic to choose the tolled grade separations (as explained in Part 7).

Given the inability to represent such point-tolls on arterial grade separations, the least-crude way to model the traffic flow implication of MAs was determined, in cooperation with FDOT District 4 and the modelers, to include the grade separations in the model's definition of the roadway system, but without an explicit toll being charged. This crude approximation was the best that could be done, within the time and cost limitations of this project. The delay-reduction results for the MAs are therefore likely higher than would be achieved in the actual, tolled situation. But since SERPM modeling results were not used for estimating toll revenues, this simplification does not affect those numbers.

Table 21 provides a summary of key parameters comparing the 2035 status quo (dubbed "current plan," meaning implementation of the current cost-feasible 2035 long-range plan) with a 2035 system that also includes the complete network of MLs and MAs discussed in previous sections.

Table 21: SERPM Modeling Results: Key Parameters

Statistic (daily)	Current Plan	With ML + MA Network	Change	Percent Change
Total lane-miles	16,928	17,783	855	5.1%
Vehicle miles of travel	155,961,344	159,568,144	3,606,800	2.3%
Volume/capacity	0.67	0.61	-.06	-9.0%
Vehicle hours of travel	5,289,645	5,093,170	-196,475	-3.7%
Accidents	598.4	584.9	-13.5	-2.2%
Injuries	365.9	358.4	-7.5	-2.0%
Fatalities	2.26	2.26	0	0
CO emissions (kg)	2,987,170	2,972,510	-14,660	-0.05%
HC emissions (kg)	209,286	208,273	-1,013	-0.05%
NO emissions (kg)	320,824	337,215	16,391	5.1%
Vehicle hours of delay	1,649,463	1,429,298	-220,165	-13.3%
Congested speed (mph)	28.74	30.37	1.63	5.6%

Several key points are worth emphasizing. The addition of modest amounts (5.1%) of priced capacity facilitates a modest increase in travel (2.3% increase in daily vehicle miles of travel). But because the vehicles on average move faster, vehicle *hours* of travel are reduced by 3.7%. The combination leads to significant congestion reduction, with vehicle hours of delay being *13.3% less* than in the "current plan" case.

Because stop-and-go traffic that is typical of congestion is reduced, we also see modest reductions in accidents and injuries. And thanks to fewer vehicles operating in high-polluting stop-and-go conditions, there are slight decreases in carbon monoxide (CO) and hydrocarbon (HC) emissions, but a slight increase in nitrogen oxides (NO), which is consistent with faster average speeds. (These minor changes are probably not statistically significant.)

B. Direct Savings to Road Users

The widely cited *Urban Mobility Reports* from the Texas Transportation Institute each year estimate the direct costs of congestion to highway users. The vast majority of this cost is wasted time, which the Institute values at $16/hour for automobiles and $106/hour for trucks. Other transportation analysts use higher values, but since most "congestion cost" figures are based on the Institute's work, we will use those time values here.

In the *2010 Urban Mobility Report*, the Southeast Florida urbanized area was reported as experiencing 140,972,000 annual vehicle hours of delay (VHD). The modeling discussed above estimated that if the complete ML and MA network were in place, it would save 66,049,500 annual hours of delay. That is 47% of the current total, though the model was estimating delay savings in 2035, when there would be 37.6% more home-to-work trips using the region's highway system. Nevertheless, that is a very substantial amount of congestion reduction from what would otherwise be experienced in 2035.

The Institute estimates that of the current annual congestion cost of $3.27 billion, trucks account for 27% of the cost and cars the other 73%. Taking into account the much higher delay cost for trucks ($106/hr. for trucks and $16/hr. for cars), we find that 95% of the vehicle hours of delay (VHD) accrues to cars and 5% to trucks. Thus, the 66.05 million hours of delay savings per year work out to a savings of $1.004 billion for cars and $350 million for trucks, for a total value of time saved of $1.35 billion per year.

The 13.3% reduction in VHD estimated by the SERPM 6.5 modeling runs is comparable to results achieved in other recent studies of adding ML networks to the expressways of large metro areas. Modeling for the San Francisco Bay Area's planned 2030 HOT Network found an overall reduction in delay hours of 13% compared with the same network operated as HOV-only.[38] In a forthcoming Reason Foundation study modeling a ML network and several other improvements to the Chicago metro area's roadway network, Smart Mobility estimated that VHD would be reduced by between 10.3 and 11.8%.[39] Georgia DOT's two-year analysis of its proposed ML network found an overall 8% reduction in vehicle hours of delay in 2035 compared with not adding the network.[40]

C. Economic Productivity Gains

As noted in Part 1, congestion has larger economic costs than just the time wasted by commuters and truckers stuck in traffic. Part 1 noted the findings of Prud'homme and Lee, studying mobility and accessibility in 22 French metro areas. They found that a 10% improvement in how far one could travel in 25 minutes increased the productivity of a metro area by 1.3%.[41] That is because increasing the distance one can travel within a given commuting time budget opens up a larger area in which optimal matching of job openings and skill sets can take place. Robert Cervero extended Prud'homme and Lee's methodology to the United States, finding that every 10% increase in commuting speed in the San Francisco Bay Area increased economic output by 1%.[42]

In 2009, David Hartgen and colleagues did comparable studies for eight U.S. metro areas, ranging in size from Salt Lake City (1.5 million people) to the San Francisco Bay Area (6.8 million). Their analysis looked at how travel times influenced the size of the labor market, as well as access to key destinations within the region. Their analysis used 25 minutes as the standard, since this was the median commute time for workers in major U.S. urban areas. They found effects similar in magnitude to those found by Prud-homme and Lee in Europe and by Cervero in San Francisco, specifically that a 10% increase in distance traveled within 25 minutes would lead to a 1% increase in regional economic productivity.[43]

The SERPM modeling results discussed earlier found that the network of MLs and MAs would increase overall average travel speeds during congested periods from 28.74 mph to 30.37 mph. That would increase the average distance traveled in 25 minutes from 12.07 miles to 12.76 miles. That may seem like a small amount (5%), but since that distance defines the radius of a circle whose area is proportional to the radius squared, that modest increase in travel distance provides access to 162.7 square miles, rather than the previous 145.7 square miles. Since a 10% increase in distance traveled within 25 minutes corresponds to a 1% increase in gross regional product (GRP), the 5% increase derived from the modeling results should lead to a 0.5% increase in GRP. The Southeast Florida GRP is $698 billion per year. Hence, a 0.5% increase amounts to $3.49 billion per year. Since this is a change in economic productivity of the region due to better matching of employee talents with employer needs, this $3.5 billion per year benefit is in addition to the $1.35 billion per year in vehicle operator time and fuel savings.

D. Transit Benefits

The adopted cost-feasible long-range transportation plan for the tri-county region places great emphasis on expanding transit capacity and use, but the available resources provide for only very minor increases in rail transit and modest increases in bus service, focused mostly on arterials. The proposal set forth in this report would provide the infrastructure for region-wide BRT service, not only on arterials but also a large-scale expansion of BRT express service across county lines, using the extensive network of expressway managed lanes, supplemented by a significant number of managed arterials that would deliver regional BRT vehicles to within-county activity centers and to next-county activity centers via the expressway ML network.

Our preliminary estimate is that premium BRT daily boardings in 2035 would be 150,000 per weekday, two-thirds of this on within-county routes using the managed arterials and the other one-third as inter-county trips using expressway managed lanes. As noted in Part 7, that is 36% of the current total bus ridership in the three counties. And the net new farebox revenue produced by the premium BRT service is estimated at $31.3 million per year (in today's dollars) as of 2035.

The transit capital dollars that would, in the cost-feasible plan, be spent on converting existing arterial lanes into bus-only lanes or on acquiring new right of way to add bus-only lanes to arterials would instead be available to pay for additional park-and-ride facilities and bus transfer stations incorporated into arterial underpasses at key intersections. The infrastructure of "virtual exclusive busways" would be produced at no cost to the region's transit providers, saving some portion of what the three counties would otherwise have to invest in bus lanes on arterials. (The Broward MPO's 2035 plan, for example, calls for investing $1.39 billion in capital costs on "premium high capacity" arterial BRT.)

The network of MLs and MAs would also facilitate expansion of highly cost-effective vanpool services, under the auspices of South Florida Commuter Services.

E. Revenues vs. Costs

Unlike most major transportation infrastructure investments, managed lanes and managed arterials generate significant revenues from those who choose to use them. In Part 7 we estimated the annual revenues that could be produced from these networks. To recap, based on annual revenues from the full ML network, and using a typical 10X factor used in toll road feasibility assessment, the network's toll revenues should be able to support financing of approximately $13 billion. As noted previously, that is nearly 80% of the network's estimated cost to construct of $16.4 billion. Likewise, our estimated annual revenues from the network of managed arterials should be able to support $2.8 billion in financing, which is 75% of the $3.8 billion cost of the proposed MA network. Together, toll revenues should permit financing over 78% of the capital cost of the overall ML/MA network. If the shortfall is $4.4 billion of the estimated $20.2 billion cost, that sum could be obtained by reallocating a portion of the $58 billion of federal, state and local transportation revenue in the current long-range plan. Cost-benefit analysis of the projects planned for funding should be undertaken to identify $4.4 billion in proposed projects that have lower benefit/cost ratios than the proposed network; that would mean reallocating 7.6% of the $58 billion over the 20-year period from 2015 through 2035. Since the network would be developed incrementally over that period, the reallocated funds would average $220 million per year.

These proposed networks differ in a fundamental way from nearly all the other transportation investments included in the cost-feasible long-range plans. By and large, the highway improvements in the plan are based on the limited federal and state fuel-tax revenues expected to be available between now and 2035. Except for toll-funded improvements to various Turnpike and Miami-Dade Expressway Authority facilities, all the other highway projects produce no new revenues. Likewise, transit projects produce only modest farebox revenues that in most cases do not cover operating and maintenance costs and which cover none of the capital costs. And sidewalk and bikeway projects produce no revenue of any sort.

Managed lanes and managed arterials could therefore provide significant mobility benefits while being largely self-supporting from net new revenues not currently included in the long-range transportation plan.

F. Safety Benefits

The modeling results estimated minor (2%) reductions in accidents and injuries, due to reduced congestion. While the economic value of those reductions is modest compared with $1.35 billion per year in time savings and $3.5 billion per year in economic productivity gains, eliminating more than a dozen accidents a day will lead to additional minor reductions in traffic congestion from fewer obstacles to the flow of traffic caused by those accidents.

Another very important safety benefit is greatly improved access for emergency vehicles, on both expressways and on arterials equipped with grade separations at major intersections. Police, fire and paramedic vehicles will all be able to do their jobs faster and more effectively if they can bypass traffic congestion by using the ML/MA network. When responding to life-threatening emergencies, timely response can make the difference between life and death. In recent decades, growing chronic traffic congestion has had negative effects on emergency vehicle response times nationwide. Uncongested managed lanes offer a very real improvement in emergency vehicle response times.

G. Environmental Benefits

Vehicles in stop-and-go traffic burn more fuel and emit more pollutants than vehicles moving at a relatively steady speed of between 25 and 60 mph. The same is true of CO_2 emissions, which are directly proportional to fuel consumption. While the emission reductions from a single ML project are very small as a fraction of an urbanized area's total vehicular emissions, the emission reductions from a large network of uncongested lanes can be significant. Modeling done for the Metropolitan Transportation Commission (the MPO for the San Francisco Bay Area) compared the emissions that would result if it built out and operated the remainder of its already extensive HOV network with the alternate plan: converting existing HOV lanes to priced MLs and filling in missing links to produce an 800 lane-mile ML network instead. The modeling results showed that AM peak emissions in 2030 would be reduced by the following percentages if the network were built as MLs rather than HOVs:

- Reactive organic gases 2% less
- Nitrogen oxides 3% less
- Carbon dioxide (CO_2) 7% less
- Particulates (PM10) 10% less[44]

These emission reductions come about because congestion pricing on the managed lanes permit traffic to flow at relatively steady, uncongested speeds.

H. Overall Benefits vs. Costs

The Reason Foundation mobility plan for Southeast Florida would produce numerous benefits, including improved (affordable) transit service, increased safety and improved air quality. Its largest benefits would be the $3.5 billion annual economic productivity gain (due to better matching of job opportunities with job seekers) and the $1.35 billion in direct time and fuel savings to those (including buses) using the region's roadway network. Thus, *annual* economic benefits would be $4.85 billion.

Those gains could be had for a one-time investment, over the next 25 years, of $20.2 billion. That is an annual return of 24% on the one-time investment. Another way of looking at this is that since most of the revenue to support this investment would come from those paying tolls to use the new infrastructure, the net public-sector investment in the plan is simply the difference between the $20.2 billion cost and the amount financeable from toll revenues (which we previously estimated at $15.8 billion). Thus, a one-time public-sector investment of $4.4 billion would yield annual mobility and economic benefits of $4.85 billion. That strikes us as an investment opportunity worth serious investigation.

Part 9

Conclusions and Recommendations

A. Principal Findings

This report has analyzed the future of mobility in Miami-Dade, Broward and Palm Beach Counties between now and 2035. Under current plans, as set forth in the adopted cost-feasible long-range transportation plan, mobility in 2035 will be significantly worse than it is today. Currently, the Southeast Florida urbanized area is the seventh most congested in the nation, with the narrowest definition of congestion cost running at $3.3 billion per year (in wasted time and fuel). By 2035, congestion will be much worse as the region accommodates 36% more people and 38% more vehicle miles of travel. The result will be congestion of an intensity greater than today's Los Angeles metro area, with vehicles moving 20% slower than they do today during seven hours of daily peak traffic.

The adopted long-range plan devotes 62% of all available funds ($35.5 billion out of $57.8 billion) to investments in transit between 2015 and 2035.[45] Yet the result barely changes the fraction of trips made by car. Counting all trips made in 2035, the long-range plan projects transit trips decreasing from 2.9% now to only 2.6% of all trips in 2035. During peak periods, transit is expected to increase its mode share modestly, from today's 3.7% to 4.7%. But the impact on the drive-alone share of commute trips is very small; drive-alone trips would decrease only slightly from 81.4% to 80%.

This report suggests that Southeast Florida can and should do better than that. The most important ingredient missing from the current long-range plan is congestion pricing: creating uncongested alternatives for cars and buses using variable pricing, as on the successful I-95 Express Lanes. A large-scale network of managed lanes and managed arterials can be implemented throughout the region by 2035, at an estimated cost of $20.2 billion. Estimated toll revenues should support 78% of this sum, with the remaining $4.4 billion coming from federal, state and local transportation funds.

From the standpoint of transit agencies, creating an uncongested network is the virtual equivalent of getting 409 route-miles of exclusive guideway at no cost. That is because congestion-priced facilities remain uncongested even during peak periods. The pricing limits the number of vehicles using them to an amount that is consistent with uncongested traffic flow at the speed limit. This gives premium bus rapid transit (BRT) service performance equivalent to what it would have on bus-only facilities. Instead of having to devote scarce transit capital dollars to guideways, transit agencies could use those funds for more and better park-and-ride lots, transfer stations and vehicles.

B. Recommendations

Embrace Managed Lanes in the Next Long-Range Plan

The current 2035 long-range plan was researched and written during the time period when the I-95 Express Lanes were being conceived and implemented. No accurate performance data (e.g., on the first full year of both northbound and southbound operations) were available in time to consider more-ambitious applications of managed lanes in the long-range plan. Yet as the FDOT "Managed Lanes Vision Report" of 2009 and this more-comprehensive report in 2011 have set forth, the potential mobility improvement offered by a network of managed lanes and managed arterials is very large: a 13% reduction in vehicle hours of delay in 2035, leading to direct *annual* savings to vehicle operators of $1.35 billion and regional productivity gains of some $3.5 billion per year. And the network will facilitate both within-county and inter-county premium BRT service, consistent with goals in the long-range plan.

The ML network will obviously be developed incrementally, building on the initial links on I-95 and I-595 and gradually expanding to other expressways, preferably the most congested corridors first (both to provide more congestion relief sooner and to generate more revenue sooner). Likewise, as explained in Part 6, adding grade separations to congested arterial corridors can be done in an incremental manner, starting with the most impacted intersections and adding others as conditions warrant. Florida DOT is currently conducting a statewide assessment of managed lanes for the state's major urbanized areas. It will consider the sequence in which MLs should be implemented, to maximize their impact on regional mobility and to make them attractive to potential concession companies and investors. The sequencing will consider the incremental mobility improvements and return-on-investment benefits and costs in relation to developing individual ML facilities into a ML network.

Hence, our first recommendation is that the next long-range transportation plan, for 2040, should incorporate managed lanes and managed arterials, with the aim of developing a complete network by the 2035–40 time-frame. Transit plans should be modified accordingly, to shift transit capital spending from bus-only lanes (which would no longer be needed thanks to the virtual equivalent busways provided by the MLs and MAs) and focus those funds instead on mobility hubs, transfer stations, park-and-ride facilities and bus purchases. All three MPOs—in Miami-Dade, Broward and Palm Beach Counties—should work closely with Florida DOT and the region's toll operators— Miami-Dade Expressway Authority and Florida Turnpike Enterprise—in planning the ML and MA network.

In developing plans for the ML network, improvements to the SERPM 6.5 model would be worth making. As we discovered during this project, the model as currently defined can handle tolled lanes (though not explicitly variably priced lanes) but it cannot handle point tolls such as we proposed for traversing an arterial grade separation of the type needed for the proposed managed arterials. Some engineers have also questioned whether the current version of SERPM can properly estimate future congestion in a constrained system, or forecast revenues generated by variable tolling (congestion pricing), or forecast ridership on new transit modes such as premium BRT. Hence, refinements to SERPM 6.5 should be a priority.

Develop the Managed Lanes Concept of Operations

In 2010, Florida DOT District 6 was awarded a grant from the Federal Highway Administration's Value Pricing Program to develop the nation's first "Concept of Operations" for a network of managed lanes. As stated in FDOT's winning grant application:

> *To fully realize and maximize the benefit provided by managed lanes, FDOT will develop each individual managed lanes facility as part of an overall network of managed lanes facilities. All [such] facilities will be linked and interconnected to create a seamless, region-wide network of unobstructed managed lanes utilizing a variable toll/congestion pricing strategy. Only then will South Florida motorists and Bus Rapid Transit (BRT) riders be fully capable of taking full advantage of the benefits of time savings and increased travel reliability offered by managed lanes*.

The Concept of Operations will develop consistent policies for such issues as pricing, signage and messages, managed lane access points, managed lanes eligibility and many other issues that are far more complex for an integrated network of facilities than for a single facility such as the I-95 Express Lanes. It will also need to address governance issues: which agency will be in charge of planning, operating and managing the network, with what kind of involvement from other transportation stakeholders? Other large metro areas are grappling with these questions as they plan comparable ML networks.

Developing the Concept of Operations will, of necessity, involve all key stakeholders, including the providers of expressways (FDOT Districts 4 and 6, FTE, MDX), the three transit providers (Miami-Dade Transit, Broward County Transit and PalmTran), the three metropolitan planning organizations and South Florida Commuter Services. The efforts involved in developing the Concept of Operations will help lay the basis for the 2040 regional long-range transportation plan to include the managed lanes network.

Regionwide BRT Service Delivery

Transit service in Southeast Florida is provided by three county-specific agencies. Until the opening of the I-95 Express Lanes, the only "express" bus service between Fort Lauderdale and

Miami required passengers to transfer between a Broward County Transit bus and a Miami-Dade Transit bus at the Golden Glades park-and-ride lot. During 2010, the two agencies worked cooperatively to develop single-bus service using the Express Lanes between several points in Broward County and the downtown Miami area.

The development of a regional managed lanes network spanning all three counties opens up new possibilities for region-wide BRT service using that network. In turn, that raises the question of whether such service might be provided by a separate entity specializing in relatively long-distance express service. There is a long history of the private sector providing express bus service, often under contract. Perhaps the most extensive such service in the United States is offered in New Jersey, where 13 private bus companies offer service on 77 different routes, including approximately four dozen between various suburban residential areas and Manhattan. [46]

Other examples include the Foothill Transit Zone in Los Angeles County, which operates 34 routes in the San Gabriel Valley—all operated by private contractors—including five very heavily used express lines on the El Monte Busway to the Los Angeles central business district.[47] (The Busway was originally opened in 1972 on the I-10 San Bernardino Freeway, added HOV-3 service in 1976, and is currently being converted into a Busway/HOT facility by the Los Angeles County Metropolitan Transportation Authority).[48] Another is the Denver Regional Transportation District, which has 438 of its 1,050 transit buses operated by private contractors and is currently well along in the planning, design, construction, financing, and then operations and maintenance of its Eagle Commuter Rail line by a public-private partnership entity.[49] Competitive contracting of bus transit service is widespread in Britain, as well as in dozens of other nations around the world.[50]

We recommend that this option be explored during the development of the managed lanes network Concept of Operations. It should be noted that, for the most part, region-wide BRT service using the ML network would be net new service, hence, contracting with one or more companies to develop and operate these services would not threaten the jobs of existing transit agency employees. As the only transportation agency with region-wide operating responsibilities, the South Florida Regional Transportation Authority is a possible candidate to manage this contracted service. SFRTA already outsources the management and operation of the Tri-Rail commuter rail service.

Consider Further Use of PPP Concessions

The managed lanes network (and the associated network of managed arterials) would cost a combined total of $20 billion (in 2010 dollars) between now and 2035. Though it will not be implemented as a single project, even individual corridors will likely constitute “mega-projects,” as the term is used in transportation planning (referring to projects of at least $0.5 billion in cost). Because such projects carry significant risks, it is worth considering procurement methods that can minimize those risks.

A major international study found that transportation mega-projects typically experience significant cost overruns, late completion, and shortfalls in traffic or ridership. The researchers assembled a global database of 258 highway and rail mega-projects, worth $90 billion, in 20 countries over several decades. Some 90% of these projects experienced cost over-runs, with the average rail project costing 45% more than projected and the average highway project 20% more. Rail projects generated an average of 39% less ridership than forecast, though highway projects averaged 9% more traffic than forecast.[51]

Flyvbjerg and co-authors went to some length to explain why such results are so prevalent. Besides the inherent riskiness of mega-projects, they concluded that the basic problem is one of incentives. If taxpayers are picking up the tab for cost overruns or future excessive maintenance caused by poor design, the companies designing and building the project do not have strong incentives to control costs without sacrificing quality. Conventional procurement “is likely to increase the total costs and risks of a project,” they conclude. A much better model is a long-term public-private partnership (PPP) that “allocates risks to parties who have an incentive to reduce the negative impacts.” Construction cost risk, on-time completion risk, and even traffic and revenue risk can be transferred to investors via a carefully structured long-term PPP. One of Flyvbjerg’s strongest conclusions is that the decision to proceed with a transportation mega-project should be based on the willingness of the private-sector team to put their own capital at risk.[52]

California, Texas and Virginia all have experience with this form of PPP: the *long-term concession*. Under this approach, the private partner takes major responsibility for financing the project, investing equity for perhaps one-quarter to one-third of the project cost. And it takes long-term ownership responsibility for a defined period of years (e.g., 35 to 50 years) during which it must build, operate, manage and maintain the facility at its own risk. In recent years, Florida has begun making use of this model, with the first two concession projects being the Port of Miami Tunnel and the reconstruction of I-595 (including the addition of reversible express toll lanes).

Traffic and revenue risk is a serious issue for new toll facilities. Recent reports by two of the leading bond rating agencies, Fitch and Standard & Poor’s, point to a tendency of such forecasts to be overly optimistic, which puts the bondholders at risk. Several recent PPP projects of the type noted above, in which the private sector develops the project but does not take on ownership-type risks, have experienced serious shortfalls in early-years traffic and revenue.

Minimizing life-cycle cost is also facilitated by a long-term concession approach. If the same enterprise that is designing and building the toll facility must also operate it successfully for 50 years, it has a strong incentive to build it right in the first place, rather than cut corners to get the initial cost down. Spending an extra 10–15% on a more durable pavement in the first instance generally pays for itself several times over in lower ongoing maintenance costs over the roadway’s lifetime.

Cost-sharing is possible under a concession agreement for those projects that cannot be fully supported by toll revenue financing. In such cases, the public sector (e.g., FDOT, MDX, or FTE) would have to make an "equity" investment for, say, 20% of the project cost, with the balance being financed out of toll revenues, and the responsibility to collect and manage these toll revenues falling to the concessionaire. In most cases, with this type of mixed funding, the concession company agrees to share toll revenue above a certain level with the state agency.

C. Conclusion

Improved mobility is crucially important to the future economic vitality of Southeast Florida. Traffic congestion during peak periods already extracts a major cost, reducing the quality of life of the region's residents in general, and impairing the region's economic productivity and its competitiveness with other large urbanized areas as a place to live and work. Unfortunately, though adopted with the best of intentions, the current regional long-range transportation plan will lead to substantially worse mobility by 2035, with congestion exceeding that of Los Angeles today.

This report offers a revised approach to improving the region's mobility, largely by drawing on the success of congestion pricing in the I-95 corridor in Miami-Dade County. An extensive network of such priced managed lanes, supplemented by improved arterials, could reduce the extent of 2035 congestion by 13% compared with what it would be under the existing long-range plan. And that network would provide a virtually exclusive guideway for region-wide bus rapid transit service, thereby achieving significant transit ridership at lower transit agency cost than what is called for in the existing long-range plan. Based on our preliminary estimates, the toll revenues generated by this network would be sufficient to finance nearly 80% of its $20.2 billion cost.

The benefits of taking this new approach would be large. They include direct annual savings to roadway users of $1.35 billion per year, plus much larger gains in regional economic productivity of $3.5 billion per year. The network would give transit agencies an extensive region-wide network of uncongested guideways for both within-county and inter-county premium bus rapid transit services. Reduced congestion would also lead to reduced accidents and injuries, and faster access for all types of emergency vehicles.

These improvements are all available to Southeast Florida, if business, community and government leaders embrace this approach to improving mobility.

About the Authors

Robert Poole is director of transportation policy, and Searle Freedom Trust Transportation Fellow, at Reason Foundation. In 2010, he was a member of the transportation policy transition team for Florida Governor-Elect Rick Scott. In 2010 he served as a member of the Expert Review Panel convened by the Washington State DOT to advise on a proposed $1.5 billion managed lanes project. In 2008 he was a gubernatorial appointee to the Texas Study Committee on the Role of Private Provision in Toll Projects. He has advised the U.S. DOT Office of the Secretary of Transportation, the Federal Highway and Federal Transit Administrations, and the state DOTs of a number of states, including California and Florida. He is a member of the Transportation Research Board's standing committees on Congestion Pricing and on Managed Lanes. Poole has also testified before U.S. House and Senate Committees, as well as a number of state legislatures. He is the author of several dozen Reason Foundation policy studies on surface transportation. Poole, a Florida resident, received his B.S. and M.S. in mechanical engineering from MIT, and did additional graduate work in operations research at NYU.

Thomas A. Rubin, CPA, CMA, CMC, CIA, CGFM, CFM has over 30 years of public transit experience as a senior executive in major transit agencies and as an auditor, consultant, and author. He has served well over 100 transit operators of all sizes operating almost all transit modes, metropolitan planning organizations, state departments of transportation, the U.S. Department of Transportation, industry associations, suppliers to the industry, and transit labor unions. He is currently a sole practitioner consultant specializing in major transit and educational capital projects and long-term transit capital/operations/financial planning.

Mr. Rubin founded and directed the transit industry practice of what is now Deloitte & Touche, LLP, growing it to the largest in the accounting/consulting industry, and personally selling over $100 million worth of services. From 1989 to 1993 he was Controller-Treasurer of the Southern California Rapid Transit District. He has managed projects including financial, grant, performance, and contract audits; design and implementation of management information systems; construction project management oversight; long-term operating/capital/financial planning and modeling and preparation of bond official statements and tax revenue projections; grant applications and indirect cost allocation systems; fare collection security reviews; merger and reorganization; subsidy allocation; privatization and contracting, labor negotiation, expert/expert witness work, and many other types of projects.

Chris Swenson, senior supervising engineer at Parsons Brinckerhoff in Fort Myers, Florida, has been involved in numerous aspects of transportation engineering and planning for 23 years. Mr. Swenson is nationally known for his work in the development of market-based transportation demand management programs, particularly variably priced tolls. He has personally supervised Project Development and Environment (PD&E) studies, the development of area-wide master plans, and large transportation corridor planning projects, as well as traditional and non-traditional transportation financing projects. While much of Mr. Swenson's experience is in his home state of Florida, he has also supervised or participated in transportation studies in California, Nevada, Texas, Oregon, Virginia and Arizona. Mr. Swenson has authored multiple papers and has presented at numerous conferences including the annual meeting of the Transportation Research Board, annual meetings of the Institute of Transportation Engineers, the annual meeting of ITS America, and the ITS World Congress. Mr. Swenson received a Bachelor of Civil Engineering degree in 1984 from the Georgia Institute of Technology followed by a Master of Science in Civil Engineering, also from the Georgia Institute of Technology, in 1985. Mr. Swenson is a registered engineer in the state of Florida.

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