

**Working Paper 04-06**

**Variations in Traffic Accident Rates for Northeastern Illinois by Vehicle  
Miles of Travel and Facility Type for Each Hour of the Week**

By Parry M. Frank  
*Transportation System Analyst*

September 2004

**Chicago Area Transportation Study**  
300 West Adams Street, Chicago, Illinois 60606

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## **Abstract**

The purpose of this report is to examine how traffic accidents vary throughout the day and week by facility type and in relation to vehicle miles of travel (VMT) within northeastern Illinois.

This analysis examines the rate of traffic accidents and casualties per vehicle miles of travel over the 24 hours in a day, and for the 168 hours in a week. Additionally, these accident rates are stratified by facility type over the 24-hour period. Pedestrian travel might follow a different 24-hour travel pattern than vehicular traffic. To account for this pedestrian travel, all pedestrian accidents were removed from the analysis to determine their impact on the results.

The major finding in this analysis is that the highest rate of fatalities per VMT in northeastern Illinois occurs in the period covering the late evening through the beginning of the morning peak. During this time period, 39% of fatal accidents occur; 13% of the VMT are traveled; 14% of nonfatal accidents take place; and 14% of property-damage-only accidents (PDO) happen.

For the 24-hour analysis period, the highest hourly rate of fatal accidents per VMT occurred between 2 and 3 a.m. This rate was 22.6 times greater than the lowest rate, which occurred between 9 and 10 a.m. There was a factor of 96.1 between the lowest number of fatal accidents per VMT (7 to 8 a.m. Wednesday) and the highest (1 to 2 a.m. Sunday).

As the week progressed from Tuesday morning through Sunday morning, fatal accidents per VMT continually increased during late evening and the morning peak period.

Nonfatal accidents and PDO accidents displayed similar trends that were closely associated with VMT for each hour from the morning peak period through the late evening. For the hours between late evening and the beginning of the morning peak period, the rate of nonfatal accidents increased in patterns similar to those of fatal accidents, although the increases were much smaller. The rate of increase in nonfatal accidents was smaller than the rate of increase in fatal accidents.

## **PURPOSE**

This analysis compares 2002 hourly traffic accident data for northeastern Illinois with hourly traffic for the region. The goal of this analysis is to determine how fatal and nonfatal accident rates vary with vehicle miles of travel for each hour of the day over the course of a week. Typically, the accident rate for a region is stated in terms of accidents per 100,000,000 vehicle miles of travel. This measure does not provide information regarding which time periods have the greatest number of accidents per VMT.

If accident rates per VMT are shown to vary throughout the day or week, it may be possible to improve traffic safety by increasing travel during time periods when fewer accidents typically occur and increasing safety measures during periods when accidents are more likely to happen.

## **DATA AND MEASURES**

This analysis is primarily based on two pieces of information: the times during which traffic accidents occurred; and the distribution of VMT for the Chicago region (Cook, DuPage, Kane, Lake, McHenry and Will counties). The raw data for both of these items was provided by the Illinois Department of Transportation (IDOT). The data collected for this analysis included the times and dates when accidents occurred, the facility type involved, the severity of the accident, and the mode of transportation used by those involved in the accident.

An accident frequency profile was created by calculating the share of weekly accidents that occurred in each hour. Separate profiles were developed for fatal accidents, accidents with injuries and PDO accidents. An hourly profile was calculated for each facility type. The 168-hour profiles were also constructed both with and without consideration of pedestrian fatalities.

Traffic volumes were stratified for each hour of the week. This process involved sampling traffic volumes for each hour<sup>1</sup>, aggregating them by facility type to create a profile for each facility type, and factoring the facility type totals to make them equal to regional facility type totals published by IDOT.

This analysis often compares the distribution of data that are measured on very different scales. In order to compare these distributions with each other, the data were normalized to the value of one. Each hourly data point represents a decimal fraction of the total. If a data point measuring VMT has the value of 0.07, this means that the VMT in that hour was 7.0% of the total VMT in the analysis. The data in this analysis would be more correctly depicted by graphing individual points. The sum of the values for each of these points would equal one. In order to increase the legibility of the graphs, individual data points were minimized and a line was drawn through the data points.

The process of dividing the hourly share of accidents by the hourly share of VMT results in a measurement of the units of share of accidents per share of VMT. In this analysis, the ratio of

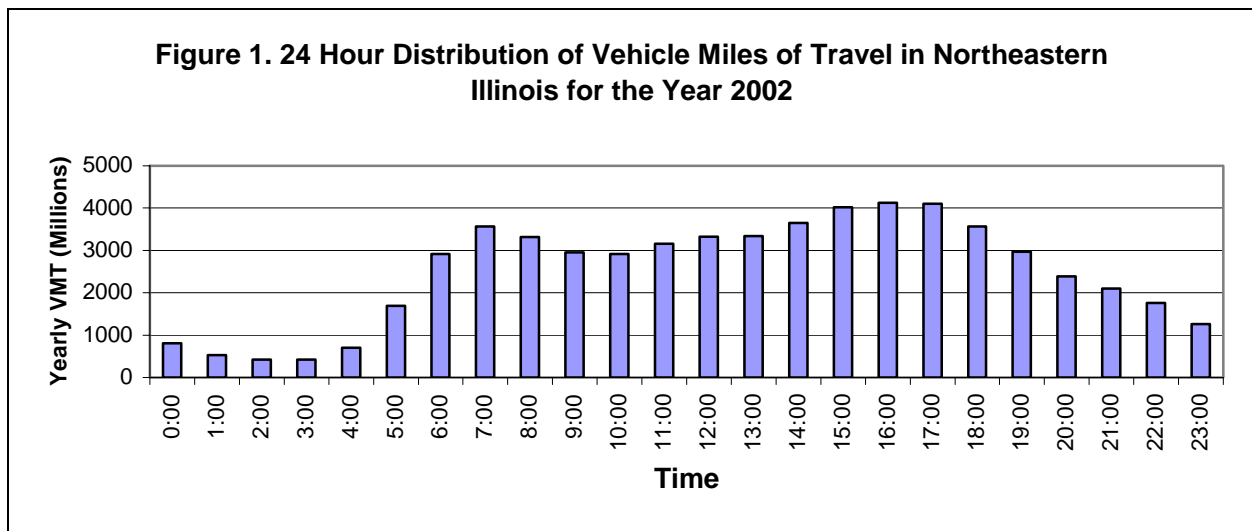
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<sup>1</sup> Hourly traffic counts from TSC and all 28 HPMS sites in IDOT District One were collected for the week of Sept 15-21, 2003.

accident share per VMT share will be the main unit of comparison of safety for each of the hours in the week.

## DAILY DISTRIBUTION OF VMT BY HOUR

Vehicles traveled approximately 58 billion miles in the northeastern Illinois region during 2002. Figure 1 displays the distribution of VMT calculated for each hour of the day. There are two main peak periods which correspond to the morning and afternoon rush hours. The evening peak period is longer in duration than the morning peak and has more VMT per hour. The busiest hours are between 3 and 6 p.m. The lowest volumes of traffic are found in the period between 2 and 4 a.m. If traffic accidents and the resulting casualties are directly linked to VMT, then this distribution profile of daily VMT should be matched by a similar pattern for each accident type.



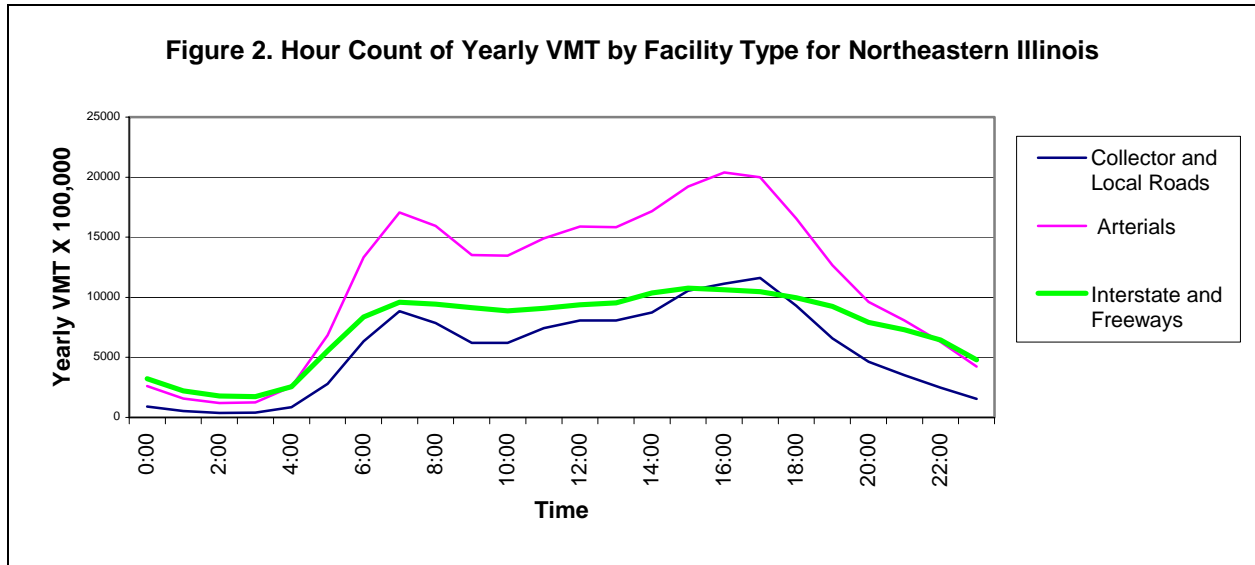
### 24 Hour VMT Distribution by Facility Type

Each facility type has a different hourly distribution of traffic. The expressways in the region carry 30.56% of the region’s traffic (Table 1). Compared to the other facility types, the hourly volumes on the expressway system have the smallest range between the highest and lowest amounts of traffic. The lowest hourly volume represented 16.1% of the volume of the busiest hour. Traffic occurring between the beginning of the morning peak period through the end of the evening peak period has the smallest range of any facility type (Figure 2). If traffic accidents are directly related to VMT, then the expressway system should have less hourly variation in accidents than the other facility types.

**Table 1: Distribution of Accidents and VMT by Facility Type**

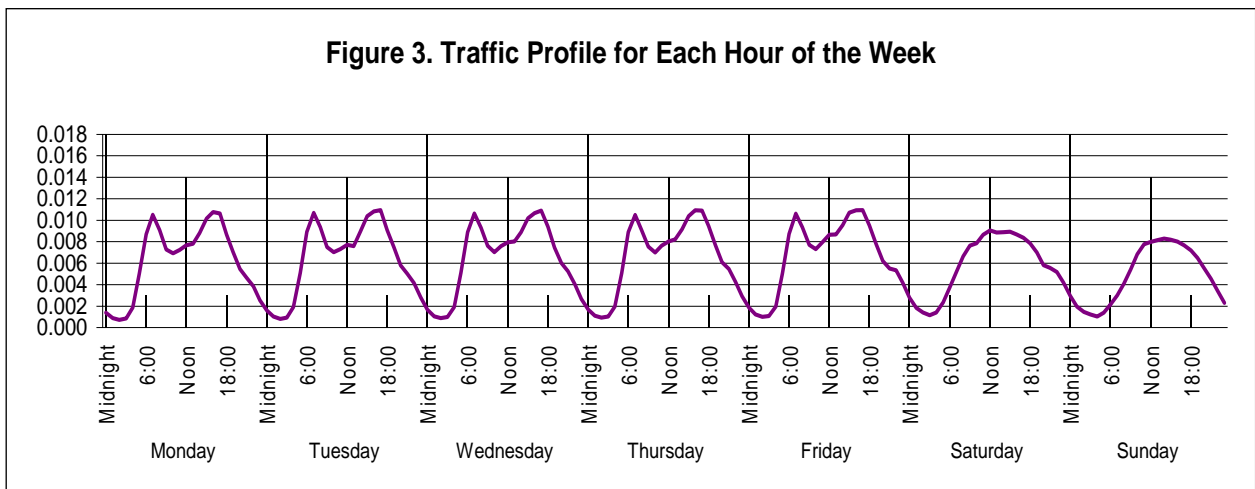
	Fatal Accidents	Injury Accidents	Property Damage Only Accidents	Share of VMT	Range of Hourly VMT by Percent
Collector and Local Roads	258	33,867	157,023	23.10%	3.10%
Arterials	239	18,937	66,756	46.25%	5.90%
Interstates	94	5,574	23,644	30.56%	16.10%

Arterials carry 46.25% of the region’s traffic, Interstates carry 30.56% and collectors/local streets account for the remaining 23.1%. Arterials and collectors/local roads are similar in that they handle a greater range of traffic between the busiest and slowest periods. Peak periods tend to be much busier than off-peak periods, and there is very little traffic in the early morning hours. If VMT is directly related to accidents and casualties, the off-peak hours should be relatively safe on these types of roads.

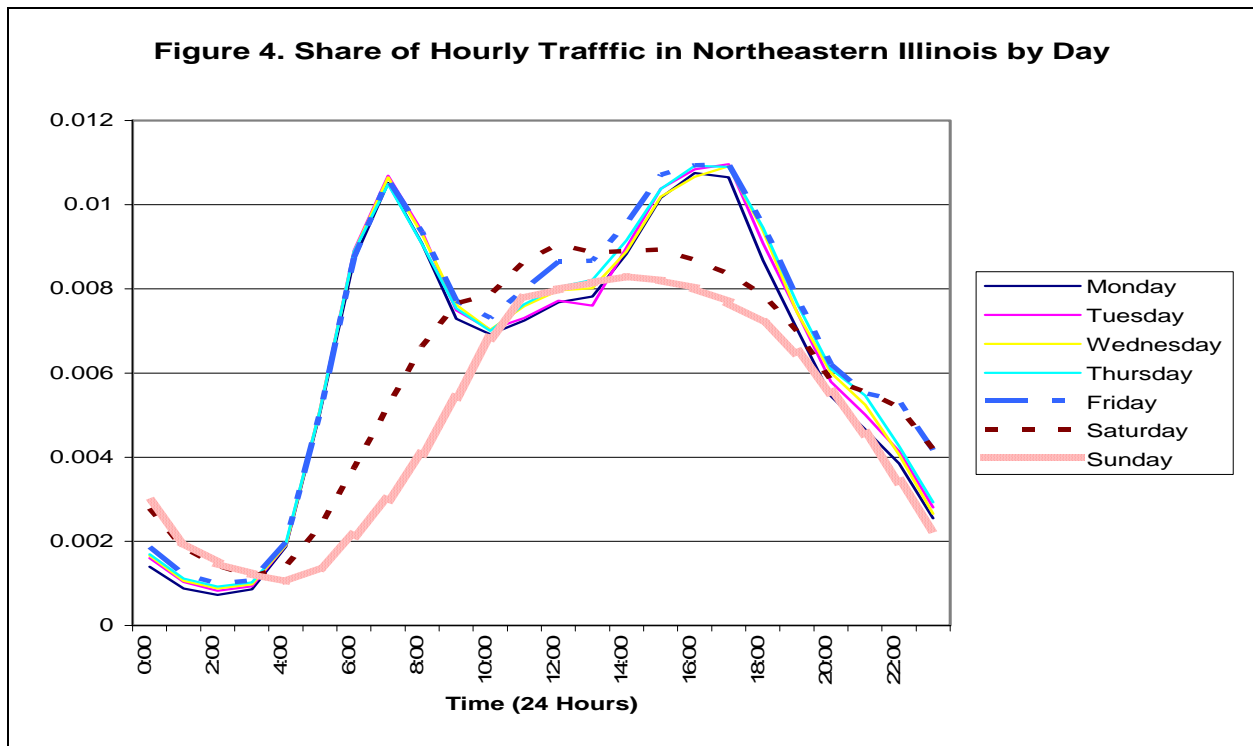


### WEEKLY DISTRIBUTION OF VMT BY HOUR

An examination of traffic patterns over the 168 hours of the week reveals two major trends. The first is that the travel pattern for the period spanning Monday morning through Friday evening is very consistent on a daily basis (Figure 3). The pattern consists of a morning and evening peak period, and a dip in traffic that occurs during midday. The afternoon peak period is longer and has a slightly larger volume than the morning peak.



The second trend manifests itself between Friday evening and early Monday morning. As shown in Figure 4, which charts the hourly VMT for each day of the week, there are no morning or evening peak travel periods on Saturday or Sunday. The peak travel periods are during midday and early afternoon. The periods spanning 8 p.m. to 4 a.m. Friday night through Saturday morning, and Saturday night through Sunday morning, are different than the same time periods for the rest of the week. The VMT during each of these periods is between 16% and 26% higher than the same time periods for Monday through Thursday, and 31% higher than the same period covering Sunday night to Monday morning.



If there is a direct relationship between the VMT in the region and the number of accidents and casualties, then the distribution of accidents should be similar to the hourly distribution of VMT. Accident distributions will have two peaks Monday through Friday and one midday peak on Saturday and Sunday.

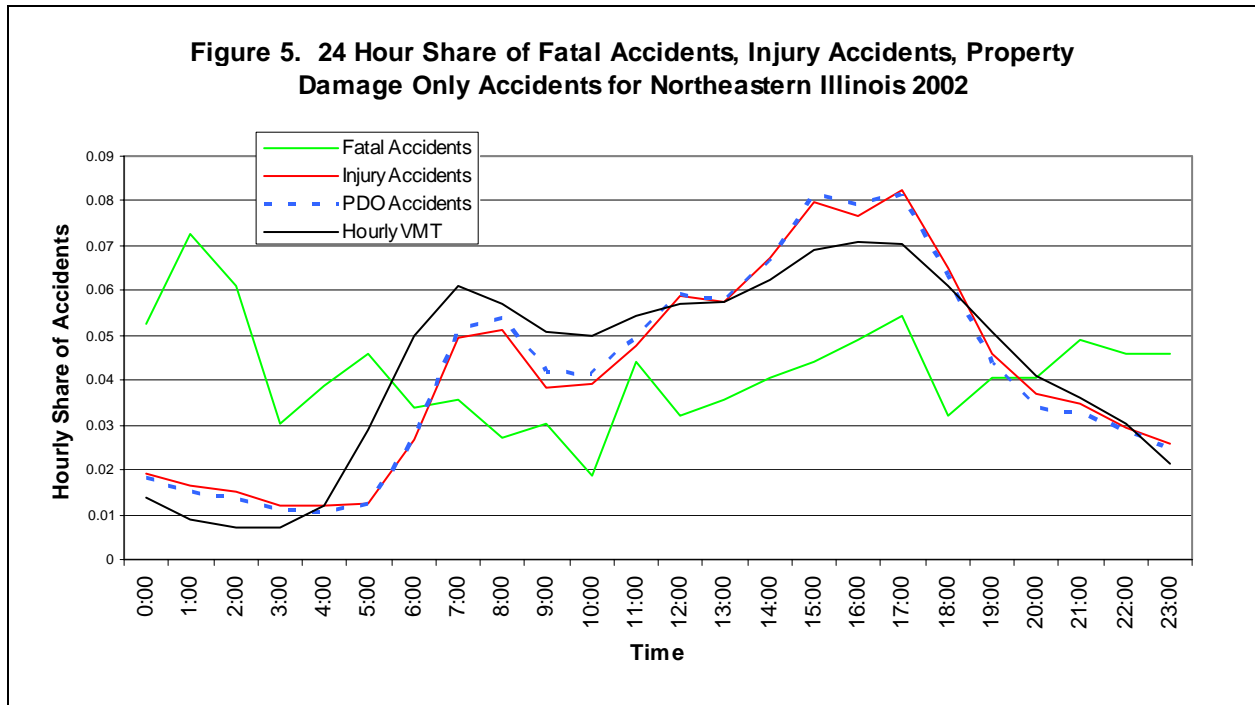
## 24 HOUR DISTRIBUTION OF TRAFFIC ACCIDENTS

The typical description of accident rates in the Chicago region is 528 accidents per 100,000,000 VMT, resulting in 146 injuries and 1.19 fatalities per 100,000,000 VMT. The distribution of these accidents varies across the 24 hours in a day. Figure 5 depicts the profile of the 24-hour distribution of accidents. Property-damage-only accidents and injury-causing accidents have a very similar profile. It appears that these two types of nonfatal accidents vary in similar ways with regard to the distribution of VMT and the time of the day.

Both types of nonfatal accidents have a slightly lower rate of accidents per VMT in the morning period and a slightly higher rate of accidents per VMT in the afternoon. During peak travel

periods, the highest rate of accidents per VMT occurs in the time periods with the most VMT. There is a higher share of accidents than the share of VMT between 11 p.m. and 5 a.m.

The simple trend between fatal accidents and VMT is not as well defined as trends for injury-causing or PDO accidents and VMT. The largest hourly shares of fatal accidents occur during the hours with relatively low VMT shares.

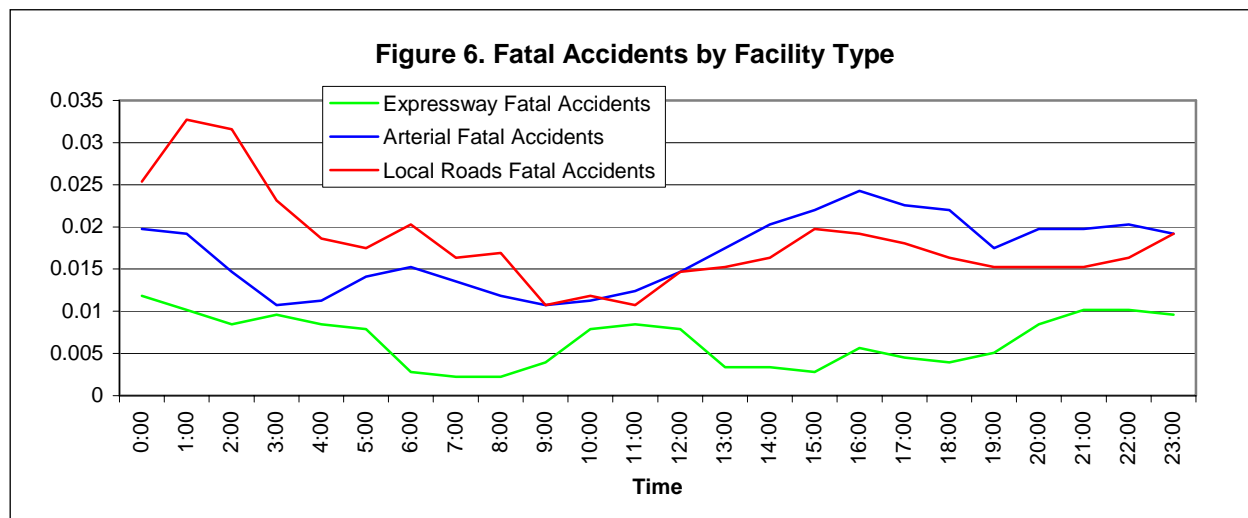


## . 24-Hour Accident Distribution by Facility Type

### Fatal Accidents

There is significant variation in the hourly distribution of fatal accidents for each facility type. The total number of fatal accidents is lowest on the expressways (Figure 6). Incidences of fatal accidents on expressways have an inverse relationship to VMT; expressways have lower numbers of fatal accidents in the peak travel periods and higher numbers of fatal accidents in the periods with lower traffic totals. The expressways have the lowest average rate of fatal accidents per VMT of any facility type.

The number of fatal accidents on local roads and collectors is lowest in the midday period, and highest between midnight and 4 a.m. Peak travel periods have a greater number of fatal accidents than the midday period. This trend is similar to the VMT profile for the period spanning the morning rush hour through the end of the evening rush hour. The late evening and early morning periods have much higher rates of fatal accidents per VMT. Far more fatal accidents occur after midnight than during the evening peak period. Local roads and collectors have the highest number of fatal accidents per VMT of any facility type.



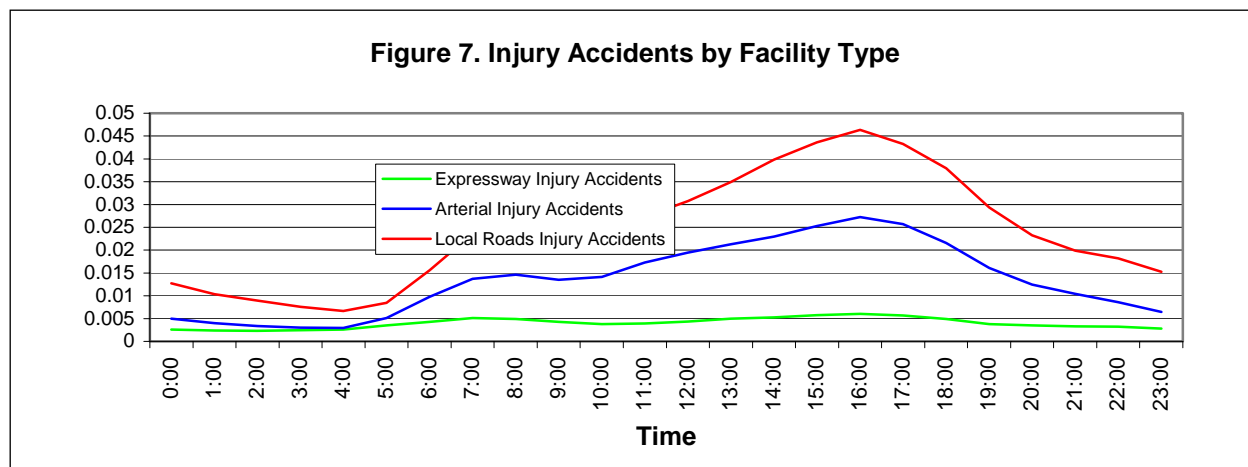
Fatal accident trends on arterials are similar to those for local roads and collectors. Fatal accident trends mirror the VMT profile during the daytime. During the evening and early morning periods, there is a much higher rate of fatal accidents per VMT. Trends for fatal accidents on arterials differ from trends for local streets and collectors in that the number of fatal accidents in the early morning hours is similar to, not greater than, the number of fatal accidents that occur in the highest volume peak hour.

### Injury Accidents

Accidents that result in injuries tend to mirror the VMT profile much more closely than is the case for fatal accidents. Figure 7 shows that the majority of injury-causing accidents take place on local roads and collectors. For these types of roads, the number of accidents increases with the VMT from the beginning of the morning peak through the end of the evening peak. From late evening through the beginning of the morning rush hour, the rate of accidents per VMT is higher than the rates observed for the remainder of the day.

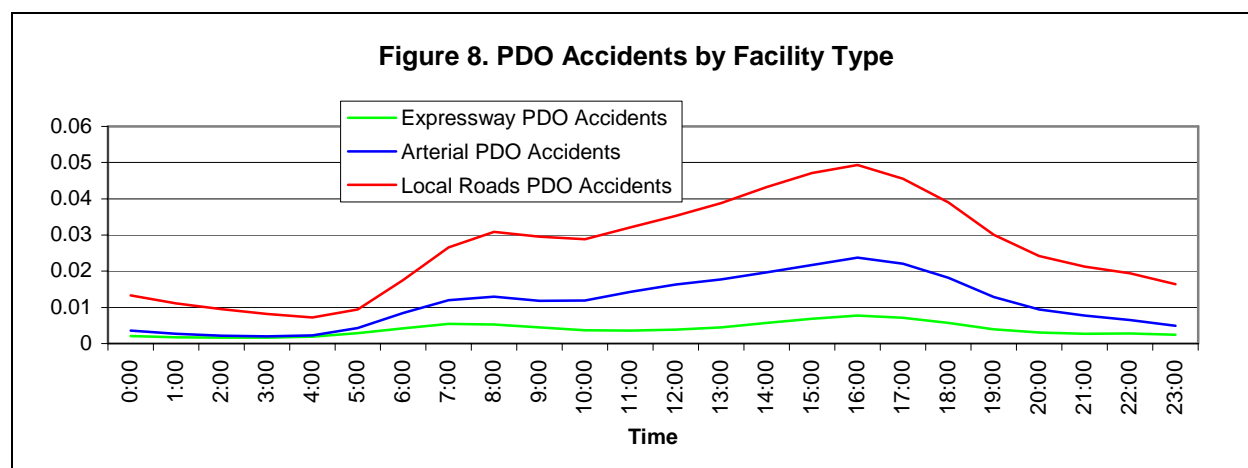
Injury-causing accident rates per VMT for the arterial system show a similar trend to that of the local streets/collectors facility type, but the accident rates are lower. Off-peak travel at night seems to have a much lower rate of injury-causing accidents in relationship to VMT on arterials, compared to local roads/collectors.

Hourly VMT is most uniform on the expressway system, and injury-causing accidents have very little variation throughout the 24-hour time period. The expressway system has the lowest rate of injury-causing accidents per VMT.



### Property-Damage-Only Accidents

Property-damage-only accidents have profiles for the 24-hour period that are very similar to those for injury-causing accidents for each facility type, as shown in Figure 8.

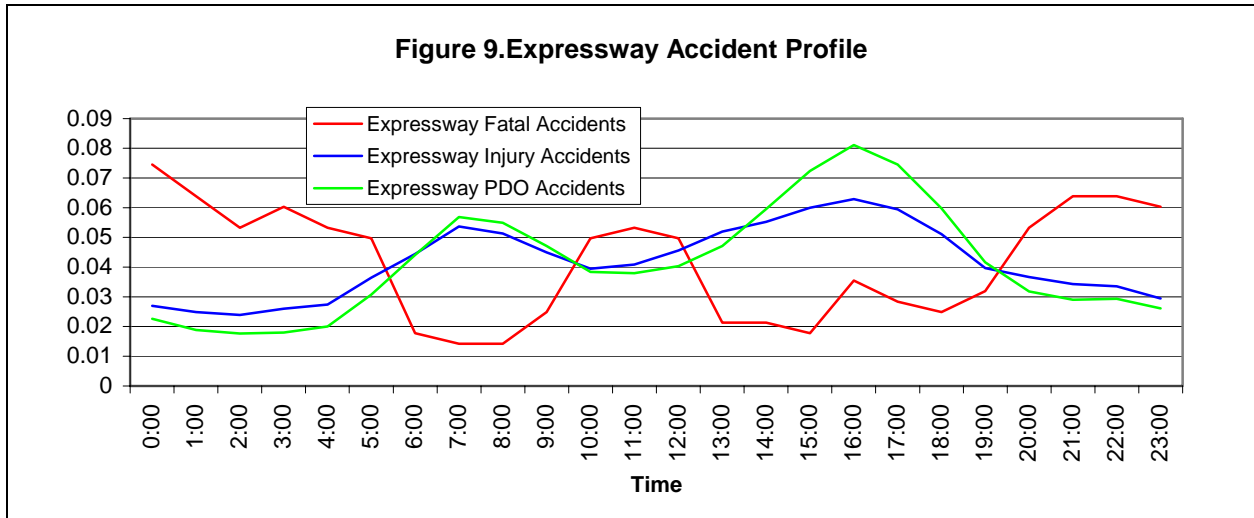


Each facility type has a unique relationship between the number of injury-causing accidents per VMT and the number of PDO accidents per VMT. The relationship between these nonfatal accidents and VMT is fairly stable throughout the period from the beginning of the morning rush hour through the end of the evening rush hour. The amount of nonfatal accidents per VMT increases for these facility types from the end of the evening peak through the beginning of the morning peak. Fatal accidents do not show a simple direct relationship to VMT.

### Expressway Accidents

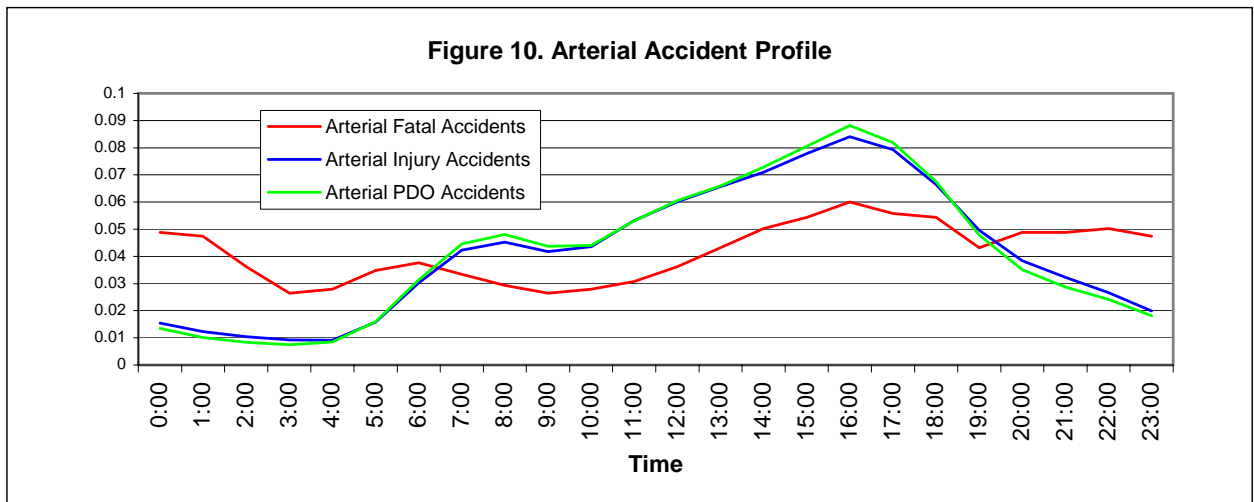
In Figure 9, profiles for fatal accidents, injury-causing accidents and PDO accidents on the expressway system are overlaid. Property-damage-only and injury accidents vary in a similar fashion – except for an increase in PDO accidents during the evening rush hour, which has the highest volumes of traffic. The most significant trend on the expressway system is the inverse relationship between fatal accidents and both nonfatal accidents and VMT. High levels of traffic are associated with a high number of accidents and a low number of fatal accidents. The time

periods with low levels of traffic on the expressways are associated with low levels of accidents and high levels of fatal accidents. This is true even during the midday period – when there is less of a chance that alcohol, darkness or drowsy drivers would be factors.



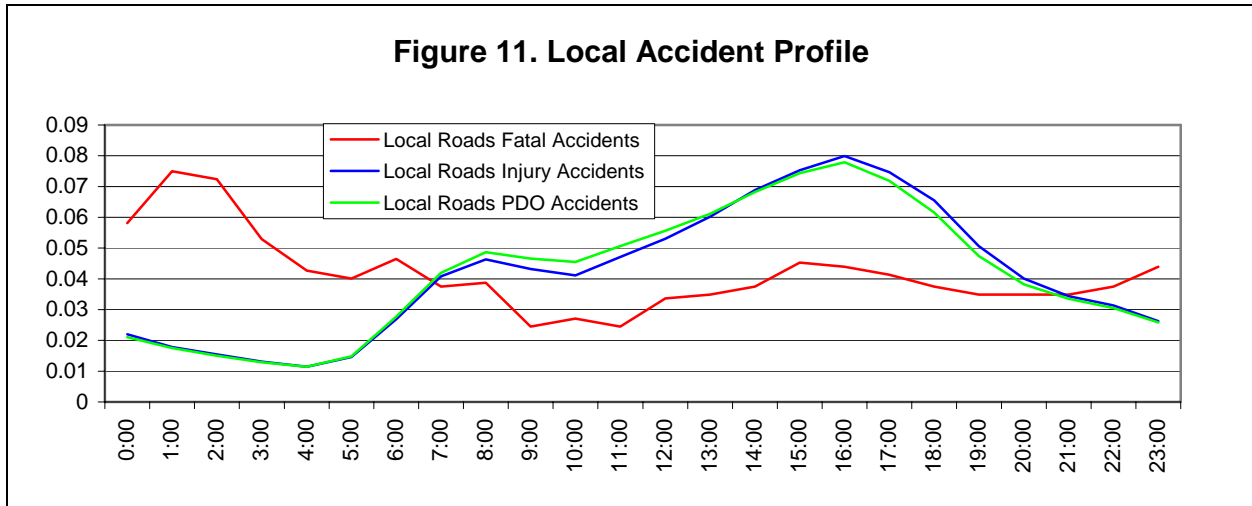
### Arterial Accidents

On the arterial system in northeastern Illinois, PDO accidents and injury-causing accidents vary in a uniform fashion and are closely linked to the hourly distribution of VMT (Figure 10). Fatal accidents seem to vary in a similar fashion to nonfatal accidents between the beginning of the morning peak and the end of the evening peak. Between the evening peak and the beginning of the morning peak, there is little evidence of a simple link between increasing VMT and fatal accidents. The number of fatal accidents in the most dangerous off-peak hour is equal to the number of fatalities in the most dangerous hour in the evening peak period.



### Accidents on Local Roads and Collector Streets

The relationship between traffic accidents and VMT for local roads and collectors is similar to the relationship between traffic accidents and VMT for arterials. A close association exists between VMT and all types of accidents from the morning peak through the end of the evening peak. The period between the evening peak and the morning peak has a large increase in the rate of accidents per VMT. Fatal accidents have the greatest increase in the proportion of accidents per VMT. During this period, the number of fatal accidents in the most dangerous off-peak hour is 67% higher than the number of fatalities in the most dangerous hour in the evening peak period (Figure 11).

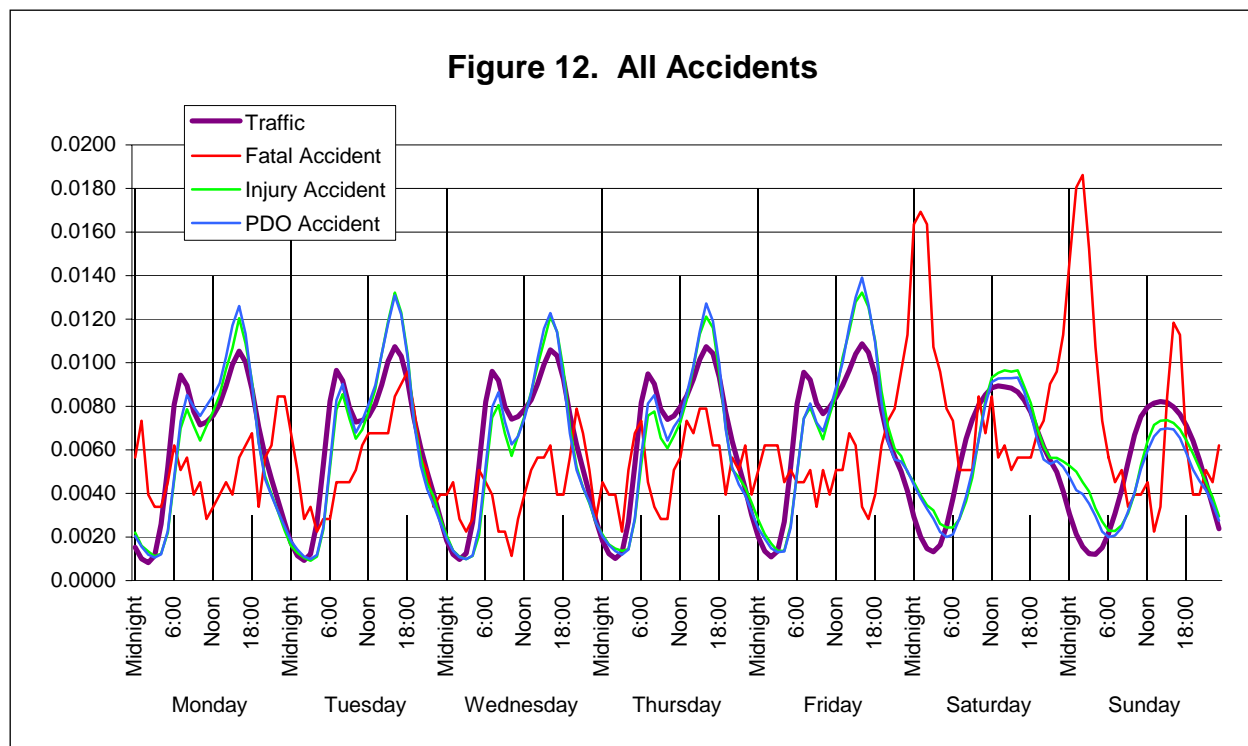


### Accident and Traffic Distributions by Hour of the Week

The distribution of the hourly share of VMT, PDO accidents, injury-causing accidents and fatal accidents for each hour in the week is shown in Figure 12. The profile for PDO and injury accidents is very similar throughout the week. It seems that the chance that an accident will result in an injury is fairly uniform throughout each hour of the week.

The distribution of nonfatal accidents follows a trend that is similar to the trend in the distribution in VMT. Between the start of the morning peak period on Monday, through the end of the evening peak period on Friday, there are slightly fewer nonfatal accidents compared with VMT for those time periods. During the morning peak period, and in the afternoon, there are slightly more nonfatal accidents compared with VMT. On Friday and Saturday evenings after 9 p.m. there is an increase in the number of nonfatal accidents compared with VMT – this pattern continues until 6 a.m. the following morning. The late morning time period on Saturday has relatively fewer accidents than VMT, and the early afternoon time period has a slightly higher share of accidents than the share of VMT. On Sunday, between 6 a.m. and midnight, there are lower shares of nonfatal accidents than VMT share for each hour.

Fatal accident distribution is dominated by the large number of fatal accidents that occur in time periods with low levels of traffic. The periods between the end of the evening peak and the beginning of the morning peak have much larger shares of fatal accidents than shares of VMT.



This same period on Friday-Saturday and Saturday-Sunday are the most lethal periods of the week, both in terms of total fatal accidents and the rate of fatal accidents per VMT.

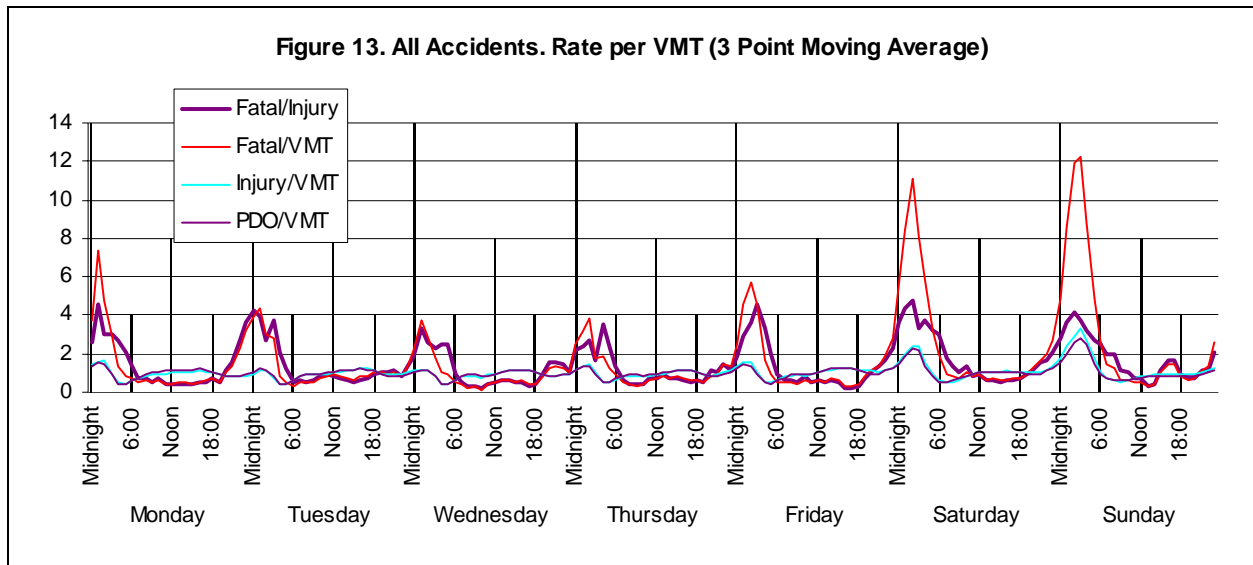
### **Accidents per VMT and Traffic per VMT Distributions (168 Hours)**

It is easier to examine the relationship between accidents and VMT if the accident rates are normalized by the VMT. Figure 13 depicts the hourly share of weekly accidents divided by the hourly share of VMT. In addition to the ratios of PDO, injury-causing and fatal accidents to VMT, this figure also charts the ratio of the share of fatal accidents to the share of injury accidents. This ratio represents the increase in likelihood that an accident with an injury will result in a fatality. The greater this number is, the more likely it is that accidents will result in a fatality. Conversely, the smaller this number is, the less likely it is that accidents will result in a fatality. A three-point moving average was applied to all of the data in order to smooth out the fatal accident trend.

For each hour of the week, the ratio of injury-causing accident share to VMT share is very similar to the ratio of PDO accident share to VMT share. The chance that a nonfatal accident will result in an injury is consistent for each hour in the week. Although the relationship between PDO accidents and injury-causing accidents is steady throughout the week, there are variations between the share of nonfatal accidents and the share of VMT throughout the week.

For each day in the week, the lowest rate of nonfatal accidents to VMT occurs between 4 and 6 a.m. From the beginning of the morning peak through the end of the evening peak, the rate of nonfatal accidents per VMT is fairly constant, increasing only slightly from the morning through the evening. For each 24-hour period, the rate of nonfatal accidents to VMT begins increasing at 9 p.m. and reaches its highest daily rates between 1 and 3 a.m. The rate of nonfatal injuries per VMT is fairly consistent for the same hour on each day of the week (e.g. 2 p.m. on Monday is

similar to 2 p.m. the other days in the week). However, there are two exceptions to this trend: the rate of nonfatal accidents per VMT is much higher between 11 p.m. Friday and 5 a.m. Saturday than it is in the period covering Monday night through Thursday night; the same time period covering Saturday night to Sunday morning has the highest level of nonfatal accidents per VMT of the entire week.



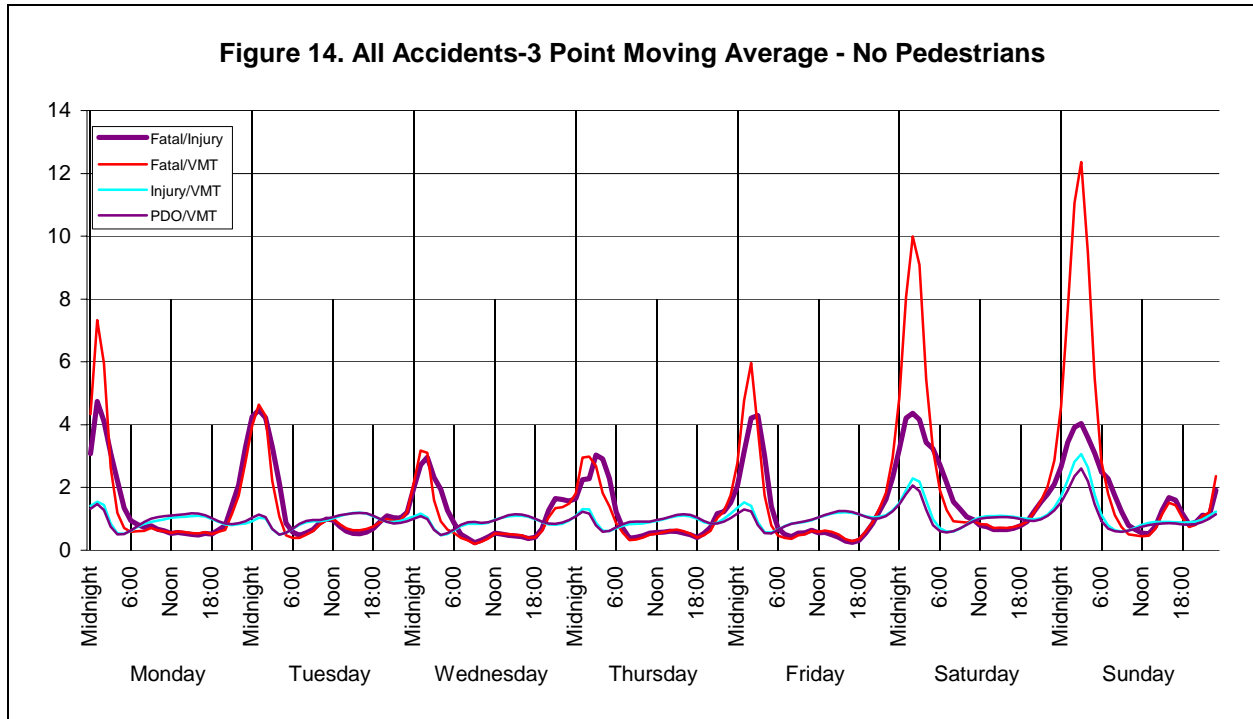
The rate of fatal accidents per VMT varies greatly throughout the week; however, there are some trends. The period from the beginning of the morning peak period through the end of the evening peak, Monday through Friday, generally has a steady relationship between fatal accidents and VMT. For this timeframe, there is a direct relationship between the number of fatal accidents and VMT for a given period.

The largest variation in fatal accidents per VMT occurs in the period that begins each night at around 9 p.m. and peaks between 2 and 3 a.m. the following morning. This large peak in fatal accidents per VMT increases greatly each night from Wednesday evening through early Sunday morning, and then decreases each day through Wednesday morning. For each 24-hour period in this progression, there is a higher rate of fatal accidents per VMT during these low-traffic-volume/high fatal accident periods.

Throughout the 168 hours in the week, there is a difference in the relationship between injury accidents and fatal accidents. For most of the period that spans the morning peak through the evening peak, the ratio of fatal accidents to injury accidents is fairly constant. The ratio of fatal accidents to injury-causing accidents is slightly higher in the midday than either of the peak periods. For each day of the week, the share of injury-causing accidents that result in a fatality increases after the end of the evening rush and peaks between 1 and 3 a.m. The percentage of accidents that result in a fatality in the most dangerous hour of the night is fairly consistent for the period covering early Friday morning through early Tuesday morning. The remaining two days have a lower rate of accidents that result in a fatality. The periods covering late Friday night to early Saturday morning and late Saturday night to early Sunday morning have more hours with the highest shares of fatal accidents compared to the remainder of the week.

### Accidents per VMT Distributions without Pedestrian Accidents (168 Hours)

The analysis described above was repeated with pedestrian accidents removed. The results are shown in Figure 14. Traffic accidents that involve pedestrians tend to occur in a distribution that is similar enough to non-pedestrian traffic accidents that the overall relationship between the share of accidents to the share of VMT is not greatly affected.



## CONCLUSIONS

This analysis compares 2002 hourly traffic accident data in northeastern Illinois with hourly traffic volumes for the area. Traffic volumes were stratified for each hour of the week. This process involved sampling traffic volumes for each hour, aggregating them by facility type to create a profile for each facility type, and factoring facility type totals so they matched regional facility type totals published by IDOT. Much of this analysis relied on comparing the hourly share of the weekly totals for accidents with VMT. This provided a means by which accident rates could be compared with each other.

Accident rates for expressways, arterials and collectors/local roads vary in their relationships to VMT and to the time of day. The expressway system in northeastern Illinois has the lowest rates of both fatal and nonfatal accidents per VMT of all facility types in the region. Nonfatal accidents on expressways have a fairly direct relationship to VMT; fatal accidents on expressways have an indirect relationship. High levels of VMT are associated with low levels of fatal accidents, while low levels of VMT are associated with high rates of fatal accidents.

Local roads and collectors have the highest number of nonfatal accidents, and the highest rate of fatal and nonfatal accidents per VMT. Nonfatal accidents vary directly with VMT throughout the

day and night, but fatal accidents tend to occur in different patterns. Fatal accidents fluctuate with VMT from the beginning of the morning peak period through the end of the evening peak. After the evening rush hour, the rate of fatal accidents per VMT increases until it reaches a peak at 2 a.m. This hour has 67% more total fatal accidents than the hour in the evening peak that has the highest VMT.

The arterials in the northeastern Illinois region have a similar number of fatal accidents; however, they have significantly fewer nonfatal accidents than local roads and collectors – even though arterials carry twice as much of the regional VMT. Arterial fatal and nonfatal accidents exhibit similar trends to those of local roads and collectors, with two notable exceptions: the number of arterial nonfatal accidents is lower, and the fatal accident rate is flatter throughout the 24-hour period. The number of fatal accidents from 2 to 3 a.m. is similar to, not greater than, the number of fatal accidents occurring in the most dangerous hour during the evening peak period.

When all of the facility types are analyzed together, the relationship between nonfatal accidents and vehicle miles of travel is more direct than the relationship between fatal accidents and VMT. For most of the hours in a day, from the beginning of the morning peak period through the end of the evening peak period, there is a consistent relationship between each type of accident and VMT. In the period from the end of the evening peak to the beginning of the morning peak, the relationship between the number of accidents and VMT varies. The rate of accidents per VMT steadily increases until it peaks between 1 and 3 a.m. The increase in the rate of nonfatal accidents per VMT is far less than the increase for fatal accidents. After the initial peak in accidents per VMT, the number of accidents per VMT decreases until it reaches a minimum about one hour before the beginning of the morning rush.

The relationship between fatal accidents and VMT varies much more than the relationship between nonfatal accidents and VMT. The rate of fatal accidents per VMT increases greatly after the evening peak and reaches its maximum between 1 and 3 a.m. This is similar to what occurs with nonfatal accidents, but the increases in fatal accidents are much greater. For the most dangerous nights, the share of fatal accidents is more than four times larger than the share of nonfatal accidents. There are more total accidents per VMT during this time, and the chance that any one accident will result in a fatality is at its highest level during this early morning period.

Finally, excluding pedestrian traffic accident data from the analysis did not change the relationships between hourly shares of accidents and hourly shares of VMT.