THE 2005 URBAN MOBILITY REPORT

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2005 Urban Mobility Report

Congestion continues to grow in America's urban areas. Despite a slow growth in jobs and travel in 2003, congestion caused 3.7 billion hours of travel delay and 2.3 billion gallons of wasted fuel, an increase of 79 million hours and 69 million gallons from 2002 to a total cost of more than $63 billion. The solutions to this problem will require commitment by the public and by national, state and local officials to increase investment levels and identify projects, programs and policies that can achieve mobility goals. The 2005 Report shows that the current pace of transportation improvement, however, is not sufficient to keep pace with even a slow growth in travel demands in most major urban areas. The complete report, methodology, data, charts and tables can be found at: http://mobility.tamu.edu/ums

Major Findings for 2005 – The Big Numbers

The problem can be stated simply – **urban areas are not adding enough capacity, improving operations or managing demand well enough to keep congestion from growing larger.** Over the most recent 3 years, the contribution of operations improvements has grown from 260 to 340 million hours of congestion relief, but delay has increased by 300 million hours over the same period. Congestion occurs during longer portions of the day and delays more travelers and goods than ever before. And if the **current fuel prices are used, the congestion "invoice" climbs another $1.7 billion which would bring the total cost to about $65 billion**. Some important statistics are shown below.

Measures of…	**1982**	**1993**	**2002**	**2003**
… Individual Traveler Congestion				
Annual delay per peak traveler (hours)	16	40	47	47
Travel Time Index	1.12	1.28	1.37	1.37
Number of urban areas with more than 20 hours of delay per peak traveler	5	37	50	51
… The Nation's Congestion Problem				
Total hours of delay (billion)	0.7	2.4	3.6	3.7
Total gallons of "wasted" fuel (billion)	0.4	1.3	2.2	2.3
Cost of congestion (billions of 2003 $)	$12.5	$39.4	$61.5	$63.1
… Travel Needs Served				
Daily vehicle-miles of travel on major roads (billion)	1.06	1.66	2.09	2.14
Annual person-miles of public transportation travel (billion)	22.9	35.1	43.7	43.4
… Expansion Needed to Keep Today's Congestion Level				
Additional lane-miles of freeways and major streets	7,638	6,459	4,927	5,002
Additional daily public transportation riders (million)	8.6	8.2	7.2	7.3
… The Effect of Some Solutions				
Hours of delay saved by				
Operational treatments (million)	NA	NA	301	336
Public transportation (million)	269	696	1,097	1,096
Congestion costs saved by				
Operational treatments (billions of 2003 $)	NA	NA	$5.0	$5.6
Public transportation (billions of 2003 $)	$4.6	9.0	$18.2	$18.2

NA – No Estimate Available

Pre-2000 data do not include effect of operational strategies and public transportation.

Travel Time Index – The ratio of travel time in the peak period to travel time at free-flow conditions. A Travel Time Index of 1.35 indicates a 20-minute free-flow trip takes 27 minutes in the peak.

Delay per Peak Traveler – The extra time spent traveling at congested speeds rather than free-flow speeds divided by the number of persons making a trip during the peak period.

Wasted Fuel – Extra fuel consumed during congested travel.

Expansion Needed – Either lane-miles or daily riders to keep pace with travel growth (maintain congestion).

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What's New?

Each year the Urban Mobility Report revises procedures and improves the processes and data used in the estimates. In doing so, the report also revises all previous estimates so that true trends can be developed whenever possible. Some key changes for this year are:

- Four urban areas moved into a new population group in 2003. All historical statistics were updated with these changes. Atlanta and Phoenix were moved into the “Very Large” group. Providence was moved into the “Large” group. Allentown-Bethlehem was moved into the “Medium” group.
- The researchers have refined the numerous equations and calculations used to produce the Urban Mobility Report. Minor changes to the computer programs have been made and the historical trend data reflect the new information and procedures. Additional changes are anticipated at the conclusion of the study.
- The calculation methodology has been changed to provide an improved estimate of fuel wasted during congested conditions. The new values show the amount of wasted fuel as approximately half of the previous total. The year-to-year trend is the same—increasing fuel consumption and fuel costs.
- The operational treatment effects are included for 2000, 2001, 2002 and 2003 mobility estimates. The data provide a better picture of the travel conditions in those four years. Unfortunately, the long-term trend analysis for years before 2000, does not yet include this information.

The Problem

Mobility problems have increased at a relatively consistent rate during the two decades studied. Congestion is present on more of the transportation systems, affecting more of the trips and a greater portion of the average week in urban areas of all sizes.

Congestion affects more of the roads, trips and time of day. The worst congestion levels increased from 12% to 40% of peak period travel. And free-flowing travel is less than half of the amount in 1982 (Exhibit 1).

Congestion has grown in areas of every size. Measures in all of the population size categories show more severe congestion that lasts a longer period of time and affects more of the transportation network in 2003 than in 1982. The average annual delay for every person using motorized travel in the peak periods in the 85 urban areas studied climbed from 16 hours in 1982 to 47 hours in 2003 (Exhibit 2).

The delay statistics in Exhibit 2 point to the importance of action. Major projects, programs and funding efforts take 10 to 15 years to develop. In that time, congestion endured by travelers and businesses grow to those of the next largest population group. So in ten years, medium-sized regions will have the traffic problems that large areas have now, if trends do not change.

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Exhibit 1. Percent of Travel in Each Congestion Level

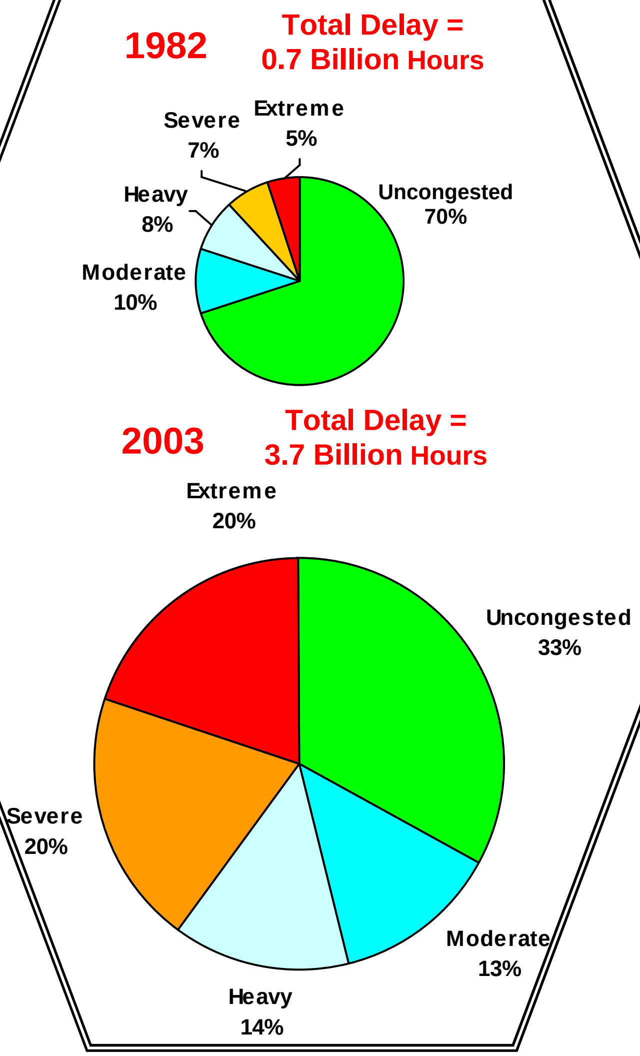

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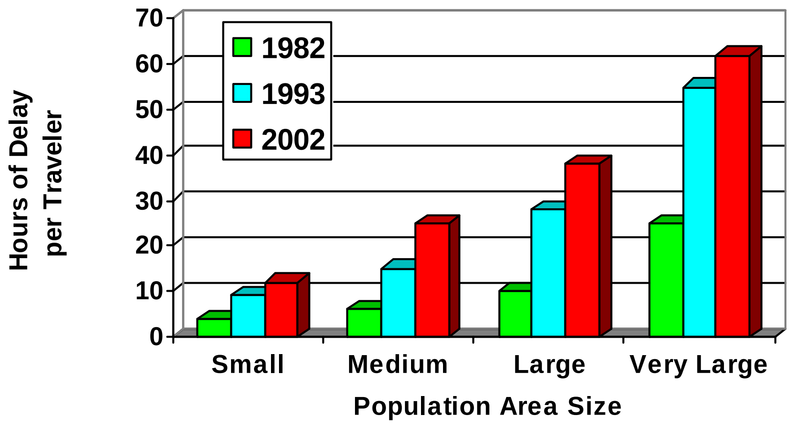
Exhibit 2. Congestion Growth Trend

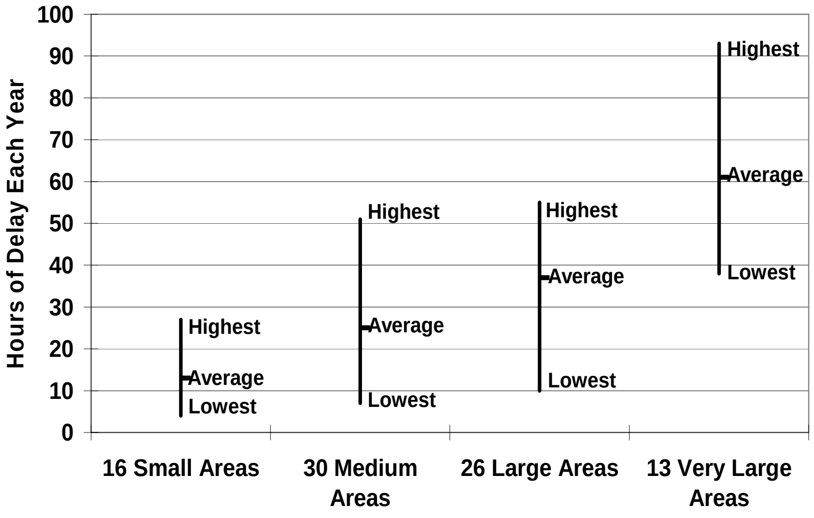


Very Large = more than 3 million
Large = 1 million to 3 million
Medium = 500,000 to 1 million
Small = less than 500,000

Congestion costs are increasing. The total congestion “invoice” for the 85 areas in 2003 was approximately $63 billion, an increase from about $62 billion in 2002. The 3.7 billion hours of delay and 2.3 billion gallons of fuel consumed due to congestion are only the elements that are easiest to estimate. The effect of uncertain or longer delivery times, missed meetings, business relocations and other congestion results are not included.

Congestion is more severe in larger areas. Exhibit 3 shows the range of congestion levels for each population size group. It is not surprising that congestion is more severe in larger urban areas. What might not be expected is the large range of values. Congestion problems occur in many ways. Some congestion is determined by the design of an area, some is determined by geographic features, weather, collisions and vehicle breakdowns, and some congestion is the result of decisions about investment levels. Likewise, the mobility levels targeted by agencies in each area will vary as well. The answer is not to grade every city, every project and every hour of delay on the same scale, but rather to identify the community goals, benefits, and costs and decide how to reach the mobility targets.

Exhibit 3. Congestion and Urban Area Size, 2003



The Solutions

The problem has grown too rapidly and is too complex for only one technology or service to be “the solution.” The increasing trends also indicate the urgency of the improvement need. Major improvements can take 10 to 15 years and smaller efforts may not satisfy all the needs. So we recommend a ***balanced approach***—begin to plan and design ***major capacity increasing projects, plans or policy changes*** while immediately relieving critical ***bottlenecks*** or chokepoints, and aggressively pursuing ***operations*** improvements and ***demand*** management options that are available.

- **More capacity**— More road and public transportation improvement projects are part of the equation. New streets and urban freeways will be needed to serve new developments; public transportation improvements are particularly important in congested corridors and to serve major activity centers; and, toll highways and toll lanes are being used more frequently in urban corridors. Capacity expansions are also important additions for freeway-to-freeway interchanges and connections to ports, rail yards, intermodal terminals and other major activity centers for people and freight transportation.

- **Greater efficiency**—More efficient operation of roads and public transportation can provide more productivity from the existing system at relatively low cost. Some of these can be accelerated by information technology, some are the result of educating travelers about their options, and some are the result of providing a more diverse set of travel and development options than are currently available. This report presents information on the effect of five prominent operational treatments.

- **Manage the demand**—The way that travelers use the transportation network can be modified to accommodate more demand. Using the telephone or internet for certain trips, traveling in off-peak hours and using public transportation and carpools are examples. Projects that use tolls or pricing incentives can be tailored to meet both transportation needs and economic equity concerns. The key will be to provide better conditions and more travel options for shopping, school, health care and a variety of other activities.

- **Development patterns**—There are a variety of techniques that are being tested in urban areas to change the way that commercial, office and residential developments occur. These also appear to be part, but not all, of the solution. Sustaining the urban “quality of life” and gaining an increment of economic development without the typical increment of mobility decline is one way to state this goal.

- **Realistic expectations** are also part of the solution. Large urban areas will be congested. Some locations near key activity centers in smaller urban areas will also be congested. But congestion does not have to be an all-day event. Identifying solutions and funding sources that meet a variety of community goals is challenging enough without attempting to eliminate congestion in all locations.

The solutions will vary not only by the state or city they are implemented in, but also by the type of development, the level of activity and constraints in particular sub-regions, neighborhoods and activity centers. Portions of a city might be more amenable to construction solutions, other areas might use more demand management, efficiency improvements and land use pattern or redevelopment solutions.

The Benefits of Action

All types of improvement actions are necessary. Without a detailed analysis it is impossible to say which action or set of actions will best meet the corridor or community needs. But, it is important to recognize that actions can make a difference. It is possible to at least slow the growth and in the right circumstances, reduce congestion.

Roadway Capacity Increases

Urban areas that address the growing travel demand have seen lower delay growth than areas where travel growth greatly exceeds supply growth. Exhibit 4 illustrates that when changes in supply more closely match changes in demand, there is less increase in delay. The three groups were studied using data from 1982 to 2003. The change in miles traveled was compared to the change in lane-miles for each of the 85 urban areas. The change in congestion level was calculated for the following groups:

- **Significant mismatch**—Traffic growth was more than 30 percent faster than the growth in road capacity for the 53 urban areas in this group.
- **Closer match**—Traffic growth was between 10 percent and 30 percent more than road capacity growth. There were 28 urban areas in this group.
- **Narrow gap**—Road growth was within 10 percent of traffic growth for the 4 urban areas in this group.

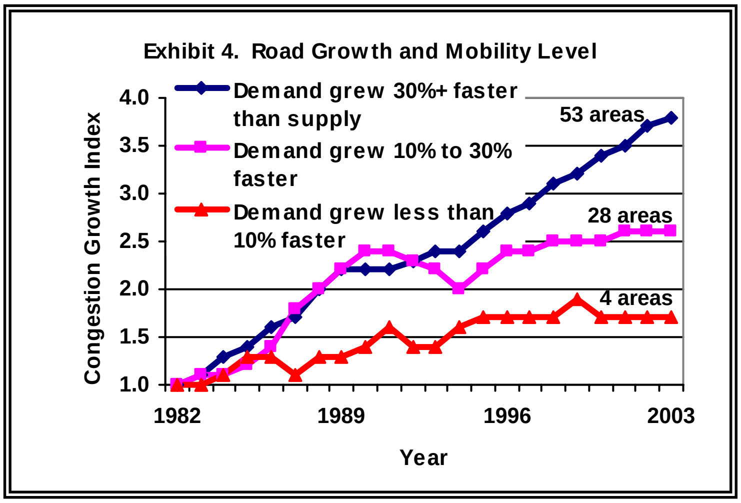


Exhibit 4. Road Growth and Mobility Level

Additional roadways reduce the rate of increase in the time it takes travelers to make congested period trips. It appears that the growth in facilities has to be at a rate slightly greater than travel growth in order to maintain constant travel times if additional roads are the only solution used to address mobility concerns. It is clear that adding roadway at about the same rate as traffic grows will slow the growth of congestion.

It is equally clear, however, that if only four of the 85 areas studied were able to accomplish that rate, ***there must be a broader set of solutions*** applied to the problem, as well as more of each solution.

Public Transportation Service

Regular route public transportation service on buses and trains provides a significant amount of peak period travel in the most congested corridors and urban areas in the U.S. If public transportation service was discontinued and the riders traveled in private vehicles, the 85 urban areas would have suffered an additional 1.1 billion hours of delay in 2003.

Public transportation service provides many additional benefits in the corridors and areas it serves. Access to jobs, shops, medical, school and other destinations for those who do not have access to private transportation may provide more societal benefits than the congestion relief, but this report only examined part of the mobility aspect. Typically, in contrast to roads, the ridership is concentrated in a relatively small portion of the urban area. That is often the most congested area and the locations where additional road capacity is difficult to construct.

In the 85 urban areas studied there were approximately 43 billion passenger-miles of travel on public transportation systems in 2003 (1). The annual travel ranges from an average of 17 million miles per year in Small urban areas to about 2.7 billion miles in Very Large areas. Overall, if these riders did not have access to public transportation systems, the 1.1 billion hours of additional roadway delay would represent a 27 percent increase in delay and an additional congestion cost of $18 billion. More information on the effects for each urban area is included in Table 3.

- The Very Large areas would experience an increase in delay of about 920 million hours per year (33 percent of total delay) if there were no public transportation service. Most of the urban areas over 3 million population have significant public transportation ridership, extensive rail systems and very large bus systems.

- The Large urban areas would experience the second largest increase in delay with about 150 million additional hours of delay per year (16 percent of today delay) if public transportation service were not available.

Exhibit 5. Delay Increase if Public Transportation Service Were Eliminated – 85 Areas

Population Group and Number of Areas	Average Annual Passenger-Miles of Travel (Million)	Delay Reduction Due to Public Transportation		
		Hours of Delay (Million)	Percent of Base Delay	Dollars Saved ($ Million)
Very Large (13)	2,718	919	33	15,289
Large (26)	233	148	16	2,485
Medium (30)	58	27	9	444
Small (16)	17	2	4	25
85 Area Total	43,403	1,096	27	18,243

Source: APTA Operating Statistics and TTI Review

High-Occupancy Vehicle Lanes

High-occupancy vehicle lanes (also known as diamond lanes, bus and carpool lanes, transitways) provide a high-speed travel option to buses and carpools as an incentive to reduce the number of vehicle trips. The lanes are most used during the peak travel periods when congestion is worst and the time savings compared to the general travel lanes are the most significant. In addition to saving time on an average trip, the HOV lanes also provide more reliable service because they are less affected by collisions or vehicle breakdowns.

The Urban Mobility Report includes estimates of the mobility improvements provided by HOV lanes in eight regions where detailed project data are available. Because HOV lane travel is not included in the basic freeway statistics, the person miles traveled and the travel time can be added directly to the mobility measures. The effect of this is to create an estimate of the mobility level provided to the combination of travelers in the slow speed freeway lanes and the higher speed HOV lanes. While only a partial list of HOV projects are included in the current study database (see http://mobility.tamu.edu/ums/hov), it provides a way to understand the measures and the mobility contribution provided by HOV facilities.

Data for the 19 significantly congested corridors studied showed a median decline of 0.20 for the Travel Time Index measure. This involved comparing the mainlane freeway congestion levels and the combined freeway and mainlane value. This is equivalent to 10 to 15 years worth of congestion growth in the average area. These HOV lanes carry one-third of the peak-direction passenger load, providing significant passenger movement at much higher speeds and with more reliable travel times than the congested mainlanes.

Operational Treatments

The 2005 Urban Mobility Report includes the effect of four technologies or treatments designed to gain more benefits from the existing infrastructure (2). These four techniques provide smoother and more regular traffic flow, which also reduces collision rates and the effect of vehicle breakdowns. Freeway entrance ramp metering, freeway incident management, traffic signal coordination and arterial street access management were estimated to provide 336 million hours of delay reduction and $5.6 billion in congestion savings for the 85 urban areas studied with 2003 data. If these treatments were deployed on all the major roads in every area, an estimated 613 million hours of delay and more than $10.2 billion would be saved.

Freeway Entrance Ramp Metering

Entrance ramp meters regulate the flow of traffic on freeway entrance ramps using traffic signals similar to those at street intersections. They are designed to create more space between entering vehicles so those vehicles do not disrupt the mainlane traffic flow. The signals allow one vehicle to enter the freeway at some interval (for example, every two to five seconds). They also reduce the number of entering vehicles due to the short distance trips that are encouraged to use the parallel streets to avoid the ramp wait time (3).

Twenty-five of the urban areas reported ramp metering on some portion of their freeway system in 2003 (4,5) for a total of 33 percent of the freeway miles. The effect was to reduce delay by 102 million person hours, approximately 5 percent of the freeway delay in those areas.

Freeway Incident Management Programs

Freeway Service Patrol, Highway Angel, Highway Helper, The Minutemen and Motorists Assistance Patrol are all names that have been applied to the operations that attempt to remove crashed and disabled vehicles from the freeway lanes and shoulders. They work in conjunction with surveillance cameras, cell phone reported incident call-in programs and other elements to remove these disruptions, decrease delay and improve the reliability of the system. The benefits of these programs can be significant. Benefit/cost ratios from the reduction in delay between 3:1 and 10:1 are common for freeway service patrols (6). An incident management program can also reduce "secondary" crashes—collisions within the stop-and-go traffic caused by the initial incident. The range of benefits is related to traffic flow characteristics as well as to the aggressiveness and timeliness of the service.

Seventy-one areas reported one or both treatments in 2003, with the coverage representing from 40 percent to 67 percent of the freeway miles in the urban areas (4,5). The effect was to reduce delay by 177 million person hours, approximately 7 percent of the freeway delay in those areas.

Traffic Signal Coordination Programs

Traffic signal timing can be a significant source of delay on the major street system. Much of this delay is the result of managing the flow of intersecting traffic, but some of the delay can be reduced if the traffic arrives at the intersection when the signal is green instead of red. This is difficult in a complex urban environment, and when traffic volumes are very high, coordinating the signals does not work as well due to the long lines of cars already waiting to get through the intersection in both directions.

All 85 areas reported some level of traffic signal coordination in 2003, with the coverage representing slightly over half of the street miles in the urban areas (4,5). Signal coordination projects have the highest percentage treatment within the urban areas studied because the technology has been proven, the cost is relatively low and the government institutions are familiar with the implementation methods. The effect of the signal coordination projects was to reduce delay by 11 million person hours, approximately one percent of the street delay. While the total effect is relatively modest, the cost is relatively low and the benefits decline as the system becomes more congested. The modest effect does not indicate that the treatment should not be implemented—why should a driver encounter a red light if it were not necessary?

Arterial Street Access Management Programs

Providing smooth traffic flow and reducing collisions are the goal of a variety of individual treatments that make up a statewide or municipal access management program. Typical treatments include consolidating driveways to minimize the disruptions to traffic flow, median turn lanes or turn restrictions, acceleration and deceleration lanes and other approaches to reduce the potential collision and conflict points. Such programs are a combination of design standards, public sector regulations and private sector development actions.

Eighty-three areas reported characteristics of an access management treatment in 2003, with the coverage representing just less than 40 percent of the major street miles in the urban areas (4,5). The effect was to reduce delay by 46 million person hours, approximately 3.5 percent of the street delay in those areas.

Operational Treatment Summary

Estimating the effect of a few operational projects on urban area congestion levels with a "national default value" sort of analysis may not be a particularly useful exercise. This type of methodology misses the importance of addressing the operating bottlenecks in the system and do not accommodate the benefits from exceptionally aggressive operating practices or policies aimed at congested locations. Recognizing these shortcomings, the information suggests that 9 percent of the roadway delay is being addressed by these four operational treatments for a total of 336 million hours in 2003 (Exhibit 6). And if the treatments were deployed on all major freeways and streets, the benefit would expand to about 15 percent of delay. These are significant benefits, especially since these techniques can be enacted much quicker than significant roadway or public transportation system expansions can occur. But the operational treatments do not replace the need for those expansions.

Exhibit 6. Operational Improvement Summary

	Delay Reduction from Current Projects		Possible Delay Reduction if Implemented on All Roads (Million Hours)
Operations Treatment	**Hours Saved (Million)**	**Dollars Saved ($ Million)**	
Ramp Metering	102	1,698	230
Incident Management	177	2,926	250
Signal Coordination	11	187	25
Access Management	46	779	108
TOTAL	336	5,590	613

Note: This analysis uses nationally consistent data and relatively simplistic estimation procedures. Local or more detailed evaluations should be used where available. These estimates should be considered preliminary pending more extensive review and revision of information obtained from source databases.

Other Actions

Most large city transportation agencies are pursuing all of these strategies as well as others. The mix of programs, policies and projects may be different in each city and the pace of implementation varies according to overall funding, commitment, location of problems, public support and other factors. It also seems that big city residents should expect congestion for 1 or 2 hours in the morning and in the evening. The agencies should be able to improve the performance and reliability of the service at other hours and they may be able to slow the growth of congestion, but they cannot expand the system or improve the operation rapidly enough to eliminate congestion.

Methodology

The base data for the 2005 Annual Report come from the states and the US Department of Transportation (4,5). The travel and road inventory statistics are analyzed with a set of procedures developed from computer models and empirical studies. The travel time and speed estimation process is described at: http://mobility.tamu.edu/ums/report/methodology.stm

The methodology creates a set of "base" statistics developed from traffic density values. The density data—daily traffic volume per lane of roadway—is converted to average peak-period speed using a set of estimation curves based on relatively ideal travel conditions—no crashes, breakdowns or weather problems for the years 1982 to 2003.

The "base" estimates, however, do not include the effect of many transportation improvements. The 2005 Report addresses this estimation deficiency with methodologies designed to identify the effect of operational treatments and public transportation services. The delay, cost and index measures for 2000, 2001, 2002 and 2003 include these treatments and identify them as "with strategies." The effects of public transportation, however, are shown for every year since 1982.

The calculation details for estimating the effect of operational treatments and public transportation service are described in a separate report available at http://mobility.tamu.edu/ums/report/methodology.stm

Combining Performance Measures

Table 6 illustrates an approach to understanding several of the key measures. The value for each statistic is rated according to the relationship to the average value for the population group. The terms "higher" and "lower" than average congestion are used to characterize the 2003 values and trends from 1982 to 2003. These descriptions do not indicate any judgment about the extent of mobility problems. Urban areas that have better than average rankings may have congestion problems that residents consider significant. What Table 6 does, however, is provide the reader with some context for the mobility discussion.

CONCLUSIONS

Careful examination of the data in the 2005 Urban Mobility Report will leave the reader with no doubt as to the growing urban congestion problem. The broad set of solutions recommended in the Report, is a diverse reaction to the problem. The future is not about a choice between or among these solutions, the choice is about how to use each project, program or strategy and how much transportation improvement will be pursued. In 2004, over three-quarters of the initiatives dealing with transportation at the state and local levels were approved by voters, indicating that travelers, shippers, businesses and elected leaders do support improvements.

To highlight the need for a broad solution set, the 2003 Urban Mobility Report presented an estimate of the effect of operational treatments on urban congestion. Those benefits have expanded in subsequent years, but the increase has not been significant enough to stop the growth in congestion. In fact, if the five operating improvements studied in this report were deployed on all major streets and freeways in the 85 urban areas the total delay would decline by an important 300 million hours per year. Delay per traveler would decline to 44 hours per year.

The next question is obvious: Is that good enough? If not, the future will require more roadway and public transportation capacity, and that capacity will have to be operated as efficiently as possible. The travel patterns of commuters and businesses, and the design of developments must also be examined if the current congestion levels are to be reduced and the estimated 65 million new urban residents accommodated over the next 20 years.

Table 1. Key Mobility Measures, 2003

Urban Area	Annual Delay per Traveler		Travel Time Index	
	2003 Hours	Rank	2003 Values	Rank
85 Area Average	47		1.37	
Very Large Average	61		1.48	
Very Large (13 areas)				
Los Angeles-Long Beach-Santa Ana, CA	93	1	1.75	1
San Francisco-Oakland, CA	72	2	1.54	3
Washington, DC-VA-MD	69	3	1.51	4
Atlanta, GA	67	4	1.46	5
Houston, TX	63	5	1.42	6
Dallas-Fort Worth-Arlington, TX	60	6	1.36	19
Chicago, IL-IN	58	7	1.57	2
Detroit, MI	57	8	1.38	12
Miami, FL	51	13	1.42	6
Boston, MA-NH-RI	51	13	1.34	21
New York-Newark, NY-NJ-CT	49	18	1.39	10
Phoenix, AZ	49	18	1.35	20
Philadelphia, PA-NJ-DE-MD	38	27	1.32	25
85 Area Average	47		1.37	
Large Average	37		1.28	
Large (26 areas)				
Riverside-San Bernardino, CA	55	9	1.37	14
Orlando, FL	55	9	1.30	28
San Jose, CA	53	11	1.37	14
San Diego, CA	52	12	1.41	8
Denver-Aurora, CO	51	13	1.40	9
Baltimore, MD	50	17	1.37	14
Seattle, WA	46	20	1.38	12
Tampa-St. Petersburg, FL	46	20	1.33	23
Minneapolis-St. Paul, MN	43	22	1.34	21
Sacramento, CA	40	25	1.37	14
Portland, OR-WA	39	26	1.37	14
Indianapolis, IN	38	27	1.24	32
St. Louis, MO-IL	35	31	1.22	35
San Antonio, TX	33	33	1.22	35
Providence, RI-MA	33	33	1.19	42
Las Vegas, NV	30	39	1.39	10
Cincinnati, OH-KY-IN	30	39	1.22	35
Columbus, OH	29	42	1.19	42
Virginia Beach, VA	26	46	1.21	39
Milwaukee, WI	23	48	1.21	39
New Orleans, LA	18	54	1.19	42
Kansas City, MO-KS	17	57	1.11	60
Pittsburgh, PA	14	63	1.10	64
Buffalo, NY	13	65	1.10	64
Oklahoma City, OK	12	68	1.10	64
Cleveland, OH	10	73	1.09	69

Very Large Urban Areas—over 3 million population.
Large Urban Areas—over 1 million and less than 3 million population.

Annual Delay per Traveler – Extra travel time for peak period travel during the year divided by the number of travelers who begin a trip during the peak period (6 to 9 a.m. and 4 to 7 p.m.). Free-flow speeds (60 mph on freeways and 35 mph on principal arterials) are used as the comparison threshold.

Travel Time Index – The ratio of travel time in the peak period to the travel time at free-flow conditions. A value of 1.35 indicates a 20-minute free-flow trip takes 27 minutes in the peak

2003 values include the effects of operational treatments.

Note: Users of this data are cautioned to avoid placing too much value on the rankings of all 85 urban areas. Often, there is little difference between being 6th on the list and being 12th, for example. Furthermore, these rankings compare all urban areas without respect to population or other differences which can significantly influence the ranking outcomes. Rankings should be used to make broad, general comparisons only and not distinguish between urban areas based on small differences in ranking outcomes.

Table 1. Key Mobility Measures, 2003, Continued

Urban Area	Annual Delay per Traveler		Travel Time Index	
	2003 Hours	Rank	2003 Values	Rank
85 Area Average	47		1.37	
Medium Average	25		1.18	
Medium (30 areas)				
Austin, TX	51	13	1.33	23
Charlotte, NC-SC	43	22	1.31	26
Louisville, KY-IN	42	24	1.24	32
Nashville-Davidson, TN	37	29	1.18	48
Tucson, AZ	36	30	1.31	26
Jacksonville, FL	34	32	1.18	48
Oxnard-Ventura, CA	33	33	1.23	34
Memphis TN-MS-AR	33	33	1.22	35
Bridgeport-Stamford, CT-NY	32	37	1.29	29
Salt Lake City, UT	31	38	1.28	30
Albuquerque, NM	30	39	1.17	52
Raleigh-Durham, NC	27	43	1.19	42
Birmingham AL	27	43	1.17	52
Omaha NE-IA	23	48	1.18	48
Honolulu, HI	20	50	1.19	42
New Haven, CT	20	50	1.13	58
Sarasota-Bradenton, FL	19	52	1.25	31
Grand Rapids, MI	19	52	1.14	55
El Paso, TX-NM	18	54	1.17	52
Allentown-Bethlehem, PA-NJ	17	57	1.14	55
Richmond, VA	17	57	1.09	69
Hartford, CT	16	60	1.11	60
Fresno, CA	13	65	1.14	55
Albany-Schenectady, NY	13	65	1.08	72
Toledo, OH-MI	12	68	1.10	64
Tulsa, OK	12	68	1.10	64
Akron, OH	12	68	1.09	69
Dayton, OH	11	72	1.08	72
Rochester, NY	7	80	1.07	77
Springfield, MA-CT	7	80	1.06	80
85 Area Average	47		1.37	
Small Average	13		1.11	
Small (16 areas)				
Colorado Springs, CO	27	43	1.19	42
Charleston-North Charleston, SC	25	47	1.20	41
Pensacola, FL-AL	18	54	1.12	59
Cape Coral, FL	15	61	1.18	48
Salem, OR	15	61	1.11	60
Beaumont, TX	14	63	1.07	77
Spokane, WA	10	73	1.08	72
Little Rock, AR	10	73	1.06	80
Eugene, OR	9	76	1.11	60
Boulder, CO	9	76	1.08	72
Columbia, SC	9	76	1.06	80
Laredo, TX	8	79	1.08	72
Bakersfield, CA	7	80	1.07	77
Corpus Christi, TX	7	80	1.05	84
Anchorage, AK	5	84	1.05	84
Brownsville, TX	4	85	1.06	80

Medium Urban Areas—over 500,000 and less than 1 million population.
Small Urban Areas—less than 500,000 population.

Annual Delay per Traveler – Extra travel time for peak period travel during the year divided by the number of travelers who begin a trip during the peak period (6 to 9 a.m. and 4 to 7 p.m.). Free-flow speeds (60 mph on freeways and 35 mph on principal arterials) are used as the comparison threshold.

Travel Time Index – The ratio of travel time in the peak period to the travel time at free-flow conditions. A value of 1.35 indicates a 20-minute free-flow trip takes 27 minutes in the peak.

2003 values include the effects of operational treatments.

Note: Users of this data are cautioned to avoid placing too much value on the rankings of all 85 urban areas. Often, there is little difference between being 6th on the list and being 12th, for example. Furthermore, these rankings compare all urban areas without respect to population or other differences which can significantly influence the ranking outcomes. Rankings should be used to make broad, general comparisons only and not distinguish between urban areas based on small differences in ranking outcomes.

Table 2. Components of the Congestion Problem, 2003 Urban Area Totals

Urban Area	Travel Delay		Excess Fuel Consumed		Congestion Cost	
	(1000 Hours)	Rank	(1000 Gallons)	Rank	($ Million)	Rank
85 Area Total	3,723,157		2,258,708		63,085	
85 Area Average	43,802		26,573		742	
Very Large Average	194,317		115,272		3,290	
Very Large (13 areas)						
Los Angeles-Long Beach-Santa Ana, CA	623,796	1	407,147	1	10,686	1
New York-Newark, NY-NJ-CT	404,480	2	198,217	2	6,780	2
Chicago, IL-IN	252,822	3	150,728	3	4,274	3
San Francisco-Oakland, CA	152,352	4	96,571	4	2,605	4
Dallas-Fort Worth-Arlington, TX	151,840	5	82,862	7	2,545	5
Miami, FL	147,294	6	87,249	6	2,486	6
Washington, DC-VA-MD	145,484	7	87,567	5	2,465	7
Houston, TX	135,652	8	80,707	8	2,283	8
Detroit, MI	119,581	9	72,796	9	2,019	9
Philadelphia, PA-NJ-DE-MD	112,309	10	60,323	11	1,884	10
Atlanta, GA	103,618	11	70,829	10	1,754	11
Boston, MA-NH-RI	100,237	12	59,556	12	1,692	12
Phoenix, AZ	76,662	14	43,988	15	1,294	14
85 Area Total	3,723,157		2,258,708		63,085	
85 Area Average	43,802		26,573		742	
Large Average	33,647		21,541		572	
Large (26 areas)						
San Diego, CA	81,756	13	59,215	13	1,411	13
Seattle, WA	72,461	15	49,220	14	1,237	15
Denver-Aurora, CO	64,506	16	37,792	17	1,087	16
Baltimore, MD	62,436	17	39,502	16	1,057	17
Minneapolis-St. Paul, MN	57,537	18	37,324	18	975	18
Tampa-St. Petersburg, FL	51,360	19	29,098	21	865	19
Riverside-San Bernardino, CA	50,155	20	34,952	19	863	20
San Jose, CA	48,134	21	30,691	20	823	21
St. Louis, MO-IL	39,936	22	26,362	22	675	22
Orlando, FL	38,157	23	22,104	24	643	23
Sacramento, CA	35,929	24	25,609	23	619	24
Portland, OR-WA	33,387	25	21,857	25	569	25
Cincinnati, OH-KY-IN	27,288	26	16,694	26	461	26
San Antonio, TX	23,788	27	14,518	27	401	27
Las Vegas, NV	22,245	29	14,354	28	380	29
Virginia Beach, VA	21,746	30	13,839	31	367	30
Providence, RI-MA	21,668	31	10,725	37	363	31
Indianapolis, IN	21,358	32	14,032	30	362	32
Columbus, OH	18,550	35	11,507	34	314	35
Milwaukee, WI	18,249	36	11,834	33	310	36
Pittsburgh, PA	14,530	42	7,355	45	243	42
Kansas City, MO-KS	13,874	43	9,095	42	235	43
New Orleans, LA	10,853	46	6,792	48	183	46
Cleveland, OH	10,709	47	6,931	47	182	47
Oklahoma City, OK	7,218	55	4,792	52	122	55
Buffalo, NY	6,981	56	3,869	57	118	56

Very Large Urban Areas—over 3 million population.
Large Urban Areas—over 1 million and less than 3 million population.

Travel Delay – Travel time above that needed to complete a trip at free-flow speeds.

Excess Fuel consumed – Increased fuel consumption due to travel in congested conditions rather than free-flow conditions.

Congestion Cost – Value of travel time delay (estimated at $13.45 per hour of person travel and $71.05 per hour of truck time) and excess fuel consumption (estimated using state average cost per gallon).

2003 values include the effects of operational treatments.

Note: Users of this data are cautioned to avoid placing too much value on the rankings of all 85 urban areas. Often, there is little difference between being 6th on the list and being 12th, for example. Furthermore, these rankings compare all urban areas without respect to population or other differences which can significantly influence the ranking outcomes. Rankings should be used to make broad, general comparisons only and not distinguish between urban areas based on small differences in ranking outcomes.

Table 2. Components of the Congestion Problem, 2003 Urban Area Totals, Continued

Urban Area	Travel Delay		Excess Fuel Consumed		Congestion Cost	
	(1000 Hours)	Rank	(1000 Gallons)	Rank	($ Million)	Rank
85 Area Total	3,723,157		2,258,708		63,085	
85 Area Average	43,802		26,573		742	
Medium Average	9,598		5,995		162	
Medium (30 areas)						
Austin, TX	23,201	28	14,073	29	391	28
Louisville, KY-IN	19,916	33	12,329	32	336	33
Nashville-Davidson, TN	18,890	34	10,960	35	318	34
Memphis TN-MS-AR	17,465	37	10,066	40	294	37
Jacksonville, FL	16,850	38	10,159	39	285	38
Charlotte, NC-SC	16,692	39	10,564	38	282	39
Salt Lake City, UT	15,094	40	9,821	41	257	40
Bridgeport-Stamford, CT-NY	14,550	41	11,032	35	250	41
Tucson, AZ	13,767	44	8,424	43	233	44
Raleigh-Durham, NC	11,481	45	7,608	44	194	45
Oxnard-Ventura, CA	10,249	48	7,121	46	176	48
Birmingham AL	9,705	49	6,564	49	165	49
Albuquerque, NM	9,258	50	5,338	50	156	50
Richmond, VA	8,305	51	4,763	52	140	51
Omaha NE-IA	7,984	52	4,431	55	134	52
Honolulu, HI	7,476	53	4,541	54	129	53
Hartford, CT	7,434	54	4,923	51	127	54
El Paso, TX-NM	6,491	58	4,172	56	110	58
Grand Rapids, MI	5,852	60	3,598	61	99	61
New Haven, CT	5,848	61	3,940	57	100	60
Sarasota-Bradenton, FL	5,772	62	3,480	62	97	62
Allentown-Bethlehem, PA-NJ	5,618	63	3,514	62	95	63
Tulsa, OK	5,419	64	3,255	64	91	64
Dayton, OH	4,438	65	2,836	65	75	65
Fresno, CA	4,180	66	2,678	66	72	66
Albany-Schenectady, NY	3,784	67	2,276	67	64	67
Akron, OH	3,672	68	2,217	68	62	68
Toledo, OH-MI	3,391	69	2,094	69	57	69
Springfield, MA-CT	2,,619	72	1,526	73	44	72
Rochester, NY	2,547	73	1,559	71	43	73
85 Area Total	3,723,157		2,258,708		63,085	
85 Area Average	43,802		26,573		742	
Small Average	2,142		1,265		36	
Small (16 areas)						
Colorado Springs, CO	6,953	57	3,694	60	117	57
Charleston-North Charleston, SC	6,364	59	3,879	57	107	59
Pensacola, FL-AL	2,977	70	1,701	70	50	70
Cape Coral, FL	2,712	71	1,572	71	46	71
Columbia, SC	2,029	74	1,331	75	34	74
Little Rock, AR	1,884	75	1,400	74	32	75
Spokane, WA	1,881	76	1,146	76	32	75
Bakersfield, CA	1,776	77	1,083	76	30	77
Salem, OR	1,714	78	1,005	78	29	78
Corpus Christi, TX	1,238	79	683	79	21	79
Eugene, OR	1,196	80	744	79	20	80
Beaumont, TX	1,101	81	610	81	18	81
Laredo, TX	835	82	461	82	14	82
Anchorage, AK	691	83	386	83	12	83
Boulder, CO	543	84	324	84	9	84
Brownsville, TX	380	85	221	85	6	85

Medium Urban Areas—over 500,000 and less than 1 million population.
Small Urban Areas—less than 500,000 population.

Travel Delay – Travel time above that needed to complete a trip at free-flow speeds.

Excess Fuel consumed – Increased fuel consumption due to travel in congested conditions rather than free-flow conditions.

Congestion Cost – Value of travel time delay (estimated at $13.45 per hour of person travel and $71.05 per hour of truck time) and excess fuel consumption (estimated using state average cost per gallon).

2003 values include the effects of operational treatments.

Note: Users of this data are cautioned to avoid placing too much value on the rankings of all 85 urban areas. Often, there is little difference between being 6th on the list and being 12th, for example. Furthermore, these rankings compare all urban areas without respect to population or other differences which can significantly influence the ranking outcomes. Rankings should be used to make broad, general comparisons only and not distinguish between urban areas based on small differences in ranking outcomes.

Table 3. 2003 Effect of Mobility Improvements

	Operational Treatment Savings				Public Transportation Savings		
Urban Area	**Treatments**	**Delay (1000 Hours)**	**Rank**	**Cost ($ Million)**	**Delay (1000 Hours)**	**Rank**	**Cost ($ Million)**
85 Area Total		336,758		5,589.7	1,107,509		18,444.5
85 Area Average		3,962		65.8	13,030		217.0
Very Large Average		19,634		325.1	71,531		1,190.0
Very Large (13 areas)							
Los Angeles-Long Beach-Santa Ana, CA	r,i,s,a	95,032	1	1,579.9	129,442	2	2,167.9
New York-Newark, NY-NJ-CT	i,s,a	52,118	2	854.3	379,168	1	6,284.3
San Francisco-Oakland, CA	r,i,s,a	18,137	3	301.6	82,702	4	1,382.8
Miami, FL	i,s,a	12,966	4	214.8	20,133	12	333.9
Chicago, IL-IN	r,i,s,a	12,327	5	205.0	94,448	3	1,577.3
Houston, TX	r,i,s,a	12,134	6	200.2	20,579	10	341.7
Dallas-Fort Worth-Arlington, TX	i,s,a	10,088	7	166.1	15,068	13	248.8
Atlanta, GA	i,s,a	9,448	8	156.9	27,765	9	463.3
Philadelphia, PA-NJ-DE-MD	i,s,a	7,588	11	125.3	34,890	7	576.2
Washington, DC-VA-MD	r,i,s,a	6,837	12	114.2	59,502	5	997.9
Detroit, MI	r.i,s,a	6,455	13	107.7	5,763	19	96.0
Phoenix, AZ	r.i,s,a	6,260	15	103.4	5,967	18	98.8
Boston, MA-NH-RI	i,s,a	5,856	16	97.0	54,482	6	900.3
85 Area Total		336,758		5,589.7	1,107,509		18,444.5
85 Area Average		3,962		65.8	13,030		217.0
Large Average		2,563		42.9	5,753		96.4
Large (26 areas)							
San Diego, CA	r,i,s,a	8,770	9	147.9	13,163	15	224.1
Minneapolis-St. Paul, MN	r,i,s,a	8,217	10	136.1	9,823	17	163.7
Seattle, WA	r,i,s,a	6,417	14	107.4	33,693	8	566.4
Riverside-San Bernardino, CA	r,i,s,a	5,792	17	97.5	2,894	30	48.7
San Jose, CA	r,i,s,a	4,689	18	78.6	4,584	21	77.1
Tampa-St. Petersburg, FL	i,s,a	3,988	19	66.4	1,589	36	26.3
Sacramento, CA	r,i,s,a	3,799	20	64.5	4,410	22	75.1
Denver-Aurora, CO	r,i,s,a	3,642	21	60.5	10,260	16	170.3
Baltimore, MD	i,s,a	3,629	22	60.2	20,175	11	335.7
Portland, OR-WA	r,i,s,a	3,487	23	58.2	14,487	14	242.4
Milwaukee, WI	r,i,s,a	2,066	24	34.4	3,463	27	57.9
St. Louis, MO-IL	i,s,a	1,776	25	29.8	3,362	28	56.5
Orlando, FL	i,s,a	1,689	26	28.2	2,619	32	43.5
Virginia Beach, VA	i,s,a	1,514	27	25.3	1,396	37	23.3
Cincinnati, OH-KY-IN	i,s,a	1,055	31	17.5	2,810	31	47.0
San Antonio, TX	i,s,a	1,041	32	17.3	3,465	26	57.8
Indianapolis, IN	i,s,a	866	36	14.6	684	47	11.5
Las Vegas, NV	i,s,a	804	38	13.5	4,316	24	72.6
Pittsburgh, PA	i,s,a	782	40	12.9	3,724	25	61.5
New Orleans, LA	i,s,a	709	42	11.8	2,127	34	35.7
Kansas City, MO-KS	i,s,a	621	44	10.4	673	48	11.3
Cleveland, OH	i,s,a	600	45	10.0	2,407	33	40.3
Columbus, OH	r,i,s,a	354	50	6.0	1,047	41	17.5
Buffalo, NY	i,s,a	161	58	2.7	880	44	14.6
Providence, RI-MA	i,s,a	122	61	2.1	1,352	38	22.4
Oklahoma City, OK	s,a	49	72	0.9	166	69	2.8

Very Large Urban Areas—over 3 million population.
Large Urban Areas—over 1 million and less than 3 million population.

Operational Treatments – Freeway incident management (i), freeway ramp metering (r) arterial street signal coordination (s) and arterial street access management (a).

Public Transportation – Regular route service from all public transportation providers in an urban area.

Delay savings are affected by the amount of treatment or service in each area, as well as the amount of congestion and the urban area population.

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Table 3. 2003 Effect of Mobility Improvements, Continued

	Operational Treatment Savings				Public Transportation Savings		
Urban Area	Treatments	Delay (1000 Hours)	Rank	Cost ($ Million)	Delay (1000 Hours)	Rank	Cost ($ Million)
85 Area Total		336,758		5,589.7	1,107,509		18,444.5
85 Area Average		3,962		65.8	13,030		217.0
Medium Average		467		7.8	885		14.8
Medium (30 areas)							
Austin, TX	i,s,a	1,334	28	22.1	2,952	29	49.0
Salt Lake City, UT	i,s,a	1,327	29	22.1	4,374	23	73.0
Nashville-Davidson, TN	i,s,a	1,067	30	17.6	634	51	10.5
Memphis TN-MS-AR	i,s,a	1,008	33	16.6	1,259	39	20.9
Jacksonville, FL	i,s,a	987	34	16.5	738	45	12.4
Louisville, KY-IN	i,s,a	956	35	15.9	924	42	15.3
Charlotte, NC-SC	i,s,a	845	37	14.0	2,082	35	34.6
Tucson, AZ	i,s,a	792	39	13.3	1,059	40	17.6
Omaha NE-IA	i,s,a	746	41	12.4	259	58	4.3
Bridgeport-Stamford, CT-NY	i,s,a	700	43	11.8	286	57	4.8
Albuquerque, NM	i,s,a	563	46	9.4	244	61	4.0
Birmingham AL	i,s,a	493	47	8.3	254	59	4.3
El Paso, TX-NM	i,s,a	476	48	8.0	881	43	14.7
Hartford, CT	i,s,a	400	49	6.7	652	50	11.0
Sarasota-Bradenton, FL	i,s,a	346	51	5.8	185	68	3.1
Fresno, CA	r,i,s,a	323	52	5.5	351	55	5.9
Raleigh-Durham, NC	i,s,a	279	53	4.7	693	46	11.6
Richmond, VA	i,s,a	238	54	4.0	366	54	6.1
New Haven, CT	i,s,a	232	55	3.9	657	49	11.0
Oxnard-Ventura, CA	i,s,a	191	56	3.3	422	52	7.1
Honolulu, HI	i,s,a	153	59	2.6	5,146	20	86.9
Dayton, OH	s,a	123	60	2.1	250	60	4.2
Allentown-Bethlehem, PA-NJ	r,s,a	122	61	2.1	206	66	3.5
Albany-Schenectady, NY	i,s,a	95	63	1.6	290	56	4.9
Grand Rapids, MI	s,a	81	66	1.4	230	62	3.9
Rochester, NY	i,s,a	49	72	0.8	392	53	6.6
Tulsa, OK	i,s,a	30	76	0.5	155	73	2.6
Toledo, OH-MI	i,s,a	24	77	0.4	209	65	3.5
Springfield, MA-CT	i,s,a	22	78	0.4	158	72	2.7
Akron, OH	s,a	4	84	0.1	230	62	3.9
85 Area Total		336,758		5,589.7	1,107,509		18,444.5
85 Area Average		3,962		65.8	13,030		217.0
Small Average		54		0.9	94		1.6
Small (16 areas)							
Colorado Springs, CO	i,s,a	189	57	3.2	210	64	3.5
Little Rock, AR	i,s,a	92	64	1.6	35	84	0.6
Cape Coral, FL	s,a	82	65	1.4	93	76	1.6
Spokane, WA	i,s,a	74	67	1.3	189	67	3.2
Bakersfield, CA	i,s,a	72	68	1.2	159	71	2.7
Charleston-North Charleston, SC	i,s	70	69	1.2	147	74	2.5
Eugene, OR	i,s,a	68	70	1.2	163	70	2.8
Pensacola, FL-AL	i,s,a	64	71	1.1	38	82	0.6
Columbia, SC	i,s,a	46	74	0.8	23	85	0.4
Boulder, CO	i,s,a	35	75	0.6	36	83	0.6
Anchorage, AK	s,a	20	79	0.3	50	80	0.8
Laredo, TX	i,s,a	19	80	0.3	75	78	1.2
Salem, OR	i,s,a	18	81	0.3	88	77	1.5
Beaumont, TX	s,a	9	82	0.2	39	81	0.7
Brownsville, TX	s,a	9	82	0.1	52	79	0.9
Corpus Christi, TX	s,a	3	85	0.1	101	75	1.7

Medium Urban Areas—over 500,000 and less than 1 million population.
Small Urban Areas—less than 500,000 population.

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Table 4. Trends—Annual Delay per Traveler, 1982 to 2003

Urban Area	Annual Hours of Delay per Traveler				Long-Term Change 1982 to 2003	
	2003	2002	1993	1982	Hours	Rank
85 Area Average	47	47	40	16	31	
Very Large Average	61	62	55	23	38	
Very Large (13 areas)						
Atlanta, GA	67	64	38	14	53	1
Washington, DC-VA-MD	69	66	51	21	48	2
Dallas-Fort Worth-Arlington, TX	60	61	47	13	47	3
Los Angeles-Long Beach-Santa Ana, CA	93	98	113	47	46	4
Chicago, IL-IN	58	55	42	16	42	8
San Francisco-Oakland, CA	72	75	62	30	42	8
Detroit, MI	57	54	77	17	40	11
Miami, FL	51	53	39	11	40	11
Boston, MA-NH-RI	51	48	38	14	37	15
New York-Newark, NY-NJ-CT	49	50	34	18	31	22
Phoenix, AZ	49	49	42	18	31	22
Houston, TX	63	65	38	39	24	38
Philadelphia, PA-NJ-DE-MD	38	40	25	14	24	38
85 Area Average	47	47	40	16	31	
Large Average	37	36	28	9	28	
Large (26 areas)						
Riverside-San Bernardino, CA	55	54	51	9	46	4
San Diego, CA	52	51	29	8	44	6
Orlando, FL	55	55	40	12	43	7
Baltimore, MD	50	47	30	9	41	10
Minneapolis-St. Paul, MN	43	43	30	3	40	11
Denver-Aurora, CO	51	52	38	16	35	16
Indianapolis, IN	38	37	28	4	34	17
Seattle, WA	46	48	56	12	34	17
Portland, OR-WA	39	41	33	7	32	20
Providence, RI-MA	33	31	17	5	28	26
Sacramento, CA	40	38	28	12	28	26
San Jose, CA	53	54	53	25	28	26
Tampa-St. Petersburg, FL	46	42	42	18	28	26
Cincinnati, OH-KY-IN	30	30	18	4	26	33
San Antonio, TX	33	36	12	7	26	33
Columbus, OH	29	29	24	4	25	36
Las Vegas, NV	30	29	22	7	23	41
St. Louis, MO-IL	35	38	31	14	21	43
Milwaukee, WI	23	24	19	5	18	47
Kansas City, MO-KS	17	15	13	2	15	50
Virginia Beach, VA	26	27	18	12	14	51
Buffalo, NY	13	11	6	3	10	60
Cleveland, OH	10	11	10	1	9	65
New Orleans, LA	18	17	16	9	9	65
Oklahoma City, OK	12	14	7	3	9	65
Pittsburgh, PA	14	13	14	10	4	81

Very Large Urban Areas—over 3 million population.
Large Urban Areas—over 1 million and less than 3 million population.

Annual Delay per Traveler – Extra travel time for peak period travel during the year divided by the number of travelers who begin a trip during the peak period (6 to 9 a.m. and 4 to 7 p.m.). Free-flow speeds (60 mph on freeways and 35 mph on principal arterials) are used as the comparison threshold.

2002 and 2003 data Include the effects of operational treatments.

Note: Users of this data are cautioned to avoid placing too much value on the rankings of all 85 urban areas. Often, there is little difference between being 6th on the list and being 12th, for example. Furthermore, these rankings compare all urban areas without respect to population or other differences which can significantly influence the ranking outcomes. Rankings should be used to make broad, general comparisons only and not distinguish between urban areas based on small differences in ranking outcomes.

Table 4. Trends—Annual Delay per Traveler, 1982 to 2003, Continued

Urban Area	Annual Hours of Delay per Traveler				Long-Term Change 1982 to 2003	
	2003	2002	1993	1982	Hours	Rank
85 Area Average	47	47	40	16	31	
Medium Average	25	24	15	5	20	
Medium (30 areas)						
Austin, TX	51	50	24	11	40	11
Charlotte, NC-SC	43	45	27	10	33	19
Louisville, KY-IN	42	40	25	10	32	20
Tucson, AZ	36	31	15	5	31	22
Memphis TN-MS-AR	33	32	15	3	30	25
Salt Lake City, UT	31	30	14	3	28	26
Bridgeport-Stamford, CT-NY	32	33	17	5	27	31
Oxnard-Ventura, CA	33	32	15	6	27	31
Jacksonville, FL	34	31	27	8	26	33
Albuquerque, NM	30	28	23	6	24	38
Nashville-Davidson, TN	37	39	20	14	23	41
Birmingham AL	27	26	13	6	21	43
Raleigh-Durham, NC	27	26	21	7	20	45
Omaha NE-IA	23	23	13	4	19	46
El Paso, TX-NM	18	19	8	2	16	48
New Haven, CT	20	22	10	4	16	48
Grand Rapids, MI	19	18	17	5	14	51
Richmond, VA	17	15	13	4	13	55
Hartford, CT	16	17	10	4	12	56
Albany-Schenectady, NY	13	12	8	2	11	59
Akron, OH	12	12	8	2	10	60
Allentown-Bethlehem, PA-NJ	17	17	14	7	10	60
Honolulu, HI	20	18	28	10	10	60
Toledo, OH-MI	12	13	7	2	10	60
Tulsa, OK	12	13	5	3	9	65
Dayton, OH	11	12	11	3	8	70
Sarasota-Bradenton, FL	19	19	14	12	7	71
Rochester, NY	7	6	4	1	6	76
Fresno, CA	13	15	11	8	5	79
Springfield, MA-CT	7	9	7	7	0	84
85 Area Average	47	47	40	16	31	
Small Average	13	13	9	4	9	
Small (16 areas)						
Colorado Springs, CO	27	29	8	2	25	36
Charleston-North Charleston, SC	25	22	21	11	14	51
Pensacola, FL-AL	18	19	17	4	14	51
Cape Coral, FL	15	14	10	3	12	56
Salem, OR	15	15	10	3	12	56
Beaumont, TX	14	15	8	5	9	65
Boulder, CO	9	10	6	2	7	71
Eugene, OR	9	9	6	2	7	71
Little Rock, AR	10	9	6	3	7	71
Spokane, WA	10	10	11	3	7	71
Columbia, SC	9	8	7	3	6	76
Laredo, TX	8	7	3	2	6	76
Bakersfield, CA	7	7	5	2	5	79
Brownsville, TX	4	5	3	1	3	82
Corpus Christi, TX	7	6	5	5	2	83
Anchorage, AK	5	5	3	5	0	84

Medium Urban Areas—over 500,000 and less than 1 million population.
Small Urban Areas—less than 500,000 population.

Annual Delay per Traveler – Extra travel time for peak period travel during the year divided by the number of travelers who begin a trip during the peak period (6 to 9 a.m. and 4 to 7 p.m.). Free-flow speeds (60 mph on freeways and 35 mph on principal arterials) are used as the comparison threshold.

2002 and 2003 data Include the effects of operational treatments.

Note: Users of this data are cautioned to avoid placing too much value on the rankings of all 85 urban areas. Often, there is little difference between being 6th on the list and being 12th, for example. Furthermore, these rankings compare all urban areas without respect to population or other differences which can significantly influence the ranking outcomes. Rankings should be used to make broad, general comparisons only and not distinguish between urban areas based on small differences in ranking outcomes.

Table 5. Trends—Travel Time Index, 1982 to 2003

	Travel Time Index				Point Change in Peak-Period Time Penalty 1982 to 2003	
Urban Area	2003	2002	1993	1982	Points	Rank
85 Area Average	1.37	1.37	1.28	1.12	25	
Very Large Area Average	1.48	1.49	1.38	1.18	30	
Very Large (13 areas)						
Los Angeles-Long Beach-Santa Ana, CA	1.75	1.77	1.73	1.30	45	1
Chicago, IL-IN	1.57	1.54	1.34	1.18	39	2
Atlanta, GA	1.46	1.42	1.18	1.08	38	3
San Francisco-Oakland, CA	1.54	1.55	1.44	1.21	33	5
Washington, DC-VA-MD	1.51	1.50	1.38	1.18	33	5
Miami, FL	1.42	1.40	1.26	1.09	33	5
Dallas-Fort Worth-Arlington, TX	1.36	1.35	1.20	1.07	29	16
New York-Newark, NY-NJ-CT	1.39	1.40	1.28	1.13	26	17
Detroit, MI	1.38	1.36	1.36	1.12	26	17
Boston, MA-NH-RI	1.34	1.35	1.26	1.10	24	22
Phoenix, AZ	1.35	1.35	1.27	1.13	22	25
Philadelphia, PA-NJ-DE-MD	1.32	1.35	1.20	1.13	19	28
Houston, TX	1.42	1.41	1.24	1.28	14	39
85 Area Average	1.37	1.37	1.28	1.12	25	
Large Area Average	1.28	1.28	1.19	1.07	21	
Large (26 areas)						
San Diego, CA	1.41	1.40	1.22	1.06	35	4
Riverside-San Bernardino, CA	1.37	1.34	1.27	1.04	33	5
Las Vegas, NV	1.39	1.36	1.24	1.07	32	9
Portland, OR-WA	1.37	1.38	1.24	1.05	32	9
Seattle, WA	1.38	1.36	1.35	1.07	31	11
Minneapolis-St. Paul, MN	1.34	1.34	1.16	1.03	31	11
Denver-Aurora, CO	1.40	1.40	1.24	1.10	30	13
Sacramento, CA	1.37	1.34	1.19	1.07	30	13
Baltimore, MD	1.37	1.35	1.20	1.07	30	13
Orlando, FL	1.30	1.31	1.21	1.09	21	26
Indianapolis, IN	1.24	1.24	1.16	1.03	21	26
San Jose, CA	1.37	1.39	1.34	1.18	19	28
Cincinnati, OH-KY-IN	1.22	1.22	1.15	1.04	18	32
San Antonio, TX	1.22	1.23	1.07	1.05	17	33
Milwaukee, WI	1.21	1.23	1.17	1.05	16	35
Columbus, OH	1.19	1.19	1.14	1.03	16	35
Tampa-St. Petersburg, FL	1.33	1.31	1.30	1.19	14	39
Providence, RI-MA	1.19	1.18	1.11	1.05	14	39
St. Louis, MO-IL	1.22	1.24	1.18	1.09	13	46
Virginia Beach, VA	1.21	1.20	1.13	1.08	13	46
Kansas City, MO-KS	1.11	1.10	1.06	1.01	10	54
New Orleans, LA	1.19	1.18	1.16	1.10	9	56
Oklahoma City, OK	1.10	1.11	1.04	1.02	8	62
Buffalo, NY	1.10	1.08	1.04	1.03	7	67
Cleveland, OH	1.09	1.10	1.08	1.02	7	67
Pittsburgh, PA	1.10	1.10	1.09	1.08	2	82

Very Large Urban Areas—over 3 million population.
Large Urban Areas—over 1 million and less than 3 million population.

Travel Time Index – The ratio of travel time in the peak period to the travel time at free-flow conditions. A value of 1.35 indicates a 20-minute free-flow trip takes 27 minutes in the peak. Free-flow speeds (60 mph on freeways and 35 mph on principal arterials) are used as the comparison threshold.

2002 and 2003 data include the effects of operational treatments.

Note: Users of this data are cautioned to avoid placing too much value on the rankings of all 85 urban areas. Often, there is little difference between being 6th on the list and being 12th, for example. Furthermore, these rankings compare all urban areas without respect to population or other differences which can significantly influence the ranking outcomes. Rankings should be used to make broad, general comparisons only and not distinguish between urban areas based on small differences in ranking outcomes.

Table 5. Trends—Travel Time Index, 1982 to 2003, Continued

	Travel Time Index				Point Change in Peak-Period Time Penalty 1982 to 2003	
Urban Area	**2003**	**2002**	**1993**	**1982**	**Points**	**Rank**
85 Area Average	1.37	1.37	1.28	1.12	25	
Medium Area Average	1.18	1.18	1.11	1.05	13	
Medium (30 areas)						
Austin, TX	1.33	1.31	1.14	1.08	25	19
Tucson, AZ	1.31	1.28	1.14	1.06	25	19
Salt Lake City, UT	1.28	1.26	1.13	1.03	25	19
Charlotte, NC-SC	1.31	1.31	1.17	1.07	24	22
Bridgeport-Stamford, CT-NY	1.29	1.30	1.15	1.05	24	22
Oxnard-Ventura, CA	1.23	1.21	1.10	1.04	19	28
Memphis TN-MS-AR	1.22	1.22	1.11	1.03	19	28
Louisville, KY-IN	1.24	1.24	1.15	1.09	15	37
El Paso, TX-NM	1.17	1.17	1.07	1.02	15	37
Raleigh-Durham, NC	1.19	1.18	1.12	1.05	14	39
Jacksonville, FL	1.18	1.16	1.14	1.04	14	39
Omaha NE-IA	1.18	1.17	1.10	1.04	14	39
Sarasota-Bradenton, FL	1.25	1.25	1.18	1.12	13	46
Albuquerque, NM	1.17	1.17	1.14	1.04	13	46
Birmingham AL	1.17	1.16	1.08	1.05	12	50
Nashville-Davidson TN	1.18	1.19	1.09	1.07	11	52
Grand Rapids, MI	1.14	1.13	1.11	1.03	11	52
New Haven, CT	1.13	1.14	1.08	1.03	10	54
Honolulu, HI	1.19	1.18	1.21	1.10	9	56
Fresno, CA	1.14	1.15	1.12	1.05	9	56
Allentown-Bethlehem, PA-NJ	1.14	1.15	1.12	1.06	8	62
Hartford, CT	1.11	1.12	1.07	1.03	8	62
Toledo, OH-MI	1.10	1.11	1.04	1.02	8	62
Tulsa, OK	1.10	1.10	1.05	1.02	8	62
Akron, OH	1.09	1.09	1.06	1.02	7	67
Richmond, VA	1.09	1.08	1.07	1.03	6	70
Albany-Schenectady, NY	1.08	1.07	1.04	1.02	6	70
Rochester, NY	1.07	1.06	1.04	1.01	6	70
Dayton, OH	1.08	1.09	1.07	1.03	5	76
Springfield, MA-CT	1.06	1.07	1.06	1.05	1	84
85 Area Average	1.37	1.37	1.28	1.12	25	
Small Area Average	1.10	1.10	1.06	1.03	7	
Small (16 areas)						
Colorado Springs, CO	1.19	1.21	1.07	1.02	17	33
Cape Coral, FL	1.18	1.17	1.11	1.04	14	39
Charleston-North Charleston, SC	1.20	1.18	1.15	1.08	12	50
Pensacola, FL-AL	1.12	1.12	1.11	1.03	9	56
Salem, OR	1.11	1.11	1.06	1.02	9	56
Eugene, OR	1.11	1.10	1.05	1.02	9	56
Spokane, WA	1.08	1.07	1.08	1.02	6	70
Boulder, CO	1.08	1.09	1.05	1.02	6	70
Bakersfield, CA	1.07	1.06	1.04	1.01	6	70
Laredo, TX	1.08	1.07	1.04	1.03	5	76
Beaumont, TX	1.07	1.07	1.04	1.03	4	78
Little Rock, AR	1.06	1.06	1.03	1.02	4	78
Brownsville, TX	1.06	1.07	1.04	1.02	4	78
Columbia, SC	1.06	1.05	1.04	1.03	3	81
Corpus Christi, TX	1.05	1.04	1.03	1.03	2	82
Anchorage, AK	1.05	1.05	1.03	1.04	1	84

Medium Urban Areas—over 500,000 and less than 1 million population.
Small Urban Areas—less than 500,000 population.

Travel Time Index – The ratio of travel time in the peak period to the travel time at free-flow conditions. A value of 1.35 indicates a 20-minute free-flow trip takes 27 minutes in the peak. Free-flow speeds (60 mph on freeways and 35 mph on principal arterials) are used as the comparison threshold.

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Table 6. Summary of Congestion Measures and Trends

Urban Area	Congestion Levels in 2003				Congestion Increase 1982 to 2003	
	Delay per Traveler (Hours)	Travel Time Index	Total Delay (1000 Hours)	Total Cost ($ Million)	Delay per Traveler (Hours)	Total Delay (1000 Hours)
Very Large Average (13 areas)	61	1.48	194,317	325.1	38	154,841
New York-Newark, NY-NJ-CT	LL	LL	HH	HH	L	HH
Los Angeles-Long Beach-Santa Ana, CA	HH	HH	HH	HH	HH	HH
Chicago, IL-IN	L	HH	HH	H	H	HH
Philadelphia, PA-NJ-DE-MD	LL	LL	LL	L	LL	LL
Miami, FL	LL	L	LL	L	0	LL
Dallas-Fort Worth-Arlington, TX	0	LL	L	L	HH	LL
Washington, DC-VA-MD	HH	0	LL	L	HH	LL
San Francisco-Oakland, CA	HH	H	L	L	H	LL
Detroit, MI	L	LL	LL	L	0	LL
Boston, MA-NH-RI	LL	LL	LL	L	0	LL
Houston, TX	0	L	LL	L	LL	LL
Atlanta, GA	H	L	LL	L	HH	LL
Phoenix, AZ	LL	LL	LL	LL	L	LL
Large Average (26 areas)	37	1.28	33,647	42.9	28	30,784
Seattle, WA	HH	HH	HH	HH	H	HH
San Diego, CA	HH	HH	HH	HH	HH	HH
Minneapolis-St. Paul, MN	H	H	HH	H	HH	HH
Baltimore, MD	HH	HH	HH	H	HH	HH
St. Louis, MO-IL	0	L	H	0	L	0
Denver-Aurora, CO	HH	HH	HH	HH	H	HH
Tampa-St. Petersburg, FL	HH	H	HH	H	0	HH
Cleveland, OH	LL	LL	LL	L	LL	LL
Pittsburgh, PA	LL	LL	LL	L	LL	LL
San Jose, CA	HH	HH	HH	H	0	HH
Portland, OR-WA	0	HH	0	0	H	0
Riverside-San Bernardino, CA	HH	HH	HH	H	HH	HH
Sacramento, CA	H	HH	0	0	0	H
Cincinnati, OH-KY-IN	L	L	L	0	0	LL
Virginia Beach, VA	LL	L	L	L	LL	LL
Kansas City, MO-KS	LL	LL	LL	L	LL	LL
Milwaukee, WI	LL	L	LL	L	LL	LL
Las Vegas, NV	L	HH	L	L	L	LL
San Antonio, TX	L	L	L	L	0	LL
Orlando, FL	HH	0	H	0	HH	HH
Providence, RI-MA	L	LL	L	L	0	LL
Columbus, OH	LL	LL	LL	L	L	LL
Buffalo, NY	LL	LL	LL	L	LL	LL
New Orleans, LA	LL	LL	LL	L	LL	LL
Oklahoma City, OK	LL	LL	LL	L	LL	LL
Indianapolis, IN	0	L	L	L	H	LL
Interval Values – Very Large and Large	5 hours	5 index points	(5 hours x average popn. for group)	($0.2 M x average popn. for group)	5 hours	(5 hours x average change in popn. for group)

O – Average congestion levels or average congestion growth (within 1 interval of population group average)

H – Higher congestion or faster increase in congestion (between 1 and 2 intervals)

L – Lower congestion or slower congestion increase (between 1 and 2 intervals)

LL or HH – Lower / Slower or Higher / Faster by more than 2 intervals.

Interval – Within this value there may not be a difference in congestion level

Table 6. Summary of Congestion Measures and Trends, Continued

	Congestion Levels in 2003				Congestion Increase 1982 to 2003	
Urban Area	Delay per Traveler (Hours)	Travel Time Index	Total Delay (1000 Hours)	Total Cost ($ Million)	Delay per Traveler (Hours)	Total Delay (1000 Hours)
Medium Average (30 areas)	25	1.18	9,598	7.8	20	8,263
Memphis, TN-MS-AR	HH	H	HH	HH	HH	HH
Nashville-Davidson, TN	HH	0	HH	HH	H	HH
Jacksonville, FL	HH	0	HH	HH	HH	HH
Salt Lake City, UT	HH	HH	HH	HH	HH	HH
Richmond, VA	LL	LL	L	L	LL	LL
Louisville, KY-IN	HH	HH	HH	HH	HH	HH
Hartford, CT	LL	LL	L	L	LL	LL
Bridgeport-Stamford, CT-NY	HH	HH	HH	HH	HH	HH
Austin, TX	HH	HH	HH	HH	HH	HH
Tulsa, OK	LL	LL	LL	LL	LL	LL
Raleigh-Durham, NC	H	0	H	H	0	HH
Dayton, OH	LL	LL	LL	LL	LL	LL
Charlotte, NC-SC	HH	HH	HH	HH	HH	HH
Tucson, AZ	HH	HH	HH	HH	HH	HH
Honolulu, HI	LL	0	L	L	LL	LL
Birmingham, AL	H	0	0	0	H	0
El Paso, TX-NM	LL	0	L	L	L	LL
Rochester, NY	LL	LL	LL	LL	LL	LL
Springfield, MA-CT	LL	LL	LL	LL	LL	LL
Omaha, NE-IA	L	0	L	L	0	LL
Allentown-Bethlehem, PA-NJ	LL	L	LL	LL	LL	LL
Fresno, CA	LL	L	LL	LL	LL	LL
Akron, OH	LL	LL	LL	LL	LL	LL
Grand Rapids, MI	LL	L	LL	LL	LL	LL
Albuquerque, NM	HH	0	0	0	HH	0
Oxnard-Ventura, CA	HH	HH	0	0	HH	HH
Sarasota-Bradenton, FL	LL	HH	LL	LL	LL	LL
New Haven, CT	LL	LL	LL	LL	L	LL
Albany-Schenectady, NY	LL	LL	LL	LL	LL	LL
Toledo, OH-MI	LL	LL	LL	LL	LL	LL
Small Average (16 areas)	13	1.11	2,142	0.9	8	1,659
Colorado Springs, CO	HH	HH	HH	HH	HH	HH
Charleston-North Charleston, SC	HH	HH	HH	HH	HH	HH
Bakersfield, CA	LL	L	0	0	L	L
Columbia, SC	L	L	0	0	L	L
Spokane, WA	L	L	0	0	L	L
Little Rock, AR	L	L	0	0	L	L
Cape Coral, FL	H	HH	H	H	H	HH
Corpus Christi, TX	LL	LL	L	L	LL	LL
Pensacola, FL-AL	HH	H	H	H	HH	HH
Anchorage, AK	LL	LL	LL	LL	LL	LL
Eugene, OR	L	0	L	L	L	LL
Salem, OR	H	0	0	L	H	L
Laredo, TX	LL	L	L	LL	L	LL
Brownsville, TX	LL	L	LL	LL	LL	LL
Beaumont, TX	0	L	L	L	0	LL
Boulder, CO	L	L	LL	LL	L	LL
Interval Values – Medium and Small	3 hours	3 index points	(3 hours x average popn. for group)	($0.05 M x average popn. for group)	3 hours	(3 hours x average change in popn. for group)

O – Average congestion levels or average congestion growth (within 1 interval of population group average)

H – Higher congestion or faster increase in congestion (between 1 and 2 intervals)

L – Lower congestion or slower congestion increase (between 1 and 2 intervals)

LL or HH – Lower / Slower or Higher / Faster by more than 2 intervals.

Interval – Within this value there may not be a difference in congestion level

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

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Disclaimer

The contents of this report reflect the interpretation of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the sponsoring organizations or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation. In addition, this report is not intended for construction, bidding, or permit purposes. David L. Schrank and Timothy J. Lomax (PE #54597) prepared this report.

APPENDIX

WHAT IS THE SOURCE OF DATA FOR THIS REPORT?

This report uses data from federal, state, and local agencies to develop estimates of congestion and mobility within an urban area. The methodology developed by several previous research studies (2,3,4,5,6) yields a quantitative estimate of urbanized area mobility levels, utilizing generally available data, while minimizing the need for extensive data collection.

The methodology primarily uses the Federal Highway Administration's Highway Performance Monitoring System (HPMS) database, with supporting information from various state and local agencies (7). The HPMS database is used because of its relative consistency and comprehensive nature. State departments of transportation collect, review, and report the data annually. Since each state classifies roadways in a slightly different manner, TTI reviews and adjusts the data to make it comparable and then state and local agencies familiar with each urban area review the data.

The Urban Mobility Study procedures have been modified to take advantage of special issue studies that provide more detailed information, but the assumptions used in the Annual Mobility Report do not fully account for the effect of all operational improvements. Comparisons between cities are always difficult and the local and state studies are typically more detailed and relevant for specific areas. The Annual Mobility Report is more applicable for comparisons of trends for individual cities, rather than any value for a particular year.

Urban Area Boundary Effects

Urban boundaries are redrawn at different intervals in the study states. Official realignments and local agency boundary updates are sometimes made to reflect urban growth. These changes may significantly change the size of the urban area, which also causes a change in system length, travel and mobility estimates. The effect in the Urban Mobility Study database is that travel and roadways that previously existed in rural areas are added to the urban area statistics. It is important to recognize that newly constructed roads are only a portion of the "added" roads.

When the urban boundary is not altered every year in fast growth areas, the HPMS data items take on a "stair-step appearance." Each year the Annual Report process closely re-examines the most recent years to see if any of the trends or data should be altered (e.g., smoothing some of the stair steps into more continuous curves) to more closely reflect actual experience. This changes some data and measures for previous years. Any analysis should use the most recent report and data—they include the best estimates of the mobility statistics.

Why Is Free-Flow Travel Speed the Congestion Threshold?

The conditions in the middle of the day (or middle of the night) are the ones that travelers generally identify as desirable and use for comparison purposes. It is also relatively easy to understand that those conditions are not achievable during the peak travel periods without significant funding, environmental concerns and social effects. The decisions to make substantial improvements to achieve some desirable condition using investments in road, transit, operations, demand management or other strategies are products of detailed studies—studies that are not replicated in this report.

For the purposes of a national study, therefore, it is reasonable to set a congestion measurement baseline that everyone generally understands. Free-flow speed—which we estimate is 60 mph on freeways and 35 mph on major streets—is such a baseline. Speeds less than that will be an indication of delay. It is not intended to be the target for peak-hour conditions in urban corridors. The target setting exercise is discussed in more detail in a report section addressing "acceptable conditions" as targets.

Why Use Traffic Counts and Estimates Instead of "Real" Traffic Speeds?

Because there are not enough cities collecting enough high quality traffic speed data on enough roads, estimates are necessary. The Urban Mobility Report series seeks to understand congestion and mobility levels in many urban areas, and unfortunately, the best common database is one that has roadway design and traffic information. The estimation procedures are used to develop travel time and speed measures that can be used to communicate to a variety of audiences. This Annual Report also has some travel speed data from urban traffic operations centers, but until that information is more widely available, estimates will be required.

In the near future, these reports will also include estimates of the effects from several key improvements such as incident management, ramp metering, traffic signal coordination and high-occupancy vehicles lanes. The benefits of these projects are only indirectly included in the current methodology. When more cities and states conduct thorough evaluation studies and the comparison techniques are improved, the operations and demand management programs will be more completely characterized.

Detailed Speed Data and Reliability Information

The high quality speed data that are available were collected as part of the Mobility Monitoring Program (http://mobility.tamu.edu/mmp), a joint research effort of Texas Transportation Institute and Cambridge Systematics for the Federal Highway Administration (1). The MMP collected and analyzed detailed traffic volume and speed data for freeways in 29 cities for 2003. The data are prepared for 5-minute time intervals for sections of freeway between one-half and three miles in length. The base data sets were examined for quality and reasonable values and analyzed for a few key performance measures.

The continuous nature of this database provides a very good picture of the variation in conditions through the year—significantly better information than was available before. Variation or reliability in transportation conditions was studied with 2003 data. Some of that data is used in this report.

The detailed traffic operations center data also does not cover very much of the transportation system of the travel even in the most highly monitored cities. The percentage of the freeway system that was monitored during 2003 in the 29 Mobility Monitoring Program cities averaged around 50 percent. There was very little arterial street condition data. It is difficult to construct a set of city to city comparison measures or interpret the meaning of data under these conditions. While the data are very useful for examining issues, they are less useful for area or trend comparisons. Even the evaluation of incidents is hampered by the lack of arterial street data. Traffic that changes route from the freeway to a street experiences delay, but that delay is not counted because there is no monitoring equipment. So the "real" traffic data does not include all of the delay that occurs. Estimates are required to obtain a full picture of the congestion situation.

MEASURES AND RANKINGS WITHIN POPULATION GROUPS—WHICH MEASURE SHOULD BE USED?

We recommend that several measures, as well as the trend in the measures over several years, be considered before any "official rank" is determined. Just as the report indicates there is no single "solution" to the mobility problems in most areas, there is also no single "best" measure. The measures illustrate different aspects of the congestion problems and improvement strategies.

There is a temptation to choose one measure to make the interpretations and message easy. As a minimum two of the "intensity" measures and one "magnitude" measure should be used to assess the mobility situation at an areawide level. At the corridor level, where solutions are frequently implemented, more measures and more detailed analyses are needed to identify the most appropriate solution and evaluate the effects. The measures reflect travel time concerns and can be applied to a variety of evaluation cases. More information on these measures is available on the website:
http://mobility.tamu.edu.

- Travel Time Index—the ratio of peak period travel time to free-flow travel time. The TTI expresses the average amount of extra time it takes to travel in the peak relative to free-flow travel. A TTI of 1.3, for example, indicates a 20-minute free-flow trip will take 26 minutes during the peak travel periods, a 6-minute (30 percent) travel time penalty. Free-flow travel speeds are used because they are an easy and familiar comparison standard, not because they should be the goal for urban transportation system improvements.
- Delay per Traveler—the hours of extra travel time divided by the number of urban area peak period travelers. This is an annual measure indicating the sum of all the extra travel time that would occur during the year for the average traveler. All urban travelers are used as the comparison device to better relate the delay statistics to those affected on the roadways.
- Cost of Congestion—the value of the extra time and fuel that is consumed during congested travel. The value of time for 2003 is estimated for passenger vehicles and trucks and the fuel costs are the per-gallon average price for each state. The value of a person's time is derived from the perspective of the individual's value of their time, rather than being based on the wage rate. Only the value of truck operating time is included; the value of the commodities is not. The value of time is the same for all urban areas.
- Change in Congestion—not a particular measure, but a concept used in many analyses. The trends in congestion are often more important than the absolute mobility levels, because they indicate if the right amount of improvement is being funded.

The mobility performance measures and the rankings based on them are useful for a variety of purposes. They are especially good at identifying multi-year trends and in comparing relative levels of congestion. As evidenced by the continual refinement of the measures, estimation procedures and data, however, this series of reports is still a "work-in-progress."

One element of this uncertainty is that the measure values have an element of variation in them. All estimation procedures have simplifying assumptions that are not correct for every situation. And traffic data reflects the day-to-day variation in activity that affects traveler experiences. There are also locations or corridors in each urban area, especially those over one million population, where mobility levels are much lower than any average value. Those who frequently travel in these places may get a biased view of the urban areawide mobility level.

HOW CONGESTED ARE THE ROADS? ARE THEY GETTING WORSE?

Congestion levels and the trends in congestion growth are important aspects of the database. Where and when congestion occurs is important within an urban network, as well as for comparing urban areas to each other. Comparisons should include considerations such as, areawide congestion levels tend to be worse in the larger urban areas, but there are some isolated pockets of very bad traffic congestion in smaller urban areas that rival some locations in larger cities. Comparisons with areas of similar population are usually more informative than broader comparisons.

Conclusions

In general, traffic congestion is worse in the larger urban areas than in the smaller ones. Traffic congestion levels have increased in every area since 1982. Congestion extends to more time of the day, more roads, affects more of the travel and creates more extra travel time than in the past. And congestion levels have risen in all size categories, indicating that even the smaller areas are not able to keep pace with rising demand.

The need for attention to transportation projects is illustrated in these trends. Major projects or programs require a significant planning and development time—10 years is not an unrealistic timeframe to go from an idea to a completed project or to an accepted program. At recent growth rates, the urban area average congestion values will jump to the next highest classification—medium areas in 2013 will have congestion problems of large areas in 2003.

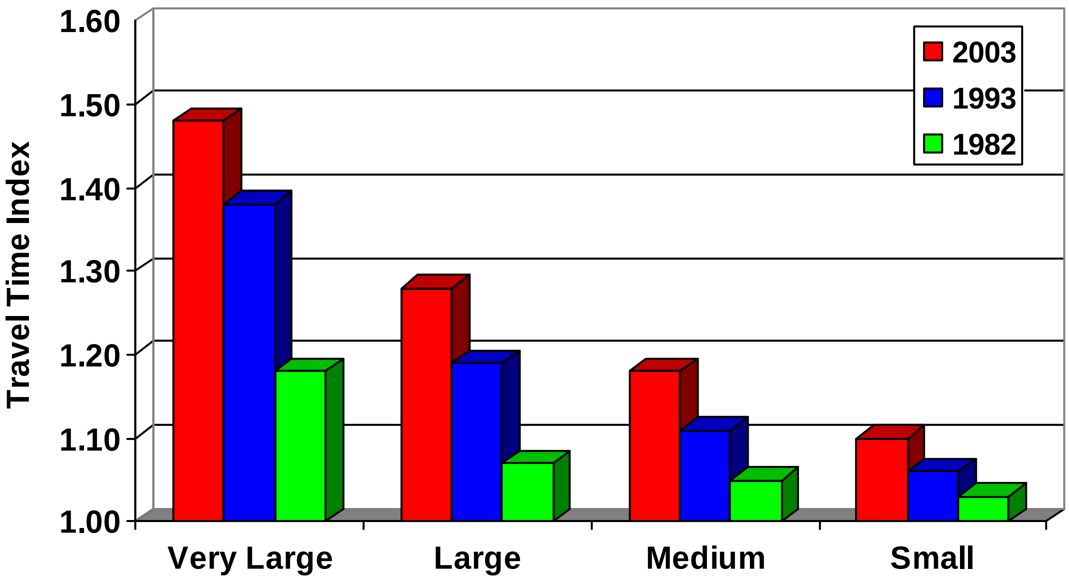
The Travel Time Index is one of two primary measures of extra travel time for travelers. (See Exhibit 1). It measures the amount of additional time needed to make a trip during a typical peak travel period in comparison to traveling at free-flow speeds.

Travel delay per peak traveler is the other individual measure that provides estimates of the mobility levels (see Exhibit 2). The extra travel time per year can be related to many other activities and may be more relevant for some discussions.

The extra travel time each year is a combination of the extra travel time for each trip (as measured by the TTI), the trip distance and the number of trips. The effect of this difference is relatively modest in most areas—that is, the TTI and delay per traveler tell basically the same story. The rankings are similar and the pattern of growth or decline are about the same. In some areas, however, the two values lead to different conclusions.

Portland is one area where the multiple performance measures help illustrate the effect of the transportation and land use policies that are being pursued to create a denser urban area that is better served by public transportation. The Travel Time Index and the delay per traveler values have both increased since 1982, indicating an increase in congestion. The Travel Time Index for Portland grew faster from 1982 to 2003 than it has for the majority of the other areas in the Large urban group. Delay per traveler, however, has grown at a rate closer to the Large area average, indicating that delay has not grown as rapidly as the per-minute travel time penalties have declined. Perhaps the urban growth and transportation policies are encouraging shorter trips and travel on light rail and other modes.

Exhibit 1. Travel Time Index Trends

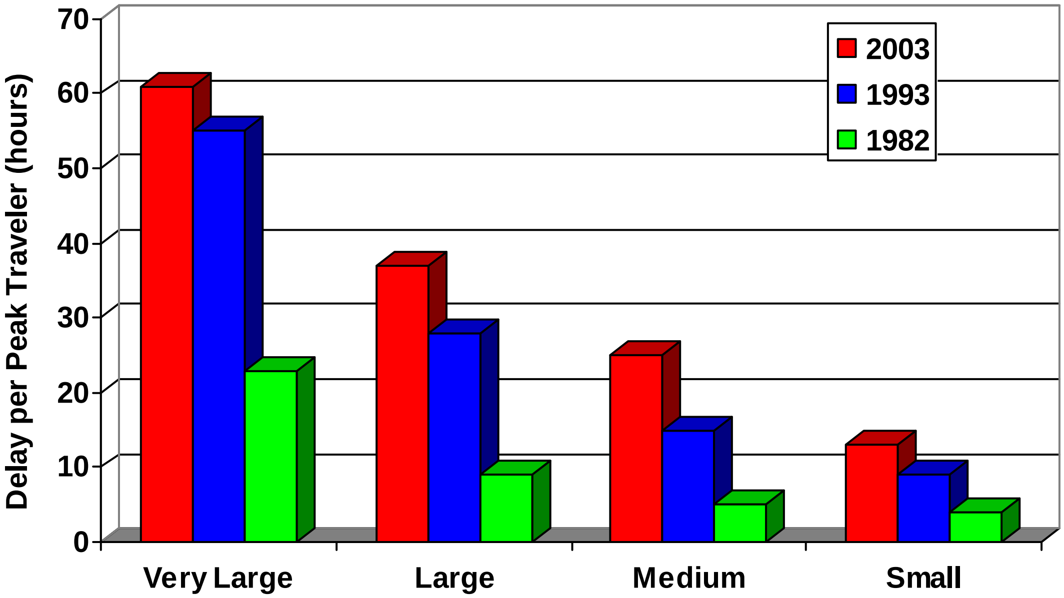


Note: The Travel Time Index is a ratio of average peak period to free-flow travel time. A value of 1.30 indicates a free-flow trip of 20 minutes takes 26 minutes in the peak due to heavy traffic demand and incidents.

- The average TTI for all 85 urban areas is 1.37. Thus, an average 20-minute off-peak trip takes almost 27 minutes to complete during the peak due to heavy traffic demand and incidents.
- Congestion problems tend to be more severe in larger cities. The average TTI for each individual population group ranges from 1.48 in the Very Large areas down to 1.10 in the Small urban areas.
- The average increase in the travel time penalty was 25 points (1.12 to 1.37) between 1982 and 2003. This gap ranges from 30 points in the Very Large group to 7 points in the Small population group.
- Twenty-eight of the 85 urban areas have a TTI of at least 1.30. Twenty-five of these urban areas are in the Very Large and Large population groups—they have populations greater than one million. Austin, Charlotte, and Tucson are the only areas with fewer than one million people and a TTI more than 1.30.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 2. Delay per Peak Traveler Trends



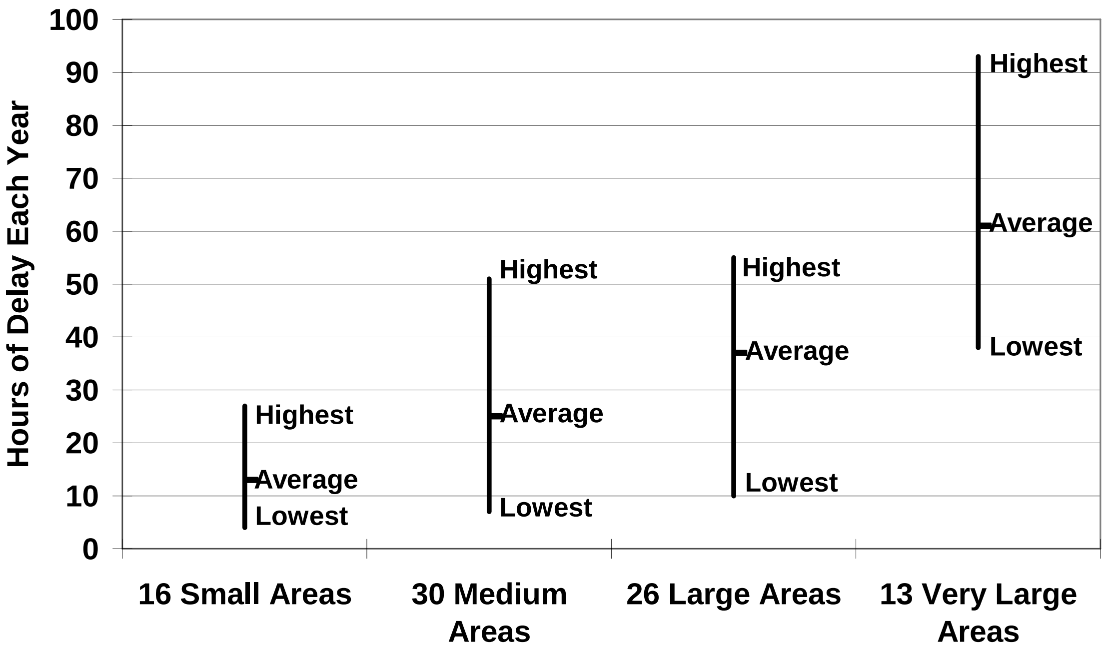
- The average delay per peak traveler in the 85 urban areas is 47 hours.
- There are 17 urban areas with delay per peak traveler values in excess of 50 hours, showing the effect of the very large delays in the areas with populations larger than 3 million.
- The average delay per peak traveler in the Large population group is about the same as the average delay in the Very Large population group in 1987.
- The average delay per peak traveler in the Medium population group is about the same as the average delay in the Large group in 1991.

WHAT CONGESTION LEVEL SHOULD WE EXPECT?

Congestion travel time penalties are related to size of the area, and Exhibit 3 illustrates this. The Delay per Traveler decreases as population does, but there is a significant amount of variation within the groups. Areas that have seen high rates of growth in recent years are more likely to be near the top of their population group because demand will increase much faster than the roadway, public transportation service, operational treatments and land use patterns.

- Areas with populations over 3 million (Very Large) should expect a minimum delay per traveler of 38 hours.
- Areas over 1 million (Large and Very Large) should expect a delay per traveler of at least 10 hours with a more likely value of around 37 hours.
- Areas over one-half million (all except Small) should expect at least 7 hours with typical values being closer to 20 to 30 hours.
- Areas less than a half million (Small) should expect a delay per traveler of up to 25 hours.

Exhibit 3. Congestion and Urban Area Size, 2003



HOW FAR HAS CONGESTION SPREAD?

Traffic congestion affects a broader segment of the transportation system each year. Several dimensions are explored within this report. Congestion has spread to **more cities** to **more** of the **road system** and **trips** in cities to **more time** during the day and to **more days** of the week in some locations.

Conclusions

Congestion has spread significantly over the 20 years of the study. A few notable changes from 1982 to 2003 include:

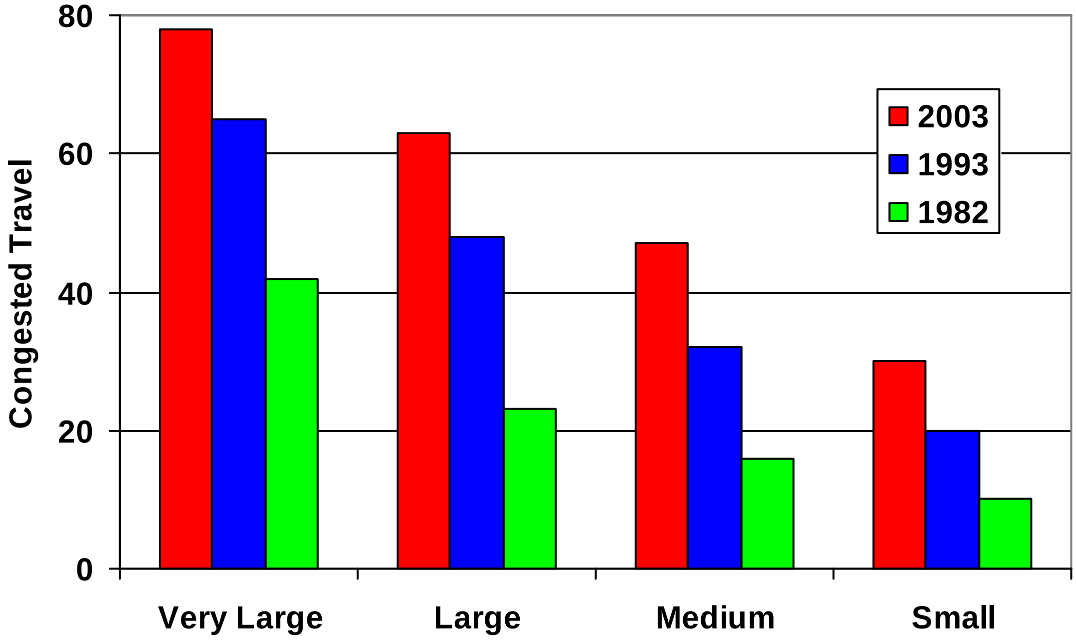
- Twenty-eight urban areas have a Travel Time Index above 1.30 compared with one such area in 1982.
- Sixty-seven percent of the peak period travel is congested compared to 32 percent in 1982.
- Fifty-nine percent of the major road system is congested compared to 34 percent in 1982.
- The number of hours of the day when congestion might be encountered has grown from about 4.5 hours to about 7.1 hours.

Most of the trend information indicates that the 2003 average values for each population group are near the 1990 value for the next highest population group. This is also the case for the 1990 and 1982 comparison. This suggests that each group will attain congestion levels of the next highest approximately each decade if trends are not reversed.

Congested Travel

The amount of traffic experiencing congested conditions in the peak travel periods (three hours in the morning and three hours in the afternoon) has doubled in 20 years of the study from 32 percent in 1982 to 67 percent in 2003. This means that two of every three cars experience congestion in their morning or evening trip. Exhibit 4 provides more information on this trend.

Exhibit 4. Percent of Travel in Congested Conditions

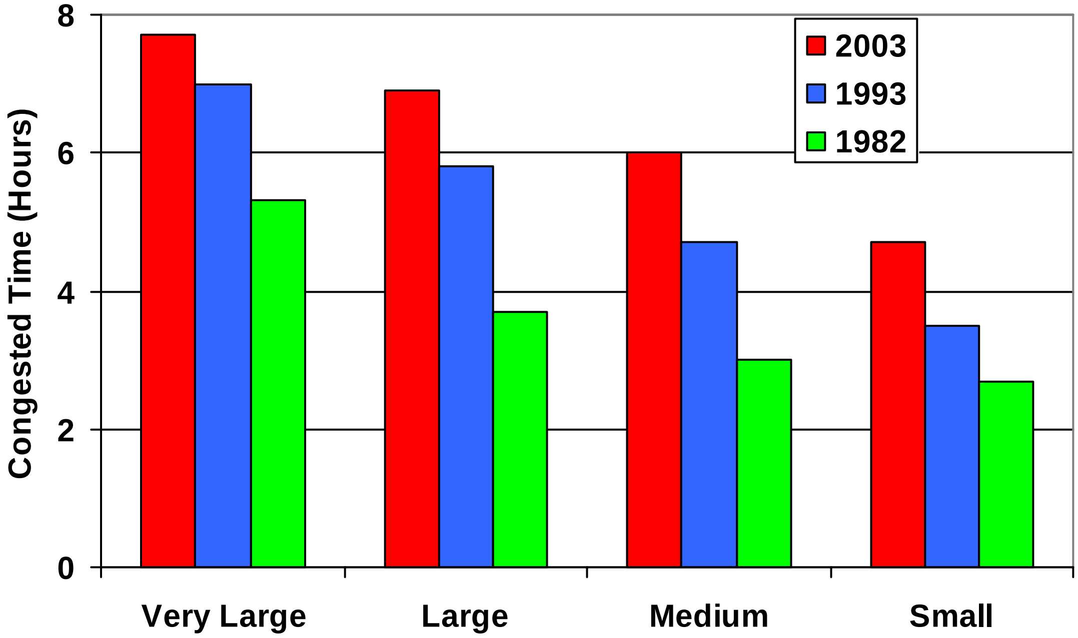


- The range of travel experiencing congestion grew from between 10 percent and 42 percent in 1982 to between 30 percent and 78 percent in 2003.
- The average percentage has increased to the next highest population group approximately each decade.

Congested Time

From the traffic database that is used for this study, it is uncertain exactly how long the congested periods last in each urban area. We can estimate, however, the amount of travel that occurs during times of the day when travelers **may** encounter congestion. This is not the amount of time when congestion occurs on a particular segment of road, but rather is the time when congestion occurs on some part of the road system. Exhibit 5 shows the average length of the congested periods for each population group for 1982, 1993 and 2003.

Exhibit 5. Hours of Day When Congestion May Occur

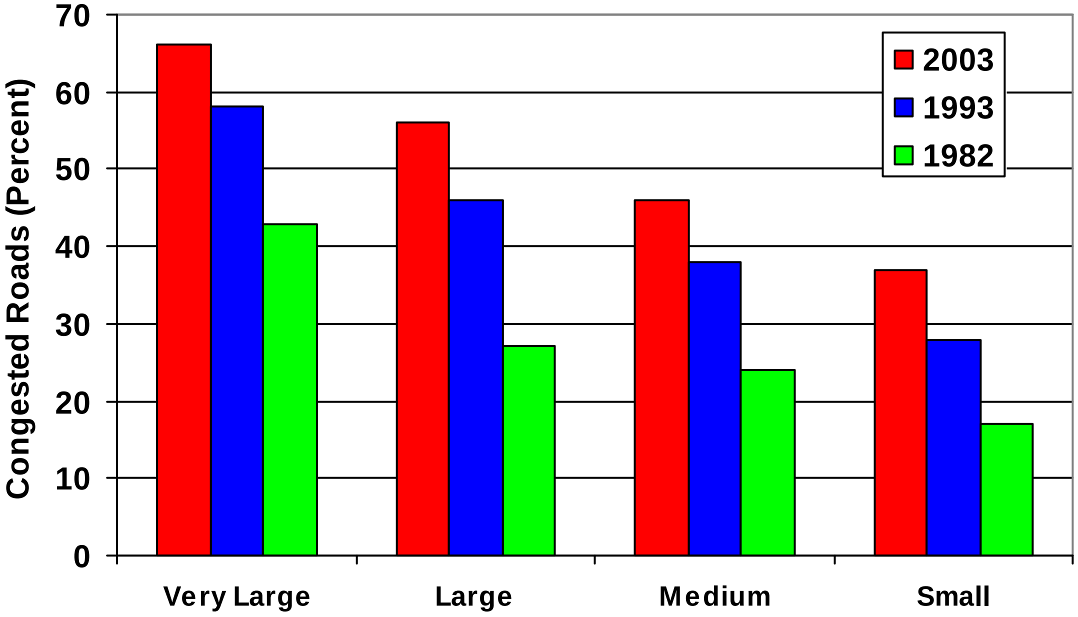


- The time when congestion might be encountered on major urban roads has grown in all population categories
- The time is near 3 hours in even the Small group—indicating that in many areas the term "rush hour" does not convey the length of time travelers may suffer slowdowns.
- Slow conditions might be encountered for 3 hours in each peak period in areas above 500,000. The amount of slowdown does not appear to be as great in the smaller areas.
- Three hours of congestion in each peak does not extend to the entire urban area, but some travelers must allow for extra time during a substantially longer portion of the day.

Congested Roads

The amount of roadways (freeways and principal arterial streets) that is congested during the peak period is shown in Exhibit 6 for 1982, 1993 and 2003. The percentage of the major roadway system that is congested has risen from 34 percent in 1982 to 59 percent in 2003.

Exhibit 6. Percentage of Roads that Experience Some Congestion During Peak Periods



- The percentage of roads where congestion might occur in the peak period has about doubled in the Small, Medium and Large areas since 1982.
- The largest percentage point increase has occurred in the Large areas.
- Each of the population groups has a 2003 value close to the 1990 value for the next highest population group. This is similar to the condition in 1990 when compared to 1982 data.

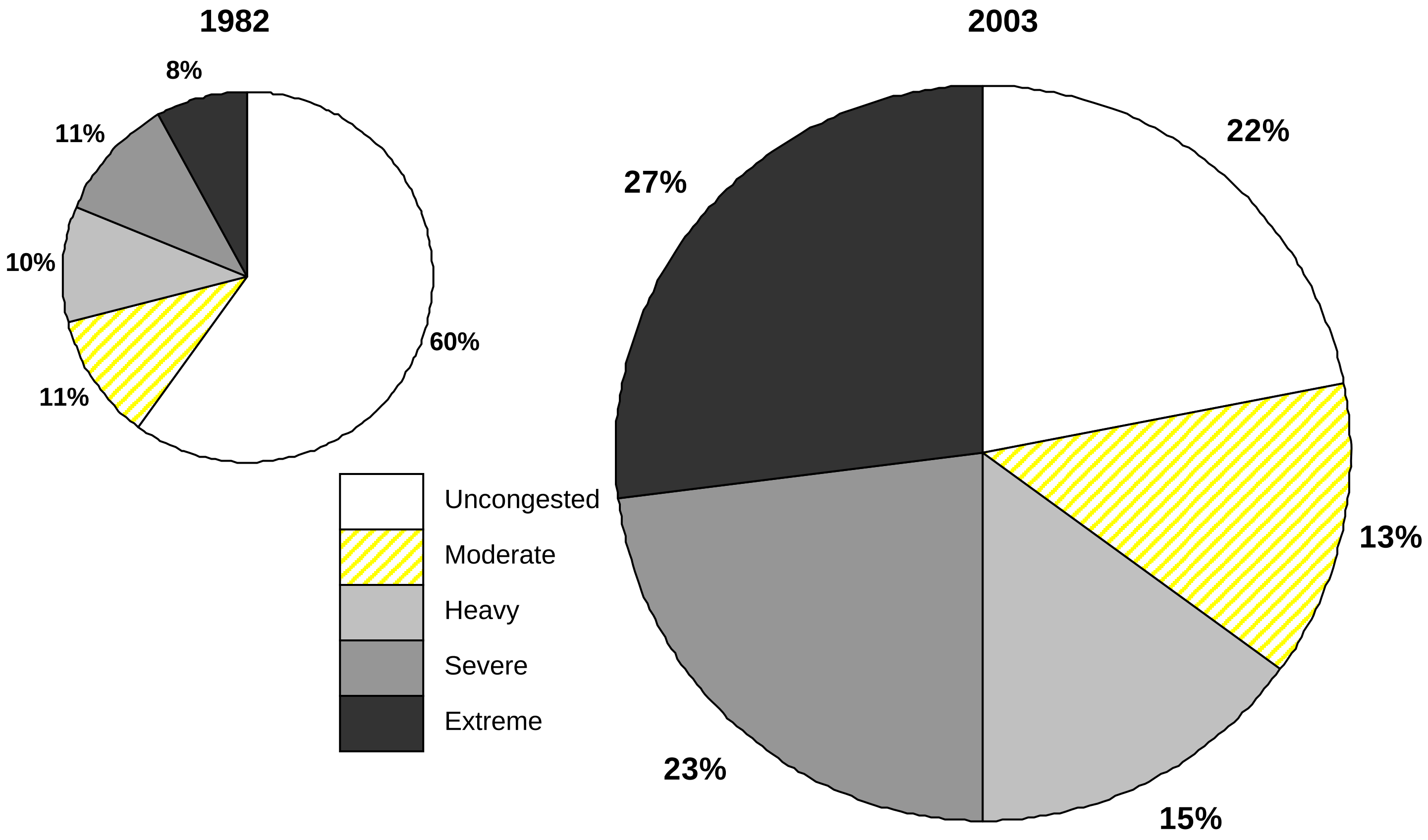
Growth in Delay and Congested Travel

This section provides a graphical comparison for each of the four population groups in the Urban Mobility Report. There are two circles on each page representing conditions in 1982 and 2003.

- The growth in the area of the circle represents the growth in travel delay for all the cities in the group from 1982 to 2003.
- The amount of miles traveled during the peak period in each of five congestion levels is also displayed for each year to give a perspective on the change in conditions experienced by travelers.

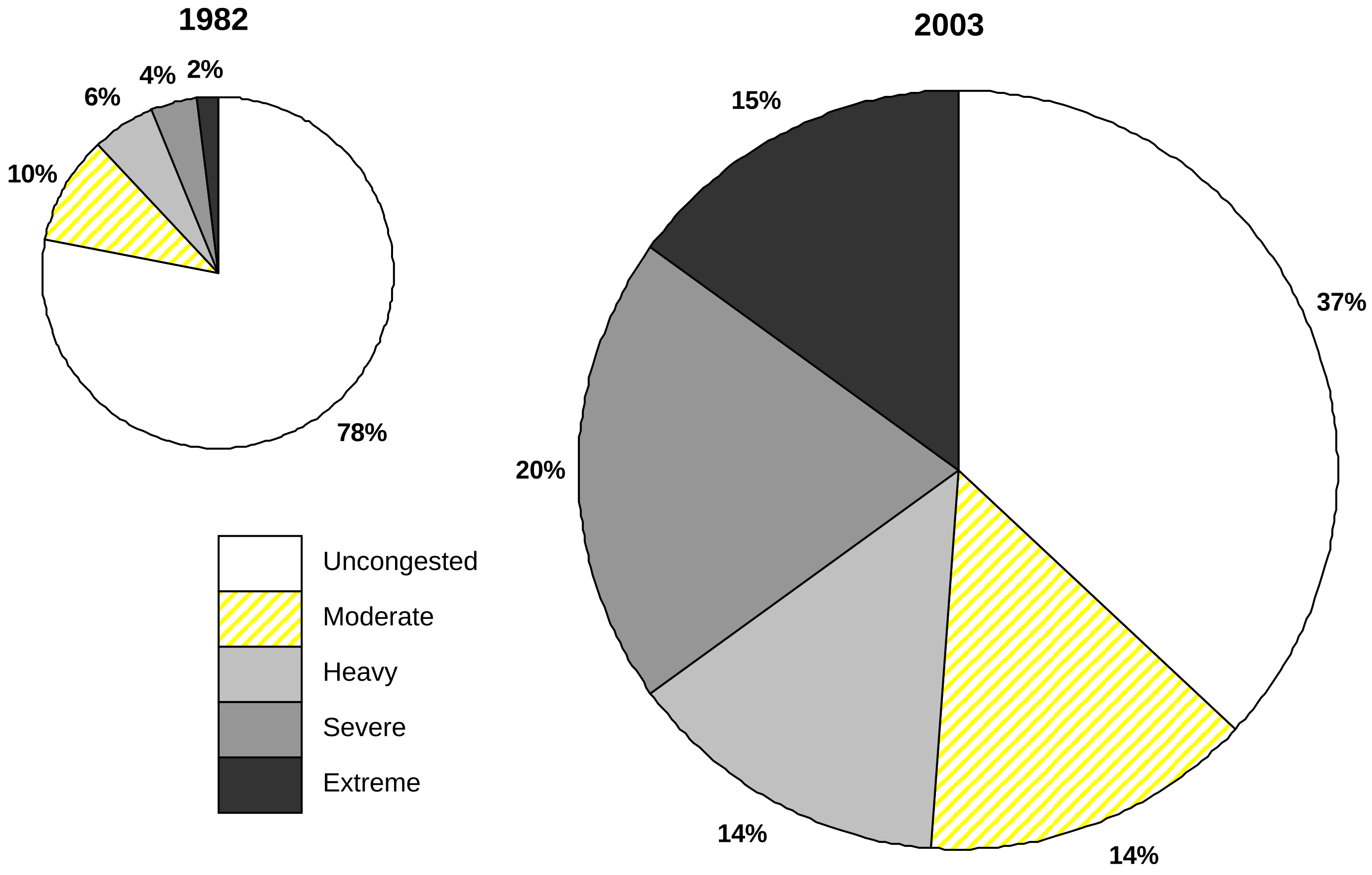
Exhibits 7 through 10 illustrate conditions for the four population groups.

Exhibit 7. Very Large Urban Area Travel Conditions



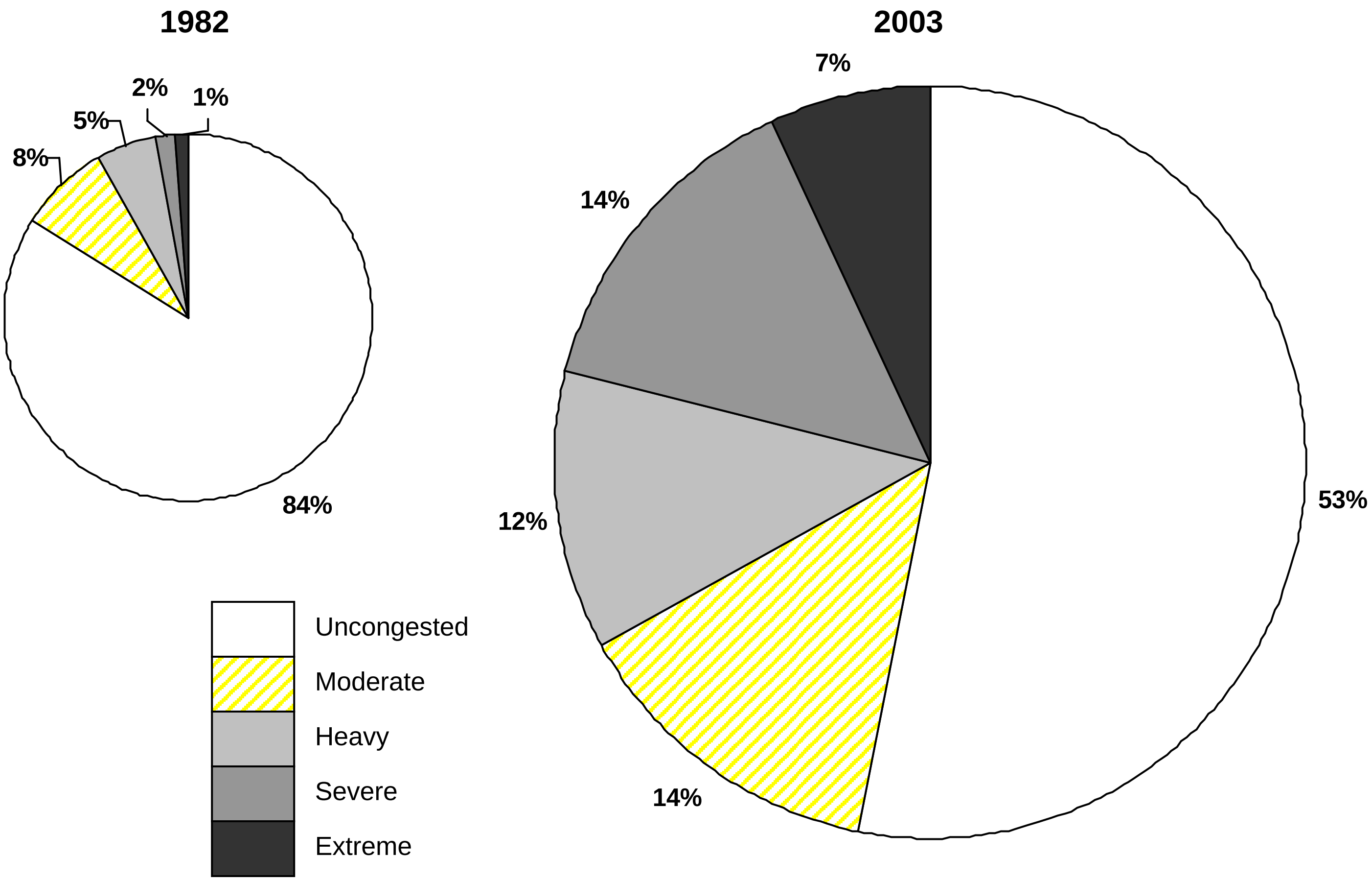
- Thirteen urban areas are included in this group representing 53 percent of the population and 68 percent of the travel delay in 2003.
- Delay grew approximately 350 percent from 1982 to 2003.
- There was significant growth in the severely and extremely congested volume ranges with travel increasing from about 19 percent to 50 percent.

Exhibit 8. Large Urban Area Travel Conditions



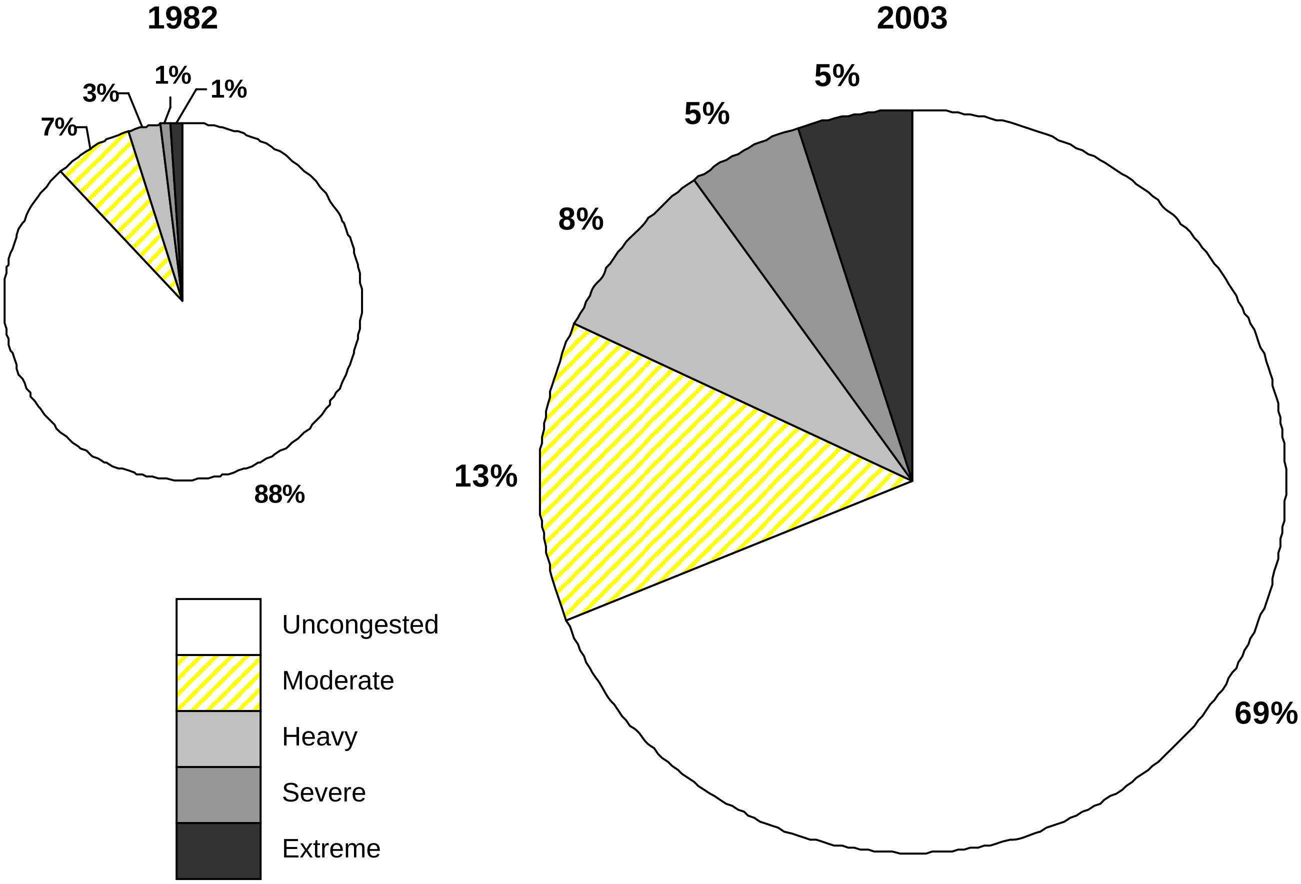
- Twenty-six urban areas are included in this group representing 29 percent of the population and 24 percent of the travel delay in 2003.
- Delay grew 655 percent from 1982 to 2003.
- There was almost no travel in the two most congested categories in 1982, while those ranges now account for over 1/3 of peak travel.

Exhibit 9. Medium Urban Area Travel Conditions



- Thirty urban areas are included in this group representing 15 percent of the population and 8 percent of the travel delay in 2003.
- Delay grew 690 percent from 1982 to 2003.
- Travel in the congested regions now accounts for almost half of travel during the peak, compared to less than 20 percent in 1982.

Exhibit 10. Small Urban Area Travel Conditions



- Sixteen urban areas are included in this group representing 3 percent of the population and 1 percent of the travel delay in 2003.
- Delay grew 525 percent from 1982 to 2003.
- Congestion, although not a significant problem for most peak period travel, has increased to about 30 percent of peak travel miles.

WHAT DOES CONGESTION COST US?

Congestion has several effects on travelers, businesses, agencies and cities. One significant element is the value of the additional time and wasted fuel. The 85 areas do not include all of the congestion in the U.S., but a substantial portion of the delay and extra fuel consumed in congested conditions is included. Of the 85 urban areas in the study, the top 12 include about two-thirds of the delay estimated for 2003, and the top 20 areas account for over 80 percent of annual delay. Some other highlights include:

- In 2003, congestion (based on wasted time and fuel) cost about $63.1 billion in the 85 urban areas, compared to $61.5 billion in 2002. (See Exhibit 11).
- The average cost per traveler in the 85 urban areas was $794 in 2003, down from $797 in 2002 (using constant dollars). The cost ranged from $1,038 per traveler in Very Large urban areas down to $222 per traveler in the Small areas.
- Exhibits 13 and 14 show that 2.3 billion gallons of fuel were wasted in the 85 urban areas. This amount of fuel would fill 46 super-tankers or 230,000 gasoline tank trucks.
- The urban areas with populations greater than 3 million accounted for 1.5 billion gallons (more than two-thirds) of wasted fuel.
- The amount of wasted fuel per traveler ranges from 36 gallons per year in the Very Large urban areas to 8 gallons per year in the Small areas.

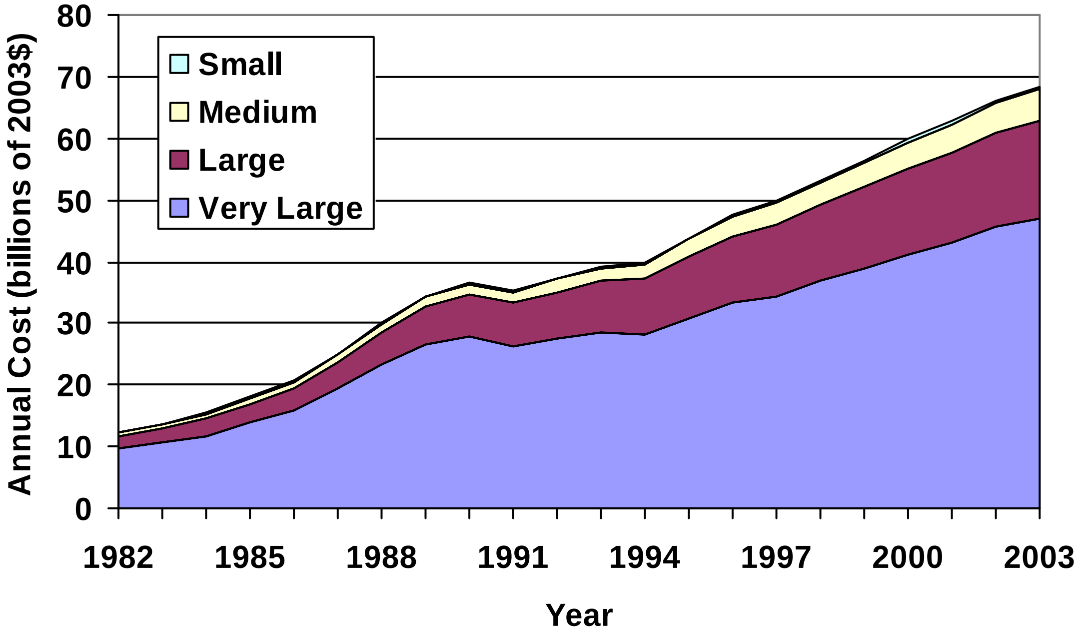
Exhibit 11. Congestion Effects on the Average Traveler – 2003

	Congestion Statistics per Traveler		
Population Group	**Average Cost ($)**	**Average Delay (hours)**	**Average Fuel (gallons)**
Very Large areas	1,038	61	36
Large areas	620	37	23
Medium areas	418	25	15
Small areas	222	13	8
85 area average	794	47	28
85 area total	$63.1 billion	3.7 billion	2.3 billion

What is the Total Cost of Congestion in the 85 Areas?

The total cost of congestion for each population size group is shown in Exhibit 12. This cost accounts for the amount of wasted time and fuel due to traffic congestion. The total cost of congestion in the 85 urban areas is $63.1 billion in 2003 or an average of $794 per traveler.

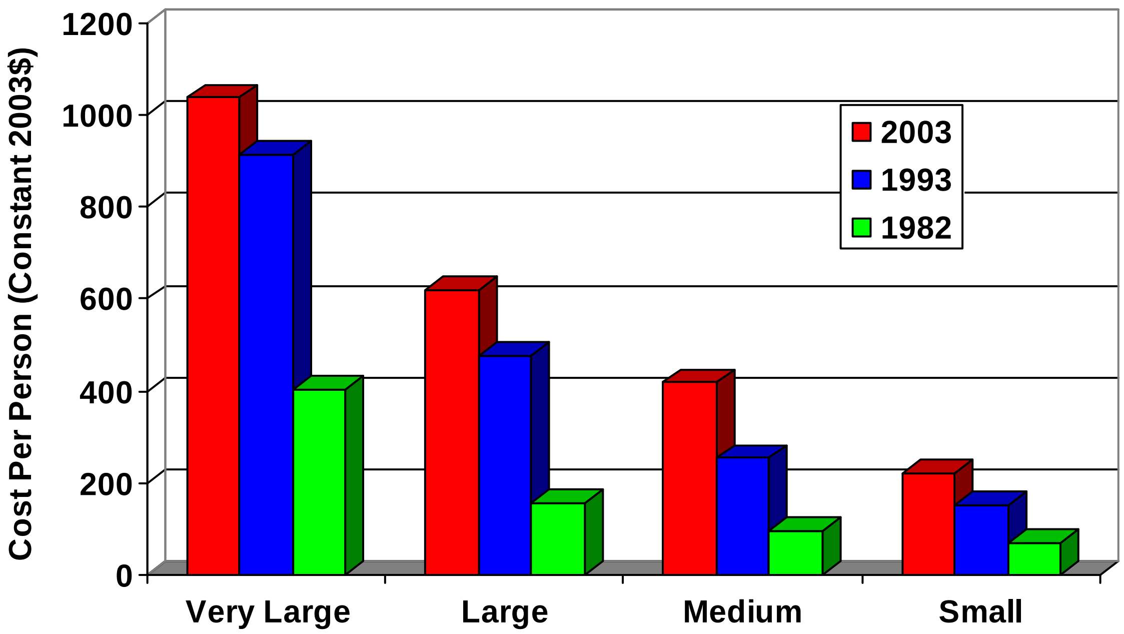
Exhibit 12. Annual Cost of Congestion



Note: Only 85 of the more than 400 urbanized areas are included.

- Seventeen urban areas had a total annual congestion cost of at least $1 billion each.
- The areas with populations over 3 million persons account for about two-thirds of the congestion cost.

Exhibit 13. Annual Cost of Congestion per Traveler



i)

Section 1.02 What is the cost of congestion for me?

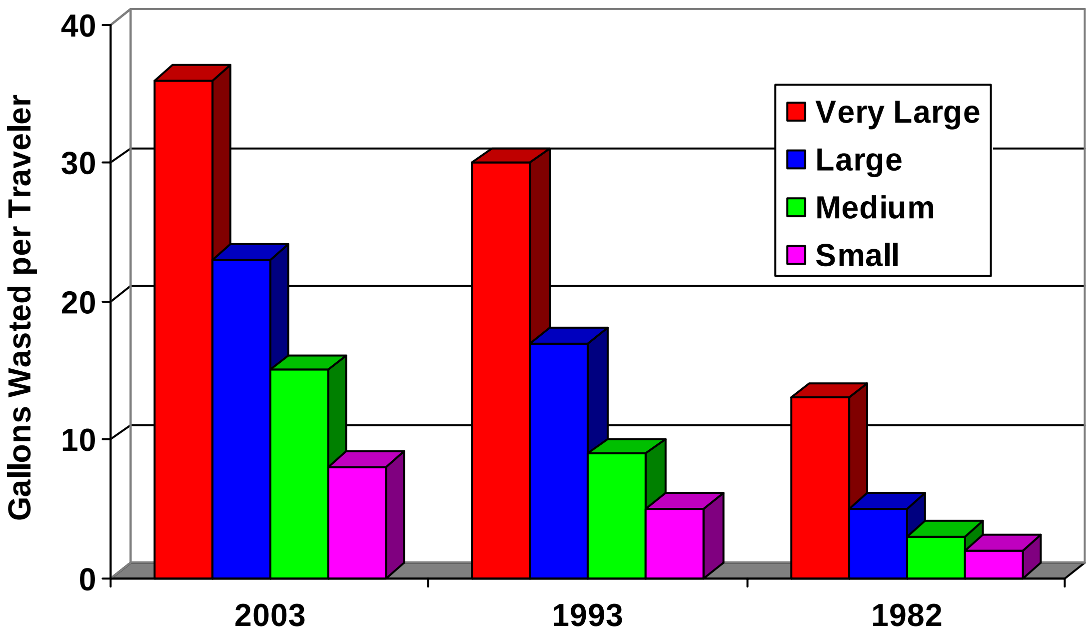
The total cost of congestion is divided by the number of peak period travelers to determine the effect of congestion on an individual (Exhibit 13). The average annual cost to each of these travelers is about $794.

- Travelers of 62 areas are “paying” more than $1 per workday in congestion costs; 41 areas have a congestion value exceeding $2 per workday.
- The average cost of congestion per traveler ranged from $1,038 in the Very Large population group to $222 in the Small population group in 2003.

How Much Fuel is Wasted in Congestion?

As with cost, the amount of fuel wasted in congestion is divided by the estimated number of persons in the urban area. This provides an estimate of the amount of fuel consumed for each individual because of congestion (Exhibit 14), a quantity that can be compared to other per capita consumptions. More than 28 gallons are wasted per traveler in the 85 urban areas. (See Exhibit 14 for more information).

Exhibit 14. Wasted Fuel per Traveler



- The average amount of wasted fuel per traveler in 2003 in the 85 study areas was 28 gallons.
- The amount of wasted fuel per traveler ranged from 8 gallons in the Small population group to 36 gallons in the Very Large population group in 2003.
- The total amount of wasted fuel in the 85 urban areas was approximately 2.3 billion gallons in 2003.

CAN MORE ROAD SPACE REDUCE CONGESTION GROWTH?

The analysis in this section (shown in Exhibit 17) addresses the issue of whether or not roadway additions made significant differences in the delay experienced by drivers in urban areas between 1982 and 2003. These years saw a range of economic conditions but a relatively consistent pattern between demand or population growth and increase in congestion. Rapid population growth was usually accompanied by significant congestion growth, while slow growth saw less congestion growth. The length of time needed to plan and construct major transportation improvements, however, means that very few areas see a rapid increase in economic activity and population without a significant growth in congestion. It also reinforces the idea that congestion is not a problem that can be addressed and then ignored for a decade.

Two measures are used to answer this question.

1. The Travel Time Index (TTI) is a mobility measure that shows the additional time required to complete a trip during congested times versus other times of the day. The TTI accounts for both recurrent delay and delay caused by roadway incidents.
2. The difference between lane-mile increases and traffic growth compares the change in supply and demand. If roadway capacity has been added at the same rate as travel, the deficit will be zero. The two changes are expressed in percentage terms to make them easily comparable. The changes are oriented toward road supply because transportation agencies have more control over changes in roadway supply than over demand changes. In most cases in the UMS database, traffic volume grows faster than lane-miles.

Conclusions

The analysis shows that **changes** in roadway supply have an effect on the **change** in delay. Additional roadways reduce the rate of increase in the amount of time it takes travelers to make congested period trips. In general, as the lane-mile "deficit" gets smaller, meaning that urban areas come closer to matching capacity growth and travel growth, the travel time increase is smaller. It appears that the growth in facilities has to be at a rate slightly greater than travel growth in order to maintain constant travel times, if additional roads are the only solution used to address mobility concerns. It is clear that adding roadway at about the same rate as traffic grows will slow the growth of congestion.

It is equally clear, however, that only five of the 85 areas studied were able to accomplish that rate. There must be a broader set of solutions applied to the problem, as well as more of each solution than has been implemented in the past, if more areas are to move into the "maintaining conditions or making progress on mobility" category.

Analyses that only examine comparisons such as travel growth vs. delay change or roadway growth vs. delay change are missing the point. The only comparison relevant to the question of road, traffic volume and congestion growth is the relationship between all three factors. Comparisons of only two of these elements will provide misleading answers.

Exhibit 17 shows the ratio of changes in demand (miles traveled) and supply (roadway) and the resulting change in the mobility level measured by the Travel Time Index. If road growth is a useful strategy for reducing the growth of congestion, lane-mileage increases that are faster than the traffic growth should improve conditions. If adding roads is not an effective strategy, the relationship between added roads and added demand will not indicate lower congestion growth for a demand-supply balance.

The 85 urban areas were divided into three groups based on the differences between lane-mile growth and traffic growth. If an area's traffic volume grew relatively slowly, the road capacity would need to only grow slowly to maintain a balance. Faster traffic growth rates would require more road capacity growth. The key analysis point is to examine the **change** in demand, the **change** in supply and the **change** in congestion levels. This allows fast growth cities that have built roads in approximately the same rate that demand has grown to be judged against other areas where demand and supply changes have been balanced.

The three groups were arranged using data from 1982 to 2003:

- Significant mismatch—Traffic growth was 30 percent or more greater than the growth in road capacity for the 53 urban areas in this group.
- Closer match—Traffic growth was between 10 percent and 30 percent more than road capacity growth. There were 28 urban areas in this group.
- Narrow gap—Road growth was within 10 percent of traffic growth for the four urban areas in this group.

The resulting growth in the average Travel Time Index values is charted in Exhibit 15. The average 1982 values were assigned a value of 1.0 so that the increases could be compared (in a manner similar to the Consumer Price Index).

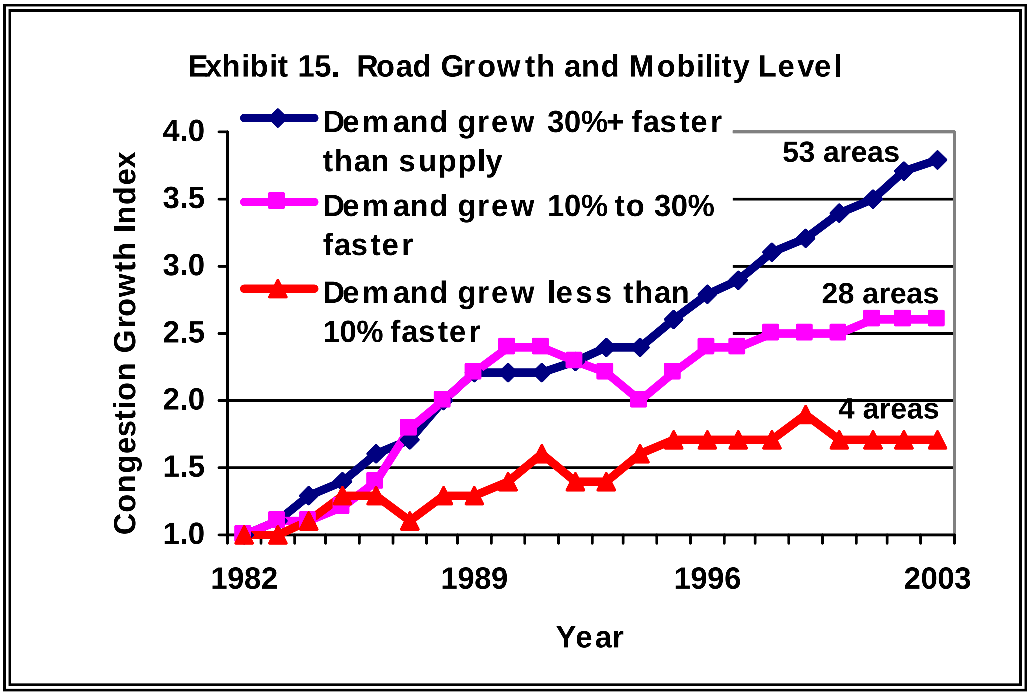


Exhibit 15. Road Growth and Mobility Level

Note: Legend represents difference between traffic growth and road additions.

- A general trend appears to hold—the more that travel growth outpaced roadway expansion, the more the overall mobility level declined.
- The four urban areas with a demand-supply growth balance had their congestion levels increase at a much lower rate than those areas where travel increased at a much higher rate than capacity expansion. The demand increases in some of these areas was also relatively low compared to other areas in the study, which made it easier to add roads at the needed rate.
- The recession in California in the early 1990s and the combination of the economy and increased road construction efforts in Texas in the late 1980s and early 1990s affects the “middle” line congestion levels.
- The number of areas in each group is another significant finding. Only four urban areas were in the Narrow Gap group. Two of those, New Orleans and Pittsburgh, had populations greater than 1 million. Tulsa and Anchorage were the other two areas. Tulsa was in the Medium population group, and Anchorage was from the Small group.

HOW MUCH MORE TRANSPORTATION CAPACITY WOULD BE NEEDED?

Road Construction

This is a difficult question to answer for at least two reasons.

- Most urban areas implement a wide variety of projects and programs to deal with traffic congestion. Each of these projects or programs can add to the overall mobility level for the area. Thus, isolating the effects of roadway construction is difficult because these other programs and projects are making a contribution at the same time.
- The relevancy of the analysis is questionable. Many areas focus on managing the growth of congestion, particularly in rapid growth areas. The analysis presented here is not intended to suggest that road construction is the best or only method to address congestion, but some readers will interpret it that way.

Conclusions

This analysis shows that it would be almost impossible to attempt to maintain a constant congestion level with road construction only. Over the past 2 decades, only about 50 percent of the needed mileage was actually added. This means that it would require at least twice the level of current-day road expansion funding to attempt this road construction strategy. An even larger problem would be to find suitable roads that can be widened, or areas where roads can be added, year after year. Most urban areas are pursuing a range of congestion management strategies, with road widening or construction being one of them.

How Much Roadway has been Added?

Before we discuss the road growth issue, a word about our data. One answer to the road addition question is "not as much as our statistics indicate." The roadway growth in the UMS database includes the roads that were added because the urban boundary grew to include areas that previously were classified as rural. These existing, but newly urbanized, roads appear as additions to the urban databases, but do not have the same effect as new roadway. Even including these redesignated roads, however, the amount of added roadway is considerably less than that needed to match travel volume growth.

Examining Road Growth

This analysis uses the premise that enough road construction should take place so that the areawide congestion level is kept constant. For every percent increase in vehicle-miles of travel, it is assumed that there should be a similar percent increase in the lane-miles of roadway. Based on these assumptions, the percentage of the "Needed" roadway that has been "Added" can be calculated (Exhibit 16). The 1982 to 2003 statistics show:

- Over the 21-year period, less than half of the roadway that was needed to maintain a constant congestion level was actually added. These percentages are actually a little higher than the amount that was "constructed" since they also include roadway mileage that was added through shifting urban boundaries and not just new construction.
- Exhibit 17 also shows that the larger urban areas have done a little better, on average, at maintaining pace with the growth of travel.

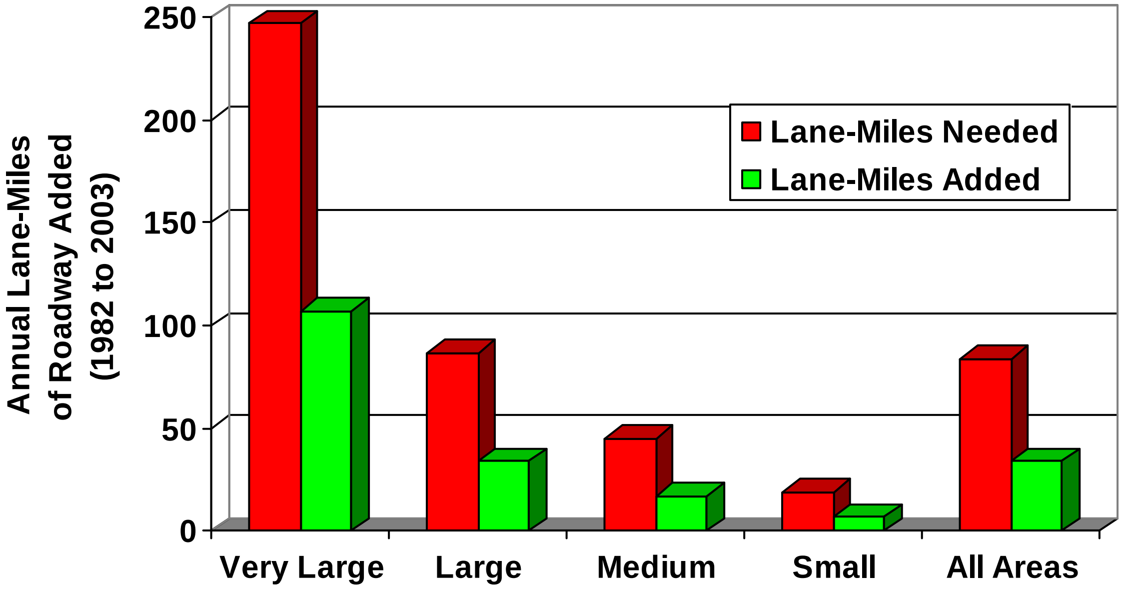
Exhibit 16. Vehicle Travel and Roadway Additions

2003 Population Group Average	Avg. Annual Growth in Vehicle-Miles of Travel (1982 to 2003)	Percentage of Needed Roadway Added[1]
Very Large areas	3.3	43
Large areas	3.6	39
Medium areas	4.0	38
Small areas	3.7	35
85 area average	3.5	41

[1] Lane-miles added divided by lane-miles needed. "Lane-miles needed" are based on matching the VMT growth rate.

Note: Assumes that all added lane-miles are roadway system expansion. The database does not include data concerning the number of lane-miles added because of changing urban boundaries.

Exhibit 17. Comparison of Roadway Added to Needed



- Over the 22-year period, less than half (41 percent) of the roadway that was needed to maintain a constant congestion level was actually added.
- There is very little difference between the roadway added percentage values for any of the population groups. Areas of all sizes are approximately equal in ability to add lane-miles.

HOW MANY NEW CARPOOLS OR BUS RIDERS WOULD BE NEEDED IF THEY WERE THE ONLY SOLUTION?

Another method of examining the role and potential of public transportation is to examine the amount of service that would be required to address the growing delay problem if this were the only solution. Just as with the "roadway construction" only solution, this analysis will focus on the changes in occupancy level needed to accommodate travel growth. The results from this analysis show the increase in occupancy level in order to maintain existing congestion levels. But they are not intended to suggest that this is a realistic solution.

Conclusions

The 85 urban areas in the Urban Mobility Study added more than 52 million additional miles of daily person travel in 2003. To accomplish a goal of maintaining a constant congestion level in these areas by only adding transit riders of carpoolers, there would have to be a substantial growth in these modes. The growth would be equivalent to an additional 3 or 4 percent of all vehicles becoming carpools, or expanding transit systems by more than one-third of the current ridership each year.

It may be very difficult to convince this many persons to begin ridesharing or riding transit. As indicated elsewhere in this report, some success with this solution, in conjunction with other techniques may give an urban area the opportunity to slow the mobility decline.

Vehicle travel volume growth is estimated with the annual growth rate for the previous five years. Passenger-miles of travel are estimated using the standard 1.25 persons per vehicle value used elsewhere in the study. The growth in demand is estimated and the number of added passenger-miles of travel is divided by a simple national average trip length to estimate the number of additional trips that would have to be made by carpool or transit. Average trip lengths vary by metropolitan area. The length of a trip can have an effect on how much exposure a traveler has to congestion. For purposes of comparison, however, this report assumes one trip length for all areas.

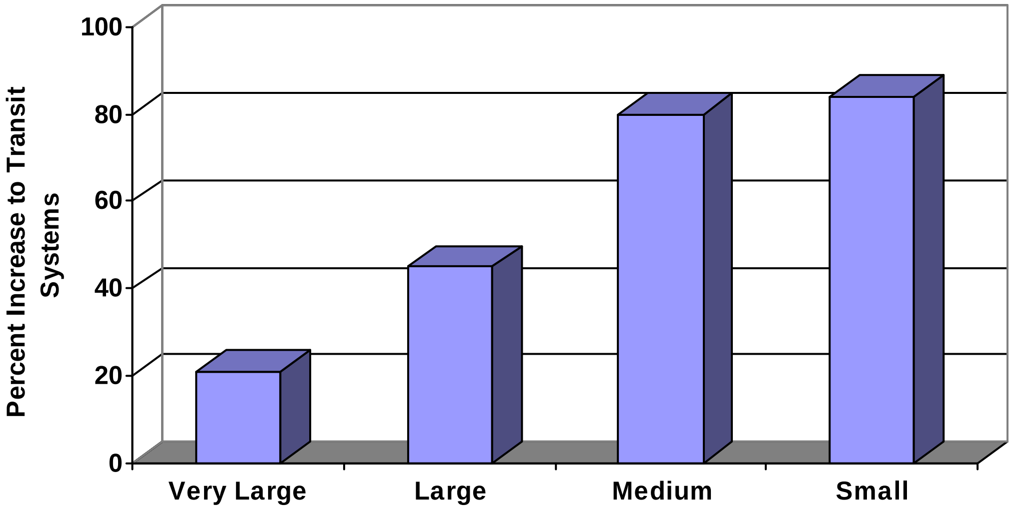
- 5.8 million trips per day would have to be made as carpools or bus trips in the 85 urban areas to handle the 52 million additional person-miles of travel if congestion levels are to remain constant.
- On average, the occupancy of each vehicle in the 85 urban areas would have to rise by about 0.03 persons or, in other words, 3 out of every 100 vehicles would have to become a new 2-person carpool to handle one year's growth.

How Many Trips Would be Needed on Transit?

Transit, like ridesharing, park-and-ride lots and high-occupancy vehicle lanes, typically have a greater effect on the congestion statistics in a corridor, rather than across a region. Transit and these other elements "compete" very well with the single-occupant vehicle in serving dense activity centers and congested travel corridors. But it is also useful to examine the data at the urban area level. Ridership statistics were gathered for the 85 urban areas to determine how much more travel the systems would have to handle to offset congestion growth—again, if transit expansion was the only method to address travel growth. The additional passenger-miles of travel (or estimated trips) from the roadway were compared with the number of trips from existing transit service.

There are no other U.S. cities with ridership like New York City. Approximately one out of five U.S. transit trips are made in the New York area. Including these statistics would not present a useful comparison for typical cities over 3 million population; the New York data were removed from this comparison. The transit ridership increase that would be needed for each year in the remaining areas is shown in Exhibit 18.

Exhibit 18. Increase in Existing Transit System to Hold Congestion Constant



Note: The New York urban area statistics have been removed from the calculation.

- The Very Large urban areas would have to increase transit trips by over 20 percent to maintain a constant congestion level.
- The Large urban areas would have to add about half as many transit trips as they already have to maintain a constant congestion level.
- The Small and Medium urban areas would have to add at least three-quarters of their existing transit ridership to maintain their congestion level.

INCORPORATING THE EFFECT OF OPERATIONAL TREATMENTS

Previous Urban Mobility Reports have included speed improvements from additional roadways and decreased volume, but no specific inclusion of operational or demand management improvements. For some of these techniques, in fact, the goal is to increase volume past a point on the road and if that is successful, the Mobility Report procedures would indicate more delay, rather than less. There is relatively little information to estimate the effect of some of the operational treatments, and the data collection and analysis procedures are not standardized. Most congestion analysis performed in government, private sector and research studies provide estimates of speed and delay for normal conditions.

Many state and local transportation agencies, as well as the federal transportation program, have invested substantial funding in these operational treatments and the future will include more of these programs in more cities. Technologies, operating practices, programs and strategies provide methods to get the most efficiency out of the road or transit capacity that is built, typically for relatively modest costs and low environmental effects. In some cases, the operational improvements are some of the few strategies that can be approved, funded and implemented.

For the Urban Mobility Report database, the operational treatments were assessed for the delay reduction that results from the strategy as implemented in the urban area. A separate report, *2005 Annual Mobility Report, Volume 2, Six Congestion Reduction Strategies and Their Effects on Mobility* (9), describes the process of estimating the delay reduction in more detail. The ITS deployment analysis system (10) model was used as the basis for the estimates of the effect of the operational treatments. The ITS deployment database (11) and the Highway Performance Monitoring System (7) include data on the deployment of several operational improvements. These two databases provide the most comprehensive and consistent picture of where and what has been implemented on freeways and streets in urban areas.

The delay reduction estimates are determined by a combination of factors:

- extent of the treatments
- congestion level of the location
- density of the treatment (if it applies)
- effect of the treatment

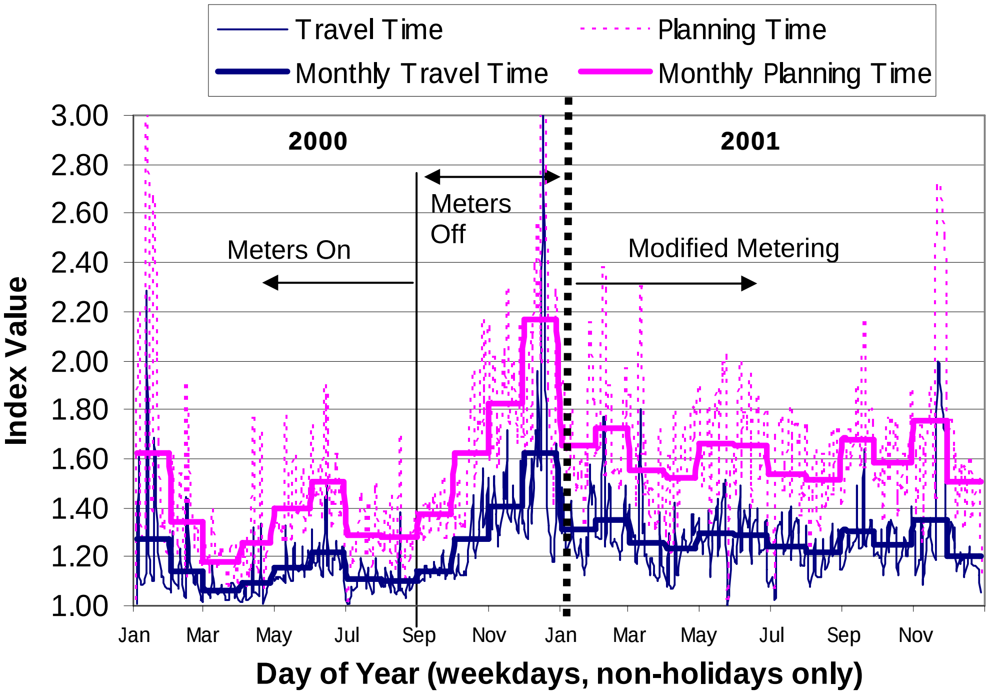
These factors are estimated from the databases, the inventory information found and applied within the existing Urban Mobility Report structure, and the delay reduction has been incorporated into several of measures calculated in the study.

Freeway Entrance Ramp Metering

Entrance ramp meters regulate the flow of traffic on freeway entrance ramps. They are designed to create more space between entering vehicles so those vehicles do not disrupt the mainlane traffic flow. The signals, just as traffic signals at street intersections, allow one vehicle to enter the freeway at some interval (for example, every two to five seconds) They also somewhat reduce the number of entering vehicles due to the short distance trips that are encouraged to use the parallel streets to avoid the ramp wait time.

The effect of ramp metering was tested in Minneapolis-St. Paul in October 2000 when the extensive metering system was turned off and the freeway operated as it does in most other cities. The basic system was relatively aggressive in that ramp wait times of five minutes were not uncommon. The results of this systemwide experiment are clearly visible in the peak period data in Exhibit 19. The Travel Time Index (average travel time) and the Planning Time Index (travel time that includes 19 out of every 20 trips) are plotted with each monthly average highlighted. Except for snowstorms, the highest values are during the shut-off experiment period. The metering experiment report produced by Cambridge Systematics (12) refers to a 22 percent increase in freeway travel time and the freeway system travel time becoming twice as unpredictable without the ramp meters. Congestion reductions are seen in January 2001 when a modified, less aggressive metering program was implemented. It might be interpreted that turning off the ramp meter system had the effect of a small snowstorm.

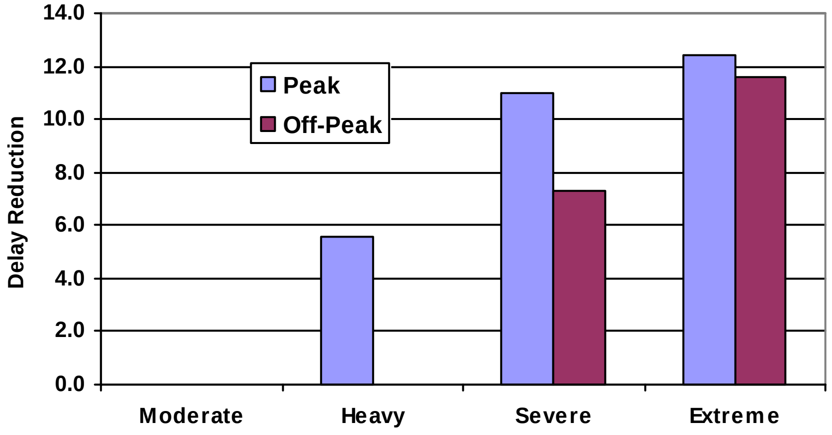
Exhibit 19. Minneapolis-St. Paul Freeway System Congestion Levels



Delay Reduction Effects

The results of the Minneapolis experiment and simulation modeling performed for the Intelligent Transportation System Deployment Analysis System (IDAS) (10) have been combined into a relatively simple delay reduction estimation procedure for use in the Annual Mobility Report. Exhibit 20 illustrates the delay reduction percentage for each of the four congestion ranges. More delay is subtracted from the more congested sections because there is more effect, particularly if the metering program can delay the beginning of stop-and-go conditions for some period of time.

Exhibit 20. Ramp Metering Delay Reduction



Twenty-four of the urban areas reported ramp metering on some portion of their freeway system in 2003 (7,11). The average metered distance was 618 lane-miles which represents less than one-third of all the miles in the 24 cities. The effect was to reduce delay by 102 million person hours, approximately five percent of the freeway delay (Exhibit 21). This value is combined in the operational effects summary at the end of this section.

- Los Angeles has the largest delay reduction estimate in the Very Large group.
- Minneapolis-St. Paul and San Diego have the most extensive metering benefits in the Large group.
- Of the 46 areas studied with under one million population, only three reported any metering.

Exhibit 21. Freeway Ramp Metering Delay Reduction Benefits

Population Group	Average Covered Freeway Lane-miles		Freeway Hours of Delay (million)
	Lane-miles	Percentage	Reduction
Very Large (9)	772	25	82.0
Large (12)	653	58	19.9
Medium (3)	107	29	0.3
Small (0)	0	0	0.0
24 Area Average	618	33	–
24 Area Total	15,453	33	102.1

Source: HPMS, IDAS, and TTI Analysis

Note: This analysis uses nationally consistent data and relatively simplistic estimation procedures. Local or more detailed evaluations should be used where available. These estimates should be considered preliminary pending more extensive review and revision of base inventory information obtained from source databases.

Section 1.03

Freeway Incident Management Programs

Freeway Service Patrol, Highway Angel, Highway Helper, The Minutemen and Motorists Assistance Patrol are all names that have been applied to the operations that attempt to remove crashed and disabled vehicles from the freeway lanes and shoulders. They work in conjunction with surveillance cameras, cell phone reported incident call-in programs and other elements to remove these disruptions and decrease delay and improve the reliability of the system. The benefits of these programs can be significant. Benefit/cost ratios from the reduction in delay between 3:1 and 10:1 are common for freeway service patrols (13). An incident management program can also reduce "secondary" crashes—collisions within the stop-and-go traffic caused by the initial incident. The range of benefits is related to traffic flow characteristics as well as to the aggressiveness and timeliness of the service.

Addressing these problems requires a program of monitoring, evaluation and action.

- Monitoring—Motorists calling on their cell phones are often the way a stalled vehicle or a crash is reported, but closed circuit cameras enable the responses to be more effective and targeted. Shortening the time to detect a disabled vehicle can greatly reduce the total delay due to an incident.

- Evaluation—An experienced team of transportation and emergency response staff provide ways for the incident to be quickly and appropriately addressed. Cameras and on-scene personnel are key elements in this evaluation phase.

- Action—Freeway service patrols and tow trucks are two well-known response mechanisms that not only reduce the time of the blockage but can also remove the incident from the area and begin to return the traffic flow to normal. Even in states where a motorist can legally move a wrecked vehicle from the travel lanes, many drivers wait for enforcement personnel dramatically increasing the delay. Public information campaigns that are effective at changing motorists' behavior (that is, move vehicles from the travel lanes when allowed by law) are particularly important.

An active management program is a part of many cities comprehensive strategy to get as much productivity out of the system as possible. Removing incidents in the off-peak periods may also be important particularly in heavily traveled corridors or those with a high volume of freight movement. Commercial trucks generally try to avoid peak traffic hours, but the value of their time and commodities, as well as the effect on the manufacturing and service industries they supply can be much greater than simple additional minutes of travel time.

Delay Reduction Effects

The basic Urban Mobility Report methodology includes an estimate of the delay due to incidents. This estimate is based on roadway design characteristics and incident rates and durations from a few detailed studies. These give a broad overview, but an incomplete picture of the effect of the temporary roadway blockages. They also use the same incident duration patterns for all urban areas. Incidents are estimated to cause somewhere between 52 and 58 percent of total delay experienced by motorists in all urban area population groups. A more complete understanding of how incidents affect travelers will be possible as continuous travel speed and traffic count monitoring equipment is deployed on freeways and major streets in U.S. cities. Unfortunately, that equipment is in place and recording data in only a few cities. These can, however, give us a view of how travel speeds and volumes change during incidents.

The results of incident management program evaluations conducted in several cities and simulation modeling performed for the Intelligent Transportation System Deployment Analysis System (IDAS) (10) have been used to develop a delay reduction estimation procedure. The process estimates benefits for monitoring cameras and service patrol vehicles (Exhibits 22 and 23) with the cameras receiving less benefit from the identification and verification actions they assist with than the removal efforts of the service patrol. As with the ramp metering programs, more delay is subtracted from the more congested sections because there is more effect.

Exhibit 22. Benefits of Freeway Service Patrols

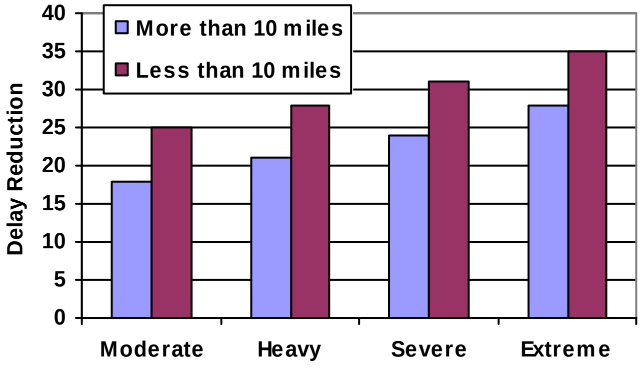
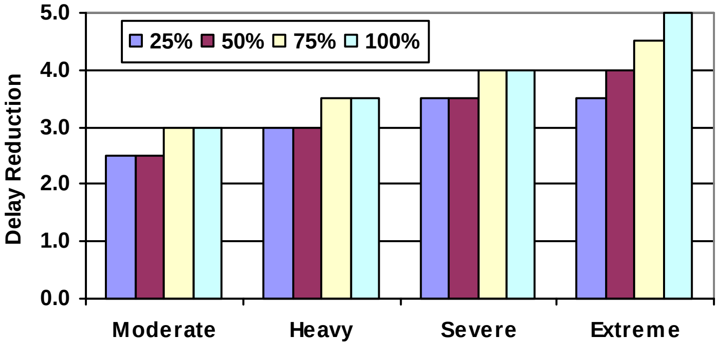


Exhibit 23. Benefits of Freeway Surveillance Cameras



More than 60 areas reported one or both treatments in 2003, with the coverage representing from one-third to two-thirds of the freeway miles in the cities (7,11). The effect was to reduce delay by 175 million person hours, approximately seven percent of the freeway delay (Exhibit 24). This value is combined in the operational effects summary at the end of this section.

Incident Management

- The New York City, Los Angeles and San Francisco-Oakland regions are estimated to derive the most benefit from incident management.
- Minneapolis-St. Paul and Seattle are estimated to have the most benefit in the Large group.
- Austin, Nashville, Memphis and Salt Lake City are the areas within the Medium group with the highest delay reduction benefit.

Exhibit 24. Freeway Incident Management Delay Reduction Benefits

Population Group	Average Covered Freeway Lane-miles		Freeway Hours of Delay (million)
	Lane-miles	Percentage	Delay Reduction
Surveillance Cameras			Delay Reduction Included Below
Very Large (13)	1,301	45	
Large (22)	399	36	
Medium (21)	196	36	
Small (6)	61	27	
62 Area Average	487	40	
62 Area Total	30,183	40	
Service Patrols			
Very Large (13)	2,118	73	136.6
Large (23)	691	63	31.6
Medium (22)	298	56	8.6
Small (6)	161	71	0.2
64 Area Average	796	67	–
64 Area Total	50,947	67	177.0

Source: HPMS, IDAS, and TTI Analysis

Note: This analysis uses nationally consistent data and relatively simplistic estimation procedures. Local or more detailed evaluations should be used where available. These estimates should be considered preliminary pending more extensive review and revision of base inventory information obtained from source databases.

Traffic Signal Coordination Programs

Traffic signal timing can be a significant source of delay on the major street system. Much of this delay is the result of the managing the flow of intersecting traffic, but some of the delay can be reduced if the streams arrive at the intersection when the traffic signal is green instead of red. This is difficult in a complex urban environment, and when traffic volumes are very high, coordinating the signals does not work as well due to the long lines of cars already waiting to get through the intersection.

There are different types of coordination programs and methods to determine the arrival of vehicles, but they all basically seek to keep moving the vehicles that approach intersections on the major roads, somewhat at the expense of the minor roads. On a system basis, then, the major road intersections are the potential bottlenecks.

Delay Reduction Estimates

Some of the delay reduction from signal coordination efforts that have been undertaken in the U.S. is the attention that is given to setting the signal timing to correspond to the current volume patterns and levels and to recalibrate the equipment. It is often difficult to identify how much of the benefit is due to this "maintenance" function and how much is due to the coordination program itself. The Annual Mobility Report methodology draws on the evaluations and simulation modeling performed for the Intelligent Transportation System Deployment Analysis System (IDAS) (10) to develop the delay reduction estimation procedure shown in Exhibits 25 and 26. There is less benefit for the more heavily congested sections of the street system due to the conflicting traffic flows and vehicle queues. The benefits of an actuated system (where the signals respond to demand) are about one-third of the benefits of a centrally controlled system that monitors and adapts the signals to changes in demand.

All 85 areas reported some level of traffic signal coordination in 2002, with the coverage representing slightly over half of the street miles in the cities (7,11). Signal coordination projects, because the technology has been proven, the cost is relatively low and the government institutions are familiar with the implementation methods, have the highest percentage of cities and road miles with a program. The evolution of programs is also evident in the lower percentage of advanced progressive systems. These systems require more planning, infrastructure, and agency coordination.

Exhibit 25. Signal Coordination Benefits (actuated)

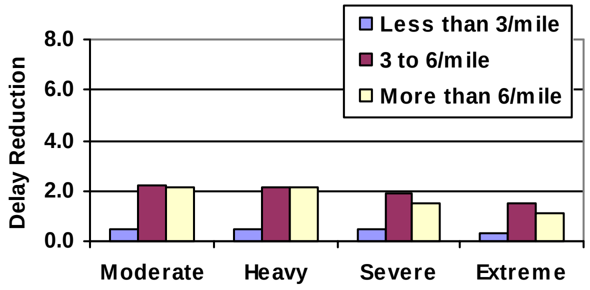
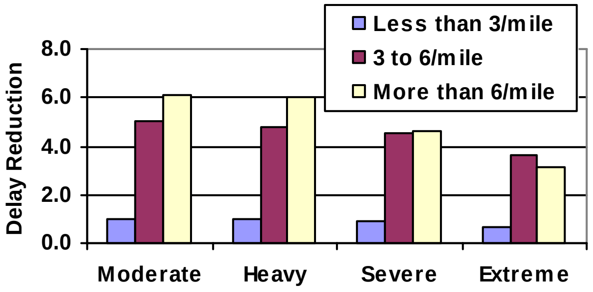


Exhibit 26. Signal Coordination Benefits (progressive)



The effect of the signal coordination projects was to reduce delay by 11 million person hours, approximately one percent of the street delay (Exhibit 27). The percentage is slightly higher in the Large population group where there is less congestion in the severely and extremely congested ranges. This value is combined in the operational effects summary at the end of this section.

While the total effect is relatively modest, the relatively low percentage of implementation should be recognized, as should the relatively low cost and the amount of benefit on any particular road section. The modest effect does not indicate that the treatment should not be implemented—why would a driver wish to encounter a red light if it were not necessary? The estimates do indicate that the benefits are not at the same level as a new travel lane, but neither are the costs or the implementation difficulties or time. It also demonstrates that if there are specific routes that should be favored—due to high bus ridership, an important freight route or parallel route road construction—there may be reasons to ignore the system or intersecting route effects.

- Los Angeles and New York are the Very large areas with the highest benefits.
- Riverside and St. Louis are the Large areas with the most hours of delay benefit from signal coordination in areas between one and three million population.
- Austin, Jacksonville and Omaha in the Medium areas and Colorado Springs in the Small areas lead their population group.

Exhibit 27. Principal Arterial Street Traffic Signal Coordination Delay Reduction Benefits

Population Group	Average Covered Lane-miles		Principal Arterial Hours of Delay (million)
	Lane-miles	Percentage	Reduction
Very Large (13)	2,884	64	6.2
Large (26)	681	50	3.1
Medium (30)	357	57	1.4
Small (16)	174	55	0.2
85 Area Average	808	58	–
85 Area Total	68,678	58	10.9

Source: HPMS, IDAS, and TTI Analysis

Note: This analysis uses nationally consistent data and relatively simplistic estimation procedures. Local or more detailed evaluations should be used where available. These estimates should be considered preliminary pending more extensive review and revision of base inventory information obtained from source databases.

Arterial Street Access Management Programs

Providing smooth traffic flow and reducing collisions are the goal of a variety of individual treatments that make up a statewide or municipal access management program. Typical treatments include consolidating driveways to minimize the disruptions to traffic flow, median turn lanes or turn restrictions, acceleration and deceleration lanes and other approaches to reduce the potential collision and conflict points. Such programs are a combination of design standards, public sector regulations and private sector development actions. The benefits of access management treatments are well documented in National Cooperative Highway Research Program (NCHRP) Report 420 (17).

Delay Reduction Estimates

NCHRP Report 395 analyzed the impacts of going from a TWLTL to a raised median for various access point densities and traffic volumes (18). Tables produced in NCHRP Report 395 were used in the Urban Mobility Report methodology to obtain delay factors for both recurring and incident delay.

There is an increase in recurring delay for through and left-turning traffic when going from a TWLTL to a raised median. This increase is primarily due to the storage limitations of select turn bay locations with the raised median treatments. As the turn bays become full, traffic spills out into the through lanes and increases the delay of through vehicles. This situation worsens with increased congestion levels and increased signal density (17). The percent increase factors shown in Exhibit 29 are applied to the recurring delay on the principal arterial streets to account for this increased delay.

Raised medians can increase roadway safety by reducing the number of conflict points and managing the location of the conflict points. The reduction in conflict points equates to a reduction in crashes. This benefit of the raised medians was included in the methodology. The delay factors were generated for roadways going from a TWLTL to a raised median. Exhibit 30 shows the percent reduction factors that range from 12 percent at low signal density (≤ signals/mile) and the lowest congestion level to 22 percent at high signal density (>3 signals/mile) and the highest congestion level (18). These percent reduction values are applied to the incident delay on the principal arterial streets in the methodology.

All 85 areas reported some level of access management in 2003, with the coverage representing about 38 percent of the street miles in the cities (7,11). The effect of access management was to reduce delay by 46 million person hours, approximately 3 and one-half percent of the principal arterial street delay (Exhibit 31). The percent reduction drops as the size of the urban area gets smaller.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 28. Access Management Recurring Delay Effects

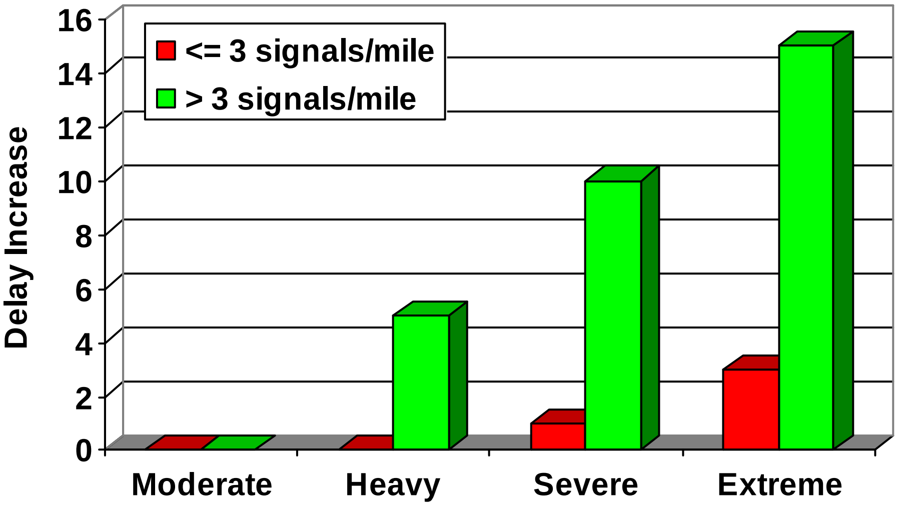
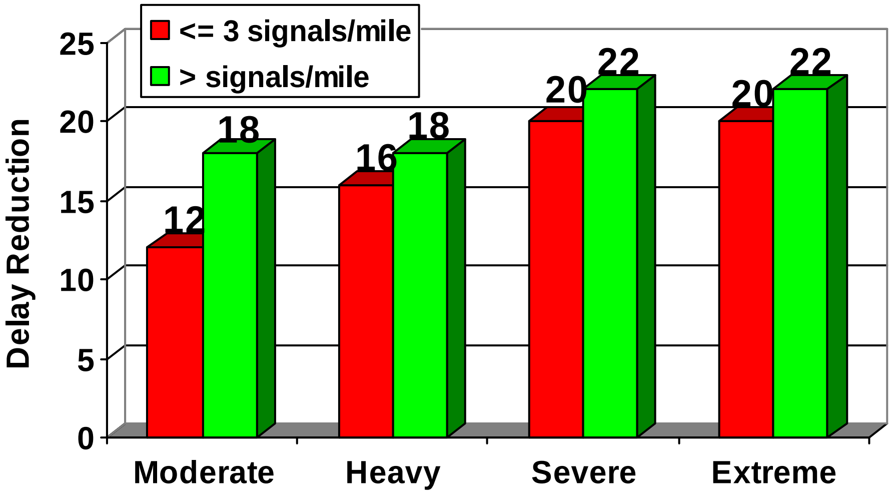


Exhibit 29. Access Management Incident Delay Effects



Source: HPMS and TTI Analysis

Exhibit 30. Principal Arterial Street Access Management Delay Reduction Benefits

Population Group	Average Covered Lane-miles		Principal Arterial Hours of Delay (million)
	Lane-miles	Percentage	Reduction
Very Large (13)	1,983	44	30.3
Large (26)	457	34	12.0
Medium (30)	201	32	3.6
Small (16)	99	31	0.5
85 Area Average	533	38	–
85 Area Total	45,291	38	46.4

Source: HPMS and TTI Analysis

Note: This analysis uses nationally consistent data and relatively simplistic estimation procedures. Local or more detailed evaluations should be used where available. These estimates should be considered preliminary pending more extensive review and revision of base inventory information obtained from source databases.

Combined Effect of Operational Treatments

The delay reduction benefits of four operational treatments analyzed in this edition of the Urban Mobility Report are combined into an estimate of the total effect of the deployed projects in the 85 urban areas. The inventory of all projects is identified in Exhibit 31 by the percentage of miles on freeways and streets that have one of the programs or projects implemented. Exhibit 31 shows the relatively low percentage of not only cities that have some treatments but also the low percentage of roads that have any treatment.

The total effect of the delay reduction programs represents 8.3 percent of the delay in the 85 cities. Again, the value seems low but when the low percentage of implementation is factored in, the benefit estimates are reasonable. The programs are also important in that the benefits are on facilities that have been constructed. The operating improvements represent important efficiencies from significant expenditures that have already been made.

Exhibit 31. Total Operational Improvement Delay Reduction

Operations Treatment	Number of Cities	Percent of System Covered	Delay Reduction Hours (millions)
Ramp Metering	24	33	102
Incident Management	62-64	40-67	177
Signal Coordination	85	58	11
Access Management	85	38	46

Note: This analysis uses nationally consistent data and relatively simplistic estimation procedures. Local or more detailed evaluations should be used where available. These estimates should be considered preliminary pending more extensive review and revision of base inventory information obtained from source databases.

MOBILITY FROM PUBLIC TRANSPORTATION SERVICE AND HIGH-OCCUPANCY VEHICLE FACILITIES

Previous Annual Mobility Reports have included examples of the amount of public transportation improvements needed to address congestion. The next step, initiated in this report, is the inclusion of public transportation service in the general measures and analysis. Buses and trains carry a significant amount of trips in many large areas, and provide some important benefits in smaller areas. Peak period public transportation service during congested hours can improve the transportation capacity, provide options for travel mode and allows those without a vehicle to gain access to jobs, school, medical facilities or other destinations. In the case of public transportation lines that do not intersect roads, the service can be particularly reliable as they are not affected by the collisions and vehicle breakdowns that plague the roadway system, and are not as affected by weather, road work and other unreliability producing events. This section provides an estimate of the benefits of general public transportation service and high-occupancy vehicle lane operations.

Public Transportation Service

The mobility report methodology uses person volume and speed as the two main elements of the measurement analysis. While this is consistent with the goals of public transportation service, there are differences between several aspects of road and transit operations. Regular route bus transit service stops frequently to allow riders to enter and leave the vehicles. Train service in many cases also makes more than one stop per mile. The goal of the service is to provide access to the area near the stops as well as move passengers to other destinations. A useful comparison with road transportation systems, therefore, cannot use the same standards or same comparison methods.

The data sources for this type of analysis are a combination of locally collected and nationally consistent information. The nationally consistent data is available for ridership, passenger miles of travel, service mileage and hours. Consistent roadway data is available for similar statistics, but the relationship between volume and speed on the roadway side is more studied and more easily estimated than for transit service. Some simplifying assumptions, therefore, have been made to initiate the analysis this year. The next few years will see additional investigations of these statistics and the data that might be available with a goal of reducing the number of assumptions that are needed as well as improving the estimates that are made.

The method used in this analysis to estimate a revised Travel Time Index focused on similar expectations. Transit service, while the average speed may be slower, is operated according to a schedule. Riders and potential riders evaluate the service and make mode choices according to either the departure and arrival times or in the case of operations that run very frequently, the travel time to the destination with the expectation that the departure time will be relatively soon after arrival in the station. In transit operations this can be thought of as similar to an uncongested trip. Public transportation service that operates on-time according to the schedule, then, would be classified as uncongested travel.

It may seem odd to disregard travel speed in this sense, but the service differences are important. Attempting to estimate the slower speeds on transit routes and incorporating them into the analysis would, in essence, double penalize the service. Travelers already use the travel times to make their decisions and the longer times are the reason ridership is relatively low during off-peak hours. Transit routes could gain speed by decreasing stops, but at the risk of losing ridership. This relationship between speed and convenience is constantly adjusted by transit agencies seeking to increase transit service and ridership. And this approach to defining a different standard speed for transit routes is similar to the different threshold used for streets and freeways.

The "penalty" or "reward" for public transportation in this revised Travel Time Index estimate comes from gain or loss in ridership. If the route travel times become unreasonably long, ridership will decline, and the amount of "uncongested" passenger-miles contributed by public transportation will also decline. The beneficial effects of faster route times, better access or improved service from interconnected networks or high-speed bus or rail links would result in higher ridership values, which would increase the amount of "uncongested" travel in the mobility measure calculations.

The delay benefits were calculated using the "what if transit riders were in the general traffic flow" case. Additional traffic on already crowded road networks would affect all the other peak period travelers as well. This is an artificial case in the sense that the effects of a transit service shutdown would be much more significant and affect more than just the transit riders or roadway travelers. Public transportation patrons who rely on the service for their basic transportation needs would find travel much more difficult, making jobs, school, medical or other trip destinations much harder to achieve. And the businesses that count on the reliable service and access to consumers and workers that public transportation provides would suffer as well.

Delay Effect Estimate

In the 85 urban areas studied, Exhibit 32 shows that there were approximately 43 billion passenger-miles of travel on public transportation systems in 2003 (14). The annual ridership ranged from about 17 million in the Small urban areas to about 2.7 billion in the Very Large areas. Overall, if these riders were not handled on public transportation systems they would contribute an additional roadway delay of over one billion hours or 29 percent of total delay. Some additional effects include:

- The Very Large areas would experience an increase in delay of about 919 million hours per year (36 percent of total delay). This is the result of the significant public transportation ridership in these areas. Most of the urban areas over 3 million population have extensive rail systems and all have very large bus systems.
- The Large urban areas would experience the second largest increase in delay with 148 million additional hours of delay per year. While the average Large area transit system

carried only 9 percent of the ridership of the Very Large area systems, the delay increase would represent 16 percent of the Very Large group because there are 26 Large areas.

- The New York urban area accounted for over one-third of the delay increase estimated in the report.
- The Los Angeles, Chicago and San Francisco-Oakland systems are each estimated to provide more than 80 million hours of benefit each year.
- The largest benefits in the Large population group are in Baltimore and Seattle.
- Honolulu, Salt Lake City and Austin have the highest delay increase in the Medium group if public transportation service were eliminated.
- Colorado Springs, Spokane and Eugene-Springfield are estimated to have the most delay increase of the Small urban area group. Only 16 cities of that size were studied, however, which should be accounted for if a broad conclusion is required.

Exhibit 32. Delay Increase if Public Transportation Service Were Eliminated – 85 Areas

		Delay Reduction Due to Public Transportation	
Population Group & Number of Areas	**Population Group Average Annual Passenger-Miles of Travel (million)**	**Hours of Delay (million)**	**Percent of Base Delay**
Very Large (13)	2,718	919.2	36.4
Large (26)	233	148.3	17.0
Medium (30)	58	26.5	9.2
Small (16)	17	1.5	4.4
85 Area Total	43,403	1,095.5	29.4

Source: APTA Operating Statistics and TTI Review (14)

Future Improvements to Public Transportation Analysis

A longer-term approach will be to develop links with the system operations databases that some agencies have. These include travel time, speed and passenger volume data automatically collected by transit vehicle monitoring systems. Linking this data with the roadway performance data in public transportation corridors would be the logical extension of the archived roadway data inclusion efforts being funded by the Federal Highway Administration (1). An alternative to the real-time data would be to estimate public transportation vehicle travel time and speed information from route schedules, and combine them with the passenger loading information collected by the public transportation systems. While these data are not reported in nationally consistent formats, most public transportation systems have some of this information; the challenge is to develop comparable datasets.

High-Occupancy Vehicle Lanes

High-occupancy vehicle lanes (also known as diamond lanes, bus and carpool lanes, transitways) provide high-speed travel option to buses and carpools as an incentive to share a vehicle and reduce the number of vehicle trips. The lanes are most used during the peak travel periods when congestion is worst and the time savings compared to the general travel lanes the most significant. In addition to saving time on an average trip, the HOV lanes also provide more reliable service as they are less affected by collisions or vehicle breakdowns.

The HOV lanes provide service similar to freeway mainlanes in that there are relatively few lanes that have stations on the route. The buses on the lanes can either pickup patrons in ways that regular route buses operate before entering the HOV lane, or they can provide service to park-and-ride lot that allow patrons to drive their private vehicle to a parking lot and use a bus to their destination. The high-speed lanes are also open to use by carpools (although there are some bus-only lanes) which provide additional flexibility for use by travelers.

Delay Reduction Estimate

The Urban Mobility Report has not included the mobility provided by HOV lanes in the regular reporting in the past. Because the HOV lanes service is similar to the general freeway operation, the operating statistics can be added to the freeway and street data using the speed and person volume on the lanes. Exhibit 33 is a summary of the effect of HOV lane operations in several urban corridors from the year 2000. While this is only a partial list of HOV projects, it provides a view of the usefulness of the data, as well as an idea of the mobility contribution provided by the facilities. The exhibit includes information about the typical peak period operating conditions (three hours in the morning and evening) on the HOV lane and freeway mainlanes. The statistics from six peak hours of operation may appear to show relatively low effects, but in some corridors the significant benefits may only be for one hour in each peak. Some other aspects of the corridor operations such as the variation in travel time and the effects of park-and-ride service or transit operations are also not fully explored in these statistics.

Most of the mainlane TTI values are above 1.30 (a speed of 45 mph) while only four of the HOV operations exceed that value. Consequently, there are significant differences in the Travel Time Index values for HOV lanes and freeways. The TTI values are averaged by including the number of persons using each facility; those values are shown in the Combined TTI column.

The greatest index point improvements are found for those projects where the peak-period mainlane speeds are very low and the HOV lane usage is relatively high compared to the mainlanes. The relatively fast and reliable speeds (indicated by the lower TTI values) attract riders into the HOV lanes causing the HOV travel time index values to be a larger part of the combined index. Ten of the projects have index point improvements of 20 or more. But many of the other projects are also identified as "good" projects by the residents of those areas and the users of the facilities.

The data for corridors in a city or region can be combined to produce an average "with and without" Travel Time Index. Exhibit 34 illustrates the averages for the six urban areas with several HOV projects. There are more HOV projects in the United States, but the travel time and person volume data needed to incorporate the mobility effects are not consistently available for 2001 through 2003.

Assessing the effect of a few HOV projects on the urban areawide Travel Time Index, however, is not a particularly useful exercise. Any small set of transportation projects will have a relatively small effect on the areawide average mobility statistics in a large urban area. The significance of the improvements is at the corridor level where the difference in travel conditions is focused.

In addition to the two listed facilities, the Minneapolis-St. Paul area has a program that allows buses to use the freeway shoulders to bypass congested traffic. This improves the travel speed and schedule reliability with a relatively inexpensive treatment. The travel time savings are highly variable due to the operating procedures that control the difference in speed between the mainlanes and buses. The routes that use the shoulders had a 9.2 percent ridership increase over a two-year period when the overall system ridership decreased 6.5 percent, illustrating the favorable passenger reaction to improved speed and reliability attributes (15).

Exhibit 33. Mobility Levels in HOV Corridors in 2000

	High-Occupancy Vehicle Lanes		Mainlanes			
Segment[1]	**Passengers**	**TTI**	**Passengers**	**TTI**	**Combined TTI**	**Index Point Improvement[2]**
Washington DC						
I-95 Shirley Hwy	16,600	1.01	19,800	2.17	1.64	53
I-66	9,500	1.31	19,800	2.35	2.01	34
VA267	5,200	1.19	14,000	1.76	1.60	16
I-270	4,400	1.26	13,600	1.87	1.72	15
New York						
Long Island Expwy	15,770	1.00	44,875	1.35	1.24	11
Miami-Dade County						
I-95	3,170	1.40	7,950	1.94	1.79	15
Minneapolis-St. Paul						
I-394	7,120	1.09	14,260	1.20	1.16	4
I-35W	5,170	1.09	12,920	1.20	1.17	3
Houston						
I-10W	9,370	1.03	16,000	1.60	1.39	21
I-45N	8,820	1.09	22,000	1.28	1.22	6
I-45S	5,800	1.09	21,000	1.30	1.25	5
US290	7,045	1.05	18,000	1.38	1.29	9
US59S	8,200	1.18	28,000	1.44	1.38	6
Dallas						
I-30 E	8,040	1.08	23,250	1.60	1.47	13
I-35N	5,270	1.04	17,110	1.75	1.58	17
I-635	5,660	1.03	20,030	1.94	1.74	20
Seattle						
I-5 N of CBD	9,580	1.18	17,960	1.59	1.45	14
I-5 S of CBD	13,440	1.18	24,880	1.53	1.42	11
I-405 N of I-90	6,020	1.26	15,725	1.91	1.73	18
I-405 S of I-90	8,920	1.13	11,230	1.91	1.56	35
I-90	3,365	1.00	15,010	1.25	1.20	5
SR 167	4,250	1.05	9,035	1.69	1.48	21
SR 520	2,725	1.00	8,180	1.30	1.23	7
Los Angeles County						
I-10	6,100	1.15	9,060	2.78	2.12	66
SR 91	3,350	1.25	7,385	2.33	1.99	34
I-110	6,625	1.23	8,100	2.56	1.96	60
I-210	3,440	1.32	8,750	1.96	1.78	18
I-405	3,430	1.51	7,390	2.34	2.08	26

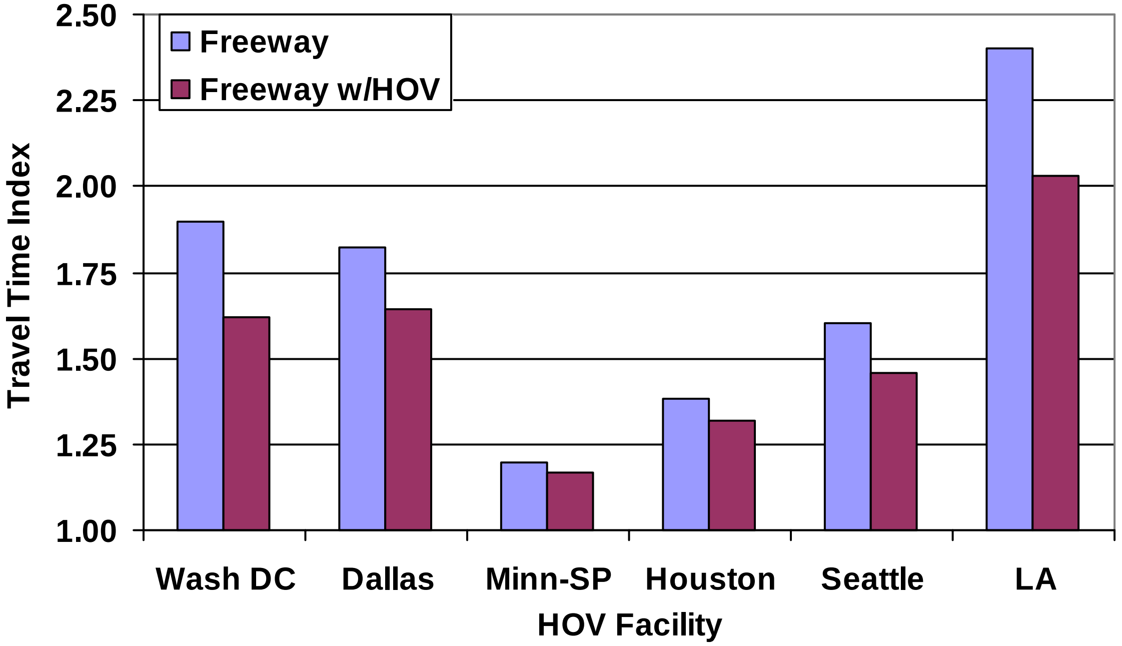
[1] Not all U.S. HOV areas are shown due to data availability problems.

[2] Mainlane TTI minus Combined TTI.

Note: Speeds in excess of 60 miles per hour were entered as 60. That speed is considered the freeflow speed for this analysis.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 34. Effects of HOV Lanes in Freeway Corridors in 2000



COMBINED EFFECT OF PUBLIC TRANSPORTATION AND OPERATIONAL IMPROVEMENTS

The analytical improvements initiated in this year's Annual Mobility Report will be refined over the next few years under a project supervised by the National Cooperative Research Program (NCHRP), a component of the Transportation Research Board. The values and approach may change, but the estimates included in this year's report represent an important first step in including all the types of transportation improvements in a comprehensive areawide mobility assessment. The use of the information may also encourage local and state transportation officials to develop their own databases and procedures to maximize the flexibility and inclusiveness of corridor and sub-regional evaluations, as some agencies are doing now.

The expanded version of the methodology used in this report is available on the website (http://mobility.tamu.edu/ums). The summary statistics at the population group level for 2003 are illustrated in Exhibit 35. Most of the delay in the 85 urban areas is in the 13 areas with populations above three million, so it should not be surprising that the majority of the operational treatment benefits are in those areas as well. Large areas not only have had large problems for longer, and thus more incentive to pursue a range of solutions, but the expertise needed to plan and implement innovative or complex programs are also more likely to be readily accessible.

Several of the areas with populations between one million and three million also have significant contributions from four or five of the six treatments identified in the report. Some of the delay reduction estimates are as large or larger than the above three million population areas. The medium group areas have relatively small overall contributions due to the low congestion level, but they are also implementing and refining techniques that will be more valuable as congestion grows.

The Travel Time Index change from the base value to the "inclusive" value follows the same pattern as the delay reduction—much more change in the Very Large group than in the others. The TTI values are presented with three decimal places to better illustrate the amount of change. The amount of change should be gauged against the base TTI value—small areas with less congestion that have implemented more operational treatments or a more extensive transit system may have larger changes as a percentage of the base value than larger areas that have not used these options.

Several other observations about this initial attempt to include a broader set of mobility treatments in the regular mobility data reporting are listed below.

- The significant investment in operations treatments in states that are widely judged to be among the leaders in these technologies is evident. California, Minnesota, Illinois, Arizona, Oregon and Washington have relatively large delay reductions, in several case for cities outside the "most congested" list.

- The delay reduction estimate for public transportation service and HOV lanes should be considered as "delay avoided" because the calculation involves comparing current operations to conditions that might exist if the service were not in operation.

- Almost three-fourths of delay reduction from incident management and ramp meters is in the Very Large group. Less than half of the signal coordination delay, however, is in that group, illustrating the more extensive deployment of that technique.

- Although the percentage of "treated" streets and freeways is relatively low, the combined effects are equal to several years of growth in the Very Large group, and one or two years in the Large and some of the Medium group cities.

Exhibit 35. Summary of Public Transportation and Operational Improvement Delay Reduction Effects - 2003

	Population Group – Annual Hours Saved (million)				
	Very Large	**Large**	**Medium**	**Small**	**All 85**
Number of Cities	13	26	30	16	85
Delay Reduction from					
Ramp Metering	82.0	19.9	0.3	0.0	102.1
Incident Management	136.6	31.6	8.6	0.2	177.0
Signal Coordination	6.2	3.1	1.4	0.2	10.9
Access Management	30.3	12.0	3.6	0.5	46.4
Delay Savings from					
High-Occupancy Vehicles	10.7	1.3	0.0	0.0	12.0
Public Transportation	919.2	148.3	26.5	1.5	1,095.5
Travel Time Index					
With operational treatments	1.48	1.28	1.18	1.10	1.37
With operational and public transportation	1.46	1.29	1.18	1.11	1.36
Without treatments	1.52	1.30	1.19	1.11	1.40

Communicating Mobility and Reliability Issues

The transportation profession is adopting a distinction between mobility—the ease of getting to a destination—and reliability—the predictability of travel times for usual trips. Travelers, elected leaders, the media and decision-makers may question the relevance of this distinction since problems with both elements cause increases in travel times and costs. The two concepts are clearly related, but the difference is useful when discussing solutions. Most of the computerized simulation and planning tools are not equipped to fully handle this issue, and so a significant amount of the data on congestion relates to the average of fairly good conditions—midweek day, clear weather and pavement, no collisions or lane-blocking roadwork, etc.—rather than the conditions that travelers and shippers must allow for to arrive on-time for important trips.

There are some strategies that focus on improving "mobility"—improving travel time—by adding capacity, improving the operational efficiency or managing demand in such way as to reduce the peak load. But there are also transportation improvements that reduce average travel time by reducing the amount of irregular problems or the influence of them on travel time. Incident management is the most obvious of these, but others such as providing bus or road routing information, improving interagency or interjurisdictional cooperation and communication and partnerships with private companies can pay huge benefits in reduction of incident clearance times and travel time variations.

The ability to predict travel times is highly valued by travelers and businesses. It affects the starting time and route used by travelers on a day-to-day basis, and the decisions about travel mode for typical trips and for day-to-day variations in decisions. Reliability problems can be traced to seven sources of travel time variation in both road and transit operations. Some are more easily addressed than others and some, such as weather problems, might be addressed by communicating information, rather than by agency design or operations actions.

- Incidents—collisions and vehicle breakdowns causing lane blockages and driver distractions.

- Work Zones—construction and maintenance activity that can cause added travel time in locations and times where congestion is not normally present.

- Weather—reduced visibility, road surface problems and uncertain waiting conditions result in extra travel time and altered trip patterns.

- Demand Changes—traffic volume varies from hour-to-hour and day-to-day and this causes travel time, crowding and congestion patterns to disappear or to significantly worsen for no apparent reason in some locations.

- Special Events—an identifiable case of demand changes where the volume and pattern of the change can frequently be predicted or anticipated.

- Traffic Control Devices—poorly timed of inoperable traffic signals, drawbridges, railroad grade crossing signals or traveler information systems contribute to irregularities in travel time.

- Inadequate Road or Transit Capacity—actually the interaction of capacity problems with the other six sources causes travel time to expand much faster than demand.

The profession is only at the start of understanding the precise mechanisms by which these sources contribute to congestion problems. Both public and private sectors undoubtedly see a cost from unreliable travel times, but those values can be very different for many situations. It is clear that there are several strategies to reduce the problem. There are construction, operations, management, operational practices, education and information components to these strategies. As more research is performed, there will be more detail about the effectiveness of the solutions as well as an idea of how much of the problem has a "solution." If drivers insist on slowing down to look at a collision on the other direction, incident management techniques will be less effective. If road construction zones are allowed to close busy rural roads, there will be problems during holiday travel. There will always be trade-offs between operational efficiencies and the costs necessary to obtain them.

Measuring Reliability

If travelers assume each trip will take the average travel time, they will be late for half of their trips. It has not been determined what level of certainty should be used for trip planning purposes, but it seems reasonable to start with an assumption that a supervisor might allow an employee to be late one day per month. This translates into a need to be on time for approximately 19 out of 20 days, or 95 percent of the time.

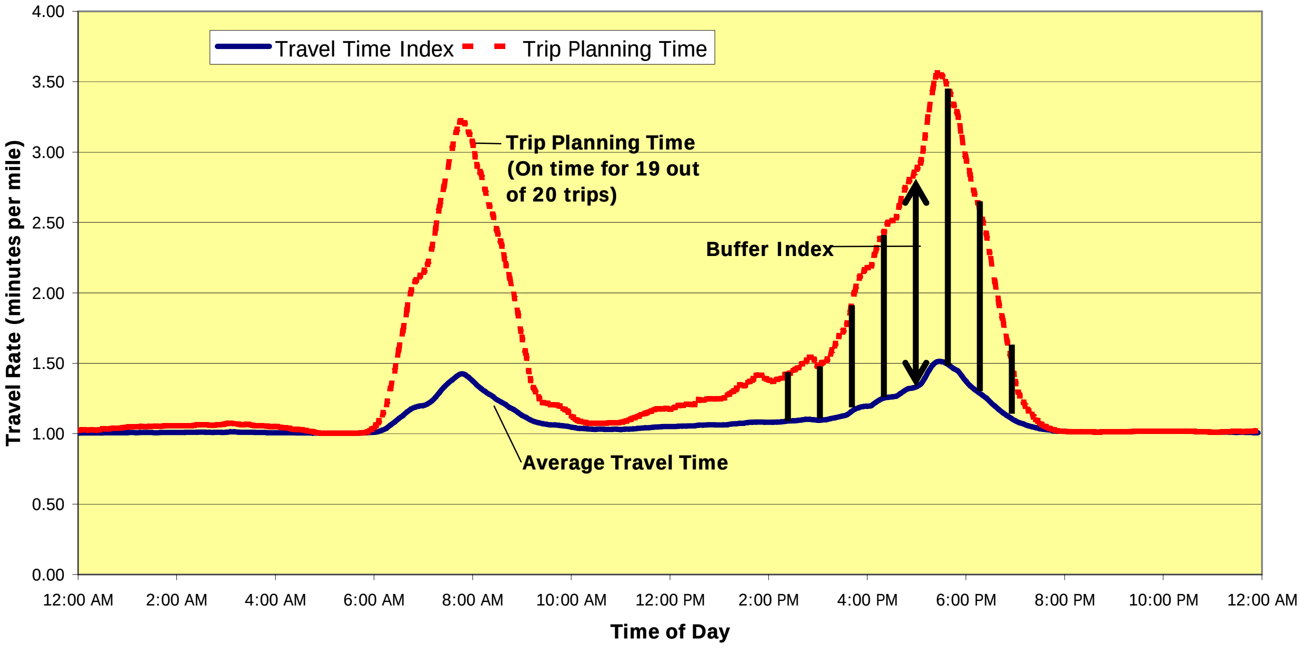
The difference between the average conditions and the 95th percentile conditions is the extra time that has to be budgeted, an illustration of the Buffer Time Index measure (Equation 1). In the middle of the peak in most cities studied in the Mobility Monitoring Program, the sources of travel time variation are more significant than in the midday.

$$\begin{array}{c}\text{Buffer}\\ \text{Time}\\ \text{Index (BTI)}\end{array} = \frac{\begin{array}{c}\text{95th percentile travel rate} - \text{Average travel rate}\\ \text{(in minutes per mile)} \qquad\quad \text{(in minutes per mile)}\end{array}}{\begin{array}{c}\text{Average travel rate}\\ \text{(in minutes per mile)}\end{array}} \times 100\% \qquad \text{Equation 1}$$

What does all this mean? If you are a commuter who travels between about 7:00 a.m. and 9:00 a.m., Exhibit 36 indicates your trip takes an average of about 30 percent longer (that is, the TTI value is 1.3) than in the off peak. A 20-mile, 20-minute trip in the off-peak would take an average of 26 minutes in a typical home-to-work trip. The Buffer Time Index during this time is between 50 and 100 percent resulting in a Trip Planning Time of 2.1 minutes per mile. So if your boss wants you to begin work on time 95 percent of the days, you should plan on 42 minutes of travel time (20 miles times an average of 2.1 minutes per mile of trip for the peak period). But, to arrive by 8:00 a.m., you might have to leave your home around 7:00 a.m. because the system is even less reliable in the period between 7:30 a.m. and 8:00 a.m.

CAUTION: See http://mobility.tamu.edu/ums for improved performance measures and updated data.

Exhibit 36. Houston Freeway System Average Time and Trip Planning Travel Times

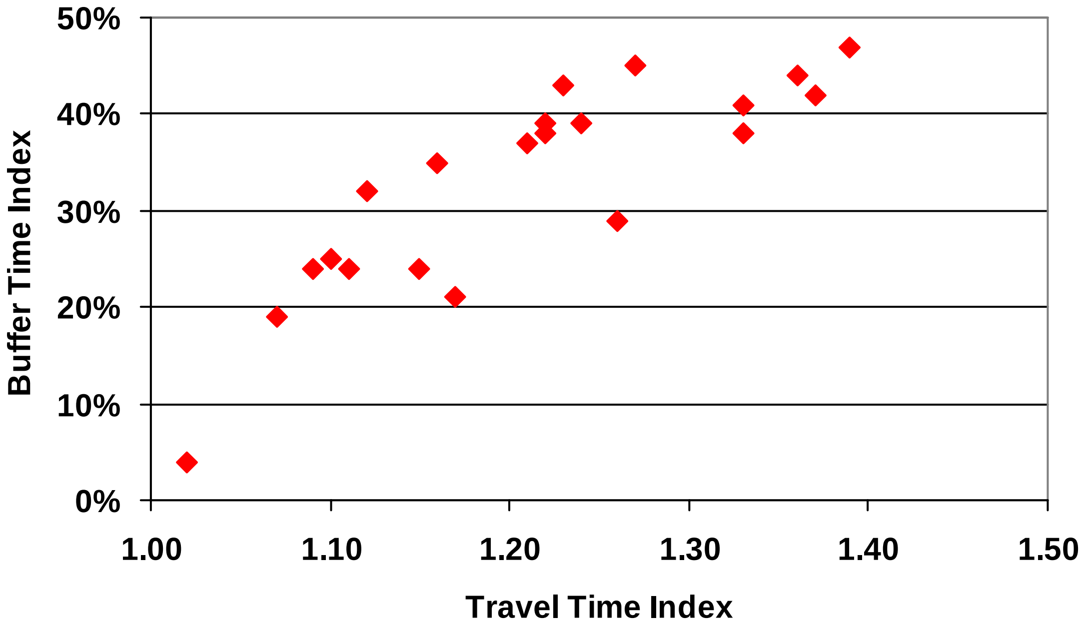


The mobility measure, the Travel Time Index, can be thought of as the time penalty for traveling in the peak period. The reliability measure, the Buffer Time Index, describes how much more time above the average should be budgeted to make an on-time trip. Reliability problems can be caused by simple variations in demand, as well as by vehicle crashes or breakdowns, weather, special events, construction, maintenance and other regular and irregular events. It can present difficulties for commuters and off-peak travelers, and for individuals and businesses (8).

With both of these measures one can tell how congested a transportation system is and how much variation there is in the congestion. This is particularly important when evaluating the wide range of improvement types that are being implemented. Traditional roadway and transit line construction and some operating improvements such as traffic signal system enhancements are oriented toward the typical, daily congestion levels. Others, such as crash and vehicle breakdown detection and removal programs, address the reliability issue. Most projects, programs and strategies have some benefits for each aspect of urban transportation problems.

Exhibit 37 indicates that there is a general consistency between mobility and reliability measures. That is, at the urban area level, places that are congested are also relatively unreliable. The data are for some freeways in a few cities selected because their archived databases were relatively complete and readily accessible for year 2001 data. The statistics developed from this database should not be used to compare systems or cities to each other. But, the data are used in the next section to analyze some aspects of reliability. Future reports will explore the subject in greater depth. For more information about the reliability database, see: http://mobility.tamu.edu/mmp.

Exhibit 37. Mobility and Reliability



HOW SHOULD WE ADDRESS THE MOBILITY PROBLEM?

Just as congestion has a number of potential causes, there are several ways to address the problem. Generally, the approaches can be grouped under four main strategies – adding capacity, increasing the efficiency of the existing system, better management of construction and maintenance projects, and managing the demand. The benefits associated with these improvements include reduced delay, and more predictable and lower trip times. Emissions may be reduced due to the reduction in demand or congestion, improved efficiencies and the change in the way travelers use the system. The locations of congestion may also move over time due to the new development that occurs or is encouraged by the new transportation facilities.

More Travel Options

While not a specific improvement, providing more options for how a trip is made, the time of travel and the way that transportation service is paid for may be a useful mobility improvement framework for urban areas. For many trips and in many cities, the alternatives for a peak period trip are to travel earlier or later, avoid the trip or travel in congestion. Given the range of choices that Americans enjoy in many other aspects of daily life, these are relatively few and not entirely satisfying options.

The Internet has facilitated electronic "trips." There are a variety of time-shift methods that involve relationships between communication and transportation. Using a computer or phone to work at home for a day, or just one or two hours, can reduce the peak system demand levels without dramatically altering lifestyles.

Using information and pricing options can improve the usefulness of road space as well as offering a service that some residents find very valuable. People who are late for a meeting, a family gathering or other important event could use a priced lane to show that importance on a few or many occasions – a choice that does not exist for most trips.

The diversity of transportation needs is not matched by the number of travel alternatives. The private auto offers flexibility in time of travel, route and comfort level. Transit can offer some advantages in avoiding congestion or unreliable travel conditions. But many of the mobility improvements below can be part of creating a broader set of options.

Add Capacity

Adding capacity is the best known, and probably most frequently used, improvement option. Pursuing an "add capacity" strategy can mean more traffic lanes, additional buses or new bus routes, new roadways or improved design components as well as a number of other options. Grade separations and better roadway intersection design, along with managed lanes and dedicated bus and carpool priority lanes, can also contribute to moving more traffic through a given spot in the same or less time. The addition of, or improvements to heavy rail, commuter rail, bus system, and improvement in the freight rail system all can assist in adding capacity to varying degrees. In growing areas, adding capacity of all types is essential to handle the growing demand and avoid rapidly rising congestion.

Manage the Demand

Demand management strategies include a variety of methods to move trips away from the peak travel periods. These are either a function of making it easier to combine trips via ridesharing or transit use, or providing methods to reduce vehicle trips via tele-travel or different development designs.

The fact is, transportation system demand and land use patterns are linked and influence each other. There is a variety of strategies that can be implemented to either change the way that travelers affect the system or the approaches used to plan and design the shops, offices, homes, schools, medical facilities and other land uses.

Relatively few neighborhoods, office parks, etc. will be developed for auto-free characteristics—that is not the goal of most of these treatments. The idea is that some characteristics can be incorporated into new developments so that new economic development does not generate the same amount of traffic volume as existing developments. Among the tools that can be employed are better management of arterial street access, incorporating bicycle and pedestrian elements, better parking strategies, assessing transportation impact before a development is approved for construction, and encouraging more diverse development patterns. These changes are not a congestion panacea, but they are part of a package of techniques that are being used to address "quality-of-life" concerns—congestion being only one of many.

Increase Efficiency of the System

Sometimes, the more traditional approach of simply adding more capacity is not possible or not desirable. However, improvements can still be made by increasing the efficiency of the existing system. These treatments are particularly effective in three ways. They are relatively low cost and high benefit which is efficient from a funding perspective. They can usually be implemented quickly and can be tailored to individual situations making them more useful because they are flexible. They are usually a distinct, visible change; it is obvious that the operating agencies are reacting to the situation and attempting improvements.

In many cases, the operations improvements also represent a "stretching" of the system to the point where the margin of error is relatively low. It is important to capitalize on the potential efficiencies – no one wants to sit through more traffic signal cycles or behind a disabled vehicle if it is not necessary – but the efficiency improvements also have limits. The basic transportation system—the roads, transit vehicles and facilities, sidewalks and more—is designed to accommodate a certain amount of use. Some locations, however, present bottlenecks, or constraints, to smooth flow. At other times, high volume congests the entire system, so strategies to improve system efficiency by improving peak hour mobility are in order. The community and travelers can benefit from reduced congestion and reduced emissions, as well as more efficiently utilizing the infrastructure already in place.

Among the strategies that fall into this category are tools that make improvements in intersections, traffic signals, freeway entrance ramps, special event management (e.g., managing traffic before and after large sporting or entertainment events) and incident management. In addition such strategies as one-way streets, electronic toll collection systems, and changeable lane assignments are often helpful.

Freeway entrance ramp metering (i.e., traffic signals that regulate the traffic flow entering the freeway) and incident management (i.e., finding and removing stalled or crashed vehicles) are two operations treatments highlighted in this report. When properly implemented, monitored and aggressively managed, they can decrease the average travel time and significantly improve the predictability of transportation service. Both can decrease vehicle crashes by smoothing traffic flow and reducing unexpected stop-and-go conditions. Both treatments can also enhance conditions for both private vehicles and transit.

Manage Construction and Maintenance Projects

When construction takes place to provide more lanes, new roadways, or improved intersections, or during maintenance of the existing road system, the effort to improve mobility can itself cause congestion. Better techniques in managing construction and maintenance programs can make a difference. Some of the strategies involve methods to improve the construction phase by shortening duration of construction, or moving the construction to periods where traffic volume is relatively low. Among the strategies that might be considered include providing contractor incentives for completing work ahead of schedule or penalties for missed construction milestones, adjustments in the contract working day, using design-build strategies, or maintenance of traffic strategies during construction to minimize delays.

Role of Pricing

Urban travelers pay for congestion by sitting in traffic or on crowded transit vehicles. Anthony Downs (16), among many, has suggested this is the price that Americans are willing to pay for the benefits that they derive from the land development and activity arrangements that cause the congestion. But for most Americans there is no mechanism that allows them to show that they place a higher value on certain trips. Finding a way to incorporate a pricing mechanism into some travel corridors could provide an important option for urban residents and freight shippers.

A fee has been charged on some transportation projects for a long time. Toll highways and transit routes are two familiar examples. An extension of this concept would treat transportation services like most other aspects of society. There would be a direct charge for using more important system elements. Price is used to regulate the use and demand patterns of telephones, movie seats, electricity, food and many other elements of the economy. In addition to direct charges, transportation facilities and operations are typically paid for by per-gallon fees, sales taxes or property taxes. One could also include the extra time spent in congestion as another way to pay for transportation.

Electronic tolling methods provide a way for travelers to pay for their travel without being penalized by stopping to pay a fee. Electronics can also be used to reduce the fee for travelers in certain social programs (e.g., welfare to work) or to vary the fee by time of day or congestion level. Implementing these special lanes as an addition to roads (rather than converting existing lanes) has been the most common method of instituting pricing options in a corridor. This offers a choice of a premium service for a fee, or lower speed, less reliable travel with no additional fee.

Importance of Evaluating Transportation Systems

Providing the public and decision-makers with a sufficient amount of understandable information can help "make the case" for transportation. Part of the implementation and operation of transportation projects and programs should be a commitment to collecting evaluation data. These statistics not only improve the effectiveness of individual projects, but they also provide the comparative data needed to balance transportation needs and opportunities with other societal imperatives whether those are other infrastructure assets or other programs.

HOW SHOULD THE MEASURES AND RANKINGS WITH THE IMPROVEMENTS STRATEGIES BE INTERPRETED?

Most of the measures presented in the report address roadway systems. While the problems and solutions are not solely focused on roads, much of the data that are available relate to roads and vehicle travel. This year's report also includes operational improvement information and public transportation data at an areawide level. While this expands the scope of the data and measures, the effect of these strategies is often at a corridor or activity center area level where they are applied. So, while the road statistics may provide a picture of urban mobility levels, the addition of the public transportation data and operational treatment effects improve the usefulness of the comparisons.

On the "solution" side of the measures, the current database and methodology include roadway lanes, public transportation and traffic volumes for the database years, and statistics on a few operational improvements for 2000 through 2003. Most larger urban areas are expanding their use of these improvements and are also increasing the data and evaluation studies. The methodologies and more detailed description of estimating the mobility effect of the operational solutions and public transportation service is also investigated in a separate report also on the Mobility Report website.

The estimates are not a replacement, a substitute or a better method of evaluating these strategies at the corridor or project level. The estimates included in this report are a way to understand the comparative mobility contributions of various strategies using a consistent methodology.

Another key manifestation of uncertainty is the ranking of the measures. Estimating the measures creates one set of variations—the "real" measure could be higher or lower—and the relatively close spacing of the measures mean that the rankings should be considered as an indication of the range within which the true measure lies. There are many instances where one or two hours of delay or one or two index points could move an urban area several ranking spots.

Rankings, whether with or without the operational improvements or public transportation service, should be examined by comparing the values for cities with similar population, density, geography or other key elements. The rankings of values with strategies are available for only the most recent year, and the performance measures are presented for mobility levels with and without the strategy contributions.

THE BIG PICTURE

There are many statistics in the Annual Mobility Study that can be applied to the search for solutions to mobility problems. It is very important, however, that the role of transportation in American cities be understood as one of many elements that determine the concept of "quality of life." Road congestion is slow speeds caused by heavy traffic and/or narrow roadways due to construction, incidents, or too few lanes for the demand. It has corollaries in transit, sidewalks and the Internet. Over the last 20 years, traffic volumes have increased faster than road capacity. Alternative modes, new technologies, innovative land-use patterns, demand management techniques and operating treatments have not provided the needed relief either because they are not extensive enough, or they are not used for enough trips.

Urban residents trade off a variety of factors and cost elements in the search for the best situation. Transportation professionals, as well as developers, land planners, government officials, and others, are realizing that these trade-offs are made across a spectrum that might best be represented as several niche markets, rather than one or two large ones. Schools, shops, jobs, parking, health care and many other issues "compete" in some sense with transportation issues for attention and investment.

Some general conclusions can be drawn from the 1982 to 2003 database.

1. **There is some good news—**The urban road and transit systems have handled a lot more travel. Congestion time penalties are three to four times greater than in 1982, but almost double the amount of travel has been accommodated.

2. **We are not doing enough**—There aren't enough improvements to the system to keep congestion from growing. Hours of delay, the time of day and the miles of road that are congested have grown every year.

3. **Roads are part of the solution.** Areas that have added roads have seen congestion levels grow more slowly than other cities. More than 90 percent of urban peak-period person travel is on roads, and a significant amount of freight moves on roads.

4. **But, roads cannot be the only solution in most cities.** It will be difficult for most big cities to address their mobility needs by only constructing more roads. This is partly a funding issue—transportation spending should probably double in larger cities if there is an interest in reducing congestion. In some corridors or some activity centers, the additional transportation needed is for walk, bike, and public transportation modes that are more consistent with the nearby developments. It is also; however, an issue of project approval. Many Americans do not want major transportation projects near their home or neighborhood. It is difficult to imagine many urban street and freeway corridors with an extra 4, 6 or 8 lanes, but it may be required if the goal is to significantly reduce congestion by adding roads.

5. **Transit improvements, better traffic signal operations, aggressive incident management programs, adjusted work hours, telecommuting and a range of other efficiency options are absolutely vital components of an overall solution.** Individually they do not seem to offer the promise of large increases in person carrying capacity for the current system. But their cumulative effects can be a substantial improvement and may represent feasible strategies in areas where no other solutions are viable. The effect of some of these treatments was included in the Annual Mobility Report for the first time this year.

6. **Policy options, including value pricing, peak-travel restrictions, education programs, innovative mortgage arrangements, and a variety of other strategies not evaluated in this report present opportunities for improving transportation**. Some of these are difficult to get approved in the political and/or public approval stages. They require some changes in the way transportation services are viewed and some changes in the way we live and travel. But for some travel markets in some areas, they may provide the right combination of service and price.

7. **Reliability in transportation service is emerging as an important issue.** The Annual Mobility Report database will be expanded in the future to include estimates and directly collected data about the variations in travel time, as well as the averages.

Some of the solution lies in better management—improving on practices that are already known and utilized and developing new expertise. In the 1950s and 1960s, state highway agencies managed the construction of a large highway system. In the 1970s transportation agencies tried to improve the system by managing the supply, and in the 1980s a variety of transportation and planning agencies and private sector companies started to manage the demand patterns. In the 1990s, the management effort was focused on better system operations for roads and transit.

- Most large city transportation agencies are pursuing all of these traditional projects and programs. The mix may be different in each city and the pace of implementation varies according to overall funding, commitment, location of problems, public support and other factors. It seems that these same agencies could also provide some information about the expected outcome of the transportation system improvements. Big city residents should expect congestion on roads for 1 or 2 hours in the morning and in the evening. The agencies should be able to improve the performance and reliability of the service at other hours and they may be able to slow the growth of congestion, but they cannot expand the system or improve the operation enough to eliminate congestion.

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