



Update of Vehicle Classification for County Road Pavement Design

Minnesota
Department of
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Final Report

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Counties that participated in the study included the following.

- Chisago
- Clay
- Cottonwood
- Dodge
- Douglas
- Freeborn
- Jackson
- Kandiyohi
- Lake
- Lake of the Woods
- Lincoln
- Meeker
- Polk
- St. Louis
- Wadena

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EXECUTIVE SUMMARY

This report describes the work conducted across Minnesota to determine if an update to the distribution of the classification of vehicles on the County State Aid Highway (CSAH) system is needed. The data were collected across the state, representing many regions, and in all seasons (although very few counts were conducted during winter). The results of this investigation include the development of updated vehicle classification tables for pavement design on the CSAH system, a manual for counties to use when conducting individual vehicle classification counts for pavement design, and a new view of the distribution of vehicle types on the CSAH system, which has not been systematically counted for many years.

The results of this study indicate that the vehicle classification distributions on the CSAH system (and likely the county road system) should be updated with new default values to reflect current traffic. In addition, improved information and training should be offered to local agencies to help improve estimates of vehicle classification for pavement design.

The data collected for this project indicate the following changes (comparing average values from the 1977 and 2009 data) in vehicle classification on the CSAH system.

Vehicle Classes	1977 Average, %	2009 Average, %	Change, %
Autos and Pickups	94.1	88.9	-5.5
Single Unit Trucks (2 axle, 6 tire)	2.6	3.7	+42
Single Unit Trucks (3+ axle)	1.7	1.9	+12
Tractor Semi-Trailers (3 axle)	0.0	0.8	<i>n/a</i>
Tractor Semi-Trailers (4 axle)	0.1	0.2	+100
Tractor Semi-Trailers (5+ axle)	0.5	2.2	+340
Buses and Trucks with Trailers	1.0	2.3	+130

Chapter 1. INTRODUCTION

This report describes the work conducted across the State of Minnesota to determine an updated distribution of the classification of vehicles on the County State Aid Highway (CSAH) system. The data were collected across the state, representing many regions, and in all seasons (although very few counts were conducted during winter). The results of this investigation include the development of updated vehicle classification tables for pavement design on the CSAH system, a manual for counties to use when conducting individual vehicle classification counts for pavement design, and a new view of the distribution of vehicle types on the CSAH system, which has not been systematically counted for many years.

Background

This project addressed the need for accurate and updated distributions of vehicle types, and also the need for vehicle classification distributions by region and season. The Minnesota Department of Transportation (Mn/DOT) has installed many vehicle classification sites throughout the state – on the interstate and state highway systems, for which there is excellent information. There are, however, often long intervals between classification counts on the county and county state aid highway road systems, and many of the established classification sites on the county road (CR) system have only been counted once.

Classification information was collected and analyzed to determine an appropriate vehicle distribution for the various regions of the state and seasons of the year. For the most part, portable traffic classifiers, on loan from the Mn/DOT District State Aid offices, were placed at various locations around the state, conducting classification counts of an average 14-day duration (the minimum was 48 hours and the longest was about 21 days).

The method for determining the distribution and classification of traffic for the design of pavements on trunk highways and county state-aid highways has been based on the guidelines in Mn/DOT's Geotechnical and Pavement Manual (1). The data in Table 4-4.2 for CSAH roads is a combination of multiple updates of data from 1977, 1983-1989, and again updated in 1997. The table also reports data for trunk highways both inside and out of the metro area within Minnesota.

Project Objectives

The primary objective of this project was to update the vehicle classification and distribution that counties use when designing pavement structures. Since the 1977 traffic distribution, there has been a continued shift in vehicle distribution, especially in the rural, agricultural areas of the state. For example, more farmers have acquired tractor semi-trailers (TST) to transport grain. In an informal "windshield" study, one county engineer observed much more than the 1.5% specified in Table 4-4.2 for all three categories of tractor semi-trailers. The vehicle classification distributions often depend on the type, or functional classification, of the road being considered. Table 4-4.2 gives an average of 6.1% vehicles with five or more axles on Trunk Highways, and only 0.5% on Rural CASH or County Roads.

In addition, as mentioned above, the updated vehicle classifications were divided into smaller categories, providing vehicle classification data by region and season. The second objective was

to develop a three-level method for local agencies to determine the appropriate vehicle classification for use in the pavement design of a particular roadway.

County Selection and Assistance

Initially, this project was limited to approximately one county for each Mn/DOT district. Later in the project, this was revised and a second group of eight counties was selected. While not all of the original selections were successful in providing the desired counts, the information in Chapter 2 describes those counties and their participation in the project.

Report Organization

The topics contained in this report include the following.

- Chapter 2. Data Collection Plan Development
- Chapter 3. Data Collection
- Chapter 4. Data Analysis
- Chapter 5. Development of a Standard Method for Local Road Classification Counts
- Chapter 6. Recommendations for Implementation

The information in Chapter 5 is organized such that it could be included as a standalone document (data collection manual or field guide). The final chapter contains recommendations for the implementation of the results of this project, and for future work that may enhance the ability of local agencies to quantify more accurately the vehicle classifications within their jurisdiction.

Chapter 2. DATA COLLECTION PLAN DEVELOPMENT

This chapter presents the development of the data collection plan for the project. The plan includes the selection of specific counties to assist in the data collection, and the selection of specific roadways within each county on which data collection would be conducted. In addition, the acquisition of equipment was required, as well as data collection standards to ensure the consistency and accuracy of the data.

Selection of Counties and Roadways

In the first phase of the project, eight counties were asked to participate but only six were able to do so. Nine counties in two categories (primary and secondary) were asked for the second phase. The primary counties in the second phase agreed to assist with data collection in each season, and Kandiyohi County agreed to conduct data collection on a limited basis. Although not every county was able to participate, others were asked and agreed to assist, and some of these spanned both phases. The counties that assisted in the data collection for this project included the following.

Phase 1

- Douglas
- Freeborn
- Jackson
- Meeker
- Polk
- St. Louis

Phase 2

- Chisago
- Clay
- Cottonwood
- Dodge
- Lake
- Lake of the Woods
- Lincoln
- Wadena
- Kandiyohi

These counties represent a mix of traffic distribution with respect to the following categories

- Population – Urban / Rural
- Geography – Southeast, South Central, Southwest, Central, Northwest, Northeast
- Commercial activity – Agriculture, Forestry, Tourism, etc.

Roadway Selection

Once the counties had been selected for assisting in the project, specific roadways for conducting the classification counts were selected. The selection of specific roadways was left to the individual county engineer, who knows best the particulars of the roadways and traffic patterns.

General guidelines were given to the local agencies by the project team and the project's Technical Liaison, Mr. Tim Stahl, Jackson County Engineer. The counties were asked to select up to five locations for classification counts. The objective of the location selection was to choose roadways that are representative of typical roads in the county. The counties were asked specifically not to purposely select roadways near major traffic generators, but at the same time, not to avoid them purposely, either. The following guidance was provided to the participating counties for use when selecting roadways.

- Select up to 5 locations representative of the traffic within the county.
- Try to select at least one location representative of each average daily traffic (ADT) category (150 – 399, 400 – 1499, 1500+ collector or arterial, and 7000+). If a county does not have any (or has very few) locations in a particular ADT category, it may select from roadways that are more representative of the traffic within the county.
- If a location is chosen that would be affected significantly by a major traffic generator (i.e. factory, ethanol plant, truck terminal) please note this in the “comments” section in the spreadsheet.

Table 1. Roadway Classification Selections by Volunteer Counties – Phase 1.

County	Highway	Location	ADT	Comments
Douglas	CSAH 1	North of TH 27	230	NS
	CSAH 3	North of CSAH 10	1,150	
	CSAH 6	North of CSAH 22	1,250	
	CSAH 46	North of CSAH 23	3,400	
	CSAH 82	East of CSAH 45	10,200	
Freeborn	CSAH 14	South of South JCT CSAH 9	230	
	CSAH 35	West of JCT CSAH 20	395	
	CSAH 25	East of JCT CSAH 20	1,150	
	CSAH 26	South of JCT CSAH 19	920	
	CSAH 46	East of JCT CSAH 14	1,750	
Jackson	CSAH 24	West of JCT TH 60	195	
	CSAH 6	West of JCT US 71	150	
	CSAH 34	East of JCT CSAH 23	1,300	
	CSAH 9	South of Heron Lake	1,000	
	CSAH 38	West of JCT CSAH 23	2,300	Industrial Park Road
Meeker	CSAH 16	West County Line to CSAH 25	115	Farm to Market route
	CSAH 23	W. County Line to TH 4	205	Farm to Market Route
	CSAH 26	Jct CSAH 12 to 2 Miles South of Jct TH 7	405	Farm to Market Route
	CSAH 1	Jct CSAH 23 to Jct CSAH 11	1,300	Farm to Market Route
	CSAH 14	Jct CSAH 18 to Jct CSAH 33	1,850	Lake Region
	CSAH 34	Jct TH 12 to Jct TH 24	3,300	City Bypass
Polk	CSAH 2	North of CSAH 74	350	Reconstructed Summer of 2006
	CSAH 9	TH 220 - TH 75	940	
	CSAH 6	South of CSAH 27	1,250	
	CSAH 21	East of TH 75	1,550	
	CSAH 46	TH 2 - CSAH 11	1,900	
St. Louis	CSAH 21	North of JCT CSAH 70	1,350	
	CSAH 44	East of JCT CSAH 37	890	
	CSAH 4	North of JCT CSAH 44	1,050	
	CSAH 32	East of JCT TH53	6,600	
	CSAH 13	North of JCT I-35	7,600	

Table 2. Roadway Classification Selections by Volunteer Counties – Phase 2.

County	Highway	Location	ADT	Comments
Chisago	CSAH 2	West of JCT CSAH 4	1,400	Located in a more rural part of the county but also chosen because of its inter-county connection.
	CSAH 9	North of JCT TH 95	900	Main N/S route in Chisago County which is not Interstate 35 or close to Interstate 35.
	CSAH 20	East of JCT CSAH 12	1,100	East/West route farm interests and commuters
	CSAH 26	South of JCT USH 8	3,400	Short cut between USH 8 and the bridge over the St. Croix to Wisconsin. Heavily used by trucks.
	CSAH 30	North of JCT CSAH 19	7,000	Close to a ramp to I-35 and is heavily used by commuters
Clay	CSAH 8	West of TH 75	255	
	CSAH 6	East of TH 32	455	
	CSAH 18	West of CSAH 19	730	
	CSAH 11	South of TH 336	1,100	
	CSAH 10	Co Rd 71	2,750	
Cottonwood	CSAH 13	Bet. CSAH 5&7	275	
	CSAH 3	Bet. CSAH 2&1	235	
	CSAH 5	S. Storden MN	800	
	CSAH 7	N. Westbrook, MN	630	
	CSAH 1	N. Jct. 27, Mt. Lake	1,650	
Dodge	CSAH 3	0.1 miles North of Jct. CSAH 4	285	
	CSAH 4	0.4 miles East of Jct. 240th Ave	215	
	CSAH 7	0.5 miles South of Jct. CSAH 16	770	
	CSAH 16	0.2 miles East of Jct. 252nd Ave	560	
	CSAH 34	0.4 miles East of North Jct. CSAH 9	3,850	
Lake	CSAH 3	West of JCT CSAH 4	325	
	CSAH 14	West of JCT CSAH 2	435	
	CSAH 12	West of JCT CSAH 2	690	
	CSAH 5	East of JCT CSAH 4	1,200	
	CSAH 2	South of JCT Co. Rd. 111	3,150	
Lake of the Woods	CSAH 2	Just north of Williams	370	
	CSAH 6	At Pitt	210	
	CSAH 17	North of CR 241	340	
	CSAH 8	East end	420	
	CSAH 1	South of CSAH 27	1,050	
Lincoln	CSAH 19	West of JCT US HWY 75	235	
	CSAH 1	North of JCT US HWY 14	310	
	CSAH 13	East of JCT US HWY 75	240	
	CSAH 17	East of JCT TH 271	630	
	CSAH 7	South of JCT US HWY 14	970	
Wadena	CR 169	N. of Jct. TH 10	150	W. Co. Line
	CSAH 21	1 Mi. E of TH 71	950	Near Menahga
	CSAH 8	W. of TH 71 Jct.	980	Sebeka, MN
	CSAH 30	In Staples, MN	1,950	
	CSAH 4	E. of Jct TH 10	1,850	In Wadena
Kandiyohi	CSAH 3	E of Us 71	315	
	CSAH 3	W of US 71	310	
	CSAH 2	S of MN 7	570	
	CSAH 5	S of MN 7	1,200	
	CSAH 23	E of Willmar	1,600	

Each county attempted to select at least one roadway from each of the ADT categories in the State Aid design charts (150 – 399, 400 – 1499, 1500+ and 7000+). For counties without any roadways in some of the categories, additional locations were made in ADT ranges with the largest amount of roads. The location selection was limited to roadways in the CSAH and

County Road systems. A spreadsheet was sent to each county with the selections for Jackson County, as an example. Each county then made selections and returned the spreadsheet. In the spreadsheet, the county, roadway, location, ADT, and any comments for each location has been recorded, as indicated in Table 1 for Phase 1 and Table 2 for Phase 2.

Equipment and Accessories Acquisition

The majority of the traffic classifying equipment used for this project was provided to the counties by the Mn/DOT District State Aid offices. Each individual county that participating in this project either contacted its state aid office to obtain the use of up to five classifiers each, or purchased enough classifiers to conduct the data collection for the project. The project budget allowed for the purchase of accessories for traffic classifying equipment loaned to the counties. This includes road tubing, nails, tape, and other necessary equipment and accessories to accomplish the classification counts.

Data Collection Plan

This section describes the overall plan for collecting the vehicle classification data across the state. The specific placement of the classifiers and tubes was according to the manufacturer requirements, and will be described in more detail in the next chapter. The Field Guide, a short document provided to the participating counties is included in Appendix A of this report.

Data Collection Standards

The data collection plan included vehicle classification throughout Minnesota for several seasonal periods over the course of one year. In each season data was collected at each site (approximately five sites in each county) for a period of about 14 days. It is understood that this time period is longer than the standard 48-hour count for vehicle classification. However, the project team decided that since the effort of placing and retrieving the equipment would be the same regardless of the count duration, longer periods would yield more data for almost no marginal cost. Therefore, the data collection should only be limited by the memory and battery power of the classifying equipment.

Chapter 3. DATA COLLECTION

Vehicle classification data was collected from November 2006 through July 2009 comprising both phases of the data collection effort. In total, 47 sets of classification counts, with approximately 5 roadways each, were counted, for a total of 239 individual roadway counts, at an average of about 12 days each. All of the data have been catalogued, analyzed, and included in the analysis that will be discussed in the following sections.

While it would be preferable to have data for the winter counts, most counties encountered trouble when attempting them. For example, the tubes would not stay in place (the tape would not adhere; the asphalt was too hard to nail down the tubes, etc.). In addition, a count longer than a few days would not normally have been possible, due to recurring snow and forecasts of snow, since traffic tubes are easily removed from the roadway surface by snow plows. Since the objective of the project is to update the vehicle classification distributions used by counties with conducting pavement designs, it was determined that the winter counts are not imperative. It is during the winter months, when the pavement surface is frozen much of the season, that the pavement structure has the most strength, in terms of withstanding traffic-related damage. In addition, some studies have shown that the volumes and proportions of heavy commercial truck traffic are lower in the winter season. Both of these cases contribute to better conditions for pavement structures. Table 3 and Table 4 indicate the counties involved in the data collection effort in Phase 1 and Phase 2 of the study, respectively, and the seasons in which counts were completed.

Table 3. Classification Counts Conducted in Phase 1.

Phase 1 Classification Counts - Season					
County	District	Winter	Spring	Summer	Fall
Douglas	4				
Freeborn	6				x2
Jackson	7				x2
Meeker	8				x2
Polk	2				x2
St. Louis	1				

Table 4. Classification Counts Conducted in Phase 2.

Phase 2 Classification Counts - Season					
County	District	Winter	Spring	Summer	Fall
Chisago	5				
Clay	4				
Cottonwood	7				
Dodge	6				
Kandiyohi	8				
Lake	1				
Lake of the Woods	2				
Lincoln	8				
Wadena	3				

Data Collection Process and Standards

This section describes the standards for data collection that were provided to each participating county in the study. The general guidelines included the following.

1. Location Selection
2. Obtaining Classification Counters
3. Counter Installation
4. Data Transmittal

Location Selection

The previous chapter described the guidelines and process for selecting the roadways to be counted. This section describes the guidelines provided by the project staff to the participating counties for selecting the specific location where the counters were to be placed.

- Counters are not to be located within 100 feet of an intersection, and preferably not within 300 feet.
- Vehicles should cross tubes in a perpendicular fashion. Avoid placing tubes on curves or in turns.
- Vehicles should cross the tubes at uniform speeds. Avoid placing tubes in zones where acceleration or deceleration is common (e.g., near stop signs or turns).
- The tubes should be placed flat against the pavement. Avoid placing tubes where curbs will prevent tubes from lying flat.
- The data collection unit should be locked to a signpost or other roadside stationary object.

These guidelines were provided to each participant at the beginning of each phase of the project. The location and placement guidelines are included in the field guide provided to the participants. The full set of guidelines is presented in Appendix A.

Counter Installation

The following steps were provided to the participants to assist them in the proper installation of the counters.

Hardware Setup

1. Cut eight 8” to 12” strips of roofing tape.
2. Warm up the roofing tape. On a warm day this may not be necessary. Otherwise, place the tape near a car heater.
3. Using mallet and stake, anchor the clamped end of one tube to the side of the roadway opposite from where the data collection unit will be placed.
4. Stretch the staked hose, perpendicular to the centerline, to the other side of the roadway. Stretch the hose about 10% of its length. For example, a 40-foot section of hose, unstretched, should be stretched about 4 feet.
5. Using mallet and stake, anchor the free end of the stretched tube.
6. Check that the staked tube is perpendicular to the centerline.
7. Using the chalk, make three marks adjacent to the staked tube. These marks should be spaced evenly across the pavement.

8. Using the tape measure and chalk, make three parallel marks exactly **16 feet** from the first set of marks. The distance must be measured, not estimated.
9. Place the second hose on top of the second set of marks. Stake the clamped end an equal distance off the road surface on the same side of the roadway as the first tube.
10. Stretch the second hose about 10% (see step 2) and stake to the other side of the road.
11. Place the data collection unit near the anchoring device (e.g., signpost).
12. Connect the tube to the data collection unit. Tube A should be the tube a vehicle goes over first when traveling in a northbound or eastbound direction. Tube B is the second tube a vehicle drives over in a northerly or easterly direction.
13. Continue with the software setup.

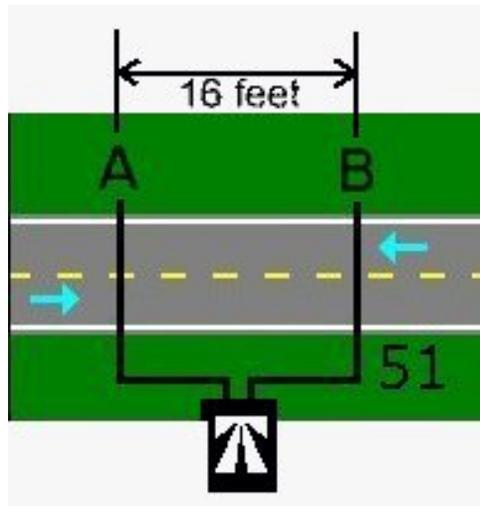


Figure 1. Layout #51 Configuration. Used with permission from TimeMark, Inc.

Software Setup

In programming the TimeMark Delta IIIIL field unit, note that the [Select] button will move between different options (indicated by flashing text) in a particular menu, while the [Enter] button will choose the option and go on to the next menu.

1. Data Collection Card: Place a data collection card with the pin connections in the memory card slot. It will fit in only one way. Make sure the fit is snug and pins are connected to the card.
2. Turn on the collection unit: An introductory screen will appear displaying the software version number. The screen will then proceed to *Main Menu* automatically.
3. Choose: Memory Manager: Under the *Main Menu*, the following options appear:
Record A New Study
Monitor Traffic
Memory Manager

Use the [Select] button to make *Memory Manager* flash. Then press [Enter]. *Memory Manager Menu* will appear.

4. Choose: Erase Flash Card: Use the [Select] button to make *Erase Flash Card* flash. Then press [Enter] *Erase Flash Card Menu* will now appear.
5. Choose Confirm, erase card: Use the [Select] button to make *Confirm, erase card* flash. Then press [Enter]. The erasing process of the flash card cleans the card of previously accumulated data. Once erased, a message appears on the screen. Press [Enter]. *The Main Menu should then appear.*
6. Choose Utility Functions: Use the [Select] button to scroll beyond *Memory Manager* until *Utility Functions* flash. Press [Enter]. The *Utility Functions* menu has the following choices:
 - Check System Status*
 - Set Clock Calendar*
 - Set Serial Baud Rate*
 - Do Function Tests*
 - Sensor Diagnostics*
 - Back To Main Menu*
7. Choose Set Clock Calendar: Use the [Select] button to make *Set Clock Calendar* flash. Press [Enter]. The *Current Time & Date* menu will appear. Correct, if necessary, the time and date stored. Utilize the numeric keypad. Once entered, the *Exit, Save New Data* line will flash. If data is correct press [Enter], otherwise press [Select] to scroll down to *Quit, Do Not Save* and the clock calendar can be redone. Cycle back through the menu and redo Step 6. Once correct, press [Enter].
8. The Main Menu should appear with *Utility Functions* flashing. Press the [Select] button and scroll through until *Record A New Study* flashes. Press [Enter]
9. Choose Select A New Study under the next menu. Press [Enter]. The *Enter Site Code* screen will appear.
10. Enter the 12-digit filename using the following guide:
 - Digits 1-2 = Month code
 - 01 = January, etc.
 - Digits 3-4 = site number, based on the two-digit county code:
 - Digit 5 = number of boxes used at this site (typically 1)
 - Digit 6 = direction of traffic in 'primary' direction. This is the direction of traffic that crossed tube A first.

N = 1	NE = 2
E = 3	SE = 4
S = 5	SW = 6
W = 7	NW = 8
 - Digit 7 = lane number for primary direction (1 = Driving, 2 = Passing), ('2' would be used if conducting a count on a 4-lane road)
 - Digit 8-9 = Route System

01 = Interstate	04 = CSAH
02 = U.S. Hwy	05 = MSAS
03 = Minn. Trunk Hwy.	07 = Co. Rd.
 - Digits 10-12 = 3 digit route number with leading zeros.

Once the data filename has been input, press [Enter] and the *Study Type Menu* will appear.

11. Choose Raw Data: Under the *Study Type Menu* use the [Select] button, if necessary, to make *Raw Data* flash. Then press [Enter]. The *Sensor Layout Menu* will appear.
12. Choose A>B, C>D spaced: Use the [Select] button, if necessary, to make *A>B, C>D spaced* flash. Then press [Enter]. The *Enter Sensor Spacing* screen will appear.
13. Enter 16.0, On the Enter Sensor Spacing screen input *16.0* ft. sensor spacing. Press [Enter].
14. Choose Start Recording Now: Under the *TUBE: RAW* menu use the [Select] button, if necessary, to make *Start Recording Now* flash. Then press [Enter]. The next screen indicates that *A Study is Currently Running* and *Go To Monitor Screen* and *End The Study*
15. Choose Go To Monitor Screen: Use the [Select] button, if necessary, to make *Go To Monitor Screen* flash. Press [Enter]. The data collection screen will now appear. The data collection screen contains a table as shown below:

RAW: TUBE	TIME	LANE I
A:	0	t
B:	0	t

The middle column contains the number of total hits on each of the two tubes, A and B.

16. Verify that the system is operational: Check that the tubes are recording hits, either by vehicles or by stepping forcefully on the far end of each of the tubes. If hits are not being recorded, there may be a problem with the connection of the tubes to the data collection unit or a tube may be damaged. The equipment and connections may need to be inspected. If hits are being recorded, continue with final setup.

Final Setup

1. Make sure tubes are aligned with chalk marks. Adjust if necessary.
2. Using precut, warm strips of tape, secure tubes in each of the wheel paths.
3. Check that collection unit is still registering hits. If necessary, even the number of hits between each tube.
4. Close box and chain to anchoring device.

After the counters had been set up, the participants left them in place to collect vehicle classification data for approximately 14 days, although some counts were only able to run for as few as 48 hours.

Data Transmittal

The participants were given instructions for dismantling the count site once the 14-day count was completed, and for transmitting the data to the project team for analysis. The format of the classifiers was such that all data was stored on a removable memory card, which was sent to the project team by US mail. After the data had been copied and analyzed, the memory cards were sent back to the participants in preparation of the next set of counts.

Chapter 4. DATA ANALYSIS

The data collected by the county volunteers was analyzed by the project team, and is reported in this chapter. Primarily, the data analysis focused on vehicle classification divided into the following categories.

- Statewide classification, including all locations, seasons, and ADT categories
- Statewide, divided by season
- Statewide, divided by ADT (traffic) category
- Statewide, divided by ADT (pavement design) category
- Statewide, weekday and weekend
- District/Region, including all seasons and ADT categories

Other analyses that will be presented in this chapter include the following.

- Variation in traffic volumes across seasons, regions, and ADT levels
- Variation in vehicle classification

Each of the categories listed above are described in more detail, along with the results of the data analysis, in the next several sections. In addition to the classification analysis, other basic analyses were conducted to determine the appropriateness of the 14-day count. It was determined that for a standard Mn/DOT 48-hour count, the daily variation in vehicle classifications over a 14-day count were not significant, and that any 48-hour period within the 14-day count could be representative of vehicle classification for that season.

Summary of Classification Data

This section presents a summary of the vehicle classification data collected over the entire project. For comparison purposes, Table 5 is the classification breakdown included in the 1994 and the new 2007 Pavement Manuals, published by Mn/DOT.

Table 5. Mn/DOT Pavement Manual – 1977 Vehicle Classification, revised 1997 (1).

VEHICLE CLASS PERCENT OF AADT Analysis of 1983-1989 Data							
Vehicle Classes	Trunk Highways Greater Minnesota			Trunk Highways Mpls/St. Paul Seven County Area			Rural CSAH or County Road
	Average	Min/Max	95% of data sites	Average	Min/Max	95% of data sites	Average
Autos, pickups	89			93			94.1
2 ax, 6 tire SU	2.7	.4 / 9.3	< 4.9	2.2	.8 / 7.6	< 3.6	2.6
3+ ax SU	1.5	0 / 28.7	< 4.1	1.0	0 / 8.9	< 2.8	1.7
3 ax TST	.1	0 / 1.1	< .3	.2	0 / 1.2	< .4	0.0
4 ax TST	.2	0 / 1.6	< .6	.2	0 / 1.1	< .6	0.1
5+ ax TST	6.1	0 / 31.0	< 15.5	3.2	0 / 22.6	< 10.6	0.5
Buses, Trucks w/Trailers	.4	0 / 3.9	< 1.2	.3	0 / 2.7	< .9	1.0
Twin Trailers	.1	0 / 1.0	< .3	.0	0 / .4	< .2	0.0
Total Number of Sites	N = 837			N = 239			1977 County Road Study

Since this report focuses on the CSAH system, only the far right column of data in Table 5 (indicated with a heavy black outline) applies when making comparisons to the new data presented in this section. The new data presented in this report, however, will follow the format of that presented in the trunk highway system (using the *average*, *minimum*, *maximum*, and *95% of data sites* sub-columns).

Statewide

The data presented in this report is divided into several combinations. The first is for the state as a whole, including all counts in all locations and all seasons. This set of data most directly relates to the *Rural CSAH or County Road* column in Table 5. Table 6 shows the updated data in a similar format.

The largest difference in this updated data is the percentage of five-axle TSTs. The average column in Table 6 indicates 2.2% of these vehicles in the average traffic on a CSAH roadway, whereas the same number from the existing pavement manual is 0.5%. This represents almost a four-fold increase in the number of five-axle TSTs in the overall statewide traffic mix. Since these heavy trucks represent a large contribution to the pavement damage, this increase has a significant impact on the proper design of pavements on the CSAH system.

Considering all commercial vehicles (all vehicles except the “Autos, pickups” classification) the existing pavement manual recommends using a total of 5.9% while the data collected for this project suggests that 11.1% may be more appropriate. Again, this is a significant increase over the recommended values in the current pavement design manual.

Table 6. Vehicle Classification – Statewide.

Vehicle Class	Average %	Maximum %	95% of data
Autos, pickups	88.9		
SU (2 axle, 6 tire)	3.7	35.6	8.8
SU (3+ axle)	1.9	27.7	6.1
TST (3 axle)	0.8	15.3	2.7
TST (4 axle)	0.2	4.5	1.0
TST (5+ axle)	2.2	34.7	8.3
Buses, Trucks w/ Trailers	2.3	37.1	9.6

The data in Table 7 and Table 8 show the same information as Table 6, but are divided into weekdays and weekends. This data can be used by those interested in a weighted average of classification by weekday and weekend days.

Table 7. Vehicle Classification – Statewide – Weekday.

Vehicle Class	Weekday	95% of data
Autos, pickups	86.6	
SU (2 axle, 6 tire)	4.3	9.5
SU (3+ axle)	2.3	6.8
TST (3 axle)	0.9	3.1
TST (4 axle)	0.3	1.1
TST (5+ axle)	2.8	9.4
Buses, Trucks w/ Trailers	2.9	11.0

Table 8. Vehicle Classification – Statewide – Weekend.

Vehicle Class	Weekend	95% of data
Autos, pickups	94.4	
SU (2 axle, 6 tire)	2.3	6.6
SU (3+ axle)	0.8	3.9
TST (3 axle)	0.5	1.6
TST (4 axle)	0.1	0.6
TST (5+ axle)	0.9	4.5
Buses, Trucks w/ Trailers	1.0	4.9

Statewide by Season

Another categorization of the data is the vehicle classification divided by season. As can be seen in Table 9, the proportion of passenger cars and pickups is greatest in the spring season, presumably before much farming and other industries have begun their major work efforts. All classification counts during the spring season were conducted after spring load restrictions were removed for the year, and prior to the commencement of major farming activities in the late

spring and early summer. The spring and fall seasons, predictably, had the lowest proportion of non-commercial vehicles (87.7% and 87.6%, respectively), as a greater proportion of farming and harvesting vehicles are active in those seasons. As mentioned previously, most counties had difficulties in conducting winter counts (keeping tubes on the road, finding a two-week window without snow, etc.) The proportion of heavy commercial vehicles in the spring, summer, and fall seasons was measured at 12.3%, 8.7%, and 12.4%, respectively.

Table 9. Vehicle Classification – Statewide by Season.

Vehicle Class	Season		
	Spring	Summer	Fall
Autos, pickups	87.7	91.3	87.6
SU (2 axle, 6 tire)	4.4	3.1	3.7
SU (3+ axle)	1.8	1.5	2.3
TST (3 axle)	0.8	0.6	0.9
TST (4 axle)	0.2	0.2	0.3
TST (5+ axle)	2.1	1.6	2.8
Buses, Trucks w/ Trailers	3.0	1.6	2.4

Statewide by ADT Category

A further method of dividing the vehicle classification data is by ADT category. There are two types of ADT categories – used for traffic analysis and for pavement design. In traffic analysis mode, the County State Aid Highways are divided by ADT level into the following categories.

- Less than 400 vpd
- Between 400 and 1499 vpd
- Between 1500 and 7000 vpd
- More than 7000 vpd

For pavement design, the following categories are used.

- Less than 400 vpd
- Between 400 and 999 vpd
- More than 1000 vpd

This data is shown in Table 10 and Table 11. It would be expected that roadways with smaller ADT, and in rural areas, would have higher proportions of trucks. The result of the data collection and analysis, however, showed that only a small change is evident. The proportion of *5+ axle trucks* and *trucks with trailers* for each traffic analysis category was 3.9%, 5.1%, 4.1%, and 2.9%, respectively. The proportion of heavy commercial vehicles for these four ADT categories is 10.6%, 12.4%, 9.4%, and 5.7%, respectively.

Table 10. Vehicle Classification – Statewide by ADT Category (Traffic Analysis).

Vehicle Class	ADT Range			
	< 400	400 - 1499	1500 - 7000	> 7000
Autos, pickups	89.4	87.6	91.6	94.3
SU (2 axle, 6 tire)	3.9	3.9	2.6	1.7
SU (3+ axle)	1.9	2.2	1.1	0.9
TST (3 axle)	0.8	0.9	0.3	0.1
TST (4 axle)	0.2	0.3	0.1	0.1
TST (5+ axle)	2.1	2.5	1.7	1.5
Buses, Trucks w/ Trailers	1.8	2.6	2.4	1.4

For the pavement design ADT categories, the proportion of 5+ axle trucks and trucks with trailers is 3.9%, 6.1%, and 3.7%, respectively. The proportion of heavy commercial vehicles for each category is 9.6%, 14.4%, and 8.3%.

Table 11. Vehicle Classification – Statewide by ADT Category (Pavement Design).

Vehicle Class	ADT Range		
	< 400	400 - 1000	> 1000
Autos, pickups	89.4	85.6	91.7
SU (2 axle, 6 tire)	3.9	4.5	2.7
SU (3+ axle)	1.9	2.5	1.3
TST (3 axle)	0.8	1.0	0.4
TST (4 axle)	0.2	0.3	0.2
TST (5+ axle)	2.1	2.9	1.8
Buses, Trucks w/ Trailers	1.8	3.2	1.9

Region (Mn/DOT District)

The vehicle classification data divided by region (represented by data collected in representative counties for each district) is shown in Table 12 and Table 13. The highest proportion of heavy commercial vehicles (18.4%) occurred in District 4.

Table 12. Vehicle Classification – Regional (Districts 1-4).

Vehicle Class	Mn/DOT District			
	District 1	District 2	District 3	District 4
Autos, pickups	92.9	89.3	92.9	81.7
SU (2 axle, 6 tire)	3.1	3.3	5.3	3.8
SU (3+ axle)	1.3	2.2	0.8	2.9
TST (3 axle)	0.4	0.4	0.2	0.9
TST (4 axle)	0.1	0.2	0.0	0.3
TST (5+ axle)	0.9	2.5	0.4	4.7
Buses, Trucks w/ Trailers	1.3	2.1	0.4	5.7

Table 13. Vehicle Classification – Regional (Districts 5-8).

Vehicle Class	Mn/DOT District			
	District 5	District 6	District 7	District 8
Autos, pickups	93.2	87.0	87.7	91.5
SU (2 axle, 6 tire)	4.3	4.1	4.5	3.0
SU (3+ axle)	0.9	2.6	1.7	1.4
TST (3 axle)	0.3	0.7	1.6	0.8
TST (4 axle)	0.1	0.3	0.4	0.2
TST (5+ axle)	0.5	2.4	2.1	1.9
Buses, Trucks w/ Trailers	0.7	2.9	2.0	1.2

Variation in Traffic Volumes

Additional analyses of the large set of data were conducted to determine the level of variability in the traffic volumes and vehicle classification distributions. As can be seen in Figure 2, as the level of ADT increases, the coefficient of variation (COV) decreases, which is the standard deviation divided by the mean. In the lower ADT ranges this is expected, since with larger volumes of traffic the same numerical difference will have less of an impact on the standard deviation. However, since the project only included the CR and CSAH roadway systems, very few of the roadways counted had volumes greater than 2000 vpd. This can be seen in Figure 2 and Figure 3, by the striped bars, indicating that fewer than 30 data points are included in the COV calculation. It is interesting to note that at the higher ADT ranges, the COV is lower than 5%.

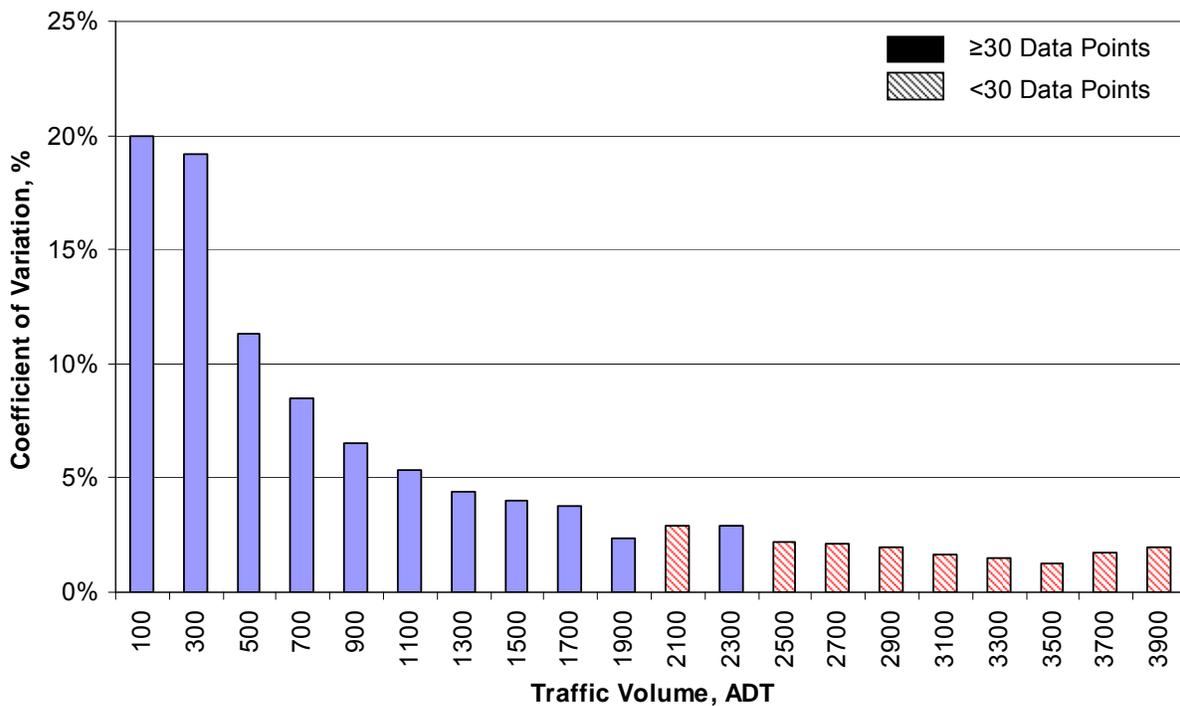


Figure 2. Variability in Traffic Volumes, All Counts.

In a comparison of COV in traffic volumes when the data is divided by season, slightly higher values are seen, but are still at or below 5% at about 1000 vpd. At the very low end of ADT levels, the spring and summer traffic volumes are less variable than those in the fall. Besides this discrepancy, the variability measures are similar across all ADT levels.

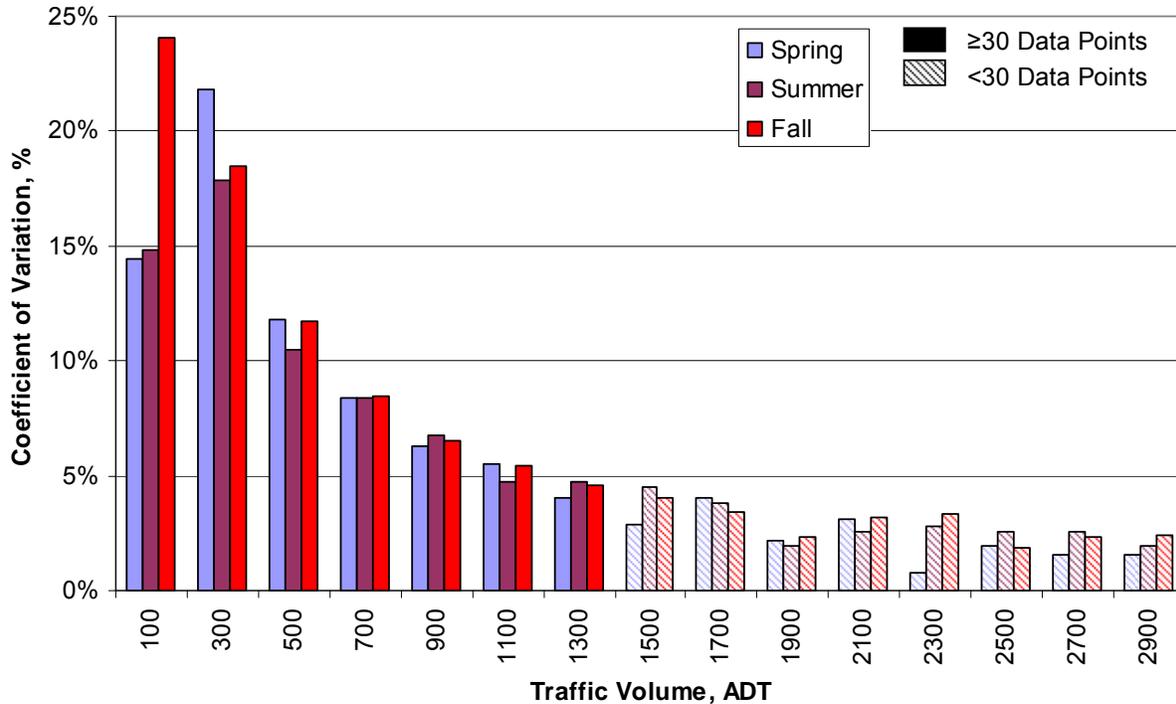


Figure 3. Variability in Traffic Volumes, by Season.

Variation in Vehicle Classification

Measuring and reporting on the variability in vehicle classification distributions is more difficult, especially with vehicle types having very low percentages. Small numbers of additional vehicles in one classification can cause the percentage of those vehicles to increase significantly. For this reason, the data shown in Figure 4 presents the COV for the “autos and pickups” vehicle classification, divided by season. Several items are of interest in this figure. The summer season has the smallest COV for autos and pickups in the three measures indicated – all seven days of the week, weekdays, and weekends. In addition, across all three seasons when most of the classification counts were conducted, the weekend days have the smallest variability.

Other vehicle classifications were analyzed in the same manner, but since the autos and pickups classification comprises 88.9% of the traffic makeup, and the other six vehicle classes make up the remaining 11.1%, some very large COV values were obtained that would not be of much use.

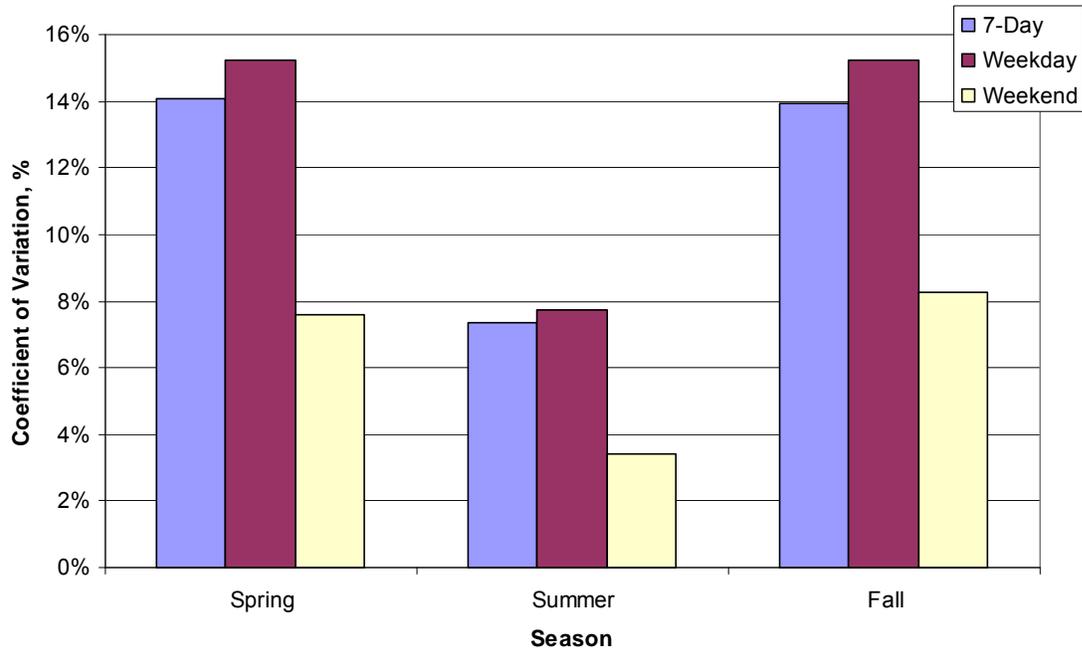


Figure 4. Variability in Vehicle Classification – Autos and Pickups, by Season.

Conclusion

It is clear that the distribution of vehicle types in the traffic mix has changed since the last update of the classification tables. The changes are most prominent in the increase in 5+axle TST trucks, as indicated in Table 14. On a statewide basis, the largest trucks are those that have seen the greatest increase, with each of them at least doubling since the last update.

Table 14. Changes in Vehicle Classification Tables.

Vehicle Class	1977	2009	Change, %
	Average, %	Average, %	
Autos and Pickups	94.1	88.9	-5.5
Single Unit Trucks (2 axle, 6 tire)	2.6	3.7	+42
Single Unit Trucks (3+ axle)	1.7	1.9	+12
Tractor Semi-Trailers (3 axle)	0.0	0.8	<i>n/a</i>
Tractor Semi-Trailers (4 axle)	0.1	0.2	+100
Tractor Semi-Trailers (5+ axle)	0.5	2.2	+340
Buses and Trucks with Trailers	1.0	2.3	+130

Chapter 5 presents guidelines in the form of a manual for local agencies to conduct their own vehicle classification determination – whether by using a statewide data table a table developed for the specific region and level of ADT, or by conducting a classification count on the specific roadway to be designed. Chapter 6 presents several recommendations for the implementation of the findings of this study, and for further guidance in assisting local agencies in implementing the methods described in Chapter 5.

Chapter 5. STANDARD METHOD FOR LOCAL ROAD CLASSIFICATION COUNT

This chapter is presented as a potentially stand-alone guide for local agencies to develop vehicle classification distributions, using one of three methods:

1. Use of the statewide classification data table (Table 17 in this chapter)
2. Use of tables categorized by region, ADT, and season (Table 18 through Table 23 in this chapter).
3. Use of vehicle classification count hardware available through the district state aid offices to conduct a count of the specific roadway in question (the *Individual Classification Counts* section of this chapter).

For each method listed above and described in this chapter, a detailed method for developing an appropriate classification distribution is provided.

Introduction

This manual describes several methods for determining the appropriate vehicle classification mix for use in pavement designs on the County State Aid Highway (CSAH) System. The current vehicle classification distribution as a percent of AADT is included in the Mn/DOT Geotechnical and Pavement Manual (the Pavement Manual) and has been for many years. The manual was recently updated from its 1994 version, although the distributions were not updated. During this time, many changes in actual vehicle use and the types of vehicles used have occurred, resulting in a general increase in the proportion of heavy commercial vehicles in the traffic mix. Significant among these is the increase in ownership of five axle tractor semi-trailer trucks by farmers throughout the state. As ownership of larger trucks increases, and as crop yields per acre also increase, there are more loads carried by larger trucks throughout the CSAH system in the State of Minnesota.

Three Levels of Classification Data

This manual provides detailed information for determining the vehicle classification mix with three different methods. The first two are similar, and involve selecting the vehicle classification from a general table or by combining the data in two or more tables. The third is more involved, and requires actual vehicle classification counts to be conducted on the roadway in question. The three methods are:

1. Use statewide classification table,
2. Use regional and/or seasonal classification tables, and
3. Conduct individual counts.

Each of these methods is described in this manual, along with potential advantages and disadvantages of utilizing them.

Vehicle Classifications

The specific vehicle classifications used for pavement design in the Mn/DOT Geotechnical and Pavement Manual are indicated in Figure 5 (taken from Table 4-4.1 in the Pavement Manual).

The classifications are further reduced in Table 4-4.2 in the Pavement Manual, as shown in Table 15, below.

Table 15. Vehicle Classification Categories.

Vehicle Types	Vehicle Classifications
1, 2, and 3	<ul style="list-style-type: none"> • Passenger Cars • Panel and Pickups • Single Unit – 2 axle, 4-tire
4	<ul style="list-style-type: none"> • Single Unit – 2 axle, 6-tire
5	<ul style="list-style-type: none"> • Single Unit – 3 axle and 4 axle
6	<ul style="list-style-type: none"> • Tractor Semi trailer Combination – 3 axle
7	<ul style="list-style-type: none"> • Tractor Semi trailer Combination – 4 axle
8 and 9	<ul style="list-style-type: none"> • Tractor Semi trailer Combination – 5+ axle
10	<ul style="list-style-type: none"> • Trucks with Trailers and Buses
11	<ul style="list-style-type: none"> • Twin Trailers

Type Number	Illustration	Description
1		Passenger Cars
2		Panel and Pickups (under 1 ton)
3		Single Unit – 2 axle, 4-tire
4		Single Unit – 2 axle, 6-tire
5		Single Unit – 3 axle and 4 axle
6		Tractor semitrailer Combination – 3 axle
7		Tractor Semitrailer Combination – 4 axle
8		Tractor Semitrailer Combination – 5 axle
9		Tractor Semitrailer Combination – 6 axle
10		Trucks with Trailers and Buses

Figure 5. Mn/DOT Vehicle Types (1).

Statewide Classification

Based on the Vehicle Classification Study performed by Minnesota State University, Mankato between 2007 and 2009, an updated statewide classification was developed to update the values in the Pavement Manual's Table 4-4.2. The information in Table 16 is from the 1994 Mn/DOT Pavement Manual (1). The column to the far right in the table is specified for pavement designs on rural CSAH and county roads.

The classification values in Table 17 are those measured across the state and include data from 15 counties, counted over three seasons (Spring, Summer and Fall) for periods of about two weeks each. The basic information in this table is the average value for each classification type, although minimum, maximum, and 95%ile data are also provided. For a pavement design where no other information is known, and where no actual counts will be conducted, it is recommended that the values in the "Average %" column be used.

Table 16. Vehicle Classification Percentages from 1994 Mn/DOT Pavement Manual (1).

VEHICLE CLASS PERCENT OF AADT Analysis of 1983-1989 Data							
Vehicle Classes	Trunk Highways Greater Minnesota			Trunk Highways Mpls/St. Paul Seven County Area			Rural CSAH or County Road
	Average	Min/Max	95% of data sites	Average	Min/Max	95% of data sites	Average
Autos, pickups	89			93			94.1
2 ax, 6 tire SU	2.7	.4 / 9.3	< 4.9	2.2	.8 / 7.6	< 3.6	2.6
3+ ax SU	1.5	0 / 28.7	< 4.1	1.0	0 / 8.9	< 2.8	1.7
3 ax TST	.1	0 / 1.1	< .3	.2	0 / 1.2	< .4	0.0
4 ax TST	.2	0 / 1.6	< .6	.2	0 / 1.1	< .6	0.1
5+ ax TST	6.1	0 / 31.0	< 15.5	3.2	0 / 22.6	< 10.6	0.5
Buses, Trucks w/Trailers	.4	0 / 3.9	< 1.2	.3	0 / 2.7	< .9	1.0
Twin Trailers	.1	0 / 1.0	< .3	.0	0 / .4	< .2	0.0
Total Number of Sites	N = 837			N = 239			1977 County Road Study

Table 17. Updated Statewide Classification Percentages.

Vehicle Class	Average %	Maximum %	95% of data
Autos, pickups	88.9		
SU (2 axle, 6 tire)	3.7	35.6	8.8
SU (3+ axle)	1.9	27.7	6.1
TST (3 axle)	0.8	15.3	2.7
TST (4 axle)	0.2	4.5	1.0
TST (5+ axle)	2.2	34.7	8.3
Buses, Trucks w/ Trailers	2.3	37.1	9.6

Regional, Seasonal, and Other Classifications

The second and more involved method of determining classification values is to break up the statewide values by region, season, and/or ADT level. The tables in this section provide classification value splits by region of the state (divided into Mn/DOT districts) as shown in Table 18 and Table 19, by season (spring, summer or fall) as shown in Table 20, and by two ADT level schemes (<400, 400-1500, 1500-7000 and >7000; and <400, 400-1000 and >1000) as shown in Table 21 and Table 22. In addition, the classification percentages were divided into weekday and weekend values, as shown in Table 23.

Table 18. Classification Percentages by Mn/DOT District.

Vehicle Class	Mn/DOT District			
	District 1	District 2	District 3	District 4
Autos, pickups	92.9	89.3	92.9	81.7
SU (2 axle, 6 tire)	3.1	3.3	5.3	3.8
SU (3+ axle)	1.3	2.2	0.8	2.9
TST (3 axle)	0.4	0.4	0.2	0.9
TST (4 axle)	0.1	0.2	0.0	0.3
TST (5+ axle)	0.9	2.5	0.4	4.7
Buses, Trucks w/ Trailers	1.3	2.1	0.4	5.7

Table 19. Classification Percentages by Mn/DOT District, Continued.

Vehicle Class	Mn/DOT District			
	District 5	District 6	District 7	District 8
Autos, pickups	93.2	87.0	87.7	91.5
SU (2 axle, 6 tire)	4.3	4.1	4.5	3.0
SU (3+ axle)	0.9	2.6	1.7	1.4
TST (3 axle)	0.3	0.7	1.6	0.8
TST (4 axle)	0.1	0.3	0.4	0.2
TST (5+ axle)	0.5	2.4	2.1	1.9
Buses, Trucks w/ Trailers	0.7	2.9	2.0	1.2

Table 20. Classification Percentages by Season.

Vehicle Class	Season		
	Spring	Summer	Fall
Autos, pickups	87.7	91.3	87.6
SU (2 axle, 6 tire)	4.4	3.1	3.7
SU (3+ axle)	1.8	1.5	2.3
TST (3 axle)	0.8	0.6	0.9
TST (4 axle)	0.2	0.2	0.3
TST (5+ axle)	2.1	1.6	2.8
Buses, Trucks w/ Trailers	3.0	1.6	2.4

Table 21. Classification Percentages by ADT Range (Traffic).

Vehicle Class	ADT Range			
	< 400	400 - 1499	1500 - 7000	> 7000
Autos, pickups	89.4	87.6	91.6	94.3
SU (2 axle, 6 tire)	3.9	3.9	2.6	1.7
SU (3+ axle)	1.9	2.2	1.1	0.9
TST (3 axle)	0.8	0.9	0.3	0.1
TST (4 axle)	0.2	0.3	0.1	0.1
TST (5+ axle)	2.1	2.5	1.7	1.5
Buses, Trucks w/ Trailers	1.8	2.6	2.4	1.4

Table 22. Classification Percentages by ADT Range (Pavement Design).

Vehicle Class	ADT Range		
	< 400	400 - 1000	> 1000
Autos, pickups	89.4	85.6	91.7
SU (2 axle, 6 tire)	3.9	4.5	2.7
SU (3+ axle)	1.9	2.5	1.3
TST (3 axle)	0.8	1.0	0.4
TST (4 axle)	0.2	0.3	0.2
TST (5+ axle)	2.1	2.9	1.8
Buses, Trucks w/ Trailers	1.8	3.2	1.9

Table 23. Classification Percentages – Statewide, Weekday and Weekend.

Vehicle Class	Weekday	Weekend
Autos, pickups	86.6	94.4
SU (2 axle, 6 tire)	4.3	2.3
SU (3+ axle)	2.3	0.8
TST (3 axle)	0.9	0.5
TST (4 axle)	0.3	0.1
TST (5+ axle)	2.8	0.9
Buses, Trucks w/ Trailers	2.9	1.0

Determining Appropriate Classification Values

While not enough data were collected to provide reliable classification values for multiple subdivisions (i.e. District 3 / Spring / <400 ADT), these factors can be combined in an average value to provide a more accurate prediction of the classification. A simple average value would assume that each category is weighted evenly within a set of categories. For example, a composite vehicle classification for Autos and pickups for District 3 (92.9%) in the Spring (87.7%) for an ADT less than 400 (89.4%) would be 90.0%. Additionally, not enough data were collected to determine the appropriate weights for each of the categories presented in the preceding example. Therefore it is recommended that equal weights be applied and that a standard average of the three be taken in this type of analysis. There may be evidence or other

reason to use classification values from one particular category rather than averaging over three categories. This determination is best left to the County Engineer.

Seasonal Classifications

When determining classification percentages using the seasonal breakdowns, it is important to consider ADT over a given length of season for the particular area. The annual ESALs can then be determined through a weighted average of season length, ADT, and classification for the three seasons indicated. It is assumed that the ADT and vehicle classification percentages in the winter months have negligible effects on the pavement structure. However, since pavement design methods in use in Minnesota use annual ESALs or design ESALs, it is suggested that the winter classification percentages be set to the same as those in summer. This is due to the lower percentage of farm trucks and other commercial vehicles evident in summer rather than in spring and fall.

As an example, the implementation of the seasonal classifications to determine an annual ESAL value could be determined as shown in Table 24. This example only shows how the ESALs per year would be calculated for the 5-axle TST vehicle. This process would be completed for each vehicle in the traffic mix, and the sum of ESALs per year for each vehicle would be computed for a total annual ESAL value.

Table 24. Sample Annual ESAL Calculation – 5-axle TST.

Season	Begin and End Dates of Season	Length of Season, days	Average ADT	% 5+ axle TST	Seasonal ESALs
Spring	15 Apr – 15 Jun	61	814	1.5	840
Summer	16 Jun – 30 Sep	107	778	1.9	1790
Fall	1 Oct – 15 Dec	76	963	2.9	2400
Winter	16 Dec – 14 Apr	120	721	1.9	1860
Total ESALs per year (5-axle TST only)					6890

In this example, the length of each season is determined for the geographical area within which the highway is located, and the average ADT for each season is estimated or measured. The percentage of each vehicle classification is found from the tables in this manual, and the seasonal ESAL value for each vehicle is determined using the following calculation.

$$\text{Seasonal ESAL} = (\text{Average ADT})(\% \text{ Vehicle Classification})(\text{Season Length})(\text{ESAL per Vehicle})$$

The total ESALs per year is then determined conducting the above equation for each vehicle, and by summing the ESALs for each of the four seasons and for all vehicles. This example makes the assumption that all vehicles included in the analysis are legally loaded. Any overloaded vehicles will still be counted as a single vehicle, but for pavement design purposes, overloaded vehicles can represent a significant increase in the damage caused in the pavement, and therefore the effect of that vehicle type can be underrepresented.

The differences between classification percentages on weekdays and weekends should also be taken into consideration. If weekday and weekend ADT values are known, a calculation similar to that for seasonal classification can be conducted. In this case, however, a weekday ADT can be multiplied by five and a weekend ADT by two, and the result summed to produce a weekly ESAL value. It must be noted, however, that the seasonal adjustment factors that are applied to traffic volumes and vehicle classification distributions normally consider the differences in weekday and weekend traffic.

Individual Classification Counts

The third and most involved method of determining vehicle classification percentages for a pavement design is to conduct classification counts on the actual roadway that will be designed. With this method, the actual traffic volumes and classification can be determined over a period of time, and these counts can be adjusted to represent annual counts. The statewide and the seasonal and regional counts from the previous methods are not utilized. Since this method does not rely on statewide or regional averages, it is a better representation of the traffic volumes and classification that can be expected on the particular roadway.

Once the roadway to be counted has been selected, the process of conducting individual counts and in interpreting the results consists of the following steps.

1. Determine best location(s) for locating classifiers
2. Determine appropriate dates and length of counts
3. Install equipment, set up hardware and software
4. Retrieve equipment and download data at end of study
5. Conduct data analysis and interpretation of results

Each step in developing traffic counts and interpreting the results is described in the following sections.

Determine Count Locations

Once the roadway to be counted has been selected, it is important to determine an appropriate location within that roadway to provide the most accurate information. The following guidelines will assist in determining these locations.

1. Locate classifier(s) within the limits of the project planned for design and construction, and on a long stretch of roadway with few turns, avoiding proximity to intersections with other major roadways.
2. Count locations should be about 300 feet from an intersection, and should never be placed within 100 feet of an intersection. Turning vehicles may hit the tubes at an angle and register one hit for each tire, rather than one for each axle.
3. Do not locate the count location on a horizontal curve in the roadway. Ensure that tubes are perpendicular to the centerline of the roadway.
4. It is useful to locate the classifier(s) near a sign post or other anchor to which the box may be chained and locked.

Determine Count Dates and Lengths

The standard Mn/DOT count duration is 48 hours. Thus, if equipment is set on a Monday, it can be retrieved on a Wednesday, at the same time it was set on the previous Monday. Likewise, if the equipment is set on a Tuesday, it can be retrieved on a Thursday and produce two full 24-hour periods.

Normally, traffic classifiers will have enough battery power and memory to conduct vehicle classification counts for up to two weeks or more. While additional data can be helpful, it is not necessary, since the 48-hour count will be adjusted (in a later section) for the days of the week and season of the year.

Install Equipment

The classifiers and tubes are to be installed following a prescribed procedure. The following guidelines and steps will assist in positioning the equipment and setting up the on-board software to conduct the appropriate count. There are two types of TimeMark Delta III classifiers (Delta III L – with a memory card, and Delta III C – without a memory card), and both have similar setup instructions (2, 3). Figure 6 shows the appropriate setup of the classifier and the tubes for the “Configuration 51” setup, which is for the vehicle classification study.

Guidelines

1. Vehicles should cross tubes in a perpendicular fashion. Avoid placing tubes on curves or in turns.
2. Vehicles should cross the tubes at uniform speeds. Avoid placing tubes in zones where acceleration or deceleration is common (e.g., near stop signs or turns).
3. The tubes should be placed flat against the pavement. Avoid placing tubes where curbs will prevent tubes from lying flat.
4. The data collection unit should be locked to a signpost or other roadside stationary object.

Hardware Setup Instructions

1. Cut eight 8” to 12” strips of roofing tape.
2. Warm up the roofing tape if necessary
3. Using mallet and stake (or P-K nail), anchor the clamped end of one tube to the side of the roadway opposite from where the data collection unit will be placed.
4. Stretch the staked hose, perpendicular to the centerline, to the other side of the roadway. Stretch the hose about 10% of its length. For example, a 40-foot section of hose, unstretched, should be stretched about 4 feet.
5. Using mallet and stake, anchor the free end of the stretched tube.
6. Check that the staked tube is perpendicular to the centerline.
7. Using the chalk, make three marks adjacent to the staked tube. These marks should be spaced evenly across the pavement.
8. Using the tape measure and chalk, make three parallel marks exactly 16 feet from the first set of marks. The distance must be measured, not estimated.
9. Place the second hose on top of the second set of marks. Stake the clamped end an equal distance off the road surface on the same side of the roadway as the first tube.
10. Stretch the second hose about 10% (see step 2) and stake to the other side of the road.
11. Place the data collection unit near the anchoring device (e.g., signpost).

12. Connect the tube to the data collection unit. Tube A should be the tube a vehicle goes over first when traveling in a northbound or eastbound direction. Tube B is the second tube a vehicle drives over in a northerly or easterly direction.
13. Continue with the software setup.

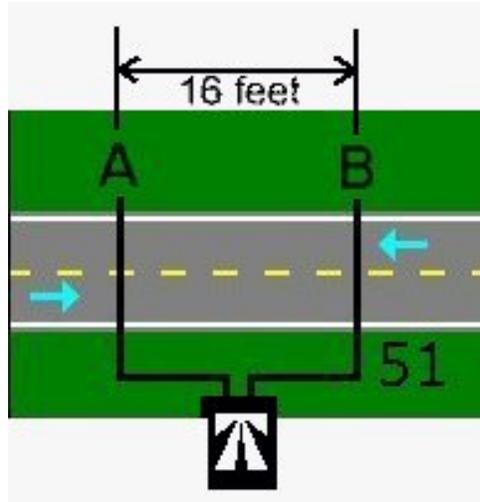


Figure 6. Layout #51 Configuration. Used with permission from TimeMark, Inc.

Software Setup Instructions

The software for both TimeMark Delta III classifier models is similar, but must be set up differently. For either model, however, the 12-digit filename / code is the same. The method for determining this code is presented first, followed by specific instructions for each model of classifier.

Determine 12-Digit Code

Digits 1-2 = Month code
01 = January, etc.

Digits 3-4 = site number, based on the county code:
01 = Aitkin
02 = Anoka
03 = Becker, etc.

Digit 5 = number of boxes used at this site (typically 1)

Digit 6 = direction of traffic in 'primary' direction. This is the direction of traffic that crossed tube A first.

N = 1	NE = 2
E = 3	SE = 4
S = 5	SW = 6
W = 7	NW = 8

- Digit 7 = lane number for primary direction (1 = Driving, 2 = Passing), ('2' would be used if conducting a count on a 4-lane road)
- Digit 8-9 = Route System
- 01 = Interstate
 - 02 = U.S. Hwy
 - 03 = Minn. Trunk Hwy.
 - 04 = CSAH
 - 05 = MSAS
 - 07 = Co. Rd.
- Digits 10-12 = 3 digit route number with leading zeros.

TimeMark Delta III L (with memory card)

In programming the TimeMark Delta III L, note that the [Select] button will move between different options (indicated by flashing text) in a particular menu, while the [Enter] button will choose the option and go on to the next menu.

1. Data Collection Card: Place a data collection card with the pin connections in the memory card slot. It will fit in only one way. Make sure the fit is snug and pins are connected to the card.
2. Turn on the collection unit: An introductory screen will appear displaying the software version number. The screen will then proceed to *Main Menu* automatically.
3. Choose: Memory Manager: Under the *Main Menu*, the following options appear:

Record A New Study
Monitor Traffic
Memory Manager

Use the [Select] button to make *Memory Manager* flash. Then press [Enter]. *Memory Manager Menu* will appear.

4. Choose: Erase Flash Card: Use the [Select] button to make *Erase Flash Card* flash. Then press [Enter] *Erase Flash Card Menu* will now appear.
5. Choose Confirm, erase card: Use the [Select] button to make *Confirm, erase card* flash. Then press [Enter]. The erasing process of the flash card cleans the card of previously accumulated data. Once erased, a message appears on the screen. Press [Enter]. The *Main Menu* should then appear.
6. Choose Utility Functions: Use the [Select] button to scroll beyond *Memory Manager* until *Utility Functions* flash. Press [Enter]. The *Utility Functions* menu has the following choices:

Check System Status
Set Clock Calendar
Set Serial Baud Rate
Do Function Tests

Sensor Diagnostics
Back To Main Menu

7. Choose *Set Clock Calendar*: Use the [Select] button to make *Set Clock Calendar* flash. Press [Enter]. The *Current Time & Date* menu will appear. Correct, if necessary, the time and date stored. Utilize the numeric keypad, and enter the time using standard military time format (e.g.: 00:00 to 23:59). Once entered, the *Exit, Save New Data* line will flash. If data is correct press [Enter], otherwise press [Select] to scroll down to *Quit, Do Not Save* and the clock calendar can be re-entered. Cycle back through the menu and redo Step 6. Once correct, press [Enter].
8. The *Main Menu* should appear with *Utility Functions* flashing. Press the [Select] button and scroll through until *Record A New Study* flashes. Press [Enter]
9. Choose *Select A New Study* under the next menu. Press [Enter]. The *Enter Site Code* screen will appear.
10. Enter the 12-digit filename / code. Once the data filename has been input, press [Enter] and the *Study Type Menu* will appear.
11. Choose *Raw Data*: Under the *Study Type Menu* use the [Select] button, if necessary, to make *Raw Data* flash. Then press [Enter]. The *Sensor Layout Menu* will appear.
12. Choose *A>B, C>D spaced*: Use the [Select] button, if necessary, to make *A>B, C>D spaced* flash. Then press [Enter]. The *Enter Sensor Spacing* screen will appear.
13. Enter *16.0*, On the *Enter Sensor Spacing* screen input *16.0* ft. sensor spacing. Press [Enter].
14. Choose *Start Recording Now*: Under the *TUBE: RAW* menu use the [Select] button, if necessary, to make *Start Recording Now* flash. Then press [Enter]. The next screen indicates that *A Study is Currently Running* and also shows *Go To Monitor Screen* and *End The Study*
15. Choose *Go To Monitor Screen*: Use the [Select] button, if necessary, to make *Go To Monitor Screen* flash. Press [Enter]. The data collection screen will now appear. The data collection screen contains a table as shown below:

RAW: TUBE	TIME	LANE I
A:	0	t
B:	0	t

The middle column contains the number of total hits on each of the two tubes, A and B.

16. Continue to *Final Setup* section.

TimeMark Delta IIIC (without memory card)

The TimeMark Delta IIIC is best programmed through the VIAS software on the computer. This manual describes the steps required in the VIAS Version 1.2.1.5. This can be installed on either a desktop (and programmed in the office prior to installation in the field) or on a laptop (and

programmed at the installation location). The classifier may also be started, with minimal information (simply the layout type) in the field without a computer. The following steps are used to establish and start the classifier.

1. Connect the classifier to a computer running TimeMark VIAS Software
2. Turn on the classifier. Several red lights on the classifier will blink. This is normal.
3. Open VIAS software on the computer.
4. Click on “Counter”. Among the large buttons across the top. The software will attempt to communicate with the classifier and may take several seconds. If the classifier is not found, it may not be connected properly, or a COM port may not be established in the computer’s operating system software.
5. Set the clock on the counter. Press the “...” button next to *Counter Clock* and select *Synchronize with this computer* or enter the time manually.
6. Click on the Setup tab. This will bring the counter preparation screen to the front.
7. Enter site code. This is the site code described in an earlier section.
8. Enter descriptions. There are several text boxes available for custom descriptions of the count and location.
9. Select Raw Data in the *Study Type* drop-down box.
10. Enter Start and Stop times based on the dates and times selected for the study.
11. Press Change Layout to select the layout corresponding to the layout of the tubes to be installed. For classification counts this is normally *Layout #51/52*.
12. Click Save.
13. Click OK when the message box labeled *Automatic Start Enabled* appears.
14. Press Disconnect to disengage the classifier from the computer and the VIAS software. Do not turn the classifier off.
15. Continue to *Final Setup* section.

Final Setup

1. Verify that the system is operational. Check that the tubes are recording hits, either by vehicles or by stepping forcefully on the far end of each of the tubes. If hits are not being recorded, there may be a problem with the connection of the tubes to the data collection unit or a tube may be damaged. The equipment and connections may need to be inspected.
2. Make sure tubes are aligned with chalk marks. Adjust if necessary.
3. Using precut, warm (if necessary) strips of tape, secure tubes in each of the wheel paths.
4. Check that collection unit is still registering hits.
5. Close box and chain to anchoring device.

Retrieve Equipment and Data

After the count is complete, the classifier should be retrieved, following the instructions below (for the appropriate classifier).

TimeMark Delta III L (with memory card)

1. Open the classifier and hold down the [Enter] button for 3-5 seconds. The unit has been “asleep” and collecting data in a power conservation mode. Verify that the data was collected, and that it is still operating.
2. Manually record the number of hits on each tube. The count should be nearly the same on each tube.
3. Press [Enter] button twice. This will scroll by a screen that gives the current battery status and start/stop times programmed. The screen you want to view states: *A Study is Currently Running, Go To Monitor Screen* and *End The Study*. Use the [Select] button, if necessary, to make *End The Study* flash. Press [Enter].
4. A *Terminate Study* menu will appear. Use the [Select] button, if necessary, to make *Yes, End The Study* flash. Press [Enter]. The *Yes, End The Study* message will flash for a few seconds and then the screen will return to the *Main Menu*. At this point the data is saved to the data card.
5. Turn the data collection unit off.
6. Remove equipment from roadside and roadway.
7. Eject the memory card and send it (or the classifier and card) to the District State Aid office.

TimeMark Delta III C (without memory card)

1. Open the classifier and turn the power switch off. This ends the study but saves all collected data.
2. Return the classifier to the District State Aid office for data retrieval and analysis.

Data Analysis and Interpretation

The preferred method of data analysis is to send it to the District State Aid office for extraction and interpretation. However, local agencies who own a copy of the VIAS software may download and analyze their own data. The Mn/DOT office of Traffic Forecasting and Analysis requests that you simply send a copy of your raw data for inclusion in the statewide data collection efforts.

Data Analysis by Mn/DOT

The data that is submitted on the classifier or memory card will be extracted and analyzed according to Mn/DOT Traffic Forecasting and Analysis office standards. This includes vehicle classification over the 48-hour period and adjustment for the days of the week and season in which the count was performed.

The resulting information will be similar to that in Table 17, and may be used by the local agency in place of the vehicle classification data in Table 4-4.2 of the Geotechnical and Pavement Manual published by Mn/DOT.

Data Analysis Conducted by Local Agency

If the local agency owns a copy of the TimeMark VIAS software, the data analysis can be done in-house. If his option is selected, the basic classification analysis should be conducted as directed in the VIAS software manual. The user will be required to download and install the proper axle spacing schemas from the Mn/DOT Traffic Forecasting and Analysis office.

Once a set of vehicle classifications is determined, the following Seasonal Adjustment Factors must be applied to the data, based on the location (urban or rural) and month in which the count was conducted. The following tables are taken from the report *Determination of Seasonal Adjustment Factors for Vehicle Class Counts* (4) developed by the Traffic Forecasting and Analysis Section. Table 25 provides the adjustment factors for urban areas and Table 26 provides the factors for rural areas. Urban areas are defined as areas within the city limits and with a population greater than 5,000. All other areas are considered rural.

Table 25. New (2008) Seasonal Adjustment Factors for Urban Areas (4).

Vehicle Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Autos, pickups	1.10	1.04	1.02	0.98	0.98	0.95	0.90	0.89	0.85	0.98	1.05	1.13
SU (2axle, 6 tire)	0.90	0.92	0.88	0.84	0.80	0.91	0.80	0.75	0.67	0.81	0.88	0.95
SU (3+ axle)	1.19	1.20	1.15	0.88	0.79	0.84	0.68	0.67	0.58	0.61	0.74	1.00
TST (3 axle)	1.12	1.10	1.03	0.90	0.84	0.86	0.79	0.67	0.67	0.89	0.83	1.08
TST (4 axle)	1.12	1.10	1.03	0.90	0.84	0.86	0.79	0.67	0.67	0.89	0.83	1.08
TST (5+ axle)	0.87	0.88	0.86	0.81	0.79	0.83	0.71	0.71	0.66	0.75	0.90	0.94
Buses, Trucks w/ Trailers	1.41	1.33	1.16	1.03	0.93	0.86	0.77	0.62	0.59	0.78	0.88	1.17
Trucks with Twin Trailers	0.89	0.85	0.82	0.75	0.78	0.91	0.83	0.72	0.70	0.75	0.89	0.88

Table 26. New (2008) Seasonal Adjustment Factors for Rural Areas (4).

Vehicle Class	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Autos, pickups	1.31	1.26	1.22	1.13	0.97	0.88	0.81	0.84	0.95	1.03	1.13	1.20
SU (2axle, 6 tire)	1.04	1.08	1.07	0.97	0.88	0.85	0.85	0.83	0.81	0.83	0.93	0.96
SU (3+ axle)	1.34	1.44	1.28	0.93	0.81	0.61	0.71	0.69	0.70	0.70	0.85	1.25
TST (3 axle)	1.57	1.54	1.49	1.22	0.90	0.82	0.73	0.68	0.74	0.88	1.10	1.27
TST (4 axle)	1.57	1.54	1.49	1.22	0.90	0.82	0.73	0.68	0.74	0.88	1.10	1.27
TST (5+ axle)	0.98	0.90	0.86	0.82	0.78	0.72	0.77	0.75	0.76	0.74	0.88	0.93
Buses, Trucks w/ Trailers	2.05	2.06	1.55	1.11	0.87	0.74	0.71	0.67	0.70	0.79	1.01	1.58
Trucks with Twin Trailers	1.42	0.95	0.94	0.94	0.86	0.87	0.83	0.66	0.69	0.61	0.76	0.89

Chapter 6. RECOMMENDATIONS FOR IMPLEMENTATION

Based on the data presented in the previous chapters, it is clear that a change has taken place in the proportion of vehicles in the different classifications in Minnesota. From a level of 0.5% for 5+ axle TSTs in the 1977 study (updated in 1997) to 2.2% measured in the period from 2007 – 2009, an increase of 340% in the proportion of these trucks is observed, using the statewide average. In a similar comparison, from an average of 5.9% commercial trucks to 11.1% today represents an increase of 88% since this data was last observed.

Three major recommendations resulting from this effort are presented below.

1. Update the default vehicle classification data in the Pavement Design Manual.

The first step in releasing an official update of the vehicle classification for local roadway pavement design is to conduct an internal review and validation of the data developed by MSU for this project. Once this data is validated and/or modified based on the validation analysis, a new “default” table for vehicle classification should be released to the local agencies, and encouraged for use. Action on this recommendation for using the updated statewide default classifications should be done in consideration of the other recommendations in this section, particularly the for the encouragement to conduct individual roadway counts. For pavement designs where no other information is available, agencies should be advised to use the “average” column in the updated table.

2. Encourage individual roadway counts.

The best method for determining traffic volumes and vehicle classifications at the project level is to conduct the counts on the actual roadway of interest. Many local agencies own the equipment to conduct such counts, and otherwise can obtain the proper equipment from the district state aid offices. While the data analysis is most often conducted at the district state aid offices, the local agencies often have the knowledge and the desire for more detailed information when conducting pavement designs in their jurisdiction. In the cases where less information is desired by the local agency, the default traffic maps and vehicle classification tables are available. As mentioned in the next recommendation, additional information should be provided to local agencies regarding the interpretation of the data they collect, for adjustments such as seasonal adjustment factors, etc.

3. Provide additional guidance/training on collecting, analyzing, and interpreting classification data.

There is a need for additional guidance from the state aid office in collecting, analyzing, and interpreting traffic and classification data. Many county engineers are interested in how the county traffic maps are produced, or how to use the seasonal adjustment factors, for example. Potential topics for guidance and/or training could include the following.

- Selecting individual count locations
- Conducting volume and classification counts (setting up the hardware, obtaining and analyzing the raw data, etc.)
- Adjusting analyzed data using proper Mn/DOT techniques
- Using the resulting data in standard and advanced pavement design methods.

4. Investigate the distribution of vehicle weight within each classification category.

Properly assessing the vehicle classification distribution for a particular roadway is an important part of developing an appropriate pavement design. Understanding the distribution of vehicle weights is another very important part. While the damage done to pavements varies linearly with the *number* of axle loads, it varies to approximately a fourth power relationship with the weight of axle loads (5, 6).

Following these recommendations and the approach suggested for conducting vehicle classification counts (encouraging local agencies to conduct their own counts) will help advance the knowledge and information at the local level, thus preparing local agency engineers to make better, more informed decisions regarding the roadways and pavements for which they are responsible.

REFERENCES

1. *Mn/DOT Geotechnical and Pavement Manual*, Minnesota Department of Transportation, St. Paul, MN, 1994.
2. *Delta IIII Operations Manual*, TimeMark, Inc., Salem, OR, 2003.
3. *Delta IIIC Operations Manual*, TimeMark, Inc., Salem, OR, 2006.
4. Wei, C., *Determination of Seasonal Adjustment Factors for Vehicle Class Counts*, Traffic Forecasting and Analysis Section, Minnesota Department of Transportation, St. Paul, MN, 2008.
5. *AASHTO Guide for Design of Pavement Structures*, AASHTO, Washington, D.C., 1993.
6. Huang, Y.H., *Pavement Analysis and Design*, Prentice-Hall, Upper Saddle River, NJ, 2004.

APPENDIX A. DATA COLLECTION AND EQUIPMENT INSTALLATION STANDARDS

LRRB VEHICLE CLASSIFICATION FOR COUNTY ROAD PAVEMENT DESIGN

VEHICLE CLASSIFICATION FIELD GUIDE USING TIMEMARK DELTA IIII UNIT

Thank you for offering to assist the Local Road Research Board and Minnesota State University, Mankato, in this study to update the vehicle classification tables for county road pavement designs. The purpose of this field guide is to give specific directions in setting up and performing vehicle classification studies on roads for the LRRB Vehicle Classification Update project. Please follow these procedures for each of the five count locations in your county.

WHEN TO CONDUCT THE COUNTS

The counts should be done at “representative” times of each season. The LRRB project funding this study requests that the counts be done for a period of two weeks in each season. Although it may be difficult to predict a two-week period of time without snow in the winter (where plows would rip out the tubes), a shorter counting period is preferable to none. Dr. Wilde at Minnesota State University will help coordinate the counts. They do not need to be conducted at the same time as any other county in the study, but at “representative” times during the seasons.

EQUIPMENT LIST

- 1 TimeMark Delta IIII vehicle classification data collection unit
- 2 pneumatic air tubes of equal length capable of spanning entire pavement width and connecting to the data collection unit. (50-60’ tubes are normally adequate)
- 4 metal stakes
- 4 anchoring brackets
- chain and lock
- sidewalk chalk
- tape measure (capable of measuring 16’)
- mallet
- gloves
- asphalt backed roofing tape, 2” or 4” wide (available from Dr. Wilde at Minnesota State University, Mankato)

If you need any of this equipment, please contact Dr. W. James Wilde at Minnesota State University, Mankato immediately. Dr. Wilde can be contacted at

507-389-5252 (voice)
j.wilde@mnsu.edu

EQUIPMENT POSITIONING

Once a roadway has been selected for a classification study, it is important to consider the following factors in placing the air tubes:

- Vehicle should cross tubes in a perpendicular fashion. Avoid placing tubes on curves or in turns.
- Vehicles should cross the tubes at uniform speeds. Avoid placing tubes in zones where acceleration or deceleration is common (e.g., near stop signs or turns).
- The tubes should be placed flat against the pavement. Avoid placing tubes where curbs will prevent tubes from lying flat.
- The data collection unit should be locked to a signpost or other roadside stationary object.

EQUIPMENT SETUP

1. Cut eight 8" to 12" strips of roofing tape.
2. Warm up the roofing tape. On a warm day this may not be necessary. Otherwise, place the tape near a car heater.
3. Using mallet and stake, anchor the clamped end of one tube to the side of the roadway opposite from where the data collection unit will be placed.
4. Stretch the staked hose, perpendicular to the centerline, to the other side of the roadway. Stretch the hose about 10% of its length. For example, a 40-foot section of hose, unstretched, should be stretched about 4 feet.
5. Using mallet and stake, anchor the free end of the stretched tube.
6. Check that the staked tube is perpendicular to the centerline.
7. Using the chalk, make three marks adjacent to the staked tube. These marks should be spaced evenly across the pavement.
8. Using the tape measure and chalk, make three parallel marks exactly **16 feet** from the first set of marks. The distance must be measured, not estimated.
9. Place the second hose on top of the second set of marks. Stake the clamped end an equal distance off the road surface on the same side of the roadway as the first tube.
10. Stretch the second hose about 10% (see step 2) and stake to the other side of the road.
11. Place the data collection unit near the anchoring device (e.g., signpost).
12. Connect the tube to the data collection unit. Tube A should be the tube a vehicle goes over first when traveling in a northbound or eastbound direction. Tube B is the second tube a vehicle drives over in a northerly or easterly direction.
13. Continue with the software setup.

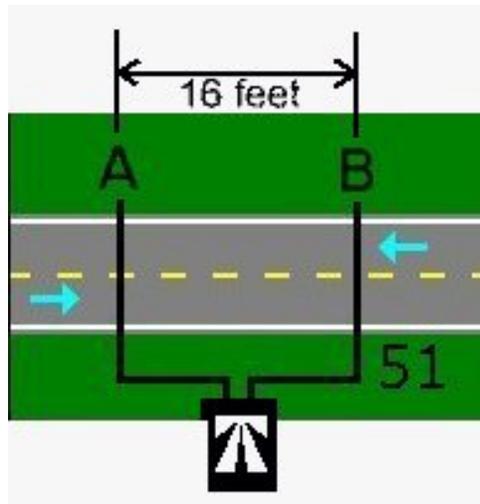


Figure 1. Layout #51 Configuration. Used with permission from TimeMark, Inc.

SOFTWARE SETUP

In programming the TimeMark Delta IIIIL field unit, note that the [Select] button will move between different options (indicated by flashing text) in a particular menu, while the [Enter] button will choose the option and go on to the next menu.

1. Data Collection Card: Place a data collection card with the pin connections in the memory card slot. It will fit in only one way. Make sure the fit is snug and pins are connected to the card.
2. Turn on the collection unit: An introductory screen will appear displaying the software version number. The screen will then proceed to *Main Menu* automatically.
3. Choose: *Memory Manager*: Under the *Main Menu*, the following options appear:
Record A New Study
Monitor Traffic
Memory Manager

Use the [Select] button to make *Memory Manager* flash. Then press [Enter]. *Memory Manager Menu* will appear.

4. Choose: *Erase Flash Card*: Use the [Select] button to make *Erase Flash Card* flash. Then press [Enter] *Erase Flash Card Menu* will now appear.
5. Choose *Confirm, erase card*: Use the [Select] button to make *Confirm, erase card* flash. Then press [Enter]. The erasing process of the flash card cleans the card of previously accumulated data. Once erased, a message appears on the screen. Press [Enter]. The *Main Menu* should then appear.
6. Choose *Utility Functions*: Use the [Select] button to scroll beyond *Memory Manager* until *Utility Functions* flash. Press [Enter]. The *Utility Functions* menu has the following choices:
Check System Status
Set Clock Calendar
Set Serial Baud Rate
Do Function Tests

Sensor Diagnostics
Back To Main Menu

7. Choose *Set Clock Calendar*: Use the [Select] button to make *Set Clock Calendar* flash. Press [Enter]. The *Current Time & Date* menu will appear. Correct, if necessary, the time and date stored. Utilize the numeric keypad. Once entered, the *Exit, Save New Data* line will flash. If data is correct press [Enter], otherwise press [Select] to scroll down to *Quit, Do Not Save* and the clock calendar can be redone. Cycle back through the menu and redo Step 6. Once correct, press [Enter].
8. The *Main Menu* should appear with *Utility Functions* flashing. Press the [Select] button and scroll through until *Record A New Study* flashes. Press [Enter]
9. Choose *Select A New Study* under the next menu. Press [Enter]. The *Enter Site Code* screen will appear.
10. Enter the 12-digit filename using the following guide:
 - Digits 1-2 = Month code
 01 = January, etc.
 - Digits 3-4 = site number, based on the two-digit county code:
 - Digit 5 = number of boxes used at this site (typically 1)
 - Digit 6 = direction of traffic in 'primary' direction. This is the direction of traffic that crossed tube A first.

N = 1	NE = 2
E = 3	SE = 4
S = 5	SW = 6
W = 7	NW = 8
 - Digit 7 = lane number for primary direction (1 = Driving, 2 = Passing), ('2' would be used if conducting a count on a 4-lane road)
 - Digit 8-9 = Route System

01 = Interstate	04 = CSAH
02 = U.S. Hwy	05 = MSAS
03 = Minn. Trunk Hwy.	07 = Co. Rd.
 - Digits 10-12 = 3 digit route number with leading zeros.

Once the data filename has been input, press [Enter] and the *Study Type Menu* will appear.

11. Choose *Raw Data*: Under the *Study Type Menu* use the [Select] button, if necessary, to make *Raw Data* flash. Then press [Enter]. The *Sensor Layout Menu* will appear.
12. Choose *A>B, C>D spaced*: Use the [Select] button, if necessary, to make *A>B, C>D spaced* flash. Then press [Enter]. The *Enter Sensor Spacing* screen will appear.
13. Enter *16.0*, On the *Enter Sensor Spacing* screen input *16.0* ft. sensor spacing. Press [Enter].
14. Choose *Start Recording Now*: Under the *TUBE: RAW* menu use the [Select] button, if necessary, to make *Start Recording Now* flash. Then press [Enter]. The next screen indicates that *A Study is Currently Running* and *Go To Monitor Screen* and *End The Study*
15. Choose *Go To Monitor Screen*: Use the [Select] button, if necessary, to make *Go To Monitor Screen* flash. Press [Enter]. The data collection screen will now appear. The data collection screen contains a table as shown below:

RAW: TUBE	TIME	LANE I
A:	0	t
B:	0	t

The middle column contains the number of total hits on each of the two tubes, A and B.

16. Verify that the system is operational: Check that the tubes are recording hits, either by vehicles or by stepping forcefully on the far end of each of the tubes. If hits are not being recorded, there may be a problem with the connection of the tubes to the data collection unit or a tube may be damaged. The equipment and connections may need to be inspected. If hits are being recorded, continue with final setup.

FINAL SETUP

1. Make sure tubes are aligned with chalk marks. Adjust if necessary.
2. Using pre-cut, warm strips of tape, secure tubes in each of the wheel paths.
3. Check that collection unit is still registering hits. If necessary, even the number of hits between each tube.
4. Close box and chain to anchoring device.

LENGTH OF STUDY

The duration of the study is up to two weeks. The actual length will be determined by the amount of traffic on the roadway. The traffic classifier unit may store up to about 100,000 vehicles, which should be enough for up to about 7100 ADT.

Please retrieve the traffic classifier and return it to the office at the end of the seasonal count.

AFTER THE COUNT IS COMPLETE

1. Open the classifier and hold down the [Enter] button for 3-5 seconds. The unit has been “asleep” and collecting data in a power conservation mode. Verify that the data was collected, and that it is still operating.
2. Manually record the number of hits on each tube. The count should be nearly the same on each tube.
3. Press [Enter] button twice. This will scroll by a screen that gives the current battery status and start/stop times programmed. The screen you want to view states: *A Study is Currently Running*, and *Go To Monitor Screen* and *End The Study*. Use the [Select] button, if necessary, to make *End The Study* flash. Press [Enter].
4. A *Terminate Study* menu will appear. Use the [Select] button, if necessary, to make *Yes, End The Study* flash. Press [Enter]. The *Yes, End The Study* message will flash for a few seconds and then the screen will return to the *Main Menu*. At this point the data is saved to the data card installed and the data collection unit may now be turned off.
5. Remove equipment from roadside and roadway.
6. Eject the memory card and send it in the pre-addressed envelope to:

W. James Wilde

Minnesota State University, Mankato
205 E. Trafton Science Center
Mankato, MN 56001

7. Please take the data collection unit back to the office and charge the batteries. The units will operate for about one month, but should begin each two-week period with freshly charged batteries.

GENERAL NOTES

Be aware of safety concerns when placing tubes. Follow safety precautions established by your county when in the traveled way.

Do not locate the counter and tubes within 100 feet of an intersection. Please try to locate the setup about 300 feet from an intersection. Do not locate the counter on a curve in the roadway. Turning vehicles may hit the tubes at an angle and register one hit for each tire, rather than one for each axle.