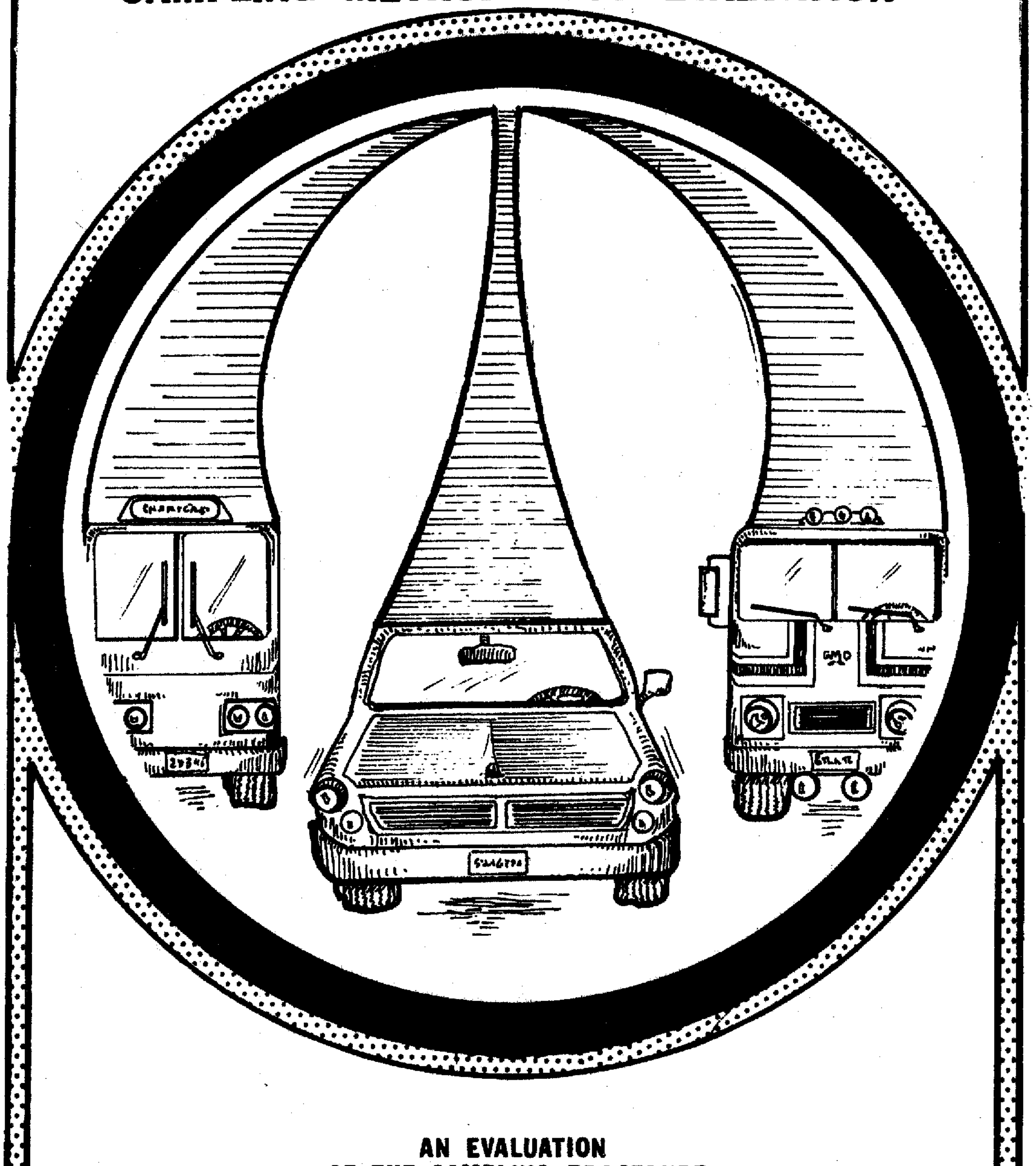
VEHICLE CLASSIFICATION SAMPLING METHODOLOGY EVALUATION



AN EVALUATION OF THE SAMPLING PROCEDURE USED BY THE WISCONSIN DEPARTMENT OF TRANSPORTATION TO COLLECT TRAFFIC COMPOSITION INFORMATION

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the Wisconsin Department of Transportation
to Collect Traffic Composition Information

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16. Abstract

The Wisconsin Department of Transportation, Division of Planning & Budget is engaged in a planning-research project to evaluate its Highway Vehicle Classification Program. This paper documents the results of an evaluation of the design and administration of the temporal and spatial sampling procedures currently being employed to collect traffic composition data in Wisconsin.

This evaluation focuses on how well the data being obtained under the current sampling framework is satisfying the informational needs of the principal data users. The chief obstacle to further substantive accomplishment of the ideal objectives of the vehicle classification program is the lack of adequately refined mechanical classifying equipment. The adequacy of the spatial distribution of classification stations should be determined on the basis of the road facility and travel characteristics unique to each state. The Wisconsin sampling procedures have conceptual and administrative shortcomings, some of which may be objectively measured, but most of which must be subjectively evaluated. Improvements in the current classification sampling frame are warranted and should be pursued.

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EXECUTIVE SUMMARY

This research phase examines the supply side of traffic composition information by focusing on how well the WisDOT classification data collection program satisfies some of the specific data quality and format requirements of the principal data users. The need for further research and improvement in the sample design and in its administration is identified. The implications for research and program improvement may be summarized as follows:

1. Improvements to the WisDOT classification program should be independent of the current FHWA criteria for classification sampling, in both the temporal and spatial dimension.

2. The data produced under the present WisDOT spatial sampling frame does not fully satisfy the rather specific geographic detail needs of the primary users of the data.

3. The present WisDOT temporal sampling frame produces data of adequate detail for most data users; however, the format in which such information is published could be improved.

4. The reliability of the data being produced by the WisDOT classification program is reasonably sufficient for most data user applications; however, no guarantee can be made that the program sampling frame can satisfy the expressed data user demand for traffic mix information which has a maximum error of 10 percent.

5. The adequacy of the idealized sampling design for classification data collection in Wisconsin is compromised by shortcomings in the administration of manual field counting operations, which reflect a number of serious real-world constraints concerning budgeting and manpower; therefore, program improvements should address administrative problems as well as sampling frame inadequacies.

6. The employment of a reliable mechanical classifying device which produces adequately detailed data would be of enormous benefit in the efficient collection of a sufficiently broad base of traffic composition information; however, to date no such device has been fully developed which can record adequately detailed data by vehicle type.

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INTRODUCTION

One of the functional responsibilities of the Travel Statistics and Data Coordination Section of the Wisconsin Department of Transportation (WisDOT), Division of Planning and Budget, Bureau of Data Resources, is to coordinate the systematic collection and dissemination of information which describes the vehicular composition of the traffic stream on Wisconsin highways. The Data Coordination Unit of this Section is currently conducting research on the sampling methodology being employed to collect vehicle classification information. Previous working papers have examined the variety of classification methodologies currently in use by other state-level transportation agencies[1] and have identified some of the general characteristics of the user demand for classification data.[2] This paper documents an evaluation of the sampling methodology being used in Wisconsin to collect traffic composition data. Although this evaluation is restricted to an examination of the sampling problems particular to the WisDOT vehicle classification program, it is believed that the conceptual approach followed during this evaluation, as well as the identification of fundamental problems in the design and administration of the sampling methodology, will be of general benefit to all agencies charged with the responsibility of collecting statewide traffic data.

There are at least three potential sources of data error in the systematic collection of classification data. These areas of potential error include (1) sampling framework inadequacies (both conceptual and administrative); (2) simple recording errors in field observation of traffic; and, (3) employing statistically questionable procedures in processing field classification reports. The primary purpose of this paper is to document the major aspects of the vehicle classification sampling methodology currently employed by the Traffic Data Unit of this Section, and to identify and discuss some of the more significant problems with this methodology. The probability of recording errors in field observation will not be discussed in this paper. However, it will be shown that some degree of data inaccuracy due to problems in the processing of field reports may be directly related to inadequacies in the execution of the sampling frame. The identification and discussion of problem areas in the sampling methodology will provide some useful guidelines for substantive program modifications and improvements.

This program evaluation examines current WisDOT vehicle classification sampling procedures over two distinct sampling dimensions--space and time--in terms of satisfying the data user demand for such information. The spatial dimension, for example, is addressed in terms of meeting the rather specific geographic detail requirements for most data user applications; that is,

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[1]The major findings of a nationwide survey of traffic data collection agencies were summarized in a May 1977 Wisconsin Data Coordination Unit working paper entitled "Vehicle Classification Survey: Data Collection Methods & Analysis."

[2]The results of this research phase were presented in a March 1978 Data Coordination Unit working paper entitled "Vehicle Classification Data User Demand."

emphasis is placed on determining whether classification counting stations are located in the right places and in sufficient numbers. The temporal dimension is addressed in terms of meeting the time period detail requirements of most data users with statistically reliable information.[3] Emphasis is given to determining whether the data collection stations are being operated frequently enough and for a sufficient duration to obtain such data.

PROGRAM DESCRIPTION

Scope

The Federal Highway Administration (FHWA) has established minimum sampling criteria for the collection of vehicle classification data by state-level transportation agencies. The FHWA Highway Planning Program Manual asserts that the objective of collecting vehicle classification data is "...to provide estimates of the composition of traffic by vehicle types by the most economical sampling procedures."[4] The Traffic Data Unit strives to follow these sampling guidelines in pursuit of this objective within the organizational context of WisDOT.

The best known and most widely used form of statewide traffic information is simple traffic volume data. The idealized objective of vehicle classification data collection is very similar to that for traffic volume monitoring: to develop an information base by which one can determine how many vehicles by type are likely to pass over any given highway segment during any period of time. Mechanical devices, known as automatic traffic recorders (ATR's), are employed by the Traffic Data Unit at over 60 permanent locations throughout Wisconsin to continuously count and record the number of vehicles traveling over the highway. Similar devices are also used on a temporary basis at numerous seasonal and coverage counting locations elsewhere on the highway network. The continuous ATR volume data, when complemented by the large body of seasonal and coverage count volume data, represent a rather extensive information base. By conscientiously employing well-developed, statistically proven expansion procedures for traffic volume data, virtually all aspects of the basic sampling objectives of the traffic volume program are being met.

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[3]As reported in the second working paper in this series, the principal users of classification data within WisDOT need traffic composition data most frequently on a daily or annual basis, with some preference for hourly data as well. In addition, these data users generally agreed that a 10 percent data error is the maximum tolerable limit for classification data. See Tables 5 and 6 below.

[4]U.S. Department of Transportation, Federal Highway Administration, Highway Planning Program Manual, Volume IV: Traffic, Chapter II, Transmittal 112, September 23, 1971. (These FHWA criteria are used only as a basis for comparison with the current WisDOT sampling methodology. It should not be inferred that these criteria are necessarily valid for all state highway networks, nor that the information obtained by following such sampling guidelines will have a satisfactory level of utility for all data users.)

In comparison, however, the data base for traffic composition, as generated by the WisDOT classification program, is much more limited in terms of geographic coverage, time period detail, and statistical reliability. The principal reason is that at the present time there are no commercially available mechanical devices which can automatically detect, count, and classify a continuous stream of traffic in sufficient detail by vehicle type.[5] This important technological gap means that manual field observations of vehicles in the traffic stream must be taken. Therefore, field observations are made during a sample of representative time periods throughout the year. Likewise, a number of representative field locations on the state highway system have been selected for classification counting operations. Unfortunately, the relatively high per-unit cost of manual data collection severely restricts the frequency and duration of field counts. It also limits the total number of count station locations, much more so than if adequate mechanical classification devices could be employed. These shortcomings--limited counting periods and limited counting locations--in combination with organizational problems in sample frame administration, seriously preclude the full accomplishment of the ideal objective of the vehicle classification data collection program.

The Traffic Data Unit coordinates the statewide collection of traffic composition data with the cooperation of the nine district offices of the Division of Transportation Districts and the seven district offices of the Division of Enforcement and Inspection. The location of each counting station has been determined by mutual agreement between the Traffic Data Unit and the district offices. A timetable for field operations at each non-loadometer counting station has also been established. Since 1972, the actual field counting operations have been performed by personnel from the various highway and inspection district offices, the scheduling of which reflects individual district office work loads, program priorities, and work rules. Each district office forwards all classification field count reports to the Traffic Data Unit for central office data processing. An annual report summarizing the traffic composition data collected at each station is published and distributed to a variety of classification data users in planning, research, and design offices within WisDOT. Additional copies of the annual report are made available to other data users in both the public and private sectors.

Spatial Sampling Format

The FHWA sampling guidelines on the number and spatial distribution of classification counting stations are rather broad. The FHWA Highway Planning Program Manual states that traffic composition data "...should be collected at each continuous-count station and at sufficient additional volume counting stations to obtain samples which are representative of all significant variations in traffic characteristics throughout the State, both in rural and urban areas... [and] also at truck weighing stations."[6] The Manual also prescribes the minimum number of stations "necessary to derive reliable estimates of vehicle-miles by vehicle type and system for an average State." These minimum station numbers and their distribution are as follows:

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[5]The primary shortcoming of the several mechanical classifiers which have been developed is the inadequate level of detail by vehicle type.

[6]FHWA, Highway Planning Program Manual.

Rural Systems:	Interstate	- 1 Station/50 Miles
	Federal Aid Primary	- 1 Station/200 Miles
	Federal Aid Secondary	- 1 Station/500 Miles
Urban Systems:	Interstate (including Fed. Aid Primary)	- 1 Station/25 Miles
	Federal Aid Secondary	- 1 Station/25 Miles

The Manual suggests that at least two counting stations are needed for any of the federal-aid road systems in a state.

Table 1 illustrates how the spatial distribution of Wisconsin's vehicle classification counting stations compares with these FHWA minimum guidelines. On this basis, it appears that the WisDOT program oversamples rural Federal Aid Primary (FAP) highways, and undersamples rural Federal Aid Secondary (FAS) highways and all urban federal aid systems. The largest deficiency appears to be in terms of urban highways. It is also interesting to note that no FHWA guidelines have been established for non-federal aid highways. Classifying vehicles on such highways is apparently at the discretion of the individual states, as is the exact sampling distribution and sample size for all road systems a matter of state choice. This is reflected in the FHWA Highway Planning Program Manual as follows:

> "Classification...data should be collected and analyzed on a statewide basis in both rural and urban areas with the frequency and extent of coverage related to the *administrative importance and usage* [emphasis added] of each highway system."[7]

The FHWA station distribution guidelines for vehicle classification data collection are presented as the *minimum* number of stations which should be sufficient for the *average* state to obtain reliable and representative data. It would follow that when the actual sample size is under or over these minimums, the sample is either inadequate or superfluous. However, the comparison of the Wisconsin spatial sampling frame to the FHWA guidelines, as presented in Table 1, assumes that the state's network of streets and highways fits the mold of the "average" state. A more meaningful description of the spatial sampling frame is one which considers the unique spatial distribution of the state's road systems, i.e., one that is tailored to reflect the relative "administrative importance and usage" of each road system in Wisconsin.

The Traffic Data Unit has designated 139 locations throughout the state as vehicle classification stations.[8] Of this total, 77 stations are located at permanent ATR locations. Another 17 stations are also Vehicle Weight and Characteristics Study locations (loadometers). Six stations are located at important state line bridges, and the rest are located at various selected intersections and along important recreational routes.[9]

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[7] FHWA, Highway Planning Program Manual.

[8] This total differs from that presented in Table 1 because it double-counts those stations located on divided highways and it deletes one station for every pair of counting locations on opposite legs of a single, low-volume intersection.

[9] See Appendix A for a list of these classification stations by highway district, road system, and functional classification.

TABLE 1

Comparison of the Wisconsin Spatial Sampling Frame with FHWA Guidelines (1976)

Road System	Mileage	Minimum No. of Stations Needed by FHWA Guidelines	Number of Stations in Operation	Difference	Miles Per Station
Rural Interstate	474	10	14.5	+ 4.5	33
Rural FAP	5,011	26	60.0	+34.0	84
Rural FAS	18,074	37	7.0	-30.0	2,582
Total Rural	*23,559*	*73*	*81.5*	*+ 8.5*	
Urban Interstate and FAP	927	38	12.0	-26.0	77
Urban FAS	460	19	-	-19.0	-
Total Urban	*1,387*	*57*	*12.0*	*-45.0*	
Non-Federal Aid	77,707	-	4.0	+ 4.0	19,427
TOTAL	*105,107*	*130*	*97.5*	*-32.5*	

Table 2A illustrates the statewide distribution of these classification stations in terms of physical miles of highway facility by rural and urban road systems, including local roads and streets. Although total rural and total urban mileages compare quite well with the number of stations allocated to each general road system (88 percent rural mileage versus 82 percent rural stations and 12 percent urban mileage versus 18 percent urban stations), disparities in numerical representation do exist for individual road system types. For example, rural interstate highways account for less than one percent of the total highway mileage in Wisconsin, yet one out of every five classification stations (20.9 percent) are allocated to this road system. On the other hand, only 10 stations are allocated to rural local roads, which account for more than three-fourths (78.3 percent) of the total highway mileage. Rural non-interstate State Trunk Network (STN) highways are numerically the most overrepresented, with 54 percent of all stations to cover less than 10 percent of the highway mileage. Urban STN highways (including urban interstate highway mileage) are also overrepresented, with 18 percent of the stations to cover less than two percent of the mileage. This is in stark contrast to urban local streets, which are not sampled at all for vehicle classification purposes.

Table 2B presents these same figures as totals for STN highway systems and for local roads. By this grouping, it appears that the STN highway system as a whole is numerically overrepresented--92.9 percent of all stations for only 11.3 percent of the total miles of facility. In addition, local roads and streets are grossly underrepresented on this basis. However, using simple physical miles of highway to describe the distribution of classification stations may be misleading, since not all road systems carry the same type of traffic by trip purpose or vehicle mix, nor do they carry the same volume of traffic on every mile of highway. In other words, physical mileage figures do not necessarily reflect the relative degree of "administrative importance and usage" for each road system.

Vehicle-miles of travel is a more meaningful basis for describing the distribution of vehicle classification count stations because it is a measure of the actual usage of each road system.[10] Tables 3A and 3B illustrate the station distribution for rural-urban and STN-local roads, respectively, on the basis of estimated annual vehicle-miles of travel. Disparities in numerical representation among individual road systems still exist, though in most cases less severely than on the basis of physical mileage. For example, rural interstate highways are still overrepresented, with 20.9 percent of all stations for only 8.8 percent of the total annual vehicle-miles of travel. However, rural local roads seem much more equitably represented than by the previous measure, with 7.1 percent of all stations for 12.6 percent of the total vehicle-miles. Urban STN roads are also more equitably represented, with 18 percent of all stations for 20.9 percent of the total vehicle-miles.

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[10]In 1975, the FHWA drafted a proposed revision to the vehicle classification station spatial sampling guidelines using annual vehicle-miles of travel rather than physical miles of highway facility as the basic criterion. The proposed revision, however, have not been formally adopted by FHWA.

TABLE 2A

Distribution of Wisconsin Classification Stations
By Facility Mileage (1976)

Rural vs. Urban

Road System	Total Mileage	% Total Mileage	1977-79 Count Stations	% Total Stations
Rural Interstate	411.77	0.4%	29	20.9%
Other Rural STN	9,774.72	9.3	75	54.0
Rural Local Roads	82,664.15	78.3	10	7.1
Total Rural	*92,850.64*	*88.0%*	*114*	*82.0%*
Urban STN	1,740.28	1.6%	25	18.0%
Urban Local Streets	10,929.26	10.4	-	-
Total Urban	*12,669.54*	*12.0%*	*25*	*18.0%*
STATE TOTAL	105,520.18	100.0%	139	100.0%

TABLE 2B

Distribution of Wisconsin Classification Stations
By Facility Mileage (1976)

State Trunk Network vs. Local Roads

Road System	Total Mileage	% Total Mileage	1977-79 Count Stations	% Total Stations
Rural Interstate	411.77	0.4%	29	20.9%
Other Rural STN	9,774.72	9.3	75	54.0
Urban STN	1,740.28	1.6	25	18.0
Total STN	*11,926.77*	*11.3%*	*129*	*92.9%*
Rural Local Roads	82,664.15	78.3%	10	7.1%
Urban Local Streets	10,929.26	10.4	-	-
Total Local	*93,593.41*	*88.7%*	*10*	*7.1%*
STATE TOTAL	105,520.18	100.0%	139	100.0%

offices which receive the annual report on a regular basis and which apply the data in the normal course of their activities. In September 1977, the Data Coordination Unit conducted a survey of these vehicle classification data users to determine the level of geographic detail which is most often sufficient for traffic composition information to be useful. Table 4 summarizes the responses to the survey question dealing with this issue. The overwhelming preference was for classification data at the specific highway level of detail. Very little preference was expressed for statewide traffic composition information, i.e., system-level data. By simply adhering to the FHWA minimum guidelines described above, the lowest level of geographic detail that could be achieved would be at the road system level, in which case the needs of the principal classification data users could not be adequately met.

At the present time, the only circumstances under which the specific geographic detail requirements of the principal users of Wisconsin traffic composition data are adequately satisfied occur when the users happen to need information on the traffic mix for a highway segment at or very near a classification counting station. Such data can be reliably extended to cover a short distance in either direction from the station location, provided the level of physical access to the highway is sufficiently limited to preclude significant numbers of vehicle entries or exits. The degree to which the traffic mix can deviate from that observed at a classification counting station is directly related to the physical opportunity for vehicles to enter or exit the traffic stream, which, of course, is most limited on highways built to freeway standards, i.e., no at-grade intersections. However, this method of geographic data expansion can be subject to judgmental errors and can be applied at only a few count stations. In most cases, traffic composition percentages derived from tables which summarize the data for all stations on each general road type represent the best classification information available to the data user. Such figures usually are subjectively "adjusted" to produce a reasonable representation of the traffic mix at a given location. Obviously a better method is needed for the geographic expansion of traffic composition data collected by the Traffic Data Unit.

The best developed traffic data expansion procedures employed by the Traffic Data Unit and most other state-level traffic data collection agencies are those for traffic volume data. However, these procedures provide for the temporal, not spatial, expansion of traffic volume data. The procedures involve the use of numerical factors based on characteristics of data collected on a continuous basis at ATR stations which have been grouped according to similarities in traffic volume patterns. The vehicle classification program is much more limited in the number of data collection stations, none of which are operated on a continuous basis. What appears to be needed is a method of grouping classification stations on the basis of similarities in those locational characteristics, other than simply road system type, which are most closely correlated with observable patterns of average traffic composition.

TABLE 4

Level of Geographic Detail Preferred By the Principal Users of Wisconsin Vehicle Classification Data

	Activity	Specific Highway	Region or Corridor	Statewide	Location Unimportant
A.	Project-Level Traffic Forecasting	11	2	-	-
B.	System-Level Traffic Forecasting	2	4	1	-
C.	Highway Pavement Design	14	-	-	-
D.	Pavement Materials Research	4	1	-	-
E.	Programming Highway Maintenance	1	-	-	-
F.	Project-Level Bridge Design	2	-	-	-
G.	System-Level Bridge Design	-	1	1	-
H.	Traffic Operations Analysis	6	-	-	-
I.	Accident Analysis	6	2	1	-
J.	Project-Level Investment Analysis	3	-	-	-
K.	System-Level Investment Analysis	-	2	-	-
L.	Highway Geometric Design	10	-	1	-
M.	Long-Range Transportation System Planning	2	1	1	-
N.	Environmental Impact Analysis -Air	12	3	-	-
O.	Environmental Impact Analysis -Noise	10	1	-	-
P.	Vehicle-Miles of Travel Determination	-	1	1	-
Q.	Freight Movement Analysis	3	1	2	-
R.	Vehicle Weight Enforcement	-	1	-	-
S.	Speed Study Analysis	3	-	-	-
T.	Other	6	1	-	-
	TOTAL	95	21	8	-
	Total as Percent of Responses	77%	17%	6%	0%

Source: Wisconsin Department of Transportation, Division of Planning, <u>Vehicle Classification Data User Demand</u>, Working Paper No. 2, March 1978, p. 11.

The present distribution of classification data collection stations is based primarily on ATR and loadometer station locations. ATR stations are located to meet traffic volume data needs, not the least of which is to form a broad data base for the development and refinement of factor groups for expanding seasonal and coverage volume counts. Loadometer stations, on the other hand, are located exclusively on important truck routes and are operated primarily to provide truck weight, commodity, and fuel-type data, and to enforce vehicle weight limits. In neither case are the geographic detail requirements for vehicle classification data significant criteria for designating specific station locations. Since there is a need to reexamine the spatial distribution of classification stations in terms of the locational characteristics which can be employed as geographic station grouping factors for vehicle classification purposes, it is quite likely that changes to the present station distribution will be justified.

Temporal Sampling Frame

The frequency and duration of the field counting operations of the WisDOT vehicle classification data collection program should be directly related to the level of time period detail and the degree of statistical accuracy which are desired for the data. Meeting the FHWA guidelines for temporal sampling may produce adequate data if the only desired level of time period detail is the annual average daily traffic mix. Since the FHWA guidelines do not mention data accuracy in quantitative terms, it must be assumed that strict adherence to the FHWA temporal sampling guidelines will result in sufficiently representative estimates of traffic composition (for the "average" state.)

From the description of the currently employed temporal sampling frame presented above, however, it is obvious that important deviations from the FHWA guidelines do exist. For example, no weekend vehicle classification counts have been taken since 1972; hence, the data being produced are for the average weekday only. Also, monthly counts were abandoned even before 1972. Perhaps the most dramatic departure from the FHWA temporal sampling criteria has been the employment of a three-year counting cycle for all non-loadometer classification stations.[16] Because of these significant deviations from the FHWA guidelines, and because of the ill-defined qualification "average state," Wisconsin's temporal sampling frame for vehicle classification data collection must be evaluated on its own merits.

The key considerations in evaluating the design and operation of the current temporal sampling methodology remain unchanged: determining how well data user needs are being met in terms of both time period detail and statistical accuracy. Tables 5 and 6 below summarize the responses to a pair of questions from a September 1977 survey dealing with these two principal classification data user concerns. Based on these responses, the Traffic Data Unit should strive to obtain and report traffic composition data for each hour of the day, each day of the week, and for an annual average day; in addition, the data should have only a $\pm$ 10 percent maximum error.

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[16] The three-year counting cycle probably will not seriously disrupt the continuity of traffic composition data, since the year-to-year variations in traffic mix are minimal. However, it may present problems in adequately monitoring the short-term impact on travel patterns and traffic mix of legislative changes, such as the recent decision to allow double-bottom trailers on some Wisconsin highways.

TABLE 5

Level of Time Period Detail Preferred By the Principal Users of Wisconsin Vehicle Classification Data

	Activity	Hourly	Daily	Monthly	Seasonally	Annually
A.	Project-Level Traffic Forecasting	6	5	1	-	5
B.	System-Level Traffic Forecasting	-	2	-	-	5
C.	Highway Pavement Design	-	8	-	1	5
D.	Pavement Materials Research	-	2	1	1	3
E.	Programming Highway Maintenance	-	-	-	-	1
F.	Project-Level Bridge Design	-	1	-	-	1
G.	System-Level Bridge Design	-	2	-	1	-
H.	Traffic Operations Analysis	3	2	1	3	4
I.	Accident Analysis	2	3	2	1	4
J.	Project-Level Investment Analysis	-	1	-	-	2
K.	System-Level Investment Analysis	-	1	-	-	1
L.	Highway Geometric Design	5	9	1	2	4
M.	Long-Range Transportation System Planning	-	-	-	-	4
N.	Environmental Impact Analysis -Air	9	5	-	-	3
O.	Environmental Impact Analysis -Noise	7	4	-	-	3
P.	Vehicle-Miles of Travel Determination	1	1	-	-	1
Q.	Freight Movement Analysis	-	2	-	-	2
R.	Vehicle Weight Enforcement	1	1	1	-	-
S.	Speed Study Analysis	1	-	-	1	2
T.	Other	4	3	1	3	-
	TOTAL	39	52	8	13	50
	Total as Percent of Responses	24%	32%	5%	8%	31%

Source: Wisconsin DOT, Vehicle Classification Data User Demand, p. 13.

TABLE 6

Maximum Data Error Preferred By the Principal Users of Wisconsin Vehicle Classification Data

	Activity	Less Than 10% Error	10% Error	Between 10-20% Error	20% Error
A.	Project-Level Traffic Forecasting	-	9	1	1
B.	System-Level Traffic Forecasting	-	6	-	-
C.	Highway Pavement Design	2	8	1	4
D.	Pavement Materials Research	-	3	-	2
E.	Programming Highway Maintenance	-	-	1	-
F.	Project-Level Bridge Design	1	-	1	-
G.	System-Level Bridge Design	1	-	-	1
H.	Traffic Operations Analysis	1	4	1	-
I.	Accident Analysis	1	4	1	-
J.	Project-Level Investment Analysis	1	2	-	-
K.	System-Level Investment Analysis	1	-	-	1
L.	Highway Geometric Design	1	9	1	1
M.	Long-Range Transportation System Planning	-	2	1	1
N.	Environmental Impact Analysis -Air	1	6	1	4
O.	Environmental Impact Analysis -Noise	1	6	1	4
P.	Vehicle-Miles of Travel Determination	-	1	-	-
Q.	Freight Movement Analysis	-	3	-	1
R.	Vehicle Weight Enforcement	-	1	-	-
S.	Speed Study Analysis	-	2	1	1
T.	Other	1	4	1	-
	TOTAL	12	70	12	21
	Total as Percent of Responses	10%	61%	10%	18%

Source: Wisconsin DOT, Vehicle Classification Data User Demand, p. 15.

It should be pointed out that in reality there is a great deal of difference between the design of the WisDOT temporal sampling program and its actual operation. The primary reason for this is the superficial administrative control which the Traffic Data Unit has been able to exercise over the specific scheduling of vehicle classification field counting operations since the decentralization of all traffic counting programs within WisDOT in 1972. This lack of central office control and district office accountability contributes to, and is reflected by, a variety of digressions from the idealized field counting schedules which have been established for each station (as discussed in the Program Description and as summarized in Appendix A). Each deviation from the idealized counting schedule creates problems in the processing of field reports and further reduces the degree of reliability which can be subjectively placed on the data product.

In practice, the key factors influencing the specific scheduling of field counting operations do not focus on classification data integrity or representativeness, but rather they hinge primarily upon district office work rules and manpower availability. There are nine Division of Highways district offices, hence nine distinct field count scheduling environments. Each district office has its own relatively unique set of work rules, supervisory arrangements, program priorities, manpower expertise and availability, as well as budgetary constraints.[17] These are the factors which are most influential in determining how and when classification field counts are actually carried out, not the generalized counting timetable distributed by the Traffic Data Unit.

Perhaps an illustration of this point is necessary. When the three-year counting cycle was implemented in 1977, with only one-third of all non-loadometer classification stations scheduled to be counted each year, the intent was to reduce the counting work load on the district offices. This reduction in work load should have resulted in a better adherence to the idealized temporal sampling schedule for those stations actually being counted. Appendix B illustrates how many hours were actually counted in 1977 at those stations which were scheduled for counting. Incomplete counts, as well as counts taken too often in a single season, were still frequent occurrences. (The second table in Appendix B illustrates a slightly better counting record for the loadometer/classification stations, all of which were scheduled for 24 hours of counting in 1977.) When hourly counts are missing on field reports, classification data must be substituted, since at least one count total is required for each of the 24 hours in a composite day to execute the data processing procedures. The seasonal lapses illustrated in Appendix B present obvious problems. In such cases, hourly data from the other six-month period in the current counting year, or hourly data collected during a previous counting year, are entered for the missing counts. Only the dates are changed; no systematic factoring is made to account for probable changes in total volume. Any such data substitution reduces the reliability of the final data product.

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[17] A closely related problem is the rather menial nature of the task of manually observing and classifying a traffic stream for a long period of time, and usually for a low rate of pay. The nature of the work generally discourages permanent staff, or even limited-term employees, from willingly accepting such an assignment.

There are other problems in field count scheduling which are at least partly related to the superficial central office control which the Traffic Data Unit can exercise. A recurrent problem is classification field counting during periods of rather atypical traffic conditions. For example, classification counts have been taken on Friday afternoons. Unfortunately, the "weekend" travel period begins on Friday afternoons at many stations, thus the traffic patterns may be atypical relative to other weekday afternoons. Severe weather such as heavy snow or icy road conditions may deter discretionary travelers, yet classification counts have been taken during such periods. Localized construction activity may generate an inordinate amount of heavy vehicle traffic, or it may interfere with normal travel patterns. In either case, the classification counts taken near such activity are likely to reflect atypical traffic composition conditions. Likewise, localized recreational or social events may generate unusual traffic conditions, such as military convoys or funeral processions, but these kinds of atypical vehicle movements have been recorded during classification field counts. Considering the very few work shifts which are counted for vehicle classification during the year, the unrepresentative bias in the annual average traffic mix due to the observation of such atypical traffic conditions can be significant.

Despite all these administrative problems, the basic question is whether the data user needs for traffic composition information by certain levels of time period detail are being met by the temporal sampling methodology currently employed by WisDOT. The present method will produce classification data for the annual average non-holiday weekday but not for the annual average 24-hour day (which includes Saturdays and Sundays). The present method cannot produce classification data expressed by day of the week, since not every day of the week is counted for a full 24-hour period during the year. Traffic composition data for each hour of a composite 24-hour average annual non-holiday weekday are produced within the computerized data processing procedures, but the data are not reported regularly in that format. The reliability of such hourly figures would be suspect, probably more so than for data aggregated to the composite 24-hour day.

The other main consideration, ensuring a high degree of statistical accuracy for the principal users of vehicle classification data, is a much more difficult sampling frame quality to evaluate in quantitative terms. The numerous inconsistencies in the execution of field counting operations and the frequent data substitutions which are necessary during the processing of inadequate field reports contribute to a reduction in the statistical accuracy, or "representativeness," of the final data product. However, even the statistical reliability of data produced by the idealized temporal sampling frame is difficult to objectively evaluate due to a serious lack of quality control classification data against which the data product can be compared. This is due, of course, to the lack of a mechanical system for classifying and recording adequately detailed traffic composition data on a continuous basis.

Accurate objective measures of the temporal variation in traffic composition over any time period are simply not available. Reliable estimates of the true mean values of the proportional traffic mixes on each temporal level, as well as good estimates of the standard deviation of these values at each level, are necessary for the employment of mathematical formulae which can determine the minimum number of sample periods needed to obtain data that meet predetermined degrees of statistical accuracy. Measures that are available are at best only subjective guesses based on past classification data (which were suspect in any case), on national traffic composition trends, or on a general knowledge of traffic conditions and travel patterns. This lack of adequately reliable, objective estimates of traffic composition averages and patterns of variation over time necessitates the examination of loosely analogous data collection procedures.

Sampling Frame Analogy

An analogy can be drawn between traffic composition data collection and traffic volume monitoring. Although the exact relationship between traffic mix and traffic volume is unknown, and probably varies among stations and among the various vehicle type categories, it is reasonable to assume that a temporal sampling frame which is of sufficient frequency to produce accurate estimates of the average weekday traffic volume should also be adequate to produce fairly reliable estimates of the average weekday traffic composition. For illustrative purposes, 16 ATR/classification stations, for which complete traffic volume data are available and which were scheduled for 80 hours of classification counting in 1977, have been selected. As Table 7 indicates, these 16 stations are a diverse cross-section of classification locations in terms of highway type, functional system, average traffic volume, and general traffic composition.

As indicated above, the principal users of vehicle classification data within WisDOT generally prefer a maximum $\pm$ 10 percent data error. Therefore, this value has been used as a data accuracy criterion for estimating the average weekday traffic (AWDT) volume at the 16 selected ATR/classification stations. In addition, since it is quite likely that traffic composition shows less variation over time than does traffic volume, a $\pm$ 20 percent error in the AWDT volume estimate has also been used as a data accuracy criterion for purposes of this analogy. The following formula was employed to determine the minimum number of eight-hour count shifts and 24-hour continuous count shifts which would be necessary to obtain estimates of AWDT volume with predetermined accuracy and reliability levels:

$$\text{Minimum Sample Size} = \left(\frac{\text{Z-Value} \times \text{Standard Deviation}}{\text{Interval} \times \text{Mean Volume}}\right)^2$$

where, Z-Value = 1.645 at the 90% confidence level
Z-Value = 1.96 at the 95% confidence level
Interval = .10 for $\pm$ 10% error
Interval = .20 for $\pm$ 20% error

Appendix C summarizes the minimum number of counting shifts needed for each of the three eight-hour count shift periods and for a 24-hour continuous count period at each of the 16 stations (using 1976 traffic volume data). Using $\pm$ 10 percent as the accuracy criterion, only the classification sampling

TABLE 7

ATR/Classification Stations Selected for Evaluation (All Data From 1976)

Station Number	Highway Type	Functional System	ADT	% Light Vehicles	% Heavy Vehicles
11-0002E	Interstate	Principal Arterial	10,492	71.4%	28.6%
11-0002W	Interstate	Principal Arterial	10,559	68.7	31.3
12-0003	Rural STN	Primary Arterial	1,125	80.2	19.8
14-0001	Rural STN	Principal Arterial	6,033	83.4	16.6
21-0001	Rural STN	Primary Arterial	1,476	88.0	12.0
22-0002	Rural STN	Primary Arterial	1,497	77.3	22.6
40-0006E	Urban STN	Principal Arterial	33,877	84.5	15.5
40-0006W	Urban STN	Principal Arterial	33,633	88.8	11.2
48-0001	Rural STN	Primary Arterial	2,643	83.3	16.7
51-0001E	Interstate	Principal Arterial	19,397	75.2	24.8
51-0001W	Interstate	Principal Arterial	19,340	73.4	26.6
60-0001	Rural STN	Primary Arterial	3,195	88.0	12.0
61-0001	Rural STN	Primary Arterial	2,684	82.4	17.6
67-0001N	Urban STN	Secondary Arterial	5,732	93.7	6.3
67-0001S	Urban STN	Secondary Arterial	5,787	95.8	4.2
69-0001	Rural STN	Standard Arterial	4,116	72.2%	27.8%

schedules for the relatively high-volume urban freeway stations, 40-0006E/W and 67-0001N/S, meet the minimum sample sizes necessary for good estimates of AWDT volume.[18] This is due to the very high and rather stable weekday traffic volumes which characterize such highways throughout the year. The greater variability and lower volumes of traffic at rural STN locations are reflected in the higher sample sizes indicated for such stations by the ± 10 percent criterion. Using the more liberal ± 20 percent figure, however, several additional stations appear to meet or approach the minimum sample sizes required for a reasonably good estimate of AWDT volume.

The sampling frame analogy can be illustrated in a more direct manner. If the confidence interval remains unspecified and the actual sampling frequencies for each eight-hour shift are known, then the minimum sample size formula presented above can be solved for the estimated interval about the mean AWDT volumes. Table 8 summarizes these estimated confidence intervals for each of the 16 selected stations for each eight-hour counting period at the 90 percent and 95 percent confidence levels. Those intervals which are within the ± 20 percent range are indicated by italics. Note the relatively good confidence intervals indicated for the 6 AM-2 PM period at most stations, contrasted with the rather poor confidence intervals indicated for the 10 PM-6 AM period at lower volume stations.

Table 9 illustrates an even more direct comparison between the traffic volume and traffic composition sampling frames. This table compares the actual AWDT volume for each station with the estimated AWDT volumes which were reported in the 1976 vehicle classification report. It is interested to note that the estimates, which were based on averaging and aggregating hourly volumes observed during classification field counts and which include some degree of data substitution where hourly counts were missing, are generally within reasonable intervals from the actual AWDT volumes which are based on continuous traffic counts recorded by the ATR's. If no data substitution is included and only the actual corresponding hourly volume counts taken during classification operations are considered, then AWDT volume estimates for six of the 16 stations cannot even be made, because some hours were not counted at all during 1976. The other ten stations, however, have reasonably good estimates of the actual AWDT if only the hourly volumes observed during actual classification counting operations are used.

The minimum sample sizes and the estimated confidence intervals which are illustrated in Appendix C and Table 8, respectively, suggest a rather pessimistic assessment of the statistical adequacy of the WisDOT temporal sampling methodology. This rather indirect analogy is contradicted somewhat by the direct comparison between actual AWDT volumes and estimated AWDT volumes which are based on hourly volume counts from actual classification field count operations, as illustrated in Table 9. This contradiction is due to

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[18] Remember that the 80 hours of scheduled classification counting include two 10 PM-6 AM shifts, four 6 AM-2 PM shifts, and four 2 PM-10 PM shifts.

TABLE 8

Estimated Confidence Intervals About the Mean Eight-Hour Volume At 16 Selected ATR/Classification Stations At the 90% and 95% Confidence Levels (1976)

- Weekdays Only -

Station Number	10 PM-6 AM (n = 2/Year) @ 90%	10 PM-6 AM (n = 2/Year) @ 95%	6 AM-2 PM (n = 4/Year) @ 90%	6 AM-2 PM (n = 4/Year) @ 95%	2 PM-10 PM (n = 4/Year) @ 90%	2 PM-10 PM (n = 4/Year) @ 95%
11-0002E	± 29.2%	± 34.8%	± 32.2%	± 38.3%	± 40.2%	± 47.8%
11-0002W	50.1	59.8	33.7	40.1	52.0	62.0
12-0003	40.7	48.5	18.2	21.7	27.0	32.2
14-0001	20.9	24.9	10.2	12.1	21.1	25.2
21-0001	43.5	51.8	27.8	33.2	31.9	38.0
22-0002	31.9	38.0	14.4	17.2	23.7	28.3
40-0006E	15.9	18.9	9.1	10.8	9.8	11.7
40-0006W	17.0	20.3	7.9	9.4	14.5	17.3
48-0001	33.4	39.9	20.8	24.8	31.3	37.3
51-0001E	17.6	21.0	12.6	15.0	17.5	20.9
51-0001W	24.7	29.5	10.9	13.0	23.5	28.0
60-0001	41.7	49.7	15.6	18.6	22.9	27.3
61-0001	28.1	33.5	13.5	16.1	16.3	19.5
67-0001N	24.4	29.1	9.0	10.8	8.9	10.6
67-0001S	19.2	22.9	8.0	9.5	8.9	10.7
69-0001	± 45.5%	± 54.3%	± 26.6%	± 31.7%	± 43.4%	± 51.7%

TABLE 9

Average Weekday Traffic (AWDT) At 16 Selected ATR/Classification Stations (1976)

Station Number	AWDT	Estimated AWDT from Annual Classification Report	% Difference from Actual AWDT	Estimated AWDT Using Corresponding ATR Counts	% Difference from Actual AWDT
11-0002E	9,371	8,470	- 9.6%	8,525	- 9.0%
11-0002W	10,112	7,746	-23.4	8,250	-18.4
12-0003	1,067	970	- 9.1	**	
14-0001	5,898	6,325	+ 7.2	**	
21-0001	1,485	1,690	+13.8	1,598*	+ 7.3
22-0002	1,474	1,581	+ 7.3	1,573	+ 6.7
40-0006E	34,842	34,671	- 0.5	35,850*	+ 2.9
40-0006W	35,048	40,218	+14.8	36,390*	+ 3.8
48-0001	2,486	2,169	-12.8	**	
51-0001E	18,551	18,585	+ 0.2	**	
51-0001W	18,957	18,747	- 1.1	**	
60-0001	3,182	3,057	- 3.9	3,053	- 4.1
61-0001	2,692	2,598	- 3.5	2,548	- 5.3
67-0001N	6,076	5,766	- 5.1	**	
67-0001S	6,085	6,244	+ 2.8	6,333*	+ 4.1
69-0001	3,850	3,438	-10.7%	3,393	-11.9%

*Estimate based on fewer hours than were scheduled for classification counting.

**Insufficient data for estimating 24-hour total count. (No classification counts were taken from 10 PM-6 AM.)

the non-random nature of the temporal sampling procedures employed in the WisDOT classification program. Field counts are taken only on non-holiday weekdays and thus avoid the very atypical traffic volume and composition patterns which characterize weekend and holiday travel periods. Even less random is the practice of scheduling counts by calendar quarter. This eliminates any possibility that all counts will be taken during low-volume winter periods or high-volume summer periods.[19] This temporal stratification violates the assumption of random sampling which is basic to the employment of the minimum sample size formula used above. Therefore, the estimates derived using this formula are relatively high; that is, the actual degree of data error for traffic composition collected according to the idealized sampling methodology is probably within the ± 20 percent interval for most count stations and within the ± 10 percent interval for most high-volume urban stations.

SUMMARY OF IMPLICATIONS FOR PROGRAM IMPROVEMENT

This research phase examined the supply side of traffic composition information by focusing on how well the WisDOT classification data collection program satisfies some of the specific data quality and format requirements of the principal data users. The need for further research and improvement in the sample design and in its administration has been identified. The following points summarize these research and program improvement needs:

1. *Meeting FHWA Sampling Guidelines*. The current sampling methodology, both the spatial and temporal components, deviates from the minimum sampling guidelines presented by FHWA in 1971 in the Highway Planning Program Manual. Although the methodology is loosely based on FHWA minimum sampling criteria, it has been amended from time to time in response to WisDOT organizational priorities and constraints. It should be noted that the FHWA criteria were not promulgated as binding specifications for all state-level classification data collection programs, but only as minimum guidelines for spatial and temporal sampling for the "average" state.[20] Even if the Traffic Data Unit more closely adhered to the FHWA sampling criteria, the principal users of traffic composition information within WisDOT could not be more adequately satisfied in terms of specific geographic detail nor could such data be available to them by day of the week. Therefore, revising the current sampling method to more closely conform to the FHWA guidelines should not be the primary objective when considering alternatives for improving the classification sampling program.

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[19] This procedure does, however, require the assumption that the atypical summer peak volume traffic composition is sufficiently offset by an "opposite" atypical traffic mix during lower volume winter counting periods. This may not be a valid assumption for those stations at which the seasonal variation in recreational travel, for example, is significant.

[20] This was evidenced in the responses to a November 1976 Data Coordination Unit nationwide survey of state-level traffic data collection agencies. This survey identified the wide variety of sampling methods being employed to collect traffic composition data. The results of this survey were summarized in a May 1977 Data Coordination Unit working paper referred to above.

2. *Spatial Sampling Frame.* The present practice of aggregating classification data to the road system level does not fully satisfy the needs of most of the principal users of the information. There is a need to develop a systematic and reliable procedure for the geographic expansion of traffic composition data down to the specific highway level of detail. The development of such a procedure could be enhanced by the identification and analysis of the locational characteristics of classification count stations which are most highly correlated with observed variations in average traffic composition.[21] There might be justification for a redistribution of Wisconsin's vehicle classification count stations based on the results of such an analysis. In any event, the redistribution of counting stations to provide better coverage of presently undersampled road systems should be pursued, particularly in regard to low- and medium-volume urban STN streets and highways.

3. *Time Period Detail.* At the present time, the Traffic Data Unit produces traffic composition information as percentages of an estimated annual average weekday traffic volume. It is suggested that the format of the annual vehicle classification report be revised to better emphasize this important data limitation by (1) acknowledging that no recent weekend classification data are available, and thus the data apply only to weekday traffic; and (2) illustrating, if possible, the accuracy of the estimated AWDT volume derived from actual hourly classification count volumes. Under the present manual observation procedure, the cost of obtaining weekend traffic composition information at every count station is prohibitive; however, it may be worthwhile to identify a few of the most representative stations in each category of counting locations at which weekend classification operations could be conducted to obtain at least a minimal amount of weekend data. An alternative would be to conduct weekend classification counting on a special project-level, "as-needed" basis. An additional consideration to better satisfy data user needs is to obtain hourly data by simply modifying the present data processing procedures to output data into an hour-of-the-day format. This can be done on a demand basis, or aggregated hourly data can be summarized for each station and published in the annual report.

4. *Data Accuracy.* The statistical accuracy of WisDOT vehicle classification data cannot be determined in strictly quantitative terms. However, subjective examination, if indirect, leads to the conclusion that the accuracy of the classification data being obtained by the current sampling methodology is probably within $\pm$ 20 percent for most counting stations and may be even better (within $\pm$ 10 percent) for some high-volume/low-seasonal variation stations. The exact degree of accuracy will vary among the stations and for the different levels of time period detail.[22] A more specific evaluation of classification data accuracy

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[21] It must be assumed that the accuracy of existing traffic composition data is sufficient to such an analysis.

[22] Data aggregates for the average 24-hour weekday traffic composition, for example, are probably more reliable than data expressed for individual hours of the day.

may be possible if a body of reliable control data for temporal variations in traffic composition could be developed. For the present time, the general degree of reliability of Wisconsin's vehicle classification data is reasonably sufficient for most data user applications, though no guarantees of meeting the ten percent maximum data error criterion can be made.

5. *Administration of Field Counting.* The above conclusions regarding time period detail and the adequacy of the present temporal sampling procedure for producing sufficiently reliable classification data are based, of course, on an idealized sampling methodology. In reality, there are numerous digressions from this idealized methodology in the execution of actual field counting operations. Each of these digressions, and the data substitution procedures to which they lead, reduce the integrity of the final data product. The most significant improvement which could be made in the current WisDOT vehicle classification data collection program would be the elimination of all inappropriate or missing field counts. Reducing the field counting work load on the district offices by instituting a three-year count cycle in 1977 did not eliminate these problems. It is suggested that the Traffic Data Unit pursue a more active role in the supervision of actual traffic composition monitoring operations. Simply making district offices more accountable for incomplete or improper field counts will not eliminate the underlying manpower and scheduling problems. Serious consideration should be given to returning the functional responsibility for conducting classification field counts to the Traffic Data Unit in the WisDOT central office. In any event, the basic principle is clear: the conscientious administration of a sampling framework is equal in importance to its conceptual design.

6. *Mechanical Classifiers.* The Traffic Data Unit should continue to employ a manual procedure for the collection of traffic composition information until such time that a reliable mechanical device becomes commercially available for the automatic classification of vehicles on a continuous basis and in sufficient detail. The principal obstacle to the development and employment of a mechanical classifier is the rather specific degree of detail by vehicle type that seems to be required by many data users. Therefore, further research into the issue of revising vehicle grouping criteria may be warranted; however, such research is beyond the scope of the current Data Coordination Unit project. The development of any device or manual procedure for efficiently collecting continuous vehicle classification data will be of great benefit to further improving the sampling framework for statewide traffic composition monitoring. In the interim, it may be worthwhile for WisDOT to consider the limited employment of the most reliable and mechanically advanced classifying devices which are currently available. This would help develop a broader information base regarding the patterns of temporal variation in traffic composition on Wisconsin highways, even if on a less detailed level of vehicle types.

REFERENCES

Babbie, Earl R., Survey Research Methods, Belmont, California, Wadsworth Publishing Company, 1973.

Blalock, Hubert M., Social Statistics, New York, McGraw-Hill Book Company, 1972.

Frankel, Martin R., Inference From Survey Samples, Ann Arbor, Michigan, University of Michigan, 1971.

Peat, Marwick, Mitchell & Co., Guidelines For Designing Travel Surveys For Statewide Transportation Planning, Prepared for U. S. Department of Transportation, Federal Highway Administration, May 1976.

U. S. Department of Transportation, Federal Highway Administration, Highway Planning Program Manual, Volume IV: Traffic, Chapter II, Transmittal 112, September 23, 1971.

Wisconsin Department of Transportation, Division of Planning, Bureau of Data Resources, Travel Statistics and Data Coordination Section, Vehicle Classification Data User Demand, Working Paper No. 2, March 1978.

__________________________, Vehicle Classification Survey: Data Collection Methods and Analysis, Working Paper No. 1, May 1977.

APPENDIX A

Wisconsin Classification Counting Program

HIGHWAY DISTRICT #1
(Madison)

Station Number	Highway Type	Functional System	Number of Shifts Counted 1977	1978	1979
11-0002E	Interstate	Principal Arterial	10		
11-0002W	Interstate	Principal Arterial	10		
13-0001	Rural STN	Primary Arterial			10
22-0001	Rural STN	Principal Arterial			10
22-0002	Rural STN	Primary Arterial	10		
25-0001	Rural STN	Primary Arterial		10	
25-0002	Rural CTN	Local Road]	6		
25-0009	Rural STN	Principal Arterial]			
28-0001E	Interstate	Principal Arterial		10	
28-0001W	Interstate	Principal Arterial		10	
28-0002	Rural STN	Primary Arterial			6
33-0001	Rural STN	Primary Arterial		10	
53-0001E	Interstate	Principal Arterial			10
53-0001W	Interstate	Principal Arterial			10
53-0002	Town Road	Local Road]	6		
53-0006	Rural CTN	Local Road]			
53-0009	Rural STN	Primary Arterial]		6	
53-0008	Rural STN	Standard Arterial]			
Shift Totals	(18 Stations)		42	46	46

District Loadometers (5 Classified Every Year):

13-0006E	Interstate	Principal Arterial
13-0007W	Interstate	Principal Arterial
13-0008E	Interstate	Principal Arterial
28-0007W	Interstate	Principal Arterial
53-0005	Rural STN	Standard Arterial

HIGHWAY DISTRICT #2
(Waukesha)

Station Number	Highway Type	Functional System	Number of Shifts Counted 1977	1978	1979
14-0001	Rural STN	Principal Arterial	10		
20-0003N	Rural STN	Principal Arterial		10	
20-0003S	Rural STN	Principal Arterial			
30-0003E	Interstate	Principal Arterial		6	
30-0008N	Urban STN	Primary Arterial	6		
30-0008S	Urban STN	Primary Arterial			
51-0001E	Interstate	Principal Arterial	10		
51-0001W	Interstate	Principal Arterial	10		
64-0002E	Rural STN	Principal Arterial			10
64-0002W	Rural STN	Principal Arterial			
67-0001N	Urban STN	Secondary Arterial	10		
67-0001S	Urban STN	Secondary Arterial			
67-0003E	Urban STN	Principal Arterial		14*	
67-0003W	Urban STN	Principal Arterial		14*	
67-0004N	Urban STN	Principal Arterial			10
67-0004S	Urban STN	Principal Arterial			10
67-0005	Urban STN	Secondary Arterial		10	
67-0007E	Rural STN	Primary Arterial			10
67-0007W	Rural STN	Primary Arterial			
67-0010E	Rural STN	Principal Arterial			10
67-0010W	Rural STN	Principal Arterial			
Shift Totals		(21 Stations)	46	54	50

District Loadometers (5 Classified Every Year):

20-0001	Rural STN	Primary Arterial
30-0003W	Interstate	Principal Arterial
51-0002E	Interstate	Principal Arterial
64-0009E	Rural STN	Principal Arterial
64-0009W	Rural STN	Principal Arterial

*Six-hour shifts only at Stations 67-0003E and 67-0003W.

HIGHWAY DISTRICT #3*
(Green Bay)

Station Number	Highway Type	Functional System	Number of Shifts Counted 1977	1978	1979
05-0001N	Rural STN	Principal Arterial		10	
05-0001S	Rural STN	Principal Arterial		10	
36-0001	Rural STN	Principal Arterial	10		
36-0005	Rural CTN	Local Road			
38-0002	Rural STN	Primary Arterial			10
58-0001	Rural STN	Principal Arterial		10	
58-0002	Rural CTN	Local Road			6
58-0003	Rural STN	Principal Arterial			
59-0001	Rural STN	Standard Arterial	10		
70-0001N	Rural STN	Principal Arterial			6
70-0001S	Rural STN	Principal Arterial			6
Shift Totals		(11 Stations)	20	30	28

District Loadometers (3 Classified Every Year):

05-0006S	Rural STN	Principal Arterial
42-0004	Rural STN	Principal Arterial
44-0005N	Rural STN	Principal Arterial

HIGHWAY DISTRICT #4
(Wisconsin Rapids)

Station Number	Highway Type	Functional System	Number of Shifts Counted 1977	1978	1979
01-0001	Rural STN	Standard Arterial	10		
29-0001E	Interstate	Principal Arterial		10	
29-0001W	Interstate	Principal Arterial			
37-0001N	Rural STN	Principal Arterial		6	
37-0001S	Rural STN	Principal Arterial			
49-0004N**	Rural STN	Principal Arterial			6
49-0004S**	Rural STN	Principal Arterial			
68-0002	Rural STN	Principal Arterial			10
69-0001	Rural STN	Principal Arterial	10		
71-0003	Rural CTN	Local Road		6	
71-0002	Rural STN	Standard Arterial			
Shift Totals		(11 Stations)	20	22	16

*District #3 uses seven-hour shifts only. No counts taken between 3 AM and 6 AM.

**Stations 49-0004N and 49-0004S are also loadometers and, as such, are classified every year.

HIGHWAY DISTRICT #5
(La Crosse)

Station Number	Highway Type	Functional System	Number of Shifts Counted 1977	1978	1979
06-0001	Rural STN	Standard Arterial		6	
12-0002	Rural STN	Primary Arterial			6
12-0003	Rural STN	Primary Arterial	10		
27-0001E	Interstate	Principal Arterial]		10	
27-0001W	Interstate	Principal Arterial]			
27-0002	Rural STN	Principal Arterial]		6	
27-0003	Rural CTN	Local Road]			
32-0001E	Interstate	Principal Arterial]			10
32-0001W	Interstate	Principal Arterial]			
41-0001	Rural STN	Standard Arterial			6
61-0001	Rural STN	Primary Arterial	10	—	—
Shift Totals	(11 Stations)		20	22	22

District Loadometers (2 Classified Every Year):

41-0008W	Interstate	Principal Arterial
41-0009E	Interstate	Principal Arterial

HIGHWAY DISTRICT #6
(Eau Claire)

Station Number	Highway Type	Functional System	Number of Shifts Counted 1977	1978	1979
09-0001N	Rural STN	Principal Arterial		6	
09-0001S	Rural STN	Principal Arterial		6	
10-0001	Rural STN	Principal Arterial		10	
47-0001	Rural STN	Primary Arterial	6		
47-0002	Rural STN	Primary Arterial		6	
47-0003	Rural STN	Primary Arterial		6	
55-0002E	Interstate	Principal Arterial	9		
55-0002W	Interstate	Principal Arterial	9		
55-0006E	Interstate	Principal Arterial			10
55-0006W	Interstate	Principal Arterial			10
55-0007	Rural STN	Primary Arterial			6
55-0010	Rural STN	Primary Arterial			6
60-0001	Rural STN	Primary Arterial	10	—	—
Shift Totals	(13 Stations)		34	34	32

District Loadometers (2 Classified Every Year):

17-0001E	Interstate	Principal Arterial
17-0001W	Interstate	Principal Arterial

HIGHWAY DISTRICT #7
(Rhinelander)

Station Number	Highway Type	Functional System	Number of Shifts Counted 1977	1978	1979
21-0001	Rural STN	Primary Arterial]	10		
21-0003	Town Road	Local Road			
26-0001	Rural STN	Principal Arterial		10	
34-0001	Rural STN	Primary Arterial			10
35-0001	Rural STN	Principal Arterial			6
35-0002N	Rural STN	Principal Arterial	10		
35-0002S	Rural STN	Principal Arterial	10		
43-0001	Rural STN	Standard Arterial		10	
50-0002	Rural STN	Primary Arterial			6
Shift Totals	(9 Stations)		30	20	22

HIGHWAY DISTRICT #8
(Superior)

Station Number	Highway Type	Functional System	Number of Shifts Counted 1977	1978	1979
03-0010N	Rural STN	Principal Arterial]	10		
03-0010S	Rural STN	Principal Arterial			
04-0002	Rural STN	Principal Arterial]		10	
04-0003	Town Road	Local Road			
16-0002N	Rural STN	Principal Arterial]			10
16-0002S	Rural STN	Principal Arterial			
48-0001	Rural STN	Primary Arterial]	10		
48-0004	Town Road	Local Road			
48-0002	Rural STN	Standard Arterial		10	
48-0006	Rural STN	Primary Arterial		6	
54-0001	Rural STN	Standard Arterial			10
65-0002	Rural STN	Primary Arterial	10		
Shift Totals	(12 Stations)		30	26	20

HIGHWAY DISTRICT #9*
(Milwaukee)

Station Number	Highway Type	Functional System	Number of Shifts Counted 1977	1978	1979
40-0002E	Urban STN	Principal Arterial	6		
40-0002W	Urban STN	Principal Arterial			
40-0003E	Urban STN	Principal Arterial		6	
40-0003W	Urban STN	Principal Arterial			
40-0004E	Urban STN	Principal Arterial			6
40-0004W	Urban STN	Principal Arterial			
40-0006E	Urban STN	Principal Arterial	6		
40-0006W	Urban STN	Principal Arterial			
40-0007E	Urban STN	Principal Arterial		6	
40-0007W	Urban STN	Principal Arterial			
40-0017N	Urban STN	Primary Arterial			6
40-0017S	Urban STN	Primary Arterial			
40-0022N	Urban STN	Primary Arterial	3½		
40-0022S	Urban STN	Primary Arterial			
40-0025E	Urban STN	Principal Arterial		3½	
40-0025W	Urban STN	Principal Arterial			
Shift Totals		(16 Stations)	15½	15½	12

*District #9 uses six-hour shifts, split shifts, and five-minute lane counting.

APPENDIX B

Actual Hours Counted At Wisconsin Classification Stations (1977)

Actual Hours Counted At *Non-Loadometer* Classification Stations (1977)

Division of Highways District	Station Number	Hours Scheduled	Hours Actually Counted: Winter	Spring	Summer	Fall	Total Hours Counted
1	11-0002E	80	16	24	24	16	80
	11-0002W	80	16	24	24	16	80
	22-0002	80	16	24	24	16	80
	25-0003 } 25-0009 }	48	16	8	16	8	48
	53-0002 } 53-0003 } 53-0004 } 53-0006 }	48	16	8	16	8	48
Total		336					336
2	14-0001	80	6	30	39	6	81
	30-0008N }	48	-	-	21	-	21
	30-0008S }		8	20	-	-	28
	51-0001E	80	12	37	43	-	92
	51-0001W	80	13	37	35	-	75
	67-0001N }	80	6	32	5	-	43
	67-0001S }		-	-	16	8	24
Total		368					374
3	36-0001 } 36-0005 } 36-0006 } 36-0007 }	80	16	21	24	16	77
	59-0001	80	14	21	20	7	62
Total		160					139
4	01-0001	80	16	24	24	16	80
	69-0001	80	16	24	24	16	80
Total		160					160
5	12-0003	80	16	24	24	16	80
	61-0001	80	24	24	8	16	72
Total		160					152

Actual Hours Counted At *Non-Loadometer* Classification Stations (1977) (Continued)

Division of Highways District	Station Number	Hours Scheduled	Hours Actually Counted				Total Hours Counted
			Winter	Spring	Summer	Fall	
6	47-0001	48	23	-	24	-	47
	55-0002E	72	7	24	23	8	62
	55-0002W	72	15	23	24	16	78
	60-0001	80	16	24	24	15	79
Total		272					266
7	21-0001 } 21-0002 } 21-0003 }	80	16	24	24	16	80
	35-0002N	80	8	24	24	16	72
	35-0002S	80	14	24	24	8	70
Total		240					222
8	03-0010N } 03-0010S }	80	16	21	-	-	47
	48-0001 } 48-0003 }	80	16	24	-	-	40
	65-0002	80	9	24	-	-	33
Total		240					120
9	40-0002E }	48	-	24	-	-	24
	40-0002W }		-	24	-	-	24
	40-0006E }	48	-	24	-	-	24
	40-0006W }		-	24	-	-	24
	40-0022N }	28	-	24	-	-	24
	40-0022S }		-	24	-	-	24
Total		124					144
Non-Loadometer Total		*2,060*					*1,913*

Actual Hours Counted At *Loadometer* Classification Stations (1977)

Division of Enforcement & Inspection District	Loadometer Station	Hours Actually Counted				Total Hours Counted
		Winter	Spring	Summer	Fall	
1	13-0006E	-	16	-	8	24
	13-0007W	-	16	8	6	30
	13-0008E	-	16	-	8	24
	28-0007W	-	14	-	2	16
	53-0005	-	22	-	-	22
2	30-0003W	-	24	8	-	32
	64-0009E	-	-	16	8	24
	64-0009W	-	-	16	-	16
3	20-0001	-	-	16	8	24
	44-0005	-	16	-	8	24
4	42-0004	-	-	8	8	16
	49-0004N	-	8	8	8	24
	49-0004S	-	8	8	8	24
5	41-0008	-	-	24	-	24
	41-0009	-	-	24	-	24
6	17-0001E	-	-	*	8	8
	17-0001W	-	-	16	8	24
Loadometer Total						*380*

*Counted 16 hours at wrong location.

APPENDIX C

Sample Sizes Needed Using Traffic Volume Analogy

Minimum Sample Sizes Needed to Obtain Estimates
of Average Traffic Volume Within ± 10% & ± 20%
At 16 Selected ATR/Classification Stations (1976)

- Weekdays Only -

Station Number	Time Period	Mean Volume	Standard Deviation	Minimum Number of Counts Needed: At 90% Conf. Level ± 10%	At 90% Conf. Level ± 20%	At 95% Conf. Level ± 10%	At 95% Conf. Level ± 20%
11-0002E	10 PM-6 AM	1203	302	17	5	25	6
	6 AM-2 PM	3755	1468	42	11	59	15
	2 PM-10 PM	4420	2158	65	17	92	23
	12 AM-12 AM	9369	3812	45	12	64	16
11-0002W	10 PM-6 AM	1315	567	51	13	72	18
	6 AM-2 PM	4183	1712	46	12	65	16
	2 PM-10 PM	4616	2921	109	27	154	39
	12 AM-12 AM	10112	4875	63	16	90	23
12-0003	10 PM-6 AM	100	35	34	9	47	12
	6 AM-2 PM	456	101	14	4	19	5
	2 PM-10 PM	511	168	30	8	42	11
	12 AM-12 AM	1067	268	18	5	25	6
14-0001	10 PM-6 AM	451	81	9	3	13	4
	6 AM-2 PM	2676	331	5	1	6	2
	2 PM-10 PM	2773	713	18	5	26	7
	12 AM-12 AM	5899	1000	8	2	12	3
21-0001	10 PM-6 AM	99	37	38	10	54	14
	6 AM-2 PM	712	241	31	8	44	11
	2 PM-10 PM	676	262	41	11	58	15
	12 AM-12 AM	1486	517	33	9	47	12
22-0002	10 PM-6 AM	124	34	21	5	29	8
	6 AM-2 PM	679	119	9	2	12	3
	2 PM-10 PM	672	194	23	6	32	8
	12 AM-12 AM	1474	310	12	3	17	5

Minimum Sample Sizes Needed to Obtain Estimates
of Average Traffic Volume Within ± 10% & ± 20%
At 16 Selected ATR/Classification Stations (1976)
(Continued)

\- Weekdays Only -

Station Number	Time Period	Mean Volume	Standard Deviation	Minimum Number of Counts Needed: At 90% Conf. Level ± 10%	At 90% Conf. Level ± 20%	At 95% Conf. Level ± 10%	At 95% Conf. Level ± 20%
40-0006E	10 PM-2 AM	4680	640	5	2	8	2
	6 AM-2 PM	14454	1596	4	1	5	2
	2 PM-10 PM	15714	1876	4	1	6	2
	12 AM-12 AM	34845	3648	3	1	5	1
40-0006W	10 PM-6 AM	4227	618	6	2	9	2
	6 AM-2 PM	15363	1477	3	1	4	1
	2 PM-10 PM	15458	2722	9	2	12	3
	12 AM-12 AM	35047	4371	5	1	6	2
48-0001	10 PM-6 AM	233	67	23	6	32	8
	6 AM-2 PM	1089	276	18	5	25	7
	2 PM-10 PM	1165	444	40	10	56	14
	12 AM-12 AM	2486	710	23	6	32	8
51-0001E	10 PM-6 AM	2371	359	7	2	9	3
	6 AM-2 PM	8107	1241	7	2	9	3
	2 PM-10 PM	8076	1720	13	3	18	5
	12 AM-12 AM	18555	2976	7	2	10	3
51-0001W	10 PM-6 AM	2351	500	13	3	18	5
	6 AM-2 PM	7890	1050	5	2	7	2
	2 PM-10 PM	8721	2494	23	6	32	8
	12 AM-12 AM	18158	5151	22	3	31	4
60-0001	10 PM-6 AM	240	86	35	9	50	13
	6 AM-2 PM	1436	272	10	3	14	4
	2 PM-10 PM	1506	419	21	6	30	8
	12 AM-12 AM	3181	723	14	4	20	5

Minimum Sample Sizes Needed to Obtain Estimates
of Average Traffic Volume Within ± 10% & ± 20%
At 16 Selected ATR/Classification Stations (1976)
(Continued)

- Weekdays Only -

Station Number	Time Period	Mean Volume	Standard Deviation	Minimum Number of Counts Needed: At 90% Conf. Level ± 10%	At 90% Conf. Level ± 20%	At 95% Conf. Level ± 10%	At 95% Conf. Level ± 20%
61-0001	10 PM-6 AM	240	58	16	4	23	6
	6 AM-2 PM	1188	195	8	2	11	3
	2 PM-10 PM	1264	251	11	3	16	4
	12 AM-12 AM	2691	455	8	2	11	3
67-0001N	10 PM-6 AM	533	112	12	3	17	5
	6 AM-2 PM	1929	212	4	1	5	2
	2 PM-10 PM	3597	389	4	1	5	2
	12 AM-12 AM	6079	587	3	1	4	1
67-0001S	10 PM-6 AM	484	80	8	2	11	3
	6 AM-2 PM	3003	292	3	1	4	1
	2 PM-10 PM	2601	283	4	1	5	2
	12 AM-12 AM	6087	526	3	1	3	1
69-0001	10 PM-6 AM	355	139	42	11	49	15
	6 AM-2 PM	1656	536	29	7	41	10
	2 PM-10 PM	1839	971	76	19	107	27
	12 AM-12 AM	3850	1520	43	11	60	15