

Performance Measure Summary

There are several inventory and performance measures listed in the pages of this Urban Area Report for the years from 1982 to 2005. There is no single performance measure that experts agree “says it all.” The best comparison of congestion levels and trends is done between regions of similar size, over several years, and with a few measures of congestion aspects. Examining a few measures over many years reduces the chance that data variations or the estimating procedures may have caused a “spike” in any single year. A few key points should be recognized by users of the Urban Mobility Report data.

Use the Trends – The multi-year performance measures are better indicators, in most cases, than any single year. (*5 years is 5 times better than 1 year*).

Use several measures – Each performance measure illustrates a different element of congestion. (*The view is more interesting from the top of a few measures*).

Compare to similar regions – Congestion analyses that compare areas with similar characteristics (for example population, growth rate, road and public transportation system design) are usually more insightful than comparisons of different regions. (*Los Angeles is not Peoria*).

Compare ranking changes and performance measure values – In some performance measures a small change in the value may cause a significant change in rank from one year to the next. This is the case when there are several regions with nearly the same value. (*15 hours is only 1 hour more than 14 hours*).

Consider the scope of improvement options – Any improvement project in a corridor within most of the regions will only have a modest effect on the regional congestion level. (*To have an effect on areawide congestion, there must be significant change in the system or service*).

Comparison of Several Key Mobility Performance Measures Medium Group – 500,000 to 1 million population urban areas

Urban Area	Delay per Traveler	Travel Time Index	Total Delay	1982 to 2005	
				Delay per Traveler	Total Delay
Jacksonville, FL	H+	H+	H+	F	F+
Nashville-Davidson, TN	H+	0	H+	0	F+
Salt Lake City, UT	0	H	H	0	F+
Raleigh-Durham, NC	H+	H	H+	F+	F+
Richmond, VA	L-	L-	0	S-	S
Louisville, KY-IN	H+	H+	H+	F+	F+
Hartford, CT	L-	L-	L	S	S-
Bridgeport-Stamford, CT-NY	H	H+	H+	F	F+
Charlotte, NC-SC	H+	H+	H+	F+	F+
Austin, TX	H+	H+	H+	F+	F+
Oklahoma City, OK	L-	L-	L	S	S-
Tulsa, OK	L-	L-	L	S-	S-
Tucson, AZ	H+	H+	H+	0	F+
Dayton, OH	L-	L-	L-	S-	S-
Honolulu, HI	L	H+	L	S-	S-
Birmingham, AL	H+	0	H	F+	F+
El Paso, TX-NM	L	0	L	F	S-
Rochester, NY	L-	L-	L-	S-	S-
Springfield, MA-CT	L-	L-	L-	S-	S-
Omaha, NE-IA	L	0	L	0	S-
Sarasota-Bradenton, FL	L	H	L	S-	S-
Allentown-Bethlehem, PA-NJ	L-	L	L-	S-	S-
Akron, OH	L-	L-	L-	S-	S-
Fresno, CA	L-	L	L-	S-	S-
Grand Rapids, MI	L	L-	L-	0	S-
Oxnard-Ventura, CA	H+	H+	0	F+	F+
Albuquerque, NM	H+	0	0	F	S
New Haven, CT	L-	L-	L-	S-	S-
Albany-Schenectady, NY	L-	L-	L-	S-	S-
Toledo, OH-MI	L-	L-	L-	S-	S-

0 – Average congestion levels or average congestion growth

H Higher congestion; H+ Much higher congestion; F Faster congestion growth; F+ Much faster growth

L Lower congestion; L- Much lower congestion; S Slower congestion growth; S- Much slower growth

Performance Measures and Definition of Terms

Travel Time Index – A measure of congestion that focuses on each trip and each mile of travel. The ratio of travel time in the peak period to travel time in free-flow. A value of 1.30 indicates a 20-minute free-flow trip takes 26 minutes in the peak.

Peak Travelers – Number of travelers (using any travel mode) who begin a trip during the morning or evening peak travel periods (6 to 9 a.m. and 4 to 7 p.m.).

Annual Delay per Traveler – A yearly sum of all the per-trip delays. This measure illustrates the effect of the per-mile congestion as well as the length of each trip. The extra time required to travel in the peak period is 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.).

Total Delay – The overall size of the congestion problem. Measured by the total travel time above that needed to complete a trip at free-flow speeds. The ranking of total delay usually follows the population ranking (larger regions usually have more delay).

Free-Flow Speeds (60 mph on freeways and 35 mph on arterials) – These values are used as the national comparison thresholds. Other speed values may be appropriate for urban areas or sub-regions.

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

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

Operations Treatments – Freeway incident management, freeway ramp metering, arterial street signal coordination and arterial street access management.

Congestion Cost – Value of travel delay for 2005 (estimated at \$14.60 per hour of person travel and \$77.10 per hour of truck time) and excess fuel consumption (estimated using state average cost per gallon).

Annual Increase Needed to Maintain Constant Congestion Level – Number of lane-miles that must be added to the road system each year – or – the number of new transit riders or carpoolers that must be added to keep congestion levels the same as the previous year.

Urban Area – The developed area (population density more than 1,000 persons per square mile) within a metropolitan region. The urban area boundaries change frequently (every year for most growing areas). The annual change in miles traveled, therefore, includes both new travel due to growth and travel that previously occurred in areas designated as rural.

Number of Rush Hours – Time when system might have congestion

Key Mobility Performance Measure Labels

Note: Designation of an urban area congestion problem as “Much higher”, “Much faster growth”, etc. is determined using a general indicator of the accuracy of the congestion estimates. For regions with the same indicator label, there may be no difference in congestion levels. Different values are used for the indicators in regions over 1 million population and below 1 million population.

Measures	Differences Within These Values May Not Indicate a Difference in Congestion Level	
	Above 1M Population	Below 1M Population
2005 Values Delay per Traveler - Travel Time Index - Total Delay -	5 Hours 5 Index Points 5 Hours x Average Population	3 Hours 3 Index Points 3 Hours x Average Population
1982 to 2005 Trends Delay per Traveler - Total Delay -	5 Hours 5 Hours x Average Population	3 Hours 3 Hours x Average Population

The Mobility Data for Richmond, VA

Inventory Measures	2005	2004	2003	2002	2001	2000
Urban Area Information						
Population (1000s)	920	920	915	870	830	790
Rank	44	43	43	45	45	48
Urban Area (square miles)	695	690	685	600	550	500
Popn Density (persons/sq mile)	1,324	1,333	1,336	1,450	1,509	1,580
Peak Travelers (1000s)	500	497	491	462	435	408
Freeway						
Daily Vehicle-Miles of Travel (1000s)	11,680	11,510	10,830	9,965	9,425	9,290
Lane Miles	1,045	1,035	990	960	940	920
Arterial Streets						
Daily Vehicle-Miles of Travel (1000s)	9,760	9,730	9,895	9,350	8,840	8,335
Lane Miles	2,200	2,200	2,190	2,030	1,900	1,830
Public Transportation						
Annual Psgr-Miles of Travel (millions)	47	44	43	54	51	44
Annual Unlinked Psgr Trips (millions)	13	12	13	14	16	14
Cost Components						
Value of Time (\$/hour)	14.60	14.10	13.75	13.45	13.25	12.85
Commercial Cost (\$/hour)	77.10	74.60	72.65	71.05	69.95	68.00
Fuel Cost (\$/gallon)	2.24	1.85	1.46	1.32	1.47	1.49
System Performance						
Congested Travel (% of peak VMT)	28	28	26	23	24	23
Congested System (% of lane-miles)	30	30	28	27	30	30
Congested Time (number of "Rush Hours")	4.0	4.0	4.0	3.6	3.4	3.4
Annual Increase Needed To Maintain Constant Congestion Level:						
Lane-Miles	130	148	140	103	75	78
Transit Riders or Carpoolers (millions)	30	34	32	23	17	17
Annual Excess Fuel Consumed						
Total Fuel (1000 gallons)	6,388	6,319	5,713	4,952	4,651	4,271
Rank	52	51	52	55	56	58
Fuel per Peak Traveler (gallons)	13	13	12	11	11	10
Rank	59	57	59	63	63	67
Annual Delay						
Total Delay (1000s of person-hours)	10,081	10,017	9,085	8,010	7,387	6,739
Rank	51	50	52	54	56	61
Delay per Peak Traveler (person-hrs)	20	20	18	17	17	16
Rank	56	57	61	66	65	68
Delay due to Incidents (percent)	59	59	58	58	57	57
Travel Time Index						
Rank	1.09	1.09	1.08	1.08	1.08	1.07
Rank	64	65	72	70	70	73
Congestion Cost						
Total Cost (\$ millions)	181	172	150	129	117	104
Rank	51	50	51	55	56	60
Cost per Peak Traveler (\$)	362	346	305	279	269	255
Rank	58	58	63	66	67	66

Note: System Performance statistics for 2000 through 2005 data reflect the effects of operational treatments.

Note: Zeroes in the table reflect values less than 0.5.

The Mobility Data for Richmond, VA, Continued

Inventory Measures	1999	1998	1997	1996	1995	1994
Urban Area Information						
Population (1000s)	755	740	730	720	715	705
Rank	48	47	47	47	47	47
Urban Area (square miles)	485	485	480	480	475	475
Popn Density (persons/sq mile)	1,557	1,526	1,521	1,500	1,505	1,484
Peak Travelers (1000s)	386	374	364	354	347	338
Freeway						
Daily Vehicle-Miles of Travel (1000s)	8,960	9,175	9,270	9,315	9,020	8,315
Lane Miles	910	890	840	790	740	700
Arterial Streets						
Daily Vehicle-Miles of Travel (1000s)	8,025	7,540	7,030	6,715	6,320	6,015
Lane Miles	1,775	1,715	1,655	1,600	1,520	1,465
Public Transportation						
Annual Psgr-Miles of Travel (millions)	41	39	37	38	36	39
Annual Unlinked Psgr Trips (millions)	14	16	16	17	15	17
Cost Components						
Value of Time (\$/hour)	12.40	12.15	12.00	11.70	11.40	11.05
Commercial Cost (\$/hour)	65.80	64.35	63.40	61.95	60.20	58.50
Fuel Cost (\$/gallon)	1.05	1.02	1.13	1.21	1.15	1.03
System Performance						
Congested Travel (% of peak VMT)	22	24	24	26	26	23
Congested System (% of lane-miles)	30	33	33	32	28	29
Congested Time (number of "Rush Hours")	3.2	3.4	3.8	4.4	4.6	4.4
Annual Increase Needed To Maintain Constant Congestion Level:						
Lane-Miles	92	129	140	155	143	130
Transit Riders or Carpoolers (millions)	20	29	32	36	34	30
Annual Excess Fuel Consumed						
Total Fuel (1000 gallons)	4,498	4,478	4,597	4,998	4,720	3,809
Rank	55	55	53	48	47	49
Fuel per Peak Traveler (gallons)	12	12	13	14	14	11
Rank	63	59	55	48	46	53
Annual Delay						
Total Delay (1000s of person-hours)	7,399	7,249	7,584	8,209	7,590	6,267
Rank	55	55	53	47	47	49
Delay per Peak Traveler (person-hrs)	19	19	21	23	22	19
Rank	62	59	53	45	46	53
Delay due to Incidents (percent)	59	58	58	58	58	57
Travel Time Index						
Rank	71	70	66	59	57	58
Congestion Cost						
Total Cost (\$ millions)	109	104	108	115	103	82
Rank	56	55	53	49	48	51
Cost per Peak Traveler (\$)	282	279	298	324	298	242
Rank	62	59	55	47	49	54

Note: System Performance statistics for 2000 through 2005 data reflect the effects of operational treatments.

Note: Zeroes in the table reflect values less than 0.5.

The Mobility Data for Richmond, VA, Continued

Inventory Measures	1993	1992	1991	1990	1989	1988
Urban Area Information						
Population (1000s)	700	690	685	680	665	650
Rank	47	46	46	46	45	46
Urban Area (square miles)	450	420	400	380	365	355
Popn Density (persons/sq mile)	1,556	1,643	1,713	1,789	1,822	1,831
Peak Travelers (1000s)	332	323	316	310	301	292
Freeway						
Daily Vehicle-Miles of Travel (1000s)	7,500	7,100	6,700	6,300	5,800	5,025
Lane Miles	650	625	610	605	585	570
Arterial Streets						
Daily Vehicle-Miles of Travel (1000s)	5,610	5,300	5,000	4,985	4,905	4,790
Lane Miles	1,710	1,350	1,300	1,295	1,265	1,235
Public Transportation						
Annual Psgr-Miles of Travel (millions)	49	48	48	48	59	60
Annual Unlinked Psgr Trips (millions)	20	23	23	23	26	26
Cost Components						
Value of Time (\$/hour)	10.75	10.50	10.25	10.00	9.25	8.80
Commercial Cost (\$/hour)	57.05	55.40	53.80	51.60	48.95	46.70
Fuel Cost (\$/gallon)	1.07	1.08	1.08	1.06	1.10	1.02
System Performance						
Congested Travel (% of peak VMT)	21	20	19	19	18	18
Congested System (% of lane-miles)	29	27	27	30	31	31
Congested Time (number of "Rush Hours")	3.6	3.8	3.6	3.0	3.0	2.8
Annual Increase Needed To Maintain Constant Congestion Level:						
Lane-Miles	141	114	106	154	149	124
Transit Riders or Carpoolers (millions)	27	25	23	32	30	24
Annual Excess Fuel Consumed						
Total Fuel (1000 gallons)	2,998	2,833	2,389	2,173	2,030	1,783
Rank	54	53	53	53	54	55
Fuel per Peak Traveler (gallons)	9	9	8	7	7	6
Rank	57	56	56	58	55	59
Annual Delay						
Total Delay (1000s of person-hours)	4,856	4,658	3,839	3,490	3,307	2,929
Rank	54	53	55	55	54	54
Delay per Peak Traveler (person-hrs)	15	14	12	11	11	10
Rank	58	55	57	59	57	60
Delay due to Incidents (percent)	56	55	56	55	55	54
Travel Time Index						
Rank	62	59	59	60	58	58
Congestion Cost						
Total Cost (\$ millions)	62	58	47	42	37	31
Rank	54	53	55	55	55	54
Cost per Peak Traveler (\$)	187	179	148	134	122	106
Rank	57	56	58	59	58	61

Note: System Performance statistics for 2000 through 2005 data reflect the effects of operational treatments.

Note: Zeroes in the table reflect values less than 0.5.

The Mobility Data for Richmond, VA, Continued

Inventory Measures	1987	1986	1985	1984	1983	1982
Urban Area Information						
Population (1000s)	635	630	620	615	610	600
Rank	45	45	45	45	46	46
Urban Area (square miles)	340	325	315	300	290	280
Popn Density (persons/sq mile)	1,868	1,938	1,968	2,050	2,103	2,143
Peak Travelers (1000s)	283	278	272	268	264	256
Freeway						
Daily Vehicle-Miles of Travel (1000s)	4,645	4,415	3,520	3,365	3,215	3,000
Lane Miles	550	535	500	470	420	395
Arterial Streets						
Daily Vehicle-Miles of Travel (1000s)	4,720	4,520	4,120	3,900	3,810	3,760
Lane Miles	1,205	1,150	1,100	1,095	1,060	1,005
Public Transportation						
Annual Psgr-Miles of Travel (millions)	60	64	64	62	62	62
Annual Unlinked Psgr Trips (millions)	26	27	26	25	25	25
Cost Components						
Value of Time (\$/hour)	8.50	8.20	8.00	7.75	7.45	7.20
Commercial Cost (\$/hour)	44.85	43.30	42.50	41.05	39.35	38.10
Fuel Cost (\$/gallon)	1.02	0.99	1.30	1.31	1.34	1.41
System Performance						
Congested Travel (% of peak VMT)	16	16	13	13	14	14
Congested System (% of lane-miles)	27	27	22	22	23	23
Congested Time (number of "Rush Hours")	2.7	2.7	2.5	2.5	2.5	2.6
Annual Increase Needed To Maintain Constant Congestion Level:						
Lane-Miles	118	--	--	--	--	--
Transit Riders or Carpoolers (millions)	22	--	--	--	--	--
Annual Excess Fuel Consumed						
Total Fuel (1000 gallons)	1,610	1,547	1,087	980	1,009	984
Rank	55	52	58	61	55	50
Fuel per Peak Traveler (gallons)	6	6	4	4	4	4
Rank	58	55	63	61	58	53
Annual Delay						
Total Delay (1000s of person-hours)	2,708	2,646	1,886	1,666	1,715	1,664
Rank	54	51	56	59	54	51
Delay per Peak Traveler (person-hrs)	10	10	7	6	7	6
Rank	56	55	62	63	55	52
Delay due to Incidents (percent)	54	54	54	54	54	54
Travel Time Index						
Rank	58	54	57	58	52	48
Congestion Cost						
Total Cost (\$ millions)	27	26	18	16	16	15
Rank	54	52	58	61	56	52
Cost per Peak Traveler (\$)	97	92	67	58	59	57
Rank	57	56	62	63	56	53

Note: System Performance statistics for 2000 through 2005 data reflect the effects of operational treatments.

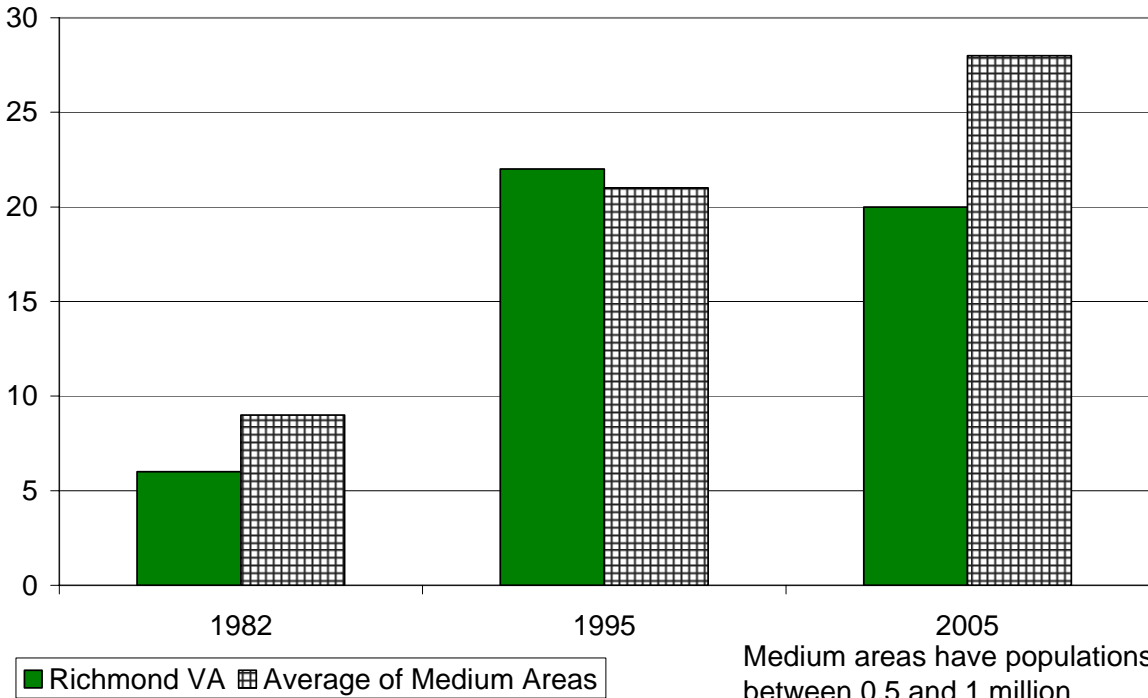
Note: Zeroes in the table reflect values less than 0.5.

Benefits From Public Transportation Service and Operations Strategies for Richmond, VA

Operations Strategies	2005	2004	2003	2002	2001	2000
Freeway Ramp Metering						
Percent of Roadway Miles	--	--	--	--	--	--
Annual Delay Reduction (1000 hours)	--	--	--	--	--	--
Freeway Incident Management						
Cameras						
Percent of Roadway Miles	20	20	21	4	--	--
Service Patrols						
Percent of Roadway Miles	19	19	20	21	--	--
Annual Delay Reduction (1000 hours)	116	115	89	77	--	--
Arterial Signal Coordination						
Percent of Roadway Miles	37	37	37	37	38	39
Annual Delay Reduction (1000 hours)	90	90	88	80	83	41
Arterial Access Management						
Percent of Roadway Miles	26	25	25	27	28	30
Annual Delay Reduction (1000 hours)	107	79	75	93	110	74
HOV Lanes						
Daily Passenger-miles of Travel (1000s)	--	--	--	--	--	--
HOV User Delay Savings	--	--	--	--	--	--
Total Effect of Operations Treatments						
Annual Delay Reduction (1000 hours)	313	284	252	250	193	115
Annual Delay Saved per Peak Traveler (hours)	1	1	1	1	0	0
Annual Congestion Cost Savings (\$million)	5.6	4.8	4.2	4.0	3.0	1.8
Travel Time Index with Strategies	1.091	1.091	1.083	1.077	1.077	1.073
Travel Time Index (Base)	1.093	1.093	1.085	1.079	1.078	1.074
Public Transportation Service						
Existing Service						
Annual Passenger-miles of Travel (million)	47	44	43	54	51	44
Unlinked Passenger Trips (million)	13	12	13	14	16	14
Travel Time Index (combined road and transit)	1.090	1.090	1.083	1.076	1.076	1.072
Condition if Public Transportation Service were Discontinued						
Travel Time Index	1.094	1.094	1.088	1.081	1.081	1.075
Annual Delay Increase (1000 hours)	196	276	329	249	354	171
Annual Delay Increase per Peak Traveler (hours)	0	1	1	1	1	0
Annual Congestion Cost Increase (\$million)	3.5	4.7	5.4	4.0	5.6	2.6

Growth in Delay per Peak Traveler

Hours of Delay



Growth in Total Delay

Annual Hours of Delay (million)

