

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 Large Group – 1 million to 3 million population urban areas

Urban Area	Delay per Traveler	Travel Time Index	Total Delay	1982 to 2005	
				Delay per Traveler	Total Delay
San Diego, CA	H+	H+	H+	F+	F+
Minneapolis-St. Paul, MN	H	0	H+	F+	F+
Baltimore, MD	H	H	H+	F	F+
Tampa-St. Petersburg, FL	H+	H	H+	S	F+
St. Louis, MO-IL	L	L-	0	S	0
Denver-Aurora, CO	H+	H+	H+	F+	F+
Pittsburgh, PA	L-	L-	L-	S-	S-
Riverside-San Bernardino, CA	H+	H+	H+	F+	F+
Cleveland, OH	L-	L-	L-	S-	S-
Sacramento, CA	H	H+	H	0	F+
Portland, OR-WA	0	H	0	0	0
San Jose, CA	H+	H+	H+	F	F+
Cincinnati, OH-KY-IN	L-	L	L	S	S-
Virginia Beach, VA	L	L	L	S-	S-
Kansas City, MO-KS	L-	L-	L-	S-	S-
Milwaukee, WI	L-	L-	L-	S-	S-
Las Vegas, NV	0	H	L	F	0
Orlando, FL	H+	H	H	F+	F+
San Antonio, TX	0	0	L	F	S
Providence, RI-MA	L-	L-	L-	0	S-
Columbus, OH	L	L	L	F	S-
Buffalo, NY	L-	L-	L-	S-	S-
New Orleans, LA	L-	L-	L-	S-	S-
Indianapolis, IN	H	0	L	0	S-
Memphis, TN-MS-AR	L	L-	L-	0	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 Denver-Aurora, CO

Inventory Measures	2005	2004	2003	2002	2001	2000
Urban Area Information						
Population (1000s)	2,090	2,065	2,050	2,030	2,025	1,910
Rank	20	20	19	19	19	20
Urban Area (square miles)	855	855	855	850	850	840
Popn Density (persons/sq mile)	2,444	2,415	2,398	2,388	2,382	2,274
Peak Travelers (1000s)	1,294	1,272	1,257	1,214	1,183	1,089
Freeway						
Daily Vehicle-Miles of Travel (1000s)	19,900	18,615	17,960	17,400	17,250	16,905
Lane Miles	1,250	1,240	1,140	1,110	1,080	1,050
Arterial Streets						
Daily Vehicle-Miles of Travel (1000s)	23,380	22,820	21,790	20,925	20,520	20,185
Lane Miles	3,670	3,640	3,510	3,385	3,350	3,300
Public Transportation						
Annual Psgr-Miles of Travel (millions)	443	402	383	385	391	375
Annual Unlinked Psgr Trips (millions)	86	82	79	81	80	77
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)	2.32	1.94	1.51	1.39	1.70	1.55
System Performance						
Congested Travel (% of peak VMT)	67	66	67	67	67	67
Congested System (% of lane-miles)	54	54	55	55	52	52
Congested Time (number of "Rush Hours")	7.4	7.2	7.4	7.2	7.4	7.4
Annual Increase Needed To Maintain Constant Congestion Level:						
Lane-Miles	154	138	144	149	164	175
Transit Riders or Carpoolers (millions)	47	41	43	44	48	52
Annual Excess Fuel Consumed						
Total Fuel (1000 gallons)	42,519	37,970	36,354	35,075	36,333	34,327
Rank	16	18	18	18	17	17
Fuel per Peak Traveler (gallons)	33	30	29	29	31	32
Rank	15	18	18	15	11	10
Annual Delay						
Total Delay (1000s of person-hours)	64,997	58,291	55,133	53,208	54,574	51,654
Rank	16	16	16	16	17	16
Delay per Peak Traveler (person-hrs)	50	46	44	44	46	47
Rank	11	14	14	13	10	8
Delay due to Incidents (percent)	53	53	52	52	52	52
Travel Time Index	1.33	1.30	1.30	1.30	1.32	1.30
Rank	13	15	13	10	9	9
Congestion Cost						
Total Cost (\$ millions)	1,176	1,006	915	863	886	813
Rank	16	17	17	18	17	16
Cost per Peak Traveler (\$)	909	791	728	711	750	747
Rank	13	20	21	16	12	10

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 Denver-Aurora, CO, Continued

Inventory Measures	1999	1998	1997	1996	1995	1994
Urban Area Information						
Population (1000s)	1,860	1,830	1,800	1,770	1,730	1,675
Rank	20	20	20	22	22	22
Urban Area (square miles)	830	820	810	800	770	750
Popn Density (persons/sq mile)	2,241	2,232	2,222	2,213	2,247	2,233
Peak Travelers (1000s)	1,034	994	954	915	874	826
Freeway						
Daily Vehicle-Miles of Travel (1000s)	16,500	16,120	15,700	15,100	14,285	13,475
Lane Miles	1,030	1,020	1,015	1,000	1,000	1,000
Arterial Streets						
Daily Vehicle-Miles of Travel (1000s)	19,520	17,990	16,850	16,410	16,170	15,685
Lane Miles	3,280	3,220	3,175	3,115	3,105	3,050
Public Transportation						
Annual Psgr-Miles of Travel (millions)	365	325	313	298	265	236
Annual Unlinked Psgr Trips (millions)	75	72	71	70	67	63
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)	1.16	1.10	1.24	1.36	1.22	1.16
System Performance						
Congested Travel (% of peak VMT)	66	61	60	57	54	49
Congested System (% of lane-miles)	52	47	47	46	46	45
Congested Time (number of "Rush Hours")	7.2	7.2	7.0	6.8	6.4	6.0
Annual Increase Needed To Maintain Constant Congestion Level:						
Lane-Miles	186	167	182	206	216	210
Transit Riders or Carpoolers (millions)	54	47	49	55	56	52
Annual Excess Fuel Consumed						
Total Fuel (1000 gallons)	32,048	29,033	26,772	24,216	21,321	17,622
Rank	18	17	17	19	21	21
Fuel per Peak Traveler (gallons)	31	29	28	26	24	21
Rank	12	12	10	11	14	19
Annual Delay						
Total Delay (1000s of person-hours)	48,524	43,901	40,125	36,845	32,449	27,364
Rank	17	17	17	19	21	21
Delay per Peak Traveler (person-hrs)	47	44	42	40	37	33
Rank	9	10	10	11	13	19
Delay due to Incidents (percent)	52	52	53	53	54	54
Travel Time Index						
	1.29	1.28	1.27	1.25	1.22	1.19
Rank	13	11	11	14	15	19
Congestion Cost						
Total Cost (\$ millions)	726	643	586	529	452	367
Rank	17	17	17	20	21	21
Cost per Peak Traveler (\$)	702	647	614	578	517	444
Rank	11	10	10	11	14	20

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 Denver-Aurora, CO, Continued

Inventory Measures	1993	1992	1991	1990	1989	1988
Urban Area Information						
Population (1000s)	1,610	1,600	1,580	1,580	1,565	1,550
Rank	22	22	22	22	22	22
Urban Area (square miles)	735	720	700	660	630	600
Popn Density (persons/sq mile)	2,190	2,222	2,257	2,394	2,484	2,583
Peak Travelers (1000s)	774	750	724	706	693	680
Freeway						
Daily Vehicle-Miles of Travel (1000s)	12,950	12,430	11,425	11,205	10,500	10,315
Lane Miles	1,000	960	885	880	860	860
Arterial Streets						
Daily Vehicle-Miles of Travel (1000s)	15,170	13,900	13,240	12,365	12,170	12,120
Lane Miles	3,040	3,035	3,030	3,005	2,995	2,975
Public Transportation						
Annual Psgr-Miles of Travel (millions)	237	241	231	220	202	214
Annual Unlinked Psgr Trips (millions)	60	59	57	53	52	51
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)	1.21	1.23	1.19	1.11	1.15	1.06
System Performance						
Congested Travel (% of peak VMT)	45	41	41	37	33	33
Congested System (% of lane-miles)	41	37	37	33	32	32
Congested Time (number of "Rush Hours")	5.6	5.4	5.2	5.0	4.4	4.4
Annual Increase Needed To Maintain Constant Congestion Level:						
Lane-Miles	186	137	96	65	21	57
Transit Riders or Carpoolers (millions)	45	31	21	14	4	12
Annual Excess Fuel Consumed						
Total Fuel (1000 gallons)	15,704	12,932	11,664	10,044	8,728	8,224
Rank	20	22	23	23	23	23
Fuel per Peak Traveler (gallons)	20	17	16	14	13	12
Rank	21	25	26	32	32	30
Annual Delay						
Total Delay (1000s of person-hours)	24,201	19,521	17,482	14,870	13,131	12,257
Rank	20	21	22	22	23	23
Delay per Peak Traveler (person-hrs)	31	26	24	21	19	18
Rank	20	28	29	35	36	33
Delay due to Incidents (percent)	54	55	55	55	55	55
Travel Time Index						
Rank	1.17	1.15	1.15	1.13	1.12	1.11
Rank	24	26	27	29	31	31
Congestion Cost						
Total Cost (\$ millions)	320	254	222	184	152	134
Rank	20	21	23	22	23	23
Cost per Peak Traveler (\$)	413	339	306	260	219	197
Rank	23	29	29	36	36	33

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 Denver-Aurora, CO, Continued

Inventory Measures	1987	1986	1985	1984	1983	1982
Urban Area Information						
Population (1000s)	1,510	1,500	1,485	1,460	1,375	1,350
Rank	22	22	22	22	22	22
Urban Area (square miles)	570	550	515	485	460	435
Popn Density (persons/sq mile)	2,649	2,727	2,883	3,010	2,989	3,103
Peak Travelers (1000s)	657	647	634	618	578	562
Freeway						
Daily Vehicle-Miles of Travel (1000s)	10,135	9,765	9,510	9,865	9,180	8,900
Lane Miles	855	840	825	810	795	795
Arterial Streets						
Daily Vehicle-Miles of Travel (1000s)	12,115	12,100	12,195	12,215	11,665	11,530
Lane Miles	2,940	2,875	2,845	2,825	2,780	2,705
Public Transportation						
Annual Psgr-Miles of Travel (millions)	208	226	244	239	239	239
Annual Unlinked Psgr Trips (millions)	51	54	58	51	51	51
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)	1.06	1.04	1.36	1.37	1.41	1.47
System Performance						
Congested Travel (% of peak VMT)	32	34	32	35	29	28
Congested System (% of lane-miles)	32	36	35	35	30	30
Congested Time (number of "Rush Hours")	4.2	4.2	4.2	4.6	4.2	4.0
Annual Increase Needed To Maintain Constant Congestion Level:						
Lane-Miles	66	--	--	--	--	--
Transit Riders or Carpoolers (millions)	13	--	--	--	--	--
Annual Excess Fuel Consumed						
Total Fuel (1000 gallons)	7,902	8,007	7,722	9,374	5,825	5,838
Rank	20	19	19	17	20	18
Fuel per Peak Traveler (gallons)	12	12	12	15	10	10
Rank	29	23	17	9	20	13
Annual Delay						
Total Delay (1000s of person-hours)	11,852	12,073	11,920	15,062	9,049	9,085
Rank	20	20	19	17	20	18
Delay per Peak Traveler (person-hrs)	18	19	19	24	16	16
Rank	30	28	25	11	23	16
Delay due to Incidents (percent)	55	55	55	56	54	54
Travel Time Index						
Rank	1.11	1.11	1.11	1.13	1.08	1.09
Rank	28	22	21	13	26	21
Congestion Cost						
Total Cost (\$ millions)	125	123	121	149	85	84
Rank	20	20	20	17	20	19
Cost per Peak Traveler (\$)	191	191	190	241	148	149
Rank	30	27	23	10	20	15

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

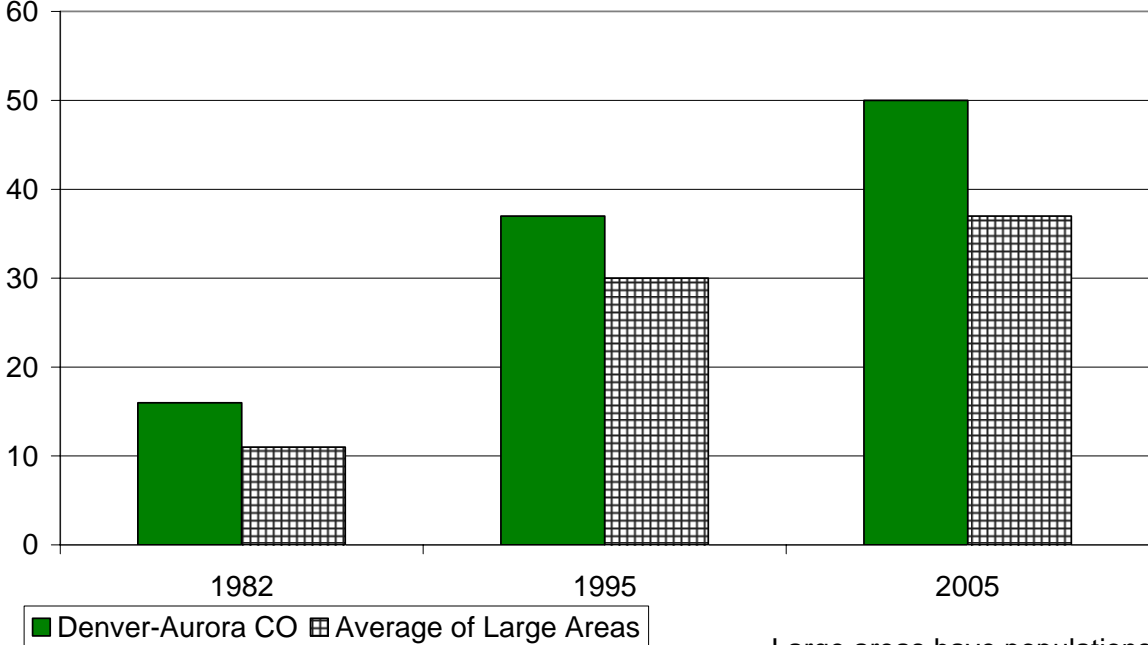
Note: Zeroes in the table reflect values less than 0.5.

Benefits From Public Transportation Service and Operations Strategies for Denver-Aurora, CO

Operations Strategies	2005	2004	2003	2002	2001	2000
Freeway Ramp Metering						
Percent of Roadway Miles	14	15	13	14	--	--
Annual Delay Reduction (1000 hours)	210	173	137	135	--	--
Freeway Incident Management						
Cameras						
Percent of Roadway Miles	15	15	17	17	--	--
Service Patrols						
Percent of Roadway Miles	47	48	55	55	--	--
Annual Delay Reduction (1000 hours)	1,500	1,193	1,095	1,074	--	--
Arterial Signal Coordination						
Percent of Roadway Miles	68	63	47	44	42	41
Annual Delay Reduction (1000 hours)	371	381	265	323	388	398
Arterial Access Management						
Percent of Roadway Miles	53	52	51	50	50	50
Annual Delay Reduction (1000 hours)	1,271	1,359	934	928	620	517
HOV Lanes						
Daily Passenger-miles of Travel (1000s)	136	133	131	128	125	123
HOV User Delay Savings	176	145	141	139	156	146
Total Effect of Operations Treatments						
Annual Delay Reduction (1000 hours)	3,528	3,251	2,572	2,599	1,165	1,061
Annual Delay Saved per Peak Traveler (hours)	3	3	2	2	1	1
Annual Congestion Cost Savings (\$million)	63.5	55.8	42.9	42.3	18.3	16.2
Travel Time Index with Strategies	1.327	1.302	1.301	1.301	1.317	1.304
Travel Time Index (Base)	1.342	1.317	1.314	1.315	1.323	1.310
Public Transportation Service						
Existing Service						
Annual Passenger-miles of Travel (million)	443	402	383	385	391	375
Unlinked Passenger Trips (million)	86	82	79	81	80	77
Travel Time Index (combined road and transit)	1.310	1.286	1.288	1.287	1.302	1.289
Condition if Public Transportation Service were Discontinued						
Travel Time Index	1.356	1.331	1.328	1.330	1.341	1.326
Annual Delay Increase (1000 hours)	4,464	4,415	4,238	4,236	4,355	4,151
Annual Delay Increase per Peak Traveler (hours)	3	3	3	3	4	4
Annual Congestion Cost Increase (\$million)	81.2	76.6	70.8	69.1	71.3	65.7

Growth in Delay per Peak Traveler

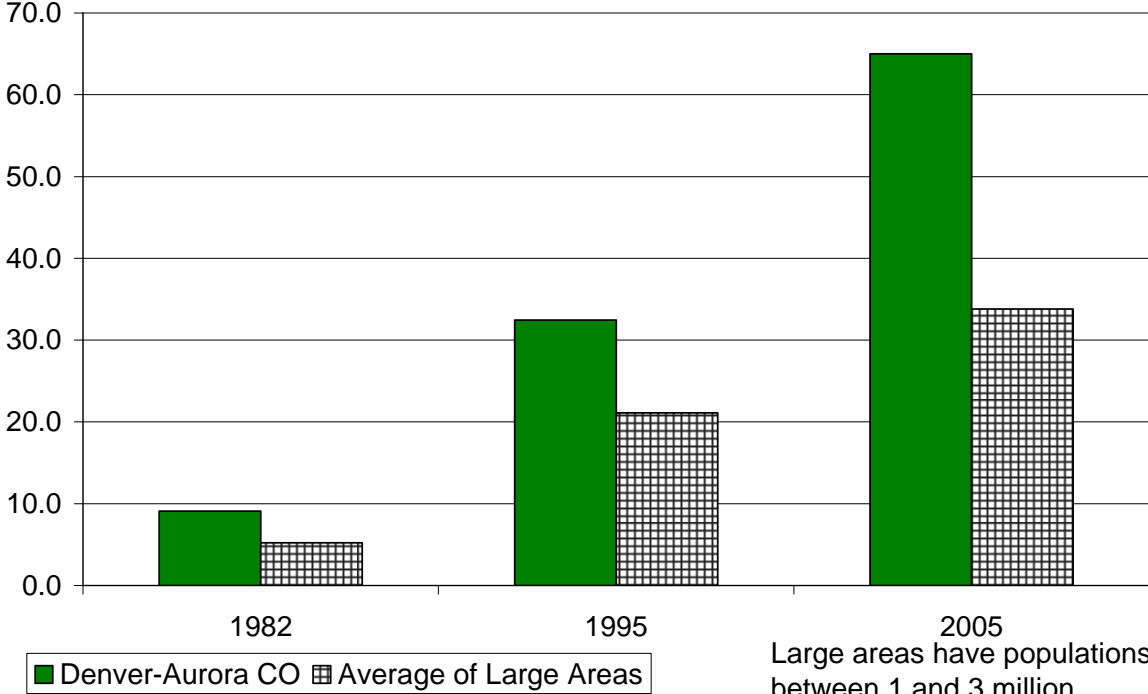
Hours of Delay



Large areas have populations between 1 and 3 million

Growth in Total Delay

Annual Hours of Delay (million)



Large areas have populations between 1 and 3 million