OSU STATISTICAL CONSULTING SERVICE
MEMORANDUM REPORT

To: **The Ohio State Highway Patrol**

From: **Christopher Holloman**

Subject: **Predictive Model Results for Thanksgiving, Cuyahoga County**

Date: **November 17, 2006**

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1. Overview

Over the past several months, the Ohio State Highway Patrol (OSHP) and the Statistical Consulting Service (SCS) at The Ohio State University have worked together to produce a probabilistic model for forecasting the likely locations of fatal and injury crashes. The model that was developed predicts the likelihood of crashes on interstates, US routes, and State routes throughout Ohio.

This report presents the model's forecasts for the 2006 Thanksgiving weekend (Wednesday, November 22 through Sunday, November 26). These results can be used to allocate troopers to different roadways throughout the day allowing OSHP to make the best use of available resources. Crash forecasts are provided for all interstates, US routes, and state routes in Cuyahoga County.

Although the Thanksgiving holiday covers five days, there are only three types of days that need to be analyzed. The first type of day is the last workday before the long weekend: Wednesday, November 22. The second type of day to be analyzed is the holidays that fall on weekdays: Thursday, November 23 and Friday, November 24. The third type of day to be analyzed is the ordinary weekend days: Saturday, November 25 and Sunday, November 26. Section 2 of this report gives forecasts for each of these types of days separately.

2. Forecasts

The forecasts are broken down by the three types of days that occur over the Thanksgiving weekend.

2.1. Wednesday, November 22, 2006

Wednesday, November 22 is the last working day before the long weekend, so the crash patterns are predicted to be different from the crash patterns on the other days of the holiday. Figure 1 shows the overall crash rates for fatal and injury crashes expected throughout the day. These are

the crash rates across all interstates, US routes, and state routes in the analysis. The black line in this figure shows the crash rates predicted by the model, and a smooth red curve has been superimposed to show the overall pattern. In addition, a smooth green line has been added to the plot showing the crash rates expected on an ordinary Wednesday in November, one not preceding a holiday weekend.

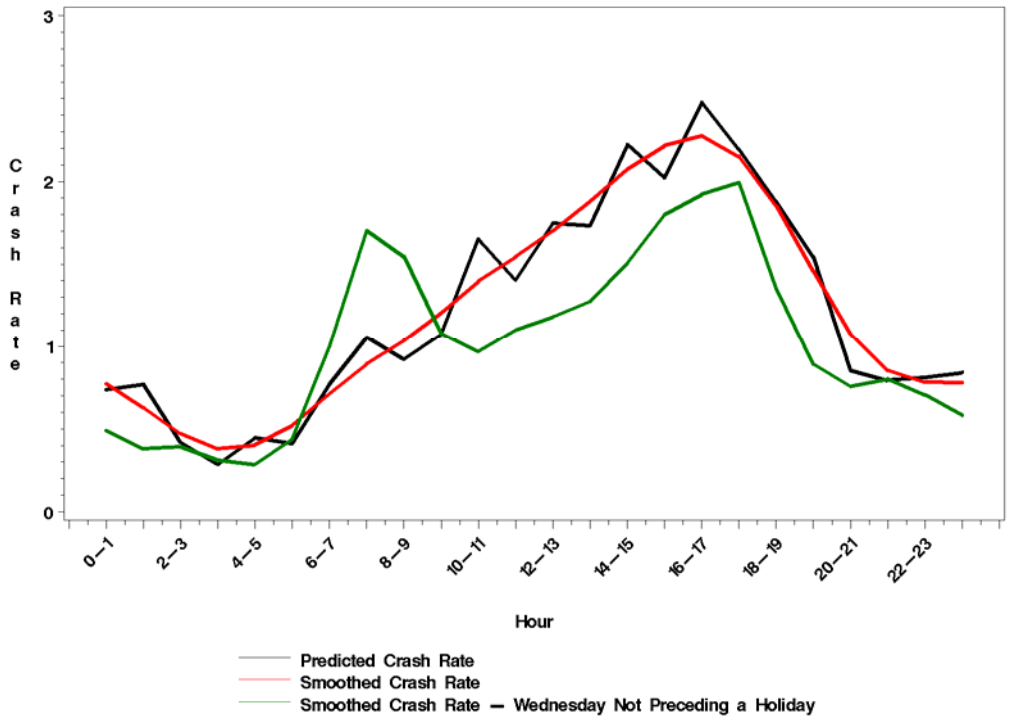

Figure 1. Overall Forecasted Fatal and Injury Crash Rates on November 22, 2006, by Hour.

While Figure 1 gives broad information on what times officers should be patrolling, it does not give much information on the types of crashes on which they should focus. By examining time-series plots of the crash rates for alcohol-related, speed-related, and commercial vehicle-related crashes, it is possible to determine which types of crashes are most likely during different hours of the day. Figure 2 through Figure 4 show the crash rates for these different groups.

Figure 2 shows the expected crash rates for alcohol-related crashes on November 22. It appears that the fatal and injury crash rates from alcohol-related crashes are much higher in the early morning hours than what is typically seen on a Wednesday. Also, the lunch hour shows a significantly higher spike, and the evening hours appear to be much more dangerous than usual.

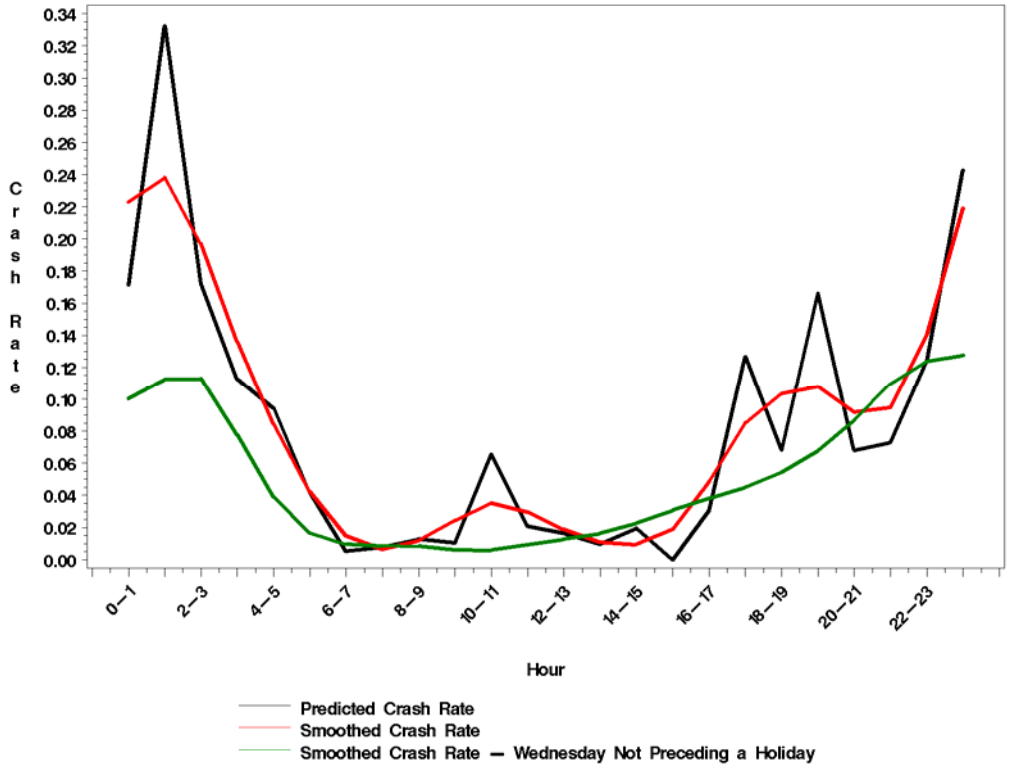

Figure 2. Forecasted Fatal and Injury Alcohol-related Crash Rates on November 22, 2006, by Hour.

Figure 3 suggests that resources for preventing speed-related crashes should be primarily allocated to the late afternoon and evening hours. In particular, the time after 7PM shows a very high crash rate compared to what is usually seen on a Wednesday. Earlier in the day, speed-related crash rates are similar to what is usually seen on a Wednesday.

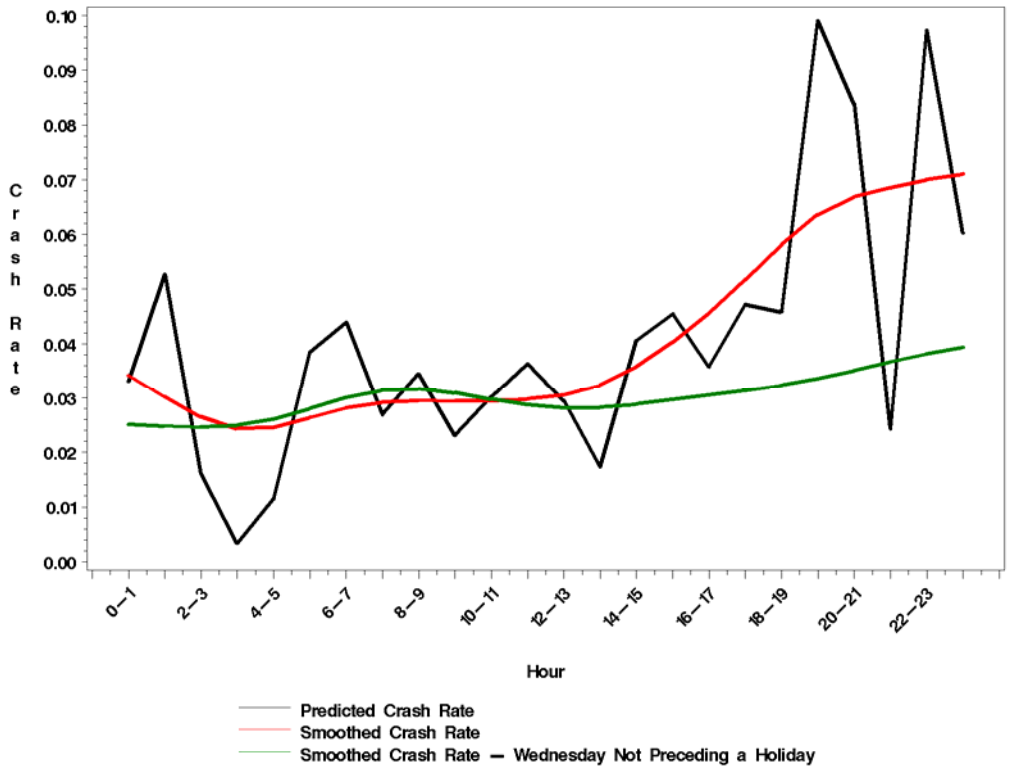

Figure 3. Forecasted Fatal and Injury Speed-related Crash Rates on November 22, 2006, by Hour.

Figure 4 suggests that commercial vehicle-related crashes are likely to occur later in the afternoon than they usually occur on a Wednesday. Between noon and 5 PM are the most likely times to observe commercial vehicle-related crashes.

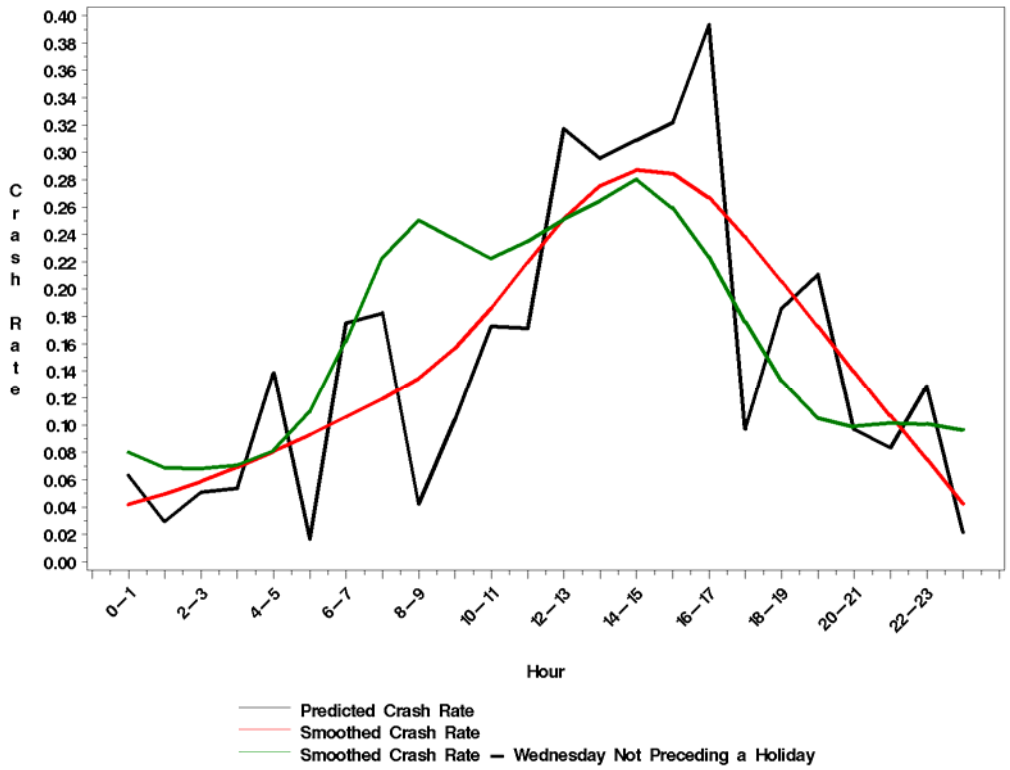

Figure 4. Forecasted Fatal and Injury Commercial Vehicle-related Crash on November 22, 2006, by Hour.

Examining these plots provides information about each of the types of crashes on its own, but it does not provide information on the relative rates at which these types of crashes will occur. Figure 5 presents the crash rates for alcohol-, speed-, and commercial vehicle-related crashes together. From this plot, it is clear that alcohol-related crashes are the biggest threat in the early morning hours, commercial vehicle-related crashes dominate the morning commute and the middle of the day, and all three crash causes create approximately equal amounts of risk toward the end of the day.

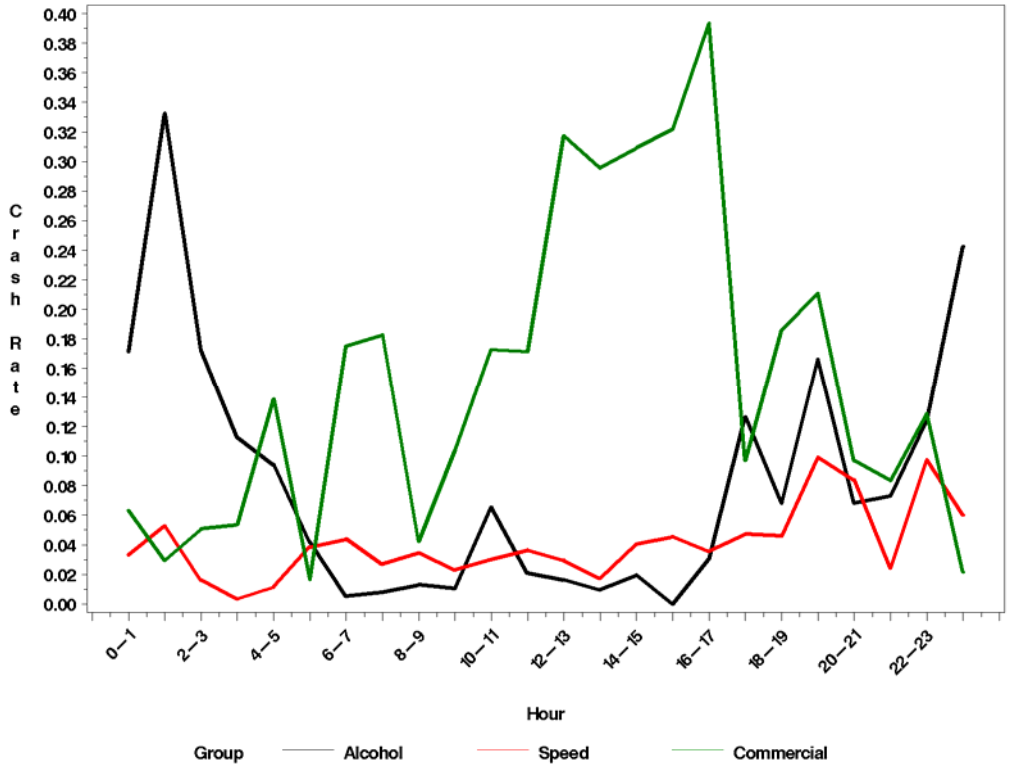

Figure 5. Overlay of Forecasted Alcohol-, Speed-, and Commercial Vehicle-related Crash Rates on November 22, 2006, by Hour.

Having determined the best allocation of resources throughout the day, the next question to answer is where those resources should be allocated. The following series of figures shows different levels of danger for the categories broken out in the time-series plots above. In each map, the top 20% crash risk interstate segments are colored in red. Also, the top 20% crash risk US/State route segments are colored in red. As a result, the red interstate segments do not have risk levels comparable to the red US/State route segments. The following key explains the coloring scheme.

Interstates

Top 20% crash risk
Next 40% crash risk
Lowest 40% crash risk

US/State routes

Top 20% crash risk
Next 40% crash risk
Lowest 40% crash risk

The remainder of this section contains 6 figures. The first figure shows the overall crash risk on November 22, 2006, for all roads that were modeled in the district. The next two pictures show the exact same information, but one picture shows only the interstates and the next picture shows only the US/State routes. The remaining pictures show the levels of risk for different crash

groups. These pictures show the risk for alcohol-related crashes, speed-related crashes, and commercial vehicle-related crashes on November 22, 2006.

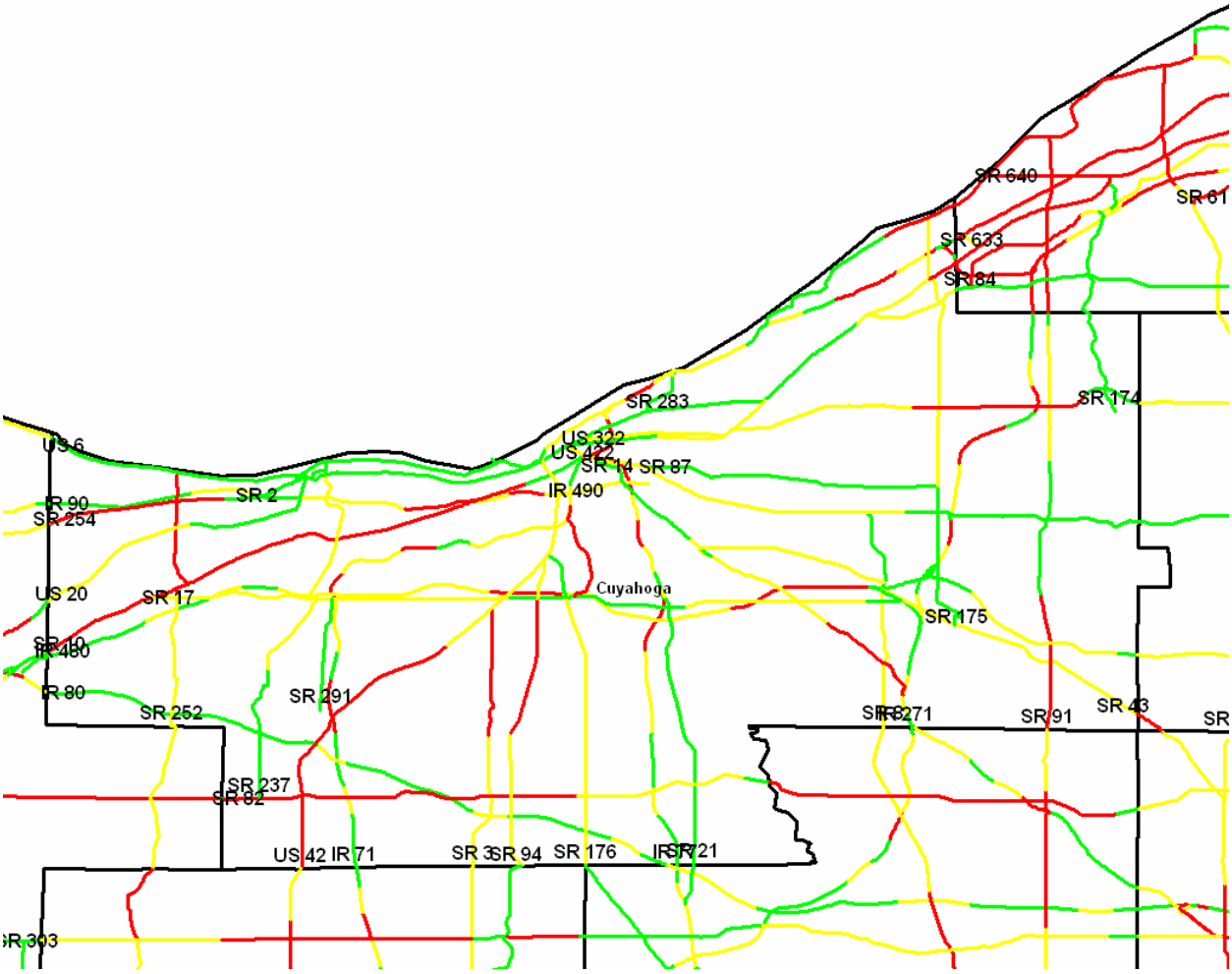

Figure 6. Cuyahoga County overall fatal and injury crash rate for all roads, November 22, 2006.

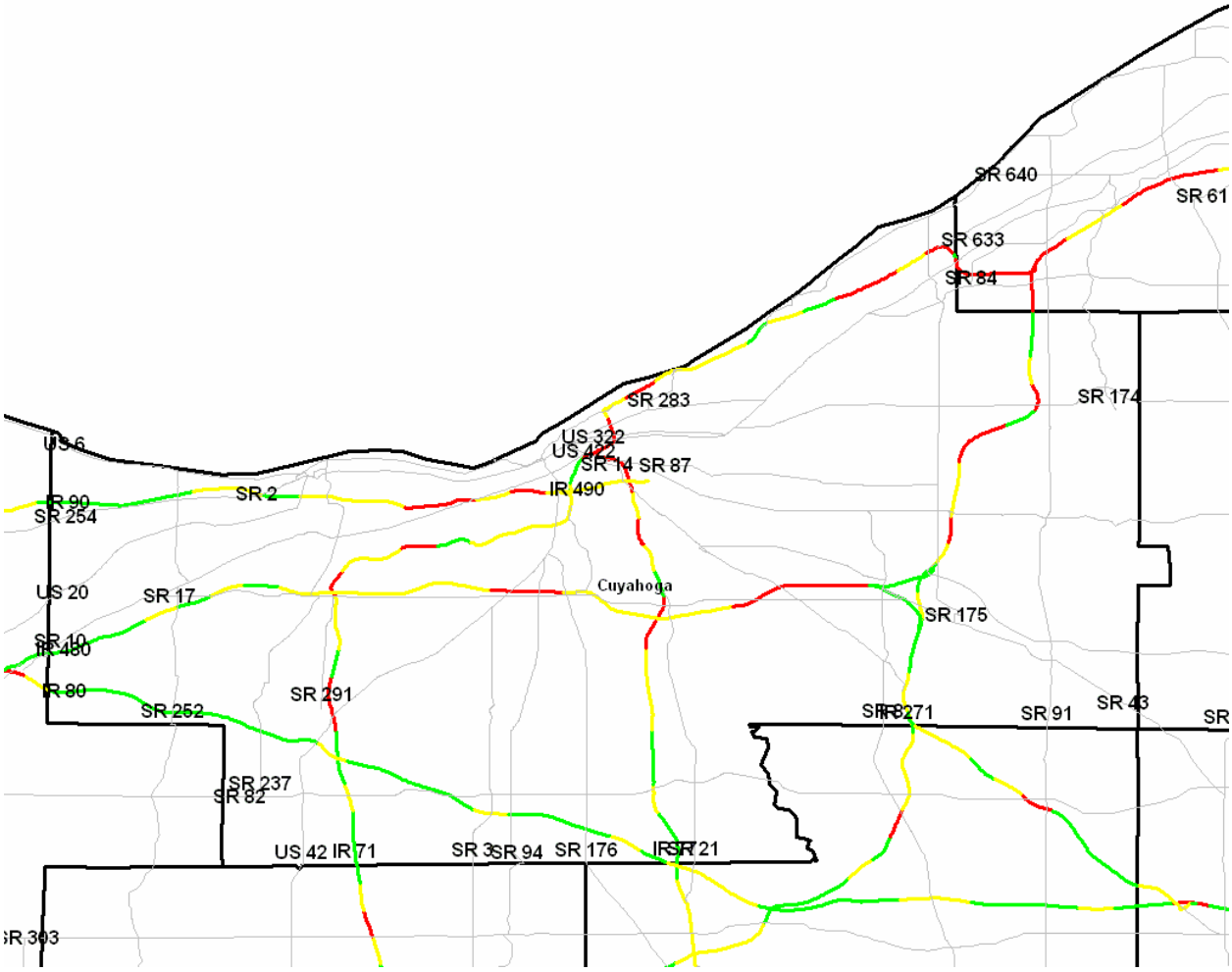

Figure 7. Cuyahoga County overall fatal and injury crash rate for interstates, November 22, 2006.

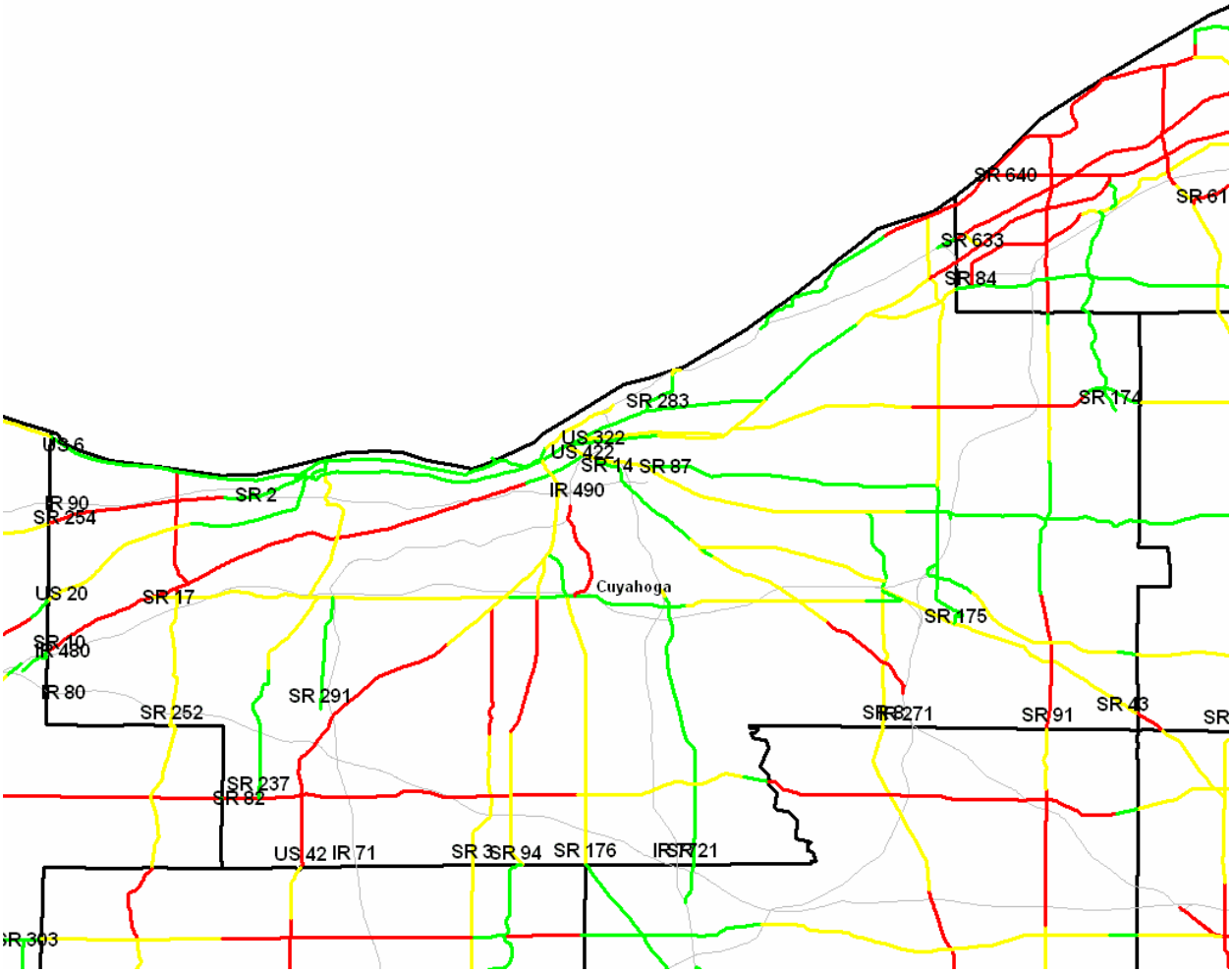

Figure 8. Cuyahoga County overall fatal and injury crash rate for US/State routes, November 22, 2006.

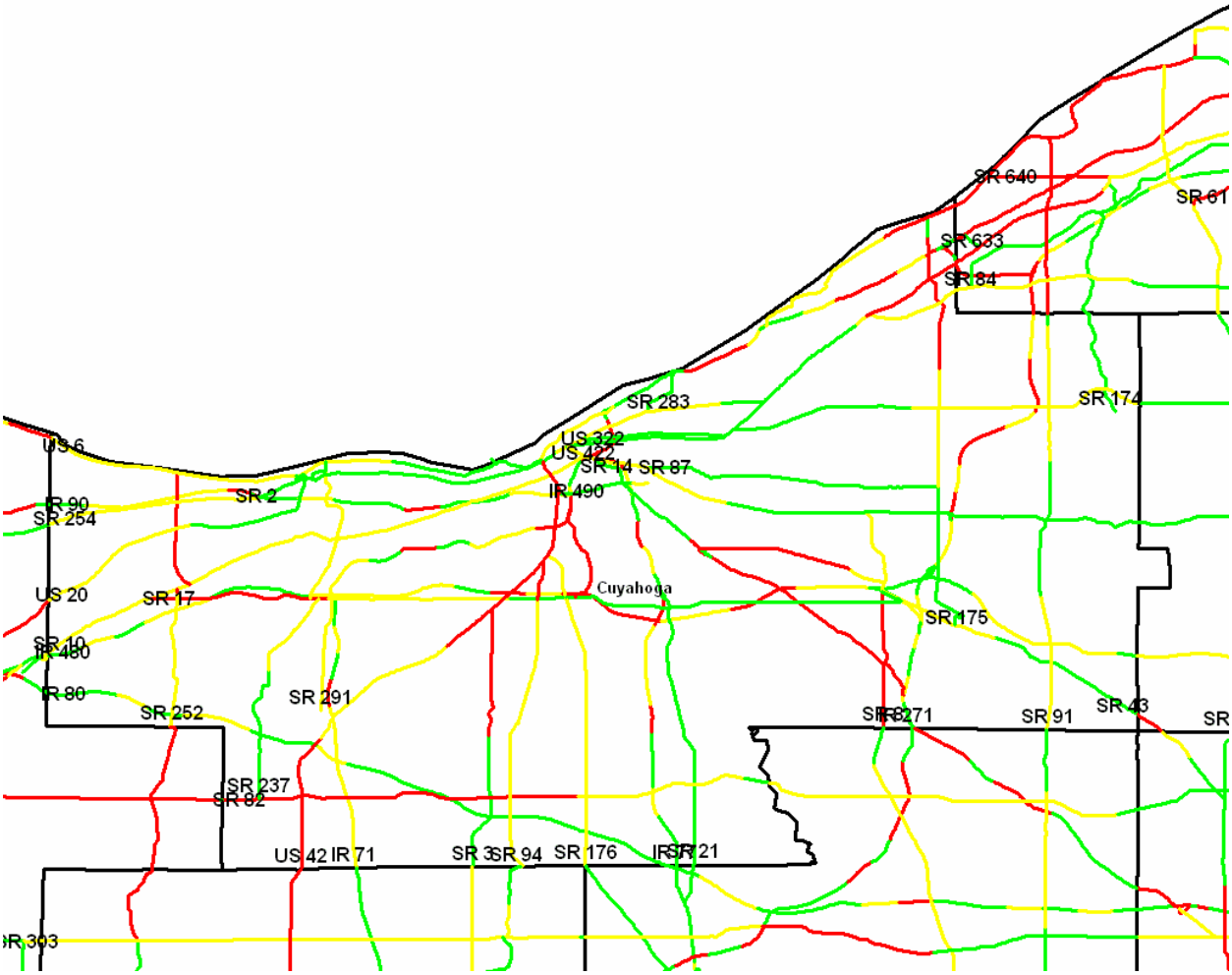

Figure 9. Cuyahoga County alcohol-related fatal and injury crash rate for all roads, November 22, 2006.

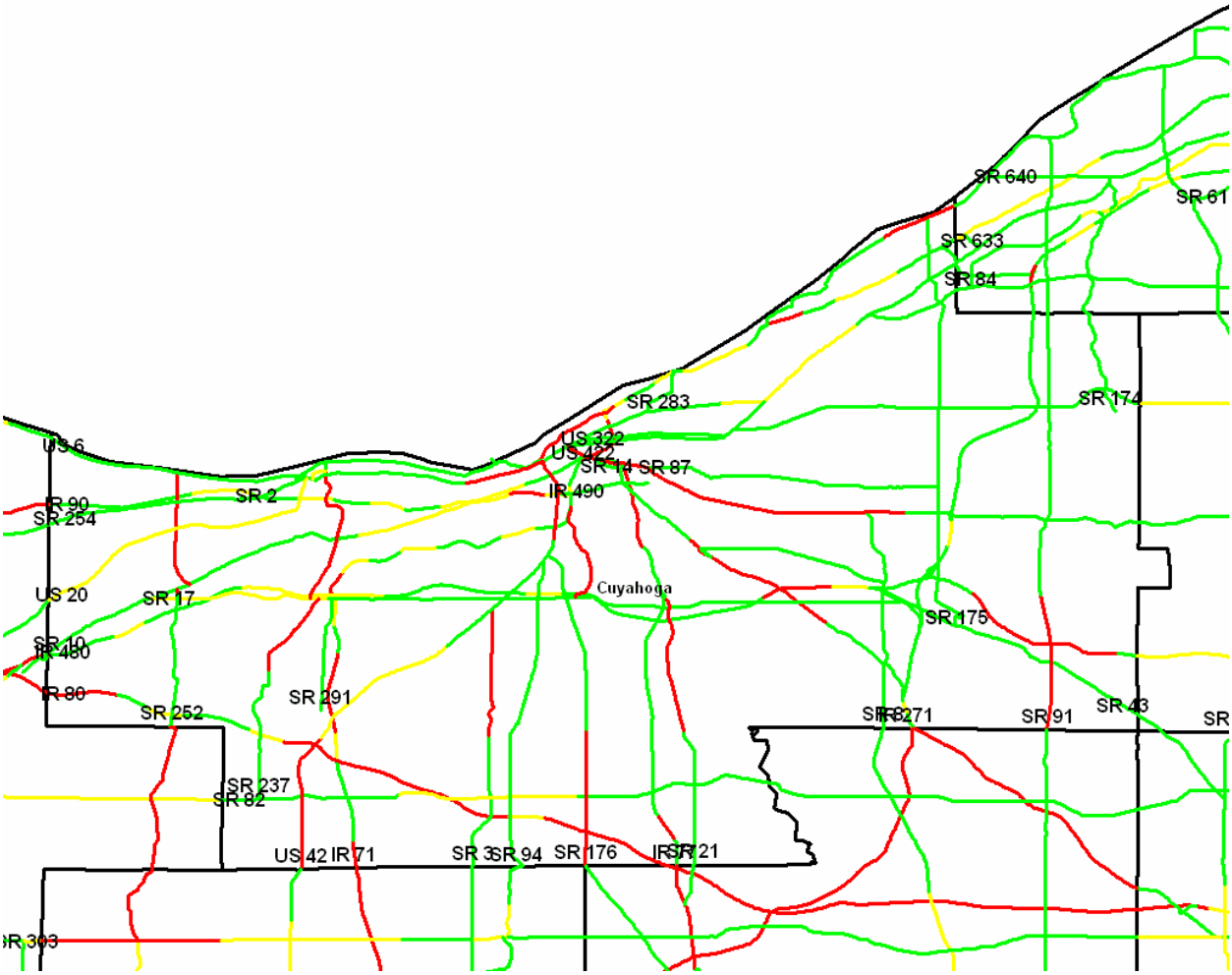

Figure 10. Cuyahoga County speed-related fatal and injury crash rate for all roads, November 22, 2006.

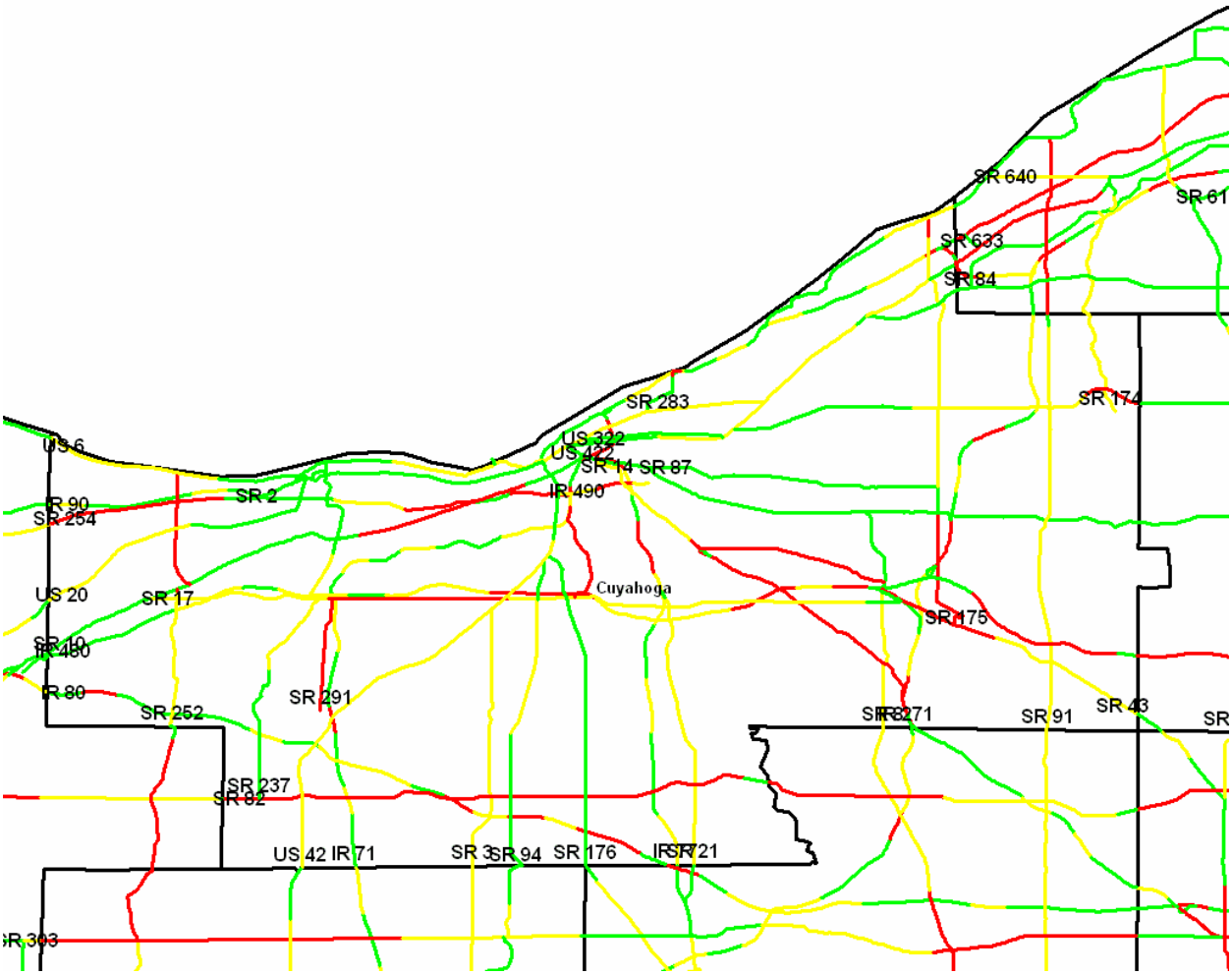

Figure 11. Cuyahoga County commercial vehicle-related fatal and injury crash rate for all roads, November 22, 2006.

2.2. Thursday, November 23, and Friday, November 24, 2006

Thursday, November 23, and Friday, November 24, are both considered holidays in the crash model, so their predicted crash patterns are the same. Figure 12 shows the overall crash rates for fatal and injury crashes expected throughout the day. These are the crash rates across all interstates, US routes, and state routes in the analysis. The black line in this figure shows the crash rates predicted by the model, and a smooth red curve has been superimposed to show the overall pattern. In addition, a smooth green line has been added to the plot showing the crash rates expected on an ordinary Thursday in November.

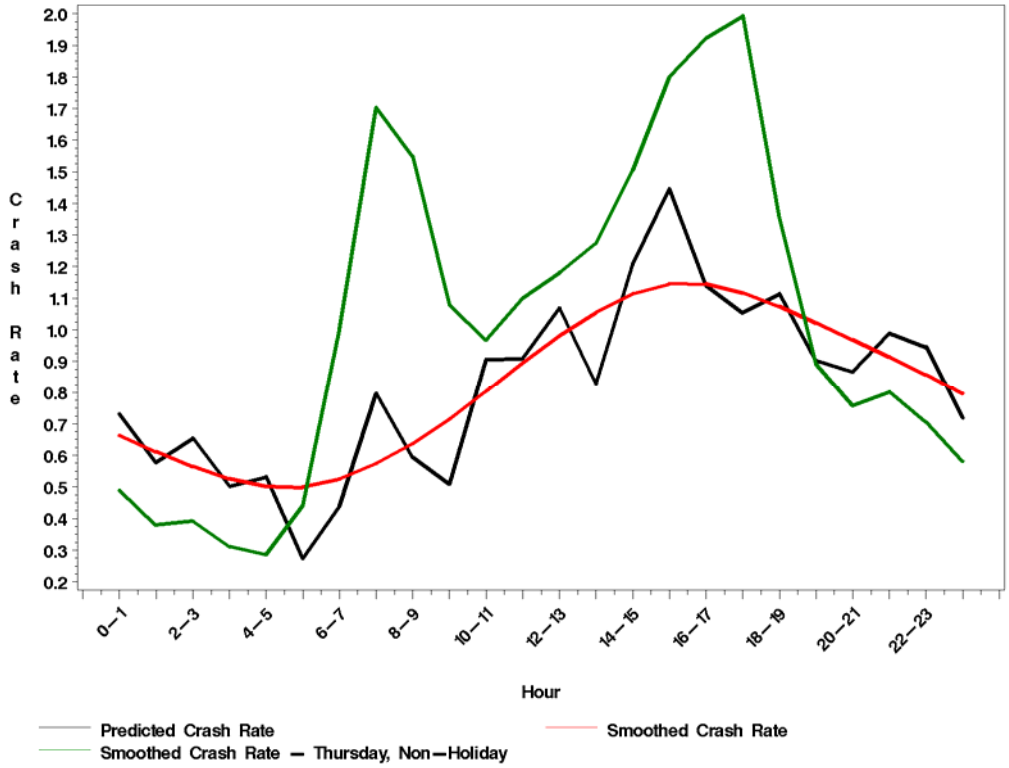

Figure 12. Overall Forecasted Fatal and Injury Crash Rates on November 23-24, 2006, by Hour.

While Figure 12 gives broad information on what times officers should be patrolling, it does not give much information on the types of crashes on which they should focus. By examining time-series plots of the crash rates for alcohol-related, speed-related, and commercial vehicle-related crashes, it is possible to determine which types of crashes are most likely during different hours of the day. Figure 13 through Figure 15 show the crash rates for these different groups.

Figure 13 shows the risk of injury and fatal alcohol-related crashes throughout the day. Overall, the risk of alcohol-related crashes is higher than what is observed on a usual Thursday. The risk is highest in the early morning hours, drops in the middle of the day, and then increases quickly through the afternoon and evening hours.

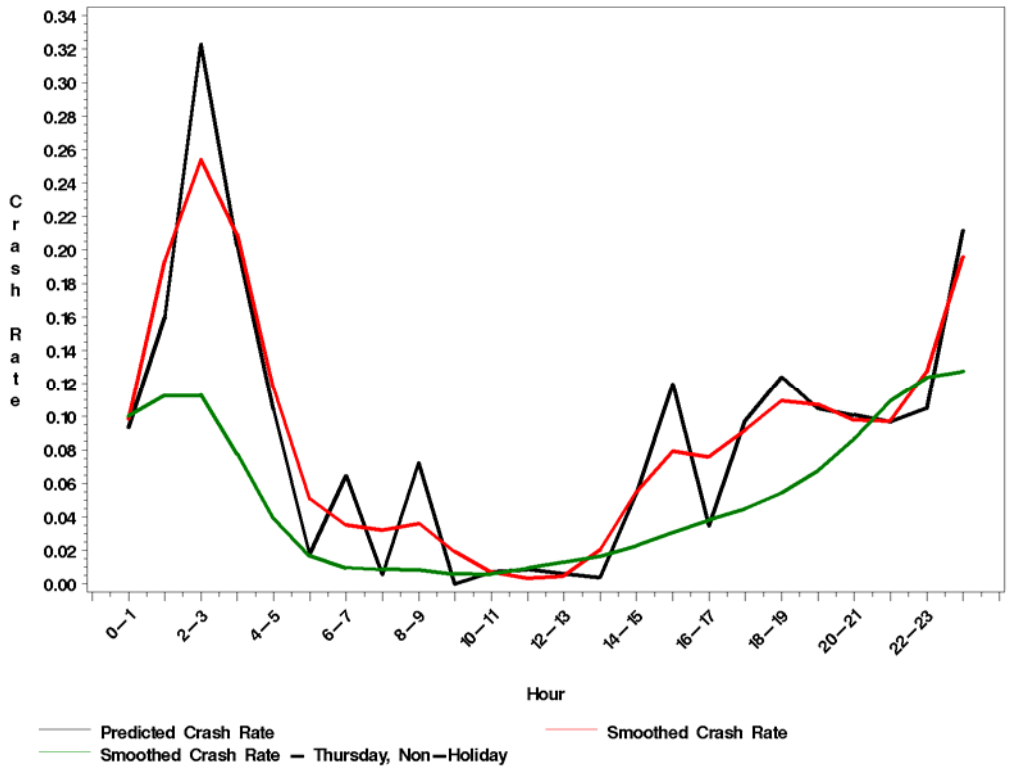

Figure 13. Forecasted Fatal and Injury Alcohol-related Crash Rates on November 23-24, 2006, by Hour.

Figure 14 suggests that resources for preventing speed-related crashes should be primarily allocated in the early morning hours and near the end of the day. The risk of speed-related crashes is higher throughout the entire day than it is on a normal Thursday.

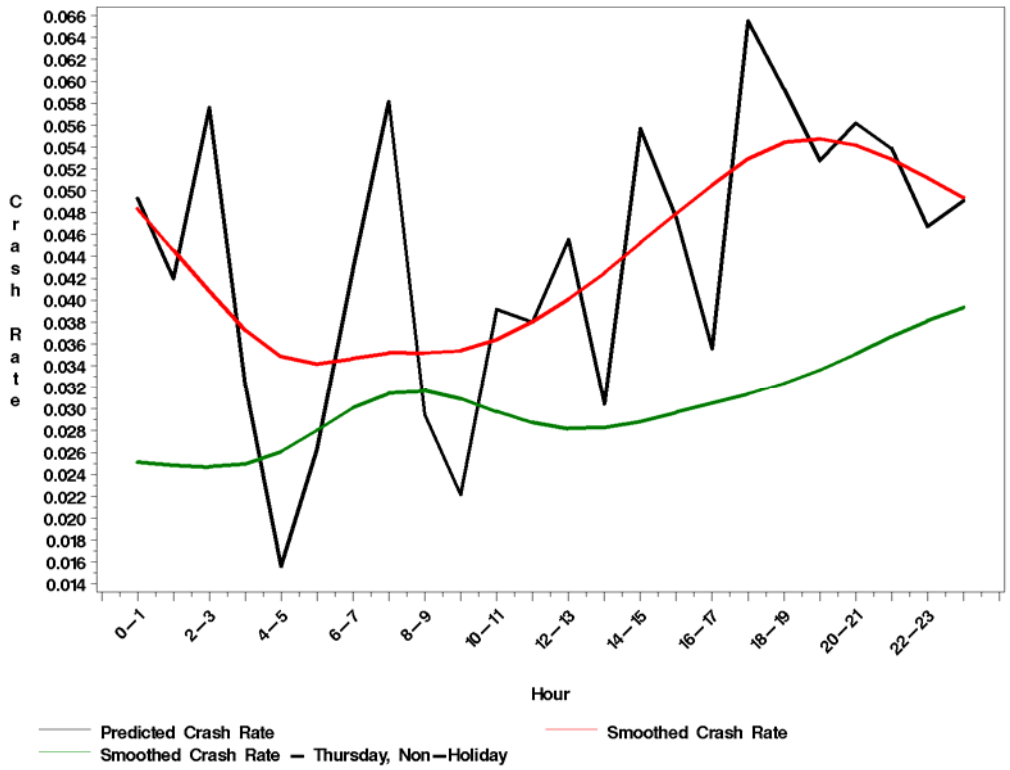

Figure 14. Forecasted Fatal and Injury Speed-related Crash Rates on November 23-24, 2006, by Hour.

Figure 15 suggests that commercial vehicle-related crashes are likely to occur at approximately the same rate throughout the day. Unlike a normal Thursday, the crash rates do not increase significantly for commercial vehicles during the middle part of the day.

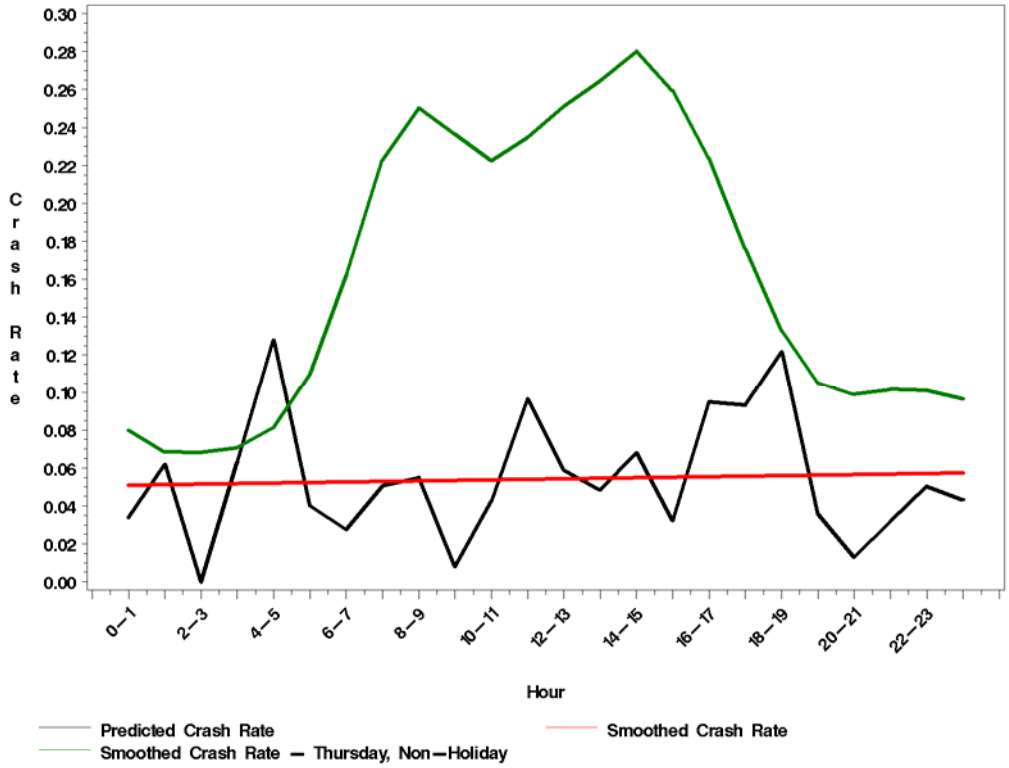

Figure 15. Forecasted Fatal and Injury Commercial Vehicle-related Crash on November 23-24, 2006, by Hour.

Examining these plots provides information about each of the types of crashes on its own, but it does not provide information on the relative rates at which these types of crashes will occur. Figure 16 presents the crash rates for alcohol-, speed-, and commercial vehicle-related crashes together. From this plot, it is clear that alcohol-related crashes present the biggest risk at the beginning and end of the day. In the middle of the day, speed- and commercial vehicle-related crashes present the highest risk.

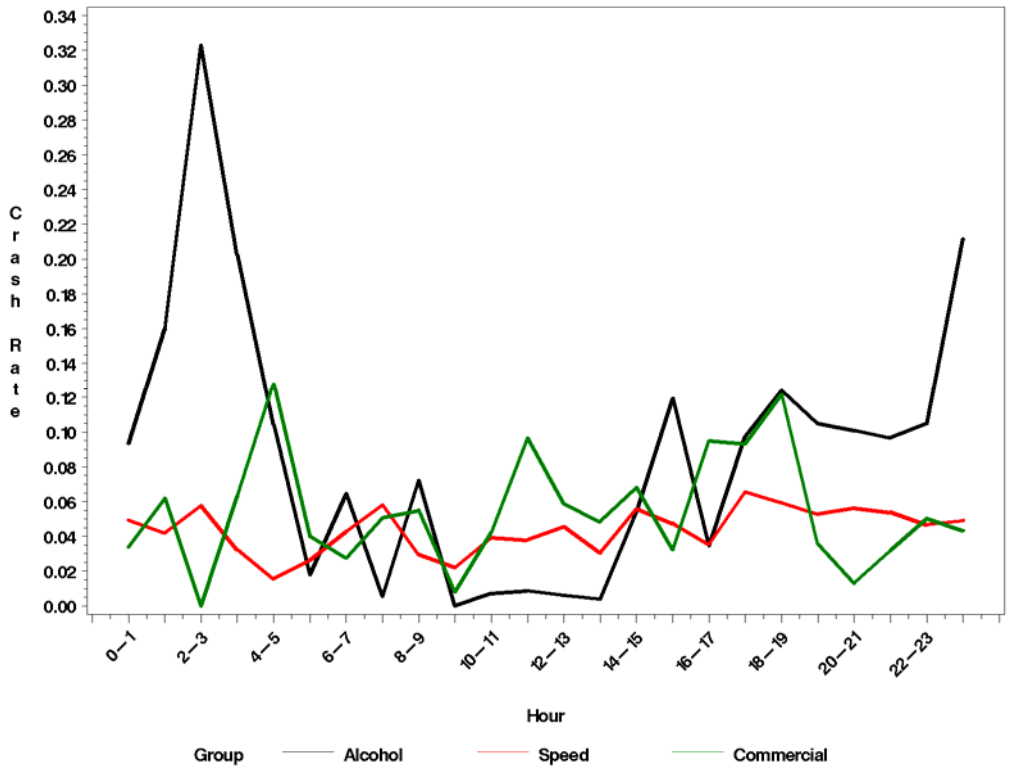

Figure 16. Overlay of Forecasted Alcohol-, Speed-, and Commercial Vehicle-related Crash Rates on November 23-24, 2006, by Hour.

Having determined the best allocation of resources throughout the day, the next question to answer is where those resources should be allocated. The following series of figures shows different levels of danger for the categories broken out in the time-series plots above. In each map, the top 20% crash risk interstate segments are colored in red. Also, the top 20% crash risk US/State route segments are colored in red. As a result, the red interstate segments do not have risk levels comparable to the red US/State route segments. The following key explains the coloring scheme.

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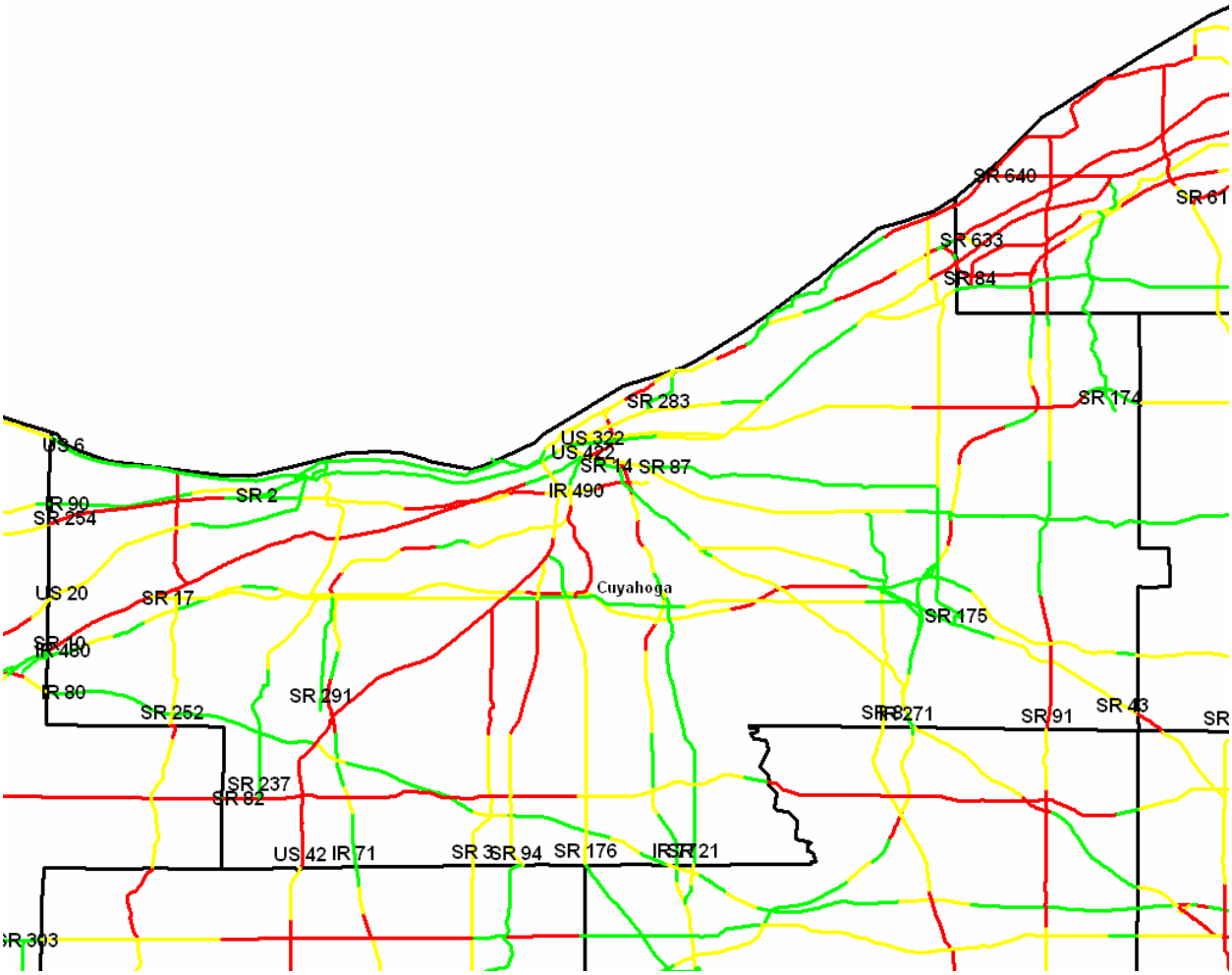

Figure 17. Cuyahoga County overall fatal and injury crash rate for all roads, November 23-24, 2006.

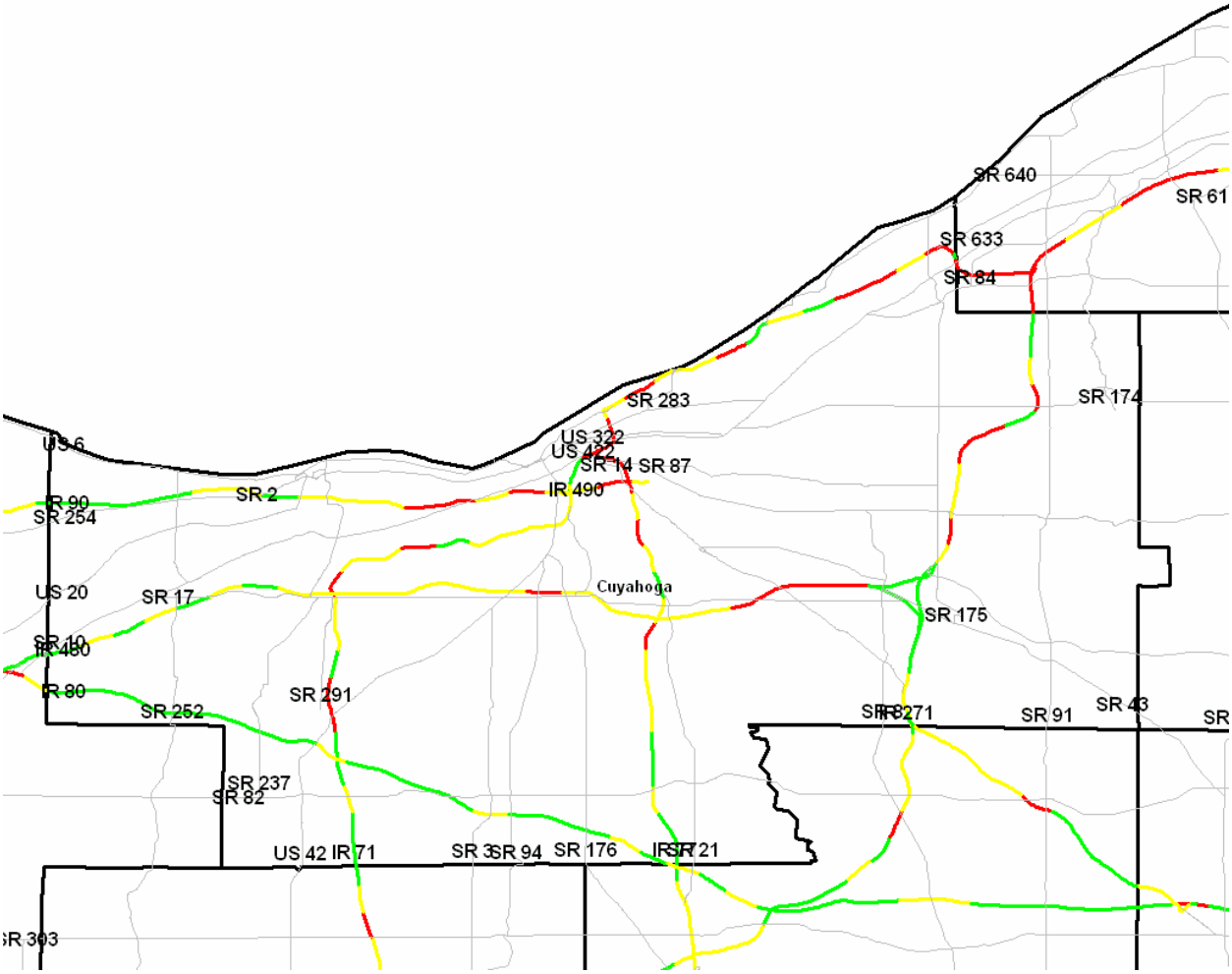

Figure 18. Cuyahoga County overall fatal and injury crash rate for interstates, November 23-24, 2006.

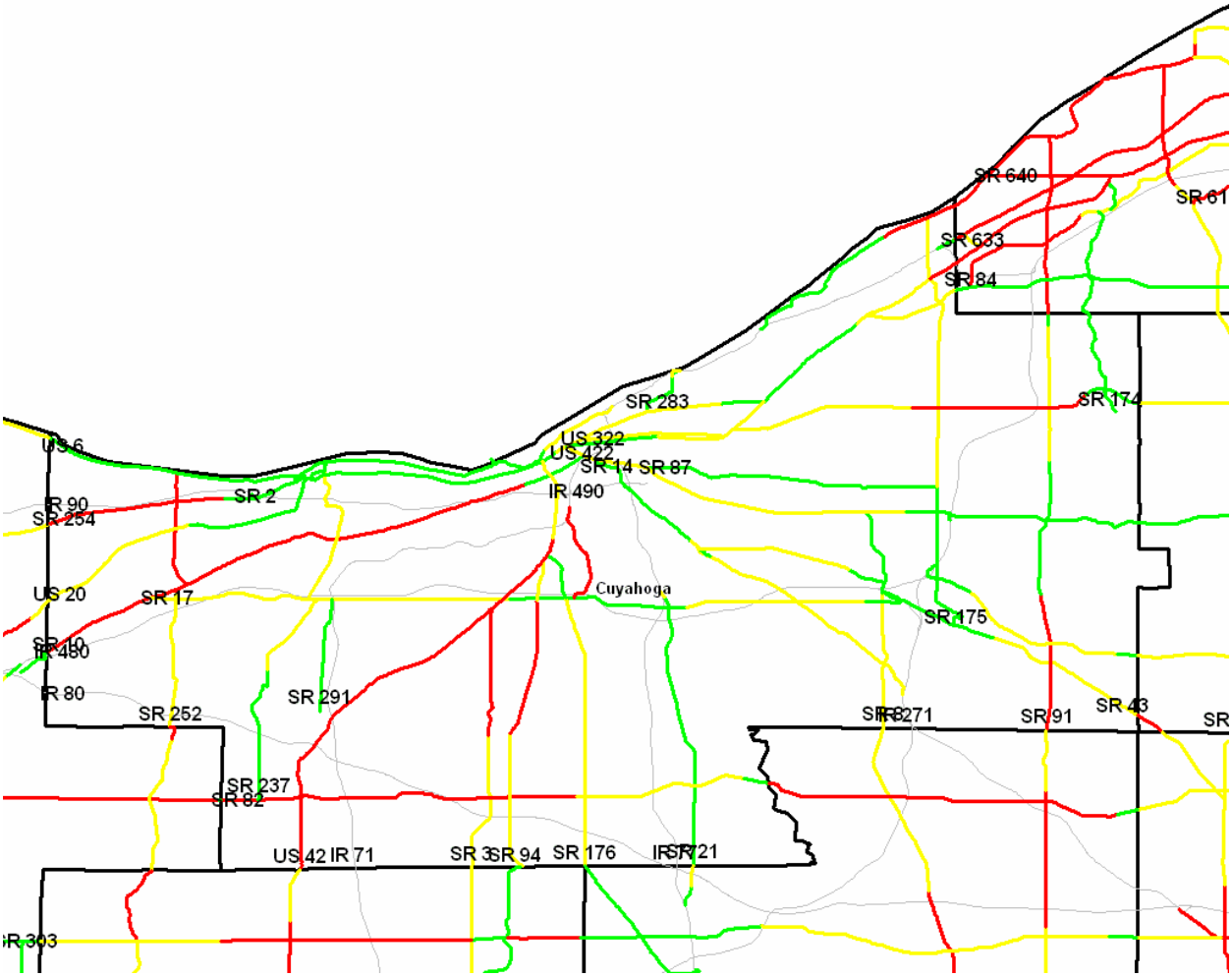

Figure 19. Cuyahoga County overall fatal and injury crash rate for US/State routes, November 23-24, 2006.

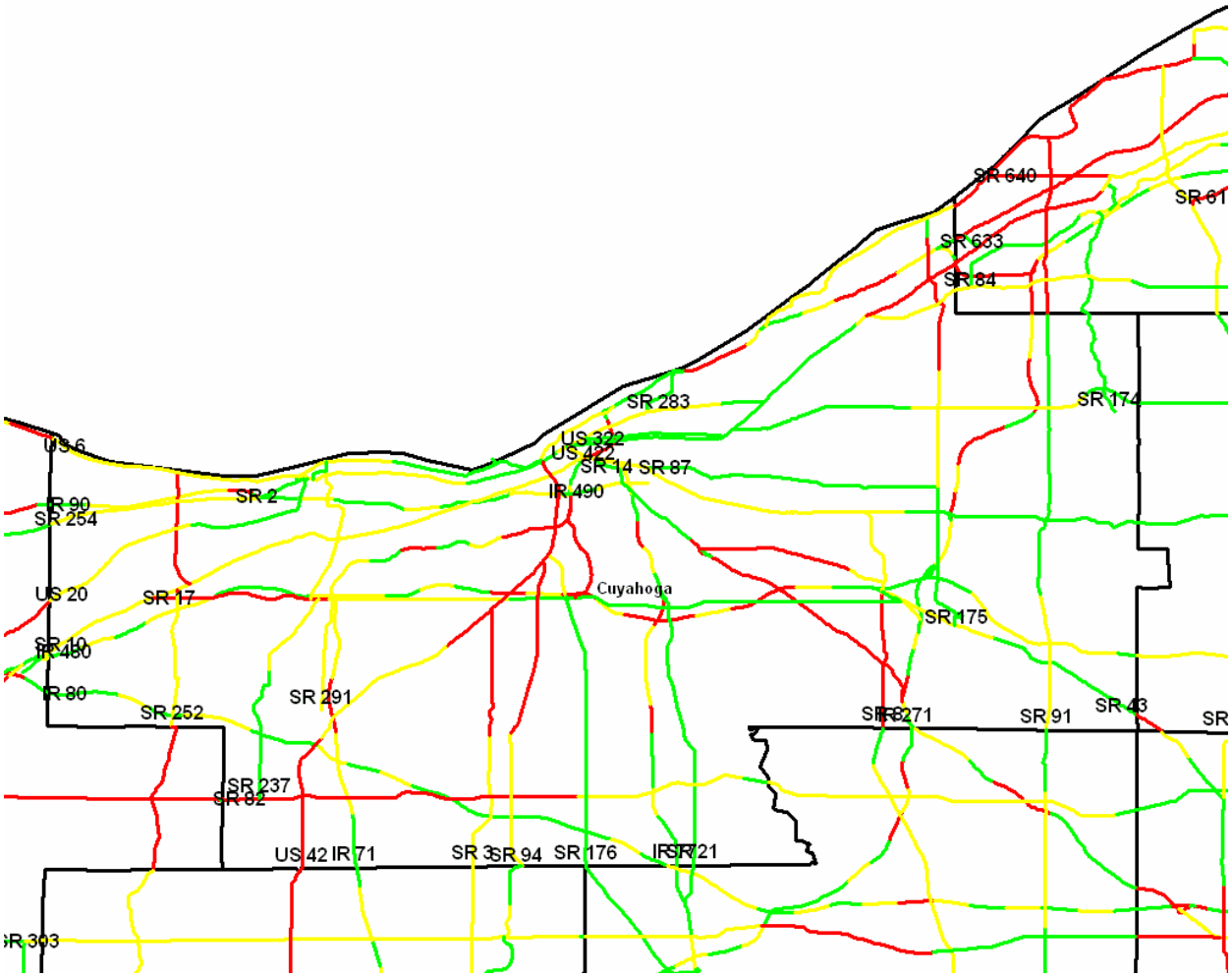

Figure 20. Cuyahoga County alcohol-related fatal and injury crash rate for all roads, November 23-24, 2006.

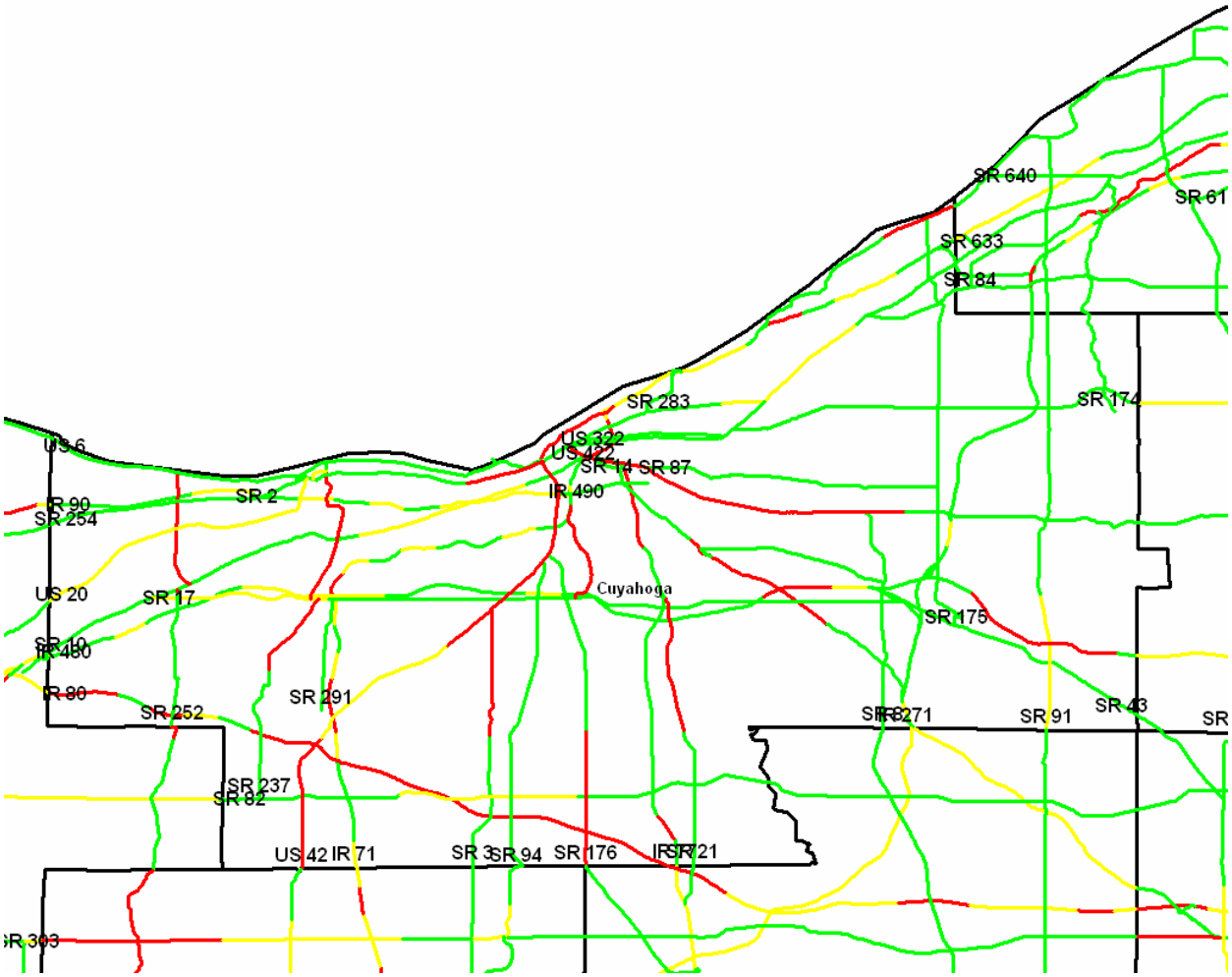

Figure 21. Cuyahoga County speed-related fatal and injury crash rate for all roads, November 23-24, 2006.

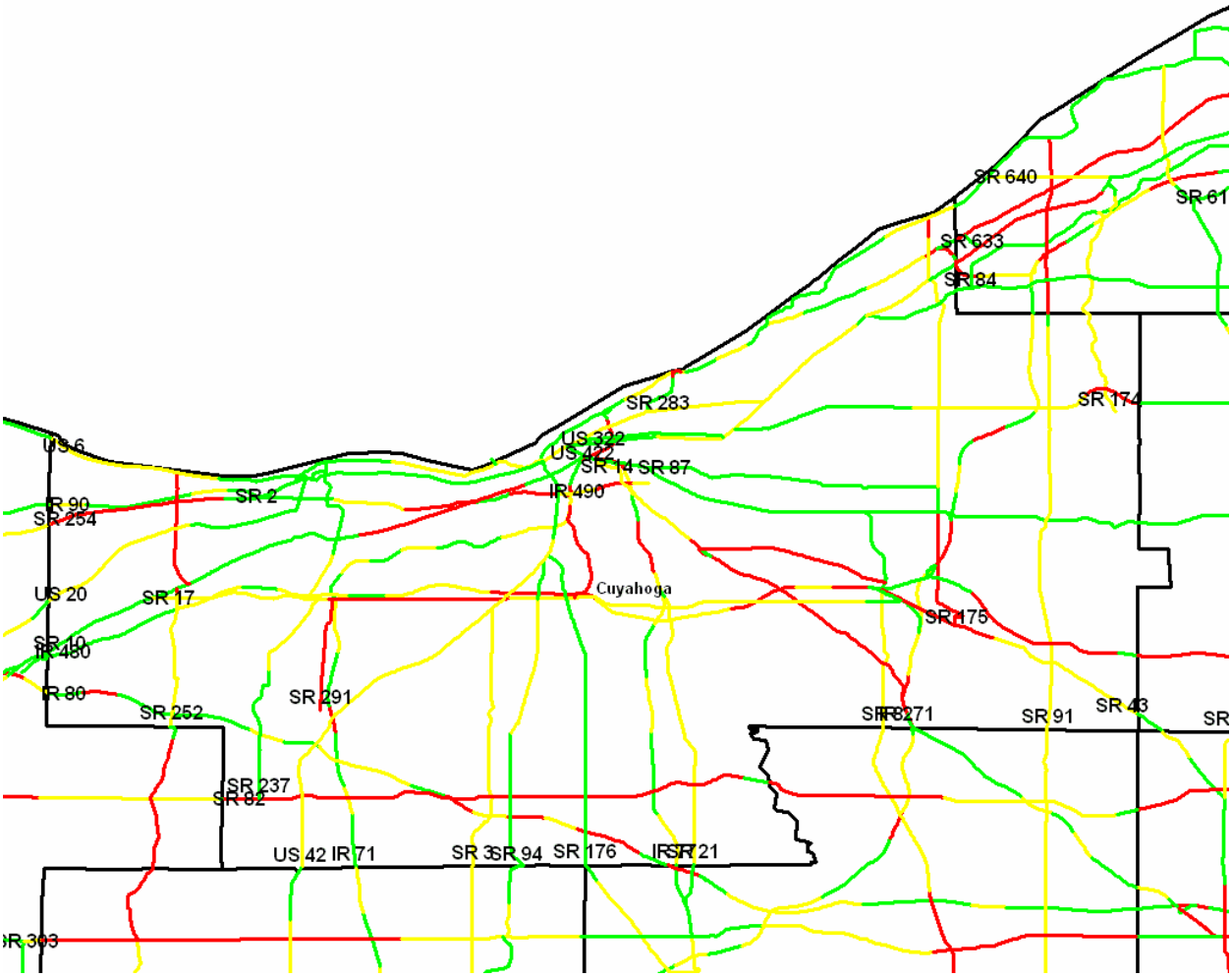

Figure 22. Cuyahoga County commercial vehicle-related fatal and injury crash rate for all roads, November 23-24, 2006.

2.3. Saturday, November 25, and Sunday, November 26, 2006

Saturday, November 25, and Sunday, November 26, are both considered ordinary weekend days in the crash model, so their predicted crash patterns are the same. Figure 23 shows the overall crash rates for fatal and injury crashes expected throughout the day. These are the crash rates across all interstates, US routes, and state routes in the analysis. The black line in this figure shows the crash rates predicted by the model, and a smooth red curve has been superimposed to show the overall pattern. In Figure 23 and Figure 24 the smooth red curve falls on top of the black line, so only one line is visible.

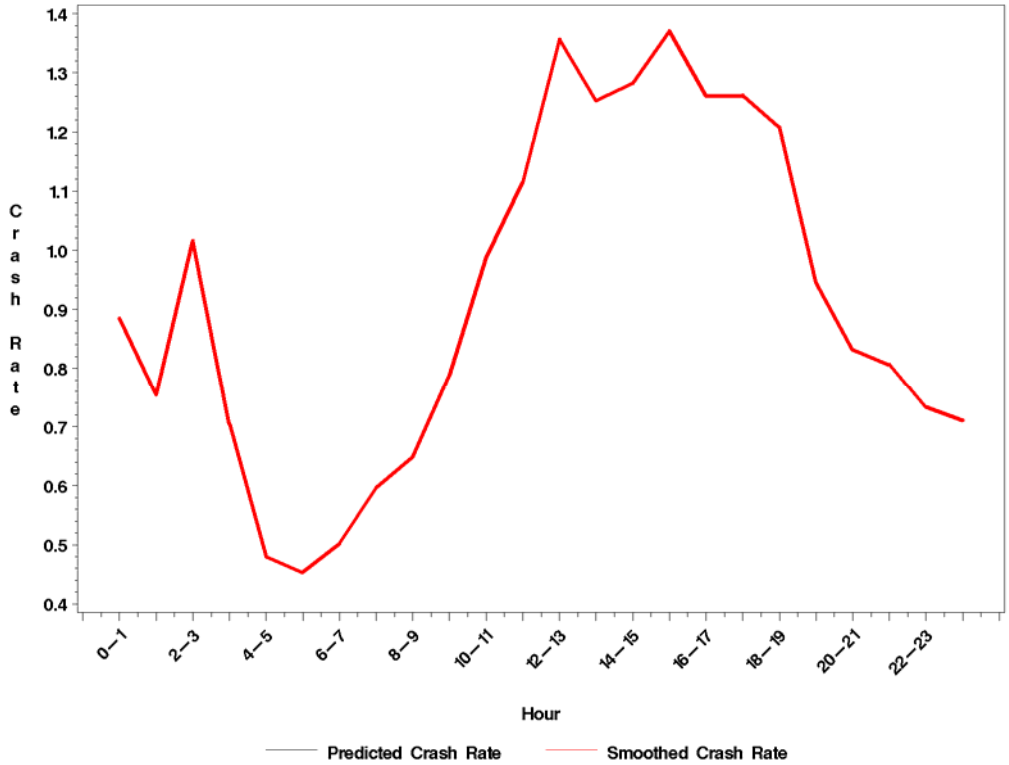

Figure 23. Overall Forecasted Fatal and Injury Crash Rates on November 25-26, 2006, by Hour.

While Figure 23 gives broad information on what times officers should be patrolling, it does not give much information on the types of crashes on which they should focus. By examining time-series plots of the crash rates for alcohol-related, speed-related, and commercial vehicle-related crashes, it is possible to determine which types of crashes are most likely during different hours of the day. Figure 24 through Figure 26 show the crash rates for these different groups.

Figure 24 indicates that the highest risk for injury and fatal alcohol-related crashes is in the early morning hours on Saturday and Sunday. The crash rate reaches its peak between 2AM and 3AM. The crash rate then drops through the early morning hours reaching a low in the late morning. In the afternoon and evening, the crash rate begins to increase once again.

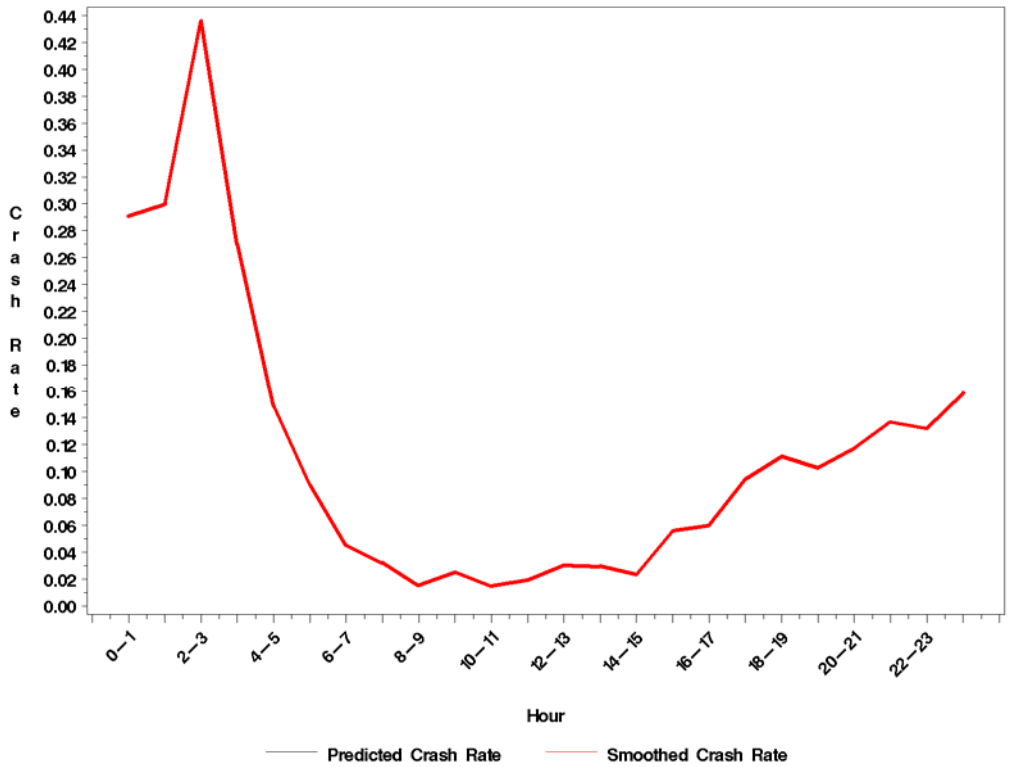

Figure 24. Forecasted Fatal and Injury Alcohol-related Crash Rates on November 25-26, 2006, by Hour.

Figure 25 suggests that resources for preventing speed-related crashes should be primarily allocated to the early morning and mid-afternoon hours. Speed-related crashes appear to be problematic between 2AM and 3AM, but they drop off quickly in the early morning hours. In the middle of the day and the evening, the crash rates return to a higher level.

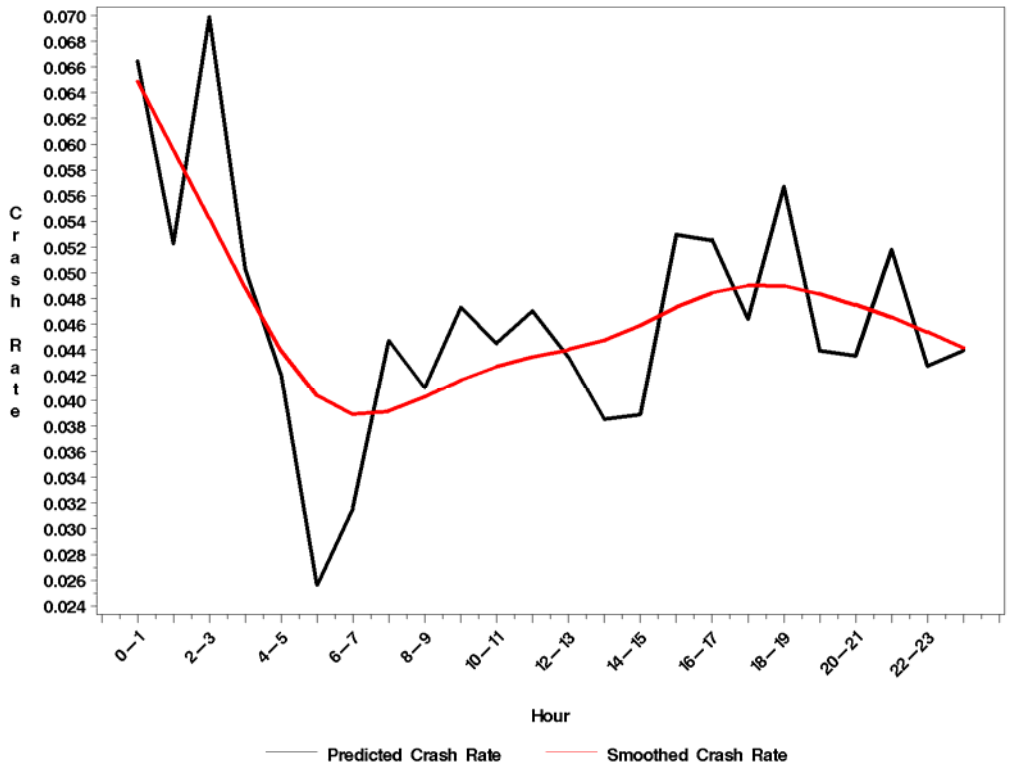

Figure 25. Forecasted Fatal and Injury Speed-related Crash Rates on November 25-26, 2006, by Hour.

Figure 26 suggests that commercial vehicle-related crashes are likely to occur in the middle of the day. These crashes show the lowest risk in the early morning and evening hours.

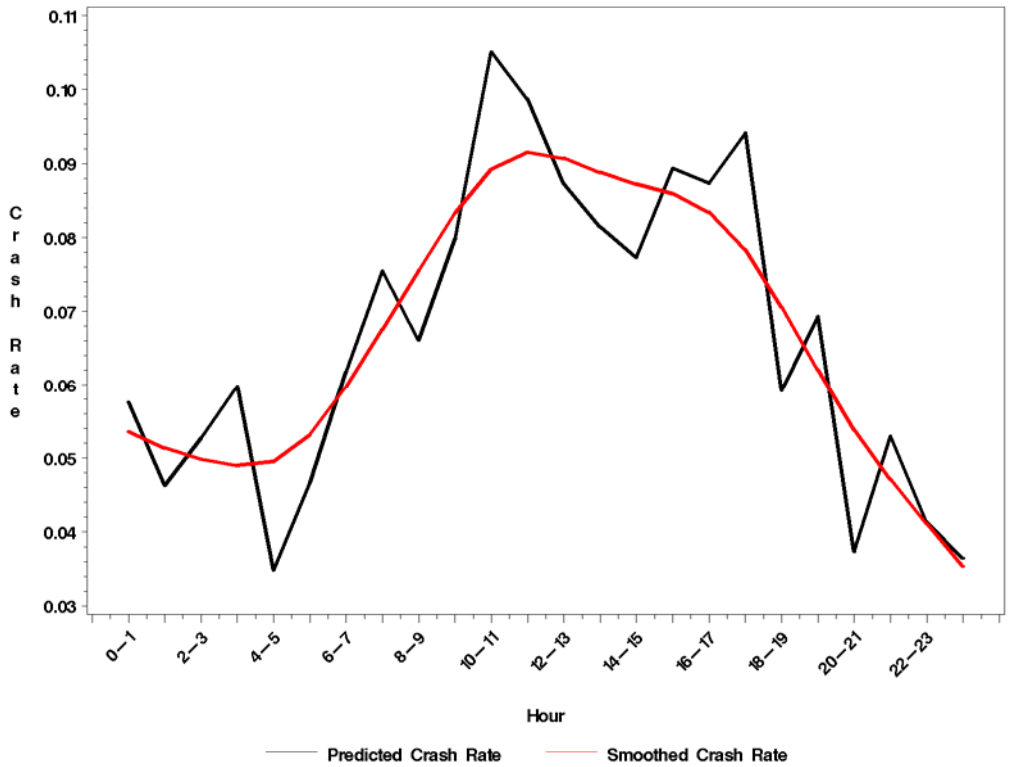

Figure 26. Forecasted Fatal and Injury Commercial Vehicle-related Crash on November 25-26, 2006, by Hour.

Examining these plots provides information about each of the types of crashes on its own, but it does not provide information on the relative rates at which these types of crashes will occur. Figure 27 presents the crash rates for alcohol-, speed-, and commercial vehicle-related crashes together. From this plot, it appears that alcohol-related crashes present the most risk during the morning and evening hours. In the middle of the day, commercial vehicle-related crashes are more prevalent. Speed-related crashes are not forecasted to create as high of a risk throughout the day as the other factors.

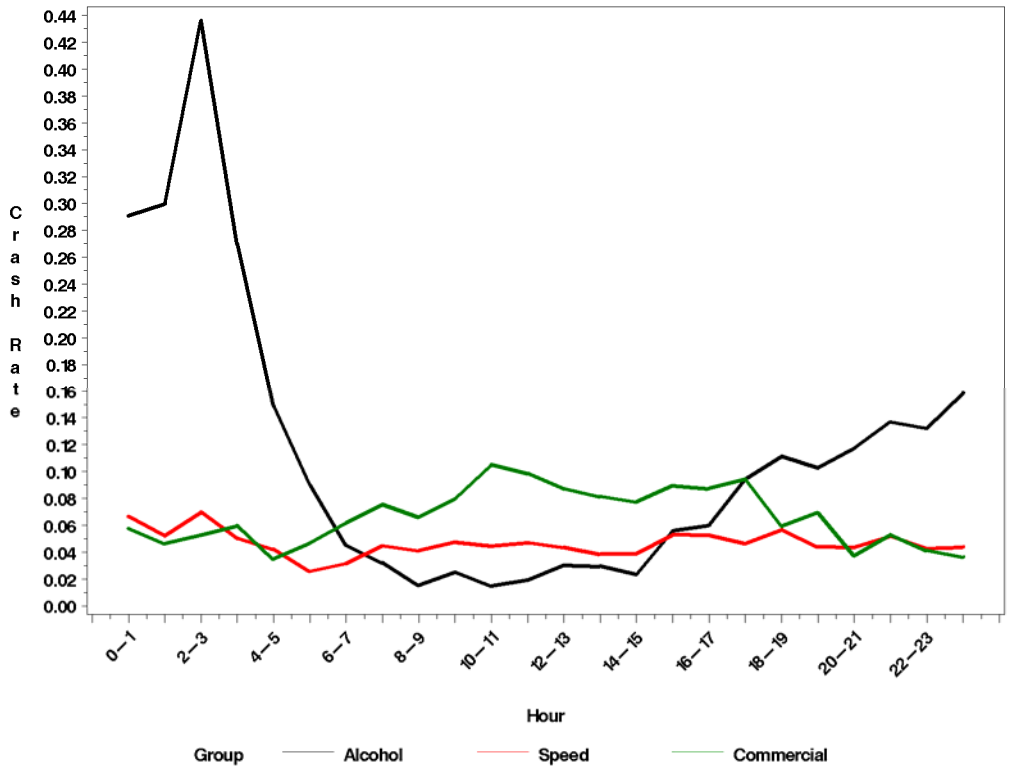

Figure 27. Overlay of Forecasted Alcohol-, Speed-, and Commercial Vehicle-related Crash Rates on November 25-26, 2006, by Hour.

Having determined the best allocation of resources throughout the day, the next question to answer is where those resources should be allocated. The following series of figures shows different levels of danger for the categories broken out in the time-series plots above. In each map, the top 20% crash risk interstate segments are colored in red. Also, the top 20% crash risk US/State route segments are colored in red. As a result, the red interstate segments do not have risk levels comparable to the red US/State route segments. The following key explains the coloring scheme.

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crash groups. These pictures show the risk for alcohol-related crashes, speed-related crashes, and commercial vehicle-related crashes on November 25-26, 2006.

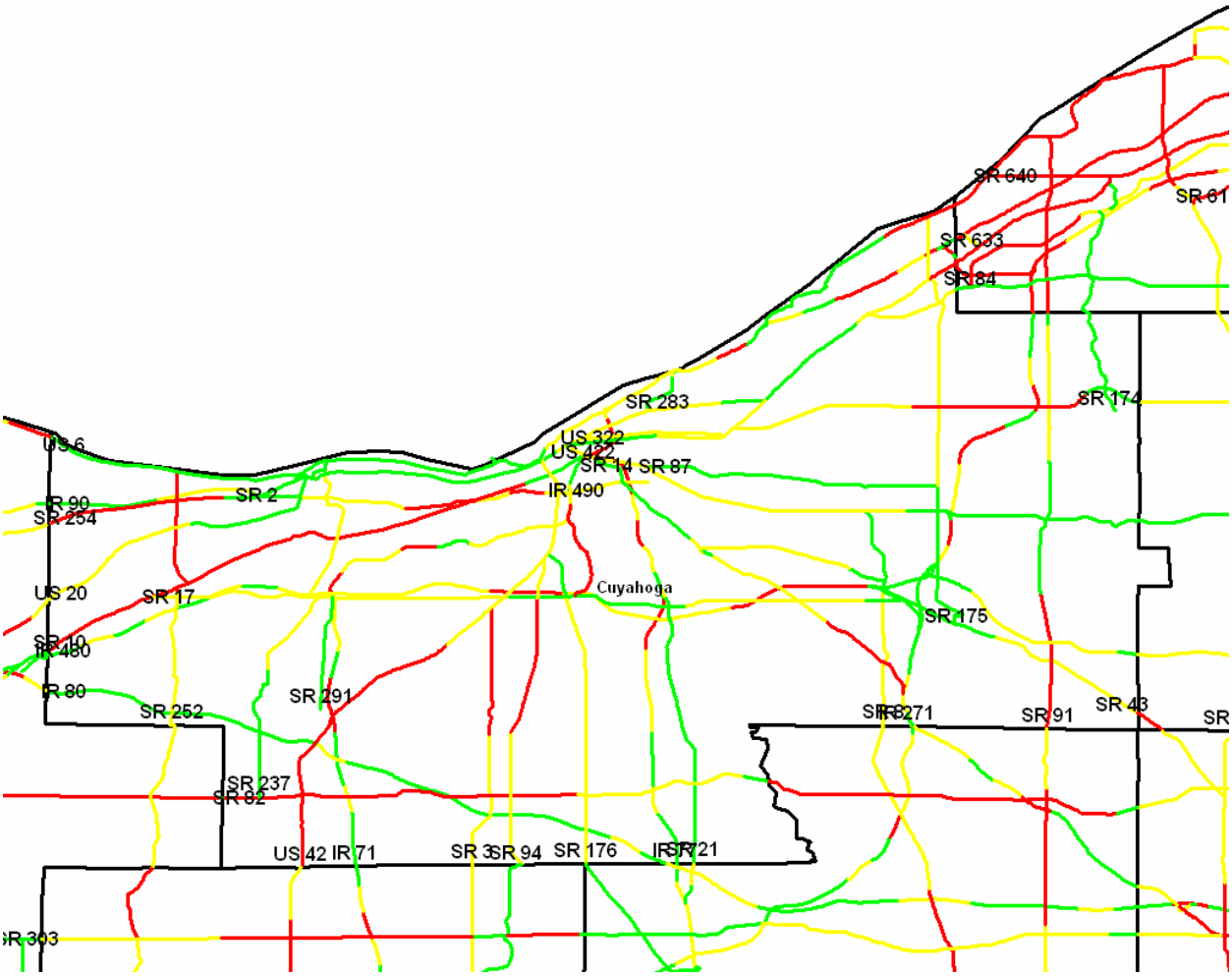

Figure 28. Cuyahoga County overall fatal and injury crash rate for all roads, November 25-26, 2006.

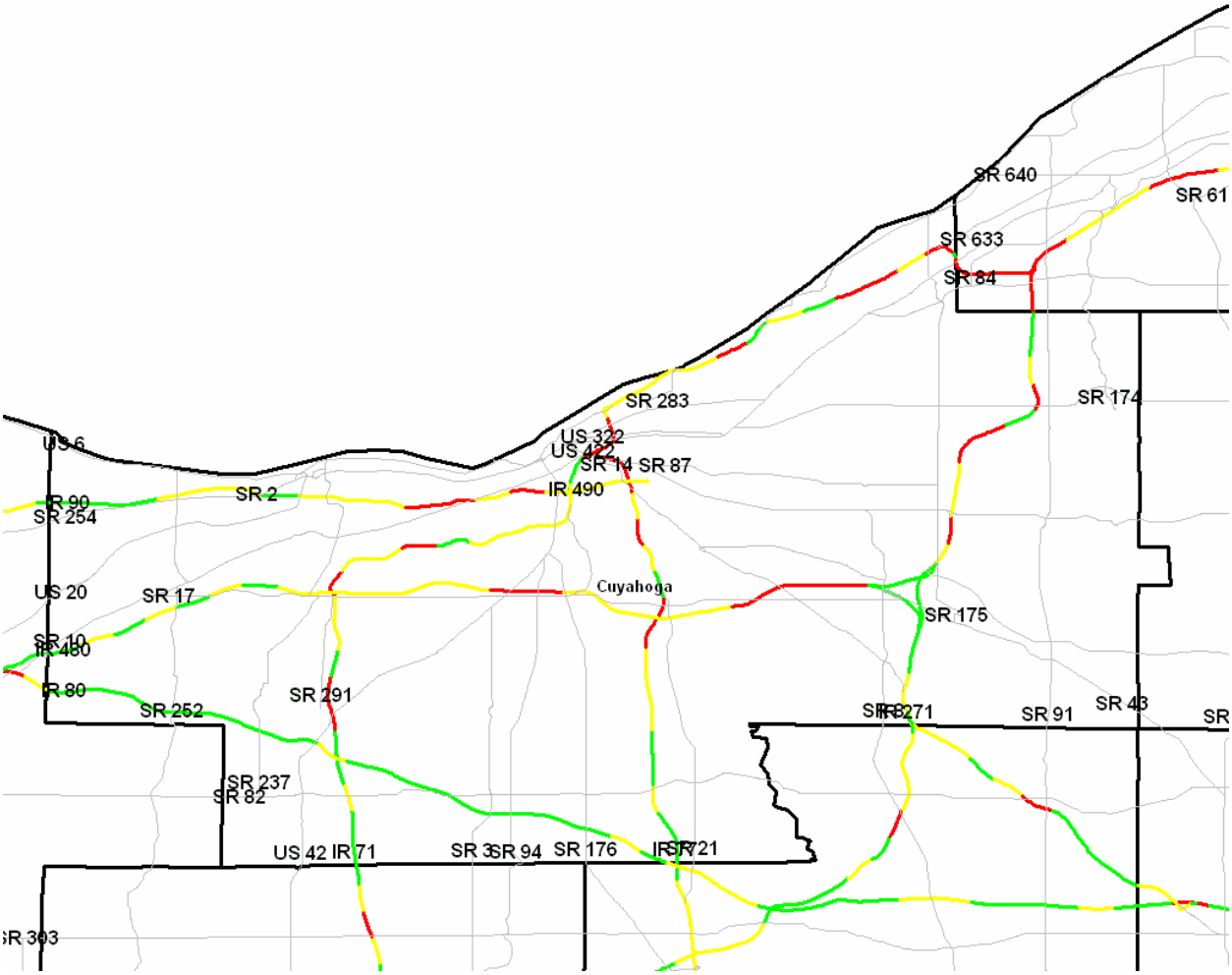

Figure 29. Cuyahoga County overall fatal and injury crash rate for interstates, November 25-26, 2006.

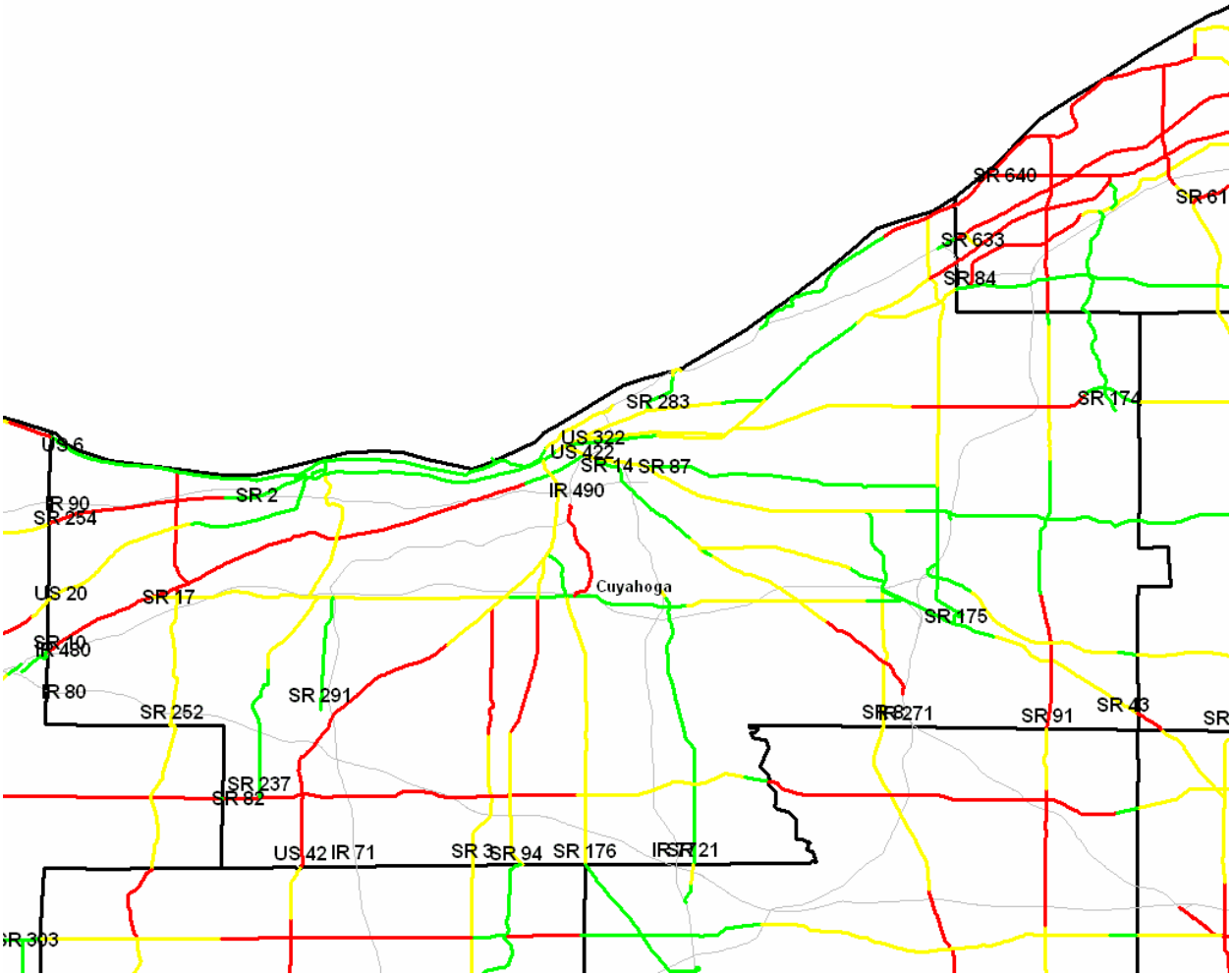

Figure 30. Cuyahoga County overall fatal and injury crash rate for US/State routes, November 25-26, 2006.

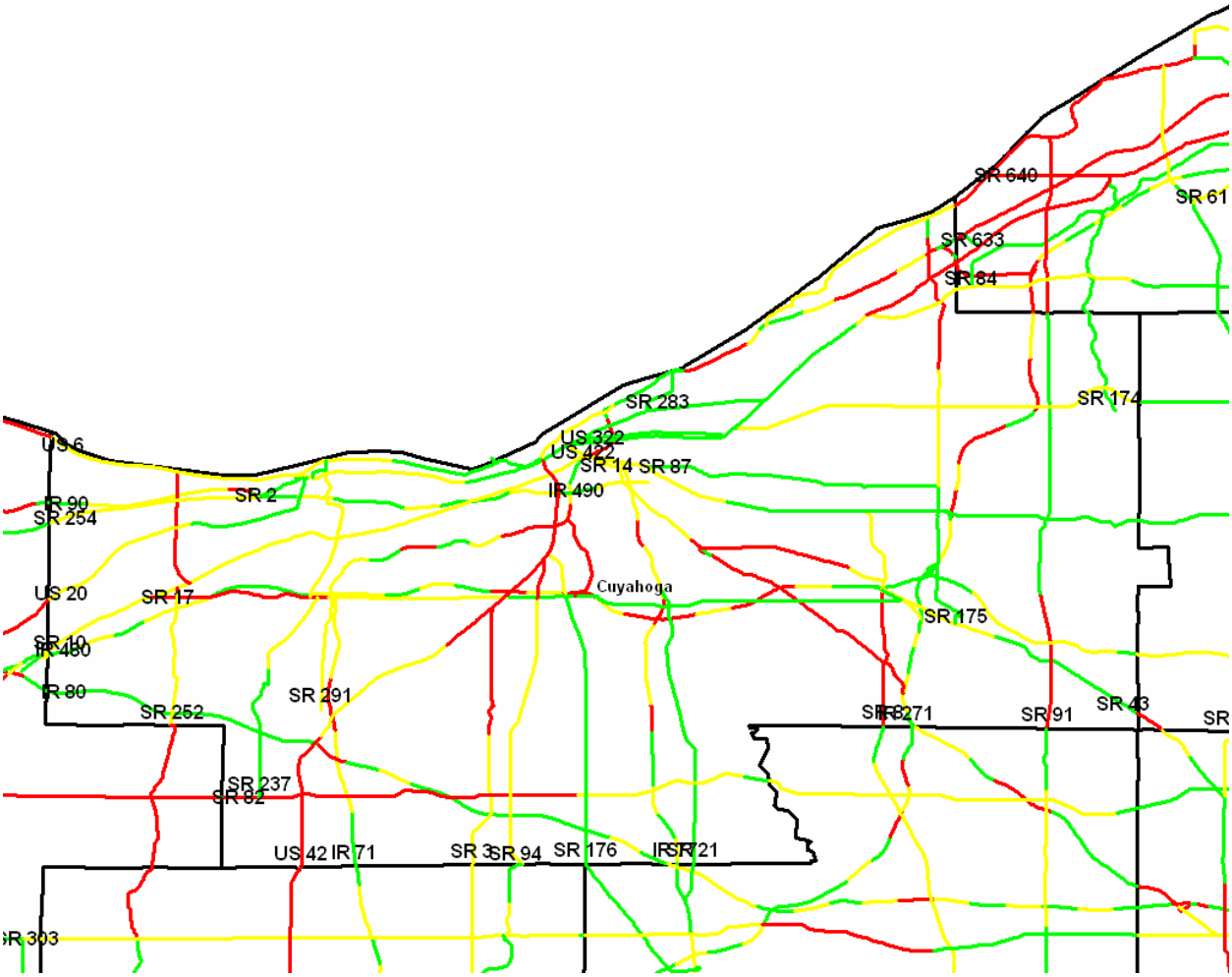

Figure 31. Cuyahoga County alcohol-related fatal and injury crash rate for all roads, November 25-26, 2006.

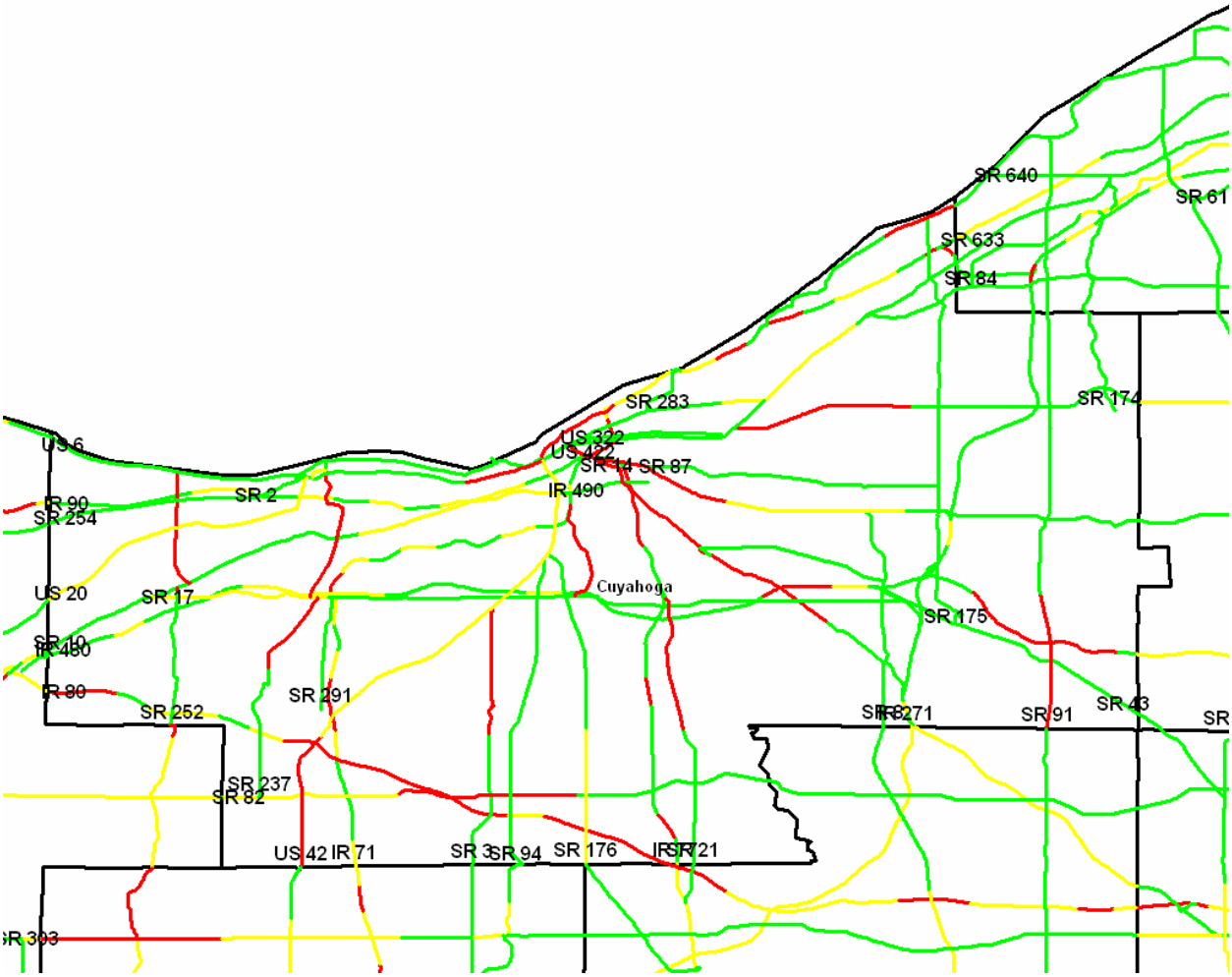

Figure 32. Cuyahoga County speed-related fatal and injury crash rate for all roads, November 25-26, 2006.

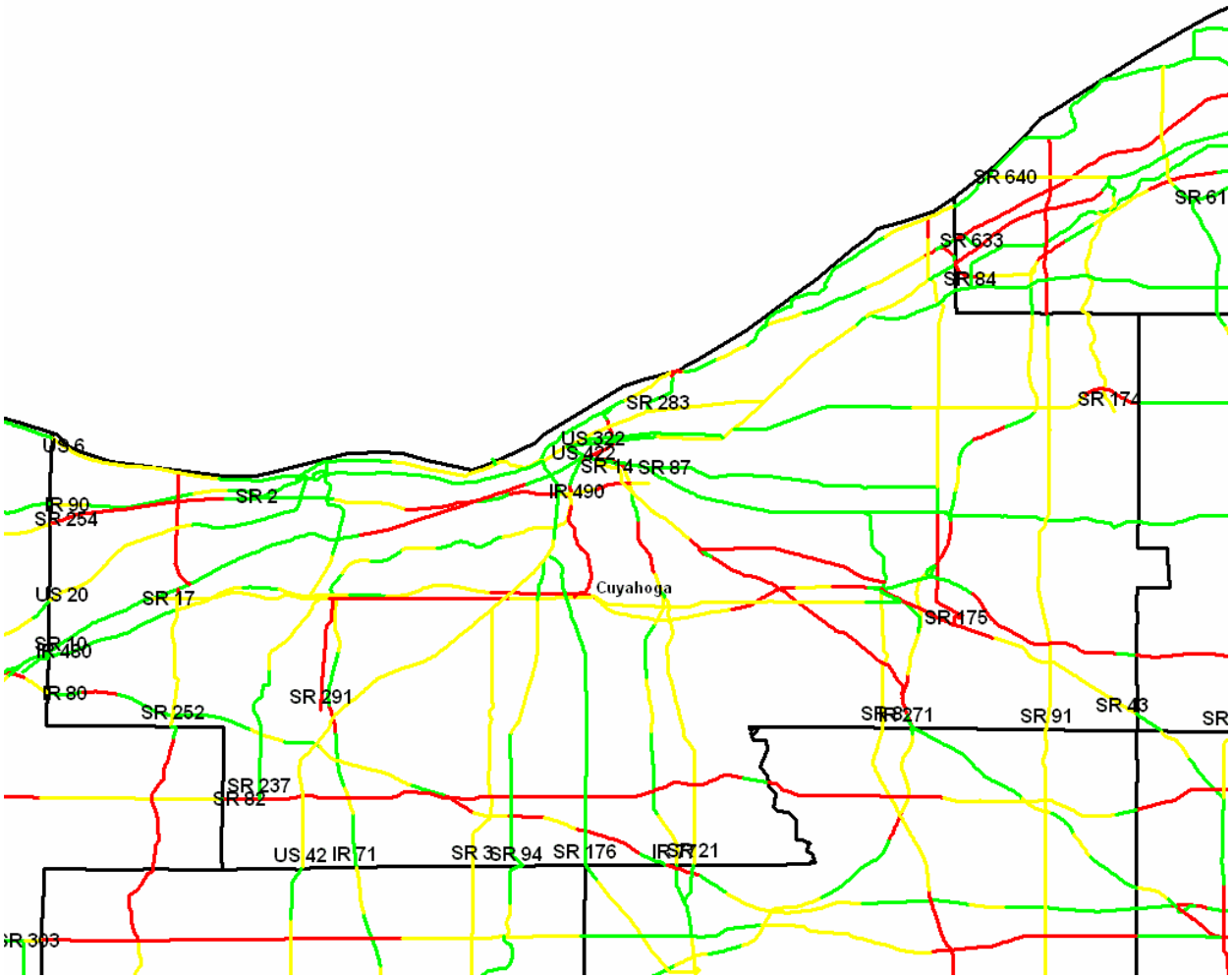

Figure 33. Cuyahoga County commercial vehicle-related fatal and injury crash rate for all roads, November 25-26, 2006.