

Appendix SAN – San Diego, California 2003 Annual Report on Freeway Mobility and Reliability

This report is a supplement to: *Monitoring Urban Freeways in 2003: Current Conditions and Trends from Archived Operations Data*. Texas Transportation Institute and Cambridge Systematics, Inc., Report No. FHWA-HOP-05-018, December 2004, available at <http://mobility.tamu.edu/mmp>.

Exhibit SAN-1: Current Measures and Trends

Measures	Current Year	Last Year		Two Years Ago	
	2003	2002	Change	2001	Change
Performance Measures					
Travel Time Index	1.18	1.18	0% —	1.21	-2% ↓
Planning Time Index	1.41	1.41	0% —	1.48	-5% ↓
Buffer Index	15%	16%	-1% ↓	18%	-3% ↓
% Congested Travel	20%	33%	-13% ↓	40%	-20% ↓
Total Delay (veh-hours) per 1000 VMT	2.99	3.24	-8% ↓	3.48	-14% ↓
Explanatory Measures					
Peak Period VMT (000)	5,670	6,050	-6% ↓	5,260	+8% ↑
Avg. Annual DVMT (000)	21,520	21,570	0% —	17,550	+23% ↑
Data Quality Measures					
% complete	92%	88%	+4% ↑	38%	+54% ↑
% valid	99%	94%	+5% ↑	98%	+1% ↑
% of VMT covered	64%	64%	0% —	51%	+13% ↑
% of freeway miles	53%	65%	-12% ↓	66%	-13% ↓

* See pages 8 and 9 for maps of freeway coverage, measure definitions, and further documentation.

Exhibit SAN-2: 2000 to 2003 Annual Trends

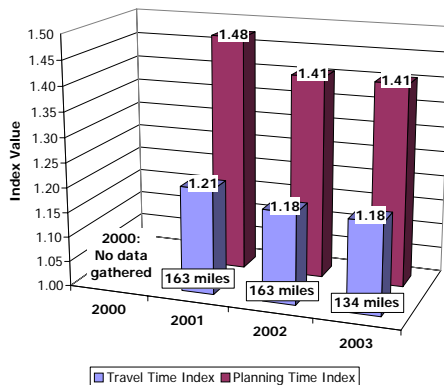
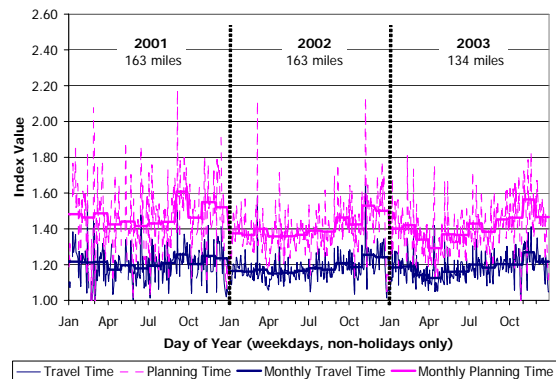


Exhibit SAN-3: Daily and Monthly Trends



Comments

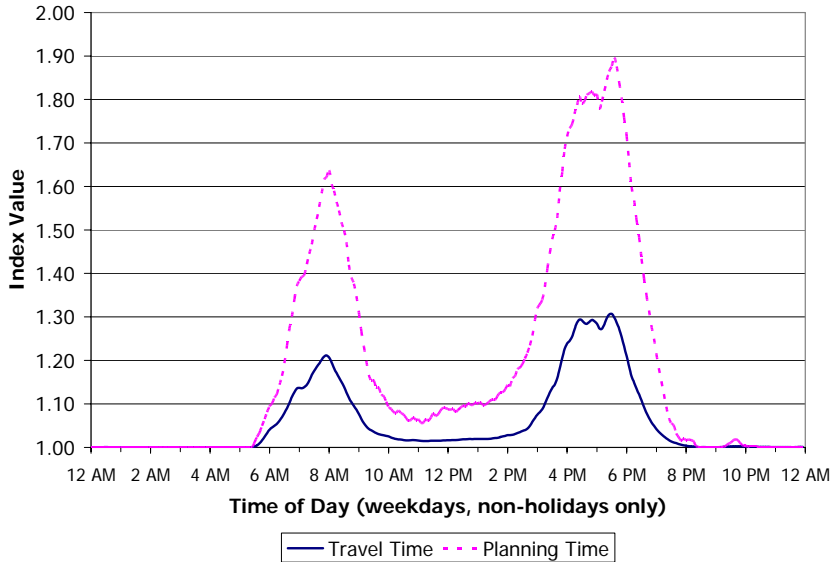
- The travel time index and the buffer index remained stable in 2003, while the congested travel dropped by 13% and the total delay decreased by 8%. These decreases could be due to a decrease in peak period travel (6% drop from 2002 to 2003) or a decrease in freeway coverage.
- Data completeness and validity improved by 4-5% over 2002 levels. The freeway mileage decreased by 12% due to changes in the data source's definition of sensor locations.

Data Source(s): PeMS (<http://pems.eecs.berkeley.edu>) in cooperation with Caltrans (<http://www.dot.ca.gov/>)
Includes 134 of 254 (53%) total freeway miles in San Diego; collected using loop detectors; see page 8 for additional information on the data source

Data Analysis: Texas Transportation Institute, analysis completed September 2004

Time of Day Patterns and Trends

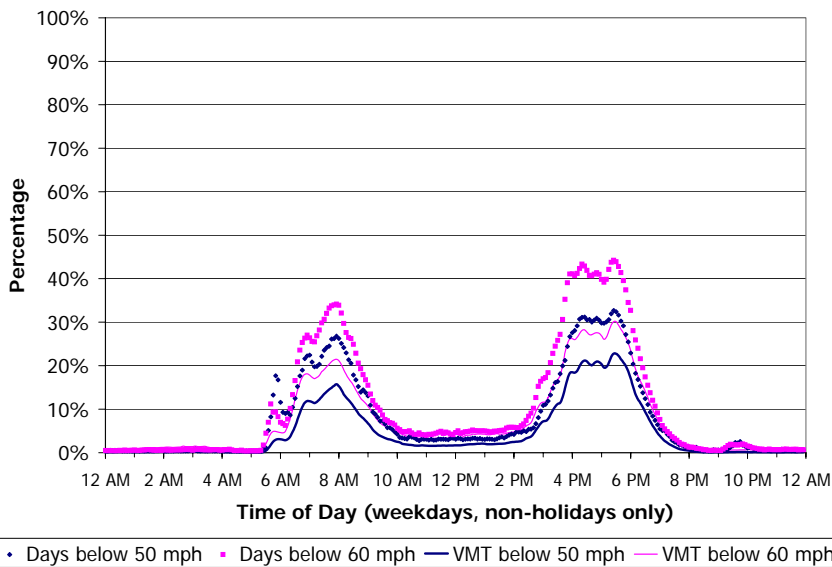
The charts on this page illustrate average weekday (no holidays included) traffic patterns and trends that were measured on the freeway sections instrumented with operations-based traffic sensors.



Comments

- This chart shows areawide congestion and reliability patterns. The difference between the solid line (travel time index) and the dashed line (planning time index) is the additional “buffer” or “time cushion” that travelers must add to average trip times to ensure 95% on-time arrival.
- The evening congestion is more severe and longer than the morning congestion.
- Travelers must add 30-40% additional buffer time during peak times to account for traffic unreliability.

Exhibit SAN-4: Mobility and Reliability by Time of Average Weekday



Comments

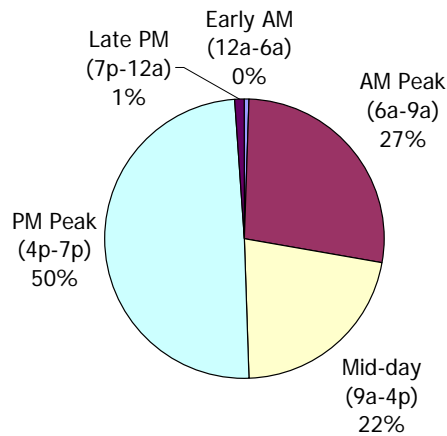
- This chart illustrates the difference in using two different speed thresholds (50 and 60 mph) to compute the percent of congested days as well as the percent of congested travel.
- There does not appear to be a significant difference in using a 50 mph or 60 mph congestion threshold.

Exhibit SAN-5: Frequency and Percentage of Congested Travel by Time of Average Weekday

Time Period of the Day Patterns and Trends

The charts on this page illustrate average weekday (no holidays included) traffic patterns and trends that were measured on the freeway sections instrumented with operations-based traffic sensors. The time periods are defined uniformly for all cities to facilitate trend analysis over time and between cities. The time periods are defined as follows:

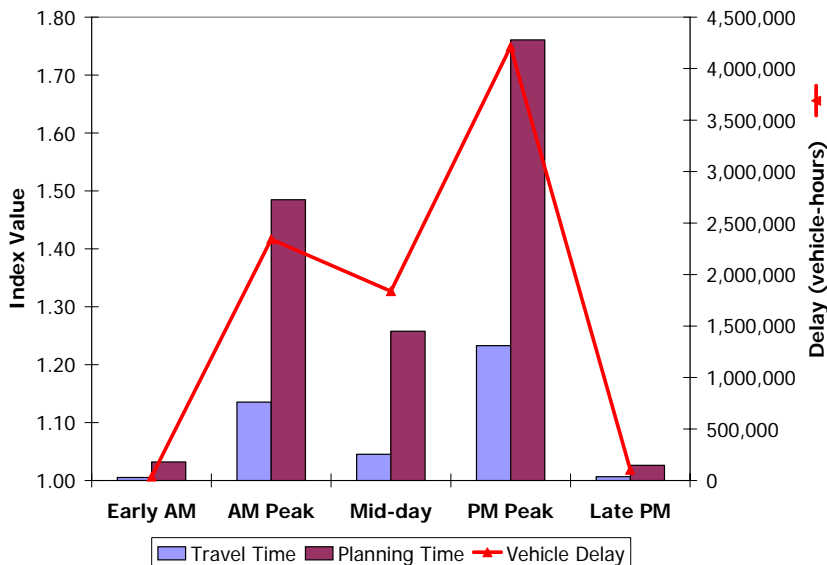
- Early AM: 12 to 6 am
- AM Peak: 6 to 9 am
- Mid-day: 9 am to 4 pm
- PM Peak: 4 to 7 pm
- Late PM: 7 pm to 12 am



Comments

- This chart shows the percent of delay that occurred during different time periods of an average weekday. Note that the AM and PM peak periods are the same duration, but that the other time periods have different lengths.
- The delay in the afternoon peak period is significantly greater than the morning peak period.
- Delay during the mid-day period is slightly less than delay during the morning peak period.

Exhibit SAN-6: Percent of Delay by Time Period



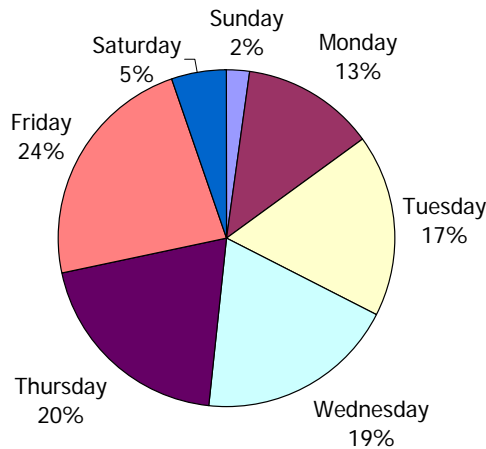
Comments

- This chart shows congestion and reliability (shown as bars) as well as delay (shown as a line) during different time periods of an average weekday.
- The trends in this chart follow closely those shown in Exhibit 6.
- The travel time index for the mid-day period is low, but the delay is relatively high because of the length of this time period (7 hours).

Exhibit SAN-7: Mobility, Reliability, and Delay by Time Period

Day of Week Patterns and Trends

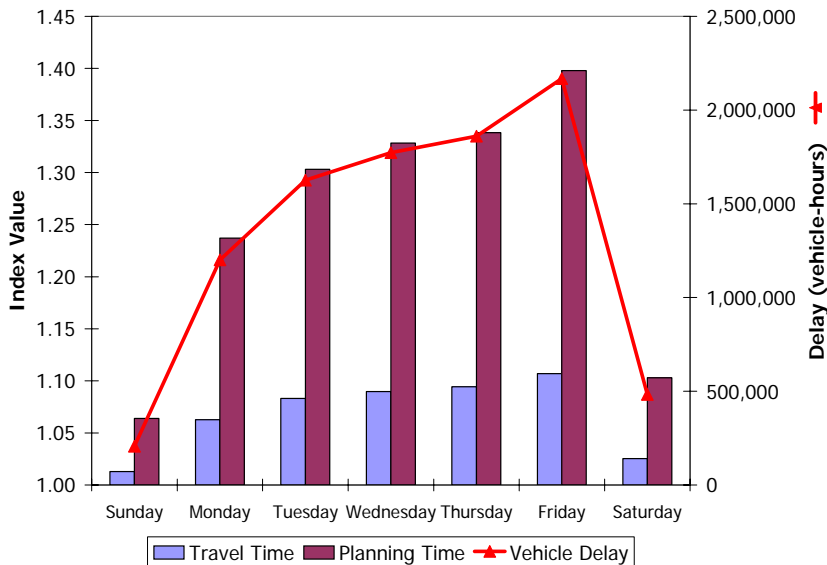
The charts on this page illustrate average traffic patterns and trends that were measured on the freeway sections instrumented with operations-based traffic sensors. Because of different peak period times and lengths on weekdays and weekends, the statistics presented on this page are 24-hour daily totals or averages.



Comments

- This chart shows the percent of total daily delay that occurred during each day of the week.
- The delay on Friday is greater than all other weekdays. Delay on Monday is about half of the delay on Friday.
- Both weekend days combined have about 30-50% of the normal weekday delay.

Exhibit SAN-8: Percent of Daily Vehicle Delay by Day of Week



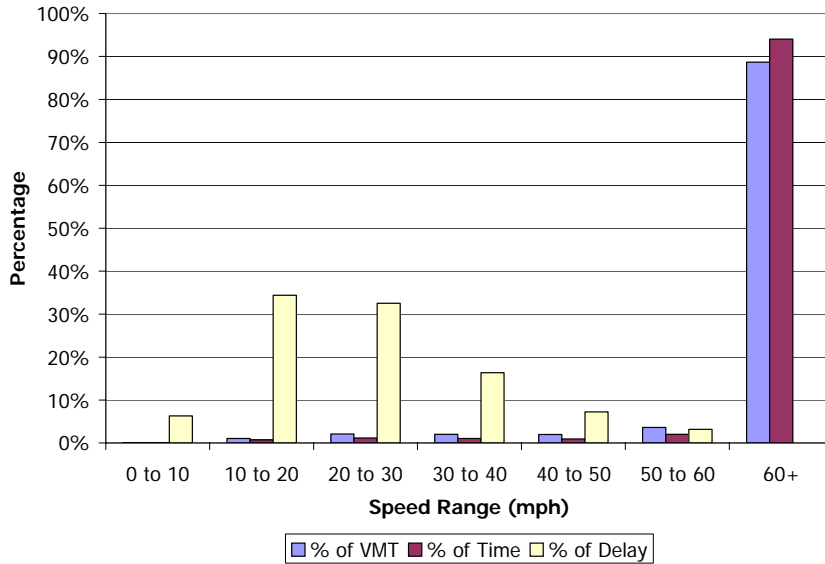
Comments

- This chart shows average daily congestion and reliability (shown as bars) as well as total daily delay (shown as a line) during each day of the week.
- The trends in this chart follow closely those shown in Exhibit 8.
- Friday has the most delay and is the least reliable day (highest planning time index).

Exhibit SAN-9: Mobility, Reliability, and Delay by Day of Week

Other Traffic Data Patterns and Trends

The charts on this page illustrate average traffic patterns and trends that were measured on the freeway sections instrumented with operations-based traffic sensors.



Comments

- This chart shows the percent of VMT, time, and delay in different speed ranges. This chart is useful to determine how much VMT and delay occurred at different congestion levels.
- Almost 90% of the VMT is at speeds greater than 60 mph.
- Nearly three-fourths of the delay occurred at speeds less than 30 mph.

Exhibit SAN-10: Percent of VMT, Delay and Time Periods in Different Speed Ranges

Mobility and Reliability Statistics for Specific Freeway Sections

The table in this section illustrates average weekday (no holidays included) statistics from the freeway sections instrumented with operations-based traffic sensors. Where possible, the freeway sections have been defined to begin and end at major interchanges, streets, or other locations where traffic conditions are likely to change. The freeway sections are typically between 5 and 10 miles in length.

Exhibit SAN-11. Mobility and Reliability by Section and Time Period

Freeway Section (sorted from most congested to least congested sections)	Length (mi)	Travel Time Index				Buffer Index			
		Morning Peak (6a-9a)	Midday (9a-4p)	Evening Peak (4p-7p)	Average peak period	Morning Peak (6a-9a)	Midday (9a-4p)	Evening Peak (4p-7p)	Average peak period
I-15 NB: SR 56 to Rancho Bernardo Rd	6.03	1.01	1.28	2.80	1.94	0%	128%	62%	33%
I-15 SB: SR 78/EI Norte Pkwy to Rancho Bernardo Rd	8.85	2.28	1.07	1.04	1.70	87%	30%	0%	46%
I-5 NB: SR 56 to CR-S11/Manchester Ave	8.21	1.00	1.21	1.88	1.48	0%	76%	40%	22%
I-805 NB: I-8 to E Plaza Blvd	7.73	1.00	1.03	1.69	1.45	0%	20%	80%	51%
I-5 SB:CR-S12 to CR-S11/Manchester Ave	8.31	1.72	1.20	1.14	1.43	86%	76%	76%	81%
I-5 SB: SR 56/I-805 to SR 52	5.98	1.00	1.02	1.54	1.34	0%	0%	89%	56%
I-15 NB: SR 52 to SR 56	7.15	1.03	1.13	1.52	1.27	17%	62%	113%	64%
I-15 SB: Rancho Bernardo Rd to SR 56	5.20	1.26	1.04	1.24	1.25	78%	10%	118%	97%
I-8 EB: SR 163 to I-15	4.20	1.01	1.03	1.38	1.25	0%	2%	80%	52%
I-15 SB: SR 52 to NB 805	7.65	1.00	1.02	1.44	1.25	0%	9%	65%	36%
I-5 NB: Leucadia Blvd to Cannon Rd	7.84	1.00	1.04	1.41	1.23	0%	25%	63%	35%
SR 78 EB: CR-S10 to I-15	6.02	1.02	1.06	1.34	1.19	0%	35%	71%	38%
I-805 NB: I-5 to I-8	10.43	1.00	1.04	1.31	1.19	0%	26%	49%	30%
I-15 SB: SR 56 to SR 52	8.18	1.18	1.04	1.17	1.18	45%	27%	45%	45%
I-805 NB: E Plaza Blvd to I-8	7.96	1.26	1.01	1.00	1.16	56%	0%	0%	34%
I-805 NB: I-8 to I-5	9.53	1.21	1.01	1.01	1.14	59%	0%	0%	37%
I-8 WB: SR 125 to I-15	5.92	1.22	1.01	1.00	1.13	73%	0%	0%	43%
SR 94 WB: SR 125 to I-5	7.62	1.17	1.00	1.00	1.11	56%	0%	0%	36%
SR 78 EB: I-5 to CR-S10	9.46	1.02	1.02	1.17	1.10	10%	5%	45%	29%
I-5 SB: SR 52 to SR 163	9.08	1.00	1.01	1.16	1.09	0%	0%	56%	32%
I-15 NB: NB 805 to SR 52	7.96	1.11	1.01	1.03	1.08	33%	0%	0%	20%
I-5 SB: SR 76 to CR-S12	7.51	1.08	1.05	1.08	1.08	33%	30%	46%	39%
I-8 EB: I-15 to SR 125	6.93	1.00	1.01	1.11	1.08	0%	7%	24%	16%
SR 54 EB: Reo Drive to Briarwood Rd	3.03	1.02	1.03	1.09	1.06	0%	0%	51%	31%
SR 94 EB: I-5 to SR 125	9.22	1.00	1.01	1.07	1.05	0%	0%	31%	22%
SR 78 WB: I-15/N Centre City Pkwy to CR-S10	8.35	1.02	1.01	1.06	1.04	5%	0%	29%	17%
I-8 WB: I-15 to I-5	6.40	1.06	1.00	1.01	1.04	27%	0%	0%	15%
I-5 NB: SR 163/Hawthorn Street to Mission Bay Dr/SR 52	8.67	1.04	1.01	1.02	1.03	20%	0%	2%	12%
SR 125 SB: Navajo Rd to SR 94	4.03	1.00	1.01	1.04	1.03	0%	0%	26%	14%
SR 163 SB: I-15 to Robinson Ave	8.40	1.01	1.00	1.04	1.02	0%	0%	18%	9%
I-8 WB: Lake Jennings Park Rd to SR 125	9.63	1.04	1.00	1.01	1.02	15%	0%	0%	9%
I-8 EB: SR 125 to SR 54	4.87	1.00	1.01	1.04	1.02	0%	0%	22%	14%
I-5 SB: CR-S11/Manchester Ave to SR 56/I-805	7.30	1.03	1.02	1.01	1.02	7%	4%	3%	5%
SR 163 NB: SR 274 to I-15	3.31	1.01	1.00	1.02	1.02	0%	0%	0%	0%
SR 125 NB: SR 94 to Navajo Rd	3.64	1.01	1.00	1.02	1.01	0%	0%	12%	6%

Exhibit SAN-11 (Continued). Mobility and Reliability by Section and Time Period

Freeway Section (sorted from most congested to least congested sections)	Length (mi)	Travel Time Index				Buffer Index			
		Morning Peak (6a-9a)	Midday (9a-4p)	Evening Peak (4p-7p)	Average peak period	Morning Peak (6a-9a)	Midday (9a-4p)	Evening Peak (4p-7p)	Average peak period
I-15 NB: Rancho Bernardo Rd to SR 78/Valley Pkwy	6.14	1.00	1.01	1.02	1.01	0%	0%	7%	4%
SR 78 WB: CR-S10 to I-5	9.39	1.01	1.00	1.01	1.01	0%	0%	0%	0%
SR 54 WB: Briarwood Rd to Reo Drive	2.73	1.01	1.00	1.00	1.00	0%	0%	0%	0%
Average for all Sections		1.14	1.05	1.23	1.19	26%	19%	38%	32%

Comments

- This table shows average weekday congestion (travel time index) and reliability (buffer index) for specific routes for different time periods of the day.
- I-5 and I-15 appear to be the most congested corridors in the San Diego area.

Source and Coverage of Data

This report was produced using data collected by Caltrans and archived by PeMS (<http://pems.eecs.berkeley.edu>). A map of the freeway routes on which traffic data was collected is shown below (dots indicate sensor locations).

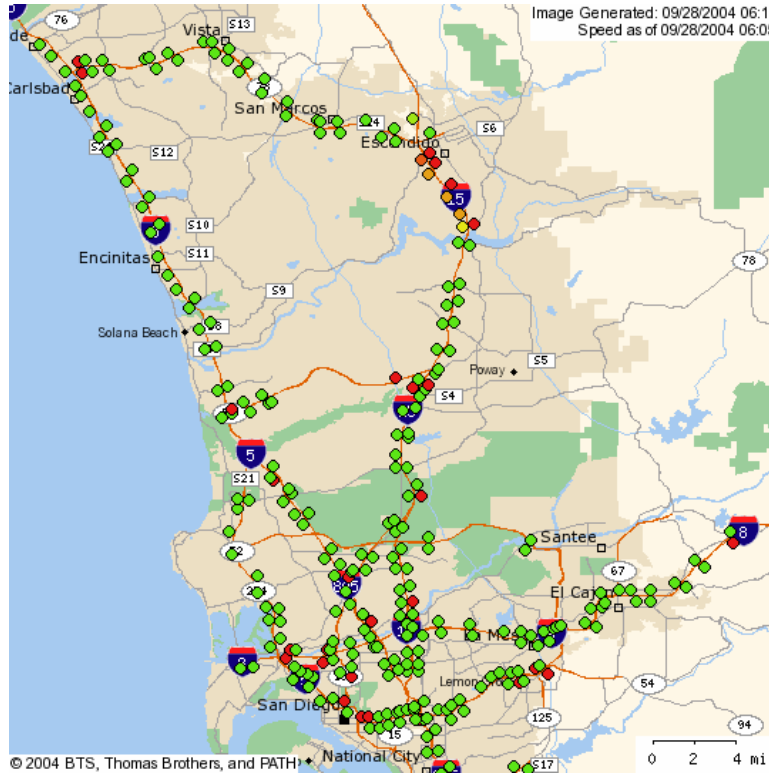


Exhibit SAN-12: Freeway Routes with Traffic Sensors in San Diego

(Source of graphic: PeMS, <http://pems.eecs.berkeley.edu>)

Exhibit SAN-13: Instrumented Freeway Coverage in San Diego

Coverage Measures	Year	Instrumented Freeway Routes	Total Freeway System ¹	Percent Coverage
Lane-miles	2000	n.a.	1,795	n.a.
	2001	1,195	1,795	67%
	2002	1,196	1,830	65%
	2003	1,065	1,848	58%
Centerline-miles	2000	n.a.	246	n.a.
	2001	163	248	66%
	2002	163	252	65%
	2003	134	254	53%
Average annual daily vehicle-miles of travel (DVMТ) (1000)	2000	n.a.	33,745	n.a.
	2001	17,550	34,590	51%
	2002	21,570	33,500	64%
	2003	21,520	33,378	64%

¹Source is FHWA's Highway Performance Monitoring System and the Texas Transportation Institute's Urban Mobility Study (<http://mobility.tamu.edu/ums>).

Documentation and Definitions

Performance Measures

- **Travel Time Index:** ratio of the average peak period travel time to an off-peak travel time. For example, a value of 1.20 means that average peak travel times are 20% longer than off-peak travel times. In this report, the morning peak period is from 6 to 9 a.m. and the evening peak period is from 4 to 7 p.m. The off-peak travel time is calculated by assuming a free-flow speed of 60 mph.
- **Planning Time Index:** statistically defined as the 95th percentile Travel Time Index, this measure also represents the extra time most travelers include when planning peak period trips. For example, a value of 1.60 means that travelers plan for an additional 60% travel time above the off-peak travel times to ensure 95% on-time arrival.
- **Buffer Index:** the extra time (or buffer) needed to ensure on-time arrival for most trips. For example, a value of 40% means that a traveler should budget an additional 8 minute buffer for a 20-minute average peak trip time to ensure 95% on-time arrival. In this report, the buffer index is a VMT-weighted average of the buffer index for each route for the morning and evening peak period. The buffer index is calculated for each route and time period as follows: $\text{buffer index} = (95^{\text{th}} \text{ percentile travel time} - \text{average travel time}) / \text{average travel time}$.
- **% Congested Travel:** the congested peak period vehicle-miles of travel (VMT) divided by total VMT in the peak period. This is a relative measure of the amount of peak period travel affected by congestion.
- **Total Delay per 1000 VMT:** the total vehicle delay (in vehicle-hours) divided by the amount of VMT. This is a relative measure of the total delay and will not be as affected by changes in the level of sensor instrumentation for a particular city.
- **Vehicle Delay:** the delay (in vehicle-hours) experienced by vehicles traveling less than free-flow speeds (assumed to be 60 mph in this report).

Explanatory Measures

- **Peak Period VMT:** the average amount of VMT within the defined peak periods (weekdays from 6 to 9 a.m. and 4 to 7 p.m.) for the year. Peak period VMT is reported by 1000s.
- **Average Annual DVMT (000):** the average annual amount of daily VMT (DVMT) for all days and times for the year. Average annual DVMT is reported by 1000s.

Data Quality Measures

- **% complete:** the number of valid reported data values divided by the number of total expected data values (given the number of active sensors and time periods). In this report, % complete is reported as the lowest value of either traffic volume or speed data.
- **% valid:** the number of reported data values that passed defined acceptance criteria divided by the total number of reported data values. In this report, % valid is reported as the lowest value of either traffic volume or speed data.
- **% of DVMT covered:** the amount of average annual DVMT reported by sensors divided by the areawide average annual DVMT as estimated in FHWA's Highway Performance Monitoring System and TTI's Urban Mobility Study. This measure characterizes the relative amount of areawide travel that has the performance indicated in this report.
- **% coverage of freeway mileage:** the amount of freeway lane-miles containing sensors divided by the areawide freeway lane-miles as estimated in FHWA's Highway Performance Monitoring System and TTI's Urban Mobility Study. This measure characterizes the relative amount of areawide freeways that has the performance indicated in this report.