

# Presentations of Alternative Demand Data Summaries

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## ABSTRACT

Automatic traffic counters collect volume data for every hour of the year. Some methods of illustrating or summarizing traffic demand data for the purposes of planning, design, or identification of systematic detection errors are presented. Alternative summaries are provided that permit a more detailed examination of peaking characteristics and time distribution, as well as of the frequency and magnitude of certain types of traffic loads. Yearly calendars, graphs of ranked hourly volumes, and various frequency distributions are illustrated using data from Ontario's permanent counting stations. Potential applications are discussed for each, sample locations are examined, and some types of useful information that can be obtained are pointed out.

Highway agencies plan the upgrading of old facilities or the construction of new ones based on anticipated traffic volume demands. Such demand data are collected by automatic counters for every hour throughout the year on the busiest highways. These data need to be summarized to identify the most critical conditions but, because of the large amounts of data that are obtained, more than one type of summary can be useful. The exact type of summary depends on specific needs. Some suggested types of summaries are illustrated using data collected at Ontario's permanent counting stations in 1980.

## SUMMARY TABLES

The traditional method of summarizing the traffic demand for a given year is by means of a set of summary tables. These tables can list the total traffic demand, maximum hourly volumes, and some measure of

the peaking characteristics. Values can be quoted either in terms of combined (two-way) traffic or as a function of direction.

Summaries for the counts obtained for 1980 at Ontario's permanent counting stations (PCSSs) are shown in Figures 1 and 2. Figure 1 shows each PCS location and lists, for the combined directions, the maximum hourly volume, the average annual daily traffic, the 30th highest hour, and a peaking ratio (i.e.,  $K = 30HV/AADT$ ). Figure 2 shows a summary of the peak directional PCS volumes in Ontario for 1980, (i.e., north- and southbound, or east- and westbound).

## YEARLY CALENDARS OF HOURLY VOLUMES

Summary tables provide only a simplified measure of the magnitude of traffic demand and its peaking characteristics. Often it is of interest to also know when, why, and how these peaking conditions occur. Therefore, a traffic calendar has been developed as a measure of the time distribution of the top traffic demands. A yearly calendar of hourly volumes provides a structured visual presentation of the time of day, week, or year during which the highest 300 (in this case) hourly volumes of the year occur. The calendar lists the year's top 300 hourly volumes according to hour (left to right) and day (top to bottom) of occurrence. The result is a sparse  $366 \times 24$  matrix of traffic volume data containing only the largest 300 elements. Because data are all presented in a single, ordered picture, patterns of high demand such as problem days or peak demand periods can be identified quite easily.

## Simple Calendars of Actual Hourly Volumes

This type of calendar lists the actual numerical volume counts for each given day and hour. Figures 3 and 4 show portions of such calendars for two sample locations. Volume counts for the late-summer months of 1980 are presented for stations 22 (Brampton) and 91 (Kirby), respectively. In each case the combined (two-directional) hourly count is presented. Station 22, at Brampton, is located on a commuter route that

STA	LOCATION	HIGHWAY DESCRIPTION	LANES	MAXH	AADT	30HH	30HH/AADT
2	HOMER	QEW - E. of Hwy 405	4	4202	28004	3407	0.122
4	SHELBYNE	10 - Hwy 10-24-89	2	1426	7529	1135	0.151
5	GRAVENHURST	11 - N. of Washago	4	3523	11790	2904	0.246
21	BRADFORD	11 - Bradford S. Lts	4	1564	12000	1352	0.113
22	BRAMPTON	7 - W. of Hwy 50	4	3493	22940	3029	0.132
27	ROWENA	401 - W. of Hwy 31	4	2075	8335	1342	0.161
30	SIMCOE	3 - W. of Simcoe	2	620	5018	537	0.107
31	DIXIE	401 - W. of Hwy 10	6	7837	67261	7217	0.107
32	PORT-HOPE	401 - W. of Port Hope	4	4997	21945	3460	0.158
33	NIPIGON	11 - W. of Nipigon	2	504	2991	414	0.136
35	DUNVEGAN	417 - W. of Hwy 34	4	1278	6774	996	0.147
36	PORT-SEVERN	69 - N. of Port Severn	2	1787	5414	1355	0.250
37	MAPLE	400 - N. of Hwy 7	6	6687	44863	6009	0.134
74	OTTAWA	417 - Ottawa Queensway	4	6638	57323	6236	0.109
75	KEELE	401 - E. of Keele St.	12	23980	227954	22880	0.100
77	LIVERPOOL	401 - W. of Pickering	6	9225	82704	8593	0.104
90	SNELGROVE	10 - N. of Snelgrove	4	1842	11110	1289	0.116
91	KIRBY	115 - N. of Kirby	2	1920	10633	1644	0.155

FIGURE 1 Description of Ontario PCS locations.

STA	LOCATION	DIR	MAXH	AADT	30HV	"K"	DIR	MAXH	AADT	30HV	"K"
2	HOMER	W	2775	14045	1854	0.132	E	2710	13964	2187	0.157
4	SHELBOURNE	W	1007	3693	736	0.199	E	1122	3833	808	0.211
5	GRAVENHURST	S	3119	5935	2375	0.400	N	2918	5872	2114	0.360
21	BRADFORD	S	1192	5986	844	0.141	N	1009	6000	803	0.134
22	BRAMPTON	W	2216	11208	1850	0.165	E	2693	11640	2087	0.179
27	ROWENA	W	1091	4111	710	0.173	E	1058	4222	722	0.171
30	SIMCOE	W	414	2514	294	0.117	E	398	2502	283	0.113
31	DIXIE	W	4606	33027	4334	0.131	E	5142	33948	4869	0.143
32	PORT-HOPE	W	3098	10865	2363	0.217	E	2335	11083	2096	0.189
33	NIPIGON	W	306	1476	238	0.161	E	348	1517	208	0.137
35	DUNVEGAN	W	881	3420	567	0.166	E	812	3352	573	0.171
36	PORT-SEVERN	S	1378	2746	981	0.357	N	1111	2678	932	0.348
37	MAPLE	S	5333	22649	4402	0.194	N	5067	22494	4403	0.196
74	OTTAWA	W	3723	28534	3560	0.125	E	3525	29457	3393	0.115
75	KEELE	W	12400	115423	11920	0.103	E	12110	112455	11600	0.103
77	LIVERPOOL	W	5937	40541	5383	0.133	E	5607	41938	5227	0.125
90	SNELGROVE	S	1328	5665	935	0.165	N	1037	5353	817	0.153
91	KIRBY	S	1535	5526	1339	0.242	N	1241	5098	1080	0.212

where :

MAX HR : the maximum combined hourly volume count observed  
 AADT : the average annual daily traffic  
 30HV : the 30th highest combined hourly volume count  
 "K" : peaking factor equal to 30HV/AADT

FIGURE 2 Directional peak PCS volumes in Ontario for 1980.

has corresponding peaks during the morning and afternoon rush hours on weekdays. Station 91, at Kirby, is located on a recreational route. Traffic on this stretch travels in a northbound direction toward "cottage country," and back southbound on Sunday evenings. This results in two peaks in traffic volume at the beginning and the end of each summer weekend. It is noted that the 4-month period, which is shown in Figure 4, contains 218 of the top 300 hours. Thus the most important part of the year can be illustrated on a single page.

#### Multidirectional Calendar of Actual Hourly Volumes

A variation of the calendars is shown in Figures 5 and 6 for stations 02 at Homer and 91 at Kirby. In these figures, the individual directional counts and the hourly counts for the combined directions are listed together for each hour of the year. Specifically, the combined hourly count is listed, followed by the east- and westbound, or south- and northbound, counts, respectively. This presentation illustrates most clearly offsets in peaking characteristics for individual directions with respect to each other and to their combined total.

Station 02 at Homer is located on the Queen Elizabeth Way. The summer traffic volume peaks in the eastbound direction (to Niagara Falls) in the early afternoon and in the westbound direction later in the afternoon. Although each direction has distinct peaks of its own, the combined peak tends to bridge the directional peaks.

For station 91 at Kirby, the nature of the traffic demand is illustrated more clearly using the bidirectional approach. The summer traffic peaks in the northbound direction on Friday evenings and Saturday mornings, with hardly any opposing volume. The reverse takes place at the end of these summer weekends, when people return south late Sunday afternoon and evening. The resulting top 300 combined volumes tend to reflect the top 150 or so hours in each direction.

#### Calendar of Relative Traffic Volume Intensity

A calendar of traffic volume intensity was introduced to provide a simple relative scale of traffic

demand as an alternative to the actual numerical volumes presented in the previous section. This allows for quick yet comprehensive visual recognition of patterns of severity and time of peaking.

The traffic volume intensity calendar is produced by mapping every traffic volume between the highest and the 300th highest hour on a scale from 1 to 5. The difference between the highest and the 300th hour is divided by 5 to create five cells of equal volume increments. The position of the cell into which an hour falls is denoted by the corresponding number of asterisks (i.e., from 1 to 5) to indicate magnitude of demand. Hourly volumes slightly larger than those of the 300th highest hour are indicated by a single asterisk, and volumes approaching the year's highest hourly volume are indicated by five asterisks.

The traffic volume intensity calendar provides the reader with a global view of the peaking patterns throughout the year. Partial calendars for directional and total volumes are shown for stations 02 at Homer, 22 at Brampton, and 91 at Kirby in Figures 7-9. In general, Homer can be seen to have a summer afternoon peak that intensifies on weekends. The Brampton station encounters a clear commuter pattern with very distinct weekday morning and evening peaks. Station 91, near Kirby, experiences a typical recreational route demand with highly directional peaks at the beginning and end of nearly all summer weekends or holidays.

#### GRAPHS OF RANKED HOURLY VOLUMES

A standard method of representing annual hourly traffic demands consists of ranking the hourly volumes. Graphs of this type are shown in Figures 10 and 11. Special emphasis is placed on their peaking characteristics, and the analyses are based on a directional approach. All graphs have two abscissa scales and ordinates with dual labels.

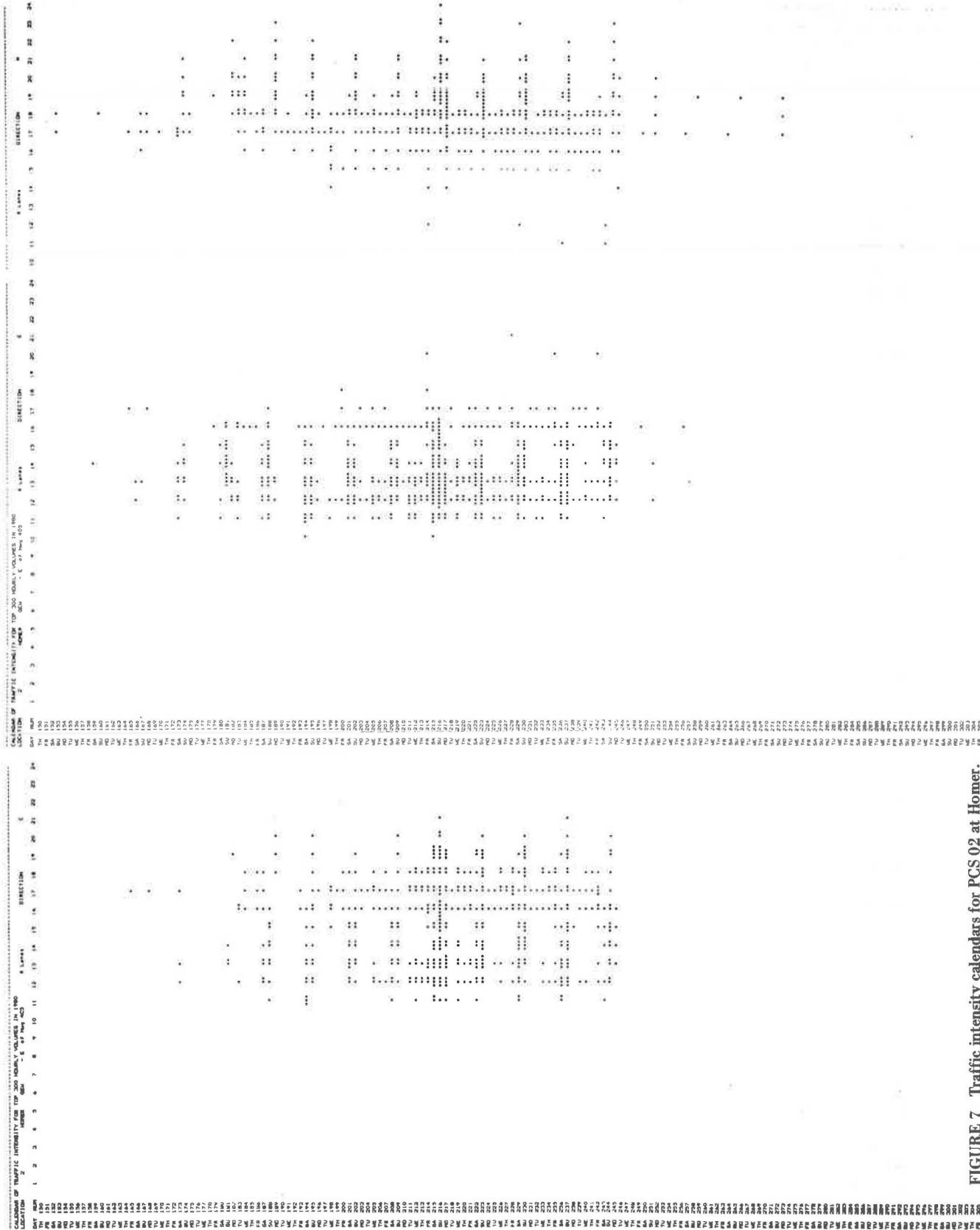
Two scales are used for the abscissas to simultaneously show the detailed peaking characteristics of the top hours and the entire annual distributions on the same figure. The top abscissa, which should be used with the top curve, indicates the ranking of the top 100 (or 200) hours. The bottom abscissa, which should be used with the bottom curve, indi-

**FIGURE 3** Calendar of actual hourly volumes for PCS 22 at Brampton.

**FIGURE 4** Calendar of actual hourly volumes for PCS 91 at Kirby.

**FIGURE 5** Multidirectional calendar for PCS 02 at Homer.

**FIGURE 6** Multidirectional calendar for PCS 91 at Kirby.



**FIGURE 7** Traffic intensity calendars for PCS 02 at Homer.

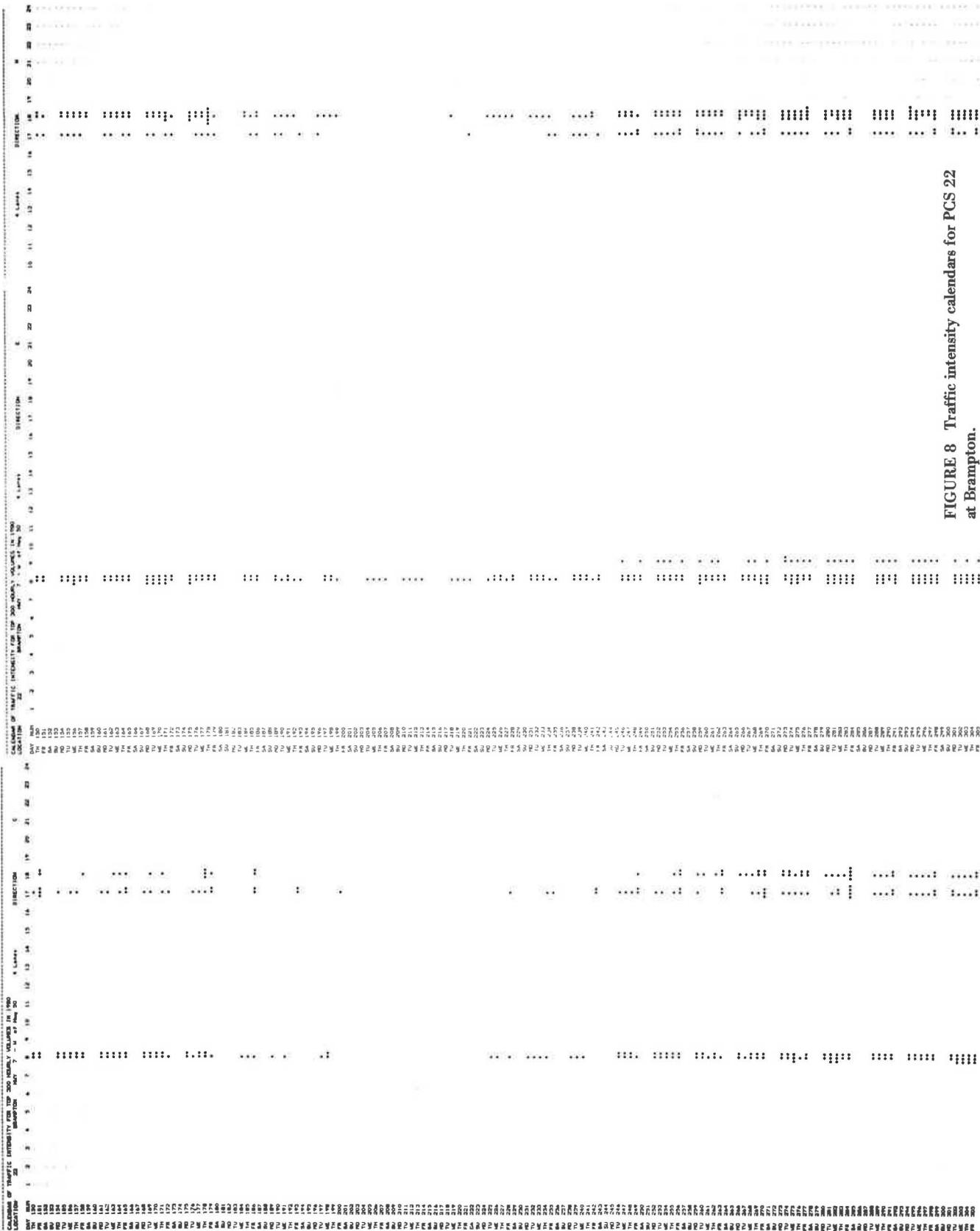


FIGURE 8 Traffic intensity calendars for PCS 22 at Brampton.

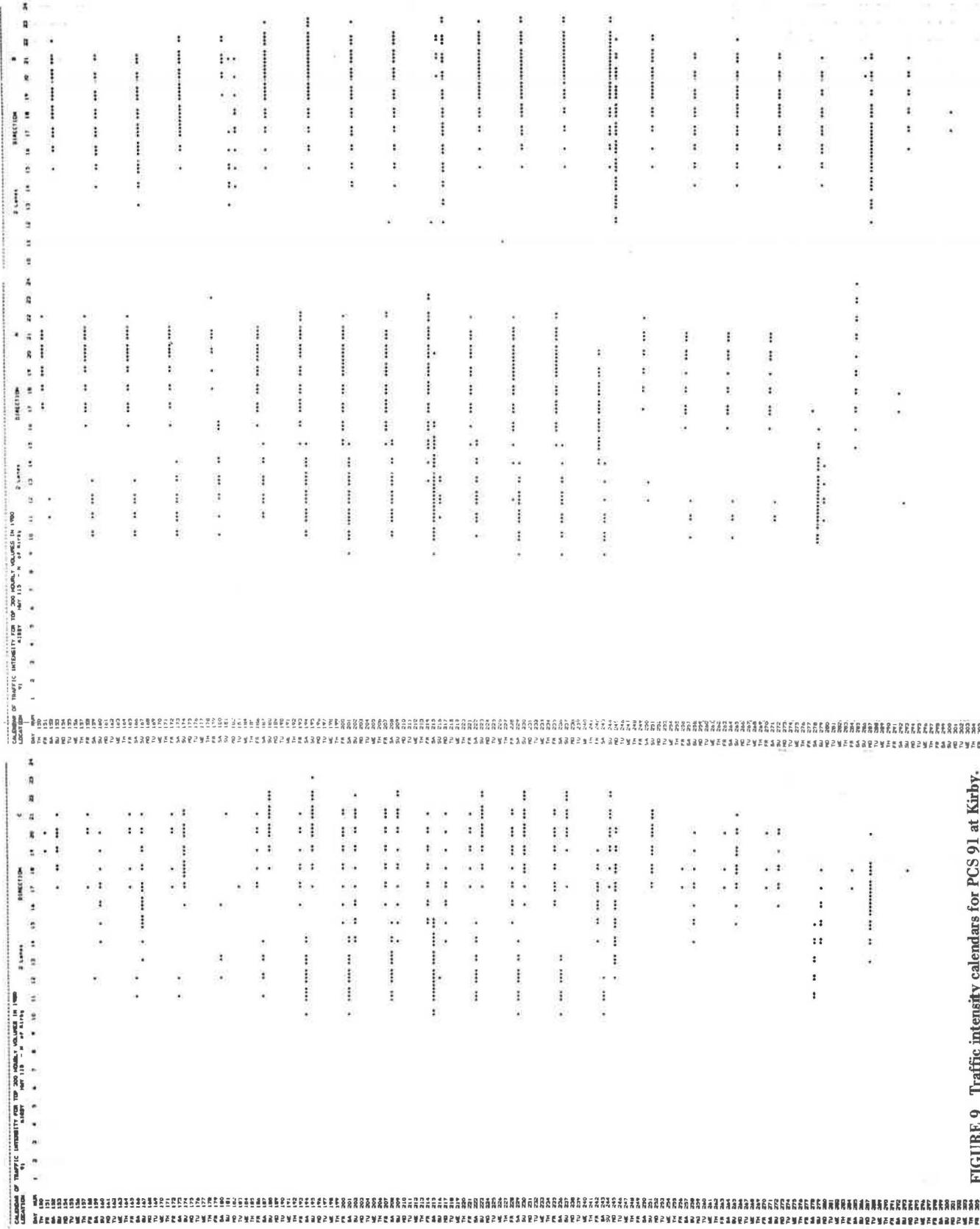


FIGURE 9 Traffic intensity calendars for PCS 91 at Kirby.

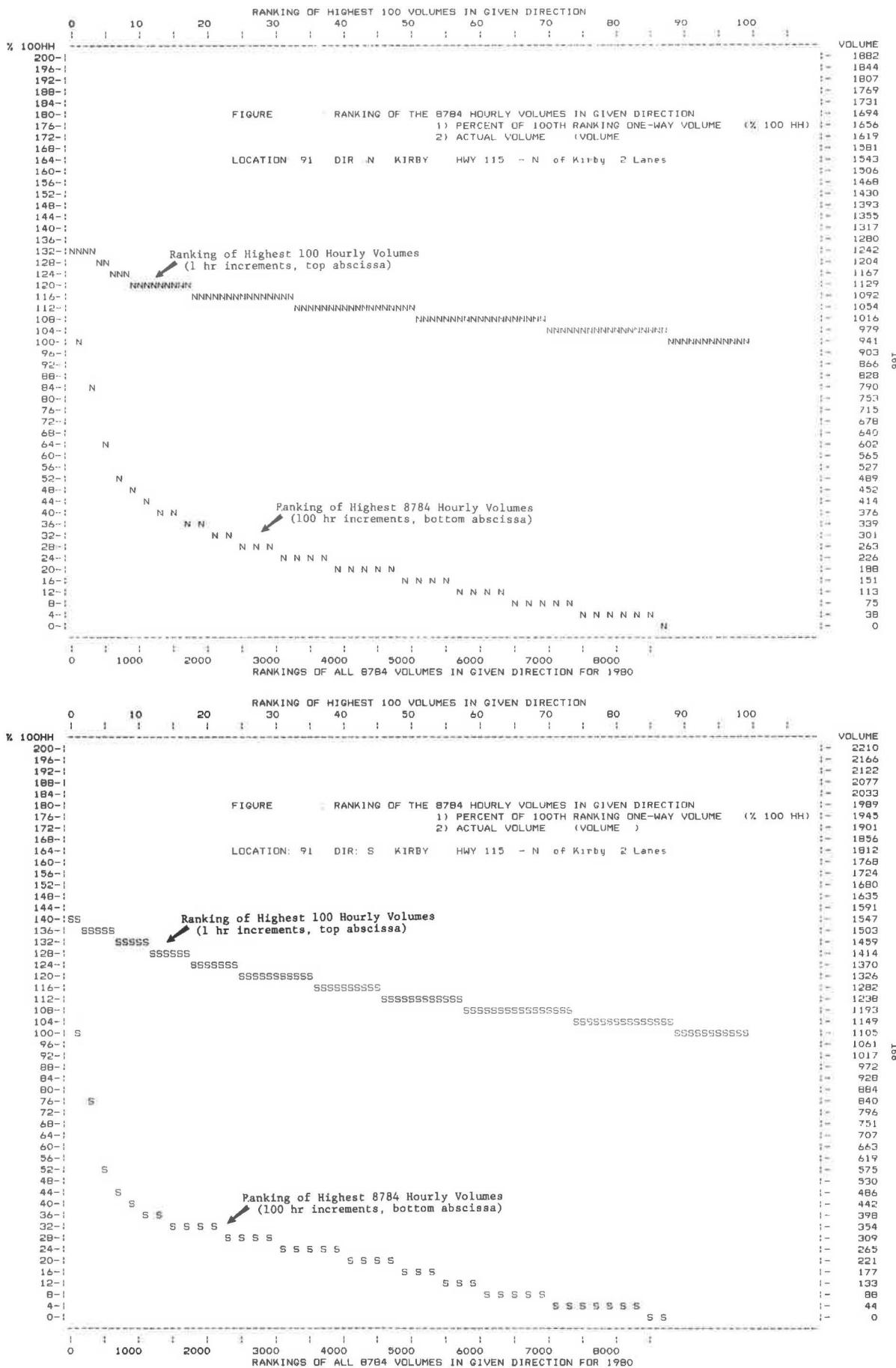


FIGURE 10 Ranking of directional volumes for PCS 91 at Kirby.

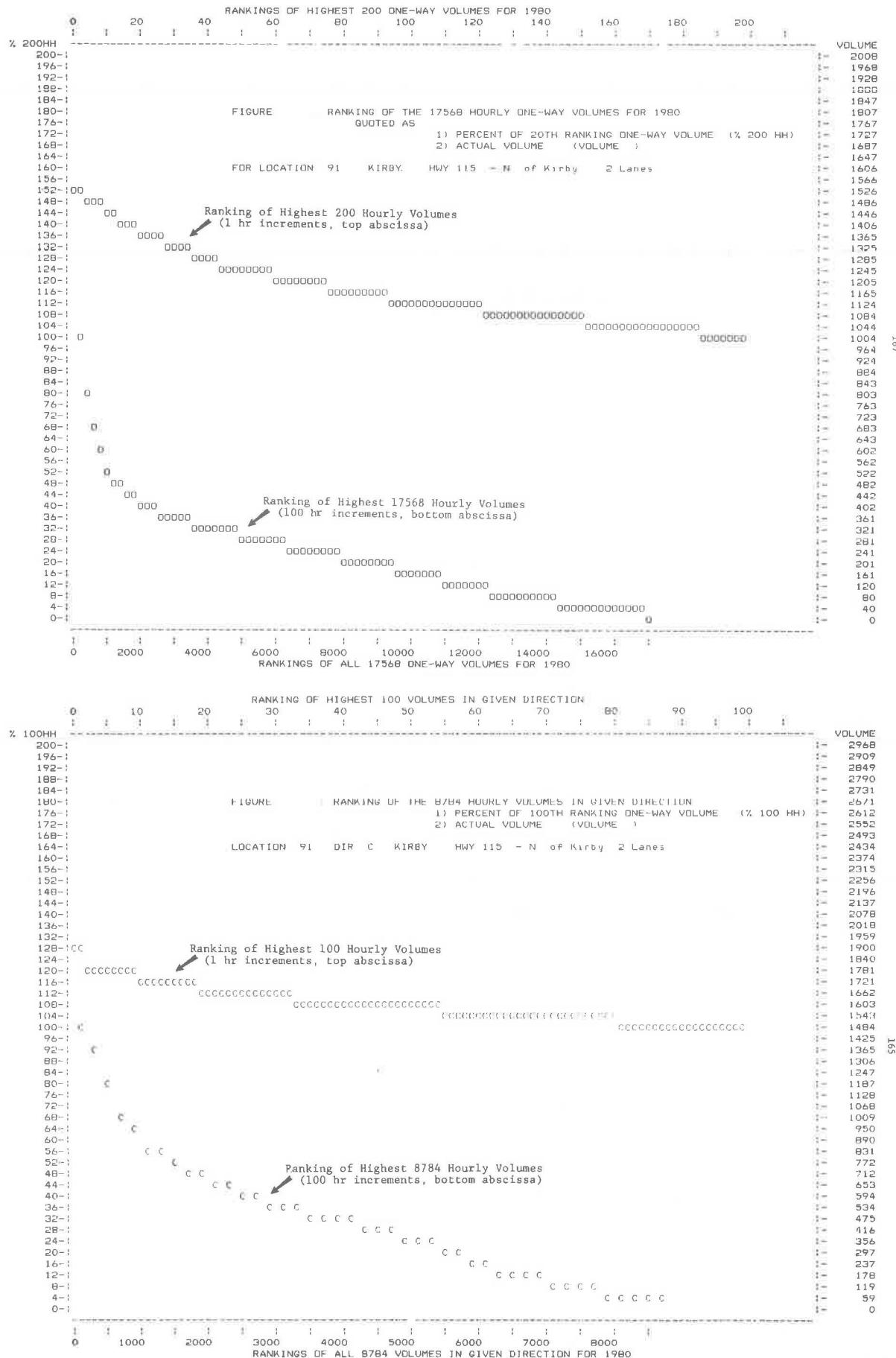


FIGURE 11 Ranking of combined two-way and one-way volumes for PCS 91 at Kirby.

cates the rank position of the total 8,784 (or 17,568) hourly volumes in the year. The ordinates of these graphs have dual labels, which simultaneously indicate the absolute demands and the relative demand distribution as a percentage. Both ordinates can be used with either the top or the bottom curve. The right ordinate indicates the magnitude of the hourly demand, expressed in vehicles per hour. The absolute scale is provided as a reference to indicate the absolute shape of the distribution and allow comparison with data from other sources. The ordinate on the left expresses the demand as a percentage of either the 100th or the 200th highest hourly volume. It is intended to emphasize relative peaking characteristics when comparing highways with either different designs or different traffic volumes. The graphs are labeled using the following plotting conventions for rank hour distributions:

C = Combined two-way volumes,  
 O = One-way volumes (independent of direction),  
 S = Southbound directional volume,  
 N = Northbound directional volume,  
 W = Westbound directional volume, and  
 E = Eastbound directional volume.

#### Directional Volumes

Because traffic capacity is, in general, virtually independent of volumes in the opposing direction, unidirectional peaks in traffic volume are of prime interest. Figure 10 shows northbound (N) and southbound (S) unidirectional plots for station 91 at Kirby. The figure shows some directional variation in peaking characteristics: southbound has a higher ultimate peak, and the northbound direction maintains its peaking over a greater range of volumes.

#### Combined Two-Way Volumes

Traditionally, the ranked combined two-way hourly demand volumes have been plotted. Although this approach has been discouraged by several authors (1,2), these traditional plots are nevertheless provided herein to allow for comparison of the Ontario demand data with other sources. Station 91, at Kirby, is used to illustrate the combined two-way volume plot. The 100th highest combined hourly volume for this location in 1980 was 1,357. The right ordinate continues with the absolute demands and the scale on the left is quoted as a percentage of 1,357, which represents the 100th highest hour.

#### Ranking of All One-Way Volumes Independent of Direction

The directional peaking characteristics of opposing directions can be simultaneously illustrated on a single graph by ranking the year's 17,564 one-way volumes, independent of direction. This represents 17,564 intensities of demand, which are generally best related to one-way volumes even for two-way, two-lane roads such as that at station 91 at Kirby. If both directions peak during the same hour, they are represented individually in the rankings. Relative peaking characteristics are expressed as a percentage of the 200th highest hour (HH) for equitable comparisons with directional and two-way graphs. Figure 11 shows such a one-way volume ranking for PCS 91 at Kirby.

#### INTERPRETATION OF DIFFERENT TYPES OF PLOTS

In general, highways have a balanced design and each

direction of travel has the same directional capacity. In this case a ranking of the 17,568 hourly one-way volumes (top of Figure 11) would indicate for how many hours throughout the year a given directional traffic volume was exceeded. Conversely, this figure can be used to estimate a directional one-way traffic volume that will be exceeded during a prespecified number of hours.

Some highways, however, have different directional capacities. Examples of these are uphill stretches, places where one direction has an additional passing lane or paved shoulder, or conditions where only one direction has a severe lateral obstruction. In this case comparable intensities of traffic would correspond to different one-way volumes for each direction. Analysis by direction would therefore be required and the directional plots in Figure 10 would be more appropriate.

#### FREQUENCY DISTRIBUTIONS FOR VOLUME LEVELS

The distribution of a year's demand is often presented as a frequency distribution. Two types of frequency distributions are discussed herein, and each is presented in both absolute and relative terms. The first distribution indicates how many hours of the year the highway operates at a given volume level, and the second indicates how many users operate at a given intensity of demand.

#### Frequency Distribution for Hours

The conventional method of presenting frequency distributions consists of tabulating the number of hours that the highway operates at a given volume level or in a given volume range. This type of frequency distribution is facility oriented in that it expresses the number of hours the facility is exposed to a given demand level or demand load.

The use of such a facility-oriented technique is somewhat limited as was pointed out by Crabtree and Deacon (3) and Yagar and Van Aerde (4). It is true that these distributions can be used to calculate the wear and tear on the facility. However, because wear and tear are a function of the total number of vehicles and their size and generally not a function of the time distribution, it is more efficient to use a simple annual or seasonal total expressed as such or in terms of annual average daily traffic (AADT) for this purpose.

Frequency distributions by hour have been provided here because their use is still part of traditional highway design thinking. Sample distributions are shown in Figure 12 for station 91. The distributions by hour are provided for each direction and the combined two-way volume in terms of both hourly frequencies and percentages of the total 8,784 hours in 1980.

#### Frequency Distribution for Drivers

Tabulating the number of drivers (or vehicles) that operate at a given volume level is perhaps a more appropriate method of presenting a station's frequency distribution. This type of frequency distribution is more user oriented because it expresses the number of drivers that will be exposed to a given demand intensity (volume) throughout the year. These user-oriented statistics are more convenient and direct and allow costs to be directly computed by multiplying the unit cost per vehicle at each volume level by the number of drivers or vehicles in the volume interval or cell. This allows highway up-

LOC:

91

KIRBY HWY 115 - N. of Kirby

2 Lanes

VOLUME RANGE	FOR BOTH DIRECTIONS				FOR NORTHBOUND DIRECTION				FOR SOUTHBOUND DIRECTION			
	HOURS		DRIVERS		HOURS		DRIVERS		HOURS		DRIVERS	
	FREQ.	PERCENT	FREQ.	PERCENT	FREQ.	PERCENT	FREQ.	PERCENT	FREQ.	PERCENT	FREQ.	PERCENT
0- 50	324	3.69	8100	0.21	1259	14.33	31475	1.66	1604	18.26	40100	1.95
50- 100	935	10.64	70125	1.78	1325	15.08	99375	5.24	1052	11.98	78900	3.84
100- 150	650	7.40	B1250	2.06	1160	13.21	145000	7.65	740	8.42	92500	4.51
150- 200	633	7.21	110775	2.80	1090	12.41	190750	10.07	631	7.18	110425	5.38
200- 250	457	5.20	102825	2.60	1084	12.34	243900	12.87	877	9.98	197325	9.61
250- 300	327	3.72	89925	2.28	729	8.30	200475	10.58	1180	13.43	324500	15.81
300- 350	350	3.98	113750	2.88	549	6.25	178425	9.41	1000	11.38	325000	15.84
350- 400	520	5.92	195000	4.94	455	5.18	170625	9.00	640	7.29	240000	11.69
400- 450	566	6.44	240550	6.09	326	3.71	138550	7.31	315	3.59	133875	6.52
450- 500	572	6.51	271700	6.88	225	2.56	106875	5.64	165	1.88	78375	3.82
500- 550	560	6.38	294000	7.44	118	1.34	61950	3.27	109	1.24	57225	2.79
550- 600	430	4.90	247250	6.26	82	0.93	47150	2.49	77	0.88	44275	2.16
600- 650	360	4.10	225000	5.70	74	0.84	46250	2.44	57	0.65	35625	1.74
650- 700	332	3.78	224100	5.67	49	0.56	33075	1.75	50	0.57	33750	1.64
700- 750	274	3.12	198650	5.03	41	0.47	29725	1.57	38	0.43	27550	1.34
750- 800	258	2.94	199950	5.06	31	0.35	24025	1.27	20	0.23	15500	0.76
800- 850	199	2.27	164175	4.16	34	0.39	28050	1.48	29	0.33	23925	1.17
850- 900	166	1.89	145250	3.68	28	0.32	24500	1.29	27	0.31	23625	1.15
900- 950	134	1.53	123950	3.14	28	0.32	25900	1.37	14	0.16	12950	0.63
950- 1000	105	1.20	102375	2.59	27	0.31	26325	1.39	25	0.28	24375	1.19
1000- 1050	78	0.89	79950	2.02	24	0.27	24600	1.30	18	0.20	18450	0.90
1050- 1100	70	0.80	75250	1.91	25	0.28	26875	1.42	16	0.18	17200	0.84
1100- 1150	69	0.79	77625	1.97	12	0.14	13500	0.71	17	0.19	19125	0.93
1150- 1200	58	0.66	68150	1.73	4	0.05	4700	0.25	18	0.20	21150	1.03
1200- 1250	54	0.61	66150	1.67	5	0.06	6125	0.32	16	0.18	19600	0.96
1250- 1300	44	0.50	56100	1.42	0	0.00	0	0.00	12	0.14	15300	0.75
1300- 1350	46	0.52	60950	1.54	0	0.00	0	0.00	12	0.14	15900	0.77
1350- 1400	51	0.58	70125	1.78	0	0.00	0	0.00	9	0.10	12375	0.60
1400- 1450	41	0.47	58425	1.48	0	0.00	0	0.00	4	0.05	5700	0.28
1450- 1500	34	0.39	50150	1.27	0	0.00	0	0.00	6	0.07	8850	0.43
1500- 1550	24	0.27	36600	0.93	0	0.00	0	0.00	6	0.07	9150	0.45
1550- 1600	16	0.18	25200	0.64	0	0.00	0	0.00	0	0.00	0	0.00
1600- 1650	18	0.20	29250	0.74	0	0.00	0	0.00	0	0.00	0	0.00
1650- 1700	11	0.13	18425	0.47	0	0.00	0	0.00	0	0.00	0	0.00
1700- 1750	8	0.09	13800	0.35	0	0.00	0	0.00	0	0.00	0	0.00
1750- 1800	7	0.08	12425	0.31	0	0.00	0	0.00	0	0.00	0	0.00
1800- 1850	1	0.01	1825	0.05	0	0.00	0	0.00	0	0.00	0	0.00
1850- 1900	1	0.01	1875	0.05	0	0.00	0	0.00	0	0.00	0	0.00
1900- 1950	1	0.01	1925	0.05	0	0.00	0	0.00	0	0.00	0	0.00
1950- 2000	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2000- 2050	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2050- 2100	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2100- 2150	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2150- 2200	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2200- 2250	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2250- 2300	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2300- 2350	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2350- 2400	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2400- 2450	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2450- 2500	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
TOTALS	8784	100.00	3949700	100.00	8784	100.00	1895140	100.00	8784	100.00	2052320	100.00

FIGURE 12 Frequency distribution for hours and users.

grading strategies to be easily evaluated in terms of user benefits. The frequencies and percentages for drivers (vehicles) in each volume range are indicated in Figure 12 for 1980 at PCS 91. Estimates of user benefits could be further enhanced if for each vehicle (or each hour) the average vehicle occupancy were known. This would allow the total number of people (drivers and passengers) exposed to a given intensity of demand to be estimated.

#### Comparison of Hour and User Frequency Distributions

The hour and user frequency distribution are similar in nature but their interpretation can be quite different. Hour distributions tend to favor the large number of off-peak hours in which the traffic volume is below average. User distributions tend to correct for this by weighting each hour by the number of users in that hour. Figure 13 shows the relative and absolute frequencies of users and hours for station 91.

The costs incurred at a given traffic demand are experienced by the facility, the vehicle and driver, or the passengers in the vehicle. Although the first

two items can be determined from the distribution for hours and vehicles or drivers, the latter must account for occupancy and becomes important when costs of delay and safety are considered.

#### CONCLUSIONS

A number of different methods for analyzing and comparing the time distribution, the peaking characteristics, and the magnitude of traffic demand were illustrated for a number of sample highways.

Summary tables are the simplest means of presenting the annual traffic demands at a given counting station. Daily averages, peak hour volume counts, and peaking ratios can be compared most easily, but the oversimplification of the traffic summaries results in the loss of some of the more detailed features and characteristics of annual traffic demand.

The calendar provides a structured visual presentation of the distribution of peak demands throughout the year and within each day. Patterns can be identified and the nature of the traffic demand is more easily understood. Plots of ranked hourly distributions provide a clear description of the peaking characteristics of traffic demands because such

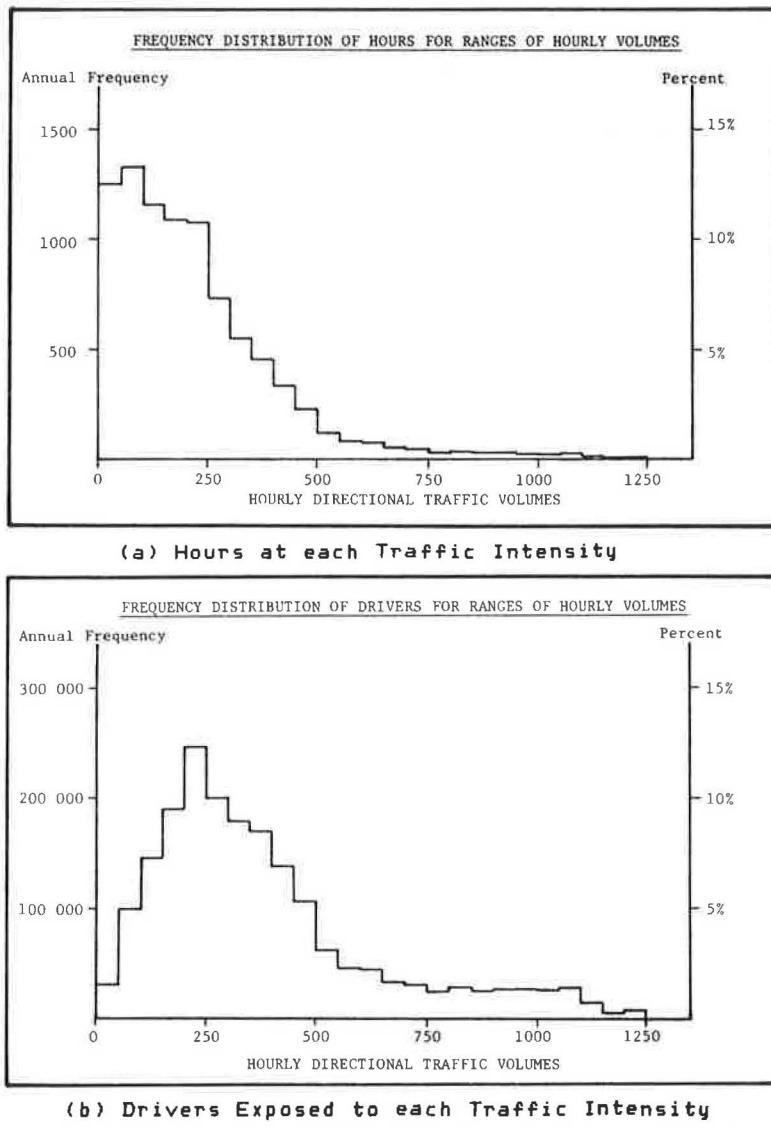


FIGURE 13 Frequency and percentage distributions for (a) hours and (b) drivers.

plots present a clear comparison of the magnitude of traffic volumes during the top hours.

Histograms of numbers of hours and vehicles in each range of traffic volumes are useful indicators of which conditions are most prevalent throughout the year. Because costs are calculated as a function of them, they identify those conditions that should be improved to yield the most significant cost savings.

As previously indicated, each of the methods is particularly useful in illustrating a specific aspect of the annual traffic demand, but each lacks some other type of information that might be desired. A highway agency should therefore use a combination of some or all of the techniques when carrying out a complete analysis of annualized traffic volumes.

#### RECOMMENDATIONS

Most current analysis is based on simple vehicle counts that do not account for vehicle type distribution. Because capacities tend to vary with the type of vehicle mix, it would be more appropriate to plot rankings, calendars, and histograms in terms of equivalent number of passenger cars. The maximum load, expressed in terms of passenger car units, would occur at times when there is a combination of large traffic volumes and a lot of heavy vehicles. This maximum load condition would not necessarily occur at the highest volume or the highest percentage of heavy vehicles. Specifically, percentage of recreational vehicles tends to be a maximum at times of maximum vehicle counts on recreational routes, but truck percentage tends to be lower during commuter peaks because truckers tend to avoid peak conditions.

Conventional analysis is based on a ranking of traffic volumes as an indication of the times when capacity is most likely to be exceeded. This assumes

capacity to be constant and makes peak volume counts concurrent with peak volume-to-capacity ratios. However, capacity can vary considerably and highway users are subjected to the lowest levels of service during times when combinations of large volumes and small capacity exist. This condition does not necessarily occur at either periods of highest volume or lowest capacity. Analysis of actual traffic volumes divided by prevailing capacity might perhaps indicate that the most critical service level conditions occur during winter holidays when traffic volumes are moderate but capacity is severely reduced.

The combined use of traffic volume, expressed in passenger car units, and capacity, matched for corresponding conditions, would provide a more accurate indication of when traffic demands are most critical.

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