

7. Performance Measures

When this region first developed a CMS, a number of performance measures were identified, as possible tools for evaluating the operation of a CMS transportation system. The following performance measures were considered:

1. Level of service (LOS);
2. Volume/capacity ratio (V/C);
3. Speed;
4. Delay;
5. Distance traveled (VMT or PMT);
6. Trip-based measure;
7. Combination of speed and distance traveled (*i.e.*, % PMT by speed range).

These performance measures were evaluated to select those that best incorporate a set of criteria that are significant to congestion analysis.

Table 2 summarizes the ways in which each performance measure would meet the criteria.

Table 2
CRITERIA FOR SELECTION
OF PERFORMANCE MEASURES

Performance Measures	Clearly Understood	Mode Sensitivity	Temporal Sensitivity	Not Expensive	Forecastable	Sensitivity to CMS Strategies
1. LOS			X	X	X	
2. V/C			X	X	X	
3. SPEED	X		X	X	X	X
4. DELAY	X	X	X	X	X	X
5. VMT/PMT		X	X		X	X
6. TRIP BASED	X	X				X
7. PMT BY SPEED	X	X	X		X	x

The following table summarizes the data collection required for each of the performance measures considered.

Table 3
DATA COLLECTION REQUIREMENTS
FOR PERFORMANCE MEASURES

<u>Performance Measures</u>	<u>Traffic Volume</u>	<u>Speed</u>	<u>Occupancy</u>	<u>Vehicle Classification</u>	<u>Roadway Characteristics</u>
1. LOS	X			X	X
2. V/C	X			X	X
3. SPEED		X			
4. DELAY	X	X			X
5. VMT/PMT	X		X	X	X
6. TRIP BASED		X	X		
7. PMT BY SPEED	X	X	X	X	X

Performance measures were discussed in 1995 by the Inter-agency Technical Task Force. On the basis of this evaluation, **speed and delay were selected** as the performance measures to be used for system monitoring and for evaluation of the effectiveness of strategies. Delay per vehicle is calculated. Total vehicular delay is also calculated by multiplying the delay per vehicle times the number of vehicles. These performance measures have been used consistently in SPC's data collection and analysis throughout the history of the CMS/CMP. They have proven meaningful because they are based on measured travel times.

Speed

This performance measure utilizes travel time. The length of time it takes to get from point to point is probably perceived by the traveling public as the most significant factor in evaluating congestion. Data can be collected by time of day to distinguish peak hours. Change in travel time is perhaps the easiest measure to comprehend.

Delay

This measure of congestion can include waiting time at signals, toll plazas and other points as well as delay caused by high traffic volume. Actual travel times are measured and compared to optimum travel times at posted speed. Delay is a concept that is easy to comprehend. Data is easy to collect and simple to evaluate. Data can be collected by time of day to reflect peak conditions. Both total vehicular delay and delay per vehicle are used extensively in this study.

8. Data collection

Speed and delay can be calculated using time, distance and traffic volume data. Data collection for the CMP monitoring network consists of travel time and distance measurements during AM and PM peak hours. For purposes of data collection and analysis, the regional CMP network is divided into corridors, which are subdivided into segments or “links”. The posted speeds are recorded along each corridor, and travel time and distance measurements are collected for each link. Corridors are scheduled for data collection in order to attempt to capture “typical” conditions, taking care to avoid on-going construction projects, special events, or other circumstances which would interfere with normal travel patterns.

Travel time and distance measurements are collected in the field by connecting a laptop computer to the diagnostic equipment of the vehicle being used. This is done through the use of an OBD Scan Tool and software from JAMAR. A remote control is also used, with the remote receiver plugged into the USB port of the laptop. A button on the remote control is pushed at each node point along the corridor, which provides travel time, distance, and speed information for each link. Data collection logs are kept for each corridor noting the time, date, field technicians, weather conditions, electronic file locations, and other information for that corridor. This log also includes any field notes taken by the technicians performing the travel time runs. These notes may include observed travel patterns, potential causes of congestion, or other unique characteristics of the corridor. PennDOT’s web-based highway video log is also utilized to document the specific locations of node points and to collect information that may have been missed in the field.

Upon completion of the travel time runs, data is downloaded from the laptop computer and compiled using JAMAR’s PC-Travel for Windows software. SPC then imports the data into its analysis spreadsheets where the travel time, distance, and speed measurements collected in the field are incorporated with traffic volume data. This traffic volume data is gathered from a number of sources including SPC’s internal databases, HPMS & RMS databases, and Traffic.com’s website. Supplemental traffic counts may be conducted by SPC when existing volume data is insufficient or too dated to be useful.

A Data Collection Report was issued in 2002, providing detailed data and analysis on the original CMS network. These reports provide baseline network monitoring information. The second round of data collection is now underway and is expected to be complete in early 2006, covering corridors in eight counties. A third round of data collection is scheduled to begin in the fall of 2006, including corridors in Fayette and Lawrence Counties for the first time.

The data collected in the ongoing CMP monitoring program yields information on the magnitude and location of congestion throughout the region. This data can be used to help set priorities for detailed corridor analysis and implementation of CMP strategies through project programming. Over a period of time, changing conditions in the region such as land use patterns, economic conditions, and transportation trends will be reflected in the monitoring program in addition to the effects of implementing congestion management strategies.

9. Data analysis and performance monitoring

A qualitative evaluation of the corridors on the CMP monitoring network was undertaken, with assistance from members of the Inter-agency Technical Task Force for Congestion Management. **Table 4** presents this analysis. Each corridor was reviewed for **types and severity of congestion**. The types considered were recurring (existing and future) and nonrecurring (incident and event). Where congestion was believed to occur, it was rated qualitatively as severe, high, or moderate. These terms were not defined quantitatively, but the task force kept in mind comparative regional standards. In the future, congestion on all the corridors may be evaluated on a quantitative scale.

TABLE 4, TYPES AND SEVERITY OF CONGESTION

CMS Monitoring Corridors					Congestion Type			
No.	Description	Limit	Limit	Mileage	Recurring		Non-recurring	
					Existing	Future	Incident	Event
ALLEGHENY COUNTY								
1	SR 8	SR 228	Butler Street (SR 2122)	16.0	H	S	S	
2	East Street/McKnight Road	SR 19/McKnight Rd (SR 4003) split	East Ohio Street	10.5	H	S		
3	I-79	Southpointe Interchange, exit 48	Rochester Road (SR 4011) overpass	25.0	M	H	H	H
4	I-279 (Parkway North)	I-79	SR 65	12.0	H	S	S	S
5	I-279 (Parkway West)	SR 65	I-79	6.5	S	S	S	S
6	SR 22	SR 22/30/60 overpass	I-79, exit 59 overpass	3.5	H	S	S	S
7	SR 22	Imperial exit underpass	SR 22/30/60 underpass	4.0	M	M	M	S
8	SR 60	Business Route 60, exit 3, SB overpass	SR 22/30/60 overpass	2.0	H	S	H	H
9	SR 60	SR 22/30/60 underpass	I-79, exit 60 overpass	3.5	H	S	S	
10	SR 65/I-279	I-79, exit 66 (Emsworth-Sewickley)	Ft. Duquesne Blvd.@Stanwix	9.1	M	H	H	S
11	McKees Rocks Bridge	SR 51 (Island Ave.)	Ohio River Blvd. (SR 65)	1.1	M	H	H	M
12	Fifth Avenue	Penn Avenue	Sixth Ave. Extension	5.0	H	H		H
13	Forbes Avenue (SR 2108)	Braddock Avenue	Sixth Ave. Extension	5.5	H	H		H
14	SR 51	I-79, exit 64 (Coraopolis)	Ramp from West End Circle	8.3	M	H	M	M
15	SR 51	RR overpass @West End Circle	Weigles Hill Rd. (S of Elizabeth)	16.0	S	S	S	S
16	SR 28	SR 366 underpass, exit 14 (Tarentum)	Anderson St.	18.3	S	S	S	
17	I-579	I-279 (Parkway North)	Liberty Bridge	1.5	M	H	H	S
18	West End Bridge	Fulton Street	RR overpass @ West End Circle	0.7	H	H	S	S
19	Liberty Bridge and Tunnel	SR 51 overpass	Forbes Avenue	1.8	S	S	S	S
20	West Liberty Avenue/Washington Road	SR 51	Connor/Gilkeson Roads	5.4	H	H	S	S
21	Three Degree Rd/Babcock Blvd/Peebles	Duncan Avenue (SR 4024)	Perry Highway (SR 19)	2.3	H			
22	Siebert Road/SR 4016	Thompson Run Road	Babcock Boulevard	1.5	H	H		
23	Cochran/Greentree Roads	I-279 (Parkway West) underpass	Washington Road (SR 3069)	4.0	H	H		
24	SR 910	SR 19 overpass	Nicholson Road (SR 4049)	2.3	H			
25	I-76 (PA Turnpike)	Exit 67 (Irwin)	Exit 57 (Monroeville)	11.0	M	M	H	
26	SR 19	SR 228	Pine Creek Rd. (SR 4086)	7.9	H	H		
27	Allegheny River Blvd/Butler St/Penn Ave	Sandy Creek Rd (SR 130)	32nd Street	7.1	H	H	H	
28	Highland Park Bridge	SR 28	Butler Street (SR 8)	0.6	H	H	H	
29	Washington Blvd. (SR 8)	Allegheny River Blvd. (SR 130)	Penn Avenue	2.2	M	M	M	
30	Negley Run Blvd./Collins St.	Washington Blvd. (SR 8)	Penn Circle	0.9	M	M	M	

S=severe congestion H=high congestion M=moderate congestion

TABLE 4, TYPES AND SEVERITY OF CONGESTION

No.	Description	Limit	Limit	Mileage	Recurring		Non-recurring	
					Existing	Future	Incident	Event
31	I-376 (Parkway East)	I-279 (merge at Fort Pitt bridge)	I-76 (PA Turnpike)	15.0	S	S	S	S
32	SR 2048 (Business 22)	I-76 (PA Turnpike) overpass	I-376 (Parkway East), Churchill ramp merge	4.0	S	S	S	
33	Penn Avenue/Ardmore Blvd	I-376 (Parkway East) overpass, exit 8 (Forest Hills)	Penn Circle East	3.5	H	S	H	
34	Centre Avenue	South Highland Avenue	Bigelow Blvd.	1.7	H	H		
35	Baum & Bigelow Blvds	South Euclid Avenue	Sixth Ave.	4.8	H	H		
36	SR 88 (Library Road)	Broughton Road	SR 51, Saw Mill Run Blvd.	3.7	S	S		
37	Beechwood Blvd/Browns Hill Road	Greenfield Bridge	SR 837 (Eighth Ave.)	2.5	M	H	H	M
38	Fifth Avenue	Sixth Ave. Extension	Liberty Avenue	0.4	H	H		H
39	Braddock Avenue/Rankin Bridge	Forbes Avenue	SR 837 (Kennywood Blvd.)	3.3	H	H	H	
40	Forbes Avenue	Stanwix Street	Grant Street	0.5	H	H		H
41	SR 837	Center Avenue in Duquesne	Tenth Street Bridge	11.3	H	S	H	
42	Second Avenue	Tenth Street Bridge	Grant Street	0.4	M	H	H	H
43	Hot Metal Bridge	SR 837 (East Carson St.)	SR 885 (Second Avenue)	0.5		M	H	H
44	Liberty Avenue	32nd Street	Grant Street	1.7	H	H	H	
45	SR 837 (East & West Carson)	Tenth Street Bridge	Ramp from West End Circle	2.5	H	H	H	
46	SR 30	I-376 overpass, exit 8 (Forest Hills)	Allegheny/Westmoreland county line	7.5	S	S	S	
47	SR 2040 (Buttermilk Hollow/Lebanon Church/Curry Hollow/Broughton Roads)	SR 2052 (Thompson Run Rd.)	SR 88 (Library Road)	7.4	H	S	H	
48	<i>Corridor number not in use</i>							
49	<i>Corridor number not in use</i>							
50	Lebanon Road (SR 885)	Lebanon Church Road (SR 2040)	Mifflin Road	2.0	H	S	H	
51	SR 885 (Mifflin Rd., Glenfield Bridge, Second Ave.)	Lebanon Road	Bates Street	4.0	H	S	H	
52	Second Avenue	Bates Street	Tenth Street Bridge	1.5	M	H	H	H
53	Bates/Bouquet Streets	Second Avenue	Forbes Avenue	1.0	H	H	H	H
54	<i>Corridor number not in use</i>							
55	Tenth Street	McArdle Roadway	Second Avenue	0.3	H	H		
56	Smithfield Street Bridge	Carson Street (SR 837)	Fort Pitt Blvd	0.3	H	H	S	H
57	Boulevard of the Allies	Bates Street	Liberty Bridge offramp	2.2	M	H	H	H
58	Grant Street	Boulevard of the Allies	Liberty Avenue	0.8	H	H	H	S
59	Liberty Avenue	Stanwix Street	Grant Street	0.6	H	H	S	S
60	Boulevard of the Allies	Liberty Bridge offramp	Stanwix Street	0.8	H	H	S	S

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No.	Description	Limit	Limit	Mileage	Recurring		Non-recurring	
					Existing	Future	Incident	Event
61	Stanwix Street	Boulevard of the Allies	Liberty Avenue	0.3	M	H	S	S
62	Craft Avenue	Fifth Avenue	Blvd. of the Allies (SR 885)	0.3	H	H	H	H
63	Steuben Street	SR 19/51 connector @ W&LE RR crossing	Noble Avenue (SR 60)	2.0	M	M	H	S
64	Connor/Gilkeson/Painters Run Roads	Bower Hill Road	SR 88 (Library Road)	3.0	M	H		
65	Banksville/McFarland Roads	I-279 (Parkway West) ramp	Washington Road (SR 3069)	3.0	H	S	H	
75	I-79	SR 228 overpass, Exit 78 (Mars/Cranberry)	Rochester Road (SR 4011) overpass	6.9	M	H	H	H
113	Penn Circle	South Highland Avenue	Centre Avenue	1.0	H	H		
ARMSTRONG COUNTY								
66	<i>Corridor number not in use</i>							
67	<i>Corridor number not in use</i>							
68	SR 1038/SR 1040/Business 422	Business 422/Old SR 28 split	SR 268	3.5	H	H	M	
69	SR 66	SR 128	Business 422	1.0		M		
BEAVER COUNTY								
70	SR 65	SR 68 overpass (Rochester)	I-79 overpass, Exit 66 (Emsworth/Sewickley)	16.9	M	H		
71	SR 68	SR 60 overpass, Exit 13A (Beaver)	SR 18, Rhode Island Ave.	2.3	M	H		
72	SR 18	SR 588 East (Beaver Falls)	SR 68 overpass (Rochester)	4.9	M	H		
103	SR 51	SR 60 overpass, Exit 15 (Chippewa)	McKinley Road (SR 4015)	1.7	M	H	H	
BUTLER COUNTY								
73	SR 68 (West)/SR 356	SR 422 overpass	McKean Street	4.0	S	S	S	S
74	SR 68 (East)	SR 422 overpass	McKean Street	1.6	H	H	S	
75	<i>See Allegheny County</i>							
76	<i>Corridor number not in use</i>							
77	SR 422	SR 528 overpass	Duffy Road overpass	5.0		M	M	M
78	Hanson Ave. (SR 3001)	SR 8	SR 68	1.1	H	S	S	
79	SR 68	I-79	SR 19	1.0	M	M	M	M
80	SR 288	SR 588	SR 19	0.8	M	M	M	M
81	SR 2004/SR 3020/SR 228	SR 2006 (Lovi Road)	SR 8	12.1	H	S	S	
82	SR 19	SR 3025 (Little Creek Rd.)	SR 228	9.5	H	S	H	H
83	SR 8	SR 228 (West)	SR 68 (Cunningham St.)	12.1	M	H	M	M
84	SR 8	SR 308	SR 68 (Cunningham St.)	2.8	H	S	S	
104	SR 356	Weitzel Road	SR 8	1.7	H	H	H	

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TABLE 4, TYPES AND SEVERITY OF CONGESTION

No.	Description	Limit	Limit	Mileage	Recurring		Non-recurring	
					Existing	Future	Incident	Event
FAYETTE COUNTY								
115	SR 21	Dixon Blvd.	SR 6040	1.7	M	H	M	
116	SR 40	Duck Hollow Road	US 119	1.9	M	H	M	
117	SR 119	Oglevee Lane	Pleasant Valley Rd (SR 982)	5.2	M	H	M	
118	SR 711	SR 201	Crawford Ave. (SR 1051)	0.9	M	M	M	
GREENE COUNTY								
105	SR 21	I-79 overpass, Exit 14 (Waynesburg)	SR 19	1.0	M	M	H	H
106	SR 19	SR 21 East	Morris St (SR 3015)	1.4	M	M	H	H
INDIANA COUNTY								
107	SR 286	Windy Ridge Road	East Pike Rd (SR 1002)	4.3	M	M	M	
108	Business 422 (SR 4422)/SR 422	SR 286	Parkwood Road (SR 3022)	3.1		M	M	
109	SR 119	SR 56	SR 422 underpass	3.3	M	M	M	
LAWRENCE COUNTY								
119	SR 18	Mahoning Ave.(SR 18) & Moravia St.(SR 168) split	Nashua Road	7.3	M	M	H	
120	SR 65	Gardner Stop Road	Taylor/Butler Sts. (SR 2004)	2.8	M	M	M	
WASHINGTON COUNTY								
85	SR 40	I-70 overpass, Exit 15 (Chestnut St.)	SR 19-SR 40 split	4.2	H	H	S	
86	SR 18	SR 4020 (Oak Grove Rd.)	SR 40 (West Chestnut St.)	2.1	H	H	S	
87	SR 19	SR 1023 (McClelland Rd.)	SR 40 (Maiden Street)	8.4	M	H	H	
110	I-70	I-79 North (exit 18)	I-79 South (exit 21)	3.6	M	H	S	
114	SR 19	Connor/Gilkeson Roads (SR 3038)	McClelland Rd. (SR 1023)	9.2	M	H	H	
WESTMORELAND COUNTY								
88	SR 119	Bovar-Luxor Rd. (SR 1028)	Toll 66 overpass	9.0	M	H	H	
89	SR 30	I-76 overpass	Allegheny County line	7.9	M	M	H	
90	Leechburg Rd. (SR 4042/SR 4044)	SR 56	SR 366	2.7	M	M	H	
91	SR 22	I-76 (PA Turnpike)	SR 66	11.0	H	H	H	
92	SR 22	SR 66	Blairsville	17.0	H	H	H	
93	SR 66	Sheffield St. (S of SR 22)	Freeport St., in Delmont	1.3	M	M	H	
94	SR 30	PA Turnpike overpass	SR 119 underpass	7.6	S	S	S	
95	SR 30	SR 30 split @ Lentz St. (S of Latrobe)	SR 119 underpass	12.0	H	H	S	
96	Pittsburgh and Otterman Streets WB thru Greensburg (SR 3030, SR 130, SR 3028)	SR 30	SR 30	2.8	H	S	S	

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No.	Description	Limit	Limit	Mileage	Recurring		Non-recurring	
					Existing	Future	Incident	Event
97	SR 356	Butler County line	SR 56 and 356 split	5.4	M	H	S	
98	SR 366	SR 28	Second Street (SR 4087)	4.5	S	S	S	
99	SR 130	Brinton Ave., in Pitcairn	SR 4002 (Pleasant Valley Drive)	14.3	M	H	H	
100	SR 201	Fayette Street, in Fayette County	Vance Dei Cas Hwy (SR 3013)	1.2		M	M	
101	SR 819	SR 119	SR 31	2.0		M	M	
102	SR 981	Henry's Road (T-888)	Main St., Latrobe	4.2	M	H	H	H
111	Pittsburgh Street EB thru Greensburg (SR 3026, SR 130, SR 3030)	SR 30	SR 30	2.5	H	S	S	

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