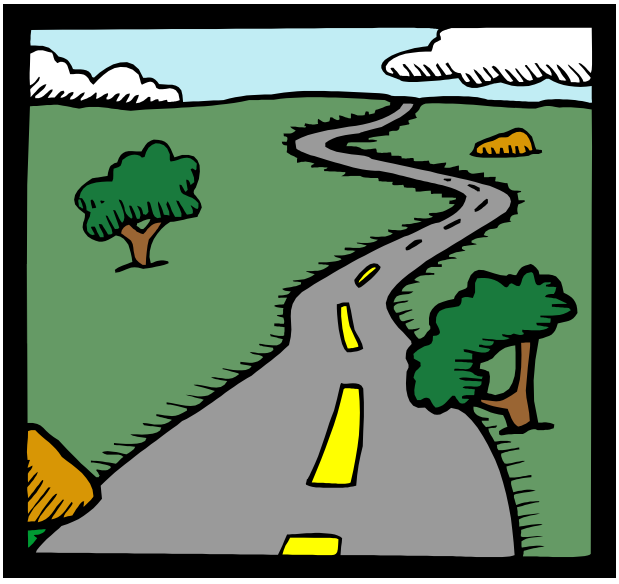
# Mn/DOT Procedure Manual for Forecasting Traffic on Minnesota's Highway Systems



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## *ABOUT THIS DOCUMENT*

Please contact Mark Levenson at 651 296-8535 or **mark.levenson@dot.state.mn.us** if you have any questions or comments on the following material. We welcome your comments, suggestions, and feedback. Any changes and revisions will be added to future editions of this report. We strive to broaden the sphere of this manual to include traffic forecasting related topics and welcome any and all ideas. This manual was originally prepared in July 2002, and has been revised in December 2002, March 2003, August 2004, August 2005 and March 2006.

Traffic forecasting functions of the Minnesota Department of Transportation (Mn/DOT) are centralized. Mn/DOT has district traffic forecasters that have been trained by the Office of Transportation Data and Analysis (TDA). They have the responsibility of preparing project level traffic forecasts. After TDA approval, a traffic forecast is dispersed to our various customers and clients – designers and engineers who use the traffic forecasts for a multitude of design applications. TDA will continue to develop and improve the traffic forecasting process. This Mn/ DOT Procedure Manual for Forecasting Traffic on Minnesota's Highway Systems and the MnESAL program are some of the products on the TDA Web Page. Check out all TDA products at **http://www.dot.state.mn.us/tda/.**

## ***INTRODUCTION***

This procedures manual is intended to be used as a guide for preparing traffic and load projections on Minnesota's roadway systems. The loads calculated are Equivalent Single Axle Loads (ESALS). Highway designers need these forecasts to ensure proper geometric and structural designs. While the geometric design is generally based on forecasted traffic volumes, the structural design is based on the ESAL forecast.

This manual encompasses changes and enhancements in the procedure used to forecast ESALS over the past several years. There has been a revised MnESAL spreadsheet that has undergone several upgrades since the change from the initial Lotus version. The ESAL factors in the spreadsheet reflect the most recent data provided by the Office of Transportation Data and Analysis (TDA). The current MnESAL program is an updated Excel spreadsheet that has been undergoing change as new techniques surface to streamline the forecasting process.

This manual contains a step-by-step approach to traffic forecasting. It also contains pertinent background information and terminology to aid the forecaster in doing a complete and thorough job.

This manual also contains discussions of such terms as Annual Average Daily Traffic (AADT), Heavy Commercial AADT (HCAADT), Tractor Semi Trailers (TSTs), ESALs, Design Hour volume (DHV), Weighing-in-Motion sites (WIM), Automatic Traffic Recorders (ATRs), etc. Knowledge of these terms is extremely important in understanding the traffic forecasting process.

The following procedures will help standardize the techniques used by traffic forecasters throughout the state. This will help establish uniform forecasting methodologies that take advantage of existing and future sources of data. They will be entered into a central database, which will allow for storing and retrieving traffic forecast information. This will help to coordinate forecasts between districts when projects abut or overlap district boundaries.

Traffic forecasting, both volume and load forecasts play an important role in corridor planning, geometric design, structural pavement design, safety analysis, benefit cost analysis, access management, and environmental analysis and mitigation. The Traffic Forecasts & Analysis Section is developing new traffic forecasting methods involving data and technology.

There soon will be new considerations in the forecasting process. Mechanistic design, which applies seasonal variations in gross weight and heavy commercial vehicle volumes, will be a new initiative. Also, enhanced vehicle class, WIM, and commodity movement data and technologies for collecting this data will be developed in the future. It is imperative that traffic forecasters keep informed about new developments and technologies involving the traffic forecasting process.

This manual should help the forecaster undertake a uniform and consistent method as well as provide for reasonable and accurate forecasts. The importance of using current and historical data appropriate to individual projects is paramount. The forecaster should have a good understanding of travel behavior principles, math and statistics, a knowledge of pavement design process, design thresholds and implications of traffic forecast results and a knowledge of applicable statewide trends and forecasts.

## ***TRAFFIC TERMINOLOGY AND DEFINITIONS***

Annual Average Daily Traffic (AADT) – the estimate of daily traffic on a road segment that represents the total traffic on a segment that occurs in a one-year period divided by 365.

Average Daily Traffic (ADT) – a 24-hour traffic volume that should be qualified by stating a time period, (e.g., average summer weekday, summer weekend, June weekday, etc). Unfortunately, ADT is sometimes used interchangeably with AADT. The terms ADT and AADT mean completely different things. AADT means average daily traffic for the year (the average traffic over the 365 day period). ADT, for example refers to average daily traffic for the month. One may say the ADT for July is 800 while the AADT is 600 for the year. In this case the average traffic for July is 800 and could be 400 in January.

Average Summer Weekday Traffic (ASWDT) – the average Monday through Friday traffic volume on a road segment from June through August.

Heavy Commercial Annual Average Daily Traffic (HCAADT) – The estimate of daily heavy commercial traffic on a road segment that represents the total heavy commercial traffic on the segment that occurs in a one year period divided by 365. Heavy commercial traffic is defined as all vehicles with at least two axles and six tires.

Average Daily Load (ADL) – the estimate of a daily load on a roadway segment calculated from the daily vehicle types multiplied times their appropriate ESAL factors.

Axle Load – the total load transmitted by all wheels in a single, tandem, or tridem axle configuration extending across the full width of the vehicle.

Maximum Loaded Vehicle – a heavy commercial vehicle type that is usually loaded to the legal gross weight limit. Examples of this would be: gravel trucks, grain trucks, tank trucks, etc. The presence of these body types in the traffic mix can indicate the need to use ESAL factors higher than the default values.

Design Hour Volume (DHV) – the traffic for a selected hour of the day - usually the 30$^{th}$ highest hour of the year for Greater Minnesota and the peak hour for the Metro Area.

Design Lane Factor (DLF) - Design Lane Factor is a factor to estimate traffic volume and truck components on heaviest traveled lanes for the purposes of ESAL estimation.

Directional Distribution (DD) – the split of traffic by direction for a selected period of time, usually the design hour.

Vehicle Classification – the classification of traffic by vehicle types, *i.e. cars, pickups, 3 axle semis, etc.).*

Vehicle Type Breakdown – the vehicle mix in a traffic volume with the following distinctions; *cars, pickups, motorcycles, 2 axle single units, 3 or more single units, 3 axle semis, 4 axle semis, 5 or more axle semis, buses, heavy single unit trucks with heavy trailers, and twin trailer semis.*

Annual Design Lane ESAL – the estimate of the total ESAL in the design lane of a roadway segment for a period of one year. This is usually reported for the base and design years of a construction project.

ESAL factor – a numeric factor that represents the average effect of each vehicle type on the pavement, based on the equivalent load concept. The concept relates the effect axles in different configurations and magnitudes have on pavement performance as compared to the effect of a single 18,000-pound axle. These ESAL factors can vary with roadway segments and season.

Automated Traffic Recorder (ATR) – Magnetic loops embedded in the pavement surface that detects the presence of metal; a permanent device that continually collects and stores traffic data. All ATRs collect volume data and systems with double loops collect speed and length data also. There are currently (8/05) 37 in the Metro area and 41 Outstate (not all are active).

Weigh in Motion (WIM) – a permanent device that continually collects and stores axle weight data. This device also collects total number of vehicles, axle spacing, length, speed, and vehicle type data. Currently, five are active.

Tube Counters – The portable devices used to count axles and classify vehicles based on their axle spacing.

Automatic Vehicle Classifiers – As of 8/05/04, there are 23 automatic vehicle classifiers. These are included in the ATR totals and not all are active at this time. Several have been recently installed and some have been active for a few years. All are being calibrated and tested to insure accuracy of classification. These are continuous vehicle type classifiers (often called Piezos due to the type of sensor used in classifying) that are located at ATR sites.

## DATA SOURCES AND HOW THEY ARE PRODUCED:

### AADT

*ATRs* –(Automatic Traffic Recorders) – loops in road, metal detectors, 78 sites on all types of roads, continuous and automatic, access at least once a week via telemetry; base for count (AADT) program. From them, adjustment factors are developed for short duration tube counts; then seasonal adjustment factors are produced. Speed data is collected at several sites. Products are annual ATR reports (rural and 7 County Metro Area), design hour volume, directional distribution, and historical AADTs. WIM sites can be considered ATRs.

*Seasonal adjustment factors* are developed from ATRs by using cluster analysis.

*Axle correction factors* – used on trunk highways only. They are developed from analyzing available vehicle class counts, then using judgment to fit them together. They were first used in 1986 and are currently being reviewed.

32,000 total short duration traffic count locations are on a two- year or a four-year counting cycle. Trunk highway count locations are taken every two years and products produced in the even year. Forty-eight hour counts are taken during the weekdays during April and October. Districts and local governments take the counts and provide the Traffic Forecasts and Analysis Section with the raw data.

*Processing of counts to determine AADT* – 48 hour tube counts have appropriate seasonal adjustment factors and axle adjustment factors applied. They are compared to previous cycle counts, compared to one another, and the final determination is made. Estimates are made for those locations where counts were not taken.

*Transportation Information System (TISO)* –Now in Oracle. Bridge data also included. All AADTs are coded into it; we make estimates for years, which were not counted, based on trends at ATRs and other trend data.

*Principal users* – forecasters for design (number of lanes, capacity during peak hours), programmers who schedule construction projects, safety engineers, preliminary design engineers, FHWA, etc.

## Vehicle Classification – Distribution of Vehicles by Type

*Manual counts* – Taken for 16 hours (6am to 10pm) on two different weekdays (usually outstate Mn); data is collected by direction; body types are noted; Metro interstates are usually counted for 8 hours (8am – 4pm).

*Tube Counts* – Timemark equipment used. Two tubes measure speed and hence axle spacing (which is the basis for classifying) - sometimes used for special studies, 48 hours, weekdays, between April and October, by lane, and no body type. These are pneumatic tubes placed across the roadway surface to count axles. Personnel from the Office of Transportation Data & Analysis collect this data.

*WIM sites (three permanent*) – International Road Dynamics (IRD), load cell technology (Kistler quartz sensor); classifies based on axle configuration in combination with weight on front axle; continuous data accessed weekly via telemetry; no body types. Products include ESAL factors for truck types; axle weights, spacing, speed, length of vehicle, seasonal adjustment factors for adjusting short duration vehicle classification counts and summary reports available upon request. WIM systems operate 24 hours a day, 365 days a year. As a result, they collect a large amount of data. The data collected by the WIM system is recorded as individual records. Both cars and trucks are monitored.

*Update Sites* –about 1000 sites, six year cycle, most on trunk highways; counted summer only – manual or tube classification (16 or 48 hours).

*Future* -Permanent vehicle class installations using Piezo sensors are being added. The purpose will be to collect continuous vehicle class data. This will help to produce factors for adjusting short-term vehicle class counts (manual or tube) to HCAADT (by vehicle type). We are currently testing and evaluating the "TIRTL" vehicle classification system. This uses infrared beams to classify vehicle types and will be used to replace the manual count system currently used. It is officially called The Infra-Red Traffic Logger – hence "TIRTL."

*Special Requests* – Primarily for forecasters, may be 20 per year.
*Processing of counts to determine vehicle class –Manual Counts* –adjust 16 hour counts using monthly/seasonal factors developed from count data at permanent WIM sites. This adjusts for the missing eight hours at night and the effects of weekends. This adjustment is made to bring the manual counts up to AADT and HCAADT. *Tube Counts* are 48-hour counts also adjusted to AADT and HCADT based on factors developed from count data at permanent WIM sties.

*Vehicle Class Program* – 200 tube sites per year and about 40 manual sites per year.

*Products* – Include HCAADT flow map, HCAADT component in TIS, vehicle classification reports, and axle correction factors. The following are vehicle class count categories by number:

| | | |
|---|---|---|
| *a.* | *1000,7000,9000* | *update every 6 years (summer)* |
| *b.* | *2000* | *special request* |
| *c.* | *3000* | *special CSAH (County State Aid Highway)* |
| *d.* | *4000-6000* | *CSAH/County Road* |

## Truck Weight

The historic method was to stop trucks and weigh them statically. Weighing-in-Motion (WIM) uses Kistler Quartz sensors at all active sites. These provide for continuous, automatic data that is accessed via telemetry. The data collected consists of axle weights, gross weight, axle spacing, length of vehicle, vehicle type, speed, time, lane, and ESALS. Currently, WIM data are used to adjust vehicle class and is available by individual records. WIM data are used as a source of ESAL factors on the trunk highway system.

ESALS (discussed previously) are calculated based on weights of individual axles or groups of axles; not based on gross weight.

Processing of weight data is done by IRD software, which produces summary tables. The purpose is to produce WIM reports that may or may not require editing to calculate ESAL factors for the year.

## General Guidelines regarding Data Sources and Traffic Terminology

*In general, a 16-hour vehicle class count taken on a weekday from 6am to 10pm will have about the same volume as the HCAADT for the year at that site.*

1. The 16-hour period referred to above will have about 90% of the volume occurring in the 24 hours. It will have about 92% of the cars and 75% of the 5 axle semis.

2. Axle correction factors at a given site have generally been stable over the last 10 or 15 years.

3. An ATR count can be used in conjunction with a tube count (which may have been taken at the same site) to determine traffic trends.

4. On the average, on rural trunk highways, 5 axle semis comprise about 25% of the truck traffic on low volume routes and about 75% on high volume routes.

5. Generally, higher volume routes are growing faster than lower volume routes. This applies to both rural and urban areas.

6. When going from a rural area into a town on a trunk highway, trucks comprise between 2 and 7% of the increase in traffic, which occurs. When there is a small

increase (2%) in trucks, there are very few 5 axle semis. When there is a larger increase (7%), there are significantly more 5 axle semis.

7. On the average, non-trunk highways county roads have about 6% trucks, and about .5% are 5 axle semis. Consequently, an increase or decrease in AADT on the trunk highway would have 6% trucks associated with it. We are currently investigating the percentage of trucks added or subtracted on the local road system. Some studies indicated that the overall percent should be higher than the 6% "default" and also indicate there should be a split between Metro and Greater Minnesota truck percentages.

## General Traffic Behavior and Flow Theory

1. Volumes generally do not change a dramatically from year to year. Changes tend to remain small (single digit percentages) as people generally drive the same routes year after year. Volumes can change if a large generator appears or disappears, or if the condition of the route is improved or if it deteriorates substantially. District personnel could verify changes in the condition.

2. The probable change in traffic from one year to another can be quantified by analyzing the ATRs grouped by functional class or some other grouping. An ATR on or close to a forecasted project will be a better source to analyze historical changes in AADT than the traffic counts shown on the maps or CD-ROM. The percentage changes can then be applied to other segments along the project route.

3. The magnitude of the change from year to year varies more on low volume roads than it does on high volume roads. Low volume routes have a wider fluctuation in growth rates than high volume routes; thus traffic is more stable from year to year on the high volume routes. For example, the rural interstate shows a shift of about 2 or 3% while the rural CSAHs have a change of 5 or 6%. As a general guideline, trunk highway traffic in Greater Minnesota averages generally between 2 to 3 % growth a year while the 7 County Twin Cities Metro Area traffic can grow from 3 to 4% annually.

4. Our present system of counting and classifying traffic usually involves counting only once at a location for 48 or 16 hours during the year. The forecaster may have a difficult time in determining if the count is in fact valid. Two counts, taken at different times of the year are much better while three are better still. If two counts agree, that is probably the correct volume. If they do not agree, one still does not know the correct volume. That is why up to four cycles of vehicle class data are averaged – representing up to 20 years of historical volumes. The forecaster needs to see if there are consistent patterns and similar vehicle class percentages.

5. When volumes do change along a route over time, the change should be quite uniform, either percentage-wise or in terms of absolute volume. For example, there should not be traffic increases of 500, 25, and 150 on three adjoining segments where the base year traffic volumes are similar. The change in absolute volume can be applied when the base year volumes along the route do not vary substantially. In those cases where the base volumes do vary a significant amount, percentages should be used either solely or in combination with absolute values. Differences in volume between adjacent segments should remain constant over time as long as traffic generators remain constant in the area. If the forecaster is unable to get recounts to verify the change in traffic, the whole series of counts taken on the road should be examined. Any counts, which show a substantial change in volume from the rest of the group, should not be used. All others should be averaged and the resulting change in volume should be applied to all segments.

6. When the history of traffic volumes for a given location has an erratic pattern, the most probable estimate of traffic over that period of years is a straight line drawn through those points (least squares). The least squares program (MnESALS) predicts future 20 year AADT as a per year growth over the base year. A constant slope (or volume) is assumed over the future 20-year period. That is not assumed to be a constant geometric percent increase. The assumption is that traffic grows in a linear fashion. For example, the 2020 volume divided by the 2000 volume may show 50% growth. We take the 50% growth and divide it by 20 years to get the per year growth rate over the base year. This number should be fairly constant along segments of a project.

7. In general, the sharper the angle of the turn from one road to another, the smaller the percentage and number of vehicles making that turn. Usually, those vehicles desiring to make that movement will have made it prior to reaching that sharp turn. The exceptions are when there are physical barriers preventing that turn or a lack of alternate roads to use prior to making that turn. Conversely, a high percentage of traffic makes the other movement.

8. A majority of the traffic, which is traveling on a minor road, will turn onto an intersecting major road when it reaches it. A small percentage of the traffic will continue on the minor road, crossing the major road. Traffic from minor roads feed onto major roads.

9. A majority of traffic on a given route goes straight through an intersection. Drivers select routes to travel, which maximize the straight stretches of road they use and minimize the number of turns. Zig-zag patterns are avoided in favor of straight line patterns.

10. Traffic diversions due to construction sometimes result in the establishment of new patterns.

11. Traffic sometimes "disappears" when a major construction project is underway. It cannot be accounted for by looking at alternative routes. The apparent explanation is that these trips must be discretionary and do not take place. They are suspended until construction is complete.

12. Traffic volumes should split close to 50-50 by direction for a 24-hour period. However, the traffic split on unique sections of roadway can be unbalanced.

## Reminders

There is a 12% "safety factor" built into the formulas in the MnESAL spreadsheet. This is provided in case of future changes in truck regulations and changes to truck weight laws. In Excel, there is a slight rounding up of two digit numbers.

There are no tube counts prior to 1994. You may want to look closely at tube data prior to 1996 also; you may want to drop those counts if they look out of line with more recent counts.

There are currently (2004) about 25 permanent Piezo vehicle class counters on Inter-regional corridor routes (high and medium priority IRC routes). Analysis of this data will allow us to examine our adjustment factors for short duration vehicle class counts.

Older counts in the 1000's have two sets of data for each year. Due to limited resources, we will not count any site more than once in any year.

Locater maps to determine the exact location of each vehicle class count are usually mailed to the districts in early spring of each calendar year.

*County Road Thresholds* -Thresholds for county roads less than 1 million ESALS can contain the following categories*:*

0-250,000 ESALS – Low
250,000 – 600,000 ESALS – Medium
600,000 – 1,000,000 ESALS – High

# ESALS, MNESALS PROGRAM, AND TRAFFIC FORECASTING

## *ESALS*

Equivalent Single Axle Loads (ESALS) are the current measure for quantifying the decrease in ride quality of a roadway over time. An ESAL should be thought of as a damage factor rather than a load. AASHTO defines an ESAL as "one 18-kip (18000 lb.) single axle load application which will have an equivalent effect upon the performance of the pavement structure." The result will be a relative decrease in ride quality. Hence, an ESAL factor is the average damage one vehicle has on the roadway. It varies with location and commodity. An ESAL depends on structure and terminal serviceability. An ESAL combined with an R-value (to be discussed later) determines structural design. At this time, a new program/model called MnPAVE is being developed which will eventually have load spectra as a traffic input rather than ESALS. MnPAVE is the name given to the new software for flexible pavement design purposes. It uses mechanistic/empirical methods to help design flexible pavements; in the MnPAVE model inputs such as climate, road structure, and load spectra will be used to determine potential pavement designs. Thus, in the future, ESALS may no longer be produced; rather, we will be providing designers with traffic input necessary to use the new AASHTO pavement design software.

## ***MNESAL Program***

At the heart of the traffic forecasting procedure is an Excel program developed to calculate ESALS and standardize forecasting methods. The MnESALS program is the documentation of Mn/DOT's traffic volume and load forecasting procedures. The current version is called "MnESAL2005" and is available upon request from the Traffic Forecasting Unit of the Office of Transportation Data and Analysis. There is a documentation tab in the spreadsheet that elaborates on details discussed here and it also appears in this manual on pages 111-113. The MnESAL program has been updated and is continually being modified as new techniques and suggestions from users are incorporated. New for 2005 are two sets of "default" factors - urban and rural.

Inputs into the MnESAL program include:

1. Historic traffic volumes (20 years)
2. Historic vehicle classification breakdowns (20 years)
3. Axle load equivalency factors
4. Descriptive data including design lane factor

Outputs from the MnESAL program include:

1. Projected average annual daily traffic (AADT) – base and design year
2. Projected heavy commercial distribution (HCAADT) – base and design year by vehicle type
3. Total 20 and 35 year design-lane cumulative ESALS (flexible and rigid)
4. Documentation of work performed and assumptions incorporated into the forecast (traffic growth, land-use, etc)

***What is Traffic Forecasting?***

Traffic forecasting is the production of future traffic volumes and loads on a specific roadway segment. The projections are derived by trending historic data and considering the effects that future changes in the socio-economic factors will have on the particular segment.

The most common requests for traffic forecasts are:

1. Base and design year annual average daily traffic (AADT)
2. Design hour volumes with associated directional distribution
3. Base year and design year heavy commercial annual average daily traffic (HCAADT)
4. 20 and 30 year cumulative equivalent single axle loads (ESALS)

***Traffic Forecasting Procedure***

The basic steps in doing a traffic forecast consist of the following:

1. A determination of what is needed
2. A check of the forecast database for previous forecasts
3. Assemble the appropriate data
4. Determine base/design year AADTs
5. Calculate vehicle type percentages
6. Create ESAL report and documentation
7. Submit copy of report to Office of TDA and they will:
    a. Enter forecast into statewide database
    b. Put location on Metro and Greater Minnesota ArcView map for inclusion onto Mn/DOT's web page
    c. Keep a file of all forecasts produced by the districts
    d. Follow guidance from certification process

***What is needed by the requester and the forecaster***?

The requester of a forecast needs to provide the forecaster with certain basic elements, even if the forecast is not on the Artemis database:

The requester needs:

1. AADT – current and future. Also, design hour volume, directional distribution, and turning movements may be needed
2. HCAADT – current and future
3. ESALS – (load spectra in the future)
4. Time constraints

The forecaster needs:

1. Time constraints – date forecast needs to be completed by
2. Trunk highway number and project limits – termini and reference points helpful
3. State project number and type of project (e.g., 5010-01 and major construction.
4. Letting date

5. County
6. Project manager
7. Past forecasts in the area
8. Forecast number – districts use sequential numbering system depicting forecast, district, year and number, (example: F-6-0215)

***Traffic Forecasting Procedure – Overview***

This manual cannot attempt to cover every situation that you may encounter in traffic forecasting. There are different considerations for each project and each project has to be approached individually. Some districts and areas, such as Rochester or the Metro area may use modeling as well as traditional forecasting methods. Any technique is acceptable as long as the guidelines and parameters of this manual are used and your work is documented.

Each project will have a different set of needs and data requirements, but certain procedures should be followed. For example, the forecaster may need to consult the video log, may need to take short counts, or may need to drive around the project and take an inventory of potential truck generators, residential streets, manufacturing plants, etc. The forecaster may want to contact various databases on the WEB (Demographers Website for projected population, employment, housing unit growth, etc) and talk to city and county officials regarding the area. In short, the amount of time and effort put into a forecast will determine its accuracy. Utilizing every possible data resource can further help. Make sure to keep copies of all documentation for future use.

This manual will describe a basic approach to traffic forecasting and provide specific examples and techniques that should be followed. It is fully intended that the Office of Transportation Data and Analysis, Traffic Forecast Unit will continue to provide the expertise and knowledge and assistance to the districts. Since the MnESAL program is in Excel, an elementary knowledge of Excel is required to properly use the program.

***Resources and Materials Required by the Districts***

The Office of Transportation Data and Analysis is the repository for much of the data needed for traffic forecasting. For the past several years, each district has been and will continue to receive the resources necessary to do a thorough job of traffic forecasting. All forecasters should have the following materials at their disposal:

1. Yearly manual or tube vehicle class count sheets by individual site by year – some counts may have the 16 or 24-hour expansion worksheets in front of the counts. In these cases, the forecaster should run through the process of expanding the raw counts to make sure their numbers agree with the previously expanded sheet. Currently, MnDOT districts are responsible for all vehicle class counts using pneumatic tubes. They will then notify the central office as to the location of the special counts, so they can be incorporated into our database. We will still be doing our regular manual count program every summer, but we need to

incorporate special counts into our program to account for all vehicle class sites. Each district will receive new individual vehicle class count sheets usually between September and February, or as completed. Any forecaster can call the Traffic Forecast Unit at (651) 296-1621 to check on the status of a particular vehicle class count. The raw data may be available even if it hasn't been sent to the districts. Vehicle class counts from 1993 onward are available in Microsoft Access. Any "problem" counts from this period can be requested by contacting the Traffic Forecast Section of TDA.

2. Vehicle Class Site Maps – are located on the TDA web site and are updated annually. If you have any questions as to a specific vehicle class count map, please call the Traffic Forecast Unit. Maps should also include locations of ATRs WIMs, and continuous classifiers in all Mn/ DOT districts.

3. Traffic Volume Maps for both Metro and Greater Minnesota have been sent out to each district and are located on the TDA web site. Each forecaster should have traffic volume maps from 1980-2004 at their disposal – some hard copy (recent) and some microfiche (historical). The TDA web site has 1998, 2000, 2002, and 2004 count maps as well as 2000 thru 2004 county and municipal coverage counts. If there are any questions on the use or access to the information, please check our web site for contact information.

4. Vehicle Class History – dating back to 1984- for all tube and manual counts. The history contains the vehicle class count locations, route, description, district and county. Each January a new vehicle class history will be prepared and sent out to each district. The TDA web site also has a version downloadable in Excel format. An "asterisk" will indicate the following year's scheduled count locations.

5. Special Requests for Vehicle Class Counts – Each February, the Traffic Forecast Units will send each district forecaster a note asking for any special request for the upcoming summer count season. If you know of a particular project in your district that does not have recent or appropriate data, you may want to have it counted as a special count. In the future, Central Office, the district, or a combination of both may collect this data.

6. A set of ESAL maps resides with the Soils Engineer. Each year, around late spring, the Traffic Forecasts unit sends out ESAL maps to each district via Mn/DOT's shared Z: drive in ArcReader. These maps contain vehicle class sites in the entire state, together with AADT (last year of count), HCAADT percents, 5-axle semi numbers, annual flexible cumulative ESALS, and 20 year flexible ESALS. These are guidelines only and are ***not*** to be used for project level forecasting. They can be used for estimating ESALS for resurfacing projects and long range planning.

7. Please notify the Traffic Forecast Section if you need vehicle class counting equipment for any special counts required by the district or the forecaster. For

example, a forecaster may want a count during sugar beet harvest season. The forecaster may want a one-week count on a particular route to measure the impact of additional heavy trucks. This process may change with the new forecasting initiatives.

8. Your repository of historical vehicle class counts should include information back 20 years. Data collected prior to 20 years is no longer required in a forecast.

9. Historical Count maps and/or Microfiche dating back 20 years (1984). Among the forecaster's resources there should be a microfiche card reader for looking at historical AADT counts. You may also have a hard copy of recent count maps as well as traffic counts on CD Rom. The TDA web site can also be used. In addition to these trunk highway counts, it is often necessary to look at historical non-trunk highway counts (i.e. county coverage of CSAHs, MSAHs, CRs, etc). The district State Aid Office should have this information. Usually, these counts are taken on a 4-year cycle. The Traffic Forecast Unit can be contacted for help in securing these historical county coverage volumes. Twin City Metro historical count maps are on the 52 series set and are available in hard copy. In addition, cities over 5000 population back to 1984 should also be available on microfiche in the district. Current county counts are also available from the TDA web site.

10. Copies of all previous forecasts - copies of approved and submitted forecasts should be kept in the district office. If the forecaster needs to retrieve a copy of a previous forecast, or a neighboring district's forecast, please contact The Traffic Forecast Unit for help. We will locate or check in our statewide database for previous forecasts on or near your specific project area.

## ***TRAFFIC FORECAST PROCEDURES / STEP BY STEP FORECASTING PROCESS***

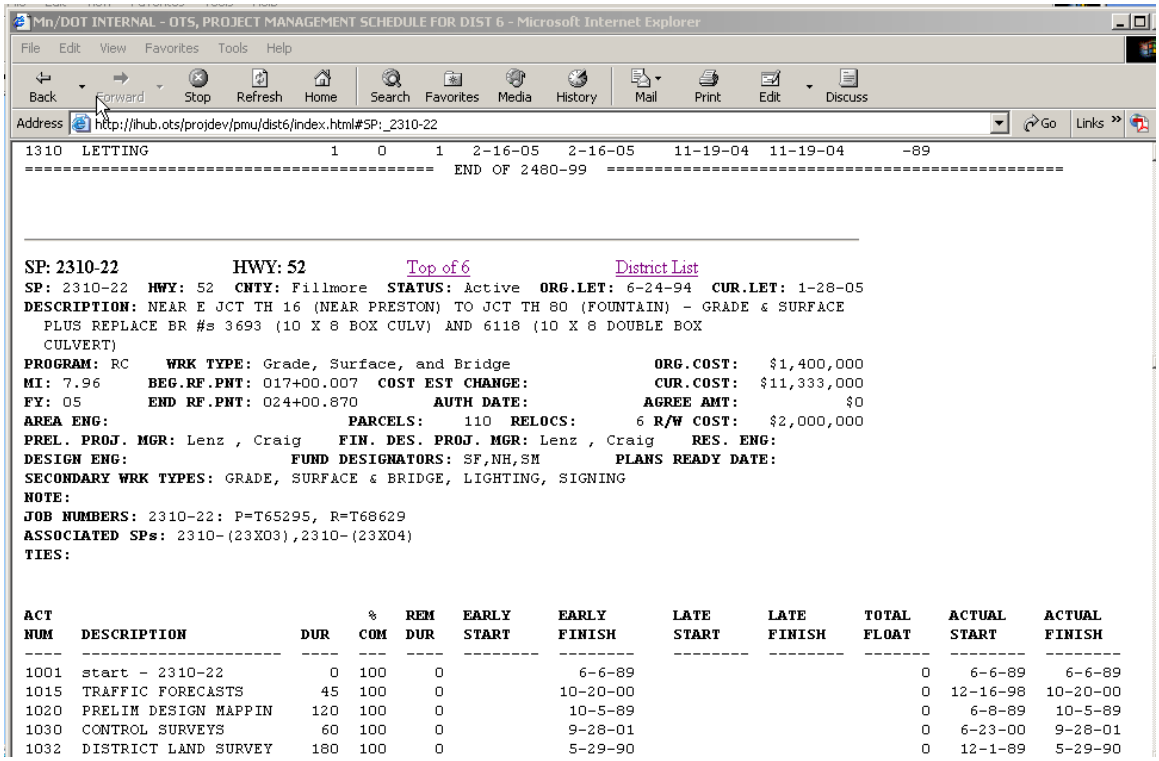
### ***1. Preliminary Information***

The first step in the traffic forecasting process is to determine the exact limits of the project from the project manager or the PPMS program listing. Some projects where forecasts are requested will not be in the PPMS database. In this case, the minimum information needed is the year of the project letting, the termini and the description of the project.

To see projects in PPMS, proceed to the Mn/Dot Internal Web page (*example 1*). The URL comes from the MN/DOT internal web site. Proceed to the Technical Support web site and then to the Project Management page. Next, proceed to the Project Activity Schedules, and then click the district that contains the project. That will take the forecaster to the desired SP number. Then, a simple print screen from Netscape or Explorer should produce a hard copy, which is needed as a part of the documentation.

The important elements here (to be placed on the first tab of your MnESALs and your project sketch) are SP number, highway, district, county, base year (year when road is open to traffic), project manager, program, type, beginning and ending reference point, and physical description. The forecaster may chose to open the MnESAL program at this point.

## *Example 1- Project and Project Management Services*




1310 LETTING 1 0 1 2-16-05 2-16-05 11-19-04 11-19-04 -89

END OF 2480-99

SP: 2310-22 HWY: 52 Top of 6 District List

**SP:** 2310-22 **HWY:** 52 **CNTY:** Fillmore **STATUS:** Active **ORG.LET:** 6-24-94 **CUR.LET:** 1-28-05
**DESCRIPTION:** NEAR E JCT TH 16 (NEAR PRESTON) TO JCT TH 80 (FOUNTAIN) - GRADE & SURFACE PLUS REPLACE BR #s 3693 (10 X 8 BOX CULV) AND 6118 (10 X 8 DOUBLE BOX CULVERT)
**PROGRAM:** RC **WRK TYPE:** Grade, Surface, and Bridge **ORG.COST:** $1,400,000
**MI:** 7.96 **BEG.RF.PNT:** 017+00.007 **COST EST CHANGE:** **CUR.COST:** $11,333,000
**FY:** 05 **END RF.PNT:** 024+00.870 **AUTH DATE:** **AGREE AMT:** $0
**AREA ENG:** **PARCELS:** 110 **RELOCS:** 6 **R/W COST:** $2,000,000
**PREL. PROJ. MGR:** Lenz , Craig **FIN. DES. PROJ. MGR:** Lenz , Craig **RES. ENG:**
**DESIGN ENG:** **FUND DESIGNATORS:** SF,NH,SM **PLANS READY DATE:**
**SECONDARY WRK TYPES:** GRADE, SURFACE & BRIDGE, LIGHTING, SIGNING
**NOTE:**
**JOB NUMBERS:** 2310-22: P=T65295, R=T68629
**ASSOCIATED SPs:** 2310-(23X03),2310-(23X04)
**TIES:**

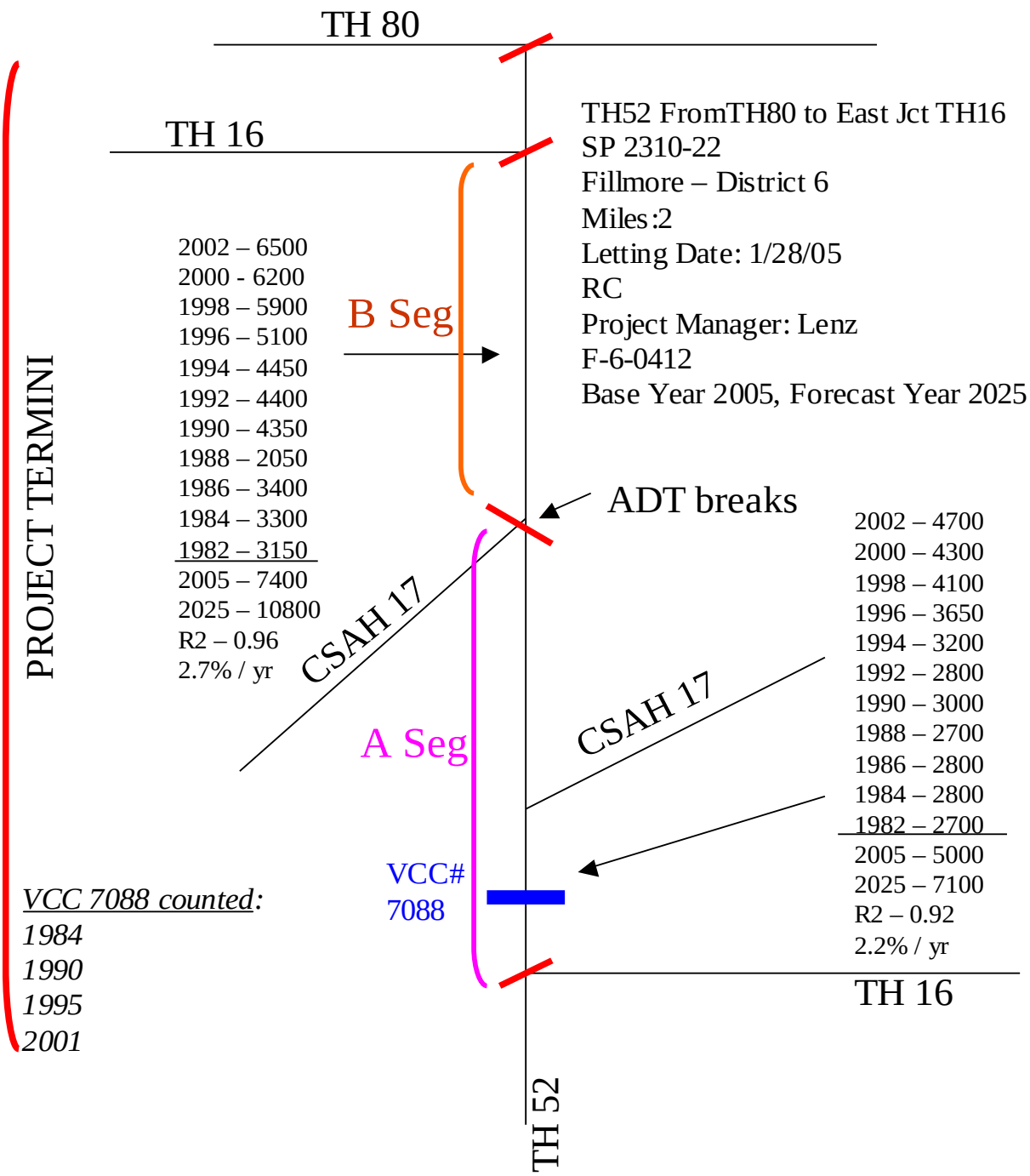
| ACT NUM | DESCRIPTION | DUR | % COM | REM DUR | EARLY START | EARLY FINISH | LATE START | LATE FINISH | TOTAL FLOAT | ACTUAL START | ACTUAL FINISH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1001 | start - 2310-22 | 0 | 100 | 0 | | 6-6-89 | | | 0 | 6-6-89 | 6-6-89 |
| 1015 | TRAFFIC FORECASTS | 45 | 100 | 0 | | 10-20-00 | | | 0 | 12-16-98 | 10-20-00 |
| 1020 | PRELIM DESIGN MAPPIN | 120 | 100 | 0 | | 10-5-89 | | | 0 | 6-8-89 | 10-5-89 |
| 1030 | CONTROL SURVEYS | 60 | 100 | 0 | | 9-28-01 | | | 0 | 6-23-00 | 9-28-01 |
| 1032 | DISTRICT LAND SURVEY | 180 | 100 | 0 | | 5-29-90 | | | 0 | 12-1-89 | 5-29-90 |

### ***2. Sketch***

Next, take the information discussed above and create a sketch of the project area. During the course of the traffic forecast, the sketch is the single most important "piece of paper" you will refer to during the process *(example 2)*. Initially, the forecaster may use the most current AADT maps (hard copy or TDA web site). For Greater Minnesota use the county maps showing the AADTs and in the 7 County Metro Area, use the 52 series maps). Place the most current traffic volumes on the sketch. Include the full length of the project termini. If the project crosses trunk highway boundaries, be sure to include the next trunk highway break in your sketch. This is important for vehicle class site determination. Always end your sketch with a trunk highway junction at each end – no matter how long the project length is (please note the example below uses 2002 data).

*Example 2- Sketch*

# TH 52 Historic Traffic Volumes



*Example 2* contains a "completed sketch" similar to what the sketch should look like when you start the ESAL forecast. Initially, the forecaster should concentrate on producing a traffic forecast for AADT. In the above example, there is a sketch, complete with verbal description of the project and other pertinent data contained on the PPMS report. Include all AADT breaks within the project termini out to the nearest trunk highway breaks. At every junction, it will be necessary to compile historic counts (in two year increments) using 20 years of data. A variety of count maps and microfiche cards with historical counts can be used during the trend analysis.

Always begin with the MOST recent count. From about 1994 to 1980, there were more count sites taken and that will be reflected on the older microfiche cards. For example, where there will be one count between AADT breaks on the 2000 count maps, there may have been three, or four, or any number between the same AADT breaks for 1994. The forecaster should take the "physical location" of the older counts and match it up with the recent counts. In other words, don't average the older counts – pick one location on the map or microfiche closest to the 2000, 1998, 1996, or 1994 count location. This is a critical phase in AADT forecasting, since using AADTs from different locations can affect the 20-year AADT projections.

On the sketch there are several other terms that will be discussed later. For now, it is sufficient to know that we will add "A" and "B" segment information as well as vehicle class site information on the sketch as we continue through the step-by-step forecasting process. Besides all vehicle class location sites, it will be necessary to look on the map and include all ATRs and WIMs. Note any of these sites adjacent to the project, or further along the trunk highway for future reference. Also, on the sketch, a 20 year AADT projection as well as a statistical value called R squared (a statistical measure of goodness of fit) and annual AADT growth over the 20 year AADT forecast have been added.

The letting date is used to determine the base year that is essentially the project completion date. If the letting year is late in the year - October, November, or December, it is likely the project will not be completed until the following year. For example, if a project shows a letting date of 11/20/01, we probably would calculate the base year as 2002 and the forecast year (design year) as 2022. However, a major project may have a letting year of 2002, and may not open until two or three years later; in this case, it is the responsibility of the forecaster to contact the project manager to determine the base year.

Thus, the starting point in developing a forecast for a project is to determine the current or base year AADT. All other items to be forecasted flow either directly or indirectly from the AADT. If the project is on a new alignment, include that on your sketch also. You may prefer to indicate that by use of a dotted line.

In most cases, the assumption will be made that the most recent historic counts are the most accurate. We will compare the AADTs to each other and to other AADTs along the project. This must be done because no individual count is necessarily correct. We will eventually adjust the AADT so that the best estimate of future traffic is obtained. It may

be desirable to look at traffic counts on parallel routes to determine the growth rate in the corridor. This helps place things in perspective.

One final word on AADT - the AADT on your sketch maps represents the traffic volume between two locations. The counts are usually located at the junction of trunk highways or at the corporate limits of towns. A problem can arise when strip development occurs at the edge of towns and traffic significantly increases as a result. The traffic beyond the development may not have increased nearly as rapidly. This is one reason why the forecaster should obtain local knowledge of the area or visit the area and make short counts. In addition, a check of the video log of the project area can yield further information on the number of lanes and the traffic patterns.

***3. MnESAL Spreadsheet –Forecast Tab***

At this point in the forecasting process, the forecaster may want to open the MnESAL spreadsheet and begin filling in the first tab. A downloadable version of this in EXCEL format is located on the TDA website at www.dot.state.mn.us/tda/docs/Mnesals2005.xls. Detailed information on the use of MnESAL begins on page 111 of this report. In order to avoid corrupting the original spreadsheet, the forecaster should immediately save the project with a different name. In our continuing TH52 example, the forecaster may want to save the forecast with the following typical name: TH52-F60412-.xls (the name of the trunk highway and the sequential number of the forecast for that particular district). *Example 3* shows the first tab on the bottom left of the MnESAL spreadsheet called "Forecast". The tabs are basically filled in from left to right, with the "Documentation" tab on the far left.

***4. Vehicle Class Site, WIM, ATR***

Vehicle type determination is the next step. The source of heavy commercial traffic (HCAADT) is the manual and tube vehicle classification counts. *Example 4* shows the location of our sample project. Vehicle class site locations can be found on the TDA website (www.dot.state.mn.us/tda/html/traffic.html#). Note the location of VCC site 7088 on our sketch. Also, within the limits of our project, VCC site 7090(not shown on sketch) would also be put on your final sketch. Any WIM or ATR sites would show up on your district vehicle class maps. The forecaster should put the location of the vehicle class sites on the sketch.

***5. Previous Forecasts***

At this point, the forecaster may check for any previous forecasts in the area. The Traffic Forecast and Vehicle Classification Unit may be contacted or the forecaster may browse the maps on TDA's website (www.dot.state.mn.us/tda/maps/trafficforecast.html#) Forecasts in the area, or on similar stretches of trunk highway should be consulted for consistency of ESAL flow.

***6. Vehicle Class History***

After determining the appropriate vehicle class site, the forecaster should then look at the vehicle class history. The history and location of vehicle class sites can be obtained from the TDA web site at www.dot.state.mn.us/tda/html/traffic.html#. The forecaster should

then list the four most recent count years (there may be only one if it is a special count). In example 2 there VCC #7708 was counted in the years 2001, 1995, 1990 and 1984.

***7. Vehicle Class Counts and Vehicle Types***

Collect copies of the raw counts from the vehicle class count books in your office. If you are missing some, contact the Traffic Forecast and Vehicle Class Unit. *Example 5 -* Hourly Vehicle Class Count for site 7088(shown on your sketch) shows a typical page from the vehicle class count records. The manual (16 hour) and tube (48 hour) counts will have different formats, but the vehicle type breakdown information at the bottom of the page is identical.

## *Example 3- Forecast Tab*

## *MNESALS Spreadsheet*

MINNESOTA DEPARTMENT OF TRANSPORTATION

**MEMO**

Transportation Data and Analysis
395 John Ireland Boulevard - MS 450
St. Paul, Minnesota 55155

Phone: (651) 296-0217
Fax: (651) 296-3311

August 9, 2004

To: GENE HICKS
SECTION DIRECTOR
CENTRAL OFFICE, MAIL STOP 450

From:

Subject: TRAFFIC FORECAST

Route: TH52
Letting Date: January 28, 2005
Program Category: RC
Project Manager: LENZ

SP# 2310-22
Forecast # F6-0412
County: FILLMORE
District: 6
Miles: 2

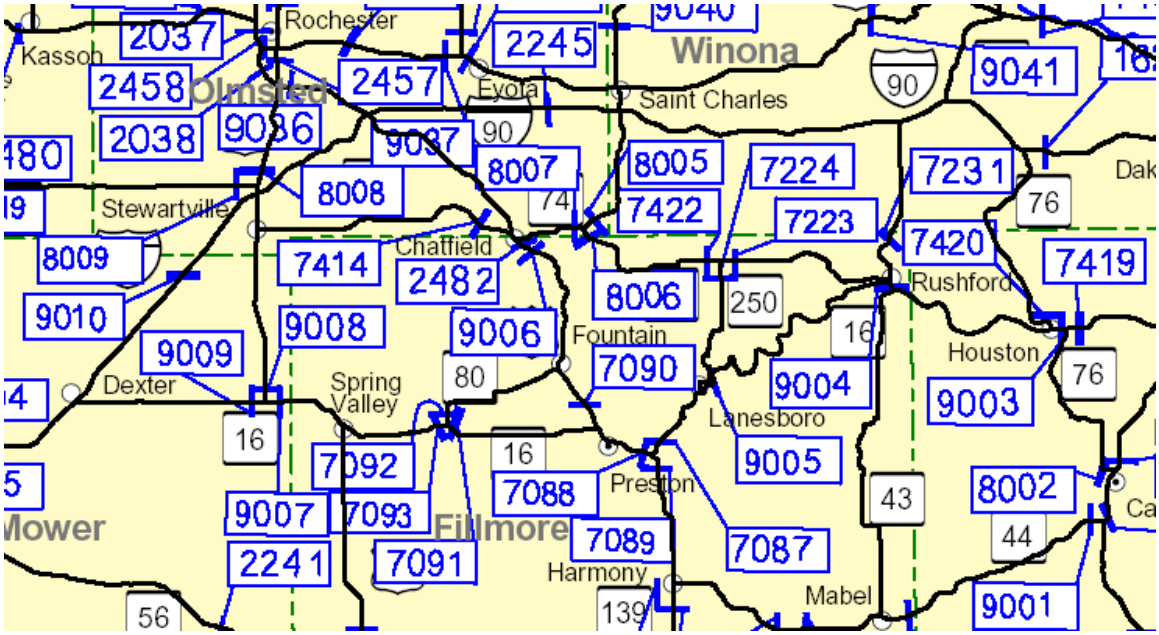
Project Limits: FROM TH80 TO E JCT TH16

Enclosures (check those that apply):

| | | | |
|---|---|---|---|
| X | Project map | X | VCL expansion worksheet |
| X | Least squares analysis | X | Cumulative ESAL Report |
| X | Cumulative ESAL worksheet, Segment A | | Other (describe) |
| X | Cumulative ESAL worksheet, Segment B | | Other (describe) |
| X | AADT and/or DHV traffic schematic diagram | | |

REMARKS:

# *Example 4- Vehicle Class Location Map*




Your vehicle class count notebooks should contain data to 1980. They may be in the form of three ring binder notebooks or printout versions for those in the 1980's. In either case, the raw data, in a 16-hour (manual) or 48-hour (tube) format, should have vehicle type breakdowns into eight categories (including passenger cars) summarized at the bottom of the page. The difference is that the tube counts DO NOT have body type breakdowns, whereas the manual counts do. *Example 6* shows the format of a typical manual vehicle class count.

Note that the semis are split into tank, dump, grain, stake, other, and 6 axles. During a forecast, it is IMPORTANT to find the body type in at least one count year at a vehicle class site. Then the forecaster will know when to split heavies; that is, allowing for higher ESAL factors for routes where there are more grain, tank, dump, and stake trucks. Those types of semis are usually heavier than the "other" category and need to be accounted for in your forecast. A later discussion will show how the body type affects the ESAL forecast.

As far as vehicle classification, it is important to know that the vehicle class count manuals in your district office have different vehicle classification groupings and totals. There is a FHWA classification scheme and a Mn/DOT vehicle classification scheme. For purposes of traffic forecasting, we use a classification scheme based on eight vehicle types. Those eight types are groupings of multiple vehicle types shown as totals at the bottom of vehicle class sheets from 1993 to the present (see bottom of *example 5*).

*Example 5- Vehicle Class Site 7088 -Tube*

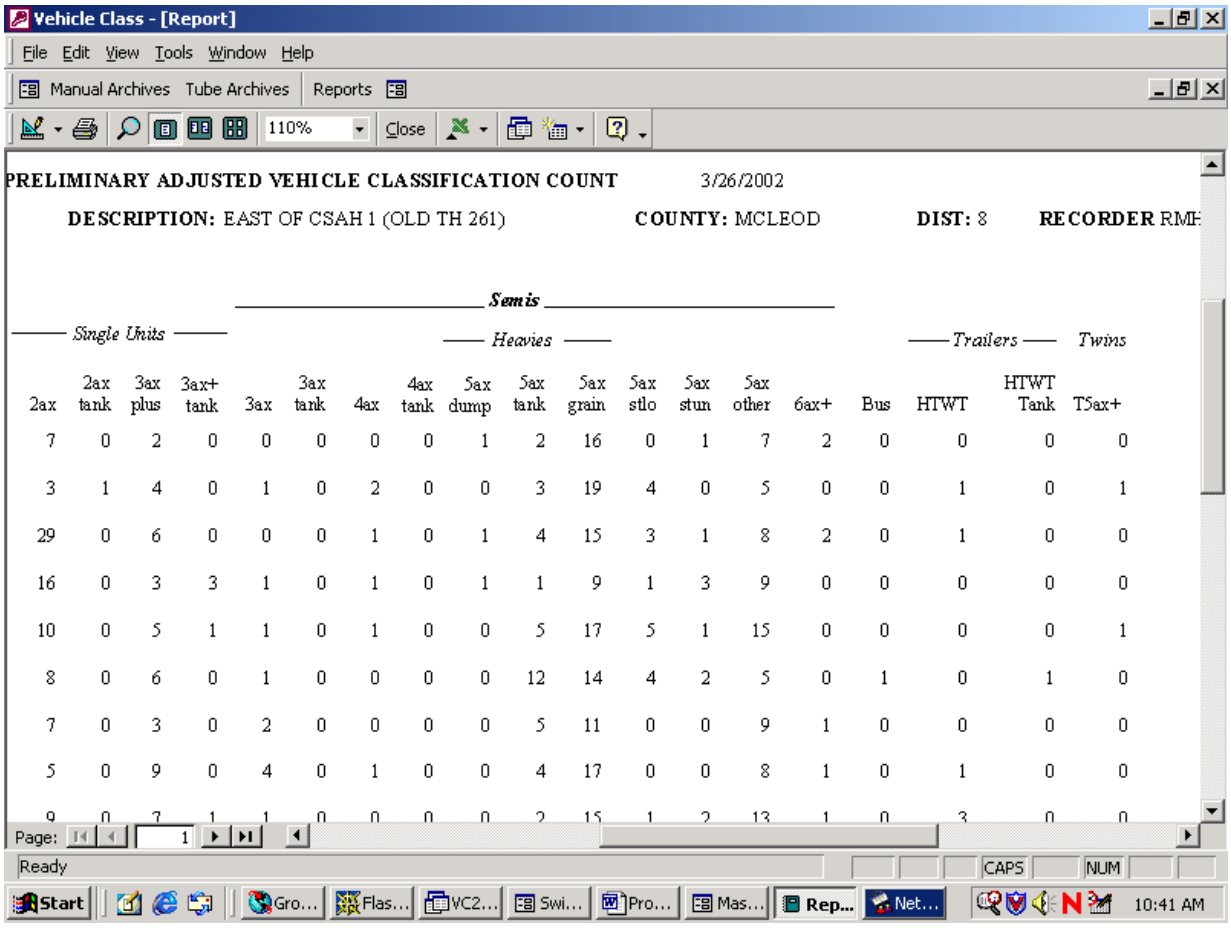
# Hourly Vehicle Class Count

**Site** 7088 **Route** TH 16 **Description** & TH52 W OF E JCT TH52 **County** FILLMORE **DIST** 6

| | DATE | TIME | M-CYCLE | CAR | PICKUP | BUS | 2AXSU | 3AXSU | 4+AXSU | 3 +4SEMI | 5AXSEMI | HTWT | TWINS | TWINS | TWINS | OTHER |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West | 07/24/01 | 15:00 | 3 | 115 | 50 | 1 | 8 | 2 | 0 | 1 | 9 | 1 | 0 | 0 | 0 | 0 |
| | 07/24/01 | 16:00 | 2 | 135 | 40 | 0 | 7 | 0 | 0 | 3 | 5 | 2 | 0 | 0 | 0 | 0 |
| | 07/24/01 | 17:00 | 0 | 118 | 51 | 0 | 5 | 0 | 0 | 0 | 9 | 1 | 0 | 0 | 0 | 0 |
| | 07/24/01 | 18:00 | 2 | 89 | 38 | 0 | 7 | 0 | 0 | 2 | 10 | 0 | 0 | 0 | 0 | 0 |
| | 07/24/01 | 19:00 | 0 | 77 | 23 | 0 | 3 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 07/24/01 | 20:00 | 0 | 54 | 21 | 0 | 1 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 |
| | 07/24/01 | 21:00 | 0 | 32 | 10 | 1 | 4 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 07/24/01 | 22:00 | 0 | 21 | 5 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| | 07/24/01 | 23:00 | 0 | 8 | 3 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 0:00 | 0 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 1:00 | 0 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 2:00 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 3:00 | 0 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 4:00 | 0 | 12 | 6 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 5:00 | 0 | 76 | 31 | 1 | 6 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 6:00 | 3 | 123 | 46 | 0 | 6 | 2 | 1 | 0 | 8 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 7:00 | 2 | 147 | 48 | 2 | 11 | 6 | 1 | 1 | 8 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 8:00 | 0 | 116 | 48 | 1 | 11 | 3 | 0 | 1 | 8 | 1 | 0 | 0 | 1 | 0 |
| | 07/25/01 | 9:00 | 2 | 108 | 47 | 3 | 6 | 1 | 0 | 3 | 9 | 1 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 10:00 | 2 | 108 | 39 | 3 | 9 | 4 | 1 | 3 | 7 | 2 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 11:00 | 2 | 125 | 40 | 2 | 7 | 2 | 0 | 2 | 15 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 12:00 | 0 | 94 | 29 | 0 | 8 | 1 | 0 | 1 | 8 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 13:00 | 3 | 113 | 39 | 1 | 2 | 5 | 2 | 3 | 11 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 14:00 | 1 | 116 | 38 | 0 | 9 | 5 | 0 | 2 | 8 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 15:00 | 2 | 116 | 49 | 2 | 6 | 1 | 1 | 5 | 11 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 16:00 | 1 | 133 | 58 | 0 | 6 | 1 | 1 | 3 | 5 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 17:00 | 1 | 163 | 75 | 1 | 6 | 0 | 0 | 1 | 7 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 18:00 | 1 | 198 | 68 | 0 | 14 | 0 | 0 | 1 | 11 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 19:00 | 0 | 84 | 36 | 0 | 4 | 0 | 0 | 1 | 5 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 20:00 | 1 | 61 | 16 | 0 | 2 | 0 | 0 | 1 | 6 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 21:00 | 1 | 43 | 12 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 22:00 | 0 | 32 | 13 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 |
| | 07/25/01 | 23:00 | 0 | 16 | 3 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| | 07/26/01 | 0:00 | 0 | 7 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 07/26/01 | 1:00 | 0 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 07/26/01 | 2:00 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 07/26/01 | 3:00 | 0 | 5 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 07/26/01 | 4:00 | 0 | 16 | 4 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| | 07/26/01 | 5:00 | 2 | 63 | 18 | 0 | 5 | 1 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| | 07/26/01 | 6:00 | 3 | 103 | 46 | 0 | 2 | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 0 | 0 |
| | 07/26/01 | 7:00 | 2 | 131 | 44 | 2 | 8 | 2 | 0 | 0 | 7 | 2 | 0 | 0 | 1 | 0 |
| | 07/26/01 | 8:00 | 1 | 115 | 47 | 0 | 7 | 2 | 1 | 1 | 8 | 3 | 0 | 0 | 0 | 0 |
| | 07/26/01 | 9:00 | 2 | 90 | 35 | 3 | 13 | 3 | 2 | 2 | 11 | 2 | 0 | 0 | 0 | 0 |
| | 07/26/01 | 10:00 | 1 | 93 | 34 | 1 | 5 | 3 | 1 | 0 | 10 | 1 | 0 | 0 | 0 | 0 |
| | 07/26/01 | 11:00 | 2 | 98 | 44 | 1 | 8 | 1 | 0 | 2 | 9 | 0 | 0 | 0 | 0 | 0 |
| | 07/26/01 | 12:00 | 1 | 119 | 40 | 3 | 7 | 3 | 0 | 0 | 9 | 1 | 0 | 0 | 0 | 0 |
| | 07/26/01 | 13:00 | 2 | 109 | 41 | 2 | 5 | 3 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 |
| | 07/26/01 | 14:00 | 4 | 118 | 39 | 2 | 7 | 3 | 0 | 3 | 11 | 0 | 0 | 0 | 0 | 0 |
| | *DIRECTION TOTALS* | | 49 | 3722 | 1386 | 36 | 220 | 56 | 12 | 47 | 274 | 17 | 0 | 0 | 2 | 0 |
| | *SITE TOTALS* | | 101 | 7208 | 3126 | 77 | 453 | 111 | 20 | 100 | 522 | 28 | 1 | 0 | 3 | 0 |

| ***Veh. Type Breakdown for ESAL Calc*** | PASS VEH | 2 AX SU | 3+ AX SU | 3 AX SEMI | 4 AX SEMI | 5+ AX SEMI | TRKTRLR/BUS | TWINS | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | 5,218 | 226 | 66 | 18 | 32 | 272 | 41 | 2 | 5875 |

# *Example 6- Vehicle Class Site- Manual*




In summary, there are vehicle class counts in various formats and groupings of vehicle types from 1970 to the present, in either manual or tube formats. From 1993 to the present, there should be summary totals of the eight vehicle groupings on the bottom of the reports. In the case of a 2-lane roadway, the summary totals will be on the bottom of one sheet, and on a 4 lane there will be two totals for each vehicle class site in these eight groupings. Example 5 shows the total for a 2-lane roadway.

From 1978 to 1992, the forecaster will see vehicle class counts in a variety of different formats. Some will contain body types on eight hour count sheets, some will have separate body type sheets, and some will be 24 hour sheets that are in reality 16 hours (since the midnight to 6am period will have zeros), and some count sheets will have manual totals on top of the count sheets.

The vehicle class counts you will encounter from 1990 until the present time will NEED TO BE EXPANDED in your MnESAL spreadsheet. The data from 1980 to 1989 HAS ALREADY BEEN EXPANDED, and should be contained in one of your resource books.

This will save the forecaster a lot of work. However, body type information will need to be collected on all data prior to 1990 to evaluate the split into heavies (again, the heavies being tank, dump, grain and stake trucks when on a timber or granite route). Vehicle class output from 1993 to the present is available in an Access database.

Examples 7, 8, and 9 show various older vehicle classification schemes and body type reports. For our forecasting procedures, combine all different vehicle classifications into the eight classification types. In every older vehicle format, it may be necessary to manually or with a calculator combine all truck types into our basic categories. The forecaster then "expands" these counts into AADT and HCAADT. The body type information is used ONLY FOR THE 5 AXLE SEMI CATEGORY.

The Eight Vehicle Types used in Traffic Forecasting:

a. Type 1 - Cars or Passenger vehicles – includes motorcycles, pickups and cars. This category includes cars pulling recreational or light trailers and all standard pickup trucks; also includes 2 axle 4 tire single unit vehicles. This could be pickups, vans, panels, motor homes, carryalls, etc. Any 2 axle 4 tire single unit vehicle pulling recreational or other trailers are included in this classification.

b. Type 2 – Two Axle Single Unit Trucks – includes all 2 axle 6 tire trucks. This includes all vehicles on a single frame, having 2 axles and dual rear wheels.

c. Type 3 - Three Plus Axle Single Unit Trucks – includes 3 or more axle single unit trucks. This includes all vehicles on a single frame having 3 or 4+ axles.

d. Type 4 – Three Axle Semis – Consists of all semis with 3 axles consisting of two units, one of which is the tractor and the other is a trailer.

e. Type 5 – Four Axle Semis – Consists of all semis with 4 axles consisting of two units, one of which is the tractor and the other is a trailer

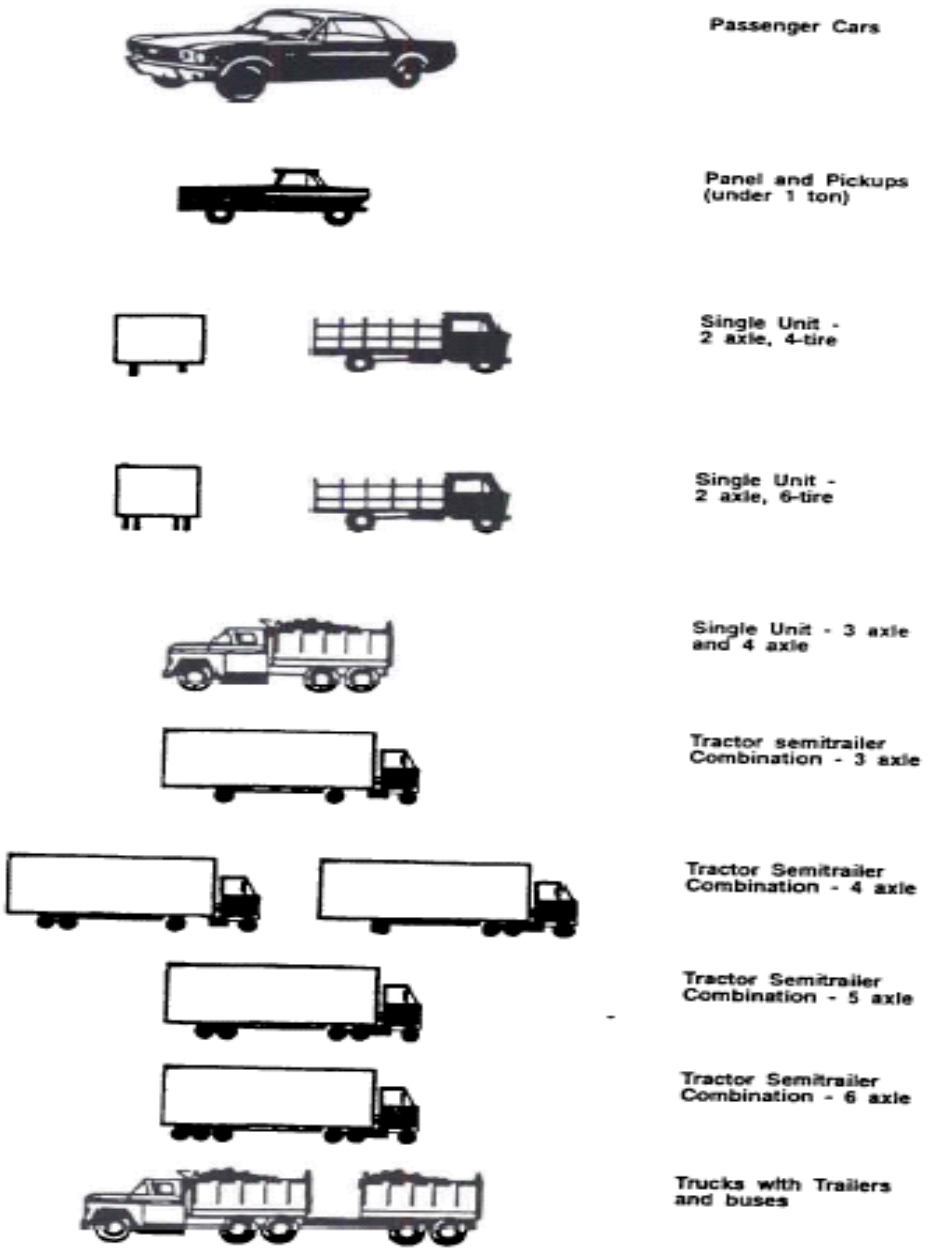
f. Type 6 – Five Plus Axle Semis – Consists of all semis with 5 or more axles consisting of two units, one of which is a tractor and the other is a trailer.

g. Type 7 – Heavy Truck with Trailer / Bus – This category includes buses and heavy trucks with trailers. A heavy truck with trailer can have 3 or more axles.

h. Type 8 – Twins – These are semis with two separate trailers. Twins can have 5 or more axles

*Figure 1-Truck Types*

***Truck Types Used In TrafficForecasting***



# *Example 7- Vehicle and Body Type Report (1992)*

HOURLY COUNTS BY VEHICLE TYPE

HO9
KLA

STUDY_____8 LOCATION #____740
DIRECTION___9-COMBINED HOURS_____14-21
CYCLE_____1-SUMMER DAY OF WEEK___2-WEEKDAY

| HR | TOT VEH | TOT TRKS | CARS PNLS PKPS | SINGLE UNIT TRUCKS 2AX | 3AX | 4+AX | BUS | SEMIS 3AX | 4AX | 5AX | 6+AX | TRUCK TRAILERS 4AX | 5AX | 6+AX | TW.TR. 5AX | 6AX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | 233 | 7 | 226 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 336 | 8 | 328 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 401 | 8 | 393 | 5 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 332 | 4 | 328 | 3 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 283 | 0 | 283 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | 209 | 1 | 208 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 208 | 0 | 208 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | 166 | 1 | 165 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 2168 | 29 | 2139 | 25 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

DATE(S):HOUR___08/11/92: 14-21

Dehdt2

VEHICLE AND BODY TYPE

STUDY_____8 LOCATION #_____740
DIRECTION___9-COMBINED DATE(S) & HOURS__08/11/92: 14-21
CYCLE_____1-SUMMER
HOURS_____14-21
DAY OF WEEK_2-WEEKDAY

BODY TYPE

| VEHICLE TYPE | TANK | STAKE | REFR | VAN | DUMP | PANEL | GRAIN | CATTLE | OTHER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-AXLE TRUCK | 0 | 8 | 1 | 14 | 0 | 2 | 0 | 0 | | 25 |
| 3-AXLE TRUCK | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 |
| 4-AXLE TRUCK | 0 | | | | 0 | | | | 0 | 0 |
| 3-AXLE SEMI | | 0 | | 0 | | | | | 0 | 0 |
| 4-AXLE SEMI | 0 | 0 | 0 | 0 | | | | 0 | 0 | 0 |
| 5-AXLE SEMI | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | | 0 |
| 6-AXLE SEMI | | | | | | | | | 0 | 0 |
| 4-AXLE HTWT | | | | | | | | | 0 | 0 |
| 5-AXLE HTWT | | | | | | | | | 0 | 0 |
| 6-AXLE HTWT | | | | | | | | | 0 | 0 |
| 5-AXLE TW.TR. | 0 | | | 0 | | | 0 | | 0 | 0 |
| 6-AXLE TW.TR. | | | | | | | | | 0 | 0 |
| TOTAL | 0 | 8 | 1 | 14 | 0 | 2 | 0 | 0 | 0 | 25 |

# *Example 8- Body Type Report (1990)*

DATE: 1990. VEHICLE AND BODY TYPE BASED ON RAW DATA FOR

STUDY 7 LOCATION 126 TH 68 E OF JCT TH15 7 BROWN

1 DIRECTION(S) 1 CYCLE(S)

16 HOUR WEEKDAY COUNTS

BODY TYPE

| VEHICLE TYPE | TANK | STAKE | REFRIG | VAN | DUMP | P/P | GRAIN | CATTLE | OTHER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| CARS,PANELS + PICKUPS | | | | | | | | | | |
| VOLUME | | | | | | | | | | 2016 |
| PERCENT | | | | | | | | | | |
| 2 AXLE-6 TIRE TRUCKS | | | | | | | | | | |
| VOLUME | 1 | 13 | 3 | 7 | 1 | 5 | 0 | 0 | | 30 |
| PERCENT | 3.3 | 43.3 | 10.0 | 23.3 | 3.3 | 16.7 | 0.0 | 0.0 | | |
| 3 AXLE TRUCKS | | | | | | | | | | |
| VOLUME | 0 | 1 | 0 | 3 | 5 | | 1 | 1 | | 11 |
| PERCENT | 0.0 | 9.1 | 0.0 | 27.3 | 45.5 | | 9.1 | 9.1 | | |
| 4+ AXLE TRUCKS | | | | | | | | | | |
| VOLUME | 0 | | | | 1 | | | | 0 | 1 |
| PERCENT | 0.0 | | | | 100.0 | | | | 0.0 | |
| BUSES | | | | | | | | | | |
| VOLUME | | | | | | | 0* | 0* | 0 | 0 |
| PERCENT | | | | | | | 0.0 | 0.0 | 0.0 | |
| 3 AXLE TRACTOR-SEMI TRLR | | | | | | | | | | |
| VOLUME | | 0 | | 4 | | | | | 0 | 4 |
| PERCENT | | 0.0 | | 100.0 | | | | | 0.0 | |
| 4 AXLE TRACTOR-SEMI TRLR | | | | | | | | | | |
| VOLUME | 0 | 1 | 0 | 4 | | | | 0 | 0 | 5 |
| PERCENT | 0.0 | 20.0 | 0.0 | 80.0 | | | | 0.0 | 0.0 | |
| 5 AXLE TRACTOR-SEMI TRLR | | | | | | | | | | |
| VOLUME | 28 | 10 | 6 | 7 | 1 | | 21 | 2 | | 75 |
| PERCENT | 37.3 | 13.3 | 8.0 | 9.3 | 1.3 | | 28.0 | 2.7 | | |
| 6+ AXL TRACTOR-SEMI TRLR | | | | | | | | | | |
| VOLUME | | | | | | | | | | 1 |
| PERCENT | | | | | | | | | | |
| 4 AXLE TRUCK TRAILER | | | | | | | | | | |
| VOLUME | | | | | | | | | | 0 |
| PERCENT | | | | | | | | | | |
| 5 AXLE TRUCK TRAILER | | | | | | | | | | |
| VOLUME | | | | | | | | | | 1 |
| PERCENT | | | | | | | | | | |
| 6+ AXLE TRUCK TRAILER | | | | | | | | | | |
| VOLUME | | | | | | | | | | 2 |
| PERCENT | | | | | | | | | | |
| 5 AXLE TWIN TRAILER | | | | | | | | | | |
| VOLUME | 0 | | | 0 | | | 0 | | 0 | 0 |
| PERCENT | 0.0 | | | 0.0 | | | 0.0 | | 0.0 | |
| 6+ AXLE TWIN TRAILER | | | | | | | | | | |
| VOLUME | | | | | | | | | | 1 |
| PERCENT | | | | | | | | | | |

NOTE - BLANKS INDICATE THAT DATA WAS NOT COLLECTED FOR THIS CATEGORY
*BUS BODY TYPES ARE COMMERCIAL + SCHOOL FOR GRAIN + CATTLE RESPECTIVELY

# *Example 9 - 16 Hour Raw Count (1990)*

RAW DATA SUMMARY STUDY: 7 LOCATION: 126 TH 68 E OF JCT TH15 7 BROWN
DATE: 1990. DIRECTION: BOTH CYCLE: 1 DAY OF WEEK: WEEKDAY DATES: AM 7/13/90 PM 7/12/90

| HOUR | | TOTAL VEHICLES | TOTAL TRUCKS | CARS & PANELS PICKUP | 2 AXLE 6 TIRE TRUCK | 3 AXLE TRUCK | 4+AXLE TRUCK | BUSES | 3 AXLE SEMI | 4 AXLE SEMI | 5 AXLE SEMI | 6+AXLE SEMI | 4 AXLE TRUCK TRLR | 5 AXLE TRUCK TRLR | 6+AXLE TRUCK TRLR | 5 AXLE TWIN TRLR | 6+AXLE TWIN TRLR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12- 1 AM | VOLUME | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1- 2 AM | VOLUME | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2- 3 AM | VOLUME | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3- 4 AM | VOLUME | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4- 5 AM | VOLUME | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5- 6 AM | VOLUME | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 6- 7 AM | VOLUME | 83 | 4 | 79 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 1 | 0 | 0 | 0 |
| | PERCENT | | 4.8 | 95.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 3.6 | 0.0 | 0.0 | 1.2 | 0.0 | 0.0 | 0.0 |
| 7- 8 AM | VOLUME | 119 | 5 | 114 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 1 |
| | PERCENT | | 4.2 | 95.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.5 | 0.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.8 |
| 8- 9 AM | VOLUME | 111 | 9 | 102 | 4 | 1 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 8.1 | 91.9 | 3.6 | 0.9 | 0.0 | 0.0 | 0.9 | 2.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9-10 AM | VOLUME | 157 | 15 | 142 | 4 | 3 | 0 | 0 | 1 | 6 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | PERCENT | | 9.6 | 90.4 | 2.5 | 1.9 | 0.0 | 0.0 | 0.6 | 3.8 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 |
| 10-11 AM | VOLUME | 119 | 11 | 108 | 2 | 0 | 1 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 9.2 | 90.8 | 1.7 | 0.0 | 0.8 | 0.0 | 0.0 | 6.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11-12 AM | VOLUME | 134 | 8 | 126 | 1 | 1 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 6.0 | 94.0 | 0.7 | 0.7 | 0.0 | 0.0 | 0.0 | 4.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 12- 1 PM | VOLUME | 133 | 12 | 121 | 3 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 9.0 | 91.0 | 2.3 | 0.0 | 0.0 | 0.0 | 0.0 | 6.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1- 2 PM | VOLUME | 140 | 6 | 134 | 2 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 4.3 | 95.7 | 1.4 | 0.0 | 0.0 | 0.0 | 0.0 | 2.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2- 3 PM | VOLUME | 154 | 13 | 141 | 4 | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 8.4 | 91.6 | 2.6 | 0.0 | 0.0 | 0.0 | 0.0 | 5.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3- 4 PM | VOLUME | 176 | 14 | 162 | 6 | 1 | 0 | 0 | 2 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 8.0 | 92.0 | 3.4 | 0.6 | 0.0 | 0.0 | 1.1 | 0.0 | 2.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 4- 5 PM | VOLUME | 201 | 12 | 189 | 2 | 3 | 0 | 0 | 1 | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 6.0 | 94.0 | 1.0 | 1.5 | 0.0 | 0.0 | 0.5 | 1.0 | 2.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5- 6 PM | VOLUME | 181 | 7 | 174 | 1 | 2 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 0 | 0 |
| | PERCENT | | 3.9 | 96.1 | 0.6 | 1.1 | 0.0 | 0.0 | 0.0 | 0.0 | 1.7 | 0.0 | 0.0 | 0.0 | 0.6 | 0.0 | 0.0 |
| 6- 7 PM | VOLUME | 150 | 6 | 144 | 1 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 4.0 | 96.0 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 2.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 7- 8 PM | VOLUME | 114 | 5 | 109 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 4.4 | 95.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.9 | 0.0 | 3.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 8- 9 PM | VOLUME | 97 | 0 | 97 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 0.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 9-10 PM | VOLUME | 78 | 4 | 74 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 5.1 | 94.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 10-11 PM | VOLUME | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11-12 PM | VOLUME | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | PERCENT | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | VOLUME | 2147 | 131 | 2016 | 30 | 11 | 1 | 0 | 4 | 5 | 75 | 1 | 0 | 1 | 2 | 0 | 1 |
| | PERCENT | | 6.1 | 93.9 | 1.4 | 0.5 | 0.0 | 0.0 | 0.2 | 0.2 | 3.5 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |

One last note on the data collection phase for vehicle class counts -- from 1993 to the present, all vehicle class counts are available via Access or Excel. The Traffic Forecast Section can send electronically any output of tube or manual counts from 1993 to the present. In 1993, there were only manual counts; from 1994 to the present, there is a mix of manual and tube counts. 1980 to 1992 counts have to be expanded, but they are not available on computer.

***8. Other Data Sources***

After gathering all the vehicle class data for a particular traffic forecast, the forecaster may want to look at a few other data sources, such as the State Demographic Office (www.demography.state.mn.us), the Minnesota Department of Employment and Economic Security (www.deed.state.mn.us), Metropolitan Planning Organizations (MPOs), Area Transportation Partnerships (ATPs), Regional Development Commissions (RDCs), and City or County Traffic Engineers. City and county planners can provide useful information about land use planning and projected developments, and county engineers may provide information about future county projects that may cause detours and changes in traffic patterns along a trunk highway. The State Demographic Office can provide useful information on population, household, labor force, and income data by county and city (as well as projections) and the Minnesota Department of Economic Security has useful information on employment by industry and region.

***9. Raw Vehicle Class Count Data***

At this point, the forecaster should have all the historical vehicle class data arranged from most recent to oldest, a sketch with historical AADT, AADT breaks, vehicle class count site locations, and pertinent Artemis data. Beginning with the most recent vehicle class count, the next step is to expand raw data into HCAADT. During this step, it is important to remember that we are basing a yearly HCAADT on a 16 or 48-hour traffic count, a snapshot in time. We assume this is representative of the month in which the count was taken.

Again, the "forecasting process" assumes that the raw data taken at that site on a typical weekday can be expanded to represent an average daily vehicle type breakdown for the entire year. With the use of three or four points in a 20-year period, the assumption is that the traffic patterns are consistent over time, and although AADT usually increases over time, the vehicle percentages usually remain constant. Studies have shown that although the vehicle class count represents 16 to 48 hours of an entire year, in general it is representative of the average weekday traffic for a given month of the year.

***10. Forecast Worksheet***

Continuing our sample forecast on TH52, we have started filling out the "Forecast" tab in MnESALS (*example 3*) from the PPMS information in *example 1* and have obtained a typical vehicle class raw data report for vehicle class site 7088 *(example 5*). The forecaster will notice the next four tabs to the right are virtually identical, allowing you to complete four vehicle class expansions. This will be accomplished by using one or more worksheets on the MnESAL - "16-24 Vehicle C.C. 1" through "16-24 Vehicle C. C.4" tabs of the spreadsheet program (example 10).

*Example 10 - 1995 Vehicle Class Expansion Worksheet*
*MNESALS*

# Vehicle Class Count Expansion Worksheet

**16 HR. OR 24 HR. VEHICLE CLASS COUNT EXPANSION WORKSHEET 1**

**SITE NUMBER:** 7088 **COUNTY:** Fillmore

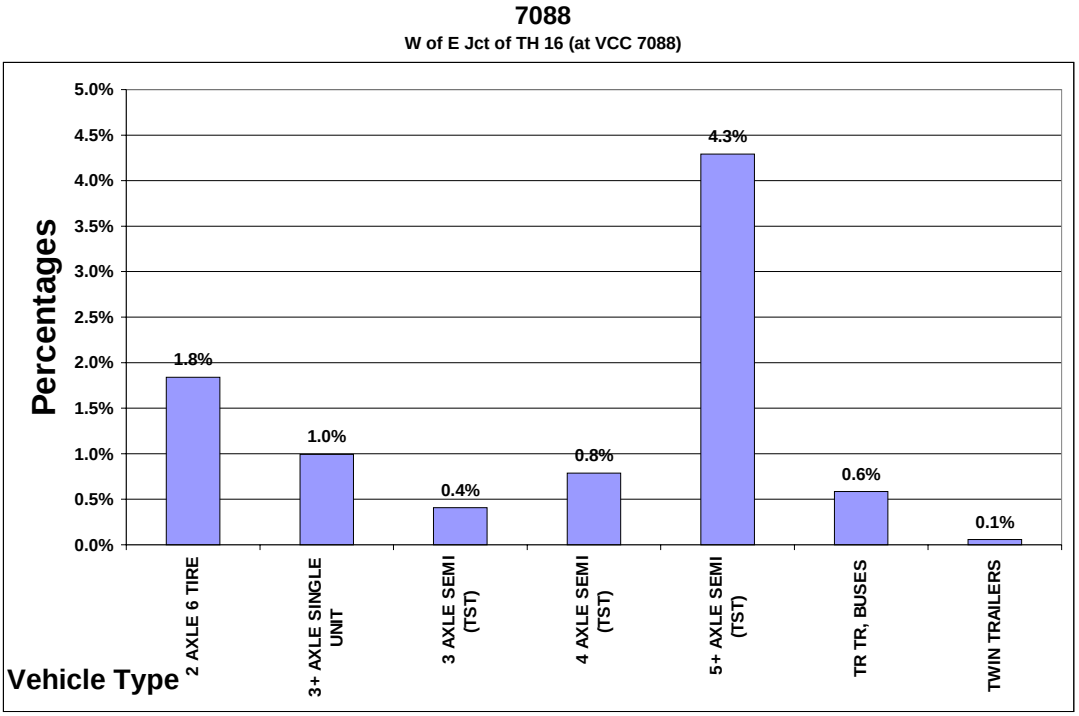
**SITE DESCRIPTION:** W of E Jct of TH 16 (at VCC 7088)

**PROJECT SP#:** 2310-22 **YEAR OF COUNT ->:** 1995

**MONTH NUMBER OF COUNT:** 9 **CONSTRAIN AADT ->:** 3425

**16 or 24 HR** 24

| VEHICLE TYPE | RAW COUNT | AADT ADJ FACTOR | | ADJUSTED RAW | VEH. TYPE PERCENTS | A.C.F. |
|---|---|---|---|---|---|---|
| CARS AND PICKUPS | 3559 | #N/A | | 3118 | | 0.92 |
| 2 AXLE 6 TIRE | 97 | 0.65 | | 63 | 1.8% | |
| 3+ AXLE SINGLE UNIT | 55 | 0.61 | | 34 | 1.0% | |
| 3 AXLE SEMI (TST) | 19 | 0.72 | | 14 | 0.4% | |
| 4 AXLE SEMI (TST) | 35 | 0.76 | | 27 | 0.8% | |
| 5+ AXLE SEMI (TST) | 210 | 0.70 | | 147 | 4.3% | |
| TR TR, BUSES | 30 | 0.65 | | 20 | 0.6% | |
| TWIN TRAILERS | 3 | 0.70 | | 2 | 0.1% | |
| TOTALS ----------> | 4008 | --------> | 0.9 | 3425 | 9.0% | (%HC) |




***11. Expansion of Vehicle Class Count Data and Axle Correction Factors***

In this example, the forecaster will expand the 1995 vehicle class count at site 7088. The bar graphs on the bottom of the page portray the eight vehicle class categories discussed

above. Those numbers are placed on the "Vehicle Class Count Expansion Worksheet" in your MnESAL in the column labeled " Raw Count" (*example 10*). The information at the top of the expansion worksheet can be obtained from the class count sheet and / or the sketch, i.e. site number, site description, project S.P#., month number of count and 16 or 24 hours (24 hours in this case since it is a tube count and not a manual count).

The "Year of Count" is the year of that particular vehicle class count (in this case, 1995). The term "Constrained AADT" means the AADT obtained for that year on the sketch (in this case, the average of the 1996 and 1994 AADT which is 3425. Next, enter 3425 on the spreadsheet. The concept of the constrained AADT is to insure that the adjusted vehicle count matches the AADT. Thus, the "raw" vehicle type percents are adjusted for the month the count is taken to develop adjusted HCAADT (seasonally adjusted volumes – called "Adjusted Raw").

The factors used to adjust the raw counts were developed from data collected at weigh in motion (WIM) sites. For example, the 5+ axle semi count taken in June is 210 (*example 10*). When adjusted for the entire year, the "adjusted" number is 147 (this means that in June, 5 + axle semi volumes are 70% higher than the average day for the year so the semis are adjusted downward to represent the entire year; conversely, if the month is changed from September (9) to January (1), a higher factor results. The graph at the bottom of the expansion worksheets is a representation of the adjusted vehicle type percents. In the MnESAL spreadsheet, the column vehicle type percents are automatically transferred to the next sheet, the "Vehicle Class Count Averages Worksheet." The chart below shows the complete table of factors used on the vehicle class count expansion worksheet.

*Figure 2 – 24 & 16 Hour Vehicle Type Adjustment Factors*

## Factors from MnESAL

### 24 Hour

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cars and Puckups | 1.14 | 1.06 | 1.04 | 0.99 | 0.94 | 0.87 | 0.87 | 0.83 | 0.92 | 0.96 | 0.99 | 1.02 |
| 2 Axle 6 Tire | 1.19 | 1.07 | 1.06 | 0.92 | 0.74 | 0.72 | 0.80 | 0.78 | 0.65 | 0.72 | 0.87 | 1.00 |
| 3+ Axle Single Unit | 1.09 | 1.05 | 1.29 | 1.15 | 0.72 | 0.60 | 0.70 | 0.65 | 0.61 | 0.63 | 0.84 | 1.06 |
| 3 Axle Semi (TST) | 1.18 | 1.13 | 1.31 | 0.94 | 0.66 | 0.68 | 0.75 | 0.73 | 0.72 | 0.86 | 0.93 | 1.27 |
| 4 Axle Semi (TST) | 1.04 | 1.00 | 1.09 | 0.94 | 0.71 | 0.66 | 0.71 | 0.63 | 0.76 | 0.75 | 0.85 | 1.03 |
| 5+ Axle Semi (TST) | 1.00 | 0.94 | 0.94 | 0.87 | 0.75 | 0.69 | 0.80 | 0.69 | 0.70 | 0.74 | 0.78 | 0.91 |
| Tr Tr, Buses | 1.19 | 1.07 | 1.06 | 0.92 | 0.74 | 0.72 | 0.80 | 0.78 | 0.65 | 0.72 | 0.87 | 1.00 |
| Twin Trailers | 1.00 | 0.94 | 0.94 | 0.87 | 0.75 | 0.69 | 0.80 | 0.69 | 0.70 | 0.74 | 0.78 | 0.91 |

## Factors from MnESAL

### 16 Hour

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cars and Pickups | 1.28 | 1.19 | 1.16 | 1.11 | 1.05 | 0.97 | 0.97 | 0.93 | 1.03 | 1.08 | 1.11 | 1.14 |
| 2 Axle 6 Tire | 1.26 | 1.13 | 1.12 | 0.98 | 0.78 | 0.76 | 0.85 | 0.83 | 0.69 | 0.76 | 0.92 | 1.06 |
| 3+ Axle Single Unit | 1.14 | 1.10 | 1.35 | 1.21 | 0.76 | 0.63 | 0.74 | 0.68 | 0.64 | 0.66 | 0.88 | 1.11 |
| 3 Axle Semi (TST) | 1.24 | 1.19 | 1.38 | 0.99 | 0.69 | 0.71 | 0.79 | 0.77 | 0.76 | 0.90 | 0.98 | 1.33 |
| 4 Axle Semi (TST) | 1.18 | 1.13 | 1.23 | 1.06 | 0.80 | 0.75 | 0.80 | 0.71 | 0.86 | 0.85 | 0.96 | 1.16 |
| 5+ Axle Semi (TST) | 1.19 | 1.12 | 1.12 | 1.04 | 0.89 | 0.82 | 0.95 | 0.82 | 0.83 | 0.88 | 0.93 | 1.08 |
| Tr Tr, Buses | 1.26 | 1.13 | 1.12 | 0.98 | 0.78 | 0.76 | 0.85 | 0.83 | 0.69 | 0.76 | 0.92 | 1.06 |
| Twin Trailers | 1.19 | 1.12 | 1.12 | 1.04 | 0.89 | 0.82 | 0.95 | 0.82 | 0.83 | 0.88 | 0.93 | 1.08 |

# Clarification of Fields - VCC Expansion Worksheet

Adjusted based on hours and month

AADT on the flow map for year of count

**16 HR. OR 24 HR. VEHICLE CLASS COUNT EXPANSION WORKSHEET**

**SITE NUMBER:** VCC 8090 **COUNTY:** BROWN

**SITE DESCRIPTIO** TJ14 AND TH68 1 MI EAST OF CSAH 12 - NEW ULM

**PROJECT SP#:** 0804-73 **YEAR OF COUNT ->:** 1996

**MONTH NUMBER OF COUNT:** 7 **CONSTRAIN AADT ->:** 4000

**16 or 24 HR** 16

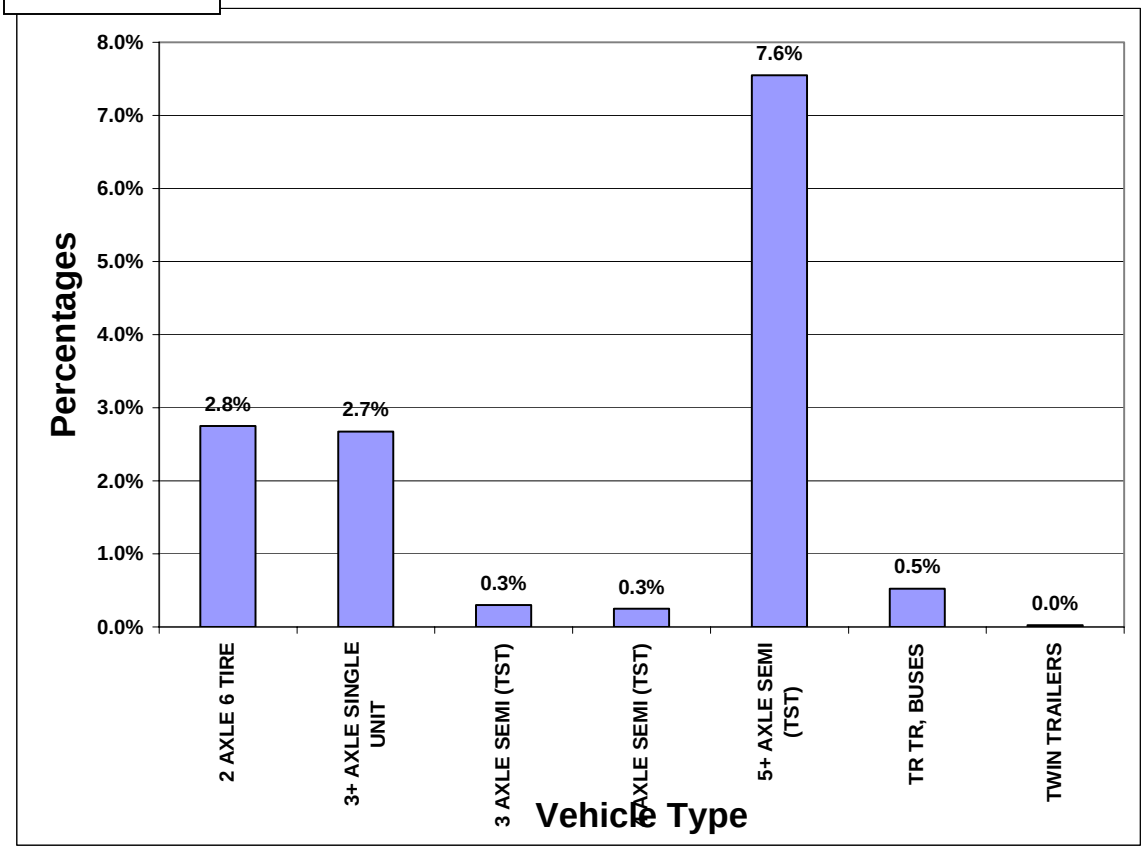
| VEHICLE TYPE | RAW COUNT | AADT ADJ FACTOR | ADJUSTED RAW | VEH. TYPE PERCENT | A.C.F. |
|---|---|---|---|---|---|
| CARS AND PICKUPS | 4375 | #N/A | 3437 | | 0.88 |
| 2 AXLE 6 TIRE | 130 | 0.85 | 110 | 2.8% | |
| 3+ AXLE SINGLE UNIT | 146 | 0.74 | 107 | 2.7% | |
| 3 AXLE SEMI (TST) | 15 | 0.79 | 12 | 0.3% | |
| 4 AXLE SEMI (TST) | 12 | 0.80 | 10 | 0.3% | |
| 5+ AXLE SEMI (TST) | 317 | 0.95 | 302 | 7.6% | |
| TR TR, BUSES | 25 | 0.85 | 21 | | |
| TWIN TRAILERS | 1 | 0.95 | 1 | | |
| TOTALS ----------> | 5021 | -------> | 4000 | | |

0.8

Raw counts adjusted to AADT or HCAADT

Normally within + or - 20% of AADT

Factors based on previous WIM studies



For clarification, there are four different formats for manual vehicle classification counts that go back to 1982. The following pages are examples of the four different formats. They are as follows:

1 Covers the years 2001 and 2002 (and the future) – These are in Microsoft Access

2 Covers the years 1993 to 2000 – These are in Paradox (and Access)

**3** Covers the years 1991 and 1992 – Not on a computer database

**4** Covers the years from 1982 to 1990 – Not on a computer database

## 2001 and 2002 Vehicle Class Count Example

**SITE: 1705** **ROUTE:** I-35 **DESCRIPTION** S OF JCT TH97 AT TRUCK WEIGHING LO **COUNTY:** ANOKA **DIST:** 9 **RECORDER:** TWP

| | | | | *Single Units* | | | | | *Semis* | | | | *Heavies* | | | | | | | *Trailers* | | *Twins* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Begin Hour | Date | Pass. Vehicle | 2ax | 2ax tank | 3ax plus | 3ax+ tank | 3ax | 3ax tank | 4ax | 4ax tank | 5ax dump | 5ax tank | 5ax grain | 5ax stlo | 5ax stun | 5ax other | 6ax+ | Bus | HTWT | HTWT Tank | T5ax+ | Total Vehicles |
| South | 6:00 | 8/16/01 | 0 | 14 | 0 | 15 | 0 | 0 | 0 | 1 | 0 | 0 | 5 | 2 | 8 | 4 | 18 | 14 | 2 | 6 | 0 | 0 | 89 |
| | 7:00 | 8/16/01 | 0 | 21 | 0 | 9 | 0 | 2 | 0 | 3 | 0 | 2 | 3 | 2 | 10 | 0 | 20 | 6 | 2 | 5 | 0 | 0 | 85 |
| | 8:00 | 8/16/01 | 0 | 24 | 1 | 16 | 2 | 3 | 0 | 1 | 0 | 3 | 9 | 3 | 11 | 2 | 29 | 9 | 0 | 4 | 0 | 2 | 119 |
| | 9:00 | 8/16/01 | 0 | 30 | 0 | 14 | 0 | 1 | 0 | 5 | 0 | 0 | 7 | 5 | 11 | 4 | 37 | 13 | 1 | 5 | 0 | 1 | 134 |
| | 10:00 | 8/16/01 | 0 | 31 | 0 | 14 | 0 | 1 | 0 | 6 | 0 | 3 | 3 | 5 | 7 | 4 | 47 | 13 | 6 | 6 | 1 | 0 | 147 |
| | 11:00 | 8/16/01 | 0 | 34 | 0 | 16 | 1 | 0 | 0 | 4 | 0 | 1 | 5 | 5 | 17 | 9 | 38 | 14 | 3 | 4 | 0 | 1 | 152 |
| | 12:00 | 8/16/01 | 0 | 31 | 0 | 12 | 1 | 3 | 0 | 2 | 0 | 0 | 11 | 3 | 14 | 10 | 38 | 14 | 4 | 4 | 0 | 1 | 148 |
| | 13:00 | 8/16/01 | 0 | 30 | 0 | 13 | 0 | 1 | 0 | 1 | 0 | 0 | 4 | 3 | 14 | 8 | 29 | 13 | 4 | 4 | 0 | 0 | 124 |
| | 14:00 | 8/20/01 | 0 | 33 | 2 | 12 | 0 | 1 | 0 | 3 | 0 | 4 | 3 | 1 | 14 | 7 | 38 | 21 | 0 | 3 | 0 | 0 | 142 |
| | 15:00 | 8/20/01 | 0 | 36 | 0 | 12 | 1 | 7 | 0 | 2 | 0 | 2 | 2 | 0 | 7 | 5 | 39 | 14 | 7 | 3 | 0 | 1 | 138 |
| | 16:00 | 8/20/01 | 0 | 30 | 0 | 7 | 0 | 0 | 0 | 5 | 0 | 4 | 6 | 2 | 10 | 4 | 19 | 17 | 0 | 5 | 1 | 0 | 110 |
| | 17:00 | 8/20/01 | 0 | 17 | 0 | 2 | 0 | 1 | 0 | 7 | 0 | 1 | 5 | 0 | 8 | 0 | 21 | 1 | 1 | 2 | 0 | 0 | 66 |
| | 18:00 | 8/20/01 | 0 | 11 | 0 | 5 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 3 | 3 | 2 | 27 | 3 | 2 | 0 | 0 | 1 | 62 |
| | 19:00 | 8/20/01 | 0 | 7 | 0 | 8 | 0 | 1 | 0 | 1 | 0 | 0 | 2 | 3 | 3 | 2 | 20 | 1 | 2 | 2 | 0 | 0 | 52 |
| | 20:00 | 8/20/01 | 0 | 8 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 7 | 0 | 8 | 0 | 28 | 0 | 0 | 0 | 0 | 1 | 54 |
| | 21:00 | 8/20/01 | 0 | 8 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 3 | 4 | 16 | 0 | 0 | 0 | 0 | 1 | 41 |
| | *Directional Totals:* | | 0 | 365 | 3 | 160 | 5 | 22 | 0 | 44 | 0 | 20 | 79 | 37 | 148 | 65 | 464 | 153 | 34 | 53 | 2 | 9 | 1663 |
| | *Site Totals:* | | 0 | 716 | 6 | 332 | 8 | 50 | 0 | 96 | 1 | 80 | 170 | 90 | 253 | 173 | 907 | 301 | 70 | 108 | 3 | 11 | 3375 |

| *16 Hour Totals for Calculating ESALS by Month:* | *Pass. Vehicles* | *2 Axle SU* | *3+ Axle SU* | *3 Axle Semi* | *4 Axle Semi* | *5+ Axle Semi* | *Trk Trl/Bus* | *Twins* | *Directional Split* |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 722 | 340 | 50 | 97 | 1974 | 181 | 11 | 1.45% |

If stakes are included in the heavy mix, then we calculate as follows: 766/1974 = 38.8%. Adding the tanks, dumps, stakes, and grain equals 766 divided by the total 5 ax and 6 ax+ semis. Including stakes makes this a heavy truck route and splits the semis into 'Maximum" and "Other" on your MnESAL spreadsheet (see Timber Map, Fig 12). Not including stake trucks means that the route is not split – 341/1974 equals 17.3%. This does not reach the default 30% split that determines to split the heavies on the MnESAL.

## 1993 to 2000 Vehicle Class Count Example

2/24/98 1997 BODY TYPE REPORT BASED ON PRELIMINARILY ADJUSTED VEHICLE CLASSIFICATION COUNT FOR LOCATION 8724 PAGE 2

Route: TH 41 — Description: S OF JCT TH5 — County: CARVER

| | | | | ++++ Single Units ++++ | | | | | | | | ++++++Heavies+++++ | | | | | | | ++ Truck ++ | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | Trailers | | Twins |
| Direction | Beghour | Date | Passenger Vehicles | 2ax | 2ax tank | 3ax+ | 3ax+ tank | 3ax | 3ax tank | 4ax | 4ax tank | 5ax dump | 5ax tank | 5ax grain | 5ax stlo | 5ax stun | 5ax other | 6ax+ | Bus | HTWT | HTWT tank | 5ax+ |
| South | 600 | 8/04/93 | 605 | 9 | 1 | 8 | | 2 | | | | | | | | | 2 | 7 | 1 | 2 | | |
| South | 700 | 8/04/93 | 878 | 12 | 1 | 19 | | 1 | | | | 5 | | 4 | | | 4 | 21 | | 1 | | |
| South | 800 | 8/04/93 | 411 | 26 | | 23 | 1 | | | 1 | | 4 | | 3 | 1 | | 2 | 8 | 3 | 4 | | |
| South | 900 | 8/04/93 | 233 | 12 | | 12 | | 1 | | | | 4 | 1 | | 1 | 2 | 6 | 5 | | 1 | | |
| South | 1000 | 8/04/93 | 325 | 12 | | 20 | | 2 | | 1 | | 3 | 1 | | 2 | | 5 | 6 | 3 | 4 | | |
| South | 1100 | 8/04/93 | 404 | 17 | 1 | 29 | | | | 2 | | 5 | | 4 | 2 | | 4 | | 3 | 4 | | |
| South | 1200 | 8/04/93 | 416 | 25 | | 15 | | | | 7 | | 5 | 4 | 4 | 3 | | 3 | 3 | | 4 | | |
| South | 1300 | 8/04/93 | 431 | 18 | 1 | 24 | | 4 | | 3 | | 10 | 1 | 3 | 1 | | 31 | 5 | 2 | 7 | | |
| South | 1400 | 8/02/93 | 384 | 15 | 1 | 21 | | 2 | | 2 | | 3 | | | 1 | 1 | 2 | 4 | | 3 | | |
| South | 1500 | 8/02/93 | 535 | 12 | | 24 | | 3 | | 2 | | 3 | | | | 1 | 7 | 3 | | 3 | | |
| South | 1600 | 8/02/93 | 707 | 11 | 1 | 21 | | 4 | | 2 | | 5 | 1 | | 2 | | 2 | 6 | | 5 | | |
| South | 1700 | 8/02/93 | 668 | 7 | 1 | 11 | | 3 | | 1 | | 5 | 3 | 1 | 1 | | 2 | 8 | 4 | 4 | | |
| South | 1800 | 8/02/93 | 383 | 4 | 1 | 2 | | 1 | | | | 1 | 1 | | | | 1 | 3 | 3 | 4 | | |
| South | 1900 | 8/02/93 | 315 | 4 | | 2 | | 1 | | | | | | 1 | | | 2 | 1 | | 5 | | |
| South | 2000 | 8/02/93 | 275 | 1 | | | | | | | | | 1 | | | | 1 | 1 | | | | |
| South | 2100 | 8/02/93 | 260 | | | | | 1 | | | | | 1 | | | | 1 | | | | | |
| DIRECTIONAL TOTALS | | | 7230 | 185 | 8 | 231 | 1 | 25 | 0 | 21 | 0 | 53 | 14 | 20 | 14 | 4 | 75 | 81 | 19 | 51 | 0 | 0 |
| LOCATION TOTALS | | | 14455 | 381 | 10 | 473 | 4 | 48 | 0 | 54 | 0 | 59 | 35 | 34 | 45 | 6 | 118 | 130 | 38 | 98 | 0 | 2 |

| 16 HOUR TOTALS FOR | CARS | 2 AXLE SU | 3+ AXLE SU | 3 AXLE SEMI | 4 AXLE SEMI | 5+ AXLE SEMI | TRK TRL/BUS | TWINS |
|---|---|---|---|---|---|---|---|---|
| CALCULATING ESALS BY MONTH | 14455 | 391 | 477 | 48 | 54 | 427 | 136 | 2 |

= split heavies

128/427 = 30.0%

In the above example, we calculate the number of dumps, tanks, and grain and divide by the total number of 5 ax and 6+ ax semis. Take 128 / 427 = 30%. In this case, we split our heavies, which is done automatically after entering 30% on the New Avg Vehicle Class Count sheet in the MnESAL spreadsheet.

**1991 to 1992 Vehicle Class Count Example – Sheet 1**

HOURLY COUNTS BY VEHICLE TYPE

STUDY_____9 LOCATION #____018
DIRECTION___9-COMBINED HOURS_____06-13
CYCLE_____1-SUMMER DAY OF WEEK___2-WEEKDAY

| HR | TOT VEH | TOT TRKS | CARS PNLS PKPS | SINGLE UNIT TRUCKS 2AX | 3AX | 4+AX | BUS | SEMIS 3AX | 4AX | 5AX | 6+AX | TRUCK TRAILERS 4AX | 5AX | 6+AX | TW.TR. 5AX | 6AX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06 | 57 | 12 | 45 | 3 | 1 | 0 | 1 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 07 | 85 | 22 | 63 | 2 | 1 | 2 | 0 | 0 | 0 | 15 | 0 | 2 | 0 | 0 | 0 | 0 |
| 08 | 106 | 22 | 84 | 2 | 5 | 2 | 2 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 |
| 09 | 109 | 24 | 85 | 4 | 0 | 0 | 0 | 0 | 0 | 19 | 0 | 1 | 0 | 0 | 0 | 0 |
| 10 | 144 | 26 | 118 | 8 | 1 | 0 | 0 | 0 | 0 | 16 | 0 | 1 | 0 | 0 | 0 | 0 |
| 11 | 113 | 27 | 86 | 10 | 1 | 0 | 0 | 0 | 1 | 15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 129 | 24 | 105 | 1 | 1 | 0 | 0 | 0 | 0 | 21 | 0 | 0 | 1 | 0 | 0 | 0 |
| 13 | 180 | 35 | 145 | 5 | 2 | 2 | 0 | 2 | 1 | 21 | 1 | 1 | 0 | 0 | 0 | 0 |
| | 923 | 192 | 731 | 35 | 12 | 6 | 3 | 2 | 2 | 125 | 1 | 5 | 1 | 0 | 0 | 0 |

DATE(S):HOUR___08/06/92: 06-13

VEHICLE AND BODY TYPE

STUDY_____9 LOCATION #_____018
DIRECTION___9-COMBINED DATE(S) & HOURS__08/06/92: 06-13
CYCLE_____1-SUMMER
HOURS_____06-13
DAY OF WEEK_2-WEEKDAY

BODY TYPE

| VEHICLE TYPE | TANK | STAKE | REFR | VAN | DUMP | PANEL | GRAIN | CATTLE | OTHER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-AXLE TRUCK | 0 | 15 | 1 | 7 | 3 | 4 | 5 | 0 | | 35 |
| 3-AXLE TRUCK | 0 | 3 | 0 | 1 | 5 | | 3 | 0 | | 12 |
| 4-AXLE TRUCK | 0 | | | | 5 | | | | 1 | 6 |
| 3-AXLE SEMI | | 1 | | 1 | | | | | 0 | 2 |
| 4-AXLE SEMI | 0 | 1 | 0 | 1 | | | | 0 | 0 | 2 |
| 5-AXLE SEMI | 0 | 8 | 4 | 13 | 1 | | 98 | 1 | | 125 |
| 6-AXLE SEMI | | | | | | | | | 1 | 1 |
| 4-AXLE HTWT | | | | | | | | | 5 | 5 |
| 5-AXLE HTWT | | | | | | | | | 1 | 1 |
| 6-AXLE HTWT | | | | | | | | | 0 | 0 |
| 5-AXLE TW.TR. | 0 | | | 0 | | | 0 | | 0 | 0 |
| 6-AXLE TW.TR. | | | | | | | | | 0 | 0 |
| TOTAL | 0 | 28 | 5 | 23 | 14 | 4 | 106 | 1 | 8 | 189 |

The above is sheet one of two – an example of a 16-hour count. Note that this is 8 hours only. We need to add the heavy total on this sheet to the total on the next sheet.

**1991 to 1992 Vehicle Class Count Example – Sheet 2**

HOURLY COUNTS BY VEHICLE TYPE

STUDY_____9 LOCATION #____018
DIRECTION___9-COMBINED HOURS_____14-21
CYCLE_____1-SUMMER DAY OF WEEK___2-WEEKDAY

| | | | CARS | SINGLE UNIT TRUCKS | | | | SEMIS | | | | TRUCK TRAILERS | | | TW.TR. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HR | TOT VEH | TOT TRKS | PNLS PKPS | 2AX | 3AX | 4+AX | BUS | 3AX | 4AX | 5AX | 6+AX | 4AX | 5AX | 6+AX | 5AX | 6AX |
| 14 | 136 | 18 | 118 | 2 | 1 | 1 | 0 | 0 | 0 | 13 | 0 | 1 | 0 | 0 | 0 | 0 |
| 15 | 160 | 18 | 142 | 3 | 2 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 159 | 18 | 141 | 5 | 0 | 0 | 0 | 2 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 138 | 6 | 132 | 2 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 114 | 6 | 108 | 0 | 2 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | 89 | 6 | 83 | 1 | 2 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 61 | 3 | 58 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | 52 | 3 | 49 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 |
| | 909 | 78 | 831 | 13 | 8 | 2 | 0 | 3 | 0 | 50 | 0 | 2 | 0 | 0 | 0 | 0 |

DATE(S):HOUR___08/05/92: 14-21

VEHICLE AND BODY TYPE

STUDY_____9 LOCATION #_____018
DIRECTION___9-COMBINED DATE(S) & HOURS__08/05/92: 14-21
CYCLE_____1-SUMMER
HOURS_____14-21
DAY OF WEEK_2-WEEKDAY

BODY TYPE

| VEHICLE TYPE | TANK | STAKE | REFR | VAN | DUMP | PANEL | GRAIN | CATTLE | OTHER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 2-AXLE TRUCK | 0 | 5 | 0 | 4 | 0 | 3 | 1 | 0 | | 13 |
| 3-AXLE TRUCK | 0 | 0 | 0 | 0 | 3 | | 5 | 0 | | 8 |
| 4-AXLE TRUCK | 0 | | | | 1 | | | | 1 | 2 |
| 3-AXLE SEMI | | 1 | | 0 | | | | | 2 | 3 |
| 4-AXLE SEMI | 0 | 0 | 0 | 0 | | | | 0 | 0 | 0 |
| 5-AXLE SEMI | (3) | 5 | 2 | 12 | (0) | | (27) | 1 | | 50 |
| 6-AXLE SEMI | | | | | | | | | 0 | 0 |
| 4-AXLE HTWT | | | | | | | | | 2 | 2 |
| 5-AXLE HTWT | | | | | | | | | 0 | 0 |
| 6-AXLE HTWT | | | | | | | | | 0 | 0 |
| 5-AXLE TW.TR. | 0 | | | 0 | | | 0 | | 0 | 0 |
| 6-AXLE TW.TR. | | | | | | | | | 0 | 0 |
| TOTAL | 3 | 11 | 2 | 16 | 4 | 3 | 33 | 1 | 5 | 78 |

This is the second 8 hours from the same vehicle class site. Adding the tank, dump, and grain on both sheets, we get 129 trucks. Divide by the total number of 5+ axle semi

trucks (all 5 and 6 or more axle semis). The resultant percent is 73.3%. In this example, we split the heavies, and the number is transferred to the MnESAL.

## 1982 to 1990 Vehicle Class Count Example

DATE: 1990. VEHICLE AND BODY TYPE BASED ON RAW DATA FOR

STUDY 7 LOCATION 31 TH 14 E OF SOUTH DAK BORDER 8 LINCOLN

1 DIRECTION(S) 1 CYCLE(S)

16 HOUR WEEKDAY COUNTS

BODY TYPE

| VEHICLE TYPE | | TANK | STAKE | REFRIG | VAN | DUMP | P/P | GRAIN | CATTLE | OTHER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CARS,PANELS + PICKUPS | | | | | | | | | | | |
| | VOLUME | | | | | | | | | | 588 |
| | PERCENT | | | | | | | | | | |
| 2 AXLE-6 TIRE TRUCKS | | | | | | | | | | | |
| | VOLUME | 1 | 9 | 1 | 8 | 0 | 1 | 7 | 0 | | 27 |
| | PERCENT | 3.7 | 33.3 | 3.7 | 29.6 | 0.0 | 3.7 | 25.9 | 0.0 | | |
| 3 AXLE TRUCKS | | | | | | | | | | | |
| | VOLUME | 5 | 1 | 0 | 0 | 0 | | 2 | 0 | | 8 |
| | PERCENT | 62.5 | 12.5 | 0.0 | 0.0 | 0.0 | | 25.0 | 0.0 | | |
| 4+ AXLE TRUCKS | | | | | | | | | | | |
| | VOLUME | 0 | | | | 0 | | | | 0 | 0 |
| | PERCENT | 0.0 | | | | 0.0 | | | | 0.0 | |
| BUSES | | | | | | | | | | | |
| | VOLUME | | | | | | | 3* | 4* | 0 | 7 |
| | PERCENT | | | | | | | 42.9 | 57.1 | 0.0 | |
| 3 AXLE TRACTOR-SEMI TRLR | | | | | | | | | | | |
| | VOLUME | | 0 | | 3 | | | | | 0 | 3 |
| | PERCENT | | 0.0 | | 100.0 | | | | | 0.0 | |
| 4 AXLE TRACTOR-SEMI TRLR | | | | | | | | | | | |
| | VOLUME | 0 | 0 | 0 | 0 | | | | 0 | 0 | 0 |
| | PERCENT | 0.0 | 0.0 | 0.0 | 0.0 | | | | 0.0 | 0.0 | |
| 5 AXLE TRACTOR-SEMI TRLR | | | | | | | | | | | |
| | VOLUME | (1) | 6 | 11 | 18 | (5) | | (10) | 4 | | 55 |
| | PERCENT | 1.8 | 10.9 | 20.0 | 32.7 | 9.1 | | 18.2 | 7.3 | | |
| 6+ AXL TRACTOR-SEMI TRLR | | | | | | | | | | | |
| | VOLUME | | | | | | | | | | 2 |
| | PERCENT | | | | | | | | | | |
| 4 AXLE TRUCK TRAILER | | | | | | | | | | | |
| | VOLUME | | | | | | | | | | 1 |
| | PERCENT | | | | | | | | | | |
| 5 AXLE TRUCK TRAILER | | | | | | | | | | | |
| | VOLUME | | | | | | | | | | 1 |
| | PERCENT | | | | | | | | | | |
| 6+ AXLE TRUCK TRAILER | | | | | | | | | | | |
| | VOLUME | | | | | | | | | | 0 |
| | PERCENT | | | | | | | | | | |
| 5 AXLE TWIN TRAILER | | | | | | | | | | | |
| | VOLUME | 4 | | | 0 | | | 0 | | 0 | 4 |
| | PERCENT | 100.0 | | | 0.0 | | | 0.0 | | 0.0 | |
| 6+ AXLE TWIN TRAILER | | | | | | | | | | | |
| | VOLUME | | | | | | | | | | 0 |
| | PERCENT | | | | | | | | | | |

DO NOT SPLIT < 307-

NOTE - BLANKS INDICATE THAT DATA WAS NOT COLLECTED FOR THIS CATEGORY
*BUS BODY TYPES ARE COMMERCIAL + SCHOOL FOR GRAIN + CATTLE RESPECTIVELY

In the above example (not on a timber route), simply add the tanks, dumps, and grain trucks (16) and divide by the total 5ax and 6 ax semis (57). The calculations show 47.3%, which is automatically transferred to the MnESAL spreadsheet.

***Axle Correction Factor***

The last concept discussed on the vehicle class expansion worksheet will be the axle correction factor (ACF). This term, discussed briefly in the Data Sources section of this manual, is represented by the number 0.92 on the expansion worksheet *(example 10)*. The axle correction factor adjusts older tube counts to correct AADT to account for trucks. The changes have been accounted for in a kind of "reverse" method in the MnESAL spreadsheet. In 2006, the concept will disappear from the "Least Squares "portion of the MnESAL (to be discussed later). The following chart should help or clarify this concept.

*Figure 3 – ACF*

# *Axle Correction Factor*

*(Adjusts older tube counts to correct AADT to account for trucks)*

## Example of total vehicles in 24 hour period

| | Tot Veh | x | Num Axles | Tot Axles |
|---|---|---|---|---|
| Cars | 1000 | x | 2 | 2000 |
| 2 axle su | 100 | x | 2 | 200 |
| 3+ axle su | 50 | x | 3 | 150 |
| 3axle semi | 25 | x | 3 | 75 |
| 4axle semi | 25 | x | 4 | 100 |
| 5+ axle semi | 300 | x | 5 | 1500 |
| TT/Bus | 50 | x | 4 | 200 |
| Twins | 50 | x | 5 | 250 |
| | 1600 | | | |

19XX-1984 Single Tube ↓

Old inaccurate method prior to 1986 (an assumed 2 axles per/veh would yield) ↓

4475 / 2 = 2238 instead of the 1600 vehicles which were actually there

To correct for this, one needs to apply an axle correction factor. In this case, the ACF is determined by dividing 1600/2238, which = .71. Thus, 2238 x .71 = 1600 vehicles

***12. Vehicle Class Count Averages Worksheet***

The next tab to the right of the four expansion worksheets is the Vehicle Class Count Averages Worksheet, called "New Avg Vehicle C.C." (example 11) . This is probably the SINGLE MOST IMPORTANT WORKSHEET in working through the MnESAL program.

# *Example 11 - Vehicle Class Count Averages Worksheet*

Vehicle Class Count Averages Worksheet

VCC Site Num. 7088
TH TH52
Description West of E JCt ht TH16 (VC 7088)

| | | 16-24 Vehicle C.C.1 | | 16-24 Vehicle C.C.2 | | 16-24 Vehicle C.C.3 | | 16-24 Vehicle C.C.4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Type | Year | Pct | Year | Pct | Year | Pct | Year | Pct | Avg Truck Volumes | Avg Vehicle Pctages |
| | | 2001 | | 1995 | | 1990 | | 0 | | | |
| | Man/Tube | tube | | tube | | tube | | | | | |
| 1 | Cars | 3983 | *88.51%* | 3118 | *91.04%* | 2728 | *90.93%* | | | | *90.16%* |
| 2 | 2 ASU | 181 | *4.02%* | 63 | *1.84%* | 85 | *2.83%* | | | *110* | *2.90%* |
| 3 | 3+ASU | 46 | *1.02%* | 34 | *0.99%* | 19 | *0.63%* | | | *33* | *0.88%* |
| 4 | 3ASemi | 14 | *0.31%* | 14 | *0.41%* | 4 | *0.13%* | | | *11* | *0.28%* |
| 5 | 4ASemi | 23 | *0.51%* | 27 | *0.79%* | 4 | *0.13%* | | | *18* | *0.48%* |
| 6 | 5+Asemi | 218 | *4.84%* | 147 | *4.29%* | 143 | *4.77%* | | | *169* | *4.63%* |
| 7 | TT/BUS | 33 | *0.73%* | 20 | *0.58%* | 17 | *0.57%* | | | *23* | *0.63%* |
| 8 | Twins | 2 | *0.04%* | 2 | *0.06%* | 0 | *0.00%* | | | *1* | *0.03%* |
| Total | | *4500* | *11.49%* | *3425* | *8.96%* | *3000* | *9.07%* | | | | *9.84%* |
| Total Heavy Comm | | *517* | | *307* | | *272* | | | | *365* | *100.00%* |
| Heavy 5 Ax Semi* | | | | | 27.1% | | | | | | 27.10% |
| Axle Corr Factor | | | 0.92 | | 0.92 | | 0.92 | | | | 0.92 |

* Heavy 5 Ax Semi = Tank, Dump, Grain (and Stake if on Timber route-Dist 1,2, or 3)
When the Tank, Dumps, & Grains and sometimes stakes are 30% or more of the 5 axle semis, then split into max and other categories (AUTOMATICALLY DONE) ---------->
Check out tube counts prior to 1996 carefully, body types are N/A prior to 1982, don't use tube collected previous to 1990.

| Heavy 5 Axle Semi Split | |
|---|---|
| *1.26%* | Max |
| *3.38%* | Others |
| ***DON'T SPLIT*** | |

NOTE: IF LESS THAN 4 ENTRIES, BE SURE
TO DELETE YEAR AND PCT COLUMN
DO NOT USE 0, LEAVE BLANK.
USER MUST THEN COPY THE FORMULA IN THE
PCT COLUMNS BACK TO THE APPROPRIATE COLUMN
FOR HELP CALL MARK LEVENSON - 651 -296-8535 OR TOM NELSON - 651-297-1197.

The adjusted raw data from *example 10* for 2001 is automatically transferred to column one and 1995 to column 3, and 1990 to column 5 (*example 11*). There is some rounding in the MnESAL process; however, the actual numbers carry out to the proper decimal place. In this example, we have three cycles of data. The "averages worksheet" allows for expansion of four cycles of vehicle class data - the maximum number of vehicle class counts for one vehicle class site that the forecaster should need. Simply tab to the right to allow up to four vehicle class count expansions. Three cycles of vehicle class count 7088 are shown above, 2001, 1990 and 1995.

***Determination of Heavy Vehicle Split Information for "Heavy" 5-axle semis***

Earlier in the Forecasting Manual, we have discussed the "splitting" of the 5+ axle semis into heavy / other trucks. The rule of thumb is that we add up the tank, dump, grain, and stakes (if on a timber route – usually in Districts 1,2, and 3) and divide by the total number of 5 and 6-axle semis. If the mix of heavies is 30% or more, it is automatically split on the MnESAL and carried through to the Averages Worksheet and the A segment worksheet.

As previously discussed, when expanding older counts – from 1980 to 1989 - the procedure is slightly different. The forecaster has previously been expanding raw 16 and 24 hour counts to AADT and HCAADT. Older counts have already been expanded to HCAADT. All that is required is to enter them onto one of the four "vehicle class count expansion worksheets" in a slightly different method. This process will still transfer counts directly to the "vehicle class count averages worksheet". Remember to enter historic vehicle class information from the newest to the oldest in a left to right manner, with the oldest counts to the right. In this case, enter all the data as before but leave the MONTH NUMBER OF COUNT BLANK. Also, unprotect the worksheet and enter a "1.00" in each cell of the AADT ADJ FACTOR column. *Example 12* shows this procedure (Note: this is not part of the sample forecast).

## *Example 12 - Entering Expanded vehicle class information on the Vehicle Class Count Expansion Averages Worksheet*

**SITE NUMBER:** 2131 **COUNTY:** ISANTI/KANABEC
**SITE DESCRIPTION:** N OF ISANTI / KANABEC COUNTY LINE
**PROJECT SP#:** 3002-09/10 3303-43 **YEAR OF COUNT ->:** 1990
**MONTH NUMBER OF COUNT:** **CONSTRAIN AADT ->:** 1000
**16 or 24 HR** 24

| VEHICLE TYPE | RAW COUNT | AADT ADJ FACTOR | | ADJUSTED RAW | VEH. TYPE PERCENTS | A.C.F. |
|---|---|---|---|---|---|---|
| CARS AND PICKUPS | 829 | 1.00 | | 829 | | 0.87 |
| 2 AXLE 6 TIRE | 53 | 1.00 | | 53 | 5.3% | |
| 3+ AXLE SINGLE UNIT | 14 | 1.00 | | 14 | 1.4% | |
| 3 AXLE SEMI (TST) | 4 | 1.00 | | 4 | 0.4% | |
| 4 AXLE SEMI (TST) | 7 | 1.00 | | 7 | 0.7% | |
| 5+ AXLE SEMI (TST) | 72 | 1.00 | | 72 | 7.2% | |
| TR TR, BUSES | 21 | 1.00 | | 21 | 2.1% | |
| TWIN TRAILERS | 0 | 1.00 | | 0 | 0.0% | |
| TOTALS ----------> | 1000 | --------> | 1.0 | 1000 | 17.1% | (%HC) |

On the example above (for previously expanded counts) always enter 24 in the 16 or 24 hour column. This is because the older counts are already factored up to AADT; this is reflected in the total column where the total raw count and adjusted raw and constrained AADT is 1000. The forecaster is not expanding anything here, simply transferring another historical vehicle count to the averages worksheet in the easiest possible manner.

If the traffic forecasting project requires the use of more than one vehicle class averages worksheet (which means more than one vehicle class site will be used to complete the traffic forecast) there is a different set of requirements in the use of the MnESAL in the traffic forecasting procedure. Our sample forecast will **include only the use of one vehicle class site**; however, there will be instances during the forecasting process where more than one "vehicle class count averages worksheet" will be needed to complete the forecast. This will be discussed later. In this case, manual manipulation of this sheet is allowed for. Suffice it to say here that THE FORECASTER SHOULD PRINT OUT EVERY PAGE OF THE MNESAL DURING THE COURSE OF THE FORECAST. This is because not every MnESAL page can be saved. It is ESSENTIAL TO HAVE A HARD COPY OF EVERY PAGE FOR DOCUMENTATION PURPOSES.

The more familiar the forecaster is with Excel, the easier it will be to "manipulate" the vehicle class averages worksheet. For example, you may "save" the work at any time or print a page and "not save" the work so you can recall the spreadsheet in a previous format. Or, you can print out a page, then do several "undos" to recall previous worksheets. Or, if desired (which may be easier for some forecasters), you may want to save another Excel file to account for another vehicle class site).

*In any case, feel free to call the Traffic Forecasting Section at any time during any or all portions of the forecasting process. Personnel from the Traffic Forecast Section will be available to answer questions and help you work through any task. For additional information on the use of the MnESAL, refer to the documentation section of the MnESAL on the last tab to the right in your spreadsheet.*

Whether the forecaster uses one, two, three, or four historical vehicle class counts, all of the vehicle class data and percentages are transferred automatically from the individual expansion worksheets. There is one exception. The forecaster must manually add the percentages of heavies calculated on the raw data i.e. THE SPLIT OF TANK, DUMP, GRAIN, AND SOMETIMES STAKES--- AND MANUALLY PLACE THEM ON THE ROWS THAT SAY "HEAVY 5+ AX SEMI" at the second from the bottom row of the "vehicle class count averages worksheet" (see bottom of *example 11).*

As per our previous discussions, the split only occurs for a manual count. Directly enter the percentage the tank, dump, grain, sometimes stake is of total 5+ axle semis as per *example 11* (27.1%). In the case of a tube count, leave the space blank, rather than entering a zero. A zero will be used in the averaging of all the locations, which the forecaster does not want to do.

The axle correction factor on the last row of the spreadsheet will automatically transfer from the expansion worksheet to the Least Squares worksheet (examples 13 & 14). There should be a number and a percent for every vehicle class count used in order for the "averages worksheet" to properly function.

Any "#" signs to the right of data will cause the averages columns to not work. Simply erase or delete any entries where the "#" shows up. Formulas can be "put back in

appropriate columns" by copying the formulas in the "Pct" categories from one to another. This spreadsheet is flexible and allows for a lot of manual manipulation if need be. The important column to use, the one which will eventually be transferred onward will be the very last column on the right, the "Avg Vehicle Pctages."
The forecaster may have anywhere from one to four years of data on the vehicle class count averages worksheet, depending on the number of years the vehicle class site was counted. For example, if the count was a special count, there may be only one count (one year of data). There may also be a "bad" count, which may have to be discarded, or there may be four years of good historical data. In any case, the forecaster will have to determine how much of the historical class count information to use in the actual ESAL forecast. To determine "good data", it is necessary to look at all of the numbers and percents of vehicle class types for consistency. If the percents look fairly consistent during all years, and the raw numbers are similar or show a consistent trend, the forecaster may use all of the information on the averages worksheet.

For instance, continuing on our sample forecast, a cursory analysis of *example 11* reveals data for 2001, 1990 and 1995. This first thing we notice is a consistent AADT growth and similar HCAADT percentages –11.49 in 2001, 8.96% in 1995 and 9.07% in 1990. Pay particular attention to the percentage of 5 axle semis, since they have the most significant effect on ESAL forecasting. In this case the percents are similar even though the raw numbers are different. In this example the forecaster will average all vehicle class data and use the percents in the averages column for heavy commercial percents. The forecaster also may choose to drop the 1995 and 1990 and go with the more recent data.

There may be instances that there have been improvements in the road or a bypass has been constructed that changes the traffic pattern. In that case, the forecaster will have to determine what year or group of years to use. A field visit may be necessary if the forecaster suspects that the most recent data at the vehicle class site reflects current conditions.

In other words, at this point, the forecaster will have to decide what historic vehicle class data to use. The purpose of using as many years as possible is that the vehicle class count is a snapshot in time – only 16 hours or 48 hours of the whole year. Since it is not known for sure whether the information is correct, the more information collected the better. If historic data shows a consistent trend or pattern, the forecaster has more "faith" that the count represents real traffic patterns. The forecaster should visit the site and observe what is going on if there is any doubt or discrepancy in the historical vehicle class data.

**When analyzing two or more cycles of vehicle class counts (count cycles at the same vehicle class site over a period up to 20 years), most often the forecaster will average all years together and use the average calculated on the Vehicle Class Count Averages Worksheet. Those average heavy commercial percentages are then transferred to the A segment worksheet for distribution based on current and future AADT** .

In most cases, the forecaster will use the average of historical vehicle class data; however, when the raw numbers and percent distributions "aren't consistent", the forecaster will use judgment as to which counts to use and which to eliminate. Usually, as AADT increases, the vehicle percentages will remain similar, although the "actual" numbers of heavy commercial vehicles may increase. The following example shows some alternative scenarios the forecaster may use when analyzing the Vehicle Class Averages Worksheet.

## Vehicle Class Count Averages Worksheet

VCC Site Num. 8784
TH TH55
Site Description SE of TH101

| | | 16-24 Vehicle C.C.1 | | 16-24 Vehicle C.C.2 | | 16-24 Vehicle C.C.3 | | 16-24 Vehicle C.C.4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Type** | **Year** | **Pct** | **Year** | **Pct** | **Year** | **Pct** | **Year** | **Pct** | **Avg Truck Volumes** | **Avg Vehicle Pctages** |
| | | 1998 Tube | | 1991 Manual | | 1986 Tube | | | | | |
| 1 | **Cars** | 23758 | *95.03%* | 18812 | *96.47%* | 15655 | *94.94%* | | | | *95.48%* |
| 2 | **2 ASU** | 407 | *1.63%* | 389 | *1.99%* | 445 | *2.70%* | | | *414* | *2.11%* |
| 3 | **3+ASU** | 137 | *0.55%* | 44 | *0.23%* | 177 | *1.07%* | | | *119* | *0.62%* |
| 4 | **3ASemi** | 53 | *0.21%* | 22 | *0.11%* | 20 | *0.12%* | | | *32* | *0.15%* |
| 5 | **4ASemi** | 103 | *0.41%* | 33 | *0.17%* | 34 | *0.21%* | | | *57* | *0.26%* |
| 6 | **5+Asemi** | 322 | *1.29%* | 192 | *0.98%* | 143 | *0.87%* | | | *219* | *1.05%* |
| 7 | **TT/BUS** | 163 | *0.65%* | 8 | *0.04%* | 16 | *0.10%* | | | *62* | *0.26%* |
| 8 | **Twins** | 57 | *0.23%* | 0 | *0.00%* | 0 | *0.00%* | | | *19* | *0.08%* |
| Total | | *25000* | *4.97%* | *19500* | *3.53%* | *16490* | *5.06%* | | | | *4.52%* |
| Total Heavy Comm | | *1242* | | *688* | | *835* | | | | *922* | *100.00%* |
| Heavy 5 Ax Semi* | | | | | 26.9% | | 25.3% | | | | 26.10% |
| Axle Corr Factor | | | 0.96 | | 0.98 | | 0.98 | | | | 0.97 |

* Heavy 5 Ax Semi = Tank, Dump, Grain (and Stake if on Timber route-Dist 1,2, or 3)
When the Tank, Dumps, & Grains and sometimes stakes are 30% or more of the 5 axle semis, then split into max and other categories (AUTOMATICALLY DONE) ---------->
Check out tube counts prior to 1996 carefully; body types are N/A prior to 1982

| Heavy 5 Axle Semi Split | |
|---|---|
| *0.27%* | Max |
| *0.77%* | Others |
| ***DON'T SPLIT*** | |

NOTE: IF LESS THAN 4 ENTRIES, BE SURE
TO DELETE YEAR AND PCT COLUMN
DO NOT USE 0, LEAVE BLANK.
USER MUST THEN COPY THE FORMULA IN THE
PCT COLUMNS BACK TO THE APPROPRIATE COLUMN
FOR HELP CALL MARK LEVENSON - 651 -296-8535 OR TOM NELSON - 651-297-1197.

In the above example, the forecaster has several options:

1. Average all 3 years
2. Drop the 1991 and 1986
3. Drop the 1986
4. Drop the 1998
5. Take a current count of heavy trucks at the site to determine which counts are more valid; in this example, the forecaster may count trucks for an hour or two and compare the same hours on the most recent vehicle class count. This will not

only give you heavy split information, but it will give you an idea of which year(s) vehicle class counts are more reflective of current conditions.

In the above example, first notice the total heavy commercial percentages are fairly close. If that was the only criteria used, the forecaster may average all 3 years worth of data, producing about a 4.5% heavy commercial percent. Since AADT is decreasing the further back you go (logical trend), the total heavy commercial percent seems logical.

On close examination, the individual vehicle type numbers and percents vary. Notice the most important vehicle type – the five axle semis and notice the disparity in numbers and percent. Often, the percent will remain stable as the numbers will change; that is ok, since what we really are concerned with is the average vehicle percent, which we are applying to the base year and forecast year AADT.

But, the forecaster sees some "funny" numbers in the 3+ axle category (137 for 1998 and 44 for 1991), the 4 axle semi category (103 in 1998 and quite a bit less in 1991 and 1986), the 5+ axle semi category (322 in 1998 and 192 in 1991), and the TT/Bus and Twins (which show much higher numbers in 1998 than previous years).

Thus, averaging all three years worth of data might not be quite right for the individual classes. Note 1998 is a tube count and the 1991 is a manual count (10 years old).

WHAT IS GOING ON? Is the gap between 1998 and 1991 too far? Does the 1998 reflect what is currently going on? Is the 1998 count overestimated?

SOLUTION: Take a one hour count at the VC site to determine the number of 5 axles(you could also do a class count of other heavy vehicles, but, just counting the 5 axle semis may give you an indication which data is correct). For this project a one hour directional count (2-3 pm—a high heavy truck hour) at VC site 8784 was taken with the following results(this is a 4-lane): 37 five-axle semis were counted at the site. Analysis of a 48 hour vehicle class data at VC8784 revealed the following 5-axle semis:

| Direction | 2pm-3pm(1st 24 hour period) | 2pm-3pm(2nd 24 hour period) /2 = Average | |
|---|---|---|---|
| N | 17 | 13 | 15 |
| N | 4 | 4 | 2 |
| S | 5 | 5 | 5 |
| S | 14 | 19 | 17 |
| | | Average 2-way total | 41 |

A one-hour count showed approximate 37 five-axle semis.

In recapping what we have done, we first determined that VC data for 1998 was 41 five-axle semis (similar to 37). A quick glance at hourly data for VC8784 for 1991 reveals 20 5-axle semis in the hour.

CONCLUSION: the one-hour count revealed the 1998 data closest to our current count. Therefore, we will drop the older counts and go with the 1998 data (shown below). As long as the forecaster documents his or her conclusion and follows forecasting procedures, there is no wrong answer. Another forecaster may have used a different technique and used all three years. As long as there is a valid reason for the judgment, the forecast will be accepted in most cases. It is the lack of documentation that may result in not approving a forecast.

Vehicle Class Count Averages Worksheet

VCC Site Num. 8784
TH TH55
Site Description SE of TH101

| | | 16-24 Vehicle C.C.1 | | 16-24 Vehicle C.C.2 | | 16-24 Vehicle C.C.3 | | 16-24 Vehicle C.C.4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Type** | **Year** | **Pct** | **Year** | **Pct** | **Year** | **Pct** | **Year** | **Pct** | **Avg Truck Volumes** | **Avg Vehicle Pctages** |
| | | 1998 Tube | | | | | | | | | |
| 1 | **Cars** | 23758 | *95.03%* | | | | | | | | *95.03%* |
| 2 | **2 ASU** | 407 | *1.63%* | | | | | | | *407* | *1.63%* |
| 3 | **3+ASU** | 137 | *0.55%* | | | | | | | *137* | *0.55%* |
| 4 | **3ASemi** | 53 | *0.21%* | | | | | | | *53* | *0.21%* |
| 5 | **4ASemi** | 103 | *0.41%* | | | | | | | *103* | *0.41%* |
| 6 | **5+Asemi** | 322 | *1.29%* | | | | | | | *322* | *1.29%* |
| 7 | **TT/BUS** | 163 | *0.65%* | | | | | | | *163* | *0.65%* |
| 8 | **Twins** | 57 | *0.23%* | | | | | | | *57* | *0.23%* |
| Total | | *25000* | *4.97%* | | | | | | | | *4.97%* |
| Total Heavy Comm | | *1242* | | | | | | | | *1242* | *100.00%* |
| Heavy 5 Ax Semi* | | | 26.1% | | | | | | | | 26.10% |
| Axle Corr Factor | | | 0.96 | | | | | | | | 0.96 |

* Heavy 5 Ax Semi = Tank, Dump, Grain (and Stake if on Timber route-Dist 1,2, or 3)
When the Tank, Dumps, & Grains and sometimes stakes are 30% or more of the 5 axle semis, then split into max and other categories (AUTOMATICALLY DONE) ---------->
Check out tube counts prior to 1996 carefully; body types are N/A prior to 1982

| Heavy 5 Axle Semi Split | |
|---|---|
| *0.34%* | Max |
| *0.95%* | Others |
| ***DON'T SPLIT*** | |

NOTE: IF LESS THAN 4 ENTRIES, BE SURE
TO DELETE YEAR AND PCT COLUMN
DO NOT USE 0, LEAVE BLANK.
USER MUST THEN COPY THE FORMULA IN THE
PCT COLUMNS BACK TO THE APPROPRIATE COLUMN
FOR HELP CALL MARK LEVENSON - 651 -296-8535 OR TOM NELSON - 651-297-1197.

Note that we used the heavy split information from the manual counts and inserted the value (26.1%) under the 1998 count.

## ***13. Least Squares Worksheet***

At this stage of the forecasting process all of the necessary historical traffic data and vehicle class data has been collected. All of the data needed to continue to do the ESAL forecast should be contained on the SKETCH *(example 2)* and the VEHICLE CLASS COUNT AVERAGES WORKSHEET *(example 11)*. On the MnESAL spreadsheet, the traffic forecaster has worked from left to right through the first six tabs. The next tab to the right is the "Least Squares" sheet. On this sheet the forecaster will analyze the historic

and current AADT and project it from the base year to the design year (example: 2005 base year to 2025 design year).

The forecaster needs to manually fill in the "Location" and "Base Year." The MnESAL spreadsheet then transfers the "Route", "SP#", "Date" and the "Forecast Year." This sheet will most likely be used multiple times. Print out this sheet and retain hard copies of each segment. *Example 13 and example 14* are the least squares for our sample project. The volumes are entered from the sketch *(example 2)*.

## *Example 13 - Least Squares Worksheet – Segment 1*

**LEAST SQUARES WORKSHEET**

**ROUTE:** TH52 **SP#:** 2310-22 **DATE** 08/02/04

**LOCATION:** From .5 Mi East of E Jct CSAH17 to East Jct TH16

**BASE YEAR** 2005 **FORECAST YEAR:** 2025

| YEAR | FLOW MAP AADT (SEG A) | SEG A HCADT | SEG A 5AX TST | FLOW MAP AADT (SEG B) | SEG A AXLE COOR. FACT. USED | SEG B AXLE COOR. FACT. USED | CORRECTED AADT-A | CORRECTED AADT-A |
|---|---|---|---|---|---|---|---|---|
| 1982 | 2700 | | | | 1.00 | 1 | 2700 | 0 |
| 1984 | 2800 | | | | 0.92 | 1 | 3043 | 0 |
| 1986 | 2800 | | | | 0.92 | 1 | 3043 | 0 |
| 1988 | | | | | 0.92 | 1 | 0 | 0 |
| 1990 | 3000 | | | | 0.92 | 1 | 3261 | 0 |
| 1992 | | | | | 0.92 | 1 | 0 | 0 |
| 1994 | 3200 | | | | 0.92 | 1 | 3478 | 0 |
| 1996 | 3650 | | | | 0.92 | 1 | 3967 | 0 |
| 1998 | 4100 | | | | 0.92 | 1 | 4457 | 0 |
| 2000 | 4300 | | | | 0.92 | 1 | 4674 | 0 |
| 2002 | 4700 | | | | 0.92 | 1 | 5109 | 0 |
| | | | | | | | 0 | 0 |
| | | | | | | | 0 | 0 |
| | | | | | | | 0 | 0 |
| | | | | | | | 0 | 0 |
| | | | | | | | 0 | 0 |

**LEAST SQUARES BASED FORECASTS:**

| Year | AADT (Seg. A) | HCADT | 5AX TXT | AADT (Seg. B) | PROJECTED Axle Corr. Factors - A | Axle Corr. Factors - B | Calc | ADT Calc |
|---|---|---|---|---|---|---|---|---|
| 2002 | 4430 | #N/A | #N/A | #DIV/0! | 0.92 | 1 | 270 | 4700 |
| 2005 | 4730 | #N/A | #N/A | 0 | 0.92 | 1 | | 5000 |
| 2025 | 6780 | #N/A | #N/A | 0 | 0.92 | 1 | | 7050 |

| Statistics | AADT (Seg. A) | HCADT | 5AX TST | AADT (Seg. B) |
|---|---|---|---|---|
| R 2 | 0.92 | #N/A | #N/A | #DIV/0! |
| SLOPE | 102.26 | #N/A | #N/A | #DIV/0! |
| INTERCEPT | -200304 | #N/A | #N/A | #DIV/0! |
| N | 9 | 0 | 0 | 0 |

**USE THIS**

| YEAR | AADT |
|---|---|
| 2002 | 4700 |
| 2005 | 5000 |
| 2025 | 7100 |

**(AADT'S AND STATISTICS INCLUDE AXLE-CORRECTION.)**

**PER YEAR GROWTH RATE OVER BASE YR -** 2005

| | | | |
|---|---|---|---|
| 2.2% | #N/A | #N/A | #DIV/0! |

# *Example 14 - Least Squares Worksheet – Segment 2*

**LEAST SQUARES WORKSHEET**

**ROUTE:** TH52 **SP#:** 2310-22 **DATE** 08/02/04

**LOCATION:** From TH16 to the N Limits of Preston

**BASE YEAR** 2005 **FORECAST YEAR:** 2025

| YEAR | FLOW MAP AADT (SEG A) | SEG A HCADT | SEG A 5AX TST | FLOW MAP AADT (SEG B) | SEG A AXLE COOR. FACT. USED | SEG B AXLE COOR. FACT. USED | CORRECTED AADT-A | CORRECTED AADT-A |
|---|---|---|---|---|---|---|---|---|
| 1982 | | | | | 1.00 | 1 | 0 | 0 |
| 1984 | 3300 | | | | 0.92 | 1 | 3587 | 0 |
| 1986 | 3400 | | | | 0.92 | 1 | 3696 | 0 |
| 1988 | | | | | 0.92 | 1 | 0 | 0 |
| 1990 | 4350 | | | | 0.92 | 1 | 4728 | 0 |
| 1992 | 4400 | | | | 0.92 | 1 | 4783 | 0 |
| 1994 | 4450 | | | | 0.92 | 1 | 4837 | 0 |
| 1996 | 5100 | | | | 0.92 | 1 | 5543 | 0 |
| 1998 | 5900 | | | | 0.92 | 1 | 6413 | 0 |
| 2000 | 6200 | | | | 0.92 | 1 | 6739 | 0 |
| 2002 | 6500 | | | | 0.92 | 1 | 7065 | 0 |
| | | | | | | | 0 | 0 |
| | | | | | | | 0 | 0 |
| | | | | | | | 0 | 0 |
| | | | | | | | 0 | 0 |
| | | | | | | | 0 | 0 |

**LEAST SQUARES BASED FORECASTS:**

| Year | AADT (Seg. A) | HCADT | 5AX TXT | AADT (Seg. B) | PROJECTED Axle Corr. Factors - A | Axle Corr. Factors - B | Calc | ADT Calc |
|---|---|---|---|---|---|---|---|---|
| 2002 | 6410 | #N/A | #N/A | #DIV/0! | 0.92 | 1 | 90 | 6500 |
| 2005 | 6960 | #N/A | #N/A | 0 | 0.92 | 1 | | 7050 |
| 2025 | 10670 | #N/A | #N/A | 0 | 0.92 | 1 | | 10760 |

| Statistics | AADT (Seg. A) | HCADT | 5AX TST | AADT (Seg. B) |
|---|---|---|---|---|
| R 2 | 0.96 | #N/A | #N/A | #DIV/0! |
| SLOPE | 185.20 | #N/A | #N/A | #DIV/0! |
| INTERCEPT | -364362 | #N/A | #N/A | #DIV/0! |
| N | 9 | 0 | 0 | 0 |

**USE THIS**

| YEAR | AADT |
|---|---|
| 2002 | 6500 |
| 2005 | 7100 |
| 2025 | 10800 |

**(AADT'S AND STATISTICS INCLUDE AXLE-CORRECTION.)**

**PER YEAR GROWTH RATE OVER BASE YR -** 2005

| | | | |
|---|---|---|---|
| 2.7% | #N/A | #N/A | #DIV/0! |

The forecaster will have to perform a least squares analysis for each segment, that is, each AADT break that has historic counts. Included on the sketch are all historic

volumes; however, on our final least squares worksheet several years have been dropped. The forecaster may first run the least squares with all values and then run it again after dropping years or volumes that seem to be "outliers." In our sample forecast, we have dropped several points from each segment.

The key element here is the "USE THIS" box on the lower right. This area rounds to the nearest hundred the values calculated on the line labeled "least squares forecasts" on the row above and to the right of the boxed values. The better the fit the higher the "R squared." The forecaster should strive for at least an "R squared" of 70. At the bottom of the least squares worksheet is a per year growth rate over the base year. As you perform different iterations in a least squares, notice how the growth rate and "R squared" values change.

An axle correction factor is transferred from the vehicle class count averages worksheet. The value of 0.92 from *example 11* from that worksheet is transferred to the least squares worksheet shown in *example 13*. The AADT base year and forecast year data as well as the "R squared" and growth rate should be manually entered on the sketch (*example 2*).

The important thing to remember is, "THE FORECASTER HAS TO COMPLETE A LEAST SQUARES ANALYSIS FOR EVERY AADT SEGMENT ALONG THE PROJECT AND AT THE VEHICLE CLASS SITE. THE VEHICLE CLASS SITE MAY NOT ALWAYS BE CONTAINED WITHIN THE PROJECT LIMITS.

***14. A and B Segment Concept***

From the Least Squares Worksheet, our focus will be on the next four tabs, which are the heart of the MnESAL spreadsheet. *This is where the forecaster will determine the ESAL forecast. The ESAL procedure is used to design both flexible (bituminous) and rigid (concrete) pavements*.

The concept of the "A" segment and "B" segment is shown on the sketch *(example 2)*. The "A" segment" is the segment that contains the vehicle class site. In our sample forecast, it is part of the project; however, it may not be contained within the project limits. Even if the "A" segment is **not** contained within the project, it is still necessary to include it on your sketch along with all historic traffic volumes. There are brackets on the AADT segment contained within the "A" segment and also around the "B" segment" on our sketch. The "B" segment is the "rest of the project." Think of the "B" segment as a series of AADT breaks along the project that do not contain vehicle class sites.

In our sample forecast there is one "A" and one "B" segment. We will discuss the use of multiple "A" segments and multiple "B" segments later. Suffice it to say is that the "A" and "B" segment are interrelated. A "B" segment is tied to a specific "A" segment. An "A" segment can stand-alone; a "B" segment cannot. *Example 15* is the next tab to the right – Cumesal A.

# *Example 15 - Cumulative ESALS Worksheet A*

**CUMULATIVE ESALS WORKSHEET** **SEGMENT A**

**SP#:** 2310-22

**ROUTE:** TH52 **# LANES:** 2 **DATE:** 08/09/04

**LOCATION:** From .35 Mi East of E Jct of CSAH17 to E Jct of TH16

**VCL SITE #:** 7088

| | YEAR | AADT | INIT CALC HCADT | CONSTRN HCADT | INIT CALC 5AX TST | CONSTRAIN 5AX TST |
|---|---|---|---|---|---|---|
| **VEH.CLASS YR.:** | 2001 | 4500 | 440 | 0.0% | --- | --- |
| **BASE YEAR:** | 2005 | 5000 | 490 | | 232 | |
| **FORECAST YEAR:** | 2025 | 7100 | 700 | | 329 | |

| **BASE YEAR PROPORTIONS** | | BASE YR. VOLUME | % TREND | FUTURE % | FUTURE VOL. |
|---|---|---|---|---|---|
| **2AX-6TIRE SU** | 2.9% | 144 | 1 | 2.9% | 206 |
| **3AX+ SU** | 0.9% | 44 | 1 | 0.9% | 63 |
| **3AX TST** | 0.3% | 14 | 1 | 0.3% | 20 |
| **4AX TST** | 0.5% | 24 | 1 | 0.5% | 34 |
| **5AX+ TST** | 4.6% | 231 | 1 | 4.6% | 330 |
| **(5AX+ TST MAX)** | 0 | 0 | 1 | 0.0% | 0 |
| **(5AX+ TST OTH)** | 0 | 0 | 1 | 0.0% | 0 |
| **TR TR, BUSES** | 0.6% | 31 | 1 | 0.6% | 45 |
| **TWIN TRAILERS** | 0.0% | 2 | 1 | 0.0% | 2 |

| **SUMMARIES:** | | AADT | HCADT | HCADT % | 20 YR DESIGN LANE CUMULATIVE ESAL |
|---|---|---|---|---|---|
| 2001 | **COUNT:** | 4500 | 440 | 9.8% | \| |
| 2005 | **FORECAST:** | 5000 | 490 | 9.8% | ********** |
| 2025 | **FORECAST:** | 7100 | 700 | 9.9% | |

| | | FLEXIBLE | RIGID |
|---|---|---|---|
| **DESIGN LANE FACTOR:** | 0.5 | **1,905,000** | **2,904,000** |
| | | ********** | ********** |

**ADDITIONAL OUTPUTS:**

| | BASE % | FORECAST % | ESAL FACTORS FLEXIBLE | RIGID |
|---|---|---|---|---|
| **2AX-6TIRE SU** | 2.9% | 2.9% | 0.25 | 0.24 |
| **3AX+ SU** | 0.9% | 0.9% | 0.58 | 0.85 |
| **3AX TST** | 0.3% | 0.3% | 0.39 | 0.37 |
| **4AX TST** | 0.5% | 0.5% | 0.51 | 0.53 |
| **5AX+ TST** | 4.6% | 4.6% | 1.13 | 1.89 |
| **(5AX+ TST MAX)** | 0.0% | 0.0% | 2.40 | 4.07 |
| **(5AX+ TST OTH)** | 0.0% | 0.0% | 0.87 | 1.44 |
| **TR TR, BUSES** | 0.6% | 0.6% | 0.57 | 0.74 |
| **TWIN TRAILERS** | 0.0% | 0.0% | 2.40 | 2.33 |

**Notes:**

# Sample Worksheet Example with Notes

**CUMULATIVE ESALS WORKSHEET** **SEGMENT A**

**SP#:** 0804-73
**ROUTE:** TH14 **# LANES:** 4 **DATE:** 01/00/00
**LOCATION:** 12TH ST NORTH TO 7TH ST N
**VCL SITE #:** VCC 9060

| | YEAR | AADT | INIT CALC HCADT | CONSTRN HCADT | INIT CALC 5AX TST | CONSTRAIN 5AX TST |
|---|---|---|---|---|---|---|
| VEH.CLASS YR.: | 2000 | 17400 | 1290 | 0.0% | --- | --- |
| BASE YEAR: | 2004 | 18200 | 1350 | | 582 | |
| FORECAST YEAR | 2024 | 24000 | 1780 | | 768 | |

Use volumes from sketch

Latest VC count

| BASE YEAR PROPORTIONS | | BASE YR. VOLUME | % TREND | FUTURE % | FUTURE VOL. |
|---|---|---|---|---|---|
| 2AX-6TIRE SU | 2.6% | 474 | 1 | 2.6% | 625 |
| 3AX+ SU | 0.5% | 91 | 1 | 0.5% | 120 |
| 3AX TST | 0.1% | 18 | 1 | 0.1% | 24 |
| 4AX TST | 0.2% | 36 | 1 | 0.2% | 48 |
| 5AX+ TST | | 0 | 1 | 0.0% | 0 |
| (5AX+ TST MAX) | 1.5% | 274 | 1 | 1.5% | 361 |
| (5AX+ TST OTH) | 1.7% | 310 | 1 | 1.7% | 409 |
| TR TR, BUSES | 0.8% | 146 | 1 | 0.8% | 192 |
| TWIN TRAILERS | 0.0% | 0 | 1 | 0.0% | 0 |

These all can be manually changed

| SUMMARIES: | | AADT | HCADT | HCADT % | 20 LANE CUMULATIVE ESAL | YR DESIGN ESAL |
|---|---|---|---|---|---|---|
| 2000 | COUNT: | 17400 | 1290 | 7.4% | \| | \| |
| 2004 | FORECAST: | 18200 | 1350 | 7.4% | ********** | ********** |
| 2024 | FORECAST: | 24000 | 1780 | 7.4% | | |

| | | FLEXIBLE | RIGID |
|---|---|---|---|
| DESIGN LANE FACTOR: | 0.45 | 5,462,000 | 8,511,000 |
| | | ********** | ********** |

Safety factor: 12% safeguard

**ADDITIONAL OUTPUTS:**

| | BASE % | FORECAST % | ESAL FACTORS FLEXIBLE | RIGID |
|---|---|---|---|---|
| 2AX-6TIRE SU | 2.6% | 2.6% | 0.25 | 0.24 |
| 3AX+ SU | 0.5% | 0.5% | 0.58 | 0.85 |
| 3AX TST | 0.1% | 0.1% | 0.39 | 0.37 |
| 4AX TST | 0.2% | 0.2% | 0.51 | 0.53 |
| 5AX+ TST | 0.0% | 0.0% | 1.13 | 1.89 |
| (5AX+ TST MAX) | 1.5% | 1.5% | 2.40 | 4.07 |
| (5AX+ TST OTH) | 1.7% | 1.7% | 0.87 | 1.44 |
| TR TR, BUSES | 0.8% | 0.8% | 0.57 | 0.74 |
| TWIN TRAILERS | 0.0% | 0.0% | 2.40 | 2.33 |

Regular Loaded (other)

AASHTO guide for design of pavements. See Fig 15 – ESAL equivalence factors

**Notes:**

***15. Cumulative ESAL Worksheet A -(Above)***

The "Cumulative ESAL Worksheet A" represents a culmination of everything completed to this point. It takes elements from previous worksheets and incorporates many of the terms and information covered in the previous pages of this manual. From this point throughout the rest of the forecasting process, the forecaster will primarily use all the information on the sketch (*example 2*) and the vehicle class count averages worksheet (*example 11*). After placing all the information from the least squares worksheet onto the sketch, the Cumulative ESAL Worksheet A is ready to be filled out. Much of the information has been transferred automatically to this sheet --the SP#, the Date, Route and Vehicle Class Site #.

THIS INFORMATION REPRESENTS THE INFORMATION COLLECTED FROM THE HISTORICAL ANALYSIS OF THE VEHICLE CLASS SITE. The data from the vehicle class count averages worksheet *(example 11),* the last column of percentages, has been transferred to the ESALS worksheet *A (example 15*). It is shown under Base Year Proportions for each heavy commercial type. The numbers have been truncated to one decimal place. If the information indicated that heavies should have been split, that also would be transferred to the worksheet.

The forecaster has to fill in # Lanes and the Location. Note that the segment containing the vehicle class site is the same and has the same location as the appropriate Least Squares Worksheet (*example 13*). Every location and segment description is usually measured between AADT breaks. As a consequence, the vehicle class site segment location is often used interchangeably as the segment description. In reality, they are the same thing since the AADT does not change (for traffic forecasting purposes) either at the vehicle class site or the segment. For forecasting purposes, always describe the segment limits at the point where AADT changes.

In addition to location and number of lanes, the Vehicle Class Year and AADT need to be filled out. That is simply the most recent year of data used in the vehicle class count averages worksheet (*example11).* In this case, the 4500 AADT interpolated from 2000 and 2002 on the sketch is used. The Base Year and Forecast Year have been automatically transferred so that all the forecaster needs to fill out is the AADT for the Base Year (2005) and the Forecast Year (2025). In this case, 5000 and 7100 respectively (from the sketch).

When the AADT has been filled out, the worksheet will calculate a 20 year cumulative flexible and rigid ESAL – the values being 1,905,000 and 2,904,000. Previously in this manual we discussed what an ESAL is. ESAL worksheet A takes all the information previously collected and calculates the above ESALS, with some rounding occurring. Again, this worksheet takes the vehicle percents from the Vehicle Class Count Averages Worksheet and calculates a Base Year and a Future Year Volume. To see how ESAL worksheet A calculates, for example, simply take the base year AADT (5000) and multiply it by the 5AX+TST category (4.6%). The resultant number is 230. That is the Base Year (year 2005) HCAADT for the 5 + axle semi category. Furthermore, doing the same calculation for the Forecast Year AADT (7100), you get the Future Volume

category for the 5 + axles (330). The HCAADT totals are then placed in two different places on the worksheet along with the total HCAADT percentages for all the truck categories.

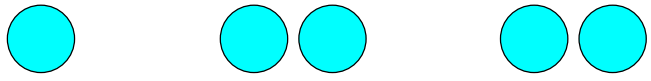
The ESAL factors at the bottom of the ESALS Worksheet A were first derived from groundwork laid by AASTHO road tests in the 1950s and 1960s and then refined using WIM data from three WIM sites in the 1980s. In 2004, ESAL factors are being analyzed from data based on 18 to 20 WIM sites between 1992 and 2004. The ESAL concept can be explained a little easier by the illustration below:

*Figure 4 – ESAL CONCEPTS*

## *ESALs and 1 fully loaded 5-axle semi (80,000 lbs)*

| Axle Group | Weight | Flexible Equivalent Factor |
|---|---|---|
| ✍ Front | 12,000 | 0.19 |
| ✍ Tandem | 34,000 | 1.10 |
| ✍ Tandem | 34,000 | 1.10 |
| | 80,000 | 2.39 ESAL Factor |

Example: 5 axle semis only! (design lane)
If we have 50/day over a 20 year period:
50 veh x 7308 days in 20 years x 2.40 (flex ESAL factor) = 876,960 ESALS



12,000 .2 Front | 34,000 1.1 Tandem | 34,000 1.1 Tandem = 2.4

***Note: 1 ESAL is equal to the damage to a flexible pavement caused by one 18,000 axle load***

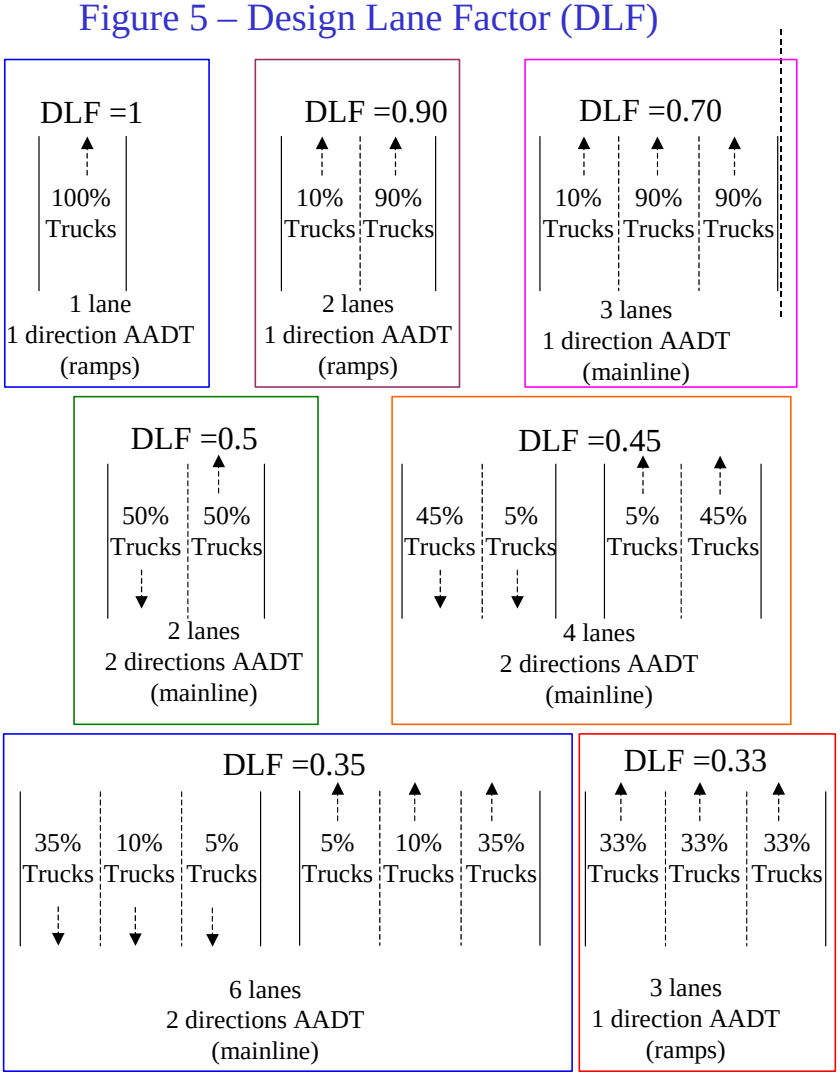
Figure 4 (previous page) shows how the 2.4 or 2.39 ESAL factor is calculated on the ESAL Worksheet A. In this example, 50 fully loaded 5-axle semis per day over the 20-year period of a bituminous roadway produce 876,960 ESALS. Compare this to our sample forecast (example 15) that produces 1,595,000 ESALS. In this comparison, 50 fully loaded 80,000 pound semis alone produce more than half the ESALS of our sample forecast. *Note that the 281 5+ axle semis in our sample forecast were not split and the 1.13 ESAL factor used is less than HALF of the maximum loaded 5-axle semi*.

There is one more concept on this worksheet that has been mentioned earlier in the manual – the Design Lane Factor (DLF). In the middle of the ESAL Worksheet A (example 15) is a number of 0.5 for design lane factor. That number is generated automatically when the forecaster enters the number of lanes for the project. One word of caution: If the existing roadway is 2 lane, for example, and the future improvement is four or six lanes, enter that number on the # lanes portion of the worksheet.

We used two lanes in our sample forecast – that translates into a DLF of 0.5. FORECASTS ARE DONE FOR THE DESIGN LANE ONLY. The illustration below shows various configurations and the appropriate design lane factors.

Design Lane Factor is a factor to estimate traffic volume and truck components on heaviest traveled lanes for the purposes of ESAL estimation.

Figure 5 – Design Lane Factor (DLF)



***16. Cumulative ESAL Report A***

The next tab to the right is called the Cumulative ESALS Report A; it shows on the MnESAL as "ESAL Report-A." Most of the information is transferred from previous spreadsheets. All that is required to enter is the author's district, name and the length of the segment. The length can be measured or estimated from any map legend. *Example 16* is a continuation of our sample forecast. There is little to do on this worksheet, as it is mainly a summary and grouping of the information from the ESAL worksheet A. ESAL Report A summarizes the base and design year AADT as well as the design lane AADT. In this case, the design lane AADT is half of two-way AADT. The heavy commercial vehicles are also grouped into total Single Units (sum of 2 plus 3 and 4+ axle single units) and total TSTs (sum of 3, 4 and 5+ axle semis). This is for the base and design year also.

There is also an annual ESAL summary and summaries for various time periods. There is also a 35 cumulative ESAL summary. In most cases, the 20 year cumulative Flexible 1,905,000 and Rigid 2,904,000 ESALs (in bold on the MnESAL spreadsheet) are what designers look for.

The State Forecasts Engineer had previously signed the bottom approval and date section, but the new district initiatives will result in the district forecasters signing, reviewing and approving their own forecasts, with TDA responsible for training and certification.

***17. Cumulative ESAL Worksheet B***

Moving to the right towards the last two tabs, we have a "Cumulative ESALs Worksheet B" and a "Cumulative ESALS Report B" – these are similar to the previous two "A" worksheets. The "B" segment or the "B" concept is shown on the original sketch *(example 2)* – the B segment is any segment that does not contain a vehicle class count location. There can be multiple B segments. Each B segment usually "belongs to" its adjacent A segment. In other words, the "B" segment concept is a way to project truck traffic along the portion of the trunk highway that does not contain a vehicle classification site.

Since there cannot be a vehicle class segment on every section of roadway we have to tie the vehicle classification site to other segments of a particular project. That is the purpose of the B segment.

*Example 17* is the "Cumulative ESALS Worksheet B" for our sample forecast. On this sheet, the number of lanes and the location should be entered. In addition, the AADT for the Base Year and the Forecast Year (similar to the A worksheets) has to be entered. The information is contained on the sketch *(example 2)*. Similar to A segments, the location of B segments is determined by AADT changes.

# *Example 16 - Cumulative ESALS Report A*

**CUMULATIVE ESAL REPORT - A**

**DATE:** 08/09/04

**ROUTE #:** TH52 **DISTRICT:** 6 **SP#:** 2310-22

**FORECAST #:** F6-0412 **COUNTY:** FILLMORE **MILES:**

**DESCRIPTION:** From .35 Mi East of E Jct of CSAH17 to E Jct of TH16

**AUTHOR'S DISTRICT: --->** **AUTHOR:** LEVENSON

**TRAFFIC SUMMARY**

**BASE YEAR NUMBER OF LANES (two way):** 2

| BASE YEAR ---> | 2005 | DESIGN YEAR ----> | 2025 | GROWTH / YR (SIMPLE %) |
|---|---|---|---|---|
| **AADT: two-way** | 5000 | | 7100 | 2.1% |
| **design-lane** | 2500 | | 3,550 | 2.1% |
| **HCADT: two-way** | 490 | | 700 | 2.1% |
| **SINGLE UNITS:two-way** | 190 | | 270 | 2.1% |
| **TST'S: two-way** | 269 | | 384 | 2.1% |

**ESAL SUMMARY**

**ANNUAL DESIGN LANE ESAL**

| | | | |
|---|---|---|---|
| **FLEXIBLE:** | 66,818 | 95,149 | + |
| **RIGID:** | 101,787 | 145,144 | + |

**CUMULATIVE DESIGN-LANE ESALS (10 TON)** **Design-lane factor:** **0.5**

| DESIGN YEAR | DESIGN-LANE TST'S | ESALS FLEXIBLE | ESALS RIGID |
|---|---|---|---|
| 2015 | 163 | 910,000 | 1,388,000 |
| 2020 | 178 | 1,388,000 | 2,115,000 |
| 2025 | 192 | **1,905,000** | **2,904,000** |
| **** OR ** DESIGN YEAR** | | | |
| 2026 | 195 | 1,938,000 | 2,955,000 |
| 2027 | 198 | 1,971,000 | 3,006,000 |
| 2028 | 201 | 2,005,000 | 3,057,000 |
| 2029 | 204 | 2,038,000 | 3,108,000 |
| 2030 | 206 | 2,071,000 | 3,159,000 |

**35 YEAR CUMULATIVE ESAL USING-->** 2005 **AS THE BASE YEAR**

| | | |
|---|---|---|
| 2040 | 3,694,000 | 5,634,000 |

**APPROVED BY:** **DATE:**

**(FOR PROJECT AADTS AND DESIGN HOUR VOLUMES PLEASE REFER TO PREVIOUSLY APPROVED FORECASTS OR ATTACHED TRAFFIC FLOW DIAGRAMS.)**

# *Example 17 - Cumulative ESALS Worksheet B*

**CUMULATIVE ESAL WORKSHEET** **SEGMENT B**

**SP#:** 2310-22

**ROUTE:** TH52 **# LANES:** 2 **DATE:** 08/09/04

**LOCATION:** W Jct of TH16 to W Jct CSAH17

| | YEAR | AADT | | | CALCULATED HCADT | CONSTRAIN HCADT |
|---|---|---|---|---|---|---|
| **BASE YEAR:** | 2005 | 7400 | 2400 | **DIFFERENCE** | 630 | 0 |
| **FORECAST YEAR:** | 2025 | 10800 | 3700 | **DIFFERENCE** | 920 | 0 |

**INCREMENTAL HCADT ON SEGMENT B (1975 AND 1977 CO. AND LOCAL ROAD STUDY)**

| **BASE YEAR PROPORTIONS** | | **BASE YR. VOLUME** | **% TREND** | **FUTURE %** | **FUTURE VOL.** |
|---|---|---|---|---|---|
| **2AX-6TIRE SU** | 2.6% | 62 | 1 | 2.6% | 96 |
| **3AX+ SU** | 1.7% | 41 | 1 | 1.7% | 63 |
| **3AX TST** | | 0 | 1 | 0.0% | 0 |
| **4AX TST** | 0.1% | 2 | 1 | 0.1% | 4 |
| **5AX+ TST** | 0.5% | 12 | 1 | 0.5% | 19 |
| **(5AX+ TST MAX)** | | 0 | 1 | 0.0% | 0 |
| **(5AX+ TST OTH)** | | 0 | 1 | 0.0% | 0 |
| **TR TR, BUSES** | 1.0% | 24 | 1 | 1.0% | 37 |
| **TWIN TRAILERS** | | 0 | 1 | 0.0% | 0 |

| **SUMMARIES:** | | 0 | **ADDED** | **COMBINED** | **20** | **YR DESIGN** |
|---|---|---|---|---|---|---|
| | | **AADT** | **HCADT %** | **HCADT %** | **LANE CUMULATIVE ESAL** | |
| **BASE YEAR:** | 2005 | 2400 | 5.9% | 8.5% | \| | \| |
| **FORECAST YEAR:** | 2025 | 3700 | 5.9% | 8.5% | ********** | ********** |

| | | **FLEXIBLE** | **RIGID** |
|---|---|---|---|
| **DESIGN LANE FACTOR:** | 0.5 | | |
| **SEGMENT B INCREMENT ONLY:** | | 380,000 | 511,000 |
| **SEGMENT A + SEGMENT B:** | | **2,285,000** | **3,415,000** |
| | | ********** | ********** |

**ADDITIONAL OUTPUTS:**

| | **BASE %** | **FORECAST %** | **ESAL FACTORS FLEXIBLE** | **RIGID** |
|---|---|---|---|---|
| **2AX-6TIRE SU** | 2.6% | 2.6% | 0.25 | 0.24 |
| **3AX+ SU** | 1.7% | 1.7% | 0.58 | 0.85 |
| **3AX TST** | 0.0% | 0.0% | 0.39 | 0.37 |
| **4AX TST** | 0.1% | 0.1% | 0.51 | 0.53 |
| **5AX+ TST** | 0.5% | 0.5% | 1.13 | 1.89 |
| **(5AX+ TST MAX)** | 0.0% | 0.0% | 2.40 | 4.07 |
| **(5AX+ TST OTH)** | 0.0% | 0.0% | 0.87 | 1.44 |
| **TR TR, BUSES** | 1.0% | 1.0% | 0.57 | 0.74 |
| **TWIN TRAILERS** | 0.0% | 0.0% | 2.40 | 2.33 |
| **BSEGment Difference OK?** | OK | OK | | |

**Notes:**

ESAL Worksheet B contains *new urban and rural default percentages (see page 152)* determined by previous studies. In most cases, the forecaster will use those percentages for the B segment. The underlying assumption has been to utilize heavy truck percentages developed 15 to 20 years ago and updated in 2005 from vehicle class counts taken on county roads and city streets. The previous default of 5.9% is represented in *example 17*. The new default heavy commercial percentages are 3.9% urban and 8.9% rural. Again, these are trucks that are "predicted" to enter and exit trunk highways from CSAHs, city streets and county roads.

The "B" segment represents the "addition" or "subtraction" of trucks on the trunk highway system to or from other road systems. Thus, the "B" concept is a way to forecast traffic and ESALS along a portion of trunk highway using vehicle class data from another road segment. The current default factors as shown on the MnESAL spreadsheet may be subject to change as more analysis on the county road system is undertaken.

In the sample forecast, the forecaster takes the base and design year AADT from the B segment on the sketch *(example 2)* – 7400 and 10800 respectively and places them on the appropriate line on ESAL Worksheet B. When this is done, *the MnESAL automatically calculates the addition or subtraction of trucks from the "A" segment.*

On our Worksheet B, the additional 5.9% trucks added from the B segment results in 380,000 additional ESALS (*example 17* – "Segment B Increment Only"). The 380,000 ESALS plus the 1,905,000 ESALS on the A Worksheet results in the ESAL value on the B Worksheet of 2,285,000 ESALS (20 year flexible). In this example, the extra 2400 AADT generated on the B segments multiplied by the default percentage (2.6%) of 2 axle 6 tire single unit results in 62 in the base year (*example 17* - "Base Yr. Volume").

*When the B Segment AADT is less than the A Segment AADT, there will be negative values under the "Base Yr Volume" on ESAL Worksheet B.* This means that a drop in AADT from the A segment to the B segment results in a decrease in heavy truck volumes between the A and B segments. The spreadsheet automatically calculates the difference in AADT and then applies the default percentages to the truck volumes. Occasionally, the MnESAL program may "take away" more trucks than exist on the A segment during the A to B segment calculation of trucks. If this situation occurs, it is up to the forecaster to "manually adjust" (lower the B segment percentages) until enough trucks remain on the A segment to account for the difference. Again, the assumption is that between the A and B segment, any change in AADT results in a loss or gain of heavy commercial traffic of 5.9% of the difference between the A and B segment.

The default percentage concept is not cast in stone. This is up to the judgment of the individual forecaster. For example, if there is a sand and gravel pit or a grain facility on a county road that produces or generates additional heavy truck traffic, those heavy trucks can be added to the mix. Examples of this will be shown later. The forecaster may prefer to take short counts or drive along any county roads or local streets that intersect the project to get a sense of the traffic flow.

The video log should be consulted in each and every project. It can produce valuable insight as to the character change of the roadway in question, and also clarify the number of lanes and land use along the project.

***18. Cumulative ESAL Report B***

The last tab to the right before the documentation on the MnESAL is the "Cumulative ESALS Report B" (*example 18*). This sheet is virtually identical to Cumulative ESAL Report A and is automatically generated. On Report B the only areas to be filled in are the miles, authors district and the author.

On the majority of forecasts, there may be multiple B segments. Again, since the MnESAL can save only one B and one A segment, it is important to *PRINT OUT EVERY A AND B SEGMENT GENERATED DURING THE COURSE OF A PROJECT.* The forecaster may chose not to use all of the A and B segments generated in a report for the final segments, but it is important to save hard copies of all the A and B segments generated during a forecast and attaching them to the final documentation.

## *DESIGN HOUR VOLUME and AADT*

The requester may ask for design hour volumes - which are not part of the MnESAL spreadsheet. The term design hour volume (DHV) and 30$^{th}$ highest hour are often used interchangeably in rural highway design. They are derived from the 30$^{th}$ highest hour of the year. It is generally expressed as a percentage of the AADT.

Automatic Traffic Recorders (ATR's) are the only source from which you can obtain DHV. It is best to check several ATRs located near the project, and/or what you feel are similar routes before making the decision on what percent to use. The most current ATR Traffic Recorder Monthly Comparison Report is available from the Traffic Forecasts Unit upon request. Historical AADT at all ATR stations by number by route system is available in the front of the ATR book. Figure 6 is an illustration of page 1 of the 2000 ATR book. As discussed previously, ATR data can be used for historical trend information. Figure 7 is also from the 2000 ATR book – it is a DHV hourly summary report from ATR 356. DHV is available by direction, but usually the request will be for both directions.

If, for example ATR 356 were near our sample forecast, one would go to the 30$^{th}$ highest hour (again, this is for non Twin City Metro Area forecasts) and see that the DHV is 9.4% of the AADT and the directional split is 42/58. On the bottom of the page, notice that there is a DHV summary as well as AADT for that ATR.

Figure 8 is also from the 2000 ATR book, and it is a monthly breakdown of AADT by direction at a particular ATR site – in this case, ATR 464. Note the AADT for year 2000 and year 1999 and the monthly variation. Please note this is the monthly variation for AADT, and not HCAADT. Figure 9 shows hourly data at a sample ATR station. This information is available upon request from the Traffic Forecast and Analysis Section. -

Design hour volume is similar to what is commonly called peak hour volumes – used primarily in discussions about the Twin City Metro area. In Greater Minnesota, we refer to peak hour volumes as DHV or the 30th highest hour. This information can be found in each ATR manual, under specific ATR numbers and routes – by direction and both directions. For forecasting, the DHV can only be known at a specific ATR. The forecaster will have to determine "similar" attributes of the traffic in your project area and apply it to the appropriate site where an ATR is located. ATR data is also available by month and hour. the 30th highest hour – which would mean a maximum of 300 vehicles per hour – both directions.

A study of historic ATR data revealed that the average DHV is from 8% in town to 10-13% out of town. If nothing else is known, the further distance from a town in Greater Minnesota, the higher the percent DHV (assumes decreasing volumes outside of a town).

For example, you may want to know the DHV at a project on TH15. There is no ATR in the project area. A quick scan of the ATR map in the book will reveal ATRs around the state. It will be the task of the forecaster to determine an ATR that has similar characteristics to the project area in question, such as similar AADT, similar characteristics as to whether the route is recreation, farm to market, grain traffic, seasonal traffic, nature of traffic, etc.

As a general rule of thumb, the DHV percent is anywhere from 8 to 13%. That means that the 30th highest hour in a typical segment of rural trunk highway may be 10% of AADT. If the AADT is 3000 on TH15, for example, and you determine the DHV both directions 10% -- then the DHV is 300. That means you would design the roadway for the 30th highest hour – which would mean a maximum of 300 vehicles per hour – in both directions.

A study of historic ATR data revealed that the average DHV is from 8% in town to 10%-13% out of town. If nothing else is known, the further distance forma town in Greater Minnesota, the higher the percent DHV (assumes decreasing volumes outside of a town).

# *Example 18 - Cumulative ESALS Report B*

**CUMULATIVE ESAL REPORT - B**

**DATE:** 08/09/04

**ROUTE #:** TH52 **DISTRICT:** 6 **SP#:** 2310-22

**FORECAST #:** F6-0412 **COUNTY:** FILLMORE **MILES:** _____

**DESCRIPTION:** W Jct of TH16 to W Jct CSAH17

**AUTHOR'S DISTRICT: --->** C.O. **AUTHOR:** LEVENSON

**TRAFFIC SUMMARY**

**BASE YEAR NUMBER OF LANES (two way):** 2

| BASE YEAR ---> | 2005 | DESIGN YEAR ----> | 2025 | GROWTH / YR (SIMPLE %) |
|---|---|---|---|---|
| **AADT: two-way** | 7400 | | 10800 | 2.3% |
| **design-lane** | 3700 | | 5,400 | 2.3% |
| **HCADT: two-way** | 630 | | 920 | 2.3% |
| **SINGLE UNITS:two-way** | 290 | | 430 | 2.4% |
| **TST'S: two-way** | 283 | | 407 | 2.2% |

**ESAL SUMMARY**

**ANNUAL DESIGN LANE ESAL**

| | | | |
|---|---|---|---|
| **FLEXIBLE:** | 79,460 | 114,824 | + |
| **RIGID:** | 118,784 | 171,594 | + |

**CUMULATIVE DESIGN-LANE ESALS (10 TON)** **Design-lane factor:** **0.5**

| DESIGN YEAR | DESIGN-LANE TST'S | ESALS FLEXIBLE | ESALS RIGID |
|---|---|---|---|
| 2015 | 173 | 1,088,000 | 1,626,000 |
| 2020 | 188 | 1,662,000 | 2,483,000 |
| 2025 | 204 | **2,285,000** | **3,415,000** |
| **** OR ** DESIGN YEAR** | | | |
| 2026 | 207 | 2,326,000 | 3,477,000 |
| 2027 | 210 | 2,368,000 | 3,539,000 |
| 2028 | 213 | 2,410,000 | 3,601,000 |
| 2029 | 216 | 2,451,000 | 3,663,000 |
| 2030 | 219 | 2,493,000 | 3,725,000 |

**35 YEAR CUMULATIVE ESAL USING-->** 2005 **AS THE BASE YEAR**

| | | |
|---|---|---|
| 2040 | 4,451,000 | 6,653,000 |

**APPROVED BY:** _____ **DATE:** _____

**(FOR PROJECT AADTS AND DESIGN HOUR VOLUMES PLEASE REFER TO PREVIOUSLY APPROVED FORECASTS OR ATTACHED TRAFFIC FLOW DIAGRAMS.)**

# *Figure 6 – Annual Daily Traffic at Station Locations*

| STA. NO. | 1980 | 1982 | 1984 | 1986 | 1988 | 1990 | 1992 | 1994 | 1996 | 1997 | 1998 | 1999 | 2000 | STA. NO. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **OUTSTATE MUNICIPAL C.S.A.H.** | | | | | | | | | | | | | | |
| 001 | 1673 | 1747 | 1535 | 1576 | 1619 | 1818 | 1816 | | | 948 | 993 | 996 | 1040 | 001 |
| 002 | | 1280 | 1209 | 1281 | 1329 | 1266 | 1319 | 1345 | 1313 | 1241 | 1207 | 1313 | 1256 | 002 |
| 003 | 2281 | 2127 | | 3744 | 3633 | 4087 | 4478 | 4445 | 4699 | 4884 | 4907 | 4915 | 4708 | 003 |
| 006 | 429 | 586 | | 395 | 465 | 468 | 332 | 252 | 227 | 224 | 214 | 203 | 198 | 006 |
| 007 | 1132 | 1094 | | 776 | 794 | 733 | 725 | 753 | 699 | 816 | 874 | 902 | 860 | 007 |
| 008 | 583 | 603 | | 651 | 619 | | 518 | 557 | 569 | 580 | 580 | 605 | 616 | 008 |
| 009 | 695 | 767 | 812 | 1050 | 1150 | 1337 | 1204 | 1159 | 1054 | 1115 | 1187 | 1188 | 1168 | 009 |
| 010 | 1010 | 1011 | | 1327 | 1538 | 1817 | 1834 | 1811 | 1989 | 2025 | 2097 | 2120 | 2084 | 010 |
| 012 | 1315 | | | 1521 | 1648 | 1536 | 1485 | | | | | | | 012 |
| 013 | 1520 | 1421 | 1490 | 1723 | 1769 | 1749 | 1675 | 1837 | 1823 | 1906 | 1929 | 1927 | 1886 | 013 |
| 014 | 1371 | | | 1462 | 1306 | 1390 | 1327 | 1302 | 1362 | 1414 | 1344 | 1317 | 1330 | 014 |
| 028 | | | | | | | 10635 | 10202 | 10918 | 10132 | 9994 | 10114 | 10348 | 028 |
| **OUTSTATE RURAL C.S.A.H.** | | | | | | | | | | | | | | |
| 050 | 1974 | | | 2341 | 2538 | 2581 | 2742 | 3144 | 3236 | 3298 | 3587 | 3749 | 3657 | 050 |
| 051 | 264 | 240 | | 376 | 420 | 488 | 582 | 502 | 543 | 478 | 503 | 529 | 531 | 051 |
| 052 | 308 | 355 | 363 | 389 | 429 | 439 | 465 | 454 | 478 | 502 | 551 | 539 | 557 | 052 |
| 053 | 343 | 448 | | 400 | 399 | 387 | 443 | | 420 | 472 | 469 | 447 | 436 | 053 |
| 054 | | 218 | 164 | 283 | 201 | 214 | 218 | | 261 | 304 | 309 | 315 | 305 | 054 |
| 055 | 421 | 427 | 486 | 516 | 587 | 644 | 656 | 686 | 744 | 766 | 847 | 909 | 891 | 055 |
| 056 | 346 | 357 | | 348 | 384 | 390 | 386 | | 401 | 407 | 412 | 390 | 384 | 056 |
| 057 | | | | 1135 | 1261 | 1274 | 1399 | 1438 | 1487 | 1586 | 1653 | 1653 | 1588 | 057 |
| **OUTSTATE MUNICIPAL TRUNK HIGHWAYS** | | | | | | | | | | | | | | |
| 100 | | 22662 | | | 28998 | 32970 | 35016 | 44623 | 40942 | 42674 | 41891 | 41791 | 41313 | 100 |
| 101 | | | | | 20816 | | | | | 28952 | 26342 | 27338 | 27503 | 101 |
| 102 | 34975 | 32465 | 32679 | | 42333 | 49101 | 52544 | 53953 | 55063 | 54001 | 56658 | 58330 | 58805 | 102 |
| 103 | 19201 | 18966 | 18948 | | 34338 | 35492 | 38194 | 40862 | 38928 | 41813 | 43036 | 43290 | 43516 | 103 |
| 104 | 15056 | 14397 | | | 23907 | 26349 | 28058 | 30092 | 30914 | | 32086 | 32347 | 32054 | 104 |
| 110 | | 12681 | | 17110 | 18180 | 20407 | 20456 | 30092 | 23622 | 24513 | 24914 | 26584 | 25028 | 110 |
| **OUTSTATE RURAL TRUNK HIGHWAYS** | | | | | | | | | | | | | | |
| 164 | 5877 | 5354 | 5710 | 5946 | 6410 | 7143 | 7456 | 8017 | 7917 | 8742 | 8963 | 9051 | 9219 | 164 |
| 166 | 3464 | 3222 | 3433 | 3351 | 3769 | 3937 | 4145 | 4227 | 4352 | 4525 | 4642 | 4753 | 4733 | 166 |
| 170 | 2331 | | 2525 | 2557 | 2685 | 2899 | 3071 | 3230 | 3262 | 3418 | 3633 | 3573 | 3412 | 170 |
| 172 | 8279 | 7914 | | 9835 | 10193 | 10599 | 11425 | | 12102 | 12361 | 13049 | 13539 | 13377 | 172 |
| 179 | 1256 | 1273 | | 1348 | 1276 | 1416 | 1561 | 1350 | 1664 | 1722 | 1756 | 1922 | 1831 | 179 |
| 187 | | | 9604 | 10103 | 11762 | 12331 | 12739 | | 14229 | 15664 | 17049 | 17896 | 18427 | 187 |
| 188 | 11731 | 12304 | | | 16567 | 18248 | | | 21722 | 23858 | 25335 | 25540 | 23786 | 188 |
| 195 | | | | | | | | | 1980 | 2051 | 2103 | 2161 | 2147 | 195 |
| 197 | 3031 | | 2915 | | 2934 | 2932 | 3459 | 3627 | 3722 | 3746 | 3943 | 4066 | 4017 | 197 |
| 198 | | 1606 | 2136 | 1911 | 1853 | 2012 | | | 2256 | 2553 | 2378 | 2502 | 2479 | 198 |
| 199 | 1182 | 1108 | 1169 | 1186 | 1227 | 1164 | 1272 | 1410 | 1372 | 1507 | 1529 | 1461 | 1449 | 199 |
| 204 | 3848 | 3997 | 4418 | 4976 | 5818 | 6152 | 7936 | 8448 | 8911 | 9101 | 9417 | 9441 | 9430 | 204 |
| 207 | 1031 | 1051 | | 1116 | 1179 | 1236 | 1698 | 1810 | 1792 | 1901 | 1854 | 1908 | 1834 | 207 |
| 209 | 911 | 778 | 776 | 719 | 680 | 724 | 686 | 690 | 696 | 709 | 701 | 734 | 685 | 209 |
| 210 | 706 | 688 | 770 | 810 | 877 | | 994 | | 1119 | 1095 | 1105 | 1120 | 1107 | 210 |
| 211 | 2419 | 2353 | 2561 | 2623 | 2795 | 3139 | 3180 | 3352 | 3463 | 3555 | 3614 | 3707 | 3820 | 211 |
| 212 | 8006 | 8763 | 9383 | 9977 | 10647 | 11291 | 12208 | 12127 | 12413 | 14212 | 16090 | 17754 | 18140 | 212 |

# *Figure 7 – Highest Hourly Volume Summary –ATR 356*

Run on Thursday, February 15, 2001 at 11:12.

Minnesota Department of Transportation (Mn/DOT)
Continuous Count Station (ATR) Report -- 2000
Highest Hourly Volume Summary

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Station 356, TH 7, W OF WILLISTON RD in MINNETONKA, HENNEPIN County, Metro District.

| | East bound | | | | | West bound | | | | | Both Directions | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Highest Hour | Traffic Volume | Date | Day | Hour | Percent of AADT | Traffic Volume | Date | Day | Hour | Percent of AADT | Traffic Volume | Date | Day | Hour | Percent of AADT | Percent Dir. Distr. |
| 1 | 3,177 | 02/07 | Mon | 07-08 AM | 14.6 | 2,766 | 05/17 | Wed | 05-06 PM | 12.2 | 4,620 | 05/04 | Thu | 05-06 PM | 10.4 | 41/59 |
| 2 | 3,177 | 02/14 | Mon | 07-08 AM | 14.6 | 2,760 | 05/16 | Tue | 05-06 PM | 12.2 | 4,608 | 05/16 | Tue | 05-06 PM | 10.4 | 40/60 |
| 3 | 3,177 | 02/21 | Mon | 07-08 AM | 14.6 | 2,750 | 05/03 | Wed | 05-06 PM | 12.2 | 4,593 | 05/02 | Tue | 05-06 PM | 10.3 | 40/60 |
| 4 | 3,177 | 02/28 | Mon | 07-08 AM | 14.6 | 2,745 | 05/02 | Tue | 05-06 PM | 12.1 | 4,560 | 05/17 | Wed | 05-06 PM | 10.3 | 39/61 |
| 5 | 3,159 | 01/03 | Mon | 07-08 AM | 14.5 | 2,738 | 05/04 | Thu | 05-06 PM | 12.1 | 4,544 | 05/03 | Wed | 05-06 PM | 10.2 | 39/61 |
| 6 | 3,159 | 01/10 | Mon | 07-08 AM | 14.5 | 2,728 | 05/01 | Mon | 05-06 PM | 12.1 | 4,450 | 01/24 | Mon | 07-08 AM | 10.0 | 71/29 |
| 7 | 3,159 | 01/17 | Mon | 07-08 AM | 14.5 | 2,620 | 05/05 | Fri | 05-06 PM | 11.6 | 4,439 | 05/01 | Mon | 05-06 PM | 10.0 | 39/61 |
| 8 | 3,159 | 01/24 | Mon | 07-08 AM | 14.5 | 2,569 | 04/17 | Mon | 05-06 PM | 11.4 | 4,396 | 05/05 | Fri | 04-05 PM | 9.9 | 42/58 |
| 9 | 3,159 | 01/31 | Mon | 07-08 AM | 14.5 | 2,569 | 05/05 | Fri | 04-05 PM | 11.4 | 4,359 | 05/05 | Fri | 05-06 PM | 9.8 | 40/60 |
| 10 | 3,157 | 02/02 | Wed | 07-08 AM | 14.5 | 2,568 | 04/10 | Mon | 05-06 PM | 11.4 | 4,326 | 04/28 | Fri | 05-06 PM | 9.7 | 41/59 |
| 11 | 3,157 | 02/09 | Wed | 07-08 AM | 14.5 | 2,561 | 04/28 | Fri | 05-06 PM | 11.3 | 4,285 | 04/27 | Thu | 05-06 PM | 9.6 | 41/59 |
| 12 | 3,157 | 02/16 | Wed | 07-08 AM | 14.5 | 2,549 | 03/13 | Mon | 05-06 PM | 11.3 | 4,271 | 04/13 | Thu | 05-06 PM | 9.6 | 41/59 |
| 13 | 3,157 | 02/23 | Wed | 07-08 AM | 14.5 | 2,537 | 04/28 | Fri | 04-05 PM | 11.2 | 4,267 | 01/04 | Tue | 05-06 PM | 9.6 | 43/57 |
| 14 | 3,144 | 02/01 | Tue | 07-08 AM | 14.4 | 2,535 | 05/17 | Wed | 04-05 PM | 11.2 | 4,266 | 04/06 | Thu | 05-06 PM | 9.6 | 41/59 |
| 15 | 3,144 | 02/08 | Tue | 07-08 AM | 14.4 | 2,523 | 04/27 | Thu | 05-06 PM | 11.2 | 4,263 | 04/14 | Fri | 05-06 PM | 9.6 | 41/59 |
| 16 | 3,144 | 02/15 | Tue | 07-08 AM | 14.4 | 2,520 | 05/03 | Wed | 04-05 PM | 11.1 | 4,250 | 04/17 | Mon | 05-06 PM | 9.6 | 40/60 |
| 17 | 3,144 | 02/22 | Tue | 07-08 AM | 14.4 | 2,509 | 04/13 | Thu | 05-06 PM | 11.1 | 4,250 | 05/17 | Wed | 04-05 PM | 9.6 | 40/60 |
| 18 | 3,144 | 02/29 | Tue | 07-08 AM | 14.4 | 2,505 | 03/21 | Tue | 05-06 PM | 11.1 | 4,249 | 04/10 | Mon | 05-06 PM | 9.6 | 40/60 |
| 19 | 3,084 | 01/05 | Wed | 07-08 AM | 14.1 | 2,505 | 08/28 | Mon | 05-06 PM | 11.1 | 4,247 | 04/11 | Tue | 05-06 PM | 9.6 | 41/59 |
| 20 | 3,084 | 01/12 | Wed | 07-08 AM | 14.1 | 2,504 | 04/06 | Thu | 05-06 PM | 11.1 | 4,241 | 04/28 | Fri | 04-05 PM | 9.5 | 40/60 |
| 21 | 3,084 | 01/19 | Wed | 07-08 AM | 14.1 | 2,498 | 04/14 | Fri | 05-06 PM | 11.0 | 4,235 | 05/03 | Wed | 04-05 PM | 9.5 | 40/60 |
| 22 | 3,084 | 01/26 | Wed | 07-08 AM | 14.1 | 2,497 | 05/16 | Tue | 04-05 PM | 11.0 | 4,203 | 03/30 | Thu | 05-06 PM | 9.5 | 41/59 |
| 23 | 3,050 | 02/03 | Thu | 07-08 AM | 14.0 | 2,495 | 07/21 | Fri | 05-06 PM | 11.0 | 4,202 | 04/26 | Wed | 05-06 PM | 9.5 | 41/59 |
| 24 | 3,050 | 02/10 | Thu | 07-08 AM | 14.0 | 2,494 | 04/11 | Tue | 05-06 PM | 11.0 | 4,201 | 01/11 | Tue | 05-06 PM | 9.5 | 43/57 |
| 25 | 3,050 | 02/17 | Thu | 07-08 AM | 14.0 | 2,484 | 03/30 | Thu | 05-06 PM | 11.0 | 4,195 | 03/23 | Thu | 05-06 PM | 9.4 | 41/59 |
| 26 | 3,050 | 02/24 | Thu | 07-08 AM | 14.0 | 2,483 | 05/02 | Tue | 04-05 PM | 11.0 | 4,195 | 05/04 | Thu | 04-05 PM | 9.4 | 41/59 |
| 27 | 2,932 | 02/04 | Fri | 07-08 AM | 13.4 | 2,482 | 05/04 | Thu | 04-05 PM | 11.0 | 4,191 | 02/29 | Tue | 07-08 AM | 9.4 | 75/25 |
| 28 | 2,932 | 02/11 | Fri | 07-08 AM | 13.4 | 2,476 | 03/23 | Thu | 05-06 PM | 10.9 | 4,188 | 02/28 | Mon | 07-08 AM | 9.4 | 76/24 |
| 29 | 2,932 | 02/18 | Fri | 07-08 AM | 13.4 | 2,476 | 07/19 | Wed | 05-06 PM | 10.9 | 4,188 | 03/21 | Tue | 05-06 PM | 9.4 | 40/60 |
| 30 | 2,932 | 02/25 | Fri | 07-08 AM | 13.4 | 2,476 | 08/31 | Thu | 05-06 PM | 10.9 | 4,178 | 04/07 | Fri | 05-06 PM | 9.4 | 42/58 |
| 31 | 2,926 | 01/04 | Tue | 07-08 AM | 13.4 | 2,472 | 01/18 | Tue | 04-05 PM | 10.9 | 4,175 | 02/22 | Tue | 07-08 AM | 9.4 | 75/25 |
| 32 | 2,926 | 01/11 | Tue | 07-08 AM | 13.4 | 2,462 | 04/26 | Wed | 05-06 PM | 10.9 | 4,172 | 05/16 | Tue | 04-05 PM | 9.4 | 40/60 |
| 33 | 2,926 | 01/18 | Tue | 07-08 AM | 13.4 | 2,459 | 08/03 | Thu | 05-06 PM | 10.9 | 4,168 | 02/01 | Tue | 07-08 AM | 9.4 | 75/25 |
| 34 | 2,926 | 01/25 | Tue | 07-08 AM | 13.4 | 2,457 | 11/01 | Wed | 05-06 PM | 10.9 | 4,160 | 03/17 | Fri | 05-06 PM | 9.4 | 42/58 |
| 35 | 2,914 | 01/07 | Fri | 07-08 AM | 13.4 | 2,450 | 05/01 | Mon | 04-05 PM | 10.8 | 4,158 | 05/02 | Tue | 04-05 PM | 9.4 | 40/60 |
| 36 | 2,914 | 01/14 | Fri | 07-08 AM | 13.4 | 2,446 | 01/04 | Tue | 05-06 PM | 10.8 | 4,153 | 04/25 | Tue | 05-06 PM | 9.3 | 42/58 |
| 37 | 2,914 | 01/21 | Fri | 07-08 AM | 13.4 | 2,443 | 07/25 | Tue | 05-06 PM | 10.8 | 4,143 | 03/13 | Mon | 05-06 PM | 9.3 | 38/62 |
| 38 | 2,914 | 01/28 | Fri | 07-08 AM | 13.4 | 2,439 | 03/22 | Wed | 05-06 PM | 10.8 | 4,142 | 02/15 | Tue | 07-08 AM | 9.3 | 76/24 |
| 39 | 2,913 | 01/06 | Thu | 07-08 AM | 13.4 | 2,439 | 11/27 | Mon | 05-06 PM | 10.8 | 4,134 | 03/09 | Thu | 05-06 PM | 9.3 | 42/58 |
| 40 | 2,913 | 01/13 | Thu | 07-08 AM | 13.4 | 2,436 | 08/08 | Tue | 05-06 PM | 10.8 | 4,132 | 02/09 | Wed | 07-08 AM | 9.3 | 76/24 |
| 50 | 2,829 | 03/22 | Wed | 07-08 AM | 13.0 | 2,415 | 03/09 | Thu | 05-06 PM | 10.7 | 4,104 | 04/04 | Tue | 05-06 PM | 9.2 | 43/57 |
| 60 | 2,787 | 03/02 | Thu | 07-08 AM | 12.8 | 2,401 | 04/14 | Fri | 04-05 PM | 10.6 | 4,070 | 01/10 | Mon | 07-08 AM | 9.2 | 78/22 |
| 80 | 2,719 | 04/25 | Tue | 07-08 AM | 12.5 | 2,376 | 09/28 | Thu | 05-06 PM | 10.5 | 4,014 | 02/23 | Wed | 07-08 AM | 9.0 | 79/21 |
| 100 | 2,572 | 05/19 | Fri | 07-08 AM | 11.8 | 2,349 | 03/20 | Mon | 04-05 PM | 10.4 | 3,967 | 03/10 | Fri | 04-05 PM | 8.9 | 42/58 |
| 130 | 2,348 | 06/07 | Wed | 07-08 AM | 10.8 | 2,330 | 05/05 | Fri | 03-04 PM | 10.3 | 3,907 | 04/26 | Wed | 07-08 AM | 8.8 | 70/30 |
| 500 | 1,811 | 12/01 | Fri | 08-09 AM | 8.3 | 2,051 | 03/15 | Wed | 03-04 PM | 9.1 | 3,561 | 01/14 | Fri | 06-07 PM | 8.0 | 49/51 |
| 1000 | 1,599 | 05/13 | Sat | 12-01 PM | 7.3 | 1,776 | 05/09 | Tue | 03-04 PM | 7.9 | 3,279 | 07/25 | Tue | 07-08 AM | 7.4 | 69/31 |
| | AADT: 21,823 | | | | | AADT: 22,632 | | | | | AADT: 44,455 | | | | | |
| | Hour1 /AADT: 14.6 % | | | | | Hour1 /AADT: 12.2 % | | | | | Hour1 /AADT: 10.4 % | | | | | |
| | Hour30 /AADT: 13.4 % | | | | | Hour30 /AADT: 10.9 % | | | | | Hour30 /AADT: 9.4 % | | | | | |
| | Hour100/AADT: 11.8 % | | | | | Hour100/AADT: 10.4 % | | | | | Hour100/AADT: 8.9 % | | | | | |

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# *Figure 8 – Average Monthly Volume Summary –ATR 464*

Run on Wednesday, February 14, 2001 at 15:03.

Minnesota Department of Transportation (Mn/DOT)
Summary of Continuous Count Station Data (ATRs)
Average Monthly Volumes

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| | Year | Jan. | Feb. | Mar. | Apr. | May | Jun. | Jul. | Aug. | Sept. | Oct. | Nov. | Dec. | YTD 12/31 | Annual Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Station 464, CSAH 19, .1 MI E OF TH61 in MAPLEWOOD, RAMSEY County, Metro District. | | | | | | | | | | | | | | | |
| East | 2000 | 10,144 | 10,392 | 11,028 | 11,307 | 11,390 | 11,565 | 10,617 | 11,368 | 11,015 | 11,070 | 11,188 | 12,355 | 11,122 | 11,122 |
| | 1999 | 9,305 | 10,167 | 10,726 | 11,440 | 11,068 | 11,369 | 10,474 | 11,459 | 11,004 | 11,592 | 11,652 | 12,945 | 11,105 | 11,105 |
| | % | 9.0 | 2.2 | 2.8 | -1.2 | 2.9 | 1.7 | 1.4 | -0.8 | 0.1 | -4.5 | -4.0 | -4.6 | 0.2 | 0.2 |
| Percent Estimated Data | 2000 | 0.0 | 0.0 | 0.0 | 2.6 | 0.0 | 0.0 | 9.3 | 0.0 | 0.0 | 3.2 | 41.0 | 0.0 | 4.6 | 4.6 |
| | 1999 | 10.1 | 50.0 | 0.0 | 1.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 4.8 | 4.8 |
| West | 2000 | 10,491 | 9,960 | 10,574 | 10,763 | 10,747 | 11,059 | 10,191 | 10,984 | 10,770 | 10,814 | 10,787 | 12,169 | 10,779 | 10,779 |
| | 1999 | 8,909 | 9,729 | 10,229 | 10,852 | 10,474 | 11,004 | 10,592 | 11,132 | 10,542 | 10,782 | 11,033 | 13,179 | 10,711 | 10,711 |
| | % | 17.8 | 2.4 | 3.4 | -0.8 | 2.6 | 0.5 | -3.8 | -1.3 | 2.2 | 0.3 | -2.2 | -7.7 | 0.6 | 0.6 |
| Percent Estimated Data | 2000 | 1.7 | 0.0 | 0.3 | 2.6 | 0.0 | 0.7 | 9.4 | 0.0 | 0.0 | 3.2 | 41.0 | 0.0 | 4.9 | 4.9 |
| | 1999 | 10.3 | 50.0 | 0.0 | 1.4 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 4.9 | 4.9 |
| Both | 2000 | 20,636 | 20,352 | 21,602 | 22,070 | 22,137 | 22,625 | 20,808 | 22,352 | 21,786 | 21,884 | 21,975 | 24,524 | 21,902 | 21,902 |
| | 1999 | 18,214 | 19,895 | 20,955 | 22,292 | 21,542 | 22,373 | 21,066 | 22,591 | 21,546 | 22,374 | 22,685 | 26,124 | 21,816 | 21,816 |
| | % | 13.3 | 2.3 | 3.1 | -1.0 | 2.8 | 1.1 | -1.2 | -1.1 | 1.1 | -2.2 | -3.1 | -6.1 | 0.4 | 0.4 |
| Percent Estimated Data | 2000 | 0.9 | 0.0 | 0.1 | 2.6 | 0.0 | 0.3 | 9.3 | 0.0 | 0.0 | 3.2 | 41.0 | 0.0 | 4.8 | 4.8 |
| | 1999 | 10.2 | 50.0 | 0.0 | 1.4 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 4.8 | 4.8 |
| Station 465, MSAS 32, .1 MI S OF ST CLAIR AVE in ST PAUL, RAMSEY County, Metro District. | | | | | | | | | | | | | | | |
| North | 2000 | 6,176 | 6,670 | 6,783 | 7,132 | 7,555 | 7,593 | 7,107 | 7,334 | 7,423 | 7,206 | 6,899 | 6,551 | 7,035 | 7,035 |
| | 1999 | 5,964 | 6,588 | 6,615 | 7,030 | 7,074 | 7,363 | 6,722 | 6,632 | 7,068 | 7,024 | 6,894 | 6,660 | 6,801 | 6,801 |
| | % | 3.6 | 1.2 | 2.5 | 1.5 | 6.8 | 3.1 | 5.7 | 10.6 | 5.0 | 2.6 | 0.1 | -1.6 | 3.4 | 3.4 |
| Percent Estimated Data | 2000 | 0.0 | 17.2 | 100.0 | 100.0 | 2.4 | 0.0 | 24.6 | 12.9 | 100.0 | 3.6 | 0.0 | 0.0 | 29.9 | 29.9 |
| | 1999 | 2.4 | 0.6 | 0.0 | 0.0 | 0.0 | 0.0 | 33.3 | 17.5 | 0.1 | 2.4 | 0.0 | 0.0 | 4.8 | 4.8 |
| South | 2000 | 5,880 | 6,401 | 6,677 | 6,893 | 7,109 | 7,230 | 6,804 | 6,893 | 7,088 | 6,865 | 6,560 | 6,218 | 6,717 | 6,717 |
| | 1999 | 5,614 | 6,279 | 6,304 | 6,741 | 6,852 | 7,054 | 6,421 | 6,352 | 6,590 | 6,668 | 6,584 | 6,383 | 6,486 | 6,486 |
| | % | 4.7 | 1.9 | 5.9 | 2.3 | 3.8 | 2.5 | 6.0 | 8.5 | 7.6 | 3.0 | -0.4 | -2.6 | 3.6 | 3.6 |
| Percent Estimated Data | 2000 | 0.0 | 17.2 | 100.0 | 100.0 | 2.4 | 0.1 | 24.6 | 13.8 | 100.0 | 4.0 | 0.0 | 0.1 | 30.1 | 30.1 |
| | 1999 | 3.0 | 1.8 | 1.1 | 0.0 | 0.0 | 0.0 | 24.2 | 18.7 | 0.0 | 2.6 | 0.0 | 0.0 | 4.3 | 4.3 |
| Both | 2000 | 12,056 | 13,071 | 13,460 | 14,025 | 14,664 | 14,822 | 13,911 | 14,226 | 14,511 | 14,070 | 13,458 | 12,769 | 13,752 | 13,752 |
| | 1999 | 11,578 | 12,868 | 12,918 | 13,772 | 13,926 | 14,417 | 13,143 | 12,984 | 13,658 | 13,692 | 13,478 | 13,043 | 13,287 | 13,287 |
| | % | 4.1 | 1.6 | 4.2 | 1.8 | 5.3 | 2.8 | 5.8 | 9.6 | 6.2 | 2.8 | -0.1 | -2.1 | 3.5 | 3.5 |
| Percent Estimated Data | 2000 | 0.0 | 17.2 | 100.0 | 100.0 | 2.4 | 0.1 | 24.6 | 13.4 | 100.0 | 3.8 | 0.0 | 0.1 | 30.0 | 30.0 |
| | 1999 | 2.7 | 1.2 | 0.5 | 0.0 | 0.0 | 0.0 | 28.8 | 18.1 | 0.1 | 2.5 | 0.0 | 0.0 | 4.6 | 4.6 |

# *Figure 9 – Hourly Volume Summary –ATR 8*

Minnesota Department of Transportation
Continuous Count Station Edited Data for January

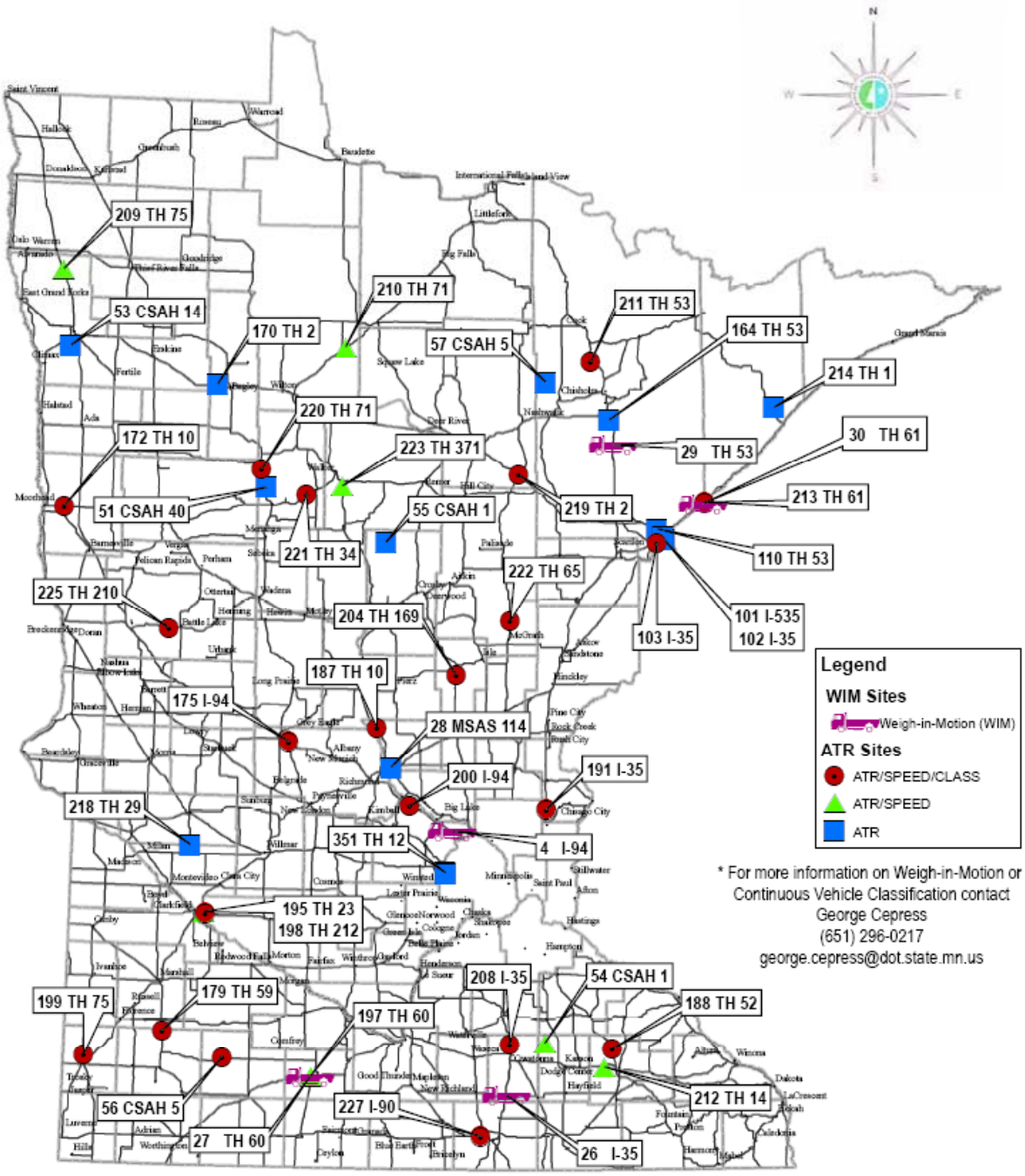
11:08 Thursday, March 28, 2002 1

Station 8, Direction East, January

| DATE | DAY | HR1 | HR2 | HR3 | HR4 | HR5 | HR6 | HR7 | HR8 | HR9 | HR10 | HR11 | HR12 | HR13 | HR14 | HR15 | HR16 | HR17 | HR18 | HR19 | HR20 | HR21 | HR22 | HR23 | HR24 | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan 1, 2002 | Tuesday | 3 | 12 | 4 | 4 | 4 | 3 | 1 | 3 | 3 | 4 | 7 | 6 | 16 | 13 | 10 | 19 | 12 | 17 | 11 | 9 | 8 | 10 | 16 | 5 | 200 |
| Jan 2, 2002 | Wednesday | 2 | 0 | 0 | 1 | 0 | 3 | 7 | 14 | 13 | 19 | 27 | 22 | 23 | 21 | 39 | 25 | 21 | 22 | 16 | 16 | 13 | 10 | 0 | 6 | 320 |
| Jan 3, 2002 | Thursday | 2 | 0 | 2 | 0 | 2 | 4 | 6 | 50 | 33 | 15 | 9 | 21 | 18 | 21 | 22 | 34 | 33 | 33 | 61 | 20 | 13 | 20 | 3 | 0 | 422 |
| Jan 4, 2002 | Friday | 4 | 1 | 1 | 0 | 0 | 3 | 5 | 39 | 28 | 31 | 18 | 28 | 20 | 15 | 21 | 40 | 47 | 94 | 76 | 48 | 25 | 49 | 25 | 28 | 646 |
| Jan 5, 2002 | Saturday | 6 | 7 | 3 | 1 | 0 | 2 | 11 | 8 | 9 | 18 | 27 | 17 | 18 | 21 | 19 | 23 | 20 | 10 | 15 | 16 | 16 | 8 | 14 | 8 | 297 |
| Jan 6, 2002 | Sunday | 2 | 4 | 2 | 0 | 0 | 1 | 2 | 6 | 16 | 13 | 15 | 6 | 15 | 9 | 12 | 21 | 11 | 5 | 27 | 15 | 19 | 12 | 9 | 1 | 223 |
| Jan 7, 2002 | Monday | 1 | 0 | 0 | 0 | 1 | 2 | 6 | 50 | 25 | 22 | 15 | 15 | 15 | 12 | 26 | 46 | 29 | 25 | 18 | 8 | 8 | 5 | 4 | 3 | 336 |
| Jan 8, 2002 | Tuesday | 2 | 2 | 2 | 0 | 0 | 4 | 6 | 52 | 24 | 27 | 16 | 19 | 23 | 19 | 24 | 39 | 46 | 82 | 53 | 36 | 8 | 42 | 6 | 5 | 537 |
| Jan 9, 2002 | Wednesday | 0 | 0 | 0 | 0 | 0 | 4 | 9 | 42 | 32 | 25 | 16 | 16 | 21 | 14 | 24 | 35 | 31 | 20 | 34 | 12 | 11 | 5 | 4 | 2 | 357 |
| Jan 10, 2002 | Thursday | 0 | 1 | 0 | 0 | 0 | 3 | 3 | 54 | 19 | 16 | 18 | 19 | 22 | 11 | 14 | 25 | 50 | 30 | 13 | 9 | 8 | 8 | 11 | 4 | 338 |
| Jan 11, 2002 | Friday | 0 | 1 | 0 | 0 | 0 | 2 | 7 | 50 | 37 | 16 | 15 | 25 | 28 | 17 | 19 | 33 | 34 | 30 | 11 | 8 | 6 | 11 | 5 | 2 | 357 |
| Jan 12, 2002 | Saturday | 1 | 7 | 2 | 1 | 1 | 1 | 4 | 20 | 36 | 25 | 19 | 8 | 19 | 16 | 11 | 14 | 12 | 16 | 13 | 11 | 7 | 9 | 13 | 12 | 278 |
| Jan 13, 2002 | Sunday | 6 | 6 | 3 | 3 | 0 | 2 | 2 | 2 | 19 | 4 | 18 | 7 | 8 | 14 | 17 | 17 | 22 | 13 | 19 | 10 | 7 | 16 | 1 | 2 | 218 |
| Jan 14, 2002 | Monday | 0 | 1 | 0 | 0 | 1 | 1 | 9 | 46 | 22 | 14 | 17 | 12 | 27 | 22 | 27 | 35 | 39 | 51 | 68 | 28 | 25 | 18 | 2 | 2 | 467 |
| Jan 15, 2002 | Tuesday | 4 | 1 | 0 | 0 | 0 | 2 | 6 | 47 | 23 | 20 | 17 | 18 | 28 | 24 | 19 | 33 | 37 | 20 | 8 | 9 | 6 | 19 | 12 | 3 | 356 |
| Jan 16, 2002 | Wednesday | 1 | 0 | 1 | 1 | 1 | 3 | 8 | 48 | 24 | 10 | 24 | 14 | 30 | 16 | 20 | 28 | 34 | 31 | 23 | 12 | 13 | 5 | 8 | 6 | 361 |
| Jan 17, 2002 | Thursday | 1 | 5 | 1 | 0 | 1 | 2 | 4 | 54 | 26 | 21 | 16 | 14 | 38 | 22 | 22 | 32 | 41 | 25 | 19 | 18 | 10 | 5 | 10 | 7 | 394 |
| Jan 18, 2002 | Friday | 2 | 3 | 0 | 0 | 0 | 2 | 8 | 23 | 19 | 18 | 14 | 15 | 23 | 21 | 16 | 21 | 26 | 19 | 25 | 10 | 13 | 9 | 4 | 3 | 294 |
| Jan 19, 2002 | Saturday | 5 | 1 | 0 | 4 | 3 | 2 | 3 | 24 | 13 | 17 | 16 | 17 | 10 | 16 | 14 | 13 | 20 | 14 | 22 | 14 | 16 | 19 | 8 | 4 | 275 |
| Jan 20, 2002 | Sunday | 10 | 1 | 3 | 1 | 0 | 2 | 1 | 6 | 6 | 14 | 34 | 9 | 18 | 13 | 15 | 10 | 8 | 13 | 30 | 10 | 14 | 10 | 8 | 9 | 245 |
| Jan 21, 2002 | Monday | 3 | 3 | 0 | 1 | 1 | 1 | 5 | 18 | 10 | 19 | 11 | 16 | 13 | 18 | 29 | 27 | 23 | 54 | 65 | 25 | 18 | 12 | 4 | 3 | 379 |
| Jan 22, 2002 | Tuesday | 3 | 1 | 1 | 0 | 0 | 2 | 6 | 49 | 18 | 15 | 23 | 17 | 21 | 13 | 19 | 33 | 43 | 22 | 10 | 10 | 3 | 17 | 11 | 6 | 343 |
| Jan 23, 2002 | Wednesday | 1 | 3 | 1 | 0 | 1 | 0 | 7 | 51 | 23 | 16 | 16 | 11 | 14 | 15 | 20 | 31 | 20 | 27 | 9 | 10 | 8 | 9 | 3 | 0 | 296 |
| Jan 24, 2002 | Thursday | 0 | 0 | 1 | 0 | 1 | 3 | 7 | 62 | 20 | 16 | 14 | 12 | 23 | 9 | 29 | 33 | 34 | 25 | 17 | 12 | 8 | 13 | 8 | 0 | 347 |
| Jan 25, 2002 | Friday | 1 | 0 | 0 | 0 | 1 | 3 | 4 | 49 | 18 | 11 | 13 | 13 | 18 | 12 | 21 | 28 | 37 | 112 | 68 | 30 | 15 | 18 | 15 | 3 | 490 |
| Jan 26, 2002 | Saturday | 7 | 2 | 1 | 0 | 0 | 0 | 1 | 11 | 10 | 13 | 18 | 15 | 16 | 8 | 12 | 14 | 13 | 18 | 14 | 12 | 12 | 7 | 8 | 6 | 218 |
| Jan 27, 2002 | Sunday | 9 | 8 | 7 | 1 | 0 | 0 | 3 | 4 | 15 | 12 | 25 | 12 | 8 | 9 | 9 | 10 | 19 | 18 | 16 | 10 | 14 | 16 | 4 | 4 | 233 |
| Jan 28, 2002 | Monday | 0 | 0 | 1 | 0 | 0 | 3 | 6 | 67 | 22 | 25 | 14 | 13 | 22 | 17 | 19 | 28 | 26 | 23 | 25 | 6 | 6 | 13 | 2 | 0 | 338 |
| Jan 29, 2002 | Tuesday | 0 | 2 | 0 | 0 | 0 | 3 | 10 | 54 | 19 | 18 | 17 | 16 | 21 | 18 | 19 | 33 | 17 | 76 | 63 | 17 | 16 | 6 | 3 | 1 | 429 |
| Jan 30, 2002 | Wednesday | 1 | 3 | 0 | 1 | 0 | 2 | 9 | 51 | 25 | 20 | 21 | 19 | 15 | 12 | 15 | 35 | 33 | 28 | 26 | 23 | 5 | 6 | 3 | 4 | 357 |
| Jan 31, 2002 | Thursday | 3 | 2 | 1 | 0 | 1 | 7 | 7 | 52 | 20 | 16 | 9 | 20 | 23 | 15 | 20 | 29 | 33 | 27 | 23 | 11 | 6 | 1 | 7 | 2 | 335 |

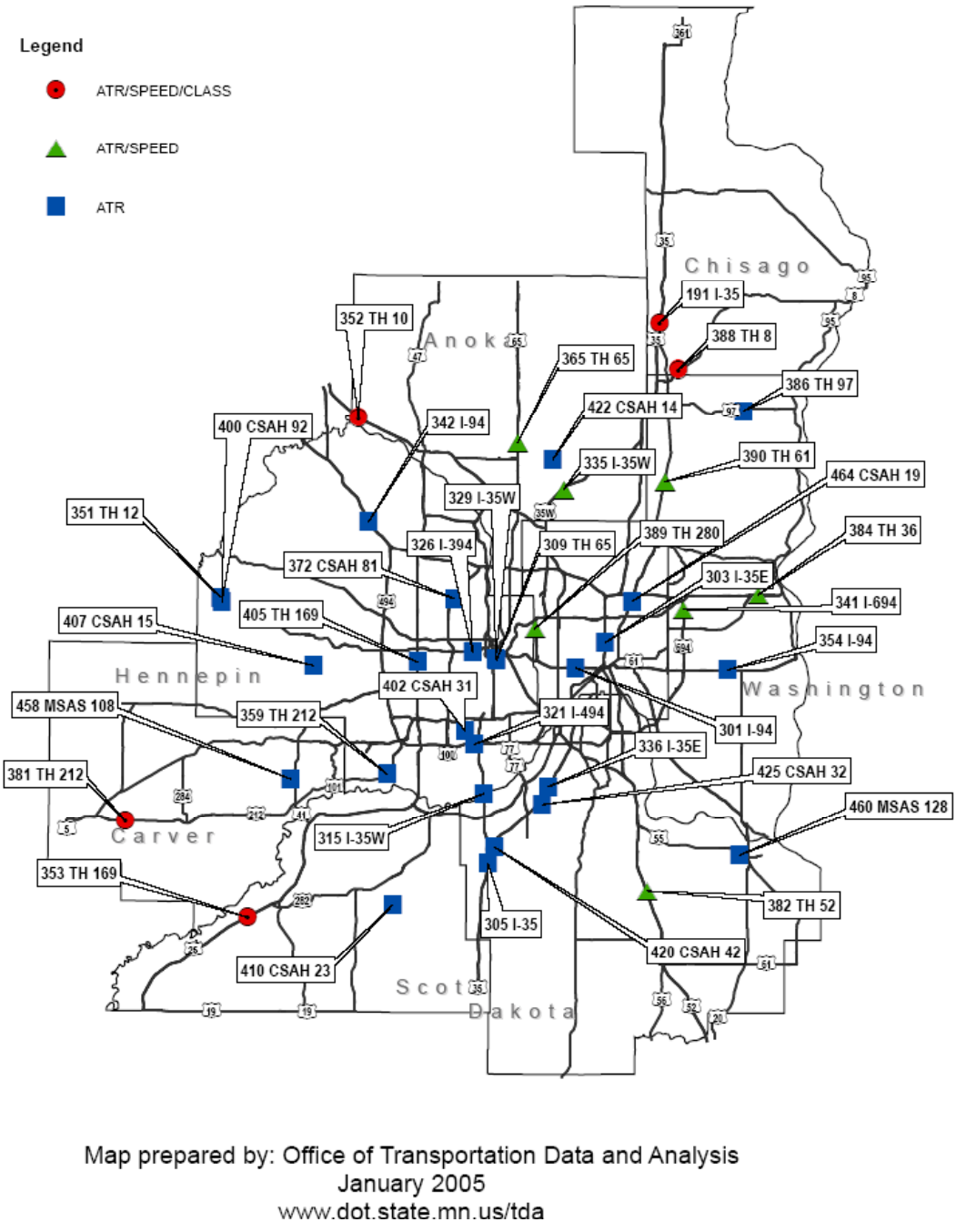
| AVERAGES: | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday | Weekday | Weekend | All Days |
|---|---|---|---|---|---|---|---|---|---|---|
| | 380 | 373 | 338 | 367 | 447 | 267 | 230 | 381 | 249 | 343 |

*Figure 10 – Continuous Counting Sites - Statewide*



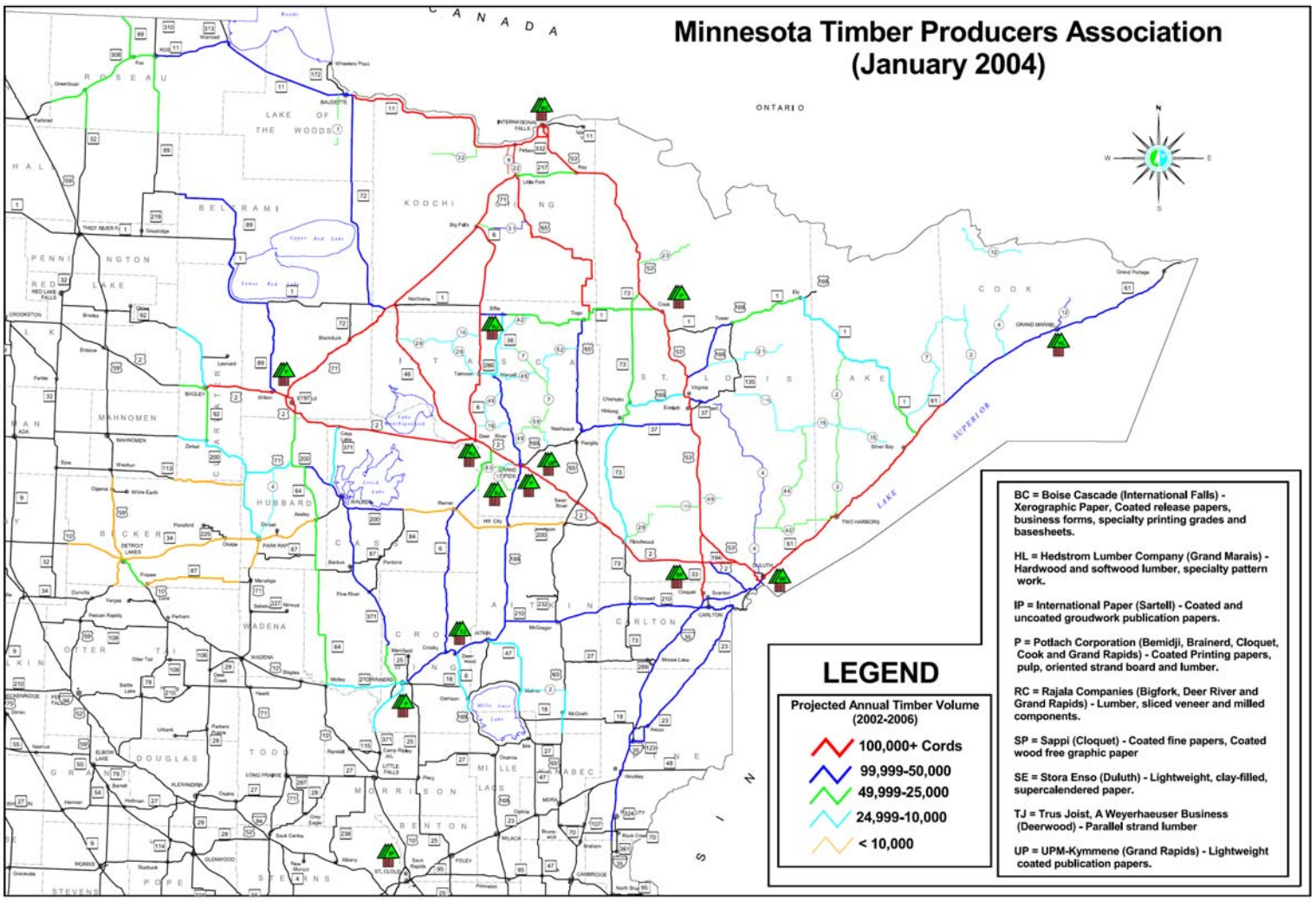

Map prepared by: Office of Transportation Data and Analysis
January 2005
www.dot.state.mn.us/tda

*Figure 11 Continuous Counting Sites – Metro Area*




Map prepared by: Office of Transportation Data and Analysis
January 2005
www.dot.state.mn.us/tda

*Figure 12 – Heavy Truck Route for Stake Trucks*



## ***FORECASTING TECHNIQUES, TIPS, HELPFUL HINTS & MISC***

***Addition of trucks above and beyond vehicle class site information***

*Example 1- adding additional trucks to a traffic forecast due to local knowledge-* During the course of a traffic forecast, the forecaster may have knowledge through counts, observation or talking with local officials that additional trucks should be added to a forecast over and above the vehicle class counts. If, for example, a vehicle class count is taken in the spring and it is suspected that the fall harvest may affect the count, additional trucks may be added to the project. This happens frequently on the county road system.

In our first example, the forecaster knows that 66 2-way additional 5-axle semis should be added to vehicle class count 9205 to account for sugar beet movements. We will assume this number will be spread out over the entire year. We are also going to observe that the 66 semis should be split (see previous discussion regarding heavy trucks) into "maximum" (fully loaded 80,000 pound trucks at a ESAL factor of 2.4) and "other" less than fully loaded at an ESAL factor of 0.87. See the bottom of ESAL worksheet A or B for these factors. In our examples we always use flexible (not rigid factors).

We are going to discuss only the A segment portion of the MnESAL, not the 16-24 vehicle expansion worksheet or the average vehicle class count worksheet. The forecaster should unprotect ESALS worksheet A by going to TOOLS –UNPROTECT—WORKSHEET in Excel. This will allow the forecaster to manually change the percents under the Base Year Proportions column. In this example, assume the following percentages have already been calculated on your Worksheet A and that 8.7% 5-axle semis have already been split automatically on your averages worksheet and transferred to the A segment. Assume there are already 70 five axle semis and we are going to add 66.

| | | | |
|---|---|---|---|
| 5 Ax+ TST | 0 | 0 | |
| 5 Ax+ TST Max | 4.5% | 30 +33 | |
| 5 Ax+ TST Other | 4.2% | 40 +33 | (70 existing) |

With the worksheet unprotected, manually "adjust" the percentage upwards until the resultant truck volumes look like the following:

| | | | |
|---|---|---|---|
| 5 Ax+ TST | 0 | 0 | |
| 5 Ax+ TST Max | 7% | 63 | |
| 5 Ax+ TST Other | 9% | 73 | (70 existing + 66 new) = 135 |

In this example, we have manipulated the percentages on the MnESAL to account for additional trucks. This procedure can likewise be done on Worksheet B – thus increasing or decreasing the 5.9% heavy commercial default percentage by unprotecting the worksheet and manipulated the percents. *Once the percents have been manually adjusted; the formatting that automatically transferred the vehicle percents from the*

*averages worksheet to the A segment worksheet is gone*; however, many forecasters find it more advantageous to do multiple A segments by just changing the heavy commercial vehicle percents with each change in vehicle class site used. In this way you can document (print) all A segments and it will eliminate some additional work, ultimately saving time. Again, more familiarity with Excel may allow the forecaster to simply save every change in the A segment worksheet to another file (if he or she wants a computer record of every A segment change or more than one vehicle class site).

*Example 2 of adding additional trucks to a traffic forecast due to local knowledge-*
In another example of adding vehicles to the mix, let us say the forecaster obtains information of a construction project involving trucks generated from two gravel pits that will add 35 five + axle semis to the mix. In this case, we are going to prorate the number of vehicles by duration. In a similar instance, the forecaster may know that there will be a two-month construction project, or a three-month harvest season. In this example, instead of five days, the construction project is six days a week; in addition, we have obtained information that the project will last for about nine months.

The forecaster may then calculate 35 five-axle trucks per day times six days per week times 31 weeks totals 6510 five-axle semis. We then proceed to divide 6510 by 365 days a year to determine the additional 5+ axle semis added to the mix. The resultant 18 five+ axle semis per day have been prorated for 9 months into a HCAADT for 5+ axle semis.

Taking the next step, we can take the 18 five-axle semis and calculate that they are one-way trips. Multiplying the 18 semis by two equals 36. Then, we may calculate that these trucks are using two gravel pits and that involves a certain amount of back and forth traffic. Finally, if we divide the 36 semis by two gravel pits we decide that about 18-20 additional 5+ axle semis should be added to the mix. Similar to previous example, we go right to the A Worksheet, unprotect it and manually increase the 5+ axle semi percent until the additional 20 are accounted for.

The above two examples show the type of judgment and logic that can be applied to any traffic forecast. As long as there is adequate analysis applied to a forecast and the reasons can be documented with valid research, there are no wrong assumptions applied to a traffic forecast. As long as the MnESALs procedure is followed correctly and there are no procedural errors, any professional judgment on any individual traffic forecast should be valid. There are no shortcuts to doing a complete and thorough job. When adding trucks, it is important to keep in mind the heavy aspect of the trucks. From our previous material, we have learned that *we split grain trucks, tank trucks, dump trucks and stake trucks on timber routes (figure 12) if the number on our vehicle class site is 30% or more*. If the forecaster suspects that the route in question may carry grain, gravel, liquids, timber, etc, short duration manual counts should be performed to make that determination. *Figure 13 (page 79)* shows samples of some various types of "heavy" trucks.

***Use of Short Traffic Counts in a Traffic Forecast***

In the discussions above, we talk about adding trucks to the mix. Previously, this manual has touched upon the importance on taking short counts and visiting the project area to increase personal knowledge of the area. This section discusses short traffic count methods and techniques that the Traffic Forecast Section uses to determine hourly percentages and enhance short counts. In essence, the forecaster can take short counts of all traffic, short counts of just heavy commercial traffic or short counts of a particular vehicle type (5-axle semis). The forecaster may also consider requesting an additional tube or manual count from the district or central office – depending on who does the traffic counting.

The following is an example of adjusting a short (less than 16 hour) count. This example is 29th Street South in St. Cloud (next to the County Highway Department). Other than using a short count, it follows the traditional technique of a traffic forecast outlined in this manual. It assumes a base year of 2001 and a forecast year of 2021. Please note the comments on the REMARKS section of the Memo page.

Subject: TRAFFIC FORECAST

Route: 28th Street South — SP#

Letting Date: May 2, 2021 — Forecast # F-Stearns-01

Program Category: Resurfacing — County: Stearns

Project Manager: Gene Skok — District: 3

Miles: 0.2

Project Limits: 28th Street in St Cloud next to County Highway Department

Enclosures (check those that apply):

| | | | |
|---|---|---|---|
| x | Project map | | VCL expansion worksheet |
| | Least squares analysis | | Cumulative ESAL Report |
| x | Cumulative ESAL worksheet, Segment A | | Other (describe) |
| | Cumulative ESAL worksheet, Segment B | | Other (describe) |
| x | AADT and/or DHV traffic schematic diagram | | |

REMARKS:

Assume 2% year traffic growth (typical outstate growth rate)
Assume 11 to 12 AM auto traffic is 5.9% of the 16 hour (6 AM to 10 PM) (from 1999 tube study)
Assume11 to 12 AM truck traffic is 8.6 percent of the 16 hour (6 AM to 10 PM (6am -10pm is roughly 90% ot the 24 hr traffic)

This is an example of an ESAL forecast that we would prepare if we were to do a vehicle class count on a road in your county (5.9% and 8.6% no's based on arc 99 study

This is a 20 year ESAL forecast with a base year of 2001 and a forecast year of 2021

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Due to the proximity of the gravel pit we split the 5 axle truck traffic to reflect the heavier loads
**NOTE THAT THIS IS AN EXAMPLE ONLY. WITH DATA COLLECTED FOR ONE HOUR.**

For this forecast, a one hour tube count (11am to 12 noon) was taken in May and then grouped into the eight vehicle types used for forecasting:

| VEH TYPE | 1 HR | | | |
|---|---|---|---|---|
| PASS VEH | 322 | / .059 | = | 5450 |
| 2 AX SU | 19 | / .086 | = | 250 |
| 3+AX SU | 25 | / .086 | = | 300 |
| 3 AX SEMI | 2 | / .086 | = | 25 |
| 4 AX SEMI | 4 | / .086 | = | 50 |
| 5+ AX SEMI | 20 | / .086 | = | 250 |
| TRKL TRLR/BUS | 6 | / .086 | = | 70 |
| TWINS | 0 | / .086 | = | 0 |
| TOTAL | 398 | | | |

Previous studies have shown that the 16-hour raw count from 6am to 10pm is approximately 90% of the 24 - hour volume. Hourly tables are included on pages 103-106 *(figures 24-26).* In this case, we will expand the class count from one hour to reflect 16 hours counted in May.

Using information from a previous study of vehicle class sites done in the Traffic Forecast Section, it was determined that in the 11am to 12 noon hour trucks were 8.6% of the 16 hour count and cars were 5.9% of the raw 16 hour count *(figure 26).* Then (above), we divide those percents to determine a 16-hour count (similar to the manual vehicle class sites we have looked at previously).

The forecaster now has all the information to complete the 16 to 24 hour vehicle class expansion worksheet (see below).

**16 HR. OR 24 HR. VEHICLE CLASS COUNT EXPANSION WORKSHEET 1**

**SITE NUMBER:** 6326 **COUNTY:** Stearns

**SITE DESCRIPTION:** 28th Street in St Cloud

**PROJECT SP#:** 0 **YEAR OF COUNT ->:** 2001

**MONTH NUMBER OF COUNT:** 5 **CONSTRAIN AADT ->:** 6400

**16 or 24 HR** 16

| VEHICLE TYPE | RAW COUNT | AADT ADJ FACTOR | | ADJUSTED RAW | VEH. TYPE PERCENTS | | A.C.F. |
|---|---|---|---|---|---|---|---|
| CARS AND PICKUPS | 5450 | #N/A | | 5642 | | | 0.92 |
| 2 AXLE 6 TIRE | 250 | 0.78 | | 196 | 3.1% | | |
| 3+ AXLE SINGLE UNIT | 300 | 0.76 | | 227 | 3.5% | | |
| 3 AXLE SEMI (TST) | 25 | 0.69 | | 17 | 0.3% | | |
| 4 AXLE SEMI (TST) | 50 | 0.80 | | 40 | 0.6% | | |
| 5+ AXLE SEMI (TST) | 250 | 0.89 | | 223 | 3.5% | | |
| TR TR, BUSES | 70 | 0.78 | | 55 | 0.9% | | |
| TWIN TRAILERS | 0 | 0.89 | | 0 | 0.0% | | |
| TOTALS ----------> | 6395 | --------> | 1.0 | 6400 | 11.8% | (%HC) | |

**6326**

**28th Street in St Cloud**

Since there is only one vehicle class count in our forecast, there is no real need to use the vehicle class count averages worksheet. The forecaster could go straight to the A segment worksheet and input the vehicle percentages and the appropriate AADT to produce the ESAL forecast. Again, in this example of a city street where no historical counts were available, a forecaster could use this method to produce a forecast. We recommend a minimum of an eight-hour count that covers the morning or afternoon peak hours (i.e., 6am-9am or 3pm to 6pm). This example or method could be used on streets and roadways where no count data is available.

## Vehicle Class Count Averages Worksheet

VCC Site Num. 6326
TH 28 TH
Description 28th Street in St Cloud

| | | 16-24 Vehicle C.C.1 | | 16-24 Vehicle C.C.2 | | 16-24 Vehicle C.C.3 | | 16-24 Vehicle C.C.4 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Type** | **Year** | **Pct** | **Year** | **Pct** | **Year** | **Pct** | **Year** | **Pct** | **Avg Truck Volumes** | **Avg Vehicle Pctages** |
| | | 2001 | | | | | | | | | |
| | **Man/Tube** | Manual | | | | | | | | | |
| 1 | **Cars** | 5642 | *88.16%* | | | | | | | | *88.16%* |
| 2 | **2 ASU** | 196 | *3.06%* | | | | | | | *196* | *3.06%* |
| 3 | **3+ASU** | 227 | *3.55%* | | | | | | | *227* | *3.55%* |
| 4 | **3ASemi** | 17 | *0.27%* | | | | | | | *17* | *0.27%* |
| 5 | **4ASemi** | 40 | *0.63%* | | | | | | | *40* | *0.63%* |
| 6 | **5+Asemi** | 223 | *3.48%* | | | | | | | *223* | *3.48%* |
| 7 | **TT/BUS** | 55 | *0.86%* | | | | | | | *55* | *0.86%* |
| 8 | **Twins** | 0 | *0.00%* | | | | | | | *0* | *0.00%* |
| Total | | *6400* | *11.84%* | | | | | | | | *11.84%* |
| Total Heavy Comm | | *758* | | | | | | | | *758* | *100.00%* |
| Heavy 5 Ax Semi* | | | 40.0% | | | | | | | | 40.00% |
| Axle Corr Factor | | | 0.92 | | | | | | | | 0.92 |

* Heavy 5 Ax Semi = Tank, Dump, Grain (and Stake if on Timber route-Dist 1,2, or 3)
When the Tank, Dumps, & Grains and sometimes stakes are 30% or more of the 5 axle semis, then split into max and other categories (AUTOMATICALLY DONE) ---------->
Check out tube counts prior to 1996 carefully, body types are N/A prior to 1982, don't use tube collected previous to 1990.

| Heavy 5 Axle Semi Split | |
|---|---|
| *1.39%* | Max |
| *2.09%* | Others |
| ***SPLIT*** | |

NOTE: IF LESS THAN 4 ENTRIES, BE SURE
TO DELETE YEAR AND PCT COLUMN
DO NOT USE 0, LEAVE BLANK.
USER MUST THEN COPY THE FORMULA IN THE
PCT COLUMNS BACK TO THE APPROPRIATE COLUMN
FOR HELP CALL MARK LEVENSON - 651 -296-8535 OR TOM NELSON - 651-297-1197.

Since we are producing an ESAL at a specific site, we will be doing an A segment only. No need for a B segment with just one location or junction. The assumption used will be a 2% growth rate per year. It is also assumed that the land use and growth patterns will not change and no new truck generators are planned; therefore a 2% growth rate over 20 years translates into multiplying the 2001 AADT by 1.4 (2% per year times 20 years). The 2001 AADT we have calculated times 1.4 is roughly the 9000 AADT number that is

entered on the A segment worksheet. See both the A segment Worksheet and A Segment Report below for the completed ESAL forecast.

**CUMULATIVE ESALS WORKSHEET** **SEGMENT A**

**SP#:** 0
**ROUTE:** 28th Street So **# LANES:** 2 **DATE:** 04/09/02
**LOCATION:** 28th Street in St Cloud
**VCL SITE #:** 6326

| | YEAR | AADT | INIT CALC HCADT | CONSTRN HCADT | INIT CALC 5AX TST | CONSTRAIN 5AX TST |
|---|---|---|---|---|---|---|
| **VEH.CLASS YR.:** | 2001 | 6400 | 760 | 0.0% | --- | --- |
| **BASE YEAR:** | 2001 | 6400 | 760 | | 223 | |
| **FORECAST YEAR:** | 2021 | 9000 | 1070 | | 314 | |

| **BASE YEAR PROPORTIONS** | | BASE YR. VOLUME | % TREND | FUTURE % | FUTURE VOL. |
|---|---|---|---|---|---|
| **2AX-6TIRE SU** | 3.1% | 197 | 1 | 3.1% | 277 |
| **3AX+ SU** | 3.5% | 228 | 1 | 3.5% | 320 |
| **3AX TST** | 0.3% | 17 | 1 | 0.3% | 24 |
| **4AX TST** | 0.6% | 40 | 1 | 0.6% | 56 |
| **5AX+ TST** | 0 | 0 | 1 | 0.0% | 0 |
| **(5AX+ TST MAX)** | 1.4% | 89 | 1 | 1.4% | 126 |
| **(5AX+ TST OTH)** | 2.1% | 134 | 1 | 2.1% | 189 |
| **TR TR, BUSES** | 0.9% | 55 | 1 | 0.9% | 78 |
| **TWIN TRAILERS** | 0.0% | 0 | 1 | 0.0% | 0 |

| **SUMMARIES:** | | AADT | HCADT | HCADT % | 20 YR DESIGN LANE CUMULATIVE ESAL |
|---|---|---|---|---|---|
| 2001 | **COUNT:** | 6400 | 760 | 11.9% | \| |
| 2001 | **FORECAST:** | 6400 | 760 | 11.9% | ********** |
| 2021 | **FORECAST:** | 9000 | 1070 | 11.9% | ********** |

| | | FLEXIBLE | RIGID |
|---|---|---|---|
| **DESIGN LANE FACTOR:** | 0.5 | **2,972,000** | **4,502,000** |
| | | ********** | ********** |

| **ADDITIONAL OUTPUTS:** | | | ESAL FACTORS | |
|---|---|---|---|---|
| | **BASE %** | **FORECAST %** | **FLEXIBLE** | **RIGID** |
| **2AX-6TIRE SU** | 3.1% | 3.1% | 0.25 | 0.24 |
| **3AX+ SU** | 3.6% | 3.6% | 0.58 | 0.85 |
| **3AX TST** | 0.3% | 0.3% | 0.39 | 0.37 |
| **4AX TST** | 0.6% | 0.6% | 0.51 | 0.53 |
| **5AX+ TST** | 0.0% | 0.0% | 1.13 | 1.89 |
| **(5AX+ TST MAX)** | 1.4% | 1.4% | 2.40 | 4.07 |
| **(5AX+ TST OTH)** | 2.1% | 2.1% | 0.87 | 1.44 |
| **TR TR, BUSES** | 0.9% | 0.9% | 0.57 | 0.74 |
| **TWIN TRAILERS** | 0.0% | 0.0% | 2.40 | 2.33 |

**Notes:**

## CUMULATIVE ESAL REPORT - A

**DATE:** 04/09/02

**ROUTE #:** 28th Street **DISTRICT:** 3 **SP#:** 0

**FORECAST #:** F-Stearns-01 **COUNTY:** STEARNS **MILES:** _____

**DESCRIPTION:** 28th Street in St Cloud

**AUTHOR'S DISTRICT: --->** C.O. **AUTHOR:** Levenson

**TRAFFIC SUMMARY**

**BASE YEAR NUMBER OF LANES (two way):** 2

| BASE YEAR ---> | 0 | DESIGN YEAR ----> | 20 | GROWTH / YR (SIMPLE %) |
|---|---|---|---|---|
| **AADT: two-way** | 6400 | | 9000 | 2.0% |
| **design-lane** | 3200 | | 4,500 | 2.0% |
| **HCADT: two-way** | 760 | | 1,070 | 2.0% |
| **SINGLE UNITS:two-way** | 430 | | 600 | 2.0% |
| **TST'S: two-way** | 280 | | 395 | 2.1% |

**ESAL SUMMARY**

**ANNUAL DESIGN LANE ESAL**

| | | | |
|---|---|---|---|
| **FLEXIBLE:** | 104,826 | 147,855 | + |
| **RIGID:** | 158,792 | 224,049 | + |

**CUMULATIVE DESIGN-LANE ESALS (10 TON)** **Design-lane factor:** **0.5**

| DESIGN YEAR | DESIGN-LANE TST'S | ESALS FLEXIBLE | ESALS RIGID |
|---|---|---|---|
| 10 | 169 | 1,424,000 | 2,157,000 |
| 15 | 183 | 2,168,000 | 3,284,000 |
| 20 | 198 | **2,972,000** | **4,502,000** |
| **** OR ** DESIGN YEAR** | | | |
| 21 | 200 | 3,022,000 | 4,579,000 |
| 22 | 203 | 3,073,000 | 4,656,000 |
| 23 | 206 | 3,123,000 | 4,732,000 |
| 24 | 209 | 3,174,000 | 4,809,000 |
| 25 | 212 | 3,225,000 | 4,886,000 |

**35 YEAR CUMULATIVE ESAL USING-->** 0 **AS THE BASE YEAR**

| | | |
|---|---|---|
| 35 | 5,745,000 | 8,705,000 |

**APPROVED BY:** _____ **DATE:** _____

**(FOR PROJECT AADTS AND DESIGN HOUR VOLUMES PLEASE REFER TO PREVIOUSLY APPROVED FORECASTS OR ATTACHED TRAFFIC FLOW DIAGRAMS.)**

Another way to factor a short duration count would be to use a nearby vehicle class count site. Suppose, for example you had a traffic forecast with one A segment and several B segments. If you wanted to count the traffic along any B segment you could compare the newly counted short duration count with the same hours at the vehicle class site. The forecaster then could calculate the percent particular hours are of the 16 or 24 count at the vehicle class site and similarly apply those percents to a new count.

After expanding the short duration count, there would be another vehicle class site to use. That means the forecaster could use another A segment in place of a B segment. Also, if the project crosses a trunk highway that has no vehicle class site at another junction, you could still use the short duration count and expand it the same way. Remember, the B segment is the default heavy commercial that is added and subtracted along a project with a change in AADT, and any count data is better than using the default.

To aid the forecaster in heavy truck recognition, the following are examples of some typical truck types. Moving from left to right, top to bottom are two examples of "heavy" single unit truck types: 4 axle single unit, 3 axle single unit (the ESAL factors can be changed manually for these truck types if necessary). The next four are examples of heavy truck body types that should be "split": dump, grain, stake, and tank. The last photo is "other" (usually not split unless it is known what commodity is being carried.

*Figure 13 Heavy Truck Types*

***Traffic Forecast Example using Short Counts***

The following is an example of a forecast done "creatively" from a short count and is for illustrative purposes only. It is merely an example of the type of judgment that can be used in the traffic forecasting process. In this instance, while the VC site was in the area, it was too far removed from the project area to be representative of the traffic on that segment. This is another example of judgment an experienced forecaster may have to use when the information available is not good enough, too far removed from the project, or the time frame of the requestor does not allow time to take a 16 hour manual or 48 hour tube count. *In actuality, a one-hour count is not enough. The percentage each hour is of the 24 hour total varies by vehicle type. TDA has done some studies that show averages for the entire state. Caution must be utilized in using statewide averages.*

This was an actual project, located on TH101 – a bridge replacement over Bluff creek where traffic was restricted (no semis were allowed on the roadway). The 2000 AADT was 3500 (estimated 3700 for year 2002). The following vehicles were recorded during a one hour period from 10-11am

| 2ax su | 3ax su | Bus | Cars | |
|---|---|---|---|---|
| 7 | 3 | 1 | 217 | =228 total vehicles |

Thus, 7/228 = 3.1%, 3/228=1.3%, 1/228=0.4%, 217/228=95.2%
We have now calculated the percentage each vehicle type was of the total vehicles at that site during the 10-11am period. Taking the next step, we multiple our known AADT(3700) by the vehicle type percents to get an "estimated" 24 hour count.

| 2ax su | 3ax su | Bus | Cars |
|---|---|---|---|
| 3700 x 3.1%=114 | 3700 x 1.3%=48 | 3700 X 0.4%=15 | 3700 x 95.2%=3322 |

We then expand the count for September and use the 2002 AADT to constrain. Since this is our only vehicle class count data, these percents are the values at our A segment. We could contact TDA for typical percents by hour for all vehicle types.

**16 HR. OR 24 HR. VEHICLE CLASS COUNT EXPANSION WORKSHEET 1**

**SITE NUMBER:** 8728 **COUNTY:** 0
**SITE DESCRIPTION:** BR 1822 Over Bluff Creek N of JCt TH212
**PROJECT SP#:** 0 **YEAR OF COUNT ->:** 2002
**MONTH NUMBER OF COUNT:** 9 **CONSTRAIN AADT ->:** 3700
**16 or 24 HR** 24

| VEHICLE TYPE | RAW COUNT | AADT ADJ FACTOR | | ADJUSTED RAW | VEH. TYPE PERCENTS | | A.C.F. |
|---|---|---|---|---|---|---|---|
| CARS AND PICKUPS | 3322 | #N/A | | 3587 | | | 0.99 |
| 2 AXLE 6 TIRE | 114 | 0.65 | | 74 | 2.0% | | |
| 3+ AXLE SINGLE UNIT | 48 | 0.61 | | 29 | 0.8% | | |
| 3 AXLE SEMI (TST) | 0 | 0.72 | | 0 | 0.0% | | |
| 4 AXLE SEMI (TST) | 0 | 0.76 | | 0 | 0.0% | | |
| 5+ AXLE SEMI (TST) | 0 | 0.70 | | 0 | 0.0% | | |
| TR TR, BUSES | 15 | 0.65 | | 10 | 0.3% | | |
| TWIN TRAILERS | 0 | 0.70 | | 0 | 0.0% | | |
| TOTALS ----------> | 3499 | --------> | 1.1 | 3700 | 3.1% | (%HC) | |

If you are taking a short count, you may find it useful to use some version of the form below. They are available from the Traffic Forecasting Analysis Unit:

## *Figure 14-Traffic Recorder Count Sheets*

Site_____ Direction___ Recorder_____ Hour_____ Date _____ Pass. Vehicle ☐ Trucks ☐ Both ☐

| SEMI | | | | SINGLE UNIT | | |
|---|---|---|---|---|---|---|
| 3 axle | 3x Tank | 4 axle | 4x Tank | Pass. Vehicle | 2 axle | 2 x Tank |
| | | | | | | |
| 5 axle Other | 5 axle Stake Unloaded | 5 axle Stake Loaded | 5 axle Grain | Bus | 3 axle PLUS | 3 axle PLUS Tank |
| | | | | | | |
| 5 axle Tank | 5 axle Dump | 6 axle PLUS | 5 axle PLUS Multi Trailer | HTWT | HTWT Tank | Break ☐ NO Beg. _____ End _____ |
| | | | | | | |

***Use of Additional Trucks in a Traffic Forecast***

Another traffic forecast example involves the addition of more than one heavy vehicle type added to the mix. The traffic forecaster may get requests to help or assist in the preparation of local or county road forecast involving some of the procedures discussed above. The next traffic forecast consists of one forecast and three alternative scenarios. Each scenario shows how with local knowledge, ESALS can increase (or perhaps decrease in another scenario). For illustrative purposes, A segment worksheets with a discussion of each is included. The final forecast involves the addition of 250 trucks in Kandiyohi County due to knowledge of beet hauling on the project. It involves the addition of 3 axle single unit trucks – fully loaded (causes the ESAL factor to be increased from .58 to 1.7), and the addition of fully loaded 5 axle semis (ESAL factor at the max of 2.4)

The first iteration is a traditional forecast using two years of data at one vehicle class site, an assumed 2% growth per year, and a 2001 letting date/base year with a 2021 forecast year.

**CUMULATIVE ESALS WORKSHEET** **SEGMENT A**

| | | | | | |
|---|---|---|---|---|---|
| **SP#:** | 34-601-25 | | | | |
| **ROUTE:** | CSAH 1 | **# LANES:** | 2 | **DATE:** | 04/10/02 |
| **LOCATION:** | TH7 TO SOUTH KANDIYOHI COUNTY LINE | | | | |
| **VCL SITE #:** | 3011 | | | | |

| | YEAR | AADT | INIT CALC HCADT | CONSTRN HCADT | INIT CALC 5AX TST | CONSTRAIN 5AX TST |
|---|---|---|---|---|---|---|
| **VEH.CLASS YR.:** | 1999 | 670 | 60 | 0.0% | --- | --- |
| **BASE YEAR:** | 2001 | 800 | 80 | | 22 | |
| **FORECAST YEAR:** | 2021 | 1200 | 110 | | 32 | |

| **BASE YEAR PROPORTIONS** | | BASE YR. VOLUME | % TREND | FUTURE % | FUTURE VOL. |
|---|---|---|---|---|---|
| **2AX-6TIRE SU** | 3.2% | 27 | 1 | 3.2% | 37 |
| **3AX+ SU** | 1.9% | 16 | 1 | 1.9% | 22 |
| **3AX TST** | 0.3% | 2 | 1 | 0.3% | 3 |
| **4AX TST** | 0.5% | 4 | 1 | 0.5% | 6 |
| **5AX+ TST** | 2.7% | 23 | 1 | 2.7% | 31 |
| **(5AX+ TST MAX)** | 0.0% | 0 | 1 | 0.0% | 0 |
| **(5AX+ TST OTH)** | 0.0% | 0 | 1 | 0.0% | 0 |
| **TR TR, BUSES** | 0.6% | 5 | 1 | 0.6% | 7 |
| **TWIN TRAILERS** | 0.4% | 3 | 1 | 0.4% | 4 |

| **SUMMARIES:** | | AADT | HCADT | HCADT % | 20 YR DESIGN LANE CUMULATIVE ESAL |
|---|---|---|---|---|---|
| 1999 | **COUNT:** | 670 | 60 | 9.0% | \| |
| 2001 | **FORECAST:** | 800 | 80 | 10.0% | ********** |
| 2021 | **FORECAST:** | 1200 | 110 | 9.2% | ********** |

| | FLEXIBLE | RIGID |
|---|---|---|
| **DESIGN LANE FACTOR:** 0.5 | **281,000** | **394,000** |
| | ********** | ********** |

| **ADDITIONAL OUTPUTS:** | | | ESAL FACTORS | |
|---|---|---|---|---|
| | **BASE %** | **FORECAST %** | **FLEXIBLE** | **RIGID** |
| **2AX-6TIRE SU** | 3.4% | 3.1% | 0.25 | 0.24 |
| **3AX+ SU** | 2.0% | 1.8% | 0.58 | 0.85 |
| **3AX TST** | 0.3% | 0.3% | 0.39 | 0.37 |
| **4AX TST** | 0.5% | 0.5% | 0.51 | 0.53 |
| **5AX+ TST** | 2.9% | 2.6% | 1.13 | 1.89 |
| **(5AX+ TST MAX)** | 0.0% | 0.0% | 2.40 | 4.07 |
| **(5AX+ TST OTH)** | 0.0% | 0.0% | 0.87 | 1.44 |
| **TR TR, BUSES** | 0.6% | 0.6% | 0.57 | 0.74 |
| **TWIN TRAILERS** | 0.4% | 0.3% | 2.40 | 2.33 |

**Notes:**

The above worksheet represents the “traditional” non adjusted ESAL Worksheet A. This was based on a tube count – which, as known from previous information, has no body type split information. An ESAL of 281,000 would thus be produced if “nothing else” was known, or there was no local knowledge, or the site wasn’t visited. However, even if the project site was visited and a short count was taken (in “non sugar beet hauling season”), results similar to the tube count would be encountered (few additional trucks). In this forecast, the count was taken in July and the additional loads did not appear until September and continued through the following February. This is illustrative of the

importance not only of visiting the site, but knowing and finding out about the roads in your district and/ or county – even knowing what season or month traffic will be affected.

**CUMULATIVE ESALS WORKSHEET** **SEGMENT A**

**SP#:** 34-601-25
**ROUTE:** CSAH 1 **# LANES:** 2 **DATE:** 04/10/02
**LOCATION:** TH7 TO SOUTH KANDIYOHI COUNTY LINE
**VCL SITE #:** 3011

| | YEAR | AADT | INIT CALC HCADT | CONSTRN HCADT | INIT CALC 5AX TST | CONSTRAIN 5AX TST |
|---|---|---|---|---|---|---|
| **VEH.CLASS YR.:** | 1999 | 670 | 160 | 0.0% | --- | --- |
| **BASE YEAR:** | 2001 | 1050 | 240 | | 189 | |
| **FORECAST YEAR:** | 2021 | 1450 | 340 | | 261 | |

| **BASE YEAR PROPORTIONS** | | BASE YR. VOLUME | % TREND | FUTURE % | FUTURE VOL. |
|---|---|---|---|---|---|
| **2AX-6TIRE SU** | 0.0% | 0 | 1 | 0.0% | 0 |
| **3AX+ SU** | 5.2% | 54 | 1 | 5.2% | 76 |
| **3AX TST** | 0.0% | 0 | 1 | 0.0% | 0 |
| **4AX TST** | 0.0% | 0 | 1 | 0.0% | 0 |
| **5AX+ TST** | 0.0% | 0 | 1 | 0.0% | 0 |
| **(5AX+ TST MAX)** | 18.0% | 186 | 1 | 18.0% | 264 |
| **(5AX+ TST OTH)** | 0.0% | 0 | 1 | 0.0% | 0 |
| **TR TR, BUSES** | 0.0% | 0 | 1 | 0.0% | 0 |
| **TWIN TRAILERS** | 0.0% | 0 | 1 | 0.0% | 0 |

| **SUMMARIES:** | | AADT | HCADT | HCADT % | 20 YR DESIGN LANE CUMULATIVE ESAL |
|---|---|---|---|---|---|
| 1999 | **COUNT:** | 670 | 160 | 23.9% | \| |
| 2001 | **FORECAST:** | 1050 | 240 | 22.9% | ********** |
| 2021 | **FORECAST:** | 1450 | 340 | 23.4% | ********** |

| | FLEXIBLE | RIGID |
|---|---|---|
| **DESIGN LANE FACTOR:** 0.5 | **2,797,000** | **4,689,000** |
| | ********** | ********** |

| **ADDITIONAL OUTPUTS:** | | | ESAL FACTORS | |
|---|---|---|---|---|
| | **BASE %** | **FORECAST %** | **FLEXIBLE** | **RIGID** |
| **2AX-6TIRE SU** | 0.0% | 0.0% | 0.25 | 0.24 |
| **3AX+ SU** | 5.1% | 5.2% | 1.70 | 2.70 |
| **3AX TST** | 0.0% | 0.0% | 0.39 | 0.37 |
| **4AX TST** | 0.0% | 0.0% | 0.51 | 0.53 |
| **5AX+ TST** | 0.0% | 0.0% | 1.13 | 1.89 |
| **(5AX+ TST MAX)** | 17.7% | 18.2% | 2.40 | 4.07 |
| **(5AX+ TST OTH)** | 0.0% | 0.0% | 0.87 | 1.44 |
| **TR TR, BUSES** | 0.0% | 0.0% | 0.57 | 0.74 |
| **TWIN TRAILERS** | 0.0% | 0.0% | 2.40 | 2.33 |

**Notes:**

For illustrative purposes, the above ESAL Worksheet A has been modified to show the effect of heavy trucks only. Note that the 2,797,000 ESALS generated by the trucks alone is about 10 times that of the first iteration (281,000 ESALS). This also shows the effect that heavy trucks have on the roadway. Note that 2001 and 2021 AADT has been increased from the previous ESAL Worksheet A – from 800 to 1050 and 1200 to 1450 respectively. Also, the 3 axle + SU ESAL factors have been manually increased from .58 and .85 to 1.7 and 2.7 respectively. The 5 axle semis are calculated to be fully loaded,

with an ESAL of 2.4. The change in ESAL factors will automatically generate the increased ESALS.

The final ESAL Worksheet A uses the additional trucks for the 3AX + SU category and 5 AX+ TST MAX (above) as well as the 1st iteration percents calculated from the vehicle class site. Of importance, again, is the fact that the other vehicle types together do not generate as many ESALS as the fully loaded 5 axle semis and the maximum loaded 3+ axle single unit vehicles. The ESALS on our final iteration only increased slightly from the heavy truck ESAL Worksheet A (2,797,000 compared to 3,091,000 ESALS).

**CUMULATIVE ESALS WORKSHEET** **SEGMENT A**

**SP#:** 34-601-25
**ROUTE:** CSAH 1 **# LANES:** 2 **DATE:** 04/10/02
**LOCATION:** TH7 TO SOUTH KANDIYOHI COUNTY LINE
**VCL SITE #:** 3011

| | YEAR | AADT | INIT CALC HCADT | CONSTRN HCADT | INIT CALC 5AX TST | CONSTRAIN 5AX TST |
|---|---|---|---|---|---|---|
| **VEH.CLASS YR.:** | 1999 | 670 | 210 | 0.0% | --- | --- |
| **BASE YEAR:** | 2001 | 1050 | 320 | | 217 | |
| **FORECAST YEAR:** | 2021 | 1450 | 450 | | 300 | |

| **BASE YEAR PROPORTIONS** | | BASE YR. VOLUME | % TREND | FUTURE % | FUTURE VOL. |
|---|---|---|---|---|---|
| **2AX-6TIRE SU** | 3.2% | 33 | 1 | 3.2% | 47 |
| **3AX+ SU** | 5.2% | 54 | 1 | 5.2% | 76 |
| **3AX TST** | 0.3% | 3 | 1 | 0.3% | 4 |
| **4AX TST** | 0.5% | 5 | 1 | 0.5% | 7 |
| **5AX+ TST** | 2.7% | 28 | 1 | 2.7% | 39 |
| **(5AX+ TST MAX)** | 18.0% | 186 | 1 | 18.0% | 264 |
| **(5AX+ TST OTH)** | 0.0% | 0 | 1 | 0.0% | 0 |
| **TR TR, BUSES** | 0.6% | 6 | 1 | 0.6% | 9 |
| **TWIN TRAILERS** | 0.4% | 4 | 1 | 0.4% | 6 |

| **SUMMARIES:** | | AADT | HCADT | HCADT % | 20 YR DESIGN LANE CUMULATIVE ESAL |
|---|---|---|---|---|---|
| 1999 | **COUNT:** | 670 | 210 | 31.3% | \| |
| 2001 | **FORECAST:** | 1050 | 320 | 30.5% | ********** |
| 2021 | **FORECAST:** | 1450 | 450 | 31.0% | ********** |

| | | FLEXIBLE | RIGID |
|---|---|---|---|
| **DESIGN LANE FACTOR:** | 0.5 | **3,091,000** | **5,095,000** |
| | | ********** | ********** |

**ADDITIONAL OUTPUTS:**

| | BASE % | FORECAST % | ESAL FACTORS FLEXIBLE | RIGID |
|---|---|---|---|---|
| **2AX-6TIRE SU** | 3.1% | 3.2% | 0.25 | 0.24 |
| **3AX+ SU** | 5.1% | 5.2% | 1.70 | 2.70 |
| **3AX TST** | 0.3% | 0.3% | 0.39 | 0.37 |
| **4AX TST** | 0.5% | 0.5% | 0.51 | 0.53 |
| **5AX+ TST** | 2.7% | 2.7% | 1.13 | 1.89 |
| **(5AX+ TST MAX)** | 17.7% | 18.2% | 2.40 | 4.07 |
| **(5AX+ TST OTH)** | 0.0% | 0.0% | 0.87 | 1.44 |
| **TR TR, BUSES** | 0.6% | 0.6% | 0.57 | 0.74 |
| **TWIN TRAILERS** | 0.4% | 0.4% | 2.40 | 2.33 |

**Notes:**

Again, when adding trucks to the mix, the forecaster will find the easiest method is to change the desired percents to reach the desired number of trucks – in that way, the

formatting is preserved that calculates future volumes and ESALS. Below is the final memo or cover page of the sample forecast discussed above. The forecaster should include similar information under the Remarks section for forecast assumptions.

From: GEORGE M. CEPRESS P.E.
STATE TRAFFIC FORECAST ENGINEER
CENTRAL OFFICE, MAIL STOP 450

Subject: TRAFFIC FORECAST

| | | | |
|---|---|---|---|
| Route: | CSAH 1 | SP# | 34-601-25 |
| Letting Date: | 2001 | Forecast # | F-KANDIYOHI-1 |
| Program Category: | | County: | KANDIYOHI |
| Project Manager: | MIKE HOFER | District: | 8 |
| | | Miles: | |
| Project Limits: | TH7 TO SOUTH KANDIYOHI COUNTY LINE | | |

Enclosures (check those that apply):

- [ ] Project map
- [ ] Least squares analysis
- [ ] Cumulative ESAL worksheet, Segment A
- [ ] Cumulative ESAL worksheet, Segment B
- [ ] AADT and/or DHV traffic schematic diagram
- [ ] VCL expansion worksheet
- [ ] Cumulative ESAL Report
- [ ] Other (describe)
- [ ] Other (describe)

## REMARKS:

ASSUME 2% YEAR TRAFFIC GROWTH
THIS ESAL FORECAST ASSUMES 2001 AS LET/BASE YEAR AND 2021 AS FORECAST YEAR
ADDITIONAL LOAD INFORMATION PROVIDED BY MIKE HOFER, KANDIYOHI COUNTY
VEHICLE CLASS SITES INFORMATION BASED ON SITE 3011 USED - 1998 & 1999 (EXPANDED)
800 AADT ASSUMED FOR 2001 (BASED ON HISTORIC AADT COUNTS FROM CSAH 1 S OF TH 7)
ADDING 188 5 AXLE SEMIS TO THE MAX CATEGORY
ADDING 55 TO THE 3AX+SU CATEGORY
ADDING 250 (188+55) AADT TO THE LETTING DATE AND BASE YEAR

*For information that requires knowledge of vehicles loaded above the average weight, the forecaster must consult the AASHTO Guide for Design of Pavement. That information is available upon request from the Traffic Forecast Section*

The following two tables (figure 15) are examples of ESAL factors for flexible pavement for single and tandem axles:

***ESAL FACTORS AND THRESHOLDS IN DESIGN***

## *Figure 15 – ESAL Equivalence Factors*

18-KIP AXLE EQUIVALENCE FACTORS
FLEXIBLE PAVEMENT, P-2.5

| Gross Axle Load (lbs.) | SN = 5 Single Axles | Tandem Axles |
|---|---|---|
| 1,000 | 0.00002 | |
| 2,000 | .00018 | |
| 3,000 | .00072 | |
| 4,000 | .00209 | |
| 5,000 | .00500 | |
| 6,000 | .01043 | |
| 7,000 | .0196 | |
| 8,000 | .0343 | |
| 9,000 | .0562 | |
| 10,000 | .0877 | 0.00688 |
| 11,000 | .1311 | .01008 |
| 12,000 | .189 | .0144 |
| 13,000 | .264 | .0199 |
| 14,000 | .360 | .0270 |
| 15,000 | .478 | .0360 |
| 16,000 | .623 | .0472 |
| 17,000 | .796 | .0608 |
| 18,000 | 1.000 | .0773 |
| 19,000 | 1.24 | .0971 |
| 20,000 | 1.51 | .1206 |
| 21,000 | 1.83 | .148 |
| 22,000 | 2.18 | .180 |
| 23,000 | 2.58 | .217 |
| 24,000 | 3.03 | .260 |
| 25,000 | 3.53 | .308 |
| 26,000 | 4.09 | .364 |
| 27,000 | 4.71 | .426 |
| 28,000 | 5.39 | .495 |
| 29,000 | 6.14 | .572 |
| 30,000 | 6.97 | .658 |
| 31,000 | 7.88 | .753 |
| 32,000 | 8.88 | .857 |
| 33,000 | 9.98 | .971 |
| 34,000 | 11.18 | 1.095 |
| 35,000 | 12.50 | 1.23 |
| 36,000 | 13.93 | 1.38 |
| 37,000 | 15.50 | 1.53 |
| 38,000 | 17.20 | 1.70 |
| 39,000 | 19.06 | 1.89 |
| 40,000 | 21.08 | 2.08 |
| 41,000 | 23.27 | 2.29 |
| 42,000 | 25.64 | 2.51 |
| 43,000 | 28.22 | 2.75 |
| 44,000 | 31.00 | 3.00 |
| 45,000 | 34.00 | 3.27 |
| 46,000 | 37.24 | 3.55 |
| 47,000 | 40.74 | 3.85 |

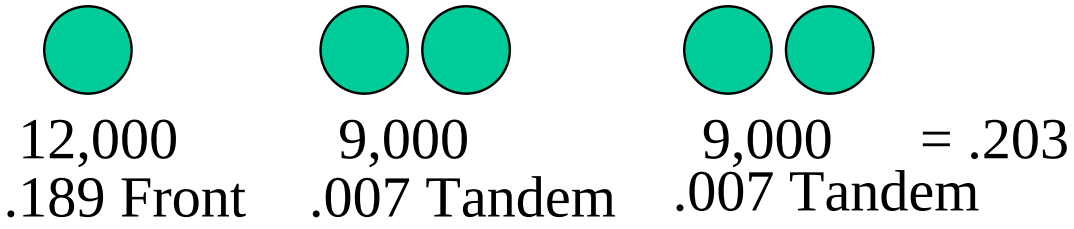
## 18-KIP AXLE EQUIVALENCE FACTORS
### FLEXIBLE PAVEMENT, P-2.5

SN = 5

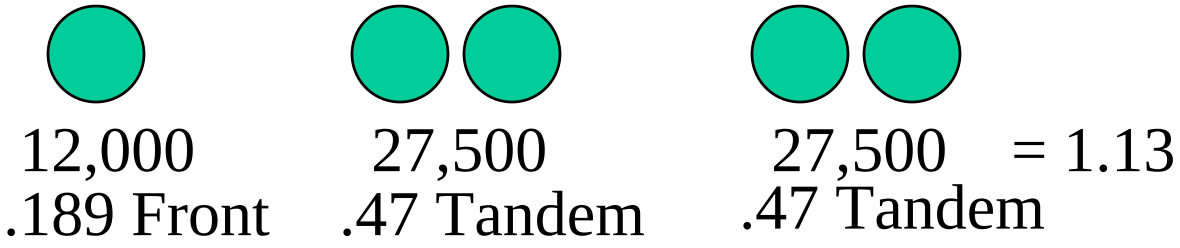
| Gross Axle Load (lbs.) | Single Axles | Tandem Axles |
|---|---|---|
| 48,000 | 44.50 | 4.17 |
| 49,000 | 48.54 | 4.51 |
| 50,000 | 52.88 | 4.86 |
| 51,000 | | 5.23 |
| 52,000 | | 5.63 |
| 53,000 | | 6.04 |
| 54,000 | | 6.47 |
| 55,000 | | 6.93 |
| 56,000 | | 7.41 |
| 57,000 | | 7.92 |
| 58,000 | | 8.45 |
| 59,000 | | 9.01 |
| 60,000 | | 9.59 |
| 61,000 | | 10.20 |
| 62,000 | | 10.84 |
| 63,000 | | 11.52 |
| 64,000 | | 12.22 |
| 65,000 | | 12.96 |
| 66,000 | | 13.73 |
| 67,000 | | 14.54 |
| 68,000 | | 15.38 |
| 69,000 | | 16.26 |
| 70,000 | | 17.19 |
| 71,000 | | 18.15 |
| 72,000 | | 19.16 |
| 73,000 | | 20.22 |
| 74,000 | | 21.32 |
| 75,000 | | 22.47 |
| 76,000 | | 23.66 |
| 77,000 | | 24.91 |
| 78,000 | | 26.22 |
| 79,000 | | 27.58 |
| 80,000 | | 28.99 |

The following is a sample of how to use the ESAL factors above:
On the above tables, you will see that 12,000 pounds on a single axle has an ESAL factor of .189 – rounded to .2 and 34,000 pounds on a tandem has a factor of 1.095 - rounded to 1.1. That portrays a fully loaded 80,000 pound 5 axle semi. The next sketch shows a typical example of an empty 5-axle semi. The ESAL factor is quite a bit lower. Below we see the addition of .2 + 1.1 + 1.1 = 2.4

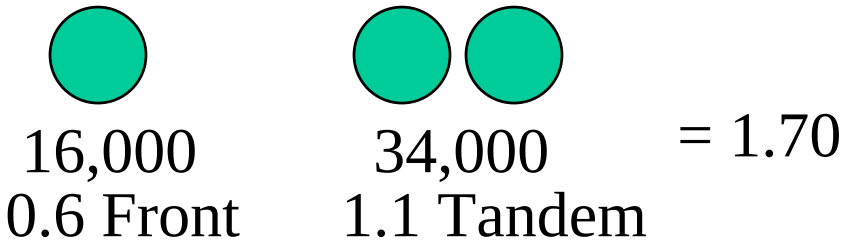
12,000 .2 Front | 34,000 1.1 Tandem | 34,000 1.1 Tandem = 2.4




The following sketch shows a sample configuration of the 5-axle TST as represented in the MnESAL when heavies are not split – ESAL factor of 1.13. This is showing a typical 5 axle semi that weights about 67,000 pounds




The next example is that the 3 axle single unit truck that we changed from a default of 0.58 to 1.70 in our CSAH 1 example (in Kandiyohi County). We assumed these 3 axle trucks were "heavy" fully loaded 3 axle single unit trucks hauling sugar beets. A typical weight of a truck of this type may be around 50,000 pounds (depending upon axle spacing).



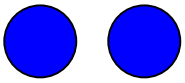

All of the above illustrations show the need for on site inspection when the body type mix is questionable or information at the vehicle class site is not adequate. Thus the forecaster does not want to underestimate the effects of heavy trucks on a project. This could lead to a low ESAL forecast and an under-designed roadway, which could lead to early pavement failure. The importance of proper fieldwork in an ESAL forecast cannot be over emphasized. The forecaster must calculate that the time spent on a forecast is justified when comparing the costs of a poorly constructed road.

***Truck Weights, Axles Configuration and ESALS***

The below table is our standard ESAL factors on the MnESAL

| | ESAL FACTORS | |
|---|---|---|
| | FLEXIBLE | RIGID |
| 2AX-6TIRE SU | 0.25 | 0.24 |
| 3AX+ SU | 0.58 | 0.85 |
| 3AX TST | 0.39 | 0.37 |
| 4AX TST | 0.51 | 0.53 |
| 5AX+ TST | 1.13 | 1.89 |
| (5AX+ TST MAX) | 2.40 | 4.07 |
| (5AX+ TST OTH) | 0.87 | 1.44 |
| TR TR, BUSES | 0.57 | 0.74 |
| TWIN TRAILERS | 2.40 | 2.33 |

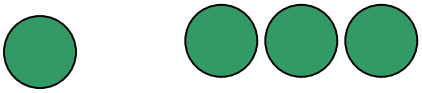
The maximum weight allowable on a single axle is 20000 pounds 

The maximum weight allowable on a tandem is 34000 pounds 

The maximum weight allowable on a tridem is about 42000-43000 pounds 

During the course of a traffic forecast, it will often be necessary to change ESAL factors for various vehicle types when information becomes available. For example, local knowledge regarding heavy truck routes, gravel or grain truck movements, lumber or stake trucks, etc. can often be obtained by on site inspections. In most cases we vary the 5-axle semi factors as far as maximum and other. In some cases, such as gravel hauling routes, single unit dump trucks (2, 3 and 4 axle single units) are fully loaded to the legal limits. The forecaster should recalculate the ESAL factors.

Pages 86 through 88 in the manual discuss single and tandem axle weights and various ESAL configurations and how ESALS are calculated. The table below also includes tridem axles, often found on 4-axle single unit dump trucks. For example, a typical "loaded 4-axle single unit gravel truck may have a configuration something like the following example:



15,000 pounds .478 Front | 42,000 pounds .595 Tridem | =1.073, or 1.1 ESAL Factor - Flexible

Since the default for a 3+ single axle unit is .58, we see that a typical loaded 4 axle single unit has an ESAL factor of about 1.1. The forecaster then would manually change the flexible ESAL on the worksheet by un-protecting the worksheet and changing the number. Note the effect on the ESALS when you "adjust" the ESAL factors. The numbers could change significantly if there were large numbers of these gravel trucks in your project area.

For a heavy 3-axle single unit gravel truck we may have the following configuration. The default ESAL is the same as the above example, .58 flexible.

| 12,000 pounds | 34,000 pounds | |
|---|---|---|
| .189 Front | 1.095 Tandem | =1.284, or 1.3 ESAL Factor – Flexible |

The information below are average rough figures derived from the State Patrol and can be used in determining the weights for 2, 3, and 4 axle "reasonably" loaded single unit gravel dump trucks. The numbers include GVW (gross vehicle weight), front axle and rear group. Again, from this weight, we can use the information from the tandem and tridem ESAL equivalent tables included in this report.

1. 2-axle dump truck -33,000 GVW. Up to 13,000 steering axle, 20,000 drive axle
2. 3-axle dump truck - 45,000 GVW. Up to 13,000 steering axle, 34,000 tandem
3. 4-axle dump truck – 57,000 GVW. 14,000+ on steering axle, 43,000 tridem

The following example on page 109-110 shows how the above information may be used to adjust the default ESAL factors for single unit trucks and the possible range of ESALS. The ultimate result in the following examples is to increase the ESAL factor for single axle unit trucks based on known number of heavy gravel trucks added to the mix.

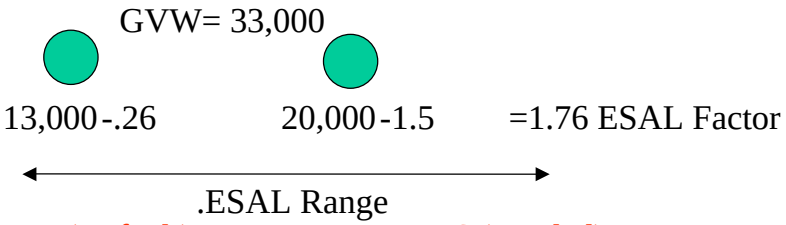
In calculating ESALS, we mainly talk about Flexible ESALS. In actuality, the Rigid ESAL, always higher on the MnESAL worksheets is the concrete equivalent to the bituminous number. These numbers do not relate to one another. They are results of the formula used in the process that develops these factors. The summation of total vehicle volumes by class are equal, the only difference is in the results of the formula.

The next page shows examples of single unit truck ESAL ranges as well as a sample page from the Pavement Manual of a triple axle load equivalency factor.

# Single Unit Truck ESAL Ranges

Sample = 200 heavy trucks, 100 unloaded trucks

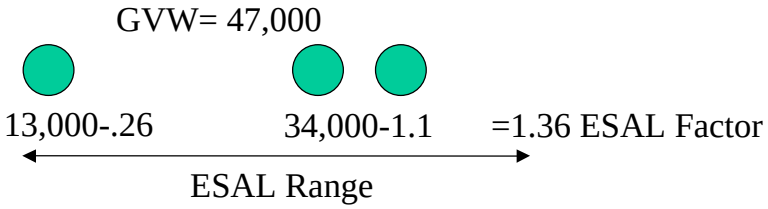
*Example of how to modify default ESAL values for 2,3, and 4 axle single unit loaded gravel trucks*




1. .25 (Default) .1.76 (Loaded)
2. 100 trucks *.25=25 200 trucks *1.76=352
3. Average Daily ESAL = 25 +352 = 377
4. 377 Average Daily ESAL / 300 = ***1.26 (Avg ESAL)***

***The weighted ESAL factors in these examples would replace default ESAL values***

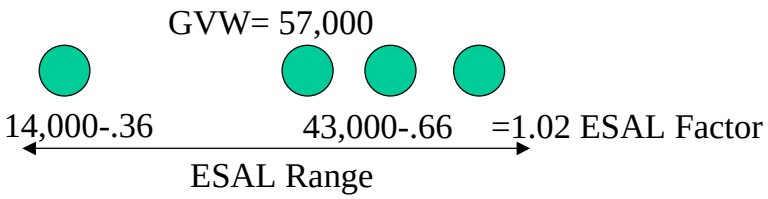
3ax su




1. .58 (Default) 1.36 (Loaded)
2. 100 trucks *.58=58 200 trucks *1.36=272
3. Average Daily ESAL = 58 +272 = 330
4. 330 Average Daily ESAL / 300 = ***1.1(Avg ESAL)***

---

4ax su



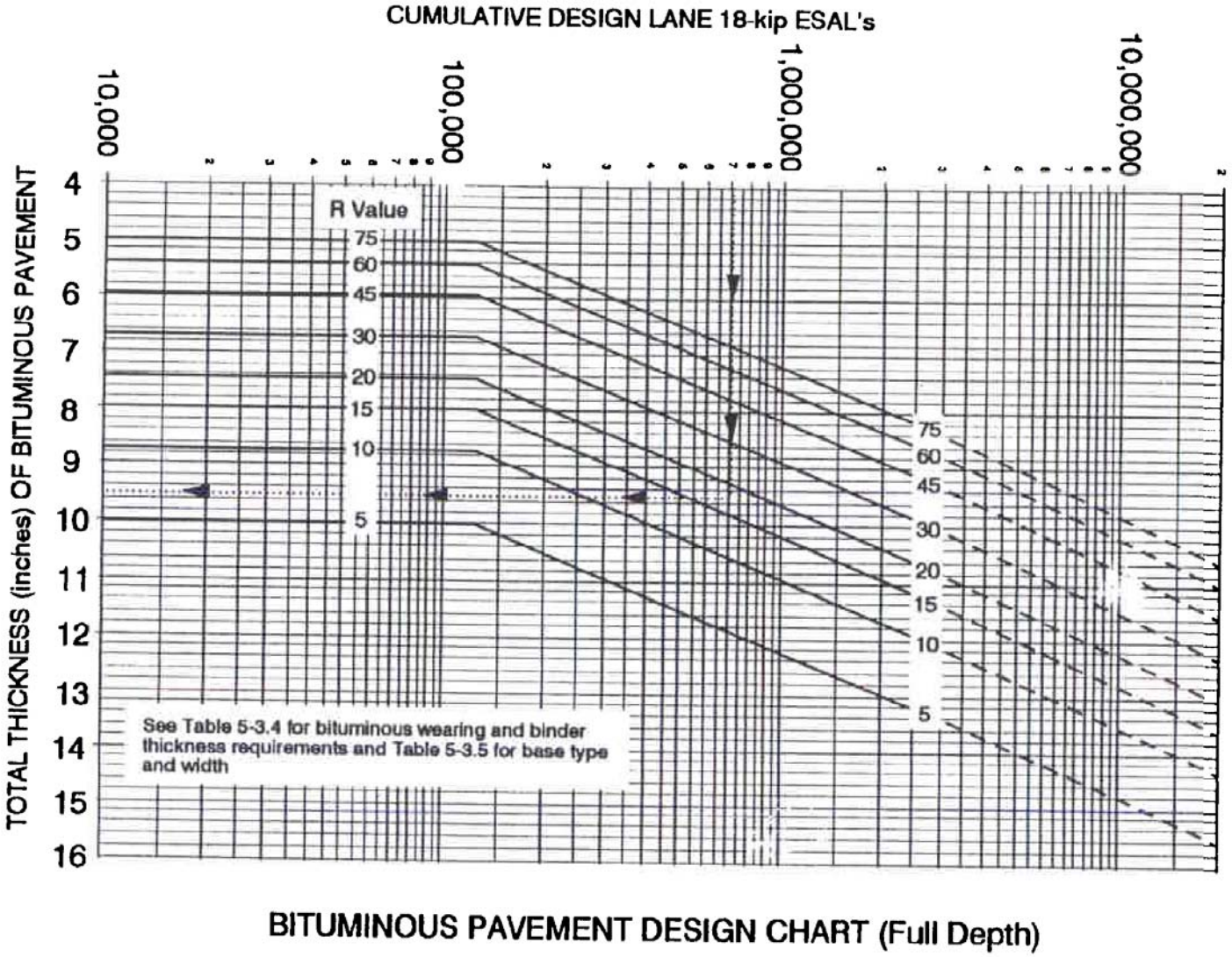

1. .58 (Default) 1.02 (Loaded)
2. 100 trucks *.58=58 200 trucks *1.02=204
3. Average Daily ESAL = 58 +204 = 262
4. 262 Average Daily ESAL / 300 = ***0.87 (Avg ESAL)***

**Table D.6. Axle load equivalency factors for flexible pavements, triple axles and $p_t$ of 2.5.**

| Axle Load (kips) | Pavement Structural Number (SN) | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 2 | .0000 | .0000 | .0000 | 0000 | .0000 | .0000 |
| 4 | .0002 | .0002 | .0002 | 0001 | .0001 | .0001 |
| 6 | .0006 | .0007 | .0005 | 0004 | .0003 | .0003 |
| 8 | .001 | .002 | .001 | 001 | .001 | .001 |
| 10 | .003 | .004 | .003 | .002 | .002 | .002 |
| 12 | .005 | .007 | .006 | .004 | .003 | .003 |
| 14 | .008 | .012 | .010 | .008 | .006 | .006 |
| 16 | .012 | .019 | .018 | .013 | .011 | .010 |
| 18 | .018 | .029 | .028 | .021 | .017 | .016 |
| 20 | .027 | .042 | .042 | .032 | .027 | .024 |
| 22 | .038 | .058 | .060 | .048 | .040 | .036 |
| 24 | .053 | .078 | .084 | .068 | .057 | .051 |
| 26 | .072 | .103 | .114 | .095 | .080 | .072 |
| 28 | .098 | .133 | .151 | .128 | .109 | .099 |
| 30 | .129 | .169 | .195 | .170 | .145 | .133 |
| 32 | .169 | .213 | .247 | .220 | .191 | .175 |
| 34 | .219 | .266 | .308 | .281 | .246 | .228 |
| 36 | .279 | .329 | .379 | .352 | .313 | .292 |
| 38 | .352 | .403 | .461 | .436 | .393 | .368 |
| 40 | .439 | .491 | .554 | .533 | .487 | .459 |
| 42 | .543 | .594 | .661 | .644 | .597 | .567 |
| 44 | .666 | .714 | .781 | .769 | .723 | .692 |
| 46 | .811 | .854 | .918 | .911 | .868 | .838 |
| 48 | .979 | 1.015 | 1.072 | 1.069 | 1.033 | 1.005 |
| 50 | 1.17 | 1.20 | 1.24 | 1.25 | 1.22 | 1.20 |
| 52 | 1.40 | 1.41 | 1.44 | 1.44 | 1.43 | 1.41 |
| 54 | 1.66 | 1.66 | 1.66 | 1.66 | 1.66 | 1.66 |
| 56 | 1.95 | 1.93 | 1.90 | 1.90 | 1.91 | 1.93 |
| 58 | 2.29 | 2.25 | 2.17 | 2.16 | 2.20 | 2.24 |
| 60 | 2.67 | 2.60 | 2.48 | 2.44 | 2.51 | 2.58 |
| 62 | 3.09 | 3.00 | 2.82 | 2.76 | 2.85 | 2.95 |
| 64 | 3.57 | 3.44 | 3.19 | 3.10 | 3.22 | 3.36 |
| 66 | 4.11 | 3.94 | 3.61 | 3.47 | 3.62 | 3.81 |
| 68 | 4.71 | 4.49 | 4.06 | 3.88 | 4.05 | 4.30 |
| 70 | 5.38 | 5.11 | 4.57 | 4.32 | 4.52 | 4.84 |
| 72 | 6.12 | 5.79 | 5.13 | 4.80 | 5.03 | 5.41 |
| 74 | 6.93 | 6.54 | 5.74 | 5.32 | 5.57 | 6.04 |
| 76 | 7.84 | 7.37 | 6.41 | 5.88 | 6.15 | 6.71 |
| 78 | 8.83 | 8.28 | 7.14 | 6.49 | 6.78 | 7.43 |
| 80 | 9.92 | 9.28 | 7.95 | 7.15 | 7.45 | 8.21 |
| 82 | 11.1 | 10.4 | 8.8 | 7.9 | 8.2 | 9.0 |
| 84 | 12.4 | 11.6 | 9.8 | 8.6 | 8.9 | 9.9 |
| 86 | 13.8 | 12.9 | 10.8 | 9.5 | 9.8 | 10.9 |
| 88 | 15.4 | 14.3 | 11.9 | 10.4 | 10.6 | 11.9 |
| 90 | 17.1 | 15.8 | 13.2 | 11.3 | 11.6 | 12.9 |

The following two charts are for illustrative purposes only, but show the effects of ESALS on total thickness of bituminous pavements (full depth) and granular equivalents (aggregate base). The roadway designers take the forecasted information and use it in a variety of ways. Below are two examples of the use of ESALS in roadway design.

## *Figure 16 –Bituminous Pavement Design Chart – Full Depth*




BITUMINOUS PAVEMENT DESIGN CHART (Full Depth)

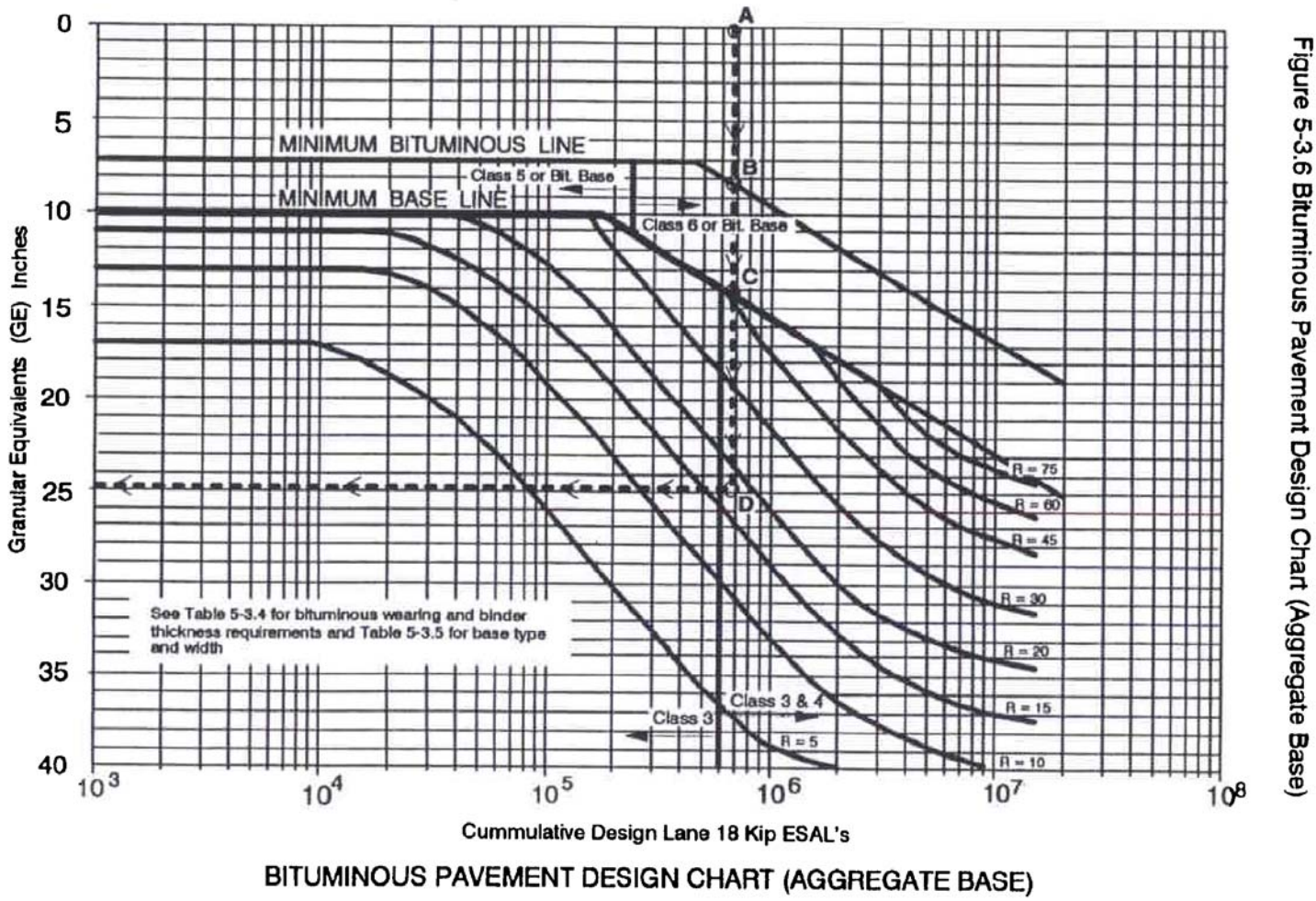



*Figure 17 –Bituminous Pavement Design Chart – Aggregate Base*

Figure 16 and 17 are from the Geotechnical and Pavement Manual. The web site below shows new updated design criteria and is updated annually. Figure 18 shows the first of three pages that are from the Office of Materials web site. The entire PDF file can be viewed at the following web site: http://www.mrr.dot.state.mn.us/pavement/bituminous/misc_documents/DesignCriteria2004.pdf. The information describes three ESAL thresholds of bituminous pavement – less than 1 million ESAL, 1 to 3 million ESALS, and > 3 million ESALS.

# *Figure 18 –Design Criteria for Bituminous Pavement*

## Design Criteria 2360 (Gyratory Mixes including SMA)

For Combined 2360/2350 (Gyratory/Marshall) Specification for 2004 Construction Season Rev. 01/26/04

| 20 yr. ESAL's [7] Design Lane X $10^6$ | | Non Wear (>100 mm (4") from surface) | Wear (≤ 100mm ( 4") from surface) |
|---|---|---|---|
| All | Specify [2] | SPNWB_ 30_ [5] | SPWEB _ 40_ [5] [9]<br>SPWEB _ 30_ [6] [9]<br>SMWEE640H [8] |
| | Option to Specify | Agg. Size A, C | Agg. Size A |

Where: SP= conventional gyratory; SM= stone matrix asphalt gyratory; WE=wear; NW=non-wear

General Notes:

1. Minimum Lift thickness:
   - Agg. **Size A** (12.5 mm **(1/2") Maximum**, 9.5 mm Nominal) – 40 mm (1 ½") minimum
   - Agg. **Size B** (19.0 mm **(3/4") Maximum**, 12.5 mm Nominal) – 40 mm (1 ½") minimum
   - Agg. **Size C** (25.0 mm **(1") Maximum**, 19.0 mm Nominal) – 60 mm (2 ½") minimum
   - All wear courses shall be at least 40 mm (1 ½") thick minimum.

2. Aggregate sizes specified and options listed should be used unless lift thickness precludes a larger aggregate size. Except for SMA, the Contractor has the option to supply recycled mixture, unless otherwise designated in the Special Provisions. With the approval of the Engineer, the Contactor may supply a gradation with a smaller max. aggregate si than that specified, i.e. size A in lieu of size B.

3. Specify size A when course/lift is less than 40 mm (1 ½").

4. See Typical Sections for individual lift/course identification.

5. For mainline paving select the asphalt binder grade from the most current Tech Memo.
   For shoulders where traffic is allowed, generally, use the same binder grade as the mainline.
   For shoulders where traffic is prohibited select either PG 52 - 34 or PG 58 - 28 by matching the mainline low t number. **I.E.. Mainline PG 64 - 28=> Shoulder PG 58 - 28**

6. Designation for wear mixture placed on shoulders. Note: 3.0 % air voids.

7. For slow and standing traffic, consider selecting a higher high temperature binder grade and/or mix type

8. Specify minimum PG 70-28 (H) for SMA mixtures. Use SMA on final wearing surface only (1.5"-2" lift).

9. For new construction, including cold inplace recycle (CIR), reclaiming, and reconstruction, specify PG XX-34 in th top 100 mm (4") of the pavement structure.

Mixture Designation Example: **SPWEB440E**

| Type | Lift | Max Agg. Size | Traffic Level (ESAL's X $10^6$) | | Air Voids | Binder Grade |
|---|---|---|---|---|---|---|
| ***SP*** | ***WE*** | A | 2 | (<1.0) | 30 (3.0) | A = PG 52 -34 |
| SM | NW | **B** | 3 | (1 - 3) | ***40*** (4.0) | B = PG 58 - 28 |
| | | C | ***4*** | (3 - 10) | | C = PG 58 - 34 |
| | | E (SMA) | 5 | (10 - 30) | | D = PG 58 - 40 |
| | | | 6 | (SMA) | | **E** = PG 64 - 28 |
| | | | | | | F = PG 64 – 34 |
| | | | | | | G = PG 64 - 40 |
| | | | | | | H = PG 70 - 28 |
| | | | | | | I = PG 70 - 34 |
| | | | | | | L = PG 64 - 22 |

The format for 2360 Pay Items will be as follows:

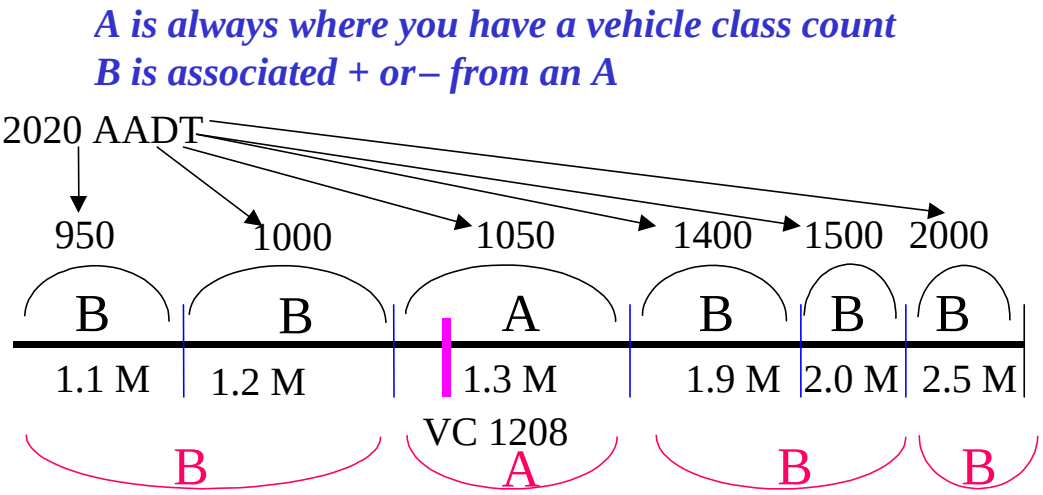
2360.501 Type SP __._ _____Course Mixture (_,_).....metric ton (English ton)

An example of the pay item for the above mixture designation is:

2360.501 Type SP12.5 Wearing Course Mixture (4,E).....metric ton (English ton)

Note: Numbers in parenthesis denote the traffic level and the PG grade.

***A and B Segment Concepts***




Initial ESAL calculation and Prelim A and B segment grouping

Final ESAL calculation and Final A and B segment grouping

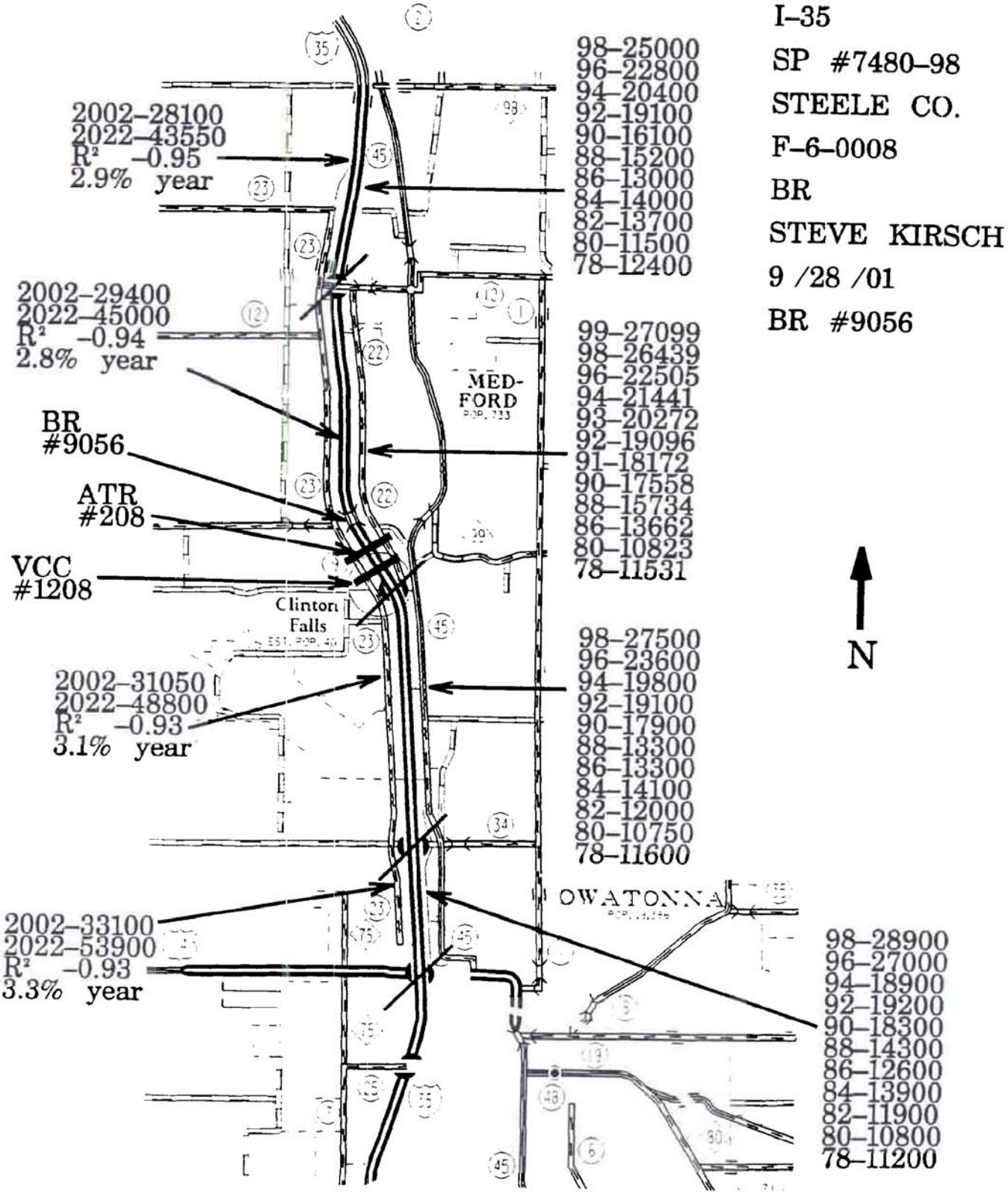
If the AADT and/or ESALS are within 10%,
segments can be combined for the final ESAL estimates.

To further clarify and expand upon the A and B segment concept, the above illustration shows how a completed ESAL forecast by individual A and B segments may be combined into the "final" ESAL forecast. In the example above, we use the "10% rule." Our preliminary ESAL forecast results in one A and five B segments. Additional analysis shows similar AADT groupings, and similar ESALS groupings.

Our final forecast has one A segment and three B segments. Note that the AADTs and ESALS are within about 10%. Using this method, the forecaster will re-work the B segments and combine termini. Each new segment will reflect the "highest" AADT in that segment and also result in a new segment description. In this example, the whole forecast could be one continuous A segment if all the AADTs and ESALS were within about 10%. Professional judgment and experience come to play here. Make sure to document any combining of A and B segments on the cover memo of the forecast.

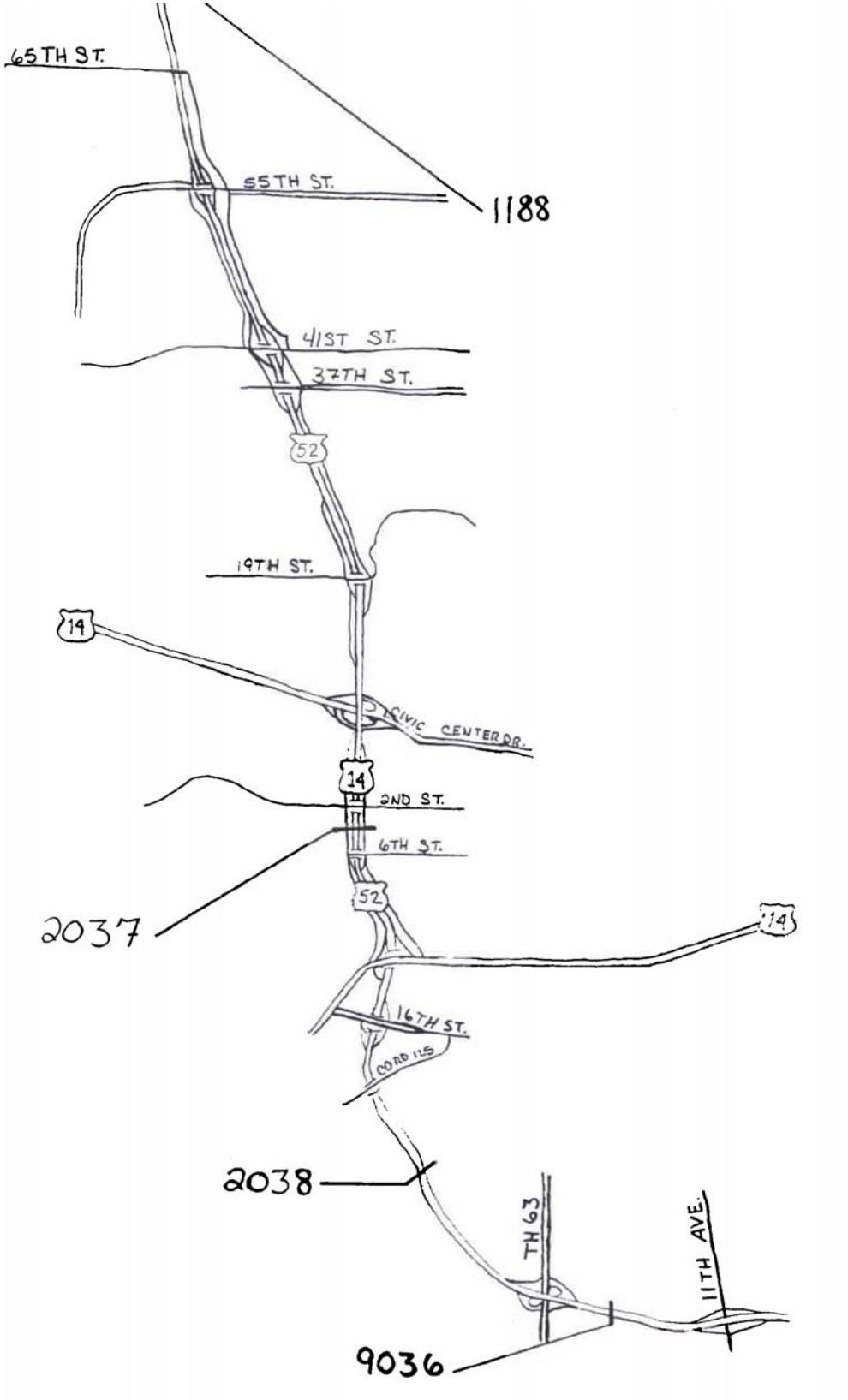
The following "computerized" sketch is an example of one A segment (VCC 1208) , three B segments and an ATR. An analysis of historical traffic data at ATR 208 should compare favorably with the historic AADT gathered from maps, CDROMS, or TDA web pages. If the forecaster has CAD or ARCVIEW experience, it may be easier to use an actual map of the project for your sketch and enhance it like the I-35 example below.

*Figure 19 –Sample Sketch of I-35 Project*



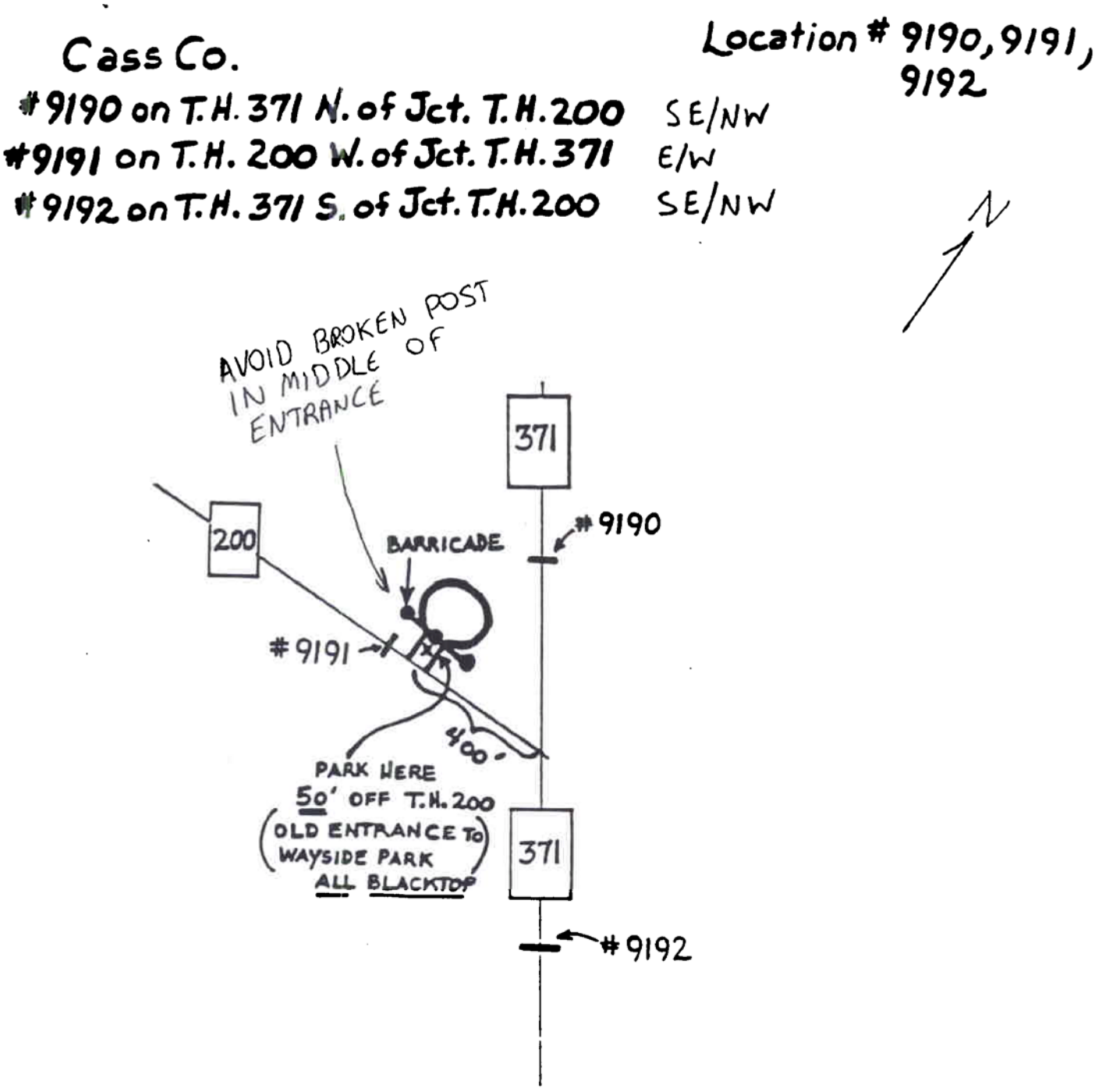
This sketch of a Rochester area project contained four vehicle class sites (four A segments) and numerous B segments. Each city street had an AADT break.

*Figure 20 –Sample Sketch of TH52 in Rochester*



On many traffic forecast projects it may be difficult to determine the exact location of the vehicle class site. The description will be available on your vehicle class history, but for placing on a map on a detailed project such as the one above, it may be necessary or helpful to request a map or sketch of the area. They have recently been sent out to district traffic forecasters. Below is a sample of three vehicle class sites in Cass County. The sketches are very precise and useful in determining specific locations.

*Figure 21–Sample Vehicle Class Site Location Map*



***Rochester, TH52 Example, Modeling, 3-Legged Intersections, and Land Use***

*Figure 20* shows the detail that can be involved in a traffic forecast. As previously mentioned, a field trip to a project of this magnitude is recommended. The forecaster may find it handy to make a rough land use sketch of the area to judge current conditions *(figure 23).* This land use sketch shows the type of information that may be helpful as you prepare a traffic forecast.

On a more complex forecast, it may be necessary to use a combination of A segments, default B segments, and A segments with default percentages for local non trunk streets. In the Rochester forecast, historical counts had to be collected on all cross streets and expanded. This was the only way to check out the traffic volumes predicted by the Rochester traffic model.

When there are several vehicle class counts and intersecting major routes, it may be necessary to combine vehicle class counts and take the averages of two or more vehicle class sites. It is important that the forecaster look at all vehicle class percentages and numbers of trucks in a complex forecast. In many cases, there is a logical flow of trucks, and often, one vehicle class site will conflict with another. Again, counts may need to be taken to achieve consistent results.

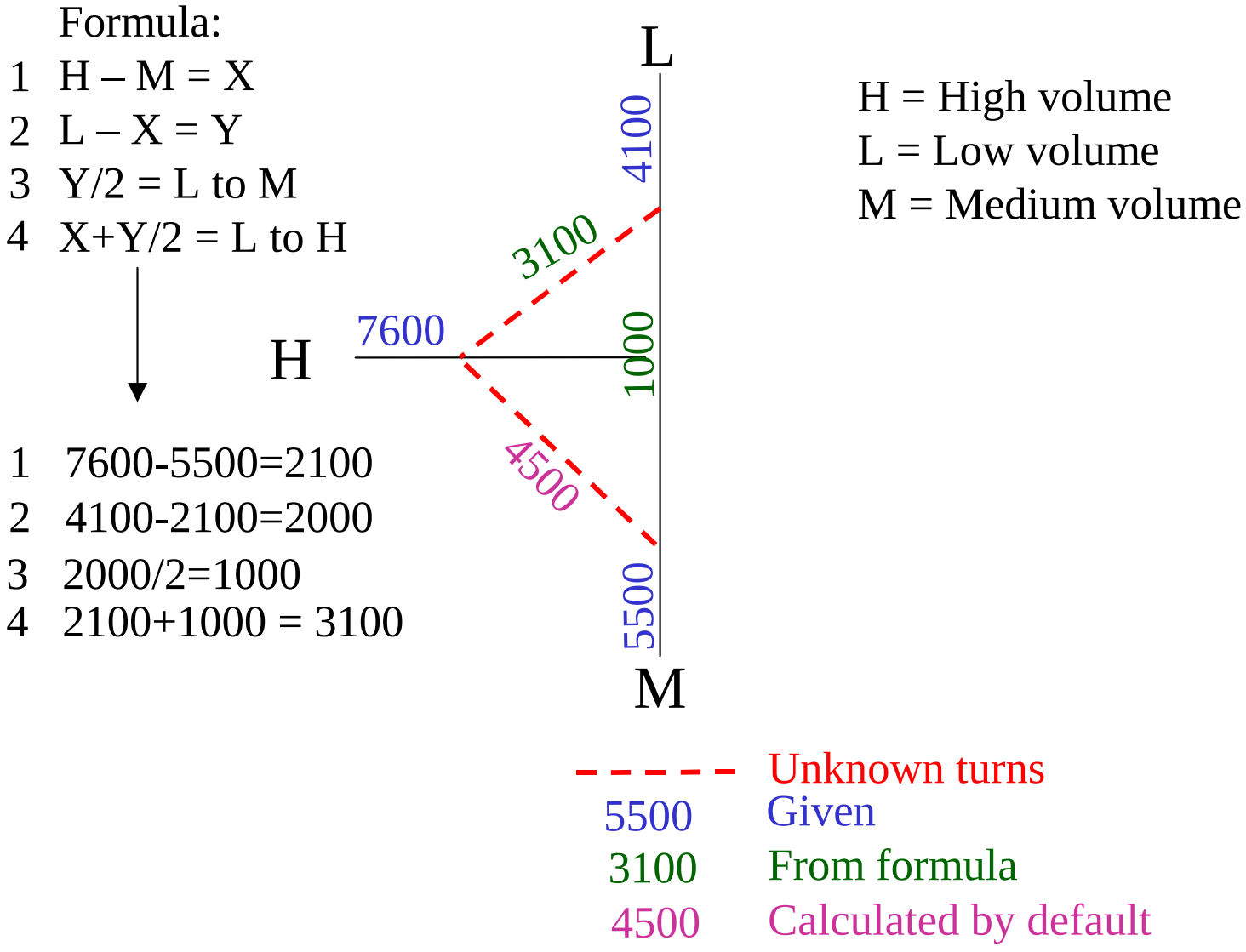
In the Rochester forecast there were 16 different combinations of vehicle class sites or 16 A segments used as well as default (5.9% HC) percentages. If the forecast involves city streets or local roads off a mainline trunk highway, there will be instances where the forecaster will determine that the default percentages will not work. A decision may be made to use a combination of default percentages and percentages from a nearby vehicle class site if it seems that truck traffic may exit or use that particular ramp or city street.

One must be careful not to solely use traffic modeling output without carefully comparing the results to actual current counts. There is no shortcut for examining each and every road and trunk highway that intersects with a project and collecting all the historic data available. Once again, the data collection phase of an ESAL and traffic forecast is the most important aspect of the process.

*Figure 22* will assist the forecaster in calculating turns on a 3-legged intersection where two legs are known. This will assist in distributing AADT and HCAADT and estimating traffic flows. If the forecaster has heavy commercial volumes at three trunk highway junctions, this method will help determine the direction of the volumes. It is also a way to “calibrate” or verify truck percentages if, for example, the forecaster has vehicle class data at two junctions and wants to determine the heavy truck movements.

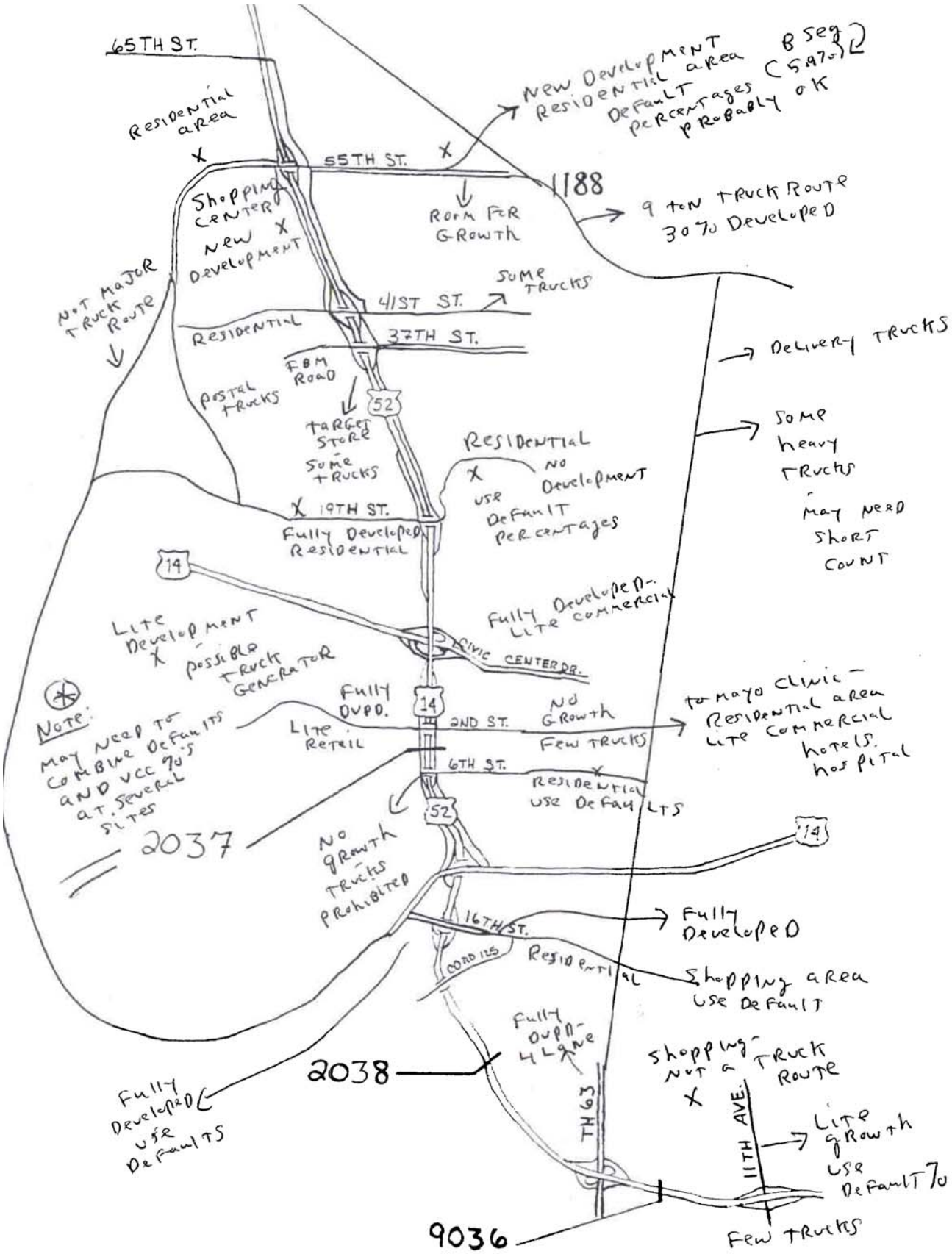
During a complicated forecast such as the Rochester TH52 example, the three legged technique was used to determine truck flow from vehicle class sites on TH14 west of TH52, TH14 east of TH52, TH14/TH52 south of north junction TH14, and TH52 south of south junction TH14. There may be occasions when the forecaster may use several average vehicle class count worksheets. This makes analyzing truck flow patterns more complicated. Then, the forecaster may use 3-legged technique to determine truck flow.

*Figure 22 -Sample of a 3 legged intersection*




The schematic drawing below illustrates the type of information the forecaster should know on most projects. In general, a drive along the project route and connecting local roads will prove invaluable. Existing land use information will help the forecaster in determining the nature of the affected areas. A determination whether the project contains residential land, commercial property, strip malls, truck stations, open space for development, likely truck routes, etc. will be extremely helpful to the forecaster.

*Figure 23 –TH52 Rochester Land Use Sketch*



***Traffic Trends and Hourly Distribution – Cars and Trucks***

The following charts and tables should assist the traffic forecaster in the data collection phase of the process. The next four charts and tables show the following: About 90% of the total traffic in the 24 hour period occurs during the 6:00 A.M. to 10:00P.M. time-frame, (hours covered in a typical 16 hr manual vehicle class count.) The next chart shows the percent each hour is of the raw 16-hour count for cars and trucks (discussed previously in this report). Additional trend data can be found in the appendix.

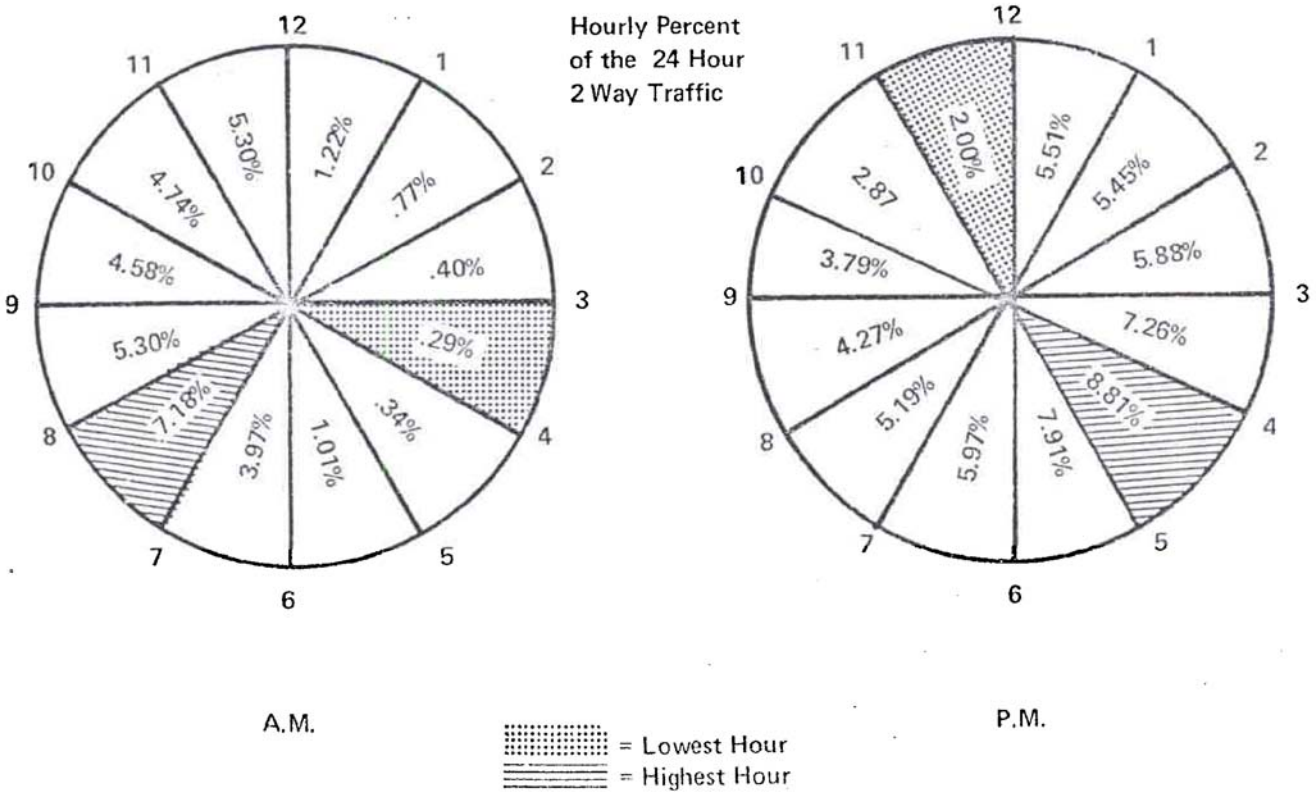
## *Figure 24 – Traffic Trends –Metro Area*

In examining traffic patterns in the seven county twin cities metropolitan area, certain trends in hourly vehicle travel emerged. This issue deals with another trend associated with the movement of people and goods, namely hourly distribution of total traffic.

In 1981, a total of 1,840 locations were analyzed with a total 24 hour vehicle count of 16,289,870 broken down into hourly totals. These 1,840 locations were distributed by county within the metro area for the following counties:

| County | Number of Sites Sampled |
|---|---|
| Anoka | 180 |
| Carver | 68 |
| Dakota | 335 |
| Hennepin | 371 |
| Ramsey | 628 |
| Scott | 56 |
| Washington | 202 |
| Total | 1,840 |

The percent of total 2- way traffic is fairly constant on an hour by hour basis for each county. For example, the charts presented below portray the seven county average hourly vehicle percent breakdown for the 24 hour period.



TWIN CITIES SEVEN COUNTY METRO AREA

HOURLY NONDIRECTIONAL DISTRIBUTION OF TOTAL TRAFFIC BY PERCENT

| HOUR | ANOKA | CARVER | DAKOTA | HENN. | RAMSEY | SCOTT | WASH. | TOTAL | |
|---|---|---|---|---|---|---|---|---|---|
| 12-1A | 1.29 | 1.12 | 1.28 | 1.11 | 1.30 | 1.25 | 1.21 | 1.22 | |
| 1-2 | .79 | .76 | .82 | .69 | .82 | .77 | .74 | .77 | |
| 2-3 | .45 | .44 | .44 | .34 | .40 | .54 | .48 | .40 | |
| 3-4 | .34 | .44 | .34 | .25 | .26 | .52 | .31 | .29 | |
| 4-5 | .42 | .45 | .41 | .30 | .28 | .63 | .38 | .34 | |
| 5-6 | 1.38 | 1.42 | 1.06 | .98 | .81 | 1.52 | 1.07 | 1.01 | |
| 6-7 | 5.07 | 4.57 | 3.98 | 4.16 | 3.31 | 4.45 | 4.02 | 3.97 | |
| 7-8 | 6.95 | 6.33 | 6.91 | 7.55 | 7.16 | 5.94 | 6.99 | 7.18 | A.M. PEAK |
| 8-9 | 4.72 | 5.23 | 5.26 | 5.74 | 5.10 | 5.39 | 5.02 | 5.30 | |
| 9-10 | 4.42 | 5.47 | 4.74 | 4.72 | 4.31 | 5.51 | 4.55 | 4.58 | |
| 10-11 | 4.57 | 5.58 | 4.94 | 4.70 | 4.62 | 5.58 | 4.83 | 4.47 | |
| 11-12N | 4.95 | 5.61 | 5.40 | 5.25 | 5.40 | 5.51 | 5.21 | 5.30 | |
| 12-1 | 5.13 | 5.40 | 5.64 | 5.38 | 5.75 | 5.44 | 5.39 | 5.51 | |
| 1-2 | 5.18 | 5.81 | 5.57 | 5.37 | 5.57 | 5.44 | 5.32 | 5.45 | |
| 2-3 | 5.77 | 6.02 | 5.88 | 5.78 | 6.00 | 6.11 | 5.95 | 5.88 | |
| 3-4 | 7.22 | 7.00 | 7.09 | 7.25 | 7.44 | 7.11 | 6.98 | 7.26 | |
| 4-5 | 8.85 | 8.42 | 8.36 | 8.63 | 9.26 | 8.42 | 8.79 | 8.81 | P.M. PEAK |
| 5-6 | 7.92 | 7.38 | 7.70 | 8.09 | 7.88 | 7.35 | 7.85 | 7.91 | |
| 6-7 | 6.16 | 5.61 | 5.97 | 6.04 | 5.86 | 5.85 | 6.03 | 5.97 | |
| 7-8 | 5.13 | 4.66 | 5.20 | 5.12 | 5.30 | 4.92 | 5.26 | 5.19 | |
| 8-9 | 4.39 | 3.95 | 4.35 | 4.11 | 4.35 | 4.11 | 4.48 | 4.27 | |
| 9-10 | 3.99 | 3.61 | 3.80 | 3.73 | 3.82 | 3.28 | 3.89 | 3.79 | |
| 10-11 | 2.95 | 2.79 | 2.84 | 2.78 | 2.93 | 2.64 | 3.06 | 2.87 | |
| 11-12P | 1.95 | 1.97 | 2.02 | 1.92 | 2.08 | 1.71 | 2.18 | 2.00 | |
| TOTAL | 99.99 | 100.04 | 100.00 | 99.99 | 100.01 | 99.99 | 99.99 | 100.01 | |
| SITES | 180 | 68 | 335 | 371 | 628 | 56 | 202 | 1840 | |
| 6A-10P-16 | 90.42 | 90.65 | 90.79 | 91.62 | 91.13 | 90.41 | 90.56 | 91.11 | |
| 6A-6P-12 | 70.75 | 72.82 | 71.47 | 72.62 | 71.80 | 72.25 | 70.90 | 71.89 | |
| 6A-9A-3 | 16.74 | 16.13 | 16.15 | 17.45 | 15.57 | 15.78 | 16.03 | 16.45 | |
| 3P-6P-3 | 23.99 | 22.80 | 23.15 | 23.97 | 24.58 | 22.88 | 23.62 | 23.98 | |
| HIGH CONSECUTIVE 8 HOURS | 51.36 | 51.25 | 51.61 | 51.79 | 53.16 | 51.23 | 51.57 | 52.09 | |
| 4-6PM HIGH 2 | 16.77 | 15.08 | 16.06 | 16.72 | 17.14 | 15.77 | 16.64 | 16.72 | |

The consistency of county wide traffic volumes becomes evident in examining the percent totals by hourly groupings for each of the seven counties.

The main conclusion drawn is that roughly 90% of the total traffic in the 24 hour period occurs during the 6:00 A.M. to 10:00 P.M. time frame.

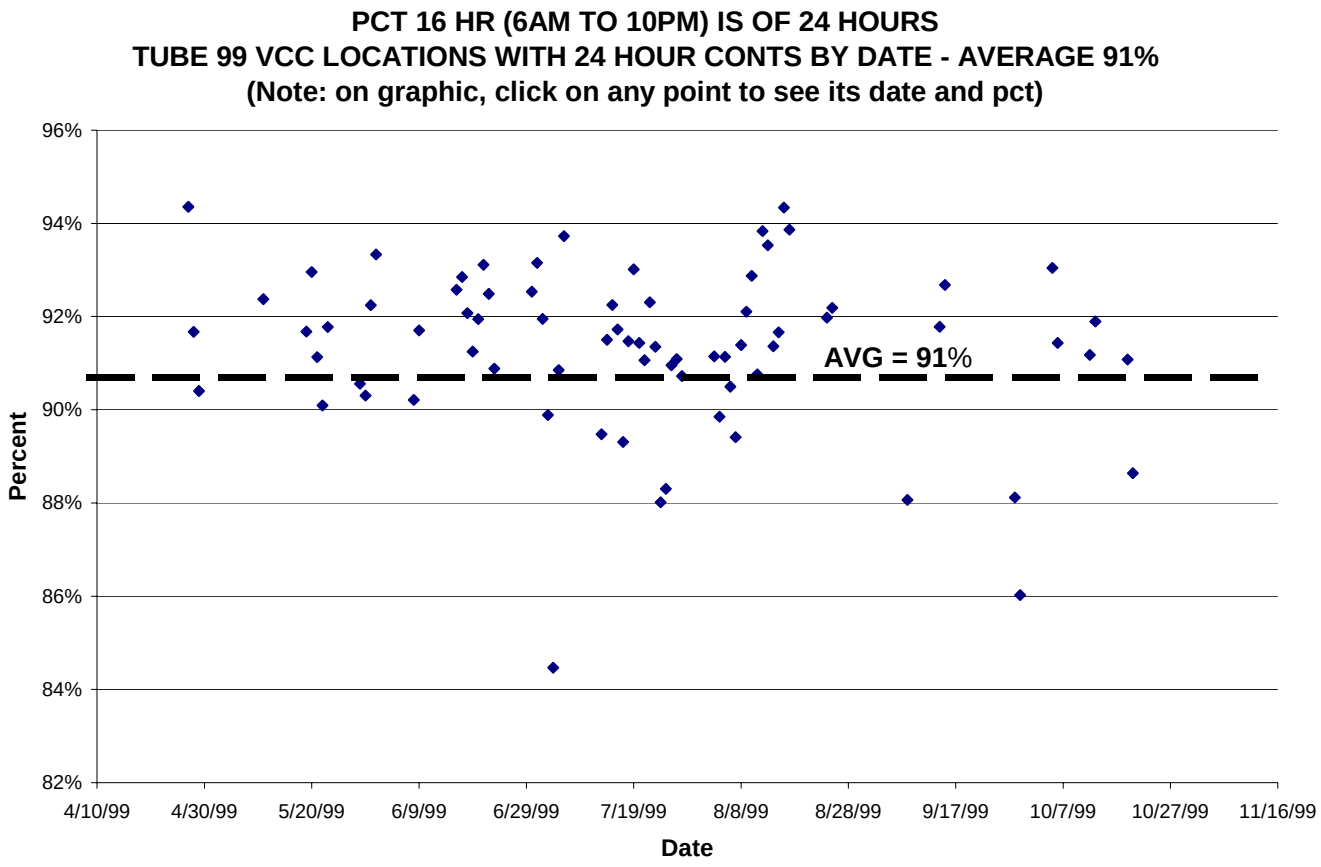
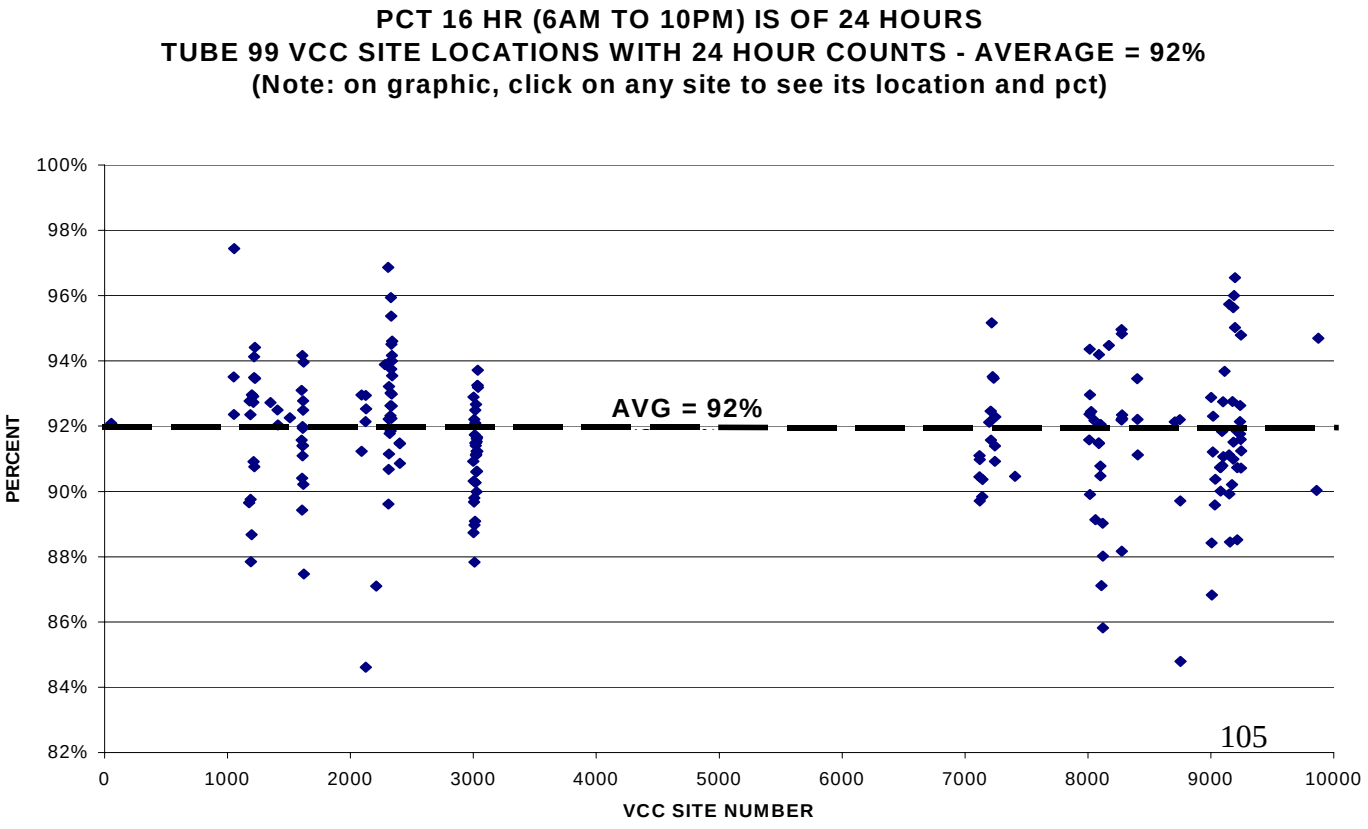



*Figure 25 – % 16 Hours of 24 Hours by Date & AADT*



As previously discussed, in taking a short count, the forecaster could use this guideline in expanding short counts to 16 hour raw counts.

*Figure 26 – Percent 16 Hours of 24 Hours –Cars & Trucks*

Percentage each hour is of raw 16 hour counts – Trucks and Cars – based on 1999 vehicle classification study

| Trucks | | Cars | |
|---|---|---|---|
| • 6-7am | 5.1% | • 6-7am | 6.0% |
| • 7-8 | 5.9 | • 7-8 | 7.2 |
| • 8-9 | 8.2 | • 8-9 | 5.9 |
| • 9-10 | 8.8 | • 9-10 | 5.4 |
| • 10-11 | 8.8 | • 10-11 | 5.4 |
| • 11-noon | 8.6 | • 11-noon | 5.9 |
| • 12-1pm | 8.4 | • 12-1pm | 6.2 |
| • 1-2 | 8.9 | • 1-2 | 6.5 |
| • 2-3 | 8.4 | • 2-3 | 6.7 |
| • 3-4 | 6.8 | • 3-4 | 8.1 |
| • 4-5 | 5.6 | • 4-5 | 8.6 |
| • 5-6 | 4.6 | • 5-6 | 8.4 |
| • 6-7 | 3.9 | • 6-7 | 6.8 |
| • 7-8 | 3.0 | • 7-8 | 4.9 |
| • 8-9 | 2.6 | • 8-9 | 4.1 |
| • 9-10 | 2.3 | • 9-10 | 3.6 |

***Default Heavy Commercial Percents and County Forecasts***

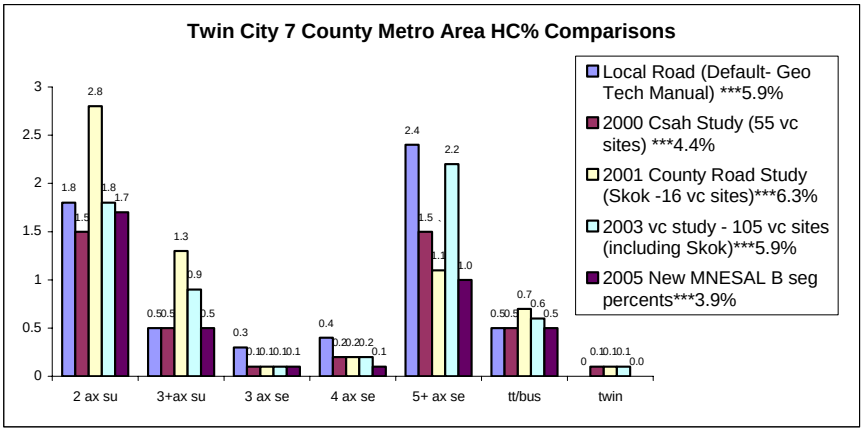
In our previous discussions regarding default percentages currently in use on the B segment, it has been noted that defaults are used when nothing else is known. The 5.9% heavy commercial number that was in use for years has been changed. We currently use an urban percentage of 3.9% and a rural percentage of 8.9%. The following chart shows a variety of past studies and their heavy commercial percents. The current 2005 percentages for the B segment (the 2005 MnESAL) default are shown in the last row.

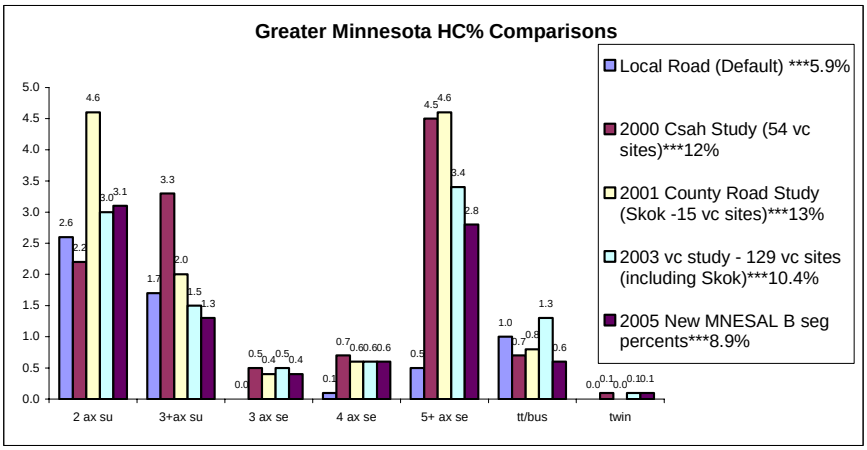
## *Figure 27 – Heavy Commercial Percent Comparisons*

County Heavy Commercial Percent Studies Comparison
Average expanded non TH counts (CSAH, CR, Local VC sites)

| TWIN CITIES 7 COUNTY METRO AREA | 2 ax su | 3+ax su | 3 ax se | 4 ax se | 5+ ax se | tt/bus | twin | hc % |
|---|---|---|---|---|---|---|---|---|
| Local Road (Default- Geo Tech Manual) ***5.9% | 1.8 | 0.5 | 0.3 | 0.4 | 2.4 | 0.5 | 0 | 5.9 |
| 2000 Csah Study (55 vc sites) ***4.4% | 1.5 | 0.5 | 0.1 | 0.2 | 1.5 | 0.5 | 0.1 | 4.4 |
| 2001 County Road Study (Skok -16 vc sites)***6.3% | 2.8 | 1.3 | 0.1 | 0.2 | 1.1 | 0.7 | 0.1 | 6.3 |
| 2003 vc study - 105 vc sites (including Skok)***5.9% | 1.8 | 0.9 | 0.1 | 0.2 | 2.2 | 0.6 | 0.1 | 5.9 |
| 2005 New MNESAL B seg percents***3.9% | 1.7 | 0.5 | 0.1 | 0.1 | 1.0 | 0.5 | <1 | 3.9 |

| GREATER MINNESOTA | 2 ax su | 3+ax su | 3 ax se | 4 ax se | 5+ ax se | tt/bus | twin | hc % |
|---|---|---|---|---|---|---|---|---|
| Local Road (Default) ***5.9% | 2.6 | 1.7 | 0.0 | 0.1 | 0.5 | 1.0 | 0.0 | 5.9 |
| 2000 Csah Study (54 vc sites)***12% | 2.2 | 3.3 | 0.5 | 0.7 | 4.5 | 0.7 | 0.1 | 12.0 |
| 2001 County Road Study (Skok -15 vc sites)***13% | 4.6 | 2.0 | 0.4 | 0.6 | 4.6 | 0.8 | 0.0 | 13.0 |
| 2003 vc study - 129 vc sites (including Skok)***10.4% | 3.0 | 1.5 | 0.5 | 0.6 | 3.4 | 1.3 | 0.1 | 10.4 |
| 2005 New MNESAL B seg percents***8.9% | 3.1 | 1.3 | 0.4 | 0.6 | 2.8 | 0.6 | 0.1 | 8.9 |



In preparation of county forecasts, some counties have used various defaults and some have used various percents, some from the Geo-technical and Pavement Manual. Different studies undertaken by the Traffic Forecast Section show the variability of local road heavy commercial percents In all previous studies, Greater Minnesota has higher default truck percentages than Metro (obviously, this is affected by the higher AADT and subsequent lower truck percentages in the Metro area)

It also appears that the percentage of 5 axle semis has been underestimated in both Metro and Greater Minnesota. The best policy is to perform a vehicle classification count on the road segment with unknown heavy commercial truck volumes. In addition, counts taken during harvest time on county roads can have inflated ESALS for that time period. The seasonal results have to be tempered with AADT and HCAADT.

The chart below shows results of 22 county forecasts and the resultant total heavy commercial percent by our 8 categories (see total in far right column). There are wide swings in heavy commercial percents, often swayed by counts during harvest versus non-harvest time.

## *Figure 28 – County Forecasts Heavy Commercial Percents*

| County | Route | Description | 2 ASU | 3+ ASU | 3 A Semi | 4 A Semi | 5+ A Semi | TT/Bus | Twins | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| RAMSEY | CSAH59 | CRF TO CSAH96 | 1.57% | 0.14% | 0.09% | 0.16% | 0.12% | 0.28% | 0.01% | 2.37% |
| RAMSEY | CSAH49 | CSAH96 TO BIRCH LANE S | 1.43% | 0.21% | 0.04% | 0.07% | 0.20% | 0.54% | 0.01% | 2.50% |
| RAMSEY | CSAH96 | CSAH51(LEXINGTON) TO TH10 | 2.34% | 0.63% | 0.08% | 0.14% | 0.34% | 0.65% | 0.03% | 4.21% |
| RAMSEY | CENTURY AVENUE | LAKE ROAD TO LOWER AFTON | 1.52% | 0.87% | 0.03% | 0.07% | 0.17% | 0.38% | 0.01% | 3.05% |
| RAMSEY | CRF (CSAH12) | TH61 TO BELLAIRE AVENUE | 1.94% | 0.11% | 0.04% | 0.07% | 0.03% | 0.26% | 0.01% | 2.46% |
| RAMSEY | CSAH19 (CRD) | CLEVELAND TO FAIRVIEW | 1.24% | 0.54% | 0.08% | 0.15% | 0.56% | 0.36% | 0.01% | 2.94% |
| RAMSEY | CRI (CSAH3) | SHUTTA RD TO LEXINGTON | 1.27% | 0.11% | 0.03% | 0.05% | 0.08% | 0.56% | 0.00% | 2.10% |
| RAMSEY | CRI (CSAH3) | SHUTTA RD TO LEXINGTON | 0.93% | 0.09% | 0.01% | 0.02% | 0.05% | 0.38% | 0.00% | 1.48% |
| PENNINGTON | CSAH27/CSAH2 | TH1 TO TH92 | 6.33% | 0.67% | 0.67% | 1.33% | 8.83% | 1.17% | 0.00% | 19.00% |
| PENNINGTON | CSAH27/CSAH2 | TH1 TO TH92 | 5.13% | 0.50% | 0.38% | 0.63% | 6.13% | 1.00% | 0.00% | 13.77% |
| MARSHALL | CSAH54/CSAH28 | TH89 TO TH1 | 4.63% | 0.88% | 0.50% | 0.88% | 7.50% | 1.25% | 0.00% | 15.64% |
| CARVER | CSAH20 | WATERTOWN TO HENN. CO. LINE | 2.98% | 0.73% | 0.14% | 0.24% | 0.41% | 0.56% | 0.00% | 5.06% |
| CARVER | CSAH10 | CSAH11 TO TH5 IN WACONIA | 3.47% | 2.22% | 0.12% | 0.20% | 1.43% | 0.55% | 0.11% | 8.10% |
| CARVER | CSAH10 | CSAH11 TO TH5 IN WACONIA | 3.97% | 1.58% | 0.16% | 0.29% | 1.32% | 0.68% | 0.08% | 8.08% |
| CARVER | CSAH18 | TH41 TO CSAH101 | 3.33% | 1.00% | 0.11% | 0.18% | 0.30% | 1.00% | 0.09% | 6.01% |
| CARVER | CSAH11 | CSAH10 TO TH5 | 6.12% | 5.40% | 0.17% | 0.31% | 4.36% | 1.79% | 0.40% | 18.55% |
| CARVER | CSAH11 | CSAH10 TO TH5 | 2.90% | 3.50% | 0.10% | 0.10% | 2.50% | 1.10% | 0.20% | 10.40% |
| CARVER | CSAH33 | TH7 TO N. CO LINE | 5.40% | 1.67% | 0.23% | 0.40% | 2.58% | 0.88% | 0.02% | 11.18% |
| CARVER | CSAH33 | TH7 TO N. CO LINE | 4.66% | 2.00% | 0.20% | 0.34% | 2.59% | 0.68% | 0.05% | 10.52% |
| OLMSTED | CR104 | CR117 TO TH14 | 7.29% | 3.06% | 0.24% | 0.35% | 1.29% | 0.82% | 0.24% | 13.29% |
| OLMSTED | CR117 | TH30 TO N JCT CR117/CR104 | 4.57% | 0.57% | 0.00% | 0.00% | 2.29% | 1.14% | 0.00% | 8.57% |
| WRIGHT | CSAH12 | TH12 TO TH25 | 4.93% | 7.17% | 0.27% | 0.43% | 1.90% | 1.23% | 0.03% | 15.96% |
| WRIGHT | CSAH12 | TH12 TO TH25 | 2.79% | 1.07% | 0.07% | 0.12% | 0.79% | 0.74% | 0.02% | 5.60% |
| CHIPPEWA | CSAH6 | TH7 TO TH29 | 4.00% | 1.33% | 0.59% | 1.11% | 7.48% | 0.44% | 0.00% | 14.95% |
| CHIPPEWA | CSAH6 | TH7 TO TH29 | 6.44% | 4.30% | 0.67% | 1.19% | 12.81% | 0.44% | 0.00% | 25.85% |
| CHIPPEWA | CSAH15/CSAH20 | WEST CO LINE TO TH7 | 3.85% | 0.31% | 0.15% | 0.31% | 0.92% | 0.15% | 0.00% | 5.69% |
| CHIPPEWA | CSAH15/CSAH20 | WEST CO LINE TO TH7 | 2.90% | 0.52% | 0.19% | 0.32% | 2.58% | 0.19% | 0.06% | 6.76% |
| CHIPPEWA | CR38 | CR5 TO TH23 | 3.60% | 1.07% | 0.13% | 0.27% | 0.93% | 0.73% | 0.00% | 6.73% |
| CHIPPEWA | CSAH10 | TH40 TO N CO LINE | 3.44% | 2.15% | 0.43% | 0.86% | 6.67% | 0.43% | 0.00% | 13.98% |
| CHIPPEWA | CSAH4 | TH23 TO TH7 | 2.95% | 4.63% | 0.74% | 1.16% | 3.16% | 0.63% | 0.00% | 13.27% |
| CHIPPEWA | CSAH4 | TH23 TO TH7 | 5.47% | 1.21% | 0.37% | 0.68% | 5.11% | 1.89% | 0.21% | 14.94% |

.***MN/DOT's Traffic Counting Program***

There is more to counting vehicle traffic on Minnesota's roadways and distributing this information than is commonly known. MN/DOT has been responsible for collecting, analyzing, and publishing traffic count, classification and weight data for the various roadway systems throughout the state for the past seventy years. These traffic data have a wide variety of users including five of the six federally mandated management systems in Mn/DOT.

The Department's current Traffic Monitoring System (TMS) bears little resemblance to the manual system for collecting and reporting used for much of the twentieth century. Today's TMS is a product of ongoing automation activities designed to improve traffic volume data quality and timeliness for traffic volume data users. Elements of the Department's TMS currently are administered cooperatively through the efforts of Mn/DOT Divisions and District Offices.

Since 1991, the Traffic Forecasting and Analysis Section of the Program Support Group has been updating the Department's traffic monitoring program. The central premise of this effort, which is called the Minnesota System for Integrated Traffic Estimation (MNSITE), are the following:

1. The TMS must be based on statistically valid principles.
2. The TMS must use a relational database that integrates all necessary data types.
3. Traffic data should be collected, processed, and reported in electronic form. Manual aspects of TMS operation should be minimized.
4. Lines of communication must be established and maintained between those involved with the TMS and the customers using information coming from it.
5. The TMS must be dynamic and flexible in order to take advantage of new methodologies and technologies that apply to traffic data.

Annual average daily traffic (AADT) volumes are the measure of roadway use commonly reported by MN/DOT. These data are estimates of how many vehicles are traveling in both directions on the state's roadway segments during an average day of the year. These traffic volume data are derived from three kinds of traffic counting activities. The first involves continuous traffic counting devices, or ATRs (automatic traffic recorders); the second involves short-term counting devices with road tubes; and the third activity involves either manual or portable automatic vehicle classification. Information from these tasks are analyzed and used to create AADT volumes that are mapped, and distributed for use by MN/DOT, county and local highway departments, and area planning organizations. Private sector business consultants, engineering firms, and real estate interests, among others, also request the department's traffic volume information.

MN/DOT's automatic traffic recorders (ATRs) are located primarily on trunk highways throughout the state. Of the total number (77), 41 ATRs are located on roadways in Greater Minnesota, while 36 are located in the metro area. Traffic volumes are retrieved from these devices by Traffic Forecasting and Analysis Section staff once or twice a week. The ATR data are then edited using a PC-based expert data editing system to

eliminate bad data and check for equipment malfunctions. After the ATR data have been edited, they are ready to be used to report and create seasonal/day-of-week adjustment factors for the short-term count data collected annually at approximately 32,000 count locations across all counting cycles throughout the state. An early part of the MNSITE program moved the ATR-based factor creation and reporting processes off mainframe computers to a PC environment. This step has led to cost and timesaving in performing the data editing and factor creation tasks that are foundational for the Department's traffic counting program.

Short-term count data are collected primarily with equipment that senses vehicle axles and records the axle count information on portable counters located at the side of the roadway. Pneumatic road tubes are used to sense vehicle axles and the axle data are stored on counters until traffic count personnel, who work in the local MN/DOT district offices, transmit the data to the Traffic Forecasting and Analysis Section for entry into the PC-based traffic count database. District traffic count personnel also can enter the data directly upon returning from the field.

After the short-term count data are entered into the database, they are evaluated against past AADT estimates and recounts are ordered when anomalous data values, equipment malfunction, or tube set failures (lost tubes) indicate the need for a recount. Prior to the implementation of database use, these analyses, designed to improve data quality, were virtually impossible because of the magnitude of manual data evaluation.

The short-term counts are factored by a database application with day of week and seasonal adjustment data from the ATR count program as well with as axle corrections from the vehicle classification program to generate adjusted average annual daily traffic volumes for the roadway segments where counts have been taken. At the end of the counting season, the short-term counts are evaluated for spatial and temporal coherency and placed on draft traffic volume maps. The draft maps are circulated to MN/DOT district and/or county and municipality engineers for feedback. Final traffic volume maps are then prepared and distributed to MN/DOT's traffic volume data users. The use of the Department's digital CADD and GIS base maps, where possible, has enhanced the legibility of the draft and final traffic maps, as well as work maps used within the count program. In conjunction with using the database, it has also made possible the automation of traffic volume mapping. These efforts have resulted in an initial timesaving of about one-year in delivering draft county coverage traffic volume maps. There is a commensurate timesaving in delivering the State Trunk Highway Traffic Volume Map as well.

Traffic volume data are also entered into the Department's Transportation Information System (TIS) so that MN/DOT safety analysts and pavement engineers, for example, can have access to traffic information vital to their work. Traffic volume information from TIS is summarized, as well, for reports required by the Federal Highway Administration.

MN/DOT counts traffic on its Greater Minnesota trunk highways on a two-year cycle during even-number years. The Department counts traffic on the Greater Minnesota county coverage system on a four-year cycle. The county coverage and trunk highway counting activities are integrated to provide a relatively even traffic counting workload from one year to the next, that is, fewer counties undergo coverage counting during the even-numbered years when trunk highways are being counted.

The seven county metropolitan area (i.e., the St. Paul-Minneapolis area) count program is a co-operative counting program involving Metropolitan District personnel, the Traffic Management Center (which monitors and manages traffic on the metro area freeways and major arterial highways), highway department staff from each of the metropolitan counties, municipal engineers, and private consultants. Short-term counts are taken over the two-year cycle. Beginning in 2003, Metro county roads will be counted in the odd numbered years.

***Mn/ESAL Documentation***

This is an Excel spreadsheet called MNESAL2005.xls. This requires only a basic knowledge of Excel. There are many steps that should make data entry easier, as there are automatic calculations that carry-over from one spreadsheet to another.
Please make a backup of the file for safekeeping.

As of April 1, 2005, we have changed the heavy commercial vehicle distribution defaults on the "Cumesal-B" tab from 5.9% to 3.9% urban and 8.9% rural. These changes were results of analysis done on previous local road studies. They do not appear in the Mn/DOT Geotechnical and Pavement Manual.

Note: The urban vehicle types were developed primarily for use in the Seven County Metropolitan Area. They can also be used for segments that are near cities with over 5,000 population.

***Caution: Use only one set of Defaults on Each A segment***

More comprehensive information on the use of this spreadsheet is on TDA's web site. Refer to "Procedures Manual for Forecasting Traffic on Minnesota's Highways" in downloadable PDF format.

The MnESAL spreadsheet is divided into 12 worksheets (4 of which are similar)

1. **Forecast** – the sheet to enter basic data that copies to other worksheets
2. **16-24 Vehicle C.C. 1, 2, 3 and 4** – four sheets can automatically transfer the numbers to the New average vehicle C.C. sheet

3. **New Avg Vehicle C.C. –** A vehicle class count average worksheet that can be utilized automatically or manually, or both – automatically transfers average percent column to Cumesal A worksheet
4. **Least Squares**
5. **Cumesal-A**
6. **ESAL Report – A**
7. **Cumesal –B**
8. **ESAL Report – B**

The entire worksheet is protected. You are not able to type (by mistake) in fields that require no data or text entry. All manual entries will be in blue. Cells with black typeface mean that the cell is locked, or protected and contains either a calculated number or a protected label. The order of worksheets should be the logical order or sequence of events for doing traffic forecast. You can unprotect an individual worksheet or the whole workbook, but be careful in typing into certain calculated cells. To unprotect an individual worksheet go to Tools, Protection, Unprotect Sheet, and to unprotect the whole workbook, go to Tools, Protection, Unprotect Workbook. To protect the sheet or workbook, simply go to Tools, Protection, Protect Workbook or Sheet.

Complete the basic information on the **Forecast** sheet first. It copies basic information to the rest of the worksheets.

The **New Avg Vehicle C.C.** offers the most flexibility and has quite a few links to other sheets. It can be used manually or automatically or a combination of both. The average percent column transfers heavy commercial percents directly to the A segment worksheet (it also carries over 5 axle split information if the bottom part of the sheet (Heavy 5 ax Semi) portion is filled out. The worksheet also automatically averages axle correction factors, which can be used on the least squares worksheet form 1986 onward. This sheet has formulas in the Pct columns that will calculate the percent of vehicle types as well as formulas to determine average numbers of vehicles and the percents. It allows from one to four entries.

To calculate averages properly (Avg Num and Avg Pct), make sure that any of the unused columns containing the # symbol are erased). Don't worry about the formulas being erased. You will be saving a copy of the main file and will be able to re-create all formulas. The year and type of count (16 or 24 hour) are automatically transferred from information in each of the four vehicle class expansion worksheets if you chose to use them Also, the four 16-24 hr expansion worksheets correspond to each of the four columns on the Vehicle Class count Averages Worksheet and will automatically transfer values.

To see how this worksheet works initially, you may want to "blank" out all entries in this worksheet, print out a hard copy and do the calculations manually; then enter them on the computer to compare results. If you have to average two vehicle class counts in your expansion procedure, you will have to enter the numbers manually, and just let the

computer calculate the percents (example: you have two 24 hour counts taken in August and July and want to average the two).

If there is more than one "A" segment in the traffic forecast, you will probably find it easier to open up a new file for each additional A segment. There probably will not be many occasions in which you will have multiple "A" segments.

Please call or Groupwise Mark Levenson if you have any questions.

***Observations Based on Analysis of 5 Axle Semi Data from Mn/DOT's WIM sites***

1. Vehicle Class
    a. The highest volume routes, which are generally the Interstate, show the least amount of seasonal variation in volume.
    b. Lower volume routes have a higher degree of variability and seasonal patterns.
    c. Truck volumes continue to increase. Growth rates have been difficult to estimate because of discontinuance of the use of bending plate sensors in the late 1990's.Currently, statewide VMT for all vehicles (car and truck) is growing at about 3% per year.
    d. Truckers will avoid permanent enforcement stations. A significant number of trucks take another route to avoid the St. Croix Weigh Station.

2. Weight
    a. Weights do not appear to have increased between 1992 and 1997 but may have increased somewhat from 1997 to 2005.
    b. Weights are quite often similar from one year to another at a given site
    c. Post 1997 information is limited because of removal of all ending plate weight sensors in Minnesota. Five new quartz sensor-equipped sites have been placed since 2002 and more are planned for the future.

3. Thoughts about the future
    a. Annual total ESALS continue to increase. This is due to increasing numbers of trucks and, to some extent, increasing weights of trucks.

    b. If truck weights were to increase, it would probably mean that more empty or partially loaded trucks were finding additional weight to carry. It would probably not mean that those that were already fully loaded were taking on an even greater load.
    c. Because of the repeatability of truck volumes and weights, we could collect data for one week in each season of the year and in most cases have a good handle on vehicle class and weight, if good portable WIM equipment were available.
    d. We may want to consider having some WIM sites operate continuously for many years to monitor trends in volume and weight

e. The weights/ESAL factors that we see at each site are dependent on the mix of body type and the loads they are carrying (stating the obvious). Figuring this out for those sites where we do not have WIM is often a challenge.

## *Figure 29– Traffic Forecast Personnel Roster*

**TRAFFIC FORECASTING CONTACTS** 2/28/2006

| DISTRICT | FORECASTER/REVIEWER | LOCATION | PHONE | FAX |
|---|---|---|---|---|
| 1 | JAMES MILES | DULUTH<br>TRAFFIC - MS 010 | 218-723-4960<br>EXT 3544 | 218-723-4874 |
| 2 | LYNN NEUBECK<br>MIKE KAMNIKAR | BEMIDJI<br>MATERIALS -MS 020 | 218-755-4533<br>218-755-3805 | 218-755-4530 |
| 3 | NANCY DAVISON<br>ROBIN DELAGE<br>TONY HUGHES | BRAINERD<br>SOILS - MS 030 | 218-828-2768<br>218-828-2240<br>218-828-2465 | 218-828-6105 |
| 4 | MILT WILSON<br>BRIDGET MILLER | DETROIT LAKES<br>PRE-D - MS 040 | 218-847-1530<br>218-847-1562 | 218-847-1583 |
| 6 | TRACY SCHNELL | ROCHESTER<br>PLANNING - MS 060 | 507-280-5028 | 507-285-7279 |
| 7 | DEBRA SCHMIDT | MANKATO<br>TRAFFIC - MS 070 | 507-389-6607 | 507-389-6281 |
| 8 | BILL LANGSTON<br>MIKE LOWNSBURY | WILLMAR<br>TRAFFIC -MS-080 | 320-214-3695<br>320-214-3726 | 320-231-5168 |
| METRO DIVISION | ALAN KRAMER<br>BRIAN ISAACSON<br>BRIAN VOLLUM | WATERS EDGE<br>METRO PLANNING<br>MS 050 | 651-582-1398<br>651-582-1402<br>651-582-1468 | 651-582-1020 |
| METRO TRAFFIC COUNTS | RON ENGH | OAKDALE<br>MS 050 | 651-775-1250 | |
| STATE AID | DIANE GOULD | CENTRAL OFFICE<br>MS - 500 | 651-296-3147 | |
| TRANSP. DATA AND ANALYSIS | TOM NELSON | ROOM 300 N<br>TRAFFIC FORECASTS | 651-297-1194 | 651-296-3311 |
| TRANSP. DATA AND ANALYSIS | MARK LEVENSON<br>DUDLEY GJERSVIG | ROOM 300 N<br>TRAFFIC FORECASTS | 651-296-8535<br>651-296-1664 | 651-296-3311 |
| TRANSP. DATA AND ANALYSIS | GENE HICKS | ROOM 300 N<br>TRAFFIC FORECASTING AND ANALYSIS | 651-296-1740 | 651-296-3311 |
| MATERIALS AND RESEARCH | DAVE JANISCH | MATERIALS AND ROAD RESEARCH - MS645<br>MAPLEWOOD | 651-779-5567 | 651-779-5616 |

# *Figure 30– TDA Personnel and Phone Numbers*

TELEPHONE NUMBERS
TRANSPORTATION DATA AND ANALYSIS
**MAIL STOP 450**
GENERAL INFORMATION NUMBER: 651-296-1411
FAX NUMBER: 651-296-3311

| ADMINISTRATION | |
|---|---|
| Kreideweis, Jonette – Office Director | 215-1854 |
| Cell Phone | 612-723-8962 |
| Pixie Peterson | 296-0623 |
| Herrmann, Fritz | 296-3193 |

| TIS, GIS BASEMAP & GEOGRAPHIC INFO & MAPPING | |
|---|---|
| Brott, Denny – Section Director | 296-1680 |
| Bronk, Mike | 296-1669 |
| Companion, Carole | 296-7907 |
| Gahr, Bill | 296-1684 |
| Hall, Deb | 296-2199 |
| Hamann, Gus | 296-1682 |
| Kong, Leng | 296-2848 |
| Krause-Reader, Amy | 215-1975 |
| Moir, Bruce | 297-7056 |
| Morancey, Joe | 296-3086 |
| Phillips-Mustain, Crystal | 296-1200 |
| Saholt, Jeff | 296-1685 |
| Schlegel, Lynna | 296-1674 |
| Sosa, Danilo (DJ) | 284-0590 |
| Trcka, Andy | 282-6756 |
| Walters, Stan | 205-4397 |
| Wolbeck, Bob | 215-1973 |
| Woods, Chuck | 297-2714 |

| DATA SYSTEMS & COORDINATION | |
|---|---|
| Koukol, Matt – Section Director | 282-2654 |
| Basney, Todd | 215-1889 |
| Carlson, Chuck | 296-6766 |
| Chen, Miin | 296-5135 |
| DeLisi, Chuck | 296-1625 |
| Patnode, Scott | 297-2926 |
| Schlosser, Richard | 296-5131 |

| TRAFFIC FORECASTING & ANALYSIS | |
|---|---|
| Hicks, Gene – Section Director | 296-1740 |
| Dasiga, Ranjani | 296-6846 |
| Flinner, Mark | 297-1466 |
| Gjersvig, Dudley | 296-1664 |
| Holasek, Tarin | 296-5461 |
| Levenson, Mark | 296-8535 |
| McKenney-Maki, Amy | 297-5502 |
| Morris, Mickey | 296-1621 |
| Nelson, Tom | 297-1194 |
| Vang, Kou | 215-1115 |

| WEIGH DATA & ENGINEERING COORDINATION | |
|---|---|
| Cepress, George – Section Director | 296-0217 |
| Martinson, Bill | 296-1663 |
| Novak, Mark | 296-2607 |

| MISCELLANEOUS NUMBERS | |
|---|---|
| Arnebeck, Rick (Acting OST Director) | 297-3590 |
| Young, Mary | 296-3732 |
| Brown, Jackie | 284-0257 |
| **Sophia Yang (Mobility)** | 284-0257 |
| Prescott, Mary | 297-2250 |
| Cell Phone: | 612-280-4078 |
| Campel, Connie (Insurance) | 284-3603 |
| Clemons, Deneen (HR-BSS Rep) | 297-5842 |
| Connolly, Barb (HR) | 284-3600 |
| Ehrisman, Karen (Training/Conf Regis) | 296-6823 |
| French, Mary Ann (Pmts/Accts Payable) | 296-6090 |
| Gibson, Barb (Budget) | 205-4557 |
| Hill, Loren | 634-5100 |
| Kochevar, Barb (HR Rep) | 296-1360 |
| Larkin, Pat (Training/Conf Regis) | 296-3920 |

| MISCELLANEOUS NUMBERS (CONT"D) | |
|---|---|
| Payton, Glenn (Benefits) | 215-1987 |
| Pitt, Sonia (Homeland Security) | 296-8895 |
| Rogers, Bernie (Payroll) | 296-3034 |
| Tkachuck, Kay (Reprographics) | 297-5214 |
| Tobritzhofer, Ruth (Payroll Admin) | 296-3259 |
| Wiese, Carol (Purchasing/DPOs) | 282-2535 |
| Arden Hills Training Center | 297-4429 |
| Desktop Support | 297-8887 |
| Mail Room | 296-2420 |
| Mn/DOT Library | 296-2385 |
| RCA Help Desk | 284-3377 |
| Record Center | 296-6552 |
| TTY # | 1-800-627-3533 |
| THE BUNKER, ROOM B27 | 282-9949 |

| SUPPLIES | |
|---|---|
| Mary Grubbs | 296-8476 |
| Aleta Ruffin | 296-5458 |

| | |
|---|---|
| LAN SUPPORT – Network Operations | 297-4000 |

| P274 | |
|---|---|
| Barnes, Mike | 297-5274 |
| Dreyer, Mark | 296-1603 |
| Harrison, John | 297-1059 |
| Hennum Linda | 296-4707 |
| Nelson, Mjyke | 296-6414 |
| Ross, Dan | 282-6113 |

| | |
|---|---|
| CENTRAL OFFICE FRONT DESK (1ST Floor Main Lobby) | 296-5463 |
| Mn/DOT's INFORMATION NUMBER | 296-3000 |

***TDA WEB PAGE INFORMATION***

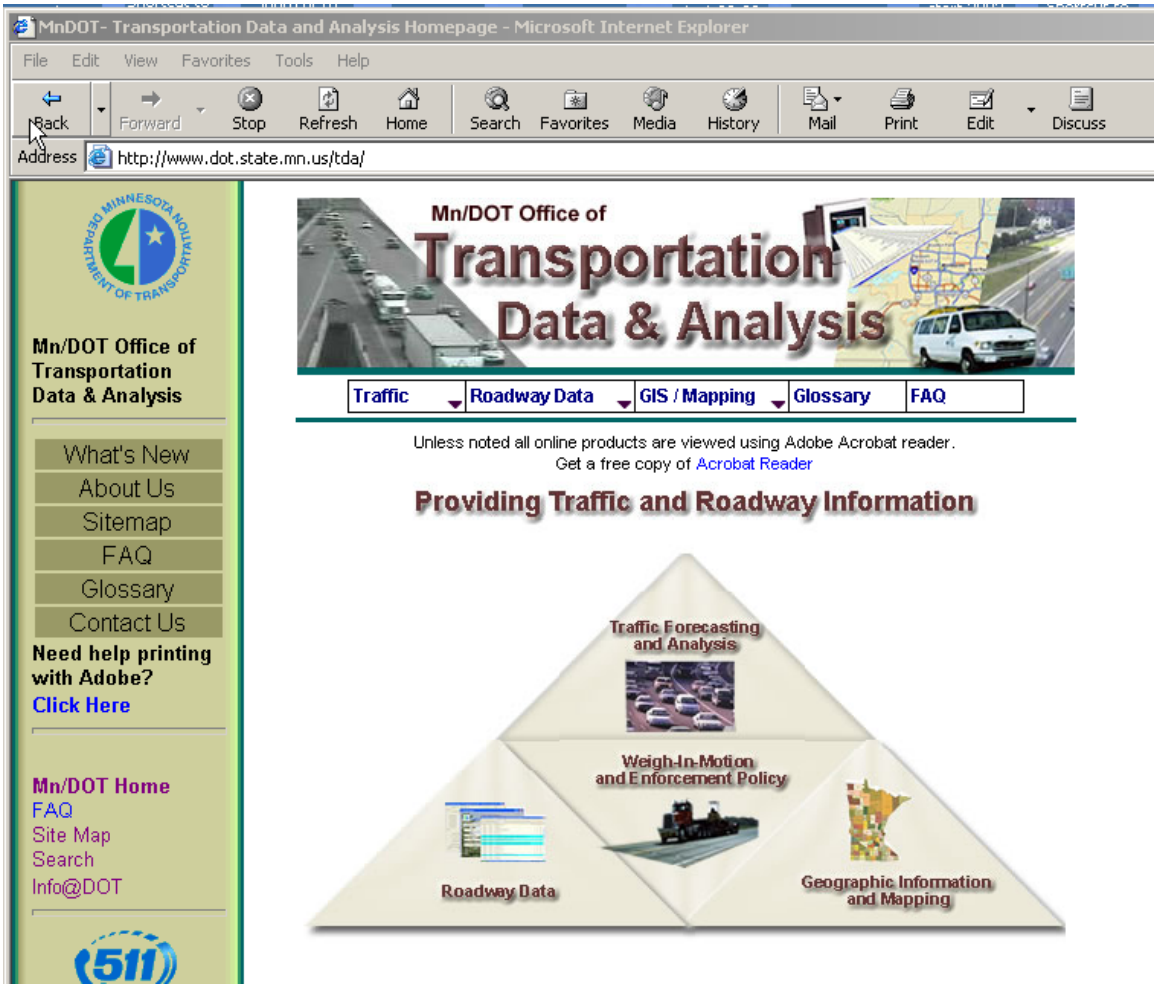
The following web pages are from Mn/DOT's Office of Transportation Data and Analysis Section and pertain to traffic forecasts, maps, and spreadsheets. The forecast maps, both Metro and Greater Minnesota are a valuable resource of previous and current forecasts. A complete record of traffic forecasts from 1995 onward is shown by ESAL range on the maps. Forecasts prior to 1995 are contained in records in the Traffic Forecasts and Analysis Section.

The web sites contain information on traffic counts, flow maps, vehicle weight analysis, roadway history, project log information, etc. In addition, recent traffic volumes for Metro and Greater Minnesota are available by county.

There are maps for vehicle classification sites, automatic traffic recorder sites, weigh-in-motion sites and continuous classifier sites. These maps and all other information may be printed and are useful in obtaining the location of vehicle class sites where there is individual forecasts.

There is a downloadable version of this manual as well as a version of the MnESAL program in Excel. In addition, an Excel spreadsheet containing vehicle class history back to 1984 is also downloadable.

Feel free to contact any of the people listed on TDA's web page or call Mark Levenson at 651-296-8535 for further information.




**The Office of Transportation Data & Analysis provides a variety of traffic and roadway data products and services.**

Information is provided in several forms such as tabular reports and graphics representations, in both hard copy and digital formats.

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Jonette Kreideweis, Office Director
jonette.kreideweis@dot.state.mn.us
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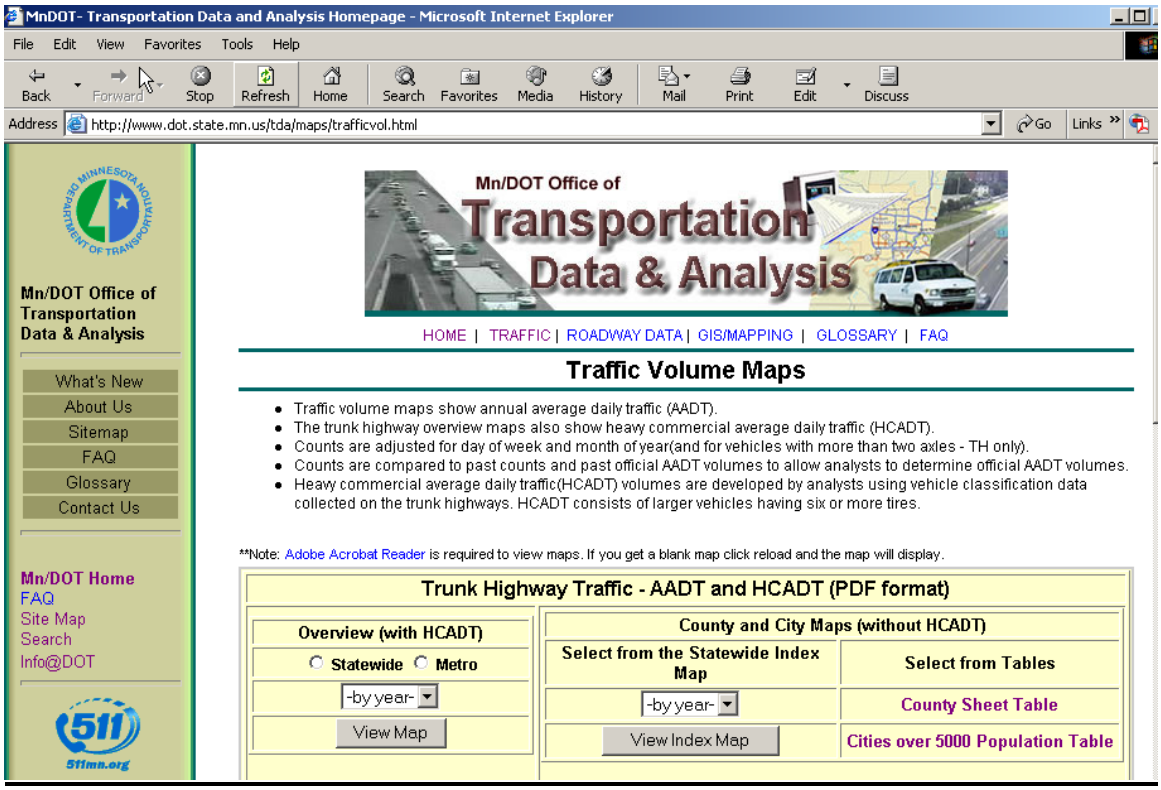
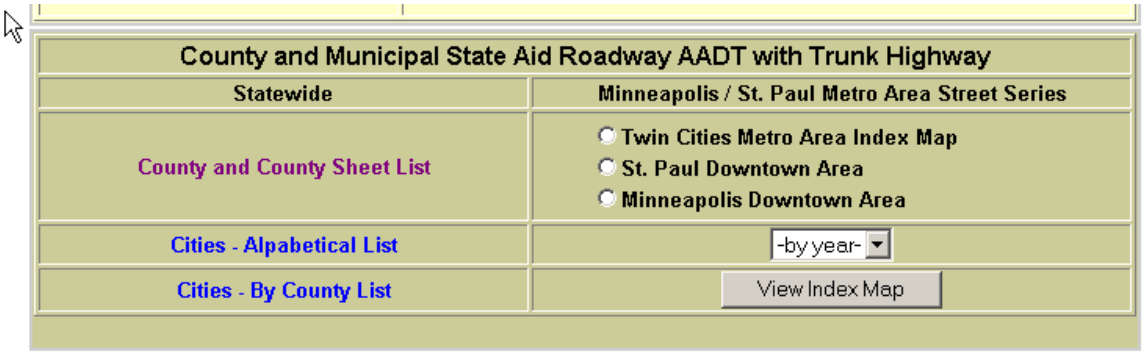
Phone: 800/657-3774 ▪ 800/627-3529(TTY, Voice, ASCII)



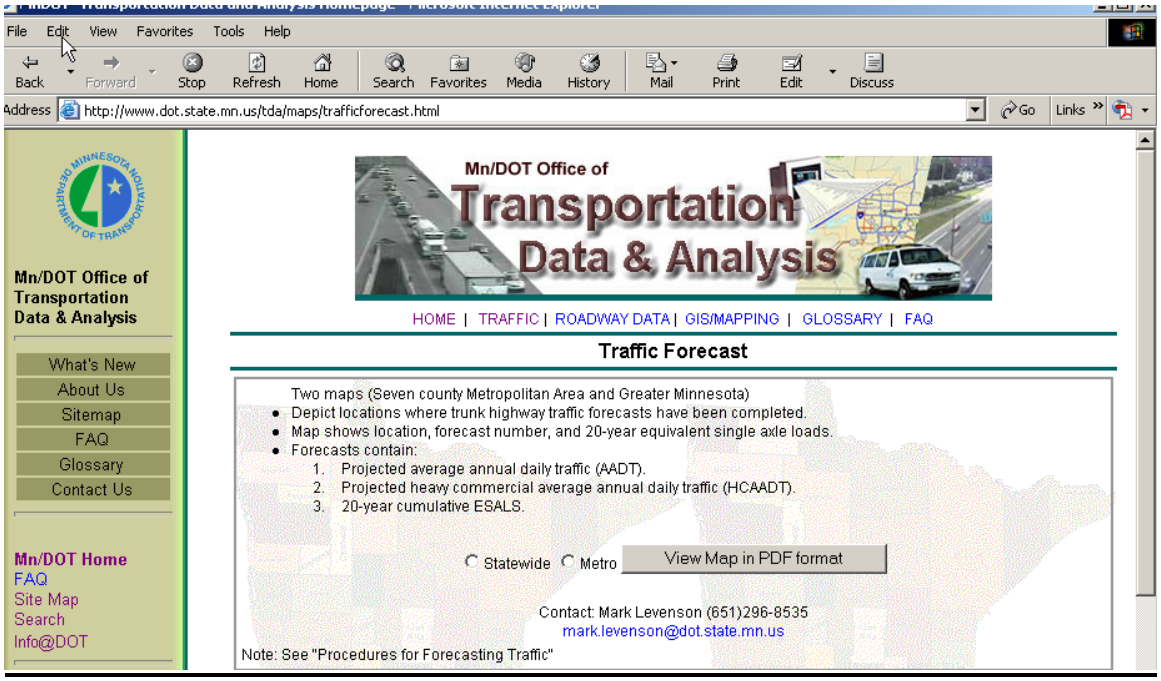




**To get paper copies of Traffic Volume Maps**
Mn/DOT Map and Manual Sales, (651) 296-2216

**Historic Trunk Highway AADT's**
University of Minnesota, John R. Borchert Map Library , (612) 624-4549
http://map.lib.umn.edu
Email: mapref@umn.edu

**Further Information - Metro**
Dudley Gjersvig (651) 296-1664,
Email: dudley.gjersvig@dot.state.mn.us
Howard Hautala (651) 296-6831,
Email: howard.hautala@dot.state.mn.us

**Further Information - Greater Minnesota**
Bill Martinson (651) 296-1663
Email: oscar.martinson@dot.state.mn.us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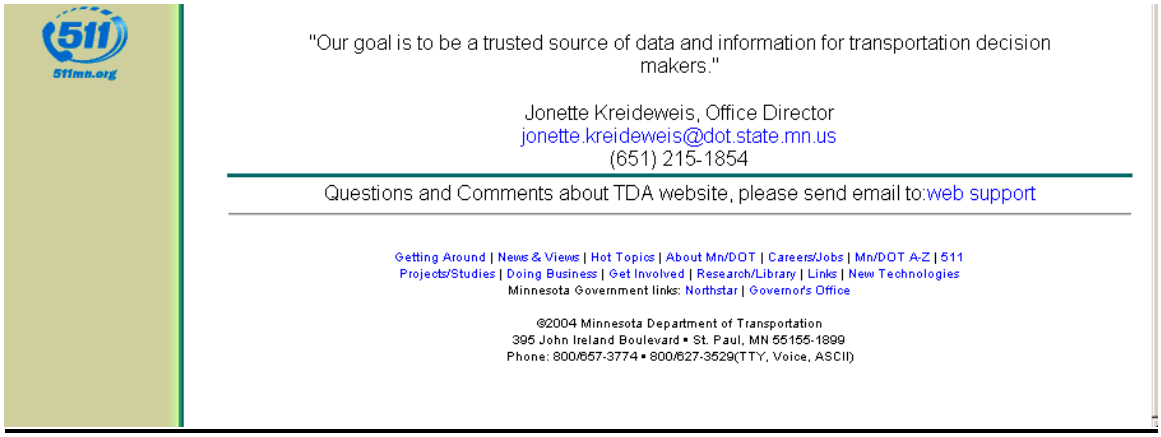
Traffic Forecast
Two maps (Seven county Metropolitan Area and Greater Minnesota)
Depict locations where trunk highway traffic forecasts have been completed.
Map shows location, forecast number, and 20-year equivalent single axle loads.
Forecasts contain:
1. Projected average annual daily traffic (AADT).
2. Projected heavy commercial average annual daily traffic (HCAADT).
3. 20-year cumulative ESALS.
Statewide Metro View Map in PDF format
Contact: Mark Levenson (651)296-8535
mark.levenson@dot.state.mn.us
Note: See "Procedures for Forecasting Traffic"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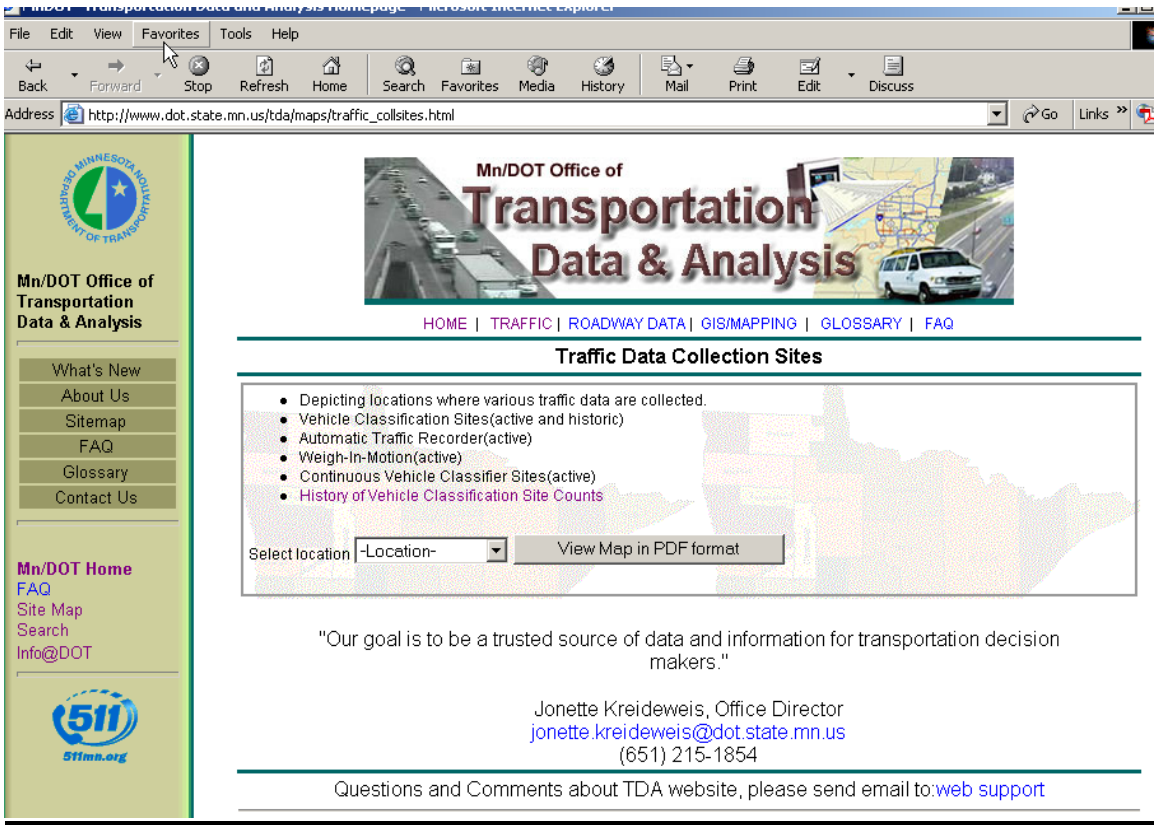
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Depicting locations where various traffic data are collected.
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Automatic Traffic Recorder(active)
Weigh-In-Motion(active)
Continuous Vehicle Classifier Sites(active)
History of Vehicle Classification Site Counts
Select location -Location-
View Map in PDF format
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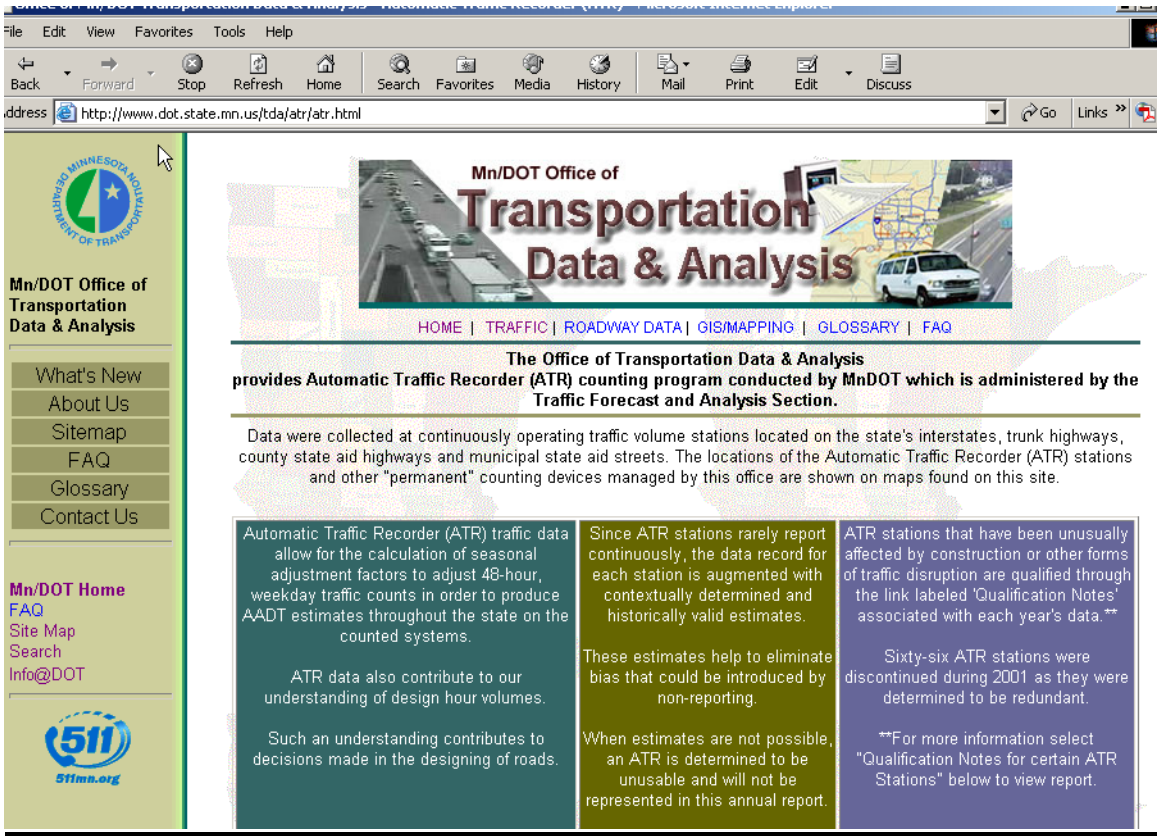
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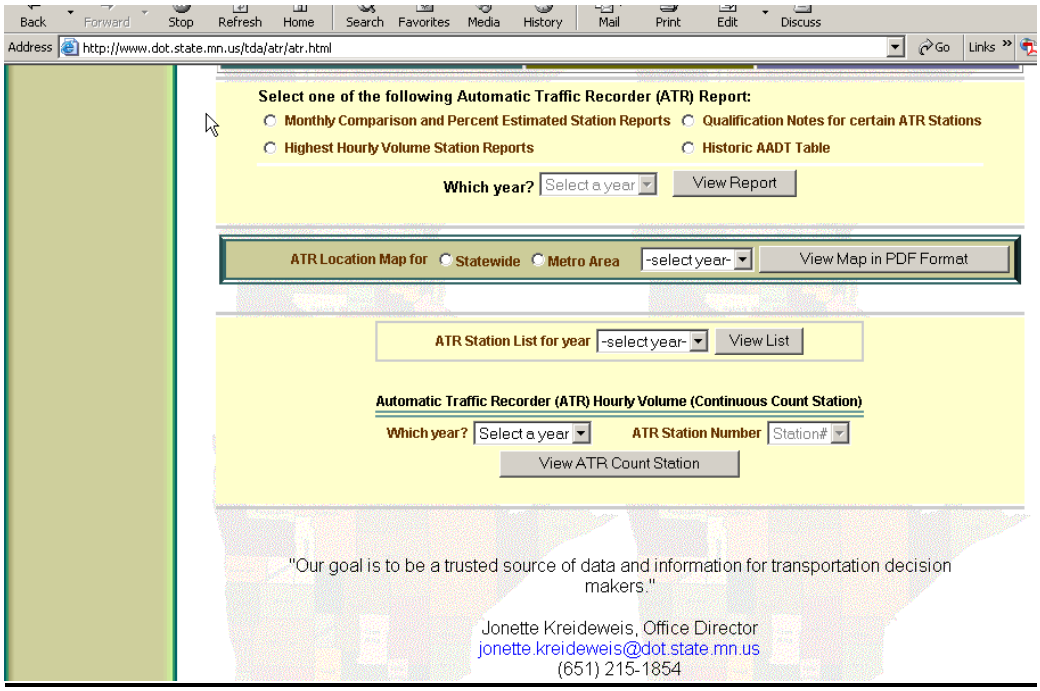
The Office of Transportation Data & Analysis
provides Automatic Traffic Recorder (ATR) counting program conducted by MnDOT which is administered by the Traffic Forecast and Analysis Section.
Data were collected at continuously operating traffic volume stations located on the state's interstates, trunk highways, county state aid highways and municipal state aid streets. The locations of the Automatic Traffic Recorder (ATR) stations and other "permanent" counting devices managed by this office are shown on maps found on this site.
Automatic Traffic Recorder (ATR) traffic data allow for the calculation of seasonal adjustment factors to adjust 48-hour, weekday traffic counts in order to produce AADT estimates throughout the state on the counted systems.
ATR data also contribute to our understanding of design hour volumes.
Such an understanding contributes to decisions made in the designing of roads.
Since ATR stations rarely report continuously, the data record for each station is augmented with contextually determined and historically valid estimates.
These estimates help to eliminate bias that could be introduced by non-reporting.
When estimates are not possible, an ATR is determined to be unusable and will not be represented in this annual report.
ATR stations that have been unusually affected by construction or other forms of traffic disruption are qualified through the link labeled 'Qualification Notes' associated with each year's data.**
Sixty-six ATR stations were discontinued during 2001 as they were determined to be redundant.
**For more information select "Qualification Notes for certain ATR Stations" below to view report.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Go Links
Select one of the following Automatic Traffic Recorder (ATR) Report:
Monthly Comparison and Percent Estimated Station Reports
Qualification Notes for certain ATR Stations
Highest Hourly Volume Station Reports
Historic AADT Table
Which year? Select a year View Report
ATR Location Map for Statewide Metro Area -select year- View Map in PDF Format
ATR Station List for year -select year- View List
Automatic Traffic Recorder (ATR) Hourly Volume (Continuous Count Station)
Which year? Select a year ATR Station Number Station#
View ATR Count Station
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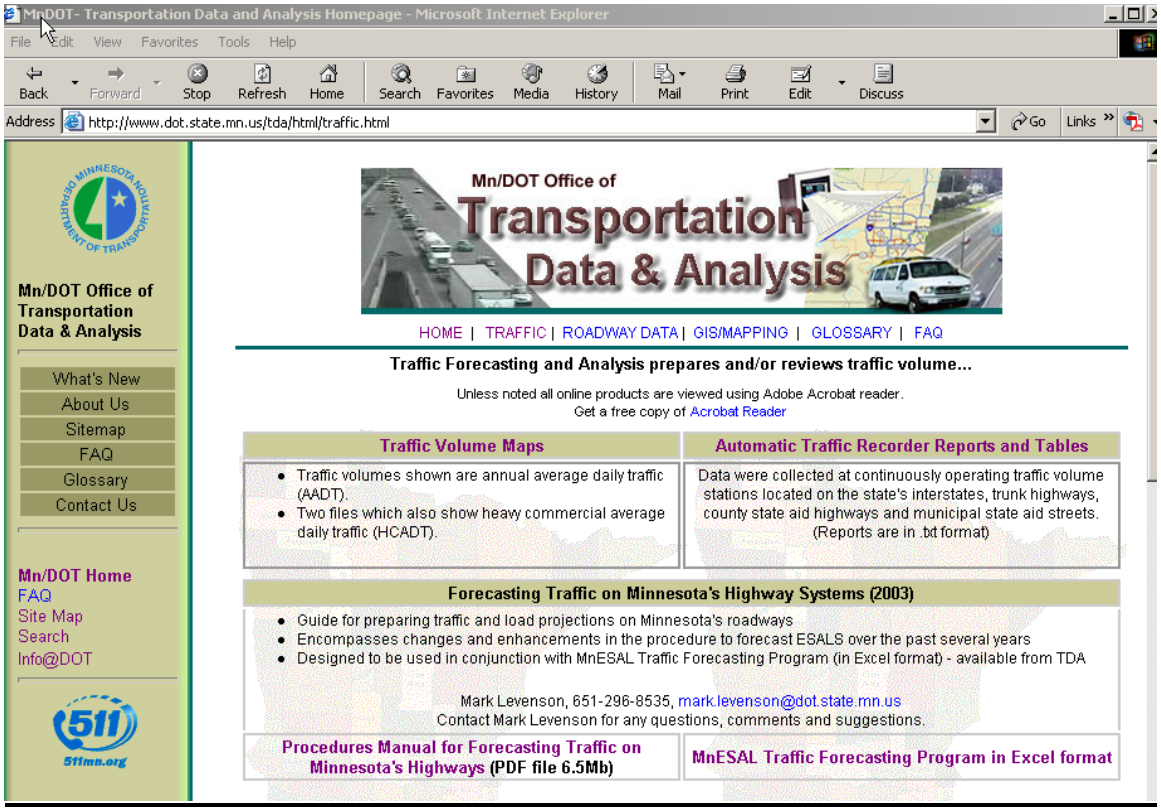
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Traffic Forecasting and Analysis prepares and/or reviews traffic volume...
Unless noted all online products are viewed using Adobe Acrobat reader.
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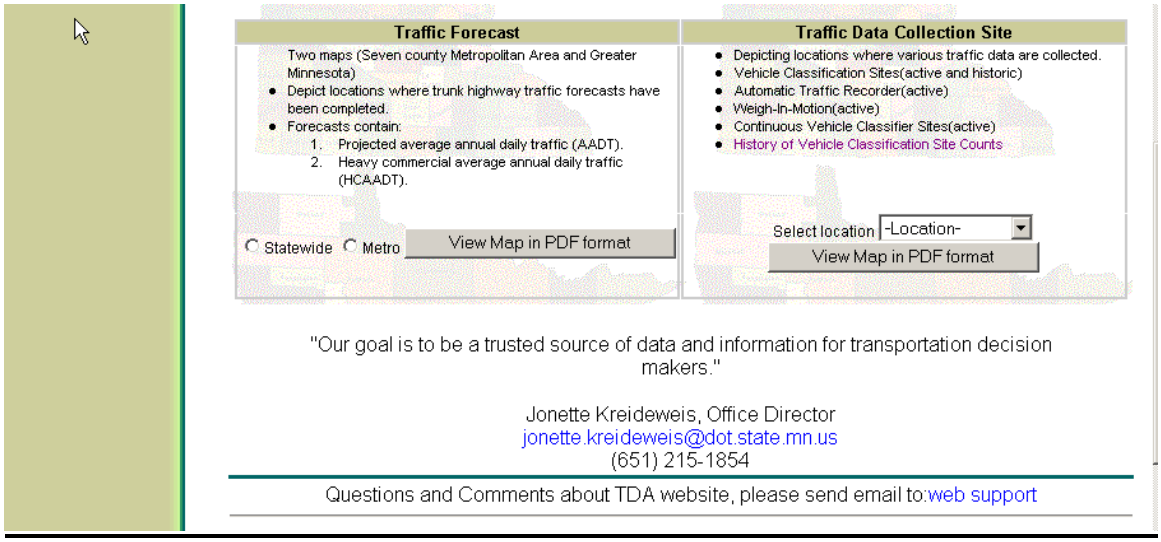
Traffic Volume Maps
Traffic volumes shown are annual average daily traffic (AADT).
Two files which also show heavy commercial average daily traffic (HCADT).
Automatic Traffic Recorder Reports and Tables
Data were collected at continuously operating traffic volume stations located on the state's interstates, trunk highways, county state aid highways and municipal state aid streets. (Reports are in .txt format)
Forecasting Traffic on Minnesota's Highway Systems (2003)
Guide for preparing traffic and load projections on Minnesota's roadways
Encompasses changes and enhancements in the procedure to forecast ESALS over the past several years
Designed to be used in conjunction with MnESAL Traffic Forecasting Program (in Excel format) - available from TDA
Mark Levenson, 651-296-8535, mark.levenson@dot.state.mn.us
Contact Mark Levenson for any questions, comments and suggestions.
Procedures Manual for Forecasting Traffic on Minnesota's Highways (PDF file 6.5Mb)
MnESAL Traffic Forecasting Program in Excel format


Traffic Forecast
Two maps (Seven county Metropolitan Area and Greater Minnesota)
Depict locations where trunk highway traffic forecasts have been completed.
Forecasts contain:
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Statewide Metro
View Map in PDF format
Traffic Data Collection Site
Depicting locations where various traffic data are collected.
Vehicle Classification Sites(active and historic)
Automatic Traffic Recorder(active)
Weigh-In-Motion(active)
Continuous Vehicle Classifier Sites(active)
History of Vehicle Classification Site Counts
Select location -Location-
View Map in PDF format
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jonette.kreideweis@dot.state.mn.us
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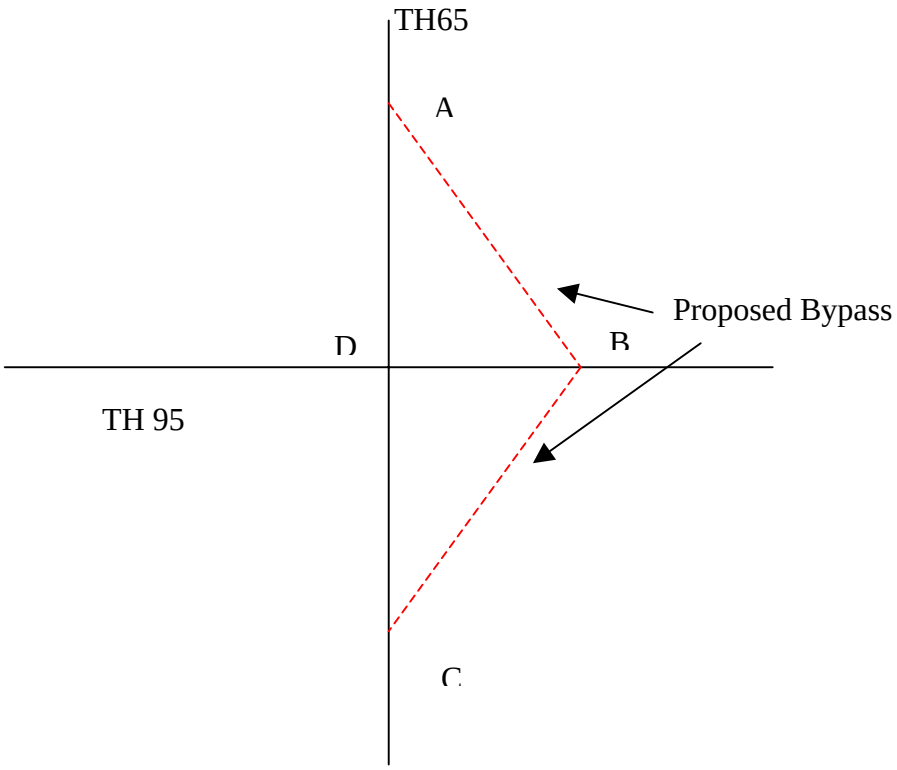
## ***Traffic Forecasting for Proposed (non-existent) Roadways***

This section is designed to outline the procedures for completing traffic and load forecasts on new roadways such as ***bypasses, new alignments or new routes*** for which there is no existing route serving a similar trip purpose.

Bypass

A bypass is generally constructed around a city for the purpose of removing through traffic from the local street network. Our bypass example was recently constructed on a portion of trunk highway 65 around the east side of the city of Cambridge in Isanti County. The problem of congestion through town, especially at the intersection of TH 95 and TH 65, will hopefully be eliminated by the construction of the bypass. To properly design the bypass structurally and geometrically, the designers needed to know the base year and design year projected traffic volumes and the 20 and 35 year cumulative ESALS. When projecting traffic and vehicle type distributions for a road that does not exist, the analyst has no historic data to use… or does he/she? The answer of course is a resounding yes.

The traffic that currently uses TH 65 going through the center of town is the maximum number of vehicles that could be assigned to the new bypass or alternate route. However, not all traffic is through traffic; (i.e., traffic that does not stop in town, rather it goes through to a destination outside of the town) the problem is how much of the traffic is through traffic? The schematic diagram below shows the general layout for the bypass.



How do we determine the percent of through traffic?

Before you can determine the through traffic percentage you need to know a few things about the bypass: 1) termini, 2) access points, 3) travel time in relation to old route, and 4) future development plans adjacent to the bypass. In general, the larger the town or city the fewer the number of through trips it will have. From experience, we have learned that small towns, (i.e., less than 5000 population) will usually have from 70 to 85 percent through trips. The only reliable way to determine the through trip percentage is to perform an origin/destination, (O-D) study.

Origin and destination studies can be accomplished by a *license plate matching study*, a *driver interview or by following vehicles to find their destinations*. A license plate matching study is performed by recording the license plates of vehicles entering and leaving the study area and also at pertinent locations within the study area. In the example above, license plates should be recorded for both directions of traffic at points A, B, C and D. Ideally the study should run from 6 AM – 9 AM, 10 AM – 2 PM and 3 PM – 6PM. Unfortunately, with resources diminishing, you may not be able to collect data for that length of time. At a minimum, data should be collected during either the AM or PM peak period and for 2 hours during the off-peak period of 10 AM – 2 PM.

Once the data has been collected, matches can be determined and the through trips can be assigned to the bypass. In the example above, vehicles that travel from points A to C, C to A, A to B, B to A, B to C or C to B within a specified amount of time, can be assigned to the bypass. Using the data collected at points A, B, C and D you can determine the percentages of vehicles that are through trips and those that have a destination in town. Once the percentages have been calculated they can be applied to the base and design year AADTs that should be projected using least squares regression analysis.

For the above example let's assume that at point A we collected license plate data from 1000 southbound vehicles and 1000 northbound vehicles in the 10 hours prescribed above. Assume that the AADT at this location is 4000 and that data collected yielded the following matches: A-B, B-A = 500, A-C,C-A = 1300, A-D, D-A = 1960. The next step would be to double all of the point-to-point movements, thus bringing the 2000 counted vehicles up to the 4000 AADT. All of the vehicles that travel from points A to C or C to A can be assigned to the entire length of the bypass. Vehicles that travel through points A and B or B and A can be assigned to the A to B portion of the bypass.

Similarly, vehicles traveling from points B to C or C to B can be assigned to the C to B portion of the bypass. Some portion of the vehicles that pass through points A and D and C and D that turn east at D can be assigned to the appropriate portion of the bypass if their destinations were near the bypass. Also, vehicles that appeared at A or C and passed through D but not C or A may be assigned to portions of the bypass depending on the destinations, the access and the decrease in trip time caused by using the usually faster bypass.

The only other vehicles that should be considered for assignment to the bypass are the additional trips that will be generated by new construction of businesses and residential developments that locate near the bypass after it is built. To answer these questions the analyst has to get information from the city regarding zoning and plans for the land development adjacent to the bypass. Those additional vehicle

trips generated from new development can be calculated using the Institution of Transportation Engineers' (ITE), manual on Trip Generation. The ITE manual is organized by development type and gives the average number of trips generated by square footage or number of employees for businesses and by dwelling type for residential developments.

### New Alignment

The second type of forecast where the road does not currently exist is the new alignment. When forecasting future traffic and loadings for a new alignment the analyst must know if the in place alignment will remain or if it is to be closed. The other issue to consider is whether or not the access points remain the same. If the access points change vehicles must be reassigned to the appropriate road segments. If the current alignment is going to be closed, all traffic that is currently using the route can be reassigned to the new alignment. The analyst should produce this type of forecast in the same manner as any other major construction project. If the old alignment is going to remain open to traffic an O-D study is necessary and the forecasting method for a bypass should be used.

### New Route

The last type of new road construction is the new route with no existing route serving the same trip purpose. In this case, all of the traffic must be assigned by using trip generation information from the ITE manual and heavy commercial types and volumes using the appropriate defaults plus the addition of trucks based on the proposed developments. If the traffic forecaster needs clarification on any of the material covered in this section the Traffic Forecasts Unit is available for consultation and training.

### Use of Vehicle Class Data on non-existing Roadways

On any new road, route, or bypass, there will be judgment as to which and how many vehicle class sites to use to represent all or portions of new roadways or new alignments. The forecaster may use, for example, averages of two vehicle class site location percentages to represent the movement on a particular roadway, ramp or street. It is important to distinguish where, or what vehicle class site the truck movements originate from and where they are going. This will ultimately help determine the vehicle type percents affecting any particular roadway. The Rochester example used in this manual discusses uses of multiple vehicle class sites affecting different segments of roadways. On a non-existing section or road, it will be important to consider all vehicle class site information, where exactly the site is located, and how to distribute the volumes or percentages between existing and non-existing roadways.

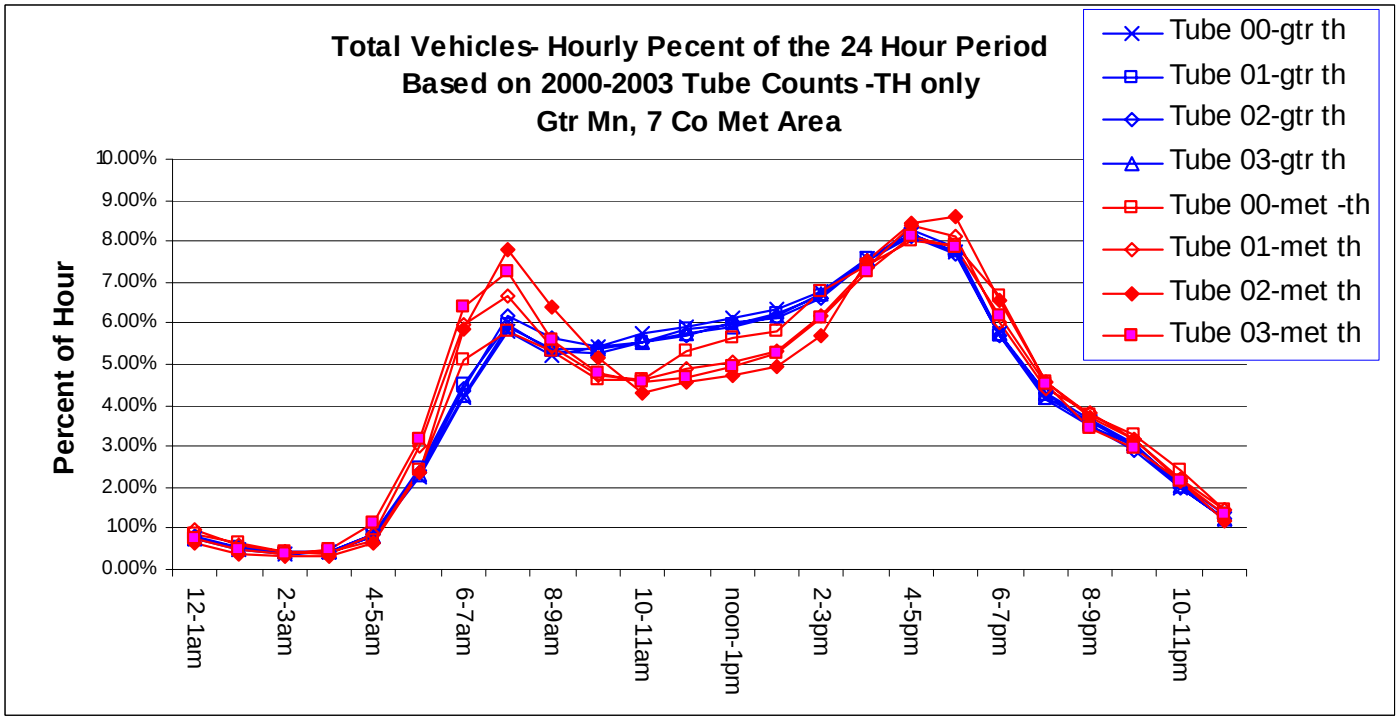
***Summary of Vehicle Classification Program, Vehicle Class Locations and Type of Data Collected***

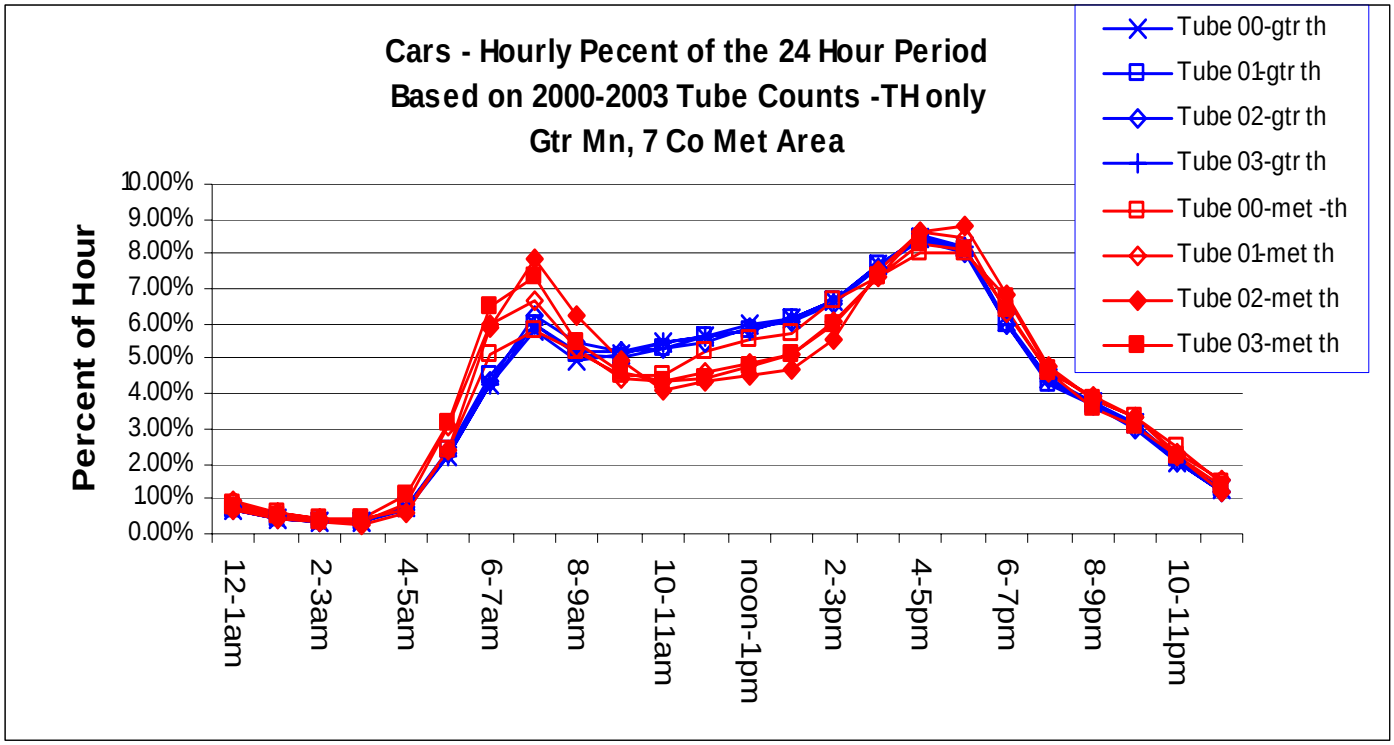
Minnesota's vehicle classification program is designed to gain an understanding of the volume and type of heavy commercial vehicles that are utilizing the Minnesota's portion of the National Highway System as well as other trunk highways, CSAHs, county roads and MSASs in Minnesota. This is being accomplished through an integrated system of data collection devices that include both continuous and short-duration counting methods. Vehicle classification data is collected from weigh-in-motion, continuous classifiers, tube counters and manual counts. The data collected is archived in an Access database for analysis and reporting purposes.

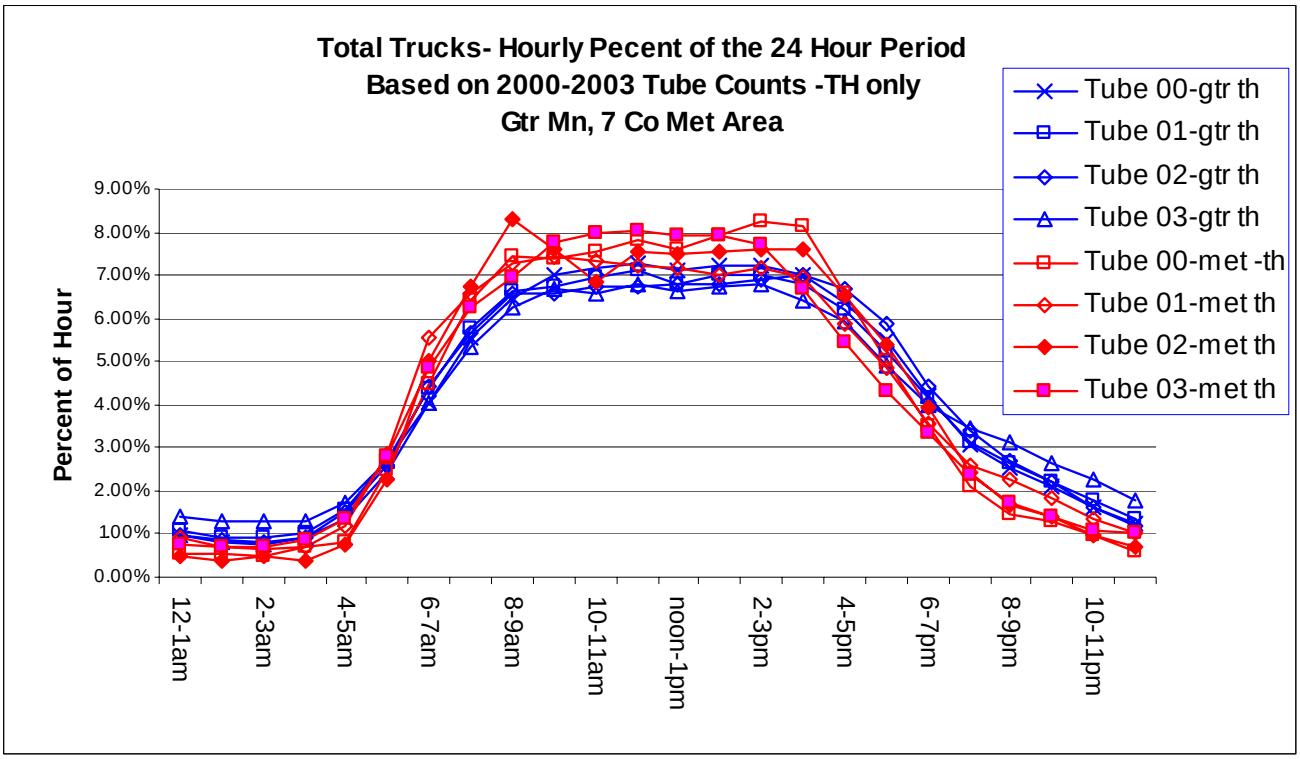
There have been 26 weigh-in-motion sites. They were removed from service because of bending plate sensors. There are currently five new weigh-in-motion sites that are in service. They use quartz sensors. There are 23 continuous classification sites (Piezo electric sensors) and about 1200 regularly scheduled vehicle classification count locations (80% tube, 20% manual). Usually,

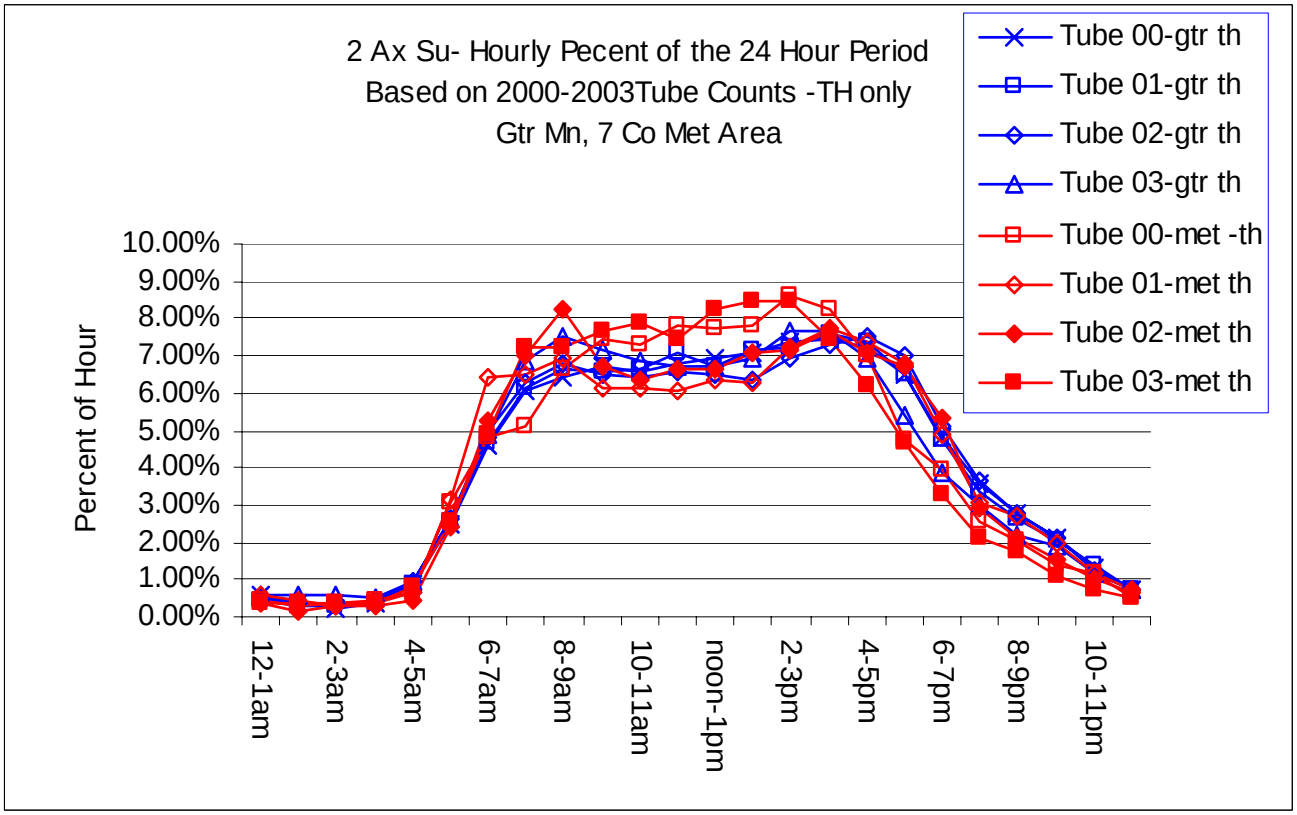
There is a Parent/ Child heavy commercial relationship established for all trunk highway traffic segments where no classification has taken place. All vehicle classifiers collect data on vehicle type (FHWA 13 classes) and are stored in the database by hour. Body type data are available for all data manually collected and speed data is available on request at all sites. Tube counts are set for 48 hours and manual counts are taken for 16 hours (6AM – 10PM), although we are taking shorter manual counts on certain routes and using factors for the remainder of the hours. The short duration classification counts are adjusted to annual average daily traffic volumes by using factors developed from continuous counters. These factors take into account the variations of truck volumes by month and day of week. The parent/child relationships developed will enable us to automate the process for the production of heavy commercial vehicle type volumes at all HPMS segments. The Office of Transportation Data & Analysis has plans to install an additional 8 Kistler WIMs and 40 continuous classification systems in the next five years.

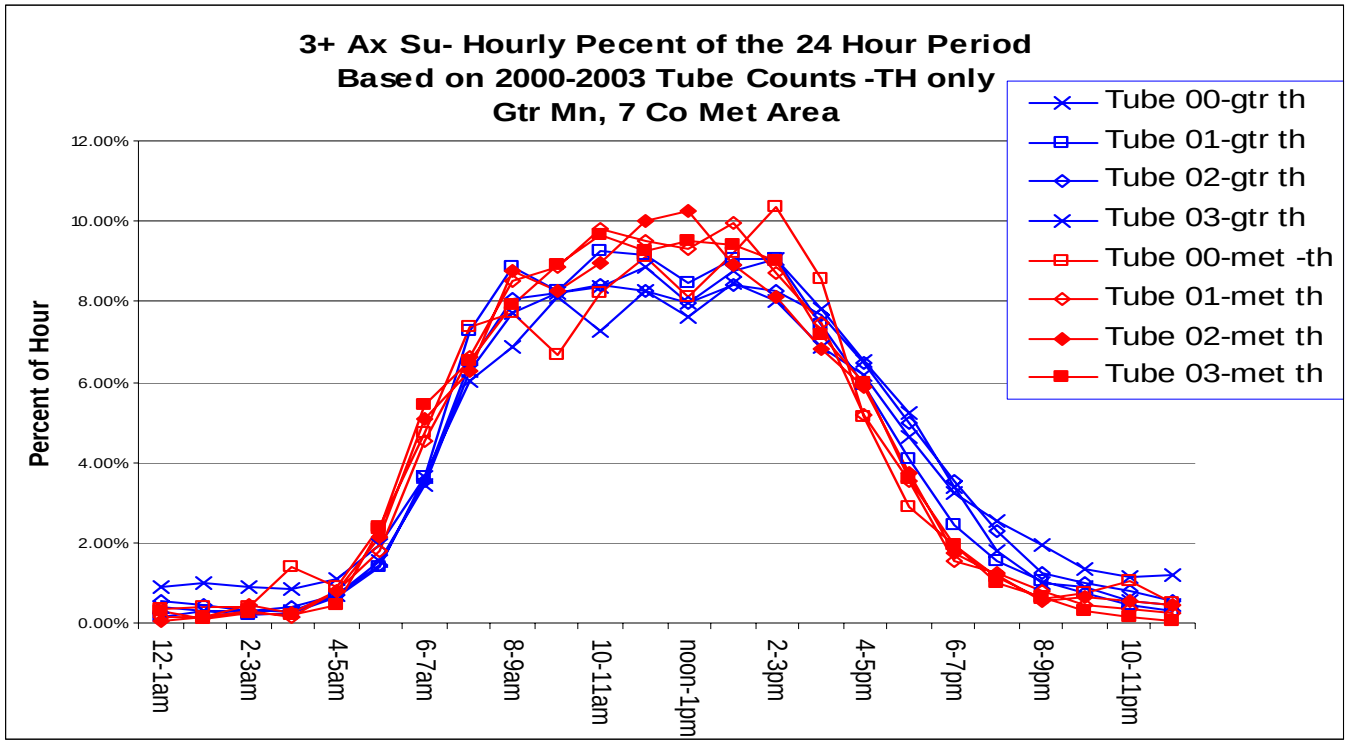
# 2000-2003 TRENDS

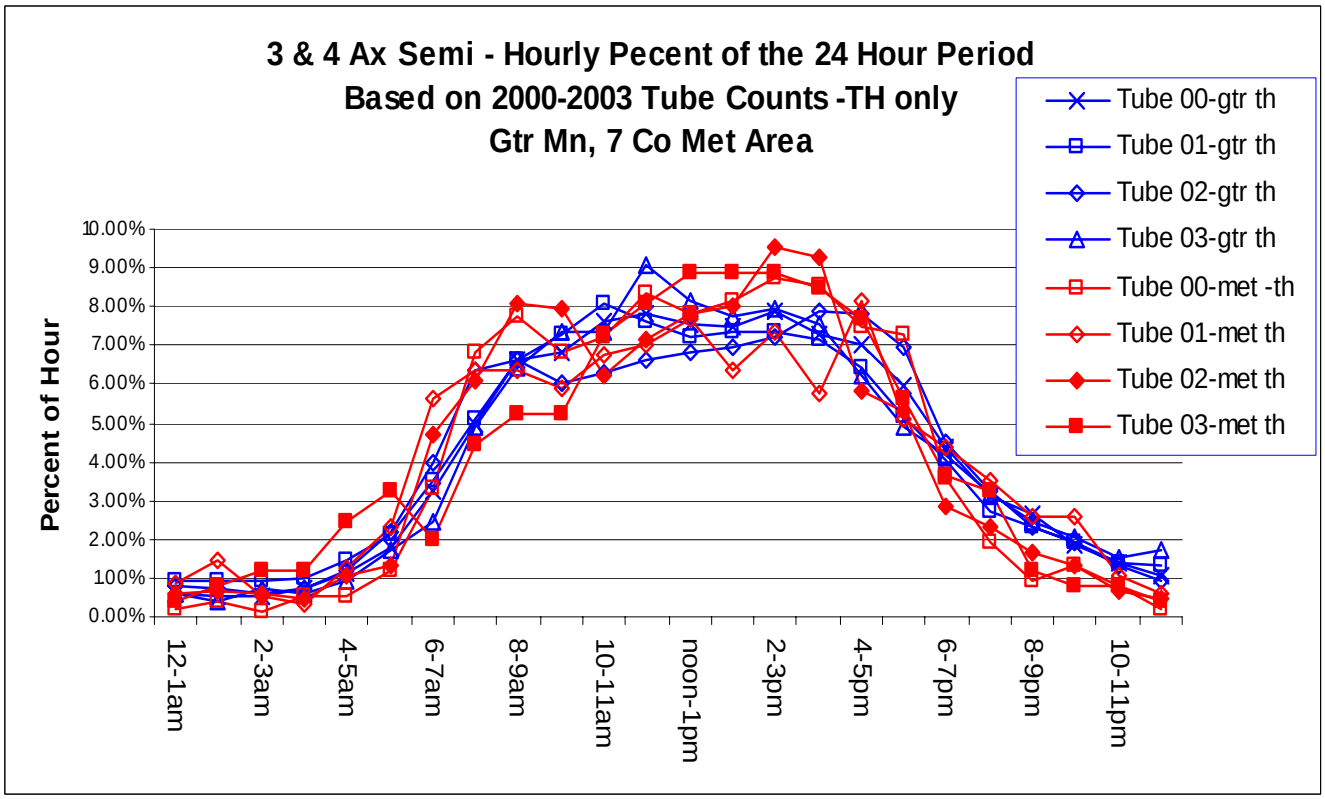


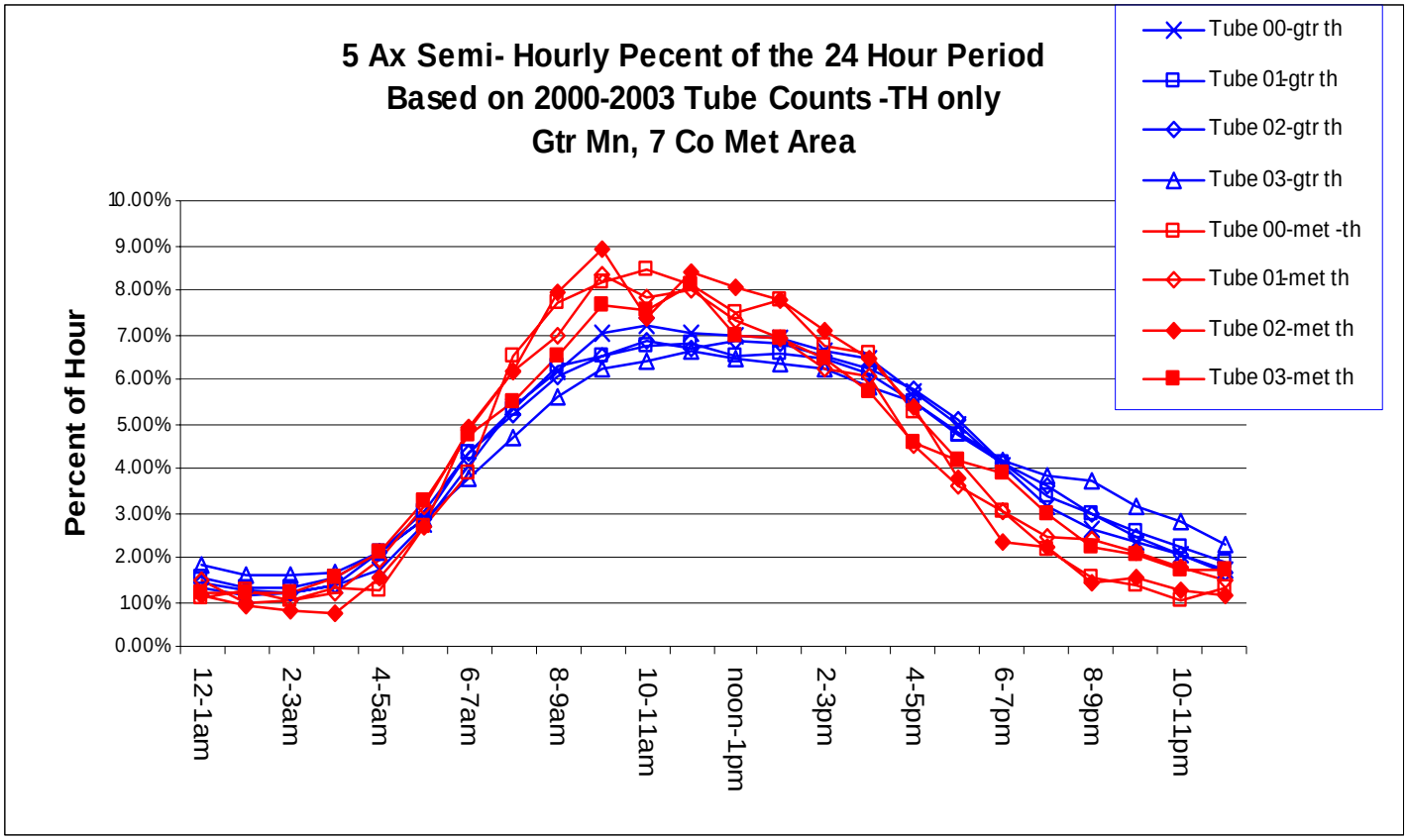



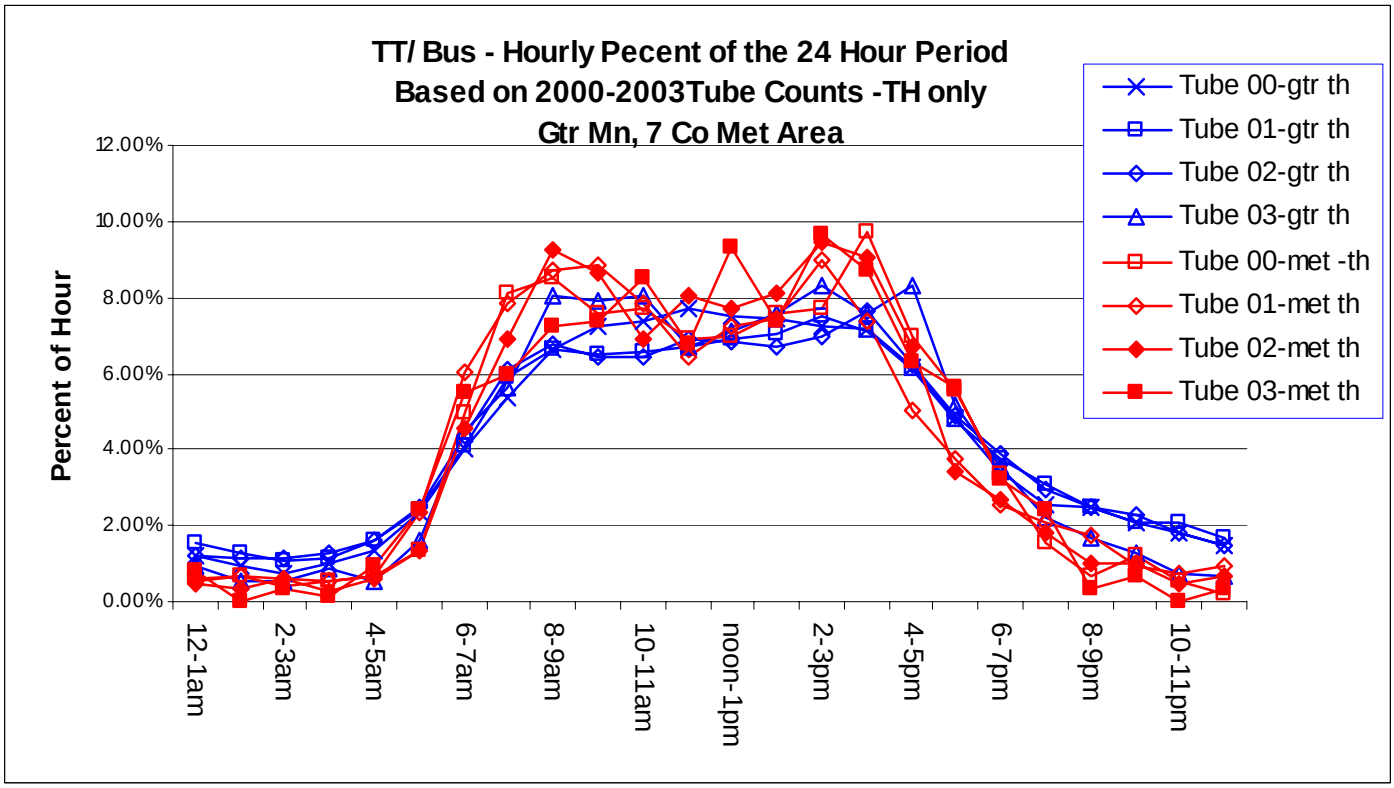

Total Trucks- Hourly Pecent of the 24 Hour Period
Based on 2000-2003 Tube Counts -TH only
Gtr Mn, 7 Co Met Area
Percent of Hour
9.00%
8.00%
7.00%
6.00%
5.00%
4.00%
3.00%
2.00%
100%
0.00%
12-1am
2-3am
4-5am
6-7am
8-9am
10-11am
noon-1pm
2-3pm
4-5pm
6-7pm
8-9pm
10-11pm
Tube 00-gtr th
Tube 01-gtr th
Tube 02-gtr th
Tube 03-gtr th
Tube 00-met -th
Tube 01-met th
Tube 02-met th
Tube 03-met th


2 Ax Su- Hourly Pecent of the 24 Hour Period
Based on 2000-2003Tube Counts -TH only
Gtr Mn, 7 Co Met Area
Percent of Hour
10.00%
9.00%
8.00%
7.00%
6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
12-1am
2-3am
4-5am
6-7am
8-9am
10-11am
noon-1pm
2-3pm
4-5pm
6-7pm
8-9pm
10-11pm
Tube 00-gtr th
Tube 01-gtr th
Tube 02-gtr th
Tube 03-gtr th
Tube 00-met -th
Tube 01-met th
Tube 02-met th
Tube 03-met th


3+ Ax Su- Hourly Pecent of the 24 Hour Period
Based on 2000-2003 Tube Counts -TH only
Gtr Mn, 7 Co Met Area
Percent of Hour
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
12-1am
2-3am
4-5am
6-7am
8-9am
10-11am
noon-1pm
2-3pm
4-5pm
6-7pm
8-9pm
10-11pm
Tube 00-gtr th
Tube 01-gtr th
Tube 02-gtr th
Tube 03-gtr th
Tube 00-met -th
Tube 01-met th
Tube 02-met th
Tube 03-met th


3 & 4 Ax Semi - Hourly Pecent of the 24 Hour Period
Based on 2000-2003 Tube Counts -TH only
Gtr Mn, 7 Co Met Area
Percent of Hour
10.00%
9.00%
8.00%
7.00%
6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
12-1am
2-3am
4-5am
6-7am
8-9am
10-11am
noon-1pm
2-3pm
4-5pm
6-7pm
8-9pm
10-11pm
Tube 00-gtr th
Tube 01-gtr th
Tube 02-gtr th
Tube 03-gtr th
Tube 00-met -th
Tube 01-met th
Tube 02-met th
Tube 03-met th

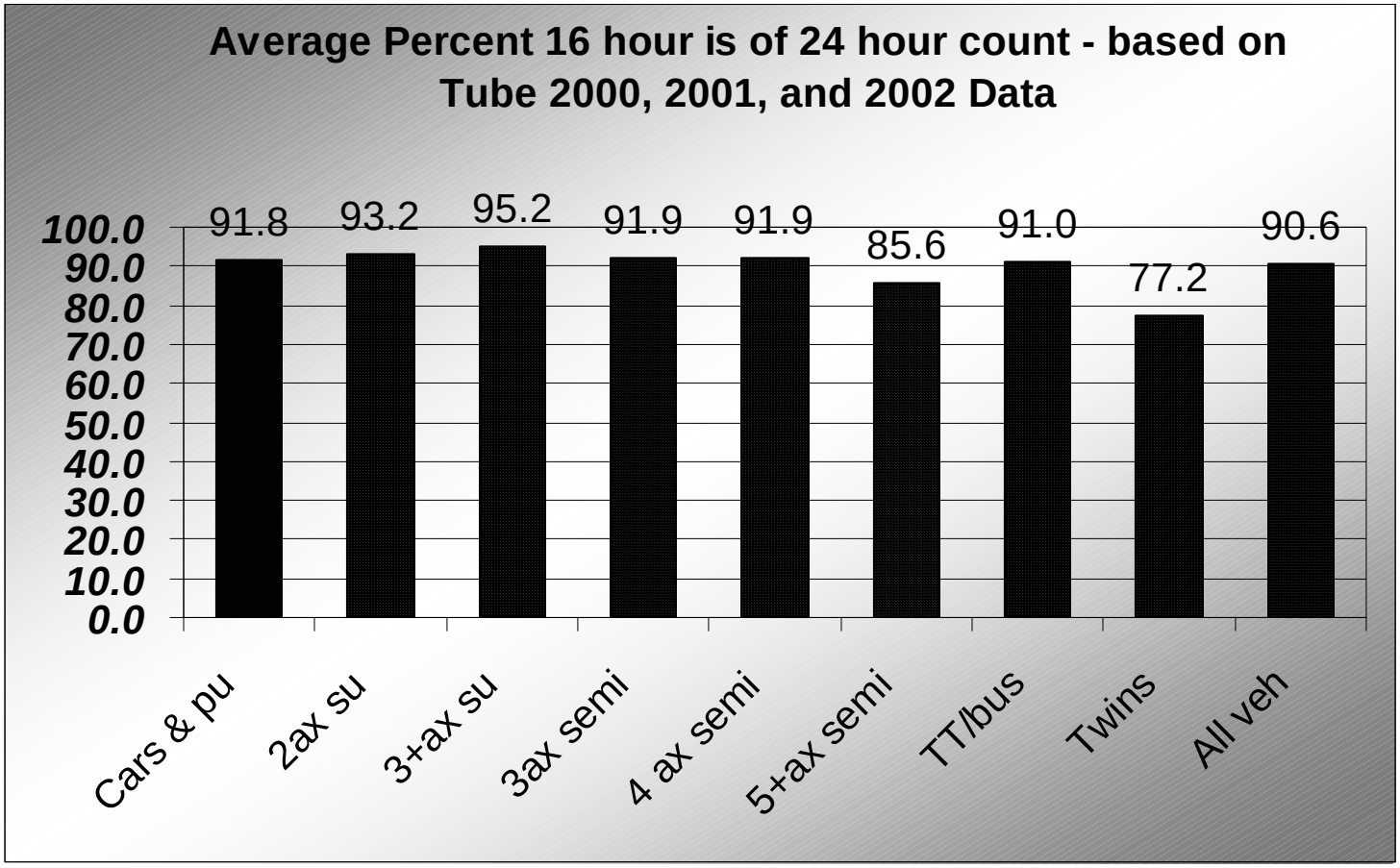

5 Ax Semi- Hourly Pecent of the 24 Hour Period
Based on 2000-2003 Tube Counts -TH only
Gtr Mn, 7 Co Met Area
Percent of Hour
10.00%
9.00%
8.00%
7.00%
6.00%
5.00%
4.00%
3.00%
2.00%
1.00%
0.00%
12-1am
2-3am
4-5am
6-7am
8-9am
10-11am
noon-1pm
2-3pm
4-5pm
6-7pm
8-9pm
10-11pm
Tube 00-gtr th
Tube 01-gtr th
Tube 02-gtr th
Tube 03-gtr th
Tube 00-met -th
Tube 01-met th
Tube 02-met th
Tube 03-met th


TT/ Bus - Hourly Pecent of the 24 Hour Period
Based on 2000-2003Tube Counts -TH only
Gtr Mn, 7 Co Met Area
Percent of Hour
12.00%
10.00%
8.00%
6.00%
4.00%
2.00%
0.00%
12-1am
2-3am
4-5am
6-7am
8-9am
10-11am
noon-1pm
2-3pm
4-5pm
6-7pm
8-9pm
10-11pm
Tube 00-gtr th
Tube 01-gtr th
Tube 02-gtr th
Tube 03-gtr th
Tube 00-met -th
Tube 01-met th
Tube 02-met th
Tube 03-met th

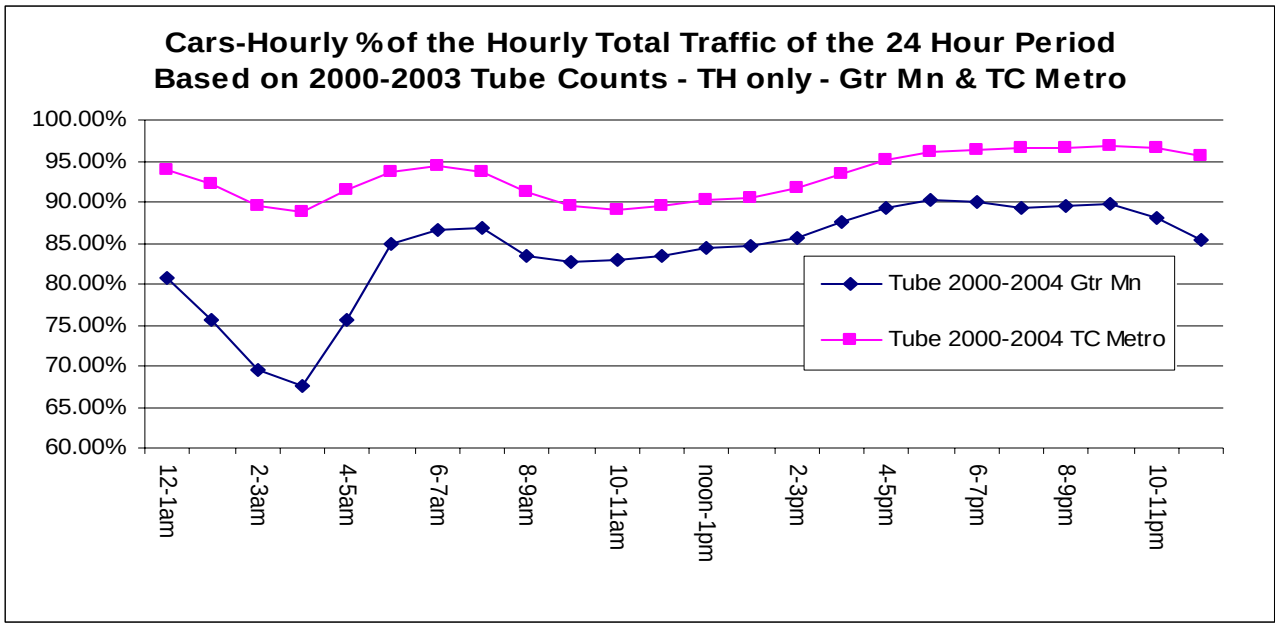
The preceding eight charts portray a consistent daily pattern of traffic flow on an hour-by-hour basis over the typical week-day period by selected vehicle classifications (weekends are excluded from this data since most of our traffic is counted on weekdays). Similar distributions are evident when comparing this data to older data presented on pages 85-86 of this manual. The data is a compilation of four years of hourly tube counts taken by Mn/DOT between 2000 and 2004. Caution must be used in that these are averages only and should not be used for any specific project determination.

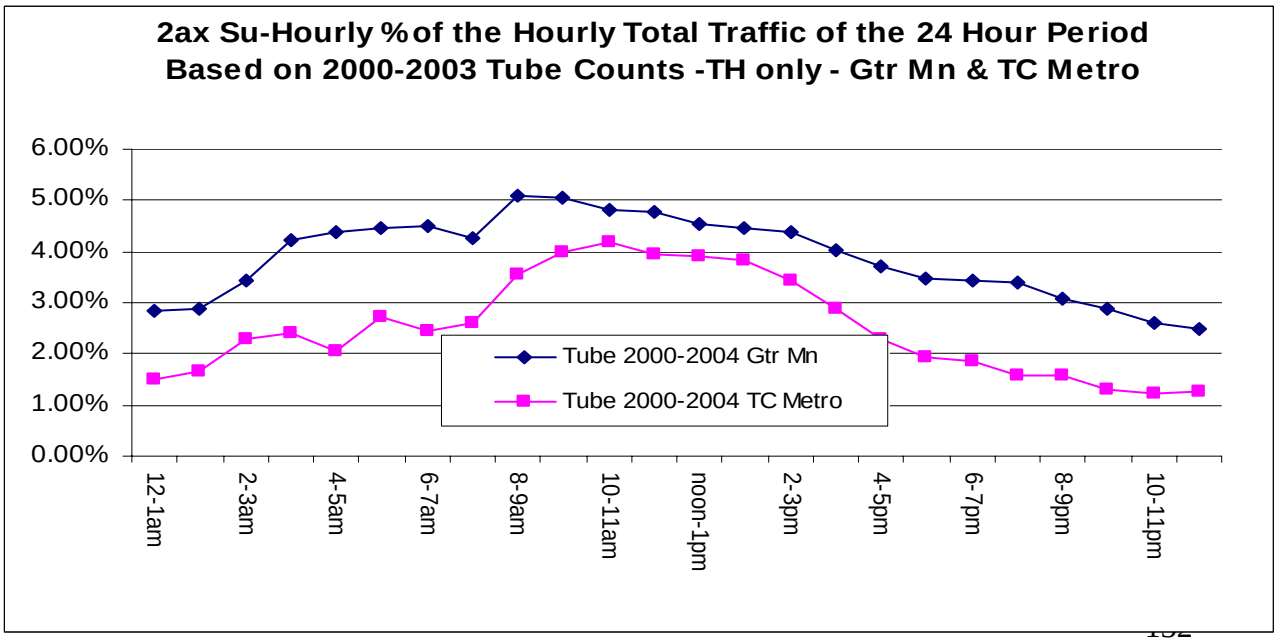
Since cars dominate the total traffic stream, the chart shows similar patterns between total vehicles and cars. However, selected truck types show a different trend. Cars in the Metro area as well as outstate Minnesota have an A.M. and a P.M. peak (usually around 7am in the morning and 4-5pm in the afternoon). Conversely, trucks display more of a bell-shaped traffic pattern – with more trucks between the hours or 8am through 3 pm (off peak rush hour). ***To summarize, the charts above show that each vehicle is X% of that specific vehicle type for 24 hours, i.e. of all 5 axles, x% occurs at xx time (the universe of 5 axles is 100***%)

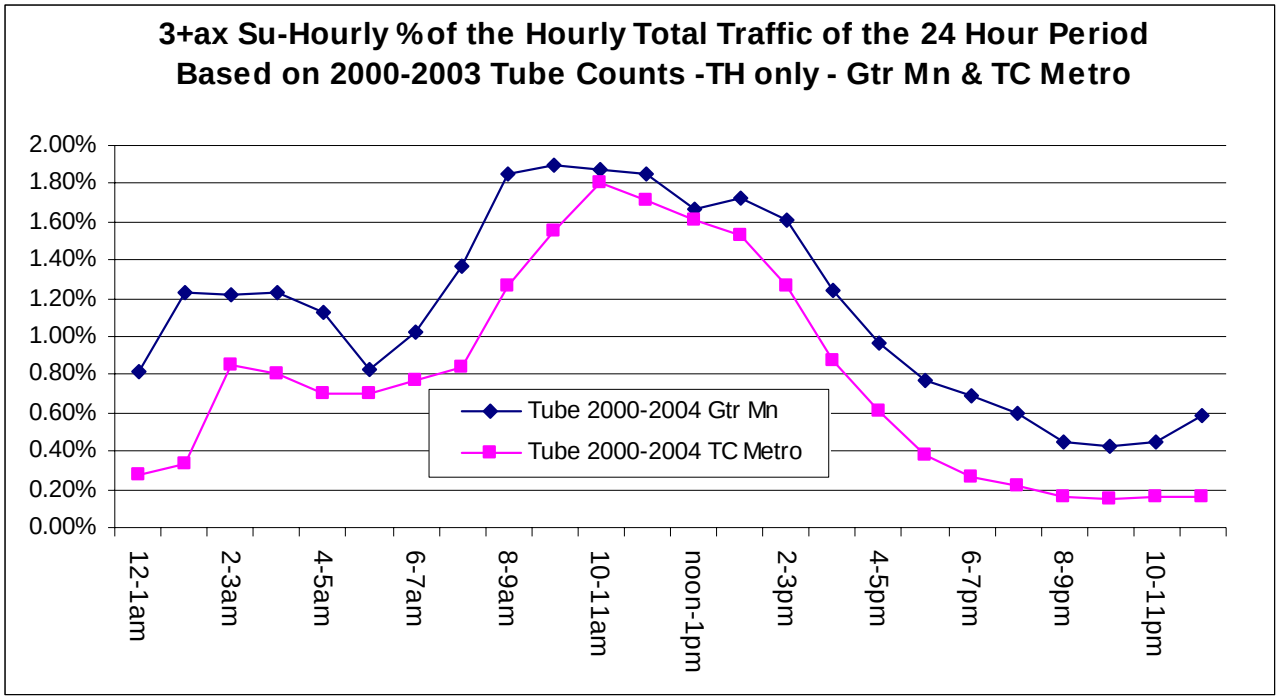
The chart below validates previous studies that show about 90% of all traffic by vehicle type (exception twin trailers) occurs between the hours of 6am to 10pm. (16 hours of the total 24 hours).

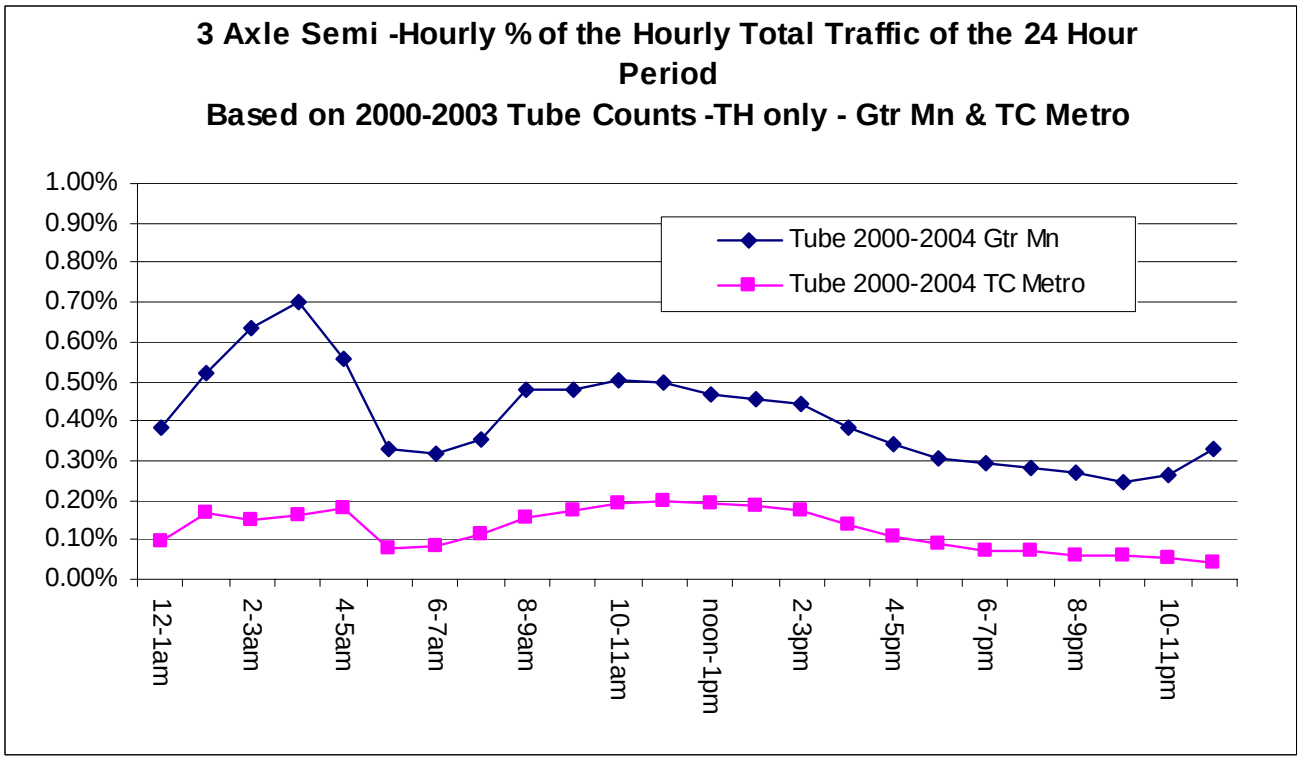


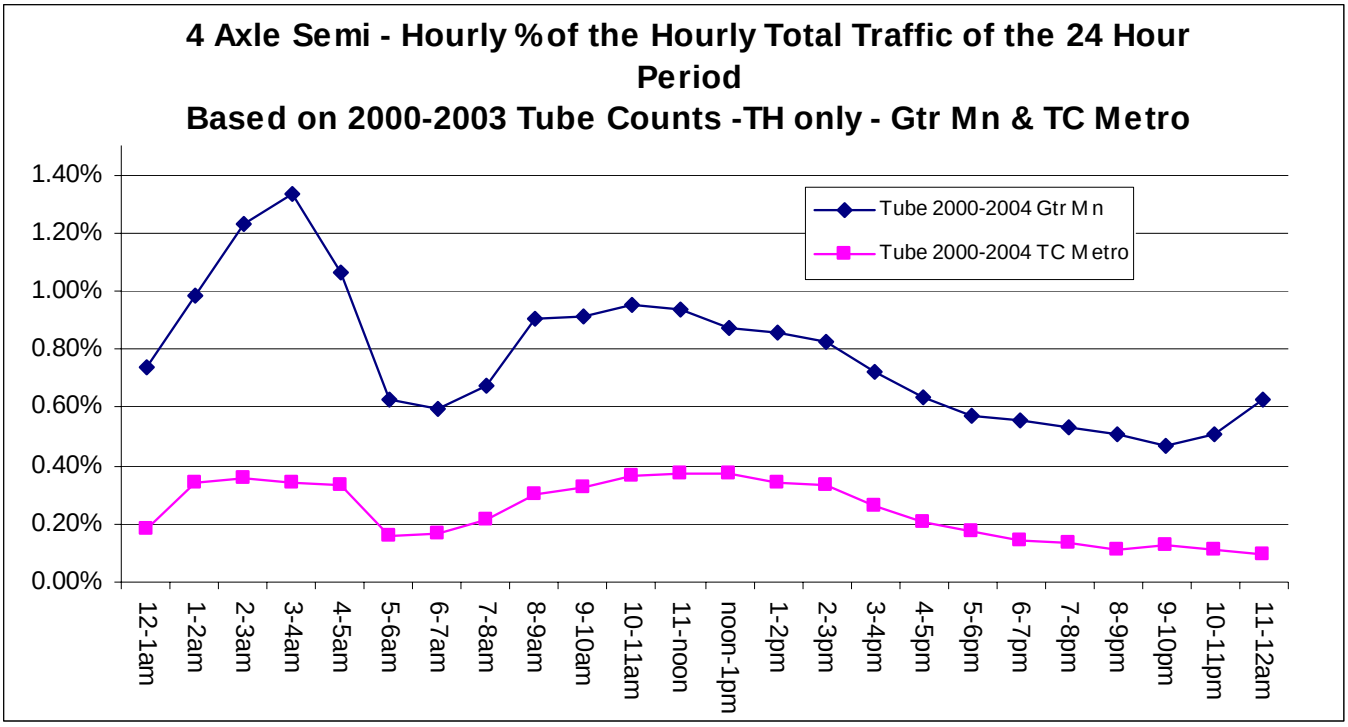
The following charts show the percent each vehicle is of hourly traffic for the 24-hour period. The data is a summation of 2000 through 2003 vehicle class tube counts and shows broad averages for selected vehicle types. Of note in the graphics is the trend of larger semis traveling between midnight and 5am – obviously avoiding the main stream of general car flow. Also note that the delivery type trucks – two and 3 axle single units- operate mid-day (between the am and pm peak hour for commuter traffic. The percents presented on the following tables are average percents, not representative of actual volumes. For example, on a lesser-traveled trunk highway in greater Minnesota there could be 20 total vehicles between 3 and 4 am and 5 five axle semis during the hour (meaning during that hour 20% of all traffic is 5 axle semis). Obviously more vehicles in the main stream or in the Metro area would reduce these percentages.

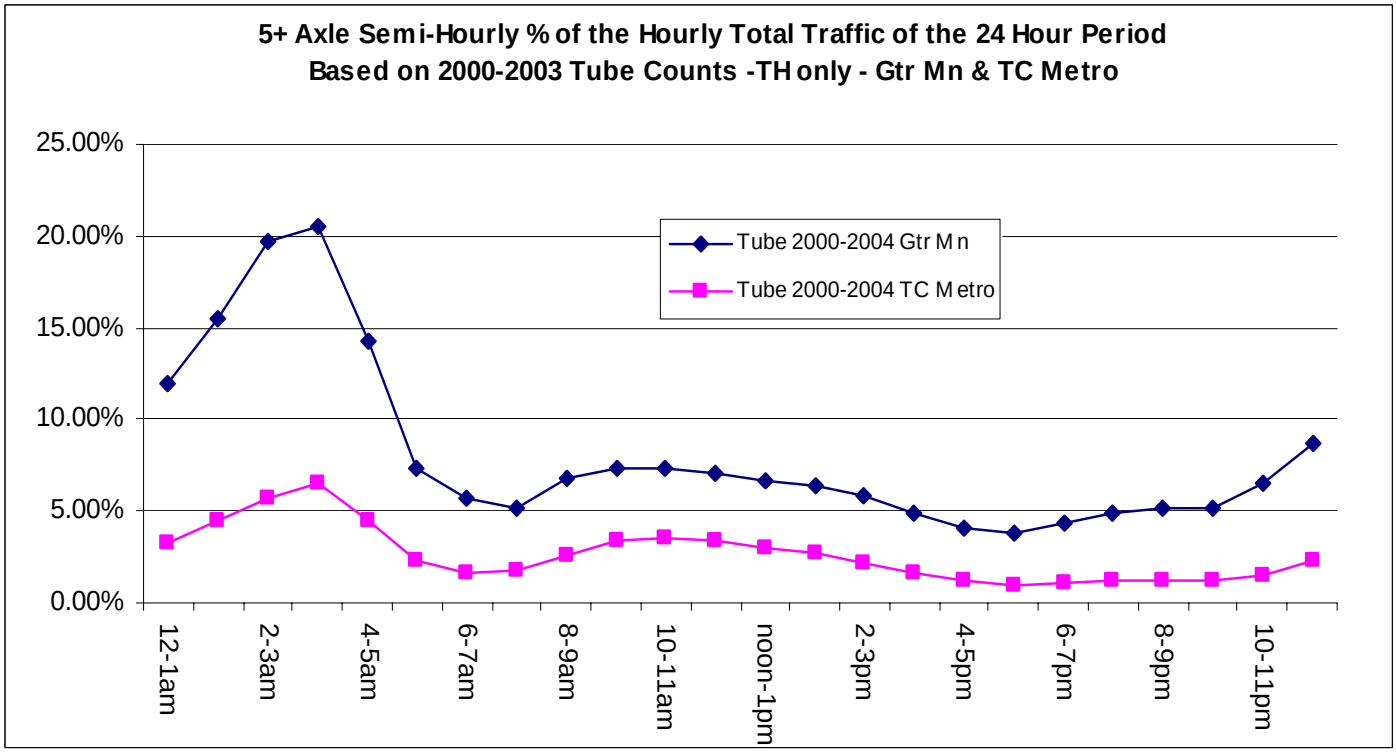


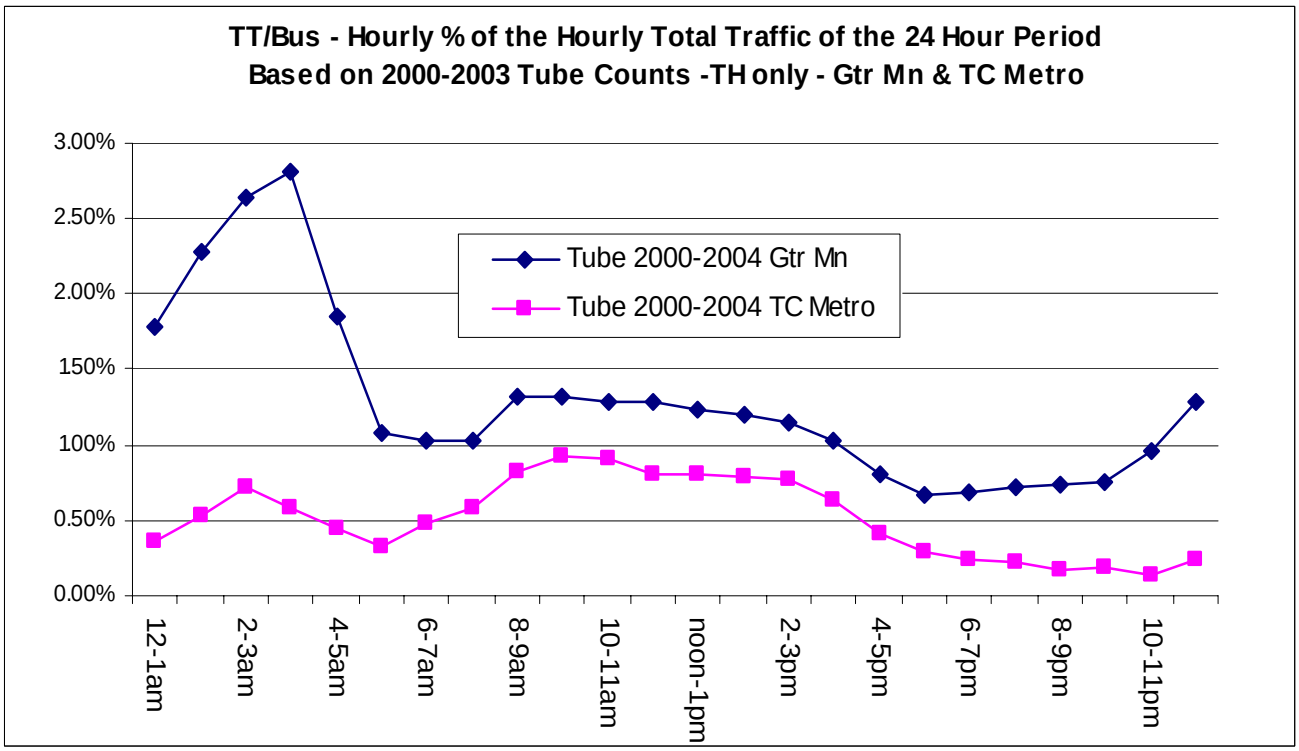



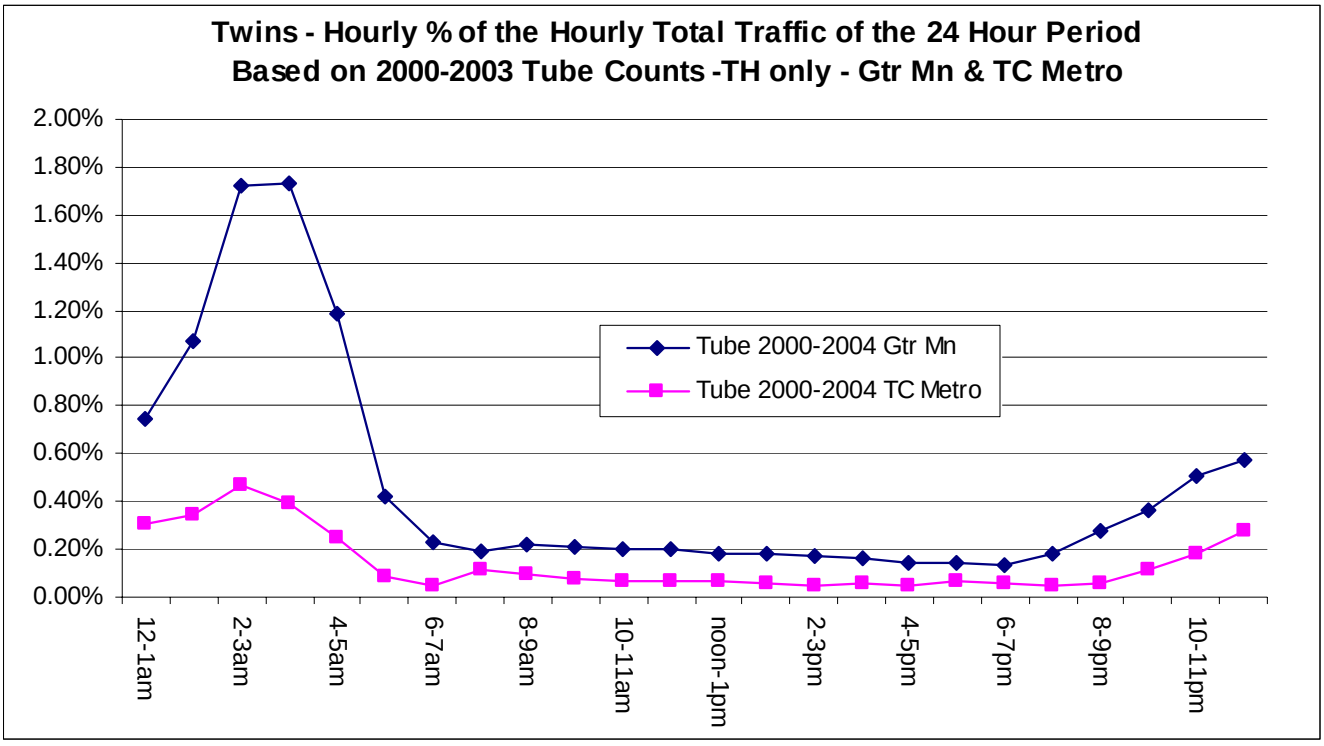

3+ax Su-Hourly %of the Hourly Total Traffic of the 24 Hour Period
Based on 2000-2003 Tube Counts -TH only - Gtr Mn & TC Metro
2.00%
1.80%
1.60%
1.40%
1.20%
1.00%
0.80%
0.60%
0.40%
0.20%
0.00%
Tube 2000-2004 Gtr Mn
Tube 2000-2004 TC Metro
12-1am
2-3am
4-5am
6-7am
8-9am
10-11am
noon-1pm
2-3pm
4-5pm
6-7pm
8-9pm
10-11pm


3 Axle Semi -Hourly % of the Hourly Total Traffic of the 24 Hour Period
Based on 2000-2003 Tube Counts -TH only - Gtr Mn & TC Metro
1.00%
0.90%
0.80%
0.70%
0.60%
0.50%
0.40%
0.30%
0.20%
0.10%
0.00%
Tube 2000-2004 Gtr Mn
Tube 2000-2004 TC Metro
12-1am
2-3am
4-5am
6-7am
8-9am
10-11am
noon-1pm
2-3pm
4-5pm
6-7pm
8-9pm
10-11pm


4 Axle Semi - Hourly % of the Hourly Total Traffic of the 24 Hour Period
Based on 2000-2003 Tube Counts -TH only - Gtr Mn & TC Metro
1.40%
1.20%
1.00%
0.80%
0.60%
0.40%
0.20%
0.00%
Tube 2000-2004 Gtr Mn
Tube 2000-2004 TC Metro
12-1am
1-2am
2-3am
3-4am
4-5am
5-6am
6-7am
7-8am
8-9am
9-10am
10-11am
11-noon
noon-1pm
1-2pm
2-3pm
3-4pm
4-5pm
5-6pm
6-7pm
7-8pm
8-9pm
9-10pm
10-11pm
11-12am

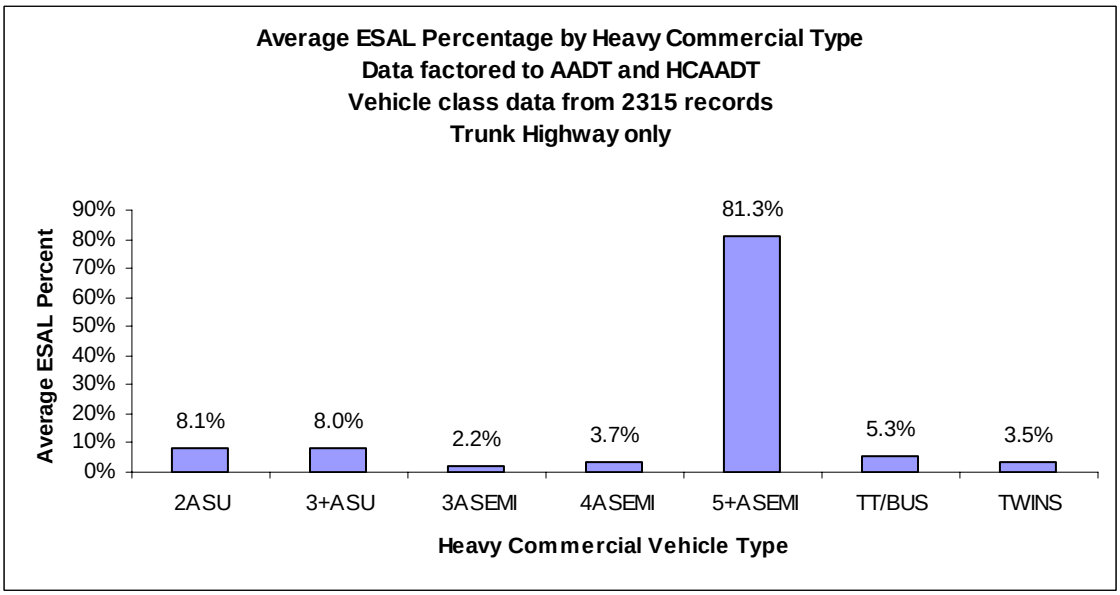

5+ Axle Semi-Hourly % of the Hourly Total Traffic of the 24 Hour Period
Based on 2000-2003 Tube Counts -TH only - Gtr Mn & TC Metro
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Tube 2000-2004 Gtr Mn
Tube 2000-2004 TC Metro
12-1am
2-3am
4-5am
6-7am
8-9am
10-11am
noon-1pm
2-3pm
4-5pm
6-7pm
8-9pm
10-11pm

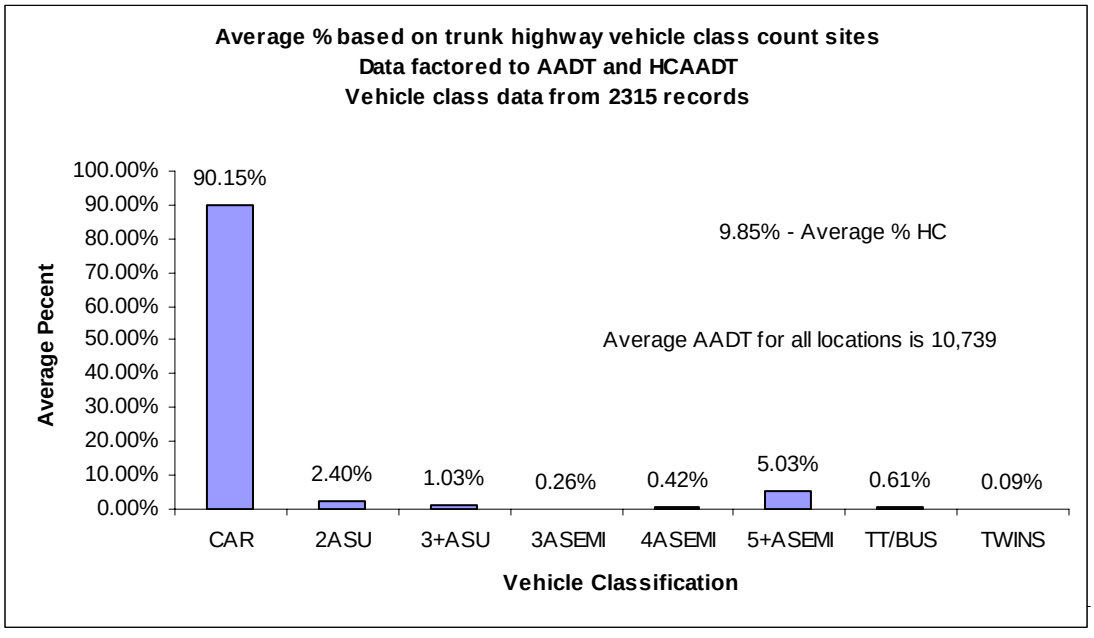

TT/Bus - Hourly % of the Hourly Total Traffic of the 24 Hour Period
Based on 2000-2003 Tube Counts -TH only - Gtr Mn & TC Metro
3.00%
2.50%
2.00%
150%
100%
0.50%
0.00%
Tube 2000-2004 Gtr Mn
Tube 2000-2004 TC Metro
12-1am
2-3am
4-5am
6-7am
8-9am
10-11am
noon-1pm
2-3pm
4-5pm
6-7pm
8-9pm
10-11pm


Twins - Hourly % of the Hourly Total Traffic of the 24 Hour Period
Based on 2000-2003 Tube Counts -TH only - Gtr Mn & TC Metro
2.00%
1.80%
1.60%
1.40%
1.20%
1.00%
0.80%
0.60%
0.40%
0.20%
0.00%
Tube 2000-2004 Gtr Mn
Tube 2000-2004 TC Metro
12-1am
2-3am
4-5am
6-7am
8-9am
10-11am
noon-1pm
2-3pm
4-5pm
6-7pm
8-9pm
10-11pm

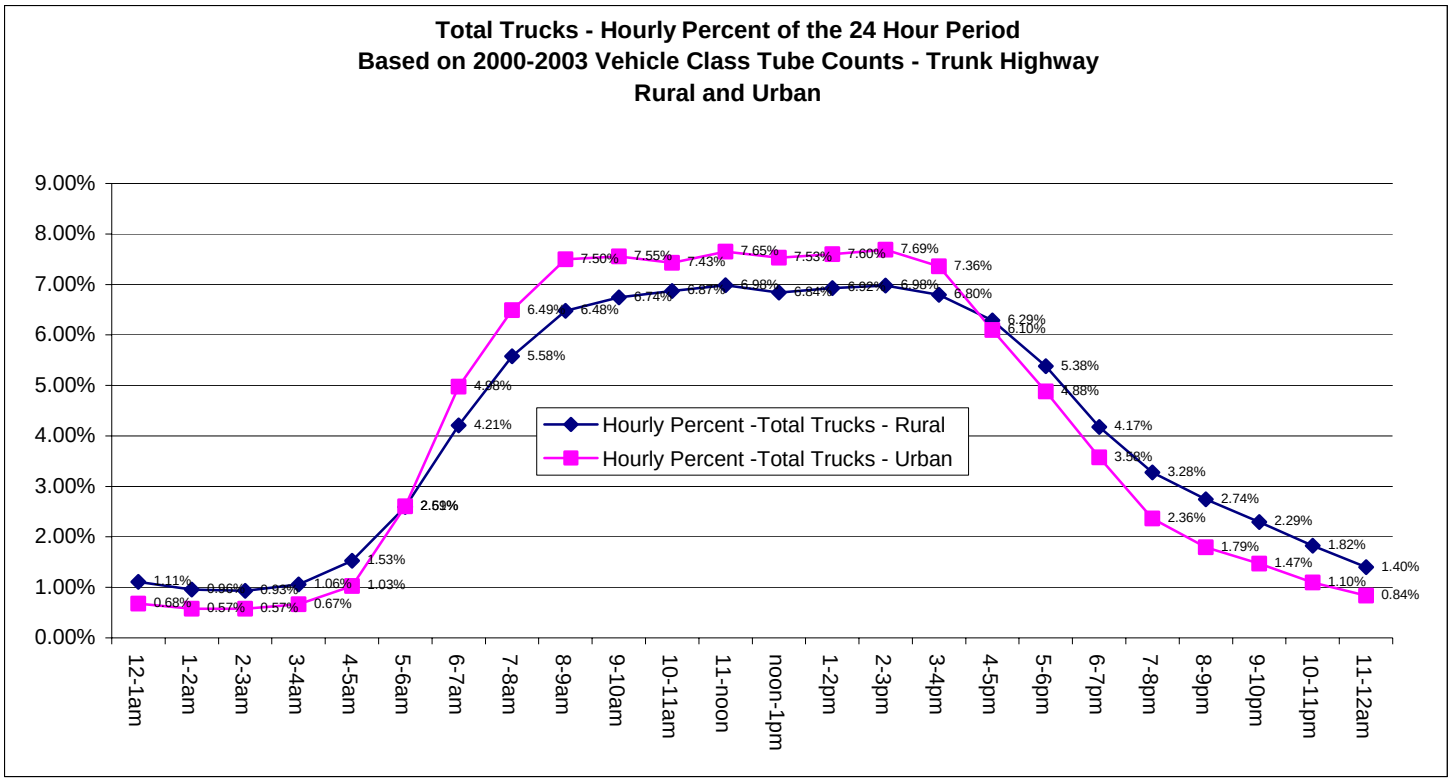
Five-axle semis have the most effect on roadways. The following chart shows how dominant the five-axle category is on pavement design compared to other truck classifications. Whether partially or full loaded, five-axle semis cause the most wear on roadways than all the other truck types combined (over 80%).

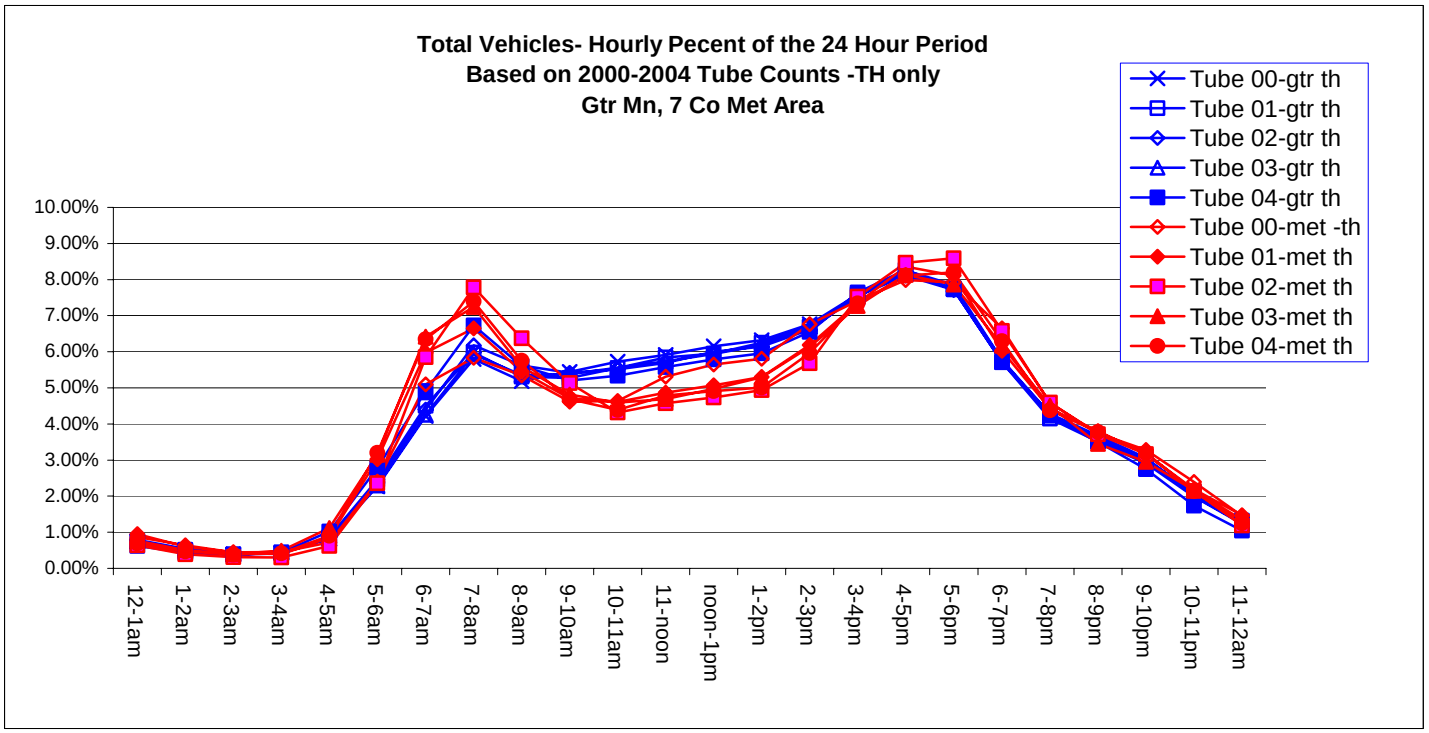
An average of selected vehicle class sites shows another trend, i.e. the five-axle semi category makes up about half of all heavy trucks (cars are about 90% of the total traffic stream). Please note that averages displayed in these charts are for illustrations only and general planning. In project specific analysis, averaging percents would probably be not statistically valid and weighted averages should be used. In many cases, analysis of percents can distort the fact that higher percent changes and variations most often occur in lower volume routes. Conversely, higher volume roadways may have smaller percent changes in volumes. Caution should be used when making comparisons using raw volumes and/or raw percents.



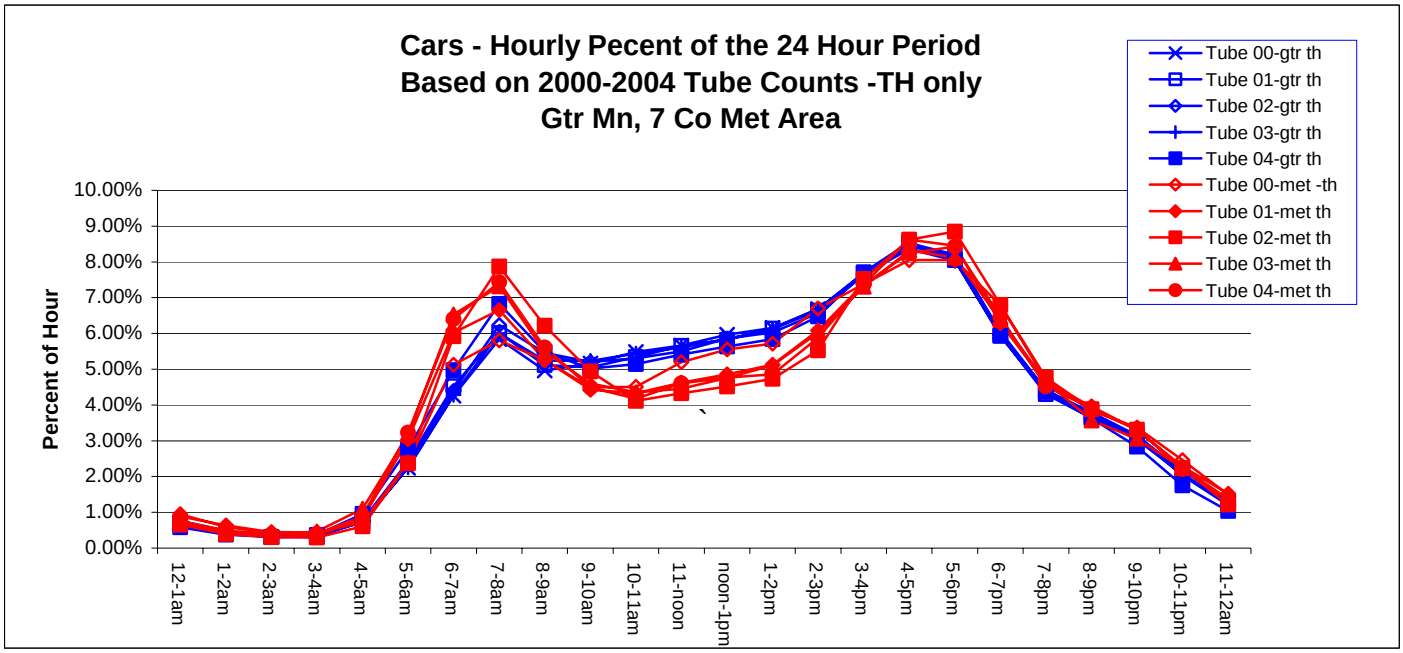



The 2004 data is similar to the 2003 data on pages 127-131. It further reiterates the bell-shaped curve distribution of total trucks. Note that the rural distribution percent is higher in the early morning and late evening hours, while the urban distribution is slightly higher in the late morning, early afternoon time period.

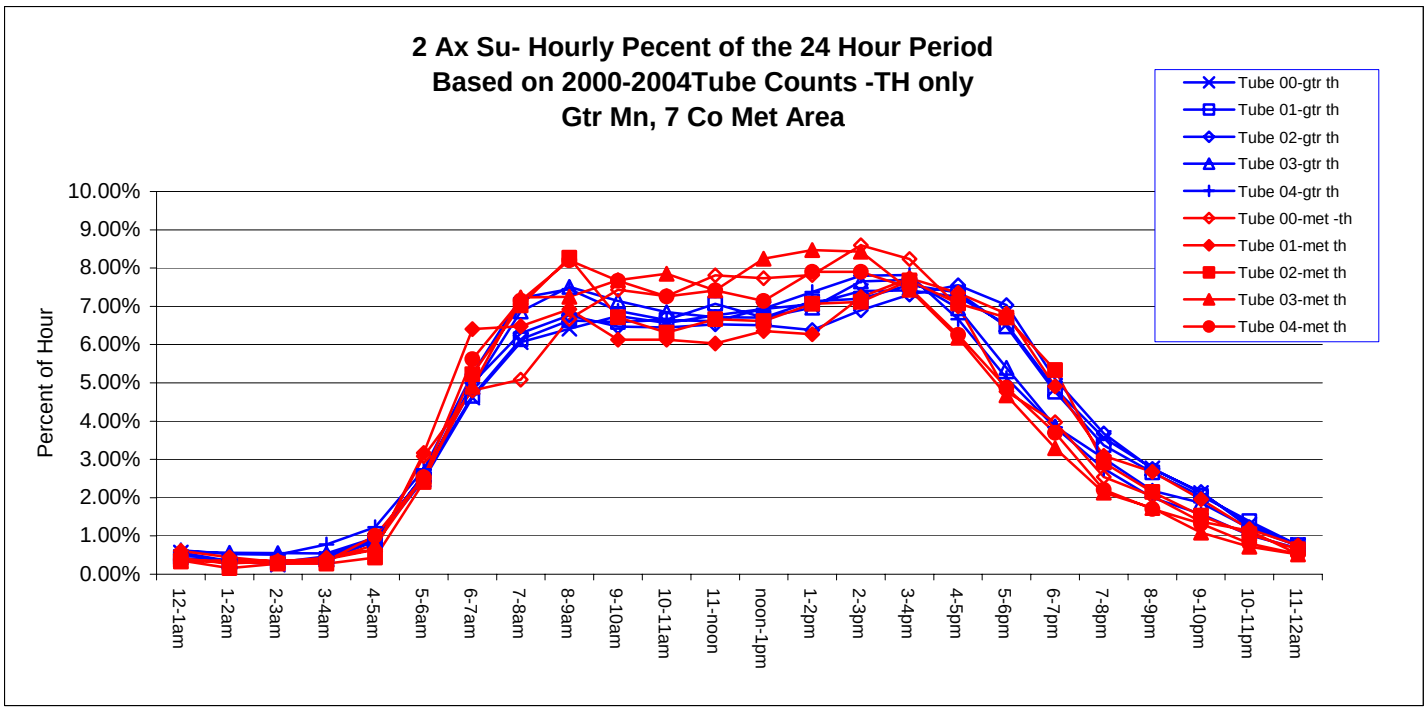


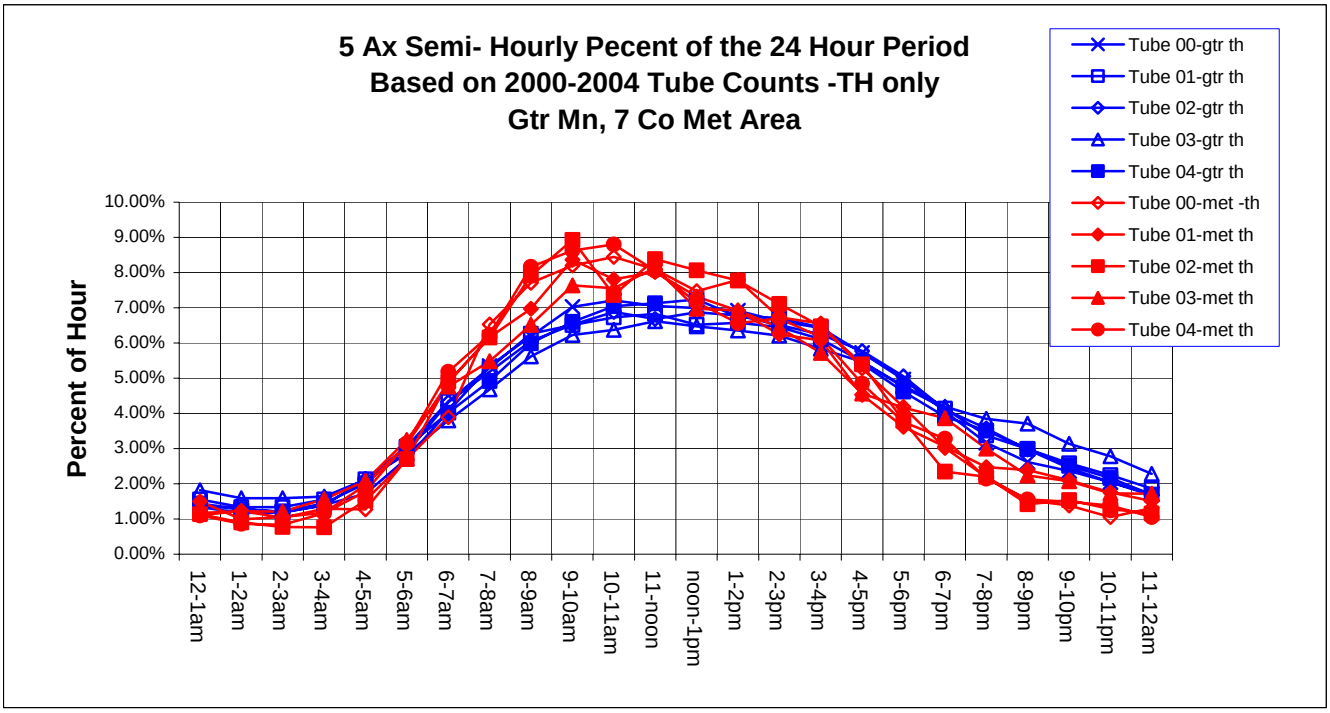
On the preceeding chart, note that with the inclusion of the 2004 data, the hourly distribution trend for total vehicles shows little change from the previous chart (see page 127). Likewise, hourly trend for cars shows the heavy influence of cars on total vehicles. It is importatant to remember that although 90% of vehicles are cars, it is the 10% trucks that generate virtually all of the ESALS used in calculating pavement deterioration. Cars have little impact on the ESAL calculation and their damage to roadways is minimal.




Note below the hourly distribution of two axle single unit trucks. These types are basically your delivery truck, garbage truck, UPS type of vehicle. Notice that the distribution of these vehicles is normally centered around the morning and afternoon commute time – which is when the vast share of these vehicles operate.



With the addition of the 2004 data, the hourly distribution trend of 5 axle semis is little changed from the previous chart (page 130). Note that metro and greater Minnesota distribution varies consistently between 6am and midnight – with metro higher in the morning and early afternoon, and greater Minnesota higher in the afternoon and evening hours.




TRANSIT, BUS AND ESALS INFORMATION

Recent research has shown that in many cases ESALS have been underestimated for buses – particularly heavy loaded regular MTC buses and articulated MBC buses. Information from MTC states that a regular MTC bus is 40 feet, weights about 29,000 pounds empty and about 35,000 pounds full (150 pound person with 43 seats). The empty weight is distributed as follows – 19,000 pound rear, 10,000 pound front axle.

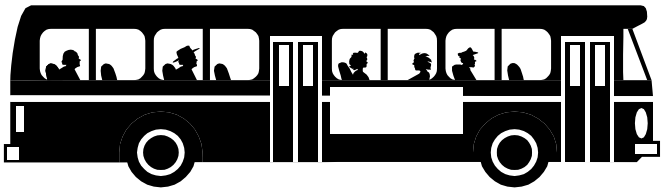
An articulated MTC bus has 3 axles and is 60 feet long, weights 41,500 pounds empty and 51,000 pounds full (150 pound person with 65 seats). The empty weight is distributed as follows – 25,000 pounds rear (heaviest with the refrigeration and transmission on the rear axle), and the front two axles about 8,200 pounds each. Our current default ESAL for buses (which we lump in with truck trailers) is .57 flexible and .74 rigid. What these means from a forecasting viewpoint is that if you know your route is a bus lane facility and contains these type of buses, you may probably want to increase

the ESAL factors for these vehicles. As you know from previous sections of the manual, pages can be un-protected and the MnESAL can be manipulated manually. In this case, merely change the factor value on the bottom of the A or B worksheet. The following shows the principles discussed above and various ESAL factors.

Obviously, the ESAL value for a bus lies somewhere in between the minimum and the maximum. The ESALs below indicate our default values are low and TDA will be revisiting the bus factor in the near future.

# Typical MTC City bus ESAL Calculations

29,000 lbs empty
35,000 lbs full



= 1.33 ESAL Empty
= 2.44 ESAL Full

Empty - 19000 lbs - 1.24 ESAL
Full - 22000 lbs - 2.18 ESAL

Empty - 10000 lbs -.0877 ESAL
Full - 13000 lbs - .264 ESAL

41,500 lbs empty
51,000 lbs full


= 3.60 ESAL Empty
= 5.70 ESAL Full

Empty - 25000 lbs – 3.53 ESAL
Full - 28000 lbs – 5.39 ESAL

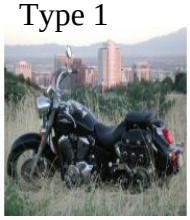
Empty - 8250 lbs - .035 ESAL
Full - 11250 lbs - .155 ESAL

Empty - 8250 lbs - .035 ESAL
Full - 11250 lbs - .155 ESAL

# Mn/DOT Vehicle Classification Scheme

## Passenger Vehicles

Type 1



Type 2

Type 3

## Buses/ Truck with Trailer – Type 4

## 2 Axle Single Unit Truck – Type 5

## 3 Axle Single Unit Truck – Type 6

## 4+ Axle Single Unit Truck -Type 7

## 3 & 4 Axle Semi Truck – Type 8


## 5 Axle Semi Truck – Type 9

## 6+ Axle Semi Truck – Type 10

## Twin Trailer Semi Truck – Type 11,12,13

The Mn/DOT scheme for classifying vehicles is shown in the above picture. Among Mn/DOT's vehicle classifying programs, there are manual counts, tube counts, "Tirtl" counts, and Piezo counts. Trucks are counted and grouped in different methods. For manual counts, as previously stated, body type is recorded (page 79) since manual counts are visually recorded by an individual. Other counting devices cannot determine the body type – only the number of axles that fit a standard classification. For traffic forecasting purposes, we use 8 vehicle types – they consist of the following categories grouped from the 13 categories shown above.

**Vehicle Class Groupings For Forecasting**

1) Passenger vehicles = Type 1 + Type 2 + Type 3 (Motorcycles + Cars + Pickups)

2) Truck Trailers and Buses = Type 4 (both categories are combined)

3) 2 Axle Single unit = Type 5 (2 axle single unit trucks)

4) 3 + Axle Single unit = Type 6 + Type 7 (3 + 4+ axle single unit trucks)

5) 3 Axle Semi = Type 8*.35 ( 3 + 4 axle semi)

6) 4 Axle Semi = Type 8*.65 ( 3 + 4 axle semi)

7) 5 + Axle Semi = Type 9 + Type 10 (5 + 6+ axle semi)

8) Twin Trailers = Type 11 + Type 12 + Type 13 (sum of 3 types of twin trailers)

**Pavement Selection Process and ESALS – Additional Information (From Technical Memorandum No. 04-06-MAR-01, 2004, Engineering Services Division**

The pavement selection process has three categories that a project may fall into: District, Informal, and Formal. They are discussed below:

1. *District Process* – where short projects meet the following criteria:
    a. Two-Lane Roadways – Projects less than 2 miles long
    b. Projects les than 30,000 square yards

The projects length/size listed above are determined using only the driving lanes, no turn lanes, parking lanes or ancillary lanes.

2. *Informal Proces*s - involves determining the pavement type based on the amount of traffic, as measured by the length-weighted Bituminous Equivalent Standard Axle Loads (BESALs), and the subgrade soil strength.

Informal Flexible: Projects where the 20-year design lane BESALS (flexible / bituminous) are 7 million or less and the design subrade R-value is greater than 40. Projects in this category will be constructed with bituminous.

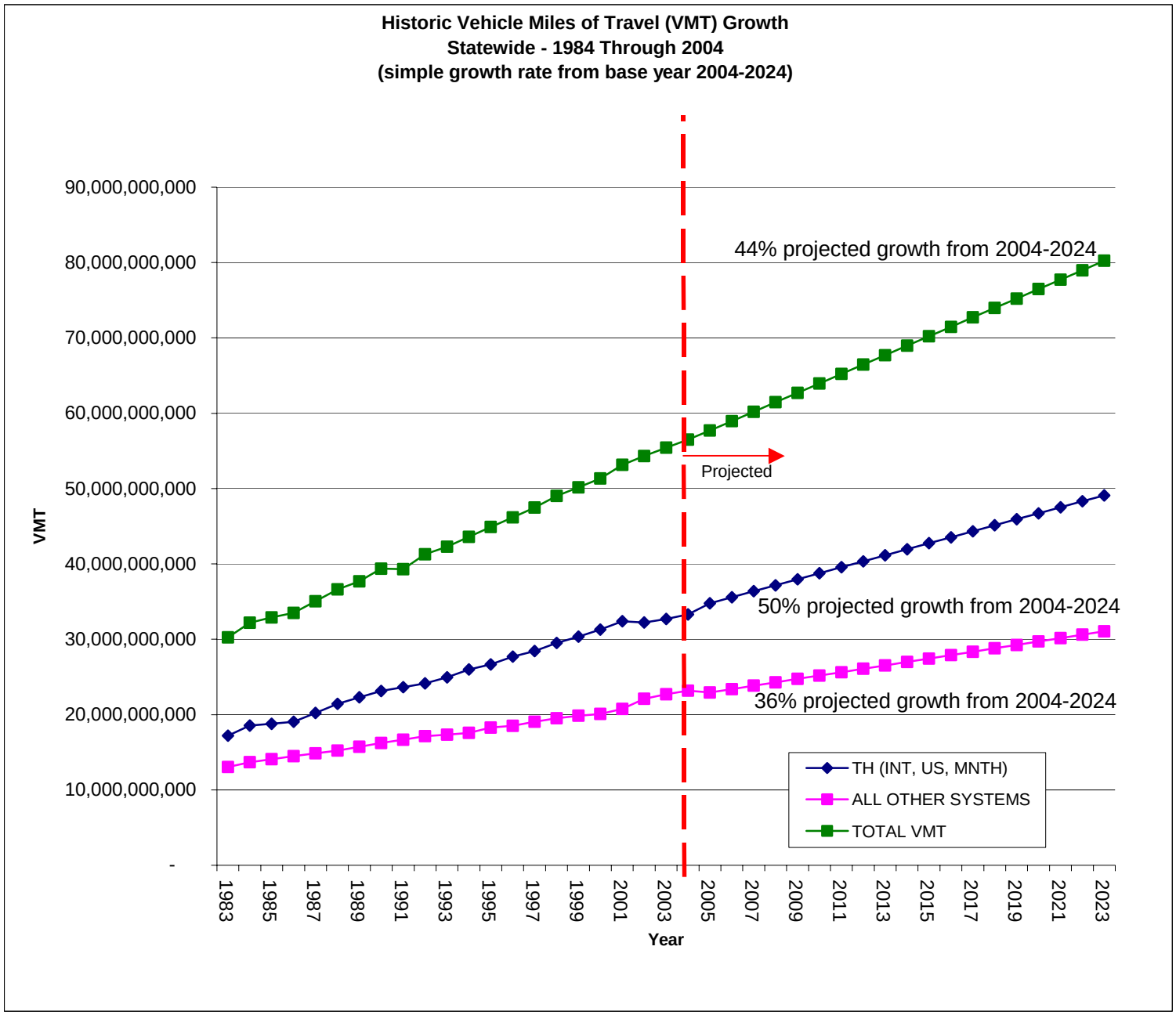
Informal Rigid: Projects where the 20-year design lane BESALS exceed 10 million. Projects in this category will be constructed with concrete.

3. *Formal Process* – All projects not meeting the Informal criteria listed above. The pavement type will be determined by a detailed cost estimate

# Pavement Selection Process and Design Options

| 20 Year Design Lane BESALs | Subgrade Soil R-Value | Process Type Design(s) | Description of Design(s) |
|---|---|---|---|
| 1,000,000 or less | >40 | Informal Flexible Design #6 | Flexible - Aggregate Base (BAB)<br>Flexible - Deep Strength (BDS) |
| 1,000,000 or less | <=40 | Formal Design #3 & 6 | Rigid - Aggregate Base<br>Flexible - Aggregate Base (BAB)<br>Flexible - Deep Strength (BDS) |
| 1,000,001 to 7,000,000 | >40 | Informal Flexible Design #4 & 5 | Flexible - Aggregate Base (BAB)<br>Flexible - Deep Strength (BDS) |
| 1,000,001 to 7,000,000 | <=40 | Formal Design #1,2,4 & 5 | Rigid - Open Graded Base<br>Rigid - Selected Granual<br>Flexible - Aggregate Base (BAB)<br>Flexible - Deep Strength (BDS) |
| 7,000,001 to 10,000,000 | All Values | Formal Design #1,2,4 & 5 | Rigid - Open Graded Base<br>Rigid - Selected Granual<br>Flexible - Aggregate Base (BAB)<br>Flexible - Deep Strength (BDS) |
| Over 10,000,000 | All Values | Informal Rigid Design #1 and 2 | Rigid - Aggregate Base<br>Rigid - Open Graded Base |

The following chart shows historical vehicle miles of travel (VMT) as well as simple projected growth from 2004 to 2024. Note that trunk highway VMT is projected to grow at a slightly faster rate than VMT growth on the local road system. The trunk highway growth is calculated from Interstates, U.S. and Minnesota Trunk Highways, while other systems growth is comprised of county state aid roadways, county and township roads, municipal state aid roadways and miscellaneous roads such as national forest roads, state forest roads, state park roads, etc. The table on page 145 shows the actual numbers.



Historical Vehicle Miles of Travel

| YEAR | TH (INT, US, MNTH) | ALL OTHER SYSTEMS | TOTAL VMT |
|---|---|---|---|
| 1983 | 17,211,083,646 | 13,050,234,108 | 30,261,317,754 |
| 1984 | 18,528,840,402 | 13,675,916,838 | 32,204,757,240 |
| 1985 | 18,780,681,586 | 14,078,133,459 | 32,910,216,605 |
| 1986 | 19,032,522,770 | 14,480,350,080 | 33,512,872,850 |
| 1987 | 20,224,841,824 | 14,847,554,946 | 35,045,303,075 |
| 1988 | 21,417,160,878 | 15,214,759,812 | 36,631,920,690 |
| 1989 | 22,284,425,682 | 15,720,230,709 | 37,683,978,240 |
| 1990 | 23,151,690,485 | 16,225,701,605 | 39,377,392,090 |
| 1991 | 23,643,375,996 | 16,679,573,439 | 39,303,748,595 |
| 1992 | 24,135,061,506 | 17,133,445,272 | 41,268,506,778 |
| 1993 | 24,933,864,305 | 17,338,664,350 | 42,272,528,655 |
| 1994 | 25,994,695,925 | 17,582,221,185 | 43,576,917,110 |
| 1995 | 26,653,795,040 | 18,261,081,765 | 44,914,876,805 |
| 1996 | 27,688,999,830 | 18,494,894,634 | 46,183,894,464 |
| 1997 | 28,435,534,145 | 19,043,137,700 | 47,478,671,845 |
| 1998 | 29,522,766,580 | 19,505,343,770 | 49,028,110,350 |
| 1999 | 30,337,552,795 | 19,842,308,485 | 50,179,861,280 |
| 2000 | 31,278,297,414 | 20,069,926,224 | 51,348,223,638 |
| 2001 | 32,400,289,705 | 20,762,338,435 | 53,162,628,140 |
| 2002 | 32,238,018,370 | 22,092,606,120 | 54,330,624,490 |
| 2003 | 32,700,927,430 | 22,712,402,400 | 55,413,329,830 |
| 2004 | 33,299,763,720 | 23,183,708,190 | 56,486,471,916 |
| 2005 | 34,782,330,218 | 22,923,498,579 | 57,695,020,364 |
| 2006 | 35,578,049,881 | 23,375,365,912 | 58,946,855,524 |
| 2007 | 36,373,769,544 | 23,827,233,245 | 60,198,690,685 |
| 2008 | 37,169,489,207 | 24,279,100,578 | 61,450,525,845 |
| 2009 | 37,965,208,870 | 24,730,967,910 | 62,702,361,005 |
| 2010 | 38,760,928,533 | 25,182,835,243 | 63,954,196,166 |
| 2011 | 39,556,648,196 | 25,634,702,576 | 65,206,031,326 |
| 2012 | 40,352,367,859 | 26,086,569,909 | 66,457,866,486 |
| 2013 | 41,148,087,522 | 26,538,437,242 | 67,709,701,647 |
| 2014 | 41,943,807,185 | 26,990,304,575 | 68,961,536,807 |
| 2015 | 42,739,526,848 | 27,442,171,908 | 70,213,371,967 |
| 2016 | 43,535,246,512 | 27,894,039,240 | 71,465,207,128 |
| 2017 | 44,330,966,175 | 28,345,906,573 | 72,717,042,288 |
| 2018 | 45,126,685,838 | 28,797,773,906 | 73,968,877,449 |
| 2019 | 45,922,405,501 | 29,249,641,239 | 75,220,712,609 |
| 2020 | 46,718,125,164 | 29,701,508,572 | 76,472,547,769 |
| 2021 | 47,513,844,827 | 30,153,375,905 | 77,724,382,930 |
| 2022 | 48,309,564,490 | 30,605,243,238 | 78,976,218,090 |
| 2023 | 49,105,284,153 | 31,057,110,570 | 80,228,053,250 |
| 2024 | 49,901,003,816 | 31,508,977,903 | 81,479,888,411 |
| % Gr 04-24 | 49.85% | 35.91% | 44.25% |

## ***Miscellaneous Tips, Hints, and Information related to Traffic Forecasting***

- Raw data on trunk highway sections are stored using "route-true mileage." The reference post is calculated by a program based on the log point listing location of the RP signs and the location of what we are looking at. Also, having True Mileage lets us plot our data on a map in Arc View.

- Either on the A or B segment, or sometimes on AADT segment breaks, segments can be combined if the current or forecasted AADT or ESALS are within 10% of each other.

- Currently, about 90% of all counts are tube counts (unless the location is impossible geometrically or structurally to count). Special requests and body type data will often necessitate manual counts. The "Tirtle" can also be used (see page 10).

- ATRs are the basis for adjustment factors used to take 48 hour tube counts and 16 hour manual counts to factor up to AADT. A SAS program is used that looks for similar characteristics—called clustering.

- On the B segment worksheet (bottom), the error message "PROBLEMS" will occur if there is an illogical subtraction from the A segment. If you try to subtract more than half of what exists on the A segment, that error will show up. Always try to make sure you don't "take away" more vehicles by individual class from the B segment then exist on the A. Remember, the B segments adds or subtracts vehicles from the A segment using two default values. The percents may have to "modified" to make sure every B segment "makes sense" when comparing to the A segment.

- In many cases, a large AADT change from A to B segment indicates there probably should be another A segment (an additional vehicles class count or a short count may be needed).

- Tube counts are set for 48 hours and manual counts are taken for 16 hours (6AM-10PM). The short duration classification counts are adjusted to annual average daily traffic volumes using factors developed from the continuous counters. These factors take into account the variations of truck volumes by month and day of week. The parent/child relationships developed have enabled the automation of the process for the production of heavy commercial vehicle type volumes at all HPMS segments. The Office of Transportation Data and Analysis has plans to install additional Kistler WIMs and continuous classification systems over the next five years.

- Of the 2004 tube counts taken in the passenger car class, 69.8% of vehicles were classified as cars, 29.2% as pickups, and 1% as motorcycles. That distribution is pretty much valid throughout the entire spectrum of class counts for type 1,2, and 3 classifications.

- In certain groupings, truck with trailers and buses are classified the same. For 2004, the distribution (again, pretty much similar throughout all data bases) is 81.1% buses and 18.9% trucks with trailers.

- Based on an average of all vehicle class count locations (mainly trunk highways and a few local roads), heavy trucks comprise about 10% of the traffic compared to 90% autos, pickups and motorcycles – of those 10% trucks, about 5% are 5 and 6 axle semis, with the next largest category 2 axle single unit trucks (at about 2.5%). The remaining truck categories usually average less than 1%.

- When doing a "backcast" or a forecast of ESALS over a prior 20 year period (say from 1984 to 2004), simply change the MnESAL forecasting program to the desired 20 year interval to obtain cumulative ESALs over a particular roadway for a specified time. Be sure and get all AADT for the years desired. For example, if you wanted to arrive at the total of cumulative ESALS over a stretch of road between 1992 and 2002, do the forecast in the regular way, only use the base year as 1992 and the forecast year as 2002 on the A or B segment of the MnESAL spreadsheet (and, of course, collect the appropriate vehicle class information).

- Just to reiterate body type data gives us a better idea of the weights of the individual truck types. We adjust these raw counts with factors that take the month of the count and the weekend volumes into account to give us a heavy commercial annual average daily traffic volume (HCAADT). The continuous classification data gives us the adjustment factors and the WIM data gives us the actual weights for every axle as it passes over the scales. TDA inputs HCAADT data into the transportation information system (TIS) for the trunk highway system at approximately 4500 locations statewide.

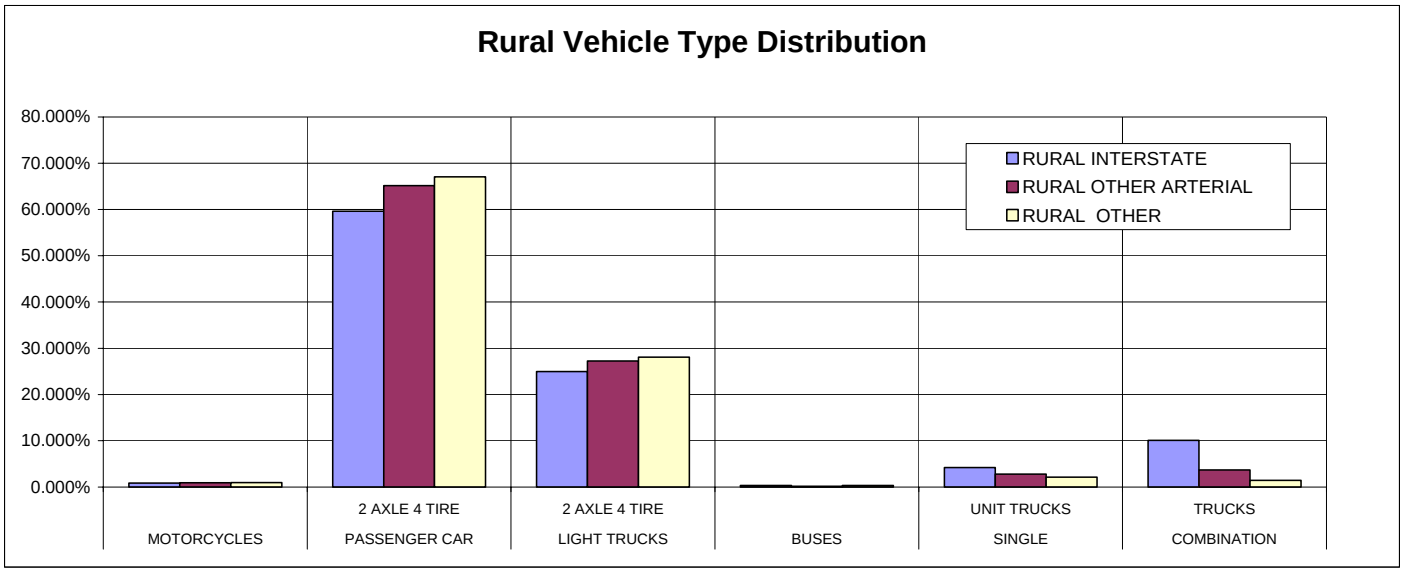
- When using stake information from manual counts, add stake loaded and unloaded together to determine heavy truck calculations from 1993 to the present. Usually, since we forecast for the design lane, unloaded stakes will be loaded in the other direction.

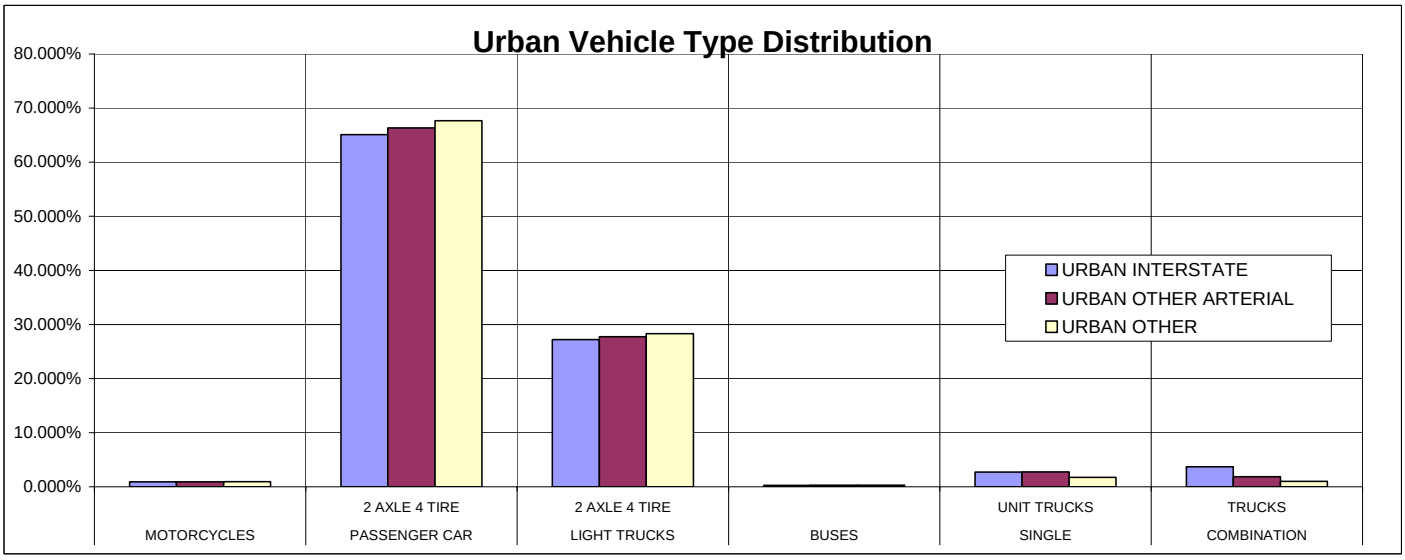
- Five plus axle semis comprise about 80% of the ESALs of the truck category – with 2 and 3 axle single units adding another 16%. The remaining categories, 3 and 4 axle semis, twins, buses, and trucks with trailers add only about 14% of the total ESALs on an average trunk highway.

The chart and table below compare an urban and rural vehicle type distribution for 2004 vehicle class data. Note the similar distribution pattern between interstate and arterial on urban and rural routes.

VEHICLE CLASS DISTRIBUTION DATA - BASED ON 2004 VEHICLE CLASS DATA

| *RURAL/URBAN* | *FUNCTIONAL SYSTEM* | *MOTORCYCLES* | *PASSENGER CAR 2 AXLE 4 TIRE* | *LIGHT TRUCKS 2 AXLE 4 TIRE* | *BUSES* | *SINGLE UNIT TRUCKS* | *COMBINATION TRUCKS* |
|---|---|---|---|---|---|---|---|
| RURAL | INTERSTATE | 0.854% | 59.587% | 24.928% | 0.330% | 4.197% | 10.105% |
| RURAL | OTHER ARTERIAL | 0.934% | 65.169% | 27.263% | 0.181% | 2.756% | 3.699% |
| RURAL | OTHER | 0.961% | 67.061% | 28.054% | 0.352% | 2.159% | 1.413% |
| URBAN | INTERSTATE | 0.932% | 65.072% | 27.222% | 0.305% | 2.748% | 3.721% |
| URBAN | OTHER ARTERIAL | 0.950% | 66.332% | 27.749% | 0.321% | 2.764% | 1.885% |
| URBAN | OTHER | 0.969% | 67.651% | 28.301% | 0.314% | 1.770% | 0.995% |



## *SAMPLE FORECAST INFORMATION*

Note the topics addressed in the REMARKS section of the MnESAL in the example below. In this section the forecaster should discuss any related documentation that explains what he or she did in the preparation of the traffic forecast.

MINNESOTA DEPARTMENT OF TRANSPORTATION

**MEMO**

Transportation Data and Analysis
395 John Ireland Boulevard - MS 450
St. Paul, Minnesota 55155

Phone: (651) 296-1740
Fax: (651) 296-3311

September 22, 2005

To: GENE HICKS
SECTION DIRECTOR
TRAFFIC FORECASTING AND ANALYSIS -MS 450

From: Mark Levenson
Traffic Forecast Section

Subject: TRAFFIC FORECAST

| | | | |
|---|---|---|---|
| Route: | TH19 | SP# | 4205-35 |
| Letting Date: | November 17, 2006 | Forecast # | F8-0501-U |
| Program Category: | RC | County: | LYON |
| Project Manager: | KNUTSON | District: | 8 |
| | | Miles: | 0.9 |
| Project Limits: | TH23 TO TWP 205 CROSSING IN MARSHALL | | |

Enclosures (check those that apply):

| | | | |
|---|---|---|---|
| | Project map | X | VCL expansion worksheet |
| X | Least squares analysis | X | Cumulative ESAL Report |
| X | Cumulative ESAL worksheet, Segment A | | Other (describe) |
| | Cumulative ESAL worksheet, Segment B | | Other (describe) |
| X | AADT and/or DHV traffic schematic diagram | | |

REMARKS:

Used vc site 2557 - counted once in 2004. In addition, a 2005 count was taken in the project area which has been currently processed. According to the district, a new high school will generate 1000 AADT around the time of the letting date for this project. Thus, we have added 1000 to the A segment future volume or 2007 and 2007, increasing the ESALS to over 3 million. Note that the 2005 manual count on the segment east of TH23 has been adjusted for some faulty equipment that resulted in the loss of 5 hours.

Note the depth of information provided on the REMARKS section of the cover letter below and on page 153.

MINNESOTA DEPARTMENT OF TRANSPORTATION

**MEMO**

Transportation Data and Analysis
395 John Ireland Boulevard - MS 450
St. Paul, Minnesota 55155

Phone: (651) 296-0217
Fax: (651) 296-3311

September 19, 2005

To: Bill Langston
District 8
Traffic Forecaster

From: Mark Levenson
Traffic Forecaster
C.O.

Subject: TRAFFIC FORECAST

Route: Th12/TH15 Junction
Letting Date: 2004
Program Category:
Project Manager:
Project Limits: Interstection of TH15 and TH12

SP#
Forecast #
County: Meeker / McLeod
District: 8
Miles:

Enclosures (check those that apply):

| | | | |
|---|---|---|---|
| | Project map | | VCL expansion worksheet |
| | Least squares analysis | | Cumulative ESAL Report |
| | Cumulative ESAL worksheet, Segment A | | Other (describe) |
| | Cumulative ESAL worksheet, Segment B | | Other (describe) |
| | AADT and/or DHV traffic schematic diagram | | |

REMARKS:

Bill, this information is for your perusal. Four VC sites were used in this analysis. VCC 7406 had some problems with the 1997 count taken during construction season and some of the 1996 counts seem to be inaccurate. I have enclosed a preliminary forecast on each of the four legs of the project. Please call me and we can discuss any questions you have on this information. All of the information is attached. The VC counts appear to be more stable on TH12. The truck volumes on TH15 just south of TH12 are a B segment, taken from the A seg on TH15 just north of TH7. Truck patterns should probably be similar, as reflected in the B segment; However, I recommend you take some short truck counts on TH15 and compare the volumes with those of the older vehicle class counts. The latest VC counts on all legs are 1997 (old?)

Notice in the example below the necessity for a field visit.

MINNESOTA DEPARTMENT OF TRANSPORTATION

**MEMO**

Transportation Data and Analysis
395 John Ireland Boulevard - MS 450
St. Paul, Minnesota 55155

Phone: (651) 296-0217
Fax: (651) 296-3311

September 19, 2005

To: Rus Maki
Traffic Forecaster
Metro Division

From: GEORGE M. CEPRESS P.E.
STATE TRAFFIC FORECAST ENGINEER
CENTRAL OFFICE, MAIL STOP 450

Subject: TRAFFIC FORECAST

| | | | |
|---|---|---|---|
| Route: | TH55 | SP# | 2723-109 |
| Letting Date: | April 25, 2003 | Forecast # | F-M-0216 |
| Program Category: | RS | County: | Hennepin |
| Project Manager: | Scott | District: | Metro |
| | | Miles: | 3.53 |
| Project Limits: | Old Rockford Road to I-494 | | |

Enclosures (check those that apply):

| | | | |
|---|---|---|---|
| | Project map | x | VCL expansion worksheet |
| x | Least squares analysis | x | Cumulative ESAL Report |
| x | Cumulative ESAL worksheet, Segment A | | Other (describe) |
| x | Cumulative ESAL worksheet, Segment B | | Other (describe) |
| x | AADT and/or DHV traffic schematic diagram | | |

REMARKS:

For this project, vehicle class sites 8785 and 8784 were used. Due to discrepancies between the 1998 data and the next most recent - 1991 - a field trip and 5 axle semi counts resulted in dropping the older vehicle class counts. The on site observation was more in line with the 1998 tube counts and verified the 5 axle numbers - resulting in higher ESALS which reflects the current traffic on TH55 West Of I-494. It should be noted the high number of 4 axle semis observed on this site - which the older counts did not reflect, but were reflected in the 1998 counts.

CC: DAVE JANISCH
FILE

## *NEW CUMULATIVE ESAL WORKSHEET B EXAMPLES*

The below is an example of the "New" Rural and Urban Default spreadsheet for the B segment. Simply type in "rural" or "urban" in the RED cell; this transfers automatically the appropriate vehicle percentage value into the Base Year Proportions column on the Cumulative ESAL Worksheet – Segment B

| CUMULATIVE ESAL WORKSHEET | | | SEGMENT B | | | | | USE THE RURAL OR | ENTER RURAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| SP#: | 4205-35 | | | | | | | URBAN PCT'S | OR URBAN BELOW | |
| ROUTE: | TH19 | # LANES: | | DATE: | 09/19/05 | | | BELOW FOR | | |
| LOCATION: | | | | | | | | TYPE OF FORECAST | | |
| | YEAR | AADT | | | CALCULATED HCADT | CONSTRAIN HCADT | | | | |
| BASE YEAR: | 2007 | | 0 | DIFFERENCE | #VALUE! | 0 | | ENTER RURAL OR URBAN | | |
| FORECAST YEAR: | 2027 | | 0 | DIFFERENCE | #VALUE! | 0 | | IN COLUMN J3 | | |
| | | | | | | | | | | |
| INCREMENTAL HCADT ON SEGMENT B (2000-2004 Local Road Studies) | | | | | | | | | | |
| BASE YEAR PROPORTIONS | | | BASE YR. VOLUME | % TREND | FUTURE % | FUTURE VOL. | | VEHICLE TYPE | Urban | Rural |
| 2AX-6TIRE SU | See J3 | | #VALUE! | 1 | #VALUE! | #VALUE! | | 2AX-6TIRE SU | 1.70% | 3.10% |
| 3AX+ SU | See J3 | | #VALUE! | 1 | #VALUE! | #VALUE! | | 3AX+ SU | 0.50% | 1.30% |
| 3AX TST | See J3 | | #VALUE! | 1 | #VALUE! | #VALUE! | | 3AX TST | 0.10% | 0.40% |
| 4AX TST | See J3 | | #VALUE! | 1 | #VALUE! | #VALUE! | | 4AX TST | 0.10% | 0.60% |
| 5AX+ TST | See J3 | | #VALUE! | 1 | #VALUE! | #VALUE! | | 5AX+ TST | 1.00% | 2.80% |
| (5AX+ TST MAX) | 0.0% | | 0 | 1 | 0.0% | 0 | | TR TR, BUSES | 0.50% | 0.60% |
| (5AX+ TST OTH) | 0.0% | | 0 | 1 | 0.0% | 0 | | TWIN TRAILERS | 0.00% | 0.10% |
| TR TR, BUSES | See J3 | | #VALUE! | 1 | #VALUE! | #VALUE! | | *TOTAL* | *3.90%* | *8.90%* |
| TWIN TRAILERS | See J3 | | #VALUE! | 1 | #VALUE! | #VALUE! | | | | |
| SUMMARIES: | | 0 | ADDED | COMBINED | 20 | YR DESIGN | | Note: The URBAN vehicle types were developed primarily for use | | |
| | | AADT | HCADT % | HCADT % | LANE CUMULATIVE ESAL | | | in the Seven County Metropolitan Area. They can also be used | | |
| BASE YEAR: | 2007 | 0 | #VALUE! | #VALUE! | \| | \| | | for segments that are near cities with over 5,000 population. | | |
| FORECAST YEAR: | 2027 | 0 | #VALUE! | | ********** | ********** | | CAUTION: USE ONLY ONE SET OF DEFAULTS ON EACH "A" SEGM | | |
| DESIGN LANE FACTOR: | | 0.45 | | | FLEXIBLE | RIGID | | | | |
| | | SEGMENT B INCREMENT ONLY: | | | #VALUE! | #VALUE! | | | | |
| | | SEGMENT A + SEGMENT B: | | | #VALUE! | #VALUE! | | | | |
| | | | | | ********** | ********** | | | | |
| ADDITIONAL OUTPUTS: | | | | ESAL FACTORS | | | | | | |
| | BASE % | FORECAST % | | FLEXIBLE | RIGID | | | | | |
| 2AX-6TIRE SU | #VALUE! | #VALUE! | | 0.25 | 0.24 | | | | | |
| 3AX+ SU | #VALUE! | #VALUE! | | 0.58 | 0.85 | | | | | |
| 3AX TST | #VALUE! | #VALUE! | | 0.39 | 0.37 | | | | | |
| 4AX TST | #VALUE! | #VALUE! | | 0.51 | 0.53 | | | | | |
| 5AX+ TST | #VALUE! | #VALUE! | | 1.13 | 1.89 | | | | | |
| (5AX+ TST MAX) | #DIV/0! | #DIV/0! | | 2.40 | 4.07 | | | | | |
| (5AX+ TST OTH) | #DIV/0! | #DIV/0! | | 0.87 | 1.44 | | | | | |
| TR TR, BUSES | #VALUE! | #VALUE! | | 0.57 | 0.74 | | | | | |
| TWIN TRAILERS | #VALUE! | #VALUE! | | 2.40 | 2.33 | | | | | |
| BSEGment | | | | | | | | | | |
| Difference OK? | #VALUE! | #VALUE! | | | | | | | | |
| Notes: | | | | | | | | | | |

Note the examples on the next few pages of a traffic forecast using rural defaults. Also of note on the following forecast is the difference between the AADT on the A and B Segment. Note that the Base Year Volume cell is unchanged (all 0's). This results in a slight decrease in ESALS for the B segment (only the Forecast year AADT shows a decrease in AADT of 100). This results in a slight decrease in ESALS from the A segment to the B segment.

# *TH25 Sample forecast A Segment Worksheet*

| CUMULATIVE ESALS WORKSHEET | | | SEGMENT A | | | |
|---|---|---|---|---|---|---|
| SP#: | 0 | | | | | |
| ROUTE: | TH25 | # LANES: | 2 | DATE: | 09/22/05 | |
| LOCATION: | BELLE PLAINE 0 CSAH6 TO CSAH14 | | | | | |
| VCL SITE #: | 8066 | | | | | |
| | YEAR | AADT | INIT CALC HCADT | CONSTRN HCADT | INIT CALC 5AX TST | CONSTRAIN 5AX TST |
| VEH.CLASS YR.: | 1998 | 2950 | 350 | 0.0% | --- | --- |
| BASE YEAR: | 2005 | 4100 | 490 | | 206 | |
| FORECAST YEAR: | 2025 | 6600 | 790 | | 332 | |
| | | | | | | |
| BASE YEAR PROPORTIONS | | | BASE YR. VOLUME | % TREND | FUTURE % | FUTURE VOL. |
| 2AX-6TIRE SU | 3.4% | | 139 | 1 | 3.4% | 224 |
| 3AX+ SU | 2.2% | | 89 | 1 | 2.2% | 144 |
| 3AX TST | 0.3% | | 13 | 1 | 0.3% | 21 |
| 4AX TST | 0.5% | | 21 | 1 | 0.5% | 34 |
| 5AX+ TST | 0 | | 0 | 1 | 0.0% | 0 |
| (5AX+ TST MAX) | 3.2% | | 131 | 1 | 3.2% | 211 |
| (5AX+ TST OTH) | 1.8% | | 75 | 1 | 1.8% | 122 |
| TR TR, BUSES | 0.4% | | 18 | 1 | 0.4% | 30 |
| TWIN TRAILERS | 0.1% | | 3 | 1 | 0.1% | 5 |
| SUMMARIES: | | AADT | HCADT | HCADT % | 20 | YR DESIGN |
| 1998 | COUNT: | 2950 | 350 | 11.9% | LANE CUMULATIVE ESAL | |
| 2005 | FORECAST: | 4100 | 490 | 12.0% | \| | \| |
| 2025 | FORECAST: | 6600 | 790 | 12.0% | ********** | ********** |
| | | | | | FLEXIBLE | RIGID |
| DESIGN LANE FACTOR: | | 0.5 | | | 2,819,000 | 4,433,000 |
| | | | | | ********** | ********** |
| ADDITIONAL OUTPUTS: | | | | ESAL FACTORS | | |
| | BASE % | FORECAST % | | FLEXIBLE | RIGID | |
| 2AX-6TIRE SU | 3.4% | 3.4% | | 0.25 | 0.24 | |
| 3AX+ SU | 2.2% | 2.2% | | 0.58 | 0.85 | |
| 3AX TST | 0.3% | 0.3% | | 0.39 | 0.37 | |
| 4AX TST | 0.5% | 0.5% | | 0.51 | 0.53 | |
| 5AX+ TST | 0.0% | 0.0% | | 1.13 | 1.89 | |
| (5AX+ TST MAX) | 3.2% | 3.2% | | 2.40 | 4.07 | |
| (5AX+ TST OTH) | 1.8% | 1.8% | | 0.87 | 1.44 | |
| TR TR, BUSES | 0.4% | 0.5% | | 0.57 | 0.74 | |
| TWIN TRAILERS | 0.1% | 0.1% | | 2.40 | 2.33 | |
| Notes: | | | | | | |

# *TH25 Sample forecast A Segment Report*

| CUMULATIVE ESAL REPORT - A | | | | | |
|---|---|---|---|---|---|
| | | | | DATE: | 09/22/05 |
| ROUTE #: | TH25 | DISTRICT: | 7 | SP#: | 0 |
| FORECAST #: | F7-0501 | COUNTY: | 0 | MILES: | |
| DESCRIPTION: | BELLE PLAINE 0 CSAH6 TO CSAH14 | | | | |
| AUTHOR'S DISTRICT: ---> | | | AUTHOR: | | |
| | | | | | |
| TRAFFIC SUMMARY | | | | | |
| BASE YEAR NUMBER OF LANES (two way): | | | 2 | | |
| | BASE YEAR ---> | 2005 | DESIGN YEAR ----> | 2025 | GROWTH / YR (SIMPLE %) |
| AADT: two-way | | 4100 | | 6600 | 3.0% |
| design-lane | | 2050 | | 3,300 | 3.0% |
| HCADT: two-way | | 490 | | 790 | 3.1% |
| SINGLE UNITS:two-way | | 230 | | 370 | 3.0% |
| TST'S: two-way | | 240 | | 388 | 3.1% |
| | | | | | |
| ESAL SUMMARY | | | | | |
| ANNUAL DESIGN LANE ESAL | | | | | |
| FLEXIBLE: | | 91,639 | | 148,064 | + |
| RIGID: | | 144,147 | | 232,826 | + |
| | | | | | |
| CUMULATIVE DESIGN-LANE ESALS (10 TON) | | | | Design-lane factor: | 0.5 |
| DESIGN YEAR | | DESIGN-LANE TST'S | | ESALS FLEXIBLE | RIGID |
| 2015 | | 157 | | 1,303,000 | 2,049,000 |
| 2020 | | 176 | | 2,021,000 | 3,179,000 |
| 2025 | | 194 | | **2,819,000** | **4,433,000** |
| ** OR ** DESIGN YEAR | | | | | |
| 2026 | | 198 | | 2,885,000 | 4,537,000 |
| 2027 | | 201 | | 2,952,000 | 4,642,000 |
| 2028 | | 205 | | 3,018,000 | 4,746,000 |
| 2029 | | 209 | | 3,084,000 | 4,850,000 |
| 2030 | | 213 | | 3,151,000 | 4,955,000 |
| | | | | | |
| 35 YEAR CUMULATIVE ESAL USING--> | | | 2005 | AS THE BASE YEAR | |
| 2040 | | | | 5,686,000 | 8,941,000 |
| | | | | | |
| | | | | | |
| | | | | | |
| APPROVED BY: | | | | DATE: | |
| | | | | | |
| (FOR PROJECT AADTS AND DESIGN HOUR VOLUMES PLEASE REFER TO PREVIOUSLY APPROVED FORECASTS OR ATTACHED TRAFFIC FLOW DIAGRAMS.) | | | | | |

# *TH25 Sample Forecast "New" B Segment Worksheet*

By entering the word "Rural" in the Red cell below, the default rural percentages is transferred to the "Base Year Proportions cell." Thus, instead of the previous version of the MnESAL where 5.9% was already filled in on the B segment, the forecaster has to determine whether to use urban or rural defaults. Normally B segments can vary within one project form urban to rural, but the user must make sure when doing this that trucks do not vary too significantly from one B segment to another. These percentages may have to be adjusted to reflect a logical flow of trucks along the A and B segments of any particular project.

| CUMULATIVE ESAL WORKSHEET | | | SEGMENT B | | | | | USE THE RURAL OR | ENTER RURAL | |
|---|---|---|---|---|---|---|---|---|---|---|
| SP#: | 0 | | | | | | | URBAN PCT'S | OR URBAN BELOW | |
| ROUTE: | TH25 | # LANES: | 2 | DATE: | 09/19/05 | | | BELOW FOR | RURAL | |
| LOCATION: | GREEN ISLE TO EAST OF GREEN ISLE | | | | | | | TYPE OF FORECAST | | |
| | YEAR | AADT | | | CALCULATED HCADT | CONSTRAIN HCADT | | | | |
| BASE YEAR: | 2005 | 4100 | 0 | DIFFERENCE | 490 | 0 | | ENTER RURAL OR URBAN | | |
| FORECAST YEAR: | 2025 | 6500 | -100 | DIFFERENCE | 780 | 0 | | IN COLUMN J3 | | |
| | | | | | | | | | | |
| INCREMENTAL HCADT ON SEGMENT B (2000-2004 Local Road Studies) | | | | | | | | | | |
| BASE YEAR PROPORTIONS | | | BASE YR. VOLUME | % TREND | FUTURE % | FUTURE VOL. | | VEHICLE TYPE | Urban | Rural |
| 2AX-6TIRE SU | 3.1% | | 0 | 1 | 3.1% | -3 | | 2AX-6TIRE SU | 1.70% | 3.10% |
| 3AX+ SU | 1.3% | | 0 | 1 | 1.3% | -1 | | 3AX+ SU | 0.50% | 1.30% |
| 3AX TST | 0.4% | | 0 | 1 | 0.4% | 0 | | 3AX TST | 0.10% | 0.40% |
| 4AX TST | 0.6% | | 0 | 1 | 0.6% | -1 | | 4AX TST | 0.10% | 0.60% |
| 5AX+ TST | 2.8% | | 0 | 1 | 2.8% | -3 | | 5AX+ TST | 1.00% | 2.80% |
| (5AX+ TST MAX) | 0.0% | | 0 | 1 | 0.0% | 0 | | TR TR, BUSES | 0.50% | 0.60% |
| (5AX+ TST OTH) | 0.0% | | 0 | 1 | 0.0% | 0 | | TWIN TRAILERS | 0.00% | 0.10% |
| TR TR, BUSES | 0.6% | | 0 | 1 | 0.6% | -1 | | *TOTAL* | *3.90%* | *8.90%* |
| TWIN TRAILERS | 0.1% | | 0 | 1 | 0.1% | 0 | | | | |
| SUMMARIES: | | 0 | ADDED | COMBINED | 20 | YR DESIGN | | Note: The URBAN vehicle types were developed primarily for use | | |
| | | AADT | HCADT % | HCADT % | LANE CUMULATIVE ESAL | | | in the Seven County Metropolitan Area. They can also be used | | |
| BASE YEAR: | 2005 | 0 | | | \| | \| | | for segments that are near cities with over 5,000 population. | | |
| FORECAST YEAR: | 2025 | -100 | 9.0% | 12.0% | ********** | ********** | | CAUTION: USE ONLY ONE SET OF DEFAULTS ON EACH "A" SEGM | | |
| DESIGN LANE FACTOR: | | 0.5 | | | FLEXIBLE | RIGID | | | | |
| | | SEGMENT B INCREMENT ONLY: | | | -13,000 | -18,000 | | | | |
| | | SEGMENT A + SEGMENT B: | | | 2,806,000 | 4,415,000 | | | | |
| | | | | | ********** | ********** | | | | |
| ADDITIONAL OUTPUTS: | | | | ESAL FACTORS | | | | | | |
| | BASE % | FORECAST % | | FLEXIBLE | RIGID | | | | | |
| 2AX-6TIRE SU | #DIV/0! | 3.0% | | 0.25 | 0.24 | | | | | |
| 3AX+ SU | #DIV/0! | 1.0% | | 0.58 | 0.85 | | | | | |
| 3AX TST | #DIV/0! | 0.0% | | 0.39 | 0.37 | | | | | |
| 4AX TST | #DIV/0! | 1.0% | | 0.51 | 0.53 | | | | | |
| 5AX+ TST | #DIV/0! | 3.0% | | 1.13 | 1.89 | | | | | |
| (5AX+ TST MAX) | #DIV/0! | 0.0% | | 2.40 | 4.07 | | | | | |
| (5AX+ TST OTH) | #DIV/0! | 0.0% | | 0.87 | 1.44 | | | | | |
| TR TR, BUSES | #DIV/0! | 1.0% | | 0.57 | 0.74 | | | | | |
| TWIN TRAILERS | #DIV/0! | 0.0% | | 2.40 | 2.33 | | | | | |
| BSEGment | | | | | | | | | | |
| Difference OK? | OK | way 50% of trucks from A segment | | | | | | | | |
| Notes: | | | | | | | | | | |

## *I-35E TRAFFIC FORECAST USING DEFAULT HOURLY PERCENTAGES*

Another real world example of a traffic forecast in which the vehicle class site was not applicable and a traffic count was necessary is the portion of I-35E from Shepard Road to Kellog Boulevard in the Twin Cities Area. In a section of this recent project, the vehicle class site was in the same trunk highway segment, but was not applicable since a portion of the project was restricted – allowing only 2 axle single unit trucks and buses. Since the project would require an actual forecast of trucks using the facility, and since illegal trucks were reported and counted during this time, it was decided to forecast the ESALS with two scenarios – one using allowed vehicles only and the other forecast including illegal vehicles using the restricted roadway.

Using default factors developed for individual vehicle types (shown below and on the graphics from pages 127-139 for the Twin Cities Metropolitan area, were able to take short counts and factor them up to the average percent each vehicle type is of a specific hour. In this instance, we need not count passenger cars since there would be too many and there were 4 loop detectors in the section of the road that captured ***total*** traffic. We simply counted and classified the number of trucks and subtracted from the total vehicles to arrive at the cars and pickups (4,513 ).

We counted and classified traffic from 9 to 10am and completed the vehicle classification shown below. Using default expansion factors derived from the table on pages 158-161 we factored up the one-hour to count to 24 hours. Note that the overweight 5 axle semis are included in this iteration for ESAL calculations only. We thus will arrive at percent heavy commercial for our traffic forecasting vehicle types, which we will run through our factoring program on the MnESAL spreadsheet. Note the 4,567 traffic total on all loop detectors shown on the next page.

EXAMPLE OF FACTORING UP ONE HOUR COUNT TO 24 HOUR USING VEHICLE CLASS COUNT AVERAGES FOR TWIN CITY METRO AREA
DATA WAS AVERAGE OF 2000 THROUGH 2004 VEHICLE CLASS TUBE COUNTS

**SUBJECT: TRAFFIC FORECAST CALCULATIONS**

**Route**: I35E
**Letting Date:** 02/27/2009
**Program Category:** Preservation
**Project Manager:** Richard Martig

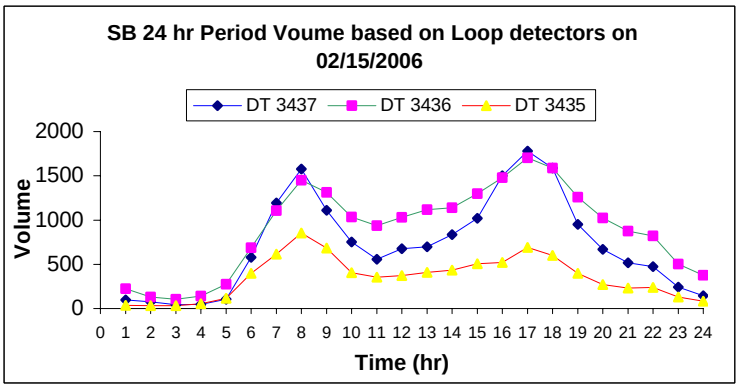
**SP**: 6280-320
**Forecast #:**
**County**: Ramsey
**District**: Metro
**Miles:** 3.95

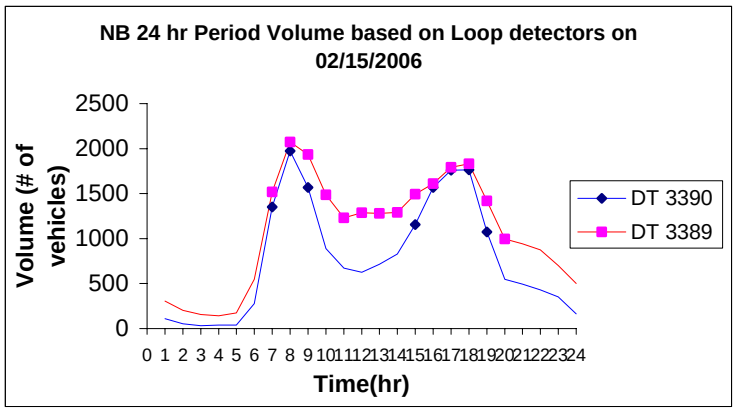
**Project Limits:** On I-35E from Shepard Road to Kellogg Blvd.
**Time: 9:00-10:00 am**

| NB+SB | 1hr | % of 24 Hour | 1 hr/ 24 hr % | Forecast 24hour count |
|---|---|---|---|---|
| CARS AND PICKUPS | 4513 | 4.59% | 98340 | 98340 |
| 2 AXLE 6 TIRE | 24 | 7.12% | 337 | 337 |
| 3+ AXSU | 0 | 8.22% | 0 | 0 |
| 3 AXLE SEMI | 0 | 6.43% | 0 | 0 |
| 4 AXLE SEMI | 0 | 6.41% | 0 | 0 |
| 5+ AXLE SEMI | 3 | 8.35% | 36 | 36 |
| TR, TR, BUSES | 27 | 7.87% | 343 | 343 |
| TWIN TRAILERS | 0 | 4.86% | 0 | 0 |
| TOTALS | 4567 | | 99056 | 99056 |

Loop Detector 24 hour volumes for the I-35E project at Shepard Road

| Time | Det 3437 | Det 3436 | Det 3435 | Det 3390 | Det 3389 | Total |
|---|---|---|---|---|---|---|
| 1:00 | 99 | 224 | 35 | 109 | 305 | 772 |
| 2:00 | 75 | 132 | 31 | 53 | 201 | 492 |
| 3:00 | 45 | 104 | 32 | 33 | 158 | 372 |
| 4:00 | 46 | 142 | 54 | 40 | 144 | 426 |
| 5:00 | 105 | 276 | 115 | 39 | 175 | 710 |
| 6:00 | 579 | 687 | 399 | 276 | 549 | 2490 |
| 7:00 | 1195 | 1107 | 614 | 1352 | 1517 | 5785 |
| 8:00 | 1578 | 1449 | 853 | 1975 | 2073 | 7928 |
| 9:00 | 1110 | 1312 | 682 | 1568 | 1934 | 6606 |
| 10:00 | 753 | 1033 | 406 | 888 | 1487 | 4567 |
| 11:00 | 557 | 937 | 353 | 672 | 1230 | 3749 |
| 12:00 | 677 | 1031 | 372 | 626 | 1287 | 3993 |
| 13:00 | 699 | 1116 | 410 | 714 | 1282 | 4221 |
| 14:00 | 835 | 1139 | 435 | 827 | 1292 | 4528 |
| 15:00 | 1020 | 1299 | 508 | 1157 | 1492 | 5476 |
| 16:00 | 1502 | 1480 | 520 | 1569 | 1610 | 6681 |
| 17:00 | 1781 | 1703 | 691 | 1760 | 1791 | 7726 |
| 18:00 | 1586 | 1588 | 599 | 1764 | 1831 | 7368 |
| 19:00 | 952 | 1258 | 398 | 1075 | 1420 | 5103 |
| 20:00 | 669 | 1025 | 270 | 549 | 995 | 3508 |
| 21:00 | 517 | 877 | 231 | 493 | 942 | 3060 |
| 22:00 | 472 | 820 | 239 | 429 | 874 | 2834 |
| 23:00 | 241 | 501 | 130 | 353 | 702 | 1927 |
| 12:00 | 146 | 377 | 82 | 164 | 500 | 1269 |
| Total | 17239 | 21617 | 8459 | 18485 | 25791 | 91591 |



## Partial Data from 2000-2004 Vehicle Class site tube Metro counts for I-35E Project

Tube counts - 2000, 2001, 2002, and 2003 - pct of 24 hour each hour is by veh type

| Vehicles | Time | Tube 00-met -th | Tube 01-met th | Tube 02-met th | Tube 03-met th | Tube 04-met th | Avg 00-04 Tube |
|---|---|---|---|---|---|---|---|
| Cars & pu | 12-1am | 0.88% | 0.95% | 0.65% | 0.76% | 0.69% | 0.79% |
| Cars & pu | 1-2am | 0.64% | 0.59% | 0.39% | 0.49% | 0.47% | 0.52% |
| Cars & pu | 2-3am | 0.44% | 0.42% | 0.30% | 0.37% | 0.37% | 0.38% |
| Cars & pu | 3-4am | 0.44% | 0.36% | 0.30% | 0.46% | 0.40% | 0.39% |
| Cars & pu | 4-5am | 0.72% | 0.82% | 0.61% | 1.10% | 0.88% | 0.82% |
| Cars & pu | 5-6am | 2.40% | 3.04% | 2.37% | 3.17% | 3.23% | 2.84% |
| Cars & pu | 6-7am | 5.13% | 6.02% | 5.92% | 6.53% | 6.40% | 6.00% |
| Cars & pu | 7-8am | 5.80% | 6.66% | 7.87% | 7.31% | 7.43% | 7.01% |
| Cars & pu | 8-9am | 5.25% | 5.26% | 6.22% | 5.49% | 5.61% | 5.57% |
| Cars & pu | 9-10am | 4.49% | 4.43% | 4.94% | 4.60% | 4.49% | 4.59% |
| Cars & pu | 10-11am | 4.51% | 4.33% | 4.12% | 4.35% | 4.18% | 4.30% |
| Cars & pu | 11-noon | 5.20% | 4.62% | 4.33% | 4.45% | 4.61% | 4.64% |
| Cars & pu | noon-1pm | 5.56% | 4.85% | 4.52% | 4.76% | 4.76% | 4.89% |
| Cars & pu | 1-2pm | 5.71% | 5.13% | 4.73% | 5.10% | 4.86% | 5.11% |
| Cars & pu | 2-3pm | 6.70% | 6.08% | 5.53% | 6.02% | 5.88% | 6.04% |
| Cars & pu | 3-4pm | 7.38% | 7.39% | 7.52% | 7.31% | 7.36% | 7.39% |
| Cars & pu | 4-5pm | 8.05% | 8.62% | 8.62% | 8.32% | 8.25% | 8.37% |
| Cars & pu | 5-6pm | 8.05% | 8.45% | 8.84% | 8.12% | 8.42% | 8.38% |
| Cars & pu | 6-7pm | 6.79% | 6.29% | 6.80% | 6.38% | 6.47% | 6.54% |
| Cars & pu | 7-8pm | 4.70% | 4.62% | 4.77% | 4.66% | 4.52% | 4.65% |
| Cars & pu | 8-9pm | 3.84% | 3.96% | 3.88% | 3.57% | 3.91% | 3.83% |
| Cars & pu | 9-10pm | 3.37% | 3.30% | 3.31% | 3.06% | 3.31% | 3.27% |
| Cars & pu | 10-11pm | 2.46% | 2.28% | 2.24% | 2.24% | 2.21% | 2.29% |
| Cars & pu | 11-12am | 1.49% | 1.52% | 1.22% | 1.37% | 1.29% | 1.38% |
| 2ax su | 12-1am | 0.42% | 0.61% | 0.36% | 0.33% | 0.37% | 0.42% |
| 2ax su | 1-2am | 0.28% | 0.45% | 0.16% | 0.37% | 0.30% | 0.31% |
| 2ax su | 2-3am | 0.34% | 0.32% | 0.28% | 0.36% | 0.32% | 0.32% |
| 2ax su | 3-4am | 0.43% | 0.39% | 0.28% | 0.38% | 0.34% | 0.36% |
| 2ax su | 4-5am | 0.65% | 0.64% | 0.44% | 0.77% | 1.01% | 0.70% |
| 2ax su | 5-6am | 3.09% | 3.17% | 2.41% | 2.55% | 2.54% | 2.75% |
| 2ax su | 6-7am | 4.80% | 6.41% | 5.23% | 4.90% | 5.62% | 5.39% |
| 2ax su | 7-8am | 5.09% | 6.48% | 7.03% | 7.24% | 7.15% | 6.59% |
| 2ax su | 8-9am | 6.67% | 6.92% | 8.27% | 7.25% | 8.20% | 7.46% |
| 2ax su | 9-10am | 7.43% | 6.13% | 6.71% | 7.69% | 7.67% | 7.12% |
| 2ax su | 10-11am | 7.27% | 6.13% | 6.31% | 7.85% | 7.25% | 6.96% |
| 2ax su | 11-noon | 7.81% | 6.03% | 6.66% | 7.41% | 7.42% | 7.07% |
| 2ax su | noon-1pm | 7.74% | 6.35% | 6.61% | 8.24% | 7.14% | 7.22% |
| 2ax su | 1-2pm | 7.82% | 6.27% | 7.06% | 8.47% | 7.90% | 7.50% |
| 2ax su | 2-3pm | 8.60% | 7.24% | 7.12% | 8.43% | 7.90% | 7.86% |
| 2ax su | 3-4pm | 8.23% | 7.74% | 7.68% | 7.44% | 7.48% | 7.71% |
| 2ax su | 4-5pm | 6.99% | 7.35% | 7.08% | 6.18% | 6.26% | 6.77% |
| 2ax su | 5-6pm | 4.77% | 6.81% | 6.70% | 4.68% | 4.88% | 5.57% |
| 2ax su | 6-7pm | 3.97% | 4.91% | 5.33% | 3.29% | 3.69% | 4.24% |
| 2ax su | 7-8pm | 2.54% | 3.09% | 2.91% | 2.13% | 2.21% | 2.58% |
| 2ax su | 8-9pm | 2.04% | 2.67% | 2.14% | 1.73% | 1.71% | 2.06% |
| 2ax su | 9-10pm | 1.37% | 1.96% | 1.53% | 1.09% | 1.32% | 1.45% |
| 2ax su | 10-11pm | 1.14% | 1.18% | 1.04% | 0.72% | 0.80% | 0.98% |
| 2ax su | 11-12am | 0.53% | 0.75% | 0.66% | 0.52% | 0.52% | 0.60% |
| 3+ax su | 12-1am | 0.35% | 0.14% | 0.03% | 0.28% | 0.31% | 0.22% |
| 3+ax su | 1-2am | 0.40% | 0.17% | 0.17% | 0.08% | 0.19% | 0.20% |
| 3+ax su | 2-3am | 0.40% | 0.31% | 0.43% | 0.23% | 0.43% | 0.36% |
| 3+ax su | 3-4am | 1.42% | 0.14% | 0.27% | 0.20% | 0.61% | 0.53% |
| 3+ax su | 4-5am | 0.89% | 0.80% | 0.80% | 0.45% | 0.80% | 0.75% |
| 3+ax su | 5-6am | 2.39% | 1.80% | 2.13% | 2.34% | 2.52% | 2.24% |
| 3+ax su | 6-7am | 4.75% | 4.55% | 5.06% | 5.44% | 6.59% | 5.28% |
| 3+ax su | 7-8am | 7.36% | 6.61% | 6.25% | 6.55% | 7.05% | 6.76% |
| 3+ax su | 8-9am | 7.72% | 8.50% | 8.78% | 7.93% | 8.23% | 8.23% |
| 3+ax su | 9-10am | 6.70% | 8.87% | 8.25% | 8.91% | 8.37% | 8.22% |

## Partial Data from 2000-2004 Vehicle Class site tube Metro counts for I-35E Project

Tube counts - 2000, 2001, 2002, and 2003 - pct of 24 hour each hour is by veh type

| Vehicles | Time | Tube 00-met -th | Tube 01-met th | Tube 02-met th | Tube 03-met th | Tube 04-met th | Avg 00-04 Tube |
|---|---|---|---|---|---|---|---|
| 3+ax su | 10-11am | 8.20% | 9.81% | 8.95% | 9.64% | 8.82% | 9.08% |
| 3+ax su | 11-noon | 9.14% | 9.53% | 10.01% | 9.27% | 8.80% | 9.35% |
| 3+ax su | noon-1pm | 8.12% | 9.30% | 10.25% | 9.49% | 7.68% | 8.97% |
| 3+ax su | 1-2pm | 9.22% | 9.98% | 8.92% | 9.39% | 8.01% | 9.11% |
| 3+ax su | 2-3pm | 10.33% | 8.72% | 8.12% | 9.02% | 7.81% | 8.80% |
| 3+ax su | 3-4pm | 8.56% | 7.47% | 6.82% | 7.18% | 6.78% | 7.36% |
| 3+ax su | 4-5pm | 5.14% | 5.18% | 5.89% | 5.97% | 5.79% | 5.59% |
| 3+ax su | 5-6pm | 2.88% | 3.52% | 3.76% | 3.58% | 4.22% | 3.59% |
| 3+ax su | 6-7pm | 1.95% | 1.54% | 1.76% | 1.94% | 2.47% | 1.93% |
| 3+ax su | 7-8pm | 1.15% | 1.23% | 1.20% | 1.01% | 1.41% | 1.20% |
| 3+ax su | 8-9pm | 0.62% | 0.77% | 0.53% | 0.63% | 1.11% | 0.73% |
| 3+ax su | 9-10pm | 0.75% | 0.46% | 0.67% | 0.30% | 0.86% | 0.61% |
| 3+ax su | 10-11pm | 1.06% | 0.34% | 0.53% | 0.13% | 0.64% | 0.54% |
| 3+ax su | 11-12am | 0.49% | 0.26% | 0.43% | 0.05% | 0.51% | 0.35% |
| 3ax semi | 12-1am | 0.18% | 0.88% | 0.57% | 0.40% | 0.50% | 0.51% |
| 3ax semi | 1-2am | 0.37% | 1.43% | 0.63% | 0.81% | 0.71% | 0.79% |
| 3ax semi | 2-3am | 0.14% | 0.54% | 0.57% | 1.21% | 0.50% | 0.59% |
| 3ax semi | 3-4am | 0.51% | 0.34% | 0.46% | 1.21% | 0.45% | 0.59% |
| 3ax semi | 4-5am | 0.51% | 1.29% | 1.09% | 2.42% | 1.31% | 1.32% |
| 3ax semi | 5-6am | 1.20% | 2.31% | 1.32% | 3.23% | 2.72% | 2.15% |
| 3ax semi | 6-7am | 3.31% | 5.64% | 4.70% | 2.02% | 4.18% | 3.97% |
| 3ax semi | 7-8am | 6.80% | 6.39% | 6.07% | 4.44% | 5.39% | 5.82% |
| 3ax semi | 8-9am | 7.77% | 6.39% | 8.08% | 5.24% | 6.50% | 6.79% |
| 3ax semi | 9-10am | 6.80% | 5.91% | 7.96% | 5.24% | 6.25% | 6.43% |
| 3ax semi | 10-11am | 7.22% | 6.73% | 6.24% | 7.26% | 7.61% | 7.01% |
| 3ax semi | 11-noon | 8.37% | 7.00% | 7.16% | 8.06% | 7.96% | 7.71% |
| 3ax semi | noon-1pm | 7.82% | 7.68% | 7.85% | 8.87% | 8.46% | 8.13% |
| 3ax semi | 1-2pm | 8.14% | 6.39% | 8.02% | 8.87% | 8.82% | 8.05% |
| 3ax semi | 2-3pm | 8.74% | 7.34% | 9.51% | 8.87% | 8.72% | 8.63% |
| 3ax semi | 3-4pm | 8.55% | 5.77% | 9.28% | 8.47% | 8.77% | 8.17% |
| 3ax semi | 4-5pm | 7.49% | 8.15% | 5.84% | 7.66% | 6.15% | 7.06% |
| 3ax semi | 5-6pm | 7.31% | 5.10% | 5.33% | 5.65% | 4.33% | 5.54% |
| 3ax semi | 6-7pm | 3.59% | 4.35% | 2.86% | 3.63% | 3.88% | 3.66% |
| 3ax semi | 7-8pm | 1.93% | 3.53% | 2.35% | 3.23% | 2.47% | 2.70% |
| 3ax semi | 8-9pm | 0.92% | 2.58% | 1.66% | 1.21% | 1.71% | 1.62% |
| 3ax semi | 9-10pm | 1.33% | 2.58% | 1.32% | 0.81% | 1.31% | 1.47% |
| 3ax semi | 10-11pm | 0.78% | 1.09% | 0.69% | 0.81% | 0.81% | 0.83% |
| 3ax semi | 11-12am | 0.23% | 0.61% | 0.46% | 0.40% | 0.50% | 0.44% |
| 4 ax semi | 12-1am | 0.18% | 0.88% | 0.57% | 1.02% | 0.50% | 0.63% |
| 4 ax semi | 1-2am | 0.37% | 1.43% | 0.63% | 0.61% | 0.71% | 0.75% |
| 4 ax semi | 2-3am | 0.14% | 0.54% | 0.57% | 0.82% | 0.50% | 0.52% |
| 4 ax semi | 3-4am | 0.51% | 0.34% | 0.46% | 1.02% | 0.45% | 0.56% |
| 4 ax semi | 4-5am | 0.51% | 1.29% | 1.09% | 2.66% | 1.31% | 1.37% |
| 4 ax semi | 5-6am | 1.20% | 2.31% | 1.32% | 2.66% | 2.72% | 2.04% |
| 4 ax semi | 6-7am | 3.31% | 5.64% | 4.70% | 2.87% | 4.18% | 4.14% |
| 4 ax semi | 7-8am | 6.80% | 6.39% | 6.07% | 5.94% | 5.39% | 6.12% |
| 4 ax semi | 8-9am | 7.77% | 6.39% | 8.08% | 5.33% | 6.50% | 6.81% |
| 4 ax semi | 9-10am | 6.80% | 5.91% | 7.96% | 5.12% | 6.25% | 6.41% |
| 4 ax semi | 10-11am | 7.22% | 6.73% | 6.24% | 7.58% | 7.61% | 7.08% |
| 4 ax semi | 11-noon | 8.37% | 7.00% | 7.16% | 7.99% | 7.96% | 7.70% |
| 4 ax semi | noon-1pm | 7.82% | 7.68% | 7.85% | 7.99% | 8.46% | 7.96% |
| 4 ax semi | 1-2pm | 8.14% | 6.39% | 8.02% | 8.61% | 8.82% | 7.99% |
| 4 ax semi | 2-3pm | 8.74% | 7.34% | 9.51% | 8.81% | 8.72% | 8.62% |
| 4 ax semi | 3-4pm | 8.55% | 5.77% | 9.28% | 7.99% | 8.77% | 8.07% |
| 4 ax semi | 4-5pm | 7.49% | 8.15% | 5.84% | 6.35% | 6.15% | 6.80% |
| 4 ax semi | 5-6pm | 7.31% | 5.10% | 5.33% | 5.12% | 4.33% | 5.44% |
| 4 ax semi | 6-7pm | 3.59% | 4.35% | 2.86% | 3.48% | 3.88% | 3.63% |
| 4 ax semi | 7-8pm | 1.93% | 3.53% | 2.35% | 3.07% | 2.47% | 2.67% |

# Partial Data from 2000-2004 Vehicle Class site tube Metro counts for I-35E Project

Tube counts - 2000, 2001, 2002, and 2003 - pct of 24 hour each hour is by veh type - trunk highways only(incl Int) - 7 co metro

| Vehicles | Time | Tube 00-met -th | Tube 01-met th | Tube 02-met th | Tube 03-met th | Tube 04-met th | Avg 00-04 Tube |
|---|---|---|---|---|---|---|---|
| 4 ax semi | 8-9pm | 0.92% | 2.58% | 1.66% | 1.84% | 1.71% | 1.74% |
| 4 ax semi | 9-10pm | 1.33% | 2.58% | 1.32% | 1.02% | 1.31% | 1.51% |
| 4 ax semi | 10-11pm | 0.78% | 1.09% | 0.69% | 1.43% | 0.81% | 0.96% |
| 4 ax semi | 11-12am | 0.23% | 0.61% | 0.46% | 0.61% | 0.50% | 0.48% |
| 5+ax semi | 12-1am | 1.11% | 1.50% | 1.14% | 1.18% | 1.10% | 1.20% |
| 5+ax semi | 1-2am | 1.23% | 0.99% | 0.90% | 1.22% | 0.86% | 1.04% |
| 5+ax semi | 2-3am | 1.03% | 1.06% | 0.78% | 1.21% | 0.84% | 0.98% |
| 5+ax semi | 3-4am | 1.29% | 1.18% | 0.76% | 1.56% | 1.16% | 1.19% |
| 5+ax semi | 4-5am | 1.28% | 1.97% | 1.53% | 2.09% | 1.78% | 1.73% |
| 5+ax semi | 5-6am | 2.70% | 3.12% | 2.70% | 3.24% | 3.15% | 2.98% |
| 5+ax semi | 6-7am | 3.89% | 4.88% | 4.90% | 4.77% | 5.18% | 4.72% |
| 5+ax semi | 7-8am | 6.52% | 6.16% | 6.15% | 5.48% | 6.23% | 6.11% |
| 5+ax semi | 8-9am | 7.71% | 6.98% | 7.91% | 6.51% | 8.16% | 7.45% |
| 5+ax semi | 9-10am | 8.20% | 8.37% | 8.93% | 7.64% | 8.63% | 8.35% |
| 5+ax semi | 10-11am | 8.44% | 7.81% | 7.37% | 7.56% | 8.80% | 7.99% |
| 5+ax semi | 11-noon | 8.09% | 8.01% | 8.38% | 8.14% | 8.05% | 8.14% |
| 5+ax semi | noon-1pm | 7.47% | 7.32% | 8.07% | 6.97% | 7.15% | 7.40% |
| 5+ax semi | 1-2pm | 7.79% | 6.92% | 7.77% | 6.92% | 6.56% | 7.20% |
| 5+ax semi | 2-3pm | 6.73% | 6.24% | 7.11% | 6.44% | 6.70% | 6.64% |
| 5+ax semi | 3-4pm | 6.55% | 6.08% | 6.47% | 5.72% | 6.16% | 6.20% |
| 5+ax semi | 4-5pm | 5.28% | 4.52% | 5.39% | 4.56% | 4.84% | 4.92% |
| 5+ax semi | 5-6pm | 4.19% | 3.62% | 3.79% | 4.16% | 3.75% | 3.90% |
| 5+ax semi | 6-7pm | 3.02% | 3.05% | 2.35% | 3.87% | 3.28% | 3.11% |
| 5+ax semi | 7-8pm | 2.19% | 2.47% | 2.20% | 3.00% | 2.14% | 2.40% |
| 5+ax semi | 8-9pm | 1.53% | 2.40% | 1.42% | 2.24% | 1.56% | 1.83% |
| 5+ax semi | 9-10pm | 1.38% | 2.10% | 1.53% | 2.08% | 1.49% | 1.72% |
| 5+ax semi | 10-11pm | 1.05% | 1.76% | 1.28% | 1.73% | 1.38% | 1.44% |
| 5+ax semi | 11-12am | 1.31% | 1.51% | 1.16% | 1.72% | 1.06% | 1.35% |
| TT/bus | 12-1am | 0.57% | 0.56% | 0.44% | 0.81% | 0.44% | 0.56% |
| TT/bus | 1-2am | 0.65% | 0.70% | 0.33% | 0.00% | 0.29% | 0.40% |
| TT/bus | 2-3am | 0.41% | 0.58% | 0.60% | 0.32% | 0.22% | 0.43% |
| TT/bus | 3-4am | 0.54% | 0.55% | 0.30% | 0.16% | 1.03% | 0.51% |
| TT/bus | 4-5am | 0.69% | 0.65% | 0.61% | 0.97% | 0.37% | 0.66% |
| TT/bus | 5-6am | 1.32% | 2.36% | 1.31% | 2.42% | 1.91% | 1.86% |
| TT/bus | 6-7am | 4.98% | 6.04% | 4.53% | 5.48% | 6.09% | 5.42% |
| TT/bus | 7-8am | 8.11% | 7.87% | 6.88% | 5.96% | 6.60% | 7.08% |
| TT/bus | 8-9am | 8.49% | 8.72% | 9.25% | 7.25% | 7.11% | 8.16% |
| TT/bus | 9-10am | 7.57% | 8.88% | 8.67% | 7.41% | 6.82% | 7.87% |
| TT/bus | 10-11am | 7.71% | 7.85% | 6.93% | 8.53% | 8.43% | 7.89% |
| TT/bus | 11-noon | 6.91% | 6.42% | 8.03% | 6.76% | 7.48% | 7.12% |
| TT/bus | noon-1pm | 6.95% | 7.27% | 7.70% | 9.34% | 8.06% | 7.86% |
| TT/bus | 1-2pm | 7.60% | 7.41% | 8.13% | 7.41% | 8.06% | 7.72% |
| TT/bus | 2-3pm | 7.74% | 8.99% | 9.47% | 9.66% | 7.99% | 8.77% |
| TT/bus | 3-4pm | 9.75% | 7.34% | 9.02% | 8.70% | 7.92% | 8.55% |
| TT/bus | 4-5pm | 6.97% | 5.02% | 6.68% | 6.28% | 6.96% | 6.39% |
| TT/bus | 5-6pm | 5.54% | 3.76% | 3.45% | 5.64% | 4.62% | 4.60% |
| TT/bus | 6-7pm | 3.32% | 2.55% | 2.68% | 3.22% | 4.18% | 3.19% |
| TT/bus | 7-8pm | 1.56% | 2.08% | 1.78% | 2.42% | 2.79% | 2.12% |
| TT/bus | 8-9pm | 0.69% | 1.75% | 1.04% | 0.32% | 1.25% | 1.01% |
| TT/bus | 9-10pm | 1.19% | 0.96% | 1.02% | 0.64% | 0.59% | 0.88% |
| TT/bus | 10-11pm | 0.55% | 0.76% | 0.50% | 0.00% | 0.66% | 0.49% |
| TT/bus | 11-12am | 0.17% | 0.92% | 0.66% | 0.32% | 0.15% | 0.44% |
| Twins | 12-1am | 0.00% | 3.45% | 1.64% | 8.02% | 2.95% | 3.21% |
| Twins | 1-2am | 0.32% | 1.62% | 2.96% | 3.09% | 4.83% | 2.56% |
| Twins | 2-3am | 0.32% | 2.43% | 1.64% | 3.70% | 3.49% | 2.32% |
| Twins | 3-4am | 0.00% | 2.84% | 0.33% | 4.32% | 4.83% | 2.46% |
| Twins | 4-5am | 0.96% | 2.64% | 1.32% | 6.79% | 5.63% | 3.47% |
| Twins | 5-6am | 0.96% | 2.23% | 4.61% | 5.56% | 1.34% | 2.94% |

# Partial Data from 2000-2004 Vehicle Class site tube Metro counts for I-35E Project

Tube counts - 2000, 2001, 2002, and 2003 - pct of 24 hour each hour is by veh type

| Vehicles | Time | Tube 00-met -th | Tube 01-met th | Tube 02-met th | Tube 03-met th | Tube 04-met th | Avg 00-04 Tube |
|---|---|---|---|---|---|---|---|
| Twins | 6-7am | 4.18% | 4.67% | 4.61% | 1.23% | 2.41% | 3.42% |
| Twins | 7-8am | 20.58% | 11.56% | 6.91% | 1.23% | 5.63% | 9.18% |
| Twins | 8-9am | 12.54% | 8.11% | 3.95% | 2.47% | 6.70% | 6.75% |
| Twins | 9-10am | 4.50% | 3.45% | 7.57% | 3.70% | 5.09% | 4.86% |
| Twins | 10-11am | 2.57% | 4.67% | 5.26% | 1.23% | 4.83% | 3.71% |
| Twins | 11-noon | 1.61% | 4.87% | 6.58% | 4.32% | 2.68% | 4.01% |
| Twins | noon-1pm | 4.50% | 4.06% | 5.59% | 3.09% | 4.02% | 4.25% |
| Twins | 1-2pm | 3.54% | 4.67% | 3.29% | 3.09% | 3.22% | 3.56% |
| Twins | 2-3pm | 2.57% | 4.46% | 3.29% | 2.47% | 4.29% | 3.42% |
| Twins | 3-4pm | 5.47% | 7.30% | 5.59% | 0.62% | 6.97% | 5.19% |
| Twins | 4-5pm | 8.04% | 3.45% | 6.91% | 1.85% | 2.14% | 4.48% |
| Twins | 5-6pm | 16.08% | 2.03% | 8.88% | 1.23% | 4.02% | 6.45% |
| Twins | 6-7pm | 8.04% | 2.03% | 3.95% | 4.32% | 3.75% | 4.42% |
| Twins | 7-8pm | 1.29% | 1.83% | 2.63% | 3.09% | 2.41% | 2.25% |
| Twins | 8-9pm | 0.64% | 3.25% | 1.97% | 4.32% | 3.49% | 2.73% |
| Twins | 9-10pm | 0.96% | 3.85% | 4.61% | 9.26% | 4.29% | 4.59% |
| Twins | 10-11pm | 0.32% | 6.09% | 3.95% | 9.88% | 5.90% | 5.23% |
| Twins | 11-12am | 0.00% | 4.46% | 1.97% | 11.11% | 5.09% | 4.53% |
| Total Veh | 12-1am | 0.87% | 0.95% | 0.64% | 0.76% | 0.69% | 0.78% |
| Total Veh | 1-2am | 0.63% | 0.60% | 0.39% | 0.50% | 0.47% | 0.52% |
| Total Veh | 2-3am | 0.44% | 0.44% | 0.31% | 0.39% | 0.38% | 0.40% |
| Total Veh | 3-4am | 0.45% | 0.39% | 0.30% | 0.49% | 0.42% | 0.41% |
| Total Veh | 4-5am | 0.72% | 0.85% | 0.62% | 1.11% | 0.90% | 0.84% |
| Total Veh | 5-6am | 2.40% | 3.02% | 2.36% | 3.15% | 3.20% | 2.83% |
| Total Veh | 6-7am | 5.10% | 5.97% | 5.85% | 6.42% | 6.35% | 5.94% |
| Total Veh | 7-8am | 5.83% | 6.65% | 7.78% | 7.24% | 7.39% | 6.98% |
| Total Veh | 8-9am | 5.34% | 5.45% | 6.38% | 5.59% | 5.75% | 5.70% |
| Total Veh | 9-10am | 4.61% | 4.71% | 5.14% | 4.81% | 4.69% | 4.79% |
| Total Veh | 10-11am | 4.64% | 4.61% | 4.32% | 4.59% | 4.39% | 4.51% |
| Total Veh | 11-noon | 5.31% | 4.87% | 4.57% | 4.69% | 4.79% | 4.84% |
| Total Veh | noon-1pm | 5.65% | 5.07% | 4.74% | 4.97% | 4.91% | 5.07% |
| Total Veh | 1-2pm | 5.81% | 5.31% | 4.94% | 5.29% | 5.01% | 5.27% |
| Total Veh | 2-3pm | 6.76% | 6.19% | 5.68% | 6.13% | 5.97% | 6.15% |
| Total Veh | 3-4pm | 7.41% | 7.35% | 7.53% | 7.27% | 7.34% | 7.38% |
| Total Veh | 4-5pm | 7.99% | 8.36% | 8.47% | 8.13% | 8.11% | 8.21% |
| Total Veh | 5-6pm | 7.92% | 8.11% | 8.59% | 7.86% | 8.20% | 8.14% |
| Total Veh | 6-7pm | 6.65% | 6.03% | 6.58% | 6.17% | 6.29% | 6.34% |
| Total Veh | 7-8pm | 4.59% | 4.42% | 4.59% | 4.50% | 4.38% | 4.50% |
| Total Veh | 8-9pm | 3.74% | 3.80% | 3.72% | 3.44% | 3.78% | 3.70% |
| Total Veh | 9-10pm | 3.28% | 3.16% | 3.16% | 2.95% | 3.20% | 3.15% |
| Total Veh | 10-11pm | 2.40% | 2.19% | 2.14% | 2.16% | 2.14% | 2.21% |
| Total Veh | 11-12am | 1.45% | 1.47% | 1.18% | 1.35% | 1.25% | 1.34% |

Current as of 11/1/04

## METROPOLITAN PLANNING ORGANIZATIONS

| MPO Staff | Phone | Fax | Email | Position | Street | City/State | ZIP |
|---|---|---|---|---|---|---|---|
| **Grand Forks/East Grand Forks Metropolitan Planning Organization (GF/EGF MPO)** | | | | | | | |
| Earl Haugen | 701-746-2657 | 701-787-3755 | ehaugen@grandforksgov.com | Director | PO Box 5200 | Grand Forks, ND | 58206 |
| Ryan Brooks | 218-773-0124 | 218-773-0128 | gf_egf_mpo@yahoo.com | MPO Planner | PO Box 373 | East Grand Forks, | 56721 |
| Lane Magnuson | 701-746-2660 | 701-787-3755 | lmagnuson@grandforksgov.com | MPO Planner | PO Box 5200 | Grand Forks, ND | 58206 |
| **Fargo-Moorhead Metropolitan Council of Governments (FMCOG)** | | | | | | | |
| Bob Bright | 701-232-3242 | 701-232-5043 | bright@fmmetrocog.org | Director | Case Plaza Center, Ste 232 | Fargo, ND | 58102 |
| Brian Gibson | 701-232-3242 | 701-232-5043 | gibson@fmmetrocog.org | MPO Transportation Analyst | Case Plaza Center, Ste 232 | Fargo, ND | 58102 |
| Mike Kunza | 701-232-3242 | 701-232-5043 | kunza@fmmetrocog.org | Regional Transportation Coordinator | Case Plaza Center, Ste 232 | Fargo, ND | 58102 |
| Wade Kline | 701-232-3242 | 701-232-5043 | kline@fmmetrocog.org | MPO Planner | Case Plaza Center, Ste 232 | Fargo, ND | 58102 |
| Chad Coziar | 701-232-3242 | 701-232-5043 | coziar@fmmetrocog.org | MPO GIS Specialist | Case Plaza Center, Ste 232 | Fargo, ND | 58102 |
| **Duluth-Superior Metropolitan Interstate Council MIC)** | | | | | | | |
| Ron Chicka | 218-529-7506 | 218-529-7592 | rchicka@ardc.org | Director | 221 West First Street | Duluth, MN | 55802 |
| Sheldon Johnson | 715-635-2197 | 218-529-7592 | sjohnson@nwrpc.com | Deputy Director | 1400 South River St. | Spooner, WI | 54801 |
| Holly Butcher | 218-529-7548 | 218-529-7592 | hbutcher@ardc.org | MPO Planner | 221 West First Street | Duluth, MN | 55802 |
| James Gittemeier | 218-529-7556 | 218-529-7592 | jgittemeier@ardc.org | MPO Planner | 221 West First Street | Duluth, MN | 55802 |
| Andy Hayden | 218-529-7515 | 218-529-7592 | ahayden@ardc.org | MPO GIS Specialist | 221 West First Street | Duluth, MN | 55802 |
| Andy McDonald | 218-529-7514 | 218-529-7592 | amcdonald@ardc.org | MPO Planner | 221 West First Street | Duluth, MN | 55802 |
| Kirk Skoog | 218-529-7531 | 218-529-7592 | kskoog@ardc.org | MPO Planner | 221 West First Street | Duluth, MN | 55802 |
| Rondi Watson | 218-529-7541 | 218-529-7592 | rwatson@ardc.org | MPO Secretary | 221 West First Street | Duluth, MN | 55802 |
| **LaCrosse Area Planning Committee (LAPC)** | | | | | | | |
| Tom Faella | 608-785-5977 | 608-785-5922 | faella.tom@co.la-crosse.wi.us | Director | 400 4th Street N, Rm. 3050 | LaCrosse, WI | 54601 |
| Jacqueline Eastwood | 608-785-6141 | 608-785-5922 | eastwood.jackie@co.la-crosse.wi.us | MPO Planner | 400 4th Street N, Rm. 3050 | LaCrosse, WI | 54601 |
| **St. Cloud Area Planning Organization (APO)** | | | | | | | |
| William Hansen | 320-252-7568 | 320-252-6557 | hansen@stcloudapo.org | Director | 1040 County Road 4 | St. Cloud, MN | 56303 |
| Scott Mareck | 320-252-7568 | 320-252-6557 | mareck@stcloudapo.org | MPO Planner | 1040 County Road 4 | St. Cloud, MN | 56303 |
| Michelle Kiley | 320-252-7568 | 320-252-6557 | kiley@stcloudapo.org | MPO Planner | 1040 County Road 4 | St. Cloud, MN | 56303 |
| Michelle Musser | 320-252-7568 | 320-252-6557 | musser@stcloudapo.org | MPO Planner/GIS Specialist | 1040 County Road 4 | St. Cloud, MN | 56303 |
| **Metropolitan Council of the Twin Cities Area (MC)** | | | | | | | |
| Connie Kozlak | 651-602-1720 | 651-602-1739 | connie.kozlak@metc.state.mn.us | Manager of Transportation Planning and Programming | Mears Park Centre, 230 East 5th Street | St. Paul, MN | 55101 |
| Kevin Roggenbuck | 651-602-1728 | 651-602-1739 | kevin.roggenbuck@metc.state.mn.us | TAB Coordinator | Mears Park Centre, 230 East 5th Street | St. Paul, MN | 55101 |
| **Rochester-Olmsted Council of Governments (ROCOG)** | | | | | | | |
| Philip Wheeler | 507-285-8215 | 507-287-2275 | wheeler.phil@co.olmsted.mn.us | Director | 2122 Campus Drive SE | Rochester, MN | 55904 |
| Charlie Reiter | 507-285-8232 | 507-287-2275 | reiter.charlie@co.olmsted.mn.us | MPO Planner | 2122 Campus Drive SE | Rochester, MN | 55904 |
| David Pesch | 507-285-8232 | 507-287-2275 | pesch.david@co.olmsted.mn.us | MPO Planner | 2122 Campus Drive SE | Rochester, MN | 55904 |
| Muhammad Khan | 507-285-8232 | 507-287-2275 | khan.muhammad@co.olmsted.mn.us | MPO Planner | 2122 Campus Drive SE | Rochester, MN | 55904 |

## MINNESOTA DEPARTMENT OF TRANSPORTATION

| Mn/DOT Staff | Phone | Fax | Email | Position | Street | City/State | ZIP |
|---|---|---|---|---|---|---|---|
| **District 1** | | | | | | | |
| Denny Johnson | 218-723-4960 ext. 3007 | 218-723-4936 | denny.johnson@dot.state.mn.us | D1 Planning Director | 1123 Mesaba Ave [MS 010] | Duluth, MN | 55811 |
| Don Mohawk | 218-263-2979 | 218-263-2978 | don.mohawk@dot.state.mn.us | D1 Transit Project Manager | 1425 E 23rd Street [MS 011] | Hibbing, MN | 55746 |
| Gus Peterson | 218-723-4960 ext. 3325 | 218-723-4936 | gus.peterson@dot.state.mn.us | D1 Program Mgt. Specialist | 1123 Mesaba Ave [MS 010] | Duluth, MN | 55811 |
| **District 2** | | | | | | | |
| Michael Kamnikar | 218-755-4521 | 218-755-2028 | michael.kamnikar@dot.state.mn.us | D2 Planning Director | 3919 Highway 2 West [MS 020 BE] | Bemidji, MN | 56619 |
| Kent Ehrenstrom | 218-755-4518 | 218-755-2028 | kent.ehrenstrom@dot.state.mn.us | D2 Transit Project Manager | 3919 Highway 2 West [MS 020 BE] | Bemidji, MN | 56619 |
| **District 3** | | | | | | | |
| Steve Voss | 218-828-2471 | 218-828-6105 | steve.voss@dot.state.mn.us steven.voss@us.army.mil | D3 Planning Director | 7694 Industrial Park Road [MS 030] | Baxter, MN | 56425 |
| Mary Safgren | 218-825-2154 | 218-828-6105 | mary.safgren@dot.state.mn.us | D3 District Planner | 7694 Industrial Park Road [MS 030] | Baxter, MN | 56425 |
| Claudia DuMont | 320-654-5134 | 320-203-6089 | claudia.dumont@dot.state.mn.us | D3 District Planner | 3725 12th Street N [MS 031] | St. Cloud, MN | 56303 |
| Sue Siemers | 320-203-6157 | 320-255-3257 | susan.siemers@dot.state.mn.us | D3 Transit Project Manager | 3725 12th Street N [MS 031] | St. Cloud, MN | 56303 |
| **District 4** | | | | | | | |
| Jody Martinson | 218-846-0418 | 218-846-0790 | jody.martinson@dot.state.mn.us | D4 Planning Director | 1000 Highway 10 West [MS 040 4A] | Detroit Lakes, MN | 56501 |
| Keven Anderson | 218-847-1532 | 218-847-1583 | keven.anderson@dot.state.mn.us | D4 Transit Project Manager | 1000 Highway 10 West [MS 040] | Detroit Lakes, MN | 56501 |
| **District 6** | | | | | | | |
| Chris Moates | 507-280-3188 | 507-285-7355 | chris.moates@dot.state.mn.us | D6 Planning Director | 2900 48th Street NW [MS 060] | Rochester, MN | 55901 |
| Fred Sandal | 507-285-7369 | 507-285-7355 | fred.sandal@dot.state.mn.us | D6 District Planner | 2900 48th Street NW [MS 060] | Rochester, MN | 55901 |
| Jean Meyer | 507-280-3100 | 507-285-7355 | jean.meyer@dot.state.mn.us | D6 Transit Project Manager | 2900 48th Street NW [MS 060] | Rochester, MN | 55901 |
| Tracy Schnell | 507-280-5028 | 507-285-7355 | tracy.schnell.dot.state.mn.us | | 2900 48th Street NW [MS 060] | Rochester, MN | 55901 |
| **District 7** | | | | | | | |
| Lisa Bigham | 507-389-6888 | 507-389-6281 | lisa.bigham@dot.state.mn.us | D7 Planning Director | PO Box 4039 | Mankato, MN | 56002 |
| Mark Scheidel | 507-389-6149 | 507-389-6281 | mark.scheidel@dot.state.mn.us | D7 District Planner | PO Box 4039 | Mankato, MN | 56002 |
| Janice Klassen | 507-831-2905 | 507-389-6281 | jannice.klassen@dot.state.mn.us | D7 District Planner | PO Box 4039 | Mankato, MN | 56002 |
| **District 8** | | | | | | | |
| Patrick Weidemann | 320-214-3753 | 320-231-5168 | patrick.weidemann@dot.state.mn.us | D8 Planning Director | 2505 Transportation Rd. Box 768 [MS 080 D8] | Willmar, MN | 56201 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Metro District** | | | | | | | |
| Tim Henkel | 651-582-1393 | 651-582-1302 | tim.henkel@dot.state.mn.us | Metro Office Director - Planning & Programming | 1500 West County Rd B-2 [MS 050] | Roseville, MN | 55113 |
| Paul Czech | 651-582-1771 | 651-582-1020 | paul.czech@dot.state.mn.us | Metro Planning Director | 1500 W Cnty Rd B-2 [MS 050] | Roseville, MN | 55113 |
| Pat Bursaw | 651-582-1397 | 651-582-1368 | pat.bursaw@dot.state.mn.us | Metro Planning Director | 1500 W Cnty Rd B-2 [MS 050] | Roseville, MN | 55113 |
| Brian Vollum | 651-582-1408 | 651-582-1020 | brian.vollum@dot.state.mn.us | Metro District Planner | 1500 W Cnty Rd B-2 [MS 050] | Roseville, MN | 55113 |
| Sherry Narusiewicz | 651-582-1400 | 651-582-1368 | sherry.narusiewicz@state.mn.us | Metro District Planner | 1500 W Cnty Rd B-2 [MS 050] | Roseville, MN | 55113 |
| Tod Sherman | 651-582-1548 | 651-582-1020 | tod.sherman@dot.state.mn.us | Metro District Planner | 1500 W Cnty Rd B-2 [MS 050] | Roseville, MN | 55113 |
| Al Kramer | 651-582-1398 | 651-582-1020 | alan.kramer@dot.state.mn.us | Metro District Planner | 1500 W Cnty Rd B-2 [MS 050] | Roseville, MN | 55113 |
| Marv Lunceford | 651-582-1385 | 651-582-1020 | marv.lunceford@dot.state.mn.us | Metro District Planner | 1500 W Cnty Rd B-2 [MS 050] | Roseville, MN | 55113 |
| Micky Gutzmann | 651-282-9950 | 651-297-7252 | michelle.gutzmann@dot.state.mn.us | Grant Specialist Coordinator-Metro Transit Project Manager | Office of Transit 395 John Ireland Blvd [MS 430] | St. Paul, MN | 55155 |
| **Central Office** | | | | | | | |
| Peggy Reichert | 651-284-0501 | 651-296-3019 | peggy.reichert@dot.state.mn.us | Director Statewide Planning | 395 John Ireland Blvd. [MS 440] | St. Paul, MN | 55155 |
| Lynne Bly | 651-296-8521 | 651-296-3019 | lynne.bly@dot.state.mn.us | MPO Coordinator | 395 John Ireland Blvd [MS 440] | St. Paul, MN | 55155 |
| Cindy Carlsson | 651-296-8761 | 651-296-3019 | cindy.carlsson@dot.state.mn.us | Access Mgt. Planner | 395 John Ireland Blvd [MS 440] | St. Paul, MN | 55155 |
| Brian Gage | 651-205-4427 | 651-296-3019 | brian.gage@dot.state.mn.us | Access Mgt. Engineer | 395 John Ireland Blvd [MS 440] | St. Paul, MN | 55155 |
| Mitch Webster | 651-206-2201 | 651-296-3019 | mitch.webster@dot.state.mn.us | Statewide Planner | 395 John Ireland Blvd. [MS 440] | St. Paul, MN | 55155 |
| Teresa Chapman | 651-297-1420 | 651-296-3019 | teresa.chapman@dot.state.mn.us | Functional Class Coordinator | 395 John Ireland Blvd. [MS 440] | St. Paul, MN | 55155 |
| Linda Zemotel | 651-296-1604 | 651-296-3019 | linda.zemotel@dot.state.mn.us | Director Programming | 395 John Ireland Blvd. [MS 440] | St. Paul, MN | 55155 |
| Shawn Chambers | 651-296-1605 | 651-296-3019 | shawn.chambers@dot.state.mn.us | STIP Planner | 395 John Ireland Blvd. [MS 440] | St. Paul, MN | 55155 |
| **Modal Contacts** | | | | | | | |
| Gerry Weiss | 651-296-1612 | 651-297-7252 | gerald.weiss@dot.state.mn.us | MPO Transit Liaison | 395 John Ireland Blvd. [MS 430] | St. Paul, MN | 55155 |
| Noel Shughart | 651-284-0085 | 651-297-7252 | noel.shughart@dot.state.mn.us | Greater MN Transit Plan | 395 John Ireland Blvd. [MS 430] | St. Paul, MN | 55155 |
| William Gardner | 651-406-4806 | 651-406-4811 | william.gardner@dot.state.mn.us | Freight Plan | 1110 Centre Pointe Curve [MS 420] | Mendota Heights, | 55150 |
| John Tompkins | 651-406-4808 | 651-406-4811 | john.tompkins@dot.state.mn.us | Freight Plan | 1110 Centre Pointe Curve [MS 420] | Mendota Heights, | 55150 |
| James Dustrude | 651-297-1838 | 651-297-7252 | james.dustrude@dot.state.mn.us | Bike/Ped/Telework Plan | 395 John Ireland Blvd. [MS 315] | St. Paul, MN | 55155 |

The above two lists are an expanded list of the governmental contacts from the previous update of the Traffic Forecast Manual. The first contains staff from Minnesota's Metropolitan Planning Organizations, followed by Minnesota District DOT planning personnel and then Central Office modal contacts.

The list below contains names of FHWA planning staff, neighboring states planning organizations, a Minnesota Pollution Control Agency contact and, finally, Regional Development Commission planning staff.

| FEDERAL HIGHWAY ADMINISTRATION | | | | | | | |
|---|---|---|---|---|---|---|---|
| **FHWA Staff** | **Phone** | **Fax** | **Email** | **Position** | **Street** | **City/State** | **ZIP** |
| Susan Moe | 651-291-6109 | 651-291-6000 | susan.moe@fhwa.dot.gov | Planning & Research Program Manager | 380 Jackson St., Suite 500 | St. Paul, MN | 55101 |
| Gerald (Jerry) Liibbe | 651-291-6111 | 651-291-6000 | gerald.liibbe@fhwa.dot.gov | Statewide Planning Engineer | 380 Jackson St., Suite 500 | St. Paul, MN | 55101 |

| NORTH DAKOTA & WISCONSIN DOT CONTACTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| **State Staff** | **Phone** | **Fax** | **Email** | **Position** | **Street** | **City/State** | **ZIP** |
| Paul Benning | 701-328-2217 | 701-328-1404 | pbenning@state.nd.us | MPO Engineer | 608 East Boulevard Ave. | Bismarck, ND | 58505 |
| John Swissler | 608-266-0169 | 608-267-0294 | john.swissler@dot.state.wi.us | Transportation Planner | WisDOT Planning (933) 4802 Sheboygan Ave. | Madison, WI | 53707 |

| MINNESOTA POLLUTION CONTROL AGENCY CONTACT | | | | | | | |
|---|---|---|---|---|---|---|---|
| **MPCA Staff** | **Phone** | **Fax** | **Email** | **Position** | **Street** | **City/State** | **ZIP** |
| Innocent Eyoh | 651-296-7739 | 651-297-2343 | innocent.eyoh@pca.state.mn.us | MPO Air Quality Contact | 520 Lafayette Road North | St. Paul, MN | 55155 |

| REGIONAL DEVELOPMENT COMMISSION CONTACTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| **RDC Staff** | **Phone** | **Fax** | **Email** | **Position** | **Street** | **City/State** | **ZIP** |
| **Northwest RDC, Region 1** | | | | | | | |
| Leon Heath | 218-745-6733 | 218-745-6438 | lheath@nwrdc.org | Director | 115 South Main Ave. | Warren, MN | 56762 |
| Troy Schroeder | 218-745-6732 | 218-745-6438 | tschroeder@nwrdc.org | RDC Transportation Contact | 115 South Main Ave. | Warren, MN | 56762 |
| **Headquarters RDC, Region 2** | | | | | | | |
| Cliff Tweedale | 218-751-3108 | 218-444-4722 | ctweedale@hrdc.org | Director | 403 4th St. NW, PO Box 906 | Bemidji, MN | 56619 |
| Joe Czapiewski | 218-333-6531 | 218-444-4722 | jczapiewski@hrdc.org | RDC Transportation Contact | 403 4th St. NW, PO Box 906 | Bemidji, MN | 56619 |
| **Arrowhead RDC, Region 3** | | | | | | | |
| John Chell | 218-722-5545 | 218-529-7592 | JChell@ardc.org | Director | 221 West First Street | Duluth, MN | 55802 |
| Bryan Anderson | 218-529-7529 | 218-529-7592 | banderson@ardc.org | RDC Transportation Contact | 221 West First Street | Duluth, MN | 55802 |
| **West Central Inititiative** | | | | | | | |
| Wayne Hurley | 800-735-2239 | 218-739-5381 | wayne@wcif.org | RDC Transportation Contact | 1000 Western Avenue | Fergus Falls, MN | 56537 |
| **Region 5 Development Commission** | | | | | | | |
| Robert Hutton | 218-894-3233 | | bhutton@regionfive.org | Director | 611 Iowa Avenue | Staples, MN | 56479 |
| Chris Etzler | 218-894-3233 Ext 15 | 218-894-3233 | cetzler@regionfive.org | RDC Transportation Contact | 611 Iowa Avenue | Staples, MN | 56479 |
| **Mid-Minnesota Development Commission, Region 6E** | | | | | | | |
| Donn Winckler | 320-235-8504 | 320-235-4329 | donn.winckler@mmrdc.org | Director | 333 West 6th Street | Willmar, MN | 56201 |
| Matt Johnson | 320-235-8504 Ext 39 | 320-235-4329 | communityplanning@tds.net | RDC Transportation Contact | 333 West 6th Street | Willmar, MN | 56201 |
| **Upper Minnesota Valley RDC, Region 6W** | | | | | | | |
| Paul Michaelson | 320-289-1981 | 320-289-1299 | paul.michaelson@umvrdc.org | Director | 323 West Schlieman Ave. | Appleton, MN | 56208 |
| Dawn Hegland | 320-289-1981 | 320-289-1983 | dawn.hegland@umvrdc.org | RDC Transportation Contact | 323 West Schlieman Ave. | Appleton, MN | 56208 |
| **East Central RDC, Region 7E** | | | | | | | |
| Robert Voss | 320-679-4065 | | robert.voss@ecrdc.org | Director | 100 South Park Street | Mora, MN | 55051 |
| Bob Bollenbeck | 320-679-4065 | | bollenbeck@ncis.com | RDC Transportation Contact | 100 South Park Street | Mora, MN | 55051 |
| **Southwest RDC, Region 8** | | | | | | | |
| Jayme Trusty | 507-836-8547 | 507-836-8866 | execdir@swrdc.org | Director | 2401 Broadway Ave., Ste. 1 | Slayton, MN | 56172 |
| Annette Bair | 507-836-8547 Ext 101 | 507-836-8866 | phydev@swrdc.org | RDC Transportation Contact | 2401 Broadway Ave., Ste. 1 | Slayton, MN | 56172 |
| **Region 9 Regional Development Commission** | | | | | | | |
| Reginald Edwards | 507-387-5643 | 507-387-7105 | reggie@rndc.mankato.mn.us | Director | Box 3367, 410 Jackson St. | Mankato, MN | 56002 |
| Troy Bonkowske | 800-450-5643 Ext 886 | 507-387-7105 | troy@rndc.mankato.mn.us | RDC Transportation Contact | Box 3367, 410 Jackson St. | Mankato, MN | 56002 |